Holden VE Commodore

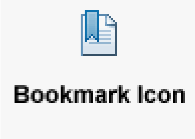
BERLINA/CALAIS/OMEGA/SV6/SS/SSV/LUMINA/SPORTWAGON

2007-2009 Service/Repair Manual

This Service Manual has been prepared with the latest service information available at the time of publication. It is subdivided into various group categories and each section contains diagnostic, disassembly, repair and installation procedures along with complete specifications and tightening references. Please read this manual carefully before proceeding, as incorrect service procedures may result in injury or death to service personnel or to the operator's of the vehicle.

How to use this manual

Use the bookmarks on the Adobe Reader by clicking onto the bookmark symbol on the left hand side like this one



This will bring up all the relevant sections of this manual.
If you click on each section, it will expand to subsections.

E.g. If you wanted to replace the Electronic Brake Control Module, you would click **Brakes** which will expand to show different sections, you would click **Antilock Brake System**, then click **Repair Instructions** which will show **Electronic Brake Control Module Replacement**.

Another way to search for the replacement of **Electronic Brake Control Module** is to use the Adobe Reader's search function located at the top right hand side of the tool bar.

It has a square box with the word "**Find**"**.** Just type in the word or phrase that you are searching for, click the menu (small triangular symbol like this on the side of the box ▼ and select **Open Full Acrobat Search and include bookmarks.**

In this example, it would be **Electronic Brake Control Module Replacement**. The search window will come up to show all the different but relevant sections. Then just click each of the search results which are relevant for you.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual |

Diagnostic Trouble Code List

Basic Search Search Help

Search documents matching all of these keywords:

Search Reset

Symptom List

Diagnostic Trouble Code (DTC) List - Vehicle

This master DTC list includes all applicable DTCs in alphanumeric order with descriptors.

DTC	DTC Descriptor	Module That Sets the DTC	Diagnostic Procedure
B0012	Driver Frontal Deployment Loop Stage 1	SDM	DTC B0012 or B0013
B0013	Driver Frontal Deployment Loop Stage 2	SDM	DTC B0012 or B0013
B0014	Driver Side Deployment Loop	SDM	DTC B0014
B0015	Driver Pretensioner Deployment Stage 1 Loop	SDM	DTC B0015
B0016	Driver Curtain Deployment Loop Initiator	SDM	DTC B0016
B0019	Passenger Frontal Deployment Loop Stage 1	SDM	DTC B0019 or B0020
B0020	Passenger Frontal Deployment Loop Stage 2	SDM	DTC B0019 or B0020
B0021	Passenger Side Deployment Loop Stage 1	SDM	DTC B0021
B0022	Passenger Pretensioner Deployment Stage 1 Loop	SDM	DTC B0022
B0023	Passenger Curtain Deployment Loop Initiator	SDM	DTC B0023
B0052	Deployment Commanded	SDM	DTC B0052 or B0053
B0053	Deployment Commanded with Loop DTCs Present	SDM	DTC B0052 or B0053
B0055	Side Airbag Deployment Commanded	SDM	DTC B0055
B0072	Driver Seat Belt Sensor Circuit	SDM	DTC B0072
B0079	Driver Seat Position Sensor Circuit	SDM	DTC B0079
B0083	Front End Sensor 1	SDM	DTC B0083 or B0084
B0084	Front End Sensor 2	SDM	DTC B0083 or B0084
B0085	Left Front Side Impact Circuit	SDM	DTC B0085 or B0086
B0086	Right Front Side Impact Sensor Circuit	SDM	DTC B0085 or B0086
	Coil Compressor Stroke Control		

B013B	Circuit	HVAC	DTC B013B
B0158	Outside Air Temperature Sensor Circuit	HVAC	DTC B0158 or B0168
B0168	Passenger Compartment Temperature Sensor Circuit	HVAC	DTC B0158 or B0168
B0183	Left Solar Load Sensor 1 Circuit	HVAC	DTC B0183 or B0188
B0188	Right Solar Load Sensor 2 Circuit	HVAC	DTC B0183 or B0188
B0193	Blower Motor Feedback Circuit	HVAC	DTC B0193
B0198	Blower Motor Feedback Circuit	HVAC	DTC B0198 2
B0228	Air Intake Flow Actuator Fault (LHD) or Recirculation Door Motor Circuit (RHD)	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531
B0238	Demist Actuator Fault (LHD) or Defogger Door Motor Circuit (RHD)	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531
B0253	Face/Floor Actuator Fault (LHD) or Vent/Floor Door Motor Circuit (RHD)	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531
B0283	Electric Rear Defrost Circuit	HVAC	DTC B0283
B0408	Drivers Side Air Mix Actuator (LHD) or Drivers Air Mix Door Motor Circuit (RHD)	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531
B0418	Passenger Side Air Mix Actuator (LHD) or Passengers Air Mix Door Motor Circuit (RHD)	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531
B0428	Rear Air Mix Door Motor Circuit	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531

B0946	Suspension Control Selection Indicator Circuit	ESCM	DTC B0946
B094A	Service Suspension Control Indicator Circuit	ESCM	DTC B094A
B0954	Park Assist Sensor Front Left Outer Circuit	UPA	DTC B0954, B0955, B0956, or B0957
B0955	Park Assist Sensor Front Left Middle Circuit	UPA	DTC B0954, B0955, B0956, or B0957
B0956	Park Assist Sensor Front Right Middle Circuit	UPA	DTC B0954, B0955, B0956, or B0957
B0957	Park Assist Sensor Front Right Outer Circuit	UPA	DTC B0954, B0955, B0956, or B0957
B0958	Park Assist Sensor Rear Left Outer Circuit	UPA	DTC B0958, B0959, B0960, or B0961
B0959	Park Assist Sensor Rear Left Middle Circuit	UPA	DTC B0958, B0959, B0960, or B0961
B0960	Park Assist Sensor Rear Right Middle Circuit	UPA	DTC B0958, B0959, B0960, or B0961
B0961	Park Assist Sensor Rear Right Outer Circuit	UPA	DTC B0958, B0959, B0960, or B0961
B0967	Park Assist Switch Circuit	UPA	DTC B0967
B0968	Park Assist Indicator Circuit Malfunction	UPA	DTC B0968
B0970	Hazard Warning Switch Stuck	BCM	DTC B0970
B0983	Security System Indicator 2 Circuit	BCM	DTC B0983
B0996	Vehicle Identification Number Mismatch	Radio, RSE	DTC B0996, 1016, or B1271
B0997	Auxiliary Electronic Control Unit (ECU) 2 Performance	Radio	DTC B0997
	Memory Seat and Mirror Module Checksum Error	MSM	DTC B0997
B0998	Screen 1 EEPROM Failure	RSE	DTC B0998 or B0999
B0999	Screen 2 EEPROM Failure	RSE	DTC B0998 or B0999
B1000	Electronic Control Unit (ECU) Performance	BCM, IPC, MSM, RFA, SDM, TDM, Telematics, UPA	DTC B1000
B1001	Option Configuration Error	BCM, IPC	DTC B1001
		SDM	DTC B1001
B1008	Calibration Data Not Programmed	Telematics	DTC B1008
		UPA	DTC B1008
B1009	EEPROM Failure	RSE	DTC B1009
B1010	System Sensor Data Mismatch Invalid Odometer Signal	NIM	DTC B1010

B1011	System Disabled Over Temperature	NIM	DTC B1011
B1015	Vehicle Identification Number (VIN) Information Error	Telematics	DTC B1015 or DTC B1016
B1016	Vehicle Identification Number (VIN) Not Programmed	BCM	DTC B1016
		Radio	DTC B0996, 1016, or B1271
		SDM	DTC B1016
		Telematics	DTC B1015 or DTC B1016
B1019	System Configuration Error	Radio	DTC B1019
B101D	ECU Hardware Performance	NIM, Radio, RSE,	DTC B101D
B101E	ECU Software Performance	Radio	DTC B101E
B1020	Auxiliary Electronic Unit (ECU) Performance	NIM	DTC B1020
B1021	SIM Mismatch	Telematics	DTC B1021
B1023	Integral Switch Performance	Radio	DTC B1023
B1024	Printed Circuit Board (PCB) Temperature Sensor Fault	IPC	DTC B1024
B1025	Audio Output 1 Left Front Circuit	Radio	DTC B1025, B1035, B1045, or B1055
B1035	Audio Output 2 Right Front Circuit	Radio	DTC B1025, B1035, B1045, or B1055
B1045	Audio Output 3 Left Rear Circuit	Radio	DTC B1025, B1035, B1045, or B1055
B1055	Audio Output 4 Right Rear Circuit	Radio	DTC B1025, B1035, B1045, or B1055
B1240	CD-Player Malfunction	Radio	DTC B1240 or B1245
B1243	CD-Player Load or Eject Malfunction	Radio	DTC B1243 or B1248
		RSE	DTC B1243
B1244	CD-Player, Disc Upside Down	Radio	DTC B1244 or B1249
B1245	CD-Changer Malfunction	Radio	DTC B1240 or B1245
B1248	CD Changer Load/Unload Performance	Radio	DTC B1243 or B1248
B1249	CD-Changer, Disc Upside Down	Radio	DTC B1244 or B1249
B1271	Theft Locked	Radio	DTC B0996, 1016, or B1271
B1277	Microphone Circuit	Telematics	DTC B1277
B1287	Radio Mute Circuit	Telematics	DTC B1287
B1325	Device Power Circuit	HVAC	DTC B1325
		RSE	DTC B1325, B1330, or B1423
	System Voltage	SDM	DTC B1325
B1330	RSE Control Panel Supplied Power	RSE	DTC B1325, B1330, or B1423
B1335	Screen 1 Power Supply Voltage Circuit	RSE	DTC B1335 or B1340

B1340	Screen 2 Power Supply Voltage Circui	RSE	DTC B1335 or B1340
B1370	Device Ignition 1 Circuit	BCM	DTC B1370-B1379, B1380-B1389, or B1440-B1443
		SDM	DTC B1370
	Wake Up Circuit	MSM	DTC B1370
B1380	Device Ignition ACCESSORY Circuit	BCM	DTC B1370-B1379, B1380-B1389, or B1440-B1443
B138A	Device Voltage Reference Group 1 Outputs	UPA	DTC B138A
B1390	Button 1 Circuit Short to Battery	MSM	DTC B1390, B1400, B1410, or B2765
B1400	Button 2 Circuit Short to Battery	MSM	DTC B1390, B1400, B1410, or B2765
B1410	Button 3 Circuit Short to Battery	MSM	DTC B1390, B1400, B1410, or B2765
B1423	Supply Voltage Circuit	RSE	DTC B1325, B1330, or B1423
B1428	Ignition Switched Power Relay 1 Circuit	BCM	DTC B1428
B1433	Ignition Switched Power Relay 2 Circuit	BCM	DTC B1433
B1440	Power Mode Master Input Circuit Malfunction	BCM	DTC B1370-B1379, B1380-B1389, or B1440-B1443
B1441	Device Ignition OFF, RUN, and CRANK Circuit	BCM	DTC B1370-B1379, B1380-B1389, or B1440-B1443
B1446	Backup Battery Timer Expired	Telematics	DTC B1446
B1447	Backup Battery Circuit	Telematics	DTC B1447
B1475	Retained Accessory Power Circuit	BCM	DTC B1475
B1516	Battery Current Sensor Performance	BCM	DTC B1516
B1517	Battery Voltage	BCM	DTC B1517
		Telematics	DTC B1517
B1527	High Parasitic Load Detected	BCM	DTC B1527
B1529	Control Module Voltage Reference Output 5 Circuit	BCM	DTC B1529
B1565	Mirror DIP Button Stuck	MSM	DTC B1565, B2755, B2760, or B3599
B1735	Front Vertical Up Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1740	Front Vertical Down Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1745	Rear Vertical Up Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1750	Rear Vertical Down Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820

B1755	Horizontal Forward Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1760	Horizontal Back Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1815	Recline Up Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1820	Recline Down Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1825	Recline Position Sensor Fault	MSM	DTC B1825, B2355, B2365, or B2375
B1831	Lumbar Forward Switch Stuck	MSM	DTC B1831 or B1836
B1836	Lumbar Rearward Switch Stuck	MSM	DTC B1831 or B1836
B1851	Lumbar Position Sensor Fault	MSM	DTC B1851
B2355	Front Vertical Position Sensor Fault	MSM	DTC B1825, B2355, B2365, or B2375
B2365	Rear Vertical Position Sensor Fault	MSM	DTC B1825, B2355, B2365, or B2375
B2375	Horizontal Position Sensor Fault	MSM	DTC B1825, B2355, B2365, or B2375
B245A	Telematics Indicator 1 Circuit	Telematics	DTC B245A
B245B	Telematics Indicator 2 Circuit	Telematics	DTC B245B
B2461	Navigation Electronic Control Unit (ECU) Synchronous Signal Error	NIM	DTC B2461
B2462	Global Positioning System (GPS) Antenna Circuit	NIM, Telematics	DTC B2462
B2464	Navigation Player Decoding Error	Radio	DTC B2464
B2469	SIM Card Invalid	Telematics	DTC B2469
B2471	Telephone Number Error	Telematics	DTC B2471
B2476	Keypad Circuit	Telematics	DTC B2476
B2484	Global Positioning System Sensor Open Circuit	NIM	DTC B2484
B2530	Front Foglamps Control Circuit	BCM	DTC B2530
B2545	Backup Lamps Circuit	BCM	DTC B2545
B2555	Passenger Compartment Lamp Control Circuit	BCM	DTC B2555
B2575	Headlamp Low Beam Control Circuit	BCM	DTC B2575
B257A	Headlamp Switch Input Signals Mismatch	BCM	DTC B257A
B2580	Headlamp High Beam Control Circuit	BCM	DTC B2580
B2585	Parklamp Control Circuit	BCM	DTC B2585
B2610	Passenger Compartment	BCM	DTC B2610

	Dimming 1 Circuit		
B2615	Passenger Compartment Dimming 2 Circuit	BCM	DTC B2615
B2625	Display Dimming Pulse Width Modulation (PWM) Output Circuit	BCM	DTC B2625
B2645	Ambient Light Sensor Circuit	BCM	DTC B2645
B2652	Passenger Compartment Dimming 3 Circuit	BCM	DTC B2652
B2705	Gearshift Unlock Circuit	BCM	DTC B2705
B2730	Interior Trunk/Liftglass/Hatch Release Switch Circuit	BCM	DTC B2730
B2745	Traction Control Switch Circuit	BCM	DTC B2745
B2750	Horn Relay Coil Circuit	BCM	DTC B2750
B2755	Memory Button 1 Stuck	MSM	DTC B1565, B2755, B2760, or B3599
B2760	Memory Button 2 Stuck	MSM	DTC B1565, B2755, B2760, or B3599
B2765	Button M Circuit Short to Battery	MSM	DTC B1390, B1400, B1410, or B2765
B2795	Suspension Control Select Switch Circuit	ESCM	DTC B2795
B2815	Steering Wheel Switch Circuit	IPC	DTC B2815
B2976	Driver Door Ajar Circuit	BCM	DTC B2976
B2991	Passenger Door Ajar Circuit	BCM	DTC B2991
B3006	Hood Ajar Circuit Plausability Failure	BCM	DTC B3006
B3055	No Transponder Modulation or No Transponder	TDM	DTC B3055
B3060	Unprogrammed Transponder Key Identification Code Received	TDM	DTC B3060
B3105	Keyless Entry System Key Not Programmed	RFA	DTC B3105
B3109	Keyless Entry Transmitter 1 Battery Low Voltage	RFA	DTC B3109
B3110	Keyless Entry Transmitter 2 Battery Low Voltage	RFA	DTC B3110
B3111	Keyless Entry Transmitter 3 Battery Low Voltage	RFA	DTC B3111
B3112	Keyless Entry Transmitter 4 Battery Low Voltage	RFA	DTC B3112
B3125	Left Front/Driver Door Only Unlock Circuit	BCM	DTC B3125, B3130, or B3135
B3130	All Door Unlock Circuit	BCM	DTC B3125, B3130, or B3135
B3135	All Door Lock Circuit	BCM	DTC B3125, B3130, or B3135

B3140	Driver Unlock Switch Circuit	BCM	DTC B3140 or B3150
B3150	Driver Lock Switch Circuit	BCM	DTC B3140 or B3150
B3265	Trunk/Hatch/Liftglass Release Output Circuit	BCM	DTC B3265
B3410	AHLD Front Axle Sensor Signal Circuit	Headlamp Control Module	DTC B3410 or B3420
B3415	AHLD Front Axle Sensor Supply Circuit	Headlamp Control Module	DTC B3415
B3420	AHLD Rear Axle Sensor Signal Circuit	Headlamp Control Module	DTC B3410 or B3420
B3435	AHLD Left Servo Driver Circuit	Headlamp Control Module	DTC B3435 or B3440
B3440	AHLD Right Servo Driver Circuit	Headlamp Control Module	DTC B3435 or B3440
B3445	Stop Lamp Circuit	BCM	DTC B3445
B3531	Rear Air Mode Door Motor Circuit	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531
B3599	Memory Button 3 Stuck	MSM	DTC B1565, B2755, B2760, or B3599
B370C	Rain Sensor Intensity Signal Circuit	BCM	DTC B370C or B370D
B370D	Rain Sensor Mode Control Circuit	BCM	DTC B370C or B370D
B3715	Front Wiper Relay Drive Circuit	BCM	DTC B3715
B3794	Cruise Control Function Request Circuit	BCM	DTC B3794
B3873	Front Washer Relay Circuit	BCM	DTC B3873
B3875	Wiper High Speed Relay Circuit	BCM	DTC B3875
B3907	Button Assembly Short to Battery	MSM	DTC B3907
B3922	Front Wiper Function Select Circuit	BCM	DTC B3922
B3924	DVD Player Theft Locked	RSE	DTC B3924
B3926	Screen 1 Theft Locked	RSE	DTC B3926 or B3927
B3927	Screen 2 Theft Locked	RSE	DTC B3926 or B3927
B3933	Evaporator Temperature Sensor Circuit	HVAC	DTC B3933
B3935	Transponder Key Identification Error	TDM	DTC B3935
B3976	Unconfigured Transponder Key	TDM	DTC B3976
	Front Left Wheel Speed Sensor		

C0035	Circuit	EBCM	DTC C0035-C0050
C0040	Front Right Wheel Speed Sensor Circuit	EBCM	DTC C0035-C0050
C0045	Rear Left Wheel Speed Sensor Circuit	EBCM	DTC C0035-C0050
C0050	Rear Right Wheel Speed Sensor Circuit	EBCM	DTC C0035-C0050
C0060	Left Front Antilock Braking System Solenoid Valve Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0065	Left Front Antilock Brake System Solenoid 2 Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0070	Right Front Antilock Braking System Solenoid Valve Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0075	Right Front Antilock Brake System Solenoid 2 Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0080	Left Rear Antilock Brake System Solenoid Valve Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0085	Left Rear Antilock Brake System Solenoid 2 Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0090	Right Rear Antilock Braking System Solenoid Valve Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0095	Right Rear Antilock Braking System Solenoid 2 Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0100	Rear Antilock Brake System Solenoid Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0105	Rear Antilock Brake System Solenoid 2 Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0110	Return Pump Circuit Malfunction	EBCM	DTC C0110
C0121	Valve Relay Circuit Malfunction	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0126	Low Brake Fluid Indicated	EBCM	DTC C0126
C0131	Antilock Brake System Pressure Circuit	EBCM	DTC C0131
C0141	Front Left/Front Right TC/ESP Priming Valve Circuit Malfunction	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156

C0146	Front Left/Front Right TC/ESP Switch Over Valve Circuit Malfunction	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0151	Rear Left/Rear Right TC/ESP Priming Valve Circuit Malfunction	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0156	Rear Left/Rear Right TC/ESP Switch Over Valve Circuit Malfunction	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0161	Brake Switch Circuit	EBCM	DTC C0161
C0186	Lateral Acceleration Sensor	EBCM	DTC C0186 or C0196
C0196	Yaw Rate Sensor	EBCM	DTC C0186 or C0196
C0245	Wheel Speed Sensor Frequency	EBCM	DTC C0245
C0252	Implausible Control	EBCM	DTC C0252
C0277	Brake Pedal Position Sensor Circuit	BCM	DTC C0277 or C0890
C0297	Brake Applied Output Circuit	BCM	DTC C0297
C0460	Steering Angle Sensor Circuit	EBCM	DTC C0460
C0550	Electronic Control Unit (ECU) Performance	EBCM	DTC C0550
C0558	Calibration Data Not Programmed	ESCM	DTC C0558
C0561	CAN-Bus Invalid Data	EBCM	DTC C0561
C0565	Vehicle Identification Number (VIN) Not Programmed/Mismatch	EBCM	DTC C0565
C0569	System Configuration Error	EBCM	DTC C0569
		RFA	DTC C0569
C0575	Left Front Solenoid/Motor/Actuator Circuit	ESCM	DTC C0575, C0580, C0585, or C0590
C0580	Right Front Solenoid/Motor/Actuator Circuit	ESCM	DTC C0575, C0580, C0585, or C0590
C0585	Left Rear Solenoid/Motor/Actuator Circuit	ESCM	DTC C0575, C0580, C0585, or C0590
C0590	Right Rear Solenoid/Motor/Actuator Circuit	ESCM	DTC C0575, C0580, C0585, or C0590
C0615	Left Front Position Sensor Circuit	ESCM	DTC C0615, C0620, C0625, or C0630
C0620	Right Front Position Sensor Circuit	ESCM	DTC C0615, C0620, C0625, or C0630
C0625	Left Rear Position Sensor Circuit	ESCM	DTC C0615, C0620, C0625, or C0630

C0630	Right Rear Position Sensor Circuit	ESCM	DTC C0615, C0620, C0625, or C0630
C0696	Position Sensor Overcurrent 5-Volt Supply	ESCM	DTC C0696
C0750	Left Front Tire Pressure Sensor	RCDLR	DTC C0750, C0755, C0760, or C0765
C0755	Right Front Tire Pressure Sensor	RCDLR	DTC C0750, C0755, C0760, or C0765
C0760	Left Rear Tire Pressure Sensor	RCDLR	DTC C0750, C0755, C0760, or C0765
C0765	Right Rear Tire Pressure Sensor	RCDLR	DTC C0750, C0755, C0760, or C0765
C0890	Device Voltage Reference Output 3 Circuit	BCM	DTC C0277 or C0890
C0899	Power Supply Circuit Low Voltage	EBCM	DTC C0899
C0900	Power Supply Circuit High Voltage	EBCM	DTC C0900
C1209	Left Rear Wheel Speed Sensor Circuit High	EBCM, ECM	DTC C1209, C1223, C1227, or C1234
C1210	Right Rear Wheel Speed Sensor Circuit High	EBCM, ECM	DTC C1210, C1224, C1228, or C1235
C1223	Left Rear Wheel Speed Sensor Circuit	EBCM, ECM	DTC C1209, C1223, C1227, or C1234
C1224	Right Rear Wheel Speed Sensor Circuit	EBCM, ECM	DTC C1210, C1224, C1228, or C1235
C1227	Left Rear Wheel Speed Sensor Circuit Range/Performance	EBCM, ECM	DTC C1209, C1223, C1227, or C1234
C1228	Right Rear Wheel Speed Sensor Circuit Range/Performance	EBCM, ECM	DTC C1210, C1224, C1228, or C1235
C1234	Left Rear Wheel Speed Sensor Circuit Low	EBCM, ECM	DTC C1209, C1223, C1227, or C1234
C1235	Right Rear Wheel Speed Sensor Circuit Low	EBCM, ECM	DTC C1210, C1224, C1228, or C1235
P0008	Engine Position System Performance Bank 1	ECM	DTC P0008 or P0009
P0009	Engine Position System Performance Bank 2	ECM	DTC P0008 or P0009
P0010	Intake Camshaft Position Control Solenoid Circuit Malfunction Bank 1	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P0011	Intake Camshaft Position Range/Performance Bank 1	ECM	DTC P0011, P0014, P0021, or P0024
P0013	Exhaust Camshaft Position Control Solenoid Circuit Malfunction Bank 1	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095

P0014	Exhaust Camshaft Position Range/Performance Bank 1	ECM	DTC P0011, P0014, P0021, or P0024
P0016	Crankshaft/Intake Camshaft Position not Plausible Bank 1	ECM	DTC P0016, P0017, P0018, or P0019 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Crankshaft Position (CKP) Camshaft Position (CMP) Correlation		DTC P0016 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0017	Crankshaft/Exhaust Camshaft Position not Plausible Bank 1	ECM	DTC P0016, P0017, P0018, or P0019
P0018	Crankshaft/Intake Camshaft Position not Plausible Bank 2	ECM	DTC P0016, P0017, P0018, or P0019
P0019	Crankshaft/Exhaust Camshaft Position not Plausible Bank 2	ECM	DTC P0016, P0017, P0018, or P0019
P0020	Intake Camshaft Position Control Solenoid Circuit Malfunction Bank 2	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P0021	Intake Camshaft Position Range/Performance Bank 2	ECM	DTC P0011, P0014, P0021, or P0024
P0023	Exhaust Camshaft Position Control Solenoid Circuit Malfunction Bank 2	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P0024	Exhaust Camshaft Position Range/Performance Bank 2	ECM	DTC P0011, P0014, P0021, or P0024
P0030	O2 Sensor Heater Circuit Malfunction Bank 1 Sensor 1	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Control Circuit Bank 1 Sensor 1		DTC P0030, P0036, P0053, P0054, P0135, or P0141 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0031	O2 Sensor Heater Circuit Low Voltage Bank 1 Sensor 1	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0032	O2 Sensor Heater Circuit High Voltage Bank 1 Sensor 1	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0036	O2 Sensor Heater Circuit Malfunction Bank 1 Sensor 2	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Control Circuit Bank 2		DTC P0030, P0036, P0053, P0054, P0135, or P0141 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0037	O2 Sensor Heater Circuit Low Voltage Bank 1 Sensor 2	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0038	O2 Sensor Heater Circuit High	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051,

	Voltage Bank 1 Sensor 2		P0052, P0056, P0057, or P0058
P0040	O2 Sensor Signals not Plausible Bank 1 Sensor 1 & Bank 2 Sensor 1	ECM	DTC P0040 or P0041
P0041	O2 Sensor Signals not Plausible Bank 1 Sensor 2 & Bank 2 Sensor 2	ECM	DTC P0040 or P0041
P0050	O2 Sensor Heater Circuit Malfunction Bank 2 Sensor 1	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Control Bank 2 Sensor 1		DTC P0050, P0056, P0059, P0060, P0155, or P0161 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0051	O2 Sensor Heater Circuit Low Voltage Bank 2 Sensor 1	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0052	O2 Sensor Heater Circuit High Voltage Bank 2 Sensor 1	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0053	O2 Sensor Heater Resistance Range/Performance Bank 1 Sensor 1	ECM	DTC P0053 or P0059 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Resistance Circuit Bank 1 Sensor 1		DTC P0030, P0036, P0053, P0054, P0135, or P0141 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0054	HO2S Heater Resistance Circuit Bank 1 Sensor 2	ECM	DTC P0030, P0036, P0053, P0054, P0135, or P0141
P0056	O2 Sensor Heater Circuit Malfunction Bank 2 Sensor 2	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Control Bank 2 Sensor 2		DTC P0050, P0056, P0059, P0060, P0155, or P0161 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0057	O2 Sensor Heater Circuit Low Voltage Bank 2 Sensor 2	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0058	O2 Sensor Heater Circuit High Voltage Bank 2 Sensor 2	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0059	O2 Sensor Heater Resistance Range/Performance Bank 2 Sensor 1	ECM	DTC P0053 or P0059 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Resistance Bank 2 Sensor 1		DTC P0050, P0056, P0059, P0060, P0155, or P0161 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0060	HO2S Heater Resistance Bank 2 Sensor 2	ECM	DTC P0050, P0056, P0059, P0060, P0155, or P0161

P0068	Throttle Body Airflow Performance	ECM	DTC P0068 or P0121
P0100	Mass Air Flow Sensor Circuit Malfunction	ECM	DTC P0100, P0102, or P0103
P0101	Mass Air Flow Sensor Circuit Range/Performance	ECM	DTC P0101 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Mass Air Flow (MAF) Sensor Performance	ECM	DTC P0101 or P1101 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0102	Mass Air Flow Sensor Voltage Low	ECM	DTC P0100, P0102, or P0103 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Mass Air Flow (MAF) Sensor Circuit Low Frequency	ECM	DTC P0102 or P0103 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0103	Mass Air Flow Sensor Voltage High	ECM	DTC P0100, P0102, or P0103 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Mass Air Flow (MAF) Sensor Circuit High Frequency	ECM	DTC P0102 or P0103 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0106	Manifold Absolute Pressure (MAP) Sensor Performance	ECM	DTC P0106
P0107	Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage	ECM	DTC P0107 or P0108
P0108	Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage	ECM	DTC P0107 or P0108
P0111	Intake Air Temperature Sensor Circuit Range/Performance	ECM	DTC P0111-P0113
P0112	Intake Air Temperature Sensor Circuit Low Voltage	ECM	DTC P0111-P0113 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
			DTC P0112 or P0113 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0113	Intake Air Temperature Sensor Circuit High Voltage	ECM	DTC P0111-P0113 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
			DTC P0112 or P0113 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0115	Engine Coolant Temperature (ECT) Sensor Circuit	TCM	DTC P0115
P0116	Engine Coolant Temperature (ECT) Sensor Performance	ECM	DTC P0116 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0116 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0117	Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage	ECM	DTC P0117 or P0118 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or

			DTC P0117 or P0118 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0118	Engine Coolant Temperature (ECT) Sensor Circuit High Voltage	ECM	DTC P0117 or P0118 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0117 or P0118 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0119	Engine Coolant Temperature Sensor Circuit Intermittent	ECM	DTC P0119
P0120	Throttle Position Sensor 1 Circuit	ECM	DTC P0120, P0122, P0123, P0220, P0222, P0223, or P2135 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
	Throttle Position (TP) Sensor Circuit	TCM	DTC P0120
P0121	Throttle Position Sensor 1 Circuit Range/Performance	ECM	DTC P0121, P0122, P0123, P0221, P0222, or P0223 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Throttle Position (TP) Sensor 1 Performance	ECM	DTC P0068 or P0121 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0122	Throttle Position Sensor 1 Circuit Low Voltage	ECM	DTC P0121, P0122, P0123, P0221, P0222, or P0223 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0120, P0122, P0123, P0220, P0222, P0223, or P2135 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0123	Throttle Position Sensor 1 Circuit High Voltage	ECM	DTC P0121, P0122, P0123, P0221, P0222, or P0223 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0120, P0122, P0123, P0220, P0222, P0223, or P2135 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0128	Engine Coolant Temperature Below Thermostat Regulating Temperature	ECM	DTC P0128 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0128 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0130	O2 Sensor Circuit Malfunction	ECM	DTC P0130 or P0150

	Bank 1 Sensor 1		
P0131	O2 Sensor Circuit Low Voltage Bank 1 Sensor 1	ECM	DTC P0131 or P0151 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit Low Voltage Bank 1 Sensor 1		DTC P0131, P0132, P0137, or P0138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0132	O2 Sensor Circuit High Voltage Bank 1 Sensor 1	ECM	DTC P0132 or P0152 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit High Voltage Bank 1 Sensor 1		DTC P0131, P0132, P0137, or P0138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0133	O2 Sensor Circuit Slow Response Bank 1 Sensor 1	ECM	DTC P0133 or P0153 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Slow Response Bank 1 Sensor 1		DTC P0133, P0134, P0140, P1133, P2270, or P2271 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0134	HO2S Circuit Insufficient Activity Bank 1 Sensor 1	ECM	DTC P0134 or P0154 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0133, P0134, P0140, P1133, P2270, or P2271 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0135	O2 Sensor Heater Circuit Range/Performance Bank 1 Sensor 1	ECM	DTC P0135, P0141, P0155, or P0161 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Performance Bank 1 Sensor 1		DTC P0030, P0036, P0053, P0054, P0135, or P0141 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0137	O2 Sensor Circuit Low Voltage Bank 1 Sensor 2	ECM	DTC P0137, P0138, P0140, P0157, P0158, or P0160 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit Low Voltage Bank 1 Sensor 2		DTC P0131, P0132, P0137, or P0138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0138	O2 Sensor Circuit High Voltage Bank 1 Sensor 2	ECM	DTC P0137, P0138, P0140, P0157, P0158, or P0160 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit High Voltage Bank 1 Sensor 2	ECM	DTC P0131, P0132, P0137, or P0138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P013A	HO2S Slow Response Rich to Lean Bank 1 Sensor 2	ECM	DTC P013A, P013C, P013E, or P014A
P013C	HO2S Slow Response Rich to Lean Bank 2 Sensor 2	ECM	DTC P013A, P013C, P013E, or P014A
P013E	HO2S Delayed Response Rich to Lean Bank 1 Sensor 2	ECM	DTC P013A, P013C, P013E, or P014A
			DTC P0137, P0138, P0140, P0157,

P0140	O2 Sensor Circuit No Activity Detected Bank 1 Sensor 2	ECM	P0158, or P0160 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit Insufficient Activity Bank 1 Sensor 2	ECM	DTC P0133, P0134, P0140, P1133, P2270, or P2271 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0141	O2 Sensor Heater Circuit Range/Performance Bank 1 Sensor 2	ECM	DTC P0135, P0141, P0155, or P0161 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Performance Bank 1 Sensor 2	ECM	DTC P0030, P0036, P0053, P0054, P0135, or P0141 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P014A	HO2S Delayed Response Rich to Lean Bank 2 Sensor 2	ECM	DTC P013A, P013C, P013E, or P014A
P0150	O2 Sensor Circuit Malfunction Bank 2 Sensor 1	ECM	DTC P0130 or P0150
P0151	O2 Sensor Circuit Low Voltage Bank 2 Sensor 1	ECM	DTC P0131 or P0151 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit Low Voltage Bank 2 Sensor 1		DTC P0151, P0152, P0157, or P0158 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0152	O2 Sensor Circuit High Voltage Bank 2 Sensor 1	ECM	DTC P0132 or P0152 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit High Voltage Bank 2 Sensor 1		DTC P0151, P0152, P0157, or P0158 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0153	O2 Sensor Circuit Slow Response Bank 2 Sensor 1	ECM	DTC P0133 or P0153 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Slow Response Bank 2 Sensor 1		DTC P0153, P0154, P0160, P1153, P2272, or P2273 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0154	HO2S Circuit Insufficient Activity Bank 2 Sensor 1	ECM	DTC P0134 or P0154 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
			DTC P0153, P0154, P0160, P1153, P2272, or P2273 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0155	O2 Sensor Heater Circuit Range/Performance Bank 2 Sensor 1	ECM	DTC P0135, P0141, P0155, or P0161 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Performance Bank 2 Sensor 1		DTC P0050, P0056, P0059, P0060, P0155, or P0161 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0157	O2 Sensor Circuit Low Voltage Bank 2 Sensor 2	ECM	DTC P0137, P0138, P0140, P0157, P0158, or P0160 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit Low Voltage Bank 2 Sensor 2		DTC P0151, P0152, P0157, or P0158 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
	O2 Sensor Circuit High Voltage		DTC P0137, P0138, P0140, P0157,

P0158	Bank 2 Sensor 2	ECM	P0158, or P0160 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit High Voltage Bank 2 Sensor 2		DTC P0151, P0152, P0157, or P0158 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0160	O2 Sensor Circuit No Activity Detected Bank 2 Sensor 2	ECM	DTC P0137, P0138, P0140, P0157, P0158, or P0160 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit Insufficient Activity Bank 2 Sensor 2		DTC P0153, P0154, P0160, P1153, P2272, or P2273 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0161	O2 Sensor Heater Circuit Range/Performance Bank 2 Sensor 2	ECM	DTC P0135, P0141, P0155, or P0161 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Performance Bank 2 Sensor 2	ECM	DTC P0050, P0056, P0059, P0060, P0155, or P0161 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0171	Fuel Trim System Lean Bank 1	ECM	DTC P0171, P0172, P0174, or P0175
P0172	Fuel Trim System Rich Bank 1	ECM	DTC P0171, P0172, P0174, or P0175
P0174	Fuel Trim System Lean Bank 2	ECM	DTC P0171, P0172, P0174, or P0175
P0175	Fuel Trim System Rich Bank 2	ECM	DTC P0171, P0172, P0174, or P0175
P0196	Engine Oil Temperature Sensor Range/Performance	ECM	DTC P0196, P0197, or P0198 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Engine Oil Temperature Sensor Circuit Range/Performance	ECM	DTC P0196, P0197, or P0198 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0197	Engine Oil Temperature Voltage Low	ECM	DTC P0196, P0197, or P0198 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Engine Oil Temperature Sensor Circuit Low Input	ECM	DTC P0196, P0197, or P0198 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0198	Engine Oil Temperature Voltage High	ECM	DTC P0196, P0197, or P0198 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Engine Oil Temperature Sensor Circuit High Input	ECM	DTC P0196, P0197, or P0198 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0201	Injector 1 Control Circuit	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine

P0202	Injector 2 Control Circuit	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0203	Injector 3 Control Circuit	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0204	Injector 4 Control Circuit	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0205	Injector 5 Control Circuit	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine

P0206	Injector 6 Control Circuit	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0207	Injector 7 Control Circuit	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208
P0208	Injector 8 Control Circuit	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208
P0218	Transmission Fluid Overtemperature	TCM	• DTC P0218 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0218 for the 5L40-E/5L50-E transmission • DTC P0218 for the 6L50/6L80/6L90 transmission
P0219	Engine Overspeed Condition	ECM	DTC P0219
P0220	Throttle Position Sensor 2 Circuit	ECM	DTC P0120, P0122, P0123, P0220, P0222, P0223, or P2135
P0221	Throttle Position Sensor 2 Circuit Range/Performance	ECM	DTC P0121, P0122, P0123, P0221, P0222, or P0223
P0222	Throttle Position Sensor 2 Circuit Low Voltage	ECM	DTC P0121, P0122, P0123, P0221, P0222, or P0223 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0120, P0122, P0123, P0220, P0222, P0223, or P2135 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0223	Throttle Position Sensor 2 Circuit High Voltage	ECM	DTC P0121, P0122, P0123, P0221, P0222, or P0223 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0120, P0122, P0123, P0220, P0222, P0223, or P2135 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0230	Fuel Pump Relay Control Circuit	ECM	DTC P0230

P0261	Injector 1 Control Circuit Low Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0262	Injector 1 Control Circuit High Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0264	Injector 2 Control Circuit Low Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0265	Injector 2 Control Circuit High Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0267	Injector 3 Control Circuit Low Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0268	Injector 3 Control Circuit High Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0270	Injector 4 Control Circuit Low Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0271	Injector 4 Control Circuit High Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0273	Injector 5 Control Circuit Low Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0274	Injector 5 Control Circuit High Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
			DTC P0201, P0202, P0203, P0204,

P0276	Injector 6 Control Circuit Low Voltage	ECM	P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0277	Injector 6 Control Circuit High Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0300	Engine Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0301	Cylinder 1 Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0302	Cylinder 2 Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0303	Cylinder 3 Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0304	Cylinder 4 Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0305	Cylinder 5 Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L,

			5.3L, 6.0L, 6.2L, or 7.0L engine
P0306	Cylinder 6 Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0307	Cylinder 7 Misfire Detected	ECM	DTC P0300-P0308
P0308	Cylinder 8 Misfire Detected	ECM	DTC P0300-P0308
P0315	Crankshaft Position System Variation Not Learned	ECM	DTC P0315
P0324	Knock Sensor Module Performance	ECM	DTC P0324 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0325	Knock Sensor (KS) Circuit Bank 1	ECM	DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333
P0326	Knock Sensor (KS) Performance Bank 1	ECM	DTC P0326, P0327, P0328, P0331, P0332, or P0333 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Knock Sensor (KS) Performance	ECM	DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0327	Knock Sensor (KS) Circuit Low Voltage Bank 1	ECM	DTC P0326, P0327, P0328, P0331, P0332, or P0333 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0328	Knock Sensor (KS) Circuit High Voltage Bank 1	ECM	DTC P0326, P0327, P0328, P0331, P0332, or P0333 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine

P0330	Knock Sensor (KS) Circuit Bank 2	ECM	DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333
P0331	Knock Sensor (KS) System Performance Bank 2	ECM	DTC P0326, P0327, P0328, P0331, P0332, or P0333
P0332	Knock Sensor (KS) Circuit Low Voltage Bank 2	ECM	DTC P0326, P0327, P0328, P0331, P0332, or P0333 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0333	Knock Sensor (KS) Circuit High Voltage Bank 2	ECM	DTC P0326, P0327, P0328, P0331, P0332, or P0333 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0335	Crankshaft Position Sensor Circuit Malfunction	ECM	DTC P0335, P0336, or P0338 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Crankshaft Position (CKP) Sensor Circuit		DTC P0335 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0336	Crankshaft Position Sensor Signal Range/Performance	ECM	DTC P0335, P0336, or P0338 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Crankshaft Position (CKP) Sensor Performance		DTC P0336 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0338	Crankshaft Position Sensor Circuit High Duty Cycle	ECM	DTC P0335, P0336, or P0338 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
P0340	Camshaft Position (CMP) Sensor Circuit	ECM	DTC P0340
P0341	Intake Camshaft Position Sensor Range/Performance Bank 1	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Camshaft Position (CMP) Sensor Performance	ECM	DTC P0341 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0342	Intake Camshaft Position Sensor Low Voltage Bank 1	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0343	Intake Camshaft Position Sensor High Voltage Bank 1	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
	Intake Camshaft Position		DTC P0341, P0342, P0343, P0346,

P0346	Sensor Range/Performance Bank 2	ECM	P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0347	Intake Camshaft Position Sensor Low Voltage Bank 2	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0348	Intake Camshaft Position Sensor High Voltage Bank 2	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0351	Ignition Coil Cylinder 1 Control Circuit	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0351-P0358 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0352	Ignition Coil Cylinder 2 Control Circuit	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0351-P0358 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0353	Ignition Coil Cylinder 3 Control Circuit	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0351-P0358 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0354	Ignition Coil Cylinder 4 Control Circuit	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0351-P0358 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
			DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313,

P0355	Ignition Coil Cylinder 5 Control Circuit	ECM	P2315, or P2316 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0351-P0358 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0356	Ignition Coil Cylinder 6 Control Circuit	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0351-P0358 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0357	Ignition Coil Cylinder 7 Control Circuit	ECM	DTC P0351-P0358
P0358	Ignition Coil Cylinder 8 Control Circuit	ECM	DTC P0351-P0358
P0366	Exhaust Camshaft Position Sensor Range/Performance Bank 1	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0367	Exhaust Camshaft Position Sensor Low Voltage Bank 1	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0368	Exhaust Camshaft Position Sensor High Voltage Bank 1	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0391	Exhaust Camshaft Position Sensor Range/Performance Bank 2	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0392	Exhaust Camshaft Position Sensor Low Voltage Bank 2	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0393	Exhaust Camshaft Position Sensor High Voltage Bank 2	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0420	Catalyst System Low EfficiencyBank 1	ECM	DTC P0420 or P0430 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0420 or P0430 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0430	Catalyst System Low Efficiency	ECM	DTC P0420 or P0430 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or

	Bank 2		DTC P0420 or P0430 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0443	Evaporative Emission Control System Purge Solenoid Circuit Malfunction	ECM	DTC P0443, P0458, or P0459 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0443 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0458	Evaporative Emission Control System Purge Solenoid Circuit Low Voltage	ECM	DTC P0443, P0458, or P0459
P0459	Evaporative Emission Control System Purge Solenoid Circuit High Voltage	ECM	DTC P0443, P0458, or P0459
P0461	Fuel Level Sensor 1 Performance	ECM	DTC P0461
P0462	Fuel Level Sensor 1 Circuit Low Voltage	ECM	DTC P0462
P0463	Fuel Level Sensor 1 Circuit HighVoltage	ECM	DTC P0463
P0480	Cooling Fan Relay 1 Control Circuit	ECM	DTC P0480, P0481, P0691, P0692, P0693, or P0694 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0480 or P0481 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0481	Cooling Fan Relay 2 Control Circuit	ECM	DTC P0480, P0481, P0691, P0692, P0693, or P0694 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0480 or P0481 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0500	Vehicle Speed Sensor Circuit Malfunction	ECM	DTC P0500
P0501	Vehicle Speed Sensor (VSS) Performance	ECM	DTC P0501 or P0502
P0502	Vehicle Speed Sensor (VSS) Circuit Low Voltage	ECM	DTC P0501 or P0502 for the Aisin AY6 transmission or DTC P0502 or P0503 for the Tremec 6-Speed transmission
	Vehicle Speed Sensor (VSS)		

P0503	Circuit Intermittent	ECM	DTC P0502 or P0503
P0506	Idle Speed Low	ECM	DTC P0506, P0507, or P050A for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0506 or P0507 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0507	Idle Speed High	ECM	DTC P0506, P0507, or P050A for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0506 or P0507 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P050A	Cold Start Idle Air Control (IAC) System Performance	ECM	DTC P0506, P0507, or P050A
P0521	Engine Oil Pressure (EOP) Sensor Performance	ECM	DTC P0521, P0522, or P0523
P0522	Engine Oil Pressure (EOP) Sensor Circuit Low Voltage	ECM	DTC P0521, P0522, or P0523
P0523	Engine Oil Pressure (EOP) Sensor Circuit High Voltage	ECM	DTC P0521, P0522, or P0523
P0532	Air Conditioning (A/C) Refrigerant Pressure Sensor Circuit	ECM	DTC P0532 or P0533
P0533	Air Conditioning (A/C) Refrigerant Pressure Sensor Circuit Low Voltage	ECM	DTC P0532 or P0533
P0560	System Voltage Malfunction	ECM	DTC P0560
P0562	System Voltage Low	ECM	DTC P0562
		TCM	• DTC P0562 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0562 for the 5L40-E/5L50-E transmission • DTC P0562 or P0563 for the 6L50/6L80/6L90 transmission
P0563	System Voltage High	ECM	DTC P0563
		TCM	• DTC P0563 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0563 for the 5L40-E/5L50-E transmission • DTC P0562 or P0563 for the 6L50/6L80/6L90 transmission
P0571	Cruise Control Brake Switch Circuit	ECM	DTC P0571
	Brake Switch Circuit 1 Low		

P0572	Voltage	ECM	DTC P0572
P0573	Brake Switch Circuit 1 High Voltage	ECM	DTC P0573
P0575	Cruise Control Enable Circuit Malfunction	ECM	DTC P0575
P0601	Control Module Read Only Memory (ROM) Error	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
	Transmission Control Module (TCM) Read Only Memory (ROM)	TCM	• DTC P0601-P0604 or P062F for the 4L60-E/4L65-E/4L70-E transmission • DTC P0601 for the 5L40-E/5L50-E transmission • DTC P0601-P0604 or P062F for the 6L50/6L80/6L90 transmission
P0602	Control Module Not Programmed	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
	Transmission Control Module (TCM) Not Programmed	TCM	• DTC P0601-P0604 or P062F for the 4L60-E/4L65-E/4L70-E transmission • DTC P0602 for the 5L40-E/5L50-E transmission • DTC P0601-P0604 or P062F for the 6L50/6L80/6L90 transmission
	Control Module Long Term Memory Reset	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or

			P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0603	Transmission Control Module (TCM) Long Term Memory Reset	TCM	• DTC P0601-P0604 or P062F for the 4L60-E/4L65-E/4L70-E transmission • DTC P0603 for the 5L40-E/5L50-E transmission • DTC P0601-P0604 or P062F for the 6L50/6L80/6L90 transmission
P0604	Control Module Random Access Memory (RAM)	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
	Transmission Control Module (TCM) Random Access Memory (RAM)	TCM	• DTC P0601-P0604 or P062F for the 4L60-E/4L65-E/4L70-E transmission • DTC P0604 for the 5L40-E/5L50-E transmission • DTC P0601-P0604 or P062F for the 6L50/6L80/6L90 transmission
P0606	Control Module Internal Performance	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0607	Control Module Performance	ECM	DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610
P060D	Control Module Accelerator Pedal Position (APP) System Performance	ECM	DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610
P0615	Starter Relay Circuit Malfunction	ECM	DTC P0615
P0616	Starter Relay Control Circuit Low Voltage	ECM	DTC P0616 or P0617
	Starter Relay Control Circuit		

P0617	High Voltage	ECM	DTC P0616 or P0617
P0621	Alternator L-Terminal Circuit Malfunction	ECM	DTC P0621
P0622	Generator F-Terminal Circuit	ECM	DTC P0622
P0625	Generator F-Terminal Low Voltage	ECM	DTC P0625 or P0626
P0626	Generator F-Terminal High Voltage	ECM	DTC P0625 or P0626
P0627	Fuel Pump Relay Control Circuit	ECM	DTC P0627, P0628, or P0629
P0628	Fuel Pump Relay Control Circuit Low Voltage	ECM	DTC P0627, P0628, or P0629
P0629	Fuel Pump Relay Control Circuit High Voltage	ECM	DTC P0627, P0628, or P0629
P062F	Control Module Long Term Memory Performance	ECM	DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
	Transmission Control Module (TCM) Long Term Memory Performance	TCM	• DTC P0601-P0604 or P062F for the 4L60-E/4L65-E/4L70-E transmission • DTC P062F for the 5L40-E/5L50-E transmission • DTC P0601-P0604 or P062F for the 6L50/6L80/6L90 transmission
P0633	Theft Deterrent Key Not Programmed	ECM	DTC P0633
P0634	Transmission Control Module (TCM) Overtemperature	TCM	DTC P0634
P0638	Commanded versus Actual Throttle Position Correlation	ECM	DTC P0638, P2100, P2101, or P2119
P0641	5-Volt Reference 1 Circuit	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	5V Reference Circuit 1 Malfunction		DTC P0641 or P0651 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0642	5-Volt Reference 1 Circuit Low Voltage	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P0643	5-Volt Reference 1 Circuit High Voltage	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P0650	Malfunction Indicator (MI) Circuit Malfunction	ECM	DTC P0650 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0650 for the 4.8L, 5.3L, 6.0L,

			6.2L, or 7.0L engine
P0651	5-Volt Reference 2 Circuit	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	5V Reference Circuit 2 Malfunction	ECM	DTC P0641 or P0651 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0652	5-Volt Reference 2 Circuit Low Voltage	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P0653	5-Volt Reference 2 Circuit High Voltage	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P0658	Solenoid High Control Circuit Group 1 Low Voltage	TCM	DTC P0658 or P0659 for the 5L40-E/5L50-E transmission or DTC P0658 or P0659 for the 6L50/6L80/6L90 transmission
P0659	Solenoid High Control Circuit Group 1 High Voltage	TCM	DTC P0658 or P0659 for the 5L40-E/5L50-E transmission or DTC P0658 or P0659 for the 6L50/6L80/6L90 transmission
P0660	Intake Manifold Tuning (IMT) Valve Solenoid Control Circuit	ECM	DTC P0660, P0661, or P0662
P0661	Intake Manifold Tuning (IMT) Solenoid Control Circuit Low Voltage	ECM	DTC P0660, P0661, or P0662
P0662	Intake Manifold Tuning (IMT) Solenoid Control Circuit High Voltage	ECM	DTC P0660, P0661, or P0662
P0667	Transmission Control Module (TCM) Temperature Sensor Performance	TCM	DTC P0667, P0668, or P0669
P0668	Transmission Control Module (TCM) Temperature Sensor Circuit Low Voltage	TCM	DTC P0667, P0668, or P0669
P0669	Transmission Control Module (TCM) Temperature Sensor Circuit High Voltage	TCM	DTC P0667, P0668, or P0669
P0685	Engine Control Ignition Relay Circuit Malfunction	ECM	DTC P0685, P0686, P0687, P0689, or P0690 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Engine Controls Ignition Relay Control Circuit	ECM	DTC P0685, P0689, or P0690 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0686	Engine Control Ignition Relay Circuit Low Voltage	ECM	DTC P0685, P0686, P0687, P0689, or P0690

P0687	Engine Control Ignition Relay Circuit High Voltage	ECM	DTC P0685, P0686, P0687, P0689, or P0690
P0689	Engine Control Ignition Relay Feedback Circuit Low Voltage	ECM	DTC P0685, P0686, P0687, P0689, or P0690 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Engine Controls Relay Feedback Circuit Low Voltage		DTC P0685, P0689, or P0690 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0690	Engine Control Ignition Relay Feedback Circuit High Voltage	ECM	DTC P0685, P0686, P0687, P0689, or P0690 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Engine Controls Relay Feedback Circuit High Voltage		DTC P0685, P0689, or P0690 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0691	Cooling Fan Relay 1 Control Circuit Low Voltage	ECM	DTC P0480, P0481, P0691, P0692, P0693, or P0694
P0692	Cooling Fan Relay 2 Control Circuit High Voltage	ECM	DTC P0480, P0481, P0691, P0692, P0693, or P0694
P0693	Cooling Fan Relay 2 Control Circuit Low Voltage	ECM	DTC P0480, P0481, P0691, P0692, P0693, or P0694
P0694	Cooling Fan Relay 1 Control Circuit High Voltage	ECM	DTC P0480, P0481, P0691, P0692, P0693, or P0694
P0697	5-Volt Reference 3 Circuit	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P0698	5-Volt Reference 3 Circuit Low Voltage	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P0699	5-Volt Reference 3 Circuit High Voltage	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P06AC	Transmission Control Module (TCM) Power Up Temperature Sensor Performance	TCM	DTC P06AC, P06AD, or P06AE
P06AD	Transmission Control Module (TCM) Power Up Temperature Sensor Circuit Low Voltage	TCM	DTC P06AC, P06AD, or P06AE
P06AE	Transmission Control Module (TCM) Power Up Temperature Sensor Circuit High Voltage	TCM	DTC P06AC, P06AD, or P06AE
P0700	Transmission Control Module (TCM) Requested MIL Illumination	ECM	DTC P0700 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0700 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0703	Torque Converter / Brake Switch Circuit Malfunction	ECM	DTC P0703
P0704	Clutch Switch Circuit	ECM	DTC P0704
			• DTC P0711 for the 4L60-

P0711	Transmission Fluid Temperature (TFT) Sensor Performance	TCM	E/4L65-E/4L70-E transmission • DTC P0711 for the 5L40-E/5L50-E transmission • DTC P0711, P0712, or P0713 for the 6L50/6L80/6L90 transmission
P0712	Transmission Fluid Temperature (TFT) Sensor Circuit Low Voltage	ECM	DTC P0712 or P0713 for the Tremec 6-Speed transmission
		TCM	• DTC P0712 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0712 for the 5L40-E/5L50-E transmission • DTC P0711, P0712, or P0713 for the 6L50/6L80/6L90 transmission
P0713	Transmission Fluid Temperature (TFT) Sensor Circuit High Voltage	ECM	DTC P0712 or P0713 for the Tremec 6-Speed transmission
		TCM	• DTC P0713 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0713 for the 5L40-E/5L50-E transmission • DTC P0711, P0712, or P0713 for the 6L50/6L80/6L90 transmission
P0716	Input Speed Sensor Performance	TCM	• DTC P0716 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0716 for the 5L40-E/5L50-E transmission • DTC P0716 or P0717 for the 6L50/6L80/6L90 transmission
P0717	Input Speed Sensor Circuit Low Voltage	TCM	• DTC P0717 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0717 for the 5L40-E/5L50-E transmission • DTC P0716 or P0717 for the 6L50/6L80/6L90 transmission
P0719	Brake Switch Circuit Low Voltage	TCM	DTC P0719
P0722	Output Speed Sensor Circuit Low Voltage	TCM	• DTC P0722 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0722 for the 5L40-E/5L50-E transmission • DTC P0722 or P0723 for the 6L50/6L80/6L90 transmission
			• DTC P0723 for the 4L60-

P0723	Output Speed Sensor Circuit Intermittent	TCM	E/4L65-E/4L70-E transmission • DTC P0723 for the 5L40-E/5L50-E transmission • DTC P0722 or P0723 for the 6L50/6L80/6L90 transmission
P0724	Brake Switch Circuit High Voltage	TCM	DTC P0724
P0727	Engine Speed No Signal	TCM	DTC P0727
P0741	Torque Converter Clutch (TCC) System - Stuck Off	TCM	• DTC P0741 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0741 for the 5L40-E/5L50-E transmission • DTC P0741 or P0742 for the 6L50/6L80/6L90 transmission
P0742	Torque Converter Clutch (TCC) System - Stuck On	TCM	• DTC P0742 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0742 for the 5L40-E/5L50-E transmission • DTC P0741 or P0742 for the 6L50/6L80/6L90 transmission
P0748	Pressure Control (PC) Solenoid Control Circuit	TCM	DTC P0748
P0751	1-2 Shift Solenoid (SS) Valve Performance - No First, Fourth or Fifth Gear	TCM	DTC P0751 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0751 for the 5L40-E/5L50-E transmission
	Shift Solenoid (SS) 1 Valve Performance - Stuck Off		DTC P0751 for the 6L50/6L80/6L90 transmission
P0752	1-2 Shift Solenoid (SS) Valve Performance - No Second or Third Gear	TCM	DTC P0752 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0752 for the 5L40-E/5L50-E transmission
	Shift Solenoid (SS) 1 Valve Performance - Stuck On		DTC P0752 for the 6L50/6L80/6L90 transmission
P0756	2-3 Shift Solenoid (SS) Valve Performance - No First or Second Gear	TCM	DTC P0756 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0756 for the 5L40-E/5L50-E transmission

	Shift Solenoid (SS) 2 Valve Performance - Stuck Off		DTC P0756 for the 6L50/6L80/6L90 transmission
P0757	2-3 Shift Solenoid (SS) Valve Performance - No Third, Fourth or Fifth Gear	TCM	DTC P0757 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0757 for the 5L40-E/5L50-E transmission
P0761	4-5 Shift Solenoid (SS) Valve Performance - No Fourth Gear	TCM	DTC P0761
P0762	4-5 Shift Solenoid (SS) Valve Performance - No Fifth Gear	TCM	DTC P0762
P0776	Clutch Pressure Control (PC) Solenoid 2 - Stuck Off	TCM	DTC P0776 or P0777
P0777	Clutch Pressure Control (PC) Solenoid 2 - Stuck On	TCM	DTC P0776 or P0777
P0787	3-2 Shift Solenoid (SS) Control Circuit Low Voltage	TCM	DTC P0787
P0788	3-2 Shift Solenoid (SS) Control Circuit High Voltage	TCM	DTC P0788
P0796	Clutch Pressure Control (PC) Solenoid 3 - Stuck Off	TCM	DTC P0796 or P0797
P0797	Clutch Pressure Control (PC) Solenoid 3 - Stuck On	TCM	DTC P0796 or P0797
P0801	Reverse Lockout Solenoid Control Circuit	ECM	DTC P0801
P0803	Skip Shift Solenoid Control Circuit	ECM	DTC P0803
P0806	Clutch Pedal Position (CPP) Sensor Circuit Performance	ECM	DTC P0806 for the Aisin AY6 transmission or DTC P0806 for the Tremec 6-Speed transmission
P0807	Clutch Pedal Position (CPP) Sensor Circuit Low Voltage	ECM	DTC P0807 or P0808 for the Aisin AY6 transmission or DTC P0807 or P0808 for the Tremec 6-Speed transmission
P0808	Clutch Pedal Position (CPP) Sensor Circuit High Voltage	ECM	DTC P0807 or P0808 for the Aisin AY6 transmission or DTC P0807 or P0808 for the Tremec

			6-Speed transmission
P080A	Clutch Pedal Position (CPP) Sensor Circuit High Voltage	ECM	DTC P080A for the Aisin AY6 transmission or DTC P080A for the Tremec 6-Speed transmission
P0815	Upshift Switch Circuit	TCM	DTC P0815, P0816, or P0826 for the 5L40-E/5L50-E transmission or DTC P0815, P0816, or P0826 for the 6L50/6L80/6L90 transmission
P0816	Downshift Switch Circuit	TCM	DTC P0815, P0816, or P0826 for the 5L40-E/5L50-E transmission or DTC P0815, P0816, or P0826 for the 6L50/6L80/6L90 transmission
P0826	Up and Down Shift Switch Circuit	TCM	DTC P0815, P0816, or P0826 for the 5L40-E/5L50-E transmission or DTC P0815, P0816, or P0826 for the 6L50/6L80/6L90 transmission
P0842	Transmission Fluid Pressure (TFP) Switch 1 Circuit Low Voltage	TCM	DTC P0842 or P0843
P0843	Transmission Fluid Pressure (TFP) Switch 1 Circuit High Voltage	TCM	DTC P0842 or P0843
P0850	Park/Neutral Position (PNP) Switch Circuit	TCM	DTC P0850 for the 5L40-E/5L50-E transmission or DTC P0850-P0852 for the 6L50/6L80/6L90 transmission
P0851	Park/Neutral Position (PNP) Switch Circuit Low Voltage	ECM	DTC P0850-P0852 for the 6L50/6L80/6L90 transmission
P0852	Park/Neutral Position (PNP) Switch Circuit High Voltage	ECM	DTC P0850-P0852 for the 6L50/6L80/6L90 transmission
P0856	Engine Control Module (ECM) Traction Control Torque Request Circuit	ECM	DTC P0856

P0872	Transmission Fluid Pressure (TFP) Switch 3 Circuit Low Voltage	TCM	DTC P0872 or P0873
P0873	Transmission Fluid Pressure (TFP) Switch 3 Circuit High Voltage	TCM	DTC P0872 or P0873
P0877	Transmission Fluid Pressure (TFP) Switch 4 Circuit Low Voltage	TCM	DTC P0877 or P0878
P0878	Transmission Fluid Pressure (TFP) Switch 4 Circuit High Voltage	TCM	DTC P0877 or P0878
P0897	Transmission Fluid Life	TCM	DTC P0897
P0961	Line Pressure Control (PC) Solenoid System Performance	TCM	DTC P0961 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0961-P0963 for the 6L50/6L80/6L90 transmission
P0962	Line Pressure Control (PC) Solenoid Control Circuit Low Voltage	TCM	DTC P0961-P0963
P0963	Line Pressure Control (PC) Solenoid Control Circuit High Voltage	TCM	DTC P0961-P0963
P0965	Clutch Pressure Control (PC) Solenoid 2 System Performance	TCM	DTC P0965-P0967
P0966	Clutch Pressure Control (PC) Solenoid 2 Control Circuit Low Voltage	TCM	DTC P0965-P0967
P0967	Clutch Pressure Control (PC) Solenoid 2 Control Circuit High Voltage	TCM	DTC P0965-P0967
P0969	Clutch Pressure Control (PC) Solenoid 3 System Performance	TCM	DTC P0969-P0971
P0970	Clutch Pressure Control (PC) Solenoid 3 Control Circuit Low Voltage	TCM	DTC P0969-P0971
P0971	Clutch Pressure Control (PC) Solenoid 3 Control Circuit High Voltage	TCM	DTC P0969-P0971
P0973	1-2 Shift Solenoid (SS) Control Circuit Low Voltage	TCM	DTC P0973 for the 4L60-E/4L65-E/4L70-E transmission or

			DTC P0973 for the 5L40-E/5L50-E transmission
	Shift Solenoid (SS) 1 Control Circuit Low Voltage		DTC P0973 or P0974 for the 6L50/6L80/6L90 transmission
P0974	1-2 Shift Solenoid (SS) Control Circuit High Voltage	TCM	DTC P0974 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0974 for the 5L40-E/5L50-E transmission
	Shift Solenoid (SS) 1 Control Circuit High Voltage		DTC P0973 or P0974 for the 6L50/6L80/6L90 transmission
P0976	2-3 Shift Solenoid (SS) Control Circuit Low Voltage	TCM	DTC P0976 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0976 for the 5L40-E/5L50-E transmission
	Shift Solenoid (SS) 2 Control Circuit Low Voltage		DTC P0976 or P0977 for the 6L50/6L80/6L90 transmission
P0977	2-3 Shift Solenoid (SS) Control Circuit High Voltage	TCM	DTC P0977 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0977 for the 5L40-E/5L50-E transmission
	Shift Solenoid (SS) 2 Control Circuit High Voltage		DTC P0976 or P0977 for the 6L50/6L80/6L90 transmission
P0979	4-5 Shift Solenoid (SS) Control Circuit Low Voltage	TCM	DTC P0979
P0980	4-5 Shift Solenoid (SS) Control Circuit High Voltage	TCM	DTC P0980
P0989	Transmission Fluid Pressure (TFP) Switch 5 Circuit Low Voltage	TCM	DTC P0989 or P0990
P0990	Transmission Fluid Pressure (TFP) Switch 5 Circuit High Voltage	TCM	DTC P0989 or P0990
P1011	Intake Camshaft Actuator Park Position Bank 1	ECM	DTC P1011-P1014
P1012	Exhaust Camshaft Actuator Park Position Bank 1	ECM	DTC P1011-P1014
P1013	Intake Camshaft Actuator Park Position Bank 2	ECM	DTC P1011-P1014
P1014	Exhaust Camshaft Actuator Park Position Bank 2	ECM	DTC P1011-P1014

P1101	Intake Air Flow System Performance	ECM	DTC P0101 or P1101
P1133	HO2S Insufficient Switching Bank 1 Sensor 1	ECM	DTC P0133, P0134, P0140, P1133, P2270, or P2271
P1153	HO2S Insufficient Switching Bank 2 Sensor 1	ECM	DTC P0153, P0154, P0160, P1153, P2272, or P2273
P1174	Fuel Trim Cylinder Balance Bank 1	ECM	DTC P1174 or P1175
P1175	Fuel Trim Cylinder Balance Bank 2	ECM	DTC P1174 or P1175
P1258	Engine Coolant Over Temperature - Protection Mode Active	ECM	DTC P1258
P1380	Misfire Detected - Rough Road Data Not Available	ECM	DTC P1380 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P1380 or P1381 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P1381	Misfire Detected - No Communication with Brake Control Module	ECM	DTC P1380 or P1381
P1400	Cold Start Emission Reduction Control System	ECM	DTC P1400
P1516	Throttle Actuator Control (TAC) Module Throttle Actuator Position Performance	ECM	DTC P1516, P2101, P2119, or P2176
P1551	Throttle Control Lower Position not Reached during Learning Mode	ECM	DTC P1551
P1631	Theft Deterrent Fuel Enable Signal Not Correct	ECM	DTC P1631
P1668	Generator L-Terminal Control Circuit	ECM	DTC P1668, P2500, or P2501
P167D	Control Module Ignition Coil Internal Circuit	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610
P1682	Ignition 1 Switch Circuit 2	ECM	DTC P1682
P1751	Shift Valve 1 Performance	TCM	DTC P1751
P1761	Up and Down Shift Switch Signal Circuit	TCM	DTC P1761
P1793	Wheel Speed Signal	TCM	DTC P1793
P1810	Transmission Fluid Pressure (TFP) Position Switch Circuit	TCM	DTC P1810
P1815	Transmission Fluid Pressure (TFP) Valve Position Switch -	TCM	DTC P1815 for the 4L60-E/4L65-E/4L70-E transmission or

	Start in Wrong Range		DTC P1815 for the 5L40-E/5L50-E transmission
P1816	Transmission Fluid Pressure (TFP) Valve Position Switch Indicates Park/Neutral (P/N) with Drive Ratio	TCM	DTC P1816
P1818	Transmission Fluid Pressure (TFP) Valve Position Switch Indicates Drive without Drive Ratio	TCM	DTC P1818
P1820	Internal Mode Switch A Circuit Low Voltage	TCM	DTC P1820
P1822	Internal Mode Switch B Circuit High Voltage	TCM	DTC P1822
P1823	Internal Mode Switch P Circuit Low Voltage	TCM	DTC P1823
P1825	Internal Mode Switch - Invalid Range	TCM	DTC P1825 or P1915
P1826	Internal Mode Switch C Circuit High Voltage	TCM	DTC P1826
P182E	Internal Mode Switch - Invalid Range	TCM	DTC P182E or P1915
P1831	Pressure Control (PC)/Shift Lock Solenoid Control Circuit Low Voltage	TCM	DTC P1831 for the 5L40-E/5L50-E transmission
P1832	Pressure Control (PC)/Shift Lock Solenoid Control Circuit High Voltage	TCM	DTC P1832 for the 5L40-E/5L50-E transmission
P1833	Torque Converter Clutch (TCC)/Shift Solenoid (SS) Control Circuit Low Voltage	TCM	DTC P1833
P1834	Torque Converter Clutch (TCC)/Shift Solenoid (SS) Control Circuit High Voltage	TCM	DTC P1834
P1876	Up and Down Shift Switch Performance - Range Switch Not in D3	TCM	DTC P1876 for the 5L40-E/5L50-E transmission or DTC P1876 for the 6L50/6L80/6L90 transmission
P1915	Internal Mode Switch Does Not Indicate Park/Neutral (P/N) During Start	TCM	DTC P1825 or P1915 for the 5L40-E/5L50-E transmission
	Internal Mode Switch Start/Wrong Range		DTC P182E or P1915 for the 6L50/6L80/6L90 transmission
P2066	Fuel Level Sensor 2 Performance	ECM	DTC P2066

P2067	Fuel Level Sensor 2 Low Voltage	ECM	DTC P2067
P2068	Fuel Level Sensor 2 High Voltage	ECM	DTC P2068
P2072	Throttle Actuator Control System - Ice Blockage	ECM	DTC P2072
P2088	Intake Camshaft Position Control Solenoid Circuit Low Voltage Bank 1	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2089	Intake Camshaft Position Control Solenoid Circuit High Voltage Bank 1	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2090	Exhaust Camshaft Position Control Solenoid Circuit Low Voltage Bank 1	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2091	Exhaust Camshaft Position Control Solenoid Circuit High Voltage Bank 1	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2092	Intake Camshaft Position Control Solenoid Circuit Low Voltage Bank 2	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2093	Intake Camshaft Position Control Solenoid Circuit High Voltage Bank 2	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2094	Exhaust Camshaft Position Control Solenoid Circuit Low Voltage Bank 2	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2095	Exhaust Camshaft Position Control Solenoid Circuit High Voltage Bank 2	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2096	Post Catalyst O2 Sensor Fuel Trim Below Lower Limit Bank 1	ECM	DTC P2096 or P2098
P2097	Post Catalyst O2 Sensor Fuel Trim Above Upper Limit Bank 1	ECM	DTC P2097 or P2099
P2098	Post Catalyst O2 Sensor Fuel Trim Below Lower Limit Bank 2	ECM	DTC P2096 or P2098
P2099	Post Catalyst O2 Sensor Fuel Trim Above Upper Limit Bank 2	ECM	DTC P2097 or P2099
P2100	Throttle Control Motor Malfunction	ECM	DTC P0638, P2100, P2101, or P2119
P2101	Throttle Control Position Range/Performance	ECM	DTC P0638, P2100, P2101, or P2119 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Throttle Actuator Position Performance		DTC P1516, P2101, P2119, or P2176 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2105	Throttle Control Forced Engine Shutdown	ECM	DTC P2105

P2119	Closed Throttle Position Range/Performance	ECM	DTC P0638, P2100, P2101, or P2119 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Throttle Closed Position Performance		DTC P1516, P2101, P2119, or P2176 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2120	Accelerator Pedal Position Sensor 1 Circuit	ECM	DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138
P2122	Accelerator Pedal Position Sensor 1 Low Voltage	ECM	DTC P2122, P2123, P2127, P2128, or P2138 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2123	Accelerator Pedal Position Sensor 1 High Voltage	ECM	DTC P2122, P2123, P2127, P2128, or P2138 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2125	Accelerator Pedal Position Sensor 2 Circuit	ECM	DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138
P2127	Accelerator Pedal Position Sensor 2Low Voltage	ECM	DTC P2122, P2123, P2127, P2128, or P2138 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2128	Accelerator Pedal Position Sensor 2 High Voltage	ECM	DTC P2122, P2123, P2127, P2128, or P2138 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
	Throttle Position Sensor 1-2		DTC P0120, P0122, P0123, P0220,

P2135	Correlation	ECM	P0222, P0223, or P2135
P2138	Accelerator Pedal Position Sensor 1-2 Correlation	ECM	DTC P2122, P2123, P2127, P2128, or P2138 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2176	Throttle Actuator Control Lower Position Not Learned	ECM	DTC P2176 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Minimum Throttle Position Not Learned		DTC P1516, P2101, P2119, or P2176 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2177	Fuel Trim Lean during Cruising/Acceleration Bank 1	ECM	DTC P2177, P2179, P2187, or P2189
P2178	Fuel Trim Rich during Cruising/Acceleration Bank 1	ECM	DTC P2178, P2180, P2188, or P2190
P2179	Fuel Trim Lean during Cruising/Acceleration Bank 2	ECM	DTC P2177, P2179, P2187, or P2189
P2180	Fuel Trim Rich during Cruising/Acceleration Bank 2	ECM	DTC P2178, P2180, P2188, or P2190
P2187	Fuel Trim Lean during Idling/Deceleration Bank 1	ECM	DTC P2177, P2179, P2187, or P2189
P2188	Fuel Trim Rich during Idling/Deceleration Bank 1	ECM	DTC P2178, P2180, P2188, or P2190
P2189	Fuel Trim Lean during Idling/Deceleration Bank 2	ECM	DTC P2177, P2179, P2187, or P2189
P2190	Fuel Trim Rich during Idling/Deceleration Bank 2	ECM	DTC P2178, P2180, P2188, or P2190
P2227	Barometric Pressure Sensor Range/Performance	ECM	DTC P2227, P2228, or P2229
P2228	Barometric Pressure Sensor Voltage Low	ECM	DTC P2227, P2228, or P2229
P2229	Barometric Pressure Sensor Voltage High	ECM	DTC P2227, P2228, or P2229
P2232	HO2S Signal Circuit Shorted to Heater Circuit Bank 1 Sensor 2	ECM	DTC P2232 or P2235
P2235	HO2S Signal Circuit Shorted to Heater Circuit Bank 2 Sensor 2	ECM	DTC P2232 or P2235
P2270	O2 Sensor Lean/Rich Switch Signal Malfunction Bank 1 Sensor 2	ECM	DTC P2270 or P2272 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Signal Stuck Lean Bank 1 Sensor 2		DTC P0133, P0134, P0140, P1133, P2270, or P2271 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine

P2271	O2 Sensor Rich/Lean Switch Signal Malfunction Bank 1 Sensor 2	ECM	DTC P2271 or P2273 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Signal Stuck Rich Bank 1 Sensor 2		DTC P0133, P0134, P0140, P1133, P2270, or P2271 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2272	O2 Sensor Lean/Rich Switch Signal Malfunction Bank 2 Sensor 2	ECM	DTC P2270 or P2272 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Signal Stuck Lean Bank 2 Sensor 2		DTC P0153, P0154, P0160, P1153, P2272, or P2273 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2273	O2 Sensor Rich/Lean Switch Signal Malfunction Bank 2 Sensor 2	ECM	DTC P2271 or P2273 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Signal Stuck Rich Bank 2 Sensor 2		DTC P0153, P0154, P0160, P1153, P2272, or P2273 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2300	Ignition Coil Cylinder 1 Circuit Low Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2301	Ignition Coil Cylinder 1 Circuit High Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2303	Ignition Coil Cylinder 2 Circuit Low Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2304	Ignition Coil Cylinder 2 Circuit High Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2306	Ignition Coil Cylinder 3 Circuit Low Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2307	Ignition Coil Cylinder 3 Circuit High Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2309	Ignition Coil Cylinder 4 Circuit Low Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2310	Ignition Coil Cylinder 4 Circuit High Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316

P2312	Ignition Coil Cylinder 5 Circuit Low Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2313	Ignition Coil Cylinder 5 Circuit High Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2315	Ignition Coil Cylinder 6 Circuit Low Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2316	Ignition Coil Cylinder 6 Circuit High Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2500	Generator L-Terminal Circuit Low Voltage	ECM	DTC P1668, P2500, or P2501
P2501	Generator L-Terminal Circuit High Voltage	ECM	DTC P1668, P2500, or P2501
P250A	Engine Oil Level Sensor Circuit	ECM	DTC P250A
P2534	Ignition 1 Switch Circuit Low Voltage	TCM	• DTC P2534 for the 4L60-E/4L65-E/4L70-E transmission • DTC P2534 for the 5L40-E/5L50-E transmission • DTC P2534 for the 6L50/6L80/6L90 transmission
P2544	Transmission Torque Request Circuit	ECM	DTC P2544 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P2544 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
		TCM	DTC P2544 for the 5L40-E/5L50-E transmission
P2610	Control Module Ignition Off Timer Performance	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2636	Fuel Transfer Pump Flow Insufficient	ECM	DTC P2636
	Transmission Torque Delivered		

P2637	Circuit	TCM	DTC P2637
P2670	Solenoid High Control Circuit Group 2 Low Voltage	TCM	DTC P2670 or P2671
P2671	Solenoid High Control Circuit Group 2 High Voltage	TCM	DTC P2670 or P2671
P2714	Clutch Pressure Control (PC) Solenoid 4 - Stuck Off	TCM	DTC P2714 or P2715
P2715	Clutch Pressure Control (PC) Solenoid 4 - Stuck On	TCM	DTC P2714 or P2715
P2719	Clutch Pressure Control (PC) Solenoid 4 System Performance	TCM	DTC P2719-P2721
P2720	Clutch Pressure Control (PC) Solenoid 4 Control Circuit Low Voltage	TCM	DTC P2719-P2721
P2721	Clutch Pressure Control (PC) Solenoid 4 Control Circuit High Voltage	TCM	DTC P2719-P2721
P2723	Clutch Pressure Control (PC) Solenoid 5 - Stuck Off	TCM	DTC P2723 or P2724
P2724	Clutch Pressure Control (PC) Solenoid 5 - Stuck On	TCM	DTC P2723 or P2724
P2728	Clutch Pressure Control (PC) Solenoid 5 System Performance	TCM	DTC P2728-P2730
P2729	Clutch Pressure Control (PC) Solenoid 5 Control Circuit Low Voltage	TCM	DTC P2728-P2730
P2730	Clutch Pressure Control (PC) Solenoid 5 Control Circuit High Voltage	TCM	DTC P2728-P2730
P2762	Torque Converter Clutch (TCC) Pressure Control Solenoid System Performance	TCM	DTC P2762, P2763, or P2764
P2763	Torque Converter Clutch (TCC) Pressure Control (PC) Solenoid Control Circuit High Voltage	TCM	DTC P2763 for the 4L60-E/4L65-E/4L70-E transmission or DTC P2763 for the 5L40-E/5L50-E transmission
	Torque Converter Clutch (TCC) Pressure Control Solenoid Control Circuit Low Voltage		DTC P2762, P2763, or P2764 for the 6L50/6L80/6L90 transmission
	Torque Converter Clutch (TCC) Pressure Control (PC) Solenoid Control Circuit Low Voltage		DTC P2764 for the 4L60-E/4L65-E/4L70-E transmission or

P2764		TCM	DTC P2764 for the 5L40-E/5L50-E transmission
	Torque Converter Clutch (TCC) Pressure Control Solenoid Control Circuit High Voltage		DTC P2762, P2763, or P2764 for the 6L50/6L80/6L90 transmission
P2769	Torque Converter Clutch (TCC) Enable Solenoid Control Circuit Low Voltage	TCM	DTC P2769
P2770	Torque Converter Clutch (TCC) Enable Solenoid Control Circuit High Voltage	TCM	DTC P2770
P3400	Cylinder Deactivation System Performance	ECM	DTC P3400
P3401	Cylinder 1 Deactivation Solenoid Control Circuit	ECM	DTC P3401, P3425, P3441, or P3449
P3425	Cylinder 4 Deactivation Solenoid Control Circuit	ECM	DTC P3401, P3425, P3441, or P3449
P3441	Cylinder 6 Deactivation Solenoid Control Circuit	ECM	DTC P3401, P3425, P3441, or P3449
P3449	Cylinder 7 Deactivation Solenoid Control Circuit	ECM	DTC P3401, P3425, P3441, or P3449
U0073	High Speed Communication Bus	--	DTC U0073
U0100 - U0249	CAN-Bus No Communication with XXX Control Module	--	DTC U0100-U0249
U1304	CAN-Bus No Communication with SIM (Seat Interface Module)	SIM	DTC U1304
U1401	No Communication with MSM (Memory Seat and Mirror Module)	SIM	DTC U1401
	Lost Communications Between AD and ADG	NIM	DTC U1401
U1814	Powertrain High Speed Communication Enable Circuit	BCM	DTC U1814
U2099	High Speed Communication Enable Circuit	BCM	DTC U2099
U2100	CAN-Bus Circuit Malfunction	--	DTC U2100
U2121	No Communication with Radio Display	Radio	DTC U2121
U2136	No Exterior Mirror Communication	MSM	DTC U2136
U2201	No Communication With DVD Player	RSE	DTC U2201
U2202	No Communication With Rear Control Panel	RSE	DTC U2202

U2203	No Communication With Screen 1	RSE	DTC U2203 or U2204
U2204	No Communication With Screen 2	RSE	DTC U2203 or U2204

Road Test Caution

Caution: Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.

Valve Springs Can Be Tightly Compressed Caution

Caution: Valve springs can be tightly compressed. Use care when removing retainers and plugs. Personal injury could result.

Torque Reaction Against Timing Drive Chain Notice

Notice: A wrench must be used on the hex of the camshaft when loosening or tightening in order to prevent component damage. Failure to prevent the torque reaction against the timing drive chain can lead to timing drive chain failure.

Window Edge Damage Notice

Notice: Avoid damage to the window from impacting objects due to an exposed edge. The window must be 1 mm (0.025 in) below the surface of the sheet metal to avoid window damage.

Relieving Fuel Pressure Caution

Caution: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

Gasoline / Gasoline Vapors Caution

Caution: Gasoline or gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.

Fuel Pipe Fitting Caution

Caution: Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings in order to reduce the risk of fire and personal injury. This will ensure proper reconnection and prevent a possible fuel leak. During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.

Safety Glasses and Compressed Air Caution

Caution: Wear safety glasses when using compressed air in order to prevent eye injury.

Fuel Gage Leak Caution

Caution: Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gage. Place the towel in an approved container when the connection of the fuel pressure gage is complete.

Fuel Storage Caution

Caution: Do not drain the fuel into an open container. Never store the fuel in an open container due to the possibility of a fire or an explosion.

Moving Parts and Hot Surfaces Caution

Caution: Avoid contact with moving parts and hot surfaces while working around a running engine in order to prevent physical injury.

Fuel and Evaporative Emission Pipe Caution

Caution: In order to reduce the risk of fire and personal injury observe the following items:

- Replace all nylon fuel pipes that are nicked, scratched or damaged during installation, do not attempt to repair the sections of the nylon fuel pipes
- Do not hammer directly on the fuel harness body clips when installing new fuel pipes. Damage to the nylon pipes may result in a fuel leak.
- Always cover nylon vapor pipes with a wet towel before using a torch near them. Also, never expose the vehicle to temperatures higher than 115°C (239°F) for more than one hour, or more than 90°C (194°F) for any extended period.
- Apply a few drops of clean engine oil to the male pipe ends before connecting fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. (During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.)

Safety Goggles and Fuel Caution

Caution: Always wear safety goggles when working with fuel in order to protect the eyes from fuel splash.

Fuel Pressure Notice

Notice: Do not allow the fuel pressure to exceed the specified value because damage to the fuel pressure regulator or the fuel pressure gage may result.

Powertrain Control Module and Electrostatic Discharge Notice

Notice: Do not touch the connector pins or soldered components on the circuit board in order to prevent possible electrostatic discharge (ESD) damage to the PCM.

OBDII Symbol Description Notice

Notice: The OBD II symbol is used on the circuit diagrams in order to alert the technician that the circuit is essential for proper OBD II emission control circuit operation. Any circuit which fails and causes the malfunction indicator lamp (MIL) to turn ON, or causes emissions-related component damage, is identified as an OBD II circuit.

ABS Component Handling Caution

Caution: Certain components in the Antilock Brake System (ABS) are not intended to be serviced individually. Attempting to remove or disconnect certain system components may result in personal injury and/or improper system operation. Only those components with approved removal and installation procedures should be serviced.

Definition of Caution, Notice, and Important

The diagnosis and repair procedures in a GM Service Manual contain both general and specific Cautions, Notices, and Importants. GM is dedicated to the presentation of service information that helps the technician to diagnose and repair the systems necessary for the proper operation of the vehicle, however, certain procedures may present a hazard to the technician if they are not followed in the recommended manner . Cautions, Notices, and Importants are elements designed to prevent these hazards, however, not all hazards can be foreseen. This information is placed at strategic locations within the service manual. This information is designed to prevent the following from occurring:

- Serious bodily injury or death to the technician
- Damage to the vehicle
- Unnecessary vehicle repairs
- Unnecessary component replacement
- Improper repair or replacement of vehicle components.
- Any caution or notice that appears in this service category is referenced from the individual service categories.

CAUTION Defined

When encountering a CAUTION, you will be asked to take a necessary action or not to take a prohibited action. If a CAUTION is not heeded, the following consequences may occur:

- Serious bodily injury or death to the technician
- Serious bodily injury or death to other technicians in the workplace area
- Serious bodily injury to the driver and/or passenger(s) of the vehicle, if the vehicle has been improperly repaired

NOTICE Defined

Notices call special attention to a necessary action or to a prohibited action. If a NOTICE is not heeded, the following consequences may occur:

- Damage to the vehicle
- Unnecessary vehicle repairs
- Unnecessary component replacement
- Improper operation or performance of the system or component under repair
- Damage to any systems or components which are dependent upon the proper operation of the system or component under repair
- Improper operation or performance of any systems or components which are dependent upon the proper operation or performance of the system or component under repair
- Damage to fasteners, basic tools, or special tools
- The leakage of coolant, lubricant, or other vital fluids

IMPORTANT Defined

IMPORTANT statements emphasize a necessary characteristic of a diagnostic or repair procedure. IMPORTANT statements are designed to do the following:

- Clarify a procedure
- Present additional information for accomplishing a procedure
- Give insight into the reason or reasons for performing a procedure in the manner recommended
- Present information that will help to accomplish a procedure in a more effective manner
- Present information that gives the technician the benefit of past experience in accomplishing a procedure with greater ease

Lower O-Ring Removal Caution

Caution: Verify that the lower (small) O-ring of each injector does not remain in the lower manifold in order to reduce the risk of fire and personal injury.

If the O-ring is not removed with the injector, the replacement injector with new O-rings will not seat properly in the injector socket. Improper seating could cause a fuel leak.

Ignition OFF When Disconnecting Battery Notice

Notice: Always turn the ignition OFF when connecting or disconnecting battery cables, battery chargers, or jumper cables. Failing to do so may damage the Powertrain Control Module (PCM) or other electronic components.

Single Cylinder Flooding Notice

Notice: In order to prevent flooding of a single cylinder and possible engine damage, relieve the fuel pressure before performing the fuel injector coil test procedure.

Adding Fluid to the Brake System Notice (Up to BSI)

Notice: When adding fluid to the brake master cylinder reservoir, use only Holden specification number HN 1796 (Super DOT 4/DOT 4 Plus) brake fluid from a clean, sealed brake fluid container. The use of any type of fluid other than the recommended type of brake fluid may cause contamination which may result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

Vehicle Lifting Caution

Caution: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Brake Dust Caution

Caution: Avoid taking the following actions when you service wheel brake parts:

- Do not grind brake linings.
- Do not sand brake linings.
- Do not clean wheel brake parts with a dry brush or with compressed air.

Some models or aftermarket brake parts may contain fibres which can become airborne in dust. Breathing dust with fibres may cause serious bodily harm. Use a water-dampened cloth in order to remove any dust on brake parts. Equipment is available commercially in order to perform this washing function. These wet methods prevent fibres from becoming airborne.

Brake Fluid Caution (Up to BSI)

Caution: Use only Heavy duty brake fluid conforming to Holden specification number HN 1796 (Super DOT 4/DOT 4 Plus), from a clean, sealed container. This polyglycol brake fluid is hygroscopic and absorbs moisture. Do not use fluid from an open container that may be contaminated with water. Improper or contaminated fluid could result in system failure, loss of vehicle control, and possible injury.

Clutch Dust Caution

Caution: When servicing clutch parts, do not create dust by grinding or sanding the clutch disc or by cleaning parts with a dry brush or with compressed air. A water-dampened cloth--NOT SOAKED--should be used. The clutch disc may contain fibres which can become airborne if dust is created during servicing. Breathing dust with fibres may cause serious bodily harm.

Differential Case Removal Caution

Caution: To prevent personal injury and/or component damage, support the differential case when removing the case from the rear subframe. If the case is not supported, the differential case could fall and cause personal injury or damage to the differential case.

Window Retention Caution

Caution: When replacing stationary windows, use a Urethane Adhesive System meeting Holden Specification Holden3651G, to maintain original installation integrity. Failure to use the urethane adhesive kit of the correct specification will result in poor retention of the window which may allow unrestrained occupants to be ejected from the vehicle resulting in personal injury.

Nylon Pipes Notice

Notice: Do not attempt to straighten any kinked nylon fuel lines. Replace any kinked nylon fuel feed or return pipes in order to prevent damage to the vehicle.

Service Programming System (SPS) Notice

Notice: Before programming a control module, the following must be observed, or control module damage may occur:

- The scan tool and the terminal must have the latest software.
- The vehicle battery must be fully charged. The battery voltage should be between 12-14 volts.
- The scan tool and the terminal cable connections must be secure.
- A battery charger must NOT be connected to the battery when programming a control module.

Test Probe Notice

Notice: Do not insert test equipment probes (DVOM etc.) into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal will cause a poor connection, which will result in a system failure. Always use the J-35616-C Holden-Approved Terminal Test Kit or the J 42675 Flat-Wire Probe Adapter in order to front probe terminals. Do not use paper clips or other substitutes to probe terminals.

When using the J-35616-C Holden-Approved Terminal Test Kit, ensure the terminal test adapter choice is the correct size for the connector terminal. Do not visually choose the terminal test adapter because some connector terminal cavities may appear larger than the actual terminal in the cavity. Using a larger terminal test adapter will damage the terminal. Refer to the J-35616-C Holden-Approved Terminal Test Kit label on the inside of the J-35616-C Holden-Approved Terminal Test Kit for the correct adapter along with the connector end view for terminal size.

Adding Fluid to the Brake System Notice (As of BSI)

Notice: When adding fluid to the brake master cylinder reservoir, use only brake fluid conforming to SAE J1704 from a clean, sealed brake fluid container. The use of any type of fluid other than the recommended type of brake fluid may cause contamination which may result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

Brake Fluid Caution (As of BSI)

Caution: Use only heavy duty brake fluid conforming to SAE 1704, from a clean, sealed container. This polyglycol brake fluid is hydroscopic and absorbs moisture. Do not use fluid from an open container that may be contaminated with water. Incorrect or contaminated fluid could result in system failure, loss of vehicle control and personal injury.

Emission Modification Notice

Notice: Modifications made to the following can affect the vehicle's emission controls and may cause the Malfunction Indicator Lamp (MIL), Check Engine or Service Engine Soon lamp to illuminate:

- The engine
- The transmission
- The exhaust
- The fuel system

Replacement tires that do not meet the same Tire Performance Criteria (TPC) of the original tires can also affect the vehicle's emission controls. This may also cause the Malfunction Indicator Lamp (MIL), Check Engine or Service Engine Soon lamp to illuminate.

Modifications to these systems or the installation of incorrect TPC tires could lead to repairs that are not covered by the manufacturer's warranty. This may also cause a required Emission Inspection/Maintenance test to fail.

Halogen Bulb Caution

Caution: Halogen bulbs contain gas under pressure. Handling a bulb improperly could cause it to shatter into flying glass fragments. To help avoid personal injury:

- Turn off the lamp switch and allow the bulb to cool before changing the bulb.
- Leave the lamp switch OFF until the bulb change is complete.
- Always wear eye protection when changing a halogen bulb.
- Handle the bulb only by its base. Avoid touching the glass.
- Keep dirt and moisture off the bulb.
- Properly dispose of the used bulb.
- Keep halogen bulbs out of the reach of children.

Component Fastener Tightening Notice

Notice: Replacement components must be the correct part number for the application. Components requiring the use of the thread locking compound, lubricants, corrosion inhibitors, or sealants are identified in the service procedure. Some replacement components may come with these coatings already applied. Do not use these coatings on components unless specified. These coatings can affect the final torque, which may affect the operation of the component. Use the correct torque specification when installing components in order to avoid damage.

Express Window Down Caution

Caution: Disconnect the power window switch when working inside the driver door. When operated, the Express Up/Down Feature allows the door window to move very quickly, without stopping, which could cause personal injury.

Engine Emission Notice

Notice: Modifications made to the engine or its individual components can effect the vehicle's emission controls and may cause the Malfunction Indicator Lamp (MIL), Check Engine, or Service Engine Soon lamp to illuminate. Modifications may also cause the vehicle to fail a required Emission Inspection/Maintenance test.

Batteries Produce Explosive Gases Caution

Caution: Batteries produce explosive gases. Batteries contain corrosive acid. Batteries supply levels of electrical current high enough to cause burns. Therefore, in order to reduce the risk of personal injury while working near a battery, observe the following guidelines:

- Always shield your eyes.
- Avoid leaning over the battery whenever possible.
- Do not expose the battery to open flames or sparks.
- Do not allow battery acid to contact the eyes or the skin.
  - Flush any contacted areas with water immediately and thoroughly.
  - Get medical help.

Brake Pipe Replacement Caution

Caution: Always use double-walled steel brake pipe when replacing brake pipes. The use of any other pipe is not recommended and may cause brake system failure. Carefully route and retain replacement brake pipes. Always use the correct fasteners and in the original location for replacement brake pipes. Failure to properly route and retain brake pipes may cause damage to the brake pipes and brake system resulting in personal injury.

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Fuel Tank Strap Fastener Notice

Notice: Tighten the strap fasteners by steps, alternating between the fasteners, until the specified torque is reached. A failure to tighten the strap fasteners as specified will cause the bottom of the tank to flex upward. This will result in the fuel gauge indicating that there is fuel remaining in the tank when the tank is empty.

Brake Fluid Irritant Caution

Caution: Brake fluid may be irritating to the skin or eyes. In case of contact, take the following actions:

- Eye contact--rinse eyes thoroughly with water.
- Skin contact--wash skin with soap and water.

Power Steering Hose Disconnected Notice

Notice: Do not start the vehicle with any power steering gear inlet or outlet hoses disconnected. When disconnected, plug or cap all openings of components. Failure to do so could result in contamination or loss of power steering fluid and damage to the system.

Belt Dressing Notice

Notice: Do not use belt dressing on the drive belt. Belt dressing causes the breakdown of the composition of the drive belt. Failure to follow this recommendation will damage the drive belt.

Installing Hoses without Twists or Bends Notice

Notice: The inlet and outlet hoses must not be twisted during installation. Do not bend or distort the inlet or outlet hoses to make installation easier. Failure to follow these procedures could result in component damage.

Using Proper Power Steering Fluid Notice

Notice: When adding fluid or making a complete fluid change, always use the proper power steering fluid. Failure to use the proper fluid will cause hose and seal damage and fluid leaks.

Fuel Vapors in Evaporative Emission Components Caution

Caution: Do not breathe the air through the EVAP component tubes or hoses. The fuel vapors inside the EVAP components may cause personal injury.

Heated Oxygen and Oxygen Sensor Notice

Notice: Do not remove the pigtail from either the heated oxygen sensor (HO2S) or the oxygen sensor (O2S). Removing the pigtail or the connector will affect sensor operation.

Handle the oxygen sensor carefully. Do not drop the HO2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Do not use cleaning solvents of any type.

Do not repair the wiring, connector or terminals. Replace the oxygen sensor if the pigtail wiring, connector, or terminal is damaged.

This external clean air reference is obtained by way of the oxygen sensor signal and heater wires. Any attempt to repair the wires, connectors, or terminals could result in the obstruction of the air reference and degraded sensor performance.

The following guidelines should be used when servicing the heated oxygen sensor:

- Do not apply contact cleaner or other materials to the sensor or vehicle harness connectors. These materials may get into the sensor causing poor performance.
- Do not damage the sensor pigtail and harness wires in such a way that the wires inside are exposed. This could provide a path for foreign materials to enter the sensor and cause performance problems.
- Ensure the sensor or vehicle lead wires are not bent sharply or kinked. Sharp bends or kinks could block the reference air path through the lead wire.
- Do not remove or defeat the oxygen sensor ground wire, where applicable. Vehicles that utilize the ground wired sensor may rely on this ground as the only ground contact to the sensor. Removal of the ground wire will cause poor engine performance.
- Ensure that the peripheral seal remains intact on the vehicle harness connector in order to prevent damage due to water intrusion. The engine harness may be repaired using Packard's Crimp and Splice Seals Terminal Repair Kit. Under no circumstances should repairs be soldered since this could result in the air reference being obstructed.

Anti-Corrosion Materials Notice

Notice: Anti-corrosion compounds have been applied to the interior surfaces of some metal panels to provide rust resistance. When servicing these panels in areas on which this material has been disturbed, or when installing new panels, avoid corrosion damage by coating with anti-corrosion compound.

Breathing R-134a Caution

Caution: Avoid breathing the A/C Refrigerant 134a (R-134a) and the lubricant vapor or the mist. Exposure may irritate the eyes, nose, and throat. Work in a well ventilated area. In order to remove R-134a from the A/C system, use service equipment that is certified to meet the requirements of SAE J 2210 (R-134a recycling equipment). If an accidental system discharge occurs, ventilate the work area before continuing service. Additional health and safety information may be obtained from the refrigerant and lubricant manufacturers.

Radiator Cap Removal Caution

Caution: To avoid being burned, do not remove the radiator cap or surge tank cap while the engine is hot. The cooling system will release scalding fluid and steam under pressure if radiator cap or surge tank cap is removed while the engine and radiator are still hot.

Silicon Contamination of Heated Oxygen Sensors Notice

Notice: Contamination of the oxygen sensor can result from the use of an inappropriate RTV sealant (not oxygen sensor safe) or excessive engine coolant or oil consumption. Remove the HO2S and visually inspect the portion of the sensor exposed to the exhaust stream in order to check for contamination. If contaminated, the portion of the sensor exposed to the exhaust stream will have a white powdery coating. Silicon contamination causes a high but false HO2S signal voltage (rich exhaust indication). The control module will then reduce the amount of fuel delivered to the engine, causing a severe driveability problem. Eliminate the source of contamination before replacing the oxygen sensor.

Handling Electrostatic Discharge Sensitive Parts Notice

Notice: Electrostatic discharge (ESD) can damage many solid-state electrical components. ESD susceptible components may or may not be labeled with the ESD symbol. Handle all electrical components carefully. Use the following precautions in order to avoid ESD damage:

- Touch a metal ground point in order to remove your body's static charge before servicing any electronic component; especially after sliding across the vehicle seat.
- Do not touch exposed terminals. Terminals may connect to circuits susceptible the ESD damage.
- Do not allow tools to contact exposed terminals when servicing connectors.
- Do not remove components from their protective packaging until required to do so.
- Avoid the following actions unless required by the diagnostic procedure:
  - Jumpering or grounding of the components or connectors.
  - Connecting test equipment probes to components or connectors. Connect the ground lead first when using test probes.
- Ground the protective packaging of any component before opening. Do not rest solid-state components on metal workbenches, or on top of TVs, radios, or other electrical devices.

Steering Wheel in the Full Turn Position Notice

Notice: Do not hold the steering wheel in the full turn position longer than 5 seconds, as damage to the steering pump may result.

Engine Lifting Notice

Notice: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or the crankshaft pulley. Lifting the engine in an unapproved manner may cause component damage.

Engine Mounting Notice

Notice: Broken engine mountings can cause misalignment of certain drive-train components. Misalignment of drive-train components causes eventual destruction of the drive-train components.

If one engine mount breaks, the rest of the engine mounts will have increased stress put on them. This could cause the rest of the engine mounts to break.

Damage to Fuel Tank Straps Notice

Notice: Do not bend the fuel tank straps. Bending the fuel tank straps may damage the straps.

Exterior Trim Emblem Removal Notice

Notice: Use a plastic, flat-bladed tool to prevent paint damage when removing an emblem/name plate.

Hot Exhaust System Caution

Caution: While engine is operating, the exhaust system will become extremely hot. To prevent burns avoid contacting a hot exhaust system.

Brake Fluid Effects on Paint and Electrical Components Notice

Notice: Avoid spilling brake fluid onto painted surfaces, electrical connections, wiring, or cables. Brake fluid will damage painted surfaces and cause corrosion to electrical components. If any brake fluid comes in contact with painted surfaces, immediately flush the area with water. If any brake fluid comes in contact with electrical connections, wiring, or cables, use a clean shop cloth to wipe away the fluid.

Fuel Rail Stop Bracket Installation Caution

Caution: The fuel rail stop bracket must be installed onto the engine assembly. The stop bracket serves as a protective shield for the fuel rail in the event of a vehicle frontal crash. If the fuel rail stop bracket is not installed and the vehicle is involved in a frontal crash, fuel could be sprayed possibly causing a fire and personal injury from burns.

Safety Glasses Caution

Caution: Wear safety glasses in order to avoid eye damage.

Excessive Force and Oxygen Sensor Notice

Notice: The oxygen sensor may be difficult to remove when the engine temperature is below 48°C (120°F). Excessive force may damage threads in the exhaust manifold or the exhaust pipe.

Liftgate Assist Rod Notice

Notice: Apply pressure only at the end of the liftgate/hood assist rod that you are removing or attaching. Do NOT apply pressure to the middle of the rod because damage or bending will result.

Fuel Injector Balance Test Notice

Notice: Do Not repeat any portion of this test before running the engine in order to prevent the engine from flooding.

Exhaust Service Caution

Caution: In order to avoid being burned, do not service the exhaust system while it is still hot. Service the system when it is cool.

Exhaust System Inspection Notice

Notice: When inspecting or replacing exhaust system components, make sure there is adequate clearance from all points on the underbody to prevent overheating of the floor pan and possible damage to the passenger compartment insulation and trim materials.

Pinion Flange / Yoke Installation Notice

Notice: Do not hammer the pinion flange/yoke onto the pinion shaft. Pinion components may be damaged if the pinion flange/yoke is hammered onto the pinion shaft.

Machined Surface Damage Notice

Notice: Do not nick, scratch or damage the sealing surface. The sealing surface is a machined surface. Damage to the machined surface can cause leakage.

Protective Goggles and Glove Caution

Caution: Approved safety glasses and gloves should be worn when performing this procedure to reduce the chance of personal injury.

Ring Gear Removal Notice

Notice: Do not pry the ring gear from the differential case. Prying the ring gear from the differential case may cause damage to the ring gear and/or the differential case.

Foam Sound Deadeners Caution

Caution: Foam sound deadeners must be removed from areas within 152.4 mm (6 in) of where flame is to be used for body repairs. When reinstalling foam sound deadeners, avoid inhaling fumes as bodily injury may result.

Assistant Driving Caution

Caution: An assistant should drive the vehicle while the technician checks for the location of the reported condition. Otherwise, personal injury could result.

Eye Protection Caution

Caution: Approved safety glasses and gloves should be worn when performing this procedure to reduce the chance of personal injury.

Clearcoat / Ultraviolet Screeners Notice

Notice: Removing more than 0.5 mils of the clearcoat can result in early paint failure. The clearcoat contains ultraviolet screeners. Do not finesse sand more than what is required to remove the defect.

Sealant Notice

Notice: Do not allow the RTV sealant to enter any blind threaded hole. RTV sealant that is allowed to enter a blind threaded hole can cause hydraulic lock of the fastener when the fastener is tightened. Hydraulic lock of a fastener can lead to damage to the fastener and/or the components. Hydraulic lock of a fastener can also prevent the proper clamping loads to be obtained when the fastener is tightened. Improper clamping loads can prevent proper sealing of the components allowing leakage to occur. Preventing proper fastener tightening can allow the components to loosen or separate leading to extensive engine damage.

Collision Sectioning Caution

Caution: Sectioning should be performed only in the recommended areas. Failure to do so may compromise the structural integrity of the vehicle and cause personal injury if the vehicle is in a collision.

Cracked Window Caution

Caution: If a window is cracked but still intact, crisscross the window with masking tape in order to reduce the risk of damage or personal injury.

Approved Equipment for Collision Repair Caution

Caution: To avoid personal injury when exposed to welding flashes or to galvanized (Zinc Oxide) metal toxic fumes while grinding/cutting on any type of metal or sheet molded compound, you must work in a properly ventilated area, wearing an approved respirator, eye protection , earplugs, welding gloves, and protective clothing.

Propeller Shaft Notice

Notice: The propeller shaft must be supported carefully during handling to avoid jamming or bending of parts.

Valve Lifter Priming Notice

Notice: Ensure each valve lifter is filled with clean engine oil and the valve lifter does not tip over (plunger down) before the installation of the valve lifters. The loss of oil in the valve lifter lower pressure chamber or the dry stroking/cycling of the valve lifter plunger will allow air to travel into the high pressure chamber of the valve lifter. Air in the high pressure chamber of the valve lifter may not be purged causing extensive engine component damage.

Brake Caliper Notice

Notice: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

Avoid Touching the Bulb Notice

Notice: Avoid touching the bulb or letting the bulb come in contact with anything damp. Oil from your skin or moisture on the bulb can cause the bulb to explode when the bulb is turned on. If either comes in contact with the bulb, clean the bulb with alcohol or a suitable degreaser and wipe the bulb dry.

SIR Caution

Caution: When performing service on or near the SIR components or the SIR wiring, the SIR system must be disabled. Refer to SIR Disabling and Enabling . Failure to observe the correct procedure could cause deployment of the SIR components, personal injury, or unnecessary SIR system repairs.

SIR Inflator Module Handling and Storage Caution

Caution: When carrying an undeployed inflator module:

- Do not carry the inflator module by the wires or connector.
- Make sure the air bag opening points away from you.

When storing an undeployed inflator module:

- Make sure the air bag opening points away from the surface on which the inflator module rests.
- Provide free space for the air bag to expand in case of an accidental deployment.
- When storing a steering column, do not rest the column with the air bag opening facing down and the column vertical. Lay the column on its side.

Failure to observe these guidelines may result in personal injury.

Fastener Notice

Notice: Use the correct fastener in the correct location. Replacement fasteners must be the correct part number for that application. Fasteners requiring replacement or fasteners requiring the use of thread locking compound or sealant are identified in the service procedure. Do not use paints, lubricants, or corrosion inhibitors on fasteners or fastener joint surfaces unless specified. These coatings affect fastener torque and joint clamping force and may damage the fastener. Use the correct tightening sequence and specifications when installing fasteners in order to avoid damage to parts and systems.

Battery Disconnect Caution

Caution: Unless directed otherwise, the ignition and start switch must be in the OFF or LOCK position, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.

Glass and Sheet Metal Handling Caution

Caution: When working with any type of glass or sheet metal with exposed or rough edges, wear approved safety glasses and gloves in order to reduce the chance of personal injury.

Approved Equipment for Collision Repair Warning

Warning: To avoid personal injury when exposed to welding flashes or to galvanized (Zinc Oxide) metal toxic fumes while grinding/cutting on any type of metal or sheet molded compound, you must work in a properly ventilated area, wearing an approved respirator, eye protection , earplugs, welding gloves, and protective clothing.

Battery Disconnect Warning

Warning: Unless directed otherwise, the ignition and start switch must be in the OFF or LOCK position, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.

Brake Dust Warning

Warning: Avoid taking the following actions when you service wheel brake parts:

- Do not grind brake linings.
- Do not sand brake linings.
- Do not clean wheel brake parts with a dry brush or with compressed air.

Some models or aftermarket brake parts may contain asbestos fibers which can become airborne in dust. Breathing dust with asbestos fibers may cause serious bodily harm. Use a water-dampened cloth in order to remove any dust on brake parts. Equipment is available commercially in order to perform this washing function. These wet methods prevent fibers from becoming airborne.

Brake Fluid Irritant Warning

Warning: Brake fluid may irritate eyes and skin. In case of contact, take the following actions:

- Eye contact--rinse thoroughly with water.
- Skin contact--wash with soap and water.
- If ingested--consult a physician immediately.

Express Window Down Warning

Warning: Disconnect the power window switch when working inside the driver door. When operated, the Express Up/Down Feature allows the door window to move very quickly, without stopping, which could cause personal injury.

Eye Protection Warning

Warning: Approved safety glasses and gloves should be worn when performing this procedure to reduce the chance of personal injury.

Foam Sound Deadeners Warning

Warning: Foam sound deadeners must be removed from areas within 152.4 mm (6 in) of where flame is to be used for body repairs. When reinstalling foam sound deadeners, avoid inhaling fumes as bodily injury may result.

Gasoline / Gasoline Vapors Warning

Warning: Gasoline or gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.

Glass and Sheet Metal Handling Warning

Warning: When working with any type of glass or sheet metal with exposed or rough edges, wear approved safety glasses and gloves in order to reduce the chance of personal injury.

Halogen Bulb Warning

Warning: Halogen bulbs contain gas under pressure. Handling a bulb improperly could cause it to shatter into flying glass fragments. To help avoid personal injury:

- Turn off the lamp switch and allow the bulb to cool before changing the bulb.
- Leave the lamp switch OFF until the bulb change is complete.
- Always wear eye protection when changing a halogen bulb.
- Handle the bulb only by its base. Avoid touching the glass.
- Keep dirt and moisture off the bulb.
- Properly dispose of the used bulb.
- Keep halogen bulbs out of the reach of children.

Hot Exhaust System Warning

Warning: While engine is operating, the exhaust system will become extremely hot. To prevent burns avoid contacting a hot exhaust system.

Moving Parts and Hot Surfaces Warning

Warning: Avoid contact with moving parts and hot surfaces while working around a running engine in order to prevent physical injury.

Relieving Fuel Pressure Warning

Warning: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

Road Test Warning

Warning: Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.

Safety Glasses Warning

Warning: Wear safety glasses in order to avoid eye damage.

Safety Glasses and Compressed Air Warning

Warning: Wear safety glasses when using compressed air in order to prevent eye injury.

SIR Deployed Inflator Modules Are Hot Warning

Warning: After deployment, the metal surfaces of the SIR component may be very hot. To help avoid a fire or personal injury:

- Allow sufficient time for cooling before touching any metal surface of the SIR component.
- Do not place the deployed SIR component near any flammable objects.

SIR Inflatable Module Deployment Outside Vehicle Warning

Warning: When you are deploying an inflator module for disposal, perform the deployment procedures in the order listed. Failure to follow the procedures in the order listed may result in personal injury.

SIR Inflator Module Disposal Warning

Warning: In order to prevent accidental deployment and the risk of personal injury, do not dispose of an undeployed inflator module as normal shop waste. Undeployed inflator modules contain substances that could cause severe illness or personal injury if their sealed containers are damaged during disposal. Use the following deployment procedures to safely dispose of an undeployed inflator module. Failure to observe the following disposal methods may be a violation of federal, state, or local laws.

Heated Oxygen and Oxygen Sensor Caution

Caution: Do not remove the pigtail from either the heated oxygen sensor (HO2S) or the oxygen sensor (O2S). Removing the pigtail or the connector will affect sensor operation.

Handle the oxygen sensor carefully. Do not drop the HO2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Do not use cleaning solvents of any type.

Do not repair the wiring, connector or terminals. Replace the oxygen sensor if the pigtail wiring, connector, or terminal is damaged.

This external clean air reference is obtained by way of the oxygen sensor signal and heater wires. Any attempt to repair the wires, connectors, or terminals could result in the obstruction of the air reference and degraded sensor performance.

The following guidelines should be used when servicing the heated oxygen sensor:

- Do not apply contact cleaner or other materials to the sensor or vehicle harness connectors. These materials may get into the sensor causing poor performance.
- Do not damage the sensor pigtail and harness wires in such a way that the wires inside are exposed. This could provide a path for foreign materials to enter the sensor and cause performance problems.
- Ensure the sensor or vehicle lead wires are not bent sharply or kinked. Sharp bends or kinks could block the reference air path through the lead wire.
- Do not remove or defeat the oxygen sensor ground wire, where applicable. Vehicles that utilize the ground wired sensor may rely on this ground as the only ground contact to the sensor. Removal of the ground wire will cause poor engine performance.
- Ensure that the peripheral seal remains intact on the vehicle harness connector in order to prevent damage due to water intrusion. The engine harness may be repaired using Packard's Crimp and Splice Seals Terminal Repair Kit. Under no circumstances should repairs be soldered since this could result in the air reference being obstructed.

Heated Oxygen Sensor Resistance Learn Reset Caution

Caution: When replacing the HO2S perform the following:

- A code clear with a scan tool, regardless of whether or not a DTC is set
- HO2S heater resistance learn reset with a scan tool, where available

Perform the above in order to reset the HO2S resistance learned value and avoid possible HO2S failure.

Silicon Contamination of Heated Oxygen Sensors Caution

Caution: Contamination of the oxygen sensor can result from the use of an inappropriate RTV sealant (not oxygen sensor safe) or excessive engine coolant or oil consumption. Remove the HO2S and visually inspect the portion of the sensor exposed to the exhaust stream in order to check for contamination. If contaminated, the portion of the sensor exposed to the exhaust stream will have a white powdery coating. Silicon contamination causes a high but false HO2S signal voltage (rich exhaust indication). The control module will then reduce the amount of fuel delivered to the engine, causing a severe driveability problem. Eliminate the source of contamination before replacing the oxygen sensor.

Test Probe Caution

Caution: Do not insert test equipment probes (DMM etc.) into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal will cause a poor connection, which will result in a system failure. Always use the J-35616 GM-Approved Terminal Test Kit in order to front probe terminals. Do not use paper clips or other substitutes to probe terminals.

When using the J-35616 GM-Approved Terminal Test Kit, ensure the terminal test adapter choice is the correct size for the connector terminal. Do not visually choose the terminal test adapter because some connector terminal cavities may appear larger than the actual terminal in the cavity. Using a larger terminal test adapter will damage the terminal. Refer to the J-35616 GM-Approved Terminal Test Kit label on the inside of the J-35616 GM-Approved Terminal Test Kit for the correct adapter along with the connector end view for terminal size.

Three-Way Catalytic Converter Damage Caution

Caution: In order to avoid damaging the replacement three-way catalytic converter, correct the engine misfire or mechanical fault before replacing the three-way catalytic converter.

Fuel Pipe Fitting Warning

Warning: Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings in order to reduce the risk of fire and personal injury. This will ensure proper reconnection and prevent a possible fuel leak. During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.

SIR Inflator Module Handling and Storage Warning

Warning: When carrying an undeployed inflator module:

- Do not carry the inflator module by the wires or connector.
- Make sure the air bag opening points away from you.

When storing an undeployed inflator module:

- Make sure the air bag opening points away from the surface on which the inflator module rests.
- Provide free space for the air bag to expand in case of an accidental deployment.
- When storing a steering column, do not rest the column with the air bag opening facing down and the column vertical. Lay the column on its side.

Failure to observe these guidelines may result in personal injury.

SIR Warning

Warning: This vehicle is equipped with a Supplemental Inflatable Restraint (SIR) System. Failure to follow the correct procedure could cause the following conditions:

- Air bag deployment
- Personal injury
- Unnecessary SIR system repairs

In order to avoid the above conditions, observe the following guidelines:

- Refer to SIR Component Views in order to determine if you are performing service on or near the SIR components or the SIR wiring.
- If you are performing service on or near the SIR components or the SIR wiring, disable the SIR system. Refer to Disabling the SIR System.

Cracked Window Warning

Warning: If a window is cracked but still intact, crisscross the window with masking tape in order to reduce the risk of damage or personal injury.

Defroster Outlet Warning

Warning: If broken glass falls into the defroster outlets, it can be blown into the passenger compartment and cause personal injury.

Exhaust Service Warning

Warning: In order to avoid being burned, do not service the exhaust system while it is still hot. Service the system when it is cool.

Protective Goggles and Glove Warning

Warning: Always wear protective goggles and gloves when removing exhaust parts as falling rust and sharp edges from worn exhaust components could result in serious personal injury.

Definition of Danger, Warning, Caution, and Note

The diagnosis and repair procedures in a GM Service Manual contain both general and specific Dangers, Warnings, Cautions, Notes or Importants. GM is dedicated to the presentation of service information that helps the technician to diagnose and repair the systems necessary for the proper operation of the vehicle, however, certain procedures may present a hazard to the technician if they are not followed in the recommended manner. Dangers, Warnings, Cautions and Notes or Importants are elements designed to prevent these hazards, however, not all hazards can be foreseen. This information is placed at strategic locations within the service manual. This information is designed to prevent the following from occurring:

- Serious bodily injury or death to the technician
- Damage to the vehicle
- Unnecessary vehicle repairs
- Unnecessary component replacement
- Improper repair or replacement of vehicle components.
- Any warning or caution that appears in this service category is referenced from the individual service categories.

DANGER Defined

When encountering a DANGER, you will be asked to take a necessary action or not to take a prohibited action. If a DANGER is not heeded, the following consequences may occur:

- Serious bodily injury or death to the technician
- Serious bodily injury or death to other technicians in the workplace area

WARNING Defined

When encountering a WARNING, you will be asked to take a necessary action or not to take a prohibited action. If a WARNING is not heeded, the following consequences may occur:

- Serious bodily injury to the technician
- Serious bodily injury to other technicians in the workplace area
- Serious bodily injury to the driver and/or passenger(s) of the vehicle, if the vehicle has been improperly repaired

CAUTION Defined

CAUTIONS call special attention to a necessary action or to a prohibited action. If a CAUTION is not heeded, the following consequences may occur:

- Damage to the vehicle
- Unnecessary vehicle repairs
- Unnecessary component replacement

- Improper operation or performance of the system or component under repair
- Damage to any systems or components which are dependent upon the proper operation of the system or component under repair
- Improper operation or performance of any systems or components which are dependent upon the proper operation or performance of the system or component under repair
- Damage to fasteners, basic tools, or special tools
- The leakage of coolant, lubricant, or other vital fluids

NOTE or IMPORTANT Defined

NOTE and IMPORTANT statements emphasize a necessary characteristic of a diagnostic or repair procedure. NOTE or IMPORTANT statements are designed to do the following:

- Clarify a procedure
- Present additional information for accomplishing a procedure
- Give insight into the reason or reasons for performing a procedure in the manner recommended
- Present information that will help to accomplish a procedure in a more effective manner
- Present information that gives the technician the benefit of past experience in accomplishing a procedure with greater ease

Collision Sectioning Warning

Warning: Sectioning should be performed only in the recommended areas. Failure to do so may compromise the structural integrity of the vehicle and cause personal injury if the vehicle is in a collision.

Fuel Rail Stop Bracket Installation Warning

Warning: The fuel rail stop bracket must be installed onto the engine assembly. The stop bracket serves as a protective shield for the fuel rail in the event of a vehicle frontal crash. If the fuel rail stop bracket is not installed and the vehicle is involved in a frontal crash, fuel could be sprayed possibly causing a fire and personal injury from burns.

Folding Top Hydraulic Pressure Warning

Warning: In order to reduce hydraulic pressure, ensure that the folding top has not been operated for 6 minutes before performing this procedure. Failure to do so may result in personal injury.

Servicing Electrical Components Warning

Warning: The ignition must be in the off position and all electrical loads must be turned off before servicing any electrical component. Failure to do so may result in personal injury or damage to the vehicle.

US English/Metric Conversion

English	Multiply/ Divide by	Metric
In order to calculate English measurement, divide by the number in the center column. In order to calculate metric measurement, multiply by the number in the center column.		
Length		
in	25.4	mm
ft	0.3048	m
yd	0.9144	
mi	1.609	km
Area		
sq in	645.2	sq mm
	6.45	sq cm
sq ft	0.0929	sq m
sq yd	0.8361	
Volume		
cu in	16,387.0	cu mm
	16.387	cu cm
	0.0164	L
qt	0.9464	
gal	3.7854	
cu yd	0.764	cu m
Mass		
lb	0.4536	kg
ton	907.18	
	0.907	tonne (t)
Force		
kg F	9.807	newtons (N)
oz F	0.2780	
lb F	4.448	
Acceleration		
ft/s^2	0.3048	m/s^2
in/s^2	0.0254	
Torque		
lb in	0.11298	N·m
lb ft	1.3558	
Power		
hp	0.745	kW

Pressure (Stress)		
inches of H2O	0.2488	kPa
lb/sq in	6.895	
Energy (Work)		
Btu	1055.0	J (J= one Ws)
lb ft	1.3558	
kW hour	3,600,000.0	
Light		
Foot Candle	10.764	lm/m²
Velocity		
mph	1.6093	km/h
Temperature		
(°F - 32) 5/9	=	°C
°F	=	(9/5 °C + 32)
Fuel Performance		
235.215/mpg	=	100 km/L

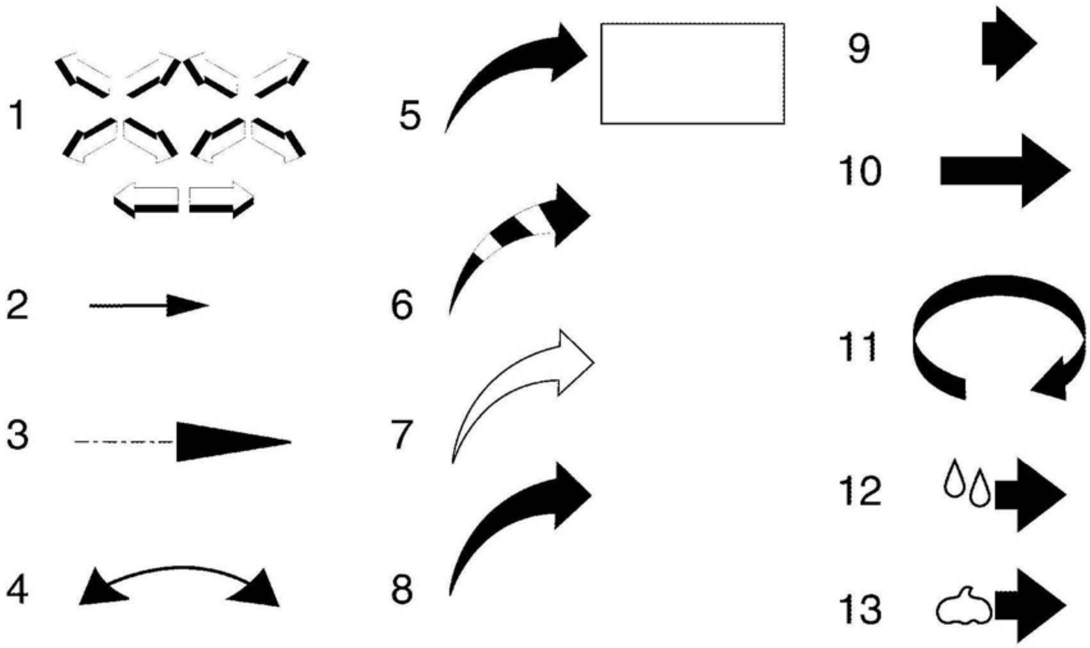
Decimal and Metric Equivalents

Fraction (in)	Decimal (in)	Metric (mm)
1/64	0.015625	0.39688
1/32	0.03125	0.79375
3/64	0.046875	1.19062
1/16	0.0625	1.5875
5/64	0.078125	1.98437
3/32	0.09375	2.38125
7/64	0.109375	2.77812
1/8	0.125	3.175
9/64	0.140625	3.57187
5/32	0.15625	3.96875
11/64	0.171875	4.36562
3/16	0.1875	4.7625
13/64	0.203125	5.15937
7/32	0.21875	5.55625
15/64	0.234375	5.95312
1/4	0.25	6.35
17/64	0.265625	6.74687
9/32	0.28125	7.14375
19/64	0.296875	7.54062
5/16	0.3125	7.9375
21/64	0.328125	8.33437
11/32	0.34375	8.73125
23/64	0.359375	9.12812
3/8	0.375	9.525
25/64	0.390625	9.92187
13/32	0.40625	10.31875
27/64	0.421875	10.71562
7/16	0.4375	11.1125
29/64	0.453125	11.50937
15/32	0.46875	11.90625
31/64	0.484375	12.30312
1/2	0.5	12.7
33/64	0.515625	13.09687
17/32	0.53125	13.49375
35/64	0.546875	13.89062
9/16	0.5625	14.2875

37/64	0.578125	14.68437
19/32	0.59375	15.08125
39/64	0.609375	15.47812
5/8	0.625	15.875
41/64	0.640625	16.27187
21/32	0.65625	16.66875
43/64	0.671875	17.06562
11/16	0.6875	17.4625
45/64	0.703125	17.85937
23/32	0.71875	18.25625
47/64	0.734375	18.65312
3/4	0.75	19.05
49/64	0.765625	19.44687
25/32	0.78125	19.84375
51/64	0.796875	20.24062
13/16	0.8125	20.6375
53/64	0.828125	21.03437
27/32	0.84375	21.43125
55/64	0.859375	21.82812
7/8	0.875	22.225
57/64	0.890625	22.62187
29/32	0.90625	23.01875
59/64	0.921875	23.41562
15/16	0.9375	23.8125
61/64	0.953125	24.20937
31/32	0.96875	24.60625
63/64	0.984375	25.00312
1	1.0	25.4

Arrows and Symbols

This service manual uses various symbols in order to describe different service operations.



(1) Front of Vehicle
(2) Dimension (1:2)
(3) Sectioning (1:3)
(4) Multidirectional Arrow
(5) View Detail
(6) Ambient Air Mixed With Another Gas or Indicate Temperature Change
(7) Ambient/Clean Air Flow or Cool Air Flow
(8) Gas Other Than Ambient Air or Hot Air Flow
(9) View Angle
(10) Task Related
(11) Motion or Direction
(12) Lubrication Point -- Oil or Fluid
(13) Lubrication Point -- Grease or Jelly

Vehicle, Engine and Transmission ID and VIN Location, Derivative and Usage (Sedan)

A Unique International Standards Vehicle Identification Number (ISOVIN) identifies the complete vehicle. This number is stamped or attached to the vehicle body at the locations shown below. Major mechanical components also have serial numbers and/or identification labels in various locations. It is essential that when compiling warranty claims or product and field reports, that the ISOVIN is quoted in conjunction with the identification data of the component affected.

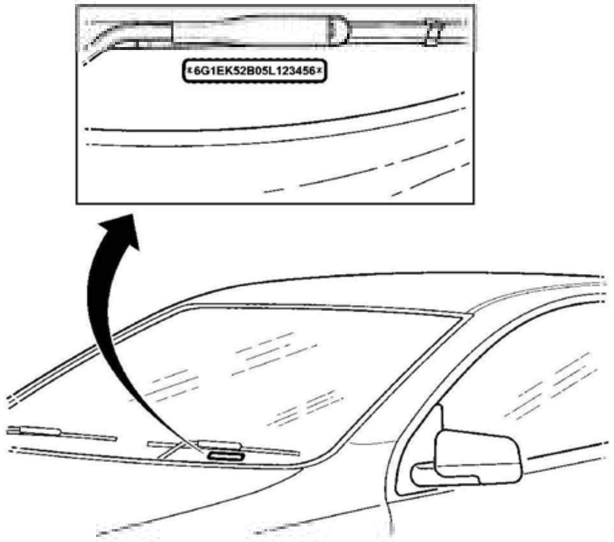
International Standards Vehicle Identification Number

The International Standards Vehicle Identification Numbering (ISOVIN) system is based on the uniform car model designation system. This identifies the vehicle in a coded series of characters.

The ISOVIN is positioned in the following locations:

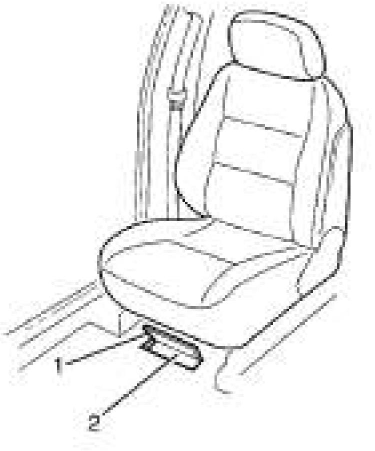
1. ISOVIN plate under the windscreen - Viewed through the windscreen aperture.
2. Body and option plate - Left hand strut tower
3. Safety compliance plate - Left hand B pillar
4. Stamping in the front floor panel under the front right-hand seat

ISOVIN Plate



The ISOVIN plate (1) is located under the windscreen and is viewed through the windscreen aperture and is attached to the dash panel assembly with unique rosette headed rivets.

ISOVIN Body Stamping



Important:

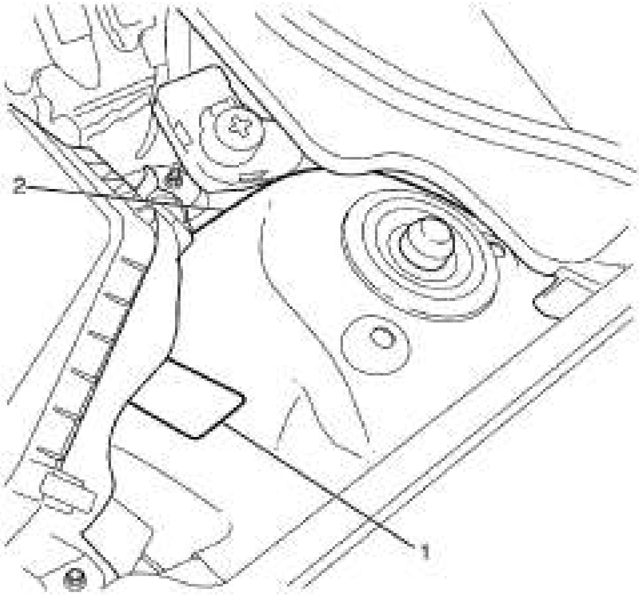
- If the front floor panel assembly is to be replaced, the ISOVIN will be lost. Contact your local Road Traffic Authority prior to replacing the panel to obtain the correct procedure for renumbering the vehicle.
- A replacement body shell assembly is stamped during manufacture with a unique ISOVIN that identifies it as a replacement part.
- If an error is made to the ISOVIN stamping during manufacture, it is crossed out so that it remains legible and the correct number is stamped underneath.

The ISOVIN is stamped into the front floor panel under the right-hand front seat. The ISOVIN (2) is visible by lifting the carpet flap (1).

Position	Description	Number / Letter	Meaning
1	Geographical Area	6	Asia Pacific
2	Country	G	Australia
3	Manufacturer Code	1	General Motors Holden
4	Carline	E	VE
		M	WM
5	Series	K	Omega / SV6 / SS
		P	SS-V
		L	Berlina
		X	Calais / Calais-V
		Y	Statesman

		Z	Caprice
6	Body Type Code	5	Sedan
7	Restraint Code	1	Active (Manual) Seat Belts
		2	Active (Manual) Seat Belts with Driver and Passenger Inflatable Restraint System
		3	Active (Manual) Seat Belts with Driver Inflatable Restraint System
		4	Active (Manual) Seat Belts with Driver, Passenger and Side Inflatable Restraint System
		5	Active (Manual) Seat Belts with Driver, Passenger, Side and Curtain Inflatable Restraint System
8	Engine Type Code	B	RPO LE0 3.6L Alloytec V6
		7	RPO LY7 3.6L Alloytec V6
		N	RPO LW2 3.6L LPG Alloytec V6
		H	RPO L98 6.0L GEN IV V8
9	VIN Check Digit	Varies	Calculated Check Digit
10	Model Year Code	6	2006
		7	2007
11	Manufacturer Plant Code	L	Adelaide (Elizabeth) South Australia
12-17	Plant Sequence Number	--	100001
Note: The production sequence number is sequentially allocated to each vehicle, regardless of vehicle type.			

Body and Option Plate



The body and option identification plate (1) is located on the left hand strut tower (2) and contains the following information:

Model

Combination of letters and numbers identifying the body style and the mechanical pack.

A listing of regular production option numbers can be found by referring to the latest spare parts information for the applicable model.

Body No

International Standards Vehicle Identification Number (ISOVIN)

Trim

Trim combination option code identification

Paint

Exterior paint material and color option code identification

Built

The date of manufacture by calendar month and year in which the body shell and powertrain are conjoined and the vehicle is driven or moved from the production line.

Susp

Suspension option code identification

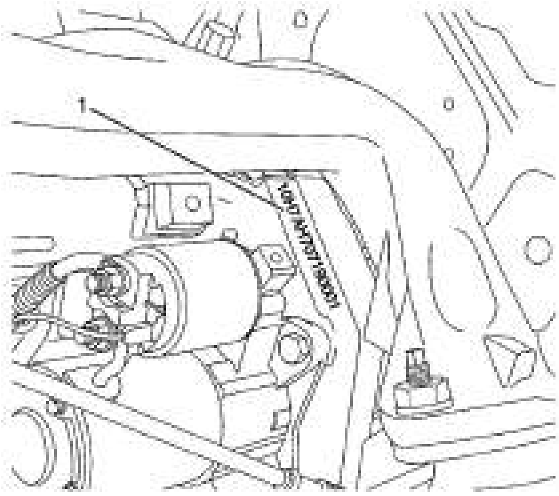
Engine, Transmission, and Axle

Identification option codes for specific engine, transmission, and rear axle (final drive)

A/C

- C60 identifies vehicles fitted with air conditioning.
- C63 identifies vehicles fitted with tri zone automatic climate control air conditioning.
- CJ2 identifies vehicles fitted with dual zone automatic climate control air conditioning.

Engine Serial Number - 3.6

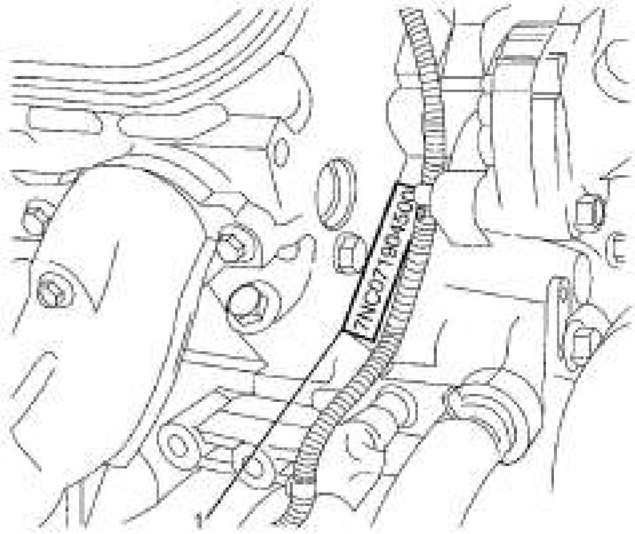


The Engine Serial Number is located on the left-hand side at the rear of the engine cylinder block (1) and is stamped or laser etched onto the block at the assembly plant. When reading the Engine Serial Number the following information can be obtained:

Engine Serial Number 10H7A H07190001 is used as an example:

- The first two digits, 10 identify the component ID.
- The next three digits, H7A, identify the engine model.
- The next digit, H, identifies the plant code as Holden.
- The next two digits, 07, identify the engine model year as 2007.
- The next three digits, 190, identify the Julian date the engine was manufactured as day 190.
- The next four digits, 0011, identify the assembly plant sequence number as 0011.

Engine Serial Number - 6.0



The Engine Serial Number is located on the right-hand side at the front of the engine cylinder block (1) and is stamped or laser etched onto the block at the assembly plant. The number is prefixed by the RPO code of the engine model. As an example 7NC is used. When reading the Engine Serial Number the following information can be obtained:

Engine Serial Number 7NC071904500 is used as an example:

- The first three digits, 7NC, identify the prefixed RPO code of the engine.
- The next two digits, 07, identify the engine model year as 2007.
- The next three digits, 190, identify the Julian date the engine was manufactured as day 190.
- The next four digits, 4500, identify the assembly plant sequence number as 4500.

Transmission Serial Number

Transmission Serial Numbers provide coded information that could be significant to parts interpretation and should be referred to when ordering replacement parts. Refer to the relevant transmission for the Transmission Serial Number location and code breakdown.

Vehicle, Engine and Transmission ID and VIN Location, Derivative and Usage (Sportwagon)

A unique International Standards Vehicle Identification Number (ISOVIN) identifies the vehicle. This number is stamped or attached to the vehicle body at the locations shown below. Major mechanical components also have serial numbers and/or identification labels in various locations. It is essential that when compiling warranty claims or product and field reports, that the ISOVIN is quoted in conjunction with the identification data of the component affected.

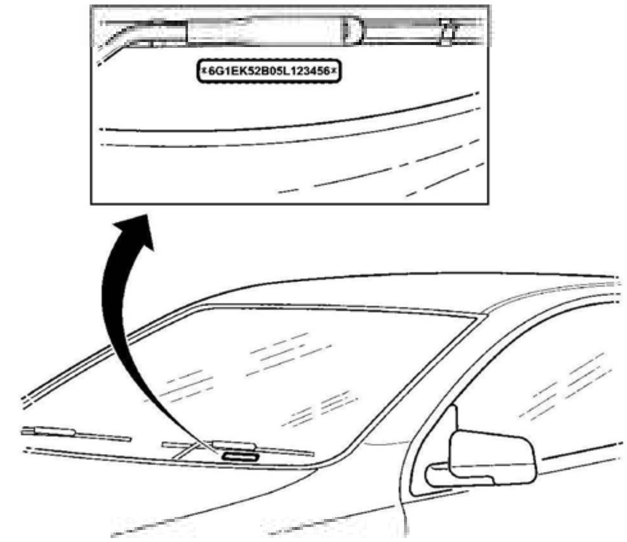
International Standards Vehicle Identification Number

The International Standards Vehicle Identification Numbering (ISOVIN) system is based on the uniform car model designation system. This identifies the vehicle in a coded series of characters.

The ISOVIN is positioned in the following locations:

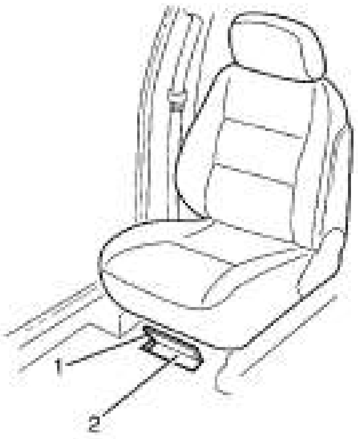
1. ISOVIN plate under the windscreen - Viewed through the windscreen aperture.
2. Body and option plate - Left hand strut tower.
3. Safety compliance plate - Left hand B pillar.
4. Stamping in the front floor panel under the front right-hand seat.

ISOVIN Plate



The ISOVIN plate (1) is located under the windscreen and is viewed through the windscreen aperture and is attached to the dash panel assembly with unique rosette headed rivets.

ISOVIN Body Stamping



Important:

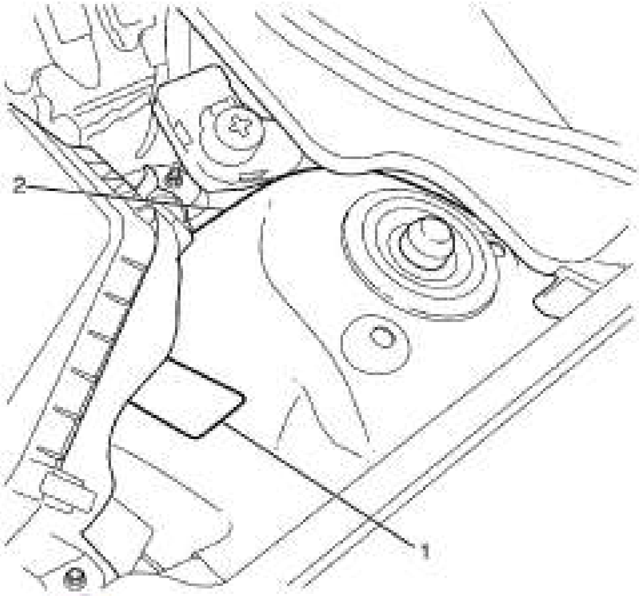
- If the front floor panel assembly is to be replaced, the ISOVIN will be lost. Contact your local Road Traffic Authority prior to replacing the panel to obtain the correct procedure for renumbering the vehicle.
- A replacement body shell assembly is stamped during manufacture with a unique ISOVIN that identifies it as a replacement part.
- If an error is made to the ISOVIN stamping during manufacture, it is crossed out so that it remains legible and the correct number is stamped underneath.

The ISOVIN is stamped into the front floor panel under the right-hand front seat. The ISOVIN (2) is visible by lifting the carpet flap (1).

Position	Description	Number / Letter	Meaning
1	Geographical Area	6	Asia Pacific
2	Country	G	Australia
3	Manufacturer Code	1	General Motors Holden
4	Carline	E	VE
5	Series	K	Omega / SV6 / SS
		P	SS-V
		L	Berlina
		X	Calais / Calais-V
6	Body Type Code	8	Sportwagon
		1	Active (Manual) Seat Belts

7	Restraint Code	2	Active (Manual) Seat Belts with Driver and Passenger Inflatable Restraint System
		3	Active (Manual) Seat Belts with Driver Inflatable Restraint System
		4	Active (Manual) Seat Belts with Driver, Passenger and Side Inflatable Restraint System
		5	Active (Manual) Seat Belts with Driver, Passenger, Side and Curtain Inflatable Restraint System
8	Engine Type Code	B	RPO LE0 3.6L Alloytec V6
		7	RPO LY7 3.6L Alloytec V6
		H	RPO L98 6.0L GEN IV V8
9	VIN Check Digit	Varies	Calculated Check Digit
10	Model Year Code	8	2008
		9	2009
11	Manufacturer Plant Code	L	Adelaide (Elizabeth) South Australia
12-17	Plant Sequence Number	--	100001
Note: The production sequence number is sequentially allocated to each vehicle, regardless of vehicle type.			

Body and Option Plate



The body and option identification plate (1) is located on the left hand strut tower (2) and contains the following information:

Model

Combination of letters and numbers identifying the body style and the mechanical pack.

A listing of regular production option numbers can be found by referring to the latest spare parts information for the applicable model.

Body No

International Standards Vehicle Identification Number (ISOVIN)

Trim

Trim combination option code identification

Paint

Exterior paint material and color option code identification

Built

The date of manufacture by calendar month and year in which the body shell and powertrain are conjoined and the vehicle is driven or moved from the production line.

Susp

Suspension option code identification

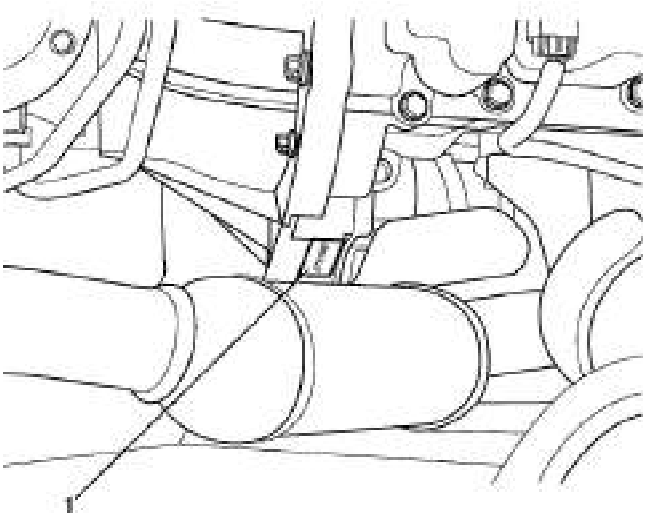
Engine, Transmission, and Axle

Identification option codes for specific engine, transmission, and rear axle (final drive)

A/C

- C60 identifies vehicles fitted with air conditioning.
- CJ2 identifies vehicles fitted with dual zone automatic climate control air conditioning.

Engine Serial Number - 3.6

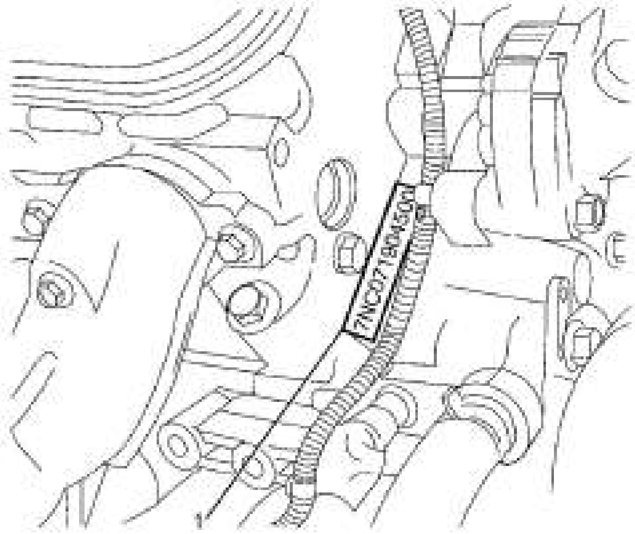


The Engine Serial Number is located on the left-hand side at the rear of the engine cylinder block (1) and is stamped or laser etched onto the block at the assembly plant. The engine serial number is viewed from underneath the vehicle. When reading the Engine Serial Number the following information can be obtained:

Engine Serial Number LY7*07190011* is used as an example:

- The next three digits, LY7*, identify the engine model.
- The next two digits, 07, identify the engine model year as 2007.
- The next three digits, 190, identify the Julian date the engine was manufactured as day 190.
- The next four digits, 0011*, identify the assembly plant sequence number as 0011*.

Engine Serial Number - 6.0



The Engine Serial Number is located on the right-hand side at the front of the engine cylinder block (1) and is stamped or laser etched onto the block at the assembly plant. The number is prefixed by the RPO code of the engine model. As an example 7NC is used. When reading the Engine Serial Number the following information can be obtained:

Engine Serial Number 7NC071904500 is used as an example:

- The first three digits, 7NC, identify the prefixed RPO code of the engine.
- The next two digits, 07, identify the engine model year as 2007.
- The next three digits, 190, identify the Julian date the engine was manufactured as day 190.
- The next four digits, 4500, identify the assembly plant sequence number as 4500.

Transmission Serial Number

Transmission Serial Numbers provide coded information that could be significant to parts interpretation and should be referred to when ordering replacement parts. Refer to the relevant transmission for the Transmission Serial Number location and code breakdown.

Security DNA

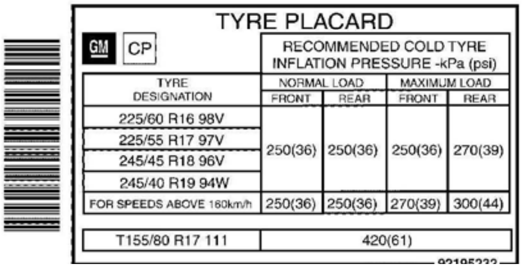
Important: Replacement datadots will not be supplied for components replaced in the field.

All HSV vehicles have Data Dots applied to major components of the vehicle. The Data Dots are imprinted with each vehicle's specific TAG number and can be seen with an illuminated magnifier. The Data Dots are applied to aid in identification of components originally fitted to the vehicle.

Tire Placard

Wheel and tyre sizes, inflation pressures and load capacity are specified on a tyre placard, located on the vehicle body surface under the driver door striker, right hand drive shown.

Except HSV



TYRE PLACARD

GM CP

TYRE DESIGNATION	RECOMMENDED COLD TYRE INFLATION PRESSURE -kPa (psi) NORMAL LOAD FRONT	NORMAL LOAD REAR	MAXIMUM LOAD FRONT	MAXIMUM LOAD REAR
225/60 R16 98V	250(36)	250(36)	250(36)	270(39)
225/55 R17 97V				
245/45 R18 96V				
245/40 R19 94W				
FOR SPEEDS ABOVE 160km/h	250(36)	250(36)	270(39)	300(44)

T155/80 R17 111	420(61)

Always check tyre pressures, with COLD tyres (after vehicle has stood for three hours or more, or driven less than 2 km) and should be checked weekly or before any extended trip.

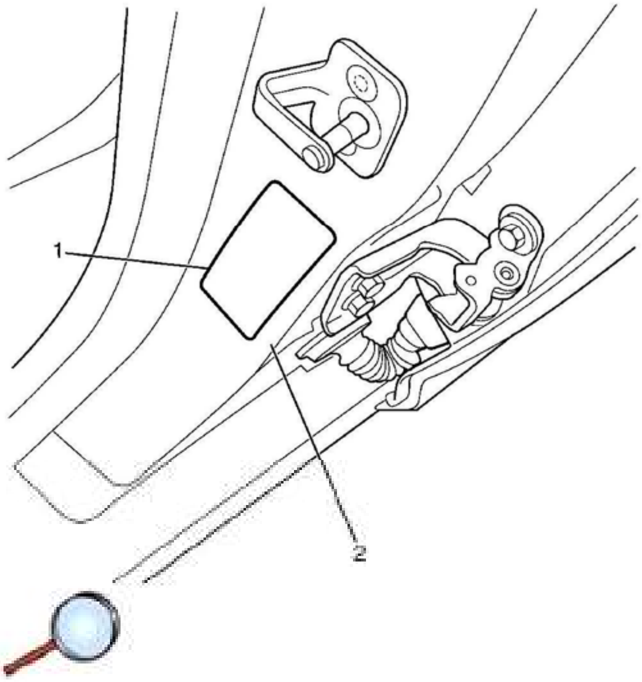
When checking tyre pressure, visually inspect tyres for excessive wear, sharp objects embedded in the tyre or damage to the sidewalls.

Important:

- Clean valve exterior, prior to applying air pressure nozzle when inflating tyre.
- Always install valve caps to keep out dust and water.

Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label

Safety Compliance Label

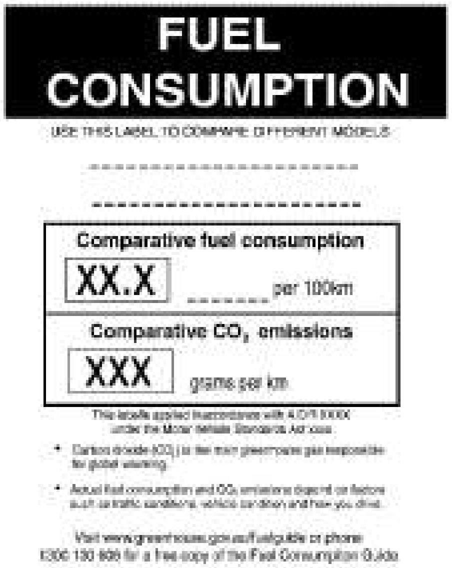


The safety compliance label (1) is located on the left hand B pillar (2).

The safety compliance plate contains the following information:

- Compliance plate approval number
- Vehicle category code
- Name appearing on compliance plate approval
- Make/Model
- Gross Vehicle Mass (GVM) - This is the maximum loaded mass at which the vehicle complies with the approved design rules. Not required for passenger vehicles. Required for utility, regular cab, and crew cab vehicles.
- Seating capacity - The number of adult positions for which seat belts are provided.
- Date of manufacture - The day, month and year that the vehicle is manufactured.
- International Standards Vehicle Identification Number (ISOVIN)

Fuel Consumption Label



FUEL CONSUMPTION

USE THIS LABEL TO COMPARE DIFFERENT MODELS

Comparative fuel consumption

XX.X per 100km

Comparative CO_2 emissions

XXX grams per km

From 1 January 2004, ADR 81/01 requires that all new domestic vehicles displayed for sale have a label attached to the windscreen similar to that shown above.

The Comparative fuel consumption figure and Comparative Carbon Dioxide emissions value quoted are the results of tests carried out in accordance with the ECE R101/00. This new Australian standard for fuel consumption and Carbon Dioxide emission testing harmonises our emission and consumption standards with those recognized internationally. Each vehicle is tested under identical conditions. The tests therefore enable a comparison to be made between vehicles.

The label should be removed from the windscreen immediately prior to the vehicle being delivered to the owner.

RPO Code List (Sedan)

Option Code	Description
11U	Exterior Paint, Heron White
17U	Exterior Paint, Switchblade Silver
18U	Exterior Paint, Evoke
26U	Exterior Paint, Red Passion
27I	Interior Trim, Urban
28U	Exterior Paint, Vespers Blue
39V	Instrument Cluster, Single MFD, Premium Sport, Red Illumination, Voodoo Dial Plate
423	Interior Trim, Metro Leather
42C	Interior Trim, Metro Cloth
443	Interior Trim, Urban Leather
44C	Interior Trim, Urban Cloth
463	Interior Trim, Onyx Leather
46C	Interior Trim, Onyx Cloth
473	Interior Trim, Redhot Leather
47C	Interior Trim, Redhot Cloth
48U	Exterior Paint, Provence
493	Interior Trim, Ignition Leather
49C	Interior Trim, Ignition Cloth
51I	Interior Trim, Onyx
53I	Interior Trim, Onyx
58U	Exterior Paint, Crema
61U	Exterior Paint, Sandstorm
63I	Interior Trim, Onyx
64U	Exterior Paint, Karma
80U	Exterior Paint, Phantom
9C1	Police Options Pack, Omega
A31	Power Windows (Front And Rear)
A45	Function, Exterior Mirror, Heat And Memory
A51	HSV Driver Front Leather Sport Seat
A88	Active Head Restraints
A8H	New Zealand Sports Merchandising
A8Q	Police Options Pack, SV6
A8V	Police Options Pack, SS
A9D	Sports Pack V6

A9F	Sports Pack V8
A9H	Low Sports Pack
A9J	60th Anniversary Merchandising
A9K	Satellite Navigation (Turn by Turn)
A9M	Satellite Navigation (Full Colour)
AE4	HSV Driver Front Cloth Sport Seat
AGA	Adjuster, Passenger Seat 10-Way Power
AGB	Adjuster, Driver Seat 10-Way Power
AG3	Adjuster, Driver Seat 8-Way Power, Memory
AG5	Adjuster, Passenger Seat 2-Way Power
AH5	Adjuster, Driver Seat 8-Way Power (No Memory)
AH6	Adjuster, Driver Seat 4-Way Power
AH7	Adjuster, Passenger Seat 4-Way Power
AH8	ADJUSTER PASS ST - POWER, 8 WAY
AQ5	Adjuster, Passenger Seat 6-Way Power
AH8	Adjuster, Passenger Seat 8-Way Power
AHU	Seatbelts, Front, Height Adjustable Anchorage
AJ6	Adjuster, Driver Seat 6-Way Power
AJ7	Restraint, Driver, Passenger And Side Inflatable (Airbags)
AK5	Restraint, Driver And Passenger Inflatable (Airbags)
AP3	Remote Start
AQ9	Seats Front, Reclining Bucket
AW5	Seats, Rear Cushion, 3 Position / 2 Bucket
AX2	Key, Common, Vehicular Unique
AY0	Restraint Package, Dual Stage Front Airbags, Front Thorax Airbags, Full Length Side Curtain Airbags
B02	Equipment Additional, South Africa
B08	Equipment Additional, Brazil
B13	Equipment Additional, Australia
B34	Mats, Fitted, Anthracite Front
B35	Mats, Fitted, Anthracite Rear
B3Y	Fleet Options Pack
B58	Mats, Fitted, Anthracite Front/Rear
B79	Instrument Cluster, Premium Sport, Bermuda Blue Dial Plate
B82	Exterior Ornamentation Delete
B86	Moulding, Body Side, Body Colour
BMK	Moulding, Body Side, Chrome
C41	Heater And Demister W/Fan
C60	HVAC Manual Control
C63	HVAC Automatic Control (Tri Zone)
CE1	Windshield Wipers With Rain Sensor

CF5	Sunroof
CED	Wipers, 2 Speed Plus Intermittent With Variable Dwell
CJ2	HVAC Dual Zone
CU7	Country: Kuwait Processing Option (Use E05)
CU8	Country: Saudi Arabia Processing Option (Use E05)
CU9	Country: United Kingdom Processing Option (Use RPO CUV)
CUV	Country: United Kingdom Additional Equipment
CV2	Country: Brazil Processing Option (Use B08)
CW2	Country: Gulf Areas. Processing Option (Use E05)
CX5	Australia, Processing Option (Use B13)
CX6	New Zealand, Processing Option (Use E13)
CZ5	South Africa, Processing Option (Use B02)
D1B	Instrument Cluster, Premium Sport, Redhot Dial Plate
D1S	Instrument Cluster, Premium Sport, Ignition Dial Plate
D52	Rear Spoiler High
D72	Exterior Door Handles - Black / Grained
D75	Exterior Door Handles - Body Color
D80	Spoiler, Rear, Lip SWB
DJ5	Exterior Mirrors - Body Color Scalp, Puddle Lamps
DL1	Exterior Mirrors - Body Color Scalp, Puddle Lamp
DL6	Exterior Mirrors - Body Color Scalp
DP2	Exterior Mirrors - Black Scalp
DV5	Instrument Cluster, Premium Sport, Silver Dial Plate, Red Illumination
E05	Equipment Additional Middle East
E13	Equipment Additional New Zealand
E20	Interior Door Handles, Body Colour & Chrome Accent
EF7	USA , Processing Option (Use GH4)
ESA	Assembly Plant, Elizabeth, South Australia
EVF	Equipment , Engine V6
EVG	Equipment , Engine V8
FE1	Suspension, Soft Ride
FE1	Suspension, Soft Ride (FE1.5)
FE2	Suspension, Sports
FR1	Suspension, Country Pack
G80	Differential (LSD)
G84	Axel, 3.70:1 Final Drive Ratio
GH4	Equipment Additional USA
GM3	Axel, 3.45:1 Final Drive Ratio
GW6	Axel, 3.27:1 Final Drive Ratio
GW8	Axel, 2.92:1 Final Drive Ratio

JF5	Alloy Pedals
JL4	Electronic Stability Program (ESP), Electronic Brake Assist (EBA), V6
JL4	Electronic Stability Program (ESP), Electronic Brake Assist (EBA), V8
JL9	Antilock Brake System (ABS)
K30	Cruise Control
K69	Keys, Additional Set
L98	Engine, 6.0 GEN IV V8
LE0	Engine, 3.6 Alloytec V6 4 valve EFI Base
LHD	Vehicle, Left-Hand Drive
LS2	Engine, 6.0 GEN IV V8 (HSV Specific)
LS3	Engine, 6.2 GEN IV V8 (HSV Specific)
LW2	Engine, 3.6 Alloytec V6 4 valve Base LPG Dual Fuel (Not With FE2)
LY7	Engine, 3.6 Alloytec V6 4 valve EFI Premium E22-E26 Ethanol
LY7	Engine, 3.6 Alloytec V6 4 valve EFI Premium
M10	Transmission, 6-Speed Manual, T56
M30	Transmission, 4-Speed Automatic, 4L60E
M32	Transmission, 4-Speed Automatic, 4L65E
M82	Transmission, 5-Speed Automatic 5L40E
MV5	Transmission, 6-Speed Manual (D173) - Alloytec V6
MYC	Transmission, 6-Speed Automatic 6L80E
N10	Dual Exhaust
N10	Quad Exhaust
N40	Power Steering (Non-Road Speed Sensitive)
N46	Steering Wheel, Urethane
N65	Wheel, Space Saver Spare
N87	Wheel, 8.00 X 18 Alloy Road (SS)
NF2	Emissions System, Federal Tier 1
NK4	Steering Wheel, Sports Leather With Controls W1Y
NP5	Steering Wheel, Leather Covered With Controls W1Y
NT3	Emissions System, Euro 3
NW9	Traction Control (With ABS Only)
P34	Wheel, Full Size Spare Alloy
P34	Wheel, Full Size Spare Steel
PF4	Wheel, 7.00 X 16 Alloy Road - 900 kg Capacity
PFE	Wheel, 7.0 X 17 Alloy Road
QC1	Wheel, 7.00 X 16 Steel Road Black
QC1	Wheel, 7.00 X 16 Steel Road Silver
QCZ	Tyre, 245/40 R19 94W
QDU	Tyre, 245/35 R20 95Y
QNY	Tyre, 225/60 R16 98V

QS4	Wheel, 8.0 X 19 Alloy Road
QUM	Tyre, 235/50 R18 97V
QUV	Tyre, 225/55 R17 97V
QWD	Tyre, 245/45 R18 96V
RHD	Vehicle, Right-Hand Drive
T43	Spoiler, Rear Low
T81	Tail Lamp Assembly, LWB, LED
T82	Daytime Running Lights (Headlamps On), Telstra
TT7	Headlamps, Hid Xenon, Auto Levelling RHD
TT8	Headlamps, Hid Xenon, Auto Levelling LHD
U32	Entertainment Package, Rear Seat Player DVD (Only With Premium Sound System And Leather Steering Wheel)
U32	Entertainment Package, Rear Seat Player DVD, SWB
U5J	Telematics Mobile Communications, Holden Assist
U5K	Telematics Mobile Communications, Fleet Monitoring
U71	Antenna, Fixed Mast, Roof Mounted
UD7	Assist, Rear Park (RPA), HSV Sportwagon with sensors
UD7	Assist, Rear Park (RPA), CSV & Vauxhall without sensors
UE1	Telematics (Holden Assist)
UEN	Seat Belt, Front Passenger Presence Detector
UFR	Assist, Front & Rear Park
UT3	Audio System, 80W Single CD
UV9	Satellite Navigation System, Colour Map,
UVC	Safety Camera Rear
UWE	Bluetooth Cellular Phone Connectivity
UWP	Audio System, 150W 6 CD Changer In Head Unit, Preset Equaliser
UWP	Audio System,230W 6 CD Changer In Head Unit, Preset Equaliser
UWQ	Audio System, 220W 6 CD Changer In Head Unit, Preset Equaliser Dsp
UWR	Audio System, 80W 6 CD Changer In Head Unit, Preset Equaliser
UY4	Satellite Navigation System, Turn by Turn
V5B	HSV Pack
V5E	HSVi Processing
V5Z	Safety Compliance Plate Delete
V7I	HSV Grange
V7O	Description, Model Year, 2009
V9Y	Package, Gulf States (Use E05)
W22	Merchandised Package -- International
W9P	Sales Package -- Tier 2 Performance Pack
XQ2	Badge Vauxhall
XQ9	Badge, Chevrolet
XW5	HSV Senator Automatic

XW6	Metallic Paint
XY2	Merchandised Package -- CSV GTS
XY3	Merchandised Package -- HSV Clubsport/GTS/VXR8
XY7	HSV Clubsport Manual
XY8	HSV Clubsport Automatic
YE3	V - Series

RPO Code List (Sportwagon)

Option Code	Description
11U	Exterior Paint, Heron White
17U	Exterior Paint, Switchblade Silver
18U	Exterior Paint, Evoke
26U	Exterior Paint, Red Passion
27I	Interior Trim, Urban
28U	Exterior Paint, Vespers Blue
39V	Instrument Cluster, Single MFD, Premium Sport, Red Illumination, Voodoo Dial Plate
423	Interior Trim, Metro Leather
42C	Interior Trim, Metro Cloth
443	Interior Trim, Urban Leather
44C	Interior Trim, Urban Cloth
463	Interior Trim, Onyx Leather
46C	Interior Trim, Onyx Cloth
473	Interior Trim, Redhot Leather
47C	Interior Trim, Redhot Cloth
48U	Exterior Paint, Provence
493	Interior Trim, Ignition Leather
49C	Interior Trim, Ignition Cloth
51I	Interior Trim, Onyx
53I	Interior Trim, Onyx
58U	Exterior Paint, Crema
61U	Exterior Paint, Sandstorm
63I	Interior Trim, Onyx
64U	Exterior Paint, Karma
80U	Exterior Paint, Phantom
9C1	Police Options Pack, Omega
A31	Power Windows (Front And Rear)
A45	Function, Exterior Mirror, Heat And Memory
A88	Active Head Restraints
A8H	New Zealand Sports Merchandising
A8Q	Police Options Pack, SV6
A8V	Police Options Pack, SS
A9D	Sports Pack V6
A9F	Sports Pack V8

A9H	Low Sports Pack
AE4	HSV Driver Front Cloth Sport Seat
AG3	Adjuster, Driver Seat 8-Way Power, Memory
AG5	Adjuster, Passenger Seat 2-Way Power
AH6	Adjuster, Driver Seat 4-Way Power
AH8	ADJUSTER PASS ST - POWER, 8 WAY
AQ5	Adjuster, Passenger Seat 6-Way Power
AHU	Seatbelts, Front, Height Adjustable Anchorage
AQ9	Seats Front, Reclining Bucket
AX2	Key, Common, Vehicular Unique
AY0	Restraint Package, Dual Stage Front Airbags, Front Thorax Airbags, Full Length Side Curtain Airbags
B13	Equipment Additional, Australia
B34	Mats, Fitted, Anthracite Front
B35	Mats, Fitted, Anthracite Rear
B3Y	Fleet Options Pack
B58	Mats, Fitted, Anthracite Front/Rear
B79	Instrument Cluster, Premium Sport, Bermuda Blue Dial Plate
B82	Exterior Ornamentation Delete
BMK	Moulding, Body Side, Chrome
C41	Heater And Demister W/Fan
C60	HVAC Manual Control
CE1	Windshield Wipers With Rain Sensor
CED	Wipers, 2 Speed Plus Intermittent With Variable Dwell
CJ2	HVAC Dual Zone
CX5	Australia, Processing Option (Use B13)
CX6	New Zealand, Processing Option (Use E13)
D1B	Instrument Cluster, Premium Sport, Redhot Dial Plate
D1S	Instrument Cluster, Premium Sport, Ignition Dial Plate
D75	Exterior Door Handles - Body Color
DJ5	Exterior Mirrors - Body Color Scalp, Puddle Lamps
DL1	Exterior Mirrors - Body Color Scalp, Puddle Lamp
DL6	Exterior Mirrors - Body Color Scalp
DV5	Instrument Cluster, Premium Sport, Silver Dial Plate, Red Illumination
E13	Equipment Additional New Zealand
E20	Interior Door Handles, Body Colour & Chrome Accent
ESA	Assembly Plant, Elizabeth, South Australia
EVF	Equipment , Engine V6
EVG	Equipment , Engine V8
FE1	Suspension, Soft Ride
FE2	Suspension, Sports

FR1	Suspension, Country Pack
G80	Differential (LSD)
G84	Axel, 3.70:1 Final Drive Ratio
GM3	Axel, 3.45:1 Final Drive Ratio
GW6	Axel, 3.27:1 Final Drive Ratio
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JL4	Electronic Stability Program (ESP), Electronic Brake Assist (EBA), V8
JL9	Antilock Brake System (ABS)
K30	Cruise Control
K69	Keys, Additional Set
L98	Engine, 6.0 GEN IV V8
LE0	Engine, 3.6 Alloytec V6 4 valve EFI Base
LS3	Engine, 6.2 GEN IV V8 (HSV Specific)
LY7	Engine, 3.6 Alloytec V6 4 valve EFI Premium
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M30	Transmission, 4-Speed Automatic, 4L60E
M82	Transmission, 5-Speed Automatic 5L40E
MYC	Transmission, 6-Speed Automatic 6L80E
N10	Dual Exhaust
N10	Quad Exhaust
N40	Power Steering (Non-Road Speed Sensitive)
N46	Steering Wheel, Urethane
N65	Wheel, Space Saver Spare
N87	Wheel, 8.00 X 18 Alloy Road (SS)
NP5	Steering Wheel, Leather Covered With Controls W1Y
NT3	Emissions System, Euro 3
P34	Wheel, Full Size Spare Alloy
P34	Wheel, Full Size Spare Steel
PF4	Wheel, 7.00 X 16 Alloy Road - 900 kg Capacity
QC1	Wheel, 7.00 X 16 Steel Road Black
QC1	Wheel, 7.00 X 16 Steel Road Silver
QCZ	Tyre, 245/40 R19 94W
Q17	Tyre, 245/45 R18 100V
Q18	Tyre, 245/45 R19 98W
QNY	Tyre, 225/60 R16 98V
QS4	Wheel, 8.0 X 19 Alloy Road
QUV	Tyre, 225/55 R17 97V
QWD	Tyre, 245/45 R18 96V

RHD	Vehicle, Right-Hand Drive
T82	Daytime Running Lights (Headlamps On), Telstra
U32	Entertainment Package, Rear Seat Player DVD, SWB
U5K	Telematics Mobile Communications, Fleet Monitoring
U71	Antenna, Fixed Mast, Roof Mounted
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UT3	Audio System, 80W Single CD
UV9	Satellite Navigation System, Colour Map,
UWE	Bluetooth Cellular Phone Connectivity
UWP	Audio System, 150W 6 CD Changer In Head Unit, Preset Equaliser
UWR	Audio System, 80W 6 CD Changer In Head Unit, Preset Equaliser
UY4	Satellite Navigation System, Turn by Turn
V5B	HSV Pack
V5E	HSVi Processing
V7O	Description, Model Year, 2009
XW6	Metallic Paint
XY2	Merchandised Package -- CSV GTS
XY3	Merchandised Package -- HSV Clubsport/GTS/VXR8
XY7	HSV Clubsport Manual
XY8	HSV Clubsport Automatic
YE3	V - Series

Fasteners

Table 1: Metric Prevailing Torque Fastener Minimum Torque Development
Table 2: English Prevailing Torque Fastener Minimum Torque Development
Table 3: Consumable Fasteners List

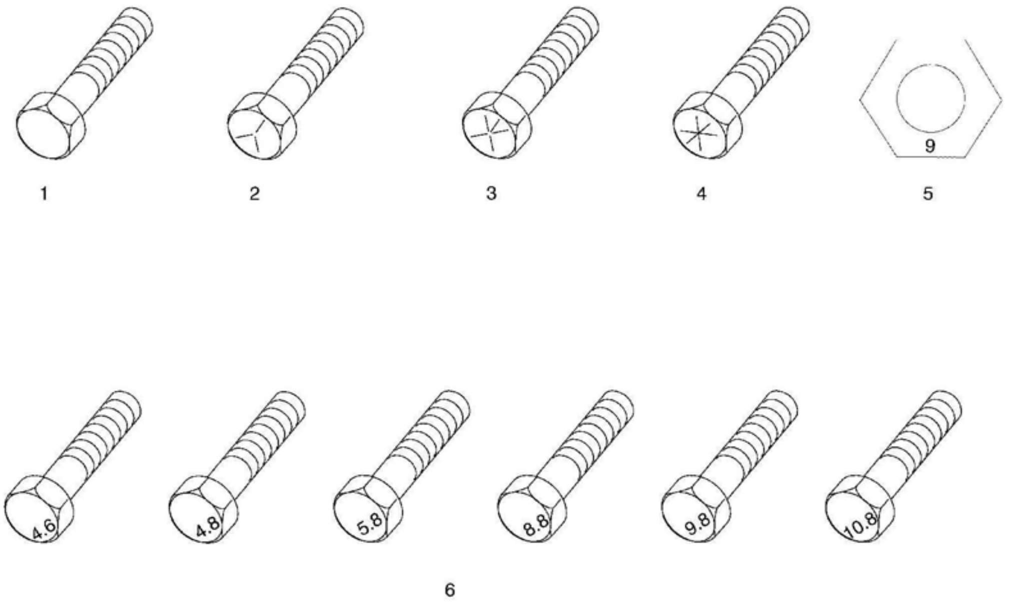
Metric Fasteners

This vehicle provides fastener dimensions using the metric system. Most metric fasteners are approximate in diameter to equivalent English fasteners. Make replacements using fasteners of the same nominal diameter, thread pitch, and strength.

A numerical marking identifies the OE metric fasteners except cross-recess head screws. The number also indicates the strength of the fastener material. A Posidrive® or Type 1A cross-recess identifies a metric cross-recess screw. For best results, use a Type 1A cross-recess screwdriver, or equivalent, in Posidrive® recess head screws.

Holden Engineering Standards have adopted a portion of the ISO-defined standard metric fastener sizes. The purpose was to reduce the number of fastener sizes used while retaining the best thread qualities in each thread size. For example, the metric M6.0 X 1 screw, with nearly the same diameter and 25.4 threads per inch replaced the English 1/4-20 and 1/4-28 screws. The thread pitch is midway between the English coarse and fine thread pitches.

Fastener Strength Identification



(1) English Bolt, Grade 2 (Strength Class)
(2) English Bolt, Grade 5 (Strength Class)
(3) English Bolt, Grade 7 (Strength Class)
(4) English Bolt, Grade 8 (Strength Class)
(5) Metric Nut, Strength Class 9
(6) Metric Bolts, Strength Class Increases as Numbers Increase

The most commonly used metric fastener strength property classes are 9.8 and 10.9. The class identification is embossed on the head of each bolt. The English, inch strength classes range from grade 2 to grade 8. Radial lines are embossed on the head of each bolt in order to identify the strength class. The number of lines on the head of the bolt is 2 lines less than the actual grade. For example, a grade 8 bolt will have 6 radial lines on the bolt head. Some metric nuts are marked with a single digit strength identification number on the nut face.

The correct fasteners are available through Holden Spare Parts Operations (HSPO). Many metric fasteners available in the aftermarket parts channels are designed to different metric standards of countries, and may exhibit the following:

- Lower strength
- No numbered head marking system
- Wrong thread pitch

The metric fasteners on Holden products are designed to new, international standards. The following are the common sizes and pitches, except for special applications:

- M6.0 X 1
- M8 X 1.25
- M10 X 1.5
- M12 X 1.75
- M14 X 2.00
- M16 X 2.00

Prevailing Torque Fasteners

Prevailing torque fasteners create a thread interface between the fastener and the fastener counterpart in order to prevent the fastener from loosening.

All Metal Prevailing Torque Fasteners

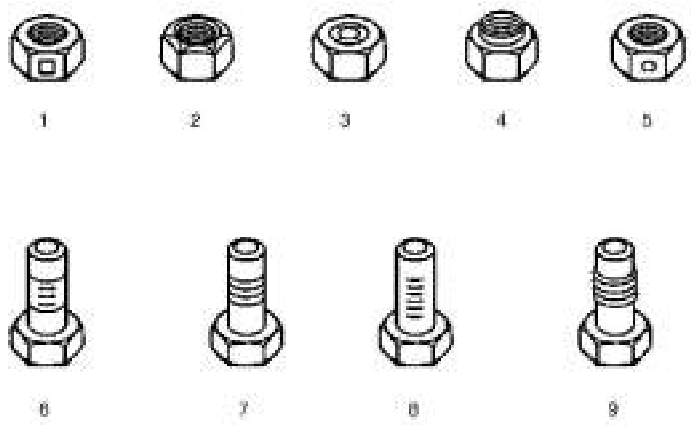
These fasteners accomplish the thread interface by a designed distortion or deformation in the fastener.

Nylon Interface Prevailing Torque Fasteners

These fasteners accomplish the thread interface by the presence of a nylon material on the fastener threads.

Adhesive Coated Fasteners

These fasteners accomplish the thread interface by the presence of a thread-locking compound on the fastener threads. Refer to the appropriate repair procedure in order to determine if the fastener may be reused and the applicable thread-locking compound to apply to the fastener.



(1) Prevailing Torque Nut, Center Lock Type
(2) Prevailing Torque Nut, Top Lock Type
(3) Prevailing Torque Nut, Nylon Patch Type
(4) Prevailing Torque Nut, Nylon Washer Insert Type
(5) Prevailing Torque Nut, Nylon Insert Type
(6) Prevailing Torque Bolt, Dry Adhesive Coating Type
(7) Prevailing Torque Bolt, Thread Profile Deformed Type
(8) Prevailing Torque Bolt, Nylon Strip Type
(9) Prevailing Torque Bolt, Out-of-Round Thread Area Type

A prevailing torque fastener may be reused only if:

- The fastener and the fastener counterpart are clean and not damaged
- There is no rust on the fastener
- The fastener develops the specified minimum torque against its counterpart prior to the fastener seating

Metric Prevailing Torque Fastener Minimum Torque Development

Application	Specification	
	Metric	English
All Metal Prevailing Torque Fasteners		
6 mm	0.4 N·m	4 lb in
8 mm	0.8 N·m	7 lb in
10 mm	1.4 N·m	12 lb in
12 mm	2.1 N·m	19 lb in
14 mm	3 N·m	27 lb in
16 mm	4.2 N·m	37 lb in
20 mm	7 N·m	62 lb in
24 mm	10.5 N·m	93 lb in
Nylon Interface Prevailing Torque Fasteners		
6 mm	0.3 N·m	3 lb in
8 mm	0.6 N·m	5 lb in
10 mm	1.1 N·m	10 lb in
12 mm	1.5 N·m	13 lb in
14 mm	2.3 N·m	20 lb in
16 mm	3.4 N·m	30 lb in
20 mm	5.5 N·m	49 lb in
24 mm	8.5 N·m	75 lb in

English Prevailing Torque Fastener Minimum Torque Development

Application	Specification	
	Metric	English
All Metal Prevailing Torque Fasteners		
1/4 in	0.5 N·m	4.5 lb in
5/16 in	0.8 N·m	7.5 lb in
3/8 in	1.3 N·m	11.5 lb in
7/16 in	1.8 N·m	16 lb in
1/2 in	2.3 N·m	20 lb in
9/16 in	3.2 N·m	28 lb in
5/8 in	4 N·m	36 lb in
3/4 in	7 N·m	54 lb in
Nylon Interface Prevailing Torque Fasteners		
1/4 in	0.3 N·m	3 lb in
5/16 in	0.6 N·m	5 lb in
3/8 in	1 N·m	9 lb in
7/16 in	1.3 N·m	12 lb in
1/2 in	1.8 N·m	16 lb in
9/16 in	2.5 N·m	22 lb in

5/8 in	3.4 N·m	30 lb in
3/4 in	5 N·m	45 lb in

Consumable Fasteners List

Application	Specification	
	Part #	Vehicle Quantity
Power Steering Pump to Bracket Attaching Bolt	11588903	2
Power Steering Pump Bracket to V6 Engine Attaching Bolt	11588734	2
Power Steering Pump Bracket to V6 Engine Attaching Bolt	92138979	1
Intermediate Steering Shaft to Pinion Shaft Retaining Bolt	92138918	1
Tie Rod End to Steering Knuckle Retaining Nut	11609618	2
Front Castor Arm Ball Joint to Steering Knuckle Retaining Nut	11900443	2
Steering Wheel to Steering Column Shaft Retaining Nut (BOLT)	11610164	1
Steering Column Assembly to Body Attaching Bolt (Lower)	92191045	2
Steering Column Assembly to Body Attaching Bolt (Upper)	92191046	2
Steering Column Shaft to Intermediate Steering Shaft Retaining Bolt	92191042	1
Front Strut to Knuckle Retaining Nut	92138862	2
Front Strut to Knuckle Retaining Bolt	92138863	2
Front Strut to Knuckle Washer	92138864	2
Front Caster Arm to Subframe Bolt (LWR CTR ARM FRONT)	92139036	2
Front Lower Control Arm to Subframe Retaining Nut	11900443	2
Front Lower Control Arm Ball Joint Nut	11900443	2
Front Lower Control Arm Bolt	92139035	2
Front Wheel Hub to Steering Knuckle Retaining Bolt	92138879	6 (3 per side)
Front Stabiliser Bar Link Ball Joint Stud Retaining Nut	92138590	4 (2 per side)
Front Stabiliser Bar Support Bracket Retaining Nut	11900440	4 (2 per side)
Steering Knuckle to Strut Assembly Retaining Bolt	92138862	2
Steering Knuckle to Strut Assembly Retaining Nut	92138863	2
Steering Knuckle to Strut Assembly Retaining Washer	92138864	2
Front Castor Arm Inner Pivot Attaching Bolt	92139036	2 (1 per side)
Front Castor Arm Inner Pivot Attaching Nut	11900443	2 (1 per side)
Rear I-Link to Subframe Attaching Nut	11900443	2 (1 per side)
Rear Lower Control Arm to Knuckle Retaining Nut	11516078	2 (1 per side)
Rear Lower Control Arm to Strut Assembly Retaining Nut	11516078	2 (1 per side)
Rear Lower Control Arm to Subframe Retaining Nut	11900443	2 (1 per side)
Wheel Drive Shaft to Spindle Retaining Nut	92138989	2 (1 per side)
Wheel Drive Shaft to Spindle Washer	92189154	2 (1 per side)
Rear Stabiliser Bar Link to Lower Control Arm Retaining Nut	11516077	2 (1 per side)
Rear Stabiliser Bar Link to Stabiliser Bar Retaining Nut	11516077	2 (1 per side)

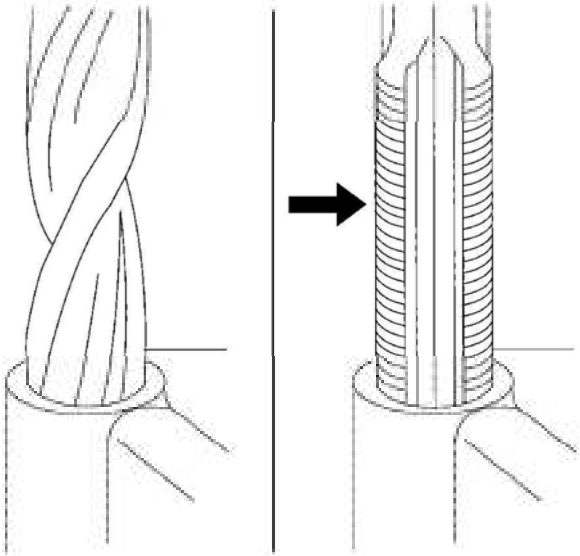
Rear Upper Control Arm Pivot Joint Bushing to Subframe Retaining Bolts	92138835	4 (2 per side)
Rear Upper Control Arm to Knuckle Retaining Nut	11516078	2 (1 per side)
Rear Y-Link to Knuckle Retaining Nut	11516078	2 (1 per side)
Rear Y-Link to Subframe Retaining Nut	11516078	2 (1 per side)
Propeller Shaft Rubber Coupling to Propeller Shaft Retaining Nut (3 Bolt/Nut Kit)	92148356	1 Kit
Propeller Shaft Rubber Coupling to Propeller Shaft Yoke Retaining Nut (3 Bolt/Nut Kit)	92148356	1 Kit
Propeller Shaft Rubber Coupling to Transmission Flange Retaining Nut (3 Bolt/Nut Kit)	92148356	1 Kit
Differential Pinion Flange Retaining Nut	92194936	1
Differential to Subframe Retaining Nut	11516078	3
Front Brake Caliper to Knuckle Retaining Bolt	92172963	4 (2 per side)
Front Brake Caliper Slide Pin Retaining Bolt	92193459	4 (2 per side)
Rear Brake Caliper to Knuckle Retaining Bolt	92172963	4 (2 per side)
Rear Brake Caliper Slide Pin Retaining Bolt	92193459	4 (2 per side)
Flywheel to V6 Engine Attaching Bolt	Not Serviced	
Flexplate to V6 Engine Attaching Bolt	11588884	8
Exhaust Manifold to Cylinder Head Attaching Bolt (V6)	11518862	8
M8 Cylinder Head to Block Attaching Bolt (V8)	11518860	7
M11 Cylinder Head to Block Attaching Bolt (V8)	12558840	10
Flywheel to V8 Engine Attaching Bolt	11519772	20
Flexplate to V8 Engine Attaching Bolt	12553332	6
Exhaust Manifold to Cylinder Head Attaching Bolt (V8)	12553332	6
Rear Subframe to Chassis Attaching Bolt	11518860	12 (6 per side)
Catalytic Converter to Exhaust Manifold Attaching Nut (V6)	92138973	4
Catalytic Converter to Exhaust Manifold Attaching Nut (V8)	15709703	4
Intermediate Exhaust Assembly to Catalytic Converter Retaining Nuts	15709703	4
V6 6 Speed (Aisin) Manual Transmission Drive Flange Retaining Nut	89058850	4
V8 6 Speed (Tremec) Manual Transmission Drive Flange Retaining Nut	89059464	1
V6 5 Speed (5L40-E) Automatic Transmission Drive Flange Retaining Nut	96041805	1
Door Hinge Pin Keeper Bolt	92138945	4 (2 per side)
Door Check Link Attaching Bolt	11517868	4 (2 per side)
Door Latch Attaching Screw (Front)	11609341	6 (3 per side)
Door Latch Attaching Screw (Rear)	11609341	6 (3 per side)

Thread Inserts

General purpose thread repair kits. These kits are available commercially.

Repair Procedure

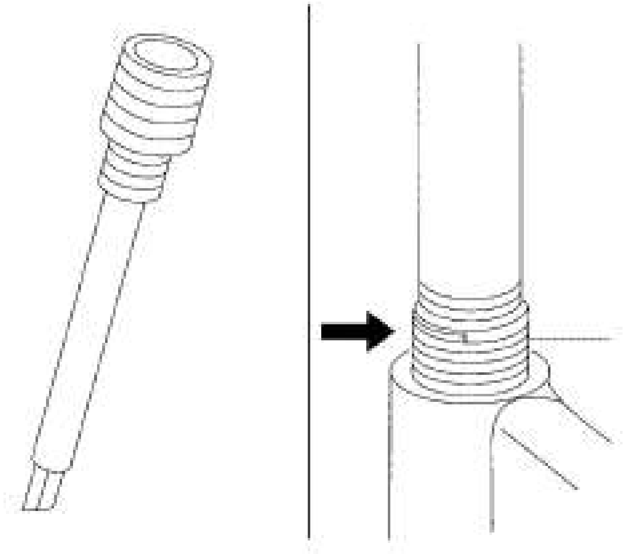
Caution: Refer to Safety Glasses Caution in the Preface section.



Important: Refer to the thread repair kit manufacturer's instructions regarding the size of the drill and tap to use.

Important: Avoid any buildup of chips. Back out the tap every few turns and remove the chips.

1. Determine the size, the pitch and the depth of the damaged thread. If necessary, adjust the stop collars on the cutting tool and tap to the required depth.
2. Drill out the damaged threads. Clean out any chips.
3. Lubricate the tap with light engine oil. Tap the hole. Clean the threads.



4. Thread the thread insert onto the mandrel of the installer. Engage the tang of the insert onto the end of the mandrel.

   Important: The insert should be flush to one turn below the surface.

5. Lubricate the insert with light engine oil, except when installing in aluminum and install the insert.
6. If the tang of the insert does not break off when backing out the installer, break the tang off with a drift.

Abbreviations and Meanings

Abbreviation	Meaning
A	
A	Ampere(s)
ABS	Antilock Brake System
A/C	Air Conditioning
AC	Alternating Current
ACC	Accessory, Automatic Climate Control
ACL	Air Cleaner
A/D	Analog to Digital
A/F	Air/Fuel Ratio
AM/FM	Amplitude Modulation/Frequency Modulation
Ant	Antenna
AP	Accelerator Pedal
APP	Accelerator Pedal Position
ASM	Assembly
A/T	Automatic Transmission/Transaxle
ATDC	After Top Dead Center
ATSLC	Automatic Transmission Shift Lock Control
Auto	Automatic
avg	Average
B	
B+	Battery Positive Voltage
BARO	Barometric Pressure
BATT	Battery
BBV	Brake Booster Vacuum
BCM	Body Control Module
BHP	Brake Horsepower
BLK	Black
BLU	Blue
BP	Back Pressure
BPMV	Brake Pressure Modulator Valve
BPP	Brake Pedal Position
BRN	Brown
BTDC	Before Top Dead Center
C	
°C	Degrees Celsius
CAFE	Corporate Average Fuel Economy

Cal	Calibration
Cam	Camshaft
cm³	Cubic Centimeters
CD	Compact Disc
cfm	Cubic Feet per Minute
cg	Center of Gravity
CID	Cubic Inch Displacement
CKP	Crankshaft Position
CKT	Circuit
CL	Closed Loop
CLS	Coolant Level Switch
CMP	Camshaft Position
CO	Carbon Monoxide
CO²	Carbon Dioxide
Coax	Coaxial
COMM	Communication
Conn	Connector
CPA	Connector Position Assurance
CPP	Clutch Pedal Position
CPS	Central Power Supply
CPU	Central Processing Unit
CS	Charging System
CTP	Closed Throttle Position
cu ft	Cubic Foot/Feet
cu in	Cubic Inch/Inches
CV	Constant Velocity Joint
Cyl	Cylinder(s)
D	
dB	Decibels
dBA	Decibels on A-weighted Scale
DC	Direct Current, Duty Cycle
DE	Drive End
DEC	Digital Electronic Controller
dia	Diameter
DIC	Driver Information Center
Diff	Differential
DK	Dark
DLC	Data Link Connector
DMM	Digital Multimeter
DOHC	Dual Overhead Camshafts

DR, Drvr	Driver
DRL	Daytime Running Lamps
DTC	Diagnostic Trouble Code
E	
EBCM	Electronic Brake Control Module
EC	Electrical Center, Engine Control
ECC	Electronic Climate Control
ECI	Extended Compressor at Idle
ECL	Engine Coolant Level
ECM	Engine Control Module, Electronic Control Module
ECS	Emission Control System
ECT	Engine Coolant Temperature
EEPROM	Electrically Erasable Programmable Read Only Memory
EI	Electronic Ignition
ELAP	Elapsed
ELC	Electronic Level Control
E/M	English/Metric
EMF	Electromotive Force
EMI	Electromagnetic Interference
Eng	Engine
EOP	Engine Oil Pressure
EOT	Engine Oil Temperature
EPA	Environmental Protection Agency
EPR	Exhaust Pressure Regulator
EPROM	Erasable Programmable Read Only Memory
ESC	Electronic Suspension Control
ESD	Electrostatic Discharge
ESN	Electronic Serial Number
ETC	Electronic Throttle Control, Electronic Temperature Control, Electronic Timing Control
ETR	Electronically Tuned Receiver
EVAP	Evaporative Emission
Exh	Exhaust
F	
°F	Degrees Fahrenheit
FC	Fan Control
FEDS	Fuel Enable Data Stream
FI	Fuel Injection
FP	Fuel Pump
ft	Foot/Feet
FT	Fuel Trim

FW	Flat Wire
FWD	Front Wheel Drive, Forward
G	
g	Grams, Gravitational Acceleration
GA	Gage, Gauge
gal	Gallon
GCW	Gross Combination Weight
Gen	Generator
GL	Gear Lubricant
GM	General Motors
gnd	Ground
gpm	Gallons per Minute
GRN	Green
GRY	Grey
GVWR	Gross Vehicle Weight Rating
H	
H	Hydrogen
H^2O	Water
Harn	Harness
HC	Hydrocarbons
HD	Heavy Duty
HDC	Heavy Duty Cooling
hex	Hexagon, Hexadecimal
Hg	Mercury
Hi Alt	High Altitude
HO^2S	Heated Oxygen Sensor
hp	Horsepower
HPL	High Pressure Liquid
HPS	High Performance System
HPV	High Pressure Vapor
HPVS	Heat Pump Ventilation System
Htd	Heated
HTR	Heater
HSPO	Holden Spare Parts Operations
HVAC	Heater-Ventilation-Air Conditioning
HVIL	High Voltage Interlock Loop
HVM	Heater Vent Module
Hz	Hertz
I	
IAC	Idle Air Control

IAT	Intake Air Temperature
IC	Integrated Circuit, Ignition Control
ICM	Ignition Control Module
ID	Identification, Inside Diameter
IDI	Integrated Direct Ignition
IGBT	Insulated Gate Bi-Polar Transistor
ign	Ignition
ILC	Idle Load Compensator
in	Inch/Inches
INJ	Injection
inst	Instantaneous, Instant
IP	Instrument Panel
IPC	Instrument Panel Cluster
ISC	Idle Speed Control
ISO	International Standards Organization
ISS	Input Speed Shaft, Input Shaft Speed
K	
KAM	Keep Alive Memory
kg	Kilogram
kHz	Kilohertz
km	Kilometer
km/h	Kilometers per Hour
km/l	Kilometers per Liter
kPa	Kilopascals
KS	Knock Sensor
kV	Kilovolts
L	
L	Liter
lb	Pound
lb ft	Pound Feet Torque
lb in	Pound Inch Torque
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LEV	Low Emissions Vehicle
LF	Left Front
lm	Lumens
LR	Left Rear
LT	Left
LT	Light
LT	Long Term

LTPI	Low Tyre Pressure Indicator
M	
MAF	Mass Air Flow
Man	Manual
MAP	Manifold Absolute Pressure
MAT	Manifold Absolute Temperature
max	Maximum
M/C	Mixture Control
MDP	Manifold Differential Pressure
MFI	Multiport Fuel Injection
mi	Miles
MIL	Malfunction Indicator Lamp
min	Minimum
mL	Milliliter
mm	Millimeter
mpg	Miles per Gallon
mph	Miles per Hour
ms	Millisecond
M/T	Manual Transmission/Transaxle
MV	Megavolt
mV	Millivolt
N	
NC	Normally Closed
NEG	Negative
Neu	Neutral
NI	Neutral Idle
NiMH	Nickel Metal Hydride
N·m	Newton-meter Torque
NO	Normally Open
NOx	Oxides of Nitrogen
NOVRAM	Non-Volatile Random Access Memory
O	
O^2	Oxygen
O^2S	Oxygen Sensor
OBD	On-Board Diagnostics
OBD II	On-Board Diagnostics Second Generation
OC	Oxidation Converter Catalytic
OCS	Opportunity Charge Station
OD	Outside Diameter
ODM	Output Drive Module

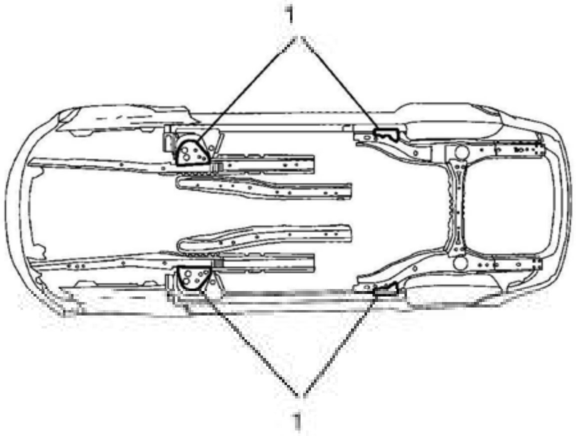
ODO	Odometer
OE	Original Equipment
OEM	Original Equipment Manufacturer
OHC	Overhead Camshaft
Ù	Ohm
OL	Open Loop, Out of Limits
ORC	Oxidation Reduction Converter Catalytic
ORN	Orange
ORVR	On-Board Refueling Vapor Recovery
OSS	Output Shaft Speed
oz	Ounce(s)
P	
PAG	Polyalkylene Glycol
PAIR	Pulsed Secondary Air Injection
PASS, PSGR	Passenger
P/B	Power Brakes
PC	Pressure Control
PCB	Printed Circuit Board
PCS	Pressure Control Solenoid
PCV	Positive Crankcase Ventilation
PEB	Power Electronics Bay
PID	Parameter Identification
PM	Permanent Magnet Generator
P/N	Part Number
PNK	Pink
PNP	Park/Neutral Position
PRNDL	Park, Reverse, Neutral, Drive, Low
POS	Positive, Position
POT	Potentiometer Variable Resistor
PPL	Purple
ppm	Parts per Million
PROM	Programmable Read Only Memory
P/S, PS	Power Steering
PSP	Power Steering Pressure
psi	Pounds per Square Inch
psia	Pounds per Square Inch Absolute
psig	Pounds per Square Inch Gauge
pt	Pint
PTC	Positive Temperature Coefficient
PWM	Pulse Width Modulated

Q	
qt	Quart(s)
R	
R-134a	Refrigerant-134a
RAM	Random Access Memory, Non-permanent memory device, memory contents are lost when power is removed.
RAP	Retained Accessory Power
RCDLR	Remote Control Door Lock Receiver
Ref	Reference
Rev	Reverse
RF	Right Front, Radio Frequency
RFA	Remote Function Actuation
RFI	Radio Frequency Interference
RH	Right Hand
Rly	Relay
ROM	Read Only Memory, Permanent memory device, memory contents are retained when power is removed.
RPM	Revolutions per Minute Engine Speed
RPO	Regular Production Option
RR	Right Rear
RSE	Rear Seat Entertainment
RT	Right
RTV	Room Temperature Vulcanizing Sealer
RWD	Rear Wheel Drive
S	
s	Second(s)
SAE	Society of Automotive Engineers
SDM	Sensing and Diagnostic Module
SEO	Special Equipment Option
SFI	Sequential Multiport Fuel Injection
SI	System International Modern Version of Metric System
SIAB	Side Impact Air Bag
sol	Solenoid
SO^2	Sulfur Dioxide
SP	Splice Pack
S/P	Series/Parallel
SPO	Service Parts Operations
SPS	Service Programming System, Speed Signal
sq ft, ft^2	Square Foot/Feet
sq in, in^2	Square Inch/Inches
SIR	Supplemental Restraint System

SS	Shift Solenoid
ST	Scan Tool
Sw	Switch
SWPS	Steering Wheel Position Sensor
syn	Synchronizer
T	
TAC	Throttle Actuator Control
Tach	Tachometer
TBI	Throttle Body Fuel Injection
TCC	Torque Converter Clutch
TCS	Traction Control System
TDC	Top Dead Center
TEMP	Temperature
Term	Terminal
TFP	Transmission Fluid Pressure
TFT	Transmission Fluid Temperature
TOC	Transmission Oil Cooler
TP	Throttle Position
TPA	Terminal Positive Assurance
TPM	Tyre Pressure Monitoring, Tyre Pressure Monitor
TR	Transmission Range
TRANS	Transmission/Transaxle
TT	Tell Tail Warning Lamp
TV	Throttle Valve
TVV	Thermal Vacuum Valve
TWC	Three Way Converter Catalytic
TWC+OC	Three Way + Oxidation Converter Catalytic
TXV	Thermal Expansion Valve
U	
UART	Universal Asynchronous Receiver Transmitter
U/H	Underhood
U-joint	Universal Joint
UV	Ultraviolet
V	
V	Volt(s), Voltage
V6	Six-Cylinder Engine, V-Type
V8	Eight-Cylinder Engine, V-Type
Vac	Vacuum
V dif	Voltage Difference
VDOT	Variable Displacement Orifice Tube

VDV	Vacuum Delay Valve
vel	Velocity
VF	Vacuum Fluorescent
VIO	Violet
VIN	Vehicle Identification Number
VLR	Voltage Loop Reserve
VMV	Vacuum Modulator Valve
VR	Voltage Regulator
V ref	Voltage Reference
VSES	Vehicle Stability Enhancement System
VSS	Vehicle Speed Sensor
W	
w/	With
W/B	Wheel Base
WHL	Wheel
WHT	White
w/o	Without
WOT	Wide Open Throttle
W/P	Water Pump
W/S	Windshield
WSS	Wheel Speed Sensor
WU-OC	Warm Up Oxidation Converter Catalytic
WU-TWC	Warm Up Three-Way Converter Catalytic
X	
X-valve	Expansion Valve
Y	
yd	Yard(s)
YEL	Yellow

Lifting and Jacking the Vehicle



Caution: To help avoid personal injury, always use jack stands when you are working on or under any vehicle that is supported only by a jack.

Caution: Refer to General Repair Instructions in the Preface section.

Notice: Refer to General Repair Instructions in the Preface section.

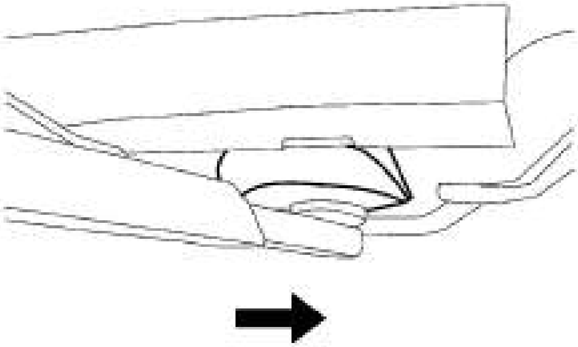
Before you begin any lifting procedure, be sure the vehicle is on a clean, hard, level surface. Be sure all the lifting equipment meets weight standards and is in good working order. Be sure all the vehicle loads are equally distributed and secure. If you are only supporting the vehicle at the frame side rails, make sure the lifting equipment does not put too much stress on or weaken the frame side rails.

If you use any other lifting methods than the preferred vehicle jacking locations (1), take special care not to damage the fuel tanks, the exhaust system or the underbody.

Notice: Refer to General Repair Instructions in the Preface section.

Vehicle Lifting - Frame Contact Hoist

Front Hoist Pads

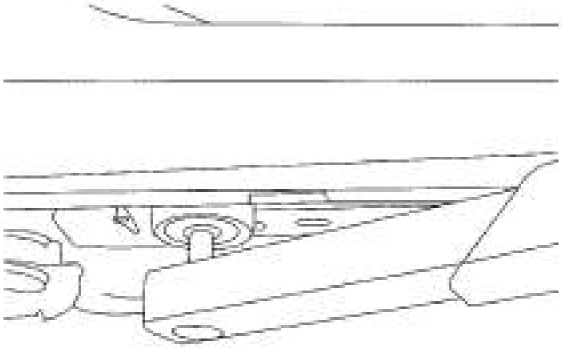


Important: The front hoist pads must not contact the rocker panels, the front mud guards, or the floor pan.

Position the front hoist pads as follows:

Under the front frame box section.

Rear Hoist Pads



Important: The rear hoist pads must not contact the rocker panels to the outside of the side frame rails or the floor pan.

Position the rear hoist pads as follows:

Under the junction between the rear frame rails and the side frame rails.

Special Tools Ordering Information

The special service tools shown in this service manual that have product numbers beginning with J, SA or BT are available for worldwide distribution from:

SPX Australia Pty.Ltd
300 Wellington Road
Mulgrave, Victoria Australia 3170

Phone: (03) 9544 6222

Fax: (03) 9544 6222

Email: sales@spx.com.au

Internet: www.spx.com.au

Air / Wind Noise

Caution: Refer to Assistant Driving Caution in the Preface section.

- Test drive the vehicle to determine the origin of the reported wind noise.
- Choose a regular route with smooth and straight roads that run in all 4 directions: North, South, East, and West. The area should have little traffic or little noise in order to eliminate interference with the test.

  Important: Often there is one primary leak source and one or more secondary leak sources that contribute to the noise condition. Repairing only one of the contributing leak sources may not completely repair the total condition but only reduce the condition.

- Drive the vehicle at the speed in which the noise was noticed, or until the noise is heard. Maintain safe and legal speeds.
- Many of the waterleak diagnosis tests are also used for the wind noise diagnosis.
- Most wind noise is caused either by leaking seals or by misaligned body surfaces.
- Wind whistle

  When moving at highway speeds, air pressure inside the vehicle becomes greater than the air pressure outside. When a leak occurs, the escaping air causes a hiss or a whistle.

- Wind roar

  Wind roar occurs when air passes over or through an opening between the 2 body surfaces. To correct the condition, adjust the alignment of the body surfaces.

- Wind rush

  Wind rush occurs when air presses over the vehicle's body, and is related to the aerodynamics of the vehicle. Wind whistle and wind roar are repairable. Rule out wind whistle and wind roar before concluding that the wind noise is due to wind rush.

Use the following inspections in order to aid in diagnosing wind whistle or wind roar:

1. Note the details for wind noise:
   - The perceived location
   - The location where the noise is loudest
   - When the noise occurs
   - The vehicle speed
   - The interior fan speed
   - The position of the windows
   - What the noise sounds like
2. Inspect the vehicle for the possible cause of the wind noise.
3. Test drive the vehicle and determine if the wind noise is external or internal.
4. Perform a visual inspection at the perceived location of the wind noise for the following:
   - Loose fasteners
   - Torn weatherstrips
   - Broken weld joints

- Sealer and/or adhesive skips

Tracing Powder or Chalk Test

1. Clean the weatherstrips and the contact surfaces with cleaning solvent.
2. Apply tracing powder or chalk in an unbroken line to the contact surface of the weatherstrip surrounding the perimeter of the suspected areas.
3. Close the panel completely without slamming the panel. Closing the panel completely presses the weatherstrip firmly against the mating surface.
4. Inspect the applied line on the weatherstrip. The applied line is marred where contact is good. A corresponding imprint is on the mating surfaces.
5. Gaps or irregularities in the powder or the chalk line on the mating surfaces indicate the areas with a poor seal.

Air Pressure Test

1. Mask off the body ventilation outlets.
2. Close all the windows.
3. Turn the vehicle's ventilation fan to the ON position, with the selector on high speed and in the defrost mode.
4. Unlock and close the doors.
5. Listen for escaping air along the door and the window seals with a mechanic's stethoscope or a length of heater hose.

Soap Suds or Bubble Test

1. Mask off the body ventilation outlets.
2. Close all the windows and the doors.
3. Turn the vehicle's ventilation fan to the ON position, with the selector on high speed and in the defrost mode.
4. Unlock and close the doors.
5. Apply the soap solution to the potential leak areas.
6. Look for bubbles revealing escaping air.

Exterior Windnoise

Caution: Refer to Assistant Driving Caution in the Preface section.

Exterior wind noise is louder when the vehicle is driven with one or more windows down. Exterior wind noise occurs when air passes over the body panels, the seams, or the openings. Use the following items during the test drive in order to aid in the detection of leaks:

- Mechanic's stethoscope or heater hose
- Masking tape - 50 mm (2 in) width

1. While driving, determine the location of the exterior wind noise by lowering one window at a time. If the location corresponds with the condition in step 2, pull over and make a temporary repair with 50 mm (2 in) wide masking tape.
2. Tape over the gaps and the moldings one at a time. Test between each taping. Taping over the gaps and moldings will correct the condition.
3. Temporarily repair the condition with masking tape. Adjust the tape when needed.
4. Continue testing in order to determine if the noise has been eliminated or other leak areas exist.
5. When all the reported leak conditions are located, make permanent repairs using the correct alignment techniques and sealing materials.

Interior Windnoise

Caution: Refer to Assistant Driving Caution in the Preface section.

Interior wind noise is not heard when the window is lowered. Interior wind noise is caused by the air leaving the inside of the vehicle through a seal or a seam.

1. Mask off the body ventilation outlets to cause added air pressure within the vehicle.
2. Test drive the vehicle and listen for wind noise or a whistle.
3. Pull the vehicle over and make the temporary repairs using masking tape. If you cannot determine the source of the wind noise, perform one or more of the following diagnostic tests:
    - Tracing Powder or Chalk Test.
    - Air Pressure Test.
    - Soap Suds or Bubble Test.

Approximate Fluid Capacities

The following approximate capacities are given in English and metric conversions. See Fluid and Lubricant Recommendations, for more information. All capacities are approximate. When adding, be sure to fill to the approximate level, as recommended in this manual. Re check fluid level after filling.

Application	Specification	
	Metric	English
Cooling System		
3.6L Engine	10 Litres	8.8 Quarts
6.0L Engine	11 Litres	9.7 Quarts
Engine Oil with Filter		
3.6L Engine	6.5 Litres	5.7 Quarts
6.L0 Engine	8.3 Litres	7.3 Quarts
Fuel Tank	73 Litres	16 Gallons
Automatic Transmission		
5L40E 5-Speed - Drain and Refill	6 liters	5.3 quarts
4L60E 4-Speed - Drain and Refill	4.8 Litres	4.22 Quarts
4L65E 4-Speed - Drain and Refill	5 Litres	4.4 Quarts
6L80E 6-Speed - Drain and Refill	5.7 Litres	6.0 Quarts
5L40E 5-Speed - Complete Overhaul	8.5 Liters	7.4 Quarts
4L60E 4-Speed - Complete Overhaul	7.9 Litres	7 Quarts
4L65E 4-Speed - Complete Overhaul	10.6 Litres	9.3 Quarts
6L80E 6-Speed - Complete Overhaul	9.9 Litres	8.7 Quarts
5L40E 5-Speed - Dry	8.5 Liters	7.4 Quarts
4L60E 4-Speed - Dry	7.9 Litres	7 Quarts
4L65E 4-Speed - Dry	10.6 Litres	9.3 Quarts
6L80E 6-Speed - Dry	9.9 Litres	8.7 Quarts
Manual Transmission		
D173 6-Speed	1.8 liters	1.6 quarts
Tremec T56 6-Speed	3.9 liters	3.4 quarts
Differential		
Drain and Fill With Cover Removed	1.2 liters	1 quart
Drain and Fill With Use of Drain Plug	1.0 liters	0.88 quarts

Tire Inflation Pressure Specifications

Inflation Pressure Conversion (Kilopascals to Psi)

Refer to the Tyre Placard located on the B pillar of the vehicle for the correct tyre inflation pressure and load for the factory installed tyres. The tyre pressures may be printed in both kilopascal (kPa) and psi. The correct tyre inflation pressures for the factory installed tyres is when the tyres are cold. "Cold" means the vehicle has been sitting for at least 3 hours or driven no more than 1.6 km (1 mi). Inspect the tyres inflation pressure when the tyres are cold. *One psi equals 6.9 kPa.*

kPa	psi	kPa	psi
140	20	215	31
145	21	220	32
155	22	230	33
160	23	235	34
165	24	240	35
170	25	250	36
180	26	275	40
185	27	310	45
190	28	345	50
200	29	380	55
205	30	415	60

Conversion: 6.9 kPa=1 psi

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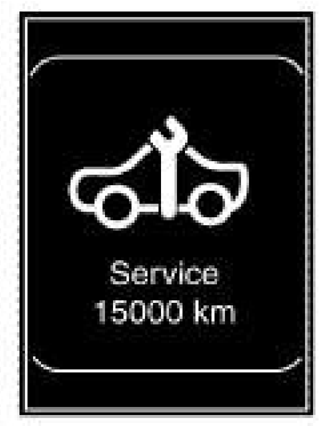
Service Display Reminders

Service Reminder Display



The instrument cluster will display the service condition of the vehicle on the Multi Function Display (MFD). Activation of the Service Reminder Display is determined on the current odometer value and value of the next service interval. The three possible states of the display are as follows:

Service Before Due

The MFD shows a reminder 1000 km before a service is due. The service interval becoming due is displayed on the MFD, and only the spanner in the icon flashes. This service reminder is displayed for up to 10 seconds whenever the ignition is switched ON or OFF. This will occur until the service reminder is cleared from the display using the TRIP or ENTER steering wheel switches or until the service reminder is reset.

Service Overdue

When a service is overdue by less than 5000 km, the MFD shows a flashing icon for up to 10 seconds when the ignition is switched ON or OFF. This will occur until the service reminder is cleared from the display using the TRIP or ENTER steering wheel switches or until the service reminder is reset.

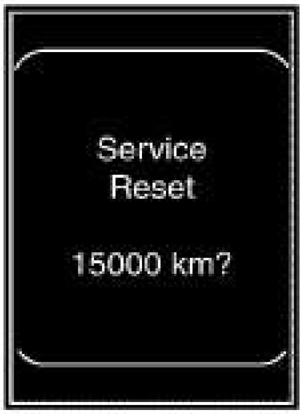
Service Well Overdue

When a service is overdue by more than 5000 km, the MFD shows a flashing icon for up to 10 seconds whenever the ignition is switched ON or OFF. This will occur until the service reminder is cleared from the display using the TRIP or ENTER steering wheel switches or until the service reminder is reset. This event is permanently logged in the instrument cluster memory (EEPROM).

Service Reminder Reset Procedure

The displayed service reminder is reset using the scan tool or by the following procedure:

1. Turn the ignition to the OFF position.
2. Press and hold the TRIP button.
3. Turn the ignition to the ON position.
4. Release the TRIP button.



Service
Reset

15000 km?

Important: A confirmation beep will sound upon reset.

5. Once in the Service Reset screen, press and hold the ENTER switch for 3-5 seconds.

   Important: If the service reminder comes back on when you start the vehicle, the Service Reminder Display has not reset. Repeat the procedure.

6. Turn the ignition to the OFF position.

GM Oil Life System Resetting

When the system has calculated that oil life has been diminished, it will indicate that an oil change is necessary. A CHANGE ENGINE OIL SOON message will come on. Change the engine oil as soon as possible within the next 600 miles (1000 km). It is possible that, if driving under the best conditions, the oil life may not indicate that an oil change is necessary for over a year. However, the engine oil and filter must be changed at least once a year and at this time the system must be reset.

If the system is ever reset accidentally, change the engine oil at 3000 miles (5000 km) since last oil change.

Resetting Procedure

Follow this procedure to reset the GM Oil Life System ™:

1. Turn the ignition to ON with the engine off.
2. Press the TRIP button so the OIL LIFE percentage is displayed.
3. Press the RESET and hold for two seconds. OIL LIFE REMAIN 100 percent will appear.

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Document ID: 2015527

Tire and Wheel Assembly Runout Measurement - Off Vehicle

Tire and Wheel Runout Measurement - Off-Vehicle

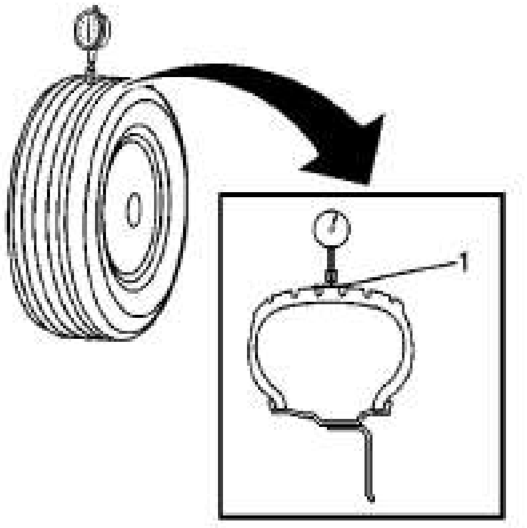
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Mark the location of each tyre and wheel assembly in relation to the vehicle.
3. Remove the tyre and wheel assemblies from the vehicle. Refer to Tire and Wheel Removal and Installation.
4. Closely inspect each tyre for correct and even bead seating.
5. If any of the tyre beads were not correctly or evenly seated, reseat the tyre bead, then proceed to step 6. Refer to Tire Dismounting and Mounting.

Important: The wheel must be mounted on the spin-type wheel balancer in accordance with manufacturers instructions.

6. Mount a tyre and wheel assembly on a spin-type wheel balancer.

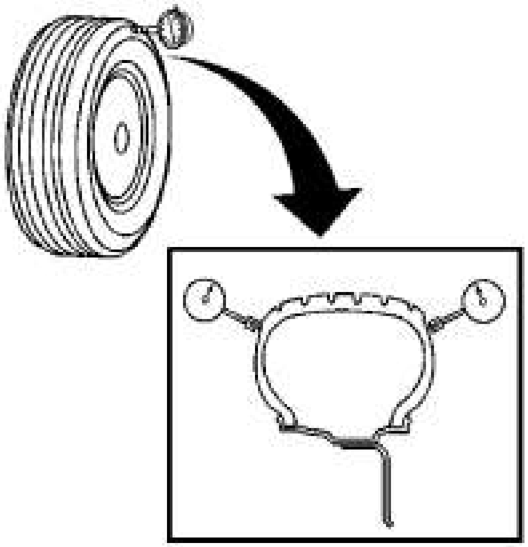


Important: Wrapping the tread with tape allows for a smooth and accurate reading of radial runout to be obtained.

7. Wrap the outer circumference of each tire with tape (1) in the center tread area.
8. Position the dial indicator fitted with a roller, on the taped portion of the tyre tread perpendicular to the surface.

9. Slowly rotate the tyre and wheel assembly one complete revolution in order to find the low point.
10. Set the dial indicator to zero at the low point.
11. Slowly rotate the tyre and wheel assembly one more complete revolution and measure the total amount of radial runout.

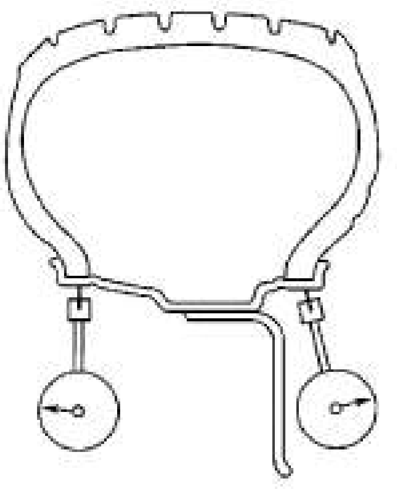
    Specification
    Maximum tyre and wheel assembly radial runout - measured off-vehicle: 1.27 mm (0.050 in)



12. Position the dial indicator fitted with a roller on a smooth portion of the tyre sidewall, perpendicular to the surface, as close as possible to the tread area.
13. Slowly rotate the tyre and wheel assembly one complete revolution in order to find the low point. Ignore any jumps or dips due to sidewall splices.
14. Set the dial indicator to zero at the low point.
15. Slowly rotate the tyre and wheel assembly one more complete revolution and measure the total amount of lateral runout. Ignore any jumps or dips due to sidewall splices and attain an average runout measurement.

    Specification
    Maximum tyre and wheel assembly lateral runout - measured off-vehicle: 1.27 mm (0.050 in)

16. Repeat steps 6 through 15 until all tyre and wheel assembly, radial and lateral runout measurements have been taken.
17. If the tyre and wheel assembly runout measurements are not within specifications, proceed to step 19.
18. If the tyre and wheel assembly runout measurements are within specifications, then the off-vehicle tyre and wheel assembly runout is considered acceptable.

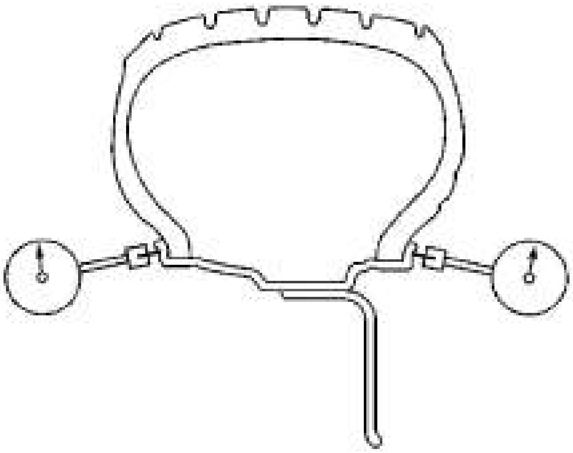


Important: Wheel runout should be measured on both the inboard and outboard rim flanges, unless wheel design will not permit. Ignore any jumps or dips due to paint drips, chips, or welds.

19. Position the dial indicator fitted with a roller perpendicular to the horizontal outer surface of the wheel rim flange, with the tyre still mounted.
20. Slowly rotate the tyre and wheel assembly one complete revolution in order to find the low point.
21. Set the dial indicator to zero at the low point.
22. Slowly rotate the tyre and wheel assembly one more complete revolution and measure the total amount of wheel radial runout.

Specification

- Maximum aluminium wheel radial runout - measured off-vehicle, tire mounted: 0.762 mm (0.030 in)
- Maximum steel wheel radial runout - measured off-vehicle, tire mounted: 1.015 mm (0.040 in)



Important: Wheel runout should be measured on both the inboard and outboard rim flanges, unless wheel design will not permit. Ignore any jumps or dips due to paint drips, chips, or welds.

23. Position the dial indicator fitted with a roller perpendicular to the vertical outer surface of the wheel rim flange, with the tyre still mounted.
24. Slowly rotate the tyre and wheel assembly one complete revolution in order to find the low point.
25. Set the dial indicator to zero at the low point.
26. Slowly rotate the tyre and wheel assembly one more complete revolution and measure the total amount of wheel lateral runout.

    Specification

    - Maximum aluminium wheel lateral runout - measured off-vehicle, tire mounted: 0.762 mm (0.030 in)
    - Maximum steel wheel lateral runout - measured off-vehicle, tire mounted: 1.143 mm (0.045 in)
27. Repeat steps 19 through 26 until all tyre and wheel assembly wheel, radial and lateral runout measurements have been taken.
28. If any of the wheel runout measurements are not within specifications. Refer to Wheel Runout Measurement below.
29. If the wheel runout measurements are within specifications, replace the tyre. Refer to Tire Dismounting and Mounting.
30. Remeasure the runout of the affected tyre and wheel assembly, or assemblies after replacement of any tyres.
31. Install the tyre and wheel assembly in the original location in relation to the vehicle. Refer to Tire and Wheel Removal and Installation.
32. Remove the safety stands.
33. Lower the vehicle.

Wheel Runout Measurement

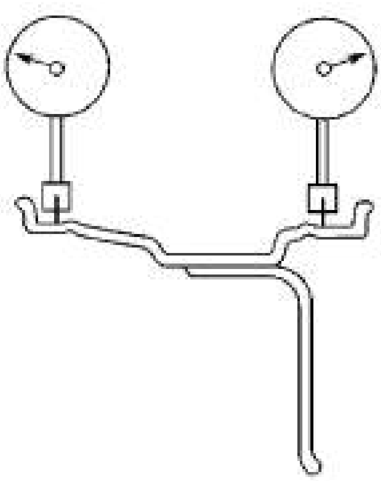
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Mark the location of each tyre and wheel assembly in relation to the vehicle.
3. Remove the tyre and wheel assemblies from the vehicle. Refer to Tire and Wheel Removal and Installation.
4. Using a suitable marker indicate on the tyre, the orientation of the tyre to the wheel valve stem.
5. Remove the tyre from the wheel. Refer to Tire Dismounting and Mounting.

Important: The wheel must be mounted on the spin-type wheel balancer in accordance with manufacturers instructions.

6. Install the wheel on a spin-type wheel balancer.

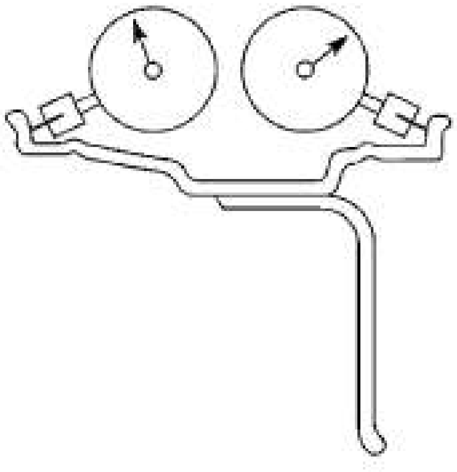


Important: Measure wheel runout on both the inboard and outboard rim flanges. Ignore any jumps or dips due to paint drips, chips, or welds.

7. Position the dial indicator fitted with a roller perpendicular to the horizontal inner surface of the wheel rim flange.
8. Slowly rotate the wheel one complete revolution in order to find the low point.
9. Set the dial indicator to zero at the low point.
10. Slowly rotate the wheel one more complete revolution and measure the total amount of wheel radial runout.

Specification

- Maximum aluminium wheel radial runout - measured off-vehicle, tyre dismounted: 0.762 mm (0.030 in)
- Maximum steel wheel radial runout - measured off-vehicle, tyre dismounted: 1.015 mm (0.040 in)



Important: Measure wheel runout on both the inboard and outboard rim flanges. Ignore any jumps or dips due to paint drips, chips, or welds.

11. Position the dial indicator fitted with a roller perpendicular to the vertical inner surface of the wheel rim flange.
12. Slowly rotate the wheel one complete revolution in order to find the low point.
13. Set the dial indicator to zero at the low point.
14. Slowly rotate the wheel one more complete revolution and measure the total amount of wheel lateral runout.

    Specification

    - Maximum aluminium wheel lateral runout - measured off-vehicle, tyre dismounted: 0.762 XX mm (0.030 in)
    - Maximum steel wheel lateral runout - measured off-vehicle, tyre dismounted: 1.143 XX mm (0.045 in)
15. Repeat steps 2 through 14 until all tyre and wheel assemblies, radial and lateral runout measurements have been taken.
16. If any of the wheel runout measurements are not within specifications, replace the wheel. Refer to Replacement Wheels Description and Tire Dismounting and Mounting.

Important: Always measure the runout of any of the tyre and wheel assemblies after mounting the tyre.

Important: If refitting the original tyre on the original wheel align the mark on the tyre with the valve stem on the wheel.

17. Install the tyre to the wheel. Refer to Tire Dismounting and Mounting.
18. Install the tyre and wheel assembly in the original location in relation to the vehicle. Refer to Tire and Wheel Removal and Installation.
19. Remove the safety stands.
20. Lower the vehicle.

Tire and Wheel Assembly Runout Measurement - On-Vehicle

Because the runout of a tyre and wheel assembly will directly affect the amount of imbalance and radial force variation, it should be minimised. The smaller the amount of runout, the less imbalance and force variation. Radial and lateral runout can be corrected at the same time. There are two methods to measure runout of the tyre and wheel assemblies:

- On the vehicle (mounted to the hub), the wheel bearing must be in good condition.
- Off the vehicle (mounted on a spin-type wheel balancer). Refer to Tire and Wheel Assembly Runout Measurement - Off Vehicle .

Measuring the tyre and wheel runout off the vehicle is most accurate. It is usually easier to mount a dial indicator in the correct position and possibilities of inaccuracies are decreased. Once the runout has been measured and corrected off the vehicle, a quick visual check of runout on the vehicle will indicate if any further problems exist.

If there is a large difference in the runout measurements from on-vehicle to off-vehicle, then the runout problem is due to hub flange runout, refer to Front Wheel Hub Assembly Inspection , or a mounting problem between the wheel and the vehicle.

Before measuring or attempting to correct excessive runout, carefully check the tyre for an uneven bead seat. The distance from the edge of the ring to the concentric rim locating-ring should be equal around the entire circumference. If the beads are not seated correctly, the tyre should be remounted. Otherwise, excessive runout and imbalance will result.

If the runout of the wheel is within tolerance, and the tyre and wheel assembly runout cannot be reduced to an acceptable level by using the match-mounting technique, the tyre must be replaced. ALWAYS MEASURE THE TYRE AND WHEEL ASSEMBLY runout AFTER REPLACING THE TYRE.

The tolerances listed are to serve as guidelines. If runout measurements are within tolerance but are marginal, some sensitive vehicles may still be affected. It is always advisable to reduce runout to as little as possible in order to attain optimum results under all conditions.

Important: If the vehicle has been sitting in one place for a long time, flat spots may exist in the area where the tyre is in contact with ground. As the flat spots affect runout readings, they should be removed by driving the vehicle until the tyres reach normal operating temperature before conducting any runout measurements.

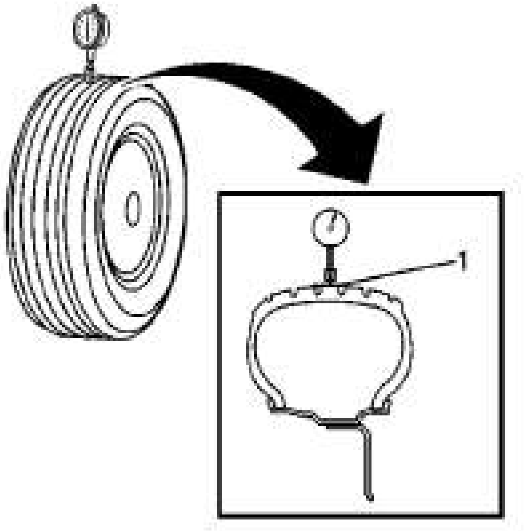
Tire and Wheel Runout Measurement - On-Vehicle

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Inspect each tyre for correct and even bead seating.
3. If any of the tyre beads are not correctly or evenly seated, reseat the tyre bead. Refer to Tire

Dismounting and Mounting , then proceed to step 4.

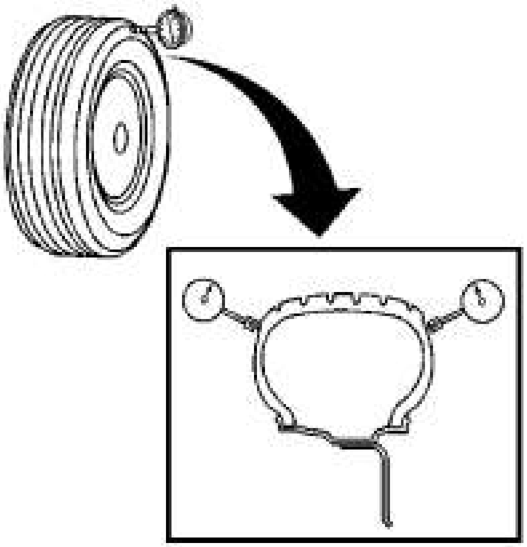


Important: Wrapping the tread with tape allows for a smooth and accurate reading of radial runout to be obtained.

4. Wrap the circumference of each tyre with tape (1) in the center of the tread area.
5. Position a dial indicator fitted with a roller, on the taped portion of the tyre tread perpendicular to the surface.
6. Slowly rotate the tyre and wheel assembly one complete revolution in order to find the low point.
7. Set the dial indicator to zero at the low point.
8. Slowly rotate the tyre and wheel assembly one more complete revolution and measure the total amount of radial runout.

Specification

Maximum tyre and wheel assembly radial runout - measured on-vehicle: 1.52 mm (0.060 in)



9. Position the dial indicator fitted with a roller on a smooth portion of the tyre sidewall, perpendicular to the surface, as close as possible to the tread area.
10. Slowly rotate the tyre and wheel assembly one complete revolution in order to find the low point. Ignore any jumps or dips due to sidewall splices.
11. Set the dial indicator to zero at the low point.
12. Slowly rotate the tyre and wheel assembly one more complete revolution and measure the total amount of lateral runout. Ignore any jumps or dips due to sidewall splices and attain an average runout measurement.

    Specification
    Maximum tyre and wheel assembly lateral runout - measured on-vehicle: 1.52 mm (0.060 in)

13. If required repeat steps 4 through 12 until all tyre and wheel assemblies, radial and lateral runout measurements have been taken.
14. Remove the dial indicator
15. Remove the safety stands.
16. Lower the vehicle.

Tire and Wheel Assembly Balancing - Off Vehicle (LWB SWB)

Caution: Failure to adhere to the following precautions before tire balancing can result in personal injury or damage to components:

- Clean away any dirt or deposits from the inside of the wheels.
- Remove any stones from the tread.
- Wear eye protection.
- Use coated weights on aluminum wheels.

Tyre and Wheel Assembly Balancer Calibration

1. Tyre and wheel balancers can drift out of calibration over time, or can become inaccurate as a result of heavy use. It is likely there will not be any visual evidence that a calibration problem exists. If a balancer is not calibrated within specifications, and a tyre and wheel assembly is balanced on that machine, the assembly may actually be unbalanced.
2. Tyre and wheel assembly balancer calibration should be checked and serviced in accordance with manufacturer's specifications and recommendations.

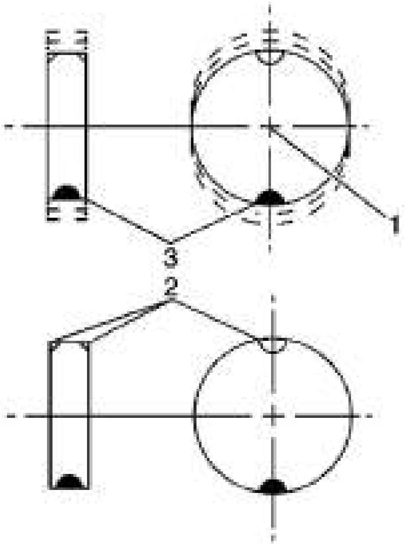
Tyre and Wheel Assembly Balancing Guidelines

Important: Tyre and wheel assemblies which exhibit excessive runout can produce vibrations even if the assemblies are balanced.

It is strongly recommended that the tyre and wheel assembly runout be measured and corrected if necessary before the assemblies are balanced.

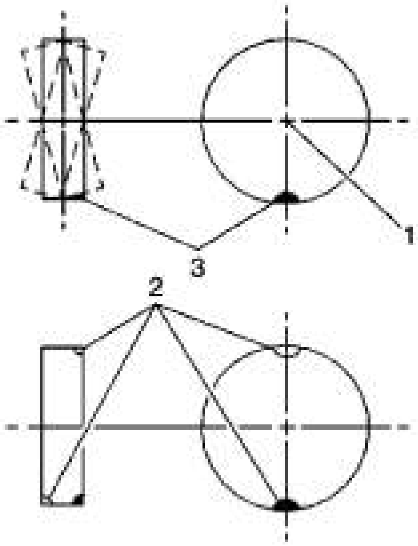
1. If the runout of the tyre and wheel assemblies has not yet been measured, refer to Tire and Wheel Assembly Runout Measurement - On-Vehicle , before proceeding.
2. There are 2 types of tyre and wheel balance:

Static Balance



1. Static balance is the equal distribution of weight around the wheel circumference. The wheel balance weights (2) are positioned on the wheel in order to offset the effects of a heavy spot (3).
2. Wheels that have static imbalance can produce a bouncing action around the wheel centre (1) called tramp.

Dynamic Balance



1. Dynamic balance is the equal distribution of weight on each side of the tyre and wheel assembly centre-line. The wheel balance weights (2) are positioned on the wheel in order to offset the effects of a heavy spot (3). Wheels that have dynamic imbalance have a tendency to move from side to side around the wheel centre (1) called shimmy.

2. Most off-vehicle balancers are capable of checking both types of balance simultaneously.
3. As a general rule, most vehicles are more sensitive to static imbalance than to dynamic imbalance; however, vehicles equipped with low profile, wide tread path, high performance tyres and wheels are susceptible to small amounts of dynamic imbalance.

Balancing Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Important: When balancing tyre and wheel assemblies, use a calibrated and well maintained, off-vehicle, two-plane dynamic balancer set to the finest balance mode available.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

   Important: Note the location of each tyre and wheel assembly in relation to the original position on the vehicle.

2. Remove the tyre and wheel assemblies. Refer to Tire and Wheel Removal and Installation.

   Important: The wheel must be mounted on the spin-type wheel balancer in accordance with manufacturers instructions.

3. Mount a tyre and wheel assembly on a spin-type wheel balancer.
4. Cycle the wheel balancer to determine if a tyre and wheel assembly imbalance exists.
   - If an imbalance is found remove and discard all wheel weights from the tyre and wheel assembly and continue the procedure.
   - If an imbalance is not found. Refer to Strategy Based Diagnosis.

   Important: The correct type of wheel balance weights for the type of wheel rim being balanced must be used. The correct type of coated wheel balance weights for aluminium wheels must be used. Refer to Wheel Weight Usage within this procedure.

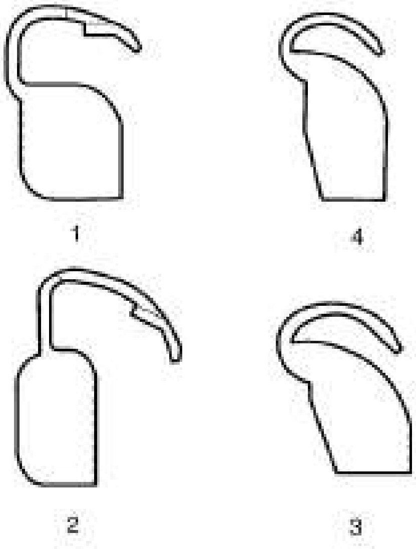
   Important: The tyre and wheel assembly must be balanced in accordance with the wheel balancer manufacturers instructions.

5. Balance all of the tyre and wheel assemblies.

   Important: The tyre and wheel assemblies must be installed in the correct location in relation to the original position on the vehicle.

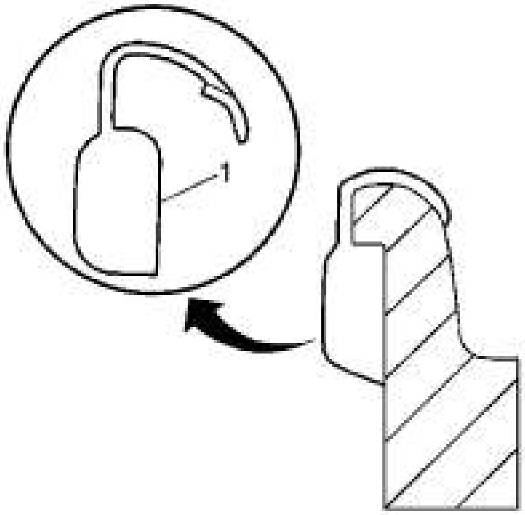
6. Install the tyre and wheel assemblies. Refer to Tire and Wheel Removal and Installation.
7. Remove the safety stands.
8. Lower the vehicle.

Wheel Weight Usage



Important: When balancing factory aluminium wheels with clip-on wheel balance weights, be sure to use special polyester-coated weights. These coated weights reduce the potential for corrosion and damage to aluminium wheels.

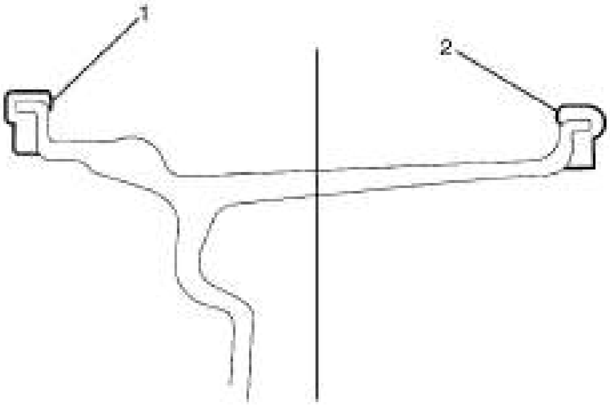
1. MC (1) and AW (2) series weights are approved for use on aluminium wheels.
2. P (3) series weights are approved for use on steel wheels only.
3. T (4) series coated weights are approved for use on both steel and aluminium wheels.



Important: A nylon or plastic-tipped hammer must be used when installing coated clip-on wheel balance weights to minimize the possibility of damage to the polyester coating and wheel surface.

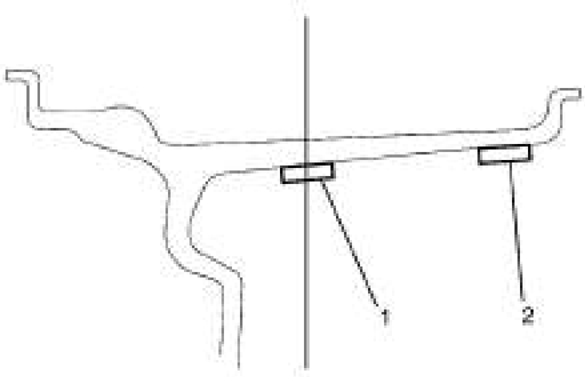
1. The contour and style of the wheel rim flange will determine which type of clip-on wheel weight (1) should be used.
2. The weight should follow the contour of the rim flange. The weight clip should firmly grip the rim flange.

Wheel Weight Placement - Clip-on Weights



When balancing, install the wheel balance weights on the inboard (2) and outboard (1) rim flanges at the positions specified by the wheel balancer.

Wheel Weight Placement - Adhesive Weights



Important: When installing adhesive balance weights on flangeless wheels, do not install the weight on the outboard surface of the rim.

1. Adhesive wheel balance weights may be used on factory aluminium wheels. Perform the following procedure to install adhesive wheel balance weights.
2. Determine the correct areas for placement of the wheel weights on the wheel.

   When balancing, locate the wheel balance weights along the wheel centre-line (1) and the inboard edge (2) of the inner wheel surface at the positions specified by the wheel balancer.

3. Make sure that there is sufficient clearance between the wheel weights and brake system components.

   Important: Do not use abrasives to clean any surface of the wheel. The balance weight attachment areas must be free from corrosion, dirt, oil or any other foreign material.

4. Clean the designated balance weight attachment areas.
5. Dry the attachment areas with hot air until the wheel surface is warm to the touch.
6. Warm the adhesive backing on the wheel balance weights to room temperature.

   Important: Do not touch the adhesive surface.

7. Remove the protective covering from the adhesive backing on the back of the balance weights.

   Important: Press the wheel balance weights into place with firm hand pressure.

8. Install the wheel balance weights to the wheel.

Tire and Wheel Assembly Balancing - On-Vehicle (LWB SWB)

Important: The tyre and wheel assembly must be balanced off vehicle before attempting to balance the tyre and wheel assembly on vehicle. Refer to Tire and Wheel Balancing.

If after following the tyre and wheel vibration diagnostic process, some amount of tyre and wheel vibration is still evident, an on-vehicle high-speed spin balancer may be used to perform an on-vehicle balance in an attempt to finish balance the tyre and wheel assemblies, wheel hubs, brake rotors and wheel trim, if equipped, simultaneously. On-vehicle balancing can also compensate for minor amounts of residual runout encountered as a result of mounting the tyre and wheel assembly on the vehicle, as opposed to the balance which was achieved with the off-vehicle balancing procedure.

Important: Note the following information before performing the on-vehicle tyre and wheel balance:

- Vehicles equipped with low profile, wide tread path, high performance tyres and wheels are susceptible to small amounts of dynamic imbalance.
- When performing an on-vehicle balance, care must be taken when placing the wheel balance weights on the wheels. If the wheel balance weights are not placed accurately, they can induce dynamic imbalance and increase the severity of the vibration.
- Inspect the wheel bearings to ensure that they are in good condition. Refer to Front Wheel Bearing and Hub Replacement or Rear Wheel Bearing and Hub Replacement.
- Thoroughly inspect all on-vehicle balancing equipment and make sure that it is within the manufacturer's recommended specifications.
- Do not remove the off-vehicle balance weights. The purpose of on-vehicle balance is to fine tune the assembly balance already achieved off-vehicle, not to start over.
- Leave all wheel trims installed whenever possible.
- If the on-vehicle balancer calls for more than 56 g (2 oz) of additional weight, split the weight between the inboard and outboard flanges of the wheel, so as not to upset the dynamic balance of the assembly achieved in the off-vehicle balance.

Perform the on-vehicle balancing procedure in accordance with the on-vehicle balancer manufacturer's instructions.

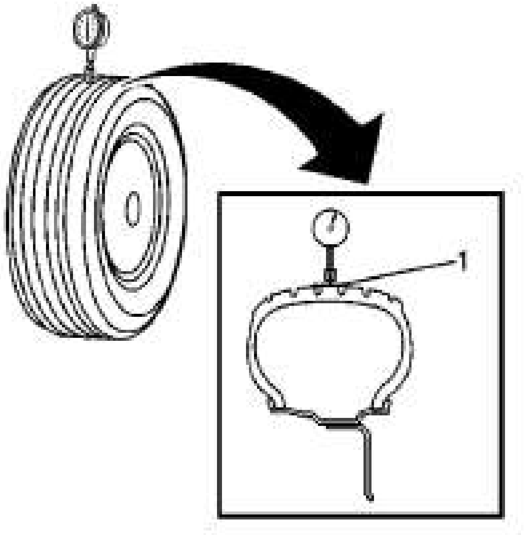
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | General Information | Vibration Diagnosis and Correction | Repair Instructions | **Document ID: 1990896**

Tire-to-Wheel Match-Mounting (Vectoring)

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the tyre and wheel assembly from the vehicle. Refer to Tire and Wheel Removal and Installation .

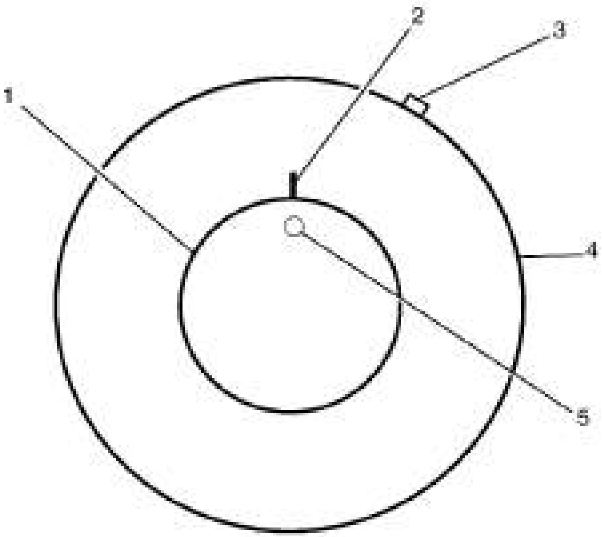
Important: The wheel must be mounted on the spin-type wheel balancer in accordance with manufacturers instructions.

3. Install the wheel on a spin-type wheel balancer.



Important: Wrapping the tread with tape allows for a smooth and accurate reading of radial runout to be obtained.

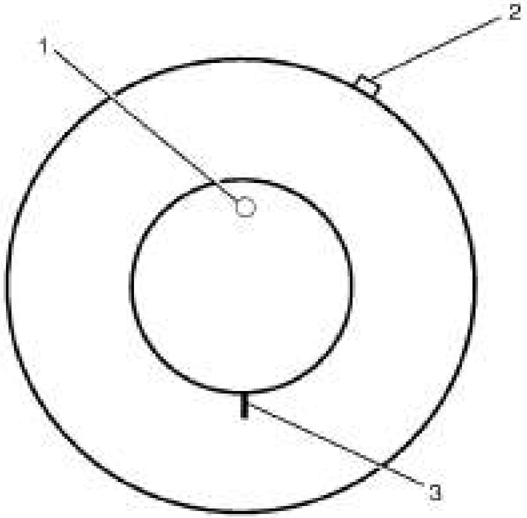
4. Wrap the circumference of each tyre with tape (1) in the center of the tread area.
5. Position a dial indicator fitted with a roller, on the taped portion of the tyre tread perpendicular to the surface.
6. Slowly rotate the tyre and wheel assembly one complete revolution in order to find the wheel high point.



7. Mark the location of the high point (3) on the tyre (4).
8. Place a reference mark (2) on the tyre sidewall at the location of the valve stem (5).
    - Always refer to the valve stem (5) as the 12 O'clock position.
    - Refer to the location of the high point (3) by its clock position on the wheel (1), relative to the valve stem (5).

Important: Do not dismount the tyre from the wheel.

9. Mount the tyre and wheel assembly on a tyre changing machine and break down the bead.



Important: lubricate the bead area in order to easily rotate the tyre on the wheel.

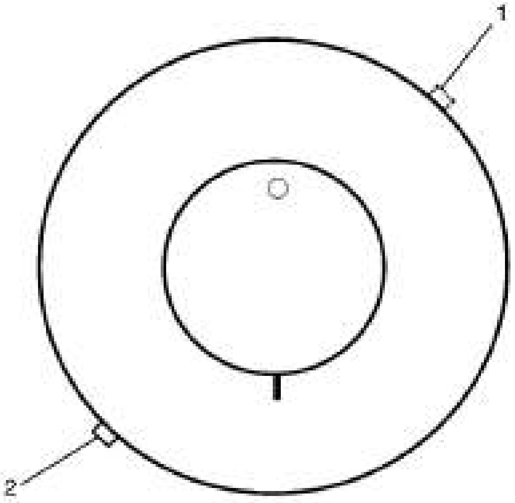
10. Rotate the tyre 180 degrees on the rim so that the valve stem reference mark (3) is now at the 6 O'clock position in relation to the valve stem (1).
11. Inflate the tyre and seat the bead, closely inspect each tyre for correct and even bead seating.

    Important: The wheel must be mounted on the spin-type wheel balancer in accordance with manufacturers instructions.

12. Install the wheel on a spin-type wheel balancer.
13. Position a dial indicator fitted with a roller, on the taped portion of the tyre tread perpendicular to the surface.
14. Slowly rotate the tyre and wheel assembly one complete revolution in order to find the wheel high point.

    Important: After remounting a tyre to a wheel or after replacing a tyre and/or a wheel, remeasure the tyre and wheel assembly runout in order to verify that the runout has been reduced and is within tolerance. Ensure that the tyre and wheel assembly is balanced before installing to the vehicle.

15. Measure the wheel and tyre assembly runout.
16. Mark the new location of the assembly runout high point on the tyre.
17. If the assembly runout has been reduced and is within tolerance, no further steps are necessary. Balance the tyre and wheel assembly, then install the assembly to the vehicle. Refer to the following:
    - Tire and Wheel Assembly Balancing - On-Vehicle Tire and Wheel Assembly Balancing - Off Vehicle .
    - Tire and Wheel Removal and Installation .
18. If the clock location of the high point remained at or near the original clock location of the high point (2) and the assembly runout has not been reduced, the wheel is the major contributor to the assembly runout concern. Replace the wheel. Refer to Tire Dismounting and Mounting and Replacement Wheels Description .



19. If the clock location of the high point has moved, however the assembly runout has not been reduced, perform the following steps:

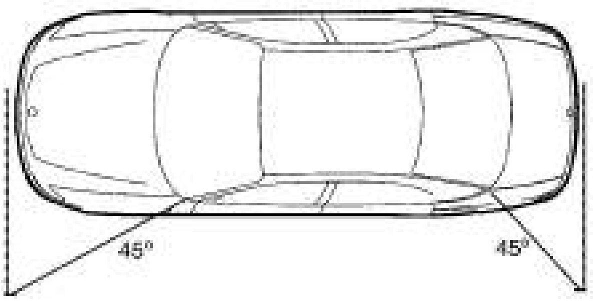
19.1. If the clock location of the high point (2) is now at or near a position 180 degrees from the original clock location of the high point (1), the tyre is the major contributor to the assembly runout concern. Replace the tyre. Refer to Tire Dismounting and Mounting .

19.2. If the clock location of the high point is now between the original high point position and the opposite extreme, then both the tyre and the wheel are contributing to the assembly runout concern. Continue rotating the tyre in relation to the wheel and remeasuring the assembly runout until the lowest amount of runout is achieved. If the lowest amount of runout achieved is not within tolerance measure the off vehicle tyre and wheel runout, refer to Tire and Wheel Assembly Runout Measurement - On-Vehicle in Tires and Wheels, in order to isolate the tyre or wheel as the cause of the runout concern.

Waterleak Test Preparation

- Holden vehicles are designed to operate under normal environmental conditions.
- The design criteria for sealing materials and components takes into consideration the sealing forces required to withstand the natural elements. These specifications cannot take into consideration any artificial conditions, i.e. high pressure car washes.
- The water leak test procedure has been correlated to the natural elements and will determine the ability of a vehicle to perform under normal operating conditions.
- The first step in diagnosing a leak is determining the conditions under which the leak occurs. If the general leak area can be found, the exact entry point can be isolated using a water hose or an air hose. Some trim panels or components may need to be removed in order to repair the leak.
- If leaks are found around a door, door window, or boot lid area this does not necessarily indicate a bad weatherstrip. An adjustment to these areas may resolve the condition.

1. Have an assistant inside of the vehicle during the test in order to locate any leaks.
2. Adjust the hose nozzle to simulate rainfall.
3. The water pressure at the nozzle should maintain a 155 kPa (22 psi), for at least 4 minutes.



4. In order to check the windscreen, aim the water spray 30 degrees down and 45 degrees toward the rear.
5. Aim the water towards the corner of the windshield.
6. In order to check the side windows for leaks aim the water spray 30 degrees down and 45 degrees toward the rear.
7. In order to check the rear windscreen, aim the water spray 30 degrees down and 30 degrees toward the front.

Dust Leaks

- Dust may leak into the vehicle where water will not. This happens particularly in the lower portion of the interior.
- Forward motion of the vehicle can create a slight vacuum which pulls air and dust into the vehicle.
- In order to determine the location of dust leaks, perform the following steps:

1. Remove the interior floor mats.
2. Remove the kick panels.
3. Remove the interior floor insulation.
4. Remove the kick panel insulation.
5. Drive the vehicle on a dusty road.
6. Examine the interior.

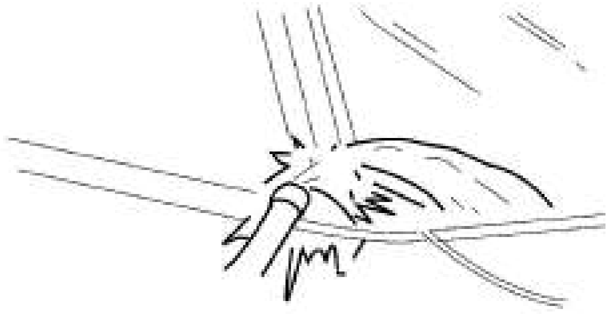
   Dust in the shape of a small cone or slit will usually be found at the point of leakage.

7. Mark the points of leakage.

   Important: Make sure that the interior is darkened when performing this step.

8. Shine bright lamps on the underside of the floor and the bulkhead.
9. Have an assistant mark any points inside of the vehicle for any points where the light shines through.
   - Inspect the weld joints.
   - Inspect the body mounts.
10. Seal any leaks with an air-drying, body-sealing compound.

Water Hose Test

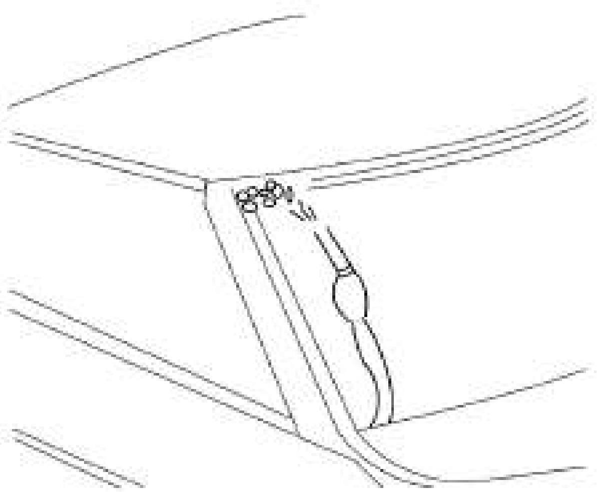


1. Have an assistant inside of the vehicle in order to locate the leak.

   Important: Use a water hose without the nozzle attached.

2. Begin testing at the base of the window or the windshield.
3. Slowly move the hose upward and across the top of the vehicle.

Air Hose Test



Notice: The air hose test should only be used on fully cured urethane adhesive. Otherwise, damage to the urethane adhesive bead could result in additional leaks.

Important: Use a liquid detergent, diluted with water in a spray bottle. Begin at the bottom and gradually move up and across the top.

1. Spray the window at the edges.

   Important: The compressed air should not exceed 205 kPa (30 psi).

2. Have an assistant inside of the vehicle with an air hose.

   Important: Bubbles will form in the soap solution at the location of the leak.

3. Have the assistant aim the compressed air at the suspected areas.

Body Waterleak Repair

Important: If any water enters the vehicle's interior up to the level of the carpet or higher and soaks the carpet, the sensing and diagnostic module (SDM) and the SDM harness connector may need to be replaced. The SDM could be activated when powered, which could cause deployment of the air bag(s) and result in personal injury. Before attempting these procedures, the SRS system must be disabled. Refer to Disabling the SRS System.

With the ignition OFF, inspect the SDM mounting area, including the carpet. If any significant soaking or evidence of significant soaking is detected, you must perform the following tasks:

1. Remove all water.
2. Repair the water damage.
3. Replace the SDM harness connector.
4. Replace the SDM.

Failure to follow these tasks could result in possible air bag deployment, personal injury, or otherwise unneeded SRS system repairs.

Depending on the location of the waterleak, you may have to remove certain interior components in order to repair the leak.

1. If the floor carpet is wet refer to Floor Carpet Drying in Interior Trim.
2. Cut out a portion of the adhesive caulking in the leak area from inside or outside of the vehicle.
3. Clean and remove all loose particles of the adhesive old caulking from the area.
4. Apply joint body and seam sealer where the old adhesive caulking was removed.
5. Allow the adhesive caulking to dry for several hours.
6. Test for leaks.
7. Install any removed trim.

Stationary Window Waterleak Repair

Important: If any water enters the vehicle's interior up to the level of the carpet or higher and soaks the carpet, the sensing and diagnostic module (SDM) and the SDM harness connector may need to be replaced. The SDM could be activated when powered, which could cause deployment of the air bag(s) and result in personal injury. Before attempting these procedures, the SRS system must be disabled. Refer to Disabling the SRS System.

With the ignition OFF, inspect the SDM mounting area, including the carpet. If any significant soaking or evidence of significant soaking is detected, you must perform the following tasks:

1. Remove all water.
2. Repair the water damage.
3. Replace the SDM harness connector.
4. Replace the SDM.

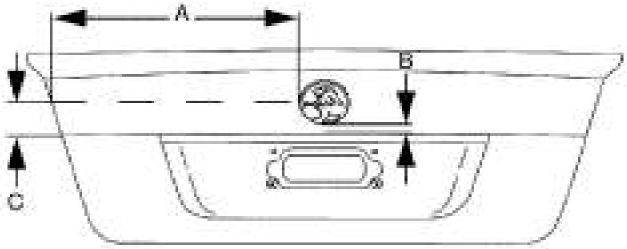
Failure to follow these tasks could result in possible air bag deployment, personal injury, or otherwise unneeded SRS system repairs.

1. If the floor carpet is wet, refer to Floor Carpet Drying in Interior Trim.
2. Remove the trim moldings or the headlining assembly in order to repair the leak, if needed. Refer to Section 8 Interior Trim, for appropriate procedures.
3. Determine the source of water entry.
4. If water is leaking at the edge of the windscreen, reseal the windscreen using a Holden approved Urethane Adhesive Caulking Kit
5. If water leaks into the vehicle at the sides of the stationary windows, reseal the window using a Holden approved Urethane Adhesive Caulking Kit.

Fastener Tightening Specifications

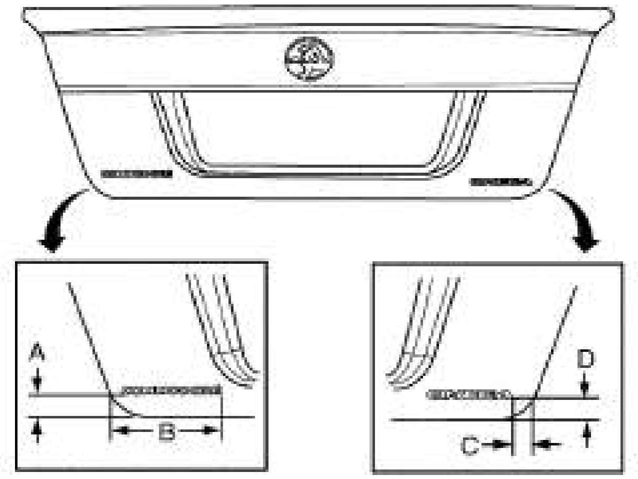
Application	Specification	
	Metric	English
Body Side Roof Drip Moulding to Vehicle Retaining Screw (Sportwagon)	2 N-m	18 lb in
Front Door Applique to Front Door Retaining Screws	3 N-m	27 lb in
Front Hood Moulding to Hood Retaining Screws	3 N-m	27 lb in
Front Wheelhouse Liner to Rocker Panel Retaining Screws (Sportwagon)	2 N-m	18 lb in
Hood Ornament to Hood Retaining Nut (LHD)	2 N-m	18 lb in
Liftgate Centre Applique to Liftgate Body Retaining Nuts (Sportwagon)	3 N-m	27 lb in
Liftgate Upper Moulding to Body Retaining Nuts (Sportwagon)	3 N-m	27 lb in
Radiator Grille to Front End Module Retaining Bolts (SWB)	4 N-m	35 lb in
Radiator Grille to Hood Retaining Nuts (LWB)	4 N-m	35 lb in
Rear Compartment Lid Applique to Rear Compartment Lid Retaining Nuts (LWB)	2 N-m	18 lb in
Rear Compartment Lid Lip Spoiler to Rear Compartment Lid Retaining Nuts	3 N-m	27 lb in
Rear Door Applique to Rear Door Retaining Screws	3 N-m	27 lb in
Rear Spoiler (Type D) Centre Stud Retainer Nut (CSV/SWB HSV/VXR8)	4 N-m	35 lb in
Rear Spoiler (Type D) to Rear Compartment Lid Retainer Nuts (CSV/SWB HSV/VXR8)	4 N-m	35 lb in
Rear Spoiler Grub Screw (LWB HSV)	4 N-m	35 lb in
Rear Spoiler Retaining Nuts (LWB HSV)	4 N-m	35 lb in
Rear Spoiler to Rear Compartment Lid Retaining Nuts	3 N-m	27 lb in
Rear Wheelhouse Liner to Rocker Panel Retaining Screws (Sportwagon)	2 N-m	18 lb in

Rear Compartment Lid



(a) 515 mm
(b) 20 mm
(c) 70 mm

Rear Compartment Lid (Commodore Omega)



(a) 40 mm

(b) 180 mm

(c) 19 mm

(d) 40 mm

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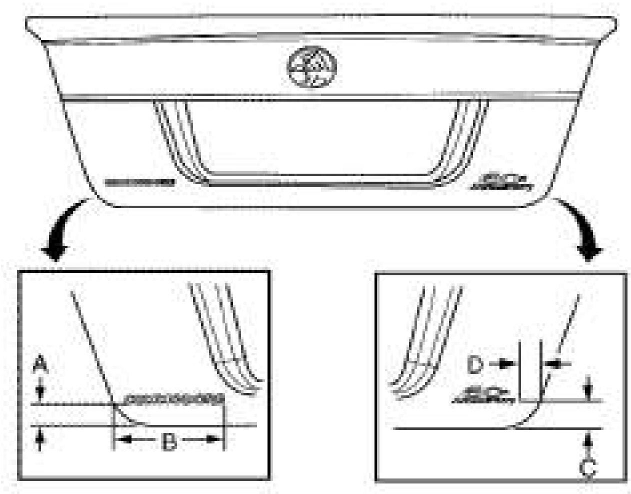
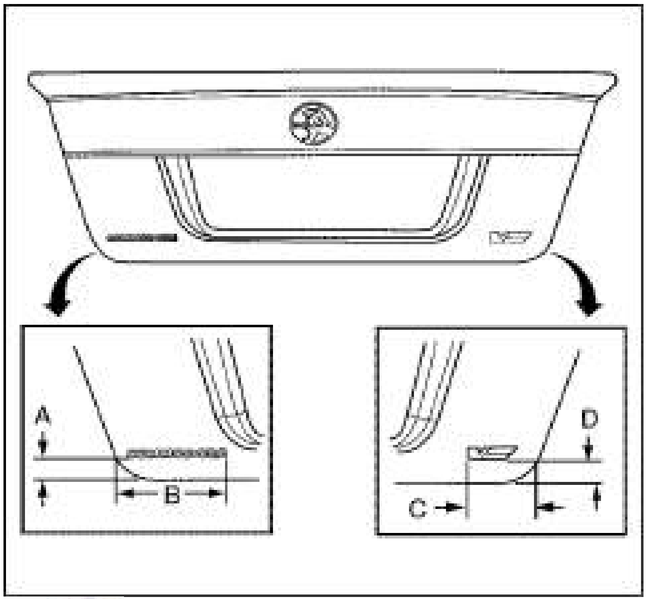
Rear Compartment Lid (Commodore Omega 60th Anniversary)



(a) 40 mm
(b) 180 mm
(c) 40 mm
(d) 27.8 mm

Rear Compartment Lid (Commodore V-Series)



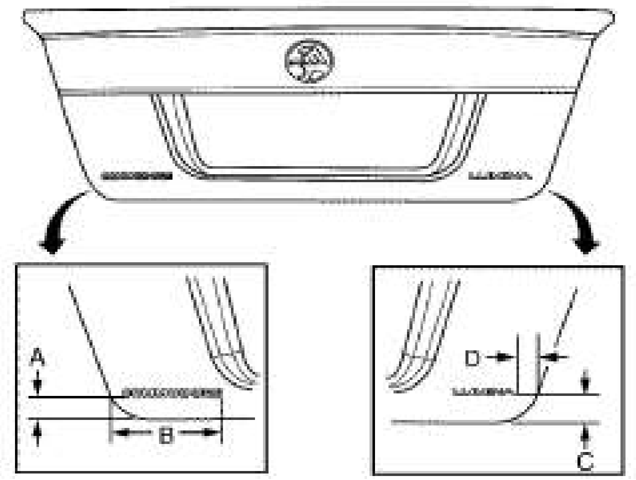
(a) 40 mm

(b) 180 mm

(c) 130 mm

(d) 40 mm

Rear Compartment Lid (Commodore Lumina)



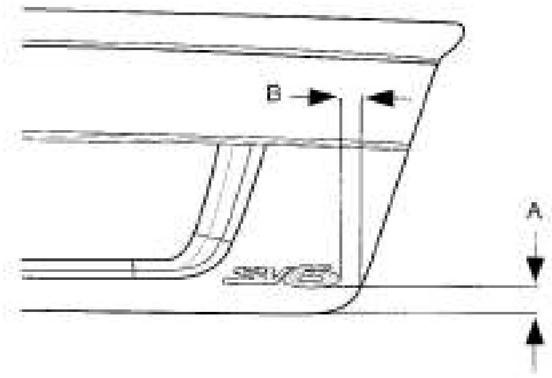
(a) 41.3 mm

(b) 177.7 mm

(c) 41.5 mm

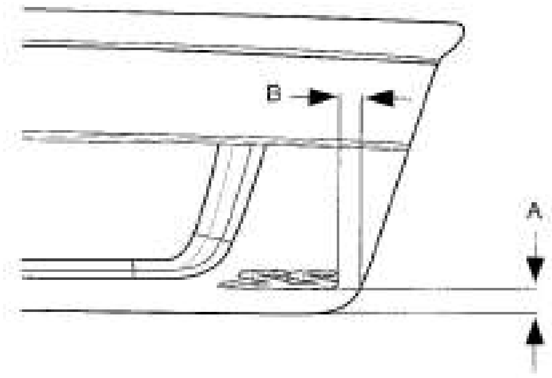
(d) 47.8 mm

Rear Compartment Lid (Commodore SV6)



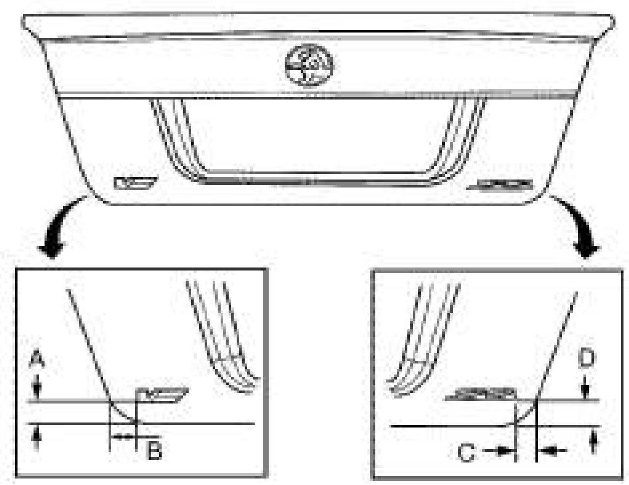
(a) 40 mm
(b) 180 mm
(c) 42 mm
(d) 36 mm

Rear Compartment Lid (Commodore SS)



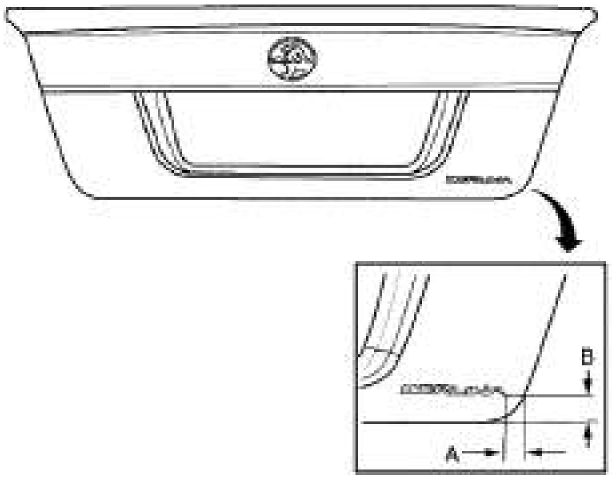
(a) 40 mm
(b) 180 mm
(c) 40 mm
(d) 18 mm

Rear Compartment Lid (SS V-Series)



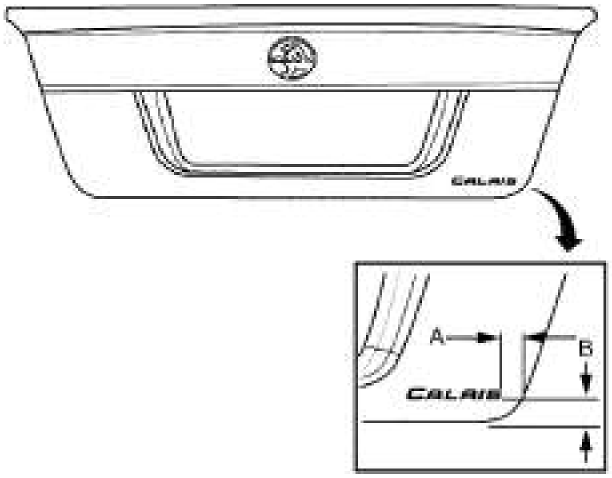
(a) 40 mm
(b) 46 mm
(c) 40 mm
(d) 18 mm

Rear Compartment Lid (Berlina)



(a) 30 mm
(b) 40 mm

Rear Compartment Lid (Calais)



(a) 30 mm

(b) 40 mm

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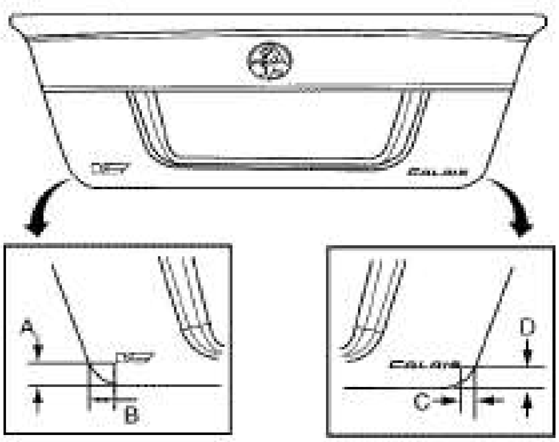
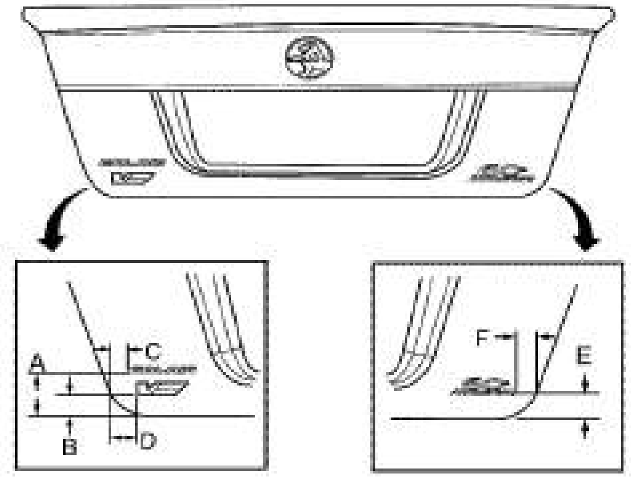
Rear Compartment Lid (Calais V-Series)



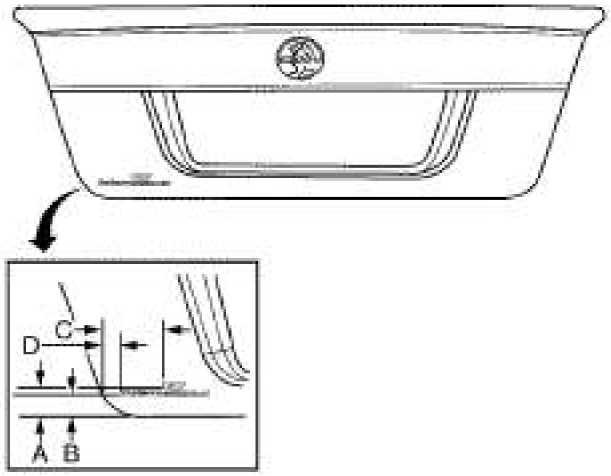
(a) 40 mm
(b) 46 mm
(c) 30 mm
(d) 40 mm

Rear Compartment Lid (Calais V-Series 60th Anniversary)



(a) 80 mm
(b) 40 mm
(c) 12 mm
(d) 46 mm
(e) 40 mm
(f) 27.8 mm

Rear Compartment Lid (V-Series International)



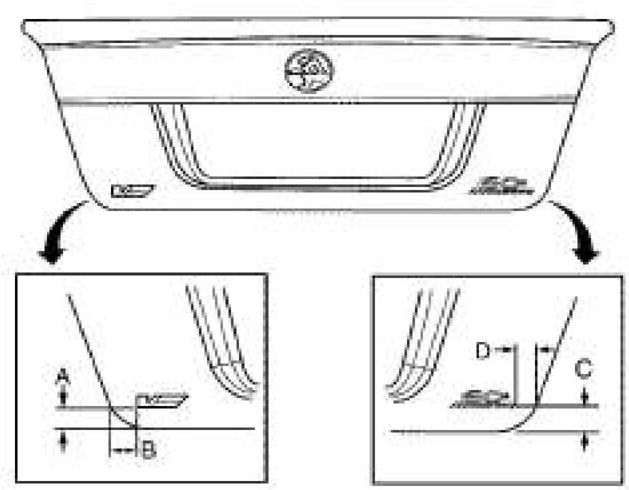
(a) 55 mm

(b) 40 mm

(c) 45.5 mm

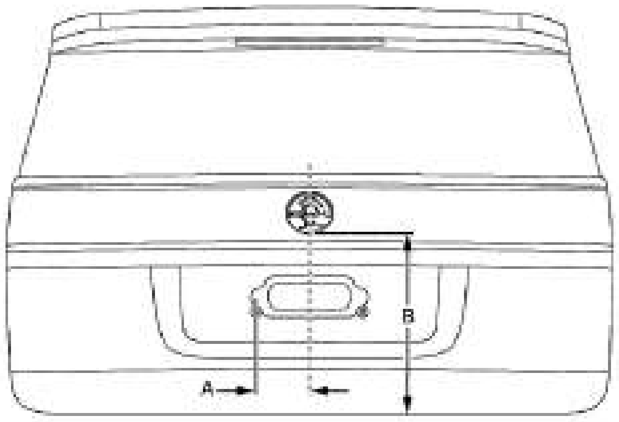
(d) 23.5 mm

Rear Compartment Lid (SS V-Series 60th Anniversary)



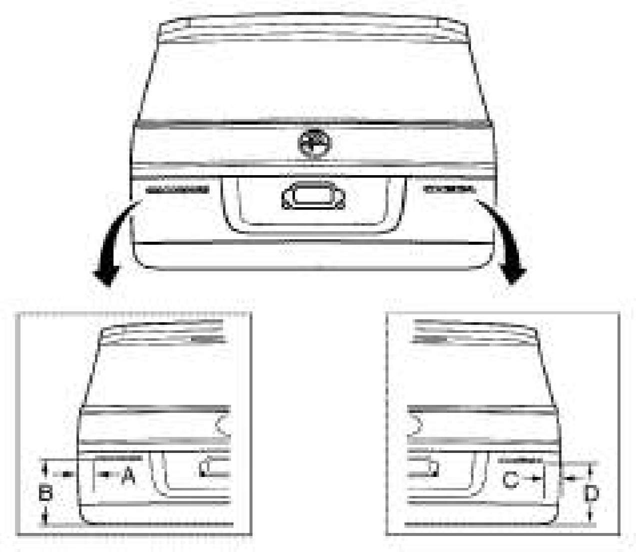
(a) 40 mm
(b) 46 mm
(c) 41.2 mm
(d) 27.8 mm

Liftgate (Holden Lion)



(a) 109 mm
(b) 382 mm

Liftgate (Commodore Omega)



(a) 69 mm

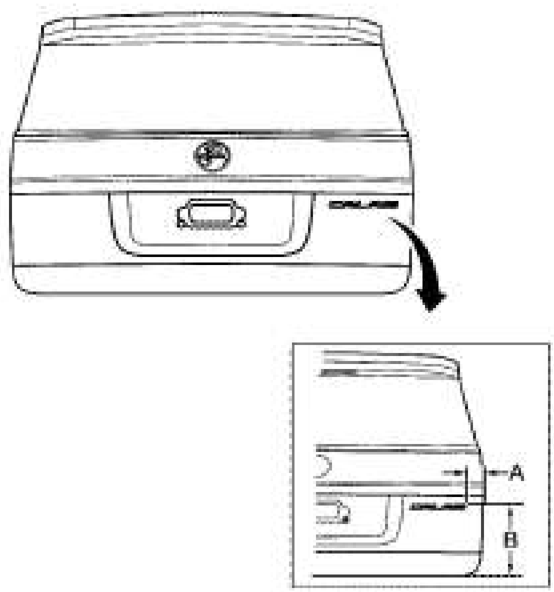
(b) 276 mm

(c) 68 mm

(d) 274 mm

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Hardware and Trim | Exterior Trim | Visual Identification | **Document ID: 2103231**

Liftgate (Calais)

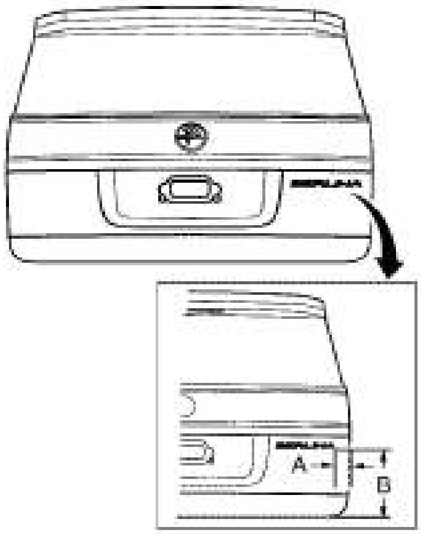


(a) 72 mm

(b) 289 mm

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Hardware and Trim | Exterior Trim | Visual Identification | Document ID: 2103226

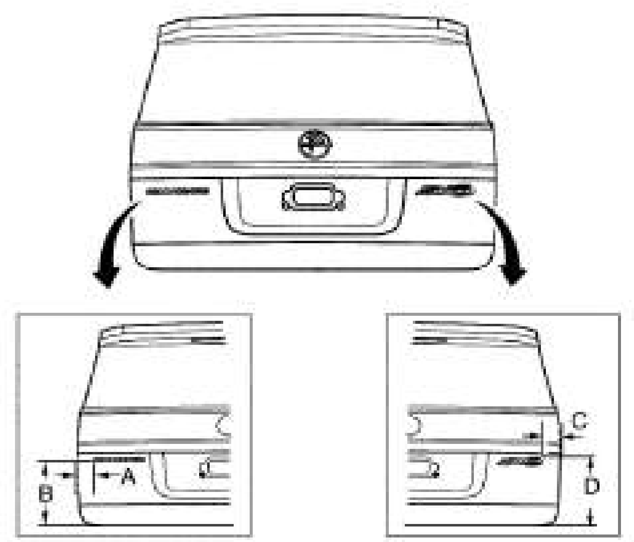
Liftgate (Berlina)



(a) 71 mm
(b) 276 mm

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Hardware and Trim | Exterior Trim | Visual Identification | Document ID: 2103235

Liftgate (Commodore SV6)



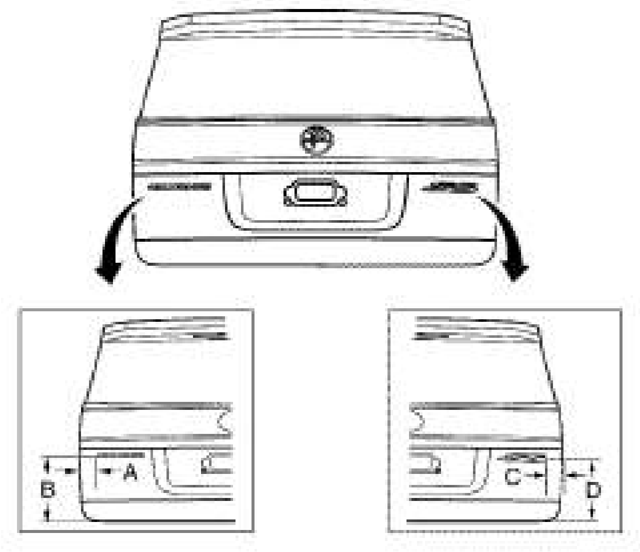
(a) 69 mm

(b) 276 mm

(c) 99 mm

(d) 293 mm

Liftgate (Commodore SS)



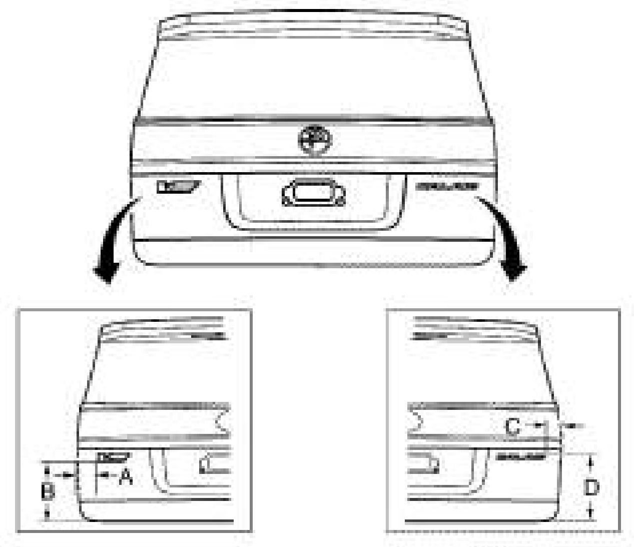
(a) 69 mm

(b) 276 mm

(c) 82 mm

(d) 264 mm

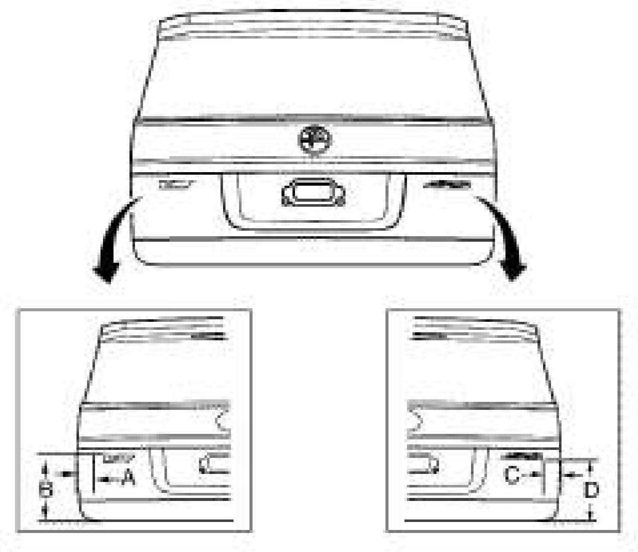
Liftgate (Calais V-Series)



(a) 73 mm
(b) 289 mm
(c) 72 mm
(d) 289 mm

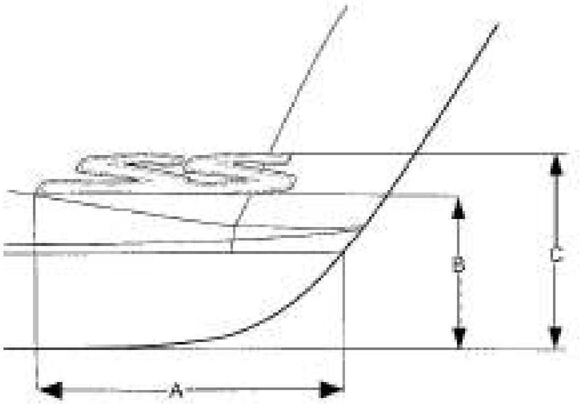
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Hardware and Trim | Exterior Trim | Visual Identification | **Document ID: 2103236**

Liftgate (SS V-Series)



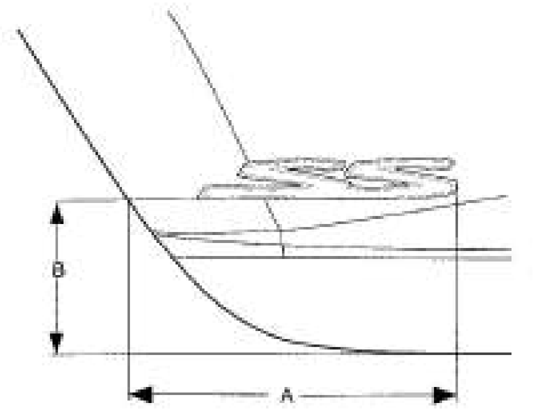
(a) 73 mm
(b) 289 mm
(c) 82 mm
(d) 264 mm

Rear Door (Left Side)



(a) 261 mm
(b) 136.5 mm
(c) 173 mm

Rear Door (Right Side)

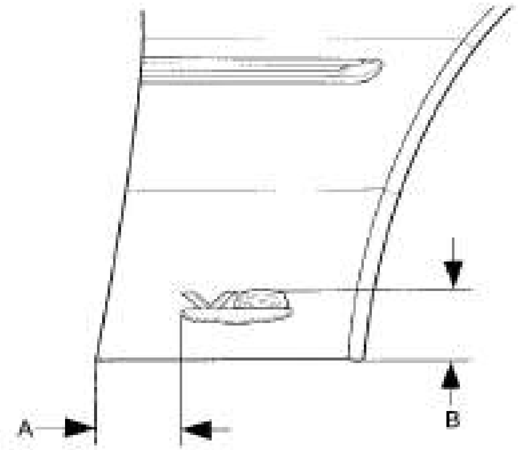


(a) 135.2 mm

(b) 288.2 mm

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Hardware and Trim | Exterior Trim | Visual Identification | **Document ID: 1996449**

V8 Fender

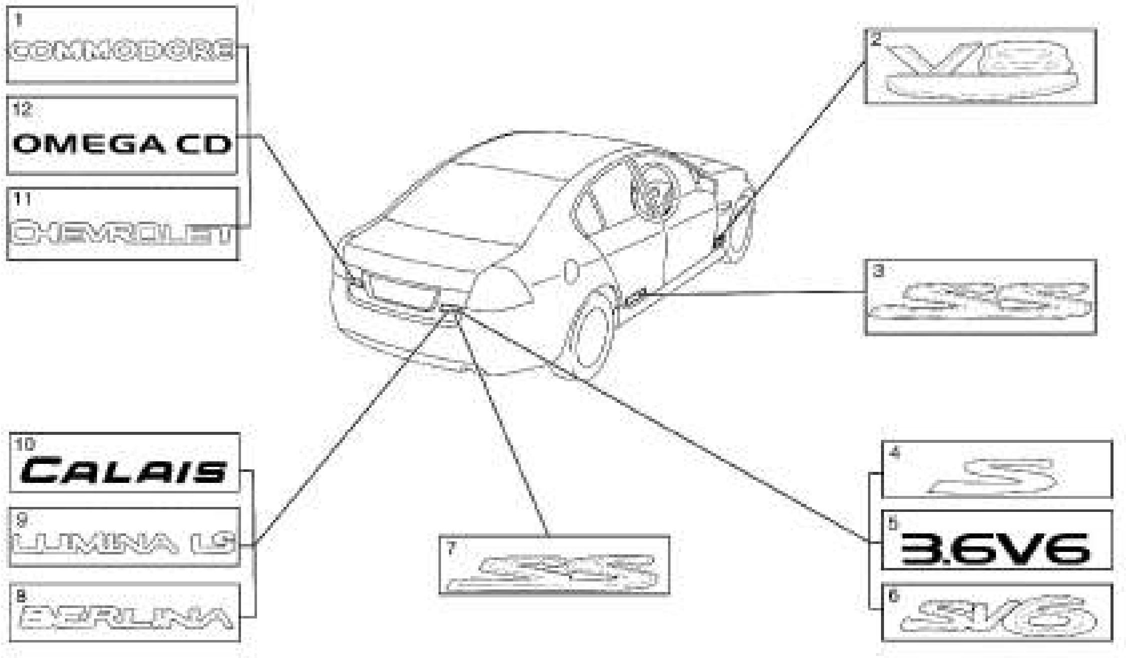


(a) 73 mm

(b) 60 mm

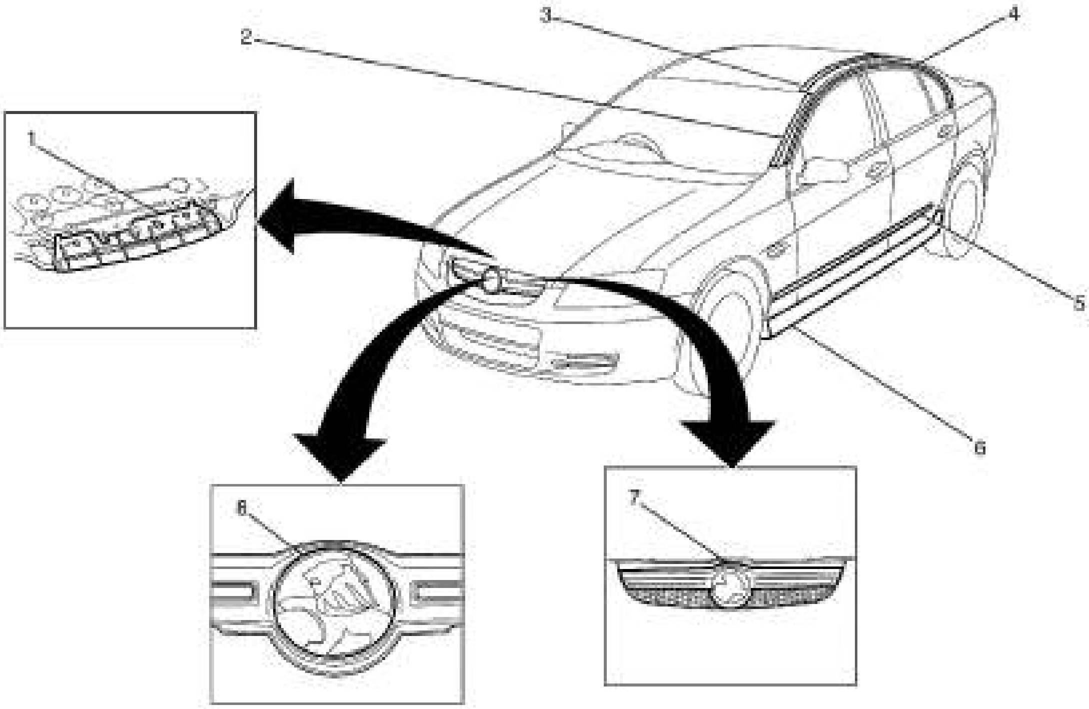
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Hardware and Trim | Exterior Trim | Component Locator | **Document ID: 1974086**

Badge Locations


1
COMMODORE
12
OMEGA CD
11
CHEVROLET
2
V8
3
SS
10
CALAIS
9
LUMINA LS
8
BERLINA
7
SS
4
S
5
3.6V6
6
SV6

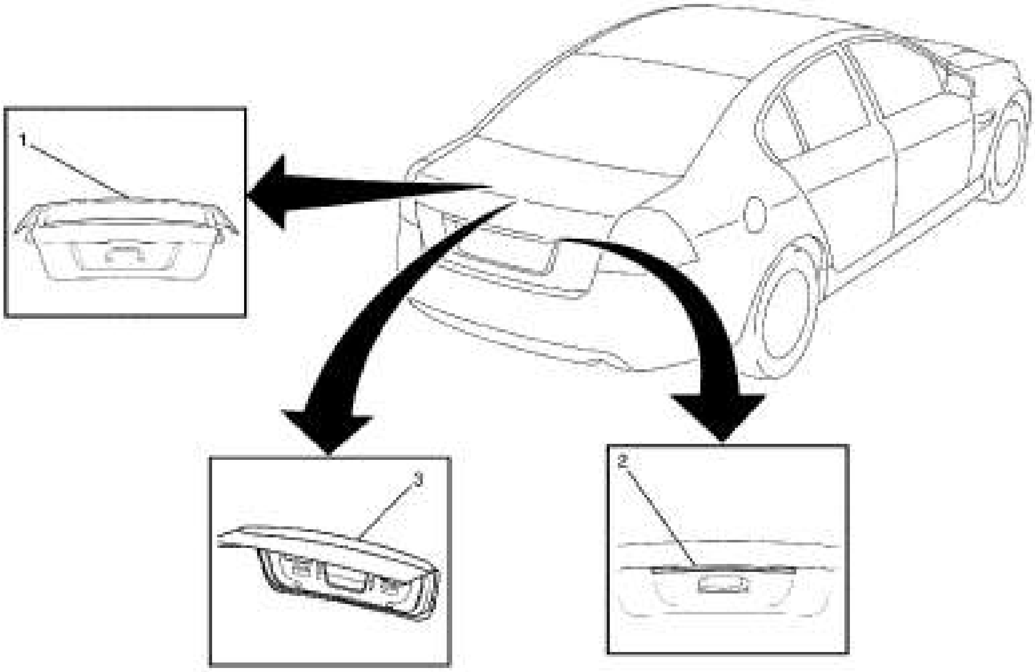
(1) Rear Compartment Lid (Commodore)
(2) Fender (V8 6.0 Litre)
(3) Rear Door (SS)
(4) Rear Compartment Lid (S)
(5) Rear Compartment Lid (3.6 V6)
(6) Rear Compartment Lid (SV6)
(7) Rear Compartment Lid (SS)
(8) Rear Compartment Lid (Lumnia LTZ)
(9) Rear Compartment Lid (Berlina)
(10) Rear Compartment Lid (Lumina LS)
(11) Rear Compartment Lid (Calais)
(12) Rear Compartment Lid (Chevrolet)
(13) Rear Compartment Lid (Omega CD)

Exterior Trim



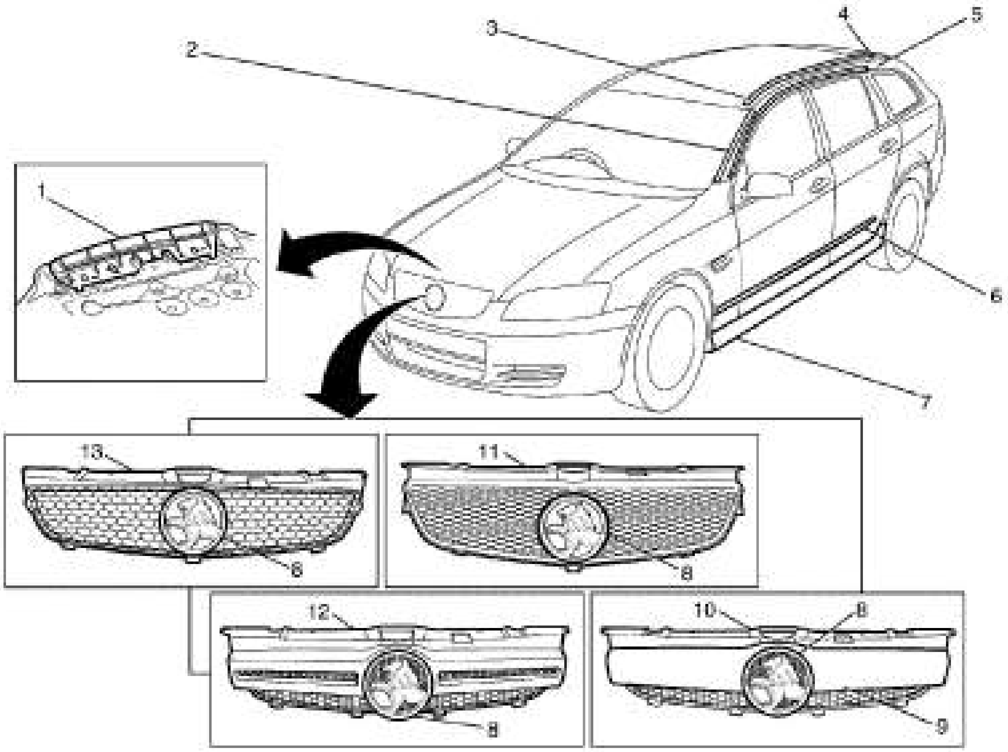
(1) Hood Front Molding
(2) Windshield Pillar Garnish Molding
(3) Roof Weld Joint Reveal Molding
(4) Body Side Roof Drip Molding
(5) Body Side Molding
(6) Rocker Panel Molding
(7) Upper Grille Applique
(8) Front Emblem/Nameplate

Exterior Trim



(1) Rear Spoiler Type A
(2) Rear Spoiler Type B
(3) Rear Compartment Lid Applique

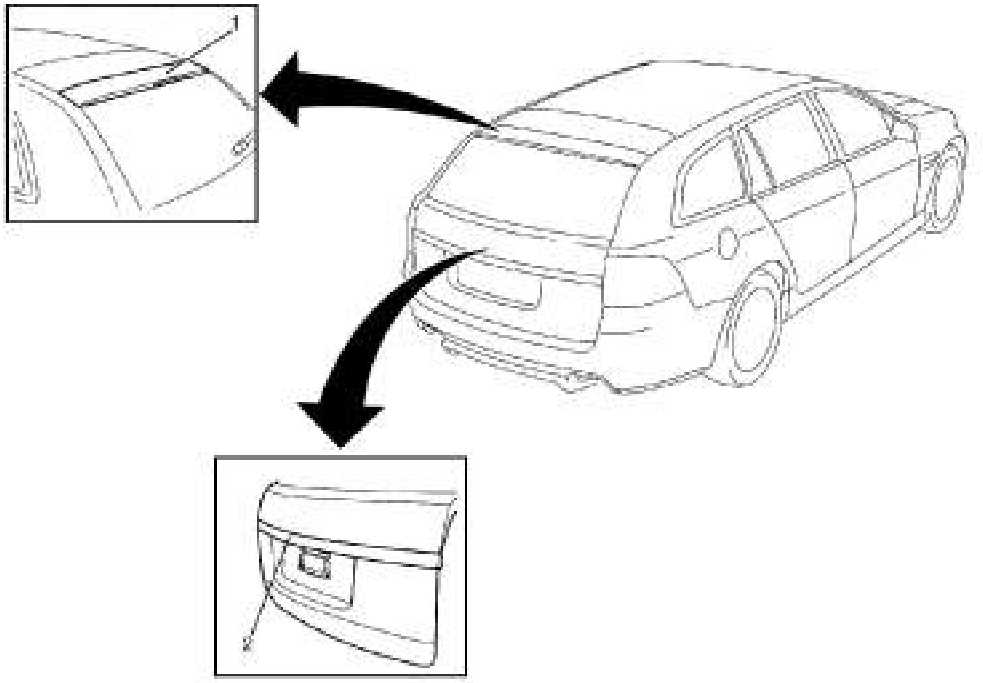
Exterior Trim (Front View)



(1) Hood Front Moulding
(2) Windshield Pillar Garnesh Moulding
(3) Roof Weld Joint Reveal Moulding
(4) Roof Weld Joint Reveal Moulding Rear
(5) Body Side Roof Drip Moulding
(6) Body Side Moulding
(7) Rocker Panel Moulding
(8) Radiator Grille Emblem/Nameplate (Holden Lion)
(9) Upper Grille Applique
(10) Radiator Grille (Omega)
(11) Radiator Grille (Calais)
(12) Radiator Grille (Berlina, Commodore 60th Anniversary)
(13) Radiator Grille (SV6, SS, SSV)

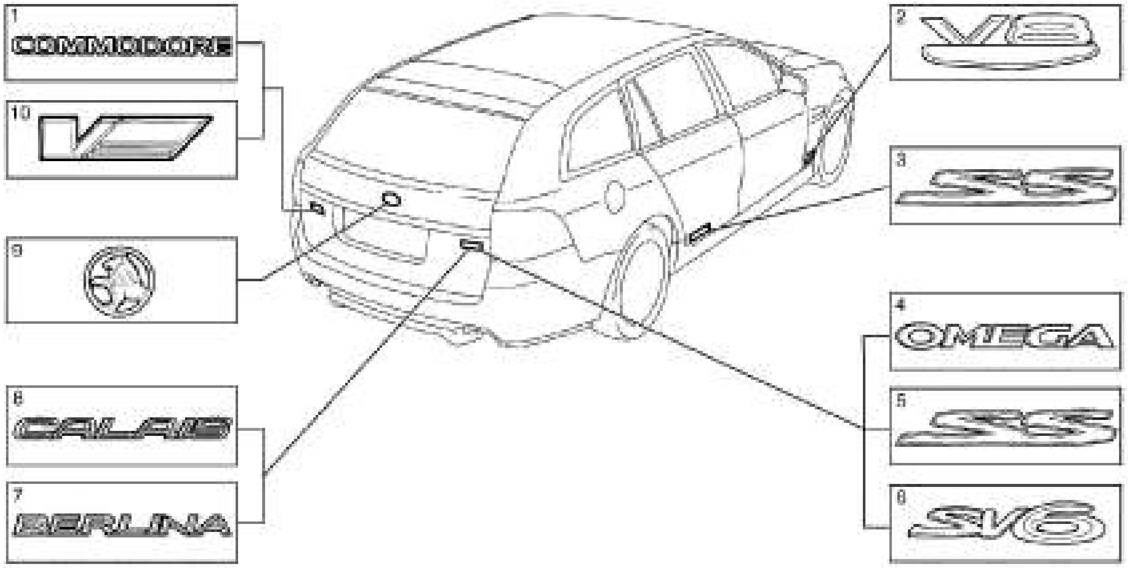
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Hardware and Trim | Exterior Trim | Component Locator | **Document ID: 2090781**

Exterior Trim (Rear View)



(1) Liftgate Upper Moulding
(2) Liftgate Centre Applique

Badge Locations



(1) Liftgate (Commodore)
(2) Fender (V8 6.0 Litre)
(3) Rear Door (SS)
(4) Liftgate (Omega)
(5) Liftgate (SS)
(6) Liftgate (SV6)
(7) Liftgate (Berlina)
(8) Liftgate (Calais)
(9) Liftgate (Holden Lion)
(10) Liftgate (V-Series)

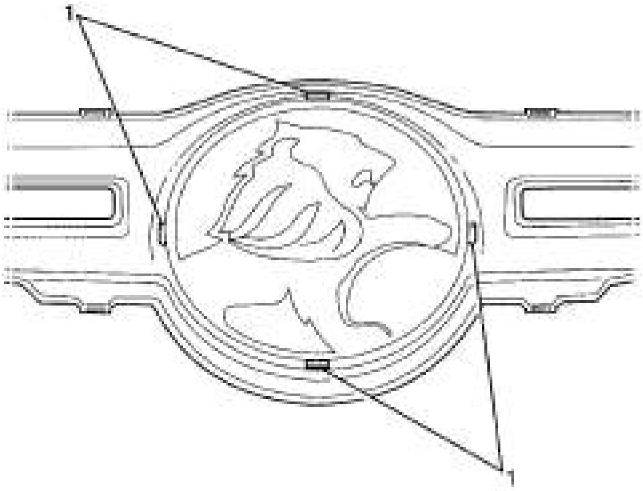
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Hardware and Trim | Exterior Trim | Repair Instructions | Document ID: 1993168

Front Emblem and Nameplate Replacement (RHD)

Removal Procedure

Important: Carefully remove the front radiator grille emblem from the radiator grille applique to avoid damage to the front radiator grille emblem.

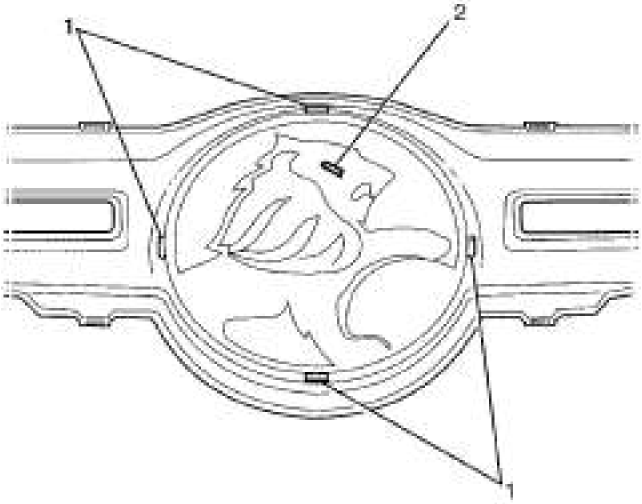
1. Remove the radiator grille applique. Refer to Radiator Grille Retainer Replacement



Important: Carefully release the radiator grille emblem to radiator grille applique retaining clips.

2. Release the radiator grille emblem to radiator grille applique retaining clips (1).
3. Remove the radiator grille emblem from the radiator grille applique.

Installation Procedure



Important: Make sure the centre retaining clip is located in position.

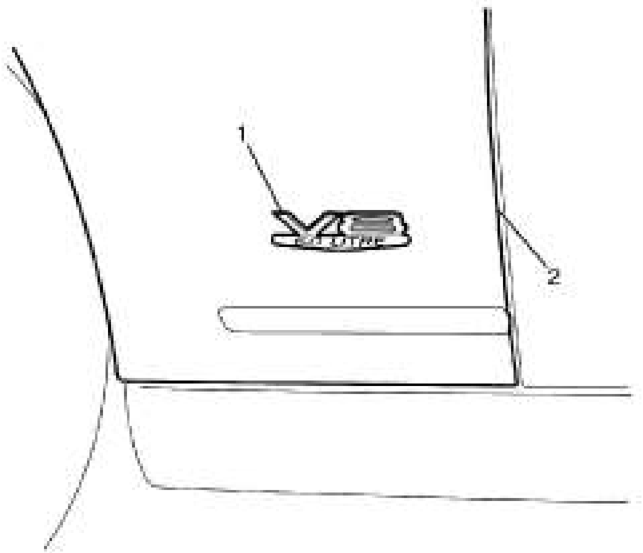
1. Install the radiator grille emblem to the radiator grille applique, locating the centre retaining clip (2).
2. Apply pressure to the radiator grille emblem retaining clips (1) to engage the radiator grille applique.
3. Install the radiator grille applique.Refer to Radiator Grille Retainer Replacement
4. Make sure that the radiator grille emblem retaining clips are secure.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Hardware and Trim | Exterior Trim | Repair Instructions | **Document ID: 1991799**

Front Fender Emblem / Nameplate Replacement

Removal Procedure

Important: Protect the paint and body work with tape or a clean cloth. Failure to do so may result in damage to the paint work.



1. To assist in the removal of the front fender emblem (1), warm the front fender emblem with a heat gun.

Important: Take care not to damage the paint work when prying the front fender emblem from the fender.

2. Use a suitable tool to carefully prise the front fender emblem from the fender.
3. Remove any remaining adhesive from the fender and clean the surface with a suitable cleaning solution using a lint free cloth.

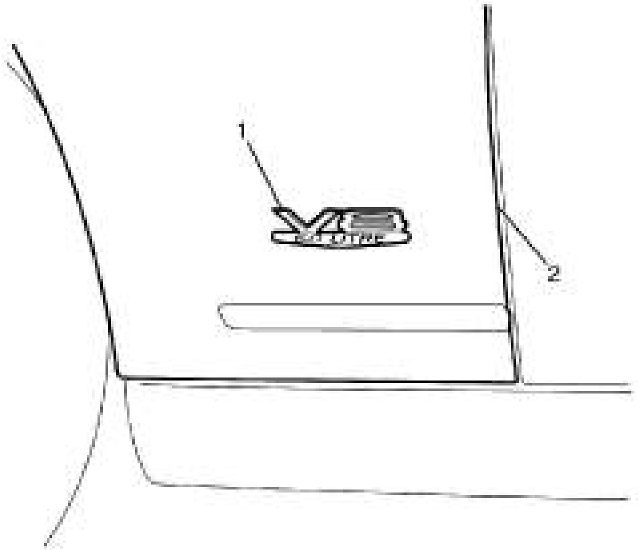
Installation Procedure

Important: Use spec HN2021 or equivalent.

1. If reusing the front fender emblem, clean the front fender emblem with a suitable cleaning solution, using a lint free cloth.
   1.1. Apply new polyethylene double sided tape to the back of the front fender emblem.
   1.2. Trim back the tape to the inner edge of the front fender emblem.

Important: Do not allow the adhesive tape to come in contact with any dirt or foreign matter.

2. Peel the backing from the adhesive tape.



3. Apply the front fender emblem (1) to the position shown, measuring from the front side of the side turn signal lamp. Make sure the front fender emblem is centred with the side turn signal lamp.
4. Firmly press the front fender emblem into place for 30 seconds to make sure proper adhesion of the front fender emblem.

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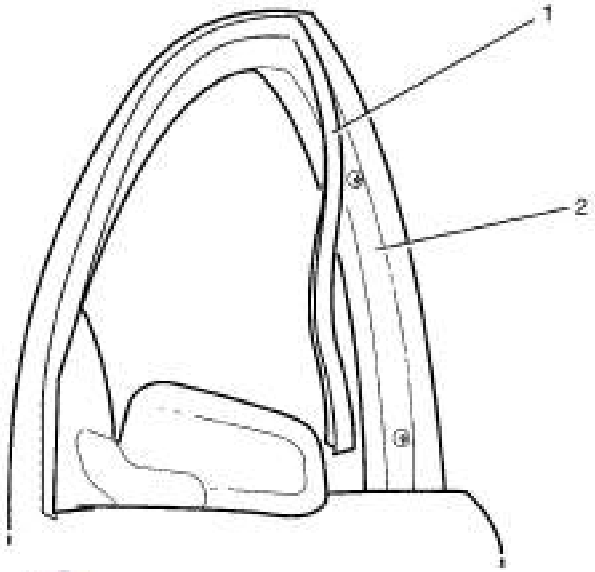
Front Door Frame Applique Replacement

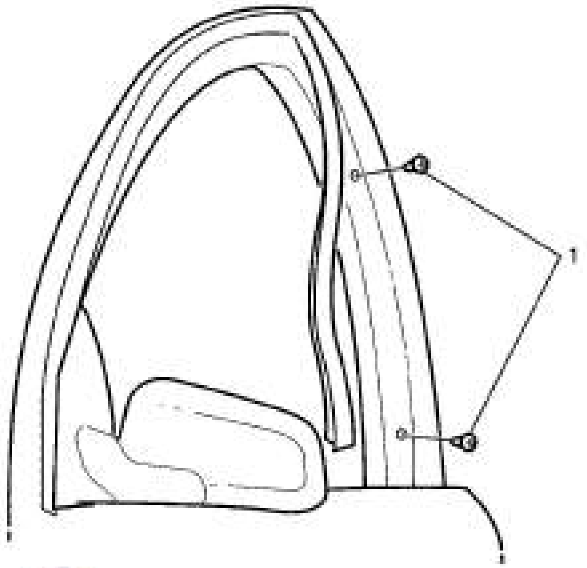
Removal Procedure

1. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement .
2. Remove the window inner belt sealing strip. Refer to Front Side Door Window Belt Inner Sealing Strip Replacement in Doors.
3. Remove the door garnish molding. Refer to Front and Rear Side Door Window Garnish Molding Replacement .

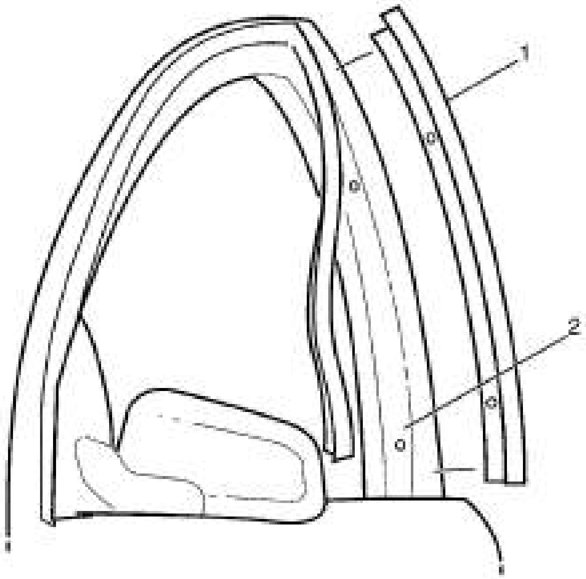


Important: Pry out the window inner sealing strip (1) then pull by hand to expose door applique retaining screws.

4. Detach the rear part of the window inner sealing strip (1) from the door (2).

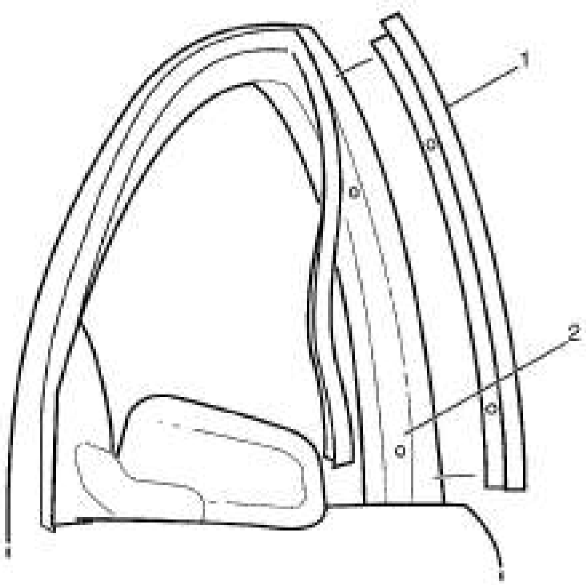


5. Remove the door applique to door retaining screws (1).



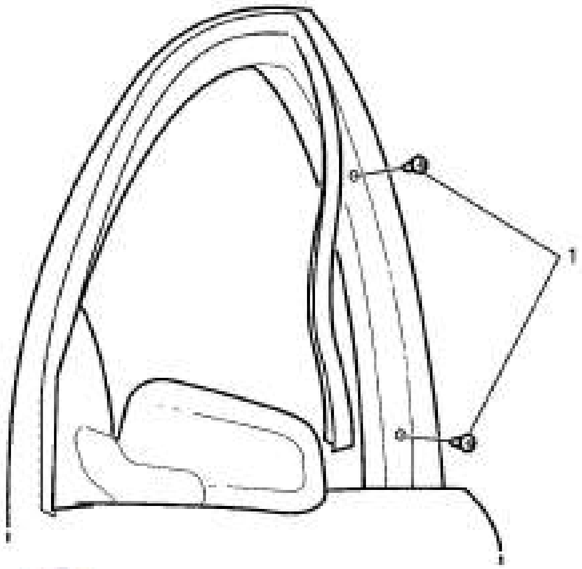
6. Remove the door applique (1) from the door (2).

Installation Procedure



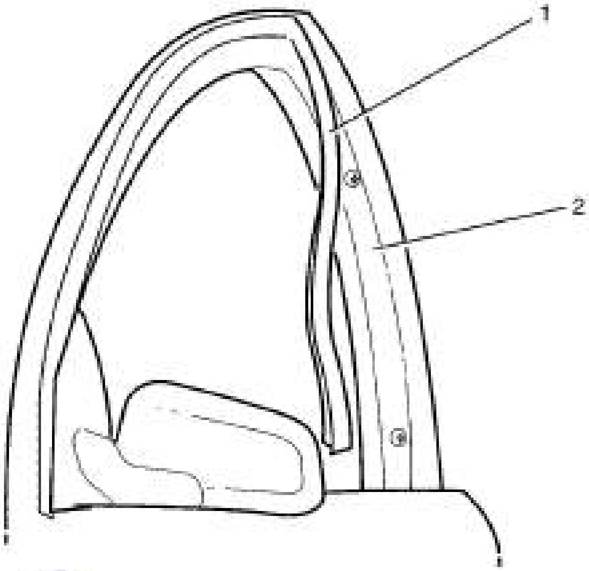
1. Position the door applique (1) to the door (2).

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the door applique to door retaining screws (1).

   Tighten
   Tighten the screws to 3 N·m (27 lb in).



3. Attach the rear part of the window inner sealing strip (1) to the door (2).
4. Install the door garnish molding. Refer to Front and Rear Side Door Window Garnish Molding Replacement .
5. Install the window inner belt sealing strip. Refer to Front Side Door Window Belt Inner Sealing Strip Replacement in Doors.
6. Install the door trim panel. Refer to Front Side Door Trim Panel Replacement .

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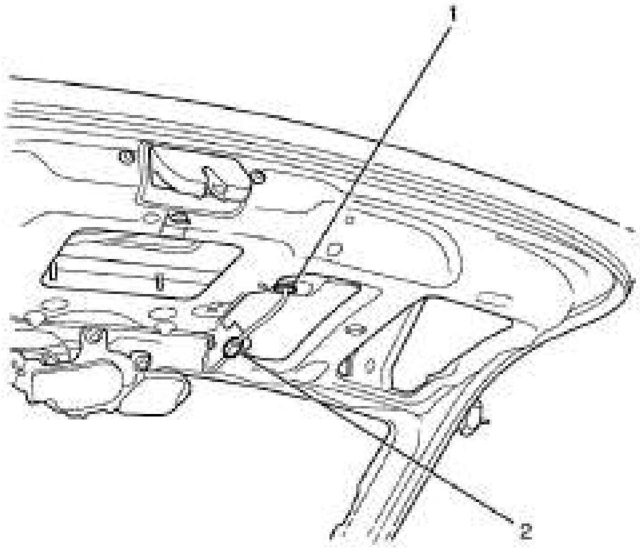
Liftgate Center Applique Replacement

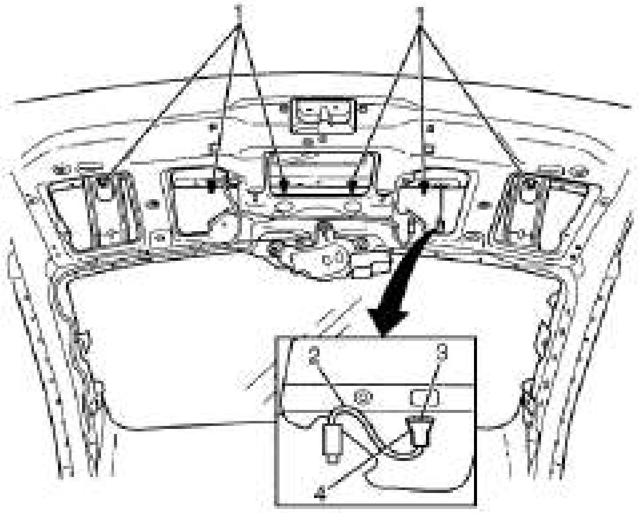
Removal Procedure

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

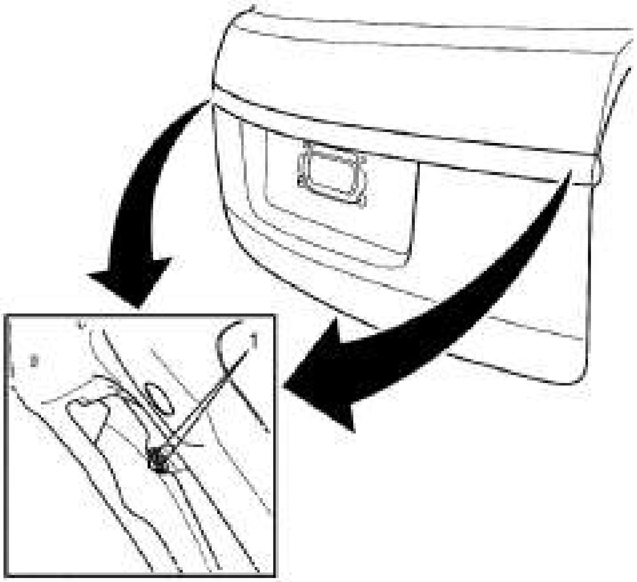
1. Open the liftgate.
2. Install a suitable liftgate brace to the vehicle.
3. Remove the liftgate window side garnish moulding. Refer to Liftgate Window Side Garnish Molding Replacement.
4. Remove the liftgate window lower garnish moulding. Refer to Liftgate Window Lower Garnish Molding Replacement.
5. Remove the liftgate trim panel. Refer to Liftgate Trim Panel Replacement.



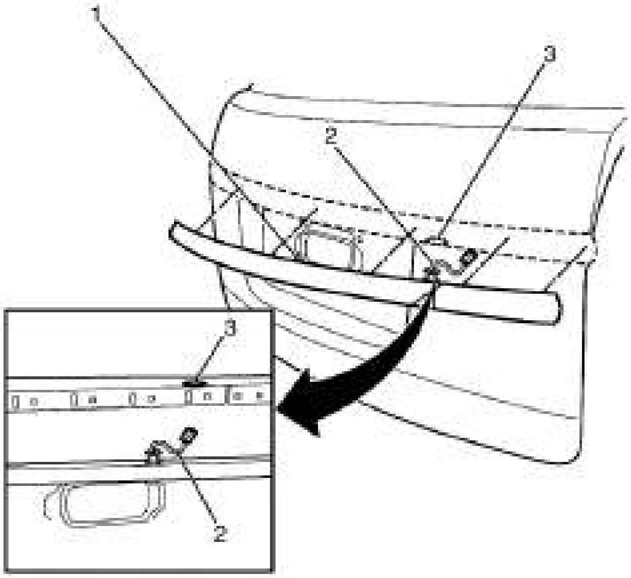
6. Disconnect the licence lamp/liftgate release electrical connector (2).
7. Detach the liftgate centre applique to body grommet (1).



8. Remove the liftgate centre applique to liftgate body retaining nuts (1).
9. Push the grommet (4) on the harness (2) through the grommet hole (3).

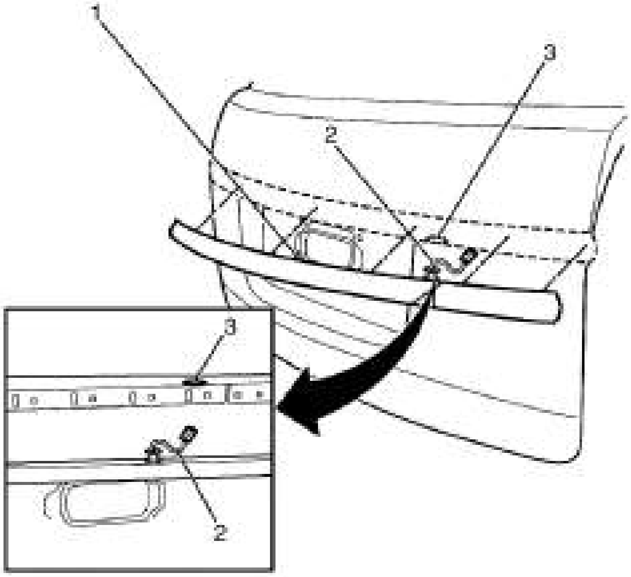


10. Carefully release the liftgate centre applique to liftgate body retaining clips tangs (1).



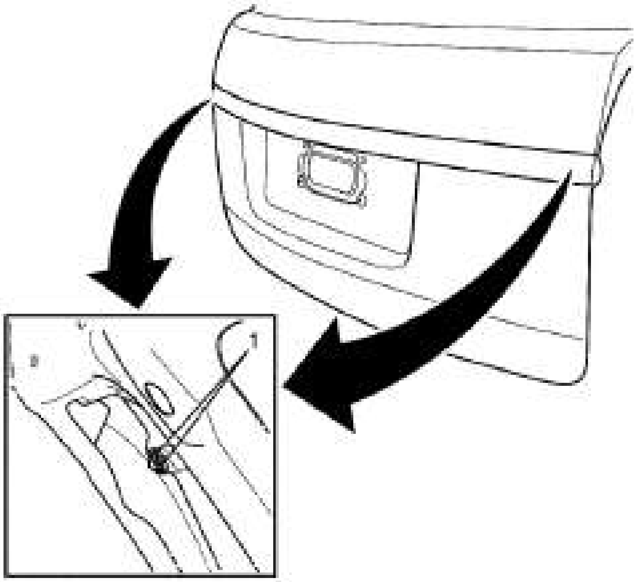
11. Pull the harness (2) through the grommet hole (3) on the liftgate.
12. Remove the liftgate centre applique (1) from the liftgate.

Installation Procedure



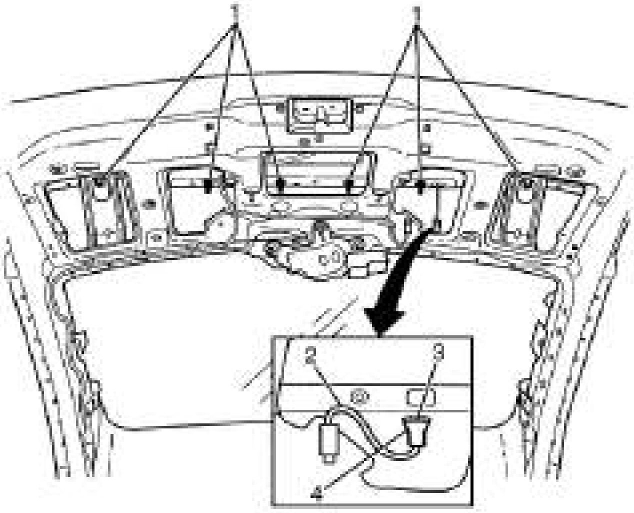
Important: Take care to feed the licence lamp/liftgate release connector through the grommet hole.

1. Insert the harness (2) through the grommet hole (3) on the liftgate.
2. Position the liftgate centre applique (1) to the liftgate.



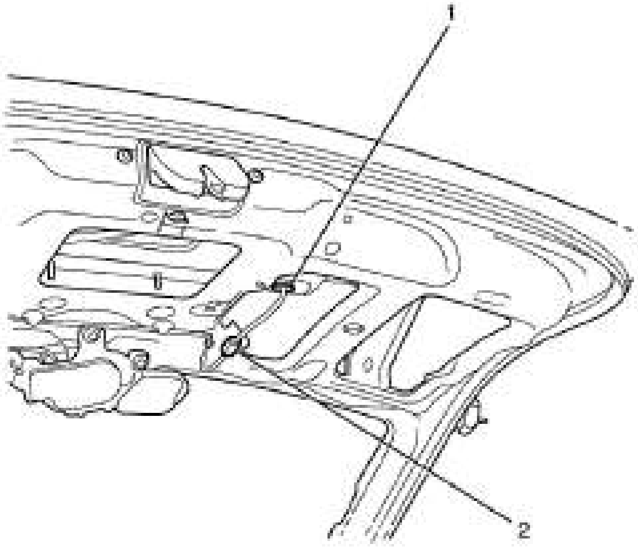
3. Carefully engage the liftgate centre applique to liftgate body retaining clips tangs (1).

   Notice: Refer to Fastener Notice in the Preface section.



4. Pull on the harness (2) to seat the grommet (4) in the grommet hole (3).
5. Install the liftgate centre applique to liftgate body retaining nuts (1).

   Tighten
   Tighten the nuts to 3 N·m (27 lb in).



6. Attach the liftgate centre applique to body grommet (1).
7. Connect the licence lamp/liftgate release electrical connector (2).
8. Install the liftgate trim panel. Refer to Liftgate Trim Panel Replacement.
9. Install the liftgate window lower garnish moulding. Refer to Liftgate Window Lower Garnish Molding Replacement.
10. Install the liftgate window side garnish moulding. Refer to Liftgate Window Side Garnish Molding Replacement.

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

11. Remove the suitable liftgate brace to the vehicle.
12. Close the liftgate.

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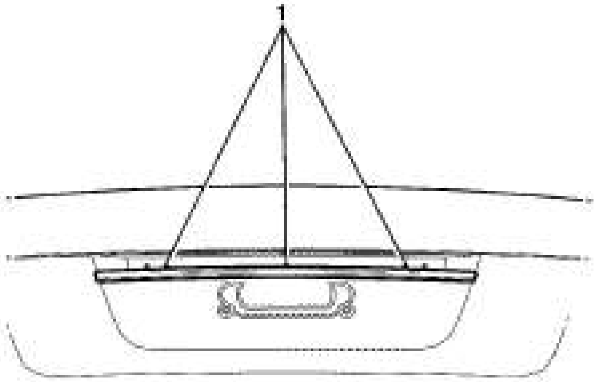
Rear Compartment Lid Applique Replacement (SWB)

Removal Procedure

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Open the rear compartment lid.
2. Support the rear compartment lid with a suitable brace.
3. Remove the rear compartment lid trim. Refer to Rear Compartment Lid Inner Panel Trim Replacement.



4. Starting from the outer edges, slowly disengage the rear compartment lid applique retaining clips (1) and discard.

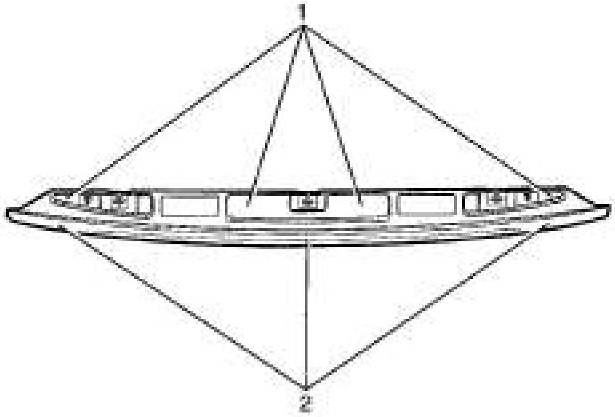
   Discard the retaining clips.

5. Remove the rear compartment lid applique from the rear compartment lid.
6. Remove any remaining adhesive from the rear compartment lid applique and clean the surface with a suitable cleaning solution, using a lint free cloth.

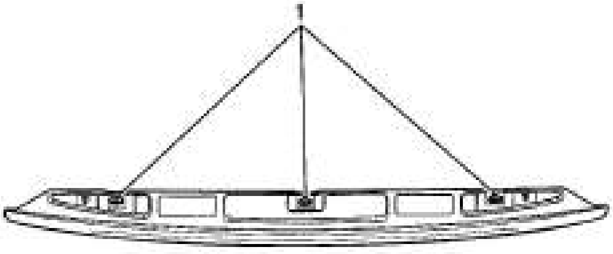
Installation Procedure

Important: Use spec HN2021 type 13A and HN2021 type 6.

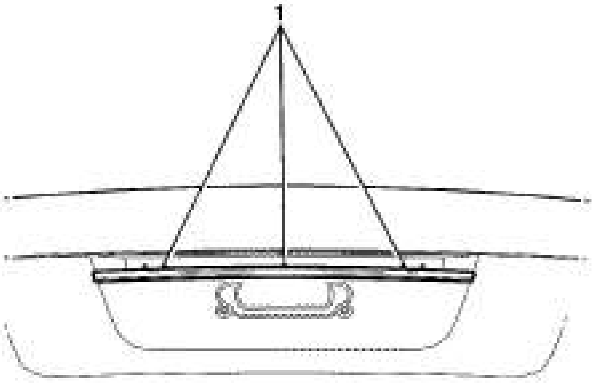
Important: Do not allow the adhesive tape to come in contact with any dirt or foreign matter.



1. If reusing the rear compartment lid applique, clean the rear compartment lid applique with a suitable cleaning solution, using a lint free cloth.
   1.1. Apply the double sided tape HN2021 type 13A (2) to the outer edges of the rear compartment lid applique.
   1.2. Trim back the double sided tape to the outer edges of the rear compartment lid applique.
   1.3. Apply the double sided tape HN2021 type 6 (1) to the centre of the rear compartment lid applique.
   1.4. Trim back the double sided tape to the centre of the rear compartment lid applique.



2. Install the NEW rear compartment lid applique retaining clips (1) to the rear compartment lid applique.

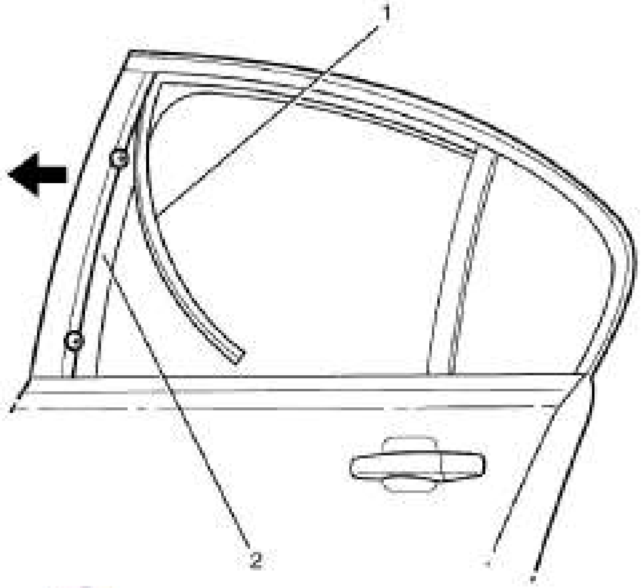


3. Install the rear compartment lid applique by starting from the centre retaining clip (1) to the rear compartment lid.
4. Make sure that the rear compartment lid applique retaining clips (2) are installed to the rear compartment lid.
5. Firmly press the rear compartment lid applique into place by starting from the centre of the rear compartment lid applique and working towards the outer edges, to prevent trapped air behind the adhesive.
6. Install the rear compartment lid trim. Refer to Rear Compartment Lid Inner Panel Trim Replacement.
7. Remove the suitable brace from the rear compartment lid.
8. Close the rear compartment lid.

Rear Door Frame Applique Replacement

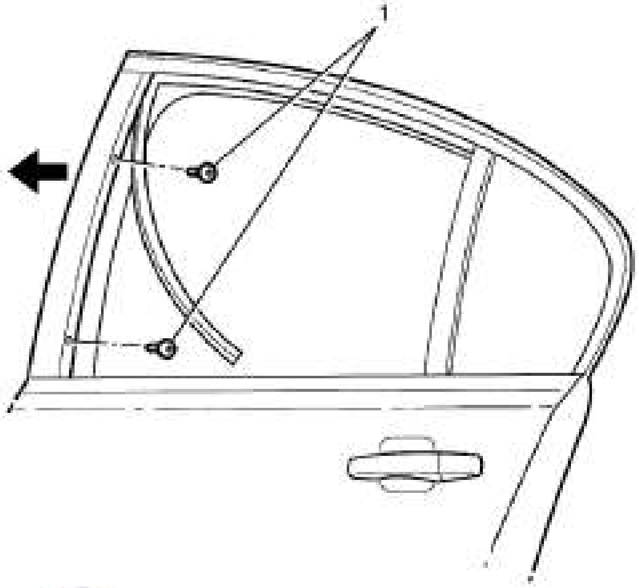
Removal Procedure

1. Remove the door trim panel. Refer to Rear Side Door Trim Panel Replacement .
2. Remove the window inner belt sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement .
3. Remove the door garnish molding. Refer to Front and Rear Side Door Window Garnish Molding Replacement .

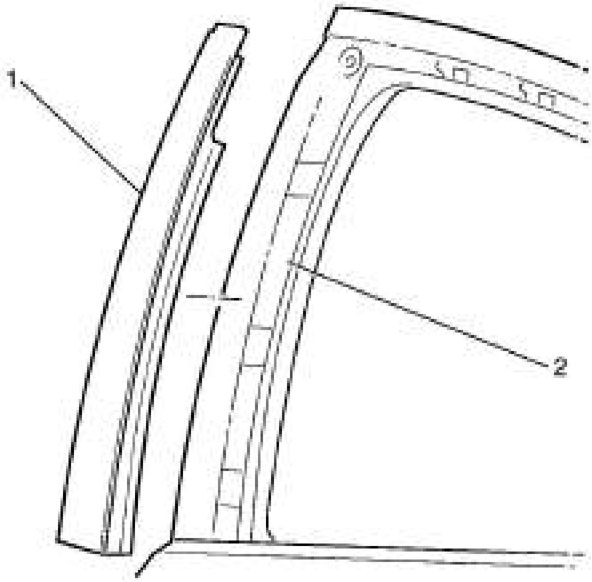


Important: Pry out the window inner sealing strip (1) then pull by hand to expose the door applique retaining screws.

4. Detach the front part of the window inner sealing strip (1) from the door (2).

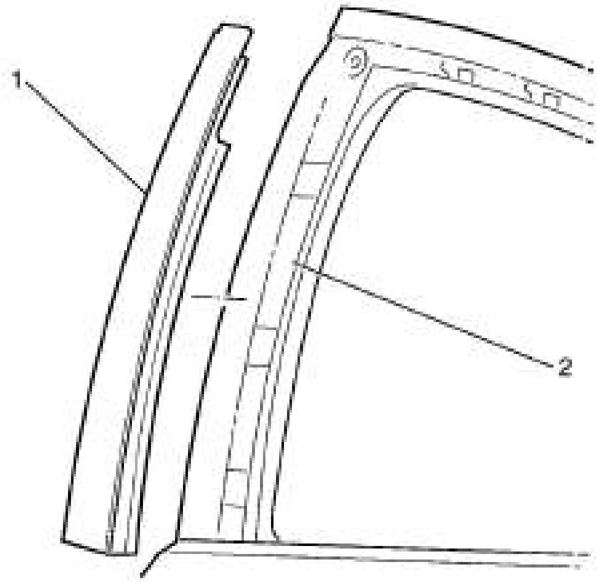


5. Remove the door applique to door retaining screws (1).



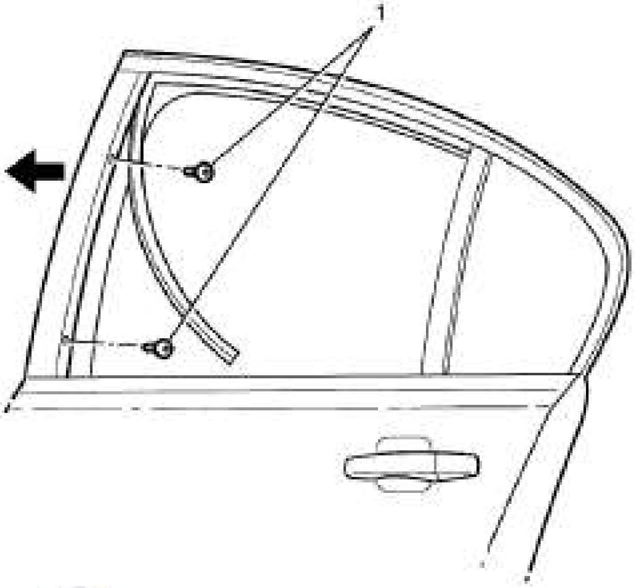
6. Remove the door applique (1) from the door (2).

Installation Procedure



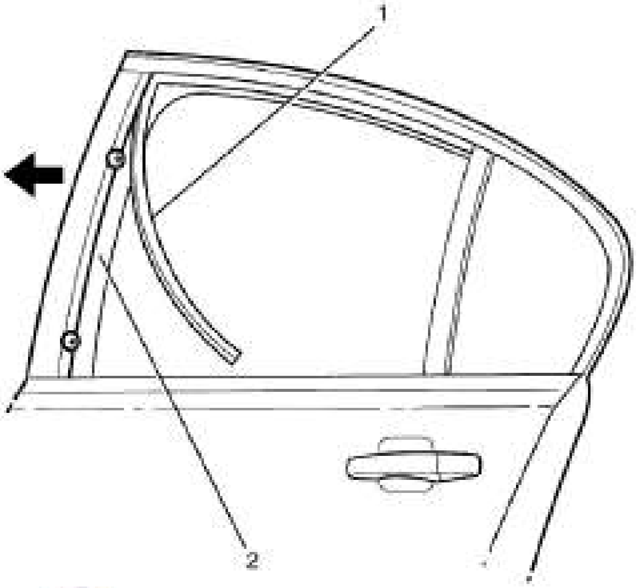
1. Position the door applique (1) to the door (2).

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the door applique to door retaining screws (1).

   Tighten
   Tighten the screws to 3 N-m (27 lb in).



3. Attach the attach part of the window inner sealing strip (1) to the door (2).
4. Install the door garnish molding.Refer to Front and Rear Side Door Window Garnish Molding Replacement .
5. Install the window inner belt sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement .
6. Install the door trim panel. Refer to Rear Side Door Trim Panel Replacement .

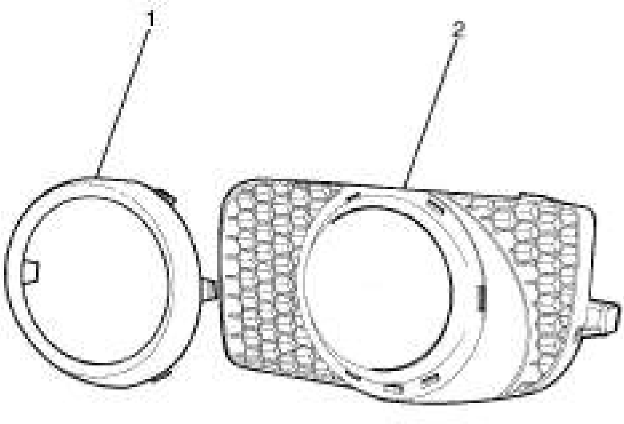
Front Fog Lamp Bezel Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

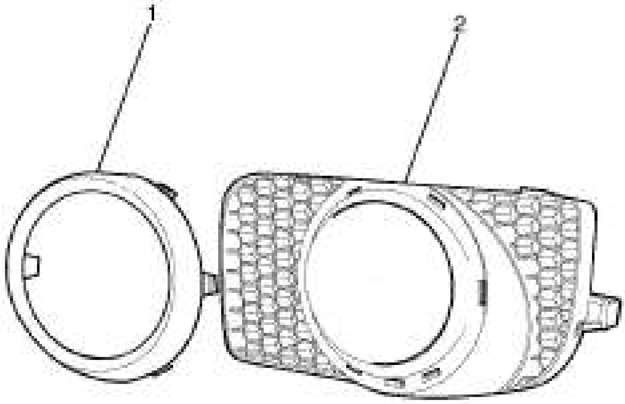
1. Remove the front fog lamp cover. Refer to Front Fog Lamp Cover Replacement.



2. Carefully pry the front fog lamp bezel (1) from the front fog lamp cover (2).
3. Remove the front fog lamp bezel from the front fog lamp cover.

Installation Procedure

1. Install the front fog lamp bezel to the front fog lamp cover.



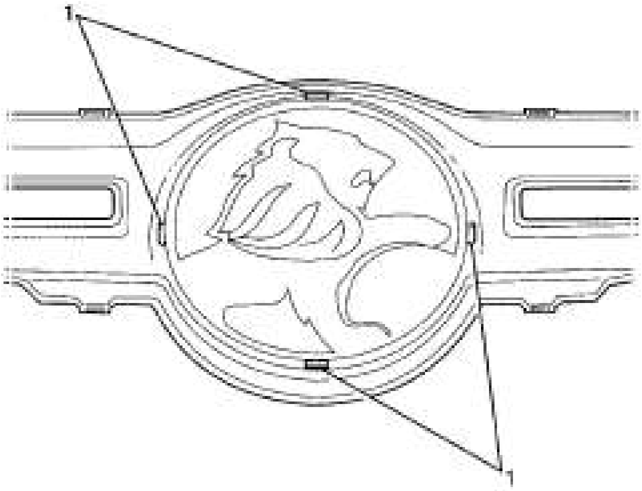
2. Firmly press the front fog lamp bezel (1) into the front fog lamp cover (2).
3. Make sure the retaining clips on the front fog lamp bezel (1) are secure to the front fog lamp cover (2).
4. Install the front fog lamp cover. Refer to Front Fog Lamp Cover Replacement.

Radiator Grille Emblem / Nameplate Replacement (RHD)

Removal Procedure

Important: Do not damage the painted radiator grille.

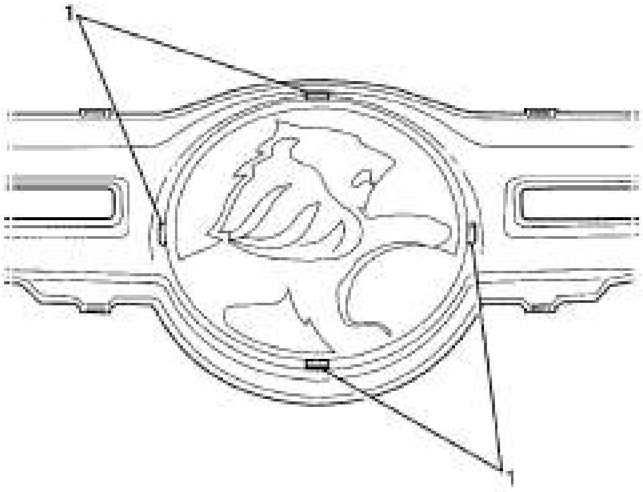
1. Remove the radiator grille applique. Refer to Radiator Grille Replacement



2. Remove the radiator grille emblem to radiator grille applique retaining clips (1).

Installation Procedure

Important: Do not damage the painted radiator grille.



1. Install the radiator grille emblem to radiator grille applique retraining clips (1).
2. Install the grille applique front upper. Refer to Radiator Grille Replacement

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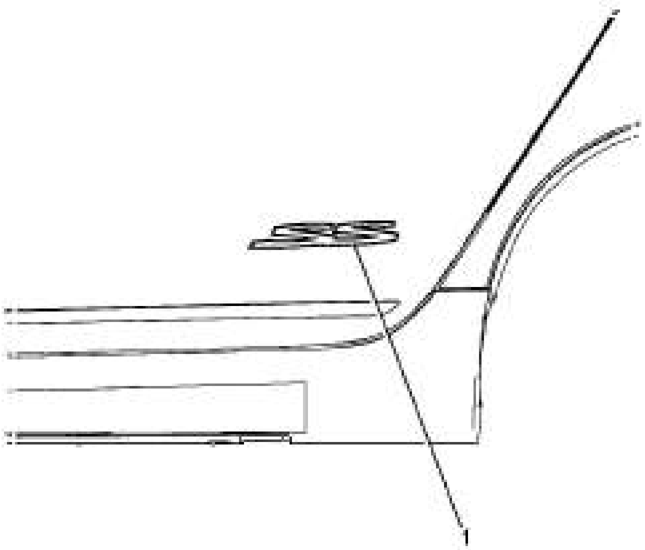
Body Side Emblem / Nameplate Replacement

Removal Procedure

Important: Protect the paint and body work with tape or a clean cloth. Failure to do so may result in damage to the paint work.



1. To assist in the removal of the body side emblem, warm the body side emblem (1) with a suitable tool.

   Important: Take care not to damage the paint on the vehicle when prying the emblem from the body.

2. Use a suitable tool to carefully prise the emblem from the body.
3. Remove any remaining adhesive from the body and clean the surface with a suitable cleaning solution using a lint free cloth.

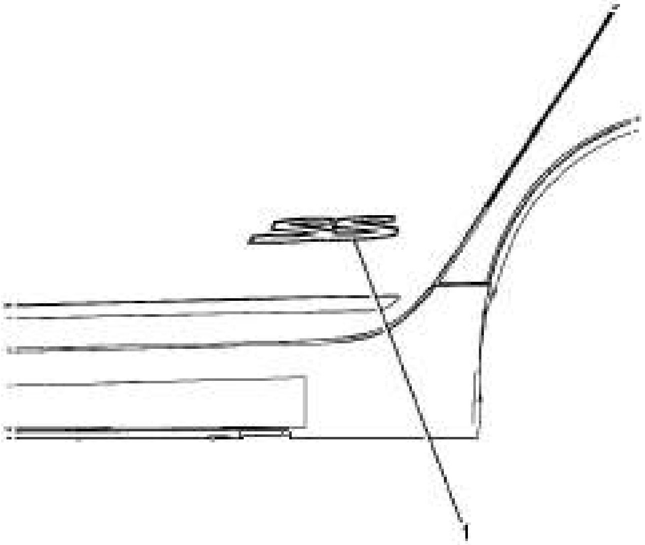
Installation Procedure

Important: Use spec HN2021 or equivalent.

Important: Do not allow the adhesive tape to come in contact with any dirt or foreign matter.

1. If reusing the body side emblem, clean the body side emblem with a suitable cleaning solution, using a lint free cloth.
   1.1. Apply new polyethylene double sided tape to the back of the body side emblem.
   1.2. Trim back the tape to the inner edge of the body side emblem.

2. Peel the backing from the adhesive tape.

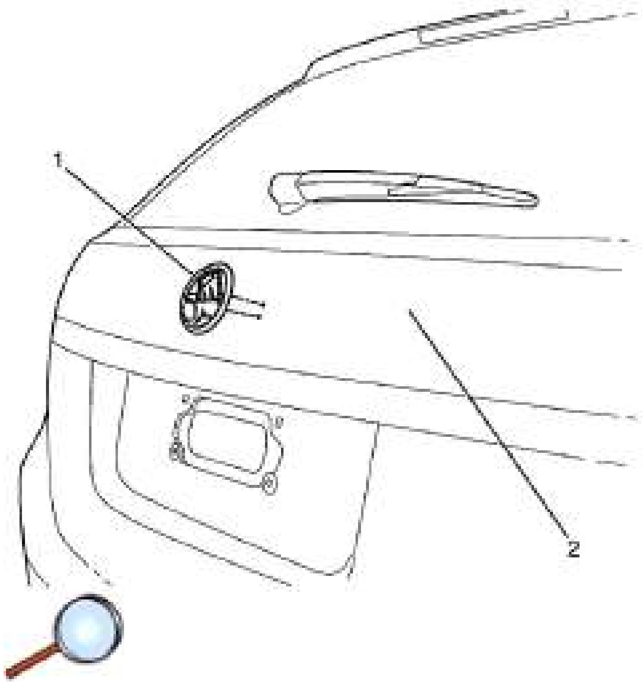


3. Apply the body side emblem (1) to the position shown,
4. Firmly press the body side emblem into place for 30 seconds to make sure proper adhesion of the body side emblem.

Liftgate Emblem / Nameplate Replacement

Removal Procedure

Important: Protect the paint and body work with tape or a clean cloth. Failure to do so may result in damage to the paint work.



Important: To assist in the removal of the liftgate emblem, warm the liftgate emblem with a suitable tool.

Important: Take care not to damage the paint work when prying the liftgate emblem from the liftgate.

1. Use a suitable tool to carefully prise the liftgate emblem (1) from the liftgate (2).
2. Remove any remaining adhesive from the liftgate and clean the surface with a suitable cleaning solution, using a lint free cloth.

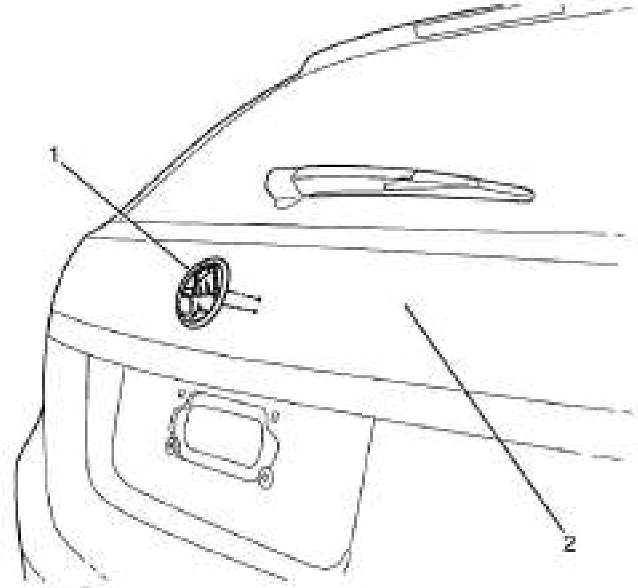
Installation Procedure

Important: Use spec HN2021 or equivalent.

1. If reusing the liftgate emblem, clean the liftgate emblem with a suitable cleaning solution, using a lint free cloth.
   1.1. Apply new polyethylene double sided tape to the back of the liftgate emblem.
   1.2. Trim back the tape to the inner edge of the liftgate emblem.

Important: Do not allow the adhesive tape to come in contact with any dirt or foreign matter.

2. Peel the backing from the adhesive tape.



3. Apply the liftgate emblem (1) to the liftgate (2) as shown. Refer to Graphics/Decals/Emblems.
4. Firmly press the liftgate emblem into place for 30 seconds to make sure proper adhesion of the liftgate emblem.

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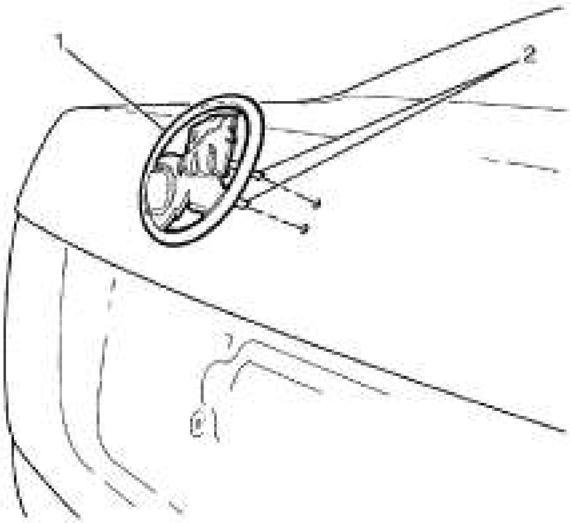
Rear Compartment Lid Emblem / Nameplate Replacement (RHD)

Removal Procedure with Locating Pins

Important: Protect the paint and body work with tape or a clean cloth. Failure to do so may result in damage to the paint work.



1. To assist in the removal of the rear compartment lid emblem, warm the rear compartment lid emblem with a suitable tool.

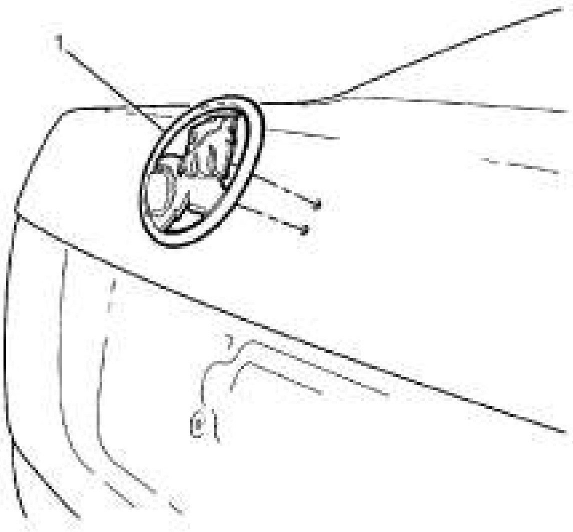
   Important: The rear compartment lid emblem has two locating pins (2). Avoid damage to the pins when removing the rear compartment lid emblem.

   Important: Take care not to damage the paint work when prying the rear compartment lid emblem from the rear compartment lid.

2. Use a suitable tool to carefully prise the rear compartment lid emblem (1) from the rear compartment lid.
3. Remove any remaining adhesive from the rear compartment lid and clean the surface with a suitable cleaning solution, using a lint free cloth.

Removal Procedure without Locating Pins

Important: Protect the paint and body work with tape or a clean cloth. Failure to do so may result in damage to the paint work.



1. To assist in the removal of the rear compartment lid emblem, warm the rear compartment lid emblem with a suitable tool.

   Important: Take care not to damage the paint work when prying the rear compartment lid emblem from the rear compartment lid.

2. Use a suitable tool to carefully prise the rear compartment lid emblem (1) from the rear compartment lid.
3. Remove any remaining adhesive from the rear compartment lid and clean the surface with a suitable cleaning solution, using a lint free cloth.

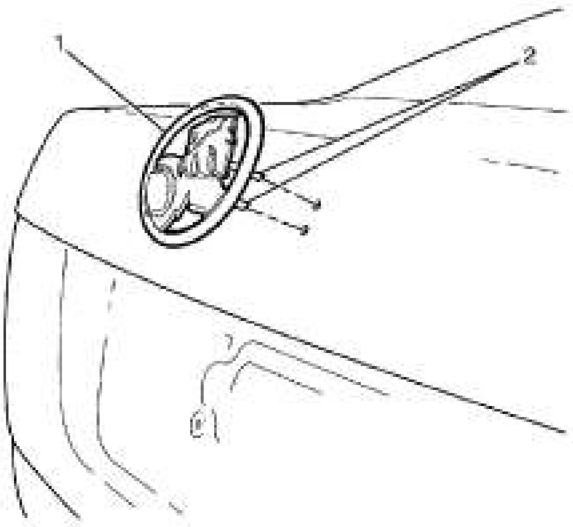
Installation Procedure with Locating Pins

Important: Use spec HN2021 or equivalent.

1. If reusing the rear compartment lid emblem, clean the rear compartment lid emblem with a suitable cleaning solution, using a lint free cloth.
   1.1. Apply new polyethylene double sided tape to the back of the rear compartment lid emblem.
   1.2. Trim back the tape to the inner edge of the rear compartment lid emblem.

   Important: Do not allow the adhesive tape to come in contact with any dirt or foreign matter.

2. Peel the backing from the adhesive tape.



3. Apply the rear compartment lid emblem (1) to the position shown, making sure that the locating pins (2) are in position.
4. Firmly press the rear compartment lid emblem into place for 30 seconds to make sure proper adhesion of the rear compartment lid emblem.

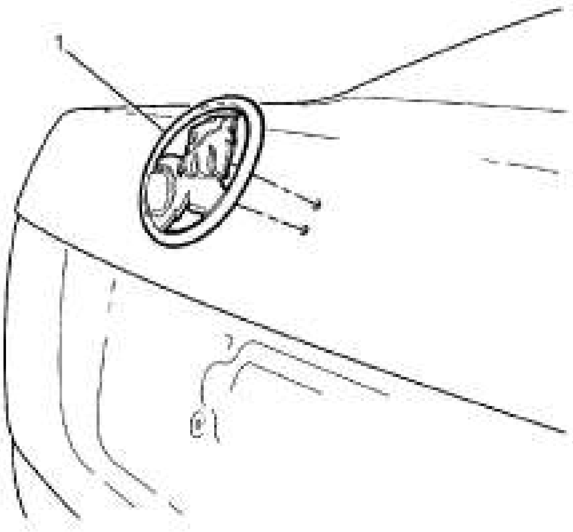
Installation Procedure without Locating Pins

Important: Use spec HN2021 or equivalent.

1. If reusing the rear compartment lid emblem, clean the rear compartment lid emblem with a suitable cleaning solution, using a lint free cloth.
   1.1. Apply new polyethylene double sided tape to the back of the rear compartment lid emblem.
   1.2. Trim back the tape to the inner edge of the rear compartment lid emblem.

Important: Do not allow the adhesive tape to come in contact with any dirt or foreign matter.

2. Peel the backing from the adhesive tape.



3. Apply the rear compartment lid emblem (1) to the position shown, making sure that the rear compartment lid emblem in position. Refer to Graphics/Decals/Emblems .
4. Firmly press the rear compartment lid emblem into place for 30 seconds to make sure proper adhesion of the rear compartment lid emblem.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Hardware and Trim | Exterior Trim | Repair Instructions | Document ID: 1990426

Front Bumper Lower Fascia Grille Replacement

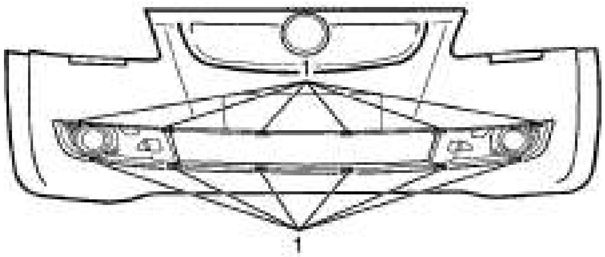
Removal Procedure

Type A

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement.



3. Carefully pry the front bumper fascia lower grille retaining tabs (1) from the front bumper fascia.
4. Remove the front bumper fascia lower grille from the front bumper fascia.

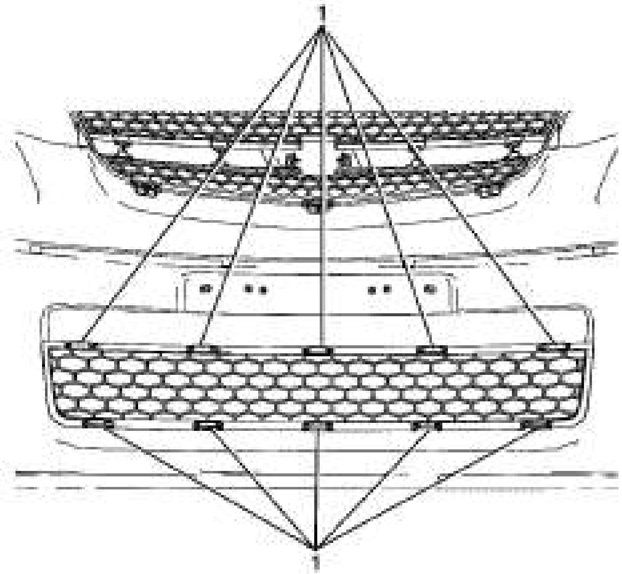
Removal Procedure

Type B

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement.

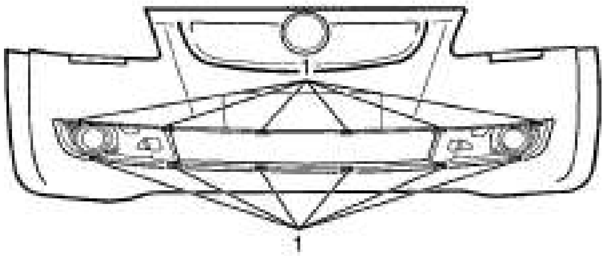


3. Carefully pry the front bumper fascia lower grille retaining tabs (1) from the front bumper fascia.
4. Remove the front bumper fascia lower grille from the front bumper fascia.

Installation Procedure

Type A

1. Install the front bumper fascia lower grille to the front bumper fascia.

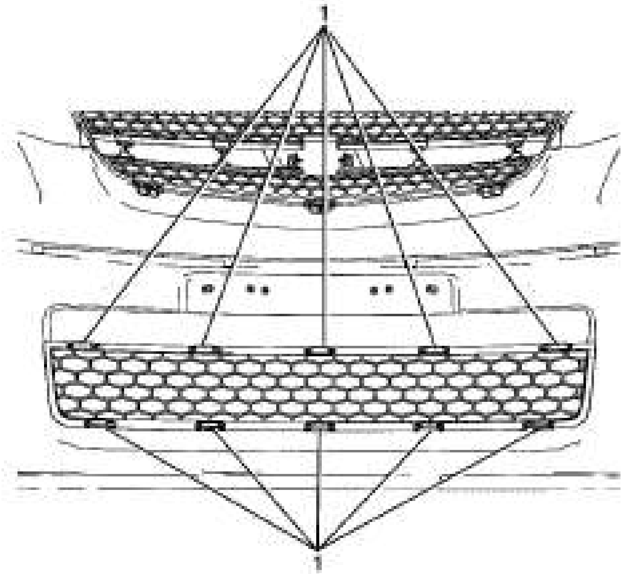


2. Firmly press the front bumper fascia lower grille retaining tabs (1) into the front bumper fascia.
3. Install the front bumper fascia. Refer to Front Bumper Fascia Replacement.
4. Lower the vehicle.

Installation Procedure

Type B

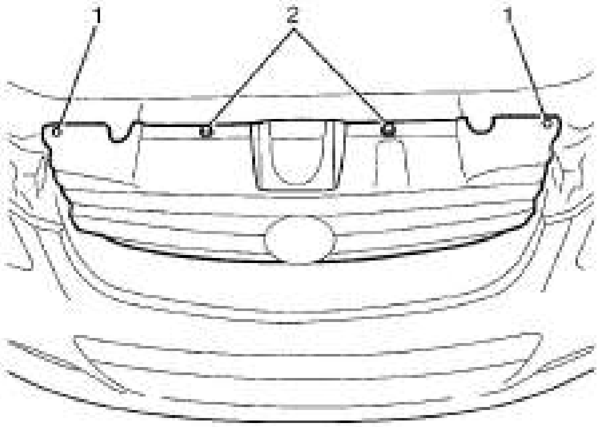
1. Install the front bumper fascia lower grille to the front bumper fascia.



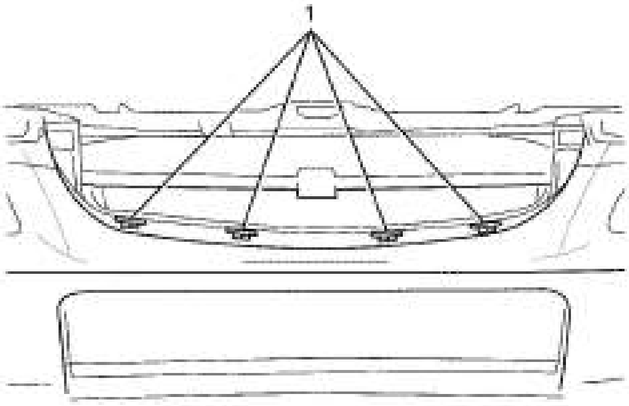
2. Firmly press the front bumper fascia lower grille retaining tabs (1) into the front bumper fascia.
3. Install the front bumper fascia. Refer to Front Bumper Fascia Replacement.
4. Lower the vehicle.

Radiator Grille Replacement (SWB)

Removal Procedure



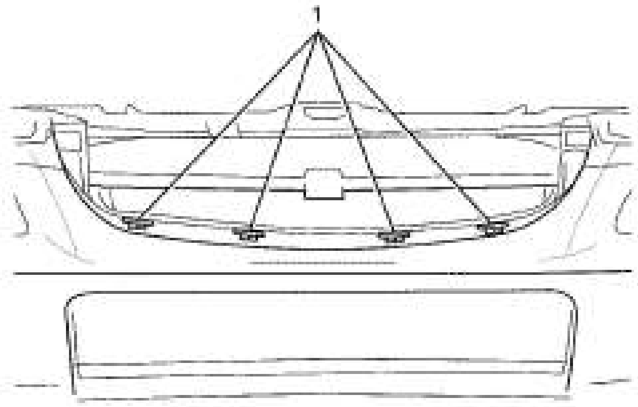
1. Remove the radiator grille to front end module retaining bolts (1).
2. Remove the radiator grille to front end module push-in retainers (2).



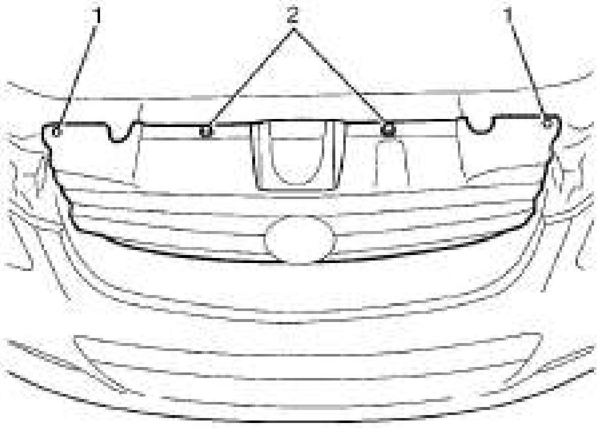
3. Carefully pry the radiator grille retaining tabs (1) from the upper edge of the front bumper fascia.
4. Remove the radiator grille from the front bumper fascia.

Installation Procedure

1. Install the radiator grille to the front bumper fascia.



2. Firmly press the radiator grille retaining tabs (1) into the upper edge of the front bumper fascia.



3. Install the radiator grille to front end module push-in retainers (2).

   Notice: Refer to Fastener Notice in the Preface section.

4. Install the radiator grille to front end module retaining bolts (1).

   Tighten
   Tighten the bolts to 4.5 N·m (39 lb in).

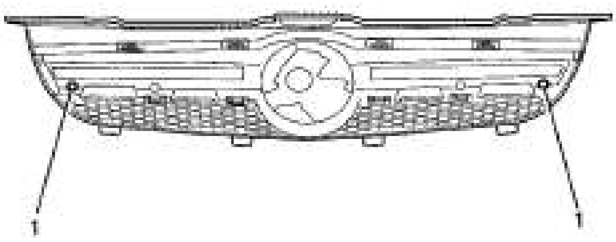
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Hardware and Trim | Exterior Trim | Repair Instructions | **Document ID: 2040115**

Radiator Grille Retainer Replacement

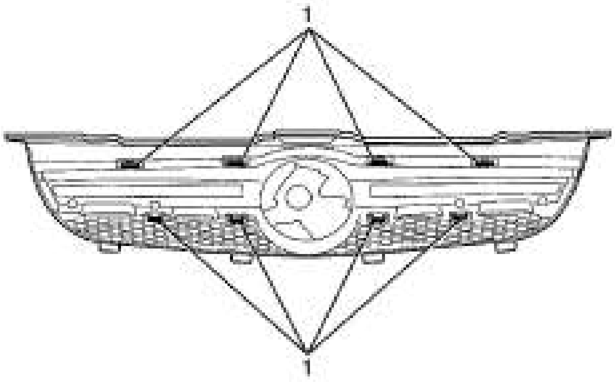
Removal Procedure

Important: Carefully remove the radiator grille applique from the radiator grille. Failure to do so will result in damage to the radiator grille applique.

1. Remove the radiator grille. Refer to Radiator Grille Replacement.



2. Remove the radiator grille applique to radiator grille retaining screws (1).

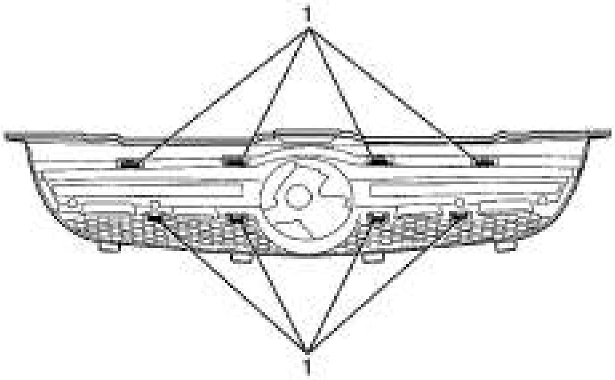


3. Remove the radiator grille applique by releasing the retaining clips (1).

4. Remove the radiator grille applique from the radiator grille.
5. Remove the radiator grille emblem. Refer to Radiator Grille Emblem/Nameplate Replacement.

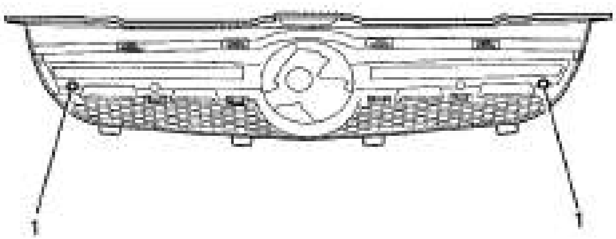
Installation Procedure

1. Install the radiator grille emblem. Refer to Radiator Grille Emblem/Nameplate Replacement.
2. Install the radiator grille applique to the radiator grille.



3. Apply pressure to the radiator grille applique to engage the retaining clips (1) to the radiator grille.
4. Make sure that the retaining clips are secure.

Notice: Refer to Fastener Notice in the Preface section.



5. Install the radiator grille applique to radiator grille retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).

6. Install the radiator grille. Refer to Radiator Grille Replacement.

Body Side Molding Replacement

Removal Procedure

Important: Protect the paint and body work with tape or a clean cloth. Failure to do so may result in damage to the paint work.

1. To assist in the removal of the body side mouldings, warm the body side mouldings with a heat gun.

Important: Take care not to damage the paint on the vehicle when prying the body side mouldings from the body.

2. Use a suitable tool to carefully prise the body side mouldings from the body.
3. Remove any remaining adhesive from the body and clean the surface with a suitable cleaning solution, using a lint free cloth.

Installation Procedure

Important: Use spec HN2021 or equivalent.

Important: Do not allow the adhesive tape to come in contact with any dirt or foreign matter.

1. If reusing the body side mouldings, clean the body with a suitable cleaning solution, using a lint free cloth.
    - 1.1. Apply new polyethylene double sided tape to the back of the body side mouldings.
    - 1.2. Trim back the tape to the inner edge of the body side mouldings.
2. Peel the backing from the adhesive tape.
3. Apply the body side mouldings to the body. Refer to Graphics/Decals/Emblems for moulding placement and measurement details.
4. Press firmly over the length of the mouldings for 10 seconds to make sure correct adhesion, starting at the front of the vehicle working towards the rear.

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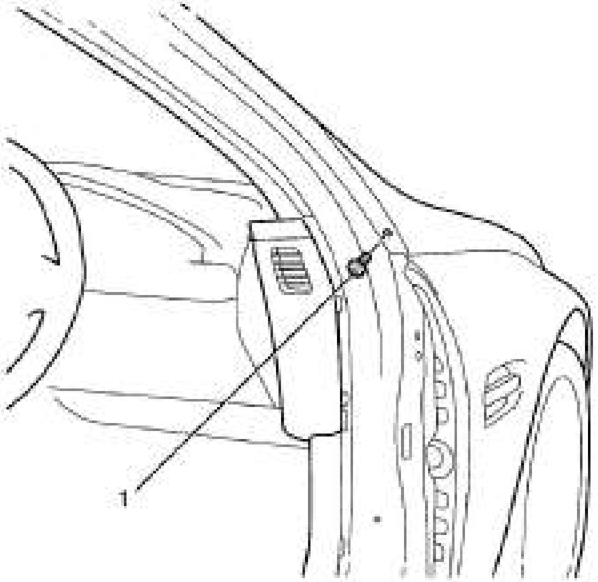
Body Side Roof Drip Molding Replacement (Sportwagon)

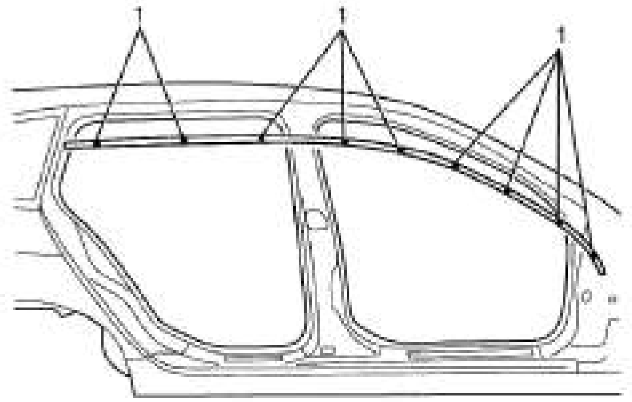
Removal Procedure

Important: Carefully remove the roof drip moulding, failure to do so will result in damage to the roof drip moulding.

1. Open the front and rear doors of the vehicle on the relevant side.



2. Remove the body side roof drip moulding to vehicle retaining screw (1).

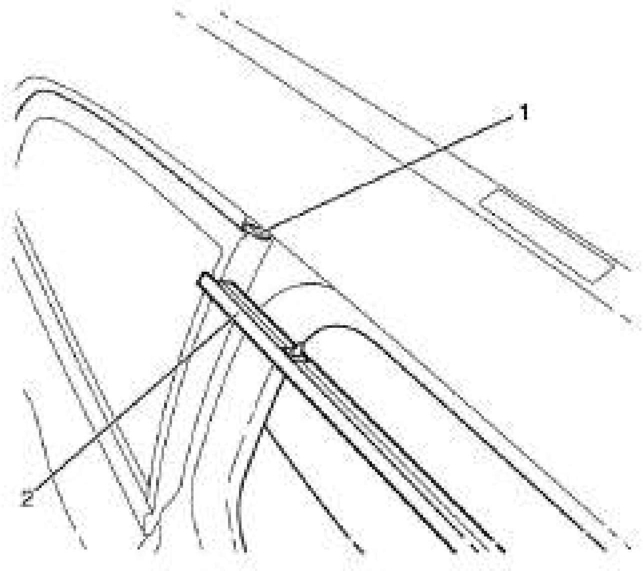


Important: Take care not to damage the paint on the vehicle when prying the roof drip moulding from the vehicle.

3. Use a suitable tool to carefully remove the roof drip moulding, starting from the front of the vehicle, by prying the roof drip moulding retaining clips (1) away from the vehicle.
4. Remove the roof drip moulding from the vehicle.

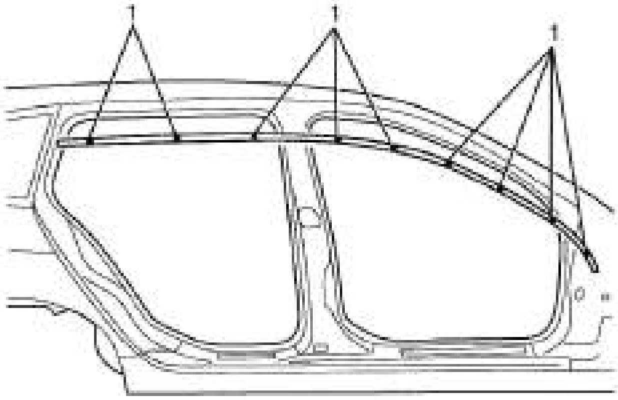
Installation Procedure

1. Clean the roof drip gutter with a suitable cleaning solution, using a lint free cloth.
2. Install the roof drip moulding starting at the rear of the moulding.



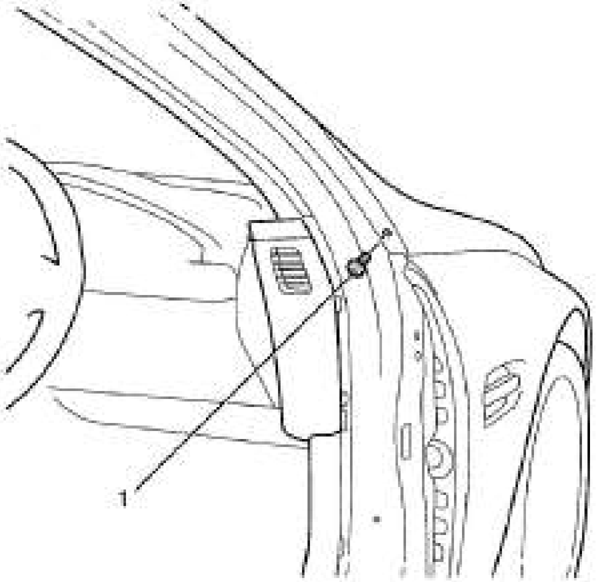
Important: Make sure that the rear of the body side roof moulding (2) is correctly positioned on the body side stationary window locating tab (1).

3. Install the body side roof drip moulding (2) to the body side stationary window locating tab (1).



4. Install the remaining roof drip moulding retaining clips (1) working from the rear to the front of the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.



5. Install the body side roof drip moulding to vehicle retaining screw (1).

   Tighten
   Tighten the screw to 2 N·m (18 lb in).

6. Close the front and rear doors of the vehicle on the relevant side.

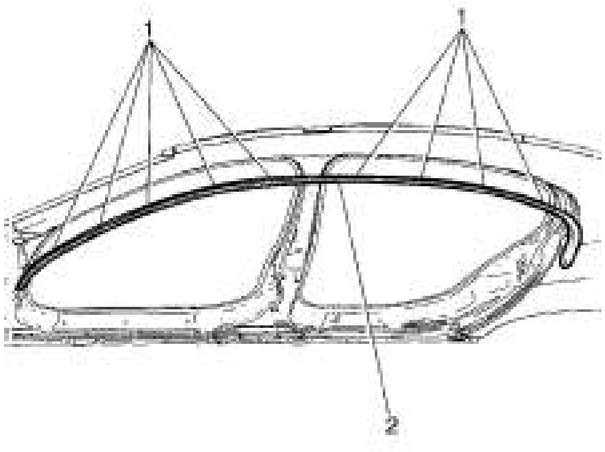
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Hardware and Trim | Exterior Trim | Repair Instructions | **Document ID: 2067488**

Body Side Roof Drip Molding Replacement (Sedan)

Removal Procedure

Important: Carefully remove the roof drip moulding, failure to do so will result in damage to the roof drip moulding.

1. Open the front and rear doors of the vehicle on the relevant side.

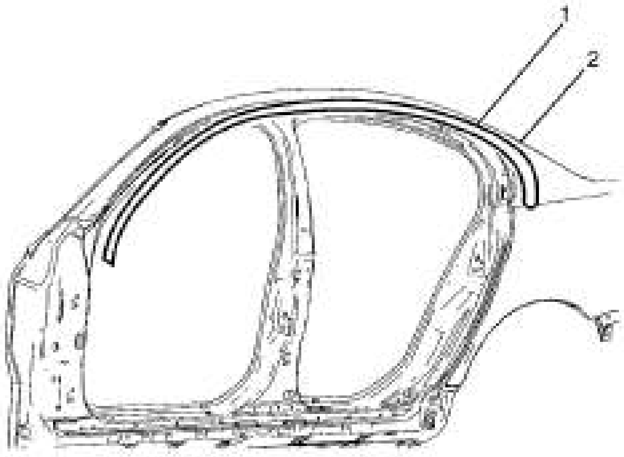


Important: Take care not to damage the paint on the vehicle when prying the roof drip moulding from the vehicle.

2. Use a suitable tool to carefully remove the roof drip moulding, starting from the front of the vehicle, by prying the roof drip moulding retaining clips (1) away from the vehicle.
3. Remove the roof drip moulding (2) from the vehicle.

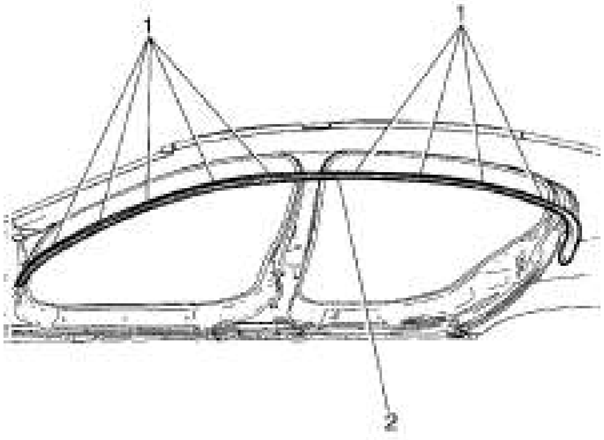
Installation Procedure

1. Clean the roof drip gutter with a suitable cleaning solution, using a lint free cloth.
2. Install the roof drip moulding (1) starting at the rear of the moulding.



Important: Make sure that the rear datum pin is secure and in the correct position.

3. Install the body side roof drip moulding (1) rear datum pin (2) to the vehicle.



4. Install the remaining roof drip moulding retaining clips (1) working from the rear to the front of the vehicle.
5. Close the front and rear doors of the vehicle on the relevant side.

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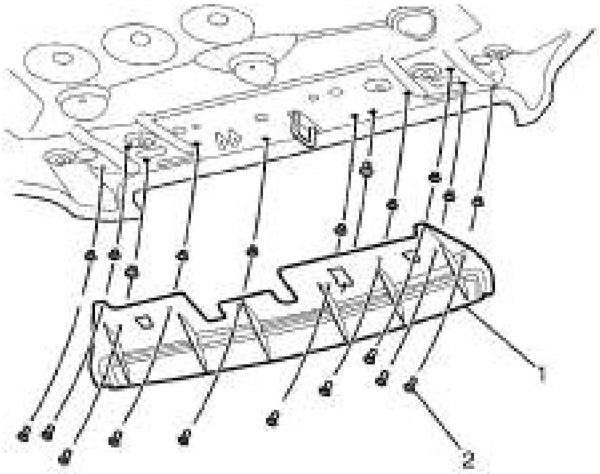
Hood Front Molding Replacement

Removal Procedure

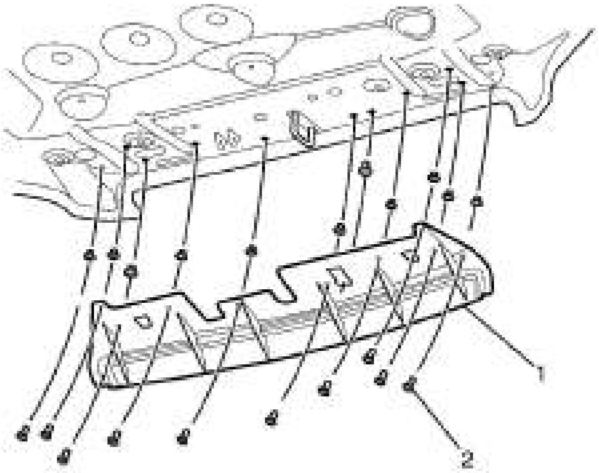
> **Important:** When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable hood brace to the vehicle.



2. Remove the front hood moulding to hood retaining screws (2).
3. Remove the front hood moulding (1) from the hood.

Installation Procedure



1. Position the front hood moulding (1) to the hood.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the front hood moulding to hood retaining screws (2).

   Tighten
   Tighten the screws to 3 N·m (27 lb in).

3. Remove the suitable hood brace from the vehicle.
4. Close the hood.

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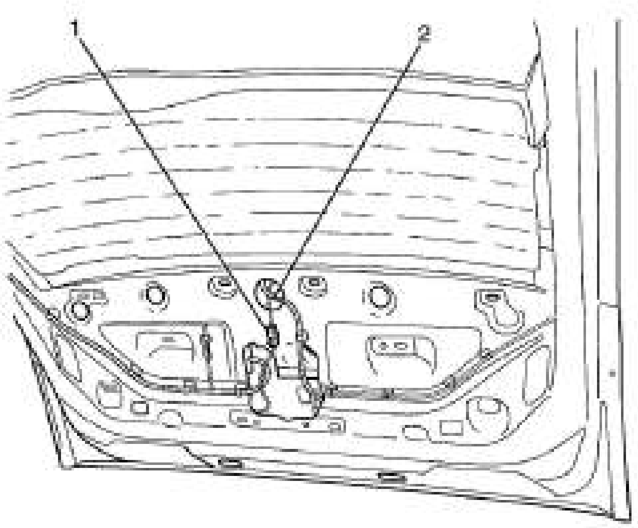
Liftgate Upper Molding Replacement

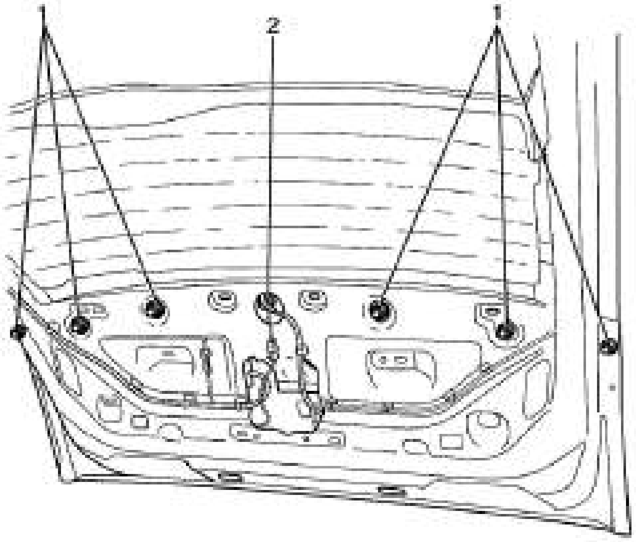
Removal Procedure

> **Important:** When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

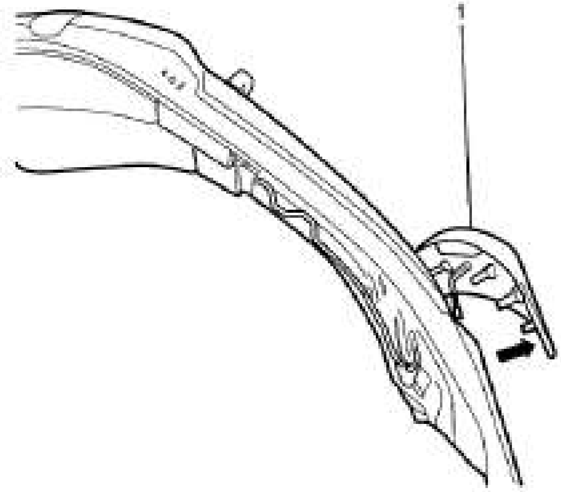
1. Open the liftgate.
2. Install a suitable liftgate brace to the vehicle.
3. Remove the liftgate window side garnish moulding. Refer to Liftgate Window Side Garnish Molding Replacement.
4. Remove the liftgate window upper garnish moulding. Refer to Liftgate Window Upper Garnish Molding Replacement.



5. Disconnect the high mounted stop lamp electrical connector (1) and detach from liftgate.
6. Disconnect the rear window washer hose (2).



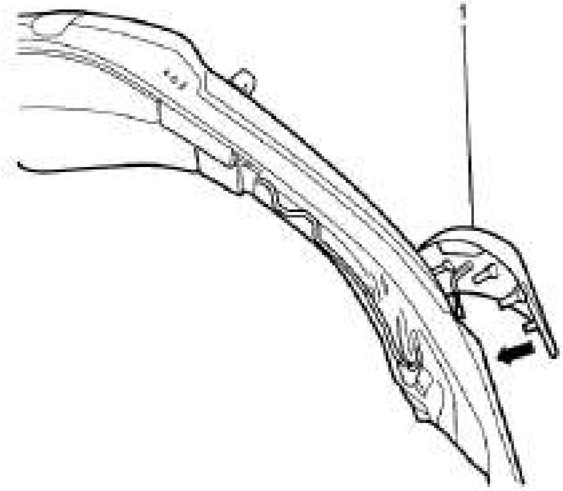
7. Remove the liftgate upper moulding to body grommet (2).
8. Remove the liftgate upper moulding to body retaining nuts (1).



Important: Take care to feed the high mounted stop lamp wiring connector and rear window washer hose through the grommet hole.

9. Remove the liftgate upper moulding (1) from the vehicle

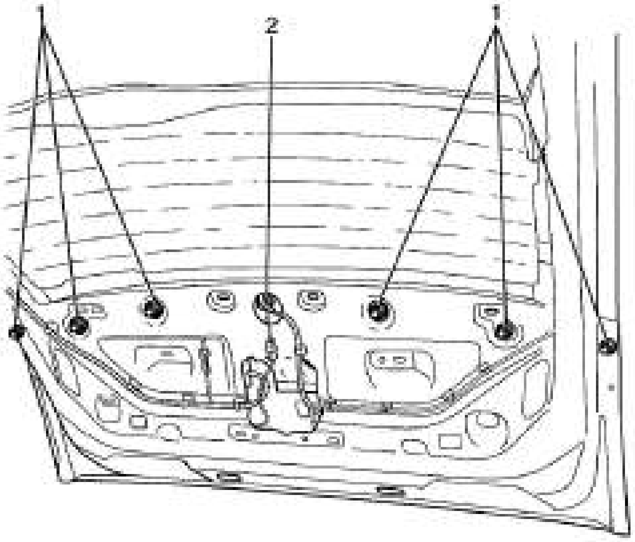
Installation Procedure



Important: Take care to feed the high mounted stop lamp wiring connector and rear window washer hose through the grommet hole.

1. Position the liftgate upper moulding to the vehicle.

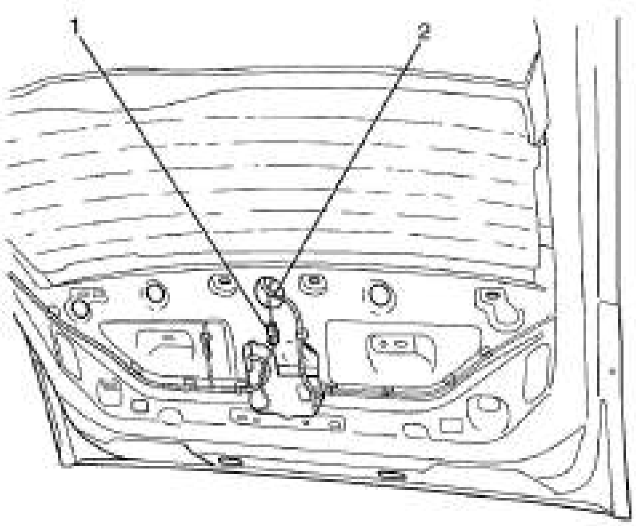
   Notice: Refer to Fastener Notice in the Preface section.



2. Install the liftgate upper moulding to body retaining nuts (1).

   Tighten
   Tighten the nuts to 3 N·m (26 lb in).

3. Install the liftgate upper moulding to body grommet (2).



Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

4. Connect the rear window washer hose (2).
5. Connect the high mounted stop lamp electrical connector (1) and attach to liftgate.
6. Install the liftgate window upper garnish moulding. Refer to Liftgate Window Upper Garnish Molding Replacement.
7. Install the liftgate window side garnish moulding. Refer to Liftgate Window Side Garnish Molding Replacement.
8. Remove the suitable liftgate brace from the vehicle.

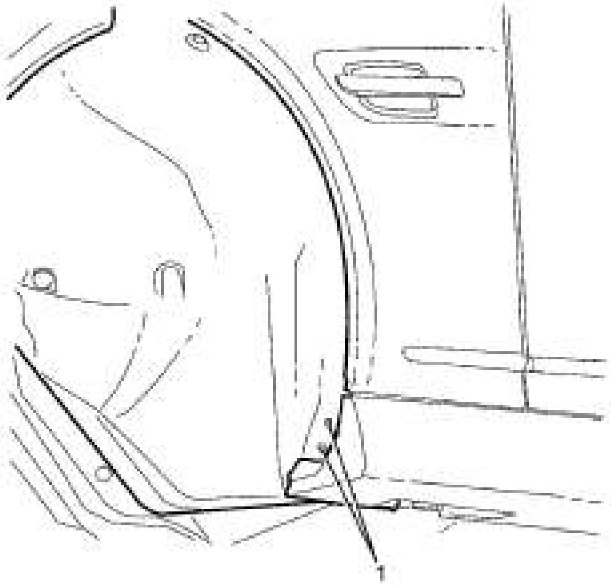
Rocker Panel Molding Replacement (Sportwagon)

Removal Procedure

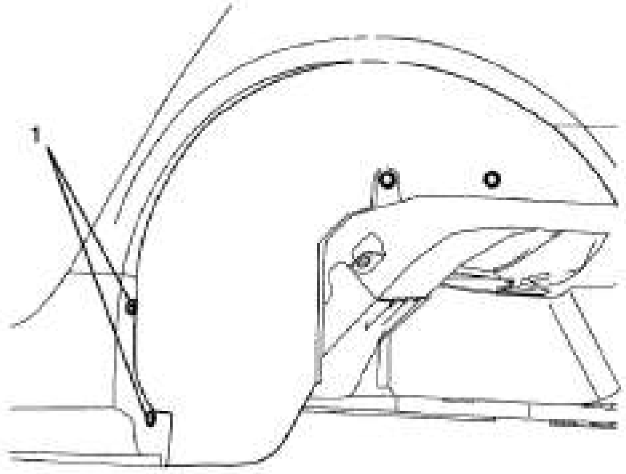
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

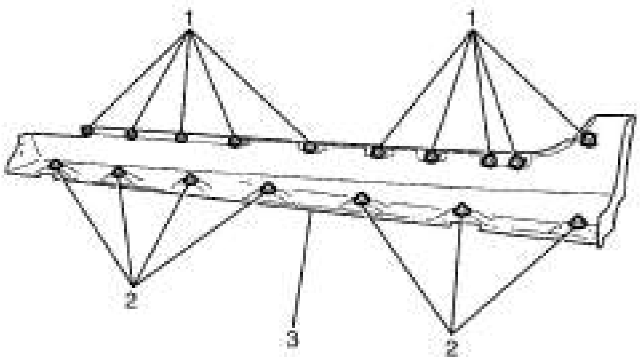
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the front and rear wheels. Refer to Tire and Wheel Removal and Installation.
3. Open the front and rear doors of the vehicle on the relevant side.
4. Remove the side door sill nameplate. Refer to Side Door Sill Nameplate Replacement.



5. Remove the front wheelhouse liner to rocker panel retaining screws (1).



6. Remove the rear wheelhouse liner to rocker panel retaining screws (1).
7. Pull the bottom edge of the rocker panel moulding away from the rocker panel to disengage the retainers.
8. Use a suitable tool to gently separate the front of the rocker panel moulding from the rocker panel.
9. With the aid of an assistant, carefully remove the rocker panel moulding from the body.

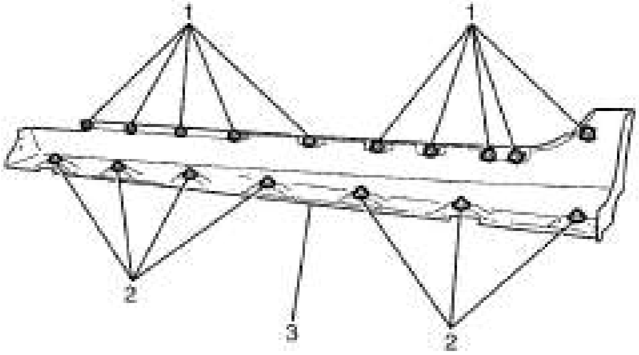


Important: The rocker panel moulding retaining clips are single use parts. They must be discarded after removal.

10. Remove the rocker panel moulding retaining clips (1 and 2) from the rocker panel moulding.

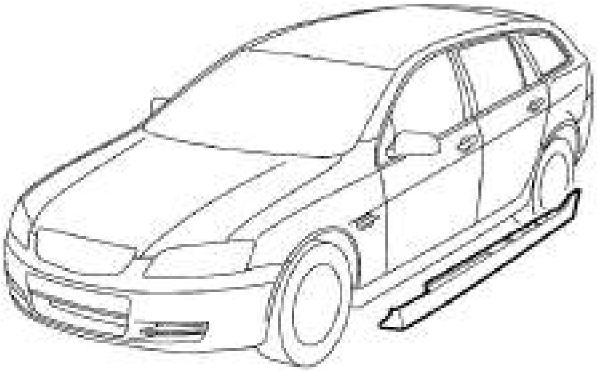
    Discard the retaining clips.

Installation Procedure

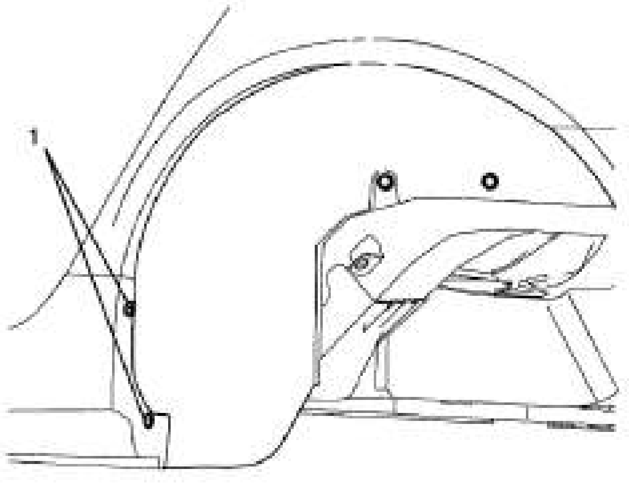


Important: New retainers are required for the installation of the rocker panel moulding. The retainer clips will break upon removal.

1. Install all new rocker panel retaining clips (1 and 2) into the rocker panel moulding.

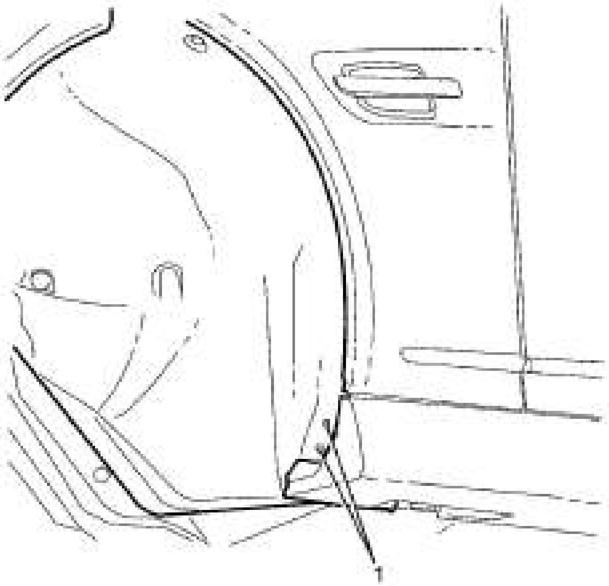


2. With the aid of an assistant, position the rocker panel moulding to the body.
3. Starting from the centre of the rocker panel moulding, apply pressure to secure the rocker panel moulding retaining clips to the upper part of the rocker panel.
4. Starting from the centre of the rocker panel moulding, apply pressure to secure the rocker panel moulding retaining clips to the lower part of the rocker panel.



5. Install the rear wheelhouse liner to rocker panel retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).



6. Install the front wheelhouse liner to rocker panel retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).

7. Install the side door sill nameplate. Refer to Side Door Sill Nameplate Replacement.
8. Install the front and rear wheels. Refer to Tire and Wheel Removal and Installation.

9. Lower the vehicle.
10. Close the front and rear doors.

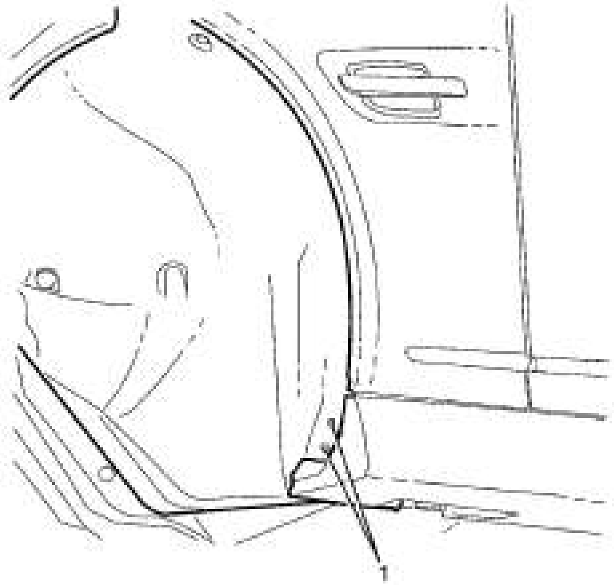
Rocker Panel Molding Replacement (Sedan)

Removal Procedure

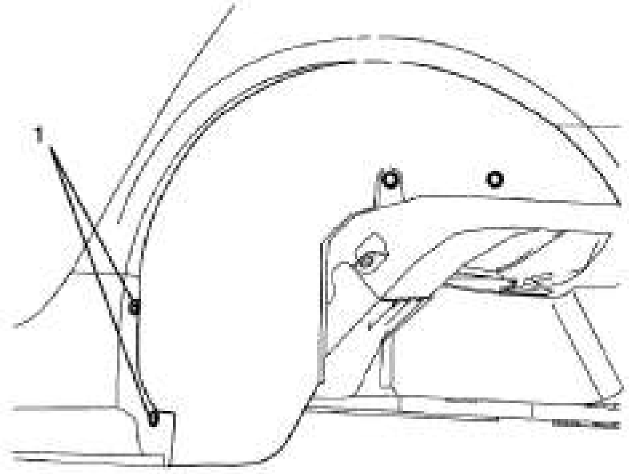
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

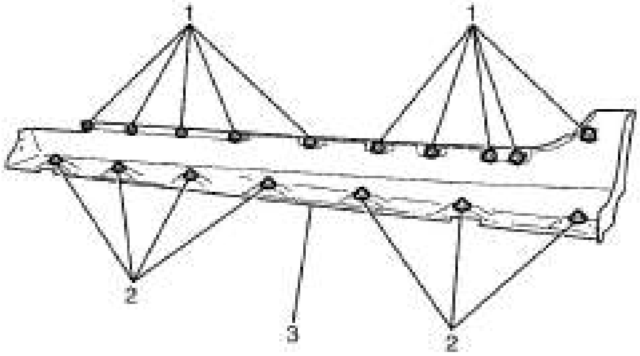
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the Side Door Sill Nameplate. Refer to Side Door Sill Nameplate Replacement.
3. Remove the front and rear wheels. Refer to Tire and Wheel Removal and Installation.
4. Open the front and rear doors of the vehicle on the relevant side.



5. Remove the front wheelhouse liner to rocker panel retaining screws (1).



6. Remove the rear wheelhouse liner to rocker panel retaining screws (1).
7. Pull the bottom edge of the rocker panel moulding away from the rocker panel to disengage the retainers.
8. Use a suitable tool to gently separate the front of the rocker panel moulding from the rocker panel.
9. With the aid of an assistant, carefully remove the rocker panel moulding from the body.

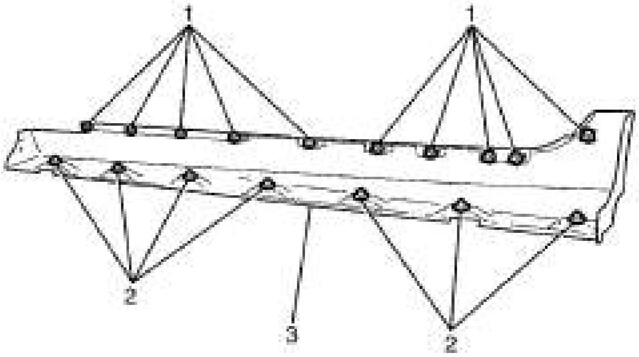


Important: The rocker panel moulding retaining clips are single use parts. They must be discarded after removal.

10. Remove the rocker panel moulding retaining clips (1 and 2) from the rocker panel moulding.

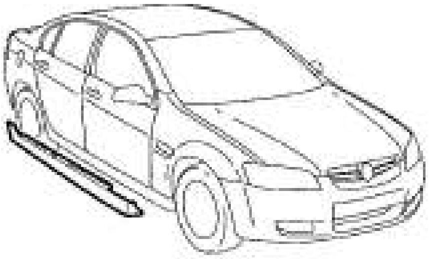
    Discard the retaining clips.

Installation Procedure

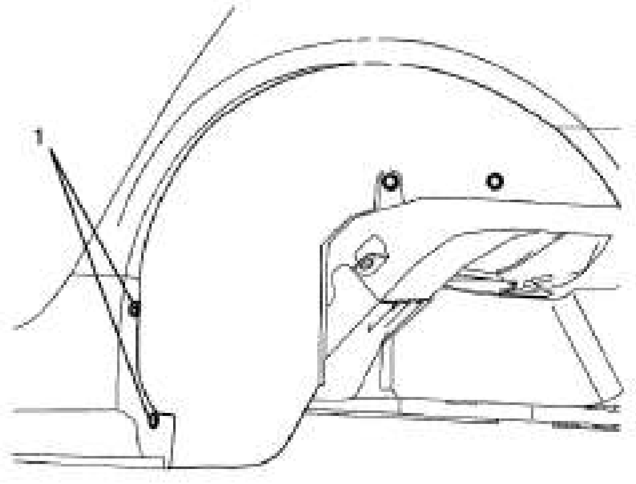


Important: New retainers are required for the installation of the rocker panel moulding. The retainer clips will break upon removal.

1. Install all new rocker panel retaining clips (1 and 2) into the rocker panel moulding.

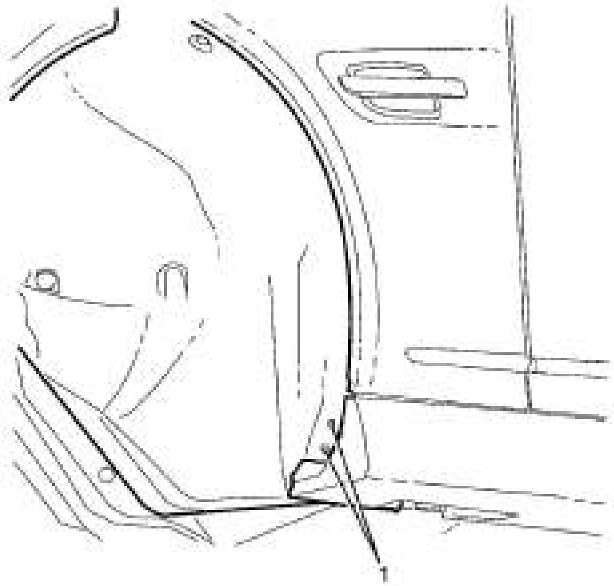


2. With the aid of an assistant, position the rocker panel moulding to the body.
3. Starting from the centre of the rocker panel moulding, apply pressure to secure the rocker panel moulding retaining clips to the upper part of the rocker panel.
4. Starting from the centre of the rocker panel moulding, apply pressure to secure the rocker panel moulding retaining clips to the lower part of the rocker panel.



5. Install the rear wheelhouse liner to rocker panel retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).



6. Install the front wheelhouse liner to rocker panel retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).

7. Install the Side Door Sill Nameplate. Refer to Side Door Sill Nameplate Replacement.
8. Install the front and rear wheels. Refer to Tire and Wheel Removal and Installation.

9. Lower the vehicle.
10. Close the front and rear doors.

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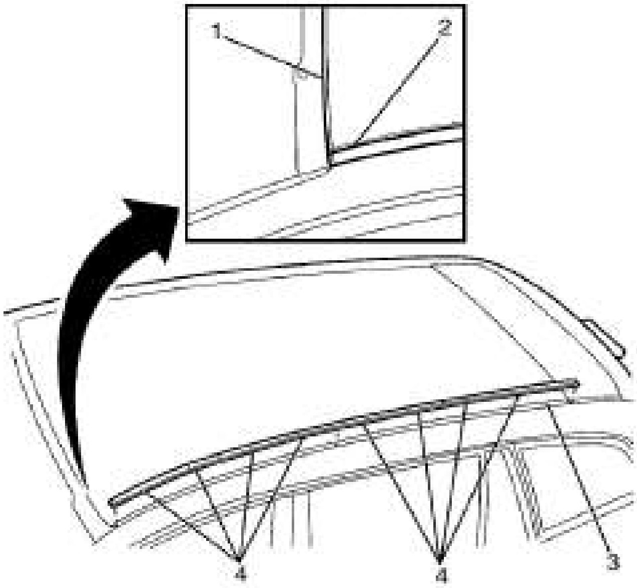
Roof Weld Joint Reveal Molding Replacement (Sportwagon)

Removal Procedure



Important: Protect the paint and body with tape or a clean cloth. Failure to do so may result in damage to the paint work.

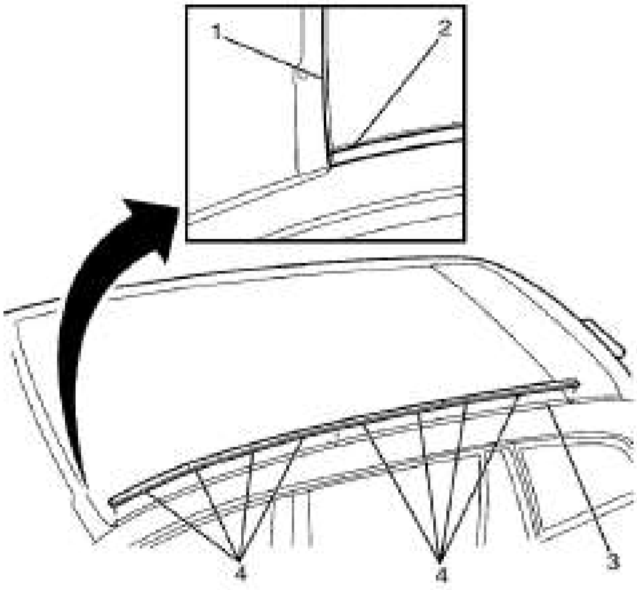
Important: Using a suitable tool lift the roof weld joint reveal moulding (2) from the roof weld joint (3) starting at the front of the vehicle at points close to the top edge of the front windshield seal (1).

1. Remove the roof weld joint reveal moulding (2) from the roof weld joint (3) by lifting the front edge of the roof weld joint reveal moulding upwards to disengage the roof weld joint reveal moulding retaining clips (4).

Important: Clean the surface with a suitable cleaning solution and a lint free cloth to remove any dirt or debris from the roof weld joint (3).

2. Remove any dirt or debris from the roof weld joint (3).

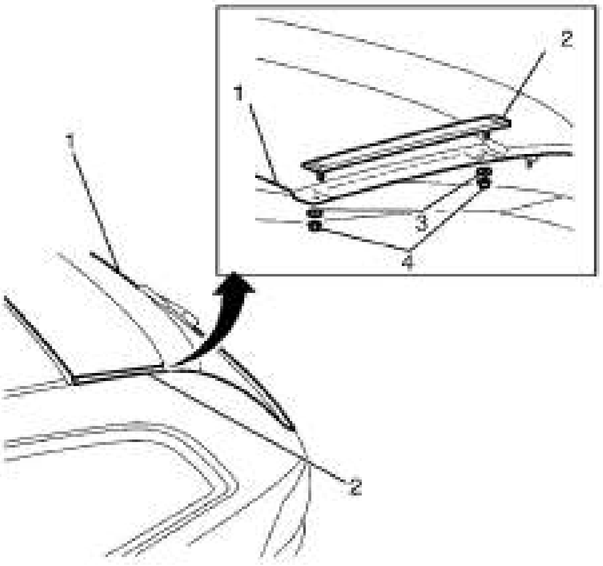
Installation Procedure



Important: If the roof weld joint reveal moulding or roof weld joint reveal moulding retaining clips are cracked, broken or damaged, replace the damaged components.

1. Make sure the front edge of the roof weld joint reveal moulding (2) is located correctly under the top edge of the front windshield seal (1).
2. Align the roof weld joint reveal moulding retaining clips (4) in the correct position and push firmly into place engaging the roof weld joint reveal moulding (2) into the body.

Removal Procedure - Rear



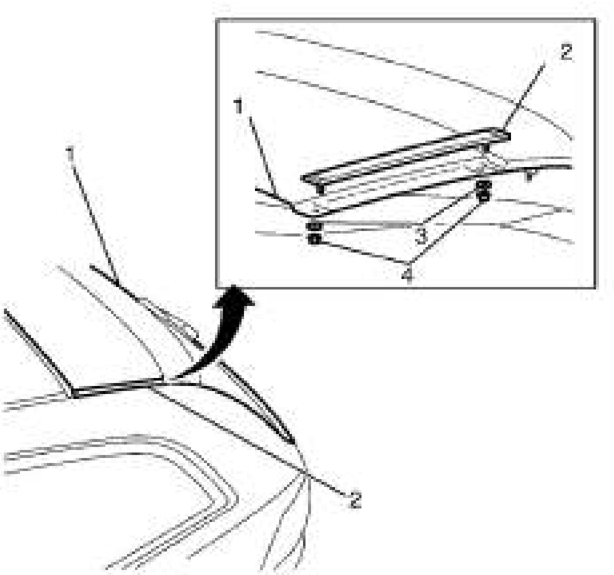
Important: Care must be taken when removing the roof weld joint rear reveal moulding (2) not to damage the vehicle paint.

1. Open the liftgate (1).
2. Remove the roof weld joint rear reveal moulding nuts (4) and washers (3).
3. Remove the roof weld joint rear reveal moulding (2) from the liftgate (1).

   Important: Clean the roof weld joint rear reveal moulding mounting surface with a suitable cleaning solution and a lint free cloth to remove any dirt or debris.

4. Remove any dirt or debris from the roof weld joint rear reveal moulding mounting surface.

Installation Procedure - Rear



1. Install the roof weld joint rear reveal moulding (2) to the liftgate (1).

   Important: NEW sealing washers (3) must be used with the roof weld joint rear reveal moulding nuts (4) when installing the roof weld joint rear reveal moulding (2).

2. Install the roof weld joint rear reveal moulding nuts (4) and washers (3).

   Notice: Refer to Fastener Notice in the Preface section.

3. Tighten the roof weld joint rear reveal moulding nuts (4).

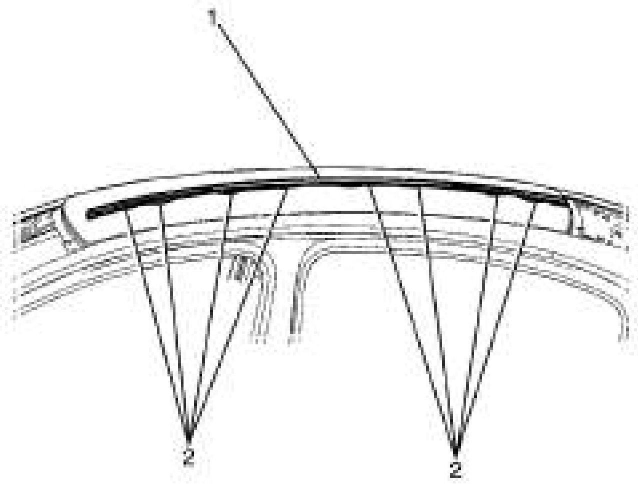
   Tighten
   Tighten the nuts to 3 N·m (27 lb in).

Roof Weld Joint Reveal Molding Replacement (Sedan)

Removal Procedure

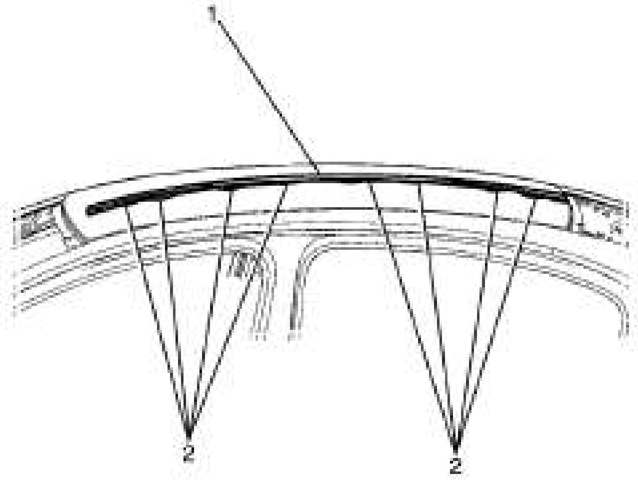
Important: If the roof weld joint reveal moulding cracks, breaks or is damaged in any way, replace the moulding.

Important: Take care not to damage the paint on the vehicle when prying the roof weld joint reveal moulding from the roof.



1. Starting at the windshield pillar rear, carefully pry off the roof weld joint reveal moulding from the roof weld joint, taking care not to break the roof weld joint reveal moulding retaining clips (2).
2. Remove the roof weld joint reveal moulding (1).
3. Clean the accessible roof weld joint with a suitable cleaning solution, using a lint free cloth.

Installation Procedure



Important: Make sure that the rear datum pin is positioned correctly.

1. Position the roof weld joint reveal moulding on the vehicle and slide the rear end of the moulding into the rear moulding retainer.
2. Seat the roof weld joint reveal moulding in the roof weld joint and starting at the rear, carefully engage the roof weld joint reveal moulding retaining clips (2) into position.

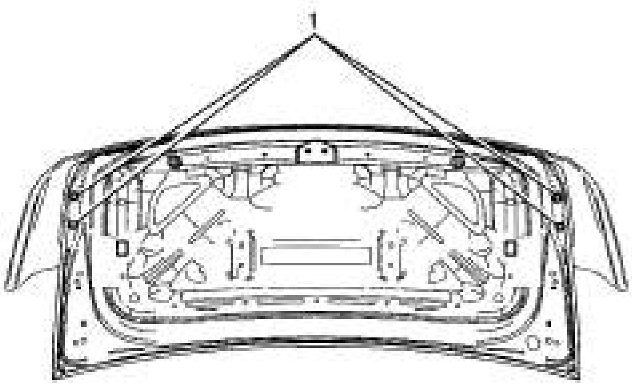
Rear Spoiler Replacement (LWB SWB CSV Clubsport GTS VXR8)

Removal Procedure

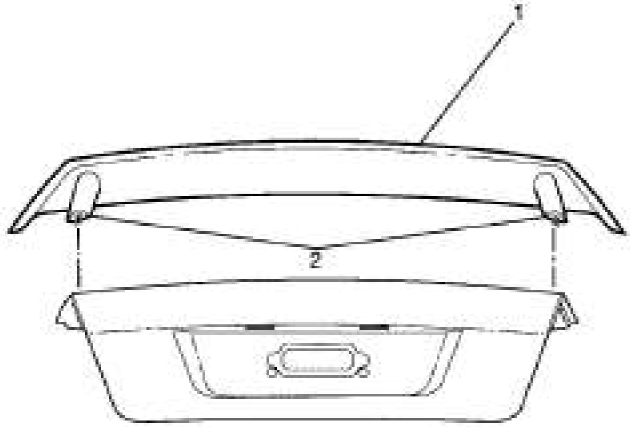
Type A

> **Important:** When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Open the rear compartment lid.
2. Support the rear compartment lid with a suitable brace.



3. Remove the rear spoiler to rear compartment lid retaining nuts (1).
4. Remove the suitable brace from the rear compartment lid.
5. Close the rear compartment lid.



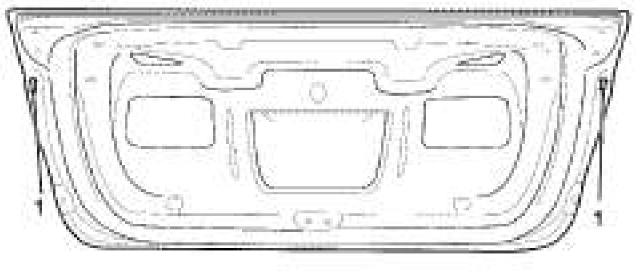
6. Carefully remove the rear spoiler (1) from the vehicle.
7. Make sure the rear spoiler gaskets (2) are intact and on the rear spoiler.
8. Clean the rear compartment lid with a suitable cleaning solution, using a lint free cloth.

Removal Procedure

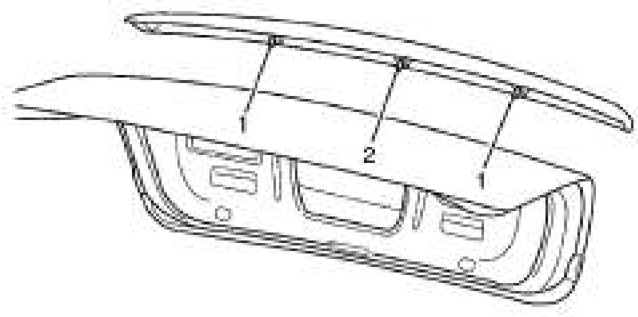
Type B

> **Important:** When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Open the rear compartment lid.
2. Support the rear compartment lid with a suitable brace.



3. Remove the rear spoiler to rear compartment lid retaining nuts (1).



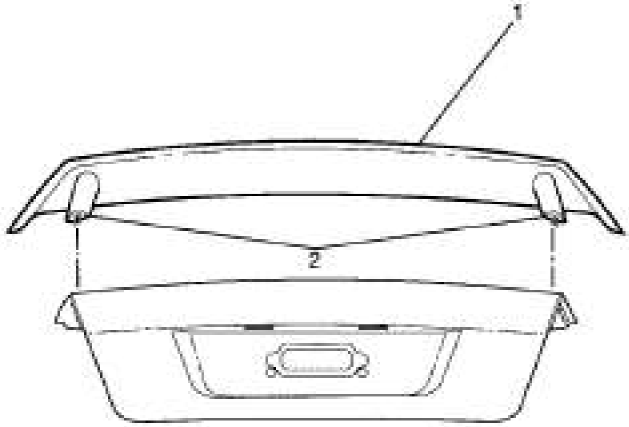
4. Carefully disengage the rear compartment lid lip spoiler retaining clips (1) from the rear compartment lid.
5. Slowly remove the rear compartment lid lip spoiler from the rear compartment lid.
6. Clean the rear compartment lid with a suitable cleaning solution, using a lint free cloth.

Installation Procedure

Type A

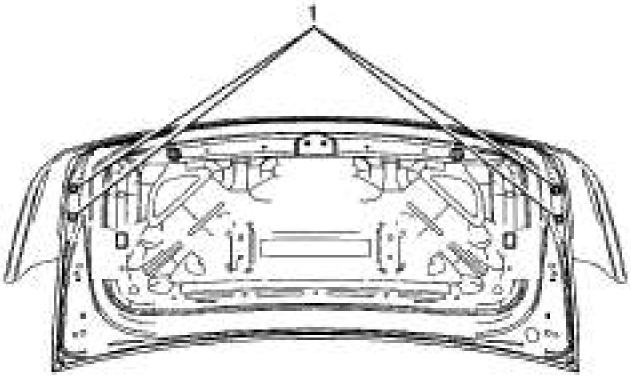
> **Important:** When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Clean the rear spoiler gaskets with a suitable cleaning solution, using a lint free cloth.



2. Install the rear spoiler (1) to the rear compartment lid.
3. Open the rear compartment lid.
4. Support the rear compartment lid with a suitable brace.

Notice: Refer to Fastener Notice in the Preface section.



5. Install the rear spoiler to rear compartment lid retaining nuts (1).

Tighten
Tighten the nuts to 3 N·m (27 lb in).

6. Remove the suitable brace from the rear compartment lid.

7. Close the rear compartment lid.

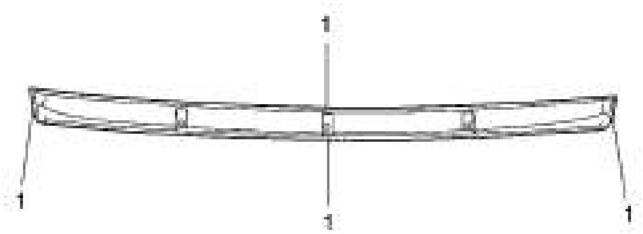
Installation Procedure

Type B

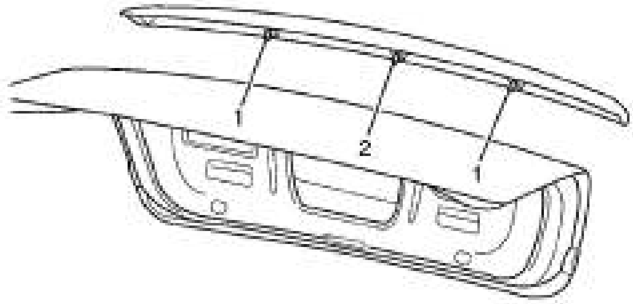
Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

Important: Use spec HN2021 type 13A and HN2021 type 6.

Important: Do not allow the adhesive tape to come in contact with any dirt or foreign matter.

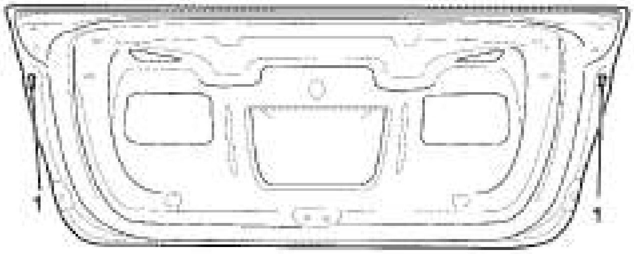


1. If reusing the compartment lid rear applique, clean the compartment lid rear applique with a suitable cleaning solution, using a lint free cloth.
   1.1. Apply the double sided tape HN2021 (1) to the outer edges of the rear compartment lid lip spoiler.
   1.2. Trim back the tape to the outer edges of the rear compartment lid lip spoiler.



2. Install the rear compartment lid lip spoiler to the rear compartment lid retraining clips (1).
3. Open the compartment lid rear.
4. Support the rear compartment lid with a suitable brace.

   Notice: Refer to Fastener Notice in the Preface section.



5. Install the rear compartment lid lip spoiler to rear compartment lid retaining nuts (1).

   Tighten
   Tighten the nuts to 3 N·m (27 lb in).

6. Remove the suitable brace from the rear compartment lid.

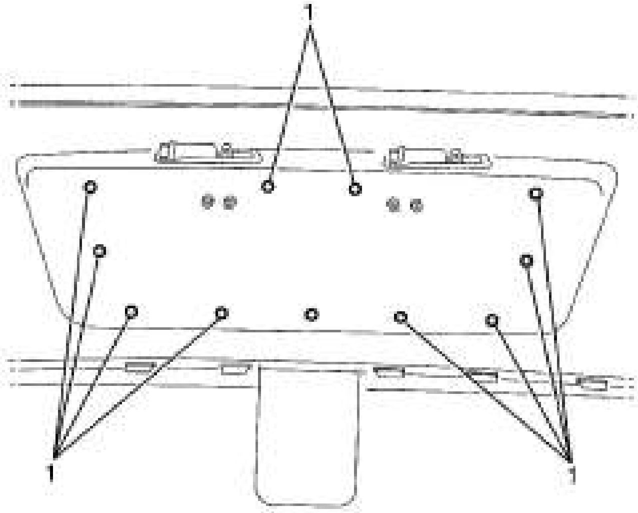
7. Close the compartment lid rear.

Rear License Plate Housing Replacement

Removal Procedure

Important: Carefully remove the licence lamp moulding. Failure to do so will result in damage to the moulding and the rear compartment lid.

1. Remove the rear licence lamp. Refer to Rear License Lamp Replacement.



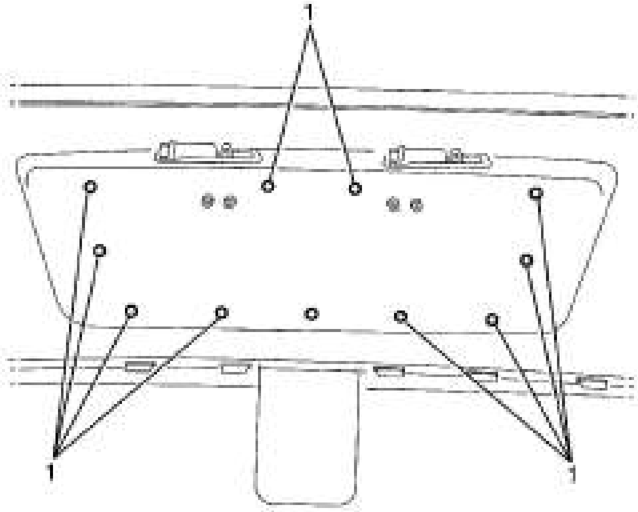
Important: Take care not to damage the paint on the vehicle when prying the rear licence lamp moulding from the rear compartment lid.

2. Remove the rear licence lamp moulding to rear bumper fascia retaining clips (1) and discard.

   Discard the retaining clips.

3. Use a suitable tool to carefully remove the rear licence lamp moulding starting from the rear edge of the rear bumper fascia by prying the rear licence lamp moulding away from the rear bumper fascia.
4. Remove the rear licence lamp moulding from the rear bumper fascia.

Installation Procedure



1. Install the licence lamp rear moulding to the rear bumper fascia.
2. Install NEW retaining clips (1) the rear licence lamp moulding.
3. Install the rear licence lamp . Refer to Rear License Lamp Replacement.

Floor Carpet Drying

If the carpet or the pad or insulator is wet, use the following criteria for drying or for replacing the components:

- For a 1-piece carpet assembly bonded to a cotton or a fiber padding, replace the entire assembly.
- For a 2-piece carpet assembly with a cotton or a fiber padding, replace the padding only. While the carpet is out of the vehicle, dry the carpet using the method described below.
- For a 1-piece carpet assembly bonded to a foam padding or attached to a synthetic padding, dry the carpet using the method described below.
- For a 2-piece carpet assembly with a synthetic padding, dry the assembly using the method described below.

Drying Method

1. If you observe puddles of liquid on the carpet face, use a wet vacuum to remove the excess moisture.
2. Blot the face of the carpet with a towel in order to absorb as much moisture as possible.
3. Point a fan at the affected area and air dry the carpet.

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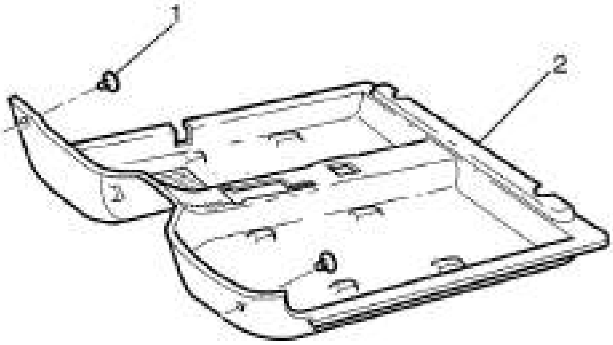
Front Floor Panel Carpet Replacement (RHD)

Removal Procedure

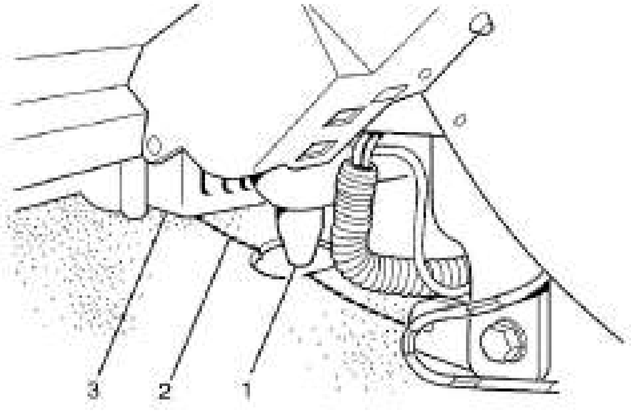
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the following components if required :
    - Front sill trim plate. Refer to Door Sill Plate Replacement.
    - Sill panel trim. Refer to Door Sill Plate Replacement.
    - Rear panel trim plate. Refer to Door Sill Plate Replacement.
    - Rear seat cushion. Refer to Rear Seat Cushion Replacement.
    - Front seat belt retaining bolts. Refer to Front Seat Belt Replacement.
    - Body hinge pillar trim assembly on both sides. Refer to Body Hinge Pillar Trim Panel Replacement.
    - Both front seat assemblies. Refer to Front Seat Replacement - Bucket.
    - Park brake assembly. Refer to Parking Brake Release Handle Assembly Replacement.
    - Instrument panel lower trim plate assembly right side. Refer to Instrument Panel Insulator Panel Replacement - Right Side.
    - Instrument panel lower trim plate assembly left side. Refer to Instrument Panel Insulator Panel Replacement - Left Side.
    - Instrument panel compartment. Refer to Instrument Panel Compartment Replacement.
    - Floor console assembly. Refer to Front Floor Console Replacement.



3. Remove the retaining clips (1) from the front floor carpet assembly (2).

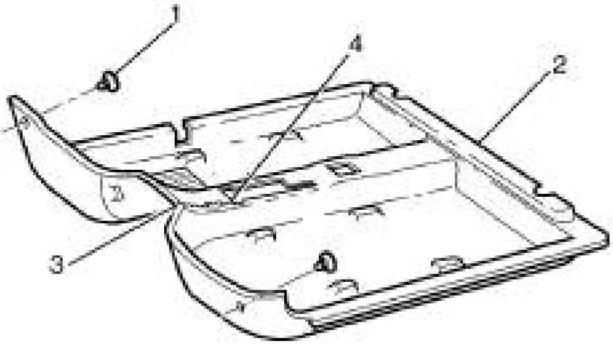
Notice: Refer to General Repair Instructions in the Preface section.



4. From inside the left-hand footwell, grasp the edge of the hole in the front carpet assembly around the evaporator drain hose (1) and carefully tear open along the perforated line (2).
5. Slide the remaining flap of carpet out from under the (HVAC) unit (3).
6. Carefully remove the front floor carpet.

Installation Procedure

Notice: Refer to General Repair Instructions in the Preface section.



1. Carefully install the front carpet (2) ensuring the cut-outs (3) and (4) are correctly aligned.
2. Install the retaining clips (1) to the front of the carpet.
3. Install the following components as per removal:
    - Floor console assembly. Refer to Front Floor Console Replacement.
    - Instrument panel compartment. Refer to Instrument Panel Compartment Replacement.
    - Instrument panel lower trim plate assembly right side. Refer to Instrument Panel Insulator Panel Replacement - Right Side.
    - Instrument panel lower trim plate assembly left side. Refer to Instrument Panel Insulator Panel Replacement - Left Side.
    - Park brake assembly. Refer to Parking Brake Release Handle Assembly Replacement.
    - Both front seat assemblies. Refer to Front Seat Replacement - Bucket.
    - Body hinge pillar trim assembly on both sides. Refer to Body Hinge Pillar Trim Panel Replacement.
    - Front seat belt retaining bolts. Refer to Front Seat Belt Replacement.
    - Rear panel trim plate. Refer to Door Sill Plate Replacement.
    - Sill panel trim. Refer to Door Sill Plate Replacement.
    - Rear seat cushion. Refer to Rear Seat Cushion Replacement.
4. Connect the battery ground lead to the vehicle. Refer to Battery Negative Cable Disconnection and Connection.
5. Carry out testing of all electrical components removed, to ensure correct operation.

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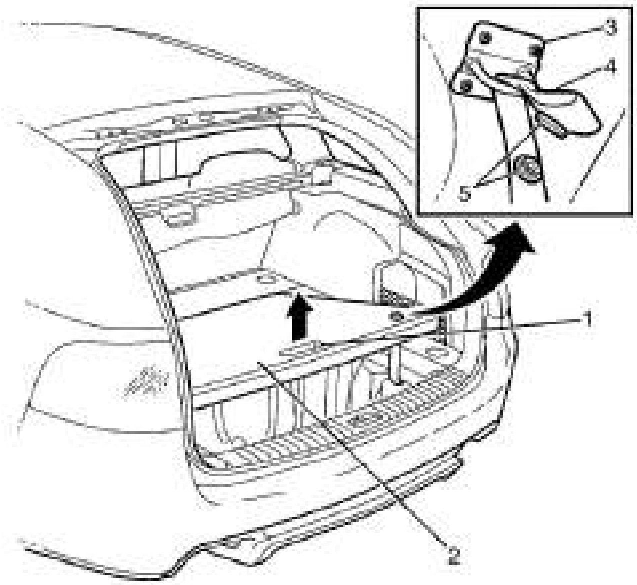
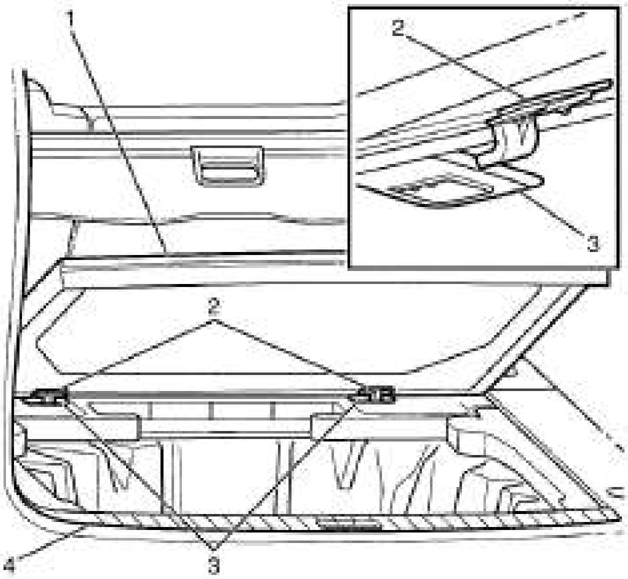
Rear Compartment Floor Panel Carpet Replacement (Sportwagon)

Removal Procedure

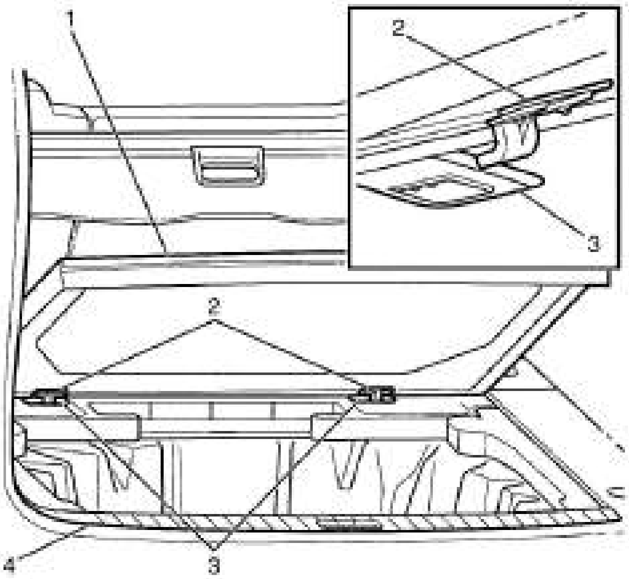


1. Open the liftgate.
2. Lift the rear compartment floor panel carpet (2) up using the rear compartment floor panel carpet handle (1).
3. Unclip the rear compartment floor panel carpet tether button (5) and thread the rear compartment floor panel carpet tether (4) out of the rear compartment floor panel carpet pad eye (3).



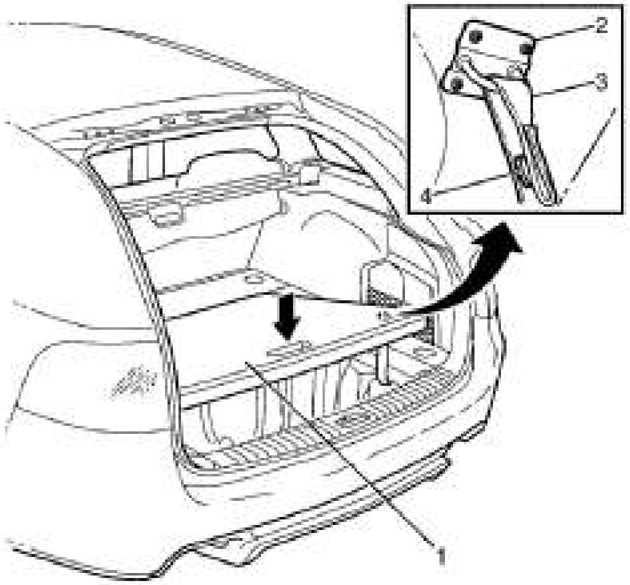
4. Lift the rear compartment floor panel carpet (1) up and out of the liftgate opening (4), disengaging the rear compartment floor panel carpet hooks (2) from the rear compartment floor panel centre support foam hook housings (3).

Installation Procedure



Important: Make sure the rear compartment floor panel carpet hooks (2) engage into the rear compartment floor panel centre support foam hook housings (3).

1. Install the rear compartment floor panel carpet (1) through the liftgate opening (4).

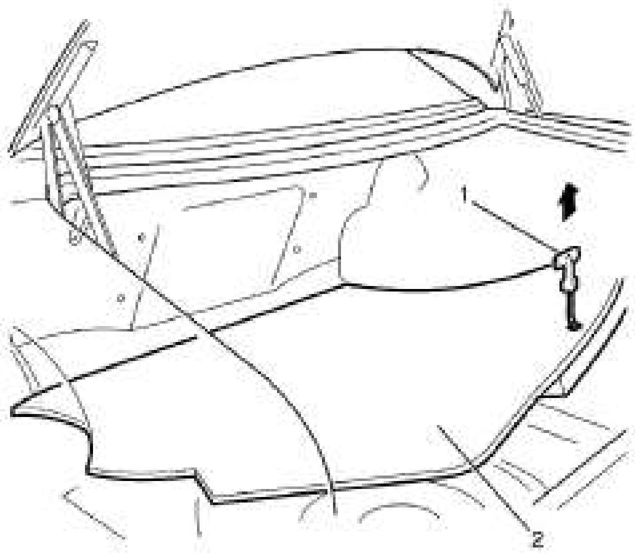


2. Thread the rear compartment floor panel carpet tether (3) through the rear compartment floor panel carpet pad eye (2) and clip the rear compartment floor panel carpet tether button (4).
3. Lower the rear compartment floor panel carpet (1) to is original position making sure it is correctly seated.

Rear Compartment Floor Panel Carpet Replacement (Sedan)

Removal Procedure

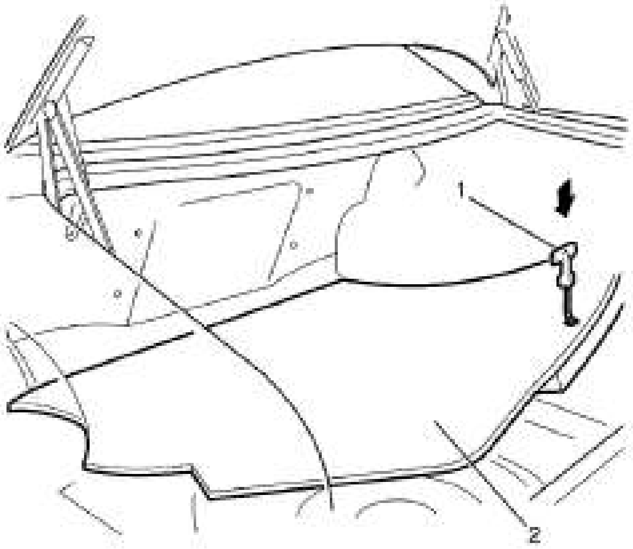
1. Open the luggage compartment lid.



2. Pull the strap (1) on the rear compartment floor panel carpet assembly (2) and lift the rear edge upward.
3. Lift and remove the rear compartment floor panel carpet assembly (2) from the rear compartment.

Installation Procedure

Notice: Refer to General Repair Instructions in the Preface section.



1. Install the rear compartment floor panel carpet assembly (2).
2. Firmly press down on the rear compartment floor panel carpet assembly (2) ensuring correct fitment with quarter panels.
3. Close the luggage compartment lid.

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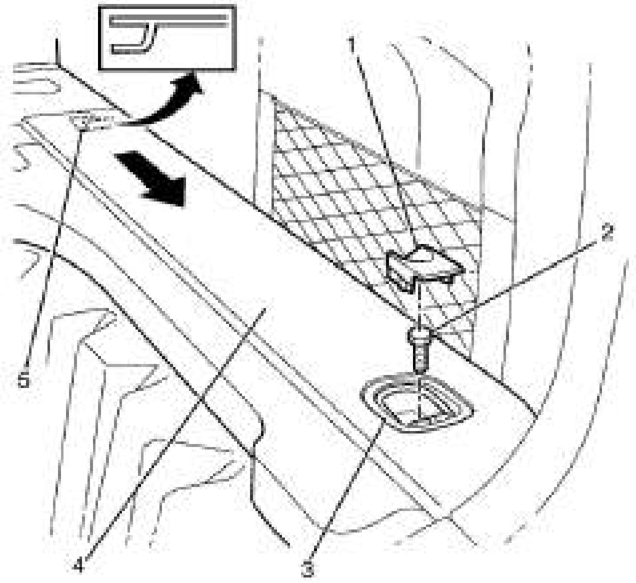
Load Floor Stationary Panel Carpet Replacement

Removal Procedure

> **Important:** When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.

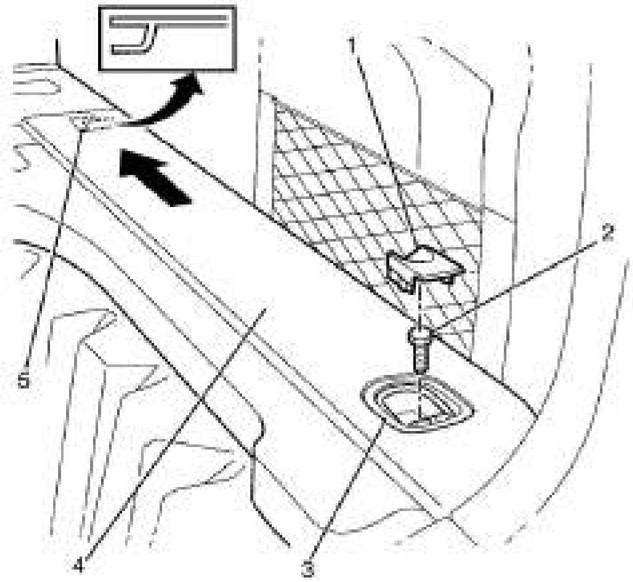


3. Remove the cargo tie down loop bolt cap (1) from the cargo tie down loop assembly (3).
4. Remove the cargo tie down loop assembly to body retaining bolt (2).

> **Important:** Remove the load floor stationary panel by sliding rearward to release the tang (5).

5. Remove the load floor stationary panel carpet (4) from the vehicle.
6. Repeat for opposite side.

Installation Procedure



Important: Install the load floor stationary panel by sliding forward to engage the tang (5).

1. Position the load floor stationary panel carpet (4) to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the cargo tie down loop assembly to body retaining bolt (2).

   Tighten
   Tighten the bolt to 20 N·m (15 lb ft).

3. Install the cargo tie down loop bolt cap (1) to the cargo tie down loop assembly (3).
4. Repeat for opposite side.
5. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.

   Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

6. Remove the suitable liftgate brace from the vehicle.

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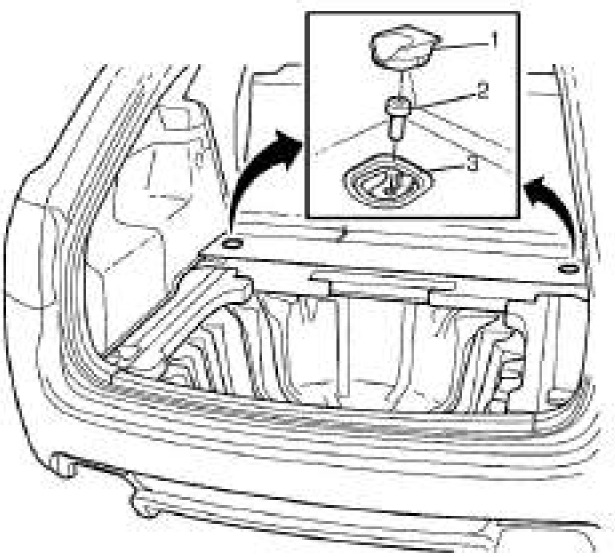
Load Floor Front Panel Carpet Replacement

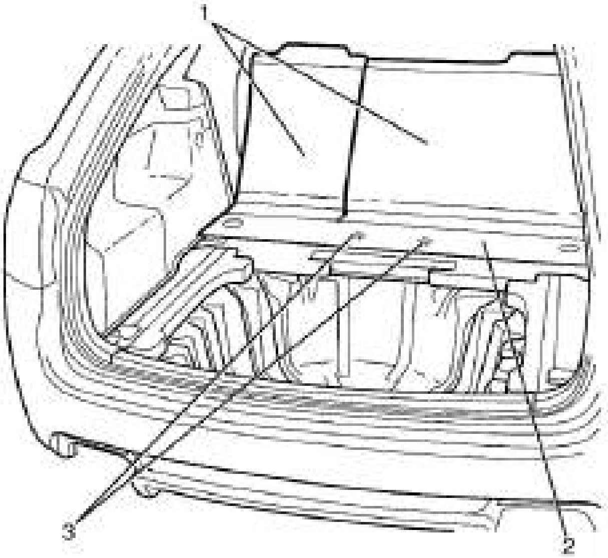
Removal Procedure

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
3. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.

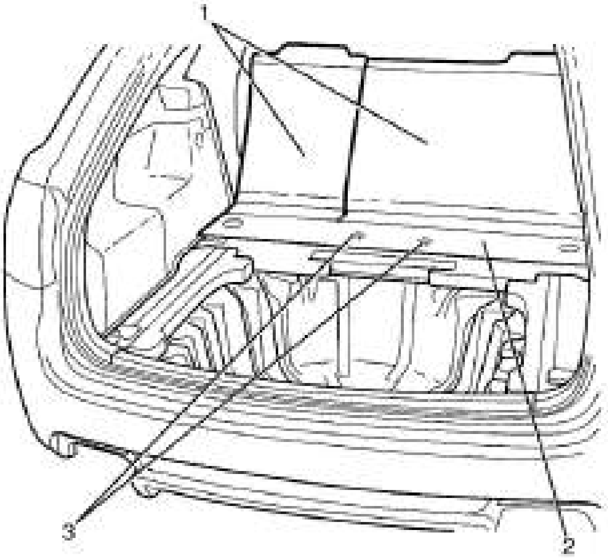


4. Remove the cargo tie down loop bolt caps (1) from the cargo tie down loop assemblies (3).
5. Remove the cargo tie down loop assembly to body retaining bolts (2).



6. Fold the rear seat backs (1) down exposing the load floor front panel carpet (2).
7. Carefully disengage the load floor front panel carpet to body retaining clips (3).
8. Remove the load floor front panel carpet (2) from the vehicle.

Installation Procedure

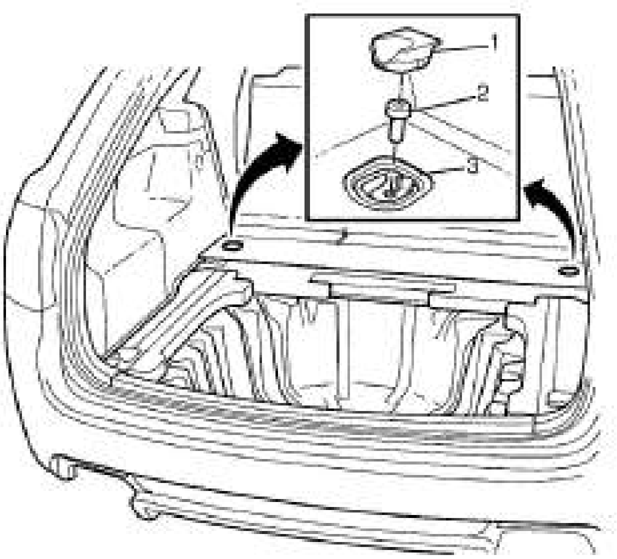


Important: Ensure front of load floor front panel carpet locates under the rear seats.

1. Position the load floor front panel carpet (2) to the vehicle.
2. Push down on the load floor front panel carpet (2) to engage the load floor front panel carpet to body retaining clips (3).

3. Fold the rear seat backs (1) to the up position.

   Notice: Refer to Fastener Notice in the Preface section.



Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

4. Install the cargo tie down loop assembly to body retaining bolts (2).

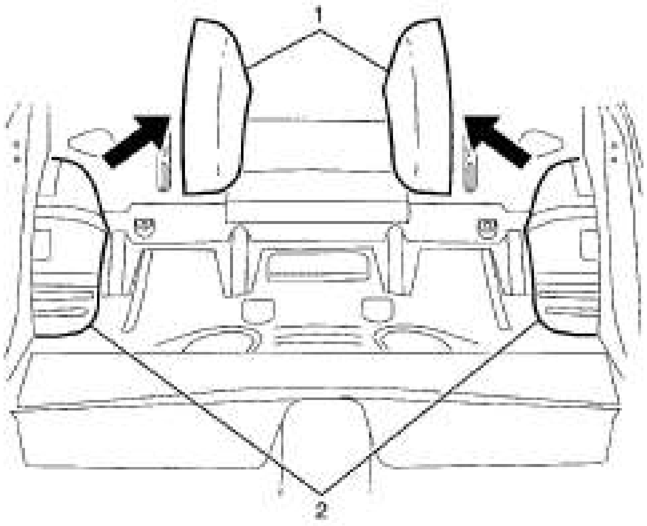
   Tighten
   Tighten the bolts to 20 N·m (15 lb ft)

5. Install the cargo tie down loop bolt caps (1) to the cargo tie down loop assemblies (3).
6. Install load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
7. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
8. Remove the suitable liftgate brace from the vehicle.

Rear Wheelhouse Inner Panel Front Sound Barrier Replacement (Sedan)

Removal Procedure

1. Remove the rear seat back. Refer to Rear Seat Back Replacement.
2. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement.
3. Remove the seat belt lower retaining bolt. Refer to Front Seat Belt Replacement.
4. Remove the lower quarter trim panel. Refer to Quarter Lower Rear Trim Panel Replacement.



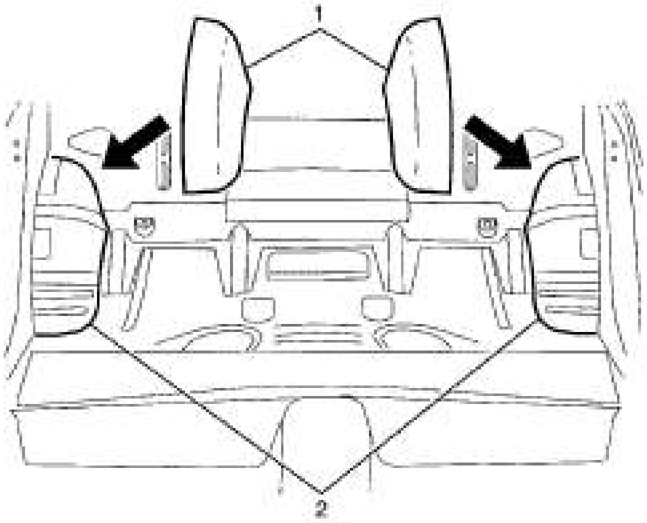
5. Remove the wheelhouse sound barriers (1) by peeling back from the wheel house panel (2).

Installation Procedure

Caution: All floor pan insulator material must meet Federal Vehicle Safety Standards for flammability. Failure to do so could result in personal injury and/or vehicle damage.

Important: Align the sound barriers in order to keep the seat belt and seat attachment areas are clear.

1. Ensure the attachment areas are clear.
2. Remove the backing of the sound barriers.



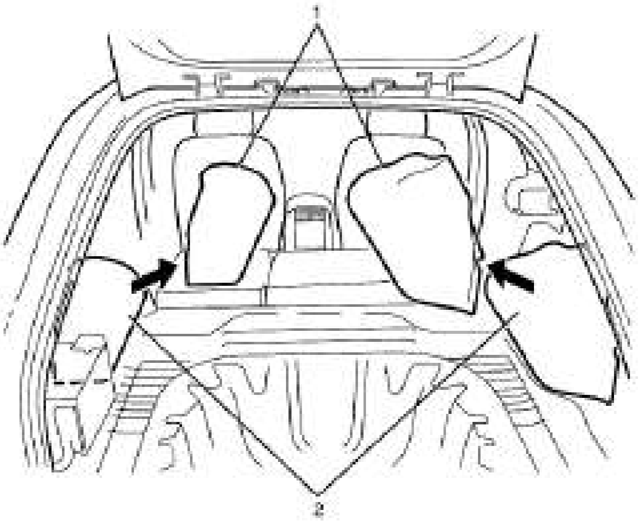
3. Press firmly in all areas in order to secure the sound barriers (1) to the wheelhouse panel (2).
4. Install the lower quarter trim panel. Refer to Quarter Lower Rear Trim Panel Replacement.
5. Install the seat belt lower retaining bolt. Refer to Front Seat Belt Replacement.
6. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.
7. Install the rear seat back. Refer to Rear Seat Back Replacement.

Rear Wheelhouse Inner Panel Front Sound Barrier Replacement (Sportwagon)

Removal Procedure

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
3. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
4. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
5. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
6. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.

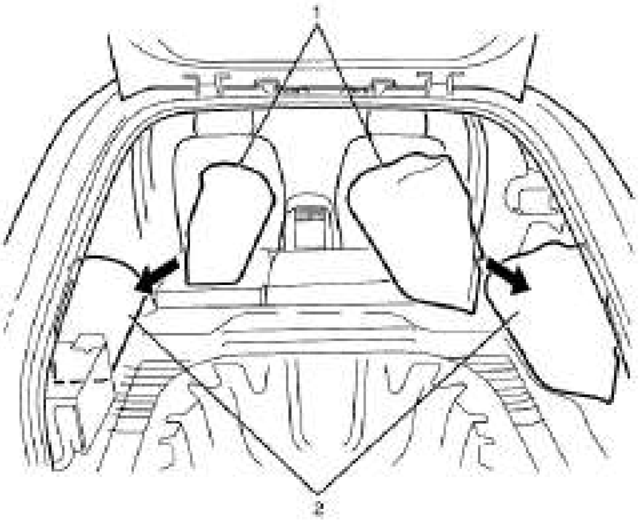


7. Remove the wheelhouse sound barriers (1) from the wheelhouse panels (2).

Installation Procedure

Important: Align the sound barriers in order to keep the seat belt and seat attachment areas clear.

1. Ensure the attachment areas are clear.



2. Install the sound barriers (1) to the wheelhouse panels (2).
3. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
4. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
5. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
6. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
7. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

8. Remove the suitable liftgate brace from the vehicle.

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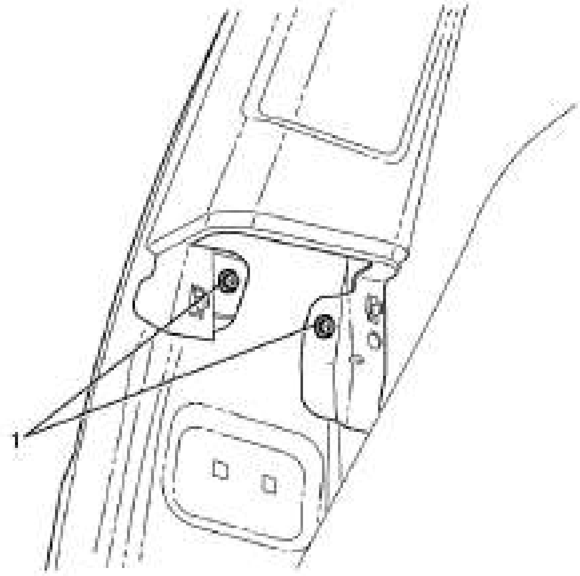
Headlining Trim Panel Replacement (Sportwagon)

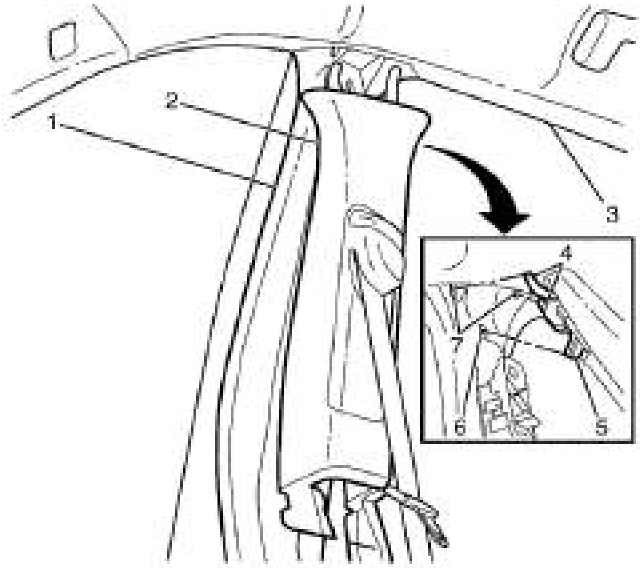
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

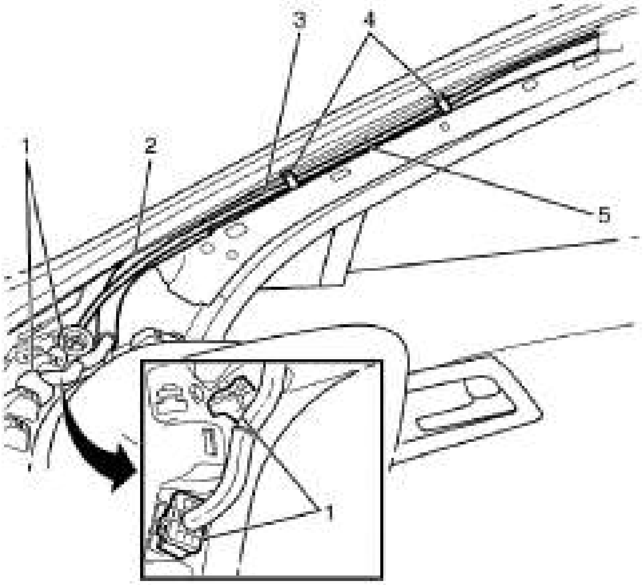
1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the dome lamp assembly. Refer to Dome Lamp Replacement.
3. Remove the rear dome lamp assembly. Refer to Dome Lamp Replacement.
4. Remove the sunshade assembly on both sides. Refer to Sunshade Replacement.
5. Remove the video disc player display bezel - Display (where fitted). Refer to Video Disc Player Bezel Replacement.
6. Remove the video disc player display bezel - Player (where fitted). Refer to Video Disc Player Display Bezel Replacement.
7. Remove the assist handles on both sides. Refer to Assist Handle Replacement.
8. Remove the windshield garnish molding on both sides. Refer to Windshield Garnish Molding Replacement.
9. Remove the center pillar lower trim panel on both sides. Refer to Center Pillar Lower Trim Panel Replacement.



10. Remove the center pillar upper trim panel retaining screws (1). Repeat on opposite side.

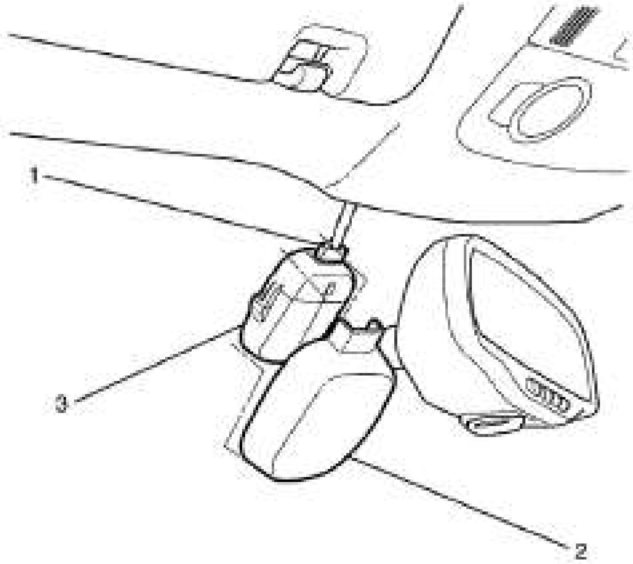


11. Tilt the base of the center pillar upper trim panel (2) away from the center pillar (1) until the center pillar upper trim panel locating dowel (5) has disengaged from the center pillar datum hole (6). Repeat on opposite side.
12. Lower the center pillar upper trim panel (2) down and away from the roof panel trim (3) until the center pillar upper trim panel locating pins (4) have disengaged from the roof panel datum holes (7). Repeat on opposite side.
13. Remove the body lock pillar upper trim panel on both sides. Refer to Body Lock Pillar Upper Trim Panel Replacement.
14. Remove the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
15. Remove the body side window rear garnish moulding on both sides. Refer to Body Side Window Rear Garnish Molding Replacement.

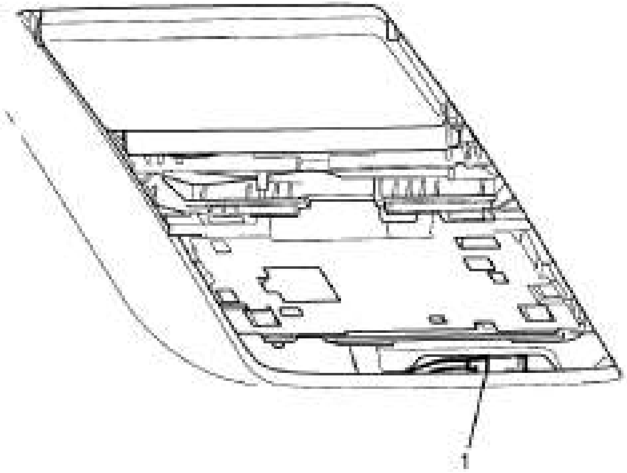


16. Detach the headlining wiring harness (2) from the headlining wiring harness/washer hose retaining clips (4).

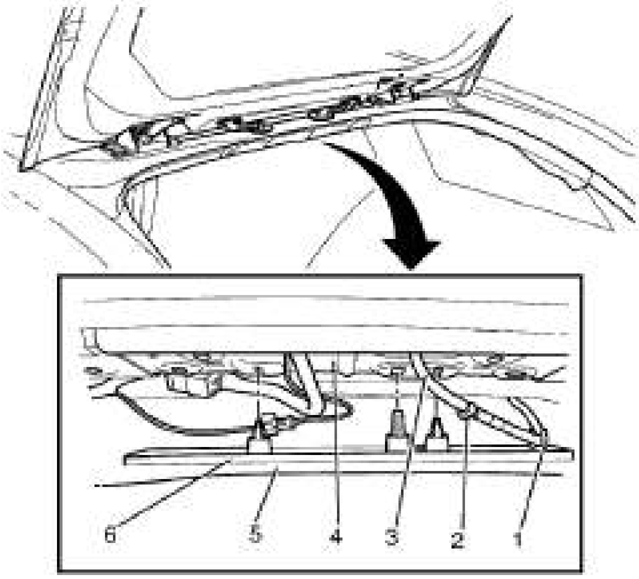
17. Disconnect the headlining wiring harness to instrument panel wiring harness electrical connectors (1).
18. Detach the headlining washer hose (3) from the headlining wiring harness/washer hose retaining clips (4).
19. Cut the headlining washer hose (3) between the headlining wiring harness/washer hose retaining clips (5).



20. Detach the windshield outside moisture sensor cover (2) from the windshield outside moisture sensor (3).
21. Disconnect the windshield outside moisture sensor electrical connector (1) from the windshield outside moisture sensor (3).

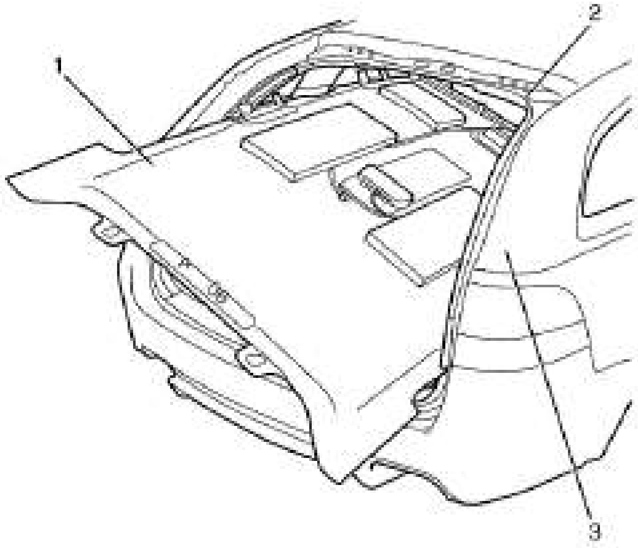


22. Disconnect the headlining wiring harness to rear seat entertainment assembly wiring harness connector (1) (where fitted).
23. Recline both the rear split fold seat backs to their forward position.
24. Recline both the front seat backs to their lowest position.



Important: To avoid damage to the headlining carefully pull down on the headlining rear clip assembly (6) to detach the headlining (5) from the roof panel (4).

25. Detach and lower the headlining (5).
26. Remove the rear window washer hose (3) from the headlining clip assembly washer hose guide (1).
27. Disconnect the rear window washer hose (3) from rear window washer connector (2).



Important: Remove the headlining (1) from the vehicle (3) with the aid or an assistant to avoid marking or damaging it.

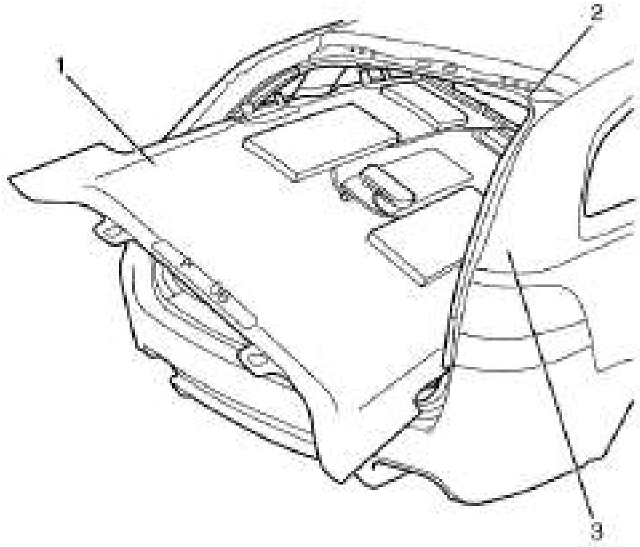
28. Tilt the headlining (1) to one side to achieve maximum clearance between the headlining (1)

and the liftgate opening (2).

Important: Care must be taken not to crease the headlining (1) when removing it through the liftgate opening (2).

29. Remove the headlining (1) from the vehicle (3) through the liftgate opening (2).

Installation Procedure

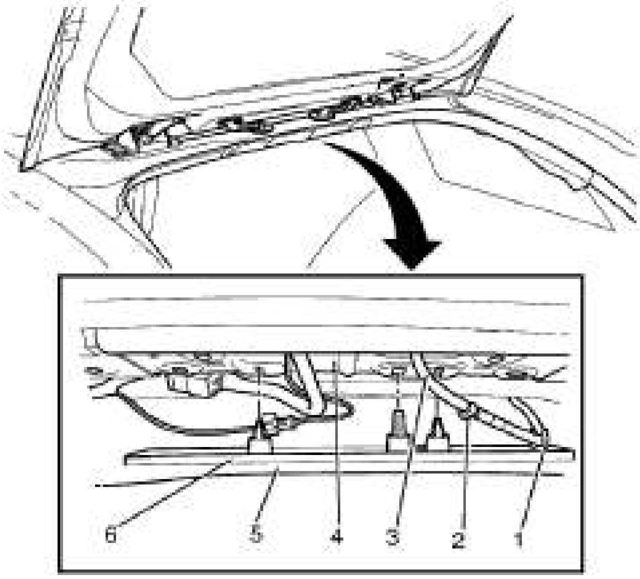


Important: Install the headlining (1) to the vehicle (3) with the aid or an assistant to avoid marking or damaging it.

1. Tilt the headlining (1) to one side to achieve maximum clearance between the headlining (1) and the liftgate opening (2).

   Important: Care must be taken not to crease the headlining (1) when installing it through the liftgate opening (2).

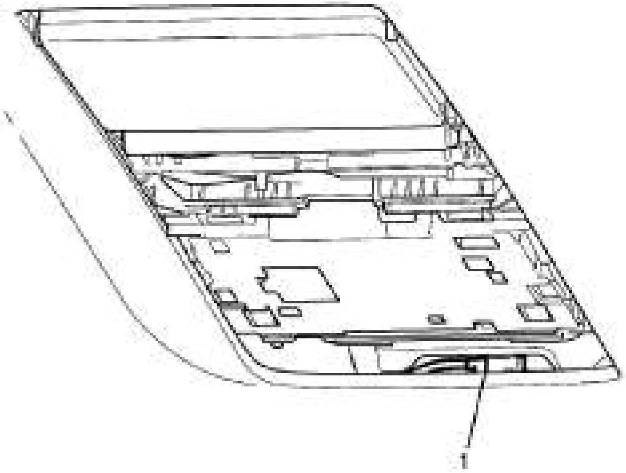
2. Install the headlining (1) to the vehicle (3) through the liftgate opening (2).



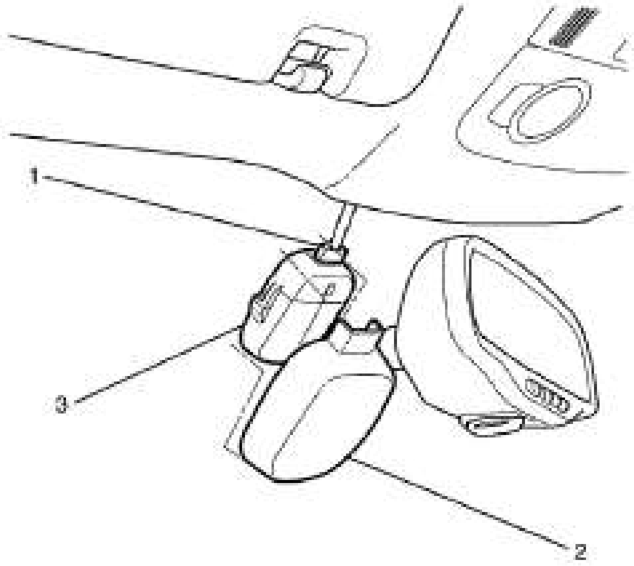
3. Connect the rear window washer hose (3) to the rear window washer connector (2).

   Important: To avoid crimping or puncturing the rear window washer hose (3) make sure it locates correctly into the headlining clip assembly washer hose guide (1).

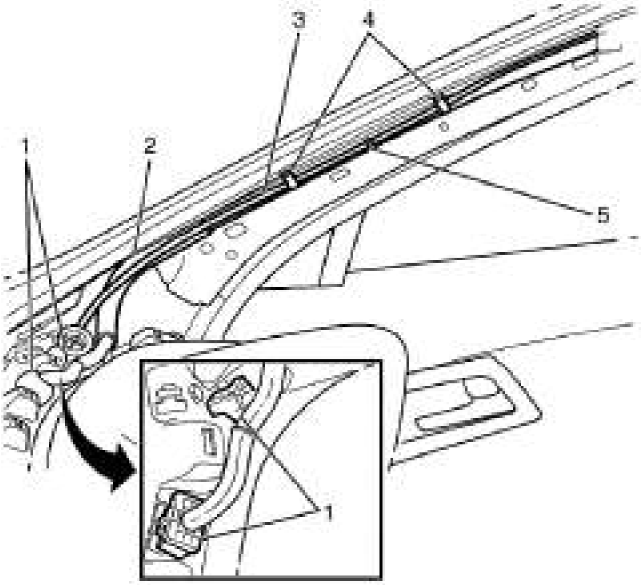
4. Install the headlining clip assembly (6) into the roof panel (4).



5. Connect the headlining wiring harness to rear seat entertainment assembly wiring harness connector (1) (where fitted).
6. Recline both the rear split fold seat backs to their upright position.
7. Recline both the front seat backs to their upright position.



8. Connect the windshield outside moisture sensor electrical connector (1) to the windshield outside moisture sensor (3).
9. Attach the windshield outside moisture sensor cover (2) to the windshield outside moisture sensor (3).

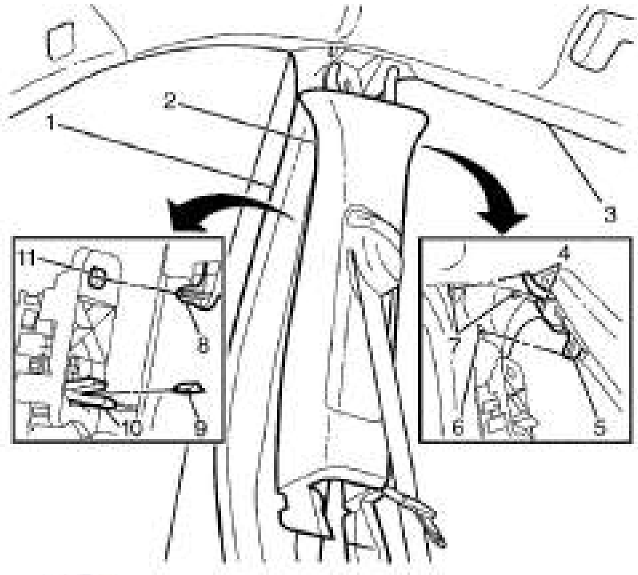


Important: Make sure the headlining washer hose in line joiner (5) is securely installed into both ends of the headlining washer hose (3).

10. Cut the NEW headlining washer hose to the correct length, so it meets up with the old headlining washer hose which was cut.
11. Join the headlining washer hose ends with an in line hose joiner, GMH part number 92213809.
12. Attach the headlining washer hose (2) to the headlining wiring harness/washer hose retaining

clips (4).

13. Connect the headlining wiring harness to instrument panel wiring harness electrical connectors (1).
14. Attach the headlining wiring harness (2) to the headlining wiring harness/washer hose retaining clips (4).
15. Install the body side window rear garnish moulding on both sides. Refer to Body Side Window Rear Garnish Molding Replacement.
16. Install the headlining rear trim panel retainer on both sides. Refer to Headlining Rear Trim Panel Retainer Replacement.
17. Install the body lock pillar upper trim panel on both sides. Refer to Body Lock Pillar Upper Trim Panel Replacement.

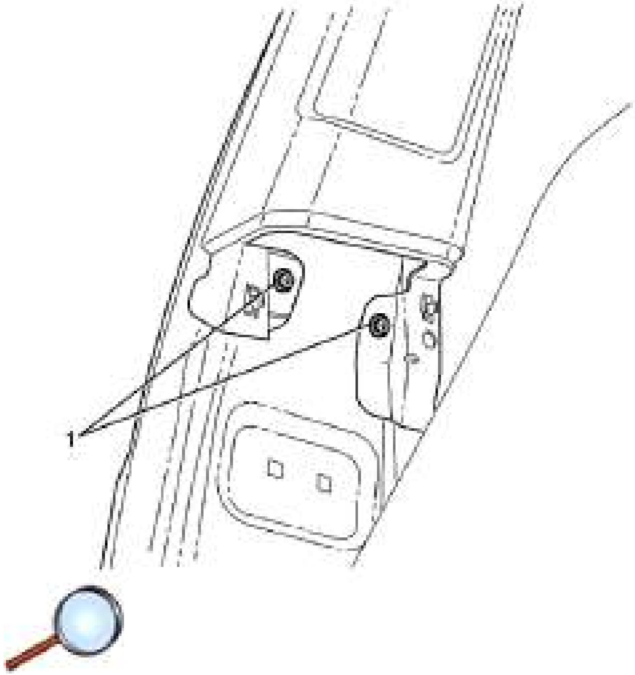


18. Raise the center pillar upper trim panel (2) up towards the roof panel trim (3) until the center pillar upper trim panel locating pins (4) have engaged into the roof panel datum holes (7). Repeat on opposite side.

Important: Make sure the center pillar upper trim height adjuster lever (9) locates into the seat belt height adjuster release lever (10) and the center pillar upper trim height adjuster dowel (8) locates into the seat belt height adjuster datum hole (11). Incorrect fitment may damage the center pillar upper trim height adjuster and/or restrict the front seat belt movement (where fitted).

19. Tilt the base of the center pillar upper trim panel (2) towards the center pillar (1) until the center pillar upper trim panel locating dowel (5) has engaged into the center pillar datum hole (6). Repeat on opposite side.

Notice: Refer to Fastener Notice in the Preface section.



20. Install the center pillar upper trim panel retaining screws (1). Repeat on opposite side.

    Tighten
    Tighten the screws to 2 N·m (18 lb in).

21. Check the seat belt operation on both sides.
22. Install the center pillar lower trim panel on both sides. Refer to Center Pillar Lower Trim Panel Replacement.
23. Install the windshield garnish molding on both sides. Refer to Windshield Garnish Molding Replacement.
24. Install the assist handles on both sides. Refer to Assist Handle Replacement.
25. Install the video disc player display bezel - Player (where fitted). Refer to Video Disc Player Display Bezel Replacement.
26. Install the video disc player display bezel - Display (where fitted). Refer to Video Disc Player Bezel Replacement.
27. Install the sunshade assembly on both sides. Refer to Sunshade Replacement.
28. Install the rear dome lamp assembly. Refer to Dome Lamp Replacement.
29. Install the dome lamp assembly. Refer to Dome Lamp Replacement.

    Caution: Refer to Battery Disconnect Caution in the Preface section.

30. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
31. Check the operation of the rear window washer and make sure there are no water leaks.

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Headlining Trim Panel Replacement (RHD Sedan)

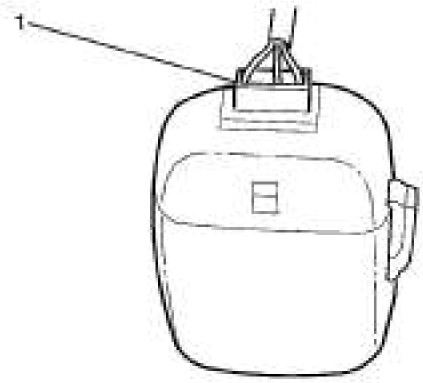
Removal Procedure

Notice: Refer to General Repair Instructions in the Preface section.

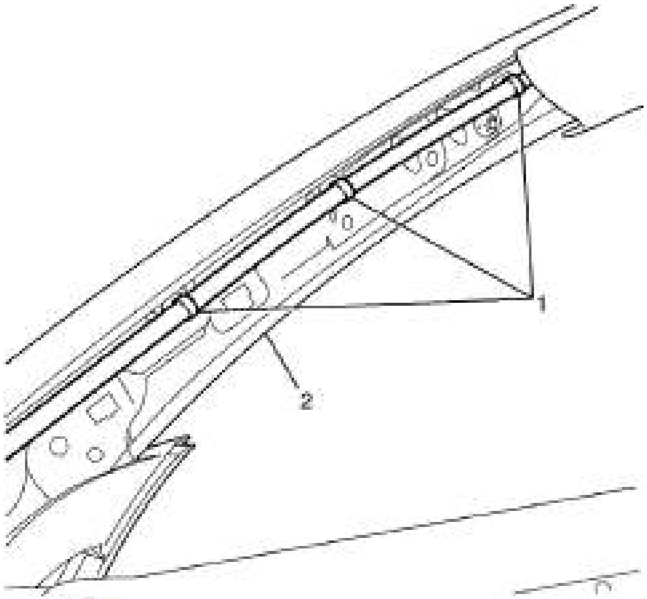
1. Remove the fuse from the passenger compartment fuse and relay panel assembly.
2. Remove the following components as required:
   - Front seats. Refer to Front Seat Replacement - Bucket.
   - Seat head restraints, if fitted. Refer to Rear Seat Head Restraint Replacement.
   - Windshield side garnish, on both sides. Refer to Windshield Garnish Molding Replacement.
   - Trim Panel - Upper Centre Pillar, on both sides. Refer to Center Pillar Upper Trim Panel Replacement.
   - Assist handles (if fitted). Refer to Assist Handle Replacement.
   - Sunshade assembly, on both sides. Refer to Sunshade Replacement.
   - Trim panel rear quarter on both sides. Refer to Quarter Upper Trim Panel Replacement.
   - Dome lamp assembly. Refer to Dome Lamp Replacement.
   - Windshield defroster grille. Refer to Defroster Grille Replacement.

Notice: Refer to General Repair Instructions in the Preface section.

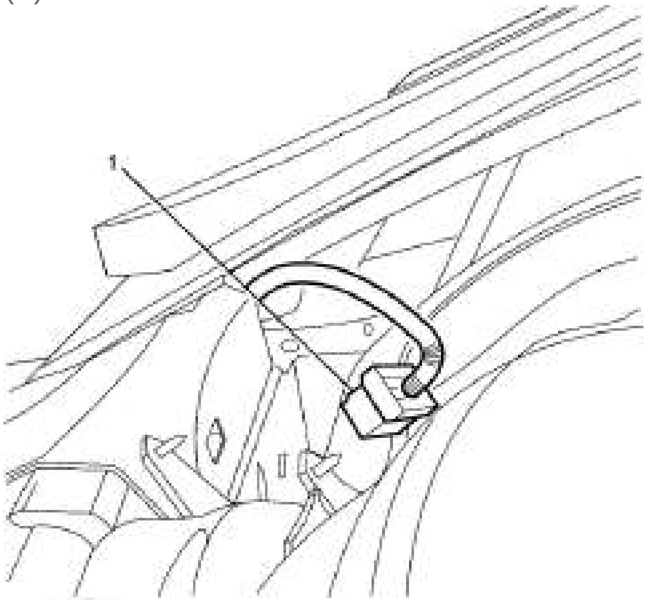
- DVD player surround. Refer to Video Disc Player Display Bezel Replacement in Entertainment.
- DVD screen surround. Refer to Video Disc Player Display Bezel Replacement in Entertainment.



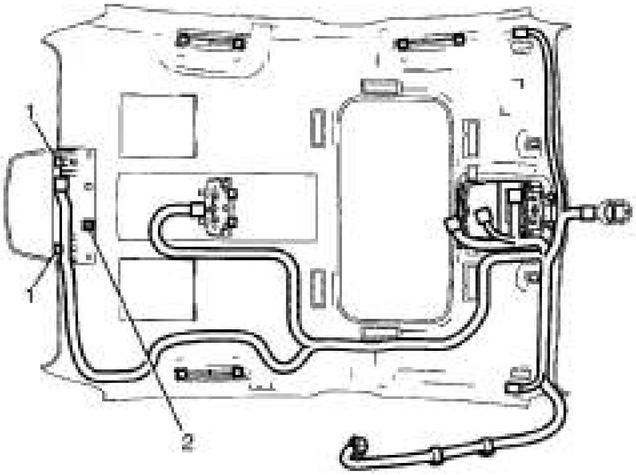
3. Disconnect the rain sensor electrical connector (1).



4. Detach the headlining wiring harness retaining clips (1) located on the A-pillar inner panel (2).

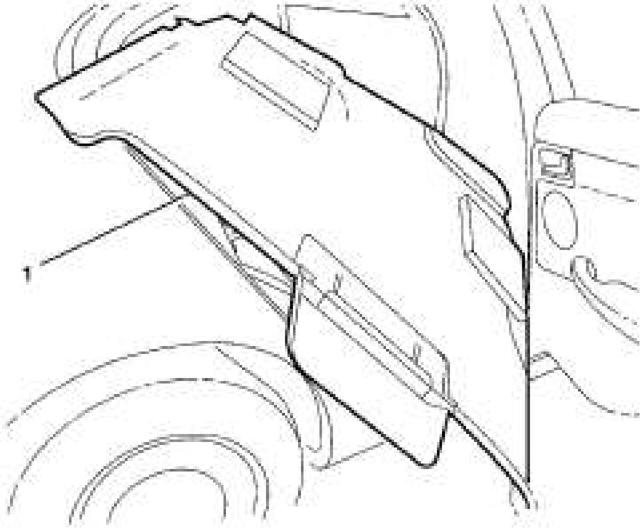


5. Disconnect the headliner electrical connector (1), which is located under the defroster grille.



Important: Removal and installation of the headliner requires the aid of an assistant, under no circumstances should it be removed or installed by one person.

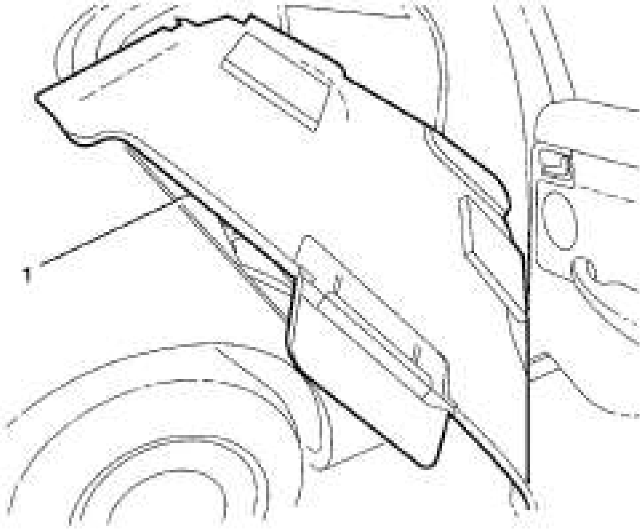
6. Once all the components have been removed, disengage the rear retaining clips (1).
7. Remove the headliner assembly.



Important: The headliner must be removed as shown above.

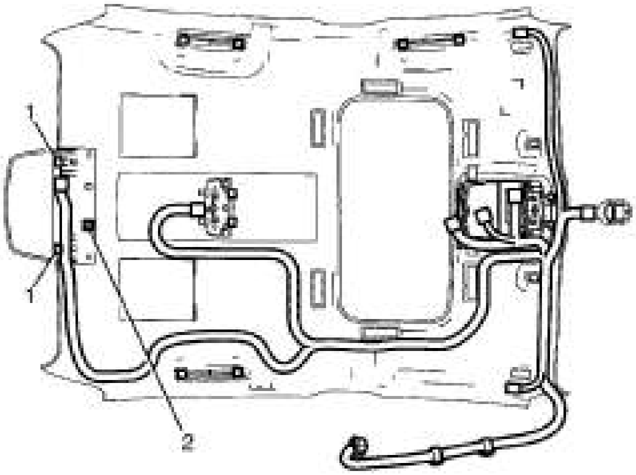
8. With the aid of an assistant, remove the headlining (1) via the right hand passenger rear door.

Installation Procedure



Important: Take care not to fold the headliner. Folding the headliner will result in visible creases in the headliner fabric.

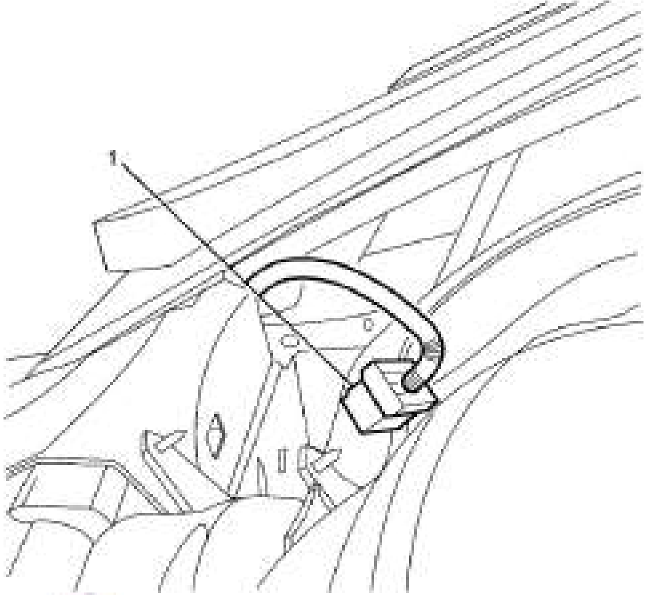
1. With the aid of an assistant, carefully place headlining (1) into vehicle via right hand rear door, as per removal.



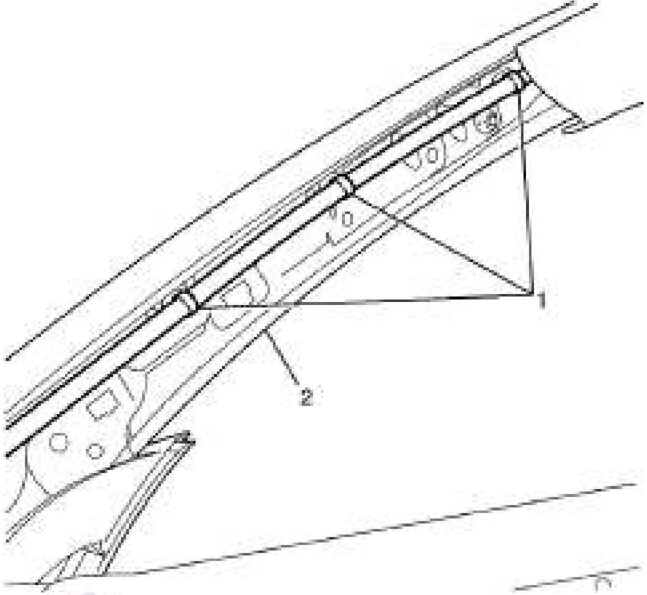
2. Locate the datum pin (2) to the rear of the roof assembly.

Important: Make sure that the headliner datum pin is located in the rear of the roof assembly.

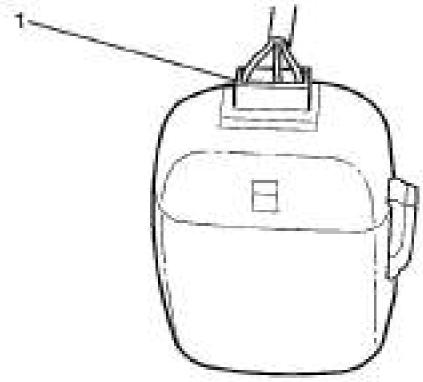
3. Carefully engage the headliner retaining clips (1).



4. Connect the headliner electrical connector (1).



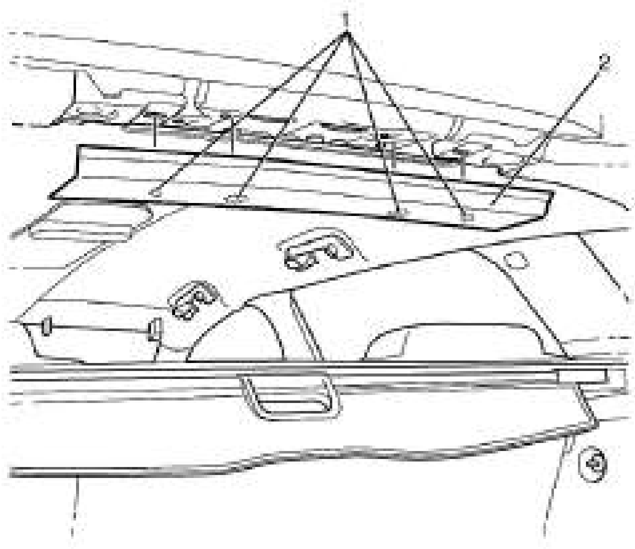
5. Attach the headlining wiring harness retaining clips (1) to the A-pillar inner panel (2).



6. Connect the rain sensor electrical connector (1).
7. Install the following components as per removal:
    - DVD player surround. Refer to Video Disc Player Display Bezel Replacement.
    - DVD screen surround. Refer to Video Disc Player Display Bezel Replacement.
    - Windshield defrost grille. Refer to Defroster Grille Replacement.
    - Dome lamp assembly. Refer to Dome Lamp Replacement.
    - Trim panel rear quarter on both sides. Refer to Quarter Upper Trim Panel Replacement.
    - Sunshade assembly, on both sides. Refer to Sunshade Replacement.
    - Assist handles (if fitted). Refer to Assist Handle Replacement.
    - Trim Panel - Upper Centre Pillar, on both sides. Refer to Center Pillar Upper Trim Panel Replacement.
    - Windshield side garnish, on both sides. Refer to Windshield Garnish Molding Replacement.
    - Seat head restraints, if fitted. Refer to Rear Seat Head Restraint Replacement.
    - Front seats. Refer to Front Seat Replacement - Bucket.
8. Test all components removed for correct operation.

Headlining Rear Trim Panel Retainer Replacement

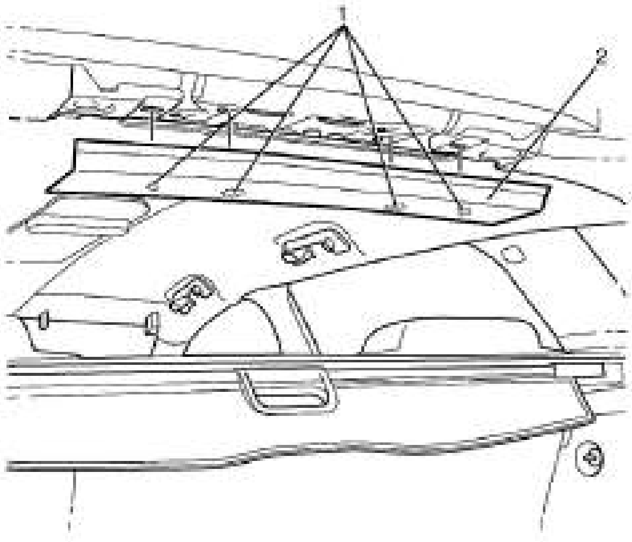
Removal Procedure



Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Using both hands, carefully disengage the headlining rear trim panel retainer forward edge to body retaining clips (1).
3. Remove the headlining rear trim panel retainer (2) from the vehicle.

Installation Procedure



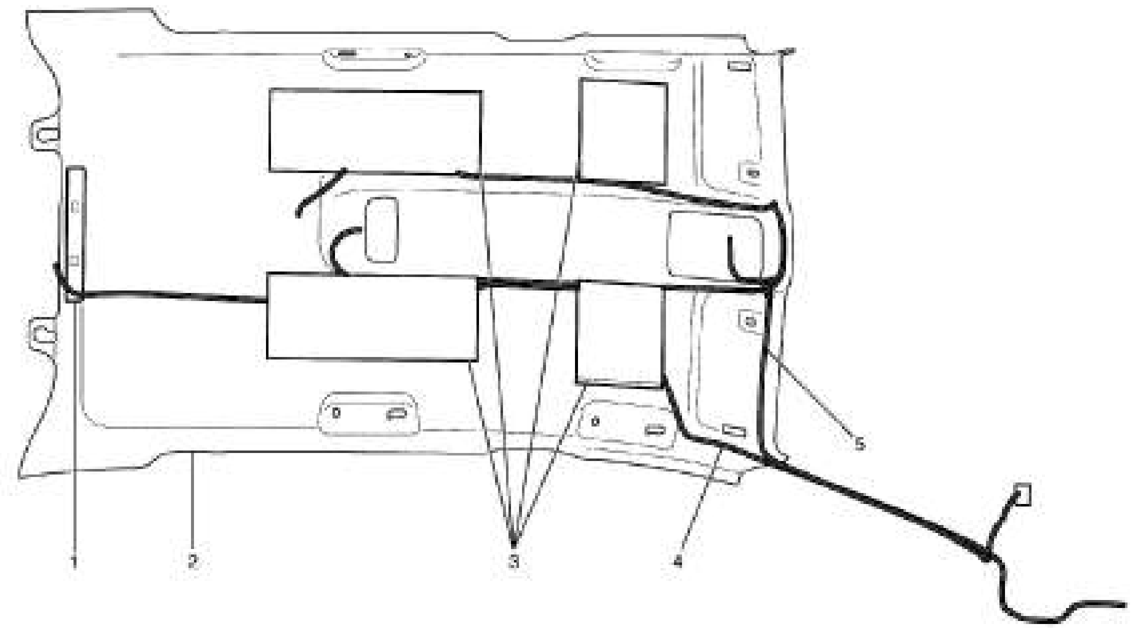
Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Position the headlining rear trim panel retainer (2) to the vehicle.
2. Carefully engage the headlining rear trim panel retainer to body retaining clips (1). An audible click will confirm correct installation.
3. Ensure the trailing edge of the headlining rear trim panel is correctly engaged into the liftgate opening seal.
4. Remove the suitable liftgate brace from the vehicle.

Headliner Description (Sportwagon)

Formed Headlining

Headliner Component View



(1) Headliner Rear Clip Assembly
(2) Headliner
(3) Acoustic Pads
(4) Washer Hose
(5) Wiring Harnesses

Important: The headlining (2) is only serviced as a complete assembly.

The headlining (2) is a one-piece composite substrate that is covered with a foam cloth facing. The construction of the composite substrate does not allow for replacement of the cloth facing and requires that the headlining substrate and cloth be serviced as a complete assembly. The headlining wiring harness (5), acoustic pads (3), and the headlining rear clip assembly (1) are an integral part of the headlining (2) and are not serviced as separate components. The rear window washer hose (4) is also an integral part of the headlining (2) but is serviceable. The headlining is retained to the roof panel by the headlining rear clip assembly (1), assist handles and the front sunshades. Additional support is also provided by interior trims and panels around the perimeter and in the centre of the headlining (2).

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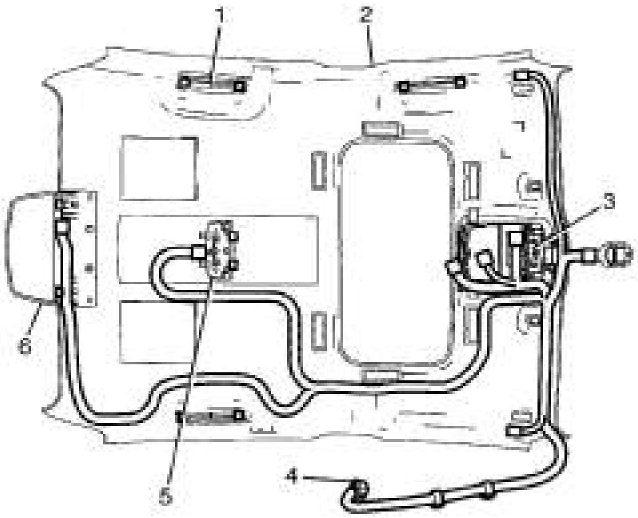
Headliner Description (RHD Sedan)

Formed Headliner

Important: The headliner is only serviced as a complete assembly



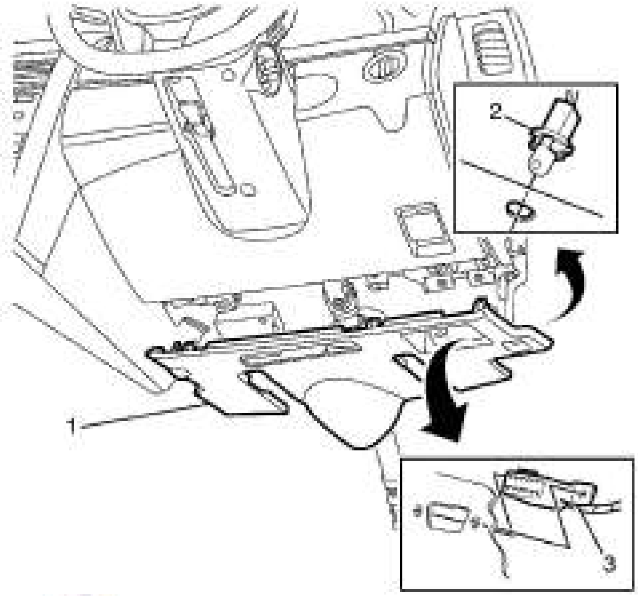
- The headliner (2) is a one-piece composite substrate that is covered with a foam cloth facing.
- The electrical wiring harness (4) for the roof lighting (3, 5), is not a serviceable item and should be left attached to the headliner when the headliner is being removed.
- The headliner is held up to the roof panel by the use of located components, the overhead console (3), the assist handles (1) fasteners, the rear high mounted stop lamp (6).
- If the vehicle is equipped with a sunroof, there are six patches of velcro™ material around the sunroof opening which add extra support for the headliner.

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Bracket to I/P Centre Support Retaining Screws	2 N-m	18 lb in
Centre Console to End Panel Retaining Screws	2 N-m	18 lb in
Centre Console to Floor Retaining Bolt	25 N-m	18 lb ft
Centre Console to Front Floor Retaining Screws	2 N-m	18 lb in
Centre Console to Park Brake Assembly Retaining Bolts	25 N-m	18 lb ft
Coin Holder to Centre Console Retaining Screw	2 N-m	18 lb in
Compartment Damper to I/P Retaining Screws	2 N-m	18 lb in
Compartment to I/P Retaining Screws	2 N-m	18 lb in
Cup Holder to Centre Console Retaining Screws	2 N-m	18 lb in
Gauge Alignment Plate Retaining Screws (CSV/SWB HSV/VXR8)	2 N-m	18 lb in
I/P Datum Pin Retaining Screws	2 N-m	18 lb in
I/P to Trim Pad Retaining Screws	2 N-m	18 lb in
Instrument Cluster Retaining Screws	2 N-m	18 lb in
Instrument Cluster Trim Assembly Screws	2 N-m	18 lb in
Left Hand Tweeter to I/P Retaining Screws	2 N-m	18 lb in
Passenger Side Air Bag Module to I/P Trim Pad Retaining Nuts	16 N-m	12 lb ft
Secondary Information Centre Housing to I/P Pad Retainer Screws (CSV/SWB HSV/VXR8)	2 N-m	18 lb in
Secondary Information Centre Module to SIC Housing Retaining Nuts (CSV/SWB HSV/VXR8)	2 N-m	18 lb in
Storage Compartment to I/P Retaining Screws	2 N-m	18 lb in
Top Trim Panel to I/P Retaining Screws	2 N-m	18 lb in
Trim Pad - Instrument Panel (I/P) Upper Retaining Screws	2 N-m	18 lb in
Trim Panel to Centre Console Retaining Screws	2 N-m	18 lb in
Trim Panel to I/P Upper Retaining Screws	2 N-m	18 lb in

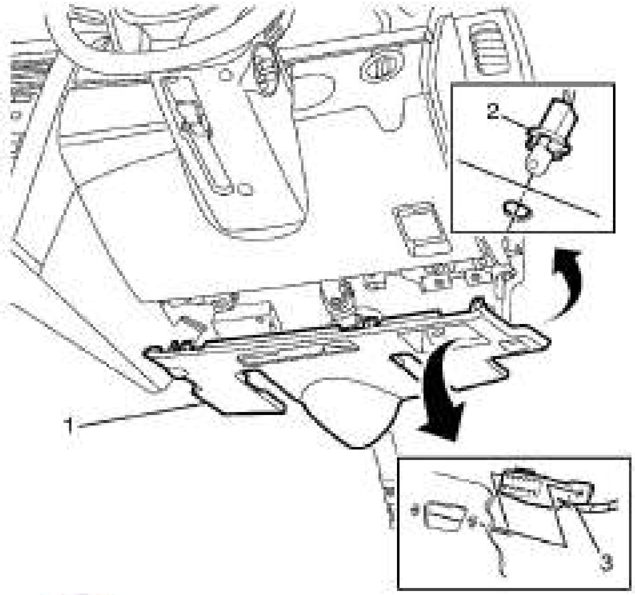
Instrument Panel Insulator Panel Replacement - Right Side (RHD)

Removal Procedure



1. Remove the diagnostic plug (3) from the I/P lower trim plate assembly (1).
2. Grasp the I/P lower trim plate assembly (1) and carefully pull downward to disengage the retaining clips.
3. Disconnect the courtesy lamp socket assembly (2) from the right lower trim plate by turning the socket counterclockwise.
4. Remove the I/P lower trim plate assembly (1).

Installation Procedure



1. Connect the courtesy lamp socket assembly (2) to the I/P lower trim plate assembly (1).
2. Install the diagnostic plug (3) to the I/P lower trim plate assembly (1).
3. Align the I/P lower trim plate assembly (1) to the I/P.
4. Install the I/P lower trim plate assembly (1) to the I/P by pushing in the area of the retaining clips (2).
5. Ensure all clips are located correctly.

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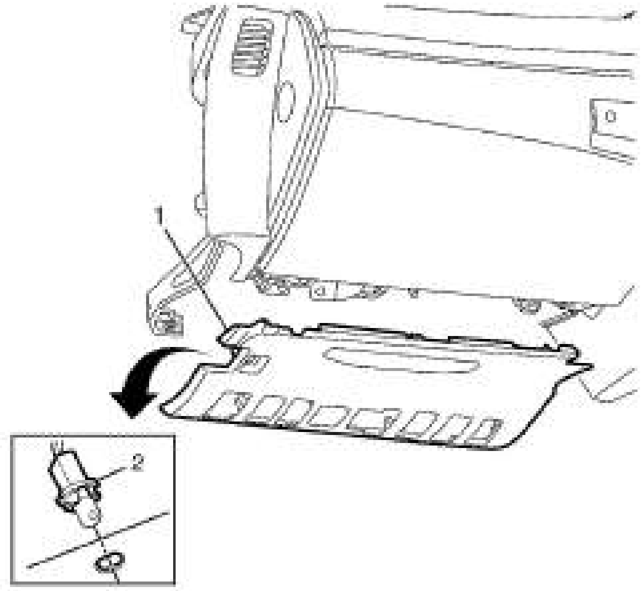
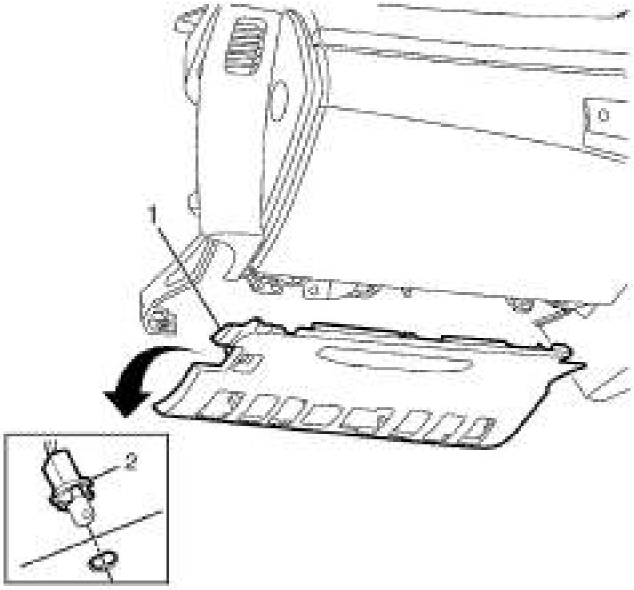
Instrument Panel Insulator Panel Replacement - Left Side (RHD)

Removal Procedure



1. Grasp the I/P lower trim plate assembly (1) and carefully pull downward to disengage the retaining clips.
2. Remove the courtesy lamp socket assembly (2) from the left lower trim plate by turning the socket counter-clockwise.
3. Remove the I/P lower trim plate assembly (1).

Installation Procedure



1. Install the courtesy lamp socket assembly (2) to the I/P lower trim plate assembly (1).
2. Align the I/P lower trim plate assembly (1) to the I/P.
3. Attach the I/P lower trim plate assembly (1) to the I/P by engaging the retaining clips.
4. Ensure all clips are located correctly.

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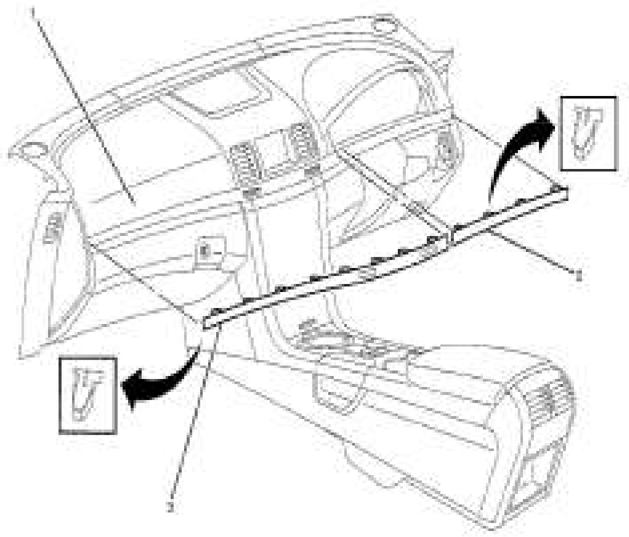
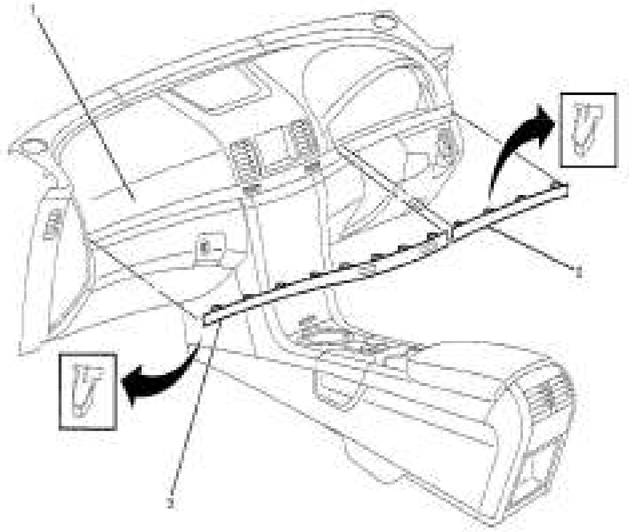
Instrument Panel Trim Panel Replacement (SWB RHD)

Removal Procedure



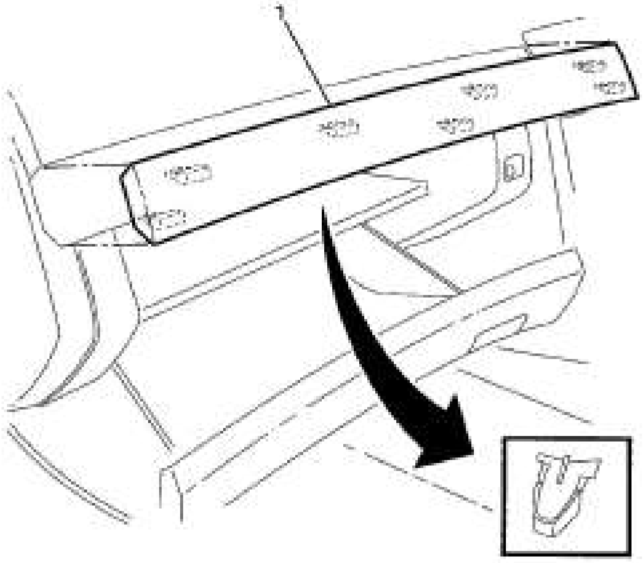
1. Using a suitable tool disengage the right hand side trim panel (2) retaining clips and remove the trim panel (2) from the I/P pad (1).
2. Using a suitable tool disengage the left hand side trim panel (3) retaining clips and remove the trim panel (3) from the I/P pad (1).

Installation Procedure



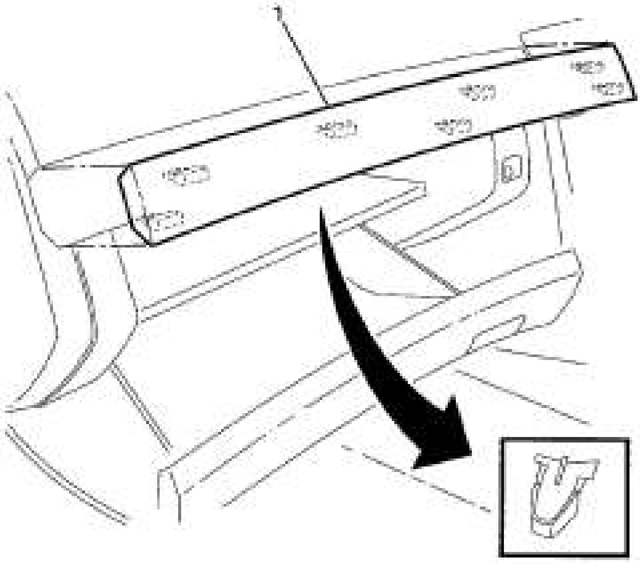
1. Align the left hand trim panel (3) with the I/P pad (1).
2. Install the trim panel (3) by firmly engaging the retaining clips.
3. Align the right hand trim (2) panel with the I/P pad (1).
4. Install the trim panel (2) by firmly engaging the retaining clips.

Removal Procedure - (SV6, SS and SSV)



1. Using a suitable tool disengage the trim panel (1) retaining clips.
2. Remove the trim panel (1) from the I/P pad.

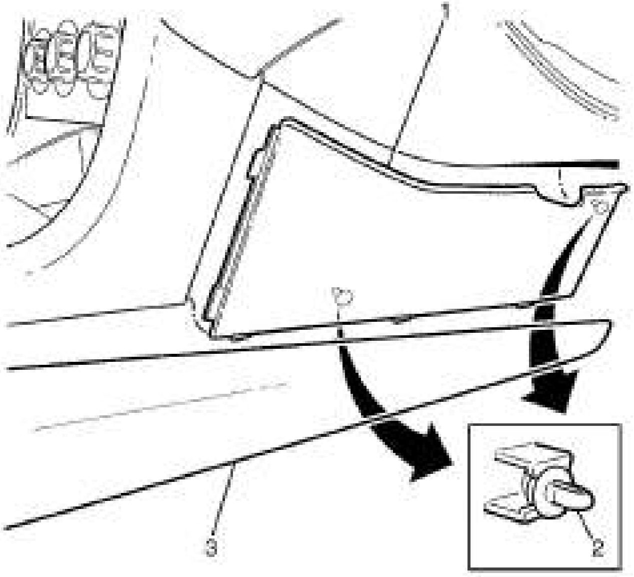
Installation Procedure



1. Align the trim panel (1) with the I/P pad.
2. Install the trim panel (1) to the I/P pad by engaging the retaining clips.
3. Ensure the trim panel (1) is flush with the I/P pad.

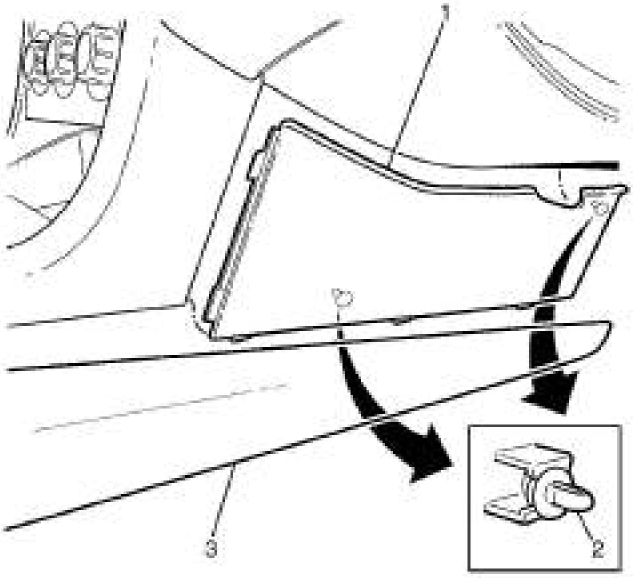
Instrument Panel Extension Replacement

Removal Procedure



1. Disengage the I/P extension panel (1) to I/P carrier retaining clips (2).
2. Remove the I/P extension panel (1) from the centre console side trim panel (3).

Installation Procedure



1. Align the I/P extension panel (1) with the I/P carrier.
2. Engage the I/P extension panel (1) to I/P carrier retaining clips (2).
3. Install the centre console side trim panel (3) to the I/Pextension panel (1).

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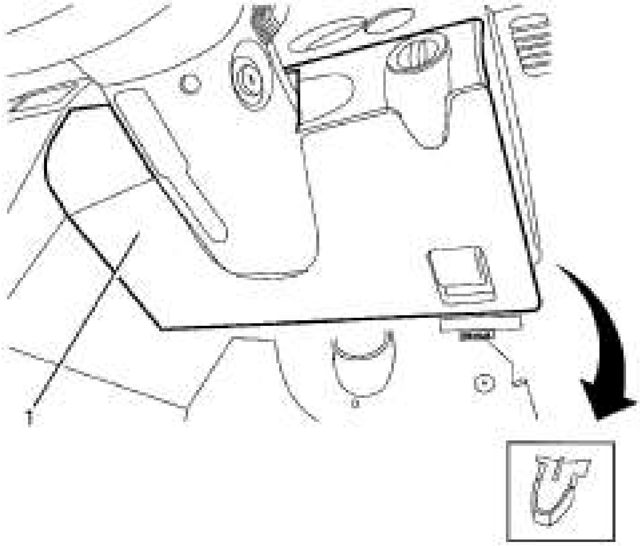
Knee Bolster Replacement (RHD)

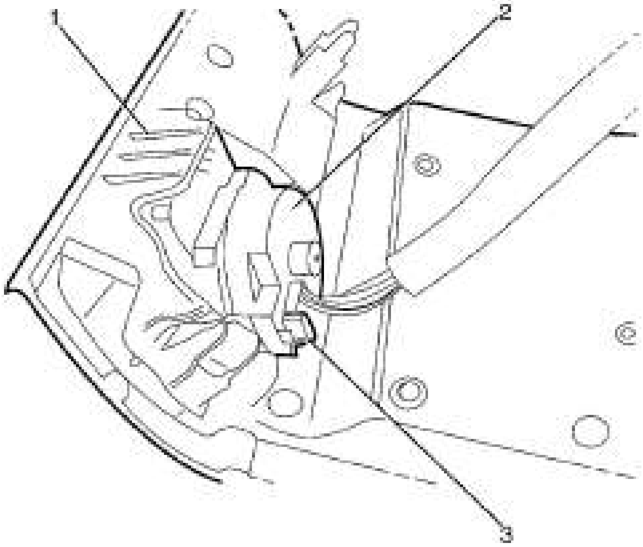
Removal Procedure

1. Remove the insulator panel. Refer to Instrument Panel Insulator Panel Replacement - Right Side .
2. Remove the Instrument Panel Outer Trim Cover. Refer to Instrument Panel Outer Trim Cover Replacement .



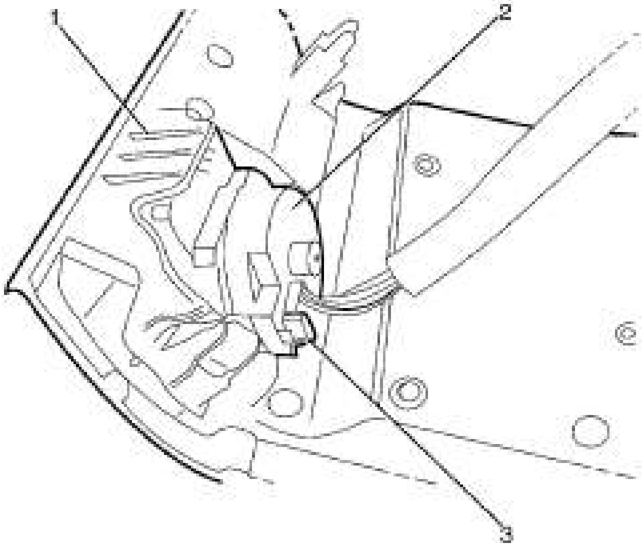
Important: When removing the knee bolster, care must be taken not to scratch the steering column cover. This can be achieved by slightly bending the knee bolster to avoid contact with the steering column.

3. Grasp the knee bolster assembly (1) and carefully pull downward to disengage the retaining clips.

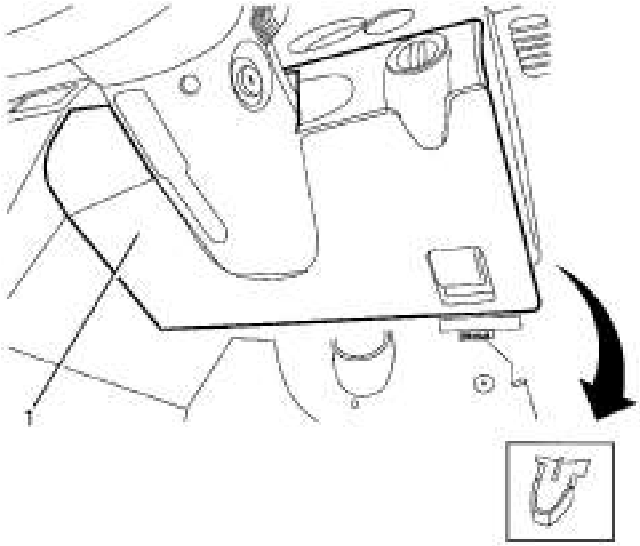


4. Disconnect the headlamp switch (2) electrical connecter (3) from headlamp switch.
5. Remove the knee bolster (1).

Installation Procedure



1. Connect the headlamp switch (2) electrical connector (3).
2. Align the knee bolster (1) with the I/P pad.



3. Install the knee bolster (1) to the I/P by engaging the retaining clips.
4. Install the Instrument Panel Outer Trim Cover. Refer to Instrument Panel Outer Trim Cover Replacement .
5. Install the insulator panel. Refer to Instrument Panel Insulator Panel Replacement - Right Side .
6. Ensure all clips are located correctly.

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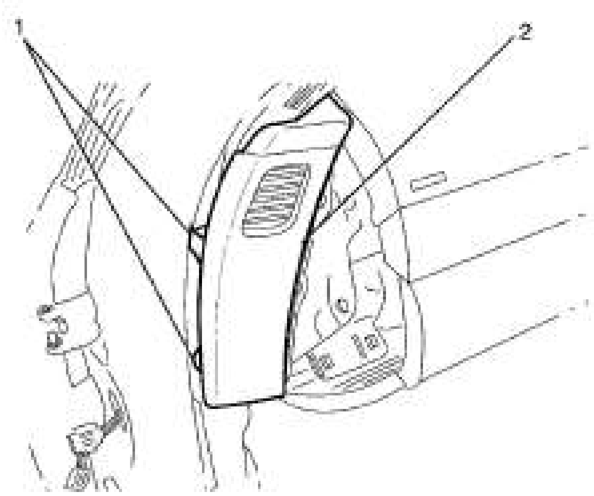
Instrument Panel Side Trim Panel Replacement

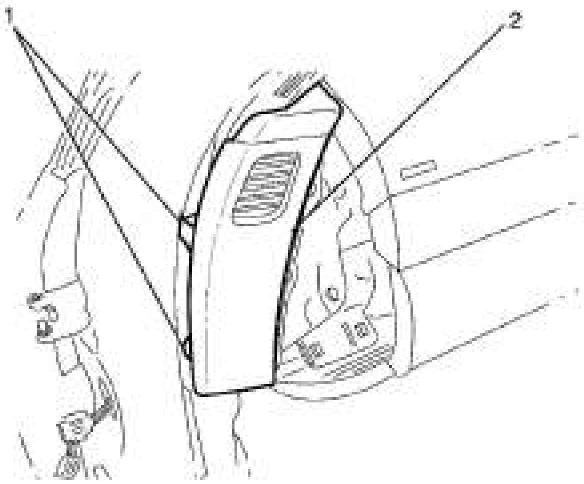
Removal Procedure

1. Remove the instrument panel outer trim cover. Refer to Instrument Panel Outer Trim Cover Replacement.



2. Grasp the front lower area of the centre A pillar ventilation trim panel (2) and carefully pull to disengage the retaining clips (1). The left side is shown, the right side is similar.
3. Remove the centre A pillar ventilation trim panel (2) rotating upwards to disengage remaining clips.

Installation Procedure



1. Align the center A pillar ventilation trim panel (2) to the A pillar and correctly locate the upper clips (1).
2. Install the center A pillar ventilation trim panel (2) to the A pillar by engaging the retaining clips (1).
3. Ensure all clips are installed correctly.
4. Install the instrument panel outer trim cover. Refer to Instrument Panel Outer Trim Cover Replacement.

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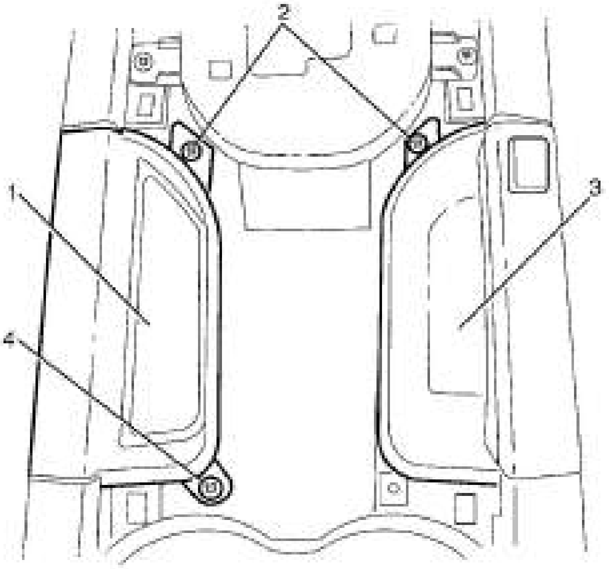
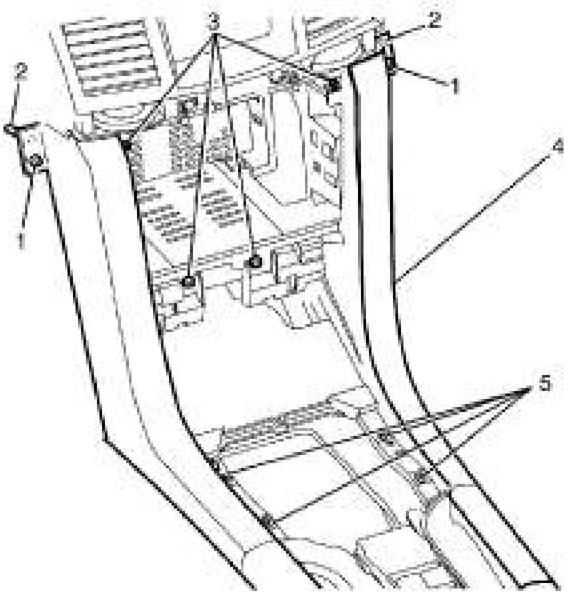
Instrument Panel Center Trim Panel Replacement (SWB RHD)

Removal Procedure - (Omega)

1. Remove the knee bolster. Refer to Knee Bolster Replacement .
2. Remove the instrument panel compartment. Refer to Instrument Panel Compartment Replacement .
3. Remove the radio. Refer to Radio Replacement .
4. Remove the centre console trim plate. Refer to Console Trim Plate Replacement .

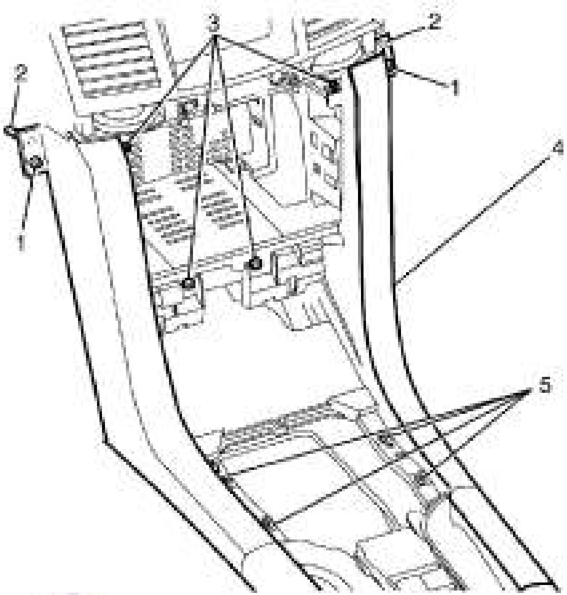


5. Remove the coin holder upper retaining screws (2,4) and remove the coin holder (1).
6. Remove the park recces tray upper retaining screw (2) and remove the recess trim (3).



7. Remove the trim panel (4) to I/P tower lower retaining screws (1).
8. Remove the upper trim panel retaining screws (1) from the trim panel (4).
9. Remove the trim panel (3) to centre console retaining screws (5).
10. Remove the trim panel (5) to centre console

Installation Procedure



1. Install the trim panel to the I/P carrier.

   Notice: Refer to Fastener Notice in the Preface section.

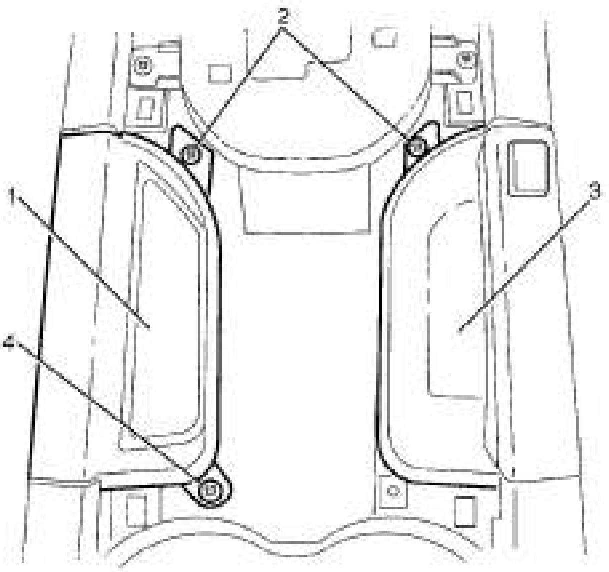
2. Install the trim panel to centre console retaining screws (1) and (3).

   Tighten
   Tighten the screws (1) and (3) to 2 N·m (18 lb in).

3. Install the trim panel (4) to I/P tower retaining screws (1) and (3).

   Tighten
   Tighten the screws (3) to 2 N·m (18 lb in).

   Notice: Refer to Fastener Notice in the Preface section.



4. Install the coin holder upper retaining screws (2,4) and remove the coin holder (1).

   Tighten
   Tighten the screws (1) to 2 N·m (18 lb in).

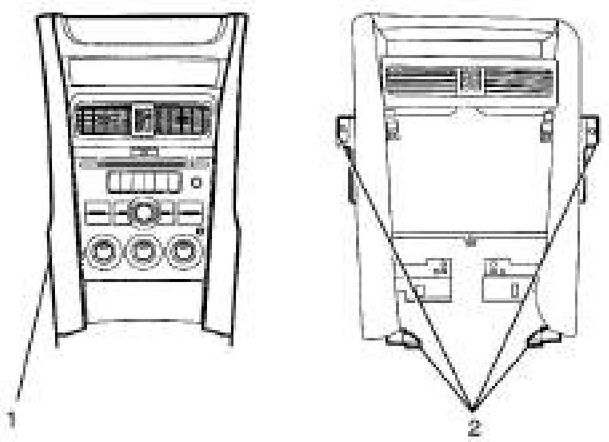
5. Install the park recces tray upper retaining screw (2) and remove the recess trim (3).

   Tighten
   Tighten the screws (1) to 2 N·m (18 lb in).

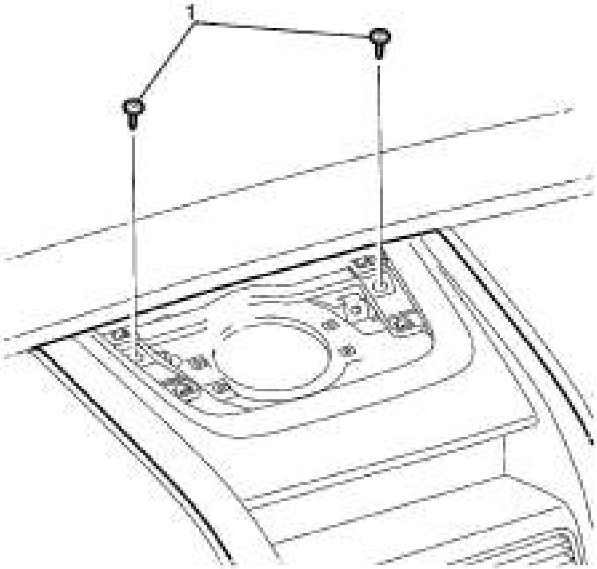
6. Install the radio. Refer to Radio Replacement .
7. Install the instrument panel compartment. Refer to Instrument Panel Compartment Replacement .
8. Install the knee bolster. Refer to Knee Bolster Replacement .
9. Install the centre console trim plate. Refer to Console Trim Plate Replacement .
10. Test radio for correct operation.

Removal Procedure - (SV6,SS and SS-V)

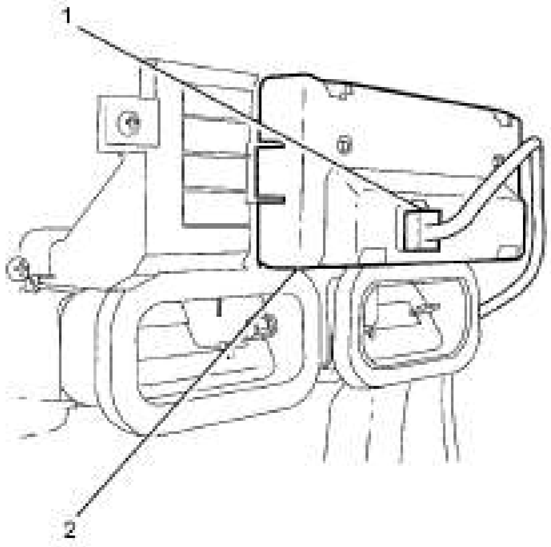
1. Remove the knee bolster. Refer to Knee Bolster Replacement .
2. Remove the instrument panel compartment. Refer to Instrument Panel Compartment Replacement .
3. Remove the radio fascia. Refer to Instrument Panel Compartment Replacement .



4. Remove the trim panel (1) to I/P tower lower retaining screws (2).

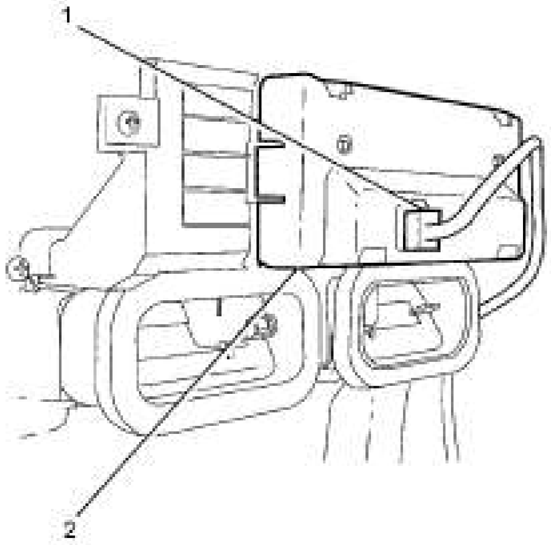


5. Remove the upper trim panel to I/P pad retaining screws (1).
6. Disengage the trim panel to I/P pad retaining clips, located at the top of the trim panel.
7. Lift the trim panel upward and forward to gain access to the multi function display unit electrical connector.



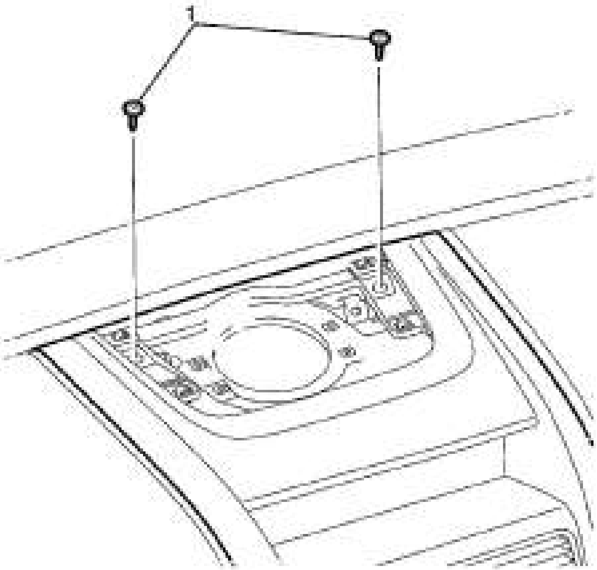
8. Disconnect the multi function display unit (2) electrical connector (1).
9. Remove the trim panel.

Installation Procedure



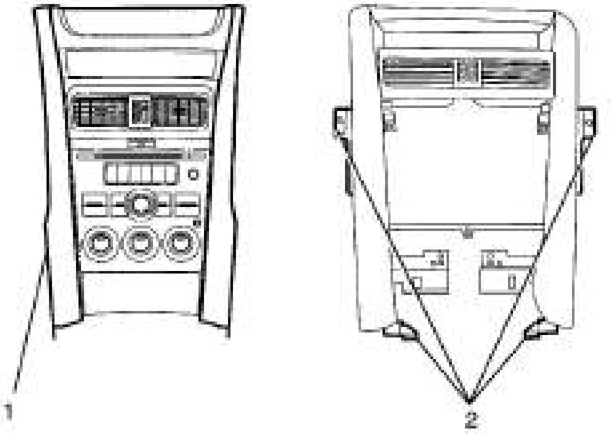
1. Connect the multi function display unit (2) electrical connector (1).

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the top trim panel to I/P pad retaining screws (1).

   Tighten
   Tighten the screws (1) to 2 N·m (18 lb in).



3. Align the trim panel (1) with the I/P tower.
4. Engage the trim panel retaining clips.

   Notice: Refer to Fastener Notice in the Preface section.

5. Install the trim panel to I/P tower retaining screws (2).

Tighten
Tighten the screws (1) to 2 N·m (18 lb in).

6. Install the radio fascia. Refer to Instrument Panel Compartment Replacement .
7. Install the instrument panel compartment. Refer to Instrument Panel Compartment Replacement
8. Install the knee bolster. Refer to Knee Bolster Replacement .
9. Test the multi function display and radio for correct operation.

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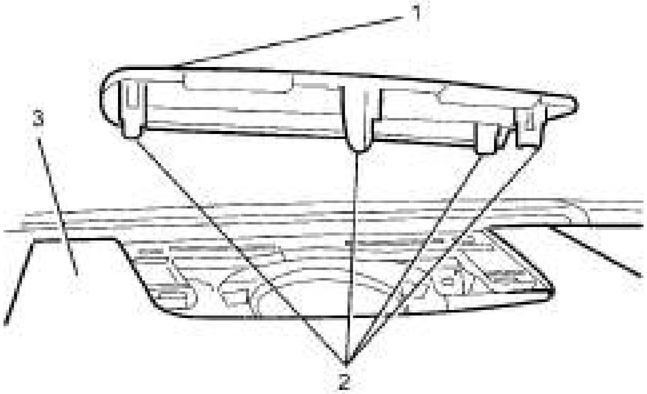
Instrument Panel Upper Trim Panel Replacement (LWB SWB)

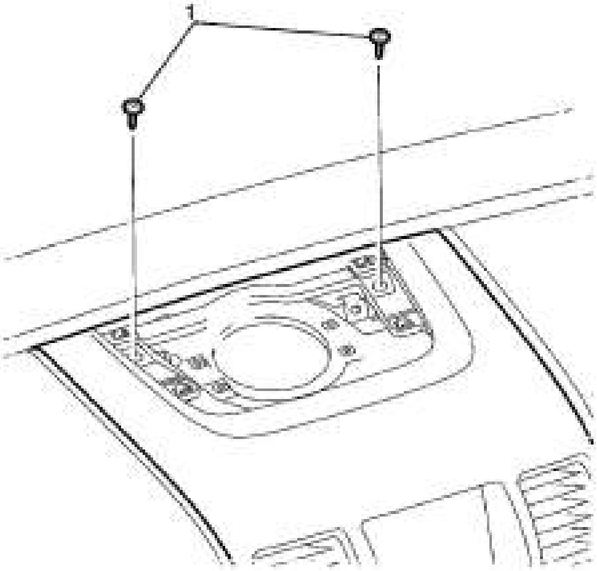
Removal Procedure

Notice: Refer to General Repair Instructions in the Preface section.

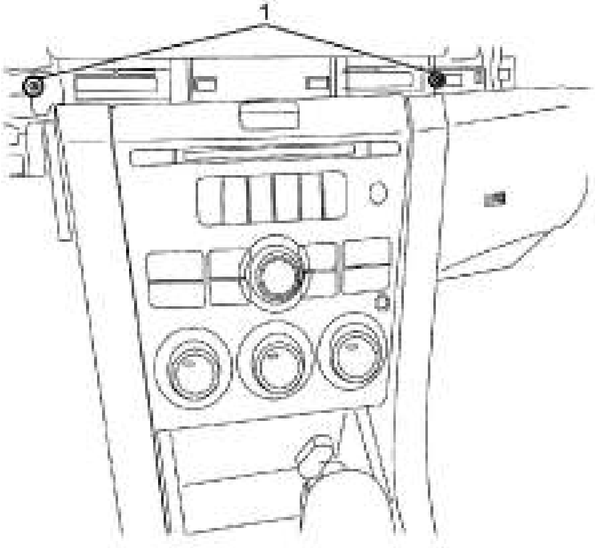
1. Remove the I/P trim panel. Refer to Instrument Panel Trim Panel Replacement.



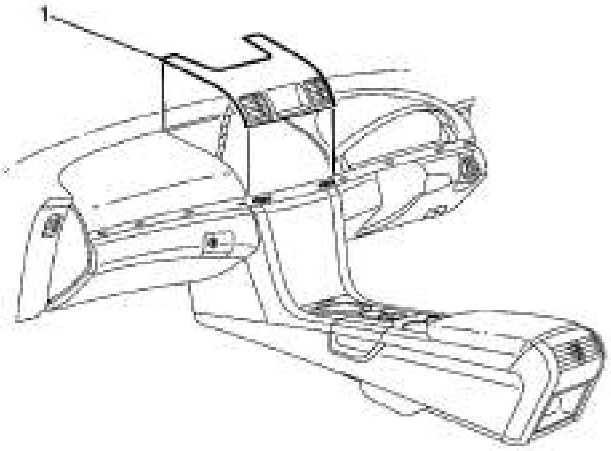
2. Remove the I/P upper trim panel (1) by disengaging the trim panel retaining clips (2) and removing the I/P upper trim panel from the I/P pad (3).



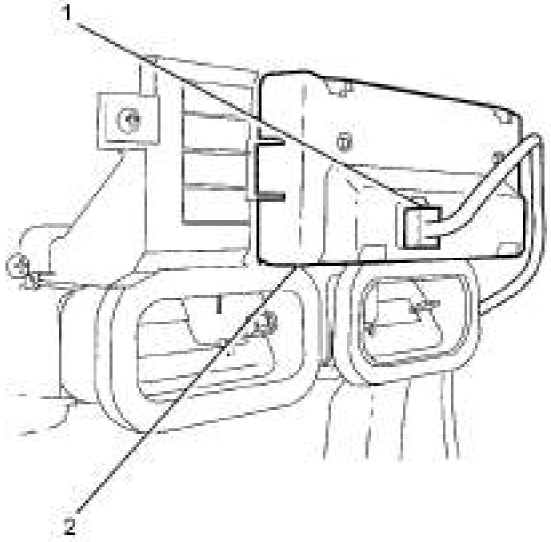
3. Remove the trim panel to I/P pad upper retaining screws (1).



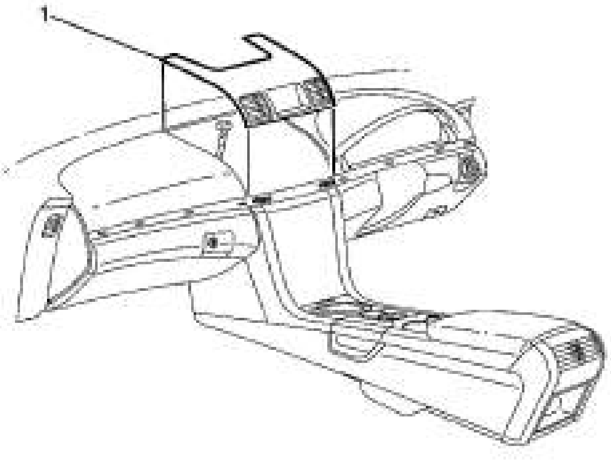
4. Remove the trim panel to I/P pad lower retaining screws (1).



5. Disengage the trim panel (1) retaining clips and raise the trim panel to gain access to the electrical connector.

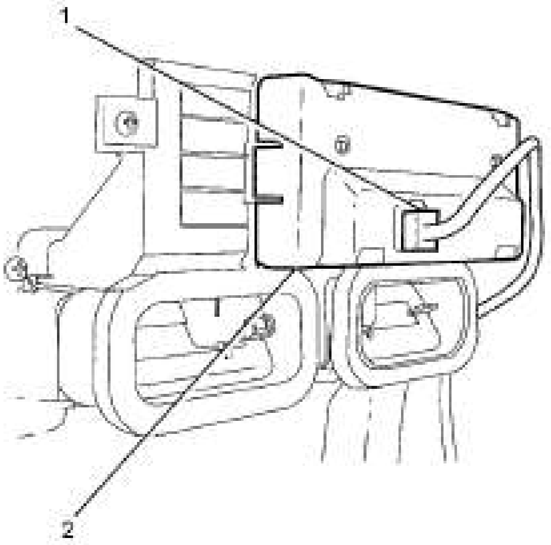


6. Disconnect the secondary information centre (2) (SIC) electrical connector (1).

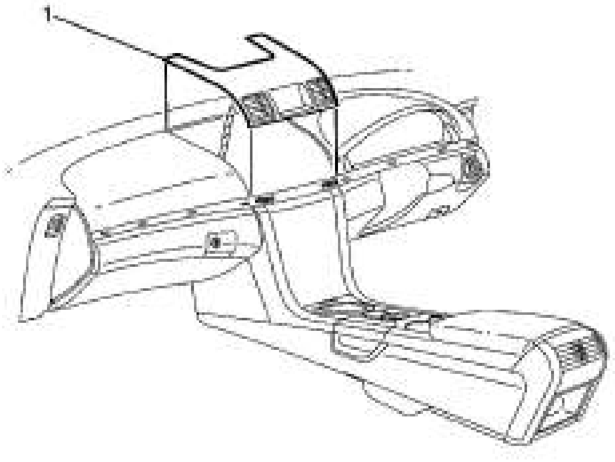


7. Remove the trim panel (1) from the I/P pad.

Installation Procedure

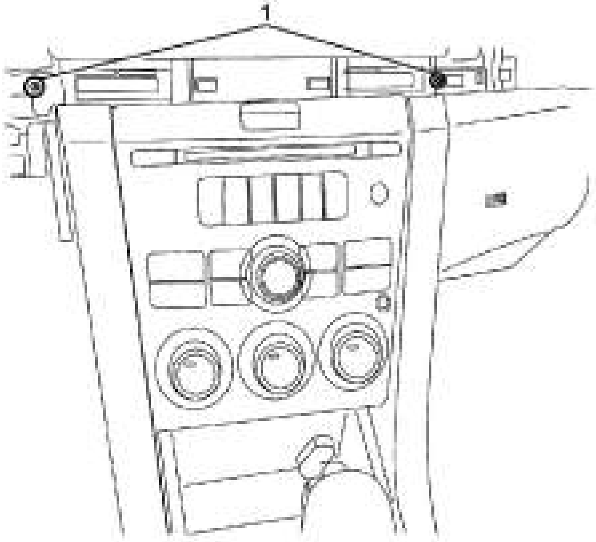


1. Connect the secondary information centre (2) (SIC) electrical connector (1).



2. Engage the trim panel (1) to I/P pad retaining clips.

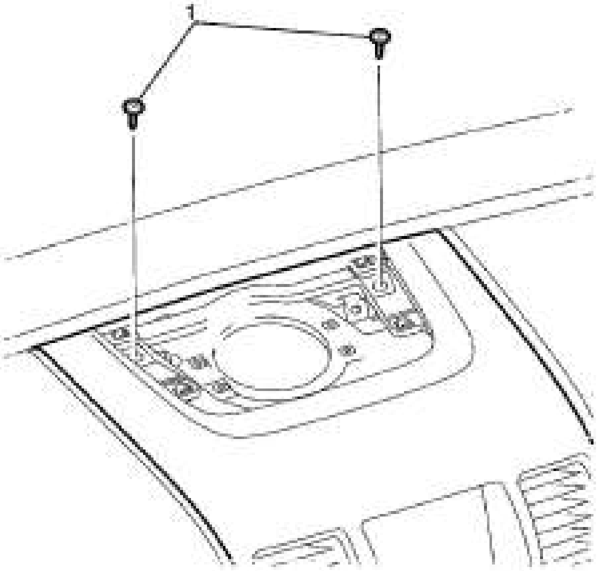
   Notice: Refer to Fastener Notice in the Preface section.



3. Install the trim panel to I/P pad lower retaining screws (1).

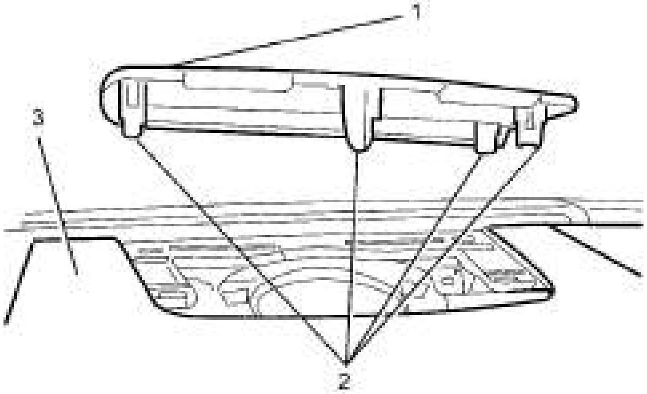
   Tighten
   Tighten the screws (1) to 2 N·m (18 lb in).

   Notice: Refer to Fastener Notice in the Preface section.



4. Install the trim panel to I/P pad upper retaining screws (1).

   Tighten
   Tighten the screws (1) to 2 N·m (18 lb in).

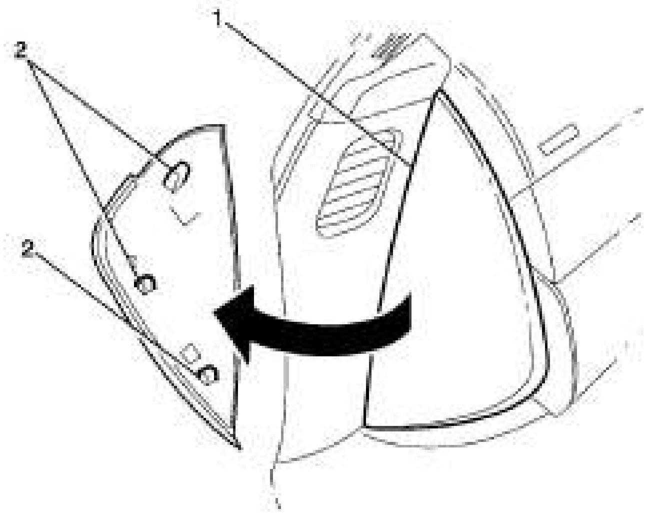


5. Install the trim panel top cover (1) by engaging the trim panel retaining clips (2) and securing it to the I/P pad.
6. Ensure the trim panel (1) is flush with the I/P pad.
7. Install the I/P trim panel. Refer to Instrument Panel Trim Panel Replacement.

Instrument Panel Outer Trim Cover Replacement

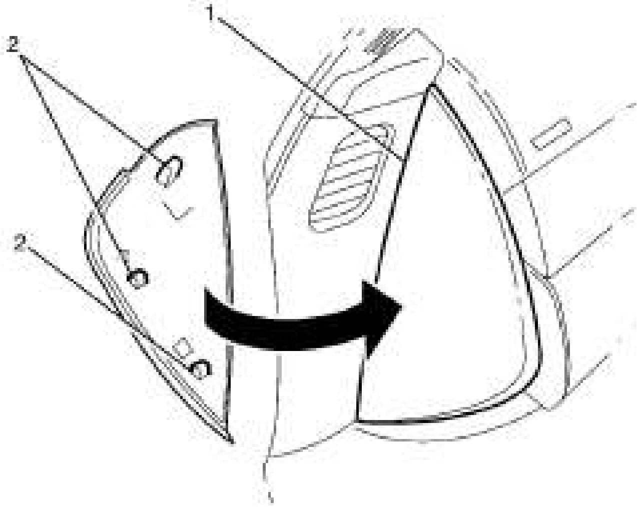
Removal Procedure

1. Remove the I/P trim panel. Refer to Instrument Panel Trim Panel Replacement.



2. Grasp the lower area of the instrument panel outer cover (1) and carefully pull to disengage the retaining clips (2). The left side is shown, the right side is similar.
3. Remove the instrument panel outer cover (1) rotating upwards to disengage remaining clip (2).

Installation Procedure

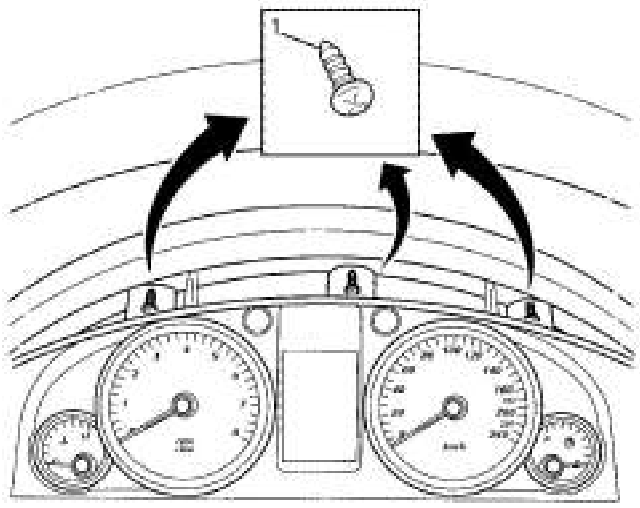


1. Align the instrument panel outer cover (1) to the I/P and correctly locate the upper clips (2).
2. Install the instrument panel outer cover (1) to the I/P by disengaging the retaining clips (2).
3. Install the I/P trim panel. Refer to Instrument Panel Trim Panel Replacement.
4. Ensure all clips are installed correctly.

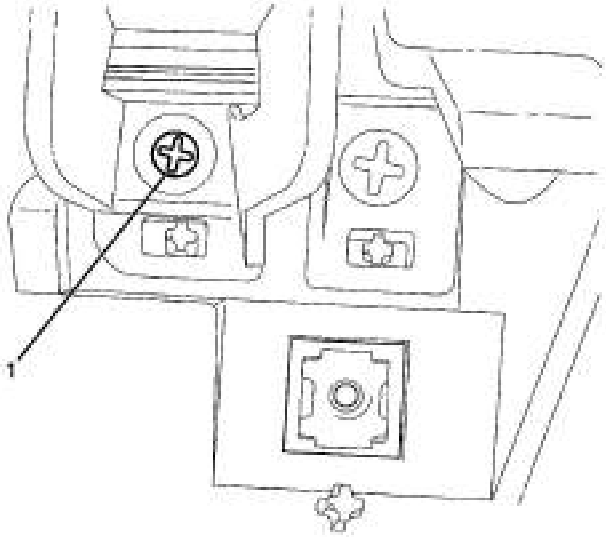
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Hardware and Trim | Instrument Panel and Console Trim | Repair Instructions | **Document ID: 1982200**

Instrument Cluster Trim Panel Replacement (SWB)

Removal Procedure

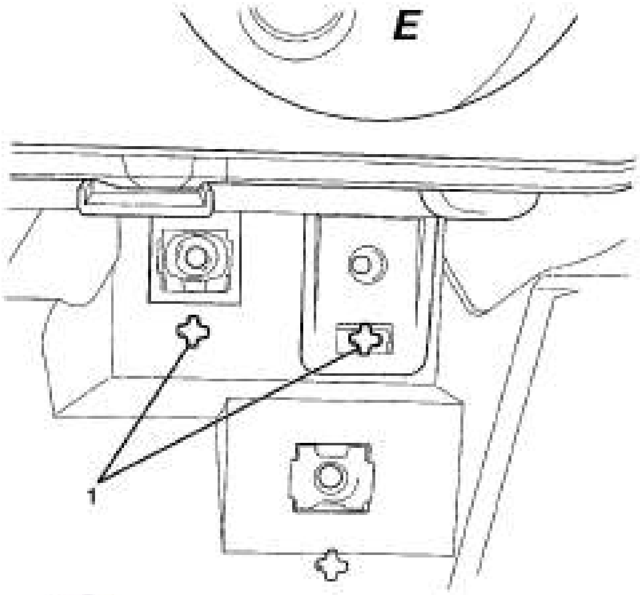


1. Remove the upper instrument cluster trim panel to I/P trim pad retaining screws (1).



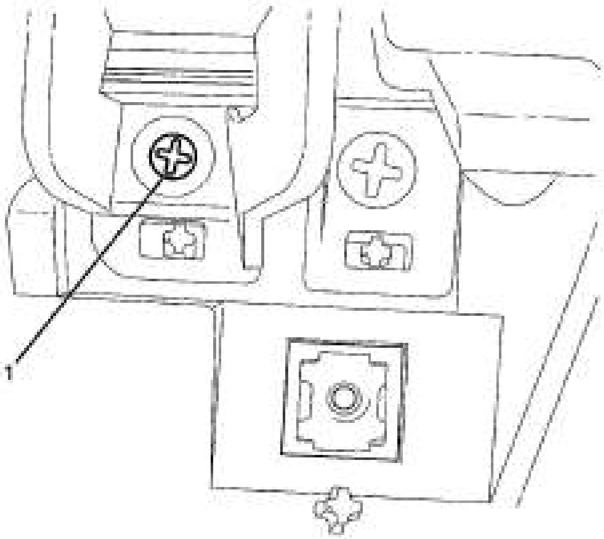
2. Remove the lower instrument cluster to I/P pad retaining screws (1), located on either side of the instrument cluster trim panel.
3. Using a suitable tool, carefully remove the top of the trim panel toward the steering wheel.
4. Remove the instrument cluster trim panel.

Installation Procedure



1. When installing the instrument cluster trim panel, make sure the locating lugs (1) are correctly located.
2. Install the instrument cluster trim panel.

   Notice: Refer to Fastener Notice in the Preface section.

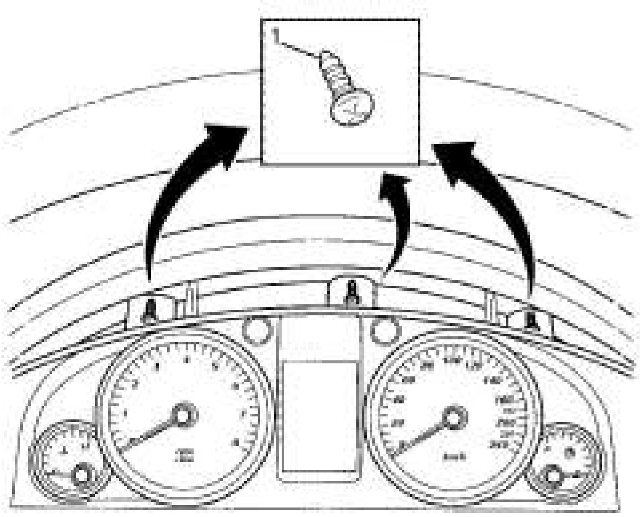


3. Install the lower instrument cluster trim panel to I/P pad retaining screws (1).

   Tighten

Tighten the screws (1) to 2 N·m (18 lb in).

Notice: Refer to Fastener Notice in the Preface section.



4. Install the upper instrument cluster trim panel to I/P trim pad retaining screws (1).

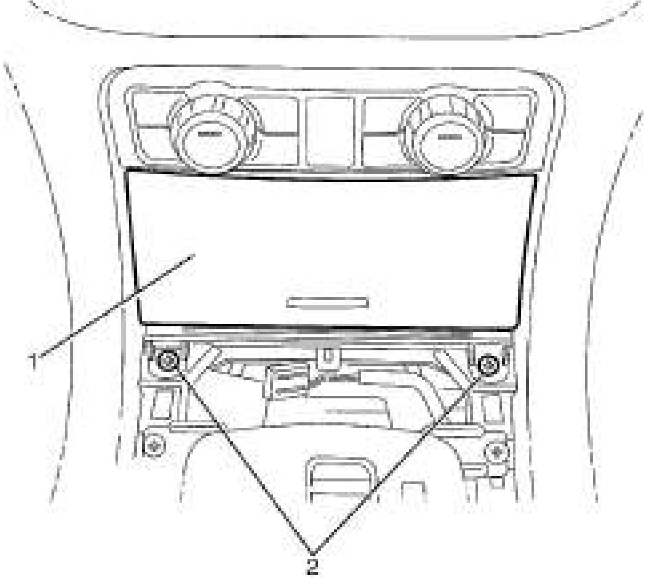
Tighten
Tighten the screws (1) to 2 N·m (18 lb in).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Hardware and Trim | Instrument Panel and Console Trim | Repair Instructions | **Document ID: 1995194**

Instrument Panel Storage Compartment Replacement (SWB)

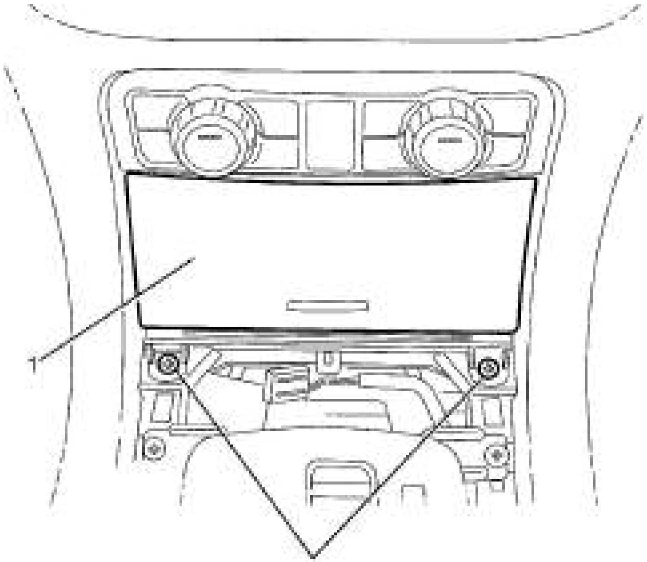
Removal Procedure - (Omega, Calais, Berlina)

1. Remove the trim plate. Refer to Console Trim Plate Replacement.



2. Remove the storage compartment (1) to I/P tower retaining screws (2).
3. Remove the storage compartment (1) from the I/P tower.

Installation Procedure



1. Install the storage compartment (1) to the I/P tower.

   Notice: Refer to Fastener Notice in the Preface section.

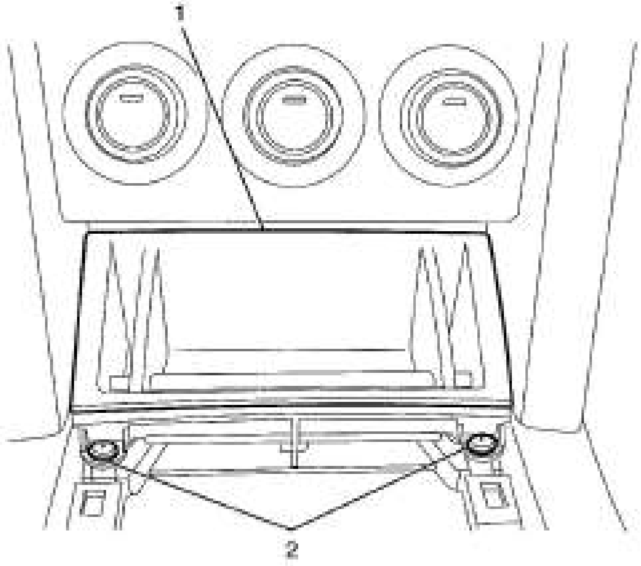
2. Install the storage compartment to I/P tower retaining screws (2).

   Tighten
   Tighten the screws (2) to 2 N·m (18 lb in).

3. Install the trim plate. Refer to Console Trim Plate Replacement.
4. Operate the storage compartment lid for correct operation.

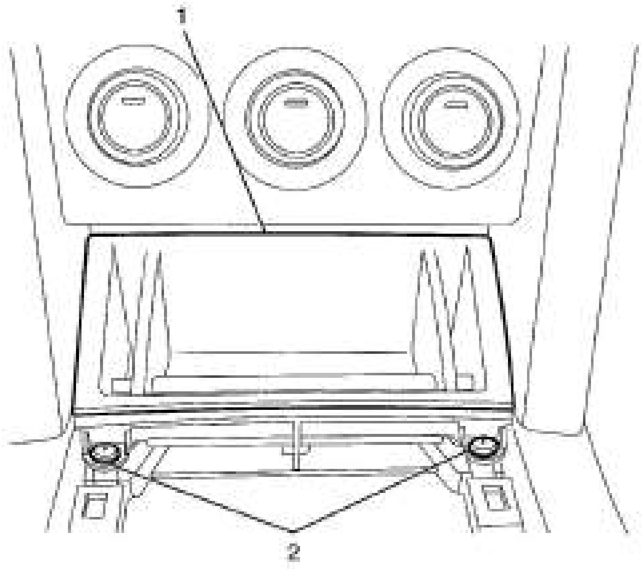
Removal Procedure - (SV6, SS and SS-V)

1. Remove the trim plate. Refer to Console Trim Plate Replacement.



2. Remove the storage compartment (1) to centre console retaining screws (2).
3. Remove the storage compartment (1) from the centre console.

Installation Procedure



1. Install the storage compartment (1) into the centre console.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the storage compartment (1) to centre console retaining screws (2).

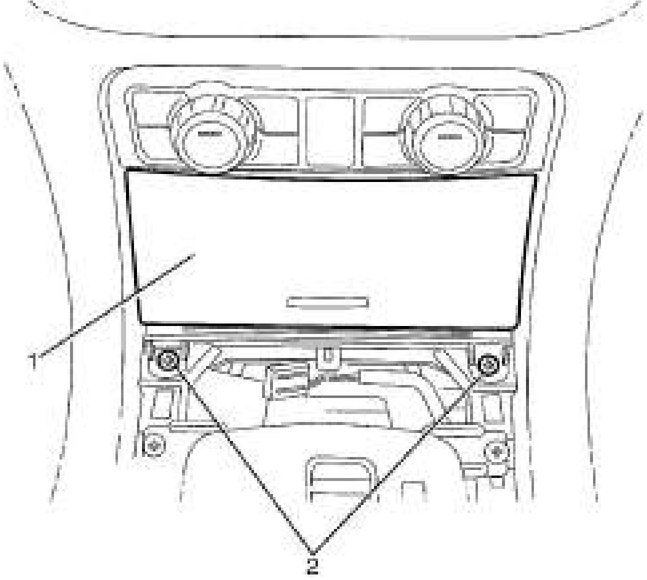
   Tighten
   Tighten the screws (2) to 2 N·m (18 lb in).

3. Install the trim plate. Refer to Console Trim Plate Replacement.

Instrument Panel Storage Compartment Replacement (LWB)

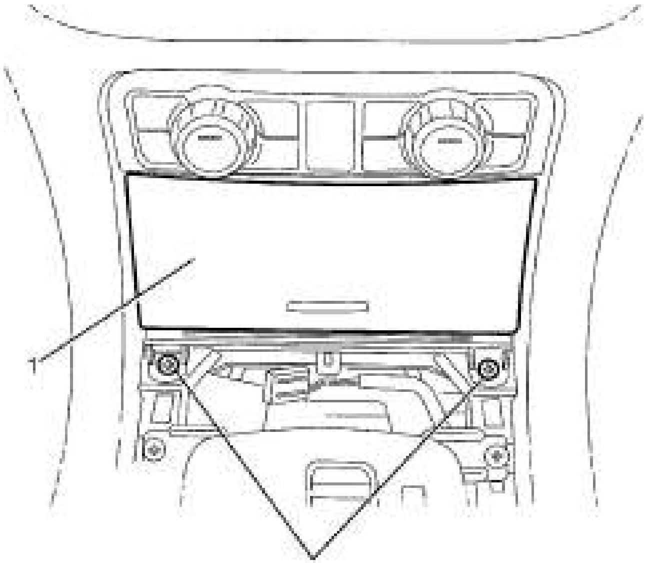
Removal Procedure

1. Remove the trim plate. Refer to Console Trim Plate Replacement.



2. Remove the storage compartment (1) to I/P tower retaining screws (2).
3. Remove the storage compartment (1) from the I/P tower.

Installation Procedure



1. Install the storage compartment (1) to the I/P tower.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the storage compartment to I/P tower retaining screws (2).

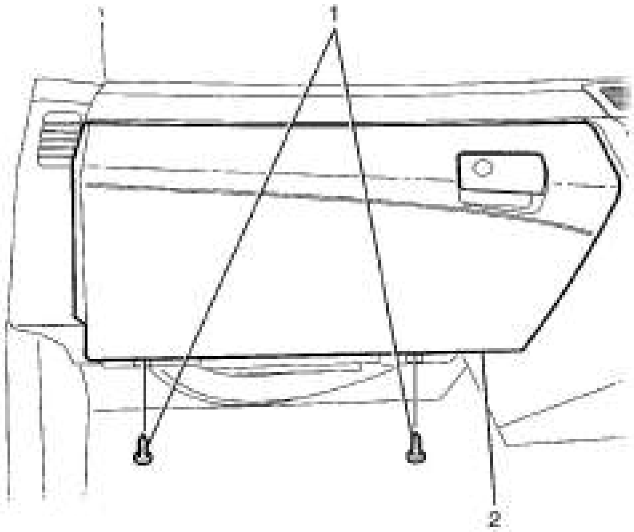
   Tighten
   Tighten the screws (2) to 2 N·m (18 lb in).

3. Install the trim plate. Refer to Console Trim Plate Replacement.
4. Operate the storage compartment lid for correct operation.

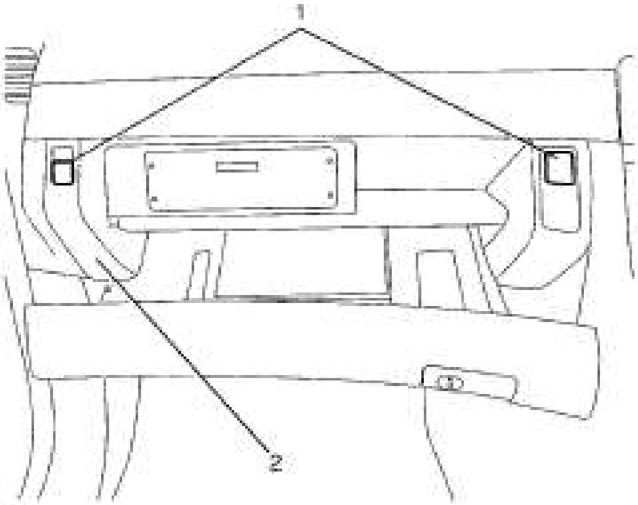
Instrument Panel Compartment Replacement (RHD)

Removal Procedure

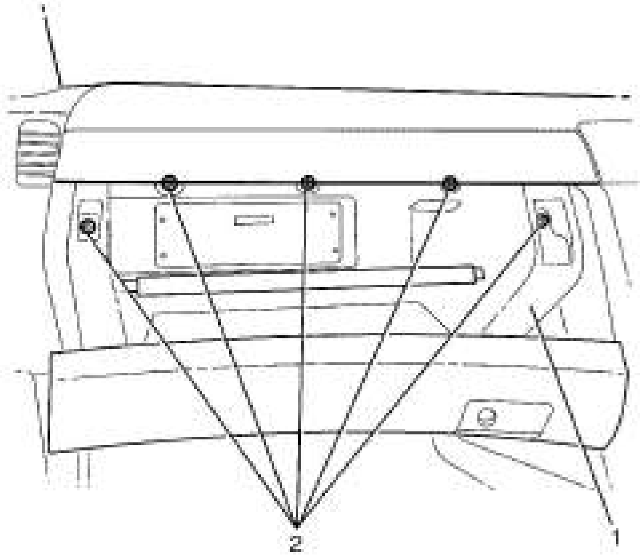
1. Remove the instrument panel insulator panel -- Left Side. Refer to Instrument Panel Insulator Panel Replacement - Right Side.
2. Remove the instrument panel outer trim cover. Refer to Instrument Panel Outer Trim Cover Replacement.



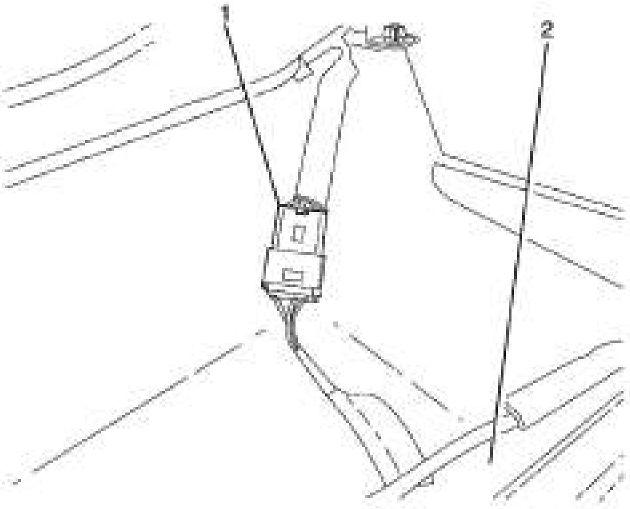
3. Remove the I/P compartment assembly lower retaining screws (1).
4. Open the I/P compartment assembly door (2).



5. Remove the I/P compartment retaining screw covers (1) from the I/P compartment (2).

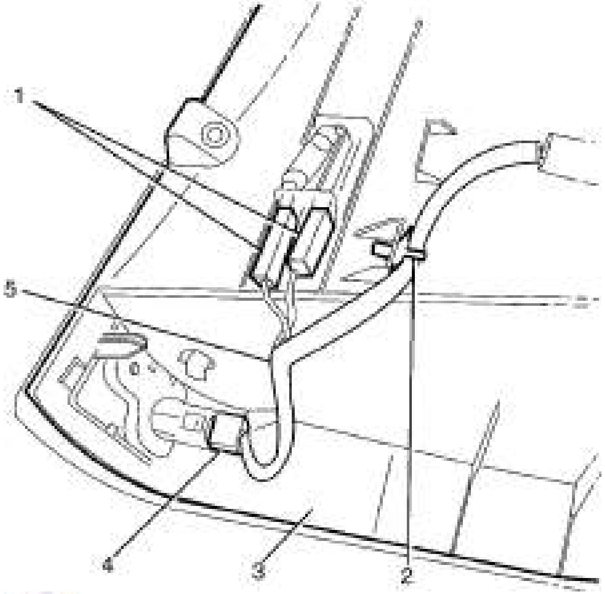


6. Remove the I/P compartment upper retaining screws (2).
7. Remove the I/P compartment (1).

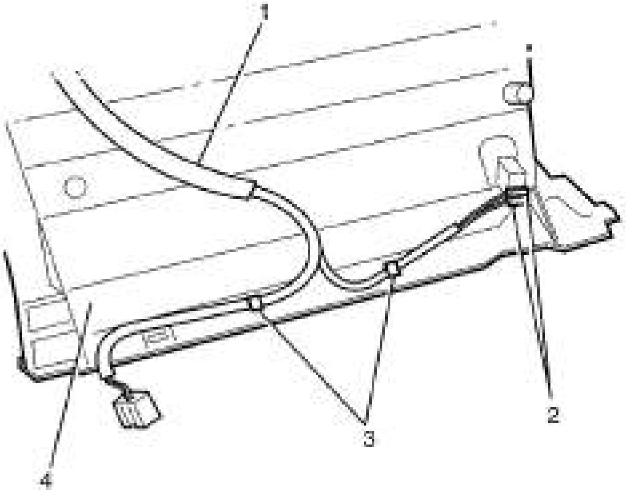


8. Disconnect the I/P compartment electrical connector (1) from the I/P compartment (2).

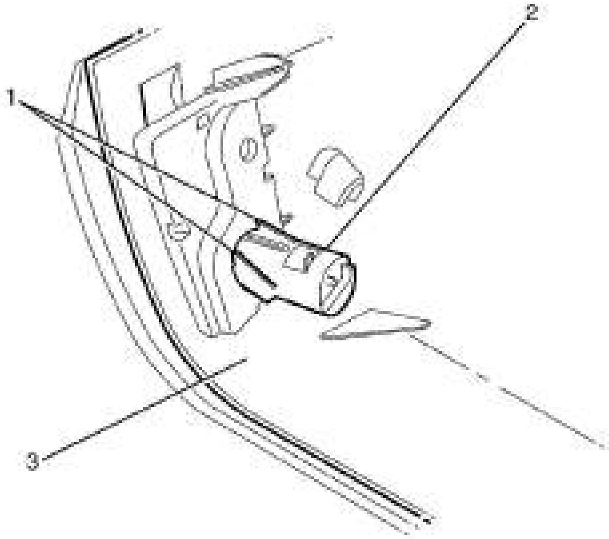
Disassemble Procedure



1. Disconnect the I/P compartment lamp electrical connectors (1), where fitted.
2. Disconnect the rear compartment release button electrical connector (4), where fitted.
3. Detach the I/P compartment electrical harness retaining clip (2) and harness (5) from the I/P compartment (3)

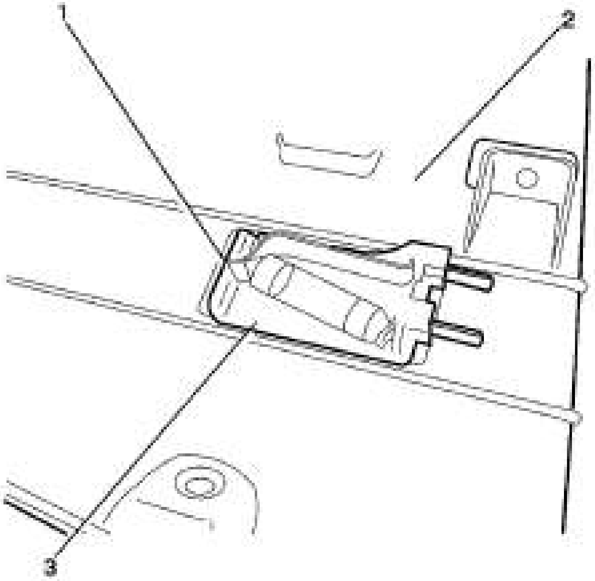


4. Disconnect the I/P compartment lamp switch electrical connectors (2), where fitted.
5. Detach the wiring harness retaining clips (3) from the I/P compartment (4).
6. Remove the I/P compartment wiring harness (1) from the I/P compartment (4).

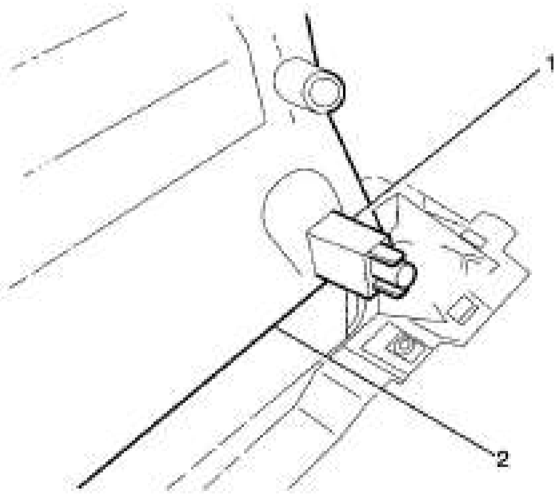


Important: Press the retaining clips (1) and push the rear compartment release button (2) through the I/P compartment (3) to remove.

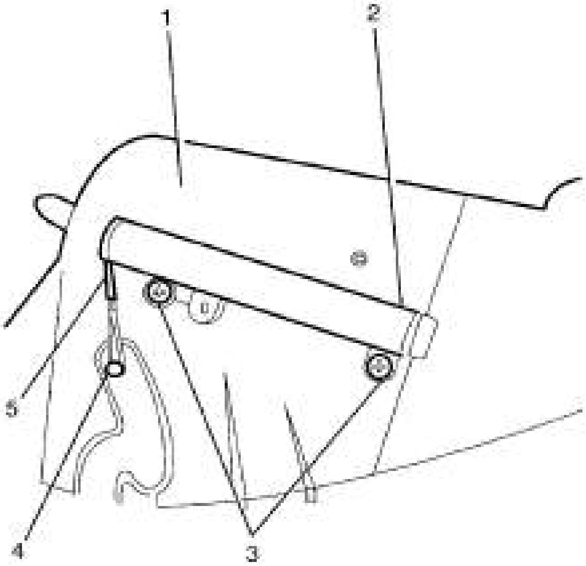
7. Remove the rear compartment release button (2) from the I/P compartment (3).



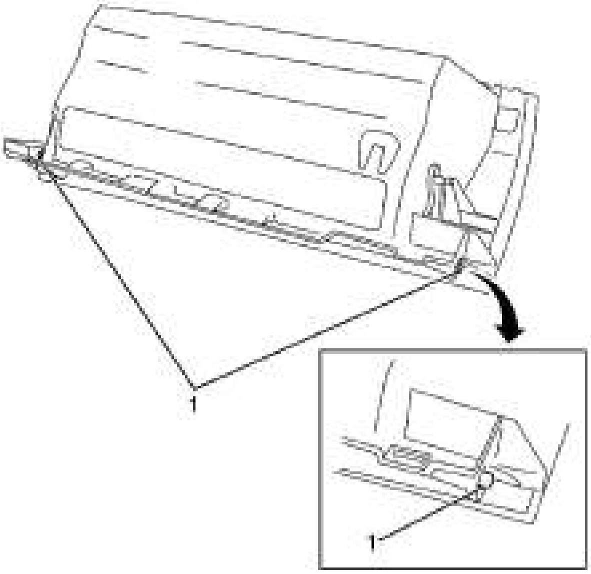
8. Remove the I/P compartment lamp (3), where fitted, by releasing the I/P compartment lamp retaining clip (1) and pushing it through the I/P compartment (2),.



9. Remove the I/P compartment lamp switch (1) from the I/P compartment (2), where fitted



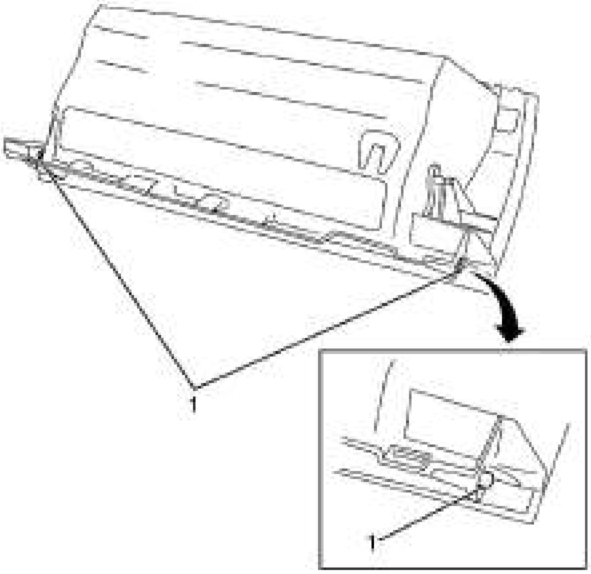
10. Remove the I/P compartment damper cord (5) by detaching it from the securing hook (4).
11. Remove the I/P compartment damper retaining screws (3).
12. Remove the I/P compartment damper (2) from the I/P compartment (1).



13. Remove the I/P compartment door hinge retaining pins (1) and remove the I/P compartment door.

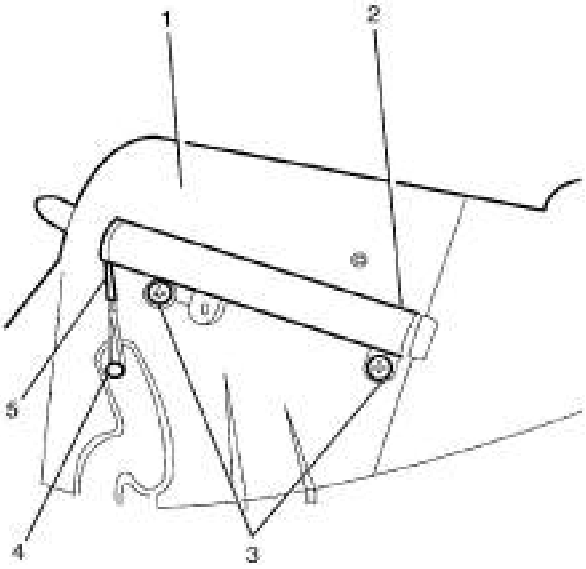
Assemble Procedure

1. Align the I/P compartment door with the I/P compartment.



2. Install the I/P compartment door hinge retaining pins (1) to the I/P compartment door.

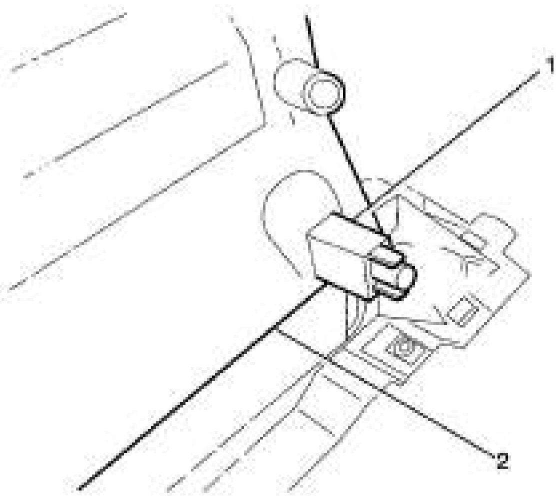
Notice: Refer to Fastener Notice in the Preface section.



3. Install the I/P compartment damper (2) to the I/P compartment (1).
4. Install the I/P compartment damper retaining screws (3).

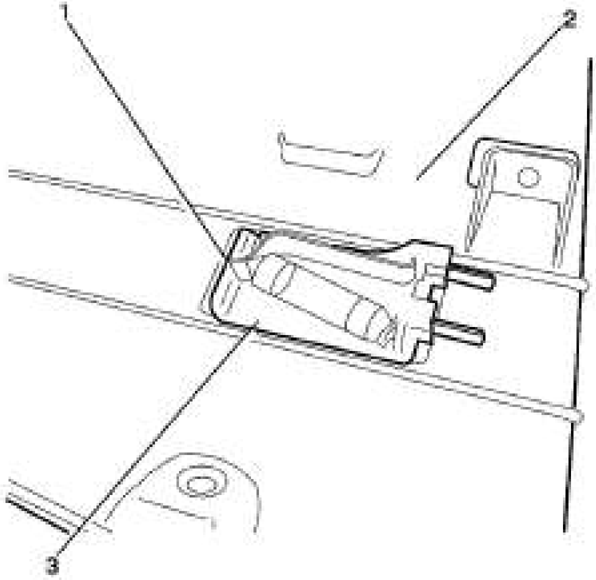
   Tighten
   Tighten the screws to 2 N·m (18 lb in).

5. Install the I/P compartment damper cord (5) by attaching it to the securing hook (4).



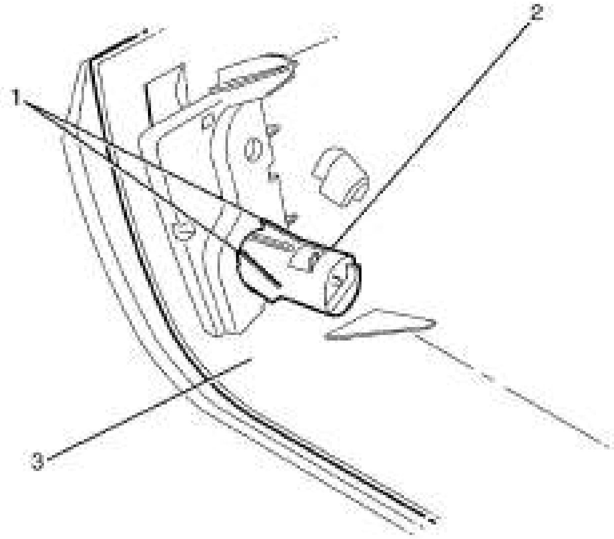
Important: Listen for audible click to confirm correct fitting

6. Install the I/P compartment lamp switch (1), where fitted, to the I/P compartment (2).



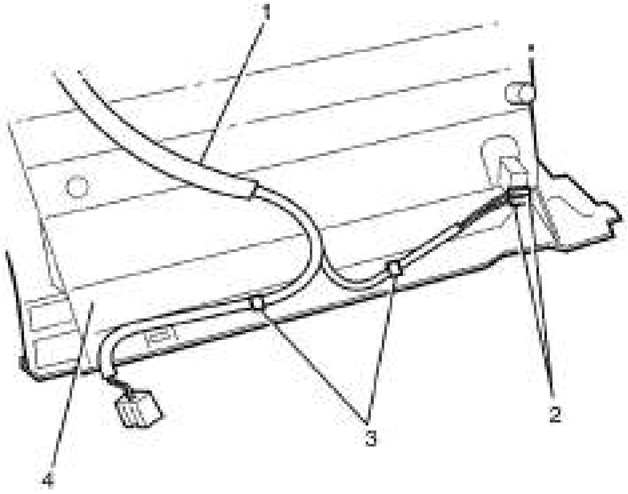
Important: Listen for audible click to confirm correct fitting

7. Install the I/P compartment lamp (3), where fitted, by pushing it through the I/P compartment (2).
8. Ensure the I/P compartment lamp retaining clip (1) is fully engaged.

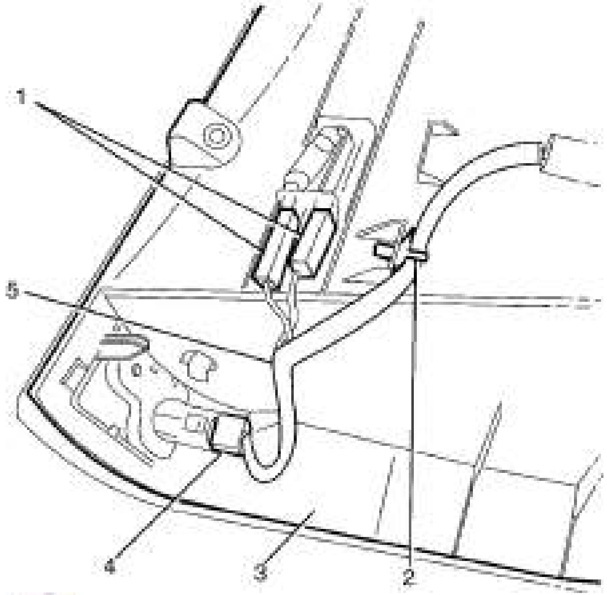


Important: When installing the rear compartment release button, take care not to damage the retaining clips (1).

9. Install the rear compartment release button (2), where fitted, to the I/P compartment (3), listen for an audible click to confirm fitting.

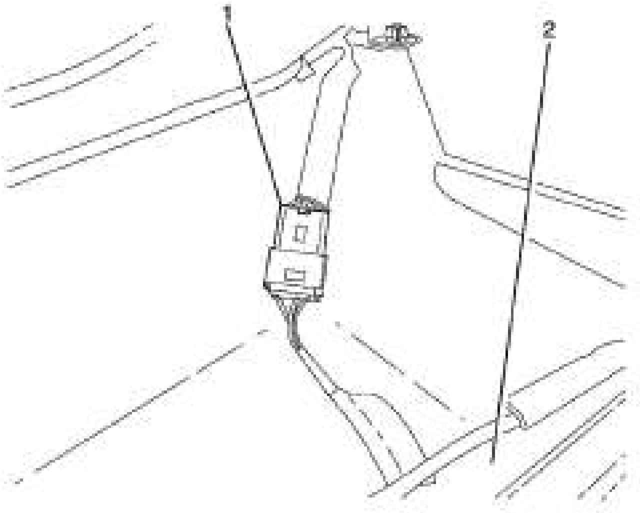


10. Position the I/P compartment wiring harness (1) to the I/P compartment (4).
11. Attach the I/P compartment wiring harness retaining clips (3).
12. Connect the I/P compartment lamp switch electrical connectors (2), where fitted.

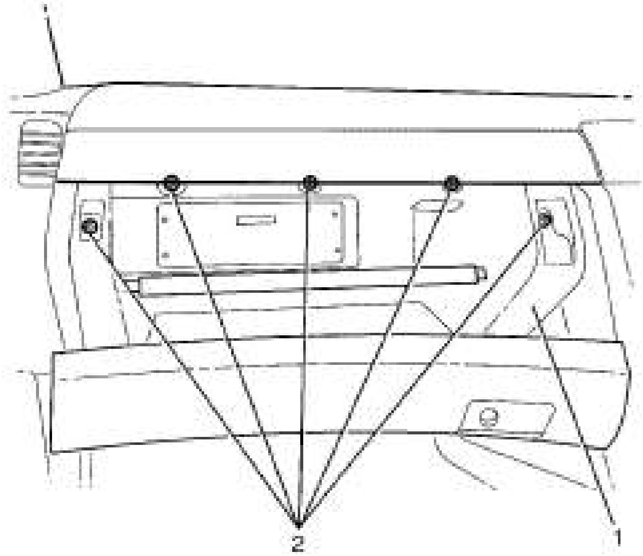


13. Position the I/P compartment harness (5) and attach the I/P compartment wiring harness retaining clip (2) to the I/P compartment (3).
14. Connect the rear compartment release button electrical connector (4), where fitted.
15. Connect the I/P compartment lamp electrical connectors (1), where fitted

Installation Procedure



1. Connect the I/P compartment electrical connector (1) to the I/P compartment (2).

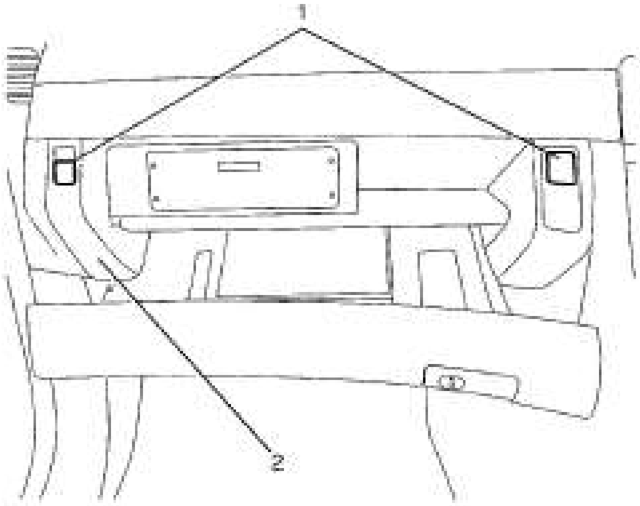


2. Install the I/P compartment (1).

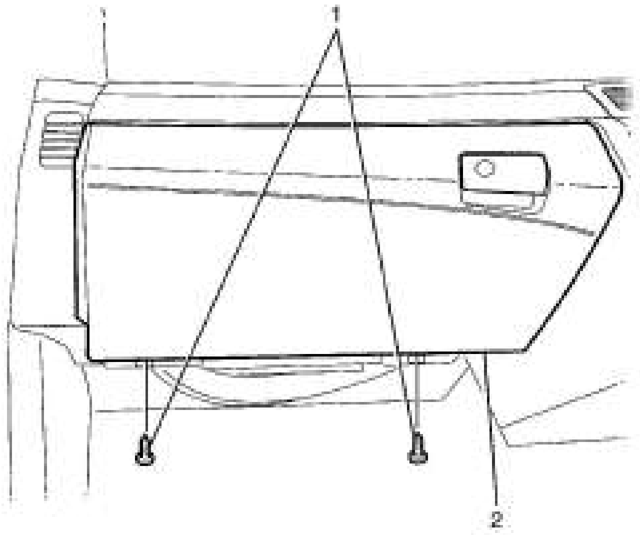
   Notice: Refer to Fastener Notice in the Preface section.

3. Install the I/P compartment upper retaining screws (2).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).



4. Install the I/P compartment retaining screw covers (1) to the I/P compartment (2)



5. Close the I/P compartment assembly door (2).
6. Install the I/P compartment lower retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).

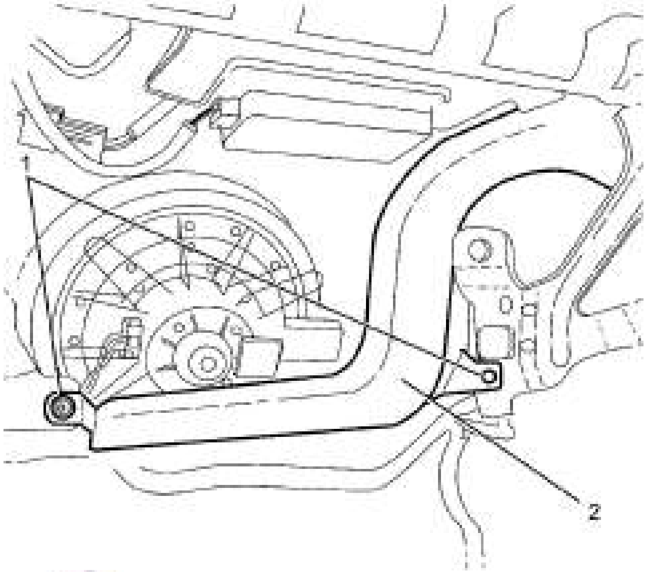
7. Install the instrument panel outer trim cover. Refer to Instrument Panel Outer Trim Cover Replacement.
8. Install the instrument panel insulator panel -- Left Side. Refer to Instrument Panel Insulator Panel Replacement - Right Side.
9. Test all electrical components for correct operation.

Instrument Panel Upper Trim Pad Replacement (RHD)

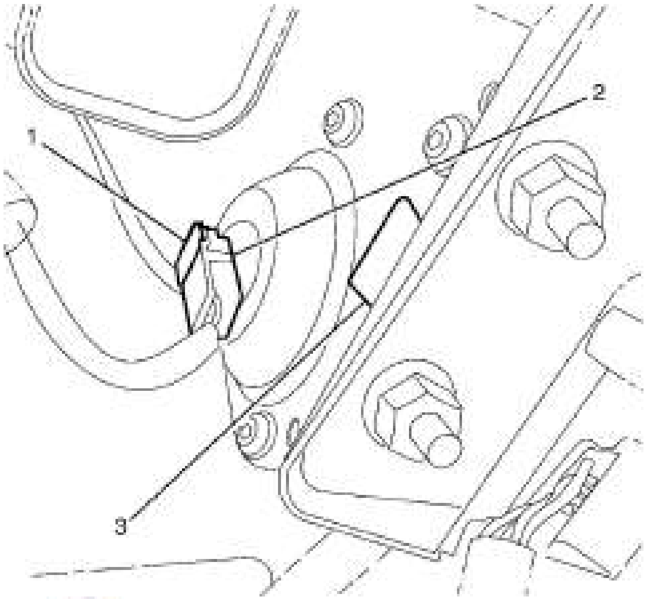
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

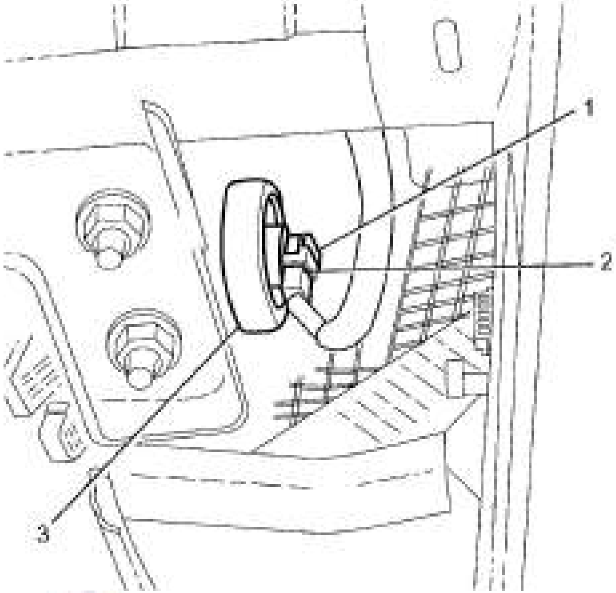
1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
2. Disable the SIR system. Refer to SIR Disabling and Enabling .
3. Remove the I/P compartment. Refer to Instrument Panel Compartment Replacement .
4. Remove the trim panel - (I/P) Upper. Refer to Instrument Panel Upper Trim Panel Replacement .
    - Trim Panel - (I/P) Upper : (with secondary information centre SIC)
    - Trim Panel - (I/P) Upper : (with multi function display)
5. Remove the outer trim covers. Refer to Instrument Panel Outer Trim Cover Replacement .
6. Remove the ventilation trim panel. Refer to Instrument Panel Side Trim Panel Replacement .
7. Remove the trim plate - console side. Refer to Console Trim Plate Replacement .
8. Remove the instrument panel trim panel. Refer to Instrument Panel Center Trim Panel Replacement .
9. Remove the instrument cluster. Refer to Instrument Cluster Replacement .
10. Remove the defroster grille. Refer to Defroster Grille Replacement .
11. Remove the knee bolster. Refer to Knee Bolster Replacement .
12. Remove the trim panel - I/P centre. Refer to Instrument Panel Center Trim Panel Replacement .
13. Remove the I/P centre speaker. Refer to Radio Front Speaker Replacement .



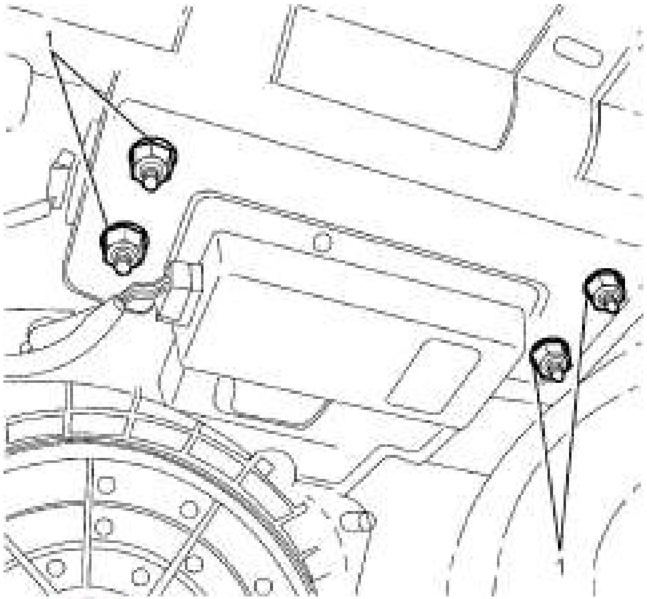
14. Remove the lower air duct (2) retaining clips (1).
15. Remove the lower air duct (2).



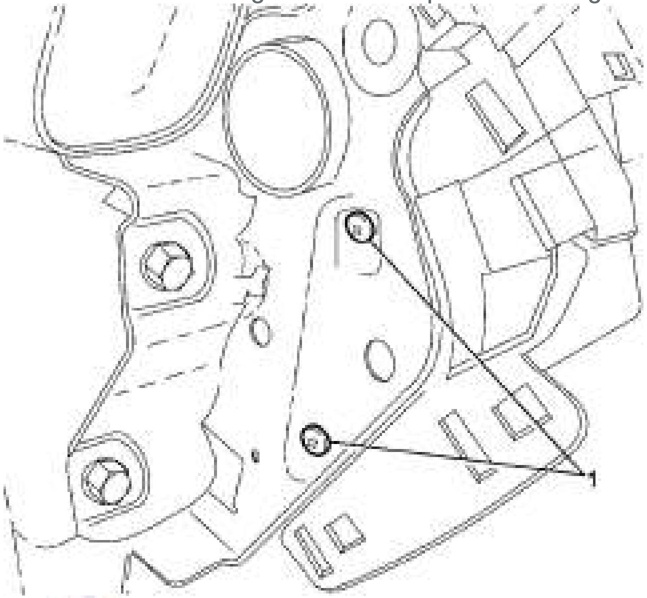
16. Release the air bag (3) electrical connector retaining clip (1) and disconnect the electrical connector (2).



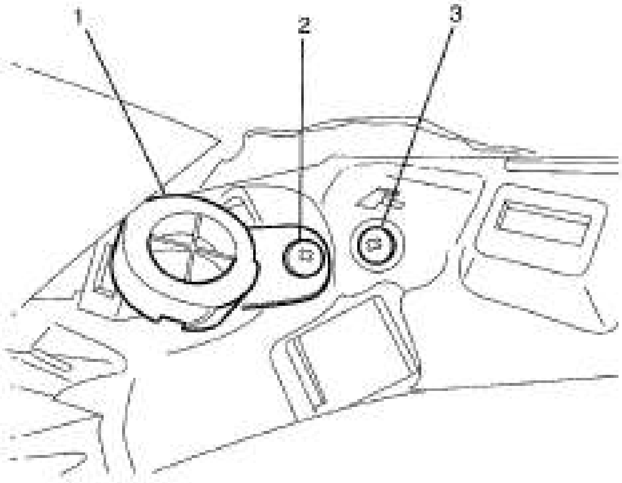
17. Release the air bag (3) electrical connector retaining clip (1) and disconnect the electrical connector (2).



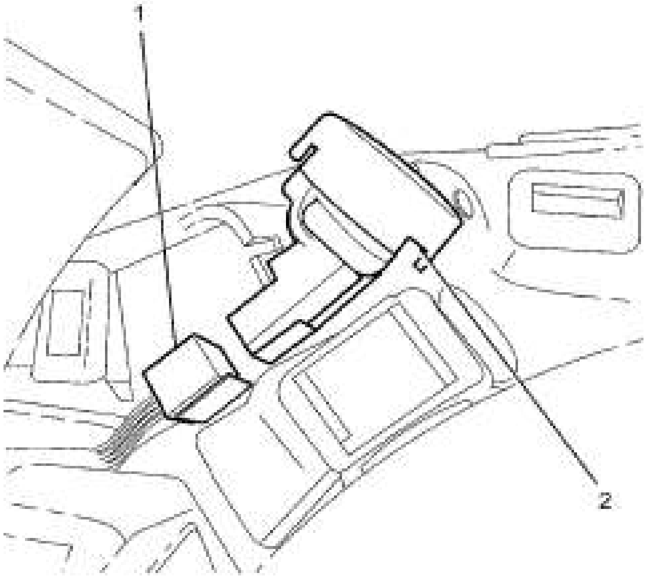
18. Remove the air bag to I/P trim pad retaining nuts (1).



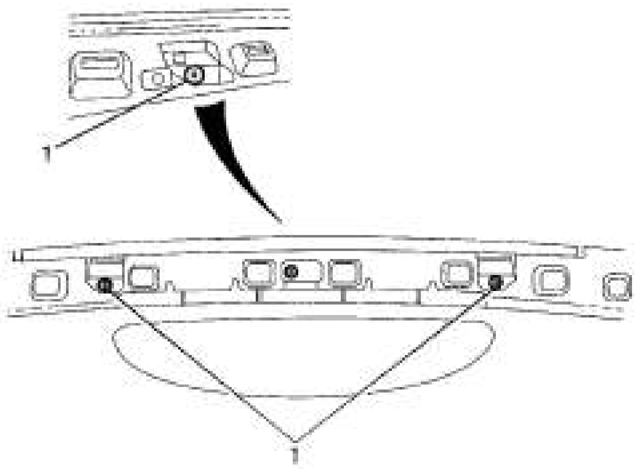
19. Remove the I/P carrier to I/P pad outer retaining screws (1).



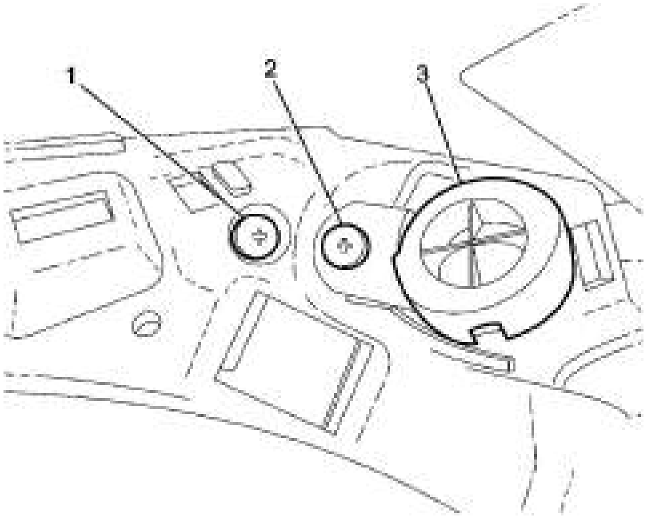
20. Remove the left hand tweeter (1) to I/P pad retaining screw (2).
21. Remove the I/P pad retaining screw (3).



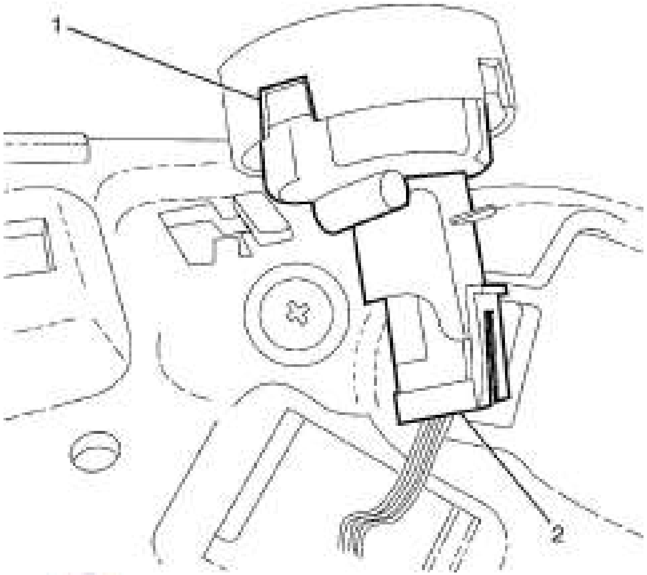
22. Disconnect the left hand tweeter (2) electrical connector (1).
23. Remove the left hand tweeter (2).



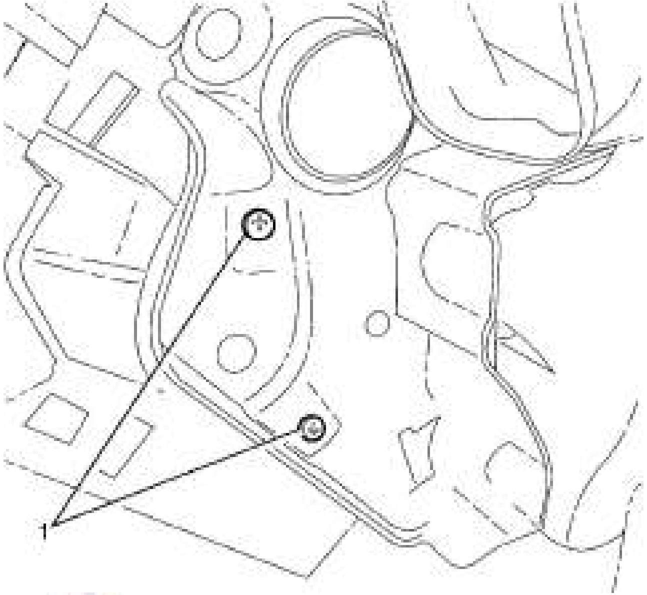
24. Remove the top I/P pad to I/P carrier retaining screws (1).



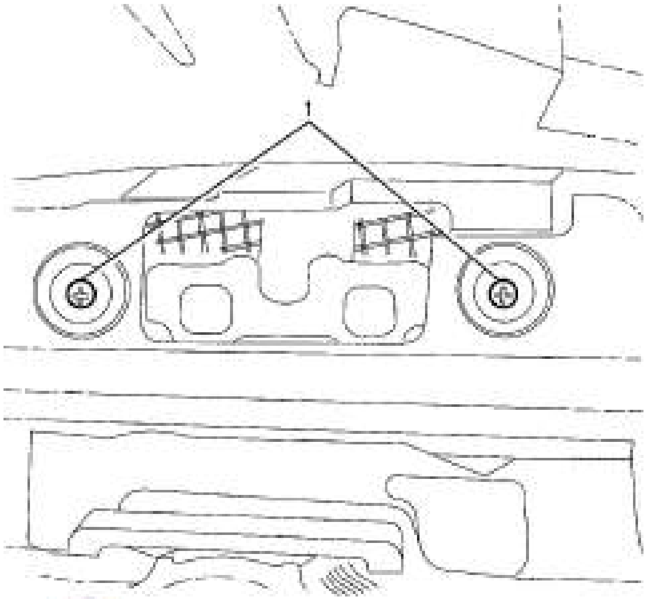
25. Remove the right hand tweeter (3) to I/P pad retaining screw (2).
26. Remove the I/P pad to I/P carrier retaining screw (1).



27. Disconnect the right hand tweeter (1) electrical connector (2).
28. Remove the right hand tweeter (1).

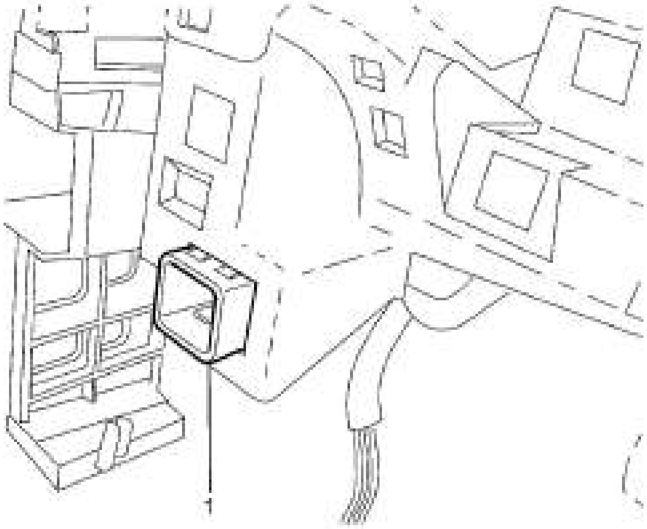


29. Remove the I/P carrier to I/P pad outer retaining screws (1).

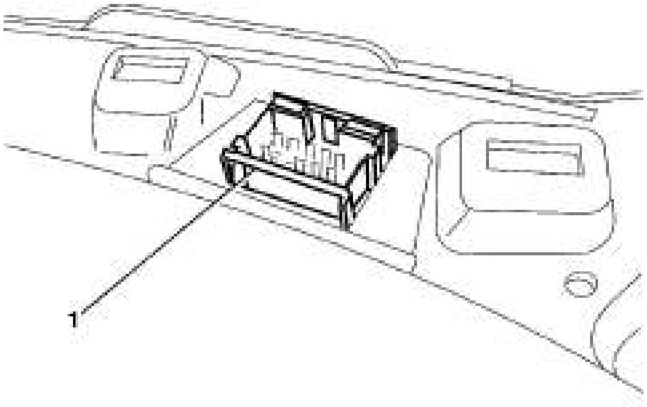


30. Remove the Instrument cluster housing to I/P pad retaining screws (1).

Notice: Refer to General Repair Instructions in the Preface section.



31. Remove the centre console fresh air vent outlet (1).



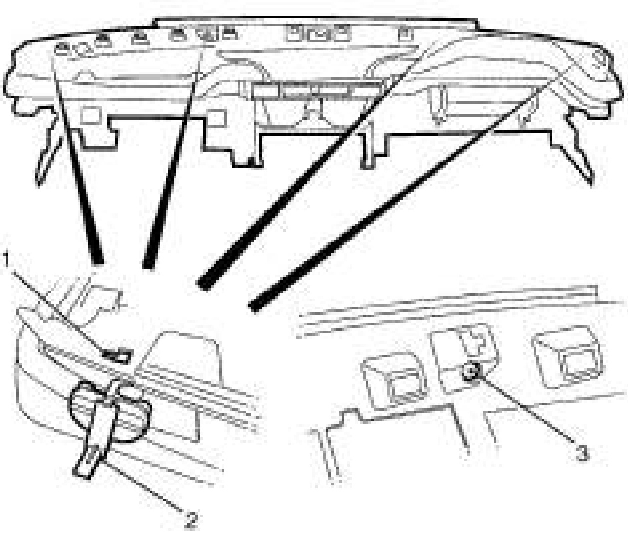
32. Detach the headliner main wiring harness connector (1).

    Important: The removal of the I/P pad must be done with the aid if an assistant under no circumstances must it be removed by one person.

33. Remove the I/P pad.
34. Remove datum four pins from vehicle.

Installation Procedure

1. Place the I/P pad on a clean and suitable work surface.

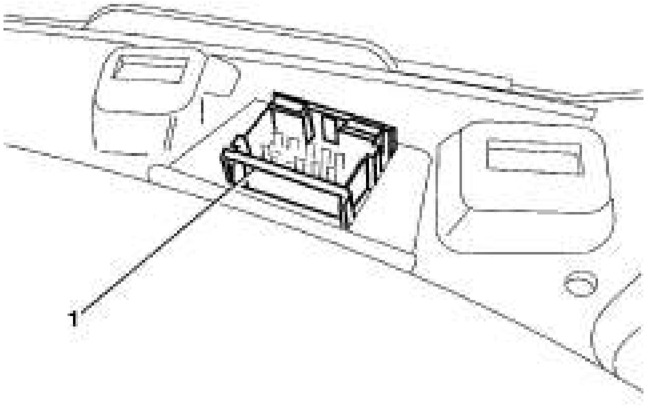


2. Install the four datum pins (2) to the I/P pad (1).
3. Secure the datum pins (2) using the datum pin retaining screws (3).

Tighten
Tighten the screws (3) to 2 N·m (18 lb in).

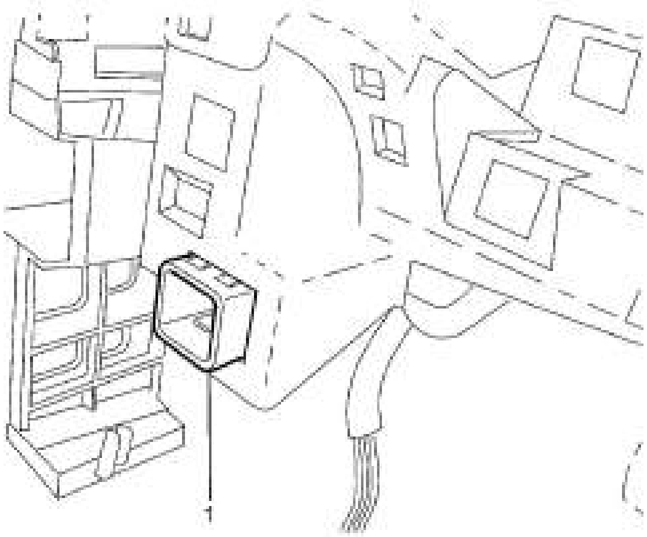
Important: Before installing the I/Ppad, ensure all electrical connectors are correctly positioned.

4. Install the I/P pad to the vehicle.



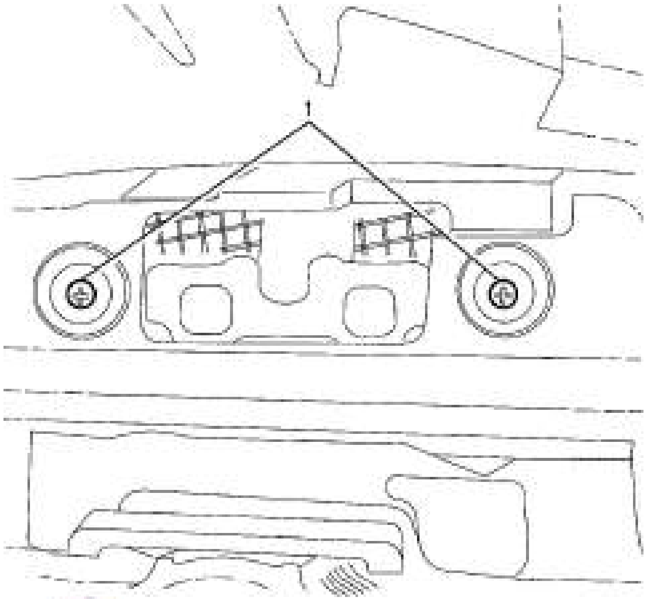
Headliner main harness connector: If difficulty is found securing the harness connector to the I/P pad, bring the I/P pad towards the steering wheel to gain access.

5. Secure the headliner main wiring harness connector (1).



6. Install the centre console fresh air vent outlet (1).

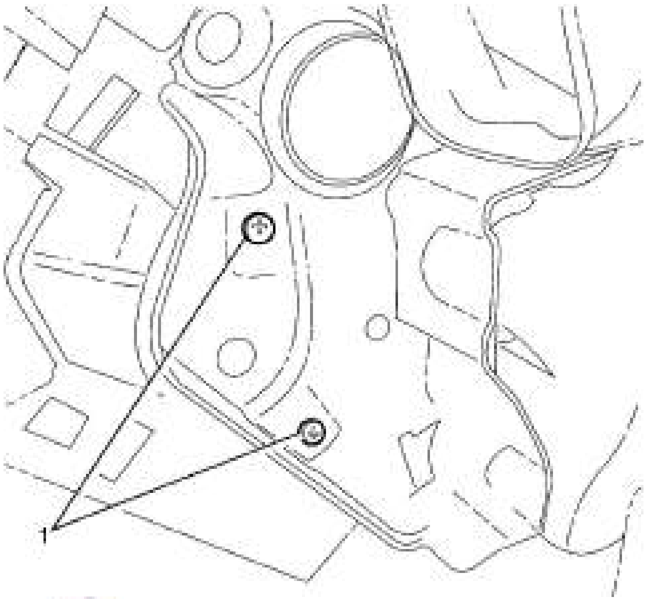
Notice: Refer to Fastener Notice in the Preface section.



7. Install the Instrument cluster to I/P pad retaining screws (1).

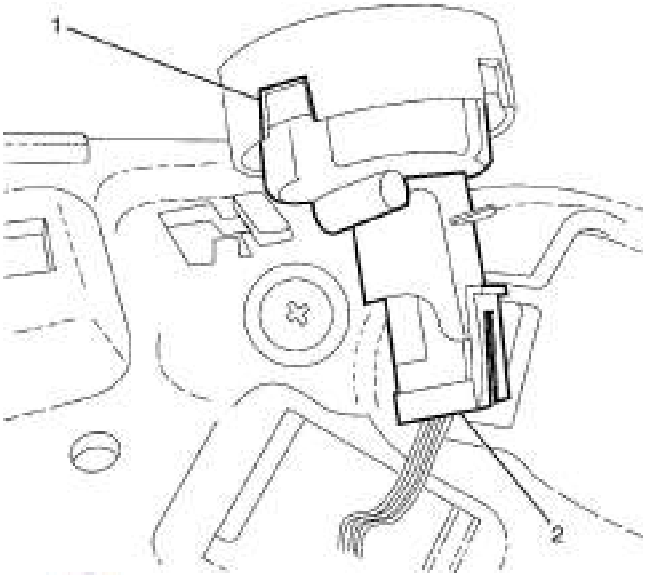
Tighten
Tighten the screws (1) to 2 N·m (18 lb in).

Notice: Refer to Fastener Notice in the Preface section.



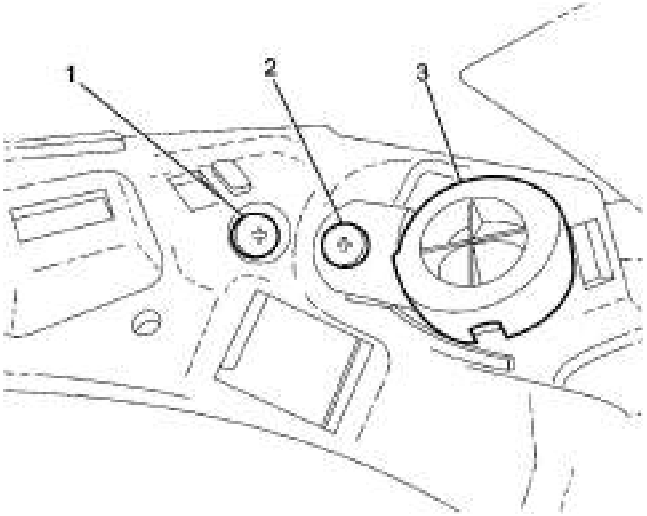
8. Install the I/P carrier to I/P pad outer retaining screws (1).

Tighten
Tighten the screws (1) to 2 N·m (18 lb in).



9. Connect the right hand tweeter (1) electrical connector (2).
10. Install the right hand tweeter (2).

Notice: Refer to Fastener Notice in the Preface section.



11. Install the right hand tweeter (3) to I/P pad retaining screw (2).

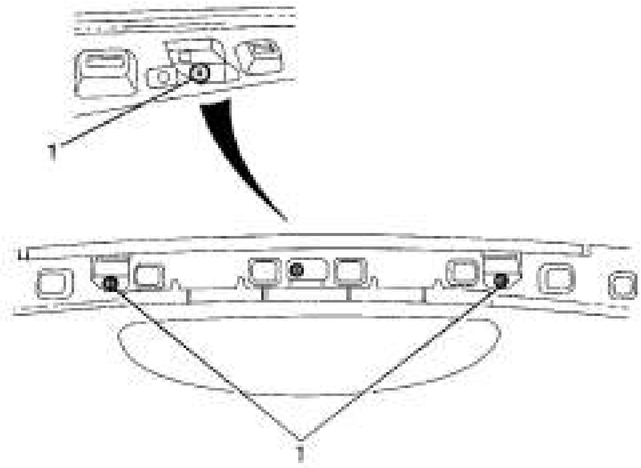
Tighten

Tighten the screws (2) to 2 N·m (18 lb in).

12. Install the I/P pad to I/P carrier retaining screw (1).

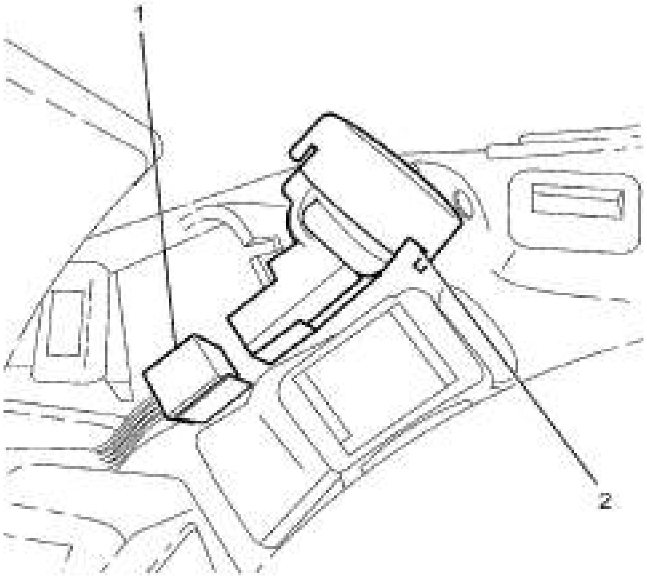
Tighten
Tighten the screws (1) to 2 N·m (18 lb in).

Notice: Refer to Fastener Notice in the Preface section.



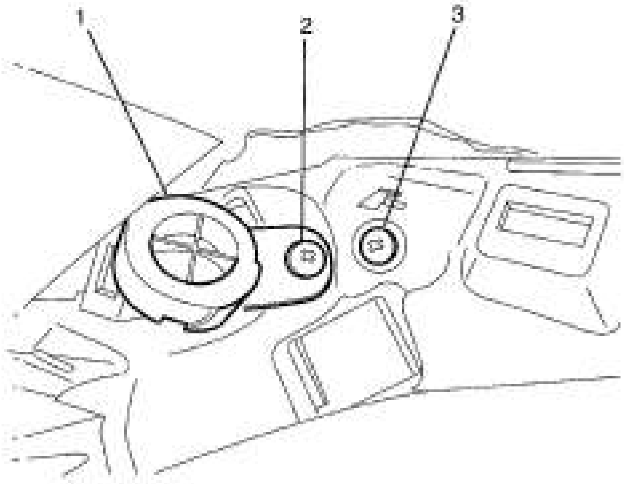
13. Install the top I/Ppad to I/P carrier retaining screws (1).

Tighten
Tighten the screws (1) to 2 N·m (18 lb in).



14. Connect the left hand tweeter (2) electrical connector (1).
15. Install the left hand tweeter (2).

Notice: Refer to Fastener Notice in the Preface section.



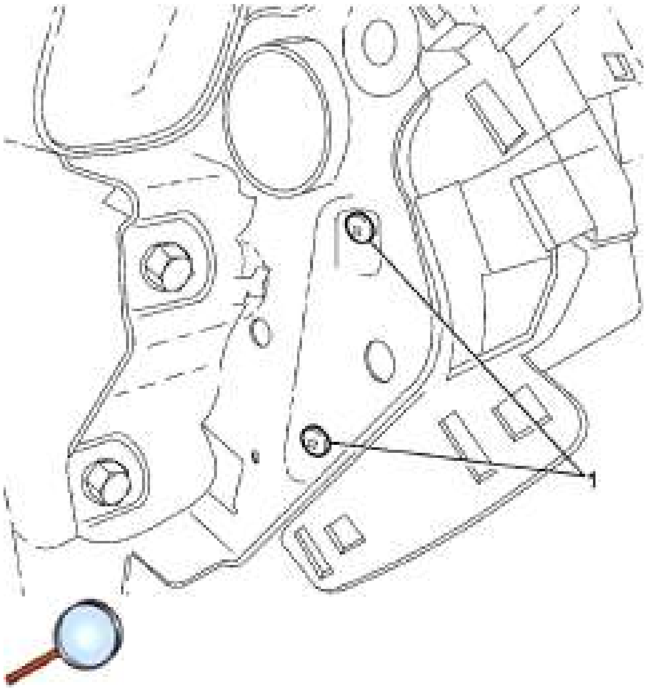
16. Install the left hand tweeter (1) to I/P pad retaining screw (2).

Tighten
Tighten the screw (2) to 2 N·m (18 lb in).

17. Install the I/P pad retaining screw (3).

Tighten
Tighten the screws (3) to 2 N·m (18 lb in).

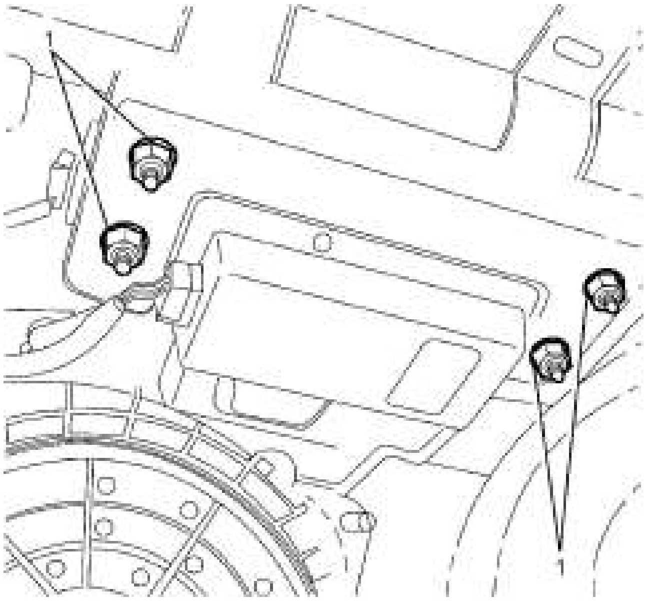
Notice: Refer to Fastener Notice in the Preface section.



18. Install the I/P carrier to I/P pad outer retaining screws (1).

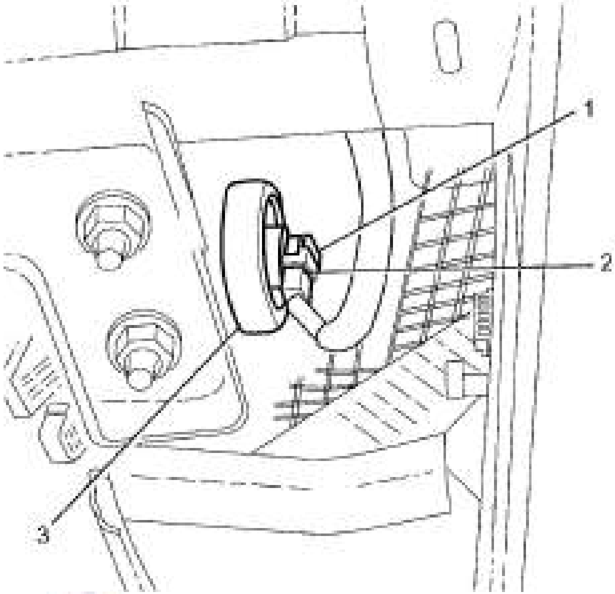
Tighten
Tighten the screws (1) to 2 N·m (18 lb in).

Notice: Refer to Fastener Notice in the Preface section.

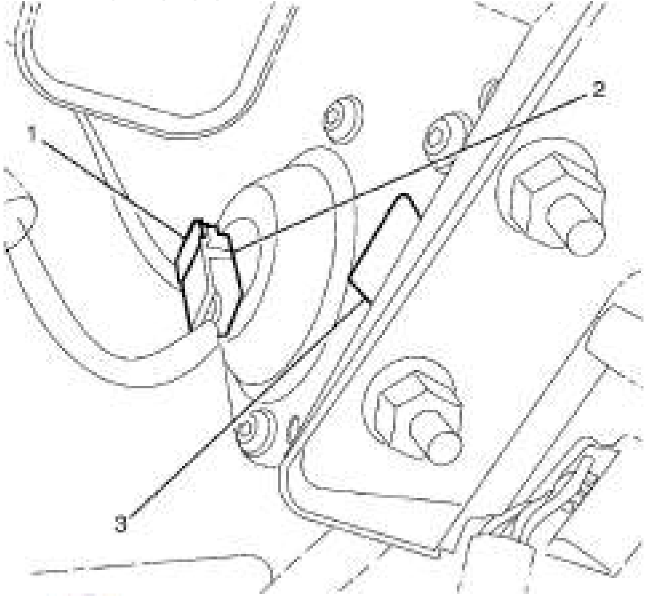


19. Install the air bag to I/P trim pad retaining nuts (1).

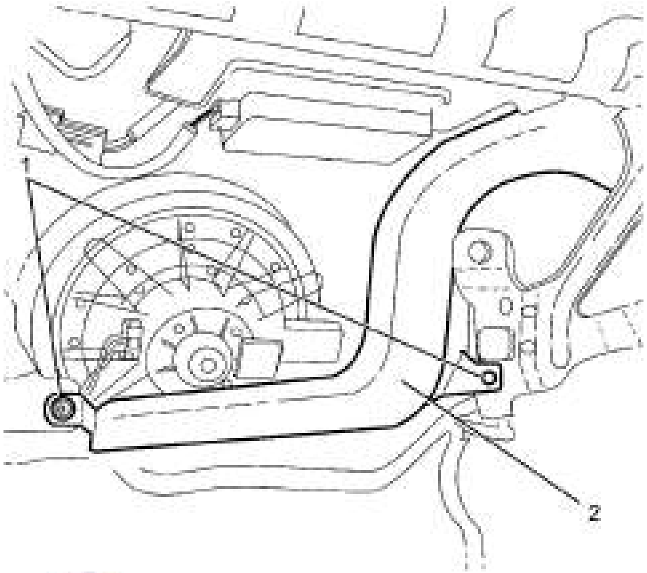
Tighten
Tighten the nuts to 16 N·m (12 lb ft).



20. Install the air bag (3) electrical connector (2) and secure by inserting the electrical connector retaining clip (1).



21. Install the air bag (3) electrical connector (2) and secure by inserting the electrical connector retaining clip (1).



22. Install the lower air duct (2).
23. Install the lower air duct (2) retaining clip (1).
24. Install the I/P centre speaker. Refer to Radio Front Speaker Replacement .
25. Install the trim panel - I/P centre. Refer to Instrument Panel Center Trim Panel Replacement .
26. Install the knee bolster. Refer to Knee Bolster Replacement .
27. Install the defroster grille. Refer to Defroster Grille Replacement .
28. Instal the instrument cluster. Refer to Instrument Cluster Replacement .
29. Install the instrument panel trim panel. Refer to Instrument Panel Center Trim Panel Replacement .
30. Install the trim plate - console side. Refer to Console Trim Plate Replacement .
31. Install the ventilation trim panel. Refer to Instrument Panel Side Trim Panel Replacement
32. Install the outer trim covers. Refer to Instrument Panel Outer Trim Cover Replacement .
33. Install the trim panel - (I/P) Upper. Refer to Instrument Panel Upper Trim Panel Replacement .
    - Trim Panel - (I/P) Upper : (with secondary information centre SIC)
    - Trim Panel - (I/P) Upper : (with multi function display)
34. Install the I/P compartment. Refer to Instrument Panel Compartment Replacement .
35. Enable the SIR system. Refer to SIR Disabling and Enabling .
36. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
37. Test all electrical components for correct operation.

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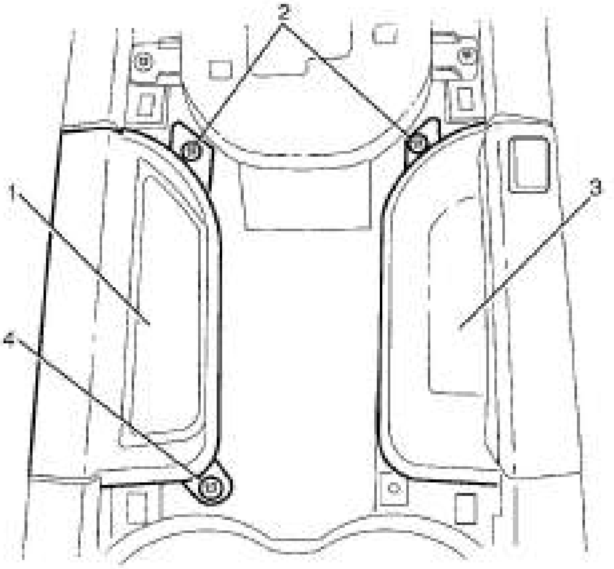
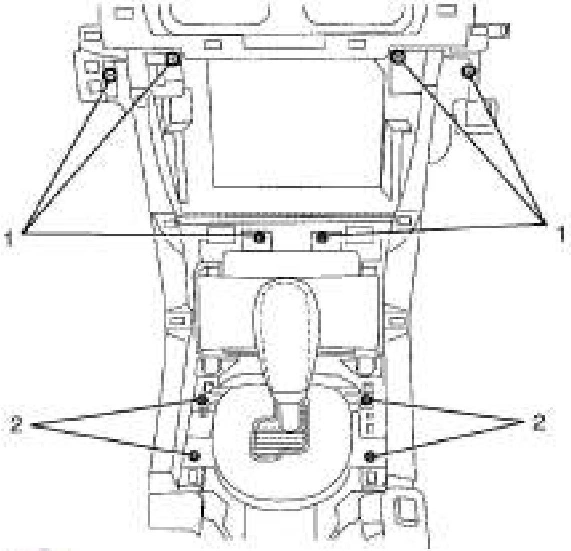
Instrument Panel Center Support Bracket Replacement

Removal Procedure

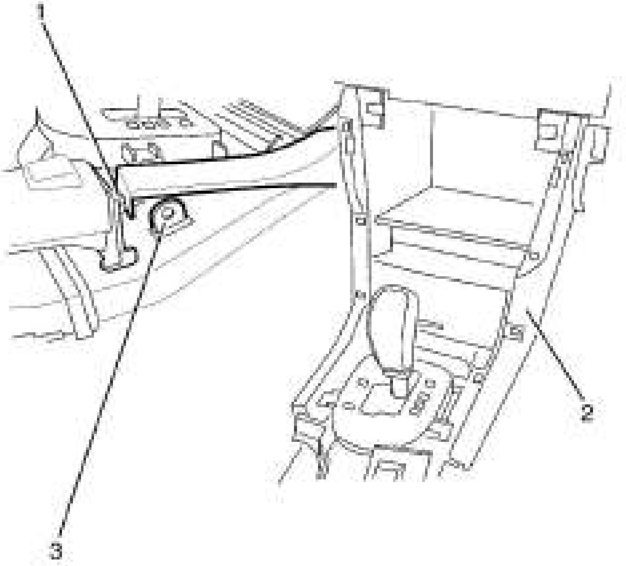
1. Remove the trim panel (I/P) centre. Refer to Instrument Panel Center Trim Panel Replacement .
2. Remove the trim plate. Refer to Instrument Panel Center Trim Panel Replacement .
3. Remove the radio. Refer to Radio Replacement .



4. Remove the coin holder upper retaining screws (2,4) and remove the coin holder (1).
5. Remove the park recess tray upper retaining screw (2) and remove the recess trim (3).

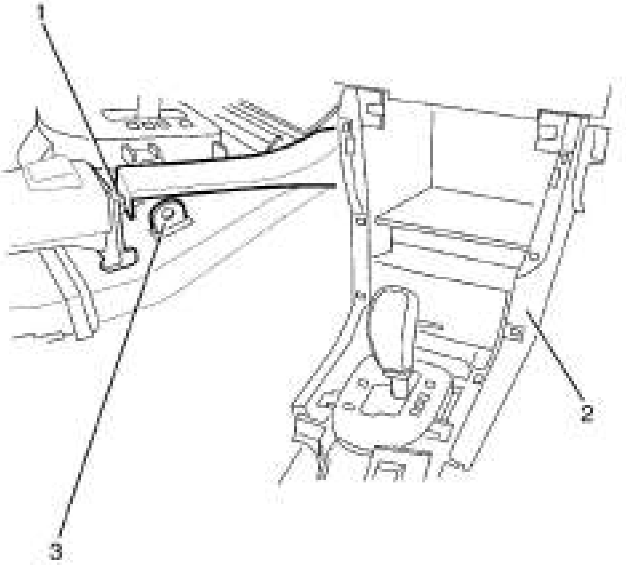


6. Remove the I/P bracket to I/P carrier retaining screws (1).
7. Remove the I/P bracket to centre console retaining screws (2).



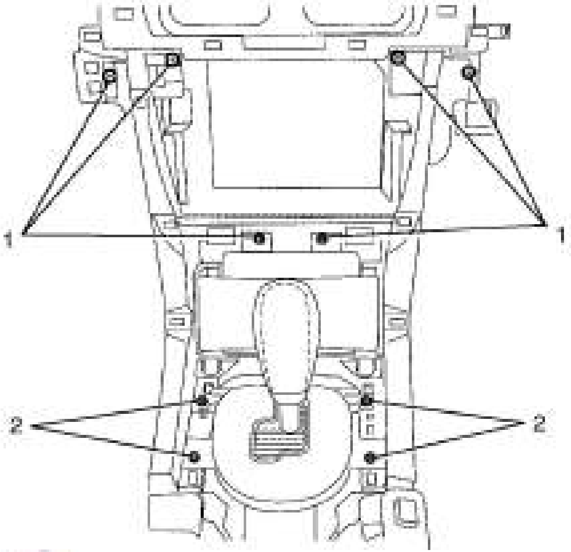
8. Remove the I/P bracket (2) to centre vent retaining clip (3).
9. Disengage the I/P bracket (2) from the centre console trim (1).
10. Carefully remove the I/P bracket (2) from the I/P carrier.

Installation Procedure



1. Install the I/P bracket into the I/P tower.
2. Carefully engage the I/P bracket (2) into the centre console trim (1).
3. Install the I/P bracket (2) to centre vent retaining clip (3).

Notice: Refer to Fastener Notice in the Preface section.



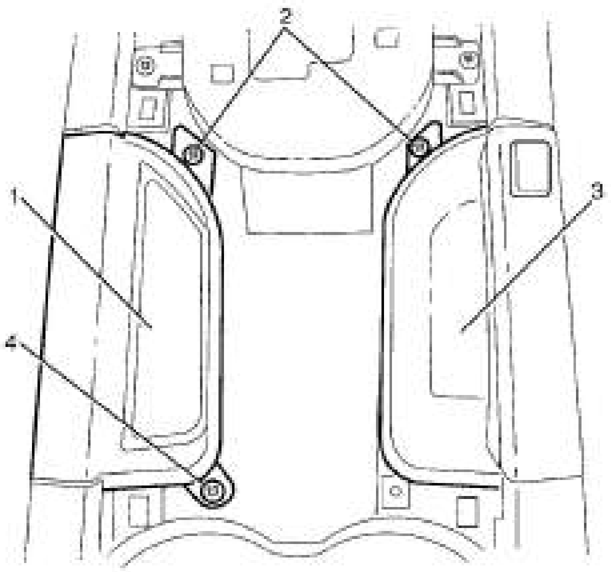
4. Install the I/P bracket to centre console retaining screws (2).

   Tighten
   Tighten the screws (1) to 2 N·m (18 lb in).

5. Install the I/P bracket to I/P carrier retaining screws (1).

   Tighten
   Tighten the screws (1) to 2 N·m (18 lb in).

   Notice: Refer to Fastener Notice in the Preface section.



6. Install the coin holder upper retaining screws (2,4) and remove the coin holder (1).

   Tighten
   Tighten the screws (2,4) to 2 N·m (18 lb in).

7. Install the park recess (3) tray upper retaining screw (2).

   Tighten
   Tighten the screws (1) to 2 N·m (18 lb in).

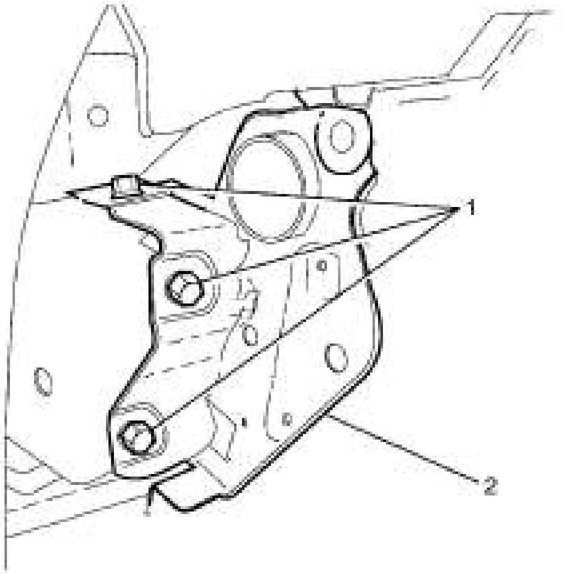
8. Install the radio. Refer to Radio Replacement .
9. Install the trim plate. Refer to Console Trim Plate Replacement .
10. Install the trim panel (I/P) centre. Refer to Instrument Panel Center Trim Panel Replacement .
11. Ensure all trims are fitted correctly and are flush with the corresponding trims.

Instrument Panel Carrier Replacement

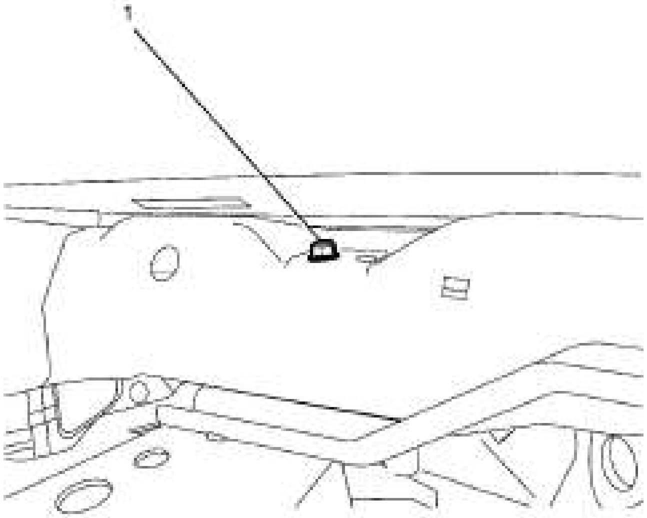
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

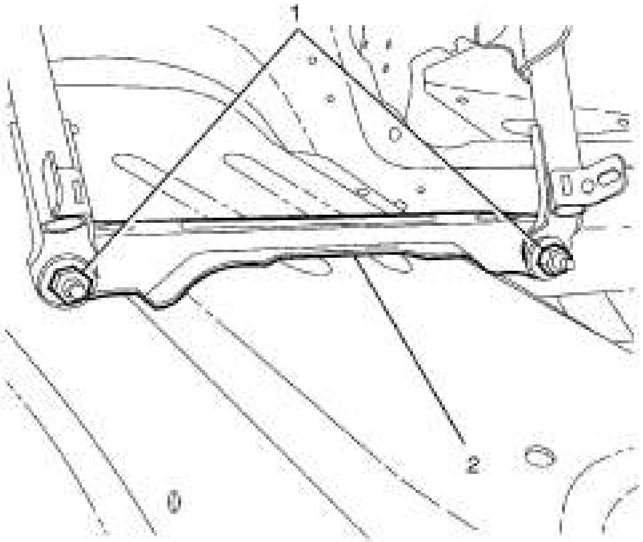
1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the trim pad - (I/P) Upper. Refer to Instrument Panel Upper Trim Pad Replacement in Instrument Panel, Gages, and Console.
3. Remove the floor console. Refer to Front Floor Console Replacement.



4. Remove the I/P carrier (2) to A - pillar retaining bolts (1) the left side is shown the right side is the same.



5. Remove the upper I/P carrier to body panel retaining bolts (1) located at the top of the I/P carrier under the windshield.



6. Remove the lower I/P carrier (2) to transmission tunnel bracket retaining bolts (1).

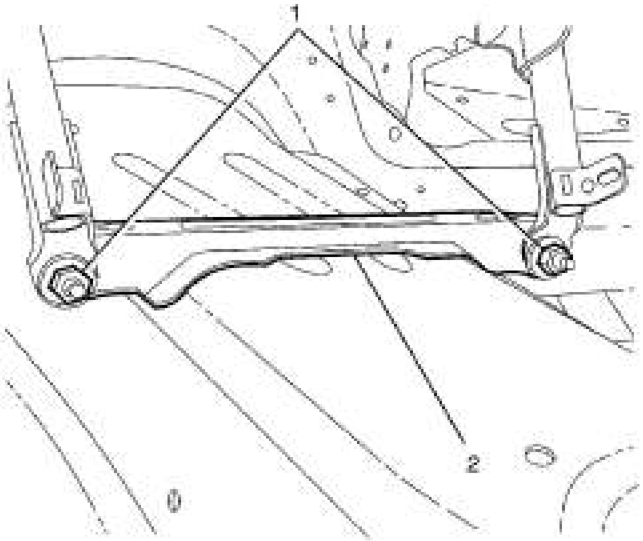
Important: When detaching the I/P wiring harness, make sure the I/P harness is attached as removed.

7. Detach the I/P electrical wiring harness.
8. Carefully remove the I/P carrier from the vehicle.

Installation Procedure

1. Carefully install the I/P carrier to the vehicle.
2. Attach the I/P electrical wiring harness the I/P carrier.

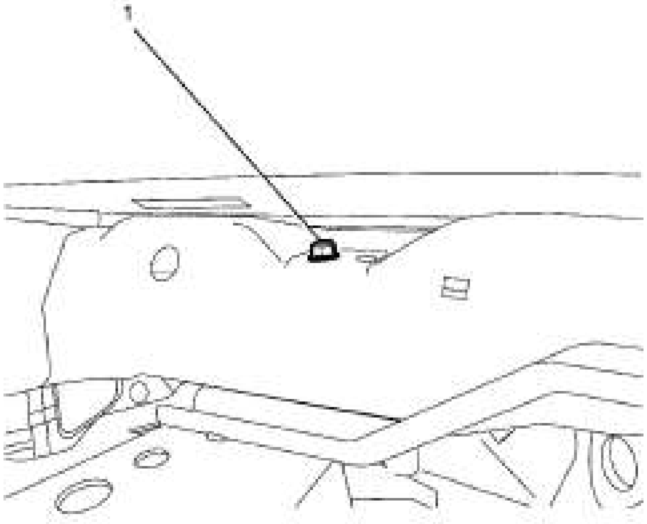
Notice: Refer to Fastener Notice in the Preface section.



3. Install the lower I/P carrier (2) to transmission tunnel bracket retaining bolts (1).

   Tighten
   Tighten the nuts to 30 N·m (22 lb ft).

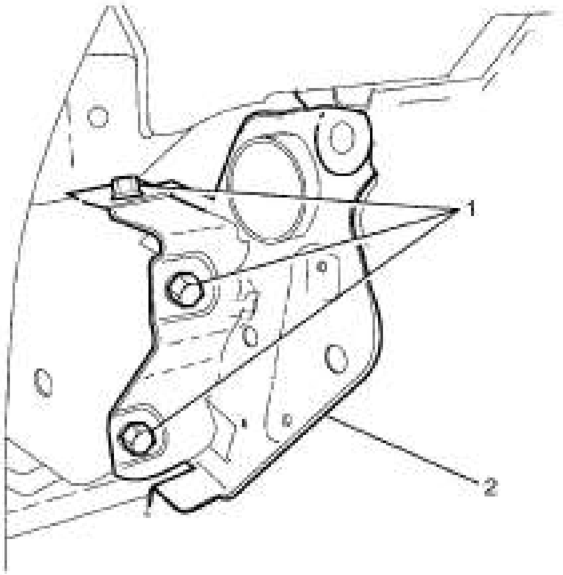
   Notice: Refer to Fastener Notice in the Preface section.



4. Install the upper I/P carrier to body panel retaining bolts (1).

   Tighten
   Tighten the bolts to 32 N·m (24 lb ft).

Notice: Refer to Fastener Notice in the Preface section.



5. Install the I/P carrier (2) to A - pillar retaining bolts (1).

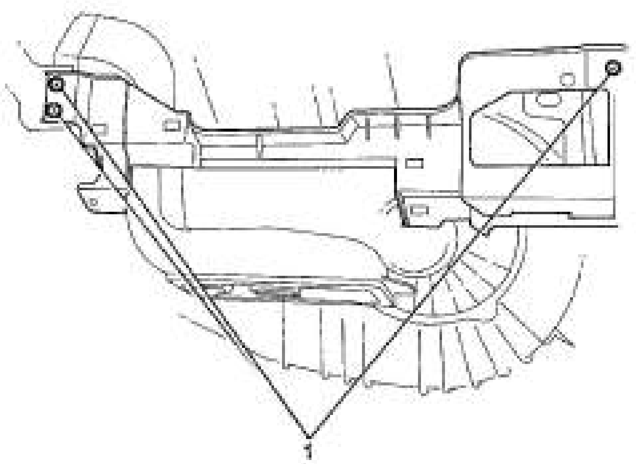
   Tighten
   Tighten the bolts to 37 N·m (27 lb ft).

6. Install the centre console. Refer to Front Floor Console Replacement.
7. Install the trim pad - (I/P) Upper. Refer to Instrument Panel Upper Trim Pad Replacement in Instrument Panel, Gages, and Console.
8. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.
9. Test all electrical components for correct operation.

Instrument Panel Retainer Replacement

Removal Procedure

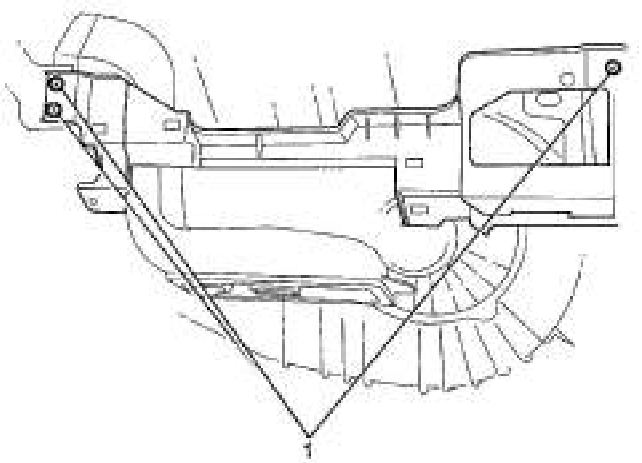
1. Remove the knee bolster. Refer to Knee Bolster Replacement .
2. Remove the right close out panel. Refer to Instrument Panel Insulator Panel Replacement - Right Side .
3. Remove the hood release handle. Refer to Hood Primary Latch Release Cable Replacement .



Important: The right side is shown, the left side is similar.

4. Remove the I/P retainer to I/P carrier retaining screws (1).
5. Remove the I/P retainer.

Installation Procedure



1. Align the I/P retainer to the I/P carrier.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the I/P retainer to I/P carrier retaining screws (1).

   Tighten
   Tighten the screws (1) to 2 N·m (18 lb in).

3. Install the hood release handle. Refer to Hood Primary Latch Release Cable Replacement .
4. Install the right close out panel. Refer to Instrument Panel Insulator Panel Replacement - Right Side .
5. Install the knee bolster. Refer to Knee Bolster Replacement .

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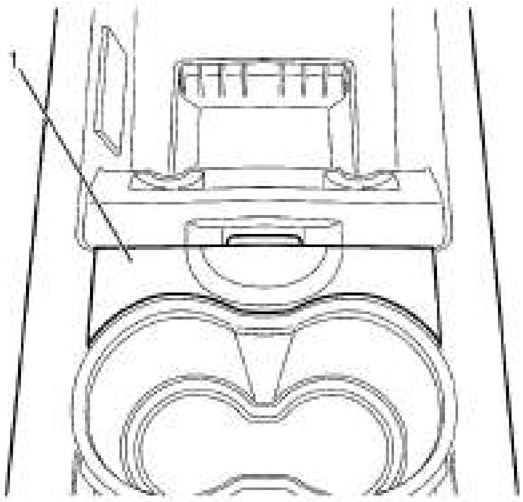
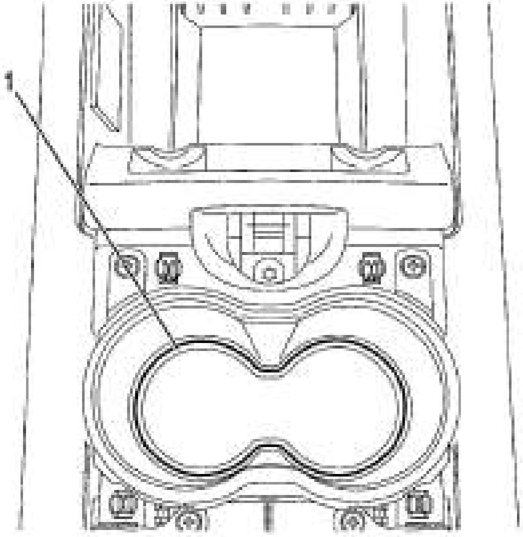
Front Floor Console Cup Holder Replacement

Removal Procedure (Up to 17 Sept 2007)

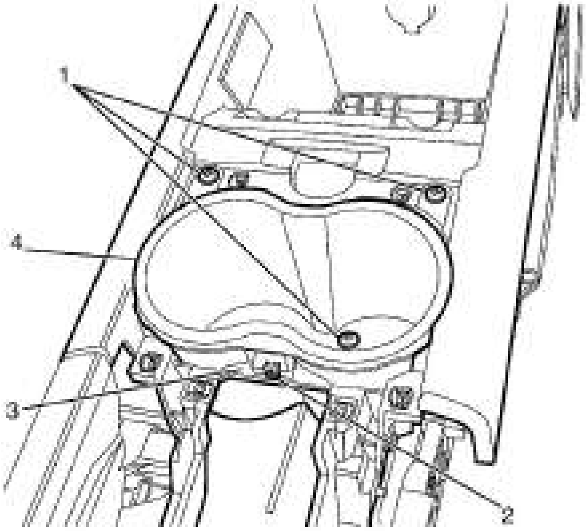
1. Remove the centre console trim plate. Refer to Console Trim Plate Replacement .



2. Using a suitable tool carefully remove cupholder trim (1) by disengaging the retaining clips.

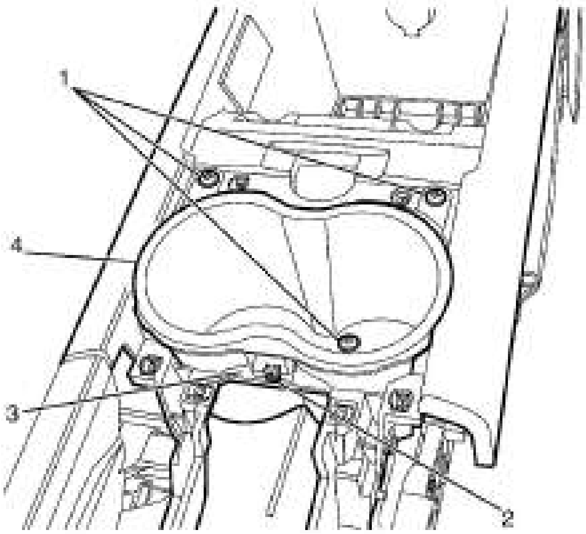


3. Remove the cupholder mat (1) located at the base of the cupholder.



4. Remove the cupholder (4) retaining screws (1).
5. Remove the cupholder (4) from the centre console (3) by releasing the retaining lug (2) and lifting upwards.

Installation Procedure (Up to 17 Sept 2007)

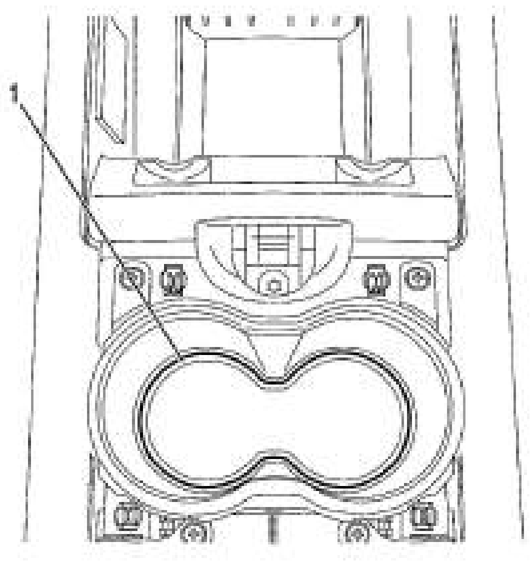


1. Install the cupholder (4) into the centre console (3) listen for an audible click from the retaining lug (2) to confirm fitting.

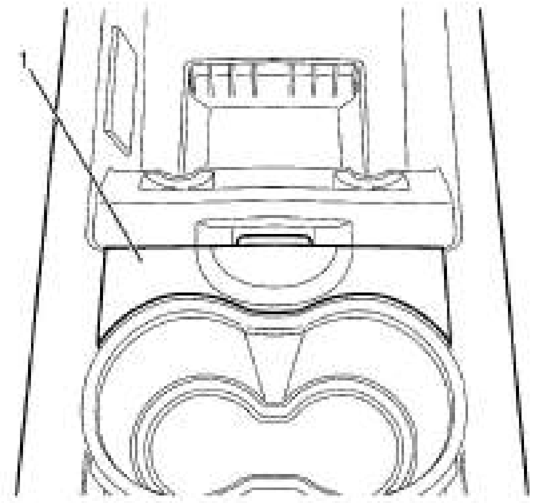
   Notice: Refer to Fastener Notice in the Preface section.

2. Install the cupholder to centre console retaining screws (1).

Tighten
Tighten the screws (1) to 2 N·m (18 lb in).



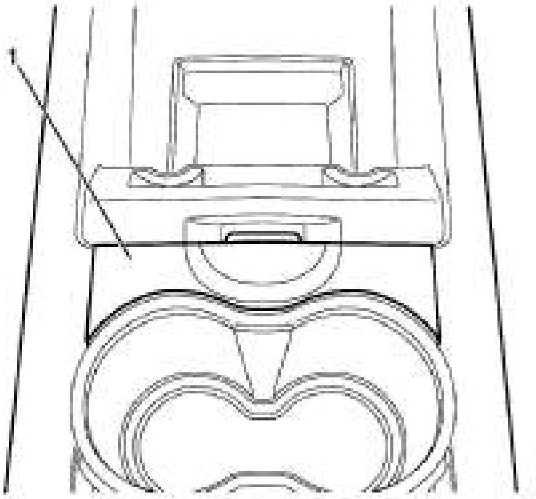
3. Install the cupholder mat (1).



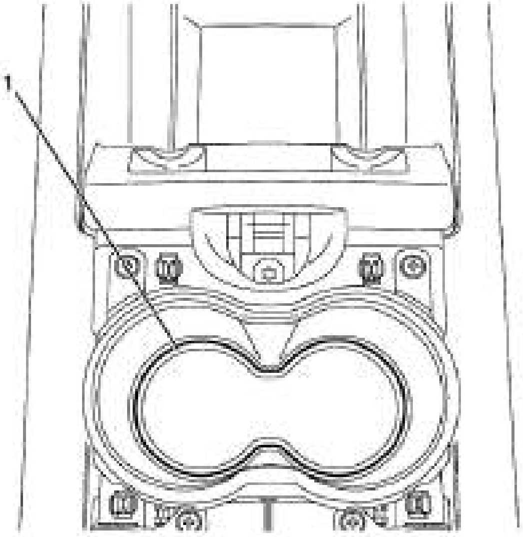
4. Install the cup holder trim (1) by firmly engaging the retaining clips.
5. Install the centre console trim plate. Refer to Console Trim Plate Replacement .

Removal Procedure (From 17 Sept 2007)

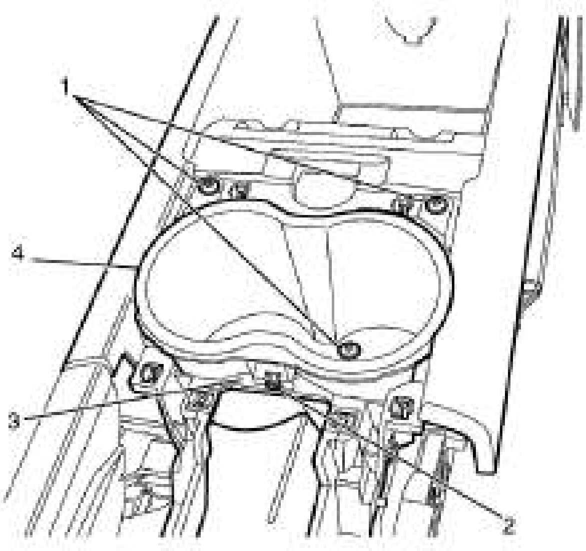
1. Remove the centre console trim plate. Refer to Console Trim Plate Replacement .



2. Using a suitable tool carefully remove the cupholder trim (1) by disengaging the retaining clips.

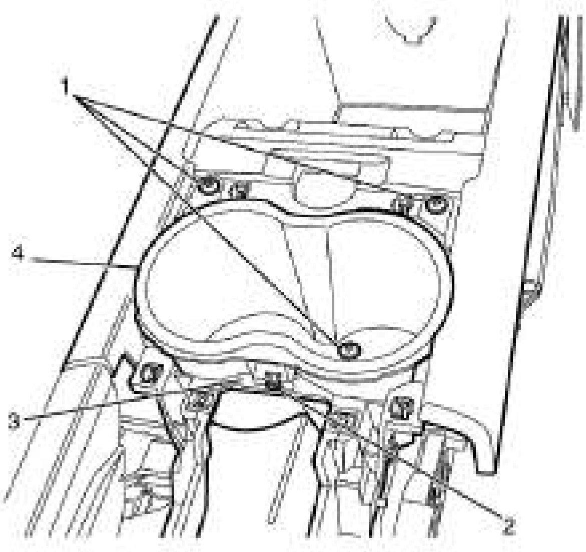


3. Remove the cupholder mat (1) located at the base of the cupholder.



4. Remove the cupholder to centre console retaining screws (1).
5. Remove the cupholder (4) from the centre console (3) by releasing the retaining lug (2) and lifting upwards.

Installation Procedure (From 17 Sept 2007)



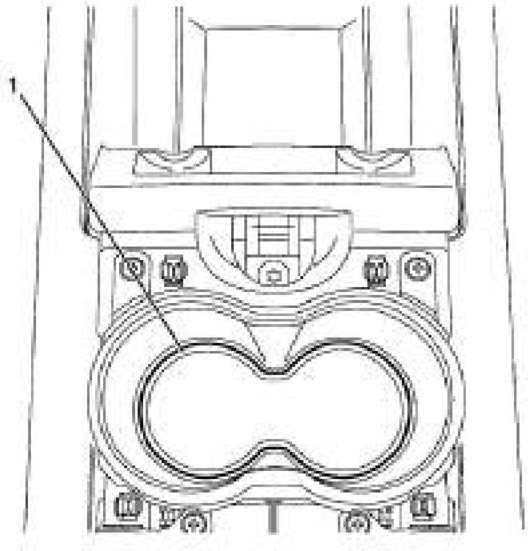
Important: Listen for an audible click from the retaining lug (2) to confirm fitting.

1. Install the cupholder (4) into the centre console (3)

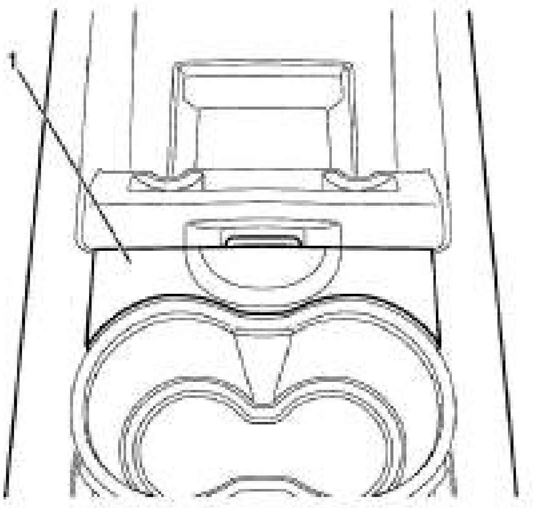
Notice: Refer to Fastener Notice in the Preface section.

2. Install the cupholder to centre console retaining screws (1).

Tighten
Tighten the screws to 2 N·m (18 lb in).



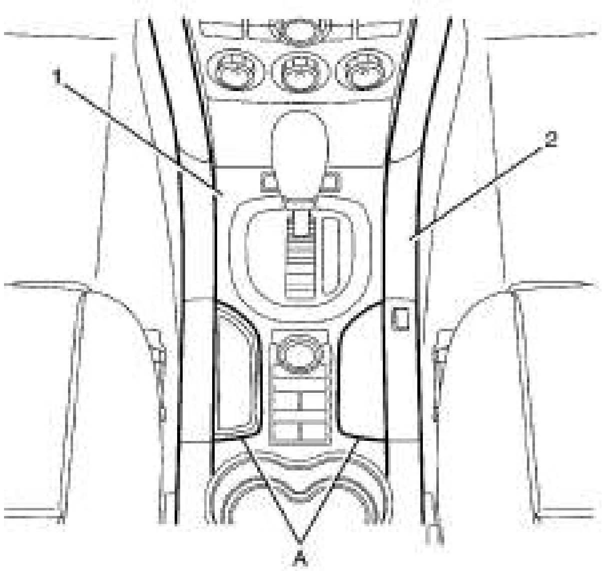
3. Install the cupholder mat (1).



4. Install the cup holder trim (1) by firmly engaging the retaining clips.
5. Install the centre console trim plate. Refer to Console Trim Plate Replacement .

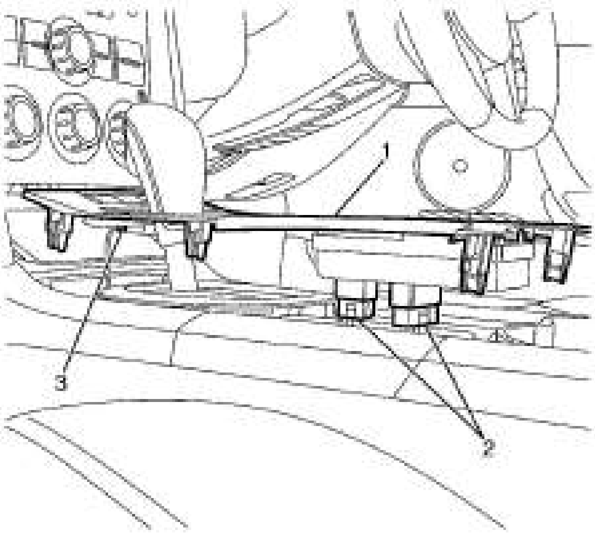
Console Trim Plate Replacement

Removal Procedure



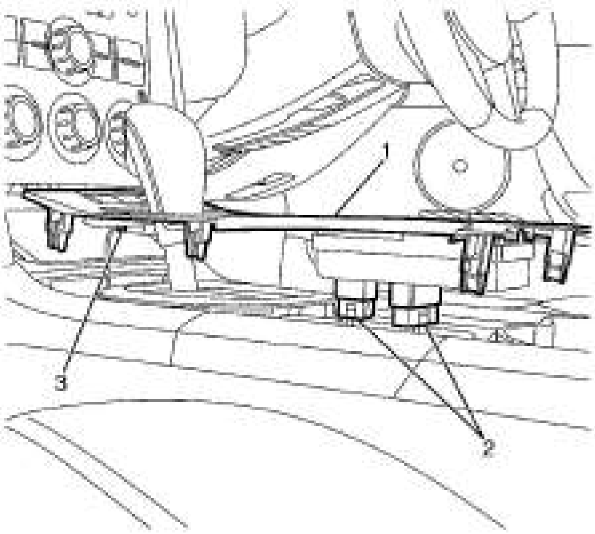
Important: The front floor console front cover (1) is retained by clips.

1. Grasp the front floor console front cover (1) at (A) and pull upwards to disengage the retaining clips from the floor console (2).

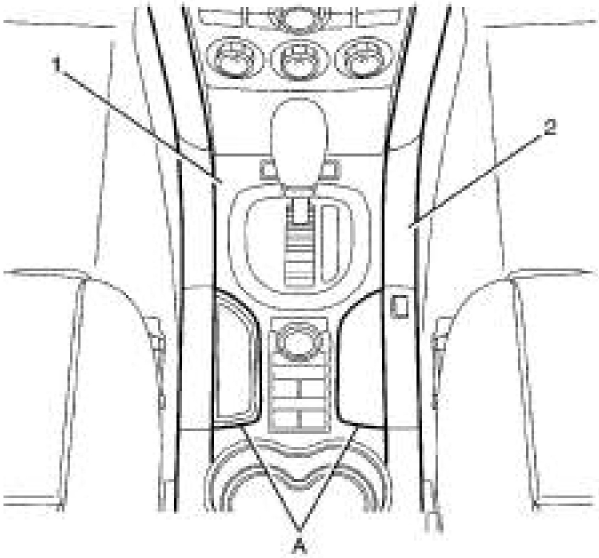


2. Disconnect the window and exterior mirror switch electrical connector (2).
3. Disconnect the Traction Control/ESP and Power switch (if fitted) electrical connectors (3).
4. Remove the front floor console front cover (1).

Installation Procedure



1. Connect the Traction Control/ESP and Power switch (if fitted) electrical connectors (3).
2. Connect the window and exterior mirror switch electrical connectors (2).
3. Install the front floor console front cover (1).

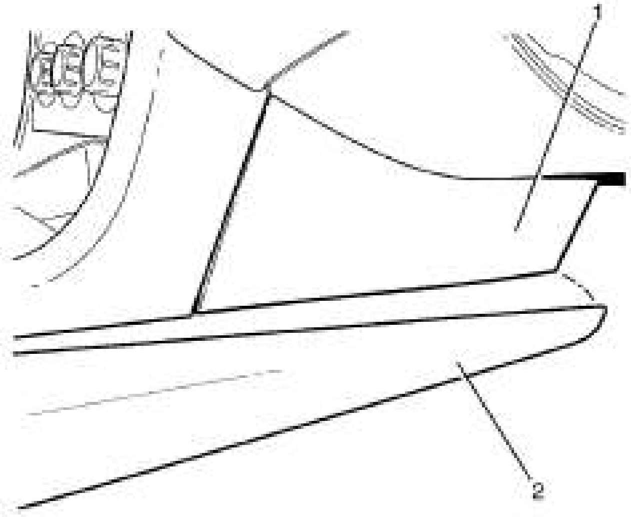


Important: The front floor console front cover (1) is retained by clips.

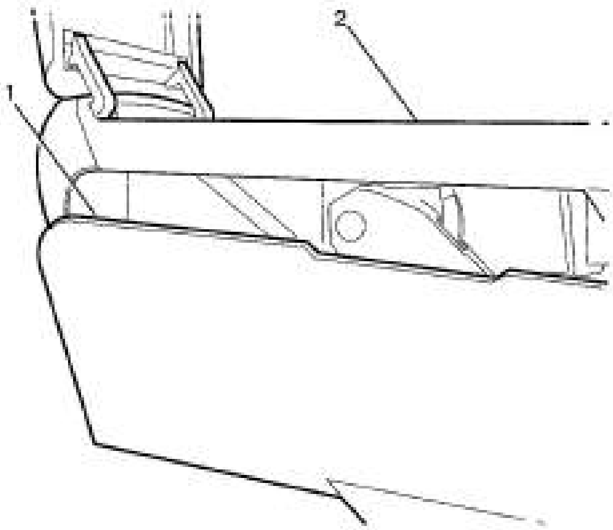
4. Install the front floor console front cover (1) and push downwards at (A) to engage the retaining clips to the floor console (2).
5. Test all switches for correct operation.

Front Floor Console Side Trim Panel Replacement - Right Side

Removal Procedure



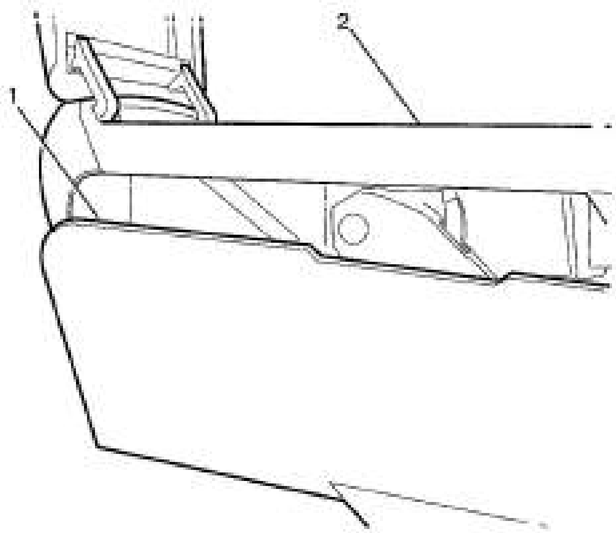
1. Slide the front of the trim plate (2) away from the centre console extension panel (1).



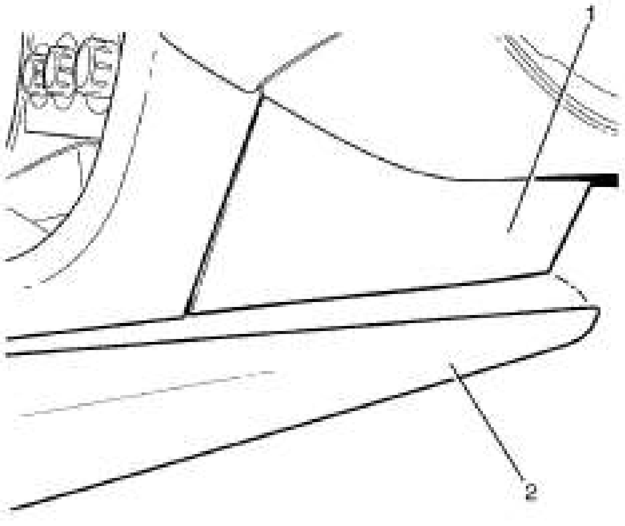
2. Detach the rear of the trim plate (1) from the centre console (2) by disengaging the retaining clips.

3. Remove the trim plate (1).

Installation Procedure



1. Engaged the retaining clips at rear of the trim plate (1) to secure it to the centre console (2).

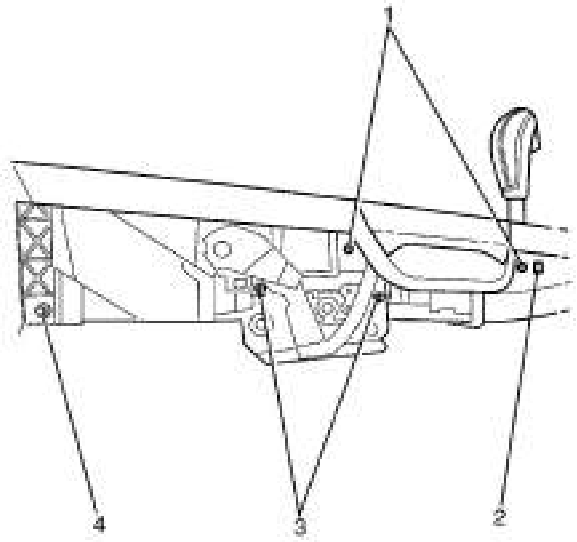


2. Slide the front of the trim plate (2) up into the centre console extension panel (1).
3. Ensure the trim plate is correctly located in the centre console and end panel.

Front Floor Console Replacement (RHD)

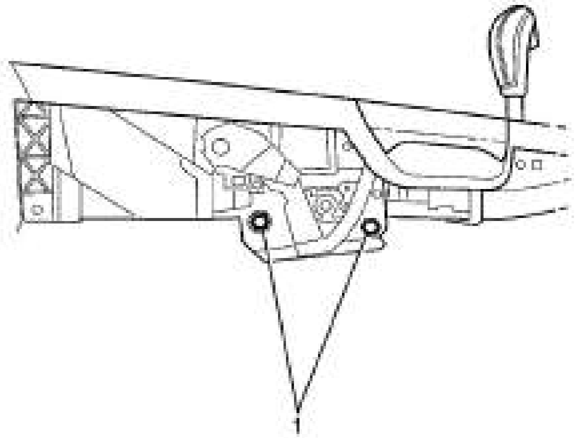
Removal Procedure

1. Remove the side trim plate - Console. Refer to Console Trim Plate Replacement .
2. Remove the centre console end panel. Refer to Center Console End Panel Replacement .
3. Remove the armrest assembly. Refer to Front Floor Console Armrest Replacement .
4. Remove the trim plate - console. Refer to Console Trim Plate Replacement .
5. Remove the centre console cupholder. Refer to Front Floor Console Cup Holder Replacement .

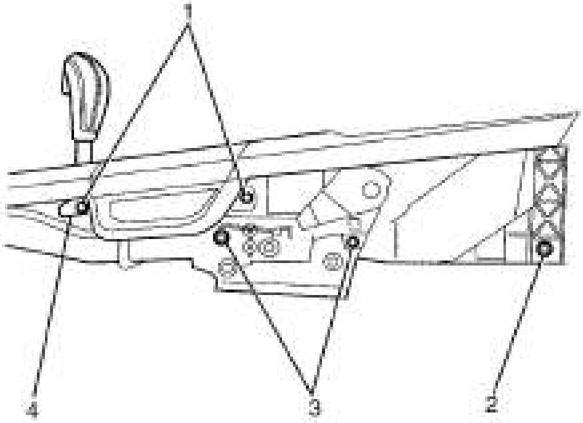


Important: The following procedure is carried out on the right side of the centre console.

6. Remove the retaining screws from the centre console (3).
7. Remove the rear centre console retaining bolt (4).
8. Remove the park recess tray retaining screws (1) and retaining clip (2).

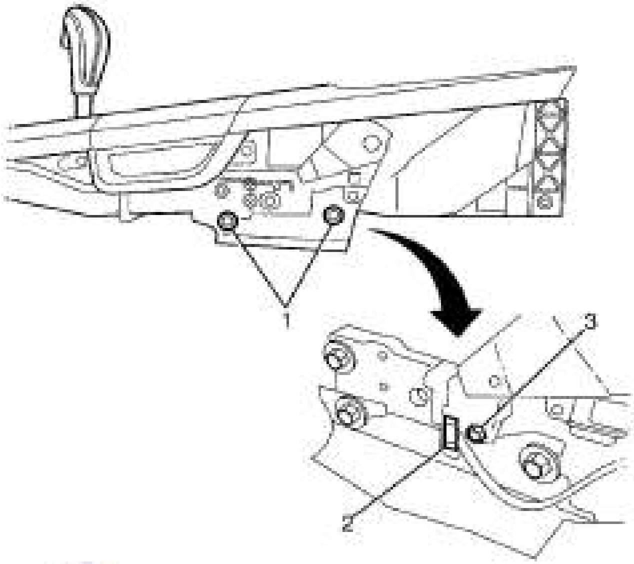


9. Loosen the centre console to park brake assembly bracket retaining bolts (1).

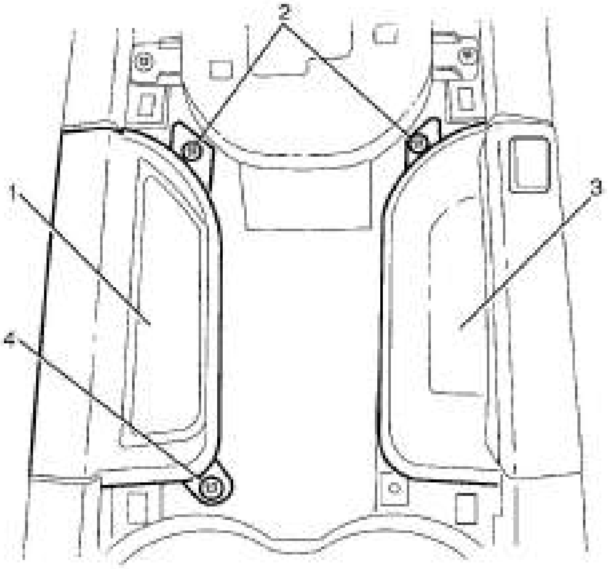


Important: The following procedures are carried out on the left hand side.

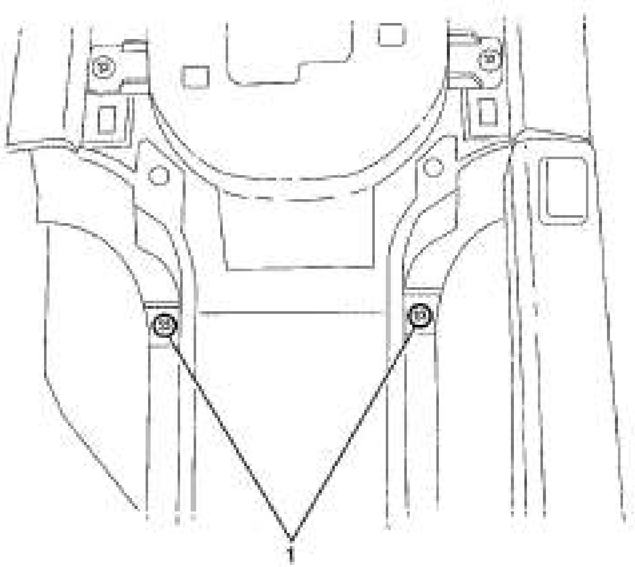
10. Remove the rear centre console retaining bolt (2).
11. Remove the centre console retaining screws (3).
12. Remove the coin holder retaining screws (1) and retaining clip (4).



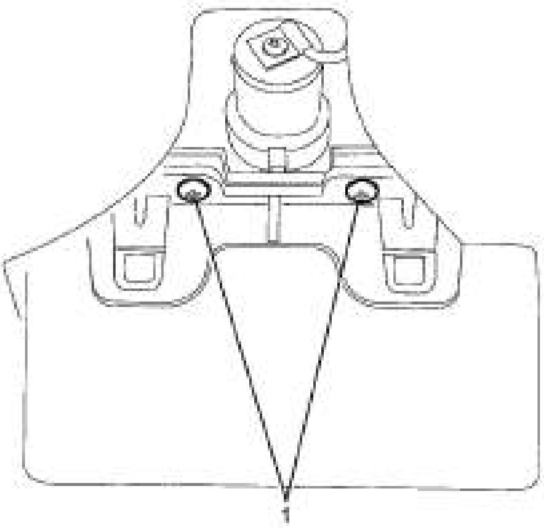
13. Remove the park brake warning lamp switch (2) retaining torx screw (3).
14. Loosen the centre console retaining bolts (1).



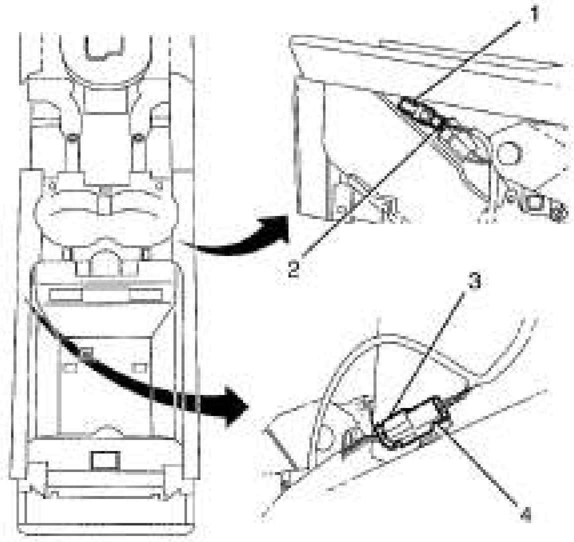
15. Remove the coin holder upper retaining screws (2,4) and remove the coin holder (1).
16. Remove the park brake recess tray upper retaining screw (2) and remove the recess trim (3).



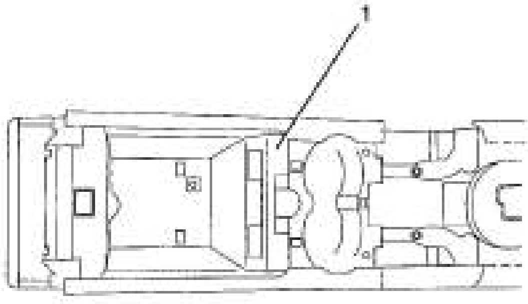
17. Remove the centre console top retaining screws (1).



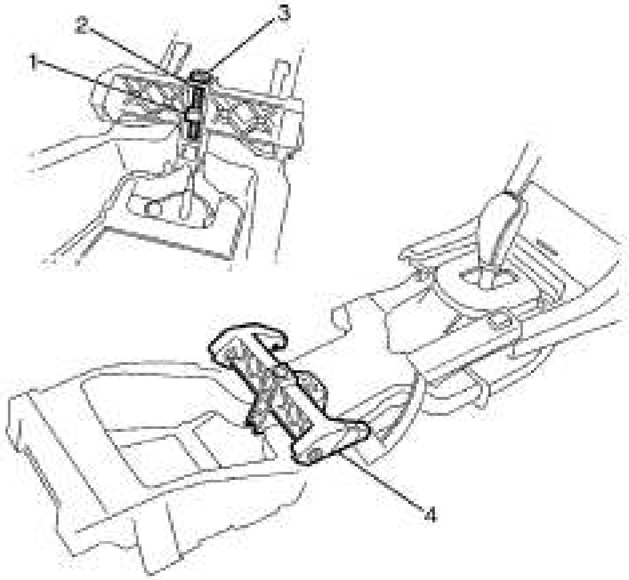
18. Remove the lower centre console retaining bolts (1).



19. Disconnect the centre console electrical connectors (1,3).
20. Detach and remove the centre console electrical connectors (4,2).



21. Remove the centre console (1).

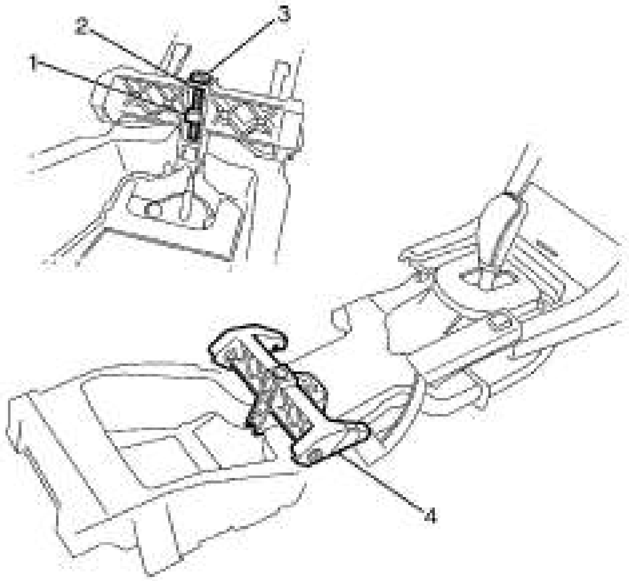


22. Remove the adjuster circlip (2) from the park brake adjuster (3).
23. Remove the park brake adjuster (3), by rotating counter clockwise until it leaves the retaining nut insert (1).
24. Remove the park brake adjuster (3) retaining nut insert (1).

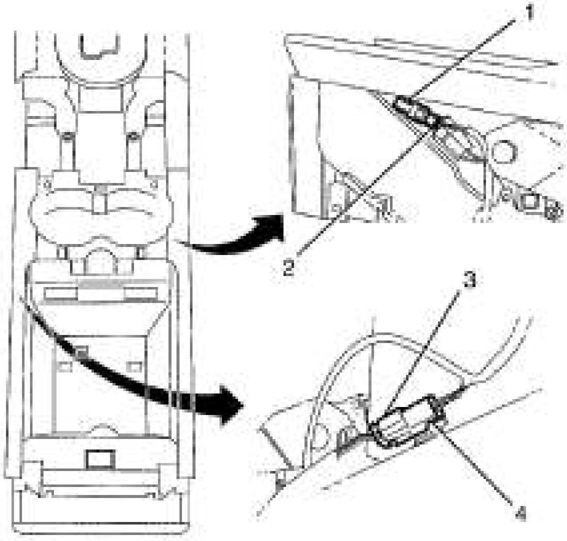
Important: If replacing the park brake assembly. Refer to Parking Brake Release Handle Assembly Replacement .

25. Remove the park brake assembly (4).

Installation Procedure

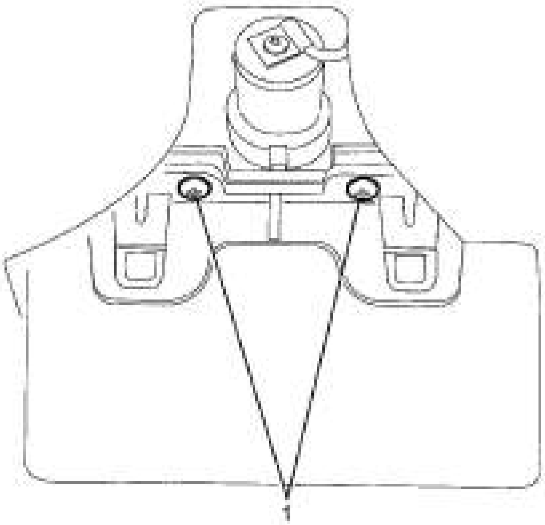


1. Align the park brake assembly (4) with the transmission tunnel.
2. Install the park brake adjuster nut insert (1) into the park brake assembly (4).
3. Install the park brake adjuster (3) by rotating it clockwise until the desired tension is reached.
4. Once the desired tension is reached install the park adjuster circlip (2).
5. Align the centre console over the park brake assembly.



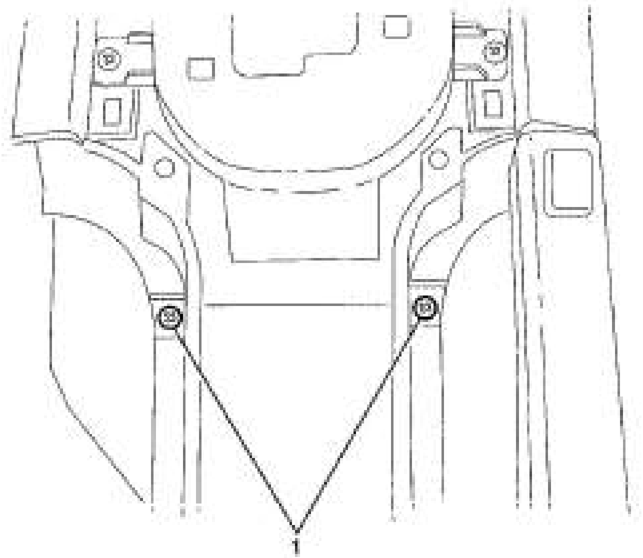
6. Attach and remove the centre console electrical connectors (4,2).
7. Connect the centre console electrical connectors (1,3).
8. Install the centre console cupholder. Refer to Front Floor Console Cup Holder Replacement .

Notice: Refer to Fastener Notice in the Preface section.



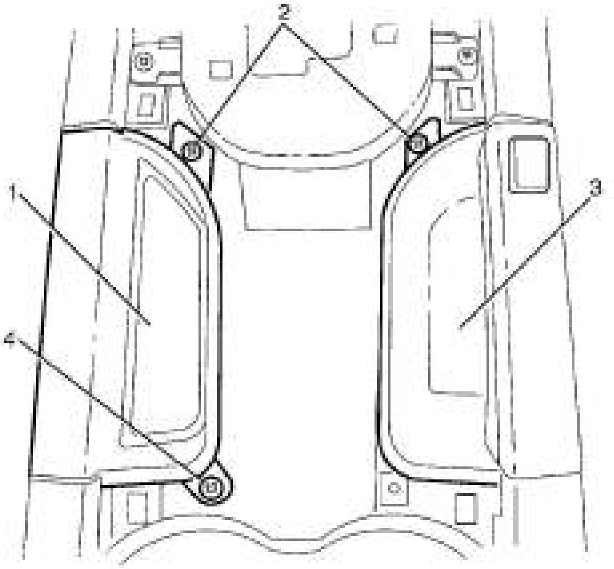
9. Install the lower centre console retaining screws (1).

Tighten
Tighten the screws (1) to 2 N·m (18 lb in).



10. Install the upper centre console retaining screws (1).

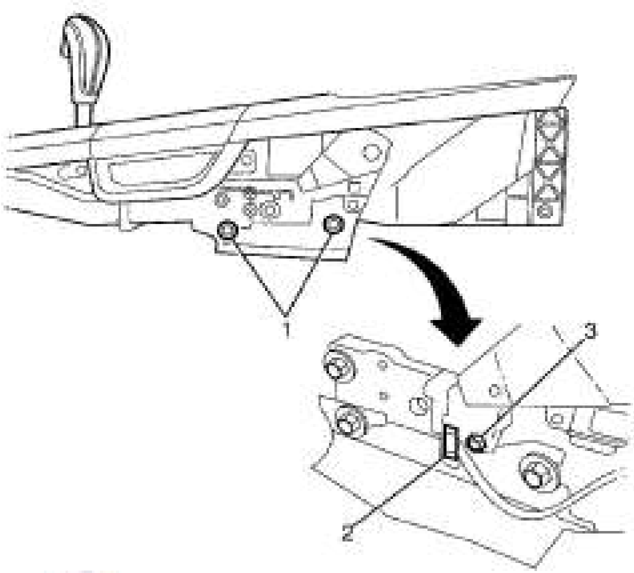
Tighten
Tighten the screws (1) to 2 N·m (18 lb in).



11. Install the coinholder (1) and park brake recess trim (3).

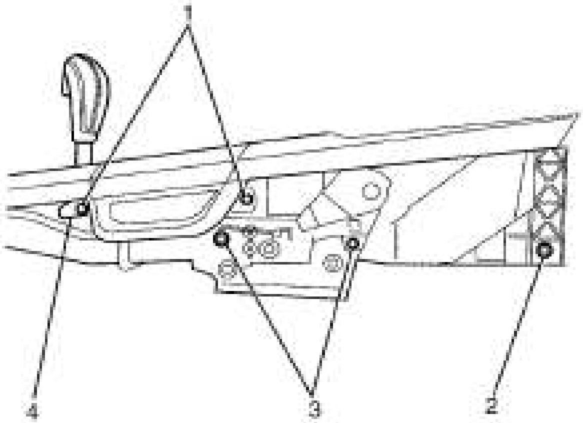
12. Install the coinholder and park brake recess trim upper retaining screws (2,4).

Tighten
Tighten the screws (2,4) to 2 N·m (18 lb in).



13. Install the park brake warning lamp switch (2).
14. Install the park brake warning lamp switch retaining torx screw (3).
15. Tighten the centre console to park brake assembly retaining bolts (1).

Tighten
Tighten the bolts to 25 N·m (18 lb ft).



16. Install the rear centre console retaining bolt (2).

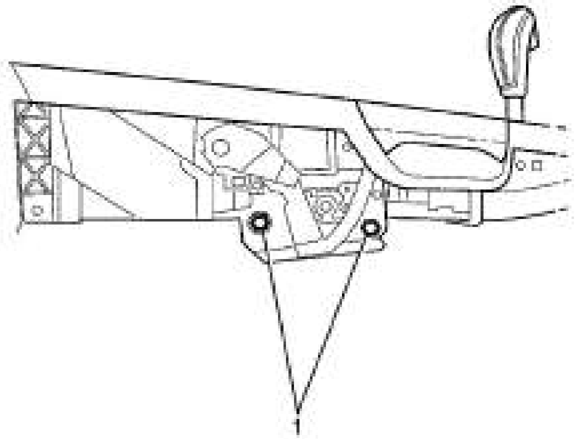
    Tighten
    Tighten the bolt to 25 N·m (18 lb ft).

17. Install the centre console retaining screws (3).

    Tighten
    Tighten the screws (3) to 2 N·m (18 lb in).

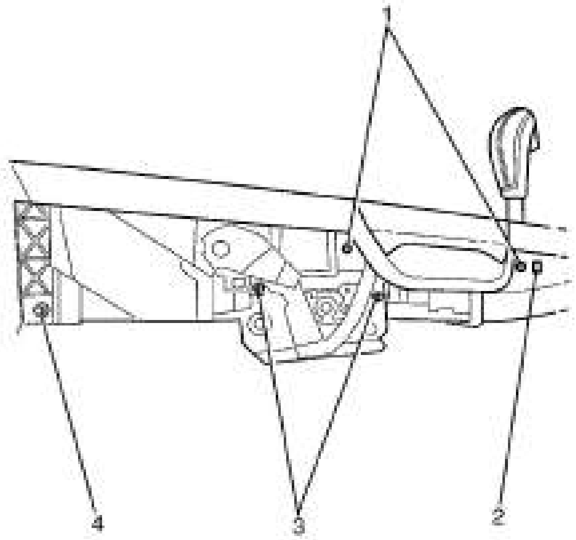
18. Install the coinholder lower retaining screws (1) and retaining clip (4).

    Tighten
    Tighten the screws (1) to 2 N·m (18 lb in).



19. Tighten the centre console to park brake assembly retaining bolts (1).

    Tighten
    Tighten the bolts to 25 N·m (18 lb ft).



20. Install the centre console retaining screws (3).

    Tighten
    Tighten the screws (3) to 2 N·m (18 lb in).

21. Install the park brake recess lower retaining screws (1) and retaining clip (2).

    Tighten
    Tighten the screws (1) to 2 N·m (18 lb in).

22. Tighten the rear centre console retaining bolt (4).

    Tighten
    Tighten the bolt to 25 N·m (18 lb ft).

23. Install the trim plate - Console. Refer to Console Trim Plate Replacement .
24. Install the armrest assembly. Refer to Front Floor Console Armrest Replacement .
25. Install the centre console end panel. Refer to Center Console End Panel Replacement .
26. Install the side trim plate - Console. Refer to Console Trim Plate Replacement .
27. Test all electrical components for correct operation.

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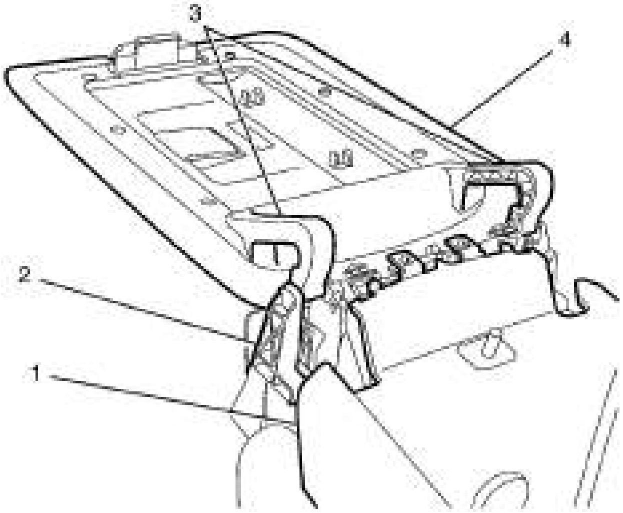
Front Floor Console Armrest Replacement

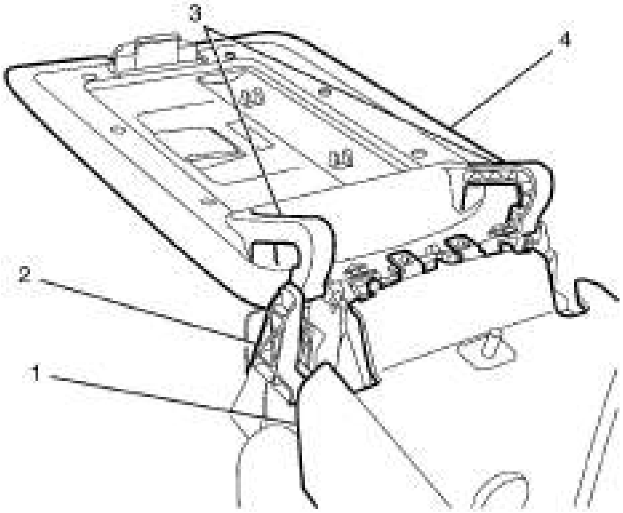
Removal procedure

1. Remove the centre console end panel. Refer to Center Console End Panel Replacement.
2. Open the armrest assembly to 180° to the horizontal position.



3. Using a suitable tool spread the centre console retaining lugs (2) away from the armrest assembly arms (3) and remove the armrest assembly (4) from the centre console (1).

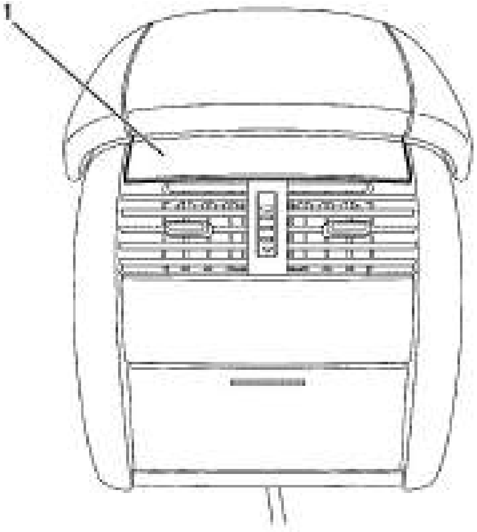
Installation Procedure



1. Align the armrest assembly (4) with centre console assembly (1).
2. Install the armrest assembly arms (3) by firmly inserting it into the centre console retaining lugs (2) listen for an audible click to confirm fitting.
3. Close the armrest assembly (4).
4. Install the centre console end panel. Refer to Center Console End Panel Replacement.

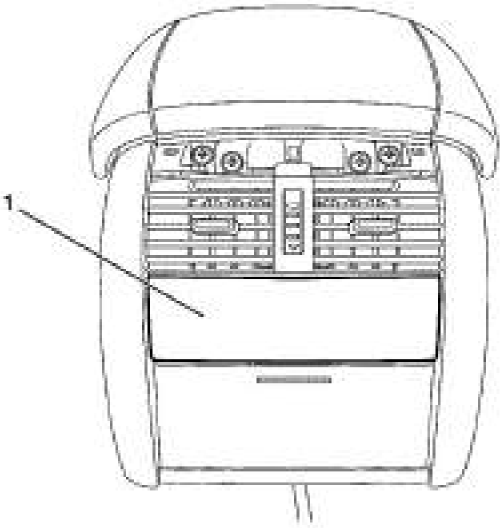
Center Console End Panel Replacement

Removal Procedure - Up to 17 Sept 2007

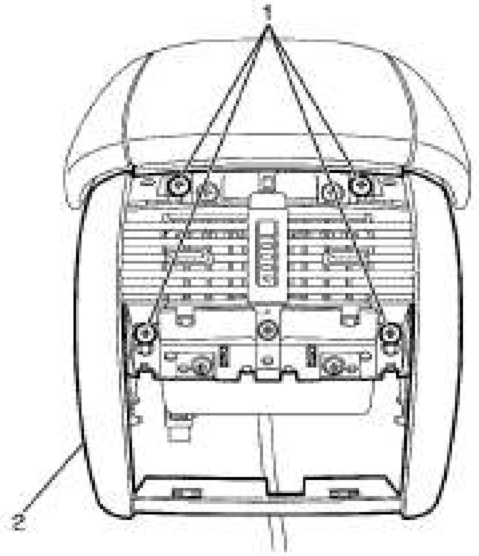


Important: From inside the front floor console compartment carefully lift upwards with a small flat blade screwdriver to detach the retaining clips. Close the armrest and remove the front floor console upper end panel (1).

1. Remove the front floor console upper end panel (1), by lifting from the base of the trim panel to disengage.

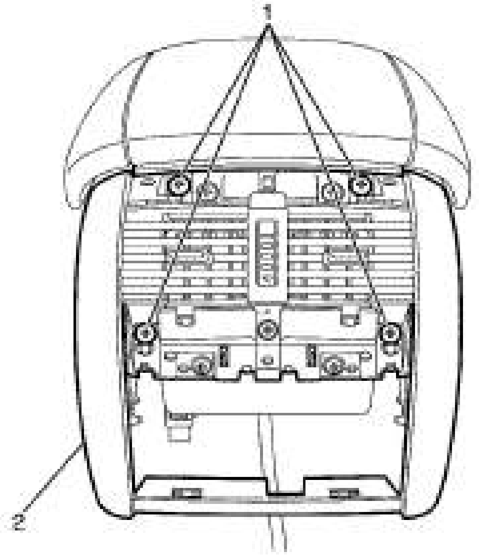


2. Remove the rear floor console rear compartment (1).



3. Remove the end panel to front floor console retaining screws (1).
4. Remove the end panel and rear air outlet assembly (2).

Installation Procedure - Up to 17 Sept 2007

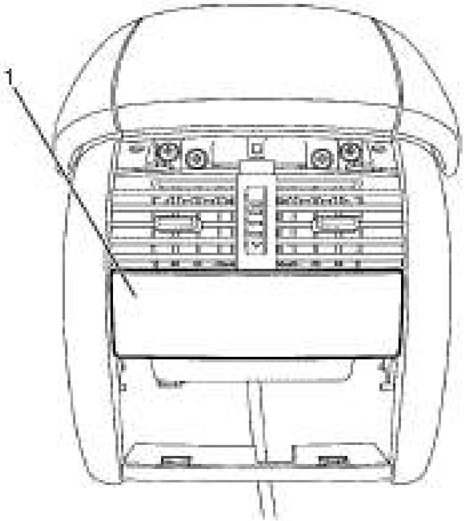


1. Install the end panel and rear air outlet assembly (2).

   Notice: Refer to Fastener Notice in the Preface section.

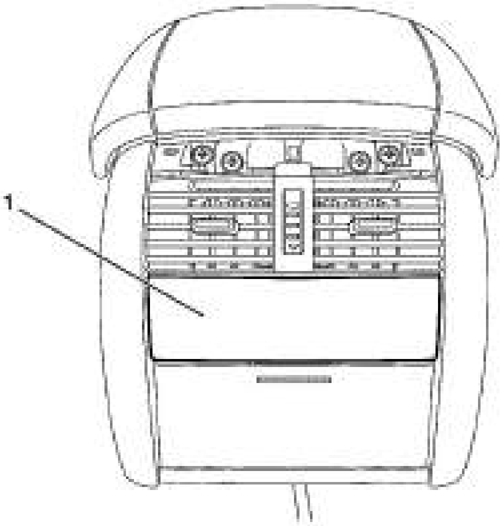
2. Install the end panel to front floor console retaining screws (1).

   Tighten
   Tighten the screws (1) to 2 N·m (18 lb in).

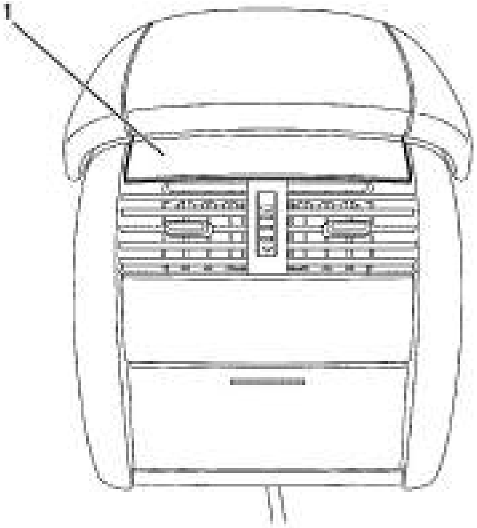


Important: The front floor console lower end panel (1) is retained by clips. Make sure all the clips are aligned with the front floor console and are engaged to avoid an induced rattle condition.

3. Install the front floor console lower end panel (1).



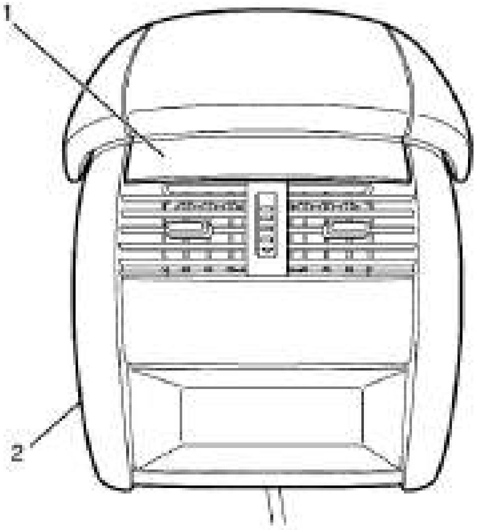
4. Install the rear floor console rear compartment (1).



Important: The front floor console upper end panel (1) is retained by clips. Make sure all the clips are aligned with the front floor console and are engaged to avoid an induced rattle condition.

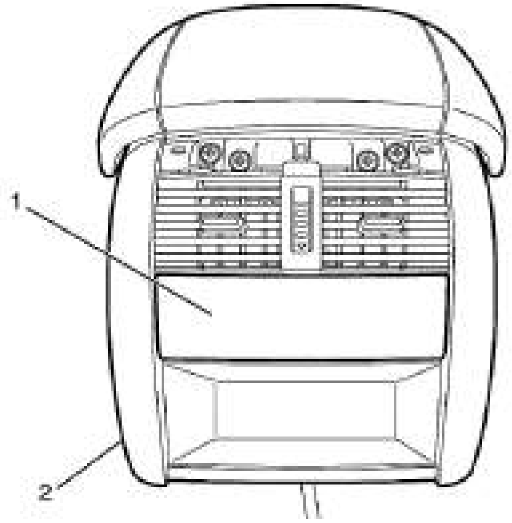
5. Align the trim panel with the console end panel.
6. Push down on trim to engage retaining clips.

Removal Procedure - From 17 Sept 2007



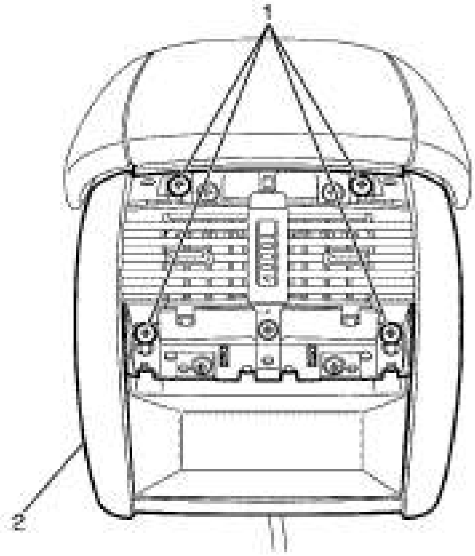
Important: Raise the arm rest and from inside the front floor console compartment carefully lift upwards with a small flat blade screwdriver to detach the retaining clips. Lower the armrest.

1. Remove the front floor console upper trim panel (1) from the end panel (2).



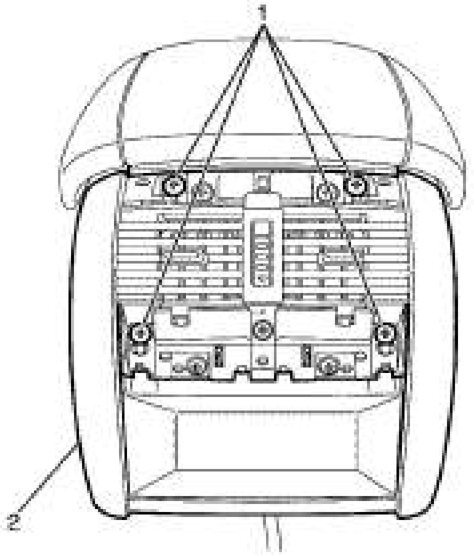
Important: Carefully lift upwards with a small flat blade screwdriver to detach the retaining clips.

2. Remove the rear floor console lower trim panel (1) from the end panel (2).



3. Remove the end panel to front floor console retaining screws (1).
4. Remove the end panel (2) from the front floor console.

Installation Procedure - From 17 Sept 2007

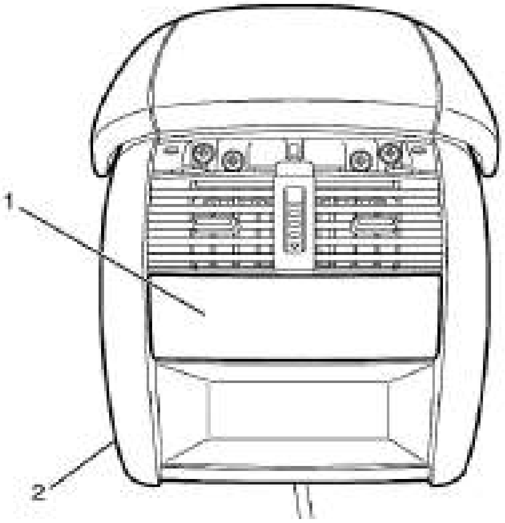


1. Install the end panel (2) to the front floor console.

   Notice: Refer to Fastener Notice in the Preface section.

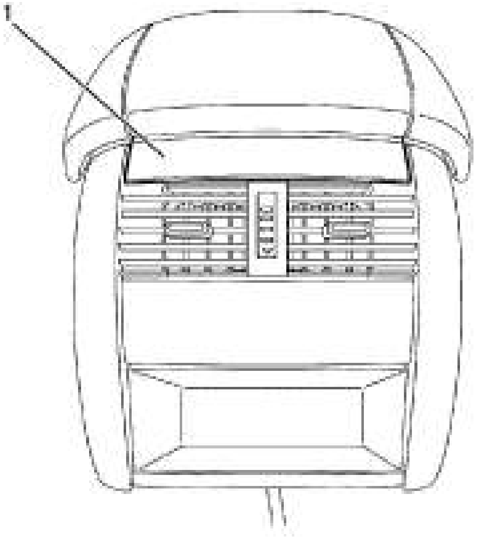
2. Install the end panel to front floor console retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).



Important: The front floor console lower trim panel (1) is retained by clips. Make sure all the clips are aligned with the front floor console and are engaged to avoid an induced rattle condition.

3. Install the front floor console lower trim panel (1) to the end panel (2). Listen for an audible click to confirm fitting.



Important: The front floor console upper trim panel (1) is retained by clips. Make sure all the clips are aligned with the front floor console and are engaged to avoid an induced rattle condition.

4. Align the upper trim panel (1) with the console end panel.
5. Push down on the upper trim panel (1) to engage retaining clips. Listen for an audible click to confirm fitting.

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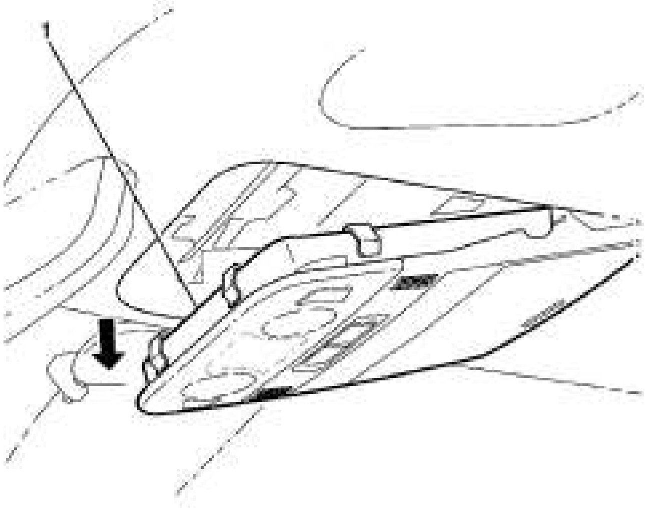
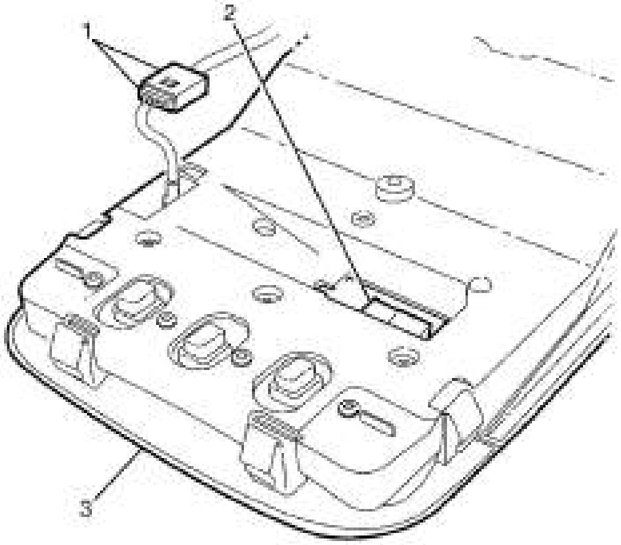
Roof Console Replacement

Removal Procedure



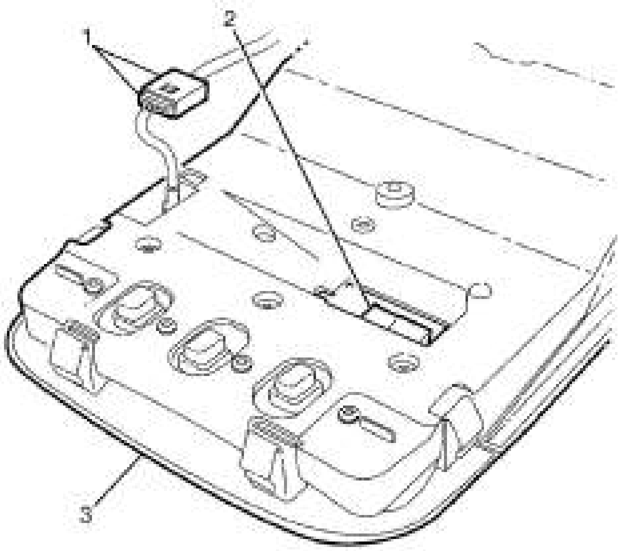
1. Grasp the front of the console compartment (1) and carefully pull away from the headlining assembly.
2. Slide the console compartment (1) in a forward motion to allow the two locator arms to clear the headlining.



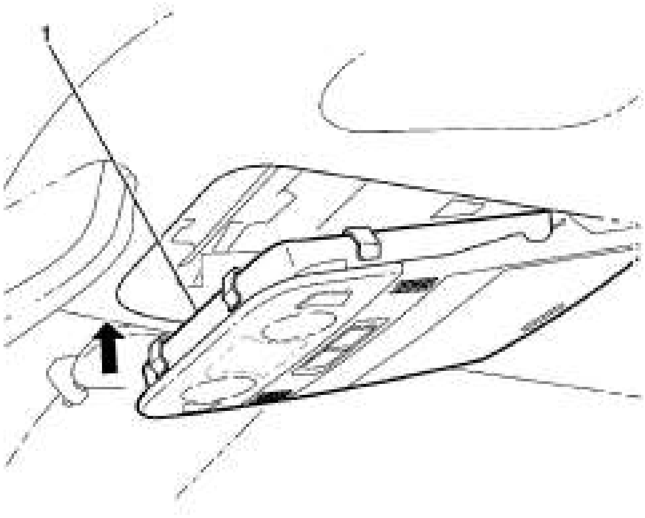
3. Disconnect the console compartment (3) electrical connector (2).

4. Disconnect the bluetooth microphone connection (1).
5. Remove the console compartment (3).

Installation Procedure



1. Connect the bluetooth microphone connection (1).
2. Connect the console compartment (3) electrical connector (1).
3. Insert the two locating arms into the headlining assembly.



4. Carefully push the console compartment (1) into the headlining assembly.
5. Test console compartment for correct operation.

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Assist Handle Retaining Screws	2 N·m	18 lb in
Body Hinge Pillar Trim Retaining Torx screw	2 N·m	18 lb in
Body Lock Pillar Trim Panel to Body Retaining Screw (Sportwagon)	2 N·m	18 lb in
Body Lock Pillar Upper Trim Panel to Body Retaining Torx Screw (Sportwagon)	2 N·m	18 lb in
Body Side Window Rear Garnish Moulding to Body Retaining Screws (Sportwagon)	3 N·m	27 lb in
Cargo Area Rear Trim Panel Retaining Hooks	2 N·m	18 lb in
Centre Pillar Upper Trim Panel Torx Screw	2 N·m	18 lb in
Centre Sill Trim Panel Retaining Torx Screw	2 N·m	18 lb in
Child Restraint Anchor Retaining Bolt	22 N·m	16 lb ft
Front Side Door Inside Door Handle to Door Trim Panel Retaining Screw	3 N·m	27 lb in
Front Side Door Trim Panel to Door Retaining Screws	3 N·m	27 lb in
Liftgate Inside Pull Handle to Liftgate Retaining Screws (Sportwagon)	2 N·m	18 lb in
Quarter Lower Trim Panel Retaining Torx Screw	2 N·m	18 lb in
Rear Quarter Upper Lower Section Retaining Torx Screw	2 N·m	18 lb in
Rear Quarter Upper Retaining Torx Screw	2 N·m	18 lb in
Rear Quarter Upper Trim Panel Retaining Screw	2 N·m	18 lb in
Rear Side Door Inside Door Handle to Door Retaining Screw	3 N·m	27 lb in
Rear Side Door Trim Panel to Door Retaining Screws	3 N·m	27 lb in
Rear Sill Panel Trim Retaining Torx Screw	2 N·m	18 lb in
Sunshade Assembly Retaining Torx Screws	2 N·m	18 lb in
Windshield Garnish Moulding Retaining Torx Screw	2 N·m	18 lb in

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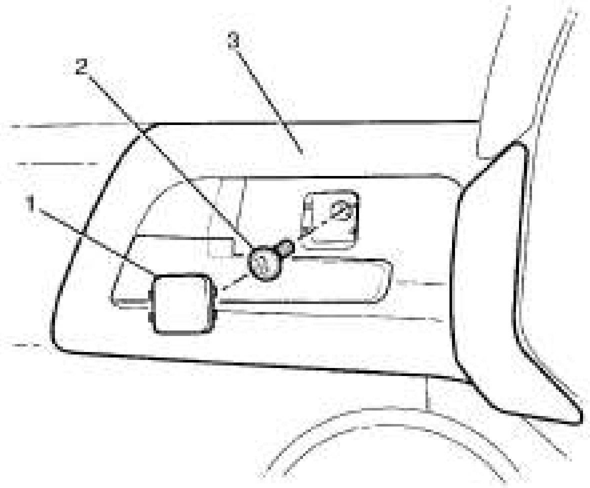
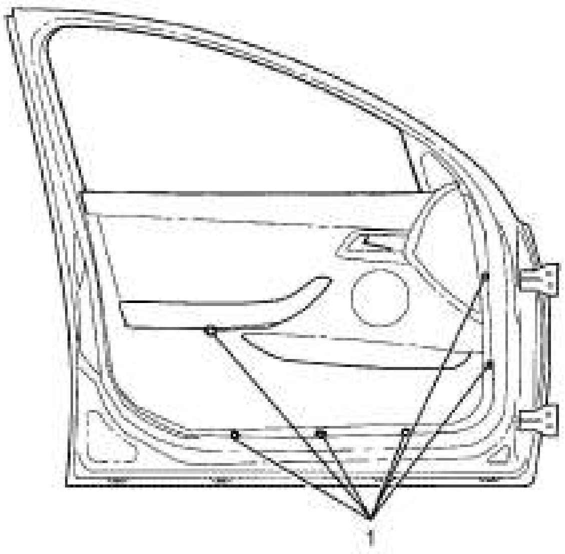
Front Side Door Trim Panel Replacement

Removal Procedure



Important: Pry the inside door handle to door retaining screw cover (1) using a suitable tool.

1. Remove the inside door handle to door retaining screw cover (1) from the door trim panel (3).
2. Remove the inside door handle to door retaining screw (2).

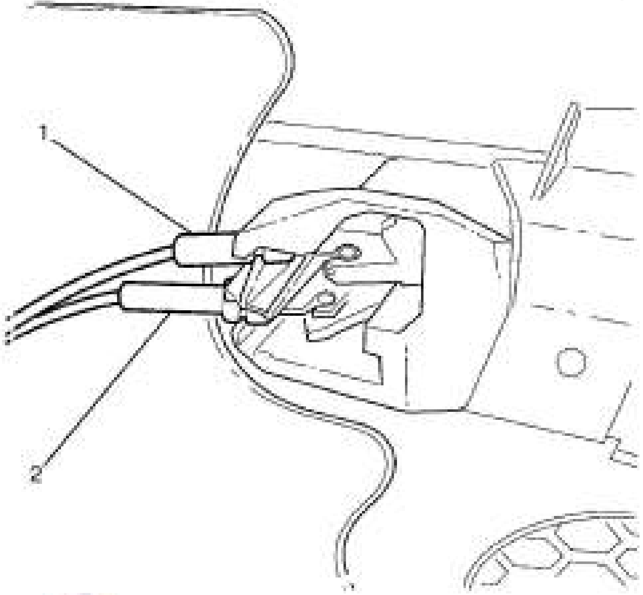


Important: Screw locations for type B door trim panel.

3. Remove the door trim panel to door retaining screws (1).

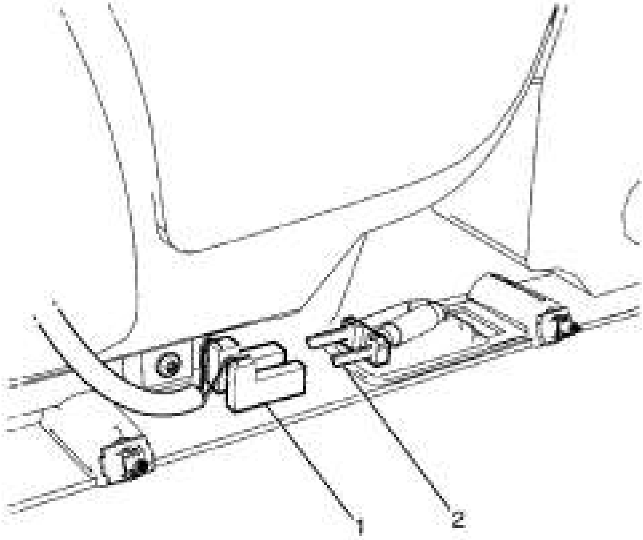
Important: Firmly pull on the armrest handle to release the door trim panel to door retaining clips.

4. Remove the door trim panel from the door to allow access to door handle cable, door lock cable and courtesy light electrical connectors (if fitted).



Important: The door handle and lock cables slide out and lift up to remove from the door trim panel.

5. Disconnect the inside door handle cable (1) and door lock cable (2) from the door trim panel.



6. Disconnect the courtesy light electrical connectors (1) from the door trim panel (2) (if fitted).
7. Remove the door trim panel (2) from the door.

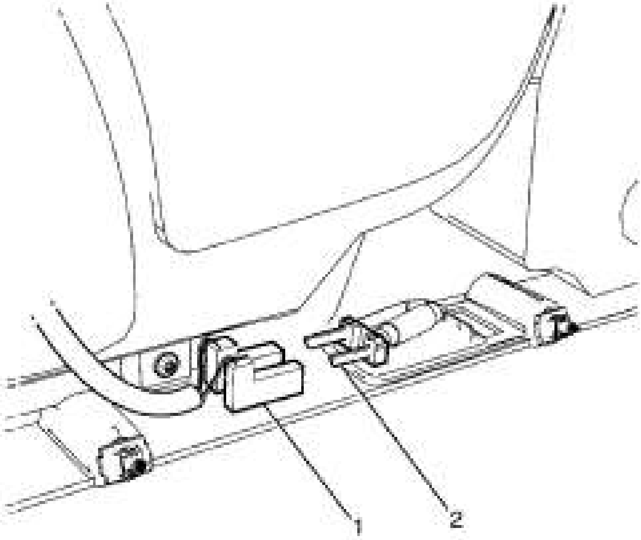
Installation Procedure

Important: Green retaining clips are along the front edge and white retaining clips are along the back edge.

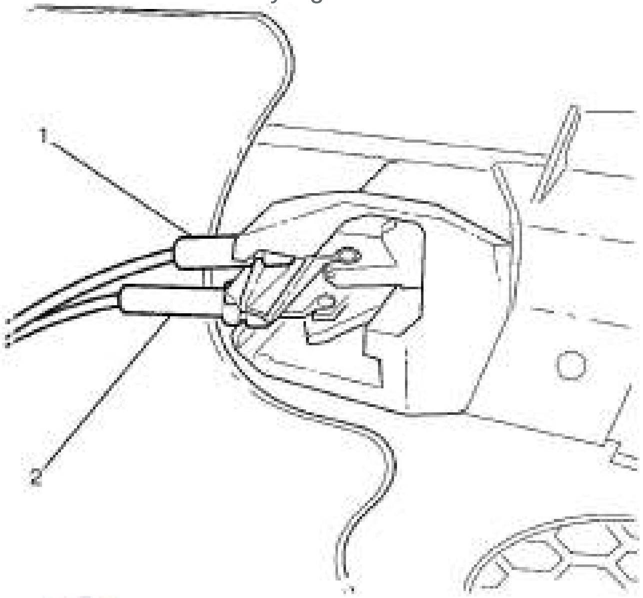
1. Make sure that all of the retaining clips are on the door trim panel and not still attached to the sheetmetal.

Important: Do not fully install the door trim panel at this stage. The inside door handle cable, door lock cable and courtesy light electrical connector have to be attached first (if fitted).

2. Position the door trim panel to the door.

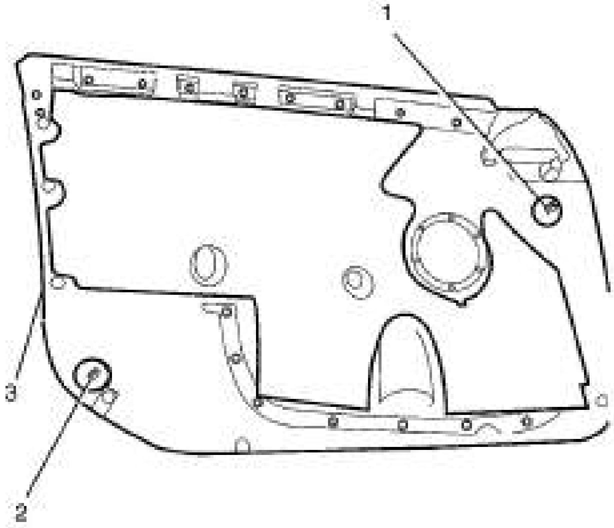


3. Connect the courtesy light electrical connectors (1) to the door trim panel (2) (if fitted).



Important: The door handle and lock cables slide down and in to the door trim panel to install.

4. Connect the inside door handle cable (2) and door lock cable (1) to the door trim panel.

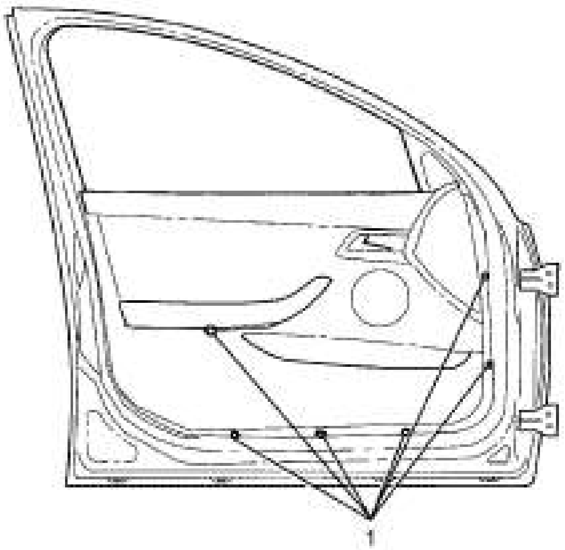


Important: Datum pins (1, 2) align the door trim panel to the door.

Important: Apply pressure around the door trim panel (3) to secure the retainers to the door.

5. Position the door trim panel (3) to the door.

   Notice: Refer to Fastener Notice in the Preface section.

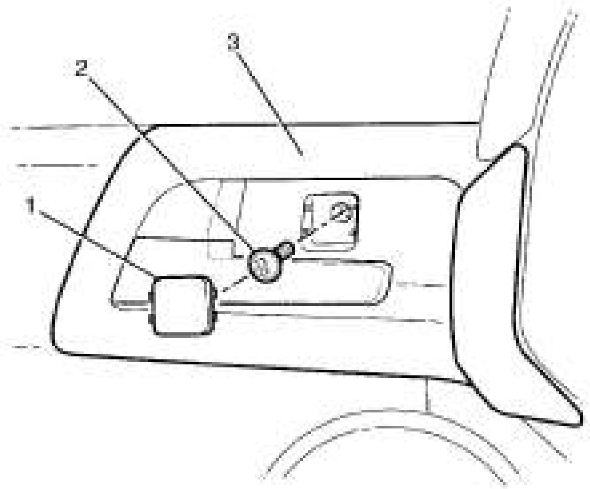


Important: Screw locations for type B door trim panel.

6. Install the door trim panel to door retaining screws (1).

   Tighten
   Tighten the screws to 3 N-m (27 lb in).

   Notice: Refer to Fastener Notice in the Preface section.



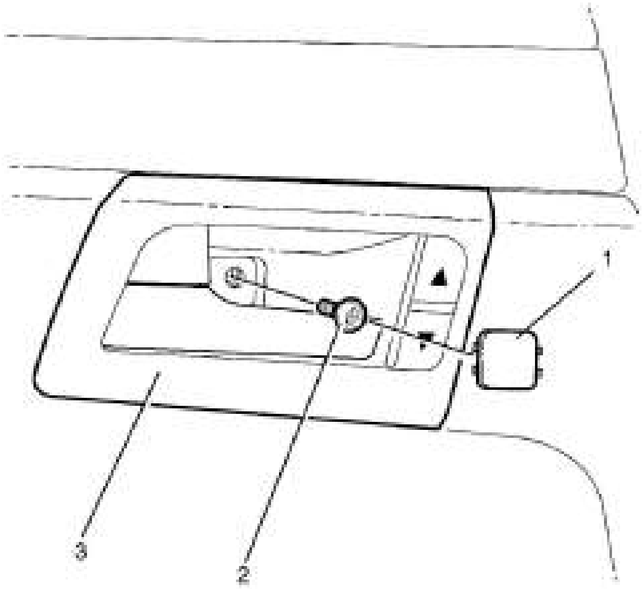
7. Install the inside door handle to door trim panel retaining screw (2).

   Tighten
   Tighten the screws to 3 N-m (27 lb in).

8. Install the inside door handle to door retaining screw cover (1) to the door trim panel (3).

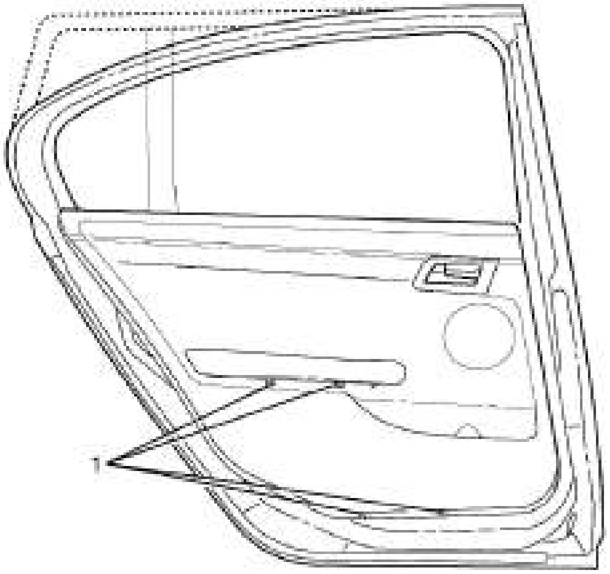
Rear Side Door Trim Panel Replacement (SWB)

Removal Procedure



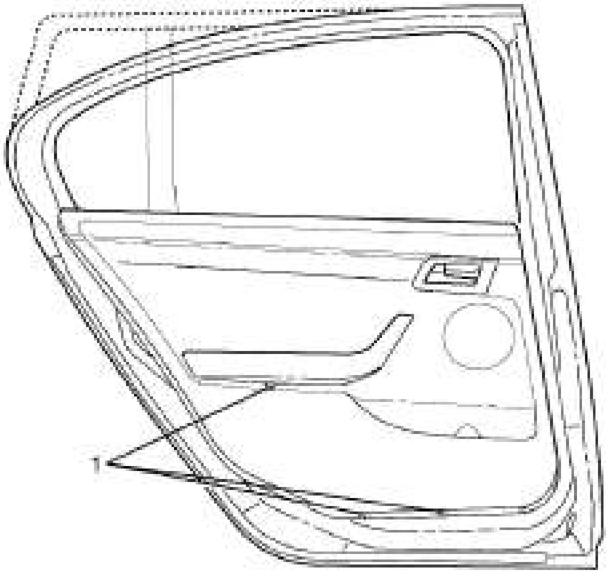
Important: Pry the inside door handle to door retaining screw cover (3) using a suitable tool.

1. Remove the inside door handle to door retaining screw cover (3) from the door trim panel (1).
2. Remove the inside door handle to door retaining screw (2).



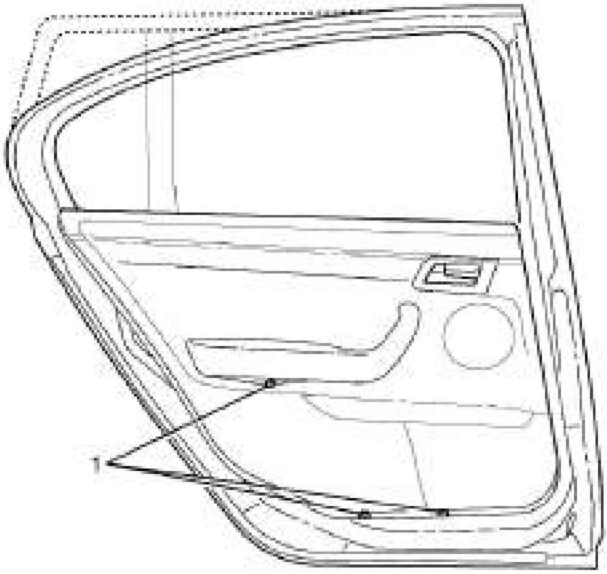
Important: Screw locations for type A door trim panel.

3. Remove the door trim panel to door retaining screws (1).



Important: Screw locations for type B door trim panel.

4. Remove the door trim panel to door retaining screws (1).

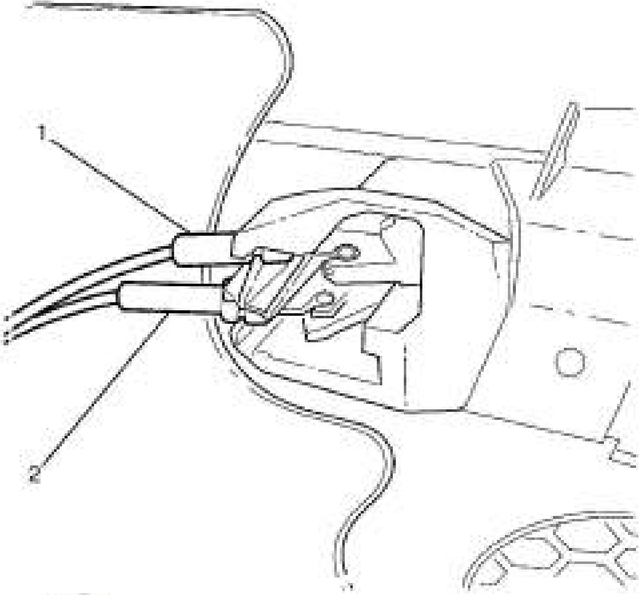


Important: Screw locations for type C door trim panel.

5. Remove the door trim panel to door retaining screws (1).
6. Pry the top of the door trim panel to release the inner belt seal clips.

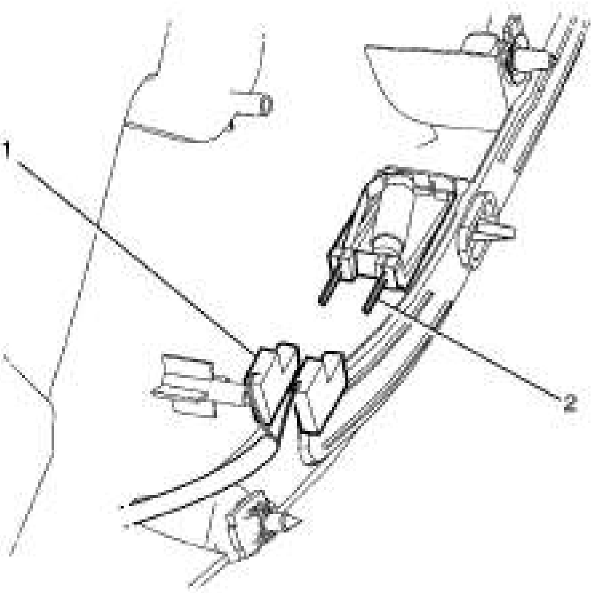
Important: Firmly pull on the armrest handle to release the door trim panel to door retaining clips.

7. Remove the door trim panel (1) from the door to allow access to door handle cable, door lock cable and courtesy light electrical connectors (if fitted).

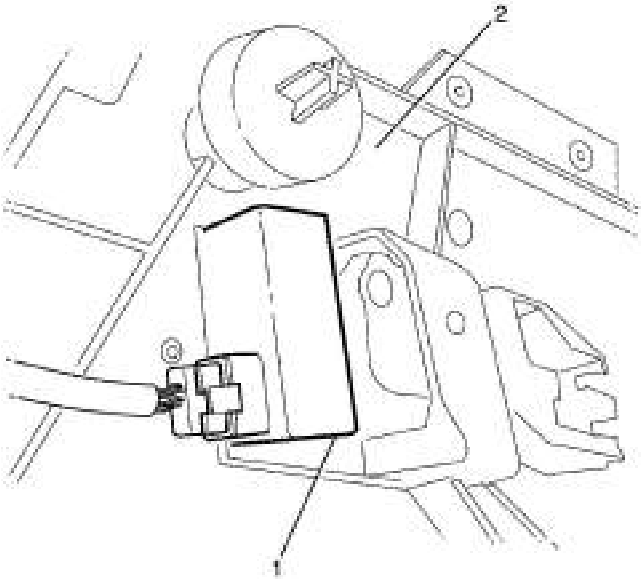


Important: The door handle and lock cables slide out and lift up to remove from the door trim panel.

8. Disconnect the inside door handle cable (1) and door lock cable (2) from the door trim panel.



9. Disconnect the courtesy light electrical connectors (1) from the door trim panel (2) (if fitted).



Important: Pull the window switch (1) from the door trim panel (2) to release the retaining clips.

10. Remove the window switch (1) from the door trim panel (1).
11. Remove the door trim panel (2) from the door.

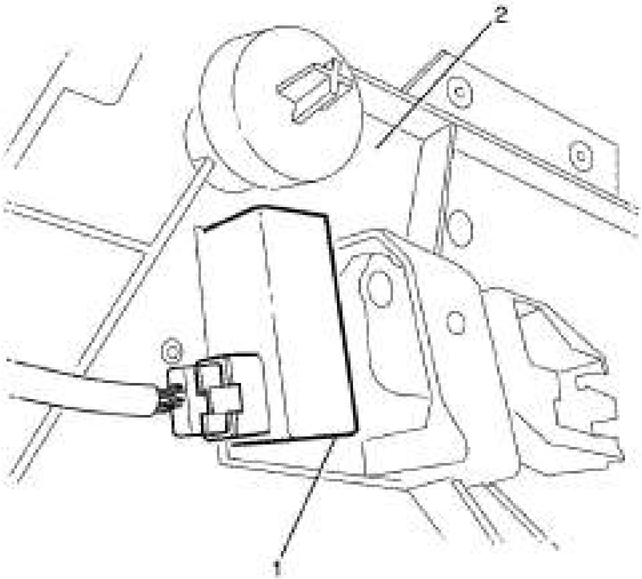
Installation Procedure

Important: Green retaining clips are along the front edge and white retaining clips are along the back edge.

1. Make sure that all of the retaining clips are on the door trim panel and not still attached to the door sheetmetal.

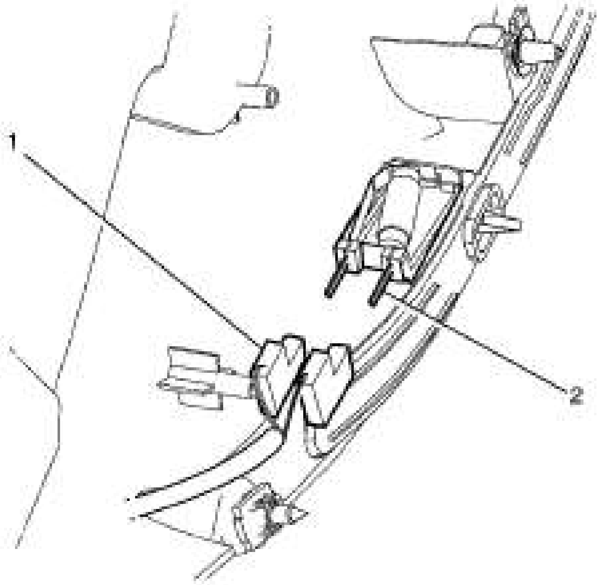
Important: Do not fully install the door trim panel at this stage. The inside door handle cable, door lock cable, window switch and courtesy light electrical connector (if fitted) have to be attached first.

2. Position the door trim panel to the door.

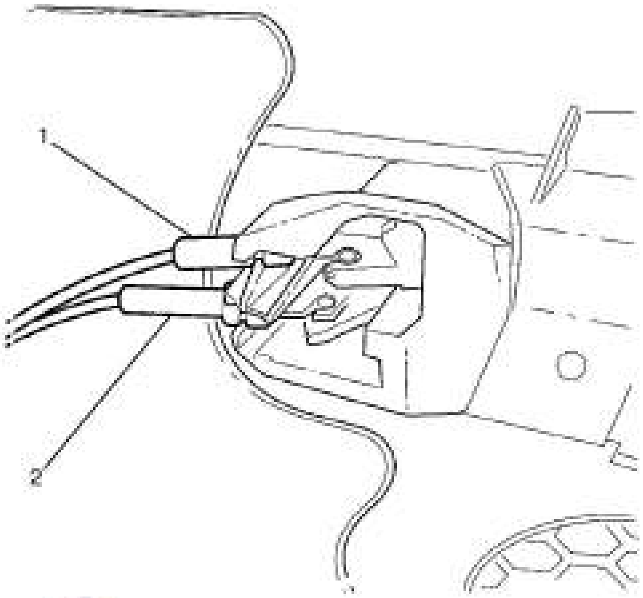


Important: Firmly push the window switch (1) to the door trim panel (2) to install.

3. Install the window switch (1) to the door trim panel (2).

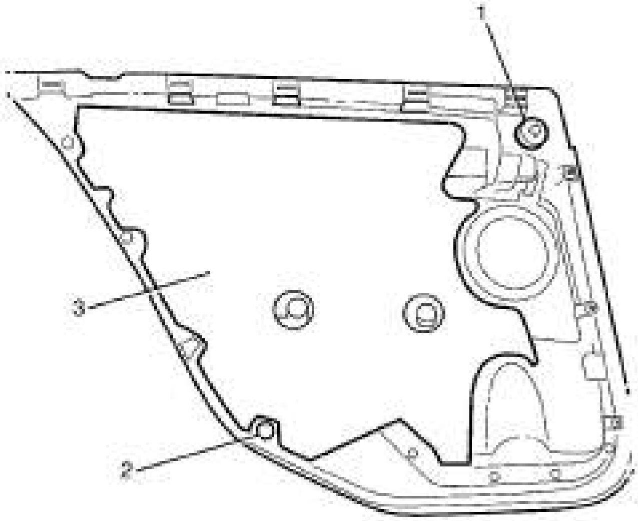


4. Connect the courtesy light electrical connectors (1) to the door trim panel (2) (if fitted).



Important: The door handle and lock cables slide down and in to the door trim panel to install.

5. Connect the inside door handle cable (2) and door lock cable (1) to the door trim panel.

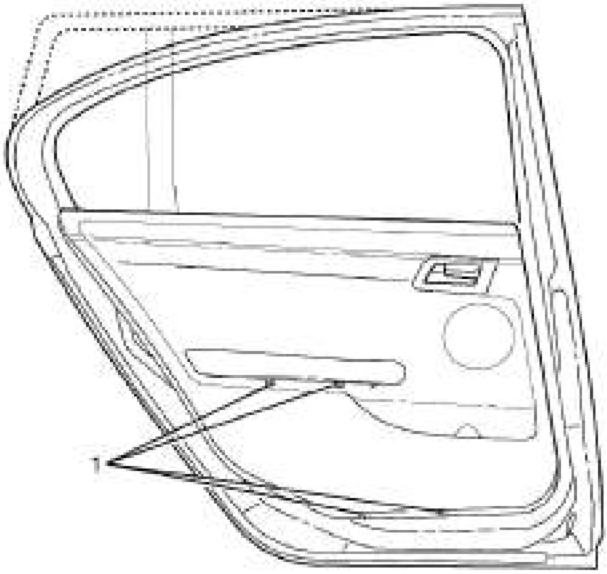


Important: Datum pins (1, 2) align the door trim panel to the door.

Important: Apply pressure around the door trim panel (3) to secure the retainers to the door.

6. Position the door trim panel (3) to the door.

Notice: Refer to Fastener Notice in the Preface section.

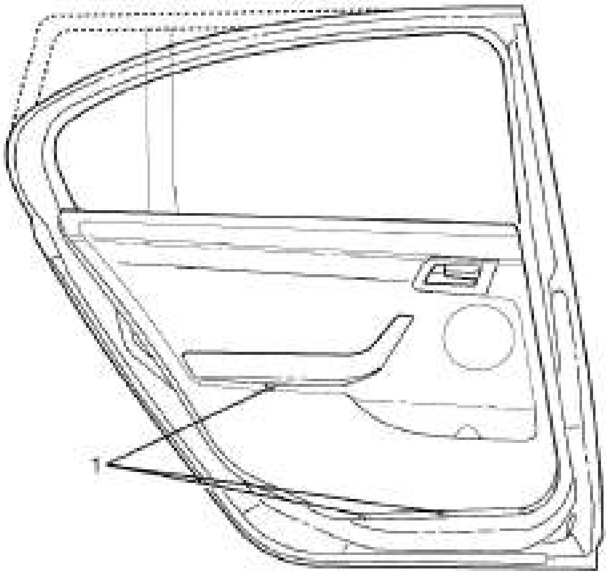


Important: Screw locations for type A door trim panel.

7. Install the door trim panel to door retaining screws (1).

Tighten
Tighten the screws to 3 N-m (27 lb in).

Notice: Refer to Fastener Notice in the Preface section.

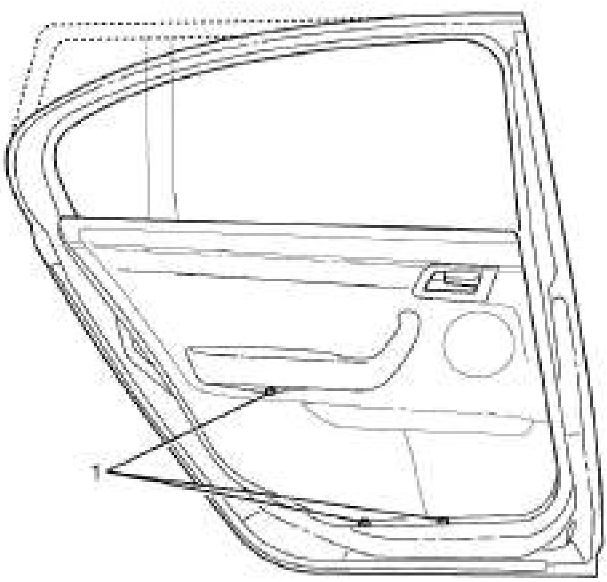


Important: Screw locations for type B door trim panel.

8. Install the door trim panel to door retaining screws (1).

   Tighten
   Tighten the screws to 3 N-m (27 lb in).

   Notice: Refer to Fastener Notice in the Preface section.

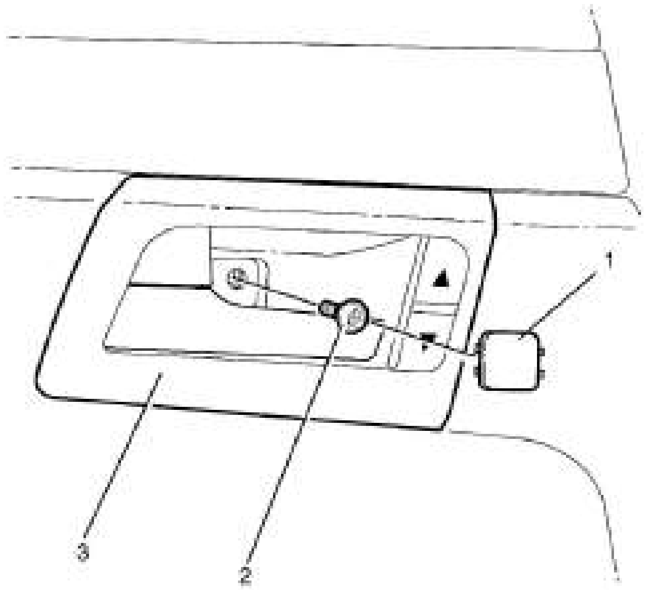


Important: Screw locations for type C door trim panel.

9. Install the door trim panel to door retaining screws (1).

   Tighten
   Tighten the screws to 3 N-m (27 lb in).

   Notice: Refer to Fastener Notice in the Preface section.



10. Install the inside door handle to door retaining screw (2).

    Tighten
    Tighten the screws to 3 N-m (27 lb in).

11. Install the inside door handle to door retaining screw cover (3) to the door trim panel (1).

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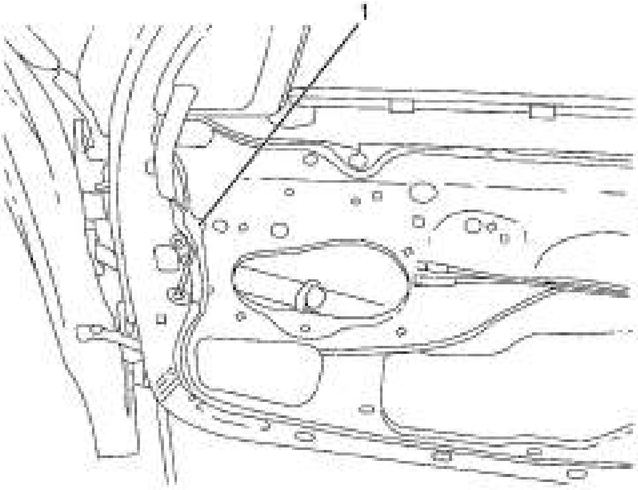
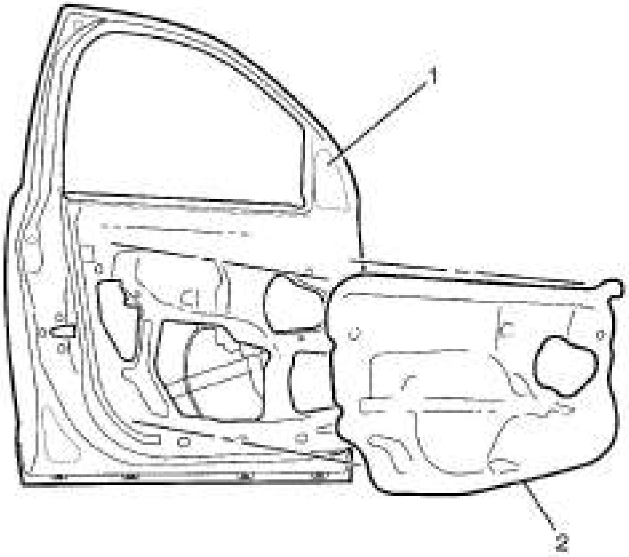
Front Side Door Water Deflector Replacement

Removal Procedure

1. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement.
2. Remove the speaker. Refer to Radio Front Side Door Lower Speaker Replacement.



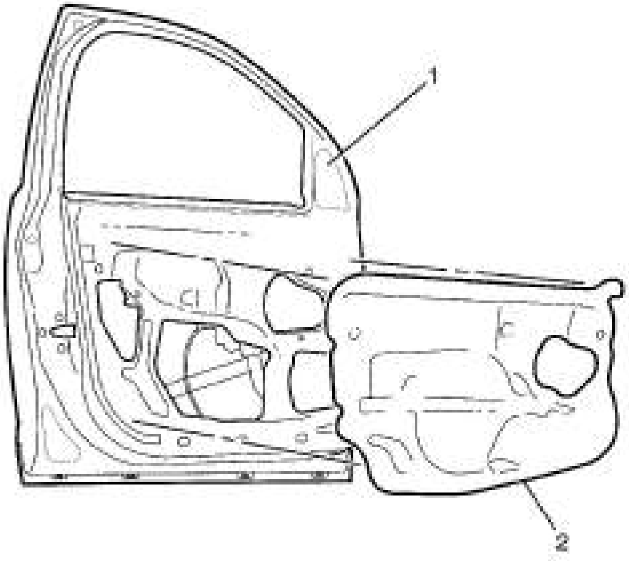
3. Detach the wiring harness to door retaining clip (1).



Important: Pull the water deflector (2) from the door (1) to release the adhesive bond.

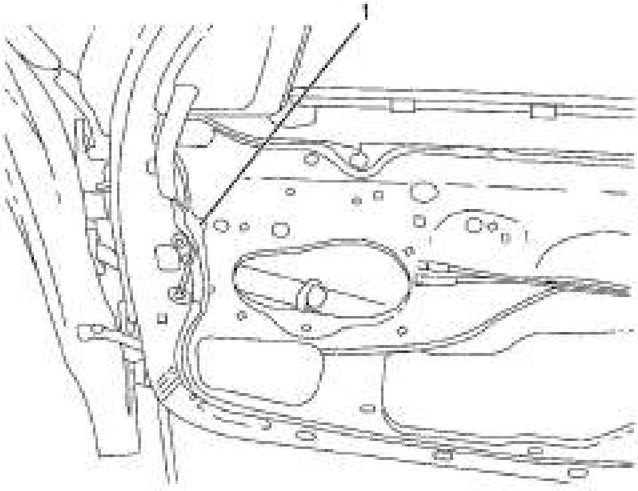
4. Remove the water deflector (2) from the door (1).

Installation Procedure



Important: Firmly press the water deflector (2) where adhesive is applied to make sure of a water tight seal to the door (1).

1. Install the water deflector (2) to the door (1).

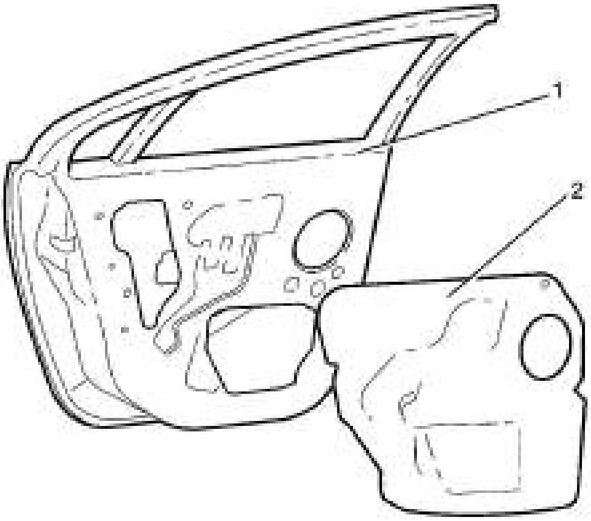


2. Attach the wiring harness to door retaining clip (1).
3. Install the speaker. Refer to Front Side Door Trim Panel Replacement.
4. Install the door trim panel. Refer to Front Side Door Trim Panel Replacement.

Rear Side Door Water Deflector Replacement

Removal Procedure

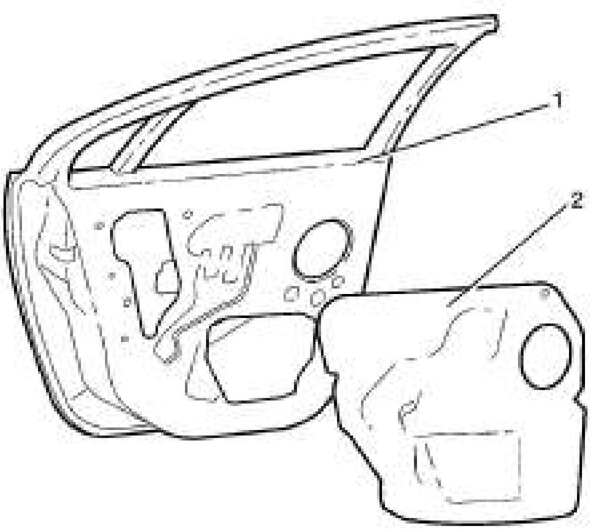
1. Remove the door trim panel. Refer to Rear Side Door Trim Panel Replacement.
2. Remove the speaker. Refer to Radio Rear Side Door Speaker Replacement.



Important: Pull the water deflector (2) from the door (1) to release the adhesive bond.

3. Remove the water deflector (2) from the door (1).

Installation Procedure



Important: Firmly press the water deflector (2) where adhesive is applied to make sure of a water tight seal to the door (1).

1. Install the water deflector (2) to the door (1).
2. Install the speaker. Refer to Radio Rear Side Door Speaker Replacement.
3. Install the door trim panel. Refer to Rear Side Door Trim Panel Replacement.

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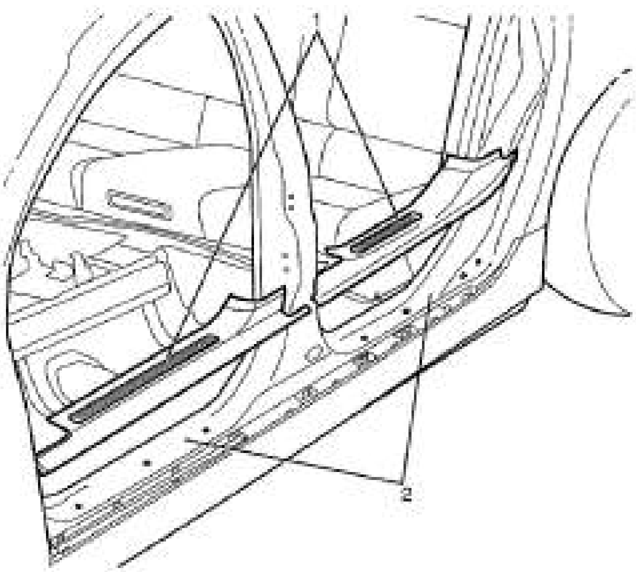
Side Door Sill Nameplate Replacement

Removal Procedure

1. Open the front and rear door.

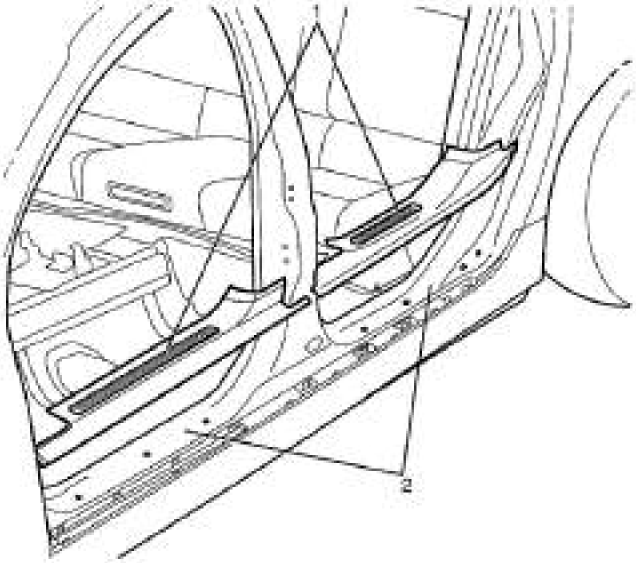
   Caution: Refer to Safety Glasses Caution in the Preface section.



Important: When removing the sill name plates (1), make sure the retaining clips are retained in the sill name plates (1).

2. Using a suitable tool carefully remove the sill name plates (1) from the vehicle (2).

Installation Procedure



Important: Before installing rear side door sill name plates (1), make sure all retaining clips are not damaged, if damaged replace as necessary.

Important: Make sure the lip of the weatherstrip sits over the sill plate.

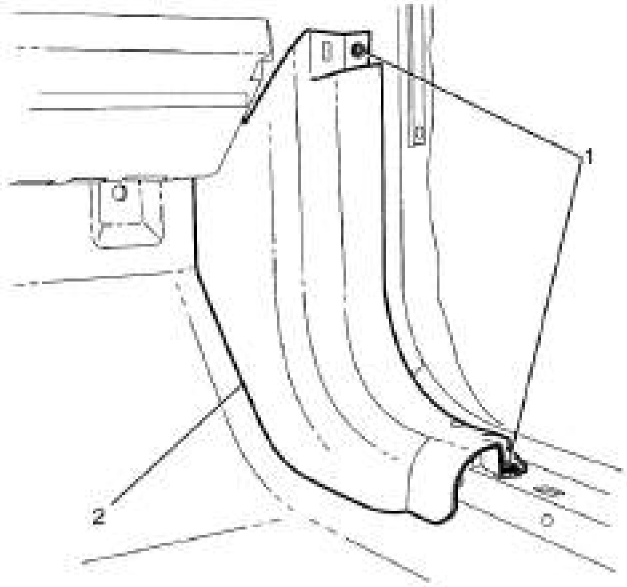
Important: Firmly push down on the sill plates (1) to install. Listen for an audible click to confirm fitting.

1. Install the rear side door sill name plates (1) to the vehicle (2).
2. Close the front and rear door.

Body Hinge Pillar Trim Panel Replacement

Removal Procedure

1. Remove the front sill trim plate. Refer to Front Side Door Sill Plate Replacement.
2. Remove the instrument panel outer trim cover. Refer to Instrument Panel Outer Trim Cover Replacement.

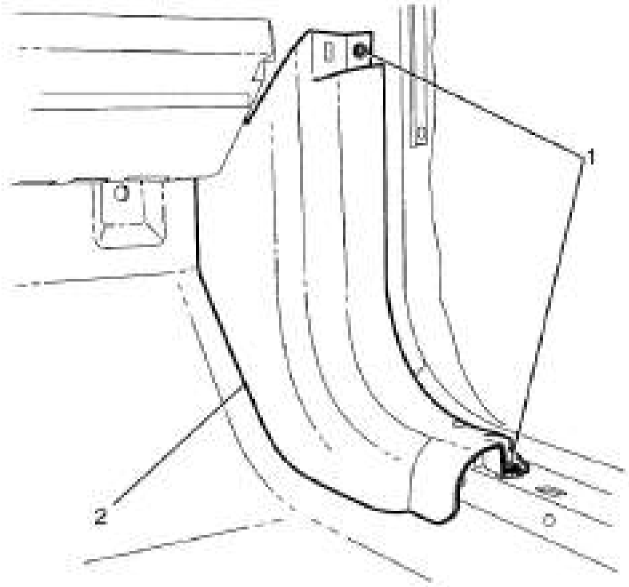


3. Remove the two retaining torx screws (1) from the body hinge pillar trim (2).
4. Disengage the body hinge pillar trim pulling upwards and then rearwards.
5. Remove the body hinge pillar trim assembly.
6. If required, remove the two nut inserts.

Installation Procedure

Important: Ensure the body hinge pillar trim clip is correctly engaged in the A-pillar inner panel.

1. Engage body hinge pillar trim (2) into the A-pillar sheetmetal.



2. Install the two body hinge pillar trim (2) retaining torx screws (1).

   Tighten
   Tighten the hinge pillar trim (2) retaining torx screws (1) to 2.0 N·m (18 lb in).

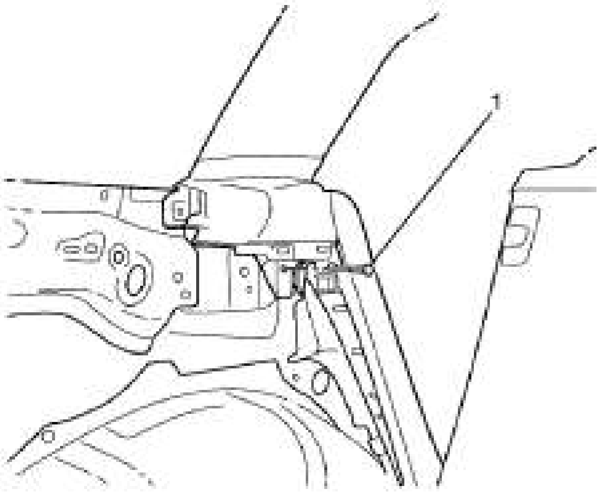
3. Install the instrument panel outer trim cover. Refer to Instrument Panel Outer Trim Cover Replacement.
4. Install the front sill trim plate. Refer to Front Side Door Sill Plate Replacement.

Body Lock Pillar Trim Panel Replacement

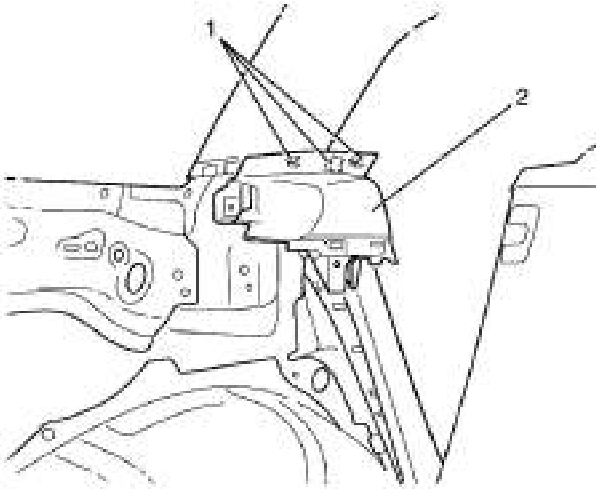
Removal Procedure

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
3. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
4. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
5. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
6. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
7. Remove the body lock pillar lower trim panel. Refer to Body Lock Pillar Lower Trim Panel Replacement.

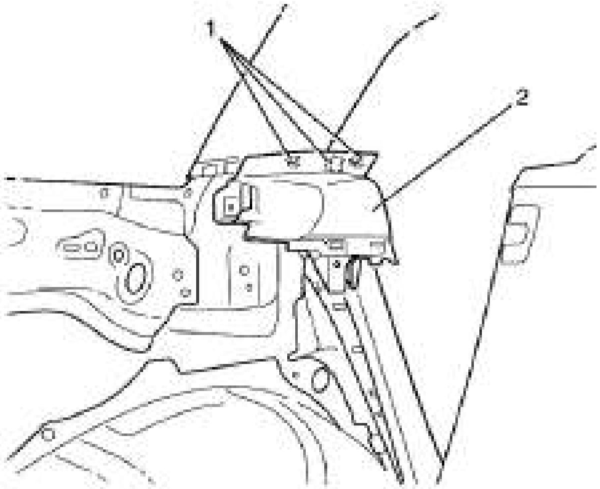


8. Remove the body lock pillar trim panel to body retaining screw (1).



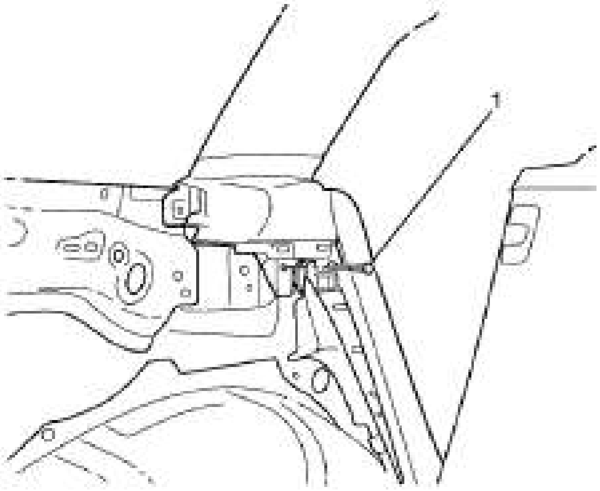
9. Carefully release the body lock pillar trim panel to body retaining clips (1).
10. Remove the body lock pillar trim panel (2) from the vehicle.

Installation Procedure



1. Position the body lock pillar trim panel (2) to the vehicle.
2. Carefully engage the body lock pillar trim panel to body retaining clips (1). An audible click will confirm correct fitment.

Notice: Refer to Fastener Notice in the Preface section.



3. Install the body lock pillar trim panel to body retaining screw (1).

   Tighten
   Tighten the screw to 2 N·m (18 lb in).

4. Install the body lock pillar lower trim panel. Refer to Body Lock Pillar Lower Trim Panel Replacement.
5. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
6. Install the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
7. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
8. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
9. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
10. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.

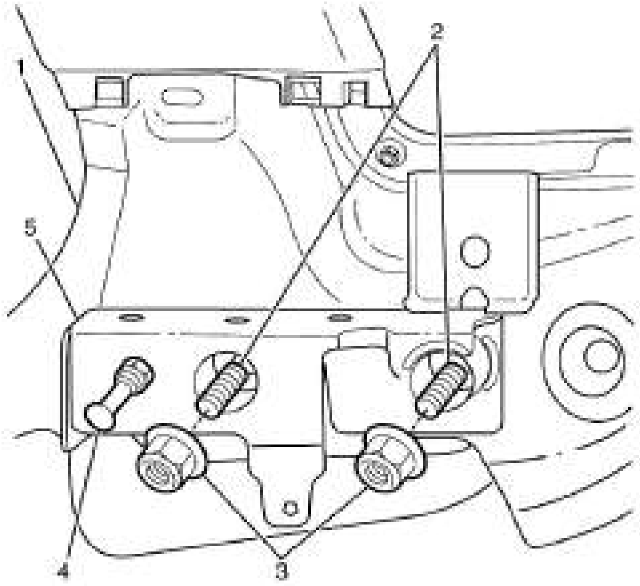
    Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

11. Remove the suitable liftgate brace to the vehicle.

Body Lock Pillar Inner Panel Bracket Replacement

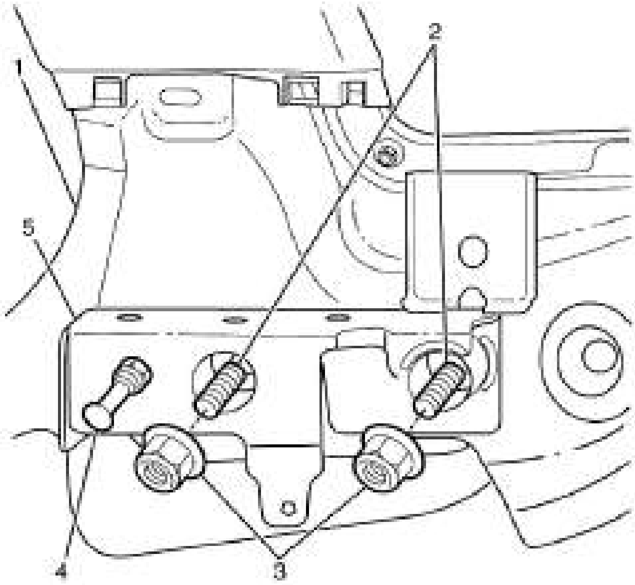
Removal Procedure

1. Remove the rear seat belt. Refer to Rear Seat Belt Replacement.



2. Remove the rear seat back cushion stop striker (4) from the body lock pillar inner panel bracket (5).
3. Remove the body lock pillar inner panel bracket nuts (3) from the body lock pillar inner panel bracket retaining studs (2).
4. Remove the body lock pillar inner panel bracket (5) from the vehicle body (1).

Installation Procedure



1. Install the body lock pillar inner panel bracket (5) to the vehicle body (1).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the body lock pillar inner panel bracket nuts (3) to the body lock pillar inner panel bracket retaining studs (2).

   Tighten
   Tighten the nuts to 35 N·m (26 lb ft).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the rear seat back cushion stop striker (4) to the body lock pillar inner panel bracket (5).

   Tighten
   Tighten the striker to 70 N·m (52 lb ft).

4. Install the rear seat belt. Refer to Rear Seat Belt Replacement.

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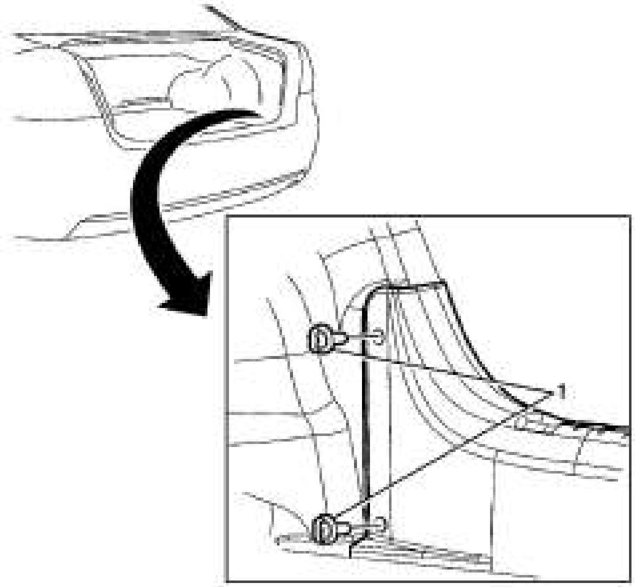
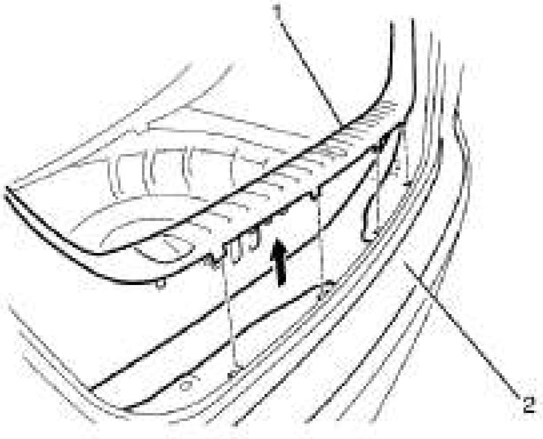
Rear Compartment Trim Panel Replacement

Removal Procedure

1. Remove the convenience net (if fitted). Refer to Rear Compartment Stowage Tray Net Replacement .
2. Remove the rear carpet. Refer to Rear Compartment Floor Panel Carpet Replacement .



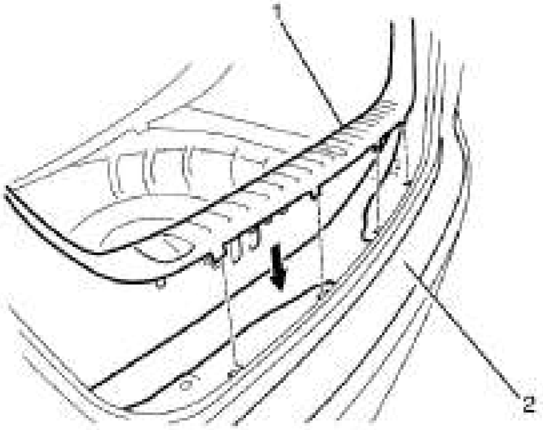
3. Remove the four convenience net retaining hooks (1) or the four fir tree retainers.



Important: Pull the end panel (1) to disengage the end panel retaining pins.

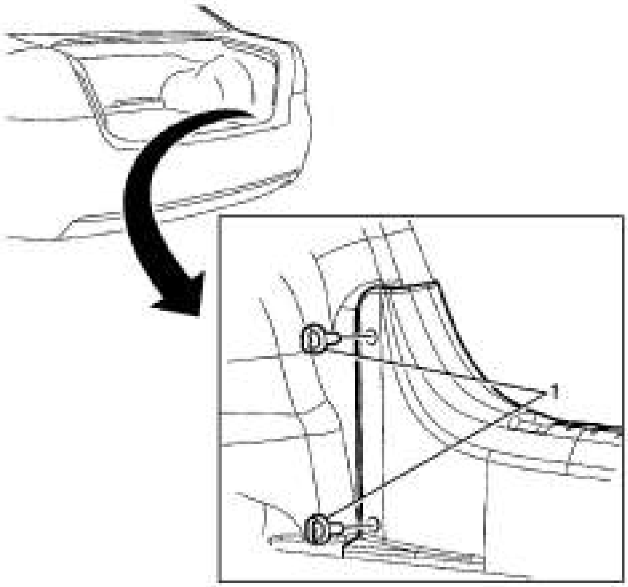
4. Remove the end panel (1) from the vehicle (2).

Installation Procedure



Important: Push the end panel (1) to engage the end panel retaining pins.

1. Install the end panel (1) to the vehicle (2).



2. Install the four convenience net retaining hooks (1) or the four fir tree retainers.
3. Install the rear carpet. Refer to Rear Compartment Floor Panel Carpet Replacement .
4. Install the convenience net (if fitted). Refer to Rear Compartment Stowage Tray Net Replacement .

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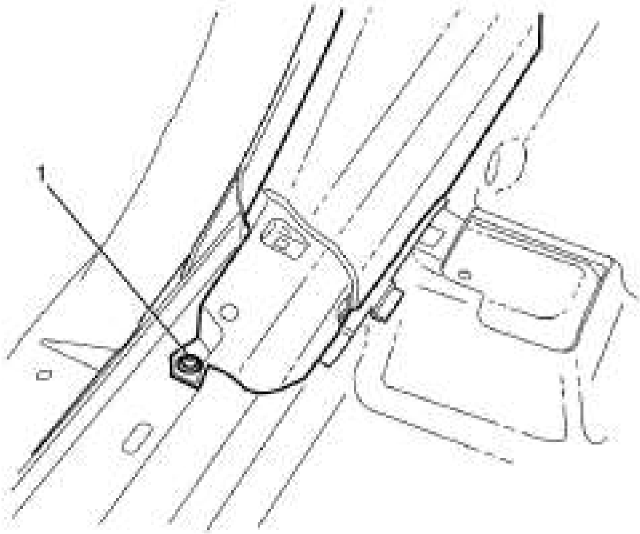
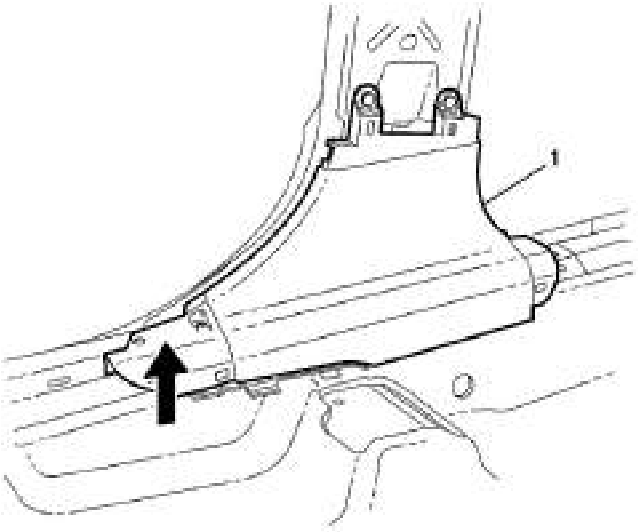
Door Sill Plate Replacement

Removal Procedure

1. Remove the centre pillar lower trim. Refer to Center Pillar Lower Trim Panel Replacement.
2. Remove the front sill trim plate. Refer to Front Side Door Sill Plate Replacement.
3. Remove the rear sill trim plate. Refer to Rear Side Door Sill Plate Replacement.



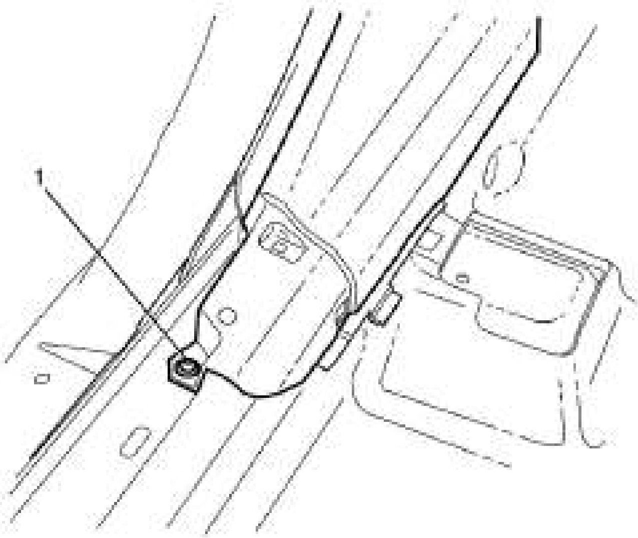
4. Remove the centre trim panel torx screw (1).



Important: When removing the centre sill trim panel, ensure the two white retaining clips at the top of the part remain in the sheet metal.

5. Remove the centre sill trim panel (1).

Installation Procedure



Important: Before installing trims, ensure all retaining clips are not damaged, if damaged replace as necessary.

1. Install the centre sill trim panel.
2. Install the centre sill trim panel torx screw

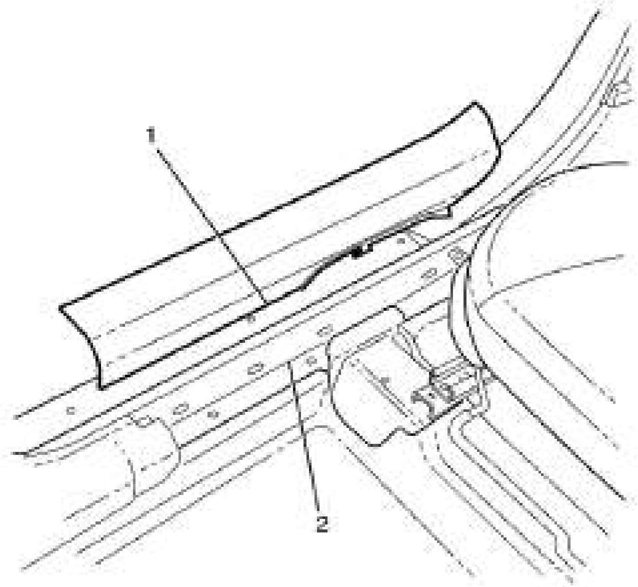
Tighten
Tighten the centre sill trim panel torx screw (1) to 2.0 N·m (18 lb in).

3. Install the rear sill trim plate. Refer to Rear Side Door Sill Plate Replacement.
4. Install the front sill trim plate. Refer to Front Side Door Sill Plate Replacement.
5. Install the centre pillar lower trim. Refer to Center Pillar Lower Trim Panel Replacement.

Front Side Door Sill Trim Plate Replacement

Removal Procedure

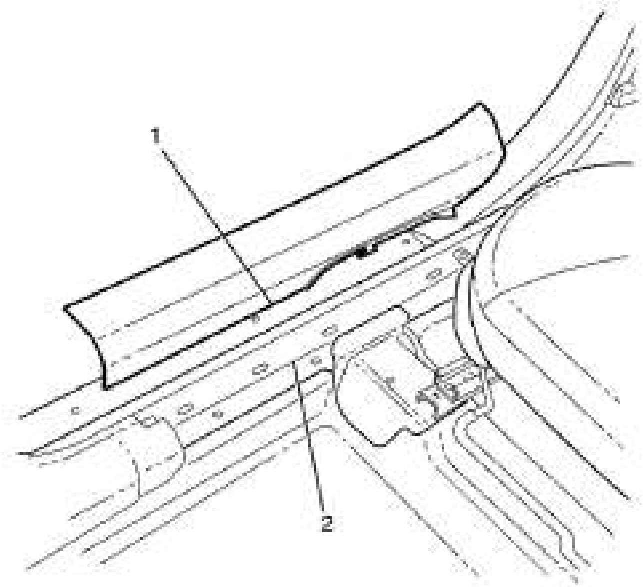
1. Remove the seat outer adjuster rear finish cover. Refer to Driver or Passenger Seat Outer Adjuster Rear Finish Cover Replacement.
2. Remove the seat outer adjuster front finish cover. Refer to Driver or Passenger Seat Outer Adjuster Front Finish Cover Replacement.



Important: While carrying out the following procedure, take care not to damage the sill panel trim (1).

3. Carefully disengage the front sill panel trim (1) from the sill (2).
4. Remove the front sill panel trim (1).

Installation Procedure

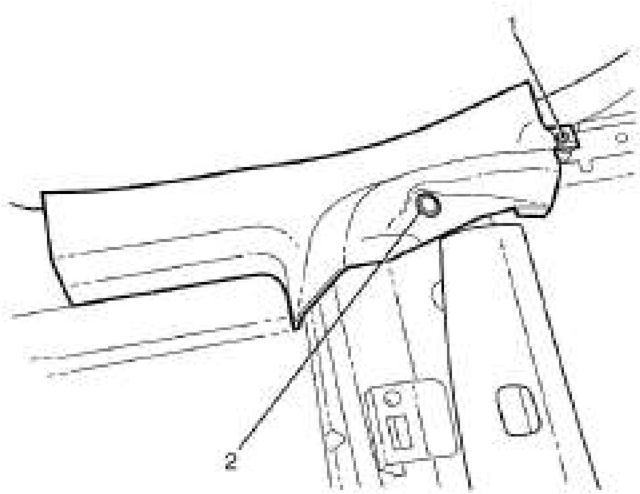


1. Install the front sill trim panel (1) to the sill (2).
2. Install the seat outer adjuster front finish cover. Refer to Driver or Passenger Seat Outer Adjuster Front Finish Cover Replacement.
3. Install the seat outer adjuster rear finish cover. Refer to Driver or Passenger Seat Outer Adjuster Rear Finish Cover Replacement.

Rear Side Door Sill Trim Plate Replacement

Removal Procedure

1. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement.

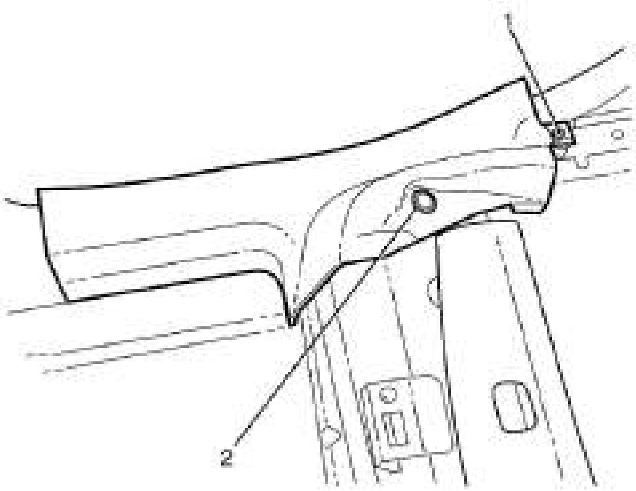


2. Remove the retaining torx screw (1) from the rear sill panel trim.
3. Remove the retaining pin (2) and remove the rear sill panel trim by pulling from the lower edge and disengaging the retaining clips.

Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.

1. Install the rear sill panel trim.



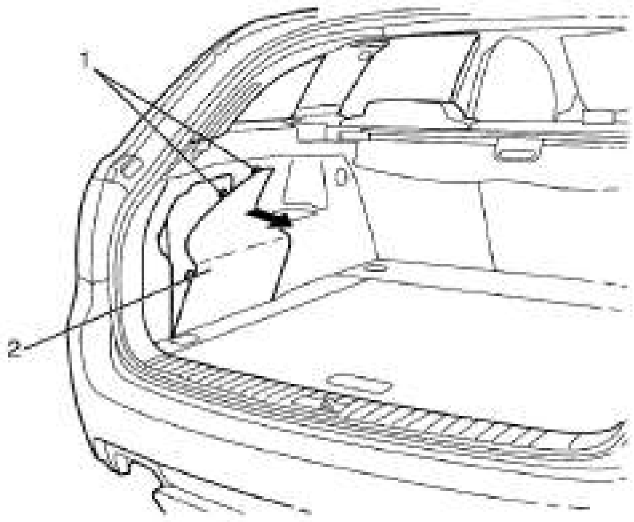
2. Install the rear sill panel trim retaining torx screw (1).

   Tighten
   Tighten the torx screw (1) to 2.0 N·m (18 lb in).

3. Install the rear sill panel trim retaining pin (2).
4. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.

Rear Compartment Side Trim Panel Access Hole Cover Replacement

Removal Procedure - Left Side

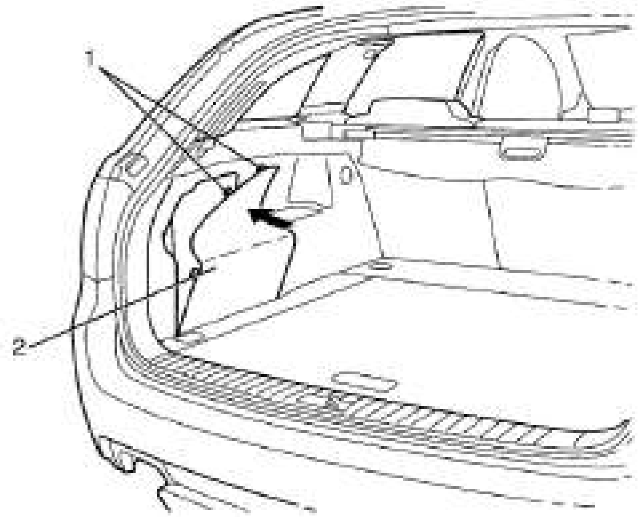


Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

Important: Push down on the centre of the rear compartment side trim panel access hole cover and pull on the top of the cover to release the upper retaining tangs.

1. Install a suitable liftgate brace to the vehicle.
2. Carefully disengage the rear compartment side trim panel access hole cover retaining tangs (1).
3. Remove rear compartment side trim panel access hole cover (2) from the vehicle.

Installation Procedure - Left Side

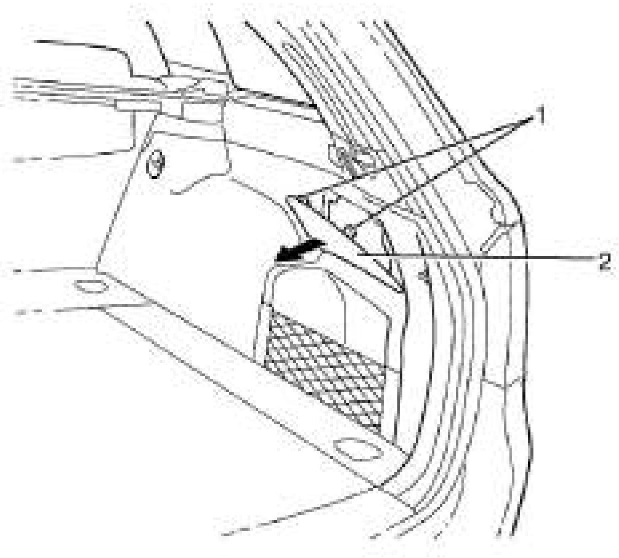


Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

Important: Insert the locating tabs on the bottom of the rear compartment side trim panel access hole cover then push the top of the rear compartment side trim panel access hole cover to engage the retaining tangs.

1. Position the rear compartment side trim panel access hole cover (2) to the vehicle.
2. Carefully engage the rear compartment side trim panel access hole cover retaining tangs (1). An audible click will confirm correct fitment.
3. Remove the suitable liftgate brace from the vehicle.

Removal Procedure - Right Side

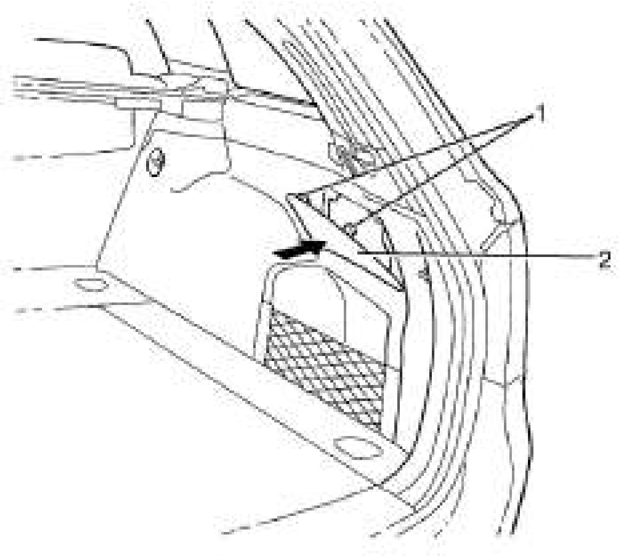


Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

Important: Push down on the centre of the tail lamp access cover trim panel and pull on the top of the tail lamp access cover trim panel to release the retaining tangs.

1. Install a suitable liftgate brace to the vehicle.
2. Carefully disengage the tail lamp access cover trim panel retaining tangs (1).
3. Remove tail lamp access cover trim panel (2) from the vehicle.

Installation Procedure - Right Side



Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

Important: Insert the locating tabs on the bottom of the tail lamp access cover trim panel then push the top of the tail lamp access cover trim panel to engage the retaining tangs.

1. Position the tail lamp access cover trim panel (2) to the vehicle.
2. Carefully engage the tail lamp access cover trim panel retaining tangs (1). An audible click will confirm correct fitment.
3. Remove the suitable liftgate brace from the vehicle.

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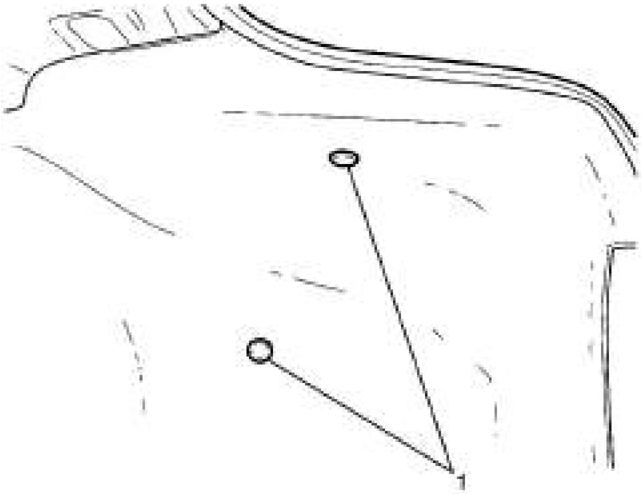
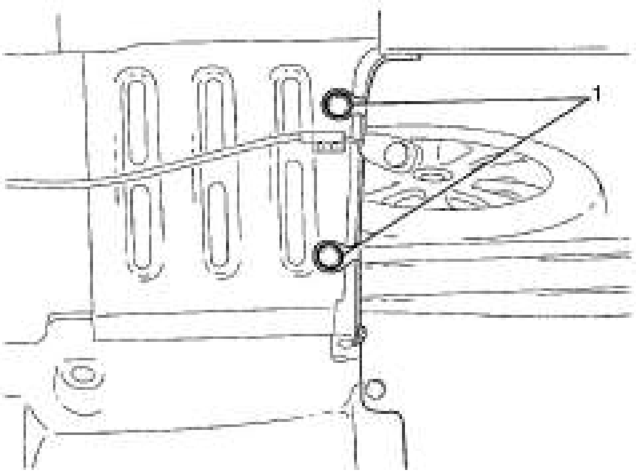
Rear Compartment Side Trim Panel Replacement

Removal Procedure (Up to 13 Jun 2007)

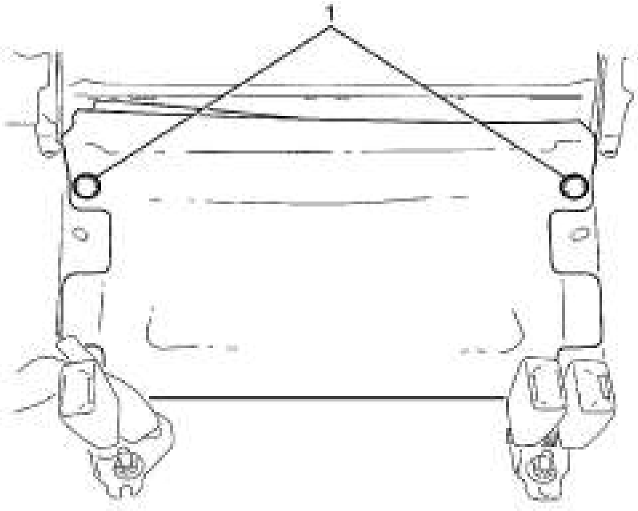
1. Remove the convenience net (if fitted). Refer to Rear Compartment Stowage Tray Net Replacement.
2. Remove the rear carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
3. Remove the rear end panel trim. Refer to Rear Compartment Trim Panel Replacement.
4. Remove the seat back assembly. Refer to Rear Seat Back Replacement.



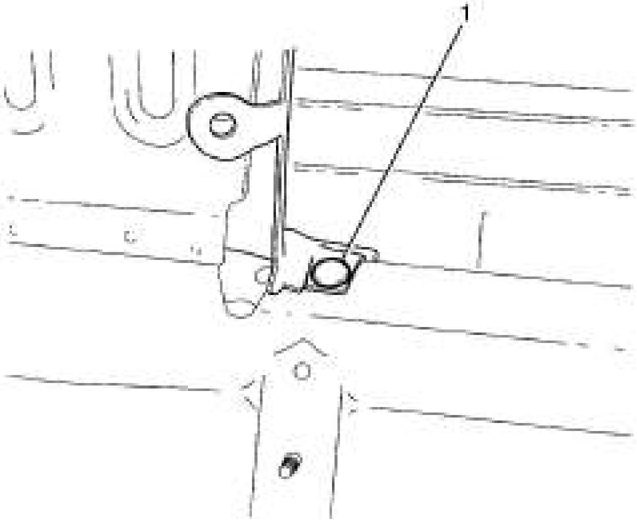
5. Remove the two carpet retainers (1) securing the rear quarter panel side carpet. The left side is shown, the right side is similar.



6. Remove the two carpet retainers (1) securing the rear quarter panel side carpet, which are located inside of the vehicle.

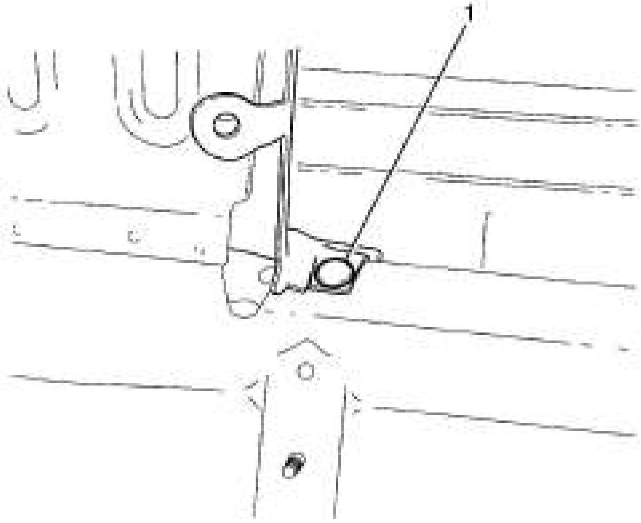


7. Remove the two carpet retainers (1) securing the centre panel carpet.

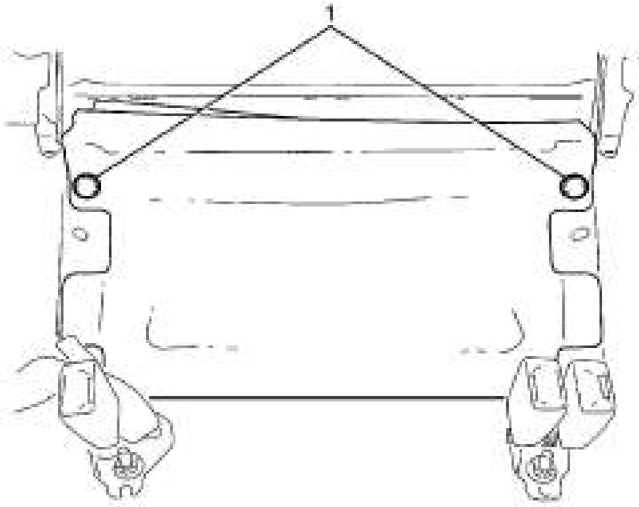


8. Remove the quarter panel side carpet retainer (1) securing the rear quarter panel side carpet.
9. Remove the quarter panel side carpet.
10. Carry out this procedure for the opposite side.

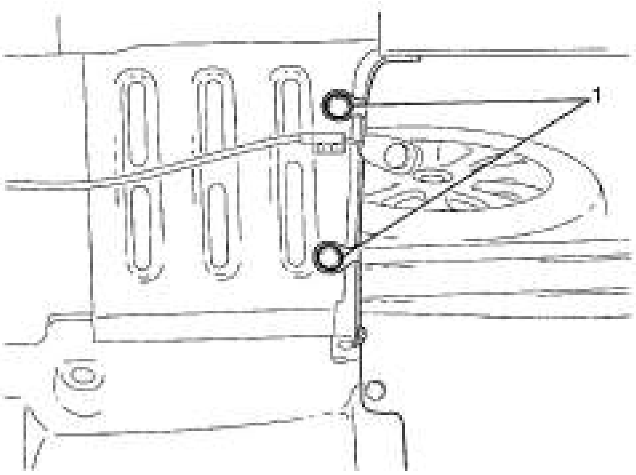
Installation Procedure (Up to 13 Jun 2007)



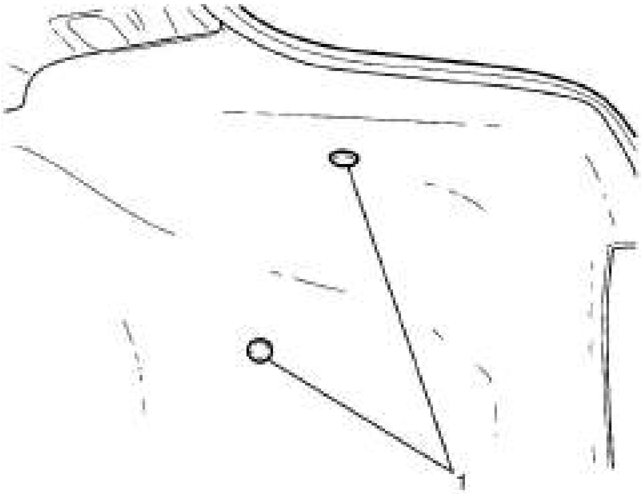
1. Install the quarter panel side carpet.
2. Install the quarter panel side carpet retainer (1).



3. Install the two carpet retainers (1) to secure the centre panel carpet.



4. Install the two carpet retainers (1) securing the rear quarter panel side carpet.

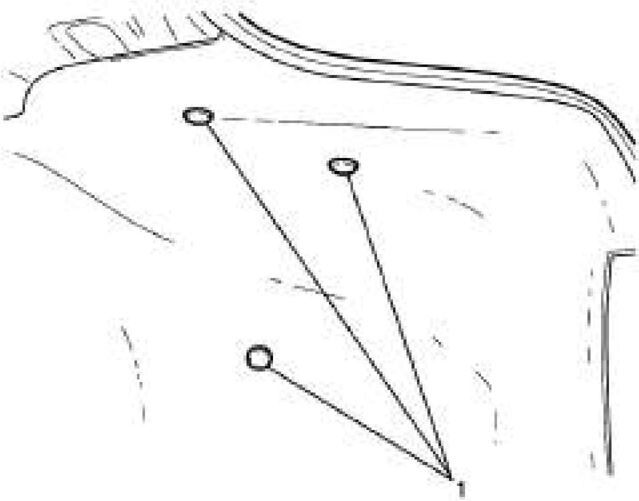


5. Install the two carpet retainers securing the rear quarter panel side carpet.
6. Ensure the carpet has a flush finish with the quarter panel.
7. Install the seat back assembly. Refer to Rear Seat Back Replacement.
8. Install the rear end panel trim. Refer to Rear Compartment Trim Panel Replacement.
9. Install the rear carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
10. Install the convenience net. Refer to Rear Compartment Stowage Tray Net Replacement.

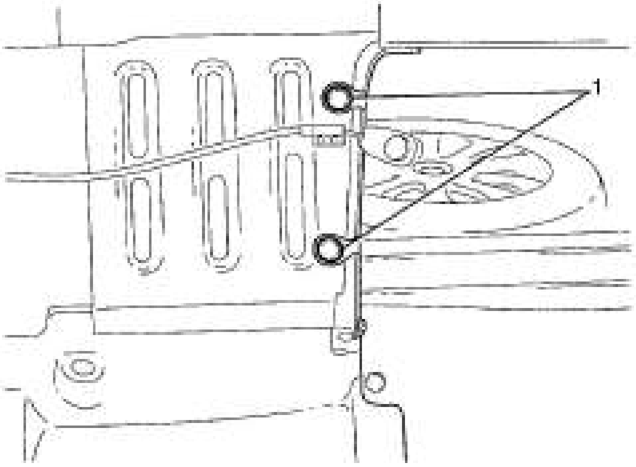
Removal Procedure (From 13 Jun 2007)

1. Remove the convenience net (if fitted). Refer to Rear Compartment Stowage Tray Net Replacement.
2. Remove the rear carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.

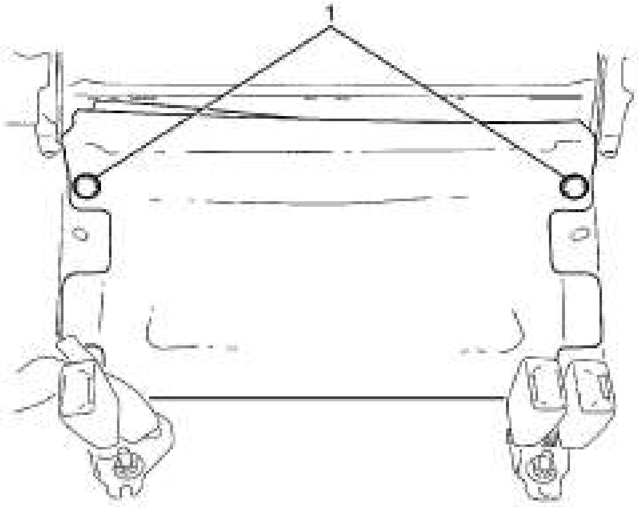
3. Remove the rear end panel trim. Refer to Rear Compartment Trim Panel Replacement.
4. Remove the seat back assembly. Refer to Rear Seat Back Replacement.



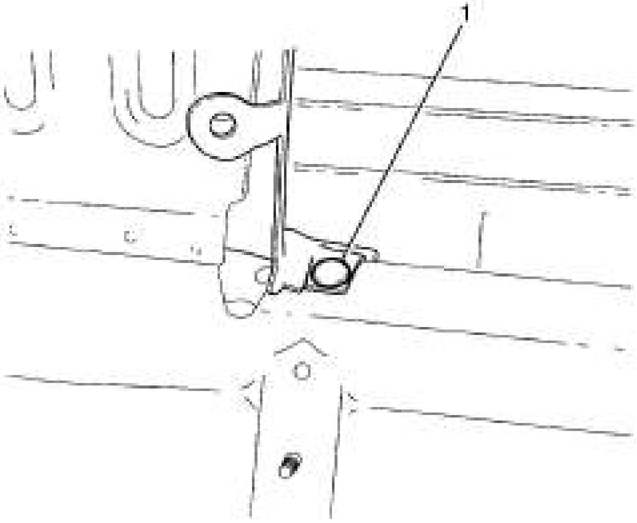
5. Remove the three carpet retainers (1) securing the rear quarter panel side carpet. The right side is shown, the left side is similar.



6. Remove the two carpet retainers (1) securing the rear quarter panel side carpet, which are located inside of the vehicle.



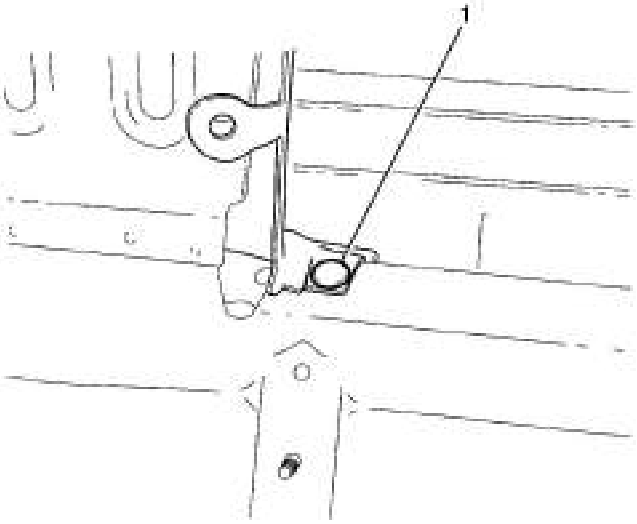
7. Remove the two carpet retainers (1) securing the centre panel carpet.



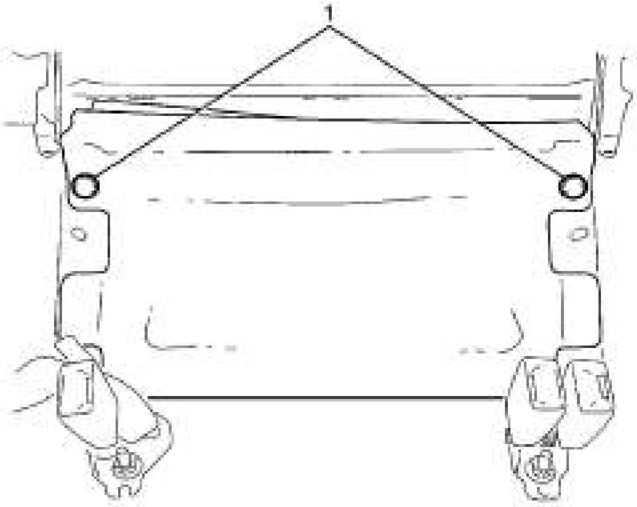
8. Remove the quarter panel side carpet retainer (1) securing the rear quarter panel side carpet.
9. Remove the quarter panel side carpet.
10. Carry out this procedure for the opposite side.

Installation Procedure (From 13 Jun 2007)

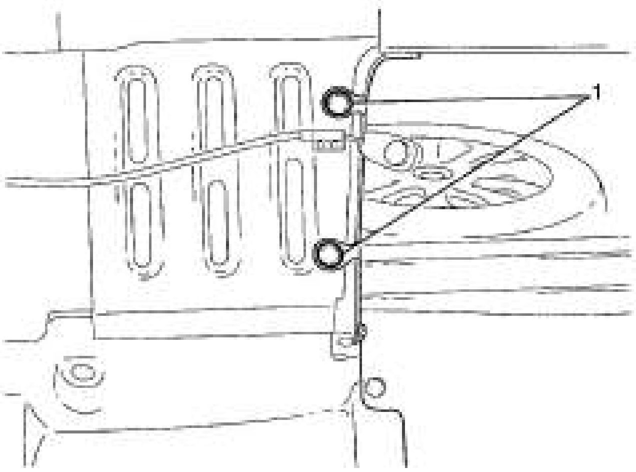
1. Install the quarter panel side carpet.



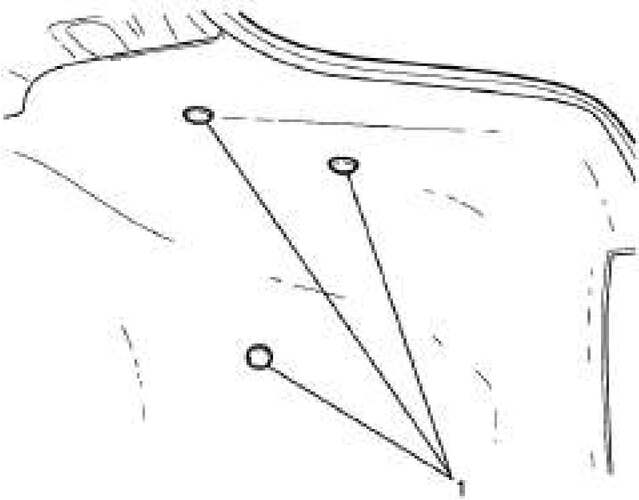
2. Install the quarter panel side carpet retainer (1).



3. Install the two carpet retainers (1) to secure the centre panel carpet.



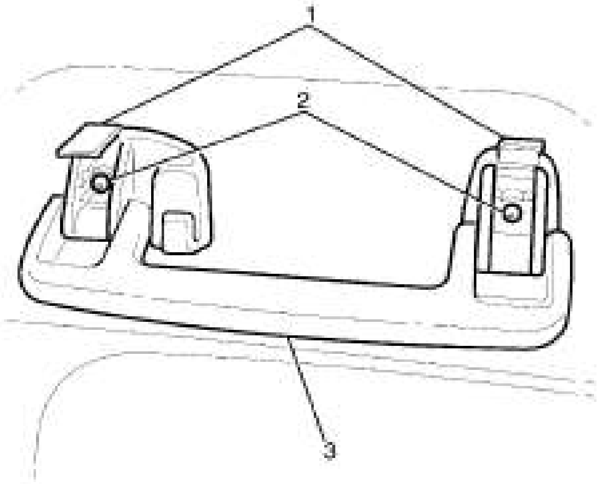
4. Install the two carpet retainers (1) securing the rear quarter panel side carpet.



5. Install the three carpet retainers (1) securing the rear quarter panel side carpet.
6. Make sure the carpet has a flush finish with the quarter panel.
7. Install the seat back assembly. Refer to Rear Seat Back Replacement.
8. Install the rear end panel trim. Refer to Rear Compartment Trim Panel Replacement.
9. Install the rear carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
10. Install the convenience net. (If fitted). Refer to Rear Compartment Stowage Tray Net Replacement..

Assist Handle Replacement

Removal Procedure - Up to xx/xx

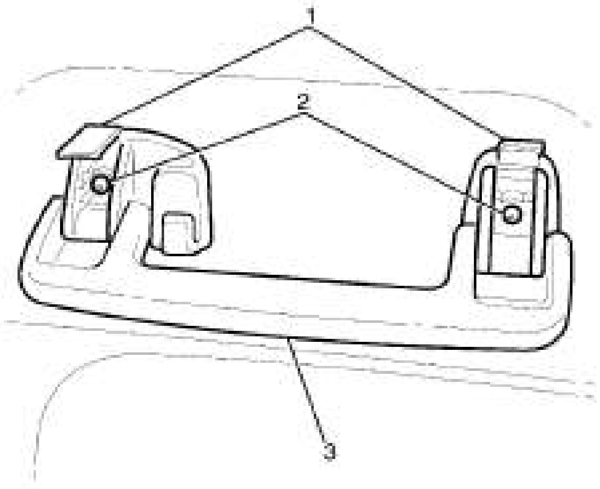


1. Pull the assist handle (3) into the down position.
2. Prise open the assist handle screw covers (1).
3. Remove the two retaining torx screws (2).

Important: When removing the assist handle assembly, take care not to damage the locating pins.

4. Remove the assist handle assembly (3).

Installation Procedure Up to xx/xx



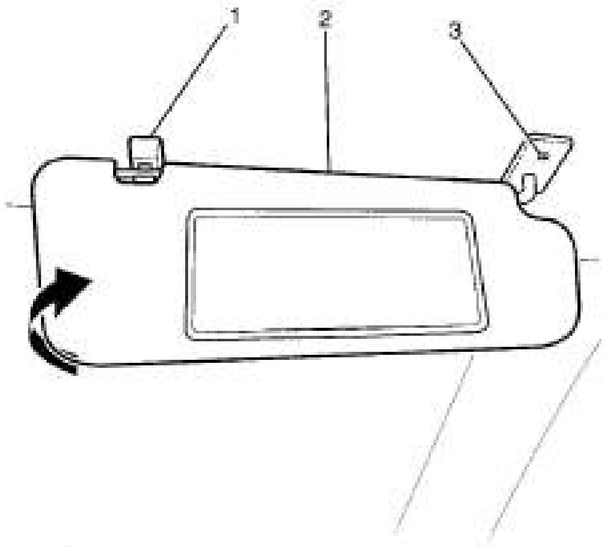
1. Install the assist handle assembly (3) ensuring that the locating pins are correctly aligned with the locating holes and spacer behind the headlining.
2. Install the assist handle retaining screws (2).

   Tighten
   Tighten the assist handle retaining screws to 2.0 N·m (18 lb in).

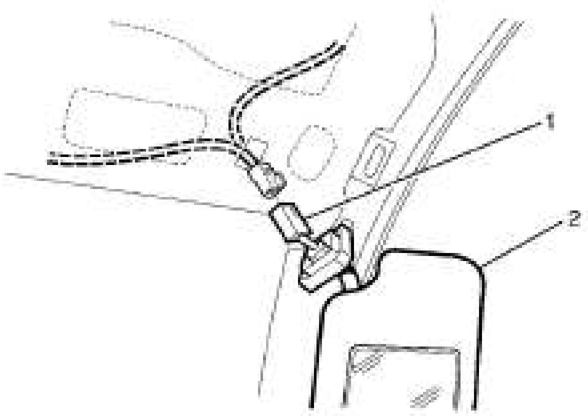
3. Close the assist handle screw covers (1).

Sunshade Replacement

Removal Procedure

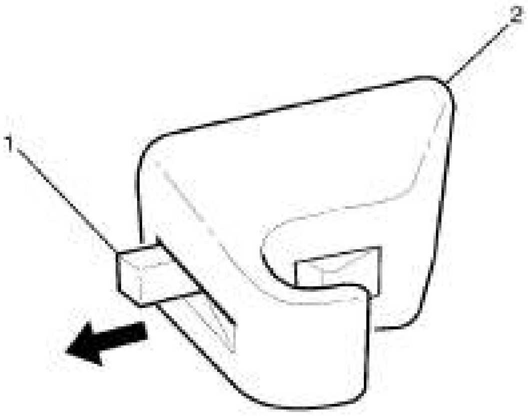


1. Detach the sunshade assembly (2) from the sunshade support (1) and rotate to gain access.
2. Remove the retaining screw (3) attaching the sunshade assembly to the head lining assembly.



3. Pull the sunshade assembly (2) away from the roof lining assembly and disconnect the sun shade assembly electrical connection (1).

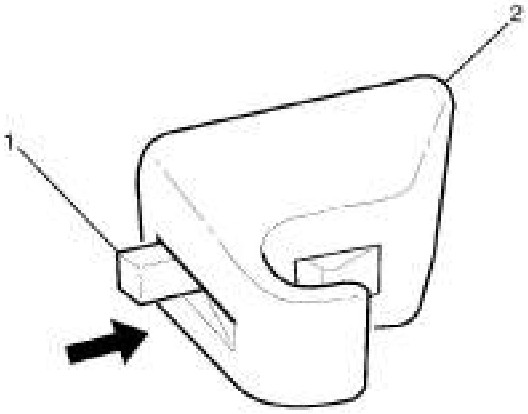
4. Remove the sunshade assembly (2). The right side is shown, the left side is the same.



Important: Take care not to loose the sunshade support retaining mechanism and spring.

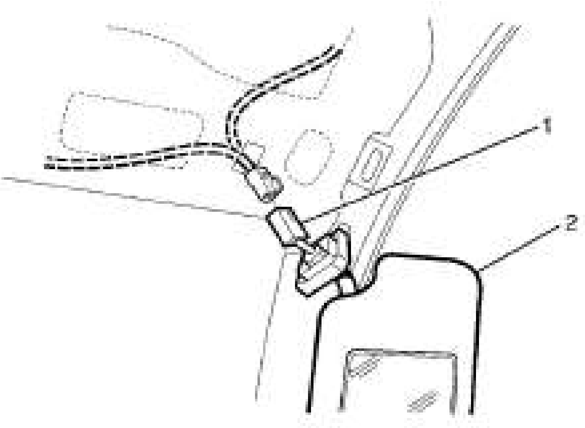
5. Remove the retaining pin (1) attaching the sunshade support (2) to the sunshade retainer.
6. Remove the sunshade support.

Installation Procedure

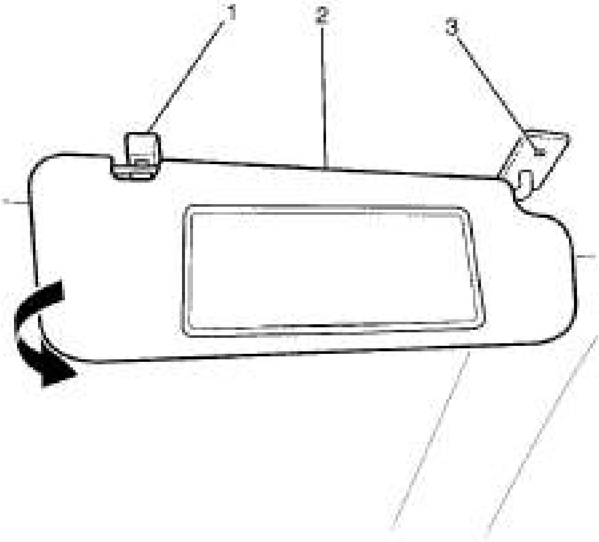


Important: When installing the sunshade, ensure the pivot line is vertical.

1. Install the sunshade support (2) by inserting the sunshade support retaining pin (1).



2. Connect the sun shade assembly (2) electrical connector (1).



3. Rotate the sunshade assembly (2) and install it into the sunshade support (1).

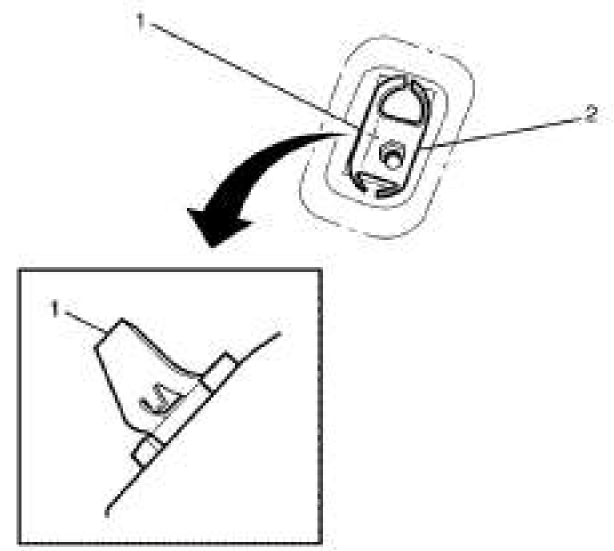
   Tighten
   Tighten the torx screw (3) to 2.0 N·m (18 lb in).

4. Install the sunshade assembly (2) into the sunshade support (1).
5. Test sunshade for correct operation.

Sunshade Retainer Bezel Replacement

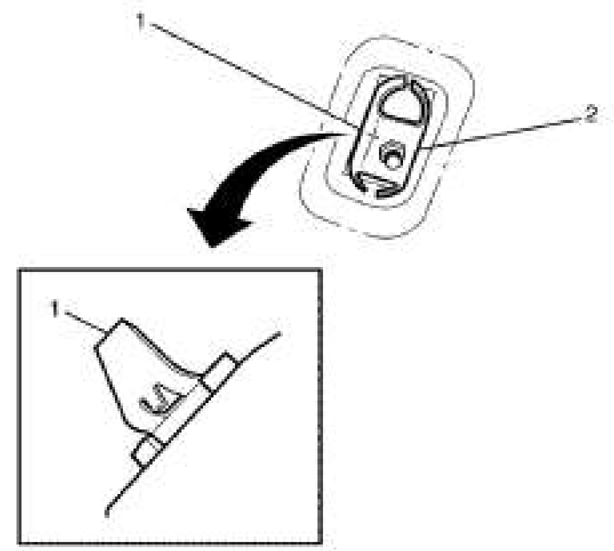
Removal Procedure

1. Remove the sunshade assembly. Refer to Sunshade Replacement.



2. Using a suitable screwdriver, release the retaining tabs (1) on the retainer (2).
3. Remove the retainer (2).

Installation Procedure



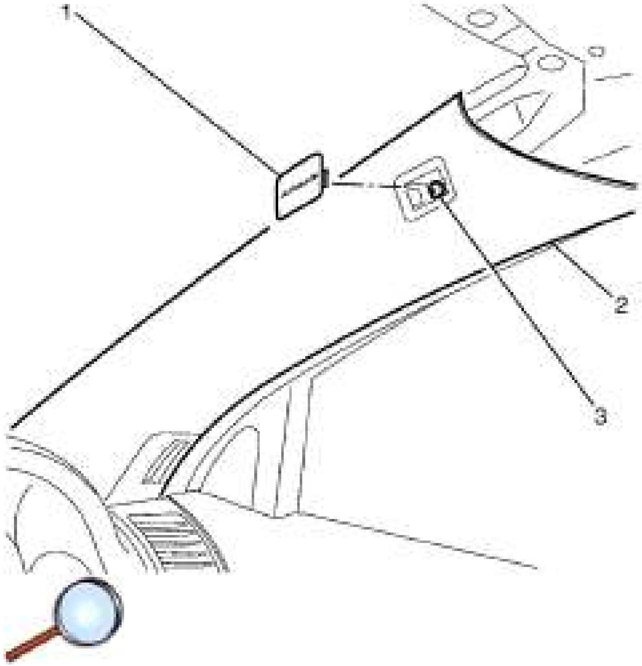
1. Install the sunshade retainer (2) by inserting the retaining tabs (1) into the roof panel, listen for an audible click to confirm fitting.
2. Install the sunshade assembly. Refer to Sunshade Replacement.

Windshield Garnish Molding Replacement

Removal Procedure

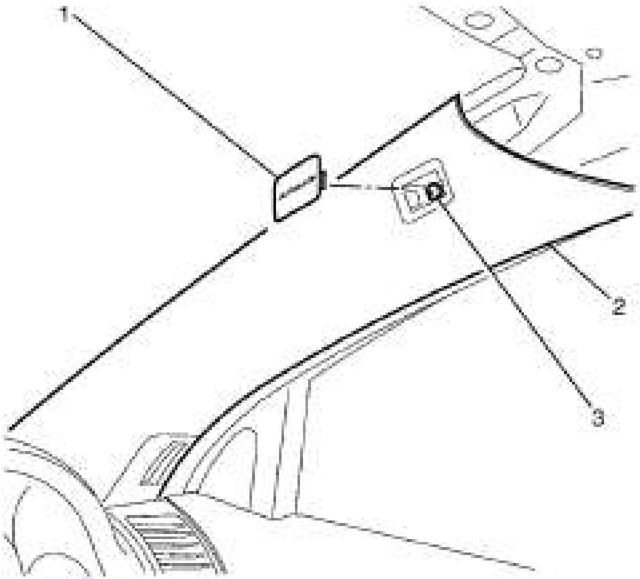
Important: If vehicle is equipped with side curtain air bags. Refer to SIR Caution .

1. Remove the defroster grille. Refer to Defroster Grille Replacement .
2. Partially detach the weatherstrip. Refer to Front Door Opening Weatherstrip Replacement .



3. Unclip the retaining torx screw cover (1) from the windshield garnish moulding (2).
4. Remove the retaining torx screw (3) from the windshield garnish moulding (2).
5. Carefully disengage the windshield garnish moulding (2) from the A pillar body panel.
6. Remove the windshield garnish moulding (2).

Installation Procedure



1. Install the windshield garnish moulding (2) ensuring the bottom edge is correctly located in the Instrument panel trim.
2. Engage the windshield garnish moulding (2) to the A-pillar body panel.

   Important: Make sure the Roof Rail Module tether is routed below the screw attachment clip and pin feature on the windshield garnish moulding when replacing this garnish. Roof Rail Air Bag deployment maybe inhibited if incorrectly installed.

3. Install the windshield garnish moulding (2) retaining torx screw (3).

   Tighten
   Tighten the retaining torx screw to 2.0 N·m (18 lb in).

4. Install the retaining torx screw cover (1).
5. Attach the weatherstrip. Refer to Front Door Opening Weatherstrip Replacement .
6. Install the defroster grille. Refer to Defroster Grille Replacement .

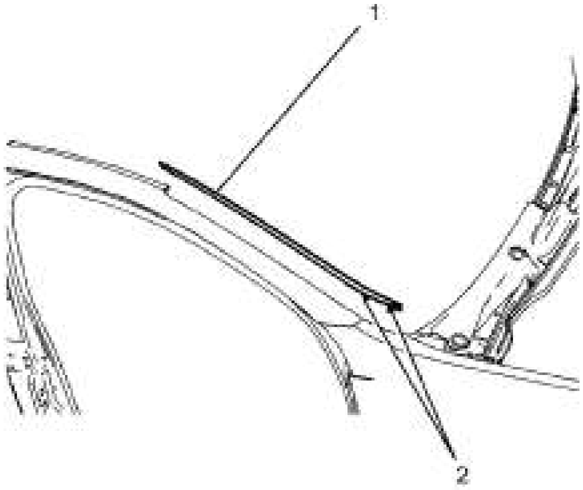
Windshield Pillar Garnish Molding Replacement

Removal Procedure

Caution: Refer to Glass and Sheet Metal Handling Caution in the Preface section.

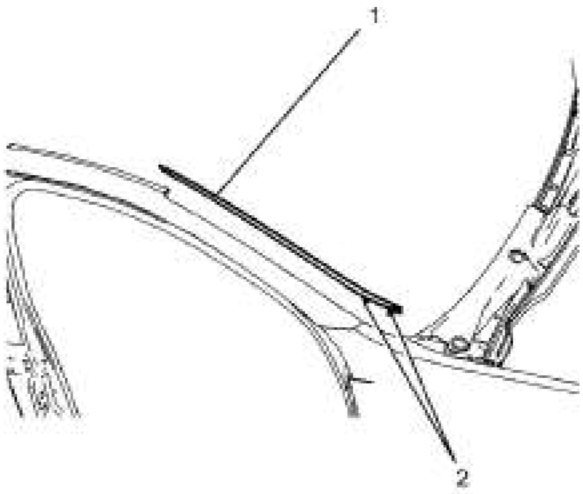
Important: Take care not to damage the paint on the vehicle when prying the windshield pillar garnish moulding from the windshield pillar.

1. Use a suitable tool to carefully pry the windshield pillar garnish moulding front from the windshield pillar.



2. Remove the windshield pillar garnish moulding by sliding the moulding towards the roof, to remove the retaining tabs (2) from the fender.
3. Remove the windshield pillar garnish moulding (1) from the vehicle.

Installation Procedure



Important: Align the locating marks on the reveal moulding (2) with the locating marks on the windshield .

1. Install the windshield pillar garnish moulding retaining tabs (2) to the fender.
2. Install the windshield pillar garnish moulding to the retaining clip on the windshield pillar.
3. Slide the windshield pillar garnish moulding towards the roof weld joint reveal moulding until the windshield pillar garnish moulding is flush with the roof weld joint reveal moulding.

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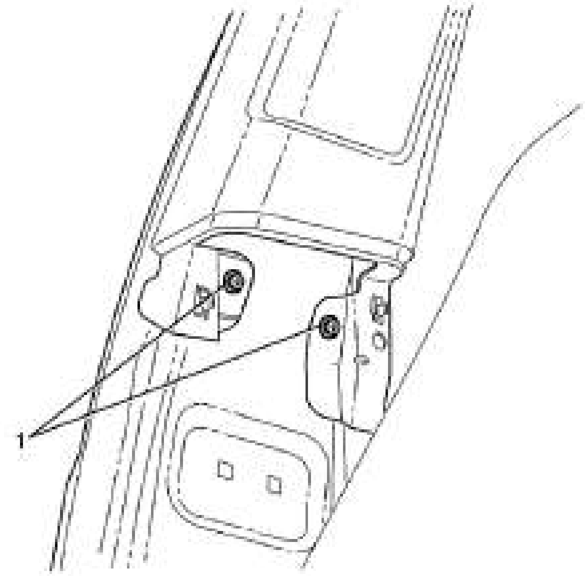
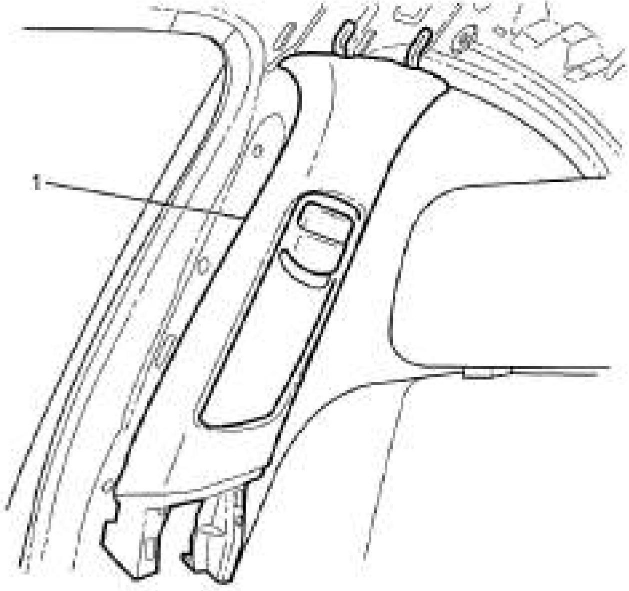
Center Pillar Upper Trim Panel Replacement

Removal Procedure

1. Remove the centre pillar lower trim. Refer to Center Pillar Lower Trim Panel Replacement.
2. Remove the lower seat belt bolt. Refer to Front Seat Belt Replacement.



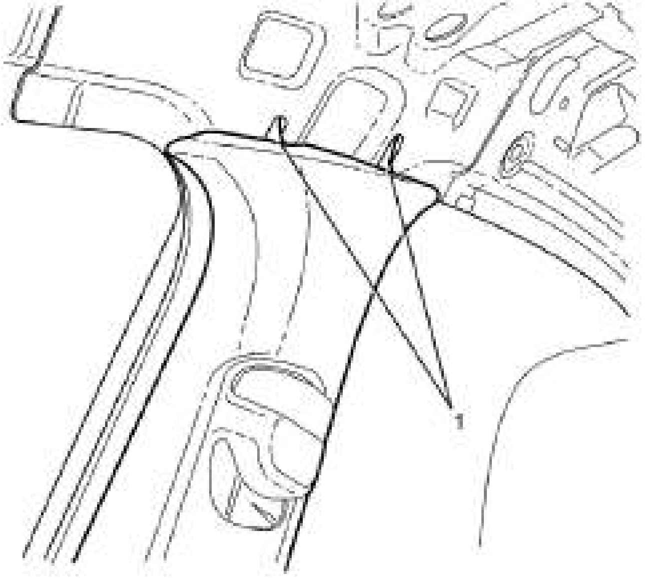
3. Remove the centre trim panel retaining torx screws (1).



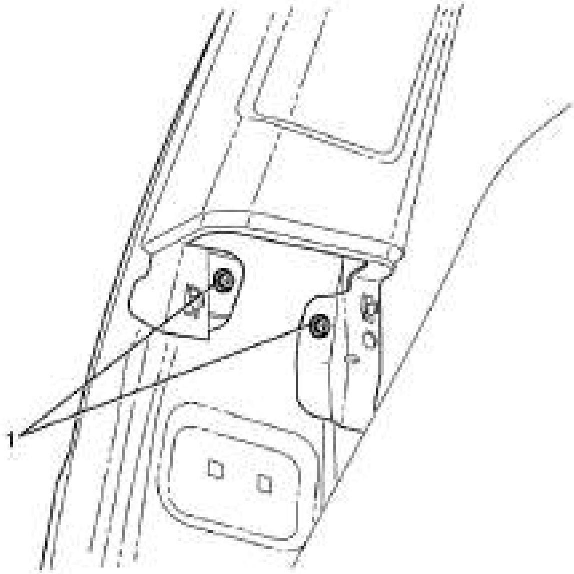
4. Detach the trim panel (1) from the B pillar by pulling inwards then downwards.

Installation Procedure

1. Move height adjuster to the upper position.
2. Move B pillar slide to the upper position.



3. Install the trim panel, by inserting the locating pins (1) into the roof panel first.
4. Line up pin on trim to slot in height adjuster.
5. Ensure main datum pin is correctly assembled into the datum hole.



6. Install the centre trim panel retaining torx screws (1).

   Tighten
   Tighten the centre trim panel retaining torx screws to 2.0 N·m (18 lb in).

7. Install the lower seat belt bolt. Refer to Front Seat Belt Replacement.
8. Install the centre pillar lower trim. Refer to Center Pillar Lower Trim Panel Replacement.

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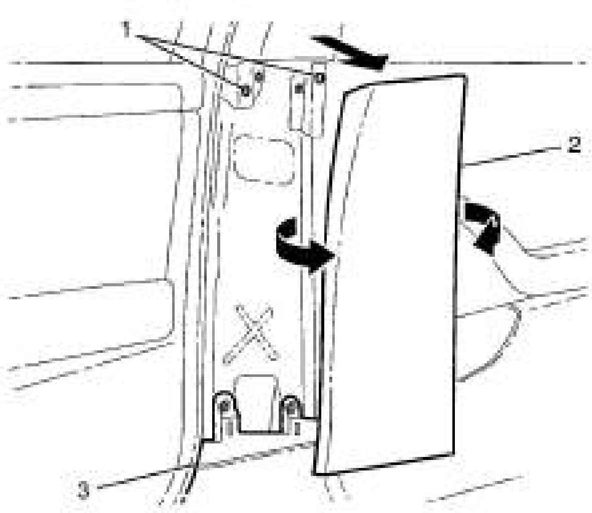
Center Pillar Lower Trim Panel Replacement

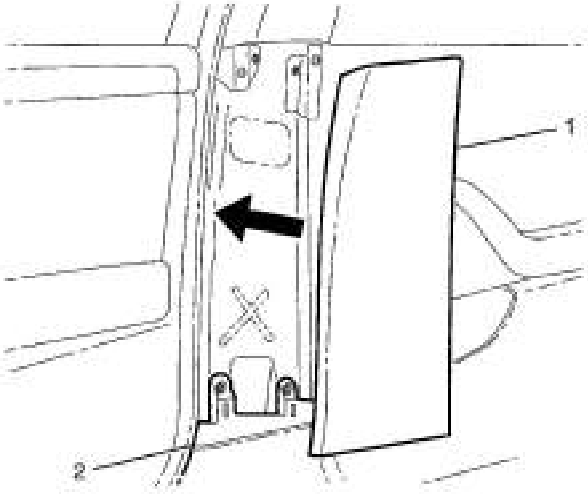
Removal Procedure

1. Partially detach the weatherstrip. Refer to Front Door Opening Weatherstrip Replacement .
2. Partially detach the weatherstrip. Refer to Rear Door Opening Weatherstrip Replacement .



3. Grasp both sides at the top of the trim panel (2) and while spreading, pull away from the door opening, disengaging the trim clip (1).
4. Pull the trim panel inward out of the lower sill trim panel (3) and remove.

Installation Procedure



1. Install the top edge of the centre trim panel (1) into upper sill trim panel.

   Important: Make sure datum pins on the lower trim panel (2) line up with the hole on the upper trim.

2. Firmly push in lower section of the trim panel (1).
3. Attach the weatherstrip. Refer to Rear Door Opening Weatherstrip Replacement .
4. Attach the weatherstrip. Refer to Front Door Opening Weatherstrip Replacement .

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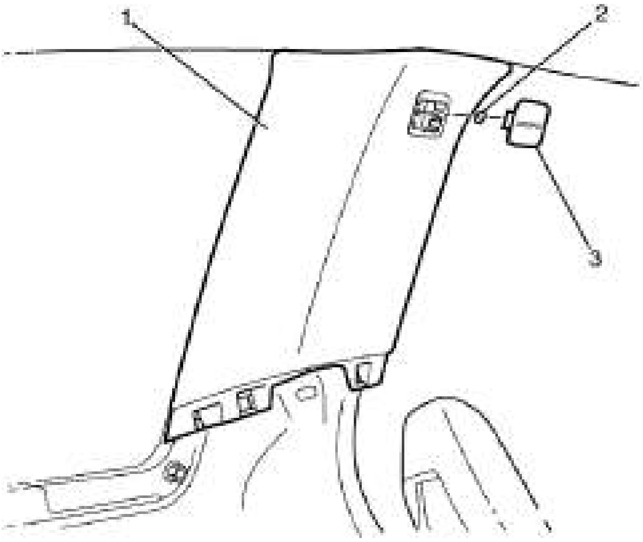
Body Lock Pillar Upper Trim Panel Replacement

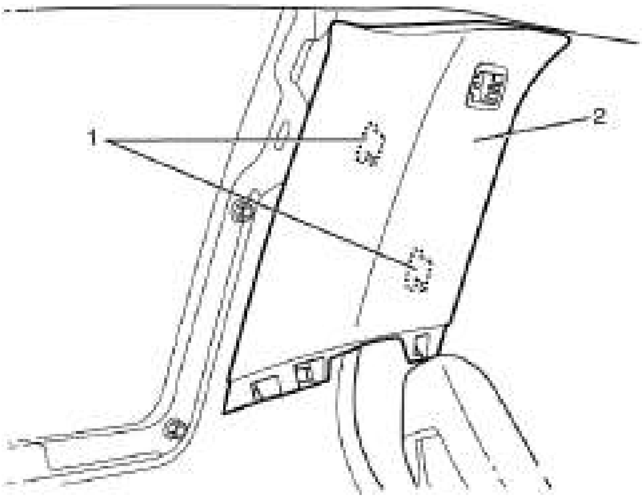
Removal Procedure

> **Important:** When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
3. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
4. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
5. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
6. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
7. Remove the body lock pillar lower trim panel. Refer to Body Lock Pillar Lower Trim Panel Replacement.
8. Remove the body lock pillar trim panel. Refer to Body Lock Pillar Trim Panel Replacement.

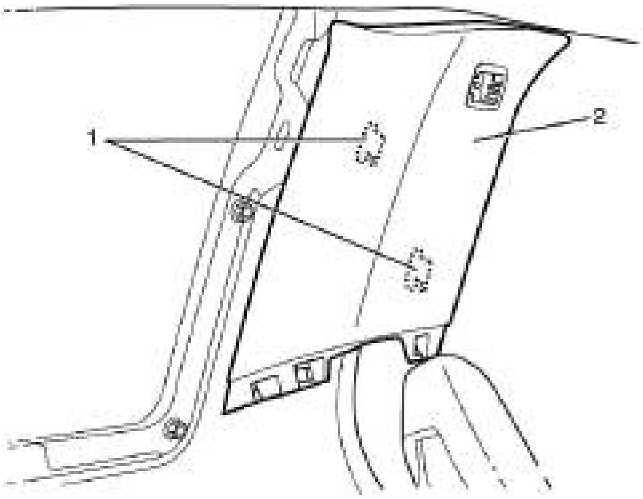


9. Remove the torx screw cover (3) from the body lock pillar upper trim panel (1).
10. Remove the body lock pillar upper trim panel to body retaining torx screw (2).



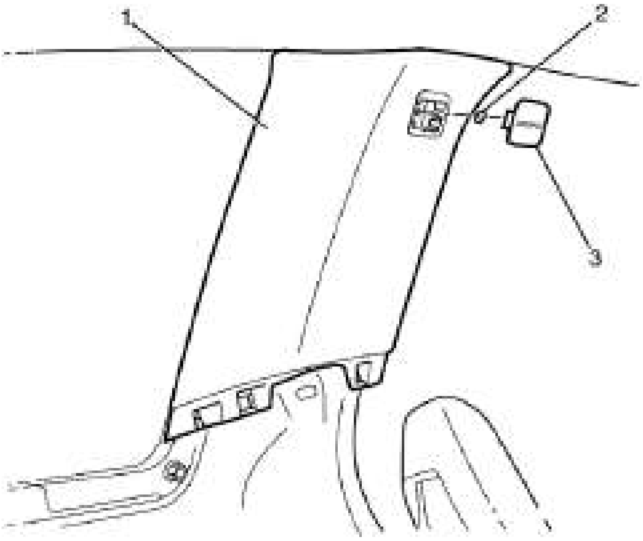
11. Carefully release the body lock pillar upper trim panel to body retaining clips (1).
12. Remove the body lock pillar upper trim panel (2) from the vehicle.

Installation Procedure



1. Position the body lock pillar upper trim panel (2) to the vehicle.
2. Carefully engage the body lock pillar upper trim panel to body retaining clips (1).

   Notice: Refer to Fastener Notice in the Preface section.



3. Install the body lock pillar upper trim panel to body retaining torx screw (2).

   Tighten
   Tighten the torx screw to 2 N·m (18 lb in).

4. Install the torx screw cover (3) to the body lock pillar upper trim panel (1).
5. Install the body lock pillar trim panel. Refer to Body Lock Pillar Trim Panel Replacement.
6. Install the body lock pillar lower trim panel. Refer to Body Lock Pillar Lower Trim Panel Replacement.
7. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
8. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
9. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
10. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
11. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.

    Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

12. Remove the suitable liftgate brace to the vehicle.

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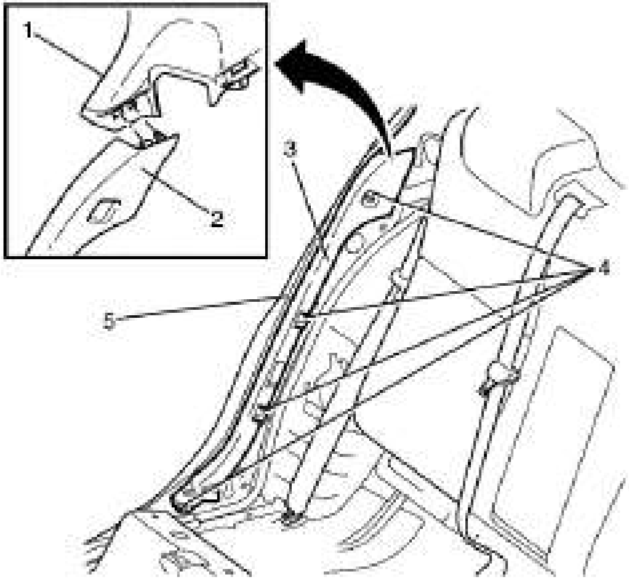
Body Lock Pillar Lower Trim Panel Replacement

Removal Procedure

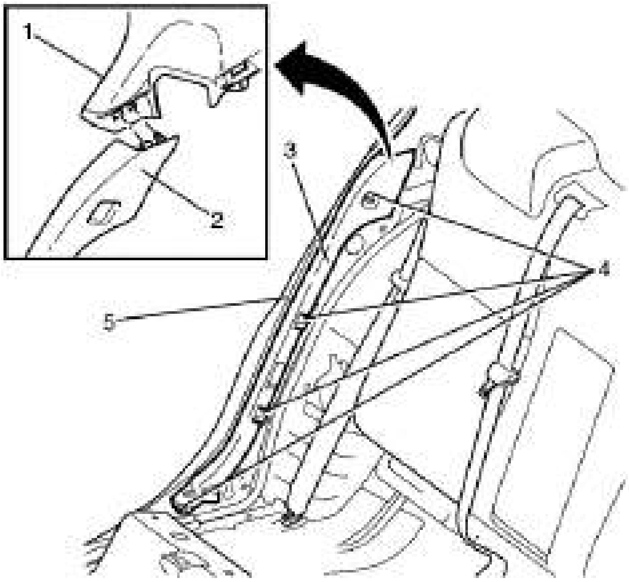
1. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement.
2. Remove the rear seat back bolster. Refer to Rear Seat Back Replacement .
3. Remove the rear sill trim panel. Refer to Rear Side Door Sill Trim Plate Replacement.



Important: When removing the body lock pillar lower trim take care not to damage the locating pins.

4. Partially remove the rear door weatherstrip to gain access behind the body lock pillar lower trim (3).
5. With a suitable tool pry the body lock pillar lower trim clips (4) away from the vehicle body (5).
6. With a suitable tool pry the body lock pillar lower trim (2) away from the body lock pillar (1).
7. Remove the body lock pillar trim (3).

Installation Procedure



Important: When installing the body lock pillar lower trim (3) ensure the retaining clips (4) and the locating pins are correctly aligned with the cavities in the vehicle body lock pillar (1).

1. Install the body lock pillar lower trim (3).

   Important: Make sure the lip of the weatherstrip sits over the trim panels.

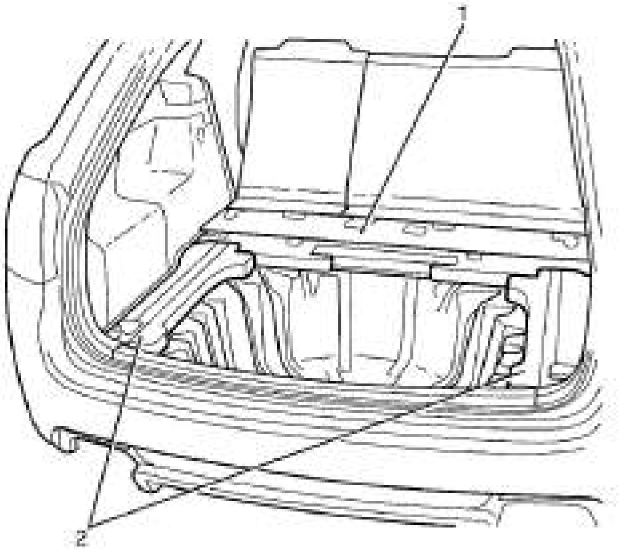
2. Install the removed portion of the rear door weatherstrip.
3. Install the rear sill trim panel. Refer to Rear Side Door Sill Trim Plate Replacement.
4. Install the rear seat back bolster. Refer to Rear Seat Back Replacement.
5. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.

Quarter Inner Trim Finish Panel Replacement

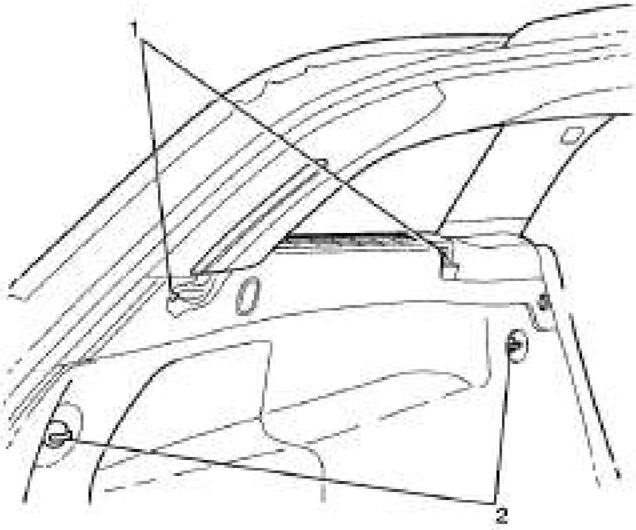
Removal Procedure

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

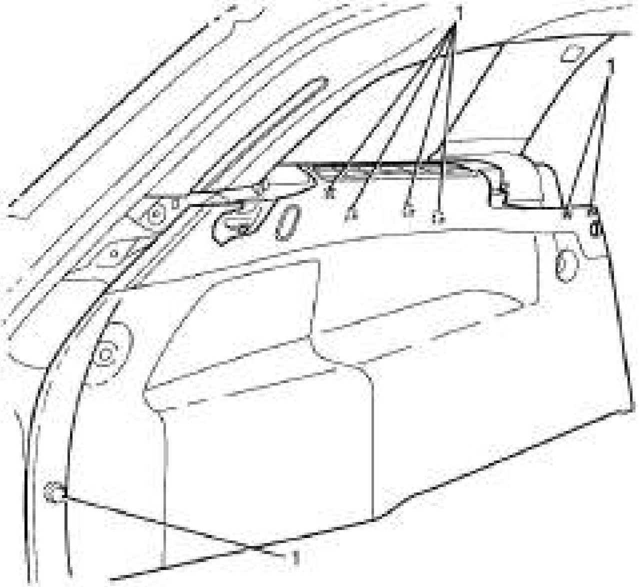
1. Install a suitable liftgate brace to the vehicle.
2. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
3. Remove the luggage shade. Refer to Luggage Shade Replacement.
4. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
5. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
6. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.



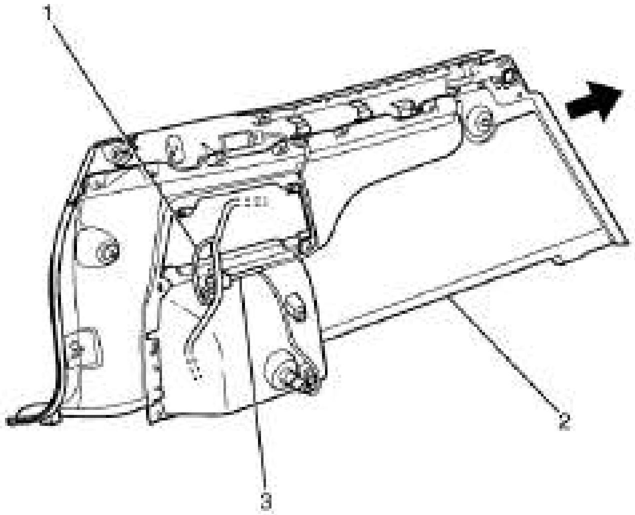
7. Remove the rear compartment floor panel carpet exterior support foams (2).
8. Remove the rear compartment floor panel centre support foam (1).
9. Fold the rear seat forward.



10. Remove the quarter upper trim panel to body retaining screws (1).
11. Remove the rear compartment convenience hooks (2).



12. Carefully disengage the quarter trim panel to body retaining clips (1).

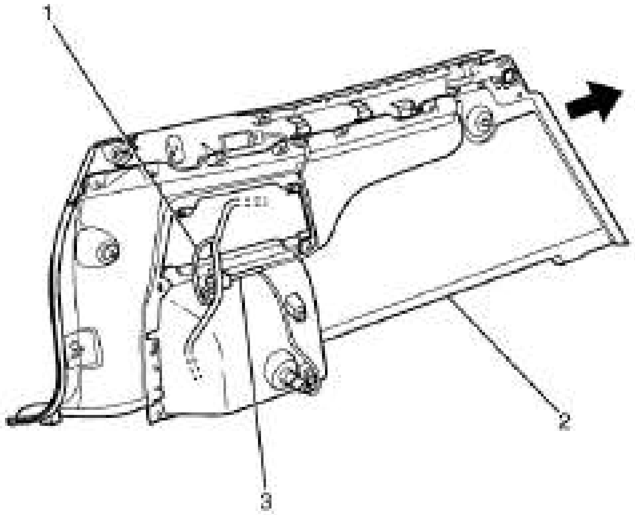


Important: Step 13 is valid for the removal of the right-hand side quarter trim panel only.

13. Disconnect the right side quarter trim panel wiring harness (1) from the rear body wiring harness (2).
14. Remove the quarter panel trim (3) from the vehicle.

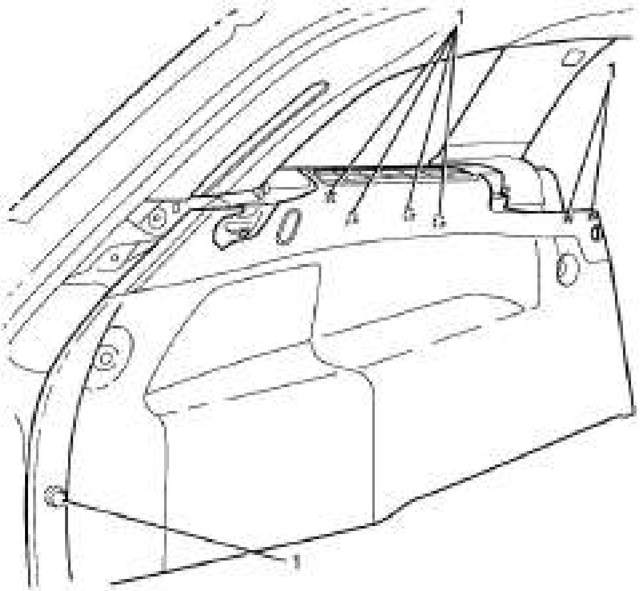
Installation Procedure

1. Position the quarter trim panel to the vehicle.

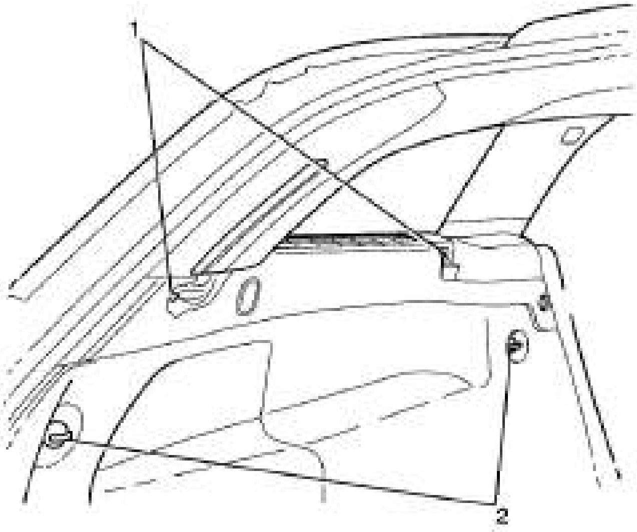


Important: Step 2 is valid for the installation of the right-hand side quarter trim panel only.

2. Connect the right side quarter trim panel wiring harness (1) to the rear body wiring harness (2).



3. Carefully engage the quarter trim panel to body retaining clips (1).



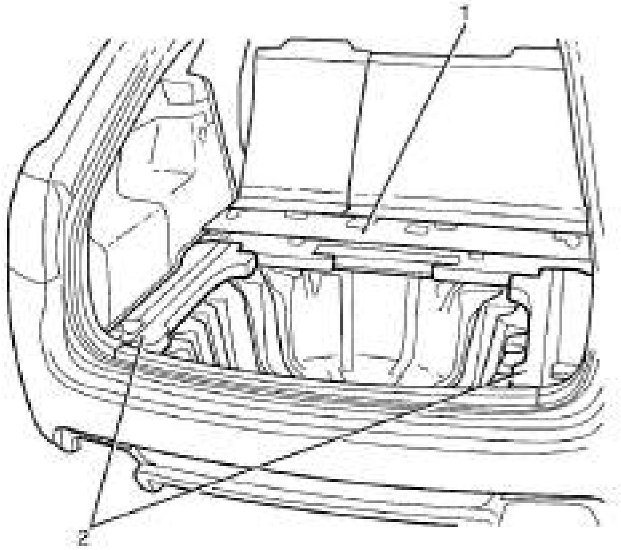
4. Install the rear compartment convenience hooks (2).

   Notice: Refer to Fastener Notice in the Preface section.

5. Install the quarter upper trim panel to body retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).

6. Position the rear seat to the original upright locked position.



7. Install the rear compartment floor panel centre support foam (1).
8. Install the rear compartment floor panel carpet exterior support foams (2).
9. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
10. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
11. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
12. Install the luggage shade. Refer to Luggage Shade Replacement.
13. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.

    Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

14. Remove the suitable liftgate brace from the vehicle.

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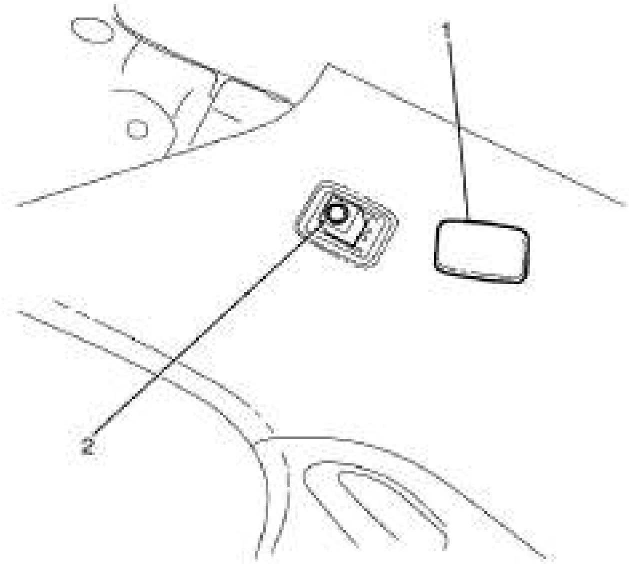
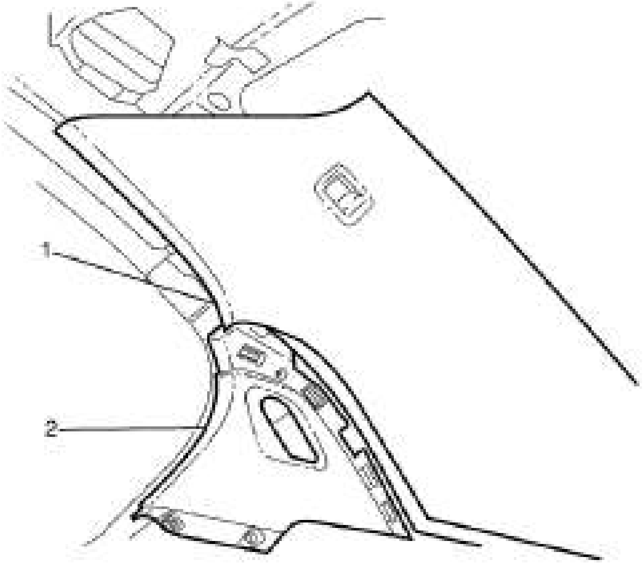
Quarter Upper Trim Panel Replacement (SWB)

Removal Procedure

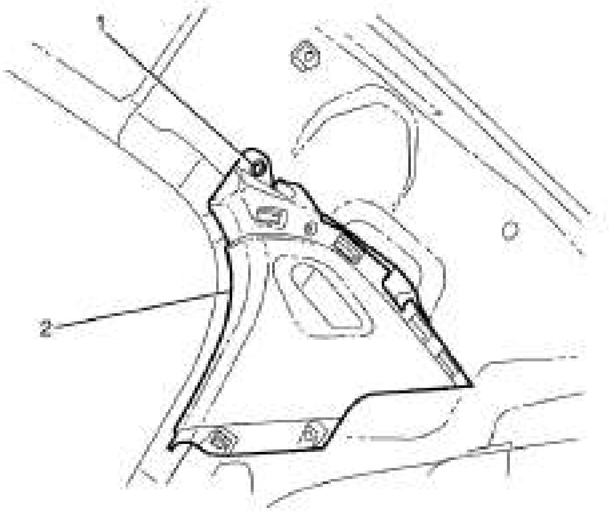
1. Remove the seat back assembly. Refer to Front Seat Back Replacement .
2. Remove the seat belt lower retaining bolt. Refer to Front Seat Belt Replacement .
3. Remove the trim panel - rear quarter lower. Refer to Quarter Lower Rear Trim Panel Replacement .



4. Remove the retaining torx screw cover (1).
5. Remove the upper quarter trim panel retaining torx screw (2).

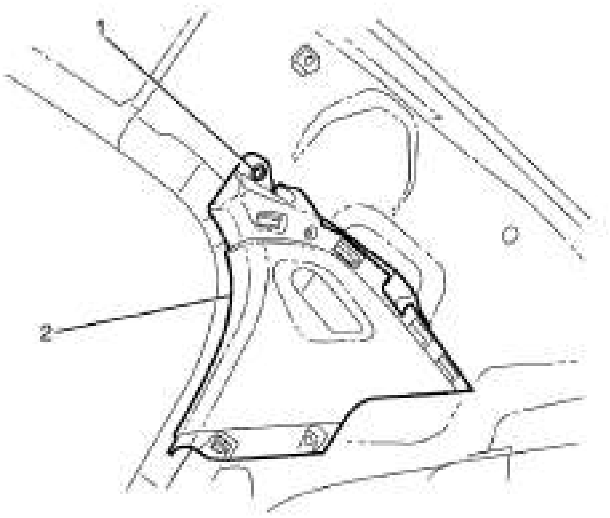


6. Working from the top of the upper quarter trim panel (1) disengage the retaining trim clips from the lower section (2).



7. Remove the lower section retaining torx screw (1).
8. Remove the trim panel (2).

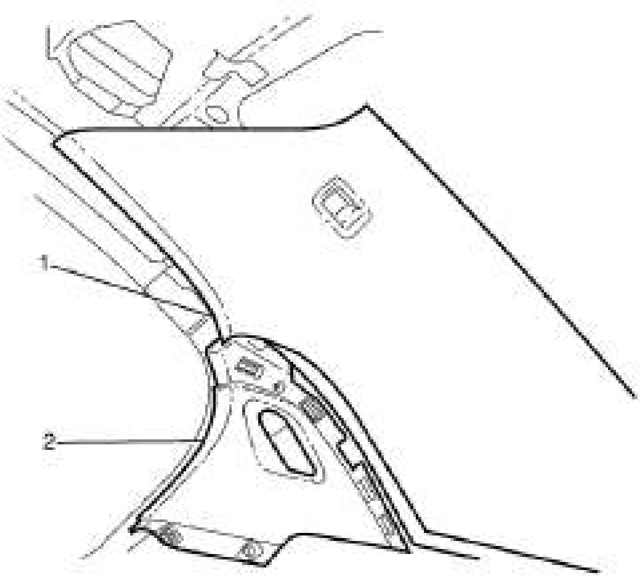
Installation Procedure



Important: When installing the upper quarter panel trim, ensure that the seat belt is correctly fed through the seat belt access hole.

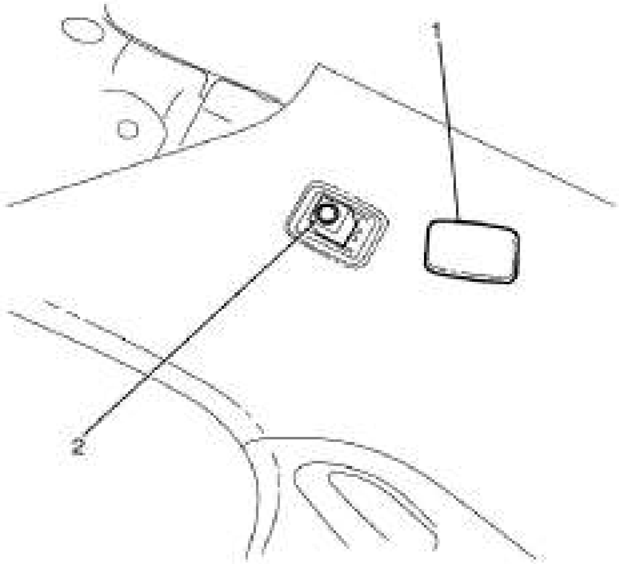
1. Install the lower section of the upper quarter trim panel (2).

Tighten
Tighten the torx screw (1) to 2.0 N·m (18 lb in).



Important: Make sure datum pins on the upper trim line up with the hole on the mid trim.

2. Install the upper quarter trim panel (1) by firmly pushing it into the lower section of the trim panel (2).



3. Install the upper quarter panel retaining torx screw (2).

Tighten
Tighten the retaining torx screw to 2.0 N·m (18 lb in).

4. Install the retaining torx screw cover (1).
5. Install the seat belt lower retaining bolt. Refer to Front Seat Belt Replacement .
6. Install the seat back assembly. Refer to Rear Seat Back Replacement .
7. Attach the rear door weatherstrip. Refer to Rear Door Opening Weatherstrip Replacement .

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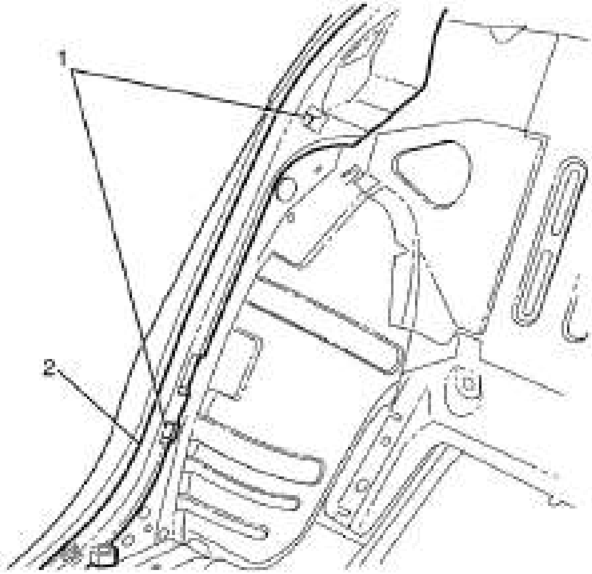
Quarter Lower Rear Trim Panel Replacement

Removal Procedure

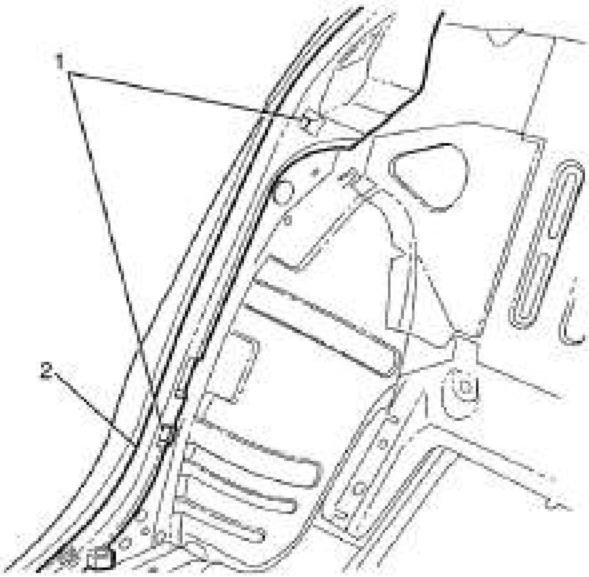
1. Remove the seat cushion. Refer to Rear Seat Cushion Replacement.
2. Remove the seat back assembly. Refer to Rear Seat Back Replacement.
3. Remove the rear sill trim panel. Refer to Rear Side Door Sill Plate Replacement.



Important: When removing the trim take care not to damage the locating pins.

4. Carefully disengage the retaining trim clips (1) and remove the trim (2).

Installation Procedure



Important: When installing the lower quarter trim panel, ensure the retaining clips are correctly aligned with the retainers before installation.

1. Carefully install the lower quarter trim panel (2) by engaging the retaining clips (1).
2. Install the rear sill trim panel. Refer to Rear Side Door Sill Plate Replacement.
3. Install the seat back assembly. Refer to Rear Seat Back Replacement.
4. Install the seat cushion. Refer to Rear Seat Cushion Replacement.

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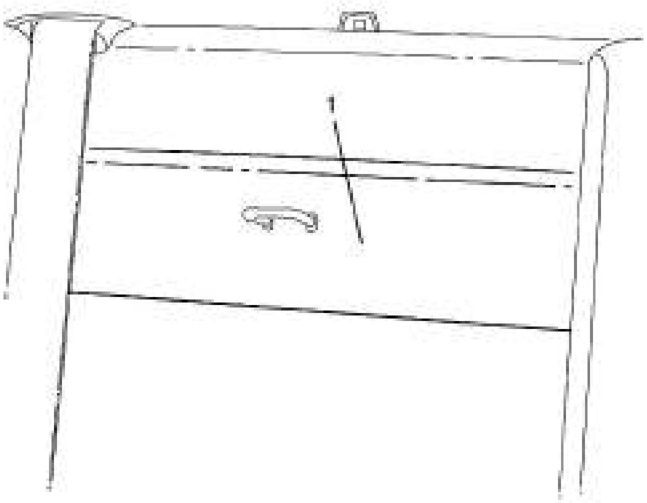
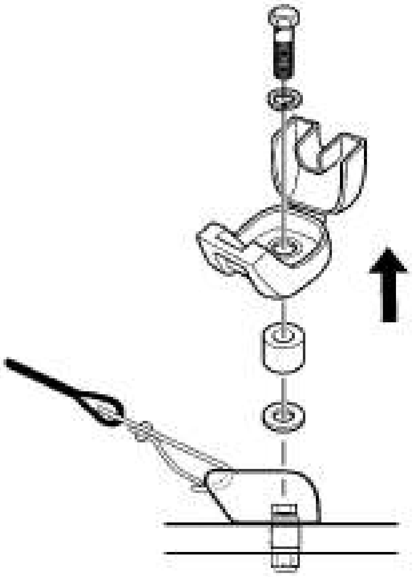
Rear Window Shelf Trim Panel Replacement (SWB)

Removal Procedure

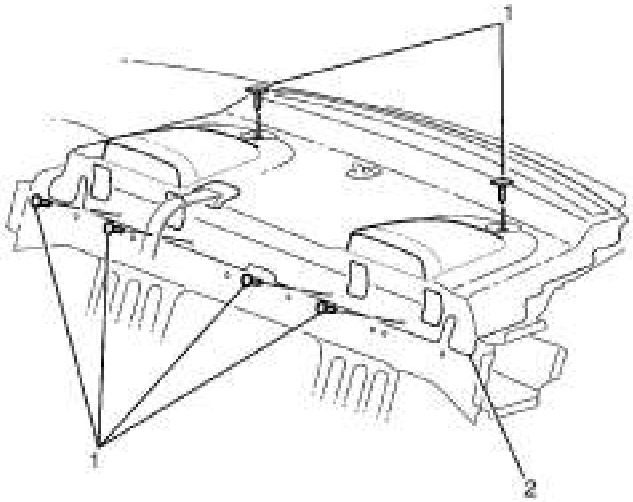
1. Remove the seat back assembly. Refer to Rear Seat Back Replacement.
2. Remove the centre seat back assembly. Refer to Rear Split Folding Seat Back Replacement.
3. Remove the upper quarter trim panel. Refer to Quarter Upper Trim Panel Replacement.
4. Remove the centre seat belt lower retaining bolt. Refer to Seat Belt Replacement - Center Rear.



5. Remove the rear lock striker trim panel by disengaging the retaining clips (1).



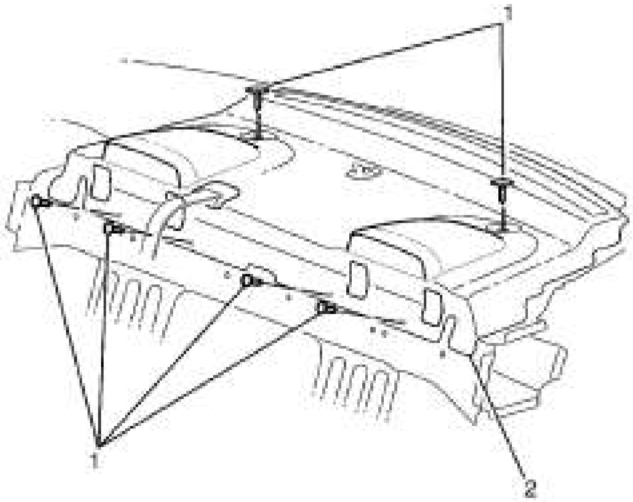
6. Remove the child restraint anchor assembly, as shown in illustration.



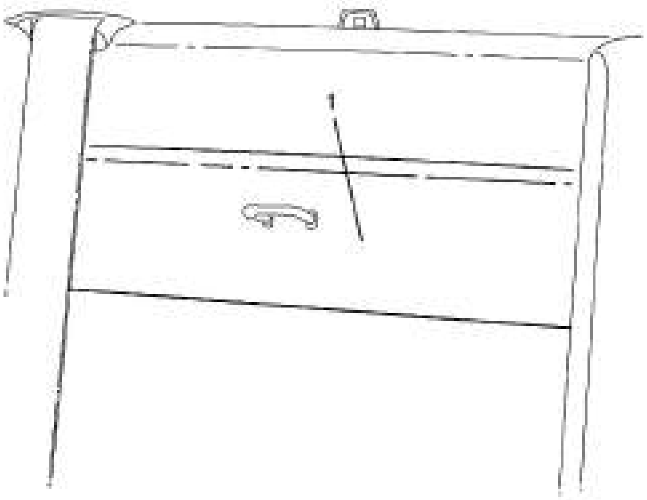
7. Remove the six retaining clips (1) two at the back of the rear window shelf trim panel (2) and six on the front.
8. Pull the rear window shelf (2) forward at centre and then lift upward to disengage datum tower from clip.
9. Slide the centre seat belt through the centre seat belt slot and remove the rear window shelf trim panel (2).

Installation Procedure

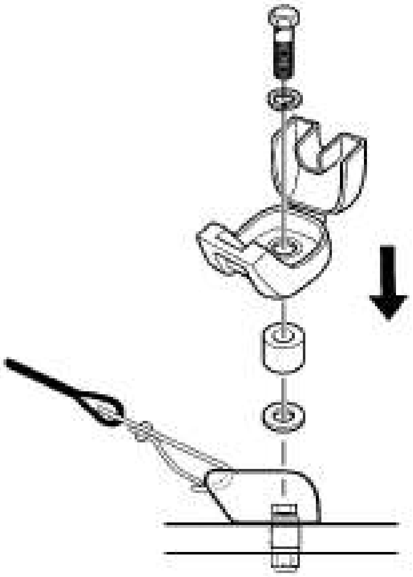
1. Install the centre seat belt by sliding the belt through the slot.



2. Install the rear window shelf trim panel (2).
3. Install the rear window shelf trim panel retaining clips (1).



4. Install the rear lock striker trim panel by engaging the retaining clips.



Important: Ensure child restraint assembly is installed as per illustration, failure to adhere to this installation will result in incorrect operation of the child restraint assembly.

5. Install child restraint anchor assembly.

   Tighten
   Tighten the retaining bolt to 22 N·m (16 lb ft).

6. Install the centre seat belt lower retaining bolt. Refer to Front Seat Belt Replacement.
7. Install the centre seat back assembly. Refer to Rear Split Folding Seat Back Replacement.
8. Install the upper quarter trim panel. Refer to Quarter Upper Trim Panel Replacement.

9. Install the seat back assembly. Refer to Rear Seat Back Replacement.

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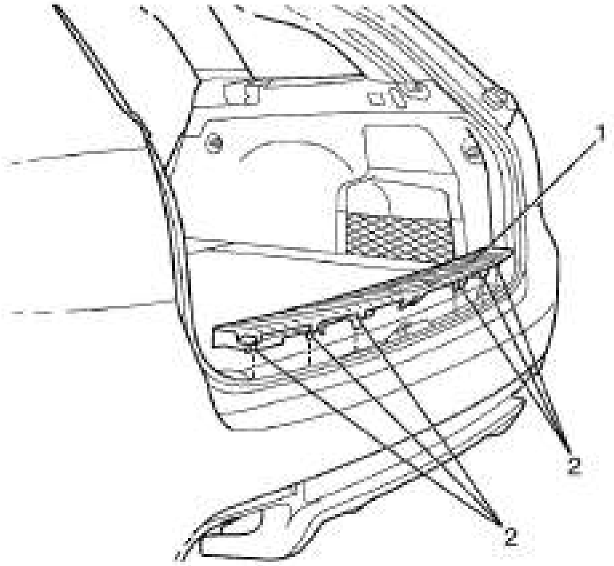
Rear End Trim Finish Panel Replacement

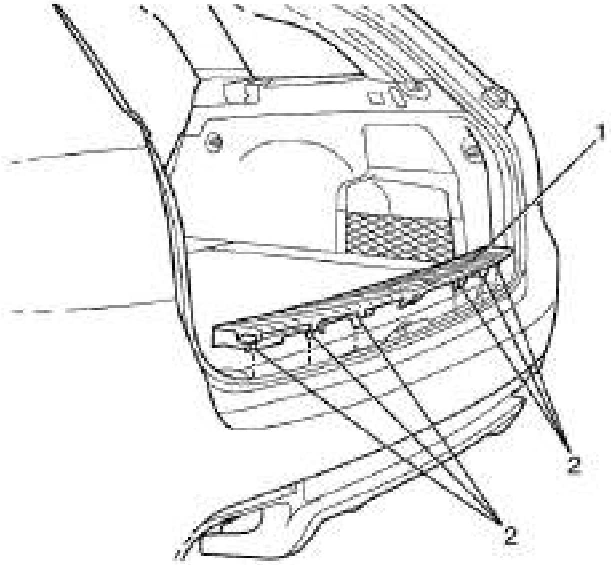
Removal Procedure



Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Using a suitable tool, carefully disengage the rear end trim finish panel to door frame retaining clips (2).
3. Remove rear end trim finish trim panel (1) from the vehicle.

Installation Procedure



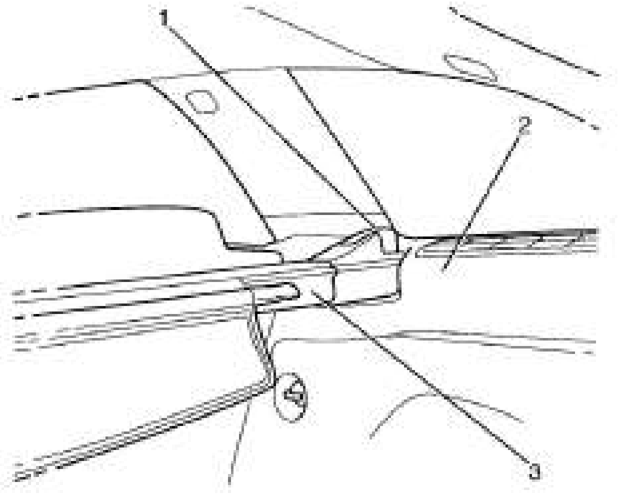
Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Position the rear end trim finish panel (1) to the door frame.
2. Carefully engage the rear end finish trim panel to door frame retaining clips (2) to the door frame. An audible click will confirm correct fitment.
3. Remove the suitable liftgate brace from the vehicle.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Hardware and Trim | Interior Trim and Paneling | Repair Instructions | **Document ID: 2067590**

Luggage Shade Replacement

Removal Procedure



Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

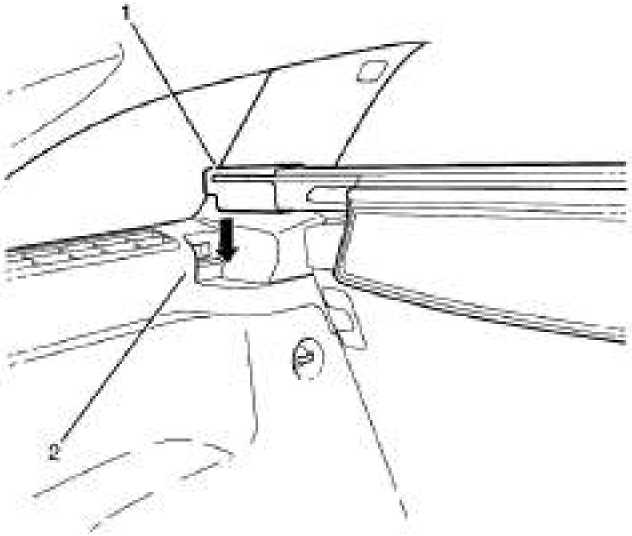
Important: Ensure the luggage shade is full retracted before begin this procedure.

1. Install a suitable liftgate brace to the vehicle.
2. Pull the luggage shade lever (1) to disengage the right-hand side of the luggage shade assembly (3) from the quarter upper trim panel (2).

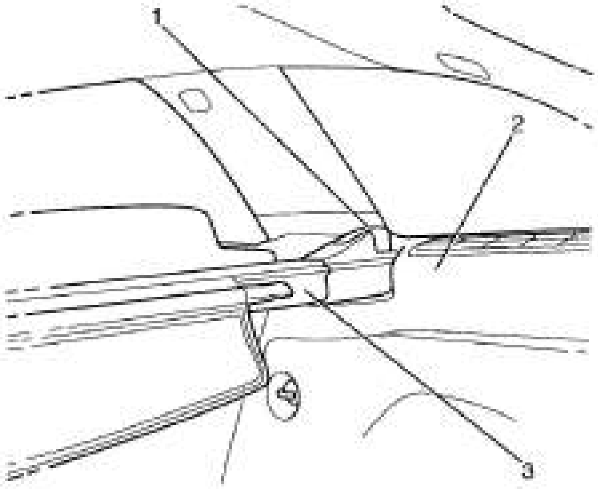
Important: Take care not to damage the surrounding trim panels.

3. Manoeuvre the luggage shade assembly (3) from the vehicle.

Installation Procedure



1. Position the left-hand side of the luggage shade assembly (1) into the quarter upper trim panel (2).

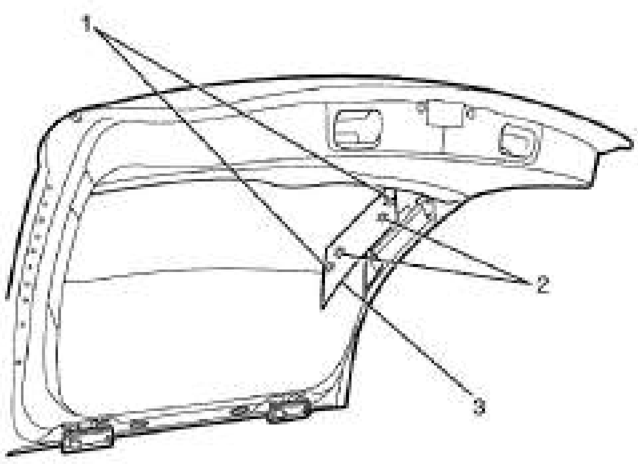


Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

2. Pull the luggage shade lever (1) and locate the right-hand side of the luggage shade assembly (3) into the quarter upper trim panel (2).
3. Check the luggage shade assembly (3) for correct operation.
4. Remove the suitable liftgate brace from the vehicle.

Liftgate Window Side Garnish Molding Replacement

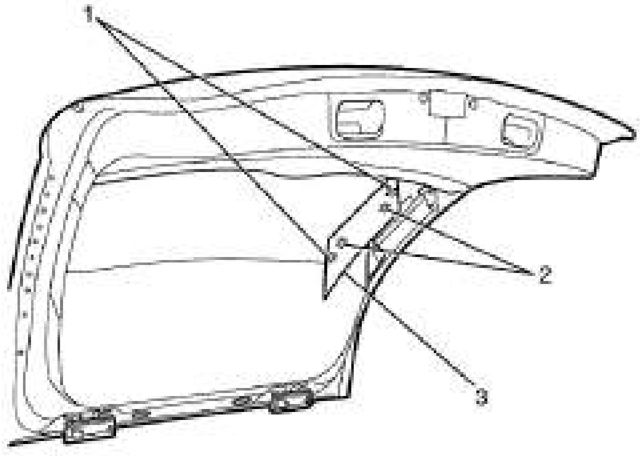
Removal Procedure



Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Using a suitable tool, carefully disengage the liftgate window side garnish moulding to liftgate window upper and lower garnish moulding retaining clips (1).
3. Using a suitable tool, carefully disengage the liftgate window side garnish moulding to liftgate retaining clips (2).
4. Remove liftgate window side garnish moulding (3) from the vehicle.

Installation Procedure



Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

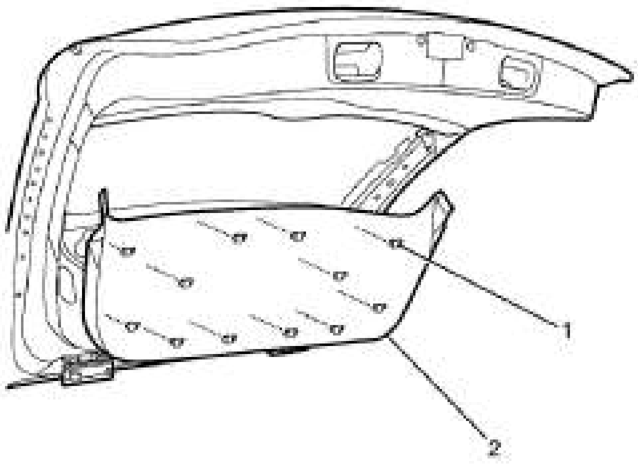
1. Position the liftgate window side garnish moulding (3) to the liftgate.
2. Carefully engage the liftgate window side garnish moulding retaining clips (2) to the liftgate. An audible click will confirm correct installation.
3. Carefully engage the liftgate window side garnish moulding retaining clips (1) to the liftgate window upper and lower garnish mouldings.
4. Remove the suitable liftgate brace from the vehicle.

Liftgate Window Upper Garnish Molding Replacement

Removal Procedure

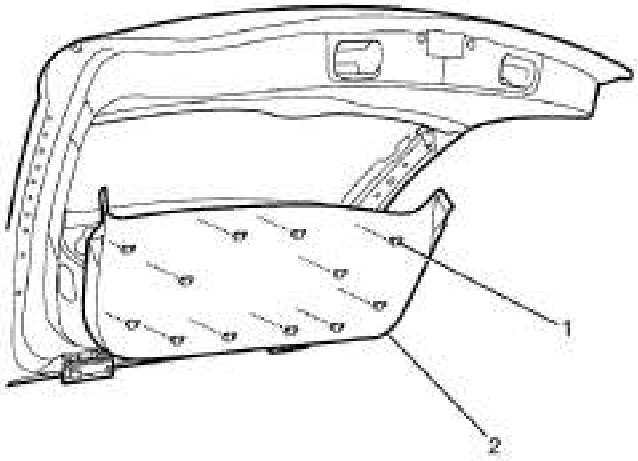
Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Remove the liftgate window side garnish moulding. Refer to Liftgate Window Side Garnish Molding Replacement.



3. Using a suitable tool, carefully disengage the liftgate window upper garnish moulding to liftgate retaining clips (1).
4. Remove the liftgate window upper garnish moulding (2) from the vehicle.

Installation Procedure



Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

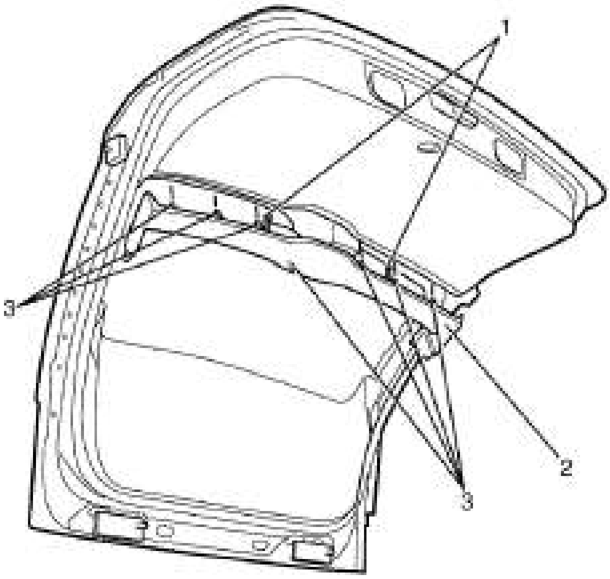
1. Position the liftgate window upper garnish moulding (2) to the liftgate.
2. Carefully engage the liftgate window upper garnish moulding retaining clips (1) to the liftgate. An audible click will confirm correct fitment.
3. Install the liftgate window side garnish moulding. Refer to Liftgate Window Side Garnish Molding Replacement.
4. Remove the suitable liftgate brace from the vehicle.

Liftgate Window Lower Garnish Molding Replacement

Removal Procedure

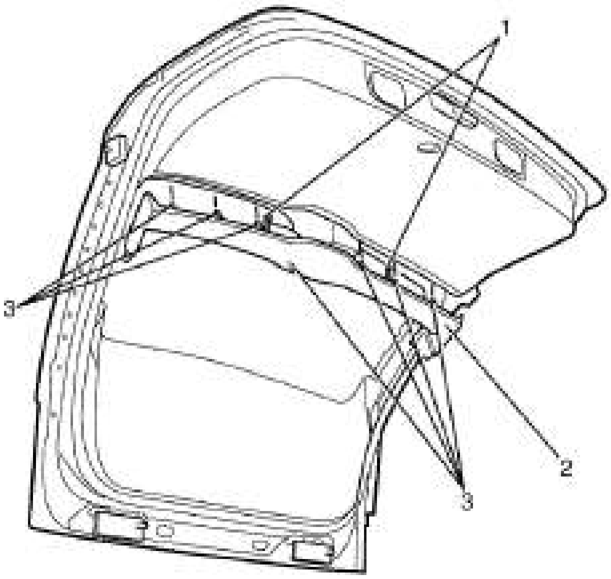
Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Remove the liftgate window side garnish moulding. Refer to Liftgate Window Side Garnish Molding Replacement.



3. Using a suitable tool, carefully disengage the liftgate window lower garnish moulding to liftgate retaining clips (3) and datum pins (1).
4. Remove liftgate window lower garnish moulding (2) from the vehicle.

Installation Procedure



Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Position the liftgate window lower garnish moulding (2) to the liftgate.
2. Carefully engage the liftgate window lower garnish moulding retaining clips (3) and datum pins (1) to the liftgate. An audible click will confirm correct installation.
3. Install the liftgate window side garnish moulding. Refer to Liftgate Window Side Garnish Molding Replacement.
4. Remove the suitable liftgate brace from the vehicle.

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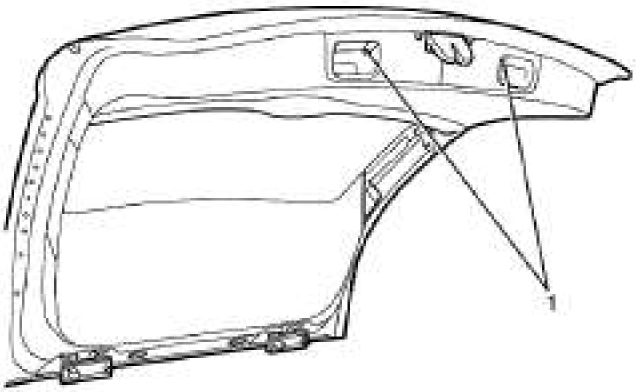
Liftgate Trim Panel Replacement

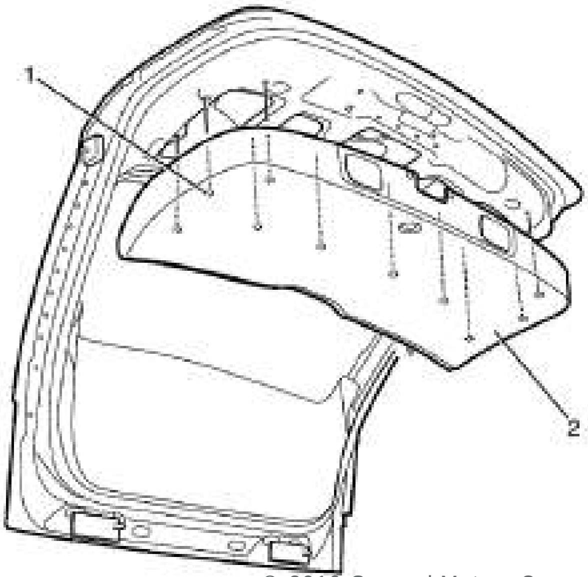
Removal Procedure

> **Important:** When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Remove the liftgate window side garnish moulding. Refer to Liftgate Window Side Garnish Molding Replacement.
3. Remove the liftgate window lower garnish moulding. Refer to Liftgate Window Lower Garnish Molding Replacement.

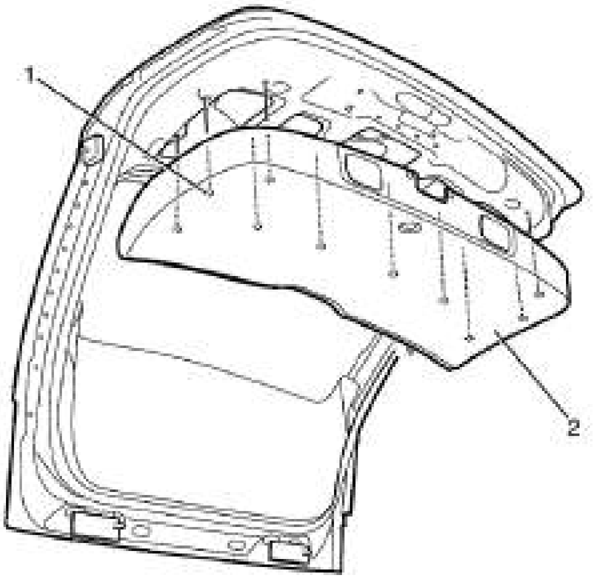


4. Remove the liftgate inside pull handle to liftgate retaining screws (1).



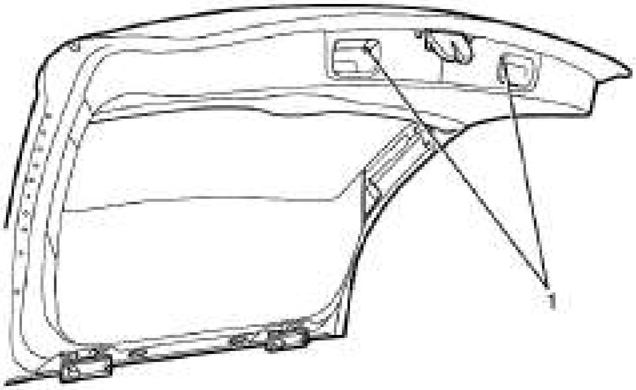
5. Using a suitable tool, carefully disengage the liftgate trim panel to liftgate retaining clips (1).
6. Remove the liftgate trim panel (2) from the vehicle.

Installation Procedure



1. Position the liftgate trim panel (2) to the vehicle.
2. Carefully engage the liftgate trim panel retaining clips (1) to the liftgate.

Notice: Refer to Fastener Notice in the Preface section.



3. Install the liftgate inside pull handle to liftgate retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb. in).

4. Install the liftgate window lower garnish moulding. Refer to Liftgate Window Lower Garnish Molding Replacement.
5. Install the liftgate window side garnish moulding. Refer to Liftgate Window Side Garnish Molding Replacement.

   Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

6. Remove the suitable liftgate brace from the vehicle.

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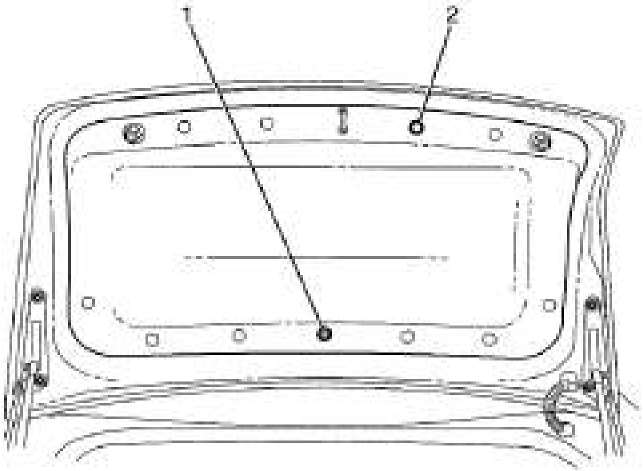
Rear Compartment Lid Inner Panel Trim Replacement

Removal Procedure

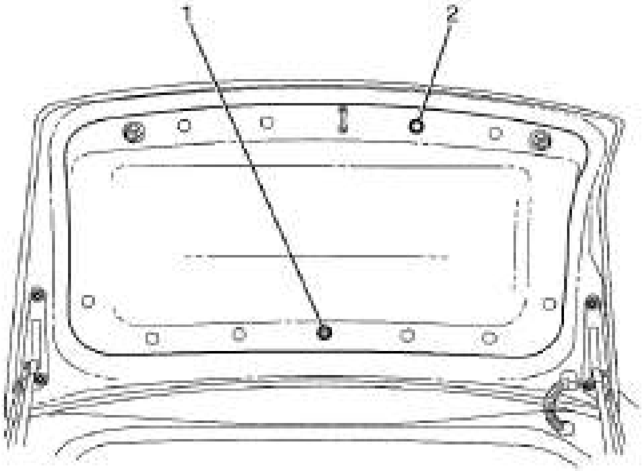
1. Open the luggage compartment lid.



2. Remove the retaining screw (1) attaching the cargo compartment carpet retaining stay to the luggage compartment lid.
3. Remove the luggage compartment lid trim retaining clips (2).
4. Remove the luggage compartment lid trim.

Installation Procedure

1. Install the luggage compartment lid trim.



2. Install the luggage compartment lid trim retaining clips (2).
3. Install the luggage compartment carpet stay and retaining screw (1).
4. Close the luggage compartment lid.

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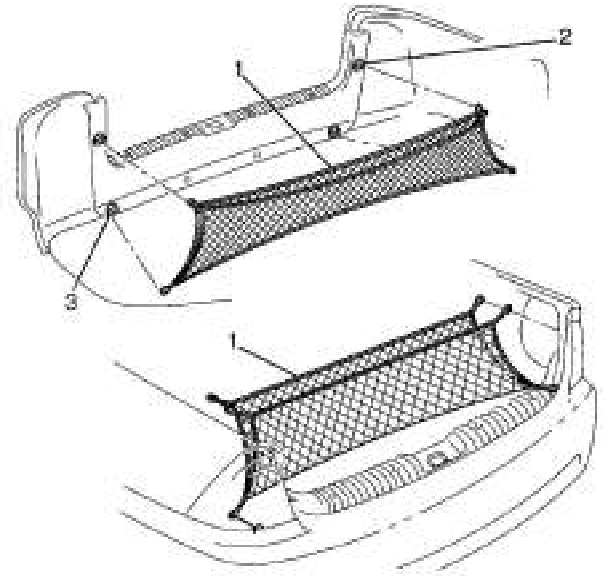
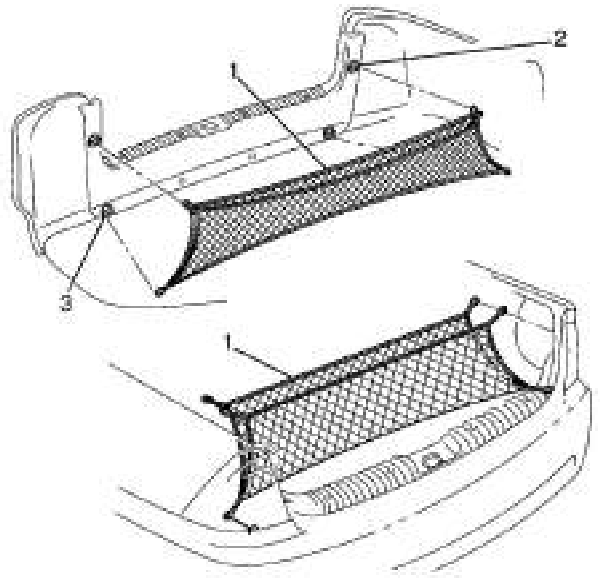
Rear Compartment Stowage Tray Net Replacement

Removal Procedure



1. Carefully unhook the convenience net (1) from the two lower retainer hooks (3) and the two upper retainer hooks (2).
2. Remove the convenience net from the rear compartment trim assembly.
3. If required, unscrew the two upper and two lower retainer hooks.

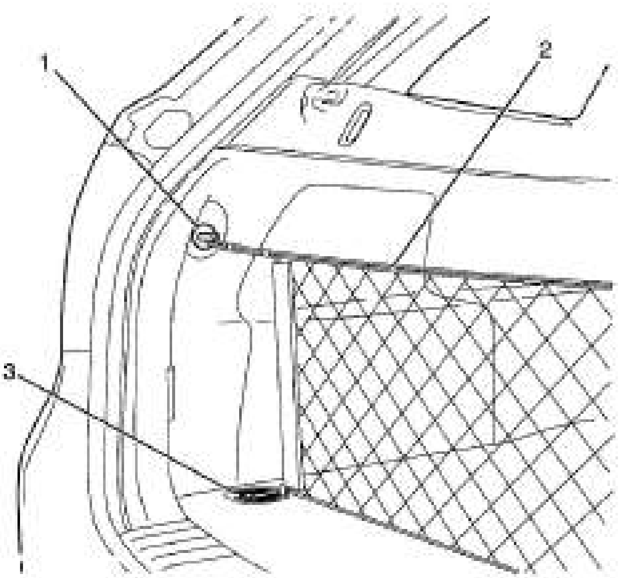
Installation Procedure



1. If removed install the upper and lower retainer hooks (2 and 3).
2. Install the convenience (1) net to the rear compartment end panel.

Convenience Net Replacement (Sportwagon)

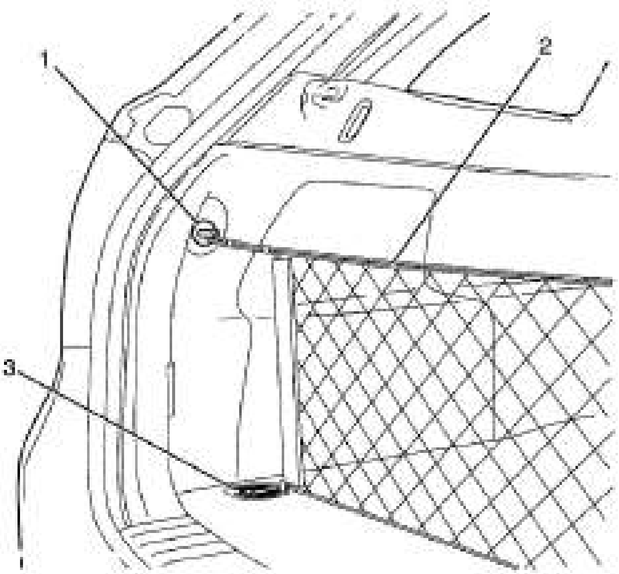
Removal Procedure



Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Carefully unhook the convenience net (2) from the cargo tie downs (3) and the rear compartment convenience hooks (1).
3. If required, unscrew the rear compartment convenience hooks (1).

Installation Procedure



Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

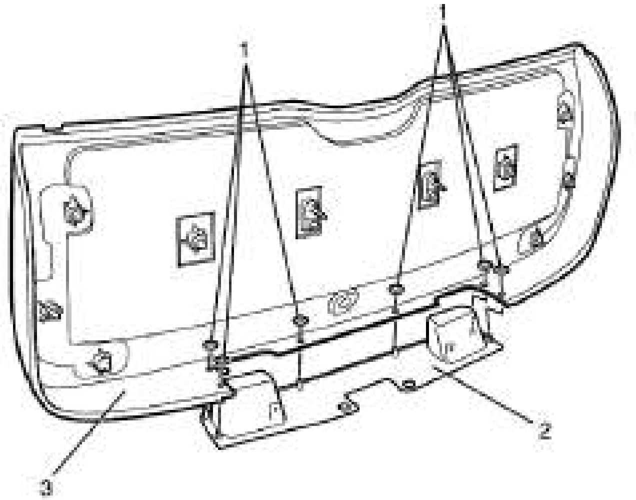
1. If removed, install the rear compartment convenience hooks (1).
2. Install the convenience net (2) to the cargo tie downs (3) and the rear compartment convenience hooks (1).
3. Remove the suitable liftgate brace from the vehicle.

Liftgate Inside Pull Handle Replacement

Removal Procedure

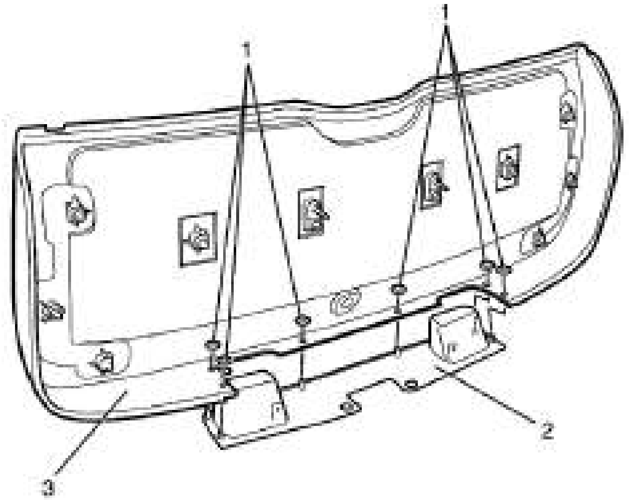
Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Remove the liftgate window side garnish moulding. Refer to Liftgate Window Side Garnish Molding Replacement.
3. Remove the liftgate window lower garnish moulding. Refer to Liftgate Window Lower Garnish Molding Replacement.
4. Remove the liftgate trim panel. Refer to Liftgate Trim Panel Replacement.



5. Remove the liftgate inside pull handle to liftgate trim panel stop nuts (1).
6. Remove the liftgate inside pull handle (2) from the liftgate trim panel (3).

Installation Procedure



Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

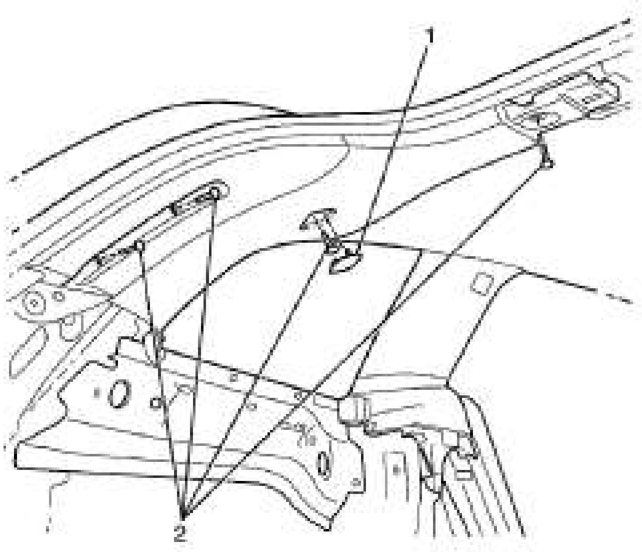
1. Position the liftgate inside pull handle (2) to the liftgate trim panel (3).
2. Install the liftgate inside pull handle to liftgate trim panel stop nuts (1)
3. Install the liftgate trim panel. Refer to Liftgate Trim Panel Replacement.
4. Install the liftgate window lower garnish moulding. Refer to Liftgate Window Lower Garnish Molding Replacement.
5. Install the liftgate window side garnish moulding. Refer to Liftgate Window Side Garnish Molding Replacement.
6. Remove the suitable liftgate brace from the vehicle.

Body Side Window Rear Garnish Molding Replacement

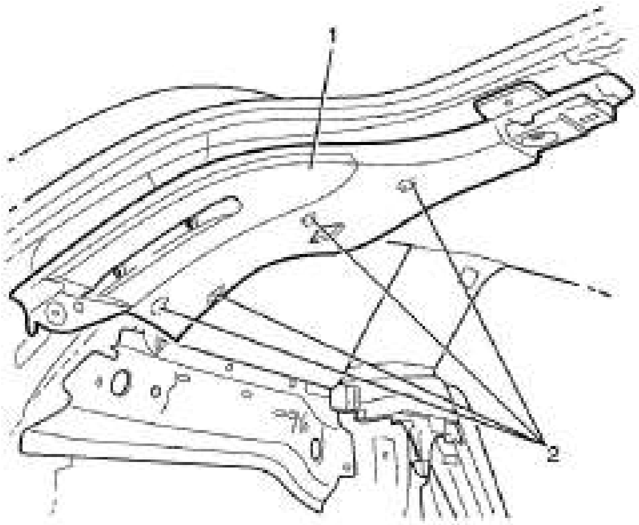
Removal Procedure

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
3. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
4. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
5. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
6. Remove the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
7. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.

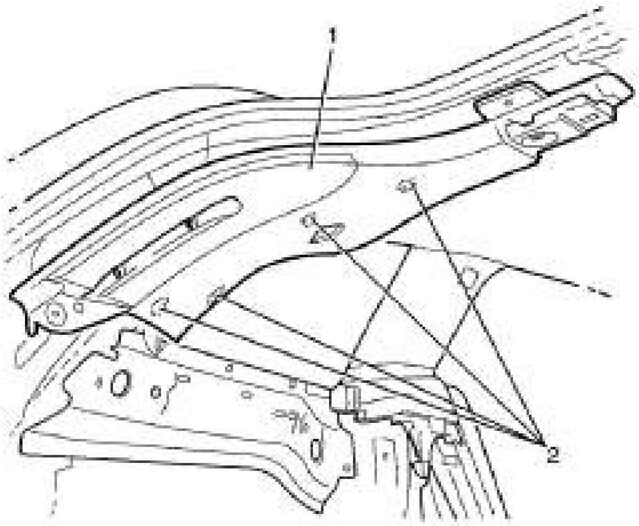


8. Remove the retaining torx screw cover (1).
9. Remove the body side window rear garnish moulding to body retaining screws (2).



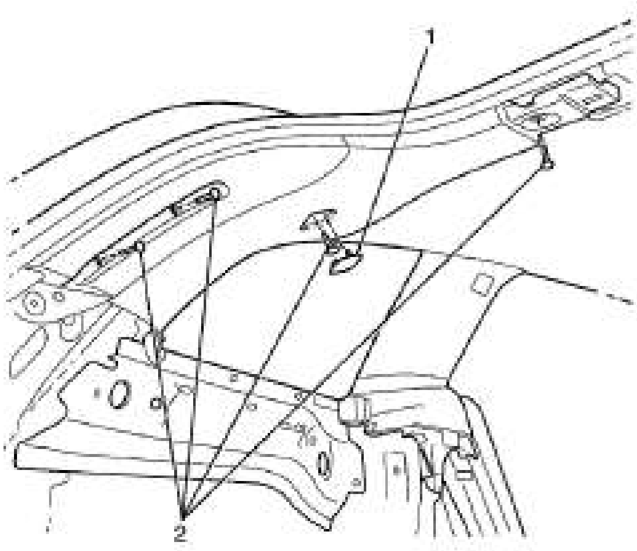
10. Carefully release the body side window rear garnish moulding to body retaining clips (2).
11. Remove the body side window rear garnish moulding (1) from the vehicle.

Installation Procedure



1. Position the body side window rear garnish moulding (1) to the vehicle.
2. Carefully engage the body side window rear garnish moulding to body retaining clips (2).

   Notice: Refer to Fastener Notice in the Preface section.



3. Install the body side window rear garnish moulding to body retaining screws (2).

   Tighten
   Tighten the screws to 3 N·m (27 ft. in).

4. Install the retaining torx screw cover (1).
5. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
6. Install the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
7. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
8. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
9. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
10. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.

    Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

11. Remove the suitable liftgate brace to the vehicle.

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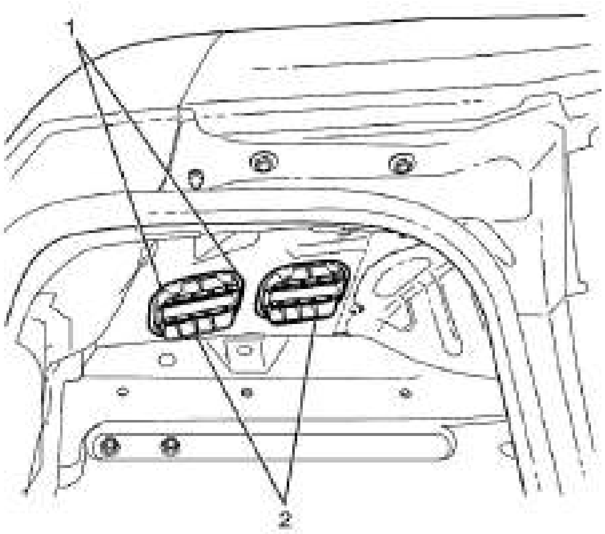
Pressure Relief Valve Replacement (Sedan)

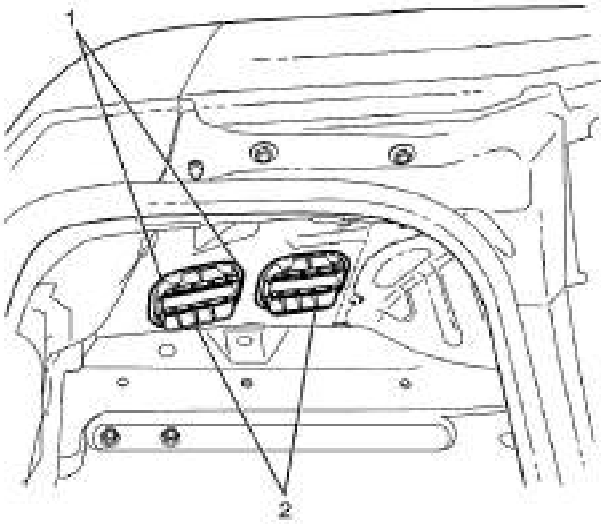
Removal Procedure

1. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
2. Remove the rear compartment side trim panel. Refer to Rear Compartment Side Trim Panel Replacement.
3. Remove the battery. Refer to Battery Replacement.
4. Remove the batter tray. Refer to Battery Tray Replacement.
5. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.



6. From inside the rear compartment, press the retaining tabs (1) while pushing outward in order to release the pressure relief valve (2) from the rear quarter panel.

Installation Procedure



1. Position the pressure relief valve (2) to the opening in the rear quarter panel.
2. Press inward on the pressure relief valve until the retaining tabs (1) engage to secure the pressure relief valve (2) to the rear quarter panel.
3. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
4. Install the battery tray. Refer to Battery Tray Replacement.
5. Install the battery. Refer to Battery Replacement.
6. Install the rear compartment side trim panel. Refer to Rear Compartment Side Trim Panel Replacement.
7. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.

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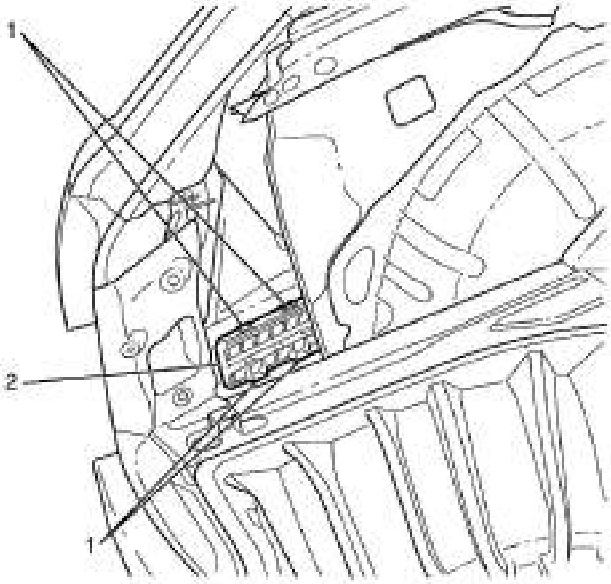
Pressure Relief Valve Replacement (Sportwagon)

Removal Procedure

1. Open the liftgate.

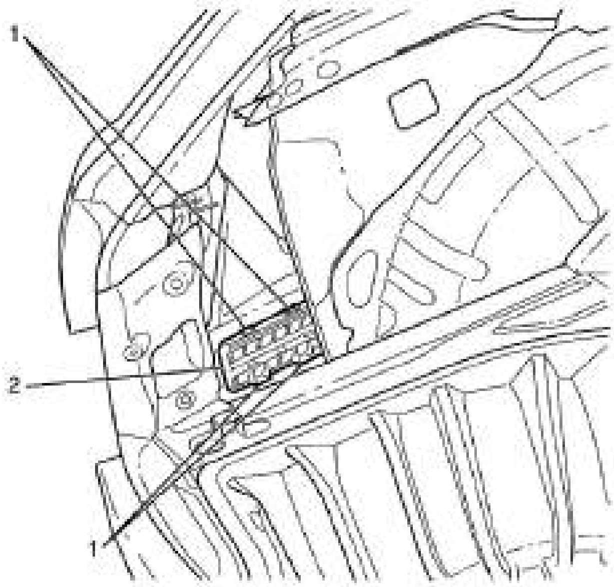
   Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

2. Install a suitable liftgate brace to the vehicle.
3. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
4. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
5. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
6. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
7. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.



8. From inside the rear compartment, press the retaining tabs (1) while pushing outward in order to release the pressure relief valve (2) from the rear quarter panel.

Installation Procedure



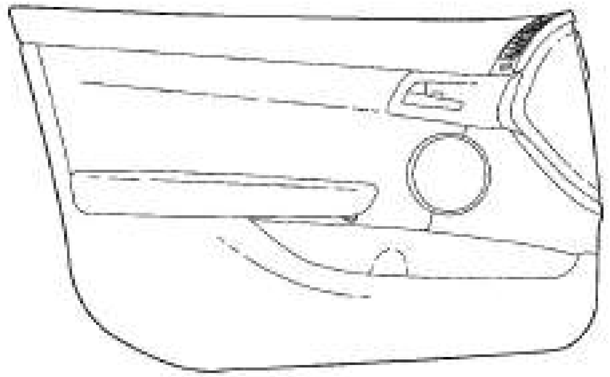
1. Position the pressure relief valve (2) to the opening in the rear quarter panel.
2. From outside the rear compartment, press inward on the pressure relief valve until the retaining tabs (1) engage to secure the pressure relief valve (2) to the rear quarter panel.
3. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
4. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
5. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
6. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
7. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

8. Remove the suitable liftgate brace from the vehicle.
9. Close the liftgate.

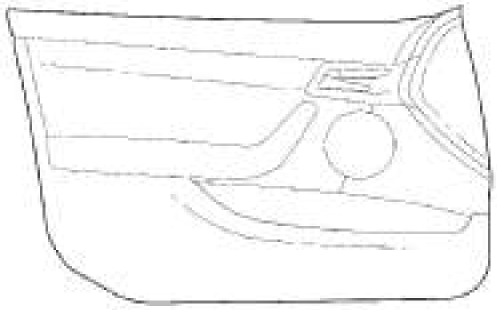
Door Trim Option Level Recognition

Type A - Front Door Trim



Type A door trims feature a flat type door handle and a fixed storage bin incorporating a cup holder.

Type B - Front Door Trim



Type B door trims feature an ergonomically styled armrest incorporating a grab handle and a fixed storage bin incorporating a cup holder.

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Door Check Link to Door Retaining Nuts	6 N·m	53 lb in
Door Check Link to Pillar Retaining Bolt	25 N·m	18 lb ft
Door Hinge Keeper Bolt	3 N·m	27 lb in
Door Hinge to Door Retaining Bolts	28 N·m	21 lb ft
Door Hinge to Pillar Retaining Bolts	28 N·m	21 lb ft
Front Bumper Impact Bar to Front End Module Retaining Bolts	22 N·m	16 lb ft
Front Fender to Body Side Retaining Bolts	9 N·m	80 lb in
Front Fender to Door Pillar Retaining Bolts	9 N·m	80 lb in
Front Fender to Front End Module Retaining Bolt	9 N·m	80 lb in
Front Fender to Inner Wheelhouse Retaining Bolts	9 N·m	80 lb in
Fuel Tank Filler Door to Rear Quarter Panel Retaining Screws	2 N·m	18 lb in
Hood Assist Rod Upper Ball Stud	18 N·m	13 lb ft
Hood Hinge to Dash And Cowl Panel Brace Retaining Bolt	20 N·m	15 lb ft
Hood Hinge to Hood Retaining Bolts	20 N·m	15 lb ft
Hood Latch to Front End Module Retaining Bolts	9 N·m	80 lb in
Liftgate Hinge to Header Bolts (Sportwagon)	58 N·m	43 lb ft
Liftgate Hinge to Header Nuts (Sportwagon)	25 N·m	18 lb ft
Liftgate Hinge to Liftgate Bolts (Sportwagon)	22 N·m	16 lb ft
Liftgate Hinge to Liftgate Retaining Bolts (Sportwagon)	22 N·m	16 lb ft
Liftgate Striker Bolts (Sportwagon)	20 N·m	15 lb ft
Liftgate Wedge to Body Torx Retaining Bolt (Sportwagon)	10 N·m	89 lb in
Liftgate Wedge to Liftgate Torx Retaining Bolt (Sportwagon)	10 N·m	89 lb in
Rear Compartment Lid Hinge to Rear Quarter Panel Retaining Bolts	22 N·m	16 lb ft
Rear Compartment Lid to Rear Compartment Lid Hinge Retaining Nuts	22 N·m	16 lb ft
Rear Quarter End Cap Retaining Nuts	3 N·m	27 lb in
Rear Window Division Channel to Door Retaining Screws	3 N·m	27 lb in

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Front End Panel Module Carrier Assembly Replacement

Removal Procedure

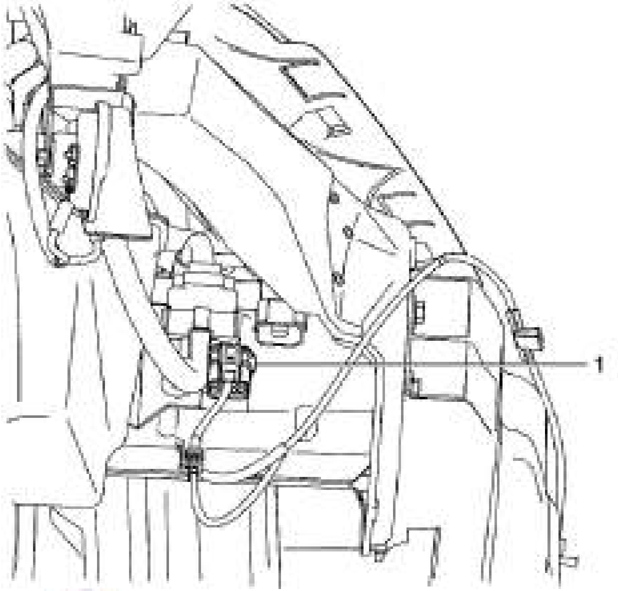
Caution: Refer to Safety Glasses Caution in the Preface section.

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

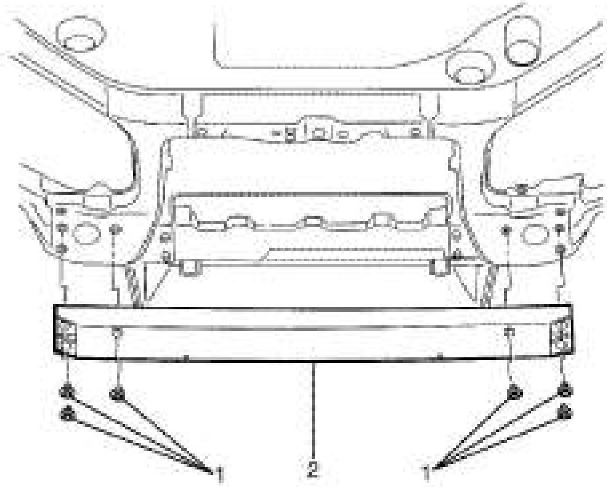
1. Install a suitable hood brace to the vehicle.
2. Apply tape to corners of the panels and adjacent surfaces to help prevent paint damage.
3. Remove the radiator air baffle. Refer to Radiator Air Upper Baffle and Deflector Replacement .

Caution: Refer to Vehicle Lifting Caution in the Preface section.

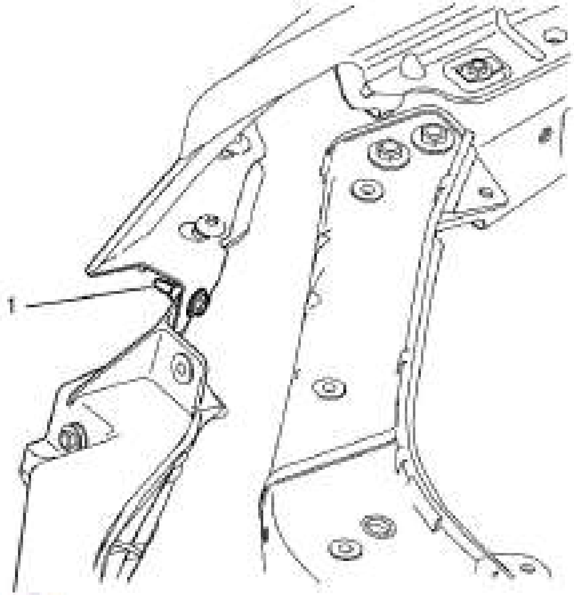
4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
5. Remove the front wheels. Refer to Tire and Wheel Removal and Installation .
6. Remove the front wheelhouse liners. Refer to Front Wheelhouse Liner Replacement .
7. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement .
8. Remove the front air deflector. Refer to Front Air Deflector Replacement .



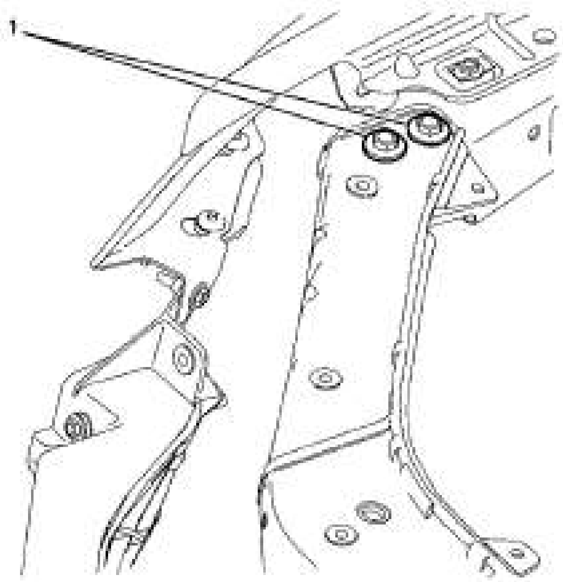
9. Disconnect the main wiring harness (1) to the front end module.
10. Remove the front bumper fascia bracket. Refer to Front Bumper Impact Bar Bracket Replacement .
11. Remove the headlights. Refer to Headlamp Replacement .
12. Remove the hood latch. Refer to Hood Primary and Secondary Latch Replacement .
13. Remove the front energy absorber. Refer to Front Bumper Fascia Energy Absorber Replacement .
14. Disconnect the washer jet pump to washer jet lines. Refer to Washer Pump Replacement .
15. Remove the fog lamp wiring loom. Refer to Front Fog Lamp Replacement .



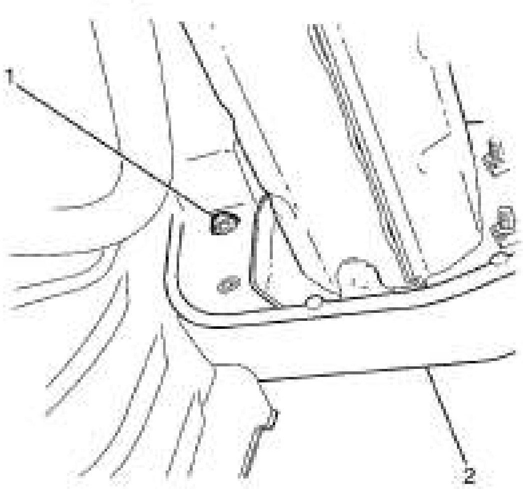
16. Remove the front bumper impact bar to front end module retaining bolts (1).



17. Remove the front fender to front end module retaining bolt (1).



18. Remove the front end module to inner wheelhouse retaining bolts (1).
19. With the aid of an assistant, remove the front end module from the vehicle.

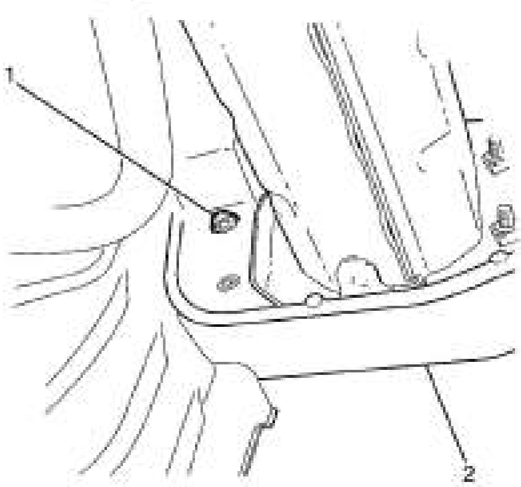


20. Remove the front end module to front bumper impact bar retaining bolts (1). Repeat for opposite side.
21. Remove the front bumper impact bar from the front end module.
22. Remove the windshield washer bottle. Refer to Windshield Washer Solvent Container Replacement .
23. Remove the radiator air intake baffle. Refer to Radiator Air Lower Baffle and Deflector Replacement .
24. Remove the horns. Refer to Horn Replacement .
25. Remove the wiring loom from the front end module.

Installation Procedure

1. Install the wiring loom to the front end module.
2. Install the horns. Refer to Horn Replacement .
3. Install the radiator air intake baffle. Refer to Radiator Air Lower Baffle and Deflector Replacement .
4. Install the windshield washer bottle. Refer to Windshield Washer Solvent Container Replacement .
5. Install the front bumper impact bar to the front end module.

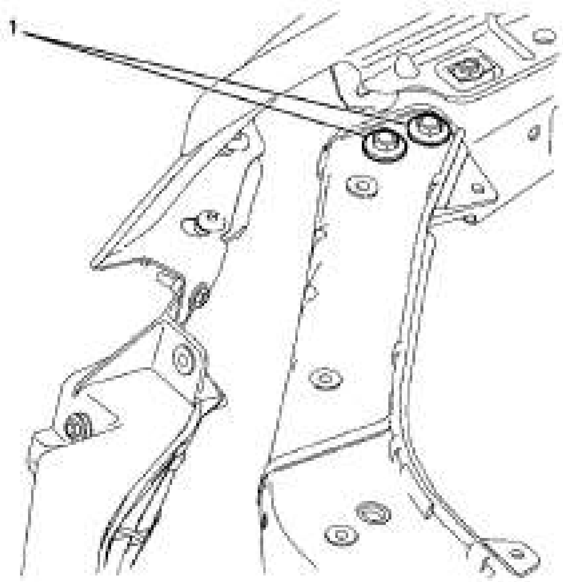
   Notice: Refer to Fastener Notice in the Preface section.



6. Install the front bumper impact bar to front end module retaining bolts (1). Repeat for opposite side.

   Tighten
   Tighten the bolts to 4 N·m (35 lb in).

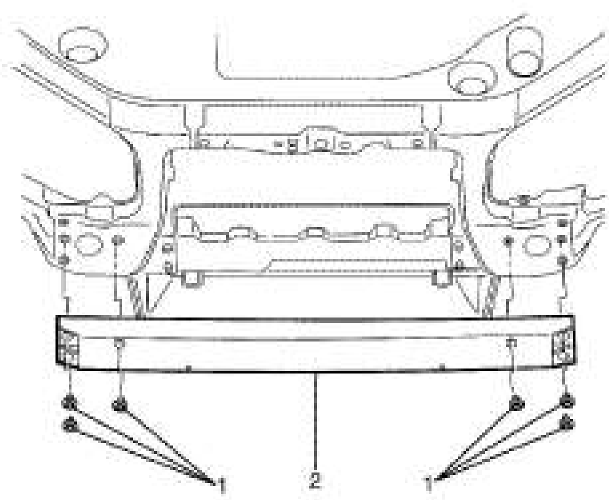
7. With the aid of an assistant, install the front end module to the vehicle.



Important: Do not fully tighten at this stage.

8. Install the front end module to inner wheelhouse retaining bolts (1).

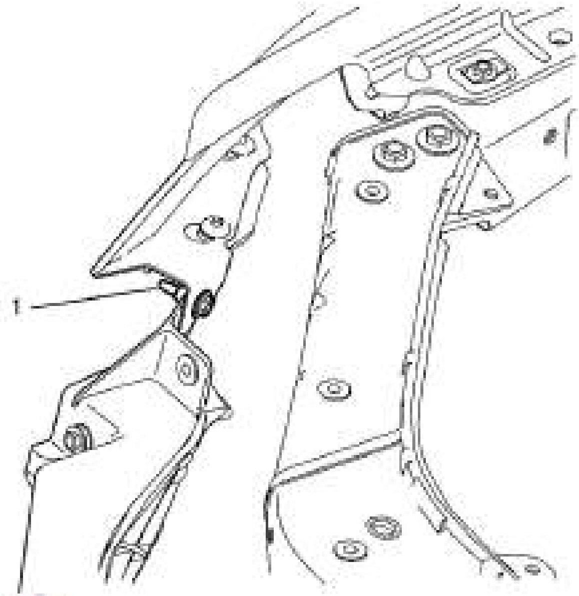
   Do not fully tighten at this stage.



Important: Do not fully tighten at this stage.

9. Install the front bumper impact bar to front end module retaining bolts (1).

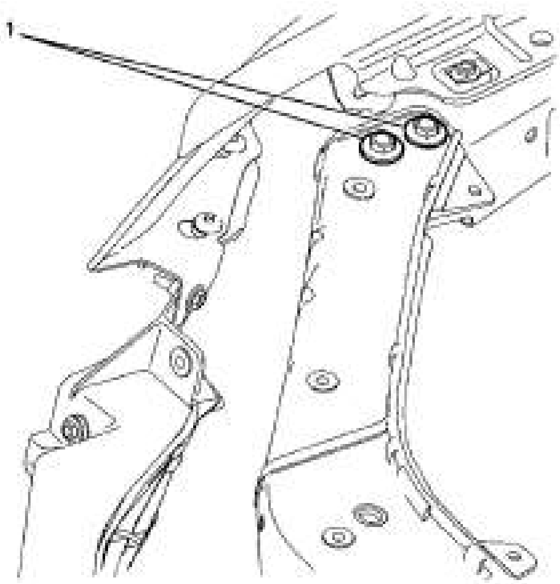
Do not fully tighten at this stage.



Important: Do not fully tighten at this stage.

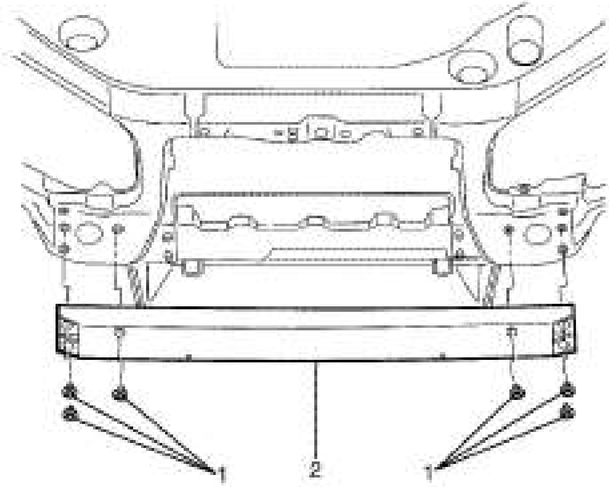
10. Install the front fender to front end module retaining bolt (1). Repeat for opposite side.

    Do not fully tighten at this stage.



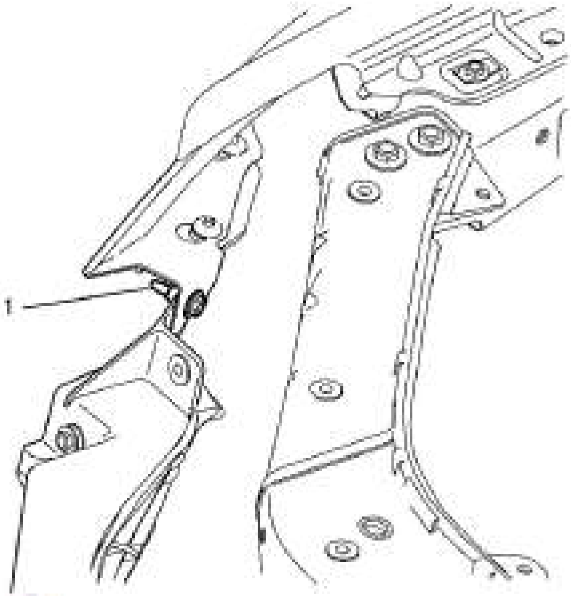
11. Tighten the front end module to inner wheelhouse retaining bolts (1).

Tighten
Tighten the bolts to 9 N·m (80 lb in).



12. Tighten the front bumper impact bar to front end module retaining bolts (1).

Tighten
Tighten the bolts to 22 N·m (16 lb ft).

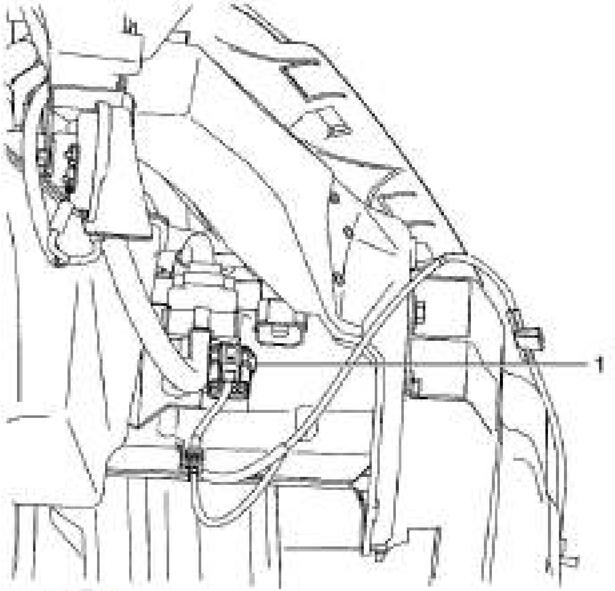


13. Tighten the front fender to front end module retaining bolt (1). Repeat for opposite side.

Tighten

Tighten the bolts to 9 N·m (80 lb in).

14. Install the washer jet pump to washer jet lines. Refer to Washer Pump Replacement .
15. Install the front energy absorber. Refer to Front Bumper Fascia Energy Absorber Replacement .
16. Install the fog lamp wiring loom. Refer to Front Fog Lamp Replacement .
17. Install the hood latch. Refer to Hood Primary and Secondary Latch Replacement .
18. Install the headlight. Refer to Headlamp Replacement .
19. Install the front bumper fascia bracket. Refer to Front Bumper Impact Bar Bracket Replacement .
20. Install the front air deflector. Refer to Front Air Deflector Replacement .
21. Install the front bumper fascia. Refer to Front Bumper Fascia Replacement .



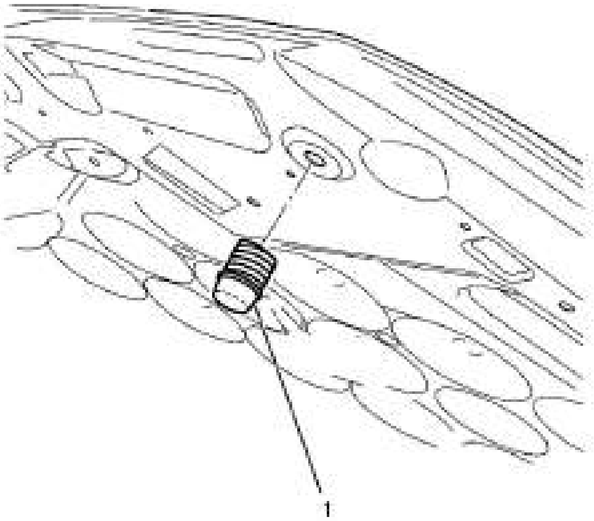
22. Connect the main wiring harness (1) to the front end module.
23. Install the front wheelhouse liners. Refer to Front Wheelhouse Liner Replacement .
24. Install the front wheels. Refer to Tire and Wheel Removal and Installation .
25. Lower the vehicle.
26. Install the radiator air baffle. Refer to Radiator Air Upper Baffle and Deflector Replacement .
27. Remove the suitable hood brace from the vehicle.
28. Remove the tape from the vehicle.

Hood Bumper Replacement

Removal Procedure

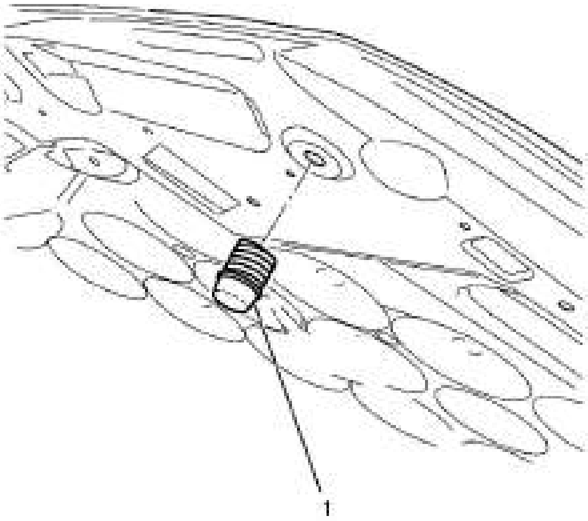
Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable hood brace to the vehicle.



2. Remove the hood bumpers (1) from the hood by turning counter clockwise.

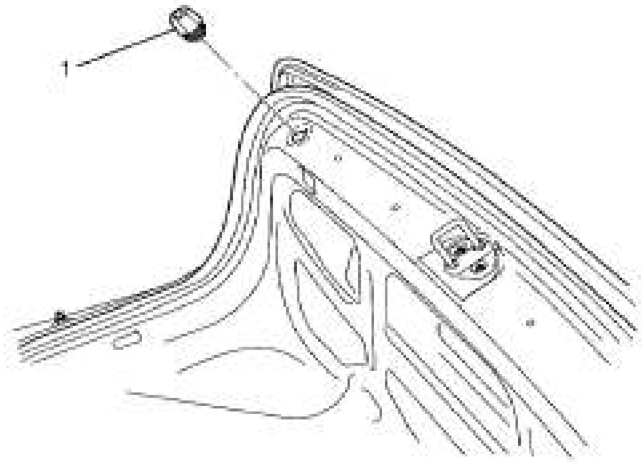
Installation Procedure



1. Position the hood bumpers (1) to the opening in the hood.
2. Turn the hood bumpers clockwise until they bottom out in the hood.
3. Turn the hood bumpers anti clockwise until the hood is flush with the fenders.
4. Remove the suitable hood brace from the vehicle.

Rear Compartment Lid Overslam Bumper Replacement

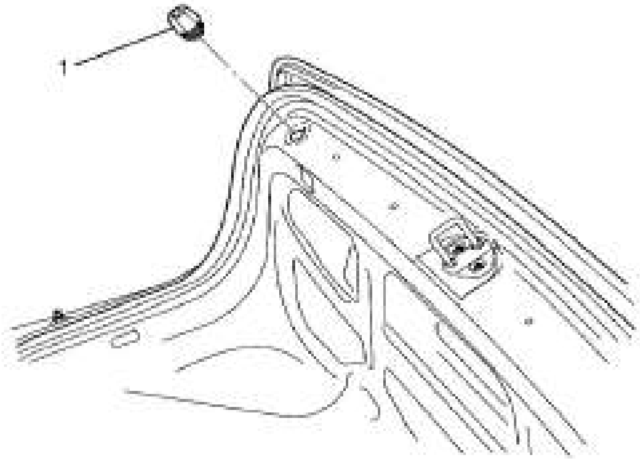
Removal Procedure



Important: Turn the overslam bumper (1) counter-clockwise to remove.

1. Remove the overslam bumper (1) from the rear compartment lid.
2. Remove the overslam bumper (1) from the vehicle.

Installation Procedure



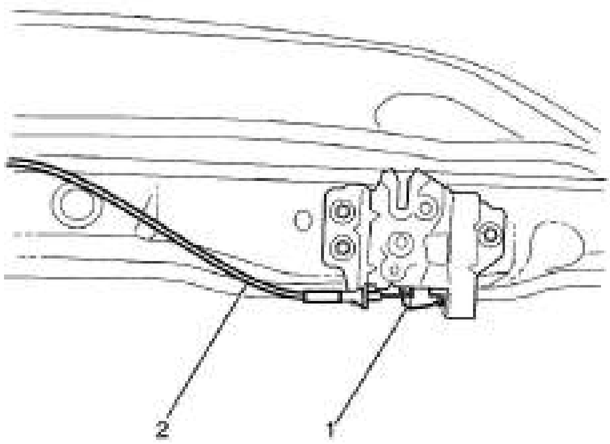
Important: Turn the overslam bumper (1) clockwise to install.

1. Install the overslam bumper (1) to the rear compartment lid.
2. Turn the overslam bumper as required for flushness. Refer to Rear Compartment Lid Adjustment .

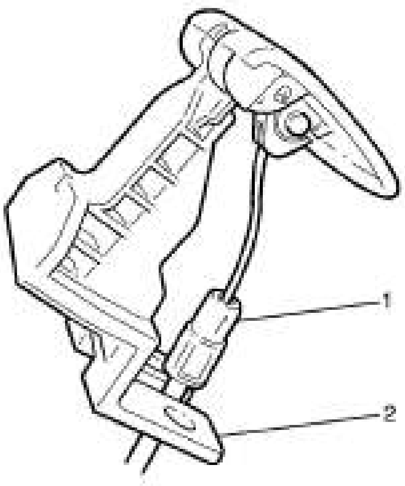
Hood Primary Latch Release Cable Replacement

Removal Procedure

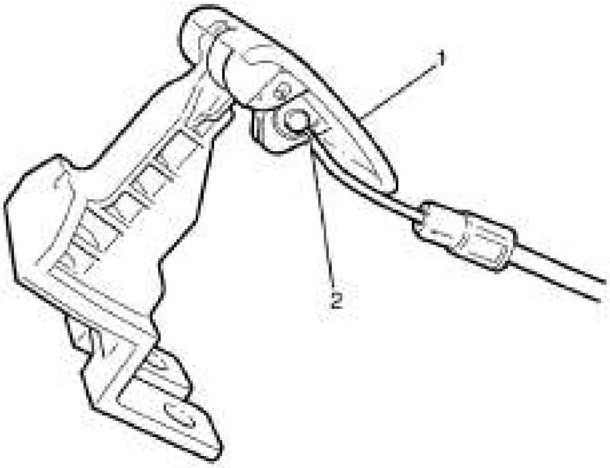
1. Remove the hood latch. Refer to Hood Primary and Secondary Latch Replacement.



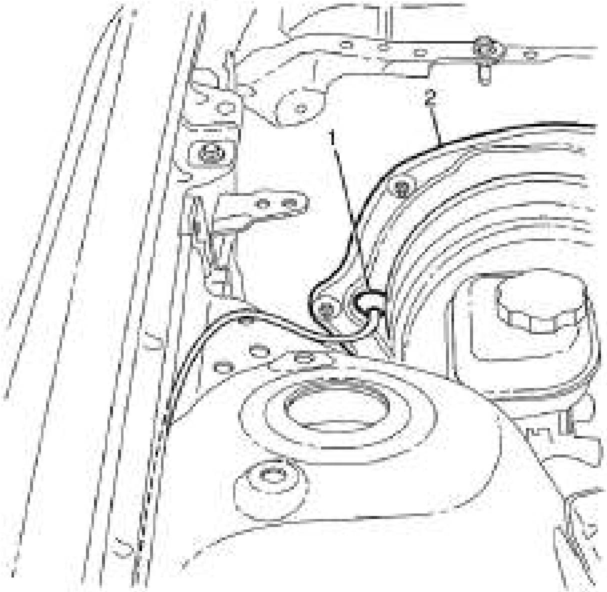
2. Attach a piece of string around the hood release cable (2). This will ease the installation of the hood release cable through the engine compartment.
3. Remove the right side hinge pillar trim panel. Refer to Body Hinge Pillar Trim Panel Replacement.
4. Remove the right knee bolster. Refer to Knee Bolster Replacement.



5. Disconnect the hood release cable (1) from the hood release handle (2).



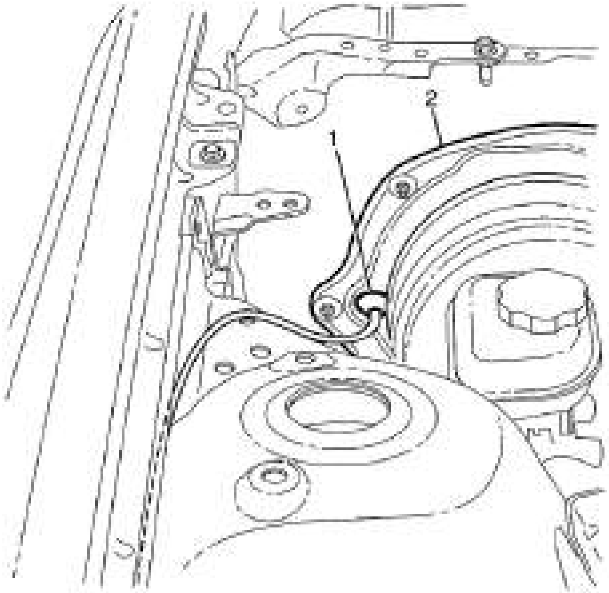
6. Rotate the hood release cable and detach the hood release cable barrel (2) from the hood release handle (1).



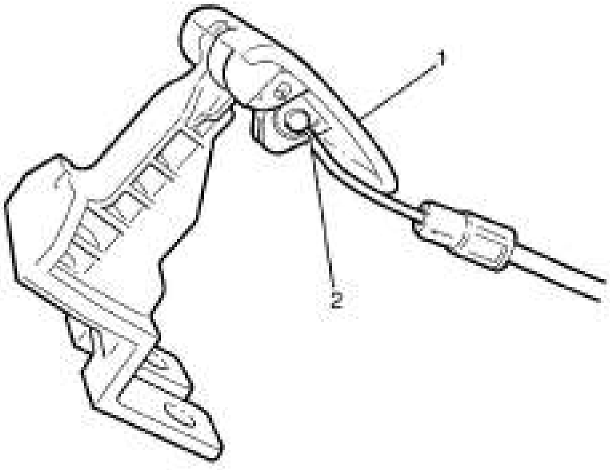
7. Remove the hood release cable grommet (1) from the mod plate (2).
8. Remove the hood release cable from the vehicle.

Installation Procedure

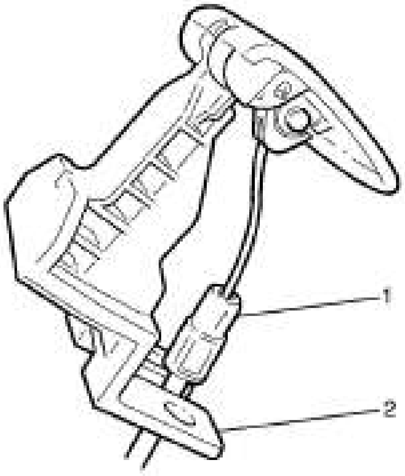
1. Transfer the string to the end of the new hood release cable.
2. Route the string and the hood release cable into the passenger compartment.
3. Remove the string from the hood release cable.



4. Seat the hood release cable grommet (1) into the mod plate (2).



5. Attach the hood release cable barrel (2) to the hood release handle (1).

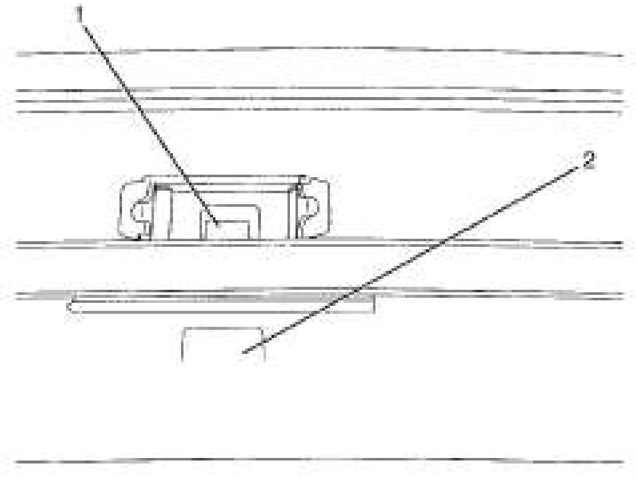


6. Rotate and connect the hood release cable (1) to the hood release handle assembly (2).
7. Install the right knee bolster. Refer to Knee Bolster Replacement.
8. Install the right side hinge pillar trim panel. Refer to Body Hinge Pillar Trim Panel Replacement.
9. Install the hood latch. Refer to Hood Primary and Secondary Latch Replacement.

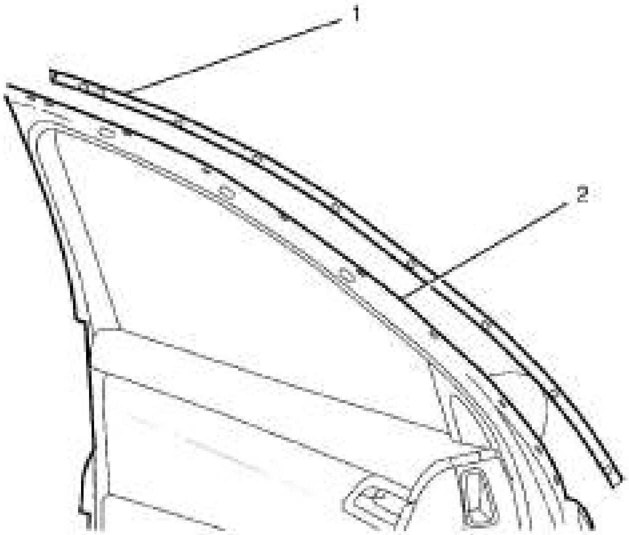
Front and Rear Side Door Window Garnish Molding Replacement (Sportwagon)

Removal Procedure - Front

1. Remove the front door upper auxiliary weatherstrip. Refer to Front Side Door Upper Auxiliary Weatherstrip Replacement.

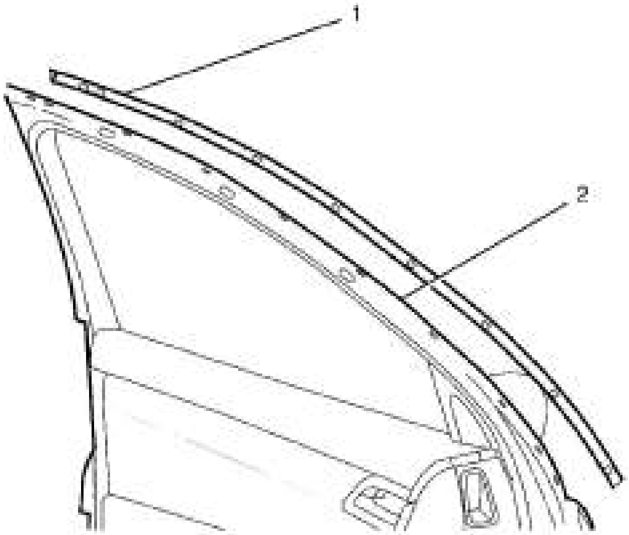


2. Detach the door frame garnish moulding locking tab (1) from the door frame (2) using a suitable flat bladed tool

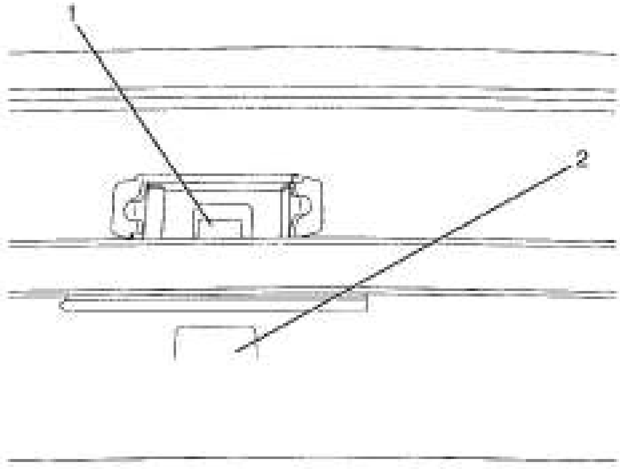


3. Remove the door frame garnish moulding (1) from the door (2).

Installation Procedure - Front



1. Position the door frame garnish moulding (1) to the door (2).

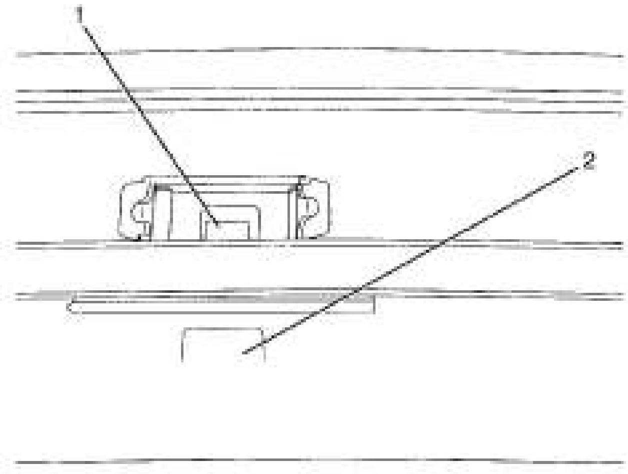


Important: Push the door frame garnish moulding until the locking tab (1) locates in the door frame (2).

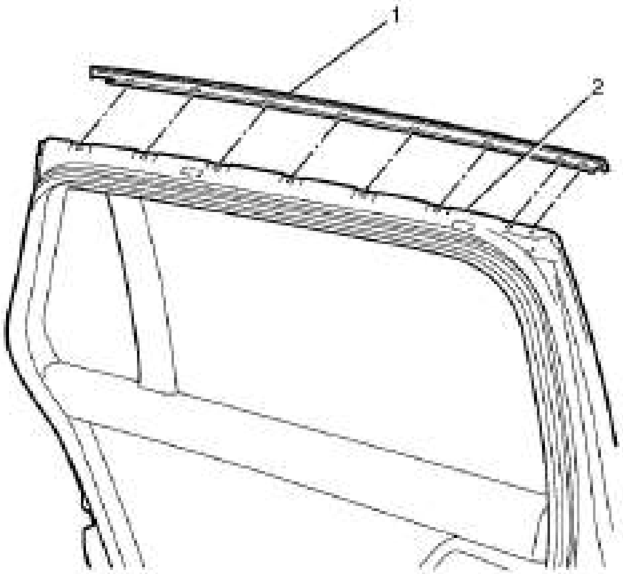
2. Attach the door frame garnish moulding locking tab (1) to the door frame (2).
3. Install the front door upper auxiliary weatherstrip. Refer to Front Side Door Upper Auxiliary Weatherstrip Replacement.

Removal Procedure - Rear

1. Remove the rear door bottom auxiliary weatherstrip. Refer to Rear Side Door Bottom Auxiliary Sealing Strip Replacement.



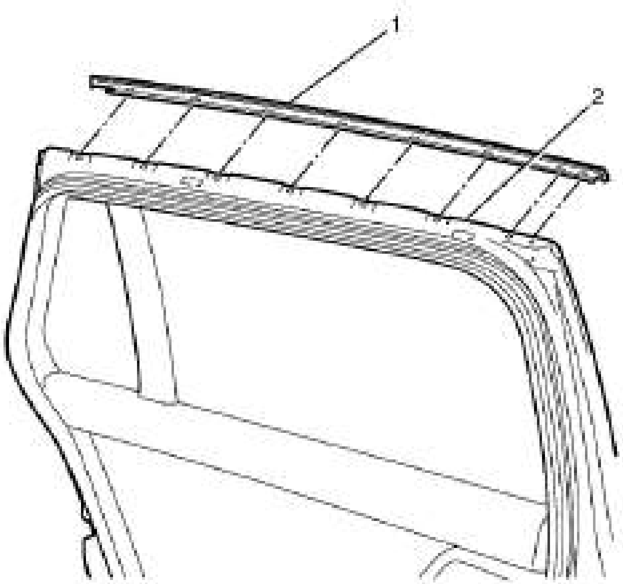
2. Detach the door frame garnish moulding locking tab (1) from the door frame (2) using a suitable flat bladed tool



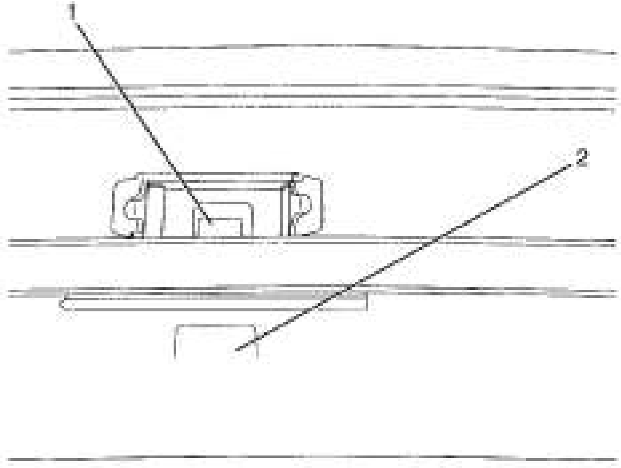
Important: Detach the clips on the door frame garnish moulding (1) with a suitable flat bladed tool.

3. Remove the door frame garnish moulding (1) from the door (2).

Installation Procedure - Rear



1. Install the door frame garnish molding (1) to the door (2).



Important: Push the door frame garnish moulding until the locking tab (1) locates in the door frame (2).

2. Attach the door frame garnish moulding locking tab (1) to the door frame (2).
3. Install the rear door bottom auxiliary weatherstrip. Refer to Rear Side Door Bottom Auxiliary Sealing Strip Replacement.

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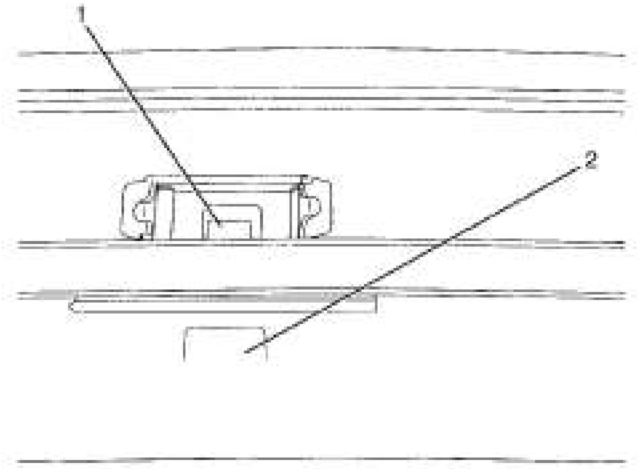
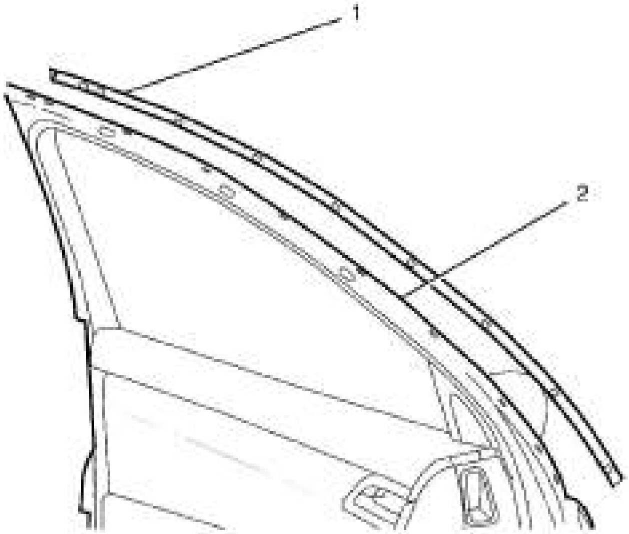
Front and Rear Side Door Window Garnish Molding Replacement (Sedan)

Removal Procedure - Front

1. Remove the front door upper auxiliary weatherstrip. Refer to Front Side Door Upper Auxiliary Weatherstrip Replacement.

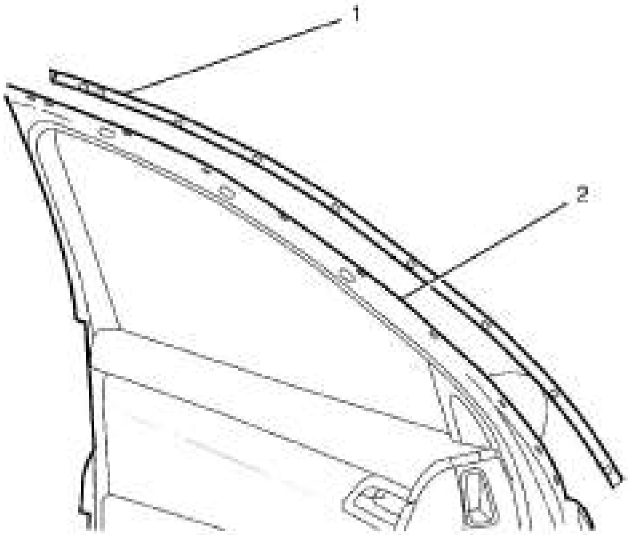


2. Detach the door frame garnish molding locking tab (1) from the door frame (2) using a suitable flat bladed tool.

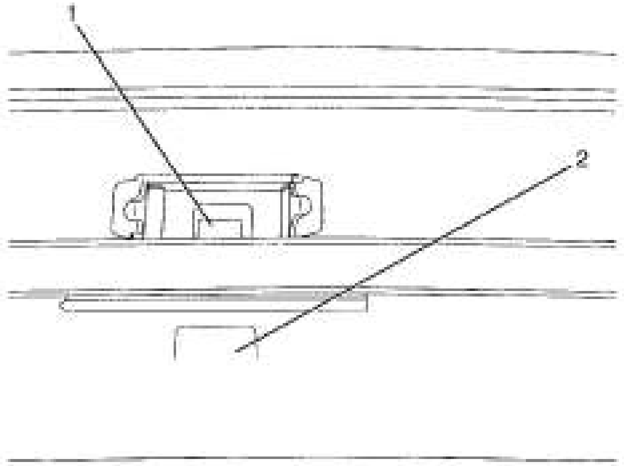


3. Remove the door frame garnish molding (1) from the door (2).

Installation Procedure - Front



1. Position the door frame garnish molding (1) to the door (2).

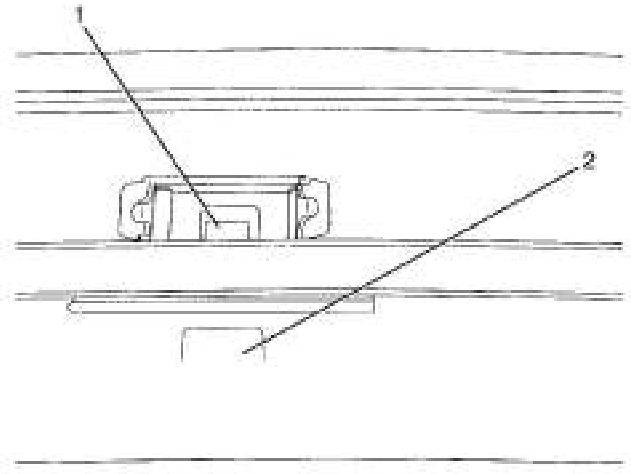


Important: Push the door frame garnish molding until the locking tab (1) locates in the door frame (2).

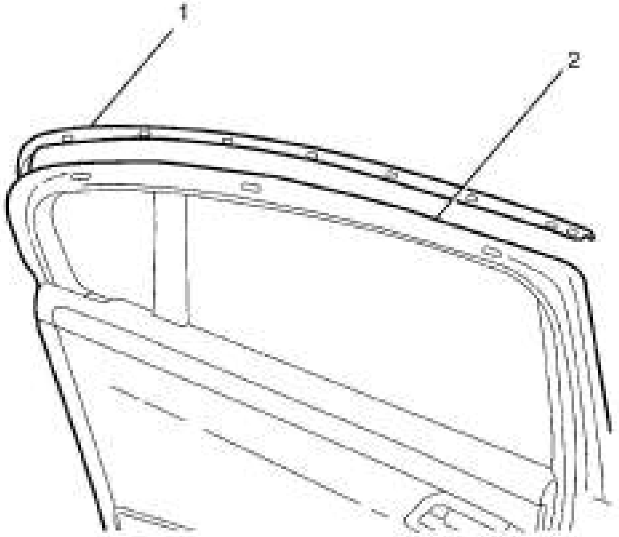
2. Attach the door frame garnish molding locking tab (1) from the door frame (2).
3. Install the front door upper auxiliary weatherstrip. Refer to Front Side Door Upper Auxiliary Weatherstrip Replacement.

Removal Procedure - Rear

1. Remove the rear door bottom auxiliary weatherstrip. Refer to Rear Side Door Bottom Auxiliary Sealing Strip Replacement.



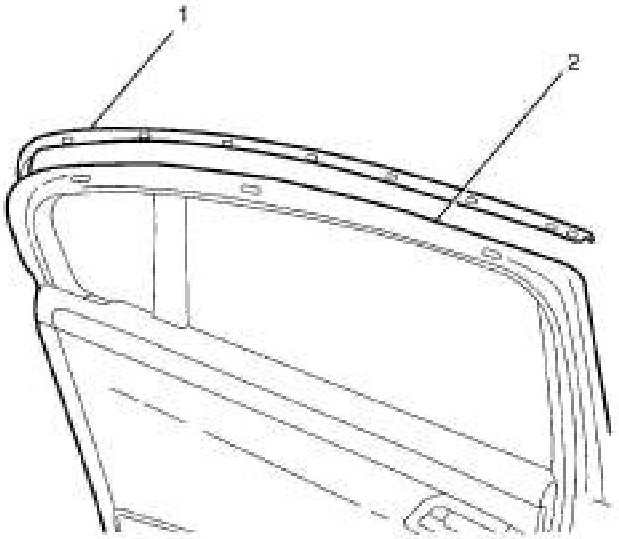
2. Detach the door frame garnish molding locking tab (1) from the door frame (2) using a suitable flat bladed tool.



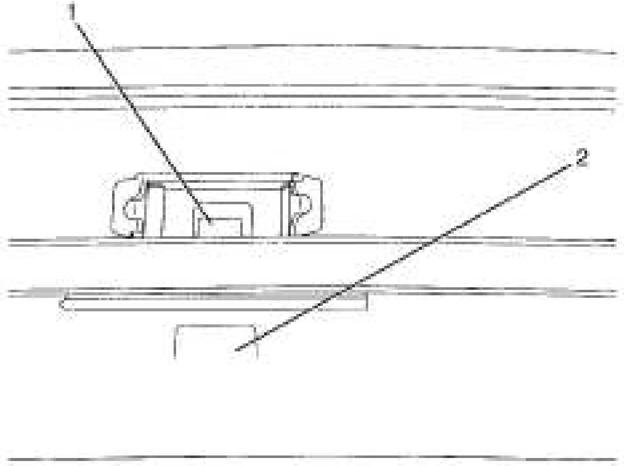
Important: Detach the clips on the door frame garnish molding (1) with a suitable flat bladed tool.

3. Remove the door frame garnish molding (1) from the door (2).

Installation Procedure - Rear



1. Install the door frame garnish molding (1) to the door (2).



Important: Push the door frame garnish molding until the locking tab (1) locates in the door frame (2).

2. Attach the door frame garnish molding locking tab (1) from the door frame (2).
3. Install the rear door bottom auxiliary weatherstrip. Refer to Rear Side Door Bottom Auxiliary Sealing Strip Replacement.

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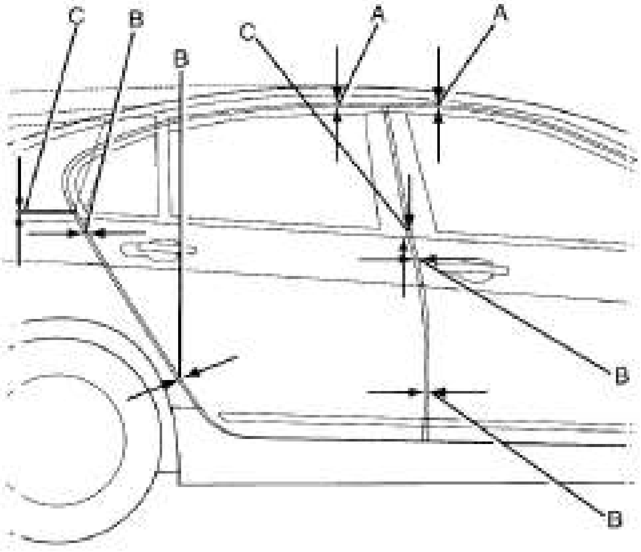
Door Adjustment



1. Loosen the door hinge to pillar retaining bolts. This will allow adjustment of the door at the hinge pillar in the following directions:
    - Up or down (a), 6.5 mm equal gap.
    - Fore or aft (b), 3.5 mm equal gap.
    - Up or down (c), 5 mm upwards.
2. Reposition the door as needed.

Notice: Refer to Fastener Notice in the Preface section.

3. Position the door fore or aft at the hinge pillar attachment. Perform the following steps as needed:
    - 3.1. Loosen the bolts.
    - 3.2. Reposition the door.
    - 3.3. Tighten the bolts.

Tighten
Tighten the bolts to 28 N-m (21 lb ft).

4. Verify the doors are flush to within 3.5 mm, with a flushing magnet located in the striker area below the beltline.
5. If in or out adjustment is needed, loosen the door hinge to door retaining bolts.
6. Align the front door to the front fender first, if needed.
7. Position the door in or out. Perform the following steps as needed:
    - 7.1. Loosen the bolts.
    - 7.2. Reposition the door.

  7.3. Tighten the bolts.

Tighten
Tighten the bolts to 28 N-m (21 lb ft).

8. Align the rear door to the front door and rear quarter, if needed.
9. Position the door in or out. Perform the following steps as needed:
   9.1. Loosen the bolts.
   9.2. Reposition the door.
   9.3. Tighten the bolts.

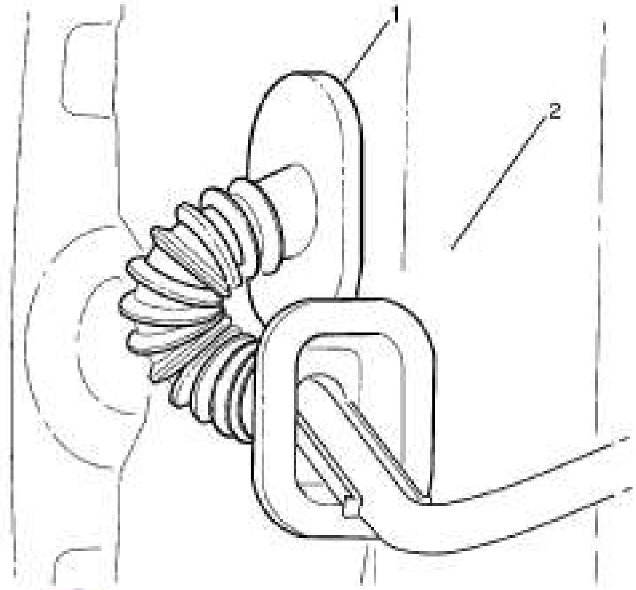
Tighten
Tighten the bolts to 28 N-m (21 lb ft).

10. Verify door header to door header at the center pillar is flush to within 3.5 mm. Adjust the door headers if necessary.
11. Verify all door gaps are within specifications.
12. Adjust the lock striker. Refer to Door Lock Striker Adjustment.

Front Side Door Replacement

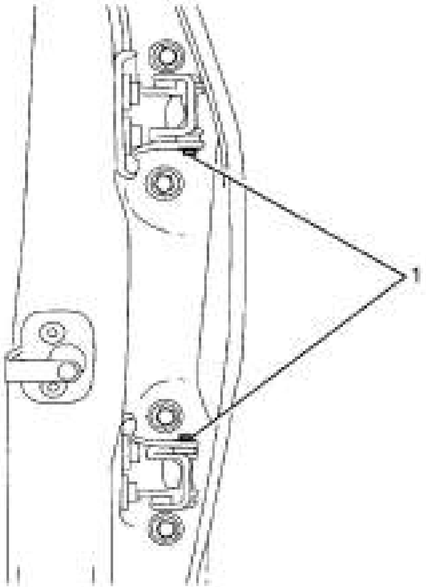
Removal Procedure - Front Door

1. Remove the check link to pillar retaining bolt. Refer to Front Side Door Check Link Replacement .

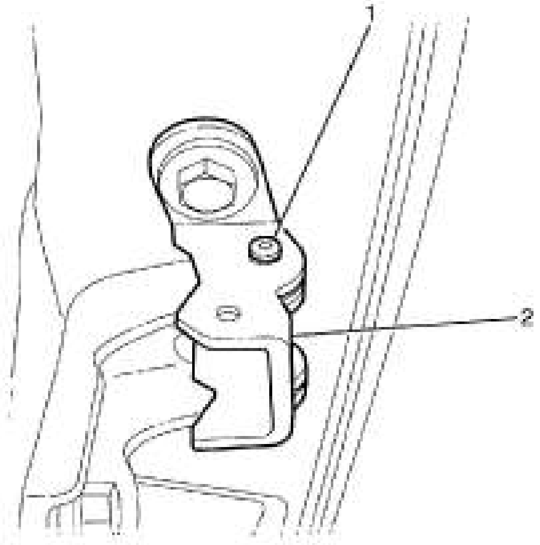


Important: Pull the rubber conduit (1) from the pillar (2) to expose the door to body wiring harness plug.

2. Remove the rubber conduit (1) from the pillar (2).
3. Disconnect the door wiring harness to body wiring harness electrical connector.



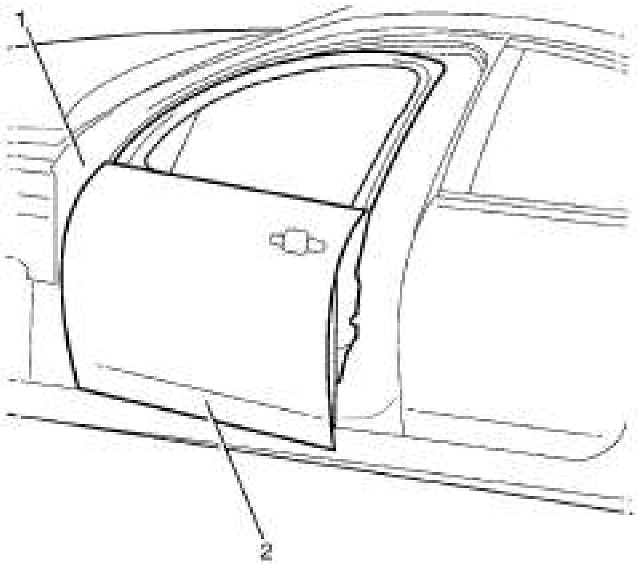
4. The keeper bolts (1) are located in the door hinges with the top door hinge keeper bolt facing downwards and the lower door hinge keeper bolt facing upwards.



Important: The keeper bolts (1) are single use parts and must be discarded after use.

5. Remove the keeper bolts (1) from the door hinges (2).

   Discard the bolts.

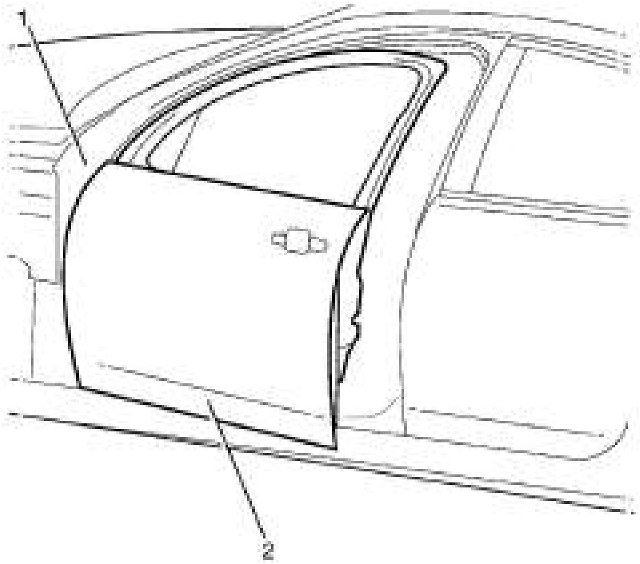


Important: The door (1) can only be removed when it is opened to 50 degrees.

Important: Lift the door (1) upwards and outwards to disengage it from the vehicle (2).

6. Remove the door (2) from the vehicle (1) with the aid of an assistant.

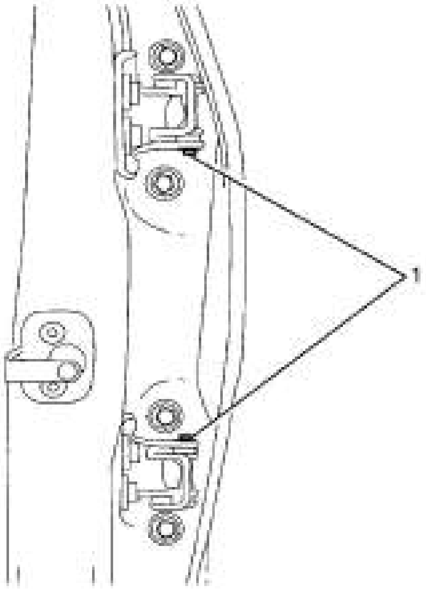
Installation Procedure - Front Door



Important: The door (1) can only be installed when it is opened to 50 degrees.

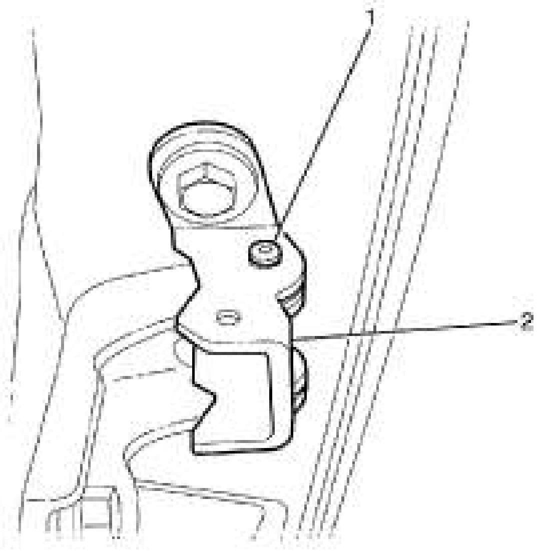
Important: Lower the door (1) downwards and inwards to engage it to the vehicle (2).

1. Install the door (2) to the vehicle (1) with the aid of an assistant.



2. The keeper bolts (1) are located in the door hinges with the top door hinge keeper bolt facing downwards and the lower door hinge keeper bolt facing upwards.

   Notice: Refer to Fastener Notice in the Preface section.

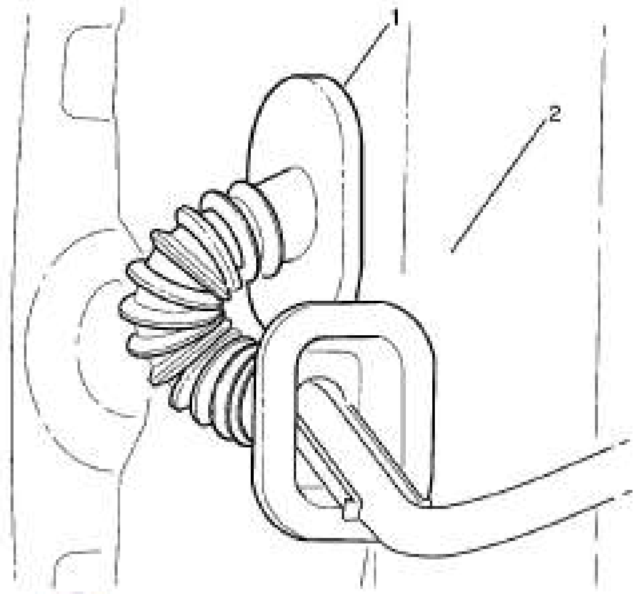


Important: Do Not over tighten the NEW keeper bolts as this will cause the door hinges to squeak.

3. Install the NEW keeper bolts (1) to the door hinges (2).

   Tighten
   Tighten the bolts to 3 N-m (27 lb in).

4. Connect the door wiring harness to body wiring harness electrical connector.



5. Install the rubber conduit (1) to the pillar (2).
6. Install the check link to pillar retaining bolt. Refer to Front Side Door Check Link Replacement .

Disassembly Procedure - Front Door

1. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement .
2. Remove the speaker. Refer to Radio Front Side Door Lower Speaker Replacement in Entertainment.
3. Remove the water deflector. Refer to Front Side Door Water Deflector Replacement .
4. Remove the outside rearview mirror. Refer to Power Mirror Replacement .
5. Remove the window inner belt sealing strip. Refer to Front Side Door Window Inner Sealing Strip Replacement in Doors.
6. Remove the window outer belt sealing strip. Refer to Front Side Door Window Belt Outer Sealing Strip Replacement in Doors.
7. Remove the window. Refer to Front Side Door Window Replacement .
8. Remove the front door upper auxiliary weatherstrip. Refer to Front Side Door Upper Auxiliary Weatherstrip Replacement .
9. Remove the front door garnish molding. Refer to Front and Rear Side Door Window Garnish Molding Replacement .
10. Remove the inner window sealing strip. Refer to Front Door Opening Weatherstrip Replacement .
11. Remove the door frame applique. Refer to Front Door Frame Applique Replacement .
12. Remove the window inner weatherstrip. Refer to Front Side Door Window Inner Weatherstrip Replacement .
13. Remove the window regulator. Refer to Front Side Door Window Regulator Replacement .
14. Remove the outside door handle. Refer to Front Side Door Outside Handle Replacement .
15. Remove the door latch. Refer to Front Side Door Latch Replacement .
16. Remove the door bottom auxiliary sealing strip. Refer to Front Side Door Bottom Auxiliary Sealing Strip Replacement .
17. Remove the door wiring harness. Refer to Front Side Door Wiring Harness Replacement .
18. Remove the door window channel. Refer to Front Side Door Window Front Channel and Rear Channel Replacement .
19. Remove the door check link. Refer to Front Side Door Check Link Replacement .

20. Remove all of the plastic nuts, grommets and retainers from the door.

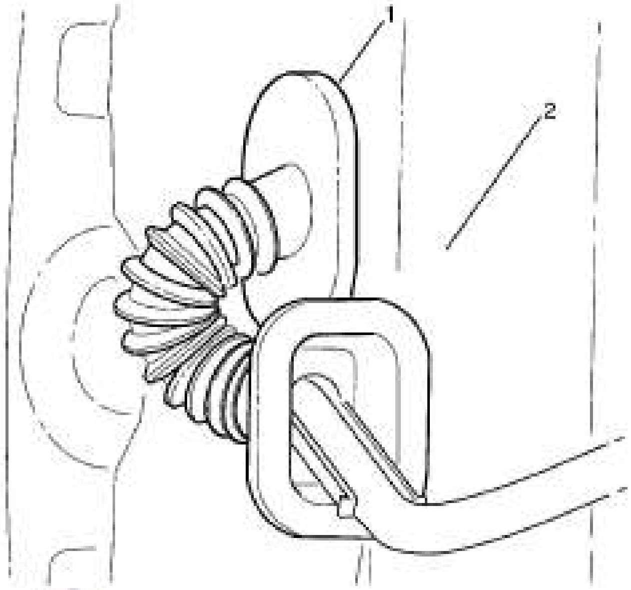
Assembly Procedure - Front Door

1. Install all the plastic nuts, grommets and retainers into the door shell that were removed during disassembly.
2. Install the door check link. Refer to Front Side Door Check Link Replacement .
3. Install the door window channel. Refer to Front Side Door Window Front Channel and Rear Channel Replacement .
4. Install the door wiring harness. Refer to Front Side Door Wiring Harness Replacement .
5. Install the door bottom auxiliary sealing strip. Refer to Front Side Door Bottom Auxiliary Sealing Strip Replacement .
6. Install the door latch. Refer to Front Side Door Latch Replacement .
7. Install the outside door handle. Refer to Front Side Door Outside Handle Replacement .
8. Install the window regulator. Refer to Front Side Door Window Regulator Replacement .
9. Install the window inner weatherstrip. Refer to Front Side Door Window Inner Weatherstrip Replacement .
10. Install the door frame applique. Refer to Front Door Frame Applique Replacement .
11. Install the window. Refer to Front Side Door Window Replacement .
12. Install the inner window sealing strip. Refer to Front Door Opening Weatherstrip Replacement .
13. Install the window outer belt seal strip.. Refer to Front Side Door Window Belt Outer Sealing Strip Replacement in Doors.
14. Install the outside rearview mirror. Refer to Power Mirror Replacement .
15. Install the window inner belt seal strip. Refer to Front Side Door Window Belt Inner Sealing Strip Replacement in Doors.
16. Install the front door garnish molding. Refer to Front and Rear Side Door Window Garnish Molding Replacement
17. Install the front door upper auxiliary weatherstrip. Refer to Front Side Door Upper Auxiliary Weatherstrip Replacement .
18. Install the water deflector. Refer to Front Side Door Water Deflector Replacement .
19. Install the speaker. Refer to Radio Front Side Door Lower Speaker Replacement in Entertainment.
20. Install the door trim panel. Refer to Front Side Door Trim Panel Replacement t in Doors.
21. Inspect for correct door adjustment. Refer to Door Adjustment .

Rear Door Replacement (SWB)

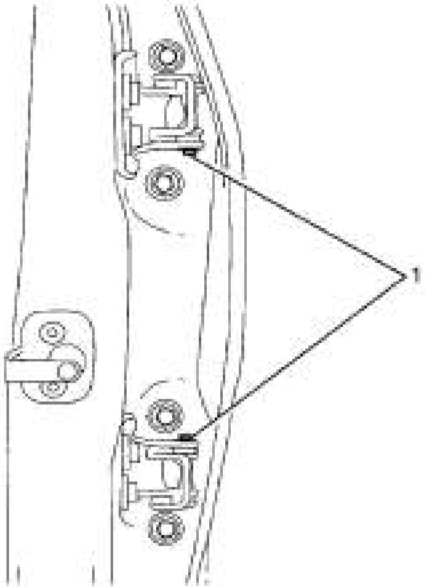
Removal Procedure - Rear Door

1. Remove the check link to pillar retaining bolt. Refer to Rear Side Door Check Link Replacement.

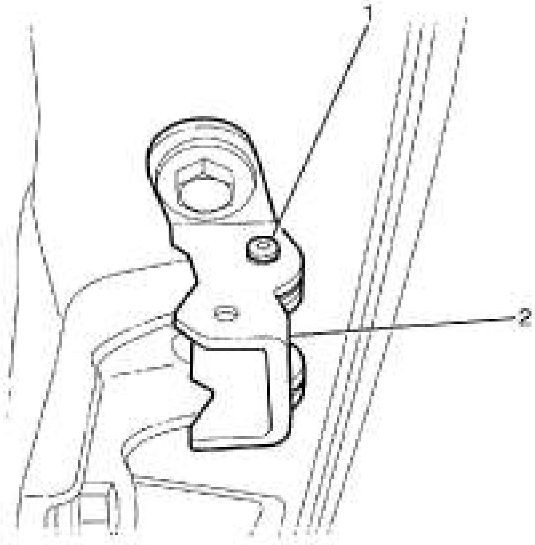


Important: Pull the rubber conduit (1) from the pillar (2) to expose the door to body wiring harness plug.

2. Remove the rubber conduit (1) from the pillar (2).
3. Disconnect the door wiring harness to body wiring harness electrical connector.



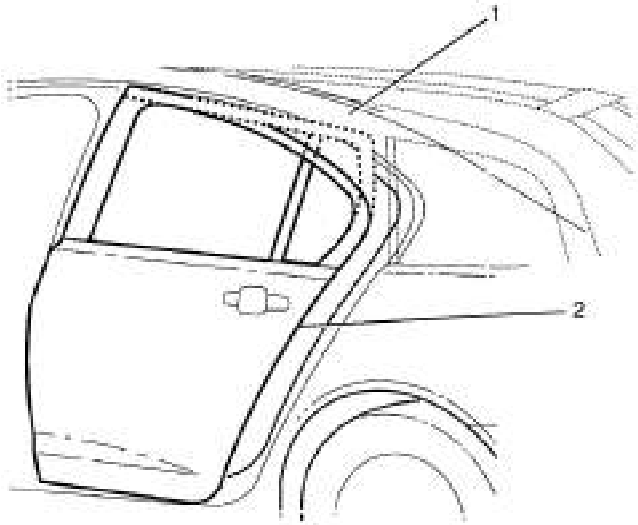
4. The keeper bolts (1) are located in the door hinges with the top door hinge keeper bolt facing downwards and the lower door hinge keeper bolt facing upwards.



Important: The keeper bolts (1) are single use parts and must be discarded after use.

5. Remove the keeper bolts (1) from the door hinges (2).

   Discard the bolts.

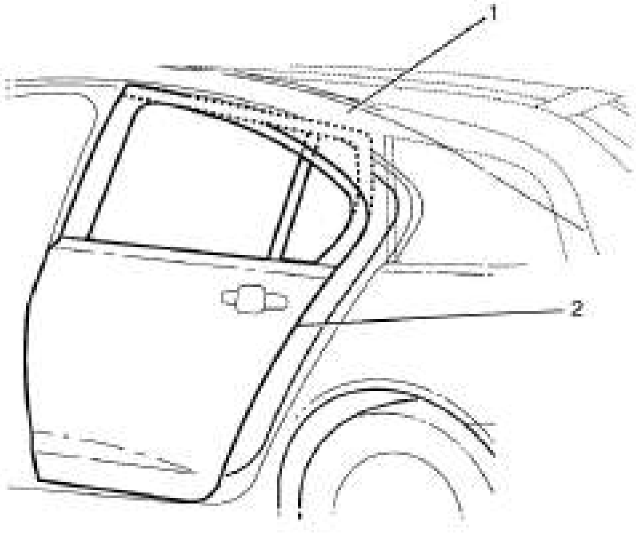


Important: The door (1) can only be removed when it is opened to 50 degrees.

Important: Lift the door (2) upwards and outwards to disengage it from the vehicle (1).

6. Remove the door (2) from the vehicle (1) with the aid of an assistant.

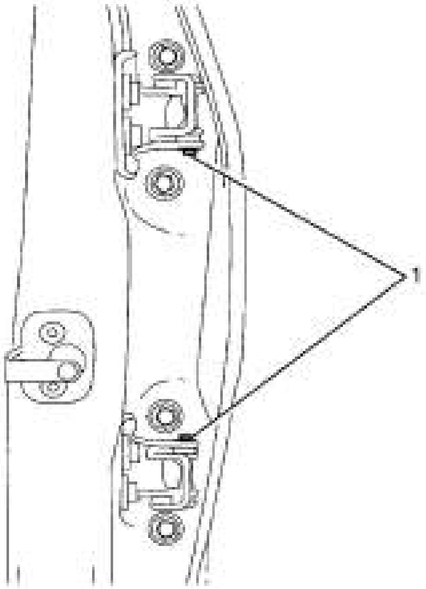
Installation Procedure - Rear Door



Important: The door (1) can only be installed when it is opened to 50 degrees.

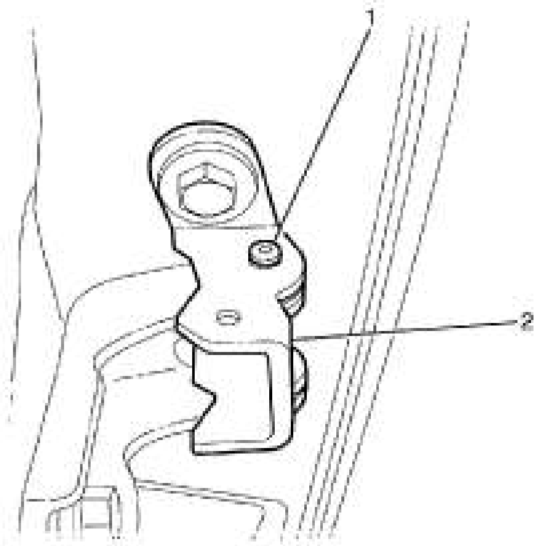
Important: Lower the door (2) downwards and inwards to engage it to the vehicle (1).

1. Install the door (2) to the vehicle (1) with the aid of an assistant.



2. The keeper bolts (1) are located in the door hinges with the top door hinge keeper bolt facing downwards and the lower door hinge keeper bolt facing upwards.

   Notice: Refer to Fastener Notice in the Preface section.

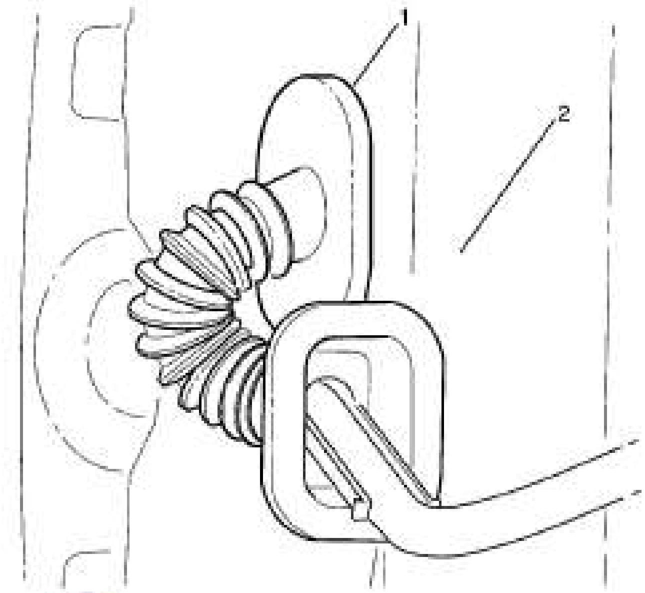


   Important: Do Not over tighten the NEW keeper bolts as this will cause the door hinges to squeak.

3. Install the NEW keeper bolts (1) to the door hinges (2).

   Tighten
   Tighten the bolts to 3 N-m (27 lb in).

4. Connect the door wiring harness to the body wiring harness electrical connector.



5. Install the rubber conduit (1) to the pillar (2).
6. Install the check link to pillar retaining bolt. Refer to Rear Side Door Check Link Replacement.

Disassembly Procedure - Rear Door

1. Remove the door trim panel. Refer to Rear Side Door Trim Panel Replacement.
2. Remove the speaker. Refer to Radio Rear Side Door Speaker Replacement in Entertainment.
3. Remove the water deflector. Refer to Rear Side Door Water Deflector Replacement.
4. Remove the window inner belt sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement.
5. Remove the window inner weatherstrip. Refer to Rear Side Door Window Inner Sealing Strip Replacement.
6. Remove the window outer belt sealing strip. Refer to Rear Side Door Window Outer Sealing Strip Replacement.
7. Remove the window inner sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement.

   Important: This step applies to VE only.

8. Remove the rear door stationary window. Refer to Rear Side Door Window Frame Rear Applique Replacement

   Important: This step applies to WM only.

9. Remove the rear door window channel. Refer to Rear Side Door Window Channel Replacement
10. Remove the door window. Refer to Rear Side Door Window Replacement.
11. Remove the window regulator. Refer to Rear Side Door Window Regulator Replacement.
12. Remove the door frame applique. Refer to Rear Door Frame Applique Replacement.
13. Remove the door bottom auxiliary sealing strip. Refer to Rear Side Door Bottom Auxiliary Sealing Strip Replacement.
14. Remove the door latch. Refer to Rear Side Door Latch Replacement.
15. Remove the outside door handle. Refer to Rear Side Door Outside Handle Replacement.

16. Remove the door wiring harness. Refer to Front Side Door Wiring Harness Replacement.
17. Remove the door check link. Refer to Rear Side Door Check Link Replacement.
18. Remove all of the plastic nuts, grommets and retainers from the door.

Assembly Procedure - Rear Door

1. Install all the plastic nuts, grommets and retainers into the door shell that were removed during disassembly.
2. Install the door check link. Refer to Rear Side Door Check Link Replacement.
3. Install the door wiring harness. Refer to Front Side Door Wiring Harness Replacement.
4. Install the outside door handle. Refer to Rear Side Door Outside Handle Replacement.
5. Install the door latch. Refer to Rear Side Door Latch Replacement.
6. Install the window inner sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement.

   Important: This step applies to VE only.

7. Install the rear door stationary window. Refer to Rear Side Door Window Frame Rear Applique Replacement.

   Important: This step applies to WM only.

8. Install the rear door window channel. Refer to Rear Side Door Window Channel Replacement.
9. Install the window inner sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement.
10. Install the window regulator. Refer to Rear Side Door Window Regulator Replacement.
11. Install the door window. Refer to Rear Side Door Window Replacement.
12. Install the door bottom auxiliary sealing strip. Refer to Rear Side Door Bottom Auxiliary Sealing Strip Replacement.
13. Install the door frame applique. Refer to Rear Door Frame Applique Replacement.
14. Install the window outer belt sealing strip. Refer to Rear Side Door Window Outer Sealing Strip Replacement.
15. Install the window inner belt sealing strip. Refer to Rear Side Door Window Inner Weatherstrip Replacement.
16. Install the water deflector. Refer to Rear Side Door Water Deflector Replacement.
17. Install the speaker. Refer to Radio Rear Side Door Speaker Replacement in Entertainment.
18. Install the door trim panel. Refer to Rear Side Door Trim Panel Replacement.
19. Inspect for correct door adjustment. Refer to Door Adjustment in Doors.

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Front Fender Replacement

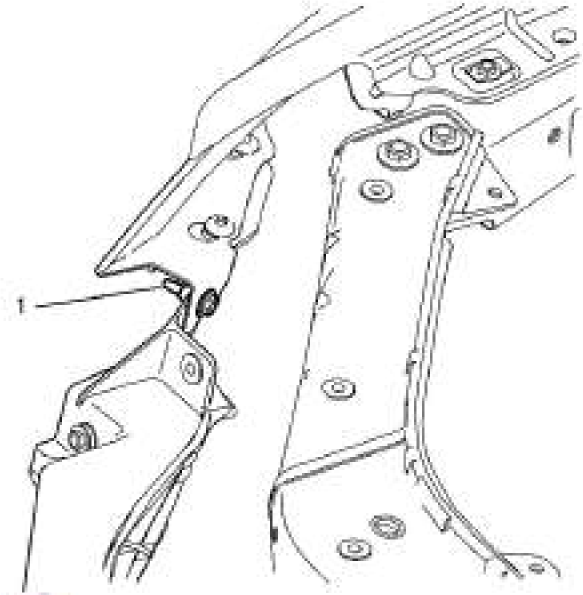
Removal Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

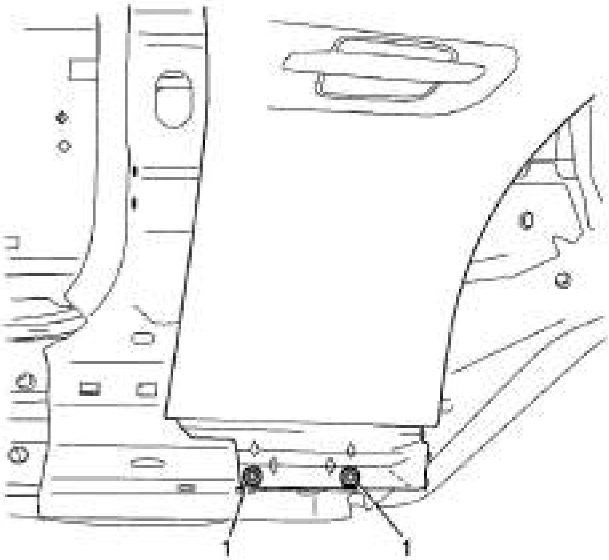
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

Caution: Refer to Safety Glasses Caution in the Preface section.

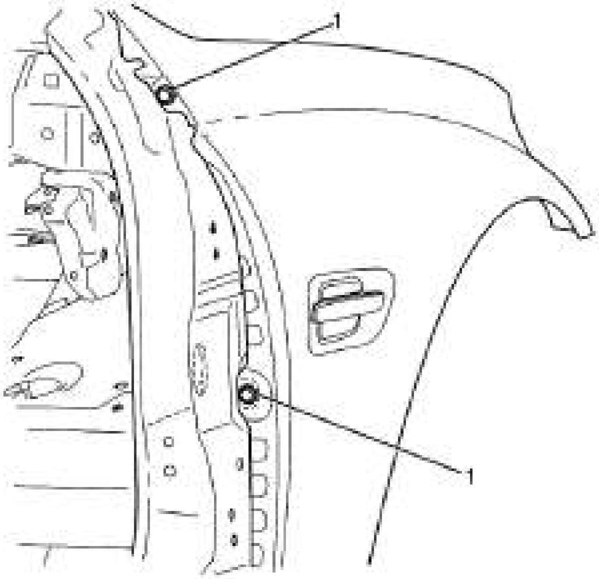
2. Apply tape to corners of panel and adjacent surfaces to help prevent paint damage.
3. Remove the hood. Refer to Hood Replacement .
4. Remove the hood hinge. Refer to Hood Hinge Replacement .
5. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
6. Remove the front wheel. Refer to Tire and Wheel Removal and Installation .
7. Remove the front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement .
8. Remove the front fender sound insulator. Refer to Front Fender Insulator Replacement .
9. Remove the rocker panel moulding. Refer to Rocker Panel Molding Replacement .
10. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement .
11. Remove the front bumper fascia bracket. Refer to Front Bumper Impact Bar Bracket Replacement .
12. Remove the headlamp. Refer to Headlamp Replacement .
13. Remove the side indicator. Refer to Repeater Lamp Replacement .



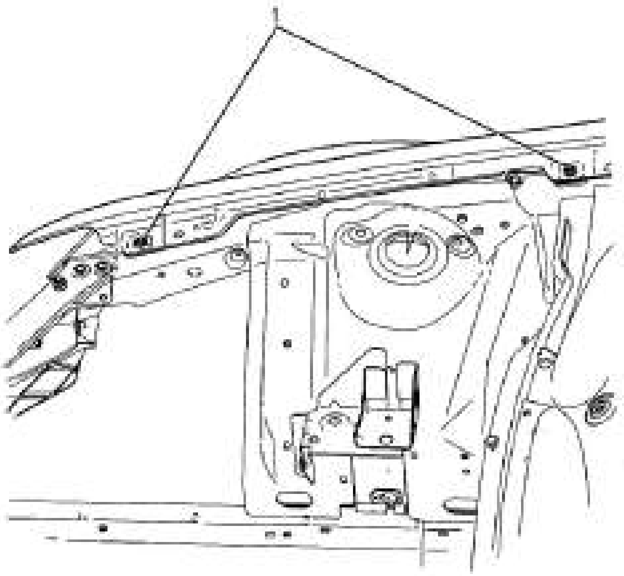
14. Remove the front fender to front end module retaining bolt (1).



15. Remove the front fender to body side retaining bolts (1).

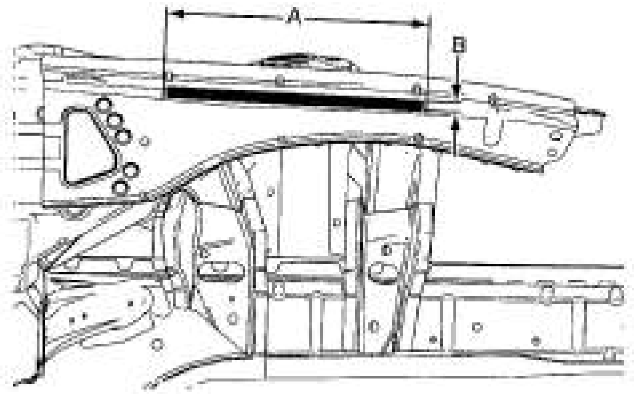


16. Remove the front fender to door pillar retaining bolts (1).



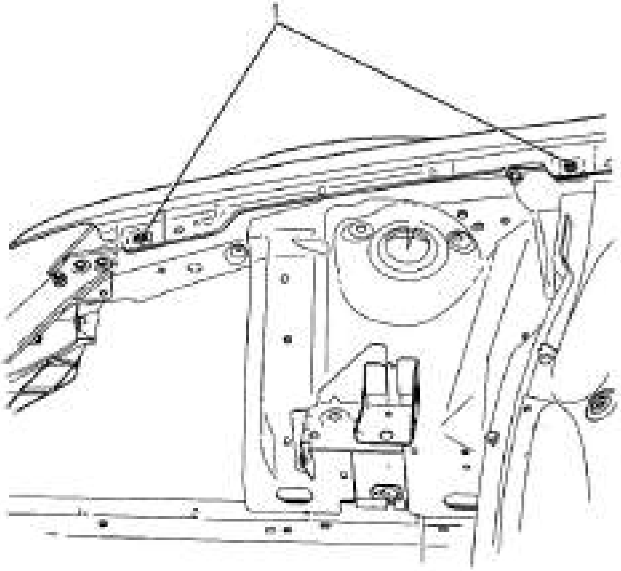
17. Remove the front fender to inner wheelhouse retaining bolts (1).
18. Remove the front fender from the vehicle.

Installation Procedure



1. Apply an even amount of urethane GMW3041 or equivalent (Between the second and fourth swage (A) and 25 mm wide (B) of the upper wheelhouse brace).
2. Position the front fender to the vehicle.

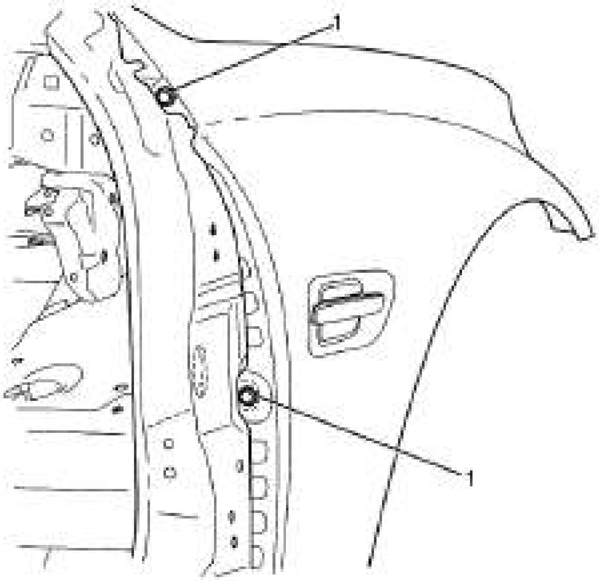
Notice: Refer to Fastener Notice in the Preface section.



Important: Do not fully tighten at this stage.

3. Install the front fender to inner wheelhouse retaining bolts (1).

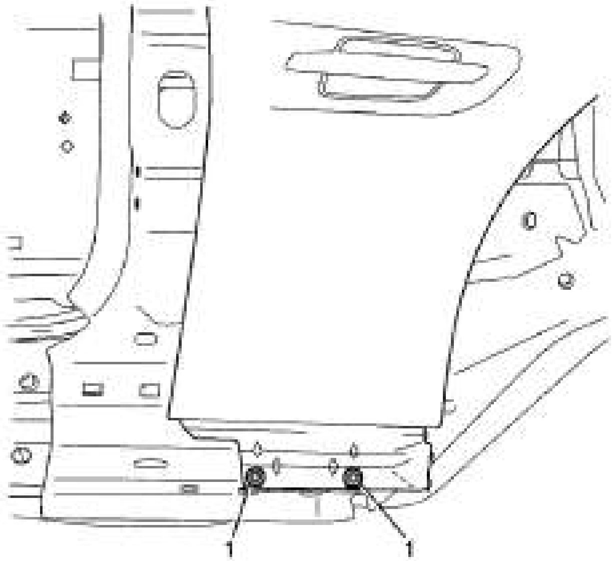
   Do not fully tighten at this stage.



Important: Do not fully tighten at this stage.

4. Install the front fender to door pillar retaining bolts (1).

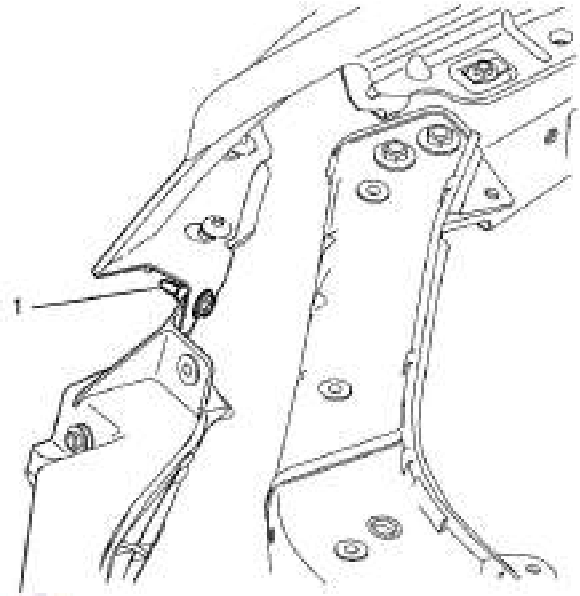
Do not fully tighten at this stage.



Important: Do not fully tighten at this stage.

5. Install the front fender to body side retaining bolts (1)

   Do not fully tighten at this stage.

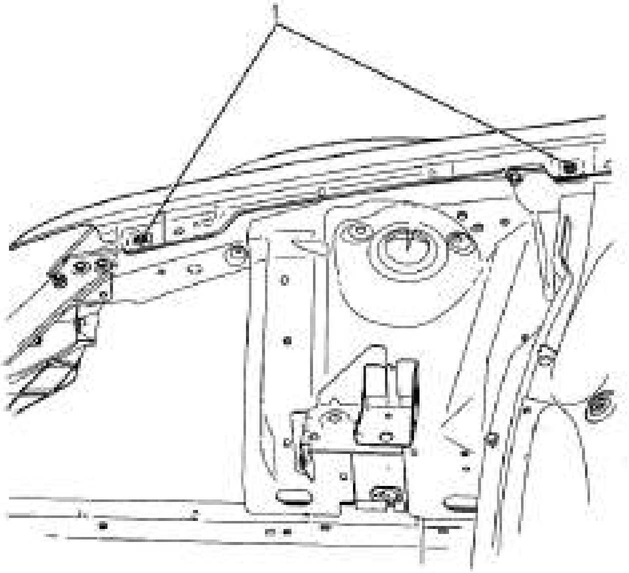


Important: Do not fully tighten at this stage.

6. Install the front fender to front end module retaining bolt (1)

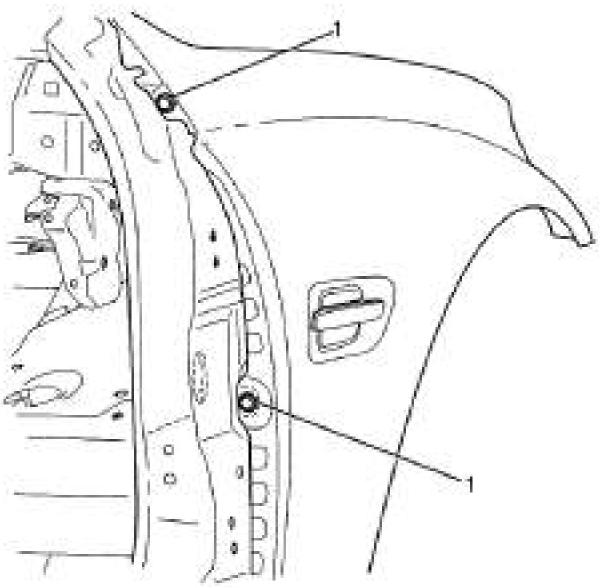
   Do not fully tighten at this stage.

7. Install the front wheel. Refer to Tire and Wheel Removal and Installation .
8. Lower the vehicle.



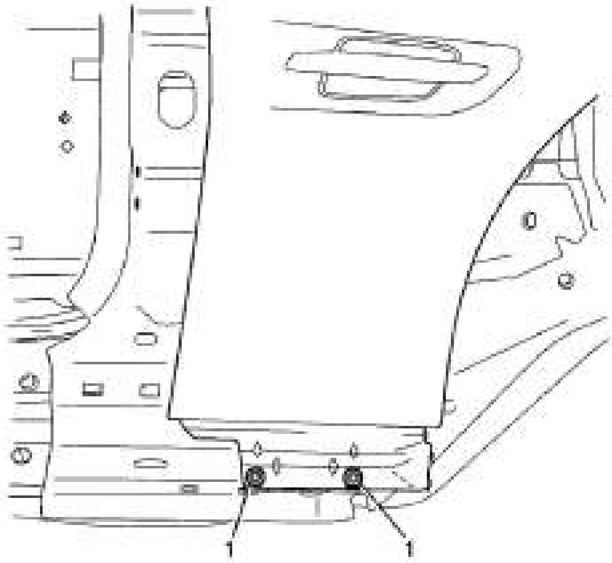
9. Tighten the front fender to inner wheelhouse retaining bolts (1)

   Tighten
   Tighten the bolts to 9 N·m (80 lb in).



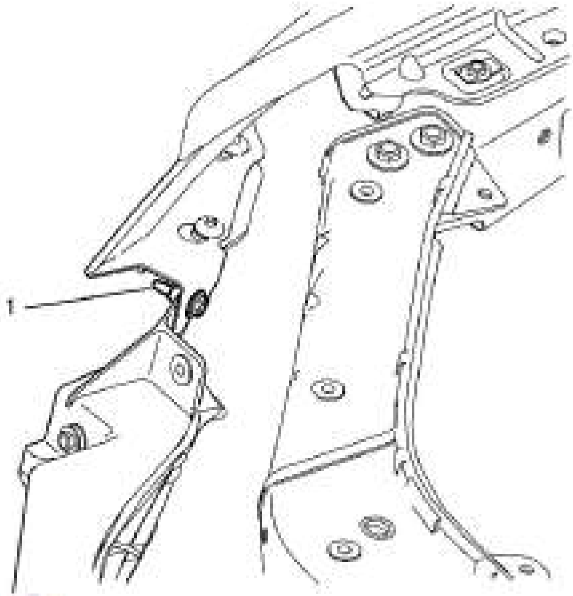
10. Tighten the front fender to door pillar retaining bolts (1).

Tighten
Tighten the bolts to 9 N·m (80 lb in).



11. Tighten the front fender to body side retaining bolts (1).

Tighten
Tighten the bolts to 9 N·m (80 lb in).



12. Tighten the front fender to front end module retaining bolt (1).

Tighten

Tighten the bolts to 9 N·m (80 lb in).

13. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
14. Remove the front wheel. Refer to Tire and Wheel Removal and Installation .
15. Install the front fender sound insulator. Refer to Front Fender Insulator Replacement .
16. Install the side indicator. Refer to Repeater Lamp Replacement .
17. Install the rocker panel moulding. Refer to Rocker Panel Molding Replacement .
18. Install the headlamp. Refer to Headlamp Replacement .
19. Install the front bumper fascia bracket. Refer to Front Bumper Impact Bar Bracket Replacement .
20. Install the front bumper fascia. Refer to Front Bumper Fascia Replacement .
21. Install the front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement .
22. Install the front wheel. Refer to Tire and Wheel Removal and Installation .
23. Lower the vehicle.
24. Install the hood hinge. Refer to Hood Hinge Replacement .
25. Install the hood. Refer to Hood Replacement .
26. Carefully remove the tape from the corners of the panels and adjacent surfaces.

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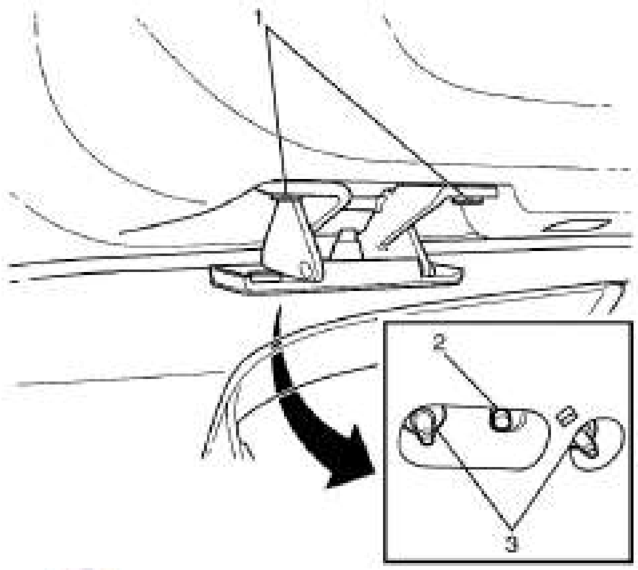
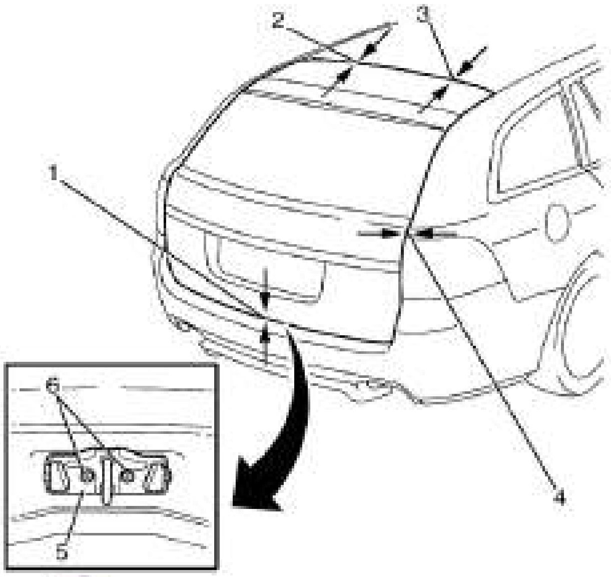
Liftgate Adjustment

1. Remove the quarter inner trim finish panels on both sides. Refer to Quarter Inner Trim Finish Panel Replacement.
2. Remove the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
3. Remove the body side window rear garnish moulds on both sides. Refer to Body Side Window Rear Garnish Molding Replacement.



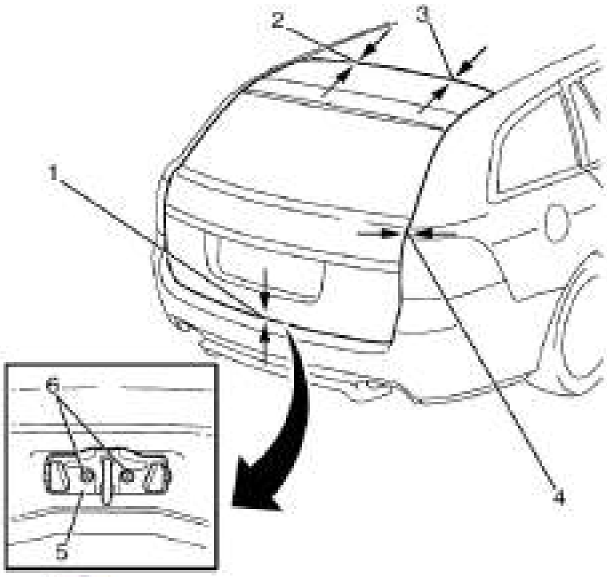
4. Loosen the liftgate hinge to liftgate bolts (1).
5. Loosen the liftgate hinge to rear header nuts (3).
6. Loosen the liftgate hinge to rear header bolt (2).



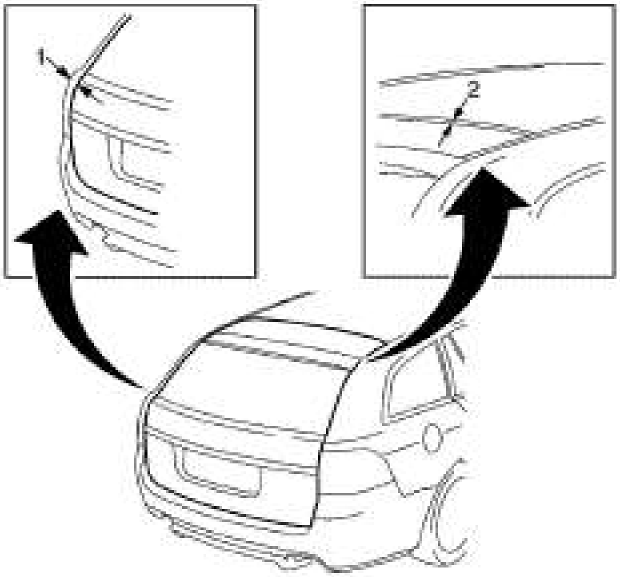
7. Mark the location of the lifgate striker (6) to the vehicle body with a wax pencil.
8. Remove the liftgate striker retaining bolts (6).
9. Remove the liftgate striker (5).
10. Remove the liftgate wedges on both sides. Refer to Liftgate Wedge Replacement.

Important: Ensure the liftgate does not contact the top and each side of the vehicle body.

11. Close the liftgate.

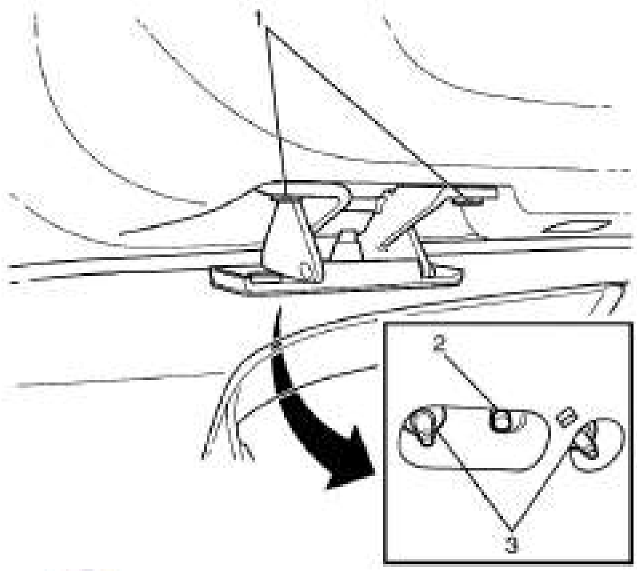


12. Align the liftgate in order to achieve an equal gap of 6.5 mm (.25 in) between the liftgate and the roof panel (2) and (3).
13. Align the liftgate in order to achieve an equal gap of 4.5 mm (.17 in) between the liftgate and the rear quarter panel on both sides (4).
14. Align the liftgate in order to achieve an equal gap of 6.7 mm (.26 in) between the liftgate and the rear bumper facia (1).



15. Align the liftgate in order to achieve a height difference of - 1.5 mm from the rear quarter panel to the liftgate (1).
16. Align the liftgate in order to achieve a height difference of - 1.0 mm from the roof panel to the liftgate (2).

Notice: Refer to Fastener Notice in the Preface section.



17. Verify the alignment of the liftgate to the vehicle body.
18. Tighten the liftgate hinge to header bolt (2).

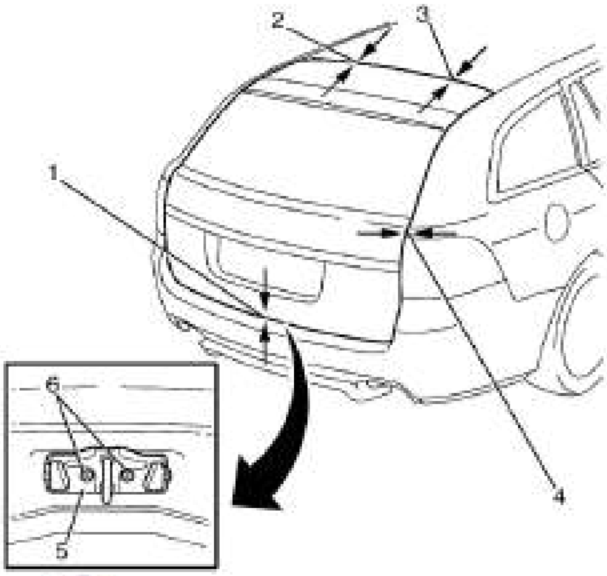
Tighten
Tighten the bolts to 58 N·m (43 lb ft).

19. Tighten the liftgate hinge to header nuts (3).

Tighten
Tighten the bolts to 25 N·m (18 lb ft).

20. Tighten the liftgate hinge to liftgate bolts (1).

Tighten
Tighten the bolts to 22 N·m (16 lb ft).



21. Install the liftgate striker (5) to the vehicle body making sure the marked location points are aligned.
22. Tighten the liftgate striker bolts (6).

    Tighten
    Tighten bolts to 20 N·m (15 lb ft).

23. Close the liftgate and ensure the liftgate striker (5) does not alter the liftgate to body alignment.
24. Adjust the liftgate striker if required.
25. Install the liftgate wedges on both sides. Refer to Liftgate Wedge Replacement.
26. Install both the body side window rear garnish moulds. Refer to Body Side Window Rear Garnish Molding Replacement.
27. Install the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
28. Install both the quarter inner trim finish panels. Refer to Quarter Inner Trim Finish Panel Replacement.

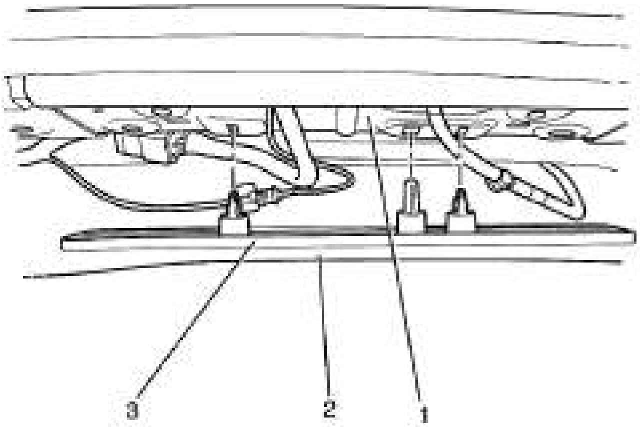
Liftgate Replacement

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

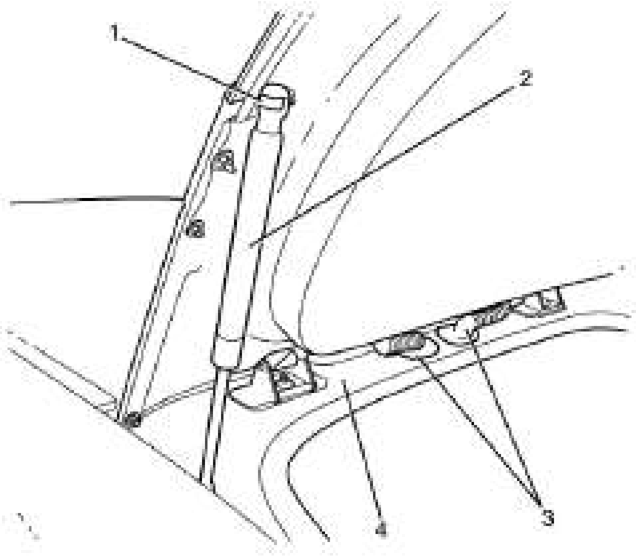
Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Open and suitably support the liftgate.
2. Remove the quarter inner trim finish panel on both sides. Refer to Quarter Inner Trim Finish Panel Replacement.
3. Remove the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
4. Remove the body side window rear garnish moulding on both sides. Refer to Body Side Window Rear Garnish Molding Replacement.



Important: To avoid damage to the headlining carefully pull down on the headlining rear clip assembly (3) to detach from the roof panel (1).

5. Detach and lower the headlining (2).



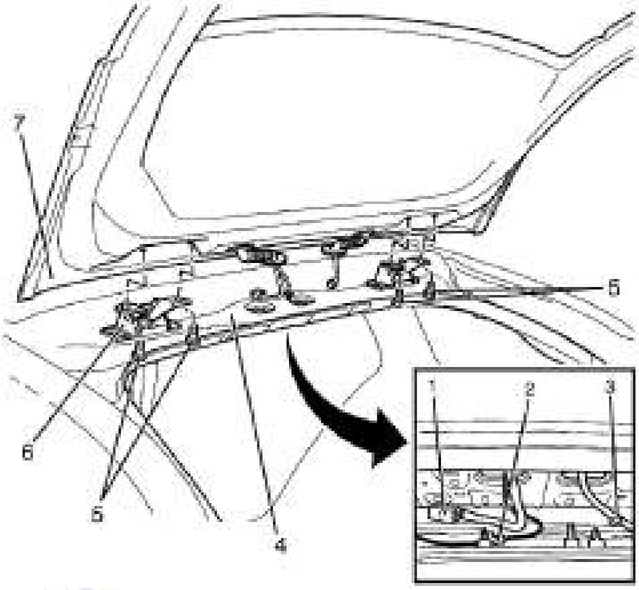
6. Pull the liftgate grommets (3) out of the rear header (4).

Important: DO NOT fully remove the liftgate upper strut retaining clip (1) as this will assist in the installation.

7. Using a suitable tool release the liftgate strut to upper strut stud retaining clip (1) on both sides.

Important: Apply pressure only at the end of the liftgate strut (2) that you are removing or attaching. DO NOT apply pressure to the middle of the strut because damage or bending will result.

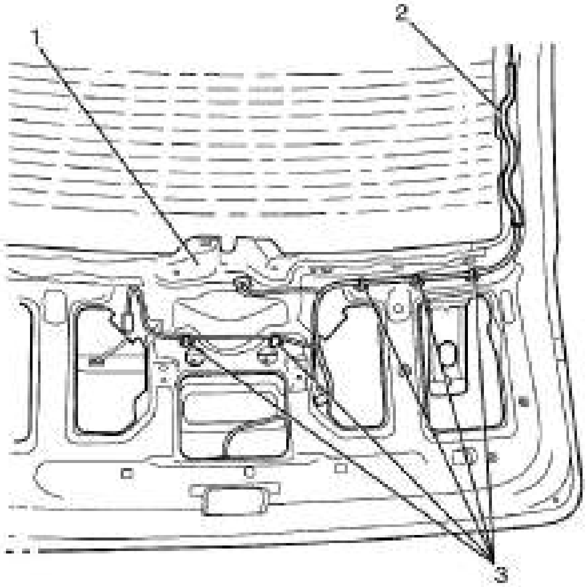
8. Detach the liftgate strut (2) on both sides.



9. Disconnect the liftgate electrical harness connector (1) and the antenna connector (2).
10. Disconnect the rear washer hose (3).
11. Mark the location of the liftgate hinge (6) to the liftgate (7) with a wax pencil.
12. Remove the liftgate hinge to liftgate retaining bolts (5).
13. With the aid of an assistant remove the liftgate from the vehicle.

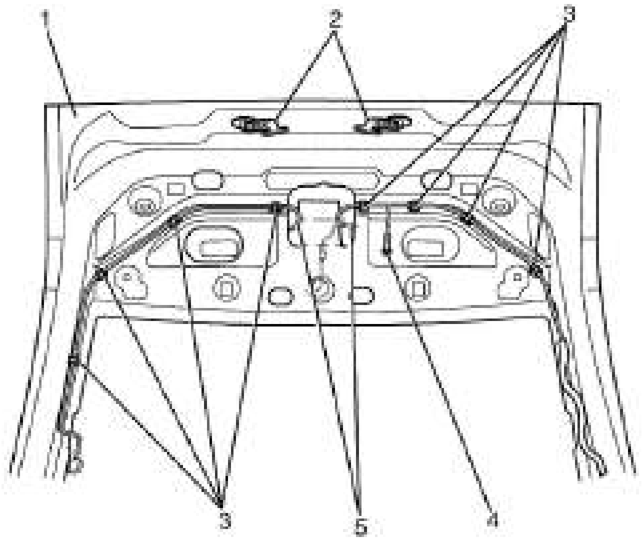
Disassembly Procedure

1. Remove the liftgate window side garnish moulding on both sides. Refer to Liftgate Window Side Garnish Molding Replacement.
2. Remove the liftgate window lower garnish moulding. Refer to Liftgate Window Lower Garnish Molding Replacement.
3. Remove the liftgate trim panel. Refer to Liftgate Trim Panel Replacement.
4. Remove the liftgate window upper garnish moulding. Refer to Liftgate Window Upper Garnish Molding Replacement.
5. Remove the liftgate emblem nameplate. Refer to Liftgate Emblem/Nameplate Replacement.
6. Remove the liftgate centre applique. Refer to Liftgate Center Applique Replacement.
7. Remove the rear window wiper arm. Refer to Rear Window Wiper Arm Replacement.
8. Remove the rear roof weld joint reveal moulding on both sides. Refer to Roof Weld Joint Reveal Molding Replacement.
9. Remove the liftgate upper moulding. Refer to Liftgate Upper Molding Replacement.
10. Remove the liftgate window. Refer to Liftgate Window Replacement.
11. Remove the liftgate latch. Refer to Liftgate Latch Replacement.
12. Remove the rear window wiper motor. Refer to Rear Window Wiper Motor Replacement.
13. Remove the liftgate wedge on both sides. Refer to Liftgate Wedge Replacement.
14. Remove the liftgate strut stud on both sides. Refer to Liftgate Strut Stud Replacement.



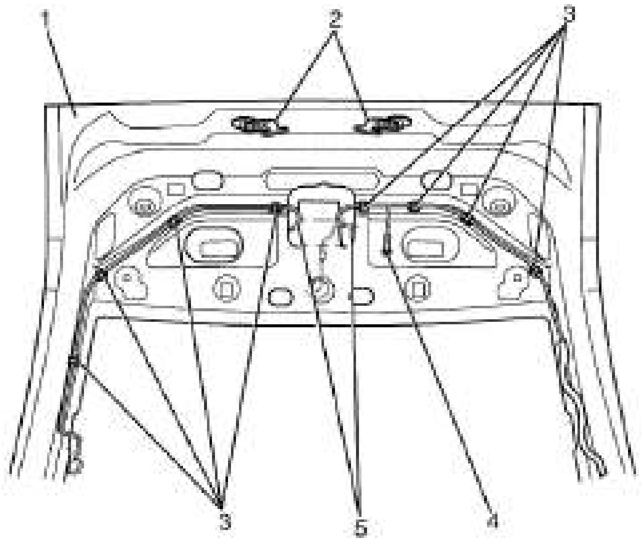
Important : A suitable tool must be used to avoid damaging the wiring harness retaining clips (3) when removing them from the liftgate (1).

15. Remove the liftgate wiring harness retaining clips (3) from the liftgate (1).
16. Remove the liftgate wiring harness former (2) from the liftgate (1).

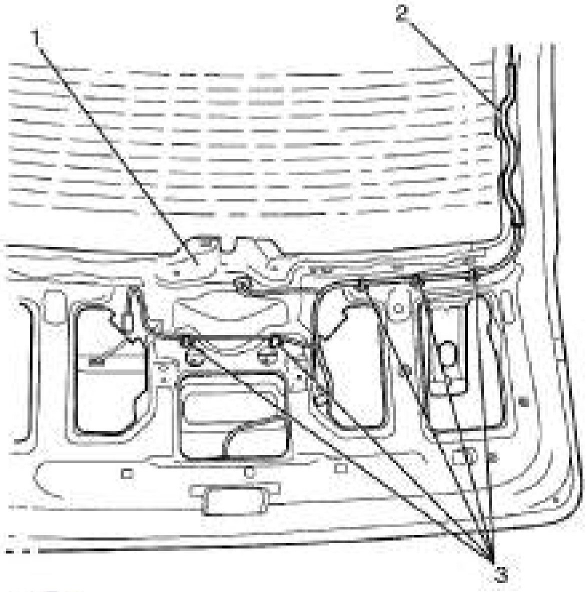


17. Remove the ground bolt (4) from the liftgate (1).
18. Remove the liftgate wiring harness retaining clips (3) from the liftgate (1).
19. Pull the liftgate grommets (2) out of the liftgate (1).
20. Remove the liftgate wiring harness (5) from the liftgate (1).

Assembly Procedure

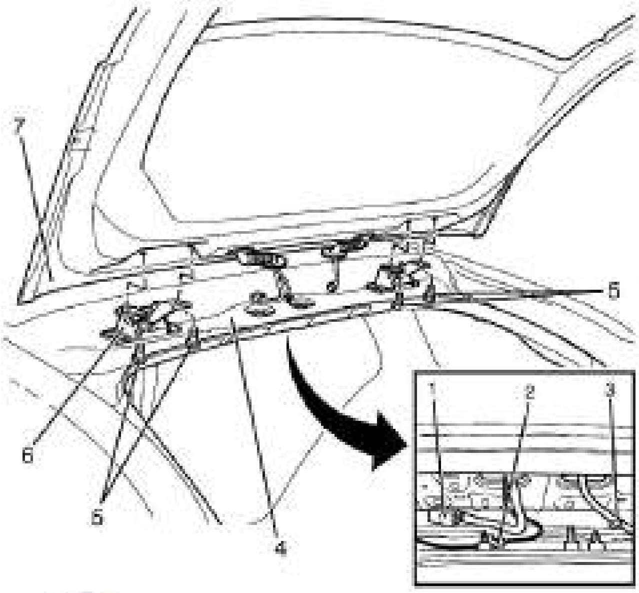


1. Install the liftgate wiring harness (5) to the liftgate (1).
2. Install the liftgate grommets (2) to the liftgate (1).
3. Install the liftgate wiring harness retaining clips (3) to the liftgate (1).
4. Install the ground bolt (4) to the liftgate (1).



5. Install the liftgate wiring harness former (2) to the liftgate (1).
6. Install the liftgate wiring harness retaining clips (3) to the liftgate (1).
7. Install the liftgate strut stud on both sides. Refer to Liftgate Strut Stud Replacement.
8. Install the liftgate wedge on both sides. Refer to Liftgate Wedge Replacement.
9. Install the rear window wiper motor. Refer to Rear Window Wiper Motor Replacement.
10. Install the lftgate latch. Refer to Liftgate Latch Replacement.
11. Install the liftgate window. Refer to Liftgate Window Replacement.
12. Install the liftgate upper moulding. Refer to Liftgate Upper Molding Replacement.
13. Install the rear roof weld joint reveal moulding on both sides. Refer to Roof Weld Joint Reveal Molding Replacement.
14. Install the rear window wiper arm. Refer to Rear Window Wiper Arm Replacement.
15. Install the lftgate centre applique. Refer to Liftgate Center Applique Replacement.
16. Install the liftgate emblem nameplate. Refer to Liftgate Emblem/Nameplate Replacement.
17. Install the liftgate window upper garnish moulding. Refer to Liftgate Window Upper Garnish Molding Replacement.
18. Install the liftgate trim panel. Refer to Liftgate Trim Panel Replacement.
19. Install the liftgate window lower garnish moulding. Refer to Liftgate Window Lower Garnish Molding Replacement.
20. Install the liftgate window side garnish moulding on both sides. Refer to Liftgate Window Side Garnish Molding Replacement.

Installation Procedure

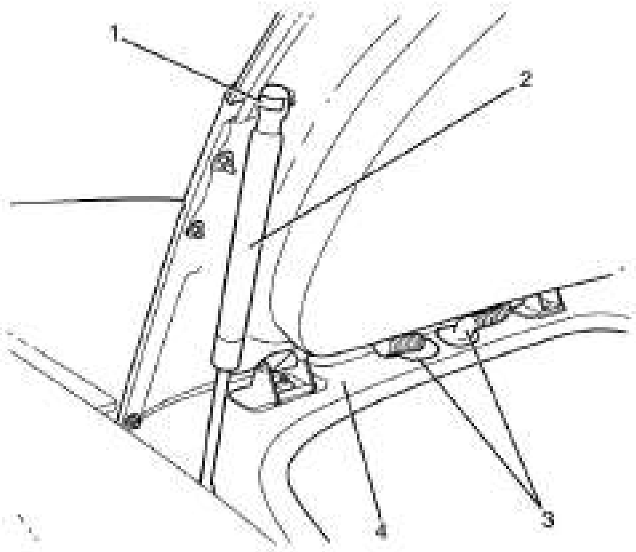


Important: DO NOT fully tighten at this stage.

1. With the aid of an assistant, position the liftgate (7) to the liftgate hinge (6) making sure the marked location points are aligned.
2. Install the liftgate hinge to liftgate retaining bolts (5).
3. Connect the rear washer hose (3).

Important : Make sure the liftgate harness connector (1) seats into the headlining electrical connector with an audible click, failure to do so could disable the liftgate release.

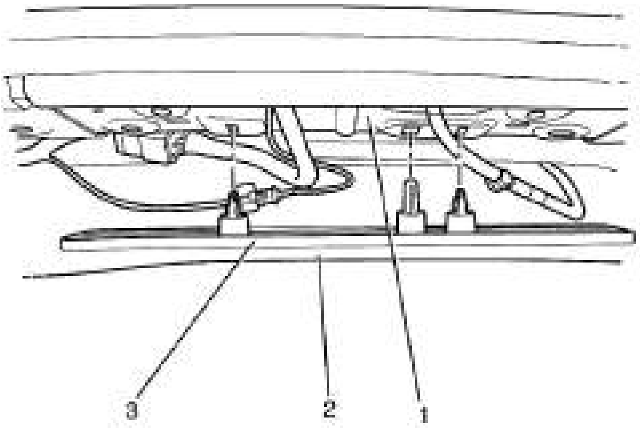
4. Connect the liftgate electrical harness connector (1) and the antenna connector (2).



5. Press the liftgate strut (2) onto the liftgate ball stud and listen for an audible click to confirm

fitting.

6. Make sure that the liftgate upper strut stud retaining clip (1) is fully seated on the liftgate strut (2).
7. Install the liftgate grommets (3) into the rear header (4).



8. Locate the headlining clip assembly (3) and attach the headlining (2) to the roof panel (1).
9. Install the body side window rear garnish moulding on both sides. Refer to Body Side Window Rear Garnish Molding Replacement.
10. Install the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
11. Install the quarter inner trim finish panel on both sides. Refer to Quarter Inner Trim Finish Panel Replacement.

Important: Make sure the liftgate does not contact the top and each side of the vehicle body.

12. Close the liftgate.
13. Verify the alignment of the liftgate to the body and adjust as necessary. Refer to Liftgate Adjustment.

Notice: Refer to Fastener Notice in the Preface section.

14. Tighten the liftgate hinge to liftgate retaining bolts (5).

Tighten
Tighten the bolts to 22 N·m (16 lb ft).

15. Install the liftgate wedge on both sides. Refer to Liftgate Wedge Replacement.

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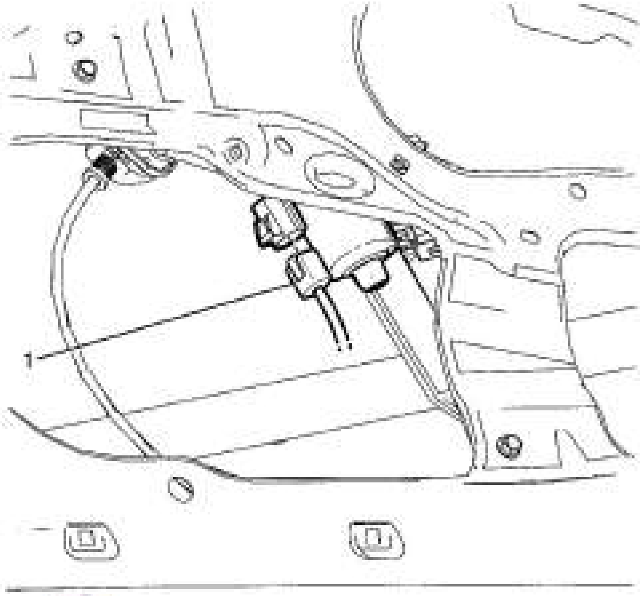
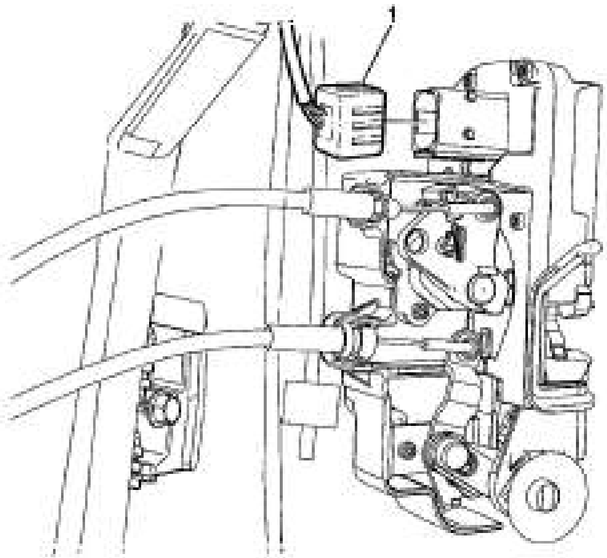
Front Side Door Wiring Harness Replacement

Removal Procedure

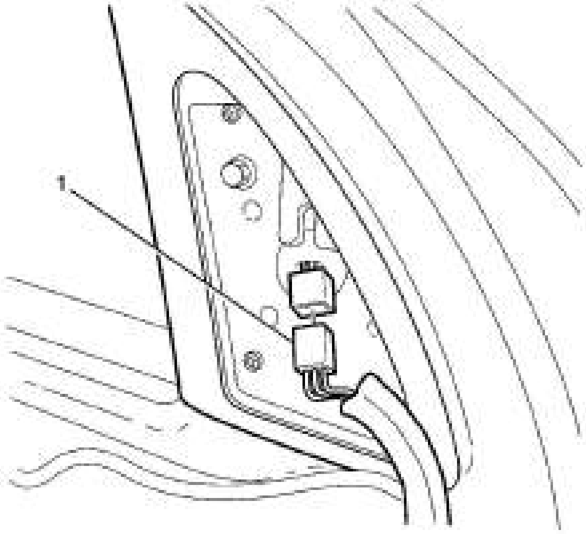
1. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement .
2. Remove the speaker. Refer to Radio Front Side Door Lower Speaker Replacement .
3. Remove the water deflector. Refer to Front Side Door Water Deflector Replacement .



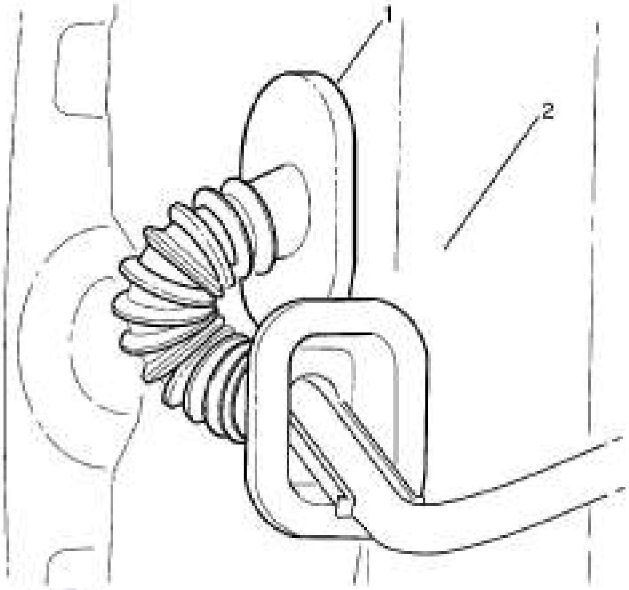
4. Disconnect the window regulator electrical connector (1).



5. Disconnect the door latch electrical connector (1).

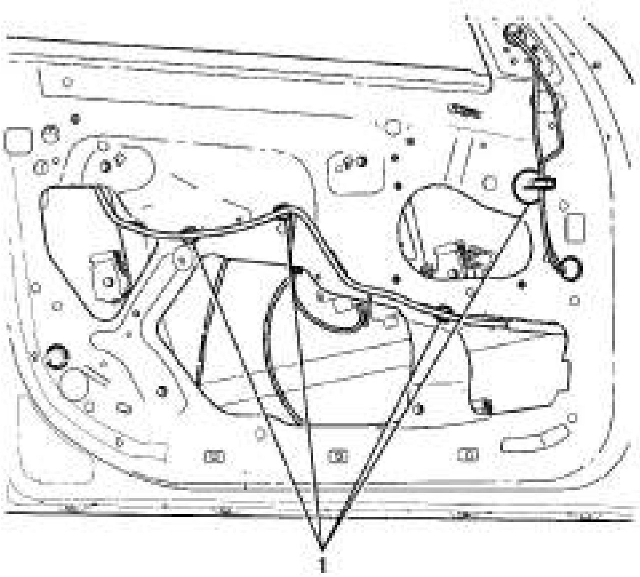


6. Disconnect the outside rearview mirror electrical connector (1).



Important: Pull the rubber conduit (1) from the pillar (2) to expose the door to body wiring harness plug.

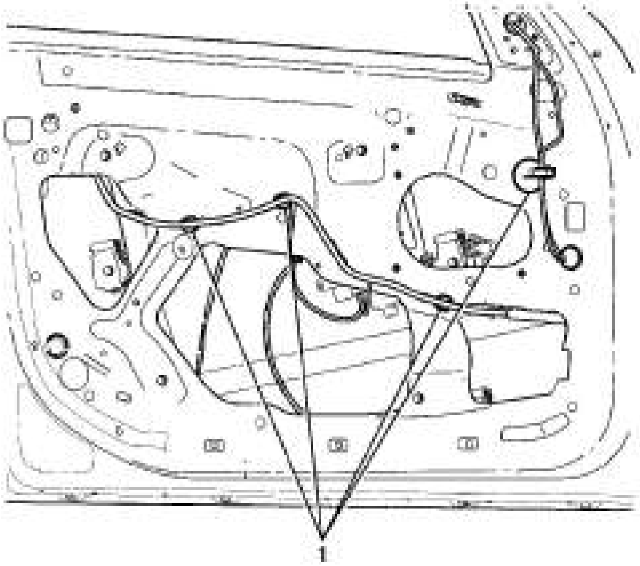
7. Remove the rubber conduit (1) from the from the pillar (2).
8. Disconnect the door wiring harness from the body wiring harness.
9. Push the wiring harness grommet and connector into the door cavity.



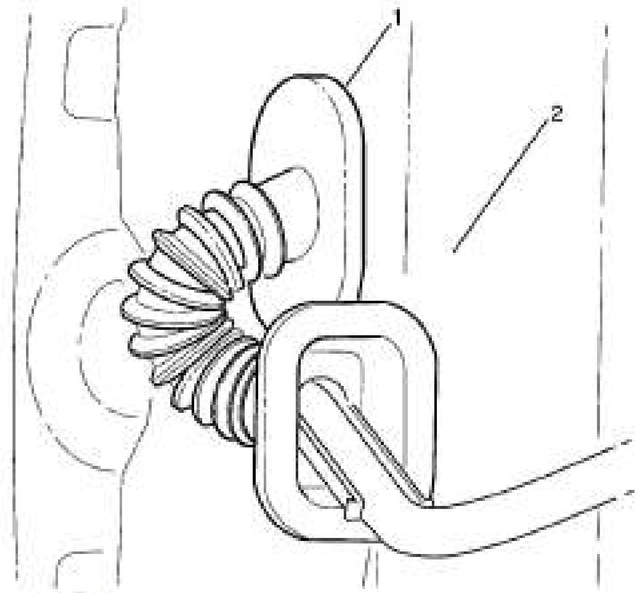
10. Disconnect the retainers securing the wiring harness to the door (1).
11. Remove the wiring harness from the door.

Installation Procedure

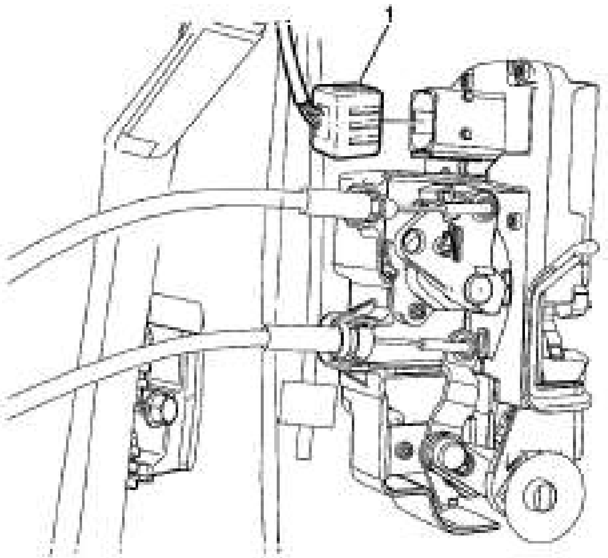
1. Position the door wiring harness into the door cavity.



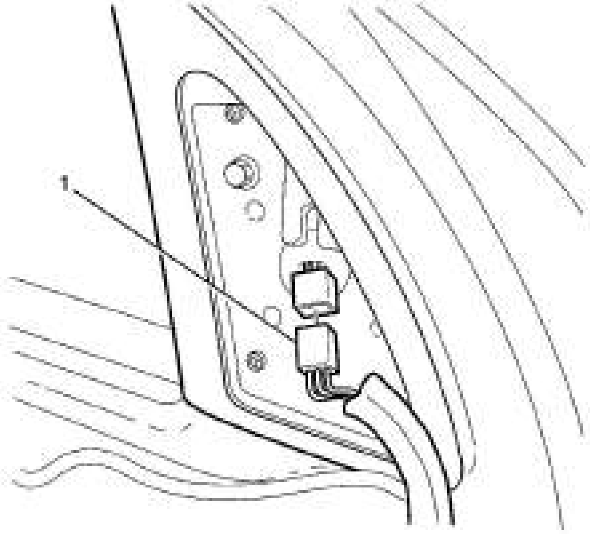
2. Connect the wiring harness retainers to the door (1).
3. Feed the trim panel connectors through the door .
4. Connect the door wiring harness to body wiring harness electrical connector.



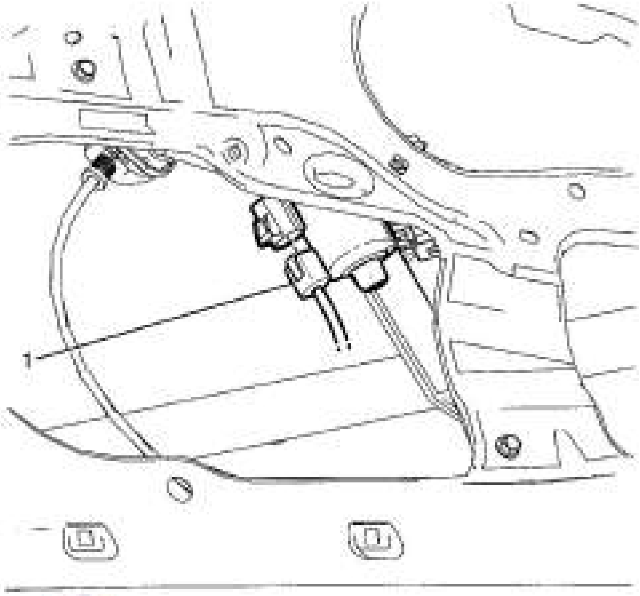
5. Install the rubber conduit (1) to the pillar (2).



6. Connect the door latch electrical connector (1).



7. Connect the outside rearview mirror electrical connector (1).

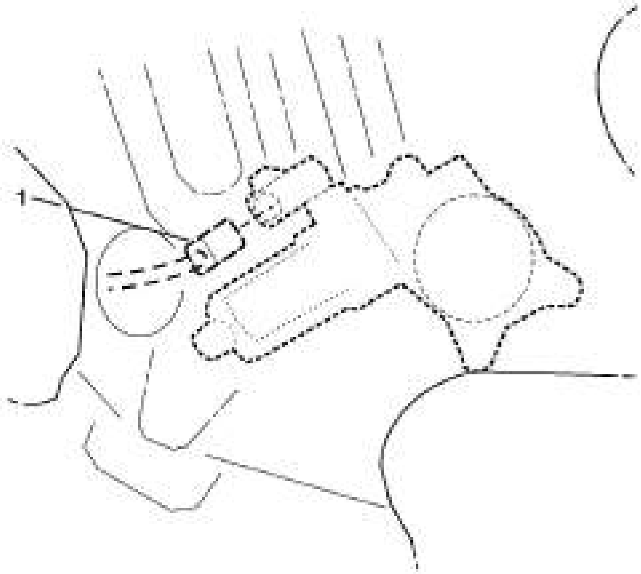


8. Connect the window regulator electrical connector (1).
9. Install the water deflector. Refer to Front Side Door Water Deflector Replacement .
10. Install the speaker. Refer to Radio Front Side Door Lower Speaker Replacement .
11. Install the door trim panel. Refer to Front Side Door Trim Panel Replacement .

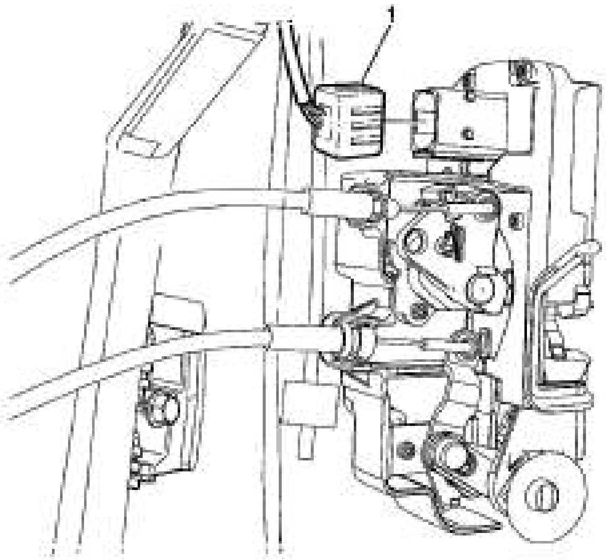
Rear Side Door Wiring Harness Replacement

Removal Procedure

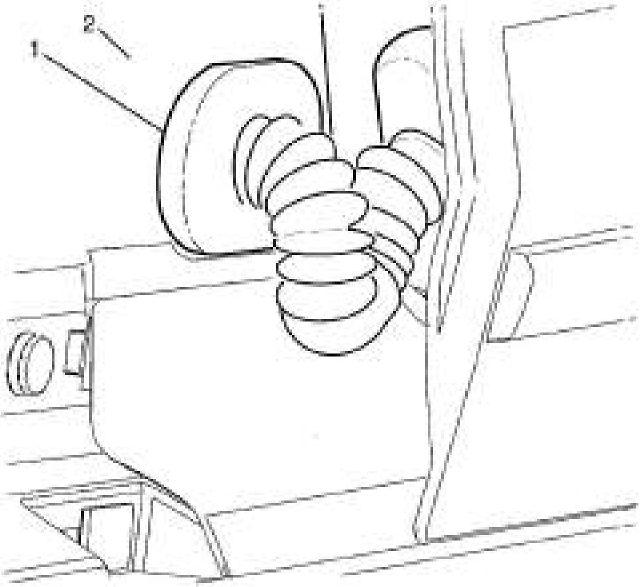
1. Remove the door trim panel. Refer to Rear Side Door Trim Panel Replacement.
2. Remove the speaker. Refer to Radio Rear Side Door Speaker Replacement in Entertainment.
3. Remove the water deflector. Refer to Rear Side Door Water Deflector Replacement.



4. Disconnect the window regulator electrical connector (1).

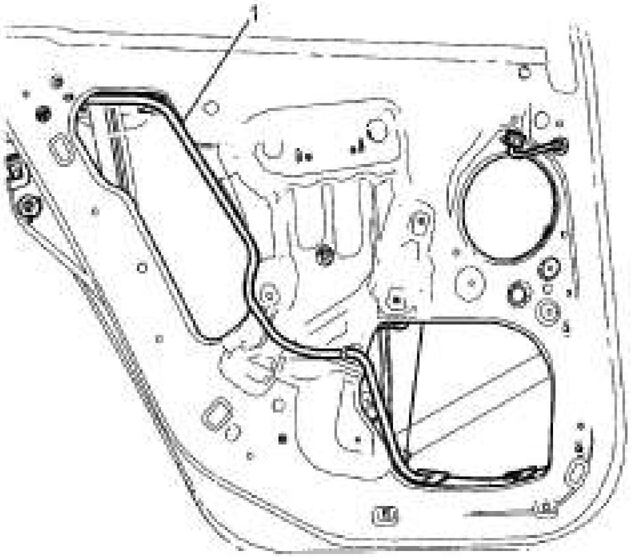


5. Disconnect the door latch electrical connector (1).



Important: Pull the rubber conduit (1) from the pillar (2) to expose the door to body wiring harness plug.

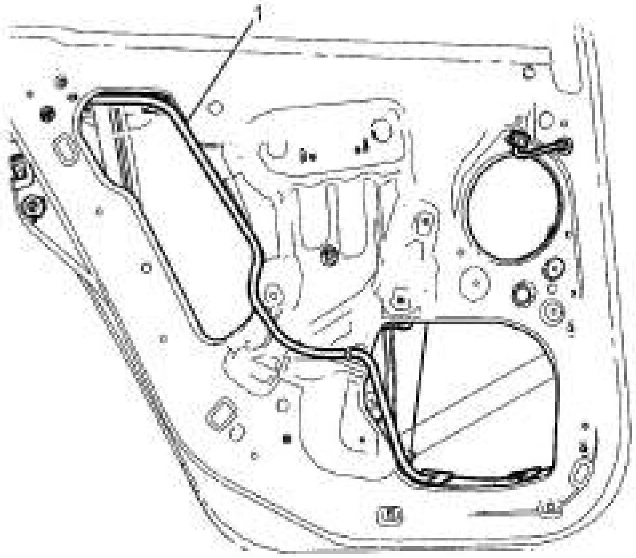
6. Remove the rubber conduit (1) from the from the pillar (2).
7. Disconnect the door wiring harness from the body wiring harness.
8. Push the wiring harness grommet and connector into the door cavity.



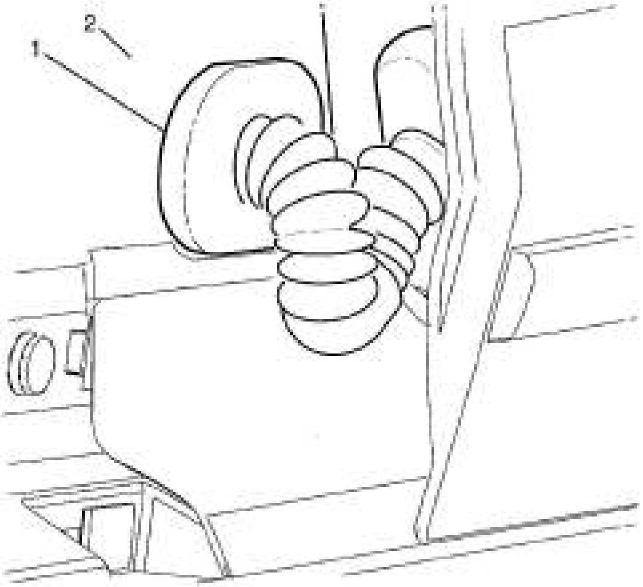
9. Disconnect the retainers securing the wiring harness (1) to the door.
10. Remove the wiring harness (1) from the door.

Installation Procedure

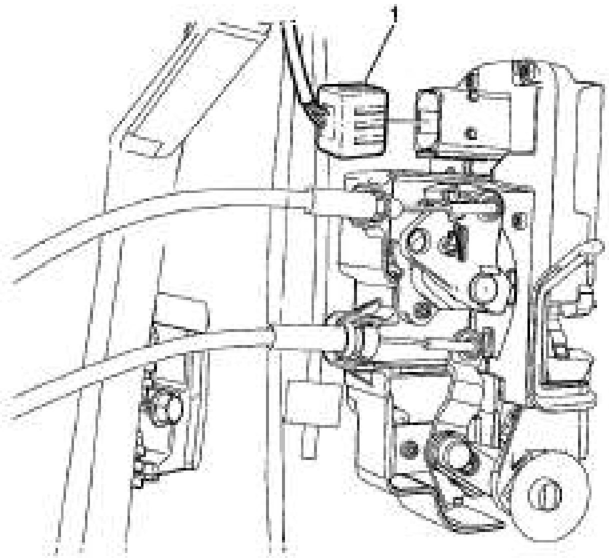
1. Position the door wiring harness into the door cavity.



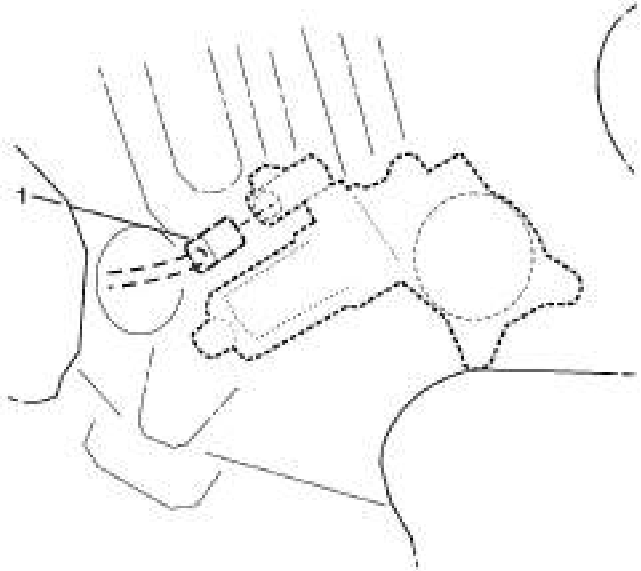
2. Connect the wiring harness (1) retainers to the door.
3. Feed the door trim panel connectors through the door.
4. Connect the door wiring harness to body wiring harness electrical connector.



5. Install the rubber conduit (1) to the pillar (2).



6. Connect the door latch electrical connector (1).



7. Connect the window regulator electrical connector (1).
8. Install the water deflector. Refer to Rear Side Door Water Deflector Replacement.
9. Install the speaker. Refer to Radio Rear Side Door Speaker Replacement in Entertainment.
10. Install the door trim panel. Refer to Rear Side Door Trim Panel Replacement.

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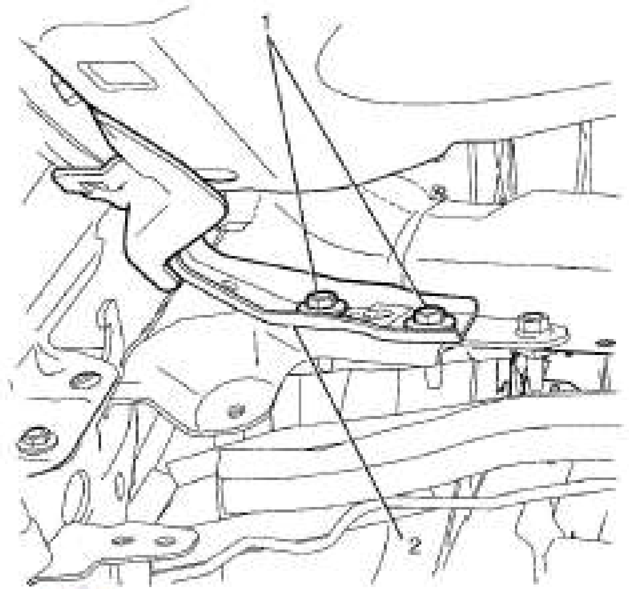
Hood Hinge Replacement

Removal Procedure

1. Apply tape to the corners of the panels and adjacent surfaces.

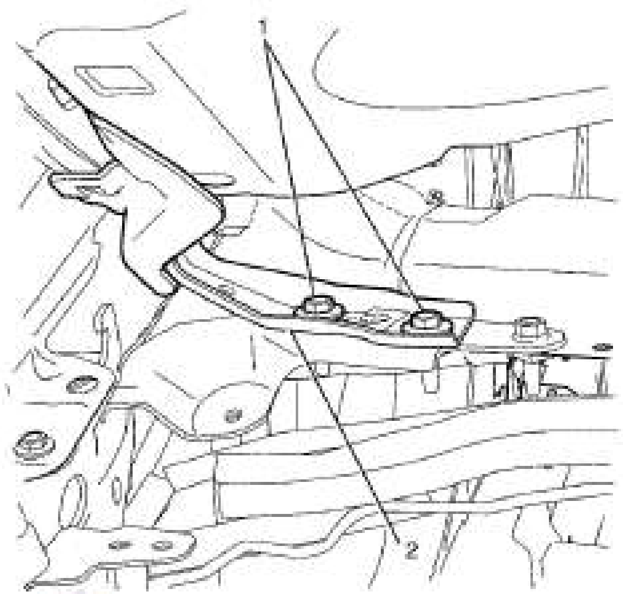
   Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

2. Remove the hood. Refer to Hood Replacement .
3. Remove the air inlet grille panel. Refer to Air Inlet Grille Panel Replacement .



4. Remove the hood hinge to dash and cowl panel brace retaining bolts (1).
5. Remove the hood hinge (2) from the vehicle.

Installation Procedure



1. Install the hood hinge (2) to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the hood hinge to dash and cowl panel brace retaining bolts (1).

   Tighten
   Tighten the bolts to 20 N·m (15 lb ft).

3. Install the air inlet grille panel. Refer to Air Inlet Grille Panel Replacement .
4. Install the hood. Refer to Hood Replacement .
5. Adjust the hood as necessary. Refer to Hood Adjustment .
6. Carefully remove the tape from the corners of the panels and adjacent surfaces.

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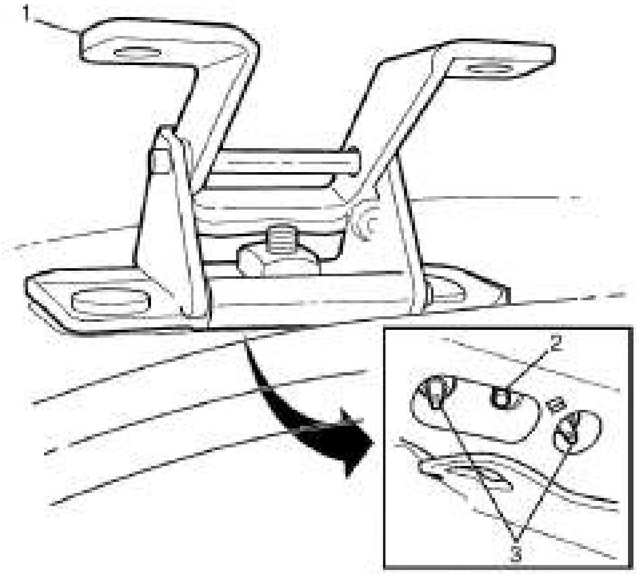
Liftgate Hinge Replacement

Removal Procedure

1. Open the liftgate.

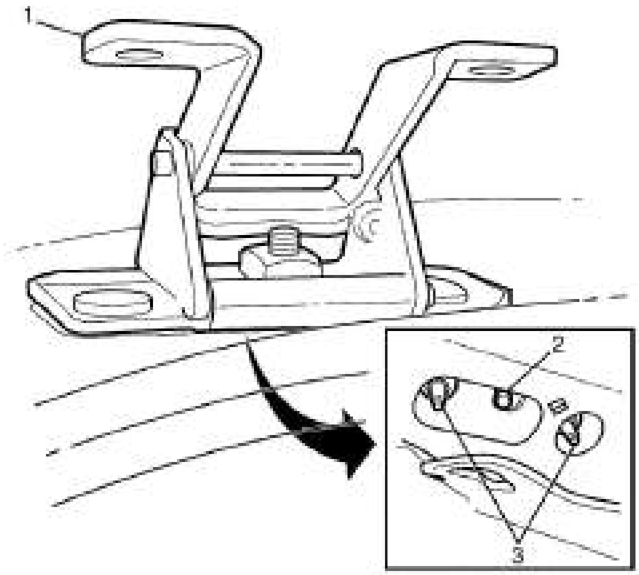
   Important: Apply pressure only at the end of the liftgate strut that you are removing or attaching. DO NOT apply pressure to the middle of the strut because damage or bending will result.

2. Install a suitable liftgate brace to the vehicle.
3. Remove the liftgate strut. Refer to Liftgate Strut Replacement.
4. Using a wax pencil, mark the location of the liftgate hinge to the liftgate and the rear quarter panel.
5. Remove the liftgate. Refer to Liftgate Replacement.
6. Remove the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
7. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
8. Remove the body side window rear garnish moulding. Refer to Body Side Window Rear Garnish Molding Replacement.



9. Remove the liftgate hinge to the rear quarter panel retaining nuts (3) and retaining bolt (2).
10. Remove the liftgate hinge (1) from the rear quarter panel.

Installation Procedure



1. Install the liftgate hinge (1) to the rear quarter panel.
2. Install the liftgate hinge to the rear quarter panel retaining nuts (3) and retaining bolt (2).

   Do not fully tighten at this stage.

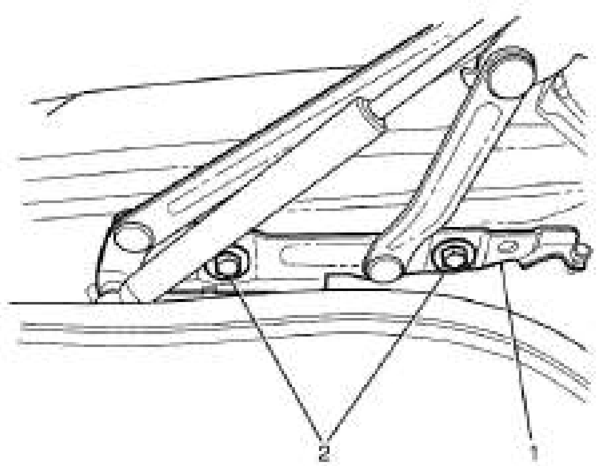
3. Install the body side window rear garnish moulding. Refer to Body Side Window Rear Garnish Molding Replacement.
4. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
5. Install the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
6. Install the liftgate. Refer to Liftgate Replacement.
7. Install the liftgate strut. Refer to Liftgate Strut Replacement.
8. Check and adjust the liftgate as necessary. Refer to Liftgate Adjustment.
9. Remove the suitable liftgate brace from the vehicle.
10. Close the liftgate.

Rear Compartment Lid Hinge Replacement

Removal Procedure

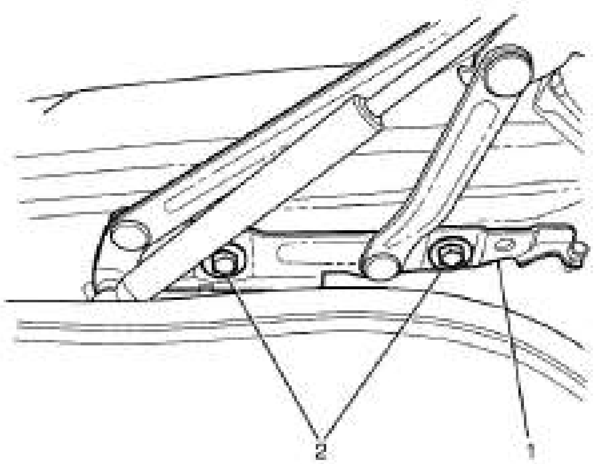
> **Important:** When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Remove the rear compartment lid strut. Refer to Rear Compartment Lid Strut Replacement.
2. Using a wax pencil, mark the retaining nut and bolt locations on both the rear compartment lid and the rear quarter panel of the hinge being replaced.
3. Remove the rear compartment lid. Refer to Rear Compartment Lid Replacement.



4. Remove the rear compartment lid hinge to rear quarter panel retaining bolts (2).
5. Remove the rear compartment lid hinge (1) from the rear quarter panel.

Installation Procedure



1. Install the rear compartment lid hinge (1) to the rear quarter panel.
2. Install the rear compartment lid hinge to rear quarter panel retaining bolts (2).

   Important: Do not fully tighten the rear compartment lid hinge retaining bolts (2) at this stage.

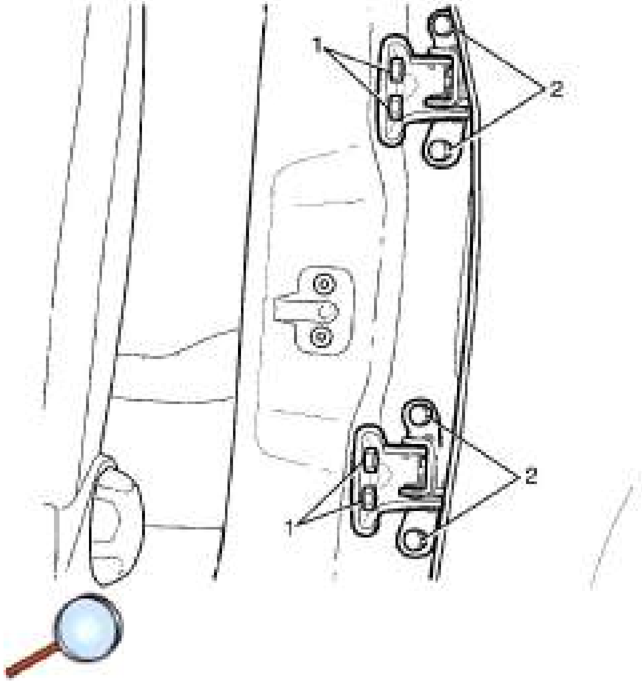
   Do not fully tighten at this stage.

3. Install the rear compartment lid. Refer to Rear Compartment Lid Replacement.
4. Install the rear compartment lid strut. Refer to Rear Compartment Lid Strut Replacement.
5. Check and adjust the rear compartment lid as necessary. Refer to Rear Compartment Lid Adjustment.

Rear Side Door Upper Hinge and Lower Hinge Replacement

Removal Procedure

1. Open front doors.
2. Mark the hinge to pillar and hinge to door location for installation alignment purposes.

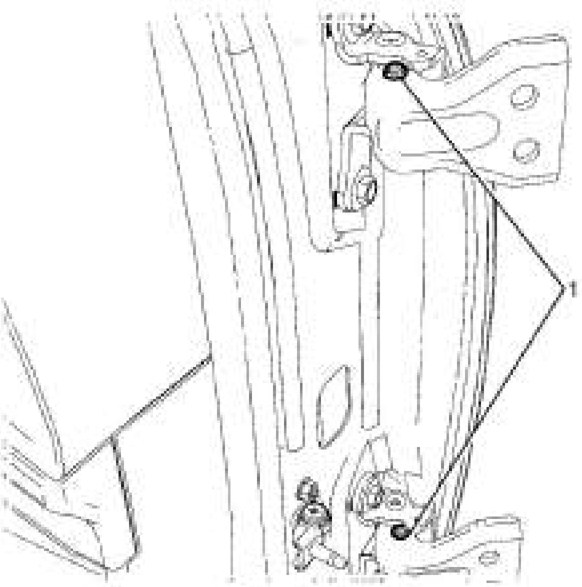


Important: Replace one hinge at a time then repeat procedure for the second hinge if needed.

Important: Remove the door hinge with the door fully latched on the striker.

3. Remove the hinge to door retaining bolts (2).
4. Remove the hinge to pillar retaining bolts (1) and remove the hinges one at a time.

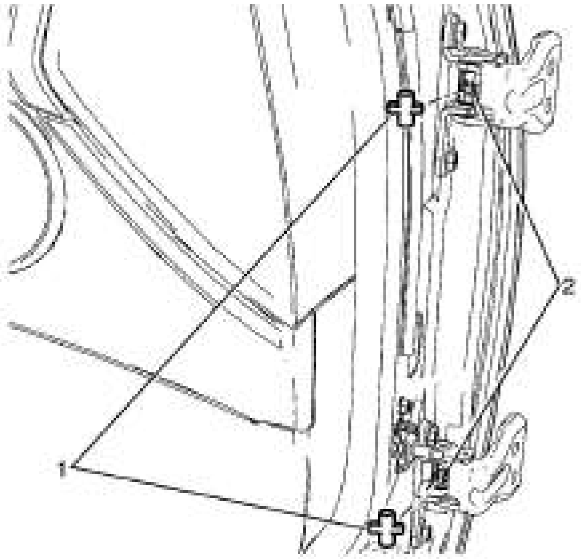
Installation Procedure



Important: Paint pins (1) are installed in NEW hinges and must be removed when fitted.

Important: Use a suitable tool to pry the paint pins (1) from the door hinges.

1. Remove the paint pins (1) from the NEW door hinges.

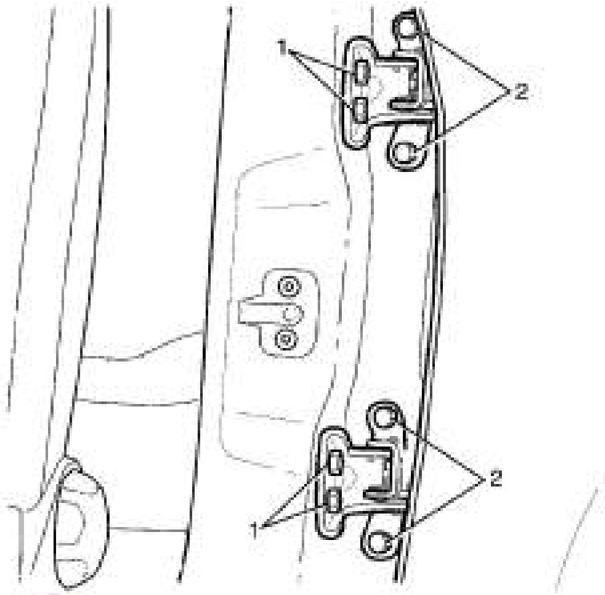


Important: The shipping clips (1) are only to hold the NEW door hinges (2) together in transit and must be removed when fitted.

Important: Use a suitable tool to remove the shipping clips (1) from the NEW door hinges (2).

2. Remove the shipping clips (1) from the NEW door hinges (2).
3. Align the hinge to pillar and hinge to door marks made prior to removal.

   Notice: Refer to Fastener Notice in the Preface section.



4. Install the hinge to pillar retaining bolts (1).

   Tighten
   Tighten the bolts to 28 N-m (21 lb ft).

5. Install the hinge to door retaining bolts (2).

   Tighten
   Tighten the bolts to 28 N-m (21 lb ft).

6. Close the front doors.

   Notice: Striker alignment is a crucial part of door latch operation. Do not use the door striker to adjust the door to the vehicle. Failure to properly adjust the striker can result in damage to the door latch and the striker.

7. Adjust the door. Refer to Door Adjustment .

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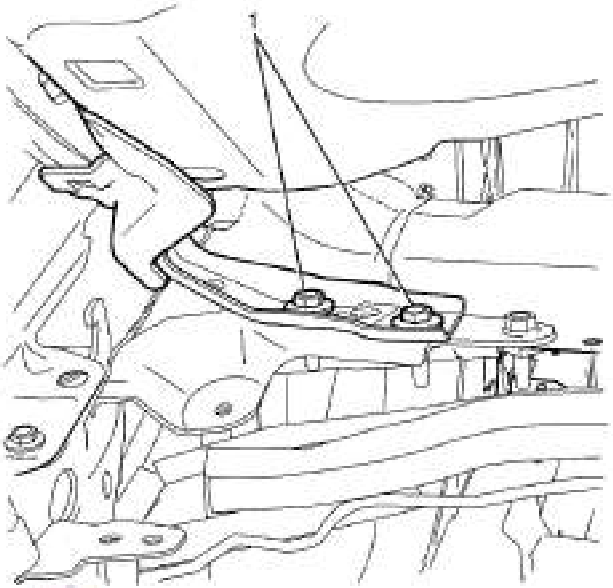
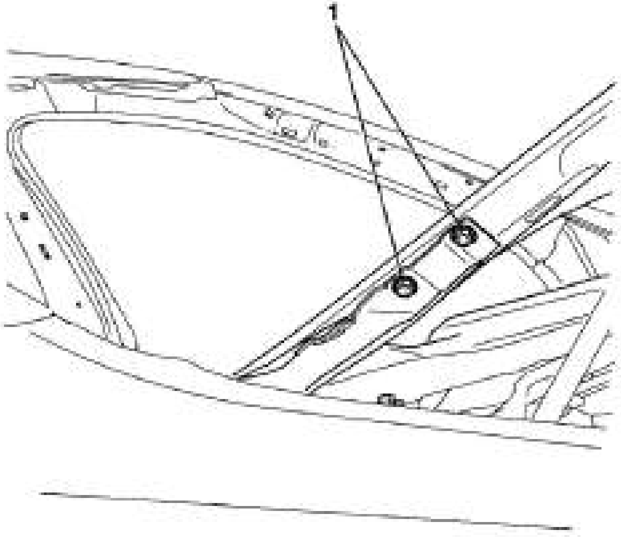
Hood Adjustment

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable hood brace to the vehicle.



2. Loosen the hood hinge to dash and cowl panel brace retaining bolts (1).



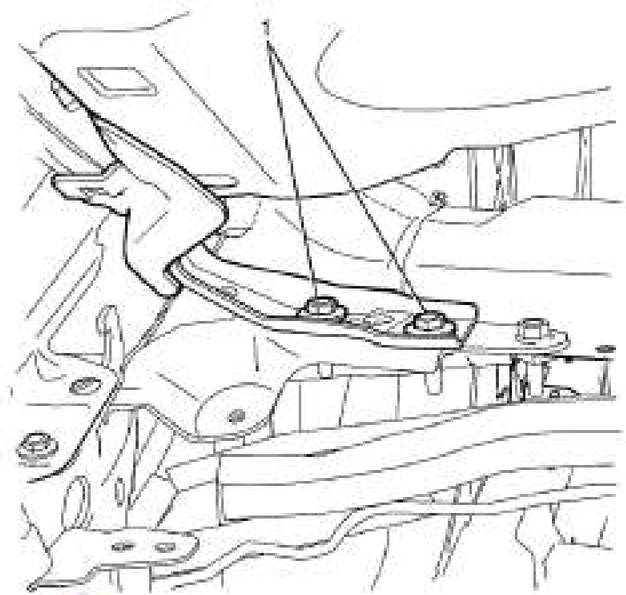
3. Loosen the hood hinge to hood retaining bolts (1).
4. Adjust the hood to obtain an even gap between 2.25 mm to 3.75 mm on both sides between the hood and the fenders, so that the hood is flush with both fenders on the front edge.

5. Adjust the hood to obtain an even gap between 2 mm to 6 mm between the hood and the front bumper fascia so that the hood is flush with the front bumper fascia.

   Notice: Refer to Fastener Notice in the Preface section.

6. Tighten the hood hinge to hood retaining bolts (1).

   Tighten
   Tighten the bolts to 20 N·m (15 lb ft).



7. Tighten the hood hinge to dash and cowl panel brace retaining bolts (1).

   Tighten
   Tighten the bolts to 20 N·m (15 lb ft).

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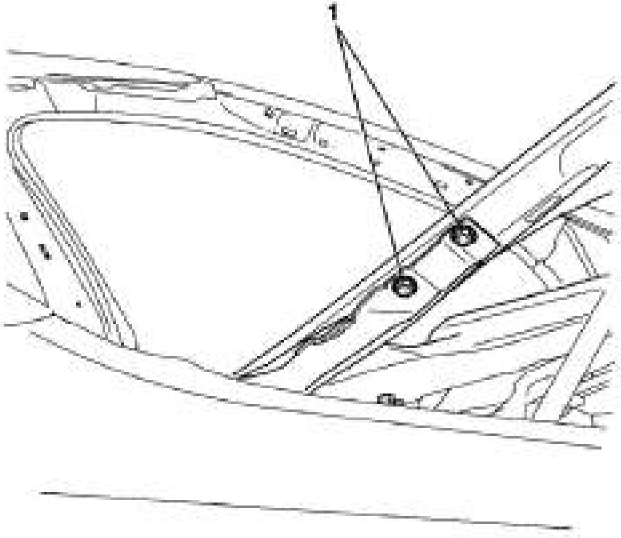
Hood Replacement

Removal Procedure

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

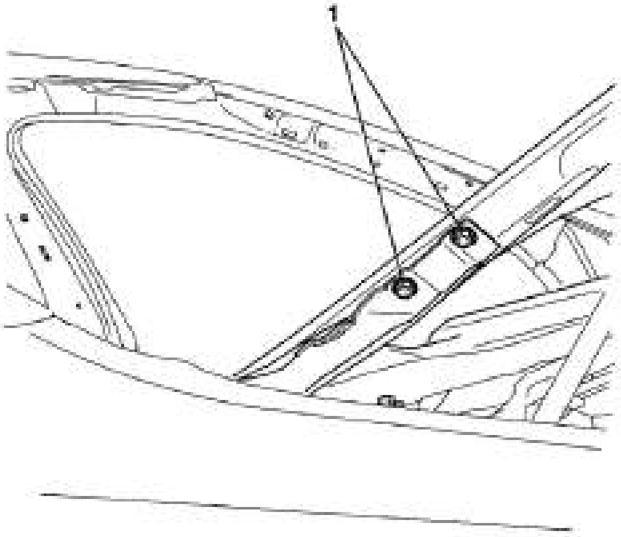
1. Install a suitable hood brace to the vehicle.
2. Apply tape to the corners of the panels and adjacent surfaces.
3. Using a grease pencil, mark the location of the hinge on the hood assembly.
4. Remove the hood bumpers from the hood. Refer to Hood Bumper Replacement .
5. Remove the hood insulator from the hood. Refer to Hood Insulator Replacement .
6. Remove the hood assist rods. Refer to Hood Open Assist Rod Replacement .



7. With the aid of an assistant, remove the hood to the hood hinge retaining bolts (1), repeat this procedure for the opposite side.
8. Remove the hood.
9. Remove the suitable hood brace from the vehicle.

Installation Procedure

1. With the aid of an assistant, install the hood to the vehicle.



2. Position the hood to the hood hinges using the grease pencil marks on the hood, repeat this procedure for the opposite side.
3. Install the suitable hood brace to the vehicle.

   Important: Do not fully tighten at this stage.

4. Install the hood to hood hinge retaining bolts (1).

   Do not fully tighten at this stage.

5. Install the hood assist rods. Refer to Hood Open Assist Rod Replacement .
6. Install the hood insulator to the hood. Refer to Hood Insulator Replacement .
7. Install the hood bumpers to the hood. Refer to Hood Bumper Replacement .
8. Adjust the hood as necessary. Refer to Hood Adjustment .

   Notice: Refer to Fastener Notice in the Preface section.

9. Tighten the hood to the hood hinge retaining bolts (1).

   Tighten
   Tighten the bolts to 20 N·m (15 lb ft).

10. Remove the suitable brace from the vehicle.
11. Carefully remove the tape from the corners of the panels and adjacent surfaces.

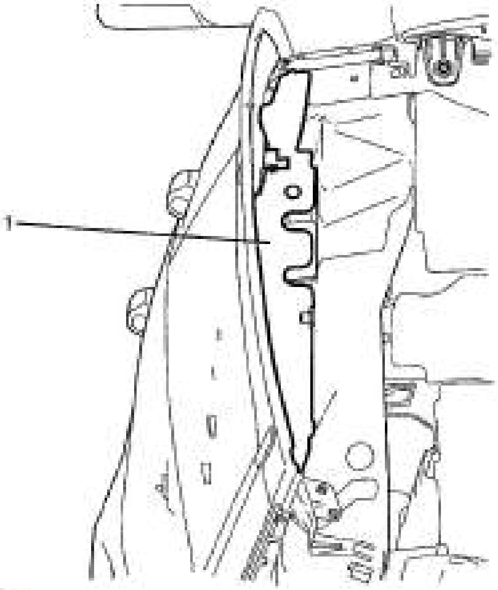
Front Fender Insulator Replacement

Removal Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

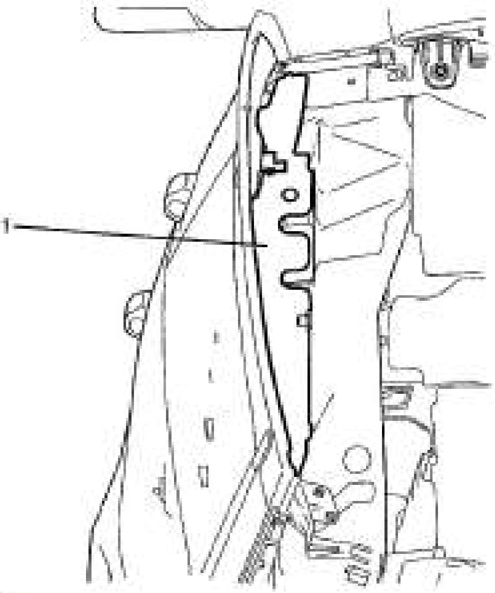
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the front wheel. Refer to Tire and Wheel Removal and Installation.
3. Remove the front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement.
4. Remove the side indicator. Refer to Repeater Lamp Replacement.



5. Remove the front fender sound insulator (1) from the vehicle.

Installation Procedure



1. Install the front fender sound insulator (1) to the vehicle.
2. Install the side indicator. Refer to Repeater Lamp Replacement.
3. Install the front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement.
4. Install the front wheel. Refer to Tire and Wheel Removal and Installation.
5. Lower the vehicle.

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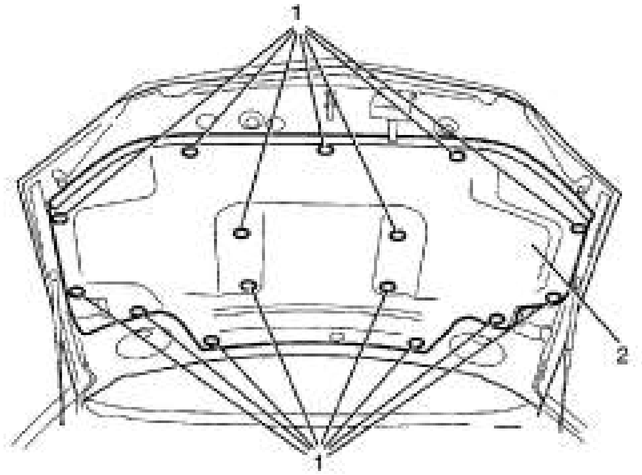
Hood Insulator Replacement

Removal Procedure

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable hood brace to the vehicle.

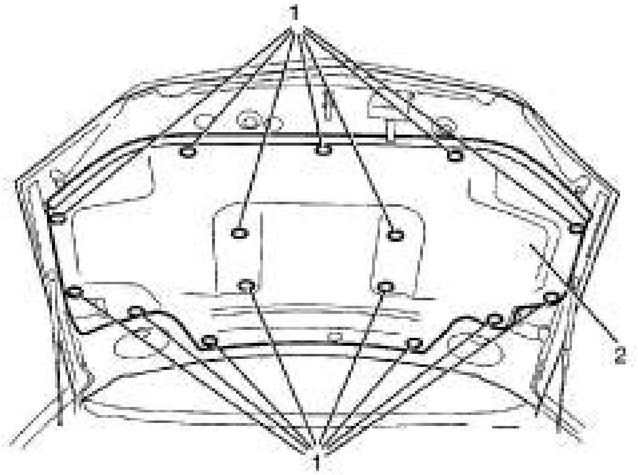


2. Remove the hood insulator to hood push-in retainers (1).

   Discard the retainers.

3. Remove the hood insulator (2) from the hood.

Installation Procedure



1. Position the hood insulator (2) to the hood.

   Important: Always use NEW push-in retainers.

2. Install the hood insulator to hood push-in retainers (1).
3. Remove the suitable hood brace from the vehicle.

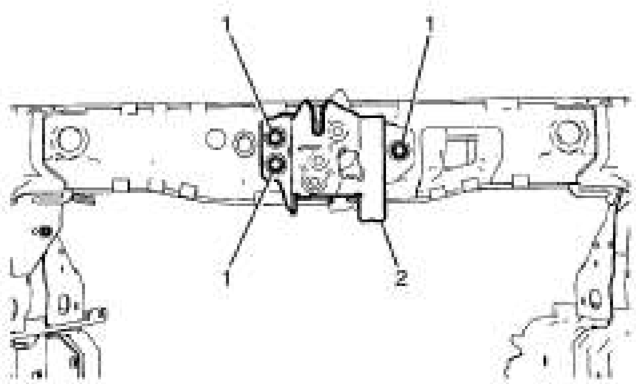
Hood Latch Adjustment

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

Important: Make sure that you have the proper alignment of the hood to the body before you tighten the hood latch retaining bolts under the following conditions:

- After removing the hood latch.
- After loosening the retaining bolts.
- After changing the hood adjustment.

1. Remove the radiator grille. Refer to Radiator Grille Replacement .



2. Loosen the hood latch to front end module retaining bolts (1).
3. With the hood latch to front end module retaining bolts loose, slowly lower the hood onto the hood latch (2) in order to achieve the proper cross vehicle adjustment of the hood latch.
4. Raise the hood.

Notice: Refer to Fastener Notice in the Preface section.

5. Tighten the hood latch to front end module retaining bolts (1).

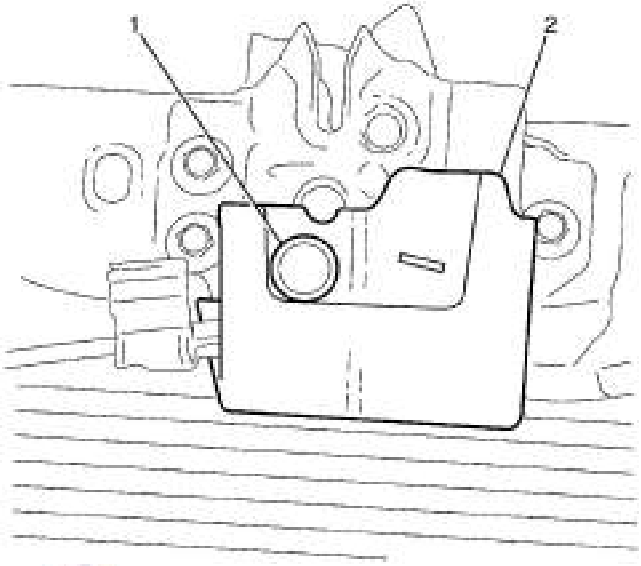
Tighten
Tighten the bolts to 9 N·m (80 lb in).

6. Install the radiator grille. Refer to Radiator Grille Replacement .
7. Close the hood and inspect for fit. Refer to Dimensions - Body .

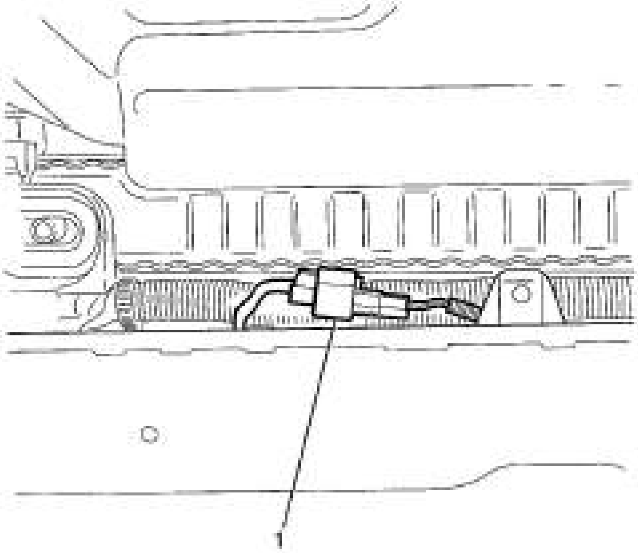
Hood Primary and Secondary Latch Replacement

Removal Procedure

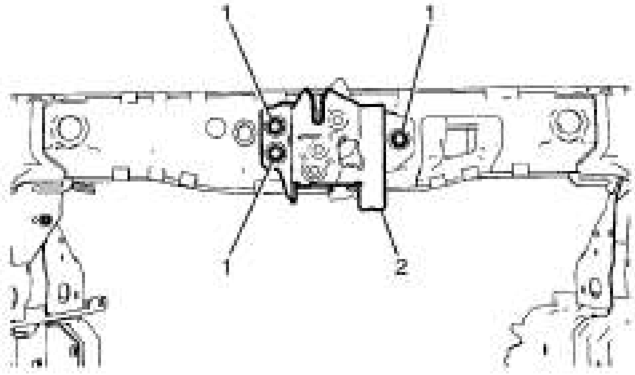
1. Remove the radiator grille. Refer to Radiator Grille Replacement .



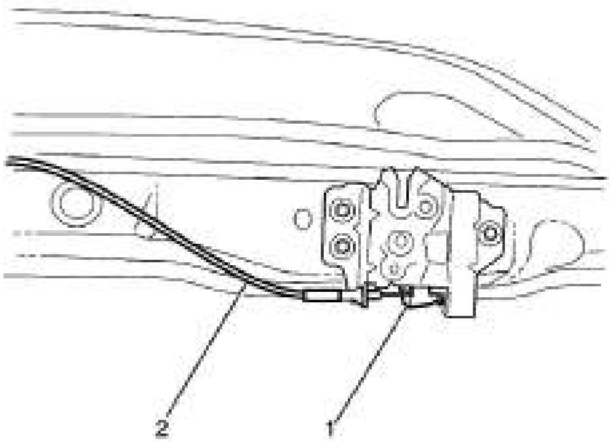
2. Remove the hood latch cover to hood latch retaining scrivet (1).
3. Remove the hood latch cover (2) from the hood latch.



4. Disconnect the hood latch wiring connector (1).

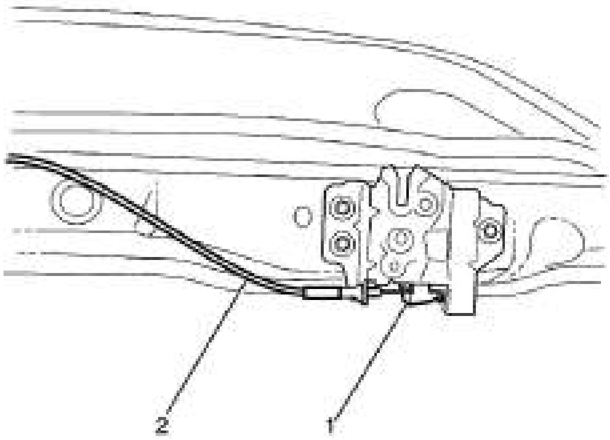


5. Remove the hood latch to front end module retaining bolts (1).
6. Detach the hood latch (2) from the front end module.

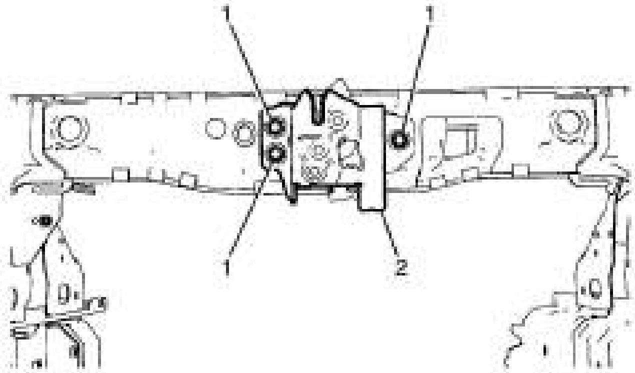


7. Disconnect the hood release cable (2) from the hood latch (1).
8. Remove the hood latch (1) from the front end module.

Installation Procedure



1. Connect the hood release cable (2) to the hood cable latch (1).



2. Position the hood latch (2) to the front end module.

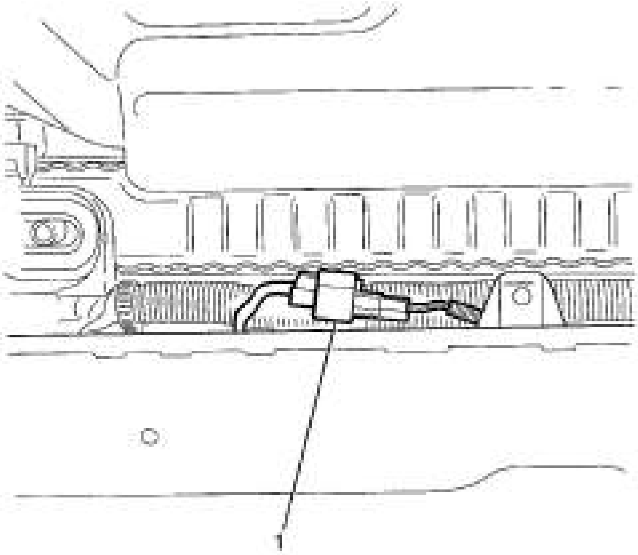
   Notice: Refer to Fastener Notice in the Preface section.

   Important: Do not fully tighten at this stage.

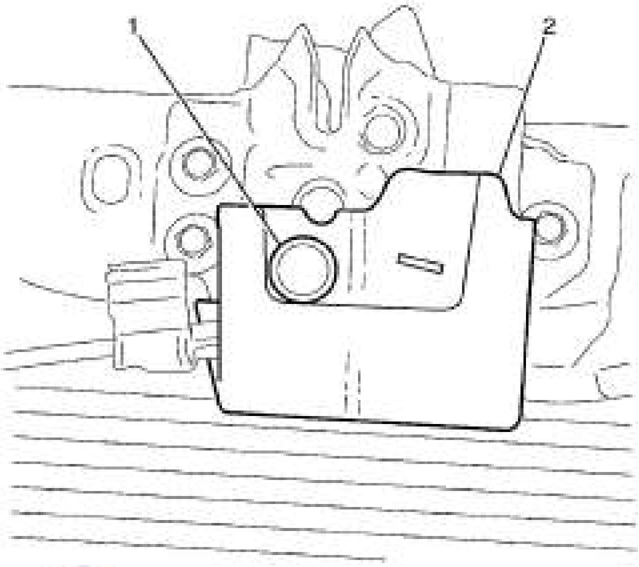
3. Install the hood latch to front end module retaining bolts (1).

   Do not fully tighten at this stage.

4. Adjust the hood latch. Refer to Hood Latch Adjustment .



5. Connect the hood latch wiring connector (1)



6. Install the hood latch cover (2) to the hood latch.
7. Install the hood latch cover to hood latch retaining scrivet (1).
8. Install the radiator grille. Refer to Radiator Grille Replacement .

Hood Primary Latch Striker Replacement

The hood latch striker is not replaceable. Refer to Hood Replacement .

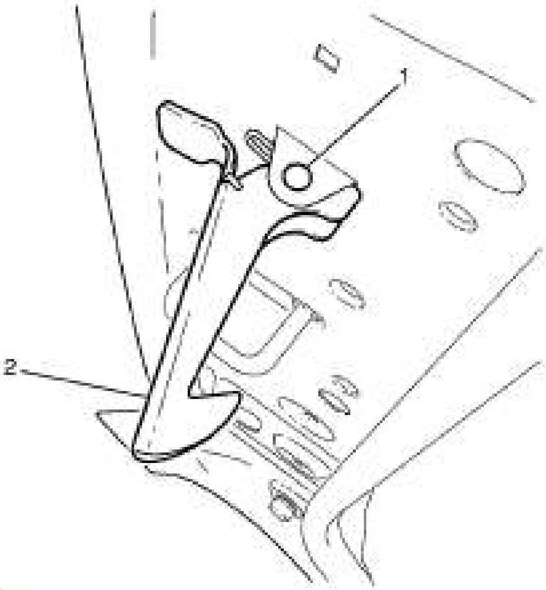
Hood Secondary Latch Replacement

Removal Procedure

Caution: Refer to Protective Goggles and Glove Caution in the Preface section.

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable hood brace to the vehicle.



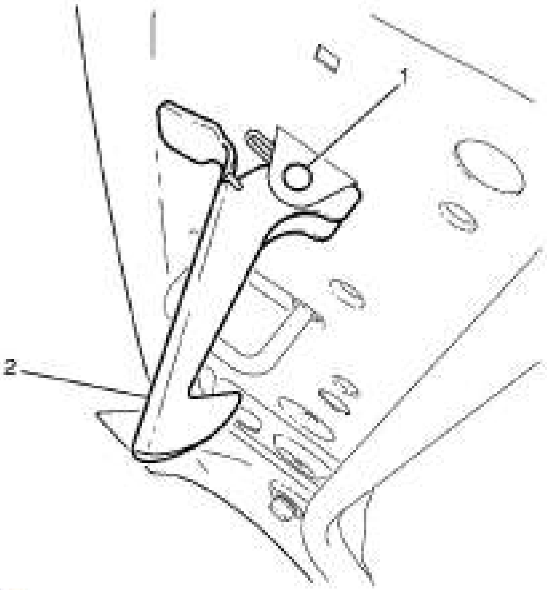
Important: The secondary hood latch retaining pin (1) is a single use part only. It must be discarded after removal.

2. Remove the secondary hood latch retaining pin (1) from the secondary hood latch (2).

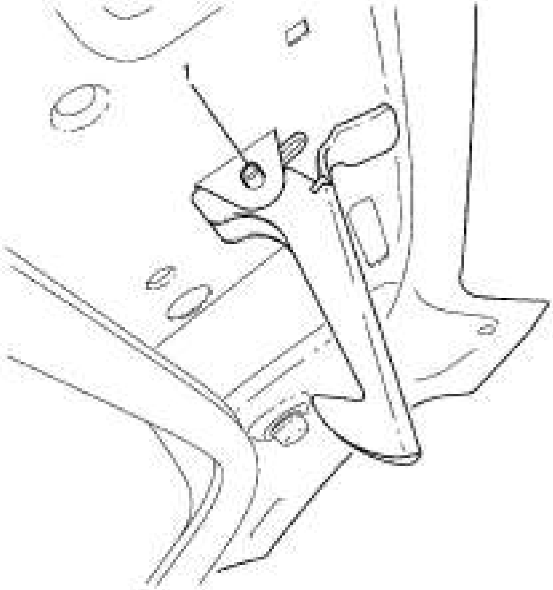
   Discard the pin.

3. Remove the secondary hood latch (2) from the vehicle.

Installation Procedure



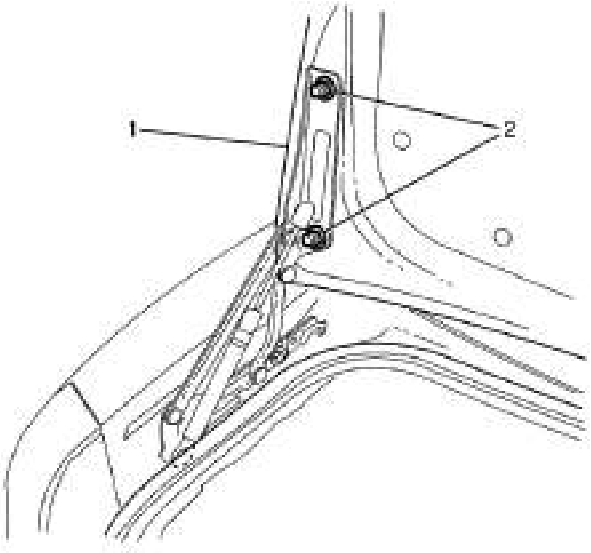
1. Install the secondary hood latch (2) to the vehicle.
2. Install a NEW secondary hood latch retaining pin (1) to the secondary hood latch.



3. Crimp the exposed end of the secondary hood latch retaining pin (1) to make sure the retaining pin is secure.

Rear Compartment Lid Adjustment

Front-to-Rear, Side-to-Side



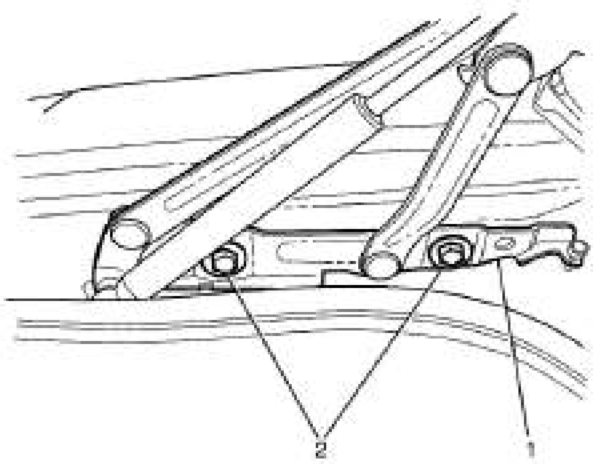
1. Loosen the rear compartment lid to rear compartment lid hinge retaining nuts (2). Repeat for opposite side.
2. Align the rear compartment lid (1) in order to achieve an equal gap of 2.25 to 3.75 mm around the rear compartment lid to the rear quarter panels.

   Notice: Refer to Fastener Notice in the Preface section.

3. Tighten the rear compartment lid to rear compartment lid hinge retaining nuts (2). Repeat for opposite side.

   Tighten
   Tighten the nuts to 22 N·m (16 lb ft).

Up and Down Adjustment



1. Loosen the rear compartment lid hinge to rear quarter panel retaining bolts (1). Repeat for opposite side.
2. Align the rear compartment lid in order to achieve an equal gap of 5 to 7 mm from the rear compartment lid to the rear bumper fascia.
3. Tighten the rear compartment lid hinge to rear quarter panel retaining bolts (2). Repeat for opposite side.

   Tighten
   Tighten the bolts to 22 N·m (16 lb ft)

4. Adjust the rear compartment overslam bumpers for flushness.

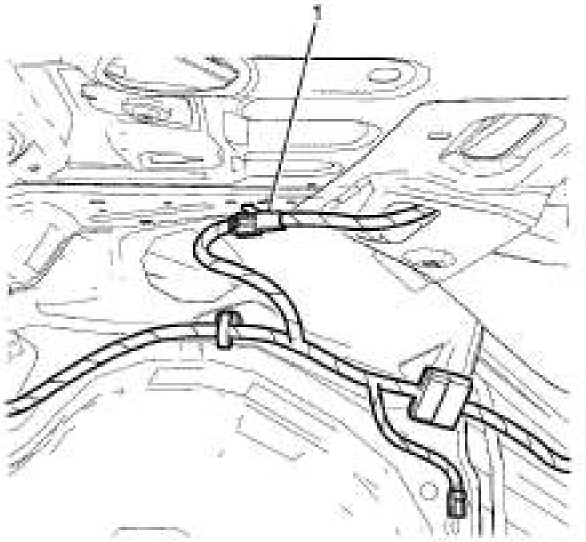
Rear Compartment Lid Replacement

Removal Procedure

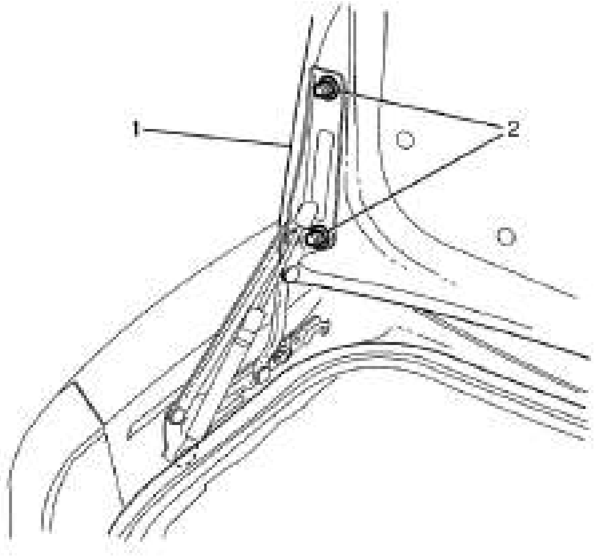
Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

Important: Insert packing foam into the corners of the rear compartment lid to the vehicle body.

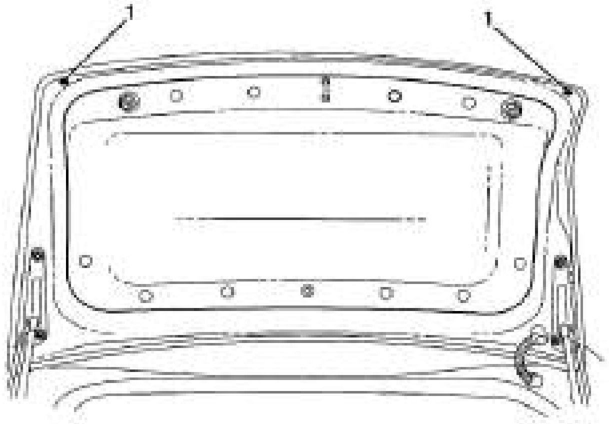
1. Support the rear compartment lid with a suitable brace.
2. Remove the rear compartment lid carpet. Refer to Rear Compartment Lid Inner Panel Trim Replacement .



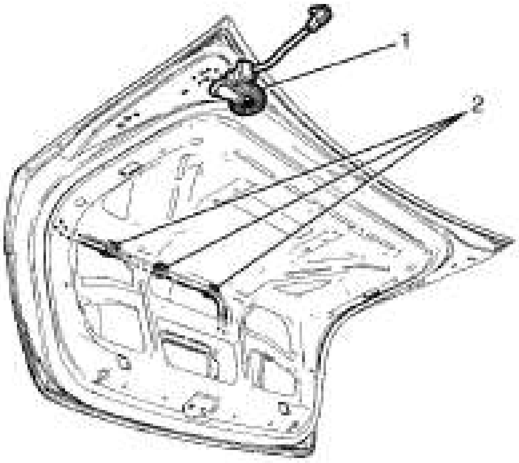
3. Disconnect the rear compartment lid wiring harness (1) from the body wiring harness.



4. With the aid of an assistant, remove the rear compartment lid to rear compartment lid hinge retaining nuts (2). Repeat for opposite side.
5. Remove the rear compartment lid (1) from the vehicle.
6. Remove the rear compartment lid applique. Refer to Rear Compartment Lid Applique Replacement .
7. Remove the rear compartment lid latch. Refer to Rear Compartment Lid Latch Replacement .
8. Remove the rear compartment lid overslam bumpers from the rear compartment lid. Refer to Rear Compartment Lid Overslam Bumper Replacement .



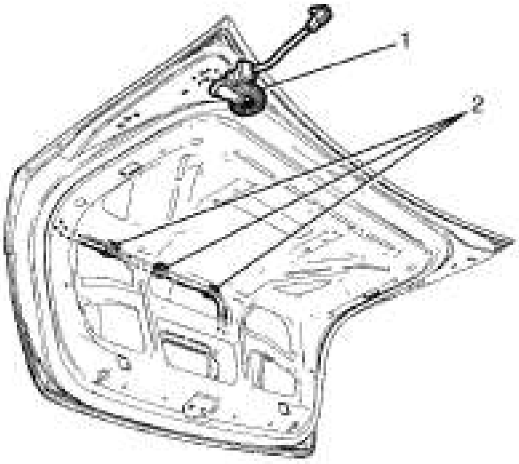
9. Remove the rear compartment lid drain plugs (1) from the rear compartment lid.



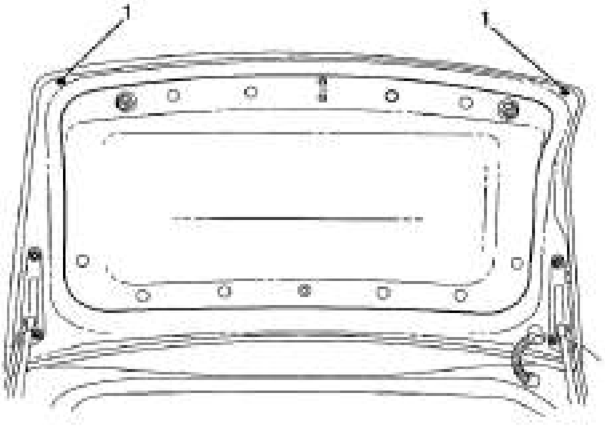
10. Remove the rear compartment lid wiring harness to rear compartment lid retaining clips (2).
11. Remove the rear compartment lid wiring harness insulator (1) from rear compartment lid.
12. Remove the rear compartment lid wiring harness from the rear compartment lid.

Installation Procedure

1. Install the rear compartment lid wiring harness to the rear compartment lid.

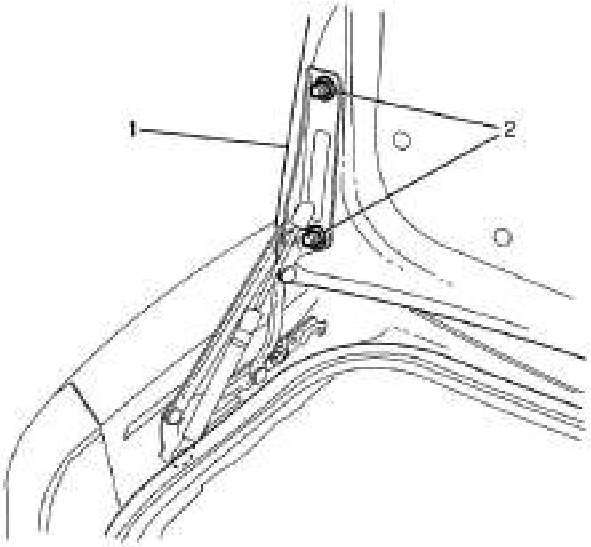


2. Install the rear compartment lid wiring harness insulator (1) to the rear compartment lid.
3. Install the rear compartment lid wiring harness to rear compartment lid retaining clips (2).



4. Install the rear compartment lid drain plugs (1) to the rear compartment lid.
5. Install the rear compartment lid overslam bumpers to the rear compartment lid. Refer to Rear Compartment Lid Overslam Bumper Replacement .
6. Install the rear compartment lid latch. Refer to Rear Compartment Lid Latch Replacement .
7. Install the rear compartment lid applique. Refer to Rear Compartment Lid Applique Replacement .

Notice: Refer to Fastener Notice in the Preface section.

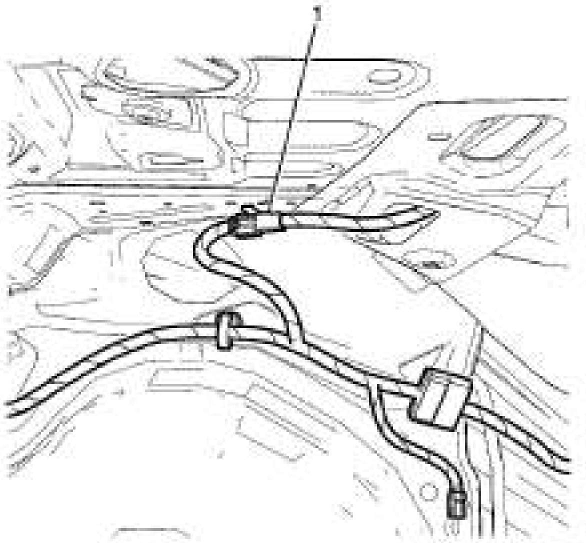


8. With the aid of an assistant, install the rear compartment lid (1) to the vehicle.
9. Support the rear compartment lid with a suitable brace.

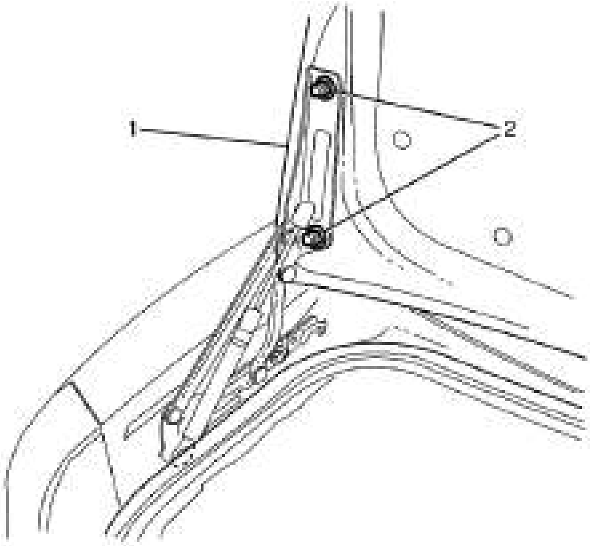
Important: Do not fully tighten the rear compartment lid retaining nuts (2) at this stage.

10. Install the rear compartment lid to rear compartment lid hinge retaining nuts (2). Repeat for opposite side.

    Do not fully tighten at this stage.



11. Connect the rear compartment lid wiring harness (1) to the body wiring harness.
12. Refer to Rear Compartment Lid Inner Panel Trim Replacement .
13. Remove the suitable brace from the vehicle.
14. Adjust the rear compartment lid as necessary. Refer to Rear Compartment Lid Adjustment .



15. Tighten the rear compartment lid to rear compartment lid hinge retaining nuts (1). Repeat

for opposite side.

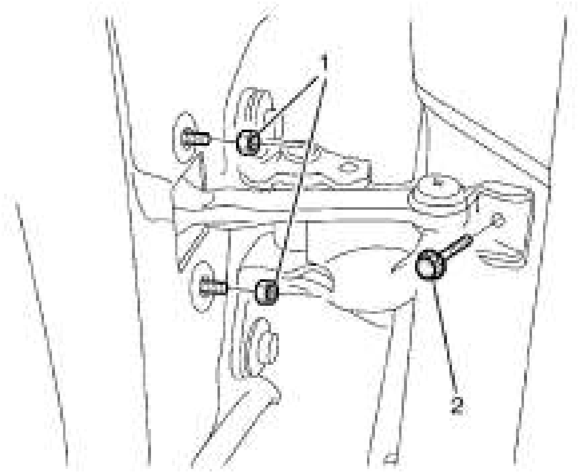
Tighten

Tighten the nuts to 22 N·m (16 lb ft).

Front Side Door Check Link Replacement

Removal Procedure

1. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement .
2. Pull back the forward half of the water deflector from the door panel to access the check link.

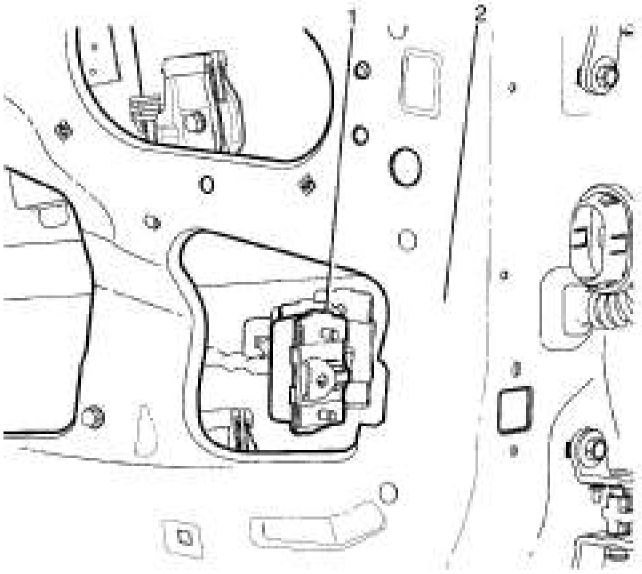


Important: The door check link to pillar retaining bolt (2) is a single use part and must be discarded after removal.

3. Remove the door check link to pillar retaining bolt (2).

   Discard the bolt.

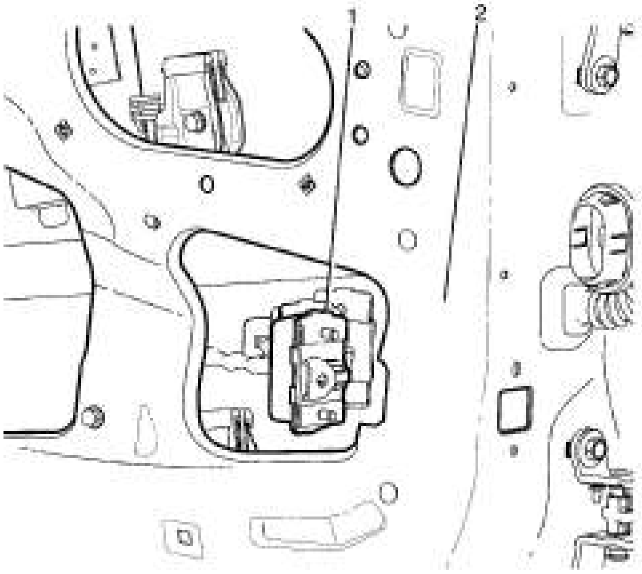
4. Remove the door check link to door retaining nuts (1).



Important: Remove the check link (1) through the front lower access hole.

5. Remove the door check link (1) from the door (2).

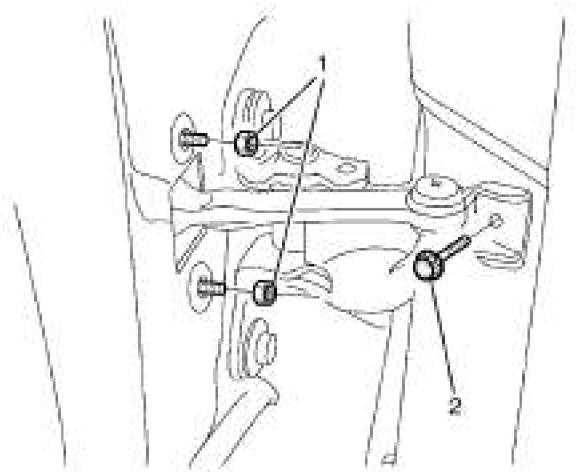
Installation Procedure



Important: Install the check link (1) through the front lower access hole.

1. Install the door check link (1) to the door (2).

Notice: Refer to Fastener Notice in the Preface section.



2. Install the NEW door check link to pillar retaining bolt (1).

   Tighten
   Tighten the bolt to 25 N-m (18 lb in).

3. Install the door check link to door retaining nuts (1).

   Tighten
   Tighten the nuts to 6 N-m (53 lb in).

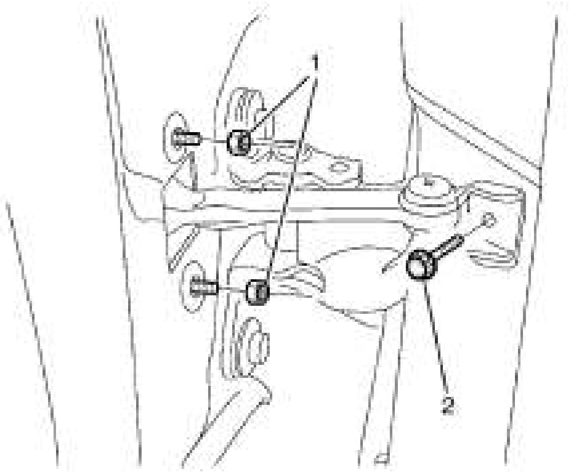
   Important: Firmly press the water deflector where adhesive is applied to make sure of a water tight bond.

4. Install the water deflector to the door.
5. Install the door trim panel. Refer to Front Side Door Trim Panel Replacement .

Rear Side Door Check Link Replacement

Removal Procedure

1. Remove the door trim panel. Refer to Rear Side Door Trim Panel Replacement.
2. Pull the forward half of the water deflector away from the door panel in order to access the check link.

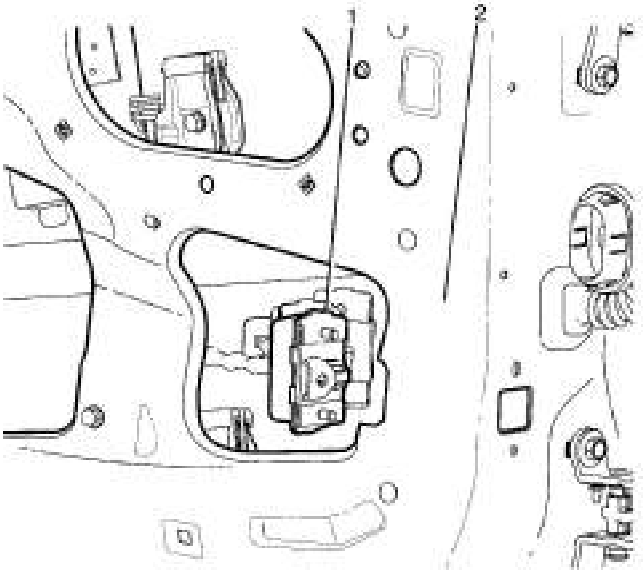


Important: The door check link to pillar retaining bolt (2) is a single use part and must be discarded after removal.

3. Remove the door check link to pillar retaining bolt (2).

   Discard the bolt.

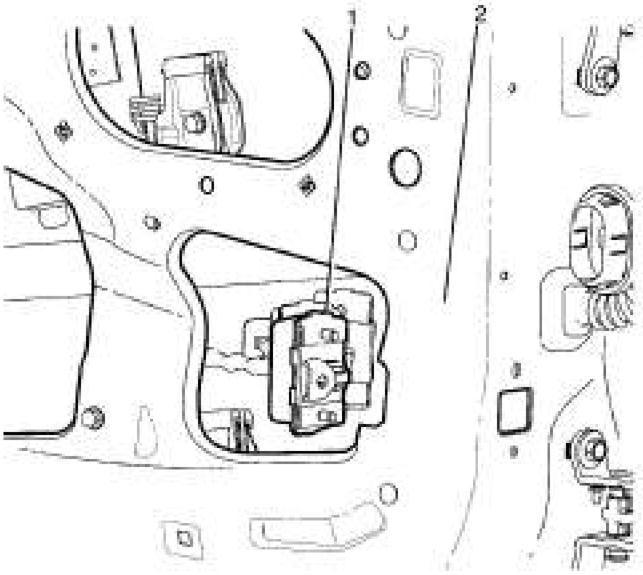
4. Remove the door check link to door retaining nuts (1).



Important: Remove the check link through the front lower access hole.

5. Remove the door check link (1) from the door (2).

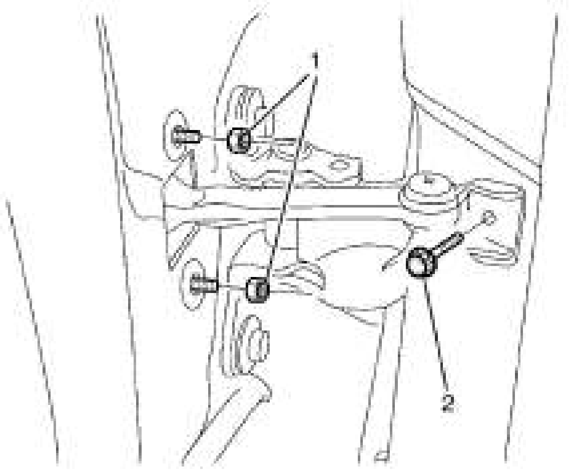
Installation Procedure



Important: Install the check link through the front lower access hole.

1. Install the door check link (1) into the door (2).

Notice: Refer to Fastener Notice in the Preface section.



2. Install the NEW door check link to pillar retaining bolt (2).

   Tighten
   Tighten the bolt to 25 N-m (18 lb in).

3. Install the door check link to door retaining nuts (1).

   Tighten
   Tighten the nuts to 6 N-m (53 lb in).

   Important: Firmly press the water deflector where adhesive is applied to make sure of a water tight bond.

4. Install the water deflector to the door.
5. Install the door trim panel. Refer to Rear Side Door Trim Panel Replacement.

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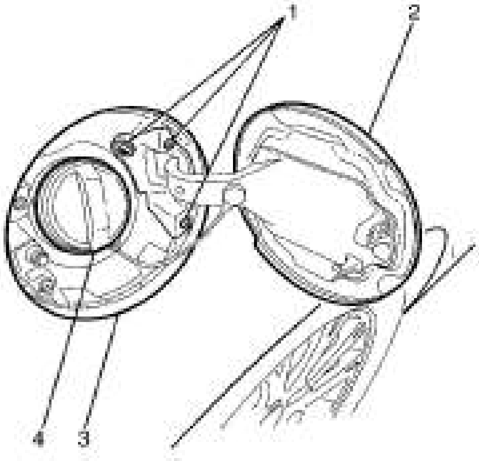
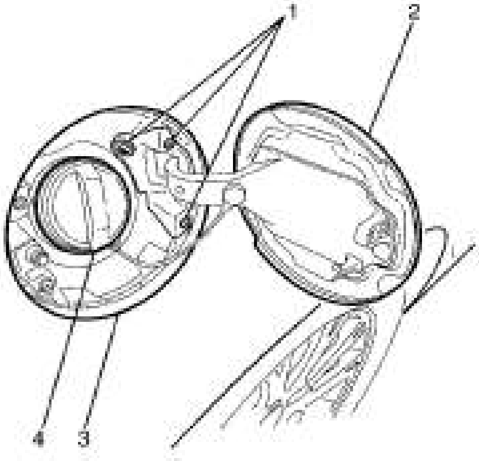
Fuel Tank Filler Door Replacement

Removal Procedure



1. Remove the fuel cap (4).
2. Remove the fuel tank filler door to rear quarter panel retaining torx screws (1).
3. Remove the fuel tank filler door (2) from the rear quarter panel (3).

Installation Procedure



1. Position the fuel tank filler door (2) to the rear quarter panel (3).
2. Install the fuel tank filler door to rear quarter panel retaining torx screws (1).
3. Align the fuel tank filler door to achieve an equal gap of 1.5 to 2.5 mm (0.06 to 0.10 in) around the fuel tank filler door (2) to the rear quarter panel (3).

   Notice: Refer to Fastener Notice in the Preface section.

4. Tighten the fuel tank filler door to rear quarter panel retaining torx screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).

5. Install the fuel cap (4).

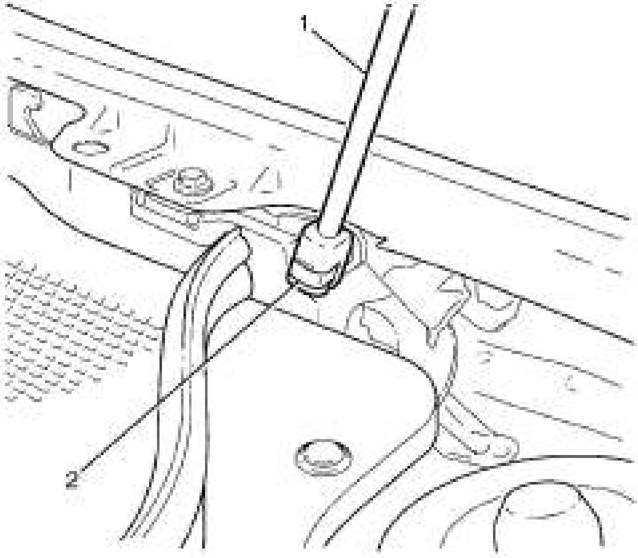
Hood Open Assist Rod Replacement

Removal Procedure

Notice: Apply pressure only at the end of the liftgate/hood assist rod that you are removing or attaching. Do NOT apply pressure to the middle of the rod because damage or bending will result.

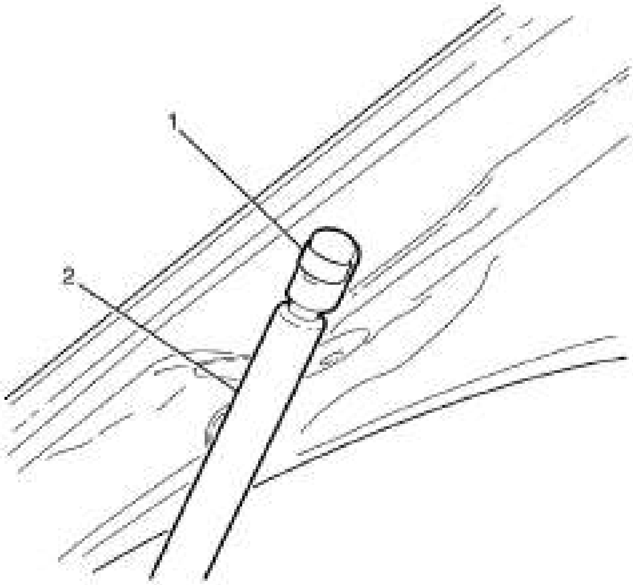
Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable hood brace to the vehicle.



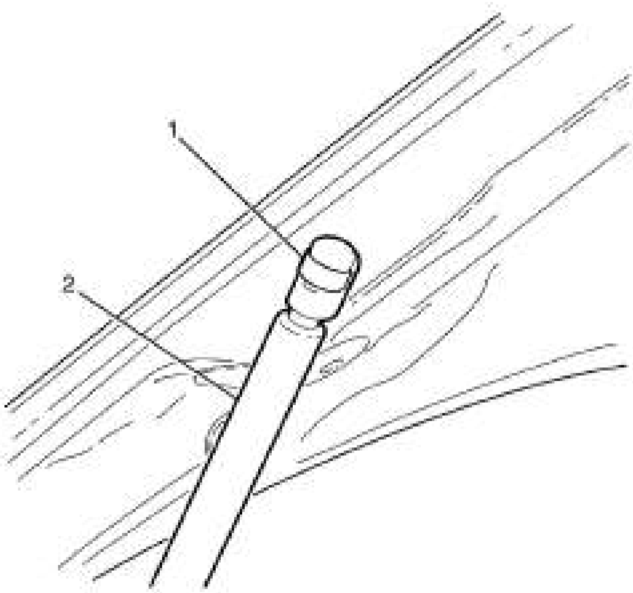
Important: Do not fully remove the hood assist rod securing clips from the hood assist rod, as this will assist in the installation.

2. Using a suitable tool, release the securing clip (2) retaining the hood assist rod (1) to the hood assist rod lower ball stud.

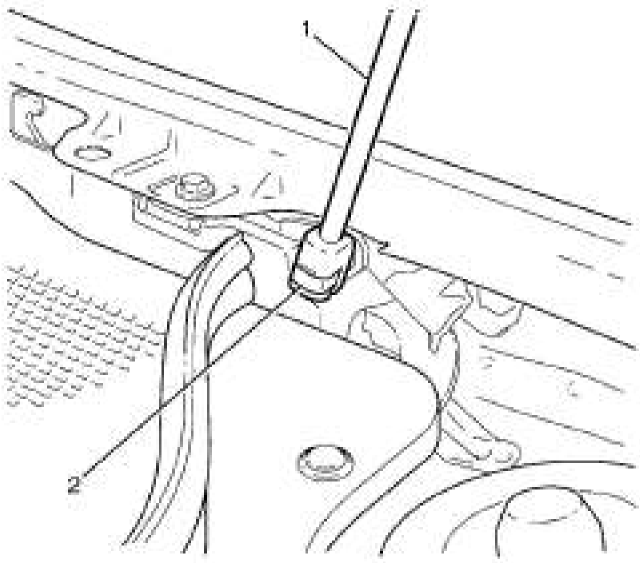


3. Using a suitable tool, release the securing clip (1) retaining the hood assist rod (2) to the hood assist rod upper ball stud.
4. Remove the hood assist rod (2) from the vehicle.

Installation Procedure



1. Press the hood assist rod (2) onto the hood assist rod upper ball stud. Listen for an audible click to confirm fitting.
2. Make sure that the hood assist rod securing clip (1) is fully seated on the hood assist rod (2).



3. Press the hood assist rod (1) onto the hood assist rod lower ball stud. Listen for an audible click to confirm fitting.
4. Make sure that the hood assist rod securing clip (2) is fully seated on the hood assist rod (1).
5. Remove the suitable hood brace from the vehicle.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Repair | Bolted Exterior Body Panels and Closures | Repair Instructions | **Document ID: 1977699**

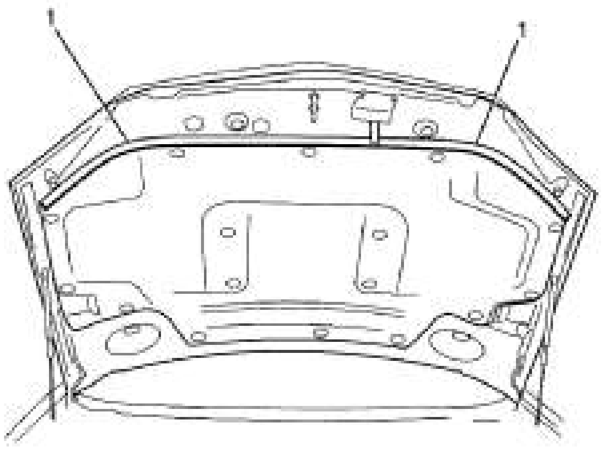
Hood Front Seal Replacement

Removal Procedure

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

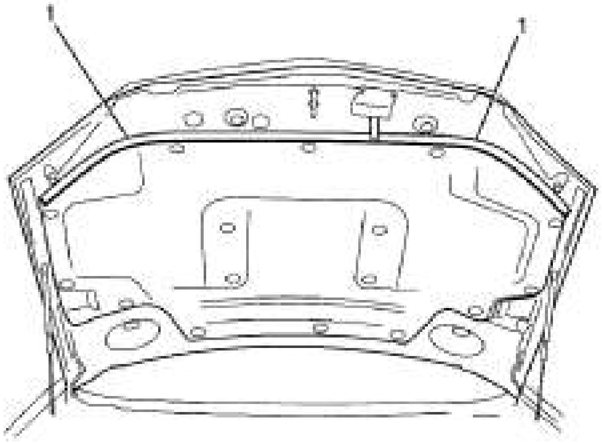
1. Install a suitable hood brace to the vehicle.

Caution: Refer to Safety Glasses Caution in the Preface section.



2. Using a suitable tool, carefully work the hood front seal (1) off the hood from side to side.
3. Remove the hood front seal (1) from the hood.

Installation Procedure



1. Position the hood front seal (1) to the hood.
2. Install the push-in retainers to secure the hood front seal (1) to the hood.
3. Remove the suitable hood brace from the vehicle.

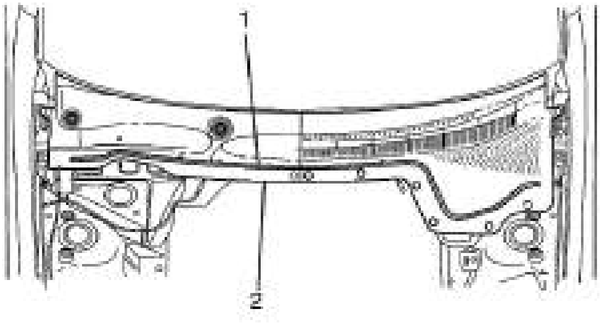
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Repair | Bolted Exterior Body Panels and Closures | Repair Instructions | **Document ID: 1977700**

Hood Rear Seal Replacement

Removal Procedure

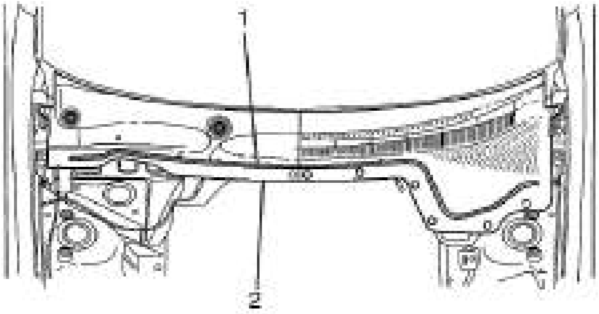
> **Important:** When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable hood brace to the vehicle.

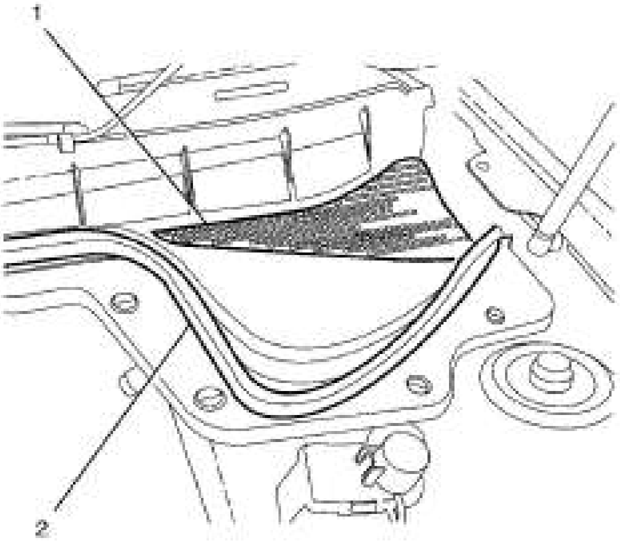


2. Remove the hood rear seal (1) from the air inlet grille panel (2) lip.

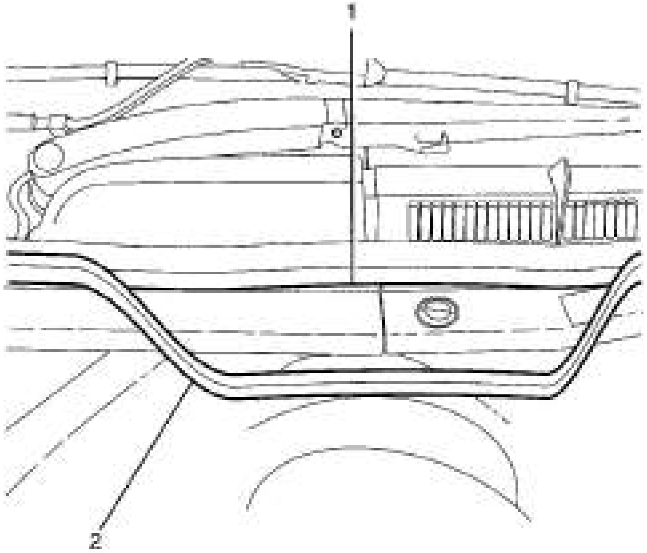
Installation Procedure



1. Install the hood rear seal (1) to the air inlet grille panel (2) lip.



2. Install the ends of the hood rear seal (2) to the ends of the air inlet grille panel (1).

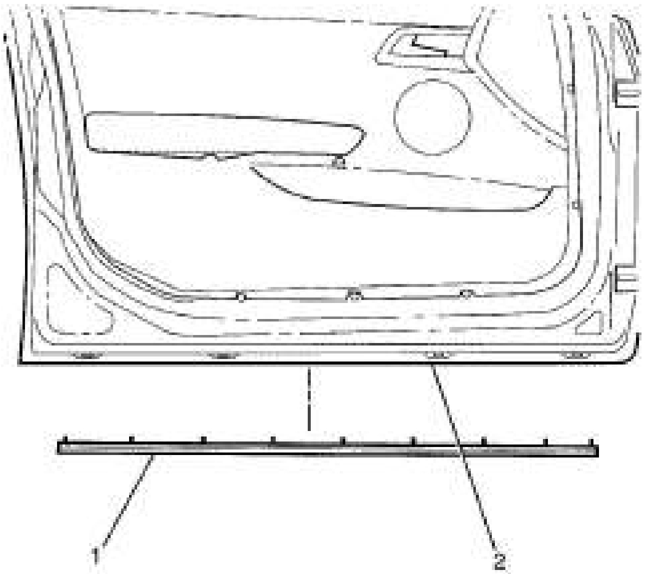


Important: The rear hood seal will stretch to fit the length across the air inlet grille panel.

3. Install the remaining portion of the hood rear seal (2) to the air inlet grille panel, working from the outer edges to the centre of the vehicle.
4. Remove the suitable hood brace from the vehicle.

Front Side Door Bottom Auxiliary Sealing Strip Replacement

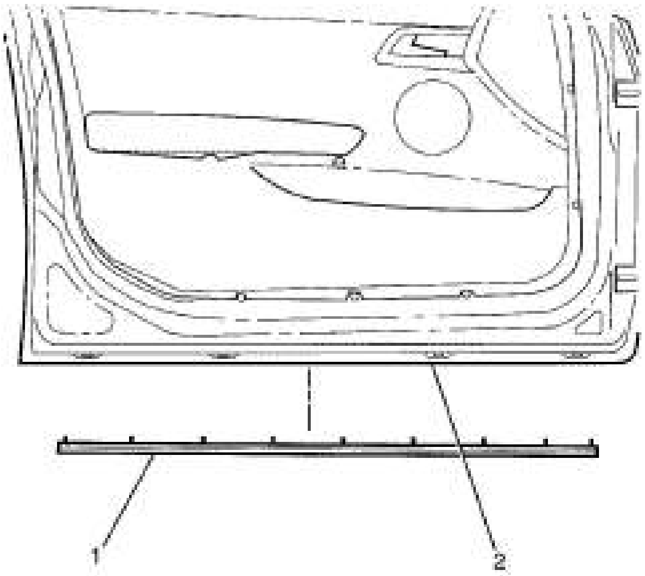
Removal Procedure



Important: Pull the front door bottom auxiliary sealing strip (1) from the door (2) to detach the retainers.

Remove the front door bottom auxiliary sealing strip (1) from the door (2).

Installation Procedure

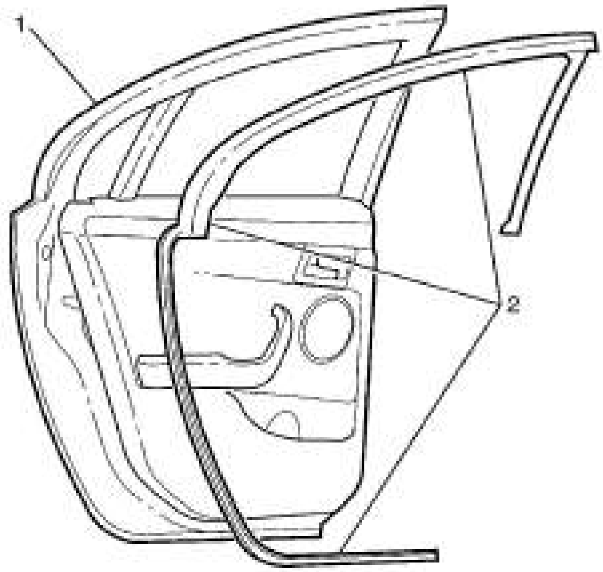


Important: Push the bottom auxiliary sealing strip (1) to the door (2) by hand to attach the retainers.

Install the front door bottom auxiliary sealing strip (1) to the door (2).

Rear Side Door Bottom Auxiliary Sealing Strip Replacement (Sedan)

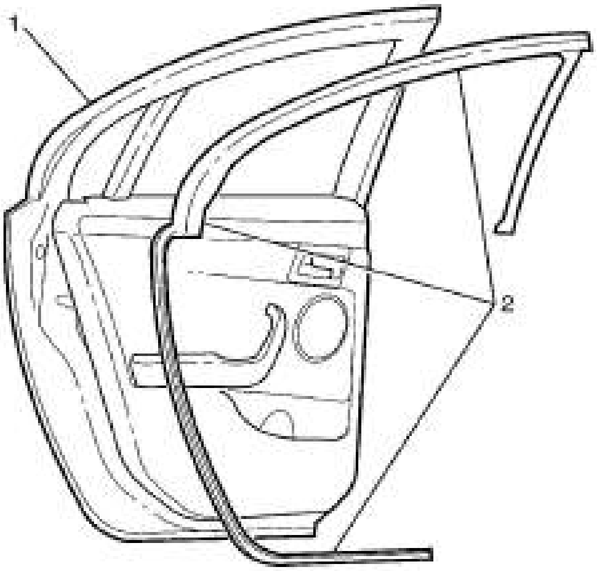
Removal Procedure



Important: Pull the sealing strip (2) from the door (1) to detach the retainers.

Remove the sealing strip (2) from the door (1).

Installation Procedure

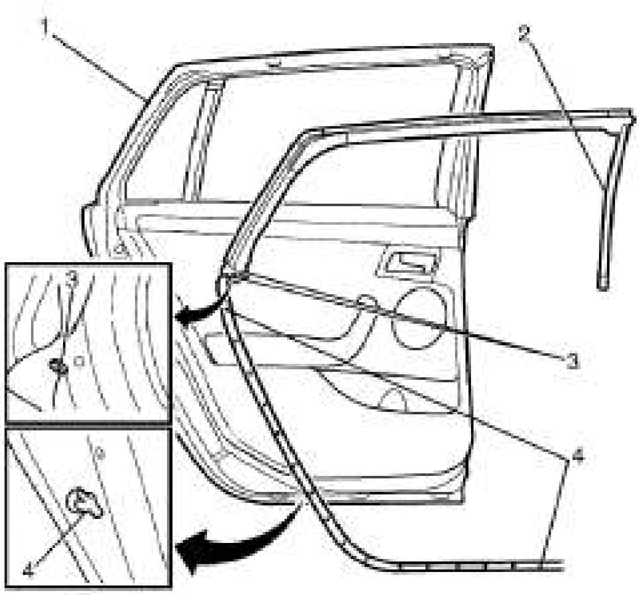


Important: Push the sealing strip (2) to the door (1) to attach the retainers.

Install the sealing strip (2) to the door (1).

Rear Side Door Bottom Auxiliary Sealing Strip Replacement (Sportwagon)

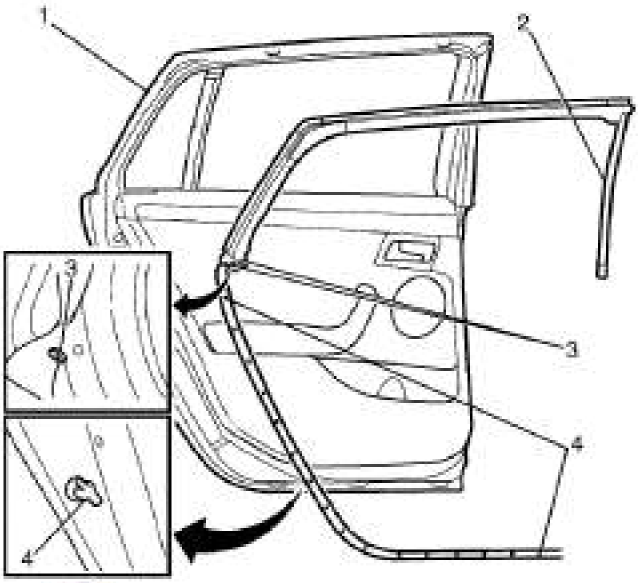
Removal Procedure



Important: Pull the sealing strip (2) from the rear door (1) to detach the retainers (3) and the lower rubber clips (4).

Detach the retaining clips all around the sealing strip (2) and remove the sealing strip (2) from the rear door (1).

Installation Procedure



Important: Push the sealing strip (2) to the rear door (1) to attach the retainers (3) and the lower rubber clips (4).

Install the sealing strip (2) to the rear door (1).

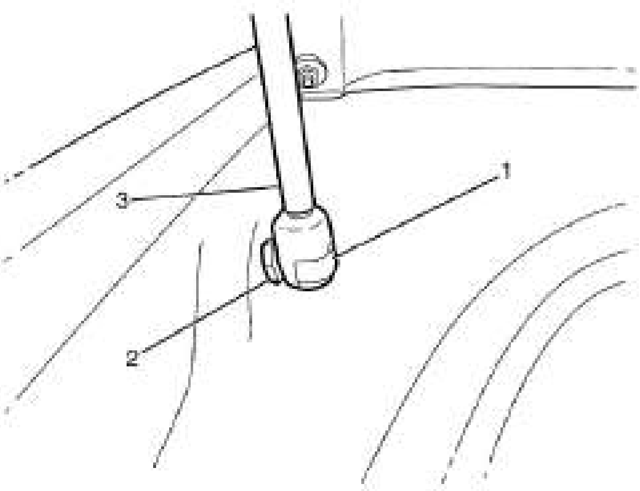
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Repair | Bolted Exterior Body Panels and Closures | Repair Instructions | Document ID: 2067497

Liftgate Strut Replacement

Removal Procedure

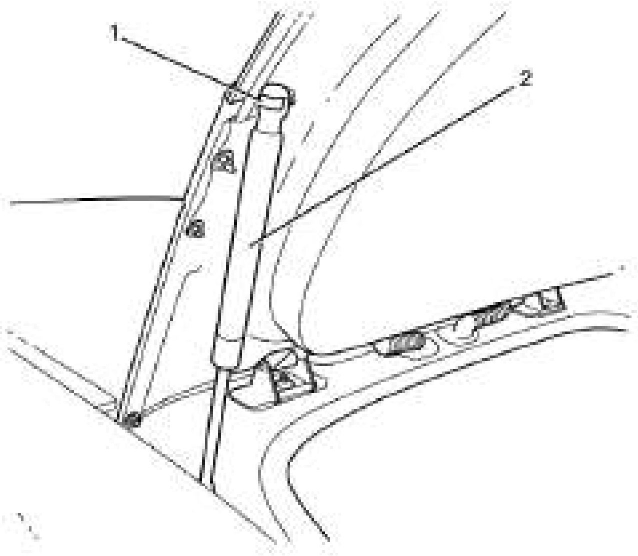
Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.



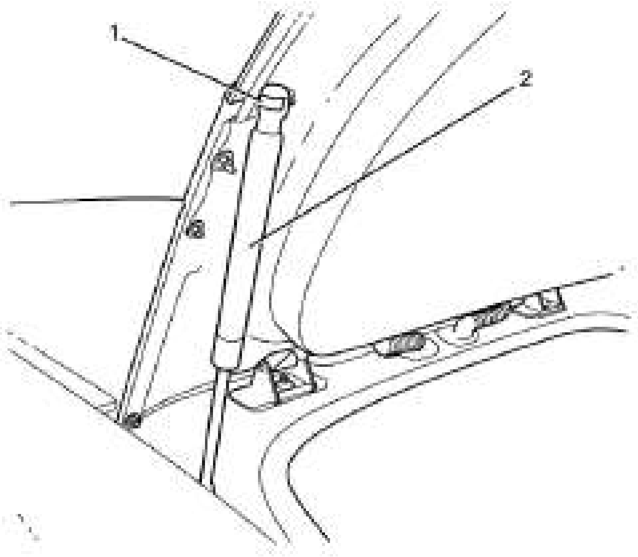
Important: Apply pressure only at the end of the liftgate strut that you are removing or attaching. DO NOT apply pressure to the middle of the strut because damage or bending will result.

2. Using a suitable tool, release the liftgate strut to lower strut stud retaining clip (1).
3. Detach the liftgate strut (3) from lower strut stud (2).



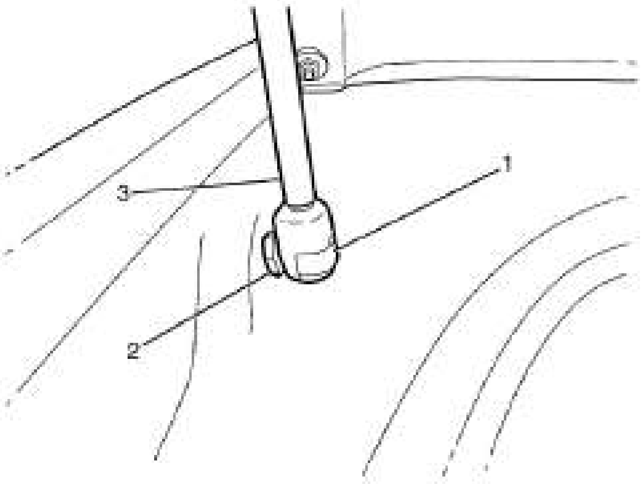
4. Using a suitable tool, release the liftgate strut to upper strut stud retaining clip (1).
5. Remove the liftgate strut (2) from the vehicle.

Installation Procedure



Important: Make sure that the liftgate strut to upper strut stud retaining clip (1) engages correctly securing the liftgate strut (2).

1. Install the liftgate strut (2) onto the upper strut stud.



Important: Apply pressure only at the end of the liftgate strut that you are removing or attaching. DO NOT apply pressure to the middle of the strut because damage or bending will result.

Important: Make sure that the liftgate strut to lower strut stud retaining clip (1) engages correctly securing the liftgate strut (2).

2. Attach the liftgate strut (3) to the lower strut stud (2).

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

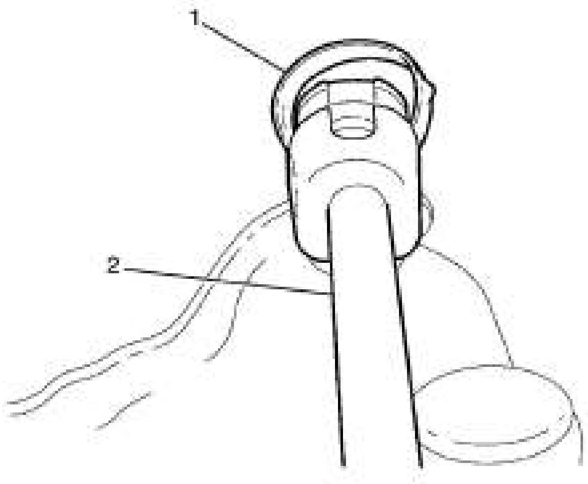
3. Remove the suitable liftgate brace from the vehicle.

Rear Compartment Lid Strut Replacement

Removal Procedure

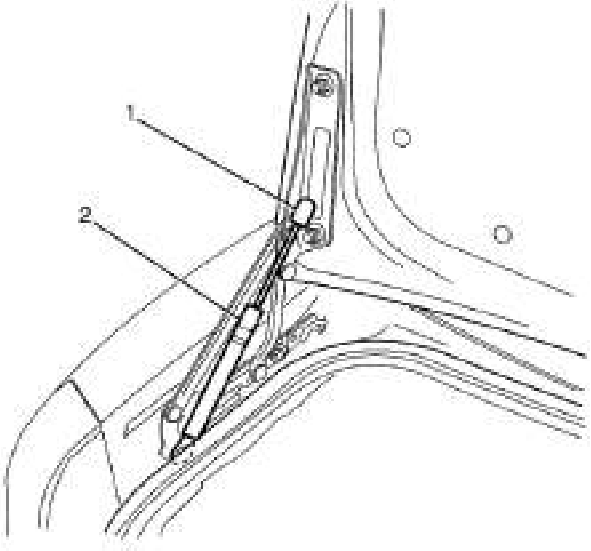
Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Support the rear compartment lid with a suitable brace.



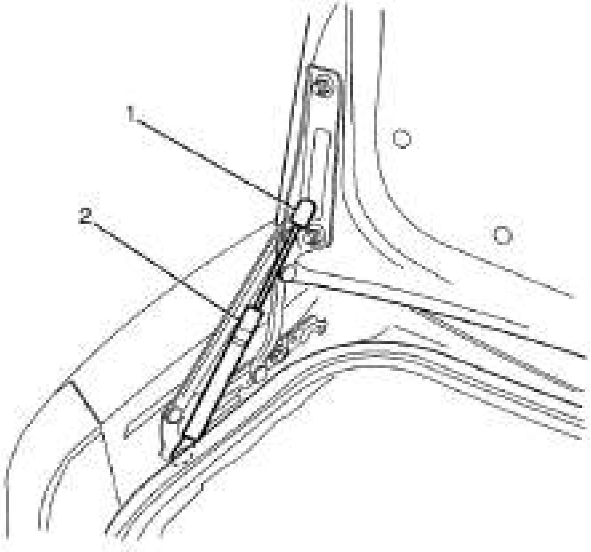
Notice: Apply pressure only at the end of the liftgate/hood assist rod that you are removing or attaching. Do NOT apply pressure to the middle of the rod because damage or bending will result.

2. Using a suitable tool, release the rear compartment lid strut to the lower strut stud retaining clip (1).

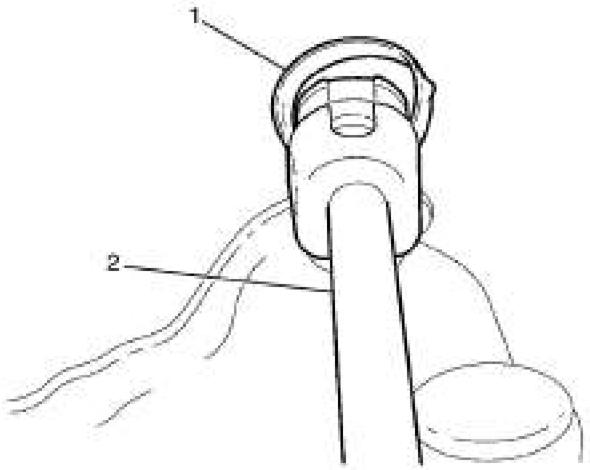


3. Using a suitable tool, release the rear compartment lid strut to the upper strut stud retaining clip (1).
4. Remove the rear compartment lid strut (2) from the vehicle.

Installation Procedure



1. Press the rear compartment lid strut (2) onto the upper strut stud.
2. Install the rear compartment lid strut stud retaining clip (1) to the rear compartment lid strut.



Notice: Apply pressure only at the end of the liftgate/hood assist rod that you are removing or attaching. Do NOT apply pressure to the middle of the rod because damage or bending will result.

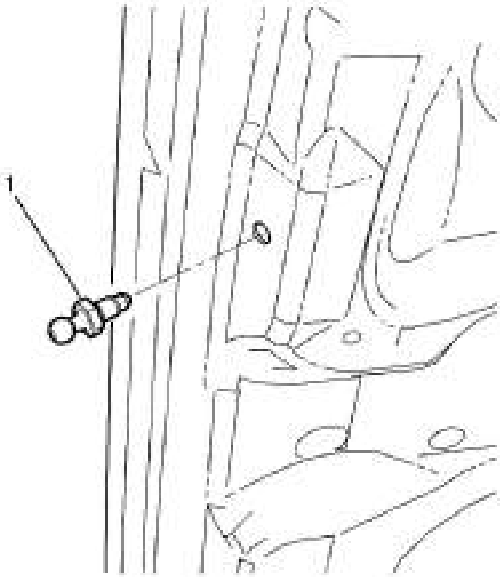
3. Press the rear compartment lid strut (2) onto the lower strut stud.
4. Install the rear compartment lid strut stud retaining clip (1) to the rear compartment lid strut.
5. Make sure that both clips are fully seated on the rear compartment lid strut.
6. Remove the suitable brace from the vehicle.

Hood Open Assist Rod Stud Replacement

Removal Procedure

> **Important:** When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

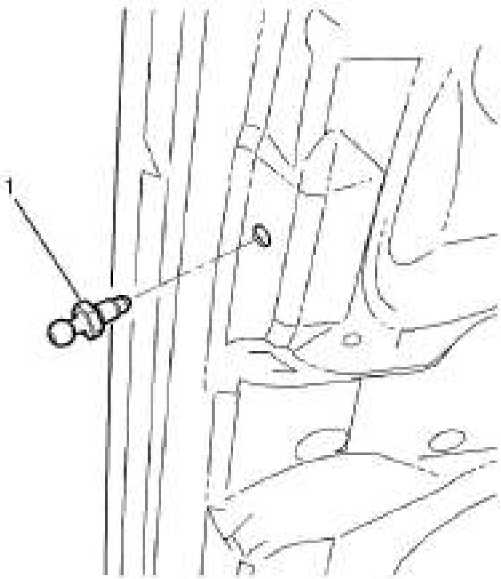
1. Install a suitable hood brace to the vehicle.
2. Remove the hood assist rod. Refer to Hood Open Assist Rod Replacement.



3. Remove the hood assist rod upper ball stud (1) from the hood.

Installation Procedure

> **Notice:** Refer to Fastener Notice in the Preface section.



1. Install the hood assist rod upper ball stud (1) to the hood.

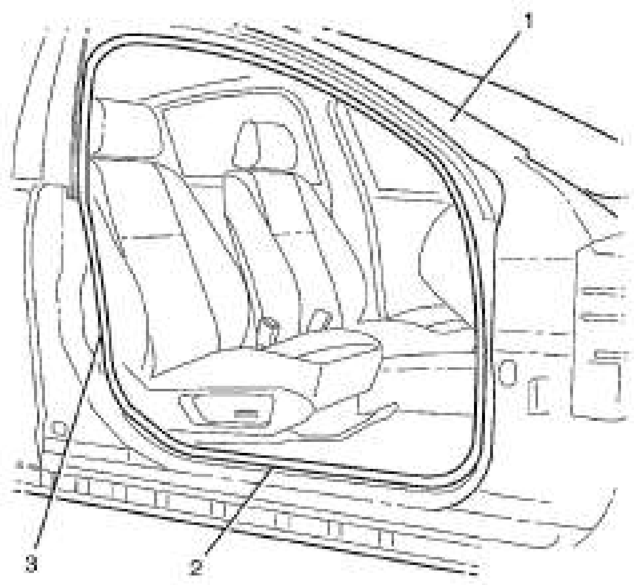
   Tighten
   Tighten the ball stud to 18 N·m (15 lb ft).

2. Install the hood assist rod. Refer to Hood Open Assist Rod Replacement.
3. Remove the suitable hood brace from the vehicle.

Front Door Opening Weatherstrip Replacement

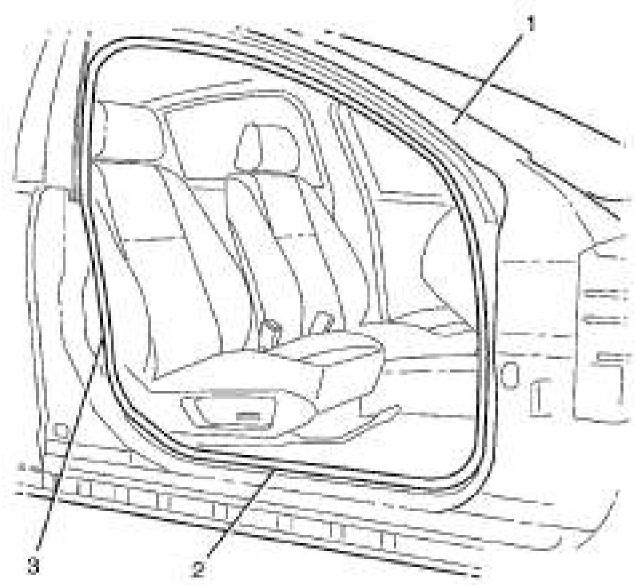
Removal Procedure

1. Remove the front sill trim panel. Refer to Door Sill Plate Replacement.
2. Remove the centre pillar lower trim. Refer to Center Pillar Lower Trim Panel Replacement.
3. Remove the trim panel - upper centre pillar, on both sides. Refer to Center Pillar Upper Trim Panel Replacement.
4. Remove the body hinge pillar trim assembly on both sides. Refer to Body Hinge Pillar Trim Panel Replacement.
5. Remove the windshield side garnish, on both sides. Refer to Windshield Garnish Molding Replacement.



6. Starting from the centre sill point (2) carefully remove the front door weatherstrip (3) from the body panel door opening (1).

Installation Procedure



Important: Make sure the lip of the weatherstrip sits over the trim panels.

Important: Make sure the weatherstrip does not short cut the corners and foul the door trim.

1. Starting at the centre sill point (2) install the front door weatherstrip (3) to the body panel door opening (1).
2. Install the windshield side garnish, on both sides. Refer to Windshield Garnish Molding Replacement.
3. Install the body hinge pillar trim assembly on both sides. Refer to Body Hinge Pillar Trim Panel Replacement.
4. Install the trim panel - upper centre pillar, on both sides. Refer to Center Pillar Upper Trim Panel Replacement.
5. Install the centre pillar lower trim. Refer to Center Pillar Lower Trim Panel Replacement.
6. Install the front sill trim panel. Refer to Door Sill Plate Replacement.

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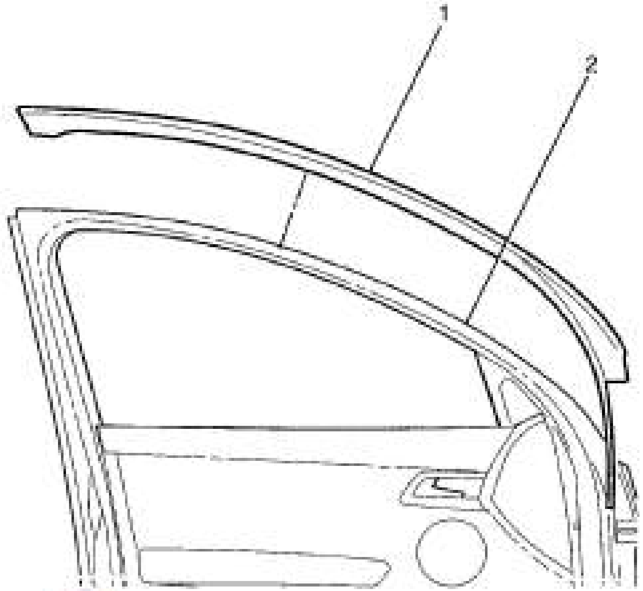
Front Side Door Upper Auxiliary Weatherstrip Replacement

Removal Procedure

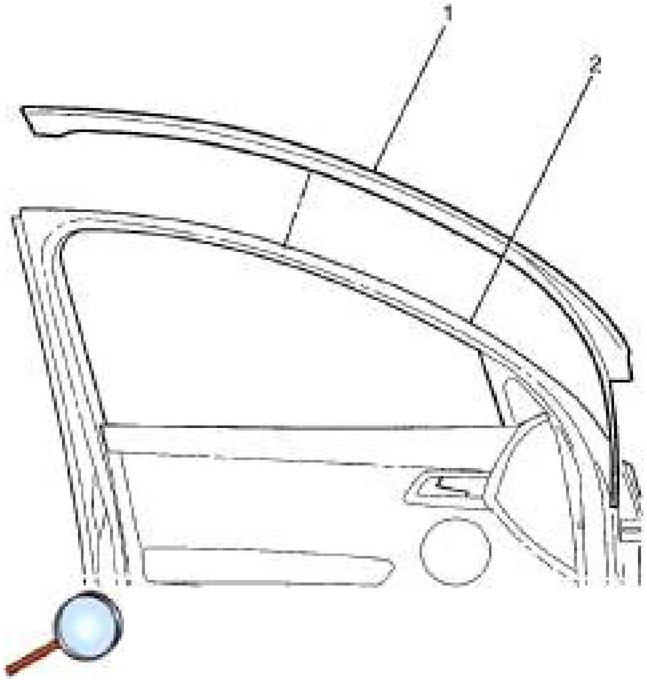
1. Remove the push-in front door upper auxiliary weatherstrip to door retaining fasteners.



Important: Remove the weatherstrip by pulling to release retaining fasteners.

2. Remove the front door upper auxiliary weatherstrip (1) from the door (2).

Installation Procedure

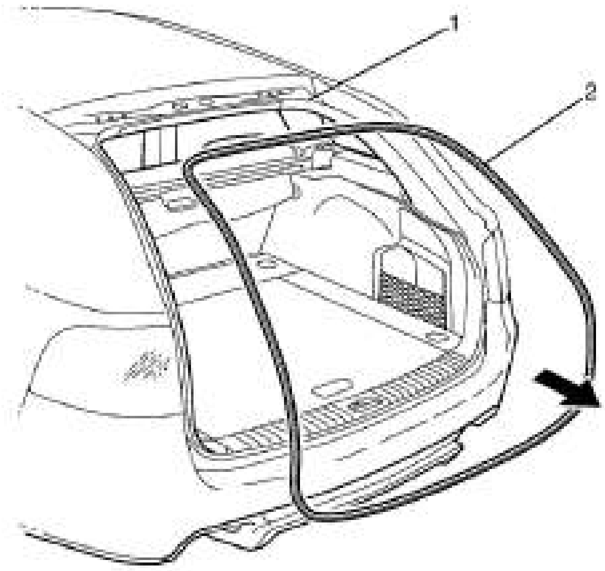


Important: Install the weatherstrip by pushing to attach retaining fasteners.

1. Install the front door upper auxiliary weatherstrip moulding (1) to the door (2).
2. Install the push-in fasteners to the door.

Liftgate Weatherstrip Replacement

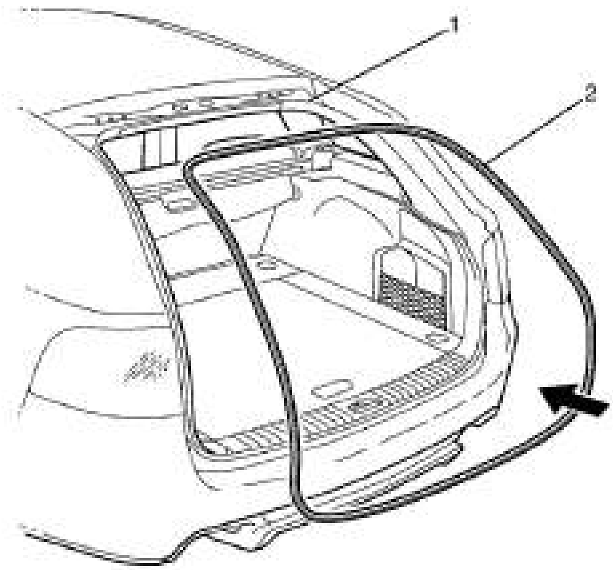
Removal Procedure



Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Pull the liftgate weatherstrip (2) from the liftgate opening pinch-weld flange (1).
3. Remove the liftgate weatherstrip (2) from the vehicle.

Installation Procedure



Important: Do not stretch the liftgate weatherstrip during installation.

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

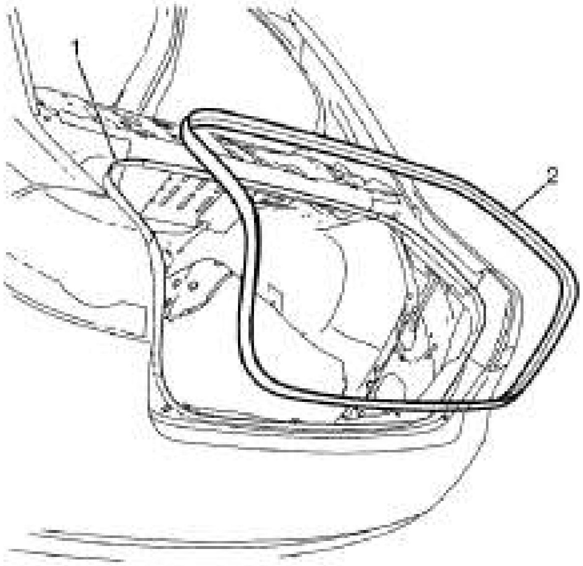
1. Position the liftgate weatherstrip (2) over the liftgate opening pinch-weld flange (1).
2. Press the liftgate weatherstrip (2) down onto the liftgate opening pinch-weld flange (1).
3. Make sure that the liftgate weatherstrip (2) is secured properly to the entire pinch-weld flange (1).
4. Remove the suitable liftgate brace from the vehicle.

Rear Compartment Lid Weatherstrip Replacement

Removal Procedure

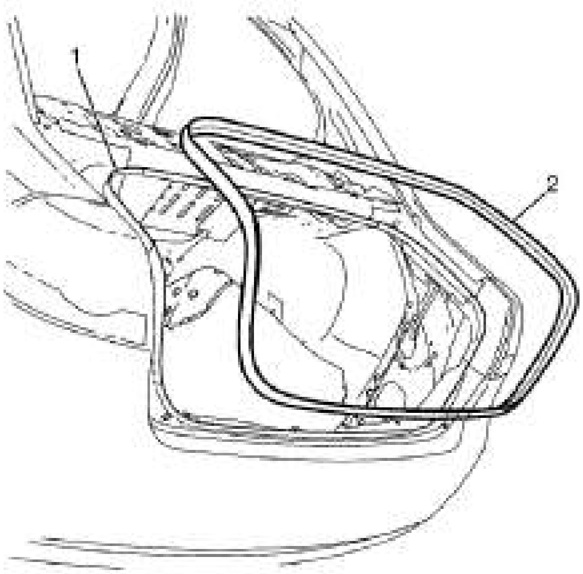
Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Support the rear compartment lid with a suitable brace.



2. Pull the rear compartment weatherstrip (2) from the rear compartment pinch-weld flange (1) on the body.
3. Remove the rear compartment weatherstrip (2) from the vehicle.

Installation Procedure

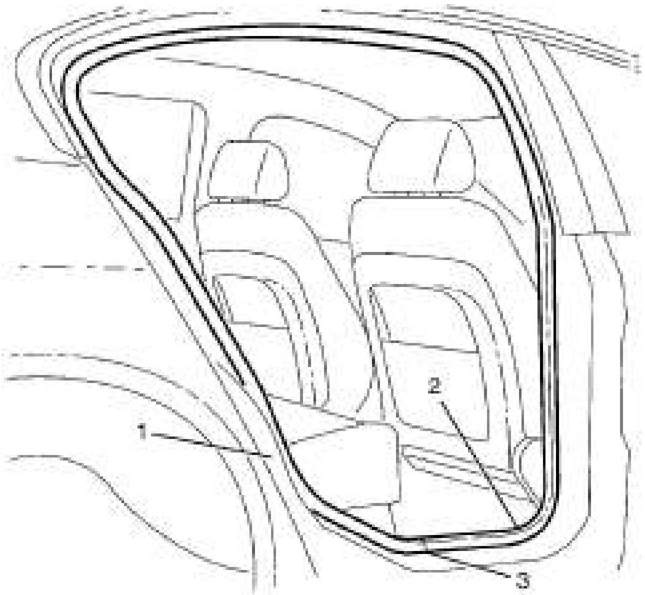


1. Position the rear compartment weatherstrip (2) over the top of the rear compartment pinch-weld flange (1).
2. Press the rear compartment weatherstrip (2) down onto the rear compartment pinch-weld flange (1).
3. Make sure that the rear compartment weatherstrip (2) is secured properly to the entire pinch-weld flange (1).
4. Remove the suitable brace from the vehicle.

Rear Door Opening Weatherstrip Replacement

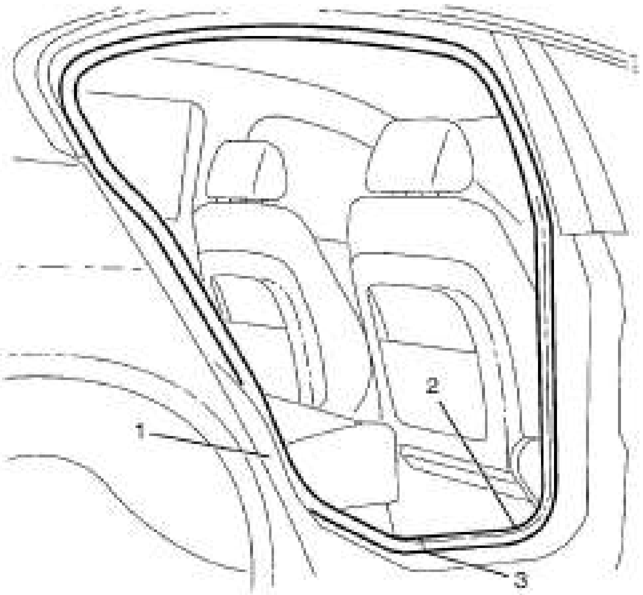
Removal Procedure

1. Remove the rear sill trim panel. Refer to Door Sill Plate Replacement.
2. Remove the centre pillar lower trim. Refer to Center Pillar Lower Trim Panel Replacement.
3. Remove the trim panel - upper centre pillar, on both sides. Refer to Center Pillar Upper Trim Panel Replacement.
4. Remove the trim panel - rear quarter lower. Refer to Quarter Lower Rear Trim Panel Replacement.
5. Remove the trim panel - rear quarter upper. Refer to Quarter Upper Trim Panel Replacement.



6. Starting from the centre sill point (3) carefully remove the rear door weatherstrip (2) from the body panel door opening (1).

Installation Procedure



Important: Make sure the lip of the weatherstrip sits over the trim panels.

Important: Make sure the weatherstrip does not short cut the corners and foul the door trim.

1. Starting at the centre sill point (2) install the rear door weatherstrip (3) to the body panel door opening (1).
2. Install the trim panel - rear quarter upper. Refer to Quarter Upper Trim Panel Replacement.
3. Install the trim panel - rear quarter lower. Refer to Quarter Lower Rear Trim Panel Replacement.
4. Install the trim panel - upper centre pillar, on both sides. Refer to Center Pillar Upper Trim Panel Replacement.
5. Install the centre pillar lower trim. Refer to Center Pillar Lower Trim Panel Replacement.
6. Install the rear sill trim panel. Refer to Door Sill Plate Replacement.

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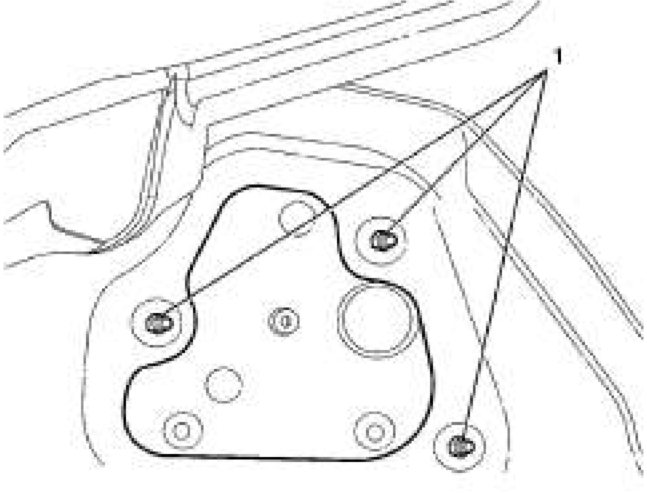
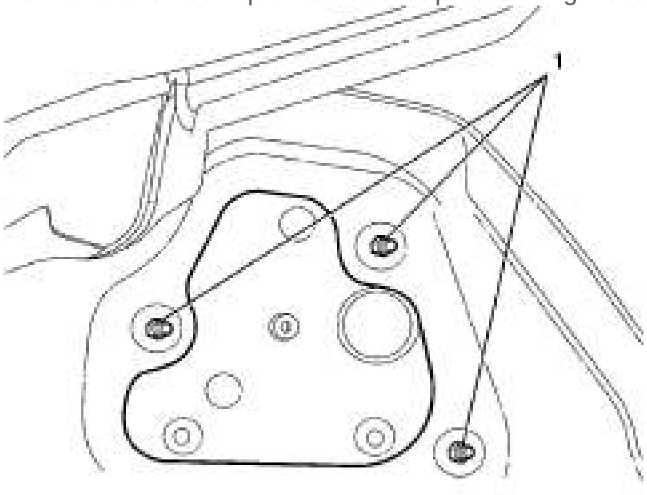
Tail Lamp Mount Panel Replacement (CSV SWBHSV VXR8)

Removal Procedure

1. Remove the tail lamp. Refer to Tail Lamp Replacement.

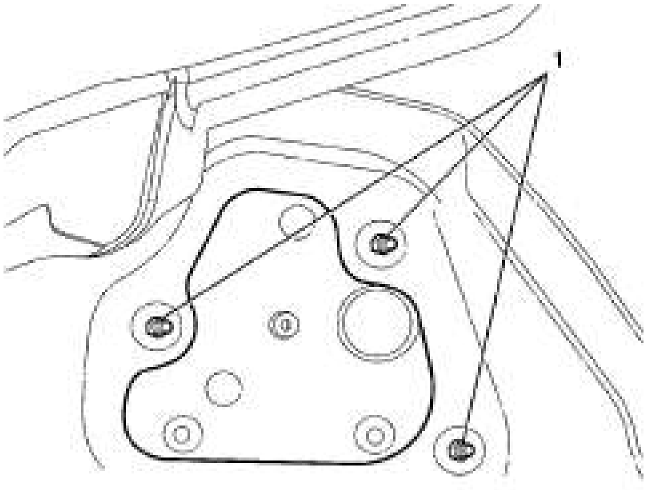


2. Remove the rear quarter end cap retaining nuts (1).



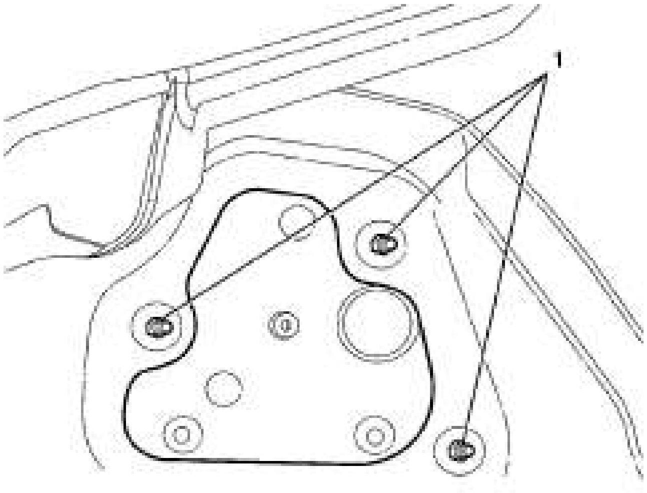
3. Remove the rear quarter end cap (1) by sliding upwards to disengage locating pins (2).

Installation Procedure



1. Install the rear quarter end cap (1) by engaging the locating pins (2) into the rear bumper fascia.

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the rear quarter end cap retaining nuts (1).

   Tighten
   Tighten the nuts to 3 Nm (26.5 lb. in).

3. Install the tail lamp. Refer to Tail Lamp Replacement.

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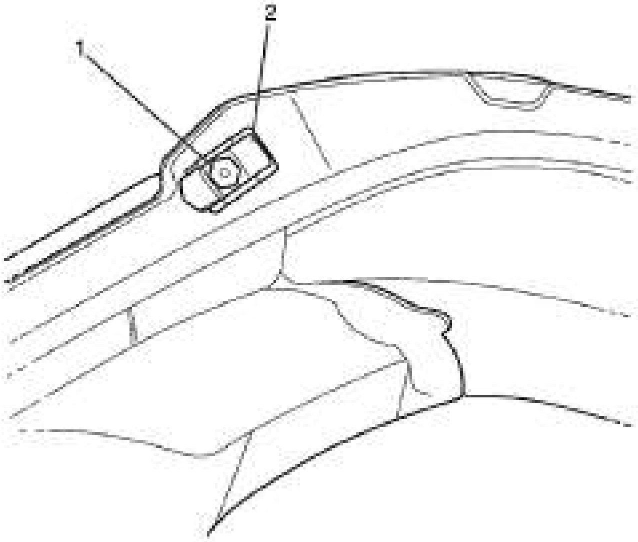
Liftgate Wedge Replacement

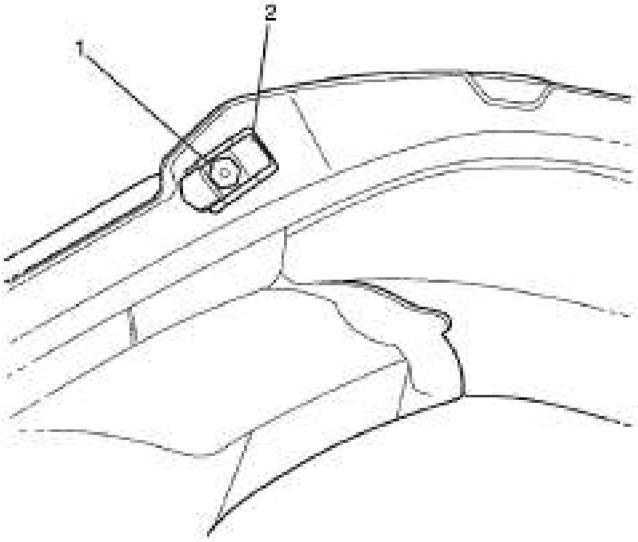
Removal Procedure

1. Open the liftgate.



2. Remove the liftgate wedge to liftgate torx retaining bolt (1).
3. Remove the liftgate wedge (2) from the vehicle.

Installation Procedure



1. Position the liftgate wedge (2) to the vehicle.
2. Close the liftgate.
3. Open the liftgate.

   Notice: Refer to Fastener Notice in the Preface section.

4. Install the liftgate wedge to liftgate torx retaining bolt (1).

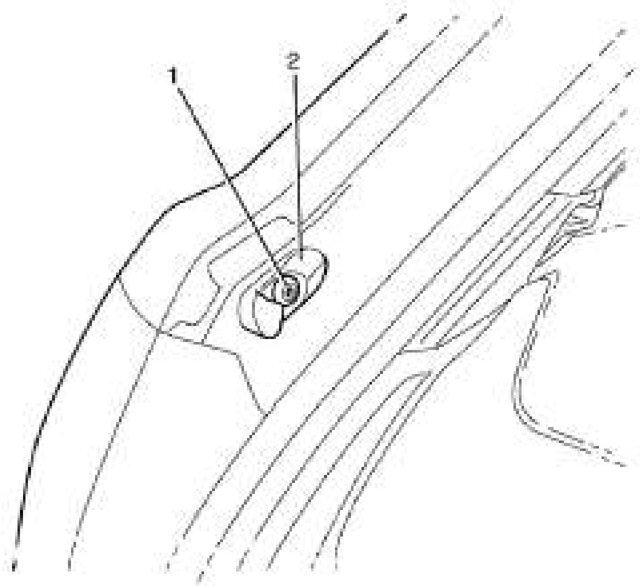
   Tighten
   Tighten the bolt to 10 N·m (89 lb in).

5. Close the liftgate.

Liftgate Wedge Replacement - Body Side

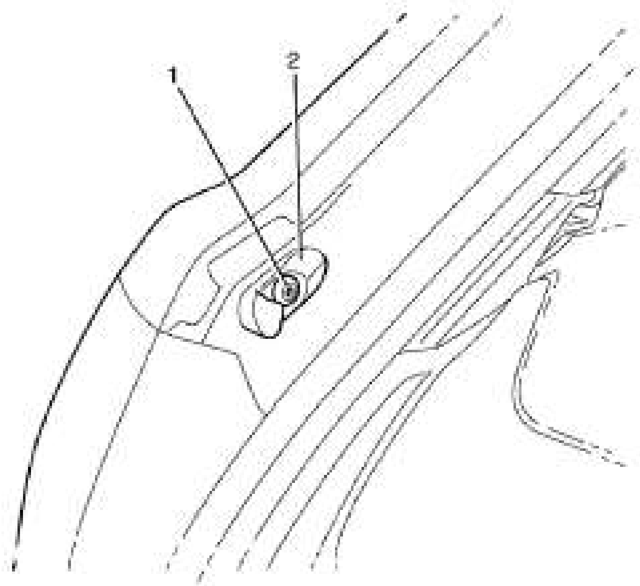
Removal Procedure

1. Open the liftgate



2. Remove the liftgate wedge to body torx retaining bolt (1).
3. Remove the liftgate wedge (2) from the vehicle.

Installation Procedure



1. Position the liftgate wedge (2) to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the liftgate wedge to body torx retaining bolt (1).

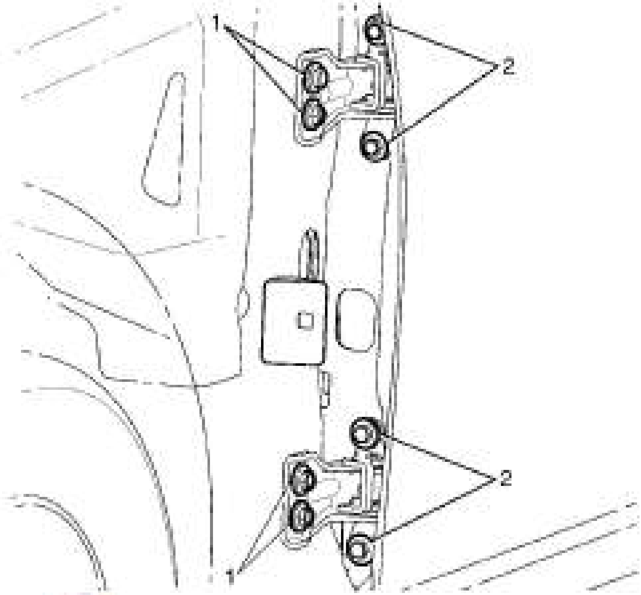
   Tighten
   Tighten the bolt to 10 N·m (89 lb in).

3. Close the liftgate.

Front Side Door Upper Hinge and Lower Hinge Replacement

Removal Procedure

1. Remove the front fender. Refer to Front Fender Replacement .
2. Mark the door hinge to pillar and door hinge to door location for installation alignment purposes.

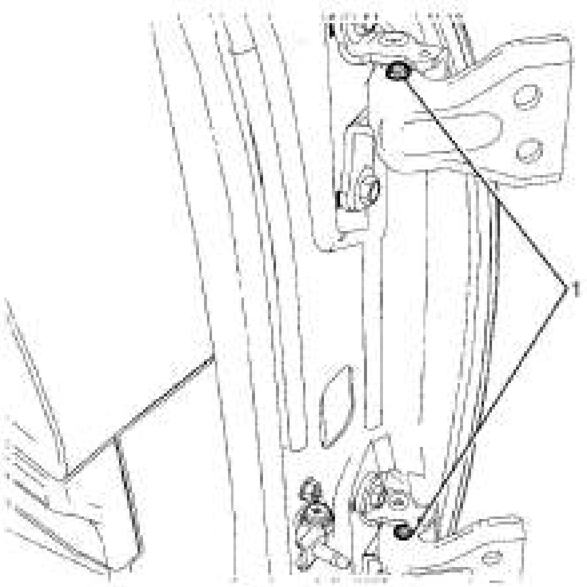


Important: Replace one hinge at a time then repeat procedure for the second hinge if needed.

Important: Remove the door hinge with the door fully latched on the striker.

3. Remove the door hinge to door retaining bolts (2).
4. Remove the door hinge to pillar retaining bolts (1) and remove the door hinges one at a time.

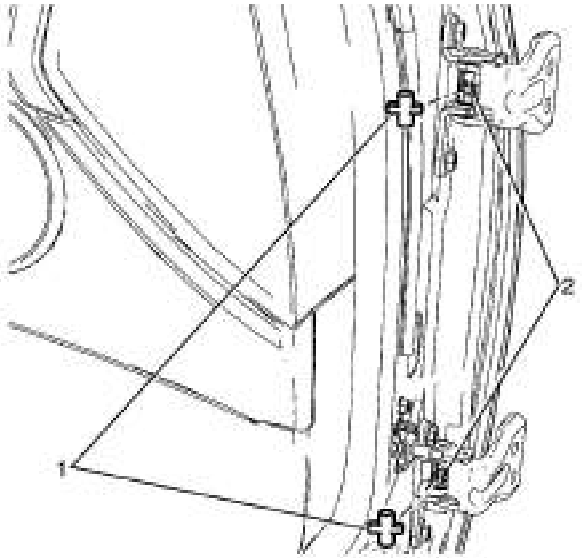
Installation Procedure



Important: Paint pins (1) are installed in NEW door hinges and must be removed when fitted.

Important: Use a suitable tool to pry the paint pins (1) from the NEW door hinges.

1. Remove the paint pins (1) from the NEW door hinges.

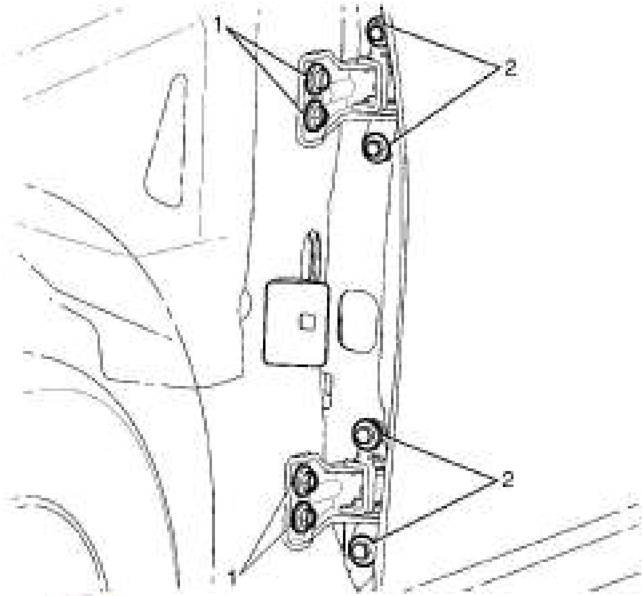


Important: The shipping clips (1) are only to hold the NEW door hinges (2) together in transit and must be removed when fitted.

Important: Use a suitable tool to remove the shipping clips (1) from the NEW door hinges (2).

2. Remove the shipping clips (1) from the NEW door hinges (2).
3. Align the door hinge to pillar and door hinge to door marks made prior to removal.

Notice: Refer to Fastener Notice in the Preface section.



4. Install the door hinge to pillar retaining bolts (1).

   Tighten
   Tighten the bolts to 28 N-m (21 lb ft).

5. Install the door hinge to door retaining bolts (2).

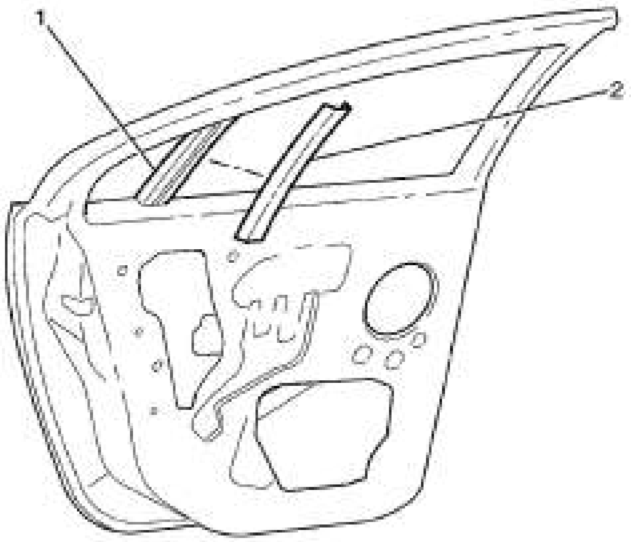
   Tighten
   Tighten the bolts to 28 N-m (21 lb ft).

6. Install the front fender. Refer to Front Fender Replacement .
7. Adjust the door. Refer to Door Adjustment .

Rear Side Door Window Frame Rear Applique Replacement

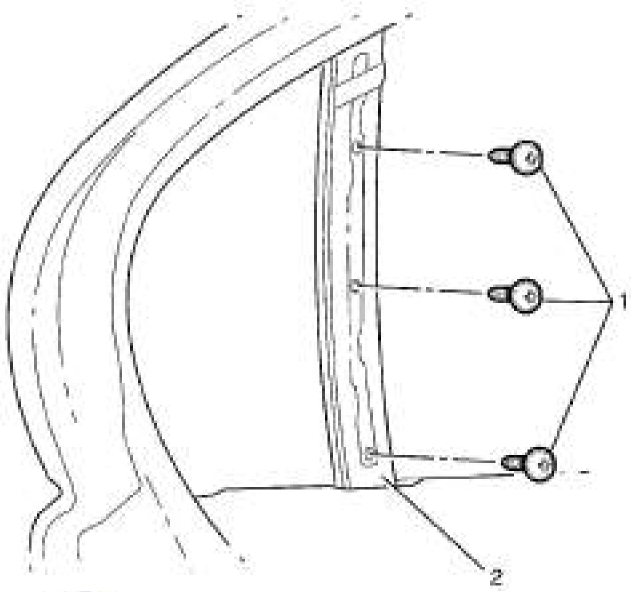
Removal Procedure

1. Lower the window to the full down position.
2. Remove the door trim panel. Refer to Rear Side Door Trim Panel Replacement.
3. Remove the window inner belt sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement.
4. Remove the window outer belt sealing strip. Refer to Rear Side Door Window Outer Sealing Strip Replacement.
5. Remove the window inner weatherstrip. Refer to Rear Side Door Window Inner Weatherstrip Replacement.
6. Remove the rear section of the window inner sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement.

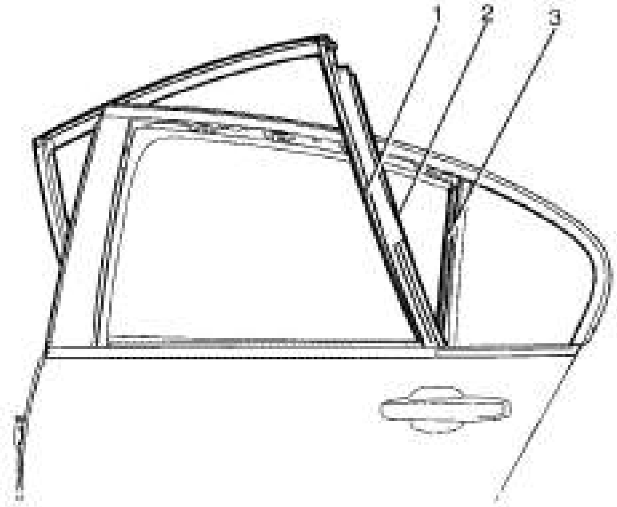


Important: Pull the rear window division channel trim to release retaining clips.

7. Remove the rear window division channel trim panel (1) from the door (2).



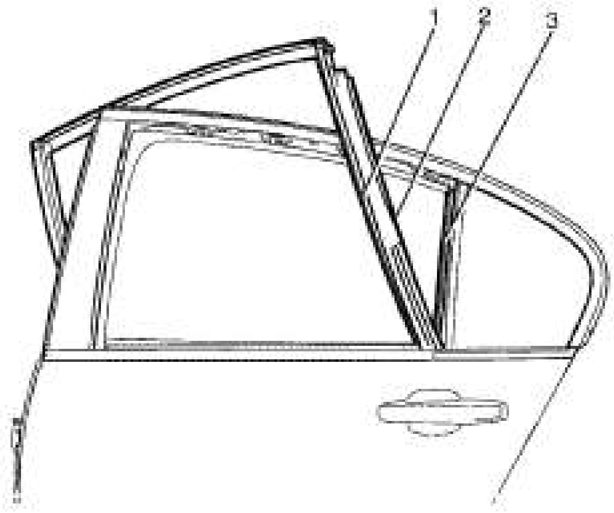
8. Remove the rear window division channel to door retaining screws (1).



Important: Remove the window/division channel (2) and inner sealing strip (1) as an assembly.

9. Remove the window/division channel (2) and inner sealing strip (1) from the door (3).

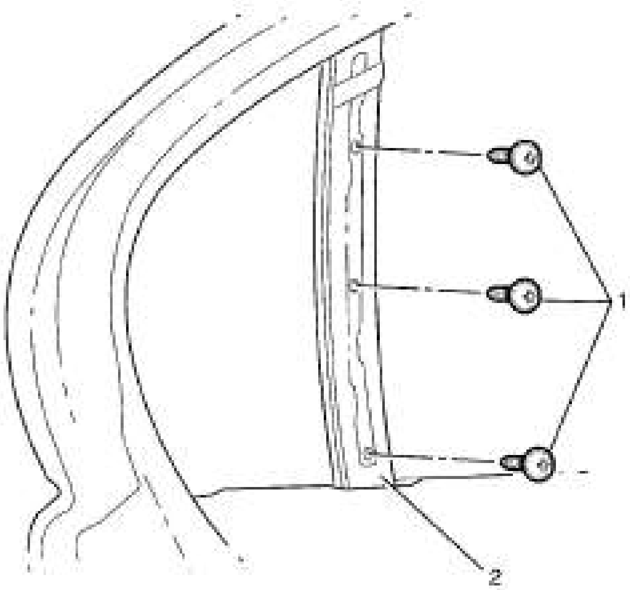
Installation Procedure



Important: Install the window/division channel (2) and inner sealing strip (1) as an assembly.

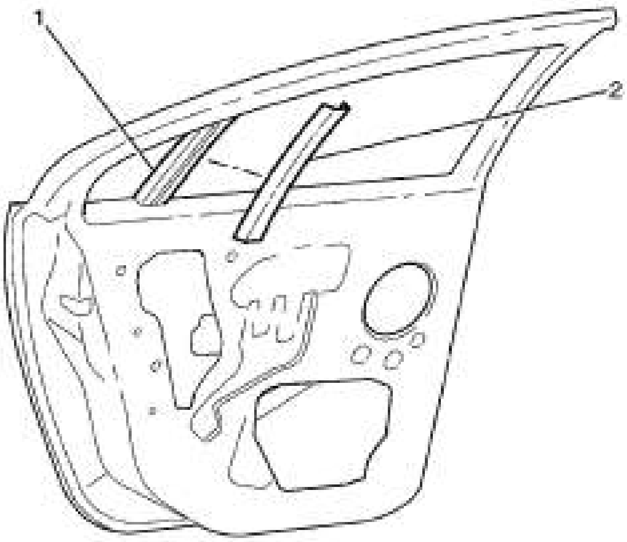
1. Install the window/division channel (2) and inner sealing strip (1) to the door (3).

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the rear window division channel to door retaining screws (1).

   Tighten
   Tighten the screws to 3 N-m (27 lb in).



Important: Push the rear window division channel trim panel (1) to attach the retaining clips.

3. Install the rear window division channel trim panel (1) to the door (2).
4. Install the rear section of the window inner sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement.
5. Install the window inner weatherstrip. Refer to Rear Side Door Window Inner Weatherstrip Replacement.
6. Install the window outer belt sealing strip. Refer to Rear Side Door Window Outer Sealing Strip Replacement.
7. Install the window inner belt sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement.
8. Install the rear door trim panel. Refer to Rear Side Door Trim Panel Replacement.

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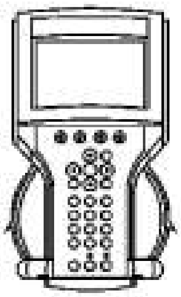
Special Tools

Illustration	Tool Number / Description
	70000861 Scan Tool Used for diagnosis of vehicle electrical system.

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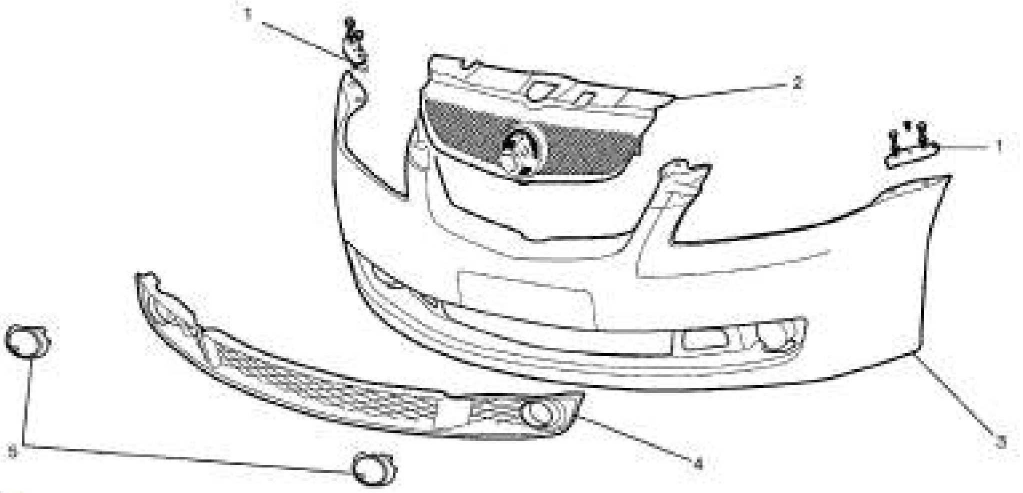
Fastener Tightening Specifications

Application	Specification	
	Metric	English
Front Air Deflector to Front Fascia Retaining Screws	3 N·m	27 lb in
Front Bumper Fascia to Fender Retaining Bolts	10 N·m	89 lb in
Front Bumper Impact Bar to Chassis Retaining Bolts	22 N·m	16 lb ft
Front Bumper Impact Bar to Front End Module Retaining Bolts	4 N·m	35 lb in
Front Energy Absorber to Front End Module Retaining Bolts	4 N·m	35 lb in
Front Fascia Bracket Retaining Bolts	4 N·m	35 lb in
Radiator Grille to Front End Module Retaining Bolts	4 N·m	35 lb in
Rear Bumper Bracket to Rear Compartment Floor Retaining Bolts (Sportwagon)	58 N·m	43 lb ft
Rear Bumper Fascia Reflector Retaining Screw (Sportwagon)	2 N·m	18 lb in
Rear Bumper Fascia to Rear End Panel Retaining Screws	2 N·m	18 lb in
Rear Bumper Fascia to Rear Quarter Panel Retaining Screws (Sportwagon)	2 N·m	18 lb in
Rear Bumper Impact Bar to Rear Bumper Impact Bar Bracket Retaining Nuts (Sportwagon)	22 N·m	16 lb ft
Rear Fascia Extension Retaining Screws	2 N·m	18 lb in
Rear Fascia to Rear Fascia Reflector Retaining Screw	2 N·m	18 lb in
Rear Impact Bar Retaining Nuts	22 N·m	16 lb ft
Rear Mud Flap to Rear Bumper Fascia Retaining Screws (Sportwagon)	4 N·m	35 lb in
Front Bumper Fascia Grille Retaining Screws (LWBHSV)	2 N·m	18 lb in
Front Bumper Fascia to Front Air Deflector Retaining Screws (LWBHSV)	2 N·m	18 lb in
Rear Bumper Fascia to Rear Quarter Panel Retaining Screws (LWBHSV)	2 N·m	18 lb in
Outer Rear Bumper Extension to Rear Bumper Fascia Retaining Screws (LWBHSV)	2 N·m	18 lb in
Front Bumper Fascia to Fender Retaining Bolts (CSV/SWBHSV/VXR8/W427)	12 N·m	106 lb in
Front Bumper Fascia Upper Retaining Screws (CSV/SWBHSV/VXR8/W427)	3 N·m	27 lb in
Front Bumper Facia Grille Emblem Boss Retaining Screws (CSV/SWBHSV/VXR8)	2 N·m	18 lb in
Front Bumper Fascia Upper Grille Retaining Screws (CSV/SWBHSV/VXR8/W427)	4 N·m	35 lb in
Front Bumper Fascia Lower Grille Retaining Screws (CSV/SWBHSV/VXR8/W427)	4 N·m	35 lb in
Front Bumper Facia Lower Grille Mesh Retaining Screws (CSV/SWBHSV/VXR8)	2 N·m	18 lb in
Front Bumper Fascia Upper Grille Mesh Retaining Screws (CSV/SWBHSV/VXR8)	2 N·m	18 lb in
Front Bumper Fascia Upper Grille Mesh Alignment Bracket Retaining	2 N·m	18 lb in

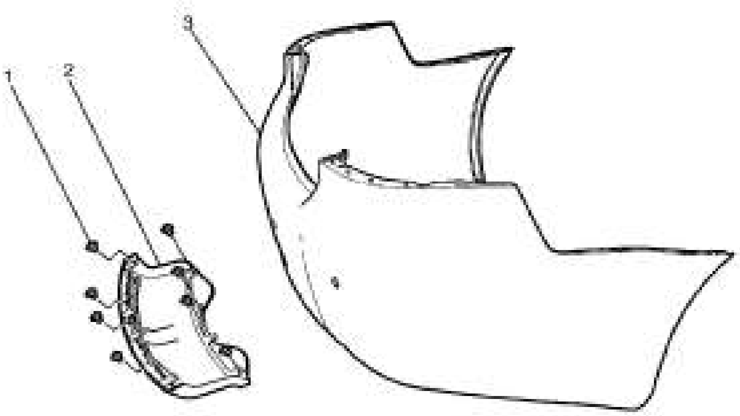
Screws (CSV/SWBHSV/VXR8)		
Rear Bumper Fascia Panel Retaining Screws (CSV/SWBHSV/VXR8/W427)	2 N·m	18 lb in
Rear Quarter End Cap Retaining Nuts (CSV/SWBHSV/VXR8/W427)	3 N·m	27 lb in

Front Fascia



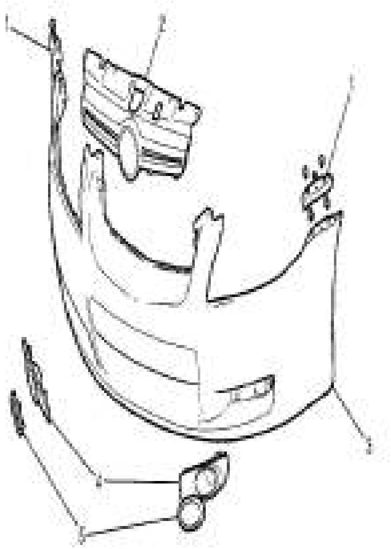
(1) Front Bumper Fascia Reinforcement
(2) Radiator Grille
(3) Front Bumper Fascia
(4) Front Bumper Fascia Lower Grille
(5) Front Fog Lamp Cover

Rear Fascia



(1) Rear Bumper Fascia Moulding Retaining Scrivet
(2) Rear Bumper Fascia Moulding
(3) Rear Bumper Fascia

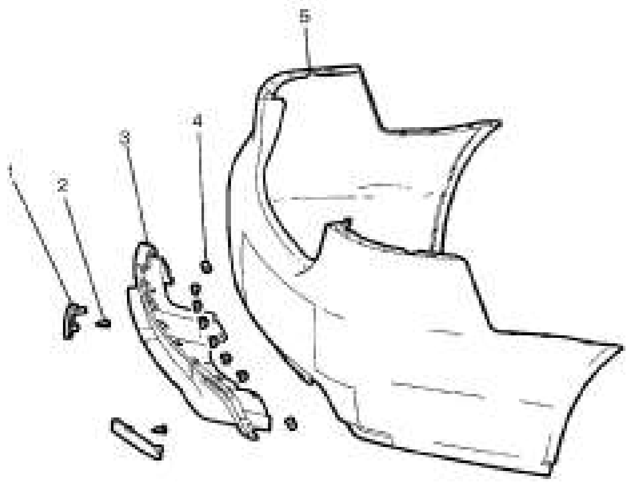
Front Fascia



(1) Front Bumper Fascia Reinforcement
(2) Radiator Grille
(3) Front Bumper Fascia
(4) Front Fog Lamp Cover (If Fitted)
(5) Front Fog Lamp Bezel (If Fitted)

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Repair | Bumpers and Fascias | Component Locator | **Document ID: 1973387**

Rear Fascia



(1) Rear Bumper Fascia Reflector
(2) Rear Bumper Fascia Reflector Retaining Screw
(3) Rear Bumper Fascia Moulding
(4) Rear Bumper Fascia Moulding Retaining Scrivet
(5) Rear Bumper Fascia

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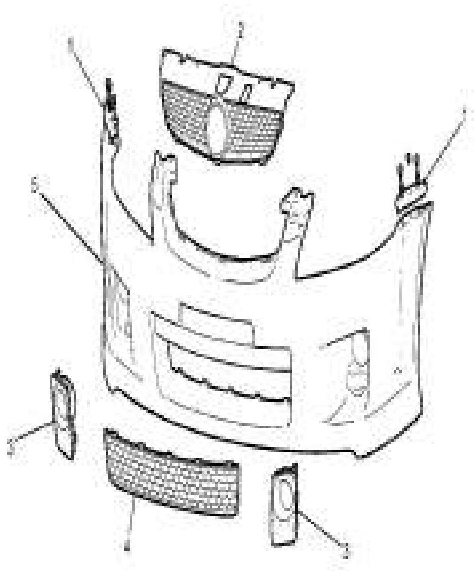
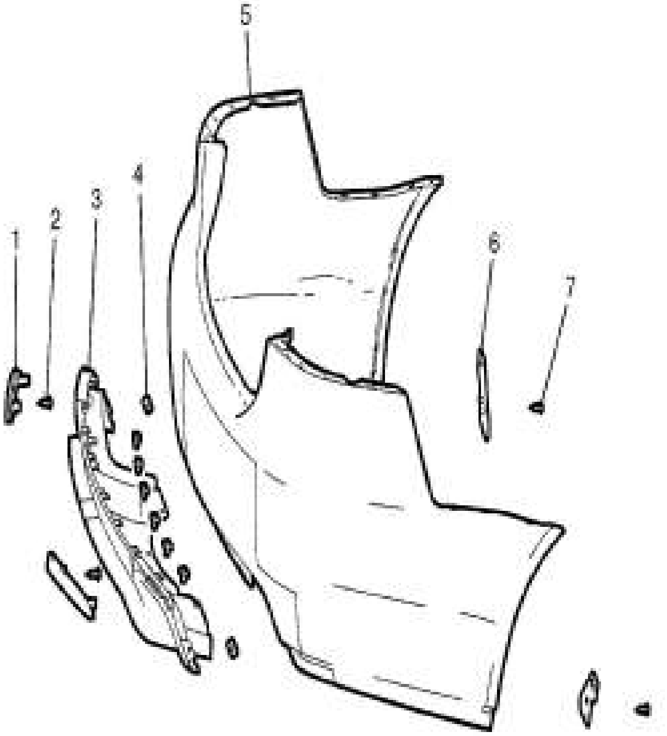
Front Fascia



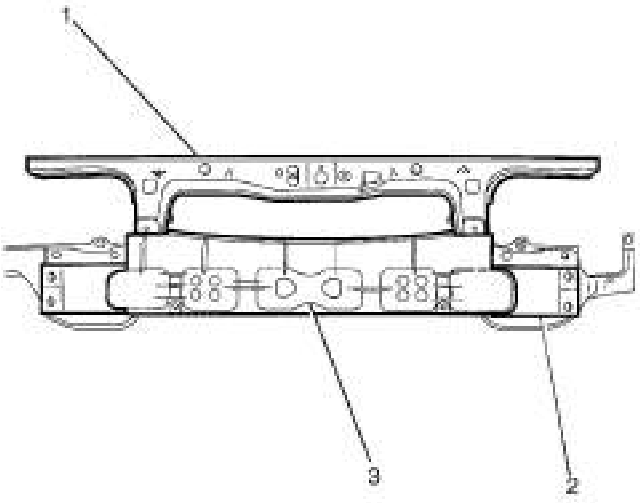
(1) Front Bumper Fascia Reinforcement
(2) Radiator Grille
(3) Front Fog Lamp Cover
(4) Front Bumper Fascia Lower Grille
(5) Front Bumper Fascia

Rear Fascia



(1) Rear Bumper Fascia Reflector
(2) Rear Bumper Fascia Reflector Retaining Screw
(3) Rear Bumper Fascia Moulding
(4) Rear Bumper Fascia Moulding Retaining Scrivet
(5) Rear Bumper Fascia
(6) Rear Bumper Fascia Extension
(7) Rear Bumper Fascia Extension Retaining Screw

Energy Absorber Damage



Important: Take note of the following statements:

- Do not try to repair a damaged energy absorber.
- Replace the energy absorber if damaged.
- Do not apply heat to the energy absorber.
- Do not weld the energy absorber.

Important: Inspect the following components for signs of visible distortion:

- Inspect the bumper impact bar (2).
- Inspect the front end module (1).
- Inspect the energy absorber (3).
- Replace the energy absorber if damage is evident. Replace the energy absorber if a collision is so severe that the bumper impact bar does not return to its original position.

Front Bumper Fascia Energy Absorber Replacement

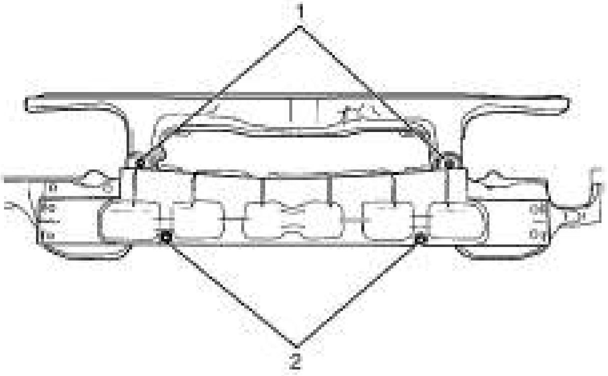
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

> **Important:** Failure to observe the following procedure when handling energy absorbers could cause personal injury.
>
> - Do not apply heat to an energy absorber.
> - Do not weld in the area of an energy absorber.
> - Do not attempt to repair a damaged energy absorber. Always replace the damaged energy absorber with a new part.

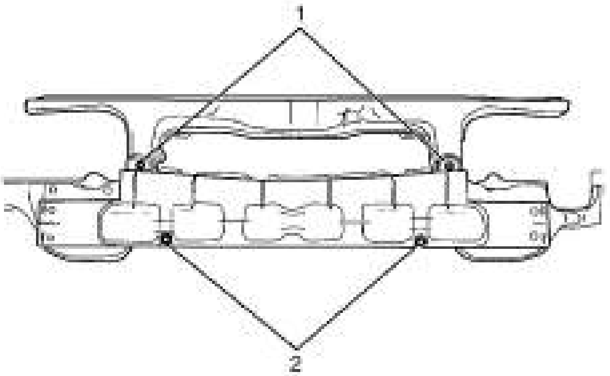
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement .



3. Remove the front energy absorber to front impact bar retaining scrivets (2).
4. Remove the front energy absorber to front end module retaining bolts (1).
5. Remove the front energy absorber from the front bumper impact bar by pulling outward.

Installation Procedure

1. Install the front energy absorber to the front bumper impact bar.



2. Install the front energy absorber to front bumper impact bar retaining scrivits (2).
3. Install the front energy absorber to front end module retaining bolts (1).

   Tighten
   Tighten the bolts to 4 N·m (35 lb in).

4. Install the front bumper fascia. Refer to Front Bumper Fascia Replacement .
5. Lower the vehicle.

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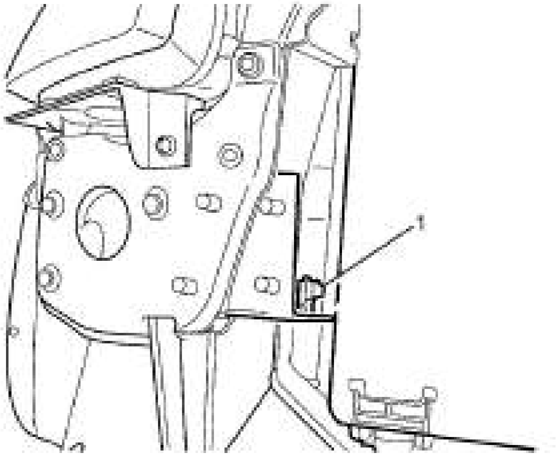
Front Bumper Impact Bar Replacement

Removal Procedure

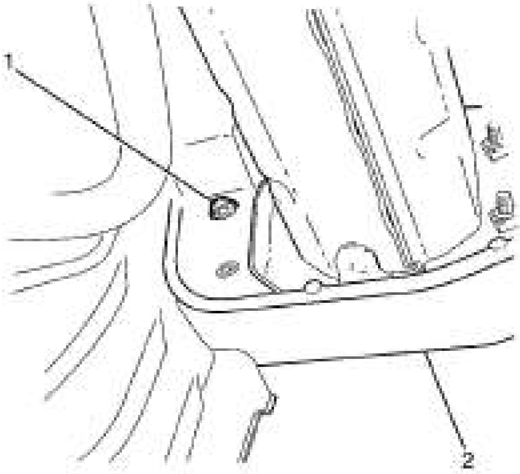
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

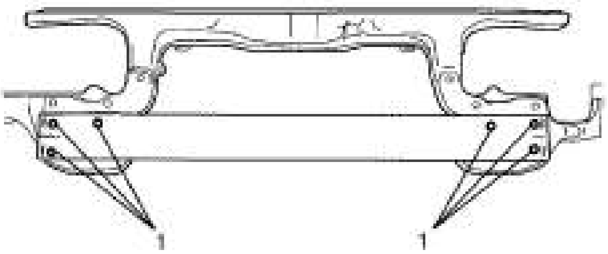
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the radiator air baffle and deflector. Refer to Front Air Deflector Replacement .
3. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement .
4. Remove the front energy absorber. Refer to Front Bumper Fascia Energy Absorber Replacement .
5. Remove the washer solvent container. Refer to Windshield Washer Solvent Container Replacement .



6. Remove the ambient temperature sensor (1) by squeezing locking tabs and pushing sensor.



7. Remove the front bumper impact bar to front end module retaining bolt (1). Repeat for opposite side.

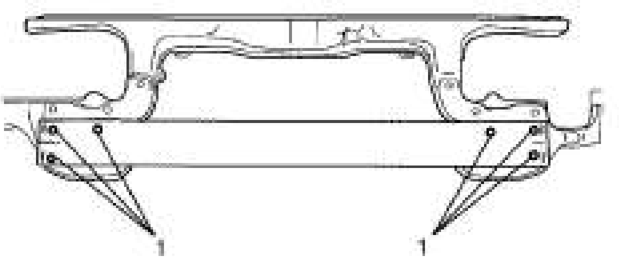


8. Remove the front bumper impact bar to front end module retaining bolts (1).
9. Remove the front bumper impact bar from the front end module.

Installation Procedure

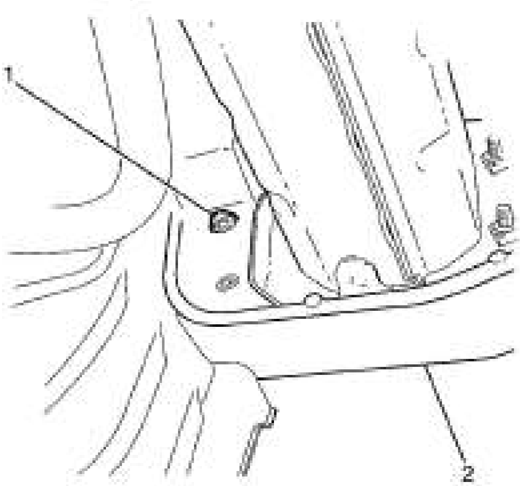
1. Install the front bumper impact bar to the front end module.

   Notice: Refer to Fastener Notice in the Preface section.



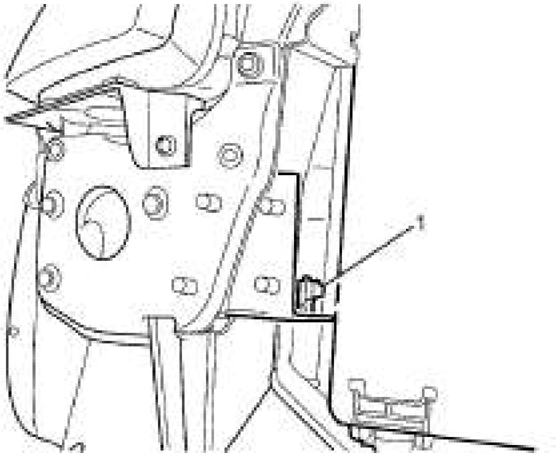
2. Install the front bumper impact bar to front end module retaining bolts (1).
   2.1. Install the inboard bolt on the right side first.
   2.2. Install the inboard bolt on the left side second.
   2.3. Install the remaining outboard bolts third.

Tighten
Tighten the bolts to 22 N·m (16 lb ft) in the above sequence.



3. Install the front bumper impact bar to front end module retaining bolt (1). Repeat for opposite side.

Tighten
Tighten the bolts to 4 N·m (35 lb in).



4. Install the ambient temperature sensor (1) by squeezing locking tabs and pushing sensor.
5. Remove the washer solvent container. Refer to Windshield Washer Solvent Container Filler Tube Replacement .
6. Install the front energy absorber. Refer to Front Bumper Fascia Energy Absorber Replacement .
7. Install the front bumper fascia. Refer to Front Bumper Fascia Replacement .
8. Install the radiator air baffle and deflector. Refer to Front Air Deflector Replacement .
9. Lower the vehicle.

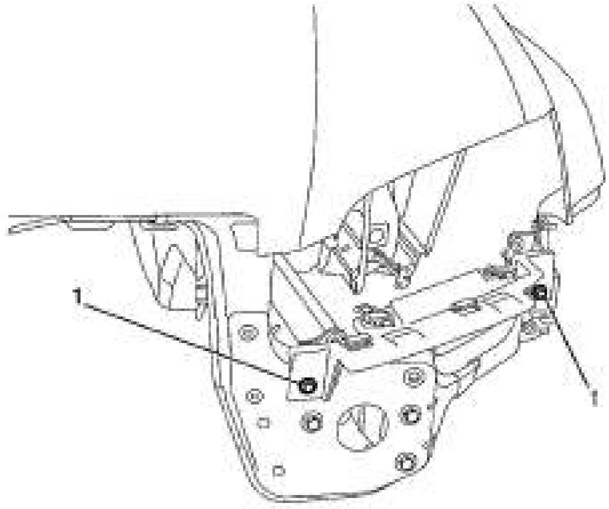
Front Bumper Impact Bar Bracket Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement .

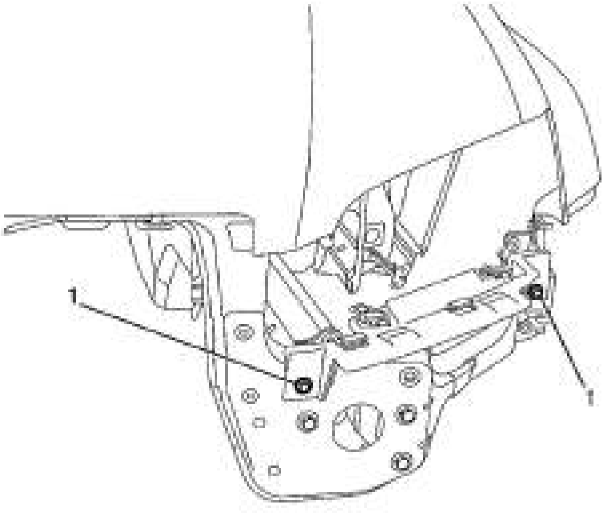


2. Remove the front bumper fascia support bracket to front end module retaining bolts (1).
3. Remove the horn wiring harness clip from the front bumper fascia support bracket.
4. Remove the front bumper fascia support bracket from the vehicle.

Installation Procedure

1. Install the front bumper fascia support bracket to the front end module.

Notice: Refer to Fastener Notice in the Preface section.



2. Install the front bumper fascia support bracket to front end module retaining bolts (1).

   Tighten
   Tighten the bolts to 4.5 N·m (39 lb in).

3. Install the horn wiring harness clip to front bumper fascia support bracket.
4. Install the front bumper fascia. Refer to Front Bumper Fascia Replacement .

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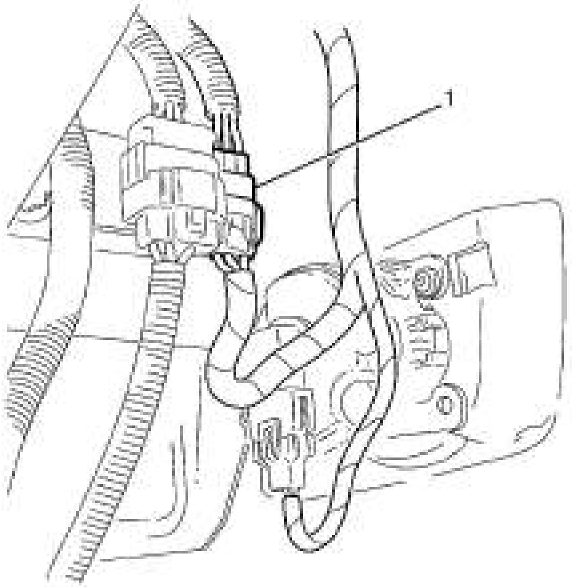
Front Bumper Fascia Replacement (SWB)

Removal Procedure

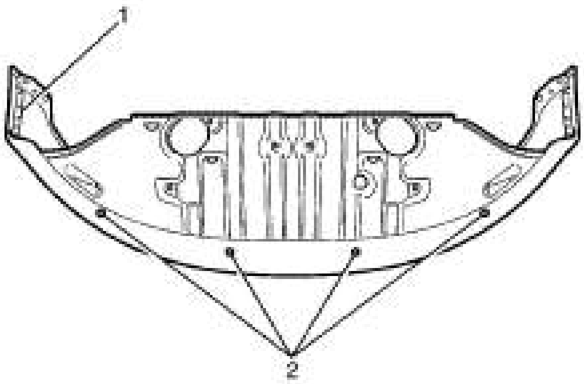
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

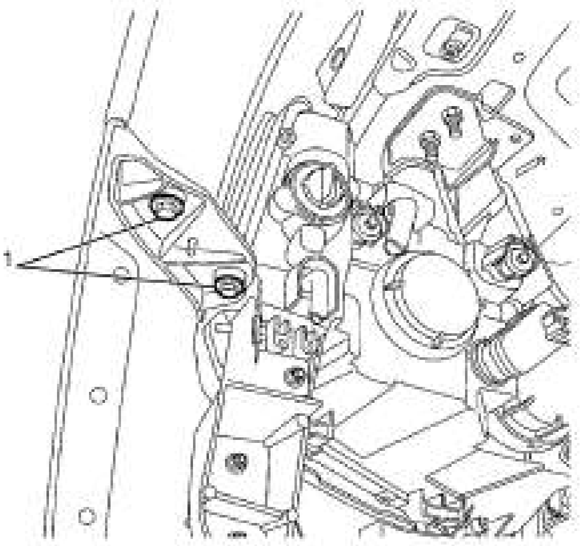
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement.



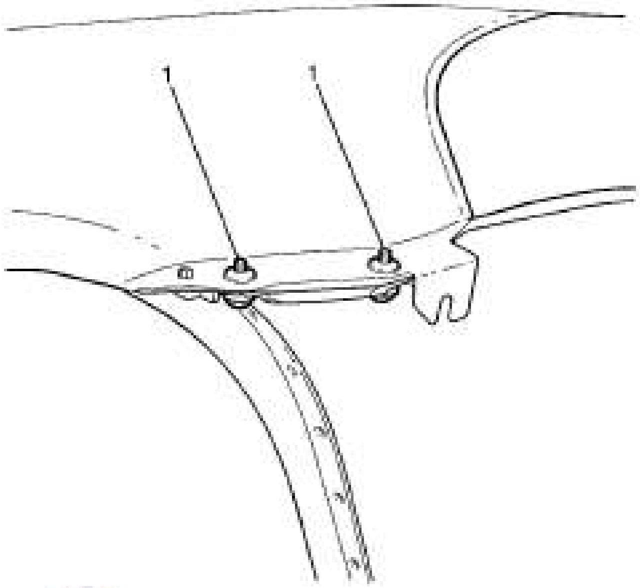
3. Disconnect the front end module to front bumper fascia wiring harness (1).



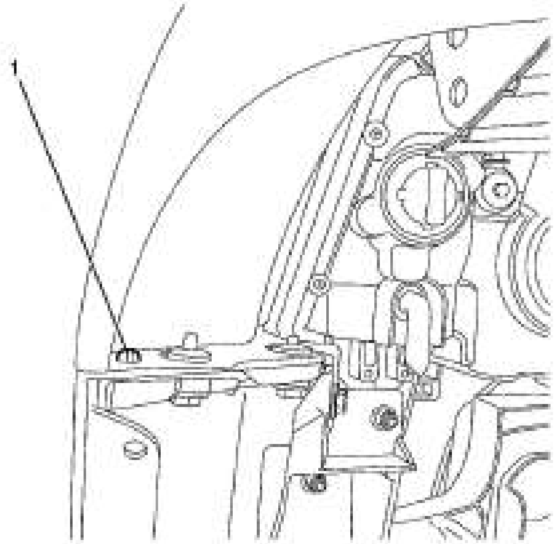
4. Remove the front bumper fascia (1) to front air deflector retaining screws (2).



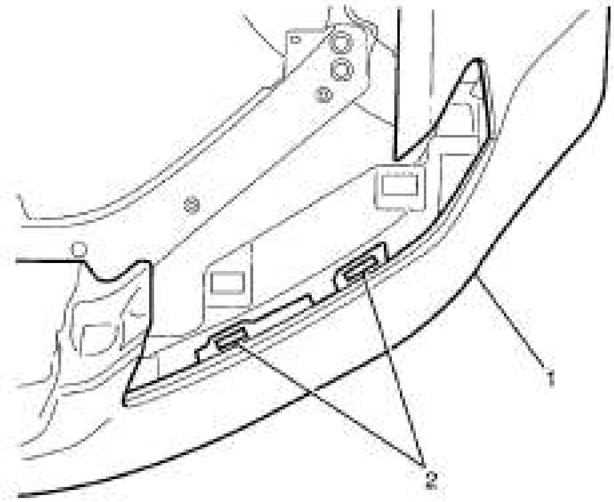
5. Loosen the front bumper fascia to fender retaining bolts (1) approximately 4 turns. Repeat for opposite side.
6. Push the front bumper fascia to fender retaining bolts (1) upwards to disengage from the fender.



7. Loosen the front bumper fascia from the key slots (1) at the fender attachments.
8. Lower the vehicle.
9. Remove the radiator grille. Refer to Radiator Grille Replacement.



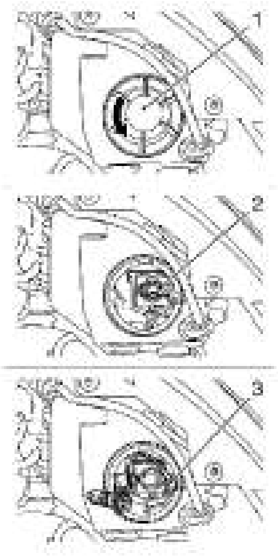
10. With the aid of an assistant, disengage the locating pin (1) from the fender. Repeat for opposite side.



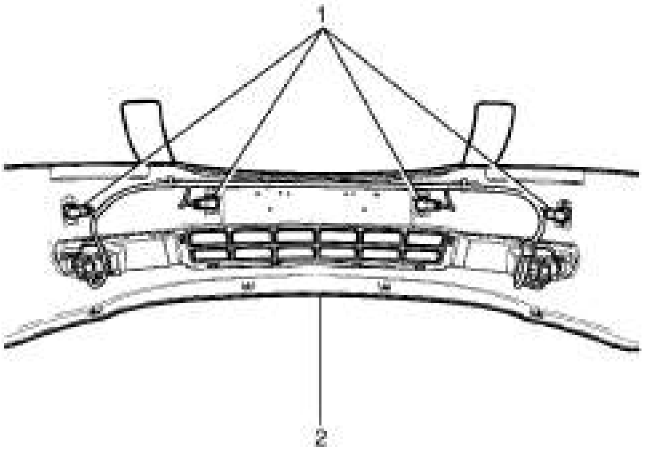
11. Disengage the front bumper fascia (1) from the front bumper fascia support bracket retaining tabs (2).
12. Remove the front bumper fascia from the vehicle.

Disassembly Procedure

1. Remove the front bumper fascia lower grille. Refer to Front Bumper Lower Fascia Grille Replacement.



2. Disconnect the front bumper fascia wiring loom retaining clips (1) to the front bumper fascia (2).
3. Disconnect the front fog lamp wiring connectors (3) to the front fog lamps.



4. Disconnect the front object alarm sensor wiring connectors (1) from the front bumper fascia (2).
5. Remove the front fog lamp covers. Refer to Front Fog Lamp Cover Replacement.
6. Remove the front fog lamps. Refer to Front Fog Lamp Replacement.

Assembly Procedure

Important: Prior to drilling the bumper fascia it is essential that the object detection bracket templates are aligned to their correct corresponding location within the bumper fascia. The location of the object detection bracket templates to the bumper fascia is alpha numeric, make sure that the letters correspond between the object detection bracket templates and the bumper fascia.

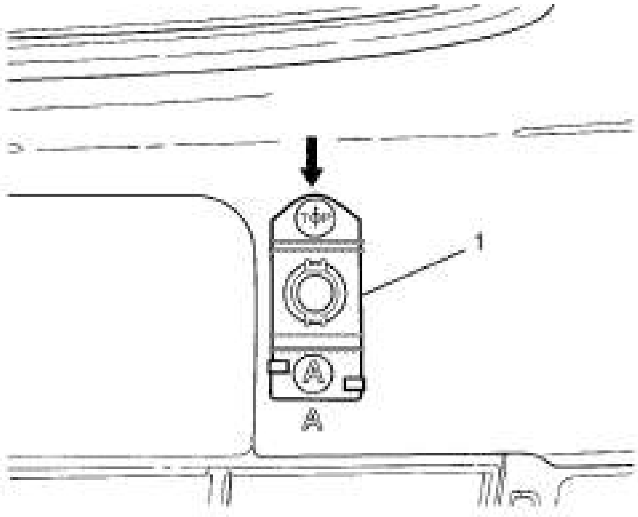
Important: Each object detection bracket template has a tolerance of 0.5 mm and must be taken into consideration.

1. Check each object detection bracket template.
2. It is essential that the object detection bracket templates are aligned to their correct corresponding location within the bumper fascia.

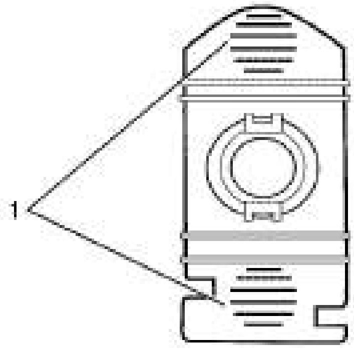
Important: The Object Detection Bracket Template, normally found in the service manual has been removed. A review of its accuracy due to the new delivery system, and different printing methods available from the web site is currently in progress. Please reference the Holden Service Information disc, Version 4.01 for a current template.

Important: This graphic is used as an example only and must not be used as a template, it displays one of the varying object detection bracket templates for reference.

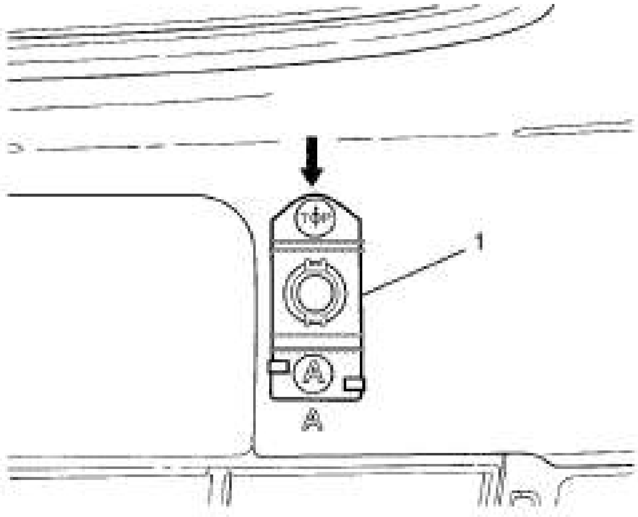
Important: When aligning the object detection bracket template make sure that the locating tags align correctly and there is little or no movement, prior to drilling.



1. Install the object detection bracket templates (1) to the front bumper fascia.
2. Mark out the sensor hole from the object detection bracket templates (1) to the front bumper fascia.
3. Remove the object detection bracket templates (1) from the front bumper fascia.
4. Drill the holes in the front bumper fascia 24.5 mm (0.96 in).
5. Remove any swarf from the front bumper fascia.
6. Clean the front bumper fascia with a suitable wax and grease remover.
7. Remove the object detection bracket templates (1) from the front bumper fascia.



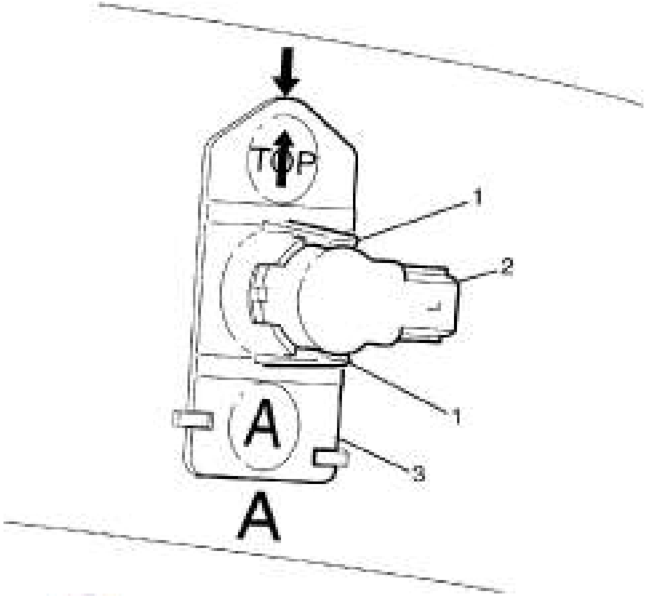
8. Apply the GM Specification 9982247 (Fusor 152-153) adhesive or equivalent to the ribs of the object detection bracket (1).



Important: This graphic is used as an example only and must not be used as a template, it displays one of the varying object detection bracket templates for reference.

Important: The location of the object detection brackets to the bumper fascia is alpha numeric, make sure that the letters correspond between the object detection brackets and the bumper fascia.

9. Install the object detection bracket (1) to the front bumper fascia.

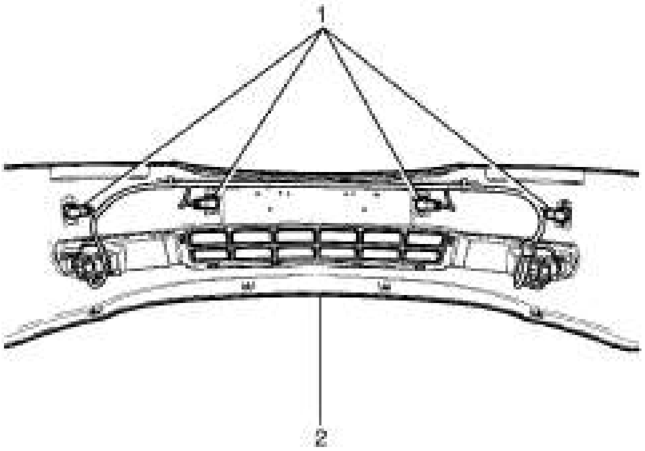


Important: Allow 20 minutes for the adhesive to cure to the front bumper fascia.

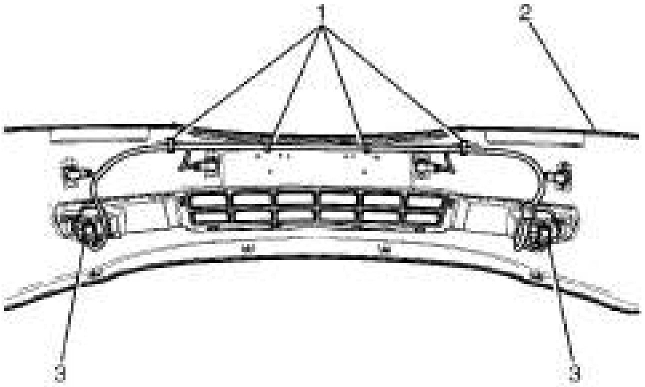
Important: Replacement front object alarm sensors (2) are not pre-painted, they will require painting before installation is carried out.

Important: Ensure that the front object alarm sensor (2) is installed correctly.

10. Locate the top and bottom housing tabs (1) to install the front object alarm sensor (2) to the front object alarm sensor housing (3).
11. Press the front object sensor bezel flush to the fascia.
12. Install the front fog lamps. Refer to Front Fog Lamp Replacement.
13. Install the front fog lamp covers. Refer to Front Fog Lamp Cover Replacement.



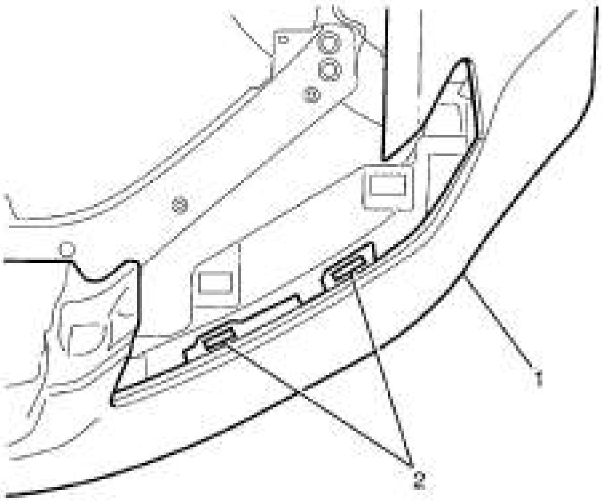
14. Connect the front object alarm sensor wiring connectors (1) to the front bumper fascia (2).



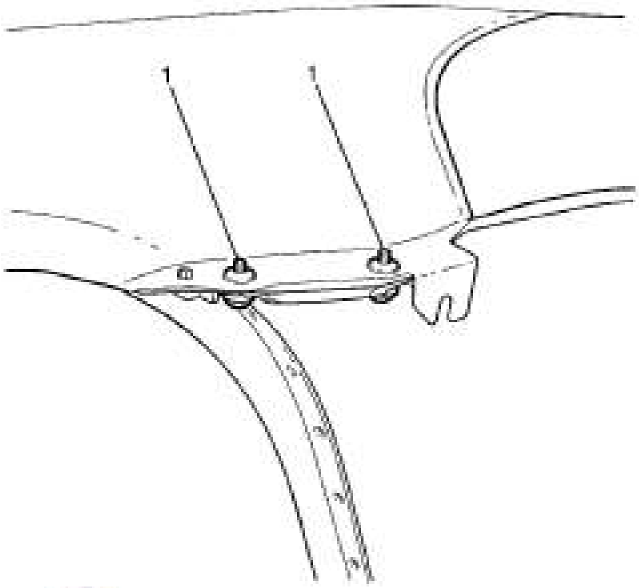
15. Connect the front bumper fascia wiring loom retaining clips (1) to the front bumper fascia (2).
16. Connect the front fog lamp wiring connectors (3) to the front fog lamps.
17. Install the front bumper fascia lower grille. Refer to Front Bumper Lower Fascia Grille Replacement.

Installation Procedure

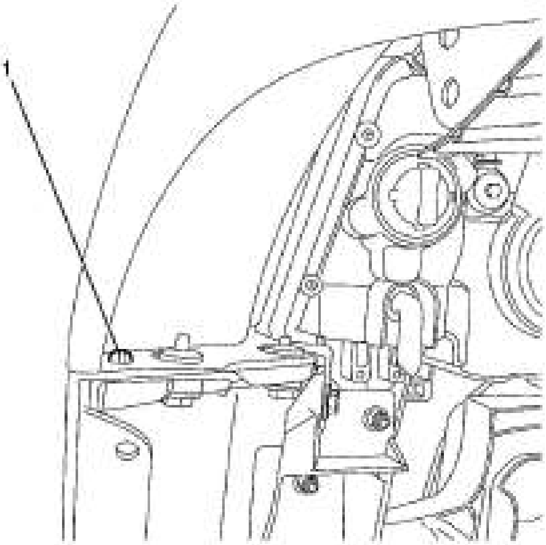
1. With the aid of an assistant, position the front bumper fascia to the vehicle.



2. Firmly press the front bumper fascia support bracket retaining tabs (2) to front bumper fascia (1).
3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

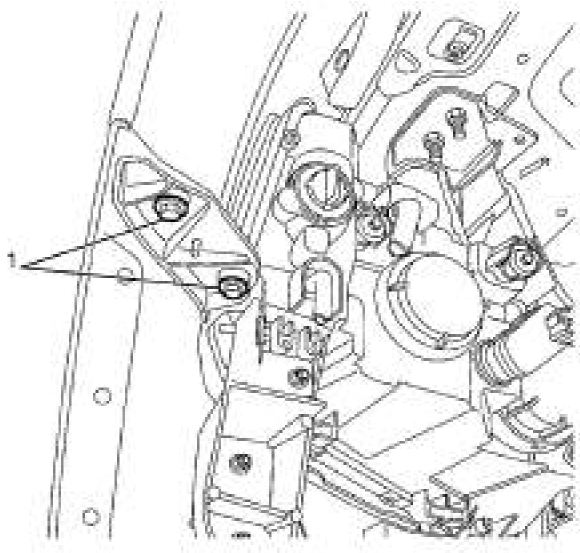


4. Position the front bumper fascia to the key slots (1) in the fender.



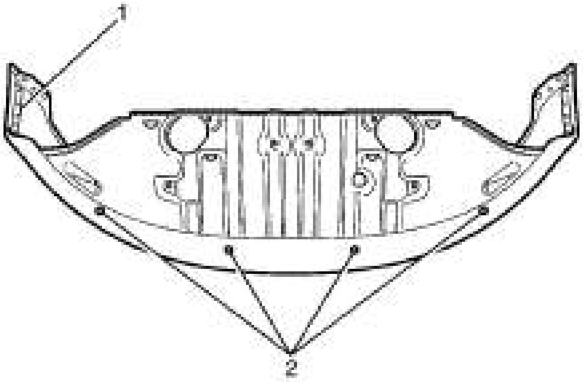
5. Align the locating pin (1) to the locating hole in the fender.
6. Push the front bumper fascia rearward in order to adjust.

Notice: Refer to Fastener Notice in the Preface section.



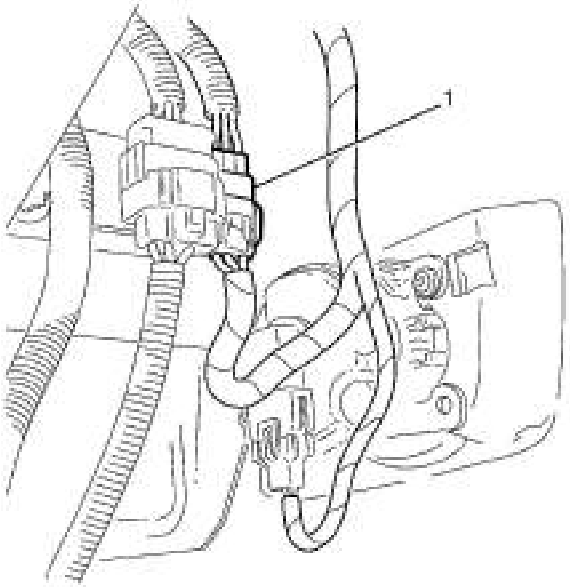
7. Tighten the front bumper fascia to fender retaining bolts (1).

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).



8. Install the front bumper fascia (1) to front air deflector retaining screws (2).

   Tighten
   Tighten the screws to 3 N·m (27 lb in).



9. Connect the front end module to front bumper fascia wiring harness (1).
10. Install the front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement.
11. Lower the vehicle.
12. Install the radiator grille. Refer to Radiator Grille Replacement.

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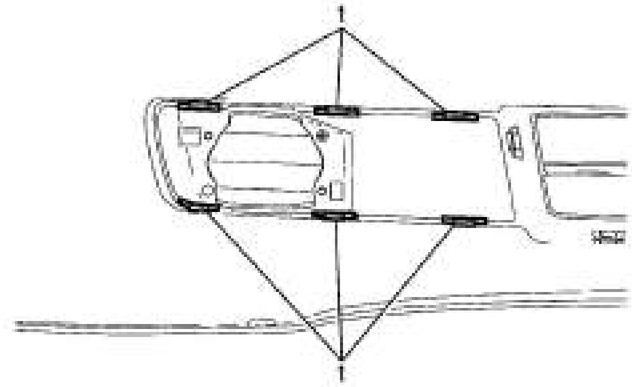
Front Bumper Fascia Insert Replacement (LWB SWB)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

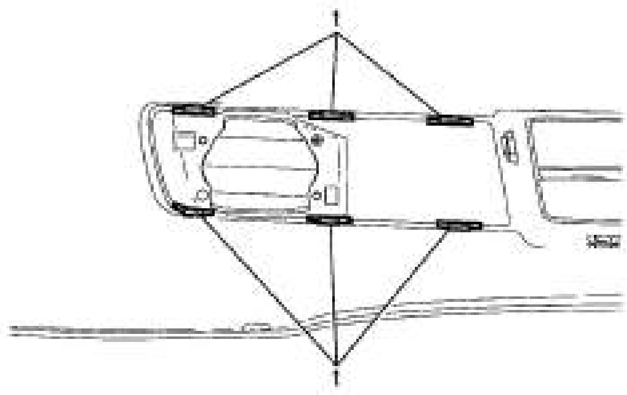
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the front air deflector. Refer to Front Air Deflector Replacement.



3. Carefully pry the front bumper fascia insert retaining tabs (1) from the front bumper fascia.
4. Remove the front bumper fascia insert from the front bumper fascia.

Installation Procedure



1. Install the front bumper fascia insert to the front bumper fascia.
2. Firmly press the front bumper fascia insert retaining tabs (1) into the front bumper fascia.
3. Install the front air deflector. Refer to Front Air Deflector Replacement.
4. Lower the vehicle.

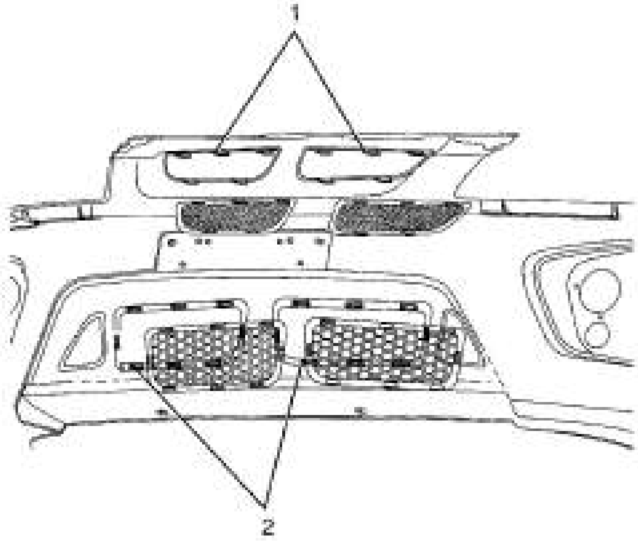
Front Bumper Fascia Insert Replacement (CSV SWBHSV VXR8)

Removal Procedure (Type C)

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

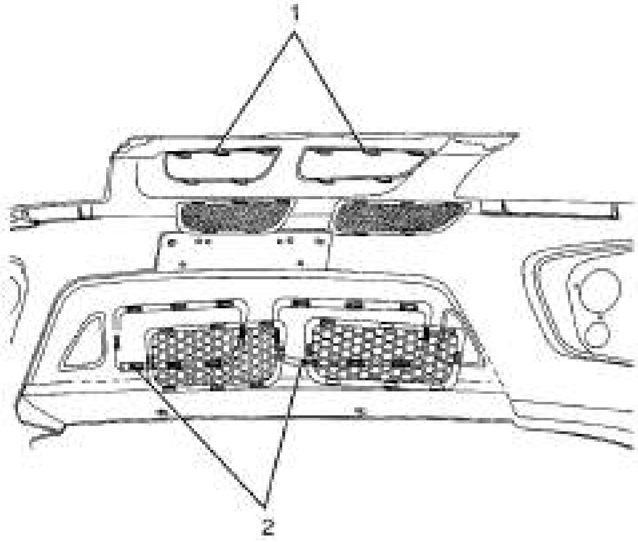
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement.



3. Carefully prise the upper grille from the front bumper fascia retaining tabs (1).
4. Carefully prise the lower grille from the front bumper fascia retaining tabs (2).
5. Remove the front bumper fascia upper and lower grilles from the front bumper fascia.

Installation Procedure (Type C)

1. Install the front bumper fascia upper and lower grilles to the front bumper fascia.



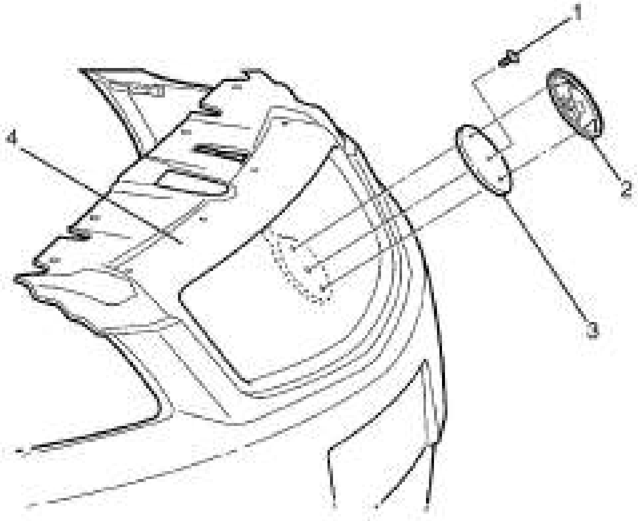
2. Firmly press the upper grille into the front bumper fascia retaining tabs (1).
3. Firmly press the lower grille into the front bumper fascia retaining tabs (2).
4. Install the front bumper fascia. Refer to Front Bumper Fascia Replacement.
5. Lower the vehicle.

Removal Procedure (Type D)

Caution: Refer to Safety Glasses Caution in the Preface section.

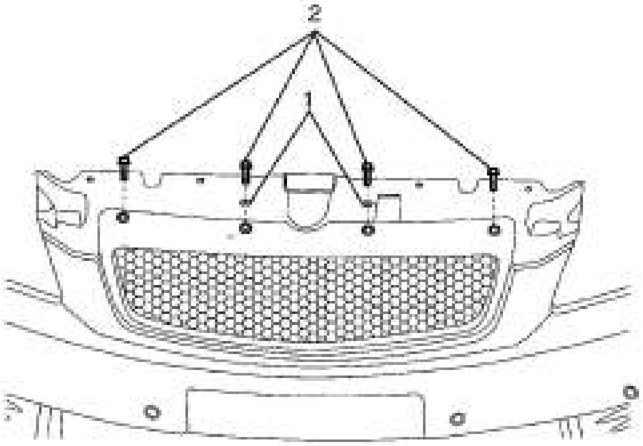
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement.

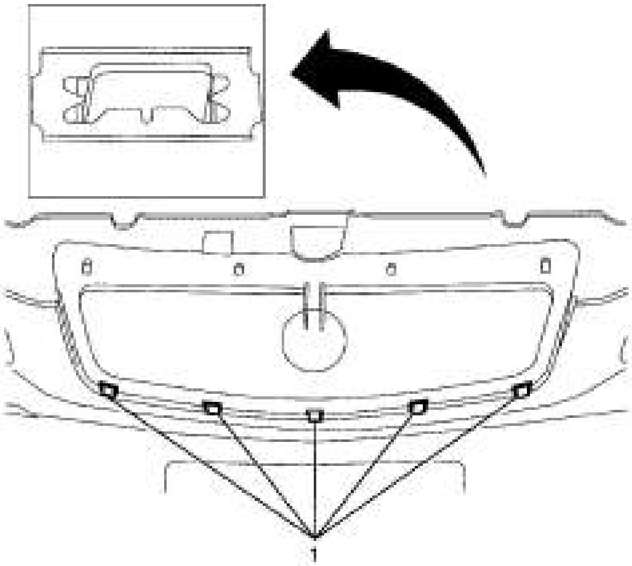


3. Remove the grille emblem (2) from the grill emblem boss (3) using a suitable tool.
4. Remove the grille emblem boss retaining screw (1) from the grille emblem boss (3).
5. Remove grille emblem boss (3) using a suitable tool.

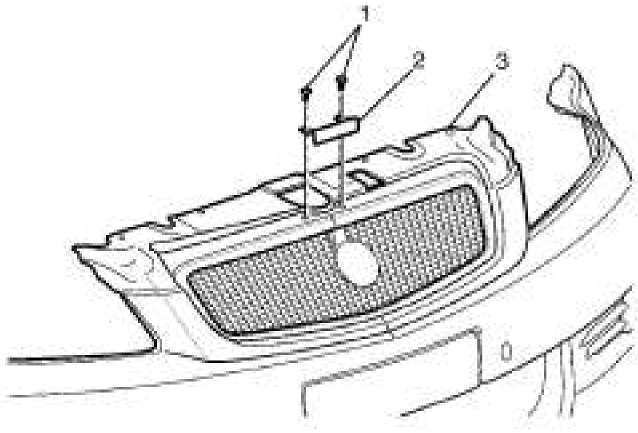
Important: Foam spacers are used in the two centre screw points. Upon removal of the front bumper fascia upper grille make sure they are retained.



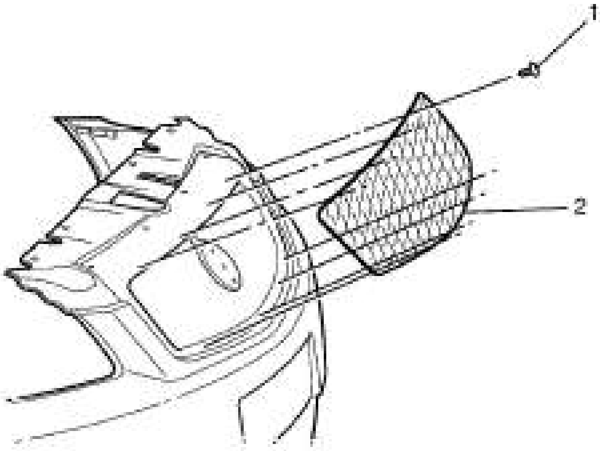
6. Remove the front bumper fascia upper grille retaining screws (1).



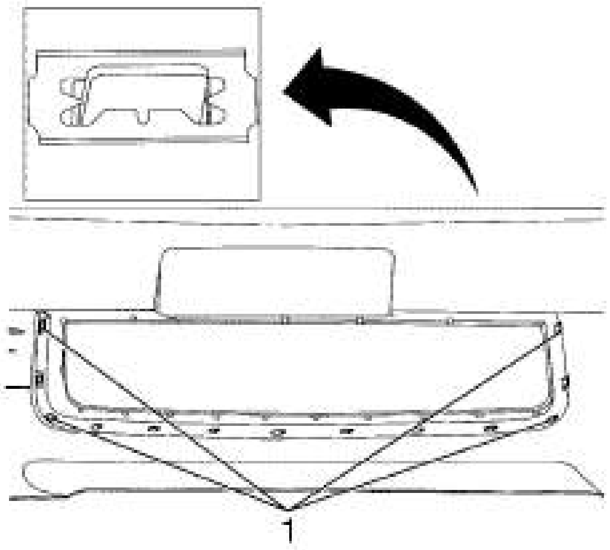
7. Carefully prise the five front bumper fascia upper grille retaining clips (1) from the front bumper fascia.
8. Remove the front bumper fascia upper grille.



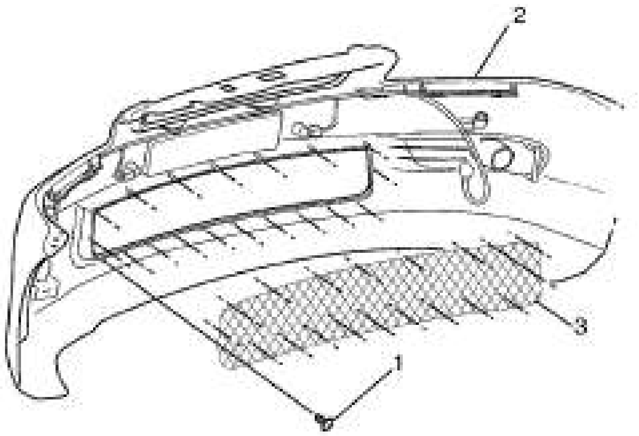
9. Remove the upper grille mesh alignment bracket retaining screws (1) and the upper grille mesh alignment bracket (2) from the fascia assembly (3).



10. Remove the eight upper grille mesh retaining screws (1) and the upper grille mesh (2).

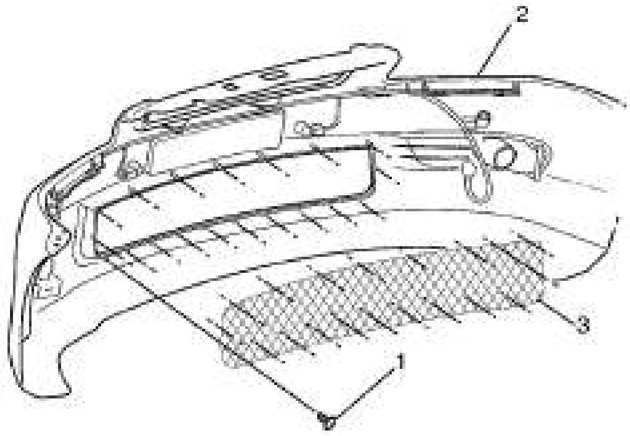


11. Carefully prise the thirteen front bumper fascia decor strip retaining clips (1) from the front bumper fascia.
12. Remove the decor strip.



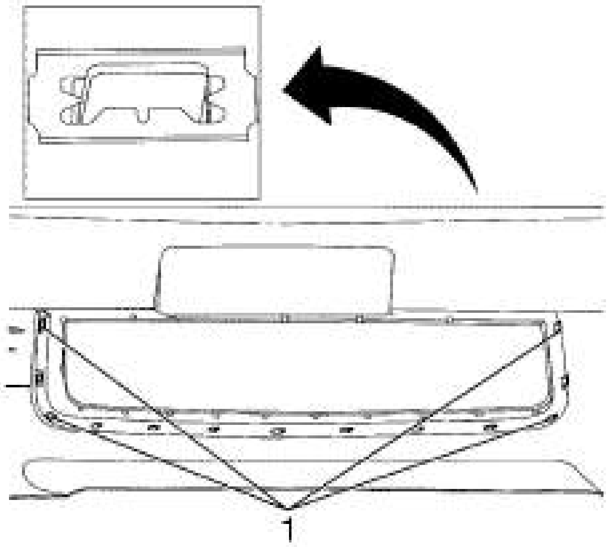
13. Remove the nineteen front bumper fascia lower grille mesh retaining screws (1) from the front bumper fascia (2).
14. Remove the lower grille mesh (3) from the front fascia assembly (2).
15. Replace components as required.

Installation Procedure (Type D)

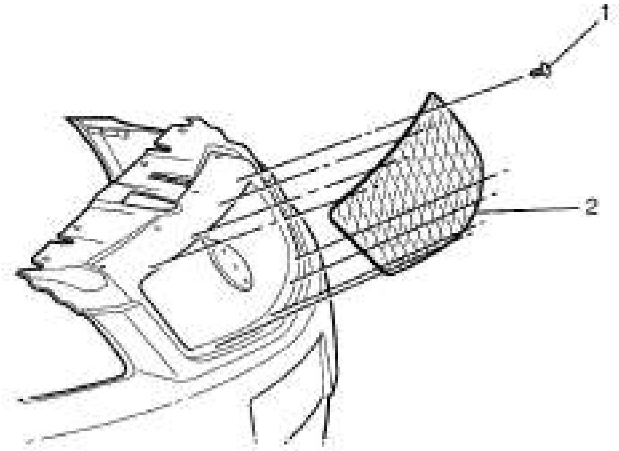


1. Install the lower grille mesh (3) to the front fascia assembly (2).
2. Install the nineteen lower grille mesh retaining screws (1) into the front bumper fascia (2).

   Tighten
   Tighten the screws to 2 Nm (18 lb. in).

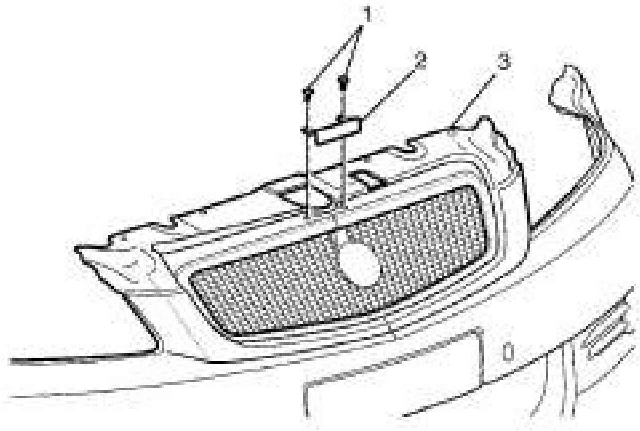


3. Install the decor strip into the front bumper fascia.
4. Carefully install the thirteen front bumper fascia decor strip retaining clips (1) onto the decor strip tangs.



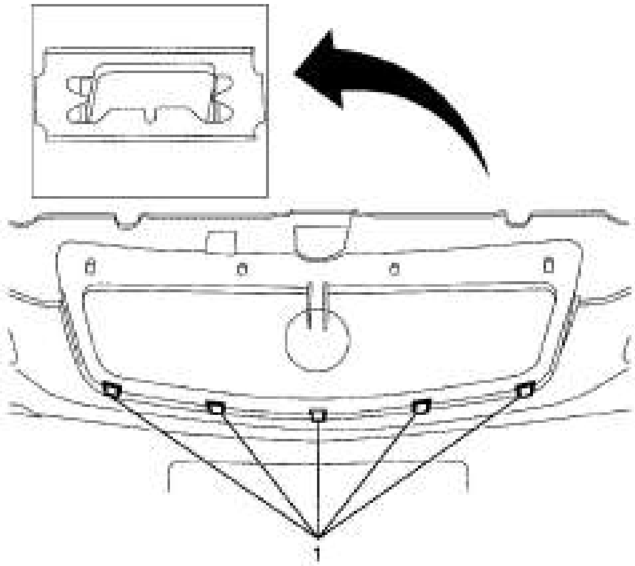
5. Install the eight upper grille mesh retaining screws (1) and upper grille mesh (2).

   Tighten
   Tighten the screws to 2 Nm (18 lb. in).



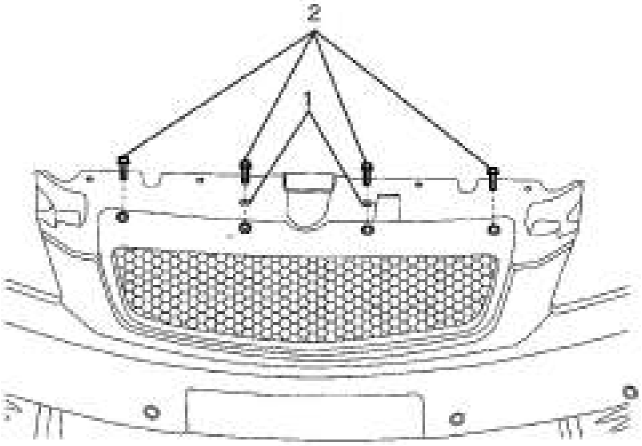
6. Install the upper grille mesh alignment bracket (2) and the upper grille mesh alignment bracket retaining screws (1) into the fascia assembly (3).

   Tighten
   Tighten the screws to 2 Nm (18 lb. in).



7. Install the front bumper fascia upper grille onto the front bumper fascia.
8. Carefully install the five front bumper fascia upper grille retaining clips (1) onto the retaining tangs.

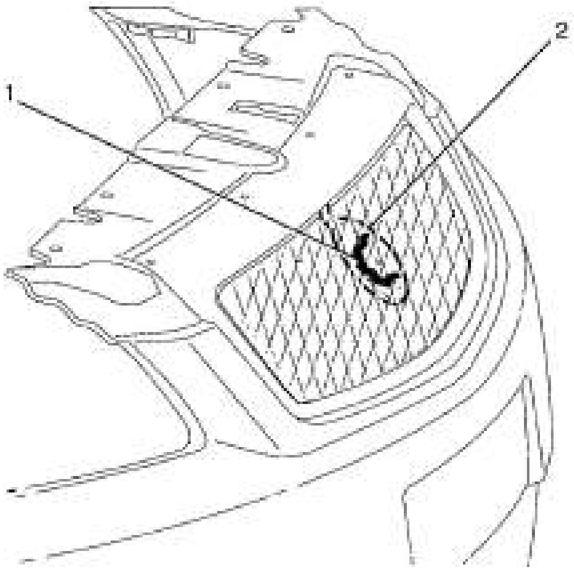
Important: Make sure spacers (1) are used between the upper grille mesh and the upper grille in the two centre screw points. The spacers will require the use of a suitable adhesive tape to hold the spacers (1) in position during the front bumper fascia upper grille retaining screw (2) installation.



9. Install spacers (1) on the inner two screw points. Retain the spacers in position with a suitable adhesive tape.
10. Install the front bumper fascia upper grille retaining screws (2).

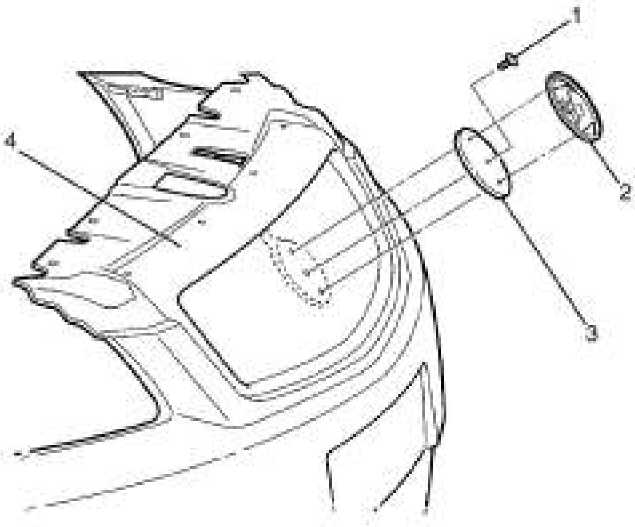
Tighten
Tighten the screws to 4 Nm (36 lb. in).

Important: Urethane adhesive should under no circumstances be visible after boss and emblem installation.



11. Apply a smear of suitable urethane adhesive (1) on the boss attachment surface of the fascia upper grille mesh assembly (2).

Important: Urethane adhesive should under no circumstances be visible after boss and emblem installation.



12. Install the grille emblem boss (3) onto the upper grille assembly (4) and install the grille emblem boss retaining screw (1).

    Tighten
    Tighten the screw to 2 Nm (18 lb. in).

13. Install the grille emblem (2) onto the grill emblem boss (3).
14. Lower the vehicle. Refer to Lifting and Jacking the Vehicle.
15. Install the front bumper fascia. Refer to Front Bumper Fascia Replacement.

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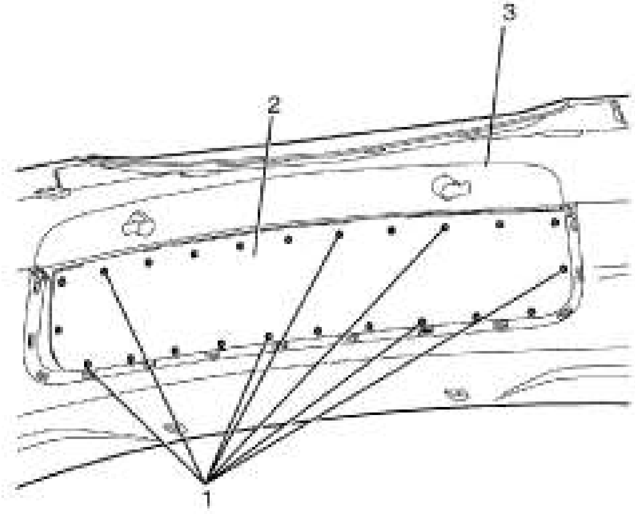
Front Bumper Fascia Insert Replacement (LWBHSV)

Removal Procedure

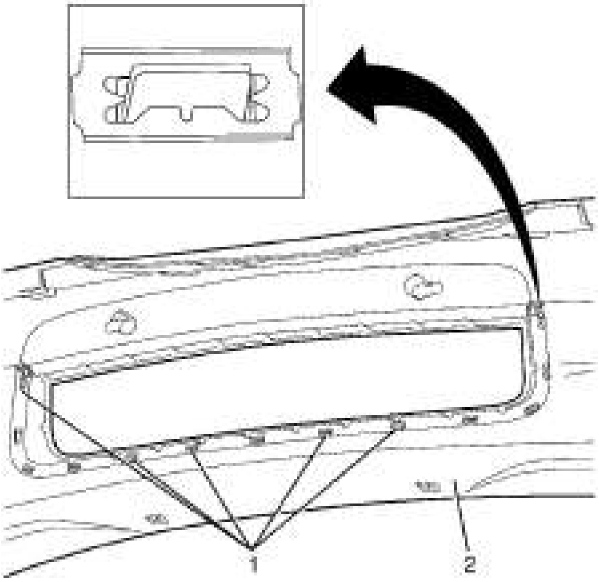
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle in General Information.
2. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement in Bumpers.

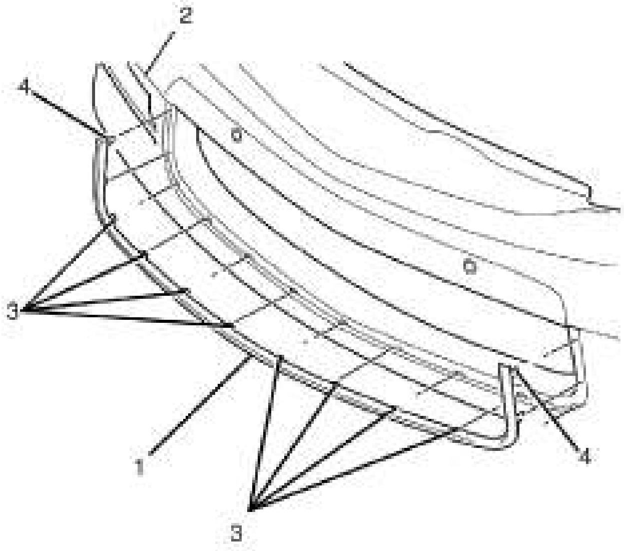


3. Remove the fourteen front bumper fascia grille retaining screws (1) and carefully remove the front bumper fascia grille (2) from the front bumper fascia (3).



4. Carefully prise the thirteen grille surround retaining clips (1) from the tabs protruding through the front bumper fascia (2).

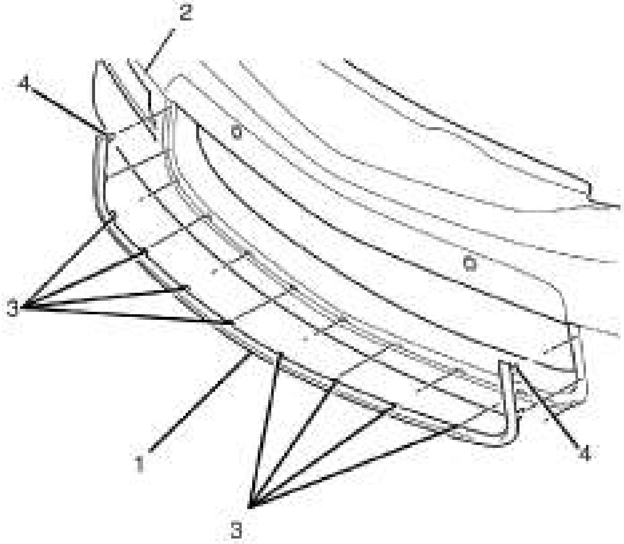
   Important: The grille surround (1) must be removed by releasing the lower grille surround tabs (3) outwards from the front bumper fascia (2) prior to the upper grille surround tabs (4).



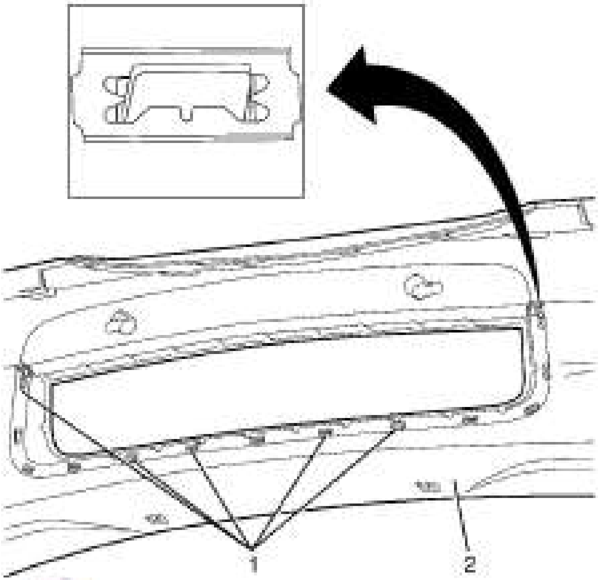
5. Carefully remove the grille surround (1) from the front bumper fascia (2) by rotating the lower grille surround tabs (3) outwards from the front bumper fascia (2) followed by releasing the upper grille surround tabs (4).

Installation Procedure

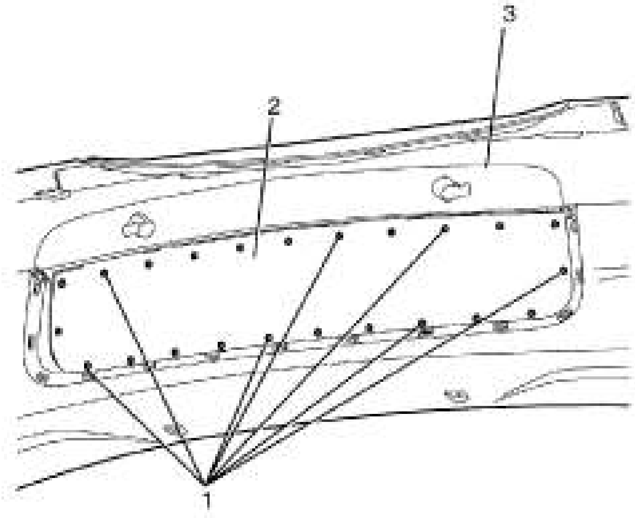
Important: The grille surround (1) must be installed by locating the upper grille surround tabs (4) prior to rotating the grille surround (1) inwards to locate the lower grille surround tabs (3) into the front bumper fascia (2).



1. Locate the upper grille surround tabs (4) into the front bumper fascia (2).
2. Rotate the grille surround inwards to locate the lower grille surround tabs (3) into the front bumper fascia (2).



3. Install the thirteen front bumper fascia grille surround retaining clips (1) onto the tabs protruding through the front bumper fascia (2).



4. Install the front bumper fascia grille (2) onto the front bumper fascia (3).

   Notice: Refer to Fastener Notice in the Preface section.

5. Install the front bumper fascia grille retaining screws (1)

   Tighten
   Tighten the screws to 2 Nm (18 lb in).

6. Install the front bumper fascia. Refer to Front Bumper Fascia Replacement in Bumpers.
7. Lower the vehicle. Refer to Lifting and Jacking the Vehicle in General Information.

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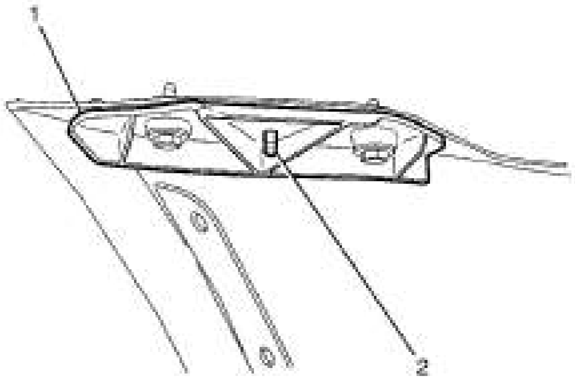
Front Bumper Fascia Reinforcement Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement .

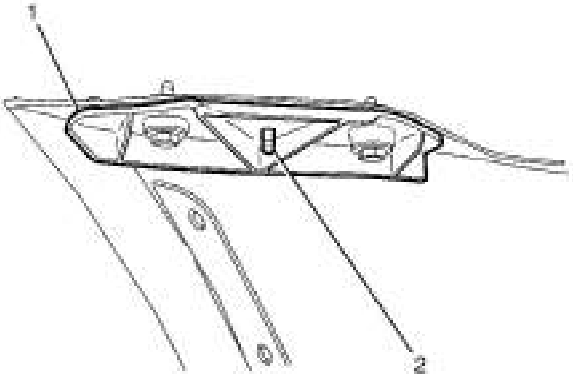


2. Remove the rivet (2) that secures the front bumper fascia reinforcement (1) to the front bumper fascia. The rivet must be discarded after removal.

   Discard the rivet.

3. Remove the front bumper fascia reinforcement (1) from the front bumper fascia.

Installation Procedure



1. Position the front bumper fascia reinforcement (1) to the front bumper fascia.
2. Install the NEW rivet (2) to secure the front bumper fascia reinforcement to the front bumper fascia.
3. Install the front bumper fascia. Refer to Front Bumper Fascia Replacement .

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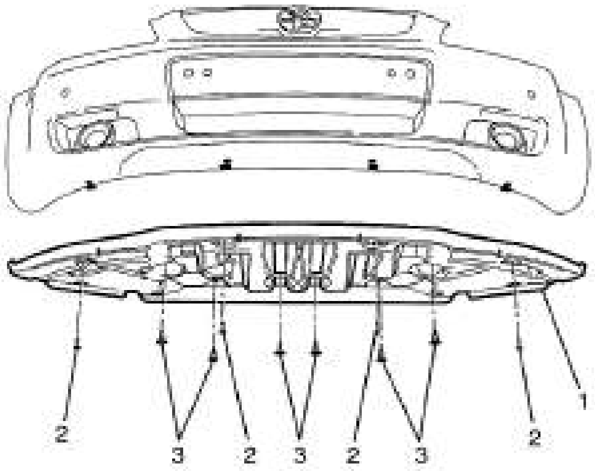
Front Air Deflector Replacement

Removal Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

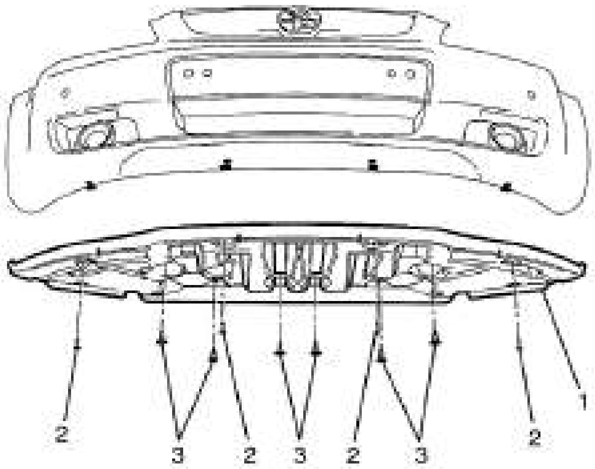
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the front wheelhouse liners. Refer to Front Wheelhouse Liner Replacement.



3. Remove the front air deflector to front bumper fascia retaining screws (2).
4. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement.
5. Remove the front air deflector to front frame push-in retainers (3).
6. Remove the front air deflector (1).

Installation Procedure



1. Position the front air deflector (1) to the vehicle.
2. Install the front air deflector to front frame push-in retainers (3).
3. Install the front bumper fascia. Refer to Front Bumper Fascia Replacement.
4. Install the front air deflector to front bumper fascia retaining screws (2)

Tighten
Tighten the screws to 3 N·m (27 lb in).

5. Install the front wheelhouse liners. Refer to Front Wheelhouse Liner Replacement.
6. Lower the vehicle.

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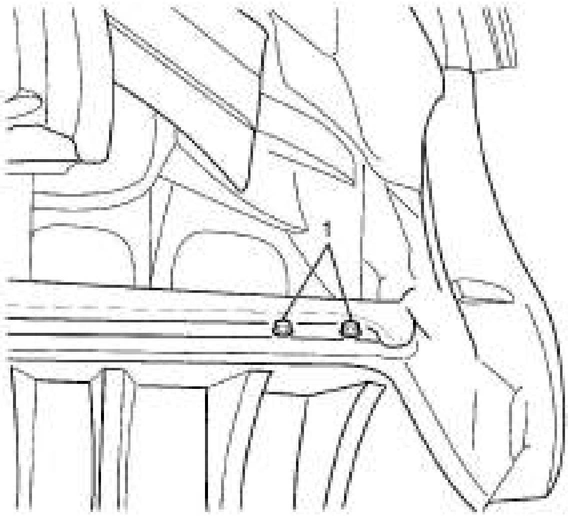
Rear Bumper Bracket Replacement (Sedan)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

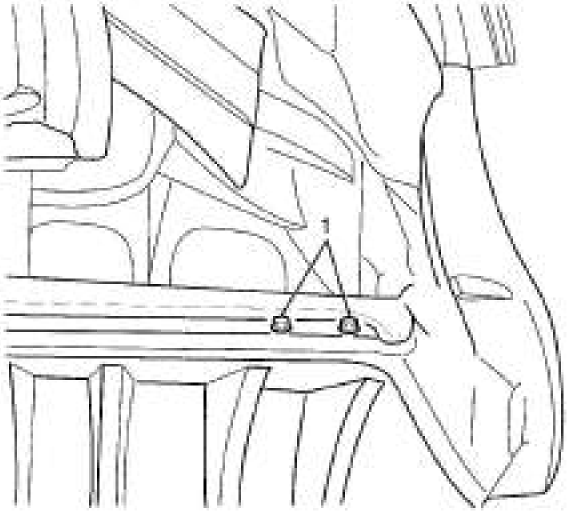
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Open the rear compartment lid.
2. Install a suitable brace to the rear compartment lid.
3. Remove the rear compartment floor carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
5. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
6. Remove the rear bumper impact bar. Refer to Rear Bumper Impact Bar Replacement.
7. Remove the rear muffler. Refer to Exhaust Muffler Replacement - Left Side and Exhaust Muffler Replacement - Right Side.
8. Remove the exhaust muffler heat shields. Refer to Exhaust Muffler Heat Shield Replacement - Left Side and Exhaust Muffler Heat Shield Replacement - Right Side.



9. Remove the rear bumper bracket to rear compartment floor retaining bolts (1).
10. Remove the rear bumper bracket.

Installation Procedure



1. Verify that the plastic retainers are secure to the rear quarter panel.
2. Install the rear bumper bracket to rear compartment floor.

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the rear bumper bracket to rear compartment floor retaining bolts (1).

   Tighten
   Tighten the bolts to 58 N·m (43 lb ft).

4. Install the exhaust muffler heat shields. Refer to Exhaust Muffler Heat Shield Replacement - Left Side and Exhaust Muffler Heat Shield Replacement - Right Side.
5. Install the rear muffler. Refer to Exhaust Muffler Replacement - Left Side and Exhaust Muffler Replacement - Right Side.
6. Install the rear bumper impact bar. Refer to Rear Bumper Impact Bar Replacement.
7. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
8. Lower the vehicle.
9. Install the rear compartment floor carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
10. Remove the suitable brace from the rear compartment lid.
11. Close the rear compartment lid.

Rear Bumper Bracket Replacement (Sportwagon)

Removal Procedure

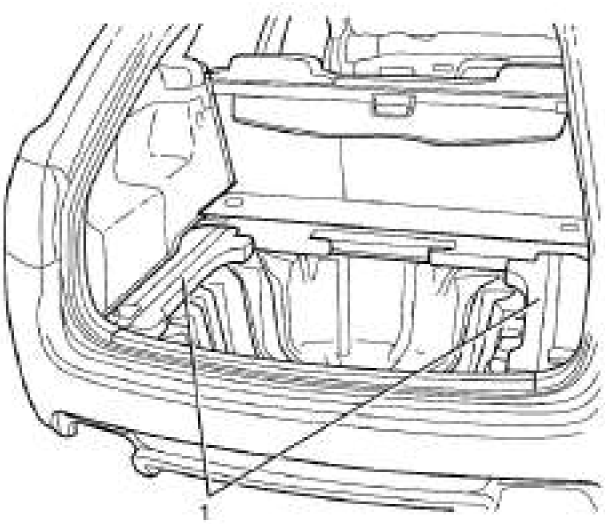
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

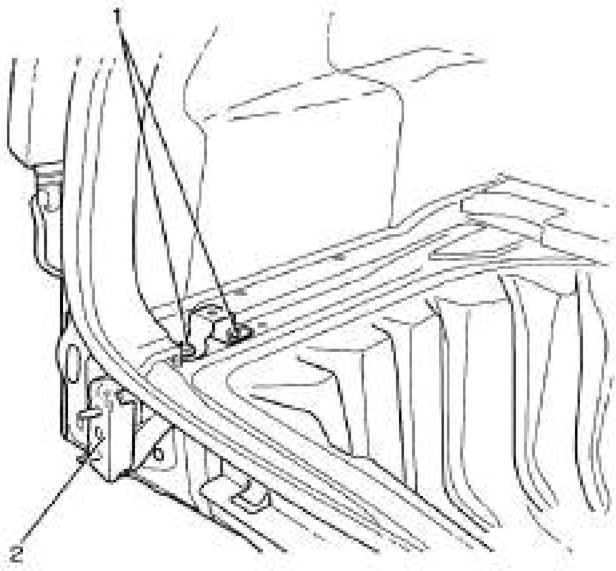
1. Open the liftgate

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

2. Install a suitable liftgate brace to the vehicle.
3. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
4. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.

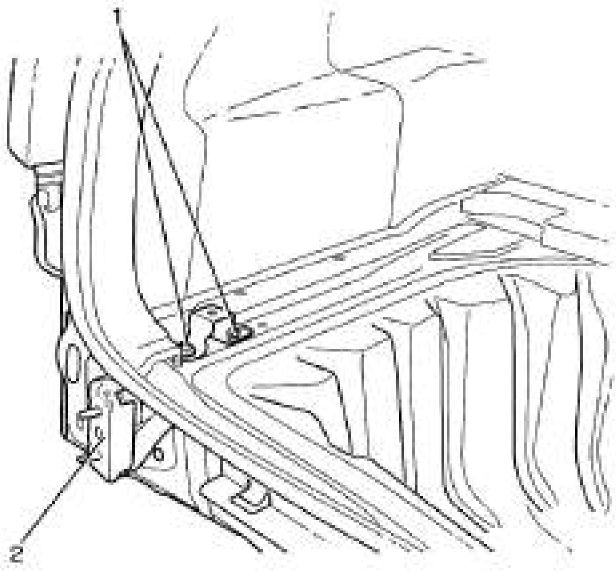


5. Remove the rear compartment floor panel carpet exterior support foams (1).
6. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
7. Remove the rear bumper impact bar. Refer to Rear Bumper Impact Bar Replacement.



8. Remove the rear bumper bracket to rear compartment floor retaining bolts (1).
9. Remove the rear bumper bracket (2) from the vehicle.

Installation Procedure



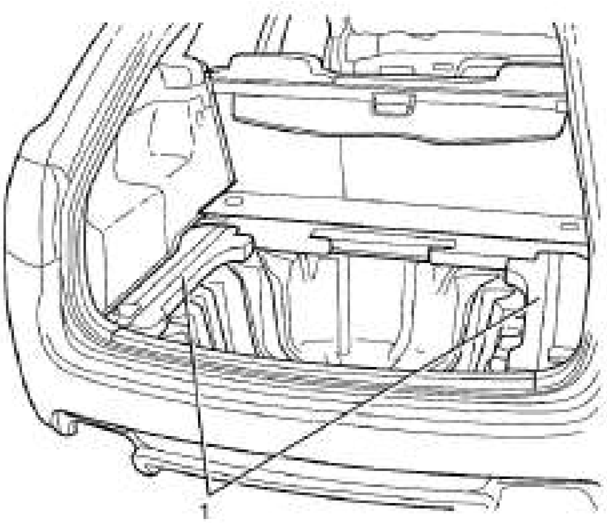
1. Position the rear bumper bracket (2) to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install rear bumper bracket to rear compartment floor retaining bolts (1).

Tighten
Tighten the bolts to 58 N·m (43 lb ft).

3. Install the rear bumper impact bar. Refer to Rear Bumper Impact Bar Replacement.
4. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.



5. Install the rear compartment floor panel carpet exterior support foams (1).
6. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
7. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
8. Remove the liftgate suitable brace from the vehicle.

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

9. Close the liftgate.

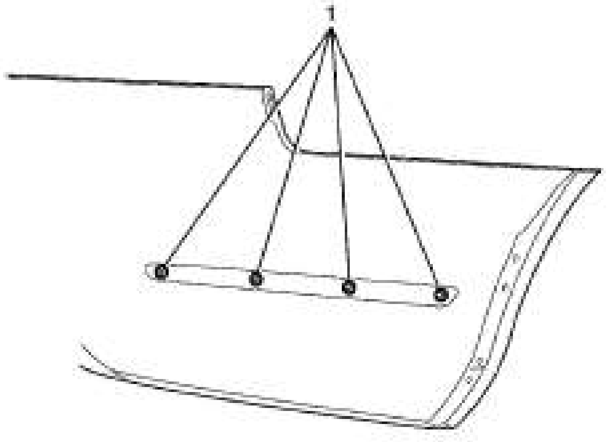
Rear Bumper Fascia Molding Replacement (SWB)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

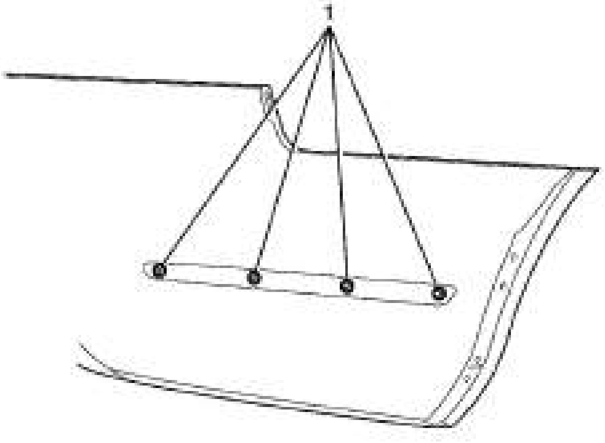
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.



3. Remove the rear bumper fascia rub-strip to rear bumper fascia retaining clips (1).
4. Remove the rear bumper fascia rub-strip from the rear bumper fascia.

Installation Procedure



1. Install the rear bumper fascia rub-strip to rear bumper fascia.
2. Install the rear bumper fascia rub-strip to rear bumper fascia retaining clips (1).
3. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
4. Lower the vehicle.

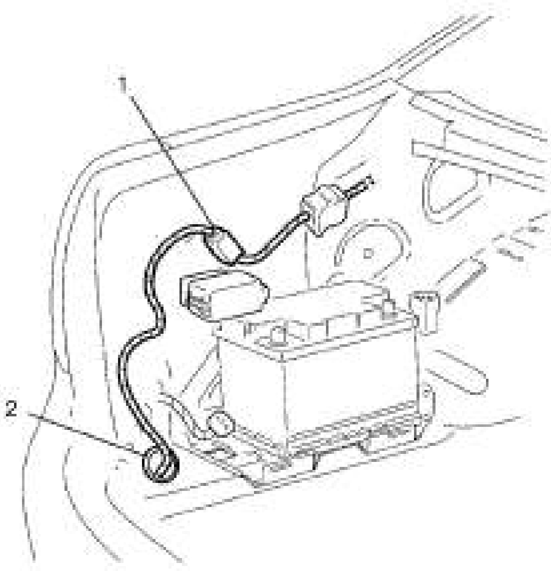
Rear Bumper Fascia Replacement (SWB)

Removal Procedure

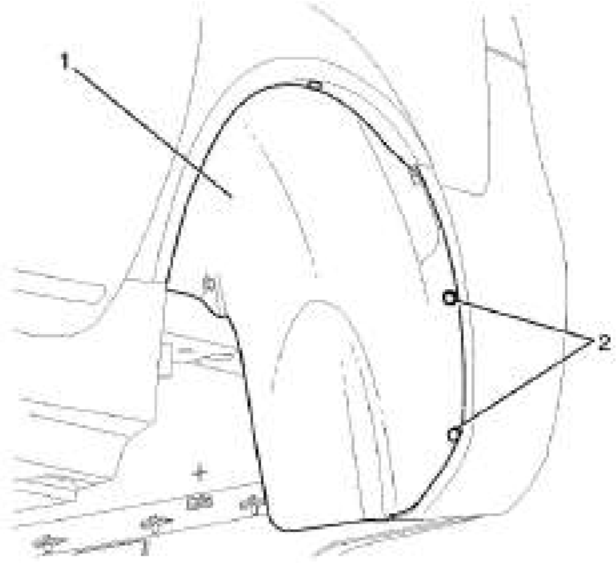
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

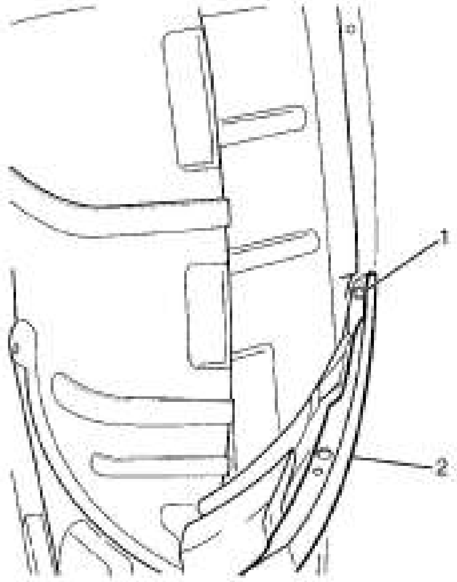
Important: Steps 1 and 2 are for the object detection assembly if fitted.



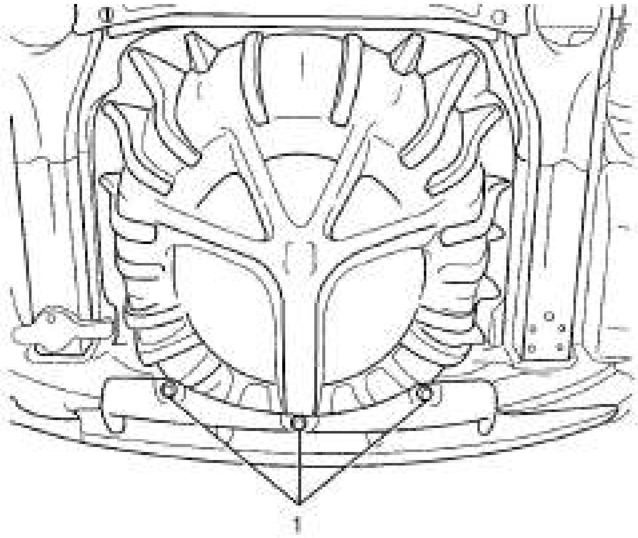
1. Disconnect the object detection electrical connector (1) from the wiring harness.
2. Feed the licence lamp wiring harness through the access hole (2).
3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



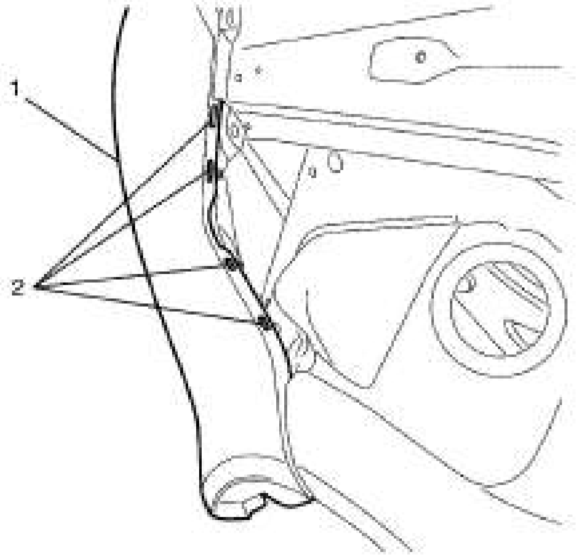
4. Remove the rear wheelhouse liner (1) to rear bumper fascia retaining scrivets (2). Repeat for opposite side.



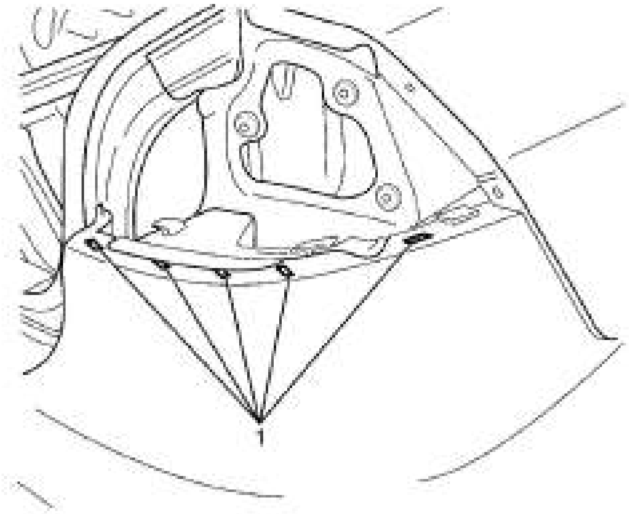
5. Remove the rear bumper fascia (2) to rear quarter panel retaining screw (1). Repeat for opposite side.



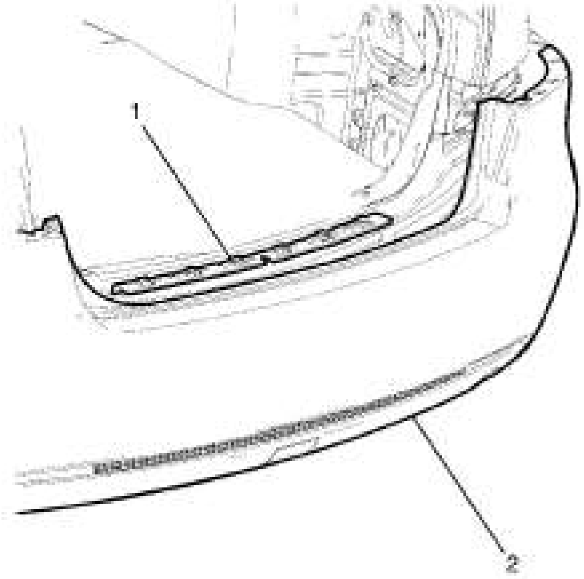
6. Remove the rear bumper fascia to spare wheel carrier retaining scrivets (1).



7. Disengage the rear bumper fascia (1) to rear bumper fascia guide rail retaining tabs (2).



8. Disengage the rear bumper fascia to rear bumper fascia outer support retaining tabs (1).



9. With the aid of an assistant, remove the rear bumper fascia by sliding rearward to disengage the rear bumper fascia (2) from the rear bumper fascia centre support (1).

Disassembly Procedure

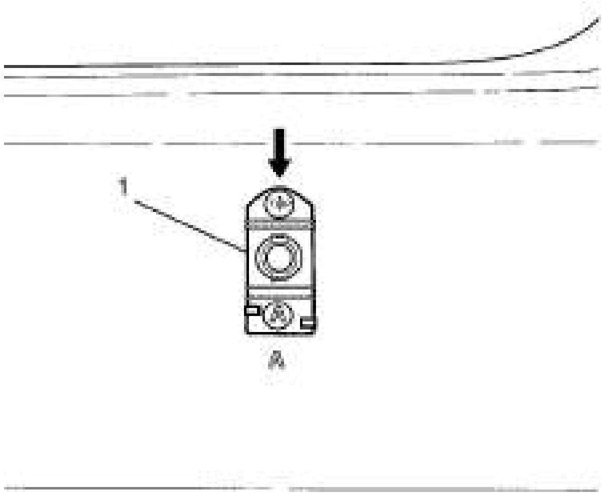
1. Remove the rear bumper fascia reflector. Refer to Rear Bumper Fascia Reflector Replacement.
2. Remove the rear bumper fascia extension. Refer to Rear Bumper Fascia Extension Replacement.

Assembly Procedure

Important: Prior to drilling the bumper fascia it is essential that the object detection bracket templates are aligned to their correct corresponding location within the bumper fascia. The location of the object detection bracket templates to the bumper fascia is alpha numeric, make sure that the letters correspond between the object detection bracket templates and the bumper fascia.

Important: Each object detection bracket template has a tolerance of 0.5 mm and must be taken into consideration.

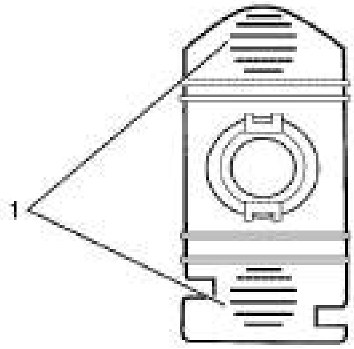
Important: The Object Detection Bracket Template, normally found in the service manual has been removed. A review of its accuracy due to the new delivery system, and different printing methods available from the web site is currently in progress. Please reference the Holden Service Information disc, Version 4.01 for a current template.



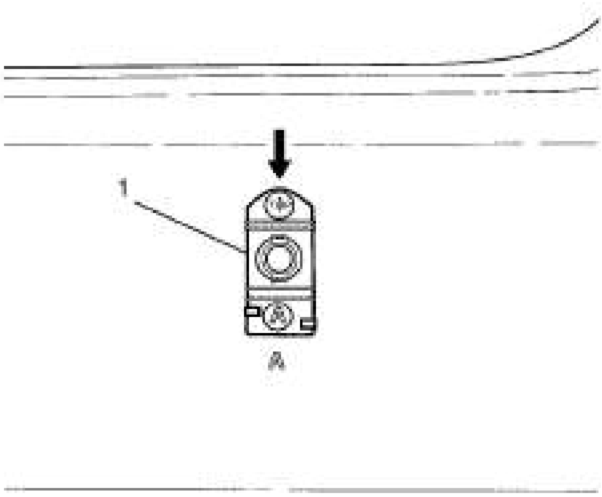
Important: This graphic is used as an example only and must not be used as a template, it displays one of the varying object detection bracket templates for reference.

Important: When aligning the object detection bracket template make sure that the locating tags align correctly and there is little or no movement, prior to drilling.

1. Install the object detection bracket templates (1) to the rear bumper fascia.
2. Mark out the sensor hole from the object detection bracket templates (1) to the rear bumper fascia.
3. Remove the object detection bracket templates (1) from the rear bumper fascia.
4. Drill the holes in the rear bumper fascia 24.5 mm (0.96 in).
5. Remove any swarf from the rear bumper fascia.
6. Clean the rear bumper fascia with a suitable wax and grease remover.
7. Remove the object detection bracket templates (1) from the rear bumper fascia.



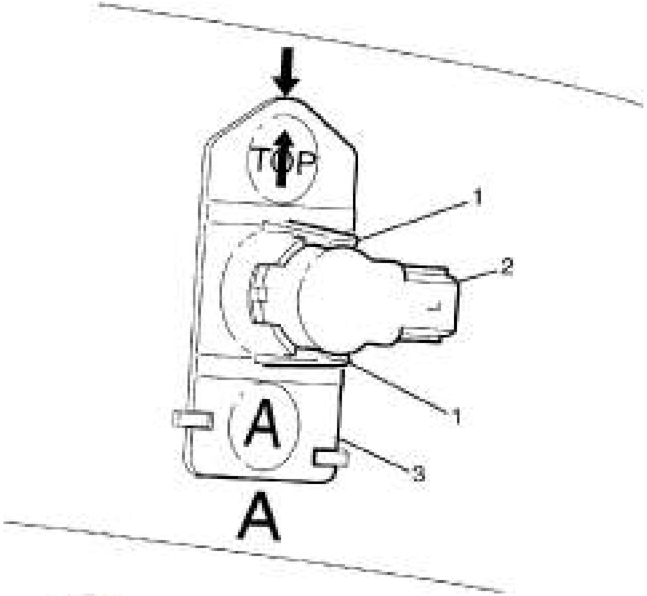
8. Apply the GM Specification 9982247 (Fusor 152-153) adhesive or equivalent to the ribs of the object detection bracket (1).



Important: This graphic is used as an example only and must not be used as a template, it displays one of the varying object detection bracket templates for reference.

Important: The location of the object detection brackets to the bumper fascia is alpha numeric, make sure that the letters correspond between the object detection brackets and the bumper fascia.

9. Install the object detection bracket (1) to the rear bumper fascia.



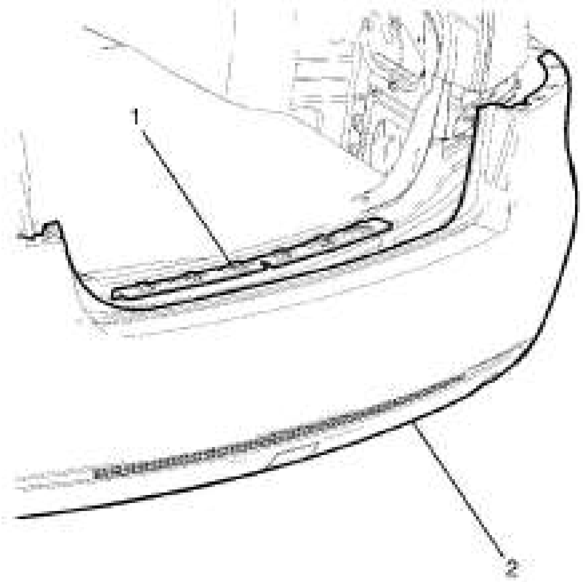
Important: Allow 20 minutes for the adhesive to cure to the rear bumper fascia.

Important: Replacement front object alarm sensors (2) are not pre-painted, they will require painting before installation is carried out.

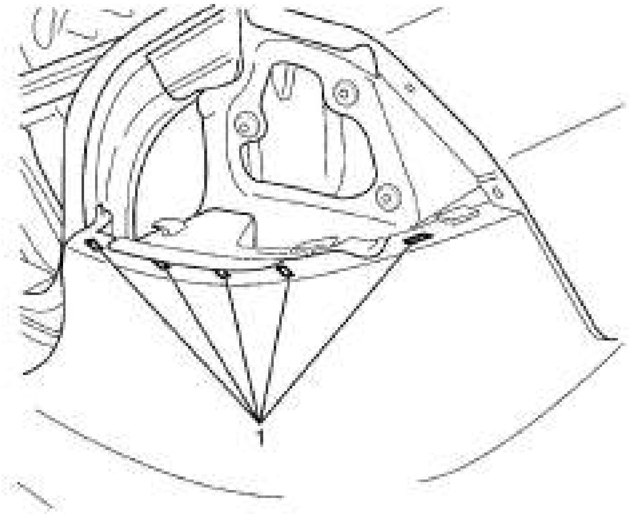
Important: Ensure that the rear object alarm sensor (2) is installed correctly.

10. Locate the top and bottom housing tabs (1) to install the rear object alarm sensor (2) to the rear object alarm sensor housing (3).
11. Press the rear object sensor bezel flush to the fascia.
12. Install the rear bumper fascia extension. Refer to Rear Bumper Fascia Extension Replacement.
13. Install the rear bumper fascia reflector. Refer to Rear Bumper Fascia Reflector Replacement.

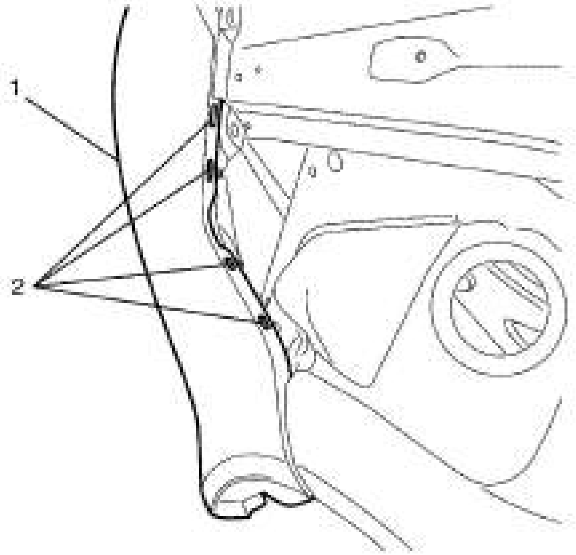
Installation Procedure



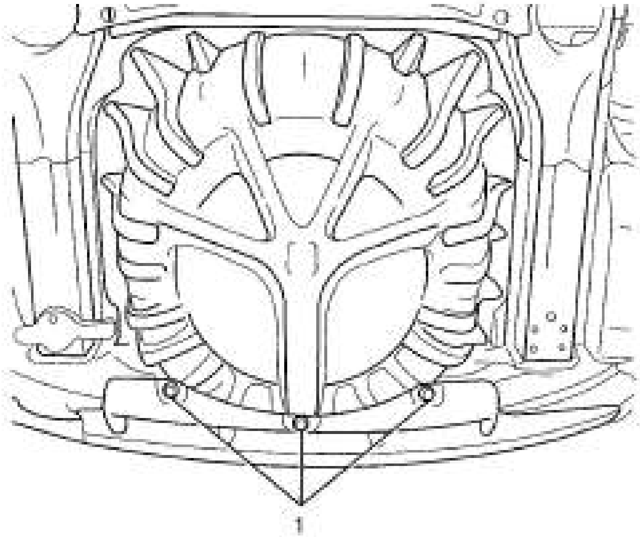
1. With the aid of an assistant, install the rear bumper fascia by sliding forward to engage the rear bumper fascia (2) to the rear bumper fascia centre support (1).



2. Engage the rear bumper fascia to rear bumper fascia outer support retaining tabs (1).

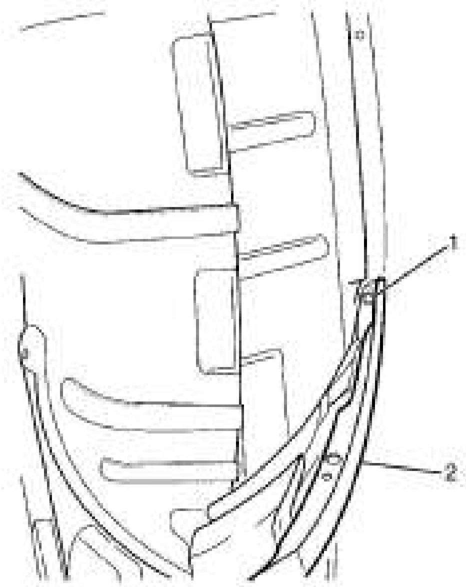


3. Engage the rear bumper fascia (1) to rear bumper fascia guide rail retaining tabs (2).
4. Make sure the rear bumper fascia is secured to the rear bumper fascia centre, outer and lower supports by hearing an audible click.



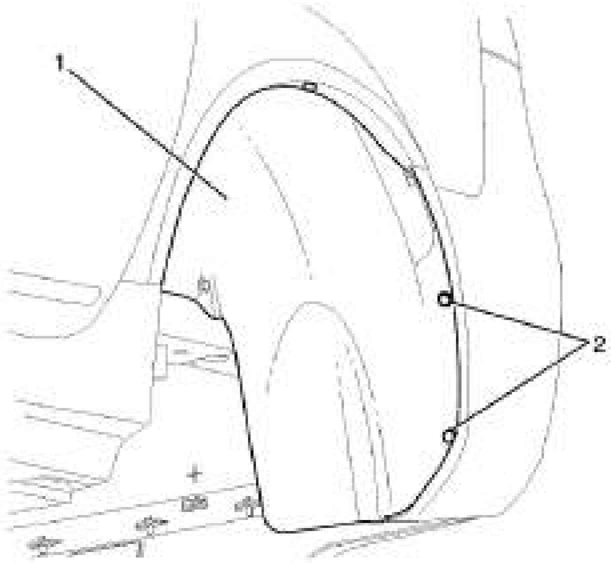
5. Install the rear bumper fascia to spare wheel carrier retaining scrivets (1).

Notice: Refer to Fastener Notice in the Preface section.



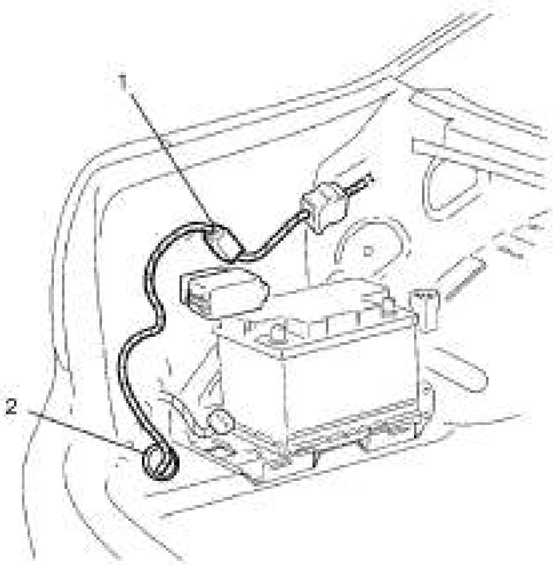
6. Install the rear bumper fascia (2) to rear quarter panel retaining screws (1). Repeat for opposite side.

   Tighten
   Tighten the screws to 2 N·m (18 lb in).



7. Install the rear wheelhouse liner (1) to rear bumper fascia retaining scrivets (2). Repeat for opposite side.
8. Lower the vehicle.

Important: The following steps are for the object detection assembly if fitted



9. Feed the licence lamp wiring harness through the access hole (2).
10. Connect the object detection electrical connector (1) to the wiring harness.

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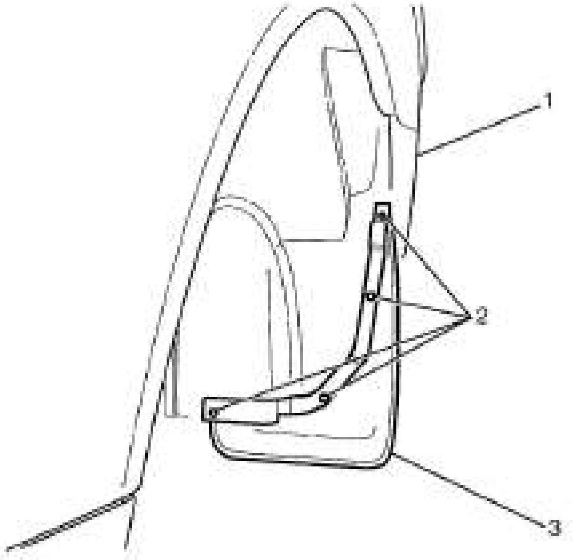
Rear Bumper Fascia Replacement (Sportwagon)

Removal Procedure

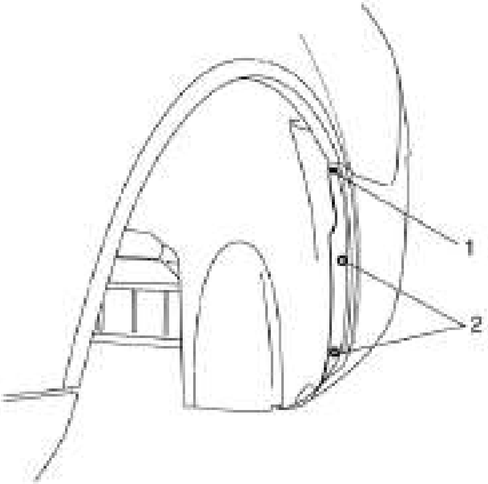
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

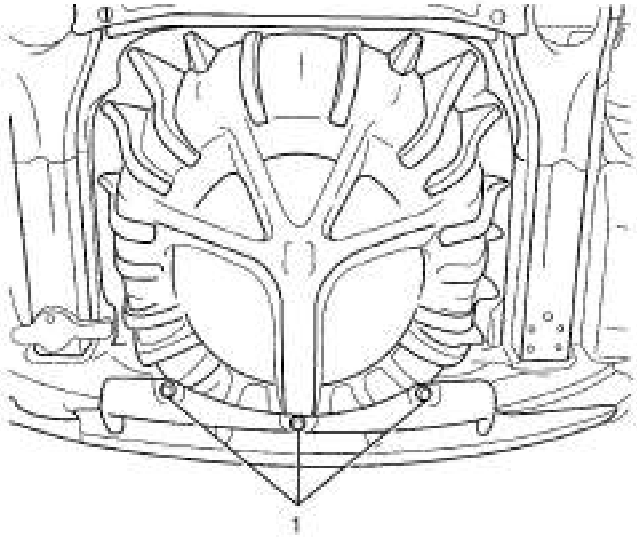
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle
2. Remove the rear wheels. Refer to Tire and Wheel Removal and Installation



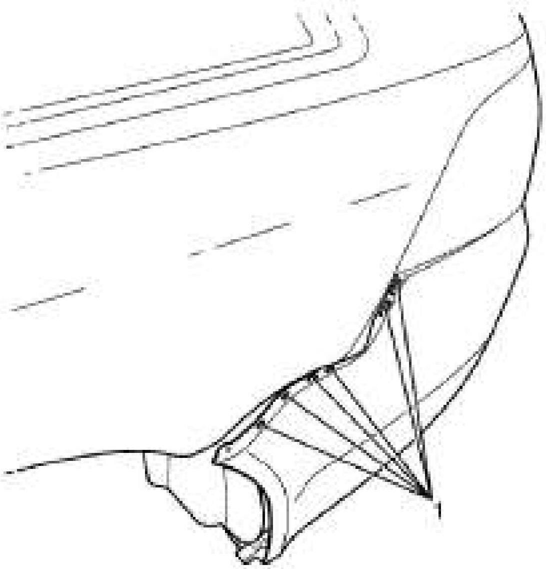
3. Where fitted, remove the rear mud flap (3) to the rear bumper fascia retaining screws (2). Repeat for the opposite side.
4. Where fitted, remove the rear mud flap (3) from the rear bumper fascia (1). Repeat for the opposite side.



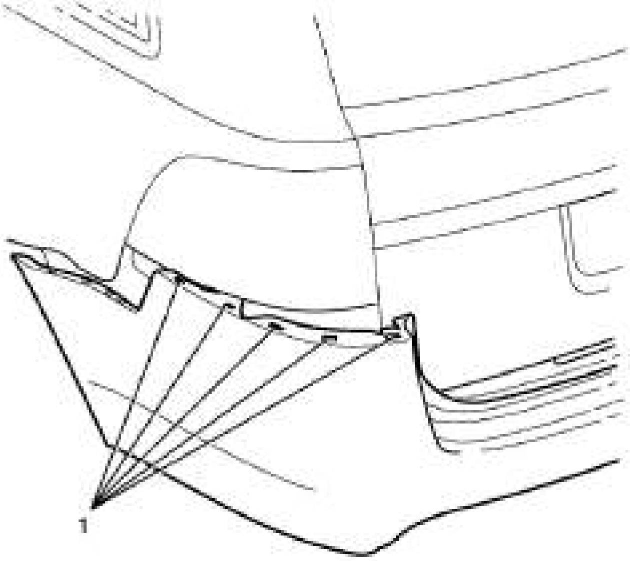
5. Remove the rear bumper fascia to rear wheelhouse liner retaining scrivets (2). Repeat for the opposite side.
6. Remove the rear bumper fascia to rear quarter panel retaining screw (1). Repeat for the opposite side.



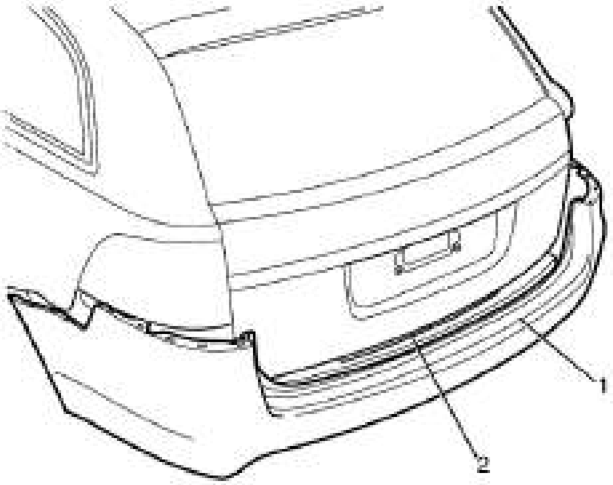
7. Remove the rear bumper fascia to spare wheel carrier retaining scrivets (1).



8. Disengage the rear bumper fascia to rear bumper fascia guide rail retaining tabs (1). Repeat for the opposite side.



9. Disengage the rear bumper fascia to rear bumper fascia outer support retaining tabs (1). Repeat for the opposite side.



Important: With the aid of an assistant, remove the rear bumper fascia by sliding rearward to disengage the rear bumper fascia (1) from the rear bumper fascia centre support (2).

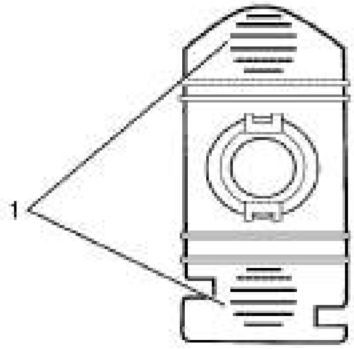
10. Remove the rear bumper fascia (1) from the rear bumper fascia centre support (2).
11. Disconnect the rear parking sensors electrical connector.
12. Remove the rear bumper fascia (1) from the vehicle.

Disassembly

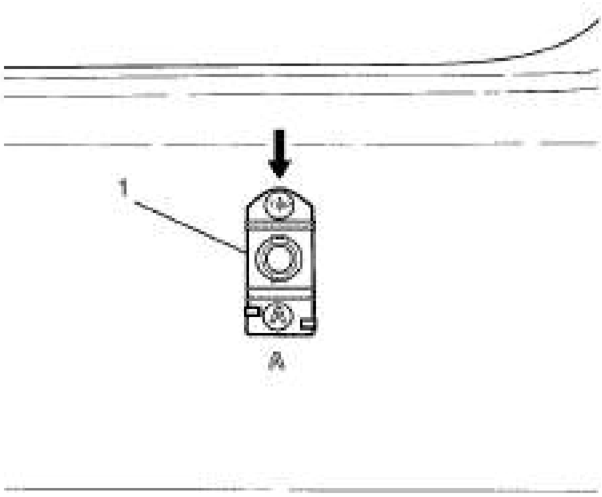
1. Remove the rear bumper fascia reflector. Refer to Rear Bumper Fascia Reflector Replacement.
2. Remove the rear bumper fascia extension. Refer to Rear Bumper Fascia Extension Replacement.

Assembly

1. Clean the rear bumper fascia with a suitable wax and grease remover.



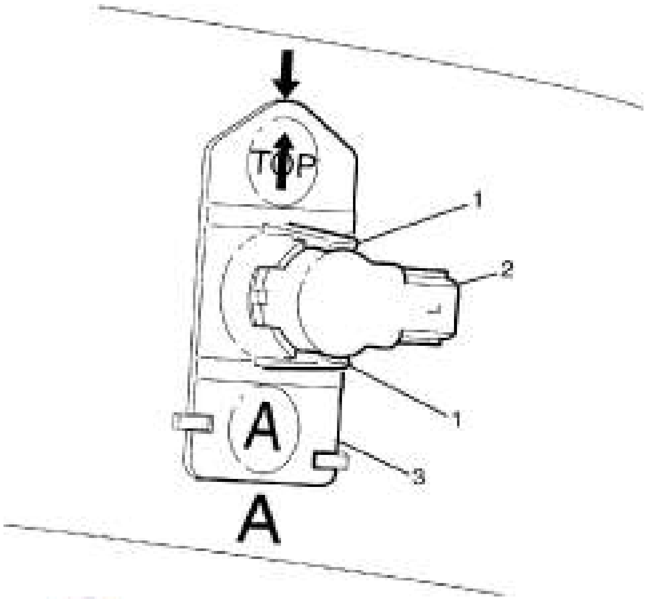
2. Apply the GM Specification 9982247 adhesive or equivalent to the ribs of the object detection bracket (1).



Important: This graphic is used as an example only and must not be used as a template, it displays one of the varying object detection bracket templates for reference.

Important: The location of the object detection brackets to the bumper fascia is alpha numeric, make sure that the letters correspond between the object detection brackets and the bumper fascia.

3. Install the object detection bracket (1) to the rear bumper fascia.



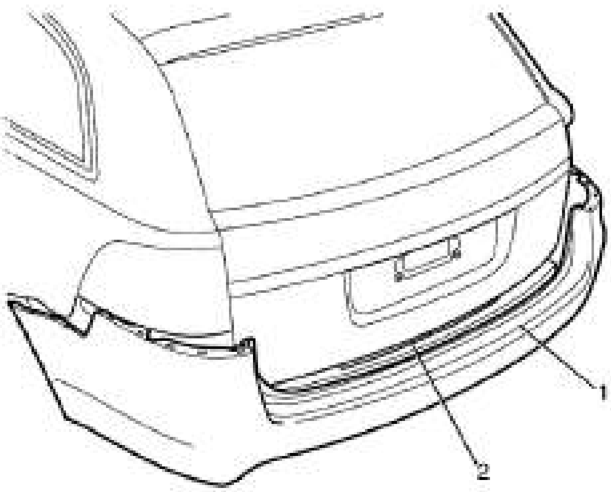
Important: Allow 20 minutes for the adhesive to cure to the rear bumper fascia.

Important: Replacement rear object alarm sensors (2) are not pre-painted, they will require painting before installation is carried out.

Important: Ensure that the rear object alarm sensor (2) is installed correctly.

4. Locate the top and bottom housing tabs (1) to install the rear object alarm sensor (2) to the rear object alarm sensor housing (3).
5. Press the rear object sensor bezel flush to the rear bumper fascia.
6. Install the rear bumper fascia extension. Refer to Rear Bumper Fascia Extension Replacement.
7. Install the rear bumper fascia reflector. Refer to Rear Bumper Fascia Reflector Replacement.

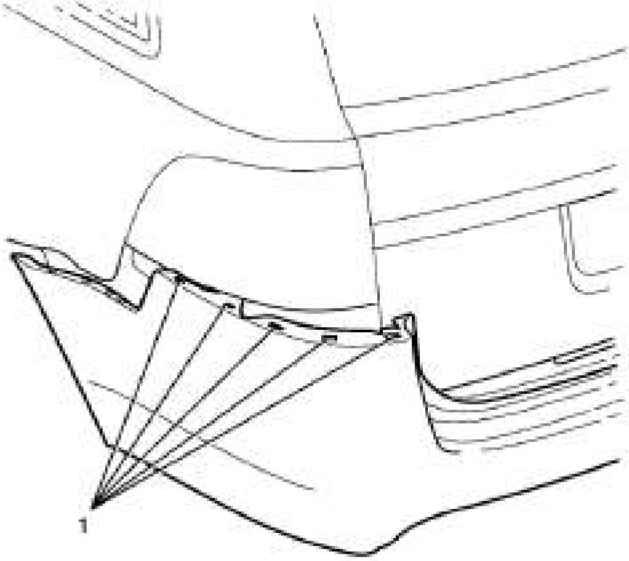
Installation Procedure



Important: With the aid of an assistant, install the rear bumper fascia (1) by sliding forward to correctly attach the rear bumper fascia (1) to the rear bumper fascia centre support (2).

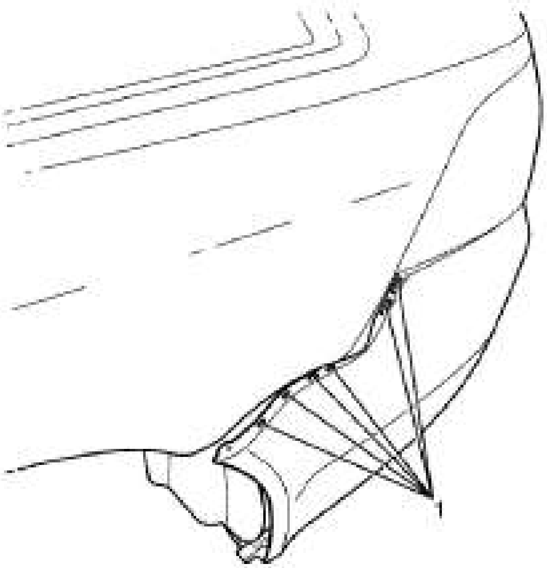
Important: Listen for an audible click when attaching the rear bumper fascia to the rear bumper fascia centre support to confirm correct fitment.

1. Connect the rear parking sensors electrical connector.
2. Install the rear bumper fascia (1) to the rear bumper fascia centre support (2).



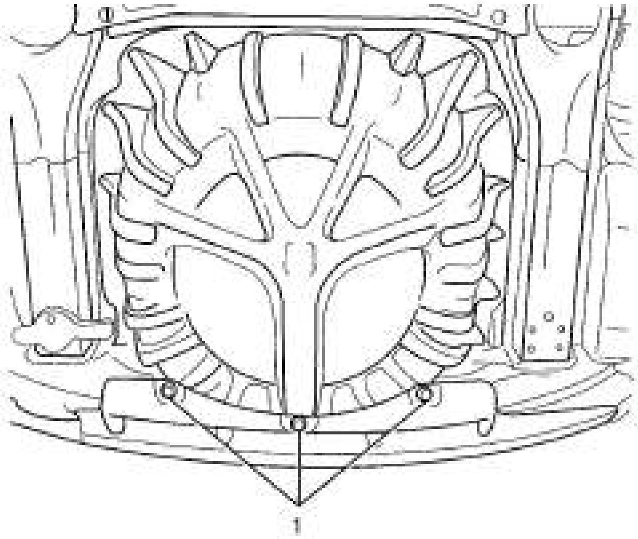
Important: Listen for an audible click when attaching the rear bumper fascia to the rear bumper fascia centre support to confirm correct fitment.

3. Engage the rear bumper fascia to rear bumper fascia support retaining tabs (1). Repeat for the opposite side.



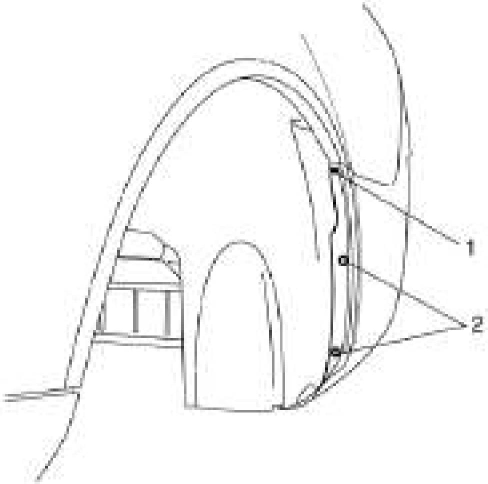
Important: Listen for an audible click when attaching the rear bumper fascia to the rear bumper fascia centre support to confirm correct fitment.

4. Engage the rear bumper fascia to rear bumper fascia guide rail retaining tabs (1). Repeat for the opposite side.



5. Install the rear bumper fascia to spare wheel carrier retaining scrivets (1).

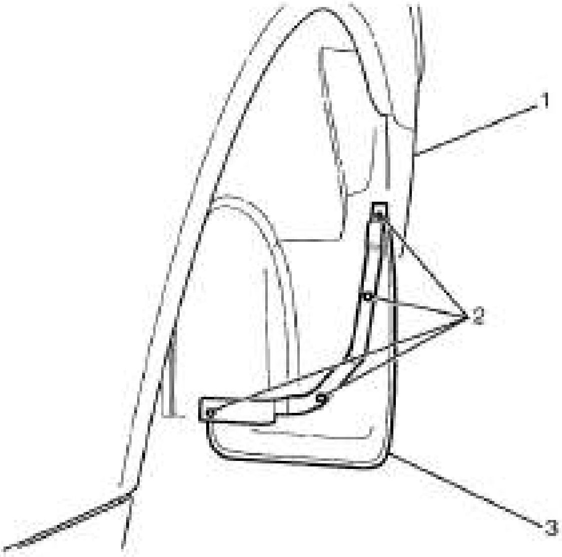
Notice: Refer to Fastener Notice in the Preface section.



6. Install the rear bumper fascia to rear quarter panel retaining screws (1). Repeat for the opposite side.

   Tighten
   Tighten the screws to 2 N·m (18 lb in).

7. Install the rear bumper fascia to rear wheelhouse liner retaining scrivets (2). Repeat for the opposite side.



8. Where fitted, position the rear mud flap (3) to the rear bumper fascia (1). Repeat for the opposite side.

   Notice: Refer to Fastener Notice in the Preface section.

9. Where fitted, install the rear mud flap to the rear bumper fascia retaining screws (2). Repeat for the opposite side.

   Tighten
   Tighten the screws to 4 N·m (35 lb in).

10. Install the rear wheels. Refer to Tire and Wheel Removal and Installation.
11. Lower the vehicle.

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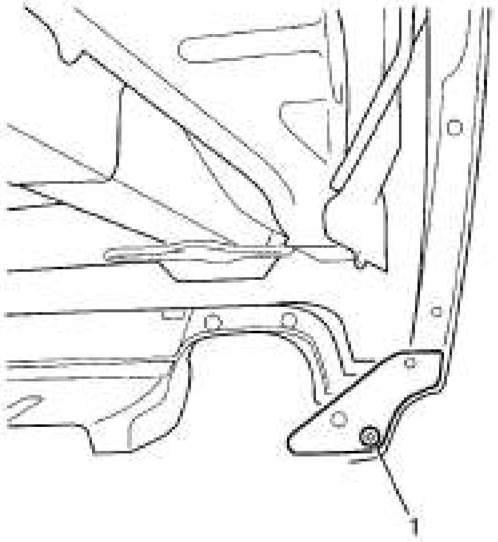
Rear Bumper Fascia Extension Replacement (SWBLWB)

Removal Procedure

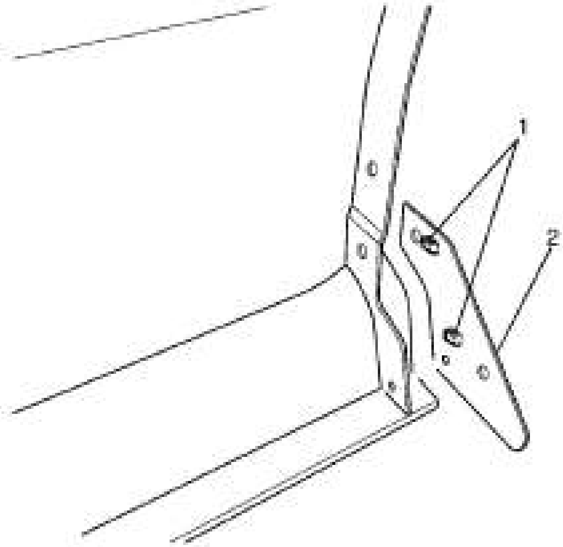
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear wheelhouse liner. Refer to Rear Inner Wheelhouse Replacement.

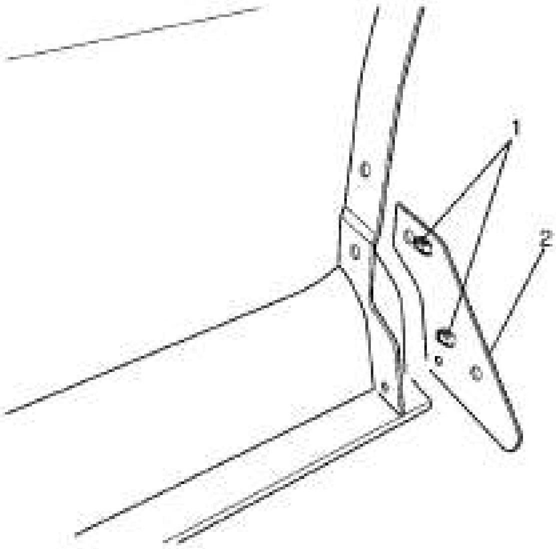


3. Remove the rear bumper fascia extension to rear bumper fascia retaining screw (1).



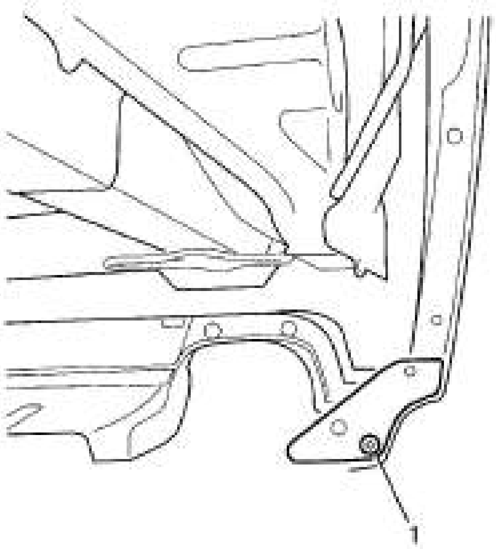
4. Disengage the rear bumper fascia extension retaining clips (1) from the rear bumper fascia.
5. Remove the rear bumper fascia extension (2) from the vehicle.

Installation Procedure



1. Position the rear bumper fascia extension (2) to the vehicle.
2. Engage the rear bumper fascia extension retaining clips (1) to the rear bumper fascia.

Notice: Refer to Fastener Notice in the Preface section.



3. Install the rear bumper fascia extension to rear bumper fascia retaining screw (1).

   Tighten
   Tighten the screw to 2 N·m (18 lb in).

4. Install the rear wheelhouse liner. Refer to Rear Inner Wheelhouse Replacement.
5. Lower the vehicle.

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Rear Bumper Fascia Center Support Replacement (Sportwagon)

Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

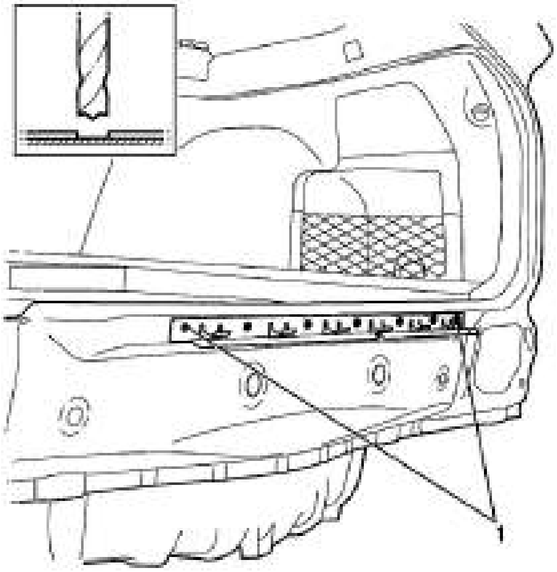
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

1. Disable the SIR system. Refer to SIR Disabling and Enabling.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement
4. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement
5. Remove the liftgate weatherstrip. Refer to Liftgate Weatherstrip Replacement.
6. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
7. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
8. Remove the rear bumper impact bar. Refer to Rear Bumper Impact Bar Replacement.
9. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.



10. Locate, mark and drill out the spot welds in the rear bumper fascia centre support to the rear end panel assembly (1).

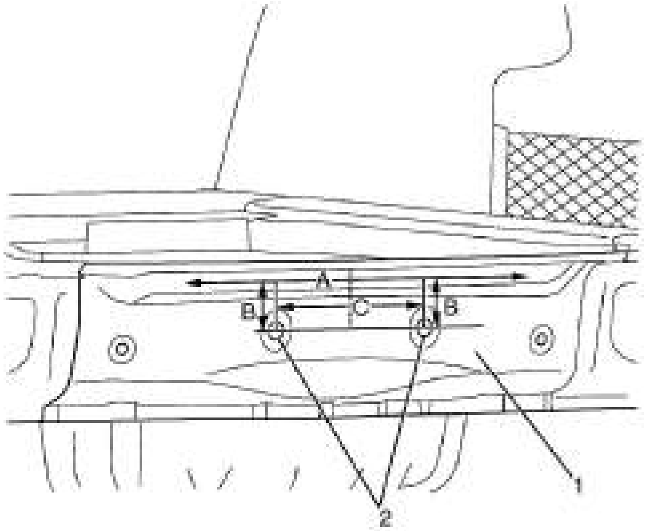
Installation Procedure

Important: Spot welding is the preferred method for attaching panels and should be used whenever possible. A plug weld should only be performed where spot welding is not possible.

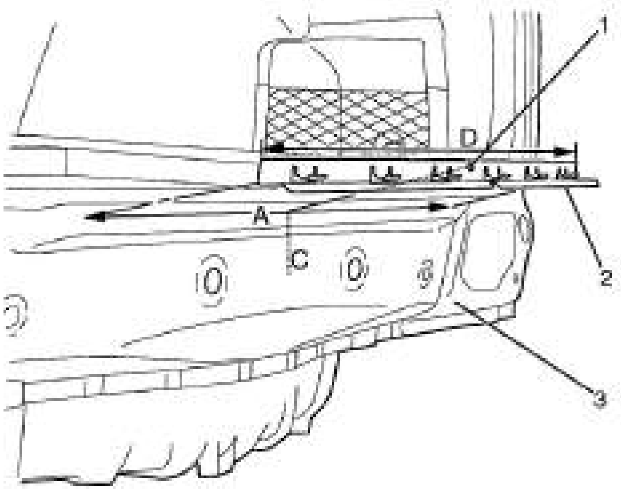
Important: If the location of the original spot weld holes cannot be determined, or if structural weld-thru adhesive is present, space the puddle weld holes every 32 mm (1¼ in).

Important: Follow the adhesive manufacturer's instructions during the assembly process. Heat must be applied as per the manufacturer's specifications to cure the adhesives and to expand the sealing baffles.

1. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted when disassembling.
2. Clean and prepare the mating surfaces of both parts of the panel.



3. Utilising the two holes in the rear end panel assembly (2) as a reference point, mark the centre line of the vehicle (C) onto the rear end panel assembly (1).
4. Utilising the two holes in the rear end panel assembly (2) as a reference point, measure 57.5 mm (B) above each hole onto the rear end panel assembly (1) to establish the rear bumper fascia centre support location alignment mark (A).



5. Measure and mark the centre point on the bumper facia centre support assembly (D).
6. Align the centre point mark on the rear bumper facia centre support assembly (1) with the centre line mark on the rear end panel assembly (C).
7. Align the lower edge of the rear bumper facia centre support assembly (2) with the alignment marks (A) on the rear end panel assembly (3).

Important: Secondary sealer must be applied to the perimeter of all flanges. Secondary sealer must be applied to all welds/joints that were originally covered by secondary sealer.

8. Weld the centre support assembly (2) to the rear end panel assembly (3).
9. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.
10. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
11. Install the rear bumper impact bar. Refer to Rear Bumper Impact Bar Replacement.
12. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
13. Lower the vehicle.
14. Install the liftgate weatherstrip. Refer to Liftgate Weatherstrip Replacement.
15. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement
16. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement
17. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
18. Enable the SIR system. Refer to SIR Disabling and Enabling.

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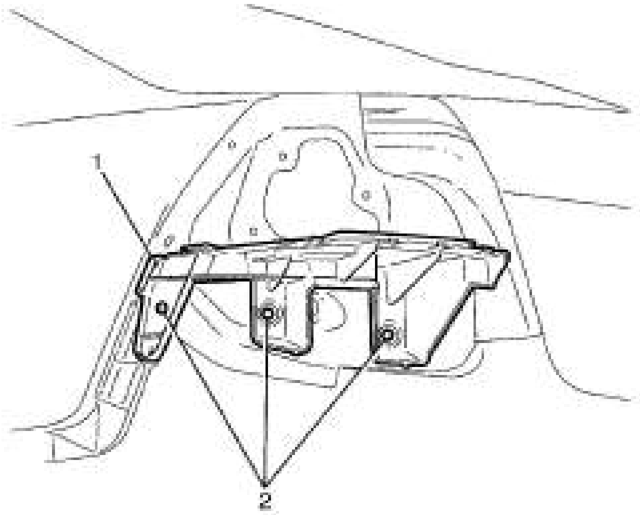
Rear Bumper Fascia Outer Support Replacement (LWB SWB)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.



Important: The rear bumper fascia outer support retaining rivets are signal use parts. They must be discarded after removal.

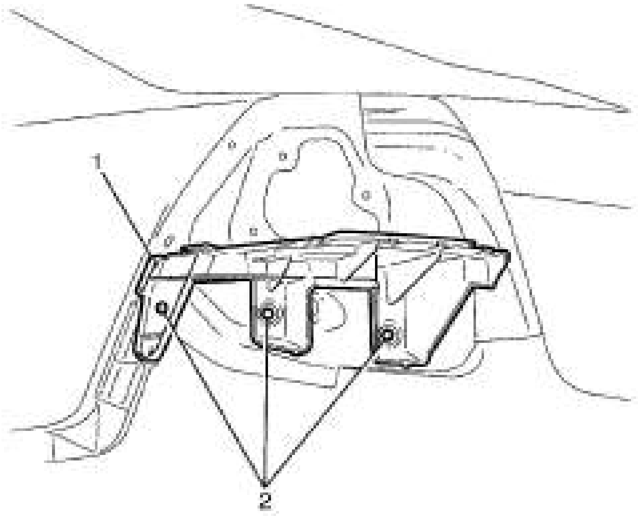
3. Drill out the rear bumper fascia guide rail retaining rivets (2).

   Discard the rivets.

4. Remove the rear bumper fascia guide rail (1) from the vehicle.

Installation Procedure

1. Position the rear bumper fascia guide rail (1) to the vehicle.



2. Install NEW rear bumper fascia outer support retaining rivets (2).
3. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
4. Lower the vehicle.

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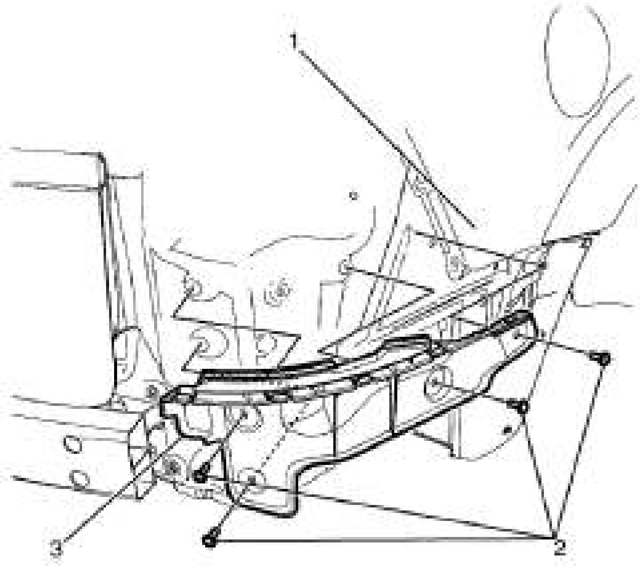
Rear Bumper Fascia Outer Support Replacement (Sportwagon)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
3. Remove the rear tail lamp assembly. Refer to Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn Signal Bulb Replacement.



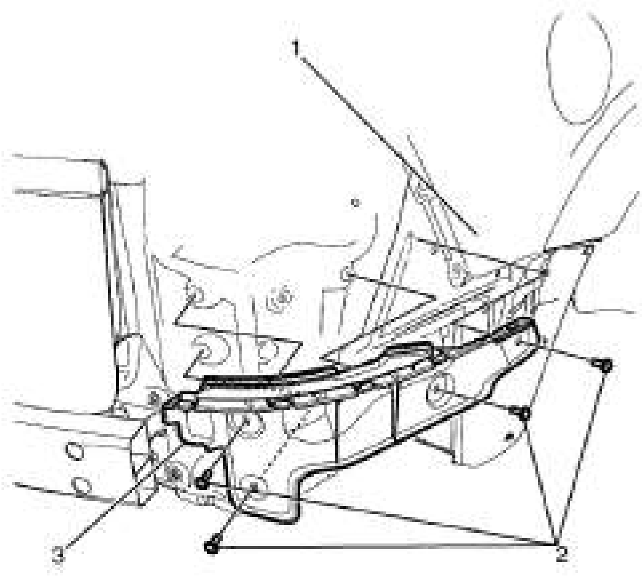
Important: The rear bumper fascia outer support retaining rivets are signal use parts. They must be discarded after removal.

4. Drill out the rear bumper fascia outer support retaining rivets (2).

   Discard the rivets.

5. Remove the rear bumper fascia outer support (3) from the quarter panel (1).

Installation Procedure



1. Position the rear bumper fascia outer support (3) to the quarter panel (1).
2. Install NEW rear bumper fascia outer support retaining rivets (2).
3. Install the rear tail lamp assembly. Refer to Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn Signal Bulb Replacement.
4. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
5. Lower the vehicle.

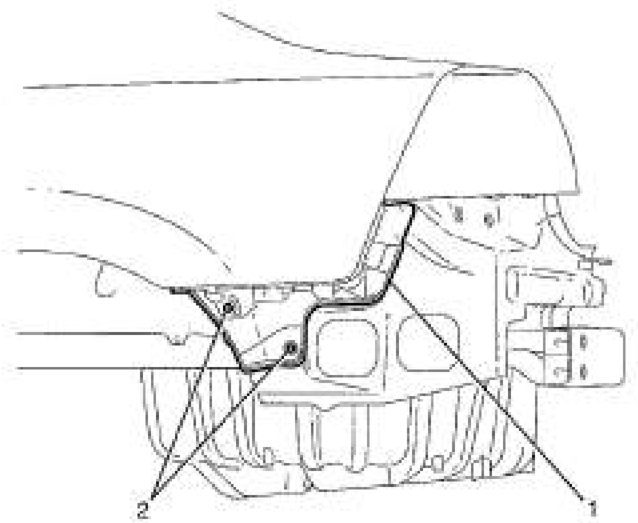
Rear Bumper Fascia Bracket Replacement (LWB SWB)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
3. Remove the rear bumper fascia guide rail. Refer to Rear Bumper Fascia Outer Support Replacement.



Important: The rear bumper fascia lower support retaining rivets are single use parts. They must be discarded after removal.

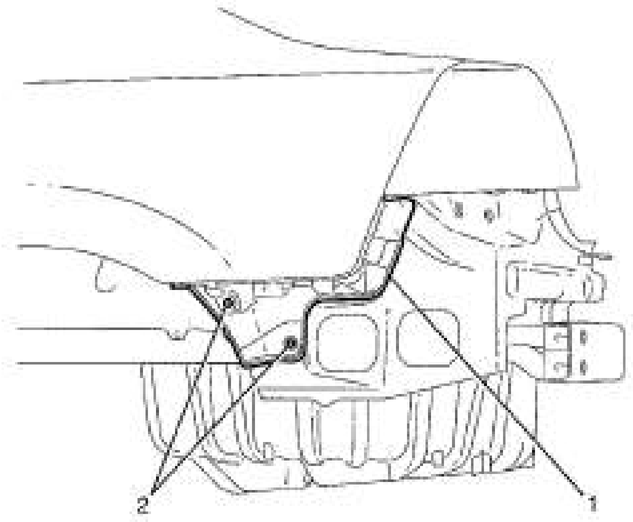
4. Drill out the rear bumper fascia guide rail retaining rivets (2).

   Discard the rivets.

5. Remove the rear bumper fascia guide rail (1) from the vehicle.

Installation Procedure

1. Position the rear bumper fascia guide rail (1) to the vehicle.



2. Install NEW rear bumper fascia guide rail retaining rivets (2)
3. Install the rear bumper fascia guide rail. Refer to Rear Bumper Fascia Outer Support Replacement.
4. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
5. Lower the vehicle.

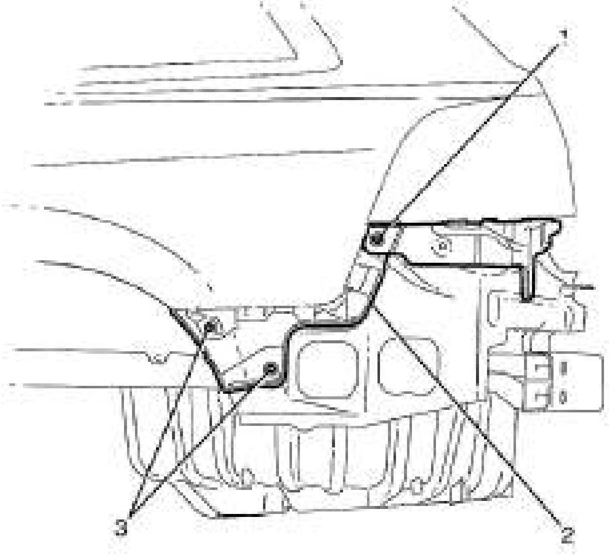
Rear Bumper Fascia Bracket Replacement (Sportwagon)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.



Important: The rear bumper fascia support to quarter panel retaining rivet (1) is a single use part and must be discarded after removal.

3. Drill out and remove the rear bumper fascia support to quarter panel retaining rivet (1).

   Discard the rivet.

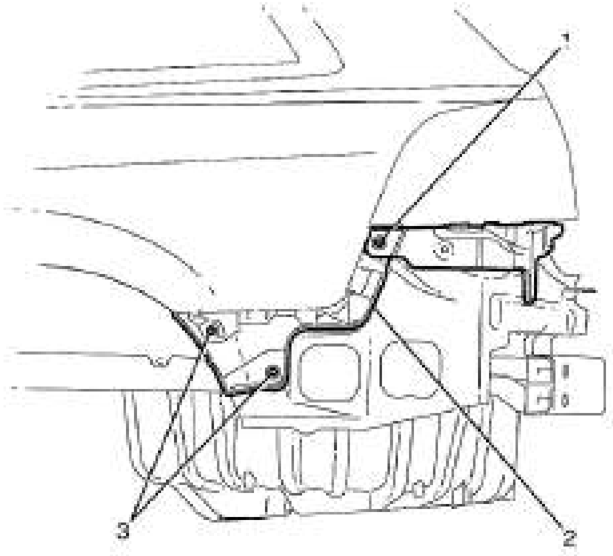
   Important: The rear bumper fascia bracket to quarter panel retaining rivets (3) are single use parts and must be discarded after removal.

4. Drill out and remove the rear bumper fascia bracket to quarter panel retaining rivets (3).

   Discard the rivets.

5. Remove the rear bumper fascia bracket (2) from the vehicle.

Installation Procedure



1. Position a NEW rear bumper fascia bracket (2) to the vehicle by sliding under the rear bumper fascia support.
2. Install NEW rear bumper fascia bracket to quarter panel retaining rivets (3).
3. Install a NEW rear bumper fascia support to quarter panel retaining rivet (1).
4. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
5. Lower the vehicle.

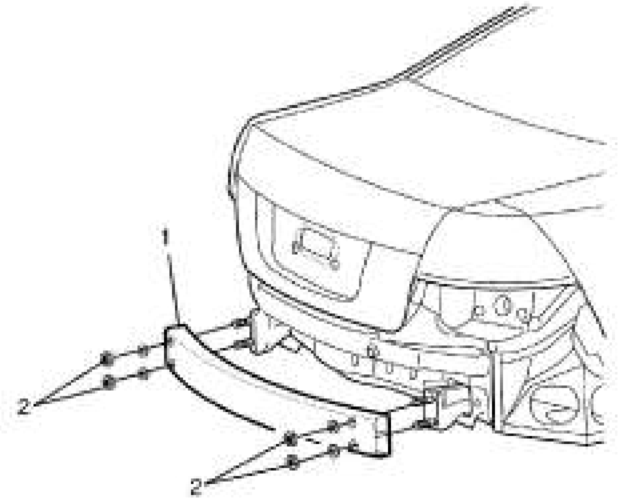
Rear Bumper Impact Bar Replacement (Sedan)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

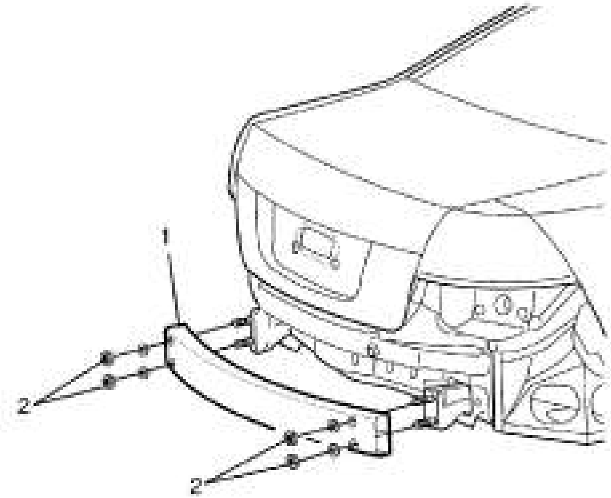
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.



3. Remove the rear bumper impact bar to rear bumper impact bar bracket retaining nuts (2).
4. Remove the rear bumper impact bar (1).

Installation Procedure



1. Install the rear bumper impact bar (1) to the rear impact bar brackets.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the rear bumper impact bar to rear bumper impact bar bracket retaining nuts (2).
   2.1. Install the upper retaining nuts first.
   2.2. Install the lower retaining nuts second.

   Tighten
   Tighten the nuts to 22 N·m (16 lb ft).

3. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
4. Lower the vehicle.

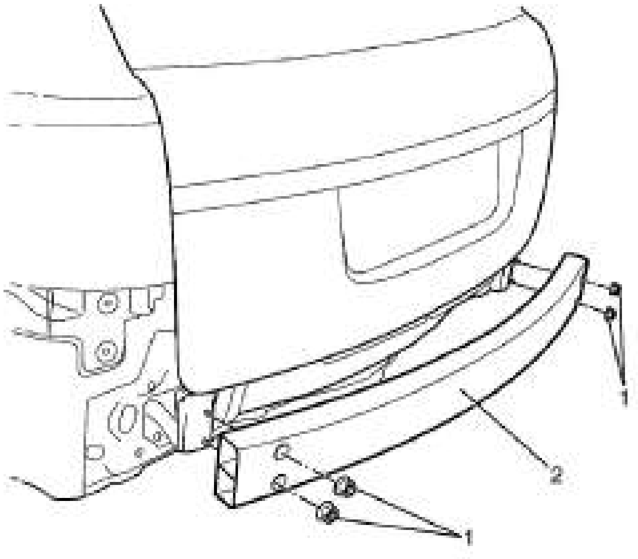
Rear Bumper Impact Bar Replacement (Sportwagon)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

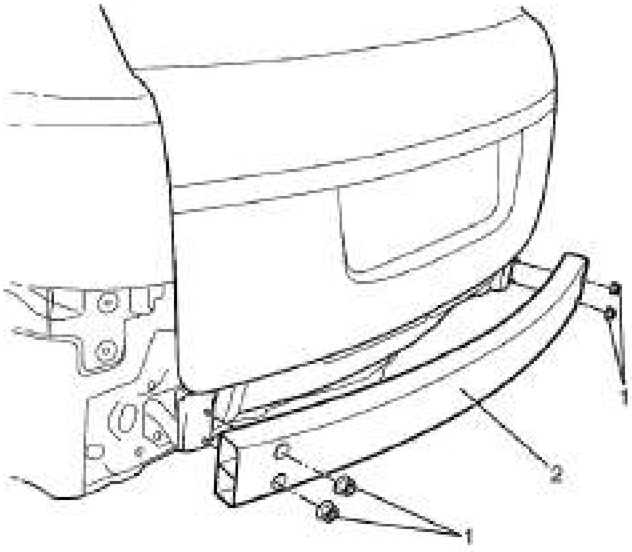
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.



3. Remove the rear bumper impact bar (2) to rear bumper impact bar bracket retaining nuts (1).
4. Remove the rear bumper impact bar (2).

Installation Procedure



1. Install the rear bumper impact bar (2) to the rear impact bar brackets.

   Notice: Refer to Fastener Notice in the Preface section.

   Important: Install the upper rear bumper impact bar to rear bumper impact bar bracket retaining studs first.

2. Install the rear bumper impact bar to rear bumper impact bar bracket retaining nuts (1).

   Tighten
   Tighten the nuts to 22 N·m (16 lb ft).

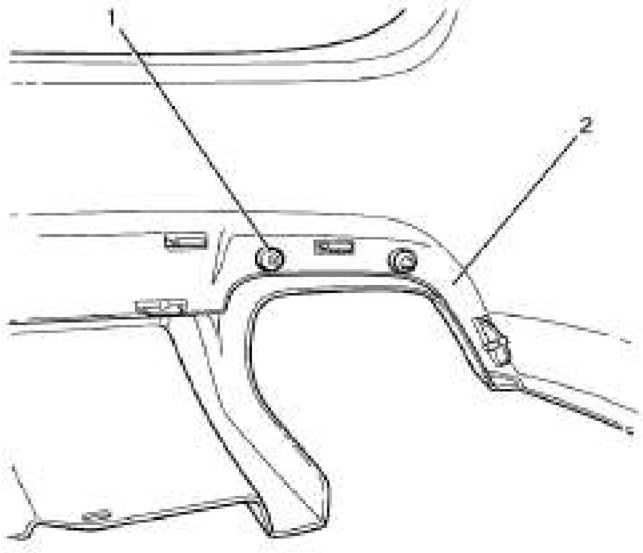
3. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
4. Lower the vehicle.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Repair | Bumpers and Fascias | Repair Instructions | **Document ID: 2067513**

Rear Bumper Fascia Reflector Replacement

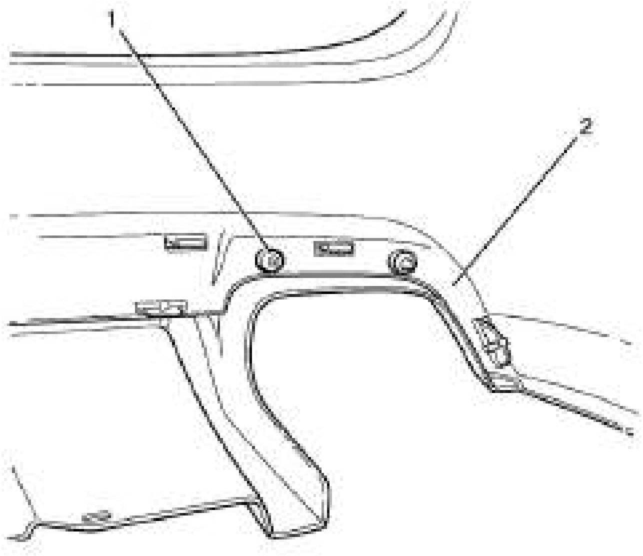
Removal Procedure

1. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.



2. Remove the rear bumper fascia reflector retaining screw (1) from behind the rear bumper fascia (2).
3. Slide the rear bumper fascia reflector towards the centre of the rear bumper fascia, disengaging clip.
4. Remove the rear bumper fascia reflector from the rear bumper fascia.

Installation Procedure



1. Install the rear bumper fascia reflector by sliding into position in the rear bumper fascia (2).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the rear bumper fascia reflector retaining screw (1).

   Tighten
   Tighten the screws (1) to 2 N·m (18 lb in).

3. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.

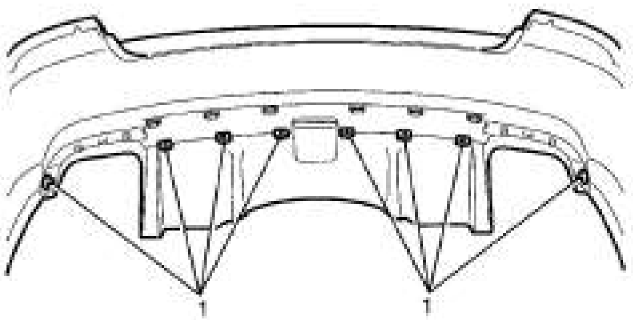
Rear Bumper Fascia Insert Replacement (SWB)

Removal Procedure

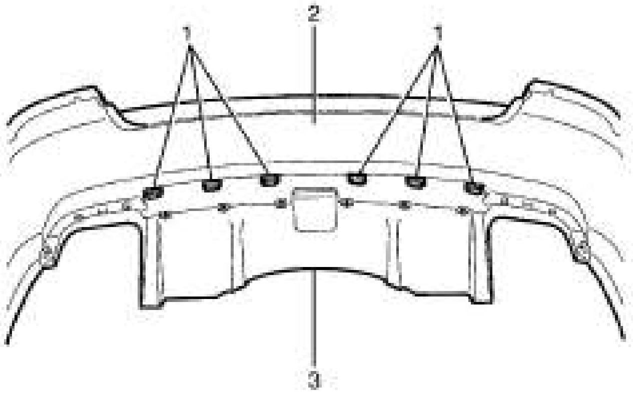
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.

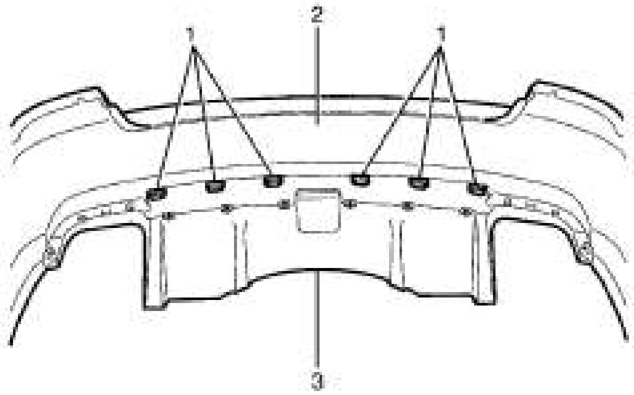


3. Remove the rear bumper fascia moulding to rear bumper fascia retaining scrivets (1).

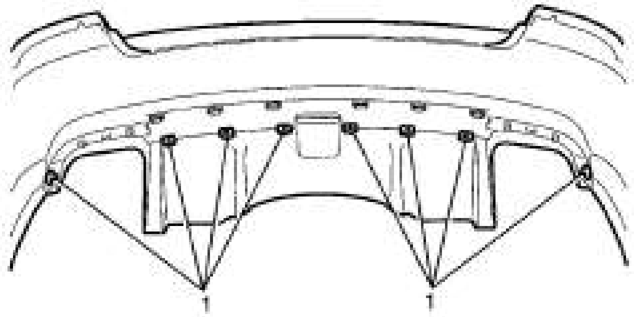


4. Disengage the retaining tabs (1) from the rear bumper fascia (2).
5. Remove the rear bumper fascia moulding (3) from the rear bumper fascia (2).

Installation Procedure



1. Install the rear bumper fascia moulding (3) to the rear bumper fascia (2).
2. Firmly press the retaining tabs (1) into the rear bumper fascia (2).



3. Install the rear bumper fascia moulding to rear bumper fascia retaining scrivets (1).
4. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.

5. Lower the vehicle.

Bumper and Fascia Description

Passenger vehicle bumpers are designed to withstand a collision into a fixed barrier at 8 km/h (5 m.p.h.). After absorbing the energy of the collision, the bumper energy absorbers rebound to 80-90 percent of their original position. The bumper energy absorbing capability of the front and the rear bumper systems are achieved through one of the following components in each bumper:

- A honeycomb type energy absorbing structure.
- A foam type energy absorbing structure.
- An impact bar bracket energy absorbing structure.

The front and the rear bumper fascias are made of urethane. Urethane withstands minor impact and returns to the original shape.

For repair or refinishing information on the bumper fascia, rear to General Plastic Repair .

Fastener Tightening Specifications

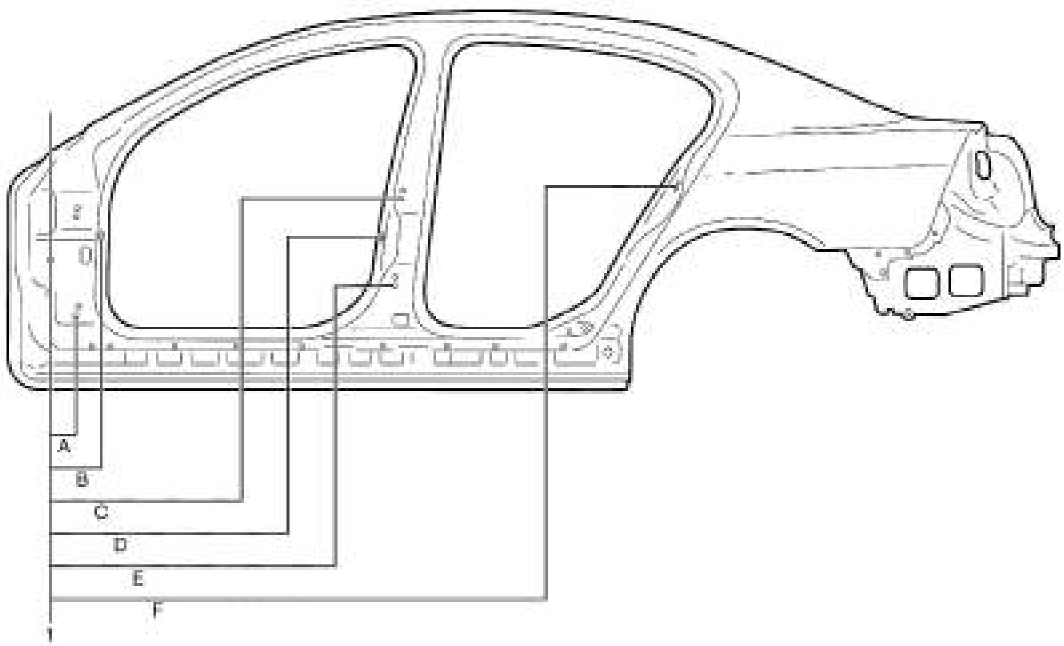
Application	Specification	
	Metric	English
Liftgate Strut To Liftgate Stud	22 N·m	16 lb ft
Liftgate Strut To Rear Quarter Panel Stud	15 N·m	11 lb ft
Rear Wheelhouse Liner To Rocker Moulding Retaining Screws	2 N·m	18 lb in

Collision Repair Specifications

Product Type	Specification	Product Name (or Equivalent)
Primary Sealer	GM6449G	3M Automix 8115
Secondary Sealer	GM9984532	3M Automix 8115
Urethane	GMW3041	Betaseal 15685
Plastic Adhesive	GM9982247	Fusor 142/143
Expanding Foam	GM9982296	Betafoam 87100/87124

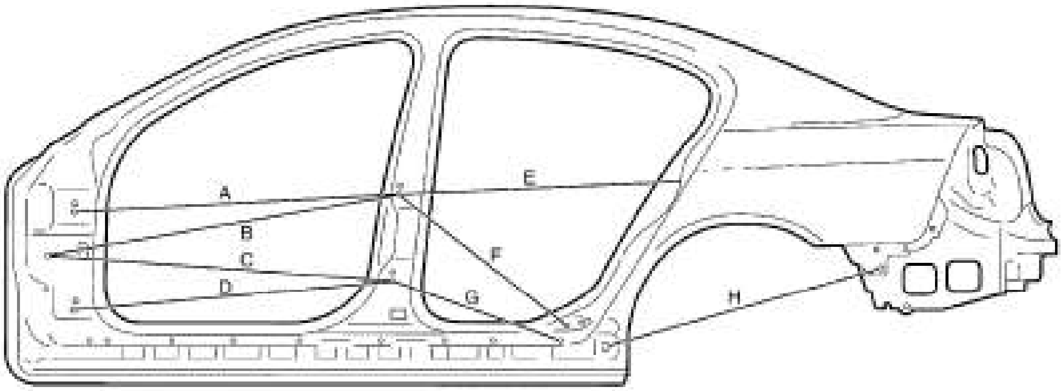
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Repair | Collision Repair | Specifications | Document ID: 1990925

Dimensions - Body (SWB)



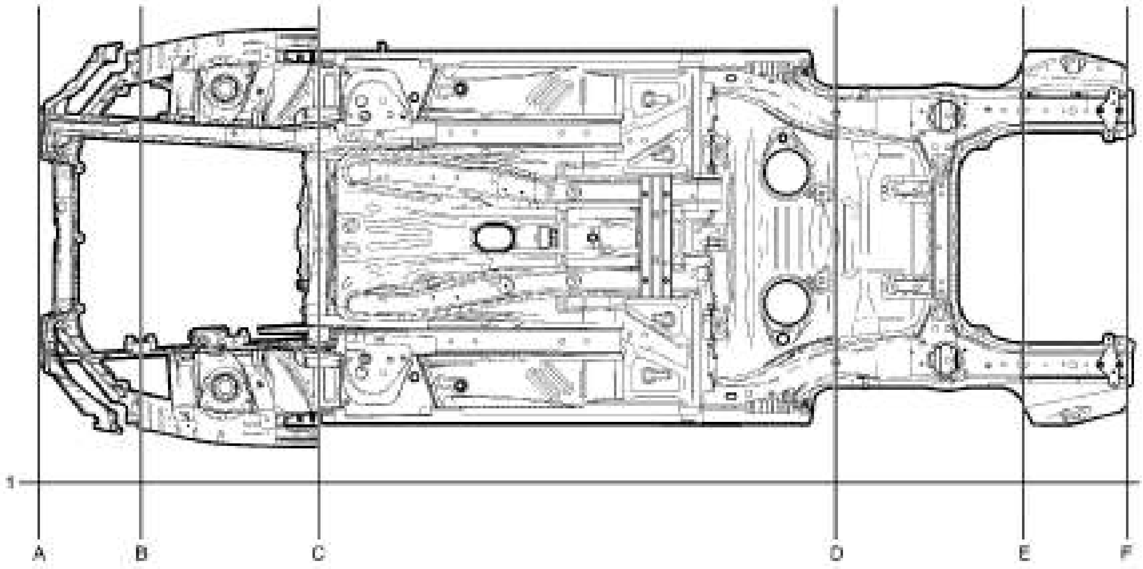
Location	Description	Length	Width	Height
1	Zero Line 25 mm Gage Hole	0	1660 mm (65.35 in)	550 mm (21.65 in)
A	Door Hinge Attach	76 mm (2.99 in)	1687 mm (66.42 in)	363 mm (14.29 in)
B	Door Hinge Attach	155 mm (6.1 in)	1592 mm (62.68 in)	452 mm (17.8 in)
C	Door Hinge Attach	1186 mm (46.69 in)	1704 mm (67.09 in)	756 mm (29.76 in)
D	Door Lock Striker Attach	1170 mm (46.06 in)	1633 mm (64.29 in)	581 mm (22.87 in)
E	Door Hinge Attach	1166 mm (45.91 in)	1702 mm (67.01 in)	461 mm (18.15 in)
F	Upper Door Lock Striker Attach	2131 mm (83.9 in)	1640 mm (64.57 in)	795 mm (31.3 in)
All dimensions are measured from a zero line, a center line, and a common datum. All dimensions are symmetrical unless otherwise specified.				

Point-to-Point Measurements



Location	Description	Length
A	Lower Top Front Door Hinge Hole to Lower Top Rear Door Hinge Hole	1103 mm (43.43 in)
B	Hinge Pillar Datum Hole to Lower Top Rear Door Hinge Hole	1205 mm (47.44 in)
C	Hinge Pillar Datum Hole to Lower Bottom Rear Door Hinge Hole	1170 mm (46.06 in)
D	Lower Bottom Front Door Hinge Hole to Lower Bottom Rear Door Hinge Hole	1086 mm (42.76 in)
E	Lower Top Rear Door Hinge Hole to Upper Rear Door Striker Hole	948 mm (37.32 in)
F	Lower Top Rear Door Hinge Hole to Lower Body Side Datum Hole	880 mm (34.65 in)
G	Lower Bottom Front Door Hinge Hole to Lower Body Side Datum Hole	763 mm (30.04 in)
H	Lower Body Side Datum Hole to Rear Body Side Datum Hole	961 mm (37.83 in)
All dimensions are symmetrical unless otherwise specified.		

Dimensions - Underbody



Location	Description	Length	Width	Height
1	Zero Line 18 mm Hole	1535 mm (60.43 in)	810 mm (31.89 in)	128 mm (5.04 in)
A	20 mm Hole	805 mm (31.69 in)	886 mm (34.88 in)	328 mm (12.91 in)
B	10 mm Bumper Mounting	1136 mm (44.72 in)	0	0
C	16 mm Hole	2140 mm (84.25 in)	1024 mm (40.31 in)	200 mm (7.87 in)
D	25.1 mm x 39.7 mm Gage Hole	2910 mm (114.57 in)	1048 mm (41.26 in)	434 mm (17.09 in)
E	25.1 mm x 39.7 mm Gage Hole	3114 mm (122.60 in)	1048 mm (41.26 in)	434 mm (17.09 in)
F	18 mm Bumper Mounting	3335 mm (131.30 in)	0	0
All dimensions are measured from a zero line, a center line, and a common datum. All dimensions are symmetrical unless otherwise specified.				

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Repair | Collision Repair | Specifications | **Document ID: 2150488**

Dimensions - Body (Sportwagon)

Vehicle Dimensions - Main

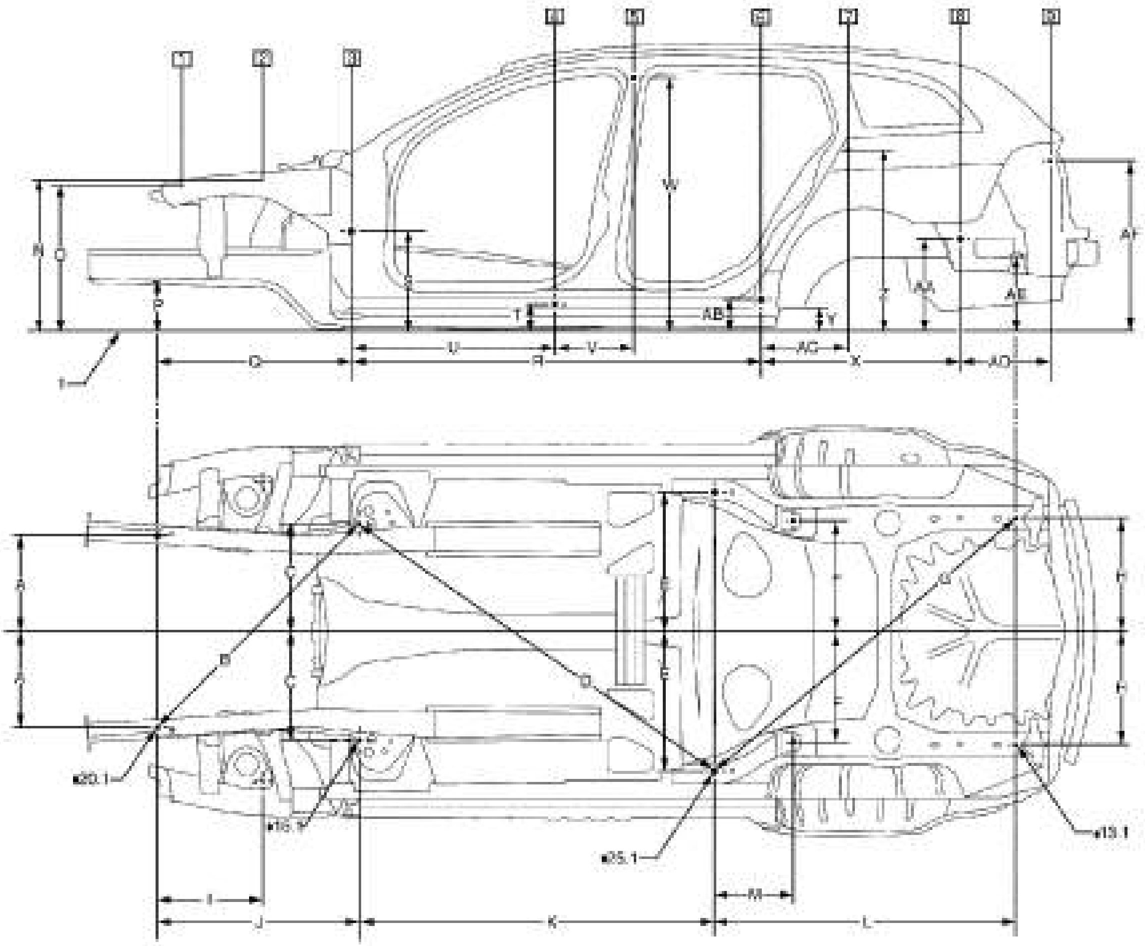
Important:: Dimensions are measured from the centre of holes, on the outer side of the metal surface.

Important:: The main datum surface (1) is the underside of each outrigger at the 16.1mm dia datum hole. The main datum surface (1) is parallel with the bottom of each rocker assembly inboard of the pinch weld flange.

Important:: All dimensions are projected to be either parallel with or at 90 degrees to the main datum surface (1).

Important:: The plan view is shown as viewed from beneath the vehicle.

Important:: For location details of measurement points 1 -- 9, refer to Vehicle Dimensions - Measuring Points.



Location	Description	Length
A	Centreline of vehicle to centre of 20.1mm dia datum hole	444 mm (17.48 in)
B	Centre of 20.1mm dia datum hole to centre of 16.1mm dia datum hole	1329 mm (52.31 in)
C	Centreline of vehicle to centre of 16.1mm datum dia hole	500 mm (19.69 in)
D	Centre of 16.1mm dia datum hole to centre of 25.1mm dia datum hole	2004 mm (78.91 in)
E	Centreline of vehicle to centre of 25.1mm datum dia hole	645 mm (25.39 in)
F	Centreline of vehicle to centre of rear frame mounting hole	512 mm (20.16 in)
G	Centre of 25.1mm dia datum hole to centre of 13.1mm dia datum hole	1820 mm (71.66 in)
H	Centreline of vehicle to centre of 13.1mm datum dia hole	524 mm (20.63 in)
I	Centre of 20.1mm dia datum hole to centre of 10.1mm dia datum hole	481 mm (18.92 in)
J	Centre of 20.1mm dia datum hole to centre of 16.1mm dia datum hole	935 mm (36.81 in)
K	Centre of 16.1mm dia datum hole to centre of 25.1mm dia datum hole	1645 mm (64.76 in)
L	Centre of 25.1mm dia datum hole to centre of 13.1mm dia datum hole	1395 mm (54.92 in)
M	Centre of 25.1mm dia datum hole to centre of rear frame mounting hole	365 mm (14.37 in)
N	Datum surface 1 to centre of 10.1mm dia datum hole	693 mm (27.27 in)
O	Datum surface 1 to centre of 9.9mm dia hole	661 mm (26.01 in)
P	Datum surface 1 to centre of 20.1mm dia datum hole	232 mm (9.14 in)
Q	Centre of 20.1mm dia datum hole to centre of 25.1mm dia datum hole	900 mm (35.43 in)
R	Centre of 25.1mm dia datum hole to centre of 25.1mm dia datum hole	1895 mm (74.61 in)
S	Datum surface 1 to centre of 25.1mm dia datum hole	455 mm (17.93 in)
T	Datum surface 1 to centre of 16.1mm dia datum hole	140 mm (5.53 in)
U	Centre of 25.1mm dia datum hole to centre of 16.1mm dia datum hole	940 mm (37.01 in)
V	Centre of 25.1mm dia datum hole to centre of 13.1mm dia datum hole	524 mm (20.63 in)
		1165 mm

W	Datum surface 1 to centre of 13.1mm dia datum hole	(45.88 in)
X	Centre of 25.1mm dia datum hole to centre of 20.1mm dia datum hole	920 mm (36.20 in)
Y	Datum surface 1 to centre of rear frame mounting hole	103 mm (4.07 in)
Z	Datum surface 1 to centre of 8.2mm dia hole	809 mm (31.83 in)
AA	Datum surface 1 to centre of 20.1mm dia datum hole	420 mm (16.54 in)
AB	Datum surface 1 to centre of 25.1mm dia datum hole	140 mm (5.52 in)
AC	Centre of 25.1mm dia datum hole to centre of 8.2mm dia hole	379 mm (15.65 in)
AD	Centre of 20.1mm dia datum hole to centre of 16.1mm dia datum hole	418 mm (16.47 in)
AE	Datum surface 1 to centre of 13.1mm dia datum hole	338 mm (13.31 in)
AF	Datum surface 1 to centre of 16.1mm dia datum hole	786 mm (30.93 in)

Vehicle Dimensions - Engine Compartment

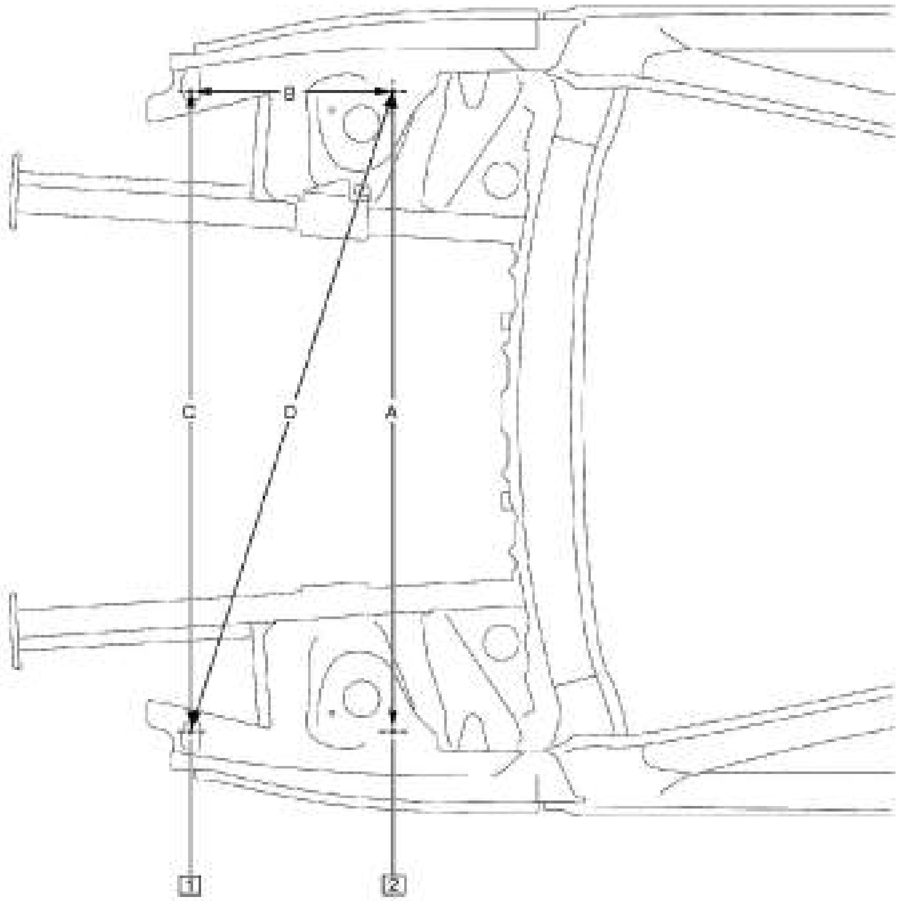
Important:: Dimensions are measured from the centre of holes, on the outer side of the metal surface.

Important:: The main datum surface (1) is the underside of each outrigger at the 16.1mm dia datum hole. The main datum surface (1) is parallel with the bottom of each rocker assembly inboard of the pinch weld flange.

Important:: All dimensions are projected to be either parallel with the main datum surface (1). Refer to Vehicle Dimensions - Main.

Important:: The plan view is shown as viewed from above the vehicle.

Important:: For location details of measurement points 1 -- 2, refer to Vehicle Dimensions - Measuring Points.

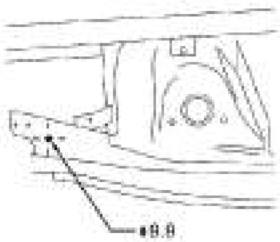


Location	Description	Length
A	Centre of 10.1mm dia datum hole to centre of 10.1mm dia datum hole	1574 mm (61.99 in)
B	Centre of 10.1mm dia datum hole to centre of 9.9mm dia hole	427 mm (16.82 in)
C	Centre of 9.9mm dia hole to centre of 9.9mm dia hole	1511 mm (59.47 in)
D	Centre of 9.9mm dia hole to centre of 10.1mm dia datum hole	1600 mm (63.00 in)

Vehicle Dimensions - Measuring Points

Important: Dimensions are measured from the centre of holes, on the outer side of the metal surface.

1



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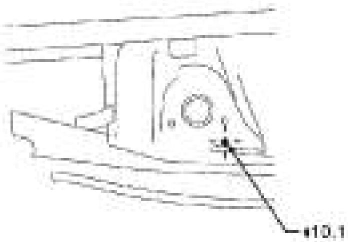

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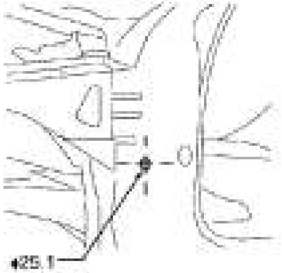

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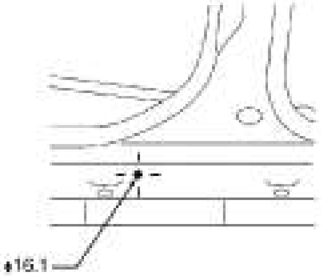

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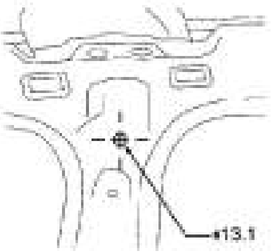

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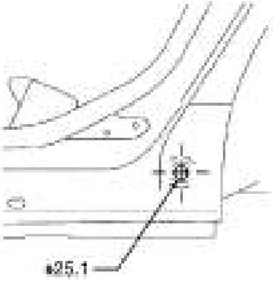

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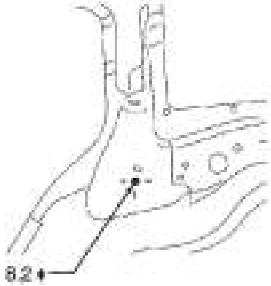

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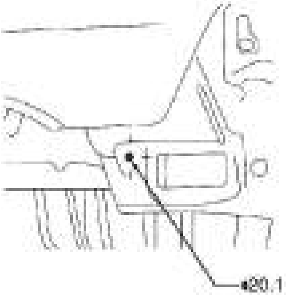

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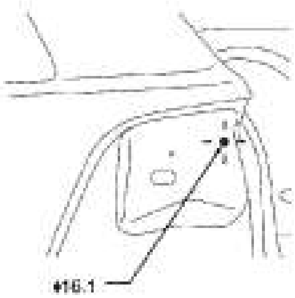
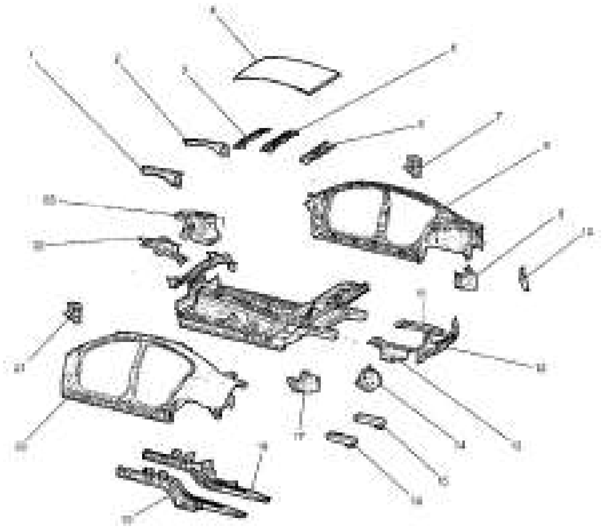


2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Repair | Collision Repair | Visual Identification | **Document ID: 1997539**

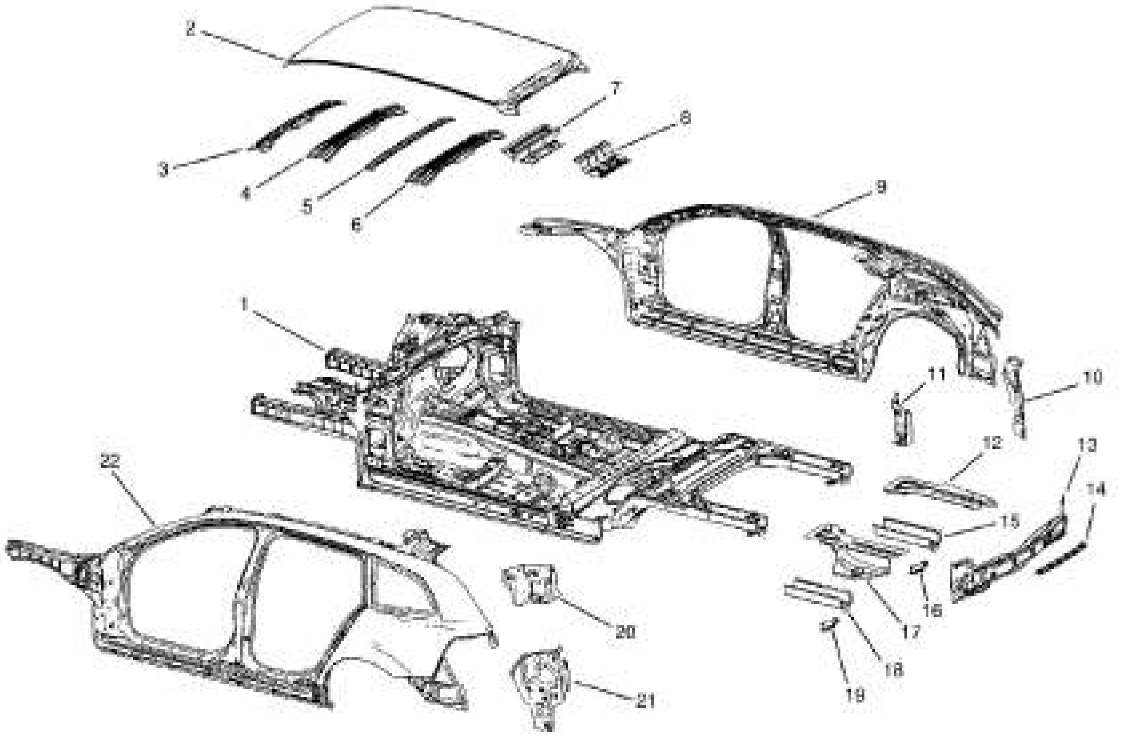
Panel Identification (SWB)



(1) Front Wheelhouse Brace Left
(2) Front Wheelhouse Brace Right
(3) Front Roof Header Bow
(4) Roof Panel
(5) Centre Roof Header Bow
(6) Rear Roof Header Bow
(7) Body Side Ring Right
(8) Hinge Pillar Brace Right
(9) Lower Quarter Panel Body Extension Right
(10) Tail Lamp Filler Right
(11) Rear Compartment Extension Floor Panel Right
(12) Rear End Panel
(13) Rear Compartment Extension Floor Panel Left
(14) Tail Lamp Filler Left
(15) Rear Chassis Rail Extension Right
(16) Rear Chassis Rail Extension Left
(17) Lower Quarter Panel Body Extension Left
(18) Front Chassis Rail Right
(19) Front Chassis Rail Left
(20) Body Side Ring Left
(21) Hinge Pillar Brace Left
(22) Front Wheelhouse Left
(23) Front Wheelhouse Right

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Repair | Collision Repair | Visual Identification | Document ID: 2100343

Panel Identification (Sportwagon)



(1) Underbody Assembly
(2) Roof Outer Panel
(3) Roof Front Header Panel
(4) Roof Panel Bow (Front)
(5) Roof Panel Bow (Centre)
(6) Roof Panel Bow (Rear)
(7) Roof Rear Header Panel (Outer)
(8) Roof Rear Header Panel (Inner)
(9) Body Side Assembly (RH)
(10) Tail Lamp Filler Panel (RH)
(11) Rear End Panel Filler (RH)
(12) Body Side Inner Panel Extension (RH)
(13) Rear End Panel Assembly
(14) Rear Bumper Fascia Centre Support
(15) Rear Rail Extension (RH)
(16) Exhaust Mount Bracket (RH)
(17) Body Side Inner Panel Extension (LH)
(18) Rear Rail Extension (LH)

(19) Exhaust Mount Bracket (LH)
(20) Rear End Panel Filler (LH)
(21) Tail Lamp Filler Panel (LH)
(22) Body Side Assembly (LH)

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Repair | Collision Repair | Repair Instructions | **Document ID: 2148102**

Front Compartment Side Rail Bracket Replacement

Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

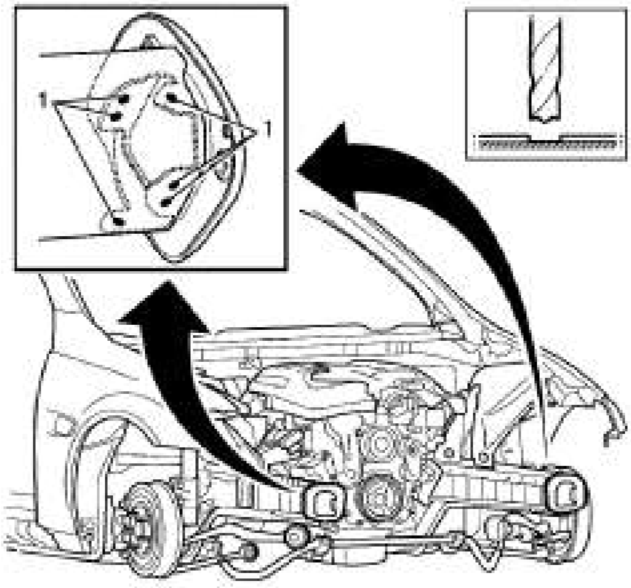
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

Caution: Refer to Battery Disconnect Caution in the Preface section.

Important: Disable the SIR system. Refer to SIR Disabling and Enabling.

1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the front fascia. Refer to Front Bumper Fascia Replacement.
3. Remove the front end module. Refer to Front End Panel Module Carrier Assembly Replacement.
4. Remove the coolant reservoir. Refer to Coolant Recovery Reservoir Replacement.
5. Remove the washer solvent container. Refer to Windshield Wiper and Washer Switch Replacement.
6. Remove the cooling fan and shroud. Refer to Cooling Fan and Shroud Replacement.
7. Remove the radiator. Refer to Radiator Replacement.
8. Remove the front bumper impact bar bracket. Refer to Front Bumper Impact Bar Replacement.
9. Note the location and remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.



Important: Note the orientation of the front rail end crush cap for installation.

10. Locate, mark and drill out all factory welds attaching the front rail end crush cap to the front rail assembly (1).

Installation Procedure

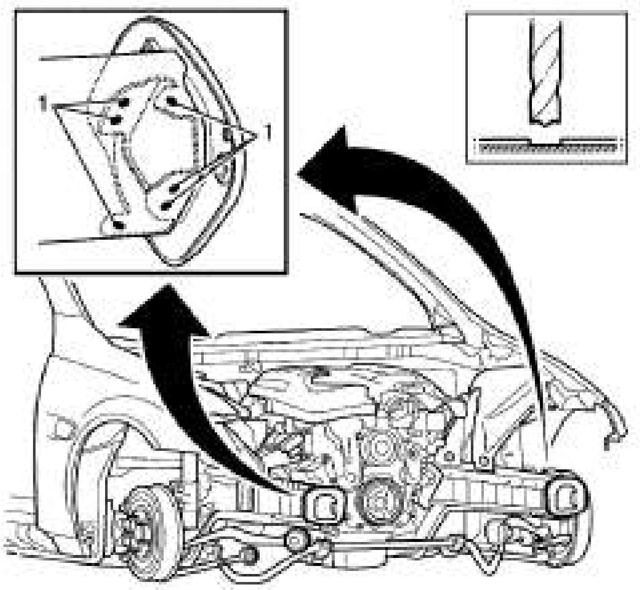
Important: If the front rail is damaged, the front rail must be replaced.

Important: Spot welding is the preferred method for attaching panels and should be used whenever possible. A plug weld should only be performed where spot welding is not possible.

Important: If the location of the original spot weld holes cannot be determined, or if structural weld-thru adhesive is present, space the puddle weld holes every 32 mm (1¼ in).

1. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted from the original assembly.
2. Clean and prepare the mating surfaces of both the front rail and the front rail end crush cap.

Important: Secondary sealer must be applied to the perimeter of all flanges. Secondary sealer must be applied to all welds/joints that were originally covered by secondary sealer.



3. Align the new front rail end crush cap to the weld points marked during the removal from the front rail assembly and weld the front end crush cap to the front rail assembly (1).
4. Install the front bumper impact bar bracket. Refer to Front Bumper Impact Bar Replacement.
5. Install the radiator. Refer to Radiator Replacement.
6. Install the cooling fan and shroud. Refer to Cooling Fan and Shroud Replacement.
7. Install the washer solvent container. Refer to Windshield Wiper and Washer Switch Replacement.
8. Install the coolant reservoir. Refer to Coolant Recovery Reservoir Replacement.
9. Install the front end module. Refer to Front End Panel Module Carrier Assembly Replacement.
10. Install the front fascia. Refer to Front Bumper Fascia Replacement.

11. Install the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
12. Enable the SIR system. Refer to SIR Disabling and Enabling.

Front Wheelhouse Replacement

Removal Procedure - After xx/xx

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

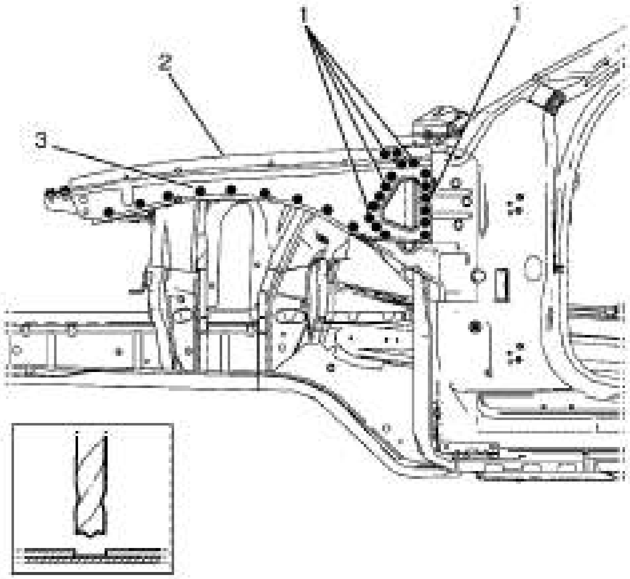
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Battery Disconnect Caution in the Preface section.

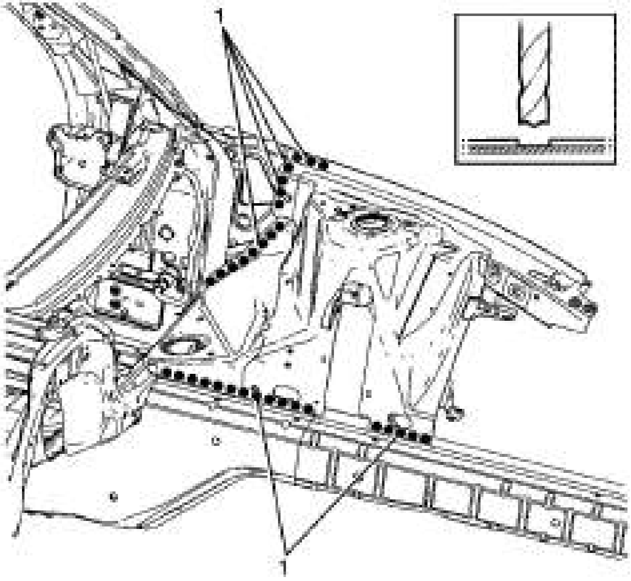
1. Disable the SIR system. Refer to SIR Disabling and Enabling.
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove the engine assembly. Refer to Engine Replacement or Engine Replacement.
4. Remove the negative cable from the engine bay. Refer to Battery Negative Cable Replacement .
5. Remove the positive cable from the engine bay. Refer to Battery Positive Cable Replacement .
6. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
7. Remove the front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement .
8. Remove the front wheel hub assembly. Refer to Front Wheel Bearing and Hub Replacement .
9. Remove the front strut assembly. Refer to Strut Assembly Replacement .
10. Lower the vehicle.
11. Remove the brake lines. Refer to Brake Pipe Replacement.
12. Remove the fender assembly. Refer to Front Fender Replacement.
13. Remove the front fascia. Refer to Front Bumper Fascia Replacement.
14. Remove the coolant reservoir. Refer to Coolant Recovery Reservoir Replacement.
15. Remove the front end module. Refer to Front End Panel Module Carrier Assembly Replacement.
16. Remove the air inlet grille. Refer to Air Inlet Grille Panel Replacement.
17. Remove the plenum chamber. Refer to Air Inlet Assembly Replacement.
18. Remove the relay box. Refer to Underhood Electrical Center or Junction Block Replacement.
19. Remove the ABS unit. Refer to Brake Pressure Modulator Valve Assembly Replacement.
20. Remove the brake master cylinder. Refer to Master Cylinder Replacement .
21. Remove the instrument panel. Refer to Instrument Panel Carrier Replacement.
22. Remove the HVAC. Refer to HVAC Module Assembly Replacement.
23. Remove the front floor carpet. Refer to Front Floor Panel Carpet Replacement .

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

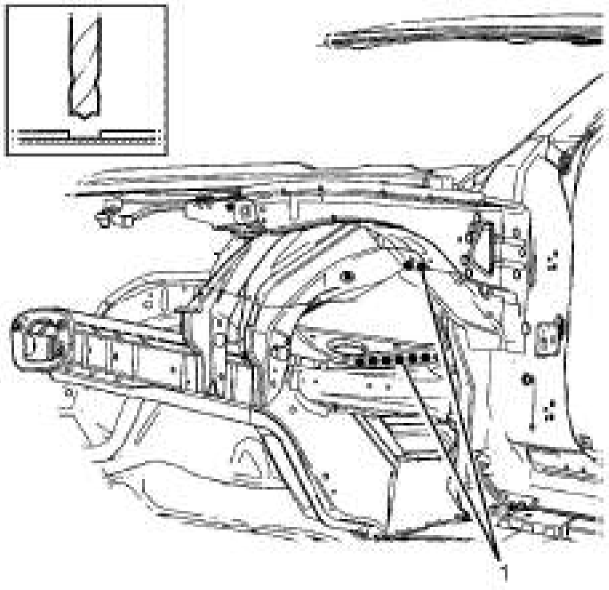
24. Note the location and remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.



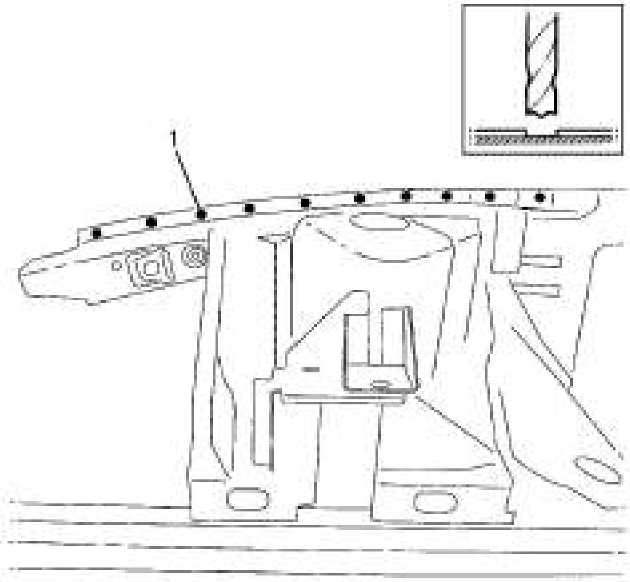
25. Locate, mark and drill out the inner factory welds (1) attaching the upper wheelhouse brace (2) to the wheelhouse assembly.
26. Locate, mark and drill out the inner factory welds (3) attaching the upper wheelhouse brace (2) to the wheelhouse assembly.



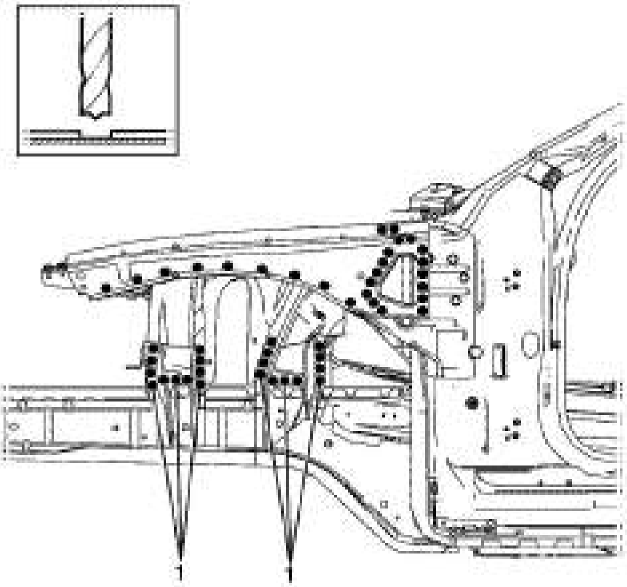
27. Locate, mark and drill out the inner factory welds (1) attaching the wheelhouse assembly to the vehicle.



28. Locate, mark and drill out the factory welds (1) attaching the wheelhouse assembly to the cowl panel.



29. Locate, mark and drill out the factory welds (1) attaching the wheelhouse assembly to the upper wheelhouse brace.



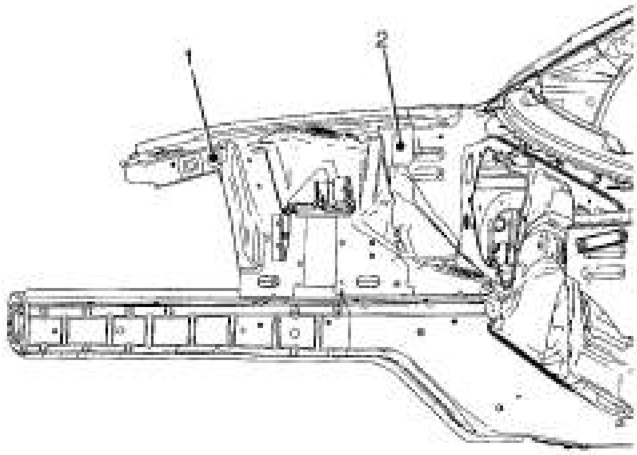
30. Locate, mark and drill out the factory welds (1) attaching the wheelhouse assembly to the front chassis rail.

Installation Procedure - After xx/xx

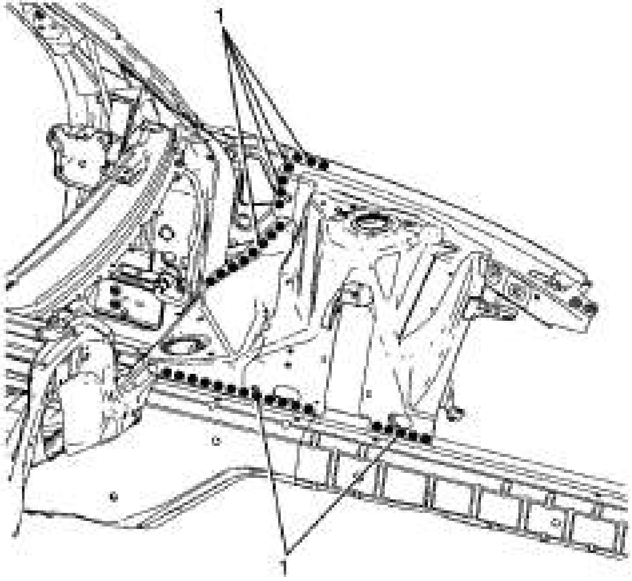
1. Clean and prepare the mating surfaces of both parts of the front chassis rail.
2. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted from the original assembly.

   Important: If the location of the original plug weld holes can not be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 32 mm (1¼ in).

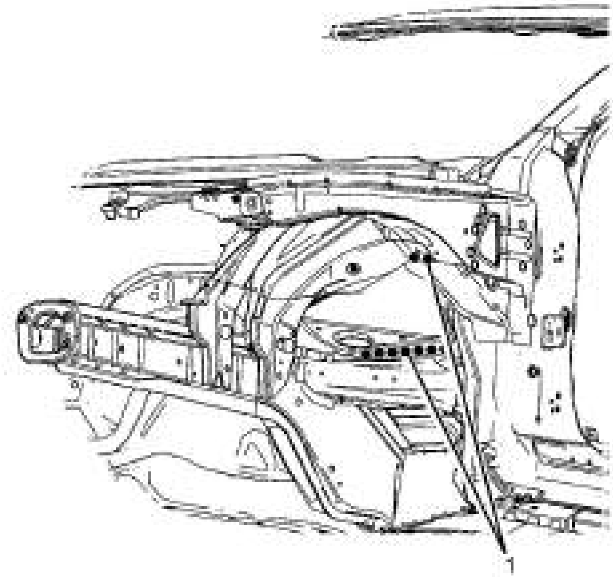
3. Position the body side on the vehicle. Verify correct alignment and position using three-dimensional measuring equipment.



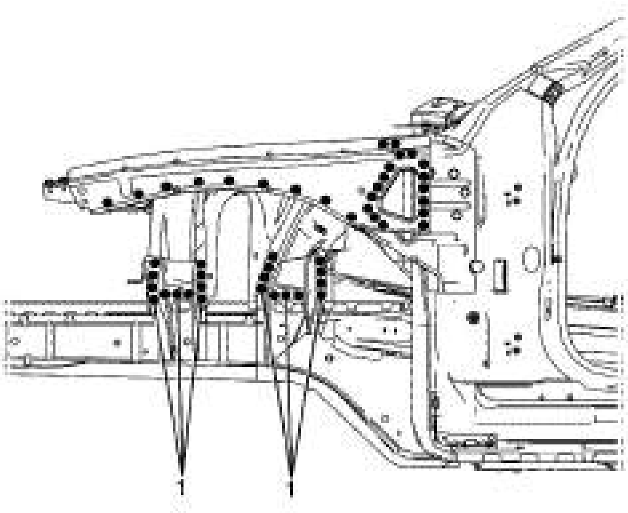
4. Align the datum points (1) and (2) to the vehicle.



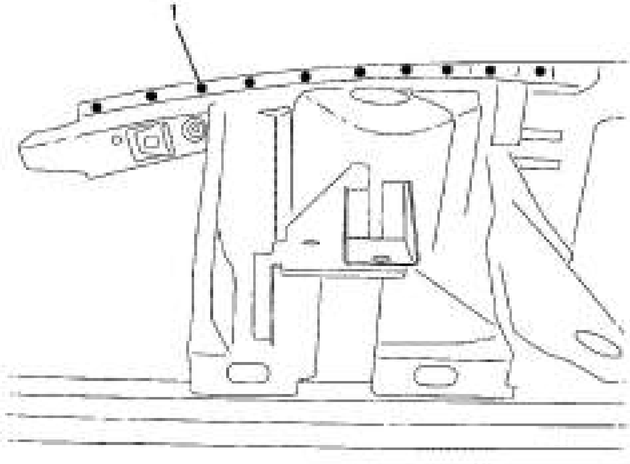
5. Weld (1) the wheelhouse assembly to the vehicle starting from the front chassis rail.



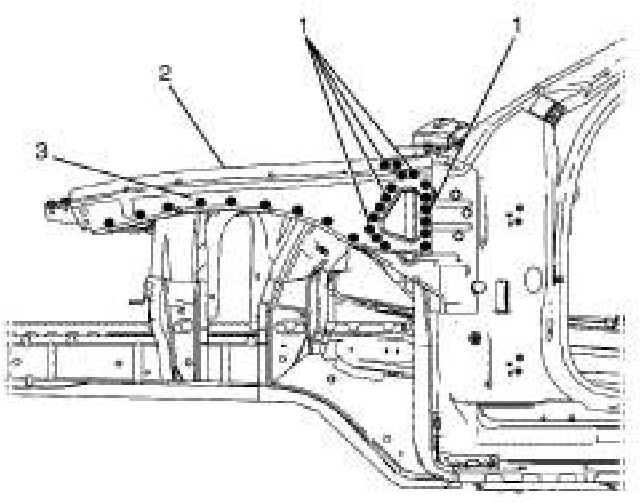
6. Weld (1) the wheelhouse assembly to the vehicle starting from the cowl panel.



7. Weld (2) the wheelhouse assembly to the vehicle starting from the front chassis rail.



8. Weld (1) the wheelhouse assembly to the upper wheelhouse brace.



9. Weld (1) the upper wheelhouse brace (2) to the wheelhouse assembly.
10. Weld (3) the upper wheelhouse brace (2) to the wheelhouse assembly.
11. Clean and prepare all welded surfaces.
12. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.
13. Install the front floor carpet. Refer to Front Floor Panel Carpet Replacement .
14. Install the HVAC. Refer to HVAC Module Assembly Replacement.
15. If re-programming is required. Refer to Control Module References .
16. Install the instrument panel. Refer to Instrument Panel Carrier Replacement .
17. If re-programming is required. Refer to Control Module References .
18. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
19. Install the brake master cylinder. Refer to Master Cylinder Replacement .
20. Install the ABS unit. Refer to Brake Pressure Modulator Valve Assembly Replacement.
21. If re-programming is required. Refer to Control Module References .
22. Install the relay box. Refer to Underhood Electrical Center or Junction Block Replacement.
23. Install the plenum chamber. Refer to Air Inlet Assembly Replacement.
24. Install the air inlet grille. Refer to Air Inlet Grille Panel Replacement .
25. Install the front end module. Refer to Front End Panel Module Carrier Assembly Replacement .
26. Install the coolant reservoir. Refer to Coolant Recovery Reservoir Replacement .
27. Install the front fascia. Refer to Front Bumper Fascia Replacement.
28. Install the fender assembly. Refer to Front Fender Replacement.
29. Install the brake lines. Refer to Brake Pipe Replacement.
30. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
31. Install the front strut assembly. Refer to Strut Assembly Replacement .
32. Install the front wheel hub assembly. Refer to Front Wheel Bearing and Hub Replacement .
33. Install the front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement .
34. Install the front wheels. Refer to Tire and Wheel Removal and Installation.
35. Lower the vehicle.
36. Install the engine assembly. Refer to Engine Replacement or Engine Replacement.
37. Install the positive cable to the engine bay. Refer to Battery Positive Cable Replacement .
38. Install the negative cable to the engine bay. Refer to Battery Negative Cable Replacement .
39. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
40. Enable the SIR system. Refer to SIR Disabling and Enabling.

41. If re-programming is required. Refer to Control Module References .

Removal Procedure - Upto xx/xx

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

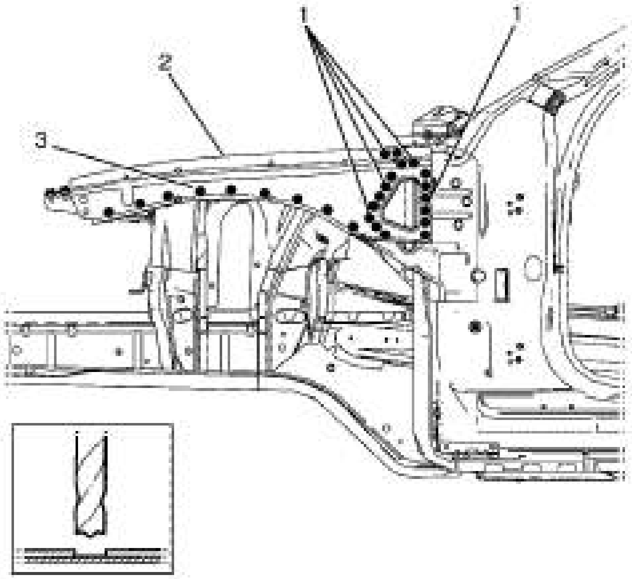
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Battery Disconnect Caution in the Preface section.

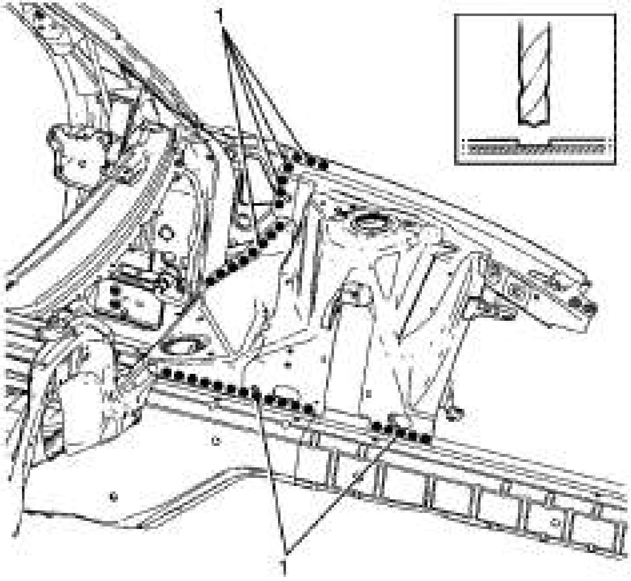
1. Disable the SIR system. Refer to SIR Disabling and Enabling.
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove the engine assembly. Refer to Engine Replacement or Engine Replacement.
4. Remove the negative cable from the engine bay. Refer to Battery Negative Cable Replacement .
5. Remove the positive cable from the engine bay. Refer to Battery Positive Cable Replacement .
6. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
7. Remove the front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement .
8. Remove the front wheel hub assembly. Refer to Front Wheel Bearing and Hub Replacement .
9. Remove the front strut assembly. Refer to Strut Assembly Replacement .
10. Lower the vehicle.
11. Remove the brake lines. Refer to Brake Pipe Replacement.
12. Remove the fender assembly. Refer to Front Fender Replacement.
13. Remove the front fascia. Refer to Front Bumper Fascia Replacement.
14. Remove the coolant reservoir. Refer to Coolant Recovery Reservoir Replacement.
15. Remove the front end module. Refer to Front End Panel Module Carrier Assembly Replacement.
16. Remove the air inlet grille. Refer to Air Inlet Grille Panel Replacement.
17. Remove the plenum chamber. Refer to Air Inlet Assembly Replacement.
18. Remove the relay box. Refer to Underhood Electrical Center or Junction Block Replacement.
19. Remove the ABS unit. Refer to Brake Pressure Modulator Valve Assembly Replacement.
20. Remove the brake master cylinder. Refer to Master Cylinder Replacement .
21. Remove the instrument panel. Refer to Instrument Panel Carrier Replacement.
22. Remove the HVAC. Refer to HVAC Module Assembly Replacement.
23. Remove the front floor carpet. Refer to Front Floor Panel Carpet Replacement .

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

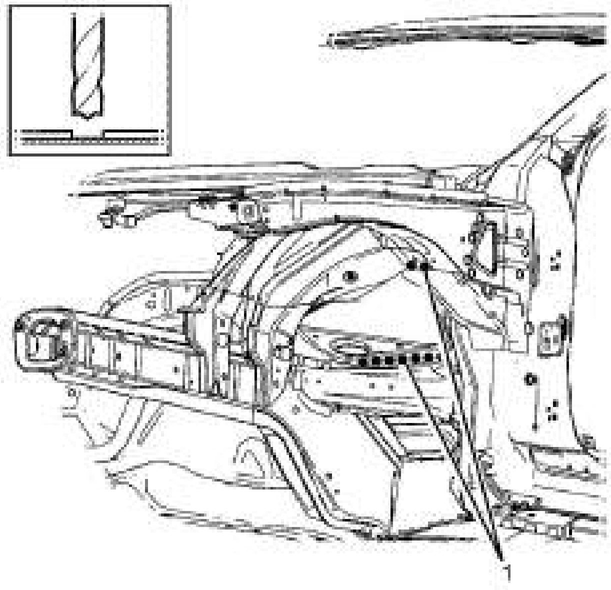
24. Note the location and remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.



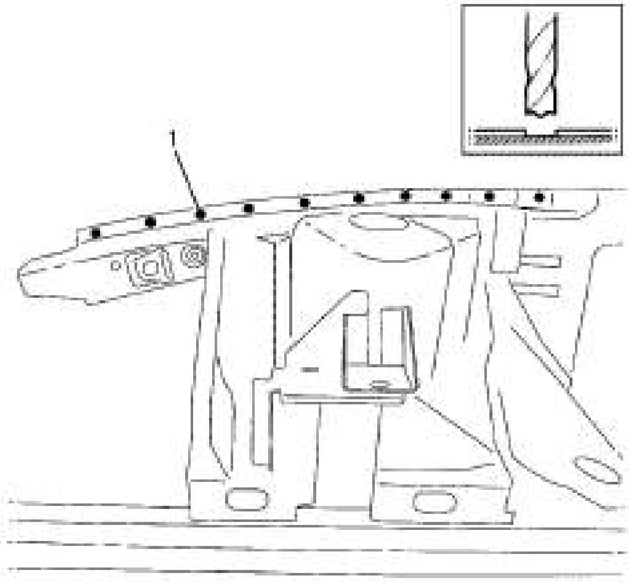
25. Locate, mark and drill out the inner factory welds (1) attaching the upper wheelhouse brace (2) to the wheelhouse assembly.
26. Locate, mark and drill out the inner factory welds (3) attaching the upper wheelhouse brace (2) to the wheelhouse assembly.



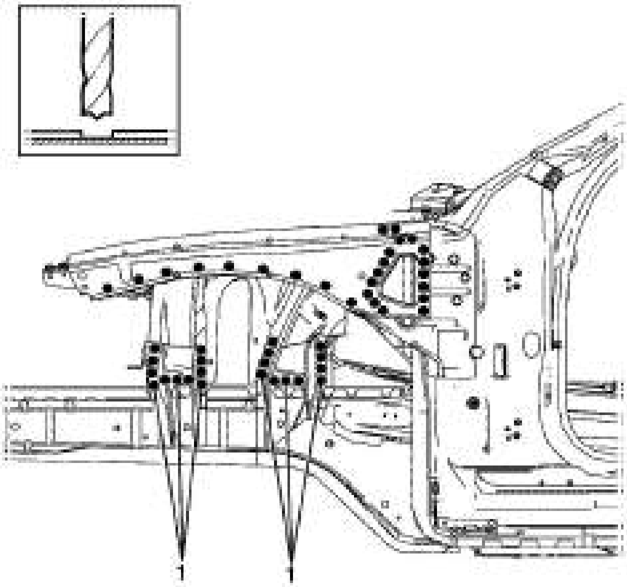
27. Locate, mark and drill out the inner factory welds (1) attaching the wheelhouse assembly to the vehicle.



28. Locate, mark and drill out the factory welds (1) attaching the wheelhouse assembly to the cowl panel.



29. Locate, mark and drill out the factory welds (1) attaching the wheelhouse assembly to the upper wheelhouse brace.



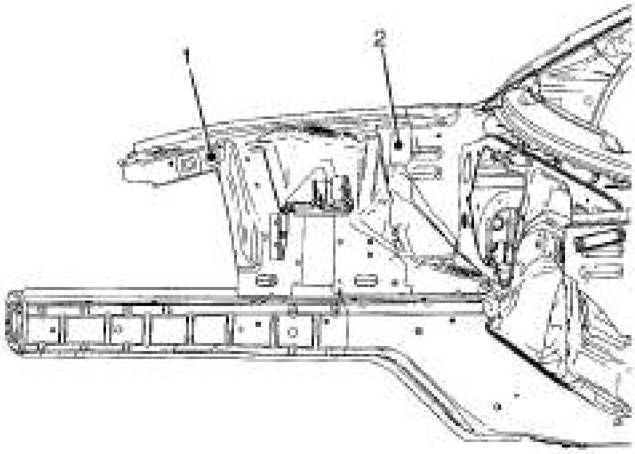
30. Locate, mark and drill out the factory welds (1) attaching the wheelhouse assembly to the front chassis rail.

Installation Procedure - After xx/xx

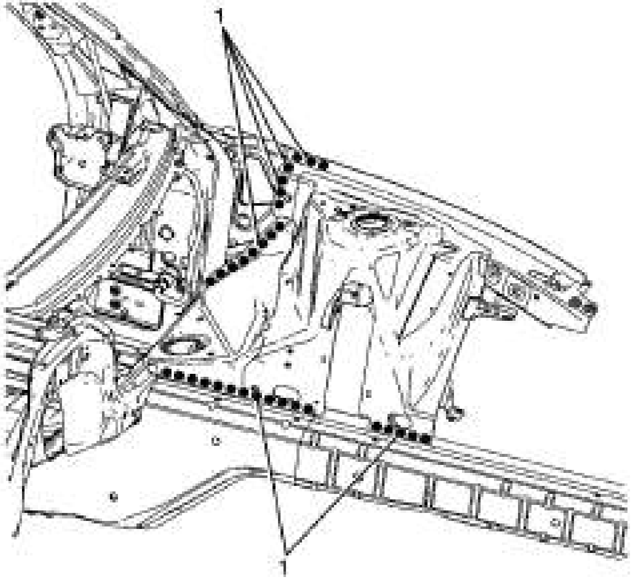
1. Clean and prepare the mating surfaces of both parts of the front chassis rail.
2. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted from the original assembly.

   Important: If the location of the original plug weld holes can not be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 32 mm (1¼ in).

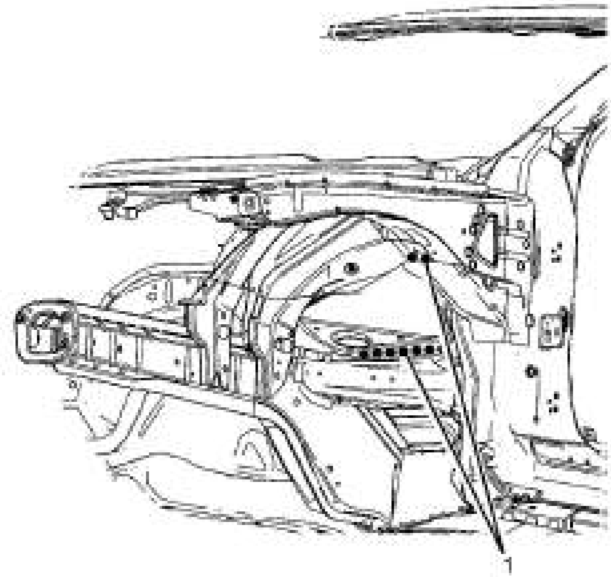
3. Position the body side on the vehicle. Verify correct alignment and position using three-dimensional measuring equipment.



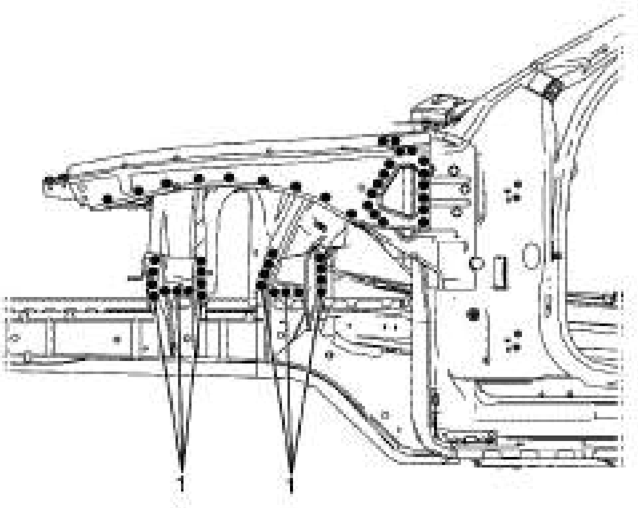
4. Align the datum points (1) and (2) to the vehicle.



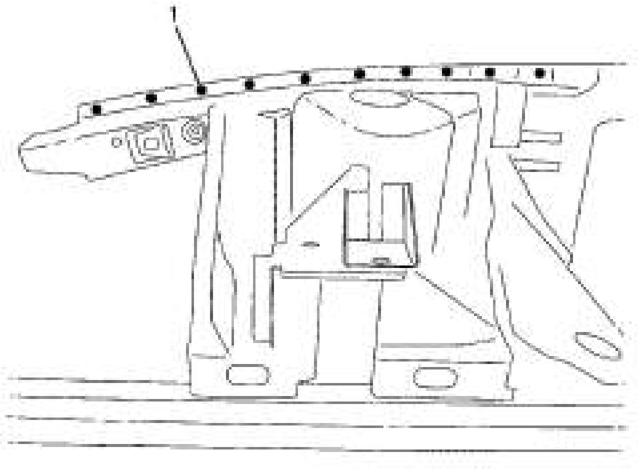
5. Weld (1) the wheelhouse assembly to the vehicle starting from the front chassis rail.



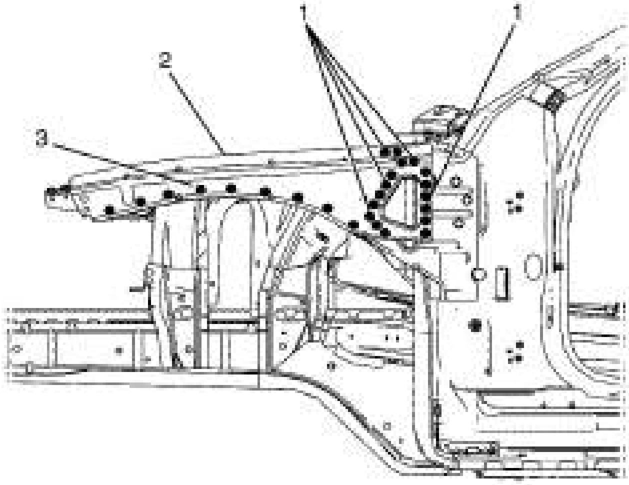
6. Weld (1) the wheelhouse assembly to the vehicle starting from the cowl panel.



7. Weld (2) the wheelhouse assembly to the vehicle starting from the front chassis rail.



8. Weld (1) the wheelhouse assembly to the upper wheelhouse brace.



9. Weld (1) the upper wheelhouse brace (2) to the wheelhouse assembly.
10. Weld (3) the upper wheelhouse brace (2) to the wheelhouse assembly.

Important: Before attaching fender, apply a film of erurethane approximately 300mm x 25mm wide to the upper wheel house brace (2).

11. Clean and prepare all welded surfaces.
12. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.
13. Install the front floor carpet. Refer to Front Floor Panel Carpet Replacement .
14. Install the HVAC. Refer to HVAC Module Assembly Replacement.
15. If re-programming is required. Refer to Control Module References .
16. Install the instrument panel. Refer to Instrument Panel Carrier Replacement .
17. If re-programming is required. Refer to Control Module References .
18. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
19. Install the brake master cylinder. Refer to Master Cylinder Replacement .
20. Install the ABS unit. Refer to Brake Pressure Modulator Valve Assembly Replacement.
21. If re-programming is required. Refer to Control Module References .
22. Install the relay box. Refer to Underhood Electrical Center or Junction Block Replacement.
23. Install the plenum chamber. Refer to Air Inlet Assembly Replacement.
24. Install the air inlet grille. Refer to Air Inlet Grille Panel Replacement .
25. Install the front end module. Refer to Front End Panel Module Carrier Assembly Replacement .
26. Install the coolant reservoir. Refer to Coolant Recovery Reservoir Replacement .
27. Install the front fascia. Refer to Front Bumper Fascia Replacement.
28. Install the fender assembly. Refer to Front Fender Replacement.
29. Install the brake lines. Refer to Brake Pipe Replacement.
30. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
31. Install the front strut assembly. Refer to Strut Assembly Replacement .
32. Install the front wheel hub assembly. Refer to Front Wheel Bearing and Hub Replacement .
33. Install the front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement .
34. Install the front wheels. Refer to Tire and Wheel Removal and Installation.
35. Lower the vehicle.
36. Install the engine assembly. Refer to Engine Replacement or Engine Replacement.

37. Install the positive cable to the engine bay. Refer to Battery Positive Cable Replacement .
38. Install the negative cable to the engine bay. Refer to Battery Negative Cable Replacement .
39. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
40. Enable the SIR system. Refer to SIR Disabling and Enabling.
41. If re-programming is required. Refer to Control Module References .

Front Compartment Front Rail Sectioning

Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

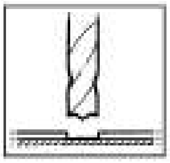
Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

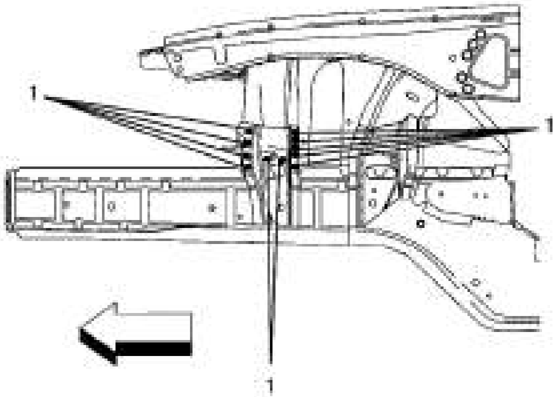
Caution: Refer to Battery Disconnect Caution in the Preface section.

Important:

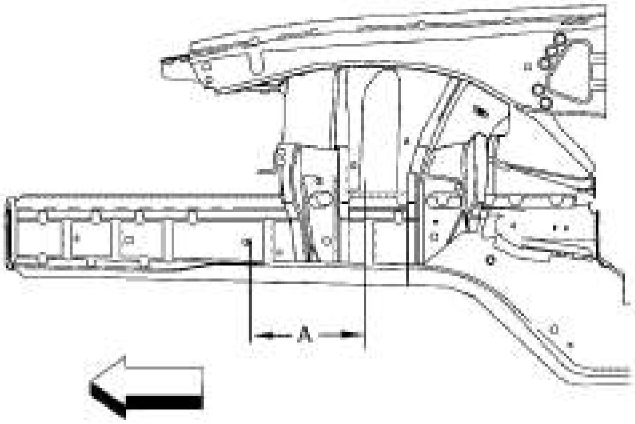
- Sectioning procedures have been developed to simplify the repair of the lower rails, as long as the damage rearward of the sectioning location can be repaired to factory specifications.
- Failure to follow the instructions may lead to improper rail sectioning, which may compromise the structural integrity of the vehicle.

1. Disable the SIR system. Refer to SIR Disabling and Enabling in SIR.
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove the engine assembly. Refer to Engine Replacement or Engine Replacement.
4. Remove the negative cable from the engine bay. Refer to Battery Negative Cable Replacement .
5. Remove the positive cable from the engine bay. Refer to Battery Positive Cable Replacement .
6. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
7. Remove the front wheels. Refer to Tire and Wheel Removal and Installation.
8. Remove the front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement .
9. Remove the front wheel hub assembly. Refer to Front Wheel Bearing and Hub Replacement .
10. Remove the front strut assembly. Refer to Strut Assembly Replacement .
11. Lower the vehicle.
12. Remove the brake lines. Refer to Brake Pipe Replacement.
13. Remove the front fascia. Refer to Front Bumper Fascia Replacement.
14. Remove the fender assembly. Refer to Front Fender Replacement.
15. Remove the coolant reservoir. Refer to Coolant Recovery Reservoir Replacement.
16. Remove the front end module. Refer to Front End Panel Module Carrier Assembly Replacement.
17. Remove the air inlet grille. Refer to Air Inlet Grille Panel Replacement.
18. Remove the plenum chamber. Refer to Air Inlet Assembly Replacement.
19. Remove the relay box. Refer to Underhood Electrical Center or Junction Block Replacement.
20. Remove the ABS unit. Refer to Brake Pressure Modulator Valve Assembly Replacement.
21. Remove the brake master cylinder. Refer to Master Cylinder Replacement .
22. Note the location and remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.



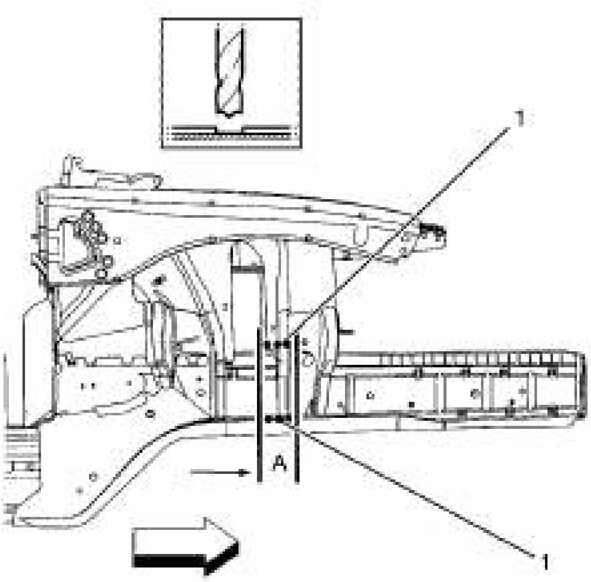


23. Locate, mark and drill out the front wheelhouse brace to front wheelhouse assembly spot welds (1).



24. Measure rearward from the datum hole to cut point 210 mm (8.27 in) (A).
25. Using a suitable tool cut through the inner and outer rail at the measurement point.
26. Remove the front section of the front chassis rail and discard.

    Discard the front section of the front chassis rail.



27. Measure rearward from the first cut point 50 mm (1.97 in) (A).
28. Locate, mark and drill out the spot welds (1) from the outer front chassis rail to the inner front chassis rail within the measurement made.

Important: Only cut the inner part of the front chassis rail to stagger the front chassis rail.

29. Using a suitable tool cut along the second cut point (A) on the inner front chassis rail and discard.

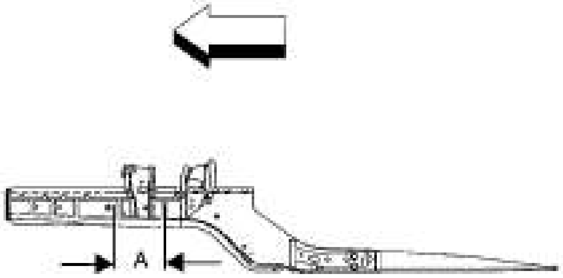
Discard the inner section of the front chassis rail.

Installation Procedure

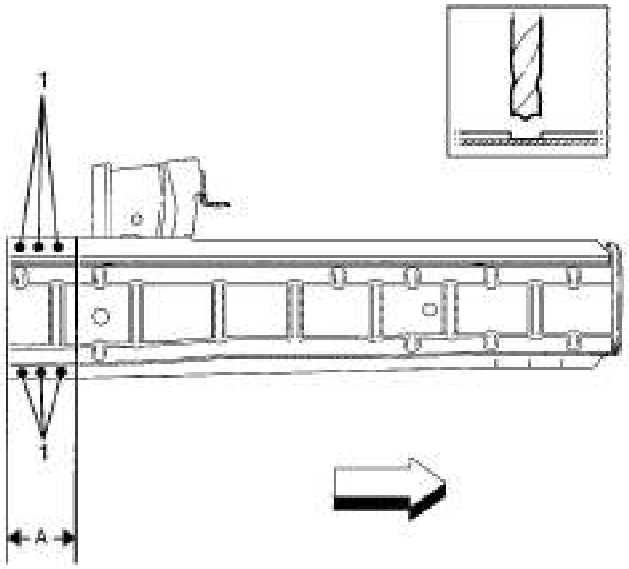
Important: Spot welding is the preferred method for attaching panels and should be used wherever possible. A plug weld should be performed where your spot welder is unable reach.

Important: If the location of the original plug weld holes can not be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 32 mm (1¼ in).

1. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted from the original assembly.
2. Clean and prepare the mating surfaces of both parts of the front chassis rail.



3. In order to create the rail section service part, cut the full rail service part at 260 mm (10.24 in) (A) rearward from the datum hole.



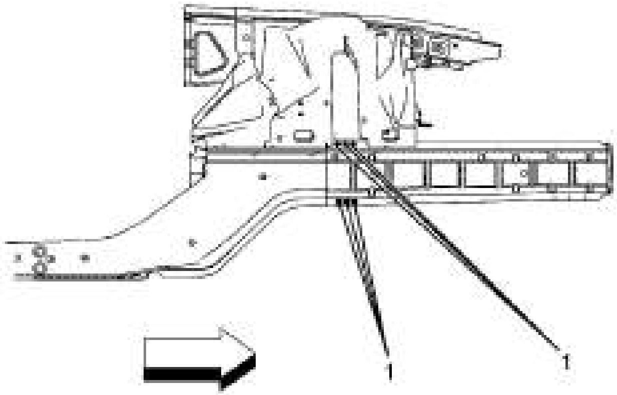
4. Measure forward from the first cut point 50 mm (1.97 in) (A) on the outer front chassis rail.
5. Locate, mark and drill out the spot welds (1) from the outer front chassis rail to the inner front chassis rail within the measurement made.

Important: Only cut the outer part of the front chassis rail to stagger the front chassis rail.

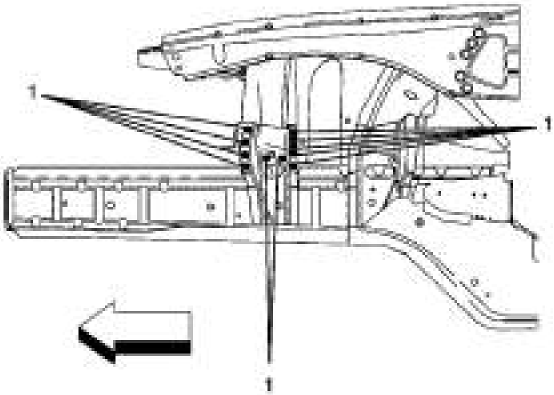
6. Cut along the second cut point (A) on the outer front chassis rail and discard.

   Discard the outer section of the front chassis rail.

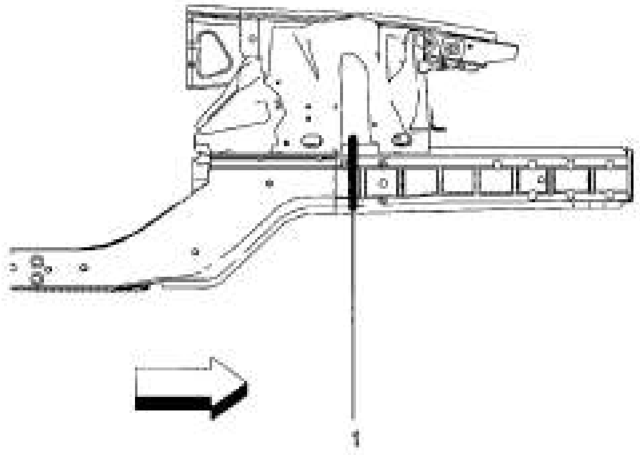
7. Clean and prepare the mating surfaces of both parts of the front chassis rail.



8. Position the front section of the front chassis rail to the remaining front chassis rail.
9. Weld the top and bottom (1) edges of the front chassis rail.

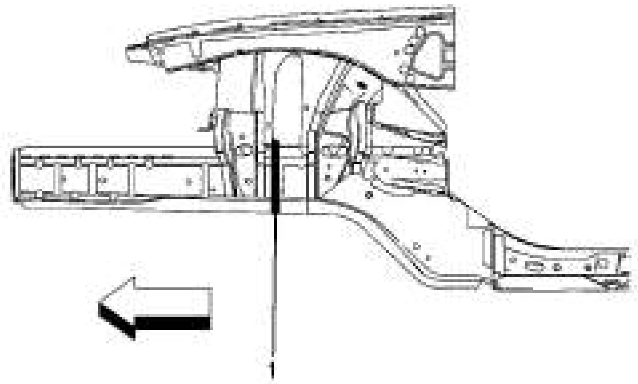


10. Weld (1) the front wheelhouse brace to front wheelhouse assembly.



Important: Care must be taken to minimise the heat absorbed by the panel which could lead to panel distortion.

11. Seam weld (1) the inner front portion of the chassis rail to the remaining front chassis rail.



12. Seam weld (1) the outer front portion of the chassis rail to the remaining front chassis rail.
13. Clean and prepare all of the welded surfaces.
14. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.
15. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
16. Install the brake master cylinder. Refer to Master Cylinder Replacement .
17. Install the ABS unit. Refer to Brake Pressure Modulator Valve Assembly Replacement.
18. If re-programming is required. Refer to Control Module References .

19. Install the relay box. Refer to Underhood Electrical Center or Junction Block Replacement.
20. Install the plenum chamber. Refer to Air Inlet Assembly Replacement.
21. Remove the air inlet grille. Refer to Air Inlet Grille Panel Replacement.
22. Install the front end module. Refer to Front End Panel Module Carrier Assembly Replacement .
23. Install the coolant reservoir. Refer to Coolant Recovery Reservoir Replacement .
24. Install the fender assembly. Refer to Front Fender Replacement.
25. Install the front fascia. Refer to Front Bumper Fascia Replacement.
26. Install the brake lines. Refer to Brake Pipe Replacement.
27. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
28. Install the front strut assembly. Refer to Strut Assembly Replacement .
29. Install the front wheel hub assembly. Refer to Front Wheel Bearing and Hub Replacement .
30. Install the front wheel house liner. Refer to Front Wheelhouse Liner Replacement .
31. Install the front wheels. Refer to Tire and Wheel Removal and Installation.
32. Lower the vehicle.
33. Install the negative cable from the engine bay. Refer to Battery Negative Cable Replacement .
34. Install the positive cable from the engine bay. Refer to Battery Positive Cable Replacement .
35. Install the engine assembly. Refer to Engine Replacement or Engine Replacement
36. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
37. Enable the SIR system. Refer to SIR Disabling and Enabling.
38. If re-programming is required. Refer to Control Module References .

Roof Front Header Panel Replacement

Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

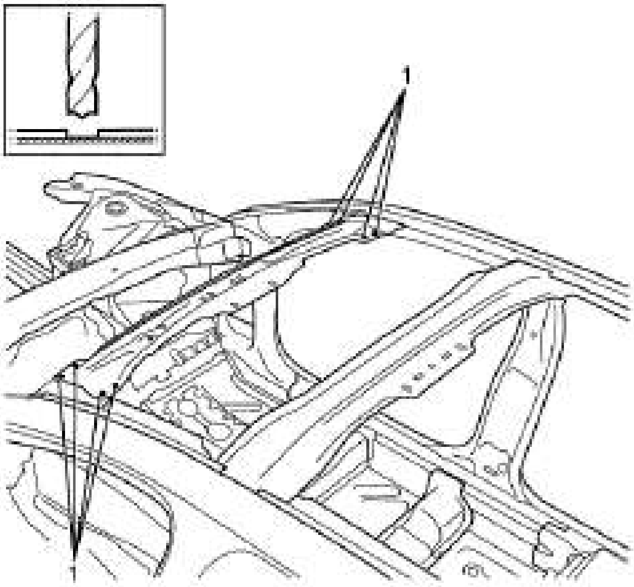
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

1. Disable the SIR system. Refer to SIR Disabling and Enabling.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

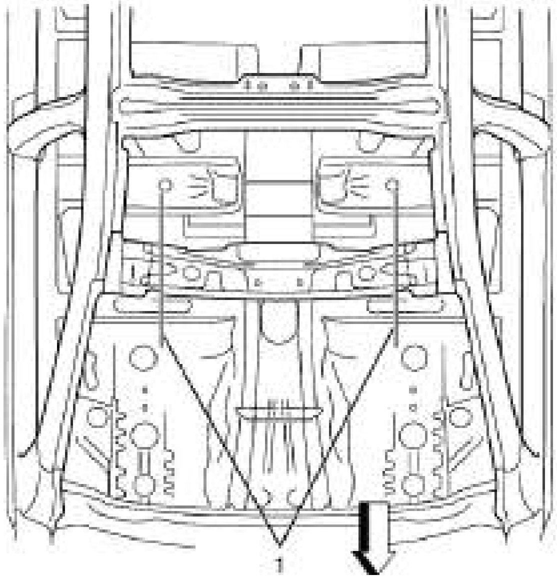
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the front doors. Refer to Front Side Door Replacement.
4. Remove the front seats. Refer to Front Seat Replacement - Bucket.
5. Remove the front seat belts. Refer to Front Seat Belt Replacement.
6. Remove the rear doors. Refer to Rear Door Replacement.
7. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
8. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
9. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
10. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
11. Remove the liftgate weatherstrip. Refer to Liftgate Weatherstrip Replacement.
12. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
13. Remove the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
14. Remove the body side window rear garnish moulding. Refer to Body Side Window Rear Garnish Molding Replacement.
15. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement.
16. Remove the rear seat back. Refer to Rear Split Folding Seat Back Replacement.
17. Remove the headliner. Refer to Headlining Trim Panel Replacement.
18. Remove the roof weld joint reveal moulding. Refer to Roof Weld Joint Reveal Molding Replacement.
19. Remove the windshield pillar garnish moulding. Refer to Windshield Pillar Garnish Molding Replacement.
20. Remove the windshield. Refer to Windshield Replacement.
21. Remove the liftgate. Refer to Liftgate Replacement.
22. Remove the liftgate hinges. Refer to Liftgate Hinge Replacement.
23. Remove the body side roof drip moulding. Refer to Body Side Roof Drip Molding Replacement.
24. Remove the roof panel. Refer to Roof Outer Replacement.
25. Note the location and remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.



Important: The roof front header panel is attached to the upper body sides with beads of adhesive and spot-welds at each end.

Important: Note the number and location of factory welds (1) for installation of the new roof front header panel.

26. Locate, mark and drill out the factory welds (1) attaching the roof front header panel to the upper body side.



27. Mark a cut line (1) on the front roof bow panel inboard of the body side assembly.

Important: Cut through the roof header panel only. Do not damage any other panels or reinforcements.

28. Using a suitable tool, cut through the roof front header panel (1) inboard of the upper body side. Remove the centre portion of the roof front header panel from the vehicle.
29. Using a suitable tool remove the remaining end portions of the front roof header panel from the upper body side. Ensure all traces of old adhesive are removed.

Installation Procedure

Important: Spot welding is the preferred method for attaching panels and should be used whenever possible. A plug weld should only be performed where spot welding is not possible.

Important: Ensure that all factory welds are replaced in their original locations.

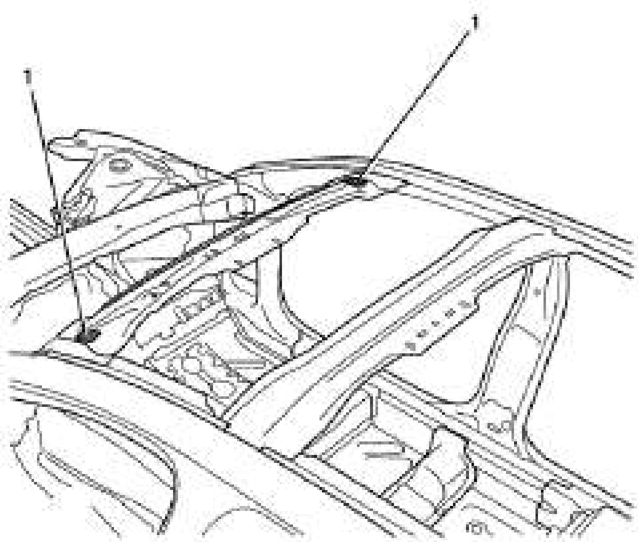
Important: Ensure that all structural adhesives and sealers are replaced in their original locations.

Important: If the location of the original plug weld holes cannot be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 32 mm (1¼ in).

Important: Follow the adhesive manufacturer's instructions during the assembly process. Heat must be applied as per the manufacturer's specifications to cure the adhesives and to expand the sealing baffles.

Important: Secondary sealer must be applied to the perimeter of all flanges and over all joints.

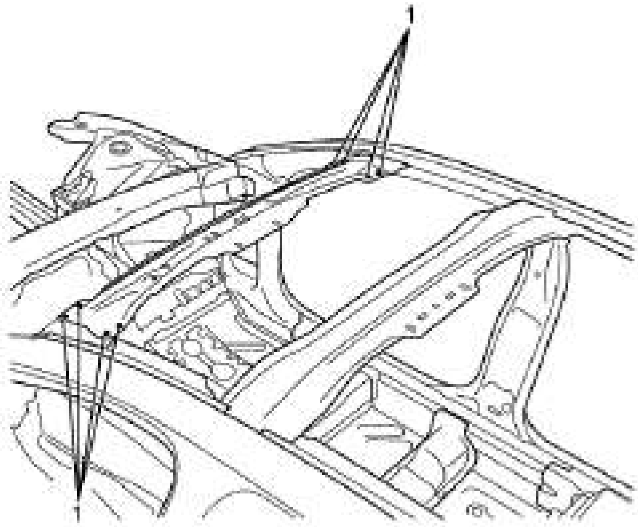
1. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted when dissembling.
2. Clean and prepare the mating surfaces of the body side and the roof front header panel. Ensure all traces of old adhesive are removed.
3. Verify that the vehicle body structure alignment is correct. Refer to Dimensions - Body.



4. Apply of approved structural adhesive (1) (GM6449G or equivalent) to the roof front header panel lower surface.

Important: As the front roof header panel is installed to the vehicle, structural adhesive should be visible on the outside edges of both surfaces (squeezed out when pushed together).

5. Position the roof front header panel to the body sides.
6. Align the front roof header panel using three dimensional measuring equipment. Refer to Dimensions - Body.



7. Weld the front roof header panel to the body sides (1).
8. Apply any sealers and anti-corrosion materials to the repair area noted on disassembly. Refer to Anti-Corrosion Treatment and Repair.
9. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
10. Install the roof outer panel. Refer to Roof Outer Replacement.
11. Install the body side roof drip moulding. Refer to Body Side Roof Drip Molding Replacement.
12. Install the liftgate hinges. Refer to Liftgate Hinge Replacement.
13. Install the liftgate. Refer to Liftgate Replacement.
14. Install the windshield. Refer to Windshield Replacement.
15. Install the windshield pillar garnish moulding. Refer to Windshield Pillar Garnish Molding Replacement.
16. Install the roof weld joint reveal moulding. Refer to Roof Weld Joint Reveal Molding Replacement.
17. Install the headliner. Refer to Headlining Trim Panel Replacement.
18. Install the rear seat back. Refer to Rear Split Folding Seat Back Replacement.
19. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.
20. Install the body side window rear garnish moulding. Refer to Body Side Window Rear Garnish Molding Replacement.
21. Install the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
22. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
23. Install the liftgate weatherstrip. Refer to Liftgate Weatherstrip Replacement.
24. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
25. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
26. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
27. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.

28. Install the rear doors. Refer to Rear Door Replacement.
29. Install the front seat belts. Refer to Front Seat Belt Replacement.
30. Install the front seats. Refer to Front Seat Replacement - Bucket.
31. Install the front doors. Refer to Front Side Door Replacement.
32. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
33. Enable the SIR system. Refer to SIR Disabling and Enabling.

Roof Panel Bow Replacement (Front - Sportwagon)

Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

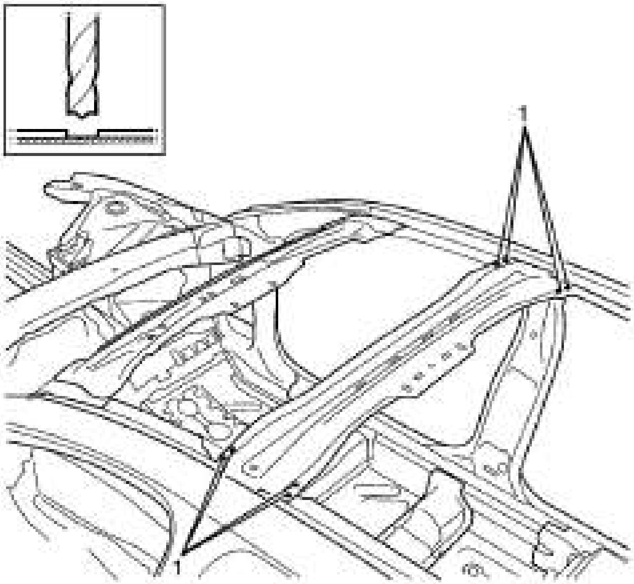
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

1. Disable the SIR system. Refer to SIR Disabling and Enabling.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the front doors. Refer to Front Side Door Replacement.
4. Remove the front seats. Refer to Front Seat Replacement - Bucket.
5. Remove the front seat belts. Refer to Front Seat Belt Replacement.
6. Remove the rear doors. Refer to Rear Door Replacement.
7. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
8. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
9. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
10. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
11. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
12. Remove the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
13. Remove the body side window rear garnish moulding. Refer to Body Side Window Rear Garnish Molding Replacement.
14. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement.
15. Remove the rear seat back. Refer to Rear Split Folding Seat Back Replacement.
16. Remove the headliner. Refer to Headlining Trim Panel Replacement.
17. Remove the roof weld joint reveal moulding. Refer to Roof Weld Joint Reveal Molding Replacement.
18. Remove the windshield pillar garnish moulding. Refer to Windshield Pillar Garnish Molding Replacement.
19. Remove the windshield. Refer to Windshield Replacement.
20. Remove the liftgate. Refer to Liftgate Replacement.
21. Remove the liftgate hinges. Refer to Liftgate Hinge Replacement.
22. Remove the body side roof drip moulding. Refer to Body Side Roof Drip Molding Replacement.
23. Remove the roof panel. Refer to Roof Outer Replacement.
24. Note the location and remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Approved Equipment for Collision Repair Caution.

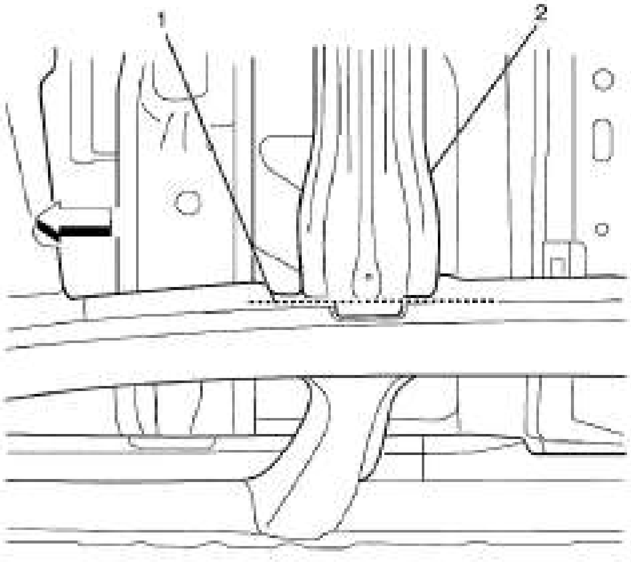


Important: Do nor damage any inner panels or reinforcements.

Important: The front roof bow panel is attached to the upper body sides with beads of adhesive and spot-welds at each end.

Important: Note the number and location of factory welds for installation of the new front roof panel bow.

25. Locate, mark and drill out the factory welds (1) attaching the front roof panel bow to the body side.



26. Mark a cut line (1) on the front roof bow panel (2) inboard of the body side assembly.

Important: Cut through the front roof bow panel only. Do not damage any other panels or reinforcements.

27. Using a suitable tool, cut along the cut line (1) on the front roof bow panel (2).
28. Remove the centre portion of the front roof bow panel (2) from the vehicle.
29. Using a suitable tool, remove the remaining portions of the front roof bow panel from the vehicle. Ensure all traces of old adhesive are removed.

Installation Procedure

Important: Spot welding is the preferred method for attaching panels and should be used whenever possible. A plug weld should only be performed where spot welding is not possible.

Important: If the location of the original plug weld holes cannot be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 32 mm (1¼ in).

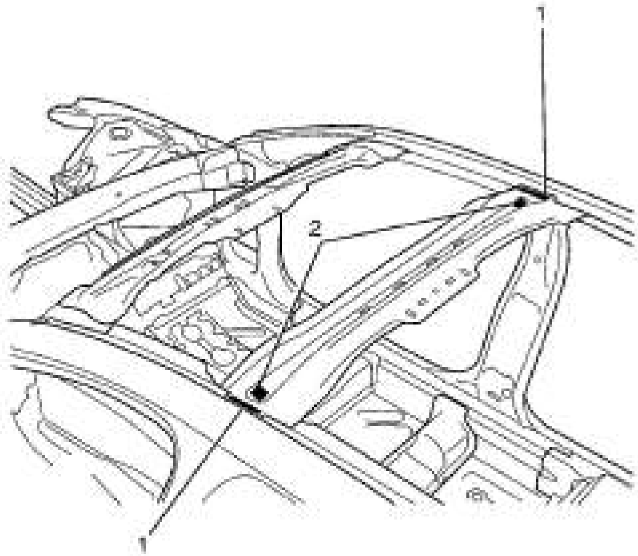
Important: Ensure that all factory welds are replaced in their original locations.

Important: Ensure that all structural adhesives and sealers are replaced in their original locations.

Important: Follow the adhesive manufacturer's instructions during the assembly process. Heat must be applied as per the manufacturer's specifications to cure the adhesives and to expand the sealing baffles.

Important: Secondary sealer must be applied to the perimeter of all flanges and over all joints.

1. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted when dissembling.
2. Clean and prepare the mating surfaces of the body side and the front roof bow panel. Ensure all traces of old adhesive are removed.
3. Verify that the vehicle body structure alignment is correct. Refer to Dimensions - Body.



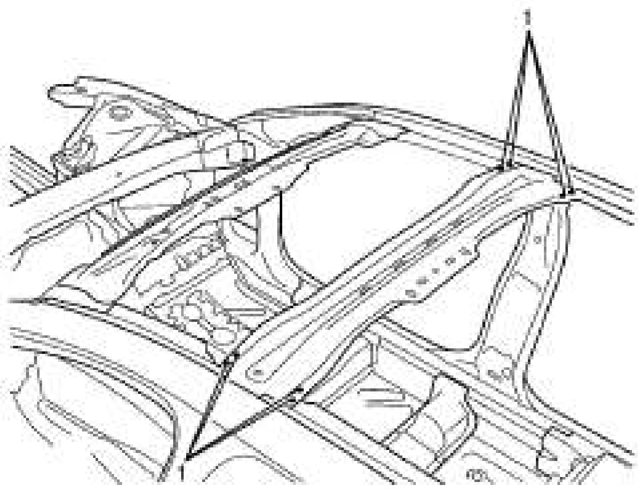
4. Apply a 13mm wide bead of approved structural adhesive (1) (GM6449G or equivalent)

between the front roof bow and body side outer panel.

5. Apply approved structural adhesive (2) (GM6449G or equivalent) between the front roof bow and the centre pillar upper reinforcement.

   Important: As the front roof bow panel is installed to the vehicle, structural adhesive should be visible on the outside edges of both surfaces (squeezed out when pushed together).

6. Install the front roof bow panel (1) to the body side.



7. Weld the front roof bow panel (1) to the body side.
8. Apply any sealers and anti-corrosion materials to the repair area noted on disassembly. Refer to Anti-Corrosion Treatment and Repair.
9. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
10. Install the roof outer panel. Refer to Roof Outer Replacement.
11. Install the body side roof drip moulding. Refer to Body Side Roof Drip Molding Replacement.
12. Install the liftgate hinges. Refer to Liftgate Hinge Replacement.
13. Install the liftgate. Refer to Liftgate Replacement.
14. Install the windshield. Refer to Windshield Replacement.
15. Install the windshield pillar garnish moulding. Refer to Windshield Pillar Garnish Molding Replacement.
16. Install the roof weld joint reveal moulding. Refer to Roof Weld Joint Reveal Molding Replacement.
17. Install the headliner. Refer to Headlining Trim Panel Replacement.
18. Install the rear seat back. Refer to Rear Split Folding Seat Back Replacement.
19. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.
20. Install the body side window rear garnish moulding. Refer to Body Side Window Rear Garnish Molding Replacement.
21. Install the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
22. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
23. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
24. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
25. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel

Carpet Replacement.

26. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
27. Install the rear doors. Refer to Rear Door Replacement.
28. Install the front seat belts. Refer to Front Seat Belt Replacement.
29. Install the front seats. Refer to Front Seat Replacement - Bucket.
30. Install the front doors. Refer to Front Side Door Replacement.
31. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
32. Enable the SIR system. Refer to SIR Disabling and Enabling.

Roof Panel Bow Replacement (Rear - Sportwagon)

Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

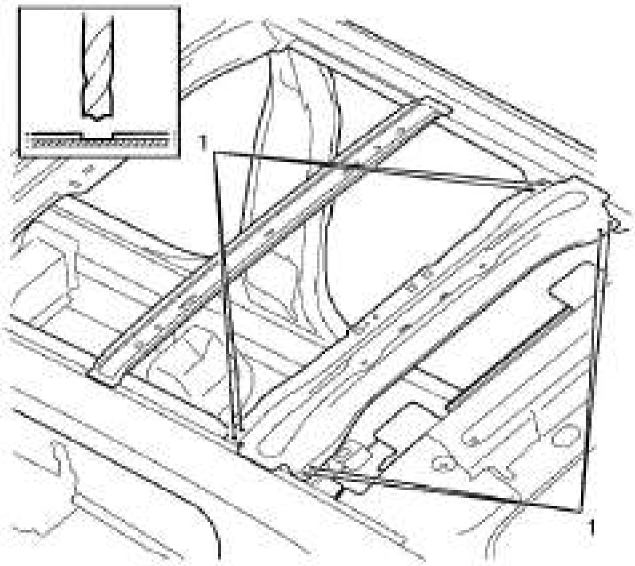
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

1. Disable the SIR system. Refer to SIR Disabling and Enabling.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

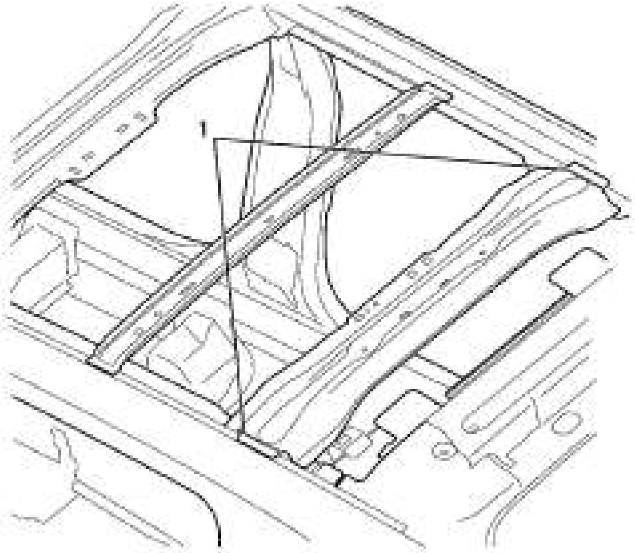
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the front doors. Refer to Front Side Door Replacement.
4. Remove the front seats. Refer to Front Seat Replacement - Bucket.
5. Remove the front seat belts. Refer to Front Seat Belt Replacement.
6. Remove the rear doors. Refer to Rear Door Replacement.
7. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
8. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
9. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
10. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
11. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
12. Remove the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
13. Remove the body side window rear garnish moulding. Refer to Body Side Window Rear Garnish Molding Replacement.
14. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement.
15. Remove the rear seat back. Refer to Rear Split Folding Seat Back Replacement.
16. Remove the headliner. Refer to Headlining Trim Panel Replacement.
17. Remove the roof weld joint reveal moulding. Refer to Roof Weld Joint Reveal Molding Replacement.
18. Remove the windshield pillar garnish moulding. Refer to Windshield Pillar Garnish Molding Replacement.
19. Remove the windshield. Refer to Windshield Replacement.
20. Remove the liftgate. Refer to Liftgate Replacement.
21. Remove the liftgate hinges. Refer to Liftgate Hinge Replacement.
22. Remove the body side roof drip moulding. Refer to Body Side Roof Drip Molding Replacement.
23. Remove the roof panel. Refer to Roof Outer Replacement.
24. Note the location and remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Approved Equipment for Collision Repair Caution.



Important: The rear roof bow panel is attached to the upper body sides with beads of adhesive and spot-welds at each end.

Important: Note the number and location of factory welds for installation of the new rear roof bow panel.

25. Locate, mark and drill out the factory welds (1) attaching the rear roof panel bow to the body side.



Important: Cut through the rear roof bow panel only. Do not damage any other panels or reinforcements.

26. Mark a cut line (1) on the rear roof bow panel (2) inboard of the body side assembly.
27. Cut along the cut line (1) on the rear roof bow panel (2) with a suitable cutting tool.
28. Remove the centre portion of the rear roof bow panel (2) from the vehicle.
29. Using a suitable tool, remove the remaining portions of the rear roof bow panel from the vehicle. Ensure all traces of old adhesive are removed.

Installation Procedure

Important: Spot welding is the preferred method for attaching panels and should be used whenever possible. A plug weld should only be performed where spot welding is not possible.

Important: Ensure that all factory welds are replaced in their original locations.

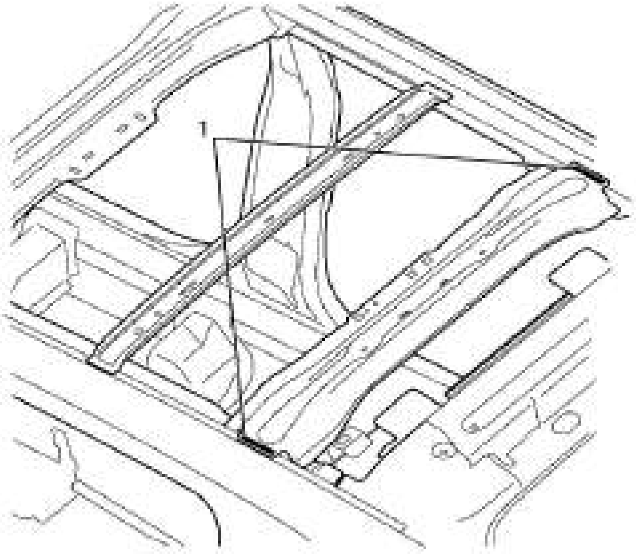
Important: Ensure that all structural adhesives and sealers are replaced in their original locations.

Important: If the location of the original plug weld holes cannot be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 32 mm (1¼ in).

Important: Follow the adhesive manufacturer's instructions during the assembly process. Heat must be applied as per the manufacturer's specifications to cure the adhesives and to expand the sealing baffles.

Important: Secondary sealer must be applied to the perimeter of all flanges and over all joints.

1. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted when dissembling.
2. Clean and prepare the mating surfaces of the body side and the rear roof bow panel. Ensure all traces of old adhesive are removed.
3. Verify that the vehicle body structure alignment is correct. Refer to Dimensions - Body.

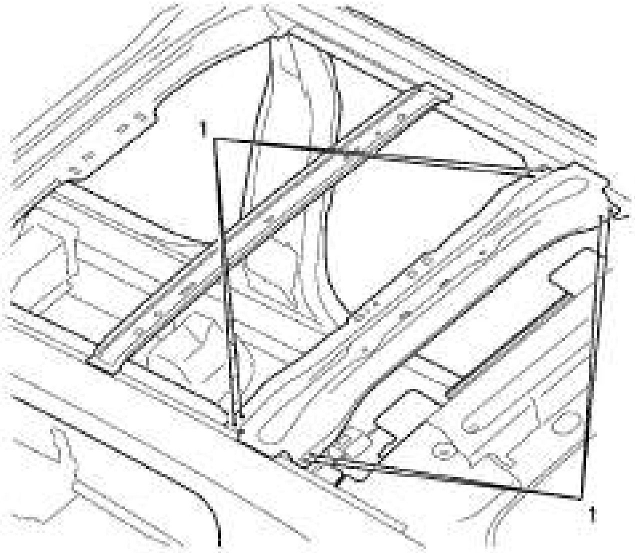


Important: Clean all the adhesives mating surfaces in accordance with the adhesive manufacturer's specifications.

4. Apply a 13mm wide bead of approved structural adhesive (1) (GM6449G or equivalent) to the rear roof bow panel lower surface. On assembly, the adhesive should be between the rear roof bow panel and the body side outer panel.

   Important: As the rear roof bow panel is installed to the vehicle, structural adhesive should be visible on the outside edges of both surfaces (squeezed out when pushed together).

5. Install the rear roof bow panel (1) to the body side.



6. Weld the rear roof bow panel (1) to the body side.
7. Apply any sealers and anti-corrosion materials to the repair area noted on disassembly. Refer to Anti-Corrosion Treatment and Repair.
8. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
9. Install the roof panel. Refer to Roof Outer Replacement.
10. Install the body side roof drip moulding. Refer to Body Side Roof Drip Molding Replacement.
11. Install the liftgate hinges. Refer to Liftgate Hinge Replacement.
12. Install the liftgate. Refer to Liftgate Replacement.
13. Install the windshield. Refer to Windshield Replacement.
14. Install the windshield pillar garnish moulding. Refer to Windshield Pillar Garnish Molding Replacement.
15. Install the roof weld joint reveal moulding. Refer to Roof Weld Joint Reveal Molding Replacement.
16. Install the headliner. Refer to Headlining Trim Panel Replacement.
17. Install the rear seat back. Refer to Rear Split Folding Seat Back Replacement.
18. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.
19. Install the body side window rear garnish moulding. Refer to Body Side Window Rear Garnish Molding Replacement.
20. Install the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
21. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
22. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
23. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
24. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel

Carpet Replacement.

25. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
26. Install the rear doors. Refer to Rear Door Replacement.
27. Install the front seat belts. Refer to Front Seat Belt Replacement.
28. Install the front seats. Refer to Front Seat Replacement - Bucket.
29. Install the front doors. Refer to Front Side Door Replacement.
30. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
31. Enable the SIR system. Refer to SIR Disabling and Enabling.

Roof Rear Header Panel Replacement (Sportwagon)

Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

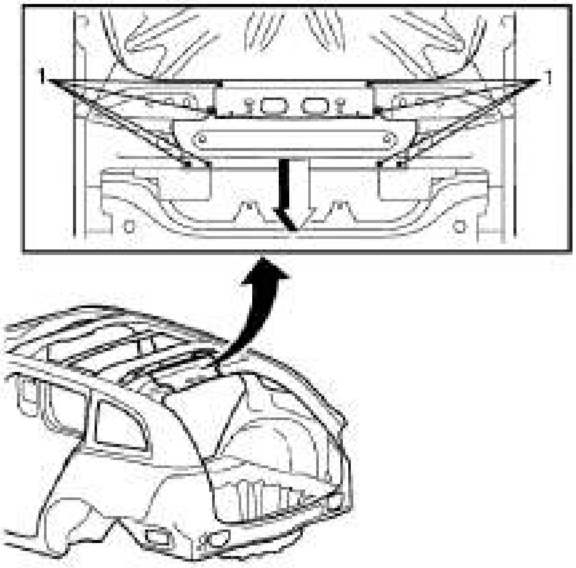
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

1. Disable the SIR system. Refer to SIR Disabling and Enabling.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

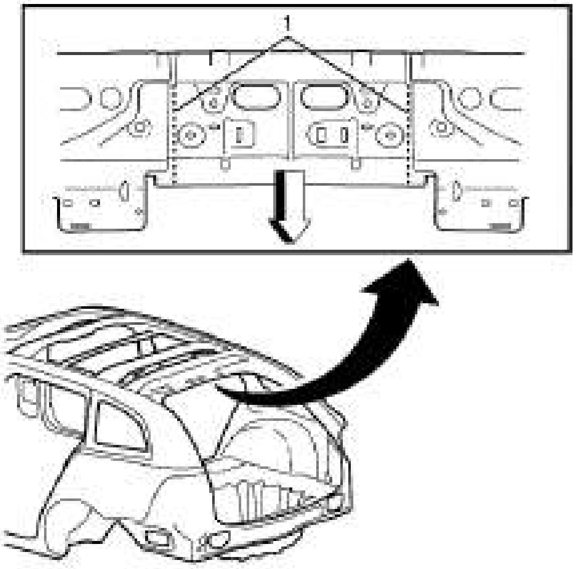
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the front doors. Refer to Front Side Door Replacement.
4. Remove the front seats. Refer to Front Seat Replacement - Bucket.
5. Remove the front seat belts. Refer to Front Seat Belt Replacement.
6. Remove the rear doors. Refer to Rear Door Replacement.
7. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
8. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
9. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
10. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
11. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
12. Remove the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
13. Remove the body side window rear garnish moulding. Refer to Body Side Window Rear Garnish Molding Replacement.
14. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement.
15. Remove the rear seat back. Refer to Rear Split Folding Seat Back Replacement.
16. Remove the headliner. Refer to Headlining Trim Panel Replacement.
17. Remove the roof weld joint reveal moulding. Refer to Roof Weld Joint Reveal Molding Replacement.
18. Remove the windshield pillar garnish moulding. Refer to Windshield Pillar Garnish Molding Replacement.
19. Remove the windshield. Refer to Windshield Replacement.
20. Remove the liftgate. Refer to Liftgate Replacement.
21. Remove the liftgate hinges. Refer to Liftgate Hinge Replacement.
22. Remove the body side roof drip moulding. Refer to Body Side Roof Drip Molding Replacement.
23. Remove the roof panel. Refer to Roof Outer Replacement.
24. Note the location and remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.



Important: Do not damage any other panels or reinforcements.

Important: The roof rear header panel asm consists of an inner and outer panel which are joined to the body structure with both spotwelds and adhesive.

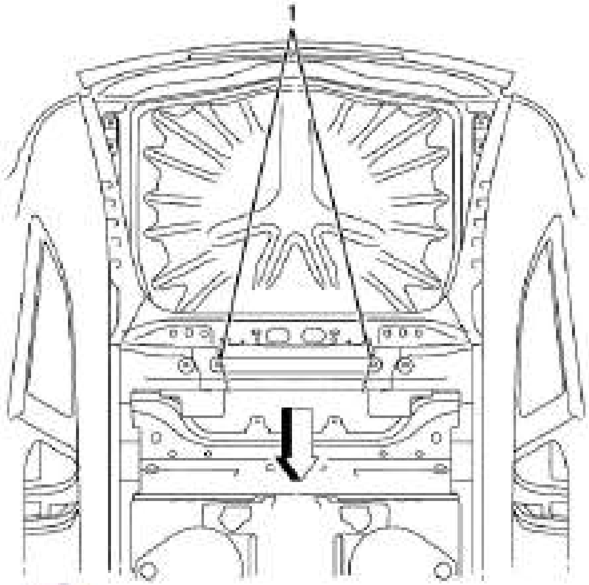
25. Locate, mark and drill out the factory welds (1) attaching the roof rear header panel asm to the body side assembly.



26. Mark cut lines (1) on the inner roof rear header panel inboard of the body side assembly.

Important: Only cut through the inner roof rear header panel. Do not damage any other panels or reinforcements.

27. Cut along the cut lines (1) on the inner roof rear header panel.



28. Mark cut lines (1) along the outer roof rear header panel inboard of the body side assembly.

Important: Use a suitable device to support the roof rear header panel assembly.

Important: Only cut through the outer roof rear header panel. Do not damage any other panels or reinforcements.

29. Cut along the cut lines (1) on the outer roof rear header panel.
30. Remove the centre section of the roof rear header panel assembly from the vehicle.

Important: Only remove the remaining portions of the roof rear header panel. Do not damage any other panels or reinforcements.

31. Using a suitable tool, remove the remaining outer portions of both the inner and outer roof rear header panel from the vehicle. Ensure that all traces of old adhesive are removed.

Installation Procedure

Important: Spot welding is the preferred method for attaching panels and should be used whenever possible. A plug weld should only be performed where spot welding is not possible.

Important: If the location of the original plug weld holes cannot be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 32 mm (1¼ in).

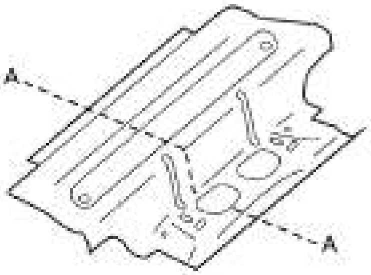
Important: Ensure that all factory welds are replaced in their original locations.

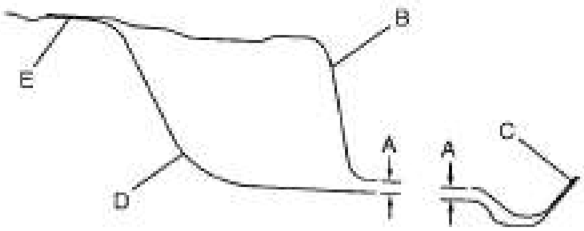
Important: Ensure that all structural adhesives and sealers are replaced in their original locations.

Important: Follow the adhesive manufacturer's instructions during the assembly process. Heat must be applied as per the manufacturer's specifications to cure the adhesives and to expand the sealing baffles.

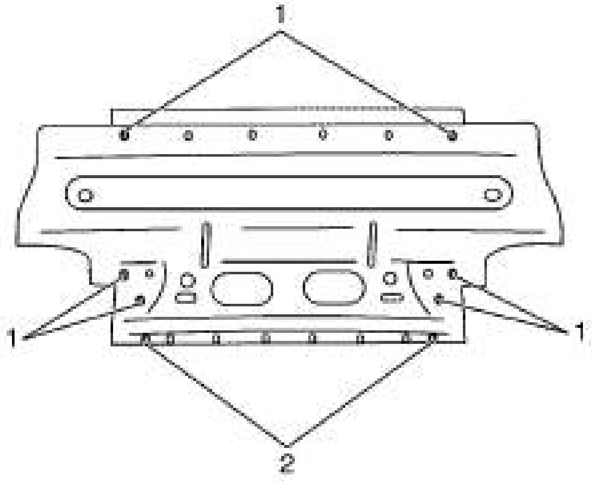
Important: Secondary sealer must be applied to the perimeter of all flanges and over all joints.

1. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted when dissembling.
2. Clean and prepare the mating surfaces of the body side and the roof rear header panel assembly.



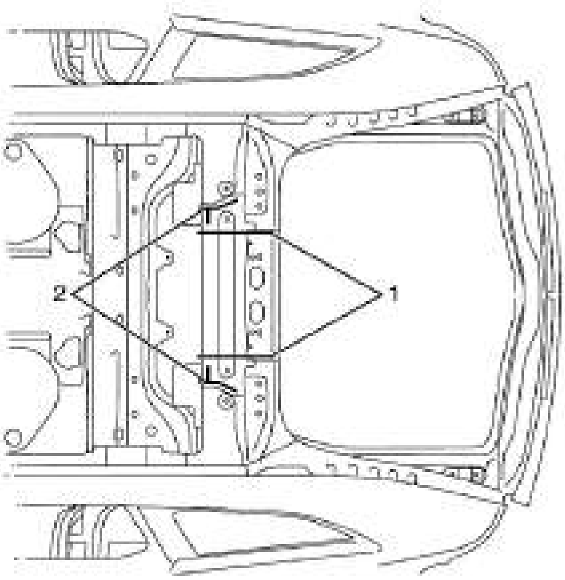


3. The roof rear header panel is supplied as separate inner and outer panels which must be welded together by the repairer. Align the inner and outer panels as shown in the diagram. Align the inner roof rear header panel, D, and the outer roof rear header panel, B, hard up against each other at locations C and E. The panels must be aligned to achieve the required gap where dimension A = 4.56mm (0.180in). This gap must be achieved symmetrically across the assembly.



Important: For weld locations, refer to the damaged rear roof header panel.

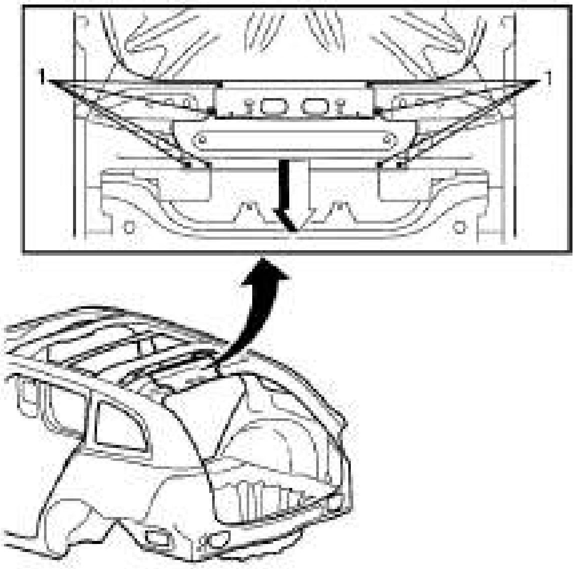
4. Weld (1) the roof rear header inner and outer panels together prior to installation to the vehicle. The welds (2) should be done when the outer roof panel is replaced. Refer to Roof Outer Replacement



5. Apply an approved structural adhesive (1) GM6449G or equivalent to the mating surface between the inner roof rear header panel and the body side assembly.
6. Apply an approved structural adhesive (2) GM6449G or equivalent to the mating surface between the outer roof rear header panel and the body side assembly.

Important: As the roof rear header panel is installed to the vehicle, structural adhesive should be visible on the outside edges of both surfaces (squeezed out when pushed together).

7. Install the roof rear header panel (1) to the body side.



8. Weld the roof rear header panel to the body side (1).
9. Install the roof panel. Refer to Roof Outer Replacement.
10. Install the body side roof drip moulding. Refer to Body Side Roof Drip Molding Replacement.
11. Install the liftgate hinges. Refer to Liftgate Hinge Replacement.
12. Install the liftgate. Refer to Liftgate Replacement.
13. Install the windshield. Refer to Windshield Replacement.
14. Install the windshield pillar garnish moulding. Refer to Windshield Pillar Garnish Molding Replacement.
15. Install the roof weld joint reveal moulding. Refer to Roof Weld Joint Reveal Molding Replacement.
16. Install the headliner. Refer to Headlining Trim Panel Replacement.
17. Install the rear seat back. Refer to Rear Split Folding Seat Back Replacement.
18. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.
19. Install the body side window rear garnish moulding. Refer to Body Side Window Rear Garnish Molding Replacement.
20. Install the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
21. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
22. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
23. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
24. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
25. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
26. Install the rear doors. Refer to Rear Door Replacement.
27. Install the front seat belts. Refer to Front Seat Belt Replacement.
28. Install the front seats. Refer to Front Seat Replacement - Bucket.
29. Install the front doors. Refer to Front Side Door Replacement.
30. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
31. Enable the SIR system. Refer to SIR Disabling and Enabling.

Rear Compartment Lid Strut Stud Replacement

Important: The rear compartment lid strut stud is not replaceable.

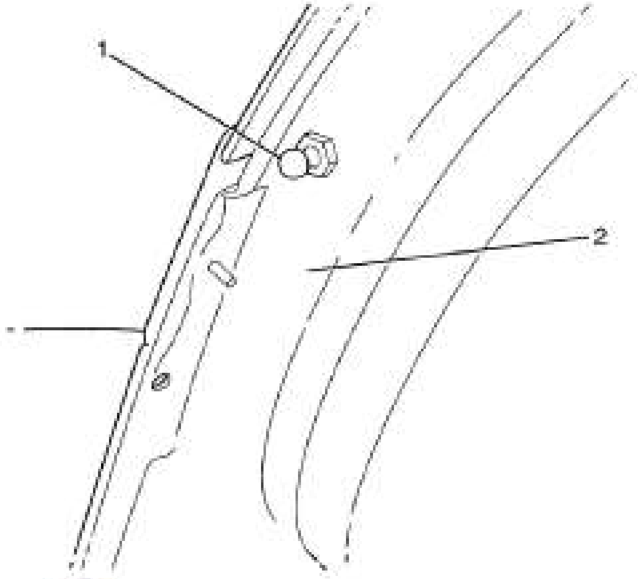
Replace the rear compartment lid hinge. Refer to Rear Compartment Lid Hinge Replacement.

Liftgate Strut Stud Replacement (Liftgate Side)

Removal Procedure

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

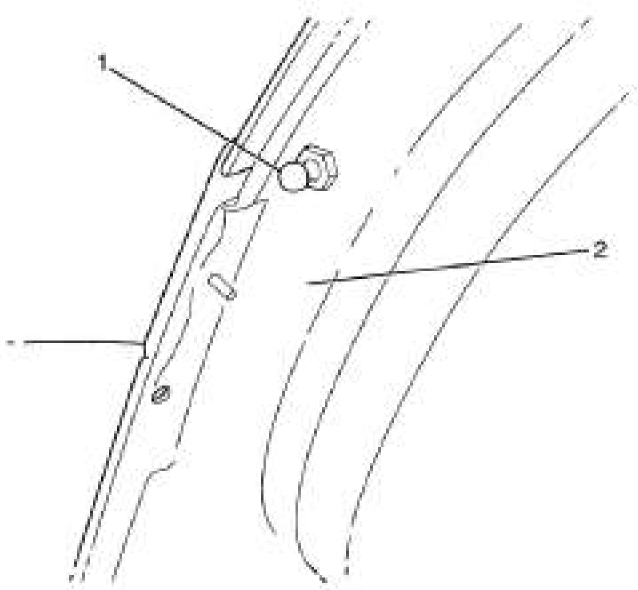
1. Install a suitable liftgate brace to the vehicle.
2. Remove the liftgate strut. Refer to Liftgate Strut Replacement.



3. Remove the liftgate strut stud (1) from the liftgate (2).

Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



1. Install the liftgate strut stud (1) to the liftgate (2).

   Tighten
   Tighten the stud to 22 N·m (16 lb ft).

2. Install the liftgate strut. Refer to Liftgate Strut Replacement.

   Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

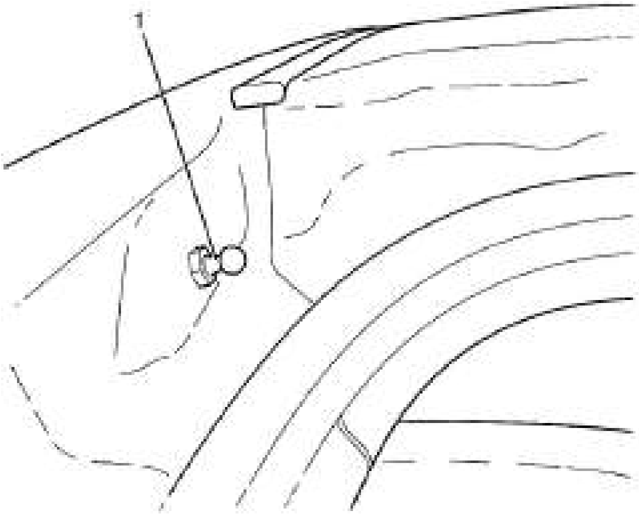
3. Remove the suitable liftgate brace from the vehicle.

Liftgate Strut Stud Replacement (Body Side)

Removal Procedure

> **Important:** When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

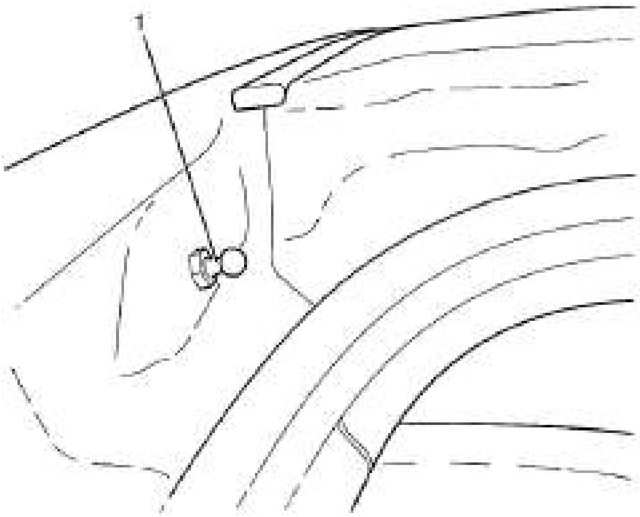
1. Install a suitable liftgate brace to the vehicle.
2. Remove the liftgate strut. Refer to Liftgate Strut Replacement.



3. Remove the liftgate strut stud (1) from the rear quarter panel.

Installation Procedure

> **Notice:** Refer to Fastener Notice in the Preface section.



1. Install the liftgate strut stud (1) to the rear quarter panel.

   Tighten
   Tighten the stud to 15 N·m (11 lb ft).

2. Install the liftgate strut. Refer to Liftgate Strut Replacement.

   Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

3. Remove the suitable liftgate brace from the vehicle.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Repair | Collision Repair | Repair Instructions | **Document ID: 1996894**

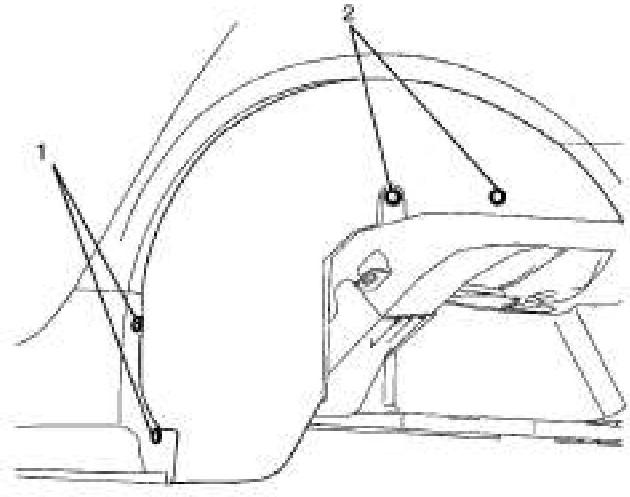
Rear Inner Wheelhouse Replacement

Removal Procedure

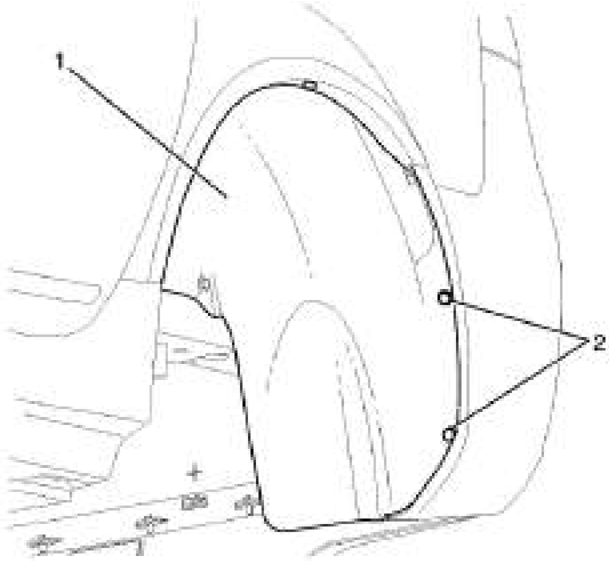
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear wheel. Refer to Tire and Wheel Removal and Installation.



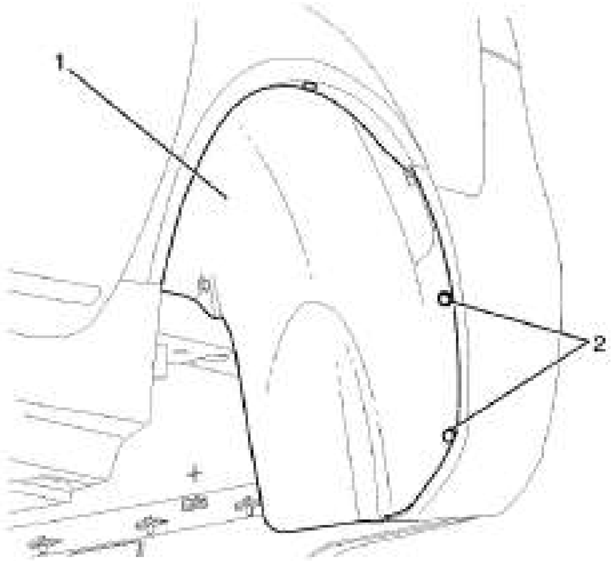
3. Remove the rear wheelhouse liner to rocker moulding retaining screws (1).
4. Remove the rear wheelhouse liner to vehicle push-in retainers (2).



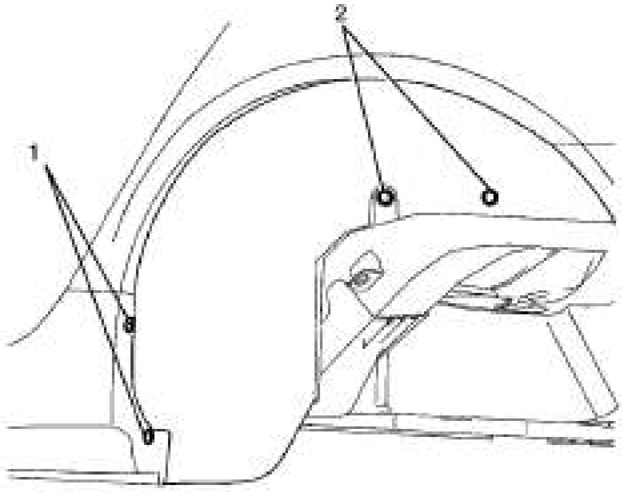
5. Remove the rear wheelhouse liner to rear bumper fascia push-in retainers (2).
6. Carefully pry the rear wheelhouse liner from the vehicle using a suitable tool.
7. Remove the rear wheelhouse liner (1) from the vehicle.

Installation Procedure

1. Position the rear wheelhouse liner (1) to the vehicle.



2. Install the rear wheelhouse liner to rear bumper fascia push-in retainers (2).



3. Install the rear wheelhouse liner to rocker moulding retaining screws (1).

Notice: Refer to Fastener Notice in the Preface section.

4. Tighten the rear wheelhouse liner to rocker moulding retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).

5. install the rear wheelhouse liner to vehicle push-in retainers (2).
6. Install the rear wheel. Refer to Tire and Wheel Removal and Installation.
7. Lower the vehicle.

Back Body Pillar Inner Upper Panel Assembly Replacement (SWB)

Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

Caution: Refer to Glass and Sheet Metal Handling Caution in the Preface section.

Caution: Refer to Battery Disconnect Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Important: When replacing panels that involve servicing of stationary glass, refer to Rear Window Replacement and Windshield Replacement, before performing any priming or refinishing. Sectioning should be performed only in the recommended areas. Failure to do so may compromise the structural integrity of the vehicle.

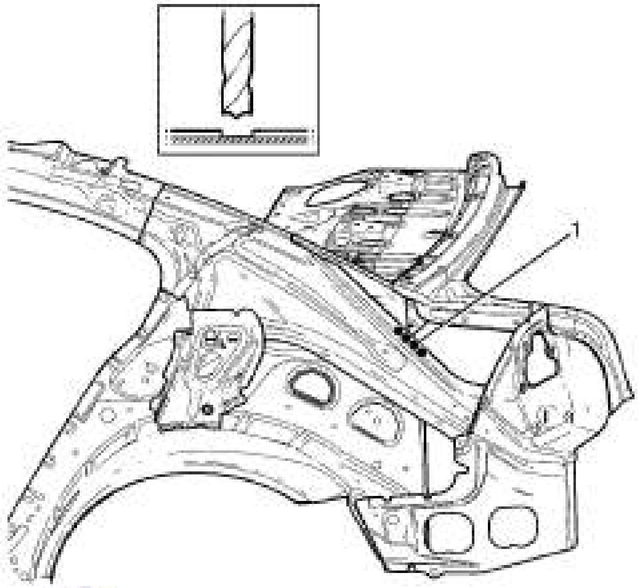
Important: The full body-side outer panel comes as a complete assembly and can be replaced after the removal of the fixed glass and roof. Any one of these service procedures can be performed separately or in any combination, dependent upon the extent of damage to the vehicle. Sectioning must take place in specified areas only.

1. Disable the SIR system. Refer to SIR Disabling and Enabling.
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the battery. Refer to Battery Replacement.
4. Remove the battery tray. Refer to Battery Tray Replacement.
5. Remove the deck lid. Refer to Rear Compartment Lid Replacement.
6. Remove the front doors. Refer to Front Side Door Replacement.
7. Remove the rear doors. Refer to Rear Door Replacement.
8. Remove the rear door seals. Refer to Rear Door Opening Weatherstrip Replacement.
9. Remove the inner rear quarter trims. Refer to Quarter Upper Trim Panel Replacement.
10. Remove the roof lining. Refer to Headlining Trim Panel Replacement.
11. Remove the rear seat back. Refer to Rear Seat Back Replacement.
12. Remove the rear seats. Refer to Rear Seat Cushion Cover and Pad Replacement.
13. Remove the rear parcel shelf. Refer to Rear Window Shelf Trim Panel Replacement.
14. Remove the deck lid release cable. Refer to Rear Compartment Lid Latch Release Cable Replacement.
15. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
16. Remove the rear wheels. Refer to Tire and Wheel Removal and Installation.
17. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
18. Remove the rear pressure relief valves. Refer to Pressure Relief Valve Replacement.
19. Remove the rocker panel moulds. Refer to Rocker Panel Molding Replacement.
20. Remove the rear wheelhouse liners. Refer to Rear Inner Wheelhouse Replacement.
21. Remove the rear exhaust assembly. Refer to Exhaust Muffler Replacement - Left Side or Exhaust Muffler Replacement - Right Side.

22. Remove the rear exhaust muffler heat shields. Refer to Exhaust Muffler Heat Shield Replacement - Left Side or Exhaust Muffler Heat Shield Replacement - Right Side.
23. Remove the rear frame. Refer to Rear Frame Replacement.
24. Remove the rear brake lines. Refer to Brake Pipe Replacement.
25. Remove the fuel tank. Refer to Fuel Tank Replacement or Fuel Tank Replacement.
26. Remove the fuel lines. Refer to Filler Tube Replacement or Filler Tube Replacement.
27. Lower the vehicle.
28. Remove the roof moulding. Refer to Body Side Roof Drip Molding Replacement.
29. Remove the rear windshield. Refer to Rear Window Replacement.

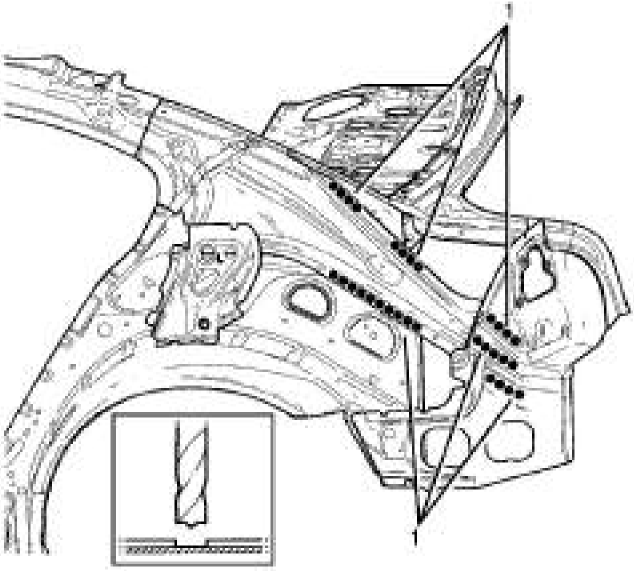
Important: This step is unique to the sunroof module.

30. Remove the rear roof drain tubes. Refer to Sunroof Housing Rear Drain Hose Replacementand Sunroof Housing Rear Drain Hose Replacement.
31. Remove the tail lights. Refer to Parking and Turn Signal Lamp Replacement.
32. Remove the quarter panel. Refer to Quarter Panel Replacement.
33. Repair as much of the damage as possible.
34. Remove sound deadeners as necessary and note their location.
35. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.

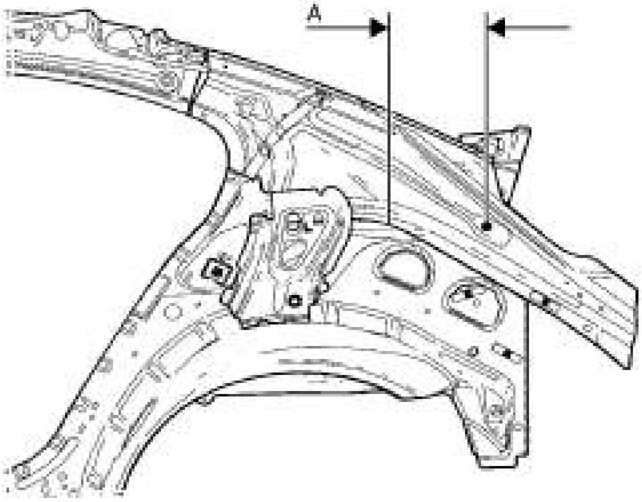


Important: Take care not to damage the rear window panel.

36. Locate, mark and carefully drill out the rear lower panel extension to rear window panel spot welds (1).



37. Locate, mark and drill out the rear lower panel extension to body ring spot welds.



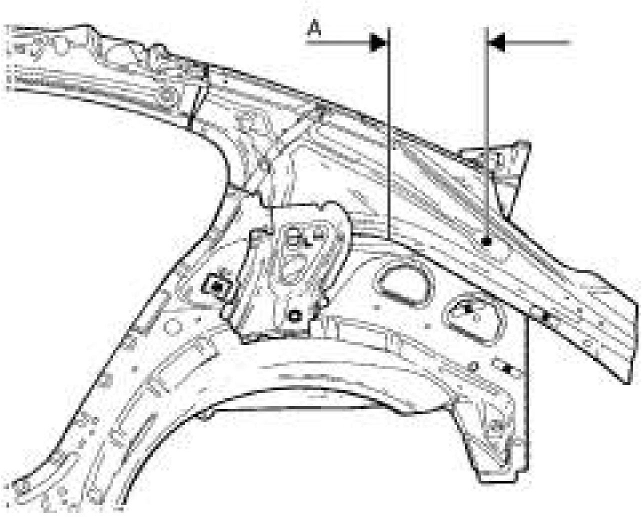
38. Measure forward from the datum hole to cut point 250 mm (9.84 in) (A).
39. Using a suitable tool cut through the rear lower panel extension at the measurement point.
40. Remove the rear lower panel extension from the vehicle.

    Discard the rear lower panel extension.

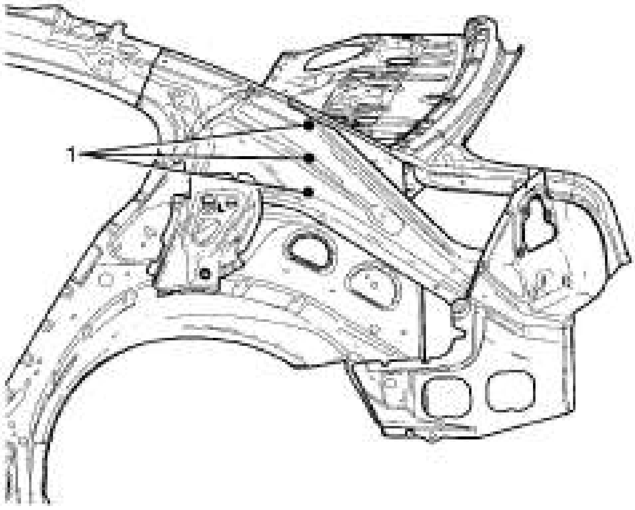
Installation Procedure

Important: If the location of the original plug weld holes can not be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 32 millimetres (1¼ in).

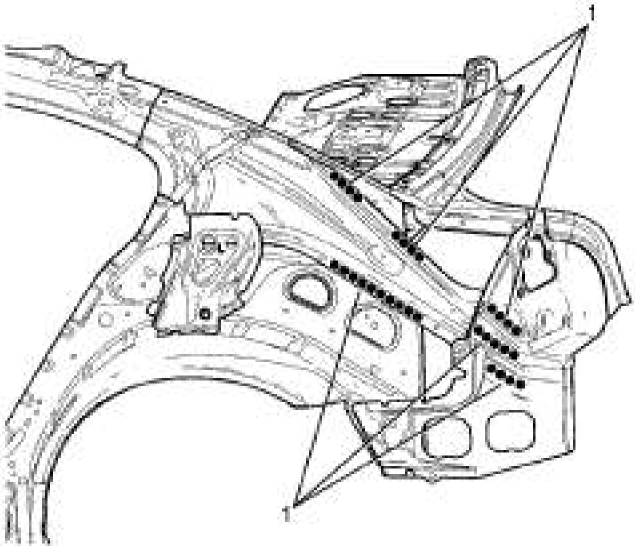
1. Drill 8 millimetres (5/16 in) plug weld holes as necessary in the locations noted from the original assembly.
2. Clean and prepare the mating surfaces of both parts of the front chassis rail.



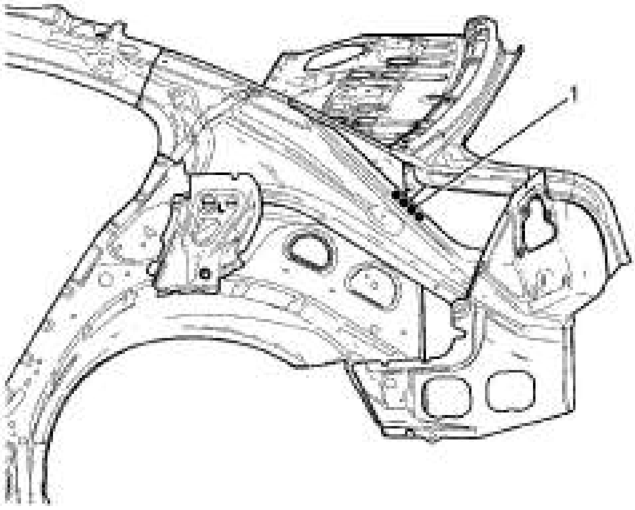
3. Measure forward from the datum hole to cut point 250 mm (9.84 in) (A) on the replacement panel.
4. Position the rear lower panel extension to the vehicle.



5. Temporarily tack weld (1) the rear lower extension panel to the remaining part of the rear lower extension panel



6. Weld the rear lower extension panel to the vehicle.



7. Weld the rear lower panel extension to rear window panel spot welds (1).
8. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.
9. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
10. Install the quarter panel. Refer to Quarter Panel Replacement.
11. Install the tail lights. Refer to Parking and Turn Signal Lamp Replacement.

Important: This step is unique to the sunroof module.

12. Install the rear roof drain tubes. Refer to Sunroof Housing Rear Drain Hose Replacement.
13. Install the rear windshield. Refer to Rear Window Replacement.
14. Install the roof moulding. Refer to Body Side Roof Drip Molding Replacement.

15. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
16. Install the fuel lines. Refer to Filler Tube Replacement or Filler Tube Replacement.
17. Install the fuel tank. Refer to Fuel Tank Replacement or Fuel Tank Replacement.
18. Install the rear brake lines. Refer to Brake Pipe Replacement.
19. Install the rear frame. Refer to Rear Frame Replacement.
20. Install the rear exhaust muffler heat shields. Refer to Exhaust Muffler Heat Shield Replacement - Left Side and Exhaust Muffler Heat Shield Replacement - Right Side.
21. Install the rear exhaust assembly. Refer to Exhaust Muffler Replacement - Left Side and Exhaust Muffler Replacement - Right Side.
22. Install the rear wheel house liners. Refer to Rear Inner Wheelhouse Replacement.
23. Install the rocker panel moulds. Refer to Rocker Panel Molding Replacement.
24. Install the rear pressure relief valves. Refer to Pressure Relief Valve Replacement.
25. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
26. Install the rear wheels. Refer to Tire and Wheel Removal and Installation.
27. Lower the vehicle.
28. Install the deck lid release cable. Refer to Rear Compartment Lid Latch Release Cable Replacement.
29. Install the rear parcel shelf. Refer to Rear Window Shelf Trim Panel Replacement.
30. Install the rear seats. Refer to Rear Seat Cushion Cover and Pad Replacement.
31. Install the rear seat back. Refer to Rear Seat Back Replacement.
32. Install the roof lining. Refer to Headlining Trim Panel Replacement.
33. Install the rear interior trims. Refer to Quarter Upper Trim Panel Replacement.
34. Install the rear door seals. Refer to Rear Door Opening Weatherstrip Replacement.
35. Install the deck lid. Refer to Rear Compartment Lid Replacement.
36. Install the front doors. Refer to Front Side Door Replacement.
37. Install the rear doors. Refer to Rear Door Replacement.
38. Install the battery tray. Refer to Battery Tray Replacement
39. Install the battery. Refer to Battery Replacement.
40. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
41. Enable the SIR system. Refer to SIR Disabling and Enabling.
42. If re-programming is required. Refer to Control Module References.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Repair | Collision Repair | Repair Instructions | Document ID: 2069465

Body Side Inner Panel Extension Replacement (Sedan)

Removal Procedure

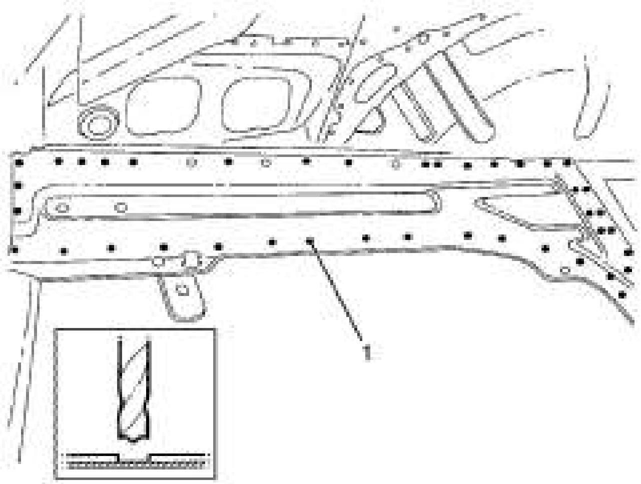
Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

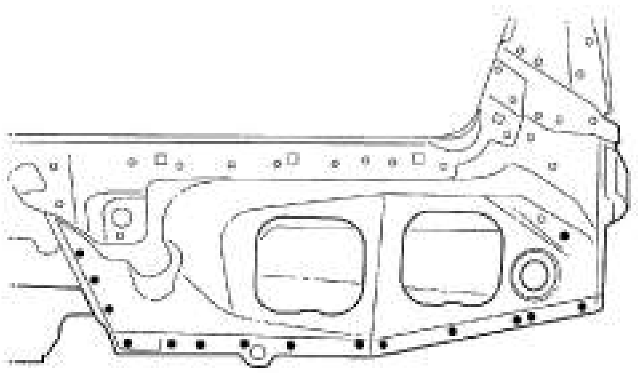
1. Disable the SIR system. Refer to SIR Disabling and Enabling .

Caution: Refer to Battery Disconnect Caution in the Preface section.

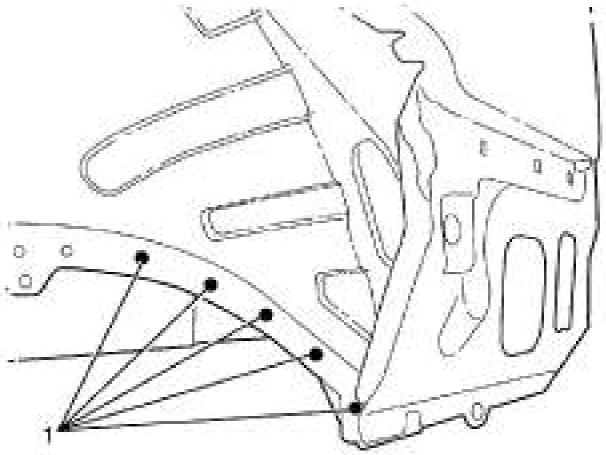
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement .
4. Remove the rear impact bar. Refer to Rear Bumper Impact Bar Replacement .
5. Remove the tail lights. Refer to Parking and Turn Signal Lamp Replacement .
6. Remove the spare wheel and emergency kit from the rear compartment.
7. Remove the spare wheel and tyre carrier. Refer to Spare Wheel Carrier Replacement .



8. Locate, mark and drill out the spot welds (1)in the side extension panel to the rear chassis rail.



9. Locate, mark and drill out the spot welds (1) in the side extension panel to the rear extension panel.

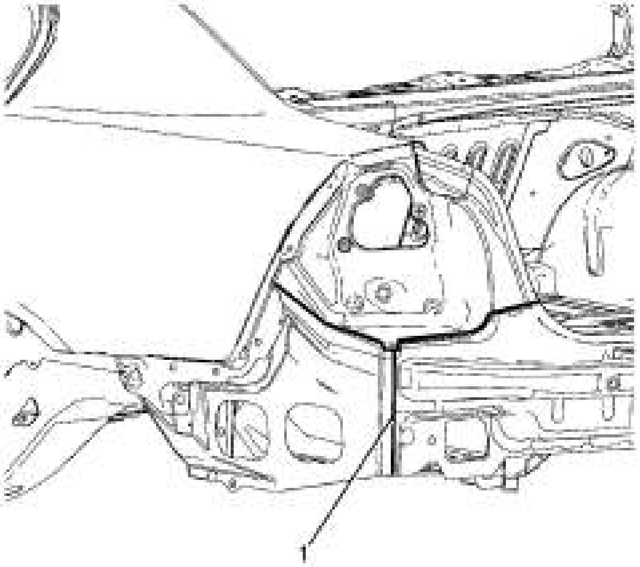


10. Locate, mark and drill out the spot welds (1) in the side extension panel to the rear extension panel.

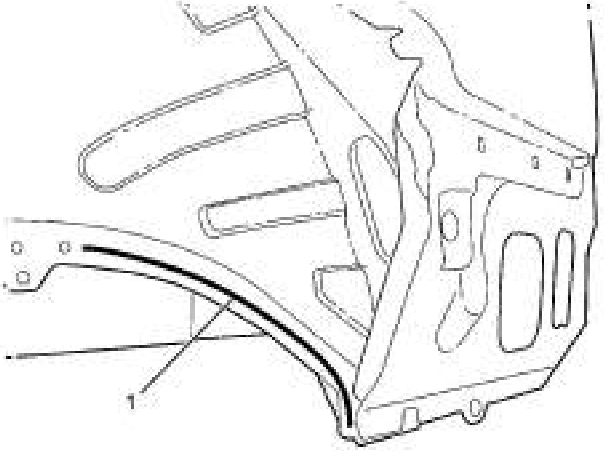
Installation Procedure

Important: If the location of the original spot weld holes can not be determined, or if structural weld-thru adhesive is present, space the puddle weld holes every 32 mm (1¼ in).

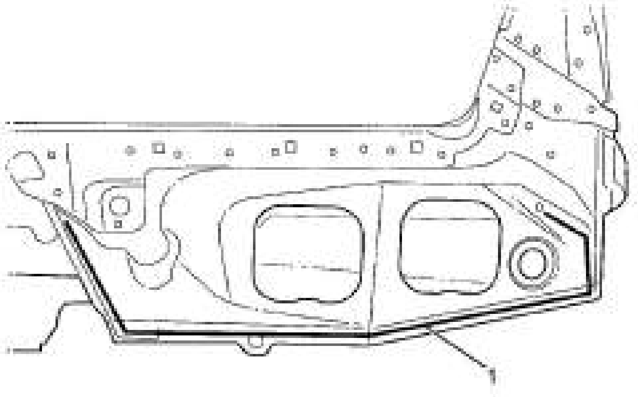
Important: Spot welding is the preferred method for attaching panels and should be used wherever possible. A puddle weld should be performed where your spot welder is unable to reach.



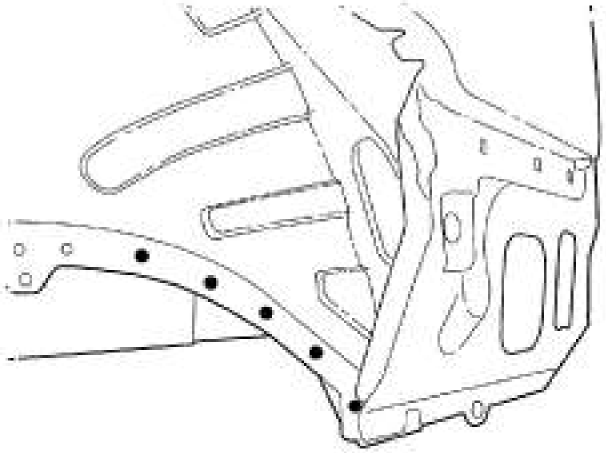
1. Apply the primary sealer (1) GM6449G or equivalent along the tail lamp filler panel and rear extension panel to the rear quarter panel.



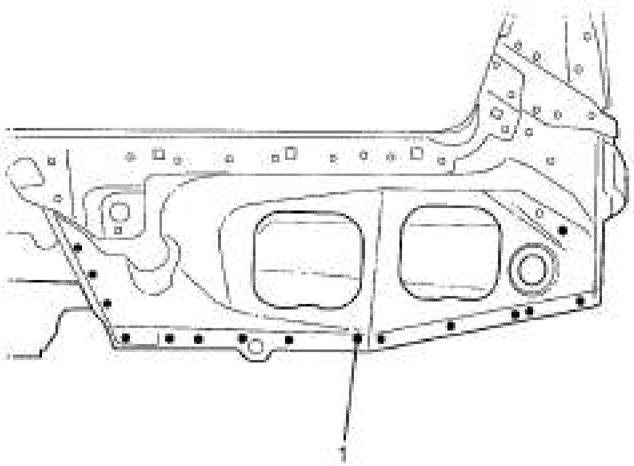
2. Apply the primary sealer (1) GM6449G or equivalent along the inner side extension panel.



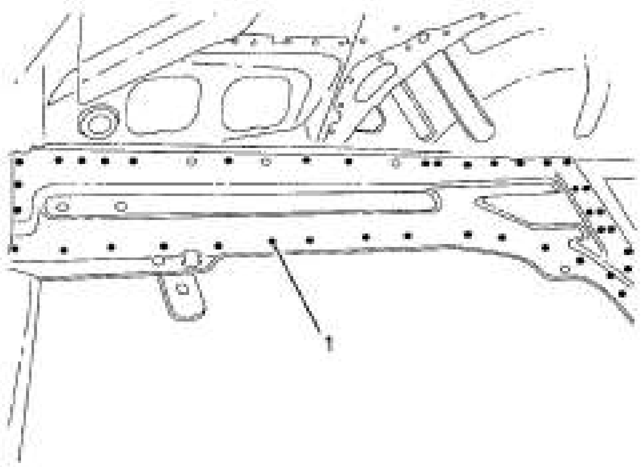
3. Apply the primary sealer (1) GM6449G or equivalent along the outer side extension panel.



4. Weld (1) the rear extension panel to the side extension panel.



5. Weld (1) the rear extension panel to the side extension panel.



6. Weld (1) the side extension panel to the rear chassis rail.
7. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair .
8. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems .
9. Install the spare wheel and tyre carrier. Refer to Spare Wheel Carrier Replacement .
10. Install the tail lights. Refer to Parking and Turn Signal Lamp Replacement .
11. Install the rear impact bar. Refer to Rear Bumper Fascia Insert Replacement .
12. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement .
13. Install the spare wheel and emergency kit from the rear compartment.

Caution: Refer to Battery Disconnect Caution in the Preface section.

14. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
15. Enable the SIR system. Refer to SIR Disabling and Enabling .
16. If re-programming is required. Refer to Control Module References .

Body Side Inner Panel Extension Replacement (Sportwagon)

Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

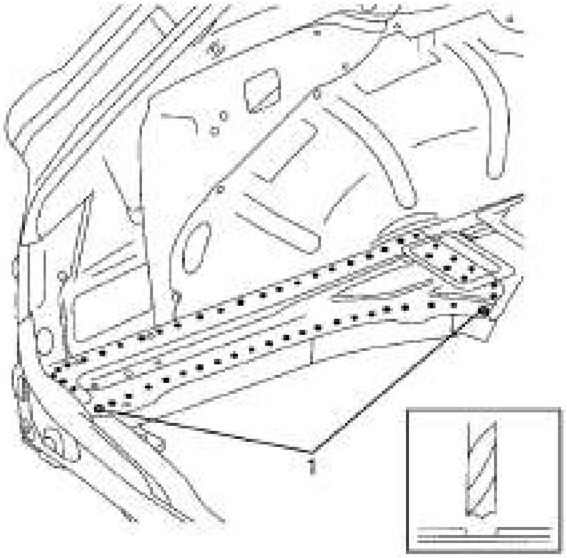
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

1. Disable the SIR system. Refer to SIR Disabling and Enabling.

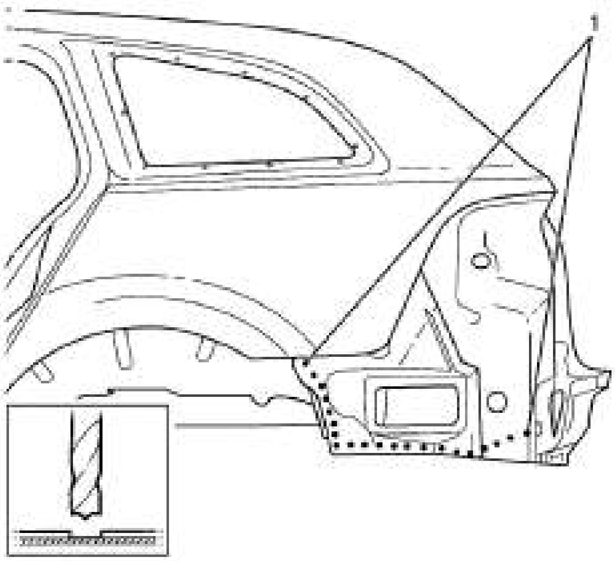
   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
4. Remove the rear impact bar. Refer to Rear Bumper Impact Bar Replacement.
5. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
6. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
7. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
8. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
9. Remove the rear bumper bracket. Refer to Rear Bumper Bracket Replacement.
10. Remove the liftgate weatherstrip. Refer to Liftgate Weatherstrip Replacement.
11. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
12. Remove the battery. Refer to Battery Replacement.
13. Remove the battery tray. Refer to Battery Tray Replacement.
14. Remove the pressure relief valve. Refer to Pressure Relief Valve Replacement.
15. Remove the tail lights. Refer to Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn Signal Bulb Replacement.
16. Remove the liftgate. Refer to Liftgate Replacement.
17. Remove the spare wheel and emergency kit from the rear compartment.
18. Remove the spare wheel carrier. Refer to Spare Wheel Carrier Replacement.
19. Remove the rear end filler panel. Refer to Rear End Panel Filler Replacement
20. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.



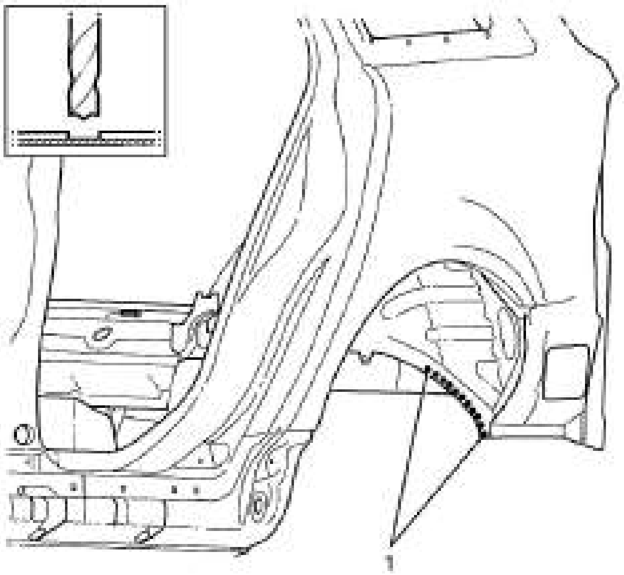
Important: Note the number and location of welds for installation on the new body side inner panel extension.

21. Locate, mark and drill out the spot welds (1) in the body side inner panel extension to the rear chassis rail.



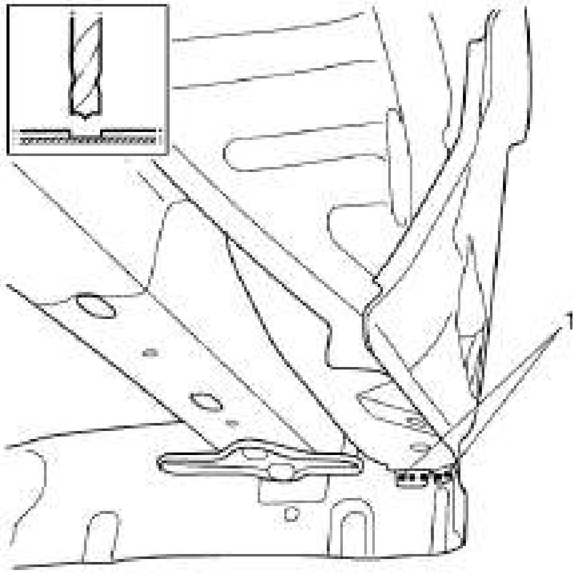
Important: Note the number and location of welds for installation on the new body side inner panel extension.

22. Locate, mark and drill out the spot welds (1) in the body side inner panel extension to the body side panel assembly.



Important: Note the number and location of welds for installation on the new body side inner panel extension.

23. Locate, mark and drill out the spot welds (1) in the body side inner panel extension to the body side panel assembly.



Important: Note the number and location of welds for installation on the new body side inner panel extension.

24. Locate, mark and drill out the spot welds (1) in the body side inner panel extension to the rear end panel assembly.
25. Remove the body side inner panel extension from the vehicle.

Installation Procedure

Important: Spot welding is the preferred method for attaching panels and should be used whenever possible. A plug weld should only be performed where spot welding is not possible.

Important: Ensure that all factory welds are replaced in their original locations.

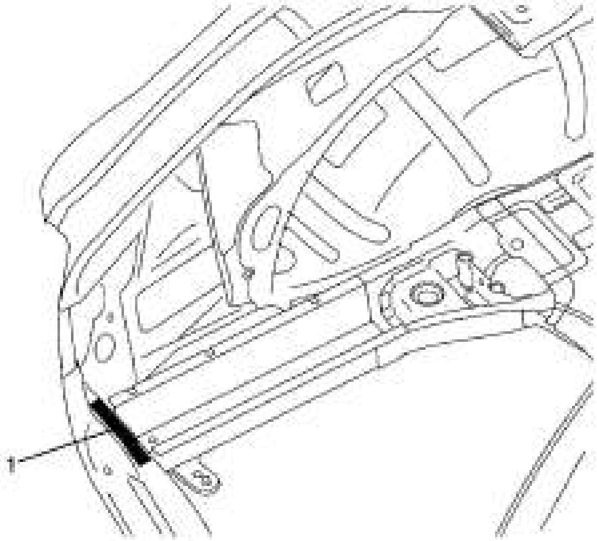
Important: Ensure that all structural adhesives are replaced in their original locations.

Important: If the location of the original plug weld holes cannot be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 32 mm (1¼ in).

Important: Follow the adhesive manufacturer's instructions during the assembly process. Heat must be applied as per the manufacturer's specifications to cure the adhesives and to expand the sealing baffles.

1. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted when disassembling.
2. Clean and prepare the mating surfaces of both parts of the body side panel assembly.

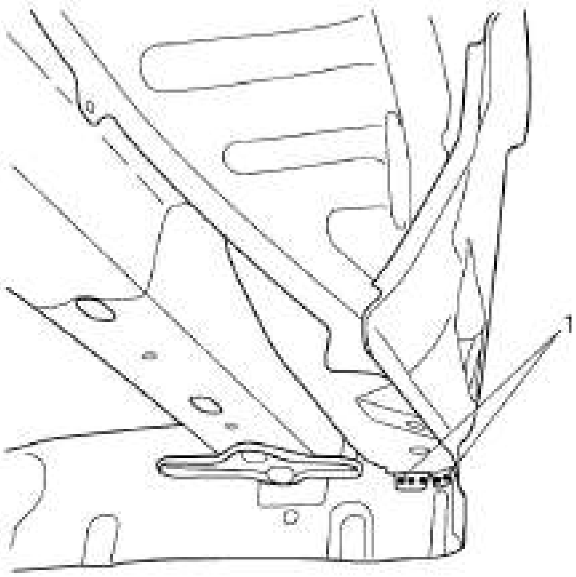
Important: Secondary sealer must be applied to the perimeter of all flanges. Secondary sealer must be applied to all welds/joints that were originally covered by secondary sealer.



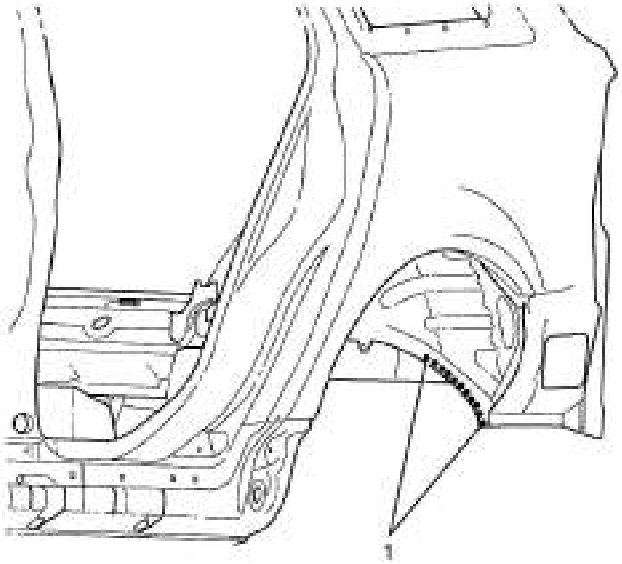
3. Apply structural adhesive (1) GM6449G or equivalent to the mating surfaces of the body side inner panel extension and rear end panel assembly.

Important: As the new body side inner panel extension is installed to the vehicle, structural adhesive should be visible on the outside edges of both surfaces (squeezed out when pushed together).

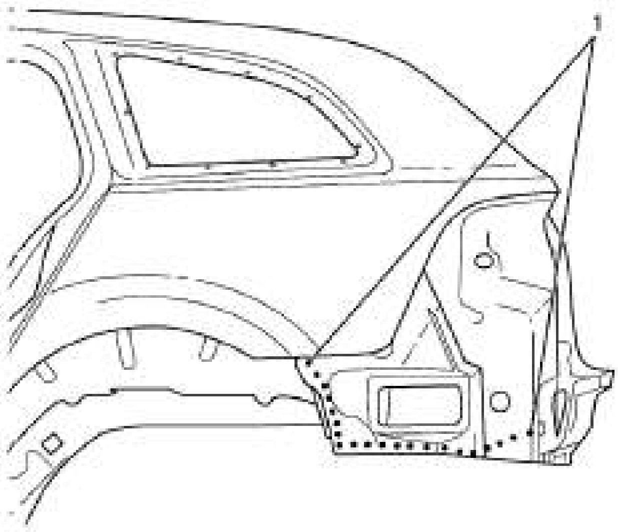
4. Position the new body side inner panel extension to the vehicle.



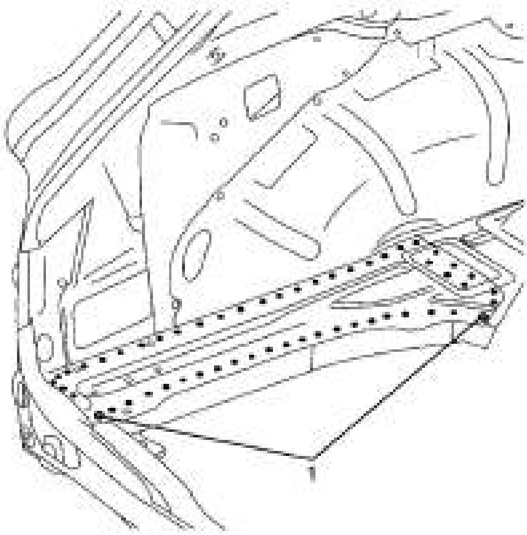
5. Weld (1) the body side inner panel extension to the rear end panel assembly.



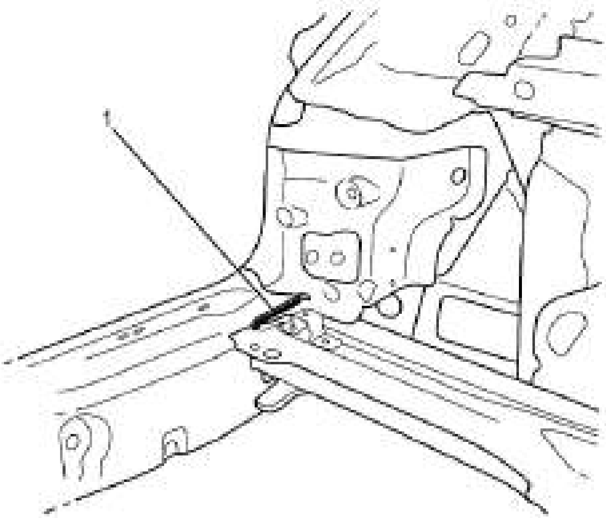
6. Weld (1) the body side inner panel extension to the body side panel assembly.



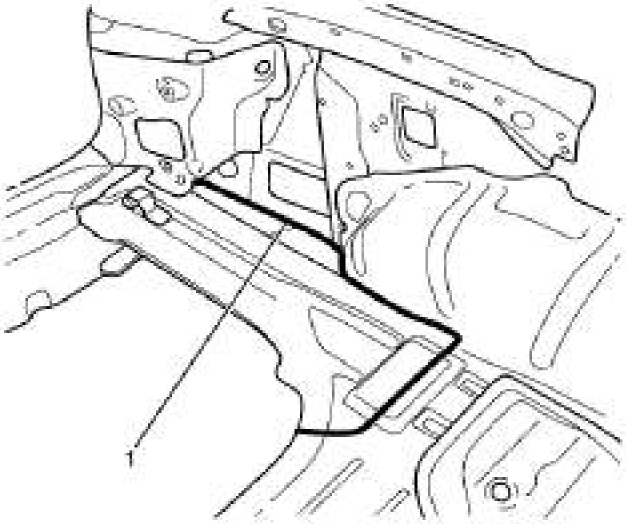
7. Weld (1) the body side inner panel extension to the body side panel assembly.



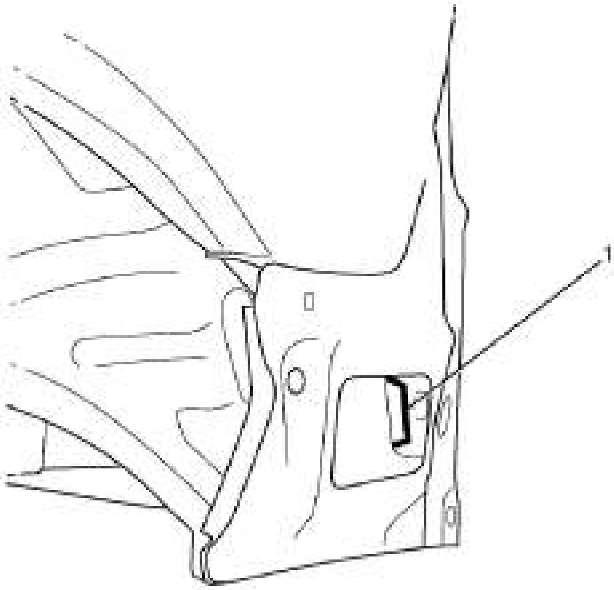
8. Weld (1) the body side inner panel extension to the rear chassis rail.



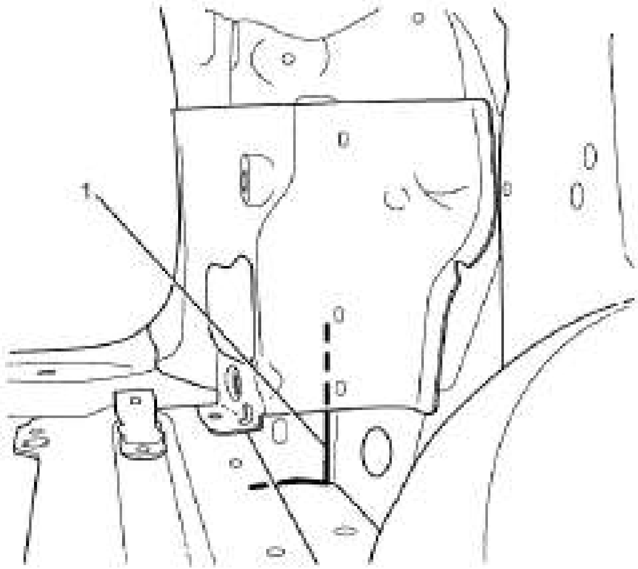
9. Apply secondary sealer (1) GM9984532 or equivalent along the rear edge of the body side inner panel extension.



10. Apply secondary sealer (1) GM9984532 or equivalent along the edge of the body side inner panel extension.



11. Apply secondary sealer (1) GM9984532 or equivalent to the rear compartment floor panel rail.



12. Apply secondary sealer (1) GM9984532 or equivalent to the body tail-lamp filler panel.
13. Install the rear end filler panel. Refer to Rear End Panel Filler Replacement
14. Apply any sealers and anti-corrosion materials to the repair area noted on disassembly. Refer to Anti-Corrosion Treatment and Repair.
15. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
16. Install the spare wheel carrier. Refer to Spare Wheel Carrier Replacement.
17. Install the spare wheel and emergency kit from the rear compartment.
18. Install the liftgate. Refer to Liftgate Replacement.
19. Install the tail lights. Refer to Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn Signal Bulb Replacement.
20. Install the pressure relief valve. Refer to Pressure Relief Valve Replacement.
21. Install the battery tray. Refer to Battery Tray Replacement.

22. Install the battery. Refer to Battery Replacement.
23. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
24. Install the liftgate weatherstrip. Refer to Liftgate Weatherstrip Replacement.
25. Install the rear bumper bracket. Refer to Rear Bumper Bracket Replacement.
26. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
27. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
28. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
29. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
30. Install the rear impact bar. Refer to Rear Bumper Impact Bar Replacement.
31. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
32. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
33. Enable the SIR system. Refer to SIR Disabling and Enabling.

Upper Rail Replacement

Removal Procedure

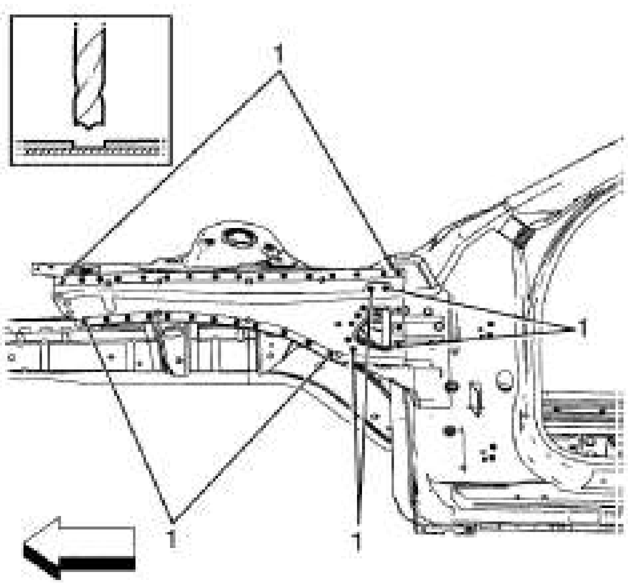
Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

1. Disable the SIR system. Refer to SIR Disabling and Enabling.
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the engine assembly. Refer to Engine Replacement or Engine Replacement.
4. Remove the negative cable from the engine bay. Refer to Battery Negative Cable Replacement.
5. Remove the positive cable from the engine bay. Refer to Battery Positive Cable Replacement.
6. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
7. Remove the front wheels. Refer to Tire and Wheel Removal and Installation.
8. Remove the front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement.
9. Remove the front wheel hub assembly. Refer to Front Wheel Bearing and Hub Replacement.
10. Remove the front strut assembly. Refer to Strut Assembly Replacement.
11. Lower the vehicle.
12. Remove the brake lines. Refer to Brake Pipe Replacement.
13. Remove the fender assembly. Refer to Front Fender Replacement.
14. Remove the front fascia. Refer to Front Bumper Fascia Replacement.
15. Remove the coolant reservoir. Refer to Coolant Recovery Reservoir Replacement.
16. Remove the front end module. Refer to Front End Panel Module Carrier Assembly Replacement.
17. Remove the air inlet grille. Refer to Air Inlet Grille Panel Replacement.
18. Remove the plenum chamber. Refer to Air Inlet Assembly Replacement.
19. Remove the relay box. Refer to Underhood Electrical Center or Junction Block Replacement.
20. Remove the ABS unit. Refer to Brake Pressure Modulator Valve Assembly Replacement.
21. Remove the brake master cylinder. Refer to Master Cylinder Replacement.
22. Note the location and remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.



23. Locate, mark and drill out the factory welds (1) attaching the upper wheelhouse brace to the front wheelhouse assembly.
24. Remove the upper wheelhouse brace from the front wheelhouse assembly and discard.

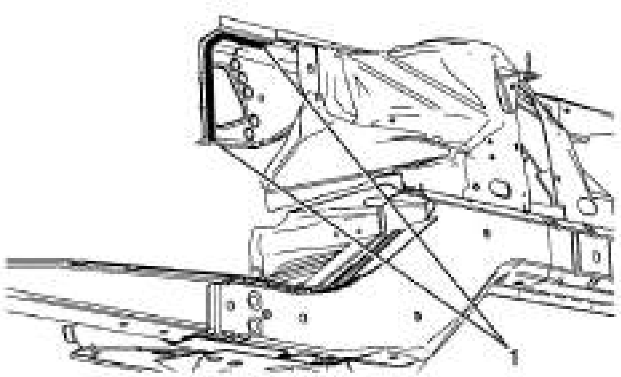
    Discard the upper wheelhouse brace.

Installation Procedure

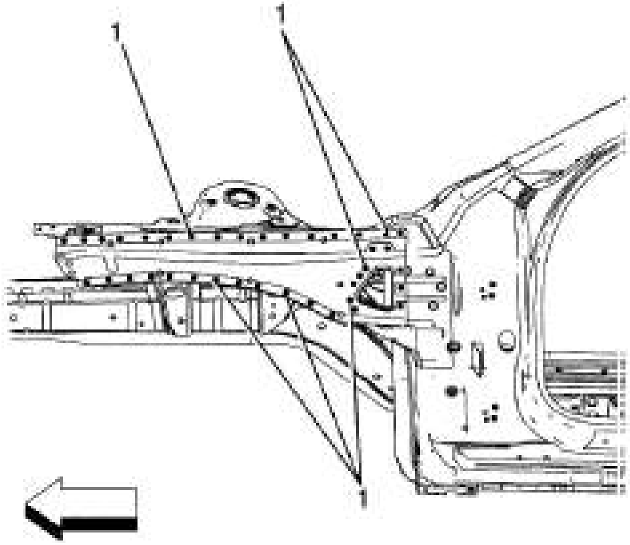
Important: Spot welding is the preferred method for attaching panels and should be used wherever possible. A plug weld should be performed where your spot welder is unable reach.

Important: If the location of the original plug weld holes can not be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 32 mm (1¼ in).

1. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted from the original assembly.
2. Clean and prepare the mating surfaces of the front wheelhouse assembly and the upper wheelhouse brace.



3. Apply the primary sealer (1) HN2484 along the rear edge of the upper wheelhouse brace.
4. Position the upper wheelhouse brace on the vehicle. Verify correct alignment and position using three-dimensional measuring equipment.



5. Puddle weld (1) the front wheelhouse assembly to the upper wheelhouse brace.
6. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.
7. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
8. Install the brake master cylinder. Refer to Master Cylinder Replacement.
9. Install the ABS unit. Refer to Brake Pressure Modulator Valve Assembly Replacement.
10. If re-programming is required. Refer to Control Module References.
11. Install the relay box. Refer to Underhood Electrical Center or Junction Block Replacement.
12. Install the plenum chamber. Refer to Air Inlet Assembly Replacement.
13. Remove the air inlet grille. Refer to Air Inlet Grille Panel Replacement.
14. Install the relay box. Refer to Underhood Electrical Center or Junction Block Replacement.

15. Install the plenum chamber. Refer to Air Inlet Assembly Replacement.
16. Remove the air inlet grille. Refer to Air Inlet Grille Panel Replacement.
17. Install the front end module. Refer to Front End Panel Module Carrier Assembly Replacement.
18. Install the brake lines. Refer to Brake Pipe Replacement.
19. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
20. Install the coolant reservoir. Refer to Coolant Recovery Reservoir Replacement.
21. Install the front fascia. Refer to Front Bumper Fascia Replacement.
22. Install the front strut assembly. Refer to Strut Assembly Replacement.
23. Install the front wheel hub assembly. Refer to Front Wheel Bearing and Hub Replacement.
24. Install the front wheel house liner. Refer to Front Wheelhouse Liner Replacement.
25. Install the front wheels. Refer to Tire and Wheel Removal and Installation.
26. Lower the vehicle.
27. Install the fender assembly. Refer to Front Fender Replacement.
28. Install the engine assembly. Refer to Engine Replacement or Engine Replacement.
29. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
30. Enable the SIR system. Refer to SIR Disabling and Enabling.
31. If re-programming is required. Refer to Control Module References.

Side Door Opening Frame Replacement (Sportwagon)

Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

1. Disable the SIR system. Refer to SIR Disabling and Enabling.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the engine assembly. Refer to Engine Replacement for the 3.6L Engine or Engine Replacement for the 6.0L Engine.
4. Remove the ABS unit. Refer to Brake Pressure Modulator Valve Assembly Replacement.
5. Remove the brake master cylinder. Refer to Master Cylinder Replacement.
6. Remove the vacuum brake booster. Refer to Power Vacuum Brake Booster Replacement.
7. Remove the engine control module. Refer to Engine Control Module Replacement for the 3.6L Engine or Engine Control Module Replacement for the 6.0L Engine.
8. Remove the underhood electrical centre. Refer to Underhood Electrical Center or Junction Block Replacement.
9. Remove the negative battery cable. Refer to Battery Negative Cable Replacement.
10. Remove the positive battery cable from the engine bay. Refer to Battery Positive Cable Replacement.
11. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
12. Remove the air inlet grille. Refer to Air Inlet Grille Panel Replacement.
13. Remove the front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement.
14. Remove the coolant reservoir. Refer to Coolant Recovery Reservoir Replacement.
15. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement.
16. Remove the front end module. Refer to Front End Panel Module Carrier Assembly Replacement.
17. Remove the front fender assembly. Refer to Front Fender Replacement.
18. Remove the front wheel hub assembly. Refer to Front Wheel Bearing and Hub Replacement.
19. Remove the front strut assembly. Refer to Strut Assembly Replacement.
20. Remove the rear wheelhouse liner. Refer to Rear Inner Wheelhouse Replacement.
21. Remove the rear frame assembly. Refer to Rear Frame Replacement.

    Important: This step is unique to the right side body ring.

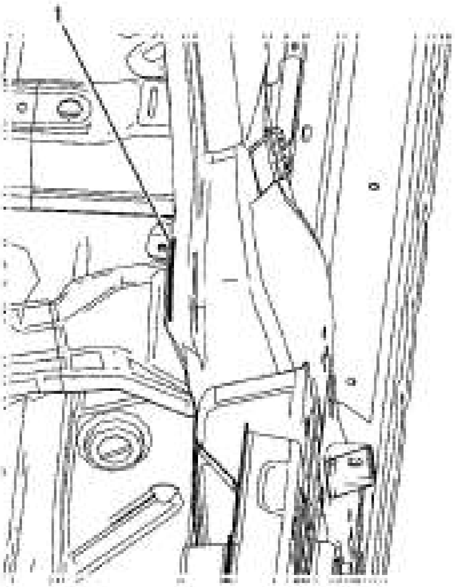
22. Remove the filler tube. Refer to Filler Tube Replacement for the 3.6L Engine or Filler Tube Replacement for the 6.0L Engine.

    Important: This step is unique to the right side body ring.

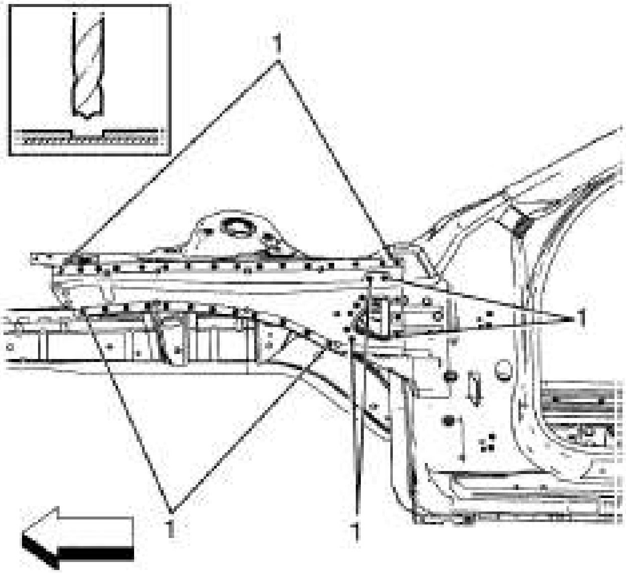
23. Remove the fuel filler door. Refer to Fuel Tank Filler Door Replacement.

Important: This step is unique to the right side body ring.

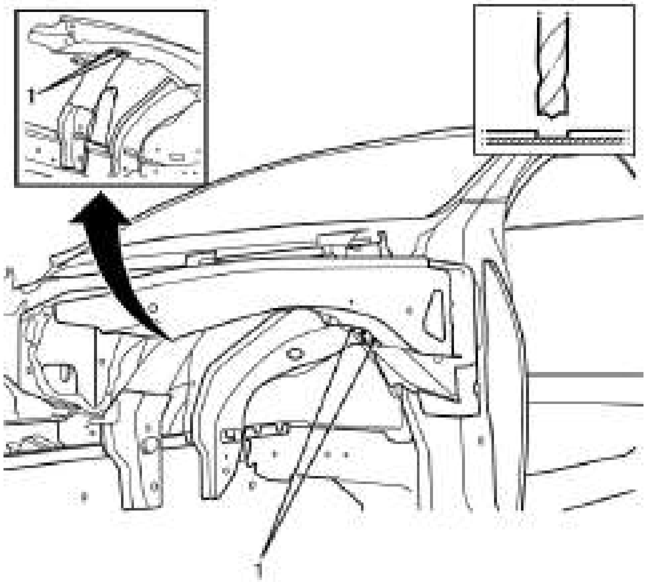
24. Remove the fuel filler door release actuator. Refer to Fuel Tank Filler Door Lock Actuator Replacement.
25. Remove the fuel lines. Refer to Fuel Hose/Pipes Replacement - Chassis for the 3.6L Engine or Fuel Hose/Pipes Replacement - Chassis for the 6.0L Engine.
26. Remove the fuel tank. Refer to Fuel Tank Replacement for the 3.6L Engine or Fuel Tank Replacement for the 6.0L Engine.
27. Remove the brake lines. Refer to Brake Pipe Replacement.
28. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
29. Remove the plenum chamber. Refer to Air Inlet Assembly Replacement.
30. Remove the front doors. Refer to Front Side Door Replacement.
31. Remove the rear doors. Refer to Rear Door Replacement.
32. Remove the front seats. Refer to Front Seat Replacement - Bucket.
33. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement.
34. Remove the rear seat back. Refer to Rear Split Folding Seat Back Replacement.
35. Remove the front seat belts. Refer to Front Seat Belt Replacement.
36. Remove the rear seat belts. Refer to Rear Seat Belt Replacement.
37. Remove the instrument panel carrier. Refer to Instrument Panel Carrier Replacement.
38. Remove the HVAC module assembly. Refer to HVAC Module Assembly Replacement.
39. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
40. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
41. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
42. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
43. Remove the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
44. Remove the body side window rear garnish moulding. Refer to Body Side Window Rear Garnish Molding Replacement.
45. Remove the headliner. Refer to Headlining Trim Panel Replacement.
46. Remove the body side stationary window. Refer to Body Side Window Replacement.
47. Remove the remote function actuator. Refer to Remote Control Door Lock Receiver and Theft Deterrent Module Replacement.
48. Remove the positive battery cable from the vehicle. Refer to Battery Positive Cable Replacement.
49. Remove roof weld joint reveal moulding. Refer to Roof Weld Joint Reveal Molding Replacement.
50. Remove the rocker panel moulding. Refer to Rocker Panel Molding Replacement.
51. Remove the windshield pillar garnish moulding. Refer to Windshield Pillar Garnish Molding Replacement.
52. Remove the body side roof drip moulding. Refer to Body Side Roof Drip Molding Replacement.
53. Remove the liftgate. Refer to Liftgate Replacement.
54. Remove the rear header panel. Refer to Customer Concern Verification Sheets.
55. Note the location and remove sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.



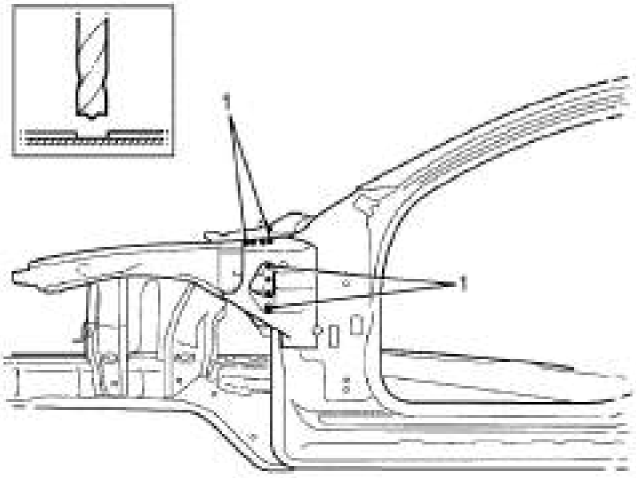
56. Remove the body side panel to upper dash panel body sealer (1).



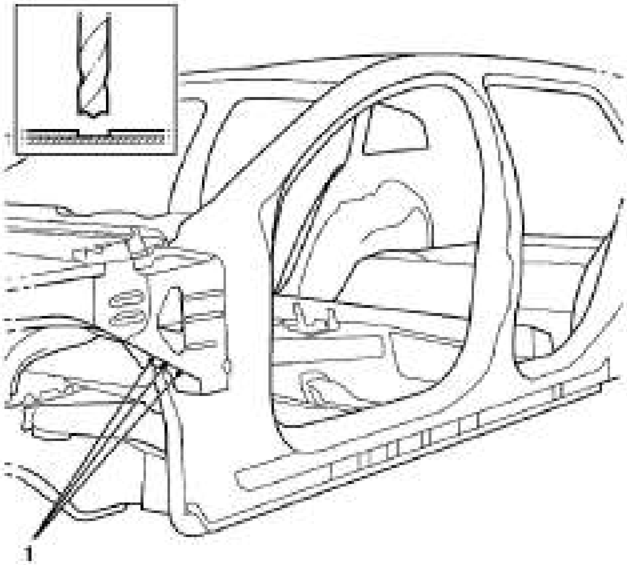
57. Locate, mark and drill out the factory welds attaching the upper wheel house brace to the front wheelhouse assembly (1).



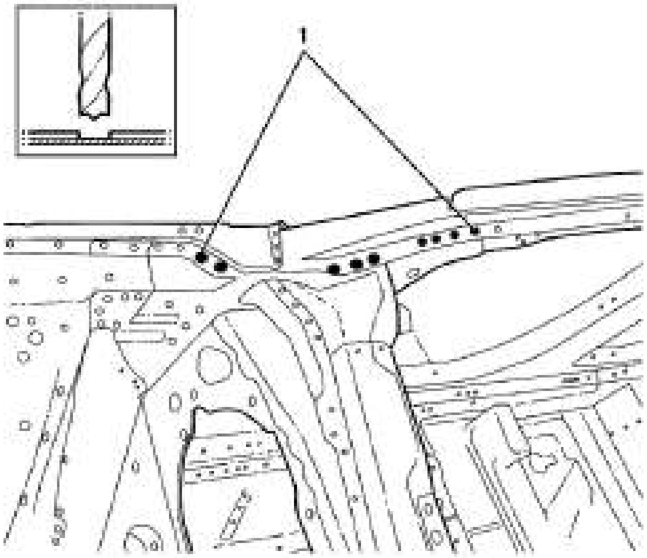
58. Locate, mark and drill out the factory welds attaching the upper wheelhouse brace to the front hinge pillar (1).



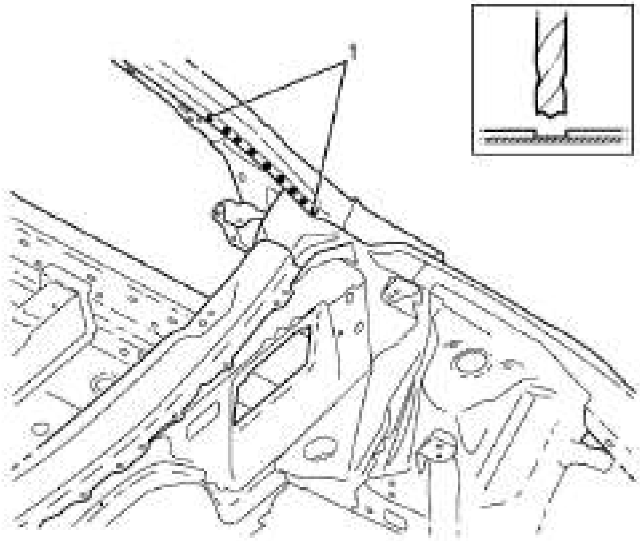
59. Locate, mark and remove the factory seam welds attaching the body side panel assembly to the front hinge pillar (1).
60. Remove the upper wheelhouse brace from the front wheelhouse assembly.



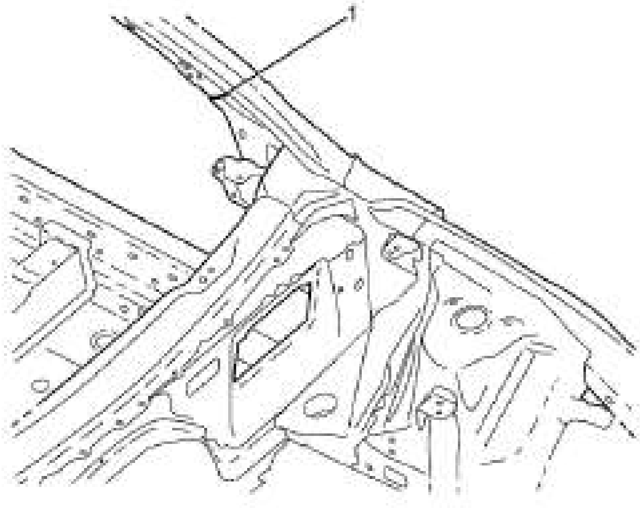
61. Locate, mark and drill out the factory welds attaching the upper wheelhouse brace to the front hinge pillar (1).



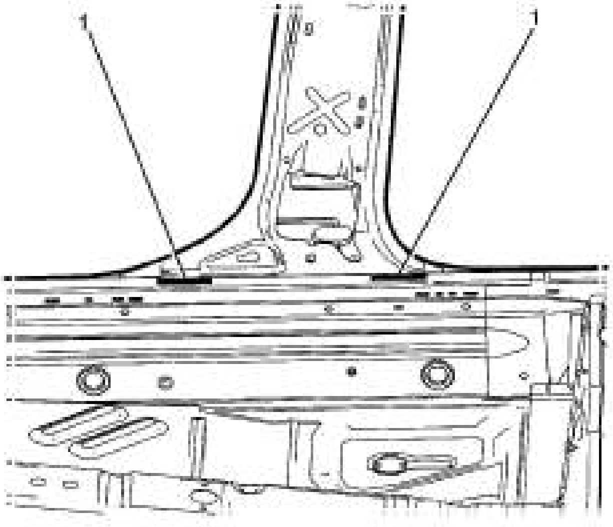
62. Locate, mark and drill out the factory welds attaching the body side panel assembly to the front hinge pillar (1).



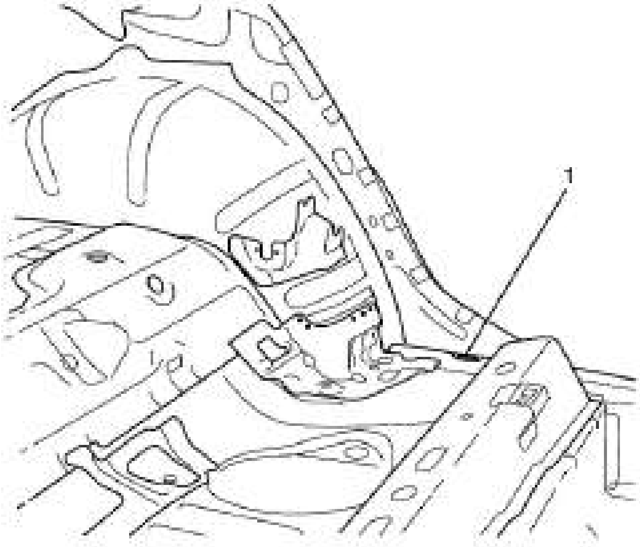
63. Locate, mark and drill out the factory welds attaching the body side panel assembly to the vehicle (1).



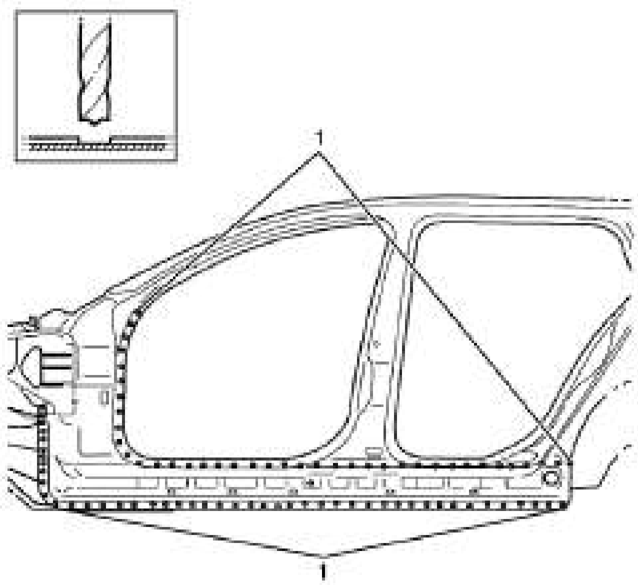
64. Locate, mark and remove the factory welds attaching the body side panel assembly to the vehicle (1).
65. Remove the Roof Rear Header Panel. Refer to Roof Rear Header Panel Replacement.
66. Remove the Roof Front Header Panel. Refer to Roof Front Header Panel Replacement.
67. Remove the Front Roof Panel Bow. Refer to Roof Panel Bow Replacement.
68. Remove the Rear Roof Panel Bow. Refer to Roof Panel Bow Replacement.



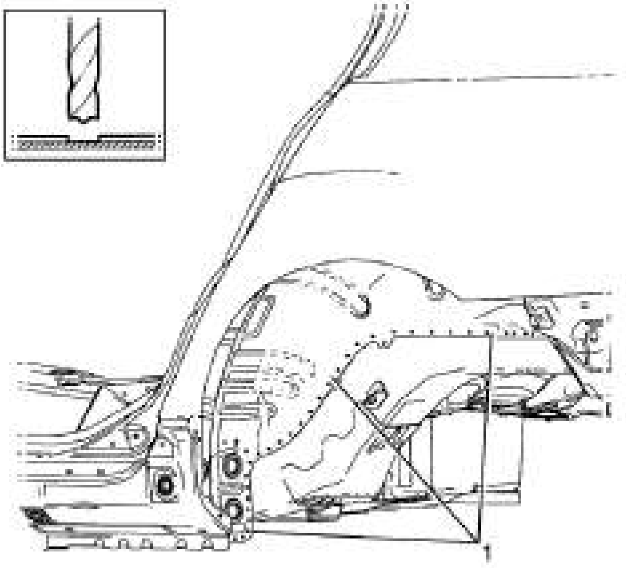
69. Locate, mark and remove the factor seam welds (1) attaching the body side panel assembly to the inner rocker panel.



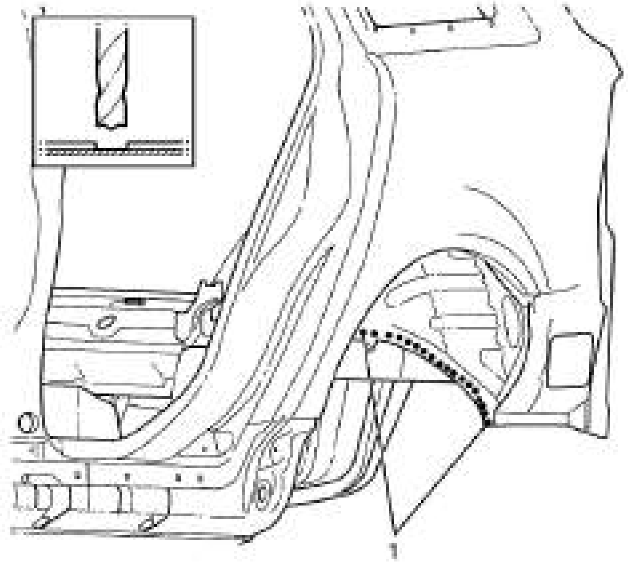
70. Locate, mark and remove the factory seam welds (1) attaching the body side panel assembly to the rear inner wheelhouse.



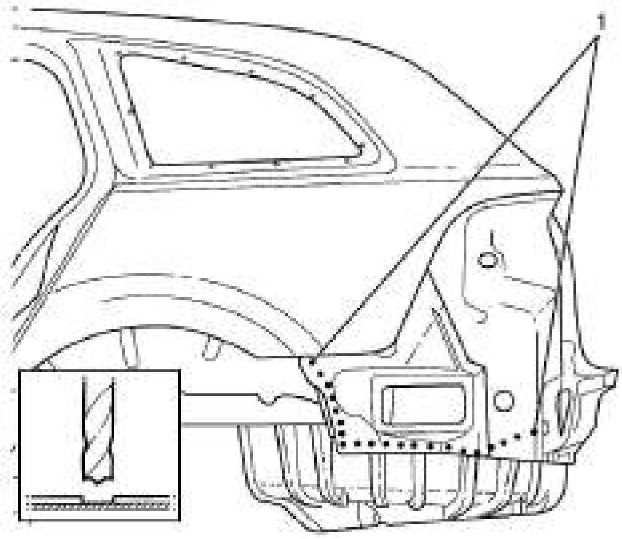
71. Locate, Mark and drill out the factory welds (1) attaching the body side panel assembly to the vehicle.



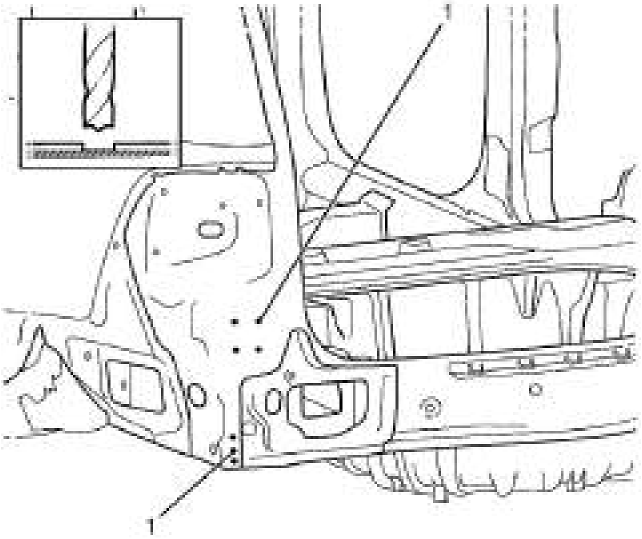
72. Locate, mark and drill out the factory welds (1) attaching the body side panel assembly to the rear floor panels.



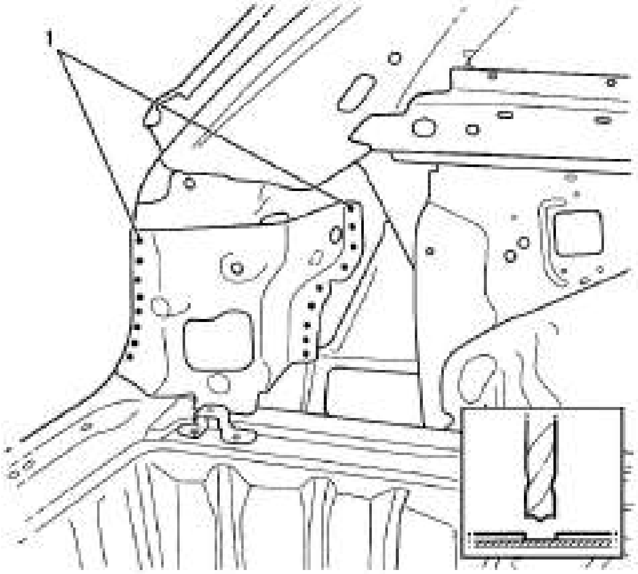
73. Locate, mark and drill out the factory welds (1) attaching the body side panel assembly to the rear floor panels.



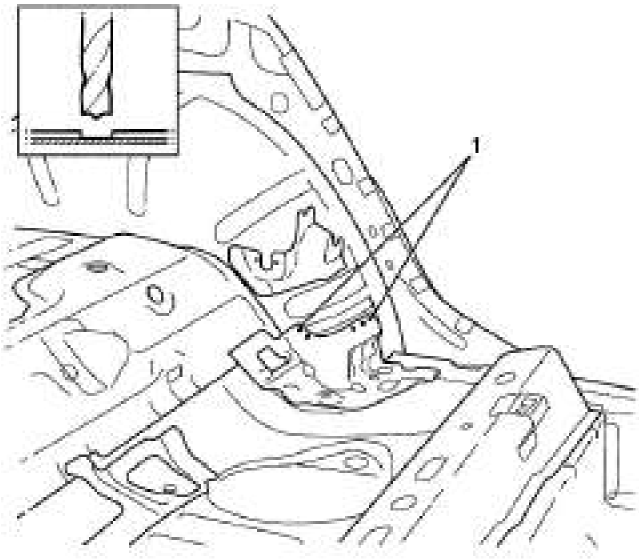
74. Locate, mark and drill out the factory welds (1) attaching the body side panel assembly to the rear floor panels.



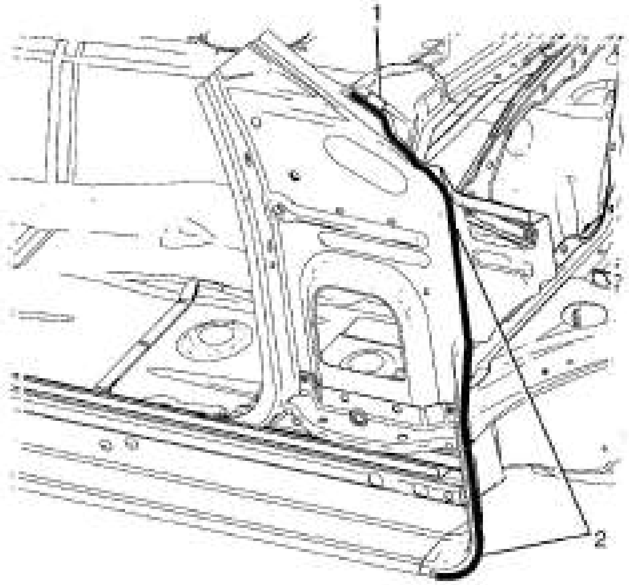
75. Locate, mark and drill out the factory welds (1) attaching the body side panel assembly to the rear floor panels.



76. Locate, mark and drill out the factory welds (1) attaching the body side panel to the back body pillar inner lower panel.

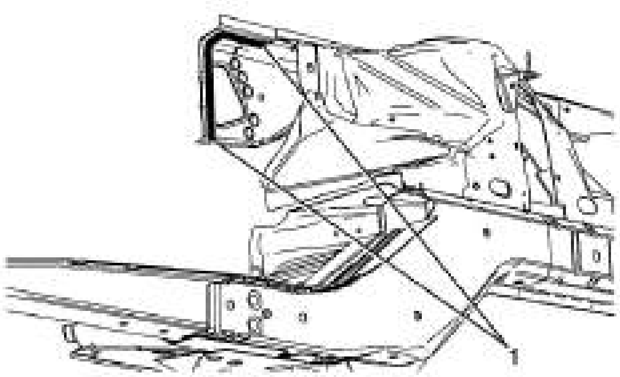


77. Locate, mark and drill out the factory welds (1) attaching the body side panel assembly to the rear wheelhouse inner panel front reinforcement.
78. Remove the body side panel assembly from the vehicle.



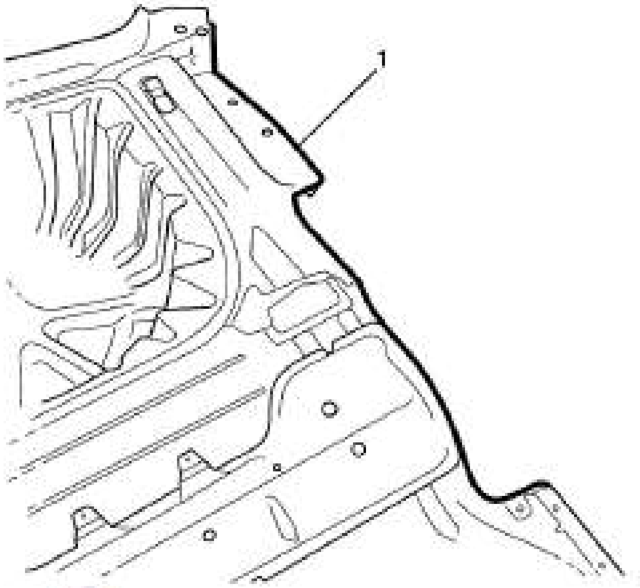
Important: Clean all adhesive mating surfaces in accordance with the adhesive manufacturer's specifications.

79. Remove the sealer (1) from the front plenum panel.
80. Remove the seam sealer (2) from the body side.



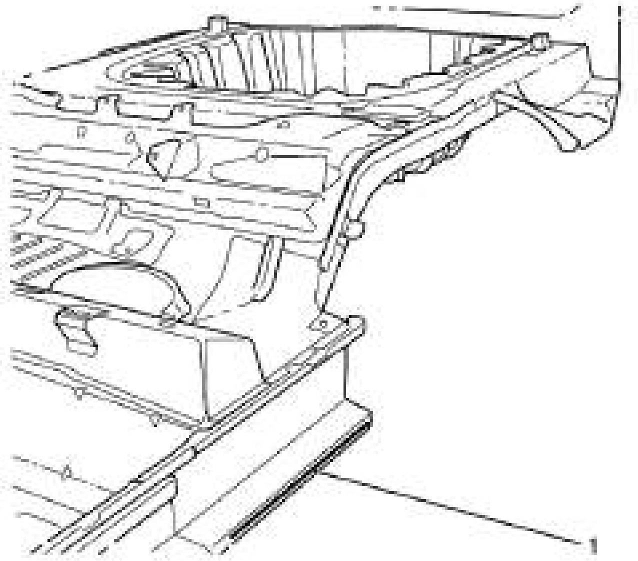
Important: Clean all adhesive mating surfaces in accordance with the adhesive manufacturer's specifications.

81. Remove the sealer (1) from the rear edge of the upper wheelhouse brace.



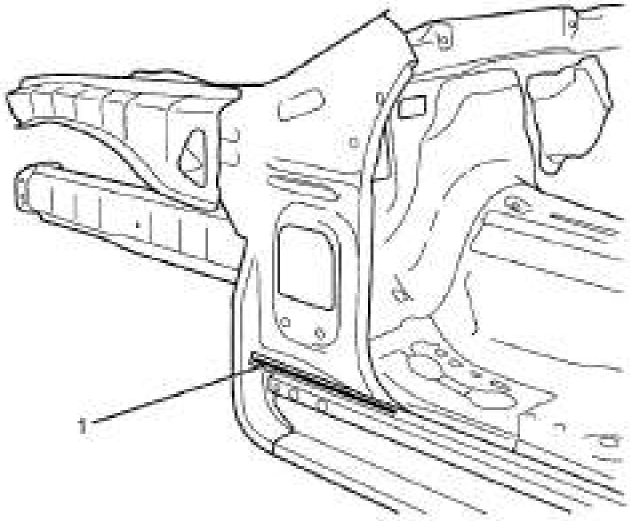
Important: Clean all adhesive mating surfaces in accordance with the adhesive manufacturer's specifications.

82. Remove the sealer (1) from the rear floor pan assembly.



Important: Clean all adhesive mating surfaces in accordance with the adhesive manufacturer's specifications.

83. Remove the sealer (1) from the inner quarter panel.



Important: Clean all adhesive mating surfaces in accordance with the adhesive manufacturer's specifications.

84. Remove the sealer (1) from the top edge of the inner hinge pillar.

Installation Procedure

Important: Spot welding is the preferred method for attaching panels and should be used whenever possible. A plug weld should only be performed where spot welding is not possible.

Important: Ensure that all factory welds are replaced in their original locations.

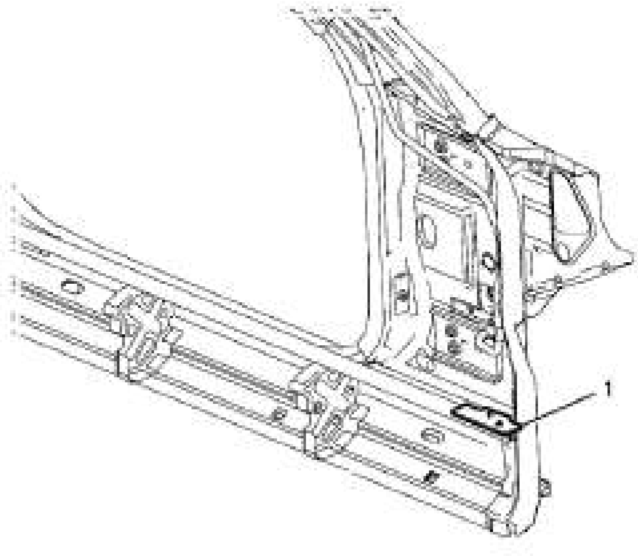
Important: Ensure that all structural adhesives and sealers are replaced in their original locations.

Important: If the location of the original plug weld holes cannot be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 32 mm (1¼ in).

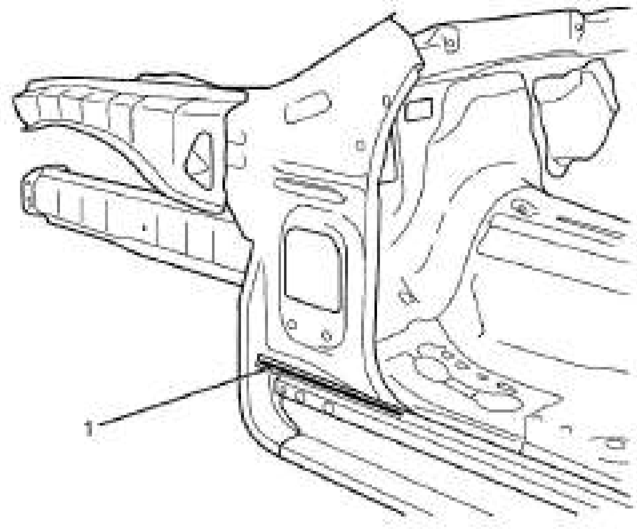
Important: Follow the adhesive manufacturer's instructions during the assembly process. Heat must be applied as per the manufacturer's specifications to cure the adhesives and to expand the sealing baffles.

1. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted when disassembling.
2. Clean and prepare the mating surfaces of both parts of the body side panel assembly.

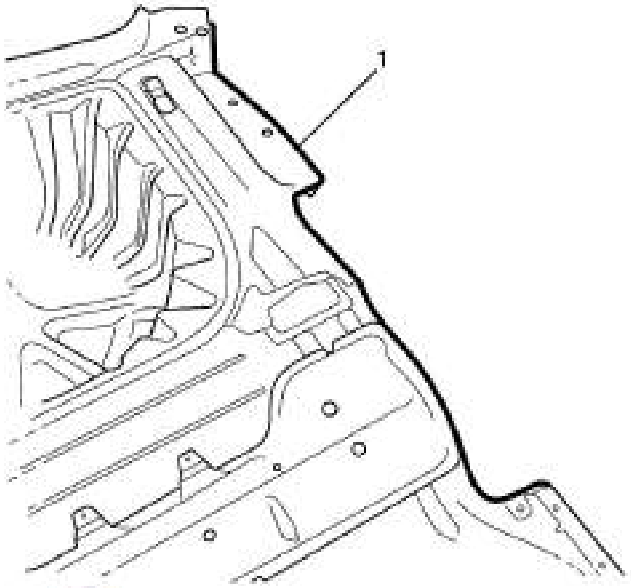
Important: Secondary sealer must be applied to the perimeter of all flanges. Secondary sealer must be applied to all welds/joints that were originally covered by secondary sealer.



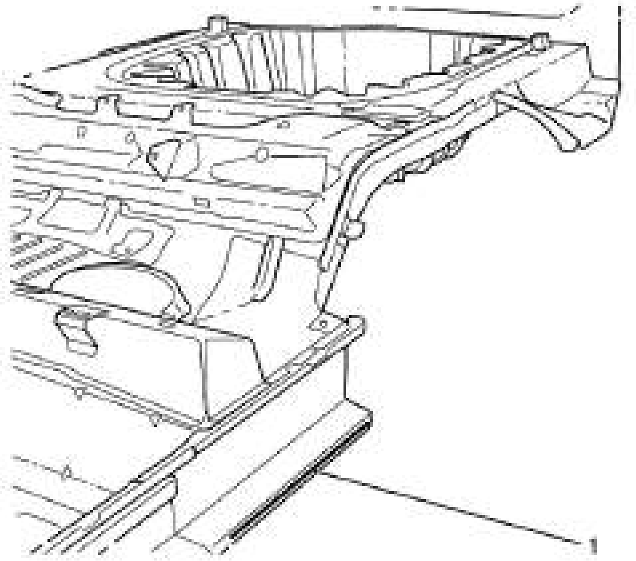
3. Install the un-expanded noise baffle (1) to the body side panel assembly.



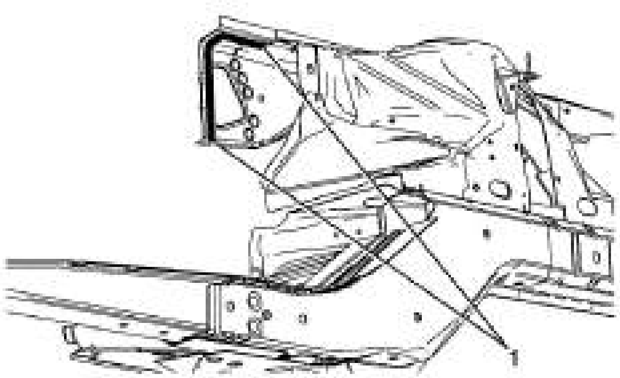
4. Apply the primary sealer to the top edge of the inner hinge pillar (1).



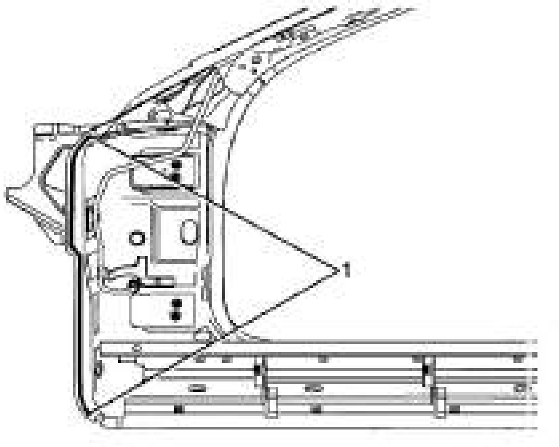
5. Apply the secondary sealer along the rear floor pan assembly (1).



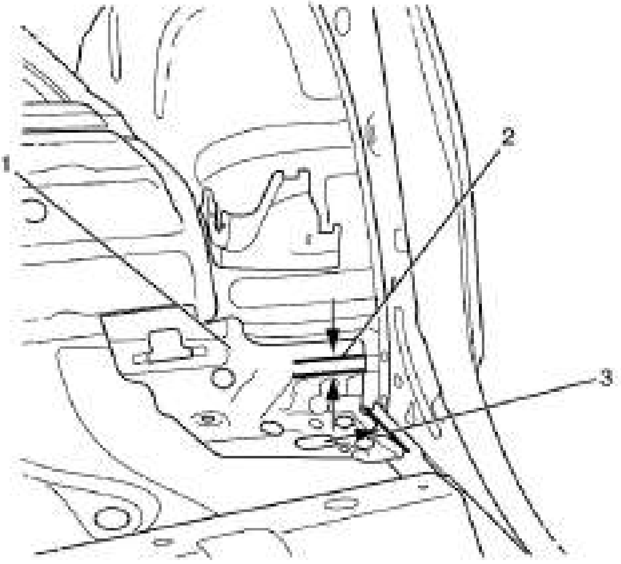
6. Apply the primary sealer (1) between the inner rocker panel and the inner quarter panel.



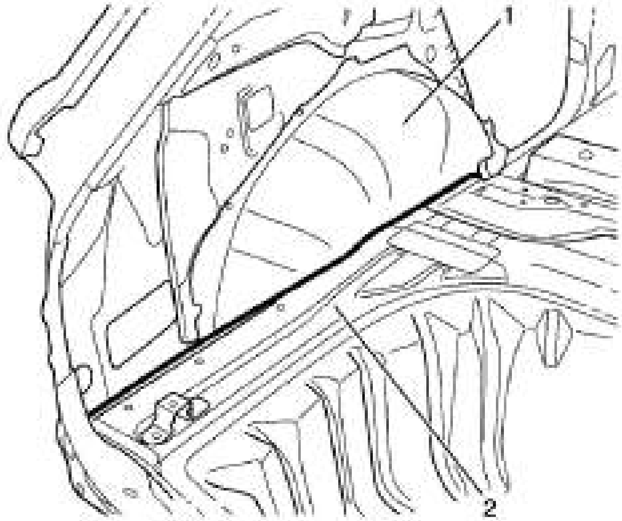
7. Apply the primary sealer along the rear edge of the upper wheelhouse brace (1).



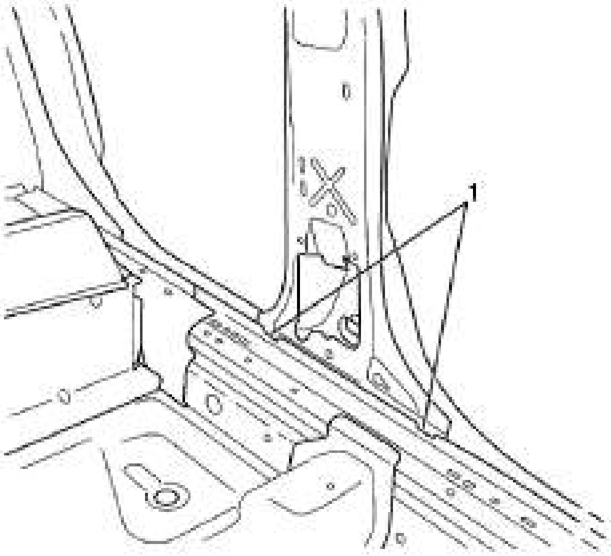
8. Apply the primary sealer along the lower hinge pillar (1).



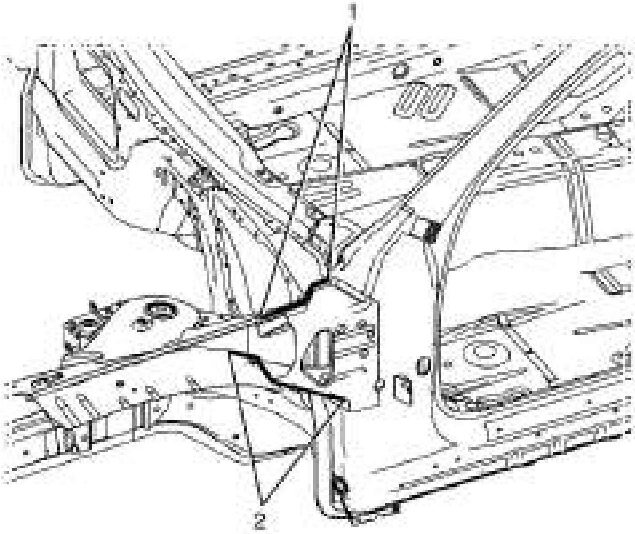
9. Align the body side panel assembly by positioning the rear wheelhouse inner panel front reinforcement flange (1) up against the inner rocker panel flange (3).
10. Align the body side panel assembly by positioning the rib in the rear wheelhouse inner panel front reinforcement (1) with the corresponding rib (2) in the rear wheelhouse inner panel.



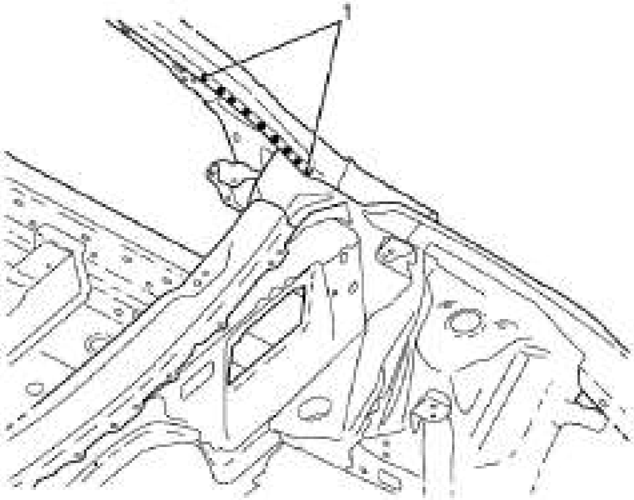
11. Align the body side panel assembly by positioning the inner wheelhouse panel (1) up against the rear floor panel (2).



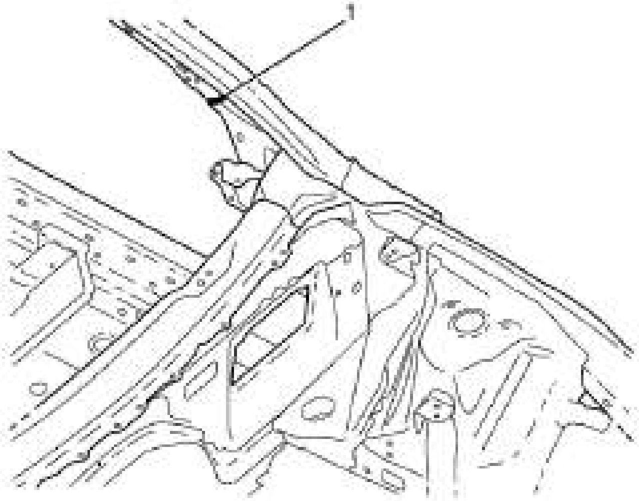
12. Align the body side panel assembly centre pillar to the indented flange on the inner rocker panel (1).



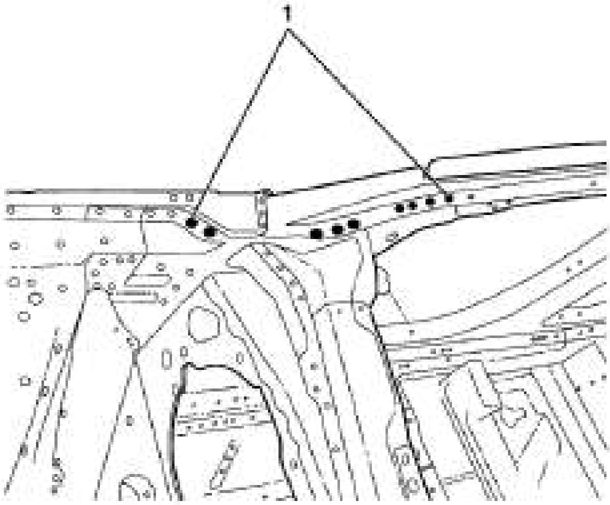
13. Align the body side panel hinge pillar (1) to the inner lower hinge pillar (2).



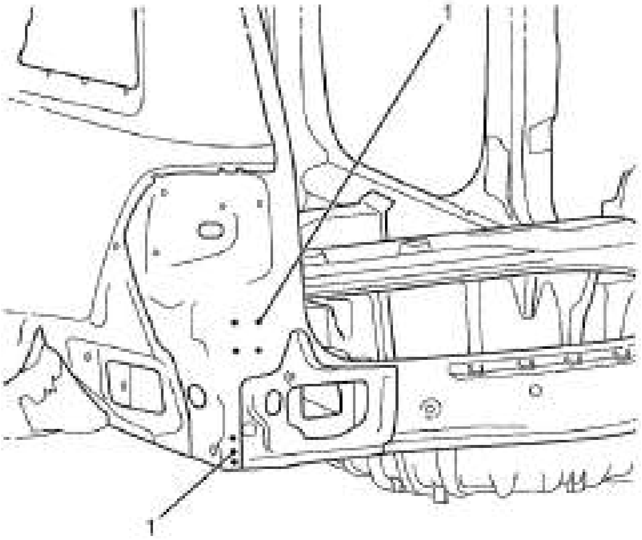
14. Weld the body side panel assembly to the front hinge pillar (1).



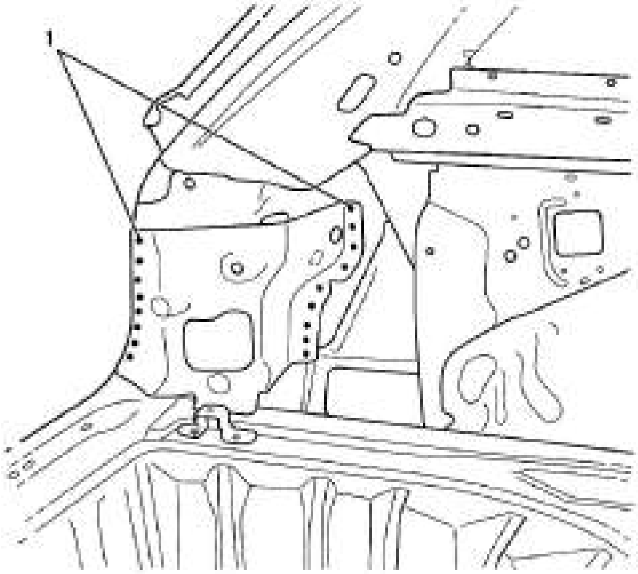
15. Seam weld the inner lower hinge pillar to inner upper hinge pillar (1) 60 mm (2.36 in) using a metal inert gas (MIG) welder.



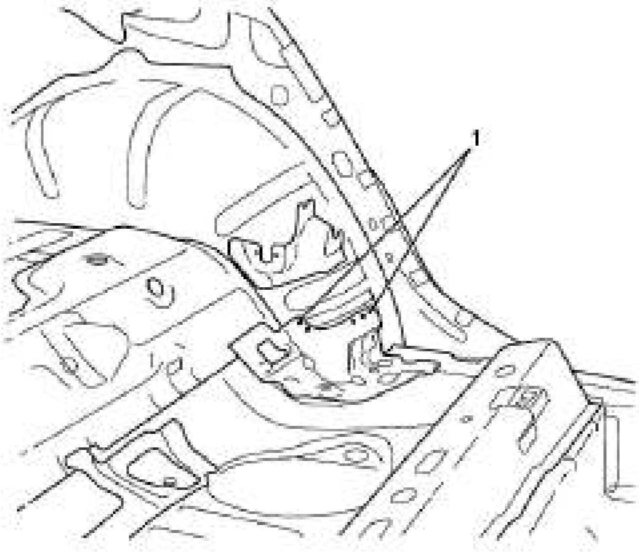
16. Weld the body side panel assembly to the front hinge pillar (1).



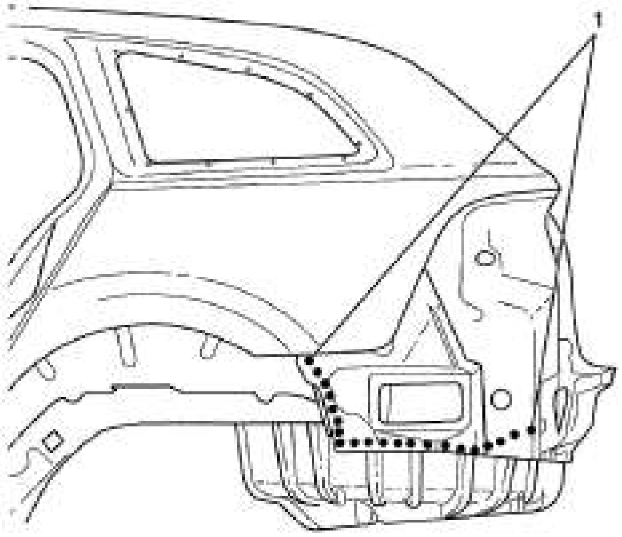
17. Weld the body side panel assembly to the rear floor panels (1).



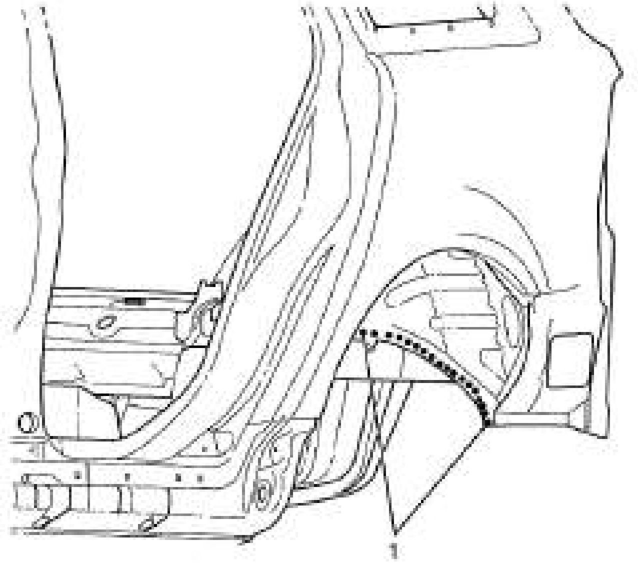
18. Weld the body side panel to the back body pillar inner lower panel (1).



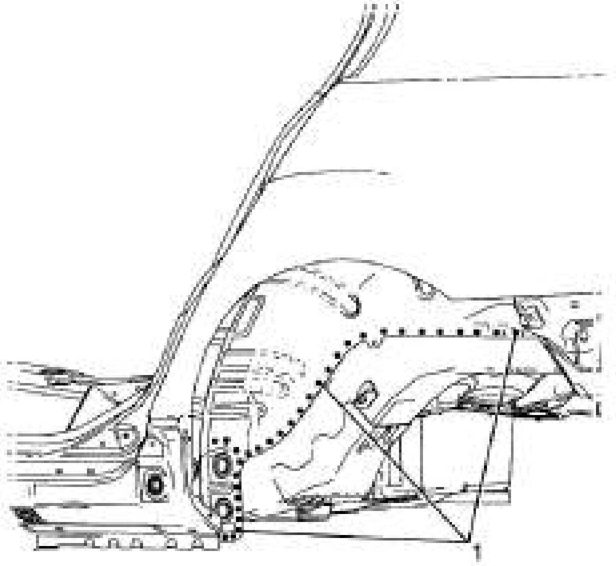
19. Weld the body side panel assembly to the rear wheelhouse inner panel front reinforcement (1).



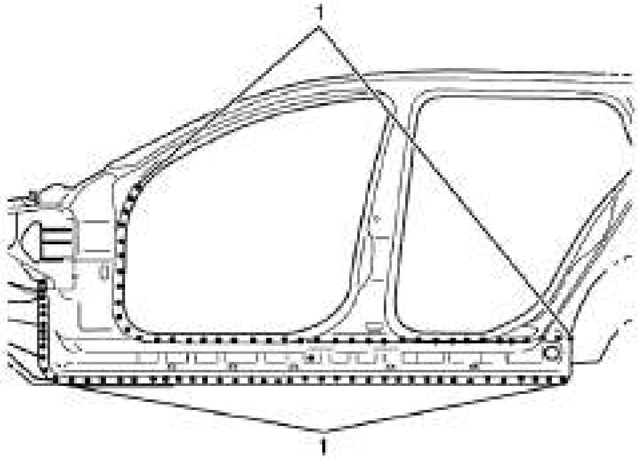
20. Weld the body side panel assembly to the rear floor panels (1).



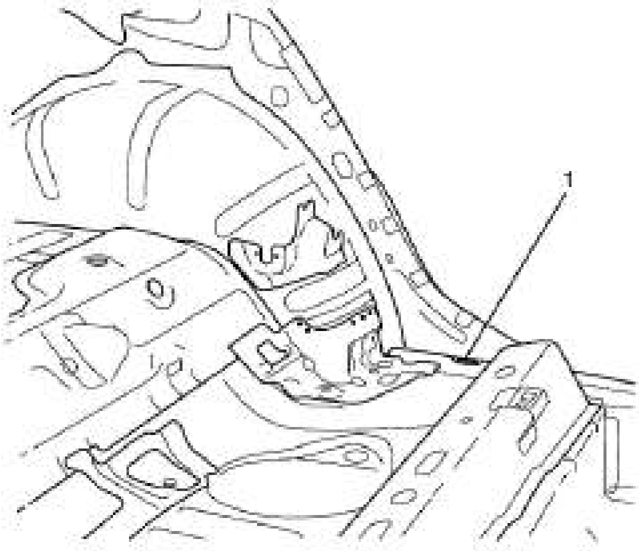
21. Weld the body side panel assembly to the rear floor panels (1).



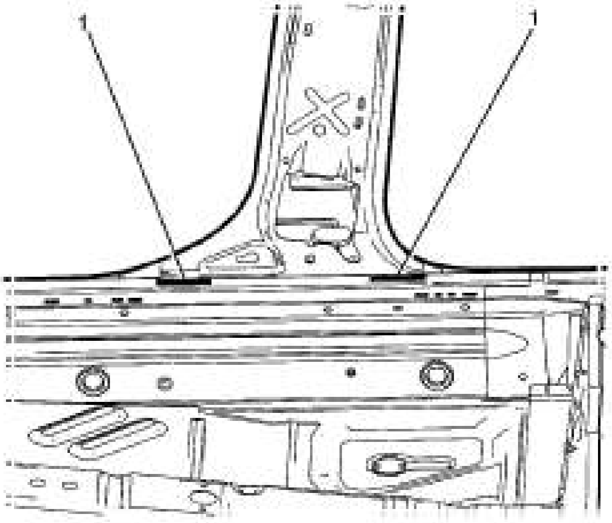
22. Weld the body side panel assembly to the rear floor panels (1).



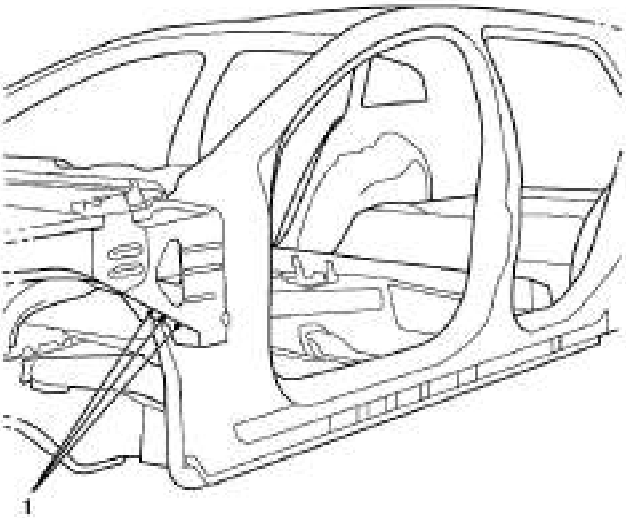
23. Weld the body side panel assembly to the vehicle (1).



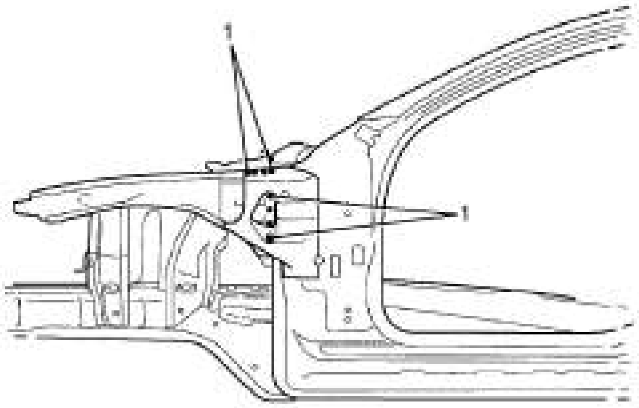
24. Seam weld the body side panel assembly to the rear inner wheelhouse (1).



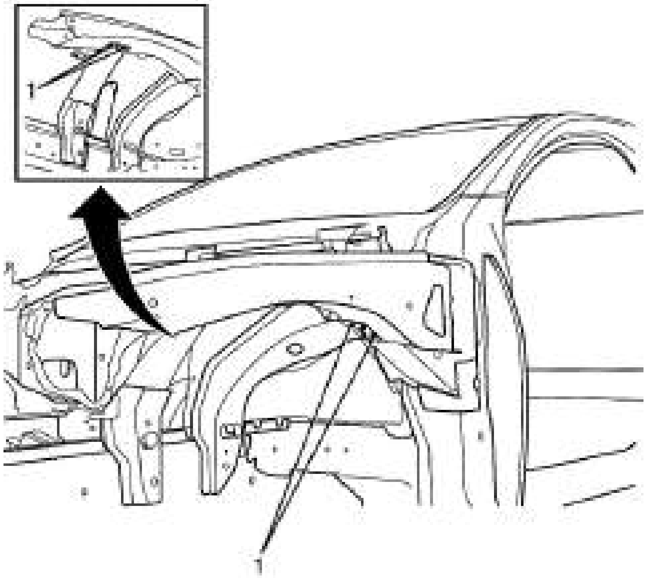
25. Seam weld the body side panel assembly to the inner rocker panel (1).
26. Install the Roof Rear Header Panel. Refer to Roof Rear Header Panel Replacement.
27. Install the Roof Front Header Panel. Refer to Roof Front Header Panel Replacement.
28. Install the Front Roof Panel Bow. Refer to Roof Panel Bow Replacement.
29. Install the Rear Roof Panel Bow. Refer to Roof Panel Bow Replacement.



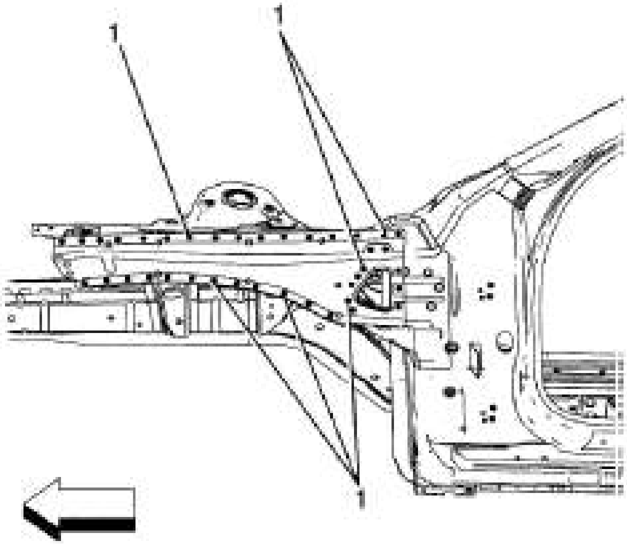
30. Weld the upper wheelhouse brace to the front hinge pillar (1).



31. Position the upper wheelhouse brace to the front wheelhouse assembly.
32. Seam weld the body side panel assembly to the front hinge pillar (1).



33. Weld the upper wheelhouse brace to the front hinge pillar (1).



34. Weld the upper wheel house brace to the front wheelhouse assembly (1).

Important: All joints and welds must be checked for water leaks before the vehicle is fully reassembled.

35. Paint the repair area. Refer to Basecoat/Clearcoat Paint Systems.
36. Install the roof outer panel. Refer to Roof Outer Replacement.
37. Install the liftgate. Refer to Liftgate Replacement.
38. Install the body side roof drip moulding. Refer to Body Side Roof Drip Molding Replacement.
39. Install the windshield pillar garnish moulding. Refer to Windshield Pillar Garnish Molding Replacement.
40. Install the rocker panel moulding. Refer to Rocker Panel Molding Replacement.
41. Install the roof weld joint reveal moulding. Refer to Roof Weld Joint Reveal Molding Replacement.
42. Install the positive battery cable from the vehicle. Refer to Battery Positive Cable Replacement.
43. Install the remote function actuator. Refer to Remote Control Door Lock Receiver and Theft Deterrent Module Replacement.
44. Install the body side stationary window. Refer to Body Side Window Replacement.
45. Install the headliner. Refer to Headlining Trim Panel Replacement.
46. Install the body side window rear garnish moulding. Refer to Body Side Window Rear Garnish Molding Replacement.
47. Install the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
48. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
49. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
50. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
51. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
52. Install the HVAC module assembly. Refer to HVAC Module Assembly Replacement.
53. Install the Instrument panel carrier. Refer to Instrument Panel Carrier Replacement.
54. Install the rear seat belts. Refer to Rear Seat Belt Replacement.

55. Install the front seat belts. Refer to Front Seat Belt Replacement.
56. Install the rear seat back. Refer to Rear Split Folding Seat Back Replacement.
57. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.
58. Install the front seats. Refer to Front Seat Replacement - Bucket.
59. Install the rear doors. Refer to Rear Door Replacement.
60. Install the front doors. Refer to Front Side Door Replacement.
61. Install the plenum chamber. Refer to Air Inlet Assembly Replacement.
62. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
63. Install the brake lines. Refer to Brake Pipe Replacement.
64. Install the fuel tank. Refer to Fuel Tank Replacement for the 3.6L Engine or Fuel Tank Replacement for the 6.0L Engine.
65. Install the fuel lines. Refer to Fuel Hose/Pipes Replacement - Chassis for the 3.6L Engine or Fuel Hose/Pipes Replacement - Chassis for the 6.0L Engine.

    Important: This step is unique to the right side body ring.

66. Install the fuel filler door release actuator. Refer to Fuel Tank Filler Door Lock Actuator Replacement.

    Important: This step is unique to the right side body ring.

67. Install the fuel filler door. Refer to Fuel Tank Filler Door Replacement.

    Important: This step is unique to the right side body ring.

68. Install the filler tube. Refer to Filler Tube Replacement for the 3.6L Engine or Filler Tube Replacement for the 6.0L Engine.
69. Install the rear frame assembly. Refer to Rear Frame Replacement.
70. Install the rear wheelhouse liner. Refer to Rear Inner Wheelhouse Replacement.
71. Install the front strut assembly. Refer to Strut Assembly Replacement.
72. Install the front wheel hub assembly. Refer to Front Wheel Bearing and Hub Replacement.
73. Install the front fender assembly. Refer to Front Fender Replacement.
74. Install the front end module. Refer to Front End Panel Module Carrier Assembly Replacement.
75. Install the front bumper fascia. Refer to Front Bumper Fascia Replacement.
76. Install the coolant reservoir. Refer to Coolant Recovery Reservoir Replacement.
77. Install the front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement.
78. Install the air inlet grille. Refer to Air Inlet Grille Panel Replacement.
79. Install the positive battery cable from the engine bay. Refer to Battery Positive Cable Replacement.
80. Install the negative battery cable. Refer to Battery Negative Cable Replacement.
81. Install the underhood electrical centre. Refer to Underhood Electrical Center or Junction Block Replacement.
82. Install the engine control module. Refer to Engine Control Module Replacement for the 3.6L Engine or Engine Control Module Replacement for the 6.0L Engine.
83. Install the vacuum brake booster. Refer to Power Vacuum Brake Booster Replacement.
84. Install the brake master cylinder. Refer to Master Cylinder Replacement.
85. Install the ABS unit. Refer to Brake Pressure Modulator Valve Assembly Replacement.
86. Install the engine assembly. Refer to Engine Replacement for the 3.6L Engine or Engine Replacement for the 6.0L Engine.
87. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
88. Enable the SIR system. Refer to SIR Disabling and Enabling.
89. If reprogramming is required. Refer to Control Module References.

Side Door Opening Frame Replacement (SWB)

Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disable the SIR system. Refer to SIR Disabling and Enabling.
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the front doors. Refer to Front Side Door Replacement.
4. Remove the rear doors. Refer to Rear Door Replacement.
5. Remove the engine assembly. Refer to Engine Replacement or Engine Replacement.
6. Remove the negative cable from the engine bay. Refer to Battery Negative Cable Replacement.
7. Remove the positive cable from the engine bay. Refer to Battery Positive Cable Replacement.
8. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

Important: This step is unique to the right body side ring.

9. Remove the Filler Tube. Refer to Filler Tube Replacement or Filler Tube Replacement.

Important: This step is unique to the right body side ring.

10. Remove the fuel filler door. Refer to Fuel Tank Filler Door Lock Actuator Replacement.

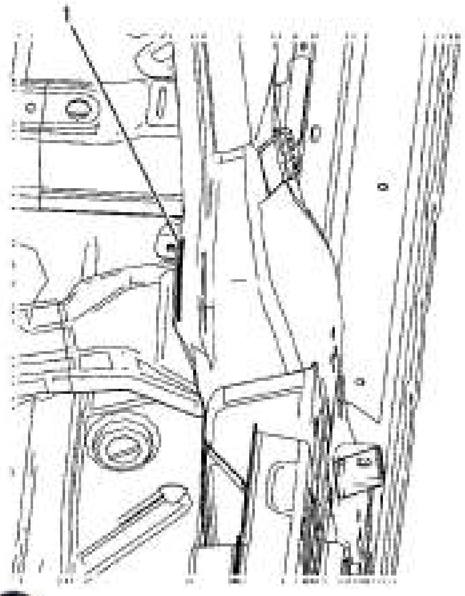
Important: This step is unique to the right body side ring.

11. Remove the fuel filler actuator. Refer to Fuel Tank Filler Door Lock Actuator Replacement.
12. Remove the fuel lines. Refer to Fuel Hose/Pipes Replacement - Chassis or Fuel Hose/Pipes Replacement - Chassis.
13. Remove the front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement.
14. Remove the rear wheelhouse liner. Refer to Rear Inner Wheelhouse Replacement.
15. Remove the rear frame assembly. Refer to Rear Frame Replacement.
16. Remove the fuel tank. Refer to Fuel Tank Replacement or Fuel Tank Replacement.
17. Remove the front wheel hub assembly. Refer to Front Wheel Bearing and Hub Replacement.
18. Remove the front strut assembly. Refer to Strut Assembly Replacement.
19. Lower the vehicle.
20. Remove the brake lines. Refer to Brake Pipe Replacement.
21. Remove the fender assembly. Refer to Front Fender Replacement.
22. Remove the front fascia. Refer to Front Bumper Fascia Replacement.
23. Remove the rear fascia. Refer to Rear Bumper Fascia Replacement.
24. Remove the coolant reservoir. Refer to Coolant Recovery Reservoir Replacement.

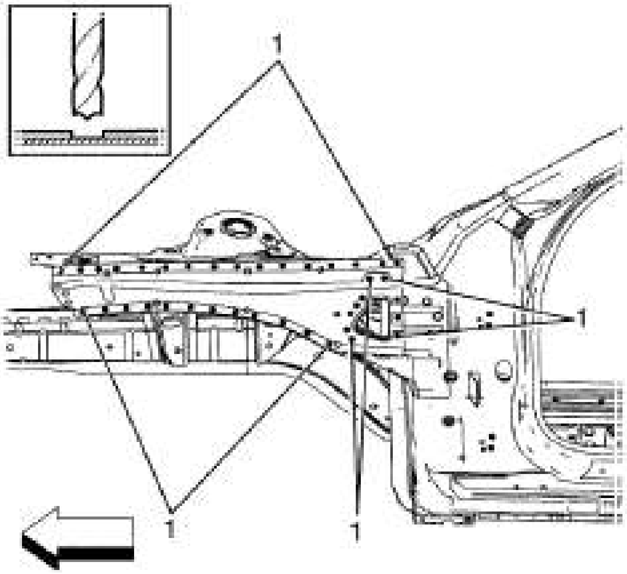
25. Remove the front end module. Refer to Front End Panel Module Carrier Assembly Replacement.
26. Remove the air inlet grille. Refer to Air Inlet Grille Panel Replacement.
27. Remove the plenum chamber. Refer to Air Inlet Assembly Replacement.
28. Remove the relay box. Refer to Underhood Electrical Center or Junction Block Replacement.
29. Remove the ABS unit. Refer to Brake Pressure Modulator Valve Assembly Replacement.
30. Remove the brake master cylinder. Refer to Master Cylinder Replacement.
31. Remove the instrument panel. Refer to Instrument Panel Carrier Replacement.
32. Remove the HVAC. Refer to HVAC Module Assembly Replacement.
33. Remove the front seats. Refer to Front Seat Replacement - Bucket.
34. Remove the rear seat back. Refer to Rear Seat Back Replacement.
35. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement.
36. Remove the rear window shelf trim. Refer to Rear Window Shelf Trim Panel Replacement.
37. Remove the front seat belts. Refer to Front Seat Belt Replacement.
38. Remove the rear seat belts. Refer to Rear Seat Belt Replacement.
39. Remove the roof rail module. Refer to Inflatable Restraint Roof Side Rail Module Replacement - Front.
40. Remove the spare wheel and emergency kit from the rear compartment.
41. Remove the rear compartment floor carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
42. Remove the battery tray. Refer to Battery Tray Replacement.
43. Remove the positive cable from the vehicle. Refer to Battery Positive Cable Replacement.

Important: This step is unique to the sunroof.

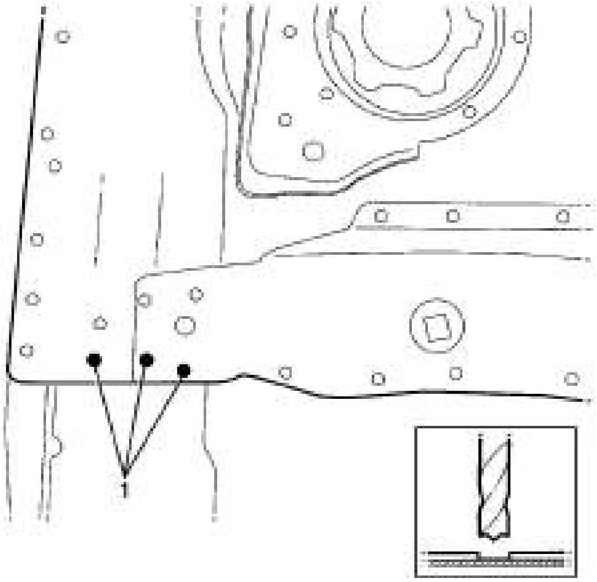
44. Remove the sunroof module. Refer to Sunroof Module Assembly Replacement
45. Remove the roof. Refer to Roof Outer Replacement.
46. Note the location and remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.



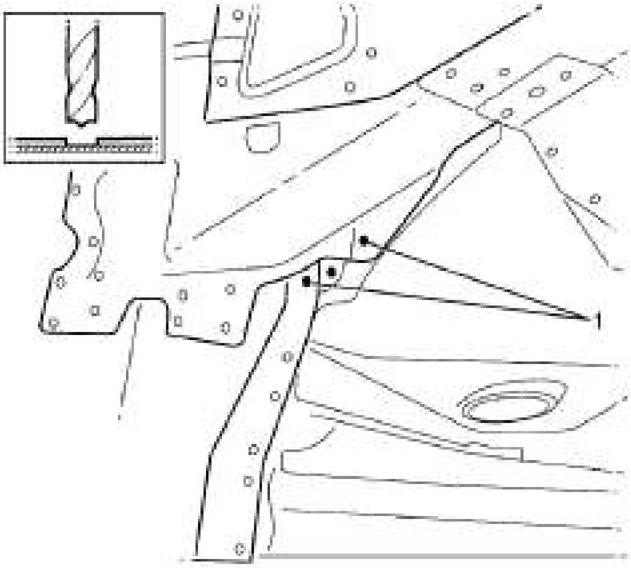
47. Remove the body side ring to upper dash panel body sealer (1)



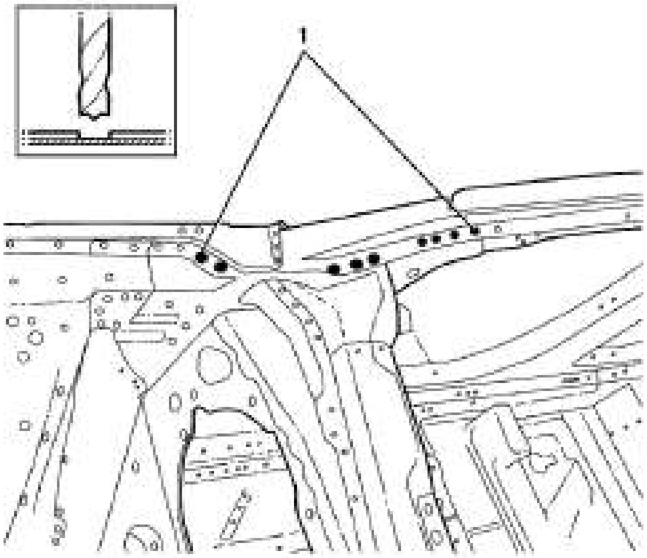
48. Locate, mark and drill out the factory welds (1) attaching the upper wheelhouse brace to the front wheelhouse assembly.
49. Remove the upper wheelhouse brace from the front wheelhouse assembly.



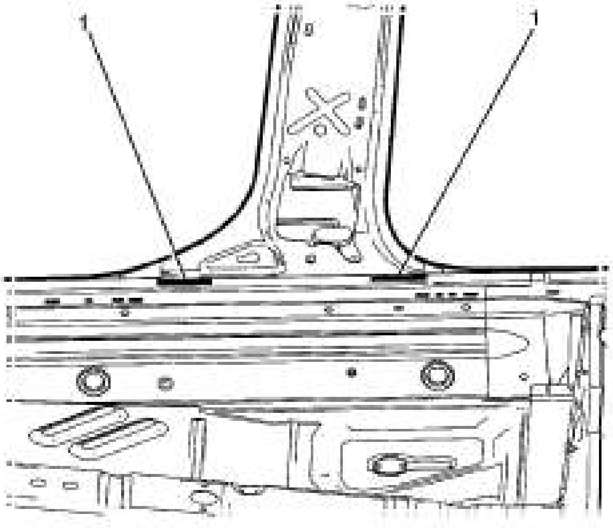
50. Locate, mark and drill out the factory welds (1) attaching the upper wheelhouse brace to the front hinge pillar.



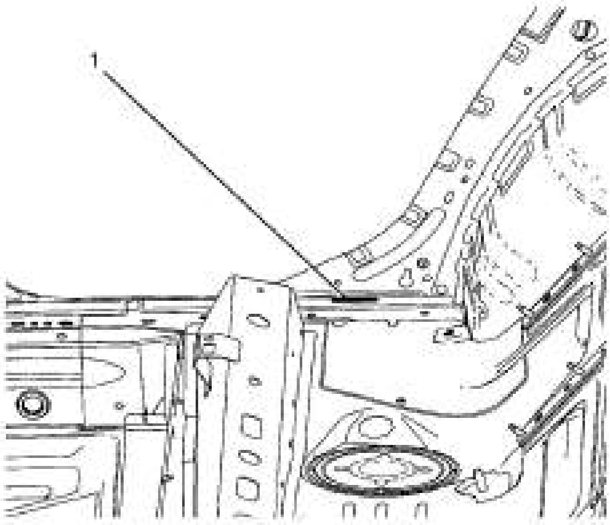
51. Locate, mark and drill out the factory welds (1) attaching the upper wheelhouse brace to the front hinge pillar.



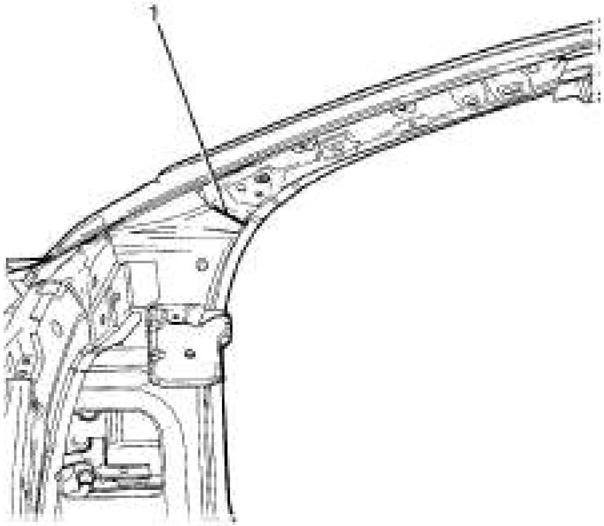
52. Locate, mark and drill out the factory welds (1) attaching the body side ring to the front hinge pillar.



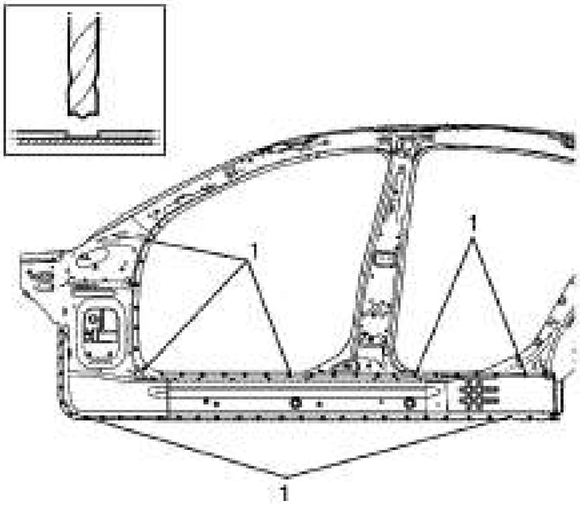
53. Locate, mark and remove the factory seam welds (1) attaching the body side ring centre pillar to the inner rocker panel.



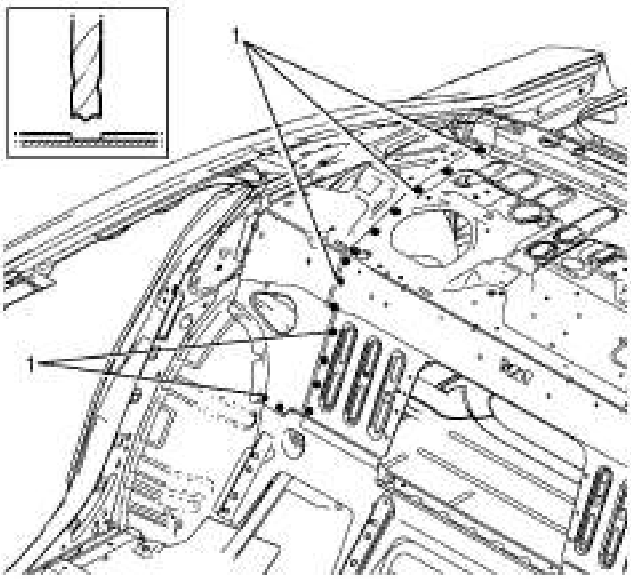
54. Locate, mark and remove the factory seam welds (1) attaching the body side ring to the rear inner wheelhouse.



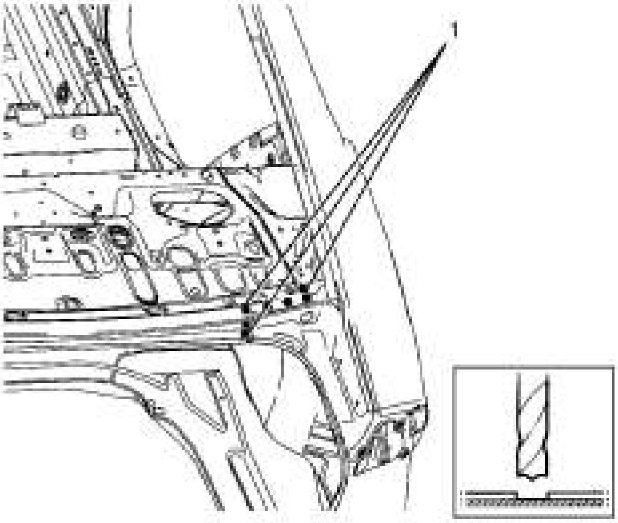
55. Locate, mark and remove the factory seam welds (1) attaching the body side ring to the front hinge pillar.



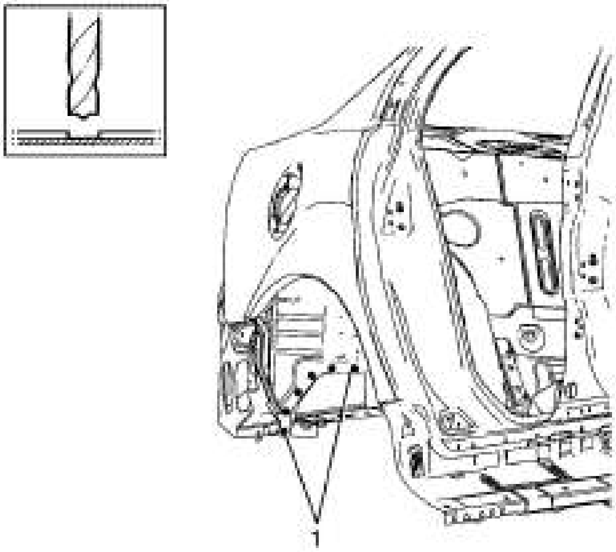
56. Locate, mark and drill out the factory welds (1) attaching the body side ring to the vehicle.



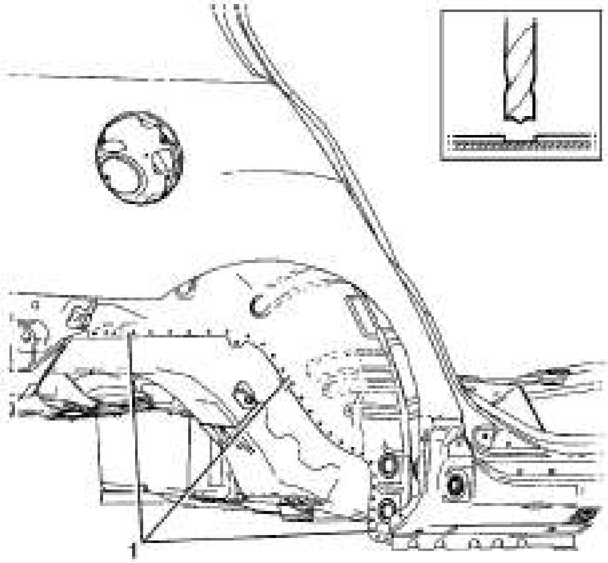
57. Locate, mark and drill out the factory welds (1) attaching the body side ring assembly to the parcel shelf assembly.



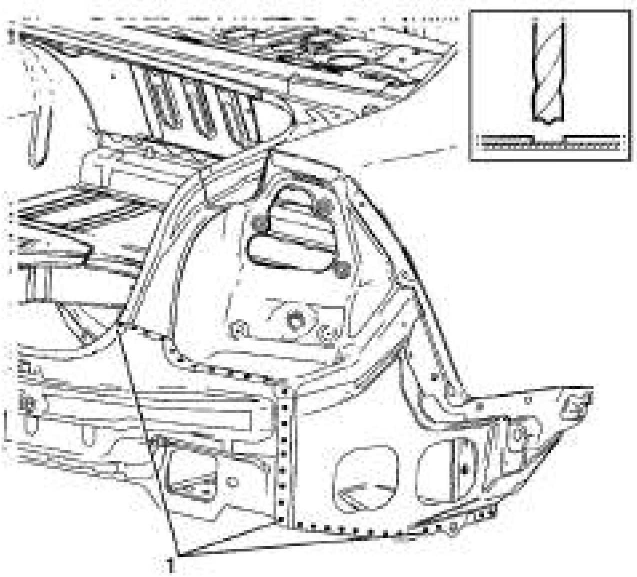
58. Locate, mark and drill out the factory welds (1) attaching the body side ring assembly to the upper parcel shelf assembly.



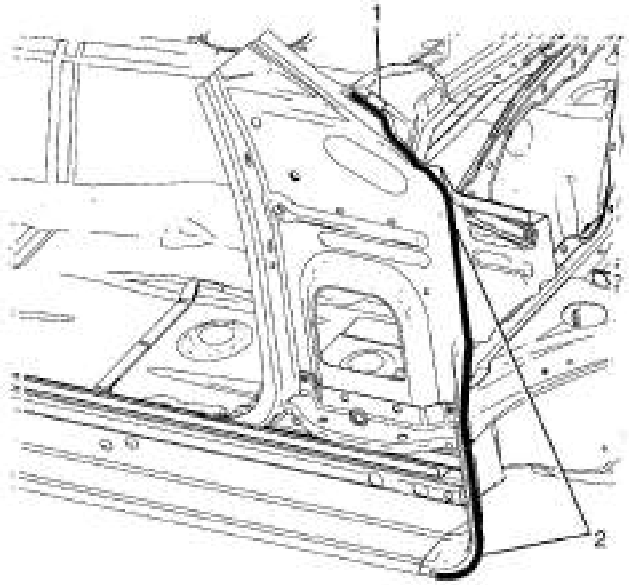
59. Locate, mark and drill out the factory welds (1) attaching the body side ring assembly to the inner rear wheelhouse.



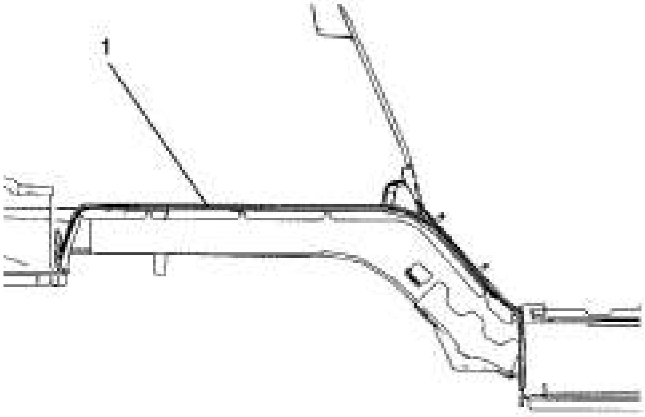
60. Locate, mark and drill out the factory welds (1) attaching the body side ring assembly to the inner rear wheelhouse.



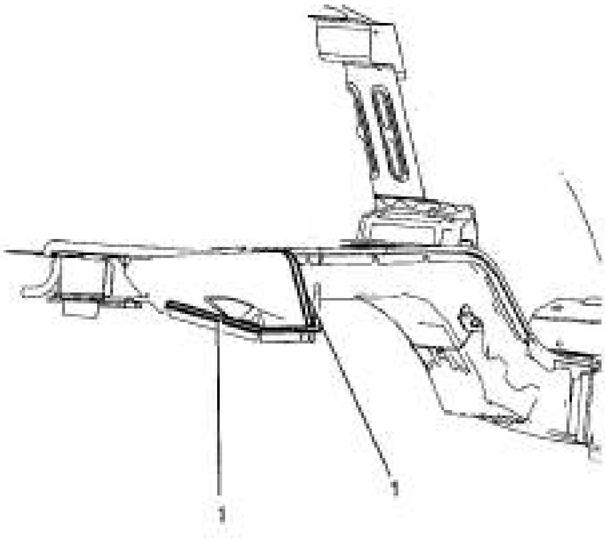
61. Locate, mark and drill out the factory welds (1) attaching the body side ring assembly to the rear end panel.
62. Remove the body side ring from the vehicle.



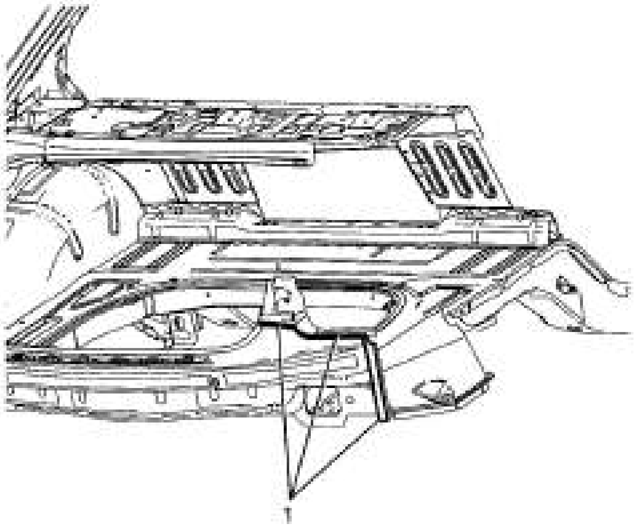
63. Remove the sealer (1) from the front plenum panel.
64. Remove the seam sealer (2) from the lower hinge pillar.



65. Remove the seam sealer (1) from the rear floor pan assembly.



66. Remove the seam sealer (1) from the inner side extension panel.



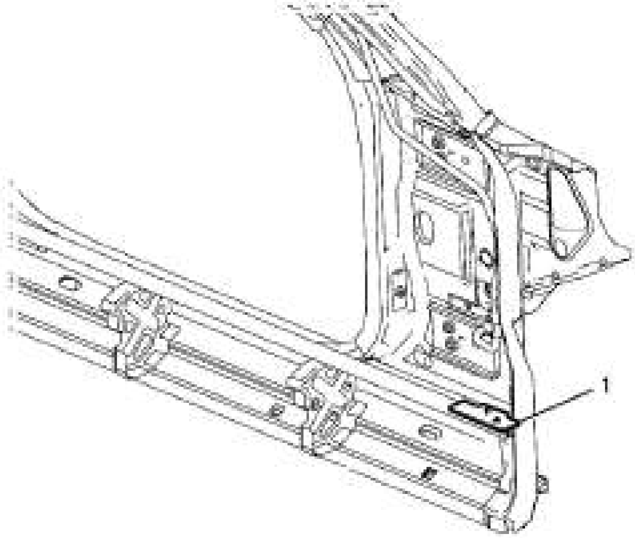
67. Remove the seam sealer (1) from the rear end panel.

Installation Procedure

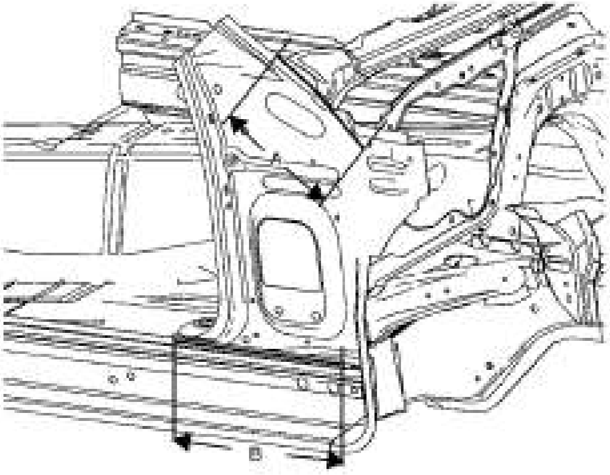
Important: If the location of the original plug weld holes can not be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 32 mm (1¼ in).

Important: Spot welding is the preferred method for attaching panels and should be used wherever possible. A plug weld should be performed where your spot welder is unable reach.

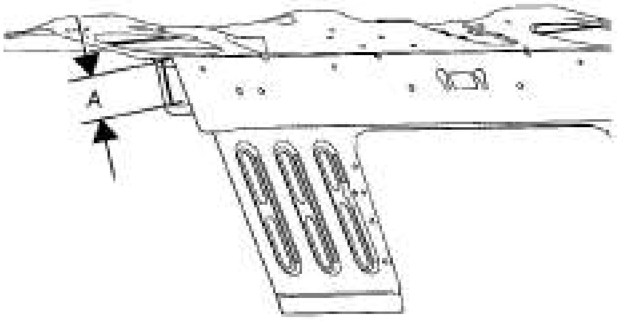
1. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted from the original assembly.
2. Clean and prepare the mating surfaces of both parts of the body side ring.



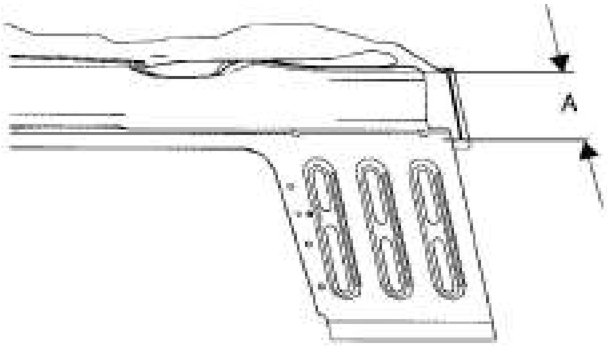
3. Remove the unexpanded noise baffle (1) from the body side ring.



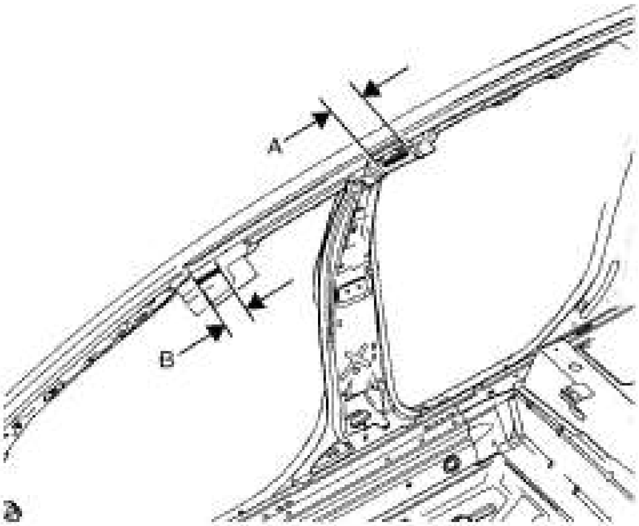
4. Apply structural adhesive GM6449G or equivalent 260 mm (10.24 in) (A) to the top edge of the inner hinge pillar.
5. Apply structural adhesive GM6449G or equivalent 400 mm (15.75 in) (B) to the inner rocker panel.



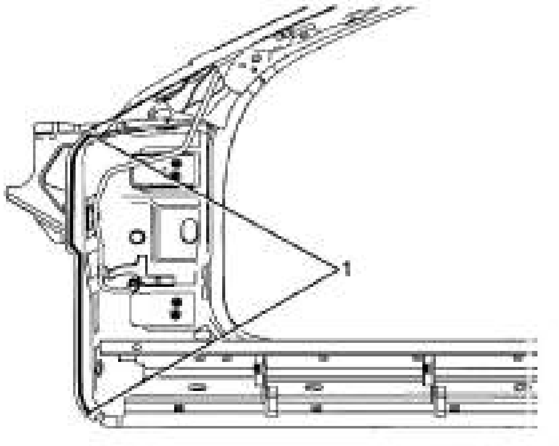
6. Apply structural adhesive GM6449G or equivalent 50 mm (1.97 in) (A) to the rear seat back on the forward facing surface.



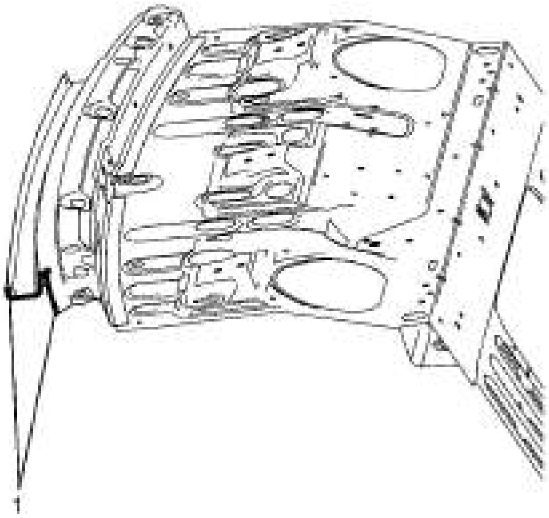
7. Apply structural adhesive GM6449G or equivalent 110 mm (4.33 in) (A) to the parcel shelf.



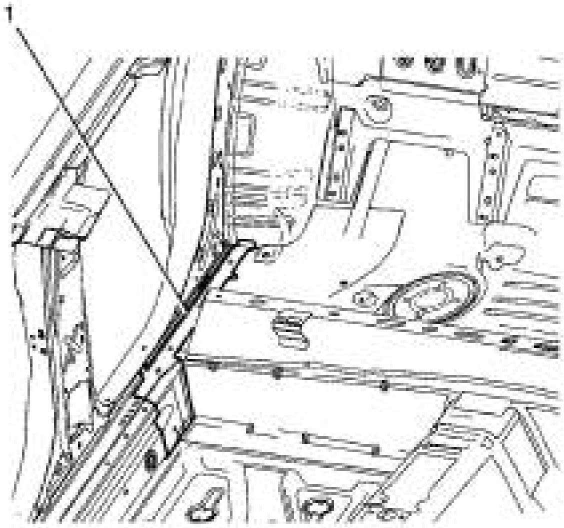
8. Apply structural adhesive GM6449G or equivalent 40 mm (1.57 in) (A) to the body side centre roof bow.
9. Apply structural adhesive GM6449G or equivalent 60 mm (2.36 (B) to the body side front roof bow.



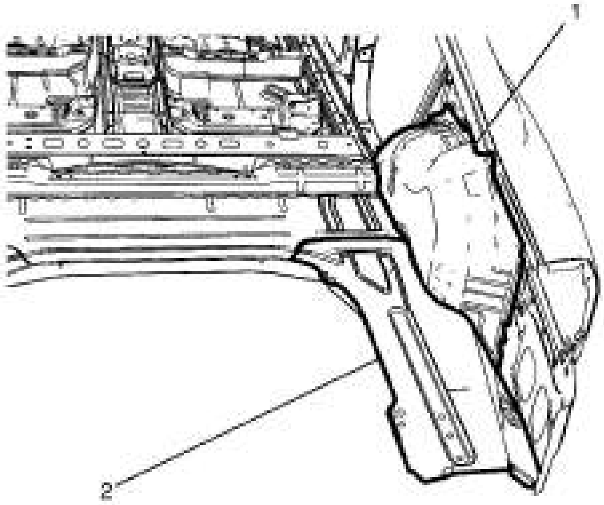
10. Apply the primary sealer (1) GM6449G or equivalent along the lower hinge pillar.



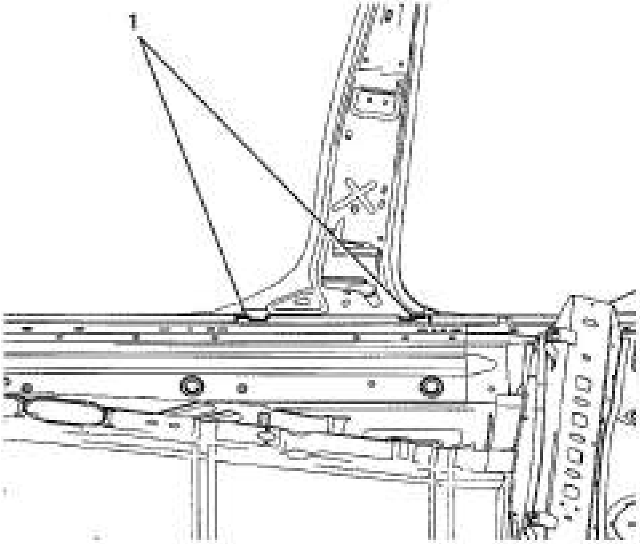
11. Apply the primary sealer (1) GM6449G or equivalent along the rear edge of the parcel shelf panel.
12. Position the body side on the vehicle. Verify correct alignment and position using three-dimensional measuring equipment.



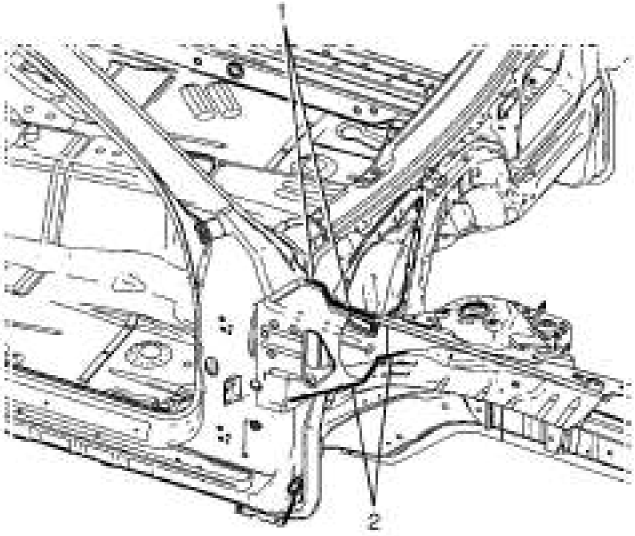
13. Align the body side ring to the inner rocker flange tab (1).



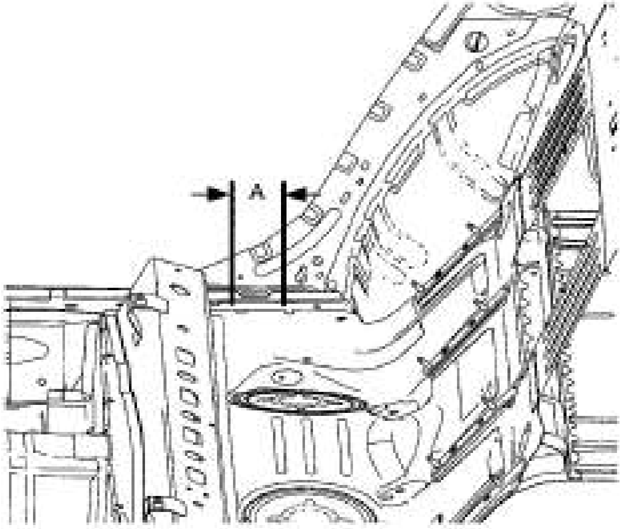
14. Align the inner rear wheelhouse (1) to side extension panel (2).



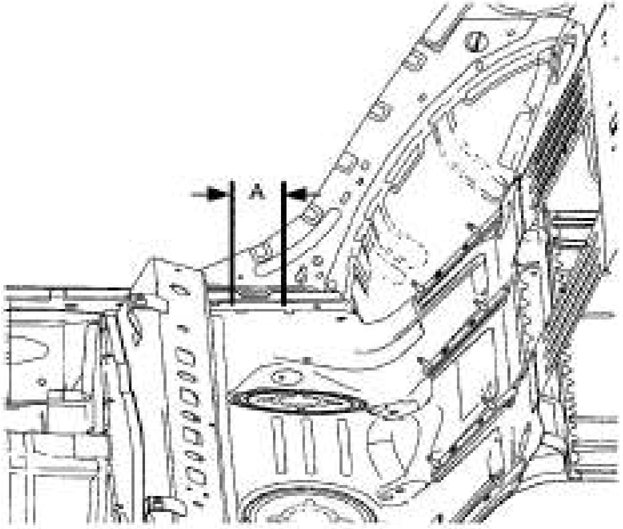
15. Align the body side ring centre pillar to the indented flange (1) on the inner rocker panel.



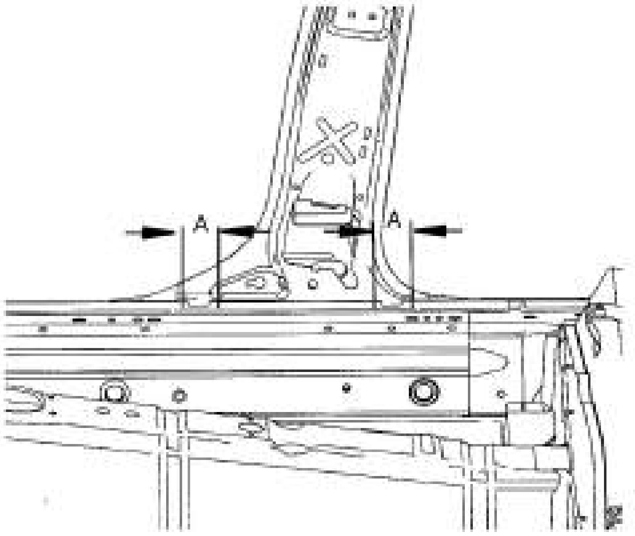
16. Align the body side ring hinge pillar (2) to the wheelhouse assembly.
17. Align the body side ring hinge pillar (1) to the inner lower hinge pillar.



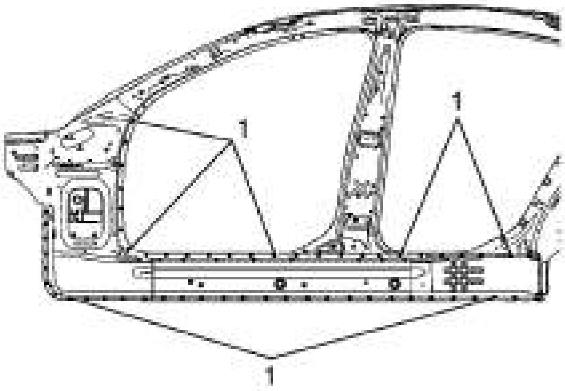
18. Seam weld the inner lower hinge pillar to inner upper hinge pillar 60 mm (2.36 in) (A) using a (Metal Inert Gas) MIG welder.



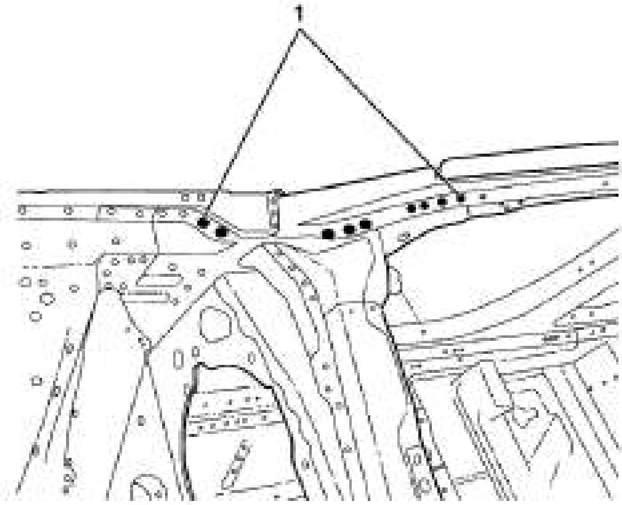
19. Seam weld the inner quarter panel to rear floor assembly 60 mm (2.36 in) (A) across the locating tag using a MIG welder.



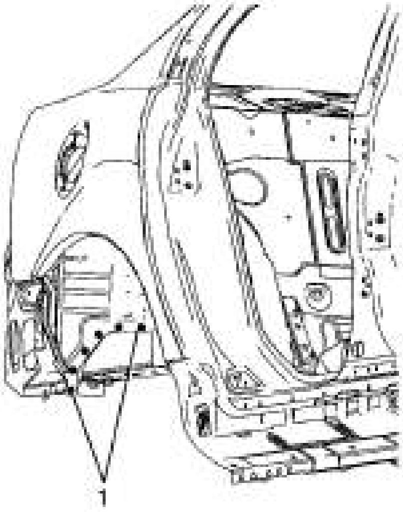
20. Seam weld the centre pillar to inner rocker panel in two places 50 mm (1.97 in) (A) across the locating tags using a MIG welder.
21. Install the roof. Refer to Roof Outer Replacement.



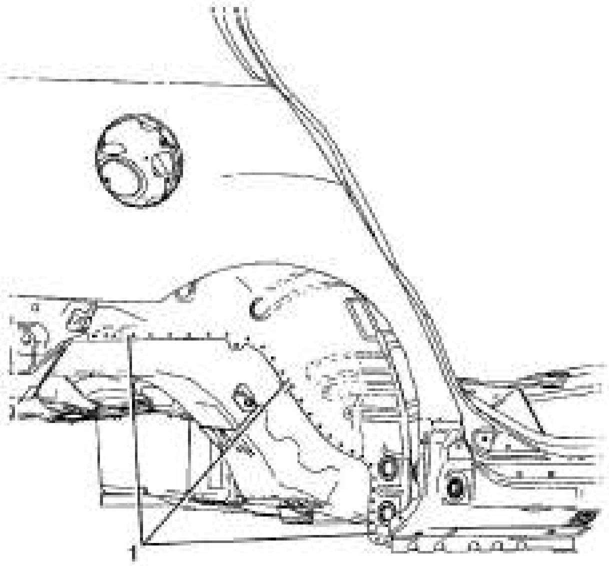
22. Weld (1) the body side ring to the vehicle.



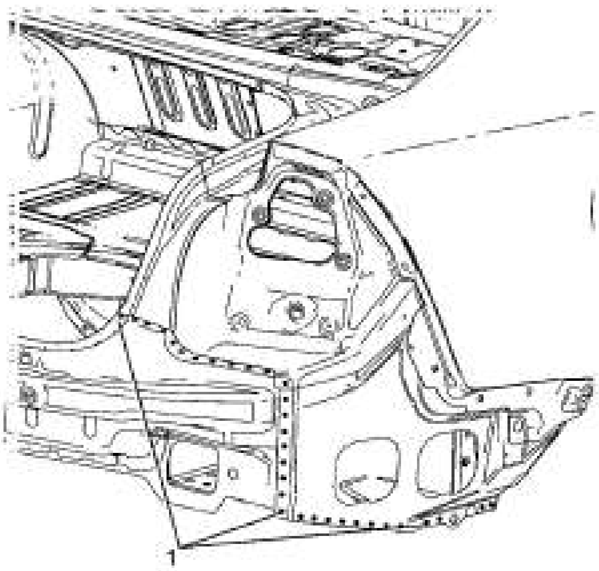
23. Weld (1) the body side ring to the front hinge pillar.



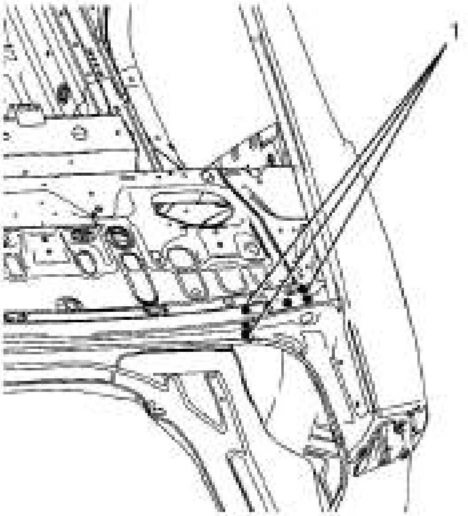
24. Weld (1) the body side ring assembly to the inner rear side extension panel.



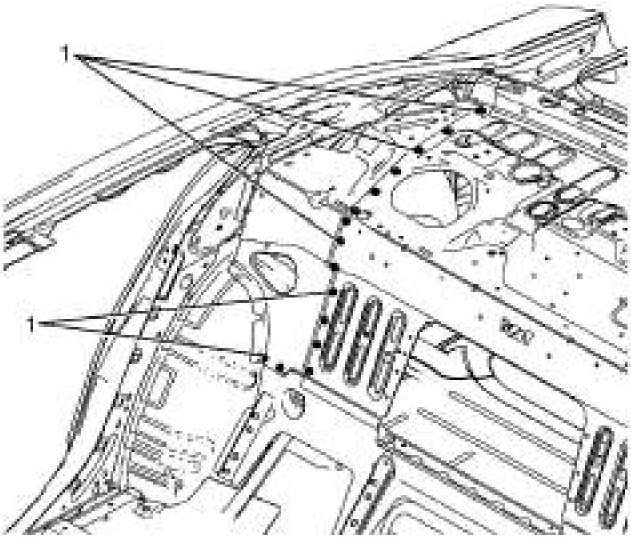
25. Weld (1) the body side ring assembly to the inner rear wheelhouse.



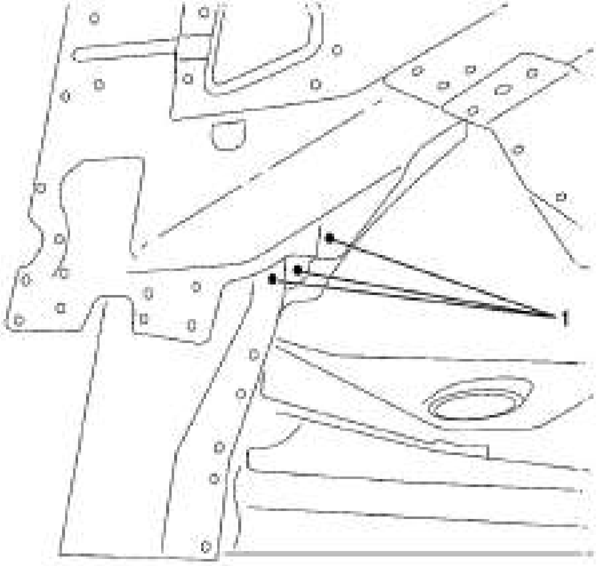
26. Puddle weld (1) the body side ring assembly to the rear end panel.



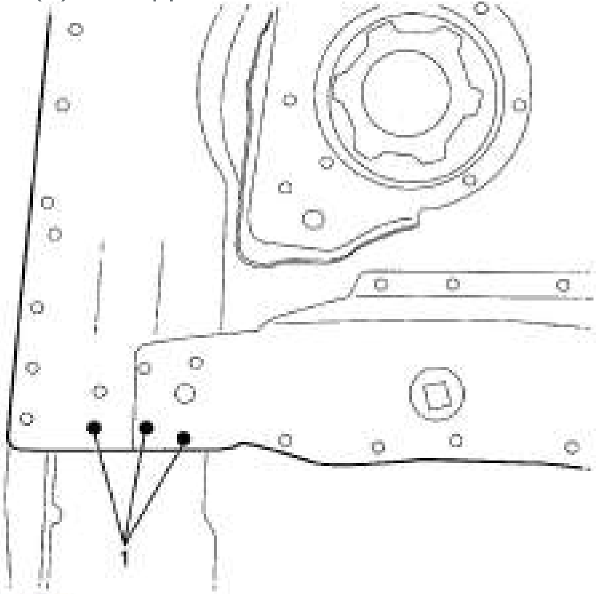
27. Weld (1) the body side ring assembly to the upper parcel shelf assembly.



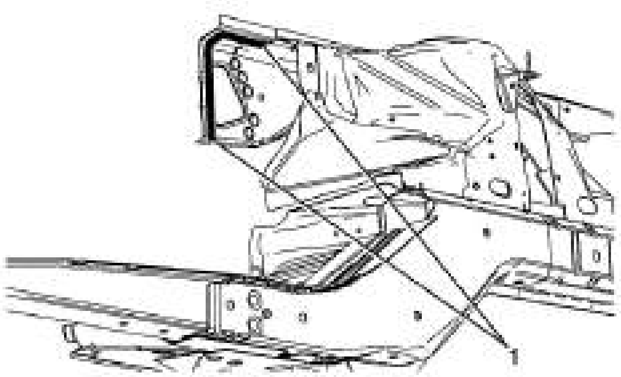
28. Weld (1) the body side ring assembly to the parcel shelf assembly.



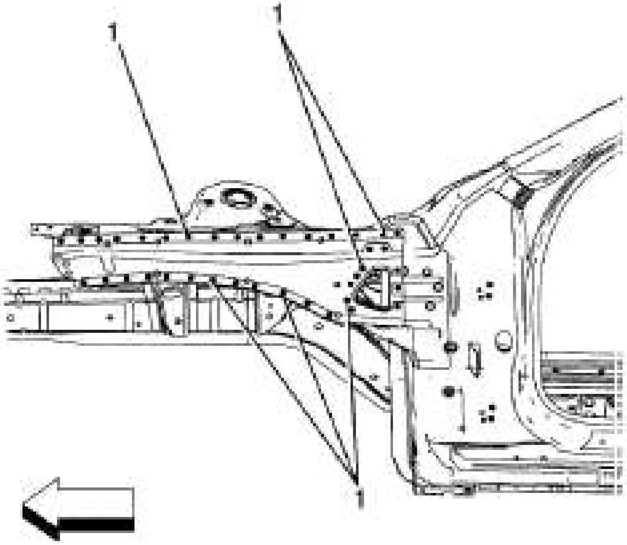
29. Weld (1) the upper wheelhouse brace to the front hinge pillar.



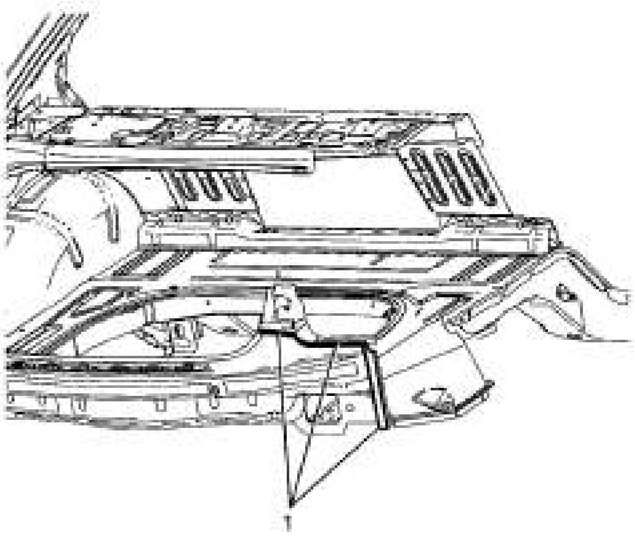
30. Weld (1) the upper wheelhouse brace to the front hinge pillar.



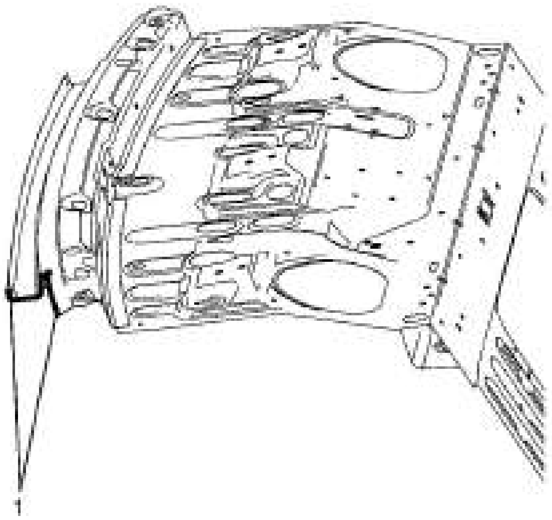
31. Apply the primary sealer (1) GM6449G or equivalent along the rear edge of the upper wheelhouse brace.



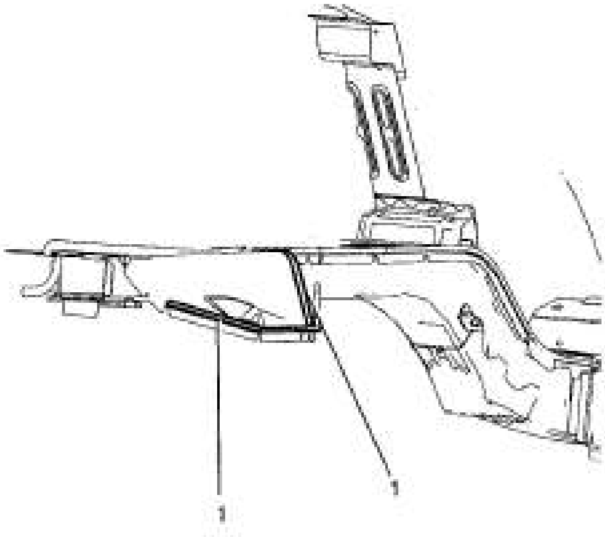
32. Weld (1) the upper wheelhouse brace to the front wheelhouse assembly.



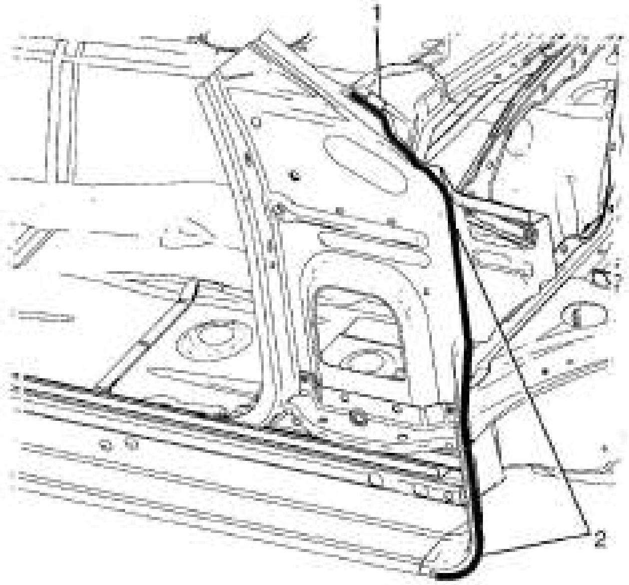
33. Apply the secondary sealer (1) GM specification 9984532 or equivalent to the tail lamp and the quarter panel extension.



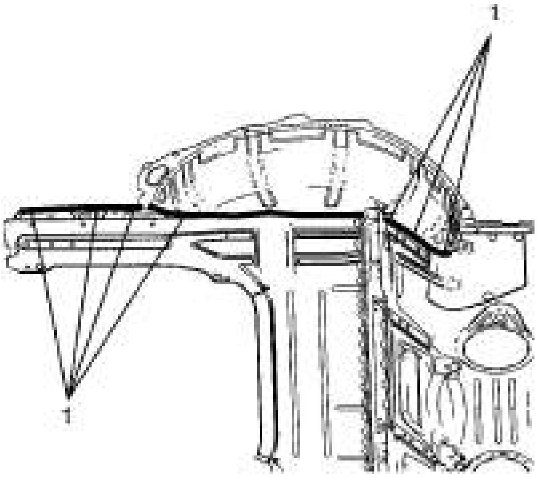
34. Apply the secondary sealer (1) GM specification 9984532 or equivalent along the rear edge of the parcel shelf panel.



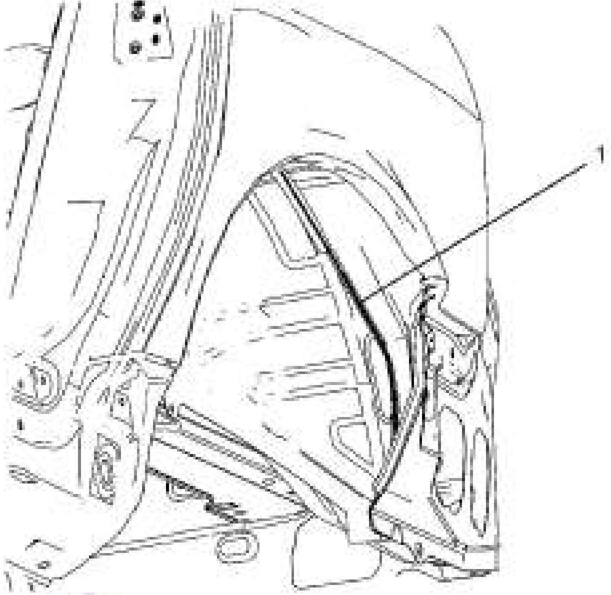
35. Apply the secondary sealer (1) GM specification 9984532 or equivalent to the quarter panel extension.



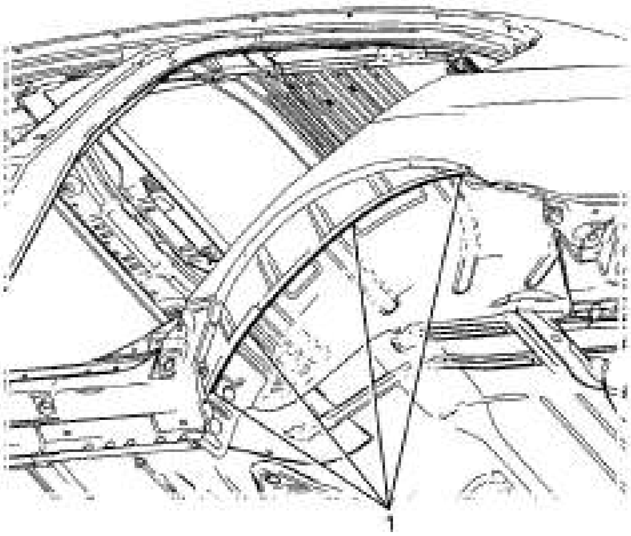
36. Apply the secondary sealer (1)GM specification 9984532 or equivalent to the front plenum panel.
37. Apply the secondary sealer (2) GM specification 9984532 or equivalent to the lower hinge pillar.



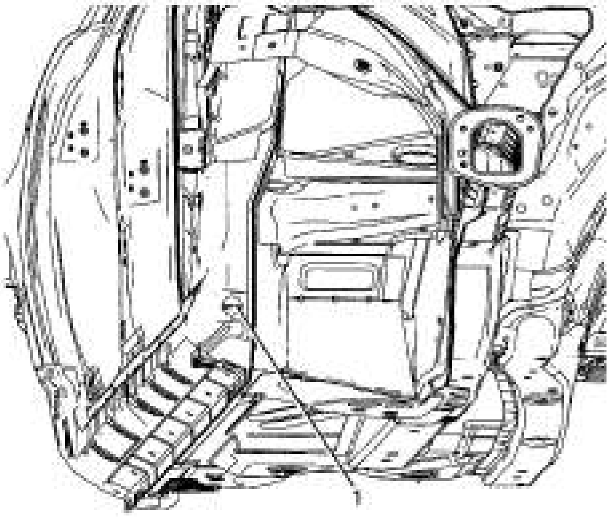
38. Apply the secondary sealer (1) GM specification 9984532 or equivalent to the inner rear wheelhouse assembly.



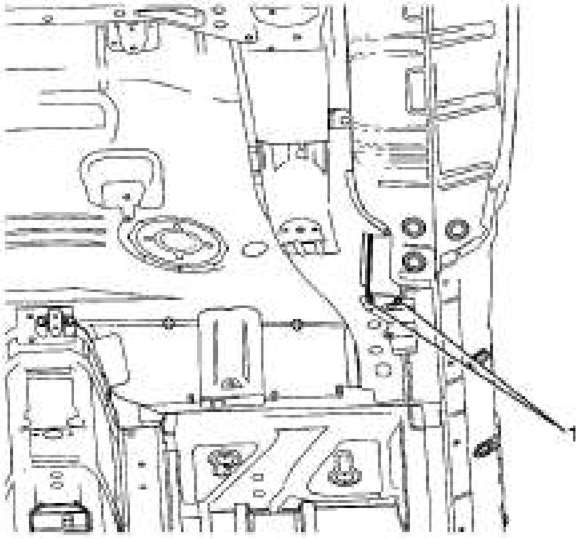
39. Apply the secondary sealer (1) GM specification 9984532 or equivalent between the outer rear wheelhouse assembly and the inner rear wheelhouse assembly.



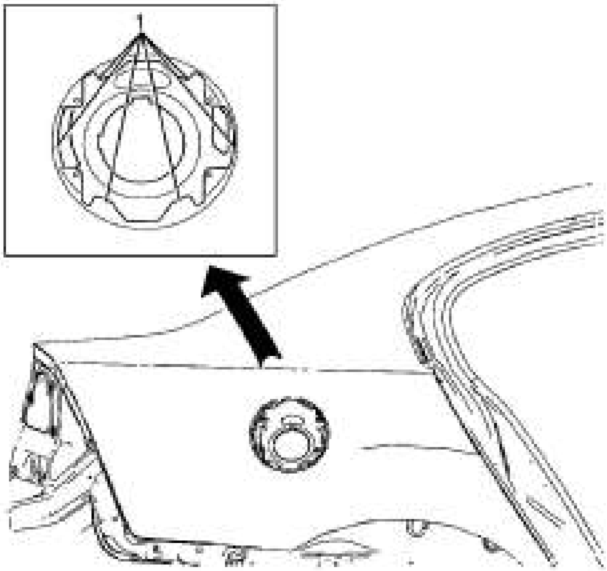
40. Apply the secondary sealer (1) GM specification 9984532 or equivalent between the outer rear wheelhouse assembly and the inner rear wheelhouse assembly.



41. Apply expanding foam sealer GM9982296 or equivalent to the front lower hinge pillar through the access hole (1).



42. Apply expanding foam sealer GM9982296 or equivalent through the two access holes (1) in the rear wheelhouse assembly.



Important: This step is unique to the right body side ring.

43. Apply the secondary sealer (1) GM specification 9984532 or equivalent to the fuel filler pocket.
44. Install the positive cable to the vehicle. Refer to Battery Positive Cable Replacement.
45. Install the battery tray. Refer to Battery Tray Replacement.
46. Install the rear compartment floor carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
47. Install the spare wheel and emergency kit from the rear compartment.
48. Install the roof rail module. Refer to Inflatable Restraint Roof Side Rail Module Replacement -

Front.

49. Install the rear seat belts. Refer to Rear Seat Belt Replacement.
50. Install the front seat belts. Refer to Front Seat Belt Replacement.
51. Install the rear window shelf trim. Refer to Rear Window Shelf Trim Panel Replacement.
52. Install the rear seat back. Refer to Rear Seat Back Replacement.
53. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.
54. Install the front seats. Refer to Front Seat Replacement - Bucket.
55. Install the HVAC. Refer to HVAC Module Assembly Replacement.
56. If re-programming is required. Refer to Control Module References.
57. Install the instrument panel. Refer to Instrument Panel Carrier Replacement.
58. If re-programming is required. Refer to Control Module References.
59. Install the brake master cylinder. Refer to Master Cylinder Replacement.
60. Install the ABS unit. Refer to Brake Pressure Modulator Valve Assembly Replacement.
61. If re-programming is required. Refer to Control Module References.
62. Install the relay box. Refer to Underhood Electrical Center or Junction Block Replacement.
63. Install the plenum chamber. Refer to Air Inlet Assembly Replacement.
64. Install the air inlet grille. Refer to Air Inlet Grille Panel Replacement.
65. Install the front end module. Refer to Front End Panel Module Carrier Assembly Replacement.
66. Install the coolant reservoir. Refer to Coolant Recovery Reservoir Replacement.
67. Install the fender assembly. Refer to Front Fender Replacement.
68. Install the front fascia. Refer to Front Bumper Fascia Replacement.
69. Install the rear fascia. Refer to Rear Bumper Fascia Replacement.
70. Install the brake lines. Refer to.
71. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
72. Install the front strut assembly. Refer to Strut Assembly Replacement.
73. Install the front wheel hub assembly. Refer to Front Wheel Bearing and Hub Replacement.
74. Install the fuel tank. Refer to Fuel Tank Replacement or Fuel Tank Replacement.

    Important: This step is unique to the right body side ring.

75. Install the fuel lines. Refer to Fuel Hose/Pipes Replacement - Chassis or Fuel Hose/Pipes Replacement - Chassis.

    Important: This step is unique to the right body side ring.

76. Install the fuel filler actuator. Refer to Fuel Tank Filler Door Lock Actuator Replacement.

    Important: This step is unique to the right body side ring.

77. Install the fuel filler door. Refer to Fuel Tank Filler Door Lock Actuator Replacement.

    Important: This step is unique to the right body side ring.

78. Install the Filler Tube. Refer to Filler Tube Replacement or Filler Tube Replacement.
79. Install the rear frame assembly. Refer to Rear Frame Replacement.
80. Install the rear wheelhouse liner. Refer to Rear Inner Wheelhouse Replacement.
81. Install the front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement.
82. Lower the vehicle.
83. Install the front doors. Refer to Front Side Door Replacement.
84. Install the rear doors. Refer to Rear Door Replacement.
85. Install the positive cable to the engine bay. Refer to Battery Positive Cable Replacement.
86. Install the negative cable to the engine bay. Refer to Battery Negative Cable Replacement.
87. Install the engine assembly. Refer to Engine Replacement or Engine Replacement.
88. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and

Connection.

89. Enable the SIR system. Refer to SIR Disabling and Enabling.
90. If re-programming is required. Refer to Control Module References.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Repair | Collision Repair | Repair Instructions | Document ID: 2069458

Roof Panel Replacement (Sedan)

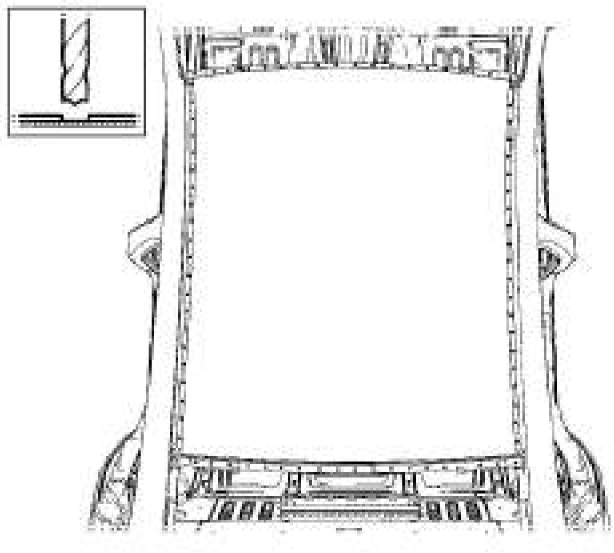
Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

Caution: Refer to Battery Disconnect Caution in the Preface section.

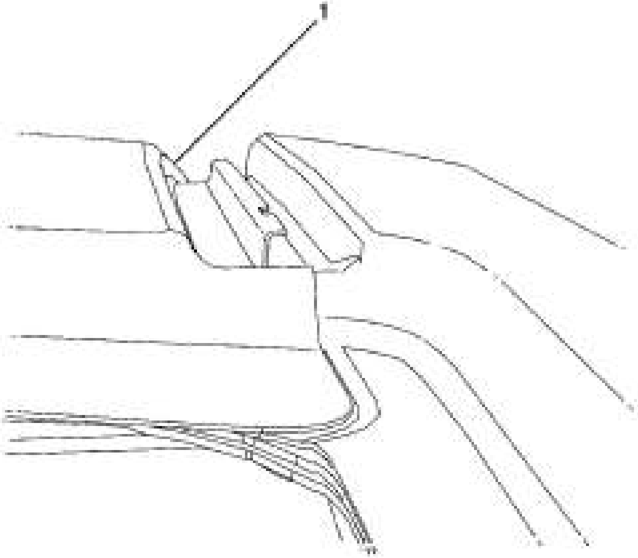
1. Disable the SIR system. Refer to SIR Disabling and Enabling in SIR.
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the windshield garnish moulding. Refer to Windshield Garnish Molding Replacement.
4. Remove the inner rear quarter trim. Refer to Quarter Upper Trim Panel Replacement.
5. Remove the inner upper centre trim. Refer to Body Hinge Pillar Trim Panel Replacement.
6. Remove the overhead lighting panel. Refer to Dome Lamp Replacement.
7. Remove the headliner. Refer to Headlining Trim Panel Replacement in Interior Trim.
8. Remove the windshield. Refer to Windshield Replacement.
9. Remove the rear window. Refer to Rear Window Replacement.
10. Remove the roof weld moulding. Refer to Roof Weld Joint Reveal Molding Replacement.
11. Visually inspect the damage. Repair as much of the damage as possible.
12. Apply tape to the corners of the panels and adjacent surfaces.
13. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.



Important: The roof panel is attached to the steel roof structure with beads of adhesive on the sides and spot-welds on the side rail, windshield and back-glass flanges. Replacement of the roof panel can be performed using conventional procedures, however, the windshield and back glass must be removed.

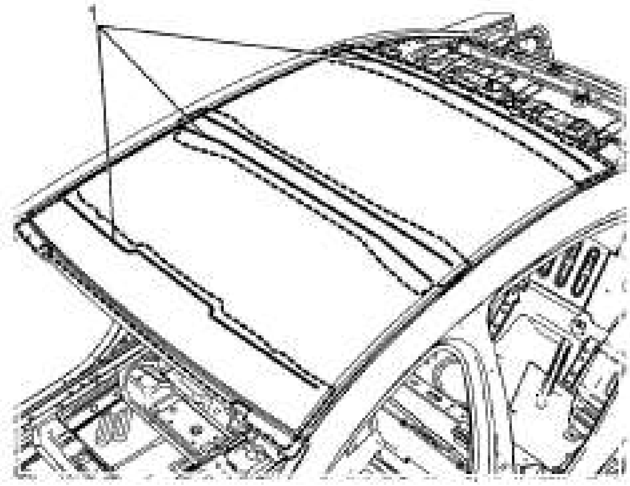
Important: The roof outer panel is secured to the body side panel with adhesive and spot welds, it cannot be removed by cutting the spot welds alone.

14. Locate, mark and drill all factory welds. Note the number and location of welds for installation of the service assembly.



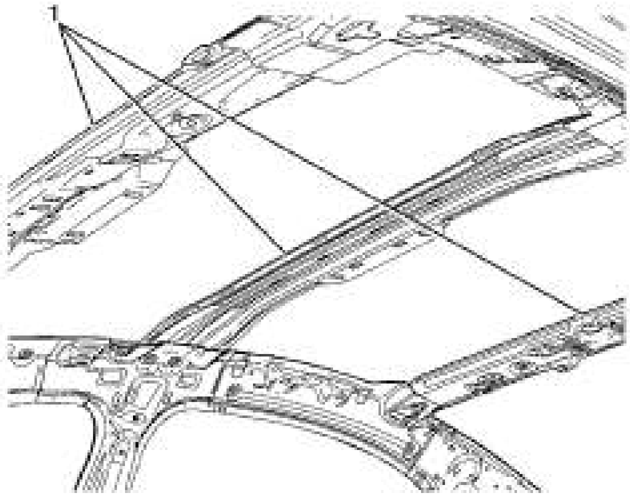
Important: Take care when cutting to protect adjacent panels. Cut inboard of the roof structure.

15. Using a suitable tool, cut through the roof outer panel along the inner side of the roof channel (1). Repeat for opposite side.



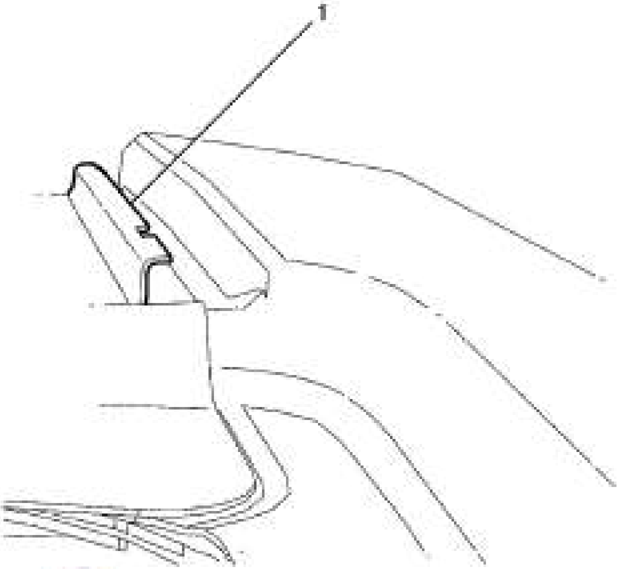
Important: Heating the 'anti-flutter' adhesive softens it making it easier to cut through.

16. Heat the 'anti-flutter' adhesive between the roof panel and the roof bows (1).



Important: The 'anti-flutter' adhesive (1) is between the roof bows and the roof outer panel.

17. Cut the 'anti-flutter' adhesive (1) with a suitable tool.
18. Remove the roof outer panel from the vehicle.



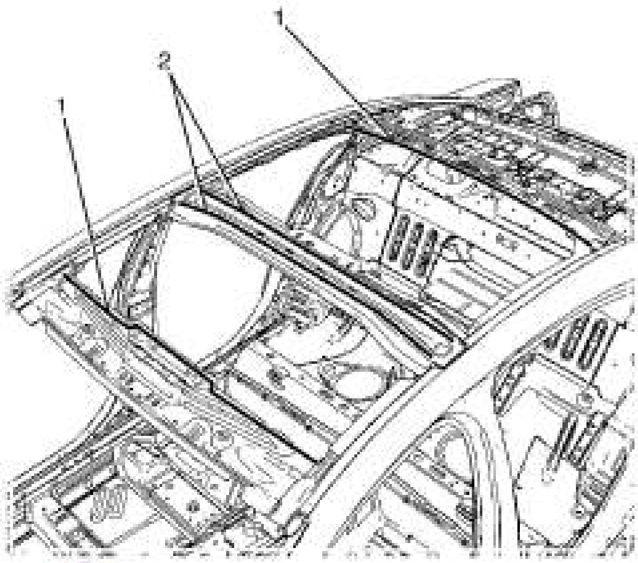
19. Using a suitable tool remove the remaining strip of roof panel (1) from the body side ring. repeat for opposite side.

Installation Procedure

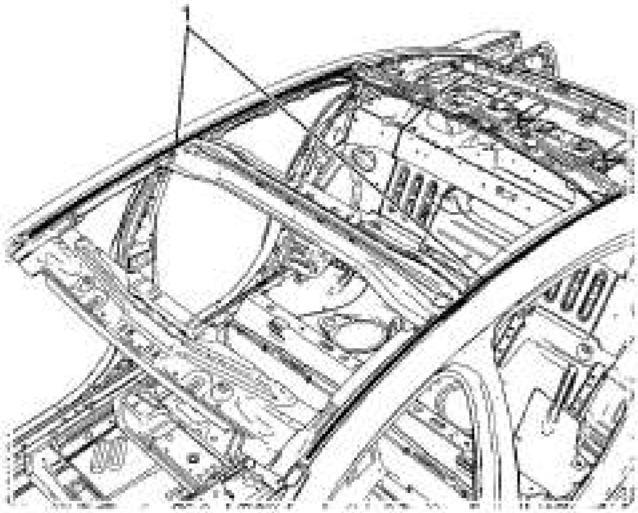
Important: If the location of the original spot weld holes can not be determined, or if structural weld-thru adhesive is present, space the puddle weld holes every 32 mm (1¼ in).

Important: Spot welding is the preferred method for attaching panels and should be used wherever possible. A puddle weld should be performed where your spot welder is unable to reach.

1. Clean and prepare the attaching surfaces for welding.
2. Clean the remaining anti-flutter adhesive from the front, centre and rear bow surfaces.
3. Drill 8 mm (5/16 in) puddle weld holes in the NEW roof outer panel in the locations to be puddle welded.

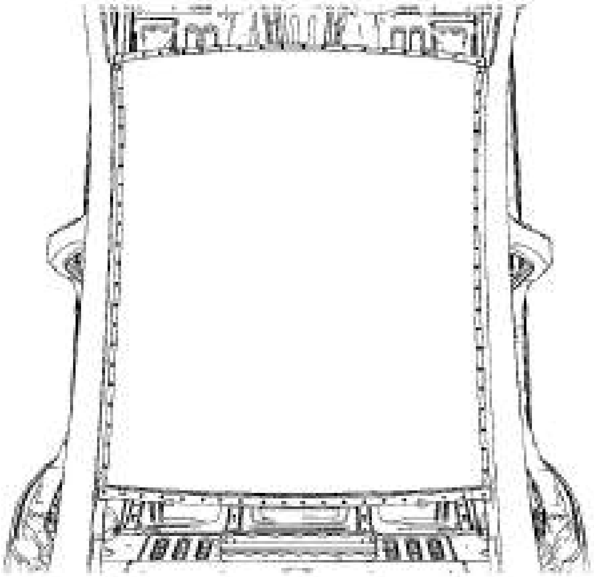


4. Apply two full beads of structural adhesive GM6449G or equivalent to the center bow (2).
5. Apply a full bead of structural adhesive GM6449G or equivalent to the front and rear bows (1).



6. Apply structural adhesive GM6449G or equivalent to the mating surfaces of the roof panel and body side panel (1).
7. Position the NEW roof outer panel to the vehicle.

8. Inspect the fit.
9. Clamp roof outer panel into correct position.



Important: Care must be taken to minimise the heat absorbed by the panel which could lead to panel distortion.

10. Spot weld or puddle weld the roof outer panel on both sides using the same number of welds as per original build.
11. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.
12. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
13. Install the roof weld moulding. Refer to Roof Weld Joint Reveal Molding Replacement.
14. Install the rear window. Refer to Rear Window Replacement.
15. Install the windshield. Refer to Windshield Replacement.
16. Install the headliner. Refer to Headlining Trim Panel Replacement in Interior Trim.
17. Install the overhead lighting panel. Refer to Dome Lamp Replacement.
18. Install the inner upper centre trim. Refer to Body Hinge Pillar Trim Panel Replacement.
19. Install the inner rear quarter trim. Refer to Quarter Upper Trim Panel Replacement.
20. Install the windshield pillar moulding. Refer to Windshield Garnish Molding Replacement.
21. Remove the tape to the corners of the panels and adjacent surfaces.
22. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
23. Enable the SIR system. Refer to SIR Disabling and Enabling in SIR.
24. If re-programming is required. Refer to Control Module References.

Roof Outer Replacement (With Sunroof) Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

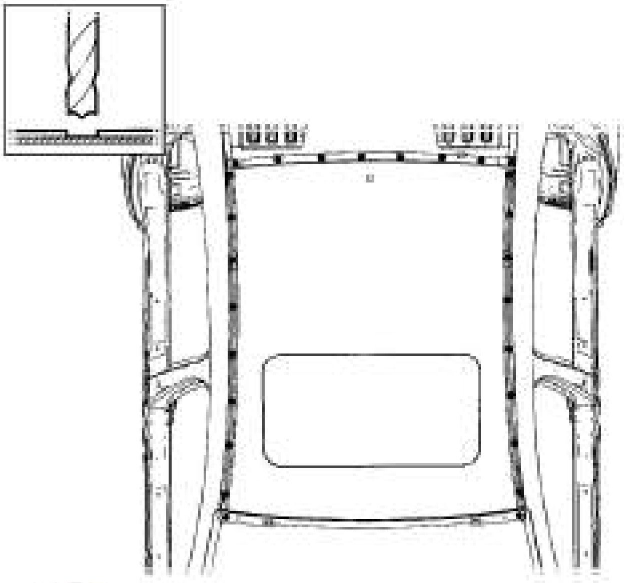
Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

Caution: Refer to Battery Disconnect Caution in the Preface section.

Important: Use care when cutting to protect adjacent panels. Cut inboard of the roof structure.

Important: The roof panel is attached to the steel roof structure with beads of adhesive on the sides and spot-welds on the side rail, windshield and back-glass flanges. Replacement of the roof panel can be performed using conventional procedures, however, the windshield and back glass must be removed.

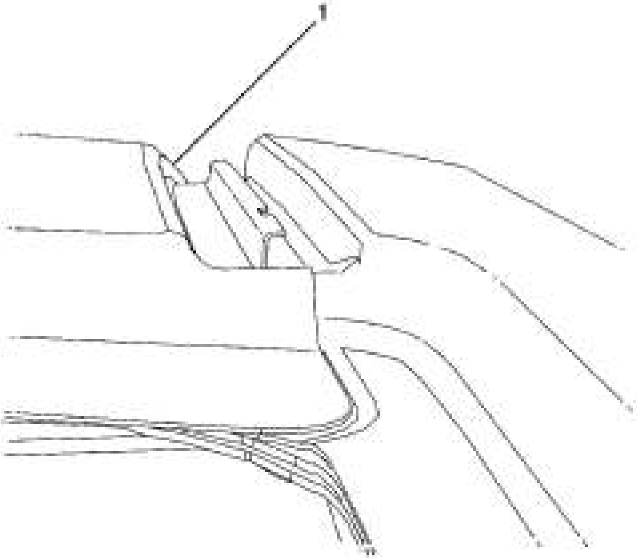
1. Disable the SIR system. Refer to SIR Disabling and Enabling in SIR.
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Apply tape to the corners of the panels and adjacent surfaces.
4. Remove the interior windshield garnish moulding. Refer to Windshield Garnish Molding Replacement.
5. Remove the inner rear quarter trim. Refer to Quarter Upper Trim Panel Replacement.
6. Remove the inner upper centre trim. Refer to Body Hinge Pillar Trim Panel Replacement.
7. Remove the over head lighting panel. Refer to Dome Lamp Replacement.
8. Remove the headliner. Refer to Headlining Trim Panel Replacement in Interior Trim.
9. Remove the windshield. Refer to Windshield Replacement.
10. Remove the rear window. Refer to Rear Window Replacement.
11. Remove the roof weld moulding. Refer to Roof Weld Joint Reveal Molding Replacement.
12. Remove the sunroof module. Refer to Sunroof Module Assembly Replacement.
13. Remove the front sunroof drain hose. Refer to Sunroof Housing Front Drain Hose Replacement.
14. Remove the rear sunroof drain hose. Refer to Sunroof Housing Rear Drain Hose Replacement.
15. Visually inspect the damage. Repair as much of the damage as possible.
16. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.
17. Locate and mark all factory welds.



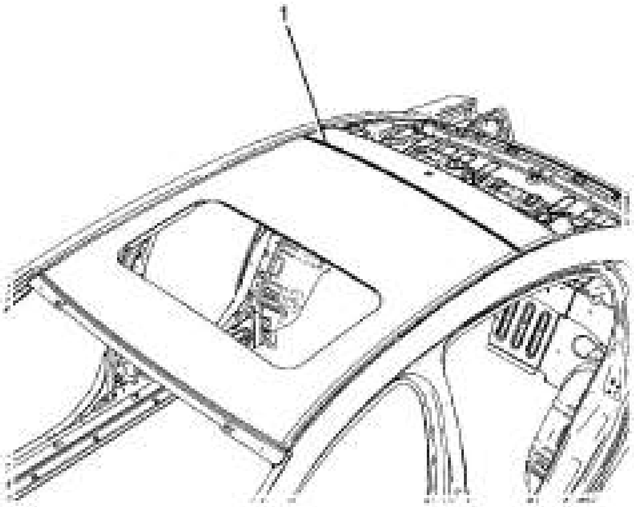
Important: The roof outer panel is secured to the body side panel with adhesive and spot welds, it cannot be removed by cutting the spot welds alone.

18. Drill all factory welds. Note the number and location of welds for installation of the service

assembly.

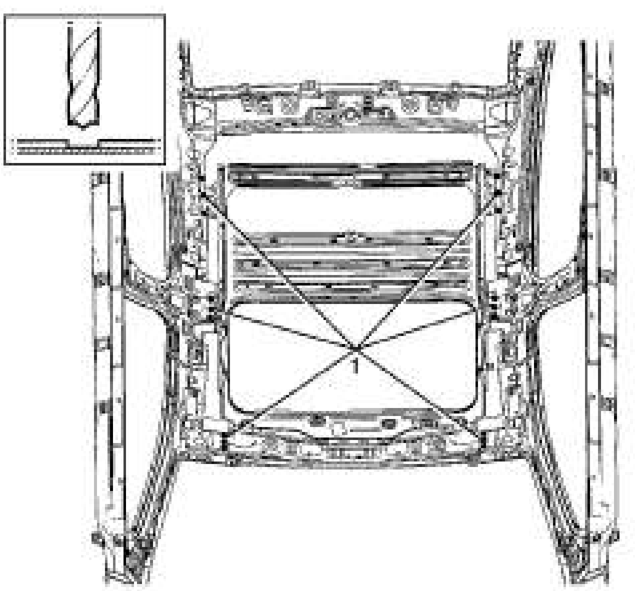


19. Using a suitable tool, cut through the roof outer panel along the side of the roof channel (1).

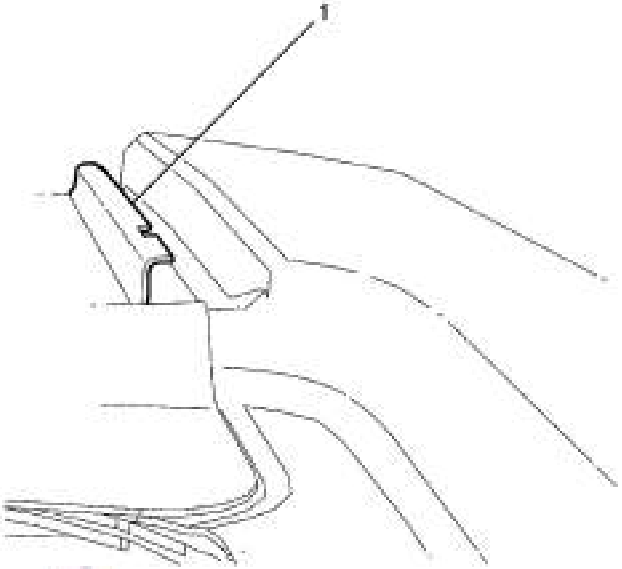


Important: Heating the 'anti-flutter' adhesive softens it making it easier to cut through.

20. Heat the 'anti-flutter' adhesive between the roof panel and the rear roof bow (1).



21. Locate, mark, and drill out the factory welds (1) attaching the roof panel assembly to the body side rings.
22. Remove the roof outer panel assembly from the vehicle.



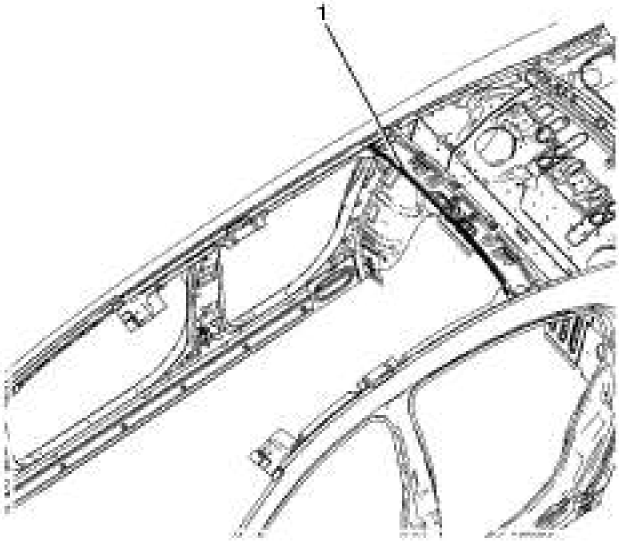
23. Using a suitable tool remove the remaining strip of roof panel (1) from the body side panel.

Roof Outer Replacement (With Sunroof) Installation Procedure

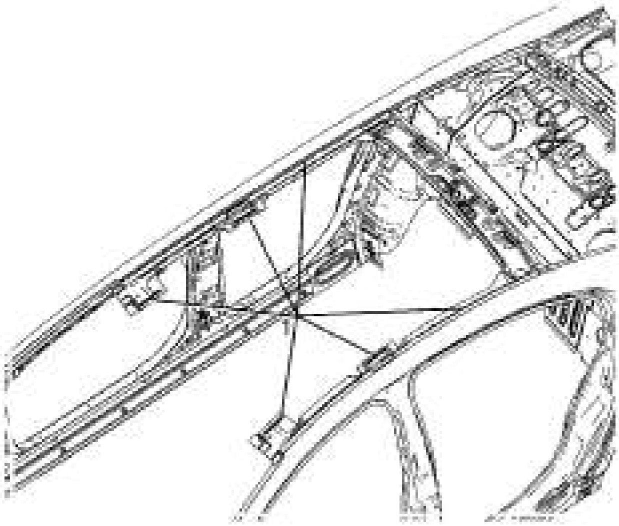
Important: If the location of the original spot weld holes can not be determined, or if structural weld-thru adhesive is present, space the puddle weld holes every 32 millimetres (1¼ in).

Important: Spot welding is the preferred method for attaching panels and should be used wherever possible. A puddle weld should be performed where your spot welder is unable to reach.

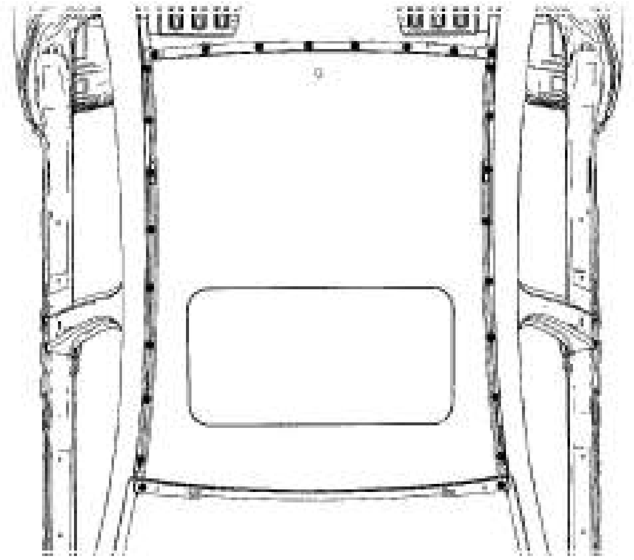
1. Clean and prepare the attaching surfaces for welding.
2. Clean the remaining anti-flutter adhesive from the front, centre and rear bow surfaces.
3. Mark the NEW roof outer panel with drilling locations, where puddle welding is necessary.
4. Drill 8 millimetres (5/16 in) puddle weld holes in the NEW roof outer panel in the locations to be puddle welded.



5. Apply a full bead of structural adhesive GM6449G or equivalent to the rear roof bow (1).



6. Apply structural adhesive GM6449G or equivalent to the mating surfaces of the roof panel and body side rings (1).
7. Position the NEW roof outer panel assembly to the vehicle.
8. Inspect for proper fitment.
9. Clamp roof outer panel into correct position.



Important: Care must be taken to minimise the heat absorbed by the panel which could lead to panel distortion.

10. Spot weld or puddle weld the roof outer panel on both sides using the same number of welds as per original build.
11. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.
12. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
13. Install the upper rear sunroof drain hose. Refer to Sunroof Housing Rear Drain Hose Replacement.
14. Install the front sunroof drain hose. Refer to Sunroof Housing Front Drain Hose Replacement.
15. Install the sunroof module. Refer to Sunroof Module Assembly Replacement.
16. If re-programming is required. Refer to Control Module References.
17. Install the roof weld moulding. Refer to Roof Weld Joint Reveal Molding Replacement.
18. Install the rear window. Refer to Rear Window Replacement.
19. Install the windshield. Refer to Windshield Replacement.
20. Install the headliner. Refer to Headlining Trim Panel Replacement in Interior Trim.
21. Install the over head lighting panel. Refer to Dome Lamp Replacement.
22. Install the inner upper centre trim. Refer to Body Hinge Pillar Trim Panel Replacement.
23. Install the inner rear quarter trim. Refer to Quarter Upper Trim Panel Replacement.
24. Install the interior windshield pillar moulding. Refer to Windshield Garnish Molding Replacement.
25. Remove the tape to the corners of the panels and adjacent surfaces.
26. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
27. Enable the SIR system. Refer to SIR Disabling and Enabling in SIR.
28. If re-programming is required. Refer to Control Module References.

Roof Panel Replacement (Sportwagon)

Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

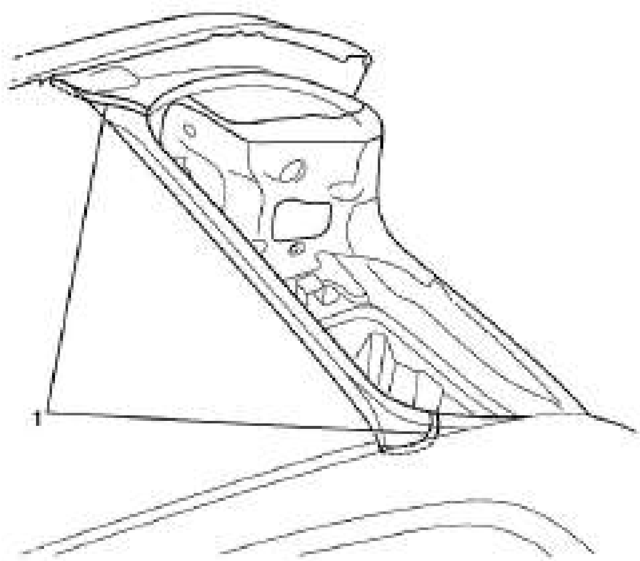
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

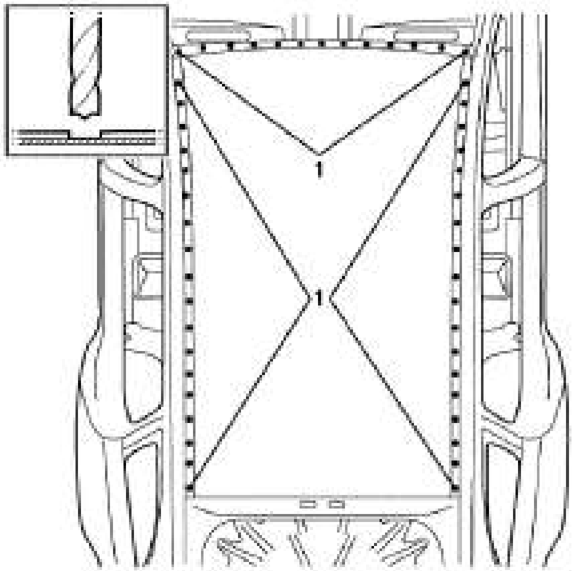
1. Disable the SIR system. Refer to SIR Disabling and Enabling.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the front seats. Refer to Front Seat Replacement - Bucket.
4. Remove the front seat belts. Refer to Front Seat Belt Replacement.
5. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
6. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
7. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
8. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
9. Remove the liftgate weatherstrip. Refer to Liftgate Weatherstrip Replacement.
10. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
11. Remove the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
12. Remove the body side window rear garnish moulding. Refer to Body Side Window Rear Garnish Molding Replacement.
13. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement.
14. Remove the rear seat back. Refer to Rear Split Folding Seat Back Replacement.
15. Remove the headliner. Refer to Headlining Trim Panel Replacement.
16. Remove the roof weld joint reveal moulding. Refer to Roof Weld Joint Reveal Molding Replacement.
17. Remove the windshield pillar garnish moulding. Refer to Windshield Pillar Garnish Molding Replacement.
18. Remove the windshield. Refer to Windshield Replacement.
19. Remove the liftgate. Refer to Liftgate Replacement.
20. Remove the liftgate hinges. Refer to Liftgate Hinge Replacement.
21. Remove the liftgate weatherstrip. Refer to Liftgate Weatherstrip Replacement.
22. Remove the body side roof drip moulding. Refer to Body Side Roof Drip Molding Replacement.
23. Visually inspect the damage. Repair as much of the damage as possible.
24. Apply tape to the corners of the panels and adjacent surfaces.
25. Note the location and remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.



26. Remove the sealer patches (1) from the joint between the roof panel and the gutter panel. Note the location of sealer patches for later installation.

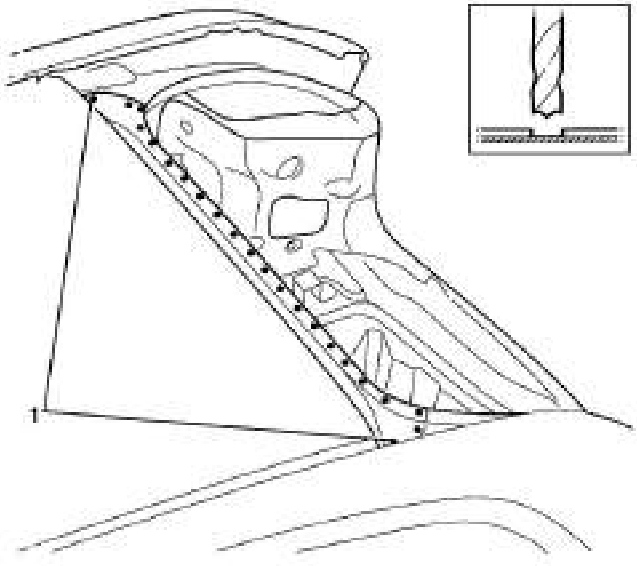


Important: The roof panel is attached to the steel roof structure with beads of adhesive on the sides and spot-welds on the side rail, windshield flange and rear roof header panel. Replacement of the roof panel can be performed using conventional procedures, however, the windshield and liftgate must be removed.

Important: The roof outer panel is secured to the body side panel with adhesive and spot welds, it cannot be removed by cutting the spot welds alone.

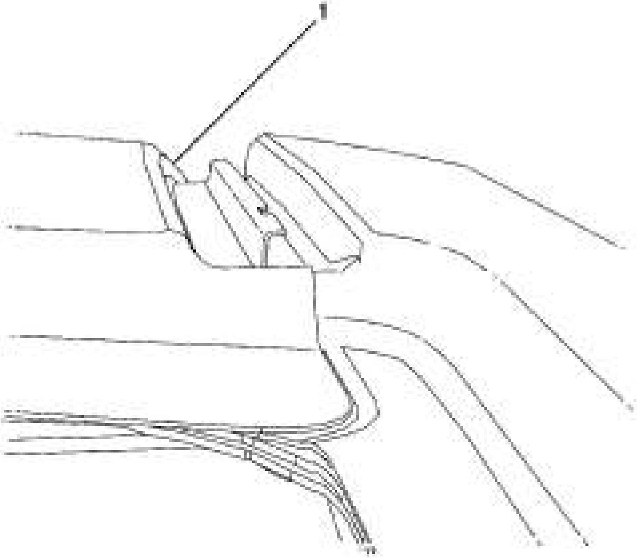
Important: Note the number and location of the factory welds for installation of the new roof outer panel assembly.

27. Locate, mark and drill out the factory welds attaching the roof outer panel to the vehicle (1). Note the number and location of welds for installation of the service assembly.



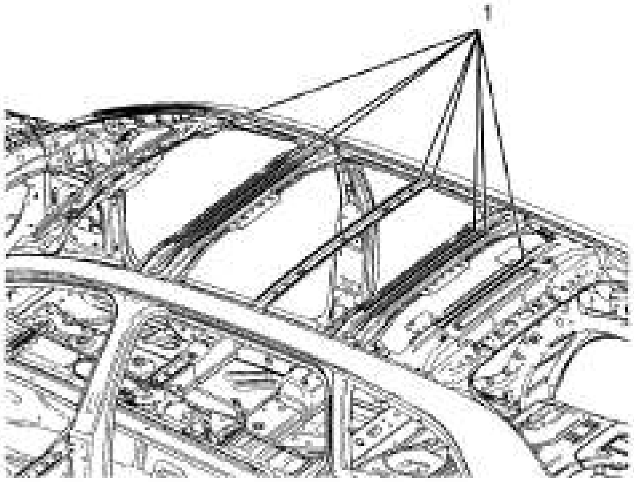
Important: Note the number and location of the factory welds for installation of the new roof outer panel assembly.

28. Locate, mark and drill out the factory welds attaching the roof outer panel to the roof rear header (1). Note the number and location of the welds for the installation of the service assembly.



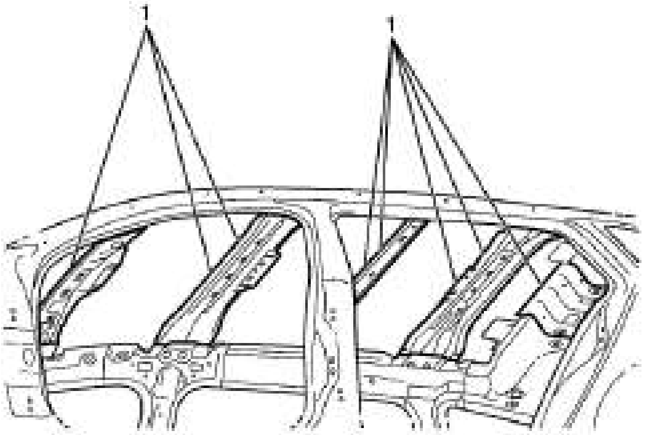
Important: Take care when cutting to protect adjacent panels. Cut inboard of the roof structure.

29. Using a suitable tool, cut through the roof outer panel along the inner side of the roof channel (1). Repeat for opposite side.



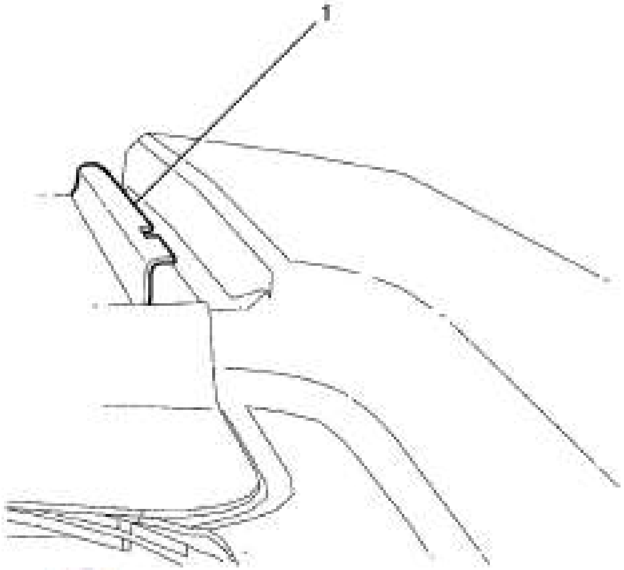
Important: Heating the 'anti-flutter' adhesive softens it making it easier to cut through.

30. Heat the 'anti-flutter' adhesive between the roof panel and the roof bows (1).

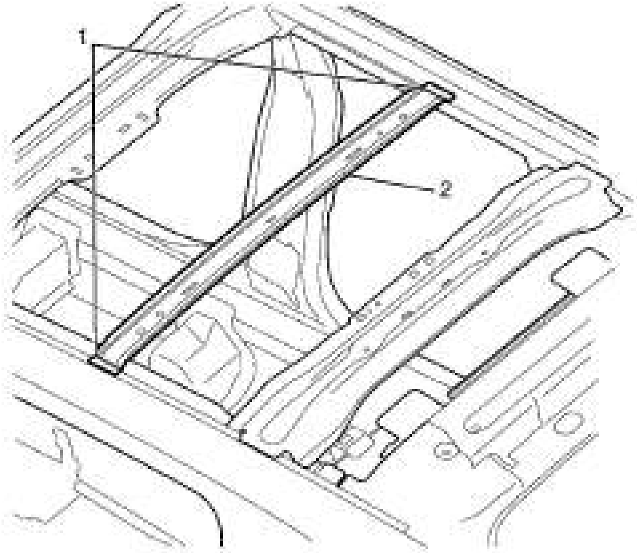


Important: The 'anti-flutter' adhesive (1) is between the roof bows and the roof outer panel.

31. Cut the 'anti-flutter' adhesive (1) with a suitable tool.
32. Remove the roof outer panel from the vehicle.



33. Using a suitable tool remove the remaining strip of roof panel (1) from the body side ring. repeat for opposite side.



Important: The centre roof bow panel is supplied welded to the roof outer panel. The centre roof bow panel is removed in this procedure as it will be replaced when the new roof outer panel is installed.

34. Mark a cut line (1) on the centre roof bow panel (2) inboard of the body side.

Important: Cut through the centre roof bow panel only. Do not damage any other panels or reinforcements.

35. Cut along the cut line (1) on the centre roof bow panel (2) with a suitable cutting tool.

36. Remove the centre portion of the centre roof bow panel (2) from the vehicle.
37. Using a suitable tool, remove the remaining outer portions of the centre roof bow panel from the vehicle. Ensure all traces of old adhesive are removed.

Installation Procedure

Important: Spot welding is the preferred method for attaching panels and should be used wherever possible. A puddle weld should be performed where your spot welder is unable to reach.

Important: Ensure that all factory welds are replaced in their original locations.

Important: Ensure that all structural adhesives are replaced in their original locations.

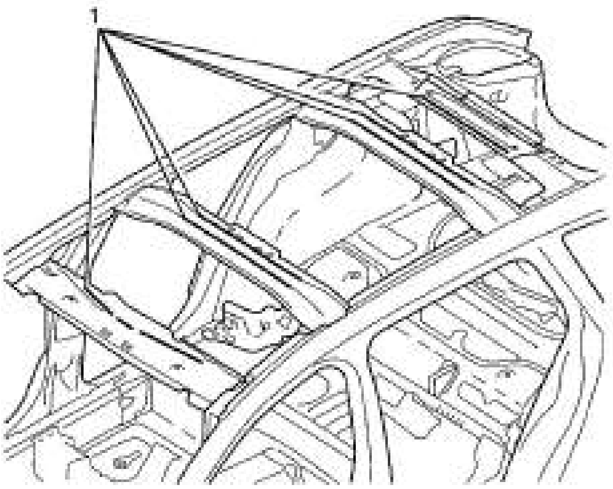
Important: If the location of the original spot weld holes can not be determined, or if structural weld-thru adhesive is present, space the puddle weld holes every 32 mm (1¼ in).

Important: Follow the adhesive manufacturer's instructions during the assembly process. Heat must be applied as per the manufacturer's specifications to cure the adhesives and to expand the sealing baffles.

1. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted when disassembling.
2. Clean and prepare the mating surfaces of both parts of the body side panel assembly.

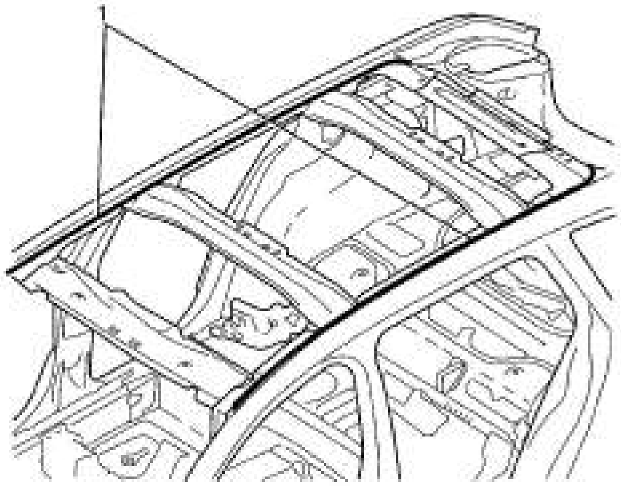
Important: Secondary sealer must be applied to the perimeter of all flanges. Secondary sealer must be applied to all welds/joints that were originally covered by secondary sealer.

3. Clean any remaining anti-flutter adhesive from the front, centre and rear roof bow and front/rear roof header surfaces.
4. Drill 8 mm (5/16 in) puddle weld holes in the NEW roof outer panel in the locations to be puddle welded.

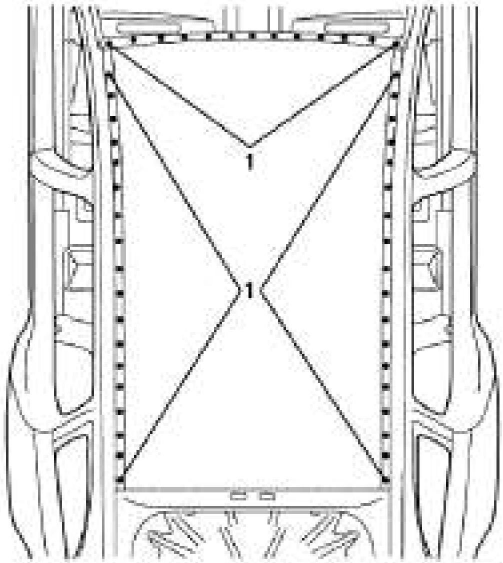


5. Apply two full beads (6mm dia) of approved anti-flutter adhesive to each of the roof bow panels (1).

6. Apply a full bead (6mm dia) of approved anti-flutter adhesive to the roof front and rear header panel (1).

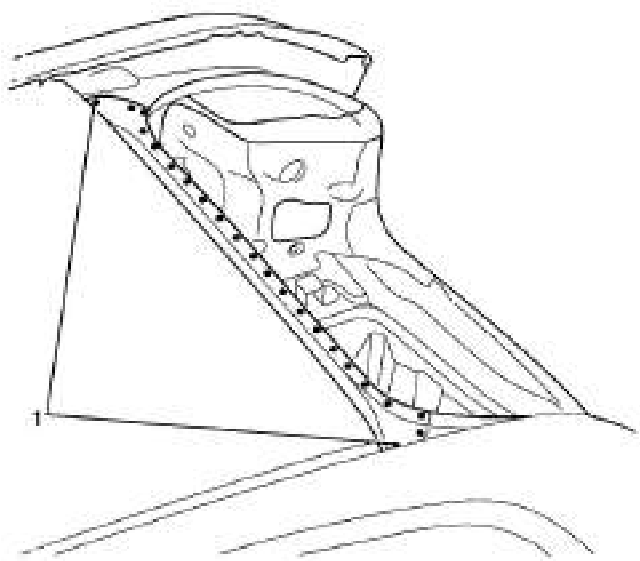


7. Apply an 8mm wide bead of structural adhesive (GM6449G or equivalent) to the mating surfaces of the Roof Outer Panel and Body Side Panel (1).
8. Position the NEW roof outer panel to the vehicle. Inspect the fit and clamp roof outer panel into correct position.



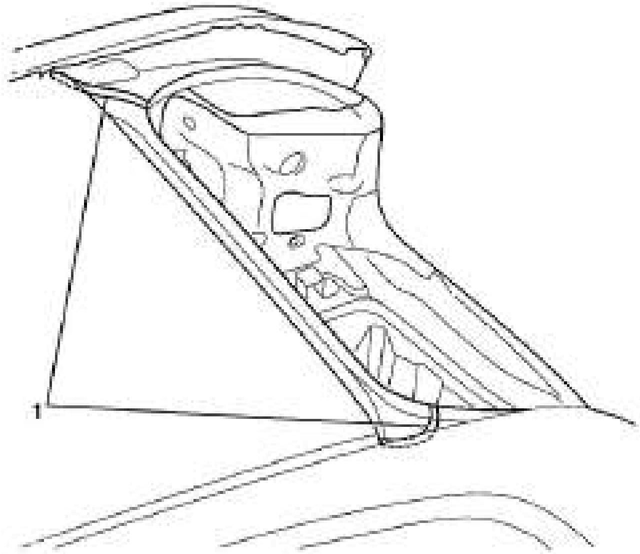
Important: Care must be taken to minimise the heat absorbed by the panel which could lead to panel distortion.

9. Weld the roof outer panel on to both sides and to the front roof header panel of the vehicle (1).



Important: Care must be taken to minimise the heat absorbed by the panel which could lead to panel distortion.

10. Weld the roof outer panel on to the rear roof header panel of the vehicle (1).



11. Apply secondary sealer (GM specification 9984532 or equivalent) (1) over the joint between the roof panel and gutter panel.
12. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.
13. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
14. Install the body side roof drip moulding. Refer to Body Side Roof Drip Molding Replacement.
15. Install the liftgate hinges. Refer to Liftgate Hinge Replacement.
16. Install the liftgate. Refer to Liftgate Replacement.

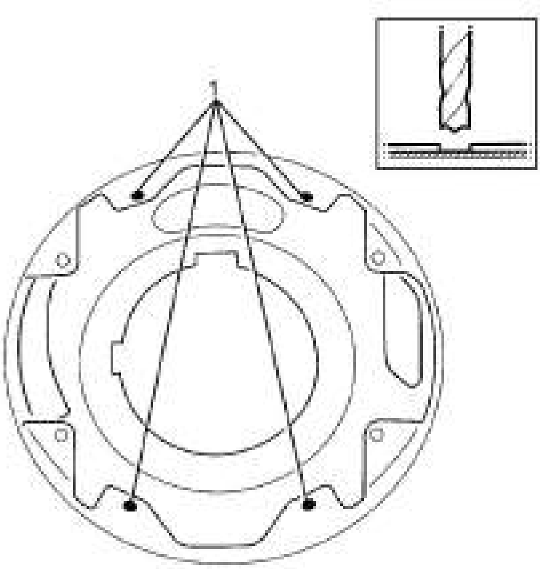
17. Install the windshield. Refer to Windshield Replacement.
18. Install the windshield pillar garnish moulding. Refer to Windshield Pillar Garnish Molding Replacement.
19. Install the roof weld joint reveal moulding. Refer to Roof Weld Joint Reveal Molding Replacement.
20. Install the headliner. Refer to Headlining Trim Panel Replacement.
21. Install the rear seat back. Refer to Rear Split Folding Seat Back Replacement.
22. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.
23. Install the body side window rear garnish moulding. Refer to Body Side Window Rear Garnish Molding Replacement.
24. Install the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
25. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
26. Install the liftgate weatherstrip. Refer to Liftgate Weatherstrip Replacement.
27. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
28. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
29. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
30. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
31. Install the front seat belts. Refer to Front Seat Belt Replacement.
32. Install the front seats. Refer to Front Seat Replacement - Bucket.
33. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
34. Enable the SIR system. Refer to SIR Disabling and Enabling.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Repair | Collision Repair | Repair Instructions | **Document ID: 2077350**

Quarter Panel Replacement (SWB)

Removal Procedure (fuel filler pocket)

Important: When removing the right side quarter panel the petrol filler pocket will be removed with it. The petrol filler pocket has to be removed from the old right side quarter panel and assembled on the NEW right side quarter panel.



1. Locate, mark and drill out the four spot welds (1) from the body side ring.
2. Remove the petrol filler pocket from the right side quarter panel.

Installation Procedure (fuel filler pocket)

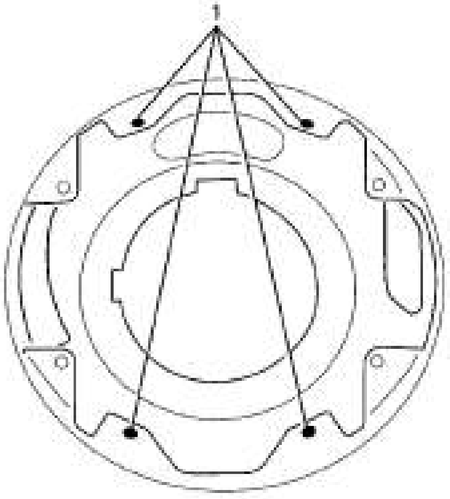
Important: If the location of the original plug weld holes can not be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 32 mm (1¼ in).

Important: Spot welding is the preferred method for attaching panels and should be used wherever possible. A plug weld should be performed where your spot welder is unable reach.

1. Clean and prepare the mating surfaces of both parts of the body side ring.

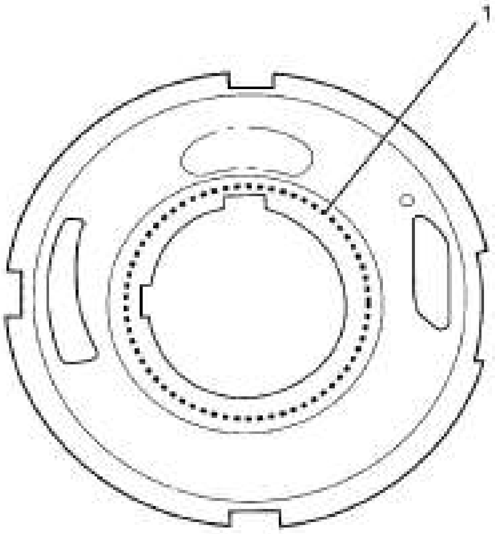
Important: Make sure that the alignment of the hinge and fuel filler door is correct.

2. Position the petrol filler pocket to the NEW right side quarter panel.

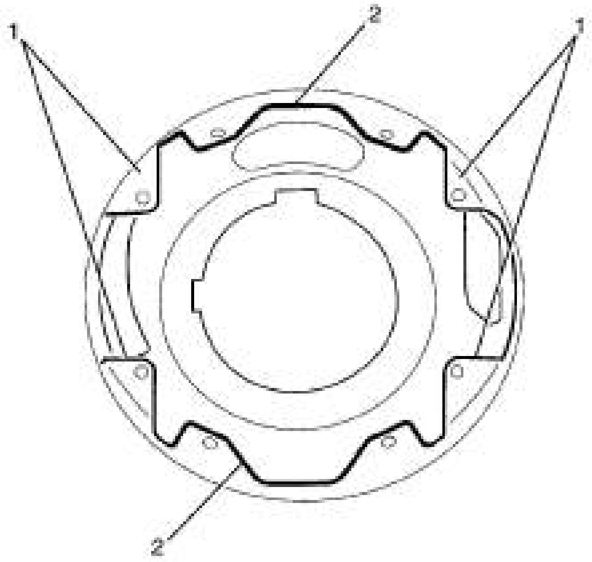


Important: Make sure that the alignment of the hinge and fuel filler door is correct.

3. Weld (1) the fuel filler pocket to the right side quarter panel.



4. Apply the primary sealer (1) GM6449G or equivalent along the fuel filler pocket and the inner panel.



Important: Seal behind the 4 tabs (1) to prevent water and fume leaks between the fuel filler pocket and the right side quarter panel.

5. Apply the secondary sealer (1) GM specification 9984532 or equivalent along the fuel filler pocket and the right side quarter panel tabs (1).

Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

Caution: Refer to Glass and Sheet Metal Handling Caution in the Preface section.

Caution: Refer to Battery Disconnect Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Important: The full body-side outer panel comes as a complete assembly and can be replaced at factory seams after the removal of the fixed glass and roof. Any one of these service procedures can be performed separately or in any combination, dependent upon the extent of damage to the vehicle. Sectioning must take place in specified areas only.

1. Disable the SIR system. Refer to SIR Disabling and Enabling in SIR.
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the battery. Refer to Battery Replacement.
4. Remove the battery tray. Refer to Battery Tray Replacement.
5. Remove the deck lid. Refer to Rear Compartment Lid Replacement.
6. Remove the rear door seals. Refer to Rear Door Opening Weatherstrip Replacement.
7. Remove the rear interior trims. Refer to Quarter Upper Trim Panel Replacement.
8. Remove the roof lining. Refer to Headlining Trim Panel Replacement.

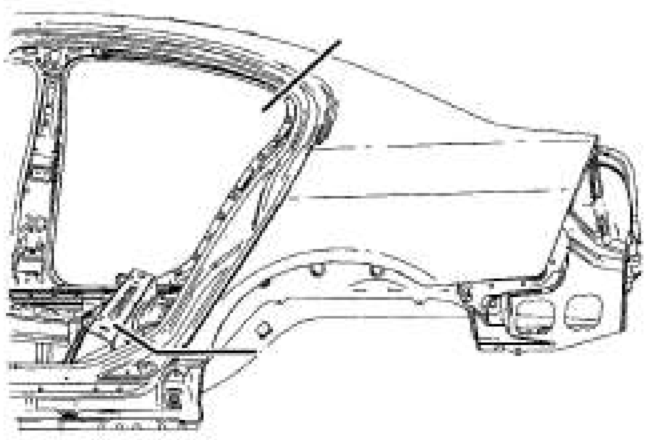
9. Remove the rear seat back. Refer to Rear Seat Back Replacement.
10. Remove the rear seats. Refer to Rear Seat Cushion Cover and Pad Replacement.
11. Remove the rear parcel shelf. Refer to Rear Window Shelf Trim Panel Replacement.
12. Remove the deck lid release cable. Refer to Rear Compartment Lid Latch Release Cable Replacement.

Important: When replacing panels that involve servicing of stationary glass, refer to Rear Window Replacement and Windshield Replacement. Sectioning should be performed only in the recommended areas. Failure to do so may compromise the structural integrity of the vehicle.

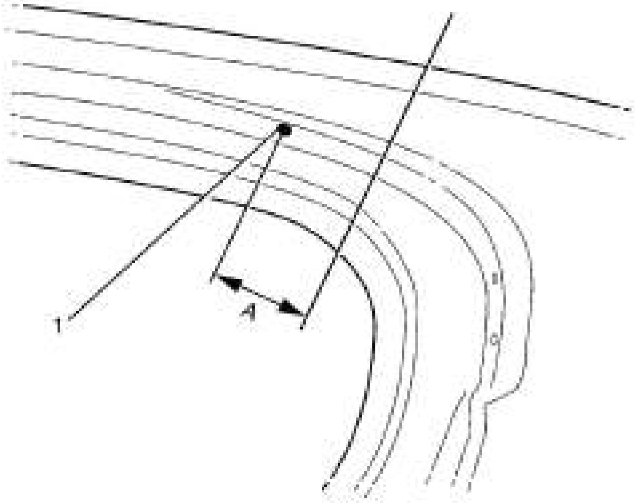
13. Remove the rear window. Refer to Rear Window Replacement.
14. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
15. Remove the rear wheels. Refer to Tire and Wheel Removal and Installation.
16. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
17. Remove the rear pressure relief valves. Refer to Pressure Relief Valve Replacement.
18. Remove the rocker panel moulds. Refer to Rocker Panel Molding Replacement.
19. Remove the rear wheelhouse liners. Refer to Rear Inner Wheelhouse Replacement.
20. Remove the rear exhaust assembly. Refer to Exhaust Muffler Replacement - Left Side and/or Exhaust Muffler Replacement - Right Side
21. Remove the rear exhaust muffler heat shields. Refer to Exhaust Muffler Heat Shield Replacement - Left Side and/or Exhaust Muffler Heat Shield Replacement - Right Side.
22. Remove the rear frame. Refer to Rear Frame Replacement.
23. Remove the rear brake lines. Refer to Brake Pipe Replacement.
24. Remove the fuel tank. Refer to Fuel Tank Replacement or Fuel Tank Replacement.
25. Remove the fuel lines. Refer to Filler Tube Replacement or Filler Tube Replacement.
26. Lower the vehicle.
27. Remove the roof moulding. Refer to Body Side Roof Drip Molding Replacement.

Important: This step is unique to the sunroof module.

28. Remove the rear sunroof drain tubes. Refer to Sunroof Housing Rear Drain Hose Replacement.
29. Remove the tail lights. Refer to Parking and Turn Signal Lamp Replacement.
30. Repair as much of the damage as possible.
31. Remove sound deadeners as necessary and note their location.
32. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.

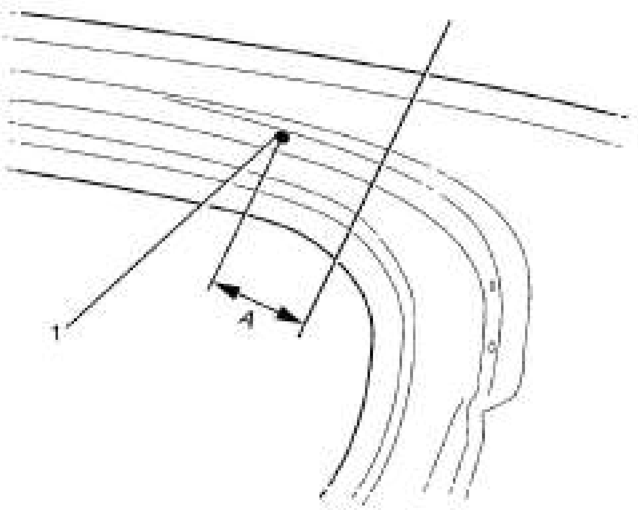


33. Create cut lines on the rocker panel and rear quarter panel within the approved sectioning locations.



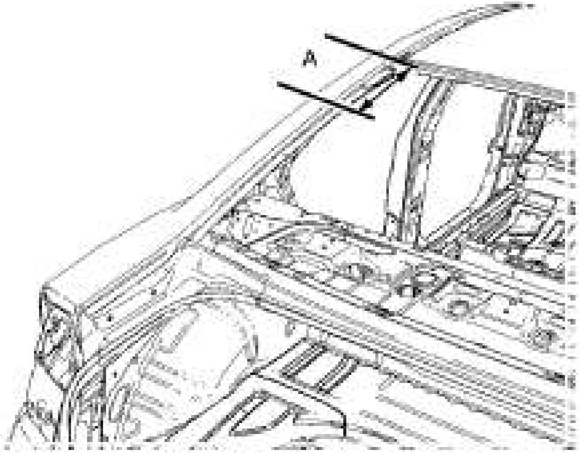
Important: Measure from the datum holes to create an accurate cut line.

34. Mark a cut line 47 mm (1.85 in) from datum point (1).
35. Mark a cut line 42 mm (1.65 in) from datum point (2).

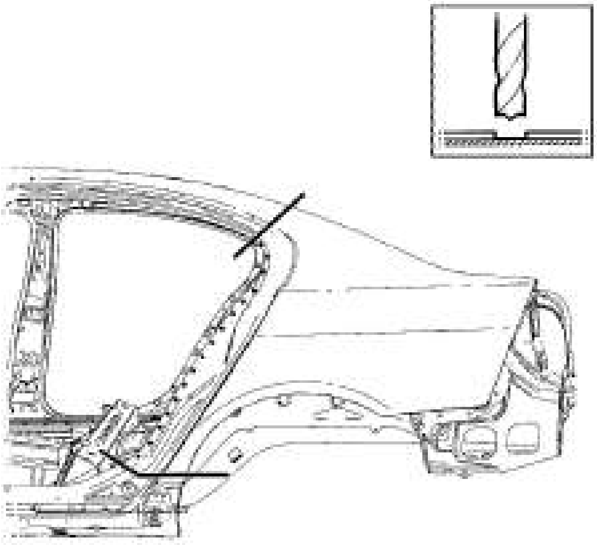


Important: Measure from the datum holes to create an accurate cut line.

36. Mark a cut line 75 mm (2.95 in) from datum point (1).

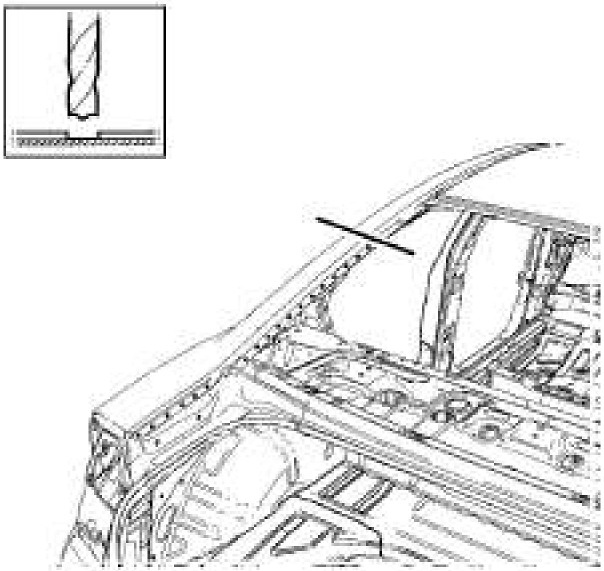


37. In the rear window opening, measure down 10 mm (0.39 in) from the rear edge of the roof (A).
38. Mark a cut line to the door opening.



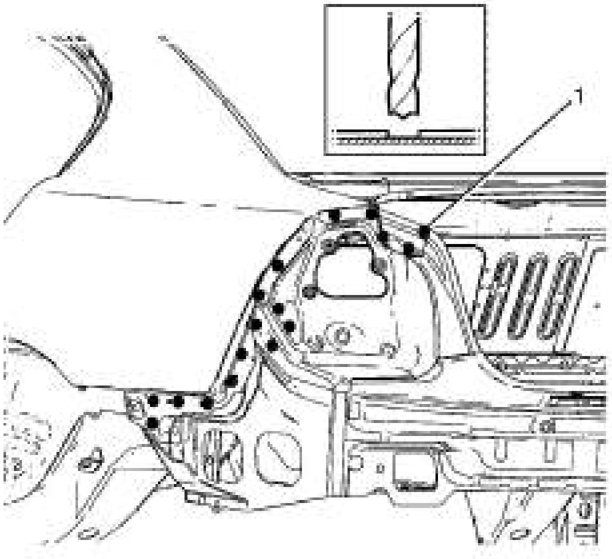
Important: Take care not damage any inner panels or reinforcements.

39. Locate, mark and drill out all the factory welds inside the cut lines on the quarter panel to body ring.



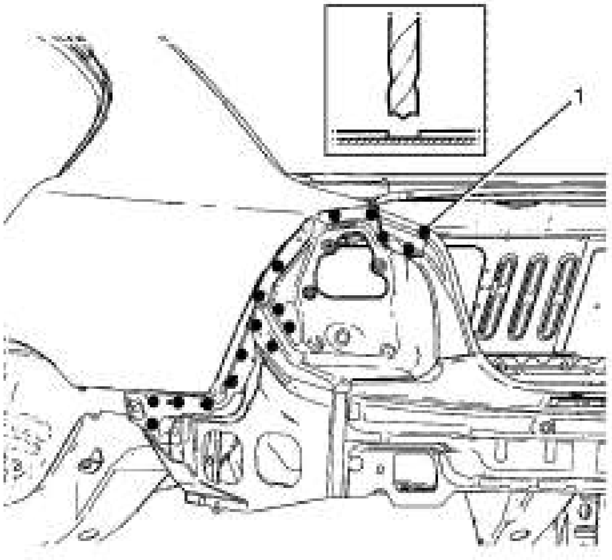
Important: Take care not damage any inner panels or reinforcements.

40. Locate, mark and drill out all the necessary factory welds inside the cut lines on the quarter panel to rear window sill.



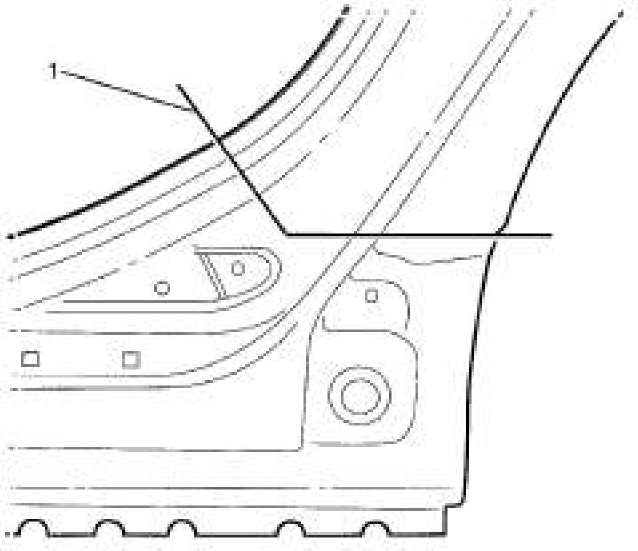
Important: Note the number and location of the factory welds for installation of the quarter panel.

41. Locate, mark, and drill out the factory welds (1) of the tail lamp and extension panel to rear quarter panel.



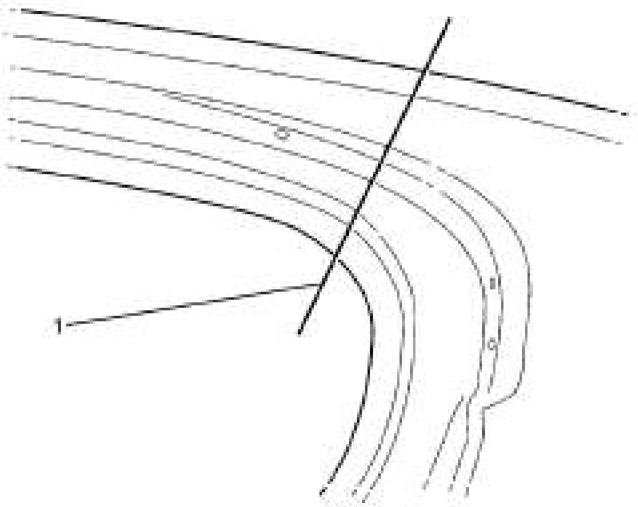
Important: Note the number and location of the factory welds for installation of the quarter panel.

42. Locate, mark and drill out factory welds (1) from the rear quarter panel to inner wheelhouse assembly.



Important: Only cut through the skin panel, outer panel. Do not damage any inner panels or reinforcements.

43. Cut along the cut line (1) on the body side outer skin panel with a suitable cutting tool.



Important: Only cut through the skin panel, outer panel. Do not damage any inner panels or reinforcements.

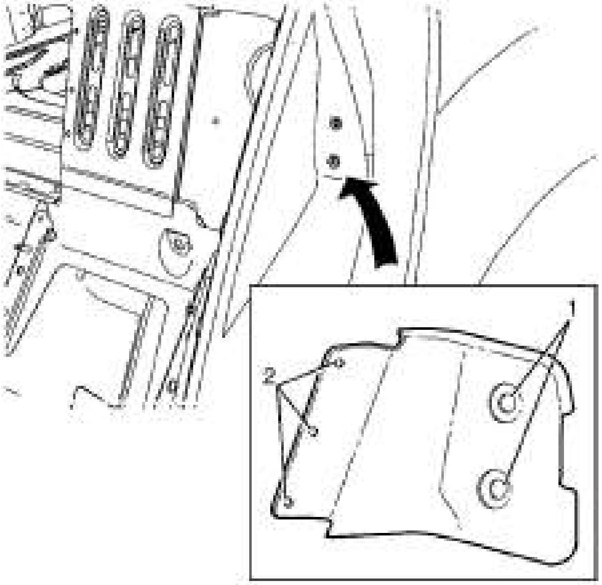
44. Cut along the cut line (1) on the body side outer skin panel with a suitable cutting tool.
45. Remove the damaged body side outer skin panel.

Installation Procedure

Important: If the location of the original spot weld holes can not be determined, or if structural weld-thru adhesive is present, space the puddle weld holes every 32 mm (1¼ in).

Important: Spot welding is the preferred method for attaching panels and should be used wherever possible. A puddle weld should be performed where your spot welder is unable to reach.

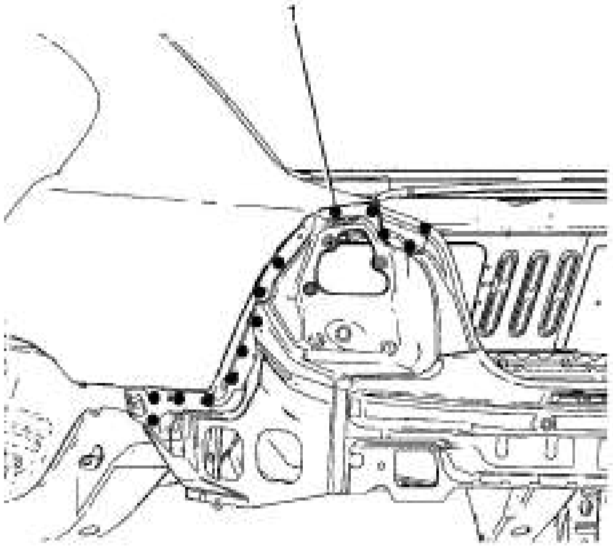
1. Cut the body side assembly in corresponding locations to fit the remaining original panel. The sectioning joint should be trimmed to allow a gap of one-and-one-half-times the metal thickness at the sectioning joint.



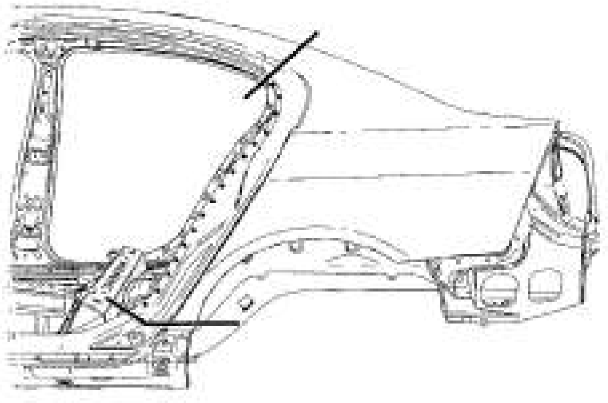
2. Align the bolt holes (1) for the rear door striker with holes in the body side outer.
3. Bolt the rear door striker into the holes (1) in the body side outer and through the reinforcement.

Important: If the location of the original spot weld holes can not be determined, or if structural weld-thru adhesive is present, space the puddle weld holes every 32 mm (1¼ in).

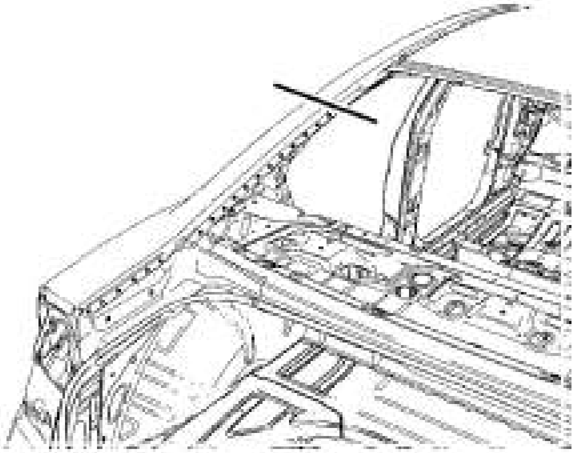
4. Drill 8 mm (5/16 in) puddle weld holes in the service part as necessary in the locations noted from the original panel.
5. Prepare all mating surfaces as necessary.
6. Position the body side outer skin panel to the vehicle.
7. Align quarter panel using three-dimensional measuring equipment.



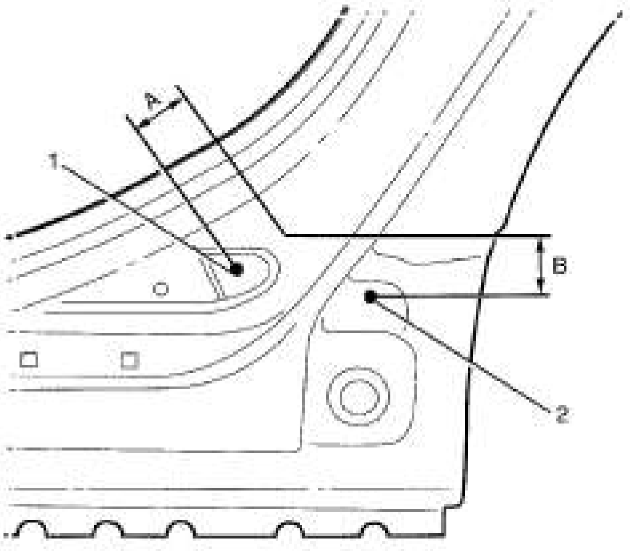
8. Weld (1) the quarter panel to the tail lamp filler panel and the inner side extension.



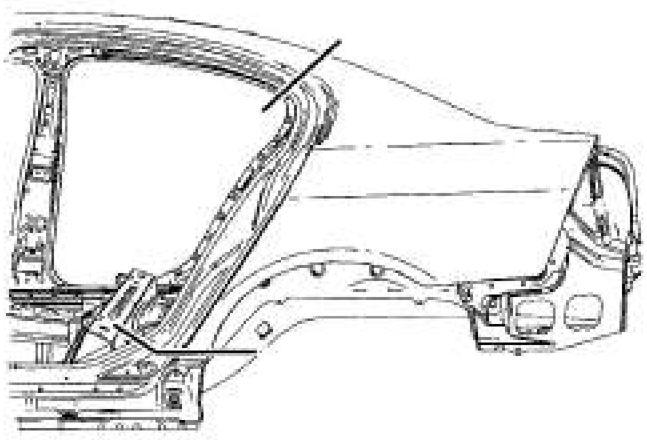
9. Weld the quarter panel to the rear door sill.
10. Weld the quarter panel to the body side ring outer panel.



11. Weld the quarter panel to the rear window sill.

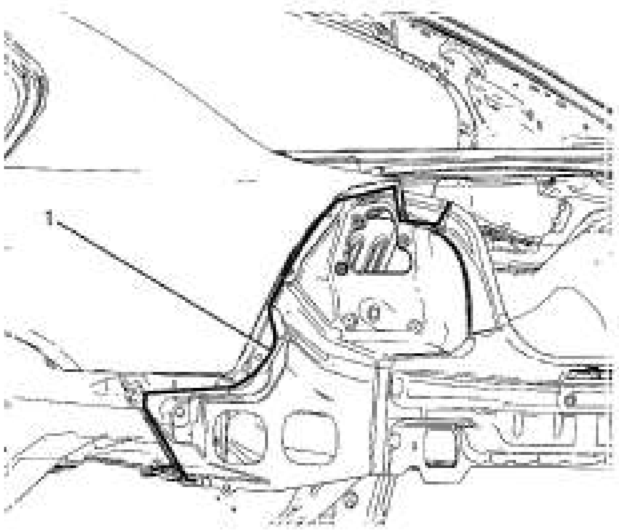


12. Weld (1) the quarter panel to the inner rear wheelhouse.

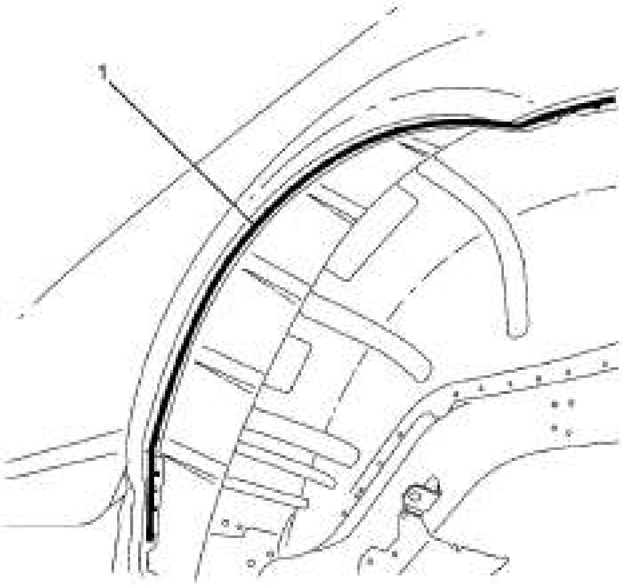


Important: To create a solid weld with minimum heat distortion, make 25 mm (1 in) stitch welds along the seam with 25 mm (1 in) gaps between them.

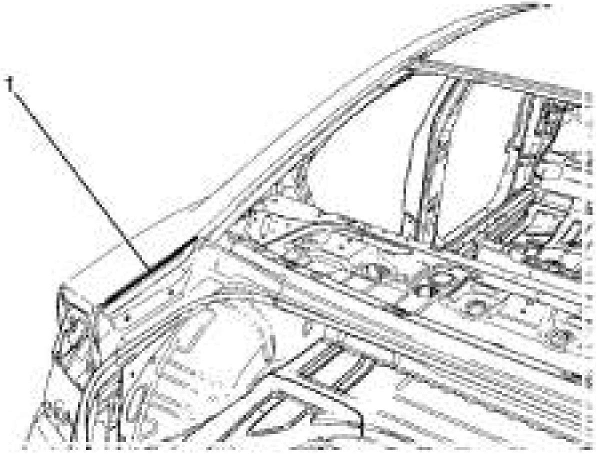
13. Stitch weld the rear quarter panel the vehicle.
14. Clean and prepare all of the welded surfaces.
15. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair in Paint/Coatings.



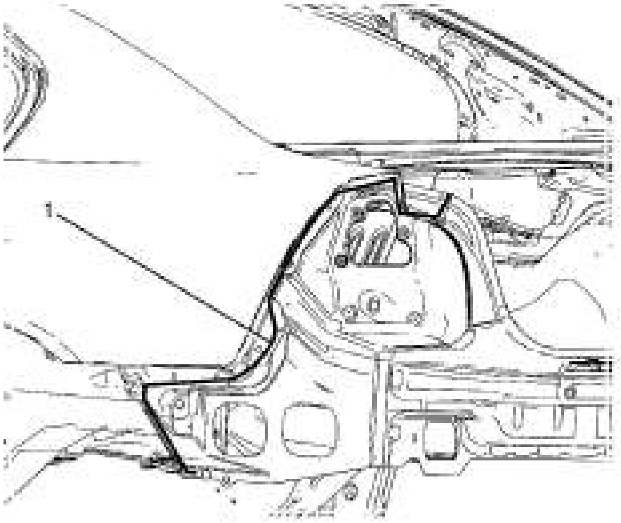
16. Apply the primary sealer (1) GM6449G or equivalent along the quarter panel to the tail lamp filler panel and side extension panel.



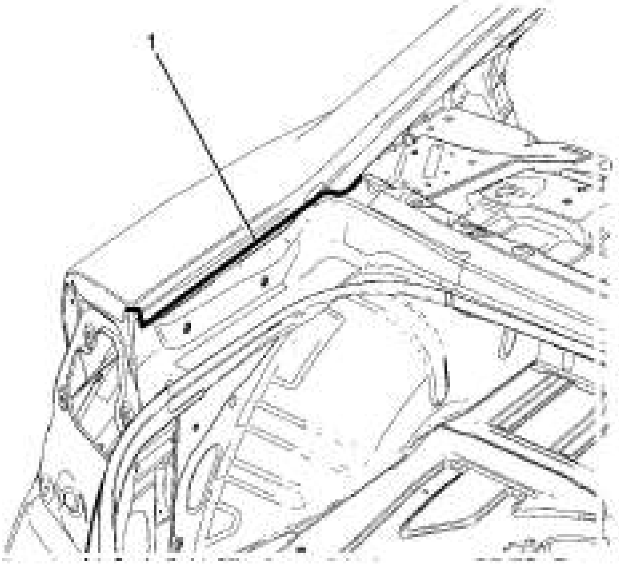
17. Apply the primary sealer (1) GM6449G or equivalent along the rear quarter panel to the rear wheel arch.



18. Apply the primary sealer (1) GM6449G or equivalent along the rear quarter panel to the body side ring outer.



19. Apply the secondary sealer (1) GM specification 9984532 or equivalent along rear quarter panel to the tail lamp filler panel and side extension panel.



20. Apply the secondary sealer (1) GM specification 9984532 or equivalent along the rear quarter panel to the body side ring outer panel.
21. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
22. Install the tail lights. Refer to Parking and Turn Signal Lamp Replacement.

Important: This step is unique to the sunroof module.

23. Install the rear roof drain tubes. Refer to Sunroof Housing Rear Drain Hose Replacement.
24. Install the rear windshield. Refer to Rear Window Replacement.
25. Install the roof moulding. Refer to Body Side Roof Drip Molding Replacement.
26. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

27. Install the fuel lines. Refer to Filler Tube Replacement or Filler Tube Replacement.
28. Install the fuel tank. Refer to Fuel Tank Replacement or Fuel Tank Replacement.
29. Install the rear brake lines. Refer to Brake Pipe Replacement.
30. Install the rear frame. Refer to Rear Frame Replacement.
31. Install the rear exhaust muffler heat shields. Refer to Exhaust Muffler Heat Shield Replacement - Left Side and Exhaust Muffler Heat Shield Replacement - Right Side.
32. Install the rear exhaust assembly. Refer to Exhaust Muffler Replacement - Left Side and Exhaust Muffler Replacement - Right Side.
33. Install the rear wheel house liners. Refer to Rear Inner Wheelhouse Replacement in Body Rear End.
34. Install the rocker panel moulds. Refer to Rocker Panel Molding Replacement.
35. Install the rear pressure relief valves. Refer to Pressure Relief Valve Replacement in Body Rear End.
36. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
37. Install the rear wheels. Refer to Tire and Wheel Removal and Installation.
38. Lower the vehicle.
39. Install the deck lid release cable. Refer to Rear Compartment Lid Latch Release Cable Replacement.
40. Install the rear parcel shelf. Refer to Rear Window Shelf Trim Panel Replacement.
41. Install the rear seats. Refer to Rear Seat Cushion Cover and Pad Replacement.
42. Install the rear seat back. Refer to Rear Seat Back Replacement.
43. Install the roof lining. Refer to Headlining Trim Panel Replacement.
44. Install the rear interior trims. Refer to Quarter Upper Trim Panel Replacement.
45. Install the rear door seals. Refer to Rear Door Opening Weatherstrip Replacement.
46. Install the deck lid. Refer to Rear Compartment Lid Replacement.
47. Install the battery tray. Refer to Battery Tray Replacement.
48. Install the battery. Refer to Battery Replacement.

    Caution: Refer to Battery Disconnect Caution in the Preface section.

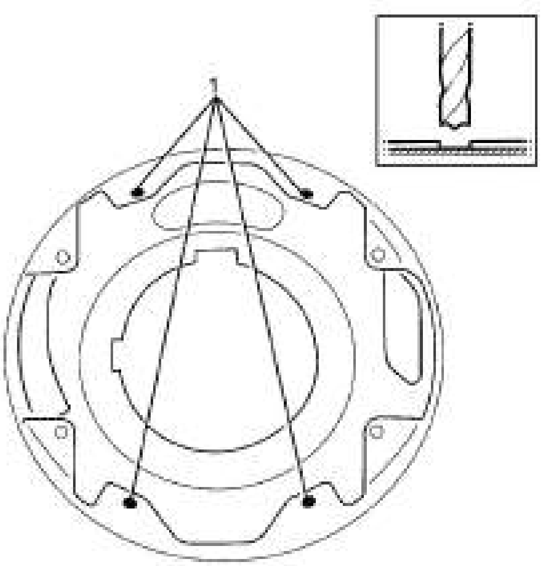
49. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
50. Enable the SIR system. Refer to SIR Disabling and Enabling.
51. If re-programming is required. Refer to Control Module References.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Repair | Collision Repair | Repair Instructions | **Document ID: 2133250**

Quarter Panel Replacement (Sportwagon)

Removal Procedure (fuel filler pocket)

Important: When removing the right side quarter portion of the body side outer panel, the petrol filler pocket will be removed with it. The petrol filler pocket can be removed from the old right side quarter panel and assembled on the NEW right side quarter panel repair section.



1. Locate, mark and drill out the four spot welds (1) from the body side ring.
2. Remove the petrol filler pocket from the right side quarter panel.

Installation Procedure (fuel filler pocket)

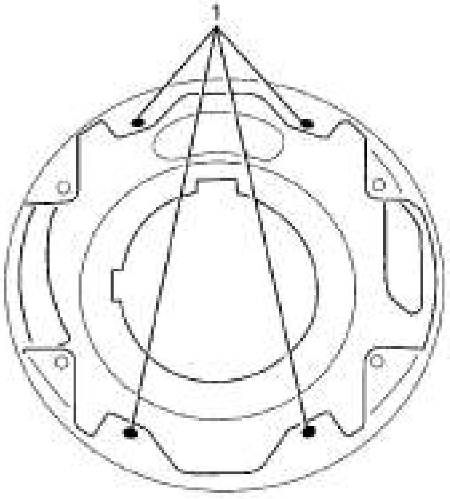
Important: If the location of the original plug weld holes can not be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 32 mm (1¼ in).

Important: Spot welding is the preferred method for attaching panels and should be used wherever possible. A plug weld should be performed where your spot welder is unable reach.

1. Clean and prepare the mating surfaces of both parts of the body side ring.

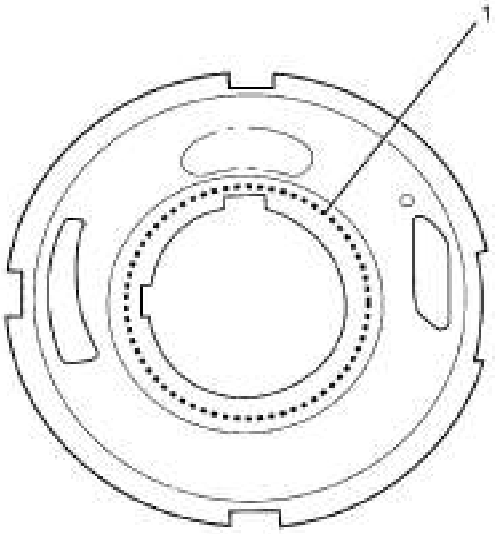
   Important: Make sure that the alignment of the hinge and fuel filler door is correct.

2. Position the petrol filler pocket to the NEW right side quarter panel.

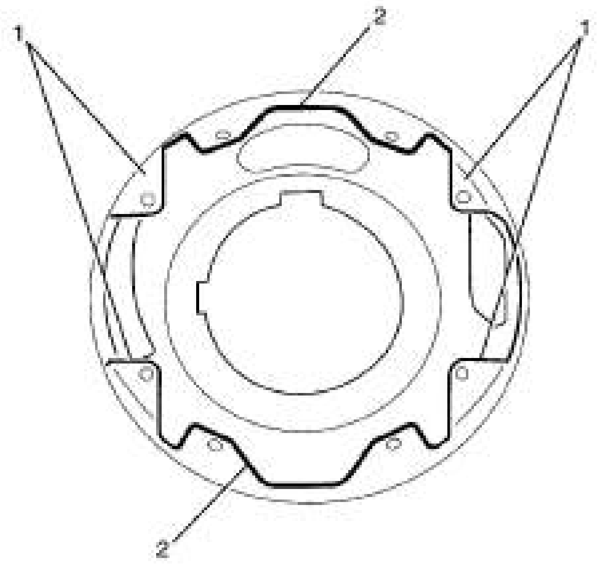


Important: Make sure that the alignment of the hinge and fuel filler door is correct.

3. Weld (1) the fuel filler pocket to the right side quarter panel.



4. Apply the primary sealer (1) GM6449G or equivalent along the fuel filler pocket and the inner panel.



Important: Seal behind the 4 tabs (1) to prevent water and fume leaks between the fuel filler pocket and the right side quarter panel.

5. Apply the secondary sealer (2) GM specification 9984532 or equivalent along the fuel filler pocket and the right side quarter panel tabs (1).

Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

Caution: Refer to Glass and Sheet Metal Handling Caution in the Preface section.

Caution: Refer to Battery Disconnect Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

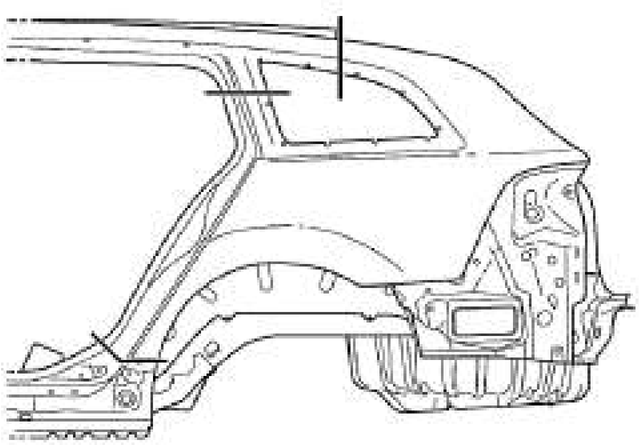
Important: The bodyside outer panel is supplied complete and must be cut to match the quarter panel repair area. Sectioning must take place in the specified areas only.

1. Disable the SIR system. Refer to SIR Disabling and Enabling in SIR.
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
4. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
5. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
6. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
7. Remove the liftgate weatherstrip. Refer to Liftgate Weatherstrip Replacement.

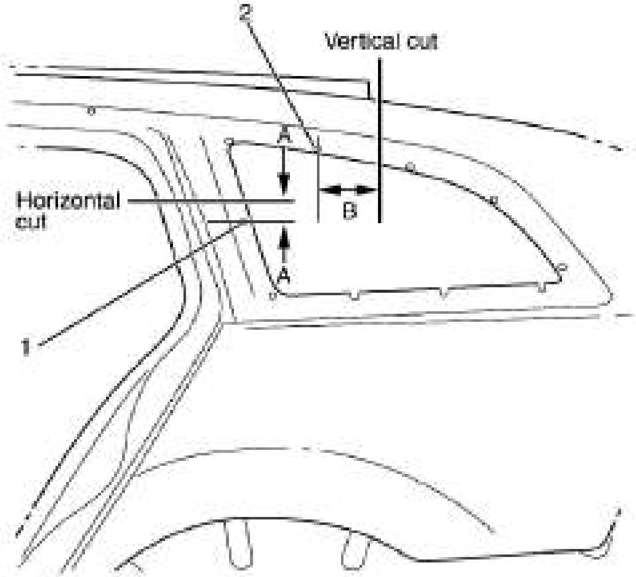
8. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
9. Remove the battery. Refer to Battery Replacement.
10. Remove the battery tray. Refer to Battery Tray Replacement.
11. Remove the liftgate. Refer to Liftgate Replacement.
12. Remove the rear door seal. Refer to Rear Door Opening Weatherstrip Replacement.
13. Remove the Body Side Roof Drip Moulding. Refer to Body Side Roof Drip Molding Replacement.
14. Remove the rear interior trims. Refer to Quarter Upper Trim Panel Replacement.
15. Remove the headliner. Refer to Headlining Trim Panel Replacement.
16. Remove the rear seat back. Refer to Rear Split Folding Seat Back Replacement.
17. Remove the rear seats. Refer to Rear Seat Cushion Cover and Pad Replacement.

Important: When replacing panels that involve servicing of stationary glass, refer to Rear Window Replacement and Windshield Replacement. Sectioning should be performed only in the recommended areas. Failure to do so may compromise the structural integrity of the vehicle.

18. Remove the rear window. Refer to Rear Window Replacement.
19. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle
20. Remove the rear wheels. Refer to Tire and Wheel Removal and Installation.
21. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
22. Remove the rear pressure relief valves. Refer to Pressure Relief Valve Replacement.
23. Remove the rocker panel moulds. Refer to Rocker Panel Molding Replacement.
24. Remove the rear wheelhouse liners. Refer to Rear Inner Wheelhouse Replacement.
25. Remove the rear exhaust assembly. Refer to Exhaust Muffler Replacement - Left Side and/or Exhaust Muffler Replacement - Right Side
26. Remove the rear exhaust muffler heat shields. Refer to Exhaust Muffler Heat Shield Replacement - Left Side and/or Exhaust Muffler Heat Shield Replacement - Right Side.
27. Remove the rear frame. Refer to Rear Frame Replacement.
28. Remove the rear brake lines. Refer to Brake Pipe Replacement.
29. Remove the fuel tank. Refer to Fuel Tank Replacement or Fuel Tank Replacement.
30. Remove the fuel lines. Refer to Filler Tube Replacement or Filler Tube Replacement.
31. Lower the vehicle.
32. Remove the roof moulding. Refer to Body Side Roof Drip Molding Replacement.
33. Remove the tail lights. Refer to Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn Signal Bulb Replacement.
34. Repair as much of the damage as possible.
35. Remove sound deadeners as necessary and note their location.
36. Remove the sealers and anti-corrosion materials from the repair area and note their location. Refer to Anti-Corrosion Treatment and Repair.

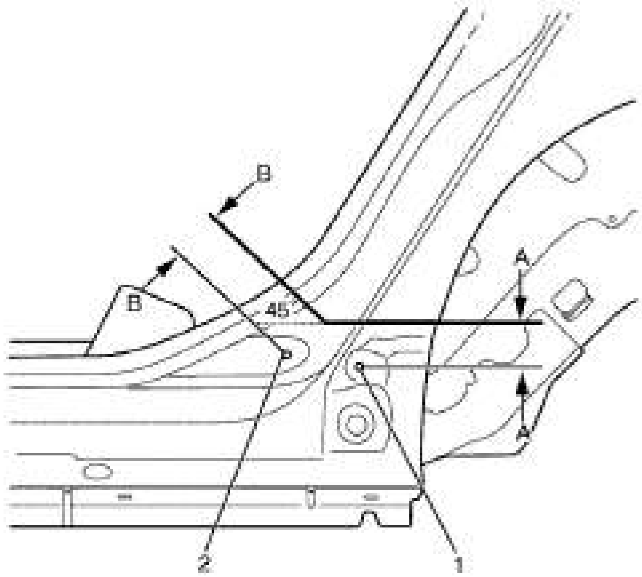


37. Create cut lines on the body side outer panel at the approved sectioning locations.



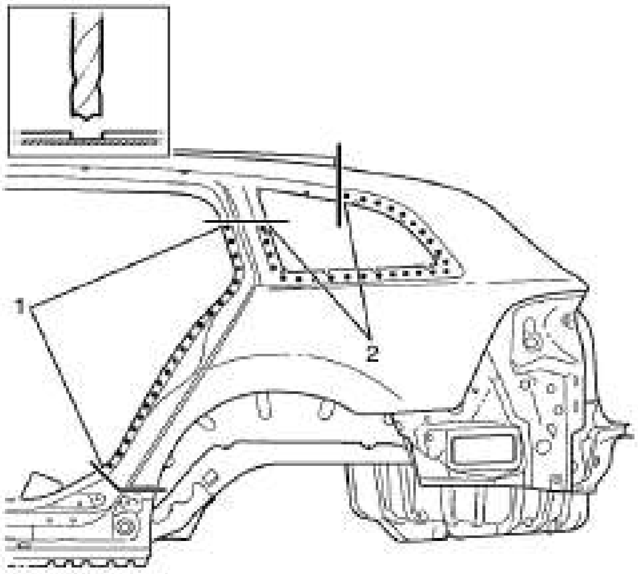
Important: Measure from the datum hole to create an accurate cut line.

38. Mark a horizontal cut line 35 mm (1.38 in) (Dimension A) above datum point (1).
39. Mark a vertical cut line 95 mm (3.74 in) (Dimension B) rearward of datum point (2).



Important: Measure from the datum holes to create an accurate cut line. Datum holes (1) and (2) are 9mm dia holes in the body side outer panel.

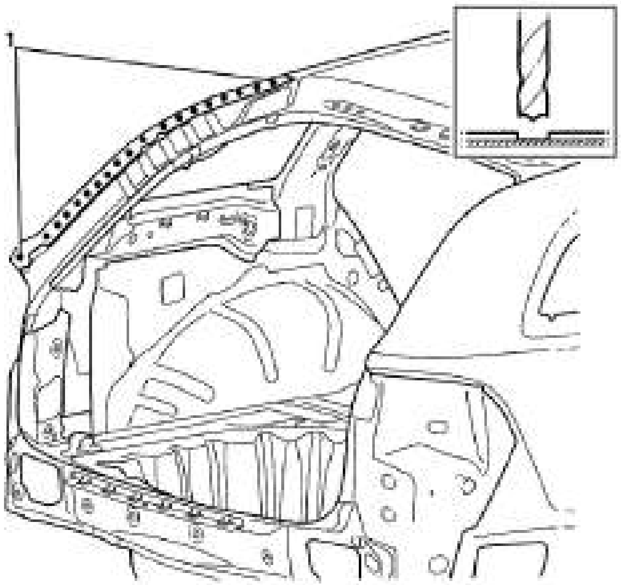
40. Mark a horizontal cut line 42 mm (1.65 in) (Dimension A) above datum point (1).
41. Mark a cut line 47 mm (1.85 in) (Dimension B) from datum point (2) measured at an angle of 45 degrees to the horizontal.



Important: Do not damage any inner panels or reinforcements.

Important: Note the number and location of the factory welds for installation of the rear quarter panel repair section.

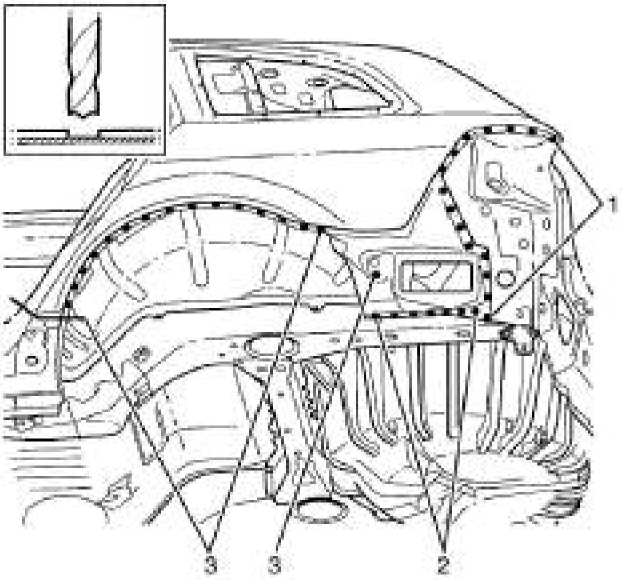
42. Locate, mark and drill out the factory welds (1) inside the cut lines on the body side outer panel to body ring.
43. Locate, mark and drill out the factory welds (2) inside the cut lines around the rear quarter window.



Important: Do not damage any inner panels or reinforcements.

Important: Note the number and location of the factory welds for installation of the rear quarter panel repair section.

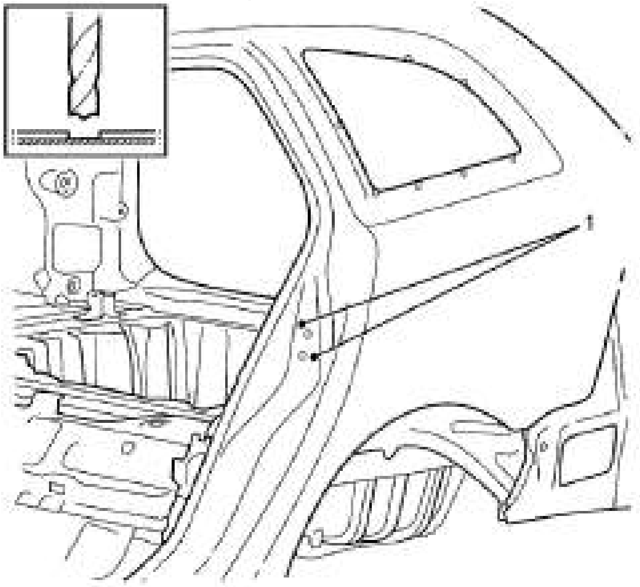
44. Locate, mark and drill out all the necessary factory welds (1) inside the cut lines on the body side outer panel to rear gutter panel.



Important: Do not damage any inner panels or reinforcements.

Important: Note the number and location of the factory welds for installation of the rear quarter panel repair section.

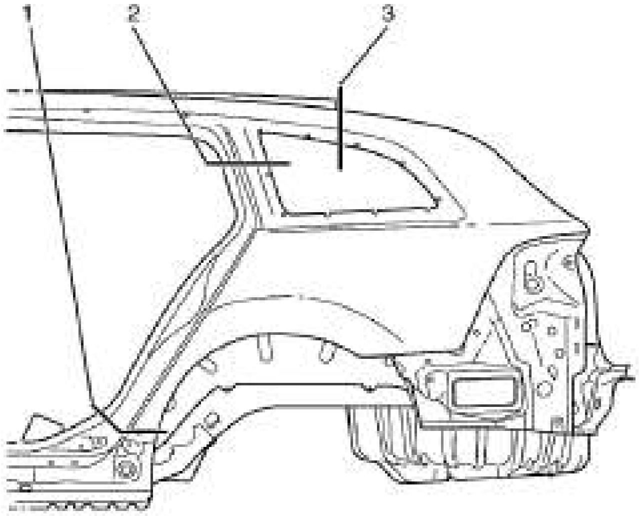
45. Locate, mark, and drill out the factory welds (1) joining the body side outer panel to the body tail lamp filler panel.
46. Locate, mark and drill out the factory welds (2) joining the body side outer panel to the body side inner panel extension.
47. Locate, mark and drill out the factory welds (3) joining the body side outer panel to the inner wheelhouse panel.



Important: Do not damage any inner panels or reinforcements.

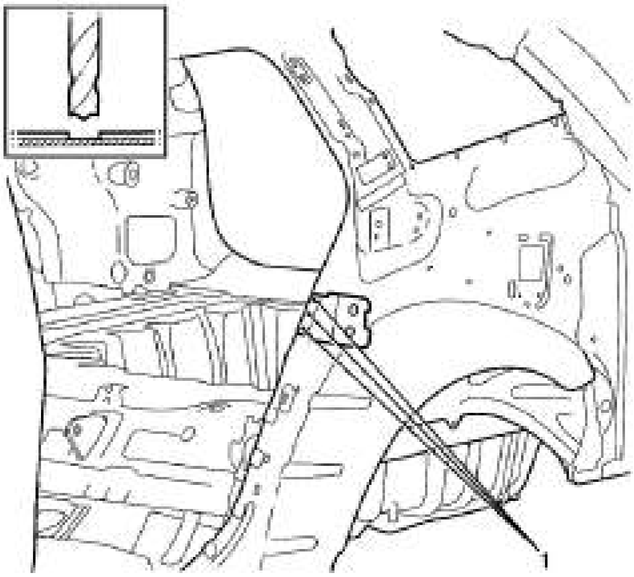
Important: Note the number and location of the factory welds for installation of the quarter panel repair section.

48. Locate, mark, and drill out the factory welds (1) joining the body side outer panel to the rear door lock striker reinforcement bracket.



Important: Only cut through the body side outer panel. Do not damage any inner panels or reinforcements.

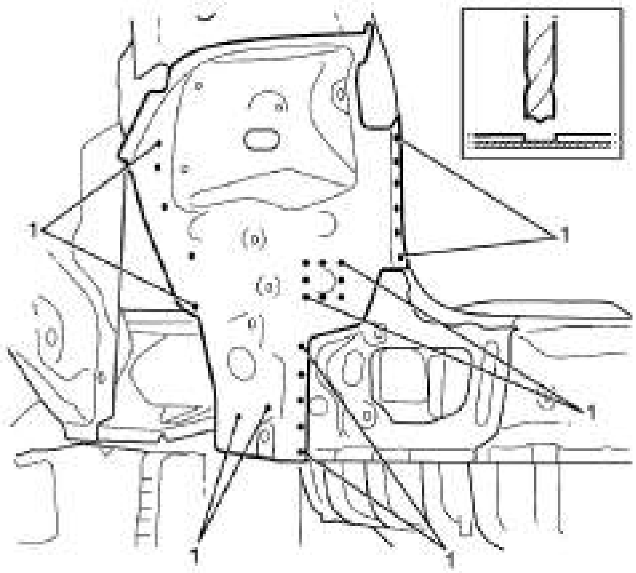
49. Cut along the cut line (1) on the body side outer panel with a suitable cutting tool.
50. Cut along the cut line (2) on the body side outer panel with a suitable cutting tool.
51. Cut along the cut line (3) on the body side outer panel with a suitable cutting tool.
52. Remove the damaged quarter portion of the body side outer panel.



Important: Note the number and location of the factory welds for installation of the quarter panel repair section.

53. Locate, mark and drill out the welds (1) joining the rear door striker reinforcement bracket

to the body ring.



Important: This step is only required if the body tail lamp filler panel is also to be replaced.

Important: Note the number and location of the factory welds for installation of the rear quarter panel repair section.

54. Locate, mark and drill out the factory welds (1) joining the body tail lamp filler panel to the vehicle.
55. Remove the damaged tail lamp filler panel from the vehicle.

Installation Procedure

Important: Spot welding is the preferred method for attaching panels and should be used wherever possible. A puddle weld should be performed where your spot welder is unable to reach.

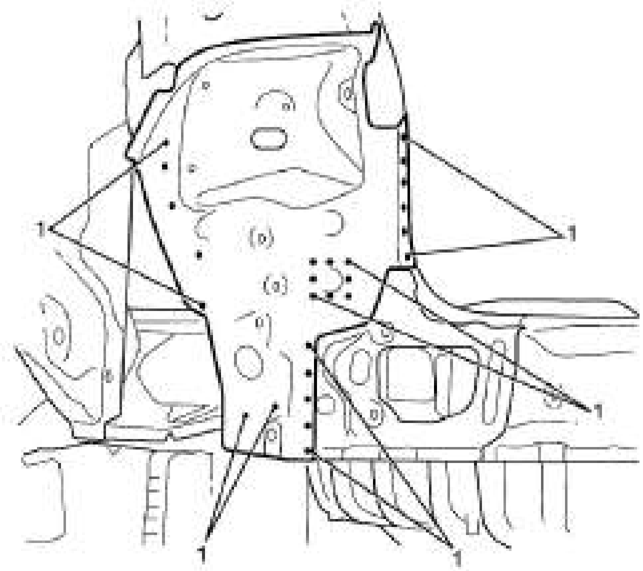
Important: Ensure that all factory welds are replaced in their original locations.

Important: Ensure that all structural adhesives and sealers are replaced in their original locations.

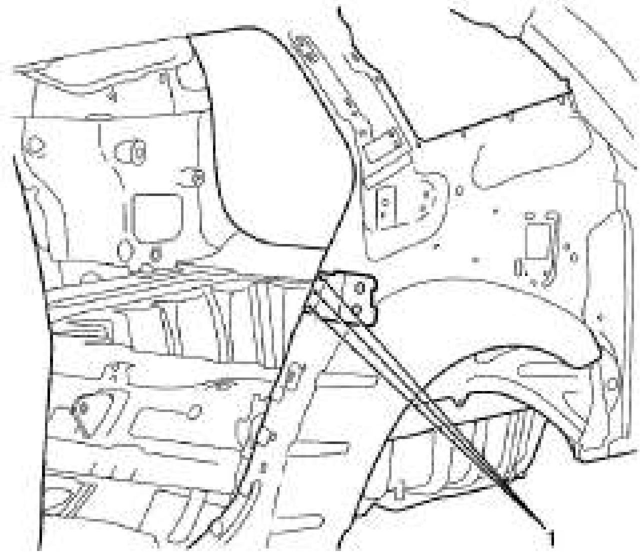
Important: If the location of the original spot weld holes can not be determined, or if structural weld-thru adhesive is present, space the puddle weld holes every 32 mm (1¼ in).

Important: This step is only required if the body tail lamp filler panel is also to be replaced.

1. Prepare all mating surfaces as necessary.
2. Drill 8 mm (5/16 in) puddle weld holes in the service part as necessary in the locations noted from the original panel.
3. Align the body tail lamp filler panel to the vehicle using three dimensional measuring equipment. Refer to Dimensions - Body



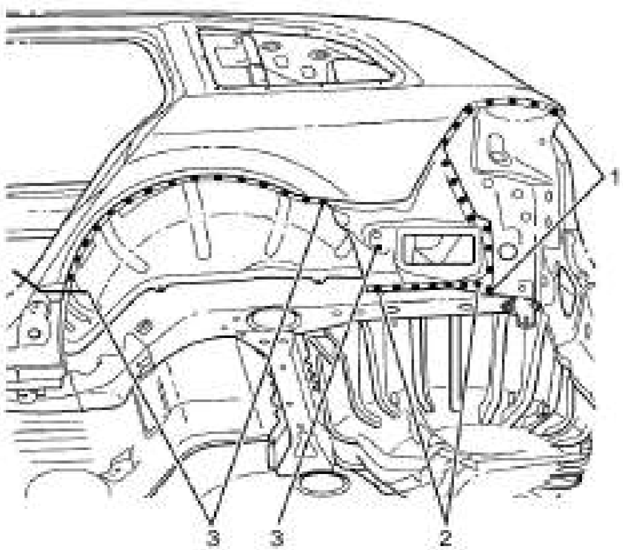
4. Weld the body tail lamp filler panel to the vehicle (1).
5. Drill 8 mm (5/16 in) puddle weld holes in the service part as necessary in the locations noted from the original panel.
6. Position and align the rear door striker reinforcement bracket to the vehicle using three dimensional measuring equipment. Refer to Dimensions - Body.



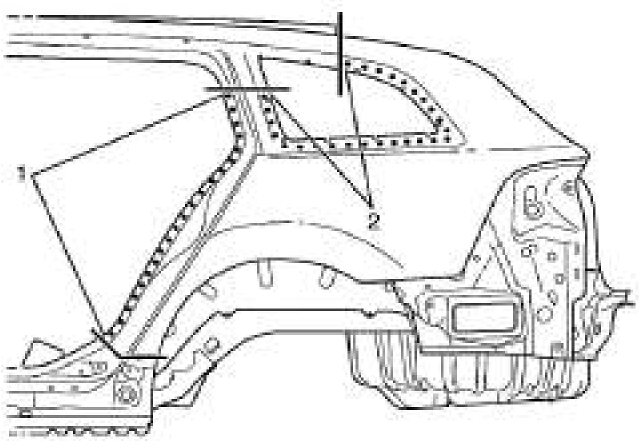
7. Weld the rear door reinforcement bracket (1) to the body ring.
8. Cut the new body side outer panel in corresponding locations to fit the remaining original body side outer panel. The sectioning joint should be trimmed to allow a gap of one-and-one-half-times the metal thickness at the sectioning joint.
9. Prepare all mating surfaces as necessary.

Important: If the location of the original plug weld holes can not be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 32 mm (1¼ in).

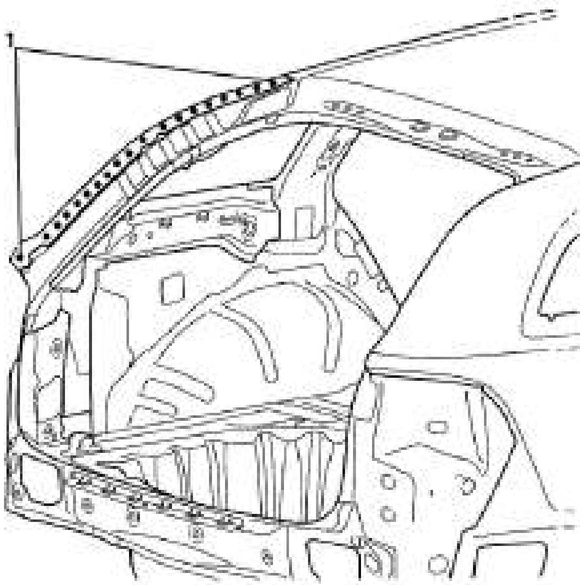
10. Drill 8 mm (5/16 in) puddle weld holes in the service part as necessary in the locations noted from the original panel.
11. Position and align the quarter panel repair section to the vehicle using three dimensional measuring equipment. Refer to Dimensions - Body.
12. Install the rear door striker into the bolt holes in the rear door striker reinforcement through the quarter panel repair section. Refer to Door Striker Replacement.



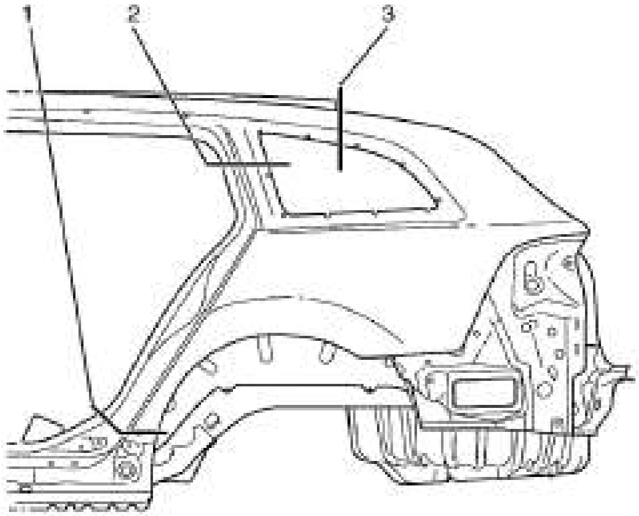
13. Weld (1) the quarter panel repair section to the body tail lamp filler panel.
14. Weld (2) the quarter panel repair section to the body side inner panel extension.
15. Weld the (3) the quarter panel repair section to the inner wheelhouse panel.



16. Weld (1) the quarter panel repair section to the body side ring outer panel.
17. Weld (2) the quarter panel repair section to the vehicle around the rear quarter window.

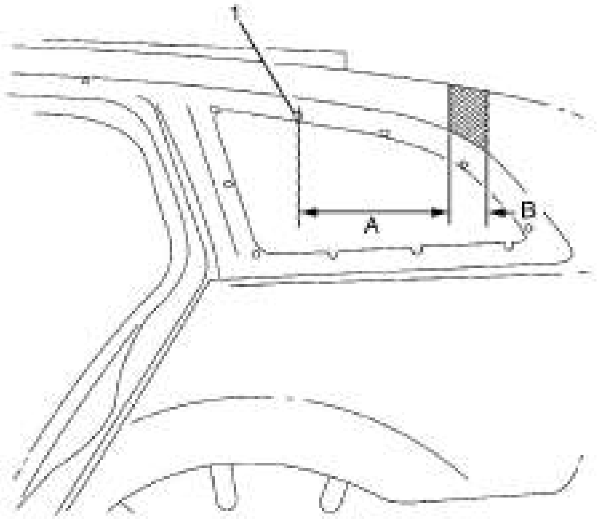


18. Weld (1) the quarter panel repair section to the rear gutter rail.

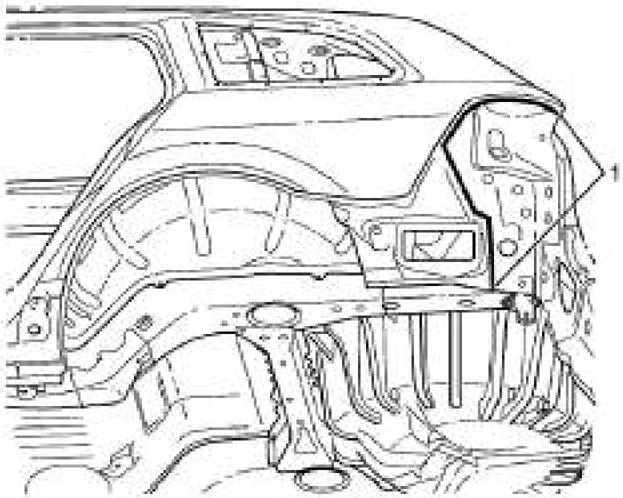


Important: To create a solid weld with minimum heat distortion, make 25 mm (1 in) stitch welds along the seam with 25 mm (1 in) gaps between them.

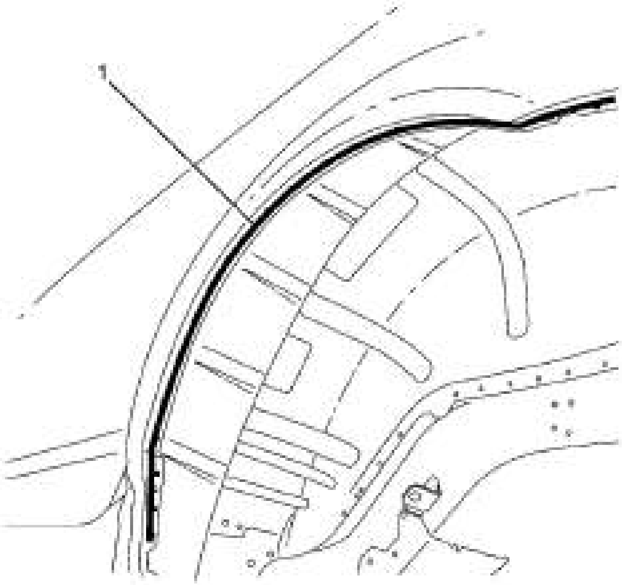
19. Stitch weld the quarter panel repair section to the body side outer panel at the three sectioning locations (1), (2) and (3).
20. Clean and prepare all of the welded surfaces.
21. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair



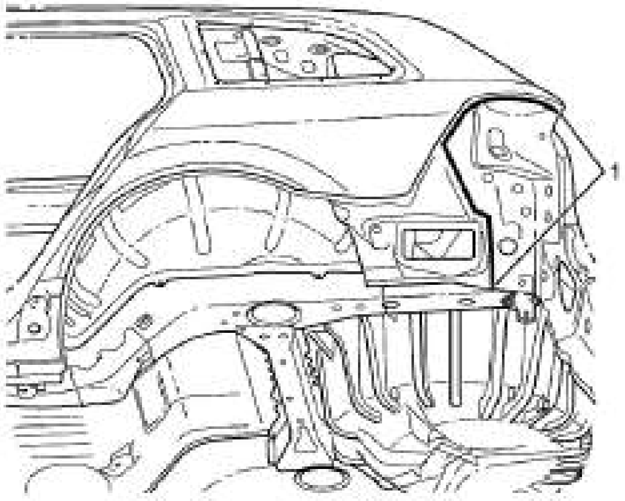
22. Apply expanding foam (GM9982296 or equivalent) to fill the space between the body side outer panel and the inner panels as shown by the shaded region in the illustration. The expanding foam is required for noise reduction. Dimension A=272 mm (10.7 in); Dimension B= 80mm (3.1 in); Measure rearward from datum point 1.



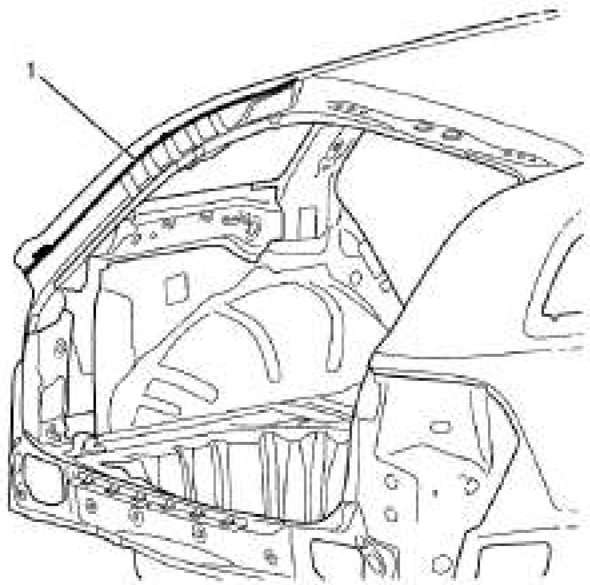
23. Apply the primary sealer (1) GM6449G or equivalent along the quarter panel to the tail lamp filler panel and side extension panel.



24. Apply the primary sealer (1) GM6449G or equivalent along the rear quarter panel to the rear wheel arch.

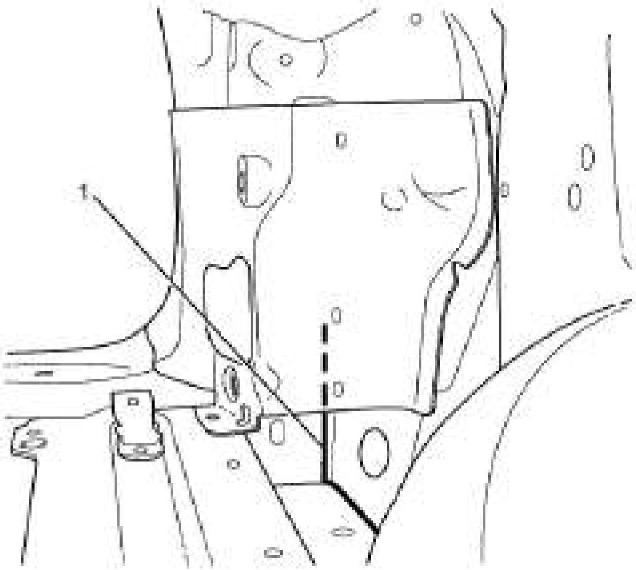


25. Apply the secondary sealer (1) GM specification 9984532 or equivalent along rear quarter panel to the tail lamp filler panel and side extension panel.



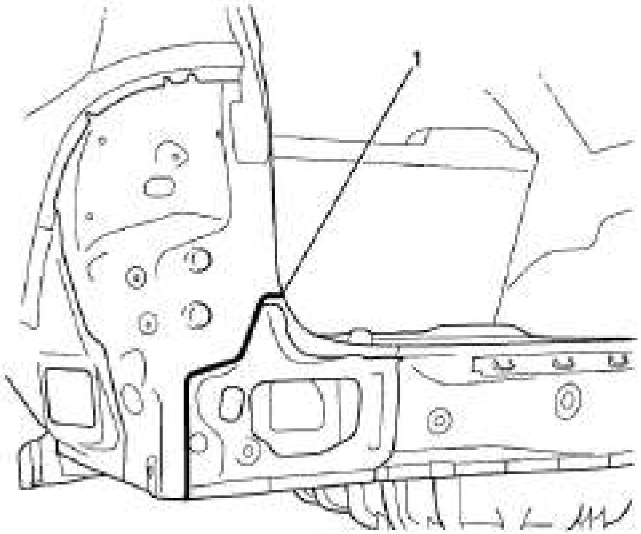
26. Apply the secondary sealer (1) GM specification 9984532 or equivalent along the rear quarter panel to the body side ring outer panel.

Important: This step is only required if the body tail lamp filler panel is also to be replaced.



27. Apply secondary sealer to the edge of the body tail lamp filler panel (1).

Important: This step is only required if the body tail lamp filler panel is also to be replaced.



28. Apply secondary sealer to the edge of the body tail lamp filler panel (1).
29. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
30. Install the tail lights. Refer to Parking and Turn Signal Lamp Replacement.

Important: This step is unique to the sunroof module.

31. Install the rear roof drain tubes. Refer to Sunroof Housing Rear Drain Hose Replacement.
32. Install the rear windshield. Refer to Rear Window Replacement.
33. Install the roof moulding. Refer to Body Side Roof Drip Molding Replacement.
34. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
35. Install the fuel lines. Refer to Filler Tube Replacement or Filler Tube Replacement.
36. Install the fuel tank. Refer to Fuel Tank Replacement or Fuel Tank Replacement.
37. Install the rear brake lines. Refer to Brake Pipe Replacement.
38. Install the rear frame. Refer to Rear Frame Replacement.
39. Install the rear exhaust muffler heat shields. Refer to Exhaust Muffler Heat Shield Replacement - Left Side and Exhaust Muffler Heat Shield Replacement - Right Side.
40. Install the rear exhaust assembly. Refer to Exhaust Muffler Replacement - Left Side and Exhaust Muffler Replacement - Right Side.
41. Install the rear wheel house liners. Refer to Rear Inner Wheelhouse Replacement in Body Rear End.
42. Install the rocker panel moulds. Refer to Rocker Panel Molding Replacement.
43. Install the rear pressure relief valves. Refer to Pressure Relief Valve Replacement in Body Rear End.
44. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
45. Install the rear wheels. Refer to Tire and Wheel Removal and Installation.
46. Lower the vehicle.
47. Install the deck lid release cable. Refer to Rear Compartment Lid Latch Release Cable Replacement.
48. Install the rear parcel shelf. Refer to Rear Window Shelf Trim Panel Replacement.
49. Install the rear seats. Refer to Rear Seat Cushion Cover and Pad Replacement.
50. Install the rear seat back. Refer to Rear Seat Back Replacement.
51. Install the headliner. Refer to Headlining Trim Panel Replacement.
52. Install the rear interior trims. Refer to Quarter Upper Trim Panel Replacement.
53. Install the rear door seals. Refer to Rear Door Opening Weatherstrip Replacement.

54. Install the liftgate. Refer to Liftgate Replacement.
55. Install the liftgate weatherstrip. Refer to Liftgate Weatherstrip Replacement.
56. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
57. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
58. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
59. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
60. Install the battery tray. Refer to Battery Tray Replacement.
61. Install the battery. Refer to Battery Replacement.

    Caution: Refer to Battery Disconnect Caution in the Preface section.

62. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
63. Enable the SIR system. Refer to SIR Disabling and Enabling.
64. If re-programming is required. Refer to Control Module References.

Rear Rail Replacement (SWB)

Removal Procedure

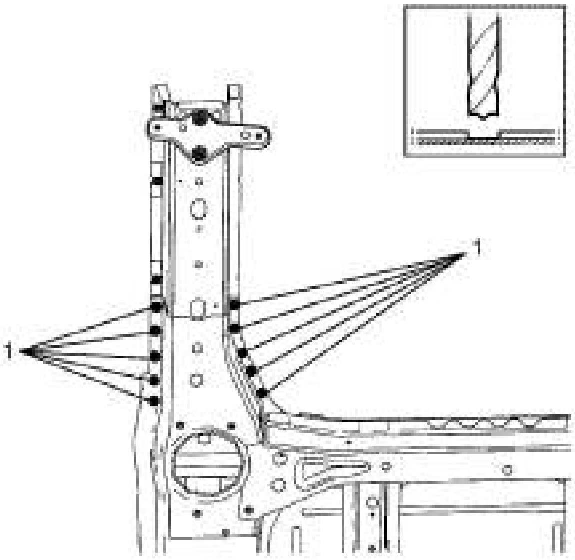
Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Important: This procedure should be used if the damage is rearward of the factory joint in the rail assembly.

1. Disable the SIR system. Refer to SIR Disabling and Enabling in SIR.
2. Remove the rear compartment floor carpet. Refer to Rear Compartment Floor Panel Carpet Replacement in Interior Trim
3. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
4. Remove the battery. Refer to Battery Replacement .
5. Remove the battery tray. Refer to Battery Tray Replacement .
6. Remove the spare wheel carrier. Refer to Spare Wheel Carrier Replacement .
7. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
8. Remove the rear wheels. Refer to Tire and Wheel Removal and Installation .
9. Remove the rear wheel liners. Refer to Rear Inner Wheelhouse Replacement in Body Rear End.
10. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement .
11. Remove the rear muffler assembly. Refer to Exhaust Muffler Replacement - Left Side and Exhaust Muffler Replacement - Right Side .
12. Remove the rear muffler heat shields. Refer to Exhaust Muffler Heat Shield Replacement - Left Side and Exhaust Muffler Heat Shield Replacement - Right Side .
13. Remove the rear muffler hanger bracket. Refer to Exhaust Hanger Mounting Bracket Replacement .
14. Remove the rear frame. Refer to Rear Frame Replacement .
15. Remove and note the location of any sound deadening materials.
16. Remove and note the location of the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair .
17. Remove the rear end panel. Refer to Rear End Panel Replacement .
18. Remove the side extension panel assembly. Refer to Body Side Inner Panel Extension Replacement .
19. Repair as much of the damage as possible.



Important: Do not damage any inner panels or reinforcements.

Important: Note the number and location of welds for installation of the service assembly.

20. Locate, mark and drill out all factory welds (1).
21. Remove the damaged rail section from the vehicle.

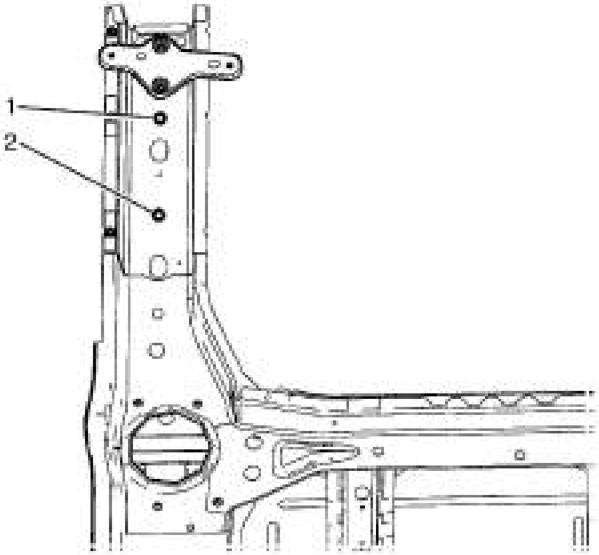
Installation Procedure

Important: This part has structural weld-thru adhesive in the joint areas. Replace this with additional spot welds at the attachment points. This can be accomplished by adding an additional weld between each factory weld in all areas.

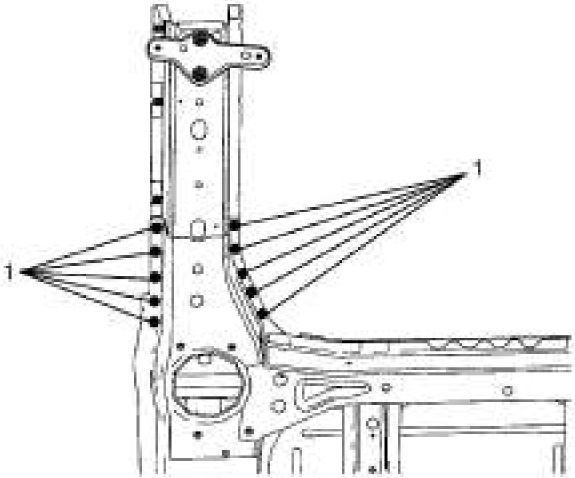
Important: If the location of the original spot weld holes can not be determined, or if structural weld-thru adhesive is present, space the puddle weld holes every 32 mm (1¼ in).

Important: Spot welding is the preferred method for attaching panels and should be used wherever possible. A puddle weld should be performed where your spot welder is unable to reach.

1. Drill 8 mm (5/16 in) puddle weld holes in the service part, as necessary, in the locations puddle welding is needed.
2. Prepare the mating surfaces, as necessary.
3. Apply structural adhesive GM6449G or equivalent to all mating surfaces.



4. Align the rear rail extension using the datum points (1) and (2) to the vehicle.



5. Weld (1) the rear rail extension to the vehicle.
6. Clean and prepare all welded surfaces.
7. Install the rear end panel. Refer to Rear End Panel Replacement .
8. Install the side extension panel assembly. Refer to Body Side Inner Panel Extension Replacement .
9. Apply the sealers, and anti-corrosion materials to the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair .
10. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems .
11. Install the rear frame. Refer to Rear Frame Replacement .
12. Install the rear muffler hanger bracket. Refer to Exhaust Hanger Mounting Bracket Replacement .
13. Install the rear muffler heat shields. Refer to Exhaust Muffler Heat Shield Replacement - Left Side or Exhaust Muffler Heat Shield Replacement - Right Side .

14. Install the rear muffler assembly. Refer to Exhaust Muffler Replacement - Left Side or Exhaust Muffler Replacement - Right Side .
15. Install the rear bumper fiasco. Refer to Rear Bumper Fascia Replacement .
16. Install the rear wheel liners. Refer to Rear Inner Wheelhouse Replacement in Body Rear End.
17. Install the spare wheel carrier. Refer to Spare Wheel Carrier Replacement .
18. Install the rear wheels. Refer to Tire and Wheel Removal and Installation .
19. Lower the vehicle.
20. Install the battery tray. Refer to Battery Tray Replacement .
21. Install the battery. Refer to Battery Replacement .
22. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
23. Install the rear compartment floor carpet. Refer to Rear Compartment Floor Panel Carpet Replacement in Interior Trim.
24. Enable the SIR system. Refer to SIR Disabling and Enabling in SIR.
25. If re-programming is required. Refer to Control Module References .

Rear Rail Replacement (Sportwagon)

Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

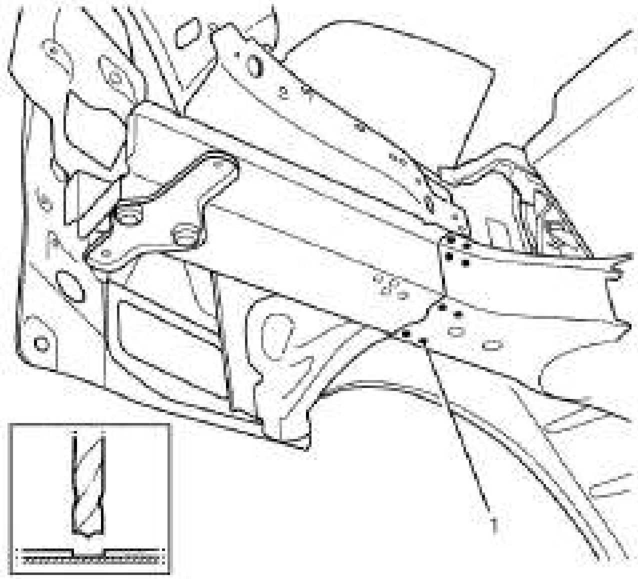
Important: This procedure should be used if the damage is rearward of the factory joint in the rail assembly.

1. Disable the SIR system. Refer to SIR Disabling and Enabling.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
4. Remove the rear bumper impact bar. Refer to Rear Bumper Impact Bar Replacement.
5. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
6. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
7. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
8. Remove the liftgate weatherstrip. Refer to Liftgate Weatherstrip Replacement.
9. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
10. Remove the battery. Refer to Battery Replacement.
11. Remove the battery tray. Refer to Battery Tray Replacement.
12. Remove the pressure relief valve. Refer to Pressure Relief Valve Replacement.
13. Remove the tail lights. Refer to Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn Signal Bulb Replacement.
14. Remove the liftgate. Refer to Liftgate Replacement.
15. Remove the rear muffler assembly. Refer to Exhaust Muffler Replacement - Left Side or Exhaust Muffler Replacement - Right Side.
16. Remove the rear muffler heat shields. Refer to Exhaust Muffler Heat Shield Replacement - Left Side or Exhaust Muffler Heat Shield Replacement - Right Side.
17. Remove the rear bumper bracket. Refer to Rear Bumper Bracket Replacement.
18. Remove the rear muffler hanger bracket. Refer to Exhaust Hanger Mounting Bracket Replacement.
19. Remove the rear frame. Refer to Rear Frame Replacement.
20. Remove and note the location of any sound deadening materials.
21. Remove the spare wheel and emergency kit from the rear compartment.
22. Remove the spare wheel carrier. Refer to Spare Wheel Carrier Replacement.
23. Remove and note the location of the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.
24. Remove the body side inner panel extension assembly. Refer to Body Side Inner Panel Extension Replacement.
25. Remove the rear end panel. Refer to Rear End Panel Replacement.

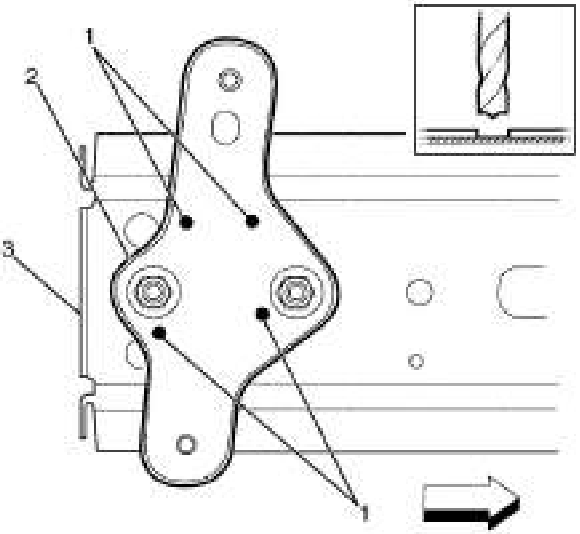
26. Repair as much of the damage as possible.



Important: Do not damage any inner panels or reinforcements.

Important: Note the number and location of welds for installation of the service assembly.

27. Locate, mark and drill out all factory welds (1) attaching the rear rail to the underbody.
28. Remove the damaged rail section from the vehicle.



Important: The following step is only required if the old exhaust bracket is undamaged and is to be re-used with the new rear rail.

29. Locate, mark and drill out the factory welds (1) attaching the exhaust hanger mounting

bracket (2) to the rear rail (3). Left hand rail shown, right hand is mirror image.

Installation Procedure

Important: This part has structural weld-thru adhesive in the joint areas. Replace this with additional spot welds at the attachment points. This can be accomplished by adding an additional weld between each factory weld in all areas.

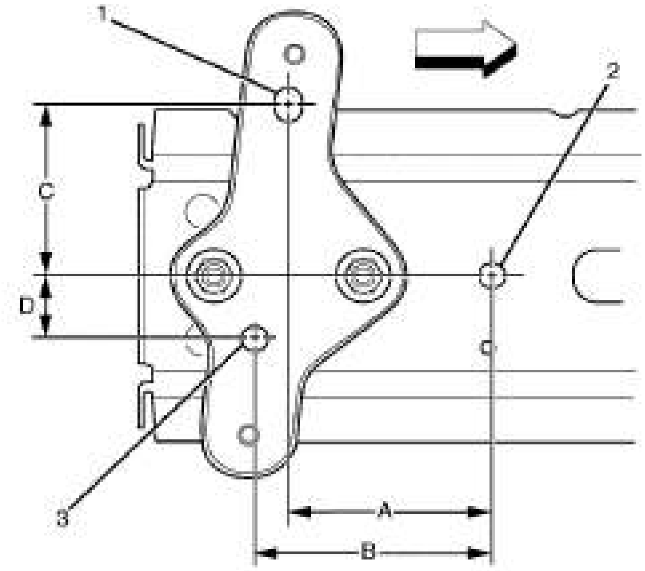
Important: If the location of the original spot weld holes can not be determined, or if structural weld-thru adhesive is present, space the puddle weld holes every 32 mm (1¼ in).

Important: Ensure that all factory welds are replaced in their original locations.

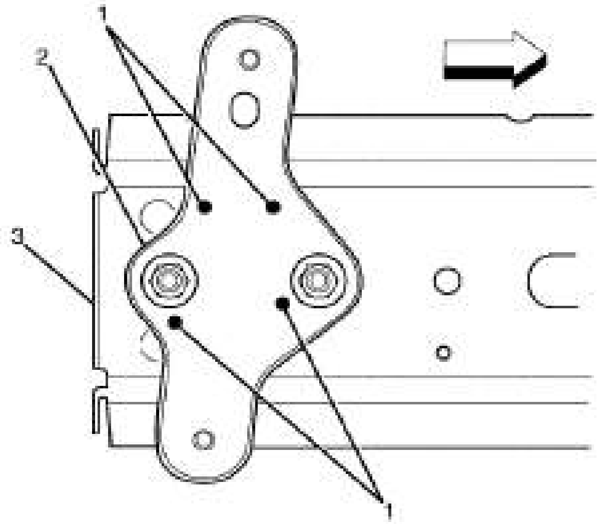
Important: Ensure that all structural adhesives and sealers are replaced in their original locations.

Important: Spot welding is the preferred method for attaching panels and should be used wherever possible. A puddle weld should be performed where your spot welder is unable to reach.

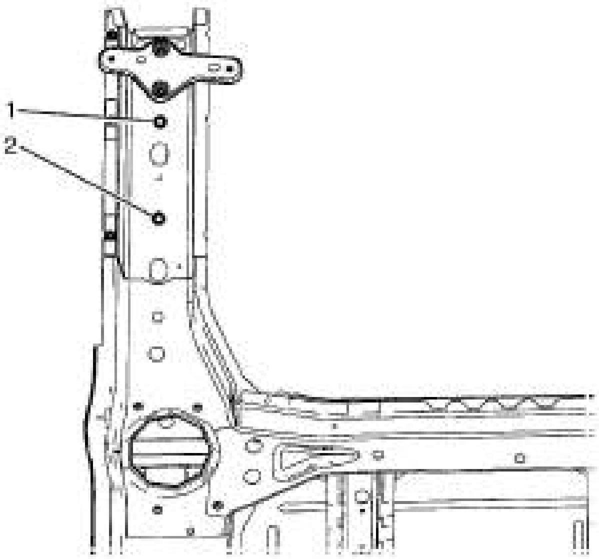
1. Drill 8 mm (5/16 in) puddle weld holes in the service part, as necessary, in the locations puddle welding is needed.
2. Prepare the mating surfaces, as necessary.



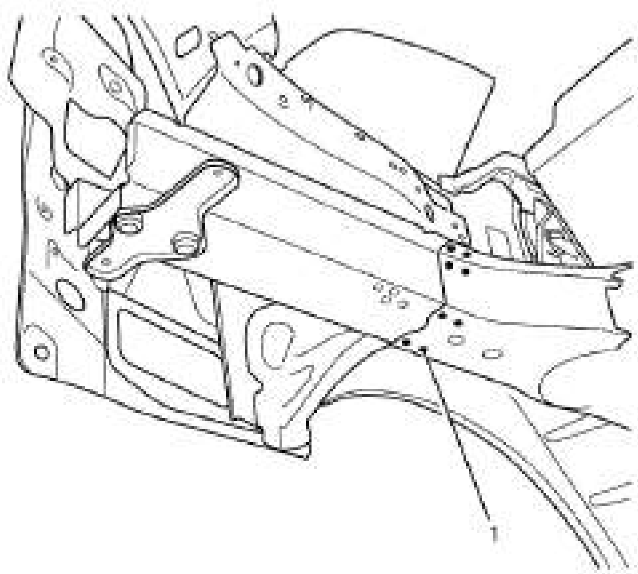
3. Align the exhaust hanger bracket to the new rear rail (left hand rail shown, right hand is mirror image). Dimensions are as follows: A = 95 mm; B = 111 mm; C = 79 mm; D = 30 mm. Datum hole identification as follows: 1 = 13.1x17.5mm; 2 = 13.1mm dia; 3 = 13.1mm dia.
4. Apply structural adhesive GM6449G or equivalent to all mating surfaces.



5. Weld (1) the exhaust hanger mounting bracket (2) to the rear rail (3).



6. Align the new rear rail to the vehicle using the datum points (1) and (2). Datum points (1) and (2) are 13.1mm dia holes. Refer to Dimensions - Body.



7. Weld (1) the rear rail to the underbody.
8. Clean and prepare all welded surfaces.
9. Install the rear end panel. Refer to Rear End Panel Replacement.
10. Install the body side inner panel extension. Refer to Body Side Inner Panel Extension Replacement.
11. Apply sealers and anti-corrosion materials to the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.
12. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
13. Install the spare wheel carrier. Refer to Spare Wheel Carrier Replacement.
14. Install the spare wheel and emergency kit to the rear compartment.
15. Install the sound deadening materials to the locations recorded on removal.
16. Install the rear frame. Refer to Rear Frame Replacement.
17. Install the rear muffler hanger bracket. Refer to Exhaust Hanger Mounting Bracket Replacement.
18. Install the rear bumper bracket. Refer to Rear Bumper Bracket Replacement.
19. Install the rear muffler heat shields. Refer to Exhaust Muffler Heat Shield Replacement - Right Side or Exhaust Muffler Heat Shield Replacement - Left Side.
20. Install the rear muffler assembly. Refer to Exhaust Muffler Replacement - Left Side or Exhaust Muffler Replacement - Right Side.
21. Install the liftgate. Refer to Liftgate Replacement.
22. Install the tail lights. Refer to Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn Signal Bulb Replacement.
23. Install the pressure relief valve. Refer to Pressure Relief Valve Replacement.
24. Install the battery tray. Refer to Battery Tray Replacement.
25. Install the battery. Refer to Battery Replacement.
26. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
27. Install the liftgate weatherstrip. Refer to Liftgate Weatherstrip Replacement.
28. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
29. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
30. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
31. Install the rear bumper impact bar. Refer to Rear Bumper Impact Bar Replacement.
32. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.

33. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
34. Enable the SIR system. Refer to SIR Disabling and Enabling.

Rear End Panel Replacement (SWB)

Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

Important: This panel is replaced at factory seams.

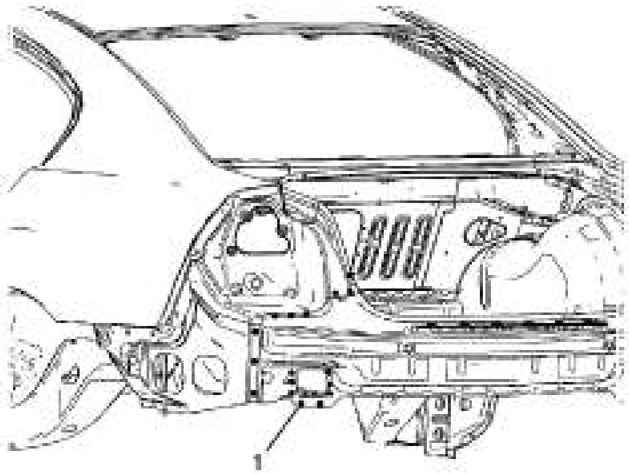
Caution: Sectioning should be performed only in the recommended areas. Failure to do so may compromise the structural integrity of the vehicle and cause personal injury if the vehicle is in a collision.

1. Disable the SIR system. Refer to SIR Disabling and Enabling .

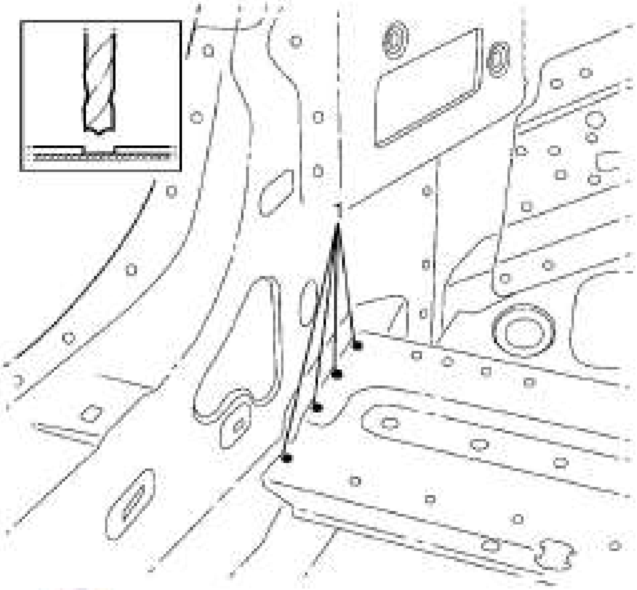
   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement .
4. Remove the rear impact bar. Refer to Rear Bumper Impact Bar Replacement .
5. Remove the rear impact bar bracket. Refer to Rear Bumper Bracket Replacement .
6. Remove the tail lights. Refer to Parking and Turn Signal Lamp Replacement .
7. Remove the spare wheel and emergency kit from the rear compartment.
8. Remove the rear lock striker. Refer to Rear Compartment Lid Latch Striker Replacement in Body Rear End.
9. Remove the spare wheel and tyre carrier. Refer to Spare Wheel Carrier Replacement .
10. Repair as much of the damage as possible.
11. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair .

    Important: Note the number and location of the factory welds for installation of the rear end panel.



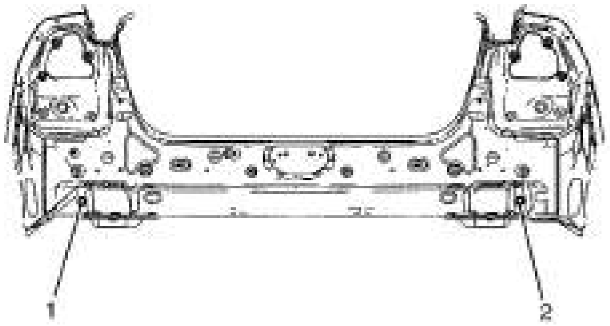
12. Locate, mark and drill out the spot welds in the rear end panel assembly to the tail lamp filler panel. Repeat for opposite side.
13. Locate, mark and drill out the spot welds in the rear end panel assembly to the rear chassis rail. Repeat for opposite side.



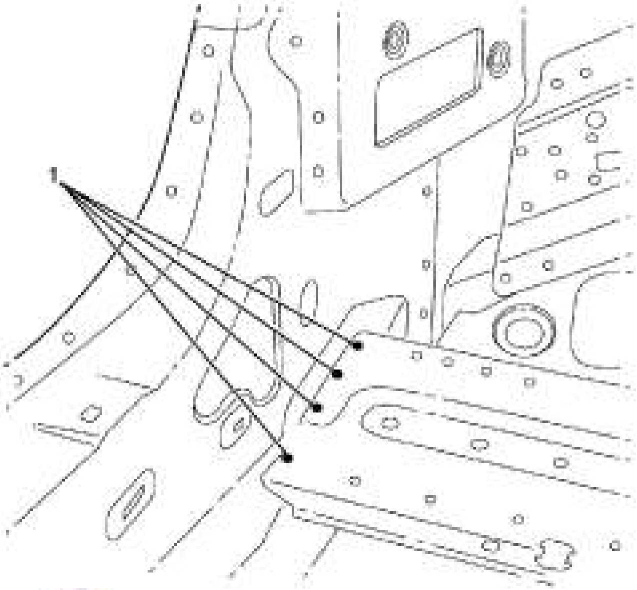
14. Locate, mark and drill out the spot welds (1) of the rear end panel assembly to the side extension. Repeat for opposite side.
15. Remove the rear end panel.

Installation Procedure

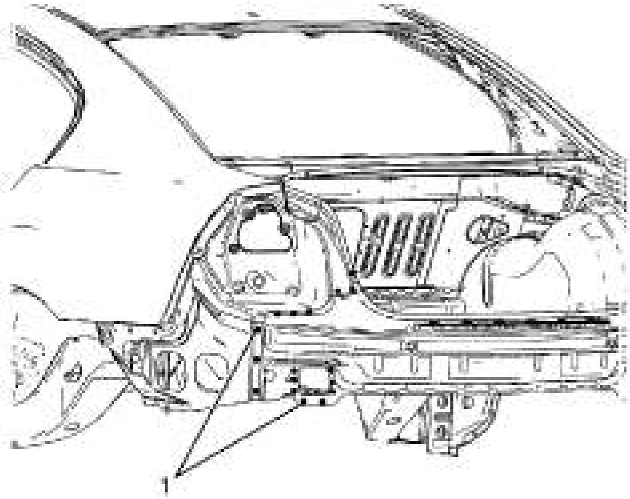
1. Prepare all mating surfaces as necessary.



2. Align the rear end panel assembly using the datum points (1) and (2) to the vehicle.



3. Weld (1) the rear end panel assembly to the side extension. Repeat for opposite side.



4. Weld (1) the rear end panel assembly to the rear chassis rail. Repeat for opposite side.
5. Weld the rear end panel assembly to the tail lamp filler panel. Repeat for opposite side.
6. Clean and prepare all of the welded surfaces.
7. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair .
8. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems .
9. Install the spare wheel and tyre carrier. Refer to Spare Wheel Carrier Replacement .
10. Install the rear lock striker. Refer to Rear Compartment Lid Latch Striker Replacement in Body Rear End.
11. Install the tail lights. Refer to Parking and Turn Signal Lamp Replacement .
12. Install the rear impact bar. Refer to Rear Bumper Fascia Insert Replacement .
13. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement .
14. Install the spare wheel and emergency kit from the rear compartment.

Caution: Refer to Battery Disconnect Caution in the Preface section.

15. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
16. Enable the SIR system. Refer to SIR Disabling and Enabling in SIR.
17. If re-programming is required. Refer to Control Module References .

Rear End Panel Replacement (Sportwagon)

Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

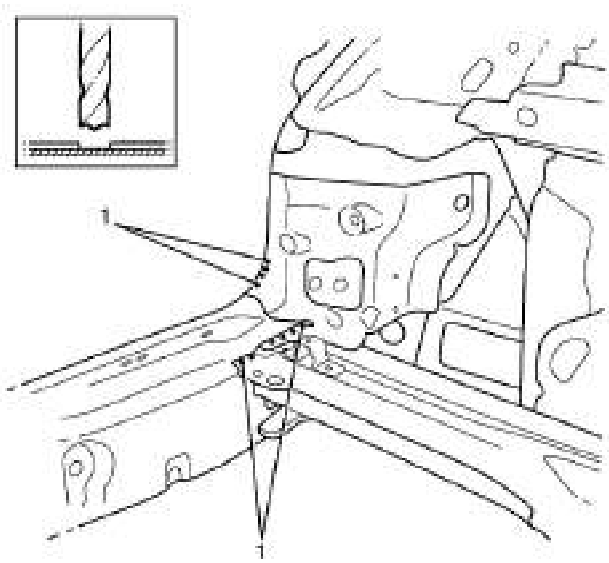
1. Disable the SIR system. Refer to SIR Disabling and Enabling.

Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
4. Remove the rear bumper impact bar. Refer to Rear Bumper Impact Bar Replacement.
5. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
6. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
7. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
8. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
9. Remove the liftgate latch striker. Refer to Liftgate Latch Striker Replacement.
10. Remove the rear bumper impact bar bracket. Refer to Rear Bumper Bracket Replacement.
11. Remove the liftgate weatherstrip. Refer to Liftgate Weatherstrip Replacement.
12. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
13. Remove the battery. Refer to Battery Replacement.
14. Remove the battery tray. Refer to Battery Tray Replacement.
15. Remove the pressure relief valve. Refer to Pressure Relief Valve Replacement.
16. Remove the tail lights. Refer to Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn Signal Bulb Replacement.
17. Remove the liftgate. Refer to Liftgate Replacement.
18. Remove the spare wheel and emergency kit from the rear compartment.
19. Remove the spare wheel carrier. Refer to Spare Wheel Carrier Replacement.

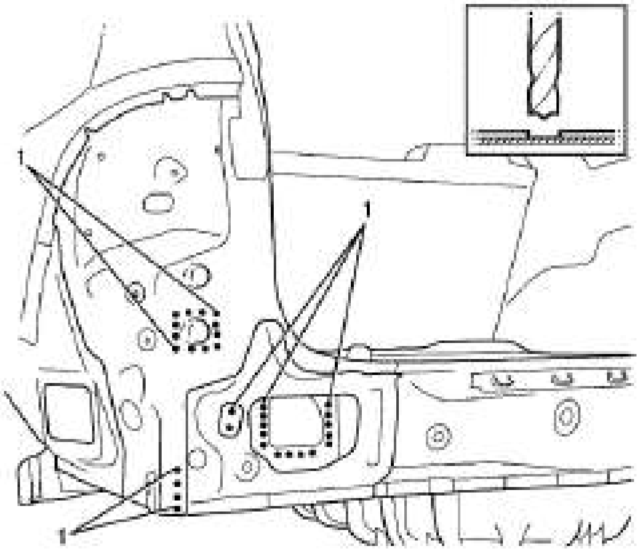
Important: Note the location of sealers and anti-corrosion materials for installation of the service assembly.

20. Remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.

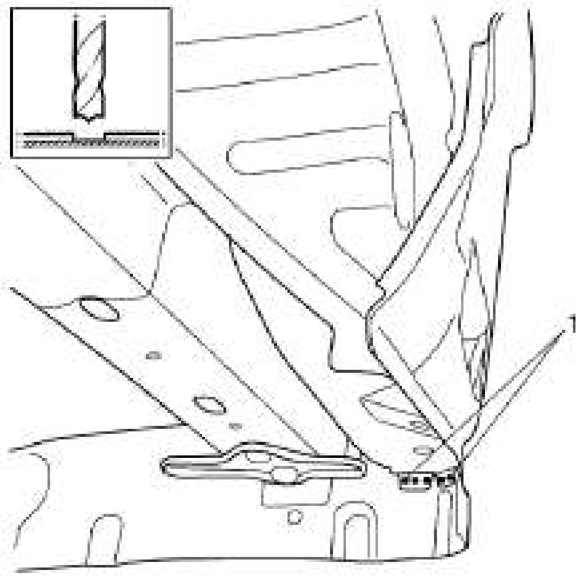


Important: Note the number and location of the factory welds for installation of the service assembly.

21. Locate, mark and drill out the factory welds attaching the rear end panel assembly to the back body pillar inner lower panel and rear compartment floor panel extension (1).
22. Repeat for the opposite side.



23. Locate, mark and drill out the factory welds attaching the rear end panel assembly to the body tail-lamp filler panel and rear compartment floor panel rail (1).
24. Repeat for the opposite side.



25. Locate, mark and drill out the factory welds attaching the rear end panel assembly to the rear compartment floor panel outer extension (1).
26. Repeat for the opposite side.
27. Remove the rear end panel assembly from the vehicle.

Installation Procedure

Important: Spot welding is the preferred method for attaching panels and should be used whenever possible. A plug weld should only be performed where spot welding is not possible.

Important: If the location of the original plug weld holes cannot be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 32 mm (1¼ in).

Important: Ensure that all factory welds are replaced in their original locations.

Important: Ensure that all structural adhesives and sealers are replaced in their original locations.

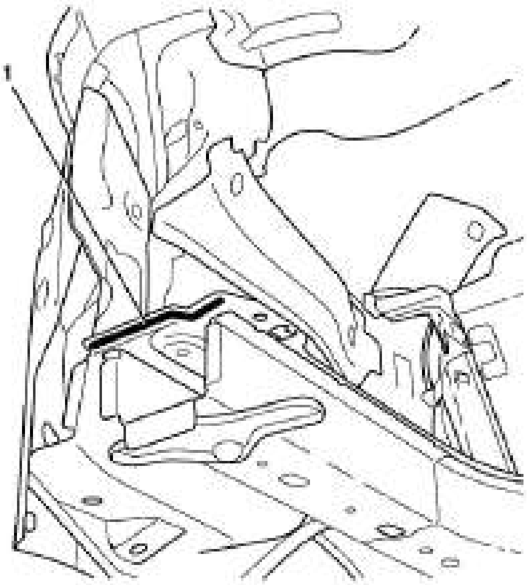
Important: Follow the adhesive manufacturer's instructions during the assembly process. Heat must be applied as per the manufacturer's specifications to cure the adhesives and to expand the sealing baffles.

Important: Secondary sealer must be applied to the perimeter of all flanges and over all joints.

1. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted when dissembling.

Important: Clean all adhesive mating surfaces in accordance with the adhesive manufacturer's specifications.

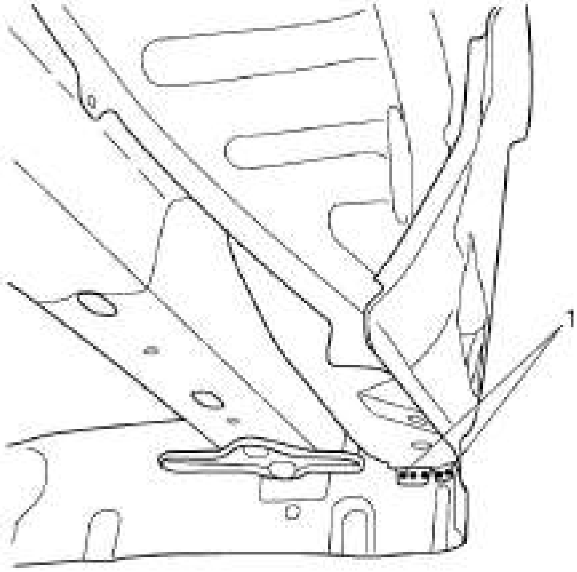
2. Clean and prepare the mating surfaces of the rear end panel assembly.
3. Repeat for the opposite side.



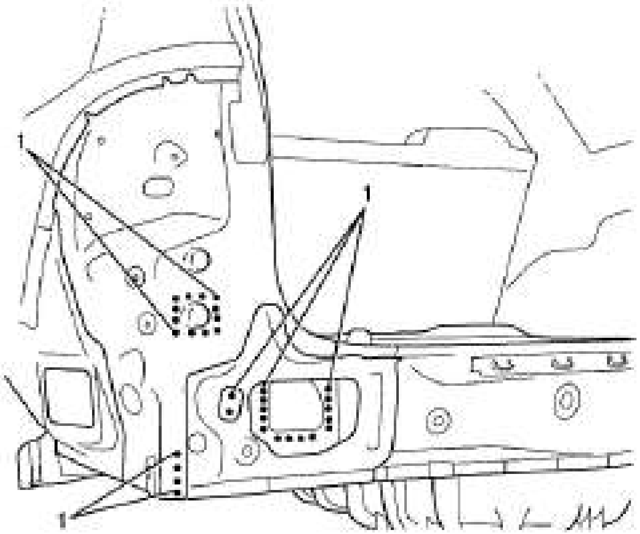
4. Apply the approved structural adhesive (1) GM6449G or equivalent along the outer edge of the rear compartment floor panel outer extension.

   Important: As the rear end panel assembly is installed to the vehicle, structural adhesive should be visible on the outside edges of both surfaces (squeezed out when pushed together).

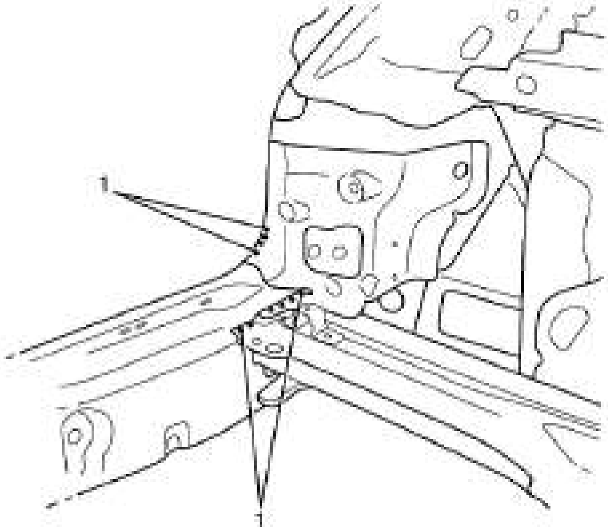
5. Install the rear end panel assembly to the vehicle.



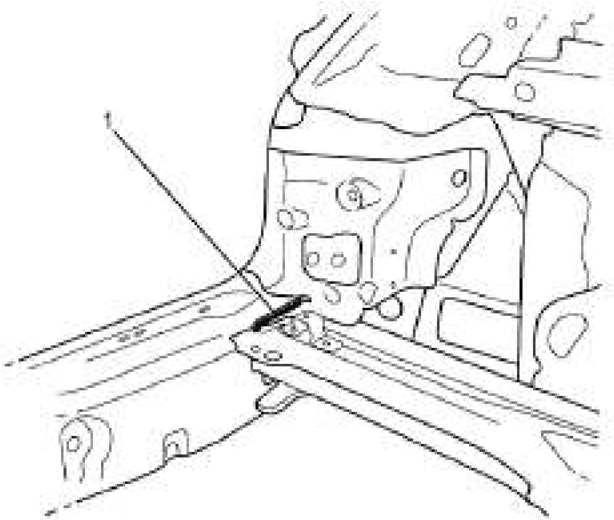
6. Weld the rear end panel assembly to the rear compartment floor panel outer extension (1).
7. Repeat for the opposite side.



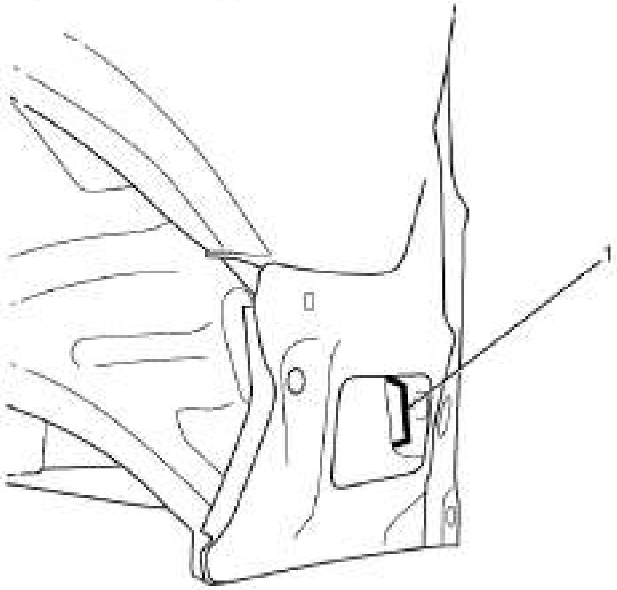
8. Weld the rear end panel assembly to the body tail-lamp filler panel and the rear compartment floor panel rail (1).
9. Repeat for the opposite side.



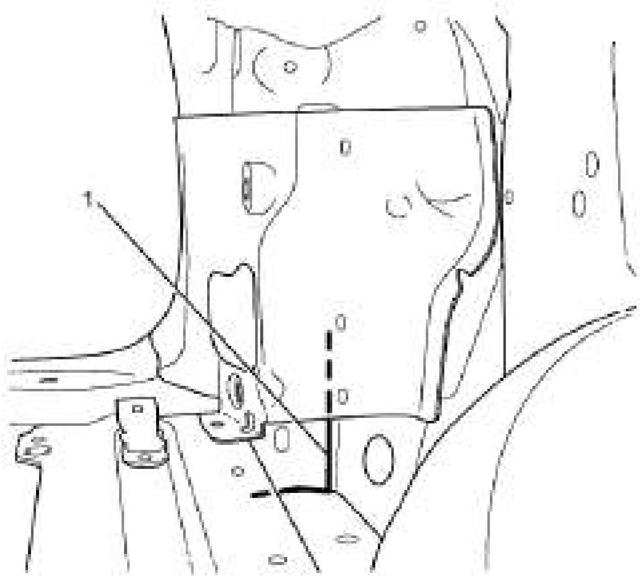
10. Weld the rear end panel assembly to the back body pillar inner lower panel and the rear compartment floor panel extension (1).
11. Repeat for the opposite side.



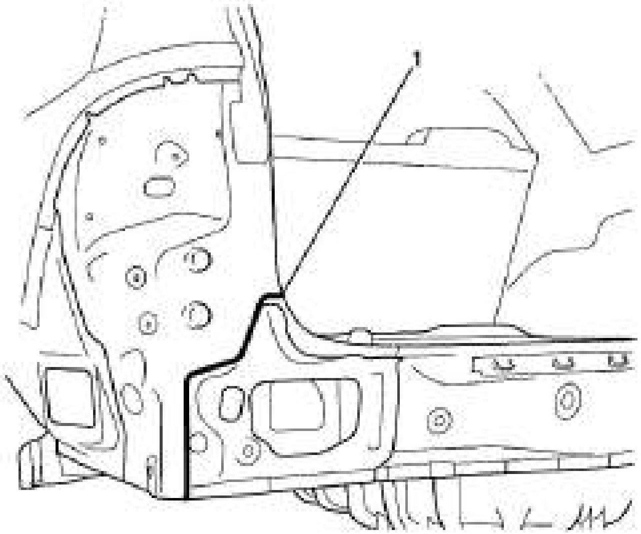
12. Apply secondary sealer (1) GM9984532 or equivalent along the rear edge of the rear compartment floor panel outer extension.
13. Repeat for the opposite side.



14. Apply secondary sealer (1) GM9984532 or equivalent to the rear compartment floor panel rail.
15. Repeat for the opposite side.



16. Apply secondary sealer (1) GM9984532 or equivalent to the body tail-lamp filler panel.
17. Repeat for the opposite side.



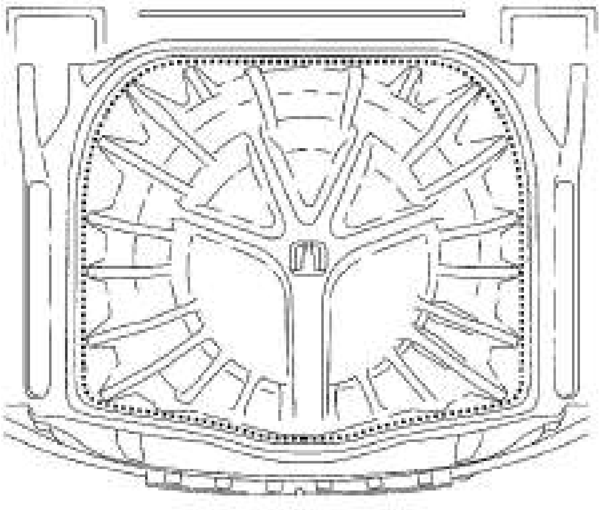
18. Apply secondary sealer (1) GM9984532 or equivalent to the body tail-lamp filler panel.
19. Repeat for the opposite side.
20. Apply anti-corrosion materials to the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.
21. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
22. Install the spare wheel carrier. Refer to Spare Wheel Carrier Replacement.
23. Install the spare wheel and emergency kit to the rear compartment.
24. Install the liftgate. Refer to Liftgate Replacement.
25. Install the tail lights. Refer to Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn Signal Bulb Replacement.
26. Install the pressure relief valve. Refer to Pressure Relief Valve Replacement.
27. Install the battery tray. Refer to Battery Tray Replacement.

28. Install the battery. Refer to Battery Replacement.
29. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
30. Install the liftgate weatherstrip. Refer to Liftgate Weatherstrip Replacement.
31. Install the rear bumper impact bar bracket. Refer to Rear Bumper Bracket Replacement.
32. Install the liftgate latch striker. Refer to Liftgate Latch Striker Replacement.
33. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
34. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
35. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
36. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
37. Install the rear bumper impact bar. Refer to Rear Bumper Impact Bar Replacement.
38. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
39. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
40. Enable the SIR system. Refer to SIR Disabling and Enabling.

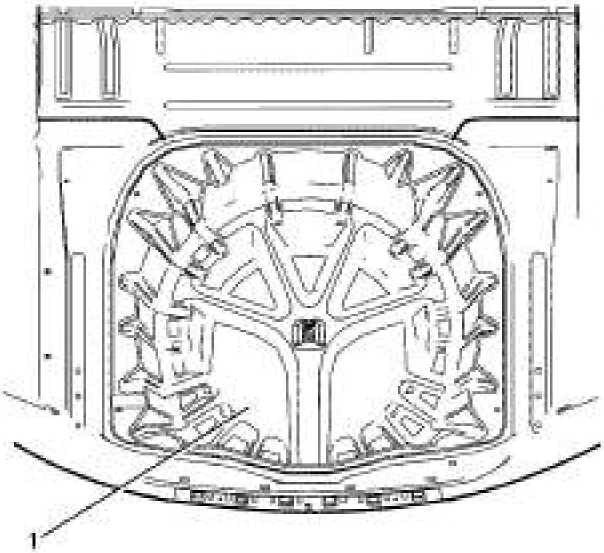
Spare Wheel Carrier Replacement (Sedan)

Removal Procedure

1. Remove the rear compartment floor carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
2. Remove the spare wheel and emergency kit from the rear compartment.
3. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.

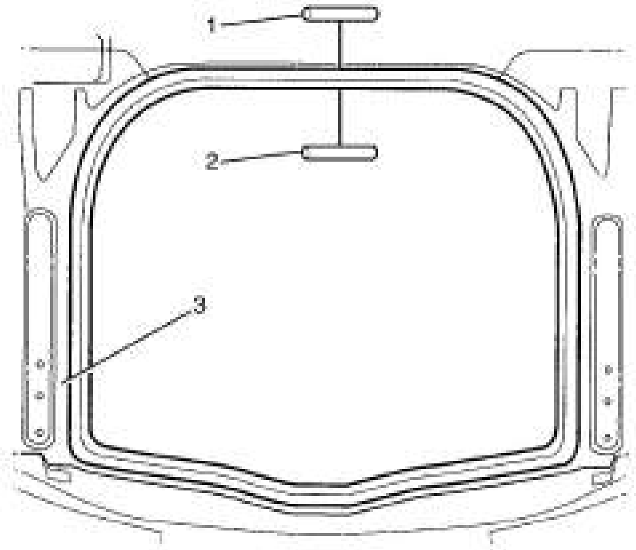


4. Cut along the spare wheel panel component as shown with a suitable air saw.



Important: The spare wheel well panel is a single use item. The spare wheel well panel must be discarded after use.

5. Remove the cut section of the spare wheel well panel component (1) from the vehicle.



Important: Use a suitable tool to install the piano wire from J-36020 (2) through the urethane at the corner of the spare wheel well compartment (1).

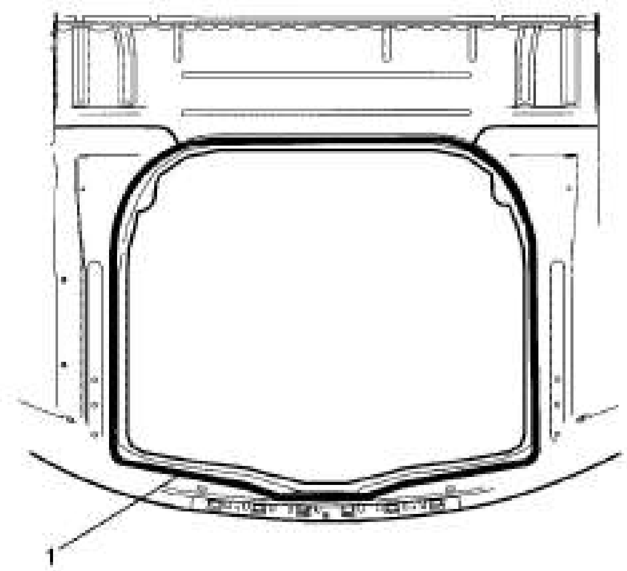
6. Install J-36020 (2) to the vehicle.
7. Connect the end of the piano wire to the other handle of the J-36020 (2).

Important: Keep the outside handle of J-36020 (1) against the rear compartment extension floor panel (3) and cycle the full length of the piano wire to prevent heat build up.

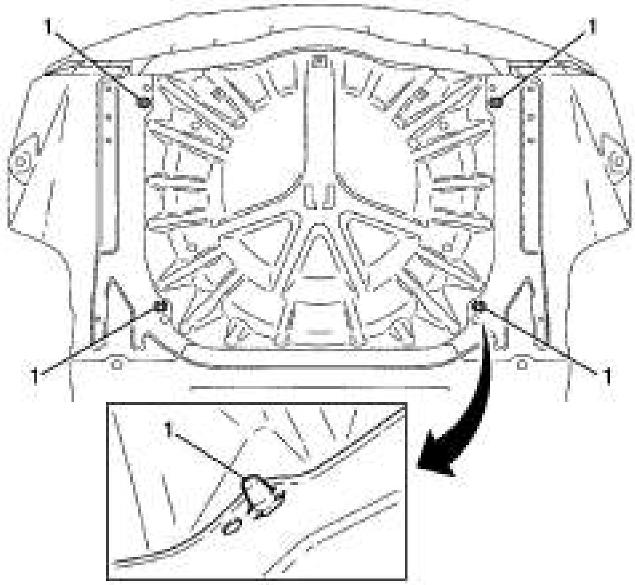
8. Cut through the urethane bead around the spare wheel well compartment (4) to the rear compartment extension floor panel (3) with the aid of an assistant.

   Discard the remaining section of the spare wheel well panel.

Installation Procedure



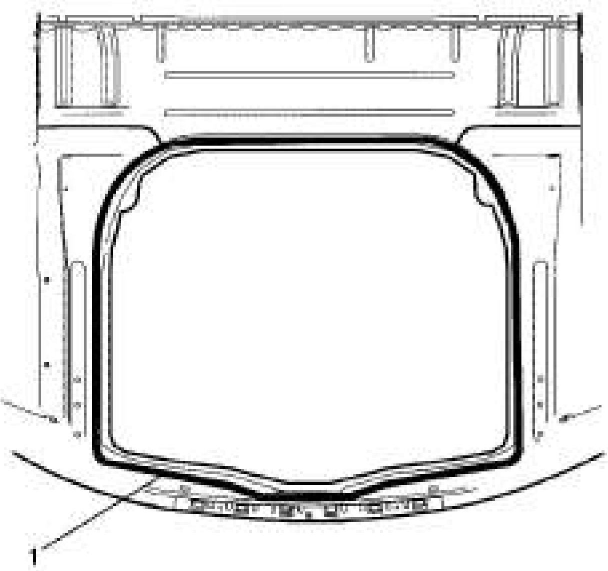
1. Clean the rear compartment panels of all adhesive (1) using a suitable cleaning solution.



Important: The Adhesive flange on the spare wheel well panel must not be handled with bare hands. This could lead to contamination of the primer on the spare wheel well panel flange.

Important: Make sure that the spare wheel well panel datum pins (1) are properly located in the rear compartment panels.

2. Test fit the spare wheel well panel to the rear compartment panels to identify any gaps around the rear compartment panels.

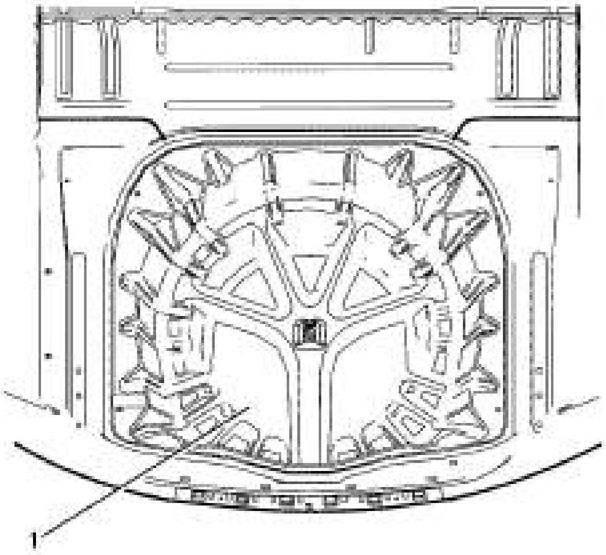


Important: Make sure that the rear compartment panels and the spare wheel well panel are free of any contaminants

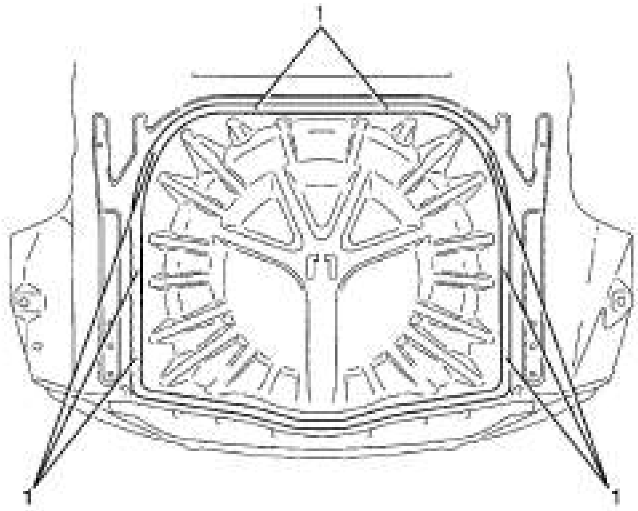
3. Apply a bead of urethane GMW3041 or equivalent approximately 10 millimetres in diameter to the rear compartment panels (1).

   Important: The adhesive begins to bond after 30 minutes, during this time fitment of the spare wheel well panel must be fitted to the rear compartment panels

4. If any gaps were identified in the test fitment, apply extra adhesive to the area.



5. Carefully install the NEW spare wheel well panel (1) to the vehicle to avoid smearing of the urethane.



6. Apply one kilogram weights (1) to the edges of the spare wheel well panel to aid in adhesion to the rear compartment panels

   Important: Allow adhesive to cure for 8 hours before fitting any other components to the spare wheel well panel.

   Important: Do NOT drive the vehicle for 24 hours after fitting the spare wheel well panel to allow the adhesive to fully cure.

7. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
8. Install the spare wheel and emergency kit to the rear compartment.
9. Install the rear compartment floor carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.

Spare Wheel Carrier Replacement (Sportwagon)

Tools Required

J-36020 Stationary Glass Removal Tool.

Removal Procedure

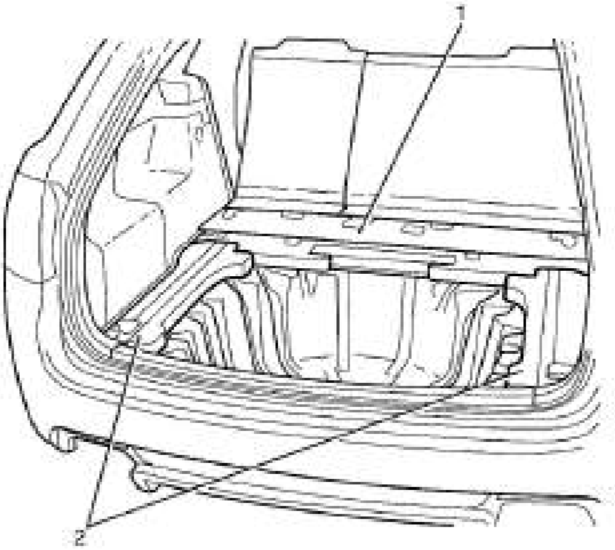
Caution: In order to reduce the risk of personal injury when exposed to toxic fumes while grinding, cutting, or applying repair material on any type of sheet molded compound or RIM rigid plastic, observe the following guidelines:

- Work in a properly ventilated area
- Apply protective cream to any exposed skin
- Remove any mixture that comes into contact with skin
- Wash skin with cold water to remove glass and resin dust
- Use a sander with a vacuum attachment
- Follow the repair material manufacturer's instructions

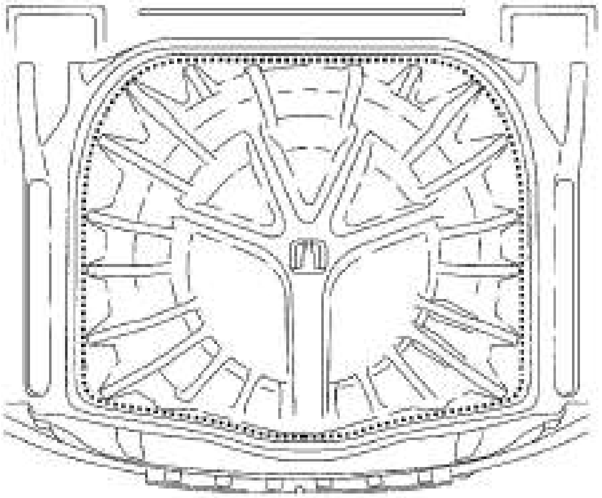
Also, always wear the following:

- An approved respirator, or air supplied respirator
- Eye protection
- Rubber gloves
- Earplugs
- Protective clothing

1. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
2. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
3. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.

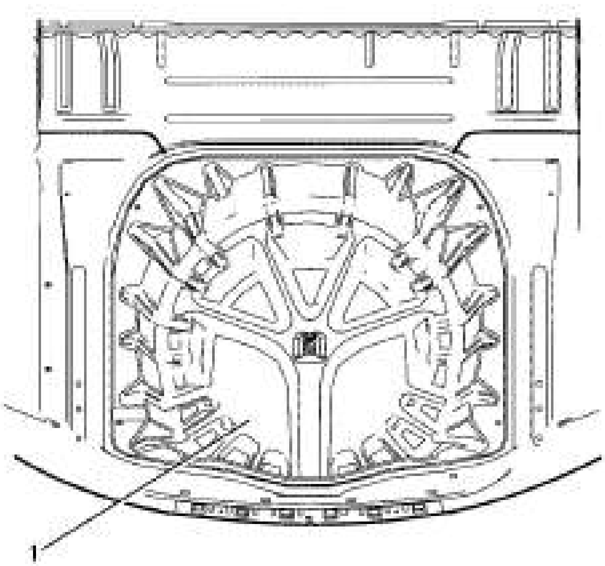


4. Remove the rear compartment floor panel carpet exterior support foams (2).
5. Remove the rear compartment floor panel centre support foam (1).
6. Remove the spare wheel and emergency kit from the rear compartment.
7. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.



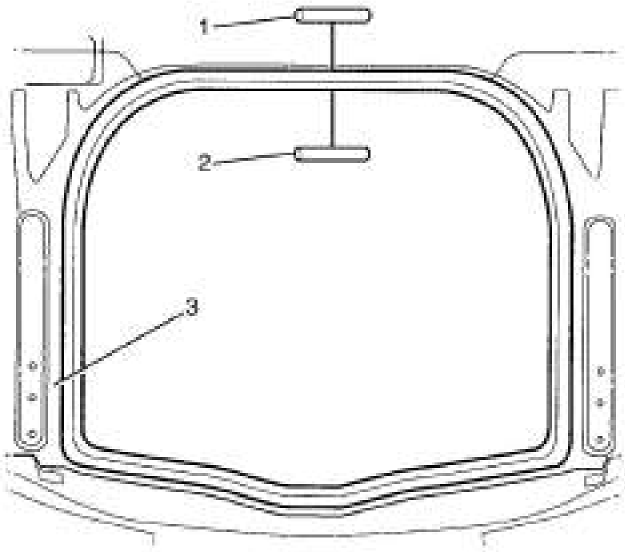
Important: Take care when cutting to avoid damage to adjacent panels and other parts of the vehicle.

8. Cut along the spare wheel panel component as shown with a suitable air saw.



Important: The spare wheel well panel is a single use item. The spare wheel well panel must be discarded after use.

9. Remove the cut section of the spare wheel well panel component (1) from the vehicle.



Important: Stationary glass removal tool J-36020 (2) is used to cut the urethane adhesive between the remaining part of the spare wheel carrier and the vehicle body. Use a suitable tool to install the piano wire from J-36020 (2) through the urethane at the corner of the spare wheel well compartment (1).

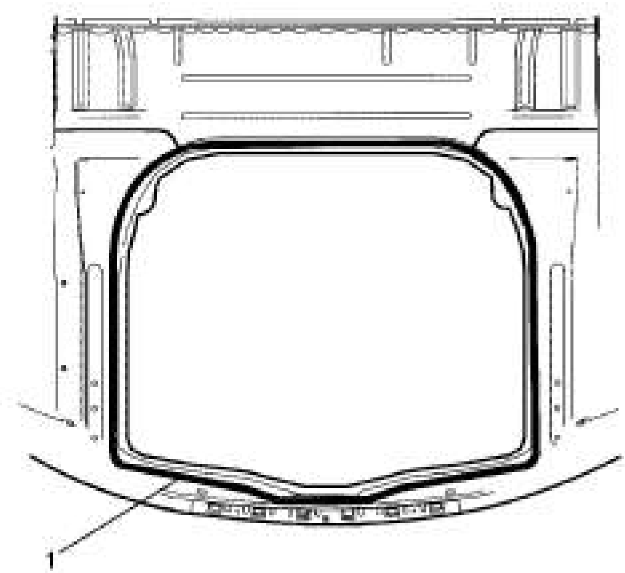
10. Install J-36020 (2) to the vehicle.
11. Connect the end of the piano wire to the other handle of the J-36020 (2).

Important: Keep the outside handle of the J-36020 (1) against the rear compartment floor panel (3) and cycle the full length of the piano wire to prevent heat build up.

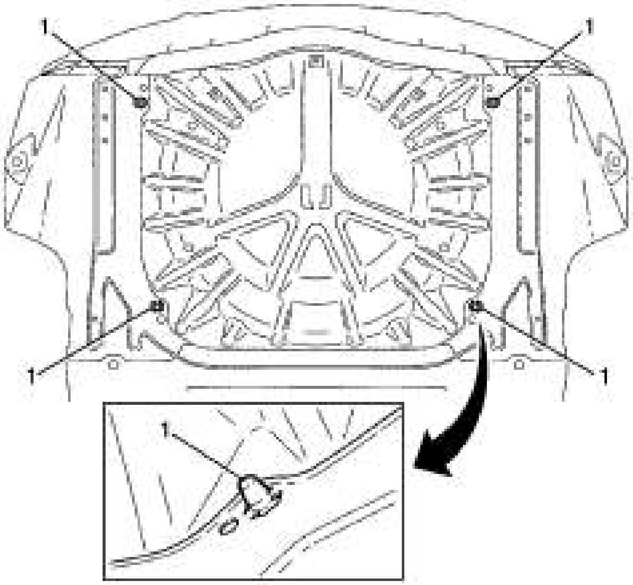
12. Cut through the urethane bead around the spare wheel well panel (4) to the rear compartment floor panel (3) with the aid of an assistant.

    Discard the remaining section of the spare wheel well panel.

Installation Procedure



1. Clean the rear compartment panels of all adhesive (1) using a suitable cleaning solution.



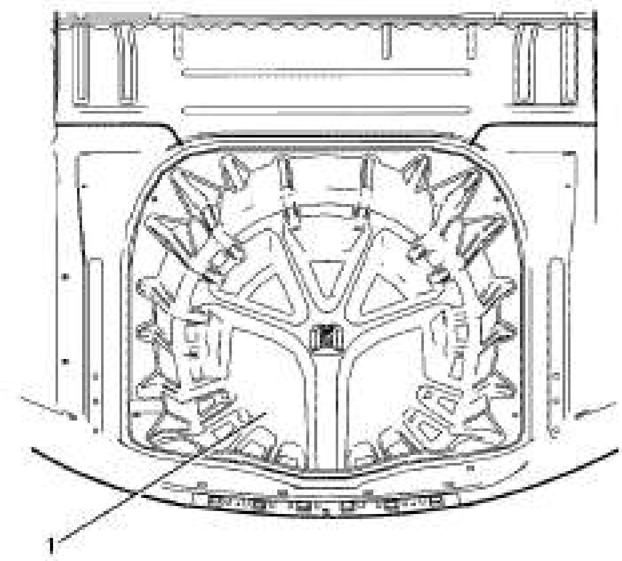
Important: The Adhesive flange on the spare wheel well panel must not be handled with bare hands. This could lead to contamination of the primer on the spare wheel well panel flange.

Important: Make sure that the spare wheel well panel datum pins (1) are properly located in the rear compartment panels.

2. Test fit the spare wheel well panel to the rear compartment panels to identify and rectify any gaps around the rear compartment panels.

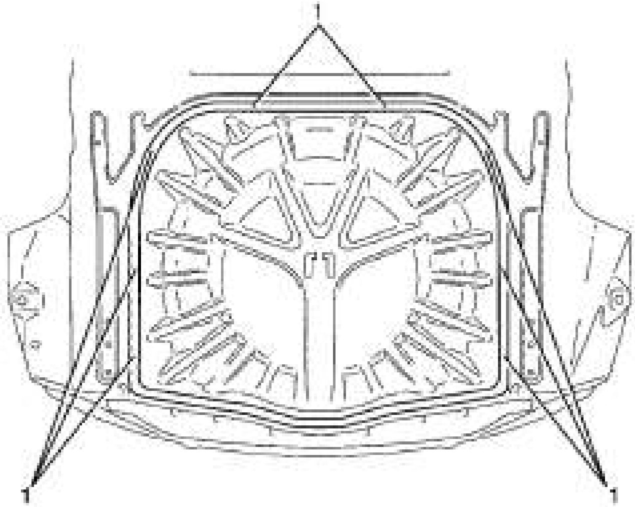
Important: Make sure that the rear compartment panels and the spare wheel well panel are free of any contaminants.

3. Apply a continuous bead of urethane GMW3041 (1) or equivalent approximately 10 millimetres in diameter to the underside of the flange on the spare wheel carrier (2). The adhesive bead should follow the centre of the channel on this flange.



Important: The adhesive begins to bond after 30 minutes. The spare wheel well panel must be fitted within this time.

4. Carefully install the NEW spare wheel well panel (1) to the vehicle to avoid smearing of the urethane. Ensure that there are no gaps between the spare wheel carrier and rear compartment panels.

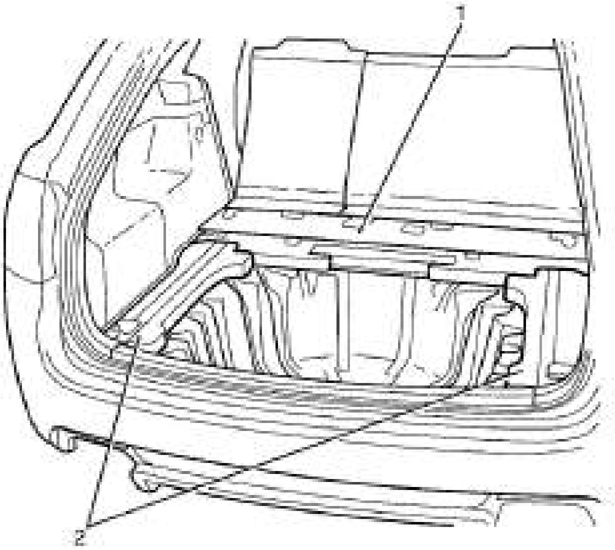


5. Apply one kilogram weights (1) to the edges of the spare wheel well panel to aid in adhesion to the rear compartment panels.

   Important: Allow adhesive to cure for 8 hours before fitting any other components to the spare wheel well panel.

   Important: DO NOT drive the vehicle for 24 hours after fitting the spare wheel well panel to allow the adhesive to fully cure.

6. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
7. Install the spare wheel and emergency kit to the rear compartment.



8. Install the rear compartment floor panel centre support foam (1).
9. Install the rear compartment floor panel carpet exterior support foams (2).

10. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
11. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
12. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Repair | Collision Repair | Repair Instructions | Document ID: 1997005

Body Tail Lamp Filler Panel Replacement (With Extension Panel SWB)

Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

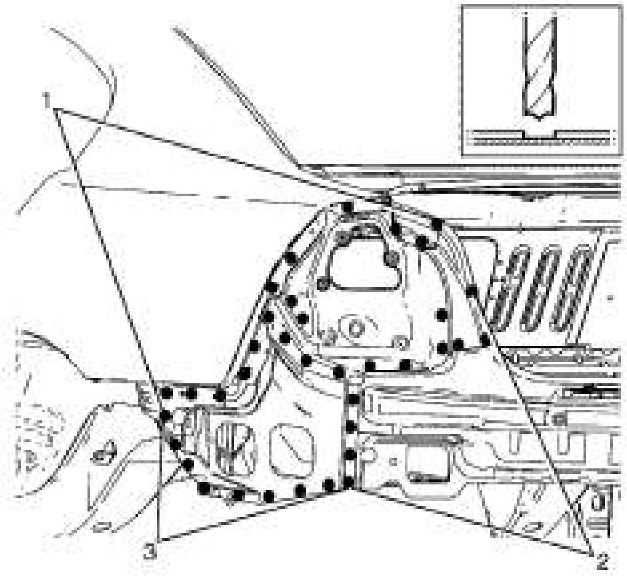
1. Disable the SIR system. Refer to SIR Disabling and Enabling.

Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the rear interior trims. Refer to Quarter Upper Trim Panel Replacement.
4. Remove the rear compartment side trims. Refer to Rear Corner Trim Panel Carpet Replacement.
5. Remove the battery. Refer to Battery Replacement.
6. Remove the battery tray. Refer to Battery Tray Replacement.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

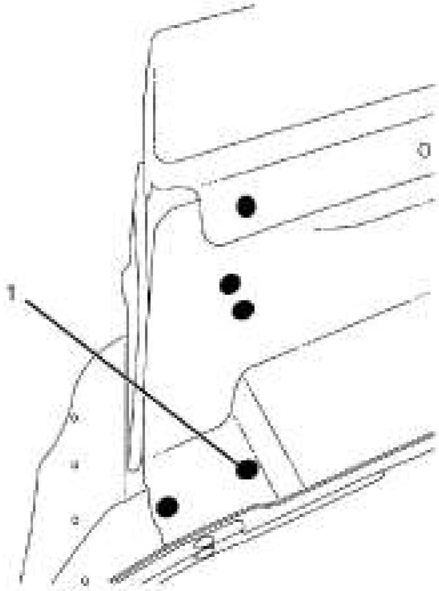
7. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
8. Remove the rear wheels. Refer to Tire and Wheel Removal and Installation.
9. Remove the rear impact bar. Refer to Rear Bumper Fascia Insert Replacement.
10. Remove the rear pressure relief valves. Refer to Pressure Relief Valve Replacement.
11. Remove the tail lights. Refer to Parking and Turn Signal Lamp Replacement.



12. Locate, mark and drill out the spot welds (1) in the tail lamp filler and rear extension panel to

rear quarter panel.

13. Locate, mark and drill out the spot welds (3) in the rear extension panel to side extension panel.
14. Locate, mark and drill out the spot welds in the tail lamp filler panel to side extension panel.
15. Locate, mark and drill out the spot welds (2) in the tail lamp filler panel to rear end panel.

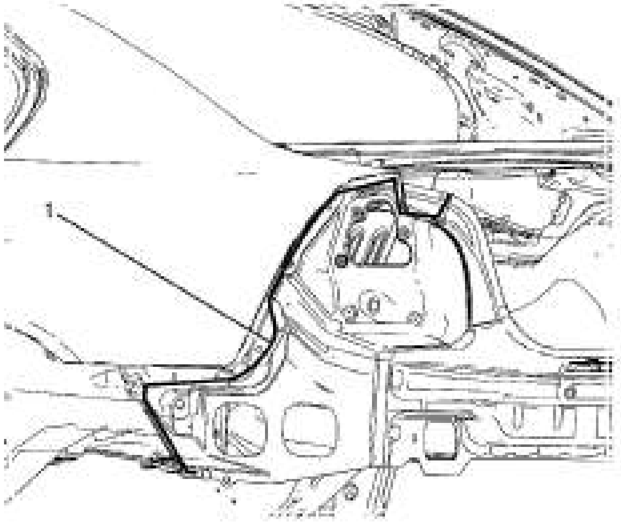


16. Locate, mark and drill out the spot welds (1) in the tail lamp filler panel to inner upper extension panel.
17. Remove the tail lamp filler panel and extension panel from the vehicle.

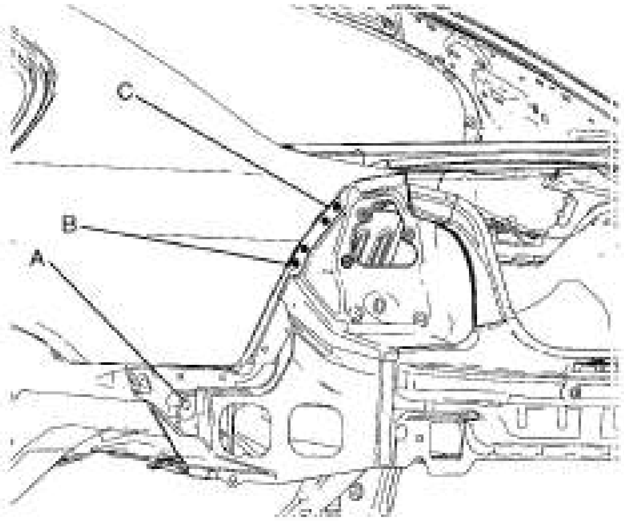
Installation procedure

Important: If the location of the original spot weld holes can not be determined, or if structural weld-thru adhesive is present, space the puddle weld holes every 32 mm (1¼ in).

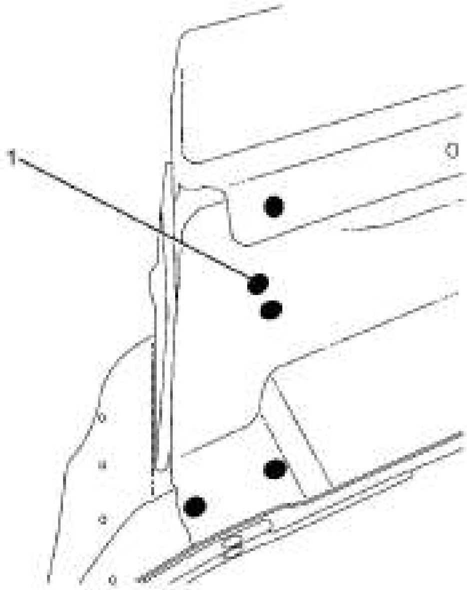
Important: Spot welding is the preferred method for attaching panels and should be used wherever possible. A puddle weld should be performed where your spot welder is unable to reach.



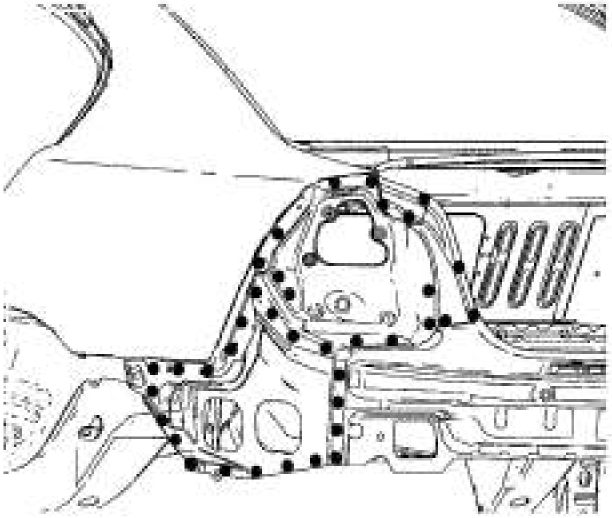
1. Apply the primary sealer (1) GM6449G or equivalent along the tail lamp filler panel and rear extension panel to the rear quarter panel.
2. Position the tail lamp filler panel to the vehicle.



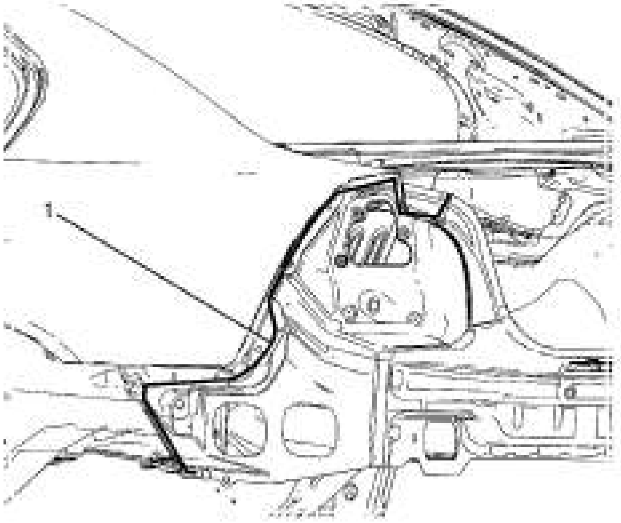
3. Align the datum hole alignment points at A, B and C.
   - Datum A is 10.5mm
   - Datum B is 10.2mm X 16.1mm
   - Datum C is 23.1mm



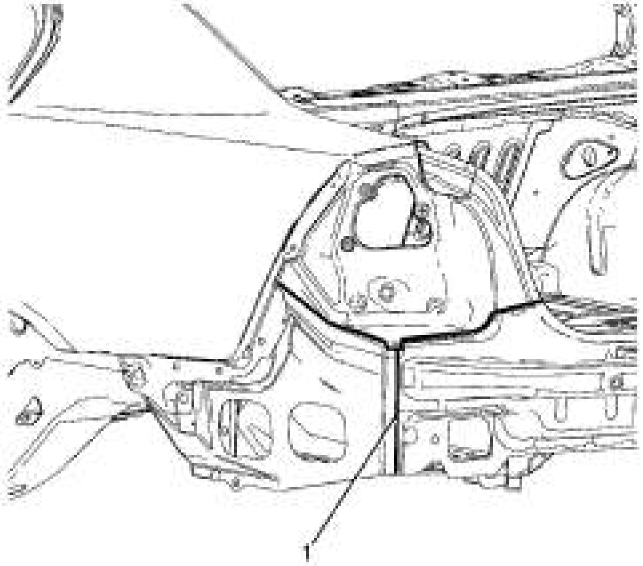
4. Weld (1) the tail light filler panel to the inner upper extension panel.



5. Weld the tail lamp filler panel to the rear end panel.
6. Weld the tail lamp filler panel to the side extension.
7. Weld the rear extension panel to the side extension panel.
8. Weld the tail lamp filler panel and the rear extension panel to the rear quarter panel.



9. Apply the secondary sealer (1) GM specification 9984532 or equivalent along the tail lamp filler panel and side extension to the rear quarter panel.



10. Apply the secondary sealer (1) GM specification 9984532 or equivalent along the tail lamp filler panel to the rear end panel.
11. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.
12. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
13. Install the tail lights. Refer to Parking and Turn Signal Lamp Replacement.
14. Install the pressure relief valves. Refer to Pressure Relief Valve Replacement .
15. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
16. Install the rear wheels. Refer to Tire and Wheel Removal and Installation.
17. Install the battery tray. Refer to Battery Tray Replacement.
18. Install the battery. Refer to Battery Replacement.
19. Install the rear compartment side trims. Refer to Rear Corner Trim Panel Carpet

Replacement.

20. Install the rear interior trims. Refer to Quarter Upper Trim Panel Replacement.

Caution: Refer to Battery Disconnect Caution in the Preface section.

21. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
22. Enable the SIR system. Refer to SIR Disabling and Enabling.
23. If re-programming is required. Refer to Control Module References.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Repair | Collision Repair | Repair Instructions | Document ID: 1997007

Body Tail Lamp Filler Panel Replacement (SWB)

Removal Procedure

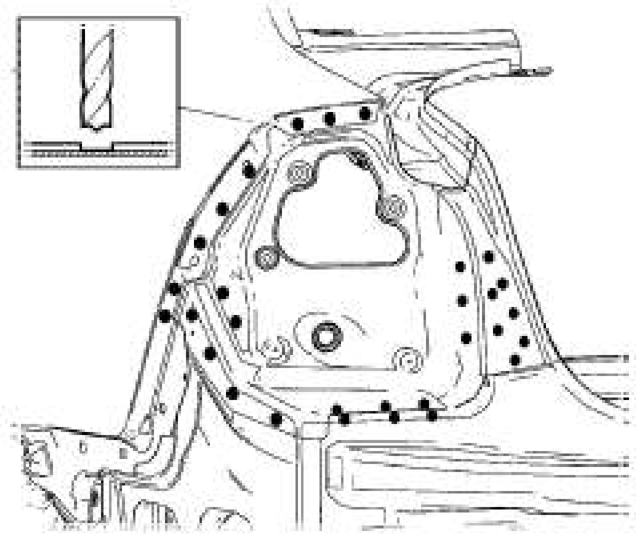
Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

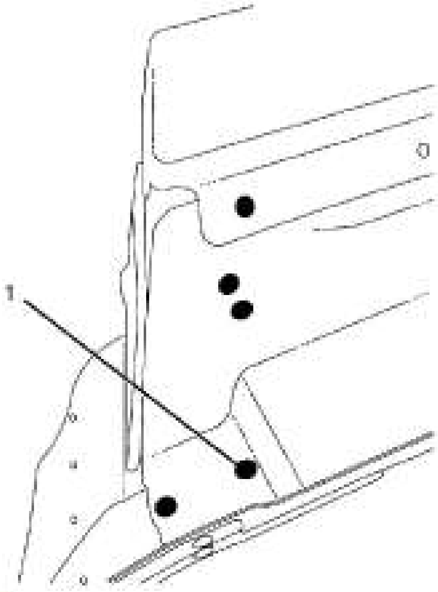
1. Disable the SIR system. Refer to SIR Disabling and Enabling.

Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the rear compartment side trims. Refer to Rear Corner Trim Panel Carpet Replacement.
4. Remove the rear interior trims. Refer to Quarter Upper Trim Panel Replacement.
5. Remove the battery. Refer to Battery Replacement.
6. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
7. Remove the tail lights. Refer to Parking and Turn Signal Lamp Replacement.

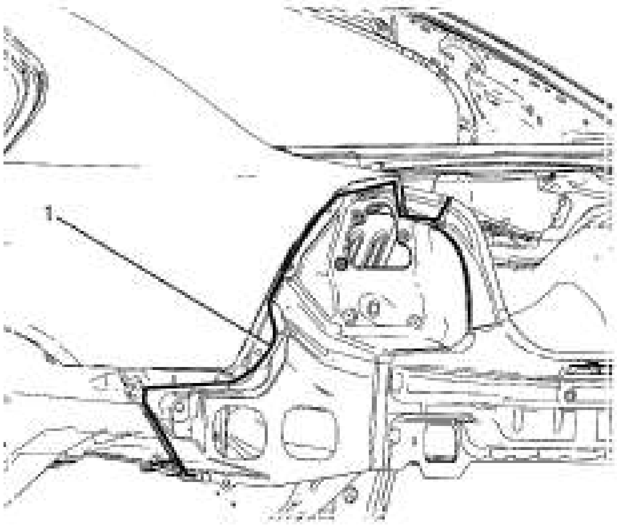


8. Locate, mark and drill out the spot welds in the tail lamp filler panel to rear quarter panel.
9. Locate, mark and drill out the spot welds in the tail lamp filler panel to rear end panel.
10. Locate, mark and drill out the spot welds in the tail lamp filler panel to side extension.

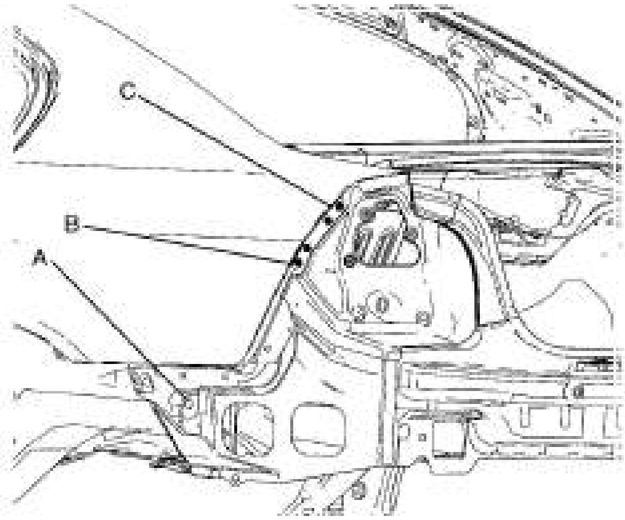


11. Locate, mark and drill out the spot welds in the tail lamp filler panel to upper extension.
12. Remove the tail lamp filler panel from the vehicle.

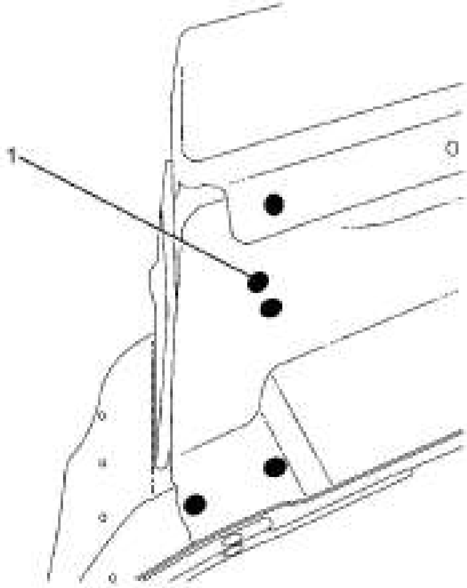
Installation procedure



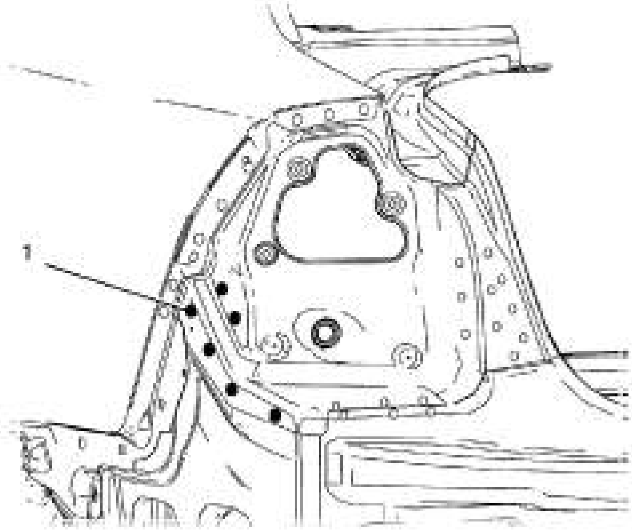
1. Apply the primary sealer (1) GM6449G or equivalent path to the tail lamp filler panel.
2. Install the tail lamp filler panel to the vehicle.



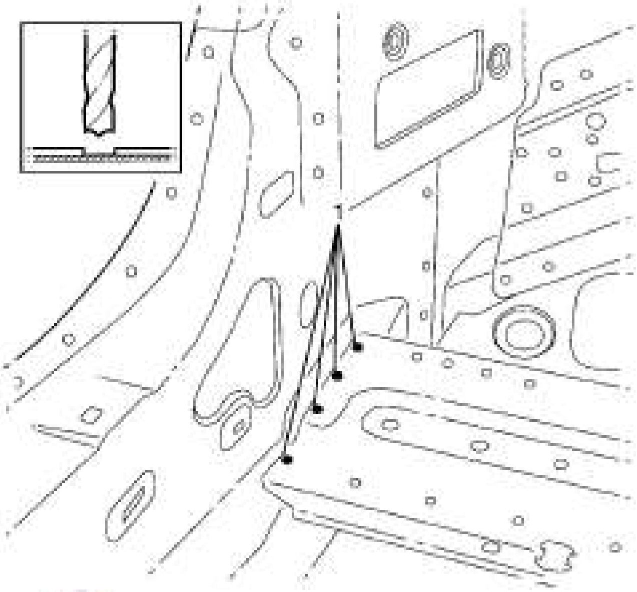
3. Align the datum hole alignment points at A, B and C.
   - Datum A is 4.1mm
   - Datum B is 10.2mm X 16.1mm
   - Datum C is 10.5mm



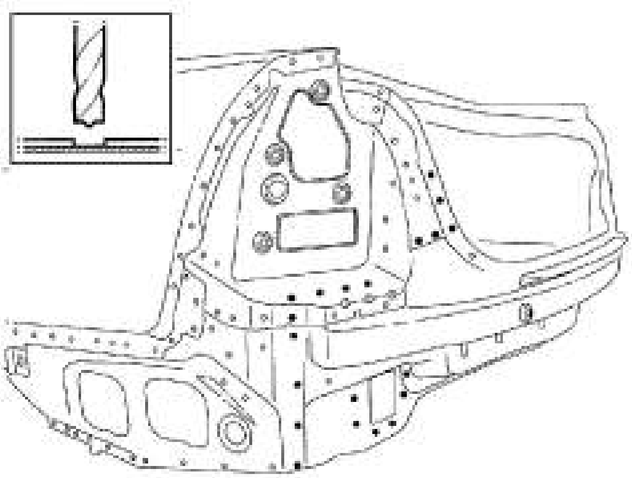
4. Weld (1) the tail light filler panel to the upper extension.



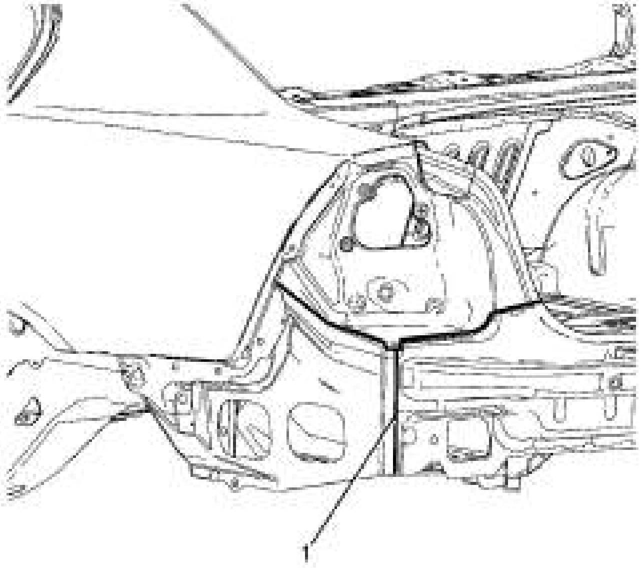
5. Weld (1) the tail light filler panel to the side extension.



6. Weld (1) the tail lamp filler panel to the rear end panel.



7. Weld (1) the tail lamp filler panel to the rear quarter panel.



8. Apply the secondary sealer (1) GM specification 9984532 or equivalent along the tail lamp filler panel to the rear quarter panel.
9. Apply the secondary sealer (1) GM specification 9984532 or equivalent along the tail lamp filler panel to the rear end panel.
10. Apply the secondary sealer (1) GM specification 9984532 or equivalent along the tail lamp filler panel to the side extension panel.
11. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.
12. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
13. Install the tail lights. Refer to Parking and Turn Signal Lamp Replacement.
14. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
15. Install the battery. Refer to Battery Replacement.
16. Install the rear compartment side trims. Refer to Rear Corner Trim Panel Carpet

Replacement.

17. Install the rear interior trims. Refer to Quarter Upper Trim Panel Replacement.

Caution: Refer to Battery Disconnect Caution in the Preface section.

18. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
19. Enable the SIR system. Refer to SIR Disabling and Enabling.
20. If re-programming is required. Refer to Control Module References.

Body Tail Lamp Filler Panel Replacement (Sportwagon)

Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

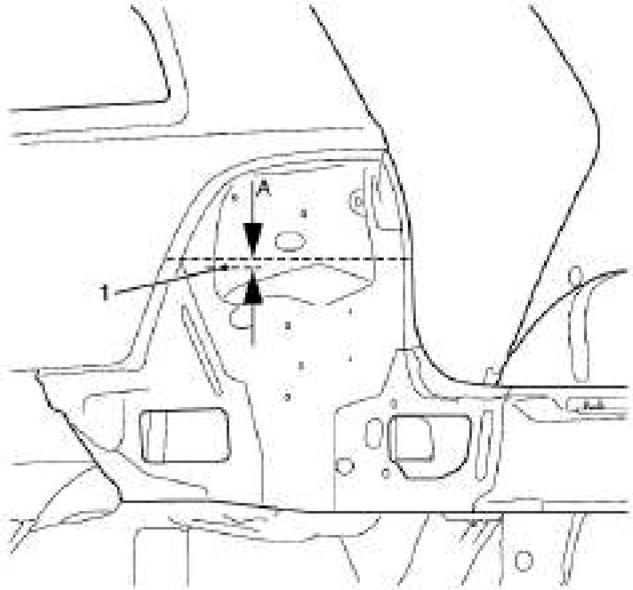
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

1. Disable the SIR system. Refer to SIR Disabling and Enabling.

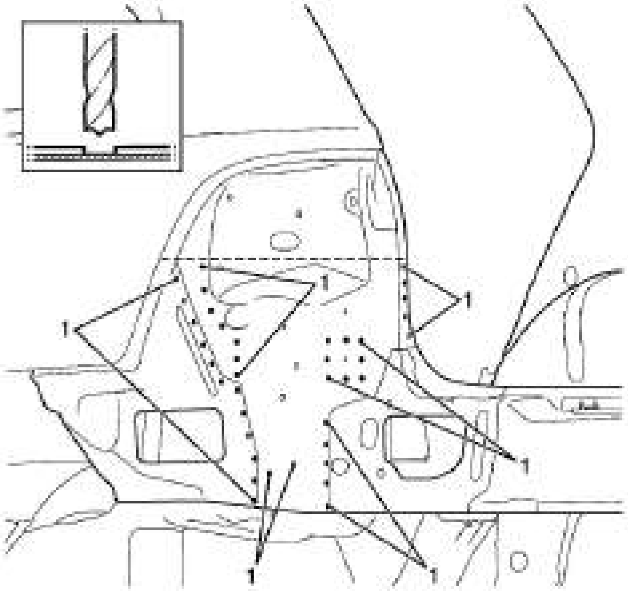
   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
4. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
5. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
6. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
7. Remove the liftgate weatherstrip. Refer to Liftgate Weatherstrip Replacement.
8. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
9. Remove the battery. Refer to Battery Replacement.
10. Remove the battery tray. Refer to Battery Tray Replacement.
11. Remove the liftgate. Refer to Liftgate Replacement.
12. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
13. Remove the tail lamp. Refer to Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn Signal Bulb Replacement.
14. Note the location and remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.



Important: Measure from the centre of the datum hole to create an accurate cut line.

15. Mark a horizontal sectioning line 16 mm above datum point (1) on the Tail Lamp Filler Panel. Datum point (1) is a 10 mm dia hole in the Tail Lamp Filler Panel.



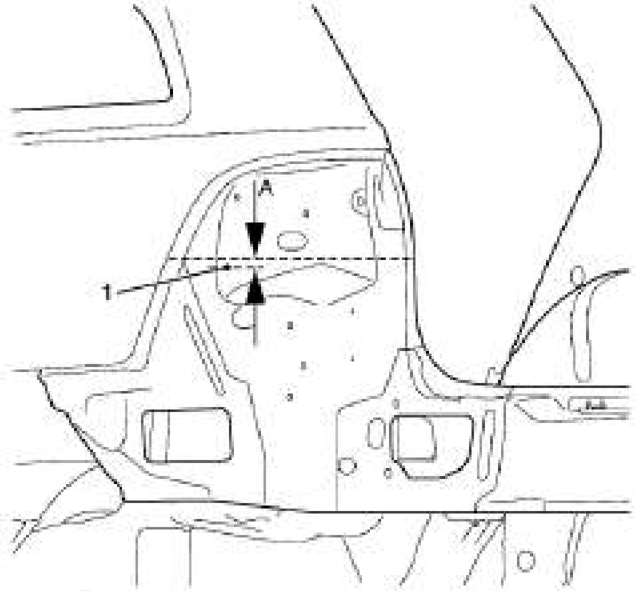
Important: Do not damage any inner panels or reinforcements.

Important: Note the number and location of welds for installation of the service assembly.

Important: Only remove welds below the sectioning line.

16. Locate, mark and drill out the spot welds (1) that attach the body tail lamp filler panel lower

section to vehicle body.



Important: Only cut through the Tail Lamp Filler Panel. Do not damage any inner panels or reinforcements.

17. Cut along the cut line (1) on the body side outer panel with a suitable cutting tool.
18. Remove the body tail lamp filler panel lower portion of the vehicle.

Installation Procedure

Important: Spot welding is the preferred method for attaching panels and should be used whenever possible. A plug weld should only be performed where spot welding is not possible.

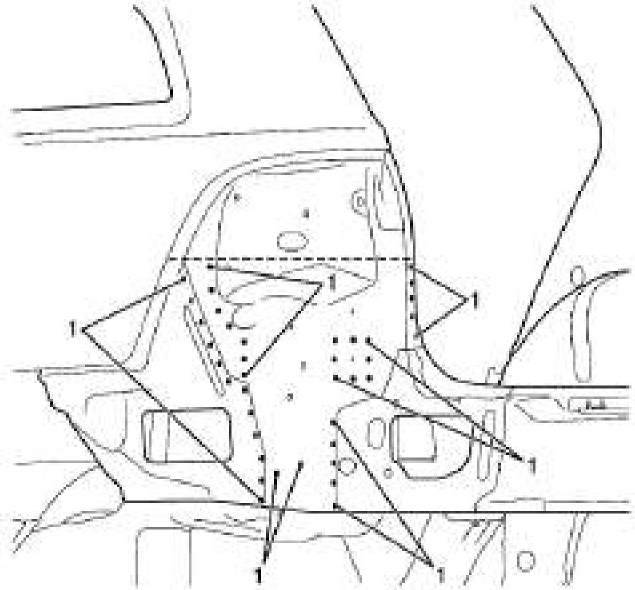
Important: If the location of the original plug weld holes cannot be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 32 mm (1¼ in).

Important: Ensure that all factory welds are replaced in their original locations.

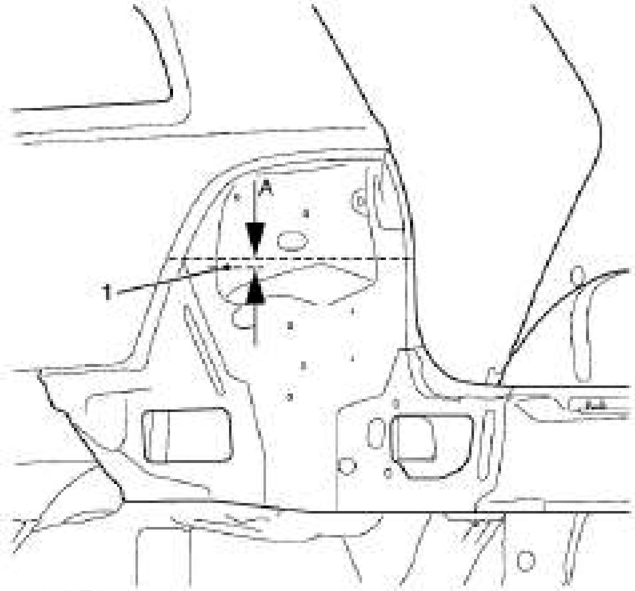
Important: Ensure that all structural adhesives and sealers are replaced in their original locations.

Important: Follow the adhesive manufacturer's instructions during the assembly process. Heat must be applied as per the manufacturer's specifications to cure the adhesives and to expand the sealing baffles.

1. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted when disassembling.
2. Cut the new Tail Lamp Filler Panel in corresponding locations to fit the remaining original Tail Lamp Filler Panel. The sectioning joint should be trimmed to allow a gap of one-and-one-half-times the metal thickness at the sectioning joint.
3. Clean and prepare the mating surfaces of the body tail lamp filler panel and the body side panel assembly.
4. Align the body Tail Lamp Filler Panel repair section to the vehicle using three dimensional measuring equipment. Refer to Dimensions - Body

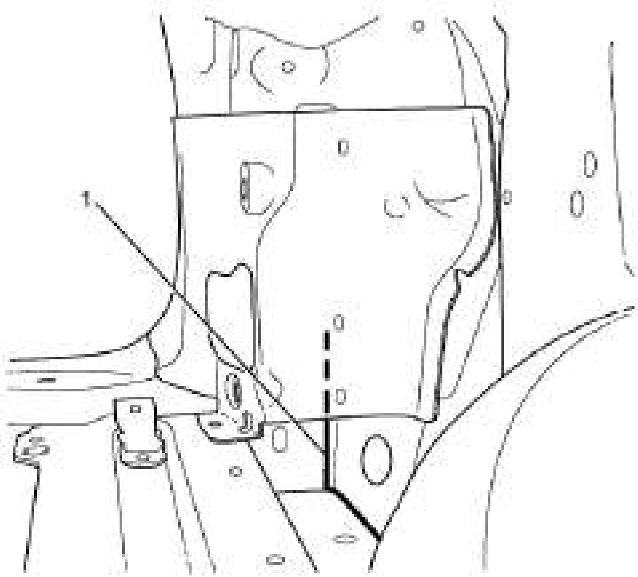


5. Weld the body tail lamp filler panel repair section (1) to the vehicle body.

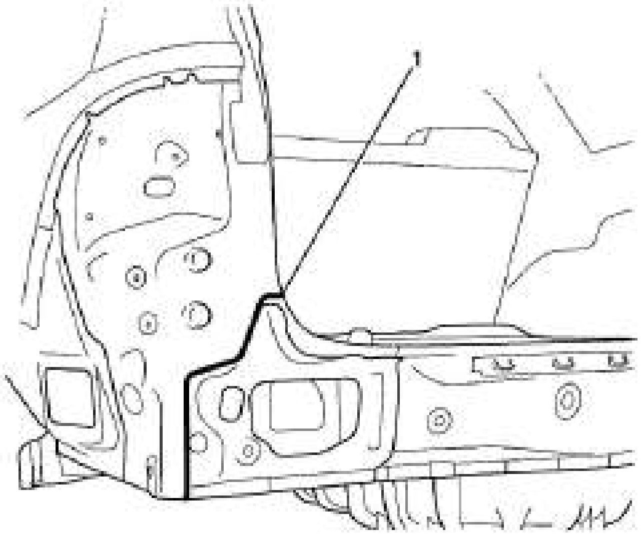


Important: To create a solid weld with minimum heat distortion, make 25 mm (1 in) stitch welds along the seam with 25 mm (1 in) gaps between them.

6. Stitch weld the Tail Lamp Filler Panel repair section to the vehicle body at the sectioning location.



7. Apply secondary sealer GM9984532 or equivalent to the edge of the body tail lamp filler panel (1).



8. Apply secondary sealer GM9984532 or equivalent to the edge of the body tail lamp filler panel (1).
9. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.
10. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
11. Install the tail lamp. Refer to Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn Signal Bulb Replacement.
12. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
13. Install the liftgate. Refer to Liftgate Replacement.
14. Install the battery tray. Refer to Battery Tray Replacement.
15. Install the battery. Refer to Battery Replacement.
16. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel

Replacement.

17. Install the liftgate weatherstrip. Refer to Liftgate Weatherstrip Replacement.
18. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
19. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
20. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
21. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
22. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
23. Enable the SIR system. Refer to SIR Disabling and Enabling.

Rear End Panel Filler Replacement (Sportwagon)

Removal Procedure

Caution: Refer to Approved Equipment for Collision Repair Caution in the Preface section.

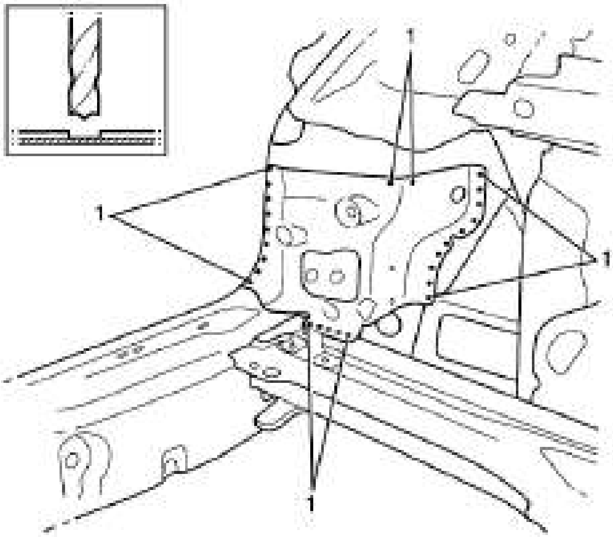
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Foam Sound Deadeners Caution in the Preface section.

1. Disable the SIR system. Refer to SIR Disabling and Enabling.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

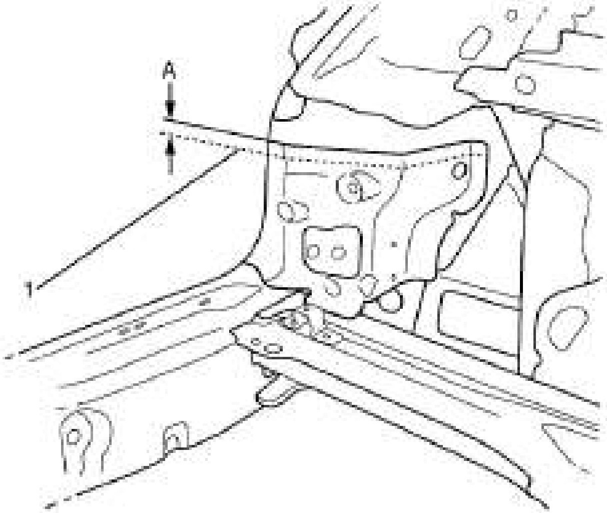
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
4. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
5. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
6. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
7. Remove the liftgate weatherstrip. Refer to Liftgate Weatherstrip Replacement.
8. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
9. Remove the battery. Refer to Battery Replacement.
10. Remove the battery tray. Refer to Battery Tray Replacement.
11. Remove the liftgate. Refer to Liftgate Replacement.
12. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
13. Remove the tail lamp. Refer to Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn Signal Bulb Replacement.
14. Note the location and remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.



Important: Note the location of the factory adhesive and sealants for installation of the service assembly.

Important: Note the number and location of the factory welds for the installation of the service assembly.

15. Locate, mark and drill out the spot welds attaching the Tail Lamp Inner Filler Panel to body side assembly and floor assembly (1).



Important: The Tail Lamp Inner Filler Panel is attached to the vehicle with spotwelds and a bead of adhesive along the top.

16. Mark a horizontal cut line 25 mm (1.0 in) (Dimension A) below the top of the Tail Lamp Inner Filler Panel. The cut line must be parallel with the top of the Tail Lamp Inner Filler Panel.

    Important: Only cut through the Tail Lamp Inner Filler Panel. Do not damage any inner panels or reinforcements.

17. Cut along the cut line (1) on the Tail Lamp Inner Filler Panel with a suitable cutting tool.
18. Remove the lower portion of the Tail Lamp Inner Filler Panel from the vehicle.

    Important: Do not damage any inner panels or reinforcements.

19. Using a suitable tool remove the remaining strip of Tail Lamp Inner Filler Panel from the inner body side. Ensure all traces of old adhesive are removed.

Installation Procedure

Important: Spot welding is the preferred method for attaching panels and should be used whenever possible. A plug weld should only be performed where spot welding is not possible.

Important: If the location of the original plug weld holes cannot be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 32 mm (1¼ in).

Important: Ensure that all factory welds are replaced in their original locations.

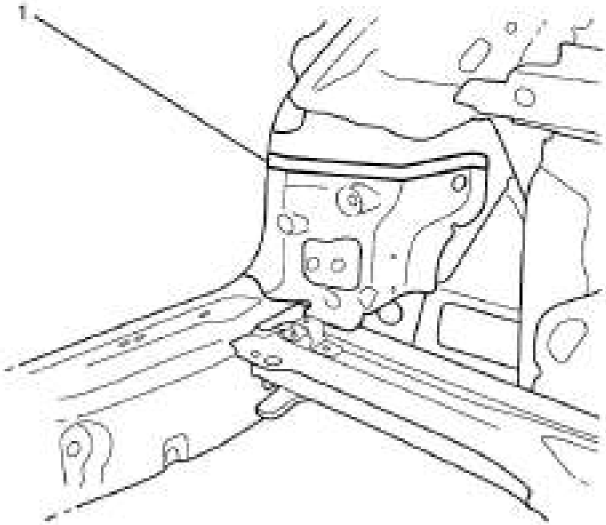
Important: Ensure that all structural adhesives and sealers are replaced in their original locations.

Important: Follow the adhesive manufacturer's instructions during the assembly process. Heat must be applied as per the manufacturer's specifications to cure the adhesives and to expand the sealing baffles.

1. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted when disassembling.

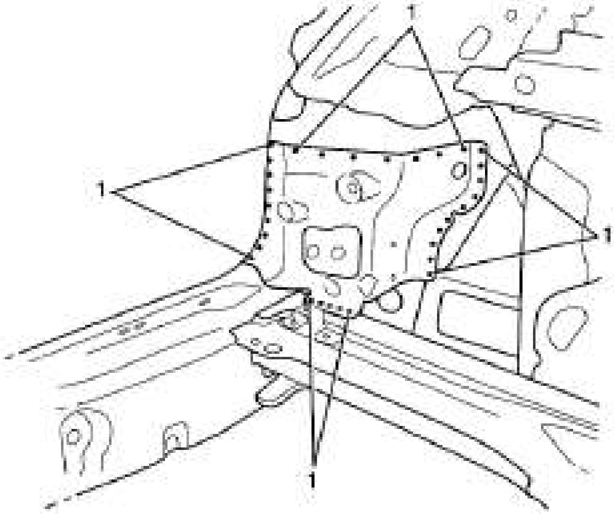
   Important: Secondary sealer must be applied to the perimeter of all flanges. Secondary sealer must be applied to all welds/joints that were originally covered by secondary sealer.

2. Clean and prepare the mating surfaces of both parts of the body side panel assembly.



3. Apply approved structural adhesive (1) GM6449G or equivalent to the mating surfaces between the tail lamp filler panel and the back body inner pillar panel.

   Important: As the tail lamp filler panel is installed to the vehicle, structural adhesive should be visible on the outside edges of both surfaces (squeezed out when pushed together).



4. Weld the tail lamp filler panel to the vehicle (1). Apply additional welds spaced every 32 mm (1¼ in) to the joint between the tail lamp filler panel and back body inner pillar panel.
5. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to Anti-Corrosion Treatment and Repair.
6. Paint the repaired area. Refer to Basecoat/Clearcoat Paint Systems.
7. Install the tail lamp. Refer to Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn

Signal Bulb Replacement.

8. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement.
9. Install the liftgate. Refer to Liftgate Replacement.
10. Install the battery tray. Refer to Battery Tray Replacement.
11. Install the battery. Refer to Battery Replacement.
12. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
13. Install the liftgate weatherstrip. Refer to Liftgate Weatherstrip Replacement.
14. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
15. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
16. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
17. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
18. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
19. Enable the SIR system. Refer to SIR Disabling and Enabling.

Metal Panel Bonding

Important: The application of heat can degrade the mechanical properties of certain high strength steel panels. With the exception of welding processes, do not use heat to repair or straighten the following panels:

- Centre Pillar Reinforcement
- Rocker Outer Panel
- Rocker Inner Panel
- #4 Crossbar
- Door Impact Beam

If required, the use of heat (maximum of 650 degrees C for up to 90 sec) is acceptable for other steel body panels.

This is intended to provide general guidelines for adhesive bonding of exterior panels to partially alleviate the requirement for extensive spot welding and plug Metal-Inert Gas (MIG) welding procedures. Bonding cannot be used for butt weld type joints. Bonding is not recommended for vertical lap joints unless specified in the repair procedure. Bonding is most effective on horizontal lap joints. The benefits of panel bonding are:

- No heat or burn damage when additional welding is not required
- Corrosion protection
- Can act as a sealant
- Improved process for complicated shapes (wheelhouse area)

The scope of this specification is intended to provide the performance guidelines of structural adhesive systems used to repair (metallic) automotive bodies in the aftermarket. These types of adhesives are intended for use when bonding replacement body panels as an option to welding as the attachment means. Holden information outlines the use of room temperature cure acrylic adhesives that contain glass bead technology.

Bonding procedures in general are applicable only to a factory seams type approach.

Sectioning or partial panelling of full panels is not supported by Holden unless specifically documented in a Service Bulletin or Manual.

Applicable components for this technology are EXTERIOR PANELS ONLY, including door skins, tail end panels, roof outer panels and quarter panels.

Important: Do not use adhesives for vehicle underbody or upper body structure type repairs such as structural rails, shock/strut towers, floor pans, upper fender rails, body side pillars, door rings--side or rear, rocker panels, unless specifically documented in a Holden Service Bulletin or Manual. If in doubt, use only the procedures referenced in the Service Manual for the specific vehicle being repaired.

Always follow the system manufacturer's instructions for application, handling, and curing.

Adhesives currently meeting the performance requirements include Holden materials and products manufactured by 3M, Lord Adhesives and Dow. Refer to Collision Repair Specifications .

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Fastener Tightening Specifications

Application	Specification	
	Metric	English
Brake Caliper Anchor Plate to Knuckle Retaining Bolts	110 N·m	81 lb ft
Front Subframe to Body Centre Retaining Bolts	160 N·m	118 lb ft
Front Subframe to Body Front Retaining Bolts	160 N·m	118 lb ft
Front Subframe to Body Rear Retaining Bolts	240 N·m	178 lb ft
I-Link to Knuckle Retaining Bolt	140 N·m	103 lb ft
I-Link to Rear Subframe Retaining Bolt and Nut	175N·m	129 lb ft
Lower Control Arm to Knuckle Retaining Bolt and Nut		
• First Pass	40 N·m	30 lb ft
• Final Pass	120 Degrees	
Lower Control Arm to Rear Subframe Retaining Bolt	175 N·m	129 lb ft
Lower Engine Mount to Front Subframe Retaining Nut	80 N·m	59 lb ft
Rear Subframe Retaining Bolts to Body		
First Pass:	65 N·m	48 lb ft
Second Pass:	125 Degrees	
Steering Gear to Front Sub Frame Retaining Bolts	65 N·m	48 lb ft
Strut Assembly to Body Retaining Bolts	58 N·m	43 lb ft
Transmission Support Retaining Bolts	58 N·m	43 lb ft
Transmission Support to Transmission Mount Retaining Nuts (Except 5L40 and 6L50)	25 N·m	18 lb ft
Transmission Support to Transmission Mount Retaining Nuts (5L40 and 6L50)	58 N·m	43 lb ft
Upper Control Arm Ball Joint to Subframe Retaining Bolt and Nut		
• First Pass	80 N·m	59 lb ft
• Final Pass	120 Degrees	
Upper Control Arm Pivot Bushing to Upper Control Arm Retaining Bolt	170 N·m	126 lb ft
Upper Control Arm to Knuckle Retaining Bolt and Nut		
First Pass:	60 N·m	44 lb ft
Second Pass:	90 Degrees	
Y-Link to Knuckle Retaining Bolt and Nut		
• First Pass	40 N·m	30 lb ft
• Final Pass	120 Degrees	
Y-Link to Rear Subframe Retaining Bolt and Nut	175 N·m	129 lb ft

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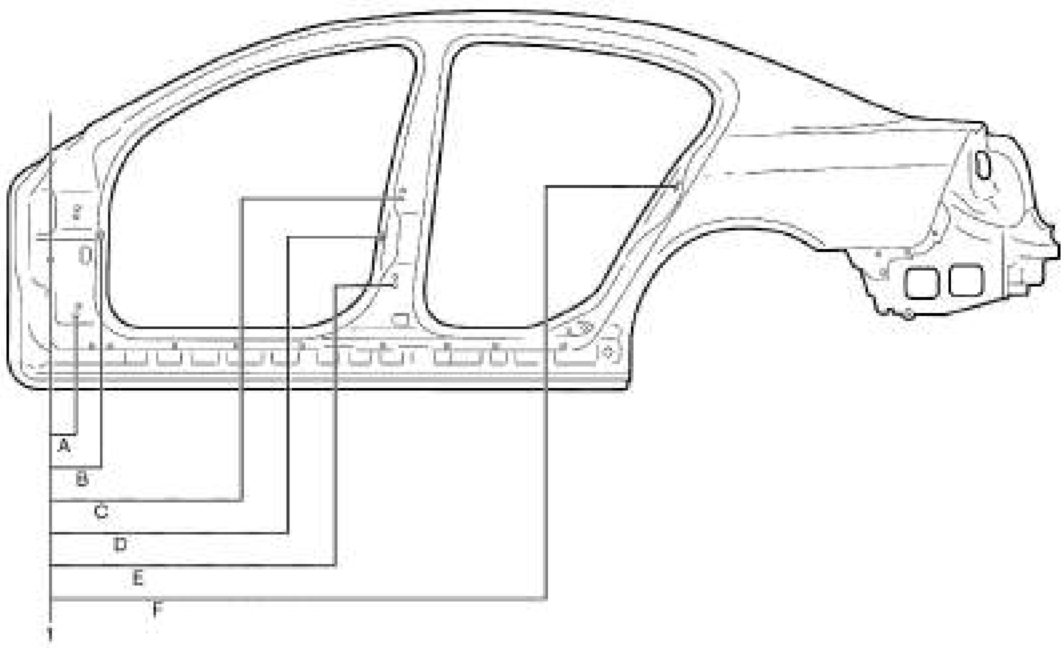
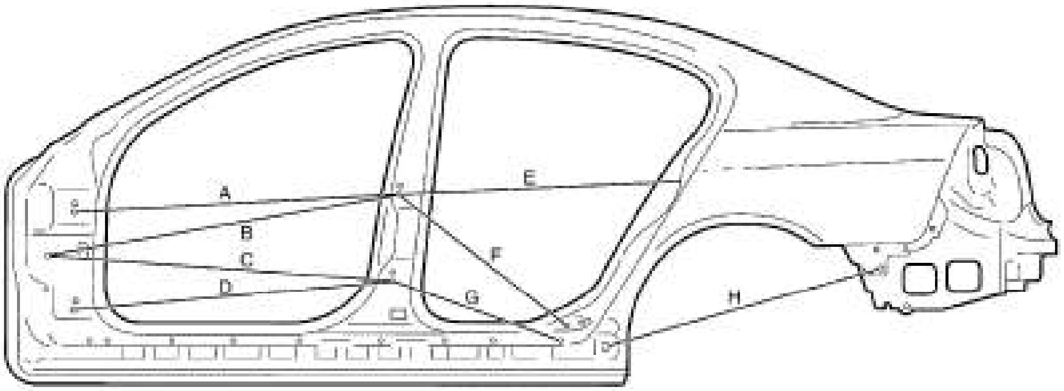
Dimensions - Body (SWB)



Location	Description	Length	Width	Height
1	Zero Line 25 mm Gage Hole	0	1660 mm (65.35 in)	550 mm (21.65 in)
A	Door Hinge Attach	76 mm (2.99 in)	1687 mm (66.42 in)	363 mm (14.29 in)
B	Door Hinge Attach	155 mm (6.1 in)	1592 mm (62.68 in)	452 mm (17.8 in)
C	Door Hinge Attach	1186 mm (46.69 in)	1704 mm (67.09 in)	756 mm (29.76 in)
D	Upper Door Lock Striker Attach	1170 mm (46.06 in)	1633 mm (64.29 in)	581 mm (22.87 in)
E	Door Hinge Attach	1186 mm (46.69 in)	1702 mm (67.01 in)	461 mm (18.15 in)
F	Upper Door Lock Striker Attach	2131 mm (83.9 in)	1640 mm (64.57 in)	795 mm (31.3 in)
All dimensions are measured from a zero line, a center line, and a common datum. All dimensions are symmetrical unless otherwise specified.				

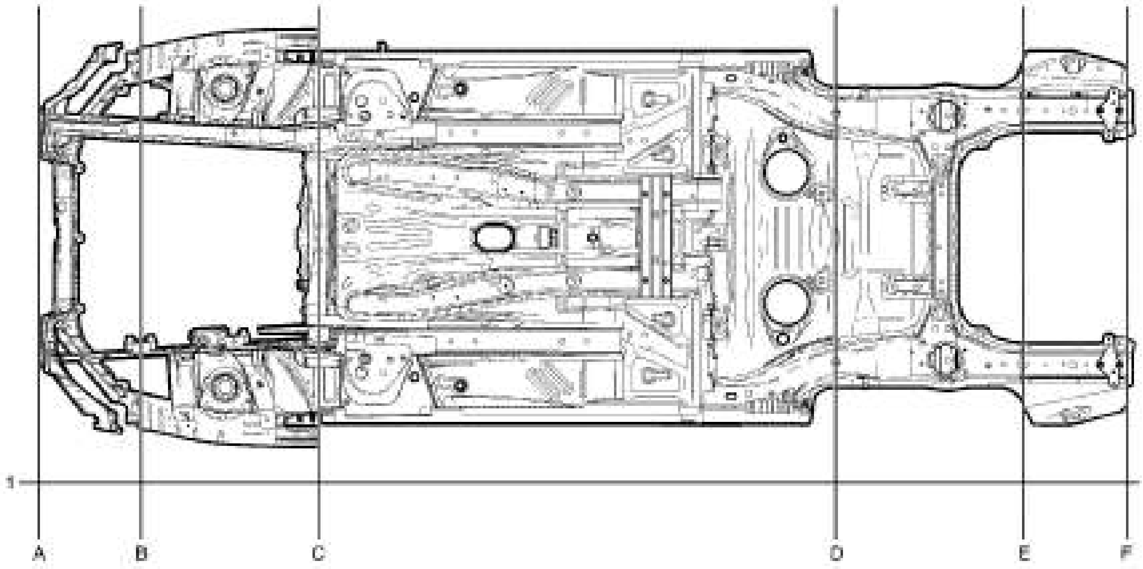
Point-to-Point Measurements



Location	Description	Length
A	Lower Top Front Door Hinge Hole to Lower Top Rear Door Hinge Hole	1103 mm (43.43 in)
B	Hinge Pillar Datum Hole to Lower Top Rear Door Hinge Hole	1205 mm (47.44 in)
C	Hinge Pillar Datum Hole to Lower Bottom Rear Door Hinge Hole	1170 mm (46.06 in)
D	Lower Bottom Front Door Hinge Hole to Lower Bottom Rear Door Hinge Hole	1086 mm (42.76 in)
E	Lower Top Rear Door Hinge Hole to Upper Rear Door Striker Hole	948 mm (37.32 in)
F	Lower Top Rear Door Hinge Hole to Lower Body Side Datum Hole	880 mm (34.65 in)
G	Lower Bottom Front Door Hinge Hole to Lower Body Side Datum Hole	763 mm (30.04 in)
H	Lower Body Side Datum Hole to Rear Body Side Datum Hole	961 mm (37.83 in)

All dimensions are measured from a zero line, a center line, and a common datum. All dimensions are symmetrical unless otherwise specified.

Dimensions - Underbody



Location	Description	Length	Width	Height
1	Zero Line 18 mm Hole	1535 mm (60.43 in)	810 mm (31.89 in)	128 mm (5.04 in)
A	20 mm Hole	805 mm (31.69 in)	886 mm (34.88 in)	328 mm (12.91 in)
B	10 mm Bumper Mounting	1136 mm (44.72 in)	0	0
C	16 mm Hole	2140 mm (84.25 in)	1024 mm (40.31 in)	200 mm (7.87 in)
D	25.1 mm x 39.7 mm Gage Hole	2910 mm (114.57 in)	1048 mm (41.26 in)	434 mm (17.09 in)
E	25.1 mm x 39.7 mm Gage Hole	3114 mm (122.60 in)	1048 mm (41.26 in)	434 mm (17.09 in)
F	18 mm Bumper Mounting	3335 mm (131.30 in)	0	0
All dimensions are measured from a zero line, a center line, and a common datum. All dimensions are symmetrical unless otherwise specified.				

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Dimensions - Body (Sportwagon)

Vehicle Dimensions - Main

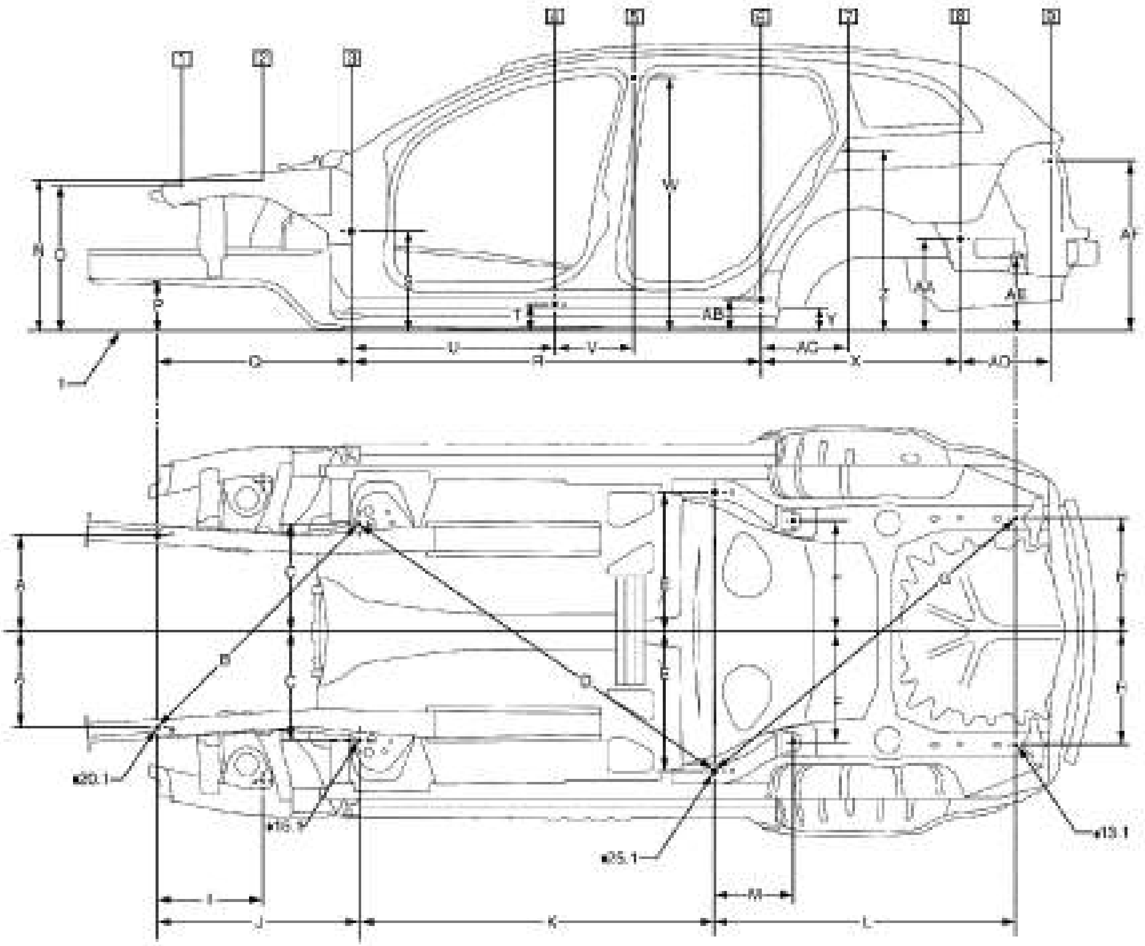
Important:: Dimensions are measured from the centre of holes, on the outer side of the metal surface.

Important:: The main datum surface (1) is the underside of each outrigger at the 16.1mm dia datum hole. The main datum surface (1) is parallel with the bottom of each rocker assembly inboard of the pinch weld flange.

Important:: All dimensions are projected to be either parallel with or at 90 degrees to the main datum surface (1).

Important:: The plan view is shown as viewed from beneath the vehicle.

Important:: For location details of measurement points 1 -- 9, refer to Vehicle Dimensions - Measuring Points.



Location	Description	Length
A	Centreline of vehicle to centre of 20.1mm dia datum hole	444 mm (17.48 in)
B	Centre of 20.1mm dia datum hole to centre of 16.1mm dia datum hole	1329 mm (52.31 in)
C	Centreline of vehicle to centre of 16.1mm datum dia hole	500 mm (19.69 in)
D	Centre of 16.1mm dia datum hole to centre of 25.1mm dia datum hole	2004 mm (78.91 in)
E	Centreline of vehicle to centre of 25.1mm datum dia hole	645 mm (25.39 in)
F	Centreline of vehicle to centre of rear frame mounting hole	512 mm (20.16 in)
G	Centre of 25.1mm dia datum hole to centre of 13.1mm dia datum hole	1820 mm (71.66 in)
H	Centreline of vehicle to centre of 13.1mm datum dia hole	524 mm (20.63 in)
I	Centre of 20.1mm dia datum hole to centre of 10.1mm dia datum hole	481 mm (18.92 in)
J	Centre of 20.1mm dia datum hole to centre of 16.1mm dia datum hole	935 mm (36.81 in)
K	Centre of 16.1mm dia datum hole to centre of 25.1mm dia datum hole	1645 mm (64.76 in)
L	Centre of 25.1mm dia datum hole to centre of 13.1mm dia datum hole	1395 mm (54.92 in)
M	Centre of 25.1mm dia datum hole to centre of rear frame mounting hole	365 mm (14.37 in)
N	Datum surface 1 to centre of 10.1mm dia datum hole	693 mm (27.27 in)
O	Datum surface 1 to centre of 9.9mm dia hole	661 mm (26.01 in)
P	Datum surface 1 to centre of 20.1mm dia datum hole	232 mm (9.14 in)
Q	Centre of 20.1mm dia datum hole to centre of 25.1mm dia datum hole	900 mm (35.43 in)
R	Centre of 25.1mm dia datum hole to centre of 25.1mm dia datum hole	1895 mm (74.61 in)
S	Datum surface 1 to centre of 25.1mm dia datum hole	455 mm (17.93 in)
T	Datum surface 1 to centre of 16.1mm dia datum hole	140 mm (5.53 in)
U	Centre of 25.1mm dia datum hole to centre of 16.1mm dia datum hole	940 mm (37.01 in)
V	Centre of 25.1mm dia datum hole to centre of 13.1mm dia datum hole	524 mm (20.63 in)
		1165 mm

W	Datum surface 1 to centre of 13.1mm dia datum hole	(45.88 in)
X	Centre of 25.1mm dia datum hole to centre of 20.1mm dia datum hole	920 mm (36.20 in)
Y	Datum surface 1 to centre of rear frame mounting hole	103 mm (4.07 in)
Z	Datum surface 1 to centre of 8.2mm dia hole	809 mm (31.83 in)
AA	Datum surface 1 to centre of 20.1mm dia datum hole	420 mm (16.54 in)
AB	Datum surface 1 to centre of 25.1mm dia datum hole	140 mm (5.52 in)
AC	Centre of 25.1mm dia datum hole to centre of 8.2mm dia hole	379 mm (15.65 in)
AD	Centre of 20.1mm dia datum hole to centre of 16.1mm dia datum hole	418 mm (16.47 in)
AE	Datum surface 1 to centre of 13.1mm dia datum hole	338 mm (13.31 in)
AF	Datum surface 1 to centre of 16.1mm dia datum hole	786 mm (30.93 in)

Vehicle Dimensions - Engine Compartment

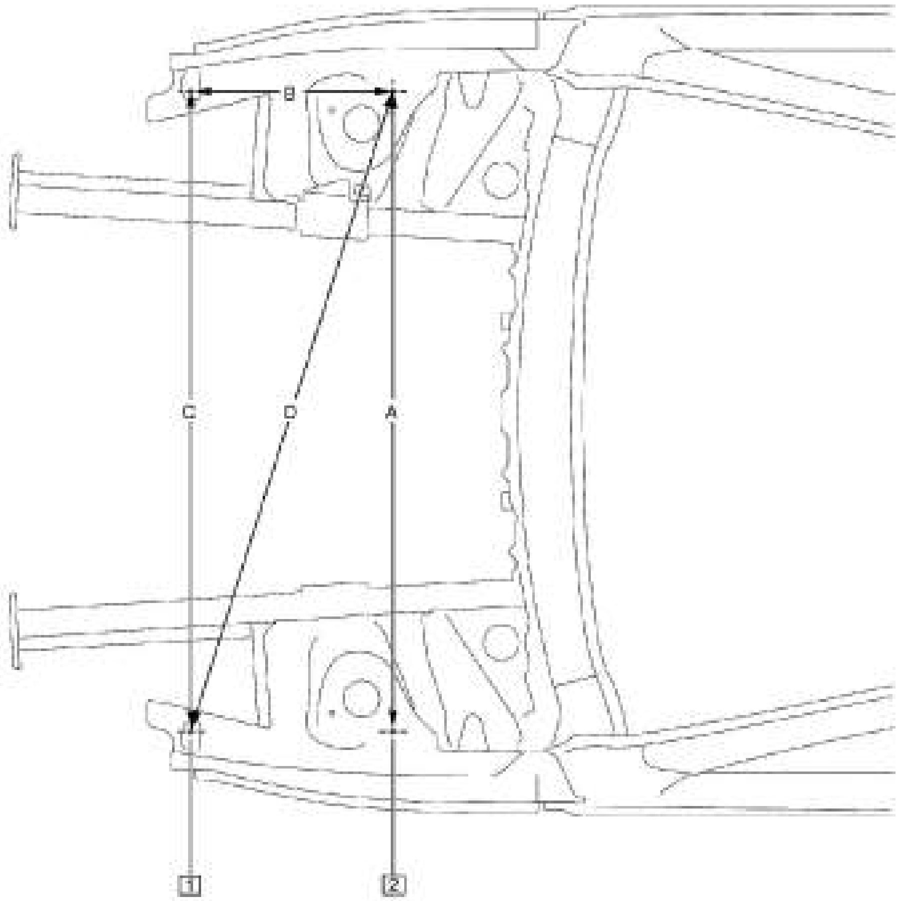
Important:: Dimensions are measured from the centre of holes, on the outer side of the metal surface.

Important:: The main datum surface (1) is the underside of each outrigger at the 16.1mm dia datum hole. The main datum surface (1) is parallel with the bottom of each rocker assembly inboard of the pinch weld flange.

Important:: All dimensions are projected to be either parallel with the main datum surface (1). Refer to Vehicle Dimensions - Main.

Important:: The plan view is shown as viewed from above the vehicle.

Important:: For location details of measurement points 1 -- 2, refer to Vehicle Dimensions - Measuring Points.

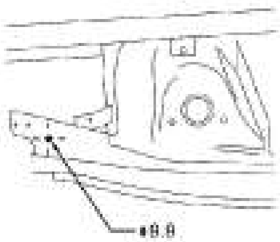


Location	Description	Length
A	Centre of 10.1mm dia datum hole to centre of 10.1mm dia datum hole	1574 mm (61.99 in)
B	Centre of 10.1mm dia datum hole to centre of 9.9mm dia hole	427 mm (16.82 in)
C	Centre of 9.9mm dia hole to centre of 9.9mm dia hole	1511 mm (59.47 in)
D	Centre of 9.9mm dia hole to centre of 10.1mm dia datum hole	1600 mm (63.00 in)

Vehicle Dimensions - Measuring Points

Important: Dimensions are measured from the centre of holes, on the outer side of the metal surface.

1



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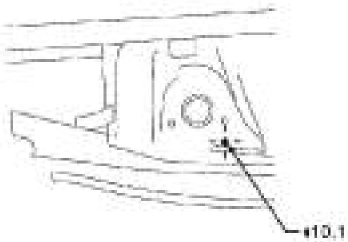

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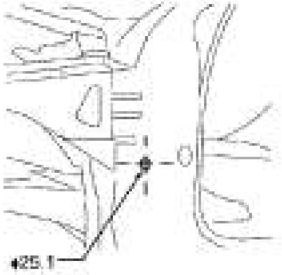

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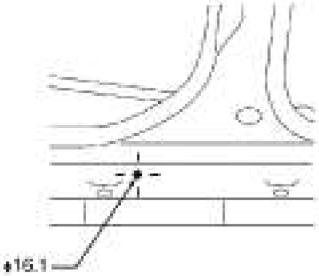

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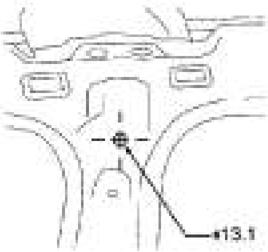

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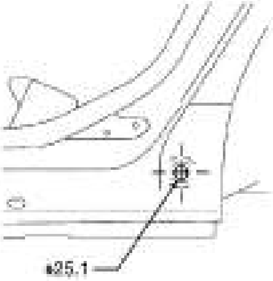

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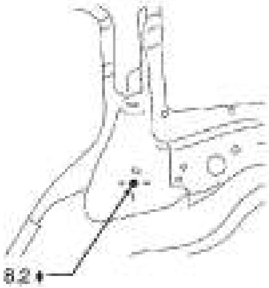

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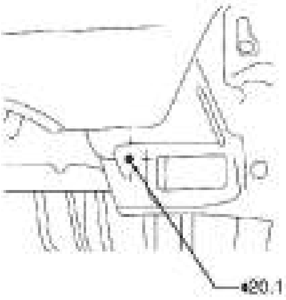

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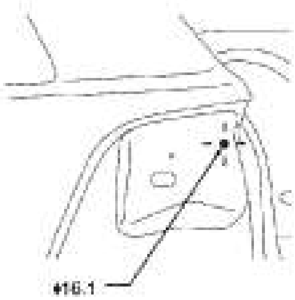


Front Frame Replacement

Tools Required

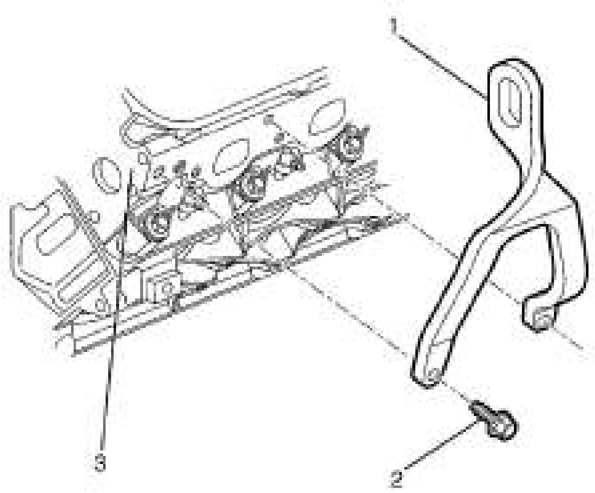
EN 46114 Engine Lift Bracket

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Remove the engine dress cover. Refer to Engine Cover Replacement for 3.6L engine or Engine Cover Replacement for 6.0L engine.
2. Remove the radiator air baffle. Refer to Radiator Air Upper Baffle and Deflector Replacement .

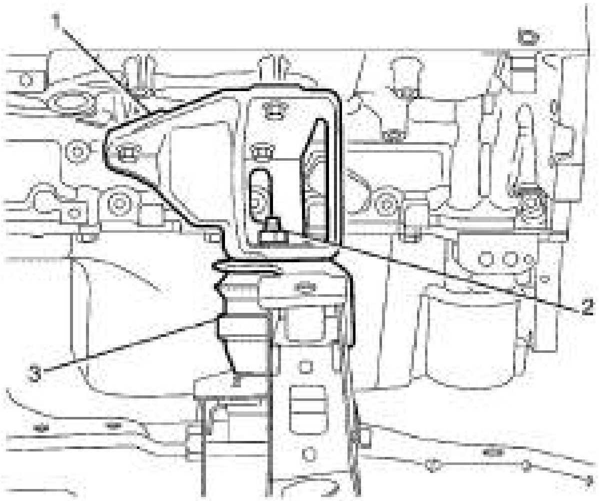


3. Position the EN 46114 (1) on the cylinder head (2).

Notice: Refer to Fastener Notice in the Preface section.

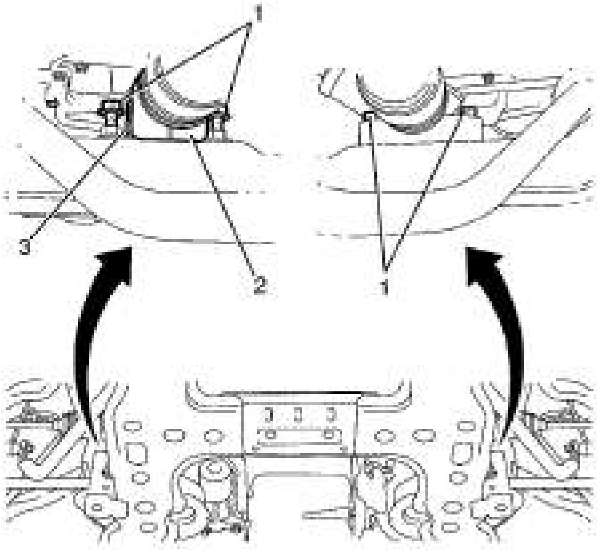
4. Install the EN 46114 to cylinder head retaining bolts (3).

Tighten
Tighten the EN 46114 to cylinder head retaining bolts (3) to 50 N·m (36 lb ft).

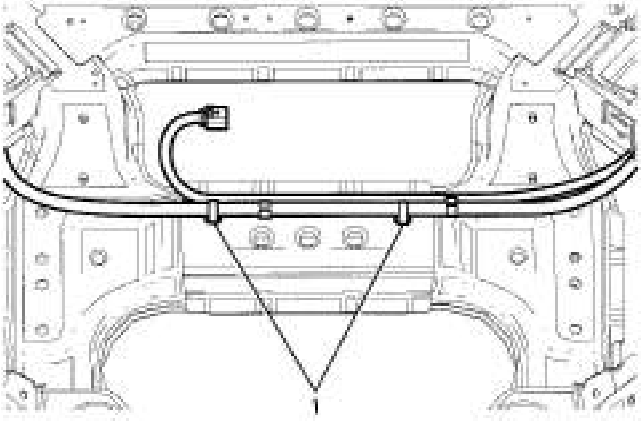


Important: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

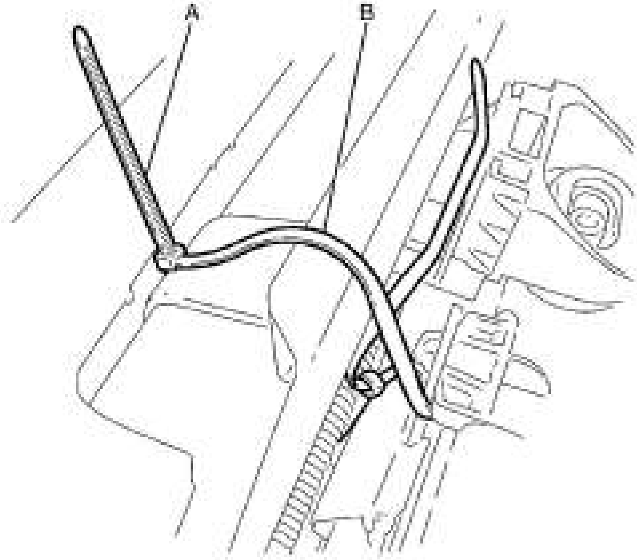
5. Install a suitable lifting tool and raise the engine assembly until the engine mount brackets (1) are clear of the engine mount retainers (2).
6. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
7. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement.
8. Remove the front air deflector. Refer to Front Air Deflector Replacement.
9. Remove the splash shield. Refer to Engine Splash Shield Replacement.
10. Remove the front control arm. Refer to Control Arm Replacement.
11. Remove the front castor arm. Refer to Front Lower Control Front Arm Replacement.
12. Remove the stabilizer shaft link. Refer to Stabilizer Shaft Link Replacement.



13. Remove the steering gear to subframe retaining bolts (1).



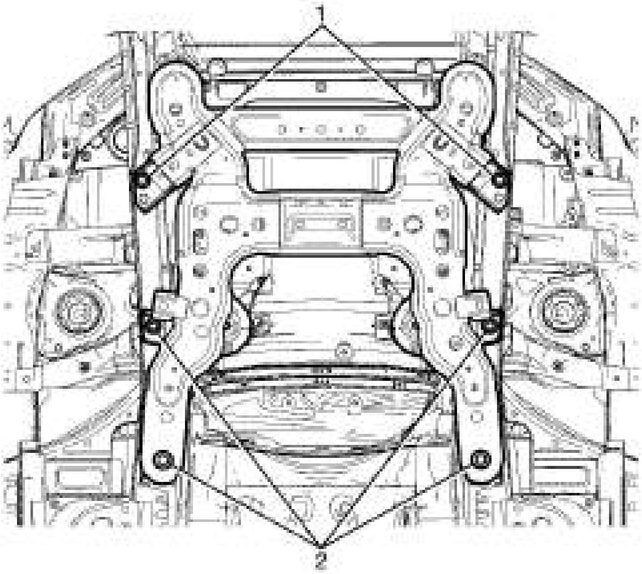
14. Disconnect the electrical harness retainers (1) securing the engine harness to the frame.



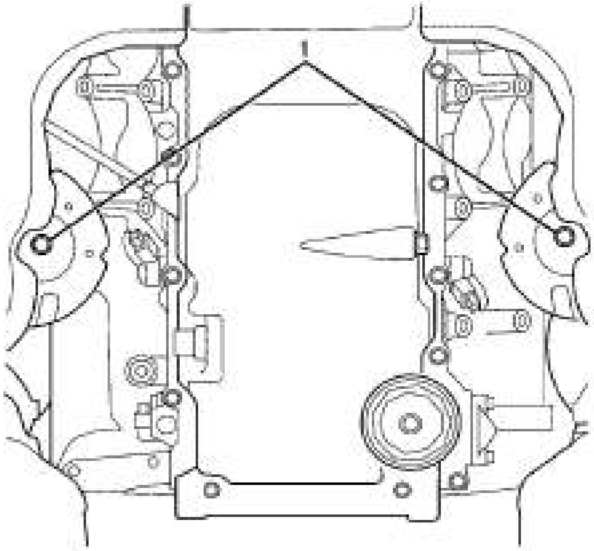
Important: It is necessary to secure the radiator to the front end assembly, as the radiator is supported by the subframe.

Important: Thread zip tie A around the front end assembly and zip tie B through the radiator and condenser mount. Insert zip tie A into the retainer of zip tie B and insert zip tie B into the retainer of zip tie A.

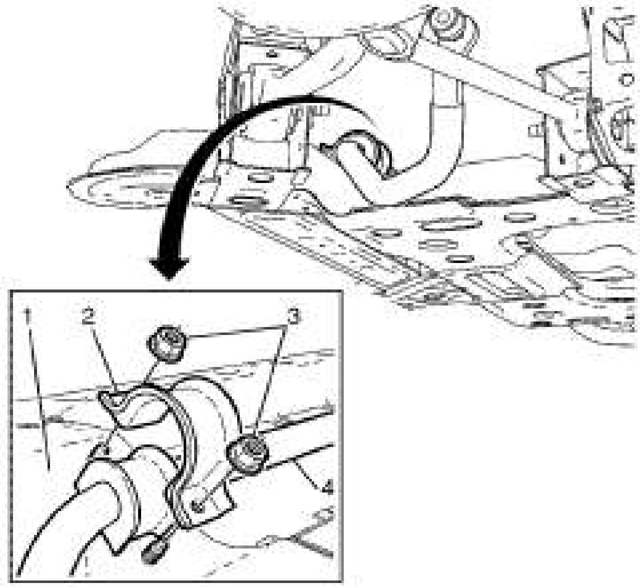
15. Secure the radiator to the radiator upper mounting brackets.



16. Install a suitable bench trolley under the frame.
17. Lower the vehicle to the frame support table.
18. Remove the front sub frame to front chassis rail retaining bolts (2).
19. Carefully raise the body from the frame.
20. Make sure when raising the body the following items are clear from the frame.
    - The brake pipes
    - The steering knuckle assembly
    - The wheel speed sensor electrical harness



21. Remove the lower engine mount to front sub frame retaining nuts (1).



Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

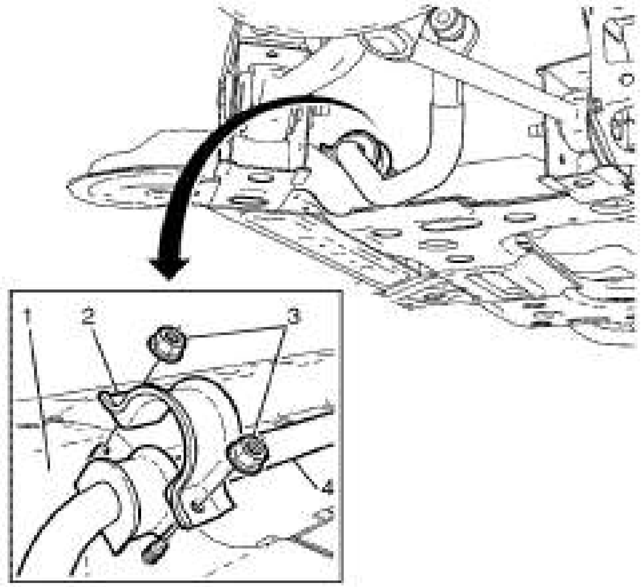
22. Remove the stabliser bar insulator bracket to subframe retaining nuts (3) on both sides of the stabiliser bar (4). Repeat for the opposite side.

    Discard the nuts.

23. Remove the stabliser bar insulator bracket (2) from the subframe (1) on both sides of the stabiliser bar.
24. Remove the stabliser bar from the front subframe.
25. With the aid of an assistant, remove the frame from the support fixture.

Installation Procedure

1. With the aid of an assistant, install the frame to the support fixture.



2. Install the stabilizer bar to the front subframe.
3. install the stabilizer bar caps (2) to the front subframe

   Important: Do not fully tighten the stabilizer shaft retaining bolts to the frame at this stage.

4. Install NEW stabilizer shaft to front sub frame retaining nuts (3).

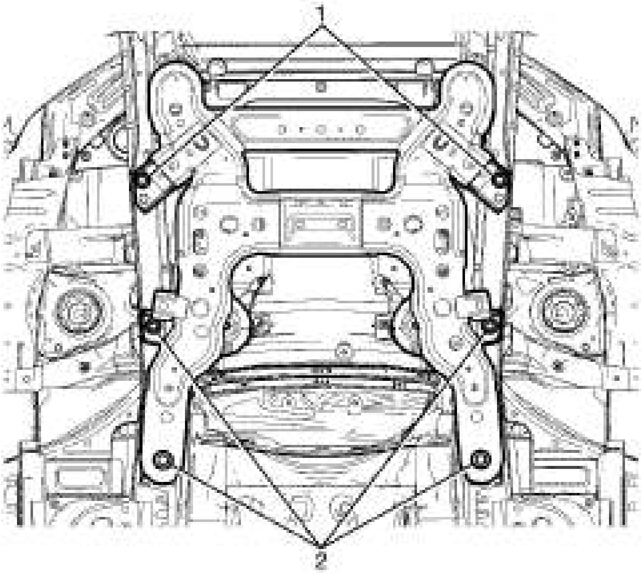
   Do not fully tighten at this stage.

5. Install the engine mount to the front subframe.
6. Install the lower engine mount to front sub frame retaining nuts (2).

   Do not fully tighten at this stage.

7. Carefully lower the body to the frame.
8. Make sure the following components are clear from the frame.
   - The wheel speed sensor electrical harness
   - The steering knuckle assembly
   - The brake pipes

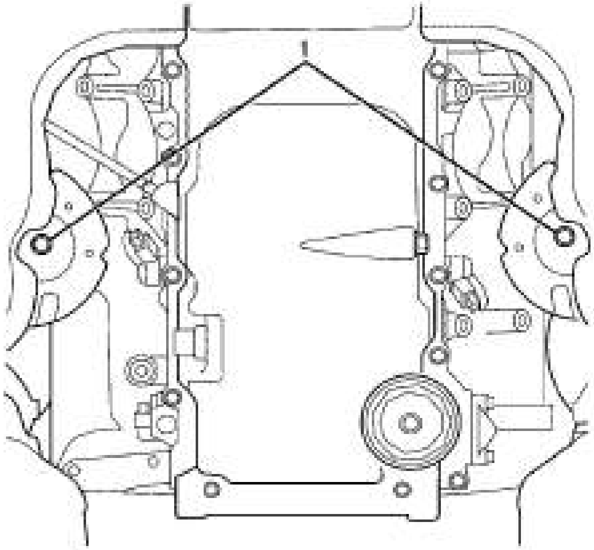
   Notice: Refer to Fastener Notice in the Preface section.



9. Install the front sub frame to front chassis rail retaining bolts (1 and 2).

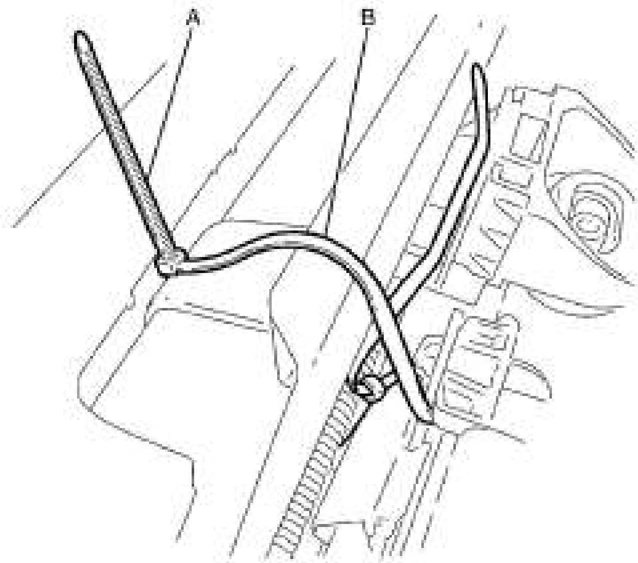
   Tighten
   Tighten the bolts to 95 N·m (70 lb ft).

10. Raise the vehicle.
11. Remove the suitable bench trolley from under the vehicle.
12. Lower the engine and remove the suitable lifting tool from the engine.

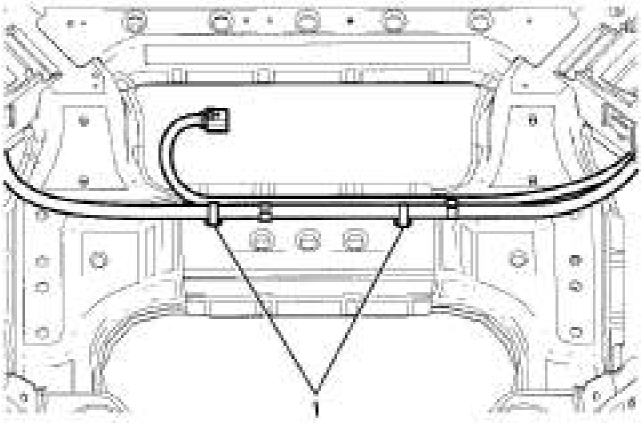


13. Install the lower engine mount to front sub frame retaining nuts (2).

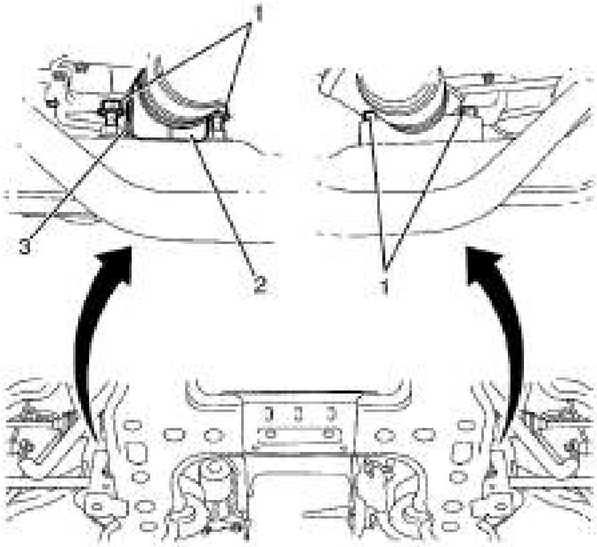
   Tighten
   Tighten the retaining nuts to 80 N·m (59 lb ft).



14. Cut zip tie A around the front end assembly and zip tie B through the radiator and condenser mount.



15. Secure the engine electrical harness retainers (1) to the frame.



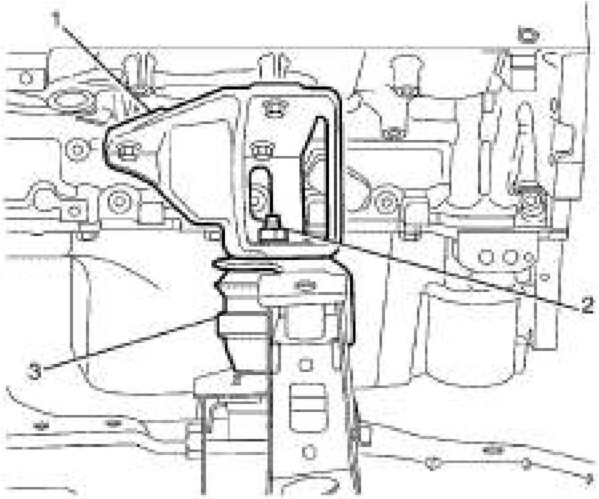
16. Install the steering gear insulator (3) to the steering gear.
17. Install the steering gear insulator retaining bracket (2) to the steering gear insulator (3).

    Notice: Refer to Fastener Notice in the Preface section.

18. Install the steering gear to subframe retaining bolts (1).

    Tighten
    Tighten the retaining bolts to 65 N·m (48 lb ft).

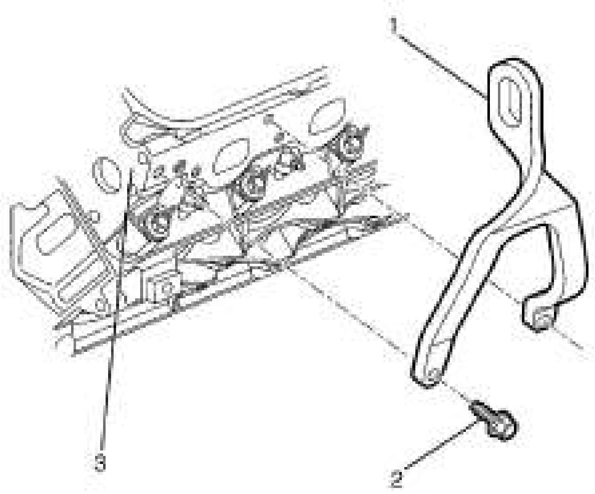
19. Install the stabilizer shaft link. Refer to Stabilizer Shaft Link Replacement.
20. Install the front castor arm. Refer to Front Lower Control Front Arm Replacement.
21. Install the front control arm. Refer to Control Arm Replacement.
22. Install the splash shield. Refer to Engine Splash Shield Replacement.
23. Install the front air deflector. Refer to Front Air Deflector Replacement.
24. Install the front bumper fascia. Refer to Front Bumper Fascia Replacement.



Important: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

25. Lower the suitable lifting tool until the engine mount brackets are located on the engine mount retainers.

Notice: Refer to Fastener Notice in the Preface section.

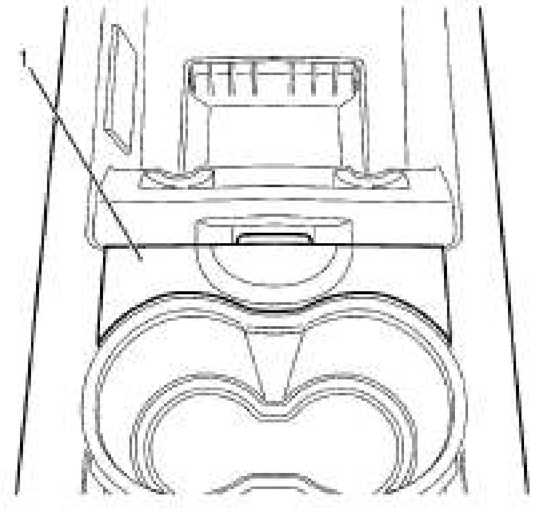


26. Remove the EN 46114 to cylinder head retaining bolts (3).
27. Remove the EN 46114 (1) from the cylinder head (2).
28. Install the radiator air baffle. Refer to Radiator Air Upper Baffle and Deflector Replacement
29. Install the engine dress cover. Refer to Engine Cover Replacement for 3.6L engine or Engine Cover Replacement for 6.0L engine.
30. Align the vehicle. Refer to Wheel Alignment Measurement .

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Repair | Frame and Underbody | Repair Instructions | **Document ID: 1993239**

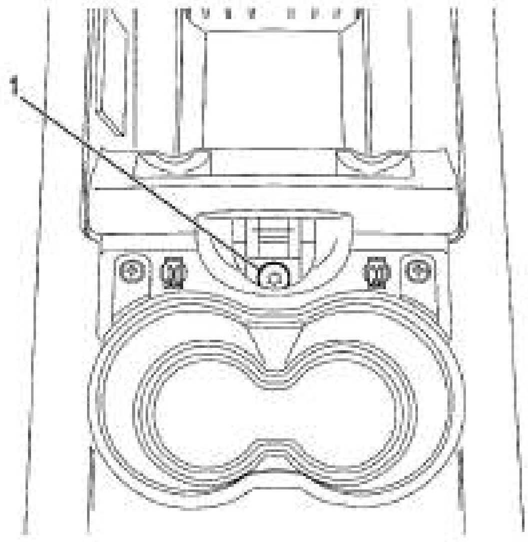
Rear Frame Replacement

Removal Procedure

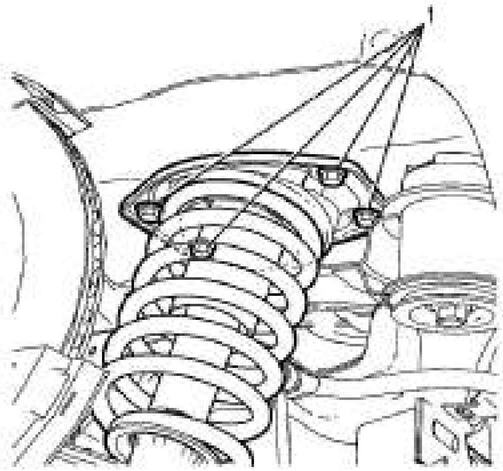


Important: The park brake cable adjustment bolt cover trim (1) is retained by two clips. Gently pry upwards with fingers at the front floor console armrest latch to remove.

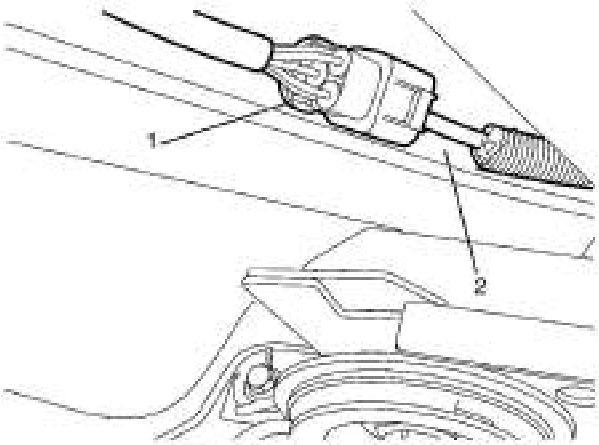
1. Remove the park brake cable adjustment bolt cover trim (1).



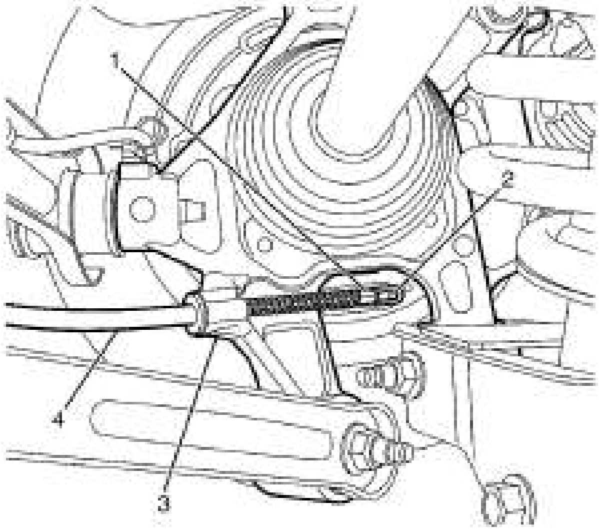
2. Loosen the park brake cable adjustment bolt (1) all the way to ensure maximum slack in the rear park brake cables.
3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
4. Remove the rear wheels. Refer to Tire and Wheel Removal and Installation .
5. Remove the exhaust system. Refer to Exhaust System Replacement .
6. Remove the propeller shaft. Refer to Propeller Shaft Replacement .
7. Remove the drive shafts. Refer to Wheel Drive Shaft Replacement .
8. Remove the differential. Refer to Differential Replacement .



9. Remove the top strut assembly to body retaining bolts (1).



10. Disconnect the wheel speed sensor jumper harness electrical connector (1).

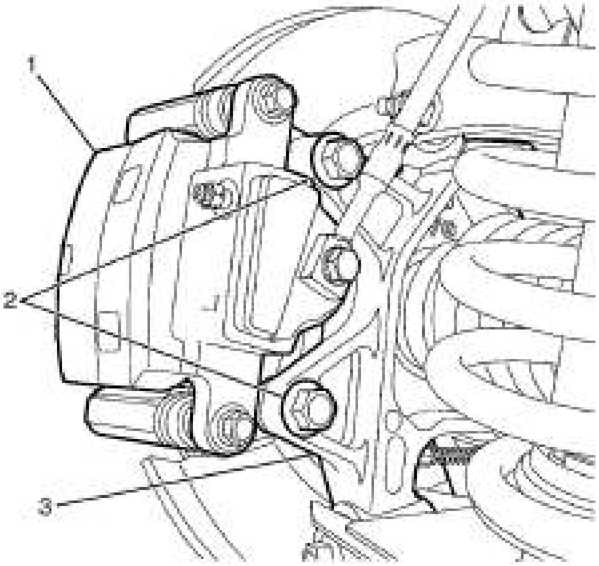


Important: Detach the rear park brake cable and clevis (1) from the park brake actuator (2) by pivoting the rear park brake cable and clevis (1) rearward using pliers.

11. Detach the rear park brake cable and clevis (1) from the park brake actuator (2).

Important: Remove the outer cable (4) from the rear knuckle (3) by pulling the outer cable (4) forward.

12. Remove the outer cable (4) from the rear knuckle (3).



Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

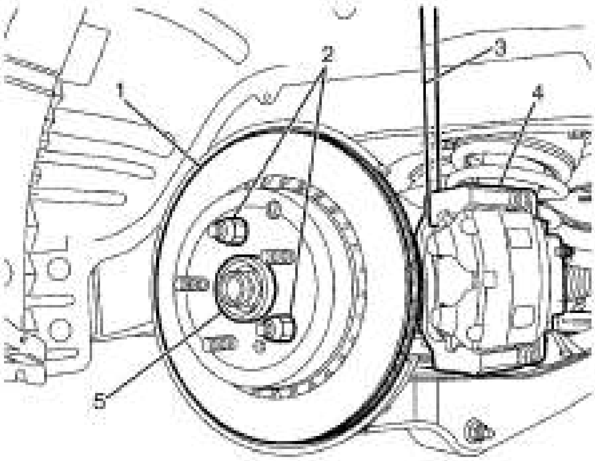
13. Remove the brake caliper anchor plate to knuckle retaining bolts (1).

    Discard the bolts.

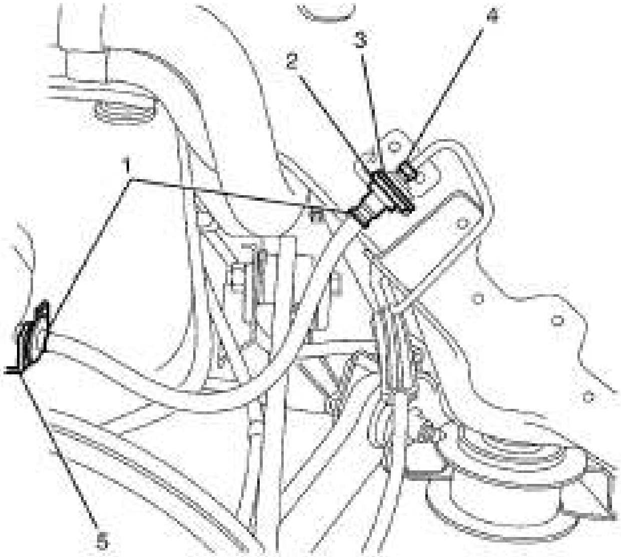
    Important: DO NOT disconnect the hydraulic brake flexible hose from the brake caliper otherwise complete bleeding of the braking system will be necessary.

14. Remove the brake caliper (2) from the knuckle (3).

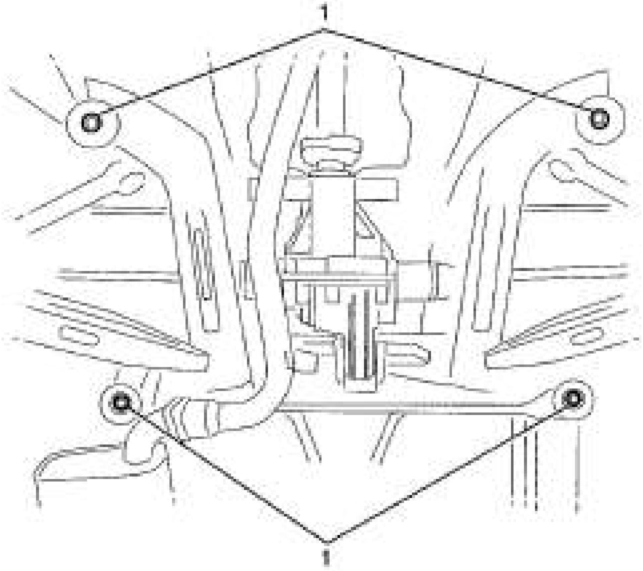
    Notice: Refer to Brake Caliper Notice in the Preface section.



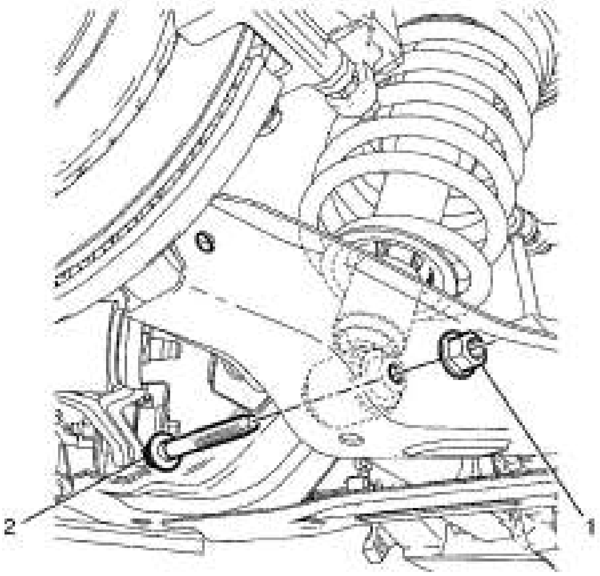
15. Support the brake caliper (1) with heavy mechanic's wire, or equivalent (2).
16. Remove the 2 wheel nuts (4) retaining the brake disc (3) to the hub (5).
17. Clean all dirt and foreign material from the brake hose and the brake pipe fittings.



18. Detach the brake hose (1) from the upper control arm mounted brake hose retaining bracket (5).
19. Position the suitable frame support table under the vehicle.
20. Using suitable frame support table, lower the vehicle to the frame support table.

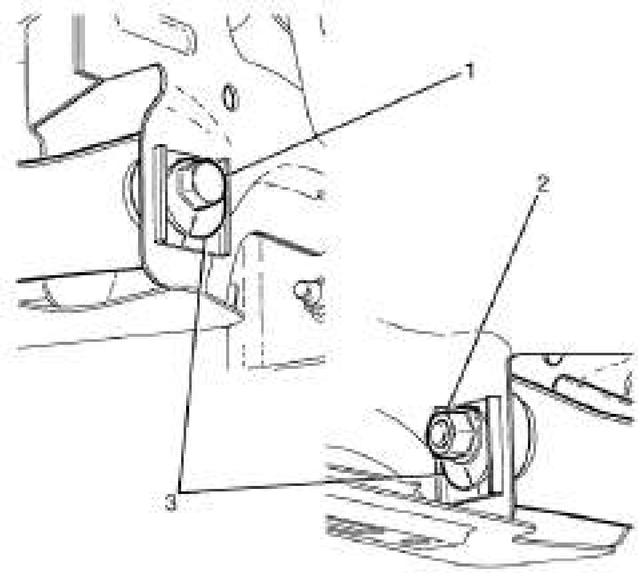


21. Remove the rear sub frame to rear chassis rail retaining bolts (4) and washers (3).
22. Carefully raise the vehicle from the rear frame assembly.
23. Remove the headlamp levelling sensor. Refer to Headlamp Leveling Module Replacement .
24. Remove the stabiliser shaft link. Refer to Stabilizer Shaft Link Replacement .
25. Remove the stabiliser shaft. Refer to Stabilizer Shaft Replacement .
26. Remove the rear wheel hub and knuckle assembly. Refer to Knuckle Replacement in rear Suspension..



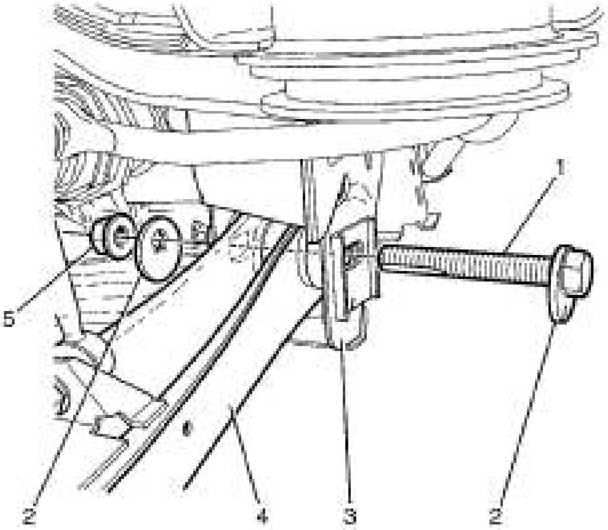
27. Remove the rear strut assembly to lower control arm retaining bolt (2) and nut (1).

    Discard the nut.



Important: The lower control arm to subframe retaining bolt (1) and nut (2) eccentric washers (3) are used to adjust the rear suspension camber. One eccentric washer (3) is mounted directly to the head of the lower control arm to subframe retaining bolt (1).

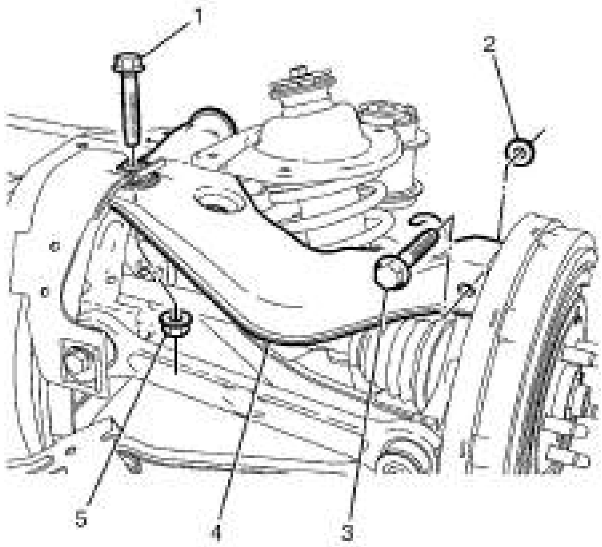
28. Scribe the eccentric washers (3) with reference to their seating position relative to the subframe.



29. Remove the lower control arm to subframe retaining bolt (1) and nut (5).

Discard the nut.

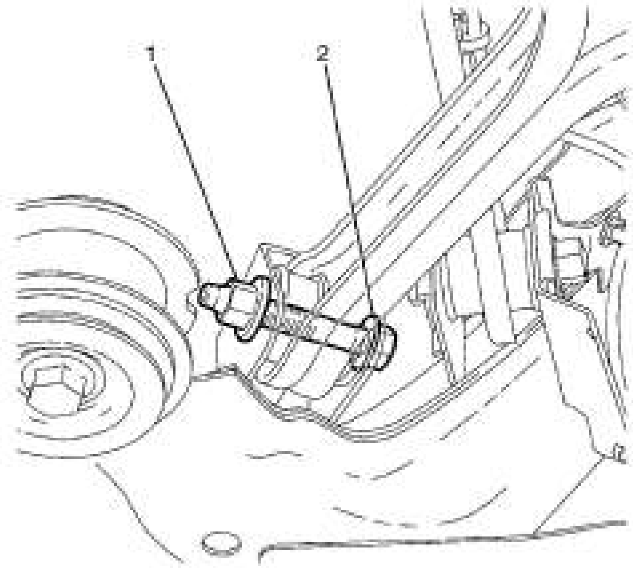
30. Remove the lower control arm (4) from the subframe (3).
31. Remove the upper control arm pivot bushing. Refer to Knuckle Replacement .



Important: Nuts with micro-encapsulated thread sealant must be replaced after removal.

32. Remove the upper control arm ball joint bushing to subframe retaining bolt (1) and nut (5).

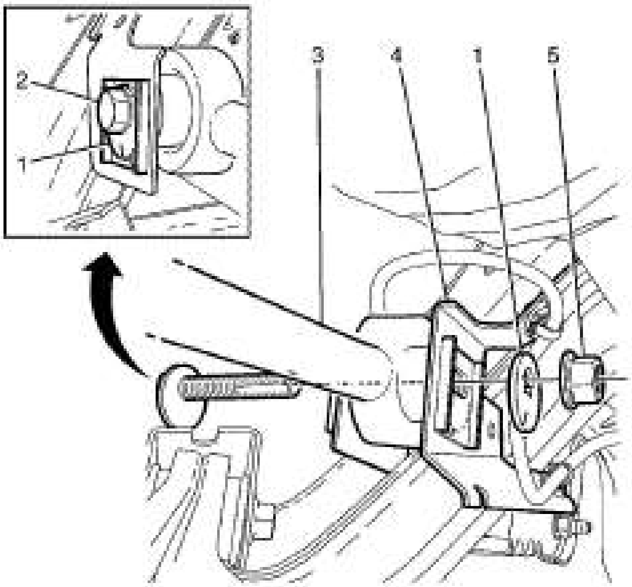
Discard the nut.



33. Remove the Y-Link to subframe retaining bolt (2) and nut (1).

Discard the nut.

34. Remove the Y-Link (5).



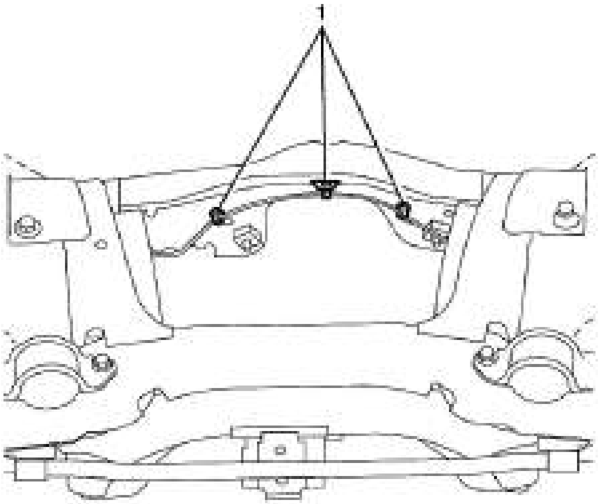
Important: The I-Link to subframe retaining bolt (2), nut (5) and eccentric washers (1) are used to adjust the rear suspension toe. One eccentric washer (1) is mounted directly to the head of the I-Link to subframe retaining bolt (2).

35. Scribe the eccentric washers (1) with reference to their seating position relative to the subframe (4).

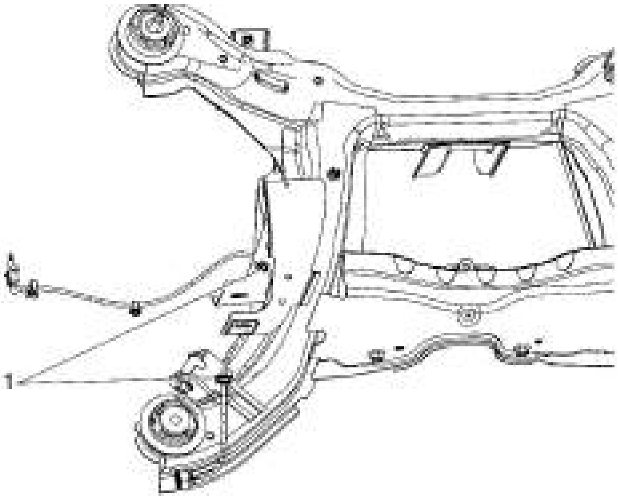
Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

Discard the nut.

36. Remove the I-Link to subframe retaining bolt (2) and nut (5).
37. Remove the I-Link (3) from the subframe (4).

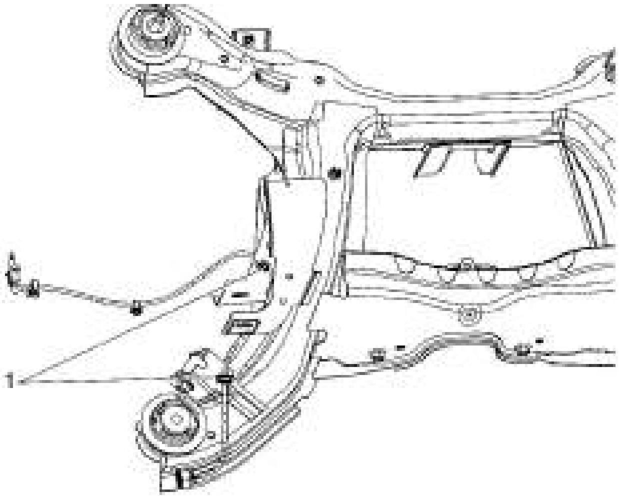


38. Disconnect the rear frame wiring harness to rear frame center retaining clips (1).

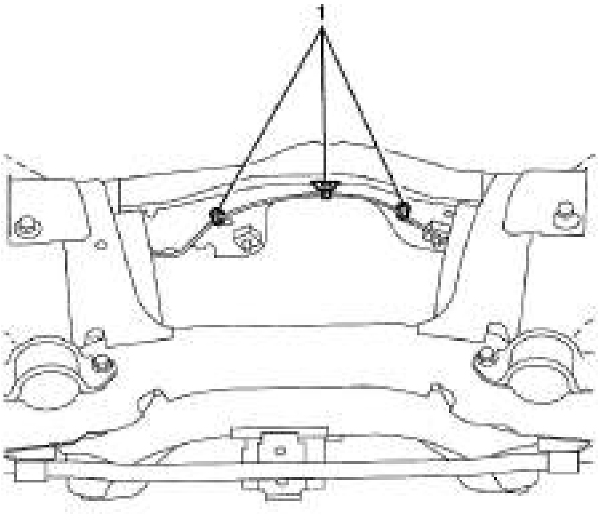


39. Disconnect the rear frame wiring harness to rear frame side retaining clips (1).

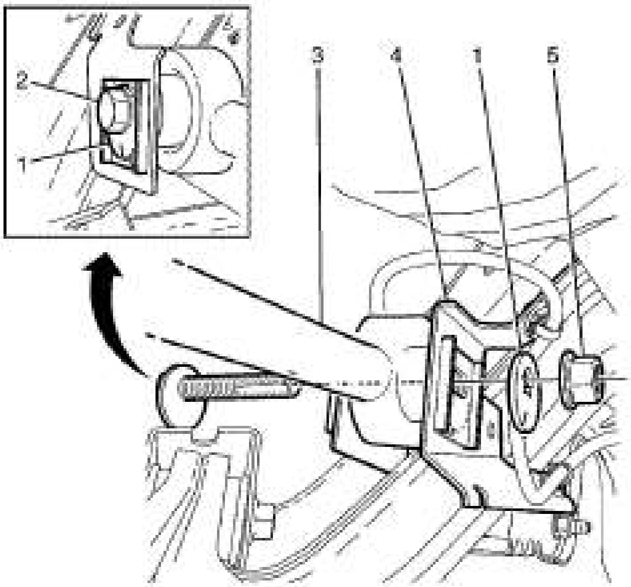
Installation Procedure



1. Connect the rear frame wiring harness to rear subframe side retaining clips (1).



2. Connect the rear frame wiring harness to rear subframe center retaining clips (1).



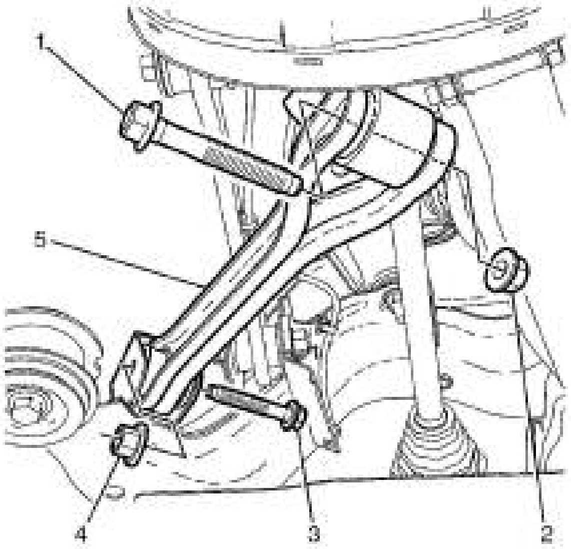
3. Install the I-Link (3) into the rear subframe (4).

Important: The eccentric washers (1) must be fitted correctly in terms of their orientation and alignment marks.

Important: The I-Link to rear subframe retaining bolt (2) and NEW nut (5) must not to be fully tightened at this stage.

4. Install the I-Link to rear subframe retaining bolt (2).
5. Install the eccentric washer (1) and the NEW nut (5).

Do not fully tighten at this stage.



6. Install the Y-Link (5) to the rear subframe.

   Important: The Y-Link to subframe retaining bolt (3) and nut (4) must not to be fully tightened at this stage.

7. Install the Y-Link to rear subframe retaining bolt (3) and NEW nut (4).

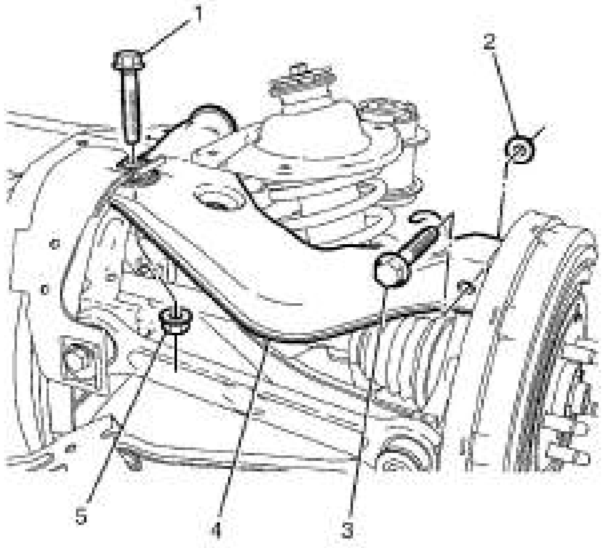
   Do not fully tighten at this stage.

   Important: The Y-Link to knuckle retaining bolt (1) and nut (2) must not to be fully tightened at this stage.

8. Install the Y-Link to knuckle retaining bolt (1) and NEW nut (2).

   Do not fully tighten at this stage.

   Notice: Refer to Fastener Notice in the Preface section.



9. Install the upper control arm (4) into the rear subframe.
10. Install the upper control arm ball joint bushing to rear subframe retaining bolt (1) and NEW nut (5).

    Tighten
    Tighten the bolt and nut a first pass to 40 N·m (30 lb ft).

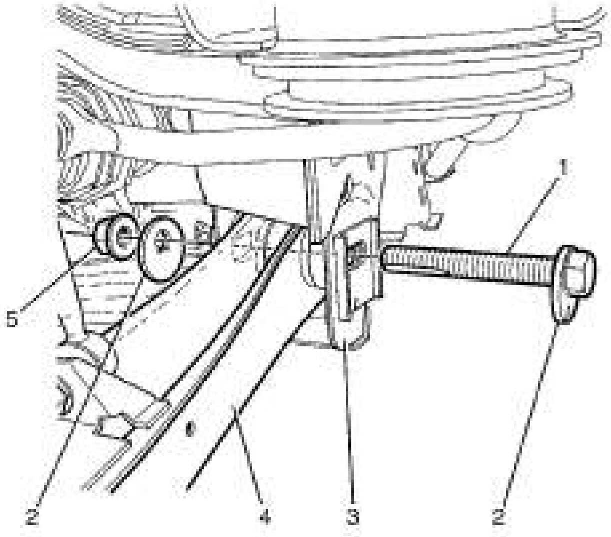
    Tighten
    Tighten the bolt and nut a final pass 90 Degrees.

11. Install the upper control arm to knuckle retaining bolt (3) and NEW nut (2).

Tighten
Tighten the bolt and nut a first pass to 60 N·m (44 lb ft).

Tighten
Tighten the bolt and nut a second pass an additional 90 degrees.

12. Install the upper control arm pivot bushing. Refer to Knuckle Replacement .



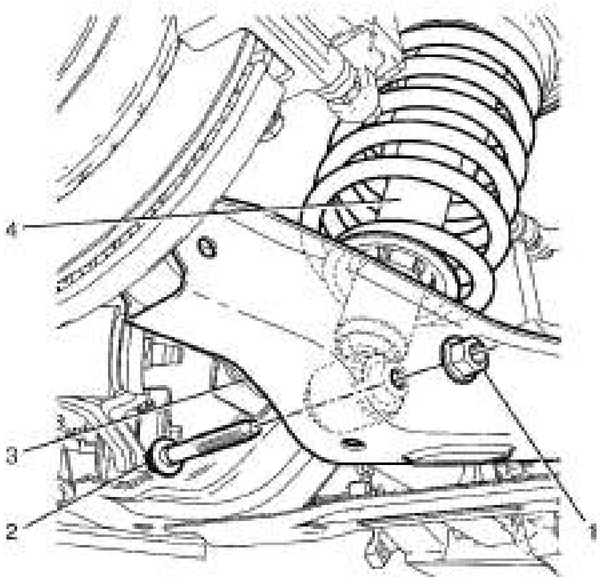
13. Install the lower control arm (4) into the rear subframe (3).

Important: The eccentric washers (2) must be fitted correctly in terms of their orientation and alignment marks.

Important: Do not fully tighten the lower control arm to rear subframe retaining bolt (1) and nut (5) at this stage.

14. Install the lower control arm to rear subframe retaining bolt (1).
15. Install the eccentric washer (2) and the NEW nut (5).

Do not fully tighten at this stage.



16. Connect the rear strut assembly (4) to the lower control arm (3).

    Important: Do not fully tighten the lower control arm to strut assembly retaining bolt (2) and nut (1) at this stage.

17. Install the lower control arm to strut assembly retaining bolt (2) and NEW nut (1).

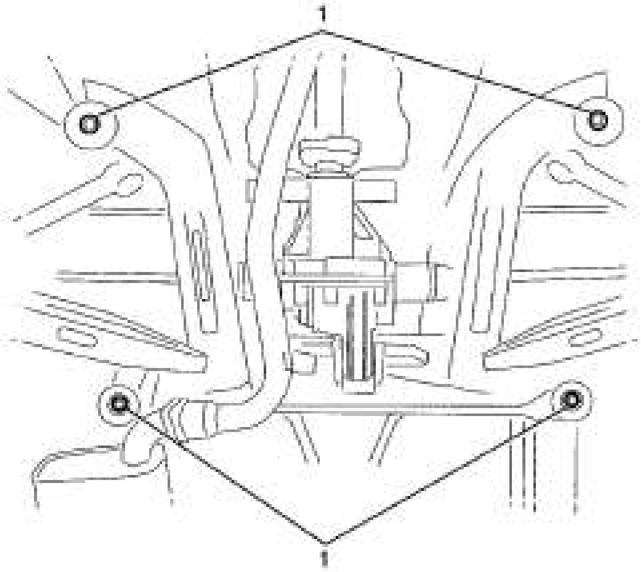
    Do not fully tighten at this stage.

18. Install the rear wheel hub and knuckle assembly. Refer to Knuckle Replacement in rear Suspension.
19. Install the stabiliser shaft. Refer to Stabilizer Shaft Replacement .
20. Install the stabiliser shaft link. Refer to Stabilizer Shaft Link Replacement .
21. Install the headlamp levelling sensor. Refer to Headlamp Leveling Module Replacement .

    Important: Make sure the intermediate brake cable is clear of the rear frame to body mount prior to securing the frame retaining bolts.

22. Lower the vehicle to the frame.
23. Index the rear side frame mounts to the rear locator sleeves located on the body.
24. Lower the vehicle until the frame mounts contact the body rail.

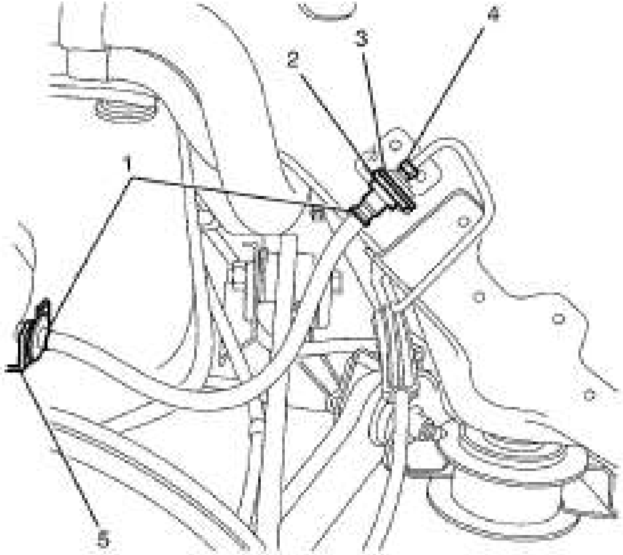
    Notice: Refer to Fastener Notice in the Preface section.



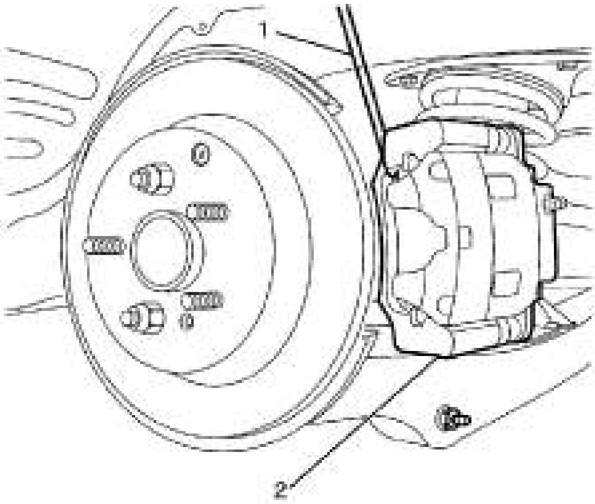
25. Install the rear sub frame to rear chassis rail retaining bolts.

    Tighten
    Tighten the bolts to 200 N·m (148 lb ft).

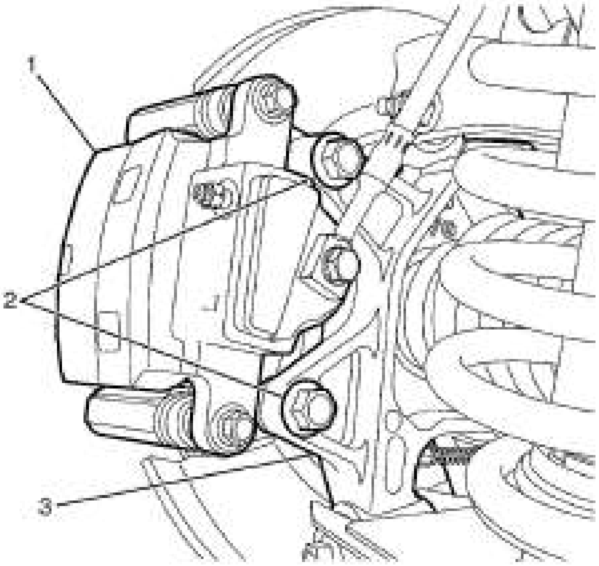
26. Raise the vehicle.
27. Remove the suitable frame support table from under the vehicle.



28. Attach the brake hose (1) from the upper control arm mounted brake hose retaining bracket (5).



29. Remove the heavy mechanic's wire, or equivalent support (2) from the brake caliper (1).



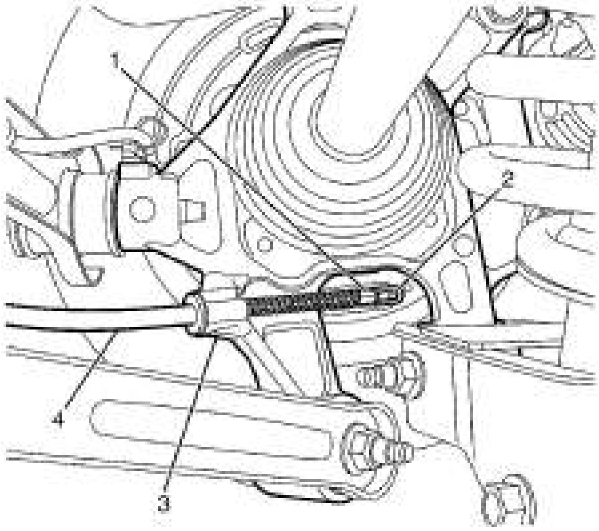
Notice: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

30. Install the brake caliper assembly (2) to the knuckle (3).

Notice: Refer to Fastener Notice in the Preface section.

31. Install the NEW brake caliper anchor plate to knuckle retaining bolts (1).

Tighten
Tighten the bolts to 110 N·m (81 lb ft).

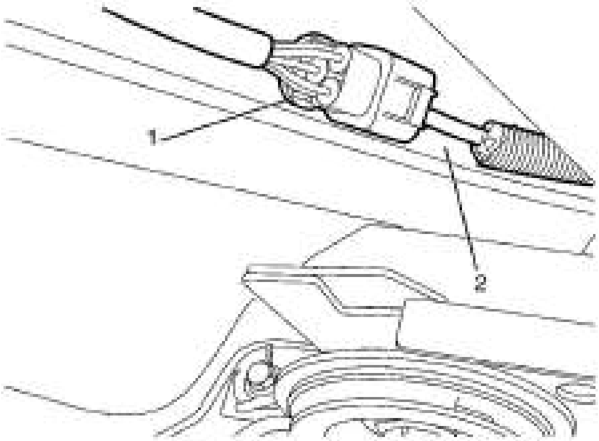


32. Install the rear park brake cable (4) into the rear knuckle (3).

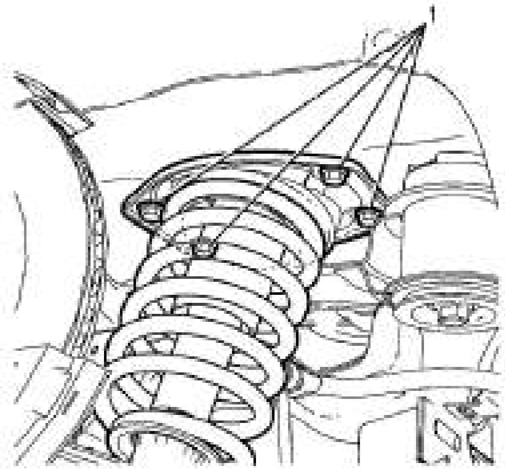
    Make sure that the rear park brake cables (4) are properly seated.

    Important: Attach the rear park brake cable and clevis (1) to the park brake actuator (2) by pivoting the rear park brake cable and clevis (1) rearward using pliers.

33. Attach the rear park brake cable and clevis (1) to the park brake actuator (2).

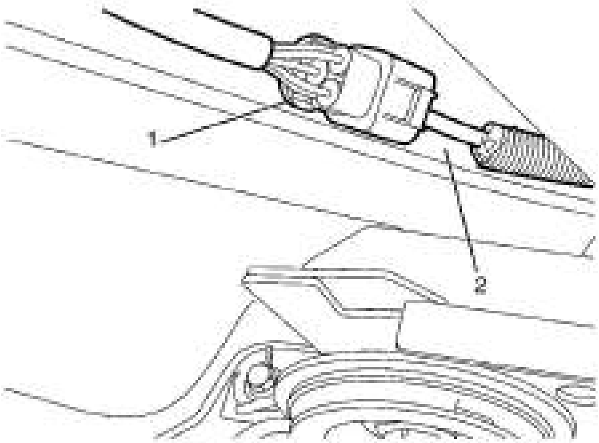


34. Connect the wheel speed sensor jumper harness electrical connector (1).

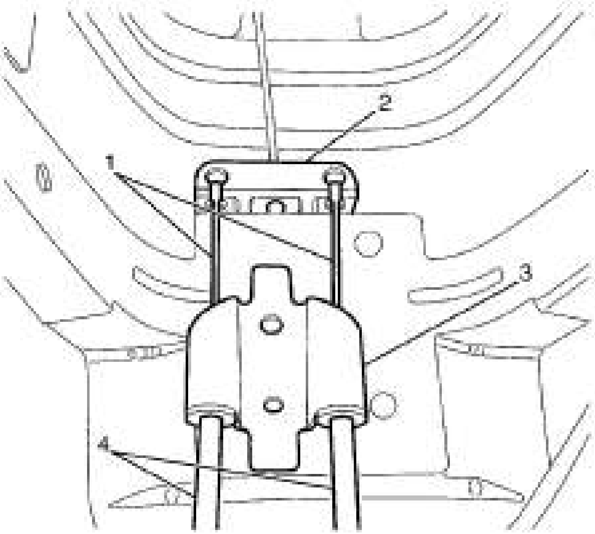


35. Install the top strut assembly to body retaining bolts (1).

    Tighten
    Tighten the bolts to 58 N·m (43 lb ft).



36. Connect the wheel speed sensor jumper harness electrical connector (1).
37. Attach the electrical connector (1) to the right hand rail (2).

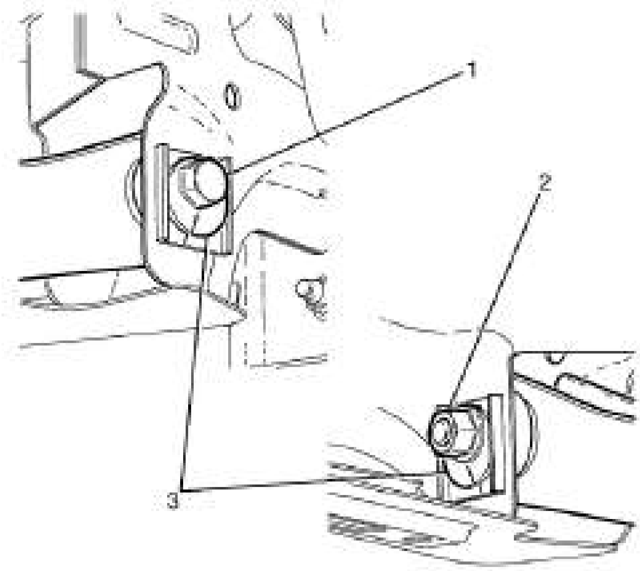


38. Install the outer cable (4) to the vehicle underbody bracket (3).

    Make sure that the outer cables (4) are properly seated in the vehicle underbody bracket (3).

    Important: Wrap a workshop cloth around the rear inner cable (1) to protect it from damage. Using pliers, pull the rear inner cable (1) forward and downwards to install the ball nipple to the front park brake cable and equaliser bracket assembly (2).

39. Install the rear inner cables (1) to the front park brake cable and equaliser bracket assembly (2).
40. Install the rear strut assembly. Refer to Strut Assembly Replacement in Rear Suspension.
41. Install the differential. Refer to Differential Replacement .
42. Install the drive shafts. Refer to Wheel Drive Shaft Replacement .
43. Install the propeller shaft. Refer to Propeller Shaft Replacement .
44. Install the exhaust system. Refer to Exhaust System Replacement .
45. Install the rear wheel. Refer to Tire and Wheel Removal and Installation .
46. Lower the vehicle to the ground.
47. Bounce the vehicle several times to settle the suspension.



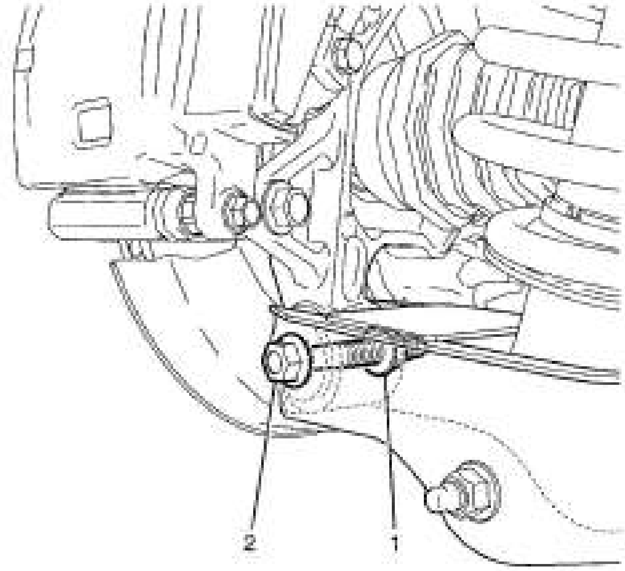
Important: The lower control arm to the subframe retaining bolt (1) and nut (2) eccentric washers (3) are used to adjust rear suspension camber.

48. Align the marks on the eccentric washers (3) with the marks on the subframe.

Important: Make sure that the vehicle is positioned on a suitable hoist to load the rear suspension bushes to the correct position.

49. Tighten the lower control arm to subframe retaining bolt (1) and nut (2).

Tighten
Tighten the bolt and nut to 175 N·m (129 lb ft).

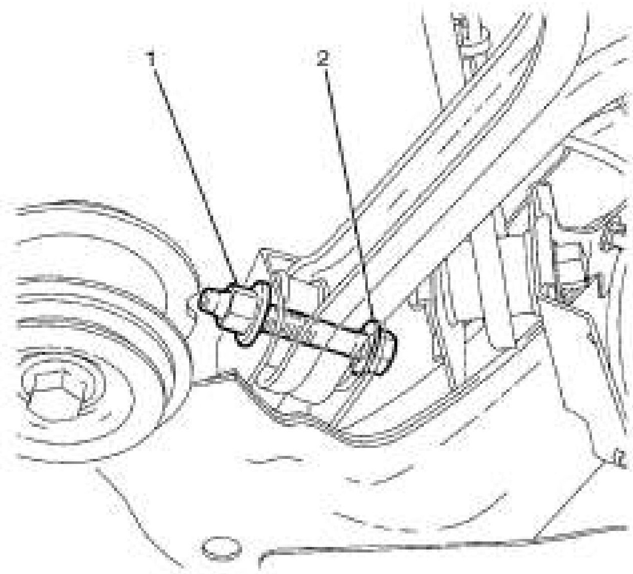


50. Tighten the lower control arm to knuckle retaining bolt (2) and nut (1).

    Tighten
    Tighten the bolt and nut a first pass to 40 N·m (30 lb ft).

    Tighten
    Tighten the bolt and nut a final pass 120 Degrees.

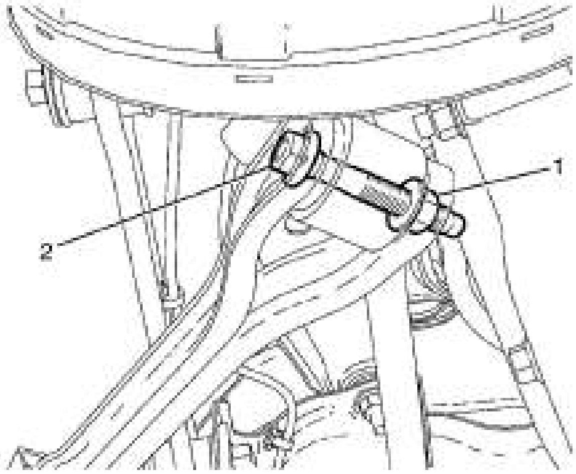
    Notice: Refer to Fastener Notice in the Preface section.



Important: Make sure that the vehicle is positioned on a suitable hoist to load the rear suspension bushes to the correct position.

51. Tighten the Y-Link to subframe retaining bolt (2) and NEW nut (1).

    Tighten
    Tighten the bolt and nut to 100 N·m (74 lb ft).

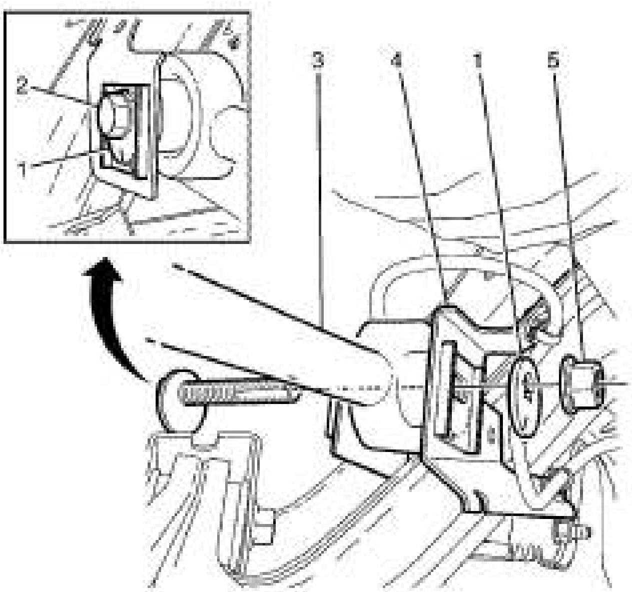


52. Tighten the Y-Link to knuckle retaining bolt (2) and NEW nut (1).

    Tighten
    Tighten the bolt and nut a first pass to 40 N·m (30 lb ft).

    Tighten
    Tighten the bolt and nut a final pass 120 Degrees.

    Notice: Refer to Fastener Notice in the Preface section.



Important: Make sure that the vehicle is positioned on a suitable hoist to load the rear suspension bushes to the correct position.

53. Align the marks on the eccentric washers (1) with the marks on the subframe (3).
54. Tighten the I-Link to subframe retaining bolt (2) and NEW nut (4).

    Tighten
    Tighten the bolt and nut to 175 N·m (129 lb ft).

55. Check the wheel alignment of the vehicle. Refer to Wheel Alignment Measurement .
56. Correct the wheel alignment of the vehicle, if necessary. Refer to Rear Camber Adjustment ; and Rear Toe Adjustment .

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Rear Suspension Support Bushing Replacement

Tools Required

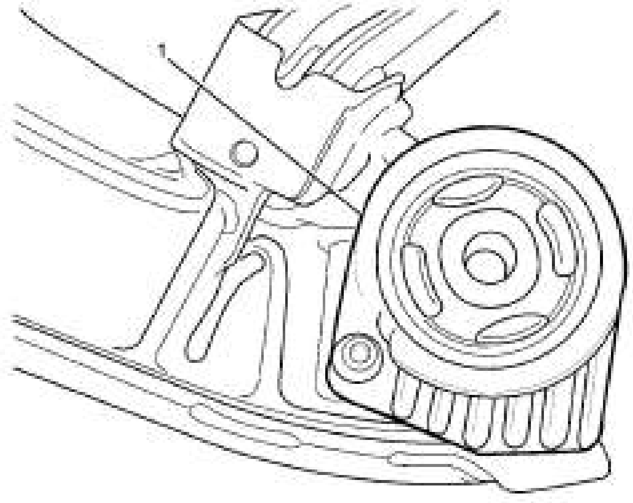
CH-49509 Rear Frame Bush Removal tool

Removal Procedure

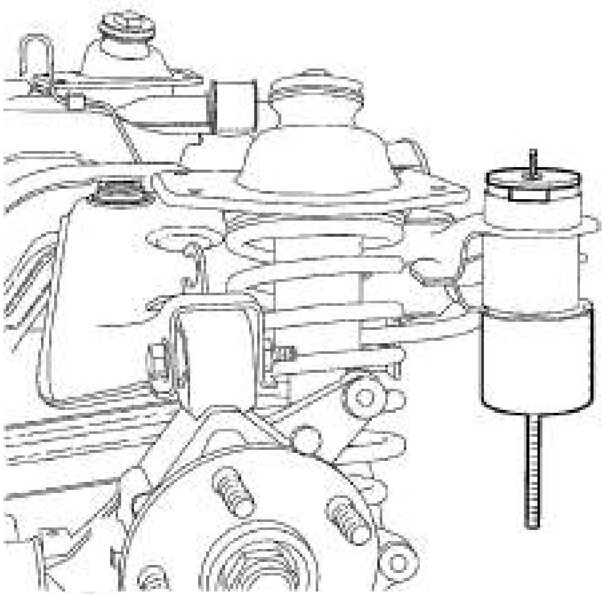
> **Caution:** Refer to Safety Glasses Caution in the Preface section.

> **Caution:** Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear sub frame from the vehicle. Refer to Rear Frame Replacement.

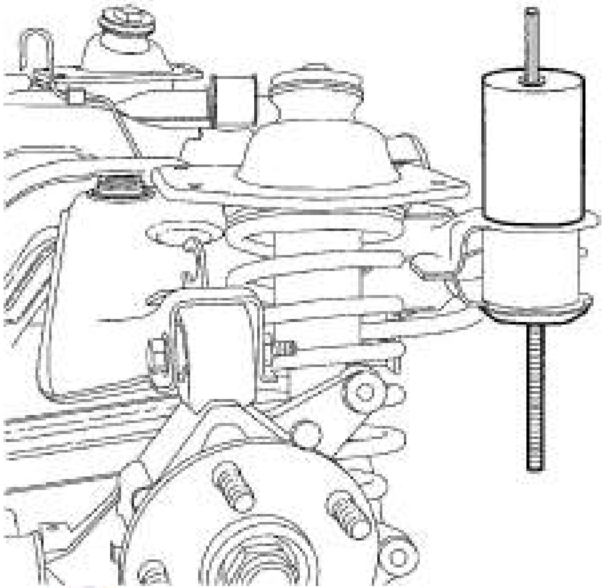


3. Remove the rear sub frame insulator rubber (1) from the rear sub frame.

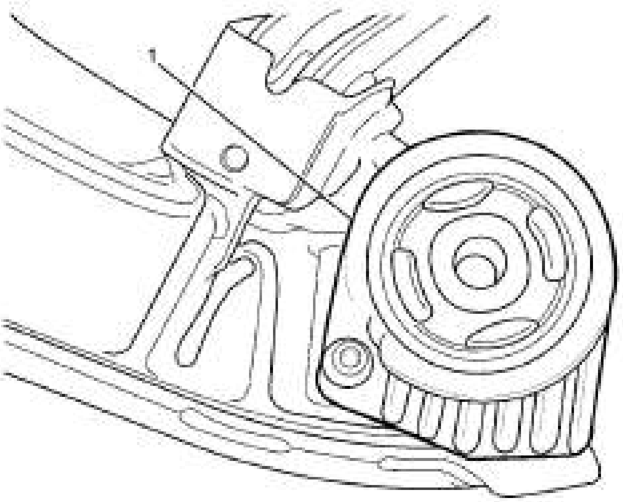


4. Install the rear sub frame bush tool CH-49509 to the rear sub frame bush.
5. Remove the rear sub frame bush by slowly pressing the rear sub frame removal tool into the rear sub frame.
6. Remove the rear sub frame bush from the rear sub frame.

Installation Procedure



1. Install the rear sub frame bush to the rear sub frame.
2. Install the rear sub frame bush tool CH-49509 to the rear sub frame bush.
3. Install the rear sub frame bush by slowly pressing rear sub frame tool.
4. Remove the rear sub frame bush tool from the rear sub frame.



5. Install the rear sub frame insulator rubber (1) to the rear sub frame.
6. Install the rear sub frame to the vehicle. Refer to Rear Frame Replacement.

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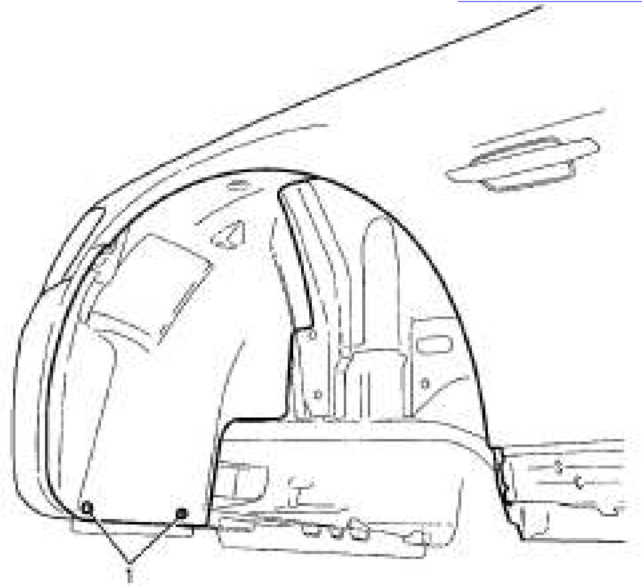
Front Wheelhouse Liner Replacement

Removal Procedure

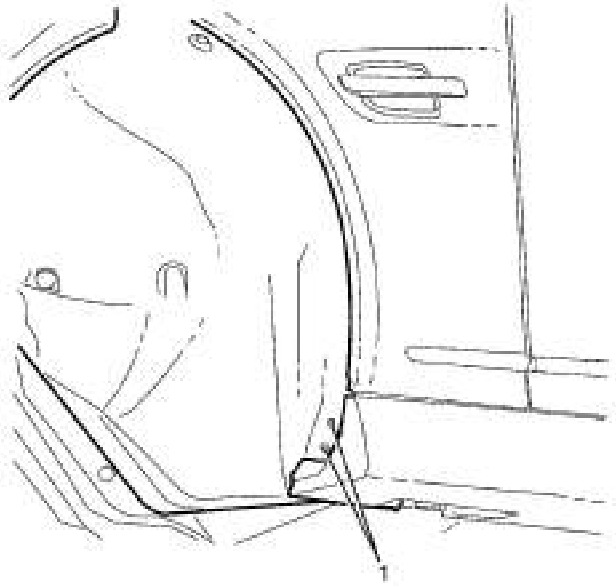
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

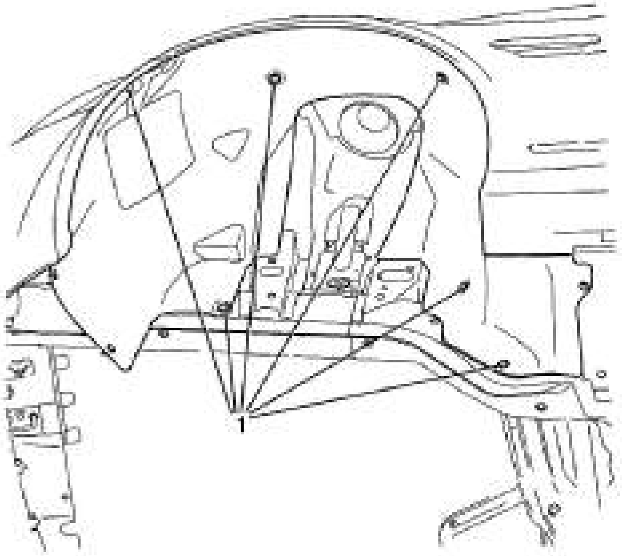
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the front wheel. Refer to Tire and Wheel Removal and Installation .



3. Remove the front wheelhouse liner to the front air deflector push-in retainers (1).



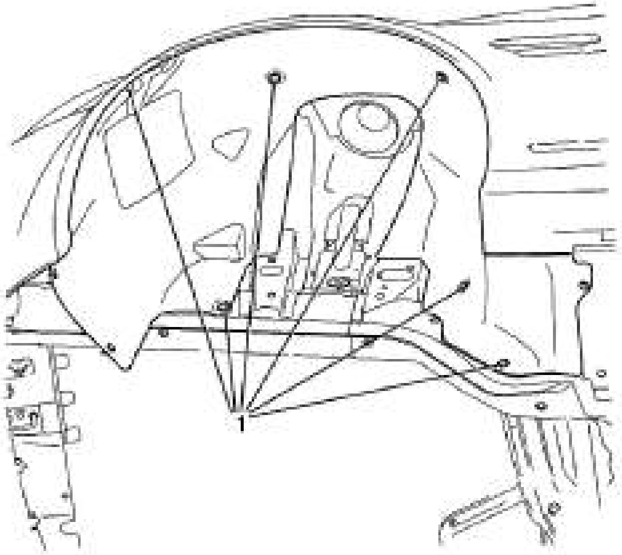
4. Remove the front wheelhouse liner to rocker panel retaining screws (1).



5. Remove the front wheelhouse liner to wheelhouse retaining scrivets (1).
6. Remove the front wheelhouse liner from the vehicle.

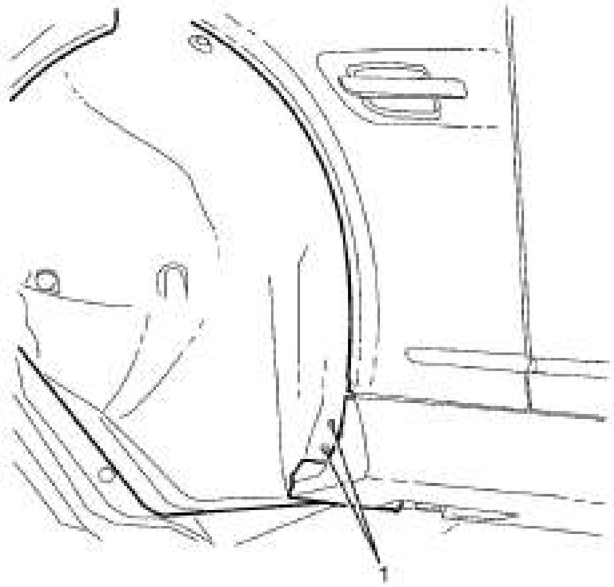
Installation Procedure

1. Position the front wheelhouse liner to the vehicle.



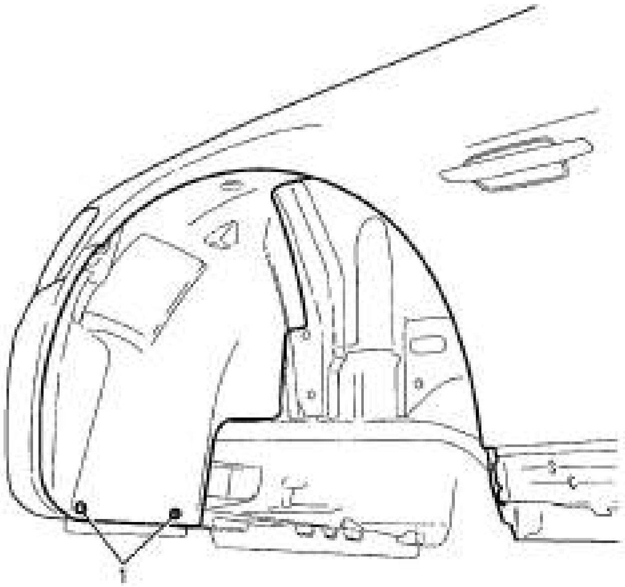
2. Install the front wheelhouse liner to wheelhouse retaining scrivets (1).

Notice: Refer to Fastener Notice in the Preface section.



3. Install the front wheelhouse liner to rocker panel retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).



4. Install the front wheelhouse liner to the front air deflector retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).

5. Install the front wheel. Refer to Tire and Wheel Removal and Installation .

6. Lower the vehicle.

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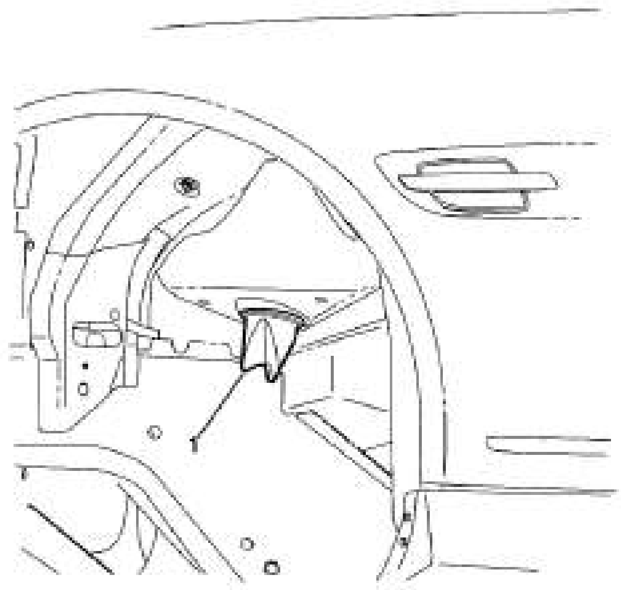
Front Wheelhouse Panel Rear Brace Drain Hole Valve Replacement

Removal Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

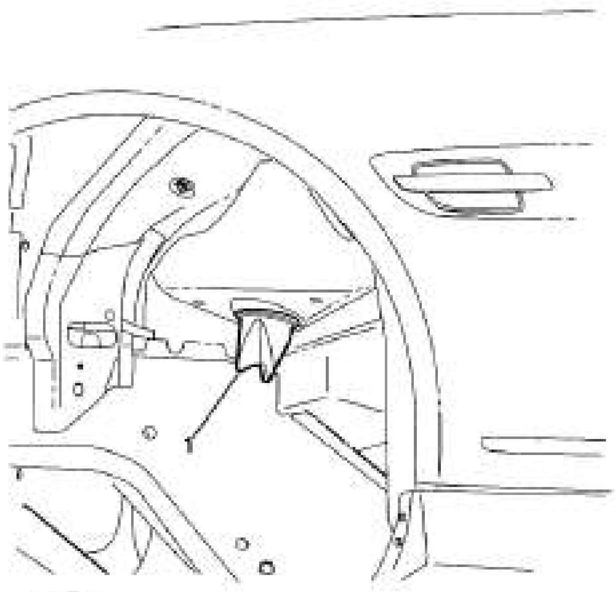
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the front wheel. Refer to Tire and Wheel Removal and Installation.
3. Remove the front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement.



4. Remove the cowl drain valve (1) by prying away from the inner wheelhouse.
5. Remove the cowl drain valve from the vehicle.

Installation Procedure



1. Install the cowl drain valve (1) to the vehicle.
2. Install the cowl drain valve by applying pressure to the inner wheelhouse.
3. Install the front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement.
4. Install the front wheel. Refer to Tire and Wheel Removal and Installation.
5. Lower the vehicle.

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Wheelhouse Splash Shield Replacement

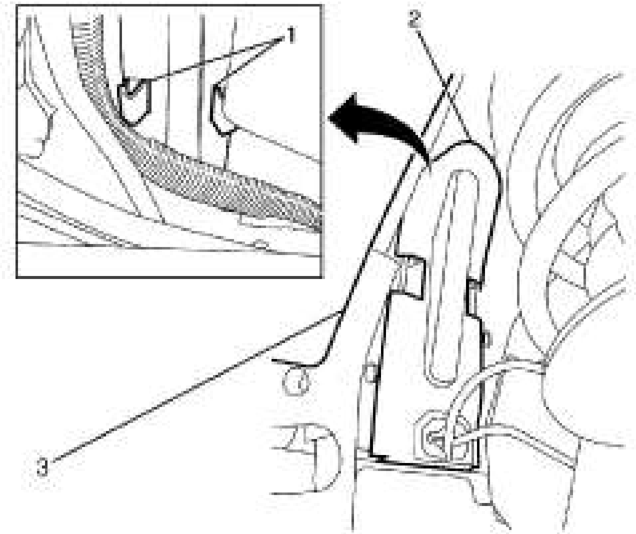
Removal Procedure - Left Side

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the left front wheel. Refer to Tire and Wheel Removal and Installation.



Important: Depress the splash guard clips (1) to disengage the splash guard (2) from the wheel house (3).

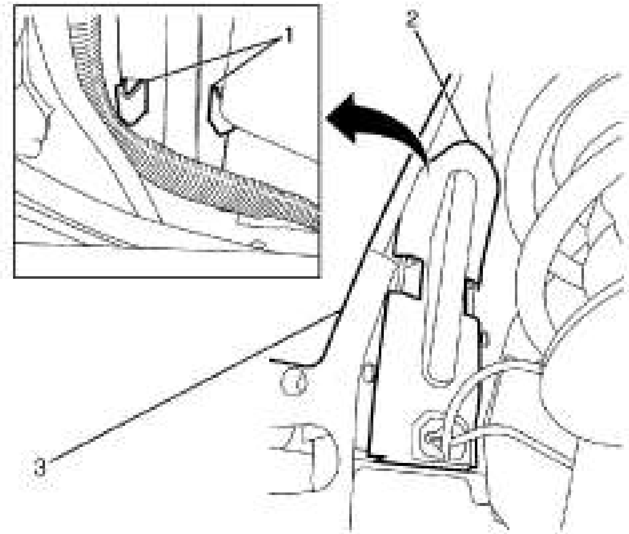
3. Remove the splash guard (2) from the wheel house (3).

Installation Procedure - Left Side

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.



Important: Make sure the splash guard clips (1) are correctly engaged with the wheel house (3) to prevent an induced rattle condition.

1. Install the splash guard (2) to the wheel house (3).
2. Install the left front wheel. Refer to Tire and Wheel Removal and Installation.
3. Lower the vehicle to the ground.

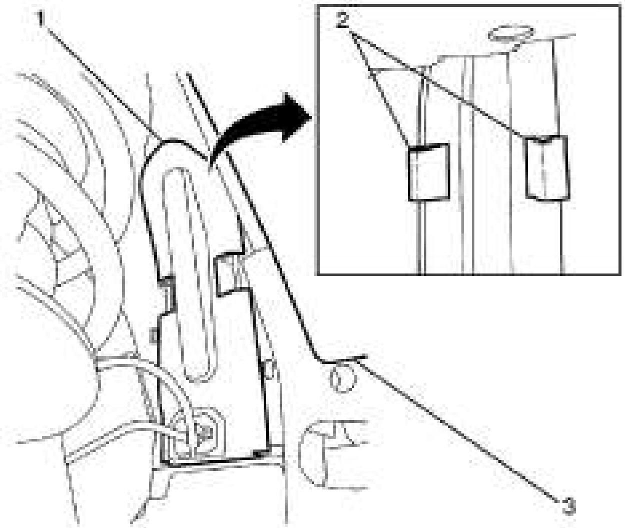
Removal Procedure - Right Side

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the right front wheel. Refer to Tire and Wheel Removal and Installation.



Important: Depress the splash guard clips (2) to disengage the splash guard (1) from the wheel house (3).

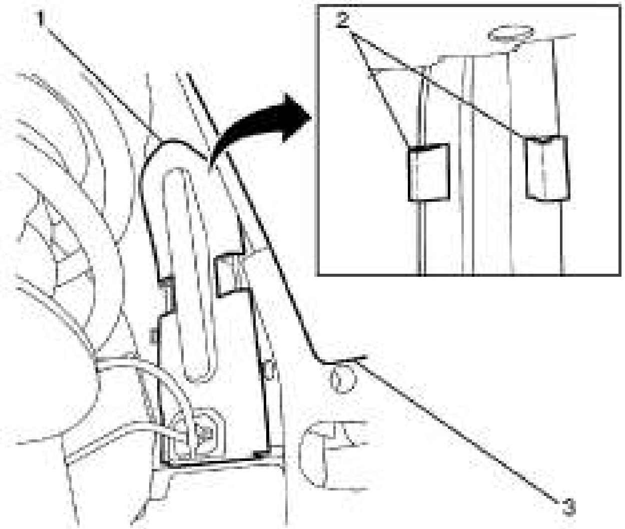
3. Remove the splash guard (1) from the wheel house (3).

Installation Procedure - Right Side

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.



Important: Make sure the splash guard clips (2) are correctly engaged with the wheel house (3) to prevent an induced rattle condition.

1. Install the splash guard (1) to the wheel house (3).
2. Install the right front wheel. Refer to Tire and Wheel Removal and Installation.
3. Lower the vehicle to the ground.

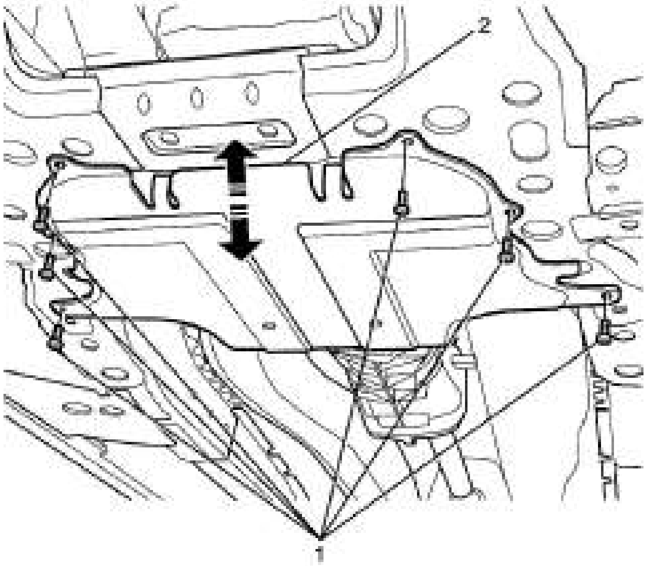
Oil Pan Drain Plug Splash Shield Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

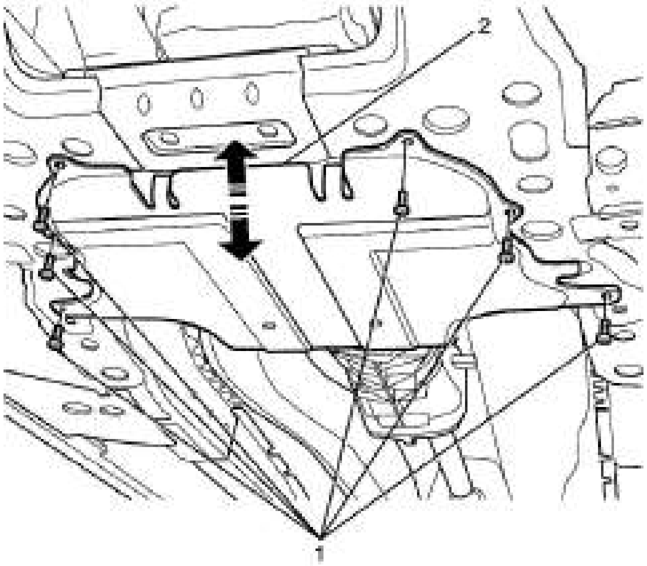
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support vehicle. Refer to Lifting and Jacking the Vehicle in General Information.



2. Remove the sump guard to engine cradle retaining bolts (1).
3. Remove the sump guard (2) from the engine cradle.

Installation Procedure



1. Align the sump guard (2) with the engine cradle.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the sump guard to engine cradle retaining bolts (1).

   Tighten
   Tighten the bolts to 19 N·m (14 lb ft).

3. Lower the vehicle.

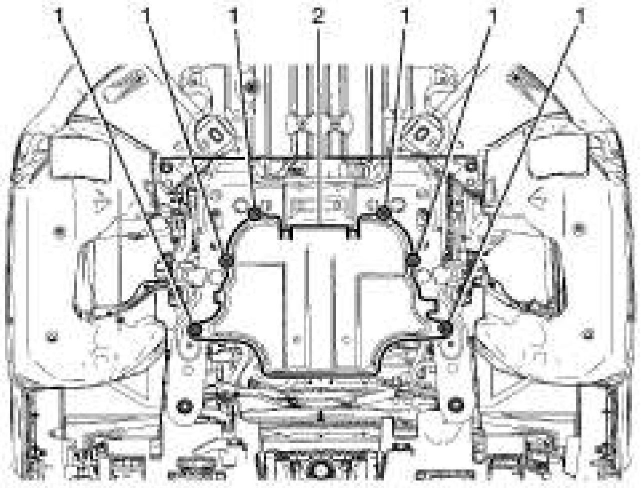
Engine Splash Shield Replacement

Removal Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

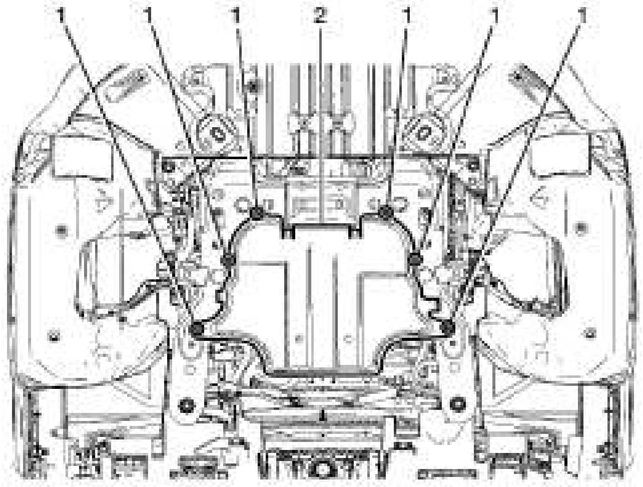
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



2. Remove the engine splash shield to front subframe retaining screws (1).
3. Remove the engine splash shield (2) from the front subframe.

Installation Procedure



1. Install the engine splash shield (2) to the front subframe.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the engine splash shield to front subframe retaining screws (1).

   Tighten
   Tighten the screws to 9 N·m (80 lb in).

3. Lower the vehicle.

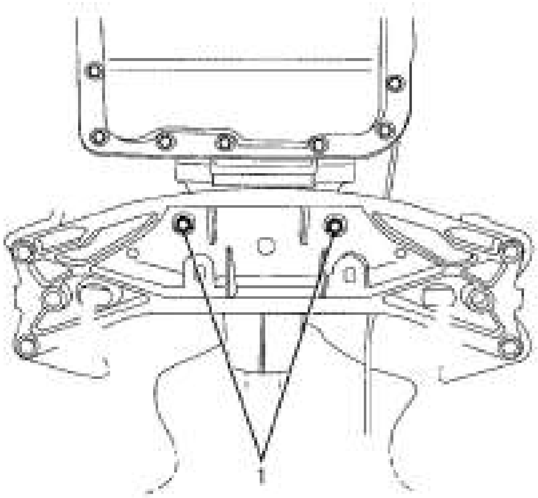
Transmission Support Replacement (Except 5L40 and 6L50)

Removal Procedure

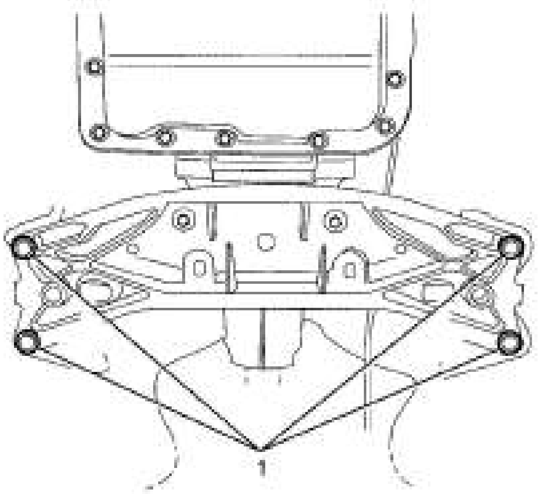
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the exhaust system. Refer to Exhaust System Replacement.

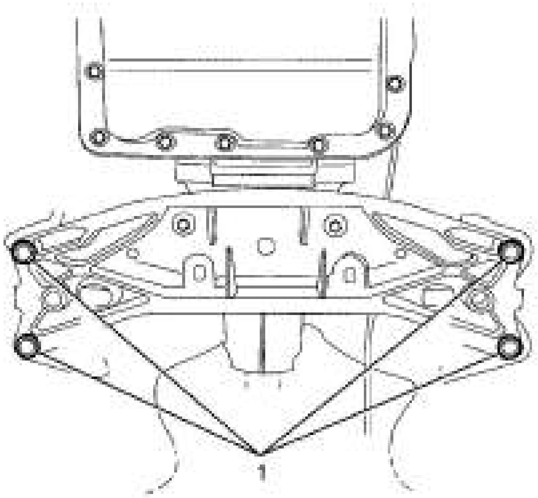


3. Remove the transmission support to transmission mount retaining nuts.
4. Support the transmission with a suitable supporting stand.



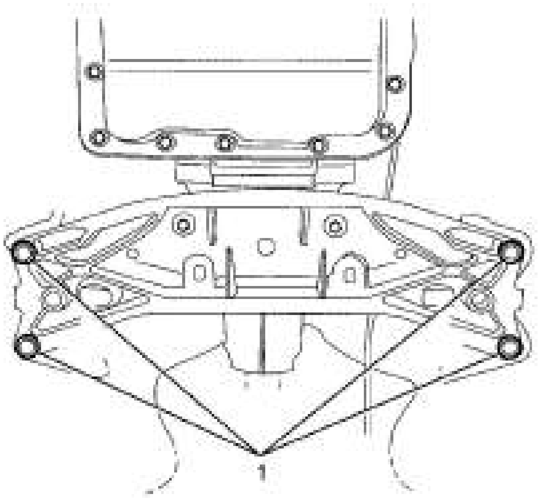
5. Remove the transmission support to lower sub frame rail retaining bolts.
6. Remove the transmission support from the vehicle.

Installation Procedure



1. Install the transmission support to the vehicle.
2. Install the transmission support to lower sub frame rail retaining bolts.

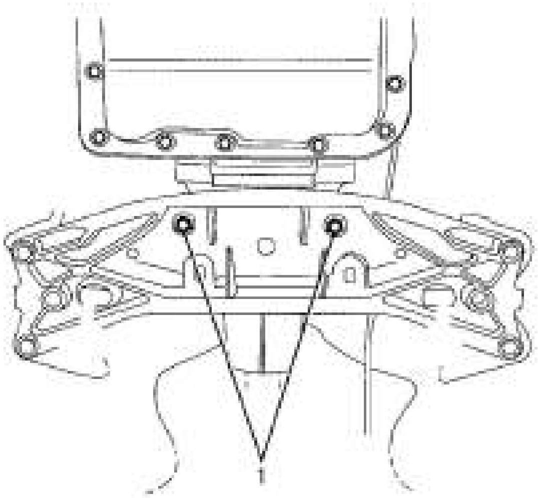
   Notice: Refer to Fastener Notice in the Preface section.



3. Tighten the transmission support to under body retaining bolts.

   Tighten
   Tighten the bolts to 55 N·m (41 lb ft).

4. Remove the suitable supporting stand from the transmission.



5. Install the transmission support to transmission mount retaining nuts.

   Tighten
   Tighten the nuts to 25 N·m (18 lb ft).

6. Install the exhaust system. Refer to Exhaust System Replacement.
7. Lower the vehicle.

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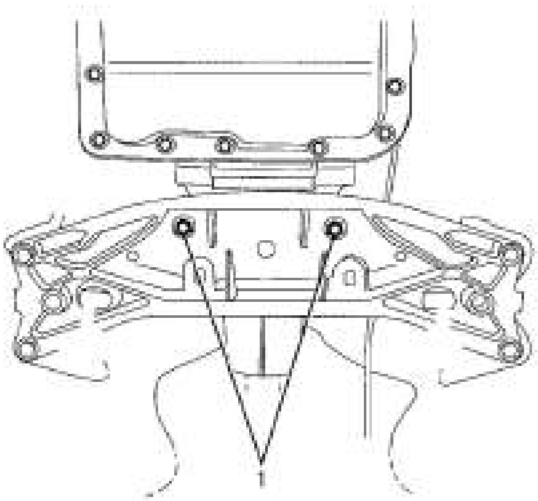
Transmission Support Replacement (5L40 and 6L50)

Removal Procedure

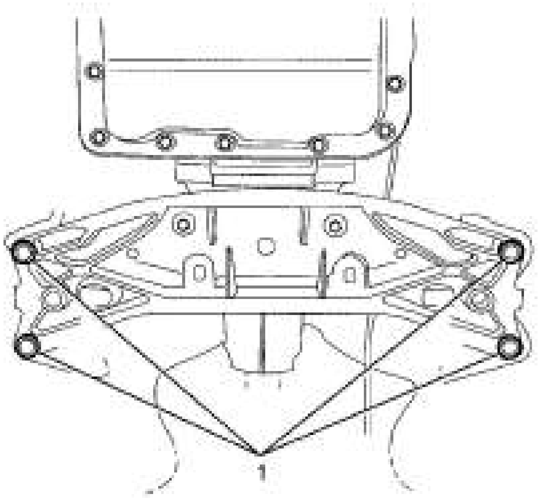
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the exhaust system. Refer to Exhaust System Replacement.

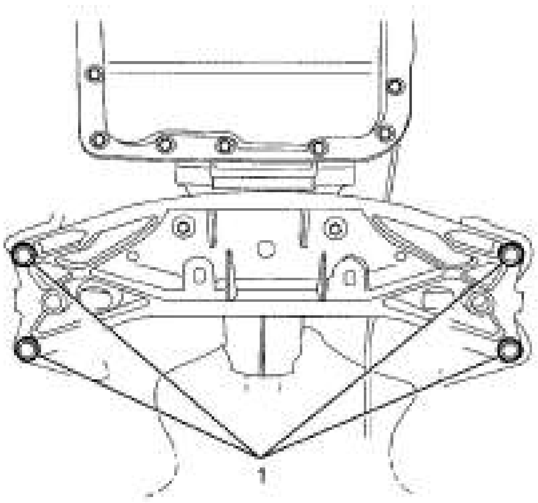


3. Remove the transmission support to transmission mount retaining nuts.
4. Support the transmission with a suitable supporting stand.



5. Remove the transmission support to lower sub frame rail retaining bolts.
6. Remove the transmission support from the vehicle.

Installation Procedure



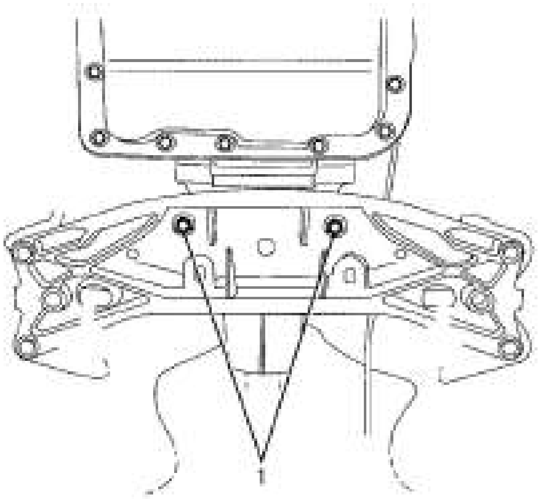
1. Install the transmission support to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the transmission support to lower sub frame rail retaining bolts (1).

   Tighten
   Tighten the bolts to 55 N·m (41 lb ft).

3. Remove the suitable supporting stand from the transmission.



4. Install the transmission support to transmission mount retaining nuts (1).

   Tighten
   Tighten the nuts to 58 N·m (43 lb ft).

5. Install the exhaust system. Refer to Exhaust System Replacement.
6. Lower the vehicle.

Underbody Inspection

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Check for obvious deterioration of the floor pan.
3. Check for loose dirt and corrosion around the inside of the floor pan reinforcement member access holes. This is the first indication that corrosion may exist in hidden areas, and repairs may be required before the final cleaning and protective treatment is performed.
4. Using a chisel, ensure that the drain provisions in the floor pan reinforcement members are open. There are drain holes in the body side panels also. These holes can be opened using a punch or a drift. The side panel drain holes are in the rear section of the rocker panels, and in the lower rear quarter panels.

Frame and Underbody Description

The following components are supported by a front crossmember frame which is rigidly bolted to the body rail at 6 locations.

- The engine
- The front suspension components
- The steering linkage

The following components are supported by the rear suspension frame which is attached to the body rail through rubber insulators at 4 locations:

- The rear drive axle assembly
- The rear suspension components

The transmission support is rigidly bolted to the floor pan and supports the transmission extension.

The underbody frames must be properly aligned to maintain the correct transmission, suspension and wheel alignment.

Important: In the event there is evidence of structural damage to the frames they must be replaced.

The individual underbody components contribute directly to the overall strength of the unibody. Use proper metal panel bonding techniques during service repair operations to the underbody. Refer to Metal Panel Bonding in Collision Repair for metal panel bonding information and for vehicle preparation.

The components must be corrosion protected whenever body repair operations damage or destroy the original sealing surfaces. Use a two part catalysed primer when corrosion protection is needed to welded surfaces. Apply the sealers and anti-corrosion materials as necessary. Refer to Anti-Corrosion Treatment and Repair. Do not combine paint systems. Refer to Basecoat/Clearcoat Paint Systems, for further information.

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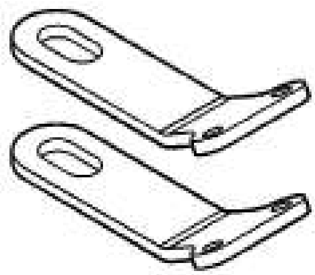
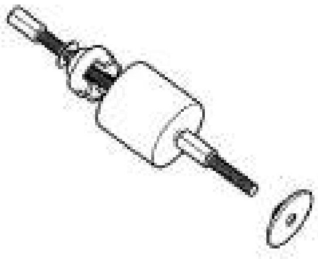
Special Tools

Illustration	Tool Number / Description
	EN 46114 Engine Lift Brackets
	CH 49509 Rear Frame Bush Remover

Clearcoat Repair Specifications - 3M Products

Paint Condition	Wet Sanding	Compounding	Rotary Polisher	Dual Action Orbital Polisher	Hand Glazing / Polishing
New vehicle prep or fine wheel marks	--	--	--	• Perfect-It Polishing Pad Glaze • Perfect-It Foam Polishing Pad • Hookit DA 6 inch Backup Pad	Premium Liquid/Paste Waxes
Swirl marks, water spotting, or light oxidation	--	--	• Perfect-It Polishing Pad Glaze • Perfect-It Foam Polishing Pad • Hookit SBS/Perfect-It Backup Pad	• Perfect-It Polishing Pad Glaze • Perfect-It Foam Polishing Pad • Hookit DA 6 inch Backup Pad	• Perfect-It Hand Glaze or • Premium Liquid/Paste Waxes
Overspray or medium oxidation	--	• Perfect-It 11 Rubbing Compound Pad • Perfect-It 11 Foam Compound Pad	• Perfect-It Polishing Pad Glaze • Perfect-It Foam Polishing Pad • Hookit SBS/Perfect-It Backup Pad	• Perfect-It Polishing Pad Glaze • Perfect-It Foam Polishing Pad • Hookit DA 6 inch Backup Pad	• Perfect-It Hand Glaze • Premium Liquid/Paste Waxes

Heavy oxidation or minor acid rain pitting	Micro Fine 2000	• Perfect-It 11 Rubbing Compound Pad • Perfect-It 11 Foam Compound Pad	• Perfect-It Polishing Pad Glaze • Perfect-It Foam Polishing Pad • Hookit SBS/Perfect-It Backup Pad	• Perfect-It Polishing Pad Glaze • Perfect-It Foam Polishing Pad • Hookit DA 6 inch Backup Pad	• Perfect-It Hand Glaze • Premium Liquid/Paste Waxes
Dust nibs, minor scratches, or major acid rain pitting	Micro Fine 1500 or 2000	• Perfect-It 11 Rubbing Compound Pad • Perfect-It 11 Foam Compound Pad	• Perfect-It Polishing Pad Glaze • Perfect-It Foam Polishing Pad • Hookit SBS/Perfect-It Backup Pad	• Perfect-It Polishing Pad Glaze • Perfect-It Foam Polishing Pad • Hookit DA 6 inch Backup Pad	• Perfect-It Hand Glaze • Premium Liquid/Paste Waxes
Orange peel, paint runs or sags	Micro fine 1200 or 1500	• Perfect-It 11 Rubbing Compound Pad • Perfect-It 11 Foam Compound Pad	• Perfect-It Polishing Pad Glaze • Perfect-It Foam Polishing Pad • Hookit SBS/Perfect-It Backup Pad	• Perfect-It Polishing Pad Glaze • Perfect-It Foam Polishing Pad • Hookit DA 6 inch Backup Pad	• Perfect-It Hand Glaze or • Premium Liquid/Paste Waxes

Clearcoat Repair Specifications - Meguiar Products

Paint Condition	Wet Sanding	Cleaning	Polishing
New car prep or fine wheel marks	--	--	Swirl Free Polish (M-82) W-6000 Pad for DA polishers
Swirl marks, chemical spotting or light oxidation	--	--	Swirl Free Polish (M-83) W-9000 Finishing Pad
Overspray or medium oxidation	--	Heavy-Cut Cleaner (M-85) W-7000 Cutting Pad	Swirl Remover (M-82) W-9000 Finishing Pad
Heavy oxidation or minor acid rain pitting	--	Compound Power Cleaner (M-84) W-4000 Cutting Pad	Swirl Free Polish (M-82) W-6000 Finishing Pad
Dust nibs	2000 Grade Unigrit Sanding Block	Compound Power Cleaner (M-84) W-7000 Cutting Pad	Swirl Free Polish (M-2) W-9000 Finishing Pad
Minor scratches or acid rain pitting	2000 Grade Unigrit Sanding Paper	Compound Power Cleaner (M-84) W-7000 Cutting Pad	Swirl Free Polish (M-2) W-9000 Finishing Pad
Major runs or sags	1500 Grade Unigrit Sanding Block	Compound Power Cleaner (M-84) W-7000 Cutting Pad	Swirl Free Polish (M-2) W-6000 Pad for DA Polishers
Major orange peel or acid rain pitting	1500 Grade Unigrit Sanding Paper	Compound Power Cleaner (M-84) W-7000 Cutting Pad	Swirl Free Polish (M-2) W-6000 Pad for DA Polishers
Need for protection	--	--	Quick Detailer (M-6601) will provide protection without streaking. Contains the mildest of cleaners which will insure even application of polish.

Basecoat/Clearcoat Paint Systems

Caution: Exposure to isocyanates during paint preparation and application processes can cause severe breathing problems. Read and follow all of the instructions from the manufacturers of painting materials, equipment, and protective gear.

All paint finish repairs of rigid exterior surfaces must meet Holden standards. Refer to the latest revision of the Holden Approved Refinish Materials book to identify the paint systems you may use that have been engineered to meet Holden standards. The Holden Approved Refinish Materials book supplies all approved products, including volatile organic compound (VOC) compliant regulations recommended by the individual manufacturer, and detailed procedures for materials used in their paint system.

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Anti-Corrosion Treatment and Repair

Caution: When applying sound deadeners, or anti-corrosion materials due care and preventative measures must be exercised to prevent any material from being sprayed into door and quarter panel mechanisms such as door locks, window run channels, window regulators and seat belt retractors, as well as any moving or rotating mechanical or suspension parts on the underbody, particularly the parking brake cable. After material application, be sure that all body drain holes are open. Improper application may increase chance of corrosion damage or limit the operation of moving parts, resulting in personal injury.

Any procedure that disturbs these special treatments, such as panel replacement or collision damage repair operations, may leave the metal unprotected and result in corrosion. Proper recoating of these surfaces with service-type anti-corrosion material is essential.

After repair and/or replacement parts are installed, all accessible bare metal surfaces must be treated with metal conditioner and reprimed. Refer to the Holden Approved Refinish Materials book which identifies the paint systems you may use.

Anti-corrosion compounds are light-bodied materials designed to penetrate between metal-to-metal surfaces, such as pinch-weld joints, hem flanges, and integral panel attaching points where metal surfaces are difficult to coat with conventional undercoating materials, and are inaccessible for painting. The materials that are suitable for interior and exterior are listed in the chart below. Conventional undercoating is recommended in order to coat large areas, such as replacement door and quarter outer panels, floor pan sections, lids, hoods, fenders, etc. During undercoating operations, care should be taken to prevent the material from being sprayed into door and quarter panel hardware mechanisms, such as door locks, window run channels, window regulators, and seat belt retractors. On the underbody, the material should not be applied to any moving or rotating part, energy absorbing bumper components, or shock absorbers. After undercoating, make sure that all body drain holes are open.

Interior Protectant

The following products are available from Holden Dealer Equipment. For technical information, call 187-Permatex (1-877-376-2839):

Exterior Protectants

The following product is available from *ECP, Inc. Contact them at 1-800-323-3521 or www.ecpinc.net.

*We believe these sources and their products to be reliable. There may be additional manufacturers of such material. General Motors does not endorse, indicate any preference for, or assume any responsibility for the products from these firms, or for any such items which may be available from other sources.

These sealers are intended to prevent water and dust from entering the vehicle and also are anti-corrosion barriers. Sealers are applied to such areas as rear compartment lid hem flanges, wheelhouse, quarter outer, floor, cowl, roof, and various other panel to panel attaching points. The originally sealed joints are obvious and any damage to these sealed locations should be corrected by resealing. Attaching points of new replacement panels should be resealed. Replacement lids and doors will also require sealing in the hem flange areas.

Flange joints, overlap joints, and seams should be sealed using a quality sealer of medium-bodied consistency. The sealer used must retain its flexible characteristics after curing and be paintable.

Open joints which require bridging of the sealer in order to close a gap should be sealed using a heavy-bodied caulking material. Follow the label directions for the material selected.

Color application may be required in order to restore repaired areas such as hood, fenders, doors, quarters, lid, roof, engine compartment, underbody, and inner panels to original appearance. When this is necessary, conventional refinishing preparation, undercoat buildup, and color application techniques should be followed.

Deadener materials, spray-on type, are used on various metal panels in order to provide corrosion resistance and joint sealing. They control the general noise level inside the passenger area of the vehicle. When deadeners are disturbed because of damage, are removed during repair operations, or a new replacement panel is installed, the deadener material must be replaced by a service equivalent material. The application pattern and location of deadener materials can be determined by observing the original production installation.

Cleaning of the interior and underbody panel surfaces is necessary when original galvanized or other anti-corrosion materials have been burned off during welding or heating operations. Removal of the residue from burning will require additional care in such areas as interior surfaces of box-type construction and when configurations of the metal panels limit access to interior surfaces.

Paint Identification

Caution: Exposure to isocyanates during paint preparation and application processes can cause severe breathing problems. Read and follow all of the instructions from the manufacturers of painting materials, equipment, and protective gear.

Important: Always refer to the Holden Approved Refinish Materials book. This book identifies the paint systems you may use.

Use the service parts identification label to identify the type of paint technology, paint codes, trim level, and any special order paint colors on the vehicle. Refer to Vehicle, Engine and Transmission ID and VIN Location, Derivative and Usage.

Clearcoat Repair without Repainting

Repair Procedure

1. Thoroughly wash the repair area with Liquid Wash and Wax, or the equivalent.
2. Environmental damage may be corrected. Refer to Environmental Fallout (Acid Rain) or Rail Dust Damage Repair.

   Important: Follow all of the instructions from the manufacturer of the polishing material.

3. If sanding and/or polishing is required , refer to Clearcoat Repair Specifications - Meguiar Products or Clearcoat Repair Specifications - 3M Products.
4. Use a paint gage before, during, and after sanding and/or polishing, to avoid removing too much clearcoat. Refer to Paint Gages.

Environmental Fallout (Acid Rain)

Notice: Refer to Clearcoat/Ultraviolet Screeners Notice in the Preface section.

Important: Always refer to the manufacturer's packaged instructions for the detailed procedures of materials used for compounding and/or polishing.

Since the severity of the condition varies from area to area, proper diagnosis of the contamination extent is critical to the success of the repairs. Perform the diagnosis under high intensity fluorescent lighting on the horizontal surfaces (hood, roof panel, rear compartment lid), after the surfaces have been properly cleaned by washing the vehicle with Liquid Wash and Wax, or equivalent.

There are 3 basic types of acid rain damage:

Surface Level Contamination: May be repaired by simply washing the vehicle, cleaning the surface with a silicone wax and grease remover, neutralizing acidic residue, and finesse polishing--Refer to Surface Level Contamination Repair.

Clearcoat Etching: Slight etching is still noticeable after the above washing and finesse polishing procedure. Refer to Slight Clearcoat Damage - Wet Sanding, Finesse Polishing.

Basecoat Etching: Severe etching beyond the clearcoat into the basecoat in the affected areas will require refinishing. Refer to Basecoat/Clearcoat Paint Systems.

Surface Level Contamination Repair

1. Thoroughly wash and dry the contaminated area with Liquid Wash and Wax, or equivalent.
2. Clean the affected area with silicone, wax and grease remover.
3. Remove and neutralize acidic residue by cleaning the contaminated areas with a mixture of baking soda and water (1 tablespoon of baking soda per 1 liter or 1 quart of water). Rinse thoroughly and dry the panel completely.
4. Apply finesse-type polish with a foam panel. If damage has been repaired, remove any swirl marks with a dual action orbital polisher and foam pad. Refer to Clearcoat Repair Specifications - Meguiar Products or Clearcoat Repair Specifications - 3M Products.
5. If some damage remains, refer to Slight Clearcoat Damage - Wet Sanding, Finesse Polishing.

Slight Clearcoat Damage - Wet Sanding, Finesse Polishing

1. Select a small contaminated test area.
2. Film thickness should be taken prior to the sanding and polishing. Refer to Paint Gages.
3. Wet sand and finesse polish the contaminated test area. Refer to Clearcoat Repair Specifications - Meguiar Products or Clearcoat Repair Specifications - 3M Products. If during the polishing you suspect or observe that etching has penetrated into the basecoat, too much clearcoat has been removed during sanding, or base color is transferred to the polishing pad during polishing, then the affected areas will require refinishing. Refer to Basecoat/Clearcoat Paint Systems.

Paint Gages

Paint thickness gages measure the total thickness of the vehicle finish. It is important to accurately measure the thickness of the finish on each vehicle as the thickness of the finish will vary on each vehicle. Use a paint gage before the sanding process in order to accurately measure how much finish there is to remove before, during, and after the sanding process. Paint gages range from magnetic pull type to sophisticated electronic types, and are available from a variety of sources. The older magnetic type gages, at best have a 5 percent accuracy range and are not sensitive enough to detect removal of 0.02 mm 0.5 mil (0.0005 in) clearcoat. The newer type magnetic gages have improved accuracy ranges. Most gages are confined to checking either ferrous metal, steel, non-ferrous metal, or aluminum panel. At this time, there are no viable gages for reading film thickness on composite (SCM doors, RIM fenders) panels. The more sophisticated (ETG) electronic paint thickness gages digital type gages are able to read film thickness on both ferrous and non-ferrous metal panel. Digital ETG gages may have an accuracy range of 1 percent and include thickness standards for recalibration. The following paint thickness gages are available.

Paint Thickness Gages

- 147-5437-ETG Standard model
- 147-5437-ETG-P Standard model with print option
- 147-5437-N-ETG-N Non-ferrous model for aluminium panels
- 147-5437-NP-ETG-NP Non-ferrous model with print option
- 147-54437-SD-ETG Steel and aluminium gage

Clearcoat Thickness

The clearcoat on the vehicle is typically 0.036-0.046 mm (0.0014-0.0018 in) thick. The clearcoat contains ultraviolet screeners. Removing more than 0.005 mm (0.0002 in) of the clearcoat may result in early paint failure.

Rail Dust Damage Repair

Caution: Refer to Eye Protection Caution in the Preface section.

Important: If rail dust has penetrated into the basecoat, the panel requires refinishing. Make sure all the rail dust has been removed prior to refinishing or the rust spots will return.

Rail dust damage comes from the tiny iron particles produced from the friction between the train wheels and the track. It can also be deposited on vehicles if stored near any operation producing iron dust (i.e., steel ore yards). This dust can either lay on top of, or embed into the paint surface. It is usually diagnosed as bumps in the paint surface or rust colored spots in the paint.

1. Move the vehicle to a cool shaded area and make sure the vehicle surfaces are cool during the removal process.
2. Thoroughly wash the repair area with Liquid Wash and Wax, or the equivalent.
3. Wipe the area dry.
4. Clean the affected area with silicone, wax and grease remover.
5. Perform the removal process according to the manufacturer's directions of the type of repair material used (Gel Type Oxalic Acid or Clay Type Non-Acid Based). If, upon inspection, some particles are still present, the process may be repeated. If the damage has been repaired, complete the repair to the entire panel.
6. Polish the entire panel after the removal process. Refer to Clearcoat Repair Specifications - Meguiar Products or Clearcoat Repair Specifications - 3M Products. If small pits remain in the clearcoat after all of the damage has been repaired, refer to Clearcoat Repair without Repainting.

Flexible Plastic Part Repair Materials

Thermoset Plastic Type	Type of Repair	Recommended Repair Material	Availability
Most flexible and semi flexible plastic*	Most repairs*	Compoxy Repair Material	Refer to your local paint supplier
		CMR-8 Composite Repair Material	Refer to your local paint supplier
* TPO, TEO, (Polyolefin Plastics) require the application of the adhesive primer before the repair compound is applied.			

Rigid Plastic Part Repair Materials

Thermoset Plastic Type	Type of Repair	Recommended Repair Material	Availability
Sheet moulding compound (SMC), RIM rigid plastic parts	Cosmetic filling	Structural Bonding Epoxy	Refer to your local paint supplier
		Sikkens Polystop LP™ or equivalent polyester repair putty	Refer to your local paint supplier
Most rigid plastic parts	Cosmetic repair, adhesive bonding	Structural Bonding Epoxy	Refer to your local paint supplier
Most rigid plastic parts	Adhesive bonding	Structural Bonding Epoxy	Refer to your local paint supplier
Most rigid plastic parts	Adhesive structural* bonding	Structural Bonding Epoxy	Refer to your local paint supplier
Most rigid plastic parts	Adhesive bonding Structural bonding	Structural Bonding Epoxy	Refer to your local paint supplier
SRIM most rigid plastic parts	Cosmetic repair, adhesive bonding	SRIM™ repair kit	Refer to your local paint supplier
* Structural adhesive bonding may require the use of a pneumatic applicator, to speed the application of the epoxy.			Refer to your local paint supplier

General Plastic Repair

Caution: In order to reduce the risk of personal injury when exposed to toxic fumes while grinding, cutting, or applying repair material on any type of sheet molded compound or RIM rigid plastic, observe the following guidelines:

- Work in a properly ventilated area
- Apply protective cream to any exposed skin
- Remove any mixture that comes into contact with skin
- Wash skin with cold water to remove glass and resin dust
- Use a sander with a vacuum attachment
- Follow the repair material manufacturer's instructions

Also, always wear the following:

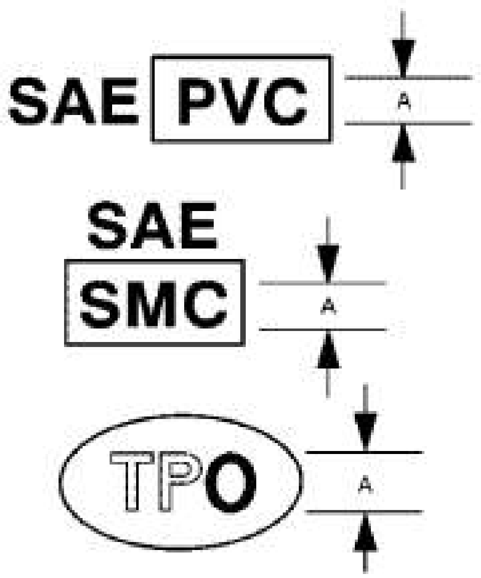
- An approved respirator, or air supplied respirator
- Eye protection
- Rubber gloves
- Earplugs
- Protective clothing

The following procedures should be followed when repairing all types of thermoset plastic:

- Follow the manufacturer's application and curing recommendations.
- Do not intermix systems. Use the supplies and the repair materials from the same manufacturer.
- Clean the inner and outer surfaces of the repair area with a soap impregnated scouring pad in order to remove any dirt or mould.
- Clean the area with a wax and grease remover, using only enough of the remover to dampen a cloth. Allow the panel to dry thoroughly.
- Remove the surface finish from the area to be repaired. Adhesives are designed to adhere to the plastic substrate, not the finish.
- Prime the surface before applying the repair material.
- Inspect the rear side of the work area before making repairs in order to avoid possible damage to wires, motors, etc.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Repair | Plastic Panel Information and Repair | Description and Operation | **Document ID: 1995247**

How to Identify Plastic Parts



Plastic parts can be identified by the SAE code, which is usually found on the rear of the part, and/or by the characteristics of the plastic. Knowing the type of plastic aids in selecting the proper repair materials and in selecting the proper repair procedure.

Look for the SAE code stamped into the part.

Code Found

Match the code to those in the plastic identification chart to determine whether the plastic is thermoplastic or thermoset plastic, and whether the plastic is rigid or flexible. Refer to Plastic Identification and Refinishing Systems.

No Code Found

Caution: Do NOT use a plastic burn test to distinguish the type of plastic. The burn test produces vapors which are harmful.

Perform one or both of the following tests to determine if the part is thermoplastic polyolefin or thermoset non-polyolefin.

Float Test

1. Cut a shaving of plastic from the back of the part.

   The shaving should be free of mould release agents and paint.

2. Place the shaving in a container of water.
    - Thermoplastic polyolefin floats.
    - Thermoset non-polyolefin sinks.

Abrasion Test

- Sand a spot near the damaged area with Grade 36 Roloc Disc.
- Thermoplastic polyolefin material melts or frays when sanded.
- Thermoset non-polyolefin material sands cleanly.

Thermoplastic and thermoset plastics can be either rigid or flexible. Thermoplastic plastic parts are best repaired with a hot iron plastic material-feed welder, but are usually replaced. Thermoset plastic can be repaired with epoxy or other more rigid 2 package repair material.

- For rigid thermoset repair materials, refer to Rigid Plastic Part Repair Materials.
- For flexible thermoset repair materials, refer to Flexible Plastic Part Repair Materials.
- For general repair instructions, refer to General Plastic Repair.

Plastic Identification and Refinishing Systems

Identifying Symbol - Old Symbol in ( )s	Chemical Composition or Plastic Family Name	Typical Area(s) Where Part is Used	Examples of Common/Trade Names	Type of Plastic
ABS	Acrylonitrile/ Butadiene-Styrene	Armrest Support, Console, Instrument Panel Console, Steering Column Bracket/Jacket, Trim Molding	ABS, Absafil, Magnum, Cycolac, Dyel, Kralastic, Lustran	Thermoplastic
ABS + PC	Acrylonitrile/ Butadiene-Styrene + Polycarbonate	Instrument Panel, Instrument Panel Console	Bayblend, Cycoloy, KHA, Pulse	Rigid
ABS/PVC	ABS/Vinyl (Soft)	Head Rest Cover, Instrument Panel Pad, Trim Molding/Panel	ABS Vinyl	Flexible, Vinyl
EPDM	Ethylene Propylene Diene Monomer	Body Panel, Bumper Impact Strip	EPDM, Nordel	Rigid
EVA (EVAC)	Ethylene/Vinyl Acetate	Head Rest Cover, Miscellaneous Soft Trim	Elvax, Microthane	Flexible
PA	Polyamide	Headlamp Bezels, Exterior Finish Trim Panels	Nylon, Capron, Zytel, Rilsan, Minion, Vydyne, Welland	Rigid
PA, PAG, PAGG	Polyamide	Exterior Finish Trim Panel, Headlamp Bezel	Capron, Minlon, Nylon, Rilsan, Vydyne, Wellamid, Zytel	Rigid, Thermoset
PA + PPE	Polymide + Polypheneylene Ether	Exterior Trim	GTX	Rigid, Thermoset
PBT + TEEE (PBTP + EEBC)	Polybutylene, Terephthalate + Ether, Ester Block Compound	Fascia, Rocker Panel Molding	Bexloy M	Rigid
PC	Polycarbonate	Interior Rigid/Hard Trim Panel, Valance Panel	Calibre, Lexan, Merlon, Makrolon	Rigid, Thermoset
PC + PETP	Polycarbonate + Polybutylene, Terephthalate	Bumper Fascia	Macroblend, Valox, Xenoy	Flexible, Thermoset
PE	Polyethylene	Interior Trim Panel, Seat Belt Cover, Spoiler, Valance	Alathon, Dylan, Foriflex, Hi-fax, Hosalen, Marlex, Paxon	Rigid, Thermoplastic

PF	Phenol Formaldehyde	Lower Storage Compartment	Amberol, Bakelite, Durez, Genal, Phenolic, Plyophen, Resinox	Rigid, Thermoset
PP	Polypropylene	Bumper Fascia, Air Inlet Grille Panel, Deflector Panel, Door Panel, Wheelhouse Liner, Interior Molding, Kick Panel, Load Floor, Radiator Shroud	Azdel, Daplen, Escorene, Marlex, Novolen, Oleflo, Profax, Tenite	Flexible, Thermoplastic
PPE (PPO)	Polyphenylene Ether	Bezels, Chromed Plastic, Headlamp Door, Ornaments	Noryl, Oleflo, Prevex	Rigid, Thermoset
PS	Polystyrene	Dash Panel, Door Panel	Durathon, Dylan, Lustrex, Polystyrol, Styron	Flexible, Soft
PUR	Polyurethane, Thermoset (Unsaturated)	Bumper Fascia, Filler Panel, Front/Rear Body Panel	Bayflex, Castethane, RIM, RRIM, SRIM	Thermoset
PVC	Polyvinyl Chloride (Vinyl)	Interior Soft Trim, Instrument Panel Skins	Geon, Pliovic, Unichem, Vinoflex, Vinyl, Vinylite	Flexible, Vinyl
SAN (SA)	Styrene Acrylonitrite	Centre Console, Glove Box Door, Interior Trim Panel	Foracryl, Lustran, Tyril	Rigid
TEO (EP, EPM, TPO)	Ethylene/Propylene (Rubber)	Bumper Fascia, Valance Panel	EPI, EPII, TPO, TPR (Thermoplastic Rubber)	Flexible, Thermoplastic
TPO	Thermal Plastic Oletin	Bumper Covers	TPO	Flexible Thermoplastic
TPU (TPUR)	Polyurethane, Polyolefin	Bumper Fascia, Soft Filler Panel, Window Molding	Estane, Pellethane, Roylar, Toxin	Flexible, Thermoplastic
UP	Polyester/Thermoset	Fascia Extension, Instrument Housing, Air Conditioning Air Deflector	Fibreglass, Premi-glass, Selectron, SMC, Vibrinmat	Rigid, Thermoset

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Body Side Stationary Window to Body Retaining Nuts (Sportwagon)	2 N·m	18 lb in
Rear Door to Window Division Channel Retaining Screws (SWB)	3 N·m	27 lb in
Rear Quarter Window Retaining Nuts (LWB)	3 N·m	27 lb in
Window Channel to Door Retaining Bolts	8 N·m	71 lb in
Window Clamp Nuts	8 N·m	71 lb in
Window Regulator Motor to Window Regulator Retaining Bolts	8 N·m	71 lb in
Window Regulator to Door Retaining Bolts	10 N·m	89 lb in
Window Regulator to Window Retaining Bolts	8 N·m	71 lb in
Window Run Channel to Door Upper Retaining Screws (LWB)	3 N·m	27 lb in

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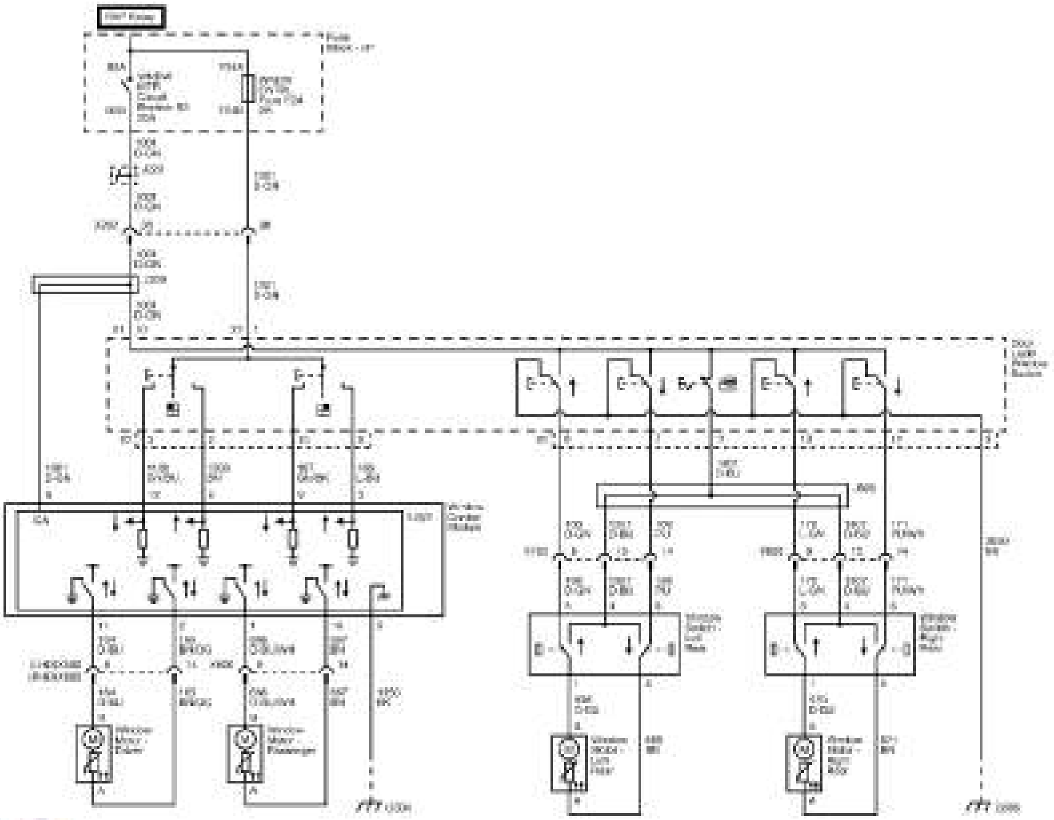
WNA



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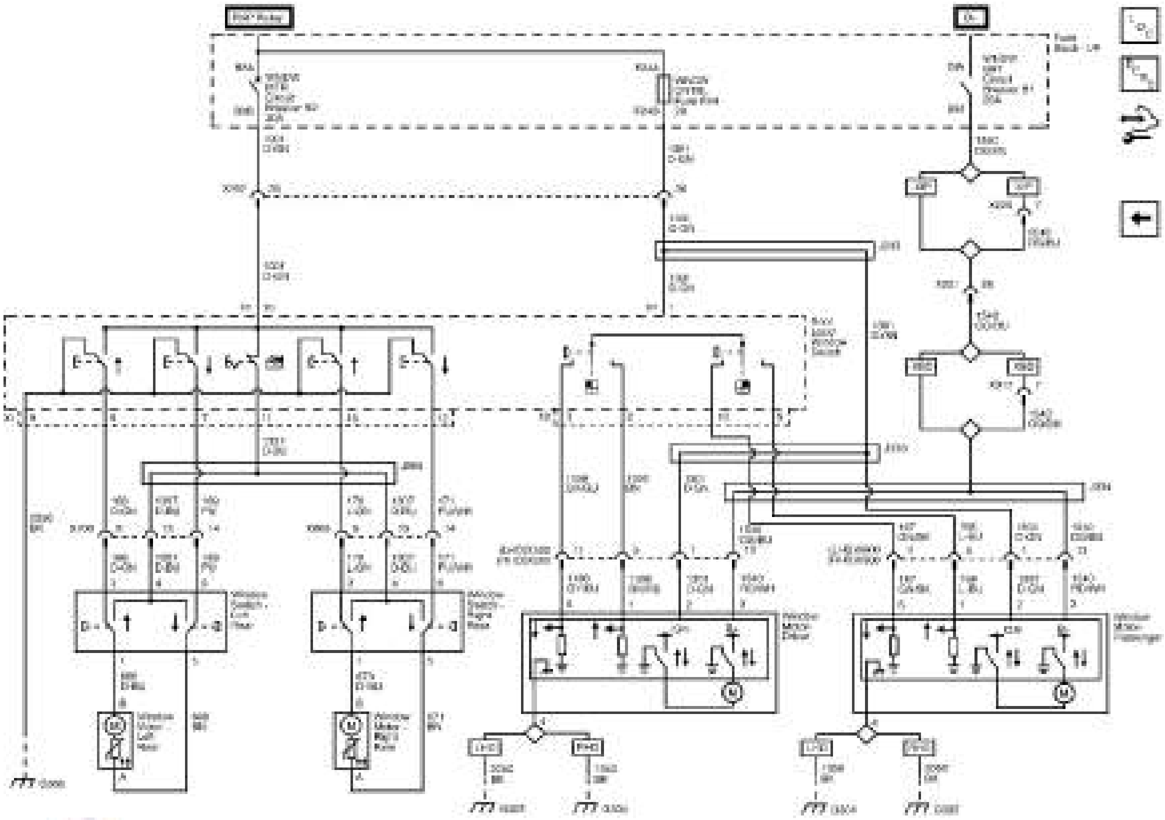
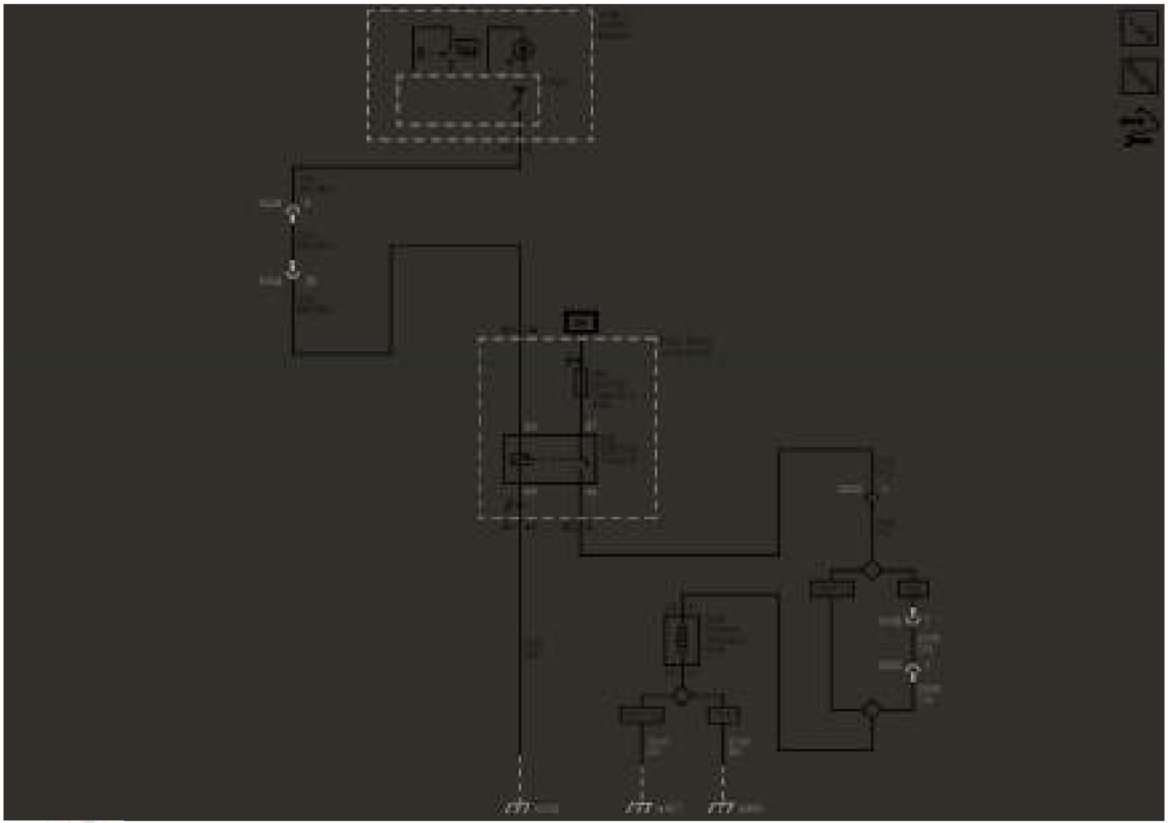
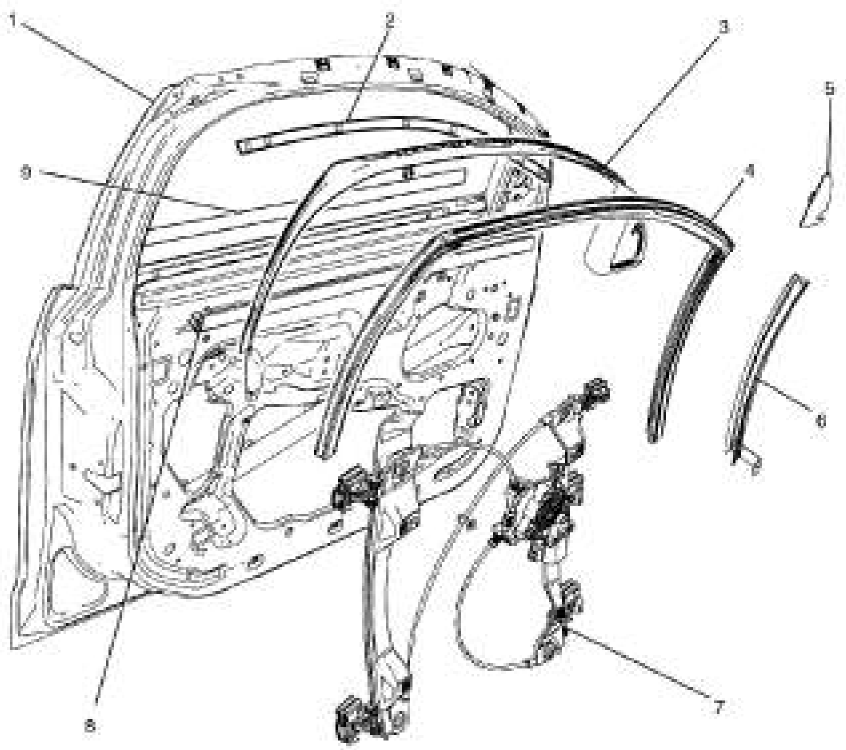
WNB



Defogger Schematics

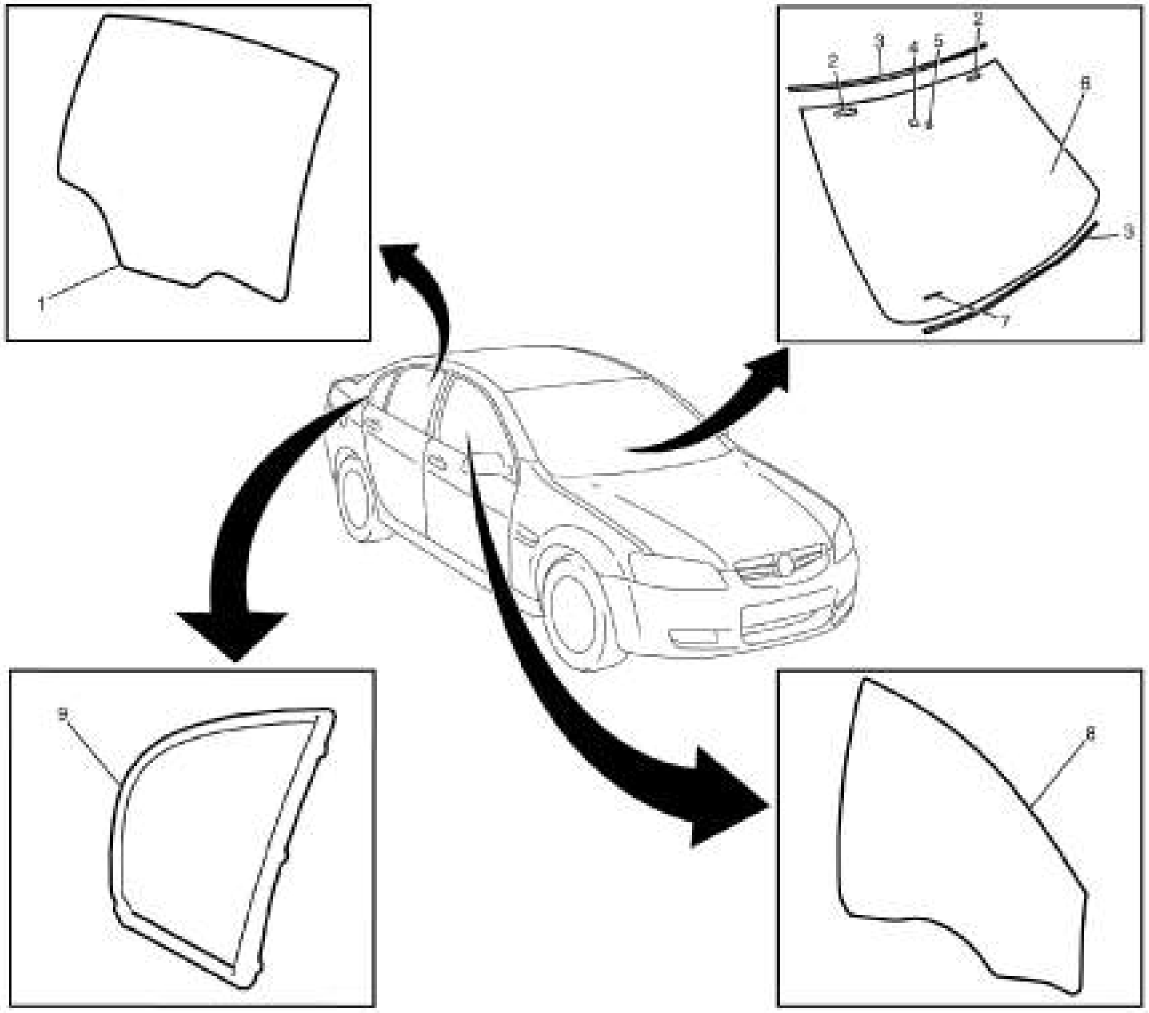


Front Door Window Component View



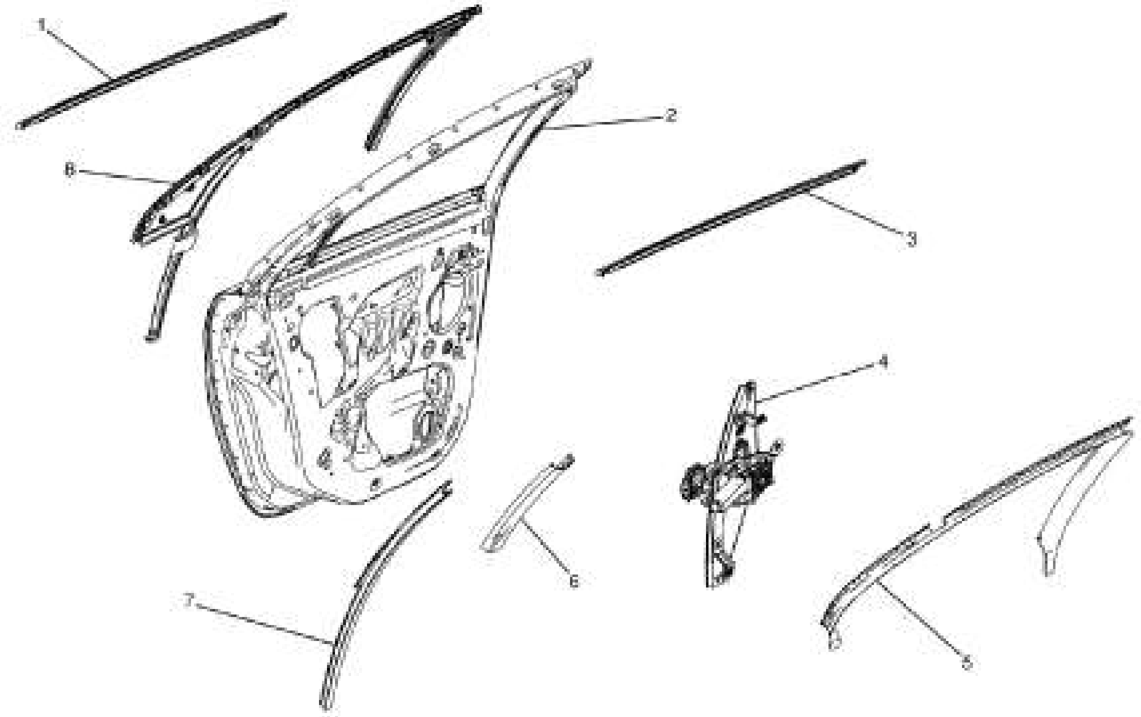
(1) Front Door Frame
(2) Inner Window Weather Seal
(3) Inner Sealing Strip
(4) Mirror Trim Panel
(5) Window Channel
(6) Front Window Regulator
(7) Sealing Strip Belt Inner
(8) Sealing Strip Belt Outer

Windshield and Body Side Glass Component Views



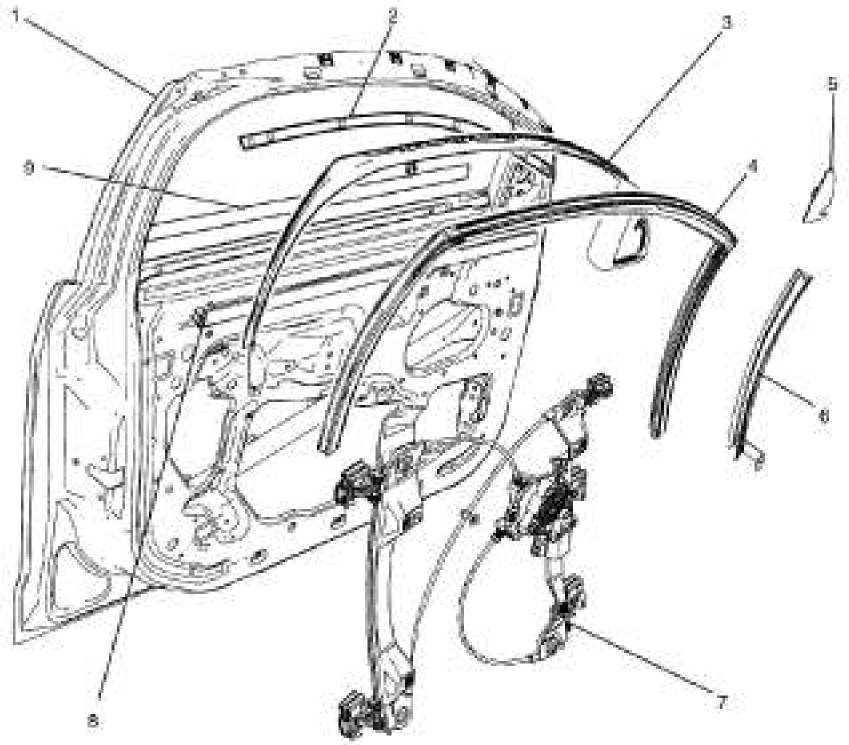
(1) Rear Door Window Glass
(2) Datum Pin
(3) Foam Spacer
(4) Rearview Mirror Boss
(5) Rain Sensor Boss (If Fitted)
(6) Windshield
(7) VIN Viewing Area
(8) Front Door Window Glass
(9) Rear Door Stationary Window Glass

Rear Door Window Component Views



(1) Sealing Strip Belt Outer
(2) Rear Door Frame
(3) Sealing Strip Belt Inner
(4) Rear Window Regulator
(5) Inner Window Weather Seal
(6) Window/Division Channel Trim Panel
(7) Window/Division Channel
(8) Outer Window Weather Seal

Front Door Window Component View



(1) Front Door Frame
(2) Inner Window Weather Seal
(3) Inner Sealing Strip
(4) Mirror Trim Panel
(5) Window Channel
(6) Front Window Regulator
(7) Sealing Strip Belt Inner
(8) Sealing Strip Belt Outer

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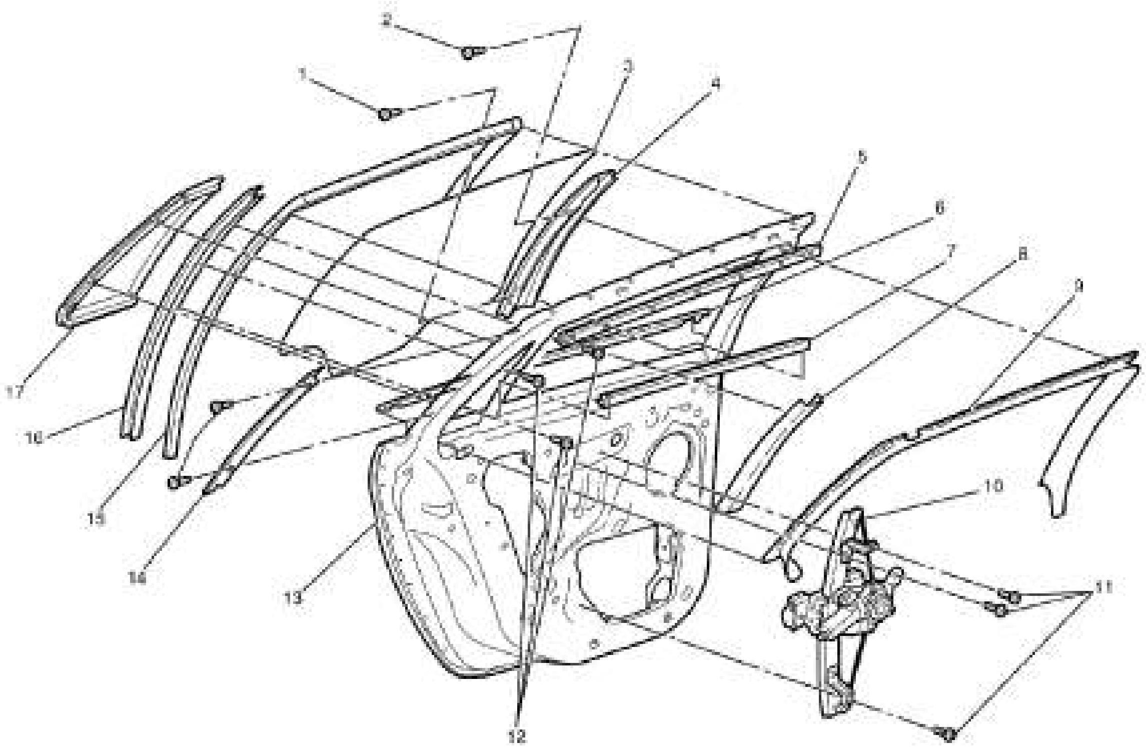
Rear Door Window Component View



(1) Rear Door Frame
(2) Rear Door Frame Applique (Rear)
(3) Screw -- Rear Door Frame Applique (Rear) to Rear Door Frame
(4) Outer Window Weather Seal
(5) Window/Division Channel
(6) Rear Side Door Window (Fixed)
(7) Rear Side Door Window (Moving)
(8) Rear Door Frame Applique
(9) Screw -- Rear Door Frame Applique to Rear Door Frame
(10) Sealing Strip Belt Outer
(11) Sealing Strip Belt Inner
(12) Window/Division Channel Trim Panel
(13) Inner Window Weather Seal
(14) Rear Window Regulator
(15) Screw -- Rear Window Regulator to Rear Door Frame

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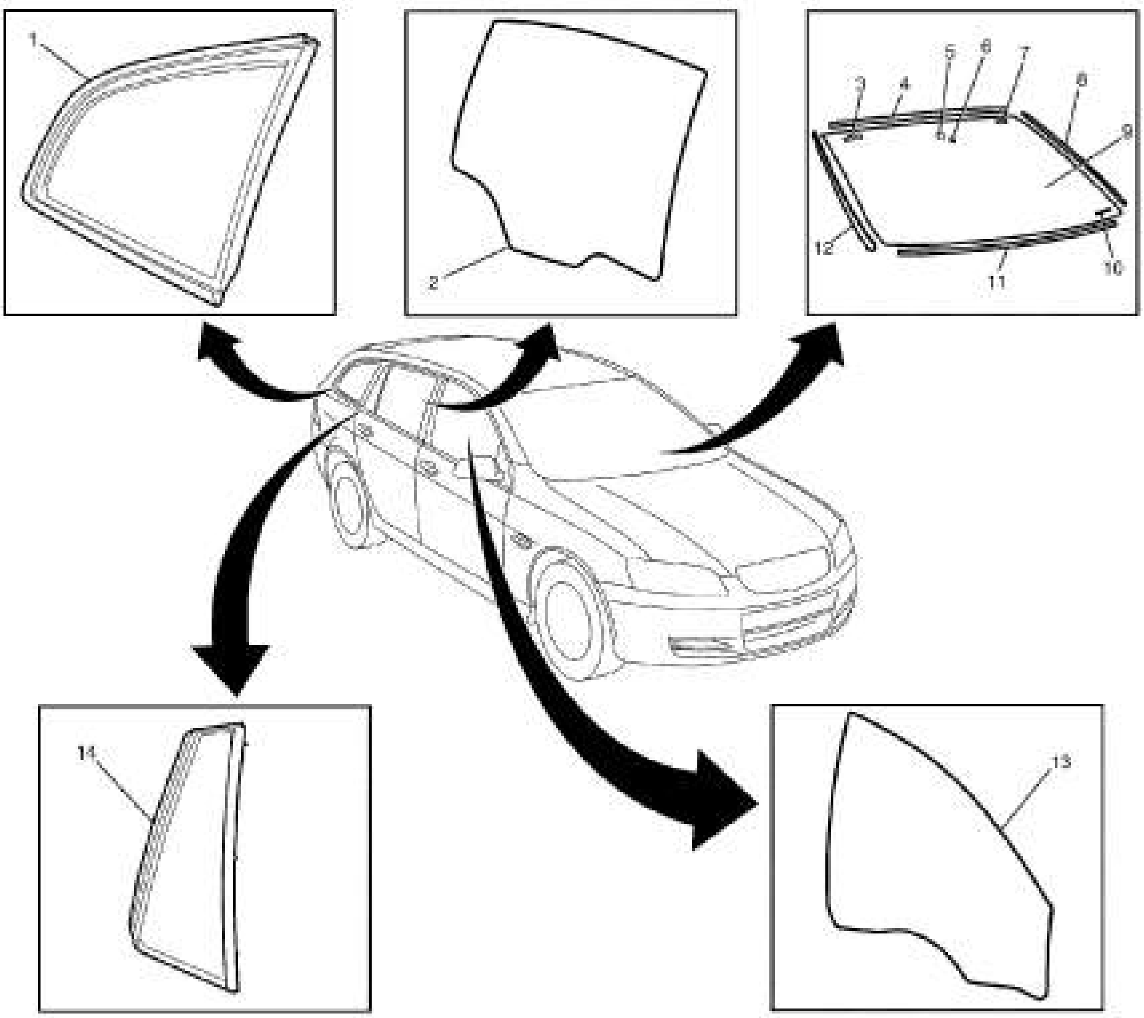
Windshield and Body Side Glass Component View



(1) Body Side Stationary Window Glass
(2) Rear Door Window Glass
(3) Datum Pin
(4) Foam Spacer
(5) Rearview Mirror Boss
(6) Rain Sensor Boss (If Fitted)
(7) Datum Pin
(8) Windshield Pillar Garnish Molding
(9) Windshield
(10) VIN Viewing Area
(11) Foam Spacer

(12) Windshield Pillar Garnish Molding
(13) Front Door Window Glass
(14) Rear Door Stationary Window Glass

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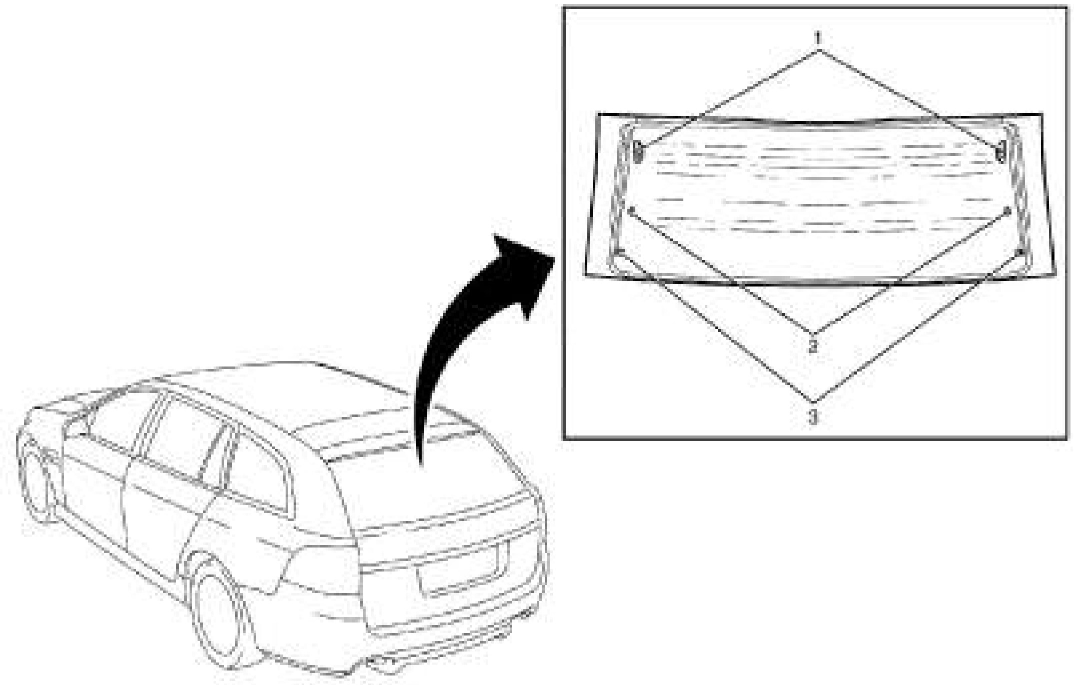
Liftgate Window Component View



(1) Datum Pins

(2) Defogger Electrical Connectors

(3) Foam Spacers

Diagnostic Starting Point - Doors

Begin the diagnosis by reviewing the system Description and Operation. Reviewing the Description and Operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the Description and Operation information will also help you determine if the condition described by the customer is normal operation. Refer to Diagnostic System Check - Vehicle , in order to identify the correct procedure for diagnosing the system and where the procedure is located.

The Diagnostic System Check will provide the following information:

- The identification of the control module which command the system
- The ability of the control module to communicate through the serial data circuit
- The identification of any stored diagnostic trouble codes (DTCs) and their status

Diagnostic Starting Point - Fixed and Moveable Windows

Begin the system diagnosis with Diagnostic System Check - Vehicle. The Diagnostic System Check - Vehicle will provide the following information:

- The identification of the control modules which command the system
- The ability of the control modules to communicate through the serial data circuit
- The identification of any stored diagnostic trouble codes (DTCs) and their status

The use of the Diagnostic System Check will identify the correct procedure for diagnosing the system and where the procedure is located.

DTC B0283

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC B0283 02: Electric Rear Defrost Circuit Short to Ground or Open

DTC B0283 05: Electric Rear Defrost Circuit Short to Battery or Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Switch B+	2	2	--	--
Rear Defog Relay Control	B0283 02	B0283 02, B0283 05	B0283 05	--
Rear Windows Defogger Grid Control	2	2	1	--
Rear Defog Relay Ground	--	B0283 02, B0283 05	2	--
Rear Window Defogger Grid Ground	--	2	2	--
1. Rear Defogger Always On 2. Rear Defogger Inoperative				

Circuit/System Description

The HVAC control module monitors the voltage level on the supply voltage circuit of the RR-Defog relay. The voltage level should be low while the RR-Defog relay is de-energized. The voltage will be near system voltage when the HVAC control module energizes the RR-Defog relay.

Conditions for Running the DTC

Battery voltage must be between 9-16 volts.

Conditions for Setting the DTC

B0283 02

When the HVAC control module detects a short to ground or an open/high resistance in the RR-Defog relay coil control circuit for 1 second or greater

B0283 05

When the HVAC control module detects a short to battery or an open/high resistance in the RR-Defog relay coil control circuit for 1 second or greater.

Action Taken When the DTC Sets

The rear window defogger will malfunction.

Conditions for Clearing the DTC

- The DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will be a history DTC.
- A history DTC will clear after 50 ignition cycles.

Reference Information

Schematic Reference

Defogger Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Rear Window Defogger Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Command the Rear Window Demister ON and OFF with the scan tool. The rear window defogger should turn ON and OFF when changing between the commanded states.

Circuit / System Testing

1. Ignition OFF, disconnect the RR-Defog relay.
2. Test for less than 1 ohm between the ground circuit terminal 85 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance
3. Connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85.
4. Ignition ON, command the Rear Window Demister ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the HVAC control module.

   If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the HVAC control module.
5. If all circuits test normal, test or replace the RR-Defog relay.

Component Testing

1. Ignition OFF, disconnect the RR-Defog relay.
2. Test for 60-180 ohms between terminals 85 and 86.

   If the not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If not the specified value, replace the relay.
4. Install a 25A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.

   If greater than the specified range, replace the relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Relay Replacement
- Control Module References for HVAC control module replacement, setup, and programming

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Symptoms - Fixed and Moveable Windows

Important Preliminary Checks Before Starting:

1. Perform the Diagnostic System Check - Vehicle before using the symptom tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data link
2. Review the power window system operation or rear window defogger system operation in order to familiarize yourself with the system functions. Refer to the following:
   - Rear Window Defogger Description and Operation
   - Power Windows Description and Operation

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the rear window defogger. Refer to Checking Aftermarket Accessories .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Important:

- Inspect for proper installation of electrical components if an intermittent condition exists. Inspect for aftermarket theft deterrent devices, lights, and cellular phones. Ensure that no aftermarket equipment is connected to the class 2 circuit. If you can not locate an intermittent condition, a cellular phone signal may cause the condition. Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections .
- The problem may or may not turn ON the SERVICE VEHICLE SOON indicator or store a DTC. Do not use the symptom tables to diagnose intermittent conditions. The malfunction must be present in order to locate the problem.

Poor electrical connections or wiring cause most intermittent conditions. Perform a careful visual/physical check for the following conditions:

- Poor mating of the connector halves or a terminal not fully seated in the connector body
- An improperly formed or damaged terminal
- Reform or replace connector terminals in the problem circuit in order to ensure proper contact tension.
- Poor terminal to wire connection requires removing the terminal from the connector body in order to perform the check.

Use a scan tool in order to help detect intermittent conditions. The scan tool has several features that can be used to locate an intermittent condition. The snapshot feature can capture and store data parameters within the scan tool when the malfunction occurs. This information can then be reviewed in order to see what caused the malfunction.

Symptom List

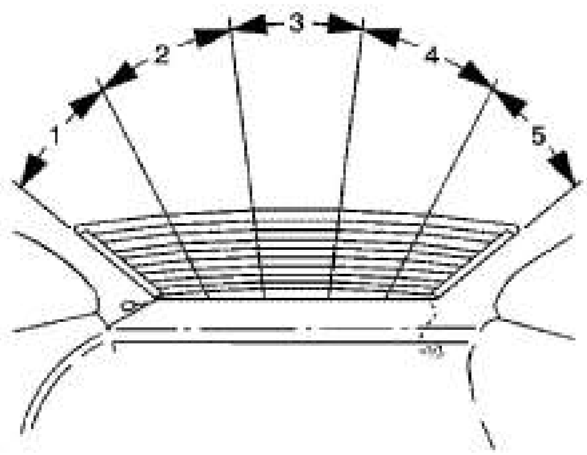
Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Rear Window Defogger Malfunction
- Power Windows Malfunction

Defogger Grid Lines Diagnosis

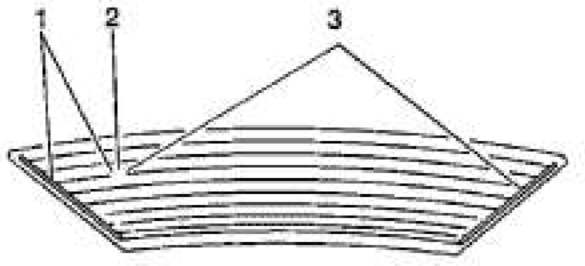
Important: This test is for reference only. A grid line fault requires rear window replacement. Refer to Rear Window Replacement.

1. Start the engine.
2. Activate the rear window defogger system.
3. Connect a test lamp to a known ground.



Important: The test lamp brilliance will decrease proportionately to the increased resistance in the grid line as the probe is moved from the battery positive bus wire to the ground bus wire. The test lamp brilliance may vary from one window to another.

4. Move the test lamp probe from zone 5 to zone 1 along each grid line.
   - If the test lamp shows full brilliance at both ends of the grid lines. Inspect for an open or poor connection in the ground circuit of the rear window defogger grid. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs.



- If the test lamp goes out, test the grid line in at least 2 places (1,3) to eliminate the possibility of bridging the open (2) in the grid line.

5. Once the open (2) is located, replace the rear window. Refer to Rear Window Replacement.

Rear Window Defogger Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
RR-Defog Relay Switch B+	2	2	--	--
Rear Defog Relay Control	B0283 02	B0283 02, B0283 05	B0283 05	--
Rear Defog Grid Control	2	2	1	--
RR-- Defog Relay Ground	--	B0283 02, B0283 05	2	--
Rear Defog Grid Ground	--	2	2	--
1. Rear Defogger Always On 2. Rear Defogger Inoperative				

Circuit/System Description

When the rear defogger button is pressed, voltage is supplied to the relay coil and the HVAC control module also illuminates the rear window defogger indicator. Battery positive voltage is supplied at all times to the relay switched input and the relay coil is always grounded. This allows battery positive voltage from the relay switched input through the switch contacts and out the relay switched output to the rear defog grid.

Reference Information

Schematic Reference

Defogger Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Rear Window Defogger Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool Rear Window Demister Switch parameter while pressing the rear window defogger switch. The parameter should change between Inactive and Active.

   If the value does not change between the commanded states, replace the HVAC control module.
2. Observe the operation of the rear window defogger indicator while pressing the rear window defogger switch. The indicator should turn ON or OFF each time the rear window defogger switch is pressed.

   If the indicator does not turn ON or OFF with each switch press, replace the HVAC control module.
3. Command the Rear Window Demister Switch ON and OFF with a scan tool. The rear window defogger should turn ON and OFF when changing between the commanded states.

Circuit/System Testing

1. Ignition OFF, disconnect the RR-Defog relay.
2. Test for less than 1 Ω between the ground circuit terminal 85 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify a test lamp does not illuminate between the control circuit terminal 30 and ground.

   If the test lamp illuminates, test the control circuit for a short to voltage.
4. Verify a test lamp illuminates between the B+ circuit terminal 87 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse is open, test the control circuit terminal 30 for a short to ground.
5. Ignition OFF, disconnect the X2 harness connector at the rear defog grid.
6. Test for less than 1 Ω between the ground circuit terminal A and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
7. Connect the X2 harness connector at the rear defog grid.
8. Ignition ON, connect a 40A fused jumper wire between the B+ circuit terminal 87 and the control circuit terminal 30. Verify the rear defog grid is activated.

   If the rear defog grid does not activate, test the control circuit for an open/high resistance. If the circuit tests normal, test or replace the rear defog grid.
9. Connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85.

10. Command the Rear Window Demister ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

    If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the HVAC control module.

    If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the HVAC control module.
11. If all circuits test normal, test or replace the RR-Defog relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the RR-Defog relay.
2. Test for 60-180 Ω between terminals 85 and 86.

   If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If not the specified value, replace the relay.
4. Install a 30A fused jumper wire between relay terminal 85 and 12V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 Ω between terminals 30 and 87.

   If greater than the specified range, replace the relay.

Rear Window Defogger Grid Test

1. Ignition ON, turn on the rear window defogger.
2. Verify that a test lamp illuminates between each rear defog grid line and ground. The test lamp should be off when testing at the ground side of the grid and get brighter as the test lamp moves closer to the voltage supply side of the grid. The test lamp should be dim when testing each grid line in the middle.

   If the test lamp remains bright at the middle of the grid line, test for an open between the test point and the ground side of the grid.

   If the test lamp remains off at the middle of the grid line, test for an open between the test point and the voltage supply side of the grid

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Relay Replacement
- Rear Window Replacement
- Control Module References for HVAC control module replacement, setup, and programming

Power Windows Malfunction (Commodore, Berlina, Calais, GTS, Club)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Door Lock Window Switch Ignition	1, 2	1, 2	--	--
Window Control Module Ignition	1	1	--	--
Rear Window Switch Signal	2	2	2	--
Lockout Switch Control	2	2	--	--
Front Window Motor Control	1	1	1	--
Rear Window Motor Control	2	2	2	--
Window Control Module Ground	--	1	1	--
Door Lock Window Switch Ground	--	2	2	--
1. Front Power Window Inoperative 2. Rear Power Window Inoperative				

Circuit/System Description

The power window system will operate any time the ignition is the ACC or RUN position. The power window system will also operate whenever the BCM is in RAP mode. The door lock window switch contains individual window switches for each power window. All windows may be controlled up and down from the door lock window switch. The individual rear passenger power window switches will only control the up and down operation of their respective power window.

Each power window contains a reversible power window motor. The direction the window travels is dependent upon the polarity of the supply voltage. By reversing polarity of the supply voltage the window motor will move up or down. Each power window motor is internally circuit breaker protected.

Reference Information

Schematic Reference

Moveable Window Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Windows Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Circuit/System Verification

1. Ignition ON, command each window UP and DOWN using the appropriate window switch on the door lock window switch and the rear door window switches. Each window should perform the UP and DOWN functions from each switch.

   If a front window does not perform the UP/DOWN function, refer to Front Window Malfunction.

   If either rear power windows do not perform the UP/DOWN function, refer to Rear Window Malfunction.
2. Disable and enable the rear window door switches by pressing and depressing the lockout switch on the door lock window switch. The rear door power window switches should be enabled and disabled when changing between the commanded states.

   If both rear window switches continue to function while disabled, refer to Lockout Switch Malfunction.
3. Command the express down function of the driver and passenger door windows by pressing the LF and RF window switches and releasing. The driver and passenger windows should perform the express down function.

   If the function does not perform as specified, replace the window control module.

Circuit/System Testing

Front Window Malfunction

1. Ignition OFF, disconnect the X2 harness connector at the door lock window switch.
2. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 1 and ground.

   If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance.

3. Ignition OFF, connect the X2 harness connector at the door lock window switch and disconnect the harness connector at the window control module.
4. Test for less than 1 ohm between the ground circuit terminal 5 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
5. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 8 and ground.

   If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance.
6. Connect a test lamp between the appropriate signal circuit terminal listed below and ground:
   - Terminal 12
   - Terminal 9
7. Command the power window DOWN by using the appropriate window switch on the door lock window switch. The test lamp should illuminate during the DOWN command.

   If the test lamp is always OFF, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the door lock window switch.

   If the test lamp is always ON, test the signal circuit for a short to voltage. If the circuit tests normal, test or replace the door lock window switch.
8. Connect a test lamp between the appropriate signal circuit terminal listed below and ground:
   - Terminal 6
   - Terminal 3
9. Command the power window UP by using the window switch on the door lock window switch. The test lamp should illuminate during the UP command.

   If the test lamp is always OFF, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the door lock window switch.

   If the test lamp is always ON, test the signal circuit for a short to voltage. If the circuit tests normal, test or replace the door lock window switch.
10. Ignition OFF, connect the harness connector at the window control module and disconnect the harness connector at the appropriate front window motor.
11. Test for less than 5 ohms between the control circuit terminal A and ground.

    If greater than the specified range, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the window control module.
12. Test for less than 5 ohms between the control circuit terminal B and ground.

    If greater than the specified range, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the window control module
13. Ignition ON, connect a test lamp between the control circuit terminal A and control circuit terminal B.
14. Command the power window UP and DOWN by using the window switch on the door lock window switch. The test lamp should illuminate during the UP and DOWN command.

    If the test lamp is always OFF during either for the commands, test either control circuit for a short to ground. If the circuit tests normal, replace the window control module.
15. If all circuits test normal, test or replace the front window motor.

Rear Window Malfunction

1. Ignition OFF, disconnect the X1 harness connector at the door lock window switch.
2. Test for less than 1 ohm between the ground circuit terminal 9 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 10 and ground.

If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance.

4. Ignition OFF, connect the X1 harness connector at the door lock window switch and disconnect the harness connector at the appropriate rear window switch.

   Important: Verify the rear window switches are enabled by checking the lockout switch on the door lock window switch.

5. Ignition ON, verify that a test lamp illuminates between the control circuit terminal 4 and ground.
   If the test lamp does not illuminate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the door lock window switch.
6. Ignition OFF, test for less than 1 ohm between the signal circuit terminal 3 and ground.
   If greater than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, test or replace the door lock window switch.
7. Test for less than 1 ohm between the signal circuit terminal 6 and ground.
   If greater than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, test or replace the door lock window switch.
8. Connect a test lamp between the signal circuit terminal 3 and the signal circuit terminal 6.
9. Ignition ON, command the rear passenger door window UP and DOWN by using the door lock window switch. The test lamp should illuminate when commanding the UP and DOWN states.
   If the test lamp does not illuminate during either of the commands, test both signal circuits for a short to ground. If the circuits test normal, test or replace the door lock window switch.
10. Ignition OFF, connect the harness connector at the rear window switch and disconnect the harness connector at the rear window motor.
11. Test for less than 5 ohms between the control circuit terminal A and ground.
    If greater than the specified range, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, test or replace the rear window switch.
12. Test for less than 5 ohms between the control circuit terminal B and ground.
    If greater than the specified range, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, test or replace the rear window switch.
13. Connect a test lamp between the control circuit terminal A and the control circuit terminal B.
14. Ignition ON, command the rear window UP and DOWN by using the rear window switch. The test lamp should illuminate when commanding the UP and DOWN states.
    If the test lamp does not illuminate during either of the commands, test both control circuits for a short to ground. If the circuits test normal, test or replace the rear window switch.
15. If all circuits test normal, test or replace the rear window motor.

Lockout Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the appropriate rear window switch.
2. Connect a test lamp between the control circuit terminal 4 and ground.
3. Ignition ON, command the rear window lockout ON and OFF by pressing and depressing the lockout switch on the door lock window switch. The test lamp should turn ON and OFF when changing between the commanded states.
   If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, test or replace the door lock window switch.

If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the door lock window switch.

4. If all circuits test normal, test or replace the rear window switch.

Component Testing

Door Lock Window Switch

1. Ignition OFF, disconnect the X1 and X2 harness connectors at the door lock window switch.
2. Test for less than 2 ohms between the control terminal 11 and the ignition terminal 10 with the lockout switch in the ENABLE position.

   If greater than the specified value, replace the door lock window switch
3. Test for infinite resistance between the control terminal 11 and the ignition circuit terminal 10 with the lockout switch in the DISABLE position.

   If less than the specified value, replace the door lock window switch.
4. With the switch in the INACTIVE position, test for infinite resistance between the control terminals listed below and the ignition terminal 10:
   - Control terminal 8
   - Control terminal 7
   - Control terminal 12
   - Control terminal 13

   If less than the specified value, replace the door lock window switch.
5. With the switch in the UP position, test for less than 2 ohms between the control terminals listed below and the ignition terminal 10:
   - LR window switch control terminal 8
   - RR window switch control terminal 13

   If greater than the specified range, replace the door lock window switch.
6. With the switch in the DOWN position, test for less than 2 ohms between the control terminals listed below and the ignition terminal 10:
   - LR window switch control terminal 7
   - RR window switch control terminal 12

   If greater than the specified range, replace the door lock window switch.

Passenger Rear Window Switch

1. Ignition OFF, disconnect the harness connector at the appropriate rear window switch.
2. Test for infinite resistance between the control terminals 1 and 5 and the control terminal 4 with the switch in the INACTIVE position.

   If less than the specified value, replace the rear window switch.
3. Test for less than 2 ohms between the control terminal 1 and the control terminal 4 with the switch in the UP position.

   If greater than the specified range, replace the rear window switch.
4. Test for less than 2 ohms between the control terminal 5 and the control terminal 4 with the switch in the DOWN position.

   If greater than the specified range, replace the rear window switch

Window Motor

> **Important:** When performing the following tests, make sure that the window motor is not all ready in the position the test is attempting to produce.

1. Ignition OFF, disconnect the harness connector at the appropriate window motor
2. Install a 20A fused jumper wire between the control terminal A and 12V. Momentarily install a jumper wire between the control terminal B and ground. The window motor should perform the UP/DOWN function.

   If the function does not perform as specified, replace the window motor.
3. Reverse the jumper wires; the window motor should perform the DOWN/UP function.

   If the function does not perform as specified, replace the window motor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Rear Side Door Window Switch Replacement
- Power Mirror Switch Replacement
- Front Side Door Window Regulator Motor Replacement
- Rear Side Door Window Regulator Motor Replacement
- Front Door Module Replacement

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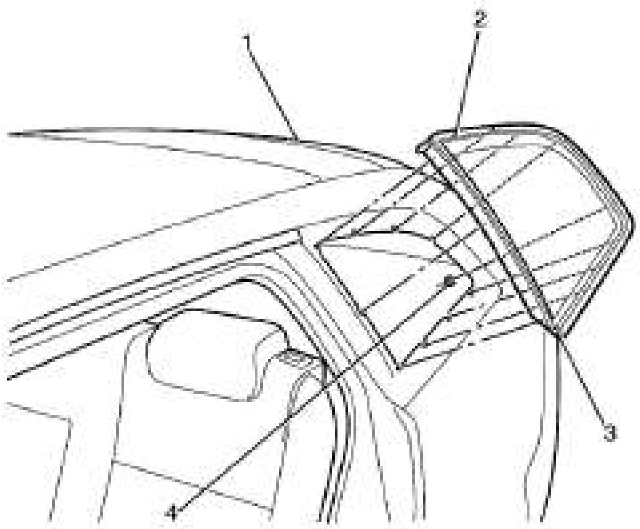
Body Side Window Replacement (Sportwagon)

Removal Procedure

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
3. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
4. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
5. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
6. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
7. Remove the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
8. Remove the body side window rear garnish moulding. Refer to Body Side Window Rear Garnish Molding Replacement.
9. Remove the body lock pillar lower trim panel. Refer to Body Lock Pillar Lower Trim Panel Replacement.
10. Remove the body lock pillar trim panel. Refer to Body Lock Pillar Trim Panel Replacement.
11. Remove the body lock pillar upper trim panel. Refer to Body Lock Pillar Upper Trim Panel Replacement.



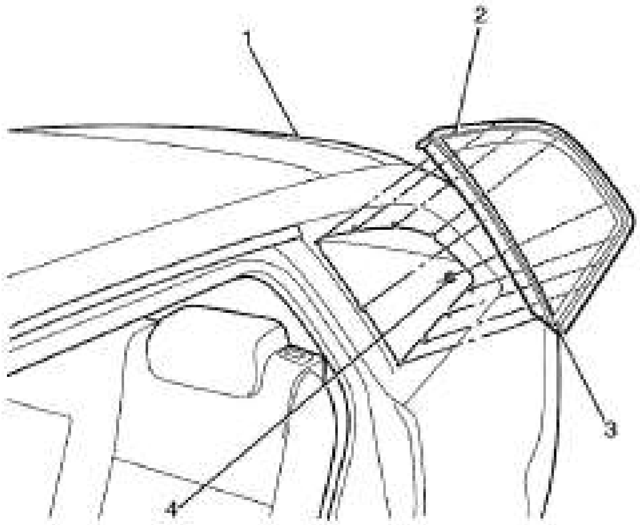
12. Remove the body side stationary window to body retaining nuts (4).

    Discard the nuts.

13. Remove the body side stationary window (2) from the vehicle (1).

14. Inspect the body side stationary window seal (3) for excessive wear and/or damage. Replace if necessary.

Installation Procedure



Important: Inspect the body side stationary window seal (3) for excessive wear and/or damage. Replace if necessary.

1. Install the body side stationary window seal (3) to the body side stationary window (2).
2. Install the body side stationary window (2) to the vehicle (1).

Notice: Refer to Fastener Notice in the Preface section.

3. Install the NEW body side stationary window to body retaining nuts (4).

Tighten
Tighten the nuts to 2 N·m (18 lb in).

4. Install the body lock upper pillar trim panel. Refer to Body Lock Pillar Upper Trim Panel Replacement.
5. Install the body lock pillar trim panel. Refer to Body Lock Pillar Trim Panel Replacement.
6. Install the body lock pillar lower trim panel. Refer to Body Lock Pillar Lower Trim Panel Replacement
7. Install the body side window rear garnish moulding. Refer to Body Side Window Rear Garnish Molding Replacement.
8. Install the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
9. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
10. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
11. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet

Replacement.

12. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
13. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

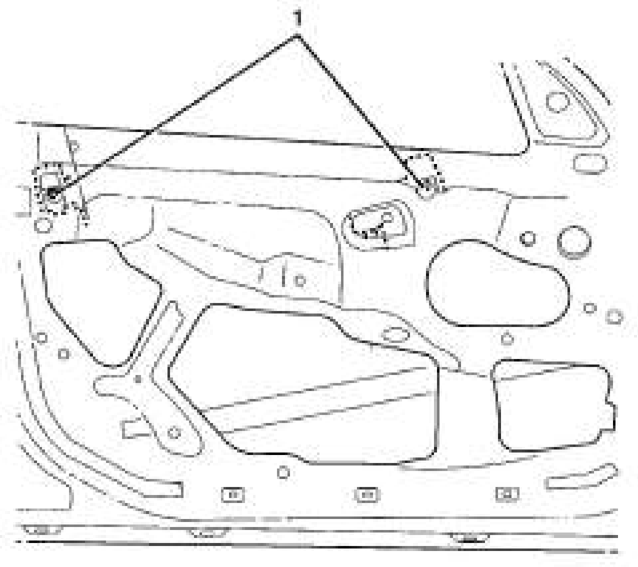
14. Remove the suitable liftgate brace to the vehicle.

Door Window Adjustment

1. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement or Rear Side Door Trim Panel Replacement.
2. Remove the water deflector. Refer to Front Side Door Water Deflector Replacement or Rear Side Door Water Deflector Replacement.

Caution: Refer to Glass and Sheet Metal Handling Caution in the Preface section.

Caution: Refer to Express Window Down Caution in the Preface section.



3. Loosen the window regulator to window glass retaining bolts (1).
4. Start the vehicle to make sure maximum power to the window motor. This is required to fully seat the window for adjustment.

Notice: Refer to Fastener Notice in the Preface section.

5. Raise the window to the full up position.

Tighten
Tighten the window clamp nuts to 8 N-m (71 lb in).

6. Inspect for correct window operation and a tight seal.
7. Shut off the vehicle.
8. Install the water deflector. Refer to Front Side Door Water Deflector Replacement or Rear Side Door Water Deflector Replacement.
9. Install the door trim panel. Refer to Front Side Door Trim Panel Replacement or Rear Side Door Trim Panel Replacement.

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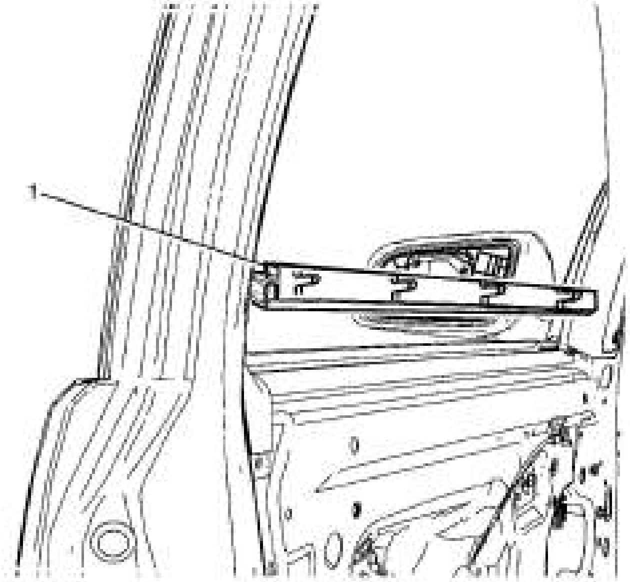
Front Side Door Window Belt Inner Sealing Strip Replacement

Removal Procedure

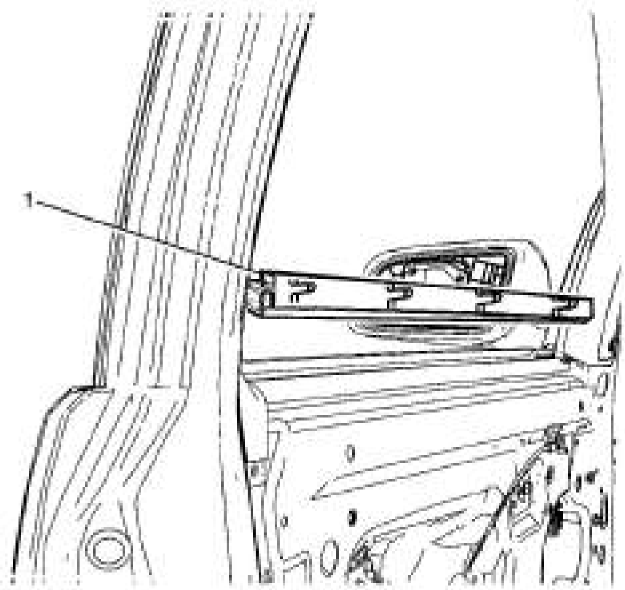
1. Lower the window to the full down position.
2. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement.



Important: Pull upward to release the window inner belt sealing strip (1).

3. Remove the window inner belt sealing strip (1).

Installation Procedure



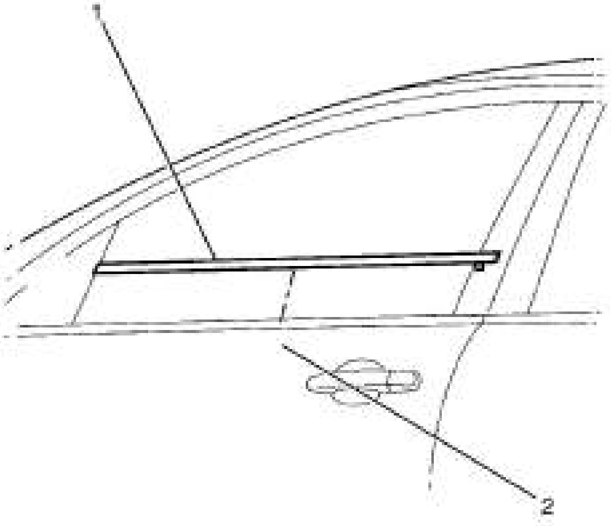
Important: Push downward to attach the window inner belt sealing strip (1).

1. Install the window inner belt sealing strip (1).
2. Install the door trim panel. Refer to Front Side Door Trim Panel Replacement.

Front Side Door Window Belt Outer Sealing Strip Replacement

Removal Procedure

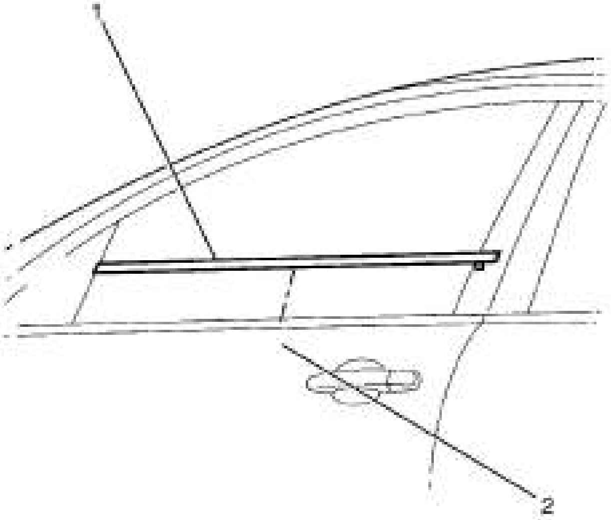
1. Remove the outside rearview mirror. Refer to Power Mirror Replacement.
2. Lower the window to the full down position.



Important: Pull the front door outer belt sealing strip (1) to detach the retainers.

3. Remove the front door outer belt sealing strip (1) from the door (2).

Installation Procedure



Important: Push the front door outer belt sealing strip (1) to attach the retainers.

1. Install the front door outer belt sealing strip (1) to the door (2).
2. Install the outside rearview mirror. Refer to Power Mirror Replacement.

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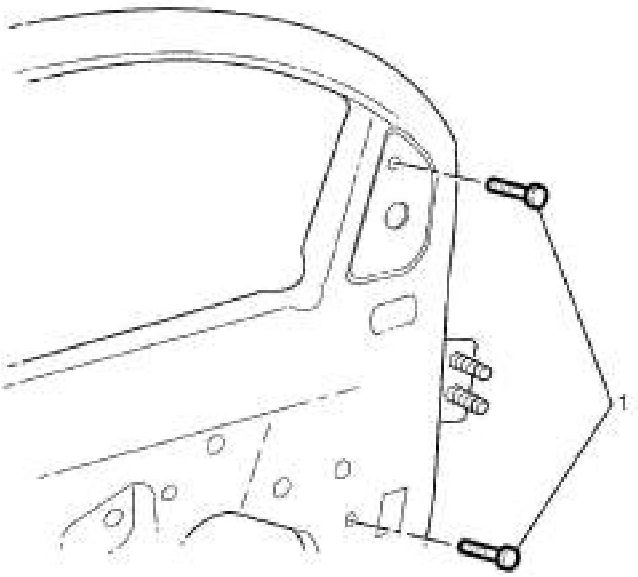
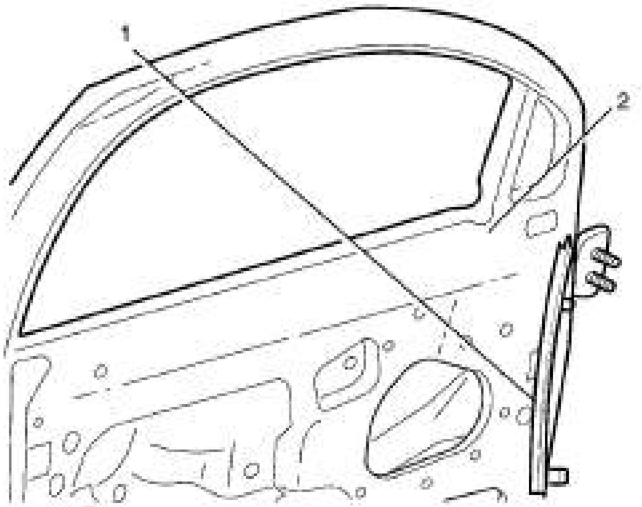
Front Side Door Window Front Channel and Rear Channel Replacement

Removal Procedure

1. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement.
2. Remove the speaker. Refer to Radio Front Side Door Lower Speaker Replacement in Entertainment.
3. Remove the water deflector. Refer to Front Side Door Water Deflector Replacement.
4. Remove the window inner belt sealing strip. Refer to Front Side Door Window Belt Inner Sealing Strip Replacement.
5. Remove the outside rearview mirror. Refer to Power Mirror Replacement.
6. Remove the window outer belt sealing strip. Refer to Front Side Door Window Belt Outer Sealing Strip Replacement in Doors.
7. Remove the window inner weatherstrip. Refer to Front Side Door Window Inner Weatherstrip Replacement.
8. Remove the window inner sealing strip. Refer to Front Door Opening Weatherstrip Replacement.



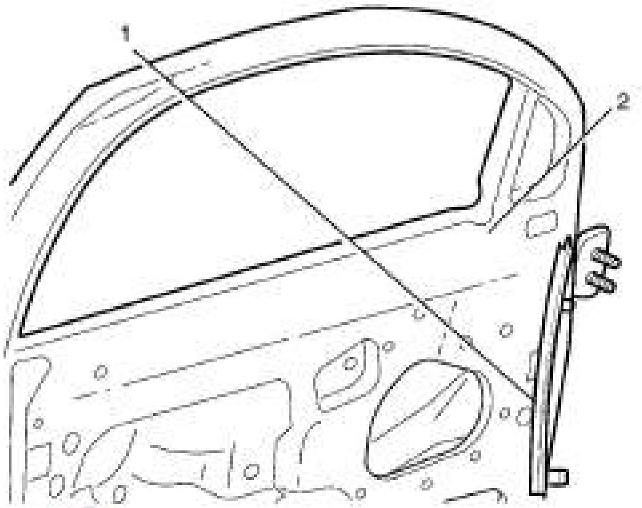
9. Remove the window channel to door retaining bolts (1).



Important: Rotate the top of the window channel (1) forward to aid in removal. Remove the window channel (1) through the large door access hole.

10. Remove the window channel (1) from the door (2).

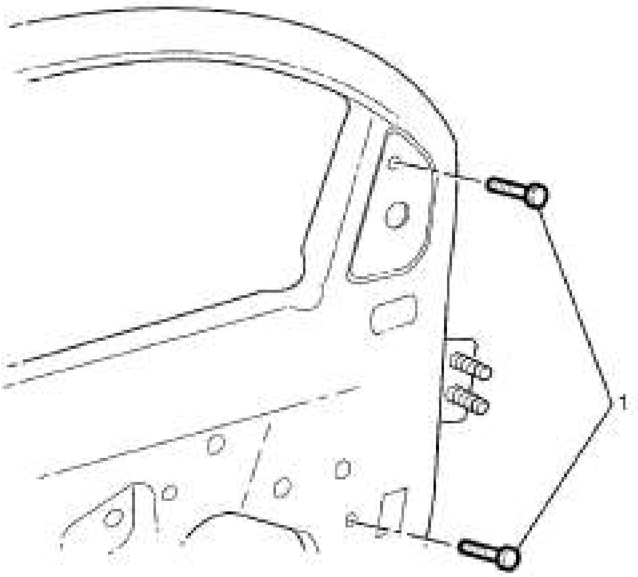
Installation Procedure



Important: Install the window channel through the large access hole and rotate the top of the window channel (1) rearward and align on the lower edge of the window.

1. Install the window channel (1) into the door (2).

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the window channel to door retaining bolts (1).

   Tighten
   Tighten the bolts to 8 N-m (71 lb in).

3. Install the window inner sealing strip. Refer to Front Door Opening Weatherstrip Replacement.
4. Install the window inner weatherstrip. Refer to Front Side Door Window Inner Weatherstrip Replacement.
5. Install the window inner belt sealing strip. Refer to Front Side Door Window Belt Inner Sealing Strip Replacement in Doors.
6. Install the window outer belt sealing strip. Refer to Front Side Door Window Belt Inner Sealing Strip Replacement in Doors.
7. Install the outside rear view mirror. Refer to Power Mirror Replacement.
8. Install the water deflector. Refer to Front Side Door Water Deflector Replacement.
9. Install the speaker. Refer to Radio Rear Side Door Speaker Replacement in Entertainment.
10. Install the door trim panel. Refer to Front Side Door Trim Panel Replacement.

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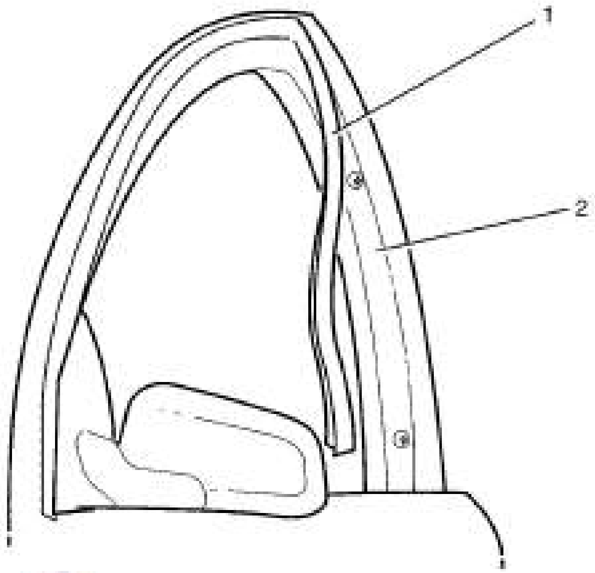
Front Side Door Window Inner Sealing Strip Replacement

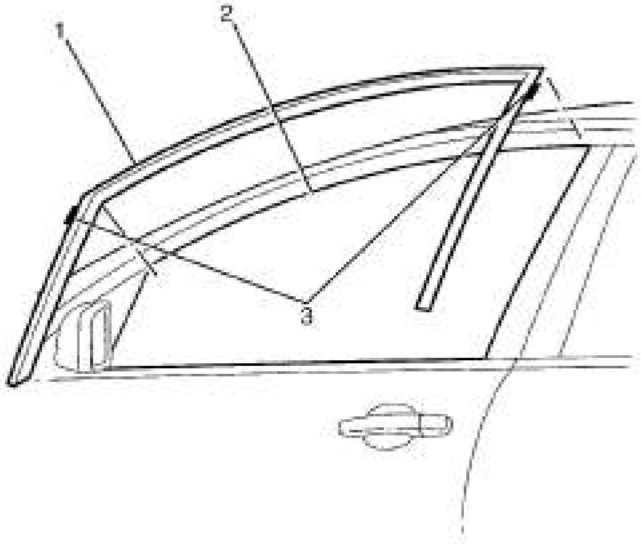
Removal Procedure

1. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement.
2. Remove the window inner belt sealing strip. Refer to Front Side Door Window Belt Inner Sealing Strip Replacement.
3. Remove the window outer belt sealing strip. Refer to Front Side Door Window Belt Outer Sealing Strip Replacement.
4. Lower the window to full down.



Important: Starting at the rear of the front door use a suitable tool to pry the window inner sealing strip (1) out of the door (2) then pull by hand.

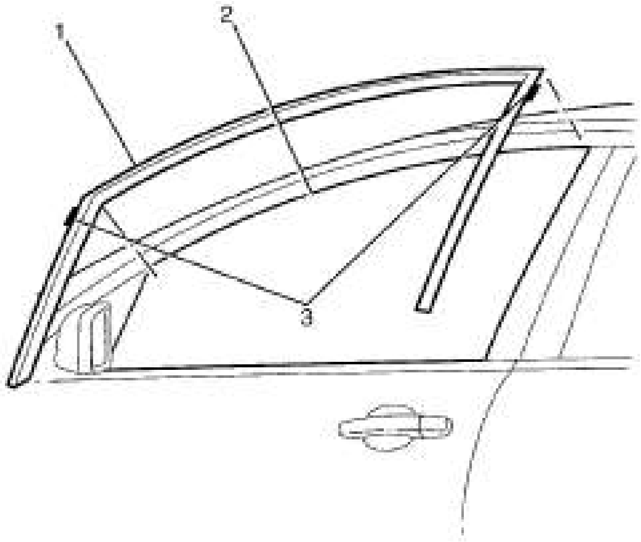
5. Remove the window inner sealing strip (1) from the rear of the front door (2).



Important: Pull remaining window sealing strip (1) from the door (2). Observe the orientation of the locating tabs (3) this will aid in correct re-installation.

6. Remove the window inner sealing strip (1) from the door (2).

Installation Procedure



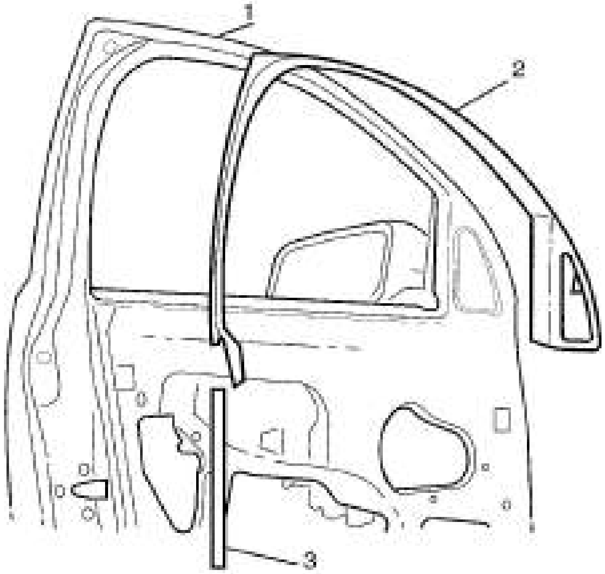
Important: Push the window inner sealing in by hand. The locating tabs (3) are at the top of the window inner sealing strip (1) and must fit into the correct location in the door (2) for correct sealing and operation.

1. Install the window inner sealing strip (1) into the door (2).
2. Install the window outer belt sealing strip. Refer to Front Side Door Window Belt Outer Sealing Strip Replacement.
3. Install the window inner belt sealing strip. Refer to Front Side Door Window Belt Inner Sealing Strip Replacement.
4. Install the door trim panel. Refer to Front Side Door Trim Panel Replacement.

Front Side Door Window Inner Weatherstrip Replacement

Removal Procedure

1. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement .
2. Remove the window inner belt sealing strip. Refer to Front Side Door Window Belt Inner Sealing Strip Replacement .

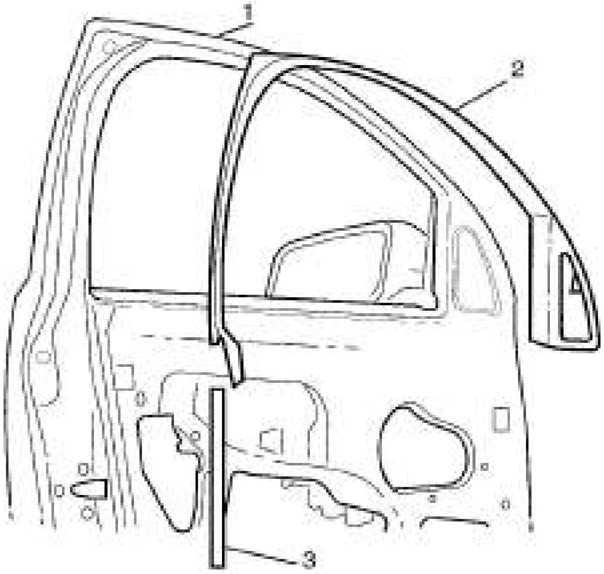


3. Remove the lower part of the inner window weatherstrip (3) from the door (1).

Important: Pull the inner window weatherstrip (2) to detach the retainers.

4. Remove the inner window weatherstrip (2) from the door (1).

Installation Procedure



Important: Locate the weatherstrip (2) at the datum located at the front first. Push the inner window weatherstrip (2) to attach the retainers.

1. Install the inner window weatherstrip (2) to the door (1).
2. Install the lower part of the inner window weatherstrip (3) to the door (1).
3. Install the window inner belt sealing strip. Refer to Front Side Door Window Belt Inner Sealing Strip Replacement .
4. Install the door trim panel. Refer to Front Side Door Trim Panel Replacement .

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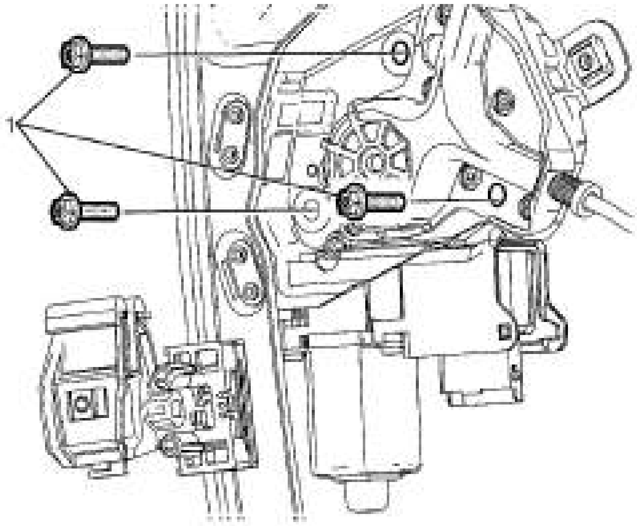
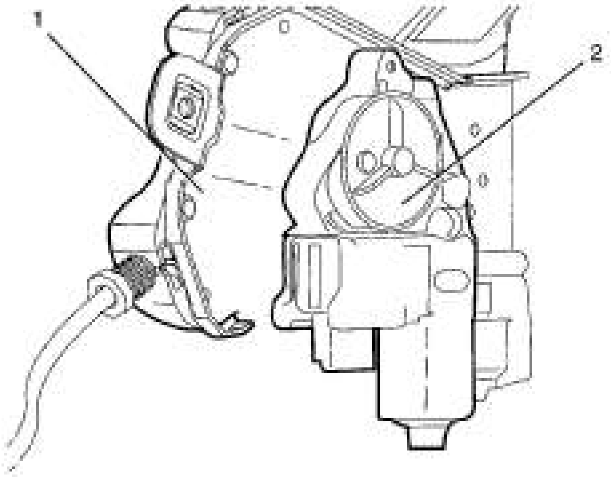
Front Side Door Window Regulator Motor Replacement

Removal Procedure

1. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement .
2. Remove the speaker. Refer to Radio Front Side Door Lower Speaker Replacement .
3. Remove the water deflector. Refer to Front Side Door Water Deflector Replacement .
4. Remove the window regulator. Refer to Front Side Door Window Regulator Replacement .

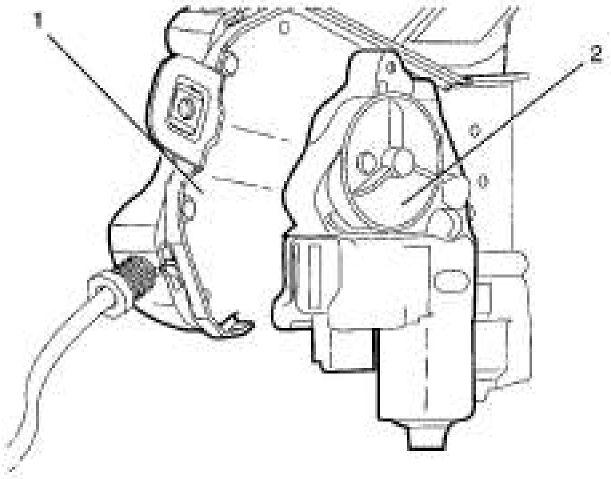


5. Remove the window regulator motor to window regulator retaining bolts (1).



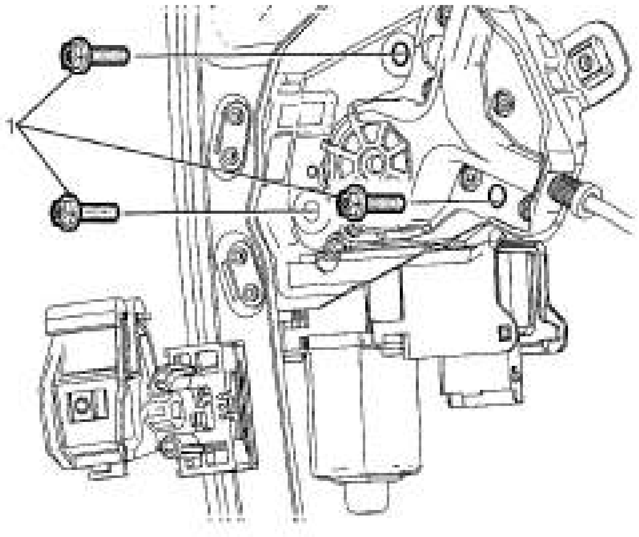
6. Remove the window regulator motor (2) from the window regulator (1).

Installation Procedure



1. Position the window regulator motor (2) to the window regulator (1).

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the window regulator motor to window regulator retaining bolts (1).

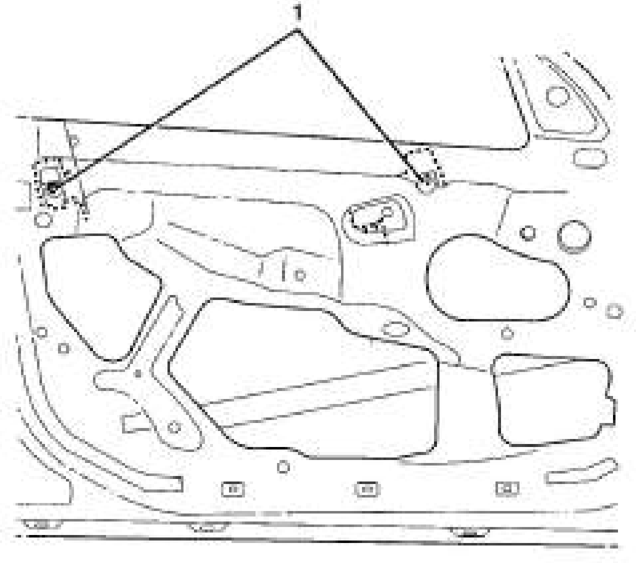
   Tighten
   Tighten the bolts to 8 N-m (71 lb in).

3. Install the window regulator. Refer to Front Side Door Window Regulator Replacement .
4. Install the water deflector. Refer to Front Side Door Water Deflector Replacement .
5. Install the speaker. Refer to Radio Front Side Door Lower Speaker Replacement .
6. Install the door trim panel. Refer to Front Side Door Trim Panel Replacement .

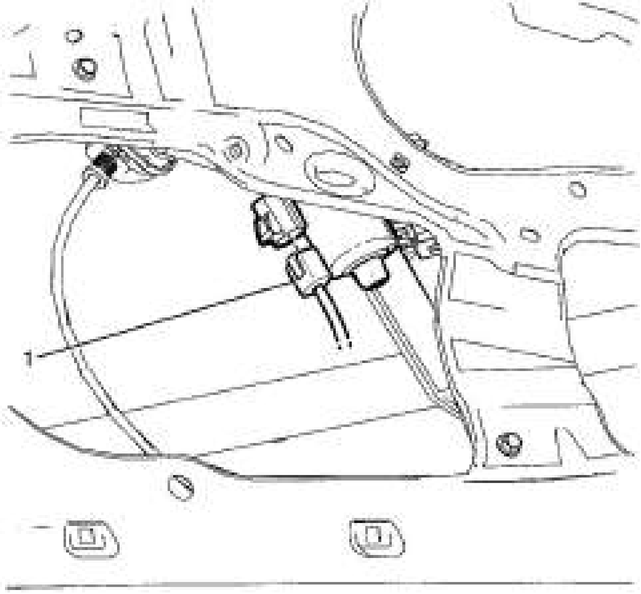
Front Side Door Window Regulator Replacement

Removal Procedure

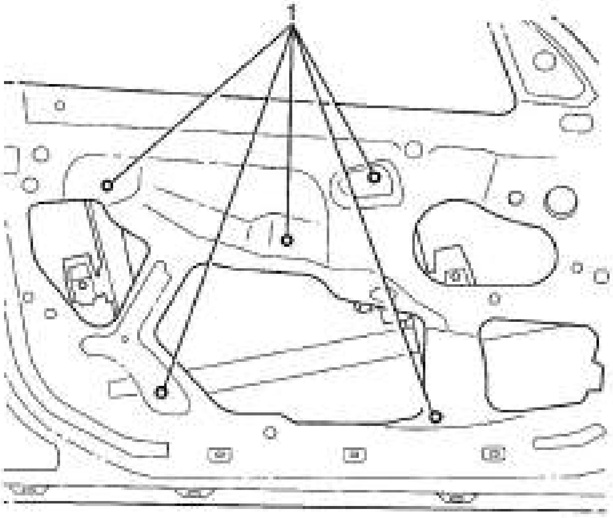
1. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement .
2. Remove the speaker. Refer to Radio Front Side Door Lower Speaker Replacement .
3. Remove the water deflector. Refer to Front Side Door Water Deflector Replacement .
4. Raise and support the window in the full up position.



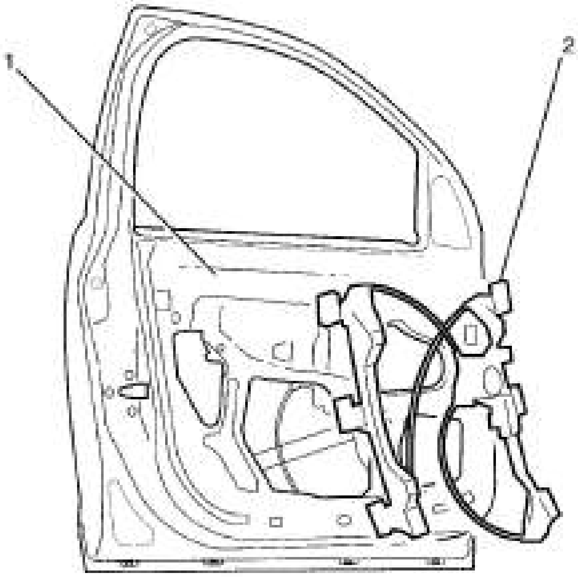
5. Loosen the window regulator to window glass retaining bolts (1).
6. Support the window glass.
7. Lower the window regulator approximately 1/2 way down.



8. Disconnect the window regulator electrical connector (1).

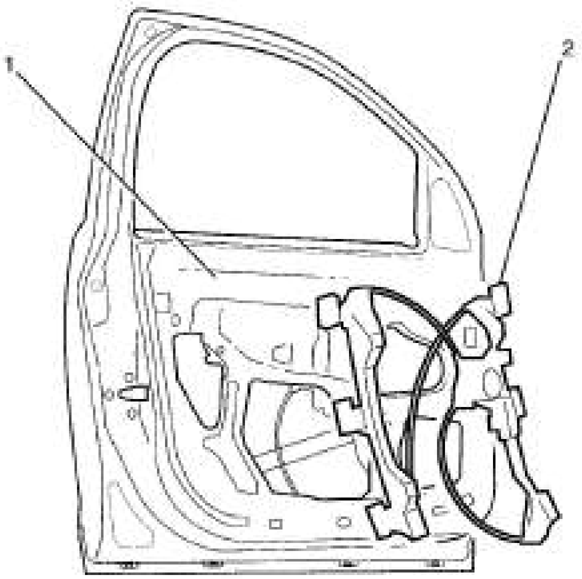


9. Remove the window regulator to door retaining bolts (1).



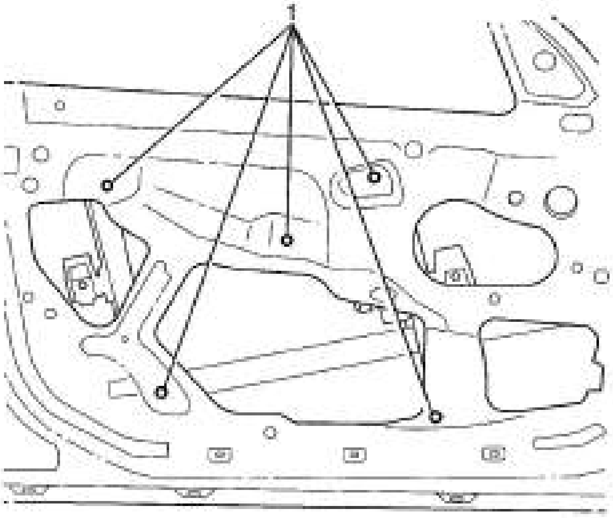
10. Remove the window regulator (2) through the large access hole in the door (1).

Installation Procedure



1. Position the window regulator (2) through the large access hole in the door (1).

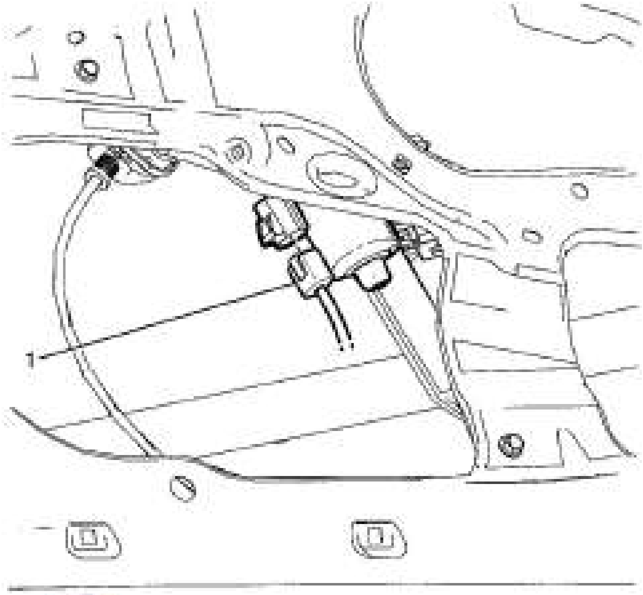
   Notice: Refer to Fastener Notice in the Preface section.



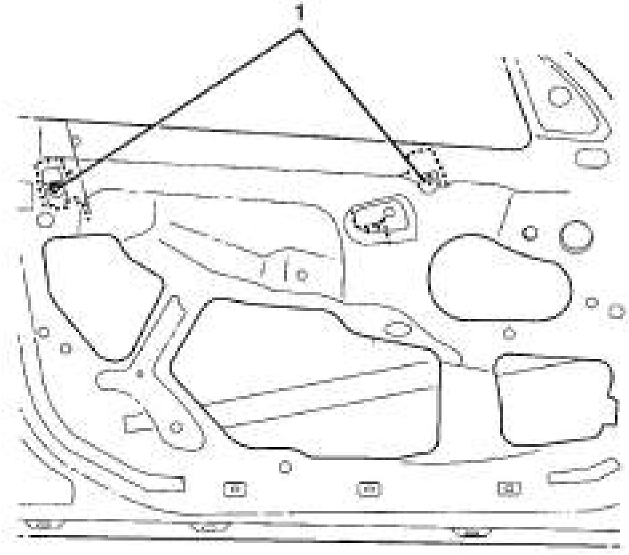
2. Install the window regulator to door retaining bolts (1).

   Tighten
   Tighten the bolts to 10 N-m (89 lb in).

3. Remove the support from the window.
4. Lower the window into the window regulator clamps.



5. Connect the window regulator electrical connector (1).
6. Start the vehicle to make sure maximum power to the window motor. This is required to fully seat the window for adjustment.
7. Raise the window to the full up position.



8. Tighten the window regulator to window glass retaining bolts (1).

   Tighten
   Tighten the bolts to 8 N-m (71 lb in).

9. Inspect the window for correct operation and a tight seal.
10. Shut off the vehicle.
11. Install the water deflector. Refer to Front Side Door Water Deflector Replacement .
12. Install the speaker. Refer to Radio Front Side Door Lower Speaker Replacement .

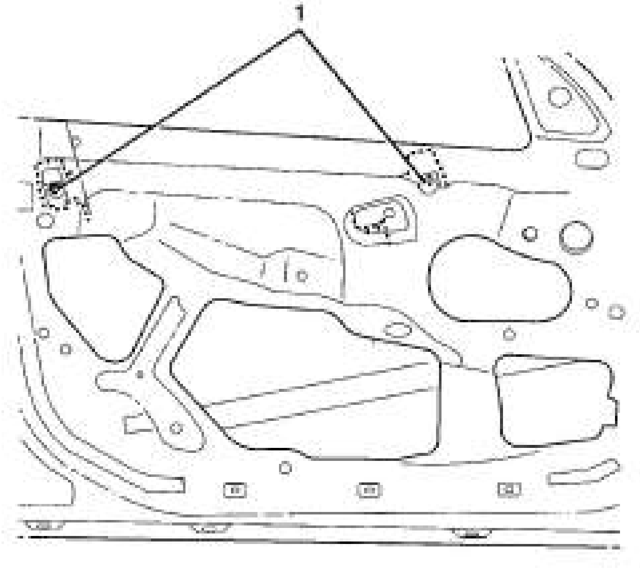
13. Install the door trim panel. Refer to Front Side Door Trim Panel Replacement .

Front Side Door Window Replacement

Removal Procedure

Caution: Refer to Glass and Sheet Metal Handling Caution in the Preface section.

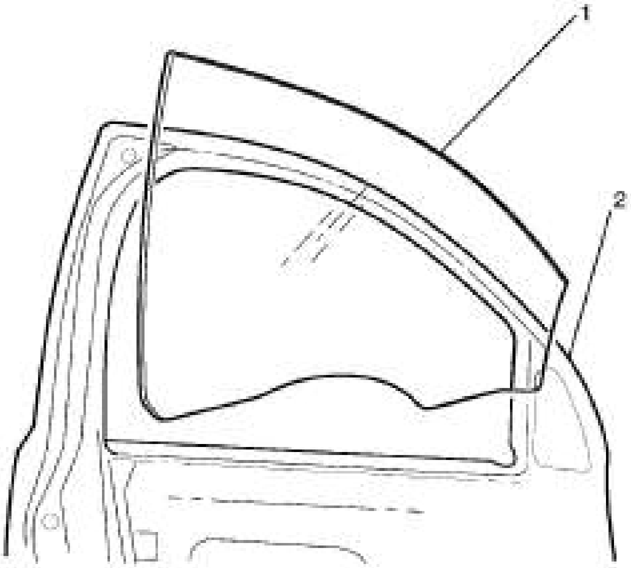
1. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement .
2. Remove the speaker. Refer to Radio Front Side Door Lower Speaker Replacement .
3. Remove the water deflector. Refer to Front Side Door Water Deflector Replacement .
4. Remove the window inner belt sealing strip. Refer to Front Side Door Window Belt Inner Sealing Strip Replacement
5. Remove the outside rearview mirror. Refer to Power Mirror Replacement .
6. Remove the window outer belt sealing strip. Refer to Front Side Door Window Belt Outer Sealing Strip Replacement .
7. Remove the window inner weatherstrip. Refer to Front Side Door Window Inner Weatherstrip Replacement .
8. Remove the window inner sealing strip. Refer to Front Door Opening Weatherstrip Replacement .
9. Raise and support the window in the full up position.



10. Loosen the window regulator to window retaining bolts (1).
11. Lower the window regulator to separate the window from the clamps.

Important: With the aid of an assistant hold the window while the support is removed.

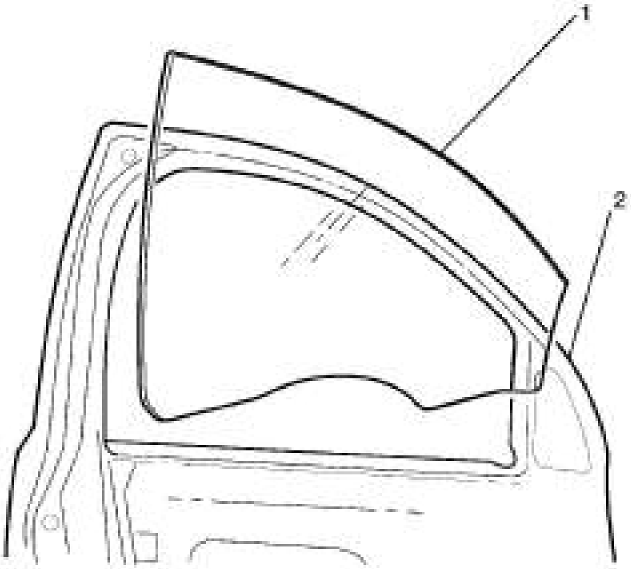
12. Remove the support from the window.



Important: Remove the window (1) with the aid of an assistant.

13. Remove the window (1) by tilting it forward then pulling it up and out of the door (2).

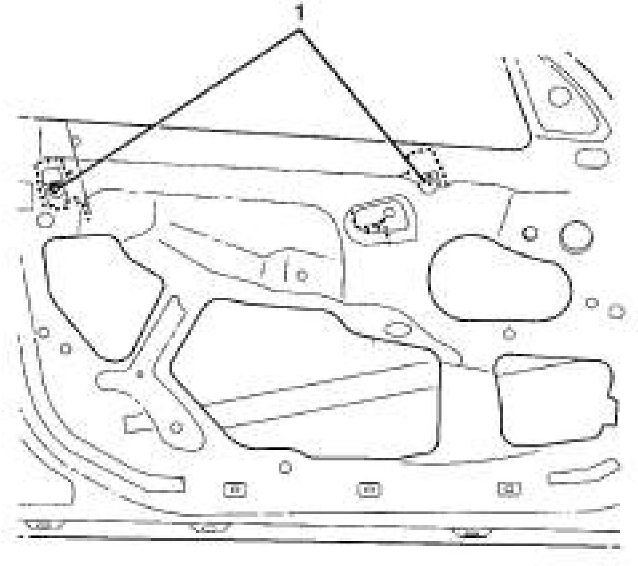
Installation Procedure



Important: Install the window (1) with the aid of an assistant.

Important: The window regulator should be approximately 1/2 way down before installing the window (1).

1. Install the window (1) down into the door (2).



2. Lower the window into the window regulator clamps (1).
3. Lower the window.
4. Install the window inner sealing strip. Refer to Front Door Opening Weatherstrip Replacement .
5. Start the vehicle to make sure maximum power to the window motor. This is required in order to fully seat the window for adjustment.
6. Raise the window to the fully closed position.

Notice: Refer to Fastener Notice in the Preface section.

7. Raise the window to the fully closed position.

Tighten
Tighten the nuts to 8 N-m (71 lb in).

8. Install the window inner weatherstrip. Refer to Front Side Door Window Inner Weatherstrip Replacement .
9. Install the outside rearview mirror. Refer to Power Mirror Replacement .
10. Install the window outer belt sealing strip.Refer to Front Side Door Window Belt Outer Sealing Strip Replacement .
11. Install the window inner belt sealing strip. Refer to Front Side Door Window Belt Inner Sealing Strip Replacement .
12. Inspect for correct window operation and a tight seal.
13. Shut off the vehicle.
14. Install the water deflector. Refer to Front Side Door Water Deflector Replacement .
15. Install the speaker. Refer to Radio Front Side Door Lower Speaker Replacement .
16. Install the door trim panel. Refer to Front Side Door Trim Panel Replacement .

Liftgate Window Replacement

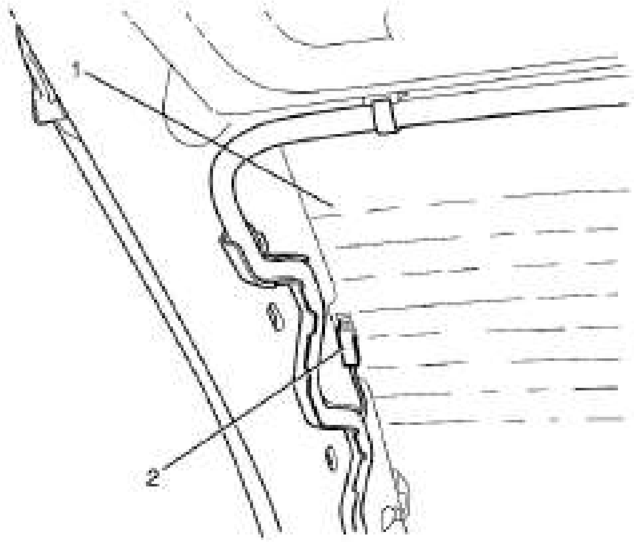
Tools Required

- J-36020 Stationary Glass Removal Tool
- J 24402-A Glass Sealant Remover (Cold Knife)
- J 24811 Urethane Adhesive Dispensing Gun
- Urethane Adhesive Kit or Equivalent
- Isopropyl Alcohol, Prepsol or Equivalent
- Commercial-type Utility Knife
- Razor Blade Scraper
- Suction Cups

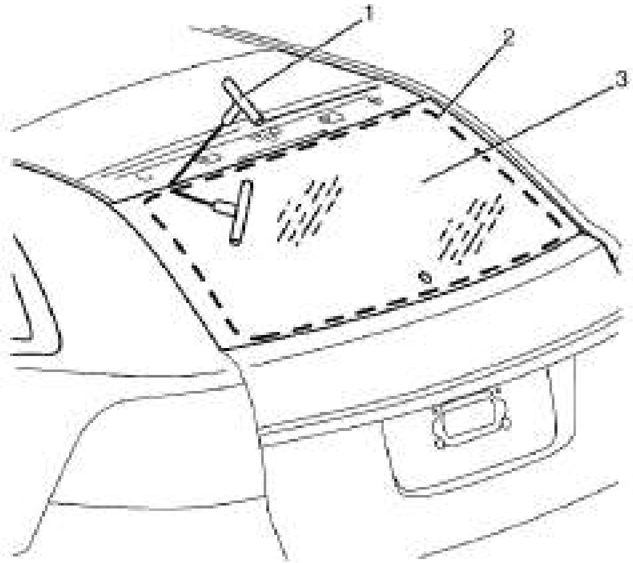
Removal Procedure

> **Important:** When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Remove the liftgate window side garnish moulding. Refer to Liftgate Window Side Garnish Molding Replacement.
3. Remove the liftgate window lower garnish moulding. Refer to Liftgate Window Lower Garnish Molding Replacement.
4. Remove the liftgate trim panel. Refer to Liftgate Trim Panel Replacement.
5. Remove the rear window wiper arm. Refer to Rear Window Wiper Arm Replacement.
6. Remove the rear window wiper motor. Refer to Rear Window Wiper Motor Replacement.
7. Remove the liftgate window upper garnish moulding. Refer to Liftgate Window Upper Garnish Molding Replacement.
8. Remove the liftgate upper moulding. Refer to Liftgate Upper Molding Replacement.



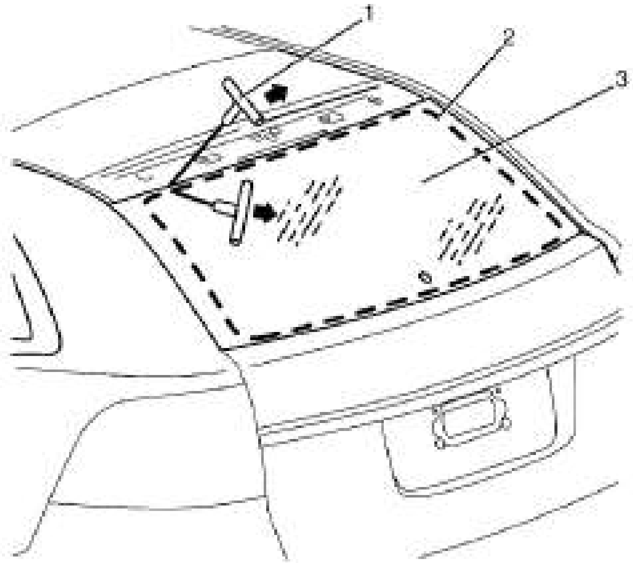
9. Disconnect the liftgate window electrical connectors (2) from the liftgate window (1).
10. Remove the suitable liftgate brace from the vehicle.
11. Close the liftgate.



Important: Before cutting out the stationary window, apply a double layer of masking tape around the perimeter of the painted surfaces and the interior trim.

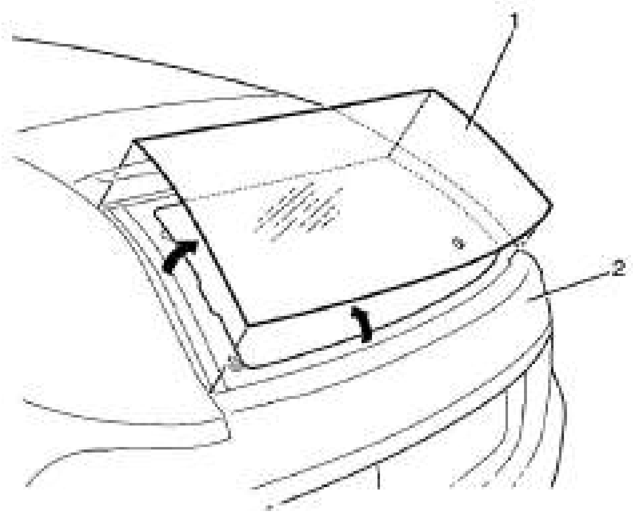
Important: Use a suitable tool to install the piano wire from J-36020 (1) through the urethane bead (2) at the upper corner of the liftgate window (3).

12. Install J-36020 (1) to the vehicle.
13. Connect the end of the piano wire to the other handle of J-36020 (1).



Important: Keep the inside handle of J-36020 (1) against the liftgate window (2) and cycle the full length of the piano wire to prevent heat build up.

14. With the aid of an assistant use tool J-36020 (1) to cut through the urethane bead (2) around the liftgate window (3) to the vehicle.



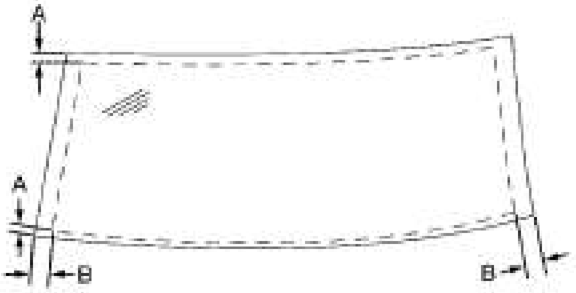
Important: The use of suction cups will aid in the liftgate window (1) removal.

15. With the aid of an assistant remove the liftgate window (1) from the vehicle (2).

Installation Procedure

Important: Use a lint free cloth and suitable oil free cleaning agent to make sure adhesion of the urethane.

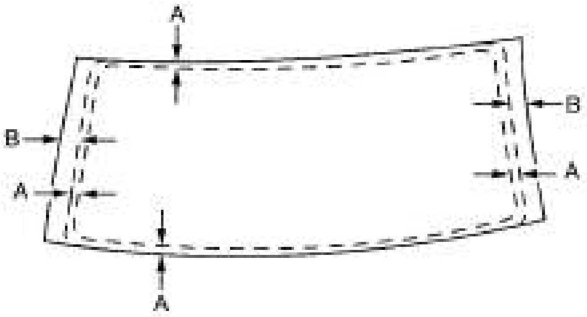
1. Clean surface and edges of liftgate window where urethane is to be applied.



Important: The clear glass primer dries almost instantly and may stain the viewing area of the liftgate window if not applied evenly. Wipe off the clear glass primer with a lint free cloth immediately after application.

Important: Apply the clear glass primer with a suitable applicator.

2. Apply clear glass primer to the inner surfaces of the liftgate window perimeter. Apply the clear glass primer as shown in the diagram where dimension A = 50mm and dimension B = 100mm.

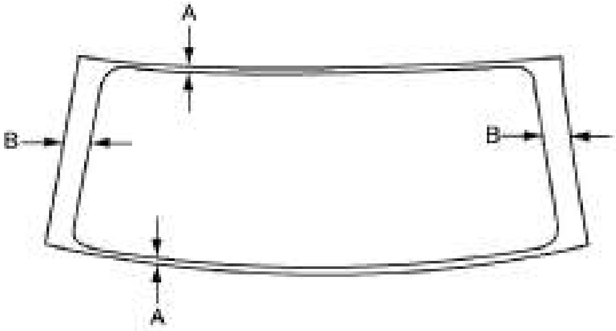


Important: Agitate the black glass primer for 1 minute to mix thoroughly.

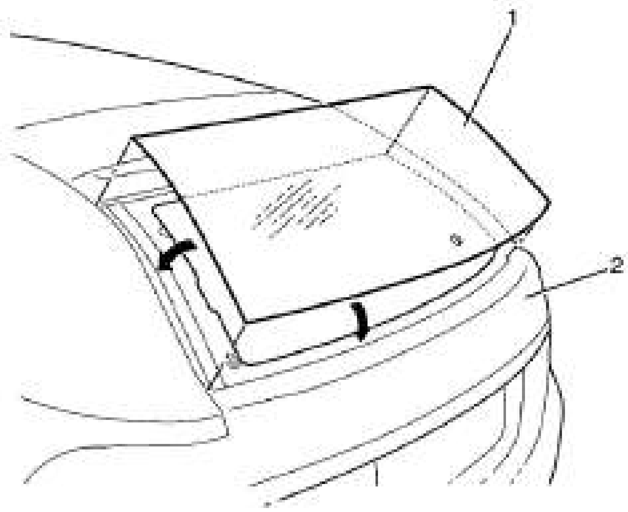
Important: Apply a 25mm wide layer of black glass primer with the applicator to the liftgate window (1) perimeter.

3. Apply the black glass primer to the liftgate window (1). Apply the clear glass primer as shown in the diagram where dimension A = 25mm and dimension B = 47mm.

Caution: Refer to Window Retention Caution in the Preface section.



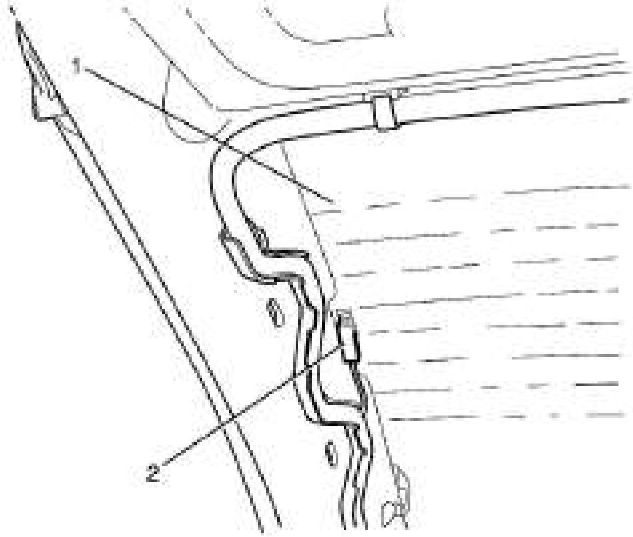
4. Apply a 7mm wide and 14mm deep continuous layer of urethane GMW3041 or equivalent to the inside perimeter of the liftgate window (1). Apply the urethane as shown in the diagram where dimension A = 12.5mm and dimension B = 59mm.



Important: The liftgate window (1) is aligned by two datum pins located on the outer upper edges of the liftgate window and two 8mm thick foam spacers located on the outer lower edges of the liftgate window (1).

Important: During the curing period of the urethane adhesive, the door windows should be left open to avoid a build up of pressure when the doors are opened and closed.

5. With the aid of an assistant install the liftgate window (1) to the vehicle (2).
6. Press the liftgate window (1) firmly into position.
7. Open the liftgate
8. Install a suitable liftgate brace to the vehicle.



9. Connect the liftgate window electrical connectors (2) to the liftgate window (1).
10. Remove the double layer of masking tape from around the perimeter of the painted surfaces and the interior trim.
11. Install the liftgate upper moulding. Refer to Liftgate Upper Molding Replacement.
12. Install the liftgate window upper garnish moulding. Refer to Liftgate Window Upper Garnish Molding Replacement.
13. Install the rear window wiper motor. Refer to Rear Window Wiper Motor Replacement.
14. Install the rear window wiper arm. Refer to Rear Window Wiper Arm Replacement.
15. Install the liftgate trim panel. Refer to Liftgate Trim Panel Replacement.
16. Install the liftgate window lower garnish moulding. Refer to Liftgate Window Lower Garnish Molding Replacement.
17. Install the liftgate window side garnish moulding. Refer to Liftgate Window Side Garnish Molding Replacement.

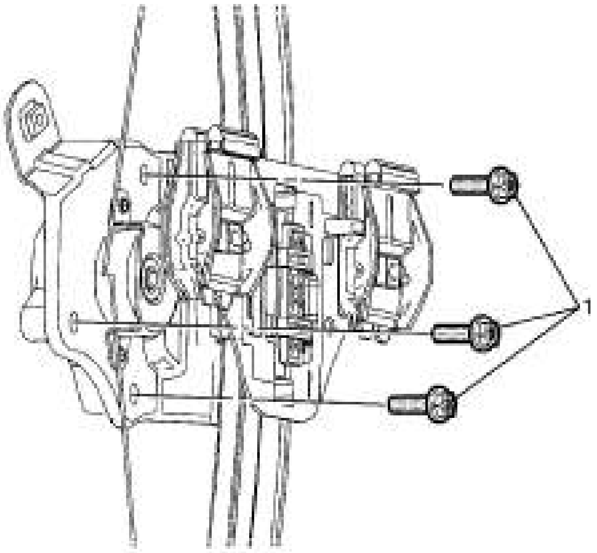
Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

18. Remove the suitable liftgate brace from the vehicle.

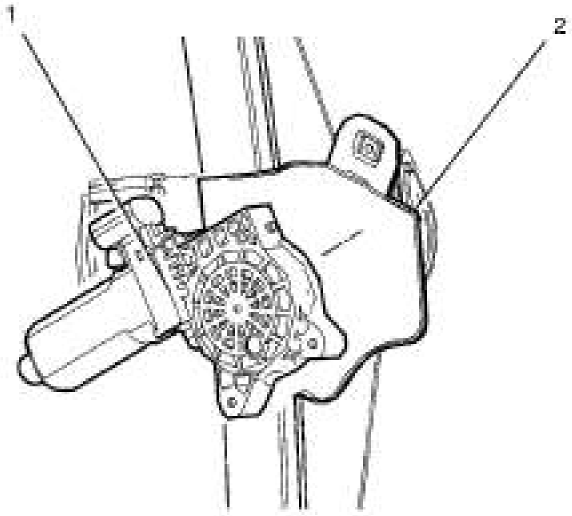
Rear Side Door Window Regulator Motor Replacement

Removal Procedure

1. Remove the door trim panel. Refer to Rear Side Door Trim Panel Replacement.
2. Remove the speaker. Refer to Radio Rear Side Door Speaker Replacement in Entertainment.
3. Remove the water deflector. Refer to Rear Side Door Water Deflector Replacement.
4. Remove the window regulator. Refer to Rear Side Door Window Regulator Replacement.

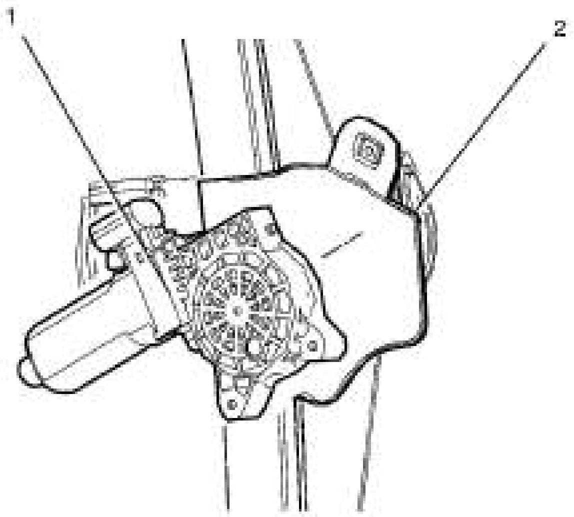


5. Remove the window regulator motor to window regulator retaining bolts (1).



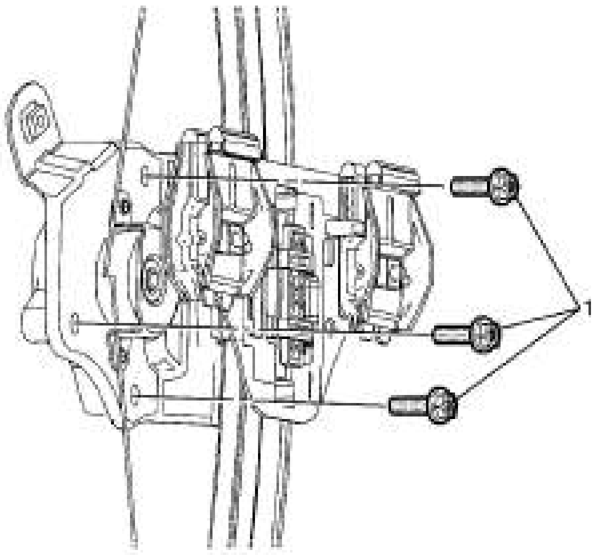
6. Remove the window regulator motor (1) from the window regulator (2).

Installation Procedure



1. Position the window regulator motor (1) to the window regulator (2).

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the window regulator motor to window regulator retaining bolts (1).

   Tighten
   Tighten the bolts to 8 N-m (71 lb in).

3. Install the window regulator. Refer to Rear Side Door Window Regulator Replacement.
4. Install the water deflector. Refer to Rear Side Door Water Deflector Replacement.
5. Install the speaker. Refer to Radio Rear Side Door Speaker Replacement in Entertainment.
6. Install the door trim panel. Refer to Rear Side Door Trim Panel Replacement.

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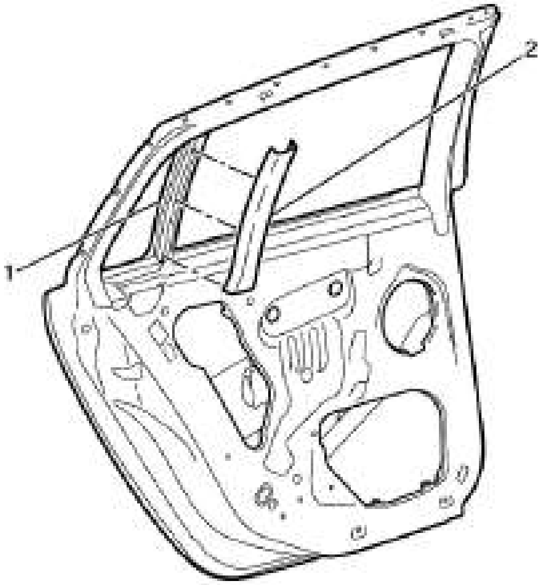
Rear Side Door Stationary Window Channel Replacement (Sportwagon)

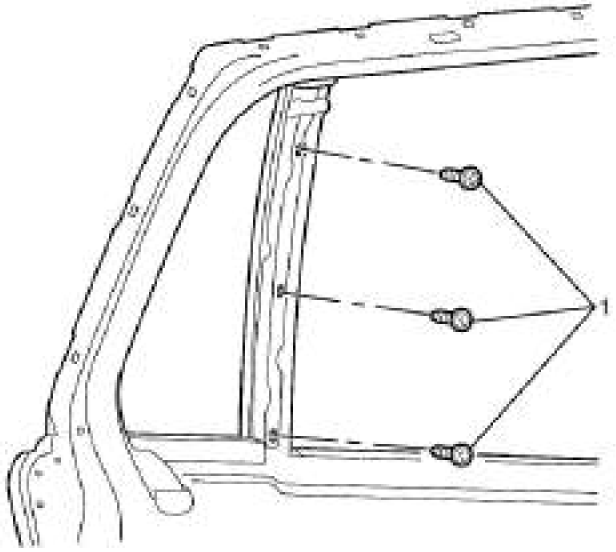
Removal Procedure

1. Remove the rear side door trim panel. Refer to Rear Side Door Trim Panel Replacement.
2. Remove the rear side door window inner belt sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement.
3. Remove the rear side door window outer sealing strip. Refer to Rear Side Door Window Outer Sealing Strip Replacement.
4. Remove the rear side door window regulator. Refer to Rear Side Door Window Regulator Replacement.
5. Remove the rear side door window from the rails.
6. Lower the rear side door window to the full down position.

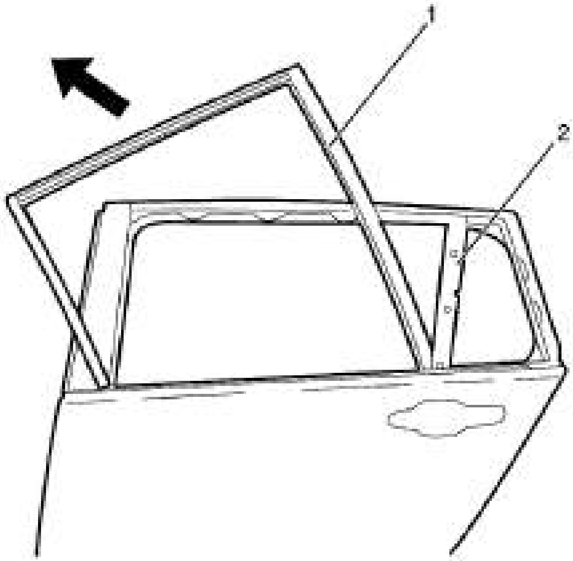


Important: Remove the rear side door stationary window channel trim panel (2) to retaining clips.

7. Remove the rear side door stationary window channel trim panel (2) from the rear side door (1).

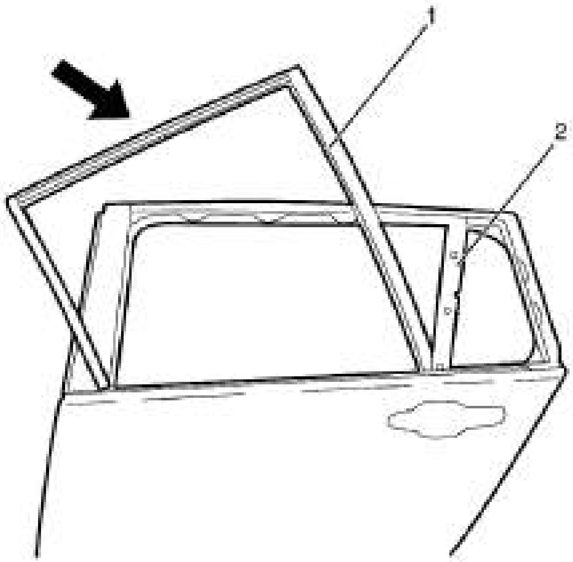


8. Remove the rear side door frame to rear side door stationary window channel retaining screws (1).



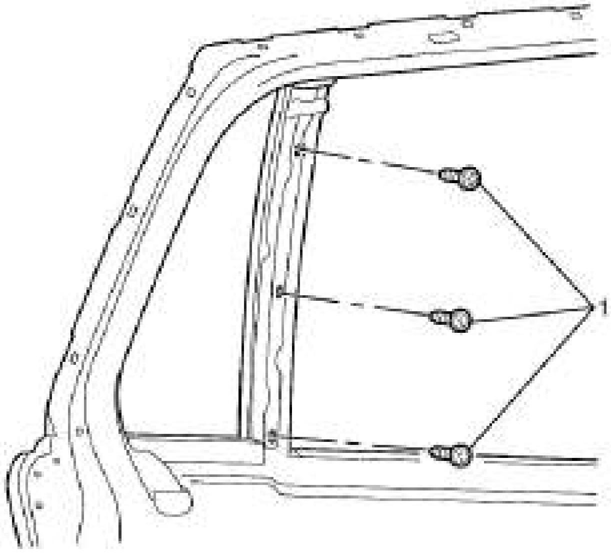
9. Remove the rear side door stationary window channel (1) from the rear side door (2).

Installation Procedure



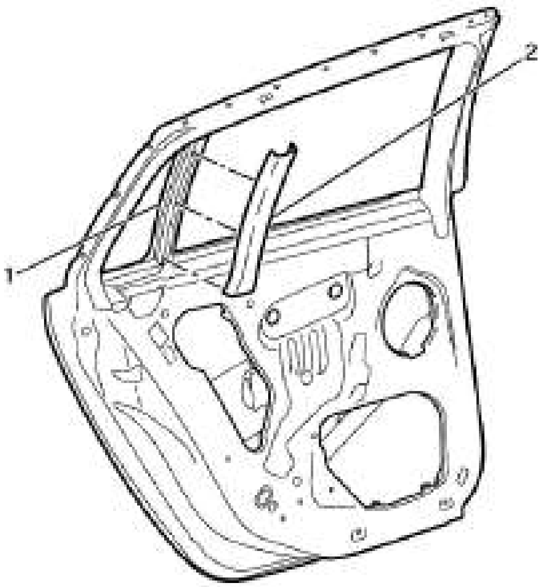
1. Install the rear side door stationary window channel (1) to the rear side door (2).

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the rear side door frame to rear side door stationary window channel retaining screws (1).

   Tighten
   Tighten the screws to 3 N·m (27 lb in).



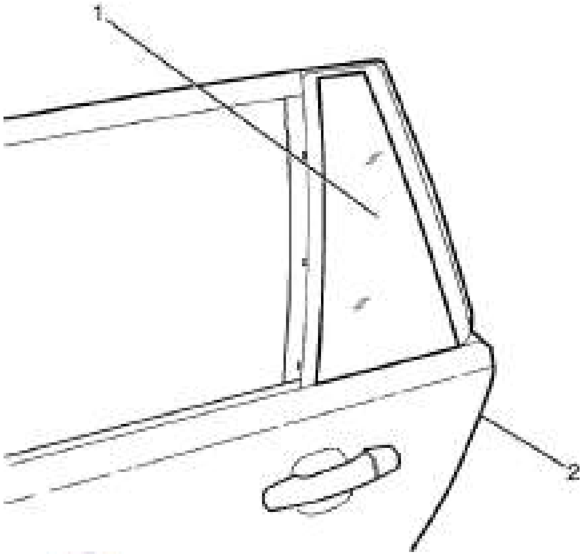
Important: Push the rear side door stationary window channel trim panel (1) to attach the retaining clips.

3. Install the rear side door stationary window channel trim panel (2) to the rear side door (1).
4. Install the rear side door window to the rails.
5. Install the rear side door window regulator. Refer to Rear Side Door Window Regulator Replacement.
6. Install the rear side door window outer sealing strip. Refer to Rear Side Door Window Outer Sealing Strip Replacement.
7. Install the rear side door window inner belt sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement.
8. Install the rear side door trim panel. Refer to Rear Side Door Trim Panel Replacement.

Rear Side Door Stationary Window Replacement (Sportwagon)

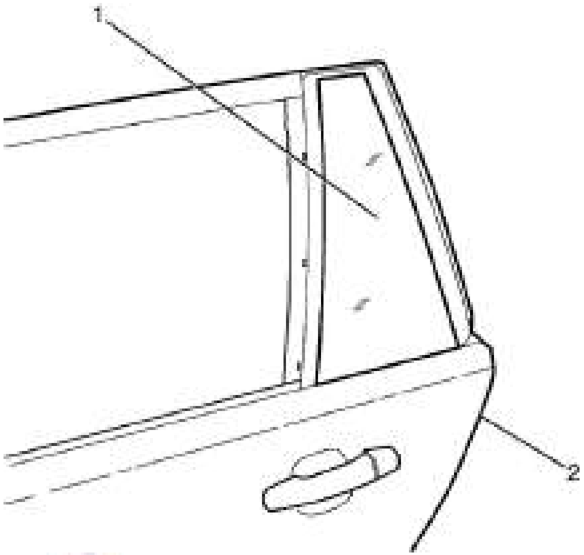
Removal Procedure

1. Remove the rear side door trim panel. Refer to Rear Side Door Trim Panel Replacement.
2. Remove the rear side door window inner belt sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement.
3. Remove the rear side door window outer sealing strip. Refer to Rear Side Door Window Outer Sealing Strip Replacement.
4. Remove the rear side door window regulator. Refer to Rear Side Door Window Regulator Replacement.
5. Remove the rear side door window from the rails.
6. Lower the rear side door window to the full down position.
7. Remove the rear side door stationary window channel. Refer to Rear Side Door Stationary Window Channel Replacement.



8. Remove the rear side door stationary window (1) from the rear side door (2).

Installation Procedure



1. Install the rear side door stationary window (1) to the rear side door (2).
2. Install the rear side door stationary window channel. Refer to Rear Side Door Stationary Window Channel Replacement.
3. Install the rear side door window to the rails.
4. Install the rear side door window regulator. Refer to Rear Side Door Window Regulator Replacement.
5. Install the rear side door window outer sealing strip. Refer to Rear Side Door Window Outer Sealing Strip Replacement.
6. Install the rear side door window inner belt sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement.
7. Install the rear side door trim panel. Refer to Rear Side Door Trim Panel Replacement.

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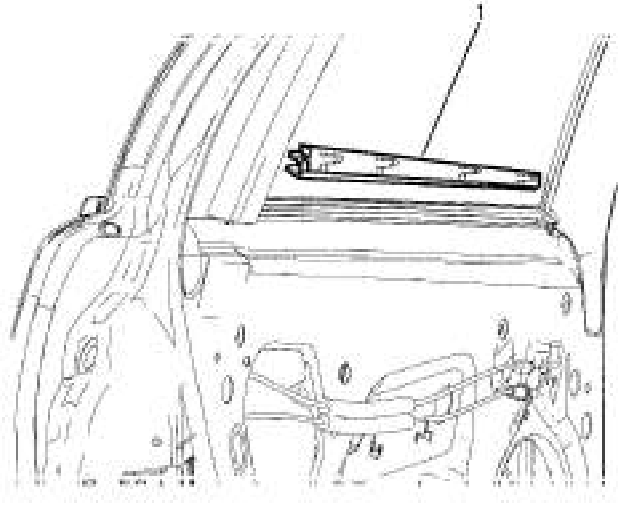
Rear Side Door Window Inner Sealing Strip Replacement (Beltline)

Removal Procedure

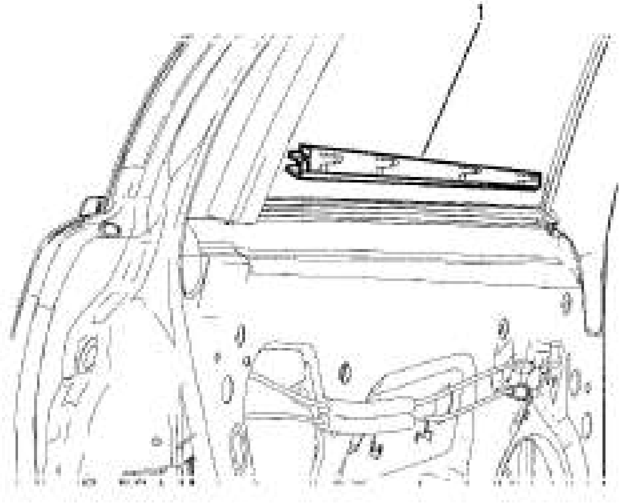
1. Lower the window to the full down position.
2. Remove the door trim panel. Refer to Rear Side Door Trim Panel Replacement.



Important: Pull upward to release the window inner belt sealing strip (1).

3. Remove the window inner belt sealing strip (1).

Installation Procedure



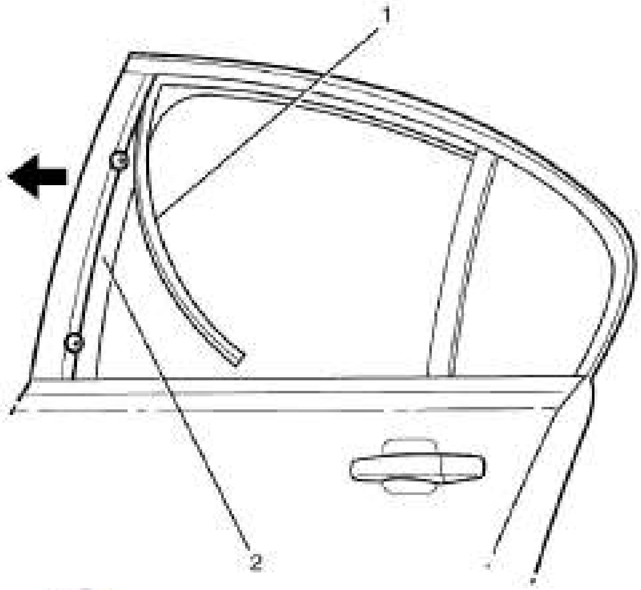
Important: Push downward to attach the window inner belt sealing strip (1).

1. Install the window inner belt sealing strip (1).
2. Install the door trim panel. Refer to Rear Side Door Trim Panel Replacement.

Rear Side Door Window Inner Sealing Strip Replacement (Window - Sedan)

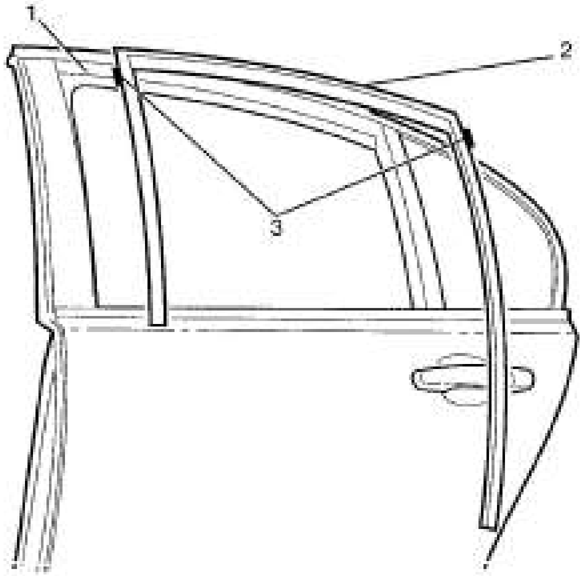
Removal Procedure

1. Remove the door trim panel. Refer to Rear Side Door Trim Panel Replacement.
2. Remove the window inner belt sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement.
3. Remove the window outer belt sealing strip. Refer to Rear Side Door Window Outer Sealing Strip Replacement.



Important: Use a suitable tool to pry the window inner sealing strip (1) out of the door (2) then pull by hand.

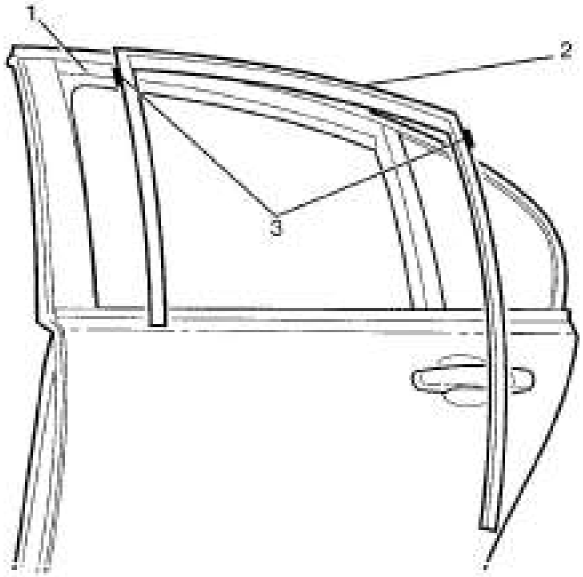
4. Remove the window inner sealing strip (1) from the front of the rear door (2).



Important: Pull remaining window sealing strip (1) from the door (2). Observe the orientation of the locating tabs (3) this will aid in correct re-installation.

5. Remove the window inner sealing (2) from the door (1).

Installation Procedure



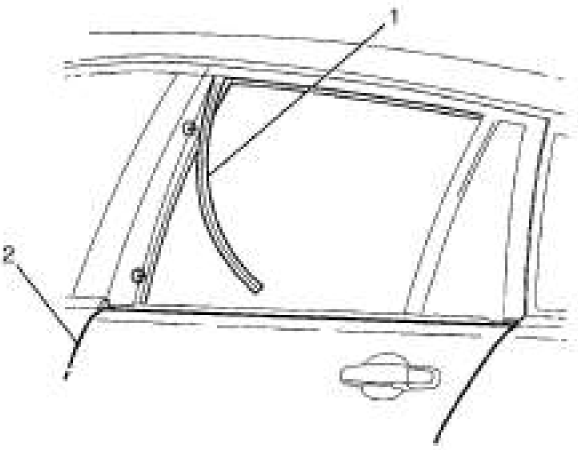
Important: Push the window inner sealing in by hand. The locating tabs (3) are at the top of the window inner sealing strip (2) and must fit into the correct location in the door (1) for correct sealing and operation..

1. Install the window inner sealing strip (2) to the door (1).
2. Install the window outer belt sealing strip. Refer to Rear Side Door Window Outer Sealing Strip Replacement.
3. Install the window inner belt sealing strip. Refer to Rear Side Door Window Inner Weatherstrip Replacement.
4. Install the door trim panel. Refer to Rear Side Door Trim Panel Replacement.

Rear Side Door Window Inner Sealing Strip Replacement (Window - Sportwagon)

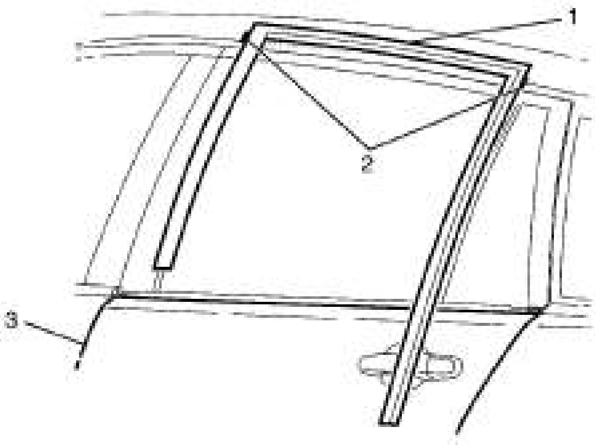
Removal Procedure

1. Remove the rear side door trim panel. Refer to Rear Side Door Trim Panel Replacement.
2. Remove the rear side door window inner belt sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement.
3. Remove the rear side door window outer belt sealing strip. Refer to Rear Side Door Window Outer Sealing Strip Replacement.



Important: Use a suitable tool to pry the rear side door window inner sealing strip (1) out of the rear side door (2) then pull by hand.

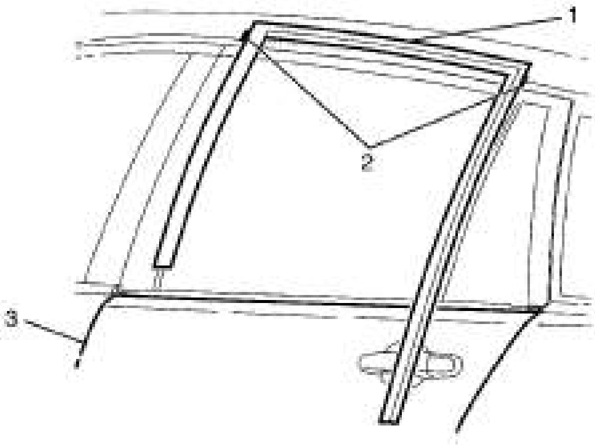
4. Remove the rear side door window inner sealing strip (1) from the rear side door (2) starting from the front.



Important: Pull remaining rear side door window inner sealing strip (1) from the rear side door (3). Observe the orientation of the locating tabs (2) as this will aid in correct installation

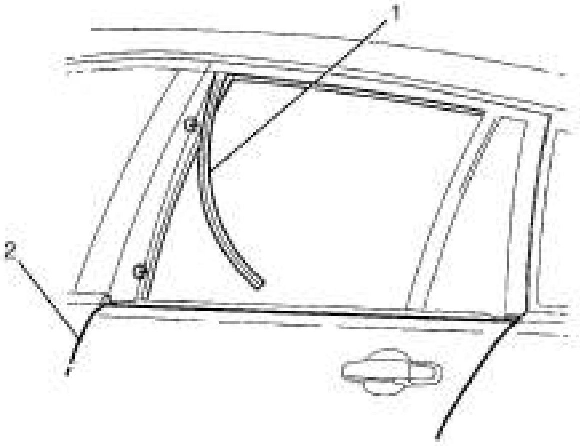
5. Remove the rear side door window inner sealing (1) from the rear side door (3).

Installation Procedure



Important: Push in the rear side door window inner sealing by hand. The locating tabs (2) are at the top of the rear side door window inner sealing strip (1) and must fit into the correct location in the rear side door (3) for correct sealing and operation.

1. Position the rear side door window inner sealing strip (1) to the rear side door (3).



2. Install the rear side door window inner sealing strip (1) to the rear side door (2).
3. Install the rear side door window outer belt sealing strip. Refer to Rear Side Door Window Outer Sealing Strip Replacement.
4. Install the rear side door window inner belt sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement.
5. Install the rear side door trim panel. Refer to Rear Side Door Trim Panel Replacement.

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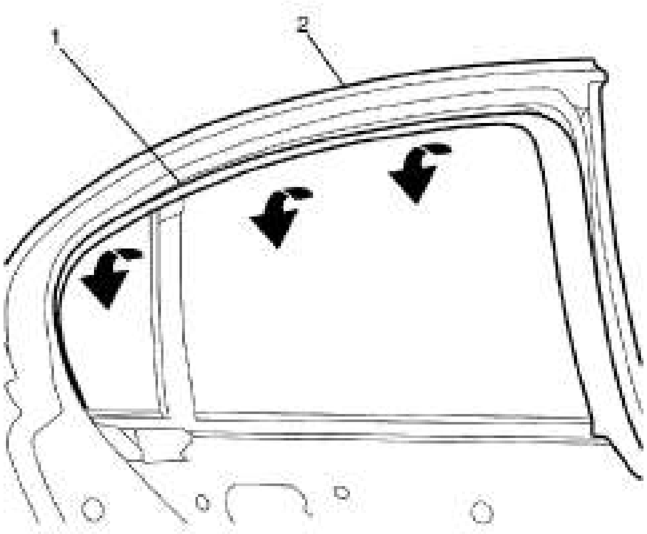
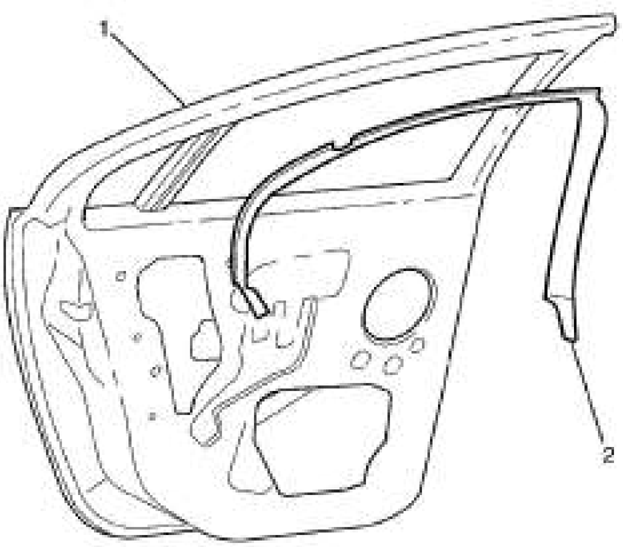
Rear Side Door Window Inner Weatherstrip Replacement (Sedan)

Removal Procedure

1. Remove the door trim panel. Refer to Rear Side Door Trim Panel Replacement.
2. Remove the window inner belt sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement.
3. Remove the rear door stationary window. Refer to Rear Side Door Window Frame Rear Applique Replacement.
4. Lower the rear window.



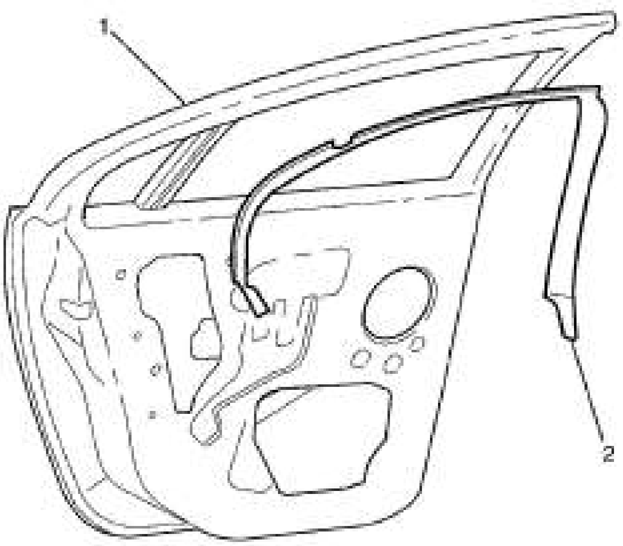
5. Push the top of the window inner weatherstrip (1) outwards to disengage from the door frame (2).



Important: Pull the window inner weatherstrip (2) inwards to remove from the door (1).

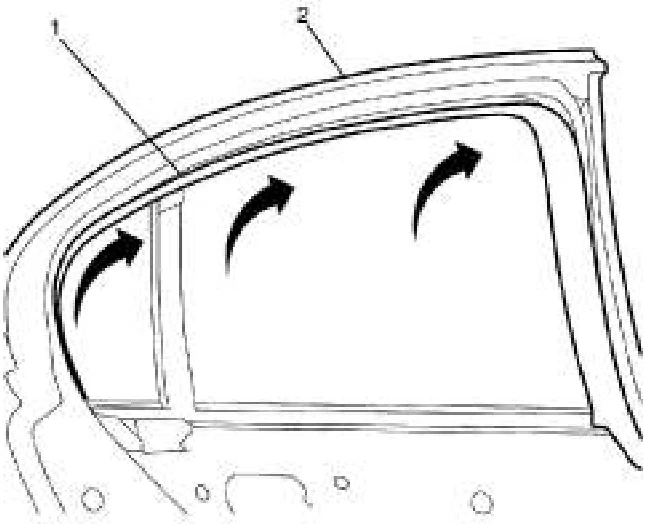
6. Remove the window inner weatherstrip (2) from the door (1).

Installation Procedure



Important: Push the top of the window inner weatherstrip (2) through the door frame (1).

1. Install the window inner weatherstrip (2) to the door (1).



2. Pull the top of the window inner weatherstrip (1) inwards to engage to the door frame (2).
3. Install the rear door stationary window.Refer to Rear Side Door Window Frame Rear Applique Replacement.
4. Install the window inner belt sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement.
5. Install the door trim panel. Refer to Rear Side Door Trim Panel Replacement.

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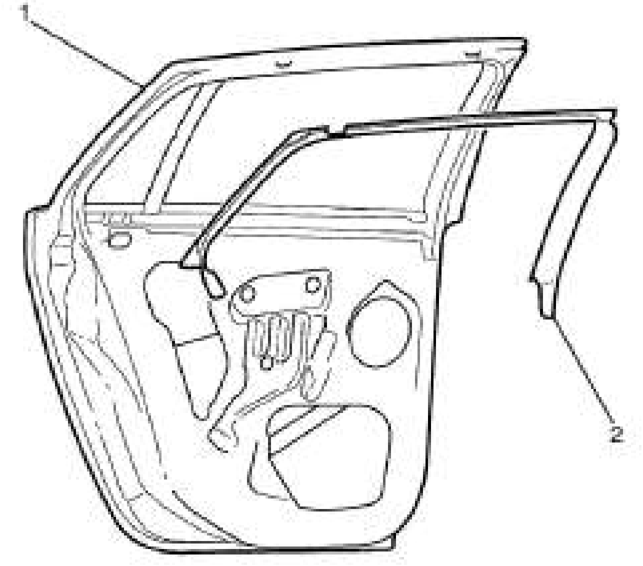
Rear Side Door Window Inner Weatherstrip Replacement (Sportwagon)

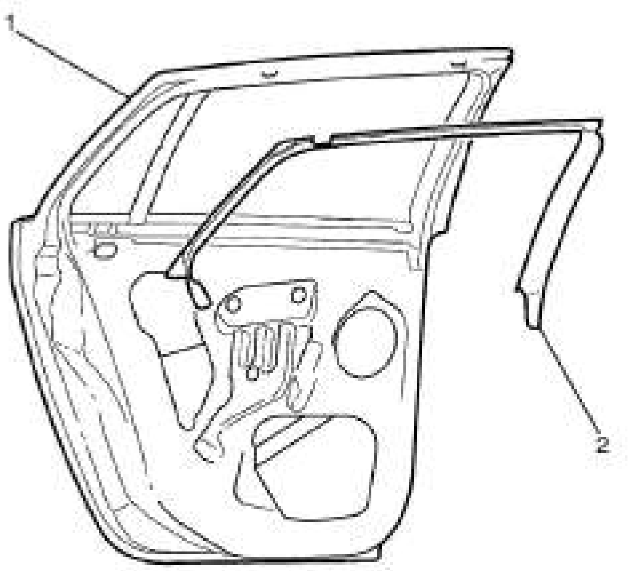
Removal Procedure

1. Remove the rear side door trim panel. Refer to Rear Side Door Trim Panel Replacement.
2. Remove the rear side door window inner belt sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement.
3. Remove the rear side door window outer sealing strip. Refer to Rear Side Door Window Outer Sealing Strip Replacement.
4. Remove the rear side door window regulator. Refer to Rear Side Door Window Regulator Replacement.
5. Remove the rear side door window from the rails.
6. Lower the rear side door window to the full down position.
7. Remove the rear side door stationary window channel. Refer to Rear Side Door Stationary Window Channel Replacement.
8. Remove the rear side door stationary window. Refer to Rear Side Door Stationary Window Replacement.



9. Remove the window inner weatherstrip (2) from the rear side door (1).

Installation Procedure

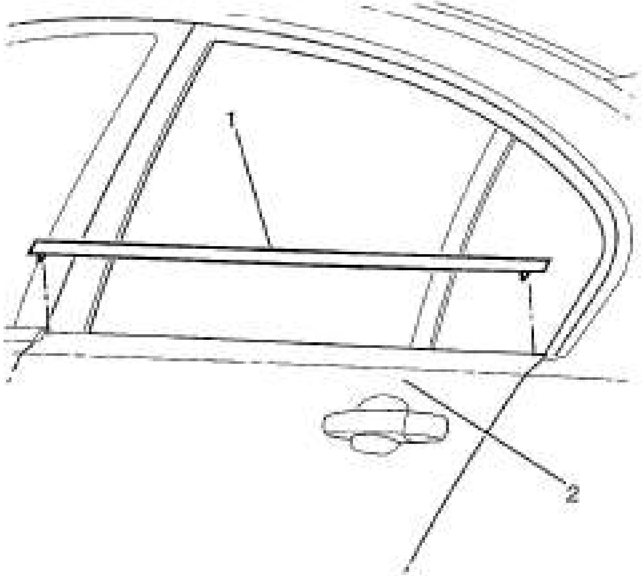


1. Install the rear window inner weatherstrip (2) to the rear side door (1).
2. Install the rear side door stationary window. Refer to Rear Side Door Stationary Window Replacement.
3. Install the rear side door stationary window channel. Refer to Rear Side Door Stationary Window Channel Replacement.
4. Install the rear side door window to the rails.
5. Install the rear side door window regulator. Refer to Rear Side Door Window Regulator Replacement.
6. Install the rear side door window outer sealing strip. Refer to Rear Side Door Window Outer Sealing Strip Replacement.
7. Install the rear side door window inner belt sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement.
8. Install the rear side door trim panel. Refer to Rear Side Door Trim Panel Replacement.

Rear Side Door Window Outer Sealing Strip Replacement (Sedan)

Removal Procedure

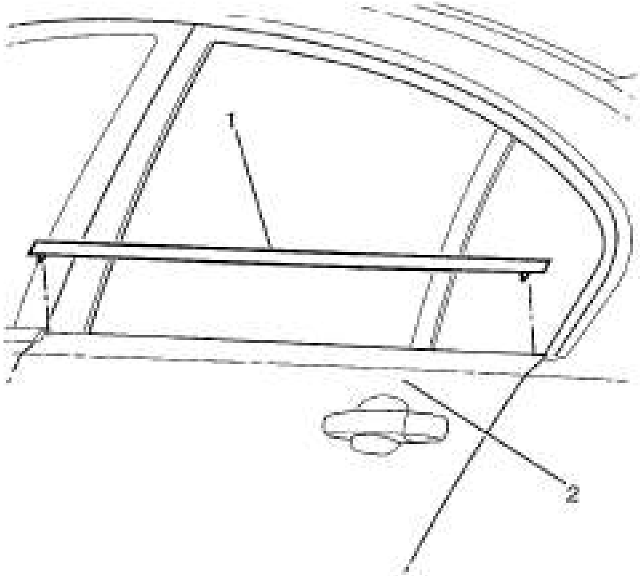
1. Lower the window to the full down position.



Important: Pull the rear door outer belt sealing strip (1) up to detach the retainers.

2. Remove the rear door outer belt sealing strip (1) from the rear door (2).

Installation Procedure



Important: Push the rear door outer belt sealing strip (1) down to attach the retainers.

1. Install the rear door outer belt sealing strip (1) to the rear door (2).
2. Raise the rear door window.

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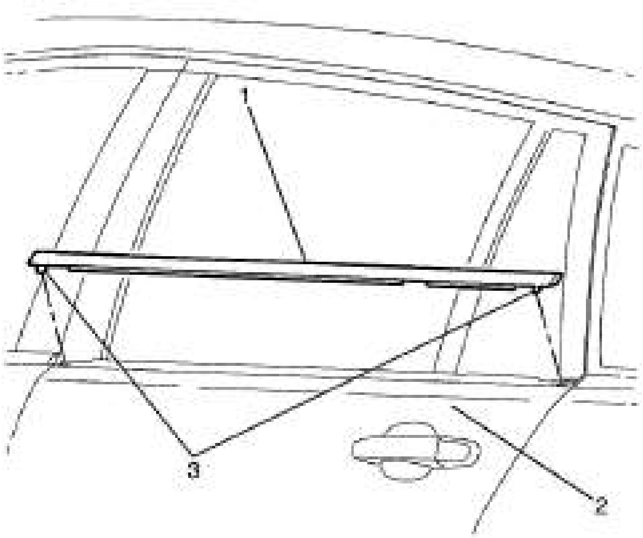
Rear Side Door Window Outer Sealing Strip Replacement (Sportwagon)

Removal Procedure

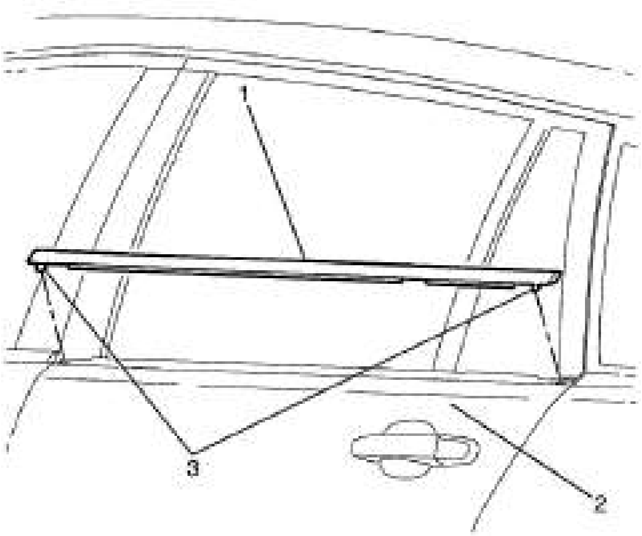
1. Lower the rear door window to the full down position.



Important: Pull the rear door outer belt sealing strip (1) up to detach the retainers (3).

2. Remove the rear door outer belt sealing strip (1) from the rear door (2).

Installation Procedure



Important: Push the rear door outer belt sealing strip (1) down to attach the retainers (3).

1. Install the rear door outer belt sealing strip (1) to the rear door (2).
2. Raise the rear door window.

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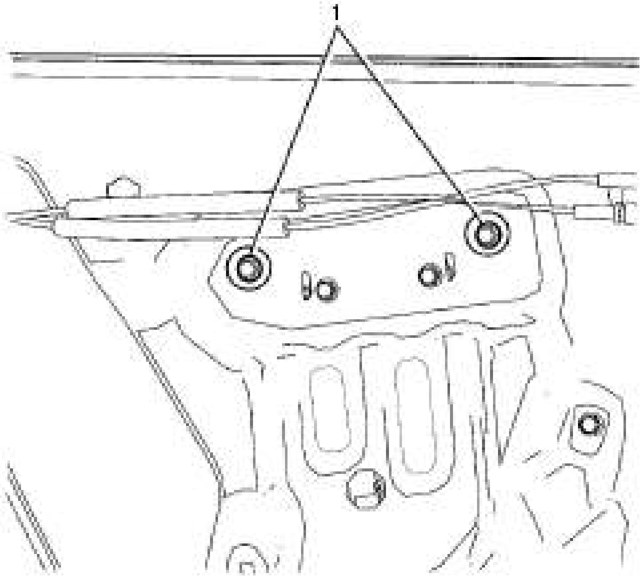
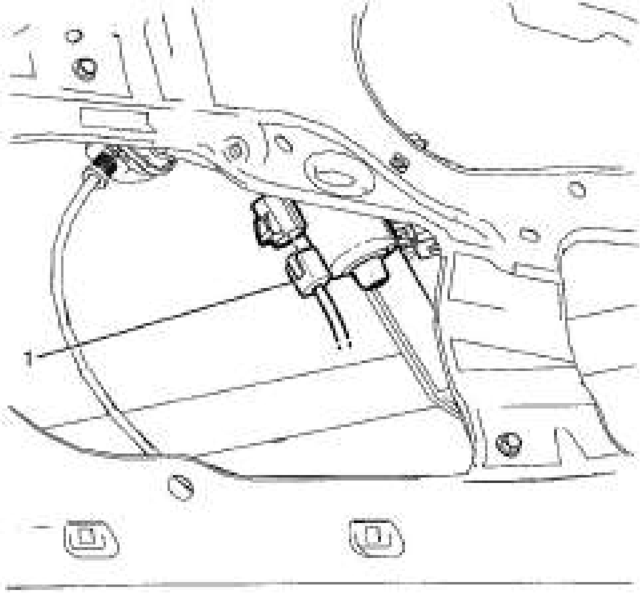
Rear Side Door Window Regulator Replacement

Removal Procedure

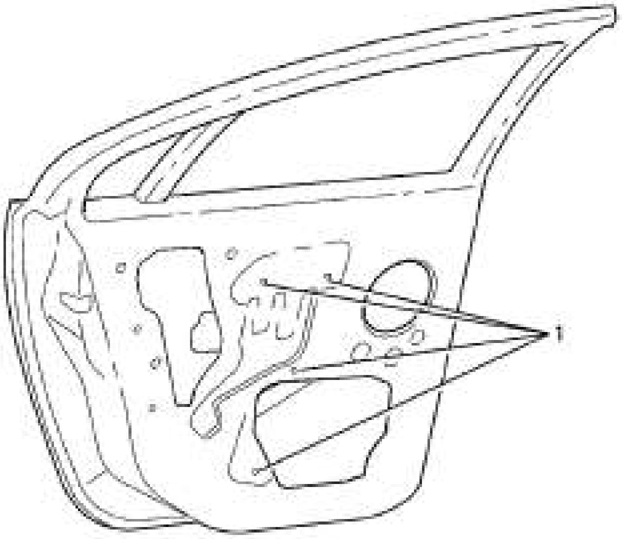
1. Remove the door trim panel. Refer to Rear Side Door Trim Panel Replacement.
2. Remove the speaker. Refer to Radio Rear Side Door Speaker Replacement.
3. Remove the water deflector. Refer to Rear Side Door Water Deflector Replacement.
4. Raise and support the window in the full up position.



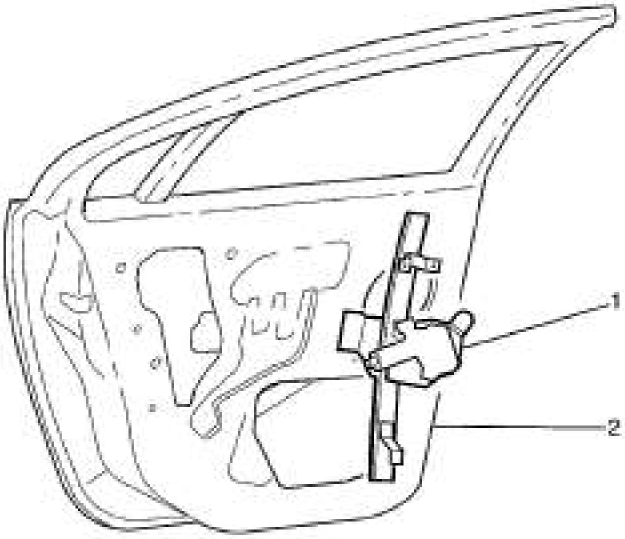
5. Loosen the window regulator to window glass retaining bolts (1).
6. Support the window glass.
7. Lower the window regulator approximately 1/2 way down.



8. Disconnect the window regulator electrical connector (1).

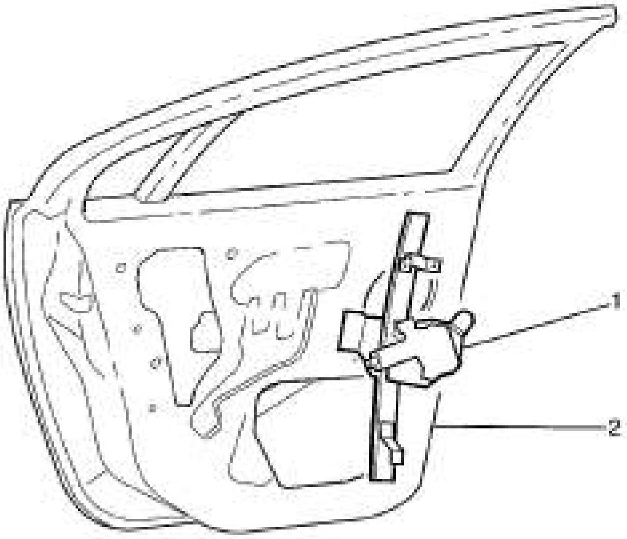


9. Remove the window regulator to door retaining bolts (1).



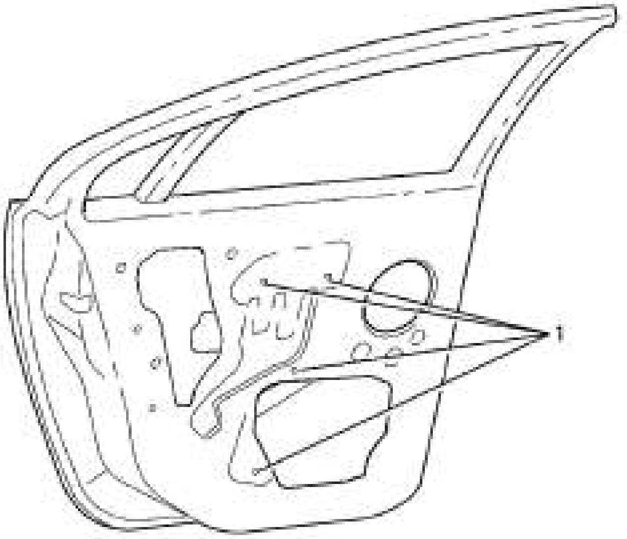
10. Remove the window regulator (1) through the large access hole in the door (2).

Installation Procedure



1. Position the window regulator (1) through the large access hole in the door (2).

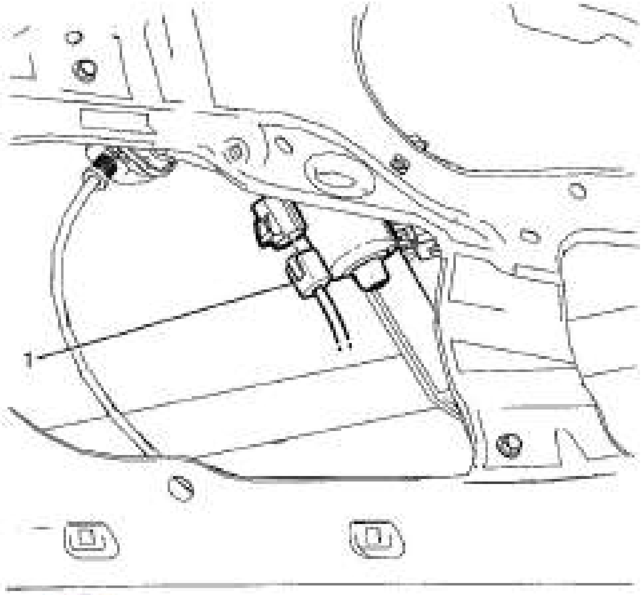
   Notice: Refer to Fastener Notice in the Preface section.



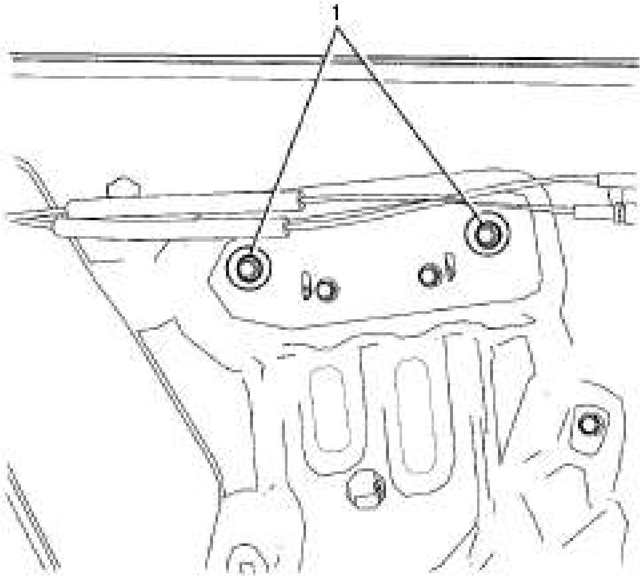
2. Install the window regulator to door retaining bolts (1).

   Tighten
   Tighten the bolts to 10 N-m (89 lb in).

3. Remove the support from the window.
4. Lower the window into the window regulator clamps.



5. Connect the window regulator electrical connector (1).
6. Start the vehicle to make sure maximum power to the window motor. This is required to fully seat the window for adjustment.
7. Raise the window to the full up position.



8. Tighten the window regulator to window glass retaining bolts (1).

   Tighten
   Tighten the bolts to 8 N-m (70 lb in).

9. Inspect the window for correct operation and a tight seal.
10. Shut off the vehicle.
11. Install the water deflector. Refer to Rear Side Door Water Deflector Replacement.
12. Install the speaker. Refer to Radio Rear Side Door Speaker Replacement.

13. Install the door trim panel. Refer to Rear Side Door Trim Panel Replacement.

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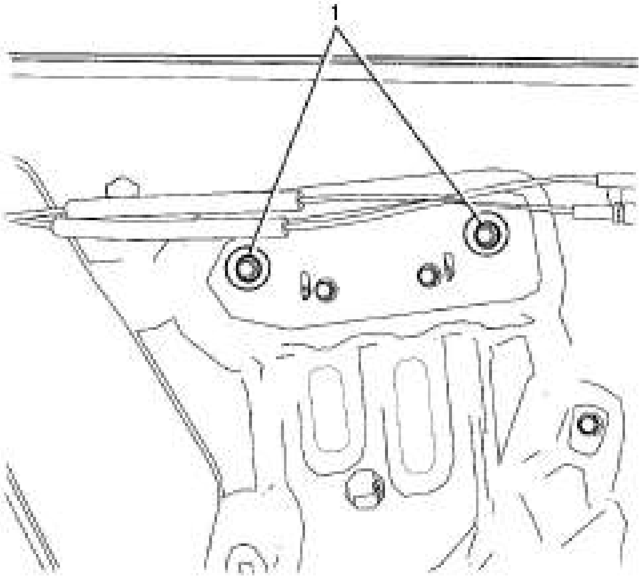
Rear Side Door Window Replacement

Removal Procedure

Caution: Refer to Glass and Sheet Metal Handling Caution in the Preface section.

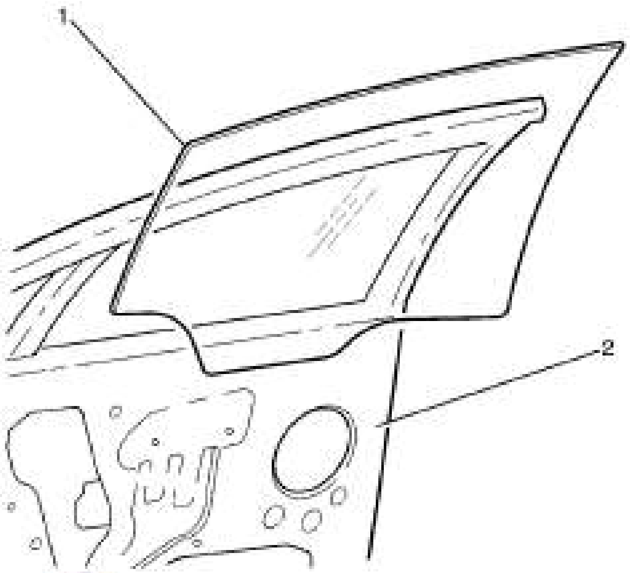
1. Remove the door trim panel. Refer to Rear Side Door Trim Panel Replacement .
2. Remove the speaker. Refer to Radio Rear Side Door Speaker Replacement .
3. Remove the water deflector. Refer to Rear Side Door Water Deflector Replacement .
4. Remove the window inner belt sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement .
5. Remove the rear door stationary window. Refer to Rear Side Door Window Frame Rear Applique Replacement .
6. Remove the window inner weatherstrip. Refer to Rear Side Door Window Inner Weatherstrip Replacement .
7. Remove the window outer belt sealing strip. Refer to Rear Side Door Window Outer Sealing Strip Replacement .
8. Remove the window inner sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement .
9. Raise and support the window to the full up position.



10. Loosen the window regulator to window retaining bolts (1).
11. Lower the window regulator approximately 1/2 way down position.

Important: With the aid of an assistant hold the window while the support is removed.

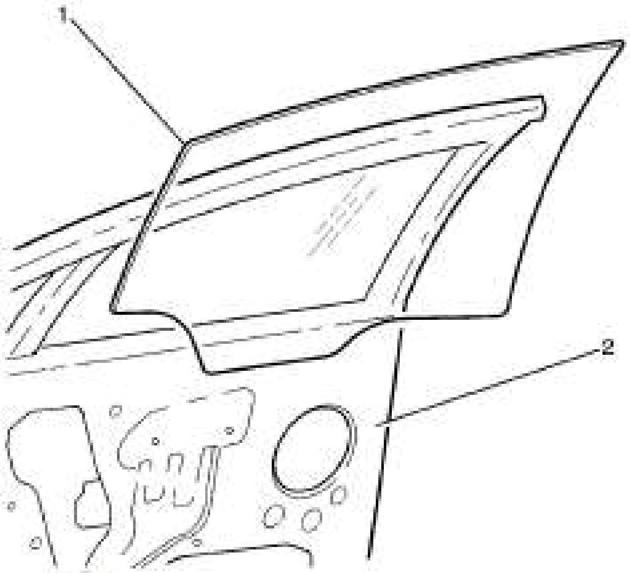
12. Remove the support from the window.



Important: Remove the window (1) with the aid of an assistant.

13. Remove the window (1) up and out of the door (2).

Installation Procedure

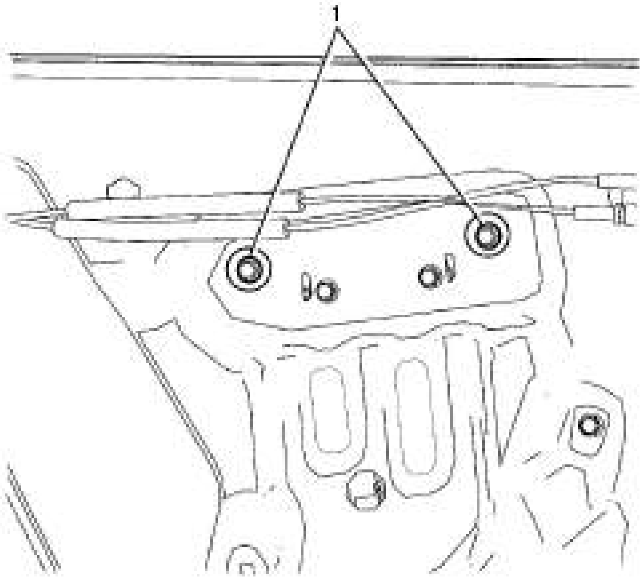


Important: Install the window (1) with the aid of an assistant.

Important: The window regulator should be approximately 1/2 way down before installing the window (1).

1. Install the window (1) down into the door (2).
2. Lower the window into the window clamps.
3. Lower the window.
4. Install the inner window weatherstrip. Refer to Rear Side Door Window Inner Weatherstrip Replacement .
5. Install the rear door stationary window. Refer to Rear Side Door Window Frame Rear Applique Replacement .
6. Install the window inner sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement .
7. Start the vehicle in order to make sure maximum power to the window motor. This is required to fully seat the window for adjustment.
8. Raise the window to full up position.

   Notice: Refer to Fastener Notice in the Preface section.



9. Tighten the window regulator to window retaining bolts (1).

   Tighten
   Tighten the nuts to 8 N-m (71 lb in).

10. Inspect the window for correct operation and a tight seal.
11. Shut off the vehicle.
12. Install the window outer belt sealing strip. Refer to Rear Side Door Window Outer Sealing Strip Replacement .
13. Install the window inner belt sealing strip. Refer to Rear Side Door Window Inner Sealing Strip Replacement .
14. Install water deflector. Refer to Rear Side Door Water Deflector Replacement .
15. Install the speaker. Refer to Radio Rear Side Door Speaker Replacement in Entertainment.
16. Install the door trim panel. Refer to Rear Side Door Trim Panel Replacement .

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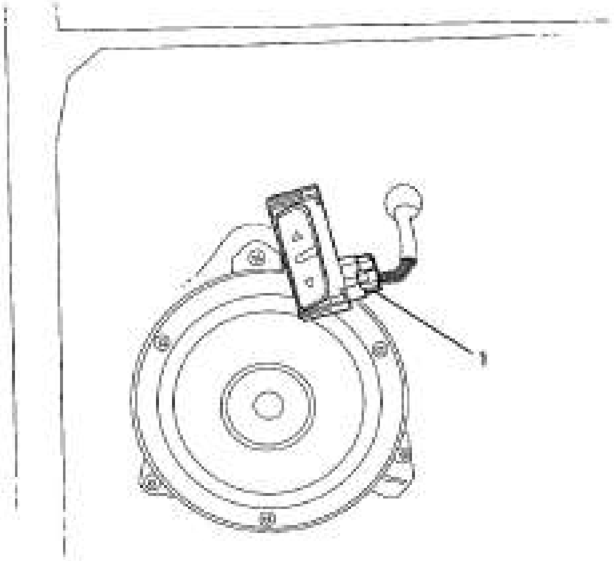
Rear Side Door Window Switch Replacement

Removal Procedure

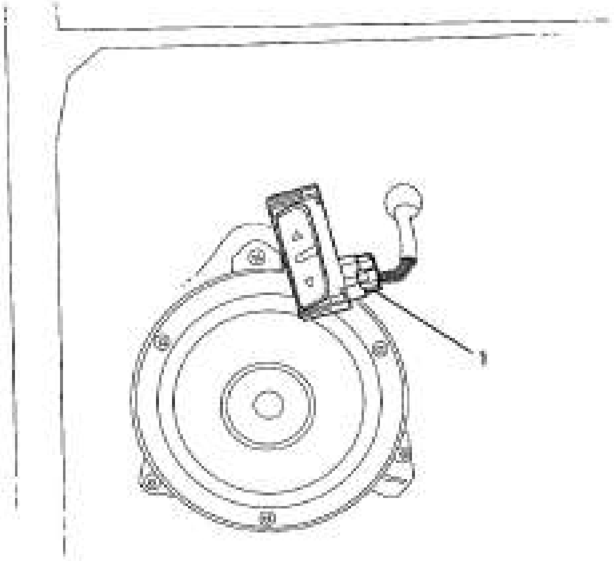
1. Remove the door trim panel. Refer to Rear Side Door Trim Panel Replacement.



2. Disconnect the power window switch electrical connector (1).
3. Remove the power window switch from the door.

Installation Procedure

1. Position the power window switch to the door (1).



2. Connect the power window switch electrical connector (1).
3. Install the door trim panel. Refer to Rear Side Door Trim Panel Replacement.

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Rear Window Replacement

Tools Required

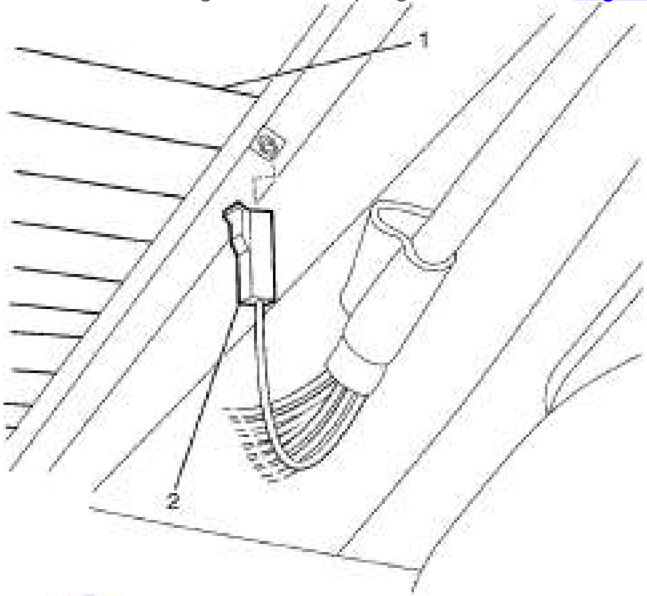
- J-36020 Stationary Glass Removal Tool
- Glass Sealant Remover (Cold Knife)
- Urethane Adhesive Kit or Equivalent
- Isopropyl Alcohol, Prepsol or Equivalent
- Cartridge-type Caulking Gun
- Commercial-type Utility Knife
- Razor Blade Scraper
- Suction Cups

Removal Procedure

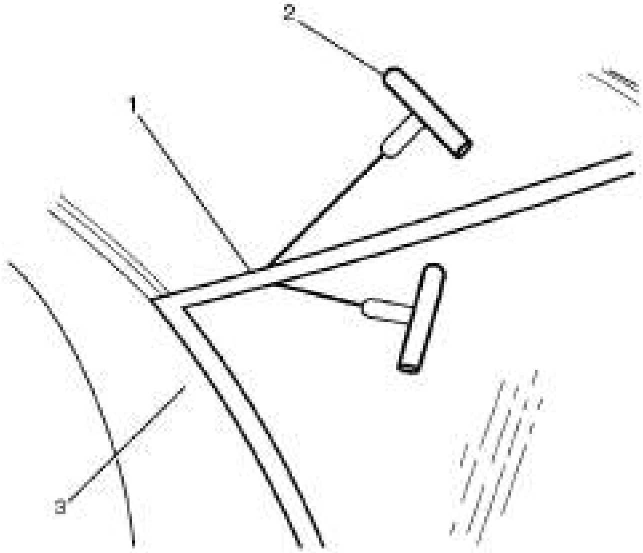
Caution: When working with any type of glass or sheet metal with exposed or rough edges, wear approved safety glasses and gloves in order to reduce the chance of personal injury.

Caution: If a window is cracked but still intact, crisscross the window with masking tape in order to reduce the risk of damage or personal injury.

1. Cover the seats and carpeting to protect them from broken glass.
2. Remove rear window upper garnish mould. Refer to Quarter Upper Trim Panel Replacement .
3. Remove the high level stop light. Refer to High Mount Stop Lamp Replacement .



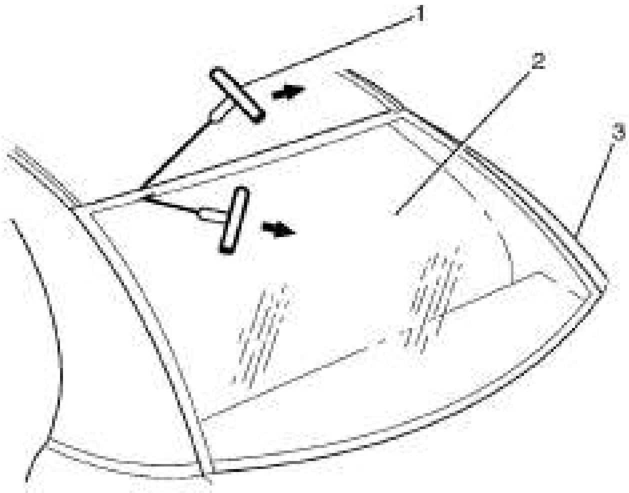
4. Disconnect the rear window electrical connectors (2) from the rear window (1).



Important: Before cutting out a stationary window, apply a double layer of masking tape around the perimeter of the painted surfaces and the interior trim.

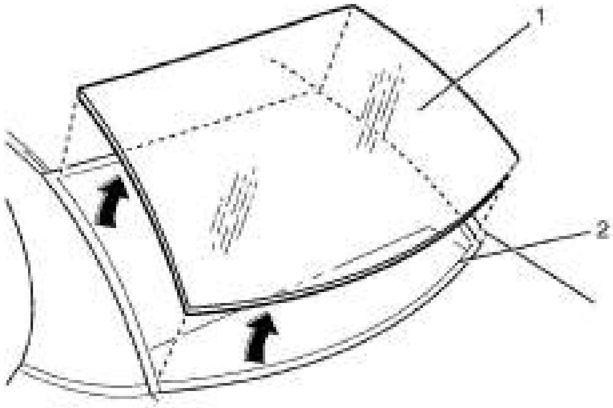
Important: Use a suitable tool to install the piano wire from J-36020 (2) through the urethane at a upper corner of the rear window (1).

5. Install J-36020 (2) to the vehicle (3).
6. Connect the end of the piano wire to the other handle of J-36020 (2).



Important: Keep the inside handle of J-36020 (1) against the rear window (2) and cycle the full length of the piano wire to prevent heat build up.

7. With the aid of an assistant cut through the urethane bead around the rear window (2) to the vehicle (3).



Important: The use of suction cups will aid in the rear window (1) removal.

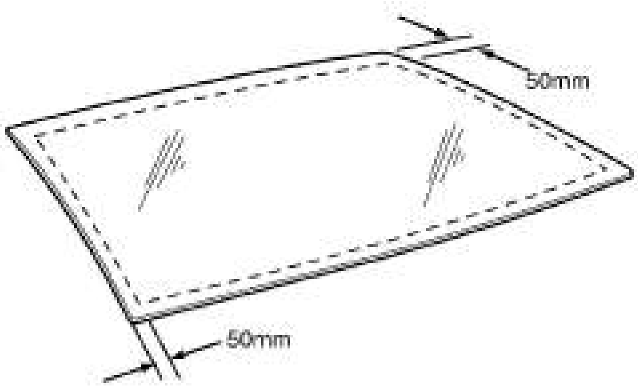
8. With the aid of an assistant remove the rear window (1) from the vehicle (2).

Installation Procedure

Caution: Failure to prep the area prior to the application of primer may cause insufficient bonding of urethane adhesive. Insufficient bonding of urethane adhesive may allow unrestrained occupants to be ejected from the vehicle resulting in personal injury.

Important: Use a lint free cloth and suitable oil free cleaning agent to make sure adhesion of the urethane.

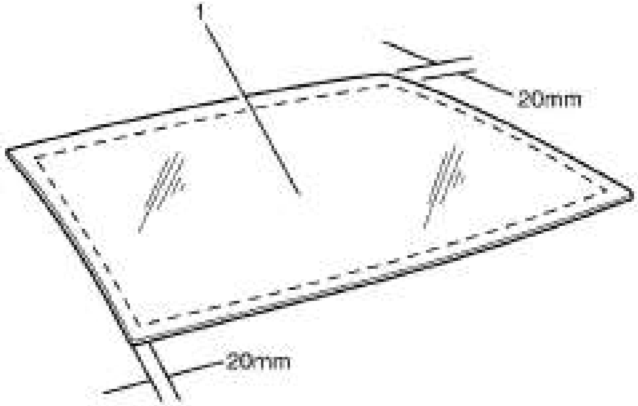
1. Clean surface and edges of rear window where urethane is to be applied.



Important: The clear glass primer dries almost instantly and may stain the viewing area of the rear window if not applied evenly. Wipe off the clear glass primer with a lint free cloth immediately after application.

Important: Apply the clear glass primer with a suitable applicator.

2. Apply a 50mm wide layer of clear glass primer to the inner surface of the rear window perimeter.

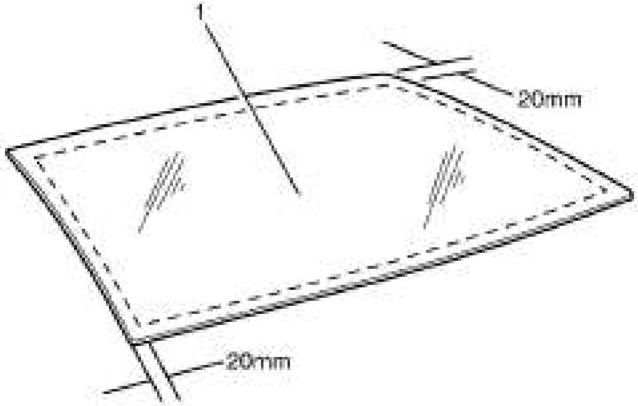


Important: Agitate the black glass primer for 1 minute to mix thoroughly.

Important: Apply a 20mm wide layer of black glass primer with the applicator to the rear window (1) perimeter.

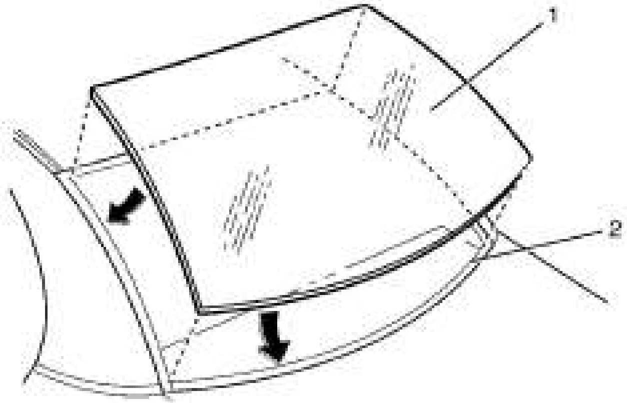
3. Apply the black glass primer to the rear window (1).

Caution: Refer to Window Retention Caution in the Preface section.



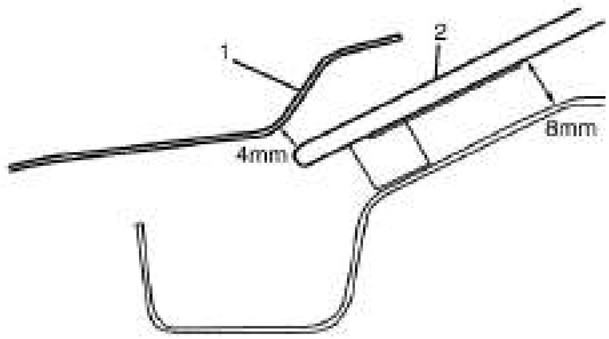
Important: Apply a 7mm wide and 14mm deep layer of urethane GMW3041 or equivalent 20mm inside the perimeter of the rear window (1).

4. Apply the urethane GMW3041 or equivalent to the rear window (1).

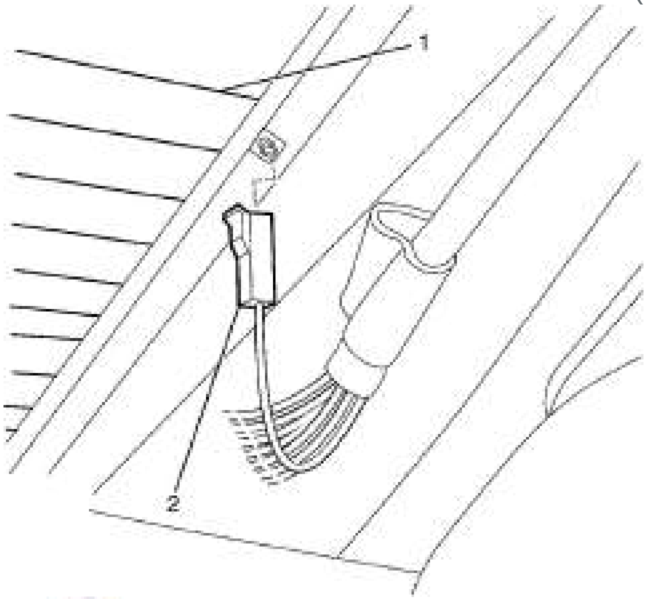


Important: The rear window (1) is aligned by two datum pins located at the top of the rear window and 8mm foam spacers one at the top and two at the bottom of the rear window (1).

5. With the aid of an assistant install the rear window (1) to the vehicle (2).
6. Press the rear window (1) firmly into position.



7. Check the clearance between the rear window (2) and the deck lid (1).



8. Connect the rear window electrical connectors (2) to the rear window (1).
9. Remove the double layer of masking tape from around the perimeter of the painted surfaces and the interior trim.
10. Install the rear window upper garnish mould. Refer to Quarter Upper Trim Panel Replacement .
11. Install the high level stop light. Refer to High Mount Stop Lamp Replacement .

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Window Motor Programming - Express Function

Important: This system is programmed after one full up and down cycle. This needs to be done when the regulators are replaced.

The following steps explain how to program the side door window regulator motors:

- Press and hold the power window switch until the window is fully DOWN.
- Continue holding the power window switch for approximately 3 seconds.
- Press and hold the power window switch until the window is fully UP.
- Continue holding the power window switch for approximately 3 seconds.
- The power window regulator motor is now programmed for the express function.
- Repeat this process for all of the power windows.

Windshield Replacement

Tools Required

- J-36020 Stationary Glass Removal Tool
- Glass Sealant Remover (Cold Knife)
- Urethane Adhesive Kit or Equivalent
- Isopropyl Alcohol, Prepsol or Equivalent
- Cartridge-type Caulking Gun
- Commercial-type Utility Knife
- Razor Blade Scraper
- Suction Cups

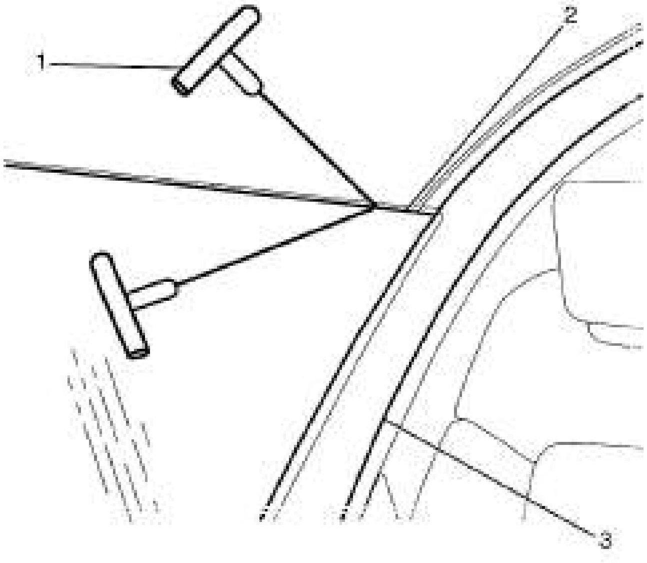
Removal Procedure

Caution: When working with any type of glass or sheet metal with exposed or rough edges, wear approved safety glasses and gloves in order to reduce the chance of personal injury.

Caution: If broken glass falls into the defroster outlets, it can be blown into the passenger compartment and cause personal injury.

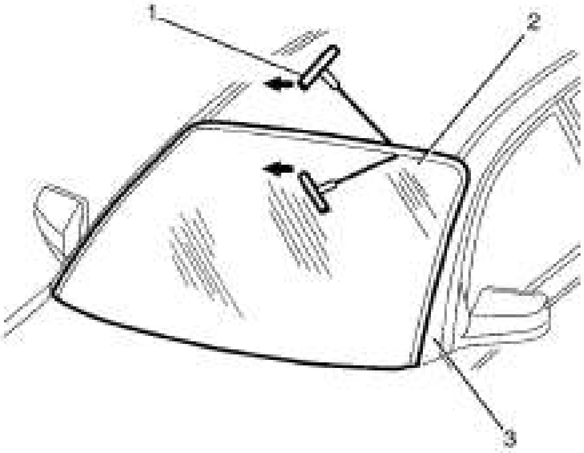
Important: Before cutting out a stationary window, apply a double layer of masking tape around the perimeter of the painted surfaces and the interior trim.

1. Remove the windshield wiper arms. Refer to Windshield Wiper Arm Replacement .
2. Remove the air inlet grille assembly. Refer to Air Inlet Grille Panel Replacement .
3. Remove the interior windshield side garnish panels. Refer to Windshield Garnish Molding Replacement .
4. Remove the internal rearview mirror. Refer to Inside Rearview Mirror Replacement .
5. Remove the rain sensor (if fitted). Refer to Windshield Outside Moisture Sensor Replacement .
6. Remove the exterior windshield garnish mouldings. Refer to Windshield Pillar Garnish Molding Replacement .
7. Protect the following parts:
    - The upper dash pad
    - The defroster outlets and A/C outlets
    - The seats and carpeting



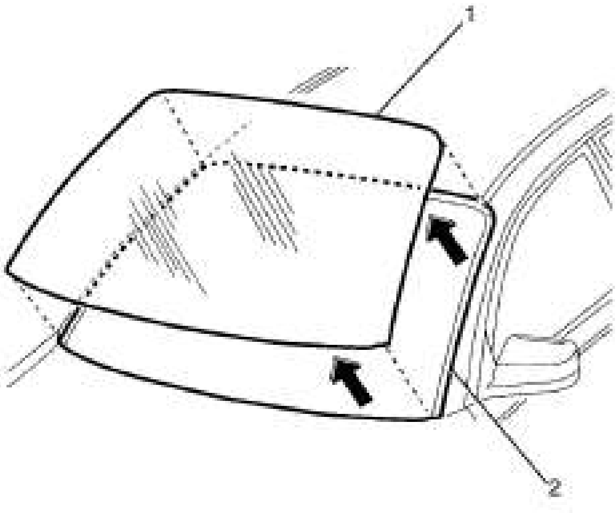
Important: Use a suitable tool to install the piano wire from J-36020 (1) through the urethane at a upper corner of the windshield (2).

8. Install J-36020 (1) to the vehicle (3).
9. Connect the end of the piano wire to the other handle of the J-36020 (2).



Important: Keep the inside handle of J-36020 (1) against the windshield (2) and cycle the full length of the piano wire to prevent heat build up.

10. With the aid of an assistant cut through the urethane bead around the windshield (2) to the vehicle (3).



Important: The use of suction cups will aid in the windshield (1) removal from the vehicle (2).

11. With the aid of an assistant remove the windshield (1) from the vehicle (2).

Installation Procedure

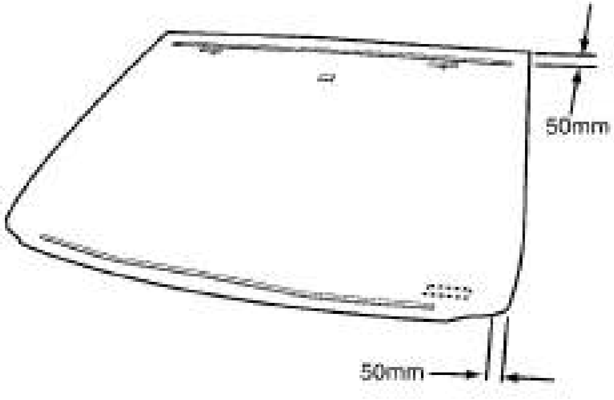
Important: Remove all of the urethane from the pinch-weld surface by using a clean utility knife or razor blade scraper. Avoid the removal of paint when removing urethane.

1. Remove any urethane from the pinch-weld.

Caution: Failure to prep the area prior to the application of primer may cause insufficient bonding of urethane adhesive. Insufficient bonding of urethane adhesive may allow unrestrained occupants to be ejected from the vehicle resulting in personal injury.

Important: Use a lint free cloth and suitable oil free cleaning agent to make sure adhesion of the urethane.

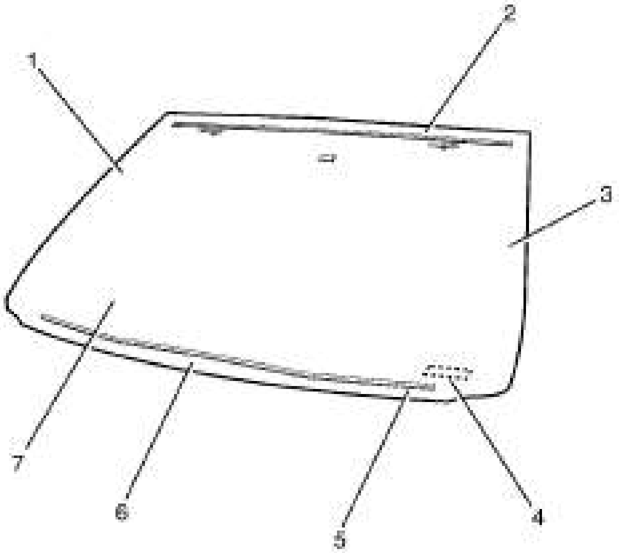
2. Clean surface and edges of the windshied where urethane is to be applied.



Important: The clear glass primer dries almost instantly and may stain the viewing area of the windshield if not applied evenly. Wipe off the clear glass primer with a lint free cloth immediately after application.

Important: Apply the clear glass primer with a suitable applicator.

3. Apply a 50mm wide layer of clear glass primer to the inner surface of the windshield perimeter.

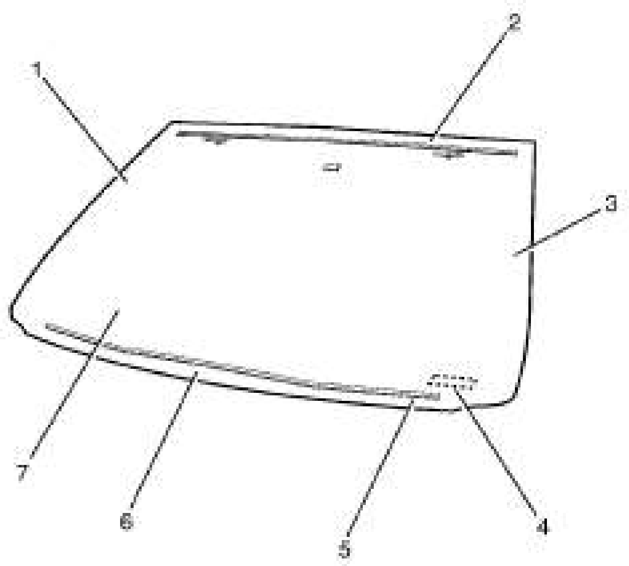


Important: Agitate the black glass primer for 1 minute to mix thoroughly.

Important: Apply a 20mm wide layer of black glass primer with a suitable applicator to the inner upper (2), left (3) and right (1) side surface of the windshield perimeter. Apply a 20mm wide layer of black glass primer 20mm from the lower edge (6) of the windshield and 15mm from the lower edge (5) of the windshield where the VIN (4) is displayed.

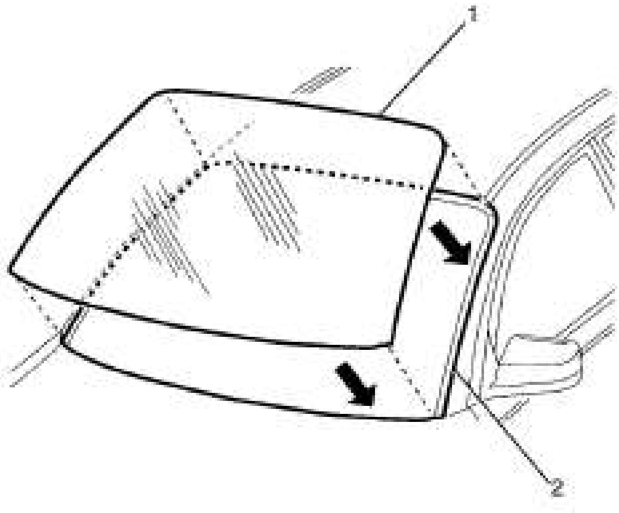
4. Apply the black glass primer to the windshield (7).

Caution: Refer to Window Retention Caution in the Preface section.



Important: Apply a 7mm wide and 14mm deep layer of urethane GMW3041 or equivalent to the inner upper (2), left (3) and right (1) side surface of the windshield perimeter. Apply a 7mm wide and 14mm deep layer of urethane 20mm from the lower edge (6) of the windshield and 15mm from the lower edge (5) of the windshield where the VIN (4) is displayed.

5. Apply the urethane GMW3041 or equivalent to the windshield (7).



Important: The windshield is aligned by two datum pins located at the top of the windshield and two 8mm foam spacers one at the top and one at the bottom of the windshield (1).

Important: The use of suction cups will aid the installation of the windshield (1) to the vehicle (2).

6. With the aid of an assistant install the windshield (1) to the vehicle (2).
7. Press the windshield (1) firmly into position.
8. Install the air inlet grille assembly. Refer to Air Inlet Grille Panel Replacement .
9. Install the windshield wiper arms. Refer to Windshield Wiper Arm Replacement .
10. Install the interior windshield side garnish panels. Refer to Windshield Garnish Molding Replacement .
11. Install the exterior windshield garnish mouldings. Refer to Windshield Pillar Garnish Molding Replacement .
12. Remove the double layer of masking tape from around the perimeter of the painted surfaces and the interior trim.
13. Install the rain sensor (if fitted). Refer to Windshield Outside Moisture Sensor Replacement .
14. Install the internal rearview mirror. Refer to Inside Rearview Mirror Replacement .

Power Windows Description and Operation

Power Window System Components

The power window system consists of the following components:

- Door lock/windowswitch
- Window control module
- Left rear window switch
- Right rear window switch
- Window regulator motors in each of the doors
- WNDW MTR Circuit Breaker 20A
- WNDW CNTRL Fuse 2A

Front Window Operation and the Master Control Window Switches

When the ignition switch is in the RUN or ACCY position, or retained accessory power (RAP) is enabled, battery positive voltage is supplied to the door lock/window switch. When the left front or right front window switch is pressed in the down position, a signal is sent to the window control module which supplies voltage to the appropriate window motor down circuit and ground to the window motor up circuit causing the window to open. When the left front or right front window switch is pulled in the up position, a signal is sent to the window control module which reverses the polarity of the window motor and the window closes.

Express Down Feature

The driver and passenger windows will travel to the fully down position when the left front or right front window switch is pressed and released. Pulling the same window switch to the up position will cancel the express down command.

Express Up Feature

Some models are equipped with smart motors which allows for express down and express up functions. When the left front or right front window switch is pulled and released, the appropriate front window will travel to the fully up position. Pressing the same window switch to the down position will cancel the express up command. As a safety feature, the smart motors will detect excessive resistance while performing the express up function and automatically reverse direction to prevent injury to any occupants that may become trapped between the closing window and the door frame. The automatic reverse safety feature can be overridden by pulling and holding the window switch.

Lockout Switch Feature

The door lock/window switch contains a rear window lockout switch which disconnects the battery positive voltage supply to the rear door window switches, disabling them. Normal rear window operation is still available from the door lock/window switch.

Rear Window Operation and the Rear Window Switches

The rear power window door switches receive battery voltage through the window lockout control circuit if the rear window switches are enabled. Ground for the rear passenger power window motors is supplied through normally closed up and down contacts of both the rear window switches and the switches on the door lock/window switch. When the either rear window switch is placed in the down position, the power window motor down control circuit is switched to 12 volts and is applied to the down side of the rear window motor. Since the other side of the rear power motor is connected to ground through the normally closed up contacts of both the rear window switch and door lock/window switch, the window travels down. By placing the rear window switch in the up position, the polarity of the power window motor is reversed and the window travels up.

Rear Window Defogger Description and Operation

System Description

The rear window defogger system consists of the following components:

- RR DEFOG fuse
- RR DEFOG relay
- Rear window defogger grid
- HVAC control module

Battery positive voltage is supplied through the RR DEFOG fuse in the underhood fuse block to the REAR DEFOG relay switched input. Ground for the RR DEFOG relay is provided by G102. Ground for the rear window defogger grid is provided by G304.

When the rear window defogger switch is pressed, the HVAC control module provides voltage to the RR DEFOG relay coil, energizing the relay. When the relay is energized, the relay switch closes allowing B+ voltage to flow through the closed relay switch to the rear window defogger grid. The properties of the rear window defogger grid has a resistance to the flow of electrical current causing the elements within the grid to radiate heat.

When the rear window defog switch is pressed, the HVAC control module keeps the RR DEFOG relay control circuit for active for 15 minutes, additional activation of the rear window defogger system results in 7.5 minute activation cycles except when the vehicle speed is greater than 80 km/h (50 mph) which results in a continuous rear window defogger operation.

Stationary Window Description (Sportwagon)

Stationary Window Description

The windshield assembly is manufactured from laminated glass and has a tinted upper band. Toughened safety glass is used for all other windows. The windshield and liftgate window are retained to the body with urethane adhesive which adheres the windshield and liftgate window to the body, increasing structural integrity. The reinstallation of the windshield and liftgate window with urethane adhesive requires complete replacement of the urethane adhesive bead. The windshield and liftgate window are positioned on the body with datum pins that are integral to the windshield and liftgate window. The body side stationary window assembly is attached to the vehicle using nuts.

Stationary Window Description (SWB)

The windshield assembly is manufactured from laminated glass and has a tinted upper band. Toughened safety glass is used for all other windows. The windshield and rear window are retained to the body with urethane adhesive which adheres the windshield and rear window to the body, increasing structural integrity. The reinstallation of the windshield and rear window with urethane adhesive requires complete replacement of the urethane adhesive bead.

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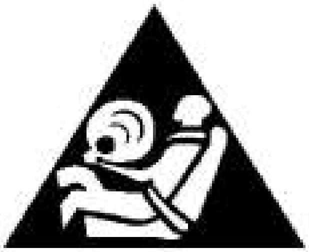
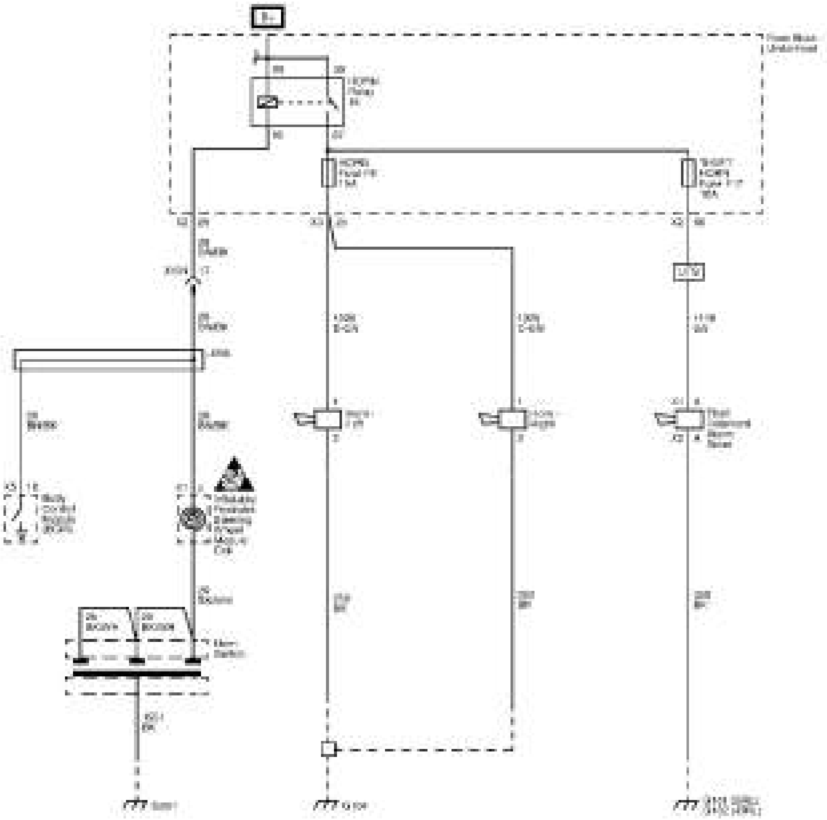
Fastener Tightening Specifications

Application	Specification	
	Metric	English
Horn Assembly To Front End Module Retaining Bolt	4.5 N-m	39 lb in

Horn Schematic Icons

Icon	Icon Definition
	**Caution:** When performing service on or near the SIR components or the SIR wiring, the SIR system must be disabled. Refer to SIR Disabling and Enabling . Failure to observe the correct procedure could cause deployment of the SIR components, personal injury, or unnecessary SIR system repairs.

Horn Schematics



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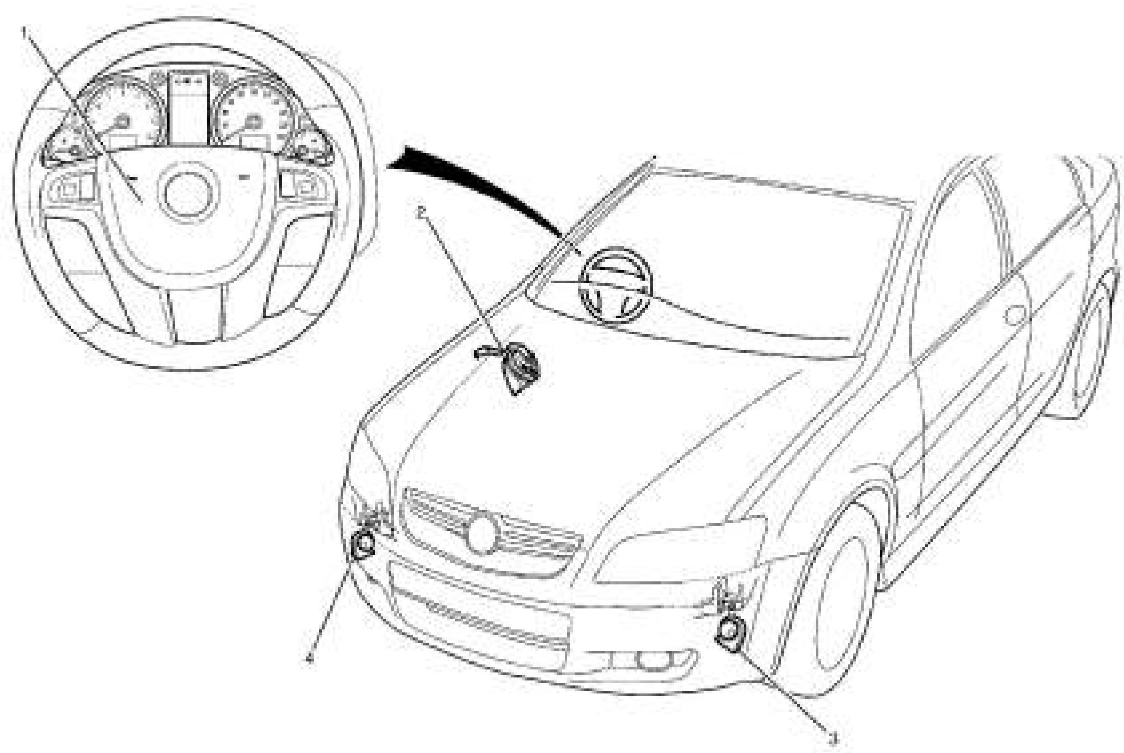
Horn Component Views (RHD)



(1) Horn Button

(2) Theft Deterrent Horn 400Mhz

(3) Horn 400Mhz

(4) Horn 500Mhz

Diagnostic Starting Point - Horns

Begin the system diagnosis with the Diagnostic System Check - Vehicle. The Diagnostic System Check will provide the following information:

- The identification of the control modules which command the system
- The ability of the control modules to communicate through the serial data circuit
- The identification of any stored diagnostic trouble codes (DTC's) and their status

The use of the Diagnostic System Check will identify the correct procedure for diagnosing the system and where the procedure is located.

DTC B2750

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B2750 00: Horn Relay Coil Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Horn Relay B+	2	2	--	--
Horn Relay Control	1	2	B2750 00	--
Horn Control	2	2	1	--
Horn Ground	--	2	2	--
1. Horn Always On 2. Horn Inoperative				

Circuit/System Description

The body control module (BCM) controls the horn relay by grounding the control circuit of the horn relay coil energizing the relay. When the horn relay is energized, the horn relay contacts close applying voltage through the horn fuse and the horn control circuit to the horns.

Conditions for Running the DTC

When the horn output is actively being requested by the BCM.

Conditions for Setting the DTC

The BCM detects a fault in the horn relay control circuit for approximately 125 milliseconds.

Action Taken When the DTC Sets

The BCM disables the output to the horn relay until the next ignition cycle.

Conditions for Clearing the DTC

- The DTC clears when the fault is no longer detected.
- The current DTC will become history when the request for the output is removed.
- The history DTC will clear after 50 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Horn Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Horns System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Command the Horn Relay Test ON and OFF with the scan tool. The horns should turn ON and OFF when changing between the commanded states.

Circuit/System Testing

1. Ignition OFF, disconnect the HORN relay.
2. Ignition ON, verify a test lamp illuminates between the B+ circuit terminal 85 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Connect a test lamp between the control circuit terminal 86 and the B+ circuit terminal 85.
4. Command the Horn Relay test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.

   If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

5. If all circuits test normal, test or replace the HORN relay.

Component Testing

1. Ignition OFF, disconnect the HORN relay.
2. Test for 60-180 ohms between terminals 85 and 86.

   If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If not the specified value, replace the relay.
4. Install a 30A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.

   If greater than the specified range, replace the relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Relay Replacement
- Control Module References for BCM replacement, setup and programming

Symptoms - Horns

Important: The following steps must be completed before using the symptom tables:

1. Perform Diagnostic System Check - Vehicle, before using the symptom tables in order to verify that all of the following are true:
   - There are no DTC's set.
   - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to Horns System Description and Operation.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the horn system. Refer to Checking Aftermarket Accessories.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Perform the following if a horn buzzes or has a harsh tone:
  - Inspect for debris in the joint where the horn fastens to the vehicle.
  - Test the torque of the horn mounting hardware. The horn mounting hardware should be tightened to a torque of 10 N·m (7 lb ft).

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to a symptom diagnostic procedure Horns Malfunction in order to diagnose the symptom.

Horns Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Horn Relay B+	2	2	--	--
Horn Relay Control	1	2	B2750 00	--
Horn Control	2	2	1	--
Horn Ground	--	2	2	--
1. Horn Always On 2. Horn Inoperative				

Circuit/System Description

Battery positive voltage is applied at all times to the horn relay coil and the horn relay switch. Pressing the horn switch applies ground through the switch contacts and the horn relay control circuit to the coil side of the relay, energizing the relay. Battery voltage is then applied through the switch side of the relay, the horn fuse, and the horn control circuit to the horns. The body control module (BCM) may also apply ground to the horn relay control circuit as described above. The horns sound as long as ground is applied to the horn relay control circuit.

Diagnostic Aids

A short to ground in the HORN relay control circuit or a short to voltage in the horn control circuit will cause the horns to sound continuously until the horns overheat and become inoperative.

Rotate the steering wheel while pressing the horn pad to identify intermittent and poor connections within the steering column.

If diagnosing a Horn- Poor Tone condition, inspect the following:

- Debris or water in the horn assembly.
- Proper horn mounting hardware torque. Refer to Fastener Tightening Specifications.
- Debris in the joint where the horns attach to the vehicle.
- Debris in direct contact with the horn

- Vehicle components vibrating while the horn is sounding

Reference Information

Schematic Reference

Horn Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Horns System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, press and release the steering wheel horn pad. The horns should sound and emit a clear and even tone only when the horn pad is pressed

    If the horns do not sound when the horn pad is pressed or continues sounding after the horn pad is released, refer to Horn Malfunction.

    If the sound emitted from the horns are not clear and even, refer to Horn - Poor Tone.
2. Command the Horn Relay Test ON and OFF with the scan tool. The horns should turn ON and OFF when changing between the commanded states.

    If the horns do not turn ON and OFF when changing between the commanded states, refer to Command Malfunction.

Circuit/System Testing

Horn Switch Circuit Test

1. Ignition OFF, disconnect the HORN relay.
2. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 87 and ground.

    If the test lamp illuminates, test the control circuit for a short to voltage.

3. Verify that a test lamp illuminates between the B+ circuit terminal 85 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
4. Verify that a test lamp illuminates between the B+ circuit terminal 30 and ground.

   If the test lamp does not illuminate, test the B+ circuit for an open/high resistance.
5. Ignition OFF, disconnect the harness connector at the appropriate horn.
6. Test for less than 1 ohm between the ground circuit terminal 2 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
7. Connect the harness connector at the horn.
8. Ignition ON, connect a 15A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87. Verify the horns are activated.

   If the horns do not activate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the horn.
9. Connect a test lamp between the B+ circuit terminal 85 and the control circuit terminal 86.
10. Press and release the steering wheel horn pad. The test lamp should turn ON and OFF when changing between the commanded states.

    If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, inspect for a sticking horn switch.

    If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, inspect for an open horn switch.
11. If all circuits test normal, test or replace the HORN relay.

Horn - Poor Tone

1. Ignition OFF, disconnect the harness connector at the appropriate horn.
2. Test for less than 1 ohm between the ground circuit terminal 2 and ground.

   If greater than the specified range, test the ground circuit for a high resistance.
3. Disconnect the HORN relay.
4. Test for less than 1 ohm between the control circuit terminal 87 and the control circuit terminal 1 at the horn.

   If greater than the specified range, test the control circuit for an open/high resistance.
5. If all circuits test normal, test or replace the horn.

Command Malfunction

1. Ignition OFF, disconnect the HORN relay.
2. Connect a test lamp between the B+ circuit terminal 85 and the control circuit terminal 86.
3. Ignition ON, command the Horn Relay Test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test circuit the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.

Component Testing

Horn Test

1. Ignition OFF, disconnect the harness connector at the appropriate horn.
2. Install a 15A fused jumper wire between the control terminal 1 and 12V. Install a jumper

wire between the ground terminal 2 and ground. Verify the horn emits a clear and even tone.

If the sound emitted is not clear and even, replace the horn.

Relay Test

1. Ignition OFF, disconnect the HORN relay.
2. Test for 60-180 ohms between terminals 85 and 86.

   If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If not the specified value, replace the relay.
4. Install a 30A fused jumper wire between relay terminal 85 and 12V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.

   If greater than the specified range, replace the relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Relay Replacement
- Horn Replacement
- Steering Wheel Inflatable Restraint Module Replacement
- Control Module References for BCM replacement, setup and programming

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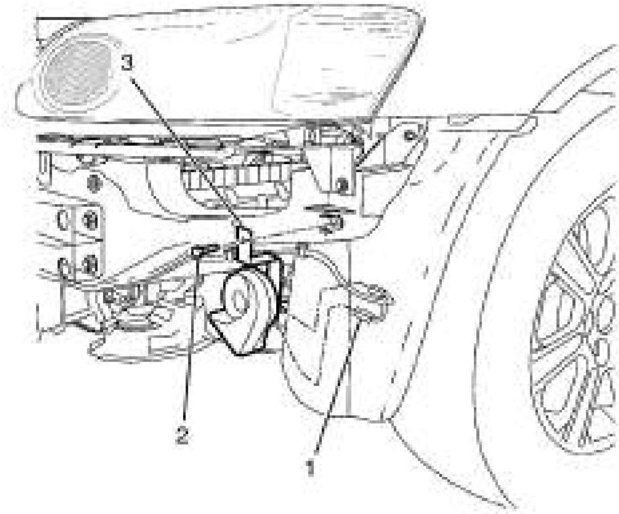
Horn Replacement

Removal Procedure

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the front facia assembly. Refer to Front Bumper Fascia Replacement.

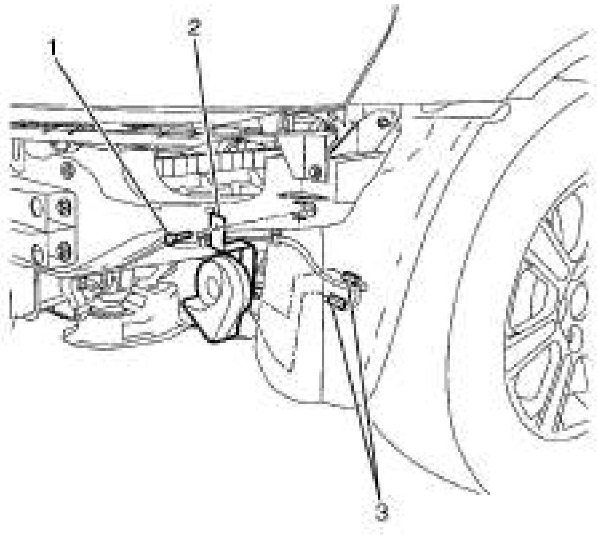


3. Disconnect the horn electrical connector from the horn unit (1)
4. Remove the horn assembly to front end module retaining bolt (2).
5. Pull the horn assembly (3) outward to remove it from the vehicle.

Installation Procedure

1. Align horn in correct position on vehicle.

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the horn assembly to front end module retaining bolt (1).

   Tighten
   Tighten the bolt to 4.5 N-m (39 lb in).

3. Connect the horn electrical connectors (3) to the horn assembly.
4. Install the front facia assembly. Refer to Front Bumper Fascia Replacement.
5. Lower the vehicle.

Horns System Description and Operation

System Description

The horn system consists of the following components:

- HORN fuse
- THEFT HORN fuse
- Horn relay
- Horn switch
- Left Horn
- Right Horn
- Theft Deterrent Alarm Siren
- Body control module (BCM)

System Operation

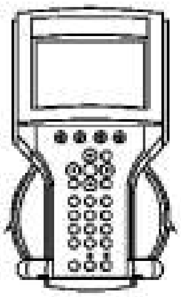
- The vehicle horns are activated whenever the horn switch is depressed.
- The BCM commands the horns ON under any of the following conditions:
  - When the immobilizer detects a vehicle intrusion.
  - When the keyless entry system is used to lock the vehicle, a horn chirp may sound to notify the driver that the vehicle has been locked. The notification feature may be enabled or disabled through personalization. For further information refer to Keyless Entry System Description and Operation.
  - When the panic button is pressed on the key fob. For further information refer to Keyless Entry System Description and Operation.

Circuit Operation

Battery positive voltage is applied at all times to the horn relay coil and the horn relay switch. Pressing the horn switch applies ground to the horn relay control circuit or when the body control module (BCM) receives a request to sound the horns, it to will provide a ground to the horn relay control circuit. When the horn relay control circuit is grounded, the horn relay is energized and battery positive voltage is applied to the horns through the horn control circuit. The horns sound as long as ground is applied to the horn relay control circuit

The theft deterrent alarm siren shares the same control circuit as the left and right horns, but the theft deterrent alarm has it's own 10A fuse so that if the HORN fuse is open while the BCM is commanding the theft deterrent alarm, the theft deterrent alarm siren will still sound independently of the left and right horns.

Special Tools

Illustration	Tool Number / Description
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

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Bulb Usage Chart

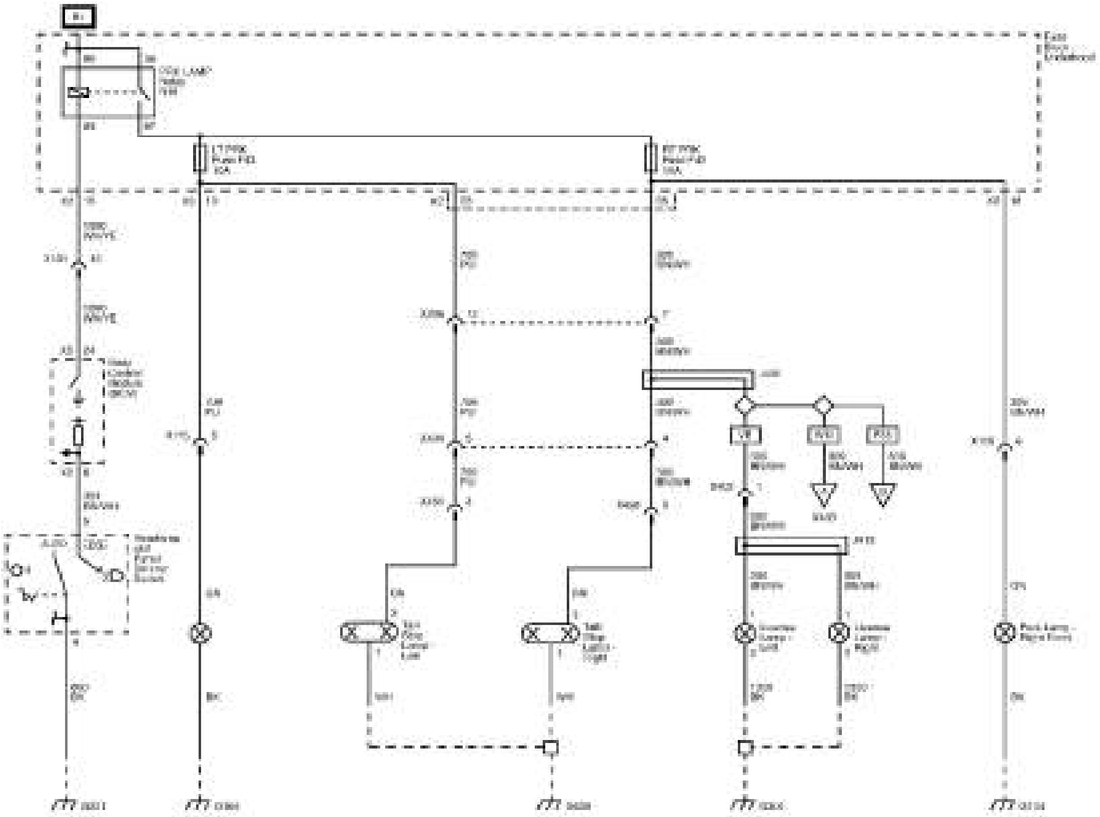
Bulb	Power Rating (Watts)	Type
Headlamp Low Beam Bulb (Type A)	55	H7
Headlamp Low Beam Bulb (Type B)	55	H7
Headlamp Low Beam Bulb (Type C)	55	H7
Headlamp Low Beam Bulb (Type D)	35	D1S
Headlamp High Beam Bulb (Type A)	65	H9
Headlamp High Beam Bulb (Type B)	65	H9
Headlamp High Beam Bulb (Type C)	55	H7
Headlamp High Beam Bulb (Type D)	55	H7
Front Fog Lamp Bulb	55	H 11
Front Fog Lamp Bulb (CSV HSV VXR8)	55	H3
Front Driving Lamp Bulb (CSV SWBHSV VXR8)	55	H3
Rear Fog Lamp Bulb (VXR8)	21	P21W
Parking Lamp Bulb	5	W5W
Front Indicator Bulb	21	PY21W
Repeater (SWB)	5	W5W
Repeater (LWB)	LED	LED
Console Lamp Bulb	5	Festoon
Instrument Panel Compartment Lamp Bulb	5	Festoon
Instrument Panel Courtesy Lamp Bulb - Left	2.7	W2.7W
Instrument Panel Courtesy Lamp Bulb - Right	2.7	W2.7W
Dome Lamp Bulb (Overhead Console)	5	Wedge base
Dome Lamp Bulb (Dome Lamp)	5	Wedge base
Reading Lamp Bulb (Overhead Console)	5	Wedge base
Reading Lamp Bulb (Dome Lamp)	5	Wedge base
Door Courtesy Lamp Bulb	10	Festoon
Ignition Lock Cylinder Lamp Bulb	1.4	W1.4W
Transmission Floor Shift Control Indicator Lamp Bulb	LED	LED
Outside Rearview Mirror Courtesy Lamp Bulb	2.5	Festoon
Rear Compartment Lamp Bulb	10	Festoon
Stop/Tail Lamp Bulb	21/5	P21/5W
Stop/Tail Lamp (LWB)	LED	LED
Stop/Tail Lamp (CSV HSV VXR8)	LED	LED
Rear Indicator Lamp (CSV SWBHSV VXR8)	LED	LED
Rear Indicator Lamp Bulb	21	PY21W
High Mounted Stop Lamp	LED	LED
Backup Lamp Bulb	21	P21W

License Lamp Bulb	5	W5W
Light Emitting Diode = LED		

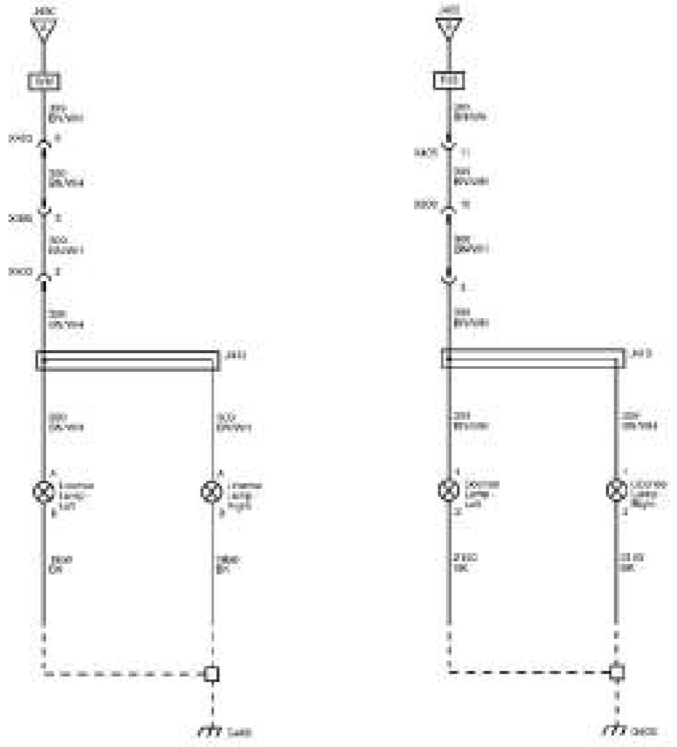
Fastener Tightening Specifications

Application	Specification	
	Metric	English
Assist Handle to Headliner Retaining Screws	2 N·m	18 lb in
Brake Pedal Position Sensor to Brake Pedal Bracket Retaining Bolt	3 N·m	27 lb in
Fog Lamp Assembly Retaining Screw	2 N·m	18 lb in
Front Driving Lamp to Bracket Retaining Bolts (CSV/SWBHSV/VXR8)	2 N·m	18 lb in
Front Driving Lamp to Bracket Retaining Nut and Bolt (CSV/SWBHSV/VXR8)	2 N·m	18 lb in
Front Flashing Light to Bumper Bar Retaining Nut	XX N·m	XX lb in
Front Fog Lamp Horizontal Adjustment Screw (LWBHSV)	2 N·m	18 lb in
Front Fog Lamp to Bracket Retaining Bolts	2 N·m	18 lb in
Front Fog Lamp Vertical Adjustment Screw (LWBHSV)	2 N·m	18 lb in
Front Lamp Assembly to Fascia Retaining Screws (CSV/SWBHSV/VXR8)	2 N·m	18 lb in
Headlamp Assembly Retaining Screw	2 N·m	18 lb in
Headlamp Assembly to Front End Module Lower Retaining Bolts	4 N·m	35 lb in
Headlamp Assembly to Front End Module Upper Retaining Bolts	4 N·m	35 lb in
Headlamp Bracket to Front End Module Retaining Bolts	4 N·m	35 lb in
Headlamp Bracket to Headlamp Assembly Retaining Screws	1 N·m	9 lb in
Headlamp Dust Cap Retaining Torx Screws (LWB)	1 N·m	9 lb in
Headlamp Levelling Module Retaining Torx Screws (LWB)	4 N·m	35 lb in
Headlamp Levelling Sensor Linkage Retaining Nut	4 N·m	35 lb in
Headlamp Levelling Sensor Retaining Bolts	9 N·m	80 lb in
Headlamp Levelling Sensor Retaining Bolts	8 N·m	71 lb in
High Mounted Stop Lamp to Liftgate Upper Moulding Retaining Screws (Sportwagon)	XX N·m	XX lb in
Lamp Monitor Module to Body Retainer Nuts (CSV/SWBHSV/VXR8)	3 N·m	27 lb in
Rear Fog Lamp Bracket to Rear Bumper Fascia Retaining Screws (VXR8)	2 N·m	18 lb in
Rear Fog Lamp Housing to Fog Lamp Bracket Retaining Screws (VXR8)	2 N·m	18 lb in
Tail Lamp Assembly Retaining Nut	5 N·m	44 lb in
Tail Lamp Assembly to Vehicle Retaining Nuts (Sportwagon)	4 N·m	35 lb in
Tail Lamp to Body Retaining Nuts (CSV/SWBHSV/VXR8)	3 N·m	27 lb in

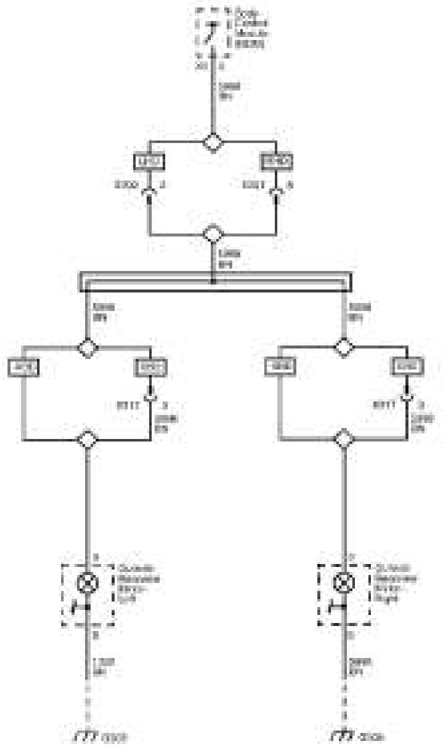
Parklamps - 1 of 2



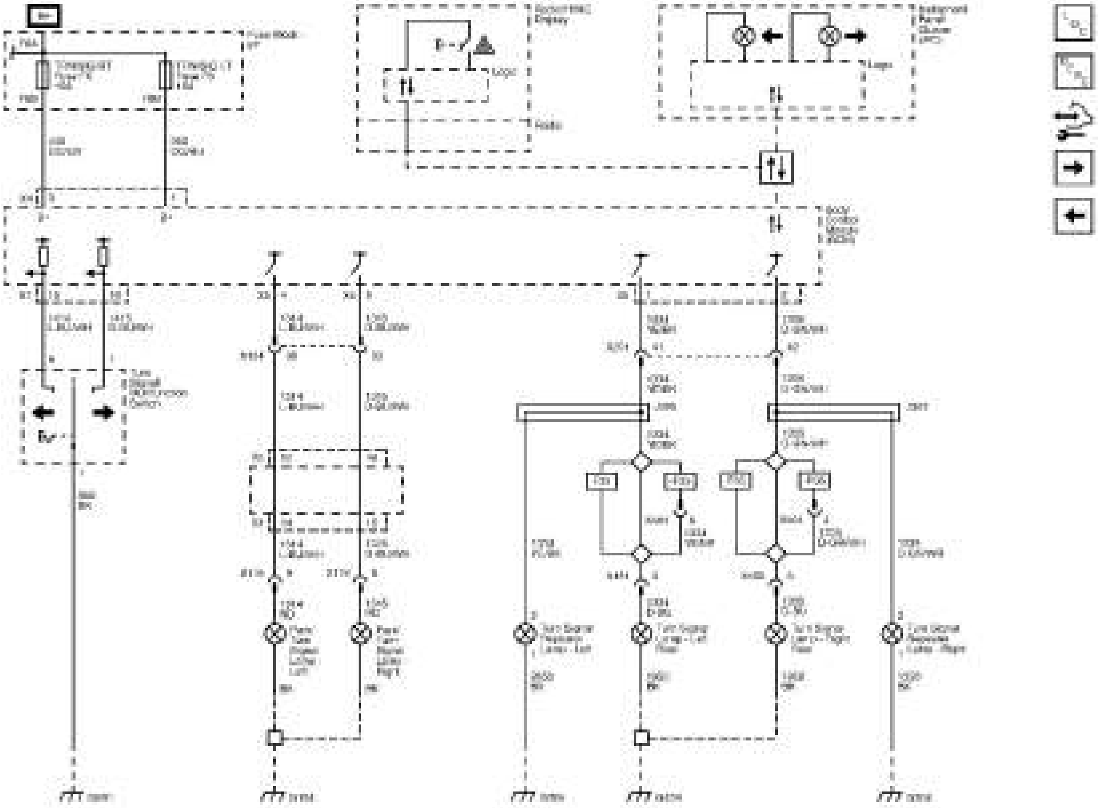
Parklamps - 2 of 2



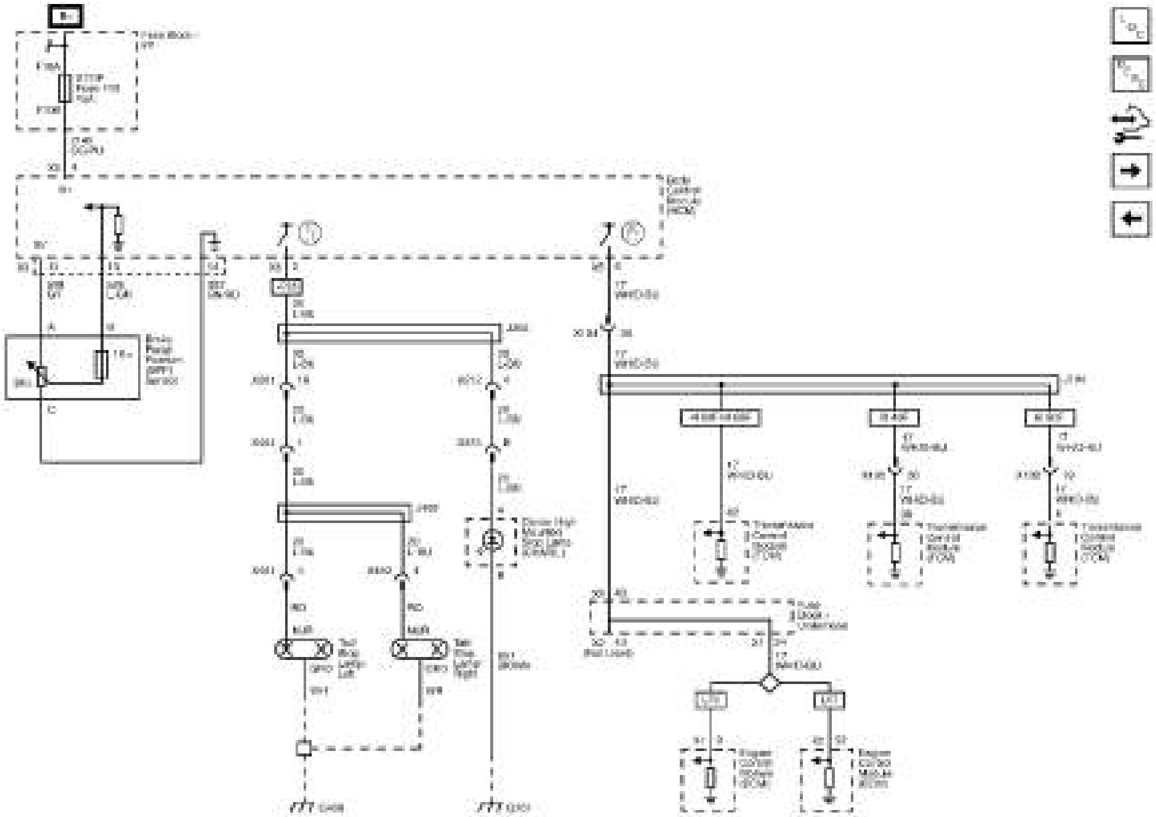
Exterior Illumination Lamps



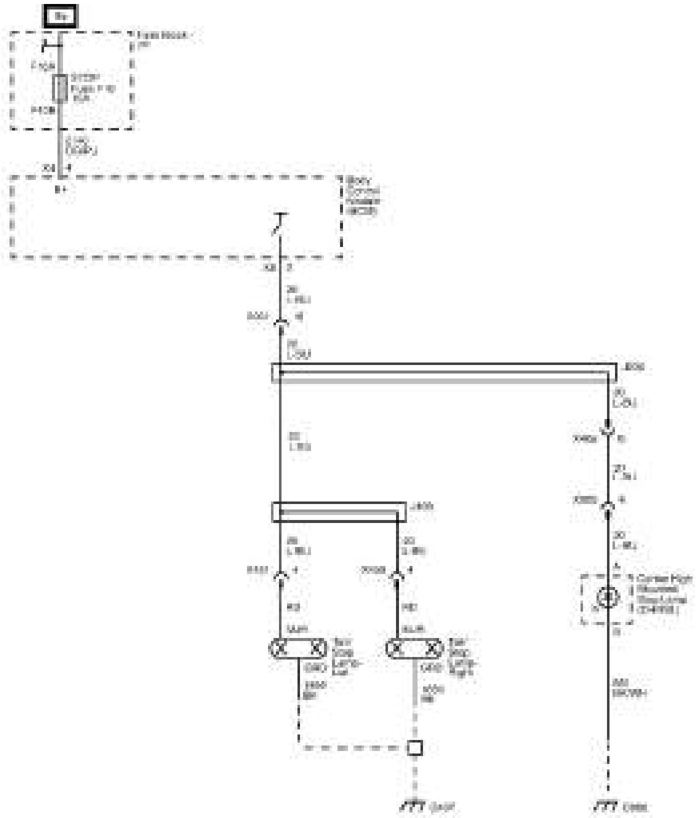
Turn Signal Lamps



Stop Lamps - 1 of 2



Stop Lamps - 2 of 2


B+
Fuse Block
Body Control Module (BCM)
Center High Mounted Stop Lamp

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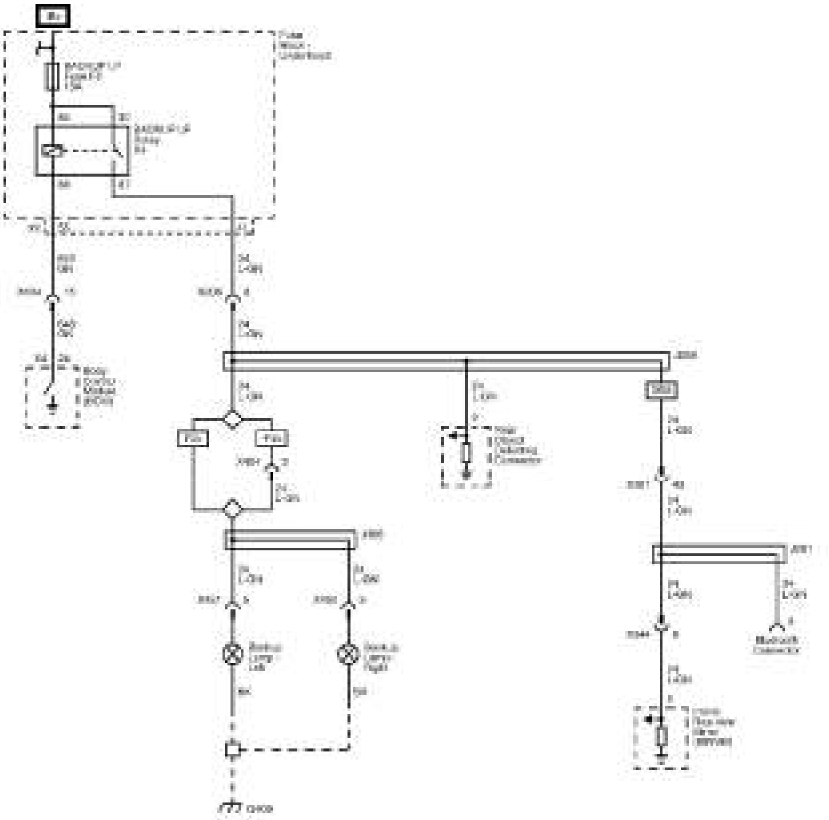
Backup Lamps


B+
Fuse Block - Underhood
Body Control Module (BCM)

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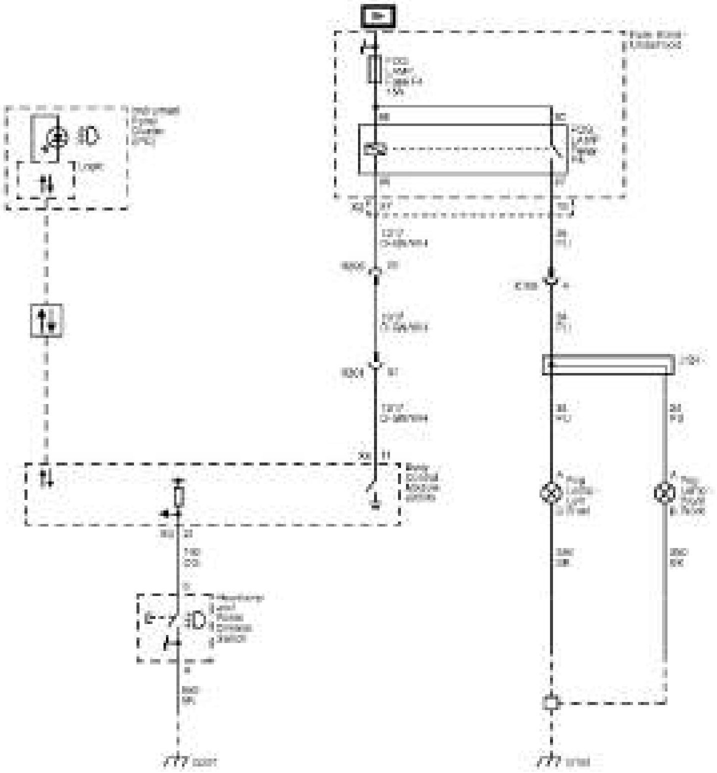
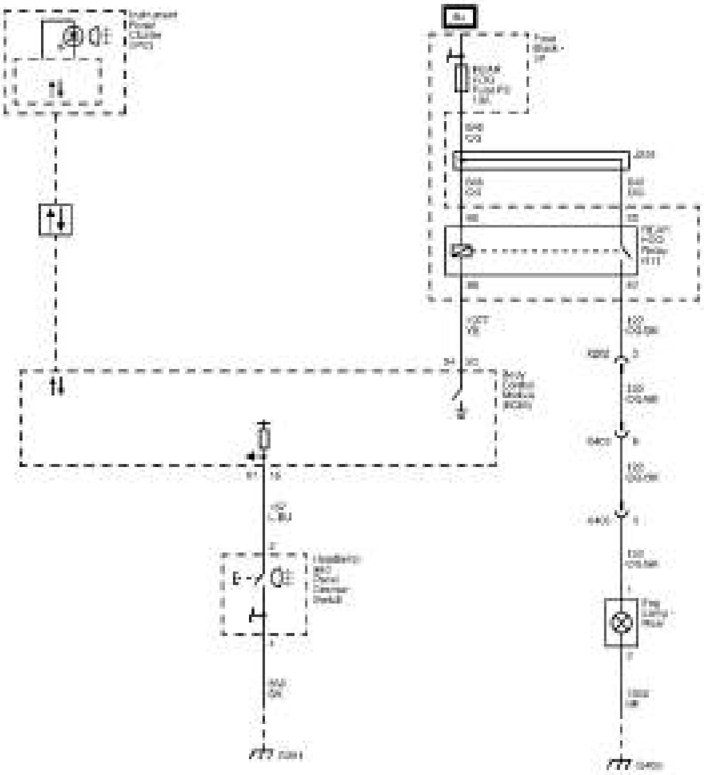
Front (T96)



Rear (T79)


Instrument Panel Cluster (IPC)
Fuse Block - IP
Body Control Module (BCM)
Fog Lamp - Rear

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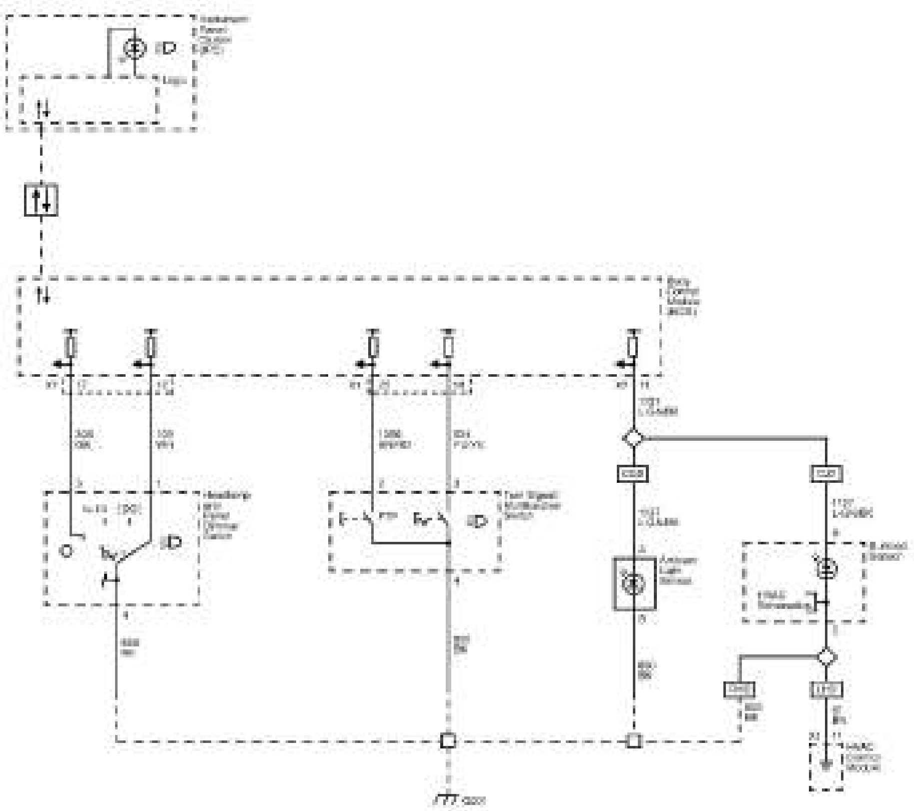
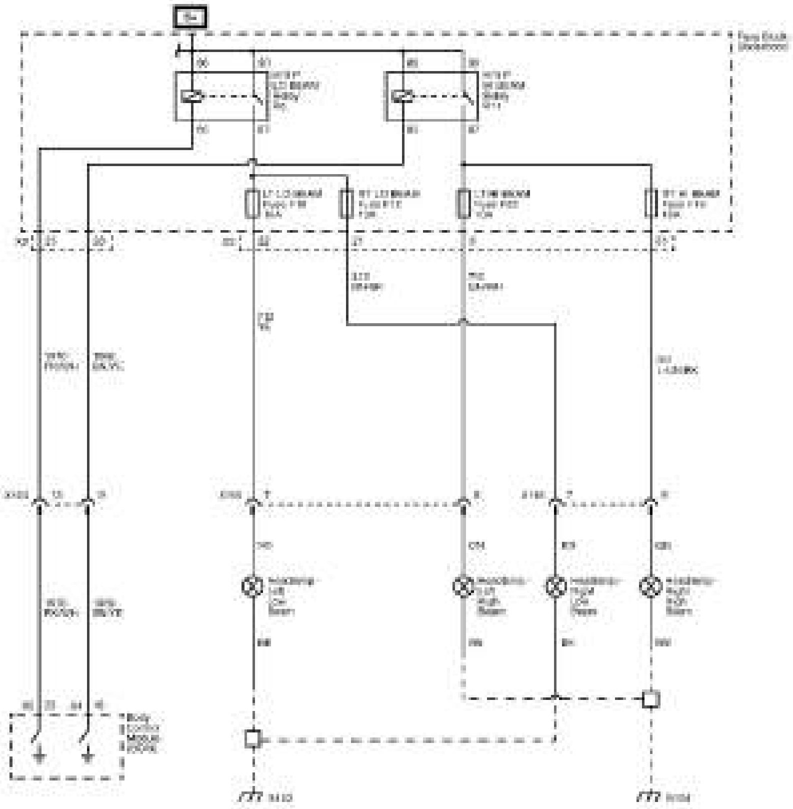
Headlamps Controls and Sensors

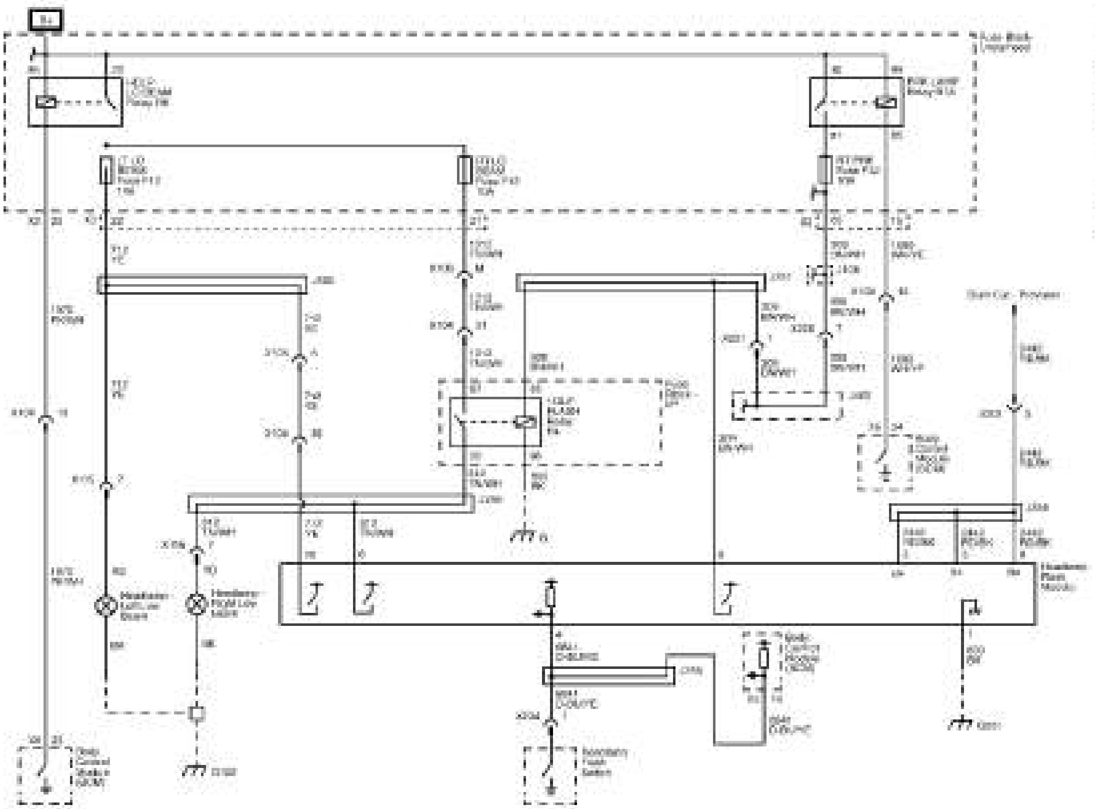

Logic
Body Control Module (BCM)
Headlamp and Panel Dimmer Switch
Turn Signal Multifunction Switch
Ambient Light Sensor
Sunload Sensor
HVAC Control Module

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Systems | Lighting | Schematic and Routing Diagrams | Document ID: 2153402

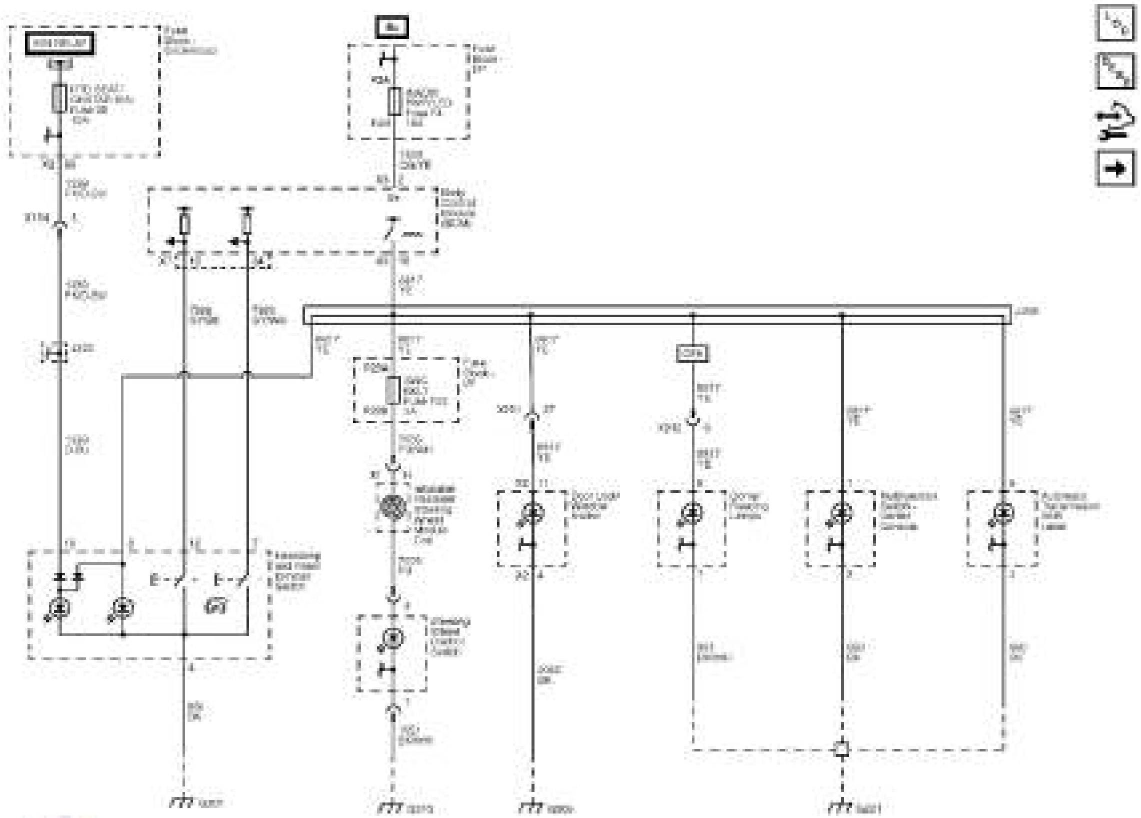
Headlamps Except 9C1


Body Control Module
Headlamp - Left Low Beam
Headlamp - Left High Beam
Headlamp - Right Low Beam
Headlamp - Right High Beam

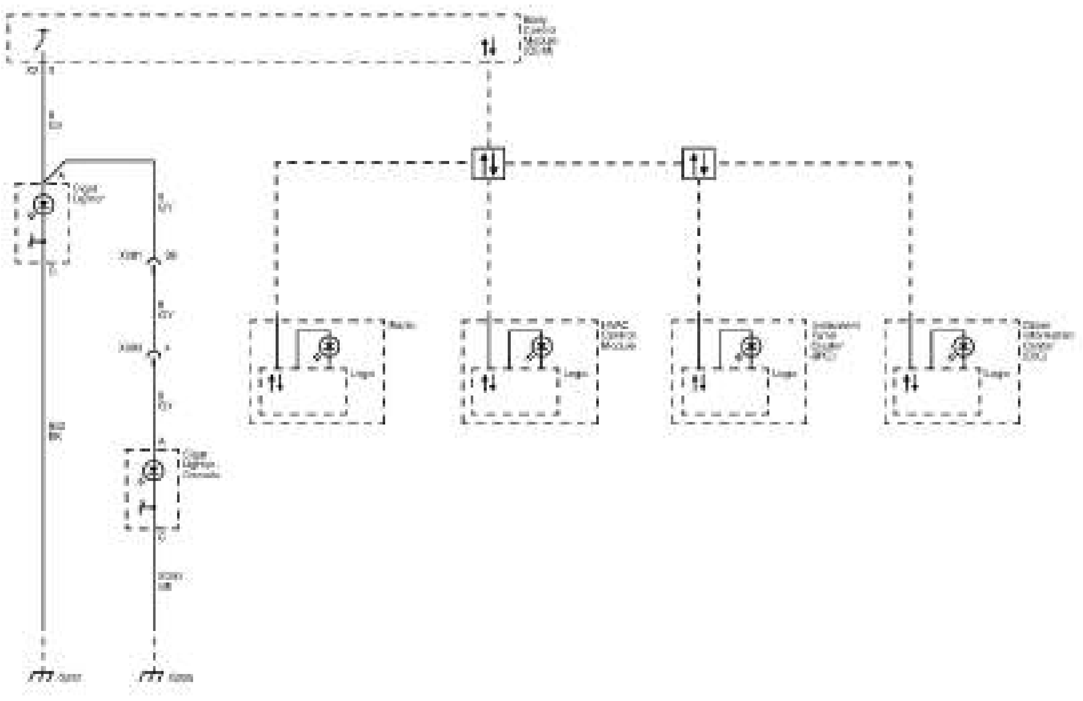
Headlamps 9C1



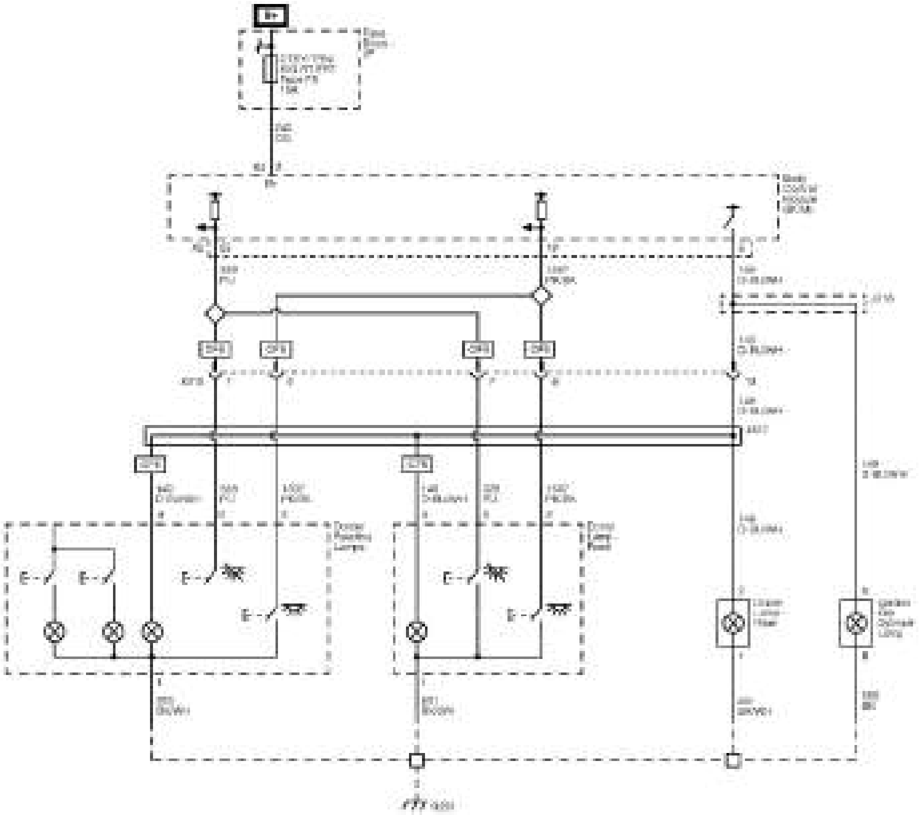
Dimming Control and LED Dimming 1 of 2



LED Dimming 2 of 2


Body Control Module (BCM)
Radio
Logic
HVAC Control Module
Logic
Logic
Logic

Courtesy Lamps



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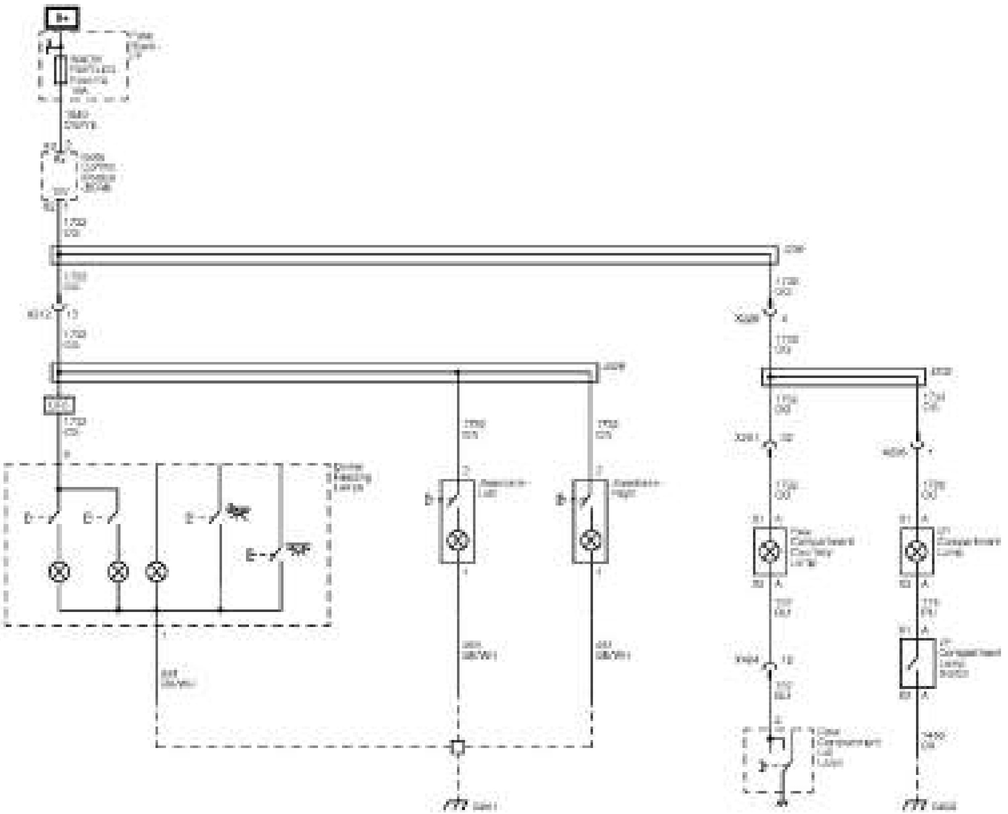
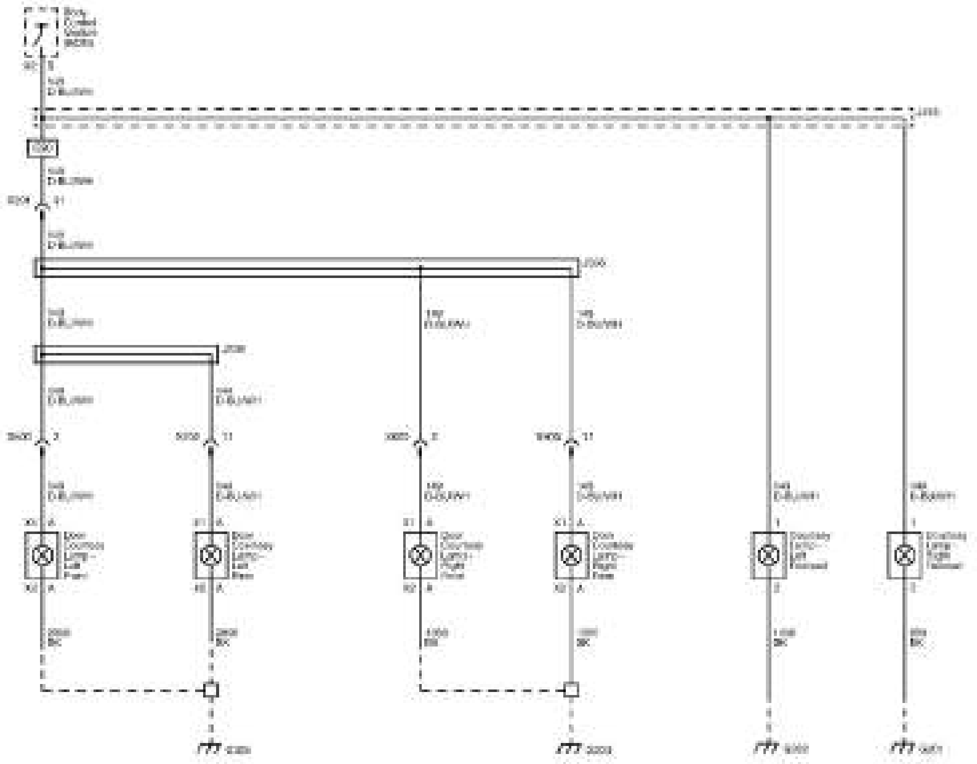
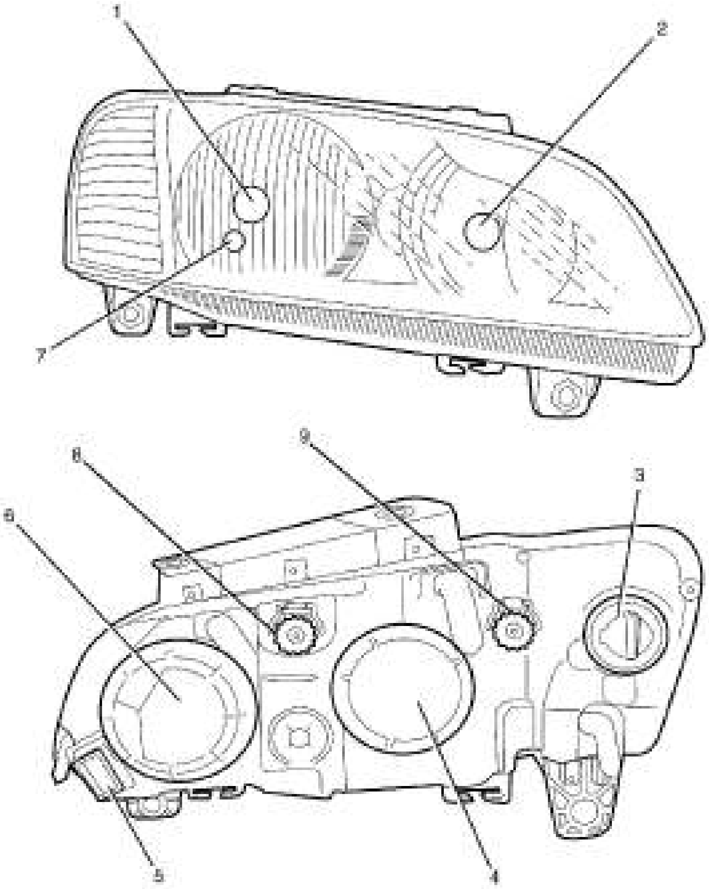
Inadvertent Lamps - 1 of 2



Inadvertent Lamps - 2 of 2

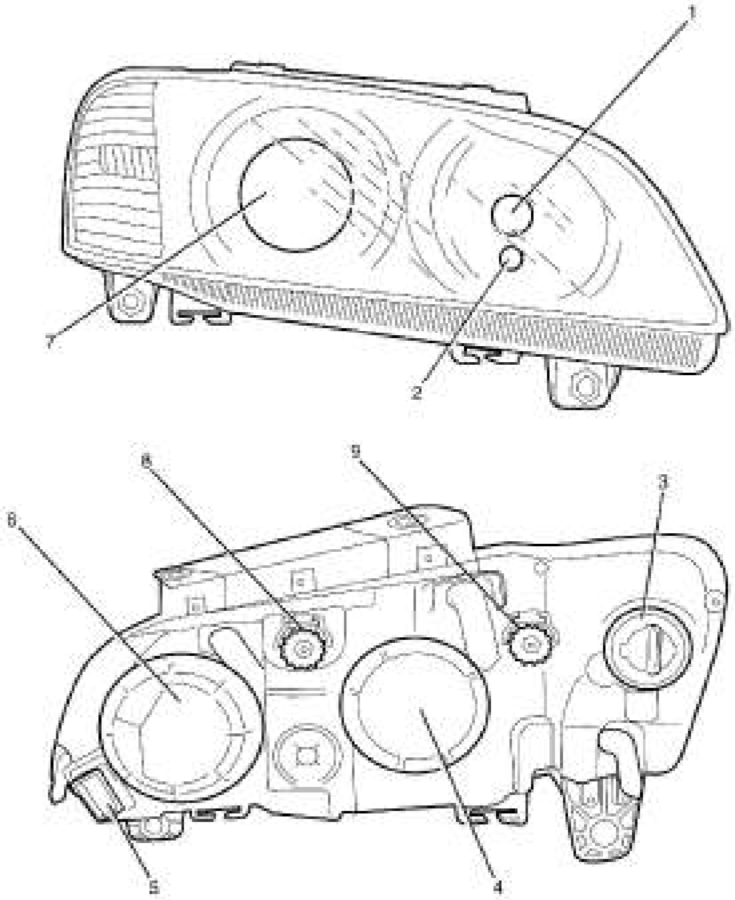

Body Control Module (BCM)
Door Courtesy Lamp - Left Front
Door Courtesy Lamp - Left Rear
Door Courtesy Lamp - Right Front
Door Courtesy Lamp - Right Rear
BK
BK
BK
BK
BK
BK

Type A Headlamp



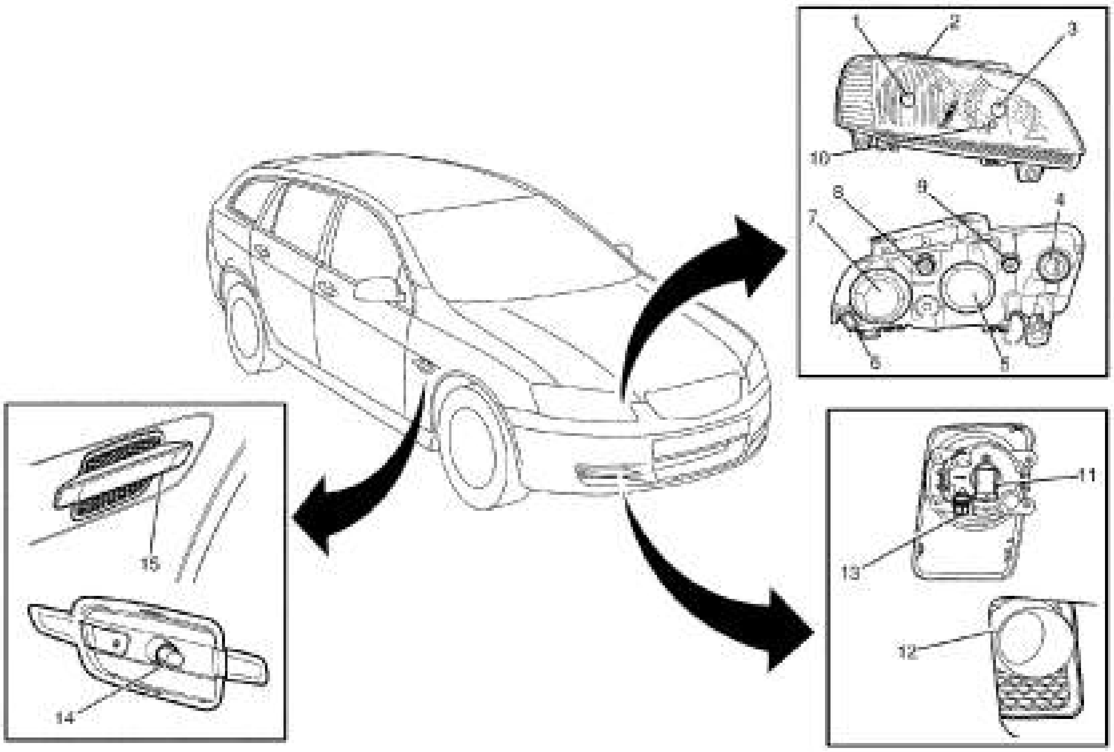
(1) Low Beam Bulb
(2) High Beam Bulb
(3) Front Indicator Socket
(4) Low Beam Dust Cover
(5) Electrical Connector
(6) High Beam Dust Cover
(7) Park Bulb
(8) Inboard Adjuster
(9) Outboard Adjuster

Type B Headlamp



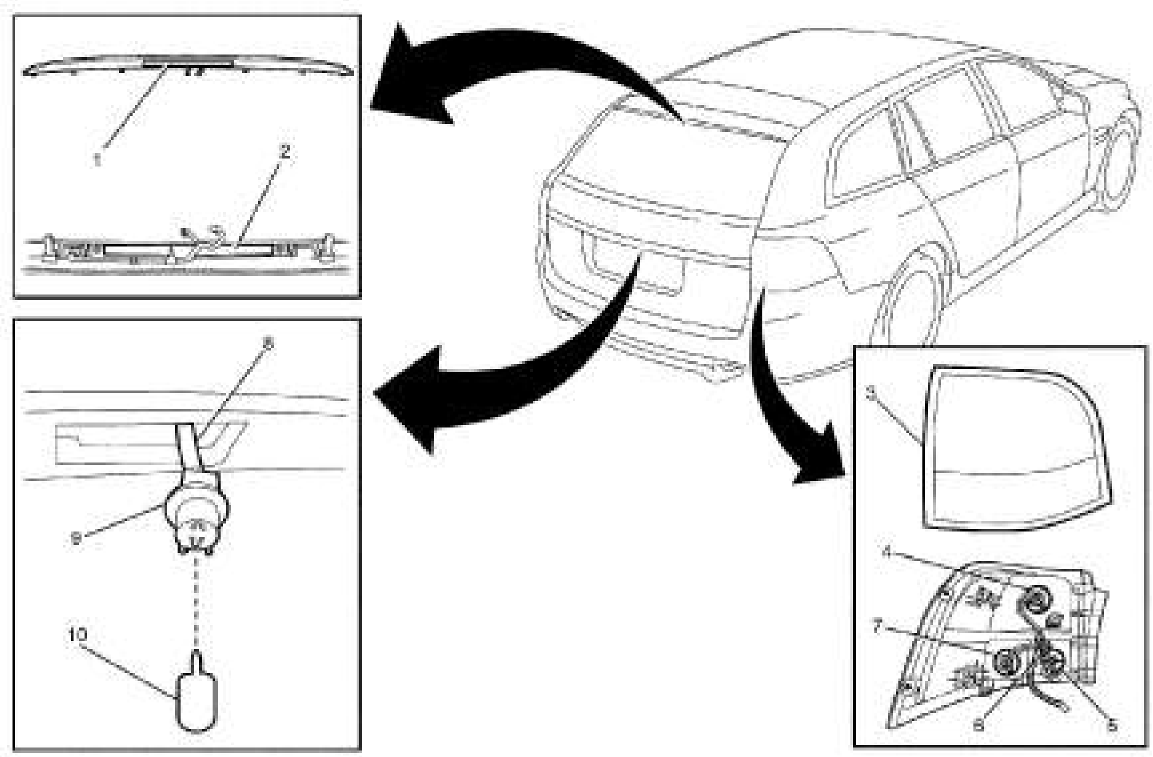
(1) Low Beam Bulb
(2) High Beam Bulb
(3) Front Indicator Socket
(4) Low Beam Dust Cover
(5) Electrical Connector
(6) High Beam Dust Cover
(7) Park Bulb
(8) Inboard Adjuster
(9) Outboard Adjuster

Exterior Lamps - Front View



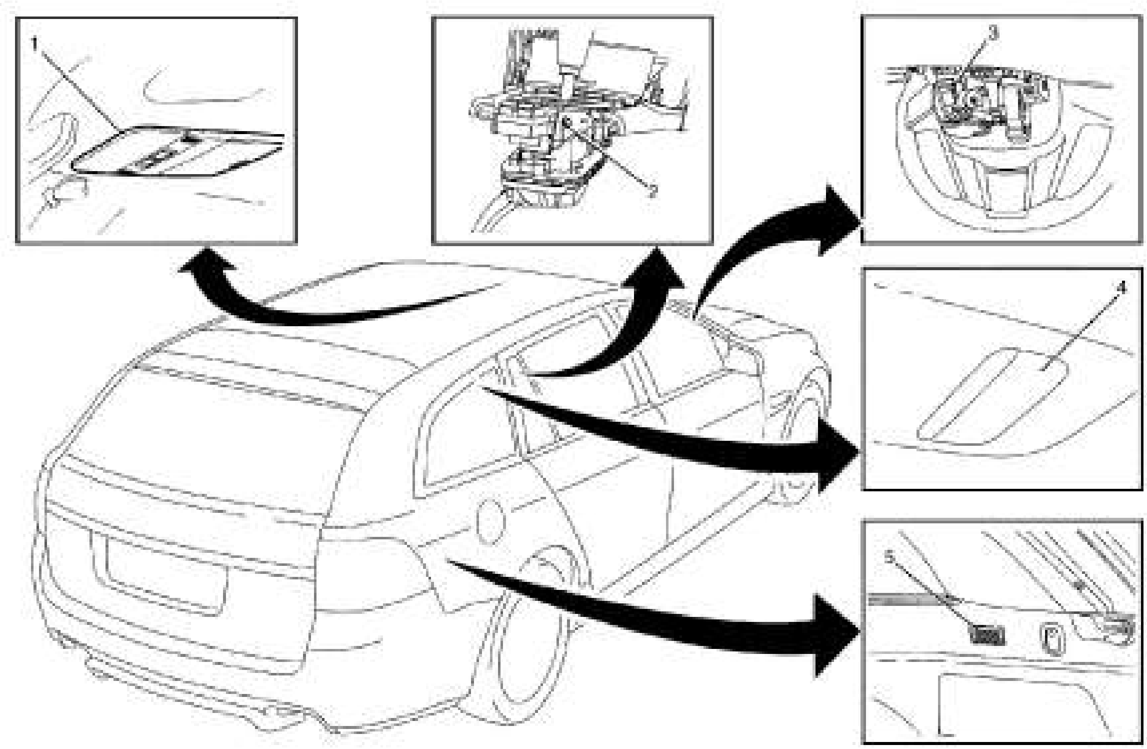
(1) Low Beam Bulb
(2) Headlamp Assembly
(3) High Beam Bulb
(4) Front Indicator Bulb
(5) Low Beam Bulb Dust Cover
(6) Headlamp Assembly Electrical Connector
(7) High Beam Bulb Dust Cover
(8) Inboard Headlamp Adjuster
(9) Outboard Headlamp Adjuster
(10) Park Lamp Bulb
(11) Fog Lamp Bulb
(12) Fog Lamp Assembly
(13) Fog Lamp Adjuster
(14) Repeater Lamp Bulb
(15) Repeater Lamp Assembly

Exterior Lamps - Rear View



(1) High Mounted Stop Lamp
(2) High Mounted Stop Lamp Light Emitting Diode (LED) Assembly
(3) Tail Lamp Assembly
(4) Stop/Tail Lamp Bulb
(5) Backup Lamp Bulb
(6) Tail Lamp Assembly Electrical Connector
(7) Rear Indicator Lamp Bulb
(8) License Lamp Bulb
(9) License Lamp

Interior Lamps



(1) Dome Lamp
(2) Transmission Floor Shift Control Indicator Lamp
(3) Ignition Lock Cylinder Lamp
(4) Interior Courtesy Lamp
(5) Rear Compartment Courtesy Lamp

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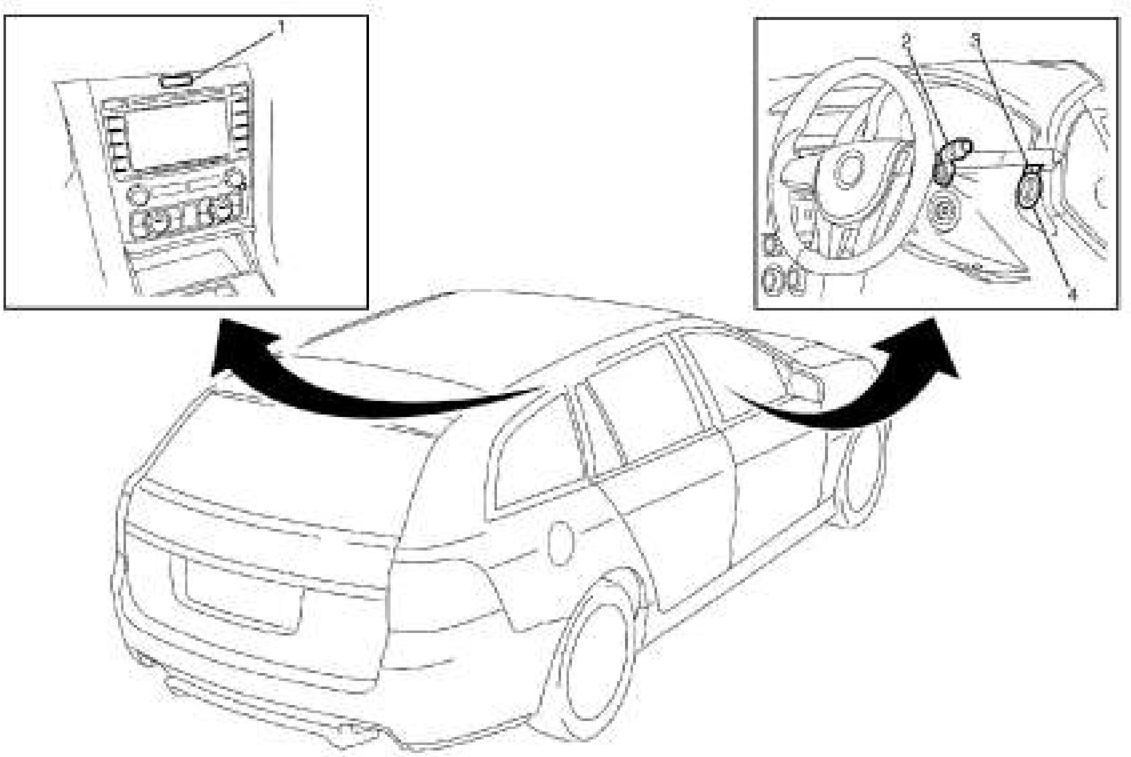
Lamp Switches



(1) Hazard Warning Switch
(2) Turn Signal Switch
(3) Instrument Panel Dimmer Switch
(4) Headlamp Switch

Diagnostic Starting Point - Lighting

Begin the system diagnosis with the Diagnostic System Check - Vehicle. The Diagnostic System Check - Vehicle will provide the following information:

- The identification of the control modules which command the system
- The ability of the control modules to communicate through the serial data circuit
- The identification of any stored diagnostic trouble codes (DTCs) and their status

The Use of the Diagnostic System Check - Vehicle will identify the correct procedure for diagnosing the system and where the procedure is located.

DTC B0970

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B0970 00: Hazard Warning Switch Stuck

Circuit / System Description

The hazard flashers may be activated in any power mode. The hazard switch is integrated into the driver information display panel. When the hazard switch is placed in the ON position, the radio communicates via serial data with the body control module (BCM) requesting the hazard lamps be activated. The BCM supplies battery voltage to all four turn signal lamps in an ON and OFF duty cycle. When the hazard switch is activated, the BCM sends a serial data message to the instrument panel cluster (IPC) requesting both turn signal indicators to be cycled ON and OFF.

Conditions for Running the DTC

Battery voltage must be between 9-16 volts.

Conditions for Setting the DTC

The radio detects the hazard switch is held in the ON position for greater that 60 seconds.

Actions Taken When the DTC Sets

Hazard lamps are always ON.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Hazards parameter while pressing and depressing the hazard switch. The parameter should change between Active and Inactive.

> If the parameter changes as the switch is activated, replace the radio.
>
> If the parameter does not change as the switch is activated, replace the driver information display.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Driver Information Display Replacement
- Control Module References for radio replacement, setup, and programming

DTC B2530

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B2530 00: Front Fog Lamps Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fog Lamp Relay B+	--	1	1	--
Fog Lamp Switch Signal	2	2	2	--
Fog Lamp Relay Control	1	1	B2530 00	--
Fog Lamp Control	1	1	1	--
Fog Lamp - LF Ground	--	1	--	--
Fog Lamp - RF Ground	--	1	--	--
Fog Lamp Switch Ground	--	2	--	--
1. Front Fog Lamps Malfunction 2. Front Fog Lamp Switch Malfunction				

Circuit/System Description

The fog lamp relay is supplied with battery voltage at all times. The fog lamp switch signal circuit is grounded momentarily by pressing the fog lamp switch. The body control module (BCM) energizes the fog lamp relay by applying ground to the fog lamp relay control circuit. When the fog lamp relay is energized, the relay switch contacts close and battery voltage is applied through the FOG LAMP fuse to the fog lamp supply voltage circuit which illuminates the fog lamps.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.

- Fog lamps ON.

Conditions for Setting the DTC

The BCM detects a short to voltage in the fog lamp relay control circuit.

Actions Taken When the DTC Sets

The front fog lamps will not operate when the park lamps are ON and the fog lamp switch is active.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Fog Lights Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the fog lamp relay.
2. Connect a test lamp between the B+ circuit terminal 86 and the control circuit terminal 85.
3. Command the Front Fog Light Test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.

4. If all circuits test normal, test or replace the fog lamp relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Underhood Electrical Center or Junction Block Replacement
- Relay Replacement
- Control Module References for BCM replacement, setup, and programming

DTC B2545

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B2545 00: Backup Lamps Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Backup Lamp Relay B+	1	1	--	--
Backup Lamp Relay Control	1	1	B2545 00	--
Backup Lamps Control	1	1	1	--
Backup Lamp Ground - Left	--	1	--	--
Backup Lamp Ground - Right	--	1	--	--
1. Backup Lamps Malfunction				

Circuit/System Description

When the transmission is placed in the REVERSE position, the transmission control module (TCM) sends a serial data message to the body control module (BCM). The message indicates that the gear selector is in the REVERSE position. The BCM applies ground to the backup lamp relay control circuit energizing the backup lamp relay coil. With the relay coil energized, the switch contacts close allowing battery voltage to flow from the BACKUP LP fuse to the left and right backup lamps. Once the driver moves the gear selector out of the REVERSE position, a message is sent by the TCM via serial data requesting the BCM to remove ground from the backup lamp relay control circuit.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Backup lamps commanded ON.

Conditions for Setting the DTC

DTC B2545 00 will set when the BCM detects a short to voltage in the backup lamp relay control circuit.

Actions Taken When the DTC Sets

When DTC B2545 00 is present, the backup lamps will not operate.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the backup lamp relay.
2. Connect a test lamp between the B+ circuit terminal 85 and the control circuit terminal 86.
3. Command the Reverse Light Test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

    If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.

4. If all circuits test normal, test or replace the backup lamp relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Underhood Electrical Center or Junction Block Replacement
- Relay Replacement
- Control Module References for BCM replacement, setup, and programming

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DTC B2555

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B2555 00: Pass Compartment Lamp Control Circuit

Diagnostic Fault Information

Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.

Circuit/System Description

The courtesy lamp fuse supplies battery voltage to the body control module (BCM). The BCM applies battery voltage to the courtesy lamps through the courtesy lamp supply voltage circuit. The courtesy lamps are triggered by the door switch, a door lock/unlock command a momentary switch located next to the centre interior light. The lamps are controlled by the BCM. When any door is opened, the door switch contacts close sending the BCM a door-open input, or if the BCM receives a door lock or unlock input, the BCM will activate the courtesy lamp supply voltage circuit, providing battery voltage to the interior lights.

Conditions for Running the DTC

Battery voltage must be between 9-16 volts.

Conditions for Setting the DTC

The BCM detects an open or short to voltage in the courtesy light control circuit.

Action Taken When the DTC Sets

When DTC B2555 is present, the courtesy lamps will only operate manually from the momentary switch.

Conditions for Clearing the DTC

- The conditions for setting the DTC are no longer present.
- The history DTC clears after 40 fault-free ignition cycles.
- The DTC can be cleared using a scan tool.

Reference Information

Schematic Reference

Interior Lights Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Verification

Ensure all the doors are closed, lock and unlock the doors. The courtesy lights should illuminate and deactivate as the doors are unlocked and locked.

Circuit/System Testing

1. Disconnect the courtesy lamp harness connector at the courtesy lamp.
2. Connect a test lamp between the courtesy lamp control circuit and a known ground at the courtesy harness connector.

   Activate and deactivate the momentary switch the test lamp should illuminate and deactivate as the switch is operated.

   If the test lamp does not illuminate and deactivate, with all doors closed, open and close the drivers door. The test lamp should illuminate and deactivate as the door is opened and closed.

   If the test lamp does not illuminate and deactivate on either circuit, locate and repair an open/high resistance or short to voltage in the control circuit.
3. If circuits test OK, replace the BCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for BCM replacement, setup and programming.

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DTC B2575

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B2575 00: Headlamp Low Beam Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Flash to Pass Switch Signal	1	1	1	--
Headlamp Switch High Beam Signal	1	1	1	--
Headlamp Switch Headlamps ON Signal	B257A 00	1	1	--
Headlamp Switch Headlamps OFF Signal	B257A 00	1	1	--
Park Lamp Switch ON Signal	2	B257A 00	2	--
Headlamp High Beam Relay Control	1	1	B2580 00	--
Headlamp Low Beam Relay Control	1	1	B2575 00	--
LF High Beam Headlamp Control	1	1	1	--
LF Low Beam Headlamp Control	1	1	1	--
RF High Beam Headlamp Control	1	1	1	--
RF Low Beam Headlamp Control	1	1	1	--
LF Headlamp Ground	--	1	--	--
RF Headlamp Ground	--	1	--	--
Headlamp and Panel Dimmer Switch Ground	--	1	--	--
Turn Signal/Multifunction Switch Ground	--	1	--	--

1. Headlamps Malfunction

2. Park, License, and/or Tail Lamps Malfunction

Circuit/System Description

When the headlamp and panel dimmer switch is placed in the headlamp position, ground is applied to the body control module (BCM) through the headlamp low beam signal circuit. The BCM then applies ground to the headlamp low beam relay control circuit which energizes the low beam relay. With the low beam relay energized, the switch contacts close allowing battery voltage to flow through the LO BEAM fuses to the low beam headlamps. Ground for the low beam headlamps is supplied at ground G102.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Headlamps ON.

Conditions for Setting the DTC

DTC B2575 00 will set when the BCM detects a short to voltage in the headlamp low beam relay control circuit.

Actions Taken When the DTC Sets

When DTC B2575 00 is present, the low beam headlamps will not operate.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing

- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the low beam relay.
2. Connect a test lamp between the control circuit terminal 85 and the B+ circuit terminal 86.
3. Command the Front Low Beam Test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test the control circuit for a short to voltage or open/high resistance. If the circuit tests normal, replace the BCM.
4. If all circuits test normal, test or replace the low beam relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Underhood Electrical Center or Junction Block Replacement
- Relay Replacement
- Control Module References for BCM replacement, setup, and programming

DTC B257A

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B257A 00: Headlamp Switch Input Signal Mismatch

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Flash to Pass Switch Signal	1	1	1	--
Headlamp Switch High Beam Signal	1	1	1	--
Headlamp Switch Headlamps ON Signal	B257A 00	1	1	--
Headlamp Switch Headlamps OFF Signal	B257A 00	1	1	--
Park Lamp Switch ON Signal	2	B257A 00	2	--
Headlamp High Beam Relay Control	1	1	B2580 00	--
Headlamp Low Beam Relay Control	1	1	B2575 00	--
LF High Beam Headlamp Control	1	1	1	--
LF Low Beam Headlamp Control	1	1	1	--
RF High Beam Headlamp Control	1	1	1	--
RF Low Beam Headlamp Control	1	1	1	--
LF Headlamp Ground	--	1	--	--
RF Headlamp Ground	--	1	--	--
Headlamp and Panel Dimmer Switch Ground	--	1	--	--
Turn Signal/Multifunction Switch Ground	--	1	--	--

1. Headlamps Malfunction

2. Park, License, and/or Tail Lamps Malfunction

Circuit/System Description

The body control module (BCM) supplies a B+ reference voltage through each of the headlamp switch signal circuits to the headlamp switch. When the headlamp switch is in the AUTO position, all headlamp switch signal circuits to the BCM are open and the BCM operates in the automatic mode. When the headlamp switch is turned to the PARK position, only the park lamp switch signal circuit is pulled low signaling the BCM park lamps ON request. When the headlamp switch is turned to the HEAD position, the park lamp and headlamp switch signal circuits are both pulled low, signaling the BCM the headlamps ON request. When the headlamp switch is turned to the OFF position, only the headlamp OFF switch signal circuit is pulled low, signaling the BCM the lights off request.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Headlamp and panel dimmer switch cycled between the AUTO, PARK, HEAD, and OFF positions.

Conditions for Setting the DTC

The BCM receives a mismatch signal between the headlamps OFF signal circuit, the headlamps ON signal circuit, and the park lamps ON signal circuit.

Action Taken When the DTC Sets

The BCM disregards the headlamp switch input and defaults to automatic headlamp function.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Testing

1. Ignition OFF, disconnect the harness connector at the headlamp and panel dimmer switch.
2. Ignition ON, verify the scan tool Headlamp Switch parameter is Off.

   If not the specified value, test the signal circuit terminal 1 for short to ground. If the circuit tests normal, replace the BCM.
3. Verify the scan tool Auto Headlamp Disable Switch parameter is Inactive.

   If not the specified value, test the signal circuit terminal 3 for short to ground. If the circuit tests normal, replace the BCM.
4. Verify the scan tool Park Lamp Switch parameter is Off.

   If not the specified value, test the signal circuit terminal 5 for short to ground. If the circuit tests normal, replace the BCM.
5. Install a 3A fused jumper wire between the signal circuit terminal 1 and ground. Verify the scan tool Headlamp Switch parameter is On.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuits test normal replace the BCM.
6. Install a 3A fused jumper wire between the signal circuit terminal 3 and ground. Verify the scan tool Auto Headlamp Disable Switch parameter is Active.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
7. Install a 3A fused jumper wire between the signal circuit terminal 5 and ground. Verify the scan tool Park Lamp Switch parameter is On.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
8. If all circuits test normal, test or replace the headlamp and panel dimmer switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Headlamp Switch Replacement
- Control Module References for BCM replacement, setup, and programming

DTC B2580

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B2580 00: Headlamp High Beam Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Flash to Pass Switch Signal	1	1	1	--
Headlamp Switch High Beam Signal	1	1	1	--
Headlamp Switch Headlamps ON Signal	B257A 00	1	1	--
Headlamp Switch Headlamps OFF Signal	B257A 00	1	1	--
Park Lamp Switch ON Signal	2	B257A 00	2	--
Headlamp High Beam Relay Control	1	1	B2580 00	--
Headlamp Low Beam Relay Control	1	1	B2575 00	--
LF High Beam Headlamp Control	1	1	1	--
LF Low Beam Headlamp Control	1	1	1	--
RF High Beam Headlamp Control	1	1	1	--
RF Low Beam Headlamp Control	1	1	1	--
LF Headlamp Ground	--	1	--	--
RF Headlamp Ground	--	1	--	--
Headlamp and Panel Dimmer Switch Ground	--	1	--	--
Turn Signal/Multifunction Switch Ground	--	1	--	--
1. Headlamps Malfunction				

2. Park, License, and/or Tail Lamps Malfunction

Circuit/System Description

When the turn signal/multifunction switch is placed in the headlamps high or flash to pass (FTP) position, ground is applied to the body control module (BCM) through the headlamp high beam signal circuit or the flash to pass switch signal circuit. The BCM applies ground to the headlamp high beam relay control circuit which energizes the high beam relay. With the high beam relay energized, the switch contacts close allowing battery voltage to flow through the HI BEAM fuses to the high beam headlamps. Ground for the high beam headlamps is supplied at ground G104.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- High beam headlamps ON.

Conditions for Setting the DTC

DTC B2580 00 will set when the BCM detects a short to voltage in the headlamp high beam relay control circuit.

Actions Taken When the DTC Sets

When DTC B2580 00 is present, the high beam headlamps and flash to pass (FTP) will not operate.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing

- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the high beam relay.
2. Connect a test lamp between the control circuit terminal 85 and the B+ circuit terminal 86.
3. Command the High Beams ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test the control circuit for a short to voltage or open/high resistance. If the circuit tests normal, replace the BCM.
4. If all circuits test normal, test or replace the high beam relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Underhood Electrical Center or Junction Block Replacement
- Relay Replacement
- Control Module References for BCM replacement, setup, and programming

DTC B2585

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B2585 00: Park Lamp Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Park Lamp Relay B+	1	1	--	--
Park Lamp Switch ON Signal	1	B257A 00	1	--
Park Lamp Relay Control	1	1	B2585 00	--
License Lamp Control	1	1	1	--
Park Lamp Control	1	1	1	--
License Lamp Ground	--	1	--	--
Park Lamps - LF Ground	--	1	--	--
Park Lamps - RF Ground	--	1	--	--
Side Marker Lamp - Left Rear Ground	--	1	--	--
Side Marker Lamp - Right Rear Ground	--	1	--	--
Tail/Stop Lamp - Left Ground	--	1	--	--
Tail/Stop Lamp - Right Ground	--	1	--	--
Headlamp And Panel Dimmer Switch Ground	--	1	--	--
1. Park, License, and/or Tail Lamps Malfunction				

Circuit/System Description

Battery voltage is applied at all times to both the coil and switch sides of the PRK LAMP relay located in the underhood fuse block. The headlamp and panel dimmer switch is suppled with ground at G201 at all times. When the headlamp switch is placed in either the HEAD or PARK position, ground is applied to the park lamp signal circuit to the body control module (BCM). The

BCM responds by applying ground to the park lamp relay control circuit. This energizes the park lamp relay coil causing the relay switch contacts to close allowing battery voltage to flow through the LT PRK and RT PRK fuses to all of the park, tail, and license lamps.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Park lamps ON.

Conditions for Setting the DTC

DTC B2585 00 will set when the BCM detects a short to voltage in the park lamp relay control circuit.

Actions Taken When the DTC Sets

When DTC B2585 00 is present, the park lamps will not operate.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the park lamp relay.
2. Connect a test lamp between the control circuit terminal 85 and the B+ circuit terminal 86.
3. Command the Parking Light Test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
4. If all circuits test normal, test or replace the park lamp relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Underhood Electrical Center or Junction Block Replacement
- Relay Replacement
- Control Module References for BCM replacement, setup, and programming

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DTC B2610

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B2610 00 : Passenger Compartment Dimming 1 Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
INADV/PWR/LED Fuse B+ Terminal 2 X3	1	1	--	--
Panel Dimmer Switch DIM Up Signal	2	2	2	--
Panel Dimmer Switch DIM Down Signal	2	2	2	--
Incandescent Backlight Dimming Control Terminal 3 X2	1	1	1	--
LED Backlight Dimming Control Terminal 18 X3	B2610 00	1	1	--
LED Backlight Dimming Control Terminal 25 X3	B2625 00	1	1	--
Automatic Transmission Shift Lever Ground	--	1	--	--
Cigar Lighter Console Ground	--	1	--	--
Cigar Lighter Front Ground	--	1	--	--
Dome/Reading Lamps Ground	--	1	--	--
Door Lock/Window Switch Ground	--	1	--	--
Headlamp and Panel Dimmer Switch Ground	--	2	--	--
Multifunction Switch - Center Console Ground	--	1	--	--
Steering Wheel Control Switch Ground	--	1	--	--

1. Interior Backlighting Malfunction

2. Dimmer Switch Malfunction

Circuit/System Description

The up/down dimmer controls located on the headlamp and panel dimmer switch is used to increase and decrease the brightness of the interior backlighting components. Each dimmer control switch provides a voltage signal that will increase as the brightness of the lights are increased and decrease as the brightness of the lights are decreased. The body control module (BCM) supplies each dimmer control switch with a signal circuit. When either the up or down dimmer control switch is placed in the desired position, the dimmed voltage setting is applied from the appropriate dimmer control switch through the dimmer switch signal circuit to the BCM. The BCM interprets the signal and applies the dimmed voltage to the LED backlight dimming control circuit and the interior backlighting components dim to the requested level.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Park lamps ON.

Conditions for Setting the DTC

DTC B2610 00 will set when the BCM detects a short to ground in the LED backlight dimming control circuit.

Actions Taken When the DTC Sets

The BCM will not dim or illuminate any indicators supplied by the LED backlight dimming control circuit.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Interior Lights Dimming Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. With a scan tool clear the DTC.
2. Ignition OFF, disconnect the harness connectors at the following components.
    - Door lock/window switch
    - Headlamp and panel dimmer switch
    - Steering wheel controls
    - Multifunction switch - center console
    - Automatic transmission shift lever
    - Dome/reading lamps - front
    - Dome/reading lamps - rear
3. Operate the vehicle within the conditions for running the DTC and verify the DTC does not reset.

    If the DTC resets, test the control circuit terminal 18 X3 for a short to ground. If the circuits test normal, replace the BCM.
4. Reconnect each component one at a time and verify the DTC does not reset as current.

    If the DTC resets as current, test or replace the component responsible for setting the DTC.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Headlamp Switch Replacement
- Cigar Lighter Receptacle or 12-Volt Accessory Power Receptacle Replacement
- Power Mirror Switch Replacement
- Control Module References for BCM replacement, setup, and programming

DTC B2615

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B2615 00 : Passenger Compartment Dimming 2 Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
CTSY/TRN SIG RT FRT Fuse B+ Terminal 2 X4	B2615 00	B2615 00	--	--
Courtesy Lamps Control	B2615 00	B2615 00	B2615 00	--

Circuit/System Description

The body control module (BCM) applies battery voltage to the courtesy lamps through the courtesy lamp control circuit. When any door is opened, the jam switch contacts close and the BCM receives a door-ajar input. If the BCM receives a door lock or unlock input or a rear hatch open input, the BCM will activate the courtesy lamp control circuit, providing battery voltage to all of the instrument panel (I/P) courtesy lamps, rearview mirror lamps, and rear compartment lamps. In the event that any of these lamps were to remain illuminated for more than 20 minutes with the ignition switch in the OFF position, the BCM will deactivate the inadvertent power courtesy lamp control circuit to prevent a total battery discharge condition.

Conditions for Running the DTC

Battery voltage must be between 9-16 volts.

Conditions for Setting the DTC

DTC B2615 00 will set for the following conditions:

- The BCM detects a short to voltage, short to ground, or an open/high resistance in the courtesy lamps control circuit.
- The BCM detects a short to ground or an open/high resistance in the CTSY/TRN SIG RT FRT fuse B+ circuit terminal 2 X4.

Actions Taken When the DTC Sets

The BCM will not illuminate any courtesy lamps supplied by the courtesy lamps control circuit.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Interior Lights Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X4 harness connector at the BCM.
2. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 2 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Ignition OFF, connect the X4 harness connector at the BCM.
4. Disconnect the harness connectors at the following components.
   - Dome/reading lamp - front
   - Dome/reading lamp - rear
   - Ignition key cylinder lamp
   - Courtesy lamp - left footwell
   - Courtesy lamp - right footwell
   - Courtesy lamp - LF door

  - Courtesy lamp - LR door
  - Courtesy lamp - RF door
  - Courtesy lamp - RR door
5. Connect a test lamp between each control circuit terminal listed below and ground.
   - Dome/reading lamp - front terminal 4
   - Dome/reading lamp - rear terminal 2
   - Ignition key cylinder lamp terminal A
   - Courtesy lamp - left footwell terminal 1
   - Courtesy lamp - right footwell terminal 1
   - Courtesy lamp - LF door terminal A
   - Courtesy lamp - LR door terminal A
   - Courtesy lamp - RF door terminal A
   - Courtesy lamp - RR door terminal A
6. Command the Interior Lamp Test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
7. Reconnect each component one at a time and verify the DTC does not reset as current.

   If the DTC resets as current, test or replace the component responsible for setting the DTC.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Ignition Lock Cylinder Bulb Replacement
- Console Lamp Replacement
- Dome Lamp Replacement
- Vanity Mirror Lamp Replacement
- Rear Compartment Courtesy Lamp Replacement
- Instrument Panel Compartment Lamp Replacement
- Instrument Panel Compartment Lamp Switch Replacement
- Door Courtesy Lamp and Reflector Replacement
- Control Module References for BCM replacement, setup, and programming.

DTC B2625

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B2625 00 : Display Dimming Pulse Width Modulation (PWM) Output Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
INADV/PWR/LED Fuse B+ Terminal 2 X3	1	1	--	--
Panel Dimmer Switch DIM Up Signal	1	1	1	--
Panel Dimmer Switch DIM Down Signal	1	1	1	--
Incandescent Backlight Dimming Control Terminal 3 X2	1	1	1	--
LED Backlight Dimming Control Terminal 18 X3	B2610 00	1	1	--
LED Backlight Dimming Control Terminal 25 X3	B2625 00	1	1	--
Automatic Transmission Shift Lever Ground	--	1	--	--
Cigar Lighter Console Ground	--	1	--	--
Cigar Lighter Front Ground	--	1	--	--
Dome/Reading Lamps Ground	--	1	--	--
Door Lock/Window Switch Ground	--	1	--	--
Headlamp and Panel Dimmer Switch Ground	--	1	--	--
Multifunction Switch - Center Console Ground	--	1	--	--
Steering Wheel Control Switch Ground	--	1	--	--
1. Interior Backlighting Malfunction				

Circuit/System Description

The up/down dimmer controls located on the headlamp and panel dimmer switch is used to increase and decrease the brightness of the interior backlighting components. Each dimmer control switch provides a voltage signal that will increase as the brightness of the lights are increased and decrease as the brightness of the lights are decreased. The body control module (BCM) supplies each dimmer control switch with a signal circuit. When either the up or down dimmer control switch is placed in the desired position, the dimmed voltage setting is applied from the appropriate dimmer control switch through the dimmer switch signal circuit to the BCM. The BCM interprets the signal and applies the dimmed voltage to the LED backlight dimming control circuits and the interior backlighting components dim to the requested level.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Park lamps ON.

Conditions for Setting the DTC

The BCM detects a short to ground in the LED backlight dimming control circuit terminal 25 X3.

Actions Taken When the DTC Sets

The BCM will not dim or illuminate any indicators supplied by the LED backlight dimming control circuit terminal 25 X3.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing

- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X2 harness connector at the center console multifunction switch.
2. Ignition ON, park lamps ON, test for B+ between the control circuit terminal 5 and ground.

   If not the specified value, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
3. If all circuits test normal, test or replace the center console multifunction switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for BCM replacement, setup, and programming

DTC B2645

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B2645 03: Ambient Light Sensor Circuit Voltage Below Threshold

DTC B2645 07: Ambient Light Sensor Circuit Voltage Above Threshold

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ambient Light Senor Signal	B2645 03	B2645 07	B2645 07	--
Headlamp- Left Low Beam Control	1	1	1	--
Headlamp- Right Low Beam Control	1	1	1	--
Ambient Light Sensor Low Reference - with LHD	--	B2645 07	B2645 07	--
Ambient Light Sensor Ground	--	B2645 07	2	--
Headlamp- Right Low Beam Ground	--	1	--	--
Headlamp- Right Low Beam Ground	--	1	--	--
1. Headlamps Malfunction 2. Daytime Running Lamps Malfunction				

Circuit/System Description

With Manual HVAC

The ambient light sensor is used to monitor outside lighting conditions. The ambient light sensor provides a voltage signal that will vary between 0.2 and 4.9 volts depending on outside lighting conditions. The body control module (BCM) provides a 5-volt reference signal to the ambient light sensor which is permanently grounded at G201. The BCM monitors the ambient light sensor signal circuit to determine if outside lighting conditions are correct for either daytime running lights (DRL) or automatic lamp control (ALC) when the headlamp switch is in the AUTO position. In daylight conditions the BCM will command the DRLs ON. The DRLs consists on the low beam headlamps illuminated at full intensity. During low light conditions the BCM will command the low beam headlamps ON. Any function or condition that turns on the headlamps will cancel DRL operation.

LHD With Automatic HVAC

The ambient light/sun load sensor is used to monitor outside lighting conditions. The ambient light sensor provides a voltage signal that will vary between 0.2 and 4.9 volts depending on outside lighting conditions. The body control module (BCM) provides a 5-volt reference signal to the ambient light sensor and the HVAC control module provides a low reference ground. The BCM monitors the ambient light sensor signal circuit to determine if outside lighting conditions are correct for either daytime running lights (DRL) or automatic lamp control (ALC) when the headlamp switch is in the AUTO position. In daylight conditions the BCM will command the DRLs ON. The DRLs consists on the low beam headlamps illuminated at full intensity. During low light conditions the BCM will command the low beam headlamps ON. Any function or condition that turns on the headlamps will cancel DRL operation.

RHD With Automatic HVAC

The ambient light/sun load sensor is used to monitor outside lighting conditions. The ambient light sensor provides a voltage signal that will vary between 0.2 and 4.9 volts depending on outside lighting conditions. The body control module (BCM) provides a 5-volt reference signal to the ambient light sensor which is permanently grounded at G201. The BCM monitors the ambient light sensor signal circuit to determine if outside lighting conditions are correct for either daytime running lights (DRL) or automatic lamp control (ALC) when the headlamp switch is in the AUTO position. In daylight conditions the BCM will command the DRLs ON. The DRLs consists on the low beam headlamps illuminated at full intensity. During low light conditions the BCM will command the low beam headlamps ON. Any function or condition that turns on the headlamps will cancel DRL operation.

Conditions for Running the DTC

Battery voltage must be between 9-16 volts.

Conditions for Setting the DTC

B2645 03

The BCM detects a short to ground in the ambient light sensor signal circuit.

B2645 07

The BCM detects a short to voltage or an open/high resistance in the ambient light sensor signal circuit.

Actions Taken When the DTC Sets

- Automatic lamp control (ALC) is inoperative.
- The BCM defaults to low light status and commands the low beam headlamps ON.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

With Manual HVAC

1. Ignition OFF, disconnect the harness connector at the ambient light sensor.
2. Ignition OFF, scan tool OFF, test for less than 1 ohm between the ground circuit terminal B and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Ambient Light Sensor parameter is greater than 4.65 volts.

   If less than the specified range, test the signal circuit terminal A for a short to ground. If the circuit tests normal, replace the BCM.
4. Install a 3 A fused jumper wire between the signal circuit terminal A and the ground circuit terminal B. Verify the scan tool Ambient Light Sensor parameter is less than 0.196 volts.

   If greater than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, replace the ambient light sensor.

With Automatic HVAC - LHD

1. Ignition OFF, disconnect the harness connector at the sunload sensor.
2. Ignition ON, verify that a test lamp illuminates between the low reference circuit terminal C and B+.

   If the test lamp does not illuminate, test the low reference circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the HVAC control module.
3. Ignition ON, verify the scan tool Ambient Light Sensor parameter is greater than 4.65 volts.

   If less than the specified range, test the signal circuit terminal D for a short to ground. If the circuit tests normal, replace the BCM.
4. Install a 3 A fused jumper wire between the signal circuit terminal D and the low reference circuit terminal C. Verify the scan tool Ambient Light Sensor parameter is less than 0.196 volts.

   If greater than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, replace the sunload sensor assembly.

With Automatic HVAC - RHD

1. Ignition OFF, disconnect the harness connector at the sunload sensor.
2. Ignition OFF, scan tool OFF, test for less than 1 ohm between the ground circuit terminal C and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Ambient Light Sensor parameter is greater than 4.65 volts.

   If less than the specified range, test the signal circuit terminal D for a short to ground. If the circuit tests normal, replace the BCM.
4. Install a 3 A fused jumper wire between the signal circuit terminal D and the ground circuit terminal C. Verify the scan tool Ambient Light Sensor parameter is less than 0.196 volts.

   If greater than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, replace the ambient light sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Sunload and Twilight Sentinel Sensor Replacement
- Control Module References for BCM replacement, setup, and programming

DTC B2652

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B2652 00 : Passenger Compartment Dimming 3 Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
INT LAMPS Fuse B+	B2652 00	B2652 00	--	--

Circuit/System Description

The up/down dimmer controls located on the headlamp and panel dimmer switch is used to increase and decrease the brightness of the interior backlighting components. Each dimmer control switch provides a voltage signal that will increase as the brightness of the lights are increased and decrease as the brightness of the lights are decreased. The body control module (BCM) supplies each dimmer control switch with a signal circuit. When either the up or down dimmer control switch is placed in the desired position, the dimmed voltage setting is applied from the appropriate dimmer control switch through the dimmer switch signal circuit to the BCM. The BCM interprets the signal and applies the dimmed voltage to the LED backlight dimming control circuit and the interior backlighting components dim to the requested level.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Park lamps ON.

Conditions for Setting the DTC

The DTC will set when the BCM detects a short to ground or an open/high resistance in the INT LAMPS fuse B+ circuit.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.

- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.
- DTC will not clear with a scan tool until the vehicles systems shut down for 10 minutes.

Reference Information

Schematic Reference

Interior Lights Dimming Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Testing

1. Ignition OFF, disconnect the X2 harness connector at the BCM.
2. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 2 and ground.
   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. If all circuits test normal, replace the BCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for BCM replacement, setup, and programming

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DTC B3410 or B3420

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC B3410 02: AHLD Front Axle Sensor Signal Circuit Short to Ground

DTC B3410 05: AHLD Front Axle Sensor Signal Circuit Short to Battery or Open

DTC B3410 08: AHLD Front Axle Sensor Signal Circuit Signal Invalid

DTC B3420 02: AHLD Rear Axle Sensor Signal Circuit Short to Ground

DTC B3420 05: AHLD Rear Axle Sensor Signal Circuit Short to Battery or Open

DTC B3420 08: AHLD Rear Axle Sensor Signal Circuit Signal Invalid

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Headlamp Leveling Sensor 5 Volt Reference - Front	B3415 02	1	B3415 01	--
Headlamp Leveling Sensor 5 Volt Reference - Rear	1	1	1	--
Headlamp Leveling Sensor Signal - Front	B3410 02	B3410 05	B3410 05	B3410 08
Headlamp Leveling Sensor Signal - Rear	B3420 02	B3420 05	B3420 05	B3420 08
Headlamp Leveling Motor Control Circuit 1 - Left	B3435 02	B3435 05	B3435 05	B3435 54
Headlamp Leveling Motor Control Circuit 2 - Left	B3435 02	B3435 05	B3435 05	B3435 54
Headlamp Leveling Motor Control Circuit 3 - Left	B3435 02	B3435 05	B3435 05	B3435 54
Headlamp Leveling Motor Control Circuit 4 - Left	B3435 02	B3435 05	B3435 05	B3435 54
Headlamp Leveling Motor Control Circuit 1 - Right	B3440 02	B3440 05	B3440 05	B3435 54
Headlamp Leveling Motor	B3440 02	B3440 05	B3440 05	B3435 54

Control Circuit 2 - Right				
Headlamp Leveling Motor Control Circuit 3 - Right	B3440 02	B3440 05	B3440 05	B3435 54
Headlamp Leveling Motor Control Circuit 4 - Right	B3440 02	B3440 05	B3440 05	B3440 39, B3440 54
Headlamp Leveling Sensor Low Reference - Front	--	1	1	--
Headlamp Leveling Sensor Low Reference - Rear	--	1	1	--
1. Headlamp Leveling Malfunction				

Circuit/System Description

Each headlamp assembly contains a headlamp leveling motor that is controlled by the headlamp control module. The front and rear headlamp leveling sensors provide the headlamp control module with suspension position information. Each sensor receives a 5-volt reference, signal, and low reference circuits from the headlamp control module. The sensors are connected to the control arms of the front and rear suspension. As the vehicle travels, the suspension compresses and rebounds moving the suspension position sensor arms. This causes the signal output of the sensor to change. The headlamp control module compares the information from both suspension position sensors and adjusts the headlamp leveling as needed. The headlamp control module is wired to each headlamp leveling motor with 4 directional motor control circuits.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Ignition in the ON or RUN position.
- Headlamps ON.

Conditions for Setting the DTC

B3410 02 or B3420 02

The headlamp control module detects a short to ground on the headlamp leveling sensor signal circuit.

B3410 05 or B3420 05

The headlamp control module detects a short to voltage or an open/high resistance on the headlamp leveling sensor signal circuit.

B3410 08 or B3420 08

The headlamp control module detects an invalid signal on the headlamp leveling sensor signal circuit.

Actions Taken When the DTC Sets

- The headlamp control module disables the headlamp leveling system.
- The driver information center (DIC) will display AFL Lamps Need Service.
- On vehicles equipped with both AFL and headlamp leveling, the AFL system will remain active.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 consecutive malfunction-free cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate headlamp leveling sensor.
2. Ignition OFF, test for less than 10 ohms between the low reference circuit terminal 1 and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the headlamp control module.
3. Ignition ON, test for 4.8-5.2 volts between the 5-volt reference circuit terminal 2 and ground.

   If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the headlamp control module.

   If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the headlamp control module.

4. Verify the appropriate scan tool Leveling Position Sensor parameter is less than 59 degrees.

   If greater than the specified range, test the signal circuit terminal 3 for a short to voltage. If the circuit tests normal, replace the headlamp control module.

5. Install a 3A fused jumper wire between the signal circuit terminal 3 and the 5-volt reference circuit terminal 2. Verify the appropriate scan tool Leveling Position Sensor parameter is greater than 59 degrees.

   If less than the specified range, test the signal circuit for short to ground or an open/high resistance. If the circuit tests normal, replace the headlamp control module.

6. If all circuits test normal, replace the appropriate headlamp leveling sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Headlamp Leveling Control Module Replacement
- Control Module References for headlamp control module replacement, setup, and programming

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DTC B3415

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC B3415 01: AHLD Front Axle Sensor Supply Circuit Short to Battery

DTC B3415 02: AHLD Front Axle Sensor Supply Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Headlamp Leveling Sensor 5 Volt Reference - Front	B3415 02	1	B3415 01	--
Headlamp Leveling Sensor 5 Volt Reference - Rear	1	1	1	--
Headlamp Leveling Sensor Signal - Front	B3410 02	B3410 05	B3410 05	B3410 08
Headlamp Leveling Sensor Signal - Rear	B3420 02	B3420 05	B3420 05	B3420 08
Headlamp Leveling Motor Control Circuit 1 - Left	B3435 02	B3435 05	B3435 05	B3435 54
Headlamp Leveling Motor Control Circuit 2 - Left	B3435 02	B3435 05	B3435 05	B3435 54
Headlamp Leveling Motor Control Circuit 3 - Left	B3435 02	B3435 05	B3435 05	B3435 54
Headlamp Leveling Motor Control Circuit 4 - Left	B3435 02	B3435 05	B3435 05	B3435 54
Headlamp Leveling Motor Control Circuit 1 - Right	B3440 02	B3440 05	B3440 05	B3435 54
Headlamp Leveling Motor Control Circuit 2 - Right	B3440 02	B3440 05	B3440 05	B3435 54
Headlamp Leveling Motor Control Circuit 3 - Right	B3440 02	B3440 05	B3440 05	B3435 54
Headlamp Leveling Motor Control Circuit 4 - Right	B3440 02	B3440 05	B3440 05	B3440 39, B3440 54
Headlamp Leveling Sensor Low Reference - Front	--	1	1	--

Headlamp Leveling Sensor Low Reference - Rear	--	1	1	--
1. Headlamp Leveling Malfunction				

Circuit/System Description

Each headlamp assembly contains a headlamp leveling motor that is controlled by the headlamp control module. The front and rear headlamp leveling sensors provide the headlamp control module with suspension position information. Each sensor receives a 5-volt reference, signal, and low reference circuits from the headlamp control module. The sensors are connected to the control arms of the front and rear suspension. As the vehicle travels, the suspension compresses and rebounds moving the suspension position sensor arms. This causes the signal output of the sensor to change. The headlamp control module compares the information from both suspension position sensors and adjusts the headlamp leveling as needed. The headlamp control module is wired to each headlamp leveling motor with 4 directional motor control circuits.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Ignition in the ON or RUN position.
- Headlamps ON.

Conditions for Setting the DTC

B3415 01

The headlamp control module detects a short to voltage on the front headlamp leveling sensor 5 volt reference circuit.

B3415 02

The headlamp control module detects a short to ground on the front headlamp leveling sensor 5 volt reference circuit.

Actions Taken When the DTC Sets

- The headlamp control module disables the headlamp leveling system.
- The driver information center (DIC) will display AFL Lamps Need Service.
- On vehicles equipped with both AFL and headlamp leveling, the AFL system will remain active.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 consecutive malfunction-free cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the front headlamp leveling sensor.
2. Ignition OFF, test for less than 10 ohms between the low reference circuit terminal 1 and ground.

    If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the headlamp control module.
3. Ignition ON, test for 4.8-5.2 volts between the 5-volt reference circuit terminal 2 and ground.

    If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the headlamp control module.

    If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the headlamp control module.
4. Verify the scan tool Front Leveling Position Sensor parameter is less than 59 degrees.

    If greater than the specified range, test the signal circuit terminal 3 for a short to voltage. If the circuit tests normal, replace the headlamp control module.
5. Install a 3A fused jumper wire between the signal circuit terminal 3 and the 5-volt reference circuit terminal 2. Verify the scan tool Front Leveling Position Sensor parameter is greater than 59 degrees.

    If less than the specified range, test the signal circuit for short to ground or an open/high resistance. If the circuit tests normal, replace the headlamp control module.
6. If all circuits test normal, replace the front headlamp leveling sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Headlamp Leveling Control Module Replacement
- Control Module References for headlamp control module replacement, setup, and programming

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DTC B3435 or B3440

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC B3435 02: AHLD Left Servo Driver Circuit Short to Ground

DTC B3435 05: AHLD Left Servo Driver Circuit Short to Battery or Open

DTC B3435 54: AHLD Left Servo Driver Circuit Over Temperature

DTC B3440 02: AHLD Right Servo Driver Circuit Short to Ground

DTC B3440 39: AHLD Right Servo Driver Circuit Short to Battery or Open

DTC B3440 54: AHLD Right Servo Driver Circuit Over Temperature

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Headlamp Leveling Sensor 5 Volt Reference - Front	B3415 02	1	B3415 01	--
Headlamp Leveling Sensor 5 Volt Reference - Rear	1	1	1	--
Headlamp Leveling Sensor Signal - Front	B3410 02	B3410 05	B3410 05	B3410 08
Headlamp Leveling Sensor Signal - Rear	B3420 02	B3420 05	B3420 05	B3420 08
Headlamp Leveling Motor Control Circuit 1 - Left	B3435 02	B3435 05	B3435 05	B3435 54
Headlamp Leveling Motor Control Circuit 2 - Left	B3435 02	B3435 05	B3435 05	B3435 54
Headlamp Leveling Motor Control Circuit 3 - Left	B3435 02	B3435 05	B3435 05	B3435 54
Headlamp Leveling Motor Control Circuit 4 - Left	B3435 02	B3435 05	B3435 05	B3435 54
Headlamp Leveling Motor Control Circuit 1 - Right	B3440 02	B3440 05	B3440 05	B3435 54
Headlamp Leveling Motor	B3440 02	B3440 05	B3440 05	B3435 54

Control Circuit 2 - Right				
Headlamp Leveling Motor Control Circuit 3 - Right	B3440 02	B3440 05	B3440 05	B3435 54
Headlamp Leveling Motor Control Circuit 4 - Right	B3440 02	B3440 05	B3440 05	B3440 39, B3440 54
Headlamp Leveling Sensor Low Reference - Front	--	1	1	--
Headlamp Leveling Sensor Low Reference - Rear	--	1	1	--
1. Headlamp Leveling Malfunction				

Circuit/System Description

Each headlamp assembly contains a headlamp leveling motor that is controlled by the headlamp control module. The front and rear headlamp leveling sensors provide the headlamp control module with suspension position information. Each sensor receives a 5-volt reference, signal, and low reference circuits from the headlamp control module. The sensors are connected to the control arms of the front and rear suspension. As the vehicle travels, the suspension compresses and rebounds moving the suspension position sensor arms. This causes the signal output of the sensor to change. The headlamp control module compares the information from both suspension position sensors and adjusts the headlamp leveling as needed. The headlamp control module is wired to each headlamp leveling motor with 4 directional motor control circuits.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Ignition in the ON or RUN position.
- Headlamps ON.

Conditions for Setting the DTC

B3435 02

The headlamp control module detects a short to ground on any of the left motor control circuits.

B3435 05

The headlamp control module detects a short to voltage or an open/high resistance on any of the left motor control circuits.

B3435 54

The headlamp control module detects an overheating condition on any of the left motor control circuits.

B3440 02

The headlamp control module detects a short to ground on any of the right motor control circuits.

B3440 05

The headlamp control module detects a short to voltage or an open/high resistance on any of the right motor control circuits.

B3440 54

The headlamp control module detects an overheating condition on any of the right motor control circuits.

Actions Taken When the DTC Sets

- When DTC B3435 or DTC B3440 sets, the headlamp control module will attempt to return the lamps to a nominal position and disable all requests to all headlamp actuators.
- The driver information center (DIC) will display AFL Lamps Need Service.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 consecutive malfunction-free cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the inoperative headlamp.
2. Remove the COMM ENABLE 10A fuse.
3. Ignition OFF, scan tool OFF, test for 20K -22K ohms between each control circuit terminal listed below and ground.
   - Headlamp leveling motor control terminal 3
   - Headlamp leveling motor control terminal 4
   - Headlamp leveling motor control terminal 5
   - Headlamp leveling motor control terminal 10

   If greater than the specified range, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the headlamp control module.

   If less than the specified range, test the control circuit for a short to ground. If the circuit tests normal, replace the headlamp control module.
4. Install the COMM ENABLE 10A fuse.
5. Ignition ON, scan tool OFF, headlamps ON, verify that a test lamp does not illuminate between each control circuit terminal listed below and ground.
   - Headlamp leveling motor control terminal 3
   - Headlamp leveling motor control terminal 4
   - Headlamp leveling motor control terminal 5
   - Headlamp leveling motor control terminal 10

   If the test lamp illuminates, test the control circuit for a short to voltage. If the circuit tests normal, replace the headlamp control module.
6. If all circuits test normal, replace the appropriate headlamp assembly.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Headlamp Replacement
- Control Module References for headlamp control module replacement, setup, and programming

DTC B3445

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B3445 00: Stop Lamp Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
BCM B+ Terminal 4 X4	B3445 00	B3445 00	--	--
Brake Pedal Position Sensor 5-Volt Reference	C0277 06, C0890 03, C0161 71	C0277 06, C0161 71	C0277 07, C0161 71	--
Brake Applied Signal Terminal 6 X5	C0297 00, P0571 00	3	3	--
Brake Pedal Position Sensor Signal	C0277 06, C0161 71	C0277 06, C0161 71	C0277 07, C0161 71	C0277 09
Stop Lamp Control	B3445 00	1	1	--
Brake Position Sensor Low Reference	--	1	1	--
Center High Mounted Stop Lamp (CHMSL) Ground	--	2	--	--
Left Rear Tail/Stop Lamp Ground	--	1	--	--
Right Rear Tail/Stop Lamp Ground	--	1	--	--

1. Stop Lamps Malfunction

2. Center High Mounted Stop Lamp (CHMSL) Malfunction

3. Cruise Control Malfunction

Circuit/System Description

The brake pedal position sensor is used to sense the action of the driver application of the brake pedal. The brake pedal position sensor provides an analog voltage signal that will increase as the brake pedal is applied. The body control module (BCM) provides a low reference signal and a 5-volt reference voltage to the brake pedal position sensor. When the variable signal reaches a voltage threshold indicating the brakes have been applied, the BCM will apply battery voltage to the stop lamp control circuit illuminating the left and right stop lamps and the center high mounted stop lamp (CHMSL). The BCM also applies battery voltage to the transmission control module (TCM) and engine control module (ECM) via the brake applied signal circuit.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Brakes APPLIED.

Conditions for Setting the DTC

- The DTC will set when the BCM detects a short to ground in the stop lamp control circuit when the stop lamps are being commanded ON.
- The DTC will set when the BCM detects a short to ground or an open/high resistance in the STOP fuse B+ circuit terminal 4 X4.

Actions Taken When the DTC Sets

The BCM will not illuminate the stop lamps.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections

- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X4 harness connector at the BCM.
2. Verify that a test lamp illuminates between the STOP fuse B+ circuit terminal 4 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Connect the X4 harness connector at the BCM.
4. Disconnect the harness connectors at the following components.
   - CHMSL
   - Tail/stop lamp - left
   - Tail/stop lamp - right
5. Connect a test lamp between the control circuit terminal 4 at the tail/stop lamp - right and ground.
6. Ignition ON, command the Brake Light Test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
7. Reconnect each component one at a time and verify the DTC does not reset as current.

   If the DTC resets as current, test or replace the component responsible for setting the DTC.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- High Mount Stop Lamp Replacement
- Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn Signal Bulb Replacement
- Control Module References for BCM replacement, setup, and programming

DTC C0277 or C0890

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC C0277 06: Brake Pedal Position Sensor Circuit Short to Ground or Open

DTC C0277 07: Brake Pedal Position Sensor Circuit Voltage Above Threshold

DTC C0277 09: Brake Pedal Position Sensor Circuit Rate of Change Above Threshold

DTC C0277 4B: Brake Pedal Position Sensor Calibration Not Learned

DTC C0890 03: Device Voltage Reference Output 3 Circuit Voltage Below Threshold

DTC C0890 07: Device Voltage Reference Output 3 Circuit Voltage Above Threshold

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
BCM B+ Terminal 4 X4	B3445 00	B3445 00	--	--
Brake Pedal Position Sensor 5-Volt Reference	C0277 06, C0890 03, C0161 71	C0277 06, C0161 71	C0277 07, C0161 71	--
Brake Applied Signal Terminal 6 X5	C0297 00, P0571 00	3	3	--
Brake Pedal Position Sensor Signal	C0277 06, C0161 71	C0277 06, C0161 71	C0277 07, C0161 71	C0277 09
Stop Lamp Control	B3445 00	1	1	--
Brake Position Sensor Low Reference	--	1	1	--
Center High Mounted Stop Lamp (CHMSL) Ground	--	2	--	--
Left Rear Tail/Stop Lamp Ground	--	1	--	--
Right Rear Tail/Stop Lamp Ground	--	1	--	--

1. Stop Lamps Malfunction

2. Center High Mounted Stop Lamp (CHMSL) Malfunction
3. Cruise Control Malfunction

Circuit/System Description

The brake pedal position sensor is used to sense the action of the driver application of the brake pedal. The brake pedal position sensor provides an analog voltage signal that will increase as the brake pedal is applied. The body control module (BCM) provides a low reference signal and a 5-volt reference voltage to the brake pedal position sensor. When the variable signal reaches a voltage threshold indicating the brakes have been applied, the BCM will apply battery voltage to the stop lamp control circuit illuminating the left and right stop lamps and the center high mounted stop lamp (CHMSL). The BCM also applies battery voltage to the transmission control module (TCM) and engine control module (ECM) via the brake applied signal circuit.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Brakes APPLIED.

Conditions for Setting the DTC

DTC C0277 06 will set for the following conditions:

- The BCM detects a short to ground or an open/high resistance in the brake pedal position sensor signal circuit.
- The BCM detects a short to ground or an open/high resistance in the brake pedal position sensor 5-volt reference circuit.

DTC C0277 07 will set for the following conditions:

- The BCM detects a short to battery voltage in the brake pedal position sensor signal circuit.
- The BCM detects a short to battery voltage in the brake pedal position sensor 5-Volt Reference circuit.

C0277 09

The DTC will set when the BCM detects the brake pedal position sensor signal is changing faster than possible under normal operating conditions.

C0277 4B

The DTC will set when the brake pedal position sensor home position is not learned.

C0890 03

The DTC will set when the BCM detects a short to ground in the brake pedal position sensor voltage reference circuit for 0.5 seconds or greater.

C0890 07

The DTC will set when the BCM detects a short to battery voltage in the brake pedal position sensor voltage reference circuits for 0.5 seconds or greater.

Actions Taken When the DTC Sets

- The ABS Fault indicator is commanded ON.
- If the DTC sets while the vehicle is running, the BCM will activate the brake lights when the vehicles transmission is not in the PARK position and the vehicle is not accelerating.
- For DTC C0277 4B the stop lamps may not activate at the expected brake pedal positions.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- For DTC C0277 07 the ignition must be cycled before the code can be cleared.
- For DTC C0277 4B a successful brake pedal position sensor calibration has been performed.
- A history DTC will clear once 50 malfunction-free ignition cycles have occurred.
- A DTC will not clear the current status until the next ignition cycle.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

C0277 06, C0277 07, C0890 03, and C0890 07

1. Ignition OFF, disconnect the harness connector at the brake pedal position sensor.
2. Ignition ON, verify that a test lamp illuminates between B+ and the low reference circuit terminal C.

   If the test lamp does not illuminate, test the low reference circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
3. Ignition ON, test for 4.8-5.2 volts between the 5-volt reference circuit terminal A and ground.

   If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.

   If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the BCM.
4. Verify the scan tool BPP Sensor parameter is less than 2 counts.

   If greater than the specified range, test the signal circuit terminal B for a short to voltage. If the circuit tests normal, replace the BCM.
5. Install a 3 A fused jumper wire between B+ and the signal circuit terminal B. Verify the scan tool BPP Sensor parameter is greater than 1000 counts.

   If less than the specified range, test the signal circuit for short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
6. If all circuits test normal, test or replace the brake pedal position sensor.

C0277 09

1. Replace the brake pedal position sensor.
2. Perform the brake pedal position sensor recalibration procedure. Refer to Brake Pedal Position Sensor Calibration.
3. Operate the vehicle within the Conditions for Running and Setting the DTC and verify the DTC does not reset.

   If the DTC resets, replace the BCM.

C0277 4B

Verify that DTC C0277 4B is not set.

If the DTC is set, perform the brake pedal position sensor calibration procedure. If the DTC resets, replace the brake pedal position sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Stop Lamp Switch Replacement
- Brake Pedal Position Sensor Calibration
- Control Module References for BCM replacement, setup, and programming

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DTC C0297

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC C0297 00: Brake Applied Output Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
BCM B+ Terminal 4 X4	B3445 00	B3445 00	--	--
Brake Pedal Position Sensor 5-Volt Reference	C0277 06, C0890 03, C0161 71	C0277 06, C0161 71	C0277 07, C0161 71	--
Brake Applied Signal Terminal 6 X5	C0297 00, P0571 00	3	3	--
Brake Pedal Position Sensor Signal	C0277 06, C0161 71	C0277 06, C0161 71	C0277 07, C0161 71	C0277 09
Stop Lamp Control	B3445 00	1	1	--
Brake Position Sensor Low Reference	--	1	1	--
Center High Mounted Stop Lamp (CHMSL) Ground	--	2	--	--
Left Rear Tail/Stop Lamp Ground	--	1	--	--
Right Rear Tail/Stop Lamp Ground	--	1	--	--

1. Stop Lamps Malfunction

2. Center High Mounted Stop Lamp (CHMSL) Malfunction

3. Cruise Control Malfunction

Circuit/System Description

The brake pedal position sensor is used to sense the action of the driver application of the brake pedal. The brake pedal position sensor provides an analog voltage signal that will increase as the brake pedal is applied. The body control module (BCM) provides a low reference signal and a 5-volt reference voltage to the brake pedal position sensor. When the variable signal reaches a voltage threshold indicating the brakes have been applied, the BCM will apply battery voltage to the stop lamp control circuit illuminating the left and right stop lamps and the center high mounted stop lamp (CHMSL). The BCM also applies battery voltage to the transmission control module (TCM) and engine control module (ECM) via the brake applied signal circuit.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Brakes APPLIED.

Conditions for Setting the DTC

The BCM detects a short to ground in the brake applied signal circuit.

Actions Taken When the DTC Sets

The Service Vehicle Soon indicator is commanded ON.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the appropriate harness connector listed below.
   - ECM X1 - with L76
   - ECM X2 - with LY7
2. Connect a test lamp between the apprpriate signal circuit terminal listed below and ground.
   - ECM terminal 9 X1 - with L76
   - ECM terminal 52 X2 - with LY7
3. Ignition ON, command the stop lamps ON and OFF by applying and releasing the brake pedal. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the signal circuit for a short to voltage. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
4. Ignition OFF, connect a test lamp between the appropriate signal circuit terminal listed below at the ECM harness connector and the connector terminal at the ECM.
   - ECM terminal 9 X1 - with L76
   - ECM terminal 52 X2 - with LY7
5. Ignition ON, command the stop lamps ON and OFF by applying and releasing the brake pedal. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp does not turn ON and OFF when commanded, replace the ECM.
6. Ignition OFF, connect the harness connector at the ECM.
7. Disconnect the harness connector at the TCM.
8. Connect a test lamp between the appropriate signal circuit terminal listed below and ground.
   - TCM terminal 42 - with 4L60E/4L65E
   - TCM terminal 38 - with 5L40E
   - Automatic transmission terminal 6 - 6L50E
9. Ignition ON, command the stop lamps ON and OFF by applying and releasing the brake pedal. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the signal circuit for a short to voltage. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
10. If all circuits test normal, replace the TCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Brake Pedal Position Sensor Calibration
- Control Module References for BCM, ECM, or TCM replacement, setup, and programming

Symptoms - Lighting

Important: The following steps must be completed before using the symptom table.

- Perform the Diagnostic System Check - Vehicle before using a symptom table in order to verify that all of the following conditions are true:
  - There are no DTCs set.
  - The control modules can communicate via the serial data link.
- Review the system description and operation in order to familiarize yourself with the system functions. Refer to the following:
  - Interior Lighting Systems Description and Operation.
  - Exterior Lighting Systems Description and Operation.

Visual/Physical Inspection

- Inspect for aftermarket devices which may affect the operation of the lighting system. Refer to Checking Aftermarket Accessories.
- Inspect the easily accessible or visible system components for obvious damage or conditions which may cause the symptom.

Intermittent

Thoroughly inspect the wiring and connectors. An incomplete inspection of the wiring and connectors may result in misdiagnosis causing part replacement with the reappearance of the malfunction. If an intermittent malfunction exists, refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Backup Lamps Malfunction
- Courtesy Lamps Malfunction
- Daytime Running Lamps Malfunction
- Front Fog Lamps Malfunction
- Rear Fog Lamps Malfunction
- Hazard Lamps Malfunction
- Headlamps Malfunction
- Headlamp Leveling Malfunction
- Interior Backlighting Malfunction
- Park, License, and/or Tail Lamps Malfunction
- Stop Lamps Malfunction
- Trailer Lamps Malfunction

- Turn Signal Lamps and/or Indicators Malfunction

Backup Lamps Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Backup Lamp Relay B+	1	1	--	--
Backup Lamp Relay Control	1	1	B2545 00	--
Backup Lamps Control	1	1	1	--
Backup Lamp Ground - Left	--	1	--	--
Backup Lamp Ground - Right	--	1	--	--
1. Backup Lamps Malfunction				

Circuit/System Description

When the transmission is placed in the REVERSE position, the transmission control module (TCM) sends a serial data message to the body control module (BCM). The message indicates that the gear selector is in the REVERSE position. The BCM applies ground to the backup lamp relay control circuit energizing the backup lamp relay coil. With the relay coil energized, the switch contacts close allowing battery voltage to flow from the BACKUP LP fuse to the left and right backup lamps. Once the driver moves the gear selector out of the REVERSE position, a message is sent by the TCM via serial data requesting the BCM to remove ground from the backup lamp relay control circuit.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the backup lamp relay.
2. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 87 and ground.

   If the test lamp illuminates, test the control circuit for a short to voltage.
3. Verify that a test lamp illuminates between the B+ circuit terminal 30 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse is open, test the control circuit terminal 87 for a short to ground. If the circuit tests normal, test or replace the backup lamp relay.
4. Verify that a test lamp illuminates between the B+ circuit terminal 85 and ground.

   If the test lamp does not illuminate, test the B+ circuit for an open/high resistance.
5. Disconnect the harness connector at the inoperative backup lamp.
6. Ignition OFF, exterior lamps OFF, test for less than 5 ohms between the ground circuit terminal 1 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
7. Connect the harness connector at the inoperative backup lamp.
8. Connect a 15A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87. Verify the backup lamps illuminate.

   If the backup lamps do not illuminate, test the control circuit for an open/high resistance. If the circuit tests normal, test or replace the inoperative backup lamp.
9. Connect a test lamp between the B+ circuit terminal 85 and the control circuit terminal 86.
10. Command the Reverse Light Test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

    If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

    If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
11. If all circuits test normal, test or replace the backup lamp relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn Signal Bulb Replacement
- Relay Replacement
- Control Module References for BCM replacement, setup, and programming

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Courtesy Lamps Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
CTSY/TRN SIG RT FRT Fuse B+ Terminal 2 X4	B2615 00	B2615 00	--	--
INADV/PWR/LED Fuse B+ Terminal 2 X3	5	5	5	--
Courtesy Lamp Defeat Signal	4	4	4	--
Courtesy Lamps Control	B2615 00	B2615 00	B2615 00	--
Console Compartment Lamp Switch Ground	--	7	--	--
Courtesy Lamp Defeat Ground	--	4	--	--
Courtesy Lamp - Left Footwell	--	1	--	--
Courtesy Lamp - Right Footwell	--	1	--	--
Door Courtesy Lamp Ground - Left Front	--	1	--	--
Door Courtesy Lamp Ground - Left Rear	--	1	--	--
Door Courtesy Lamp Ground - Right Front	--	1	--	--
Door Courtesy Lamp Ground - Right Rear	--	1	--	--
Dome/Reading Lamps Ground	--	2	--	--
Dome Lamp - Front Ground	--	1	--	--
Dome Lamp - Rear Ground	--	1	--	--
Ignition Key Cylinder Lamp Ground	--	1	--	--
I/P Compartment Lamp Switch Ground	--	8	--	--

Sunshade - Left Ground	--	3	--	--
Sunshade - Right Ground	--	3	--	--
Rear Compartment Courtesy Lamp Ground	--	6	--	--
1. Courtesy Lamps Malfunction 2. Dome Lamp Switch Malfunction 3. Sunshade Lamps Malfunction 4. Courtesy Lamp Defeat Malfunction 5. Reading Lamps Malfunction 6. Rear Compartment Lamp Malfunction 7. Console Compartment Lamp Malfunction 8. I/P Compartment Lamp Malfunction				

Circuit/System Description

The body control module (BCM) applies battery voltage to the courtesy lamps through 2 separately controlled courtesy lamp supply voltage circuits. When any door is opened, the door ajar switch contacts close and the BCM receives a door-ajar input. If the BCM receives a door lock or unlock input or a rear hatch open input, the BCM will activate the courtesy lamp supply voltage circuits, providing battery voltage to all of the dome/reading lamps, ignition key cylinder lamp, rear compartment lamp, sunshade lamps footwell lamps, and courtesy lamps. In the event that any of these lamps were to remain illuminated for more than 20 minutes with the ignition switch in the OFF position, the BCM will deactivate the courtesy lamp control circuits to prevent a total battery discharge condition.

Reference Information

Schematic Reference

Interior Lights Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing

- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, doors CLOSED, observe the scan tool Interior Lamp Activation Reason parameter while turning the courtesy lamp defeat switch ON and OFF. The parameter should change between Off and Manual Defeat.

   If the parameter does not change between the commanded states, refer to Dome Lamp Defeat Switch Malfunction.
2. Ignition ON, courtesy lamp defeat switch OFF, observe the scan tool Interior Lamp Activation Reason parameter while opening and closing each door. The parameter should change between Door Open and Door Closed.

   If the parameter does not change as each door is opened and closed, refer to Door Ajar Indicator Malfunction.
3. Operate the dome lamp switch On and Off. The dome lamps should turn On and Off as the switch is activated.

   If the dome lamps do not turn On and Off as the switch is activated, refer to Dome Lamp Switch Malfunction.
4. Command the Interior Lamp Test ON and OFF with a scan tool. The courtesy lamps should turn ON and OFF when changing between the commanded states.

   If the courtesy lamps do not turn On and Off when commanded, refer to Courtesy Lamps Malfunction.

Circuit/System Testing

Dome Lamp Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the front dome lamp.
2. Ignition OFF, scan tool OFF, doors CLOSED, interior lamps OFF, test for less than 5 ohms between the ground circuit terminal 1 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify that a test lamp does not illuminate between the signal circuit terminal 2 and ground.

   If the test lamp illuminates, test the signal circuit for a short to voltage. If the circuit tests normal, replace the BCM.
4. Test for B+ between the signal circuit terminal 2 and ground.

   If not the specified value, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, replace the dome lamp.

Dome Lamp Defeat Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the front dome lamp.

2. Ignition OFF, scan tool OFF, doors CLOSED, interior lamps OFF, test for less than 5 ohms between the ground circuit terminal 1 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify that a test lamp does not illuminate between the signal circuit terminal 3 and ground.

   If the test lamp illuminates, test the signal circuit for a short to voltage. If the circuit tests normal, replace the BCM.
4. Test for B+ between the signal circuit terminal 3 and ground.

   If not the specified value, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, replace the dome lamp.

Courtesy Lamps Malfunction

1. Ignition OFF, disconnect the harness connector at the inoperative courtesy lamp.
2. Ignition OFF, scan tool OFF, doors CLOSED, interior lamps OFF, test for less than 5 ohms between the appropriate ground circuit terminal listed below and ground.
   - Dome/reading lamp - front terminal 1
   - Dome/reading lamp - rear terminal 1
   - Ignition key cylinder lamp terminal B
   - Courtesy lamp - left footwell terminal 2
   - Courtesy lamp - right footwell terminal 2
   - Courtesy lamp - LF door terminal A X2
   - Courtesy lamp - LR door terminal A X2
   - Courtesy lamp - RF door terminal A X2
   - Courtesy lamp - RR door terminal A X2

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Connect a test lamp between the appropriate control circuit terminal listed below and ground.
   - Dome/reading lamp - front terminal 4
   - Dome/reading lamp - rear terminal 2
   - Ignition key cylinder lamp terminal A
   - Courtesy lamp - left footwell terminal 1
   - Courtesy lamp - right footwell terminal 1
   - Courtesy lamp - LF door terminal A X1
   - Courtesy lamp - LR door terminal A X1
   - Courtesy lamp - RF door terminal A X1
   - Courtesy lamp - RR door terminal A X1
4. Command the Interior Lamp Test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, replace the inoperative courtesy lamp.

Reading Lamps Malfunction

1. Ignition OFF, disconnect the X3 harness connector at the BCM.
2. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 2 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Ignition OFF, connect the X3 harness connector at the BCM.
4. Disconnect the harness connector at the inoperative dome/reading lamp assembly.
5. Ignition OFF, scan tool OFF, doors CLOSED, interior lamps OFF, test for less than 5 ohms between the ground circuit terminal 1 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
6. Ignition ON, verify that a test lamp illuminates between the appropriate control circuit terminal listed below and ground.
   - Dome/reading lamp - front terminal 5
   - Dome/reading lamp - rear terminal 3

   If the test lamp does not illuminate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
7. Remove the INADV/PWR/LED fuse and verify the test lamp turns OFF.

   If the test lamp remains illuminated, test the appropriate control circuit terminal listed below for a short to voltage. If the circuit tests normal, replace the BCM.
   - Dome/reading lamp - front terminal 5
   - Dome/reading lamp - rear terminal 3
8. If all circuits test normal, replace the inoperative dome/reading lamp assembly.

Rear Compartment Courtesy lamp Malfunction

1. Ignition OFF, disconnect the X3 harness connector at the BCM.
2. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 2 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Ignition OFF, connect the X3 harness connector at the BCM.
4. Disconnect the X1 and X2 harness connectors at the rear compartment courtesy lamp.
5. Ignition OFF, trunk OPEN, test for less than 1 ohm between the control circuit terminal A X2 and ground.

   If greater than the specified range, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the rear compartment lid latch.
6. Ignition ON, verify that a test lamp illuminates between the control circuit terminal A X1 and ground.

   If the test lamp does not illuminate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
7. Remove the INADV/PWR/LED fuse and verify the test lamp turns OFF.

   If the test lamp remains illuminated, test the control circuit terminal A X1 for a short to voltage. If the circuit tests normal, replace the BCM.
8. Ignition OFF, connect the X1 and X2 harness connectors at the rear compartment courtesy lamp. Disconnect the harness connector at the rear compartment lid latch.
9. Ignition ON, verify that a test lamp illuminates between the control circuit terminal 2 and ground.

   If the test lamp does not illuminate, test the control circuit for a short to ground or an open/high resistance.
10. If all circuits test normal, replace the rear compartment courtesy lamp.

Sunshade Lamps Malfunction

1. Ignition OFF, disconnect the X3 harness connector at the BCM.
2. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 2 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Ignition OFF, connect the X3 harness connector at the BCM.
4. Ignition OFF, disconnect the harness connector at the inoperative sunshade lamp.
5. Ignition OFF, scan tool OFF, doors CLOSED, interior lamps OFF, test for less than 5 ohms between the ground circuit terminal 1 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
6. Ignition ON, verify that a test lamp illuminates between the control circuit terminal 2 and ground.

   If the test lamp does not illuminate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
7. Remove the INADV/PWR/LED and verify the test lamp turns OFF.

   If the test lamp remains illuminated, test the control circuit terminal 2 for a short to voltage. If the circuit tests normal, replace the BCM.
8. If all circuits test normal, replace the inoperative sunshade lamp assembly.

Console Compartment Lamp Malfunction

1. Ignition OFF, disconnect the X2 harness connectors at the console compartment lamp switch.
2. Ignition OFF, test for less than 1 ohm between the ground circuit terminal A X2 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Connect the X2 harness connectors at the console compartment lamp switch.
4. Ignition OFF, disconnect the X1 and X2 harness connectors at the console compartment lamp.
5. Ignition OFF, console compartment OPEN, test for less than 1 ohm between the control circuit terminal A X2 and ground.

   If the test lamp does not illuminate, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the console compartment lamp switch.
6. Verify that a test lamp illuminates between the control circuit terminal A X1 and ground.

   If the test lamp does not illuminate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
7. Remove the INADV/PWR/LED and verify the test lamp turns OFF.

   If the test lamp remains illuminated, test the control circuit terminal A X1 for a short to voltage. If the circuit tests normal, replace the BCM.
8. If all circuits test normal, replace the console compartment lamp.

I/P Compartment Lamp Malfunction

1. Ignition OFF, disconnect the X2 harness connectors at the I/P compartment lamp switch.
2. Ignition OFF, test for less than 1 ohm between the ground circuit terminal A X2 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Connect the X2 harness connectors at the I/P compartment lamp switch.
4. Disconnect the X1 and X2 harness connectors at the I/P compartment lamp.
5. Ignition OFF, I/P compartment OPEN, test for less than 1 ohm between the control circuit terminal A X2 and ground.

   If greater than the specified range, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the I/P compartment lamp switch.

6. Verify that a test lamp illuminates between the control circuit terminal A X1 and ground.

   If the test lamp does not illuminate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
7. Remove the INADV/PWR/LED and verify the test lamp turns OFF.

   If the test lamp remains illuminated, test the control circuit terminal A X1 for a short to voltage. If the circuit tests normal, replace the BCM.
8. If all circuits test normal, replace the I/P compartment lamp.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Ignition Lock Cylinder Bulb Replacement
- Console Lamp Replacement
- Dome Lamp Replacement
- Vanity Mirror Lamp Replacement
- Rear Compartment Courtesy Lamp Replacement
- Instrument Panel Compartment Lamp Replacement
- Instrument Panel Compartment Lamp Switch Replacement
- Door Courtesy Lamp and Reflector Replacement
- Control Module References for BCM replacement, setup, and programming

Daytime Running Lamps Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ambient Light Senor Signal	B2645 03	B2645 07	B2645 07	--
Headlamp- Left Low Beam Control	1	1	1	--
Headlamp- Right Low Beam Control	1	1	1	--
Ambient Light Sensor Low Reference - with LHD	--	B2645 07	B2645 07	--
Ambient Light Sensor Ground	--	B2645 07	2	--
Headlamp- Right Low Beam Ground	--	1	--	--
Headlamp- Right Low Beam Ground	--	1	--	--
1. Headlamps Malfunction 2. Daytime Running Lamps Malfunction				

Circuit/System Description

With Manual HVAC

The ambient light sensor is used to monitor outside lighting conditions. The ambient light sensor provides a voltage signal that will vary between 0.2 and 4.9 volts depending on outside lighting conditions. The body control module (BCM) provides a 5-volt reference signal to the ambient light sensor which is permanently grounded at G201. The BCM monitors the ambient light sensor signal circuit to determine if outside lighting conditions are correct for either daytime running lights (DRL) or automatic lamp control (ALC) when the headlamp switch is in the AUTO position. In daylight conditions the BCM will command the DRLs ON. The DRLs consists on the low beam headlamps illuminated at full intensity. During low light conditions the BCM will command the low beam headlamps ON. Any function or condition that turns on the headlamps will cancel DRL operation.

LHD With Automatic HVAC

The ambient light/sun load sensor is used to monitor outside lighting conditions. The ambient light sensor provides a voltage signal that will vary between 0.2 and 4.9 volts depending on outside lighting conditions. The body control module (BCM) provides a 5-volt reference signal to the ambient light sensor and the HVAC control module provides a low reference ground. The BCM monitors the ambient light sensor signal circuit to determine if outside lighting conditions are correct for either daytime running lights (DRL) or automatic lamp control (ALC) when the headlamp switch is in the AUTO position. In daylight conditions the BCM will command the DRLs ON. The DRLs consists on the low beam headlamps illuminated at full intensity. During low light conditions the BCM will command the low beam headlamps ON. Any function or condition that turns on the headlamps will cancel DRL operation.

RHD With Automatic HVAC

The ambient light/sun load sensor is used to monitor outside lighting conditions. The ambient light sensor provides a voltage signal that will vary between 0.2 and 4.9 volts depending on outside lighting conditions. The body control module (BCM) provides a 5-volt reference signal to the ambient light sensor which is permanently grounded at G201. The BCM monitors the ambient light sensor signal circuit to determine if outside lighting conditions are correct for either daytime running lights (DRL) or automatic lamp control (ALC) when the headlamp switch is in the AUTO position. In daylight conditions the BCM will command the DRLs ON. The DRLs consists on the low beam headlamps illuminated at full intensity. During low light conditions the BCM will command the low beam headlamps ON. Any function or condition that turns on the headlamps will cancel DRL operation.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, with a scan tool command the Front Low Beam Test ON and OFF. The low beam headlamps should turn ON and OFF when changing between the commanded states.

   If the low beam headlamps do not turn ON and OFF when commanded, refer to Headlamps Malfunction.

   If the low beam headlamps turn ON and OFF when commanded, refer to Ambient Light Sensor Malfunction.
2. Ignition ON, park brake released, verify with a scan tool the Park Brake Switch parameter displays Inactive.

   If not the specified value, refer to Symptoms - Hydraulic Brakes.

Circuit/System Testing

Ambient Light Sensor Malfunction - with Manual HVAC

1. Ignition OFF, disconnect the harness connector at the ambient light sensor.
2. Ignition OFF, verify that a test lamp illuminates between the ground circuit terminal B and B+.

   If the test lamp does not illuminate, test the ground circuit for a short to voltage or an open/high resistance.
3. If all circuits test normal, replace the BCM.

Ambient Light Sensor Malfunction - LHD with Automatic HVAC

1. Ignition OFF, disconnect the harness connector at the sunload sensor.
2. Ignition ON, verify that a test lamp illuminates between the low reference circuit terminal C and B+.

   If the test lamp does not illuminate, test the low reference circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the HVAC control module.
3. If all circuits test normal, replace the BCM.

Ambient Light Sensor Malfunction - RHD with Automatic HVAC

1. Ignition OFF, disconnect the harness connector at the sunload sensor.
2. Ignition ON, verify that a test lamp illuminates between the ground circuit terminal C and B+.

   If the test lamp does not illuminate, test the ground circuit for a short to voltage or an open/high resistance.
3. If all circuits test normal, replace the BCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Sunload and Twilight Sentinel Sensor Replacement
- Control Module References for BCM replacement, setup, and programming

Front Fog Lamps Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fog Lamp Relay B+	--	1	1	--
Fog Lamp Switch Signal	2	2	2	--
Fog Lamp Relay Control	1	1	B2530 00	--
Fog Lamp Control	1	1	1	--
Fog Lamp - LF Ground	--	1	--	--
Fog Lamp - RF Ground	--	1	--	--
Fog Lamp Switch Ground	--	2	--	--
1. Front Fog Lamps Malfunction 2. Front Fog Lamp Switch Malfunction				

Circuit/System Description

The fog lamp relay is supplied with battery voltage at all times. The fog lamp switch signal circuit is grounded momentarily by pressing the fog lamp switch. The body control module (BCM) energizes the fog lamp relay by applying ground to the fog lamp relay control circuit. When the fog lamp relay is energized, the relay switch contacts close and battery voltage is applied through the FOG LAMP fuse to the fog lamp supply voltage circuit which illuminates the fog lamps.

Reference Information

Schematic Reference

Fog Lights Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Front Fog Lamp Switch parameter while turning the front fog lamp switch ON and OFF. The parameter should change between Active and Inactive.

> If the parameter does not change between the commanded states, refer to Front Fog Lamp Switch Malfunction.
>
> If the parameter changes between the commanded states, refer to Front Fog Lamps Malfunction.

Circuit/System Testing

Front Fog Lamp Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the headlamp and panel dimmer switch.
2. Ignition OFF, test for less than 5 ohms between the ground circuit terminal 4 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Front Fog Lamp Switch parameter is Inactive.

   If not the specified value, test the signal circuit terminal 6 for a short to ground. If the circuit tests normal, replace the BCM.
4. Install a 3A fused jumper wire between the signal circuit terminal 6 and the ground circuit terminal 4. Verify the scan tool Front Fog Lamp Switch parameter is Active.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the headlamp and panel dimmer switch.

Front Fog Lamps Malfunction

1. Ignition OFF, disconnect the front fog lamp relay.
2. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 87 and ground.

If the test lamp illuminates, test the control circuit for a short to voltage.

3. Verify that a test lamp illuminates between the B+ circuit terminal 30 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
4. Verify that a test lamp illuminates between the B+ circuit terminal 86 and ground.

   If the test lamp does not illuminate, test the B+ circuit for an open/high resistance.
5. Disconnect the harness connector at the inoperative fog lamp.
6. Ignition OFF, test for less than 5 ohms between the ground circuit terminal B and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
7. Connect the harness connector at the inoperative fog lamp.
8. Connect a 15A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87. Verify the fog lamps illuminate.

   If the fog lamps do not illuminate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the inoperative fog lamp.
9. Connect a test lamp between the B+ circuit terminal 85 and the control circuit terminal 86.
10. Command the Front Fog Light Test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

    If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

    If the test lamp is always OFF, test the control circuit for a short to voltage or open/high resistance. If the circuit tests normal, replace the BCM.
11. If all circuits test normal, test or replace the fog lamp relay.

Front Fog Lamp Indicator Malfunction

Ignition ON, with a scan tool perform the Display Tests for the instrument panel cluster (IPC) and observe the fog lamp indicator.

If the fog lamp indicator illuminates during the test, replace the BCM.

If the fog lamp indicator does not illuminate during the test or remains illuminated at all times, replace the IPC.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Headlamp Switch Replacement
- Front Fog Lamp Replacement
- Underhood Electrical Center or Junction Block Replacement
- Relay Replacement
- Control Module References for BCM or IPC replacement, setup, and programming

Rear Fog Lamps Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Rear Fog Lamp Relay B+	--	1	1	--
Rear Fog Lamp Switch Signal	2	2	2	--
Rear Fog Lamp Relay Control	1	1	1	--
Rear Fog Lamp Control	1	1	1	--
Rear Fog Lamp Ground	--	1	--	--
Rear Fog Lamp Switch Ground	--	2	--	--
1. Rear Fog Lamps Malfunction 2. Rear Fog Lamp Switch Malfunction				

Circuit/System Description

The rear fog lamp relay is supplied with battery voltage at all times. The rear fog lamp switch signal circuit is grounded momentarily by pressing the rear fog lamp switch. The body control module (BCM) energizes the rear fog lamp relay by applying ground to the rear fog lamp relay control circuit. When the rear fog lamp relay is energized, the relay switch contacts close and battery voltage is applied through the rear fog lamp supply voltage circuit which illuminates the rear fog lamp.

Reference Information

Schematic Reference

Fog Lights Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Rear Fog Light Switch parameter while turning the front fog lamp switch ON and OFF. The parameter should change between Active and Inactive.

If the parameter does not change between the commanded states, refer to Rear Fog Lamp Switch Malfunction.

If the parameter changes between the commanded states, refer to Rear Fog Lamp Malfunction.

Circuit/System Testing

Rear Fog Lamp Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the headlamp and panel dimmer switch.
2. Ignition OFF, test for less than 5 ohms between the ground circuit terminal 4 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Rear Fog Light Switch parameter is Inactive.

   If not the specified value, test the signal circuit terminal 2 for a short to ground. If the circuit tests normal, replace the BCM.
4. Install a 3A fused jumper wire between the signal circuit terminal 2 and the ground circuit terminal 4. Verify the scan tool Rear Fog Light Switch parameter is Active.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the headlamp and panel dimmer switch.

Rear Fog Lamp Malfunction

1. Ignition OFF, disconnect the rear fog lamp relay.
2. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 87 and ground.

   If the test lamp illuminates, test the control circuit for a short to voltage.

3. Verify that a test lamp illuminates between the B+ circuit terminal 30 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.

4. Verify that a test lamp illuminates between the B+ circuit terminal 85 and ground.

   If the test lamp does not illuminate, test the B+ circuit for an open/high resistance.

5. Disconnect the harness connector at the rear fog lamp.
6. Ignition OFF, test for less than 5 ohms between the ground circuit terminal 2 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.

7. Connect the harness connector at the rear fog lamp.
8. Connect a 10A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87. Verify the rear fog lamp illuminates.

   If the rear fog lamp does not illuminate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the rear fog lamp.

9. Connect a test lamp between the B+ circuit terminal 85 and the control circuit terminal 86.
10. Command the rear fog lamp ON and OFF with the rear fog lamp switch. The test lamp should turn ON and OFF when changing between the commanded states.

    If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

    If the test lamp is always OFF, test the control circuit for a short to voltage or open/high resistance. If the circuit tests normal, replace the BCM.

11. If all circuits test normal, test or replace the rear fog lamp relay.

Rear Fog Lamp Indicator Malfunction

Ignition ON, with a scan tool perform the Display Tests for the instrument panel cluster (IPC) and observe the fog lamp indicator.

If the rear fog lamp indicator illuminates during the test, replace the BCM.

If the rear fog lamp indicator does not illuminate during the test or remains illuminated at all times, replace the IPC.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Headlamp Switch Replacement
- Rear Fog Lamp Replacement
- Underhood Electrical Center or Junction Block Replacement
- Relay Replacement
- Control Module References for BCM or IPC replacement, setup, and programming

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Hazard Lamps Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit/System Description

The hazard flashers may be activated in any power mode. The hazard switch is integrated into the driver information display panel. When the hazard switch is placed in the ON position, the radio communicates via serial data with the body control module (BCM) requesting the hazard lamps be activated. The BCM supplies battery voltage to all four turn signal lamps in an ON and OFF duty cycle. When the hazard switch is activated, the BCM sends a serial data message to the instrument panel cluster (IPC) requesting both turn signal indicators to be cycled ON and OFF.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Hazards parameter while pressing and depressing the hazard switch. The parameter should change between Active and Inactive.

If the parameter changes as the switch is activated, replace the BCM.

If the parameter does not change as the switch is activated, replace the driver information display.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Driver Information Display Replacement
- Control Module References for BCM replacement, setup, and programming

Headlamps Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Flash to Pass Switch Signal	4	4	4	--
Headlamp Switch High Beam Signal	4	4	4	--
Headlamp Switch Headlamps ON Signal	B257A 00	1	1	--
Headlamp Switch Headlamps OFF Signal	B257A 00	1	1	--
Park Lamp Switch ON Signal	5	B257A 00	5	--
Headlamp High Beam Relay Control	3	3	B2580 00	--
Headlamp Low Beam Relay Control	2	2	B2575 00	--
LF High Beam Headlamp Control	3	3	3	--
LF Low Beam Headlamp Control	2	2	2	--
RF High Beam Headlamp Control	3	3	3	--
RF Low Beam Headlamp Control	2	2	2	--
LF Headlamp Ground	--	2	--	--
RF Headlamp Ground	--	2	--	--
Headlamp and Panel Dimmer Switch Ground	--	1	--	--
Turn Signal/Multifunction Switch Ground	--	4	--	--

1. Headlamp Switch Malfunction

2. Headlamps Malfunction - Low Beam

3. Headlamps Malfunction - High Beam

4. Turn Signal/Multifunction Switch Malfunction

5. Park, License, and/or Tail Lamps Malfunction

Circuit/System Description

With the headlamp switch in the ON position, the headlamp switch headlamp ON signal circuit is grounded through the headlamp and panel dimmer switch at G201. In response to this input, the body control module (BCM) provides ground to either the headlamp low beam relay control circuit or the headlamp high beam relay control circuit. The position of the headlamp dimmer switch determines which relay coil is supplied with ground. The BCM supplies ground to the relay coil circuits, if the headlamps are necessary. The underhood fuse block supplies battery voltage to the relay coil and switch circuits. The low beam headlamps operate when the BCM grounds the relay coil control circuit to the relay coil of the low beam relay. This energizes the low beam relay causing the switch contacts to close. With the switch contacts closed, battery voltage is applied to the LT LO and RT LO beam fuses through to the left and right low beam headlamps. When the headlamp high beam relay coil is energized, current flows through the LT HI and the RT HI beam fuses to the high beam headlamps. With the headlamp dimmer switch in the high beam position the BCM sends a serial data message to the instrument panel cluster (IPC) requesting the IPC to illuminate the high beam indicator.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, command the Parking Light Test On and Off with a scan tool. The park lamps

should turn On and Off when commanded.

If the park lamps do not turn On and Off when commanded, refer to Park, License, and/or Tail Lamps Malfunction.

2. Observe the scan tool Headlamp Switch parameter while turning the headlamp switch ON and OFF. The parameter should change between On and Off.

   If the parameter does not change between the commanded states, refer to Headlamp Switch Malfunction.
3. Observe the scan tool Flash to Pass Switch parameter while applying and releasing the flash to pass switch. The parameter should change between Active and Inactive.

   If the parameter does not change between the commanded states, refer to Turn Signal/Multifunction Switch Malfunction.
4. Observe the scan tool High Beam Switch parameter while applying and releasing the high beam select switch. The parameter should change between Active and Inactive.

   If the parameter does not change between the commanded states, refer to Turn Signal/Multifunction Switch Malfunction.
5. Observe the scan tool Auto Headlamp Disable Switch parameter while applying and releasing the automatic lamp control disable switch. The parameter should change between Active and Inactive.

   If the parameter does not change between the commanded states, refer to Headlamp Switch Malfunction.
6. Command the Front Low Beam Test ON and OFF with a scan tool. The low beam headlamps should turn ON and OFF when commanded.

   If the low beam headlamps do not turn ON and OFF when commanded, refer to Headlamps Malfunction - Low Beam.
7. Command the Front High Beam Test ON and OFF with a scan tool. The low beam headlamps should turn ON and OFF when commanded.

   If the high beam headlamps do not turn ON and OFF when commanded, refer to Headlamps Malfunction - High Beam.

Circuit/System Testing

Headlamp Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the headlamp and panel dimmer switch.
2. Ignition OFF, test for less than 5 ohms between the ground circuit terminal 4 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Headlamp Switch parameter is Off.

   If not the specified value, test the signal circuit terminal 1 for short to ground. If the circuit tests normal, replace the BCM.
4. Verify the scan tool Auto Headlamp Disable Switch parameter is Inactive.

   If not the specified value, test the signal circuit terminal 3 for short to ground. If the circuit tests normal, replace the BCM.
5. Install a 3A fused jumper wire between the signal circuit terminal 1 and ground. Verify the scan tool Headlamp Switch parameter is On.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
6. Install a 3A fused jumper wire between the signal circuit terminal 3 and ground. Verify the scan tool Auto Headlamp Disable Switch parameter is Active.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.

7. If all circuits test normal, test or replace the headlamp and panel dimmer switch.

Turn Signal / Multifunction Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the turn signal/multifunction switch.
2. Ignition OFF, test for less than 5 ohms between the ground circuit terminal 4 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Verify the scan tool Flash to Pass Switch parameter is Inactive.

   If not the specified value, test the signal circuit terminal 2 for a short to ground. If the circuit tests normal, replace the BCM.
4. Verify the scan tool High Beam Switch parameter is Inactive.

   If not the specified value, test the signal circuit terminal 3 for a short to ground. If the circuit tests normal, replace the BCM.
5. Install a 3A fused jumper wire between the signal circuit terminal 2 and ground. Verify the scan tool Flash to Pass Switch parameter is Active.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
6. Install a 3A fused jumper wire between the signal circuit terminal 3 and ground. Verify the scan tool High Beam Switch parameter is Active.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
7. If all circuits test normal, test or replace the turn signal/multifunction switch.

Headlamps Malfunction - Low Beam without 9C1

1. Ignition OFF, disconnect the low beam relay.
2. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 87 and ground.

   If the test lamp illuminates, test the control circuit for a short to voltage.
3. Verify that a test lamp illuminates between the B+ circuit terminal 30 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
4. Verify that a test lamp illuminates between the B+ circuit terminal 86 and ground.

   If the test lamp does not illuminate, test the B+ circuit for an open/high resistance.
5. Disconnect the harness connector at the inoperative low beam headlamp.
6. Ignition OFF, scan tool OFF, exterior lamps OFF, test for less than 5 ohms between the ground circuit terminal 2 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
7. Connect the harness connector at the inoperative low beam headlamp.
8. Connect a 20A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87. Verify the low beam headlamps illuminate.

   If the low beam headlamps do not illuminate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the inoperative low beam headlamp.
9. Connect a test lamp between the B+ circuit terminal 86 and the control circuit terminal 85.
10. Command the Front Low Beam Test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

    If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

    If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.

11. If all circuits test normal, test or replace the low beam relay.

Headlamps Malfunction - High Beam without 9C1

1. Ignition OFF, disconnect the high beam relay.
2. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 87 and ground.

   If the test lamp illuminates, test the control circuit for a short to voltage.
3. Verify that a test lamp illuminates between the B+ circuit terminal 30 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
4. Verify that a test lamp illuminates between the B+ circuit terminal 86 and ground.

   If the test lamp does not illuminate, test the B+ circuit for an open/high resistance.
5. Disconnect the harness connector at the inoperative high beam headlamp.
6. Ignition OFF, scan tool OFF, exterior lamps OFF, test for less than 5 ohms between the ground circuit terminal 3 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
7. Connect the harness connector at the inoperative high beam headlamp.
8. Connect a 20A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87. Verify the high beam headlamps illuminate.

   If the high beam headlamps do not illuminate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the inoperative high beam headlamp.
9. Connect a test lamp between the B+ circuit terminal 86 and the control circuit terminal 85.
10. Command the Front High Beam Test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

    If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

    If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
11. If all circuits test normal, test or replace the high beam relay.

High Beam Indicator Malfunction

Ignition ON, with a scan tool perform the Display Tests for the instrument panel cluster (IPC) and observe the high beam indicator.

If the high beam indicator illuminates during the test, replace the BCM.

If the high beam indicator does not illuminate during the test or remains illuminated at all times, replace the IPC.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Headlamp Switch Replacement
- Headlamp Replacement
- Underhood Electrical Center or Junction Block Replacement

- Relay Replacement
- Turn Signal Switch Replacement
- Control Module References for BCM or IPC replacement, setup, and programming

Headlamp Leveling Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Headlamp Leveling Sensor 5 Volt Reference - Front	B3415 02	1	B3415 01	--
Headlamp Leveling Sensor 5 Volt Reference - Rear	1	1	1	--
Headlamp Leveling Sensor Signal - Front	B3410 02	B3410 05	B3410 05	B3410 08
Headlamp Leveling Sensor Signal - Rear	B3420 02	B3420 05	B3420 05	B3420 08
Headlamp Leveling Motor Control Circuit 1 - Left	B3435 02	B3435 05	B3435 05	B3435 54
Headlamp Leveling Motor Control Circuit 2 - Left	B3435 02	B3435 05	B3435 05	B3435 54
Headlamp Leveling Motor Control Circuit 3 - Left	B3435 02	B3435 05	B3435 05	B3435 54
Headlamp Leveling Motor Control Circuit 4 - Left	B3435 02	B3435 05	B3435 05	B3435 54
Headlamp Leveling Motor Control Circuit 1 - Right	B3440 02	B3440 05	B3440 05	B3435 54
Headlamp Leveling Motor Control Circuit 2 - Right	B3440 02	B3440 05	B3440 05	B3435 54
Headlamp Leveling Motor Control Circuit 3 - Right	B3440 02	B3440 05	B3440 05	B3435 54
Headlamp Leveling Motor Control Circuit 4 - Right	B3440 02	B3440 05	B3440 05	B3440 39, B3440 54
Headlamp Leveling Sensor Low Reference - Front	--	1	1	--
Headlamp Leveling Sensor Low Reference - Rear	--	1	1	--
1. Headlamp Leveling Malfunction				

Circuit/System Description

Each headlamp assembly contains a headlamp leveling motor that is controlled by the headlamp control module. The front and rear headlamp leveling sensors provide the headlamp control module with suspension position information. Each sensor receives a 5-volt reference, signal, and low reference circuits from the headlamp control module. The sensors are connected to the control arms of the front and rear suspension. As the vehicle travels, the suspension compresses and rebounds moving the suspension position sensor arms. This causes the signal output of the sensor to change. The headlamp control module compares the information from both suspension position sensors and adjusts the headlamp leveling as needed. The headlamp control module is wired to each headlamp leveling motor with 4 directional motor control circuits.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, with a scan tool, command the AHL Motor Control Up and Down while observing both headlamps. Both headlamps should operate to the Up and Down positions when commanded.

   If the headlamps do not operate to the Up and Down positions when commanded, refer to Headlamp Leveling Actuator Malfunction.
2. Observe the scan tool Front Leveling Position Sensor voltage parameter. The parameter should be between 58 and 62 degrees.

   If the parameter is not within the specified range, refer to Headlamp Leveling Sensor Malfunction.
3. Observe the scan tool Rear Leveling Position Sensor voltage parameter. The parameter should be between 57 and 61 degrees.

   If the parameter is not within the specified range, refer to Headlamp Leveling Sensor

Malfunction.

Circuit / System Testing

Headlamp Leveling Actuator Malfunction

1. Ignition OFF, disconnect the harness connector at the inoperative headlamp.
2. Remove the COMM ENABLE 10A fuse.
3. Ignition OFF, scan tool OFF, test for 20K -22K ohms between each control circuit terminal listed below and ground.
    - Headlamp leveling motor control terminal 3
    - Headlamp leveling motor control terminal 4
    - Headlamp leveling motor control terminal 5
    - Headlamp leveling motor control terminal 10

    If greater than the specified range, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the headlamp control module.

    If less than the specified range, test the control circuit for a short to ground. If the circuit tests normal, replace the headlamp control module.
4. Install the COMM ENABLE 10A fuse.
5. Ignition ON, scan tool OFF, headlamps ON, verify that a test lamp does not illuminate between each control circuit terminal listed below and ground.
    - Headlamp leveling motor control terminal 3
    - Headlamp leveling motor control terminal 4
    - Headlamp leveling motor control terminal 5
    - Headlamp leveling motor control terminal 10

    If the test lamp illuminates, test the control circuit for a short to voltage. If the circuit tests normal, replace the headlamp control module.
6. If all circuits test normal, replace the appropriate headlamp assembly.

Headlamp Leveling Sensor Malfunction

1. Ignition OFF, disconnect the harness connector at the appropriate headlamp leveling sensor.
2. Ignition OFF, test for less than 10 ohms between the low reference circuit terminal 1 and ground.

    If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the headlamp control module.
3. Ignition ON, test for 4.8-5.2 volts between the 5-volt reference circuit terminal 2 and ground.

    If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the headlamp control module.

    If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the headlamp control module.
4. Verify the appropriate scan tool Leveling Position Sensor parameter is less than 59 degrees.

    If greater than the specified range, test the signal circuit terminal 3 for a short to voltage. If the circuit tests normal, replace the headlamp control module.
5. Install a 3A fused jumper wire between the signal circuit terminal 3 and the 5-volt reference circuit terminal 2. Verify the appropriate scan tool Leveling Position Sensor parameter is greater than 59 degrees.

    If less than the specified range, test the signal circuit for short to ground or an open/high resistance. If the circuit tests normal, replace the headlamp control module.

6. If all circuits test normal, replace the appropriate headlamp leveling sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Headlamp Replacement
- Headlamp Leveling Control Module Replacement
- Control Module References for headlamp control module replacement, setup, and programming

Interior Backlighting Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
INADV/PWR/LED Fuse B+ Terminal 2 X3	1	1	--	--
Panel Dimmer Switch DIM Up Signal	2	2	2	--
Panel Dimmer Switch DIM Down Signal	2	2	2	--
Incandescent Backlight Dimming Control Terminal 3 X2	1	1	1	--
LED Backlight Dimming Control Terminal 18 X3	B2610 00	1	1	--
LED Backlight Dimming Control Terminal 25 X3	B2625 00	1	1	--
Automatic Transmission Shift Lever Ground	--	1	--	--
Cigar Lighter Console Ground	--	1	--	--
Cigar Lighter Front Ground	--	1	--	--
Dome/Reading Lamps Ground	--	1	--	--
Door Lock/Window Switch Ground	--	1	--	--
Headlamp and Panel Dimmer Switch Ground	--	2	--	--
Multifunction Switch - Center Console Ground	--	1	--	--
Steering Wheel Control Switch Ground	--	1	--	--
1. Interior Backlighting Malfunction 2. Dimmer Switch Malfunction				

Circuit/System Description

The up/down dimmer controls located on the headlamp and panel dimmer switch is used to increase and decrease the brightness of the interior backlighting components. Each dimmer control switch provides a voltage signal that will increase as the brightness of the lights are increased and decrease as the brightness of the lights are decreased. The body control module (BCM) supplies each dimmer control switch with a signal circuit. When either the up or down dimmer control switch is placed in the desired position, the dimmed voltage setting is applied from the appropriate dimmer control switch through the dimmer switch signal circuit to the BCM. The BCM interprets the signal and applies the dimmed voltage to the LED and incandescent backlight dimming control circuits and the interior backlighting components dim to the requested level.

Reference Information

Schematic Reference

Interior Lights Dimming Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool LED Dimming PWM. Cmd. and Incand Dimming PWM Command parameters while operating the dimmer switch from high to low. The parameters should change from a high percent to a low percent as the switch is activated.

If the parameters do not change, refer to Panel Dimmer Switch Malfunction.

If the parameters change, refer to Interior Backlighting Malfunction.

Circuit/System Testing

Panel Dimmer Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the headlamp and panel dimmer switch.
2. Ignition OFF, test for less than 5 ohms between the ground circuit terminal 4 and ground.

   If not the specified value, test the ground circuit for an open/high resistance.
3. Ignition OFF, disconnect the X7 harness connector at the BCM.
4. Ignition ON, verify that a test lamp does not illuminate between the signal circuits listed below and ground.
   - Dim down signal terminal 24
   - Dim up signal terminal 10

   If the test lamp illuminates, test the signal circuit for a short to voltage.
5. Ignition OFF, connect the X7 harness connector at the BCM.
6. Ignition ON, test for B+ between the signal circuit terminal 7 and ground.

   If not the specified value, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
7. Ignition ON, test for B+ between the signal circuit terminal 12 and ground.

   If not the specified value, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
8. If all circuits test normal, test or replace the headlamp and panel dimmer switch.

Interior Backlighting Malfunction

1. Ignition OFF, disconnect the X3 harness connector at the BCM.
2. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 2 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Ignition OFF, connect the X3 harness connector at the BCM.
4. Disconnect the harness connector at the component with the inoperative backlighting.
5. Ignition OFF, scan tool OFF, interior lamps OFF, doors CLOSED, test for less than 5 ohms between the appropriate ground circuit terminal listed below and ground.
   - Automatic transmission shift lever terminal 3
   - Cigar lighter - console terminal C
   - Cigar lighter - front terminal C
   - Dome/reading lamps terminal 1
   - Door lock/window switch terminal 4 X2
   - Headlamp and panel dimmer switch terminal 4
   - Multifunction switch - center console terminal 2
   - Multifunction switch - center console terminal 7
   - Steering wheel control switch terminal 7

   If greater than the specified range, test the ground circuit for an open/high resistance.
6. Connect a test lamp between the appropriate control circuit terminal listed below and ground.
   - Automatic transmission shift lever terminal 8
   - Cigar lighter - console terminal A
   - Cigar lighter - front terminal A
   - Dome/reading lamps terminal 6
   - Door lock/window switch terminal 11 X2
   - Headlamp and panel dimmer switch terminal 8
   - Multifunction switch - center console terminal 1

- Multifunction switch - center console terminal 8
- Steering wheel control switch terminal 8

7. Command the Dimmed Illumination Test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.

   If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.

8. If all circuits test normal, test or replace the component with the inoperative backlighting.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Headlamp Switch Replacement
- Cigar Lighter Receptacle or 12-Volt Accessory Power Receptacle Replacement
- Power Mirror Switch Replacement
- Control Module References for BCM replacement, setup, and programming

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Park, License, and/or Tail Lamps Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Park Lamp Relay B+	1	1	--	--
Park Lamp Switch ON Signal	2	B257A 00	2	--
Park Lamp Relay Control	1	1	B2585 00	--
License Lamp Control	1	1	1	--
Park Lamp Control	1	1	1	--
License Lamp Ground	--	1	--	--
Park Lamps - LF Ground	--	1	--	--
Park Lamps - RF Ground	--	1	--	--
Tail/Stop Lamp - Left Ground	--	1	--	--
Tail/Stop Lamp - Right Ground	--	1	--	--
Headlamp And Panel Dimmer Switch Ground	--	2	--	--
1. Park, License, and/or Tail Lamps Malfunction 2. Park Lamp Switch Malfunction				

Circuit/System Description

Battery voltage is applied at all times to both the coil and switch sides of the PRK LAMP relay located in the underhood fuse block. The headlamp and panel dimmer switch is suppled with ground at G201 at all times. When the headlamp switch is placed in either the HEAD or PARK position, ground is applied to the park lamp signal circuit to the body control module (BCM). The BCM responds by applying ground to the park lamp relay control circuit. This energizes the park lamp relay coil causing the relay switch contacts to close allowing battery voltage to flow through the LT PRK and RT PRK fuses to all of the park, tail, and license lamps.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Park Lamp Switch parameter while turning the headlamp and panel dimmer switch to the PARK and AUTO positions. The parameter should change between On and Off.

If the parameter does not change between the commanded states, refer to Park Lamp Switch Malfunction.

If the parameter changes between the commanded states, refer to Park, License, and/or Tail Lamps Malfunction.

Circuit/System Testing

Park Lamp Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the headlamp and panel dimmer switch.
2. Ignition OFF, test for less than 5 ohms between the ground circuit terminal 4 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Park Lamp Switch parameter is Off.

   If not the specified value, test the signal circuit terminal 5 for a short to ground. If the circuit tests normal, replace the BCM.
4. Install a 3A fused jumper wire between the signal circuit terminal 5 and ground. Verify the scan tool Park Lamp Switch parameter is On.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the headlamp and panel dimmer switch.

Park, License, and/or Tail Lamps Malfunction

1. Ignition OFF, disconnect the park lamp relay.
2. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 87 and ground.

   If the test lamp illuminates, test the control circuit for a short to voltage.
3. Verify that a test lamp illuminates between the B+ circuit terminal 30 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse is open, test the control circuit terminal 87 for a short to ground. If the circuit tests normal, test or replace the park lamp relay.
4. Verify that a test lamp illuminates between the B+ circuit terminal 86 and ground.

   If the test lamp does not illuminate, test the B+ circuit for an open/high resistance.
5. Disconnect the harness connector at the inoperative park/license lamp.
6. Ignition OFF, exterior lamps OFF, test for less than 5 ohms between the ground circuit and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
7. Connect the harness connector at the inoperative park/license lamp.
8. Connect a 20A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87. Verify the park/license lamps illuminate.

   If the park/license lamps do not illuminate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the inoperative park/license lamp.
9. Connect a test lamp between the B+ circuit terminal 86 and the control circuit terminal 85.
10. Command the Parking light Test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

    If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

    If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
11. If all circuits test normal, test or replace the park lamp relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Headlamp Switch Replacement
- Rear License Lamp Replacement
- Parking and Turn Signal Lamp Replacement
- Tail Lamp Replacement
- Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn Signal Bulb Replacement
- Relay Replacement
- Control Module References for BCM replacement, setup, and programming

Stop Lamps Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
BCM B+ Terminal 4 X4	B3445 00	B3445 00	--	--
Brake Pedal Position Sensor 5-Volt Reference	C0277 06, C0890 03, C0161 71	C0277 06, C0161 71	C0277 07, C0161 71	--
Brake Applied Signal Terminal 6 X5	C0297 00, P0571 00	3	3	--
Brake Pedal Position Sensor Signal	C0277 06, C0161 71	C0277 06, C0161 71	C0277 07, C0161 71	C0277 09
Stop Lamp Control	B3445 00	1	1	--
Brake Position Sensor Low Reference	--	1	1	--
Center High Mounted Stop Lamp (CHMSL) Ground	--	2	--	--
Left Rear Tail/Stop Lamp Ground	--	1	--	--
Right Rear Tail/Stop Lamp Ground	--	1	--	--

1. Stop Lamps Malfunction

2. Center High Mounted Stop Lamp (CHMSL) Malfunction

3. Cruise Control Malfunction

Circuit/System Description

The brake pedal position sensor is used to sense the action of the driver application of the brake pedal. The brake pedal position (BPP) sensor provides an analog voltage signal that will increase as the brake pedal is applied. The body control module (BCM) provides a low reference signal and a 5-volt reference voltage to the brake pedal position sensor. When the variable signal reaches a voltage threshold indicating the brakes have been applied, the BCM will apply battery voltage to the stop lamp control circuit illuminating the left and right stop lamps and the center high mounted stop lamp (CHMSL). The BCM also applies battery voltage to the transmission control module

(TCM) and engine control module (ECM) via the brake applied signal circuit.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Brake Status parameter as you apply and unapply the brake pedal. The parameter should change between Off and On as the brake pedal is applied and released.

> If the parameter does not change as the brake pedal is applied and released, refer to Brake Pedal Position (BPP) Sensor Malfunction.
>
> If the parameter changes as the brake pedal is applied and released, refer to Stop Lamps Malfunction.

Circuit/System Testing

Stop Lamps Malfunction

1. Ignition OFF, disconnect the X4 harness connector at the BCM.
2. Verify that a test lamp illuminates between the B+ circuit terminal 4 and ground.
   > If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Connect the X4 harness connector at the BCM.
4. Disconnect the harness connector at the inoperative stop lamp.

5. Ignition OFF, exterior lamps OFF, test for less than 5 ohms between the appropriate ground circuit terminal listed below and ground.
    - Tail/stop lamp terminal GRD
    - CHMSL terminal B

    If greater than the specified range, test the ground circuit for an open/high resistance.
6. Connect a test lamp between the appropriate control circuit terminal listed below and ground.
    - Tail/stop lamp terminal MJR
    - CHMSL terminal A
7. Ignition ON, command the Brake Light Test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

    If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.

    If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
8. If all circuits test normal, replace the inoperative stop lamp.

Brake Pedal Position (BPP) Sensor Malfunction

1. Ignition OFF, disconnect the harness connector at the BPP sensor.
2. Ignition ON, verify that a test lamp illuminates between B+ and the low reference circuit terminal C.

    If the test lamp does not illuminate, test the low reference circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
3. Ignition ON, test for 4.8 volts and 5.2 volts between the 5-volt reference circuit terminal A and ground.

    If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.

    If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the BCM.
4. If all circuits test normal, test or replace the brake pedal position sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- High Mount Stop Lamp Replacement
- Tail Lamp Replacement
- Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn Signal Bulb Replacement
- Stop Lamp Switch Replacement
- Control Module References for BCM replacement, setup, and programming

Trailer Lamps Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Trailer Box Converter Module B+	1	1	--	--
Backup Lamps Signal	1	1	1	--
Park Lamps Signal	1	1	1	--
Stop Lamps Signal	1	1	1	--
Turn Signal Lamps Signal - Left	1	1	1	--
Turn Signal Lamps Signal - Right	1	1	1	--
Backup Lamps Control	1	1	1	--
Park Lamps Control	1	1	1	--
Stop Lamps Control	1	1	1	--
Turn Signal Lamps Control - Left	1	1	1	--
Turn Signal Lamps Control - Right	1	1	1	--
Trailer Box Converter Module Ground	--	1	--	--
Trailer Connector Ground	--	1	--	--
1. Trailer Lamps Malfunction				

Circuit/System Description

The trailer harness contains an electronic control unit (ECU) to control the lighting signals to the trailer lamps. The trailer harness and trailer ECU is integrated into the vehicle wiring harness and controls the signals to the standard 7-pin trailer connector. The trailer connector is mounted to the vehicles rear fascia. Battery Voltage is supplied to the trailer ECU from the 30 A Trailer fuse located in the rear fuse block. The trailer harness also provides a connection for the addition of an electronic trailer brake system.

Reference Information

Schematic Reference

Trailer Connector/Provision Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, command the Reverse Light Test On and Off with a scan tool. The vehicles backup lamps should turn on and off when commanded.

   If the backup lamps do not turn On and Off when commanded, refer to Backup Lamps Malfunction.
2. Command the Parking Light Test On and OFF with a scan tool. The vehicles park lamps should turn on and off when commanded.

   If the park lamps do not turn On and Off when commanded, refer to Park, License, and/or Tail Lamps Malfunction.
3. Command the Brake Light Test On and OFF with a scan tool. The vehicles stop lamps should turn on and off when commanded.

   If the stop lamps do not turn on and off when commanded, refer to Stop Lamps Malfunction.
4. Command the Rear Turn Signal Test On and OFF with a scan tool. The vehicles stop lamps should turn on and off when commanded.

   If the rear turn signal lamps do not turn on and off when commanded, refer to Turn Signal Lamps and/or Indicators Malfunction.
5. Verify the trailer lamps operate properly. All trailer lamps should illuminate when commanded.

   If all trailer lamps are inoperative, refer to Trailer Lamps Malfunction - All

   If individual trailer lamps are inoperative, refer to Trailer Lamps Malfunction - Individual

Circuit / System Testing

Trailer Lamps Malfunction - All

1. Ignition OFF, disconnect the harness connector at the trailer box converter module.
2. Ignition OFF, exterior lamps OFF, test for less than 5 ohms between the ground circuit terminal 3 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 6 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
4. If all circuits test normal, replace the trailer box converter module.

Trailer Lamps Malfunction - Individual

1. Ignition OFF, disconnect the harness connector at the trailer box converter module.
2. Ignition OFF, exterior lamps OFF, test for less than 5 ohms between the ground circuit terminal 3 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Connect a test lamp between the appropriate signal circuit terminal listed below and ground.
   - Backup lamp terminal 12
   - Park lamp terminal 4
   - Stop lamp terminal 5
   - Turn signal lamp - left terminal 9
   - Turn signal lamp - right terminal 10
4. Ignition ON, command the appropriate Light Test listed below On and Off with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
   - Reverse Light Test
   - Parking Light Test
   - Brake Light Test
   - Rear Turn Signal Test

   If the test lamp is always ON, test the signal circuit for a short to voltage.

   If the test lamp is always OFF, test the signal circuit for a short to ground or an open/high resistance.
5. Ignition OFF, connect the harness connector at the trailer box converter module.
6. Connect a test lamp between the appropriate control circuit terminal listed below at the trailer connector and ground.
   - Backup lamp terminal 2
   - Park lamp terminal 7
   - Stop lamp terminal 6
   - Turn signal lamp - left terminal 1
   - Turn signal lamp - right terminal 4
7. Ignition ON, command the appropriate Light Test listed below On and Off with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
   - Reverse Light Test
   - Parking Light Test

- Brake Light Test
- Rear Turn Signal Test

  If the test lamp is always ON, test the control circuit for a short to voltage.

  If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance.

8. If all circuits test normal, replace the trailer box converter module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Turn Signal Lamps and/or Indicators Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
CTSY/TRN SIG RT FRT Fuse B+	1	1	--	--
TRN/SIG RT Fuse B+	1	1	--	--
TRN/SIG LT Fuse B+	1	1	--	--
Left Turn Signal Switch Signal	2	2	2	--
Right Turn Signal Switch Signal	2	2	2	--
Left Front Turn Signal Lamp Control	1	1	1	--
Right Front Turn Signal Lamp Control	1	1	1	--
Left Rear Turn Lamp Control	1	1	1	--
Right Rear Turn Lamp Control	1	1	1	--
Left Rear Turn Lamp Ground	--	1	--	--
Left Repeater Lamp Ground	--	1	--	--
Right Repeater Lamp Ground	--	1	--	--
Right Rear Turn Lamp Ground	--	1	--	--
Turn Signal/Multifunction Switch Ground	--	2	--	--
Turn Signal Lamp - LF Ground	--	1	--	--
Turn Signal Lamp - RF Ground	--	1	--	--
1. Turn Signal Lamps and/or Indicators Malfunction 2. Turn Signal Switch Malfunction				

Circuit / System Description

Ground is applied at all times at G201 to the turn signal/multifunction switch. The turn signal lamps may only be activated with the ignition switch in the ON or START position. When the turn signal/multifunction switch is placed in either the TURN RIGHT or TURN LEFT position, ground is applied to the body control module (BCM) through either the right turn or left turn signal switch signal circuit. The BCM then applies a pulsating voltage to the front and rear turn signal lamps through there respective voltage supply circuits. When a turn signal request is received by the BCM, a serial data message is sent to the instrument panel cluster (IPC) requesting the respective turn signal indicator be pulsed ON and OFF.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

Ignition ON, observe the scan tool Right and Left Turn Signal Switch parameters while cycling the turn signal switch between the left and right positions. The parameters should change between Active and Inactive.

If the parameters do not change between the commanded states, refer to Turn Signal Switch Malfunction.

If the parameters change between the commanded states, refer to Turn Signal Lamps Malfunction.

Circuit / System Testing

Turn Signal Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the turn signal/multifunction switch.
2. Ignition OFF, test for less than 1 ohm between the ground circuit terminal 1 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Left Turn Signal Switch parameter is Inactive.

   If not the specified value, test the signal circuit terminal 8 for a short to ground. If the circuit tests normal, replace the BCM.
4. Verify the scan tool Right Turn Signal Switch parameter is Inactive.

   If not the specified value, test the signal circuit terminal 7 for a short to ground. If the circuit tests normal, replace the BCM.
5. Install a 3A fused jumper wire between the signal circuit terminal 8 and ground. Verify the scan tool Left Turn Signal Switch parameter is Active.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
6. Install a 3A fused jumper wire between the signal circuit terminal 7 and ground. Verify the scan tool Right Turn Signal Switch parameter is Active.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
7. If all circuits test normal, test or replace the turn signal/multifunction switch.

Turn Signal Lamps Malfunction

1. Ignition OFF, disconnect the X4 harness connector at the BCM.
2. Verify that a test lamp illuminates between the B+ circuit terminal 1 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Verify that a test lamp illuminates between the B+ circuit terminal 2 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
4. Verify that a test lamp illuminates between the B+ circuit terminal 3 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
5. Ignition OFF, connect the X4 harness connector at the BCM.
6. Ignition OFF, disconnect the harness connector at the inoperative turn signal lamp.
7. Ignition OFF, exterior lamps OFF, test for less than 5 ohms between the appropriate ground circuit terminal listed below and ground.
   - Left front turn signal terminal 1
   - Right front turn signal terminal 1
   - Left rear turn signal terminal 2
   - Right rear turn signal terminal 2
   - Left turn signal repeater terminal 1
   - Right turn signal repeater terminal 1

   If greater than the specified range, test the ground circuit for an open/high resistance.
8. Connect a test lamp between the appropriate control circuit terminal listed below and ground.
   - Left front turn signal terminal 9
   - Right front turn signal terminal 9
   - Left rear turn signal terminal 6

- Right rear turn signal terminal 6
- Left turn signal repeater terminal 2
- Right turn signal repeater terminal 2

9. Command the appropriate Turn Signal Test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.

10. If all circuits test normal, replace the inoperative turn signal lamp assembly.

Turn Signal Indicators Malfunction

Ignition ON, with a scan tool perform the Display Tests for the instrument panel cluster (IPC) and observe the turn signal lamp indicators.

If the turn signal lamp indicators illuminate during the test, replace the BCM.

If the turn signal lamp indicators do not illuminate during the test or remain illuminated at all times, replace the IPC.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Parking and Turn Signal Lamp Replacement
- Repeater Lamp Replacement
- Tail Lamp Replacement
- Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn Signal Bulb Replacement
- Turn Signal Switch Replacement
- Control Module References for BCM or IPC replacement, setup, and programming

Brake Pedal Position Sensor Calibration

The brake pedal position sensor (BPPS) receives a low reference signal and a 5-volt reference signal from the BCM. Whenever the brake pedal is applied, the BPPS applies a variable voltage signal to the BCM through the stop lamp switch signal circuit. The BPPS calibration must be performed after the BPPS or body control module (BCM) have been serviced. The calibration procedure will set BPPS home value. This value is used by the BCM to determine the action of the driver applying the brake system and to provide this information to the vehicle subsystems via the communication bus.

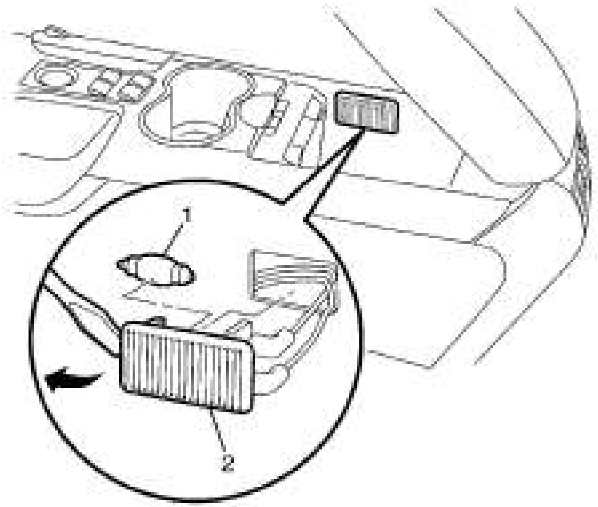
- Apply the parking brake.
- Place the transmission in the PARK position for automatic transmission or NEUTRAL for manual transmission.
- Install a scan tool.
- Clear all BCM DTCs before proceeding.
- Navigate to the Body menu.
- Select BCM menu item.
- Select Programming menu item.
- Select the Brake Pedal Position Sensor Learn procedure and follow the directions displayed on the screen.
- Turn ignition OFF and wait 30 seconds.

Console Lamp Replacement

Removal Procedure - Up to 17 Sept 2007

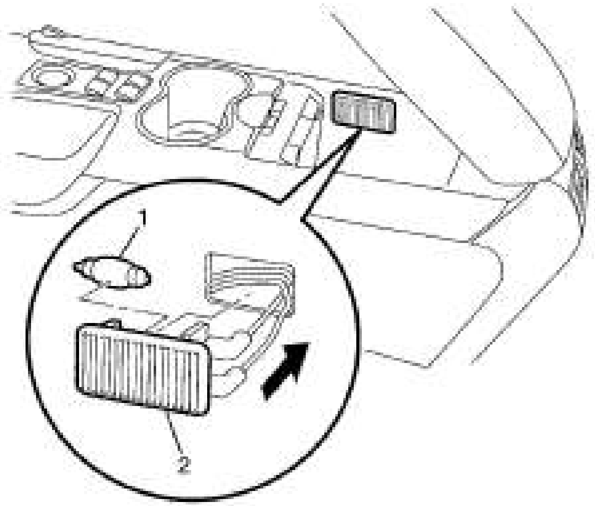
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .



2. Insert a suitable tool under the console lamp assembly (2) and gently pry the lamp from the console.
3. Bend back the lever contact that holds the bulb (1) and remove the bulb from the lamp assembly.

Installation Procedure - Up to 17 Sept 2007



1. Install the new bulb (1) to the console lamp assembly.
2. Feed the lamp wiring into the cavity and push the lamp assembly (2) back into the cavity.
3. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
4. Check all vehicle lights for correct operation.

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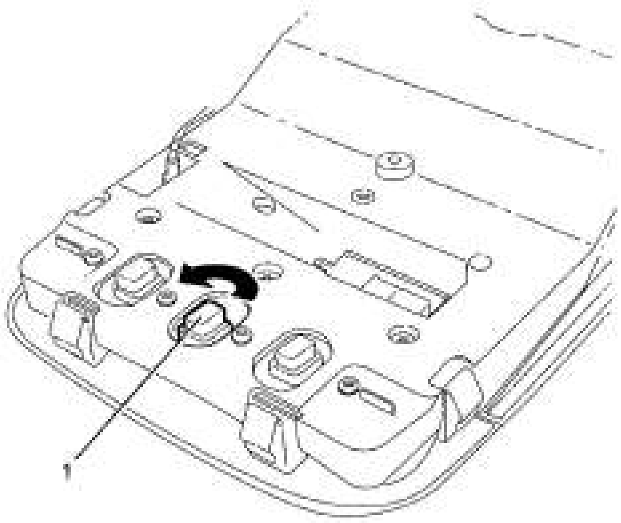
Dome Lamp Bulb Replacement

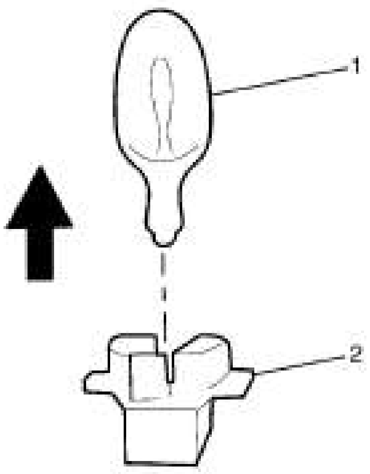
Removal Procedure - Front Bulb

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the front dome lamp assembly. Refer to Dome Lamp Replacement.

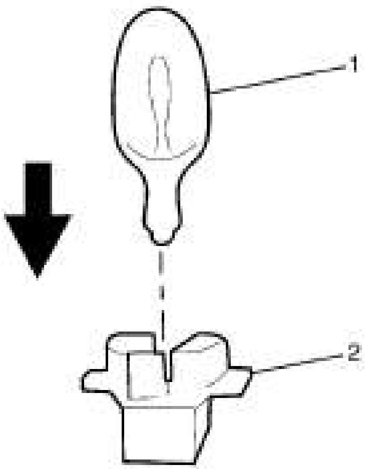


3. Twist the dome light bulb (1) assembly counter clockwise and remove from the dome lamp assembly.

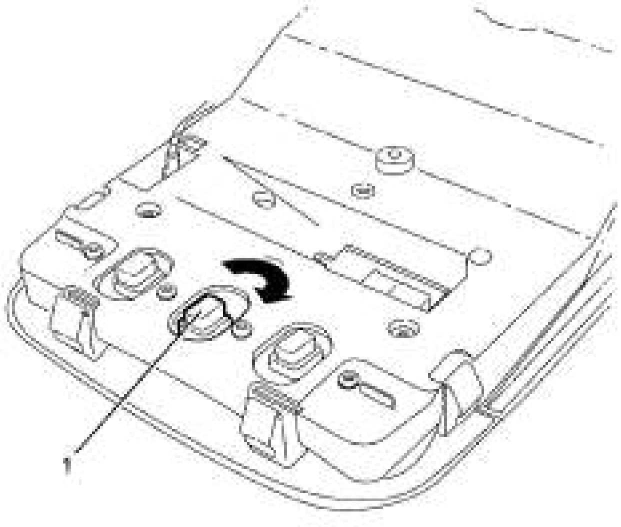


4. Remove the dome light bulb (1) by gently pulling it from the socket (2).

Installation Procedure - Front Bulb



1. Install a new dome light bulb (1) to the dome light socket (2).



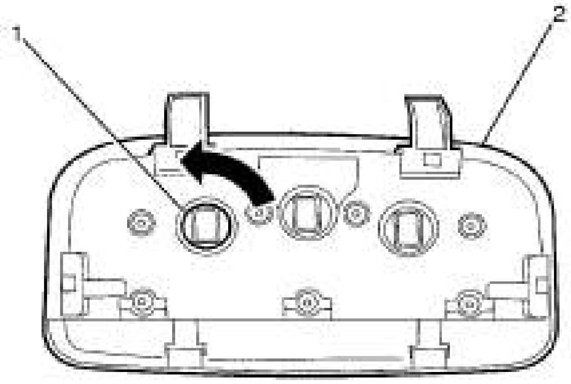
2. Install the dome light bulb (1) assembly, into the lamp assembly and twist clockwise to secure.
3. Install the front dome lamp assembly. Refer to Dome Lamp Replacement.
4. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and

Connection.

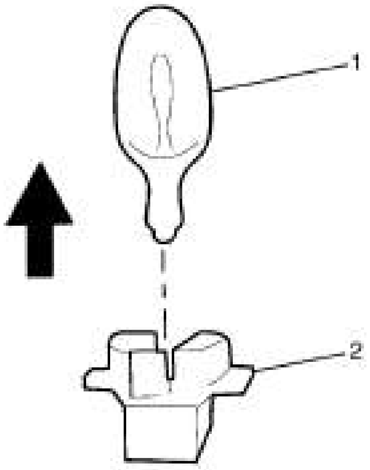
5. Test the front dome lamp for correct operation.

Removal Procedure - Rear Bulb

1. Remove the rear dome lamp assembly. Refer to Dome Lamp Replacement.

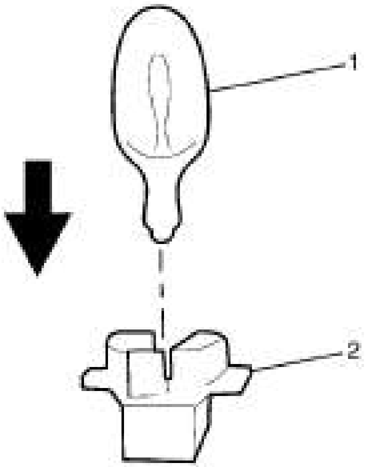


2. Twist the dome light bulb assembly (1) counter clockwise and remove from the dome lamp assembly (2).

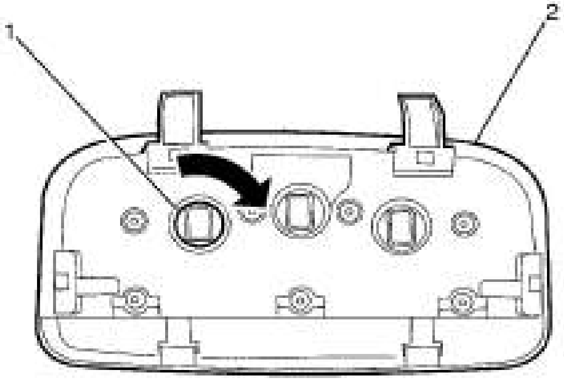


3. Remove the dome light bulb (1) by gently pulling it from the socket (2).

Installation Procedure - Rear Bulb



1. Install a new dome light bulb (1) to the socket (2).



2. Install the dome light bulb assembly, into the lamp assembly and twist clockwise to secure.
3. Install the rear dome lamp assembly. Refer to Dome Lamp Replacement.
4. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
5. Test the rear dome lamp for correct operation.

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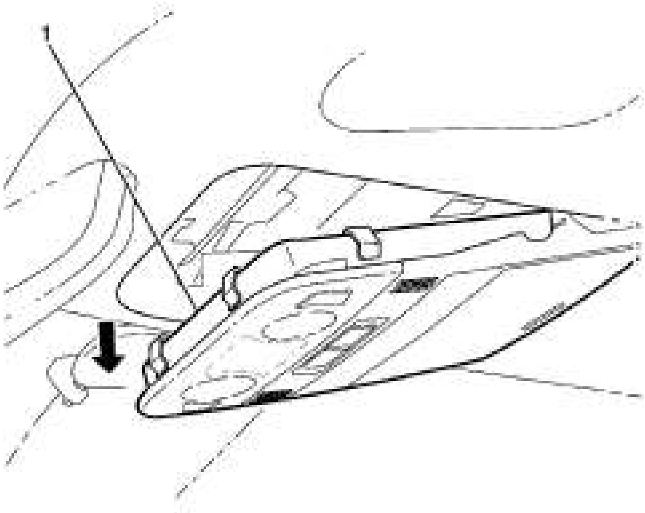
Dome Lamp Replacement

Removal Procedure - Front

Notice: Refer to General Repair Instructions in the Preface section.

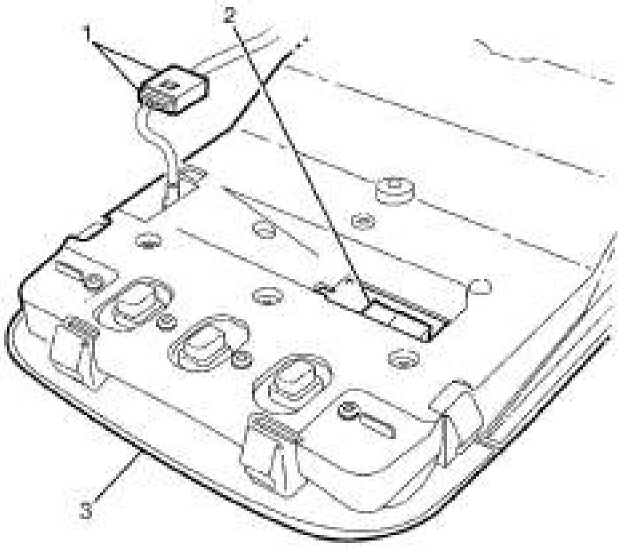
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.



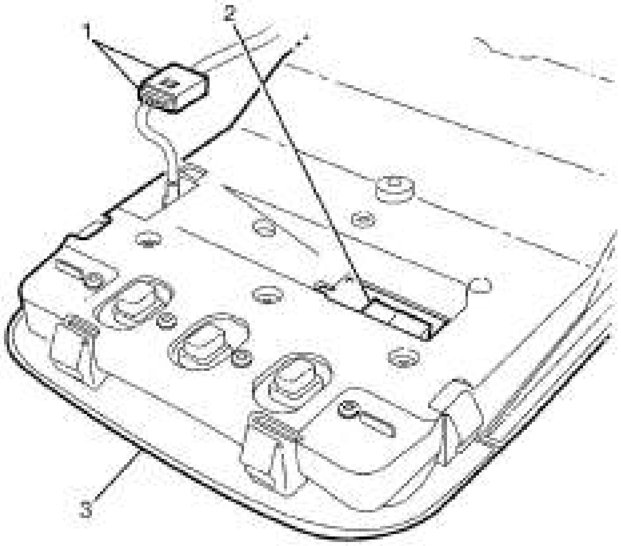
Important: The headliner can be easily damaged or discoloured. Use care when working in the area of the headliner.

2. Grasp the front of the dome lamp assembly (1) and carefully pull away from the headlining assembly.
3. Slide the dome lamp assembly (1) in a forward motion to allow the two locator arms to clear the headlining.

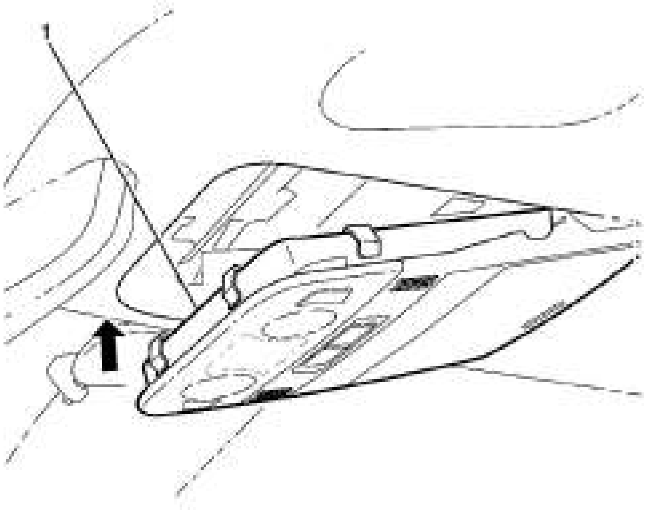


4. Disconnect the dome lamp assembly electrical connector (1).
5. Disconnect the bluetooth connection (1) from the dome lamp assembly (3).
6. Remove the dome lamp assembly (3).

Installation Procedure - Front



1. Connect the dome lamp assembly electrical connector (1).
2. Connect the bluetooth connection (1) dome lamp assembly (3).

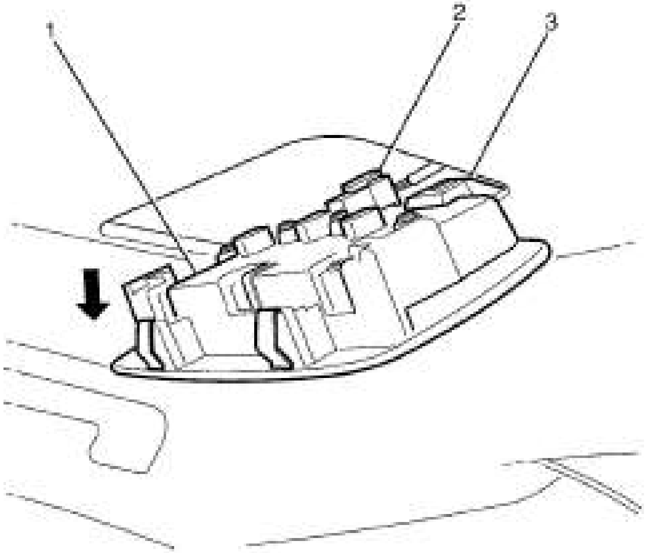


3. Insert the two locating arms into the headlining assembly.
4. Carefully push the dome lamp assembly (1) into the headlining assembly.
5. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
6. Test dome lamp assembly for the correct operation.

Removal Procedure - Rear (without Rear Seat Entertainment)

Caution: Refer to Battery Disconnect Caution in the Preface section.

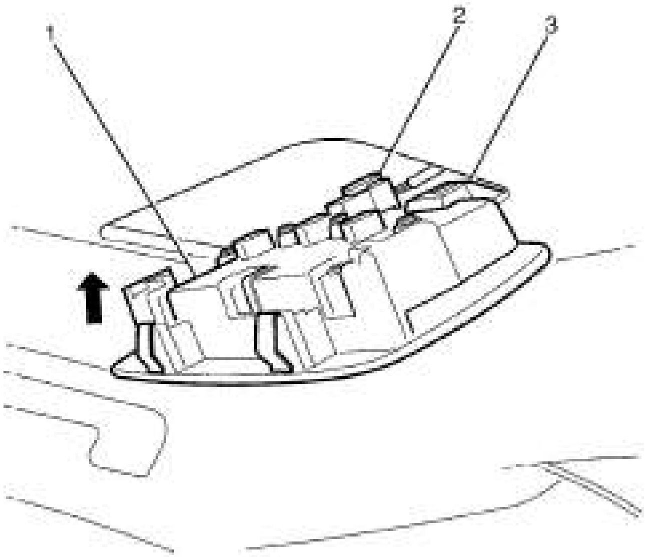
1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.



Important: The headliner can be easily damaged or discoloured. Use care when working in the area of the headliner.

2. Using a suitable tool, gently pry the front of the dome lamp assembly (1) down and lower the front of the assembly.
3. Pivot the lamp assembly down and pull the assembly forward to clear the rear locking arms (3).
4. Disconnect the dome lamp assembly electrical connector (2) and remove the dome lamp assembly.

Installation Procedure - Rear (without Rear Seat Entertainment)

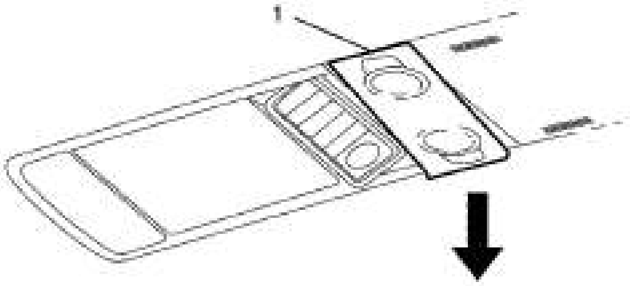


1. Connect the dome lamp assembly electrical connector (2).
2. Position the dome lamp assembly rear locking arms (3) into the headliner and pivot the front of the lamp assembly (1) up and into the headliner.
3. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
4. Check all vehicle lights for correct operation.

Removal Procedure - Rear (with Rear Seat Entertainment)

Caution: Refer to Battery Disconnect Caution in the Preface section.

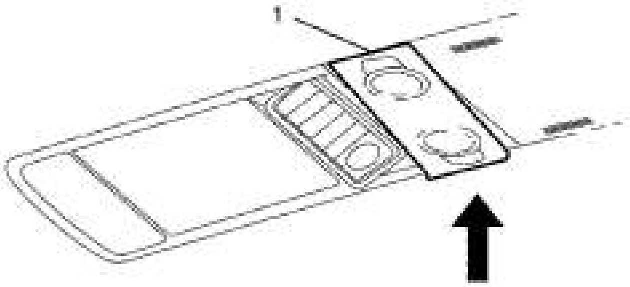
1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.



Important: The headliner can be easily damaged or discoloured. Use care when working in the area of the headliner.

2. Pull down on the left or right hand edge of the dome lamp assembly (1), using only your fingers.
3. Pull the lamp down and clear of the rear seat entertainment assembly.
4. Disconnect the dome lamp assembly electrical connector and remove the dome lamp assembly.

Installation Procedure - Rear (with Rear Seat Entertainment)



1. Connect the dome lamp assembly electrical connector.
2. Position the dome lamp assembly (1) with one side into the rear seat entertainment assembly and gently push the other side of the lamp assembly up and into the headliner.
3. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
4. Check all vehicle lights for correct operation.

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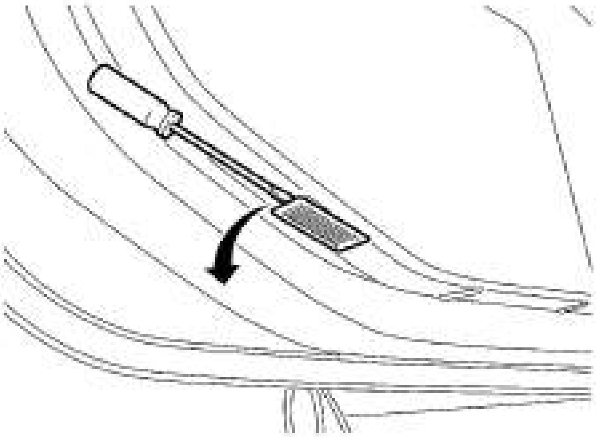
Door Courtesy Lamp and Reflector Replacement

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

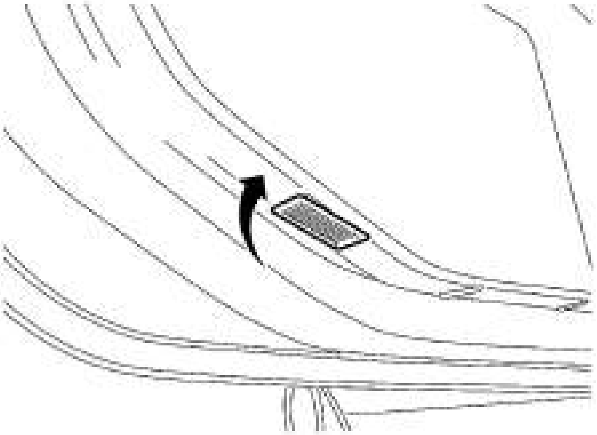
1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Open the door.



3. Insert a suitable tool under the door courtesy lamp assembly and gently pry the lamp assembly from the door trim panel.
4. Remove the lamp assembly from the door trim panel and disconnect the electrical connector.
5. Bend back the lever contact that holds the bulb and remove the bulb from the lamp housing.

Installation Procedure

1. Install the new bulb to the lamp assembly.



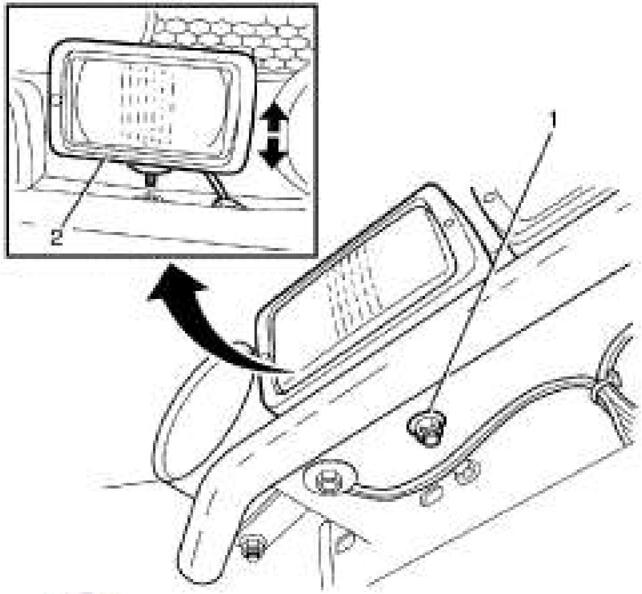
2. Connect the electrical connector to the lamp assembly.
3. Feed the lamp assembly wiring into the cavity and push the lamp back into the door panel cavity.
4. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
5. Check all vehicle lights for correct operation.

Emergency Vehicle Headlamp Flasher Replacement

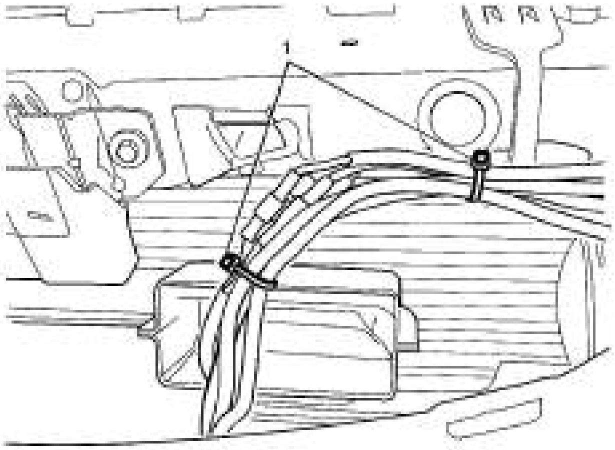
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery negative cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the radiator grille. Refer to Radiator Grille Replacement.



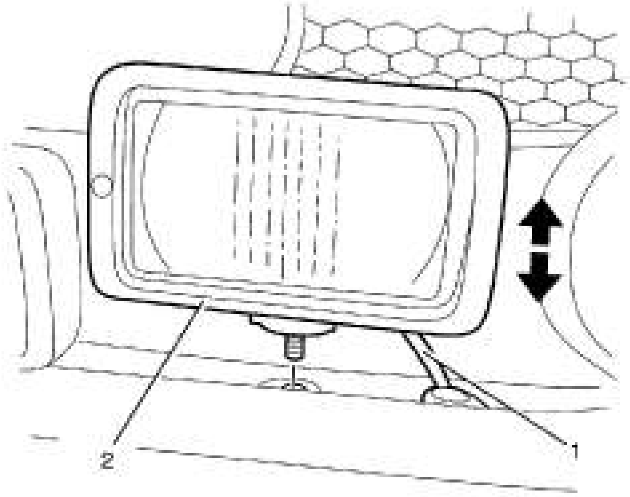
3. Remove the front flashing light to bumper bar retaining nut (1).
4. Detach the front flashing light (2) from the bumper bar.



Important: When removing the cable ties care must be undertaken not to damage the wiring loom.

Important: Cable ties are a single use item.

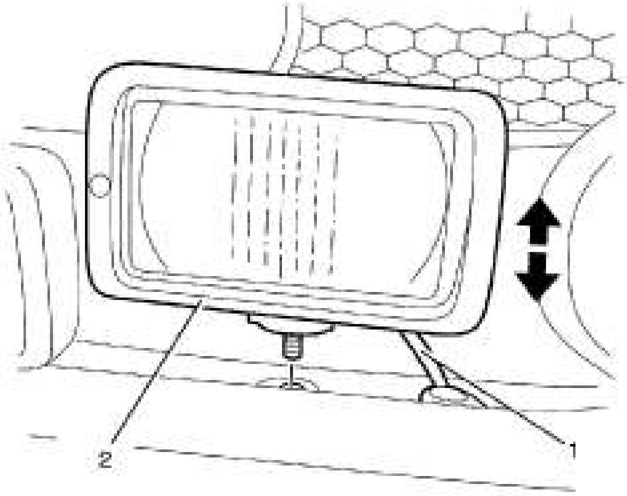
5. Remove the cable ties (1) from the wiring harness.
6. Locate the correct electrical connectors for the front flashing lights.
7. Disconnect the front flashing light electrical connectors.



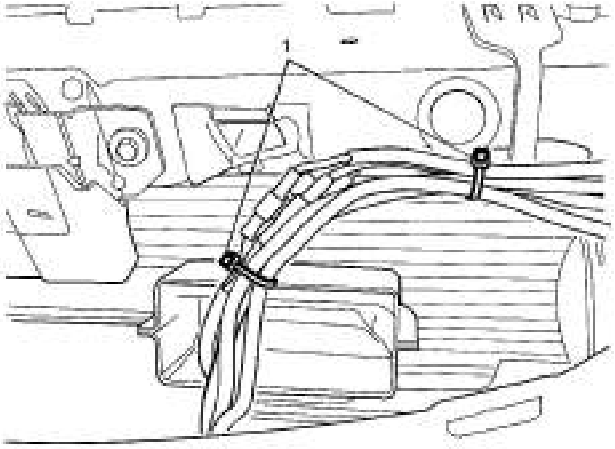
Important: When removing the front flashing light, take note of the route of the wiring harness routing.

8. Remove the front flashing lights (2) and wiring harness (1) from the vehicle.
9. Repeat steps 3 to 9 for the opposite flashing light (if required).

Installation Procedure

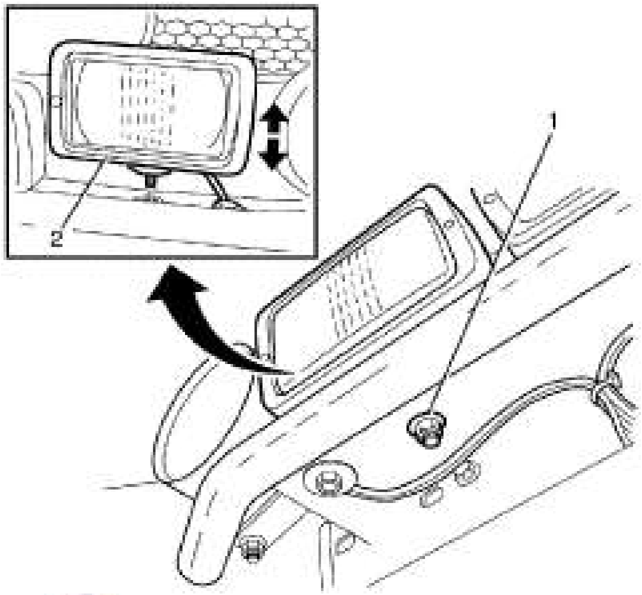


1. Install the front flashing lights (2) and wiring harness (1).



2. Connect the front flashing lights electrical connectors.
3. Secure the wiring harness with new cable ties (1).

Notice: Refer to Fastener Notice in the Preface section.



4. Install the front flashing light to bumper bar retaining nut (1).

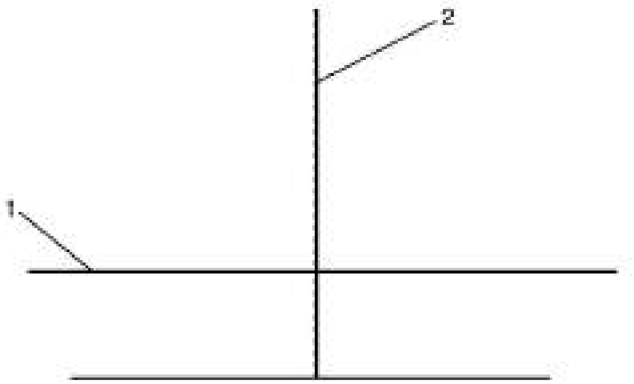
   Tighten
   Tighten the nut to xx N·m (xx lb in).

5. Install the radiator grille. Refer to Radiator Grille Replacement.
6. Repeat steps 1 to 4 for opposite side flashing light (if required).
7. Connect the battery negative cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.
8. Test the front flashing lights for the correct operation.

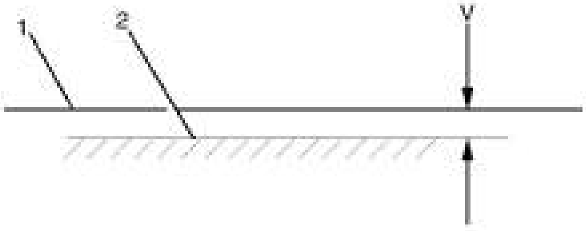
Fog Lamp Aiming (LWB SWB)

Aiming Procedure

Important: Use this procedure only when suitable test equipment is unavailable.

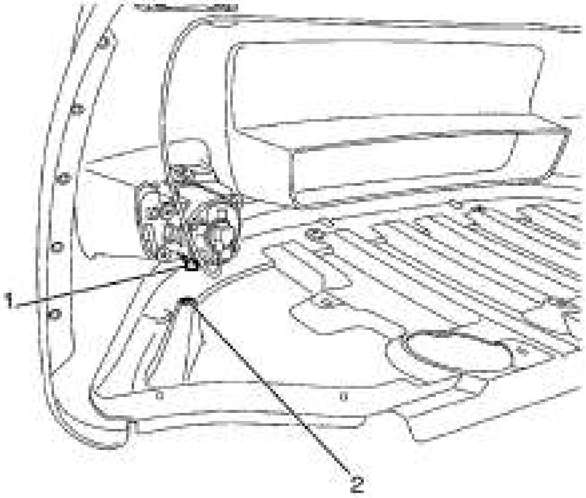


1. Set up a screen or use a vertical, with a flat horizontal wall. Park the vehicle immediately in front of the screen or wall and mark the following lines:
   - A vertical centre-line (2) that corresponds to the centre of the vehicle.
   - A horizontal line (1) that corresponds to the centre of the front fog lamp bulb.
2. Turn on the front fog lamps to check whether the marks are correctly positioned.
3. Reverse the vehicle straight back so the front is five metres in front of the screen or wall, ensuring the centre of the vehicle is aligned with the vertical centre-line mark (3) on the screen.



4. Turn on the front fog lamps. Aim each front fog lamp with the cut-off line (2) 100 mm (V) below the front fog lamp horizontal centre-line (1).

Adjustment Procedure



1. Access the fog lamp vertical adjuster (1) through the opening (2) in the front air deflector.
2. Adjust the fog lamp up or down until 100 mm is reached at the horizontal centre-line.

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Front Fog Lamp Bulb Replacement (LWB SWB)

Removal Procedure

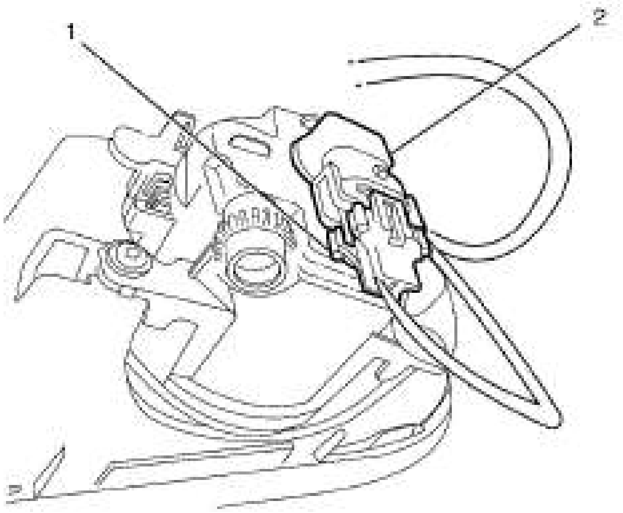
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

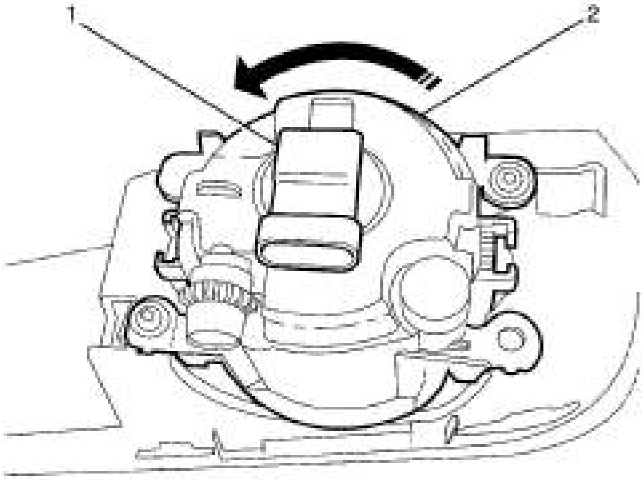
   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Remove the air deflector from the front end of the vehicle. Refer to Front Air Deflector Replacement.

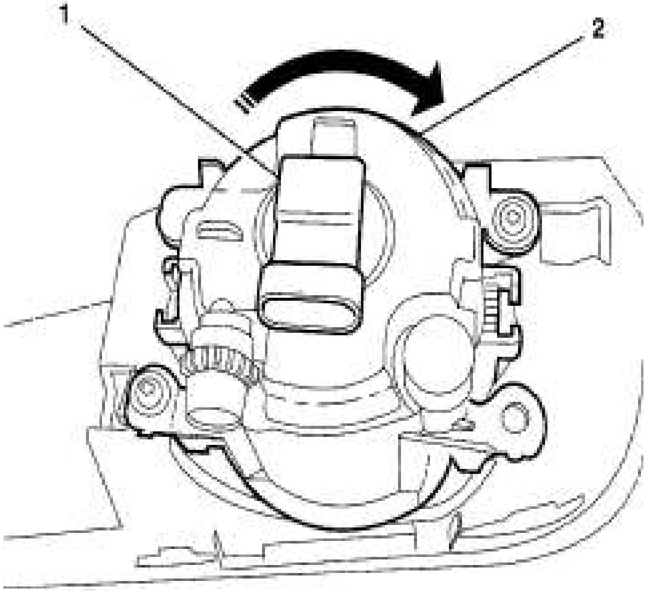


4. Disconnect the fog lamp bulb assembly electrical connector (1) from the fog lamp assembly (2).



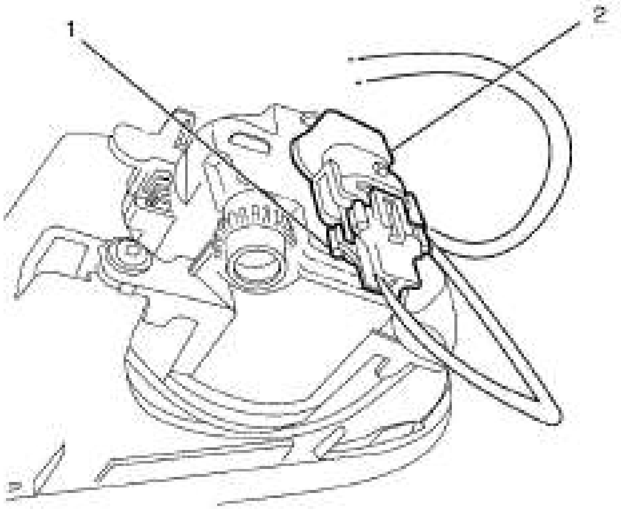
5. Remove the fog lamp bulb assembly (1) from the fog lamp assembly (2) by rotating the bulb assembly countercockwise.

Installation Procedure



Important: When replacing the fog lamp bulb do not handle the quartz envelope of the fog lamp bulb. Wipe the quartz envelope immediately with methylated spirits if it is touched accidentally or the performance of the bulb will deteriorate.

1. Install the front fog lamp bulb assembly (1) to the fog lamp assembly (2) and rotate it clockwise to secure.



2. Connect the fog lamp bulb assembly electrical connector (1) to the fog lamp assembly (2).
3. Install the air deflector to the front end of the vehicle. Refer to Front Air Deflector Replacement.
4. Lower the vehicle.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

5. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
6. Adjust the fog lamps. Refer to Fog Lamp Aiming.

Front Fog Lamp Cover Replacement

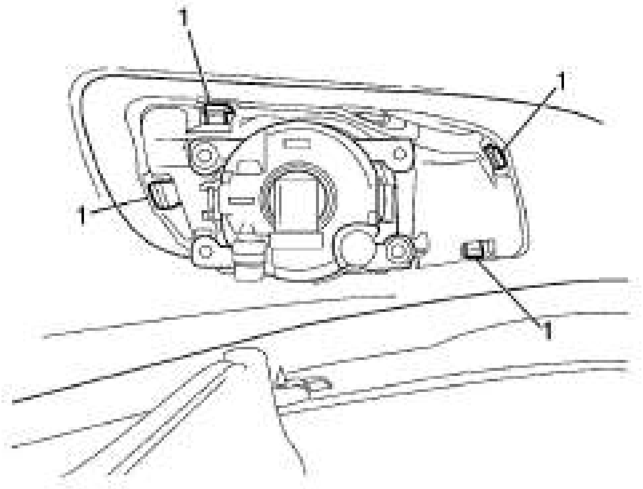
Removal Procedure

Type A

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the front air deflector. Refer to Front Air Deflector Replacement.



Important: Carefully pry the front fog lamp cover from the front bumper fascia

3. Disengage the front fog lamp cover retaining tabs (1) from the front bumper fascia.
4. Remove the front fog lamp cover from the vehicle.

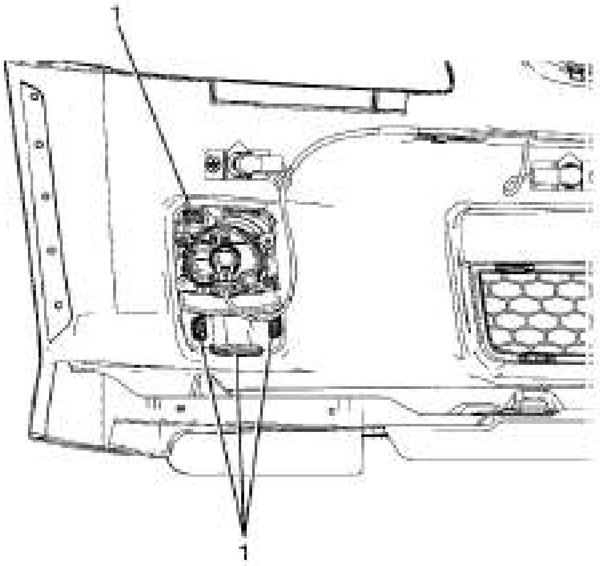
Removal Procedure

Type B

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the front air deflector. Refer to Front Air Deflector Replacement.



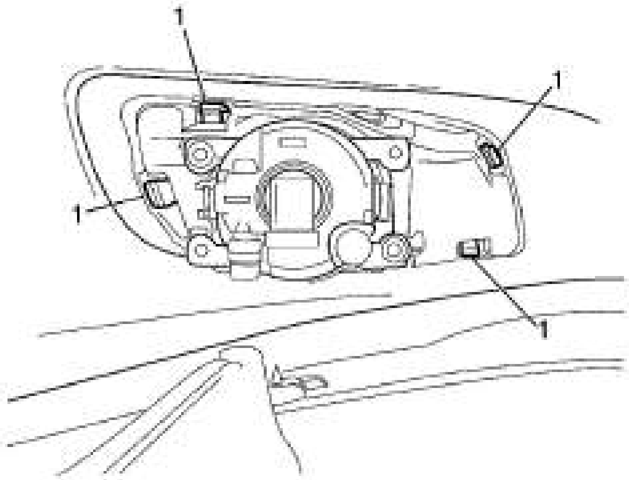
Important: Carefully pry the front fog lamp cover from the front bumper fascia

3. Disengage the front fog lamp cover retaining tabs (1) from the front bumper fascia.
4. Remove the front fog lamp cover from the vehicle.

Installation Procedure

Type A

1. Install the front fog lamp cover to the front bumper fascia.



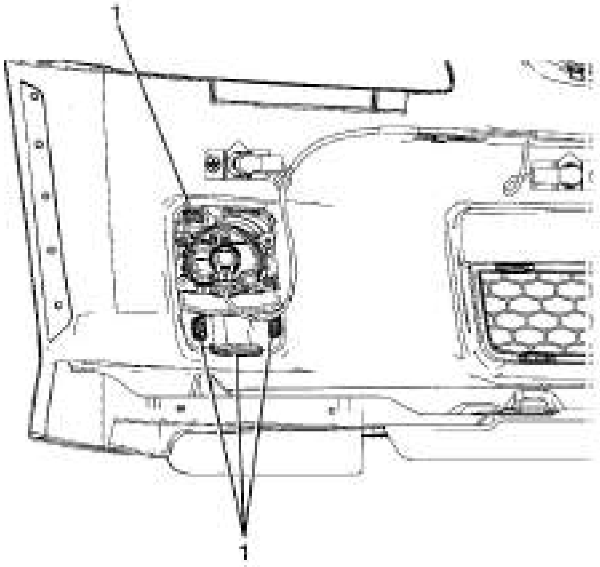
2. Firmly press the front fog lamp cover retaining tabs (1) into the front bumper fascia.

3. Install the front air deflector. Refer to Front Air Deflector Replacement.
4. Lower the vehicle.

Installation Procedure

Type B

1. Install the front fog lamp cover to the front bumper fascia.



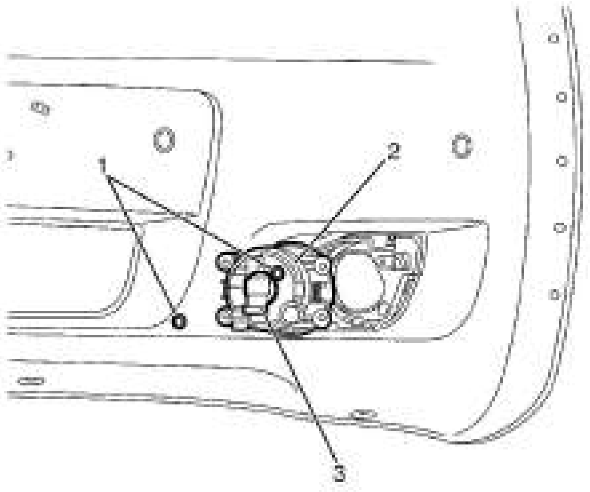
2. Firmly press the front fog lamp cover retaining tabs (1) into the front bumper fascia.
3. Install the front air deflector. Refer to Front Air Deflector Replacement.
4. Lower the vehicle.

Front Fog Lamp Replacement (LWB SWB)

Removal Procedure

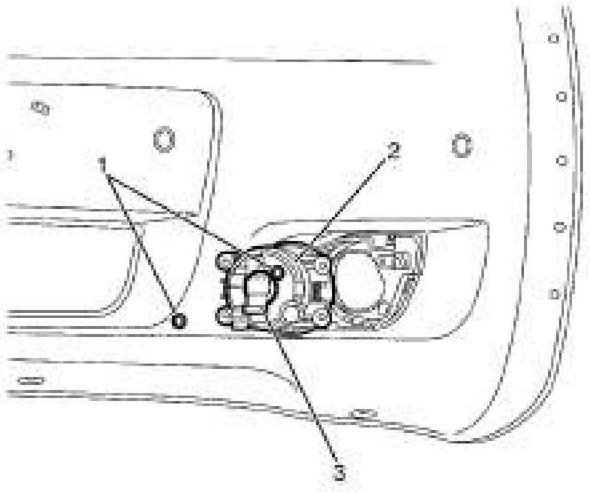
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the air deflector from the front end of the vehicle. Refer to Front Air Deflector Replacement.



3. Disconnect the electrical connector (3) from the fog lamp assembly.
4. Remove the fasteners (1) that secure the front fog lamp assembly (2) to the front fascia.
5. Remove the front fog lamp assembly from the vehicle.

Installation Procedure



Important: Do not handle the quartz envelope of the headlight bulb. Wipe the quartz envelope immediately with methylated spirits if it is touched accidentally or the performance of the bulb will deteriorate.

1. Install the front fog lamp assembly (2) to the front facia assembly.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install and tighten the retaining screws to secure the front fog lamp assembly to the front fascia.

   Tighten
   Tighten the retaining screws to 2.0 N·m (18 lb in).

3. Connect the electrical connector (3) to the fog lamp assembly.
4. Install the air deflector to the front end of the vehicle. Refer to Front Air Deflector Replacement.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

5. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
6. Adjust the fog lamps. Refer to Fog Lamp Aiming.

Hazard Warning Switch Replacement

The hazard warning switch is an integral part of the infotainment fascia, replacement of the hazard warning switch will require the replacement of the infotainment fascia. Refer to Radio Replacement

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Headlamp Aiming

Headlamp Aiming

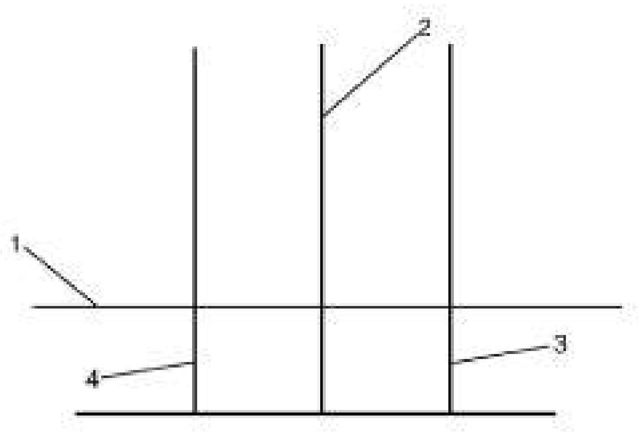
Important: During headlamp assembly aiming, do not use a cloth or similar material to cover the lens of the headlamp assembly being adjusted. Damage to the headlamp assembly will result if the headlamp beam is obstructed in this manor.

Headlamp aim should be checked:

- When a new headlamp capsule is installed.
- If service or repairs to the front end area have (or may have) disturbed the headlamps or their mounting.

Prior to aiming the headlamps, the following workshop area and equipment are needed:

- The area must consist of a level surface large enough to a mark reference line the length of a vehicle and an additional 7.62 m (25 ft) measured from the face of the lamps to the front of the aiming screen.
- The screen will be 1.52 m (5 ft) high x 3.66 m (12 ft) wide with a matte white surface well shaded from extraneous light, and correctly adjusted to the floor on which the vehicle stands. Provisions should be made to align the screen parallel with the vehicle.
-

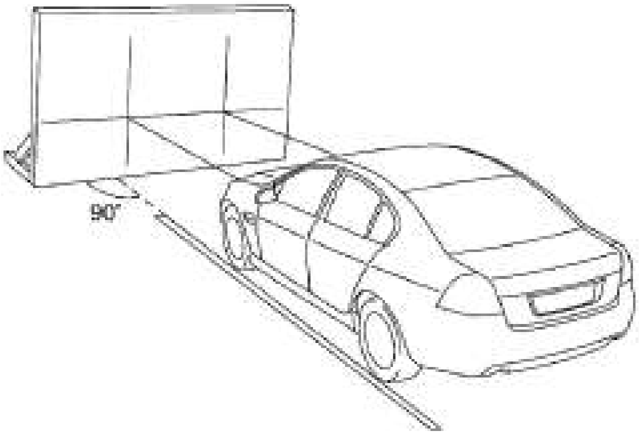


ı The screen must be provided with a fixed vertical centre-line (2) that corresponds to the centre of the vehicle, two laterally adjustable vertical lines (3 and 4) corresponding to the centre of the low beam bulb on each side of the vehicle and one vertically adjustable horizontal line (1) that corresponds to the centre of the front low beam bulb.

- If a regular commercial aiming screen is not available, the screen may consist of a vertical wall having a clear uninterrupted area approximately 1.83 m (6 ft) high and 3.66 m (12 ft) wide. The surface should be finished with a washable non-gloss white paint.

Prior to aiming the headlamps, the following steps must be taken:

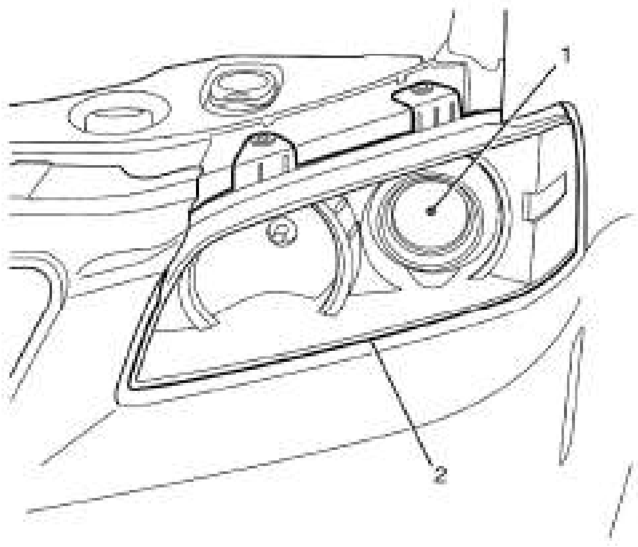
1. Remove any snow, ice or mud from the vehicle.
2. The vehicle must have a full tank of fuel.
3. Stop all other work on the vehicle.
4. If any service has been performed on the vehicle, make sure that all of the components are back in their original place.
5. The vehicle must be on a level surface.



6. The vehicle's left tires must be parallel to the reference line with the face of the headlamps extending 7.62 m (25 ft) from the front of the aiming screen.
7. DO NOT load any cargo in the vehicle.
8. The vehicle must contain 1 person or 72.56 kg (160 lb) on the driver's seat.
9. Inflate the tires to the correct pressure.
10. Simulate the vehicle loads if the intended use of the vehicle is for hauling heavy loads or towing a trailer.
11. Rock the vehicle in order to stabilize the suspension.

Headlamp Aiming Procedure

1. Open the hood.

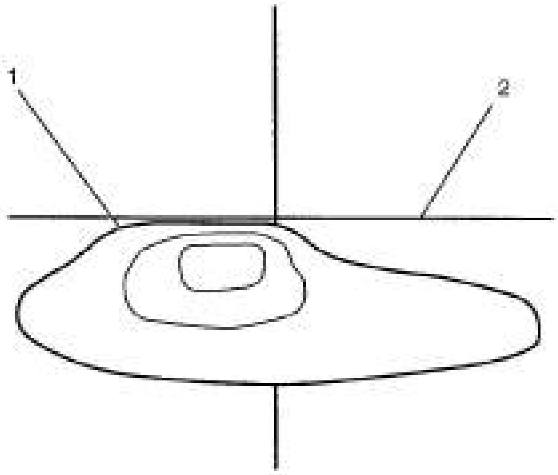


Important: Left headlamp shown. Right headlamp similar.

2. Locate the aim dot (1) on the low-beam side of the headlamp lens (2).
3. Measure the distance from the ground to the aim dot (1). Record the distance.
4. Repeat for the right headlamp.
5. At the screen, measure from the floor and place the horizontal tape at the recorded distances from steps 3 and 4.
6. Measure from the reference line on the floor to the left headlamp bulb centerline. Record the distance.
7. At the screen, measure from the reference line and place the vertical tape at the recorded distance from step 6.
8. Measure from the reference line on the floor to the right headlamp bulb centerline. Record the distance.
9. At the screen, measure from the reference line and place the vertical tape at the recorded distance from step 8.

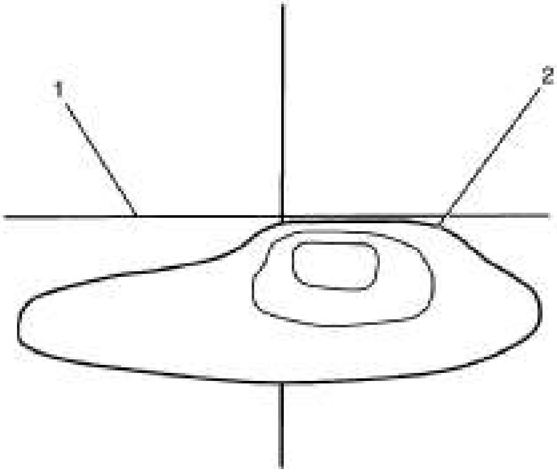
Notice: Do not cover a headlamp to improve beam cut-off when aiming. Covering a headlamp may cause excessive heat build-up which may cause damage to the headlamp.

10. Turn the low beam headlamps to the ON position and block the light from projecting onto the screen from the right headlamp.
    - For RHD drive variants go to step 11
    - For LHD drive variants go to step 12



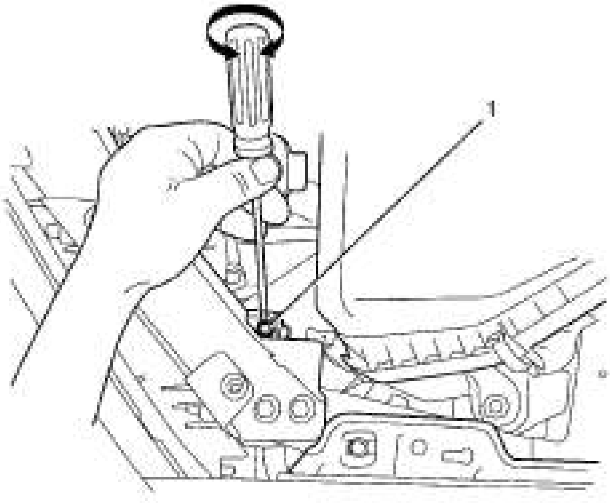
Important: This is for Right Hand Drive (RHD) variants only.

11. The top edge of the beam cut-off (2) should be positioned at the bottom edge of the horizontal tape line (1).



Important: This is for Left Hand Drive (LHD) variants only.

12. The top edge of the beam cut-off (2) should be positioned at the bottom edge of the horizontal tape line (1).



Important: Horizontal headlamp adjustment does not exist.

Important: To adjust the vertical aim of the headlamps, use a suitable tool to turn the headlamp adjuster (1) counter-clockwise to raise the beam or clockwise to lower the beam.

13. Adjust the vertical aim of the headlamps to the specifications required by the state and the local authorities, or as shown in step 11.
14. Repeat steps 11 and 12 for the right hand headlamp while blocking the light from projecting onto the screen from the left headlamp.
15. Close the hood.

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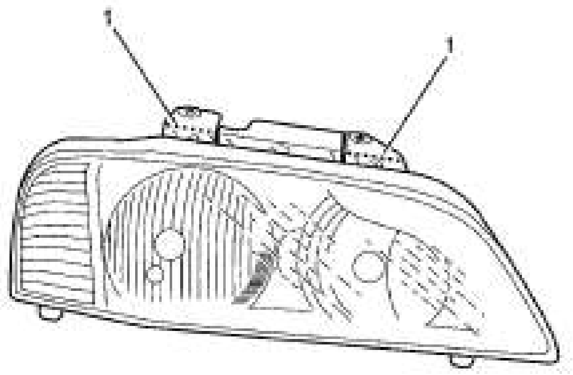
Headlamp Bracket Replacement

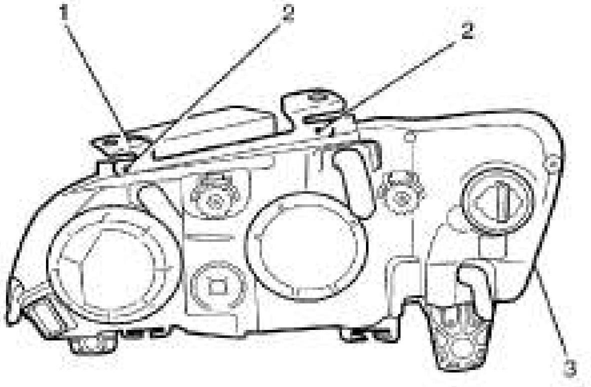
Installation Procedure (Type A)

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.
3. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement.
4. Remove the headlamp. Refer to Headlamp Replacement.



5. Cut the headlamp assembly retaining brackets along the broken line (1) shown.
6. Discard the remaining ends of the bracket.

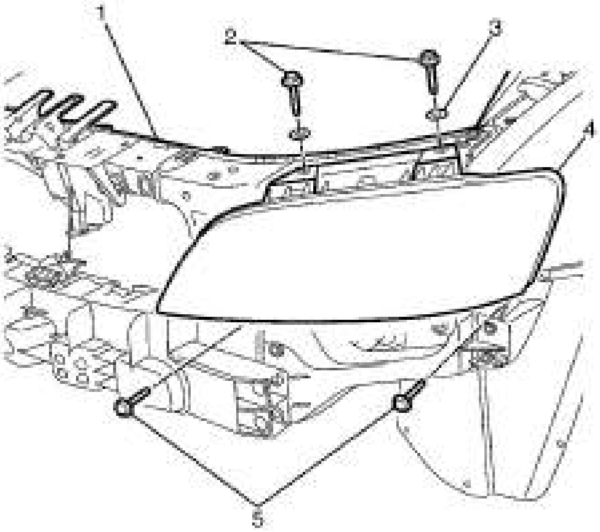


7. Install the headlamp bracket (1) to the headlamp assembly (3).

   Notice: Refer to Fastener Notice in the Preface section.

8. Install the headlamp bracket to headlamp assembly retaining screws (2).

   Tighten
   Tighten the screws to 1 N·m (9 lb in).



9. Install the headlamp assembly (4) to the front end module (1).

   Important: Replace the upper headlamp retaining bolts (2).

10. Install the NEW headlamp assembly to front end module upper retaining washers (3) and bolts (2).

    Tighten
    Tighten the bolts to 4.5 N·m (35 lb in).

11. Install the headlamp assembly to front end module lower retaining bolts (5).

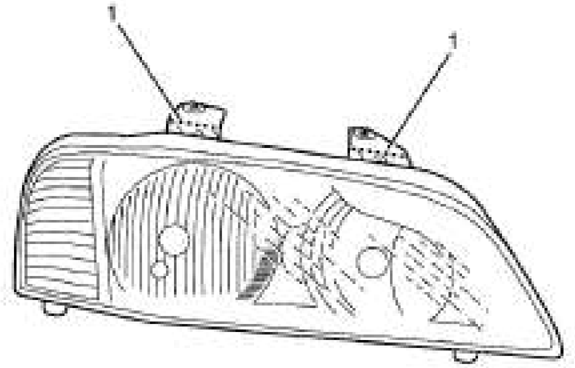
    Tighten
    Tighten the bolts to 4.5 N·m (35 lb in).

12. Install the front bumper fascia. Refer to Front Bumper Fascia Replacement.
13. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.
14. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
15. Check all vehicle lights for correct operation.
16. Adjust the headlamps. Refer to Headlamp Aiming.

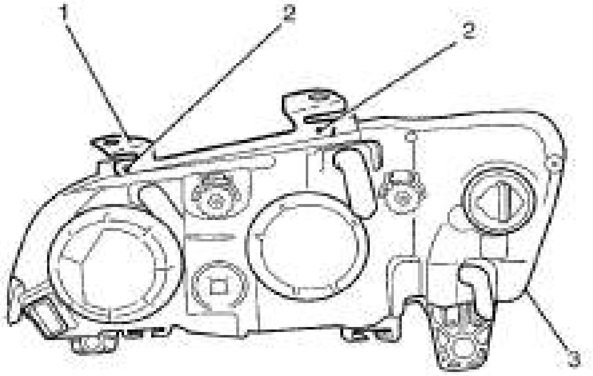
Installation Procedure (Type B)

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.
3. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement.
4. Remove the headlamp. Refer to Headlamp Replacement.



5. Cut the headlamp assembly retaining brackets along the broken line (1) shown.
6. Discard the remaining ends of the bracket.

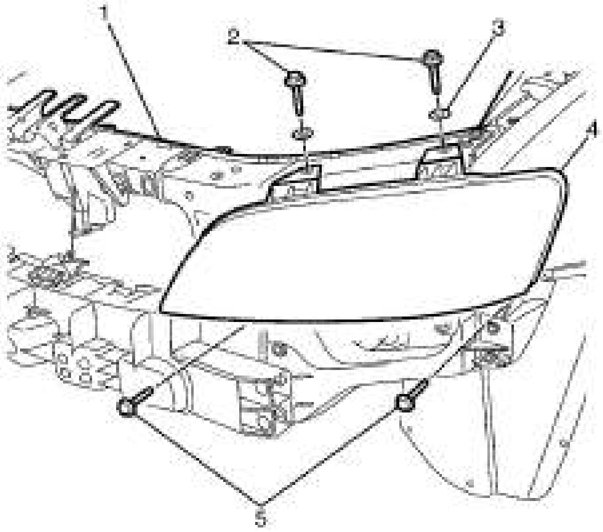


7. Install the headlamp bracket (1) to the headlamp assembly (3).

   Notice: Refer to Fastener Notice in the Preface section.

8. Install the headlamp bracket to headlamp assembly retaining screws (2).

   Tighten
   Tighten the screws to 1 N·m (9 lb in).



9. Install the headlamp assembly (4) to the front end module (1).

   Important: Replace the upper headlamp retaining bolts (2).

10. Install the NEW headlamp assembly to front end module upper retaining washers (3) and bolts (2).

    Tighten
    Tighten the bolts to 4.5 N·m (35 lb in).

11. Install the headlamp assembly to front end module lower retaining bolts (5).

    Tighten
    Tighten the bolts to 4.5 N·m (35 lb in).

12. Install the front bumper fascia. Refer to Front Bumper Fascia Replacement.
13. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.
14. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
15. Check all vehicle lights for correct operation.
16. Adjust the headlamps. Refer to Headlamp Aiming.

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Headlamp Bulb Replacement (SWB)

Removal Procedure - Low Beam (Type A and Type B)

Caution: Refer to Battery Disconnect Caution in the Preface section.

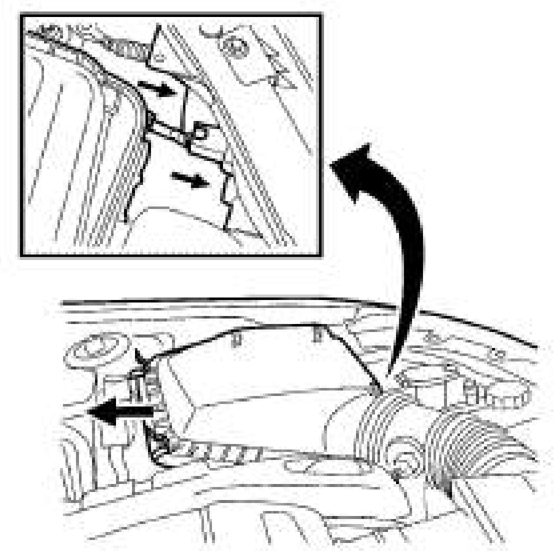
Caution: Halogen bulbs contain gas under pressure. Handling a bulb improperly could cause it to shatter into flying glass fragments. To help avoid personal injury:

- Turn off the lamp switch and allow the bulb to cool before changing the bulb.
- Leave the lamp switch OFF until the bulb change is complete.
- Always wear eye protection when changing a halogen bulb.
- Handle the bulb only by its base. Avoid touching the glass.
- Keep dirt and moisture off the bulb.
- Properly dispose of the used bulb.
- Keep halogen bulbs out of the reach of children.

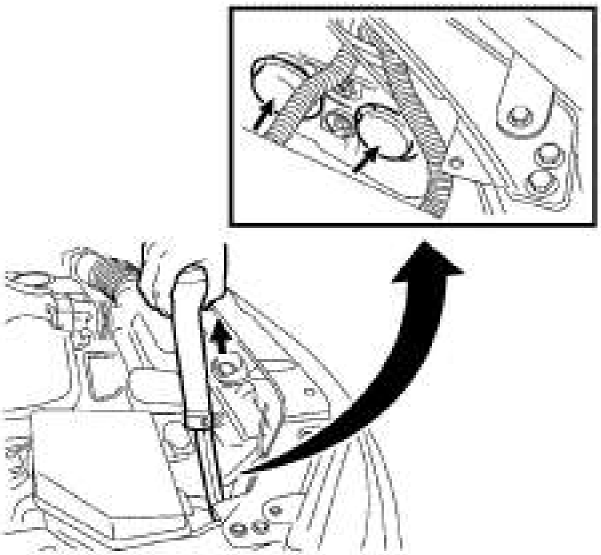
1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement

Important: For left-hand headlamp access, go to step 3.

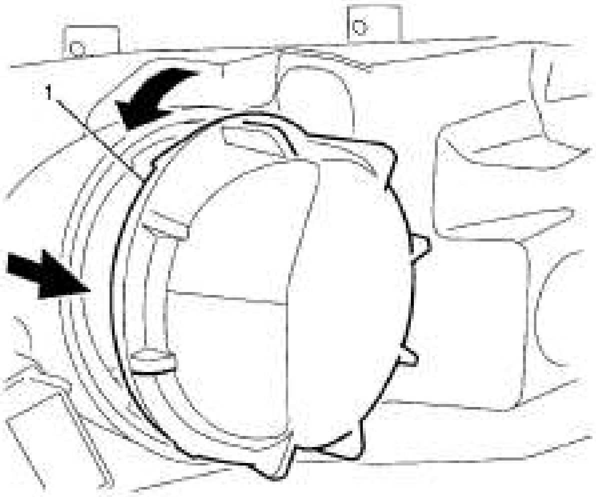
Important: For right-hand headlamp access, go to step 4.



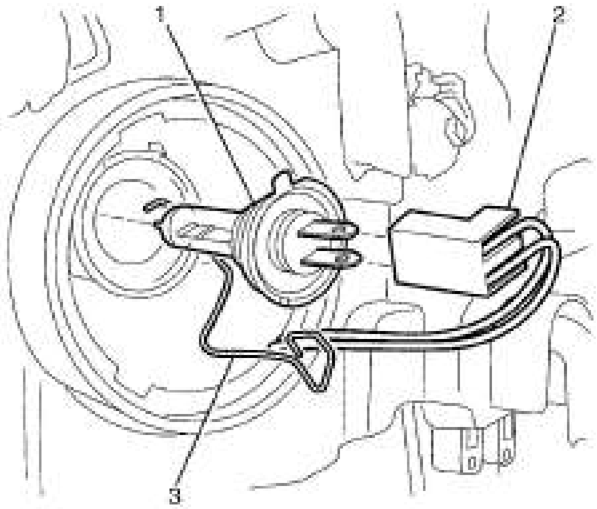
3. For access to the left-hand headlight, detach and move the airbox upper cover rearward. Go to step 4.



4. For access to the right-hand headlight, remove the coolant reservoir fill neck by pulling up on the neck assembly and position aside. Note the orientation of the aligning tabs and keyway of the coolant reservoir fill neck for installation.



5. Remove the low beam headlamp dust cap from the rear of the headlamp assembly by rotating the dust cap counter clockwise. Note orientation of the dust cap and tabs for installation.

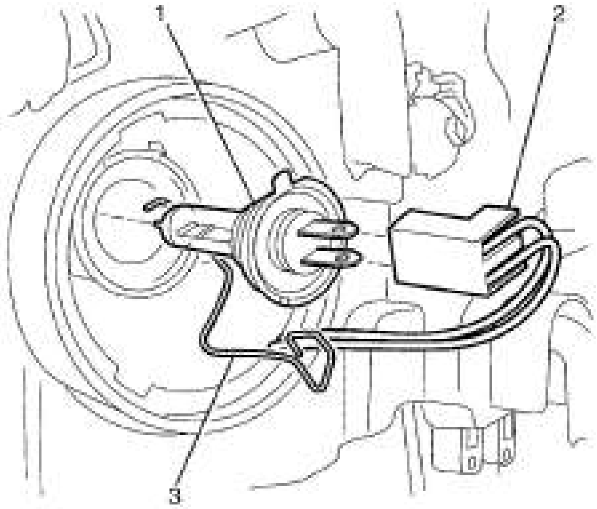


6. Disconnect the electrical connector (2) from the low beam headlight bulb (1).
7. Press and unclip the low beam headlight bulb spring retainer (3) and pivot the retainer clear from the bulb (1). Remove the bulb from the headlamp assembly.

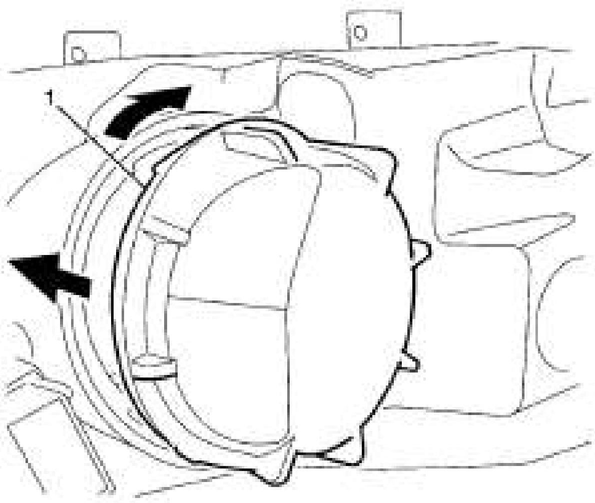
Installation Procedure - Low Beam (Type A and Type B)

Important: Do not handle the quartz envelope of the headlight bulb. Wipe the quartz envelope immediately with methylated spirits if it is touched accidentally or the performance of the bulb will deteriorate.

Important: The different-sized tabs on the bulb base and mating cut-outs in the headlamp assembly allow the bulb to seat correctly in one orientation position.



1. Install the new bulb (1) into the headlamp assembly, ensuring the locating tangs on the bulb mate correctly with the cut-outs in the headlamp.
2. Clip the bulb spring retainer (3) and secure.
3. Connect the wiring harness connector (2) to the bulb (1).
4. Inspect the low beam dust cap seal and replace if necessary.



5. Install the low beam headlamp dust cap (1) to the rear of the headlamp assembly by rotating clockwise to secure.
6. For the left-hand headlamp assembly, replace and secure the airbox upper cover. Go to step 8.
7. For the right-hand headlamp assembly, reinstall the coolant reservoir fill neck by aligning the tabs and keyway and pushing the neck into position.
8. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement
9. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
10. Check all vehicle lights for correct operation.

Removal Procedure - High Beam (Type A and Type B)

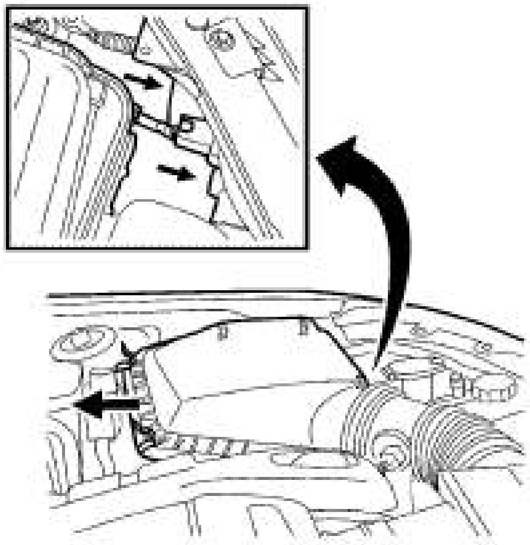
Caution: Refer to Battery Disconnect Caution in the Preface section.

Caution: Halogen bulbs contain gas under pressure. Handling a bulb improperly could cause it to shatter into flying glass fragments. To help avoid personal injury:

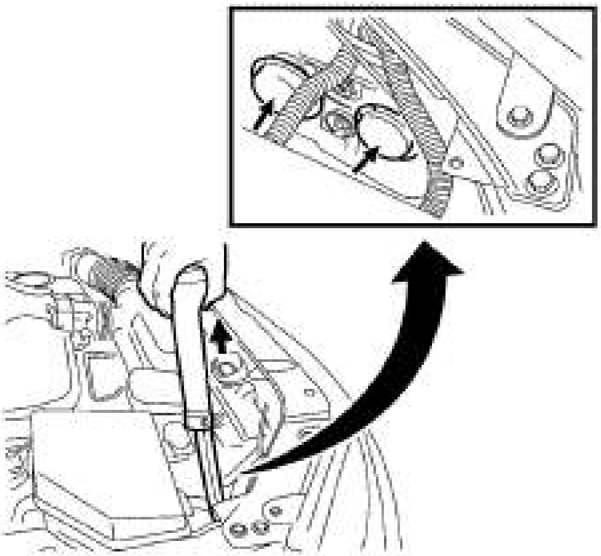
- Turn off the lamp switch and allow the bulb to cool before changing the bulb.
- Leave the lamp switch OFF until the bulb change is complete.
- Always wear eye protection when changing a halogen bulb.
- Handle the bulb only by its base. Avoid touching the glass.
- Keep dirt and moisture off the bulb.
- Properly dispose of the used bulb.

- Keep halogen bulbs out of the reach of children.

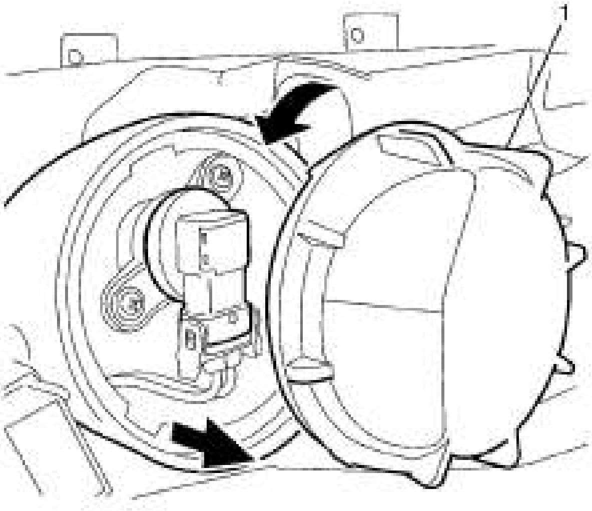
1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement



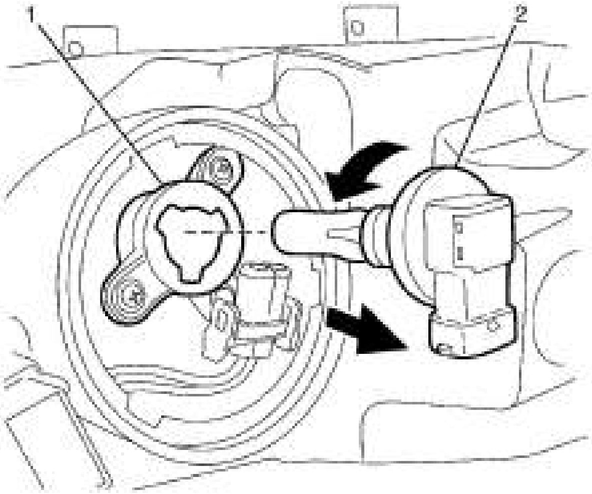
3. For access to the left-hand headlight assembly, detach and move the airbox upper cover rearward. Go to step 5.



4. For access to the right-hand headlight, remove the coolant reservoir fill neck by pulling up on the neck assembly and position aside. Note the orientation of the aligning tabs and keyway of the coolant reservoir fill neck for installation.



5. Remove the high beam headlamp dust cap (1) from the rear of the headlamp assembly by rotating the dust cap counter clockwise. Note the orientation of the dust cap and tabs for installation.
6. Disconnect the electrical connector from the high beam headlight bulb.

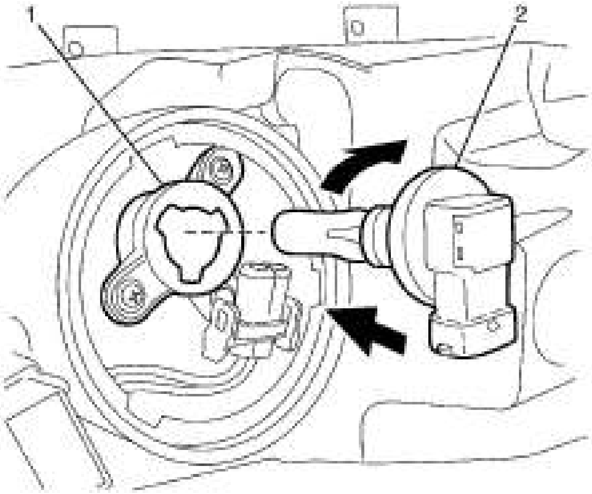


7. Rotate the high beam headlight bulb (2) counter clockwise and remove the bulb from the headlamp assembly (1).

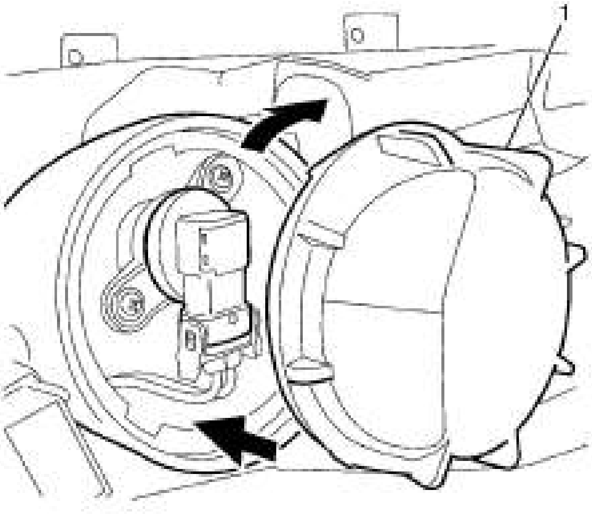
Installation Procedure - High Beam (Type A and Type B)

Important: Do not handle the quartz envelope of the headlight bulb. Wipe the quartz envelope immediately with methylated spirits if it is touched accidentally or the performance of the bulb will deteriorate.

Important: The different-sized tabs on the bulb base and mating cut-outs in the headlamp assembly allow the bulb to seat correctly in one orientation position.



1. Install the new high beam bulb (2) into the headlamp assembly (1) and lock the bulb in place by rotating it clockwise.
2. Connect the high beam bulb connector to the bulb and push the connector until the tangs of the connector engage.
3. Inspect the high beam dust cap seal and replace if necessary.



4. Install the high beam headlamp dust cap (1) to the rear of the headlamp assembly by aligning the tabs and rotating the dust cap clockwise to secure.

Important: For left-hand headlamp, go to step 5.

Important: For right-hand headlamp, go to step 6.

5. For the left-hand headlamp assembly, replace and secure the airbox upper cover. Go to step 7.
6. For the right-hand headlamp assembly, reinstall the coolant reservoir fill neck by aligning the tabs and keyway and pushing the neck into position.
7. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement

Caution: Refer to Battery Disconnect Caution in the Preface section.

8. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
9. Check all vehicle lights for correct operation.

Removal Procedure - Front Park (Type A)

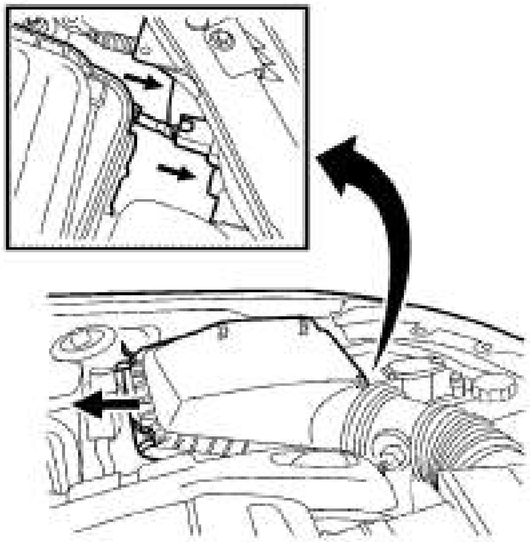
Caution: Halogen bulbs contain gas under pressure. Handling a bulb improperly could cause it to shatter into flying glass fragments. To help avoid personal injury:

- Turn off the lamp switch and allow the bulb to cool before changing the bulb.
- Leave the lamp switch OFF until the bulb change is complete.
- Always wear eye protection when changing a halogen bulb.
- Handle the bulb only by its base. Avoid touching the glass.
- Keep dirt and moisture off the bulb.
- Properly dispose of the used bulb.
- Keep halogen bulbs out of the reach of children.

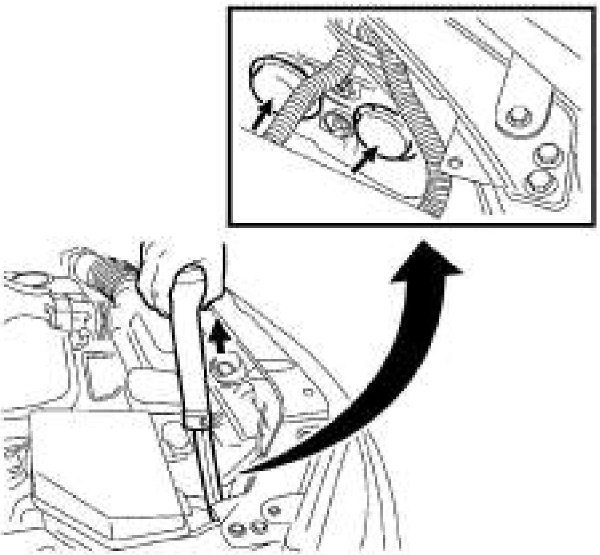
1. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement

Important: For left-hand headlamp access, go to step 3.

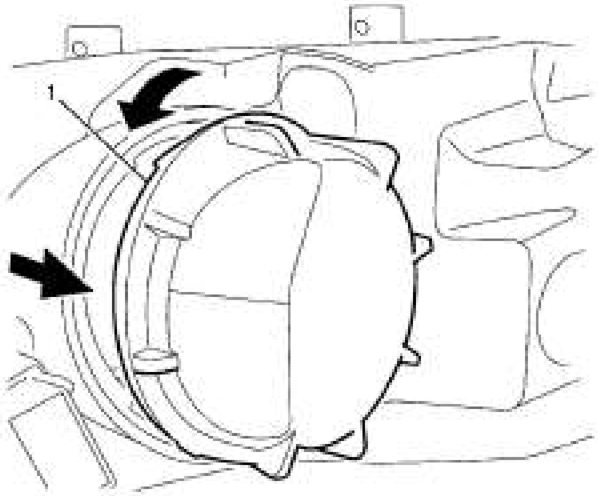
Important: For right-hand headlamp access, go to step 4.



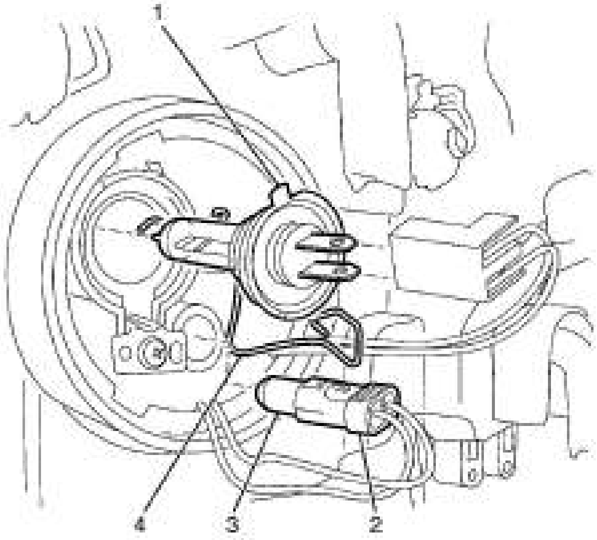
2. For access to the left-hand headlight, detach and move the airbox upper cover rearward. Go to step 4.



3. For access to the right-hand headlight, remove the coolant reservoir fill neck by pulling up on the neck assembly and position aside. Note the orientation of the aligning tabs and keyway of the coolant reservoir fill neck for installation.



4. Remove the low beam headlamp dust cap (1) from the rear of the headlamp assembly by rotating the dust cap counter clockwise. Note the orientation of the dust cap and tabs for installation.
5. Disconnect the electrical connector from the low beam headlight bulb.

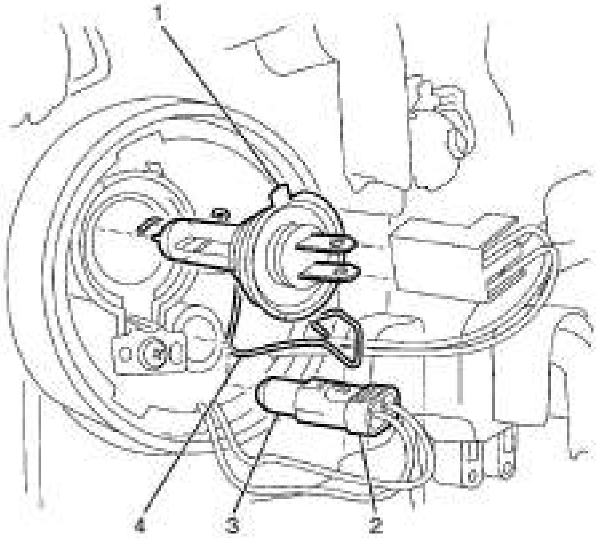


6. Press and unclip the low beam headlight bulb spring retainer (4) and pivot the retainer clear from the bulb (1). Remove the bulb from the headlamp assembly.
7. Using long nose pliers, pull the front park bulb socket (2) from the headlamp assembly.
8. Remove the front park bulb (3) from the socket.

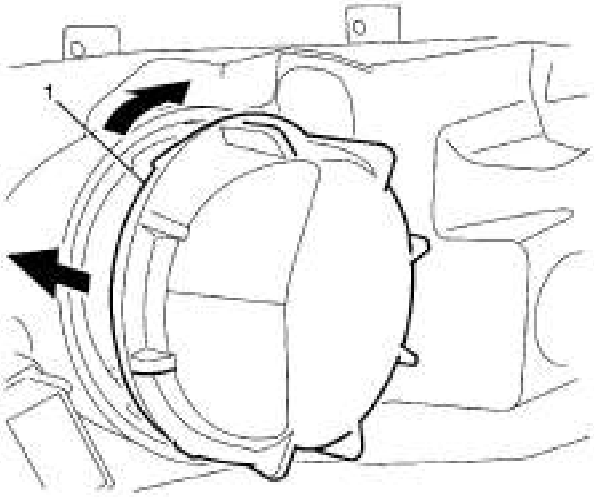
Installation Procedure - Front Park (Type A)

Important: Do not handle the quartz envelope of the headlamp bulb. Wipe the quartz envelope immediately with methylated spirits if it is touched accidentally or the performance of the bulb will deteriorate.

Important: The different-sized tabs on the bulb base and mating cut-outs in the headlamp assembly allow the bulb to seat correctly in one orientation position.



1. Install a new bulb (3) to the front park bulb socket (2).
2. Install the front park bulb socket to the headlamp assembly
3. Install the low beam bulb (1) into the headlamp assembly, ensuring the locating tangs on the bulb mate correctly with the cut-outs in the headlamp.
4. Clip the bulb spring retainer (4) and secure.
5. Connect the electrical connector to the bulb.
6. Inspect the low beam dust cap seal for damage and replace if necessary.



7. Install the low beam headlamp dust cap (1) to the rear of the headlamp assembly by aligning the tabs and rotating the dust cap clockwise to secure.
8. For the left-hand headlamp assembly, replace and secure the airbox upper cover. Go to step 9.
9. For the right-hand headlamp assembly, reinstall the coolant reservoir fill neck by aligning the tabs and keyway and pushing the neck into position.
10. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement
11. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
12. Check all vehicle lights for correct operation.

Removal Procedure - Front Park (Type B)

Caution: Refer to Battery Disconnect Caution in the Preface section.

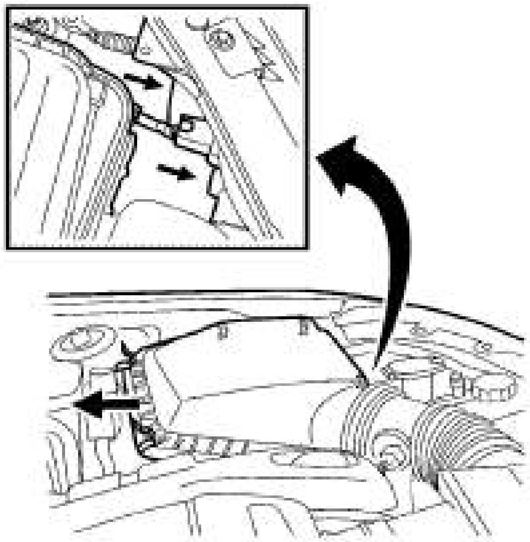
Caution: Halogen bulbs contain gas under pressure. Handling a bulb improperly could cause it to shatter into flying glass fragments. To help avoid personal injury:

- Turn off the lamp switch and allow the bulb to cool before changing the bulb.
- Leave the lamp switch OFF until the bulb change is complete.
- Always wear eye protection when changing a halogen bulb.
- Handle the bulb only by its base. Avoid touching the glass.
- Keep dirt and moisture off the bulb.
- Properly dispose of the used bulb.
- Keep halogen bulbs out of the reach of children.

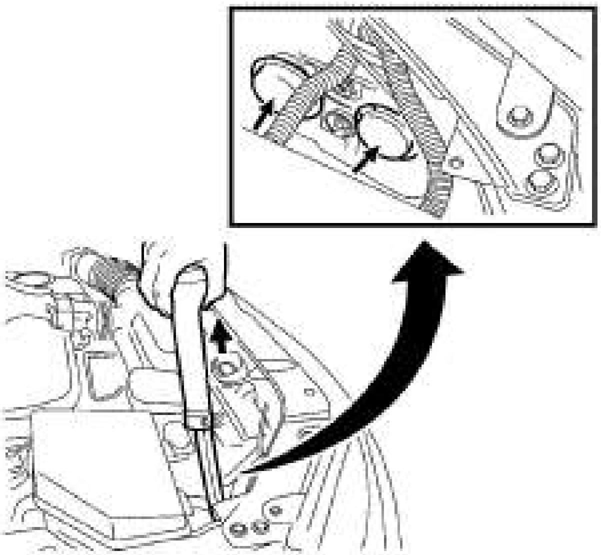
1. Disconnect the battery ground cable. Refer to Battery Disconnect Caution.
2. Remove the radiator air baffle. Refer to Radiator Air Upper Baffle and Deflector Replacement

Important: For left-hand headlamp access, go to step 3.

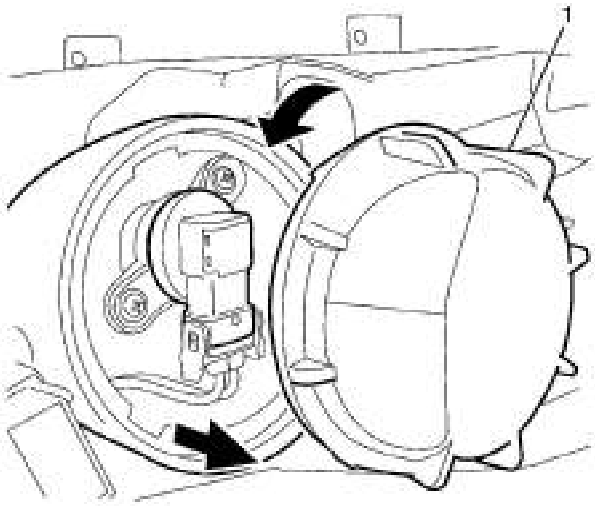
Important: For right-hand headlamp access, go to step 4.



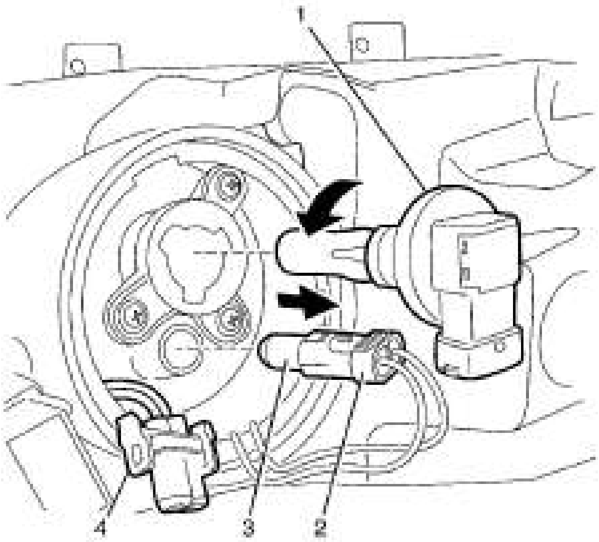
3. For access to the left-hand headlight, detach and move the airbox upper cover rearward. Go to step 4.



4. For access to the right-hand headlight, remove the coolant reservoir fill neck by pulling up on the neck assembly and position aside. Note the orientation of the aligning tabs and keyway of the coolant reservoir fill neck for installation.



5. Remove the high beam headlamp dust cap (1) from the rear of the headlamp assembly by rotating the dust cap counter clockwise. Note the orientation of the dust cap and tabs for installation.



6. Disconnect the electrical connector (4) from the high beam headlight bulb (1).
7. Rotate the high beam headlight bulb counter clockwise and remove the bulb from the headlamp assembly.

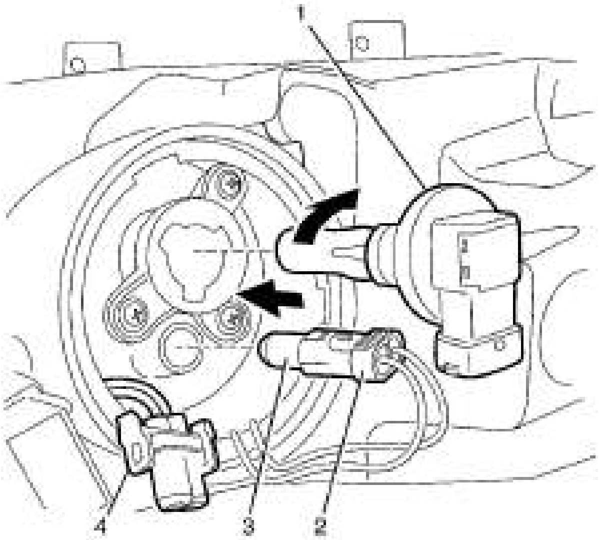
Notice: Refer to General Repair Instructions in the Preface section.

8. Pull the front park bulb socket (2) from the headlamp assembly.
9. Remove the front park bulb (3) from the socket (2).

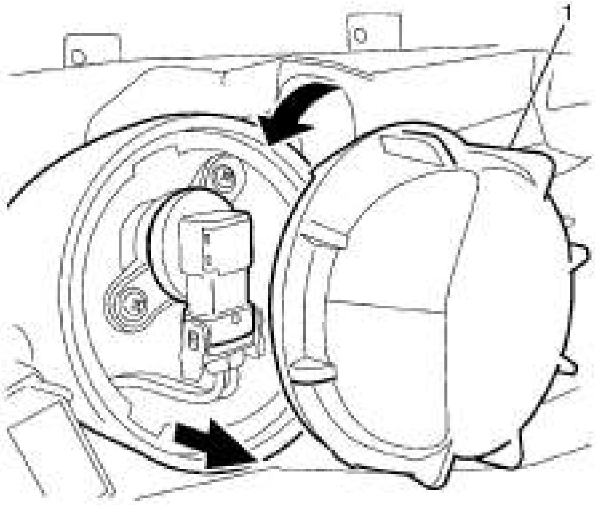
Installation Procedure - Front Park (Type B)

Important: Do not handle the quartz envelope of the headlight bulb. Wipe the quartz envelope immediately with methylated spirits if it is touched accidentally or the performance of the bulb will deteriorate.

Important: The different-sized tabs on the bulb base and mating cut-outs in the headlamp assembly allow the bulb to seat correctly in one orientation position.



1. Install a new bulb (3) to the front park bulb socket (2).
2. Install the front park bulb (3) and socket (2) to the headlamp assembly.
3. Install the high beam bulb (1) into the headlamp assembly and lock the bulb in place by rotating it clockwise.
4. Connect the high beam bulb connector (4) to the bulb and push the connector until the tangs of the connector engage.



5. Inspect the high beam dust cap seal and replace if necessary.
6. Install the high beam headlamp dust cap (1) to the rear of the headlamp assembly by aligning the tabs and rotating the dust cap clockwise to secure.

   Important: For left-hand headlamp, go to step 7.

   Important: For right-hand headlamp, go to step 8.

7. For the left-hand headlamp assembly, replace and secure the airbox upper cover. Go to step 9.
8. For the right-hand headlamp assembly, reinstall the coolant reservoir fill neck by aligning the tabs and keyway and pushing the neck into position.
9. Install the radiator air baffle. Refer to Radiator Air Upper Baffle and Deflector Replacement
10. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
11. Check all vehicle lights for correct operation.

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Headlamp Leveling Control Module Replacement (Front)

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

Caution: The high intensity discharge system produces high voltage and current. To reduce the risk of severe shocks and burns:

- Never open the high intensity discharge system ballast or the arc tube assembly starter.
- Never probe between the high intensity discharge system ballast output connector and the arc tube assembly.

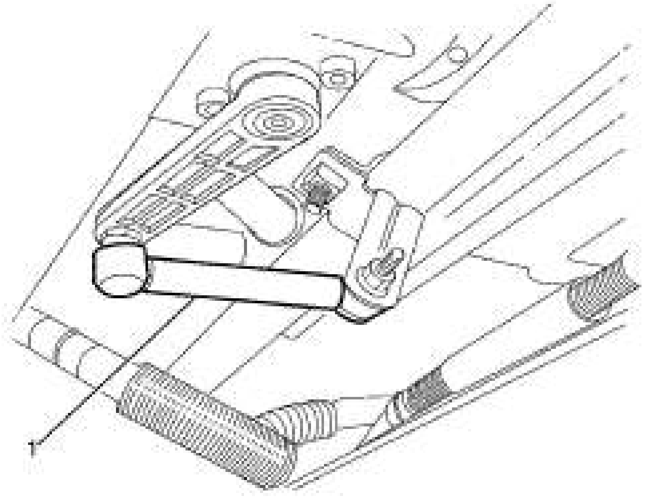
Caution: The high intensity discharge system produces high voltage and current. In order to reduce the risk of severe shocks and burns, the battery negative cable must be disconnected any time service work is being performed on or around the high intensity discharge system.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

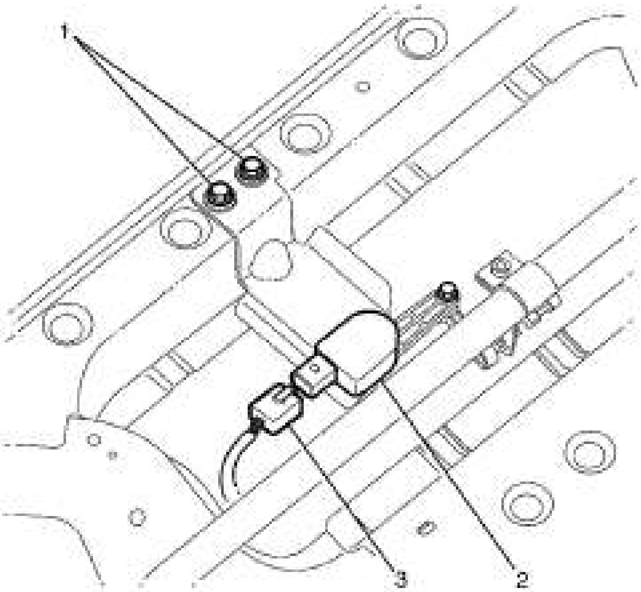
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Remove the air deflector. Refer to Front Air Deflector Replacement.

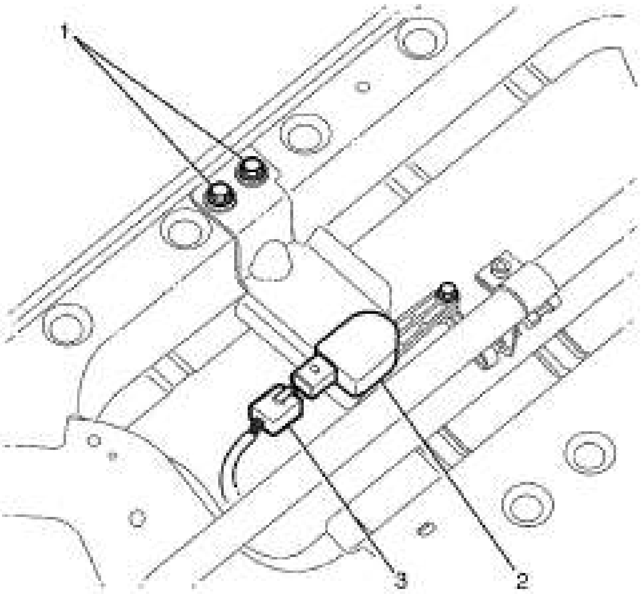


4. Using a suitable tool, remove the headlamp levelling sensor linkage (1) from the front suspension sway bar linkage.



5. Disconnect the headlamp levelling sensor electrical connector (3).
6. Remove the headlamp levelling sensor retaining bolts (1).
7. Remove the headlamp levelling sensor (2).

Installation Procedure



1. Install the headlamp levelling sensor (2).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the headlamp levelling sensor retaining bolts (1).

Tighten
Tighten the bolts to 8.0 N·m (71 lb in).

3. Connect the headlamp levelling sensor electrical connector (3).
4. Install the headlamp levelling sensor linkage to the sway bar linkage, listen for an audible click to confirm fitting.
5. Install the air deflector. Refer to Front Air Deflector Replacement.
6. Lower the vehicle. Refer to Lifting and Jacking the Vehicle.
7. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
8. Check all vehicle lights for correct operation.

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Headlamp Leveling Control Module Replacement (SWB)

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

Caution: The high intensity discharge system produces high voltage and current. To reduce the risk of severe shocks and burns:

- Never open the high intensity discharge system ballast or the arc tube assembly starter.
- Never probe between the high intensity discharge system ballast output connector and the arc tube assembly.

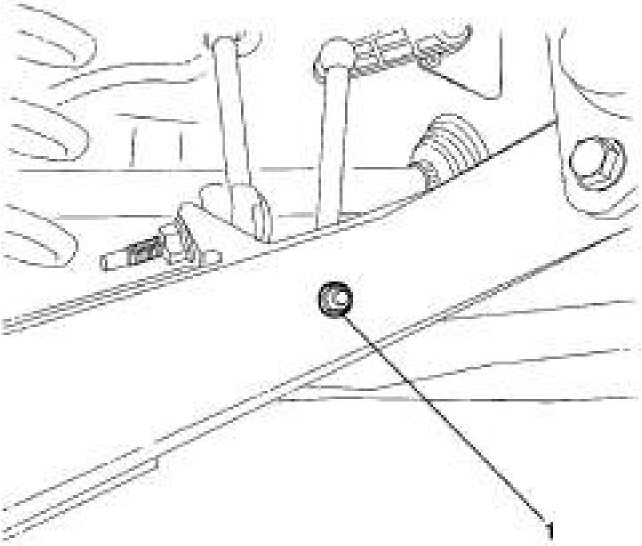
Caution: The high intensity discharge system produces high voltage and current. In order to reduce the risk of severe shocks and burns, the battery negative cable must be disconnected any time service work is being performed on or around the high intensity discharge system.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

Caution: Refer to Safety Glasses Caution in the Preface section.

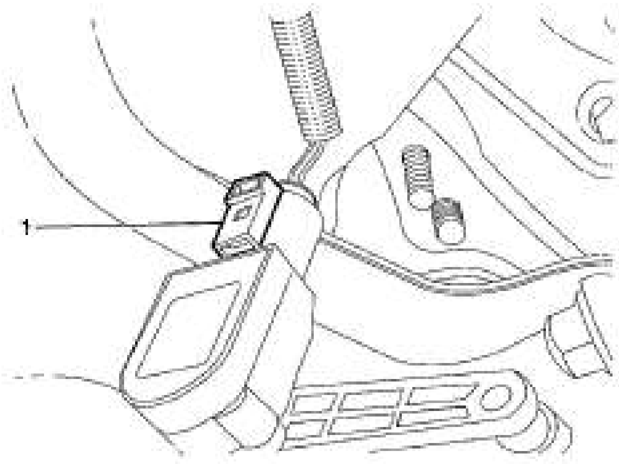
Caution: Refer to Vehicle Lifting Caution in the Preface section.

2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

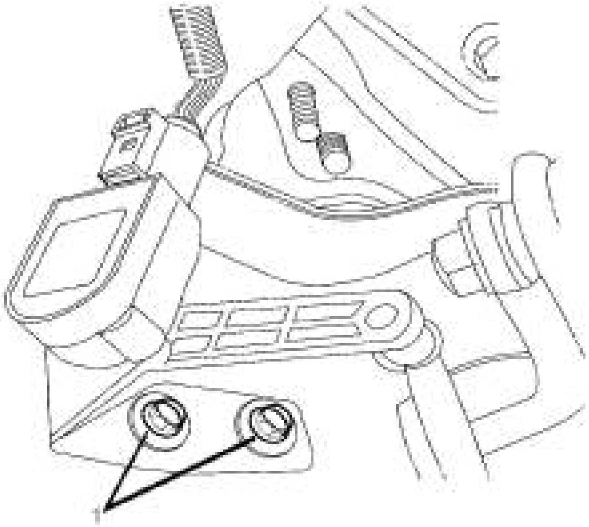


Important: The headlamp levelling linkages are not a serviceable item and should be replaced as a complete assembly.

3. Remove the headlamp levelling sensor linkage retaining bolt (1).

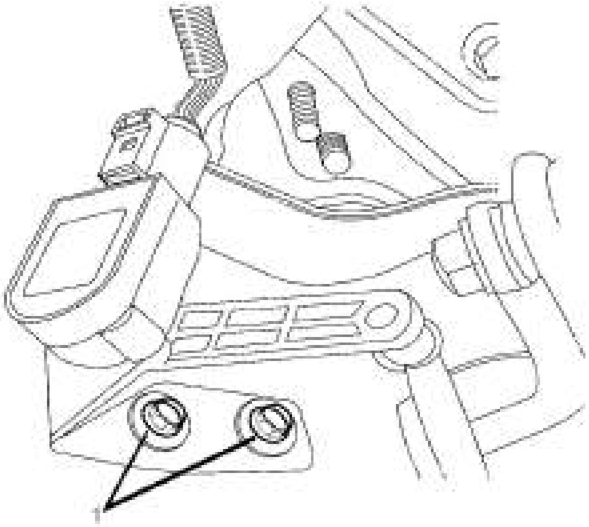


4. Disconnect the headlamp levelling sensor electrical connector (1).



5. Remove the head lamp levelling sensor retaining bolts.
6. Remove the head lamp levelling sensor.

Installation Procedure

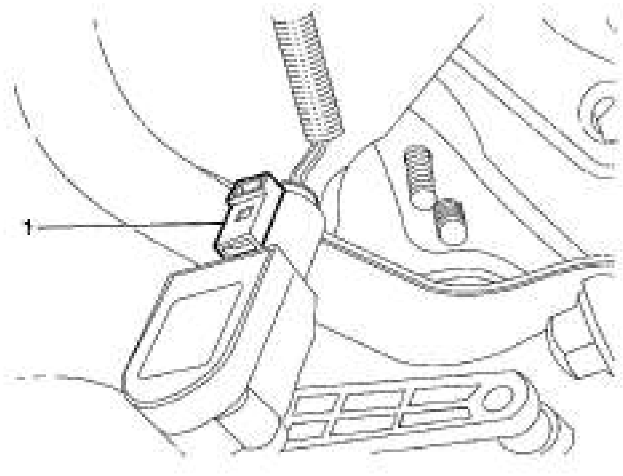


1. Install the head lamp levelling sensor.

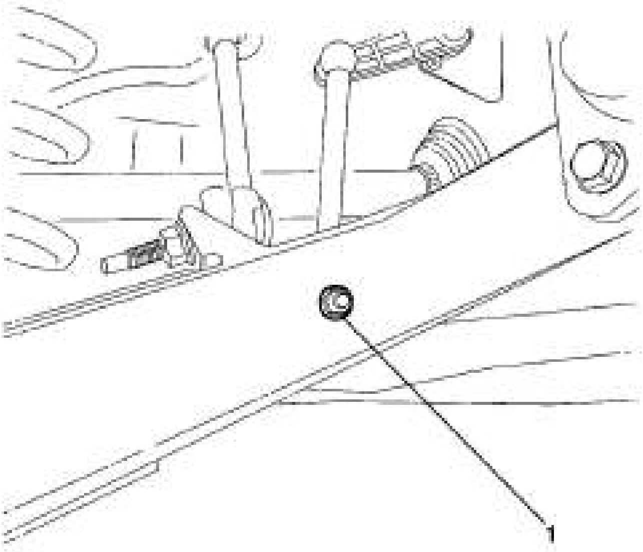
   Notice: Refer to Fastener Notice in the Preface section.

2. Install the head lamp levelling sensor retaining bolts.

   Tighten
   Tighten the bolts to 9.0 N·m (80 lb in).



3. Connect the headlamp levelling sensor electrical connector (1).



4. Install the head lamp levelling sensor linkage.

   Notice: Refer to Fastener Notice in the Preface section.

5. Install the head lamp levelling sensor linkage retaining nut (1).

   Tighten
   Tighten the nut to 4.0 N·m (35 lb in).

6. Lower the vehicle. Refer to Lifting and Jacking the Vehicle.
7. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
8. Check all vehicle lights for correct operation.

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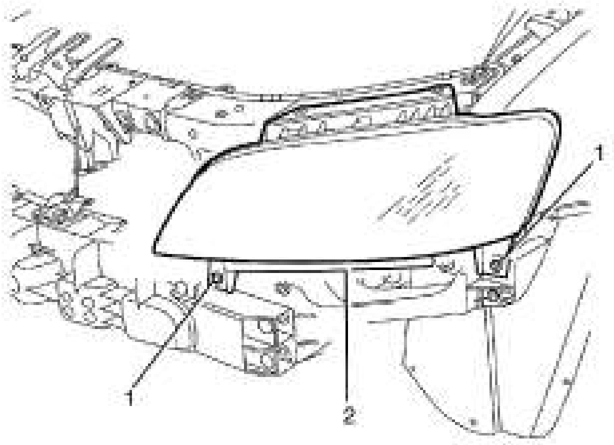
Headlamp Replacement

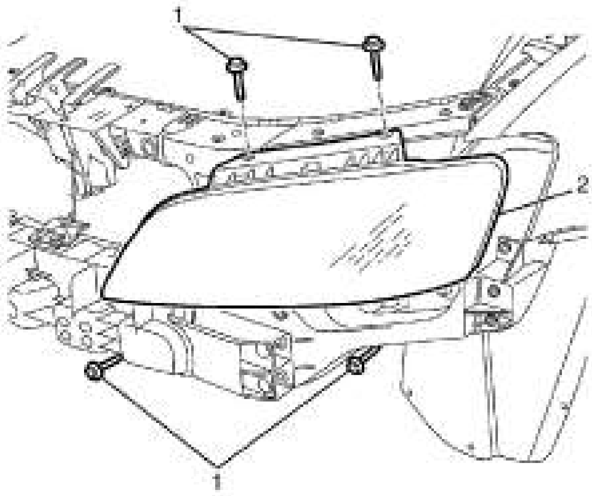
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
2. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement
3. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement .



4. Remove the headlamp bracket (2) to front end module retaining bolts (1).
5. Remove the headlamp bracket (2) from the front end module.

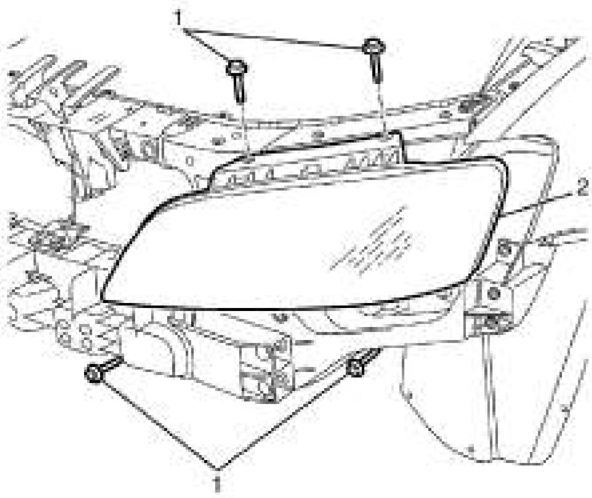


6. Remove the four bolts (1) that secure the headlamp assembly (2) to front end module.
7. Gently tilt headlamp out and disconnect the electrical connector from the headlamp assembly (2).
8. Remove the headlamp assembly (2) from the vehicle.

Installation Procedure

1. Install the headlamp assembly to the vehicle and connect the electrical connector.

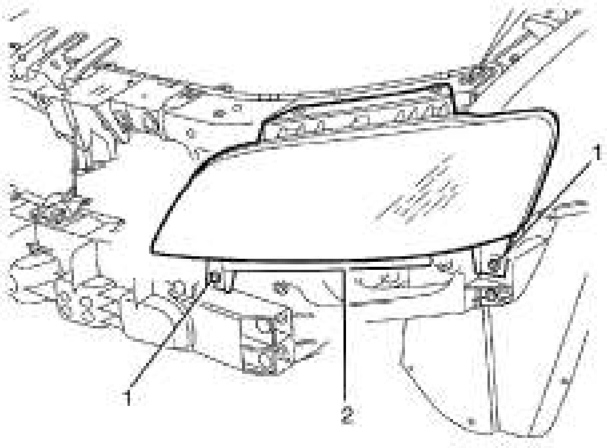
   Notice: Refer to Fastener Notice in the Preface section.



Important: Replace the upper headlamp retaining bolts.

2. Install the four bolts (1) that secure the headlamp assembly (2) to the front end module.

   Tighten
   Tighten the bolts to 4.5 N·m (35 lb in).



3. Install the headlamp bracket (2) to the front end module.

   Tighten
   Tighten the bolts to 4.5 N·m (35 lb in).

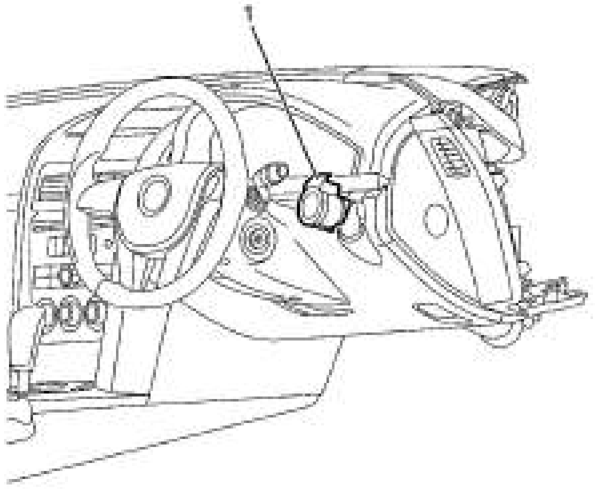
4. Install the headlamp bracket (2) to front end module retaining bolts (1).
5. Install the front bumper fascia. Refer to Front Bumper Fascia Replacement .
6. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement
7. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
8. Check all vehicle lights for correct operation.
9. Adjust the headlamps. Refer to Headlamp Aiming .

Headlamp Switch Replacement (RHD)

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

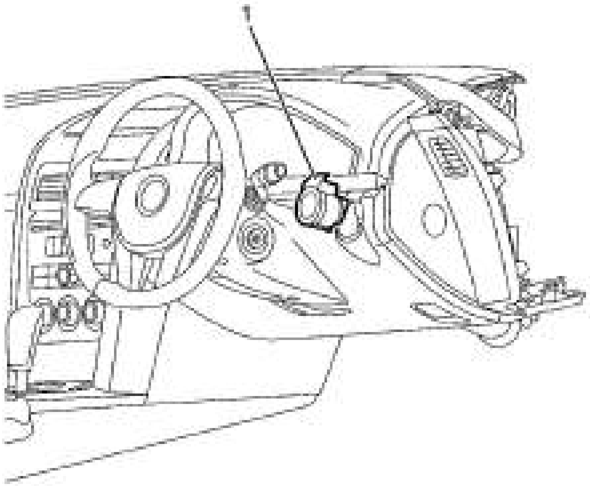
1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.



2. Remove headlamp switch (1) from I/P trim pad by gently prizing the switch assembly from the IP crashpad.
3. Disconnect the headlamp switch electrical connector.
4. Remove the headlamp switch.

Installation Procedure

1. Connect the headlamp switch electrical connector.



2. Install the headlamp switch (1) to the I/P trim pad.
3. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
4. Check all vehicle lights for correct operation.

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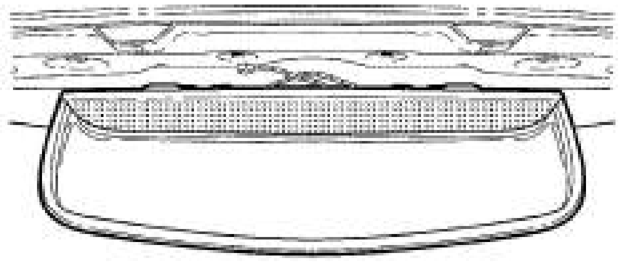
High Mount Stop Lamp Bulb Replacement

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

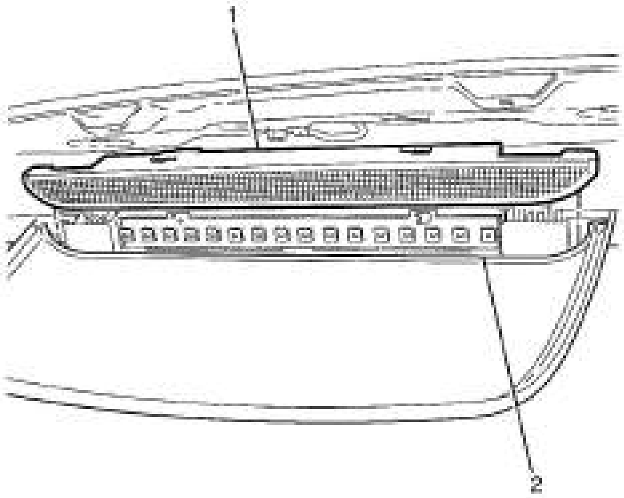
1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.



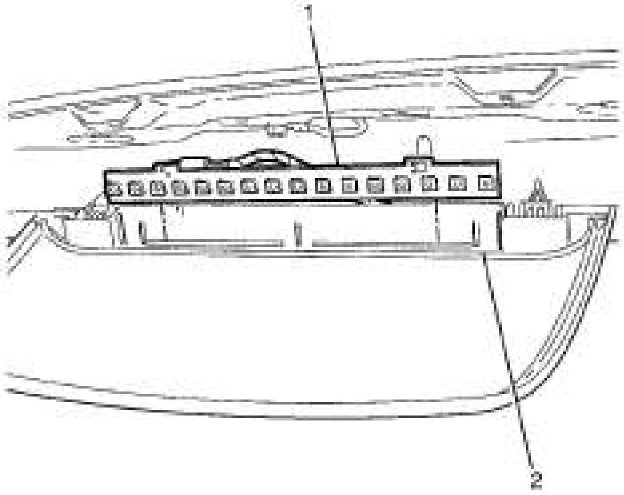
2. Pull downward on the centre high mounted stop lamp (CHMSL) bezel to disengage the retaining clips.

   Important: Force is only to be applied to CHMSL bracket not the headliner assembly.

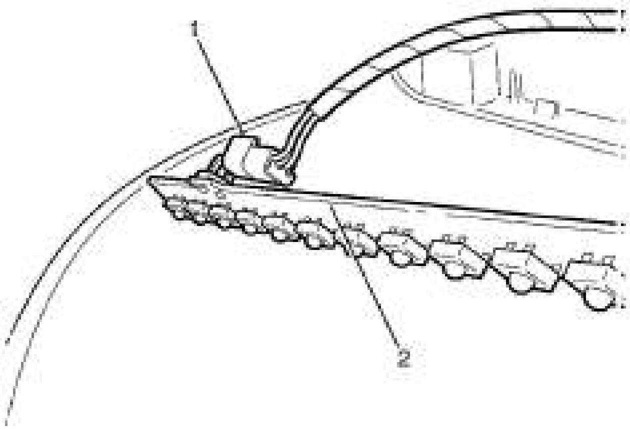
3. Pull the CHMSL bracket down as far as possible.



4. Remove the lens assembly (1) from the CHMSL (2) by unclipping the retaining lugs.

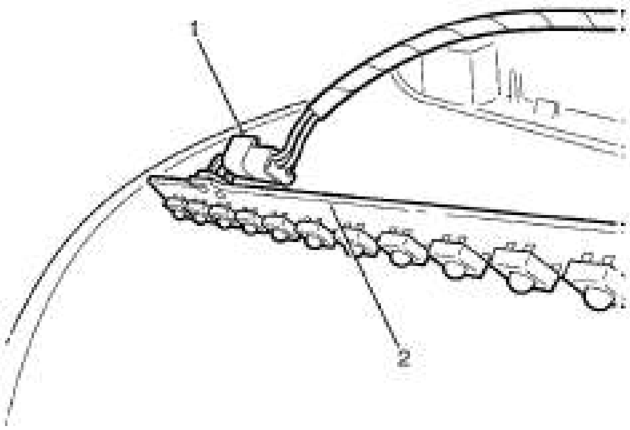


5. Carefully detach the PCB (1), by lifting it upwards out of the CHMSL (2).



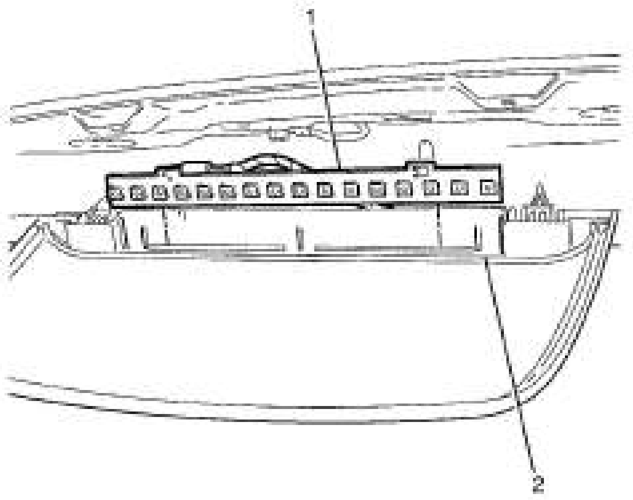
6. Disconnect the PCB (2) electrical connector (1).
7. Remove the PCB.

Installation Procedure

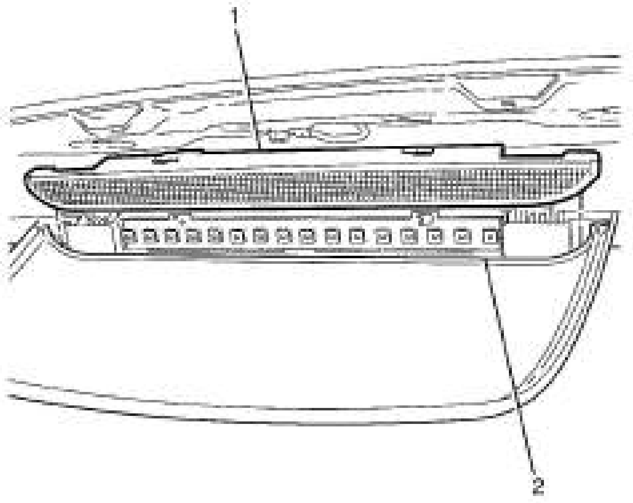


Important: When connecting the PCB electrical connector, make sure the tab on the connector is facing away from the PCB.

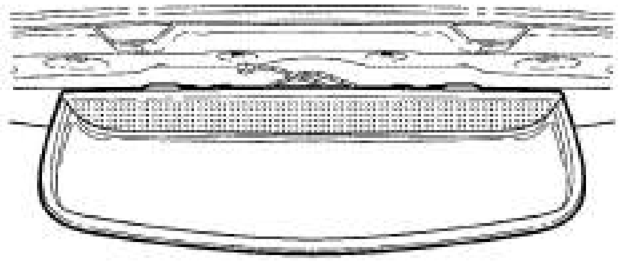
1. Connect the PCB (2) electrical connector (1).



2. Attach the PCB (1) to the CHMSL (2), by sliding it downward into the CHMSL.



3. Install the lens assembly (1) into the CHMSL (2) by clipping in the retaining lugs. Listen for an audible click to confirm fitting.



4. Install the CHMSL bezel, by engaging the retaining clips. Listen for an audible click to confirm fitting.
5. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
6. Test the stop lamp bulb for the correct operation.

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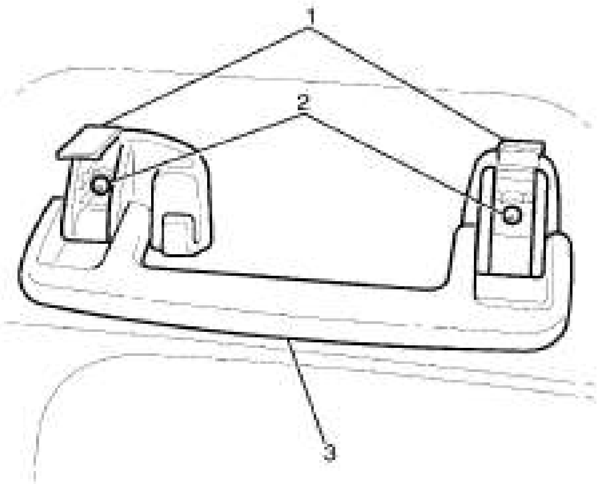
High Mount Stop Lamp Replacement (Sedan)

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

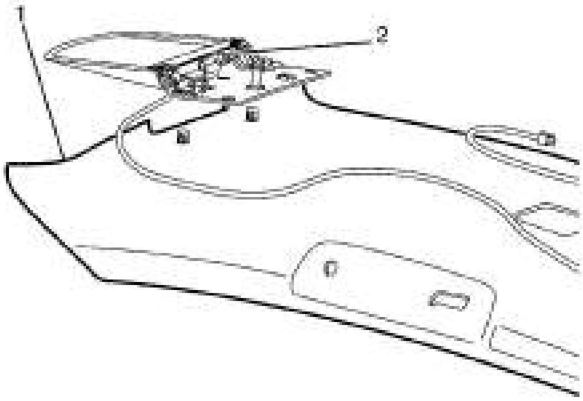
Important: If the high mounted stop lamp LED's are faulty and do not illuminate, the high mounted stop lamp PCB assembly must be replaced.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .



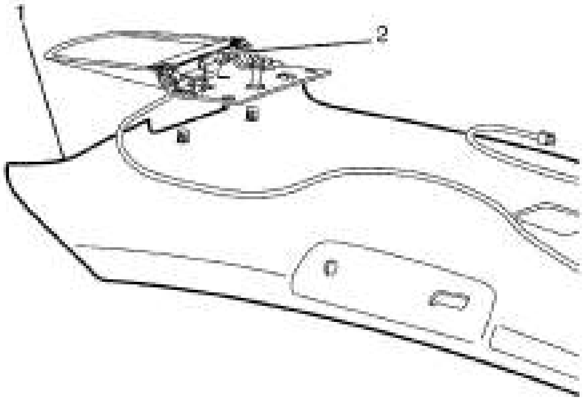
Important: Carry out for the two rear assist handles

2. Pry open the assist handle retaining screw covers (1).
3. Remove the assist handle to headliner retaining screws (2).
4. Remove the assist handles (3) from the headliner.
5. Remove the high mounted stop lamp bulb. Refer to High Mount Stop Lamp Bulb Replacement

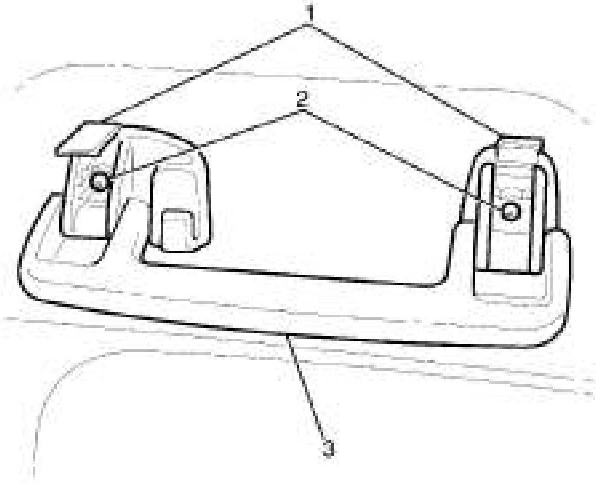


6. Unclip the high mounted stop lamp assembly (2) from the headliner (1).

Installation Procedure



1. Install the new high mounted stop lamp assembly (2) to the headliner (1).
2. Install the high mounted stop lamp bulb. Refer to High Mount Stop Lamp Bulb Replacement



Important: Carry out for the two rear assist handles

3. Install the assist handles (3) to the headliner.
4. Install the assist handle to headliner retaining screws (2).

   Tighten
   Tighten the assist handle retaining screws to 2.0 N·m (18 lb in).

5. Close the assist handle retaining screw covers (1).
6. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
7. Check all vehicle lights for correct operation.

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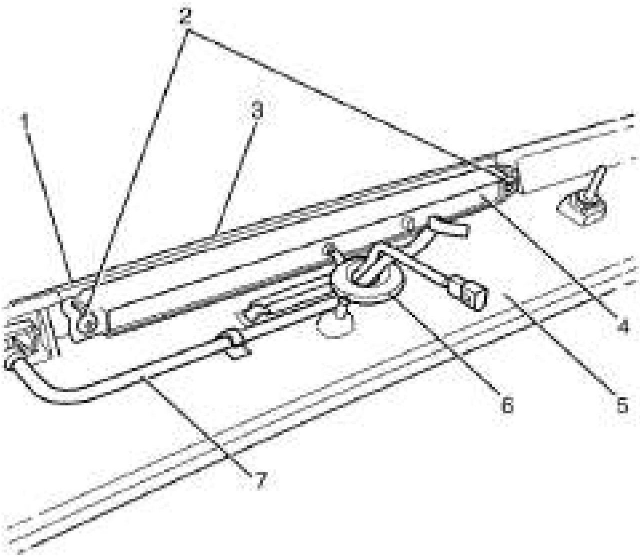
High Mount Stop Lamp Replacement (Sportwagon)

Removal Procedure

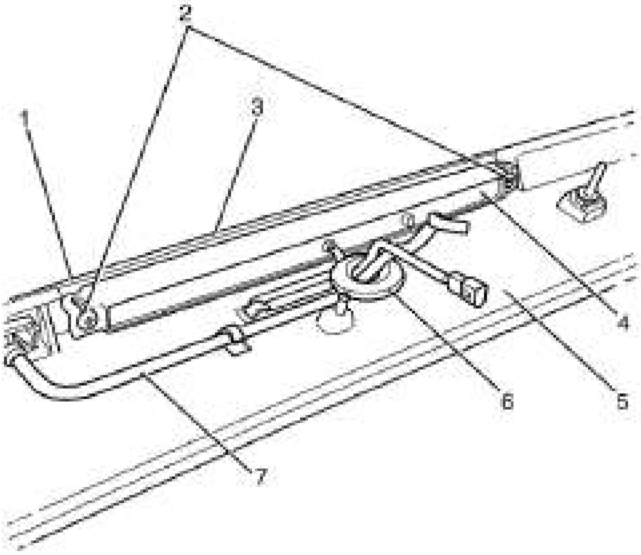
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the liftgate upper moulding. Refer to Liftgate Upper Molding Replacement.



3. Remove the high mounted stop lamp to liftgate upper moulding retaining screws (2).
4. Peel back adhesive tape (3) from top surface of the high mounted stop lamp (4), leaving the tape attached to moulding in the area under foam gasket (1).
5. Remove the high mounted stop lamp (4) from the liftgate upper moulding (5).
6. Cut cable tie on grommet (6), and slide washer hose (7) through grommet.

Installation Procedure



1. Position the NEW high mounted stop lamp (4) on the liftgate upper moulding (5).
2. Re-apply adhesive tape (3) to top surface of the high mounted stop lamp (4).

   Important: Take care to ensure that the plastic rib is correctly positioned relative to visual lamp face when re-applying tape.

3. Insert hose (7) through grommet (6), and attach new cable tie to grommet.

   Notice: Refer to Fastener Notice in the Preface section.

4. Install the high mounted stop lamp (4) to liftgate upper moulding retaining screws (2).

   Tighten
   Tighten the bolts to 2 N·m (18 lb in).

5. Install the liftgate upper moulding. Refer to Liftgate Upper Molding Replacement.
6. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

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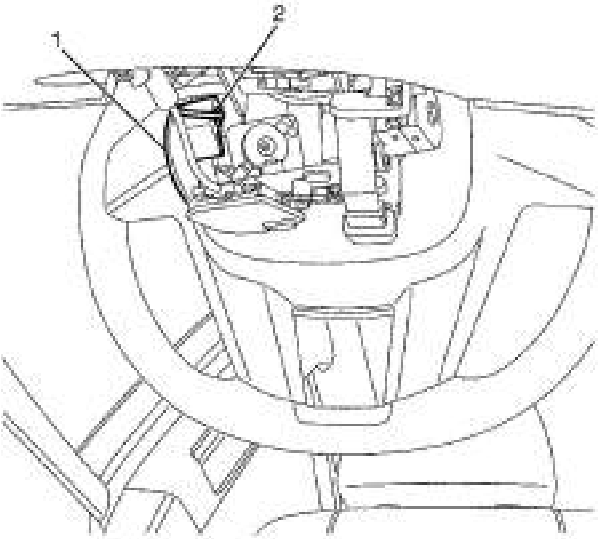
Ignition Lock Cylinder Bulb Replacement (RHD)

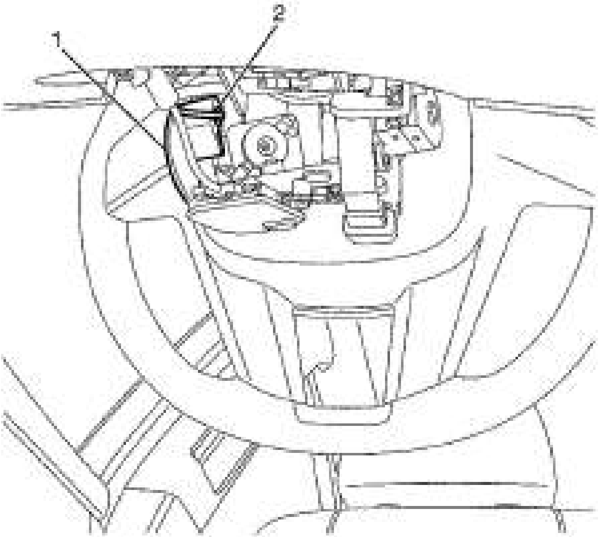
Removal Procedure

1. Remove the upper and lower steering column trim covers. Refer to Steering Column Trim Covers Replacement.



2. Remove the theft deterrent module (1) from the steering column. Refer to Theft Deterrent Module Replacement.
3. Turn the ignition lock cylinder lamp socket (2) counter clockwise and remove from the socket from the theft deterrent module (1).
4. Pull and remove the bulb from the ignition lock cylinder lamp socket.

Installation Procedure



1. Install a new bulb to the ignition lock cylinder lamp socket (2).
2. Install the ignition lock cylinder lamp socket (2) to the theft deterrent module (1) and turn clockwise to secure.
3. Install the theft deterrent module to the steering column. Refer to Theft Deterrent Module Replacement.
4. Check the operation of the ignition lock cylinder light.
5. Install the upper and lower steering column trim covers. Refer to Steering Column Trim Covers Replacement.

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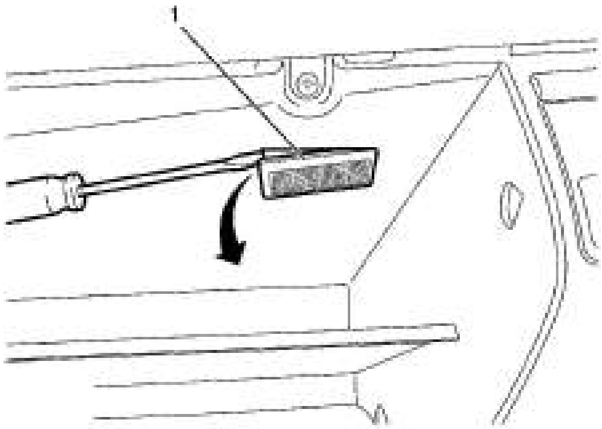
Instrument Panel Compartment Lamp Replacement

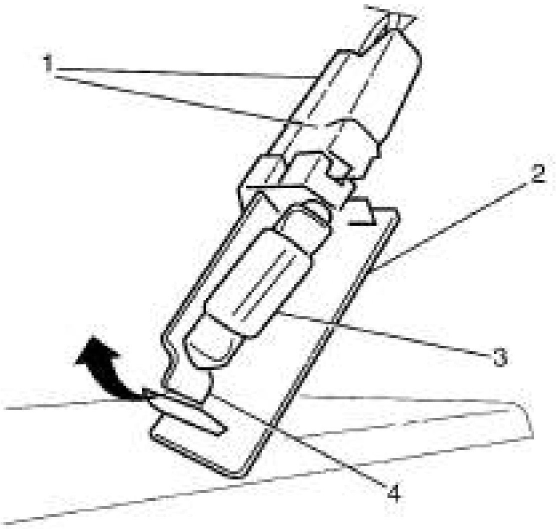
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Open the instrument panel compartment.

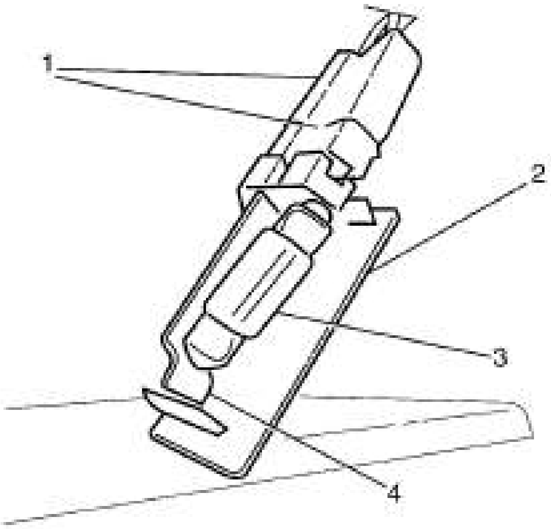


3. Insert a suitable tool under the instrument panel compartment lamp assembly (1) and gently pry the lamp assembly from the instrument panel compartment.

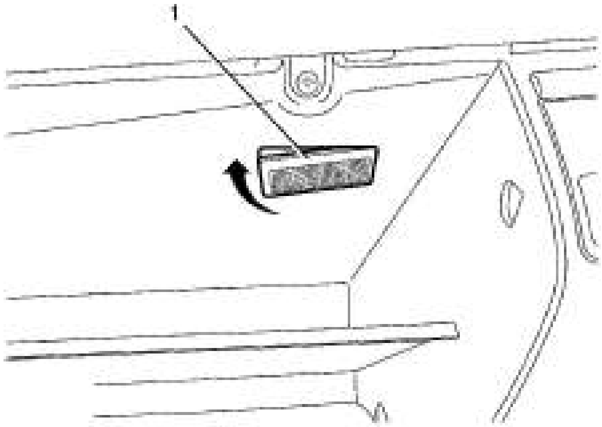


4. Disconnect the instrument panel compartment lamp (2) electrical connectors (1) and remove the lamp.
5. Bend back the contact lever (4) that secures the bulb (3) and remove the bulb from the lamp (2).

Installation Procedure



1. Install the new bulb (3) to the lamp (2), ensuring that the bulb is correctly positioned in the contact lever (4).
2. Connect the instrument panel compartment lamp (2) electrical connectors (1).



3. Feed the lamp assembly (1) wiring into the cavity and push the instrument panel compartment lamp back into the instrument panel compartment cavity. Listen for an audible click to confirm fitting.
4. Close the instrument panel compartment.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

5. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
6. Check all vehicle lights for correct operation.

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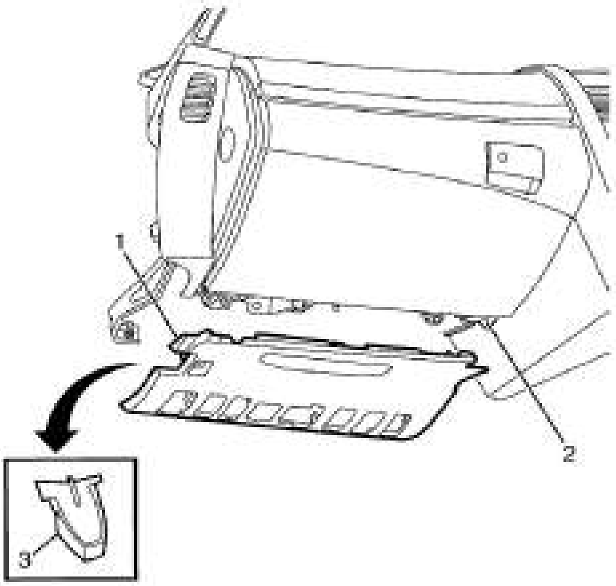
Instrument Panel Compartment Lamp Switch Replacement

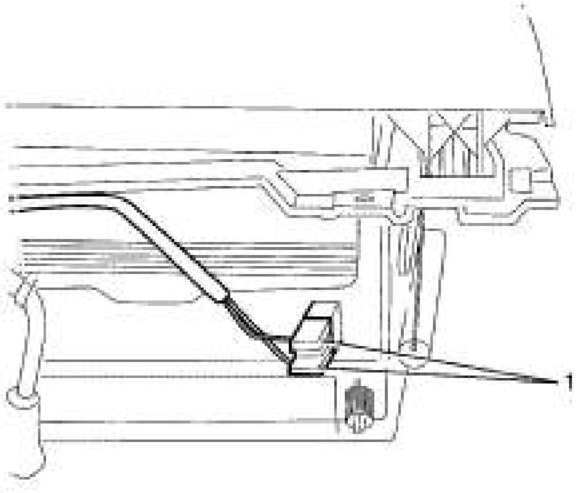
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

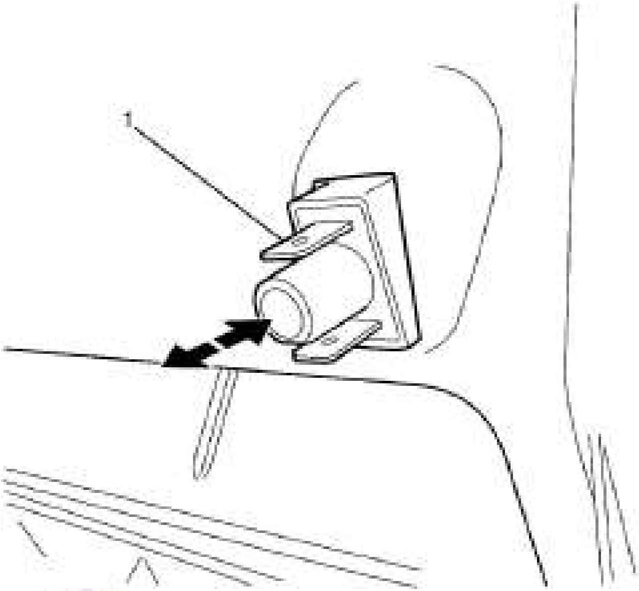
1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .



2. Remove the left instrument panel lower trim plate (1) by pulling the panel down and disengaging the retaining clips.



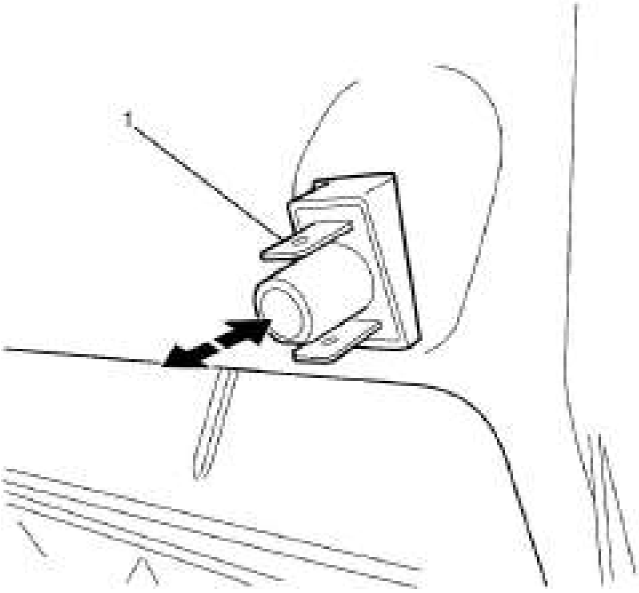
3. Disconnect the electrical connectors (1) from the instrument panel compartment lamp switch.
4. Open the instrument panel compartment.



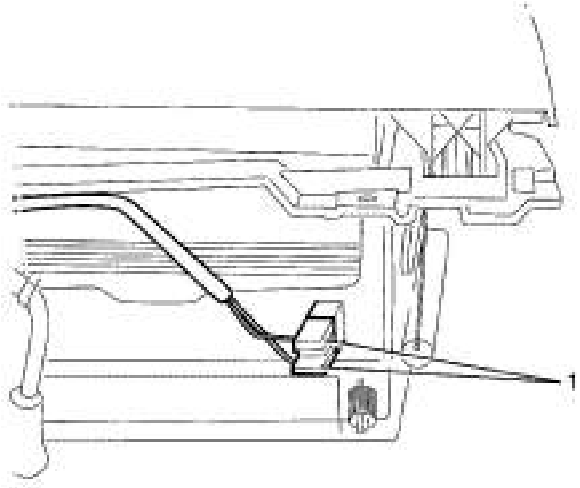
Important: Remove the instrument panel compartment lamp switch (1), by pushing it through the instrument panel compartment.

5. Remove the instrument panel compartment lamp switch (1).

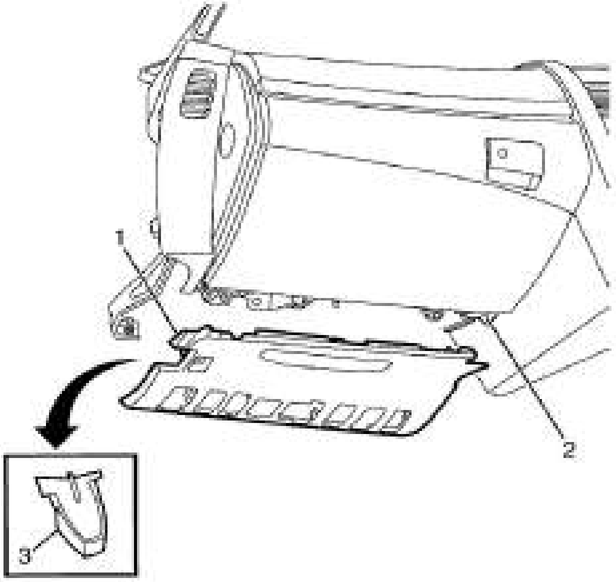
Installation Procedure



1. Install the instrument panel compartment lamp switch (1), listen for an audible click to confirm fitting.
2. Close the instrument panel compartment.



3. Connect the electrical connectors (1) to the instrument panel compartment lamp switch.



4. Install the left instrument panel lower trim plate (1) by engaging the instrument panel lower trim plate retaining clips.
5. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
6. Test the operation of the instrument panel compartment lamp switch.

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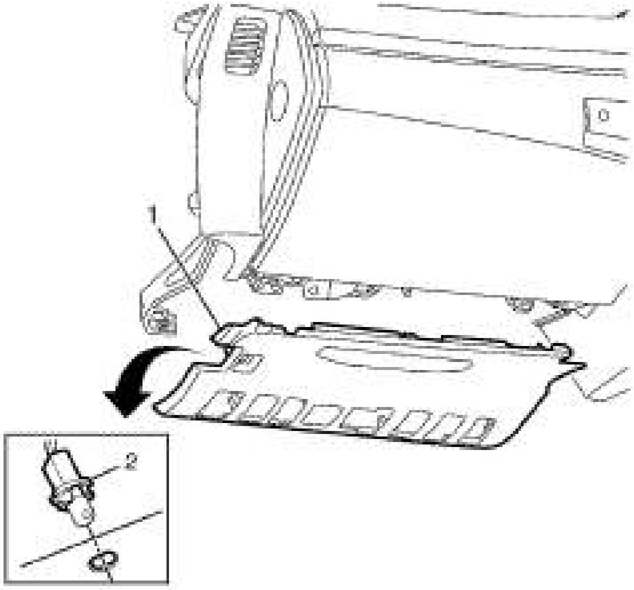
Instrument Panel Courtesy Lamp Bulb Replacement - Left Side (Left Side)

Removal Procedure

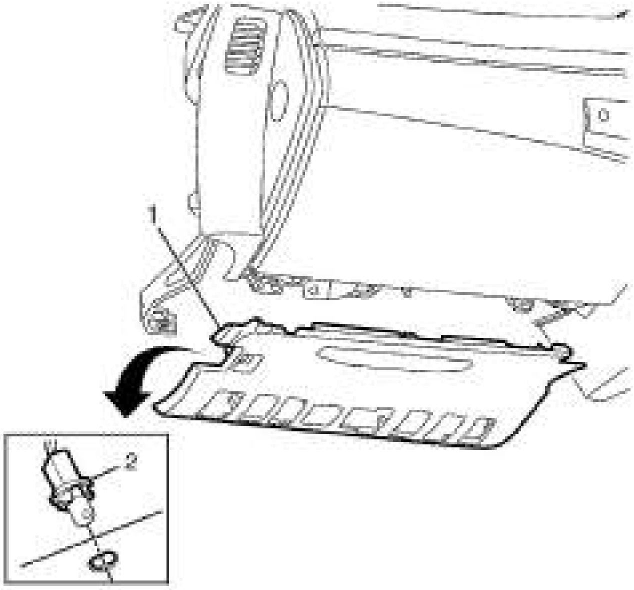
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.



2. Lower the left instrument panel lower trim plate (1) by pulling the panel down and away from the clips.
3. Remove the courtesy lamp socket assembly (2) from the left lower trim plate by turning the socket counterclockwise.
4. Pull and remove the courtesy light bulb from the courtesy lamp socket (2).

Installation Procedure



1. Install a new bulb into the bulb socket assembly (2).
2. Install the courtesy lamp socket assembly (2) to the I/P lower trim plate assembly (1) and turn the socket assembly clockwise to secure.
3. Install the left instrument panel lower trim plate (1) and make sure the trim plate clips securely engage.
4. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
5. Check all vehicle lights for correct operation.

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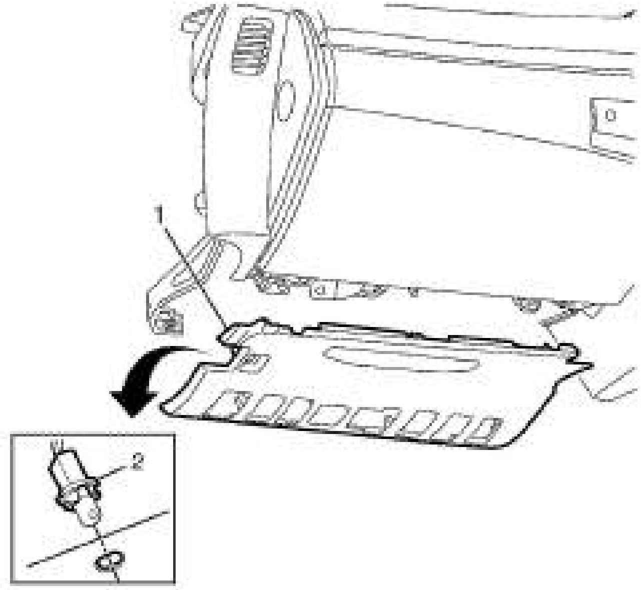
Instrument Panel Courtesy Lamp Bulb Replacement - Left Side (Right Side)

Removal Procedure

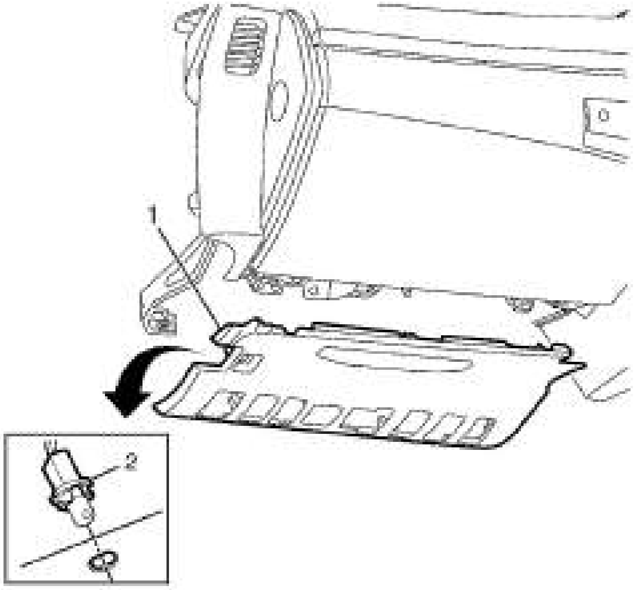
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.



2. Lower the left instrument panel lower trim plate (1) by pulling the panel down and away from the clips.
3. Remove the courtesy lamp socket assembly (2) from the left lower trim plate by turning the socket counterclockwise.
4. Pull and remove the courtesy light bulb from the courtesy lamp socket (2).

Installation Procedure



1. Install a new bulb into the bulb socket assembly (2).
2. Install the courtesy lamp socket assembly (2) to the I/P lower trim plate assembly (1) and turn the socket assembly clockwise to secure.
3. Install the left instrument panel lower trim plate (1) and make sure the trim plate clips securely engage.
4. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
5. Check all vehicle lights for correct operation.

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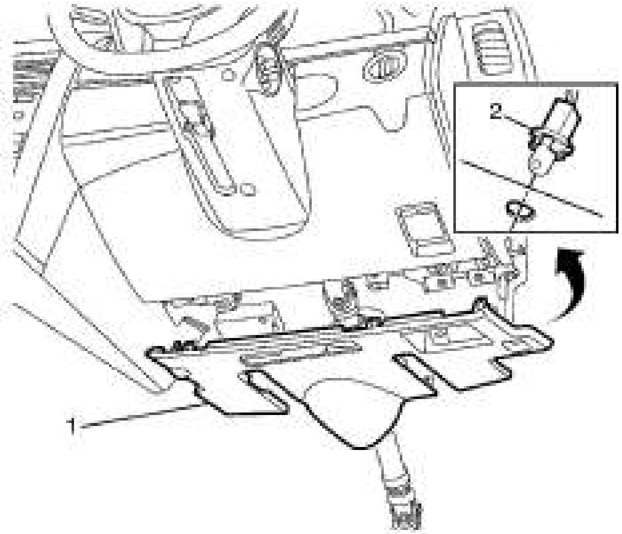
Instrument Panel Courtesy Lamp Bulb Replacement - Right Side (Left Side)

Removal Procedure

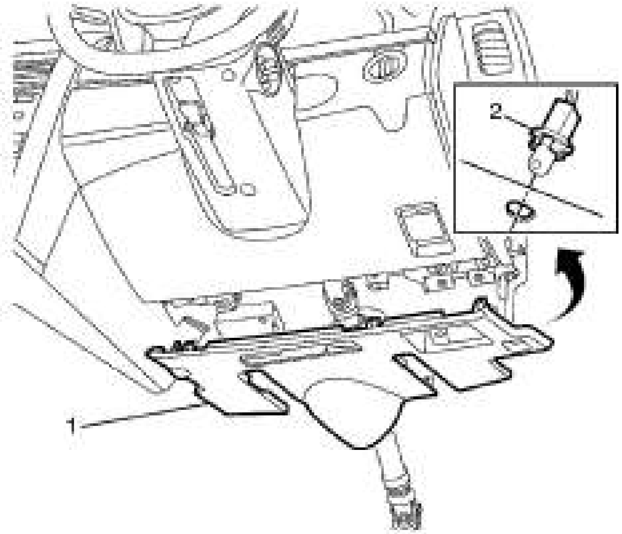
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.



2. Lower the right instrument panel lower trim plate (1) by pulling the panel down and away from the clips.
3. Remove the courtesy lamp socket assembly (2) from the left lower trim plate by turning the socket counter clockwise.
4. Pull and remove the courtesy light bulb (2) from the courtesy lamp socket.

Installation Procedure



1. Install a new bulb into the bulb socket assembly (2).
2. Install a new courtesy light bulb assembly (2) to the right instrument panel lower trim plate (1) and turn the assembly clockwise to secure.
3. Install the right instrument panel lower trim plate (1) and make sure the trim plate clips securely engage.
4. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
5. Check all vehicle lights for correct operation.

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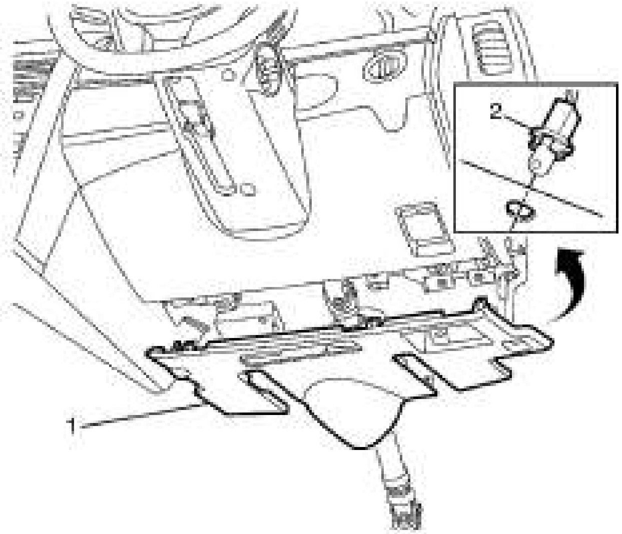
Instrument Panel Courtesy Lamp Bulb Replacement - Right Side (Right Side)

Removal Procedure

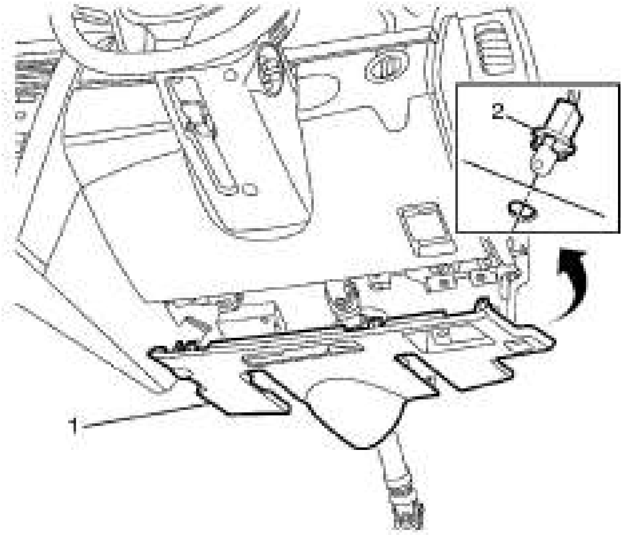
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.



2. Lower the right instrument panel lower trim plate (1) by pulling the panel down and away from the clips.
3. Remove the courtesy lamp socket assembly (2) from the left lower trim plate by turning the socket counter clockwise.
4. Pull and remove the courtesy light bulb (2) from the courtesy lamp socket.

Installation Procedure



1. Install a new bulb into the bulb socket assembly (2).
2. Install a new courtesy light bulb assembly (2) to the right instrument panel lower trim plate (1) and turn the assembly clockwise to secure.
3. Install the right instrument panel lower trim plate (1) and make sure the trim plate clips securely engage.
4. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
5. Check all vehicle lights for correct operation.

Instrument Panel Lamp Dimmer Switch Replacement

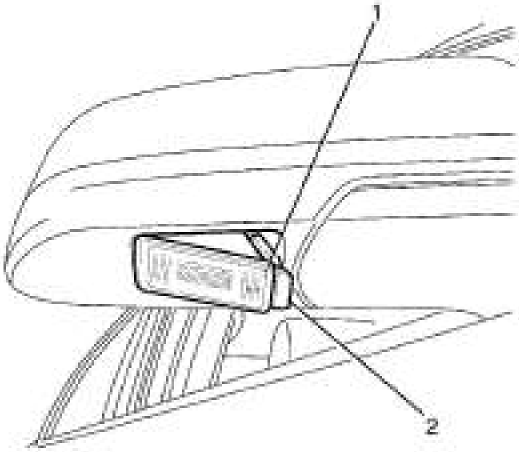
The instrument panel dimmer switch is serviced with the headlamp switch. Refer to Headlamp Switch Replacement.

Outside Rearview Mirror Courtesy Lamp Replacement

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

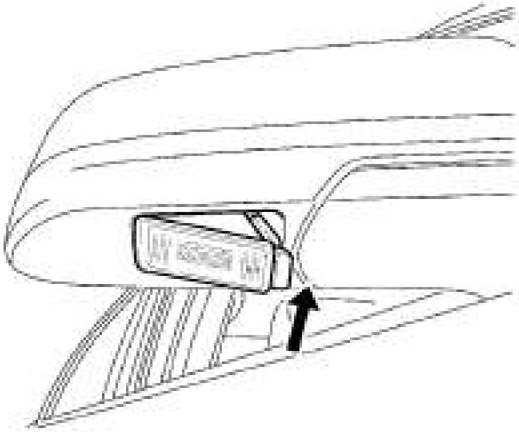
1. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.



2. Insert a suitable tool under the puddle lamp housing (1) and release the locking tab (2) of the lamp.
3. Pry the lamp assembly from the mirror and pivot and lower the assembly.
4. Bend back the lever contact that holds the bulb and remove the bulb from the lamp housing.

Installation Procedure

1. Install the new bulb to the puddle lamp assembly.



2. Feed the lamp wiring into the cavity and push the lamp back into the door mirror housing.
3. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
4. Check all vehicle lights for correct operation.

Parking and Turn Signal Lamp Replacement

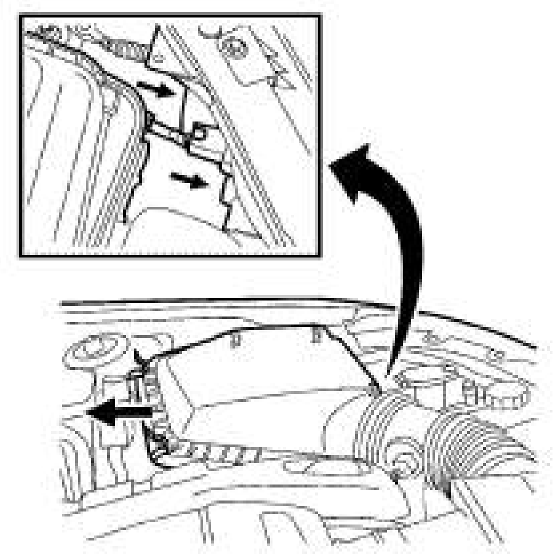
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

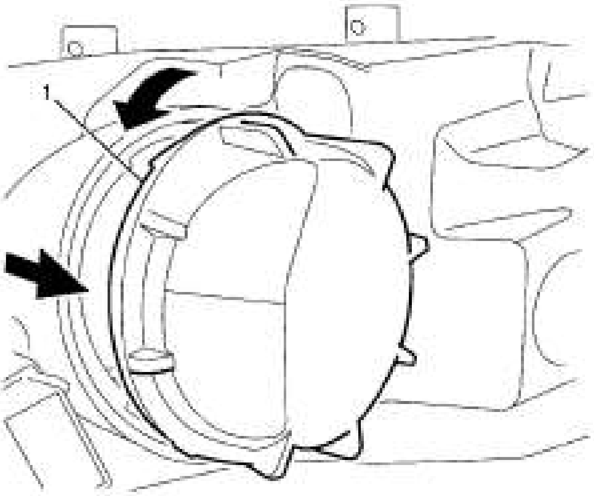
1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
2. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement

Important: For left-hand headlamp access, go to step 3.

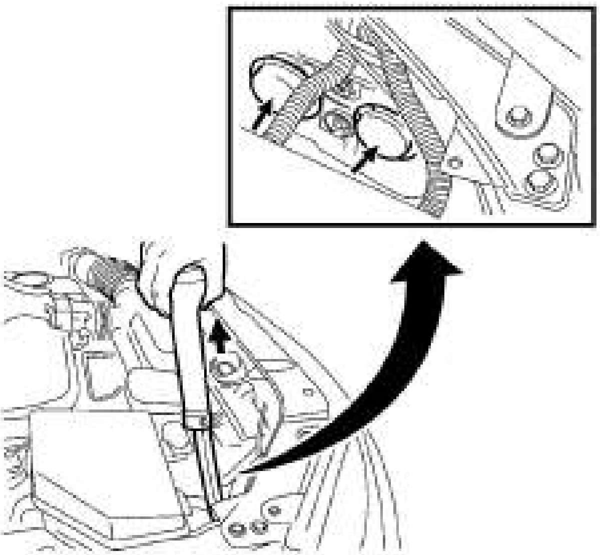
Important: For right-hand headlamp access, go to step 4.



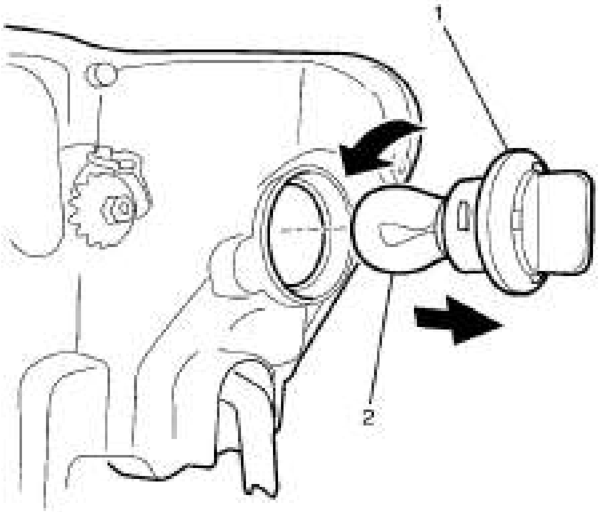
3. For access to the left-hand headlight, detach and move the airbox upper cover rearward. Go to step 5.



4. Remove the low beam headlamp dust cap from the rear of the headlamp assembly by rotating the dust cap counter clockwise. Note orientation of the dust cap and tabs for installation.

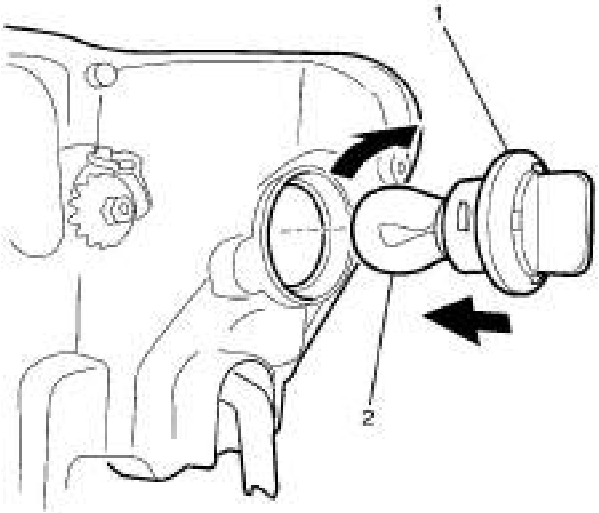


5. For access to the right-hand headlight, remove the coolant reservoir fill neck by pulling up on the neck assembly and position aside. Note the orientation of the aligning tabs and keyway of the coolant reservoir fill neck for installation.



6. Rotate the front indicator bulb (2) and socket (1) counter-clockwise and remove from the headlamp assembly.
7. Rotate the front indicator bulb (2) counter-clockwise and remove from the front indicator socket (1).

Installation Procedure



1. Install the front indicator bulb (2) into the front indicator socket (1) and secure by rotating clockwise.
2. Install the front indicator bulb (2) and socket (1) into the headlamp assembly and secure by rotating clockwise.
3. For the left-hand headlamp assembly, replace and secure the airbox upper cover.

4. For the right-hand headlamp assembly, reinstall the coolant reservoir fill neck by aligning the tabs and keyway and pushing the neck into position.
5. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement
6. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
7. Check all vehicle lights for correct operation.

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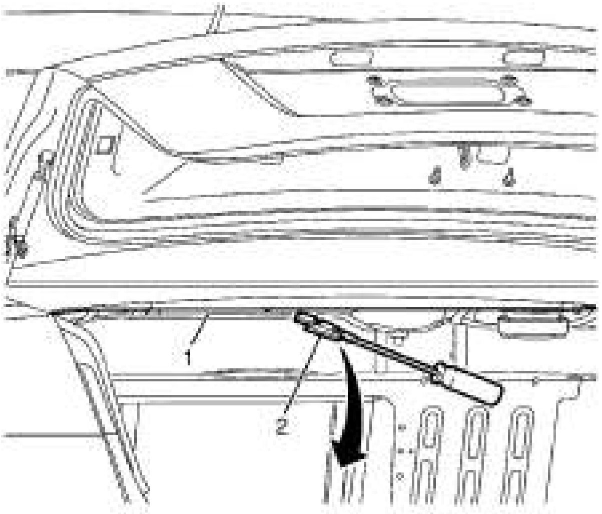
Rear Compartment Courtesy Lamp Replacement (Sedan)

Removal Procedure

1. Open rear compartment lid.

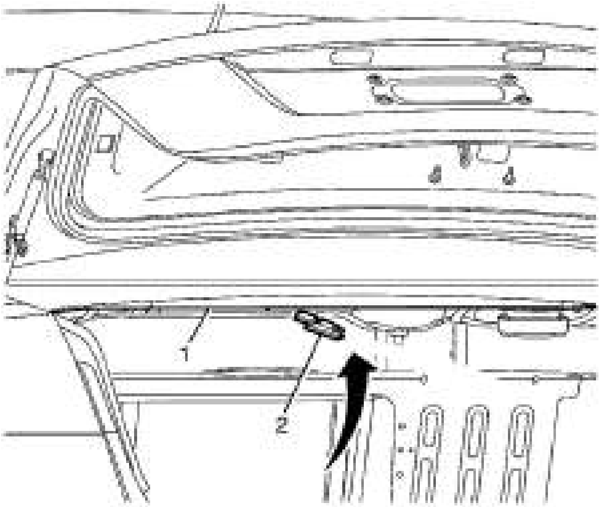
   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.



3. Remove the rear compartment lamp (2) by prizing the lamp from the rear shelf (1).
4. Bend back the lever contact that holds the bulb and remove the bulb from the lamp assembly.

Installation Procedure



1. Install a new bulb to the rear compartment lamp housing (2).
2. Install the rear compartment lamp housing (2) by pushing wiring and connector of lamp into the rear shelf (1) cavity. Snap lamp into position.
3. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
4. Check all vehicle lights for correct operation.
5. Close the rear compartment lid.

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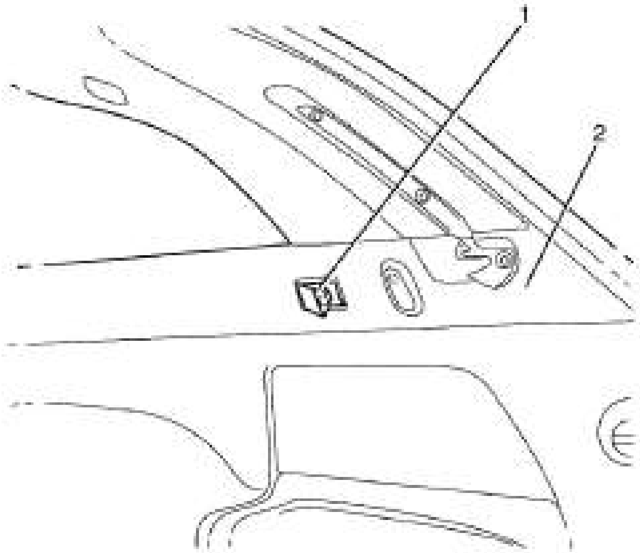
Rear Compartment Courtesy Lamp Replacement (Sportwagon)

Removal Procedure

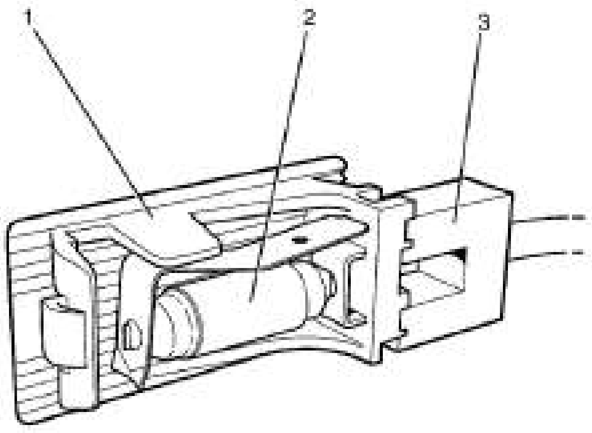
Caution: Refer to Battery Disconnect Caution in the Preface section.

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection

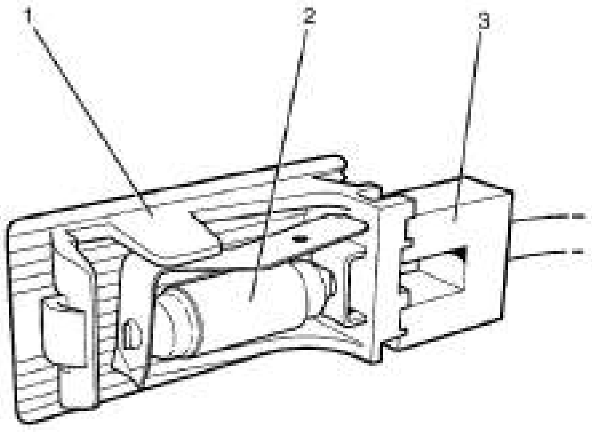


3. Using a suitable tool, pry the rear compartment courtesy lamp (1) from the quarter inner trim finish panel (2).

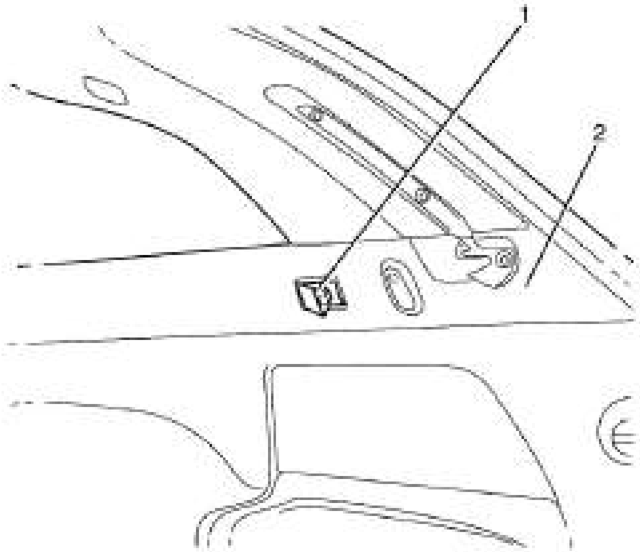


4. Disconnect the rear compartment courtesy lamp electrical connector (3) from the rear compartment courtesy lamp assembly (1).
5. Remove the rear compartment courtesy lamp bulb (2) from the rear compartment courtesy lamp assembly (1).

Installation Procedure



1. Install the rear compartment courtesy lamp bulb (2) into the rear compartment courtesy lamp assembly (1).
2. Connect the rear compartment courtesy lamp electrical connector (3) to the rear compartment courtesy lamp assembly (1).



3. Install the rear compartment courtesy lamp assembly (1) into the quarter inner trim finish panel (2).
4. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

5. Remove the suitable liftgate brace from the vehicle.
6. Check the operation of the rear compartment courtesy lamp.

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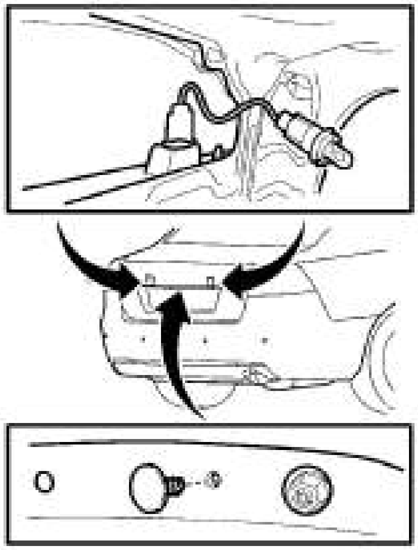
Rear License Plate Lamp Bulb Replacement (Sedan)

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Open the rear compartment lid.



Important: The license plate lamp bulbs are located in the rear compartment lid.

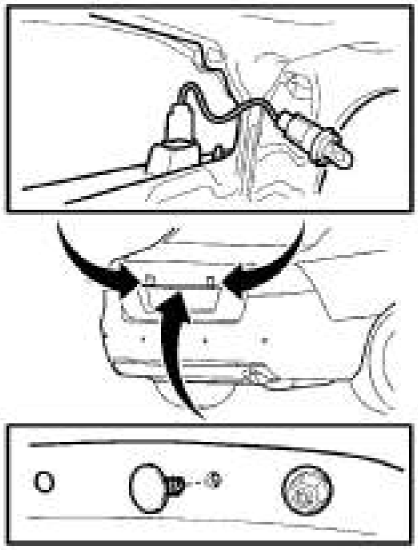
3. For access to the license plate lamp bulbs, remove the rear compartment lid interior trim clip and position the trim aside.
4. Remove the license plate lamp bulb holder from the lamp body by rotating counterclockwise.
5. Pull the license plate light bulb from the holder socket.

Installation Procedure

1. Install a new license plate light bulb into the license plate lamp bulb holder socket and push the bulb into the socket.

Important: Check the condition of license plate bulb base seal and replace if necessary. The tabs on the bulb base and mating cut-outs in the lamp assembly allow the bulb to seat correctly in the lamp housing.

2. Install the license plate lamp bulb holder to the lamp body in the rear compartment lid and rotate clockwise to secure.
3. Check all vehicle lights for correct operation.



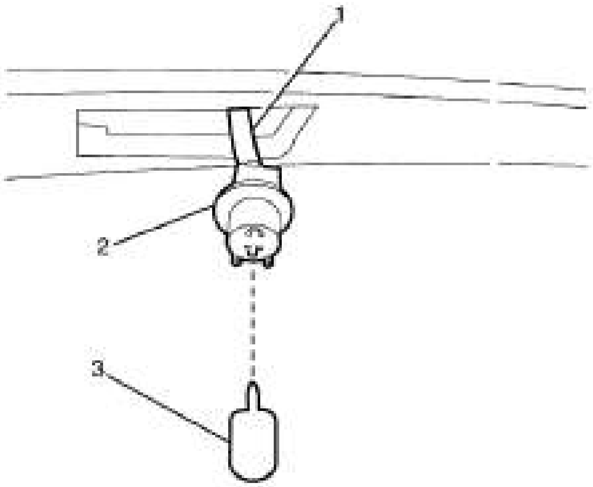
4. Install the rear compartment lid interior trim and secure with clip.
5. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
6. Close the rear compartment lid.

Rear License Plate Lamp Bulb Replacement (Sportwagon)

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the rear licence lamp assembly. Refer to Rear License Lamp Replacement.

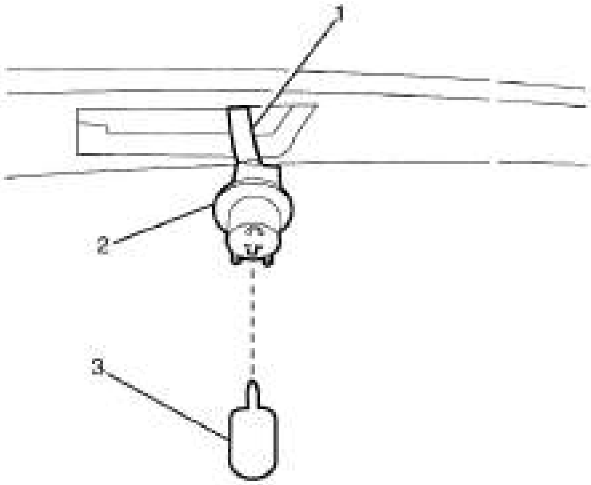


Important: DO NOT pull on the wiring harness (1). Damage to the wiring harness (1) may result.

Important: Remove the rear license lamp bulb (3) from the rear license lamp bulb holder (2) by pulling the rear license lamp bulb (3) away from the rear license lamp bulb holder (2).

3. Remove the rear license lamp bulb (3) from the rear license lamp bulb holder (2).
4. Discard the rear license lamp bulb (3).

Installation Procedure



Important: DO NOT pull on the wiring harness (1). Damage to the wiring harness (1) may result.

Important: Install the NEW rear license bulb (3) to the rear license lamp bulb holder (2) by pushing the NEW rear license bulb (3) into the rear license lamp bulb holder (2).

1. Install the NEW rear license bulb (3) to the rear license lamp bulb holder (2).
2. Install the rear license lamp assembly. Refer to Rear License Lamp Replacement.
3. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

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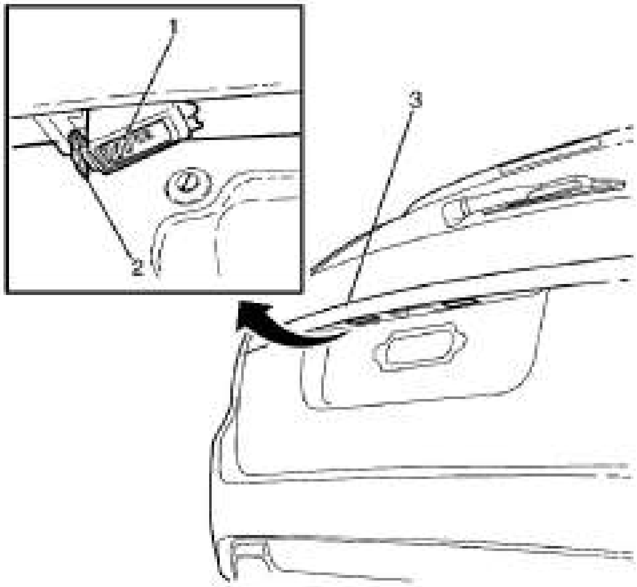
Rear License Plate Lamp Replacement (Sportwagon)

Removal Procedure

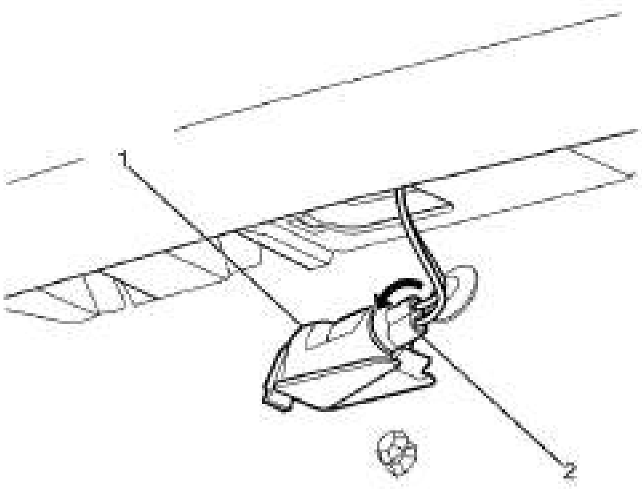
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.



Important: Remove the rear license lamp assembly (1), from the liftgate centre applique (3) by pressing the locking tab (2) toward the lamp assembly.

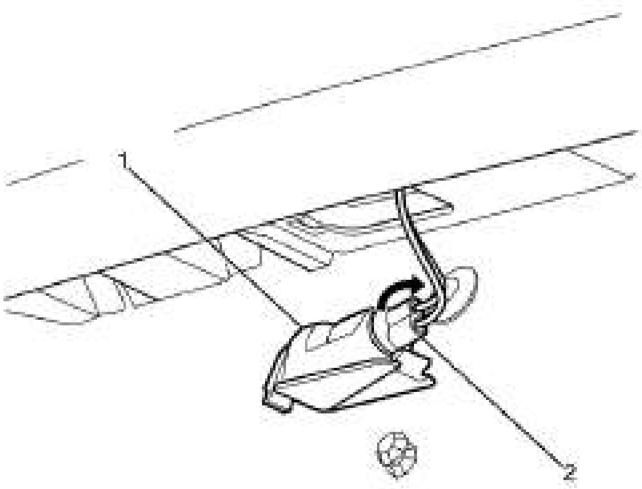
2. Remove the rear license lamp assembly (1) from the liftgate centre applique (3).



Important: Remove the rear license lamp bulb holder (2) from the rear license lamp assembly (1) by rotating the rear license lamp bulb holder (2) counter clockwise.

3. Remove the rear license lamp bulb holder (2) from the rear license lamp assembly (1).
4. Remove the rear license lamp assembly (1) from the vehicle.
5. For removal of the license lamp bulb. Refer to License Lamp Bulb Replacement.

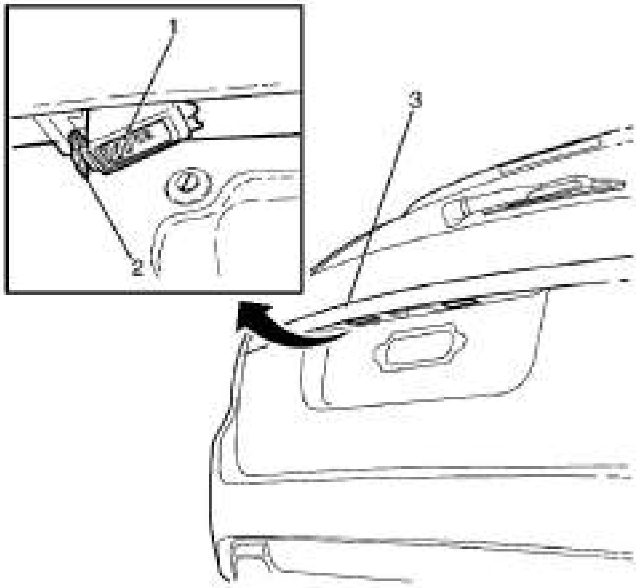
Installation Procedure



1. Position the rear license lamp assembly (1) to the vehicle.

Important: Install the rear license lamp bulb holder (2) to the rear license lamp assembly (1) by rotating the rear license lamp bulb holder (2) clockwise.

2. Install the rear license lamp bulb holder (2) to the rear license lamp assembly (1).



Important: Install the rear license lamp assembly (1) to the liftgate centre applique (3) by pushing the rear license lamp assembly (1) upwards into to the liftgate centre applique (3). Listen for an audible click from the locking tab (2) to confirm correct fitting.

3. Install the rear license lamp assembly (1) to the liftgate centre applique (3).
4. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

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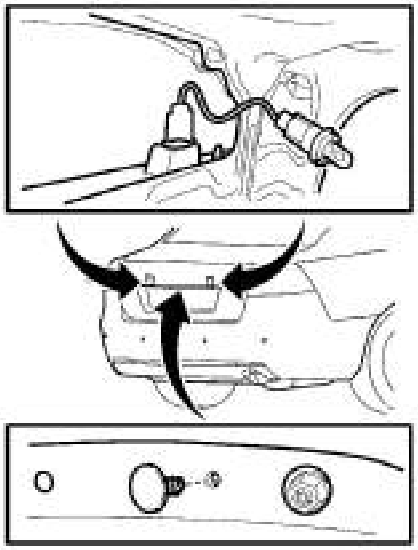
Rear License Plate Lamp Replacement (SWB)

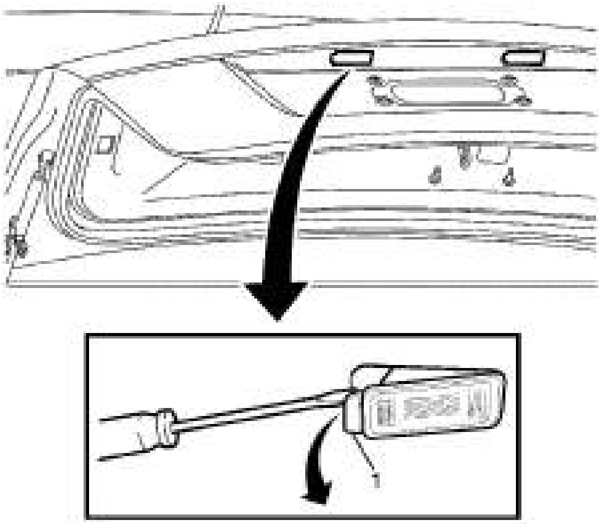
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Open the rear compartment lid.

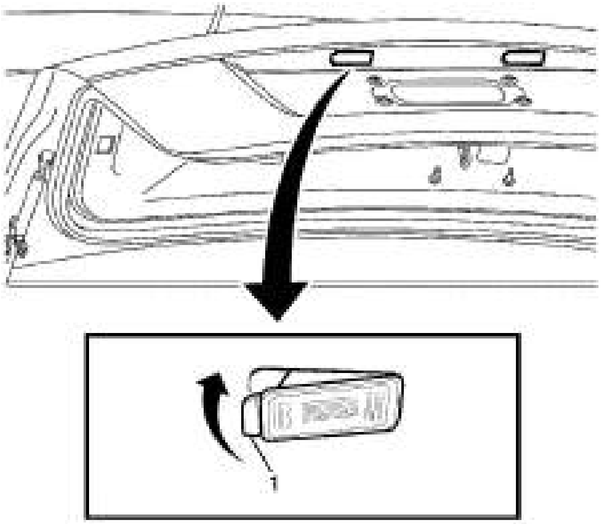


3. For access to the license plate light bulb, remove the rear compartment lid interior trim clip and position the trim aside.
4. Remove the license plate light bulb holder from the lamp body by rotating counterclockwise.



5. Insert a suitable tool under the licence plate lamp housing and release the locking tab (1) of the lamp.
6. Pry the lamp assembly from the rear compartment lid and pivot and lower the lamp assembly from the lid.

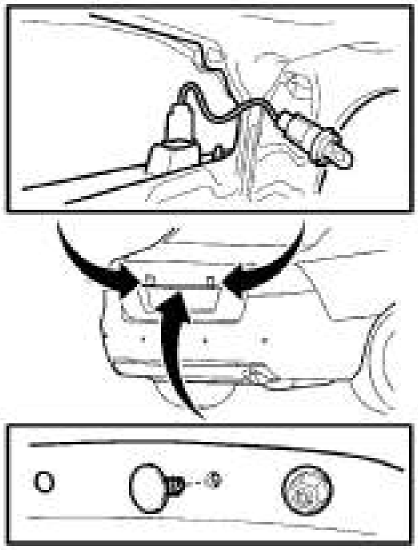
Installation Procedure



1. Install a new license plate lamp assembly to the rear compartment lid. Pivot the lamp into the cavity and snap into position. Listen for an audible click from the locking tab (1) to confirm fitting.
2. If necessary, install a new license plate light bulb into the license plate light bulb holder socket.

   Important: Check the condition of license plate bulb base seal and replace if necessary. The tabs on the bulb base and mating cut-outs in the lamp assembly allow the bulb to seat correctly in the lamp housing.

3. Install the license plate light bulb holder to the lamp body in the rear compartment lid and rotate clockwise to secure.
4. Check all vehicle lights for correct operation.



5. Install the rear compartment lid interior trim and secure with clip.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

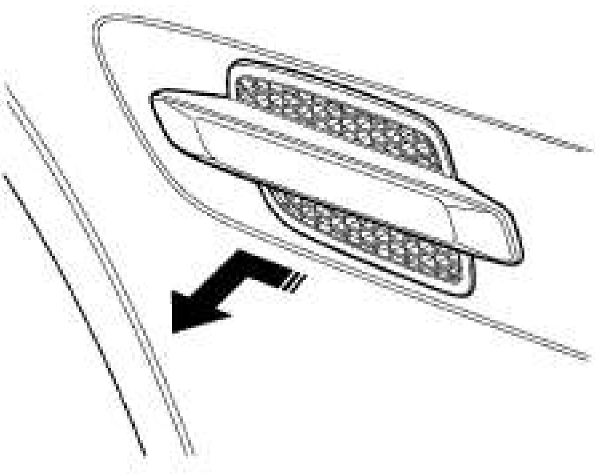
6. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
7. Close the rear compartment lid.

Repeater Lamp Bulb Replacement (LWB SWB)

Removal Procedure - Side Indicator

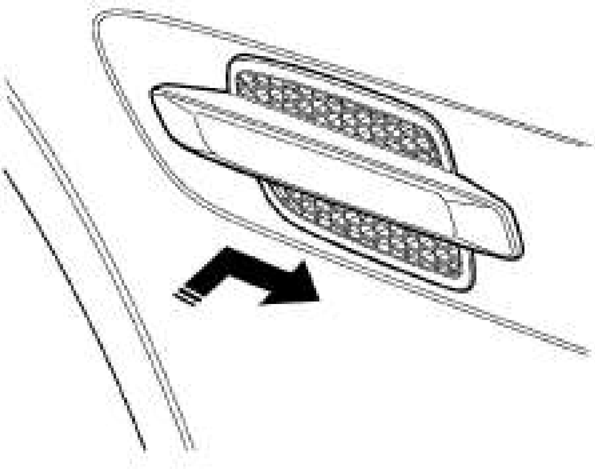
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.



2. Remove side indicator lamp assembly from the fender by grasping the assembly and pushing the assembly forward to disengage the rear clip from the fender.
3. Tilt the rear of the side indicator lamp assembly out and remove the assembly from the front fender.
4. Disconnect the electrical connector from the bulb socket, by depressing the connector clip and pulling connector from bulb socket.
5. Disconnect the bulb socket from the side indicator lamp assembly by rotating the socket counterclockwise.
6. Remove the side indicator bulb from the bulb socket.

Installation Procedure - Side Indicator



1. Install a new side indicator bulb to the bulb socket.
2. Connect electrical connector to the bulb socket, note orientation of the electrical connector.

   Important: The tabs on the bulb base and mating cut-outs in the lamp assembly allow the bulb to seat correctly in the lamp.

3. Install the bulb socket into the side indicator lamp assembly and rotate the socket clockwise to secure the bulb and socket.
4. Install rear portion of the side indicator lamp assembly into the fender and then push the front of the lamp assembly inwards to engage the front clip.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

5. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
6. Check all vehicle lights for correct operation.

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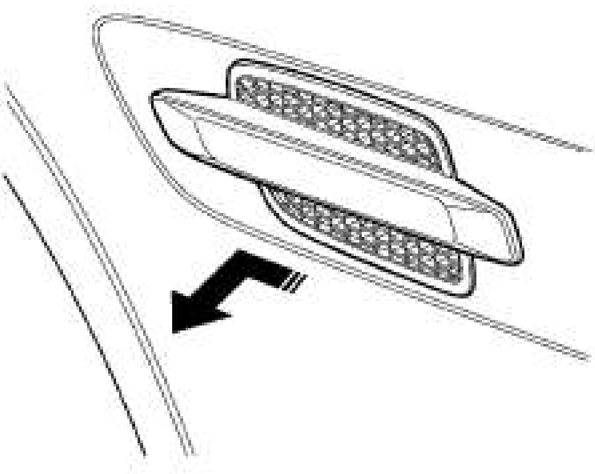
Repeater Lamp Replacement (SWB)

Removal Procedure - Side Indicator Type A

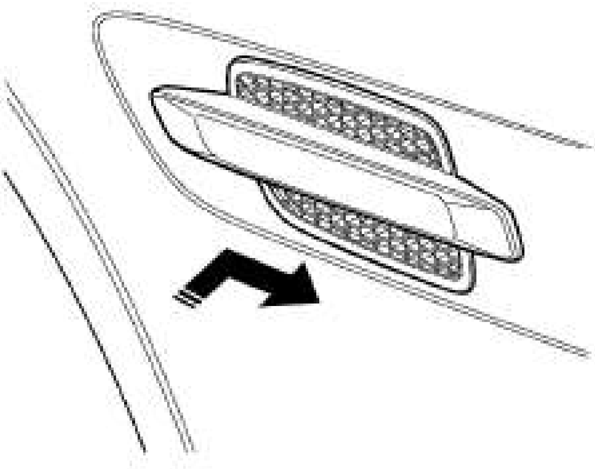
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.



2. Remove side indicator lamp assembly from the fender by grasping the assembly and pushing the assembly forward to disengage the rear clip from the fender.
3. Tilt the rear of the side indicator lamp assembly out and remove the assembly from the front fender.
4. Disconnect the bulb socket from the side indicator lamp assembly by rotating the socket counterclockwise.
5. Disconnect the electrical connector from the bulb socket, by depressing the connector clip and pulling connector from bulb socket.
6. Discard the repeater lamp.

Installation Procedure - Side Indicator Type A



1. Install the bulb socket into the new side indicator lamp assembly and rotate the socket clockwise to secure the bulb.
2. Connect electrical connector to the bulb socket, note oretayion of the electrcal connector.
3. Install rear portion of the side indicator lamp assembly into the fender and then push the front of the lamp assembly inwards to engage the front clip.

Caution: Refer to Battery Disconnect Caution in the Preface section.

4. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
5. Check all vehicle lights for correct operation.

Stop Lamp Switch Adjustment

For brake pedal position sensor (BPPS) learn. Refer to Body Control Module Programming and Setup

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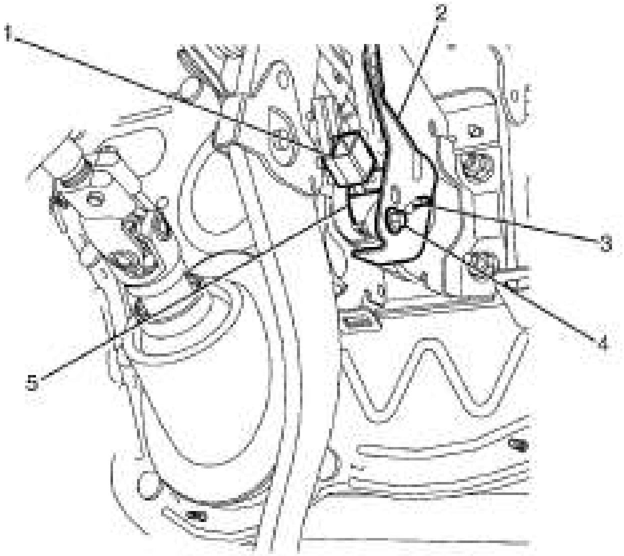
Stop Lamp Switch Replacement (RHD)

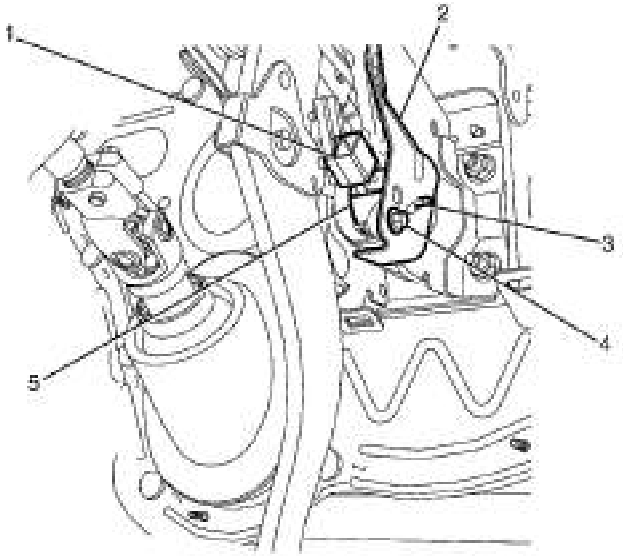
Removal Procedure

1. Remove the instrument panel lower right trim plate assembly. Refer to Instrument Panel Insulator Panel Replacement - Right Side.
2. Remove the knee bolster. Refer to Knee Bolster Replacement.



3. Disconnect the brake pedal position sensor electrical connector (1).
4. Remove the brake pedal position sensor to brake pedal bracket retaining bolt (4).
5. Disengage the brake pedal position sensor locating tab (3) from the brake pedal bracket (2).
6. Remove the brake pedal position sensor (5).

Installation Procedure



1. Connect the brake pedal position sensor electrical connector (1).
2. Align the brake pedal position sensor (5).

   Engage the brake pedal position sensor locating tab (3) to the brake pedal bracket (2).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the brake pedal position sensor to brake pedal bracket retaining bolt (4).

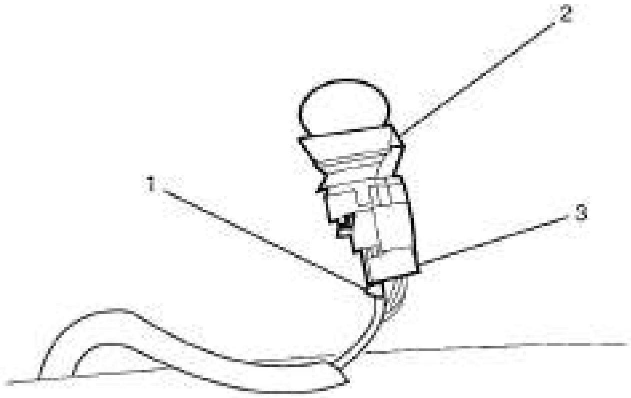
   Tighten
   Tighten the bolt to 3 N·m (26 lb ft).

4. Install the knee bolster. Refer to Knee Bolster Replacement.
5. Install the instrument panel lower right trim plate assembly. Refer to Instrument Panel Insulator Panel Replacement - Right Side.
6. Calibrate the brake pedal position sensor (5). Refer to Stop Lamp Switch Adjustment.

Sunload and Twilight Sentinel Sensor Replacement

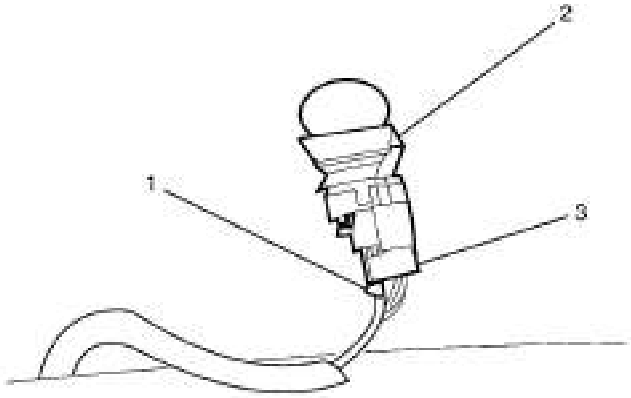
Removal Procedure

1. Remove the defrost grille. Refer to Defroster Grille Replacement.



2. Detach the sunload sensor (2) electrical connector retaining pin (3).
3. Remove the sunload sensor electrical connector (3).

Installation Procedure

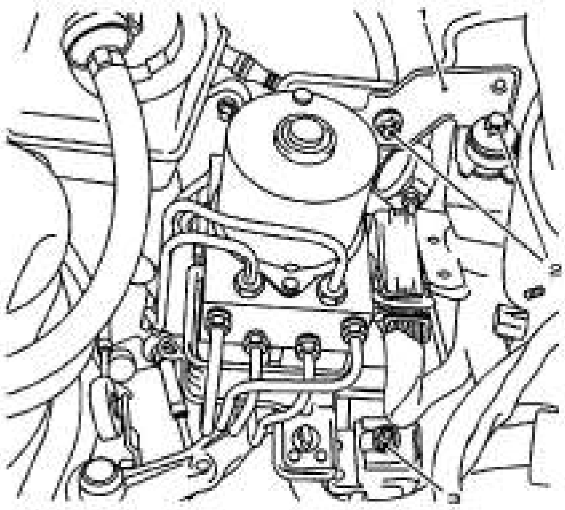


1. Install the sunload electrical connector (3).
2. Attach the sunload electrical connecter retaining pin (1).
3. Install the defrost grille. Refer to Defroster Grille Replacement.
4. Test the sunload sensor for the correct operation.

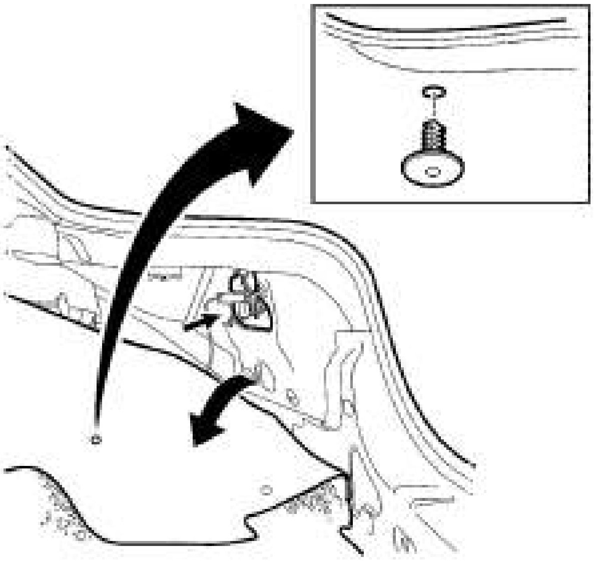
Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn Signal Bulb Replacement (LWB)

Removal Procedure - Backup Light Bulb (LED tail lamp)

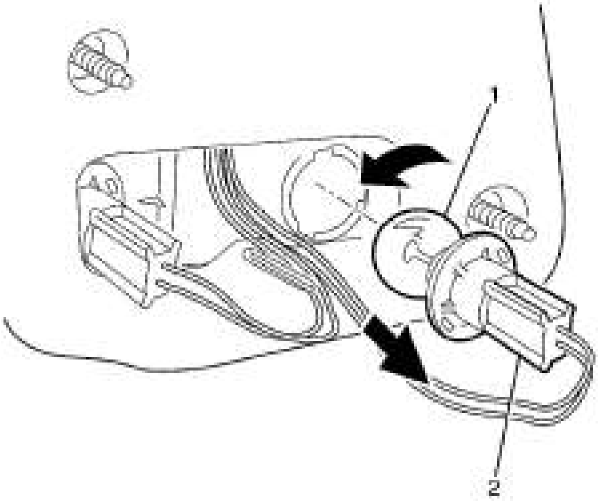
1. Open the rear compartment lid.



2. Remove the rear compartment lid trim clips and remove the trim.



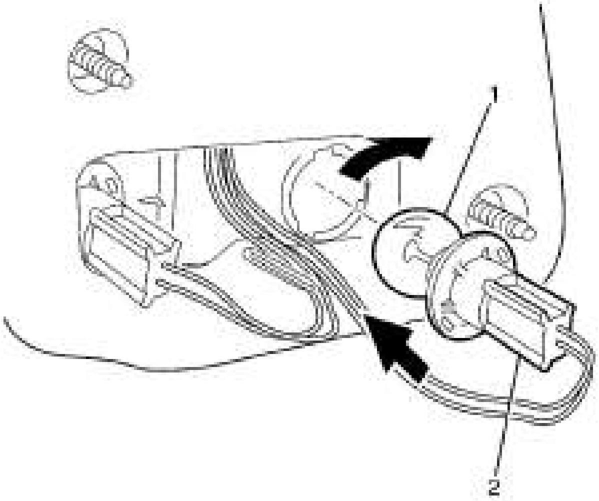
3. Remove the rear compartment lining clip and pull back the lining for access to the rear bulbs.



4. Remove the backup light bulb (1) and socket (2) from the rear tail lamp assembly by rotating the socket counterclockwise.
5. Remove the backup light bulb (1) from the socket (2) by pushing and rotating the bulb counterclockwise.

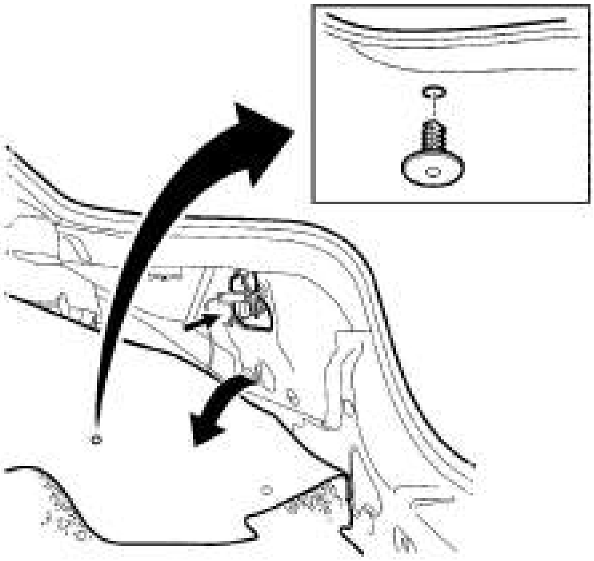
Installation Procedure - Backup Light Bulb (LED tail lamp)

1. Install the new backup light bulb into the socket by pushing and turning the bulb clockwise.

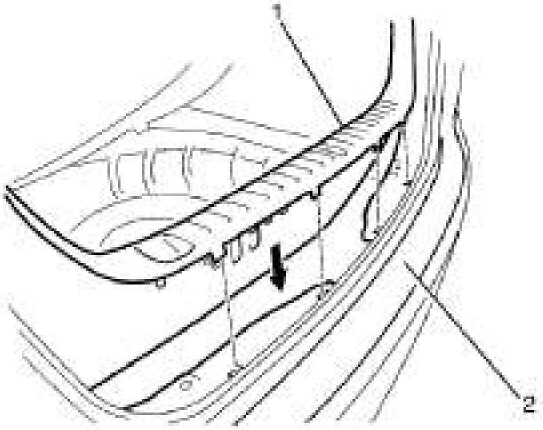


Important: The different-sized tabs on the bulb base and mating cut-outs in the tail lamp assembly allow the bulb to seat correctly.

2. Install the backup light bulb (1) and socket (2) into the rear tail lamp assembly and secure by rotating the socket clockwise.
3. Check all vehicle lights for correct operation.



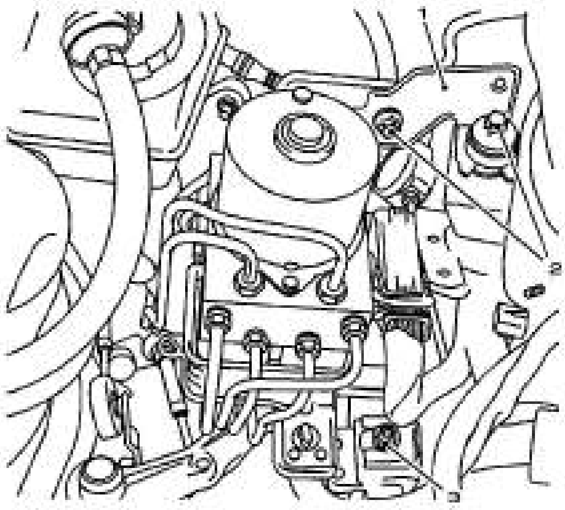
4. Install the rear compartment lining and reinstall clip to secure lining.



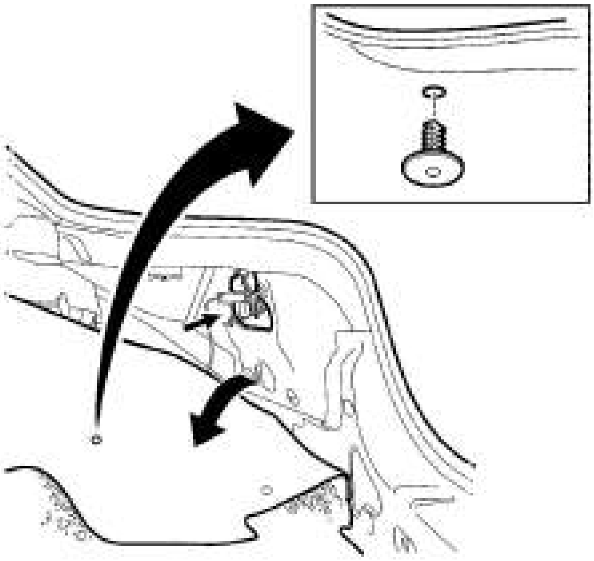
5. Install the rear compartment lid trim and reinstall the clips to secure the trim.

Removal Procedure - Rear Indicator Bulb (LED tail lamp)

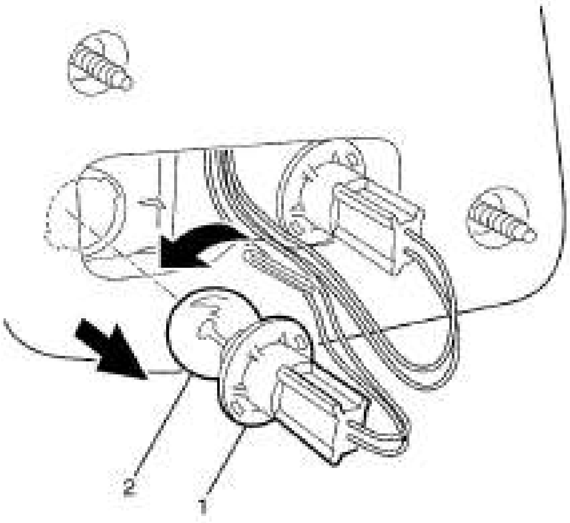
1. Open the rear compartment lid.



2. Remove the rear compartment lid trim clips and remove the trim.

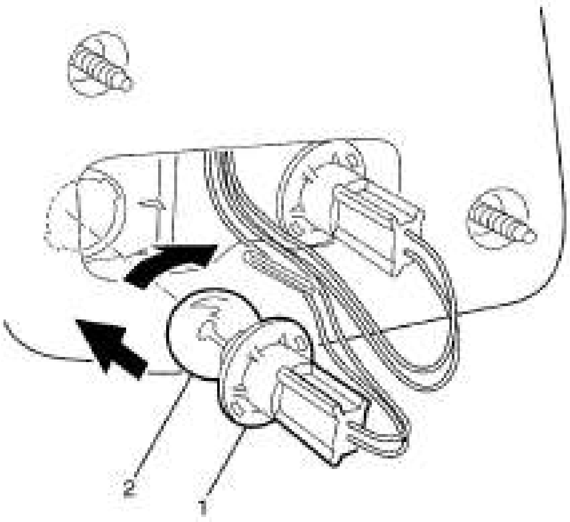


3. Remove the rear compartment lining clip and pull back the lining for access to the rear bulbs.



4. Remove the rear indicator light bulb (2) and socket (1) from the rear tail lamp assembly by rotating the socket counterclockwise.
5. Remove the rear indicator light bulb (2) from the socket (1) by pushing and rotating the bulb counterclockwise.

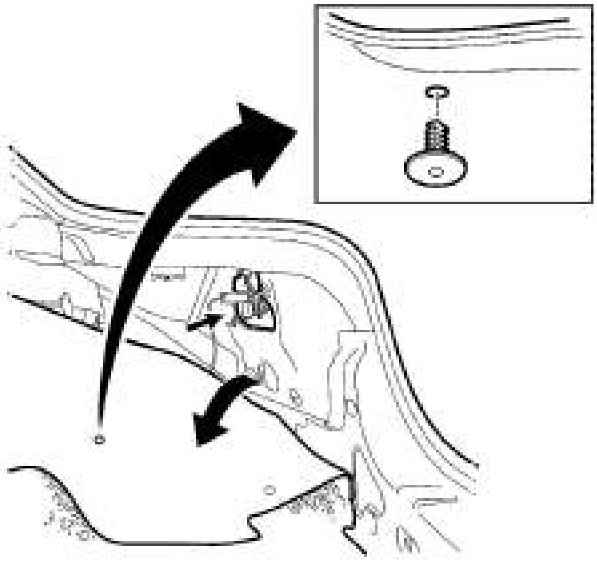
Installation Procedure - Rear Indicator Bulb (LED tail lamp)



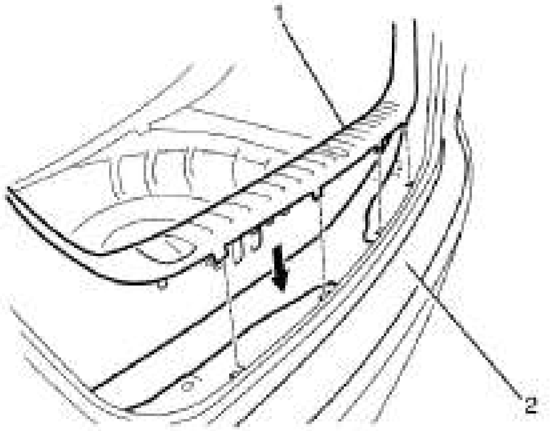
1. Install the new rear indicator light bulb (2) into the socket (1) by pushing and rotating the bulb clockwise.

Important: The different-sized tabs on the bulb base and mating cut-outs in the tail lamp assembly allow the bulb to seat correctly.

2. Install the rear indicator light bulb (2) and socket (1) into the rear tail lamp assembly and secure by rotating the socket clockwise.
3. Check all vehicle lights for correct operation.



4. Install the rear compartment lining and reinstall clip to secure lining.



5. Install the rear compartment lid trim and reinstall the clips to secure the trim.

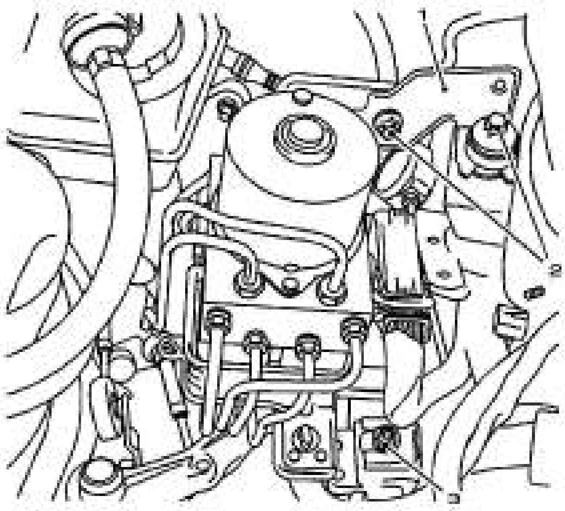
Removal Procedure - Stop/Tail Lamp Bulb (LED tail lamp)

Important: If the stop or tail LED's are faulty and do not illuminate, the tail lamp assembly must be replaced.

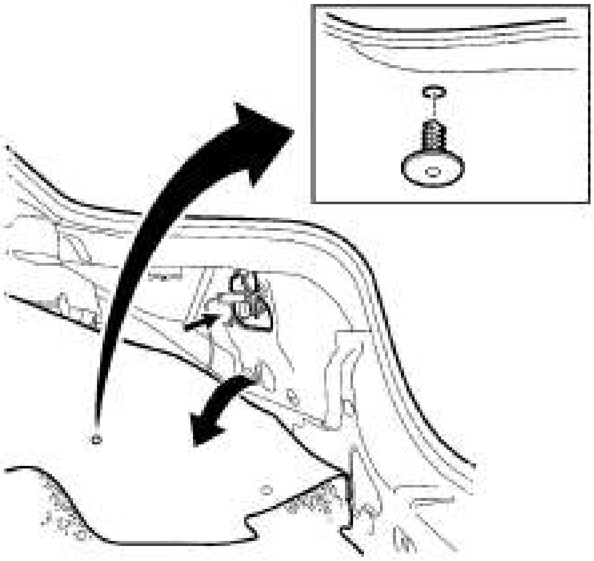
Refer to *Removal Procedure - Tail Lamp Assembly (LED tail lamp)* within this procedure for LED tail lamp replacement.

Removal Procedure - Tail Lamp Assembly (LED tail lamp)

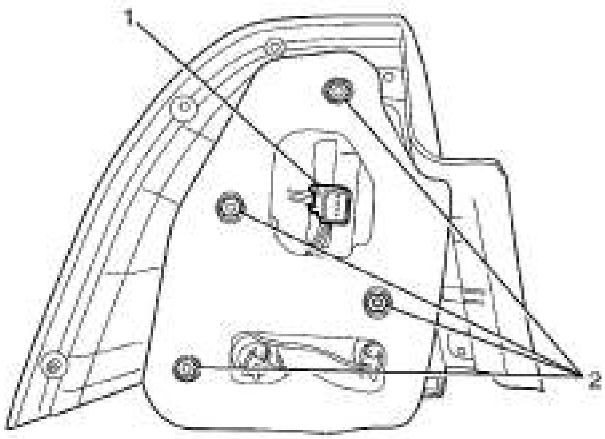
1. Open the rear compartment lid.



2. Remove the rear compartment lid trim clips and remove the trim.

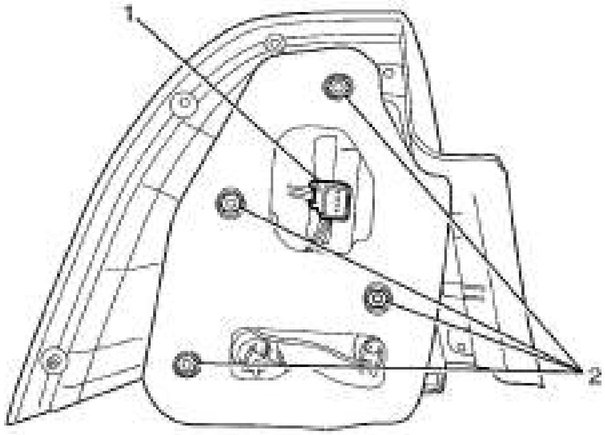


3. Remove the rear compartment lining clip and pull back the lining for access to the rear tail lamp assembly.



4. Disconnect the electrical connector (1) from the rear tail lamp assembly.
5. Remove nuts (2) that secure the rear tail lamp assembly, to rear body panel.
6. Remove the tail lamp assembly from the vehicle.

Installation Procedure - Tail Lamp Assembly



Important: Make sure the rear tail lamp sealing surface is clean to avoid damage to painted vehicle surface and to prevent water leaks.

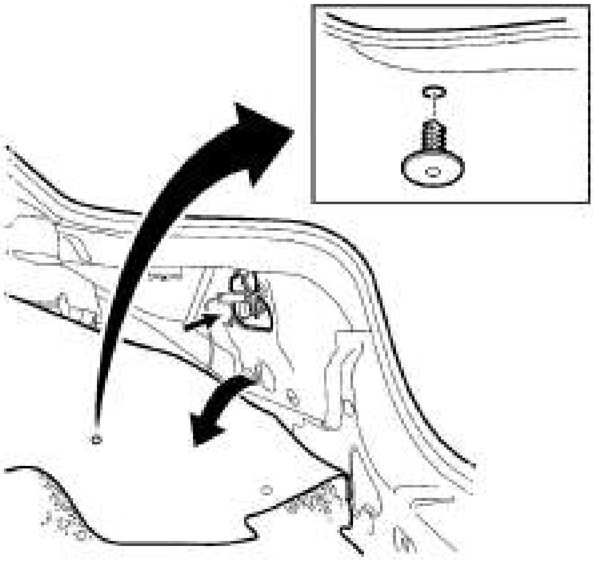
1. Install the new rear tail lamp assembly to the vehicle.

Notice: Refer to Fastener Notice in the Preface section.

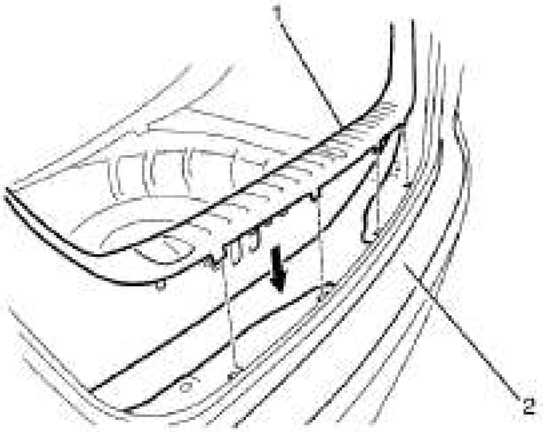
2. Install the nuts (2) that secure the rear tail lamp assembly to the rear body panel.

   Tighten
   Tighten the nuts to 3.0 N·m (27 lb in).

3. Connect the electrical connector (1) to the rear tail lamp assembly.
4. Check all vehicle lights for correct operation.



5. Install the rear compartment lining and reinstall clip to secure lining.



6. Install the rear compartment lid trim and reinstall the clips to secure the trim.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Systems | Lighting | Repair Instructions | Document ID: 2069473

Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn Signal Bulb Replacement (Sportwagon)

Removal Procedure - Tail Lamp Assembly

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.

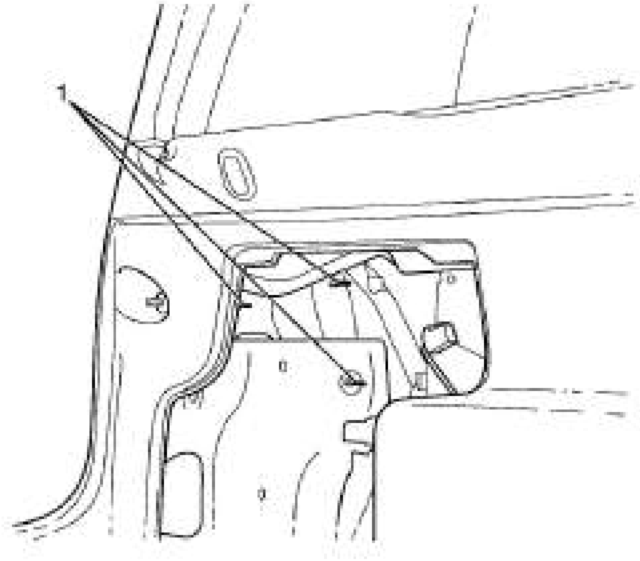
   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

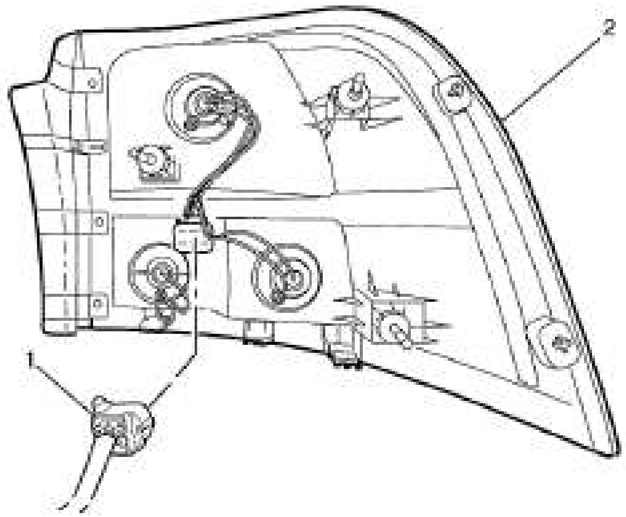
   Important: For access to the right-hand tail lamp assembly, go to step 3.

   Important: For access to the left-hand tail lamp assembly, go to step 4.

3. Remove the tail lamp access cover trim panel. Refer to Tail Lamp Replacement.
4. Remove the rear compartment side trim panel access hole cover. Refer to Rear Compartment Side Trim Panel Access Hole Cover Replacement

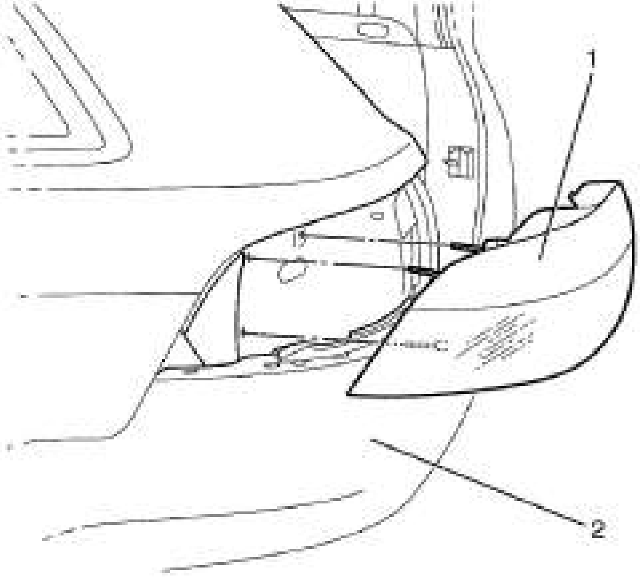


5. Remove the tail lamp assembly to vehicle retaining nuts (1).



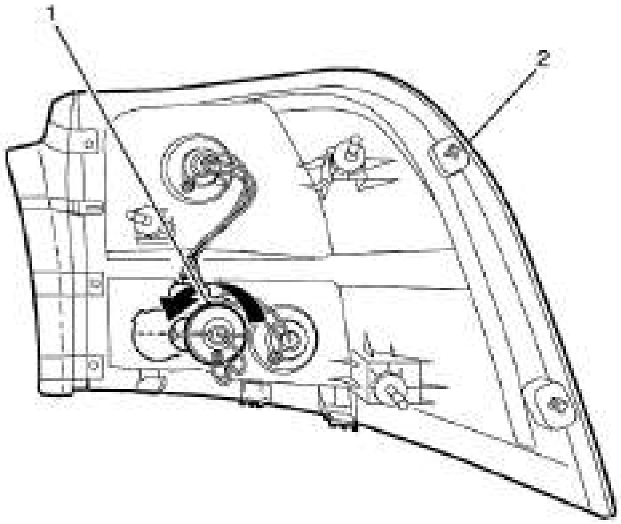
Important: Pull the tail lamp rearward to access the tail lamp electrical connector (1).

6. Disconnect the tail lamp assembly electrical connector (1) from the tail lamp assembly (2).



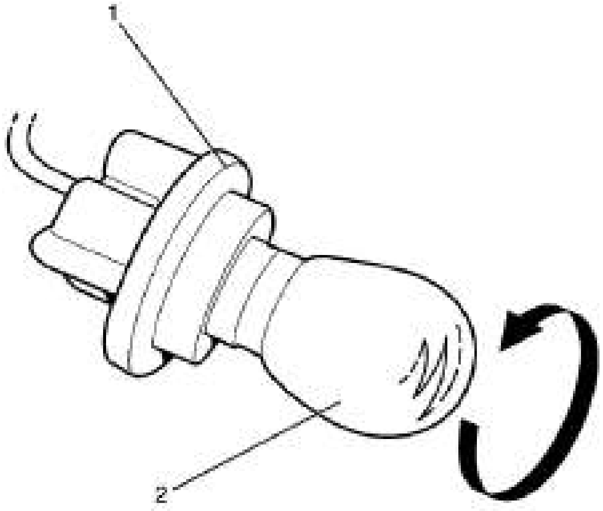
7. Remove the tail lamp assembly (1) from the vehicle (2).

Removal Procedure - Backup Lamp Bulb



Important: Remove the backup lamp bulb socket (1) from the tail lamp assembly (2) by rotating the backup lamp bulb socket (1) counter clockwise.

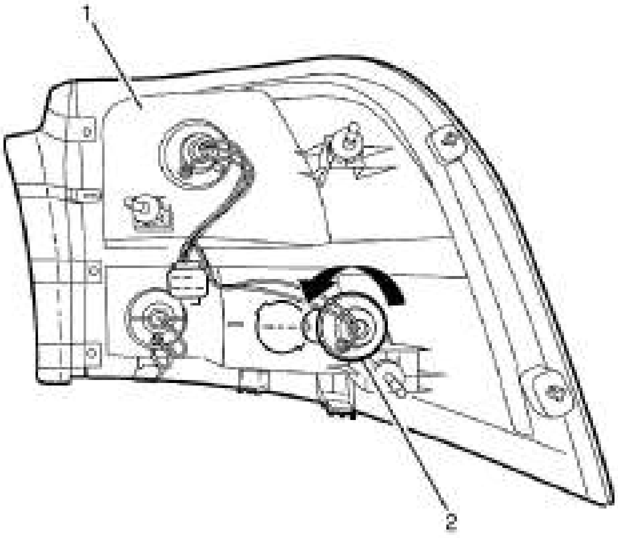
1. Remove the backup lamp bulb socket (1) from the tail lamp assembly (2).



Important: Remove the backup lamp bulb (2) from the backup lamp bulb socket (1) by pushing and rotating the backup lamp bulb (2) counter clockwise.

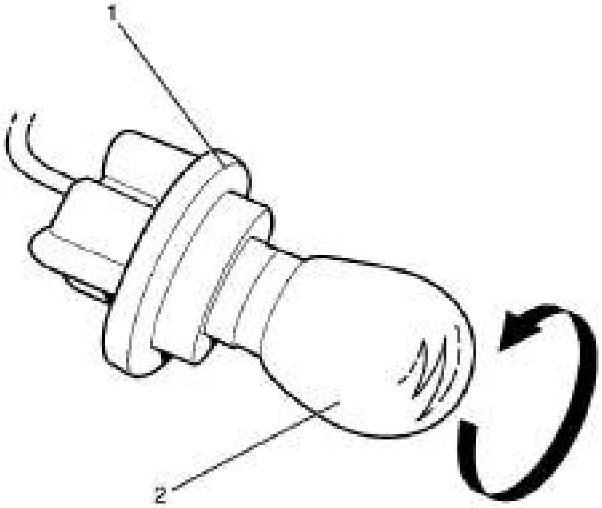
2. Remove the backup lamp bulb (2) from the backup lamp bulb socket (1).

Removal Procedure - Rear Indicator Bulb



Important: Remove the rear indicator lamp bulb socket (1) from the tail lamp assembly (2) by rotating the rear indicator lamp bulb socket (1) counter clockwise.

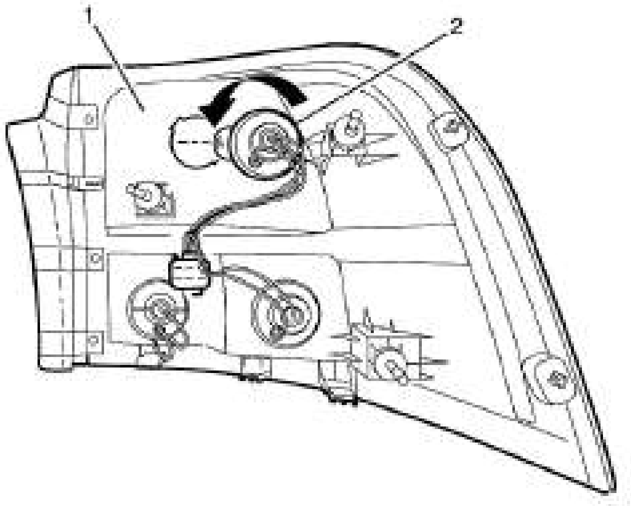
1. Remove the rear indicator lamp bulb socket (1) from the tail lamp assembly (2).



Important: Remove the rear indicator lamp bulb (2) from the rear indicator lamp bulb socket (1) by pushing and rotating the rear indicator lamp bulb (2) counter clockwise.

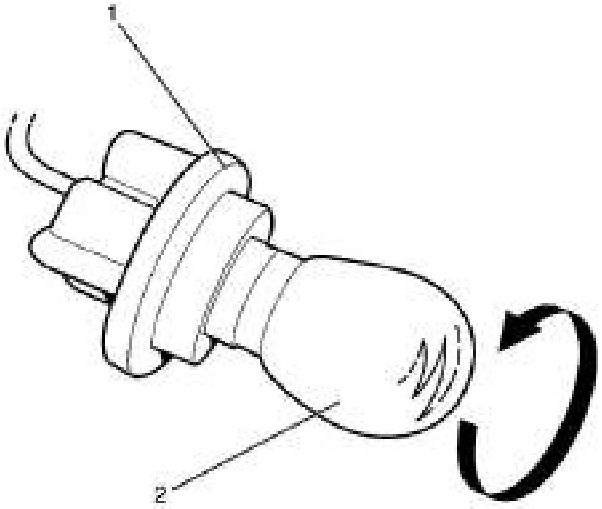
2. Remove the rear indicator lamp bulb (2) from the rear indicator lamp bulb socket (1).

Removal Procedure - Stop/Tail Lamp Bulb



Important: Remove the stop/tail lamp bulb socket (1) from the tail lamp assembly (2) by rotating the stop/tail lamp bulb socket (1) counter clockwise.

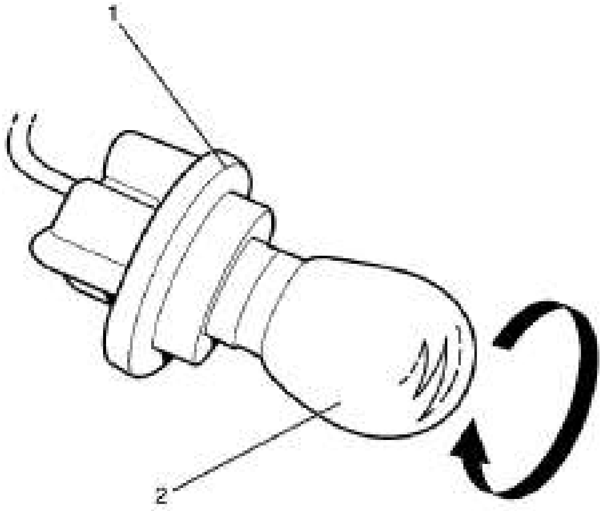
1. Remove the stop/tail lamp bulb socket (1) from the tail lamp assembly (2).



Important: Remove the stop/tail lamp bulb (2) from the stop/tail lamp bulb socket (1) by pushing and rotating the stop/tail lamp bulb (2) counter clockwise.

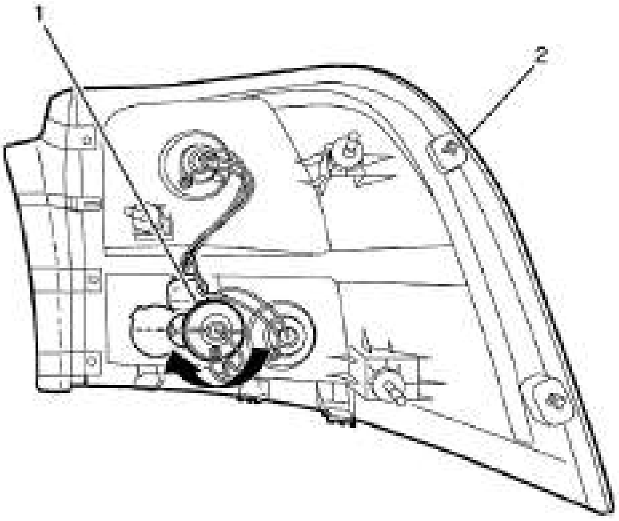
2. Remove the stop/tail lamp bulb (2) from the stop/tail lamp bulb socket (1).

Installation Procedure - Backup Lamp Bulb



Important: Install the backup lamp bulb (2) to the backup lamp bulb socket (1) by pushing and rotating the backup lamp bulb (2) clockwise.

1. Install the backup lamp bulb (2) to the backup lamp bulb socket (1).

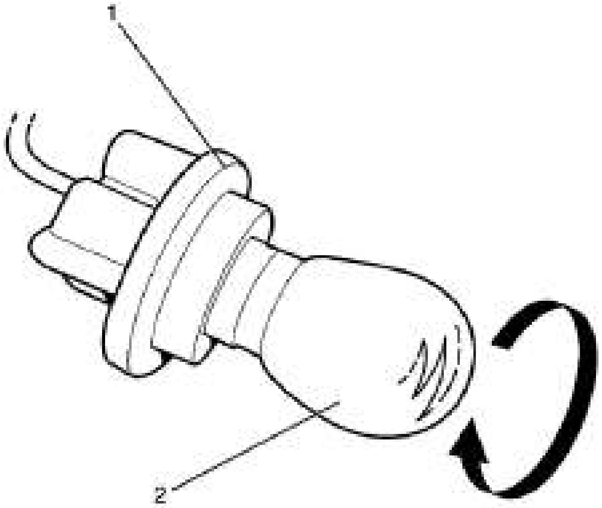


Important: The different-sized tabs on the backup lamp bulb socket (1) and mating cut-outs in the tail lamp assembly (2) allow the backup lamp bulb socket (1) to seat correctly.

Important: Install the backup lamp bulb socket (1) to the tail lamp assembly (2) by rotating the backup lamp bulb socket (1) clockwise.

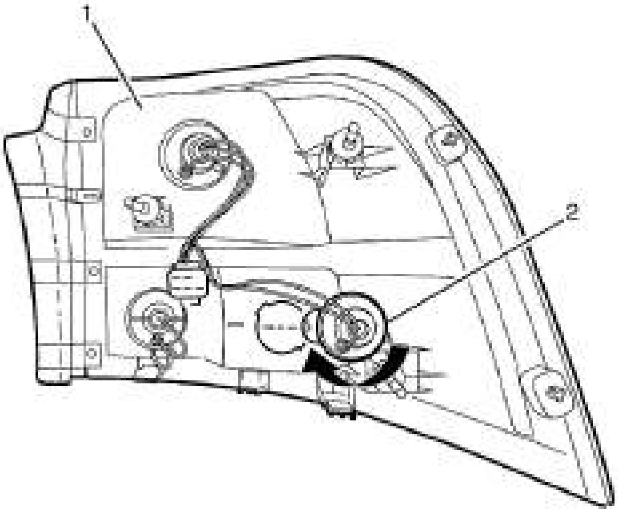
2. Install the backup lamp bulb socket (1) to the tail lamp assembly (2).

Installation Procedure - Rear Indicator Lamp Bulb



Important: Install the rear indicator lamp bulb (2) to the rear indicator lamp bulb socket (1) by pushing and rotating the rear indicator lamp bulb (2) clockwise.

1. Install the rear indicator lamp bulb (2) to the rear indicator lamp bulb socket (1).

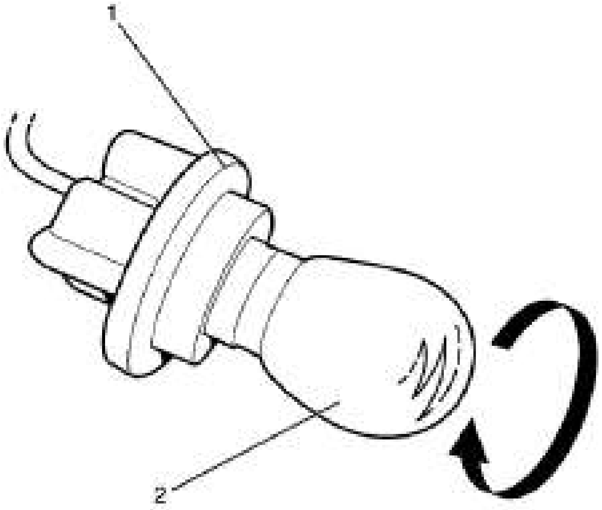


Important: The different-sized tabs on the rear indicator bulb socket (1) and mating cut-outs in the tail lamp assembly (2) allow the rear indicator lamp bulb socket (1) to seat correctly.

Important: Install the rear indicator lamp bulb socket (1) to the tail lamp assembly (2) by rotating the rear indicator lamp bulb socket (1) clockwise.

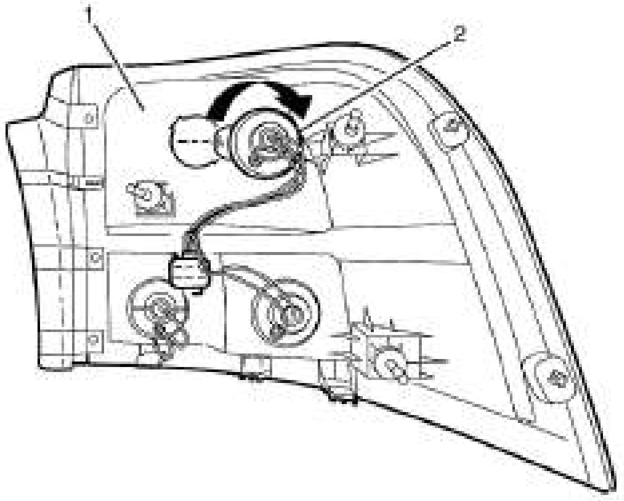
2. Install the rear indicator lamp bulb socket (1) to the tail lamp assembly (2).

Installation Procedure - Stop/Tail Lamp Bulb



Important: Install the stop/tail lamp bulb (2) to the stop/tail lamp bulb socket (1) by pushing and rotating the stop/tail lamp bulb (2) clockwise.

1. Install the stop/tail lamp bulb (2) to the stop/tail lamp bulb socket (1).

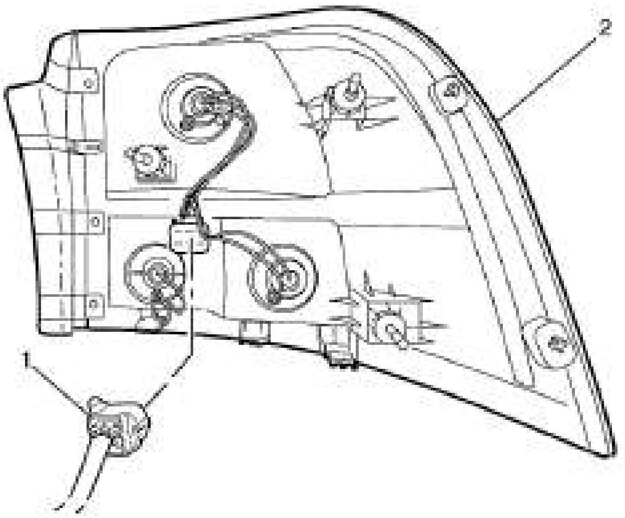


Important: The different-sized tabs on the stop/tail lamp bulb socket (1) and mating cut-outs in the tail lamp assembly (2) allow the stop/tail lamp bulb socket (1) to seat correctly.

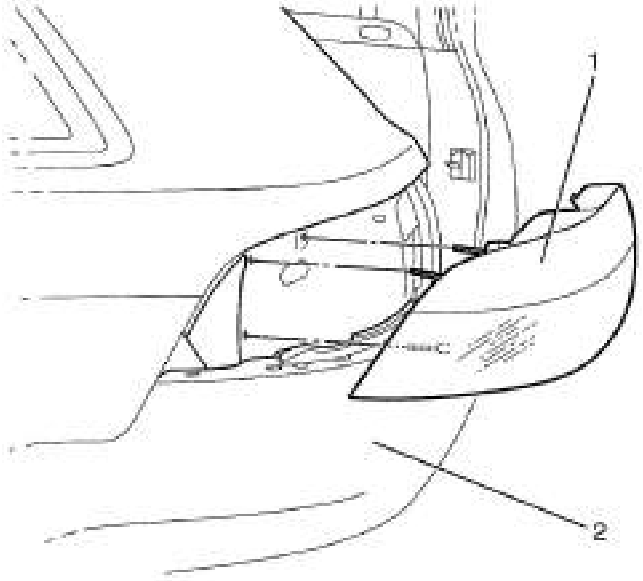
Important: Install the stop/tail lamp bulb socket (1) to the tail lamp assembly (2) by rotating the stop/tail lamp bulb socket (1) clockwise.

2. Install the stop/tail lamp bulb socket (1) to the tail lamp assembly (2).

Installation Procedure - Tail Lamp Assembly

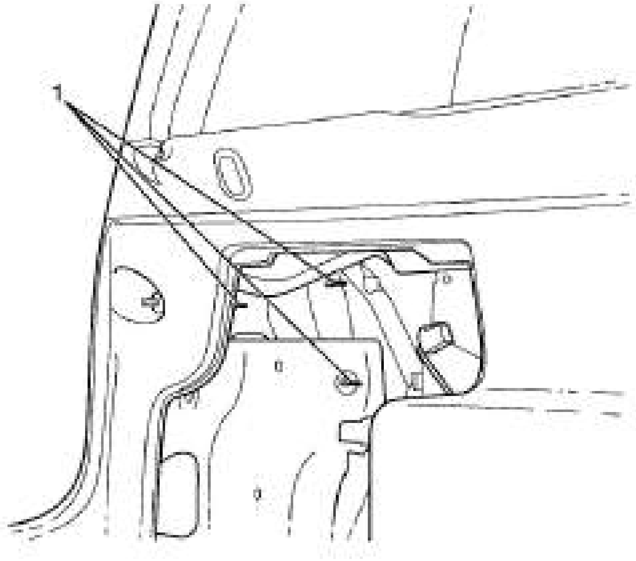


1. Connect the tail lamp assembly electrical connector (1) to the tail lamp assembly (2).



2. Install the tail lamp assembly (1) to the vehicle (2)

   Notice: Refer to Fastener Notice in the Preface section.



3. Install the tail lamp assembly to vehicle retaining nuts (1)

   Tighten
   Tighten the nuts to 4 N·m (35 lb in).

   Important: For the right-hand tail lamp assembly, go to step 4.

Important: For the left-hand tail lamp assembly, go to step 5.

4. Install the tail lamp access cover trim panel. Refer to Tail Lamp Replacement.
5. Install the rear compartment side trim panel access hole cover. Refer to Rear Compartment Side Trim Panel Access Hole Cover Replacement.
6. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

7. Remove the suitable liftgate brace from the vehicle.

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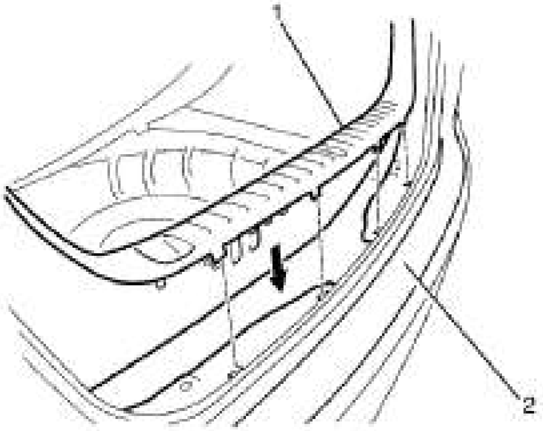
Tail Lamp Assembly and /or Backup, Sidemarker, Stop, Turn Signal Bulb Replacement (SWB)

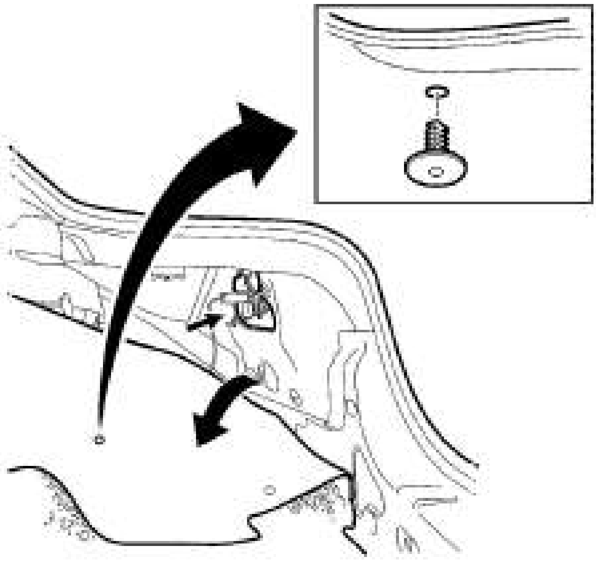
Removal Procedure - Backup Light Bulb

Caution: Refer to Battery Disconnect Caution in the Preface section.

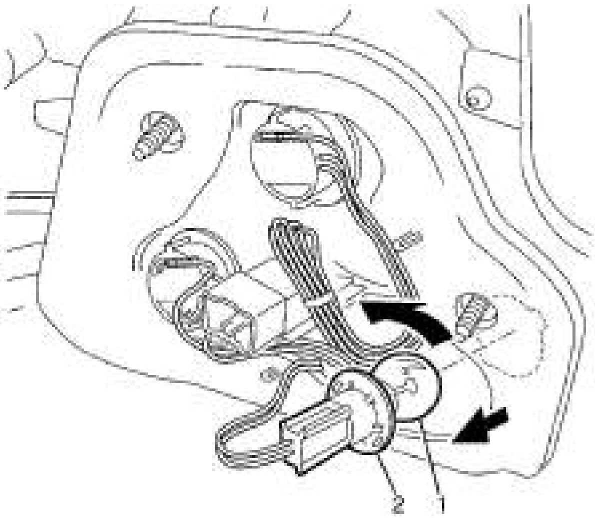
1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
2. Open the rear compartment lid.



3. Remove the rear compartment lid trim clips and remove the trim.

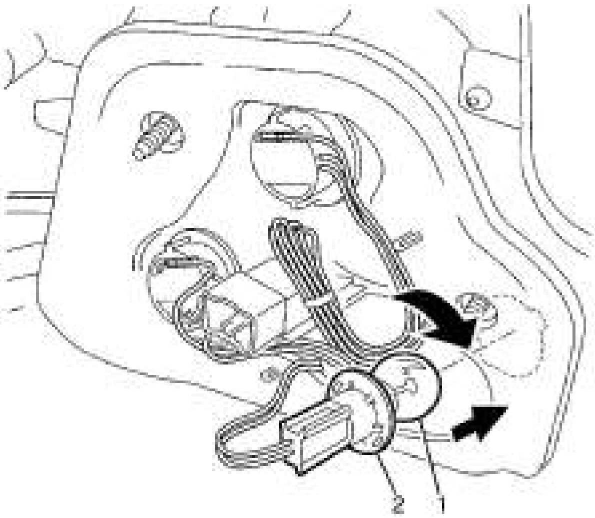


4. Remove the rear compartment lining clip and pull back the lining for access to the rear bulbs.



5. Remove the backup light bulb (1) and socket (2) from the rear lamp assembly by pushing and rotating the bulb counterclockwise.
6. Remove the backup light bulb (1) from the socket by pushing and rotating the bulb counterclockwise.

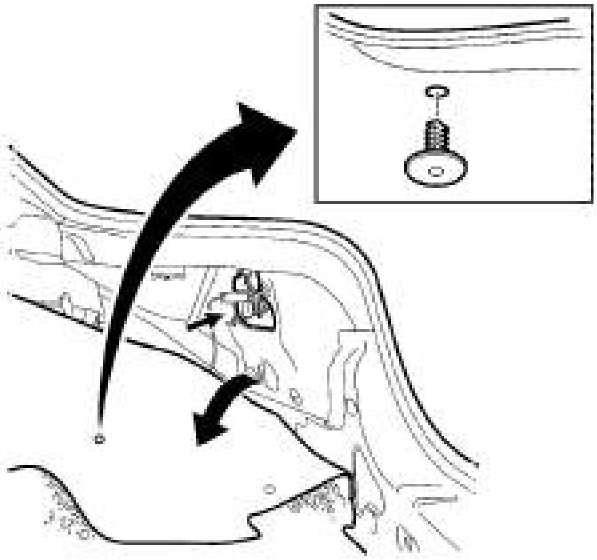
Installation Procedure - Backup Light Bulb



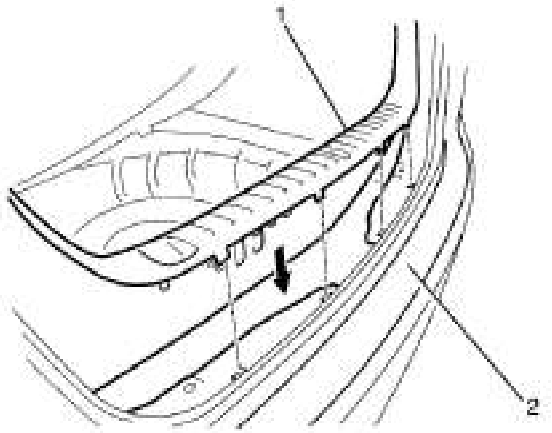
1. Install the new backup light bulb (1) into the socket (2) by pushing and rotating the bulb clockwise.

   Important: The different-sized tabs on the bulb base and mating cut-outs in the tail lamp assembly allow the bulb to seat correctly.

2. Install the backup light bulb (1) and socket (2) into the rear tail lamp assembly and secure by rotating the socket clockwise.
3. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
4. Check all vehicle lights for correct operation.



5. Install the rear compartment lining and reinstall clip to secure lining.

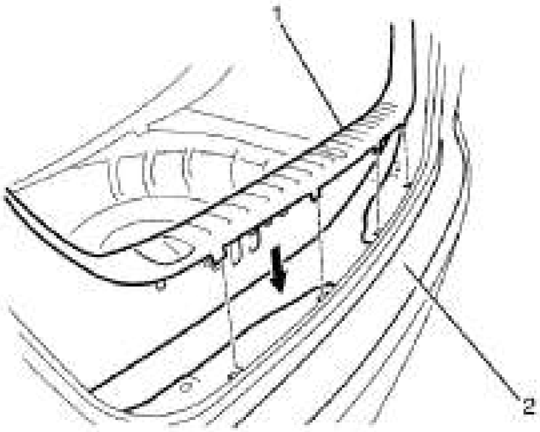


6. Install the rear compartment lid trim and reinstall the clips to secure the trim.

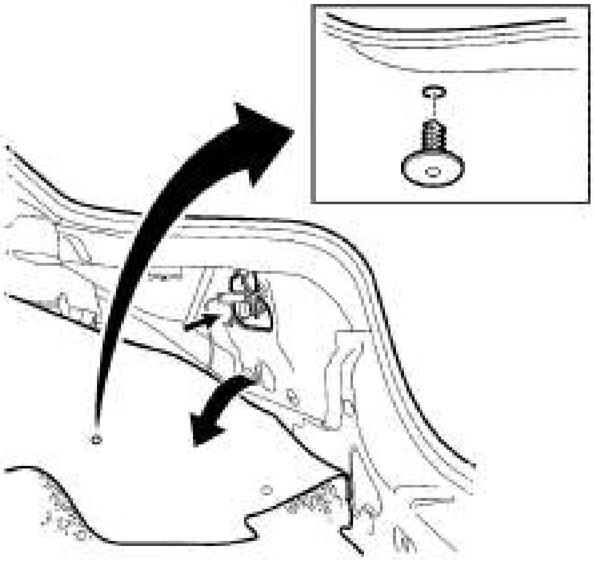
Removal Procedure - Rear Indicator Bulb

Caution: Refer to Battery Disconnect Caution in the Preface section.

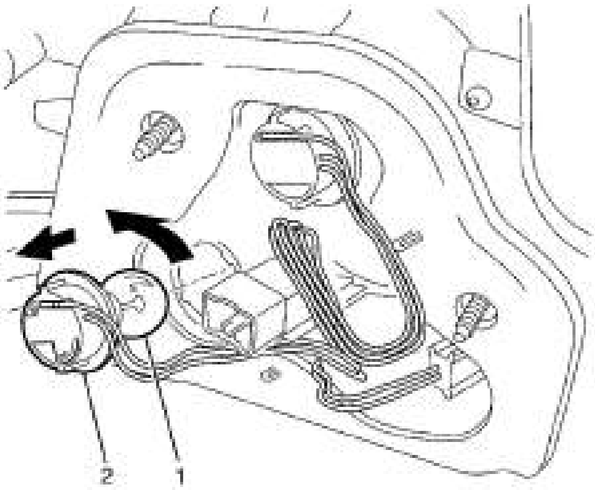
1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
2. Open the rear compartment lid.



3. Remove the rear compartment lid trim clips and remove the trim.



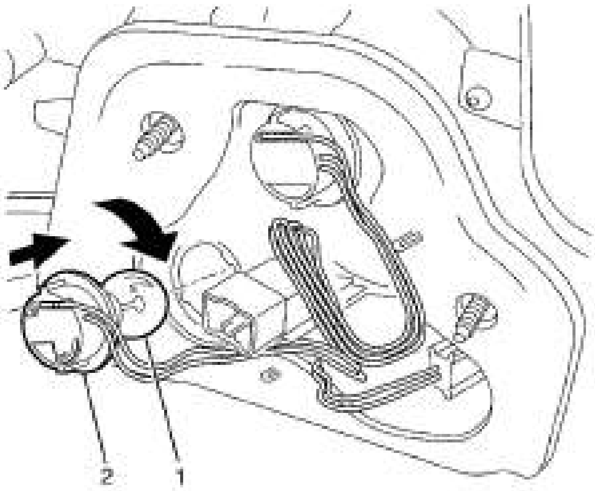
4. Remove the rear compartment lining clip and pull back the lining for access to the rear bulbs.



5. Remove the rear indicator light bulb (1) and socket (2) from the rear tail lamp assembly by rotating the socket counterclockwise.
6. Remove the rear indicator light bulb (1) from the socket (2) by pushing and rotating the bulb counterclockwise.

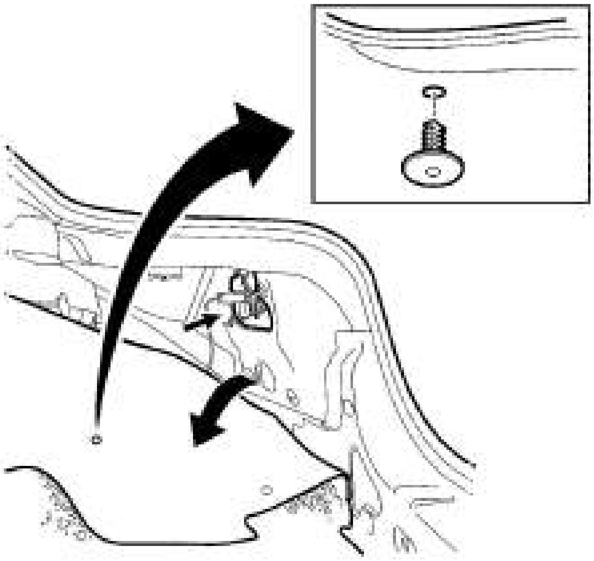
Installation Procedure - Rear Indicator Bulb

1. Install the new rear indicator light bulb into the socket by pushing and rotating the bulb clockwise.

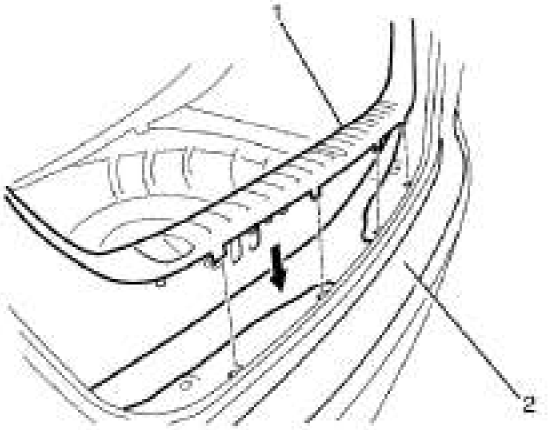


Important: The different-sized tabs on the bulb base and mating cut-outs in the tail lamp assembly allow the bulb to seat correctly.

2. Install the rear indicator light bulb (2) and socket (1) into the rear tail lamp assembly and secure by rotating the socket clockwise.
3. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
4. Check all vehicle lights for correct operation.



5. Install the rear compartment lining and reinstall clip to secure lining.



6. Install the rear compartment lid trim and reinstall the clips to secure the trim.

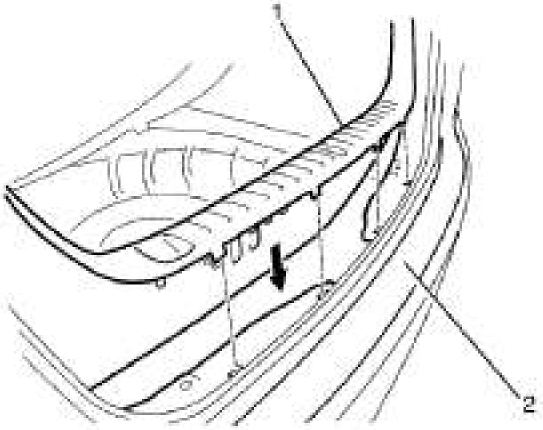
Removal Procedure - Stop/Tail Lamp Bulb

Caution: Refer to Battery Disconnect Caution in the Preface section.

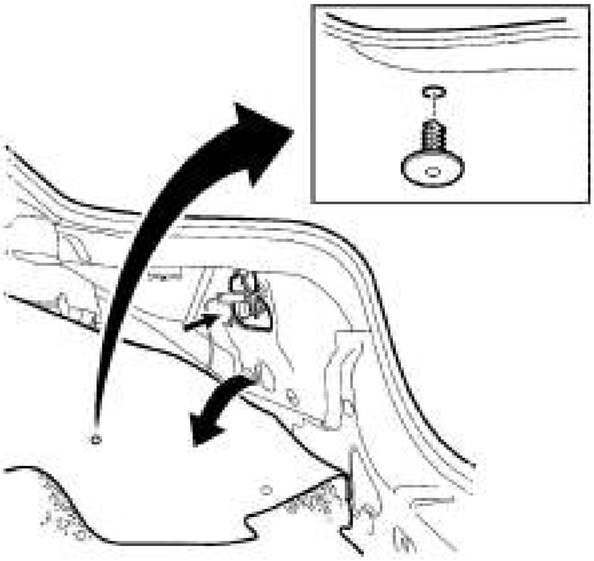
1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and

Connection .

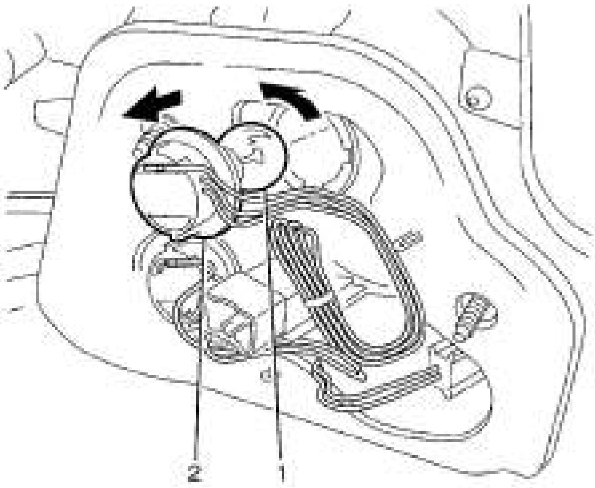
2. Open the rear compartment lid.



3. Remove the rear compartment lid trim clips and remove the trim.

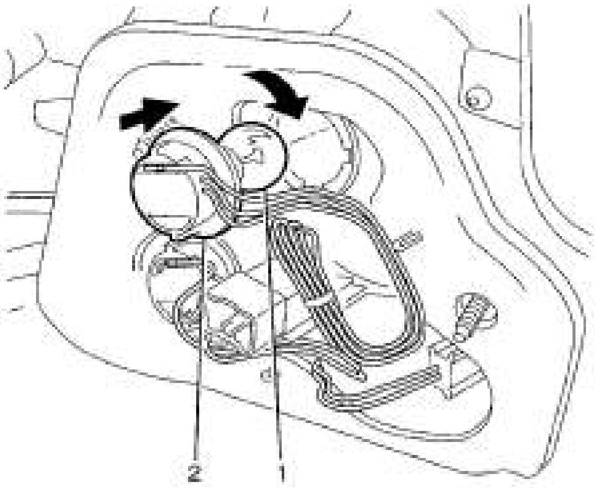


4. Remove the rear compartment lining clip and pull back the lining for access to the rear bulbs.



5. Remove the stop/tail lamp bulb (1) and socket (2) from the rear tail lamp assembly by rotating the socket counterclockwise.
6. Remove the stop/tail light bulb (1) from the socket (2) by pushing and rotating the bulb counterclockwise.

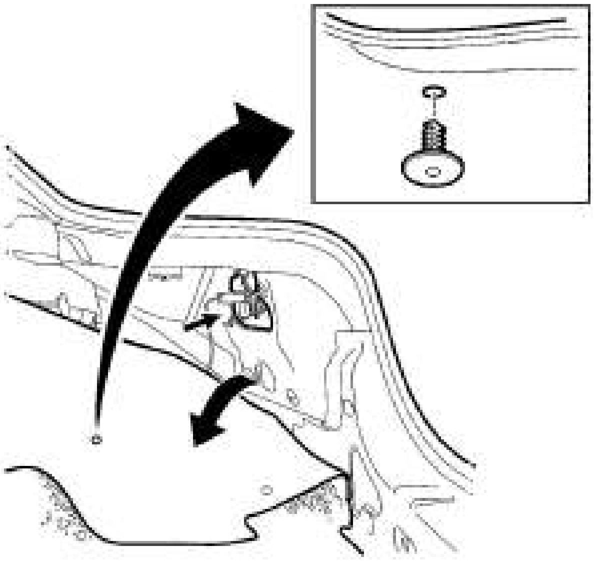
Installation Procedure - Stop/Tail Lamp Bulb



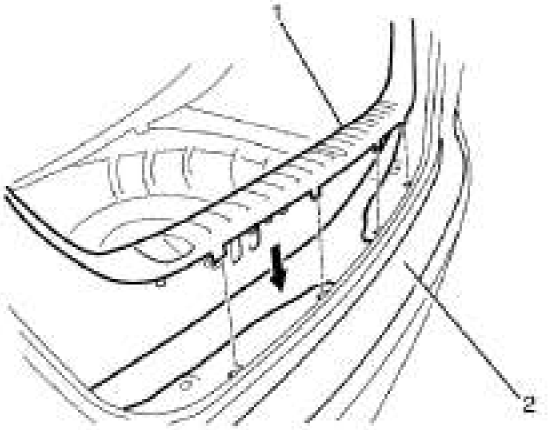
1. Install the new stop/tail light bulb (1) into the socket (2) by pushing and rotating the bulb clockwise.

   Important: The different-sized tabs on the bulb base and mating cut-outs in the tail lamp assembly allow the bulb to seat correctly.

2. Install the stop/tail lamp bulb (1) and socket (2) into the rear tail lamp assembly and secure by rotating the socket clockwise.
3. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
4. Check all vehicle lights for correct operation.



5. Install the rear compartment lining and reinstall clip to secure lining.



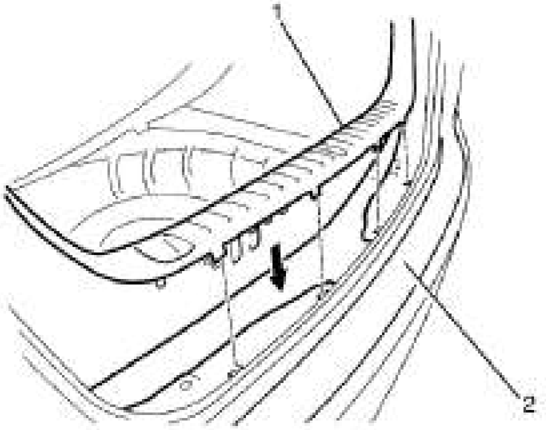
6. Install the rear compartment lid trim and reinstall the clips to secure the trim.

Removal Procedure - Tail Lamp Assembly

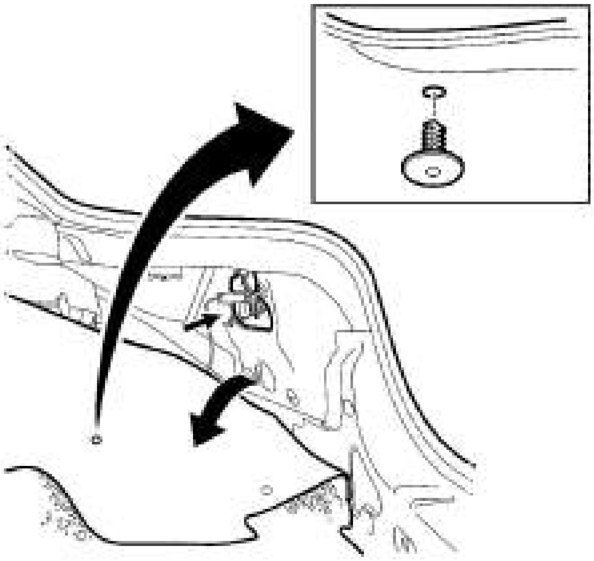
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and

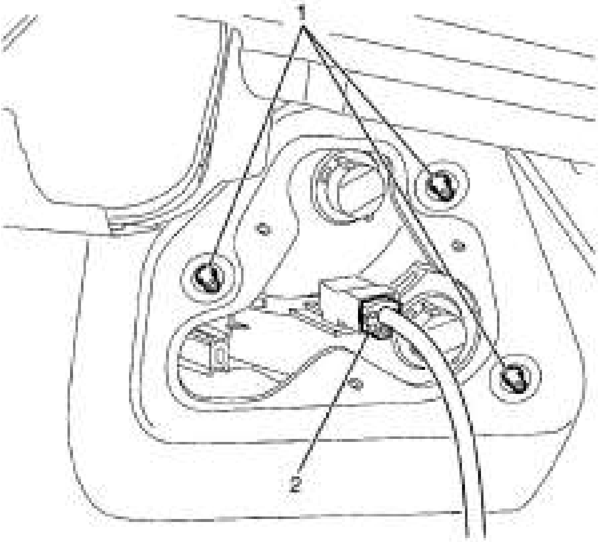
Connection .



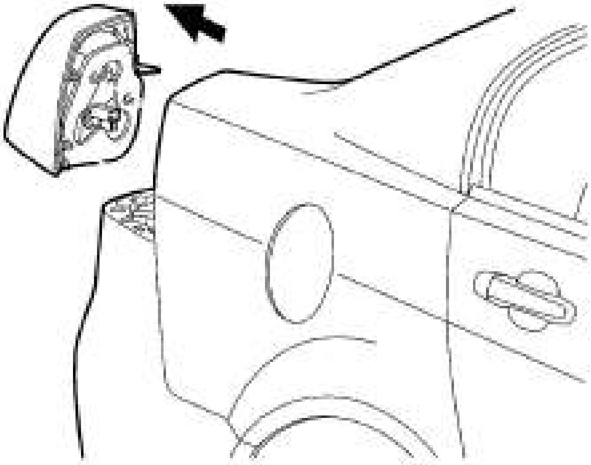
2. Remove the rear compartment lid trim clips and remove the trim.



3. Remove the rear compartment lining clip and pull back the lining for access to the rear tail lamp assembly.

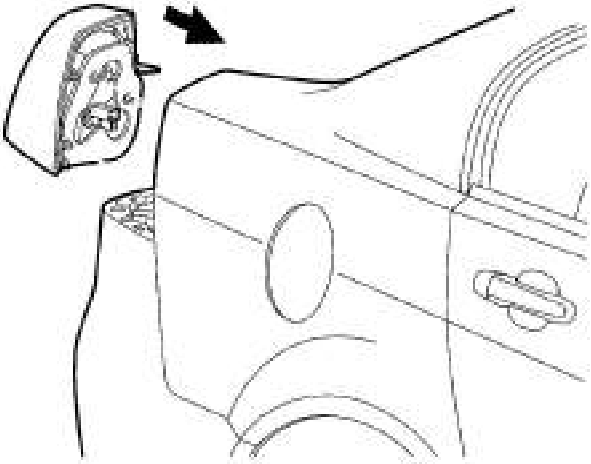


4. Disconnect the rear tail lamp electrical connector (2).
5. Remove the rear tail lamp to rear end panel retaining nuts (1).



6. Remove the rear tail lamp assembly from the vehicle.

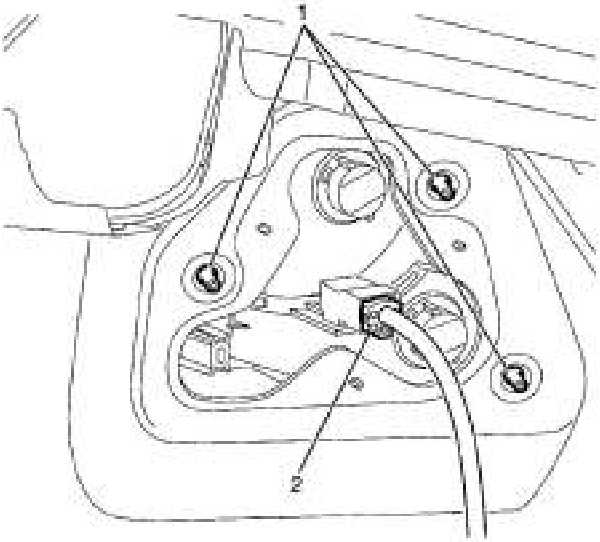
Installation Procedure



Important: Make sure the rear tail lamp sealing surface is clean to avoid damage to painted vehicle surface and to prevent water leaks.

1. Install the rear tail lamp assembly to the vehicle.

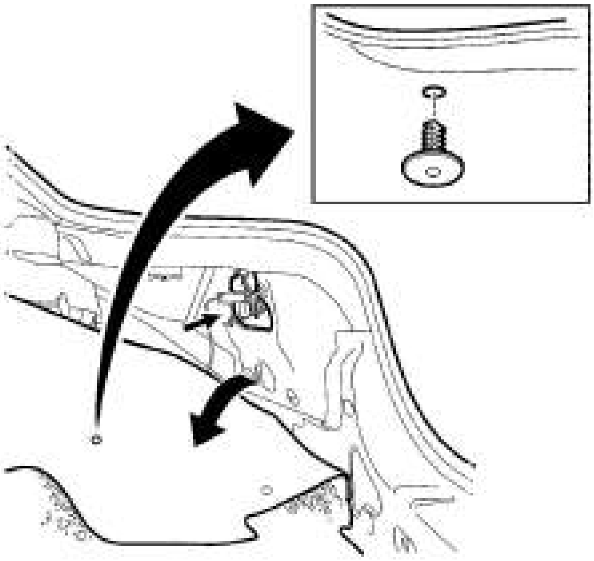
   Notice: Refer to Fastener Notice in the Preface section.



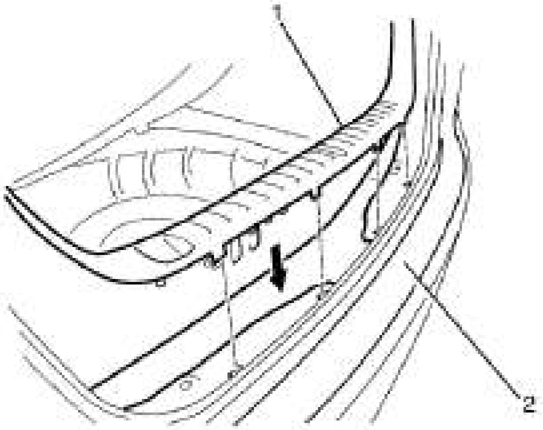
2. Install the rear tail lamp assembly retaining nuts (1).

   Tighten
   Tighten the nuts to 3.00 N·m (27 lb in).

3. Connect the rear tail lamp assembly electrical connector (2).
4. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
5. Check all lights for the correct operation.



6. Install the rear compartment lining clip and pull back the lining for access to the rear tail lamp assembly.



7. Install the rear compartment lid trim clips and remove the trim.

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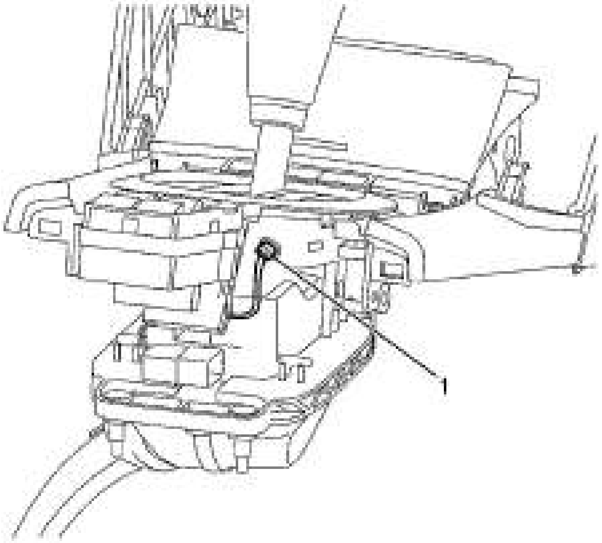
Transmission Floor Shift Control Indicator Lamp Replacement

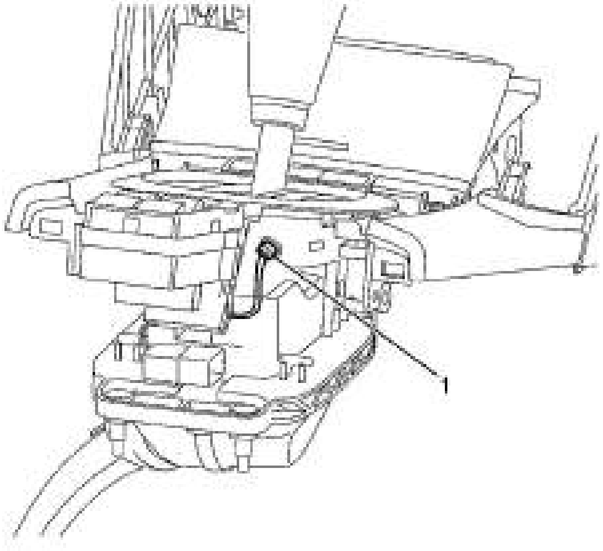
Removal Procedure

1. Remove the trim plate panel. Refer to Console Trim Plate Replacement.



2. Remove the transmission floor shift control indicator lamp from the rear of the shift control housing by turning the lamp socket (1) counter clockwise.
3. Pull the transmission floor shift control indicator light bulb from the socket.

Installation Procedure



1. Install a new transmission floor shift control indicator light bulb to the socket (1).
2. Install the transmission floor shift control indicator lamp to the rear of the shift control housing by turning the lamp socket clockwise.
3. Install the trim plate panel. Refer to Console Trim Plate Replacement.
4. Check the operation of the transmission floor shift control indicator light.

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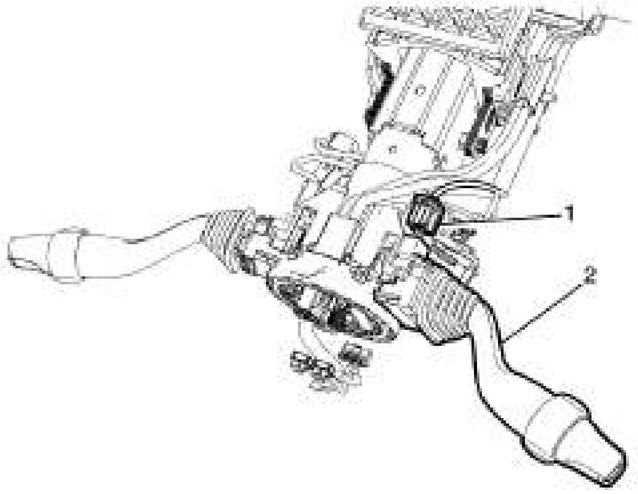
Turn Signal Switch Replacement (RHD)

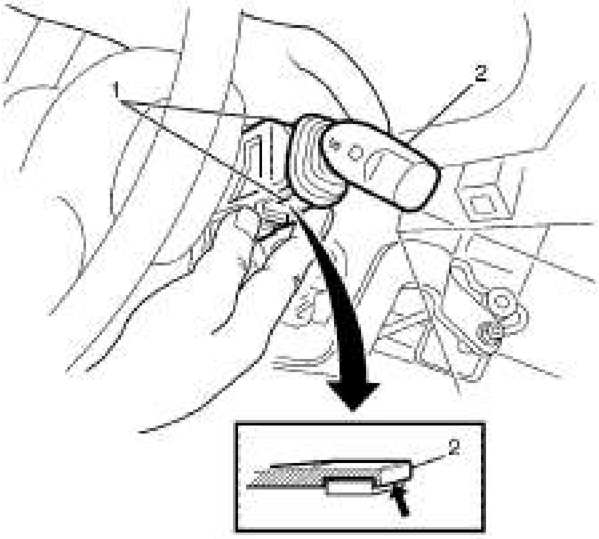
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the upper and lower steering column trim covers. Refer to Steering Column Trim Covers Replacement.

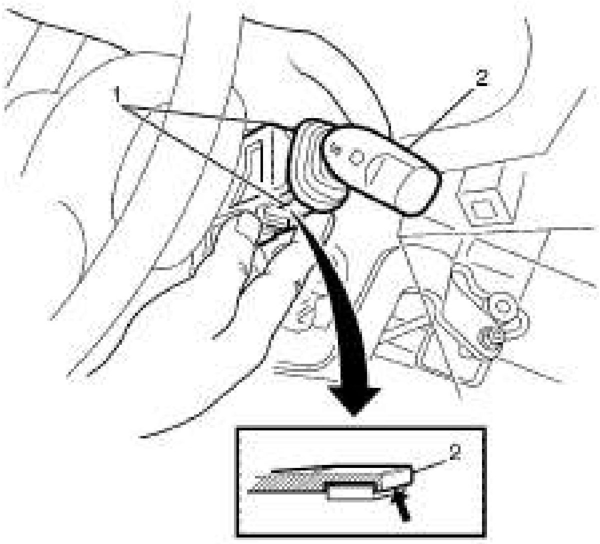


3. Disconnect the turn signal switch (2) electrical connector (1).

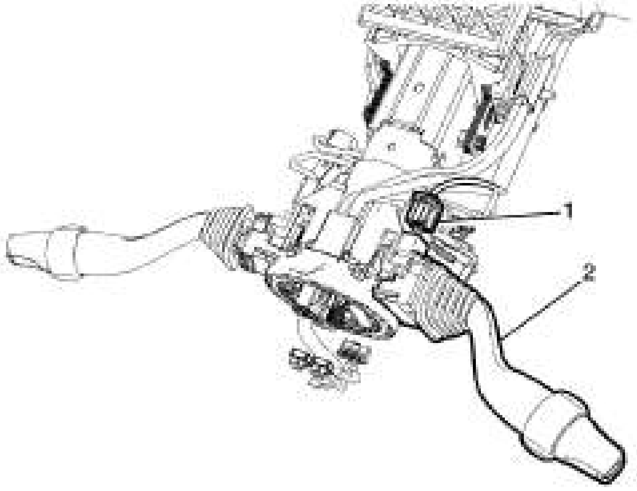


4. Press the retaining tabs (1) on the turn signal switch (2) and pull the turn signal switch assembly away from the steering column.

Installation Procedure



1. Install the new turn signal (2) switch and push the switch into position until the retaining tabs (1) seat with an audible click.



2. Connect the turn signal switch (2) electrical connector (1).
3. Install the upper and lower steering column trim covers. Refer to Steering Column Trim

Covers Replacement.

4. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
5. Check all vehicle lights for correct operation.

Vanity Mirror Lamp Replacement

1. The vanity mirror lamp is not a serviceable item.
2. If the vanity mirror lamp requires replacement it must be replaced as an assembly. Refer to Sunroof Sunshade Replacement

Exterior Lighting Systems Description and Operation (Sportwagon)

Exterior Lamps

The exterior lighting system consists of the following lamps:

- The headlamps
- The front fog lamps
- The park, tail and marker lamps
- The exterior courtesy lamps
- The turn signal/hazard lamps
- The stop lamps
- The backup lamps

Headlamps

The headlamps may be turned ON in 2 different ways. First, when the driver places the headlamp switch in the HEADLAMP position, for normal operation. Second, with the headlamp switch placed in the AUTO position, for automatic lamp control (ALC).

Headlamp ON/OFF control is determined by the body control module (BCM) by a signal on the headlamp switch on input circuit when the headlamp switch is in the HEAD position. When the headlamp switch is in the AUTO position, the BCM determines headlamps ON/OFF by the voltage from the ambient light sensor.

If the headlight switch is left in the ON position, the inadvertent power control feature will turn OFF the headlights approximately 10 seconds after the ignition switch is turned to the OFF position. If the driver places the headlight switch in the ON position after the ignition switch has been turned OFF, or if the ignition switch is in the ACCY position, the headlights will remain ON until turned OFF or the battery runs flat.

The high beam indicator is illuminated when the instrument cluster receives a GMLAN serial data message from the BCM that the high beams are illuminated.

High Beams

The high beam headlamps receive voltage from the headlamp high relay located in the underhood fuse block. The BCM controls the relay on the headlamp high beam relay control circuit. High beam control is determined by a signal on the headlamp dimmer switch high beam signal circuit from the turn signal multifunction switch. When the headlamp dimmer switch signal circuit is grounded, the BCM grounds the headlamp high beam relay control circuit, illuminating the high beam headlamps. The right and left high beam circuits are independent and are fused independently in the underhood fuse block.

Low Beams - Standard

The low beam headlamps receive voltage from the headlamp low beam relay located in the underhood fuse block. The BCM controls the relay on the headlamp low beam relay control circuit. Low beam control is activated when the headlamp switch is placed in the headlamp ON position grounding the headlamp switch headlamps on signal circuit to the BCM. The right and left low beam circuits are independent are fused independently in the underhood fuse block.

Fog Lamps

With both the ignition switch in the RUN position, and the park lamps ON, the fog lights will illuminate when the driver depresses the fog lamp switch. The BCM receives the park lamp ON signal from the interior park lamps supply voltage signal circuit. With the headlamp switch in either the park or headlamp position, and the fog lamp switch is in the ON position, the BCM will ground the fog lamp relay control circuit causing the relay to energise. The current flows from the fog lamp relay to both front fog lamps. The state of the fog lamps will remain the same until the fog lamp switch position is changed, or the ignition switch is cycled OFF and ON. Fog lamp operation will be cancelled whenever the park lamps are turned OFF or the high beam headlights have been selected.

Park, Tail and Marker Lamps

The park, tail and marker lamps, including the license lamps, are turned ON when the headlamp switch is placed in the PARK or HEAD position or anytime the headlights are requested. The underhood fuse block supplies battery positive voltage to both the park lamp relay switch contacts and the park lamp coil circuit. The BCM provides a ground or control circuit to the park lamp relay coil circuit. When the park lamps are turned ON, the BCM energises the park lamp relay. If the headlight switch is left in the ON position, the inadvertent power control feature will turn OFF the park, tail and marker lamps approximately 10 seconds after the ignition switch is turned to the OFF position. If the driver places the headlight switch in the ON position after the ignition switch has been turned OFF, or if the ignition switch is in the ACCY position, the park, tail and marker lamps will remain ON until turned OFF or the battery runs flat.

Exterior Courtesy Lamps

The BCM, driver door switch, and the passenger door switch communicate through the GMLAN serial data system. The driver door switch and passenger door switch supply power and ground to the left and right exterior lamps respectively. When the BCM commands illuminated entry, a command is also sent to the door switches for illumination of the exterior courtesy lamps. If the door locks are activated to the LOCK position, or if the ignition switch is turned to either the ON or RUN position the exterior courtesy lamps will deactivate immediately.

Turn Signal/Hazard Lamps

When the turn signal multifunction switch is placed in either the left or right position, a ground signal is completed from the turn signal switch to the BCM. The BCM then sends an ON-OFF voltage signal through the fuses to the appropriate turn signal and side repeater lamps or to all of the turn signal fuses for hazard operation. An audio chime is also activated when the turn signals are ON. The instrument panel cluster (IPC) receives the signals to activate the turn signal indicators over the GMLAN serial data system. The hazard warning switch is an integral part of the infotainment fascia, when the hazard warning switch is pressed, the infotainment unit communicates with the BCM via the GMLAN serial data system to activate the hazard warning lamps, the hazard warning switch is NOT connected directly to the turn signal/hazard lamp circuit. When activated all turn signal lamps will flash including both IPC turn indicators.

Stop Lamps

When the driver presses the brake pedal, the a variable voltage signal from the brake pedal position sensor (BPPS) is supplied to the BCM. The BCM then supplies voltage to stop lamp supply voltage circuit applying power to the stop lamps and center high mount stop lamp (CHMSL). The BCM also supplies voltage to the transmission control module (TCM), and powertrain control module (ECM) through a dedicated circuit.

Backup Lamps

The backup lamp request signal is sent from the ECM to the BCM on the GMLAN serial data system. This signal is based on the park neutral position (PNP) switch signal. The BCM supplies voltage to the backup relay and to the automatic day/night mirror when the vehicle is in reverse. The backup relay supplies a voltage on the backup lamp supply voltage circuit to the backup lamps.

Police Package Special Equipment Lighting Options

Important: GM cannot be held responsible for any changes made to the vehicle. All electrical and body modifications must be preformed by experience and qualified technicians.

- Be sure that any modified or added wiring will not impact the function of the vehicles factory wiring system.
- See that all wiring is correctly protected by fuses, and not causing a overload to connectors and components.
- Do not route wiring in areas of the vehicle where temperatures can be high or where wiring may be cut, pinched or rubbed.
- See that all wiring is of the same or smaller gauge to that of the wire it is being attached to for correct fuse protection.
- Be sure that all holes drilled in the body are correctly sealed and corrosion protected. See that the vehicles wiring harnesses, piping, and other components have not been displaced or damaged during customer installation of equipment and wiring.
- See that the vehicles wiring harnesses, piping, and other components have not been displaced or damaged during customer installation of equipment and wiring.

Electrical Connections

Overloading the vehicles electrical system may damage the vehicles accessories. Do not overload the vehicles system by having unnecessary accessories at the same time.

Exterior Lamp Flashing System

The rear flasher function is only available in police vehicles and activated by a latch switch to ground. It provides alternating flashing of the rear lamps (and side markers) out-of-phase with the reverse lamps. The flash rate of 2.4 flashes/sec, 50% duty cycle, is much faster than the normal exterior lighting turn signal rate. Normal operation of turn indicators, hazard switch, reverse gear and foot brake override this function when they are active.

Surveillance Mode (Surv Mode)

The Surveillance mode function is designed for police vehicles only, and provides a way to disable all automated lighting and sounds while the dedicated Surveillance mode switch input to the BCM is in the On (grounded) state. The Surveillance mode function is switched On and Off by an alternate press of the Surveillance button, which is the rectangular monetary push-button on the overhead console. The overhead console contains electronic switches which toggles the state of the output to the BCM between ON and Off. The default state of the battery is Surveillance mode On. When Surveillance mode is On:

- Parkers and Headlamps do not work when the headlamp switch is in the "Auto" position.
- All lamps on the inadvertent power feed will be turned off.
- Maps lights will still function, as they have a separate battery feed in police vehicles only.
- The courtesy lights will not illuminate when a door is opened or a remote key is used.
- Turn signal flashes or horn chirps will not operate when a remote key is used.
- Chimes are suppressed.
- All internal backlighting is switched Off.
- Cluster backlighting is set to minimum.

Important: At the request of the police, the BCM functionality can be changed at a future point. The external lighting (Headlamps and Parkers) will no longer be switched off by surveillance mode. The anticipated introduction date at the Holden Assembly is approximately December 2007.

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Exterior Lighting Systems Description and Operation (SWB)

Exterior Lamps

The exterior lighting system consists of the following lamps:

- The headlamps
- The front fog lamps
- The rear fog lamp (export only)
- The park, tail and marker lamps
- The exterior courtesy lamps
- The turn signal/hazard lamps
- The side repeater lamps (export only)
- The stop lamps
- The backup lamps
- The cargo lamps
- The clearance lamps

Headlamps

The headlamps may be turned ON in 2 different ways. First, when the driver places the headlamp switch in the HEADLAMP position, for normal operation. Second, with the headlamp switch placed in the AUTO position, for automatic lamp control (ALC).

Headlamp ON/OFF control is determined by the body control module (BCM) by a signal on the headlamp switch on input circuit when the headlamp switch is in the HEAD position. When the headlamp switch is in the AUTO position, the BCM determines headlamps ON/OFF by the voltage from the ambient light sensor.

If the headlight switch is left in the ON position, the inadvertent power control feature will turn OFF the headlights approximately 10 seconds after the ignition switch is turned to the OFF position. If the driver places the headlight switch in the ON position after the ignition switch has been turned OFF, or if the ignition switch is in the ACCY position, the headlights will remain ON until turned OFF or the battery runs flat.

The high beam indicator is illuminated when the instrument cluster receives a GMLAN serial data message from the BCM that the high beams are illuminated.

High Beams

The high beam headlamps receive voltage from the headlamp high relay located in the underhood fuse block. The BCM controls the relay on the headlamp high beam relay control circuit. High beam control is determined by a signal on the headlamp dimmer switch high beam signal circuit from the turn signal multifunction switch. When the headlamp dimmer switch signal circuit is grounded, the BCM grounds the headlamp high beam relay control circuit, illuminating the high beam headlamps.

The right and left high beam circuits are independent and are fused independently in the underhood fuse block.

Low Beams - Standard

The low beam headlamps receive voltage from the headlamp low beam relay located in the underhood fuse block. The BCM controls the relay on the headlamp low beam relay control circuit. Low beam control is activated when the headlamp switch is placed in the headlamp ON position grounding the headlamp switch headlamps on signal circuit to the BCM. The right and left low beam circuits are independent are fused independently in the underhood fuse block.

Fog Lamps

With both the ignition switch in the RUN position, and the park lamps ON, the fog lights will illuminate when the driver depresses the fog lamp switch. The BCM receives the park lamp ON signal from the interior park lamps supply voltage signal circuit. With the headlamp switch in either the park or headlamp position, and the fog lamp switch is in the ON position, the BCM will ground the fog lamp relay control circuit causing the relay to energise. The current flows from the fog lamp relay to both front fog lamps. The state of the fog lamps will remain the same until the fog lamp switch position is changed, or the ignition switch is cycled OFF and ON. Fog lamp operation will be cancelled whenever the park lamps are turned OFF or the high beam headlights have been selected.

Park, Tail and Marker Lamps

The park, tail and marker lamps, including the license lamps, are turned ON when the headlamp switch is placed in the PARK or HEAD position or anytime the headlights are requested. The underhood fuse block supplies battery positive voltage to both the park lamp relay switch contacts and the park lamp coil circuit. The BCM provides a ground or control circuit to the park lamp relay coil circuit. When the park lamps are turned ON, the BCM energises the park lamp relay. If the headlight switch is left in the ON position, the inadvertent power control feature will turn OFF the park, tail and marker lamps approximately 10 seconds after the ignition switch is turned to the OFF position. If the driver places the headlight switch in the ON position after the ignition switch has been turned OFF, or if the ignition switch is in the ACCY position, the park, tail and marker lamps will remain ON until turned OFF or the battery runs flat.

Exterior Courtesy Lamps

The BCM, driver door switch, and the passenger door switch communicate through the GMLAN serial data system. The driver door switch and passenger door switch supply power and ground to the left and right exterior lamps respectively. When the BCM commands illuminated entry, a command is also sent to the door switches for illumination of the exterior courtesy lamps. If the door locks are activated to the LOCK position, or if the ignition switch is turned to either the ON or RUN position the exterior courtesy lamps will deactivate immediately.

Turn Signal / Hazard Lamps

When the turn signal multifunction switch is placed in either the left or right position, a ground signal is completed from the turn signal switch to the BCM. The BCM then sends an ON-OFF voltage signal through the fuses to the appropriate turn signal and side repeater lamps or to all of the turn signal fuses for hazard operation. An audio chime is also activated when the turn signals are ON. The instrument panel cluster (IPC) receives the signals to activate the turn signal indicators over the GMLAN serial data system. The hazard warning switch is an integral part of the infotainment fascia, when the hazard warning switch is pressed, the infotainment unit communicates with the BCM via the GMLAN serial data system to activate the hazard warning lamps, the hazard warning switch is NOT connected directly to the turn signal/hazard lamp circuit. When activated all turn signal lamps will flash including both IPC turn indicators.

Stop Lamps

When the driver presses the brake pedal, the a variable voltage signal from the brake pedal position sensor (BPPS) is supplied to the BCM. The BCM then supplies voltage to stop lamp supply voltage circuit applying power to the stop lamps and center high mount stop lamp (CHMSL). The BCM also supplies voltage to the transmission control module (TCM), and powertrain control module (ECM) through a dedicated circuit.

Backup Lamps

The backup lamp request signal is sent from the ECM to the BCM on the GMLAN serial data system. This signal is based on the park neutral position (PNP) switch signal. The BCM supplies voltage to the backup relay and to the automatic day/night mirror when the vehicle is in reverse. The backup relay supplies a voltage on the backup lamp supply voltage circuit to the backup lamps.

Cargo Lamps

The cargo lamp is controlled by the dome lamp control circuit. There is not a separate switch to turn the cargo lamps ON and OFF.

Clearance Lamps

The clearance lamps, are turned ON when the headlamp switch is placed in the PARK or HEAD position or anytime the headlamps are requested. The underhood fuse block supplies battery positive voltage to both the park lamp relay switch contacts and the park lamp coil circuit. The BCM provides a ground or control circuit to the park lamps relay coil circuit. When the park lamps are turned ON, the BCM energises the park lamp relay. If the headlamp switch is left in the ON position, the inadvertent power control feature will turn OFF the park, tail and clearance lamps approximately 10 minutes after the ignition switch is turned to the OFF position. If the driver places the headlamp switch in the ON position after the ignition switch has been turned OFF, or if the ignition switch is in the ACCY position, the park, tail and marker lamps will remain ON until turned OFF or the battery runs dead.

Police Package Special Equipment Lighting Options

Important: GM cannot be held responsible for any changes made to the vehicle. All electrical and body modifications must be preformed by experience and qualified technicians.

- Be sure that any modified or added wiring will not impact the function of the vehicles factory wiring system.
- See that all wiring is correctly protected by fuses, and not causing a overload to connectors and components.
- Do not route wiring in areas of the vehicle where temperatures can be high or where wiring may be cut, pinched or rubbed.
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- Be sure that all holes drilled in the body are correctly sealed and corrosion protected. See that the vehicles wiring harnesses, piping, and other components have not been displaced or damaged during customer installation of equipment and wiring.
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Exterior Lamp Flashing System

The rear flasher function is only available in police vehicles and activated by a latch switch to ground. It provides alternating flashing of the rear lamps (and side markers) out-of-phase with the reverse lamps. The flash rate of 2.4 flashes/sec, 50% duty cycle, is much faster than the normal exterior lighting turn signal rate. Normal operation of turn indicators, hazard switch, reverse gear and foot brake override this function when they are active.

Surveillance Mode (Surv Mode)

The Surveillance mode function is designed for police vehicles only, and provides a way to disable all automated lighting and sounds while the dedicated Surveillance mode switch input to the BCM is in the On (grounded) state. The Surveillance mode function is switched On and Off by an alternate press of the Surveillance button, which is the rectangular monetary push-button on the overhead console. The overhead console contains electronic switches which toggles the state of the output to the BCM between ON and Off. The default state of the battery is Surveillance mode On. When Surveillance mode is On:

- Parkers and Headlamps do not work when the headlamp switch is in the "Auto" position.
- All lamps on the inadvertent power feed will be turned off.
- Maps lights will still function, as they have a separate battery feed in police vehicles only.
- The courtesy lights will not illuminate when a door is opened or a remote key is used.
- Turn signal flashes or horn chirps will not operate when a remote key is used.
- Chimes are suppressed.
- All internal backlighting is switched Off.
- Cluster backlighting is set to minimum.

Important: At the request of the police, the BCM functionality can be changed at a future point. The external lighting (Headlamps and Parkers) will no longer be switched off by surveillance mode. The anticipated introduction date at the Holden Assembly is approximately December 2007.

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Interior Lighting Systems Description and Operation (Sedan)

Interior Lamps

The interior lighting consists of 2 groups. The first group includes lamps that may not be dimmed.

- Courtesy/illuminated entry lamps
- Dome lamps
- Map lamps
- Reading lamps
- Vanity mirror lamps

Courtesy / Illuminated Entry Lamps

The courtesy/illuminated entry lamps, may be manually turned ON or OFF by placing the interior lamp switch in the ON or OFF position. If an outside door handle is lifted and a door is opened, the courtesy/illuminated entry lamps illuminate. After all the doors have been closed the courtesy/illuminated entry lamps will remain illuminated approximately 15 seconds. The body control module (BCM) will then turn them OFF through the theater dimming feature. The courtesy/illuminated entry lamps will also turn ON prior to any door being opened, and remain illuminated approximately 40 seconds when the driver removes the ignition key. When the driver places the dome lamp defeat switch in the OFF position, the courtesy/illuminated entry lamps will be disabled.

The BCM, the door switches communicate through the GMLAN serial data circuit for the lamp illumination commands of the doors and luggage compartment open/ajar switch signals. For all vehicles, the left and right rear door latch switches are both on one circuit that is also an input to the BCM.

The left and right front door courtesy lamps receive voltage and ground from the driver door switch and the passenger door switch respectively. The remaining courtesy lamps are controlled and receive voltage from the BCM. Voltage for the courtesy lamp supply voltage circuit is from the INT LTS fuse in the instrument panel fuse block.

Keyless Entry Interior Illumination

When the driver uses the door key in order to unlock the doors, the body control module (BCM) receives a door unlock signal. The BCM must have inputs or serial data messages that indicate that the ignition switch is OFF, the courtesy lamp switch is OFF and all the doors are closed. The BCM will then activate the interior lamps. The courtesy lamps will remain ON, approximately 15 seconds after the door is closed. The BCM will then turn them OFF through the theater dimming feature. If the door locks are activated to the LOCK position, or if the ignition switch is turned to either the RUN or CRANK position the courtesy lamps will turn OFF immediately.

When the driver uses the remote function actuator transmitter to unlock the doors, trunk or presses the panic button, the BCM will keep the courtesy lamps ON approximately 40 seconds. When the driver uses the remote function actuator transmitter to lock the doors, the BCM will keep the courtesy lamps on approximately 2 seconds. If the ignition switch is turned to either the RUN or CRANK position the courtesy lamps will turn OFF immediately.

Vanity Lamps

The inadvertent power supply voltage circuit of the body control module (BCM) provides battery positive voltage to each vanity mirror lamp. When the vanity mirror cover on the sunshade is opened, a switch closes to provide a ground circuit and the vanity lamp illuminates.

Reading Lamps

The inadvertent power supply voltage circuit of the body control module (BCM) provides battery positive voltage to the reading lamps. The reading lamps and switch are integral to the courtesy/reading lamp assembly. When the switch is closed, voltage is supplied and the lamp illuminates.

Battery Rundown Protection / Inadvertent Power

The body control module (BCM) inadvertent power supply voltage circuit provides battery positive voltage to all of the interior reading lamps, visor vanity mirror lamps, and cargo lamps if equipped. In the event that any of these lamps were to remain illuminated for a period of more than 10 seconds with the ignition switch in the OFF position, the BCM will deactivate the inadvertent power supply voltage circuit to prevent a total battery discharge condition.

Interior Lamps Dimming

The second interior lighting group includes lamps which may be dimmed. This group may use a combination of vacuum fluorescent (VF) illumination, LED illumination and incandescent lamps.

When the ignition switch is turned to the RUN position, the radio VF display turns ON at maximum brightness. When the park lamps are ON, all incandescent and LED back lighting turn ON at the dimming level indicated by the instrument panel (I/P) dimmer switch. At the same time all VF displays dim to match the indicated dimming level. The panel dimmer switch potentiometer is an input to the body control module (BCM). When the driver selects a dimming setting by moving the I/P dimming switch potentiometer, all incandescent back lighting lamps are provided with a specific voltage. When the I/P dimmer switch is moved from MIN to MAX, all VF displays, as well as all incandescent back lighting respond from minimum intensity to maximum brightness in response to the I/P dimmer switch.

The following switches and components have back lighting when the park lamps are ON:

- The instrument panel cluster (IPC)
- Window and heated seat switches
- Rear HVAC switches
- Sunroof switch
- Accessory switches
- Fog lamp switches
- Rear parking assist (RPA) disable switches
- PRNDL lamps

- Traction control switch
- Steering wheel control switches

The left and right front door switch illumination is controlled, receives voltage and ground from the driver door switch and passenger switch respectively. The radio is also a GMLAN module and has full control of its illumination. The BCM, door switches, and radio communicate through GMLAN serial data for the lamp illumination commands.

The various switches, HVAC control assembly, and the PRNDL lamps receive voltage and are controlled by the BCM on the I/P lamps dimming control circuit.

The following indicators receive voltage from the BCM and are controlled by ground from a switch or from various modules:

- Tow indicator
- Radio
- HVAC control assembly
- Instrument panel cluster (IPC)
- Driver information center (DIC)
- Headlamp and panel dimmer switch

The indicators receive voltage from the BCM on the LED dimming circuit. Control for the indicators is from the various modules or switches. Voltage for the LED dimming supply circuit, instrument panel lamps dimming control circuit and the instrument panel lamps dimming supply circuit is from the BCM.

Interior Lighting Systems Description and Operation (Sportwagon)

Interior Lamps

The interior lighting consists of 2 groups. The first group includes lamps that may not be dimmed.

- Courtesy/illuminated entry lamps
- Dome lamps
- Map lamps
- Reading lamps
- Vanity mirror lamps

Courtesy / Illuminated Entry Lamps

The courtesy/illuminated entry lamps, may be manually turned ON or OFF by placing the interior lamp switch in the ON or OFF position. If an outside door handle is lifted and a door is opened, the courtesy/illuminated entry lamps illuminate. After all the doors have been closed the courtesy/illuminated entry lamps will remain illuminated approximately 15 seconds. The body control module (BCM) will then turn them OFF through the theater dimming feature. The courtesy/illuminated entry lamps will also turn ON prior to any door being opened, and remain illuminated approximately 40 seconds when the driver removes the ignition key. When the driver places the dome lamp defeat switch in the OFF position, the courtesy/illuminated entry lamps will be disabled.

The BCM, the door switches communicate through the GMLAN serial data circuit for the lamp illumination commands of the doors and luggage compartment open/ajar switch signals. For all vehicles, the left and right rear door latch switches are both on one circuit that is also an input to the BCM.

The left and right front door courtesy lamps receive voltage and ground from the driver door switch and the passenger door switch respectively. The remaining courtesy lamps are controlled and receive voltage from the BCM. Voltage for the courtesy lamp supply voltage circuit is from the INT LTS fuse in the instrument panel fuse block.

Keyless Entry Interior Illumination

When the driver uses the door key in order to unlock the doors, the body control module (BCM) receives a door unlock signal. The BCM must have inputs or serial data messages that indicate that the ignition switch is OFF, the courtesy lamp switch is OFF and all the doors are closed. The BCM will then activate the interior lamps. The courtesy lamps will remain ON, approximately 15 seconds after the door is closed. The BCM will then turn them OFF through the theater dimming feature. If the door locks are activated to the LOCK position, or if the ignition switch is turned to either the RUN or CRANK position the courtesy lamps will turn OFF immediately.

When the driver uses the remote function actuator transmitter to unlock the doors, trunk or presses the panic button, the BCM will keep the courtesy lamps ON approximately 40 seconds. When the driver uses the remote function actuator transmitter to lock the doors, the BCM will keep the courtesy lamps on approximately 2 seconds. If the ignition switch is turned to either the RUN or CRANK position the courtesy lamps will turn OFF immediately.

Vanity Lamps

The inadvertent power supply voltage circuit of the body control module (BCM) provides battery positive voltage to each vanity mirror lamp. When the vanity mirror cover on the sunshade is opened, a switch closes to provide a ground circuit and the vanity lamp illuminates.

Reading Lamps

The inadvertent power supply voltage circuit of the body control module (BCM) provides battery positive voltage to the reading lamps. The reading lamps and switch are integral to the courtesy/reading lamp assembly. When the switch is closed, voltage is supplied and the lamp illuminates.

Battery Rundown Protection / Inadvertent Power

The body control module (BCM) inadvertent power supply voltage circuit provides battery positive voltage to all of the interior reading lamps, visor vanity mirror lamps, and cargo lamps if equipped. In the event that any of these lamps were to remain illuminated for a period of more than 10 seconds with the ignition switch in the OFF position, the BCM will deactivate the inadvertent power supply voltage circuit to prevent a total battery discharge condition.

Interior Lamps Dimming

The second interior lighting group includes lamps which may be dimmed. This group may use a combination of vacuum fluorescent (VF) illumination, LED illumination and incandescent lamps.

When the ignition switch is turned to the RUN position, the radio VF display turns ON at maximum brightness. When the park lamps are ON, all incandescent and LED back lighting turn ON at the dimming level indicated by the instrument panel (I/P) dimmer switch. At the same time all VF displays dim to match the indicated dimming level. The panel dimmer switch potentiometer is an input to the body control module (BCM). When the driver selects a dimming setting by moving the I/P dimming switch potentiometer, all incandescent back lighting lamps are provided with a specific voltage. When the I/P dimmer switch is moved from MIN to MAX, all VF displays, as well as all incandescent back lighting respond from minimum intensity to maximum brightness in response to the I/P dimmer switch.

The following switches and components have back lighting when the park lamps are ON:

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- Window and heated seat switches
- Rear HVAC switches
- Sunroof switch
- Accessory switches
- Fog lamp switches
- Rear parking assist (RPA) disable switches
- PRNDL lamps
- Traction control switch

- Steering wheel control switches

The left and right front door switch illumination is controlled, receives voltage and ground from the driver door switch and passenger switch respectively. The radio is also a GMLAN module and has full control of its illumination. The BCM, door switches, and radio communicate through GMLAN serial data for the lamp illumination commands.

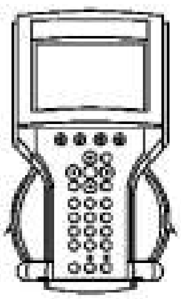
The various switches, HVAC control assembly, and the PRNDL lamps receive voltage and are controlled by the BCM on the I/P lamps dimming control circuit.

The following indicators receive voltage from the BCM and are controlled by ground from a switch or from various modules:

- Tow indicator
- Radio
- HVAC control assembly
- Instrument panel cluster (IPC)
- Driver information center (DIC)
- Headlamp and panel dimmer switch

The indicators receive voltage from the BCM on the LED dimming circuit. Control for the indicators is from the various modules or switches. Voltage for the LED dimming supply circuit, instrument panel lamps dimming control circuit and the instrument panel lamps dimming supply circuit is from the BCM.

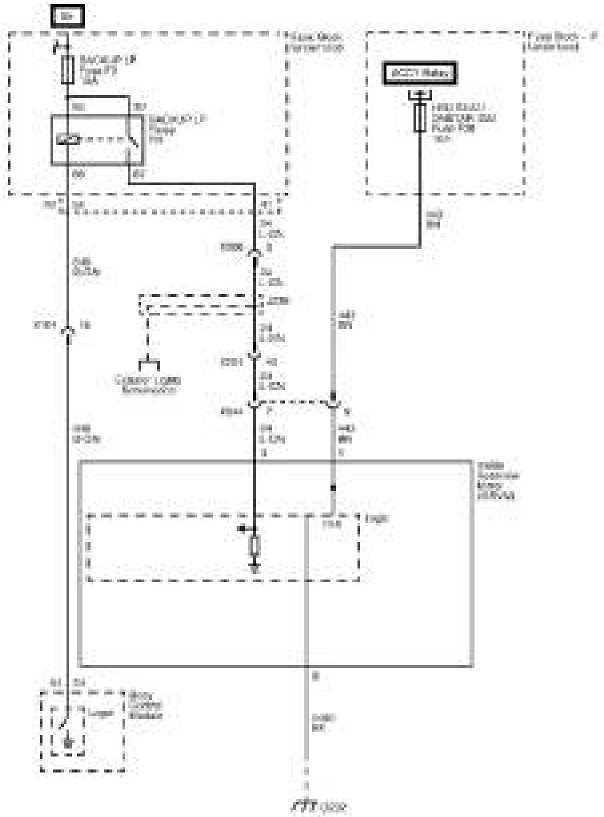
Special Tools

Illustration	Tool Number / Description
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

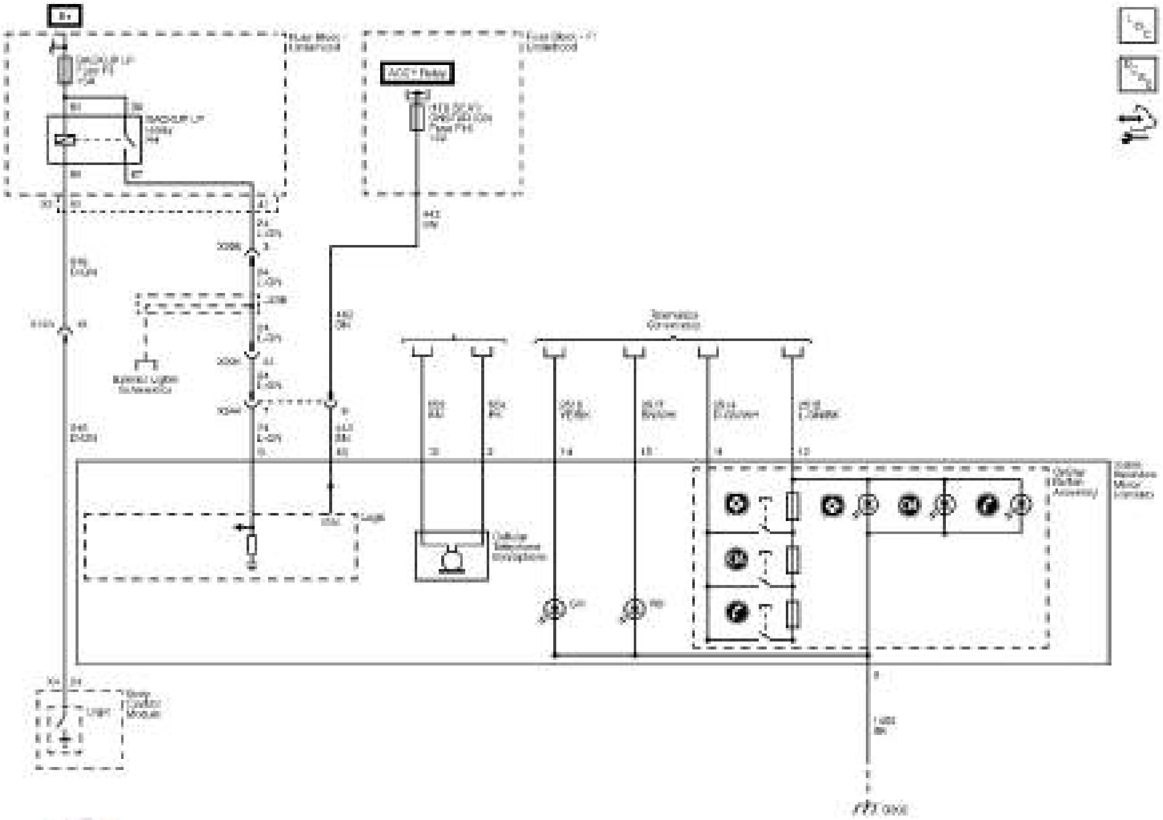
Fastener Tightening Specifications

Application	Specification	
	Metric	English
Outside Mirror to Door Retaining Screws	3 N-m	27 lb in
Telematics Inside Rear View Mirror Retaining Screw	4 N-m	35 lb in

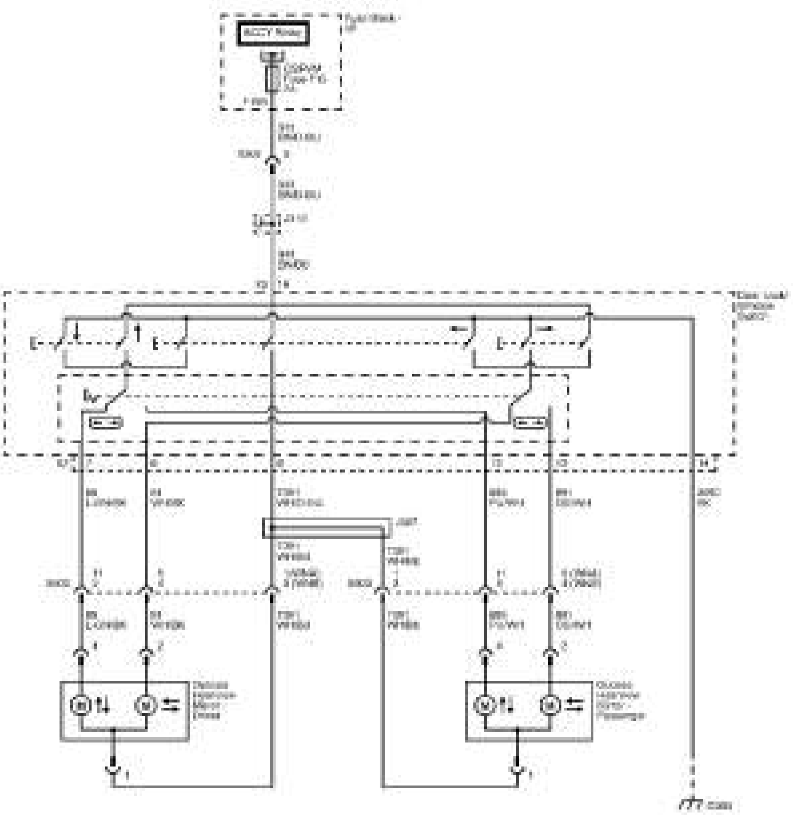
Except U5J


B+
BACKUP LP
BACKUP LP
ACC1 Relay
Logic
Logic

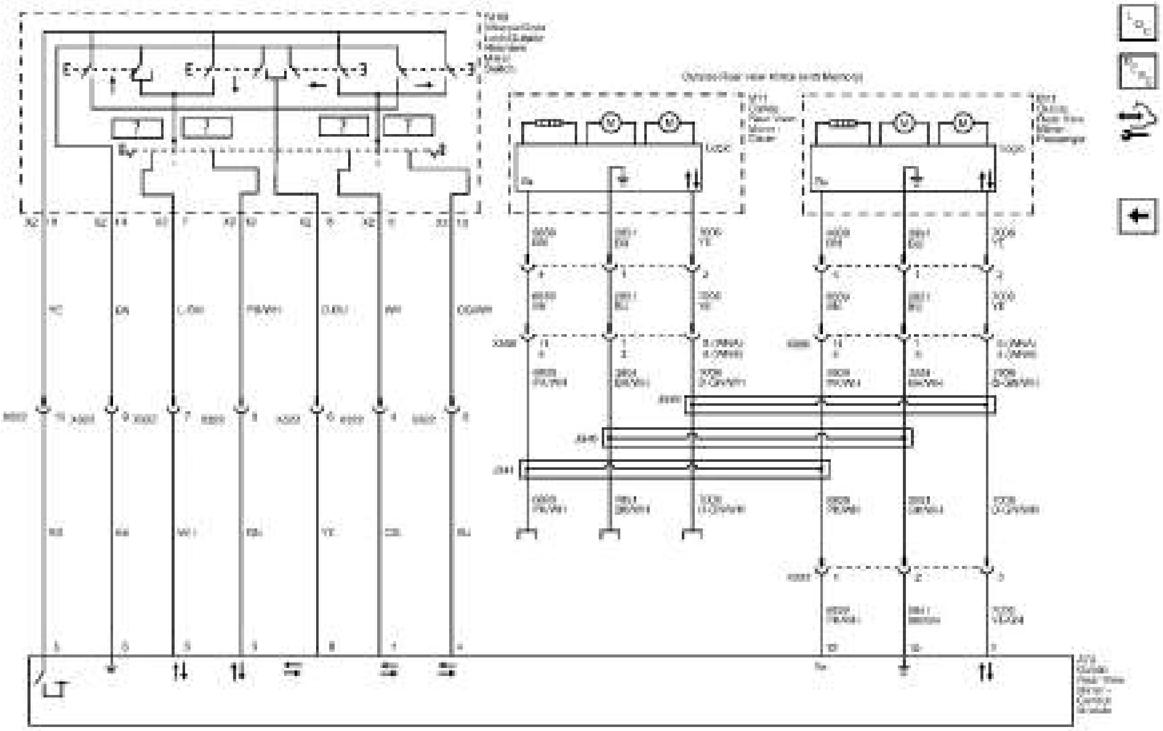
U5J


B+
Fuse Block - Underhood
Logic
Cellular Telephone Microphone

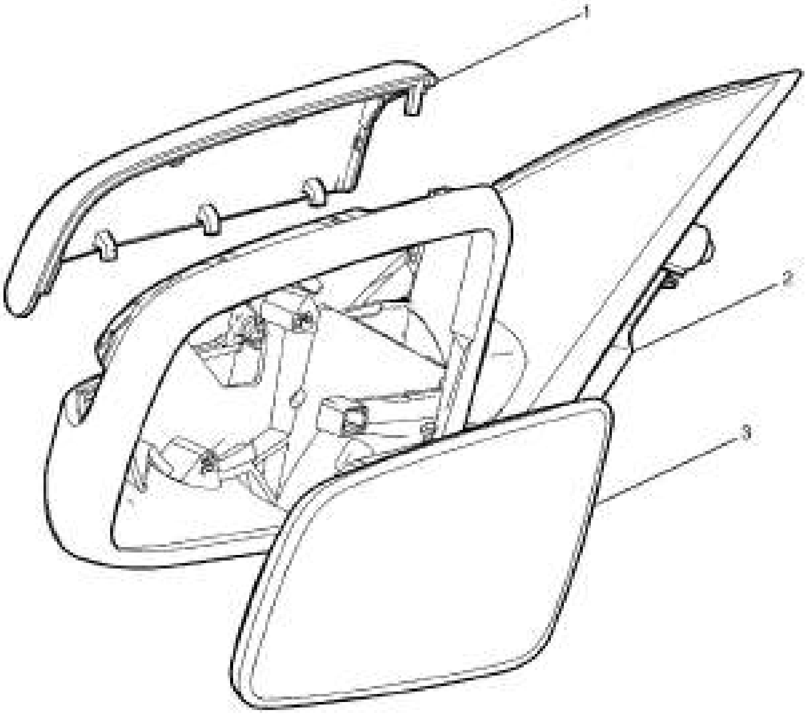
D22



A45

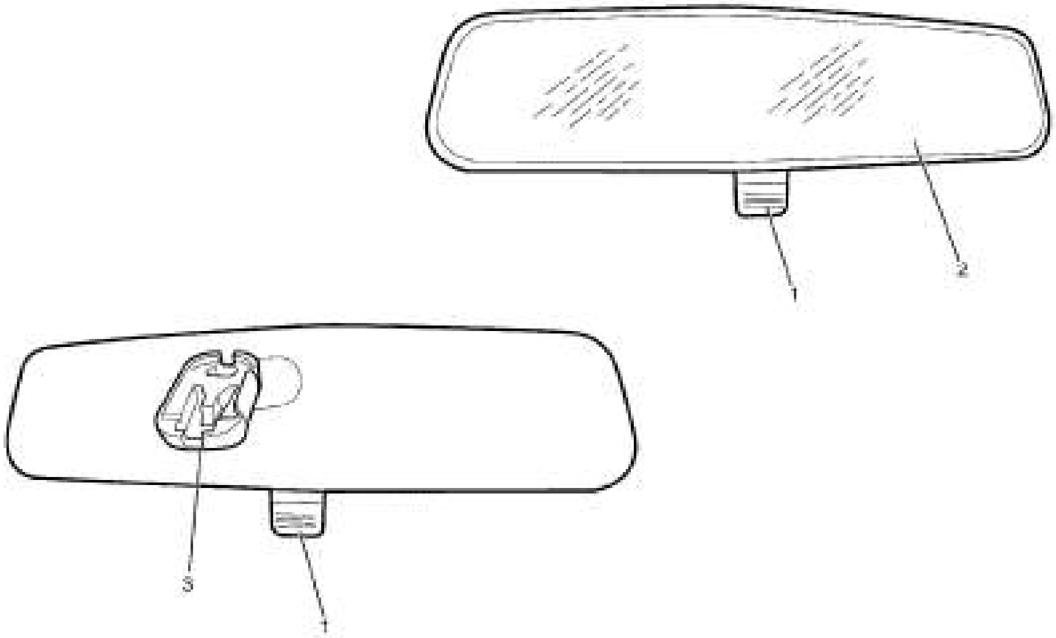


Door Mirror



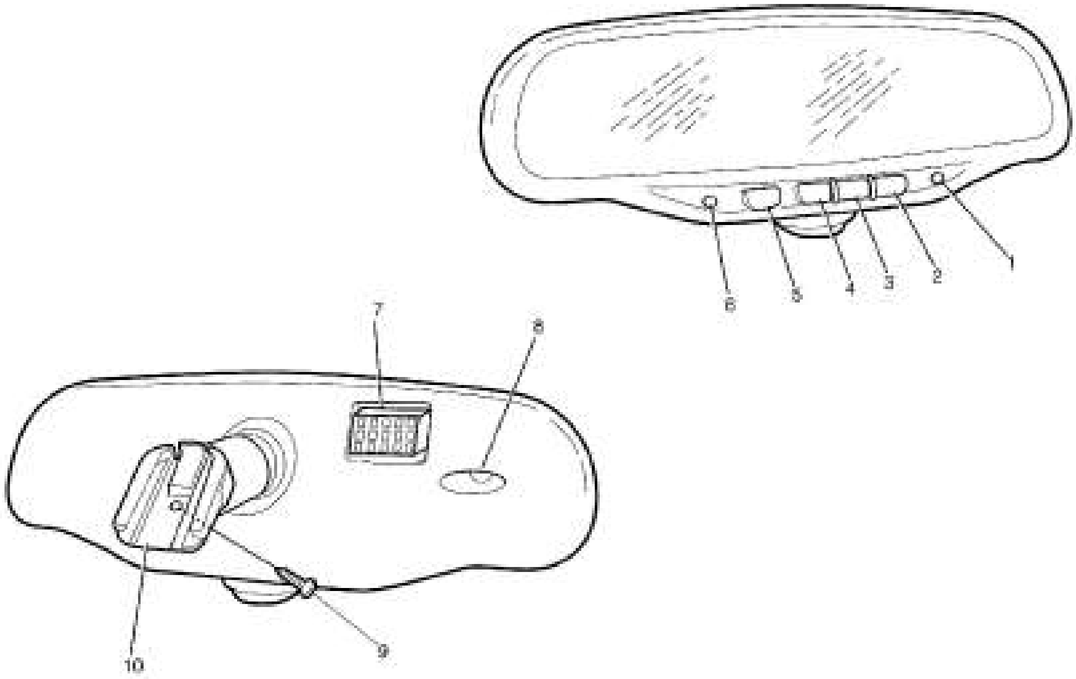
(1) Mirror Cover
(2) Mirror Assembly
(3) Mirror Glass

Manual Day / Night Rearview Mirror



(1) Manual Day-Night Adjuster
(2) Rearview Mirror
(3) Rearview Mirror Boss

Telematic Rearview Mirror



(1) Status Indicator LED
(2) Emergency Button
(3) HOLDEN ASSIST Button
(4) End Call/Information Button
(5) On/Off Button
(6) Headlight Sensor
(7) Electrical Connector
(8) Ambient Light Sensor
(9) Rearview Mirror Retaining Screw
(10) Rearview Mirror Boss

Symptoms - Stationary Windows

1. Perform the Diagnostic System Check - Vehicle , before using the symptom tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data link.
2. Review the inside rearview mirror system operation in order to familiarize yourself with the system functions. Refer to Inside Rearview Mirror Description and Operation .

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the automatic day-night feature or the telematics feature of the inside rearview mirror. Refer to Checking Aftermarket Accessories .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

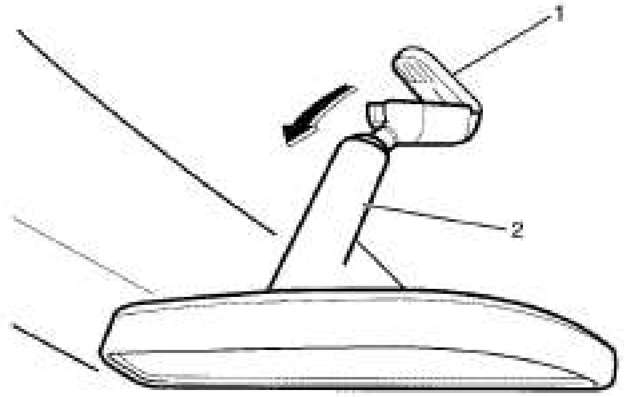
Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections .

Symptom List

Refer to the Automatic Day-Night Mirrors Inoperative symptom diagnostic procedure from in order to diagnose the symptom.

Inside Rearview Mirror Replacement

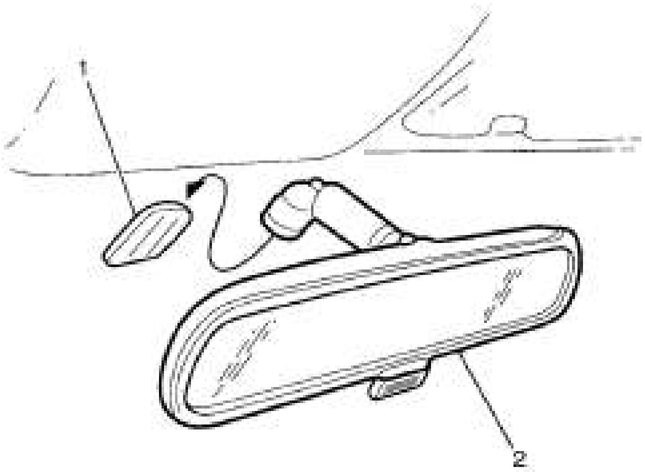
Removal Procedure - Manual Day/Night Adjustment



Important: The rearview mirror boss (1) is not serviced separately and is part of the windshield assembly.

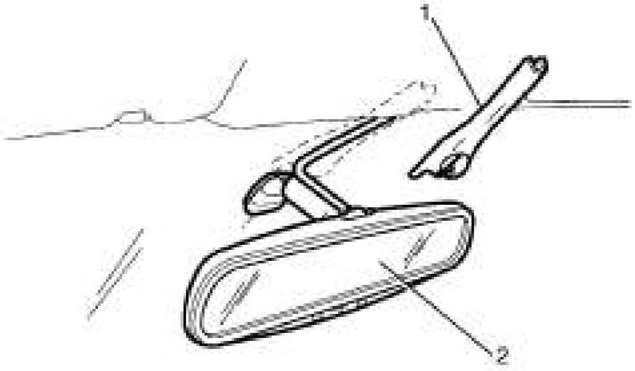
1. Detach the rearview mirror (2) from the windshield mirror boss (1) by firmly pulling downward.
2. Detach the rearview mirror (2) from the windshield mirror boss (1).

Installation Procedure - Manual Day/Night Adjustment



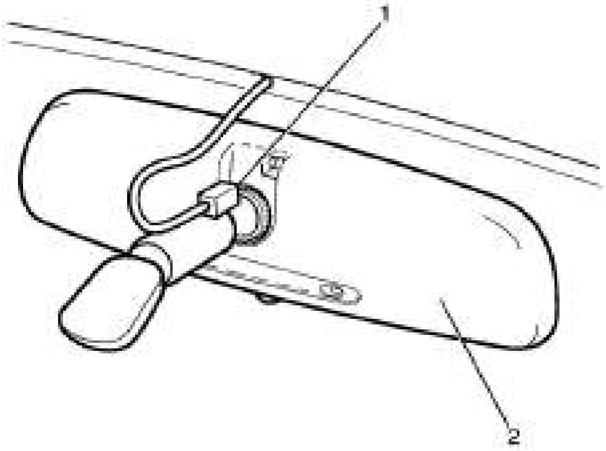
1. Slide the rearview mirror (2) downwards on the rearview mirror boss (1) until an audible click noise is heard.
2. Install the rearview mirror (2) to the rearview mirror boss (1).

Removal Procedure - Electro-chromatic

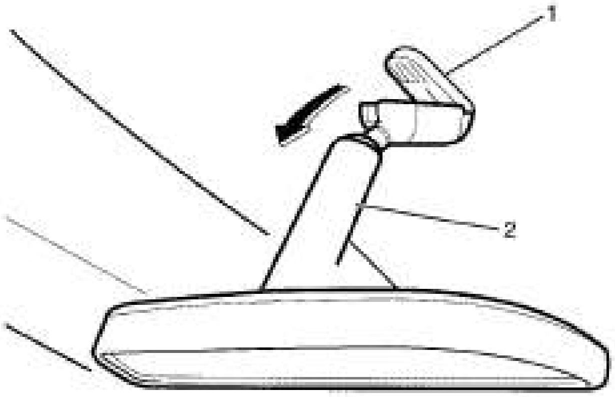


Important: Remove the rearview mirror wiring harness cover (1) by sliding it upwards and outwards.

1. Remove the rearview mirror wiring harness cover (1) from the rearview mirror (2).



2. Disconnect the rearview mirror electrical connector (1) from the rearview mirror (2).

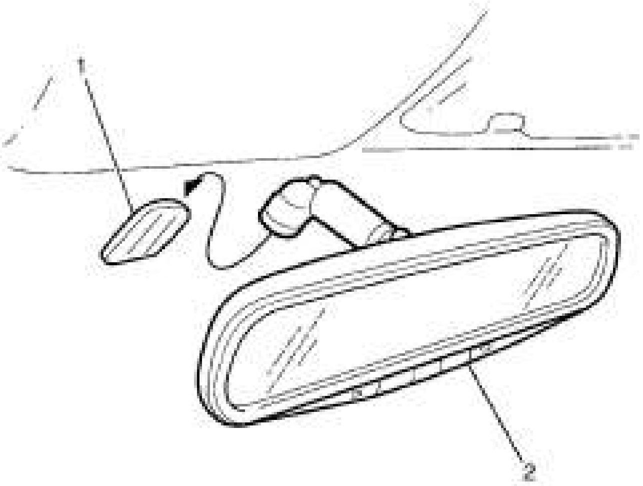


Important: Detach the rearview mirror (2) from the rearview mirror boss (1) by firmly pulling downward.

Important: The rearview mirror boss (1) is not serviced separately and is part of the windshield assembly.

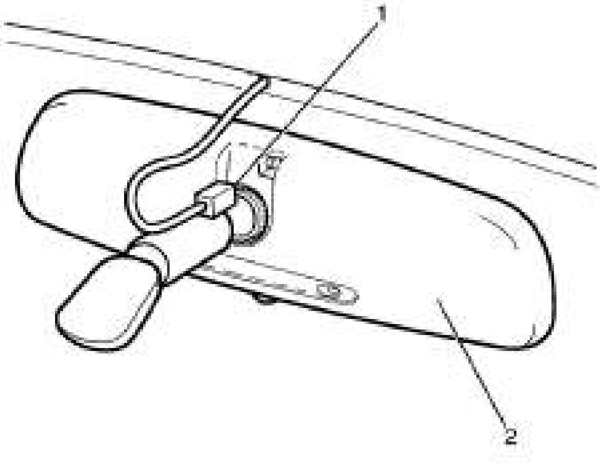
3. Detach the rearview mirror (2) from the windshield mirror boss (1).
4. Remove the rearview mirror (2) from the vehicle.

Installation Procedure - Electro-chromatic

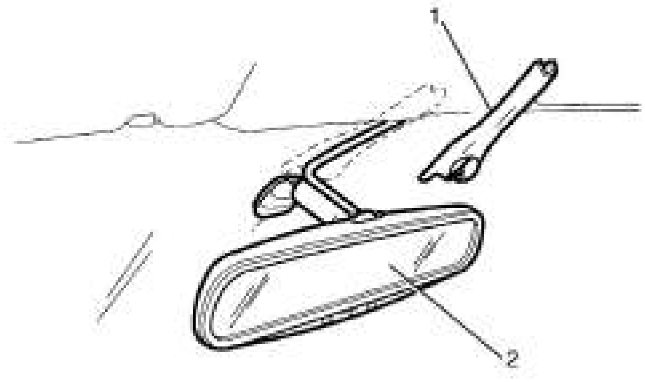


Important: Slide the rearview mirror (2) downwards on the rearview mirror boss (1) until an audible click noise is heard.

1. Install the rearview mirror (2) to the rearview mirror boss (1).



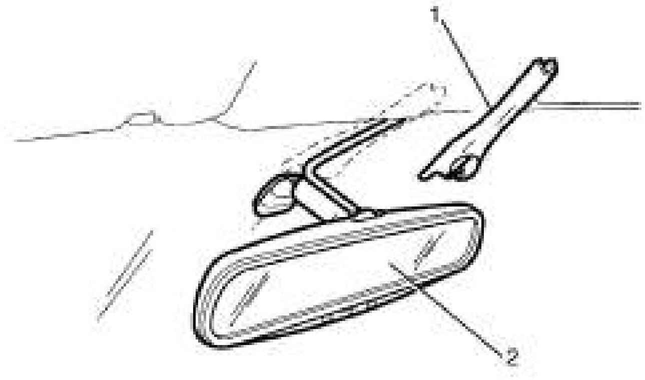
2. Connect the rearview mirror electrical connector (1) to the rearview mirror (2).



Important: Install the rearview mirror cover (1) by sliding it inwards and downwards.

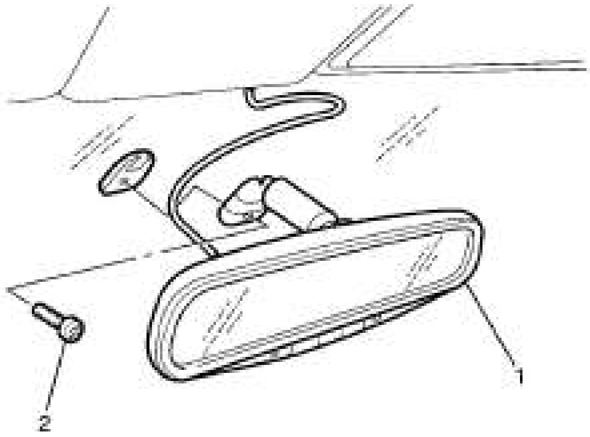
3. Install the rearview mirror wiring harness cover (1) to the rearview mirror (2).

Removal Procedure - Telematic



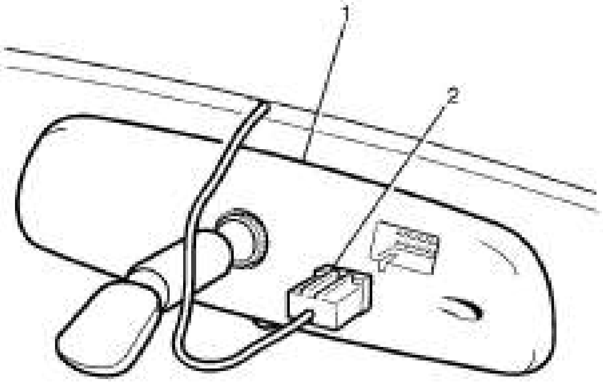
Important: Remove the rearview mirror wiring harness cover (1) by sliding it upwards and outwards.

1. Remove the rearview mirror wiring harness cover (1) from the rearview mirror (2).

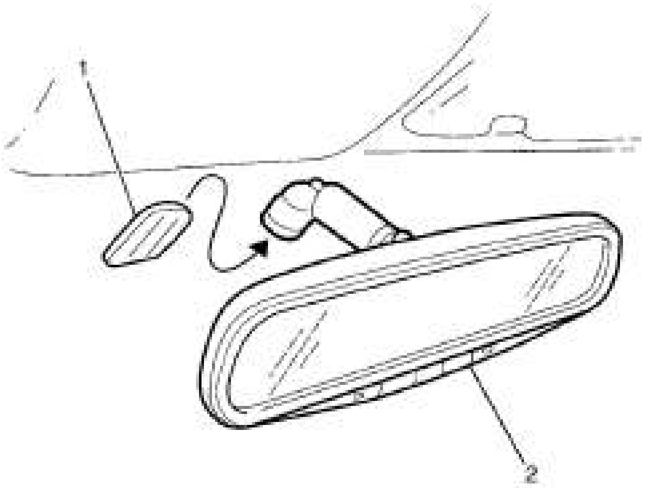


Important: The rearview mirror boss is not serviced separately and is part of the windshield assembly.

2. Remove the rearview mirror retaining screw (2) from the rearview mirror (1).



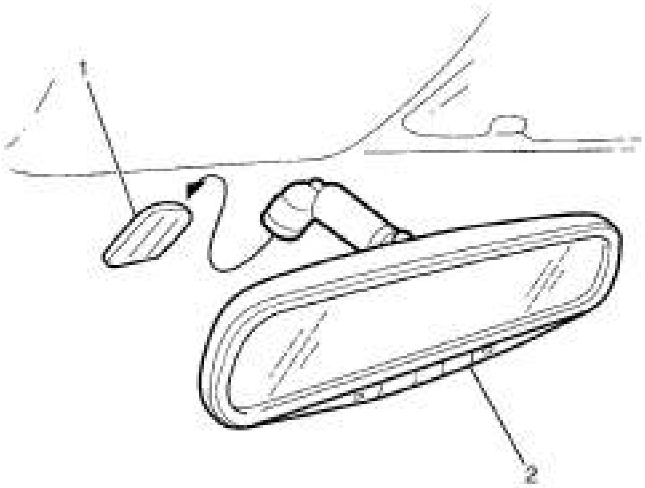
3. Disconnect the rearview mirror electrical connector (2) from the rearview mirror (1).



Important: Remove the rearview mirror (2) by sliding it upwards.

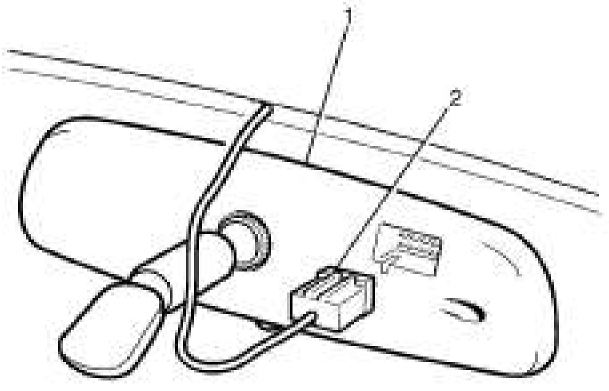
4. Remove the rearview mirror (2) from the rearview mirror boss (1).

Installation Procedure - Telematic



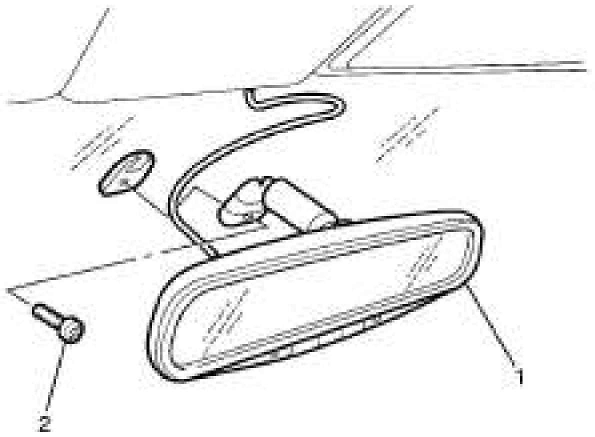
Important: Slide the rearview mirror (2) downwards on the rearview mirror boss (1).

1. Install the rearview mirror (2) to the rearview mirror boss (1).



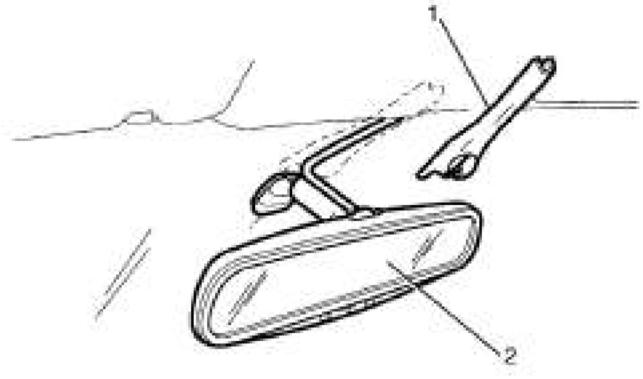
2. Connect the rearview mirror electrical connector (2) to the rearview mirror (1).

   Notice: Refer to Fastener Notice in the Preface section.



3. Install the rearview mirror retaining screw (2) to the rearview mirror (1).

   Tighten
   Tighten the screw to 4 N-m (35 lb in).



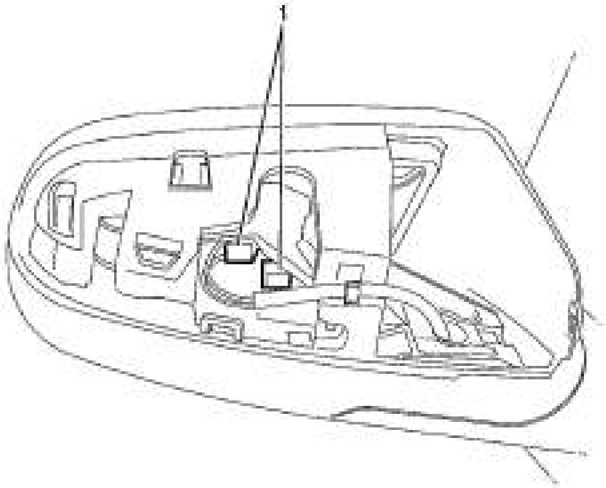
Important: Install the rearview mirror cover (1) by sliding it inwards and downwards.

4. Install the rearview mirror wiring harness cover (1) to the rearview mirror (2).

Outside Rearview Mirror Glass Replacement

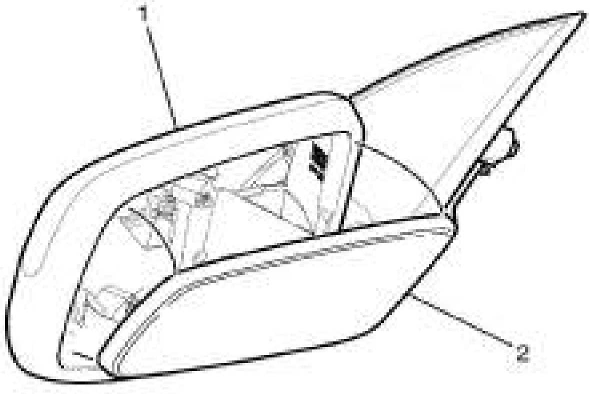
Removal Procedure

1. Remove the mirror cover. Refer to Outside Rearview Mirror Opening Cover Replacement.



2. Disconnect the mirror electrical connectors (1).

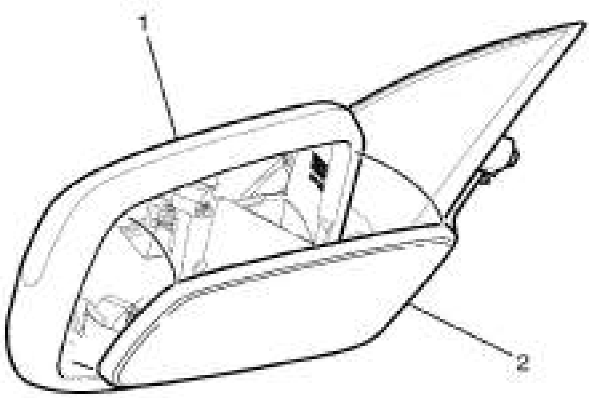
Caution: When working with any type of glass or sheet metal with exposed or rough edges, wear approved safety glasses and gloves in order to reduce the chance of personal injury.



Important: Push the mirror face (1) inward at the bottom of the face until full travel is reached. Pull the mirror face (1) from the top to release the mirror face retaining clips.

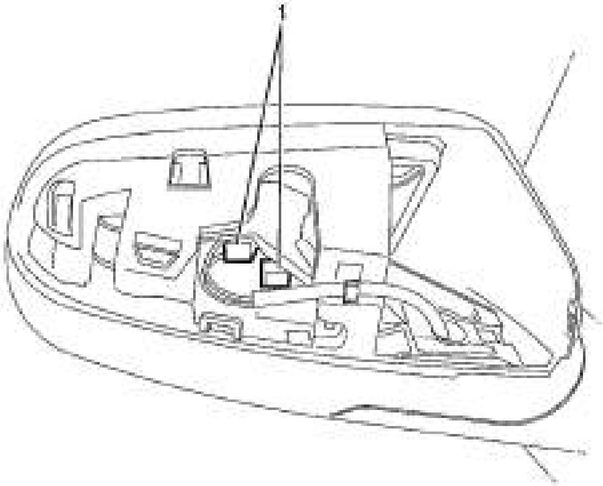
3. Remove the mirror face (1) from the mirror (2).

Installation Procedure



Important: Push the mirror face (2) into the mirror (1) until an audible click is heard.

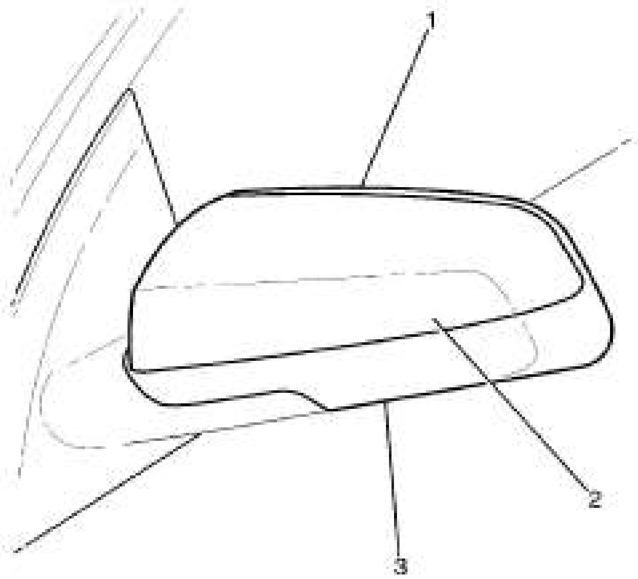
1. Install the mirror face (1) to the outside rearview mirror (2).



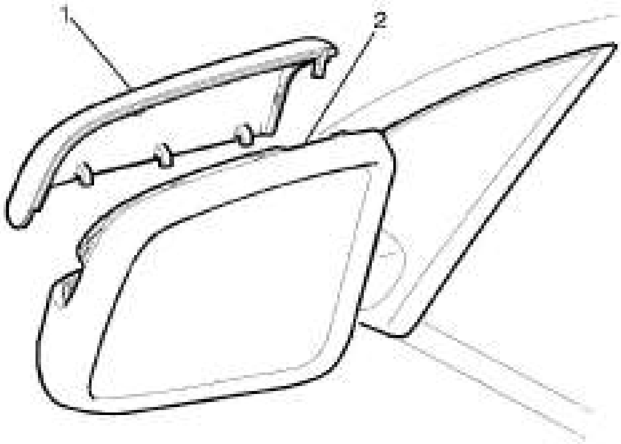
2. Connect the electrical connectors (1).
3. Install the mirror cover. Refer to Outside Rearview Mirror Opening Cover Replacement.
4. Inspect the mirror for correct operation.

Outside Rearview Mirror Opening Cover Replacement

Removal Procedure

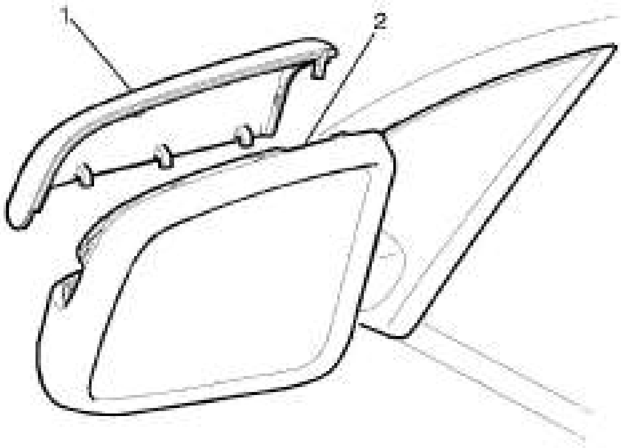


1. Firmly grasp mirror cover at (2, 1) and lift upwards then outwards from the mirror (3) to release the retainers.



2. Remove the mirror cover (1) from the mirror (2).

Installation Procedure

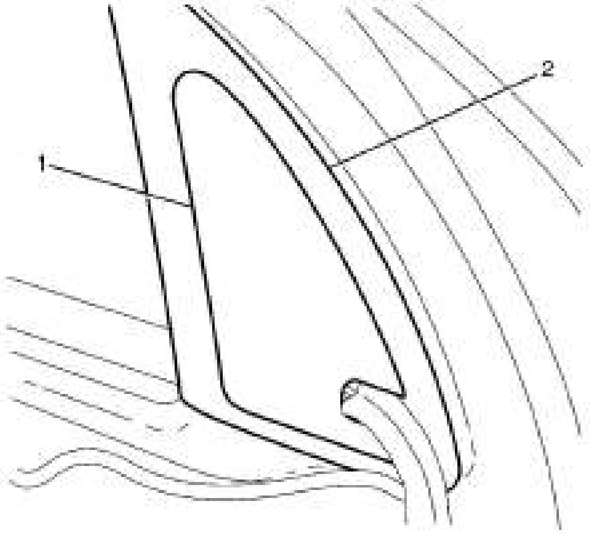


1. Push the mirror cover (1) at the top first then the lower side inwards to attach it to the mirror (2).
2. Install the mirror cover (1) to the mirror (2).

Power Mirror Replacement

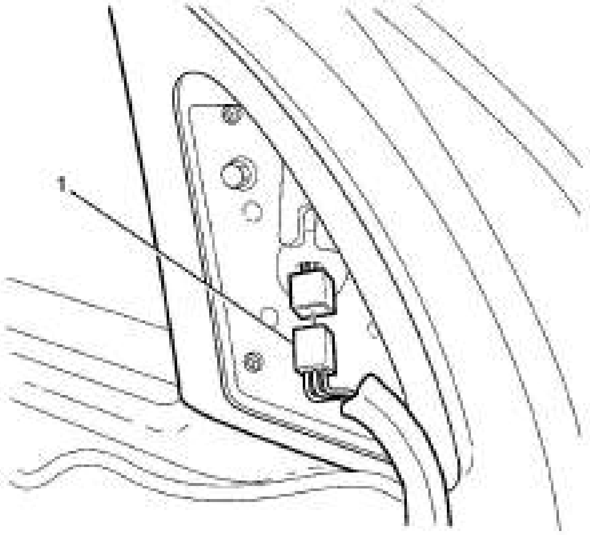
Removal Procedure

1. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement.
2. Remove the upper auxiliary weatherstrip. Refer to Front Side Door Upper Auxiliary Weatherstrip Replacement.

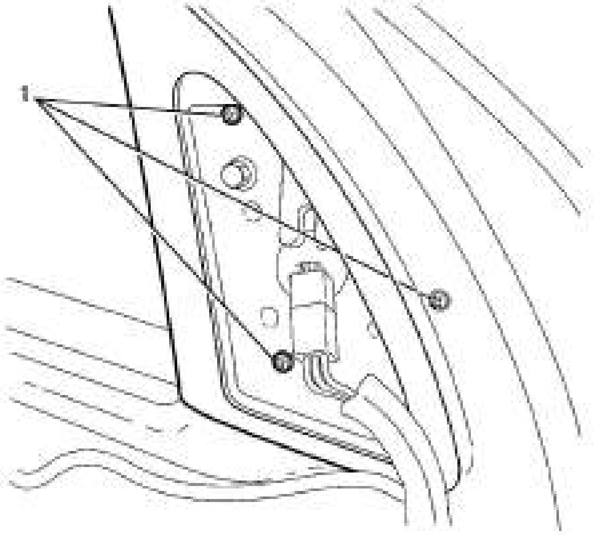


Important: Use a suitable tool to pry open inner panel (1).

3. Remove the inner panel (1) from the door (2).



4. Disconnect the mirror to door harness electrical connector (1).



Important: Position aside upper auxiliary weatherstrip to locate the front mirror to door retaining screw.

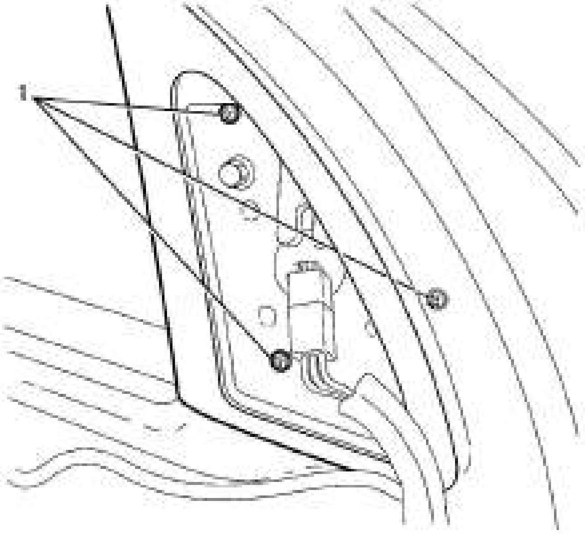
Important: Support the mirror when removing retaining screws (1).

5. Remove the mirror to door retaining screws (1).
6. Remove the mirror from the door.

Installation Procedure

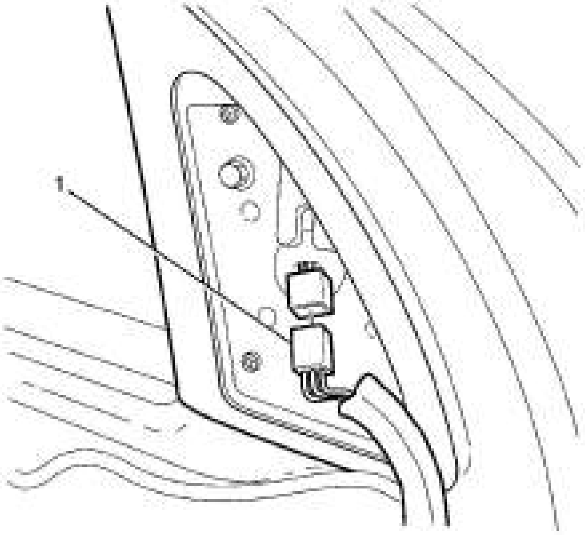
1. Position the mirror to the door.

Notice: Refer to Fastener Notice in the Preface section.

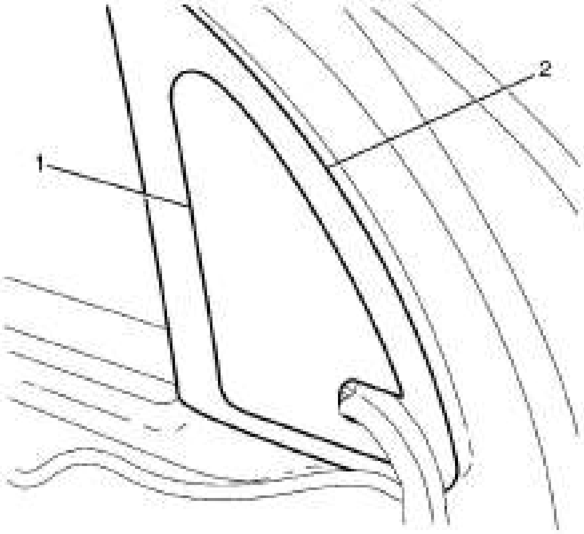


2. Install the mirror to door retaining screws (1).

   Tighten
   Tighten the screws to 3 N-m (27 lb in).



3. Connect the mirror to door harness electrical connector (1).



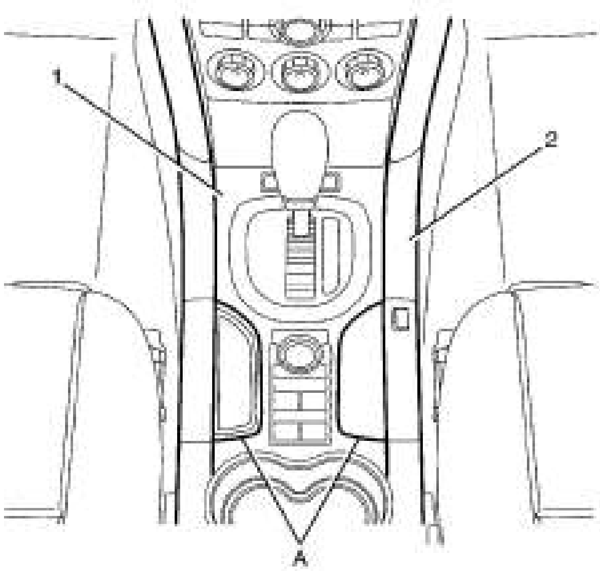
Important: Push the inner panel (1) to attach the retainers.

4. Install the inner panel (1) to the door (2).
5. Install the upper auxiliary weatherstrip. Refer to Front Side Door Upper Auxiliary Weatherstrip Replacement.
6. Install the door trim panel. Refer to Front Side Door Trim Panel Replacement.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Systems | Mirrors | Repair Instructions | Document ID: 1986609

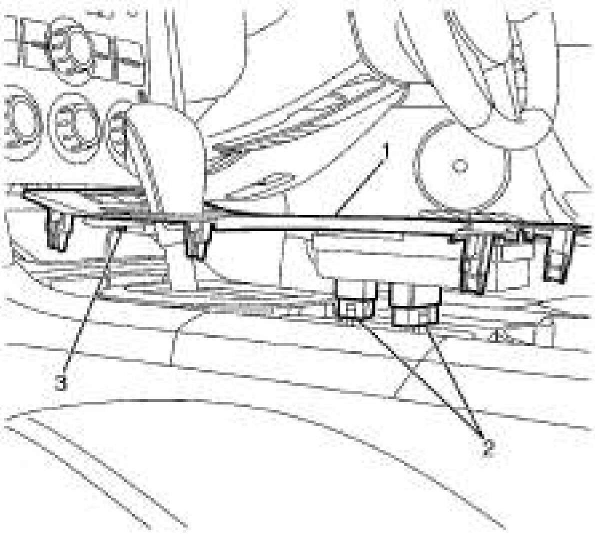
Power Mirror Switch Replacement

Removal Procedure

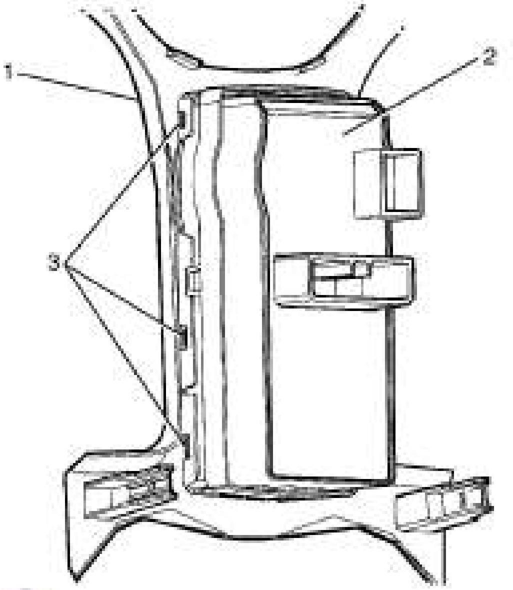


Important: The front floor console front cover (1) is retained by clips.

1. Grasp the front floor console front cover (1) at (a) and pull upwards to disengage the retaining clips from the floor console (2).



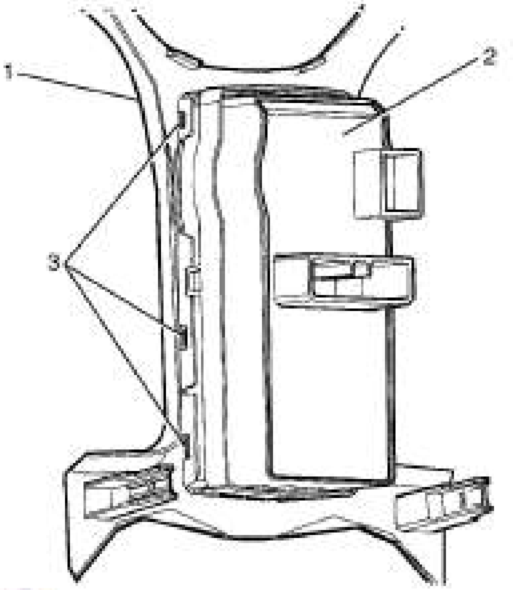
2. Disconnect the window and exterior mirror switch electrical connector (2).
3. Disconnect the Traction Control/ESP, Power and Puddle lamp switch (if fitted) assembly electrical connector (3).
4. Remove the front floor console front cover (1).



Important: Remove the power window/mirror switch (2) by releasing from the retaining clips (3) on the front floor console cover (1).

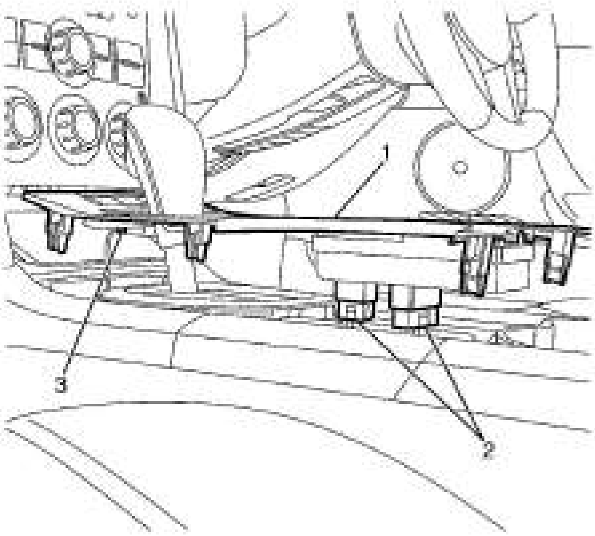
5. Remove the power window/mirror switch (2) from the front floor console front cover (1).

Installation Procedure

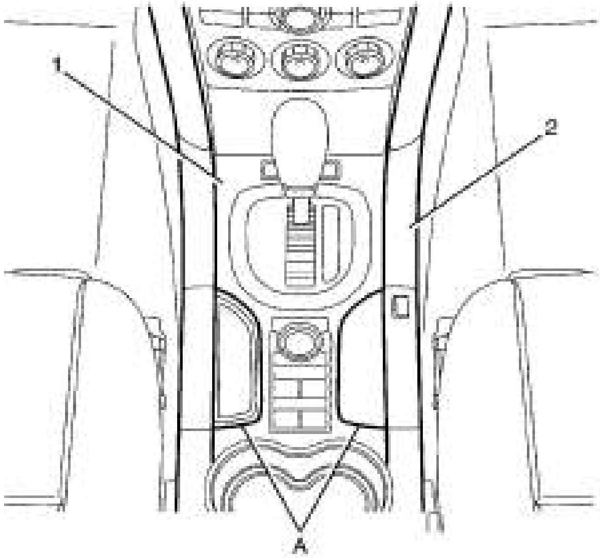


Important: Install the power window/mirror switch (2) by attaching to the retaining clips (3) on the front floor console cover (1).

1. Install the power window/mirror switch (2) to the front floor console front cover (1).



2. Position the front floor console front cover (1).
3. Connect the window and exterior mirror switch electrical connector (2).
4. Connect the Traction Control/ESP, Power and Puddle lamp switch (if fitted) assembly electrical connector (3).



Important: The front floor console front cover (1) is retained by clips.

5. Install the front floor console front cover (1) and push downwards at (a) to engage the retaining clips to the floor console (2).

Vanity Mirror Replacement

1. The vanity mirror is not a serviceable item,.
2. If the vanity mirror requires replacement it must be replaced as an assembly. Refer to Sunroof Sunshade Replacement

Inside Rearview Mirror Description and Operation (SWB)

Manual Day / Night Rearview Mirror

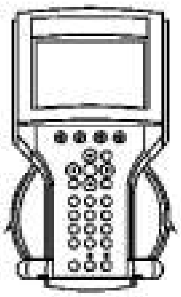
The manual day/night rearview mirror is mounted to a boss which is attached to the centre of the windshield. The boss is a part of the windshield assembly. To reduce the glare from vehicles following at night the lever at the base of the manual day/night rearview mirror can be pulled rearward to tilt the mirror. This enables rear vision to be maintained, but reduces glare.

Outside Mirror Description and Operation

The exterior mirrors are electrically controlled by 3 switches on the front center console. The mirrors have 3 controls, a left and right selection switch operating the required mirror and a directional toggle switch for adjusting the mirror glass position. Vehicles fitted with front seats that include a position memory function also include position memory of the exterior rearview mirrors. This provides the ability for the driver's seat and the rearview mirror positions to be stored for several different drivers and recalled at the press of the remote key or memory button on the side of the drivers seat. Also on these vehicles, when reverse gear is selected the passenger side mirror automatically dips to aid parking manoeuvres. On some vehicles the exterior rearview mirrors also incorporate a heating element within the mirror glass. When the rear window demister is operational, the mirror heating element also operates.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Systems | Mirrors | Special Tools and Equipment | **Document ID: 2006387**

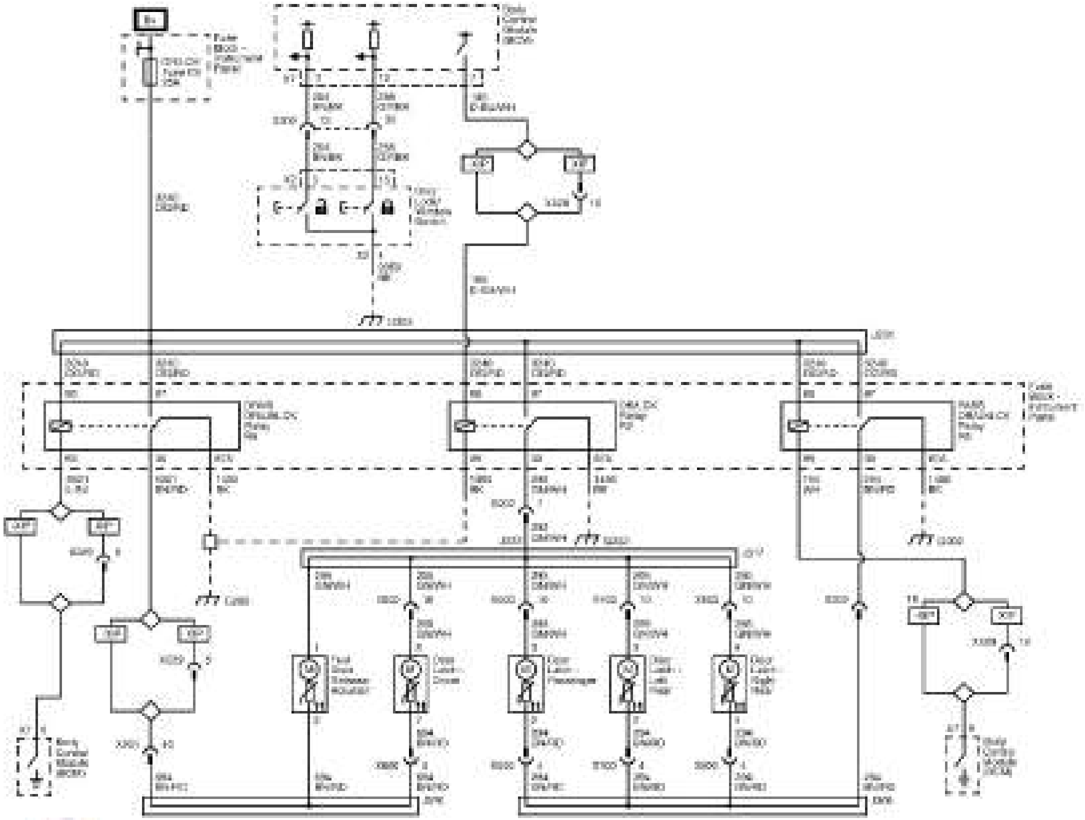
Special Tools

Illustration	Tool Number / Description
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

Fastener Tightening Specifications

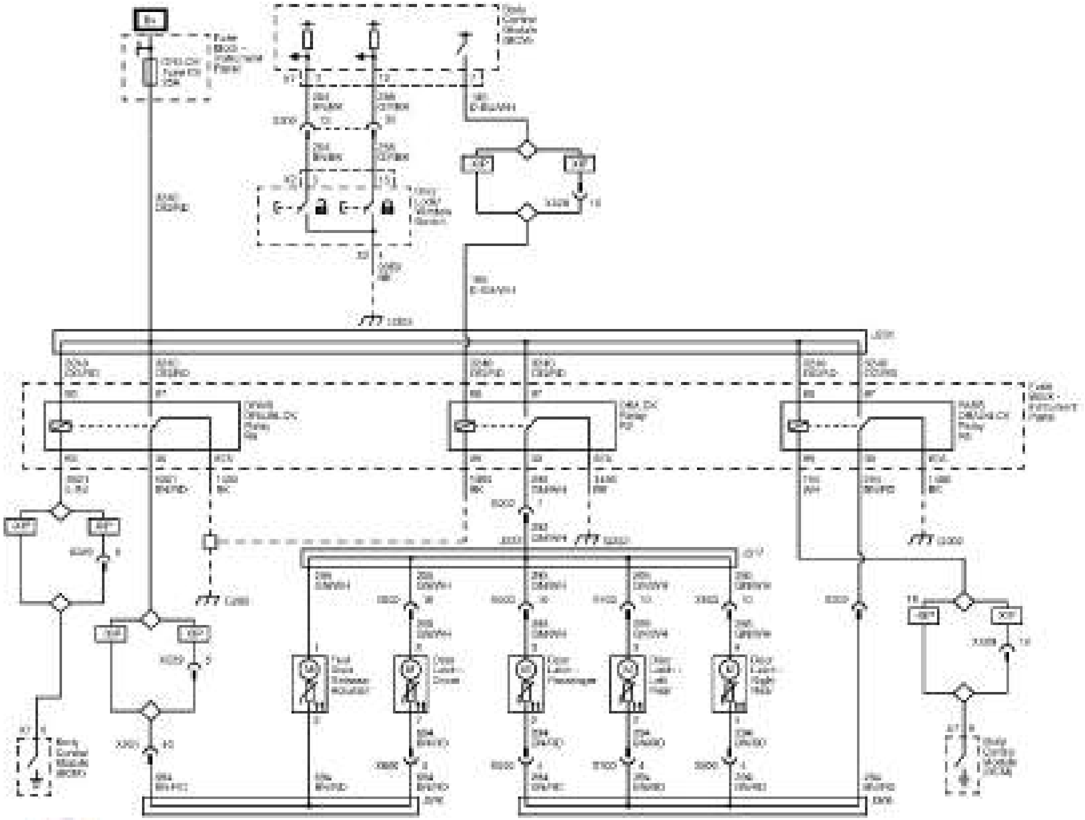
Application	Specification	
	Metric	English
Door Latch to Door Retaining Screws	13 N·m	115 lb in
Door Striker to Pillar Retaining Screws	13 N·m	115 lb in
Fuel Filler Door Release Actuator to Upper Fuel Filler Neck Retaining Screws	2 N·m	18 lb in
Inside Door Handle to Door Trim Panel Retaining Screws	3 N·m	27 lb in
Liftgate Latch Striker to Body Retaining Bolts (Sportwagon)	20 N·m	15 lb ft
Liftgate Latch to Liftgate Retaining Bolts (Sportwagon)	10 N·m	89 lb in
Lock Cylinder to Outside Door Handle Retaining Bolt	4 N·m	35 lb in
Outside Door Handle to Door Retaining Bolt	4 N·m	35 lb in
Outside Door Handle to Door Retaining Nut	4 N·m	35 lb in
Rear Compartment Lid Latch Striker to Rear Compartment Lid Retaining Torx Screw	25 N·m	18 lb ft
Rear Compartment Lid Release Cable to Rear Seat Back Panel Retaining Screw	2 N·m	18 lb in

Door Lock Controls (RHD)



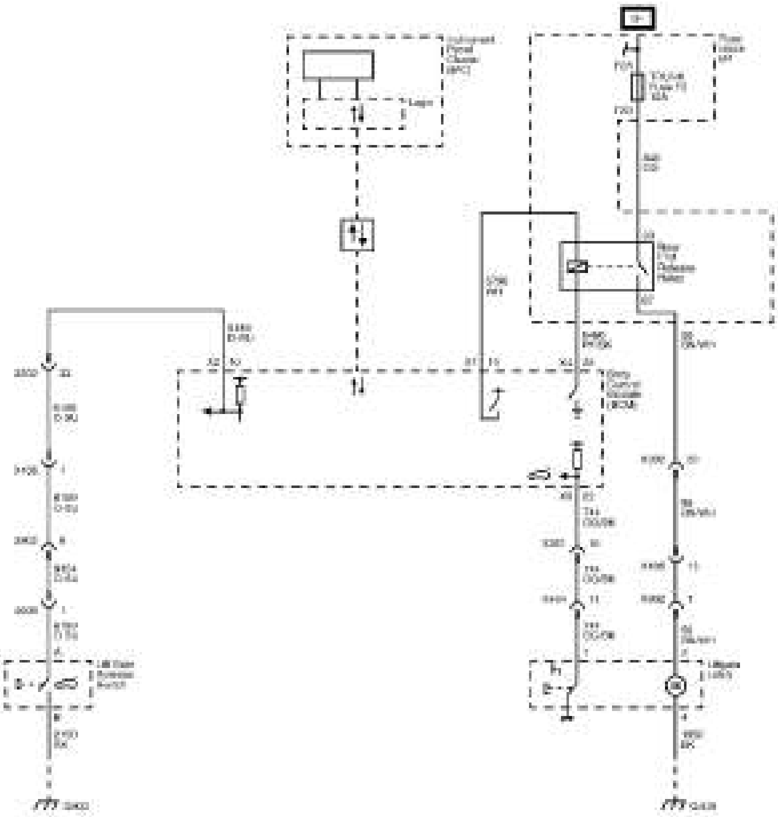
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Systems | Vehicle Access | Schematic and Routing Diagrams | **Document ID: 2153423**

Door Ajar Signals (RHD)

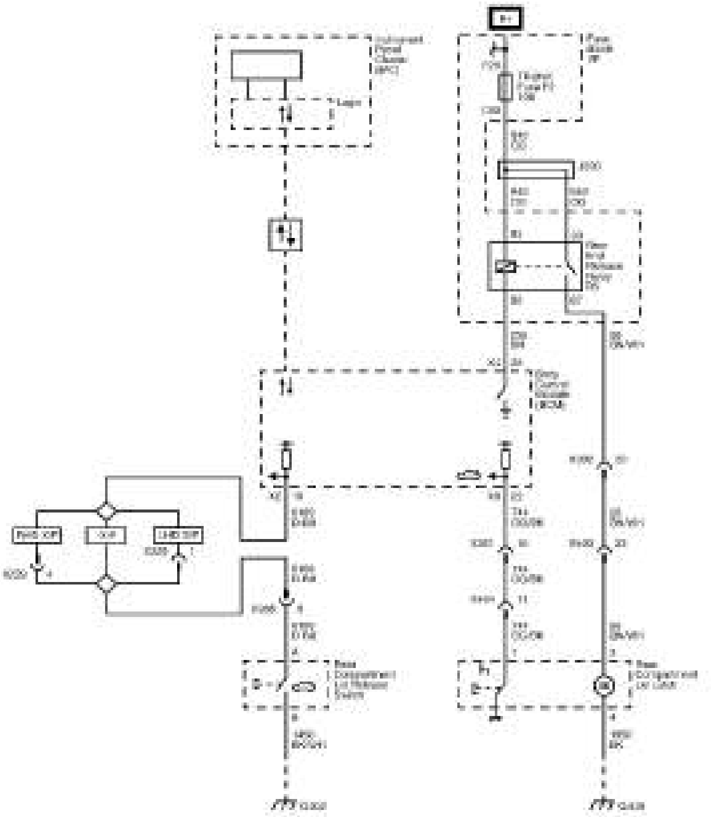


2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Systems | Vehicle Access | Schematic and Routing Diagrams | **Document ID: 2153424**

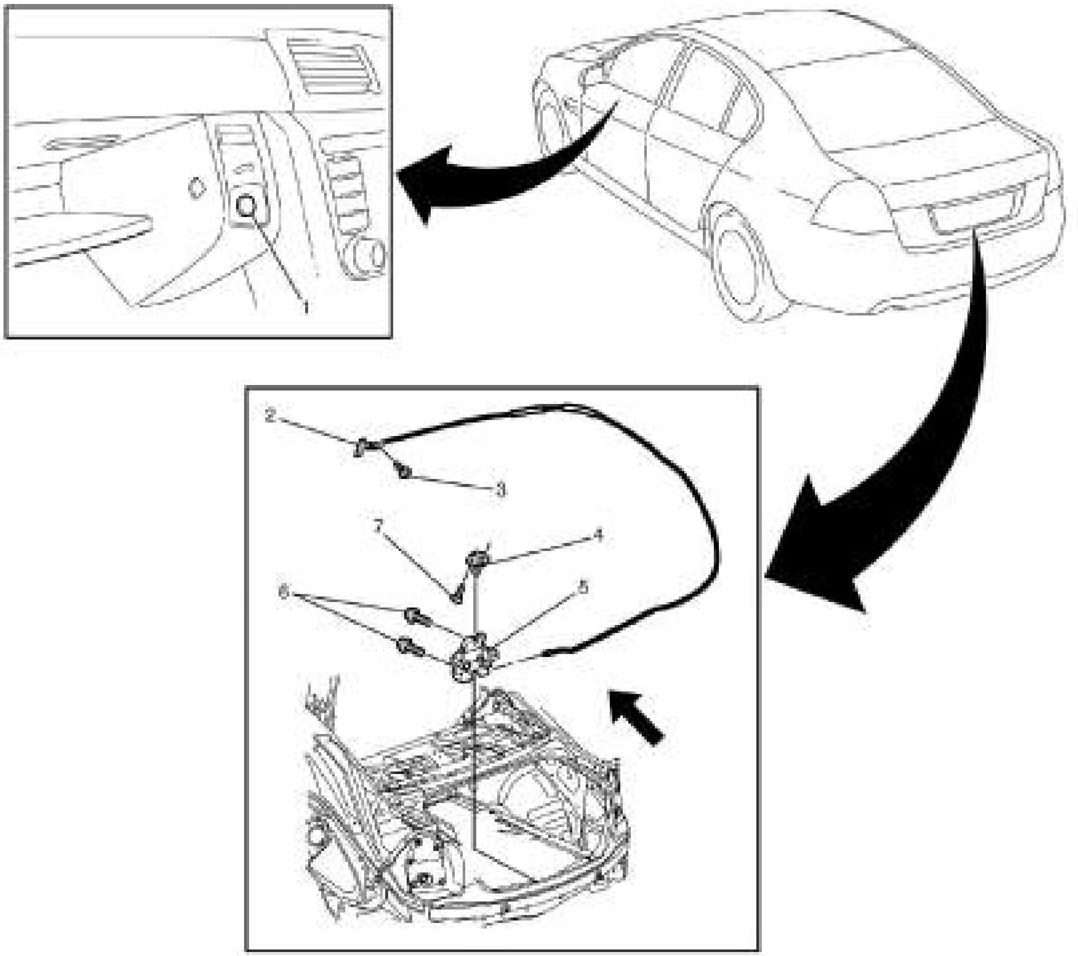
Liftgate Release


Instrument Panel Cluster (IPC)
Body Control Module (BCM)
Liftgate Latch

Rear Compartment Lid Release

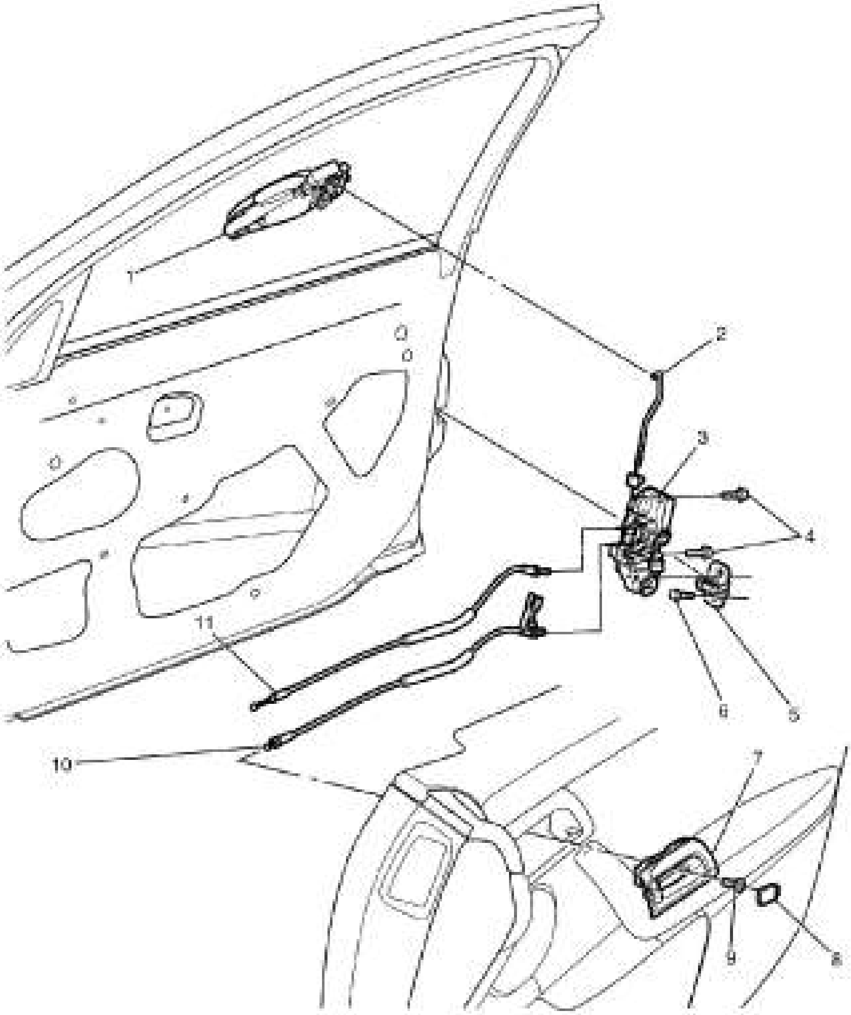

B+
Fuse Block IP
Instrument Panel Cluster (IPC)
Body Control Module (BCM)
RHD O/P
LHD O/P
Rear Compartment Lid Release Switch
Rear Compartment Lid Latch

Body Rear End Components



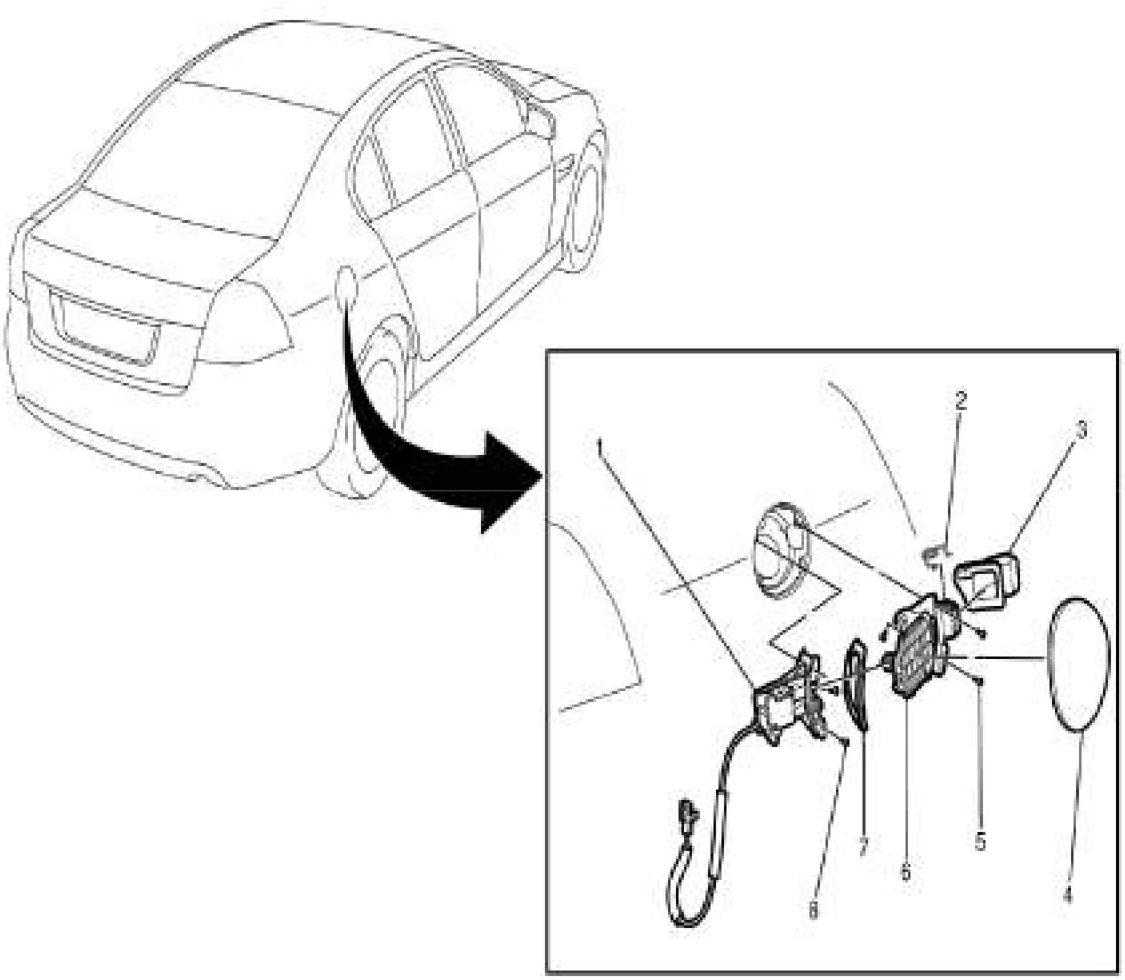
(1) Rear Compartment Lid Release Switch
(2) Rear Compartment Lid Release Cable
(3) Rear Compartment Lid Release Cable to Seat Back Retaining Screw
(4) Rear Compartment Lid Latch Striker
(5) Rear Compartment Lid Lock Actuator
(6) Rear Compartment Retaining Plate
(7) Rear Compartment Retaining Plate Captive Nuts
(8) Rear Compartment Lid Lock Actuator to Rear Compartment Retaining Bolts
(9) Rear Compartment Lid Latch Striker to Rear Compartment Lid Retaining Screw

Front Door Component Views



(1) Front Outside Door Handle
(2) Front Outside Door Handle Rod
(3) Front Door Latch
(4) Door Latch to Door Retaining Screws
(5) Door Striker
(6) Door Striker to Pillar Retaining Screw
(7) Front Inside Door Handle
(8) Front Inside Door Handle to Front Door Retaining Screw Cover
(9) Front Inside Door Handle to Front Door Retaining Screw
(10) Front Door Lock Cable
(11) Front Door Handle Cable

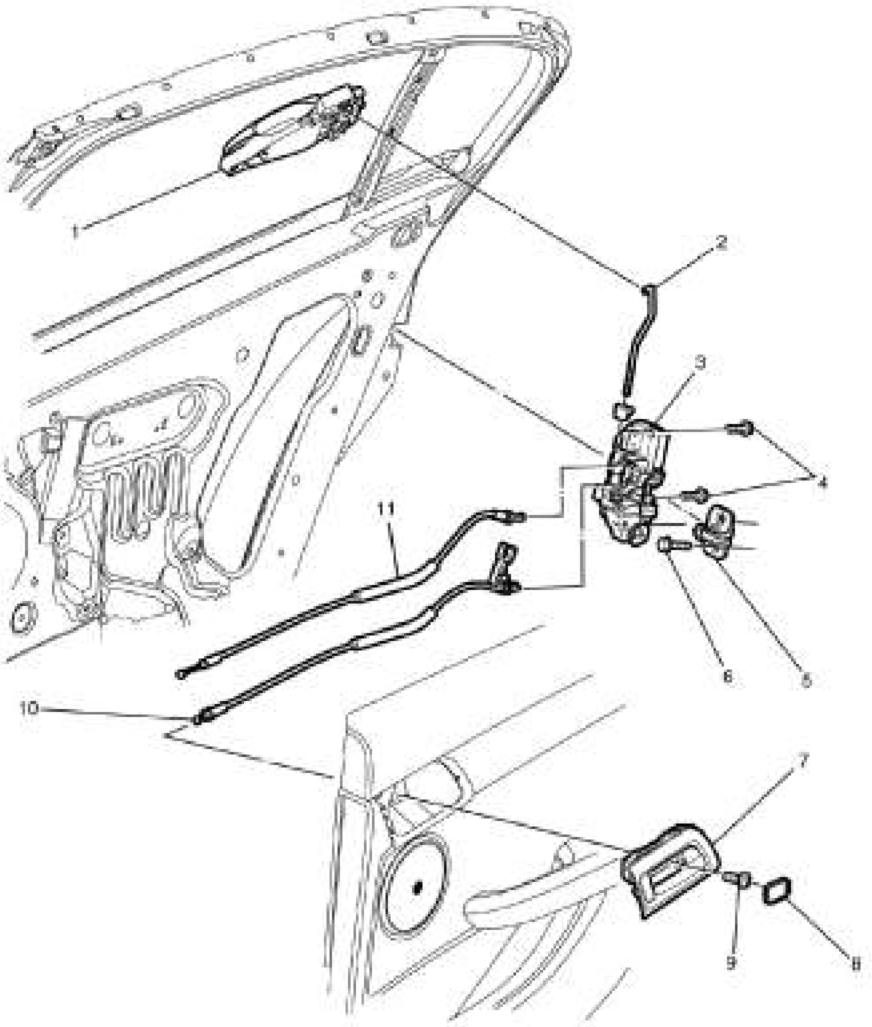
Fuel Tank Filler Door Component Views



(1) Fuel Door Release Actuator
(2) Fuel Tank Filler Door Hinge Spring
(3) Fuel Tank Filler Door Hinge
(4) Fuel Tank Filler Door Panel
(5) Fuel Tank Filler Door and Hinge to Rear Quarter Panel Retaining Screws
(6) Fuel Tank Filler Door
(7) Fuel Tank Filler Door Lock Actuator Foam Gasket
(8) Fuel Tank Filler Door Lock Actuator to Rear Quarter Panel Retaining Screws

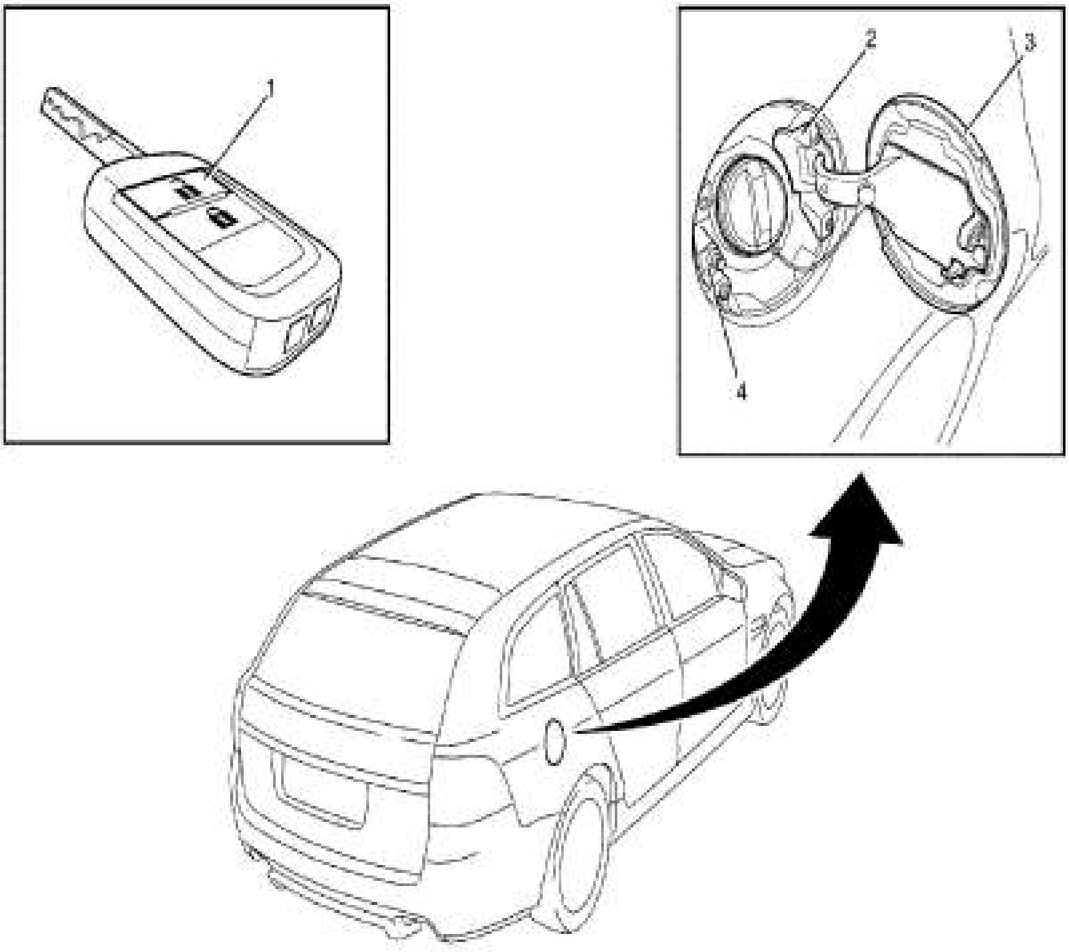
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Systems | Vehicle Access | Component Locator | **Document ID: 2007889**

Rear Door Component Views

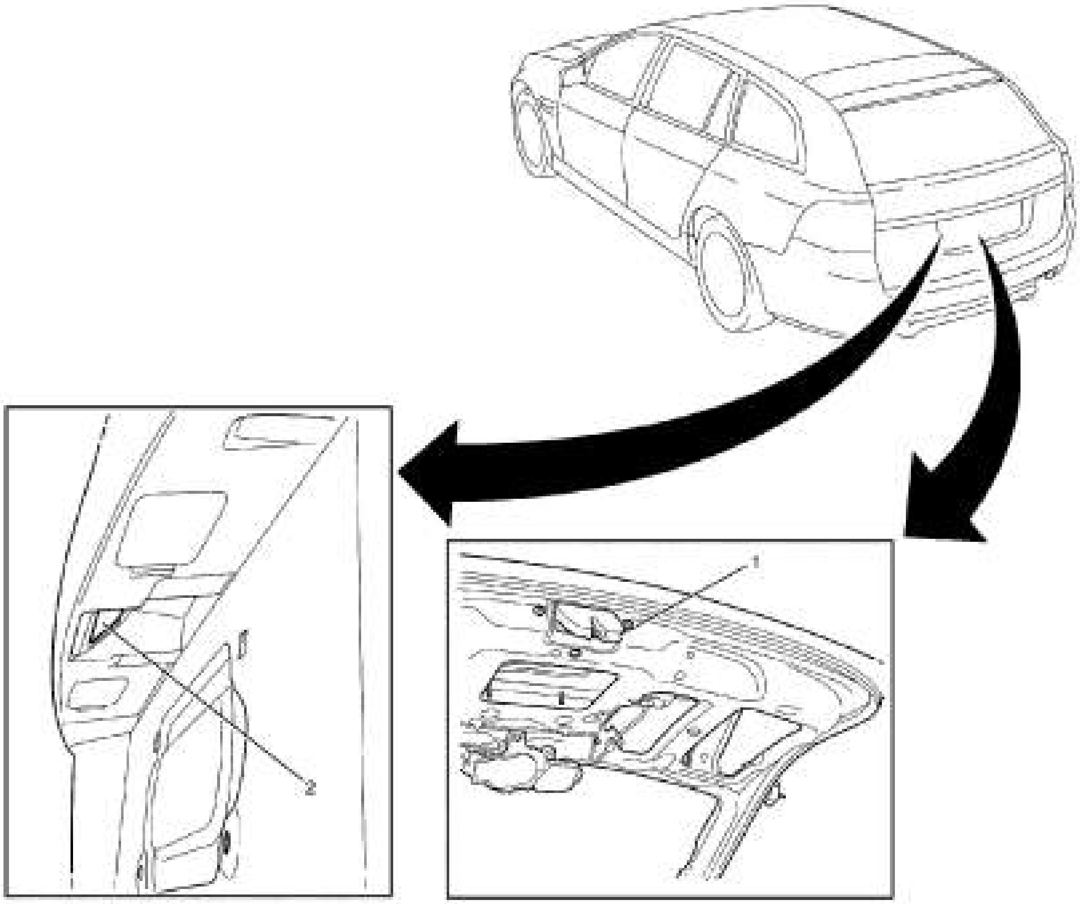


(1) Rear Outside Door Handle
(2) Rear Outside Door Handle Rod
(3) Rear Door Latch
(4) Door Latch to Door Retaining Screws
(5) Door Striker
(6) Door Striker to Pillar Retaining Screw
(7) Rear Inside Door Handle
(8) Rear Inside Door Handle to Rear Door Retaining Screw Cover
(9) Rear Inside Door Handle to Rear Door Retaining Screw
(10) Rear Window Switch
(11) Rear Door Lock Cable

(12) Rear Door Handle Cable



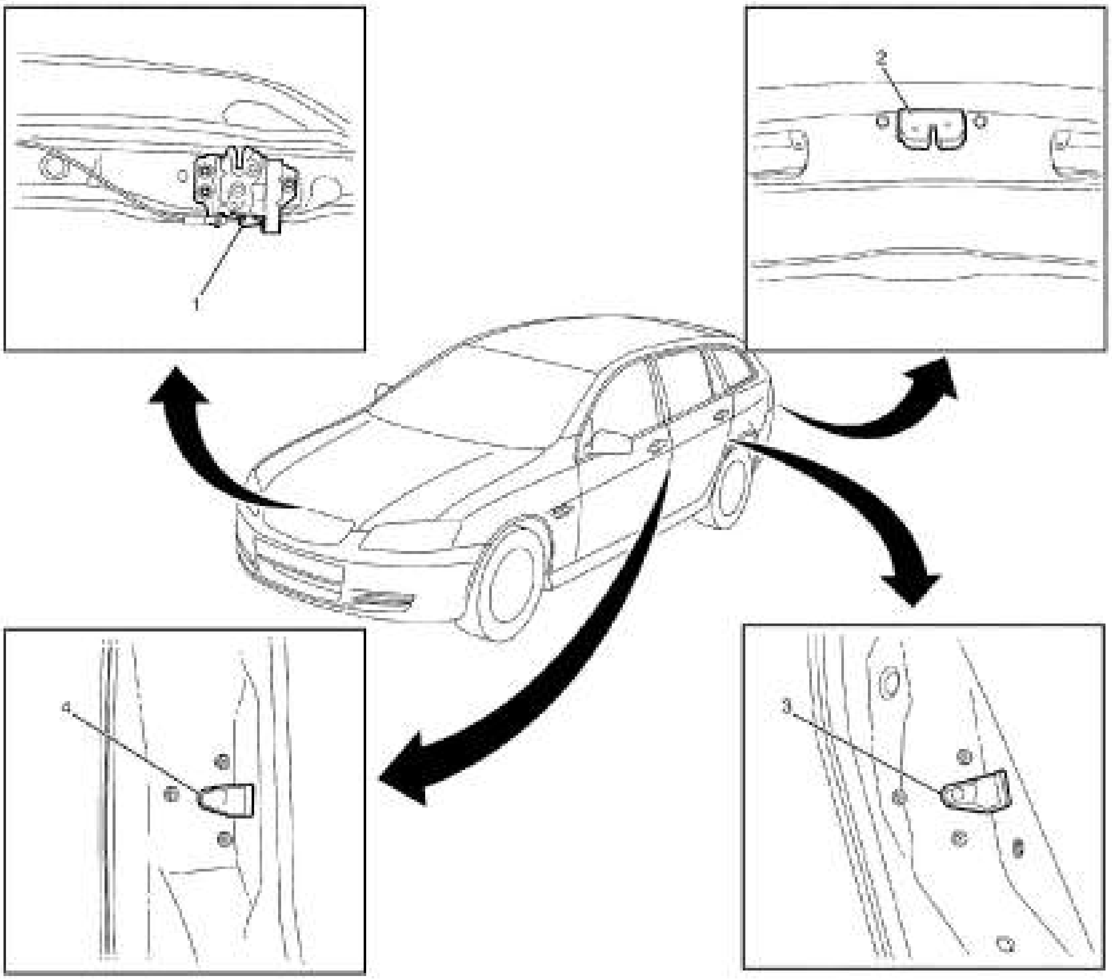
(1) Key Fob Door Release Button
(2) Fuel Filler Door Hinge
(3) Fuel Filler Door
(4) Fuel Filler Door



(1) Liftgate Release Switch
(2) Liftgate Release Actuator
(3) Liftgate Release Button

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Systems | Vehicle Access | Component Locator | **Document ID: 2100375**

Hood Latch Assembly, Liftgate Latch Assembly, Front Door Latch Assembly and Rear Door Latch Assembly



(1) Hood Latch Assembly
(2) Liftgate Latch Assembly
(3) Rear Door Latch Assembly
(4) Front Door Latch Assembly

Diagnostic Starting Point - Vehicle Access

Begin the system diagnosis with the Diagnostic System Check - Vehicle. The Diagnostic System Check will provide the following information:

- The identification of the control modules which command the system
- The ability of the control module to communicate through the serial data circuit
- The identification of any stored DTCs and their status

The use of the Diagnostic System Check will identify the correct procedure for diagnosing the system and where the procedure is located.

DTC B2730 (Sedan)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B2730 00: Interior Trunk/Liftglass/Hatch Release Switch Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Trunk Relay B+	1	1	--	--
Trunk Release Switch Signal	B2730 00	2	2	--
Rear Compartment Lid Latch Control	1	1	1	--
Trunk Release Relay Control	B3265 00	B3265 00	B3265 00	--
Rear Compartment Lid Latch Ground	--	1	1	--
Rear Compartment Lid Release Switch Ground	--	2	2	--
1. Trunk release is inoperative from both the switch and keyless entry transmitter 2. Trunk release is inoperative only from switch				

Circuit/System Description

When the ignition is ON, the body control module (BCM) supplies a signal to the rear compartment lid release switch through the trunk release switch signal circuit. When the rear compartment lid release switch is pressed, the voltage within the signal circuit is pulled low and in response, the BCM applies ground to the trunk release relay control circuit, which energizes the coil side of the trunk relay. The switch side of the trunk relay then closes, supplying battery positive voltage through the relay and the latch motor voltage control circuit to the rear compartment lid latch. The rear compartment lid latch, then releases the rear compartment lid so that it may be manually raised to an open position.

Conditions for Running the DTC

The system voltage is 9-16 volts.

Conditions for Setting the DTC

- The BCM detects a short to ground in the trunk release switch signal circuit for greater than 10 minutes.
- The rear compartment lid release switch is closed for greater than 10 minutes.

Action Taken When the DTC Sets

The rear compartment lid release switch will be inoperative.

Conditions for Clearing the DTC

- The DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will become a history DTC.
- A history DTC will clear after 50 ignition cycles

Reference Information

Schematic Reference

Release Systems Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Luggage Compartment Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Trunk Switch parameter while pressing the rear compartment lid release switch button. The parameter should change between Active and Inactive.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the rear compartment lid release switch.
2. Test for less than 1 ohm between the ground circuit terminal B and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Trunk Switch parameter is Inactive.

   If not the specified value, test the signal circuit terminal A for a short to ground. If the circuit tests normal, replace the BCM.
4. Install a 3A fused jumper wire between the signal circuit terminal A and the ground circuit terminal B. Verify the scan tool Trunk Switch parameter is Active.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the rear compartment lid release switch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the rear compartment lid release switch.
2. Test for infinite resistance between the signal terminal A and the ground terminal B with the switch in the open position.

   If not the specified value, replace the rear compartment lid release switch
3. Test for less than 2 ohms of between the signal terminal A and the ground terminal B with the switch in the closed position.

   If greater than the specified range, replace the rear compartment lid release switch.
4. Test for infinite resistance between each terminal and the lid release switch housing/case.

   If not the specified value, replace the rear compartment lid release switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Rear Compartment Lid Release Switch Replacement
- Control Module References for BCM replacement, setup and programming

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Systems | Vehicle Access | Diagnostic Information and Procedures | **Document ID: 2159030**

DTC B2730 (Wagon)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B2730 00: Interior Trunk/Liftglass/Hatch Release Switch Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Rear End Release Relay Switch B+	2	2	--	--
Liftgate Release Switch Signal	B2730 00	1	1	--
Rear End Release Relay Coil Control	--	2	2	--
Rear End Release Relay Coil Control	B3265 00	2	2	--
Liftgate Latch Control	--	2	2	--
Liftgate Latch Ground	--	2	2	--
Liftgate Release Switch Ground	--	1	1	--
1. Liftgate Release Switch Malfunction 2. Liftgate Release Malfunction				

Circuit/System Description

When the ignition is ON, the body control module (BCM) supplies a signal to the liftgate release switch through the liftgate release switch signal circuit. When the liftgate release switch is pressed, the voltage within the signal circuit is pulled low and in response, the BCM applies ground to one end of the relay control circuit and power to the other end, which energizes the coil side of the relay. The switch side of the rear end relay then closes, supplying battery positive voltage through the relay and the latch motor voltage control circuit to the liftgate latch. The liftgate latch, then releases the liftgate so that it may be manually raised to an open position.

Conditions for Running the DTC

The system voltage is 9-16 volts.

Conditions for Setting the DTC

- The BCM detects a short to ground in the liftgate release switch signal circuit for greater than 10 minutes.
- The liftgate release switch is closed for greater than 10 minutes.

Action Taken When the DTC Sets

The liftgate release switch will be inoperative.

Conditions for Clearing the DTC

- The DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will become a history DTC.
- A history DTC will clear after 50 ignition cycles

Reference Information

Schematic Reference

Release Systems Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Rear Hatch/Gate Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Trunk Switch parameter while pressing the liftgate release switch. The parameter should change between Active and Inactive.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the liftgate release switch.
2. Test for less than 1 ohm between the ground circuit terminal B and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Trunk Switch parameter is Inactive.

   If not the specified value, test the signal circuit terminal A for a short to ground. If the circuit tests normal, replace the BCM.
4. Install a 3A fused jumper wire between the signal circuit terminal A and the ground circuit terminal B. Verify the scan tool Trunk Switch parameter is Active.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the liftgate release switch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the liftgate release switch.
2. Test for infinite resistance between the signal terminal A and the ground terminal B with the switch in the open position.

   If not the specified value, replace the liftgate release switch
3. Test for less than 2 ohms between the signal terminal A and the ground terminal B with the switch in the closed position.

   If greater than the specified range, replace the liftgate release switch.
4. Test for infinite resistance between each terminal and the lid release switch housing/case.

   If not the specified value, replace the liftgate release switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for BCM replacement, setup, and programming

DTC B2976

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B2976 00: Driver Door Ajar Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Door Ajar Signal	B2976 00	1	1	--
Passenger Door Ajar Signal	B2991 00	1	1	--
Driver Door Latch Ground	--	1	1	--
Left Rear Door Latch Ground	--	1	1	--
Passenger Door Latch Ground	--	1	1	--
Right Rear Door Latch Ground	--	1	1	--
1. Door Ajar Indicator Malfunction				

Circuit/System Description

The body control module (BCM) receives a discrete input from ajar switches within driver and passenger door latches. The BCM then communicates this status to the instrument panel cluster (IPC) via a serial data message. The IPC, upon receipt of this serial data message, will illuminate the ajar icon in the driver information center (DIC) and also send a serial data massage to the radio to activate the door ajar audible warning when the engine has been started and the gear selector is moved from the P (park) position.

The door ajar switches supply a ground to the BCM when the door is open. Once the door is closed the door ajar switch opens removing the ground to the BCM. The BCM sends a signal to the IPC to illuminate the door ajar indicator when a door is open.

Conditions for Running the DTC

The system voltage is 9-16 volts.

Conditions for Setting the DTC

The BCM detects a short to ground in the driver door ajar circuit for greater than 10 minutes.

Action Taken When the DTC Sets

The door ajar indicator is on at all times.

Conditions for Clearing the DTC

- The DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will become a history DTC.
- A history DTC will clear after 50 ignition cycles.

Reference Information

Schematic Reference

Interior Lights Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Door Ajar Indicator Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Driver Door Ajar Switch parameter while opening and closing the driver door. The parameter should change between Door Closed and Door Ajar.

Circuit/System Testing

1. Ignition OFF, disconnect harness connector at the driver door latch.
2. Ignition ON, verify the scan tool Driver Door Ajar Switch parameter is Door Closed.

   If not the specified value, test the signal circuit terminal 6 for a short to ground. If the circuit tests normal, replace the BCM.
3. If all circuit tests normal, test or replace the driver door latch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the driver door latch.
2. With the switch in the open position, test for infinite resistance between the signal terminal 6 and the ground terminal 8.

   If not the specified value, replace the driver door latch.
3. With the switch in the closed position, test for less than 2 ohms between the signal terminal 6 and the ground terminal 8.

   If not the specified value, replace the driver door latch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Front Side Door Latch Replacement
- Control Module References for BCM replacement, setup, and programming

DTC B2991

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B2991 00: Passenger Door Ajar Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Door Ajar Signal	B2976 00	1	1	--
Passenger Door Ajar Signal	B2991 00	1	1	--
Driver Door Latch Ground	--	1	1	--
Left Rear Door Latch Ground	--	1	1	--
Passenger Door Latch Ground	--	1	1	--
Right Rear Door Latch Ground	--	1	1	--
1. Door Ajar Indicator Malfunction				

Circuit/System Description

The body control module (BCM) receives a discrete input from ajar switches within driver and passenger door latches. The BCM then communicates this status to the instrument panel cluster (IPC) via a serial data message. The IPC, upon receipt of this serial data message, will illuminate the ajar icon in the driver information center (DIC) and also send a serial data massage to the radio to activate the door ajar audible warning when the engine has been started and the gear selector is moved from the P (park) position.

The door ajar switches supply a ground to the BCM when the door is open. Once the door is closed the door ajar switch opens removing the ground to the BCM. The BCM sends a signal to the IPC to illuminate the door ajar indicator when a door is open.

Conditions for Running the DTC

The system voltage is 9-16 volts.

Conditions for Setting the DTC

The BCM detects a short to ground in a passenger door ajar circuit for greater than 10 minutes.

Action Taken When the DTC Sets

The door ajar indicator is on at all times.

Conditions for Clearing the DTC

- The DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will become a history DTC.
- A history DTC will clear after 50 ignition cycles.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Door Ajar Indicator Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, with all doors closed, observe the scan tool Passenger Door Ajar Switch. parameter while opening and closing the passenger and rear doors. The parameter should change between Door Closed and Door Ajar.

Circuit / System Testing

1. Ignition OFF, disconnect harness connector at the appropriate passenger or rear door latch.
2. Ignition ON, verify the scan tool Passenger Door Ajar Switch parameter is Door Closed.

   If not the specified value, test the signal circuit terminal listed below for a short to ground. If the circuit tests normal, replace the BCM.

   - Passenger door latch signal circuit terminal 1
   - Left rear door latch signal circuit terminal 4
   - Right rear door latch signal circuit terminal 1
3. If all circuit tests normal, test or replace the door latch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the appropriate door latch.
2. With the switch in the open position, test for infinite resistance between the signal terminal and the ground terminal listed below:
   - Passenger door latch signal terminal 1 and ground terminal 3
   - Right rear door latch signal terminal 1 and ground terminal 3
   - Left rear door latch signal terminal 4 and ground terminal 6

   If not the specified value, replace the door latch.
3. With the switch in the closed position, test for less than 2 ohms between the signal and the ground terminals listed below:
   - Passenger door latch signal terminal 1 and ground terminal 3
   - Right rear door latch signal terminal 1 and ground terminal 3
   - Left rear door latch signal terminal 4 and ground terminal 6

   If not the specified value, replace the door latch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Front Side Door Latch Replacement
- Rear Side Door Latch Replacement
- Control Module References for BCM replacement, setup and programming

DTC B3125, B3130, or B3135

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC B3125 00: Left Front/Driver Door Only Unlock Circuit

DTC B3130 00: All Door Unlock Circuit

DTC B3135 00: All Door Lock Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
I/P Fuse Block B+	1	1	--	--
Door Lock Switch Lock Signal	B3150 00	2	2	--
Door Lock Switch Unlock Signal	B3140 00	2	2	--
All Lock Relay Control	B3135 00	B3135 00	1	--
Door Latch Assembly Control	1	1	1	--
Driver Unlock Relay Control	B3125 00	B3125 00	B3125 00	--
Passenger Unlock Relay Control	B3130 00	B3130 00	B3130 00	--
Window/Door Lock Switch Ground	--	2	2	--
Relay Ground	--	1	1	--
1. Door Lock Malfunction 2. Door Lock Switch Malfunction				

Circuit/System Description

The body control module (BCM) controls the door lock, passenger door unlock and driver door unlock relays. Voltage is applied to the appropriate relay through the door lock/unlock control circuit when the BCM detects a door lock/unlock switch activation or a keyless entry lock or unlock command.

Conditions for Running the DTC

The system voltage is 9-16 volts.

Conditions for Setting the DTC

B3125 00

The BCM detects a fault on the DRIVER UNLOCK relay control circuit.

B3130 00

The BCM detects a fault on the PASS UNLOCK relay control circuit.

B3135 00

The BCM detects a fault on the ALL LOCK relay control circuit.

Action Taken When the DTC Sets

The power door locks will malfunction.

Conditions for Clearing the DTC

- The DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will become a history DTC.
- A history DTC will clear after 50 ignition cycles.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Door Locks Description and Operation

Electrical Information Reference

- Circuit Testing

- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, command the All Doors Unlock/Lock with the scan tool, all doors should perform the LOCK and UNLOCK function.

If B3125 00 is set, refer to DRIVER UNLOCK Relay Control Malfunction.

If B3130 00 is set, refer to PASS UNLOCK Relay Control Malfunction.

If B3135 00 is set, refer to ALL LOCK Relay Control Malfunction.

Circuit/System Testing

DRIVER UNLOCK Relay Control Malfunction

1. Ignition OFF, disconnect the DRIVER UNLOCK relay.
2. Connect a test lamp between the control circuit terminal 85 and the B+ circuit terminal 86.
3. Ignition ON, command the Driver Door Unlock with a scan tool. The test lamp should briefly illuminate when commanding the UNLOCK state.

   If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.

   If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.
4. If all circuits test normal, test or replace the DRIVER UNLOCK relay.

PASS UNLOCK Relay Control Malfunction

1. Ignition OFF, disconnect the PASS UNLOCK relay.
2. Connect a test lamp between the control circuit terminal 85 and the B+ circuit terminal 86.
3. Ignition ON, command the All Doors Unlock with a scan tool. The test lamp should briefly illuminate when commanding the UNLOCK state.

   If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.

   If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.
4. If all circuits test normal, test or replace the PASS UNLOCK relay.

ALL LOCK Relay Control Malfunction

1. Ignition OFF, disconnect the ALL LOCK relay.
2. Connect a test lamp between the control circuit terminal 85 and the ground circuit terminal 86.

3. Ignition ON, command the All Doors Lock with a scan tool. The test lamp should briefly illuminate when commanding the LOCK state.

   If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.

   If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.
4. If all circuits test normal, test or replace the ALL LOCK relay.

Component Testing

1. Ignition OFF, disconnect the appropriate relay.
2. Test for 60-200 Ω between terminals 85 and 86.

   If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If less than the specified value, replace the relay.
4. Test for less than 2 Ω between terminals 30 and 87A.

   If greater than the specified range, replace the relay.
5. Install a 3A fused jumper wire between relay terminal 85 and 12V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 Ω between terminals 30 and 87.

   If greater than specified range, replace the relay

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Relay Replacement
- Control Module References for BCM replacement, setup, and programming

DTC B3140 or B3150

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC B3140 00: Driver Unlock Switch Circuit

DTC B3150 00: Driver Lock Switch Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
I/P Fuse Block B+	1	1	--	--
Door Lock Switch Lock Signal	B3150 00	2	2	--
Door Lock Switch Unlock Signal	B3140 00	2	2	--
All Lock Relay Control	B3135 00	B3135 00	1	--
Door Latch Assembly Control	1	1	1	--
Driver Unlock Relay Control	B3125 00	B3125 00	B3125 00	--
Passenger Unlock Relay Control	B3130 00	B3130 00	B3130 00	--
Window/Door Lock Switch Ground	--	2	2	--
Relay Ground	--	1	1	--
1. Door Lock Malfunction 2. Door Lock Switch Malfunction				

Circuit/System Description

The body control module (BCM) supplies and monitors a reference voltage to the door lock/window switch through the door lock switch lock and unlock signal circuits. The door lock/window switch also receives a constant ground source. If a door lock switch is placed in the lock position or unlock position, the reference voltage is taken directly to ground and the BCM detects the voltage drop on the signal circuit.

Conditions for Running the DTC

The system voltage is 9-16 volts.

Conditions for Setting the DTC

B3140 00

The BCM detects a short to ground in the unlock switch signal circuit.

B3150 00

The BCM detects a short to ground in the lock switch signal circuit

Action Taken When the DTC Sets

The power door lock switch will malfunction.

Conditions for Clearing the DTC

- The DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will become a history DTC.
- A history DTC will clear after 50 ignition cycles.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Door Locks Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Central Door Lock Switch and Central Door Unlock Switch parameters while using the door lock/window switch. The parameter should change between Inactive and Active when changing between the commanded states.

Circuit/System Testing

1. Ignition OFF, disconnect the X2 harness connector at the door lock/window switch.
2. Test for less than 20 Ω between the ground circuit terminal 4 and ground.
   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Central Door Lock Switch parameter is Inactive.
   If not the specified value, test the signal circuit terminal 15 for a short to ground. If the circuit tests normal, replace the BCM.
4. Verify the scan tool Central Door Unlock Switch parameter is Inactive.
   If not the specified value, test the signal circuit terminal 5 for a short to ground. If the circuit tests normal, replace the BCM.
5. Install a 3A fused jumper wire between the signal circuit terminal 15 and ground. Verify the scan tool Central Door Lock Switch parameter is Active.
   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
6. Install a 3A fused jumper wire between the signal circuit terminal 5 and ground. Verify the scan tool Central Door Unlock Switch parameter is Active.
   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
7. If all circuits test normal, test or replace the door lock/window switch.

Component Testing

1. Ignition OFF, disconnect the X2 harness connector at the door lock window/switch.
2. Test for infinite resistance between the signal terminals 5 and 15 and the ground terminal 4 with the switch in the open position.
   If less than the specified value, replace the door lock/window switch.
3. Test for less than 2 Ω between the signal terminal 15 and the ground terminal 4 with the switch in the lock position.
   If greater than the specified range, replace the door lock/window switch.
4. Test for less than 2 Ω between the signal terminal 5 and the ground terminal 4 with the switch in the unlock position.
   If greater than the specified range, replace the door lock/window switch

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Power Mirror Switch Replacement
- Control Module References for BCM replacement, setup and programming

DTC B3265 (Sedan)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B3265 00: Trunk/Hatch/Liftglass Release Output Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Trunk Relay B+	1	1	--	--
Trunk Release Switch Signal	B2730 00	2	2	--
Rear Compartment Lid Latch Control	1	1	1	--
Trunk Release Relay Control	B3265 00	B3265 00	B3265 00	--
Rear Compartment Lid Latch Ground	--	1	1	--
Rear Compartment Lid Release Switch Ground	--	2	2	--
1. Trunk release is inoperative from both the switch and keyless entry transmitter 2. Trunk release is inoperative only from switch				

Circuit/System Description

The body control module (BCM) provides a low side drive output that controls the trunk relay. The BCM monitors the voltage level on the trunk release relay control circuit to determine when a failure has occurred. The voltage level on this circuit should be high while the trunk relay is not energized, that is the trunk release feature has not been activated. Voltage will be less than 1V when the relay is energized. When the BCM receives a trunk release signal from a switch or keyless entry transmitter, it responds by applying ground to the trunk release relay control circuit, which energizes the trunk relay.

Conditions for Running the DTC

The system voltage is 9-16 volts.

Conditions for Setting the DTC

The BCM detects a fault in the trunk release relay control circuit when the output is active.

Action Taken When the DTC Sets

The rear compartment lid latch will malfunction.

Conditions for Clearing the DTC

- The DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will become a history DTC.
- A history DTC will clear after 50 ignition cycles.

Reference Information

Schematic Reference

Release Systems Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Luggage Compartment Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Command the Trunk Release Test with a scan tool. The rear compartment lid release actuator should release the trunk lid.

Circuit/System Testing

1. Ignition OFF, disconnect the TRUNK RELEASE relay.

2. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 85 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse is open, test the control circuit terminal 87 for a short to ground. If the circuit tests normal, test or replace the TRUNK RELEASE relay.
3. Connect a test lamp between the control circuit terminal 86 and the B+ circuit terminal 85.
4. Command the Trunk Release Test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the TRUNK RELEASE relay.

Component Testing

1. Ignition OFF, disconnect the TRUNK RELEASE relay.
2. Test for 60-180 Ω between terminals 85 and 86.

   If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If less than the specified value, replace the relay.
4. Install a 25A fused jumper wire between relay terminal 85 and 12V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 Ω between terminals 30 and 87.

   If greater than the specified range, replace the relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Relay Replacement
- Control Module References for BCM replacement, setup and programming

DTC B3265 (Wagon)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B3265 00: Turn/Hatch/Liftglass Release Output Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Rear End Release Relay Switch B+	2	2	--	--
Liftgate Release Switch Signal	B2730 00	1	1	--
Rear End Release Relay Coil Control	--	2	2	--
Rear End Release Relay Coil Control	B3265 00	2	2	--
Liftgate Latch Control	--	2	2	--
Liftgate Latch Ground	--	2	2	--
Liftgate Release Switch Ground	--	1	1	--
1. Liftgate Release Switch Malfunction 2. Liftgate Release Malfunction				

Circuit/System Description

The body control module (BCM) provides voltage to the liftgate release relay control circuit thus energizing the Rear End Release relay which provides voltage to the liftgate latch assembly releasing the liftgate.

Conditions for Running the DTC

The system voltage is 9-16 volts.

Conditions for Setting the DTC

The BCM detects short to voltage in the liftgate latch relay coil control ground circuit.

Action Taken When the DTC Sets

The liftgate latch will malfunction.

Conditions for Clearing the DTC

- The DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will be a history DTC.
- A history DTC will clear after 50 ignition cycles.

Reference Information

Schematic Reference

Release Systems Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Rear Hatch/Gate Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Command the liftgate latch to release by pressing the liftgate release switch. The liftgate latch should release the liftgate.

Circuit/System Testing

1. Ignition OFF, disconnect the Rear End Release relay.
2. Connect a test lamp between the control circuit terminal 86 and B+.
3. Command the liftgate latch assembly by pressing and releasing the liftgate release switch.

The test lamp should turn ON and OFF when changing between the commanded states.

If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.

If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

4. If all circuits test normal, test or replace the Rear End Release relay.

Component Testing

1. Ignition OFF, disconnect the Rear End Release relay.
2. Test for 60-200 ohms between terminals 85 and 86.

   If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If less than the specified range, replace the Rear End Release relay.
4. Install a 3A fused jumper wire between the relay terminal 85 and 12V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.

   If greater than the specified range, replace the Rear End Release relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Relay Replacement
- Control Module References for BCM replacement, setup, and programming

Liftgate Release Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Rear End Release Relay Switch B+	2	2	--	--
Liftgate Release Switch Signal	B2730 00	1	1	--
Rear End Release Relay Coil Control	--	2	2	--
Rear End Release Relay Coil Control	B3265 00	2	2	--
Liftgate Latch Control	--	2	2	--
Liftgate Latch Ground	--	2	2	--
Liftgate Release Switch Ground	--	1	1	--
1. Liftgate Release Switch Malfunction 2. Liftgate Release Malfunction				

Circuit/System Description

The liftgate switch is an input to the body control module (BCM). The BCM supplies battery voltage to the signal circuit and when the liftgate switch is activated the signal circuit voltage goes low. The BCM controls the liftgate latch assembly through the liftgate Rear End Release relay. When the liftgate switch signal is activated, the BCM enables the Rear End Release relay by applying battery voltage to the liftgate relay circuit and the relay is energized when the BCM grounds the Rear End Release relay control circuit. When the relay is energized battery voltage is supplied to the liftgate latch assembly through the liftgate latch control circuit.

Reference Information

Schematic Reference

Release Systems Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Rear Hatch/Gate Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool Trunk Switch parameter while pressing and releasing the liftgate release switch. The parameter should change between Active and Inactive.

   If the value does not change, refer to Liftgate Release Switch Malfunction.
2. Command the liftgate to release by pressing the liftgate release switch. The liftgate latch should release the liftgate.

   If the liftgate latch does not release the liftgate, refer to Liftgate Latch Malfunction.

Circuit/System Testing

Liftgate Release Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the liftgate release switch.
2. Test for less than 1.0 ohm between the ground circuit terminal B and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Trunk Switch parameter is Inactive.

   If not the specified value, test the signal circuit terminal A for a short to ground. If the circuit tests normal, replace the BCM.
4. Install a 3A fused jumper wire between the signal circuit terminal A and ground. Verify the scan tool Trunk Switch parameter is Active.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM
5. If all circuits test normal, test or replace the liftgate release switch.

Liftgate Latch Malfunction

1. Ignition OFF, disconnect the Rear End Release relay.
2. Ignition ON, verify that a test lamp does not illuminate between the control circuit

terminal 87 and ground.

If the test lamp illuminates, test the control circuit for a short to voltage.

3. Verify that a test lamp illuminates between the B+ circuit terminal 30 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse is open, test the control circuit terminal 87 for a short to ground. If the circuit tests normal, test or replace the Rear End Release relay.

4. Ignition OFF, disconnect the harness connector at the liftgate latch.
5. Test for less than 1.0 ohm between the ground circuit terminal 4 and ground

   If greater than the specified range, test the ground circuit for an open/high resistance.

6. Connect the harness connector at the liftgate latch.
7. Ignition ON, connect a 10A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87. Verify the liftgate latch is activated.

   If the liftgate latch does not activate, test the control circuit for an open/high resistance. If the circuit tests normal, test or replace the liftgate latch.

8. Connect a test lamp between the control circuit terminal 86 and ground.
9. Command the liftgate latch to release by pressing and releasing the liftgate release switch. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.

10. Connect a test lamp between the control circuit terminal 85 and B+.
11. Command the liftgate latch to release by pressing and releasing the liftgate release switch. The test lamp should turn ON and OFF when changing between the commanded states.

    If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

    If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.

12. If all circuits test normal, test or replace the Rear End Release relay.

Component Testing

Liftgate Latch

1. Ignition OFF, disconnect the harness connector at the liftgate latch.
2. Install a 10A fused jumper wire between the control terminal 2 and 12 volts. Install a jumper wire between the ground terminal 4 and ground. Verify the liftgate latch activates.

   If the latch does not perform as specified, replace the liftgate latch.

Liftgate Release Switch

1. Ignition OFF, disconnect the harness connector at the liftgate release switch.
2. Test for infinite resistance between the signal terminal A and the ground terminal B with the switch in the open position.

   If not the specified value, replace the liftgate exterior switch.

3. Test for less than 2.0 ohms between the signal terminal A and the ground terminal B with the switch in the closed position.

   If greater than the specified range, replace the liftgate exterior switch.

Relay Test

1. Ignition OFF, disconnect the Rear End Release relay.
2. Test for 60-200 ohms between terminals 85 and 86.

   If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If not the specified value, replace the relay.
4. Install a 3A fused jumper wire between relay terminal 85 and 12V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.

   If greater than the specified range, replace the relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Relay Replacement
- Control Module References for BCM replacement, setup and programming

Power Door Lock Key Cylinder Switches Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Door Key Switch Signal	1	1	1	--
Right Front Door Latch Ground	--	1	1	--
1. Key Cylinder Switch Inoperative				

Circuit/System Description

The body control module (BCM) monitors the voltage level of the key switch lock and unlock signal circuits. When the key is inserted into the right front door key cylinder and turned and held to the Unlock or Lock position, a switch within the right front door latch closes causing the voltage to drop within the appropriate key switch signal circuit. When the voltage drop time exceeds 2 seconds, the BCM will command all the doors to unlock or lock.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Door Locks Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs

- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, insert the key into the right front door lock cylinder, turn the key to the LOCK position and then to the UNLOCK positon while observing the scan tool Door Key Cylinder Lock Switch and Door Key Cylinder Unlock Switch parameters. The parameters should change between Inactive and Active.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the right front door latch.
2. Test for less than 1 Ω between the ground circuit terminal 3 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Door Key Cylinder Lock Switch parameter is Inactive.

   If not the specified value, test the signal circuit terminal 9 for a short to ground. If the circuit tests normal, replace the BCM.
4. Verify the scan tool Door Key Cylinder Unlock Switch parameter is Inactive.

   If not the specified value, test the signal circuit terminal 4 for a short to ground. If the circuit tests normal, replace the BCM.
5. Install a 3A fused jumper wire between the signal circuit terminal 9 and ground, verify the scan tool Door Key Cylinder Lock Switch parameter is Active.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
6. Install a 3A fused jumper wire between the signal circuit terminal 4 and ground, verify the scan tool Door Key Cylinder Unlock Switch parameter is Active.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
7. If all circuits test normal, test or replace the right front door latch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the right front door latch.
2. Test for infinite resistance between the signal terminal 4 and the ground terminal 3 with the switch in the open position.

   If not the specified value, replace the right front door latch.
3. Test for infinite resistance between the signal terminal 9 and the ground terminal 3 with the switch in the open position.

   If not the specified value, replace the right front door latch.
4. Test for less than 2 Ω between the signal terminal 9 and the ground terminal 3 with the switch in the Lock position.

   If greater than the specified range, replace the right front door latch.
5. Test for less than 2 Ω between the signal terminal 4 and the ground terminal 3 with the switch in the Unlock position.

If greater than the specified range, replace the right front door latch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Front Side Door Latch Replacement
- Control Module References for BCM replacement, setup and programming

Fuel Filler Door Release Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
I/P Fuse Block B+	2	2	--	--
Fuel Door Release Actuator Lock Control	2	1	2	--
Fuel Door Release Actuator Unlock Control	2	1	2	--
Relay Ground	--	2	2	--
1. Fuel Door Release Actuator Inoperative 2. Fuel Door Release Actuator and Door Latches Inoperative				

Circuit/System Description

The fuel door release actuator shares the circuit with the driver door latch. The body control module (BCM), upon receipt of a lock switch lock or unlock signal, will switch the appropriate door latch, as well as a fuel filler door release actuator control circuits to battery positive voltage. The opposing side of the door latch and fuel filler door release actuator is connected to ground provided by the I/P fuse block through the other the door latch control circuits, along with the fuel filler door release actuator, will lock or unlock as commanded.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel Fill Door Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Observe the operation of the power door locks while using the door lock switch. All doors and the fuel filler door should perform the LOCK and UNLOCK function.

If any door does not function as commanded, refer to Power Door Locks Malfunction.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the fuel filler door latch.
2. Test for less than 1 ohm between the control circuit terminal 1 and ground.

   If greater than the specified range, test the control circuit for a short to voltage or an open/high resistance.
3. Test for less than 1 ohm between the control circuit terminal 2 and ground.

   If greater than the specified range, test the control circuit for a short to voltage or an open/high resistance.
4. Connect a test lamp between the control circuit terminal 1 and control circuit terminal 2.
5. Ignition ON, command the doors to LOCK and UNLOCK by using the door lock switch. The test lamp should illuminate while commanding the LOCK and UNLOCK states.

   If the test lamp remains OFF during either command, test either control circuit for a short to ground.
6. If all circuits test normal, test or replace the fuel filler door latch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the fuel filler door latch.
2. Install a 15A fused jumper wire between the control terminal 1 and 12V. Momentarily install a jumper wire between the control terminal 2 and ground. The fuel door release actuator should perform the LOCK/UNLOCK function.

   If the function does not perform as specified, replace the fuel filler door latch.
3. Reverse the jumper wires. The fuel door release actuator should perform the UNLOCK/LOCK function.

   If the function does not perform as specified, replace the fuel filler door latch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Fuel Tank Filler Door Lock Actuator Replacement

Power Door Locks Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
I/P Fuse Block B+	1	1	--	--
Door Lock Switch Lock Signal	B3150 00	2	2	--
Door Lock Switch Unlock Signal	B3140 00	2	2	--
All Lock Relay Control	B3135 00	B3135 00	1	--
Door Latch Assembly Control	1	1	1	--
Driver Unlock Relay Control	B3125 00	B3125 00	B3125 00	--
Passenger Unlock Relay Control	B3130 00	B3130 00	B3130 00	--
Window/Door Lock Switch Ground	--	2	2	--
Relay Ground	--	1	1	--
1. Door Lock Malfunction 2. Door Lock Switch Malfunction				

Circuit/System Description

The body control module (BCM) provides battery positive voltage and ground to the appropriate lock and unlock control circuits of the door lock and unlock relays. The lock control circuits of the driver and passenger door latch assemblies share a common relay; however, the unlock control circuits have separate relays. The system is designed this way so that the keyless entry transmitter may be used to unlock only the driver door.

The BCM supplies and monitors a reference voltage to the door lock/window switch through the door lock switch lock and unlock signal circuits. The door lock/window switch also receives a constant ground source. If a door lock switch is placed in the lock position or unlock position, the reference voltage is taken directly to ground and the BCM detects the voltage drop on the signal circuit.

The BCM, upon receipt of a lock switch lock signal, will switch the all lock relay control circuit to battery positive voltage. This will energize the relay. The relay will supply voltage to the door lock actuator lock control circuits to one side of the lock actuator. Since the opposing side of the lock actuators are connected to ground through the other lock actuator control circuit and the normally closed contacts of the lock or unlock relay, the doors will then lock appropriately. The remaining unlock relays receive voltage from the I/P fuse block, the BCM upon receipt of a unlock signal or driver door unlock signal will switch the appropriate unlock relay to ground. This will energize the appropriate unlock relay. The relay will supply voltage to the appropriate door unlock control circuits to one side of the lock actuator. Since the opposing side of the lock actuators are connected to ground through the other lock actuator control circuits and the normally closed contact of the lock relay, the doors will then unlock appropriately.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Door Locks Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool Central Door Lock Switch and Central Door Unlock Switch parameters while using the door lock switch. The parameter should change between Inactive and Active.

   If the value does not change between commanded states, refer to Door Lock Switch Malfunction

2. Command the driver door and passenger door latches to LOCK and UNLOCK by using the door lock switch. The doors should perform the LOCK and UNLOCK function.

   If the driver door does not UNLOCK, refer to Driver Door Unlock Relay Malfunction.

   If one or more passenger doors do not UNLOCK, refer to Door Unlock Relay Malfunction

   If one or more doors do not LOCK, refer to Door Lock Relay Malfunction

Circuit / System Testing

Door Lock Switch Malfunction

1. Ignition OFF, disconnect the X2 harness connector at the door lock/window switch.
2. Test for less than 1 Ω between the ground circuit terminal 4 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Central Door Lock Switch parameter is Inactive.

   If not the specified value, test the signal circuit terminal 15 for a short to ground. If the circuit tests normal, replace the BCM.
4. Verify the scan tool Central Door Unlock Switch parameter is Inactive.

   If not the specified value, test the signal circuit terminal 5 for a short to ground. If the circuit tests normal, replace the BCM
5. Install a 3A fused jumper wire between the signal circuit terminal 5 and ground. Verify the scan tool Central Door Unlock Switch parameter is Active.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
6. Install a 3A fused jumper wire between the signal circuit terminal 15 and ground. Verify the scan tool Central Door Lock Switch parameter is Active.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
7. If all circuits test normal, test or replace the door lock/window switch.

Driver Door Unlock Relay Malfunction

1. Ignition OFF, disconnect the DRIVER UNLOCK relay.
2. Test for less than 1 Ω between the ground circuit terminal 87A and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 30 and ground.

   If the test lamp illuminates, test the control circuit for a short to voltage.
4. Verify that a test lamp illuminates between the B+ circuit terminal 86 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
5. Verify that a test lamp illuminates between the B+ circuit terminal 87 and ground.

   If the test lamp does not illuminate, test the B+ circuit for an open/high resistance.
6. Connect a test lamp between the control circuit terminal 85 and the B+ circuit terminal 86.
7. Command the Driver Door Unlock/Lock with a scan tool. The test lamp should briefly illuminate during the UNLOCK command.

   If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.

   If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.
8. Ignition OFF, connect the DRIVER UNLOCK relay and disconnect the harness connector at the right front door latch.
9. Test for less than 5 Ω between the control circuit terminal 7 and ground.

   If greater than the specified range, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the DRIVER UNLOCK relay.
10. Connect a test lamp between the control circuit terminal 7 and control circuit terminal 8.
11. Ignition ON, command the right front door latch to LOCK and UNLOCK by using the door lock

switch. The test lamp should briefly illuminate when commanding the LOCK and UNLOCK states.

If the test lamp is always OFF, test either control circuit for a short to ground. If the circuits test normal, test or replace the DRIVER UNLOCK relay.

12. If all circuits test normal, test or replace the right front door latch.

Door Unlock Relay Malfunction

1. Ignition OFF, disconnect the PASS UNLOCK relay.
2. Test for less than 1 Ω between the ground circuit terminal 87A and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.

3. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 30 and ground.

   If the test lamp illuminates, test the control circuit for a short to voltage.

4. Verify that a test lamp illuminates between the B+ circuit terminal 86 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.

5. Verify that a test lamp illuminates between the B+ circuit terminal 87 and ground.

   If the test lamp does not illuminate, test the B+ circuit for an open/high resistance.

6. Connect a test lamp between the control circuit terminal 85 and the B+ circuit terminal 86.
7. Ignition ON, command the All Doors Unlock/Lock with a scan tool. The test lamp should illuminate druing the UNLOCK command.

   If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.

   If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

8. Ignition OFF, connect the PASS UNLOCK relay and disconnect the harness connector at the appropriate door latch.
9. Test for less than 5 Ω between the control circuit terminal listed below and ground:
   - Left rear door latch terminal 2
   - Right front door latch terminal 2.
   - Right rear door latch terminal 5

   If greater than the specified range, test the control circuit for a short to voltage or an open/high resistance. If the circuits test normal, replace the PASS UNLOCK relay.

10. Ignition ON, connect a test lamp between the control circuit terminals listed below:
    - Left rear door latch terminal 2 and terminal 3.
    - Right front door latch terminal 2 and terminal 3.
    - Right rear door latch terminal 5 and terminal 6.
11. Ignition ON, command the All Doors Unlock/Lock with a scan tool. The test lamp should briefly illuminate when commanding the UNLOCK state.

    If the test lamp is always OFF, test either control circuit for a short to ground. If the circuits test normal, test or replace the PASS UNLOCK relay.

12. If all circuits test normal, test or replace the door latch.

Door Lock Relay Malfunction

1. Ignition OFF, disconnect the ALL LOCK relay.
2. Test for less than 1 Ω between the ground circuit terminal 87A and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.

3. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 30 and ground.

   If the test lamp illuminates, test the control circuit for a short to voltage.
4. Verify that a test lamp illuminates between the B+ circuit terminal 87 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
5. Connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85.
6. Command the All Doors Unlock/Lock with a scan tool. The test lamp should illuminate druing the LOCK command.

   If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.

   If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.
7. Ignition OFF, connect the ALL LOCK relay and disconnect the harness connector at the appropriate door latch.
8. Test for less than 5 Ω between the control circuit terminal listed below and ground:
   - Right front door latch terminal 8.
   - Left rear door latch terminal 3
   - Left front door latch terminal 3.
   - Right rear door latch terminal 6

   If greater than the specified range, test the control circuit for a short to voltage or an open/high resistance. If the circuits test normal, replace the ALL LOCK relay.
9. Ignition ON, connect a test lamp between the control circuit terminals listed below:
   - Right front door latch terminal 7 and terminal 8.
   - Left rear door latch terminal 2 and terminal 3
   - Left front door latch terminal 2 and terminal 3.
   - Right rear door latch terminal 5 and terminal 6
10. Ignition ON, command the door latch to LOCK and UNLOCK by using the door lock switch. The test lamp should briefly illuminate during the LOCK command.

    If the test lamp is always OFF, test either control circuit for a short to ground. If the circuits test normal, test or replace the ALL LOCK relay.
11. If all circuits test normal, test or replace the door latch.

Component Testing

Door Lock Window/Switch Test

1. Ignition OFF, disconnect the X2 harness connector at the door lock/window switch.
2. Test for infinite resistance between the signal terminals 5 and 15 and the ground terminal 4 with the switch in the open position.

   If less than the specified value, replace the door lock/window switch.
3. Test for less than 2 Ω between the signal terminal 15 and the ground terminal 4 with the switch in the lock position.

   If greater than the specified range, replace the door lock/window switch.
4. Test for less than 2 Ω between the signal terminal 5 and the ground terminal 4 with the switch in the unlock position.

   If greater than the specified range, replace the door lock/window switch.

Door Latch Test

1. Ignition OFF, disconnect the harness connector at the appropriate door latch.
2. Install a 25A fused jumper wire between one of the control terminals and 12V. Momentarily install a jumper wire between the other control terminal and ground. Reverse the jumper wires at least two times, the door latch should perform the LOCK/UNLOCK functions

   If it does not perform as specified, replace the door latch.

Relay Test

1. Ignition OFF, disconnect the appropriate relay.
2. Test for 60-200 Ω between terminals 85 and 86.

   If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If less than the specified value, replace the relay.
4. Test for less than 2 Ω between terminals 30 and 87A.

   If greater than the specified range, replace the relay.
5. Install a 3A fused jumper wire between relay terminal 85 and 12V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 Ω between terminals 30 and 87.

   If greater than specified range, replace the relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Relay Replacement
- Front Side Door Latch Replacement
- Power Mirror Switch Replacement
- Rear Side Door Latch Replacement
- Control Module References for BCM replacement, setup and programming

Door Ajar Indicator Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Door Ajar Signal	B2976 00	1	1	--
Passenger Door Ajar Signal	B2991 00	1	1	--
Right Front Door Latch Ground	--	1	1	--
Left Rear Door Latch Ground	--	1	1	--
Left Front Door Latch Ground	--	1	1	--
Right Rear Door Latch Ground	--	1	1	--
1. Door Ajar Indicator Inoperative				

Circuit/System Description

The body control module (BCM) receives a discrete input from ajar switches within driver and passenger door latches. The BCM then communicates this status to the instrument panel cluster (IPC) via a serial data message. The IPC, upon receipt of this serial data message, will illuminate the ajar icon in the driver information center (DIC) and also send a serial data massage to the radio to activate the door ajar audible warning when the engine has been started and the gear selector is moved from the P (park) position.

The door ajar switches supply a ground to the BCM when the door is open. Once the door is closed the door ajar switch opens removing the ground to the BCM. The BCM sends a signal to the IPC to illuminate the door ajar indicator when a door is open.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Door Locks Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool Driver Door Ajar Switch parameter while opening and closing the driver door. The parameter should change between Door Closed and Door Ajar.

   If the value does not change, refer to Driver Door Ajar Malfunction
2. With the passenger and rear doors closed, observe the scan tool Passenger Door Ajar Switch parameter while opening and closing each door. The parameter should change between Door Closed and Door Ajar.

   If the value does not change, refer to Passenger Door Ajar Malfunction.

Circuit/System Testing

Driver Door Ajar Malfunction

1. Ignition OFF, disconnect the harness connector at the right front door latch.
2. Test for less than 1 ohm between the ground circuit terminal 3 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Driver Door Ajar Switch parameter and is Door Closed.

   If not the specified value, test the signal circuit terminal 1 for a short to ground. If the circuit tests normal, replace the BCM.
4. Install a 3A fused jumper wire between the signal circuit terminal 1 and the ground circuit terminal 8. Verify the scan tool Driver Door Ajar Switch parameter is Door Ajar.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the right front door latch.

Passenger Door Ajar Malfunction

1. Ignition OFF, disconnect the harness connector at the appropriate passenger or rear door

latch.

2. Test for less than 1 ohm between the ground circuit terminal listed below and ground.
   - Left rear door latch terminal 6
   - Right rear door latch terminal 3
   - Left front door latch terminal 8

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Passenger Door Ajar Switch parameter is Door Closed.

   If not the specified value, test the signal circuit terminal listed below for a short to ground. If the circuit tests normal, replace the BCM.
   - Left rear door latch terminal 4
   - Right rear door latch terminal 1
   - Left front door latch terminal 6
4. Install a 3A fused jumper wire between the signal circuit terminal and the ground circuit terminal listed below. Verify the scan tool Passenger Door Ajar Switch parameter is Door Ajar.
   - Left rear door latch terminal 4 and terminal 6
   - Right rear door latch terminal 1 and terminal 3
   - Left front door circuit terminal 6 and terminal 8

   If not the specified value, test the appropriate signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the door latch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the appropriate door latch.
2. With the switch in the open position, test for infinite resistance between the signal and the ground terminals listed below:
   - Right front door latch terminal 1 and terminal 3
   - Left rear door latch terminal 4 and terminal 6
   - Right rear door latch terminal 1 and terminal 3
   - Left front door latch terminal 6 and terminal 8

   If not the specified value, replace the door latch.
3. With the switch in the closed position, test for less than 2 ohms between the signal and the ground terminals listed below:
   - Right front door latch terminal 1 and terminal 3
   - Left rear door latchl terminal 4 and terminal 6
   - Right rear door latch terminal 1 and terminal 3
   - Left front door latch terminal 6 and terminal 8

   If greater than the specified range, replace the door latch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Front Side Door Latch Replacement

- Rear Side Door Latch Replacement
- Control Module References for BCM replacement, setup, and programming

Symptoms - Vehicle Access

Important: The following steps must be completed before using the symptom tables.

1. Perform the Diagnostic System Check - Vehicle , before using the symptom tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control module can communicate via GMLAN serial data.
2. Review the system description and operation in order to familiarize yourself with the system functions. Refer to the following:
   - Power Door Locks Description and Operation
   - Door Ajar Indicator Description and Operation
   - Luggage Compartment Description and Operation
   - Rear Hatch/Gate Description and Operation
   - Fuel Fill Door Description and Operation

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the power door locks, liftgate release or the rear compartment lid release. Refer to Checking Aftermarket Accessories.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Door Ajar Indicator Malfunction
- Power Door Locks Malfunction
- Liftgate Release Malfunction
- Power Door Lock Key Cylinder Switches Malfunction
- Trunk Release Malfunction
- Fuel Filler Door Release Malfunction

Trunk Release Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Trunk Release Relay B+	1	1	--	--
Trunk Release Switch Signal	B2730 00	2	2	--
Rear Compartment Lid Latch Control	1	1	1	--
Trunk Relay Control	B3265 00	B3265 00	B3265 00	--
Rear Compartment Lid Latch Ground	--	1	1	--
Rear Compartment Lid Release Switch Ground	--	2	2	--
1. Trunk release is inoperative from both the switch and keyless entry transmitter 2. Trunk release is inoperative only from switch				

Circuit/System Description

The rear compartment lid can be released by operating the rear compartment lid release switch or by pressing the rear compartment lid release button on the remote keyless entry transmitter. The gear selector must be in Park for the trunk to release.

The body control module (BCM) monitors the signal circuit to the rear compartment lid release switch. When the rear compartment lid release switch is pressed, the trunk release signal is pulled low within the BCM. In response, the BCM applies ground to the trunk relay control circuit, which energizes the coil side of the trunk relay. The switch side of the trunk relay then closes, supplying battery positive voltage through the relay and the control circuit to the rear compartment lid latch. The rear compartment lid latch, then releases the rear compartment lid so that it may be manually raised to an open position.

Reference Information

Schematic Reference

Release Systems Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Luggage Compartment Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Ignition ON, observe the scan tool Trunk Switch parameter while pressing the rear compartment lid release switch. The parameter should change between Active and Inactive.
   If the value does not change, refer to Trunk Release Switch Malfunction.
2. Command the Trunk Release Test with a scan tool, the rear compartment lid latch should release the trunk lid.
   If the rear compartment lid latch does not release, refer to Rear Compartment Lid Latch Malfunction.

Circuit / System Testing

Trunk Release Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the rear compartment lid release switch.
2. Test for less than 1 Ω between the ground circuit terminal B and ground.
   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Trunk Switch parameter is Inactive.
   If not the specified value, test the signal circuit terminal A for a short to ground. If the circuit tests normal, replace the BCM.
4. Install a 3A fused jumper wire between the signal circuit terminal A and the ground circuit terminal B. Verify the scan tool Trunk Switch parameter is Active.
   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the rear compartment lid release switch.

Rear Compartment Lid Latch Malfunction

1. Ignition OFF, disconnect the TRUNK RELEASE relay.

2. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 87 and ground.

   If the test lamp illuminates, test the control circuit for a short to voltage.
3. Verify that a test lamp illuminates between the B+ circuit terminal 85 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse is open, test the control circuit terminal 87 for a short to ground. If the circuit tests normal, test or replace the TRUNK RELEASE relay.
4. Verify that a test lamp illuminates between the B+ circuit terminal 30 and ground.

   If the test lamp does not illuminate, test the B+ circuit for an open/high resistance.
5. Ignition OFF, disconnect the harness connector at the rear compartment lid latch.
6. Test for less than 1 Ω between the ground circuit terminal 4 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
7. Connect the harness connector at the rear compartment lid latch.
8. Ignition ON, connect a 10A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87. Verify the rear compartment lid latch is activated.

   If the rear compartment lid latch does not activate, test the control circuit for an open/high resistance. If the circuit tests normal, test or replace the rear compartment lid latch.
9. Connect a test lamp between the B+ circuit terminal 85 and the control circuit terminal 86.
10. Command the Trunk Release Test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

    If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

    If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
11. If all circuits test normal, test or replace the TRUNK RELEASE relay.

Component Testing

Rear Compartment Lid Latch

1. Ignition OFF, disconnect the harness connector at the rear compartment lid latch.
2. Install a 10A fused jumper wire between the control terminal 3 and 12V. Install a jumper wire between the ground terminal 4 and ground. Verify the rear compartment lid latch activates.

   If the latch does not perform as specified, replace the rear compartment lid latch.

Rear Compartment Lid Release Switch

1. Ignition OFF, disconnect the harness connector at the rear compartment lid release switch.
2. Test for infinite resistance between the signal terminal A and the ground terminal B with the switch in the open position.

   If not the specified value, replace the rear compartment lid release switch
3. Test for less than 2 Ω between the signal terminal A and the ground terminal B with the switch in the closed position.

   If greater than the specified range, replace the rear compartment lid release switch.
4. Test for infinite resistance between each terminal and the lid release switch housing/case.

   If not the specified value, replace the rear compartment lid release switch.

Relay Test

1. Ignition OFF, disconnect the TRUNK RELEASE relay.
2. Test for 65-90 Ω between terminals 85 and 86.

   If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If not the specified value, replace the relay.
4. Install a 10A fused jumper wire between relay terminal 85 and 12V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 Ω between terminals 30 and 87.

   If greater than the specified range, replace the relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

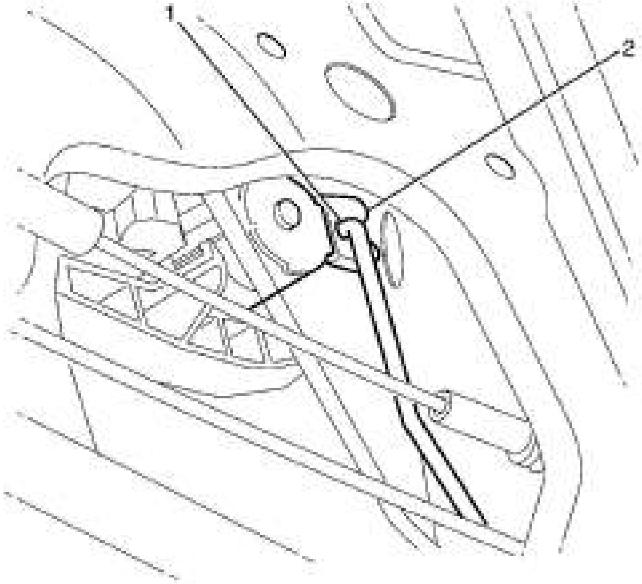
- Rear Compartment Lid Latch Replacement
- Rear Compartment Lid Release Switch Replacement
- Relay Replacement
- Control Module References for BCM replacement, setup and programming

Door Lock Cylinder Replacement

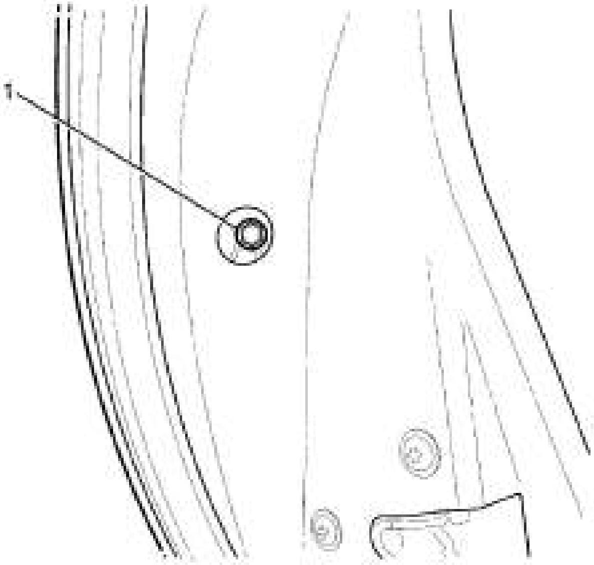
Removal Procedure

Important: Do not attempt repairs in order to correct lock cylinder discrepancies. Replace the lock cylinder.

1. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement.
2. Pull the rear half of the water deflector away from the drivers door panel in order to access the door lock cylinder.

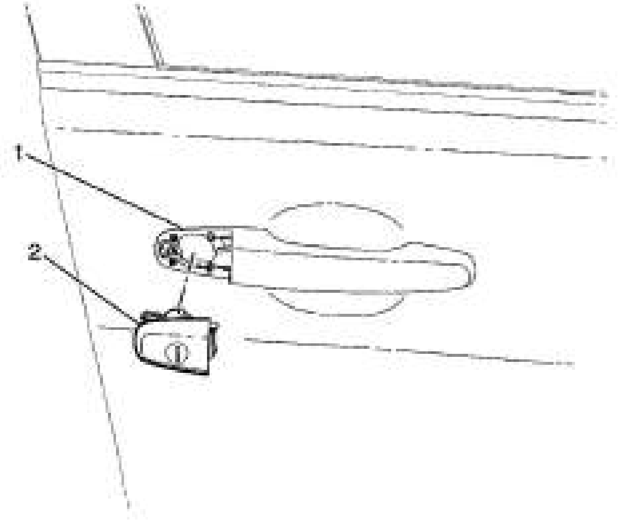


3. Remove the lock actuating rod (1) from the lock cylinder (2).



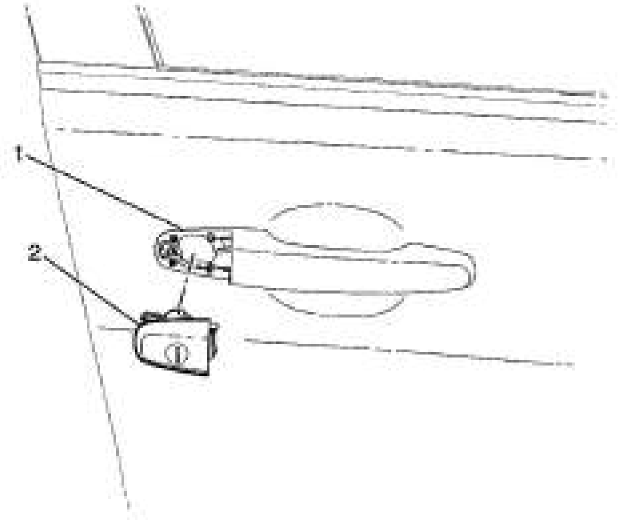
Important: Remove the rubber blanking grommet to expose lock cylinder retaining bolt (1).

4. Remove the lock cylinder to outside door handle retaining bolt (1).



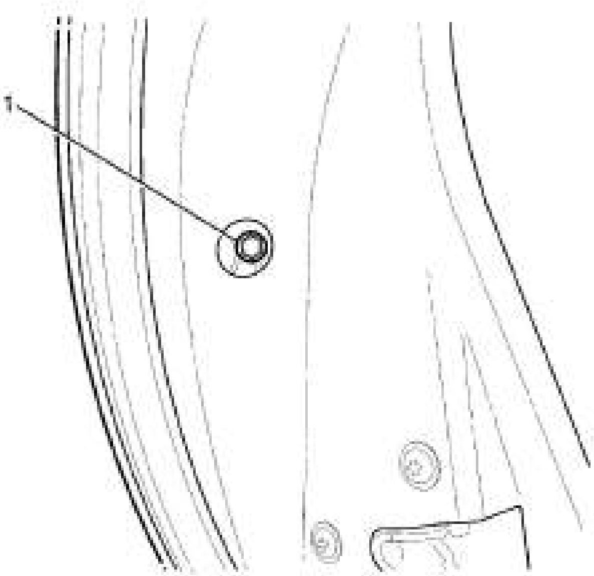
5. Remove the lock cylinder (2) from the outside door handle (1).

Installation Procedure



1. Position the lock cylinder (2) to the outside door handle (1).

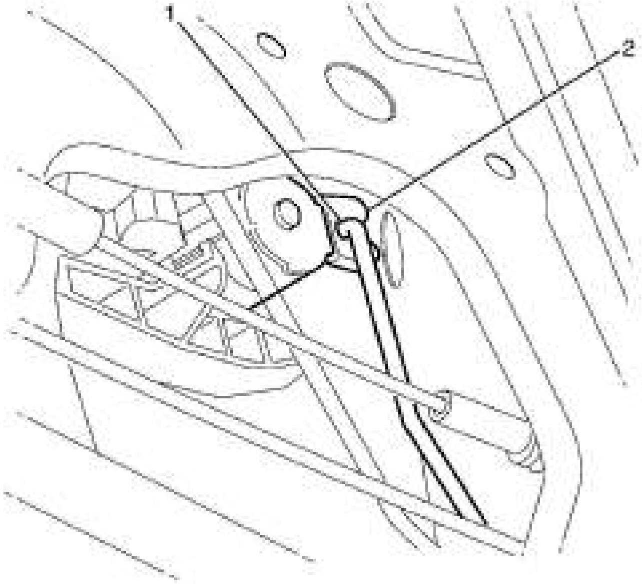
Notice: Refer to Fastener Notice in the Preface section.



2. Install the lock cylinder to outside door handle retaining bolt (1).

   Tighten
   Tighten the bolt to 4 N-m (35 lb in).

3. Install the rubber blanking grommet to the door.



Important: The lock actuating rod (2) pushes into the lock cylinder retaining clip (1).

4. Install the lock actuating rod (1) to the lock cylinder retaining clip (2) (if fitted).

Important: Firmly press the water deflector where adhesive is applied to make sure water tight bond.

5. Install the rear half of the water deflector to the door panel.
6. Install the door trim panel. Refer to Front Side Door Trim Panel Replacement.

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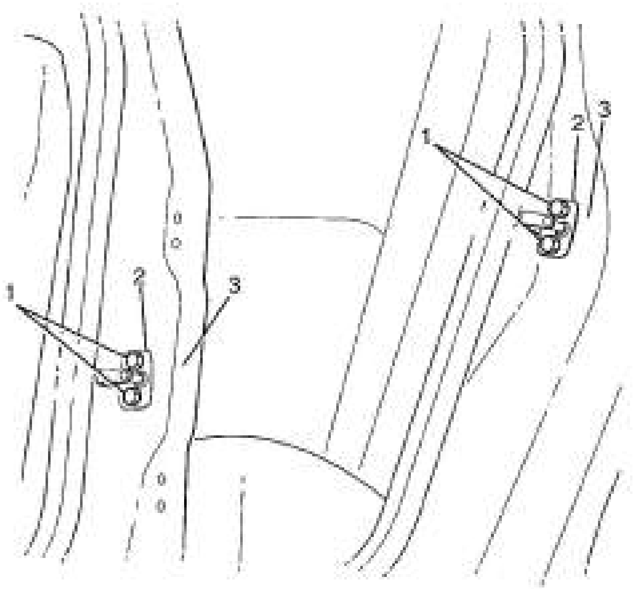
Door Lock Striker Adjustment

Caution: Striker alignment is crucial for proper operation of the door systems. Do not hit the striker with a hammer or force alignment in any other way. Failure to properly adjust striker will result in excessive door efforts or extensive damage to door system operation which could result in personal injury.

Important: If the door vibrates vertically on opening (shimmy's), adjust the striker higher relative to the latch and achieve beltline flushness by other means.



1. Loosen the door striker to pillar retaining screws (1).
2. Pull the door striker (2) outboard on the pillar (3) to the end of the adjustment travel.

Important: The door striker retaining screws (1) must not be fully tightened at this stage.

3. Tighten the door striker retaining screws (1) so that the door striker (2) can still be moved.
4. Hold the outside door handle out and gently push the door flush against the body in order to locate the door striker (2).
5. Slowly open the door.

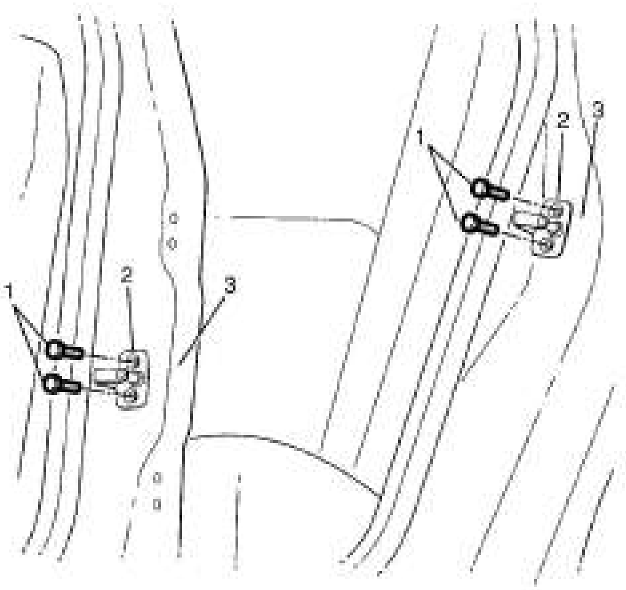
Notice: Refer to Fastener Notice in the Preface section.

6. Tighten the door striker to pillar retaining screws (2).

Tighten
Tighten the door striker screws to 13 N-m (115 lb in).

Door Striker Replacement

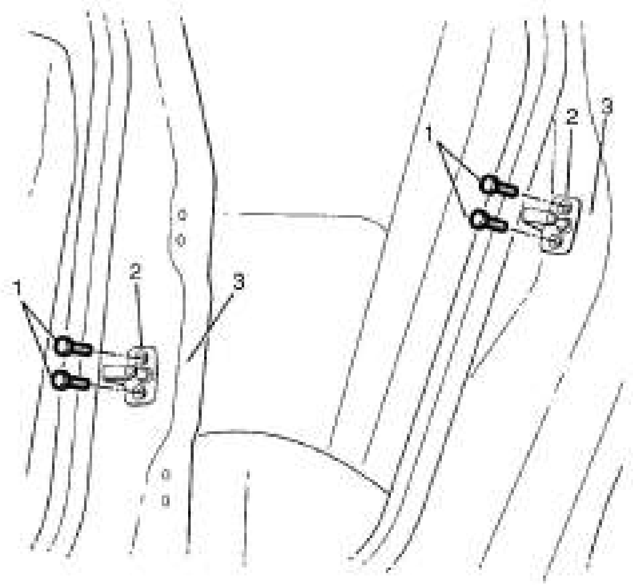
Removal Procedure



Important: Mark the door striker (2) location before removing the door striker to pillar retaining screws (1) to aid in installation.

1. Remove the door striker to pillar retaining screws (1).
2. Remove the door striker (2) from the pillar (3).

Installation Procedure



Important: The door striker to pillar retaining screws (1) must not be fully tightened at this stage.

Important: Align the door striker (2) to the marks made to the pillar (3) prior to removal.

1. Install the door striker to pillar retaining screws (1).

   Caution: Striker alignment is crucial for proper operation of the door systems. Do not hit the striker with a hammer or force alignment in any other way. Failure to properly adjust striker will result in excessive door efforts or extensive damage to door system operation which could result in personal injury.

2. Align the door striker (2). Refer to Door Lock Striker Adjustment in Doors.

   Notice: Refer to Fastener Notice in the Preface section.

3. Tighten the door striker (2) to pillar retaining screws (1).

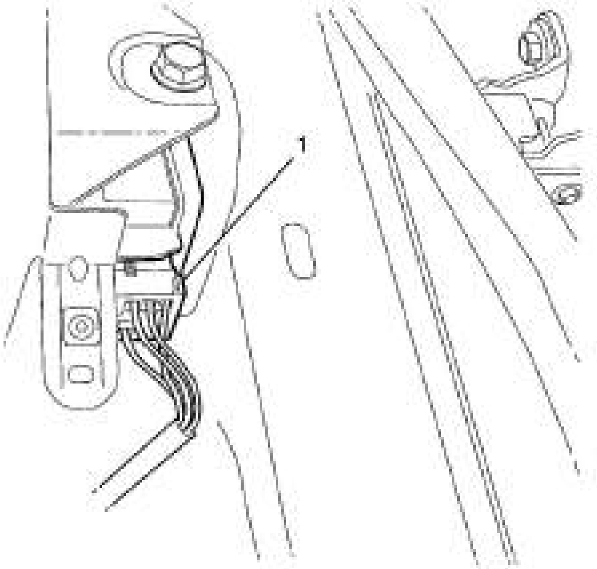
   Tighten
   Tighten the door striker screws to 13 N-m (115 lb in).

Front Door Module Replacement

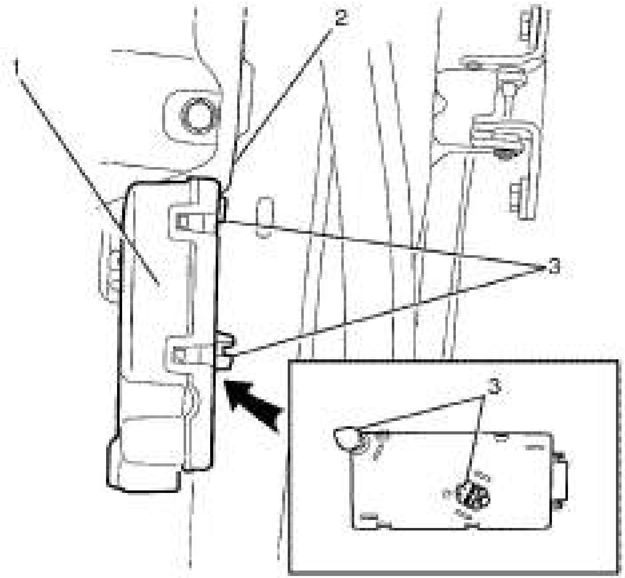
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the closeout/insulator panel. Refer to Instrument Panel Insulator Panel Replacement - Right Side.
3. Remove the knee bolster. Refer to Knee Bolster Replacement.
4. Remove the hinge pillar trim panel. Refer to Body Hinge Pillar Trim Panel Replacement.



5. Disconnect the door module electrical connector (1).

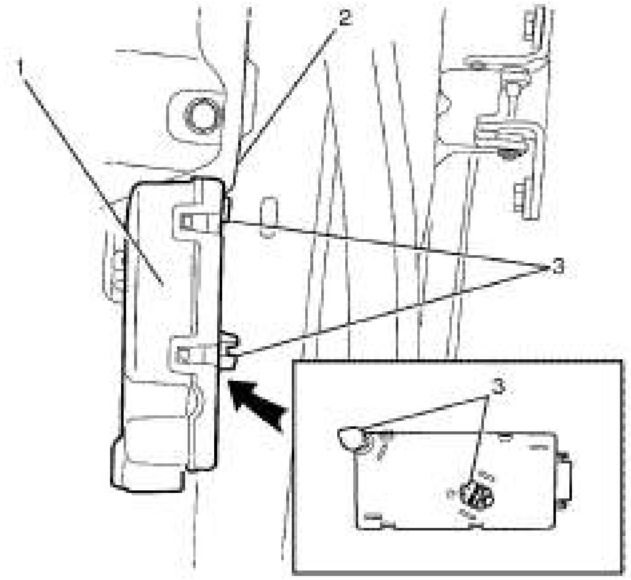


Important: The door module is located on the right side just under the instrument panel attached to the body.

Important: Pry the door module (1) with a suitable flat bladed tool then manoeuvre to release top locating retainer (3).

6. Pry the door module (1) with a suitable flat bladed tool to release the retainers (3).
7. Remove the door module (1) from the vehicle (2).

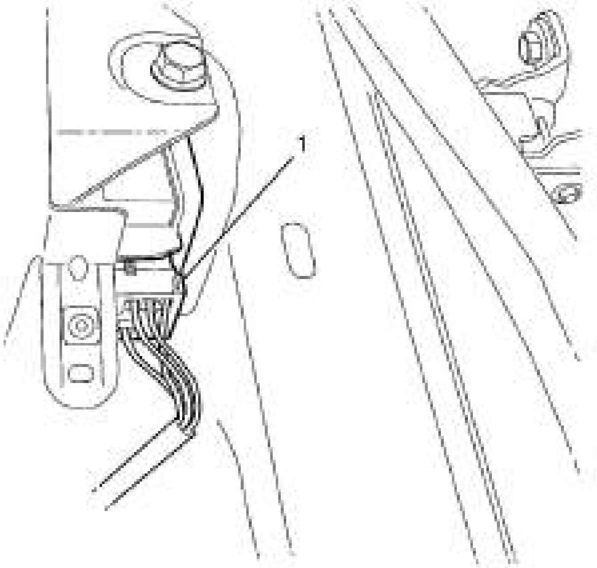
Installation Procedure



1. Position the door module (1) to the vehicle (2).

Important: Locate the top retainer first then press to engage the lower retainer.

2. Install the door module (1) and push to secure the retainers (3).

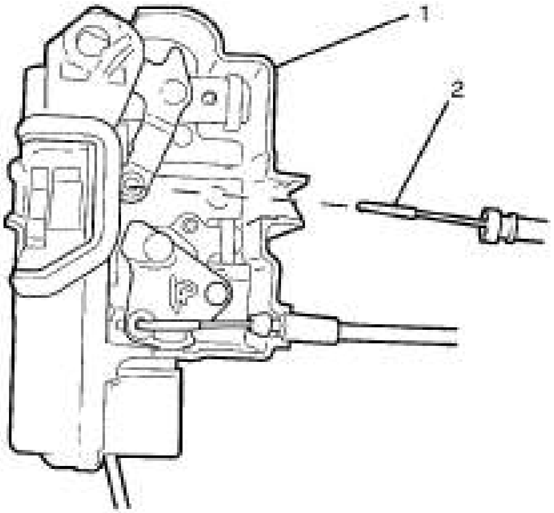


3. Connect the door module electrical connector (1).
4. Install the hinge pillar trim panel. Refer to Body Hinge Pillar Trim Panel Replacement.
5. Install the knee bolster. Refer to Knee Bolster Replacement.
6. Install the closeout/insulator panel. Refer to Instrument Panel Insulator Panel Replacement - Right Side.
7. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
8. If re-programming is required. Refer to Control Module References.

Front Side Door Inside Handle Cable Replacement

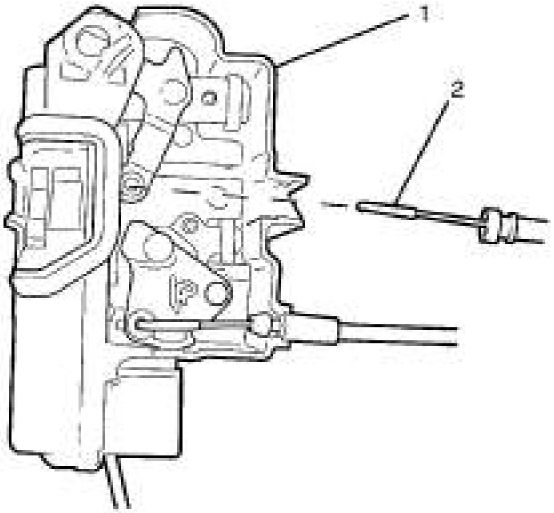
Removal Procedure - Door Handle Cable

1. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement.
2. Remove the water deflector. Refer to Front Side Door Water Deflector Replacement.
3. Remove the door latch. Refer to Front Side Door Latch Replacement.



4. Disconnect the door handle cable (2) from the door latch (1).

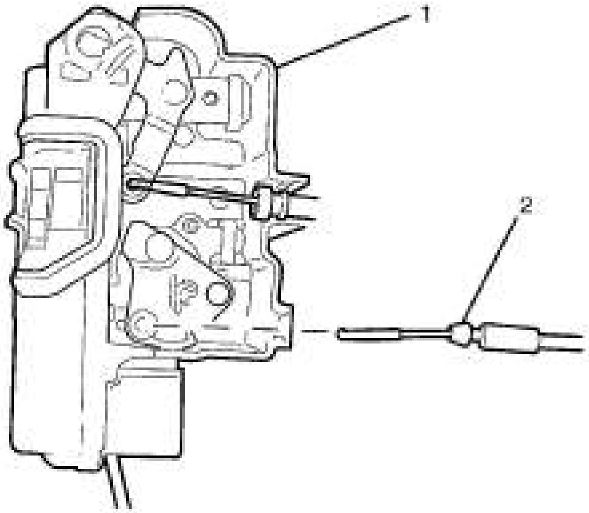
Installation Procedure - Door Handle Cable



1. Connect the door handle cable (2) to the door latch (1).
2. Install the door latch. Refer to Front Side Door Latch Replacement.
3. Install the water deflector. Refer to Front Side Door Water Deflector Replacement.
4. Install the door trim panel. Refer to Front Side Door Trim Panel Replacement.

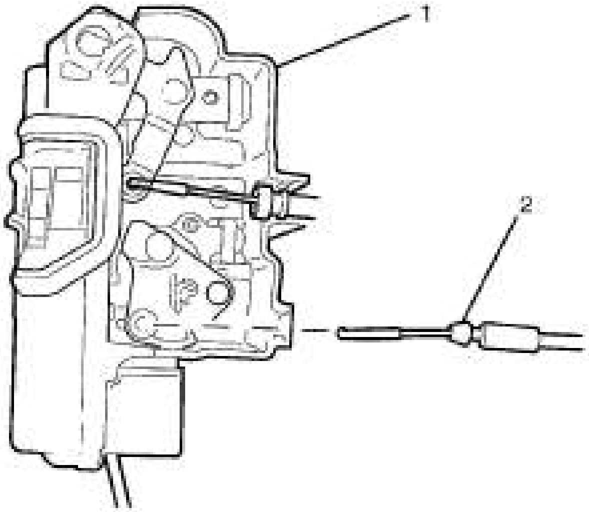
Removal Procedure - Lock Cable

1. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement.
2. Remove the water deflector. Refer to Front Side Door Water Deflector Replacement.
3. Remove the door latch. Refer to Front Side Door Latch Replacement.



4. Disconnect the door lock cable (2) from the door latch (1).

Installation Procedure - Lock Cable



1. Connect the lock handle cable (2) to the door latch (1).
2. Install the door latch. Refer to Front Side Door Latch Replacement.
3. Install the water deflector. Refer to Front Side Door Water Deflector Replacement.
4. Install the door trim panel. Refer to Front Side Door Trim Panel Replacement.

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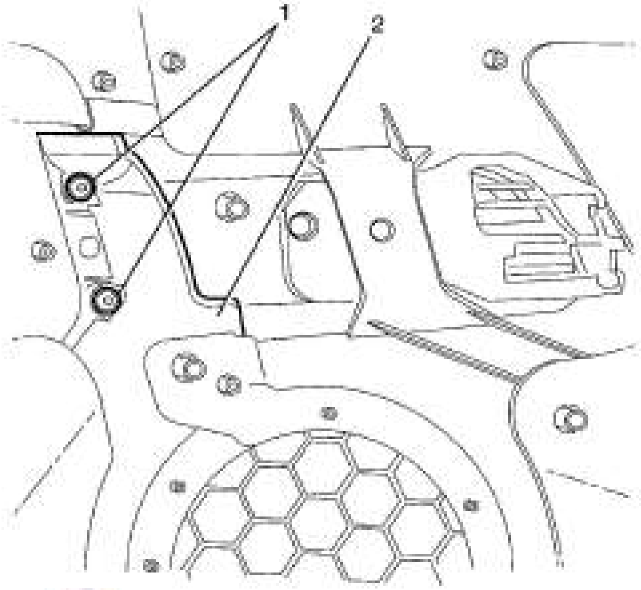
Front Side Door Inside Handle Replacement

Removal Procedure

1. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement.



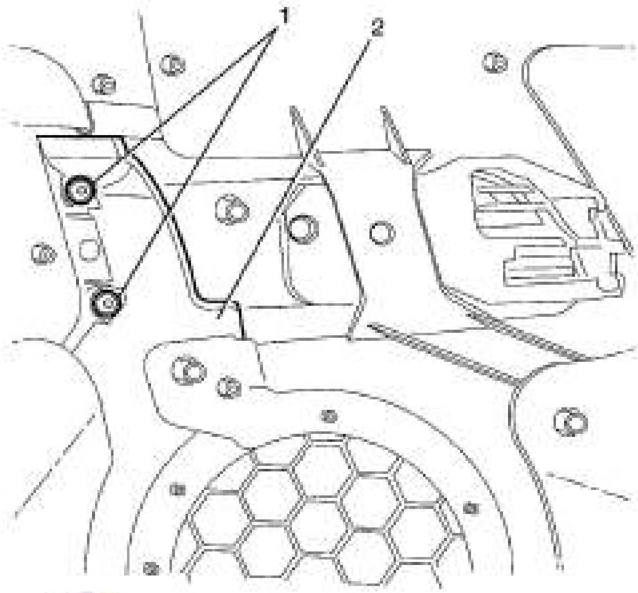
Important: The inside door handle to door trim panel retaining screws (1) are on the inside of the door trim panel (2).

2. Remove the inside door handle to door trim panel retaining screws (1).
3. Remove the inside door handle from the door trim panel (2).

Installation Procedure

1. Position the inside door handle to the door trim panel.

Notice: Refer to Fastener Notice in the Preface section.



Important: The inside door handle to door trim panel retaining screws (1) are on the inside of the door trim panel (2).

2. Install the inside door handle to door trim panel retaining screws (1).

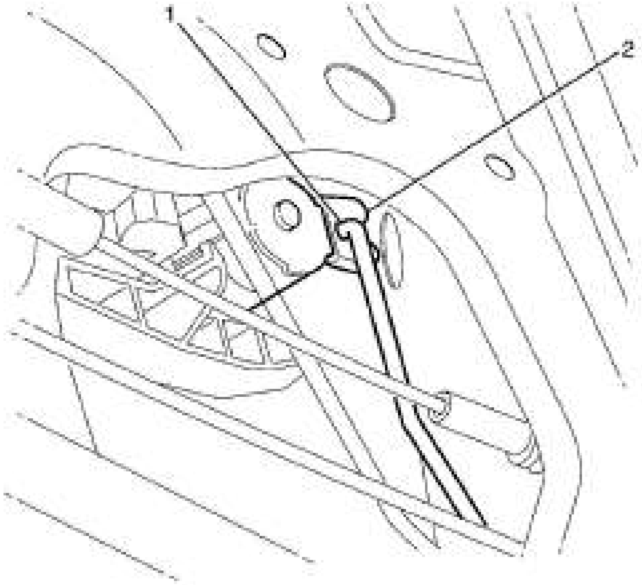
   Tighten
   Tighten the screws to 3 N-m (27 lb in).

3. Install the door trim panel (2). Refer to Front Side Door Trim Panel Replacement.

Front Side Door Latch Replacement

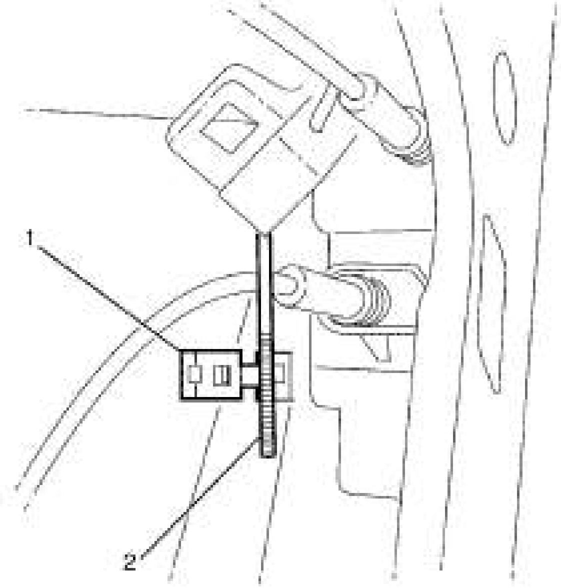
Removal Procedure

1. Raise the window to the full up position.
2. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement.
3. Pull the rear half of the water deflector away from the door panel in order to access the door handle and door lock.



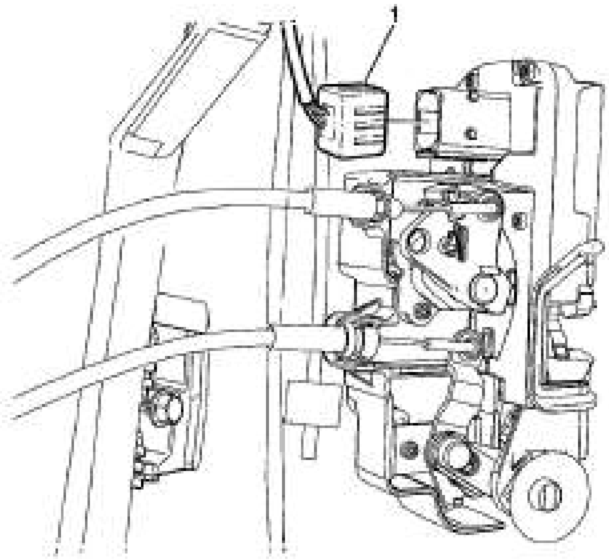
Important: The lock actuating rod (1) is only fitted to the drivers door handle.

4. Remove the lock actuating rod (1) from the door lock cylinder (2) (if fitted).

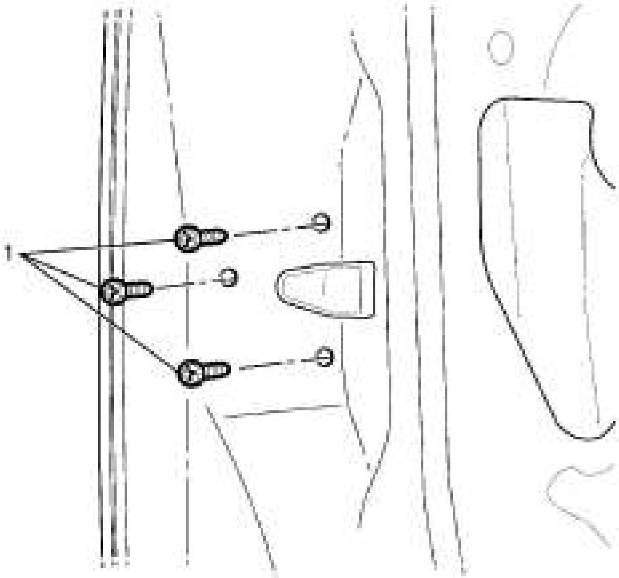


Important: Pry the outside door handle rod retaining clip (1) using a suitable tool.

5. Disconnect the outside door handle rod (2) from the door handle rod retaining clip (1).



6. Disconnect the door latch electrical connector (1).



Important: The door latch to door retaining screws (2) are single use parts and must be discarded after use.

Important: Support door latch when removing the door latch to door retaining screws (1).

7. Remove the door latch to door retaining screws (1).

   Discard the screws.

8. Remove the door latch from the door with the inside door handle cable, inside door lock cable and lock actuator rod (if fitted) attached.
9. Disconnect the inside door handle cable and inside door lock cable from the door latch. Refer to Front Side Door Inside Handle Cable Replacement.
10. Disconnect the lock rod (if fitted) from the door latch.

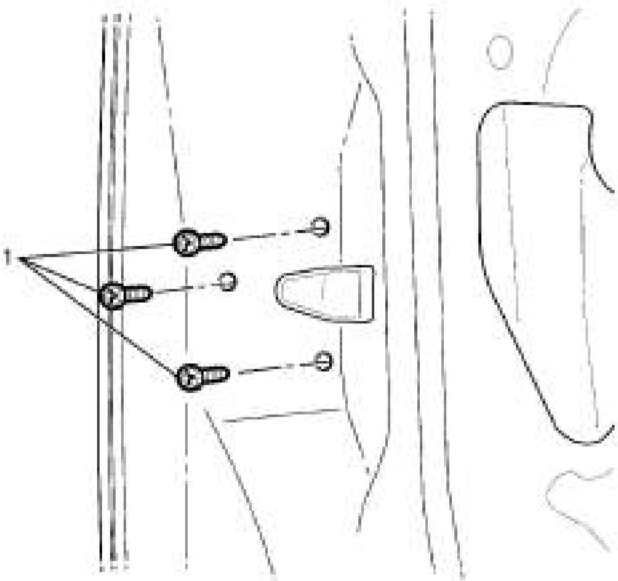
Installation Procedure

1. Connect the lock rod (if fitted) to the door latch.
2. Connect the inside door handle cable and inside door lock cable to the door latch. Refer to Front Side Door Inside Handle Cable Replacement.

   Important: Position the door latch through the door cavity and support.

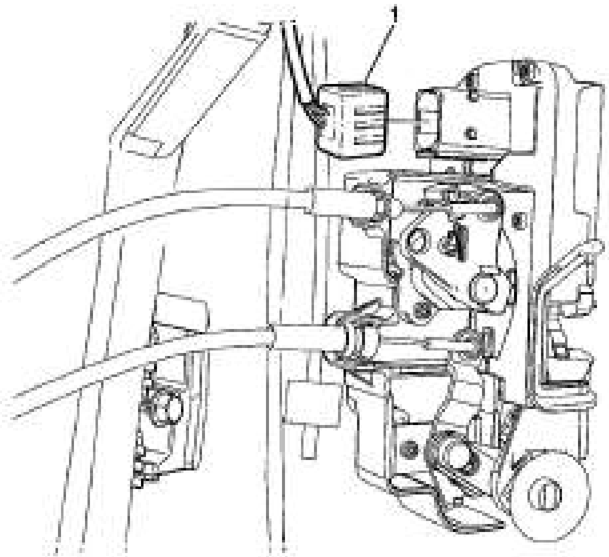
3. Position the door latch into the door.

   Notice: Refer to Fastener Notice in the Preface section.

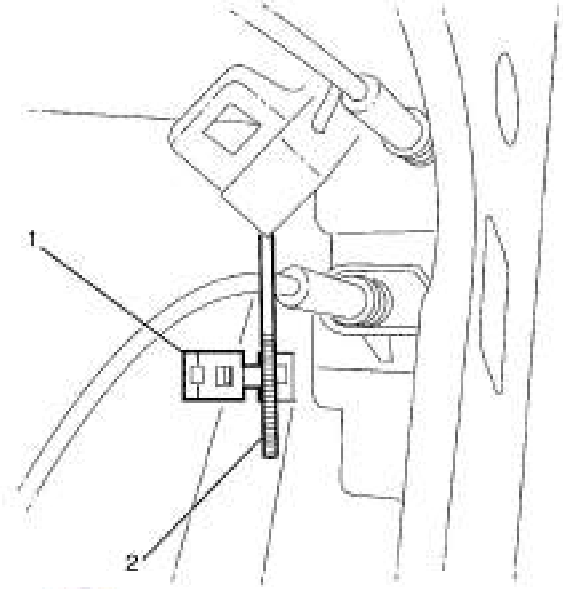


4. Install the door latch to door NEW retaining screws (1).

   Tighten
   Tighten the screws to 13 N-m (115 lb in).

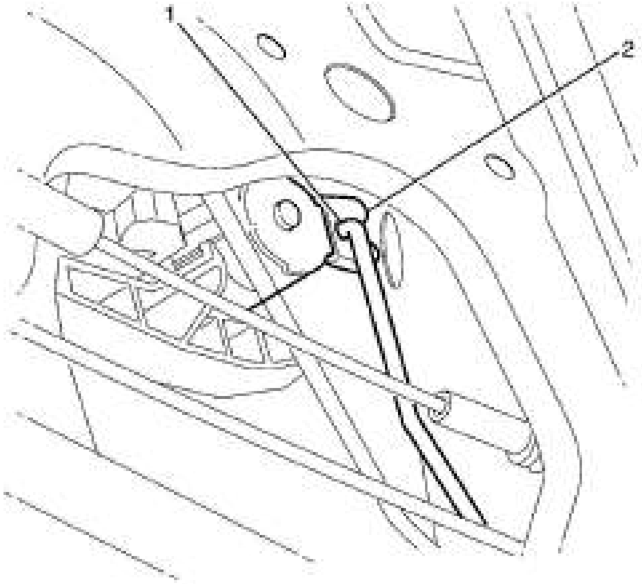


5. Connect the door latch electrical connector (1).



Important: Attach the door handle rod retaining clip (1) by pressing clip together over door handle rod until an audible click is heard.

6. Connect the outside door handle rod (2) to the door handle rod retaining clip (1).



Important: The lock actuating rod (2) pushes into the lock cylinder retaining clip (1).

7. Install the lock actuating rod (1) to the lock cylinder retaining clip (2) (if fitted).
8. Inspect for the correct operation of the door handle, lock cylinder (if fitted), and door latch.

Important: Firmly press the water deflector where adhesive is applied to make sure water tight bond.

9. Install the rear half of the water deflector to the door panel.
10. Install the door trim panel. Refer to Front Side Door Trim Panel Replacement.

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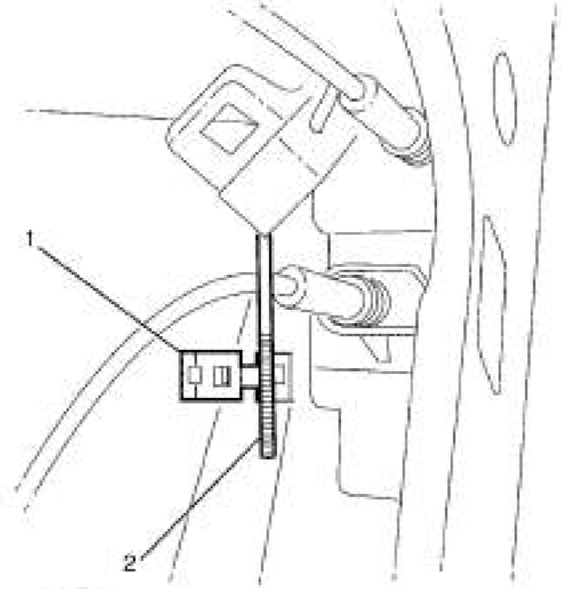
Front Side Door Outside Handle Replacement

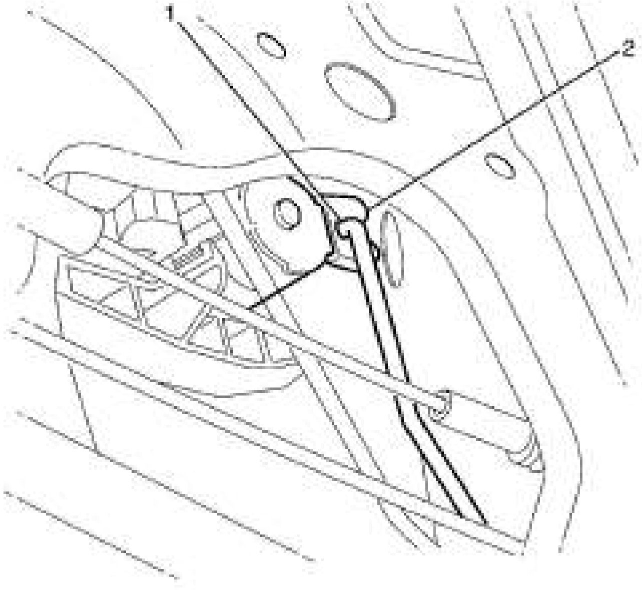
Removal Procedure

1. Remove the door trim panel. Refer to Front Side Door Trim Panel Replacement.
2. Pull the rear half of the water deflector away from the door panel in order to access the outside door handle.

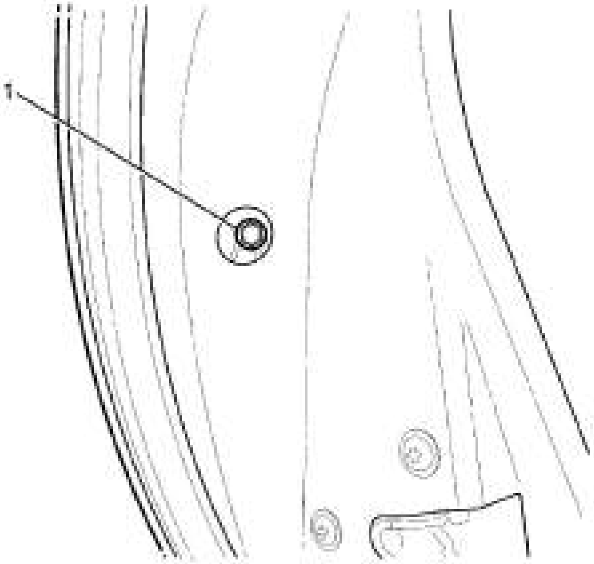


Important: Pry the outside door handle rod retaining clip (1) using a suitable tool.

3. Disconnect the outside door handle rod (2) from the door handle rod retaining clip (1).

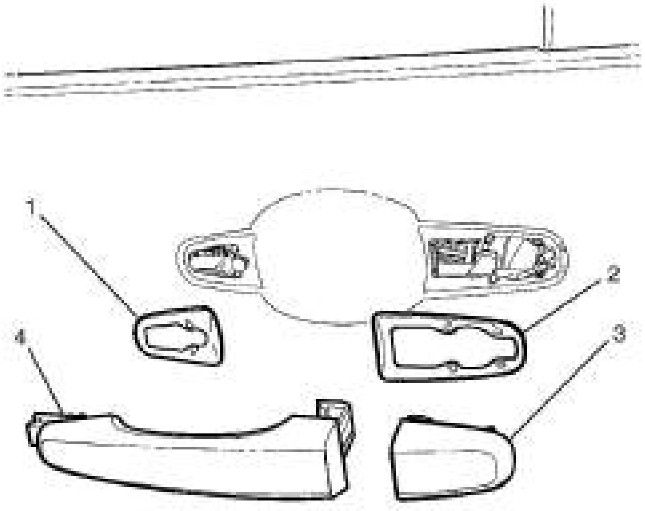


4. Remove the lock actuating rod (1) from the lock cylinder (2) (if fitted).



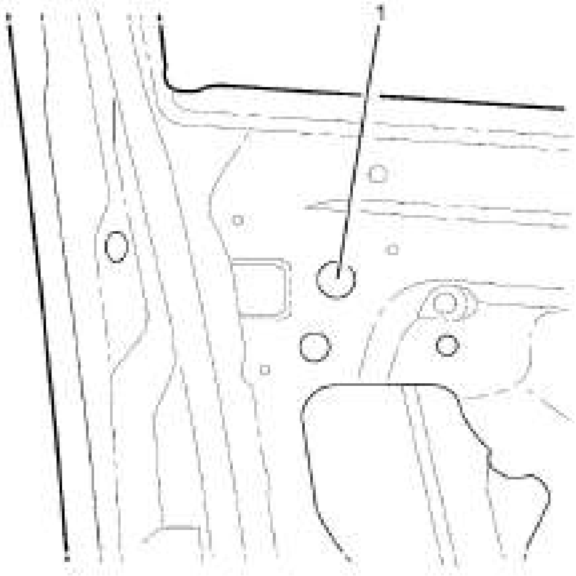
Important: Remove the rubber blanking grommet to allow access to the retaining bolt (1).

5. Remove the outside door handle to door retaining bolt (1).



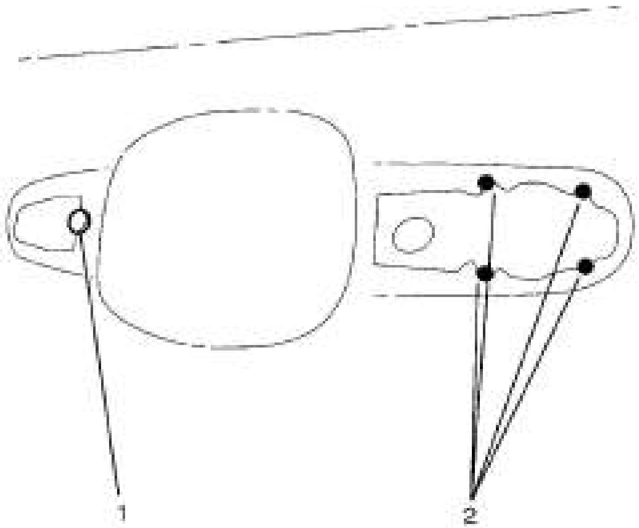
Important: Replace the gaskets (2, 3) when replacing the outside door handle (1, 4).

6. Remove the outside door handle (1, 4) from the door.



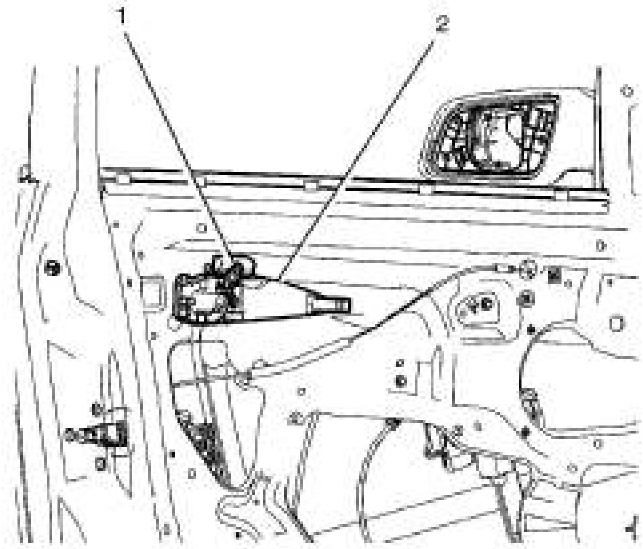
Important: The outside door handle retaining nut (1) must be loosened to remove the inner part of the outer door handle.

7. Loosen the outside door handle retaining nut (1).
8. Push on the outside door handle retaining nut and stud to relieve pressure between the inner part of the door handle and the door.



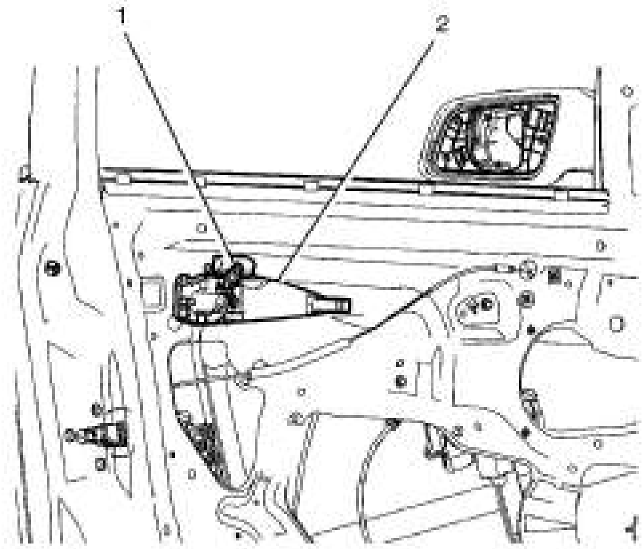
Important: Push the retaining tabs (2) inwards to release them then push the inner handle towards the front of the car to release the retaining pin (1).

9. Remove the inner part of the outer door handle (1, 2).

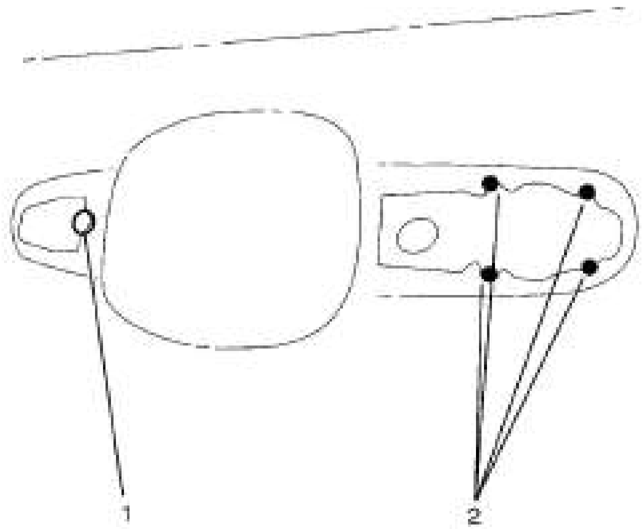


10. Remove the inner part (1) of the outer door handle from the door (2).

Installation Procedure



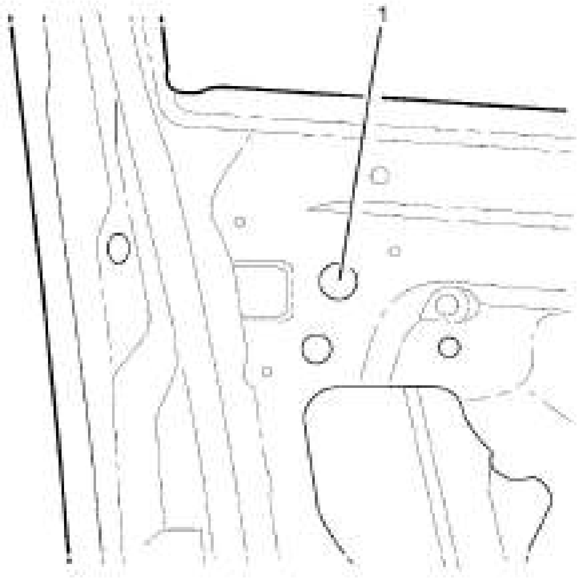
1. Position the inner part (1) of the outer door handle to the door (2).



Important: Lock in the retaining pin (1) by pushing towards the rear of the car then outwards to engage the retaining tabs (2).

2. Position the inner part of the outer door handle (1, 2).

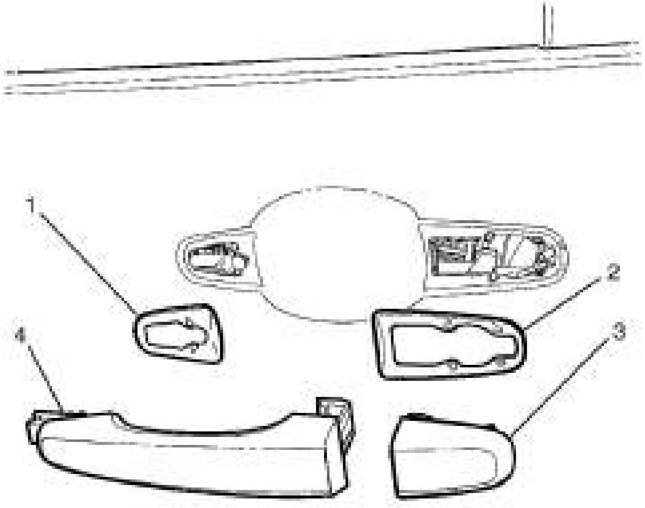
Notice: Refer to Fastener Notice in the Preface section.



Important: The outside door handle retaining nut (1) must be tightened to fasten the inner part of the outer door handle.

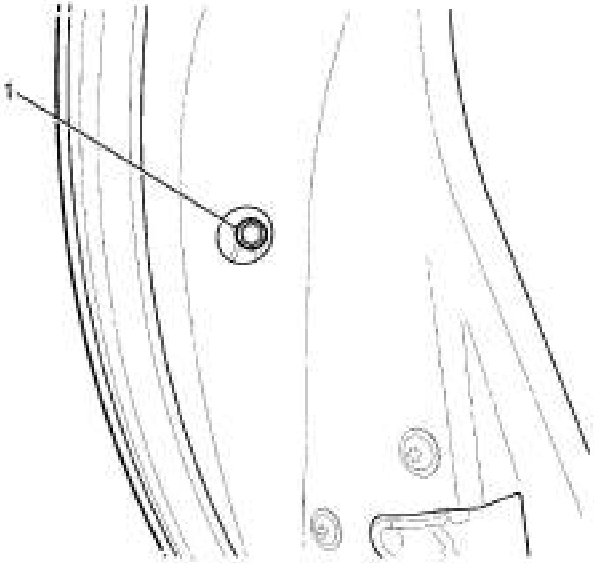
3. Tighten the outside door handle retaining nut (1).

   Tighten
   Tighten the bolt to 4 N-m (35 lb in).



Important: Replace the gaskets (2, 3) when replacing the outside door handle (1, 4).

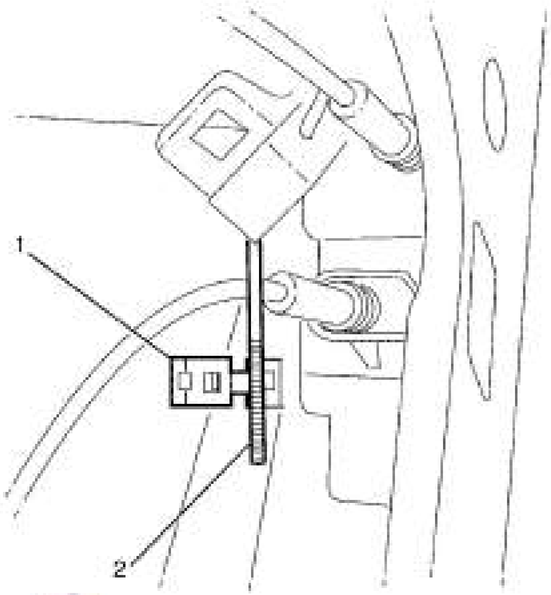
4. Position the outside door handle (1,4) to the door.



5. Install the outside door handle to door and retaining bolt (1).

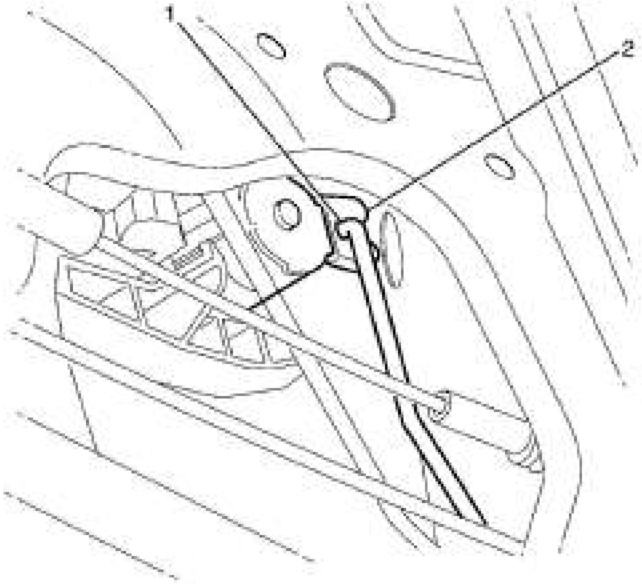
   Tighten

Tighten the bolt to 4 N-m (35 lb in).



Important: Attach the door handle rod retaining clip (1) by pressing clip together over door handle rod until an audible click is heard.

6. Connect the outside door handle rod (2) to the door handle rod retaining clip (1).



Important: The lock actuating rod (2) pushes into the lock cylinder retaining clip (1).

7. Install the lock actuating rod (1) to the lock cylinder retaining clip (2) (if fitted).

Important: Firmly press the water deflector where adhesive is applied to make sure water tight bond.

8. Install the rear half of the water deflector to the door panel.
9. Install the rubber blanking grommet.
10. Install the door trim panel. Refer to Front Side Door Trim Panel Replacement.

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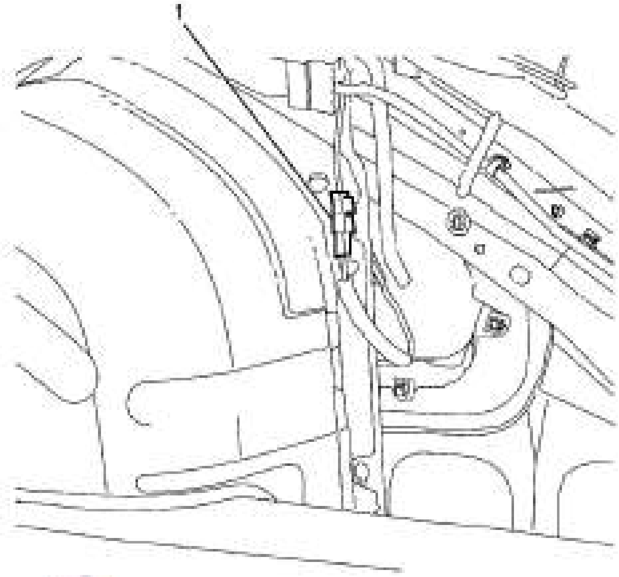
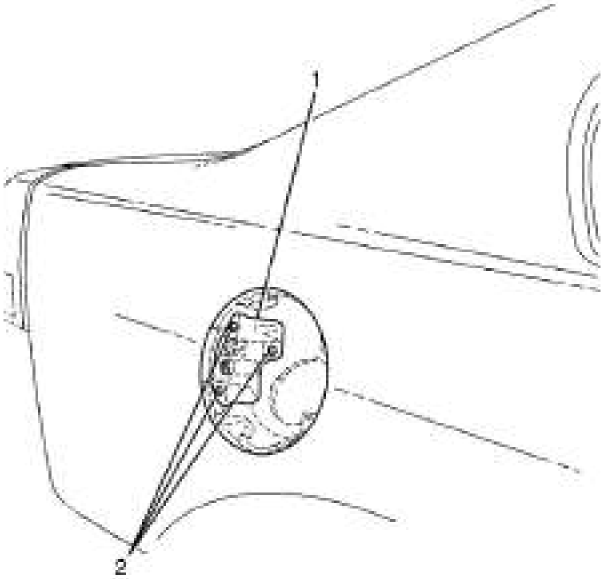
Fuel Tank Filler Door Lock Actuator Replacement (Sedan)

Removal Procedure

1. Remove the rear compartment side trim (right) panel. Refer to Rear Compartment Side Trim Panel Replacement



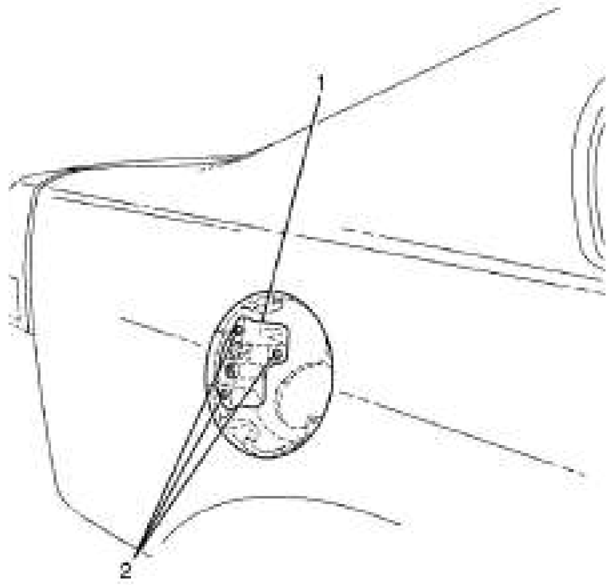
2. Disconnect the electrical connector (1) to the fuel filler door release actuator.



3. Remove the fuel filler door release actuator to fuel filler neck retaining screws (2).

4. Remove the fuel filler door release actuator (1) from the upper fuel filler neck.

Installation Procedure

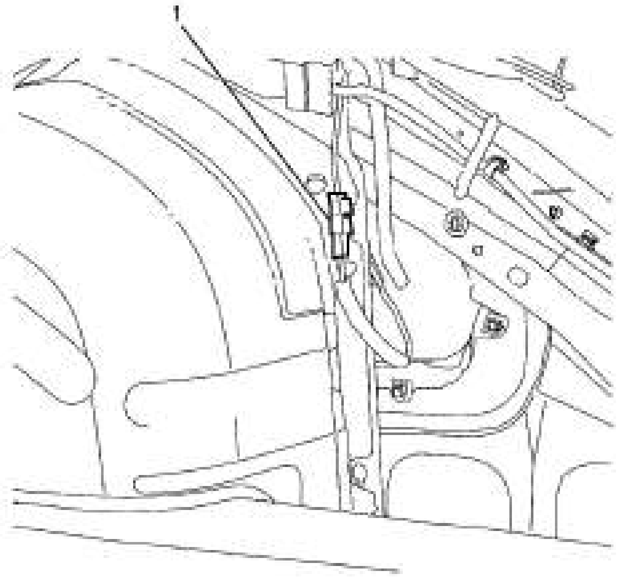


1. Install the fuel filler door release actuator (1) to the upper fuel filler neck.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the fuel filler door release actuator to upper fuel filler neck retaining screws (2).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).



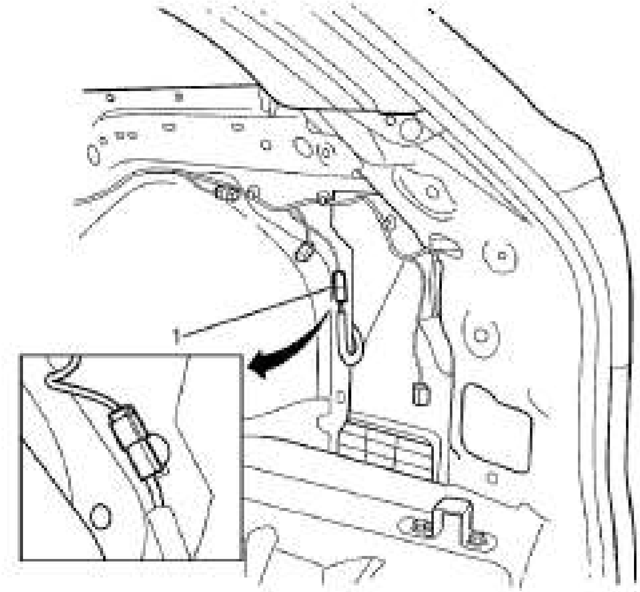
3. Connect the electrical connector (1) to the fuel filler door release actuator.
4. Install the rear compartment side trim (right) panel. Refer to Rear Compartment Side Trim Panel Replacement

Fuel Tank Filler Door Lock Actuator Replacement (Sportwagon)

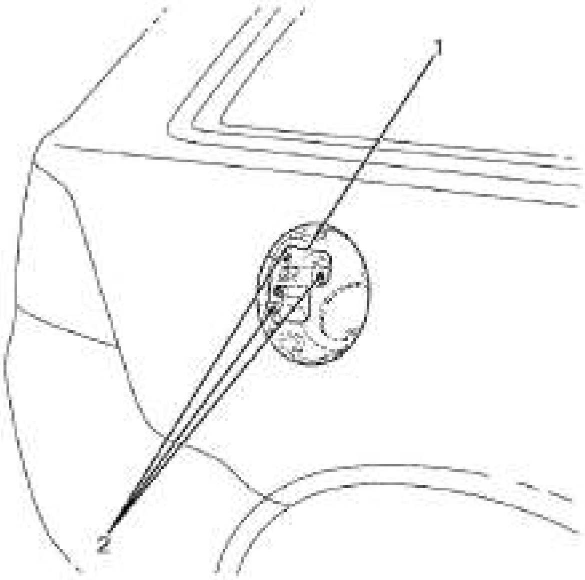
Removal Procedure

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
3. Remove the luggage shade. Refer to Luggage Shade Replacement.
4. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
5. Remove the right hand side load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
6. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
7. Remove the right hand side quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.

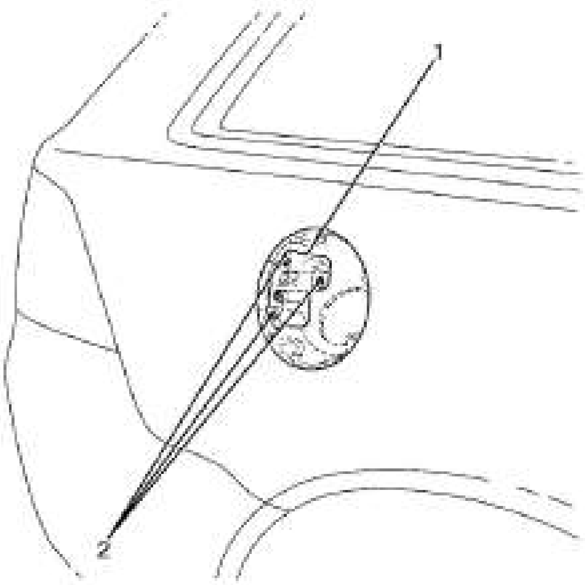


8. Disconnect the electrical connector (1) from the fuel filler door release actuator.



9. Remove the fuel filler door release actuator to upper fuel filler neck retaining screws (2).
10. Remove the fuel filler door release actuator (1) from the upper fuel filler neck.

Installation Procedure

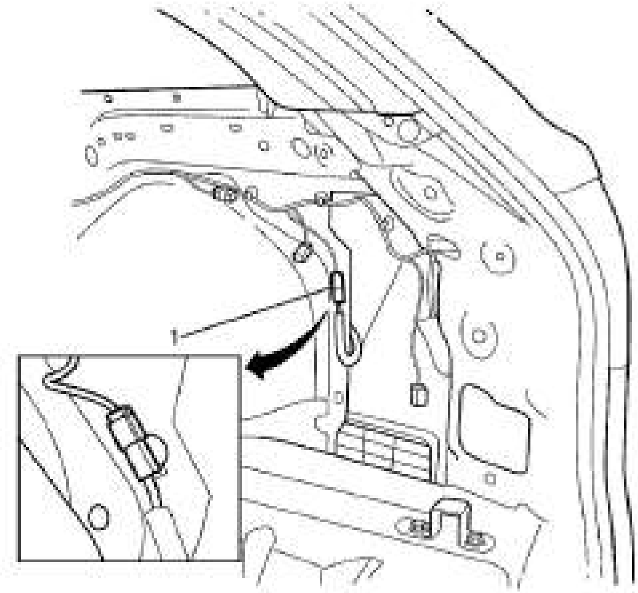


1. Install the fuel filler door release actuator (1) to the upper fuel filler neck.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the fuel filler door release actuator to upper fuel filler neck retaining screws (2).

Tighten
Tighten the screws to 2 N·m (18 lb in).



3. Connect the electrical connector (1) to the fuel filler door release actuator.
4. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
5. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
6. Install the right hand side load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
7. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
8. Install the luggage shade. Refer to Luggage Shade Replacement.
9. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

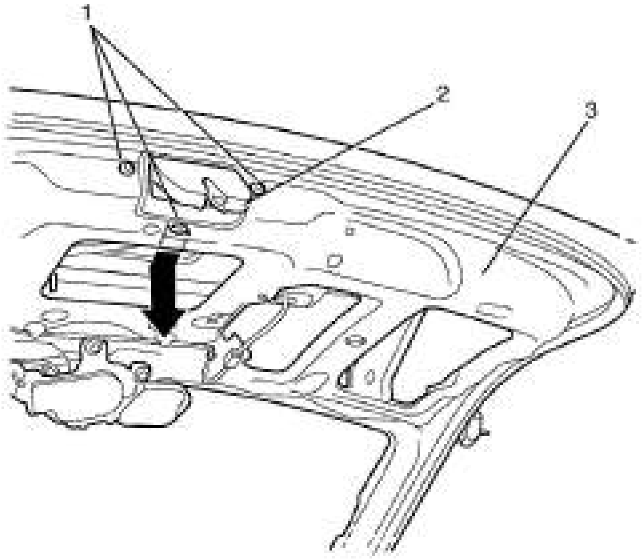
10. Remove the suitable liftgate brace from the vehicle.

Liftgate Latch Replacement

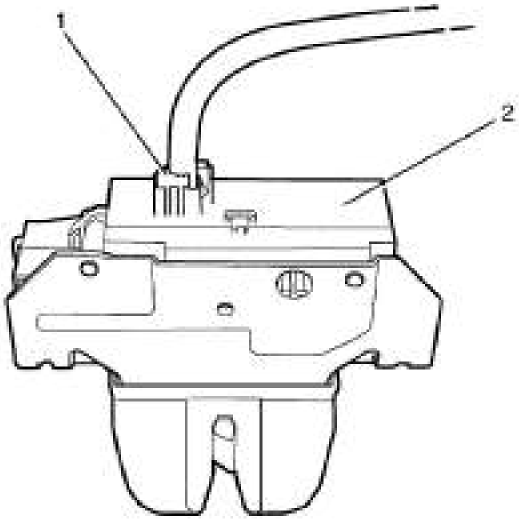
Removal Procedure

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Remove the liftgate window side garnish moulding. Refer to Liftgate Window Side Garnish Molding Replacement.
3. Remove the liftgate window lower garnish moulding. Refer to Liftgate Window Lower Garnish Molding Replacement.
4. Remove the liftgate trim panel. Refer to Liftgate Trim Panel Replacement.

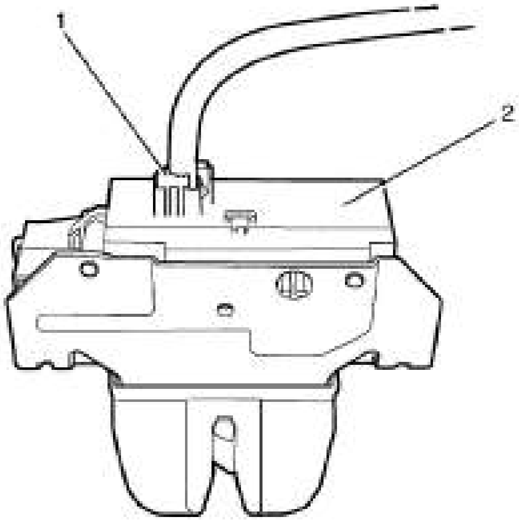


5. Remove the liftgate latch to liftgate retaining bolts (1).
6. Manoeuvre the liftgate latch (2) from the liftgate (3) through the access hole.

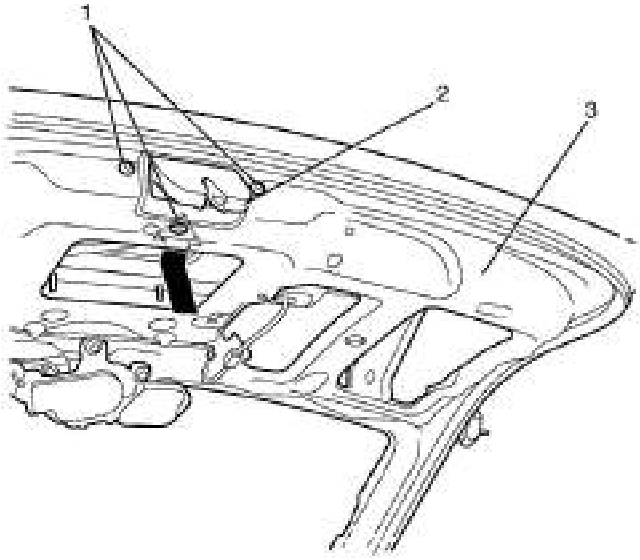


7. Disconnect the electrical connector (1) from the liftgate latch (2).
8. Remove the liftgate latch from the vehicle.

Installation Procedure



1. Connect the electrical connector (1) to the liftgate latch (2).



Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

2. Manoeuvre the liftgate latch (2) into position in the liftgate (3) through the access hole.

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the liftgate latch to liftgate retaining bolts (1).

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).

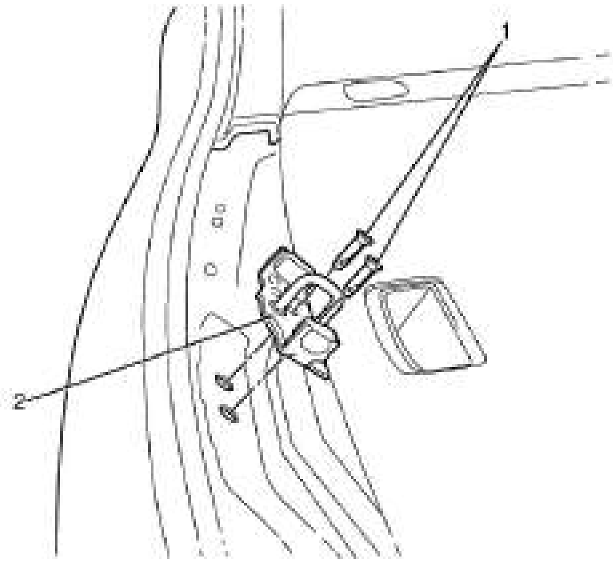
4. Install the liftgate trim panel. Refer to Liftgate Trim Panel Replacement.
5. Install the liftgate window lower garnish moulding. Refer to Liftgate Window Lower Garnish Molding Replacement.
6. Install the liftgate window side garnish moulding. Refer to Liftgate Window Side Garnish Molding Replacement.
7. Remove the suitable liftgate brace from the vehicle.

Liftgate Latch Striker Replacement

Removal Procedure

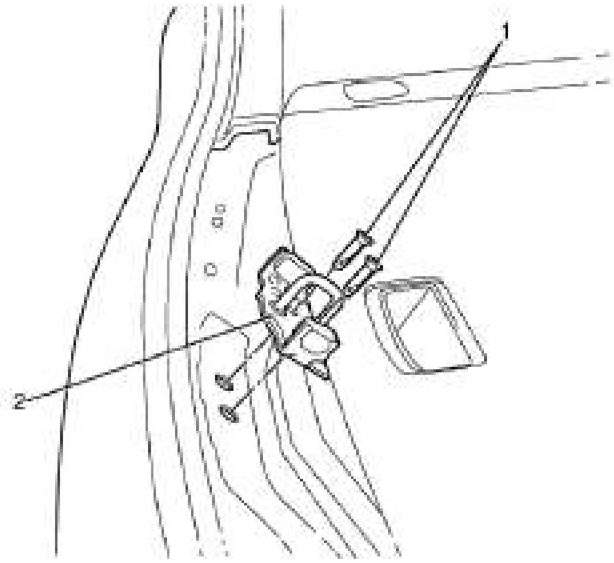
Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable liftgate brace to the vehicle.
2. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.



3. Using a wax pencil, mark the position of the liftgate latch striker to the body.
4. Remove the liftgate latch striker to body retaining bolts (1).
5. Remove the liftgate latch striker (2) from the vehicle.

Installation Procedure



Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Position the liftgate latch striker (2) to the body as marked on removal.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the liftgate latch striker to body retaining bolts (1).

   Tighten
   Tighten the bolts to 20 N·m (15 lb ft).

3. Check the operation of liftgate latch striker, adjust if necessary.
4. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
5. Remove the suitable liftgate brace from the vehicle.

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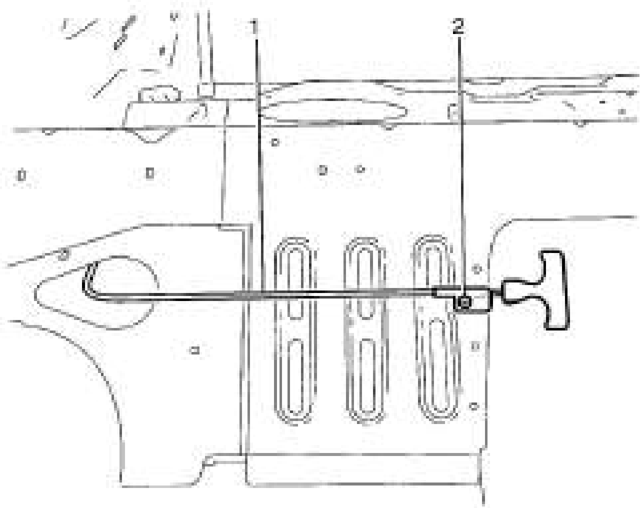
Rear Compartment Lid Latch Release Cable Replacement

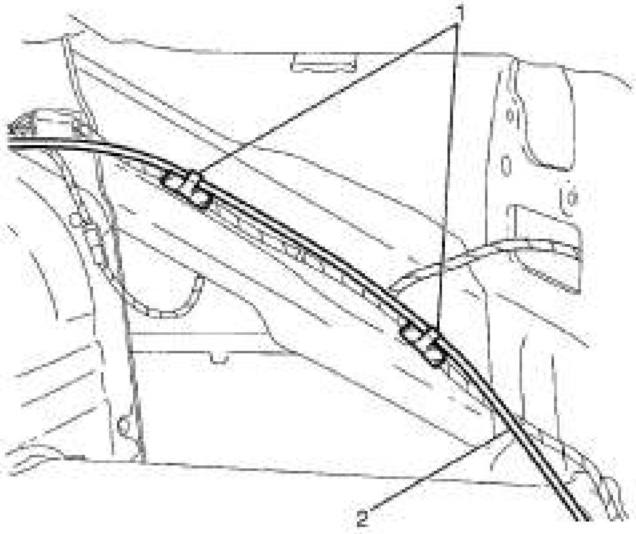
Removal Procedure

> **Important:** When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Support the rear compartment lid with a suitable brace.
2. Remove the rear seat back. Refer to Rear Seat Back Replacement .
3. Remove the rear compartment side trim (right) panel. Refer to Rear Corner Trim Panel Carpet Replacement .
4. Remove the rear compartment lid lock actuator. Refer to Rear Compartment Lid Lock Actuator Replacement .

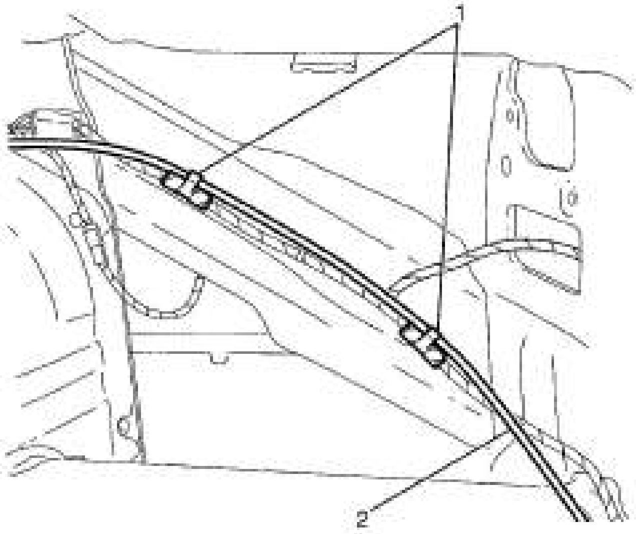


5. Remove the rear compartment lid release cable to rear seat back panel retaining screw (1)

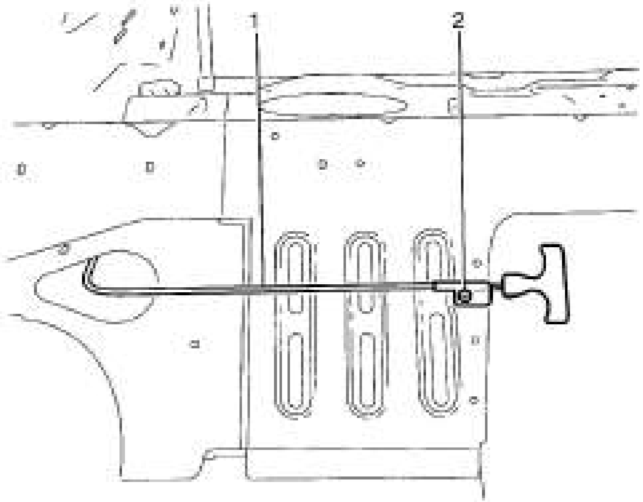


6. Remove the rear compartment lid release cable to rear compartment retaining clips (1).
7. Remove the rear compartment lid release cable (2) from the rear compartment.

Installation Procedure



1. Position the rear compartment lid release cable (2) in the rear compartment.
2. Install the rear compartment lid release cable to rear compartment retaining clips (2).



3. Install the rear compartment lid release cable to rear seat back panel retaining screw (1).

   Tighten
   Tighten the screw to 2 N·m (18 lb in).

4. Install the rear compartment lid lock actuator. Refer to Rear Compartment Lid Lock Actuator Replacement .
5. If re-programming is required. Refer to Control Module References .
6. Install the rear compartment side trim (right) panel. Refer to Rear Corner Trim Panel Carpet Replacement .
7. Install the rear seat back. Refer to Rear Seat Back Replacement .
8. Remove the suitable brace from the vehicle.

Rear Compartment Lid Latch Replacement

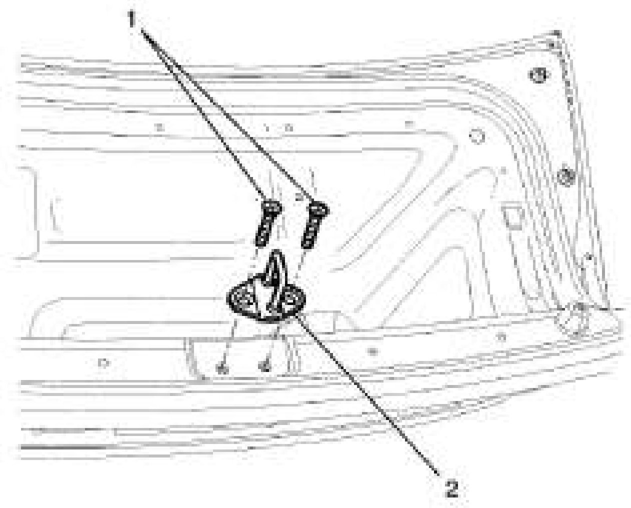
The rear compartment lid latch is part of the lock actuator Refer to Rear Compartment Lid Lock Actuator Replacement.

Rear Compartment Lid Latch Striker Replacement

Removal Procedure

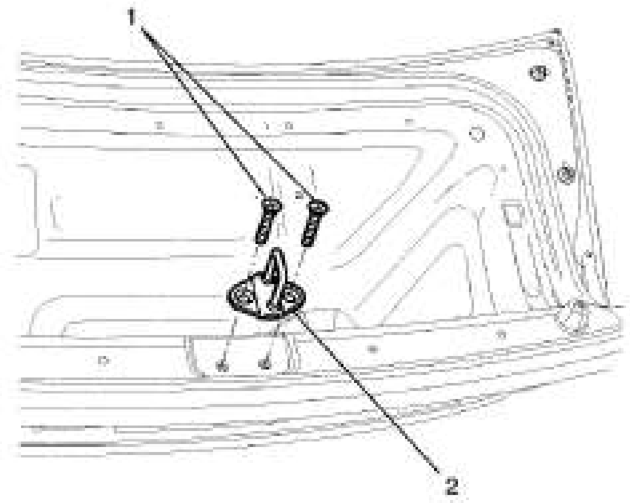
Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Support the rear compartment lid with a suitable brace.



2. Remove the rear compartment lid latch striker to rear compartment lid retaining torx screws (1).
3. Remove the rear compartment lid latch striker (2).

Installation Procedure



1. Position the rear compartment lid latch striker (2) to the rear compartment lid.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the rear compartment lid latch striker to rear compartment lid retaining torx screws (1).

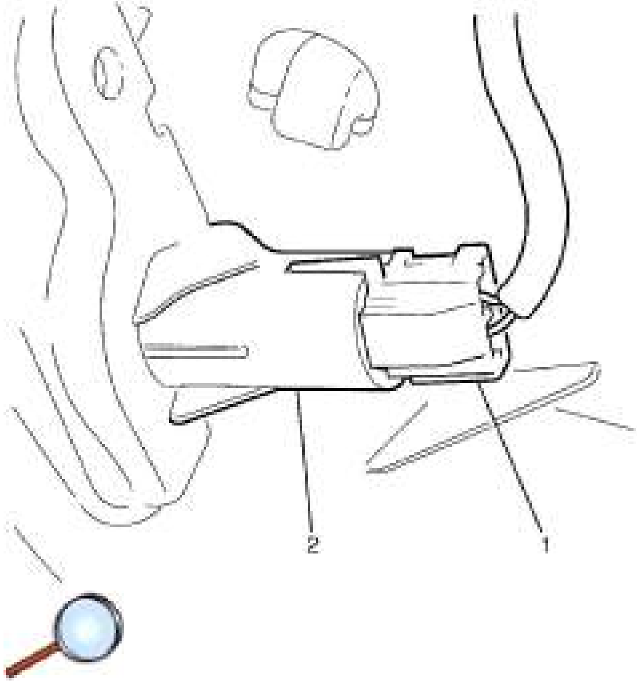
   Tighten
   Tighten the torx screws to 25 N·m (18 lb ft).

3. Remove the suitable brace from the vehicle.

Rear Compartment Lid Release Switch Replacement

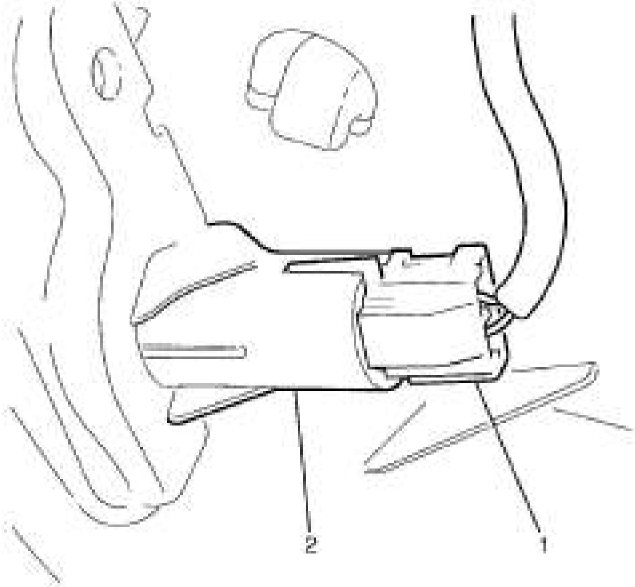
Removal Procedure

1. Remove the instrument panel compartment. Refer to Instrument Panel Compartment Replacement.



2. Disconnect the rear compartment lid wiring connector (1) to rear compartment lid release switch.
3. Remove the rear compartment lid release switch (2) from the instrument panel compartment.

Installation Procedure

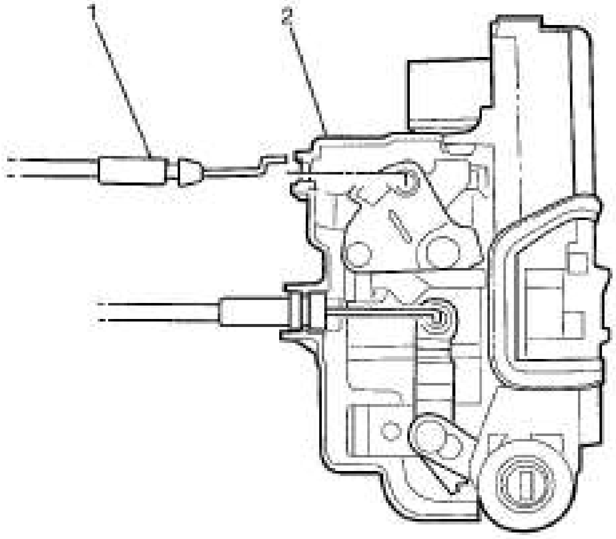


1. Install the rear compartment lid release switch (2) to the instrument panel compartment.
2. Connect the rear compartment lid wiring connector (1) to rear compartment lid release switch (2).
3. Install the instrument panel compartment. Refer to Instrument Panel Compartment Replacement.
4. If re-programming is required. Refer to Control Module References.

Rear Side Door Inside Handle Cable Replacement

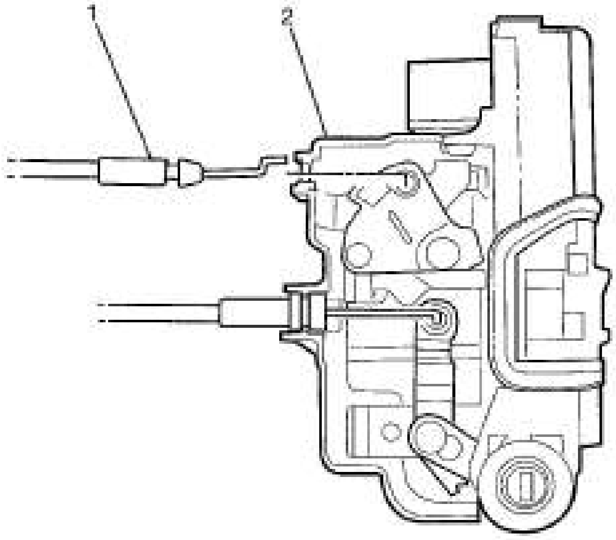
Removal Procedure - Door Handle Cable

1. Remove the door trim panel. Refer to Rear Side Door Trim Panel Replacement .
2. Remove the water deflector. Refer to Rear Side Door Water Deflector Replacement .
3. Remove the door latch. Refer to Rear Side Door Latch Replacement .



4. Disconnect the door handle cable (1) from the door latch (2).

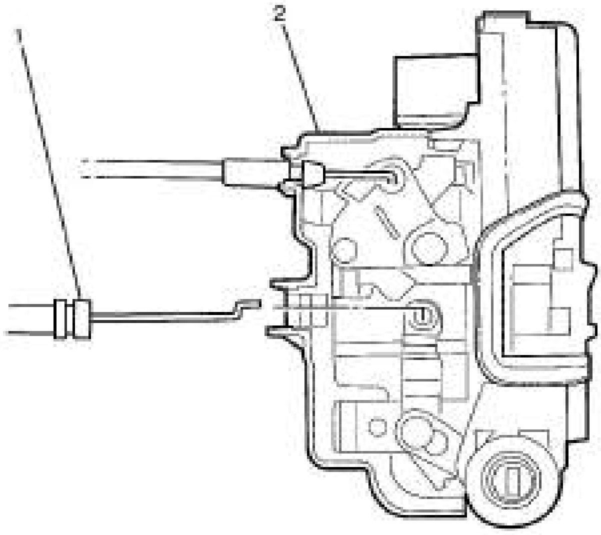
Installation Procedure - Door Handle Cable



1. Connect the door handle cable (1) to the door latch (2).
2. Install the door latch. Refer to Rear Side Door Latch Replacement .
3. Install the water deflector. Refer to Rear Side Door Water Deflector Replacement .
4. Install the door trim panel. Refer to Rear Side Door Trim Panel Replacement .

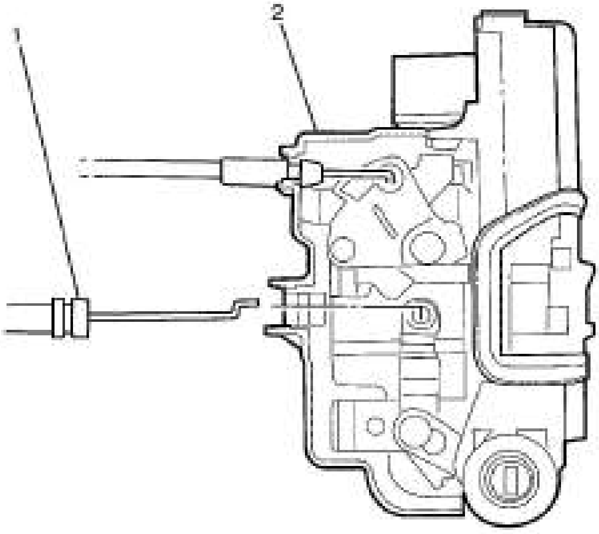
Removal Procedure - Lock Cable

1. Remove the door trim panel. Refer to Rear Side Door Trim Panel Replacement .
2. Remove the water deflector. Refer to Rear Side Door Water Deflector Replacement .
3. Remove the door latch. Refer to Rear Side Door Latch Replacement .



4. Disconnect the lock cable (1) from the door latch (2).

Installation Procedure - Lock Cable



1. Connect the door handle cable (1) to the door latch (2).
2. Install the door latch. Refer to Rear Side Door Latch Replacement .
3. Install the water deflector. Refer to Rear Side Door Water Deflector Replacement .
4. Install the door trim panel. Refer to Rear Side Door Trim Panel Replacement .

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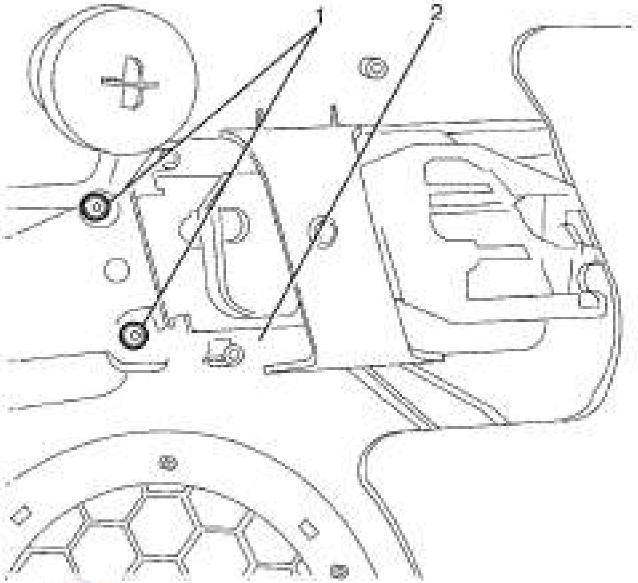
Rear Side Door Inside Handle Replacement

Removal Procedure

1. Remove the door trim panel. Refer to Rear Side Door Trim Panel Replacement .



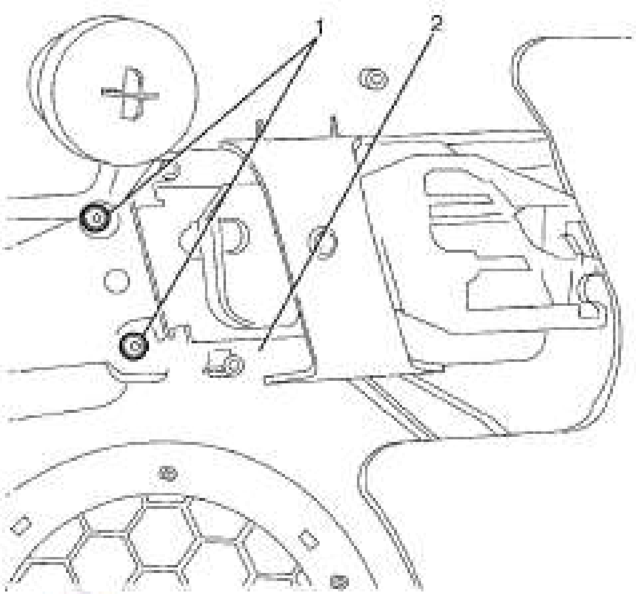
Important: The inside door handle to door trim panel retaining screws (1) are on the inside of the door trim panel (2).

2. Remove the inside door handle to door trim panel retaining screws (1).
3. Remove the inside door handle from the door trim panel (2).

Installation Procedure

1. Install the inside door handle to the door trim panel.

Notice: Refer to Fastener Notice in the Preface section.



Important: The inside door handle to door trim panel retaining screws (1) are on the inside of the door trim panel (2).

2. Install the inside door handle to door trim panel retaining screws (1).

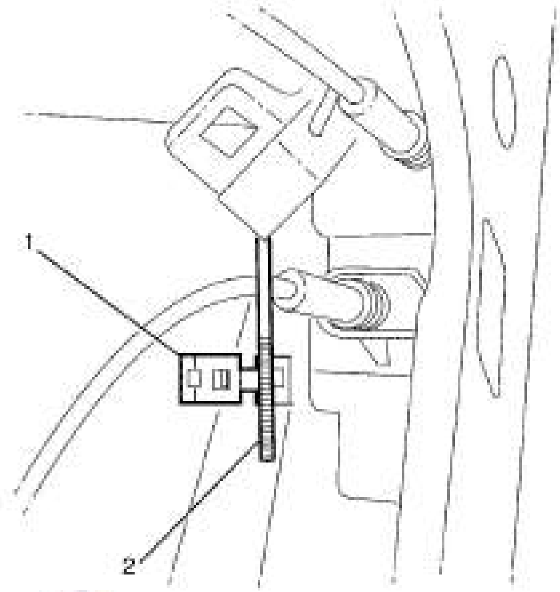
   Tighten
   Tighten the screws to 3 N-m (27 lb in).

3. Install the door trim panel (2). Refer to Rear Side Door Trim Panel Replacement .

Rear Side Door Latch Replacement

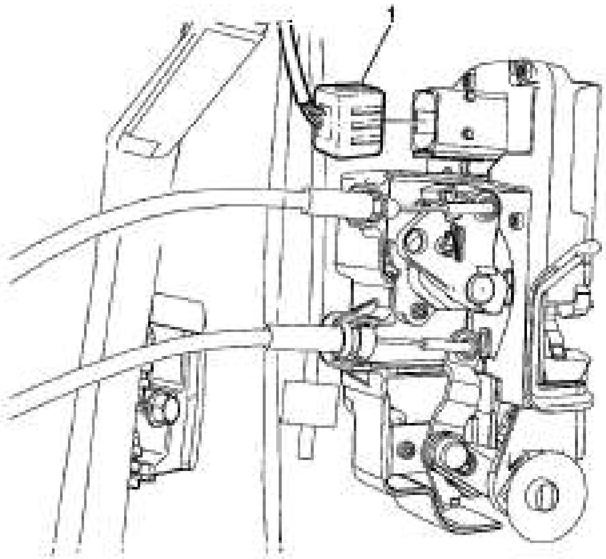
Removal Procedure

1. Raise the window to the full up position.
2. Remove the door trim panel. Refer to Rear Side Door Trim Panel Replacement.
3. Pull the rear half of the water deflector away from the door panel in order to access the door latch.

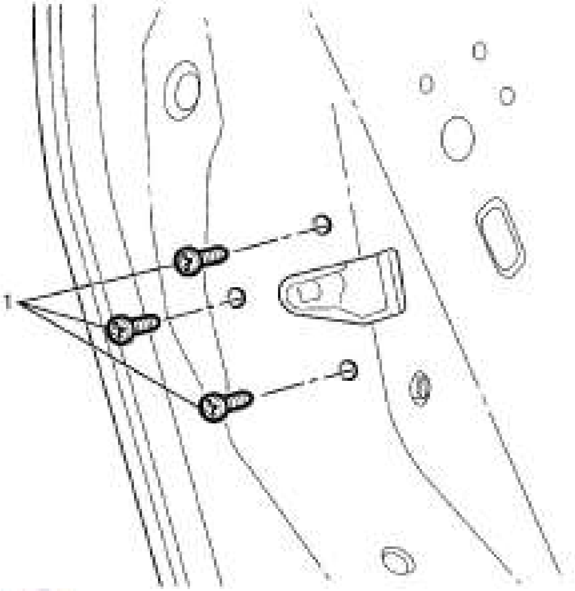


Important: Pry the outside door handle rod retaining clip (1) using a suitable tool.

4. Disconnect the outside door handle rod (1) from the door latch (2).



5. Disconnect the door latch electrical connector (1).



Important: The door latch to door retaining screws (2) are single use parts and must be discarded after use.

Important: Support the door latch when removing the door latch retaining screws (1).

6. Remove the door latch to door retaining screws (1).

   Discard the screws.

   Important: Remove the door latch through the door cavity.

7. Remove the door latch from the door with the inside door handle cable and inside door lock cable attached.
8. Disconnect the inside door handle cable and inside door lock cable from the door latch. Refer to Rear Side Door Inside Handle Cable Replacement.

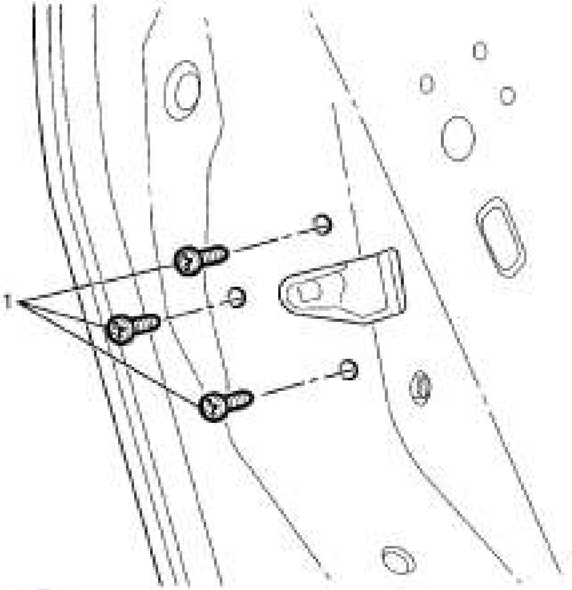
Installation Procedure

1. Connect the inside door handle cable and inside door lock cable to the door latch. Refer to Rear Side Door Inside Handle Cable Replacement.

   Important: Position the door latch through the door cavity and support. .

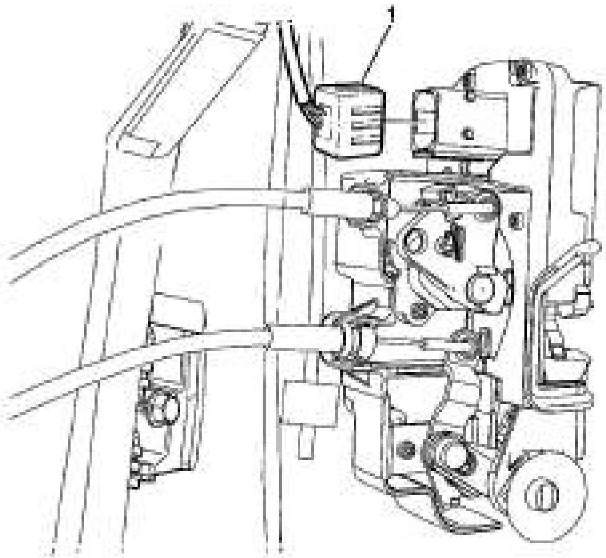
2. Position the door latch into the door.

   Notice: Refer to Fastener Notice in the Preface section.

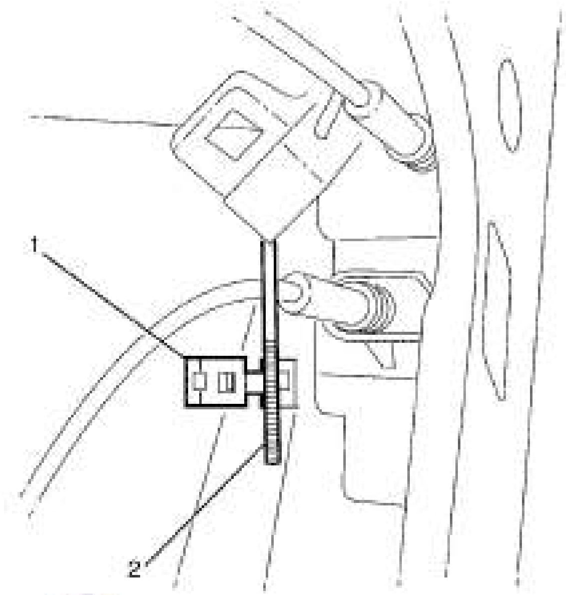


3. Install the door latch to door NEW retaining screws (1).

   Tighten
   Tighten the screws to 13 N-m (115 lb in).



4. Connect the door latch electrical connector (1).



Important: Attach the door handle rod retaining clip (1) by pressing clip together over door handle rod until an audible click is heard.

5. Connect the outside door handle rod (2) to the door handle rod retaining clip (1).
6. Inspect for the correct operation of the door handle and door latch.

Important: Firmly press the water deflector where adhesive is applied to make sure of a water tight bond.

7. Install the rear half of the water deflector to the door panel.
8. Install the door trim panel. Refer to Front Side Door Trim Panel Replacement.

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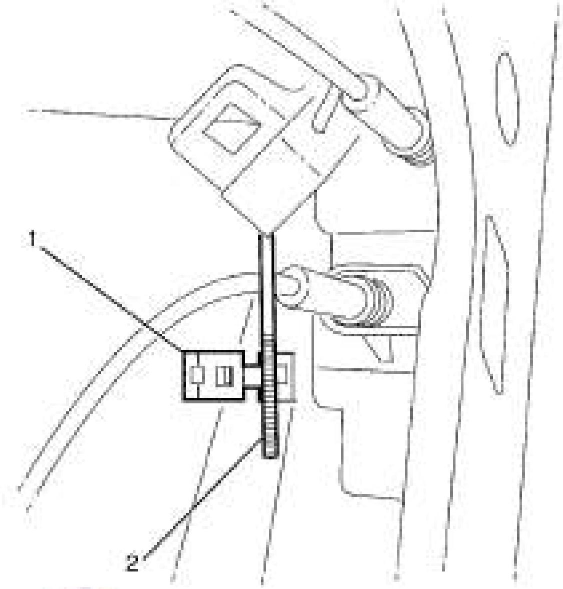
Rear Side Door Outside Handle Replacement

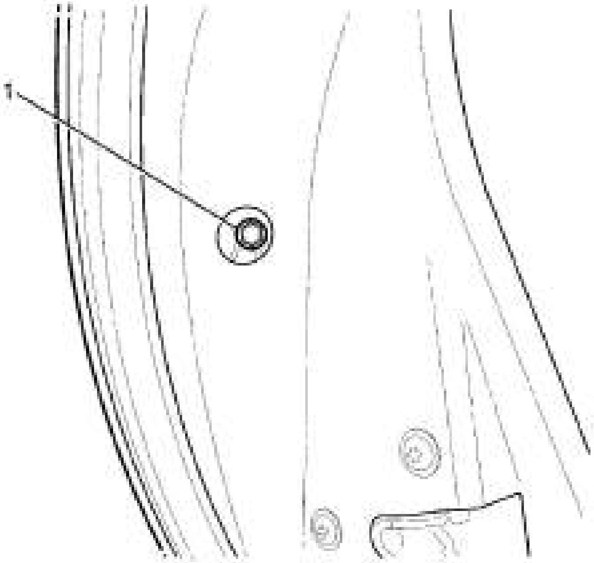
Removal Procedure

1. Remove the door trim panel. Refer to Rear Side Door Trim Panel Replacement.
2. Pull the rear half of the water deflector away from the door panel in order to access the outside door handle.



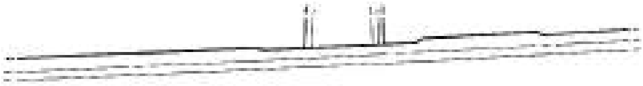
Important: Pry the outside door handle rod retaining clip (1) using a suitable tool.

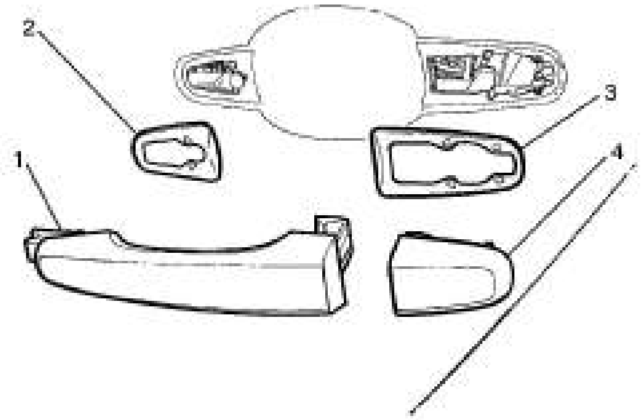
3. Disconnect the outside door handle rod (2) from the door handle rod retaining clip (1).



Important: Remove the rubber blanking grommet to expose lock cylinder retaining bolt (1).

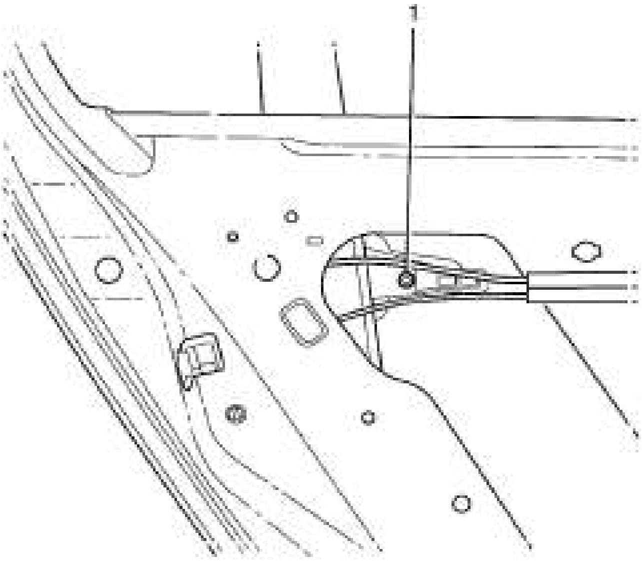
4. Remove the outside door handle to door retaining bolt (1).





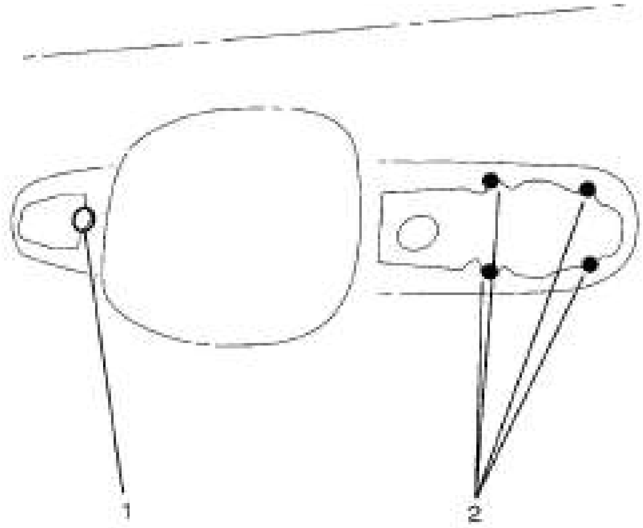
Important: Replace the gaskets (2, 3) when replacing the outside door handle (1, 4).

5. Remove the outside door handle (1, 4) from the door.



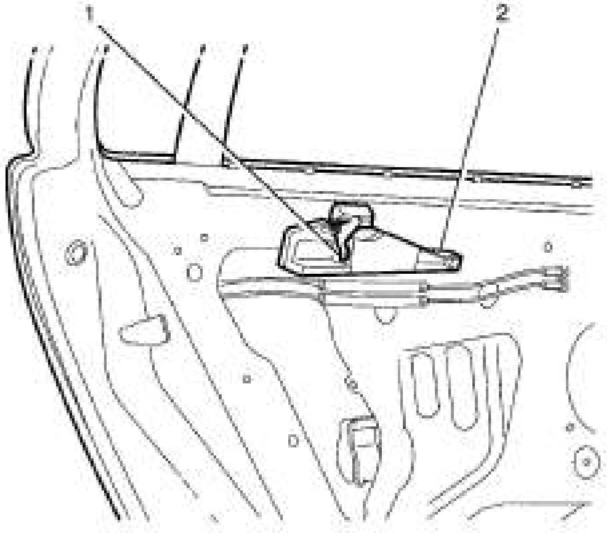
Important: The outside door handle retaining nut (1) must be loosened to remove the inner part of the outer door handle.

6. Loosen the outside door handle retaining nut (1).
7. Push on the outside door handle retaining nut and stud to relieve pressure between the inner part of the door handle and the door.



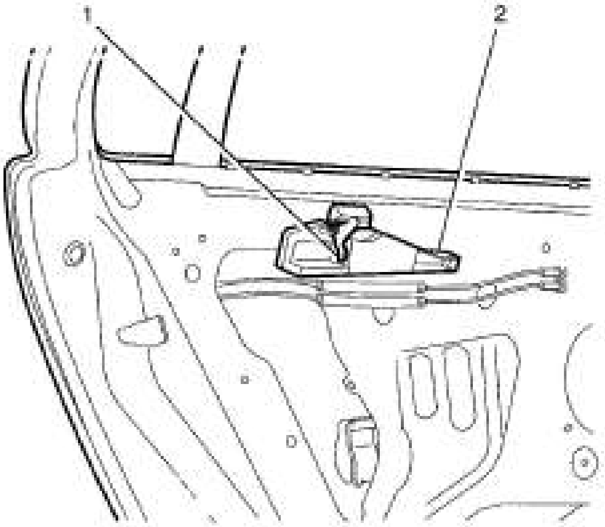
Important: Push the retaining tabs (2) inwards to release them then push the inner handle towards the front of the car to release the retaining pin (1).

8. Remove the inner part of the outer door handle (1, 2).

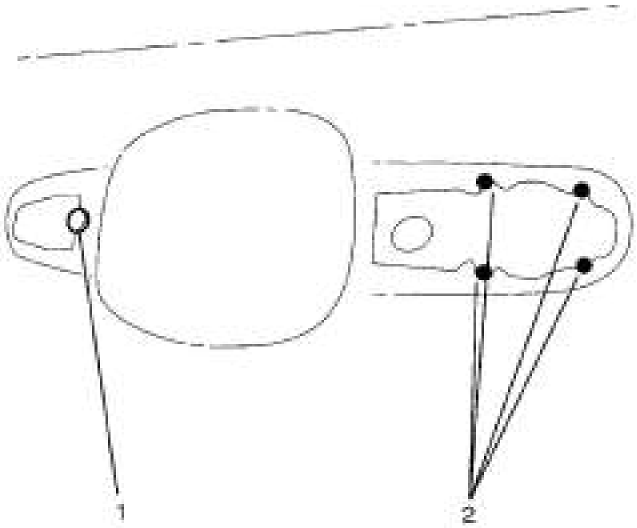


9. Remove the inner part (1) of the outer door handle from the door (2).

Installation Procedure



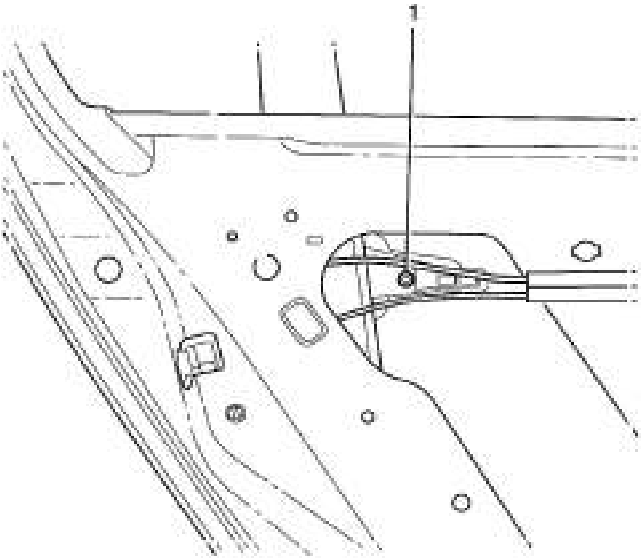
1. Position the inner part (1) of the outer door handle to the door (2).



Important: Lock in the retaining pin (1) by pushing towards the rear of the car then outwards to engage the retaining tabs (2).

2. Install the inner part of the outer door handle (1, 2).

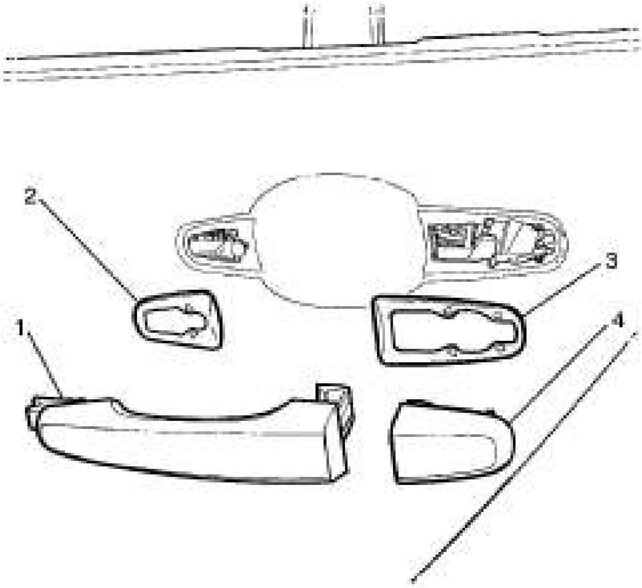
Notice: Refer to Fastener Notice in the Preface section.



Important: The outside door handle retaining nut (1) must be tightened to fasten the inner part of the outer door handle.

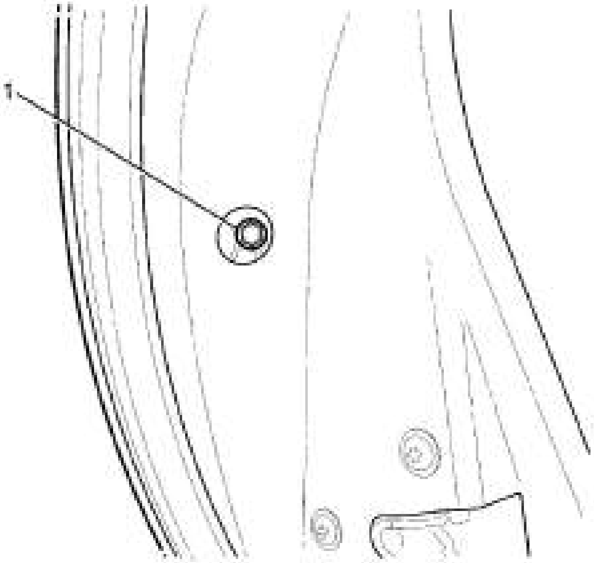
3. Tighten the outside door handle retaining nut (1).

Tighten
Tighten the bolt to 4 N-m (35 lb in).



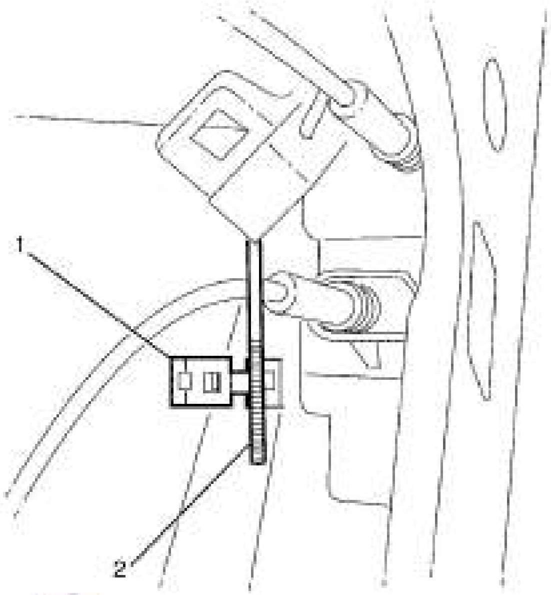
Important: Replace gaskets (2, 3) when replacing the outside door handle (1, 4).

4. Install the outside door handle (1, 4).



5. Install the outside door handle to door retaining bolt (1).

Tighten
Tighten the bolt to 4 N-m (35 lb in).



Important: Attach the door handle rod retaining clip (1) by pressing clip together over door handle rod until an audible click is heard.

6. Connect the outside door handle rod (2) to the door handle rod retaining clip (1).

Important: Firmly press the water deflector where adhesive is applied to make sure of a water tight bond.

7. Install the rear half of the water deflector to the door panel.
8. Install the rubber blanking grommet.
9. Install the door trim panel. Refer to Rear Side Door Trim Panel Replacement.

Door Ajar Indicator Description and Operation

Door Ajar Indicator System Components

The door ajar indicator system consists of the following components:

- The body control module (BCM)
- The instrument panel cluster (IPC)
- The driver door latch
- The passenger door latch
- The left rear door latch
- The right rear door latch

Driver and Passenger Door Ajar Operation

The body control module (BCM) receives discrete inputs from each of the door latches from two independent circuits. The driver door ajar signal is independent of the other door ajar signal circuits, it has a specific circuit allocated to supply an input to the BCM. The passenger, left rear and right rear door ajar signal circuits are combined into one shared circuit to the BCM. If any of the doors are open or not closed correctly, the contacts of the ajar switch are closed causing the voltage within the signal circuit to drop to zero. The BCM detects the drop in voltage and sends a serial data message to the IPC. The IPC, upon receipt of this message, will illuminate the door ajar indicator.

The IPC will also send a serial data message to the radio to activate the door ajar audible warning when the following conditions are met:

- When the engine has been started
- The transmission is shifted from PARK

Fuel Fill Door Description and Operation

The fuel door latch actuator shares the circuit with the driver door latch assembly. The body control module (BCM), upon receipt of a lock switch lock or unlock signal, will switch the appropriate door lock actuator, as well as a fuel filler door release actuator control circuits to battery positive voltage. The opposing side of the door lock and fuel filler door release actuators is connected to ground by the underhood fuse block through the other door lock actuator control circuit and the doors, along with the fuel filler door release, will lock or unlock as commanded.

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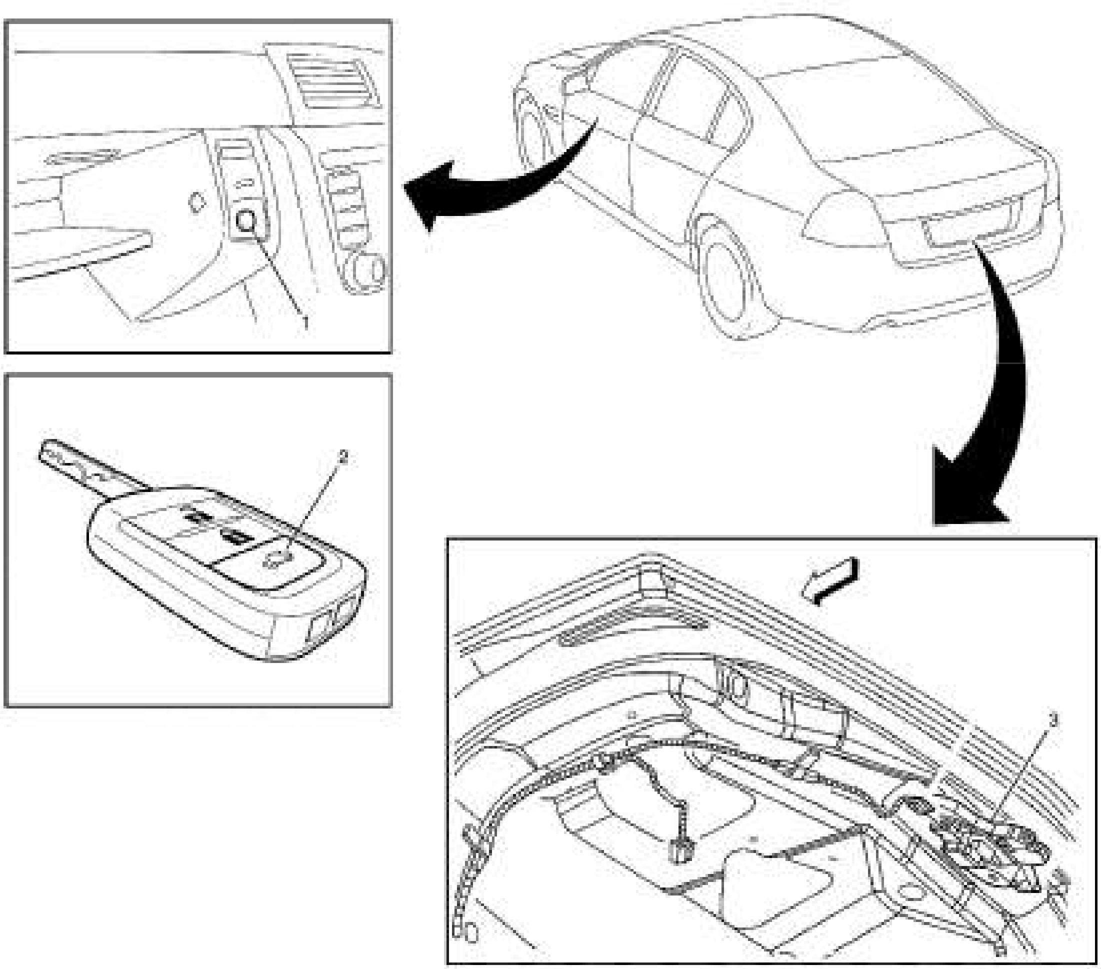
Luggage Compartment Description and Operation

Rear Compartment Lid Release

The rear compartment lid can be released by operating the rear compartment lid release switch (1) or pressing the rear compartment release button on the key fob. The transmission must be in the PARK position for the rear compartment lid to release.

When a request to open the rear compartment lid is requested by either the rear compartment lid release switch or the key fob button, the Body Control Module (BCM) activates the rear compartment lid release relay which allows the rear compartment lid latch assembly motor (3) to operate and release the rear compartment lid.



(1) Rear Compartment Lid Release Switch

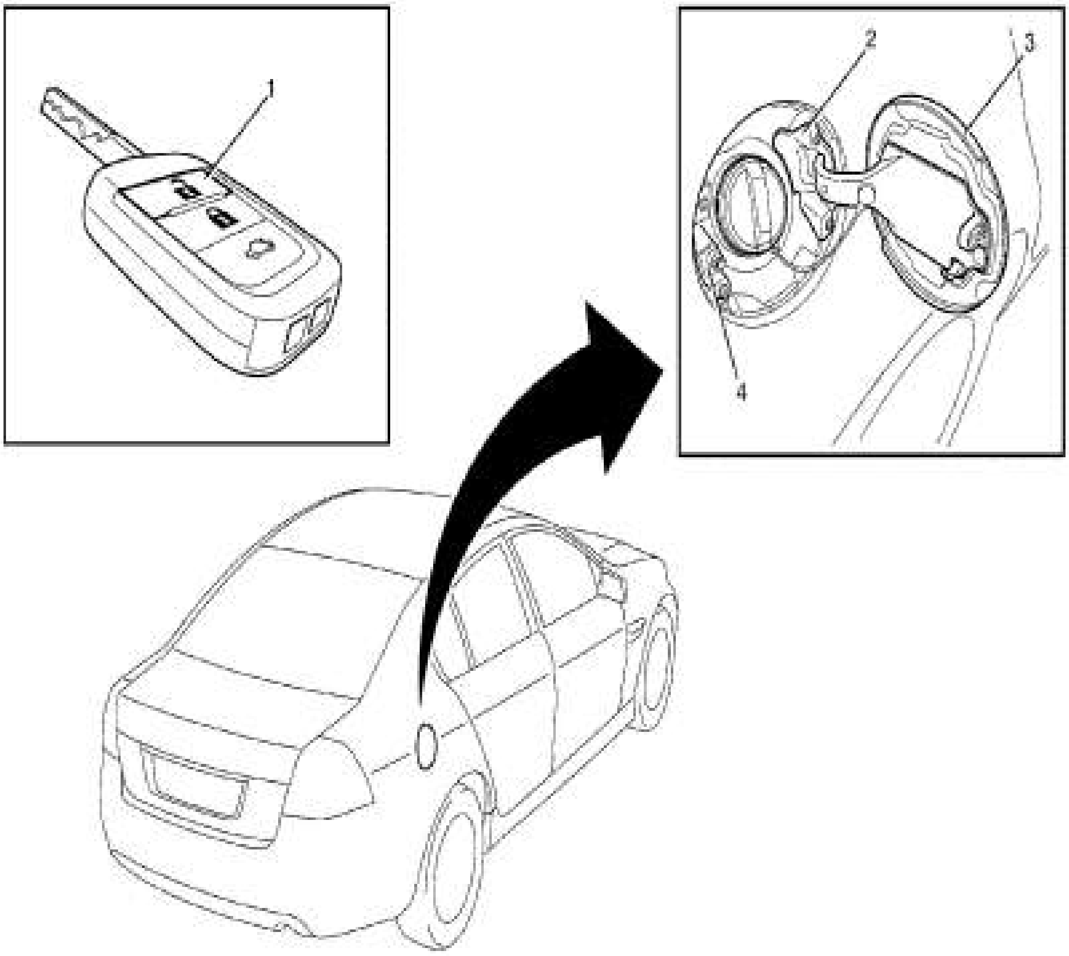
(2) Key Fob Rear Compartment Lid Release Button

(3) Rear Compartment Lid Release Actuator

Fuel Filler Door Release

The fuel filler door can be released by operating the unlock button on the key fob. The transmission must be in the PARK position for the fuel filler door to release.

When a request to open the fuel filler door is requested by the unlock button on the key fob (1), the Body Control Module (BCM) activates the fuel filler door release relay which allows the fuel filler door actuator (4) to operate and release the fuel filler door (3).



(1) Key Fob Door Release Button
(2) Fuel Filler Door Hinge
(3) Fuel Filler Door
(4) Fuel Filler Door Actuator

Power Door Locks Description and Operation

Door Lock System Components

The power door lock system consists of the following components:

- Window/door lock/outside rearview mirror switch.
- ALL LOCK relay.
- PASS LOCK relay.
- DRIVER UNLOCK relay.
- Body control module (BCM).
- Reversible door latches in each of the doors.
- Driver door key cylinder switch
- Door locks 25A fuse

Door Lock System Controls

The Power Door Lock System is controlled by the BCM and can be activated by any one of the following:

- Power door lock switch lock or unlock command
- Keyless entry lock or unlock command
- A driver door lock key cylinder switch lock or unlock command
- Programmed automatic door lock and/or unlock command
- Lockout prevention command
- Air bag deployment unlock command

Door Lock and Unlock Operation

When the door lock switch is activated in the lock or unlock position the BCM will detect a voltage drop on either the door lock switch lock or unlock signal circuits.

The BCM, upon receipt of a lock switch lock or unlock signal, will provide the appropriate relay control circuit with voltage or ground. This will energize the relay(s). The relay will supply voltage to the door lock actuator lock or unlock control circuits. Since the opposite side of the lock actuator is connected to ground through the other lock actuator control circuit and the normally closed contacts of the lock or unlock relay, the doors will then lock or unlock as commanded.

Three relays are used to operate the door latches, DRIVER UNLOCK, PASS LOCK and ALL LOCK relays. The driver door latch is isolated so that only the driver door will unlock by a command from the remote keyless entry transmitter.

Automatic Door Lock Operation

The doors can be programmed to lock and/or unlock depending upon the owner's preferences:

- Automatic lock and unlock disabled.
- Driver door unlock when key is removed from ignition
- Driver door unlock when the vehicle is shifted into PARK.
- All doors unlock when key is removed from ignition
- All doors unlock when the vehicle is shifted into PARK.
- All doors lock when the vehicle is above 13km/h (8 mph).
- All doors lock when the vehicle is shifted out of PARK.

Lockout Prevention Operation

This function is intended to prevent the vehicle operator from locking the doors if the key is left in the ignition and any vehicle door is open. The BCM will react after locking all the doors by unlocking the driver door. The lockout prevention function can be overridden by manually locking the driver door.

Key Cylinder Unlock and Lock

The BCM will unlock all doors when the key is inserted into the driver door key cylinder and turned to the unlock position for greater than 1 second and lock all doors when the key is turned to the lock position for greater than 1 second.

Air Bag Deployment Unlock

The BCM will provide unlocking of all the doors 15 seconds after determining the air bags have been deployed.

Rear Hatch / Gate Description and Operation

Liftgate System Components

The liftgate system consists of the following components:

- The liftgate system consists of the following components:
- Liftgate Release Switch
- Rear End Release Relay
- Trunk 10A Fuse
- Body Control Module (BCM)

Liftgate System Controls

The liftgate may be released by commanding all the doors to unlock and by pressing the touchpad located above the license plate.

Liftgate Release Operation

The liftgate release switch is an input to the body control module. The BCM monitors to the signal circuit and when the liftgate switch is pressed the signal circuit voltage goes low. When the BCM detects the drop in voltage in the liftgate release switch signal circuit, the BCM enables the Rear End Release relay by applying battery voltage to one side of the relay control circuit and ground the other relay control circuit. This energizes the Rear End Release relay coil which closes the contacts within the switch side of the relay and allowing voltage to flow through the relay to the liftgate control circuit and activating the liftgate latch.

The liftgate latch system will only be enabled when the doors are unlocked, the transmission is in Park or for vehicles with a manual transmission, when the vehicle is stationary.

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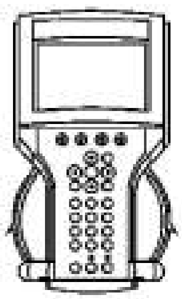
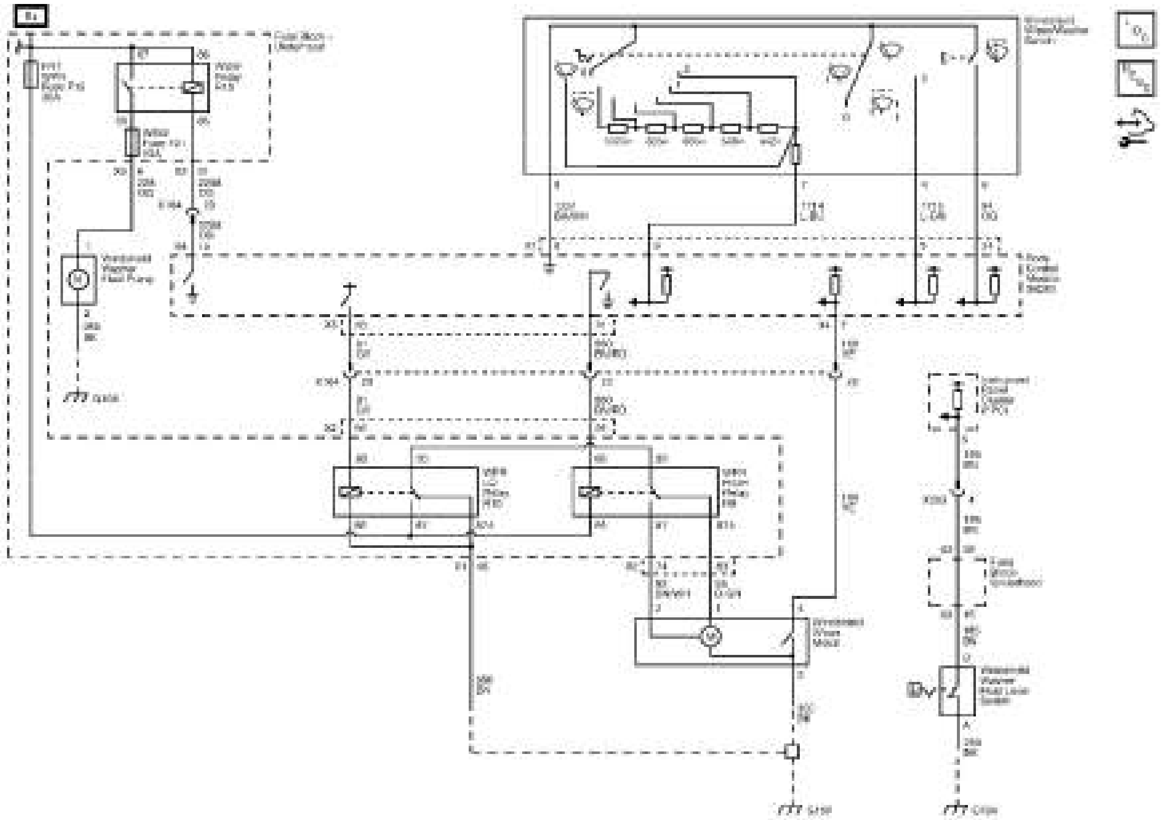
Special Tools

Illustration	Tool Number / Description
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

Fastener Tightening Specifications

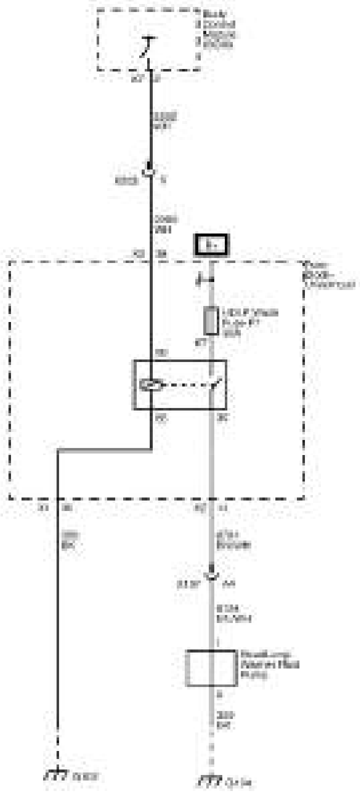
Application	Specification	
	Metric	English
Air Inlet Grille Brace to Air Inlet Grille Retaining Torx Screws (Sportwagon)	2 N·m	18 lb in
Headlamp Washer Nozzle Assembly to Headlamp Assembly Retaining Torx Bolts	1 N·m	9 lb in
Rear Window Wiper Motor to Liftgate Retaining Bolts (Sportwagon)	8 N·m	71 lb in
Rear Wiper Arm Retaining Nut (Sportwagon)	9 N·m	80 lb in
Washer Solvent Container Filler Neck to Front End Module Bracket Retaining Bolt and Nut	5 N·m	44 lb in
Washer Solvent Container Filler Neck to Front End Module Bracket Retaining Torx Screw	4 N·m	35 lb in
Washer Solvent Container to Front End Module Support Retaining Bolts	5 N·m	44 lb in
Wiper Arm to Pivot Stud Retaining Nut	35 N·m	26 lb ft
Wiper Motor Module to Bulk Head Retaining Bolts	8 N·m	71 lb in

Front Wiper / Washer Control

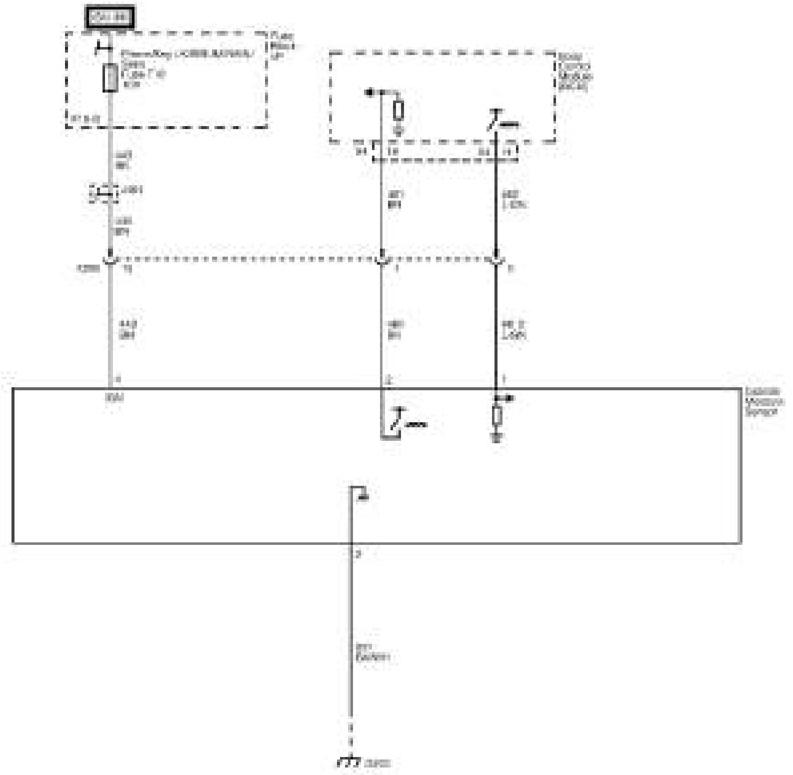

Windshield Washer Fluid Pump
Windshield Wiper Motor
Windshield Washer Fluid Level Switch

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Systems | Wipers and Washers | Schematic and Routing Diagrams | Document ID: 2153429

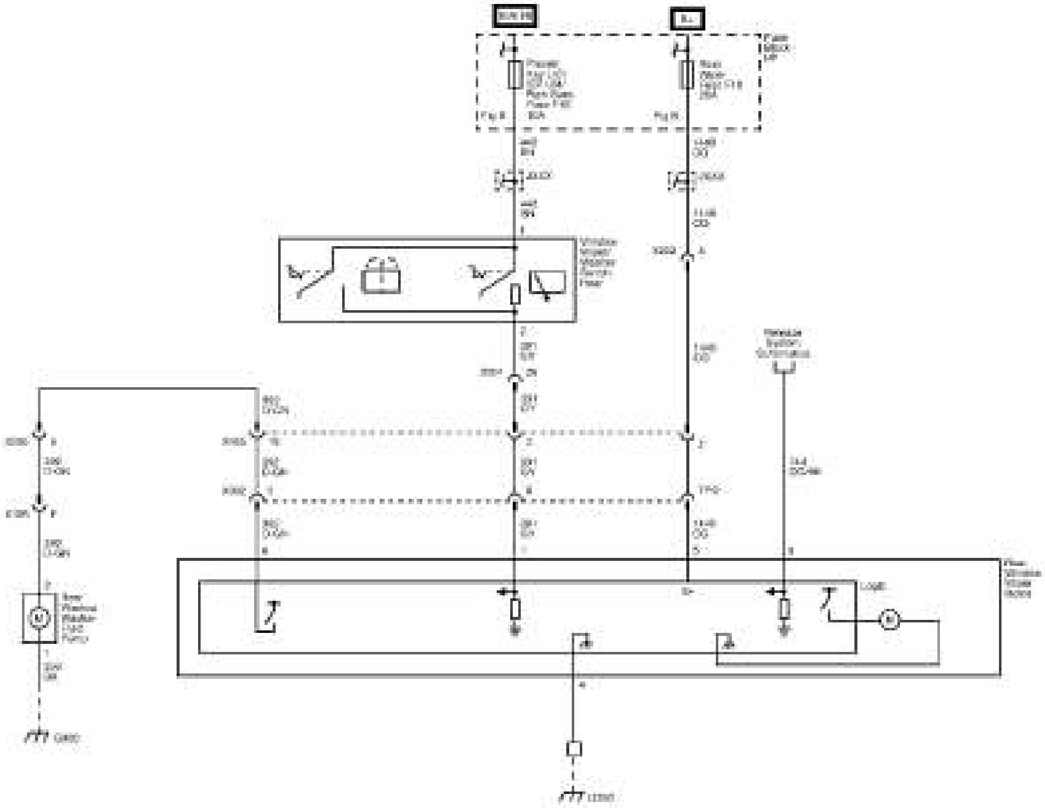
Headlamp Washers


Body Control Module
B+
BK
Headlamp Washer Fluid Pump
BK

Outside Moisture Sensing



Rear Wiper / Washer Control



Diagnostic Starting Point - Wiper / Washer Systems

Begin the diagnosis by reviewing the system Description and Operation. Reviewing the Description and Operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the Description and Operation information will also help you determine if the condition described by the customer is normal operation. Refer to Diagnostic System Check - Vehicle , in order to identify the correct procedure for diagnosing the system and where the procedure is located.

The Diagnostic System Check will provide the following information:

- The identification of the control modules which command the system.
- The ability of the control modules to communicate through the serial data circuit.
- The identification of any stored diagnostic trouble codes (DTCs) and their status.

DTC B370C or B370D

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B370C 00: Rain Sensor Intensity Signal Circuit.

DTC B370D 00: Rain Sensor Mode Control Circuit.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	1	1	1	--
Outside Moisture Sensor Signal 1	B370D	B370D	1	--
Outside Moisture Sensor Signal 2	B370C	B370C	1	--
Ground	--	1	--	--
1. Moisture sensing feature is inoperative				

Circuit/System Description

Ignition voltage is supplied to the windshield outside moisture sensor from the body control module (BCM). Whenever the ignition is in the run or accessory positions, the BCM sends the wiper/washer switch status using a pulse width modulated (PWM) signal through the windshield outside moisture sensor signal 1 circuit to the outside moisture sensor. When a wipe cycle is needed, the moisture sensor sends a PWM voltage signal through the moisture sensor signal 2 circuit back to the BCM requesting the wiper operation.

The windshield outside moisture sensor uses the moisture sensor signal 2 circuit to command wiper motor wipe cycles and to confirm the moisture sensor signal 1 is being received. If at anytime communication between the windshield outside moisture sensor and BCM is lost, the BCM will use the inputs from the windshield wiper/washer switch in the delay positions to operate the wiper motor at continuous variable delay intervals.

Conditions for Running the DTC

The ignition is in the Run or Accessory positions.

Conditions for Setting the DTC

B370C

An open, short to ground or a short to voltage has been detected on moisture sensor signal 2 circuit.

B370D

An open, short to ground or a short to voltage has been detected on moisture Sensor Signal 1 circuit.

Action Taken When the DTC Sets

Moisture sensitive wiper operation is suspended so long as the fault is present. The wipers will still operate normally in all other modes.

Conditions for Clearing the DTC

- A current DTC will clear when the fault is no longer present.
- A history DTC will clear after 40 malfunction-free ignition cycles.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, wiper switch in the LOW position. The windshield wipers should operate at low speed. If the windshield wipers do not operate, refer to Windshield Wiper System Malfunction.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the windshield outside moisture sensor.
2. Test for less than 5.0 ohms between the ground circuit terminal 3 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify that a test lamp illuminates between ignition voltage circuit terminal 4 and ground.

   If the test does not illuminate, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
4. Ignition ON, test for 4.0 - 8.5 volts between the signal circuit terminal 2 and ground.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the windshield outside moisture sensor.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the windshield outside moisture sensor.
5. Ignition OFF, connect the harness connector at the windshield outside moisture sensor.
6. Disconnect the X4 harness connector at the BCM.
7. Ignition ON, test for 8.0 - 10.0 volts between the signal circuit terminal 14 and ground.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the windshield outside moisture sensor.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the windshield outside moisture sensor.
8. If all circuits test normal, replace the BCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

For BCM replacement, setup, and programming, refer to Control Module References.

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DTC B3715

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B3715 00: Front Wiper Relay Drive Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
BCM Fuse F9 B+	B3794 00 B1529 00 B3922 00	B3794 00 B1529 00 B3922 00	--	--
FRT WPR Fuse B+	1	1	--	--
Windshield Wiper Switch Signal	B3922 00	1	1	--
Windshield Wiper Switch High Signal	3	1	1	--
Windshield Wiper Motor Park Switch Signal	2	2	--	--
WIPER LO Relay Control	B3715 00	1	3	--
WIPER HIGH Relay Control	1	1	B3875 00	--
Windshield Wiper Motor High Speed Control	1	1	1	--
Windshield Wiper Motor Low Speed Control	1	1	1	--
Windshield Wiper Switch Low Reference	--	1	1	--
Windshield Wiper Motor Ground	--	1	--	--
WIPER CONTROL Relay Ground	--	1	--	--
1.Windshield wiper system malfunction				

2. Wipers Do Not Park

3. Wipers Always ON

Circuit/System Description

The Body Control Module (BCM) monitors the control circuit of the WIPER relay. The voltage level should be low while the WIPER relay is de-energized and near system voltage when the relay is energized. After the BCM receives a low, intermittent, or mist signal from the wiper/washer switch, it responds by applying battery voltage through the WIPER relay control circuit to the coil side of the relay, energizing the WIPER relay.

Conditions for Running the DTC

The BCM output is actively being requested.

Conditions for Setting the DTC

The BCM detects a short to ground in the wiper relay control circuit.

Action Taken When the DTC Sets

The BCM will not activate the output.

Conditions for Clearing the DTC

- The current DTC will clear when the condition for setting the fault is no longer present.
- The history DTC will clear after 100 consecutive ignition cycles without a fault present.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs

- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the WIPER LO Relay.
2. Connect a test lamp between the control circuit terminal 85 and ground circuit terminal 86.
3. Ignition ON, command the low speed wipers ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test for a short to ground or an open/high resistance on the control circuit. If the circuit tests normal, replace the BCM.
4. If all circuits test normal, test or replace the WIPER LO Relay.

Component Testing

1. Ignition OFF, disconnect the Wiper LO Relay.
2. Test for 60-200 ohms between terminals 85 and 86.

   If the resistance is not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If not the specified value, replace the relay.
4. Test for less than 2 ohms between terminals 30 and 87A.

   If greater than the specified range, replace the relay.
5. Install a 10A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.

   If greater than the specified range, replace the Wiper LO relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Control Module References for BCM replacement, setup, and programming
- Relay Replacement

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DTC B3873

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B3873 00: Front Washer Relay Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Windshield Washer Switch Signal	2	1	1	--
Windshield Washer Fluid Pump Control	1	1	2	--
Windshield Washer Relay Control	2	1	B3873 00	--
Windshield Washer Switch Low Reference	--	1	--	--
Windshield Washer Fluid Pump Ground	--	1	--	--
1. Washer Inoperative 2. Washers Always ON				

Circuit/System Description

The Body Control Module (BCM) controls the washer pump motor based on an input from the windshield wiper/washer switch. The BCM monitors the washer switch through the windshield washer switch signal circuit. When the wash switch is closed, ground is supplied to the windshield washer switch signal circuit. When this is seen, the BCM will apply ground to the WSW relay control circuit and command the windshield washer fluid pump and the low speed wipers on.

Conditions for Running the DTC

A washer request is present.

Conditions for Setting the DTC

A short to voltage is detected in the windshield WSW relay control circuit.

Action Taken When the DTC Sets

Washer operation is suspended.

Conditions for Clearing the DTC

- A current DTC will clear when the condition for setting the fault is no longer seen.
- A history DTC will clear after 100 consecutive ignition cycles without a fault present.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the WSW Relay.
2. Connect a test lamp between the control circuit terminal 85 and the B+ terminal circuit 86.
3. Command the washers ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
4. If all circuits test normal, test or replace the WSW Relay.

Component Testing

1. Ignition OFF, disconnect the WSW Relay.
2. Test for 60-200 ohms between terminals 85 and 86.

   If the resistance is not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If not the specified value, replace the relay.
4. Test for less than 2 ohms between terminals 30 and 87A.

   If greater than the specified range, replace the relay.
5. Install a 10A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.

   If greater than the specified range, replace the WSW relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Control Module References for BCM replacement, setup, and programming
- Relay Replacement

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DTC B3875

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B3875 00: Wiper High Speed Relay Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
BCM Fuse F9 B+	B3794 00 B1529 00 B3922 00	B3794 00 B1529 00 B3922 00	--	--
FRT WPR Fuse B+	1	1	--	--
Windshield Wiper Switch Signal	B3922 00	1	1	--
Windshield Wiper Switch High Signal	3	1	1	--
Windshield Wiper Motor Park Switch Signal	2	2	--	--
WIPER LO Relay Control	B3715 00	1	3	--
WIPER HIGH Relay Control	1	1	B3875 00	--
Windshield Wiper Motor High Speed Control	1	1	1	--
Windshield Wiper Motor Low Speed Control	1	1	1	--
Windshield Wiper Switch Low Reference	--	1	1	--
Windshield Wiper Motor Ground	--	1	--	--
WIPER CONTROL Relay Ground	--	1	--	--
1.Windshield wiper system malfunction				

2. Wipers Do Not Park
3. Wipers Always ON

Circuit/System Description

The Body Control Module (BCM) monitors the WIPER HIGH relay control circuit only when wiper high speed mode is active. When the wiper high speed mode is requested, the BCM responds by applying a ground through the WIPER HIGH relay control circuit to the coil side of the relay, energizing the WIPER HIGH relay and applying voltage to the wiper motors high speed circuit.

Conditions for Running the DTC

The BCM output is actively being requested.

Conditions for Setting the DTC

The BCM detects a short to voltage in the WIPER HIGH relay control circuit.

Action Taken When the DTC Sets

The BCM will not activate the output.

Conditions for Clearing the DTC

- A currect DTC will clear when the condition for setting the fault is no longer present.
- A history DTC will clear after 100 consecutive ignition cycles without a fault present.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections

- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, Wiper switch in the HIGH position, verify the scan tool Windshield Wiper Switch parameter is HIGH.
2. Ignition ON, Wiper switch in the HIGH position, verify the scan tool Wiper High Speed Relay Command parameter is ON.
3. Ignition ON, Wiper switch in the HIGH position, verify the scan tool Wiper High Speed Switch parameter is Active.

Circuit/System Testing

1. Ignition OFF, remove the Wiper High relay.
2. Connect a test lamp between B+ circuit terminal 85 and the control circuit terminal 86.
3. Command the Wiper High Speed relay ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
4. If all circuits test normal, replace the WIPER HIGH relay.

Component Testing

1. Ignition OFF, disconnect the WIPER HIGH relay.
2. Test for 60-200 ohms between terminals 85 and 86.

   If the resistance is not within the specified range, replace the WIPER HIGH relay.
3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If not the specified value, replace the WIPER HIGH relay.
4. Test for less than 2 ohms between terminals 30 and 87A.

   If greater than the specified range, replace the WIPER HIGH relay.
5. Install a 10A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.

   If greater than the specified range, replace the Wiper High relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Relay Replacement
- Control Module References for BCM replacement, setup, and programming

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DTC B3922

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B3922 00: Front Wiper Function Select Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
BCM Fuse F9 B+	B3794 00 B1529 00 B3922 00	B3794 00 B1529 00 B3922 00	--	--
FRT WPR Fuse B+	1	1	--	--
Windshield Wiper Switch Signal	B3922 00	1	1	--
Windshield Wiper Switch High Signal	3	1	1	--
Windshield Wiper Motor Park Switch Signal	2	2	--	--
WIPER LO Relay Control	B3715 00	1	3	--
WIPER HIGH Relay Control	1	1	B3875 00	--
Windshield Wiper Motor High Speed Control	1	1	1	--
Windshield Wiper Motor Low Speed Control	1	1	1	--
Windshield Wiper Switch Low Reference	--	1	1	--
Windshield Wiper Motor Ground	--	1	--	--
WIPER LO Relay Ground	--	1	--	--
1.Windshield wiper system malfunction				

2.Wipers Do Not Park

3. Wipers Always ON

Circuit/System Description

The Body Control Module (BCM) monitors the windshield wiper/washer switch low signal circuit. When the wiper switch is placed in the low position, battery voltage is applied through the switch contacts, a series of resistors, and the wiper switch low signal circuit to the BCM. The BCM then applies battery voltage through the wiper relay control circuit to energize the WIPER LO relay. When energized, battery voltage from the FRT WPR fuse is applied through the switch side of the WIPER LO relay then through the switch side of the WIPER HIGH relay to the windshield wiper motor.

Conditions for Running the DTC

Battery voltage is between 9 and 16 Volts.

The low speed BCM output is actively being requested.

Conditions for Setting the DTC

The BCM detects a short to ground or open high resistance on the BCM Fuse F9 B+ circuit.

The BCM detects a short to ground on the windshield wiper switch low speed signal circuit with wiper switch in OFF position and ignition in the OFF position.

Action Taken When the DTC Sets

- The BCM will not activate the low speed output.
- The windshield wipers will only operate in the delay and high speed modes.

Conditions for Clearing the DTC

- The DTC will clear the current status when the condition for setting the fault is corrected.
- A history DTC will clear after 100 consecutive ignition cycles without a fault present.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Windshield Wiper Switch parameter while rotating the wiper switch. The reading should change between Off, Intermittent, Low and High.

Circuit/System Testing

1. Ignition OFF, disconnect the X3 harness connector at the BCM.
2. Verify that a test lamp illuminates between the B+ circuit terminal 3 and ground
   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Connect the X3 harness connector at the BCM, disconnect the harness connector at the windshield wiper/washer switch.
4. Ignition ON, verify the scan tool Windshield Wiper Switch parameter is Off.
   If not the specified value, test the signal circuit terminal 7 for a short to ground. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the windshield wiper/washer switch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the windshield wiper/washer switch.
2. With the wiper switch in the HIGH position, test for less than 2 ohms between the low reference terminal 8 and the signal terminal 4.
   If greater than the specified range, replace the windshield wiper/washer switch.

   Important: If the switch tests open in any switch position other than Off, test the signal circuits for a short to voltage before replacing the switch.

3. While cycling the wiper switch through each delay and speed position, test for the specified resistance between the low reference terminal 8 and the signal terminal 7.

Wiper Switch Values

Switch Position	Resistance

Off	Infinite
Mist	300-364 Ω
Delay 1	3.48k-4.25k Ω
Delay 2	2.52k-3.08k Ω
Delay 3	1.78k-2.18k Ω
Delay 4	1.17k-1.44k Ω
Delay 5	697-851 Ω
Low	300-364 Ω
High	300-364 Ω

If any switch position is not within the specified range, replace the windshield wiper/washer switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Control Module References for BCM replacement, setup, and programming
- Windshield Wiper and Washer Switch Replacement

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Headlamp Washer Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ -- Headlamp Washer Relay	1	1	--	--
Headlamp Washer Relay Control	1	1	2	--
Headlamp Washer Fluid Pump Control	1	1	2	--
Headlamp Washer Relay Ground	--	1	--	--
Headlamp Washer Fluid Pump Ground	--	1	--	--
1. Headlamp washer pump inoperative 2. Headlamp washer pump always on				

Circuit/System Description

When the washer switch is pressed, the windshield wiper switch sends a voltage signal through windshield washer switch signal circuit to the wiper motor module and the body control module (BCM) indicating the wash command. Every fourth time the windshield washer system is commanded ON, the BCM will initiate a headlamp wash cycle by applying B+ to the headlamp washer relay control circuit energizing the relay. The relay then closes its switch contacts applying B+ through the headlamp washer pump motor control circuit to the headlamp washer pump motor. The pump motor then runs spraying washer fluid on the headlamps. A headlamp wash cycle consists of a prewash, then a pause, and then a wash operation.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Instrument Cluster Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Headlamp Washer System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the windshield washers operate normally.
2. Verify the headlamps operate normally.
3. Verify the windshield washer fluid level is above the minimum level.

   If not above the minimum level, fill the reservoir and inspect for leaks.
4. Verify the scan tool IPC Washer Fluid Level parameter is OK.

Circuit/System Testing

1. Ignition OFF, disconnect the HEADLAMP WASH Relay.
2. Test for less than 5 ohms between the ground circuit terminal 86 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify that a test lamp illuminates between the B+ terminal 30 and ground.

   If the test lamp does not illuminate, test the HEADLAMP Circuit fuse for an open..
4. Verify that a test lamp does not illuminate between the control circuit terminal 87 and ground.

   If the test lamp illuminates, test the control circuit for a short to voltage.
5. Connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 87.
6. Command the Headlamp Washer Relay On and OFF with a scan tool. The test lamp should turn ON and OFF when changing between commanded states.

   If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test the control circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the BCM.
7. Ignition OFF, disconnect the harness connector at the headlamp washer fluid pump.
8. Test for less than 5 ohm between the ground circuit terminal 1 and ground

   If greater than the specified range, test the ground circuit for an open/high resistance.

9. Connect the harness connector at the headlamp washer fluid pump.
10. Install a 3A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87. Verify the headlamp washer fluid pump is activated.

    If it does not activate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the headlamp washer fluid pump.
11. If all circuits test normal, test or replace the headlamp washer relay.

Component Testing

Headlamp Washer Pump Circuit Test

1. Ignition OFF, disconnect the harness connector at the headlamp washer fluid pump.
2. Install a 20A fused jumper wire between the control terminal 1 and 12 volts. Install a jumper wire between the ground terminal 2and ground.
3. Verify the headlamp washer fluid pump is activated.

    If the headlamp washer fluid pump does not activate, replace the washer fluid pump.

RelayTest

1. Ignition OFF, disconnect the relay.
2. Test for 60-200 ohms between terminals 85 and 86.

    If the resistance is not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87

    If not the specified value, replace the relay.
4. Test for less than 2 ohms between terminals 30 and 87A.

    If greater than the specified range, replace the relay.
5. Install a 10A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.

    If greater than the specified range, replace the relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Headlamp Washer Pump Replacement
- Relay Replacement
- Control Module References for BCM replacement, programming, and setup

Low Washer Fluid Indicator Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Washer Fluid Level Switch Signal	1	2	--	--
Washer Fluid Level Switch Ground	--	2	--	--
1. Low washer fluid message always displayed 2. Low washer fluid message never displayed				

Circuit/System Description

The Check Washer Fluid message is controlled by the instrument panel cluster using an input from the washer fluid level switch. The washer fluid level signal circuit is supplied ignition voltage through a resistor then monitored within the instrument cluster. The washer fluid level switch is normally open so the instrument cluster detects ignition voltage on the washer fluid level signal circuit whenever the washer fluid level is not low. When the washer fluid reaches the point where the driver should be informed that the washer fluid is low, the washer fluid level switch closes. When the washer fluid level switch is closed the washer fluid level signal circuit voltage is pulled low, and the instrument panel displays the Check Washer Fluid message on the driver information center. In order to prevent the Check Washer Fluid message from being displayed while sloshing is occurring in the washer fluid container, the instrument cluster is programed with a 1 minute delay before changing states of the Check Washer Fluid message during an ignition cycle.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the windshield washer fluid level is above the minimum level.
   If not above the minimum level, fill the reservoir and inspect for leaks.
2. Verify the scan tool IPC Washer Fluid Level parameter is OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the washer fluid level switch.
2. Test for less than 1.0 ohm between the ground circuit terminal A and ground.
   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Washer Fluid Level parameter is OK.
   If not the specified value, test the signal circuit terminal B for a short to ground. If the circuit tests normal, replace the IPC.
4. Install a 3A fused jumper wire between the signal circuit terminal B and the ground circuit terminal A. Verify the scan tool IPC Washer Fluid Level parameter is Low.
   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the IPC.
5. If all circuits test normal, test or replace the washer fluid level switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Windshield Washer Solvent Level Switch Replacement
- Control Module References for IPC replacement, programming, and setup

Rear Wiper System Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Rear Window Wiper Motor B+	1	1	--	--
Rear Window Wiper Motor Ignition Voltage	1	1	--	--
Rear Window Wiper/Washer Switch Ignition Voltage	1	1	--	--
Rear Window Wiper Switch Signal	1	1	2	--
Rear Window Wiper Motor Ground	--	1	--	--
1. Rear Window Wiper Motor Inoperative 2. Rear Window Wiper Motor Always On				

Circuit/System Description

The rear wiper is controlled based on an input from the rear wiper/washer switch. When closed, the wiper ON and wiper DELAY switches provide a unique voltage signal to the rear window wiper motor indicating the desired speed. Each switch has a unique resistor that drops the voltage to a specified value which is interpreted by the rear window wiper motor as ON or DELAY. The rear wiper motor receives B+ voltage from the underhood fuse block and accessory voltage from the body control module (BCM).

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Rear Wiper/Washer System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Rear wiper switch in the WIPER position. The rear wiper should turn ON.

If the rear wiper does not turn ON, refer to circuit system testing.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the window wiper/washer switch rear.
2. Ignition ON, test for ignition voltage between the ignition voltage circuit terminal 1 and ground
   If not the specified value, test the ignition circuit for a short to ground or an open/ high resistance.
3. Ignition OFF, connect the harness connector at the window wiper/washer switch rear. Disconnect the harness connector at the rear window wiper motor.
4. Test for less than 10 ohms between the ground circuit terminal 4 and ground.
   If greater than the specified range, test the ground circuit for an open/high resistance.
5. Ignition ON, verify a test lamp illuminates between the B+ circuit terminal 5 and ground.
   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
6. Ignition ON, rear wiper/washer switch in the WIPER position, test for ignition voltagebetween the signal circuit terminal 1 and ground.
   If not the specified value, test the signal circuit for a short to ground or an open/high resistance, If the circuit tests normal, replace the window wiper/washer switch rear.
7. Liftgate closed, test for infinite resistance betweenthe signal circuit terminal 3 and ground.
   If not the specified value, test the signal circuit for a short to ground.
8. If all circuits test normal, test or replace the rear window wiper/washer module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Windshield Wiper and Washer Switch Replacement
- Rear Window Wiper Motor Replacement

- Rear Window Washer Pump Replacement

Rear Wiper Washer System Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Rear Window Wiper Motor B+	2	1	1	--
Windshield Washer Fluid Pump Control	1	1	2	--
Windshield Washer Relay Control	2	1	B3873 00	--
Windshield Washer Switch Low Reference	--	1	1	--
Windshield Washer Fluid Pump Ground	--	1	--	--
1. Washer Inoperative 2. Washers Always ON				

Circuit/System Description

The rear wiper washer control module controls the washer motor based on an input from the windshield washer switch. When the WASH switch is closed, ground is supplied to the windshield washer switch signal circuit. When this is seen, the rear wiper washer control module will command the rear washer fluid pump on.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Rear Wiper/Washer System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for Scan Tool Information

Circuit / System Verification

Rear wiper switch in the WIPER position. The rear wiper should turn ON.

If the rear wiper does not turn ON, refer to Rear Wiper System Malfunction

Circuit / System Testing

1. Ignition OFF, disconnect the harness connector at the window wiper/washer switch rear.
2. Ignition ON, wiper/washer switch rear in the WASHER position, test for ignition voltage between the signal circuit terminal 1 and ground.

   If not than the specified value, test for a short to ground or an open/high resistance.
3. Ignition OFF, connect the harness connector at the rear window wiper/washer module. Disconnect the harness connector at the rear window washer fluid pump.
4. Test for less than 10 ohms between the ground circuit terminal 1 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
5. Ignition ON, wiper/washer switch rear in the WASHER position, verify a test lamp illuminates between the control circuit terminal 2 and ground.

   If the test lamp does not illuminate, test the control circuit for a short to ground or an open/high resistance.

   If the test lamp illuminates test or replace the rear window washer fluid pump.
6. If all circuits test normal, test or replace the rear window wiper motor.

Component Testing

Wiper / Washer Switch

1. With the WASH switch in the open position, test for infinite resistance between the low reference terminal 1 and the signal terminal 2.

   If not the specified value, replace the wiper/washer switch rear.
2. With the WASH switch in the closed position, test for less than 2 ohms between the ground terminal 1 and the signal terminal 2.

   If greater than the specified range, replace the wiper/washer switch rear.

Washer Pump

1. Ignition OFF, disconnect the harness connector at the washer pump.
2. Install a 10A fused jumper wire between the control circuit terminal 1 and 12 volts. Install a jumper wire between the ground circuit terminal 2 and ground.
3. Verify the washer pump is activated.

   If the washer pump does not activate , replace the rear window washer fluid pump.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Windshield Wiper and Washer Switch Replacement
- Rear Window Wiper Motor Replacement
- Rear Window Washer Pump Replacement

Symptoms - Wiper / Washer Systems

Important: The following steps must be completed before using the symptom tables:

1. Perform the Diagnostic System Check - Vehicle , in order to verify that all of the following conditions are true.
   - No DTCs are set.
   - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to Wiper/Washer System Description and Operation.

Visual / Physical Inspection

- Inspect the washer fluid reservoir for the proper fluid level and condition.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect for aftermarket devices which could affect the operation of the Windshield Wiper/Washer System.

Intermittent

- If the wipers operate at low speed for approximately 3 seconds and then stop, the wiper motor park switch, or its signal circuit, may be malfunctioning.
- Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Windshield Wiper System Malfunction
- Windshield Wiper Washer System Malfunction

Windshield Wiper System Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
BCM Fuse F9 B+	B3794 00 B1529 00 B3922 00	B3794 00 B1529 00 B3922 00	--	--
FRT WPR Fuse B+	1	1	--	--
Windshield Wiper Switch Signal	B3922 00	1	1	--
Windshield Wiper Switch High Signal	3	1	1	--
Windshield Wiper Motor Park Switch Signal	2	2	--	--
WIPER LO Relay Control	B3715 00	1	3	--
WIPER HIGH Relay Control	1	1	B3875 00	--
Windshield Wiper Motor High Speed Control	1	1	1	--
Windshield Wiper Motor Low Speed Control	1	1	1	--
Windshield Wiper Switch Low Reference	--	1	1	--
Windshield Wiper Motor Ground	--	1	--	--
WIPER CONTROL Relay Ground	--	1	--	--

1.Windshield wiper system malfunction

2.Wipers Do Not Park

3.Wipers Always ON

Circuit/System Description

The body control module (BCM) controls the wiper motor based on input from the windshield wiper washer switch. The BCM monitors the wiper washer switch through three separate signal circuits and a ground circuit. The windshield wiper switch high signal circuit is used to determine high speed wiper operation, the windshield wiper switch low signal is used to determine low speed, intermittent, and mist operation through the use of a resistor ladder, and windshield washer switch signal circuit is used to determine washer operation.

The BCM controls the windshield wiper motor through two output controls, controlling two relays which determine the desired wiper speed, high or low.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, wiper switch OFF, verify the scan tool Windshield Washer Switch parameter is Inactive.
2. Wiper switch OFF, verify the scan tool Windshield Wiper Switch parameter is Off.
3. Wiper switch OFF, verify the scan tool Wiper High Speed Switch parameter is Inactive.
4. Wiper switch in the LOW position, verify the scan tool Windshield Wiper Switch parameter is Low.
5. Wiper switch in the HIGH position, verify the scan tool Wiper High Speed Switch parameter is Active.
6. Wiper switch in the INT position, verify the scan tool Windshield Wiper Switch parameter is Intermittent.
7. Wiper switch in the INT position, observe the scan tool Wiper Delay Setting parameter while

cycling the delay adjustment switch from long delay to short delay. The parameter should cycle between D1 and D5 as each delay position is selected.

8. Wiper switch in the LOW position, verify the windshield wipers are cycling at low speed.
9. Wiper switch in the HIGH position, verify the windshield wipers are cycling at high speed.
10. Wiper switch in the INT position, cycling the delay adjustment switch from long delay to short delay. Verify the wiper delay time decreases from long delay to short delay as each delay position is selected.

Circuit / System Testing

Windshield Wiper Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the Windshield Wiper/Washer Switch.
2. Test for less than 40 Ω between the low reference circuit terminal 8 and ground.

   If greater than the specified range, test the low reference circuit for a short to voltage or an open/high resistance. If the circuit test normal, replace the BCM.
3. Ignition ON, verify the scan tool Windshield Wiper Switch parameter is Off.

   If not the specified value, test the signal circuit terminal 7 for a short to ground. If the circuit tests normal, replace the BCM.
4. Verify the scan tool Wiper High Speed Switch parameter is Inactive.

   If not the specified value, test the signal circuit terminal 4 for a short to ground. If the circuit tests normal, replace the BCM.
5. Install a 3A fused jumper wire between the signal circuit terminal 7 and ground. Verify the scan tool Windshield Wiper Switch parameter is Switch Fault.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
6. Install a 3A fused jumper wire between the signal circuit terminal 4 and ground. Verify the scan tool Wiper High Speed Switch parameter is Active.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
7. If all circuits test normal, test or replace the Windshield Wiper/Washer Switch.

Windshield Wiper Motor Malfunction

1. Ignition OFF, disconnect WIPER LO relay.
2. Ignition OFF, wait 20 seconds, Test for less than 1Ω between the ground circuit terminal 85 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition OFF, wait 20 seconds, test for less than 1Ω between the ground circuit terminal 87A and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
4. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 87 and ground.

   If the test lamp does not illuminate, replace the underhood fuse block.
5. Ignition OFF, wait 20 seconds, connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85.
6. Ignition ON, command the WIPER LO relay ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.

If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.

7. Ignition OFF, disconnect the WIPER HIGH relay.
8. Test for less than 1 Ω between the control circuit terminal 30 at the WIPER LO relay and the control circuit terminal 30 at the WIPER HIGH relay.

   If greater than the specified range, replace the underhood fuse block.

9. Connect the WIPER LO relay.
10. Ignition OFF, wiper switch OFF, wait 20 seconds, Test for less than 1 Ω between the control circuit terminal 30 and ground.

    If greater than the specified range, test or replace the WIPER LO relay.

11. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 85 and ground.

    If the test lamp does not illuminate, replace the underhood fuse block.

12. Ignition OFF, connect a test lamp between the control circuit terminal 30 and ground.
13. Command the WIPER LO relay ON and OFF with a scan tool. The test lamp should turn illuminate.

    If the test lamp does not illuminate, replace the WIPER LO relay.

14. Ignition OFF, remove WIPER HIGH relay, connect a test lamp between the B+ circuit terminal 85 and the control circuit terminal 86.
15. Command the Wiper High relay ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between commanded states.

    If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

    If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.

16. Ignition OFF, connect the WIPER HIGH relay. Disconnect the harness connector at the windshield wiper motor.
17. Test for less than 5Ω between the ground circuit terminal 3 and ground.

    If greater than the specified range, test the ground circuit for an open/high resistance.

18. Connect a test lamp between the control circuit terminal 1 and ground.
19. Ignition ON, command the WIPER LO relay ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

    If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, test or replace the WIPER HIGH relay.

    If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the WIPER HIGH relay.

20. Ignition OFF, connect a test lamp between the control circuit terminal 2 and ground.
21. Lo wipers ON, command the Wiper High speed relay ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

    If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, test or replace the WIPER HIGH relay.

    If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the WIPER HIGH relay.

22. Wipers OFF, test for B+ between the signal circuit terminal 4 and ground.

    If not the specified value, test the signal circuit for a short to ground or an open high resistance. If the circuit tests normal, replace the BCM.

23. If all circuits test normal, test or replace the windshield wiper motor.

Component Testing

Windshield Wiper / Washer Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the Windshield Wiper/Washer Switch.
2. With the wiper switch in the HIGH position, test for less than 2 ohms between the low reference terminal 8 and the signal terminal 4.

   If greater than the specified range, replace the Windshield Wiper/Washer Switch.

   Important: If the switch tests open in any switch position other than Off, test the signal circuits for a short to voltage before replacing the switch.

3. While cycling the wiper switch through each delay and speed position, test for the specified resistance between the low reference terminal 8 and the signal terminal 7.

Wiper Switch Values

Switch Position	Resistance
Off	Infinite
Mist	300-364 Ω
Delay 1	3.48K-4.25K Ω
Delay 2	2.52K-3.08K Ω
Delay 3	1.78K-2.18K Ω
Delay 4	1.17K-1.44K Ω
Delay 5	697-851 Ω
Low	300-364 Ω

If any switch position is not within the specified range, replace the windshield wiper washer switch.

Windshield Wiper Motor

1. Ignition OFF, disconnect the harness connector at the windshield wiper motor.
2. Install a 25 A fused jumper wire between B+ and the control terminal 1. Install a jumper wire between the terminal 3 and ground.
3. Verify the wiper motor is operating in the low speed mode.

   If the wiper motor is not in the low speed mode, replace the windshield wiper motor.

4. Install a 25 A fused jumper wire between B+ and the control terminal 2. Install a jumper wire between the terminal 3 and ground.
5. Verify the wiper motor is operating in the high speed mode.

   If the wiper motor is not in the high speed mode, replace the windshield wiper motor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Control Module References for BCM replacement, setup, and programming
- Underhood Electrical Center or Junction Block Replacement
- Windshield Wiper and Washer Switch Replacement
- Relay Replacement

Windshield Wiper Washer System Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Windshield Washer Switch Signal	2	1	1	--
Windshield Washer Pump Control	1	1	2	--
Windshield Washer Relay Control	2	1	B3873 00	--
Windshield Wiper Switch Low Reference	--	1	--	--
Windshield Washer Fluid Pump Low Reference	--	1	--	--
1. Washer Inoperative 2. Washers Always ON				

Circuit/System Description

The windshield washer function is controlled by the Body Control Module (BCM). When the washer switch is pressed, ground is applied through the switch contacts and the signal circuit to the BCM indicating the wash request. The BCM then applies ground through the control circuit to the coil side of the WSW relay energizing the relay. With the relay energized, B+ from the WSW fuse is applied through the switch contacts of the relay to the windshield washer fluid pump.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, wiper switch OFF, observe the scan tool Windshield Washer Switch parameter while cycling the washer switch ON and OFF. The parameter should change between Active and Inactive.

    If the parameter does not cycle between the specified values, refer to Windshield Washer Switch Malfunction.

2. Operate the washers using the washer switch. Verify the washer pump activates and the low speed wipers turn on.

    If the washer pump does not activate, refer to Washer Pump Circuit Malfunction.

    If the low speed wipers do not turn on refer to Windshield Wiper System Malfunction

Circuit/System Testing

Windshield Wiper/Washer Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the windshield wiper/washer switch.
2. Test for less than 40 Ω between the low reference circuit terminal 8 and ground.

    If greater than the specified range, test the low reference circuit for a short to voltage or an open/high resistance. If the circuit test normal, replace the BCM.

3. Ignition ON, verify the scan tool Windshield Washer Switch parameter is Inactive.

    If not the specified value, test the signal circuit terminal 6 for a short to ground. If the circuit tests normal, replace the BCM.

4. Install a 3A fused jumper wire between the signal circuit terminal 6 and ground. Verify the scan tool Windshield Washer Switch parameter is Active.

    If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.

5. If all circuits test normal, test or replace the windshield wiper/washer switch.

Washer Pump Circuit Malfunction.

1. Ignition OFF, disconnect the WSW relay.
2. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 30 and ground.

    If the test lamp illuminates, test the control circuit for a short to voltage.

3. Verify that a test lamp illuminates between the B+ circuit terminal 87 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open high/resistance.
4. Verify a test lamp illuminates between the B+ circuit terminal 86 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open high/resistance.
5. Disconnect the harness connector at the windshield washer fluid pump.
6. Ignition OFF, test for less than 5 ohms between the ground circuit terminal 2 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
7. Connect the harness connector at the windshield washer fluid pump.
8. Connect a 15A fused jumper wire between the B+ circuit terminal 87 and the control circuit terminal 30. Verify the windshield washer fluid pump is activated.

   If the windshield washer fluid pump does not activate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the windshield washer fluid pump.
9. Connect a test lamp between the B+ circuit terminal 86 and the control circuit terminal 85.
10. Command the windshield washer fluid pump ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

    If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

    If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
11. If all circuits test normal, test or replace the WSW Relay.

Component Testing

Windshield Washer Switch

1. Ignition OFF, disconnect the harness connector at the windshield wiper/washer switch.
2. With the wash switch in the Open position, test for infinite resistance between the low reference terminal 8 and the signal terminal 6.

   If not the specified value, replace the windshield wiper/washer switch.
3. With the WASH switch in the closed position, test for less than 2 ohms between the low reference terminal 8 and the signal terminal 6.

   If greater than the specified range, replace the windshield wiper/washer switch.

Washer Pump

1. Ignition OFF, disconnect the harness connector at the washer pump.
2. Install a 10A fused jumper wire between the control terminal 1 and 12 volts. Install a jumper wire between the ground terminal 2 and ground.
3. Verify the washer pump is activated.

   If the washer pump does not activate , replace the washer pump.

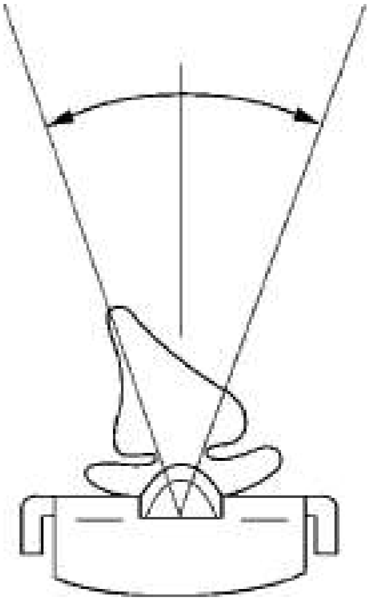
Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Control Module References for BCM replacement, setup, and programming

- Windshield Wiper and Washer Switch Replacement
- Underhood Electrical Center or Junction Block Replacement
- Relay Replacement
- Washer Pump Replacement

Wiper Blade Element Check



1. Remove the wiper blades from the wiper arms. Refer to Windshield Wiper Arm Replacement.
2. Inspect the length of the wiper blade element.

   Important: Replace the wiper blade element if the rubber element is deflected more than 15 degrees from the centre line of the blade.

3. Install the wipers blades on the wiper arms. Refer to Windshield Wiper Arm Replacement.
4. Operate the Wipers to Inspect for correct operation.

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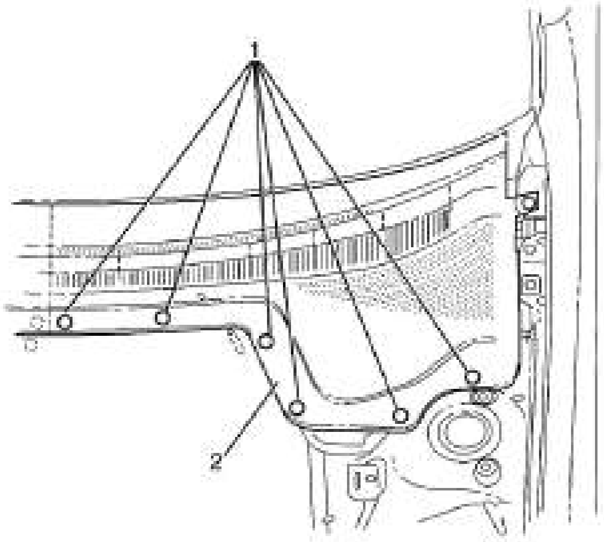
Air Inlet Grille Panel Replacement

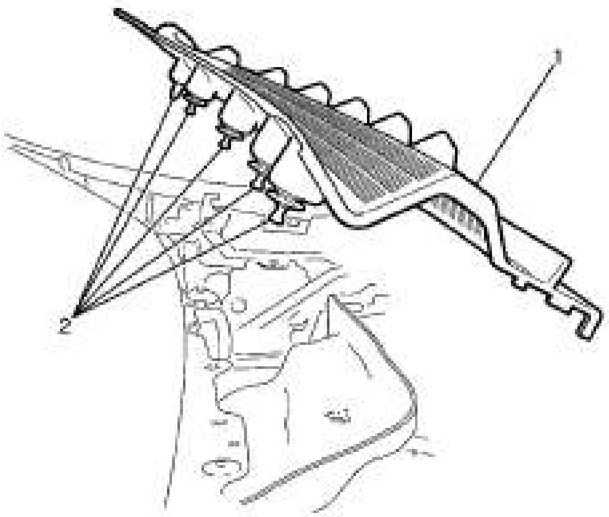
Removal Procedure

> **Important:** When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable hood brace to the vehicle.
2. Remove the windshield wiper arms. Refer to Windshield Wiper Arm Replacement.
3. Remove the hood rear seal. Refer to Hood Rear Seal Replacement.



4. Remove the passenger side air inlet grille panel to air inlet grille panel lower retaining scrivets (1).



Important: The outer rear edges of the air inlet grille panels are positioned around the rear of the hood hinges and are tucked under the front hood assist rods.

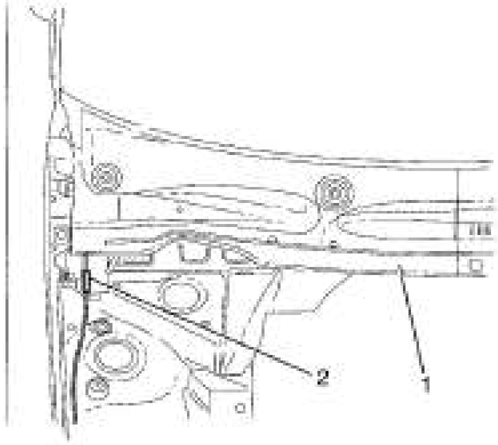
Important: The air inlet grille panel retaining grommets are single use parts. They must be discarded after removal.

5. Lift the air inlet grille panel upper (1) on the passenger side and pull upwards and inwards from the outboard of the vehicle, working towards the centre, to disengage the retaining clips (2) from the air inlet grille panel lower and discard the retaining clips.

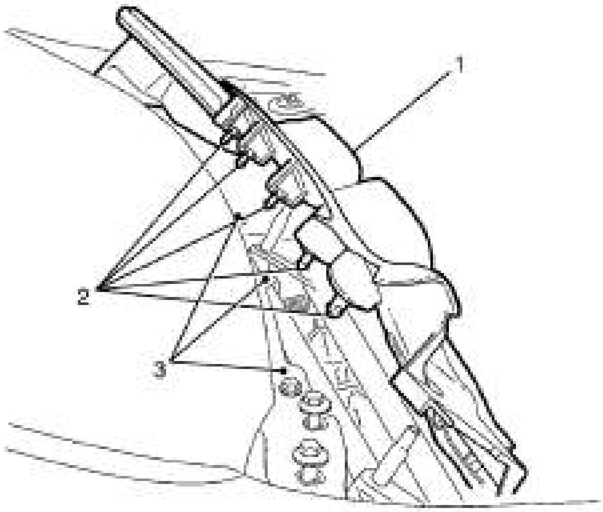
   Discard the clips.

6. Remove the air inlet grille panel upper retaining grommets (3) from the air inlet grille panel lower (1).

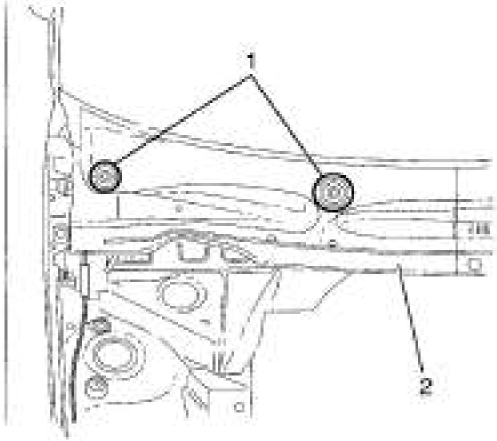
   Discard the grommets.



7. Disconnect the washer jet feed line (2) from the driver side air inlet grille panel lower (1).

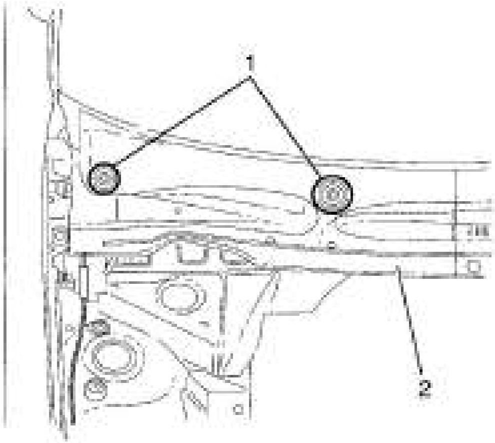


8. Lift the air inlet grille panel lower (1) on the driver side and pull upwards and inwards from the outboard of the vehicle, working towards the centre to disengage the retaining clips (2).

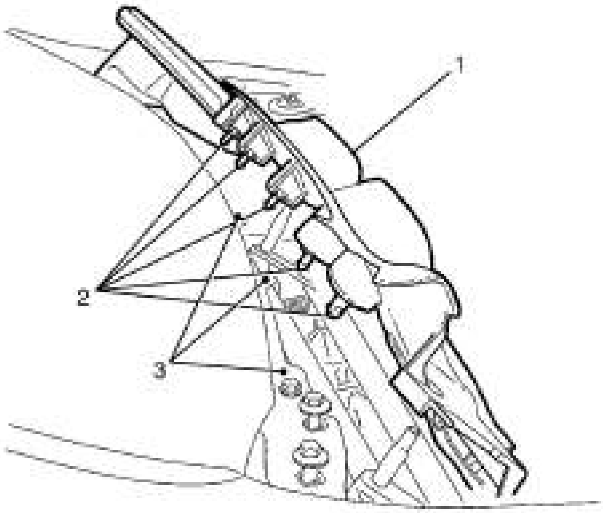


9. Lift the remaining air inlet grille panel (2) over the wiper arm drive spindles (1).
10. Remove the driver side air inlet grille panel from the vehicle.

Installation Procedure

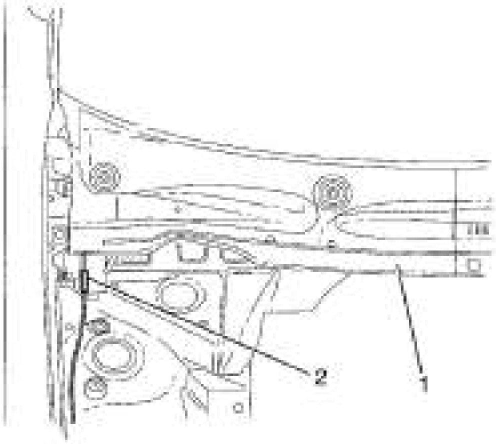


1. Position the driver side air inlet grille panel (2) to the vehicle, over the wiper arm drive spindles (1) and in behind the hood hinge.

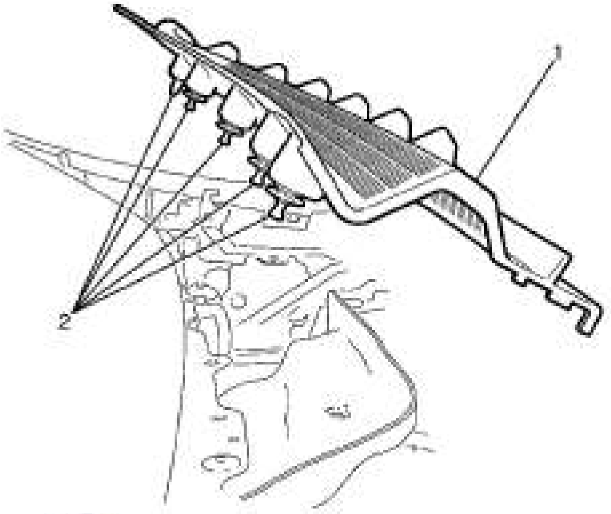


Important: Make sure that the retaining pins are not damaged during installation.

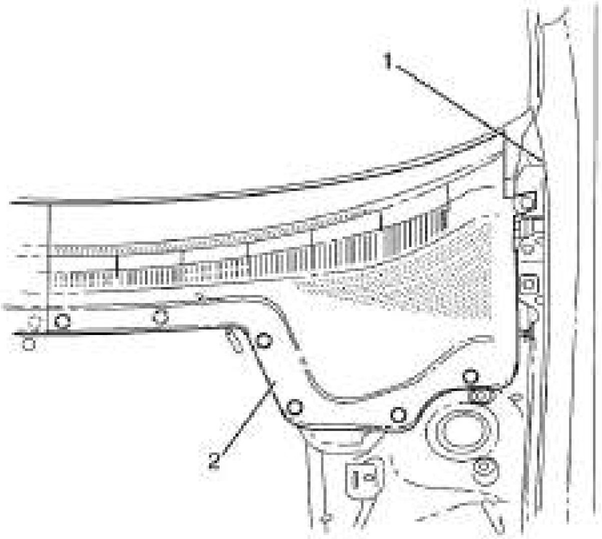
2. Locate the air inlet grille panel (1) to cowl panel retaining pins (2).
3. Firmly press the cowl panel retaining pins to secure the air inlet grille panel to the retaining grommets (3).



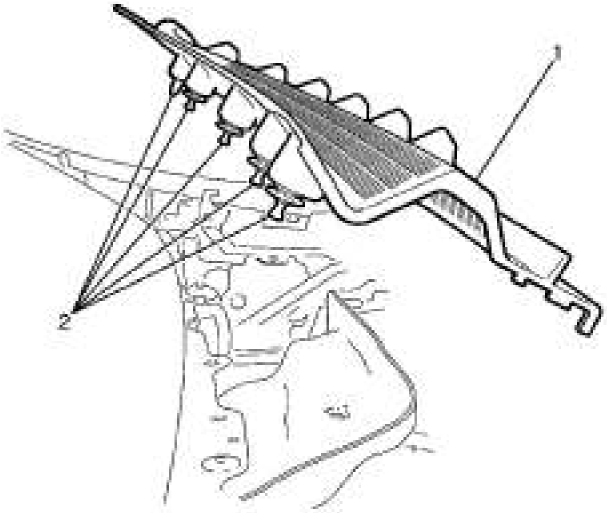
4. Connect the washer jet feed line (2) to the driver side air inlet grille panel (1).



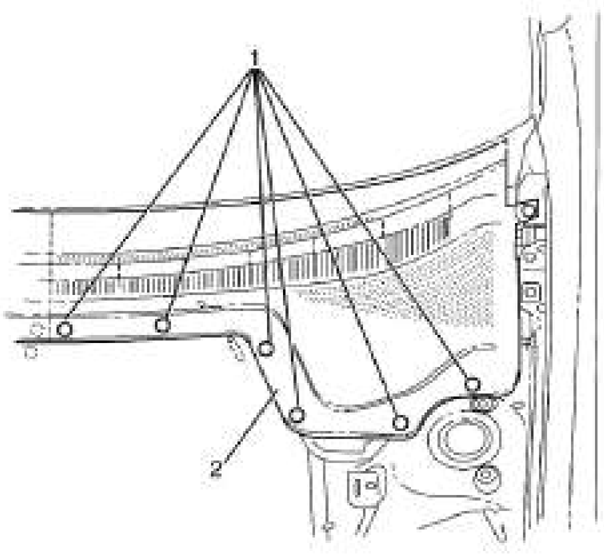
5. Install new retaining pins (2) to the air inlet grille upper panel (1).



6. Position the passenger side air inlet grille panel (2) around the hood hinge (1) and under the front hood assist rod.



7. Make sure the retaining pins (1) align with the retaining grommets during installation.
8. Engage the outboard retaining pin and work towards the centre of the vehicle.
9. Make sure that the air inlet grille seal is positioned on the lower edge of the windshield.



10. Install the passenger side air inlet grille panel to cowl panel retaining scrivets (1).
11. Install the hood rear seal to the flange on the air inlet grille panel. Refer to Hood Rear Seal Replacement.
12. Apply pressure to the seal to secure.
13. Install the windshield wiper arms. Refer to Windshield Wiper Arm Replacement.
14. Remove the suitable hood brace from the vehicle.

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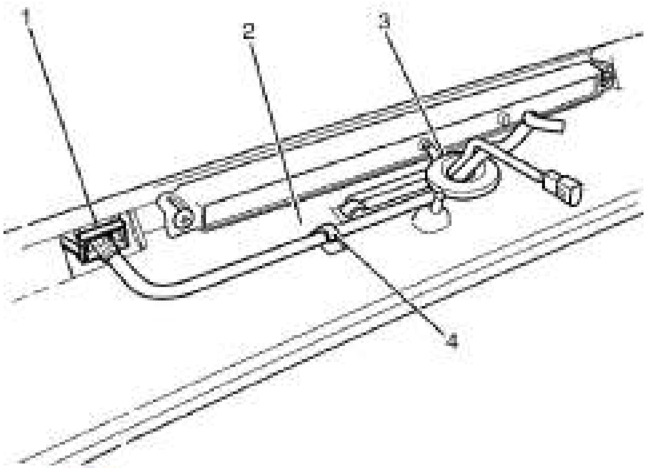
Rear Window Washer Nozzle Replacement

Removal Procedure

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

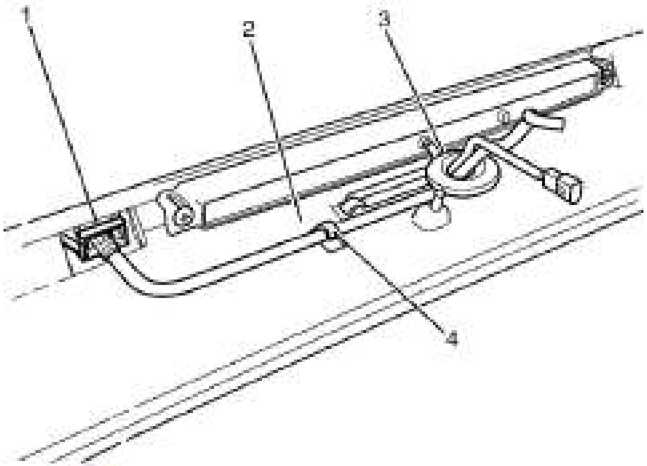
1. Install a suitable liftgate brace to the vehicle.
2. Remove the liftgate upper moulding. Refer to Liftgate Upper Molding Replacement.



Important: Take care not to pierce the washer hose.

3. Release the liftgate window washer nozzle (1) from the liftgate upper moulding (2).
4. Cut the cable tie on grommet (3), and slide washer hose (4) through grommet.

Installation Procedure



1. Engage the liftgate window washer nozzle (1) to the liftgate upper moulding (2).
2. Pass washer hose (4) through grommet (3) and attach new cable tie to grommet (3)
3. Install the liftgate upper moulding. Refer to Liftgate Upper Molding Replacement.
4. Test the liftgate window washer nozzle for correct operation.

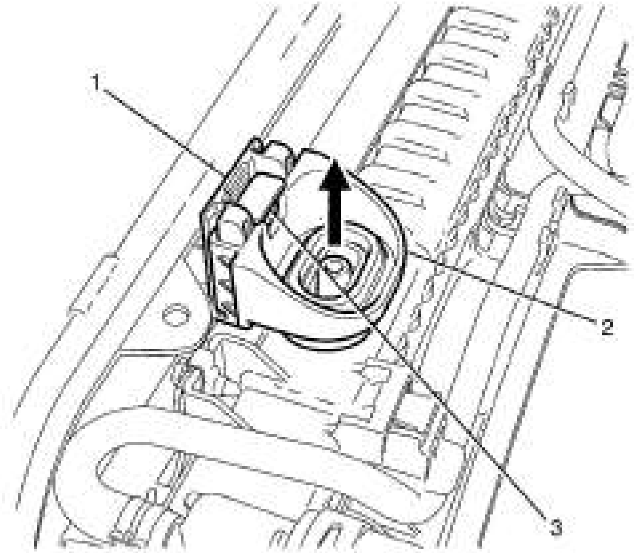
Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

5. Remove the suitable liftgate brace from the vehicle.

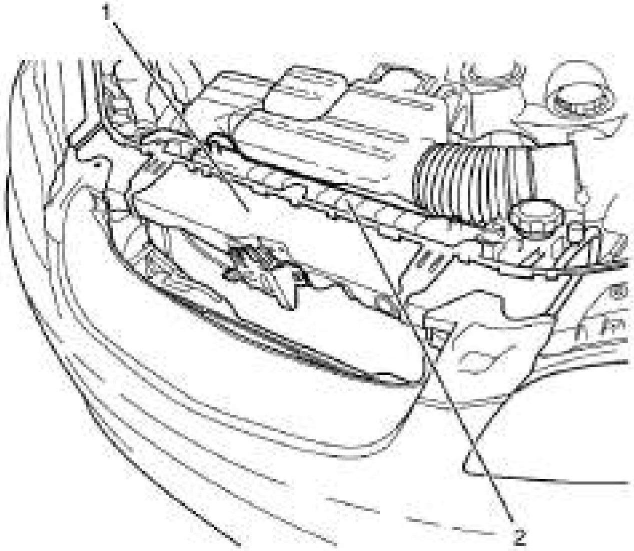
Rear Window Washer Pump Hose Replacement - Liftgate

Removal Procedure - Washer Pump to Front Fender Connector

1. Remove the radiator grille. Refer to Radiator Grille Replacement.

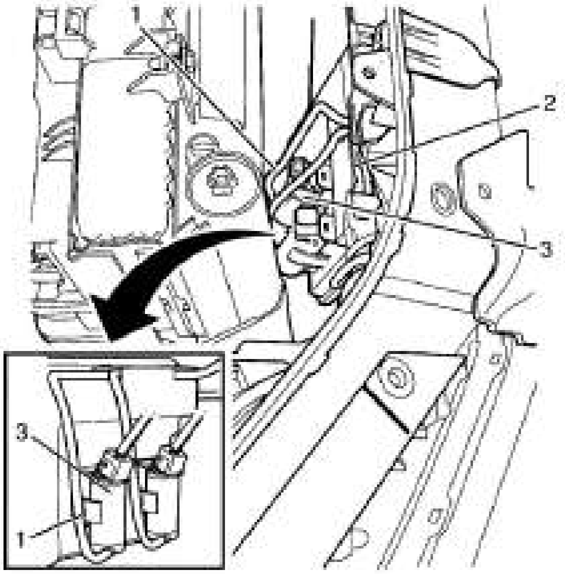


2. Raise the securing lock (3) from the radiator support bracket (2) by 10 mm on both sides.
3. Remove the radiator support bracket (2) from the radiator slide pin assembly (1) on both sides.



Important: Care must be taken when tilting the radiator assembly (2) away from the front end panel (1) as excessive force may damage the radiator assembly (2).

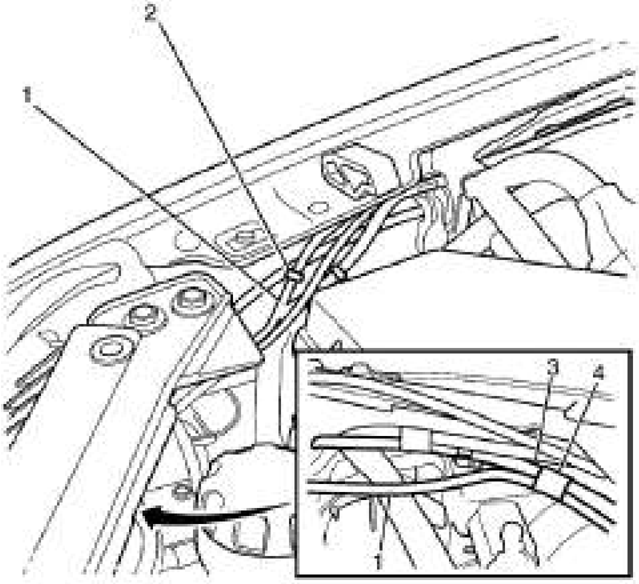
4. Tilt the radiator assembly (2) away from the front end panel (1).
5. Insert a suitable holding device between the front end panel (1) and the radiator assembly (2).



6. Place a suitable container under the rear window washer pump (3).

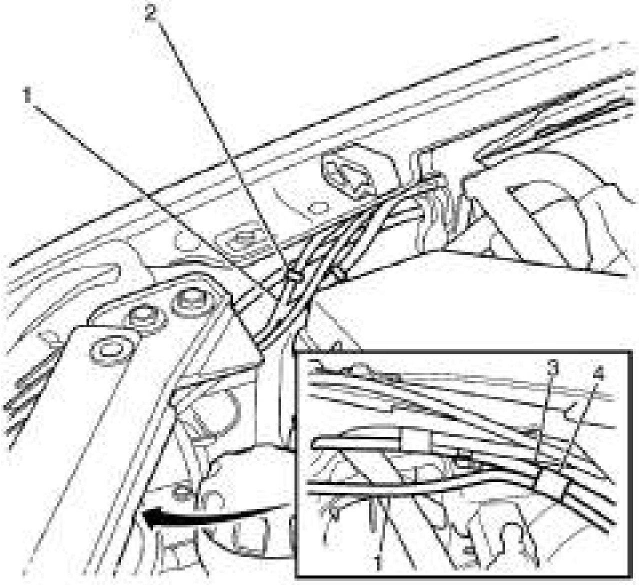
Important: Take care not to damage the condenser cooling fins when removing the rear window washer hose (1) from the rear window washer pump (3).

7. Disconnect the rear window washer hose (1) from the rear window washer pump (3).
8. Detach the rear window washer hose (1) from the solvent container (2).



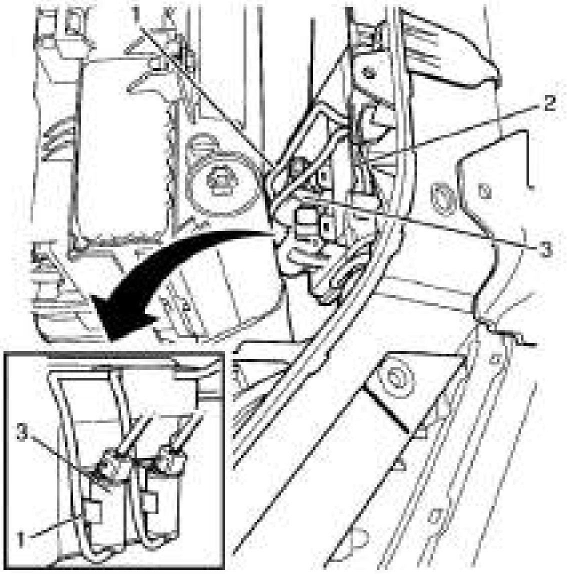
9. Mark the windshield washer hose (3) at the location of the rear window washer hose to windshield washer hose retaining tape (4).
10. Remove the rear window washer hose to windshield washer hose retaining tape (4).
11. Disconnect the rear window washer hose (1) from the rear window washer hose front fender connector (2).
12. Remove the rear window washer hose (1).

Installation Procedure - Washer Pump to Front Fender Connector



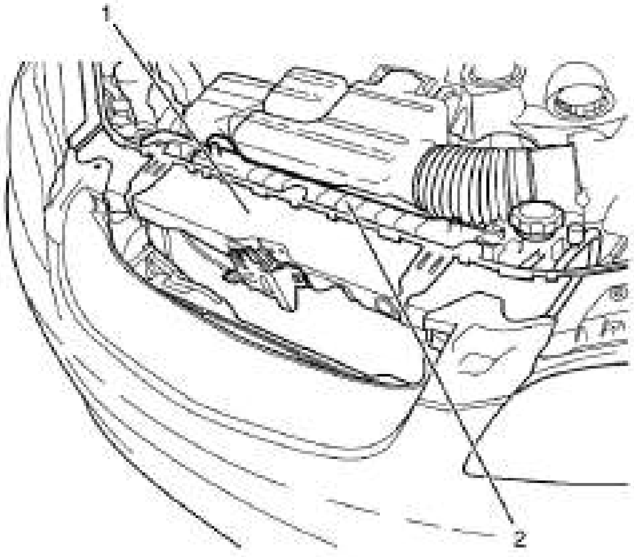
Important: When installing the rear window washer hose make sure it follows the original hose routing.

1. Connect the rear window washer hose (1) to the rear window washer hose front fender connector (2).
2. Attach the rear window washer hose (1) to the marked location on the windshield washer hose (3) with adhesive tape (4).

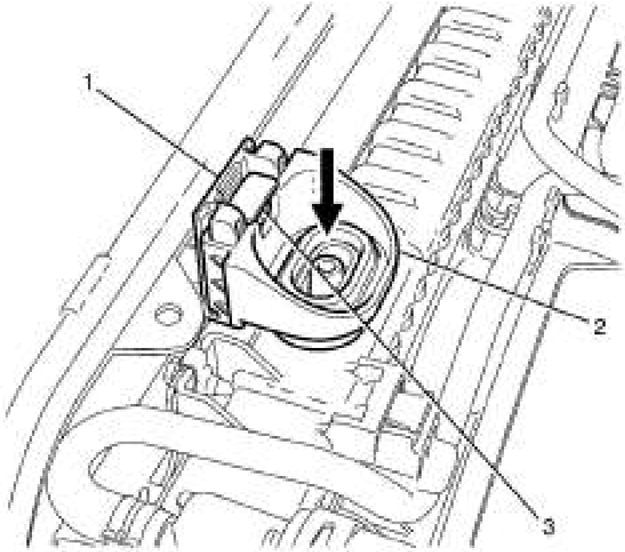


Important: Take care not to damage the condenser cooling fins when installing the rear window washer hose (1) to the rear window washer pump (3).

3. Attach the rear window washer hose (1) to the solvent container (2).
4. Connect the rear window washer hose (1) to the rear window washer pump (3).

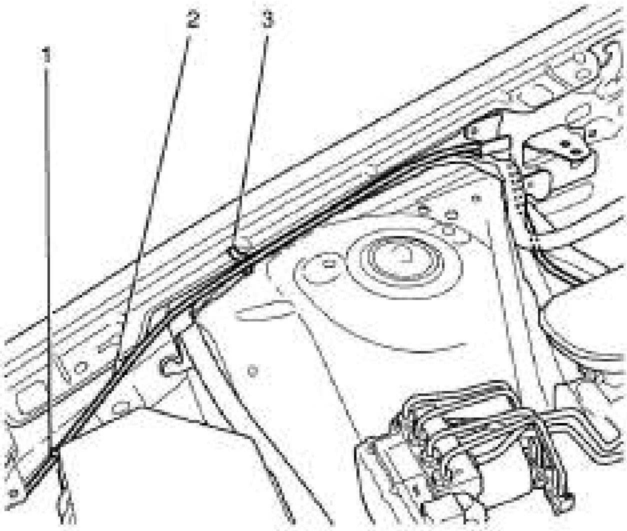


5. Remove the holding device between the radiator assembly (1) and front end panel (2).
6. Position the radiator assembly (2) to its original position, towards the front end panel (1).



7. Install the radiator support bracket (2) to the radiator slide pin assembly (1) on both sides.
8. Push the securing lock (3) into the radiator support bracket (2) making sure it is correctly seated on both sides.
9. Install the radiator grille. Refer to Radiator Grille Replacement.
10. Fill the washer fluid container with solvent.
11. Check the operation of the rear window washer and make sure there are no solvent leaks.

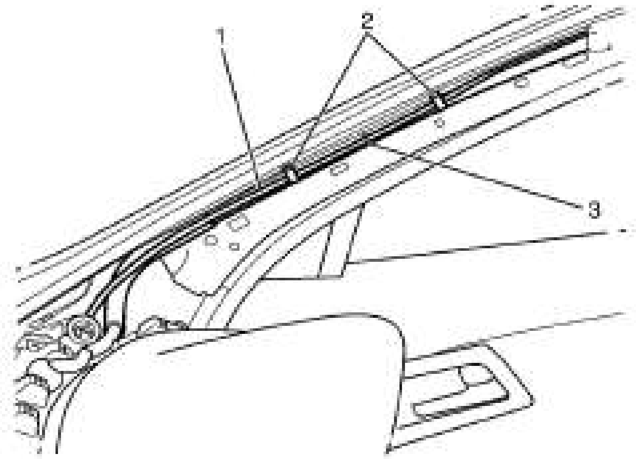
Removal Procedure - Front Fender Connector to A Pillar



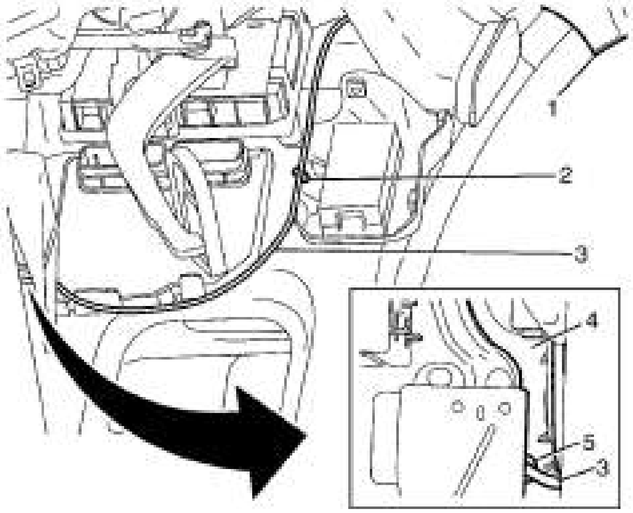
1. Disconnect the rear window washer hose (2) from the rear window washer hose front fender connector (1).
2. Detach the rear window washer hose (2) from the rear window washer hose front fender

retaining clip (3).

3. Attach a guide rope/wire to the rear window washer hose (2).
4. Remove the theft deterrent alarm. Refer to Theft Deterrent Alarm Replacement.
5. Remove the right windshield garnish molding. Refer to Windshield Garnish Molding Replacement.
6. Remove the right body hinge pillar trim panel. Refer to Body Hinge Pillar Trim Panel Replacement.
7. Remove the knee bolster. Refer to Knee Bolster Replacement.
8. Remove the instrument panel retainer. Refer to Instrument Panel Retainer Replacement.
9. Remove the accelerator pedal position sensor. Refer to Accelerator Pedal Position Sensor Replacement.

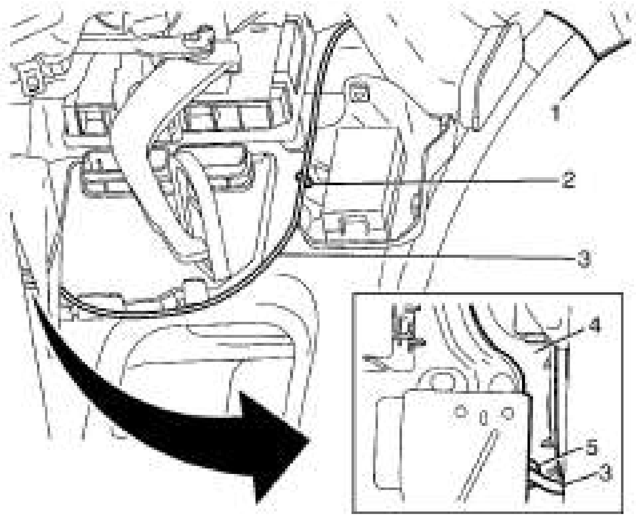


10. Detach the rear window washer hose (1) from the headlining wiring harness/washer hose retaining clips (2).
11. Cut the rear window washer hose (1) at position (3) between the headlining wiring harness/washer hose retaining clips (2).
12. Attach a guide rope/wire to the instrument panel side of rear window washer hose (1).

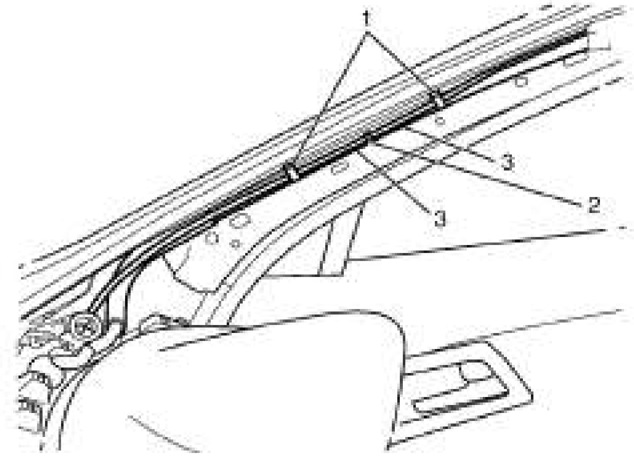


13. Detach the rear window washer hose (3) from the rear window washer hose body hinge pillar retaining clip (2).
14. Pull the rear window washer hose (3) down through the instrument panel assembly (1).
15. Detach the rear window washer hose grommet (5) from the bulkhead (4).
16. Pull the engine compartment section of the rear window washer hose (3) through the bulkhead (4) into the footwell.
17. Remove the remaining guide rope/wire from the rear window washer hose (3).
18. Remove the rear window washer hose (3).
19. Measure and cut a hose of equal diameter and length to the rear window washer hose (3) which has been removed.
20. Using the original rear window washer hose (3) as a guide, mark the position of the rear window washer hose grommet (6) and install it to the NEW rear window washer hose.
21. Attach the guide ropes/wires to each end of the NEW rear window washer hose.

Installation Procedure - Front Fender Connector to A Pillar



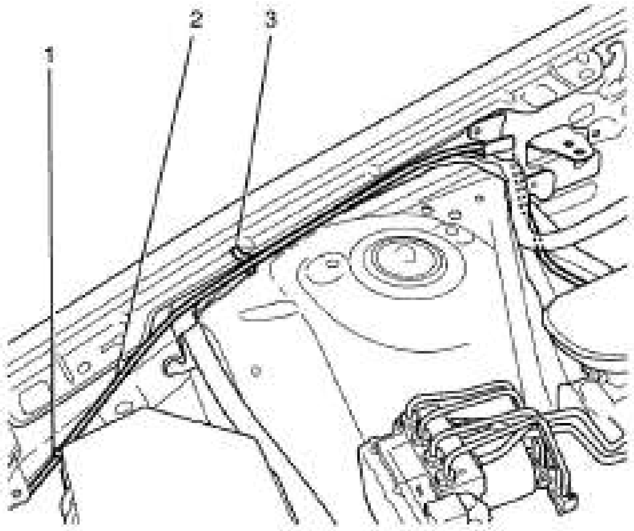
1. Gently pulling on the guide rope thread the engine compartment section of the rear window washer hose (3) through the bulkhead (4).
2. Attach the rear window washer hose grommet (6) to the bulkhead (4).
3. Attach the rear window washer hose (3) to the rear window washer hose body hinge pillar retaining clip (2).
4. Gently pulling on the guide rope thread the rear window washer hose (3) through the instrument panel assembly (1) towards the A pillar.



5. Remove the guide rope/wire from the rear window washer hose (3).

Important: Make sure the rear window washer hose in line joiner (2) is securely installed into both ends of the rear window washer hose (3).

6. Join the rear window washer hose ends (3) with in line hose joiner (2), GMH part number 92213809.
7. Attach the rear window washer hose (3) to the headlining wiring harness/washer hose retaining clips (1).
8. Install the accelerator pedal position sensor. Refer to Accelerator Pedal Position Sensor Replacement.
9. Install the instrument panel retainer. Refer to Instrument Panel Retainer Replacement.
10. Install the knee bolster. Refer to Knee Bolster Replacement.
11. Install the body hinge pillar trim panel. Refer to Body Hinge Pillar Trim Panel Replacement.
12. Install the windshield garnish molding. Refer to Windshield Garnish Molding Replacement.

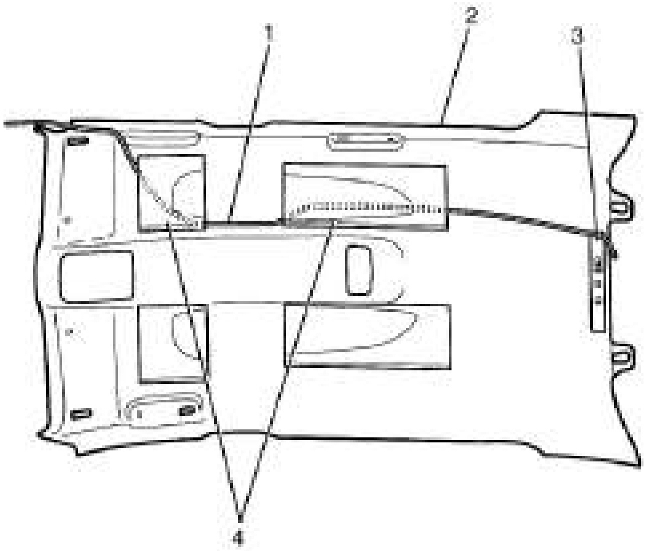


13. Attach the rear window washer hose (2) to the front fender hose retaining clip (3).
14. Remove the guide rope/wire from the rear window washer hose (2).
15. Connect the rear window washer hose (2) to the front fender hose connector (1).
16. Check the operation of the rear window washer, and make sure there are no solvent leaks.

Removal Procedure - A Pillar to Liftgate Connector

Important: This procedure should only be carried out if the headliner has not been damaged due to solvent leakage.

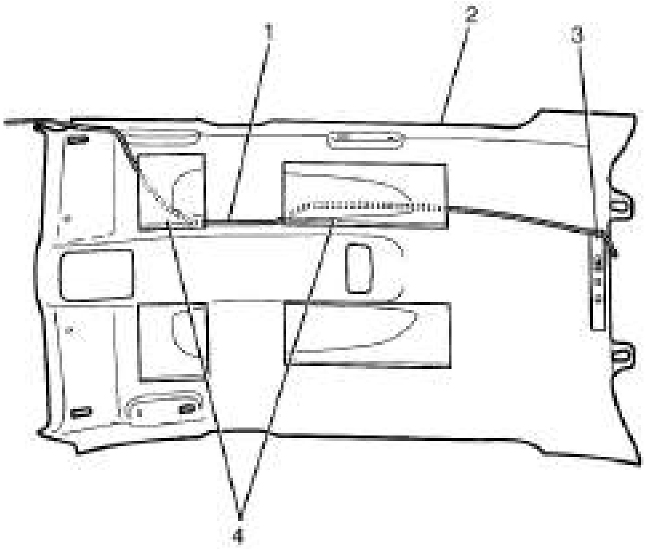
1. Remove the headlining. Refer to Headlining Trim Panel Replacement.



Important: Care must be taken not to damage the headlining (2) when removing the headlining acoustic pads (4) and the rear window washer hose (1).

2. Peel back the headlining acoustic pads (4) to access the rear window washer hose (1).
3. Using a wax pencil, mark the route of the rear window washer hose (1) onto the headlining (2).
4. Using a wax pencil, mark the position of the rear headlining clip assembly washer hose guide (3) onto the washer hose (2).
5. Remove the rear window washer hose (1) from the headlining (2).
6. Measure and cut a hose of equal diameter and length to the rear window washer hose (1) which has been removed.
7. Using the original washer hose reference marks as a guide, mark the position of the rear headlining clip assembly washer hose guide (3) to the NEW washer hose.

Installation Procedure - A Pillar to Liftgate Connector

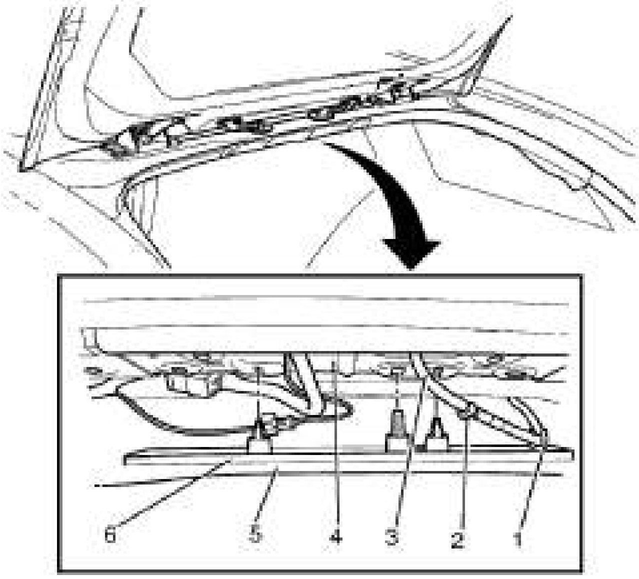


1. Align the reference mark on the new washer hose with the rear headlining clip assembly hose guide (3).
2. Install the NEW rear window washer hose to the marked location on the headlining (2).
3. Apply the GM specification GM3628M adhesive or equivalent to attach the NEW rear window washer hose (1) to the headlining (2).
4. Install the headlining. Refer to Headlining Trim Panel Replacement.
5. Check the operation of the rear window washer and make sure there are no solvent leaks.

Removal Procedure - Liftgate Connector to Washer Nozzle Hose Connector

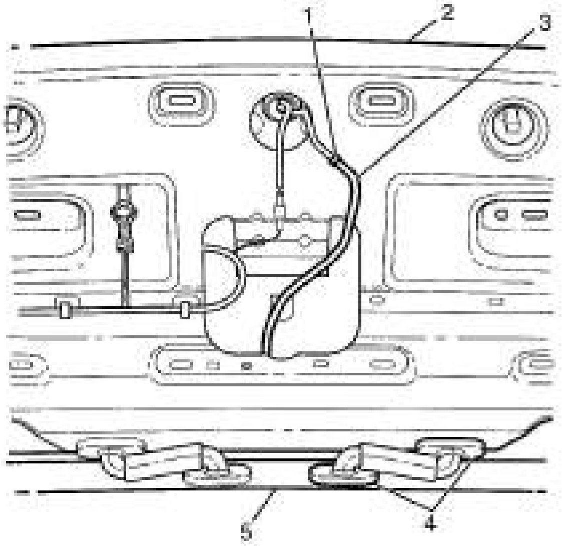
Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Open and suitably support the liftgate.
2. Remove the quarter inner trim finish panel on both sides. Refer to Quarter Inner Trim Finish Panel Replacement.
3. Remove the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
4. Remove the body side window rear garnish moulds on both sides. Refer to Body Side Window Rear Garnish Molding Replacement.



Important: To avoid damage to the headlining carefully pull down on the headlining rear clip assembly (6) to detach from the roof panel (4).

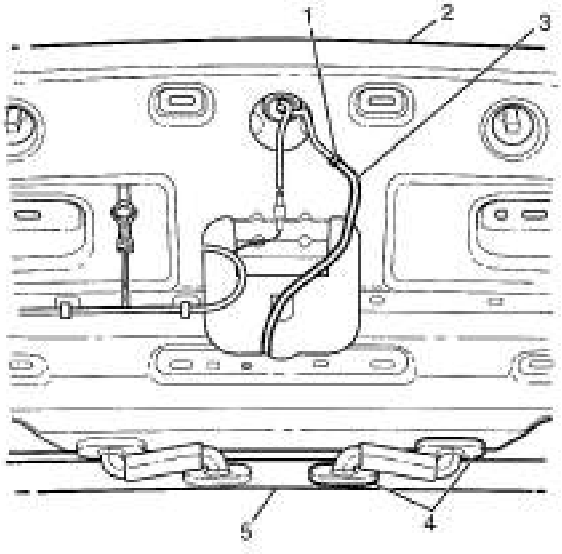
5. Detach and lower the headlining (5).
6. Remove the rear window washer hose (3) from the headlining clip assembly washer hose guide (1).
7. Disconnect the rear window washer hose (3) from rear window washer connector (2).
8. Remove the liftgate window side garnish moulding on both sides. Refer to Liftgate Window Side Garnish Molding Replacement.
9. Remove the liftgate window upper garnish moulding. Refer to Liftgate Window Side Garnish Molding Replacement.



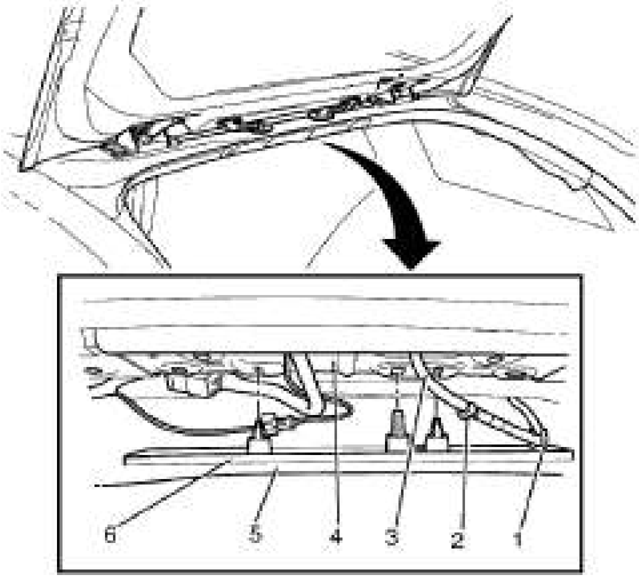
10. Disconnect the rear window washer hose (3) from the rear washer nozzle connector (1).

11. Detach the liftgate rear window washer hose grommet (4) from the rear header (5) and the liftgate (2).
12. Remove the rear window washer hose (3) from the rear header (5) and the liftgate (2).

Installation Procedure - Liftgate Connector to Washer Nozzle Hose Connector



1. Install the rear window washer hose (3) into the rear header (5) and the liftgate (2).
2. Install the liftgate rear window washer grommet (4) into the rear header (5) and the liftgate (2).
3. Connect the rear window washer hose (3) to the rear washer nozzle connector (1).
4. Install the liftgate window upper garnish moulding. Refer to Liftgate Window Side Garnish Molding Replacement.
5. Install the liftgate window side garnish moulding on both sides. Refer to Liftgate Window Side Garnish Molding Replacement.



6. Connect the rear window washer hose (3) to the rear window washer connector (2).

   Important: To avoid crimping or puncturing the rear window washer hose (3) make sure it locates correctly into the headlining clip assembly washer hose guide (1).

7. Install the headlining clip assembly (6) into the roof panel (4).
8. Install the body side window rear garnish moulds on both sides. Refer to Body Side Window Rear Garnish Molding Replacement.
9. Install the headlining rear trim panel retainer. Refer to Headlining Rear Trim Panel Retainer Replacement.
10. Install the quarter inner trim finish panel on both sides. Refer to Quarter Inner Trim Finish Panel Replacement.
11. Check the operation of the rear window washer and make sure there are no solvent leaks.

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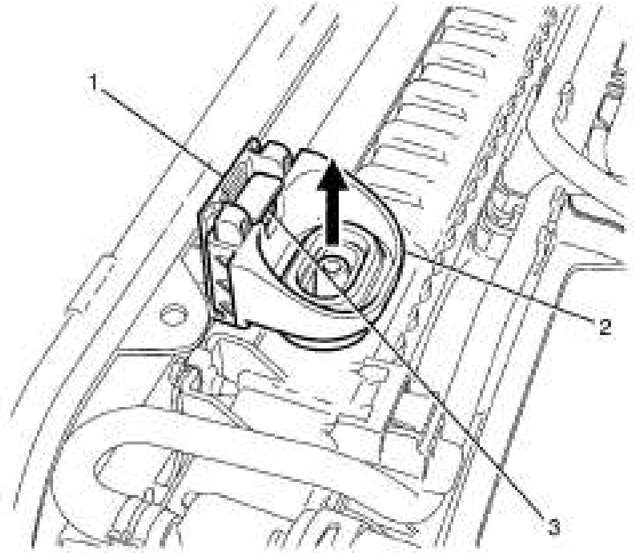
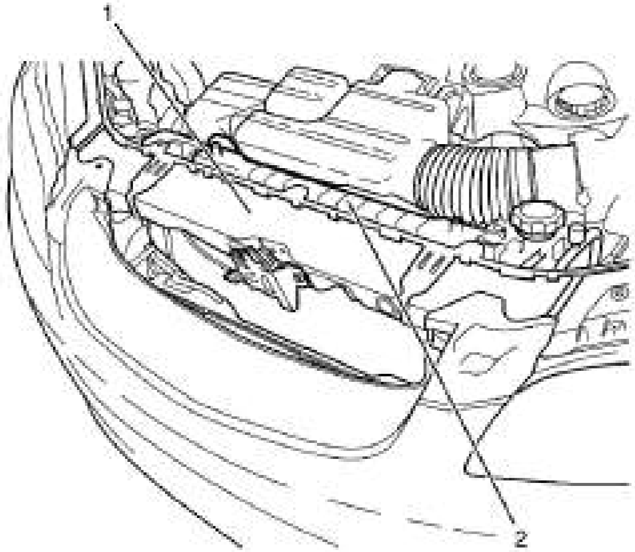
Rear Window Washer Pump Replacement

Removal Procedure

1. Remove the radiator grille. Refer to Radiator Grille Replacement.

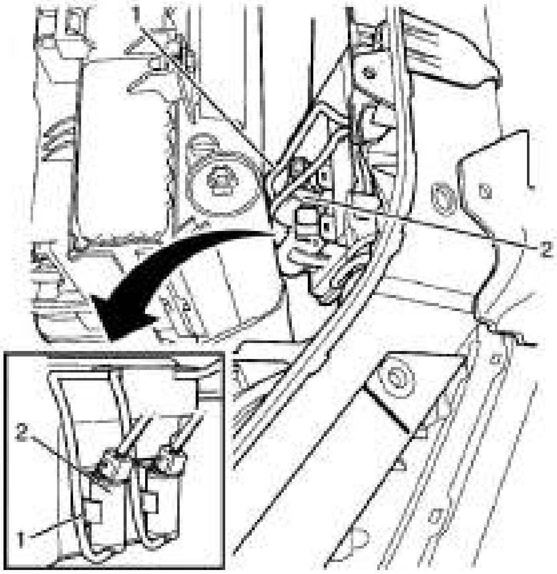


2. Raise the securing lock (3) from the radiator support bracket (2) by 10 mm on both sides.
3. Remove the radiator support bracket (2) from the radiator slide pin assembly (1) on both sides.



Important: Care must be taken when tilting the radiator assembly (2) away from the front end panel (1), as excessive force may damage the radiator assembly (2).

4. Tilt the radiator assembly (2) away from the front end panel (1).
5. Insert a suitable holding device between the front end panel (1) and the radiator assembly (2).

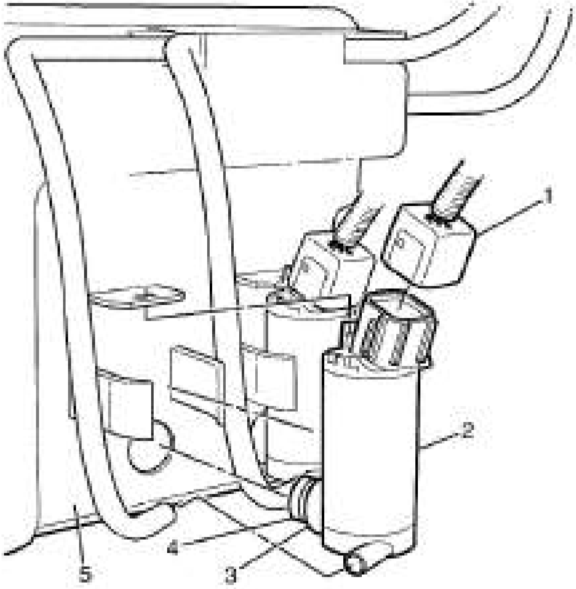


6. Place a suitable container under the rear window washer pump (2).

Important: Take care not to damage the condenser cooling fins when removing the rear window washer pump hose (1).

Important: Take care not to puncture the rear window washer pump hose (1) when removing it from the rear window washer pump (2).

7. Disconnect the rear window washer pump hose (1) from the rear window washer pump (2).



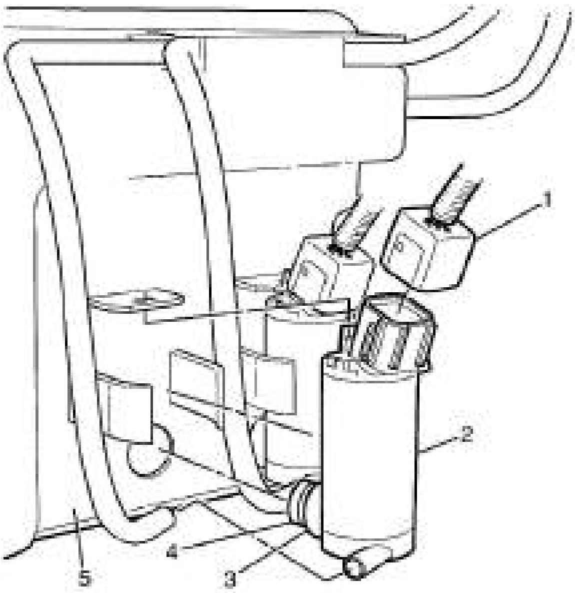
8. Disconnect the rear window washer pump electrical connector (1) from the rear window washer pump (2).

   Important: Take care not to damage the condenser cooling fins when removing the rear window washer pump (2).

   Important: Inspect the rear window washer pump inlet port rubber seal (3) for damage and replace as necessary.

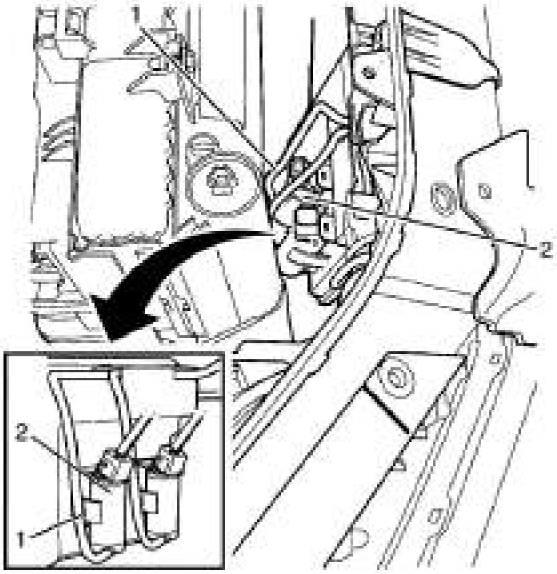
9. Remove the rear window washer pump (2) from the washer solvent container (5) .

Installation Procedure



Important: Take care not to damage the condenser cooling fins when Installing the rear window washer pump (2).

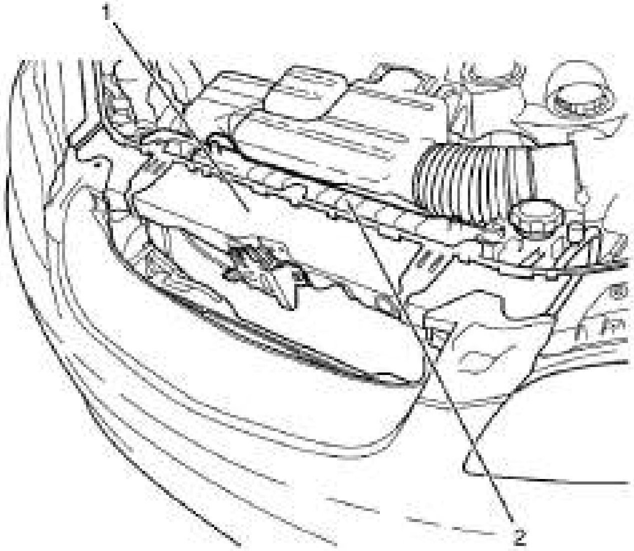
1. Install the rear window washer pump inlet port rubber seal (3) onto the rear window washer pump inlet port (4).
2. Install the rear window washer pump (2) to the washer solvent container (5) making sure the rear window washer pump inlet port (4) is securely seated into the solvent container (5).
3. Connect the rear window washer pump electrical connector (1) to the rear window washer pump (2).



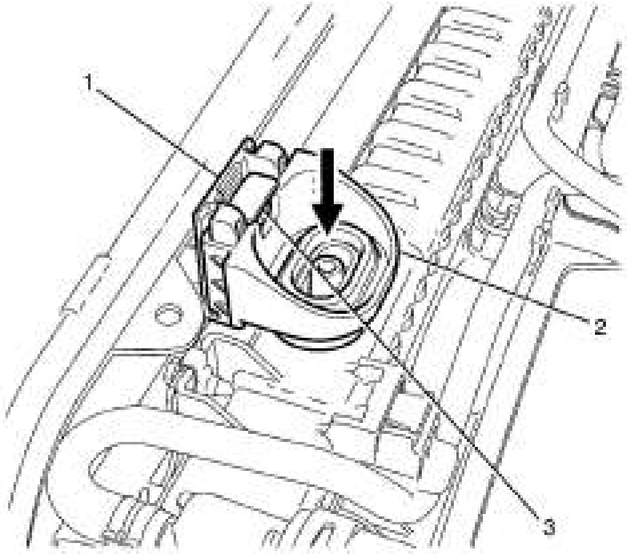
Important: Take care not to damage the condenser cooling fins when installing the rear window washer pump hose (1).

Important: Take care not to puncture the rear window washer pump hose (1) when installing it to the rear window washer pump (2).

4. Connect the rear window washer pump hose (1) to the rear window washer pump (2).



5. Remove the holding device between the radiator assembly (2) and front end panel (1).
6. Position the radiator assembly (2) towards the front end panel (1) to its original position.



7. Install the radiator support bracket (2) to the radiator slide pin assembly (1) on both sides.
8. Push the securing lock (3) into the radiator support bracket (2) making sure it is correctly seated on both sides.
9. Install the radiator grille. Refer to Radiator Grille Replacement.
10. Fill the washer solvent container with solvent.
11. Check the operation of the rear window washer and make sure there are no solvent leaks.

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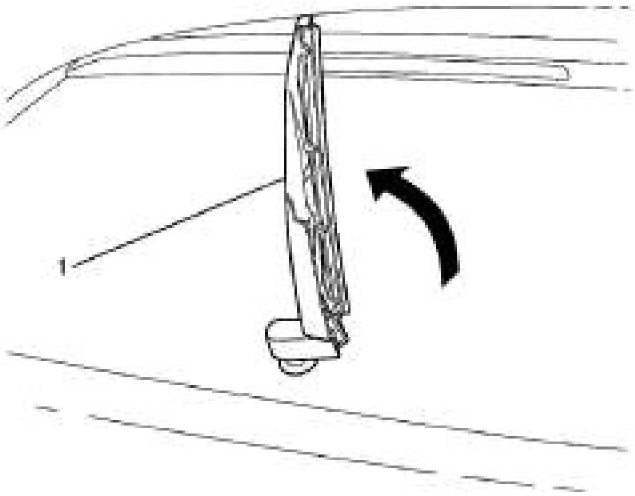
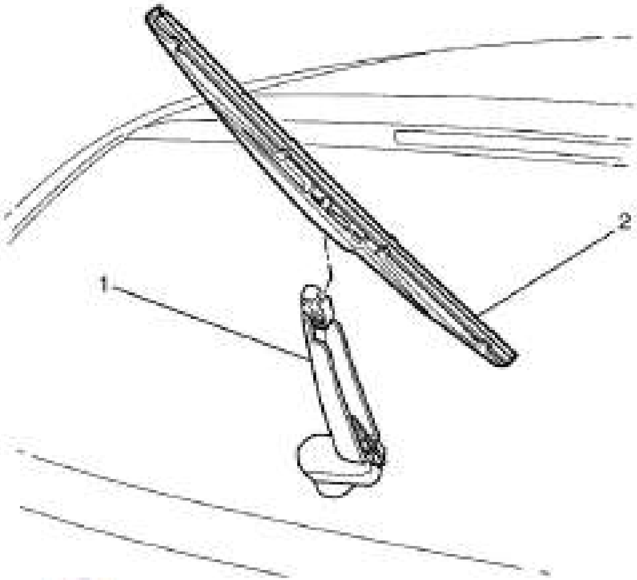
Rear Window Wiper Blade Replacement

Removal Procedure



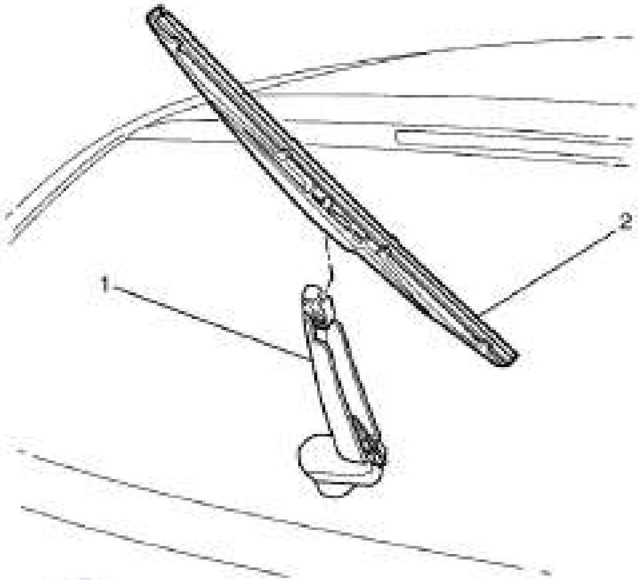
1. Lift the wiper arm (1) away from the rear window to the upright position.



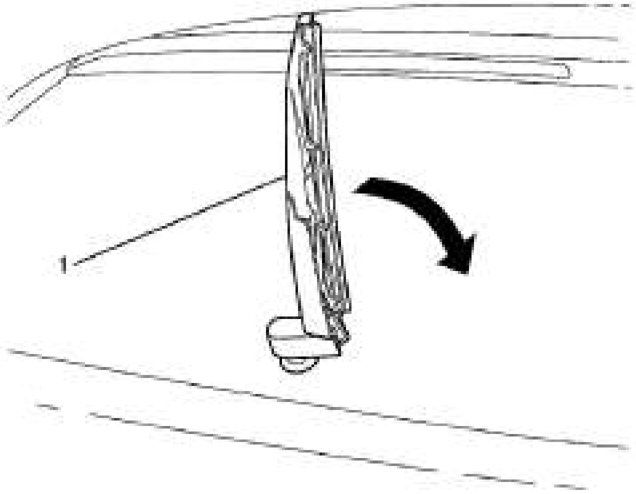
Important: Ensure that the wiper arm remains at rest position and Does Not spring back onto the windscreen.

2. Disengage the rear wiper blade lock by rotating the lower end of the rear wiper blade (2) away from the wiper arm (1).
3. Remove the rear wiper blade (2) out of the opening in the rear wiper arm (1).

Installation Procedure



1. Install the rear wiper blade (2) into the opening in the rear wiper arm (1).
2. Rotate the rear wiper blade towards the rear wiper arm (1) to engage the lock. Listen for an audible click to confirm fitting.



3. Lower the wiper arm (1) to its rest position.
4. Test the rear window wiper for correct operation.

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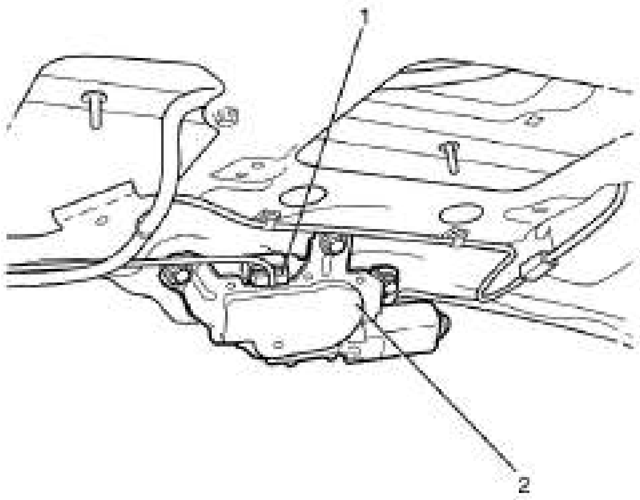
Rear Window Wiper Motor Replacement

Removal Procedure

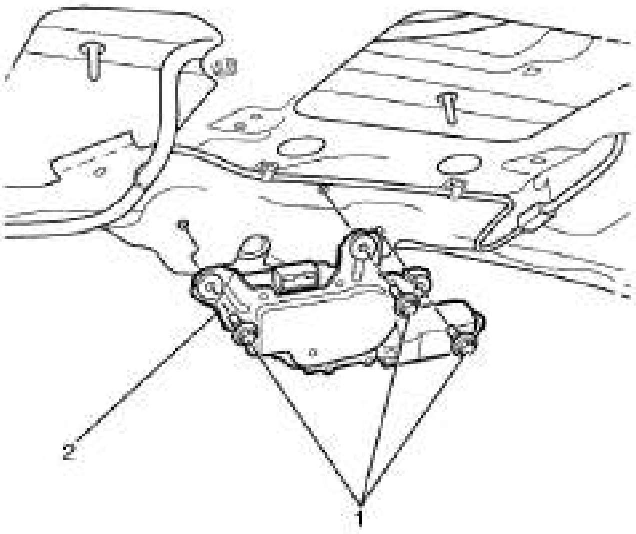
1. Remove the rear window wiper arm. Refer to Rear Window Wiper Arm Replacement.

   Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

2. Open liftgate and install a suitable liftgate brace to the vehicle.
3. Remove the liftgate window side garnish mouldings. Refer to Liftgate Window Side Garnish Molding Replacement.
4. Remove the liftgate window lower garnish moulding. Refer to Liftgate Window Lower Garnish Molding Replacement.
5. Remove the liftgate trim panel. Refer to Liftgate Trim Panel Replacement.

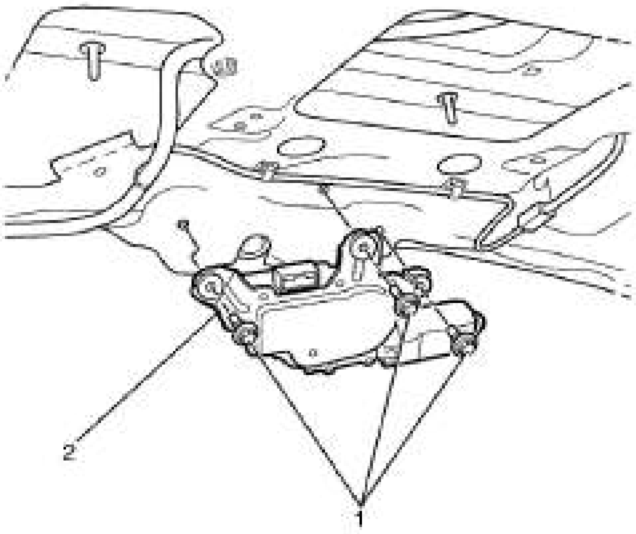


6. Disconnect the rear window wiper motor electrical connector (1) from the rear window wiper motor (2).



7. Remove the rear window wiper motor to liftgate retaining bolts (1).
8. Remove the rear window wiper motor (2) from the vehicle.

Installation Procedure

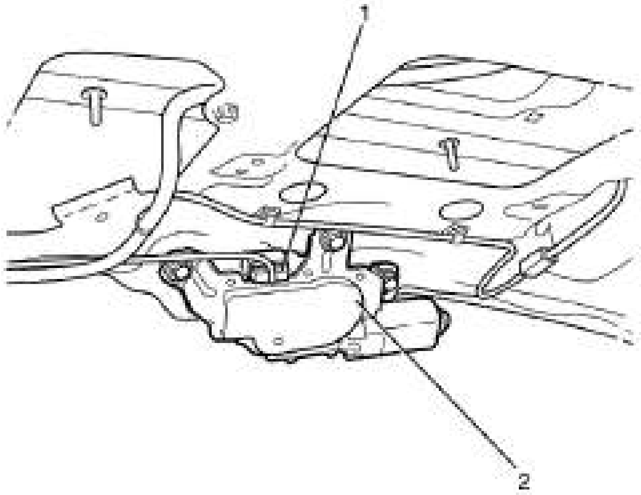


1. Position the rear window wiper motor (2) to the liftgate.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the rear window wiper motor to liftgate retaining bolts (1).

Tighten
Tighten the bolts to 8 N·m (71 lb in).



3. Connect the rear window wiper motor electrical connector (1) the rear window wiper motor (2).
4. Install the liftgate trim panel. Refer to Liftgate Trim Panel Replacement.
5. Install the liftgate window lower garnish moulding. Refer to Liftgate Window Lower Garnish Molding Replacement.
6. Install the liftgate window side garnish mouldings. Refer to Liftgate Window Side Garnish Molding Replacement.

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

7. Remove the suitable liftgate brace from the vehicle and close the liftgate.
8. Install the rear window wiper arm. Refer to Rear Window Wiper Arm Replacement.

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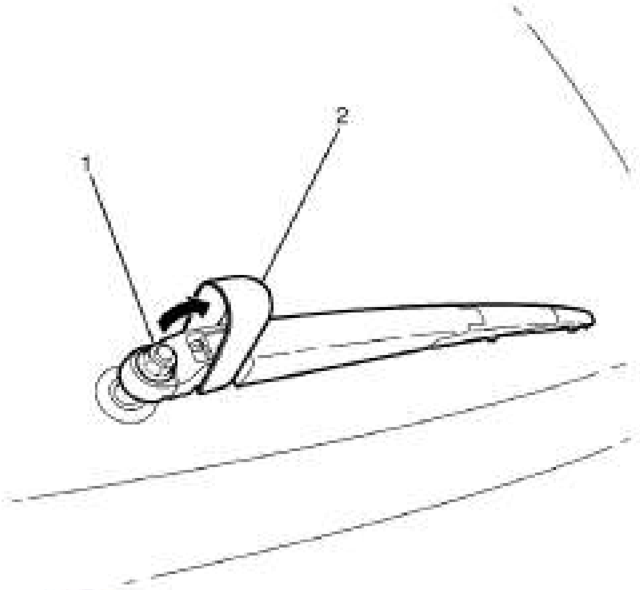
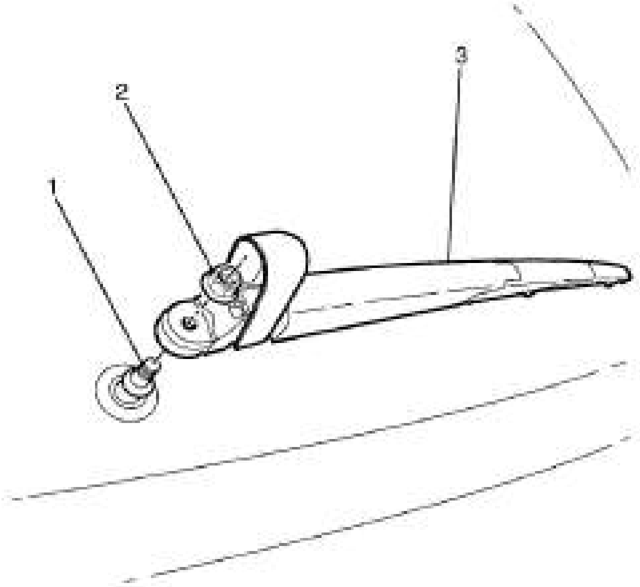
Rear Window Wiper Arm Replacement

Removal Procedure



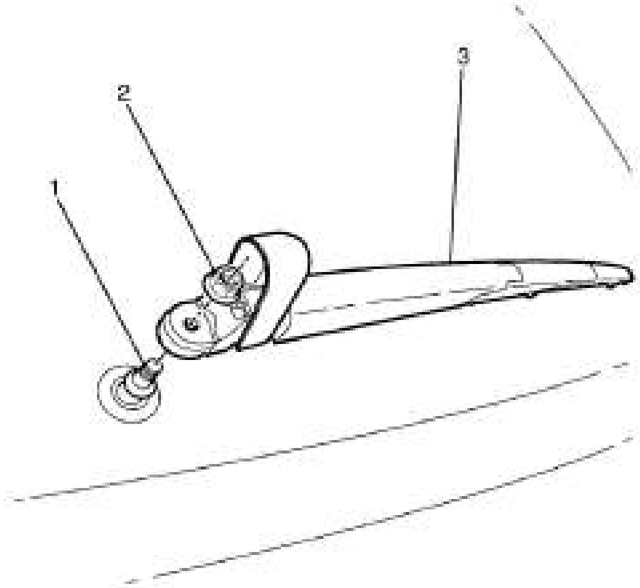
Important: Ensure the wiper arm is in the park position before commencing procedure.

1. Lift the rear wiper arm cover (2) away from the rear window to access the rear wiper arm retaining nut (1).



2. Remove the rear wiper arm retaining nut (2) from the rear wiper pivot stud (1).
3. Mark the position of the rear wiper arm (2) to the rear wiper pivot stud (1).
4. Remove the rear wiper arm (3) from the rear wiper pivot stud (2).

Installation Procedure

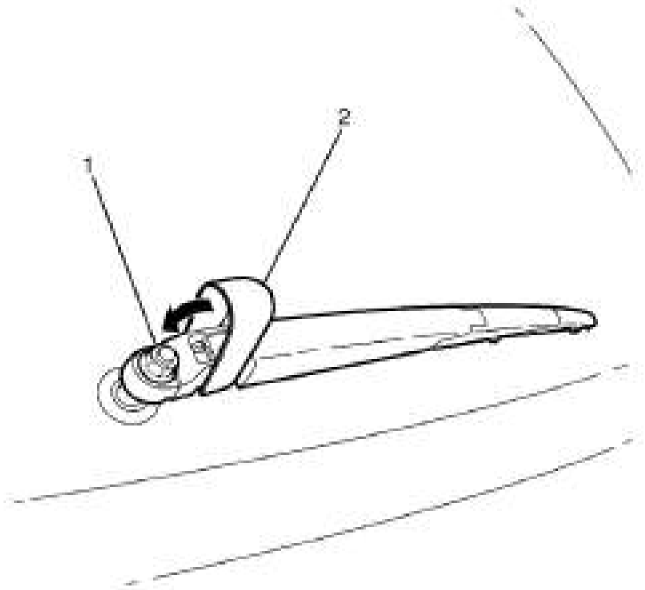


1. Install the rear wiper arm (3) to the rear wiper pivot stud (2) making sure the marked location point is aligned.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the rear wiper arm retaining nut (2) to the rear wiper pivot stud (3).
3. Tighten the rear wiper arm retaining nut (2).

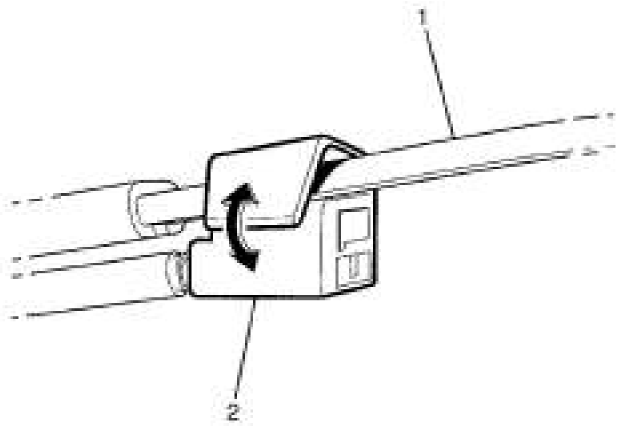
   Tighten
   Tighten the nut to 9 N·m (80 lb in).



4. Push the rear wiper arm cover (2) down towards the rear window. Listen for an audible click to confirm fitting.
5. Check the rear window wiper for correct operation and alignment.

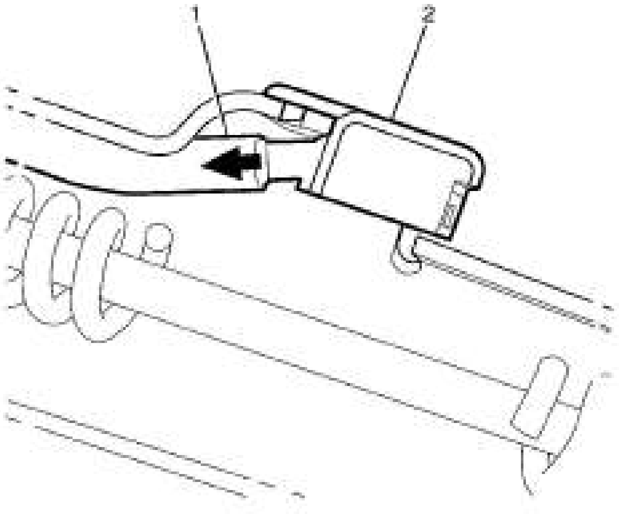
Washer Nozzle Replacement

Removal Procedure



Important: Exercise gentle force with fragile washer nozzle clips.

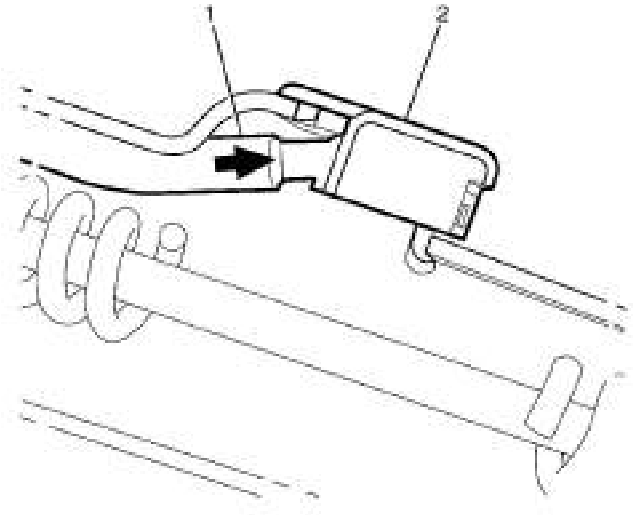
1. Unclip the washer nozzle (2) from the wiper arm (1).



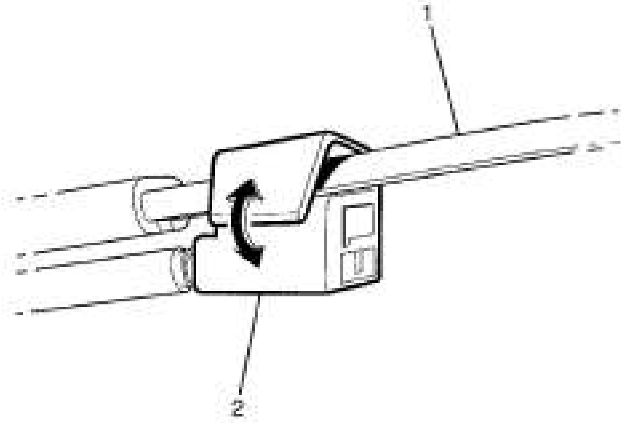
Important: Take care not to pierce the washer hose.

2. Using a suitable tool disconnect the washer hose (1) from the washer nozzle (2).

Installation Procedure



1. Connect the washer hose (1) onto the washer nozzle (2).



2. Press the washer nozzle (2) onto the wiper arm (1) clipping it firmly into place. Listen for an audible click to confirm fitting.
3. Test washer nozzle for correct operation.

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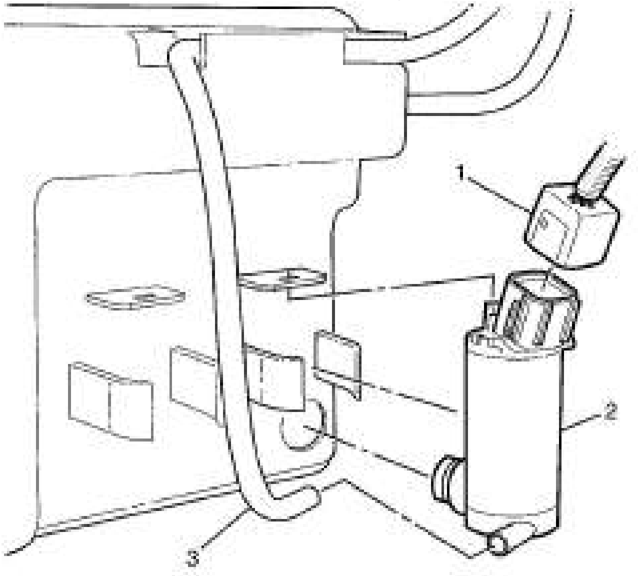
Washer Pump Replacement (Sedan)

Removal Procedure

1. Remove the radiator assembly. Refer to Radiator Replacement.



2. Disconnect the washer pump electrical connector (1).
3. Place a suitable container under the washer pump (2).

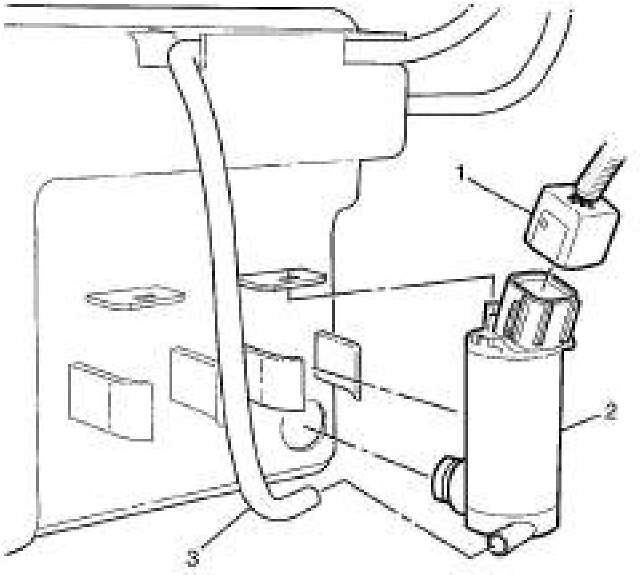
Important: Take care not to pierce the washer hose.

4. Remove the washer pump hose (3).

Important: Inspect the rubber seal for damage, due to perishing and replace as necessary.

5. Remove the washer pump (2).

Installation Procedure

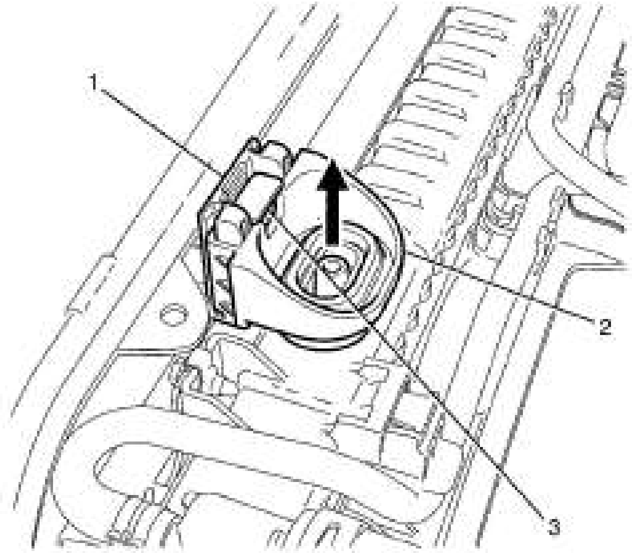


1. Position the seal to the washer pump (2) pressing in the washer pump until fully seated.
2. Connect the washer pump electrical connector (1).
3. Connect the washer pump hose (3).
4. Fill the washer solvent container with washer solvent.
5. Test the washer pump for correct operation.
6. Install the radiator assembly. Refer to Radiator Replacement.

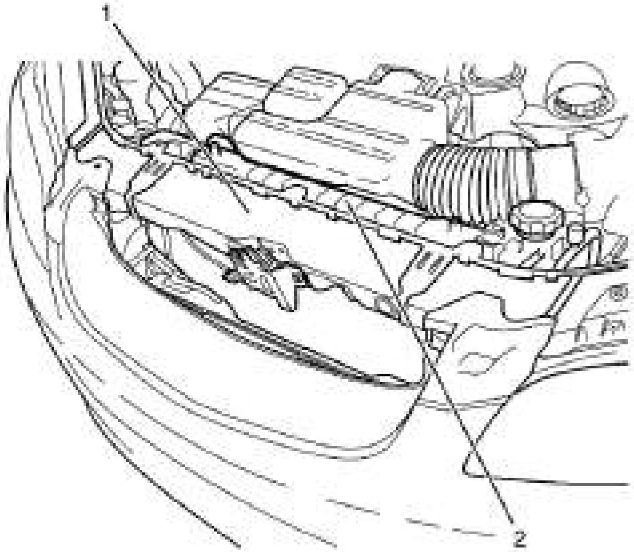
Washer Pump Replacement (Sportwagon)

Removal Procedure

1. Remove the radiator grille. Refer to Radiator Grille Replacement.

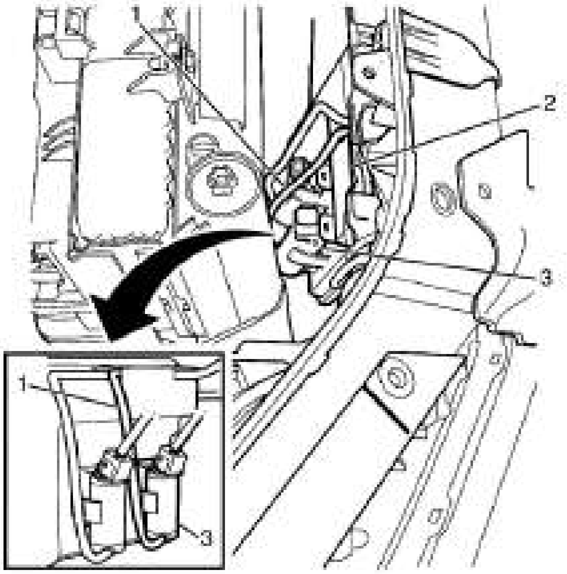


2. Raise the securing lock (3) from the radiator support bracket (2) by 10 mm on both sides.
3. Remove the radiator support bracket (2) from the radiator slide pin assembly (1) on both sides.



Important: Care must be taken when tilting the radiator assembly (2) away from the front end panel (1), as excessive force may damage the radiator assembly (2).

4. Tilt the radiator assembly (2) away from the front end panel (1).
5. Insert a suitable holding device between the front end panel (1) and the radiator assembly (2).

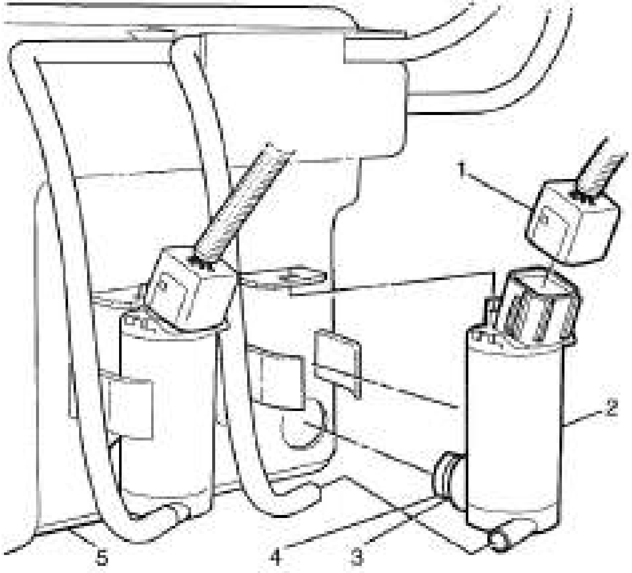


6. Place a suitable container under the rear window washer pump (3).

Important: Take care not to damage the condenser cooling fins when removing the windshield washer hose (1).

Important: Take care not to puncture the windshield washer hose (1) when removing it from the windshield washer pump (3).

7. Disconnect the windshield washer hose (1) from the windshield washer pump (3).
8. Detach the windshield washer hose (1) from the solvent container (2).

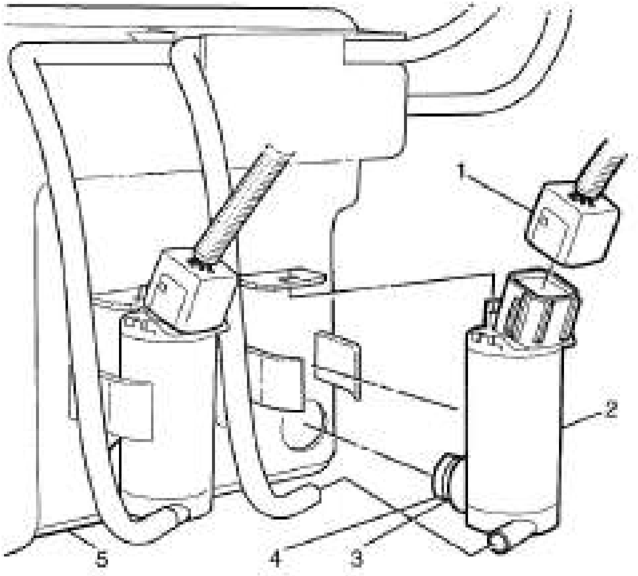


9. Disconnect the windshield washer pump electrical connector (1) from the windshield washer pump (2).

   Important: Inspect the windshield washer pump inlet port rubber seal (3) for damage and replace as necessary.

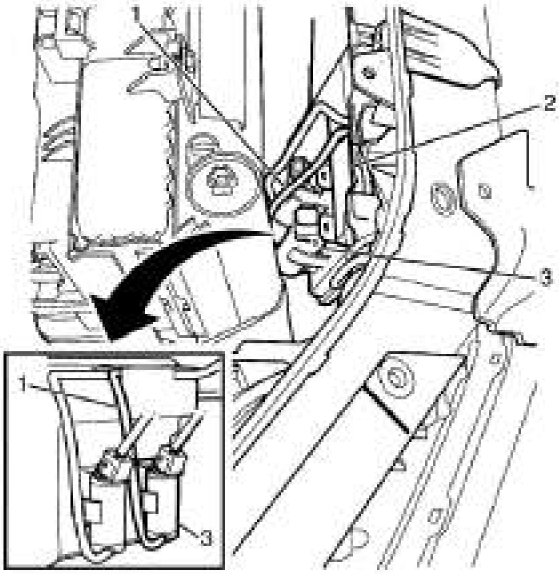
10. Remove the windshield washer pump (2) from the washer solvent container (5).

Installation Procedure



Important: Take care not to damage the condenser cooling fins when Installing the windshield washer pump (2).

1. Install the windshield washer pump inlet port rubber seal (3) onto the windshield washer pump inlet port (4).
2. Install the windshield washer pump (2) to the washer solvent container (5) making sure the windshield washer pump inlet port (4) is securely seated into the solvent container (5).
3. Connect the windshield washer pump electrical connector (1) to the windshield washer pump (2).

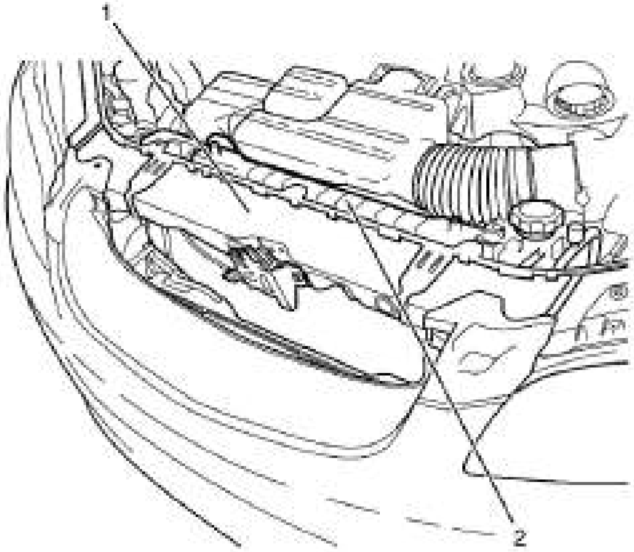


4. Attach the windshield washer hose (1) to the solvent container (2).

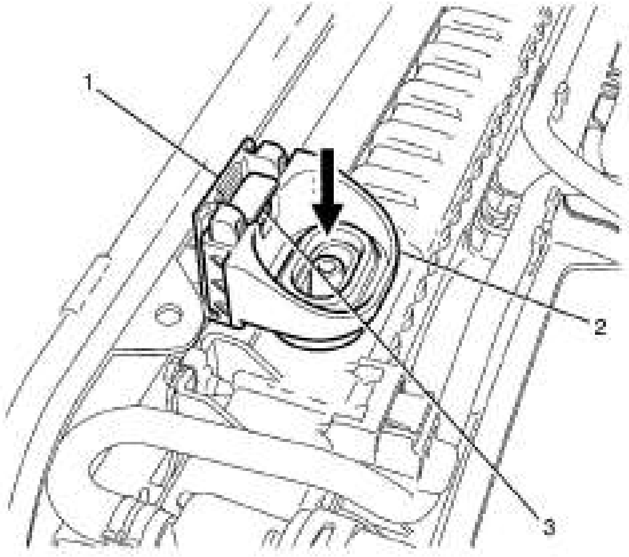
   Important: Take care not to damage the condenser cooling fins when installing the windshield washer hose (1).

   Important: Take care not to puncture the windshield washer hose (1) when installing it to the windshield washer pump (3).

5. Connect the windshield washer hose (1) to the windshield washer pump (3).



6. Remove the holding device between the radiator assembly (2) and front end panel (1).
7. Position the radiator assembly (2) towards the front end panel (1) to its original position.



8. Install the radiator support bracket (2) to the radiator slide pin assembly (1) on both sides.
9. Push the securing lock (3) into the radiator support bracket (2) making sure it is correctly seated on both sides.
10. Install the radiator grille. Refer to Radiator Grille Replacement.
11. Fill the washer solvent container with solvent.
12. Check the operation of the rear window washer and make sure there are no solvent leaks.

Windshield Glass Cleaning

Important: The cleaner should not harm the paint finish or scratch the glass. The glass is clean when the water no longer beads, but sheets across the entire glass surface.

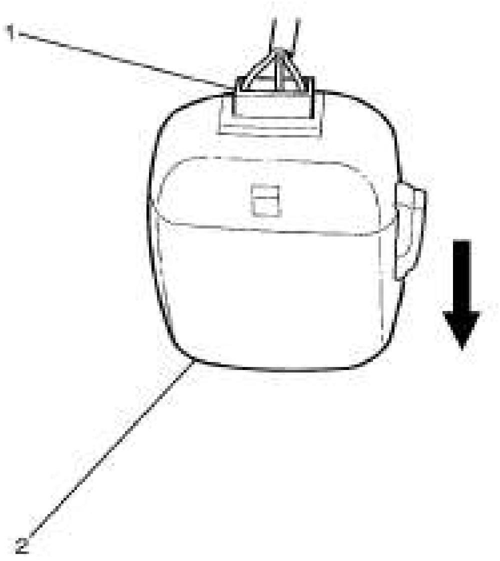
Clean the windshield with windshield cleaner, Optikleen P/N 92140004 or equivalent.

Windshield Outside Moisture Sensor Replacement

Removal Procedure

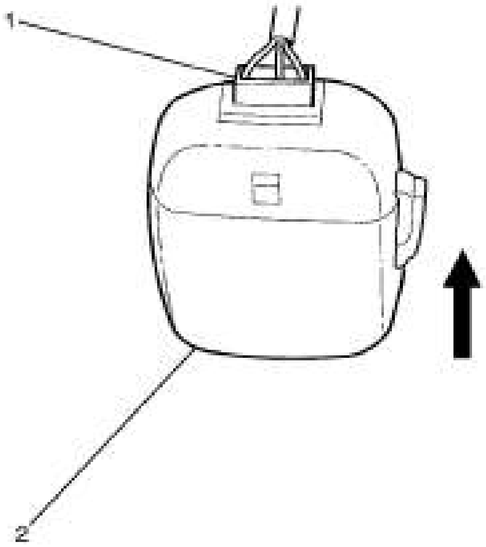
1. Position the rear view mirror away from rain sensor, in order to obtain access to the rain sensor.

   Notice: Refer to General Repair Instructions in the Preface section.



2. Disconnect the rain sensor (2) electrical connector (1).
3. Using a suitable tool Separate the rain sensor covers.
4. Slide the rain sensor (2) downward off the rain sensor boss.

Installation Procedure



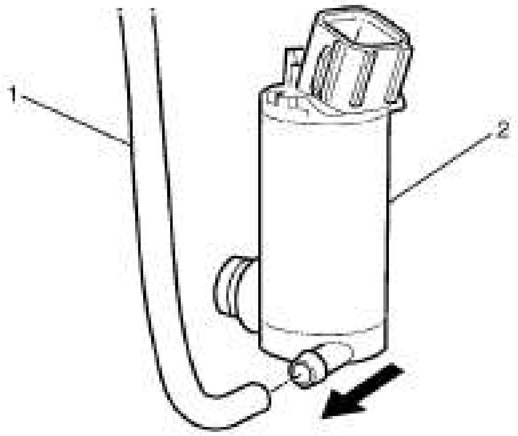
1. Position the rain sensor (2) on to the rain sensor boss.
2. Slide the rain sensor (2) upward onto the rain sensor boss, slightly pull onto the rain sensor to confirm fitting.
3. Lock the two rain sensor covers together, slightly pull onto the rain sensor to confirm fitting.
4. Connect the rain sensor (2) electrical connector (1).
5. Position the rear view mirror into its original position.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Body Systems | Wipers and Washers | Repair Instructions | Document ID: 2069402

Windshield Washer Hose Replacement (Sedan)

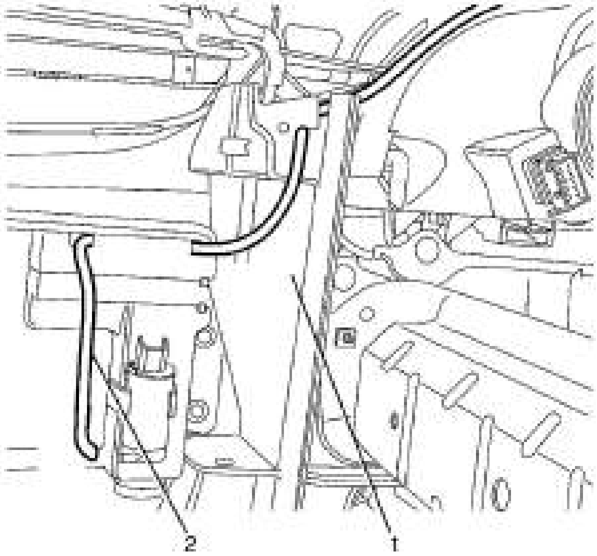
Removal Procedure (Up to 01 Sept 2007)

1. Remove the radiator assembly. Refer to Radiator Replacement .

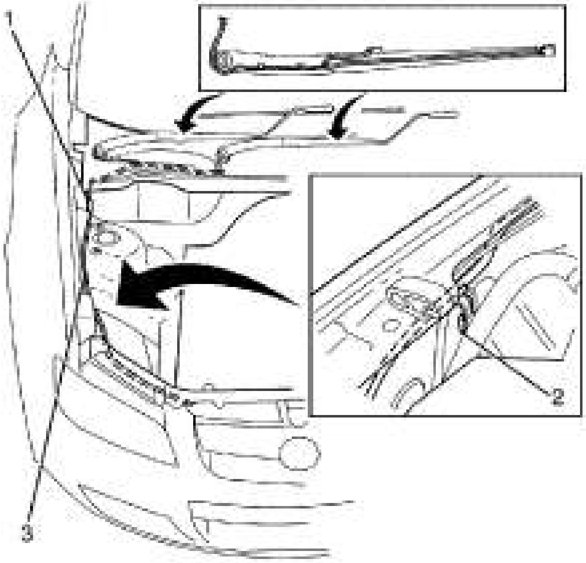


Important: Take care not to pierce the washer hose. Use a suitable cap to cap off the washer motor after removing the hose to prevent spillage.

2. Use a suitable tool to separate the windshield washer hose (1) from the washer pump (2).

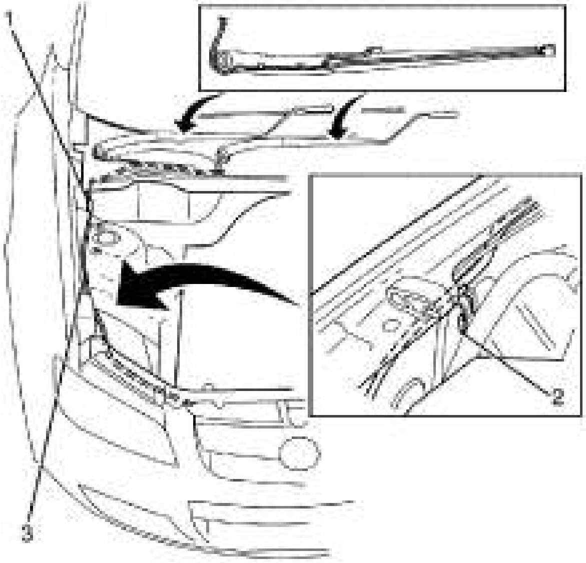


3. Detach the washer hose (2) from the radiator air intake baffle (1).

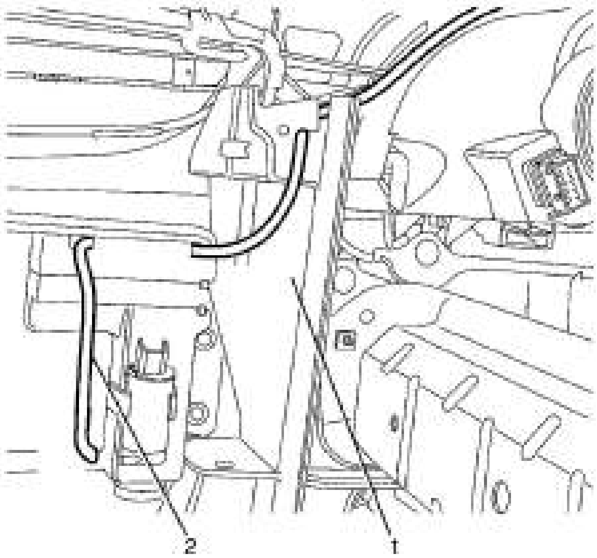


4. Detach the washer hose (3) from the fender retaining clip (2).
5. Disconnect the washer hose (3) from the washer hose connection (1).
6. Remove the windshield washer hose (3).

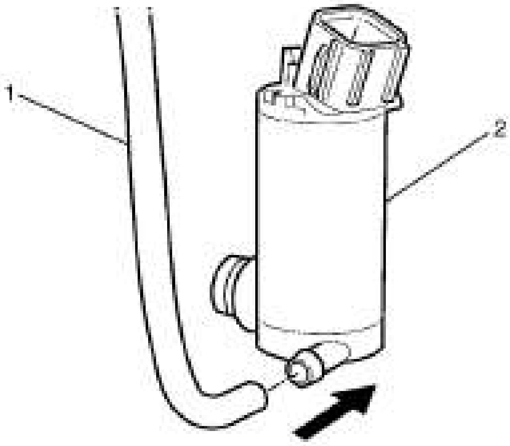
Installation Procedure (Up to 01 Sept 2007)



1. Attach the washer hose (3) to the washer hose connection (1).
2. Attach the washer hose (3) to the fender clip (2).



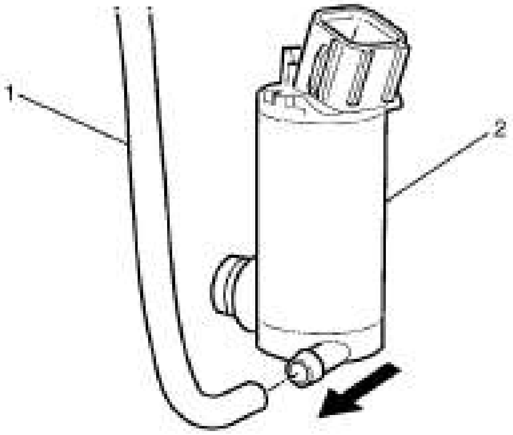
3. Route the washer hose (2) through the radiator air intake baffle (1).



4. Install the washer hose (1) onto the washer pump (2).
5. Install the radiator assembly. Refer to Radiator Replacement .
6. Test the washer pump for correct operation.

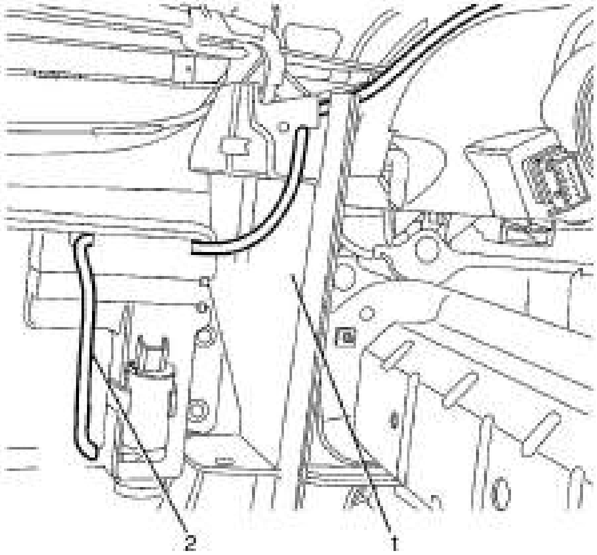
Removal Procedure (From 01 Sept 2007)

1. Remove the radiator assembly. Refer to Radiator Replacement .

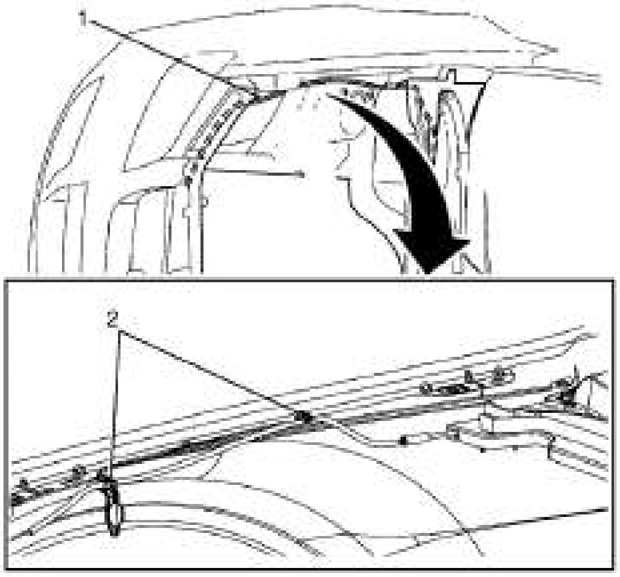


Important: Take care not to pierce the washer hose. Use a suitable cap to cap off the washer motor after removing the hose to prevent spillage.

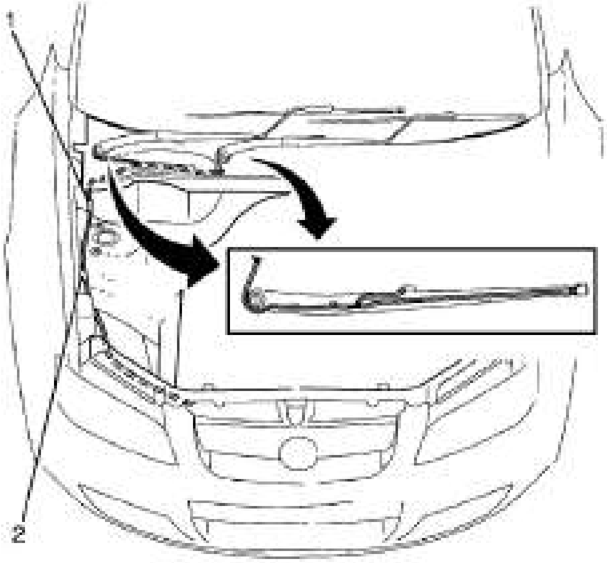
2. Use a suitable tool to separate the windshield washer hose (1) from the washer pump (2).



3. Detach the washer hose (2) from the radiator air intake baffle (1).

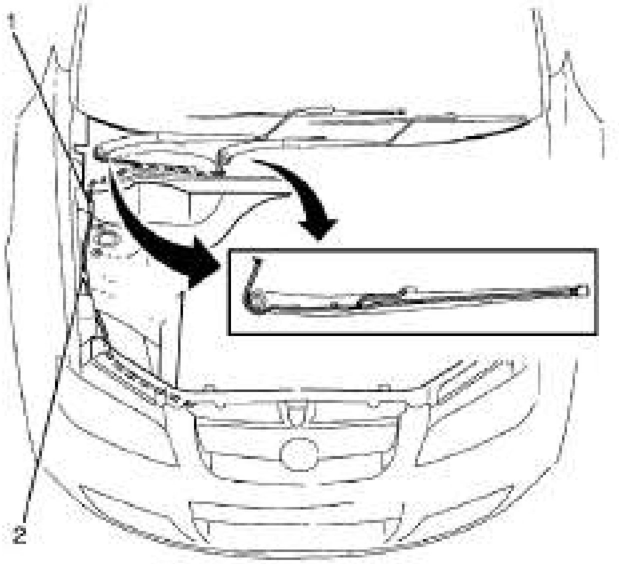


4. Detach the washer hose (1) from the fender retaining clips (2).

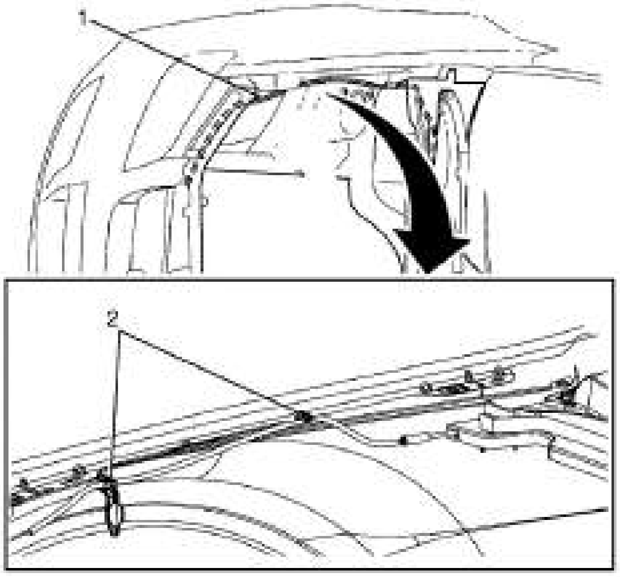


5. Disconnect the washer hose (2) from the washer hose connection (1).
6. Remove the windshield washer hose (2).

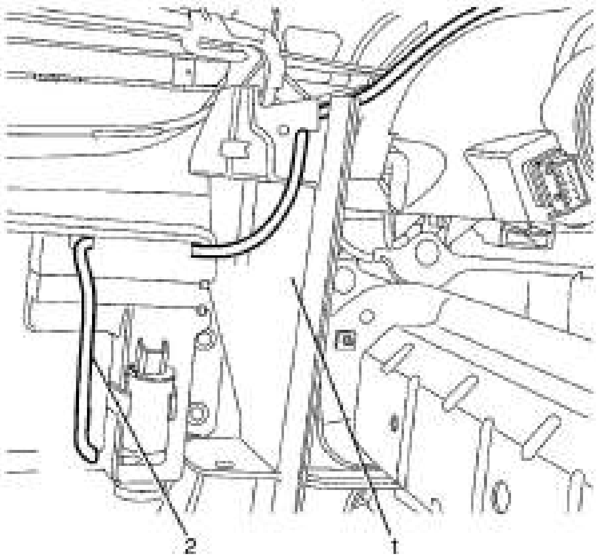
Installation Procedure (From 01 Sept 2007)



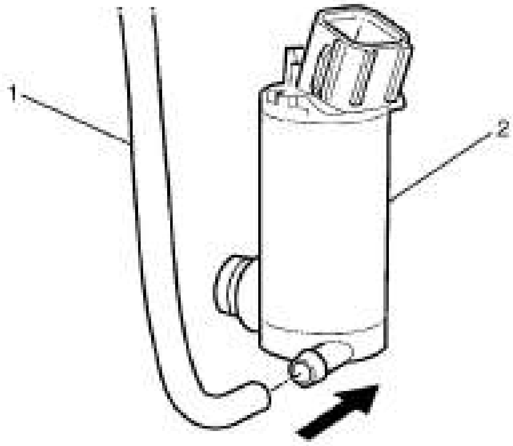
1. Attach the washer hose (2) to the washer hose connection (1).



2. Attach the washer hose (1) to the fender retaining clips (2).



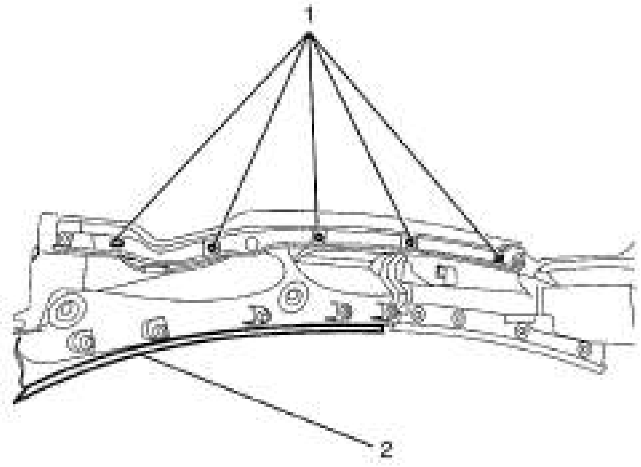
3. Route the washer hose (2) through the radiator air intake baffle (1).



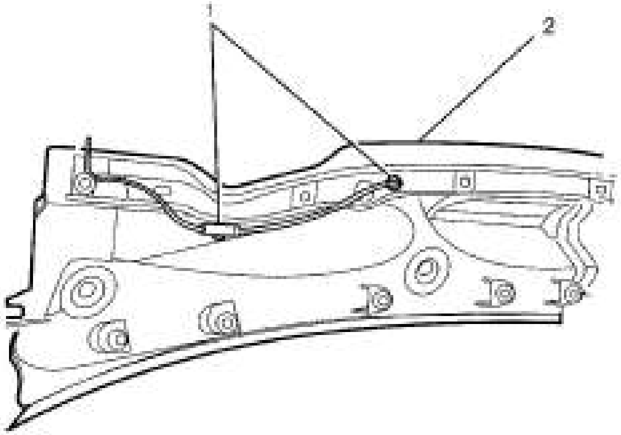
4. Install the washer hose (1) onto the washer pump (2).
5. Install the radiator assembly. Refer to Radiator Replacement .
6. Test the washer pump for correct operation.

Removal Procedure (Air Inlet Grill Hose)

1. Remove the wiper arms. Refer to Windshield Wiper Arm Replacement .
2. Remove the air inlet grille. Refer to Air Inlet Grille Panel Replacement .

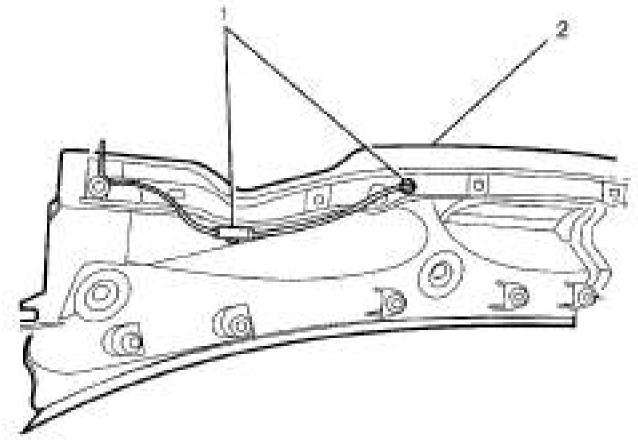


3. Remove the retaining torx screws (1) from the air inlet grille brace.
4. Remove the air inlet grille brace from the air inlet grille.

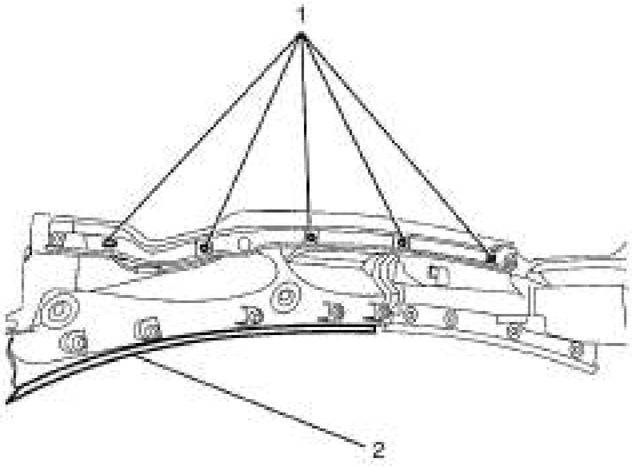


5. Detach and remove the air inlet grille hose (1) from the air inlet grille (2).

Installation Procedure



1. Attach the air inlet grille hose (1) to the air inlet grille (2).



2. Install the air inlet grille brace (2) to the air inlet grille

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the air inlet grille brace (2) to the air inlet grille retaining torx screws (1).

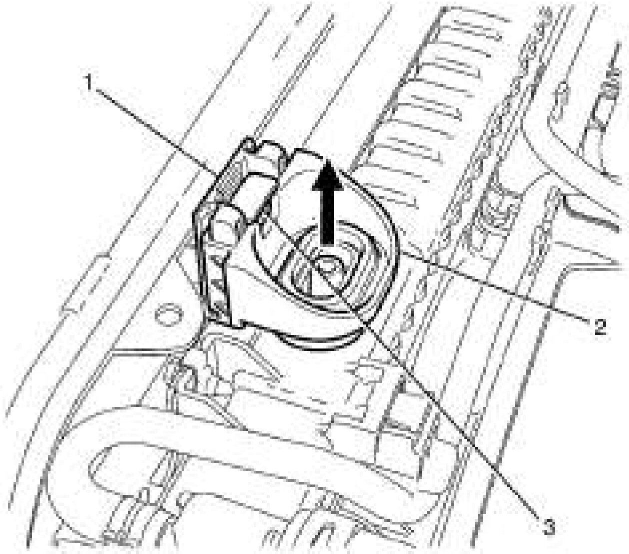
   Tighten
   Tighten the torx screws to (2.0 N·m (18 lb in).

4. Install the air inlet grille. Refer to Air Inlet Grille Panel Replacement .
5. Install the wiper arms. Refer to Windshield Wiper Arm Replacement .

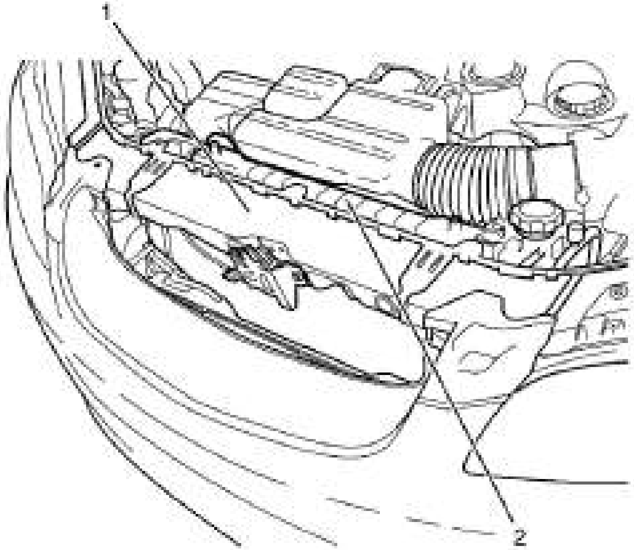
Windshield Washer Hose Replacement (Sportwagon)

Removal Procedure - Washer Pump to Front Fender Connector

1. Remove the radiator grille. Refer to Radiator Grille Replacement.

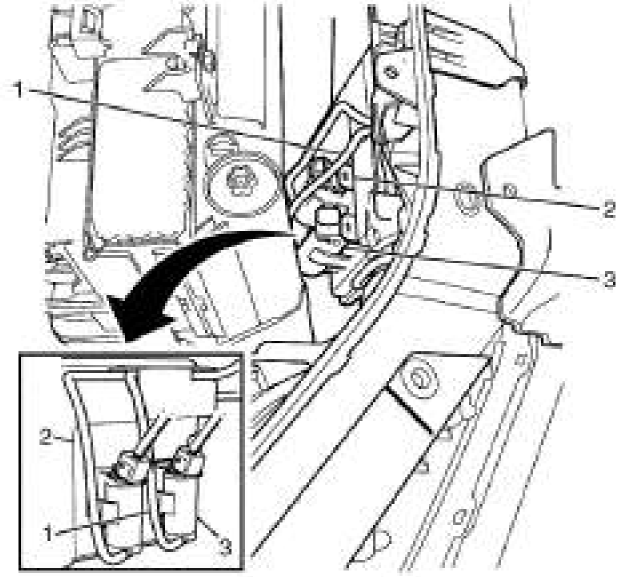


2. Raise the securing lock (3) from the radiator support bracket (2) by 10 mm on both sides.
3. Remove the radiator support bracket (2) from the radiator slide pin assembly (1) on both sides.



Important: Care must be taken when tilting the radiator assembly (2) away from the front end panel (1), as excessive force may damage the radiator assembly (2).

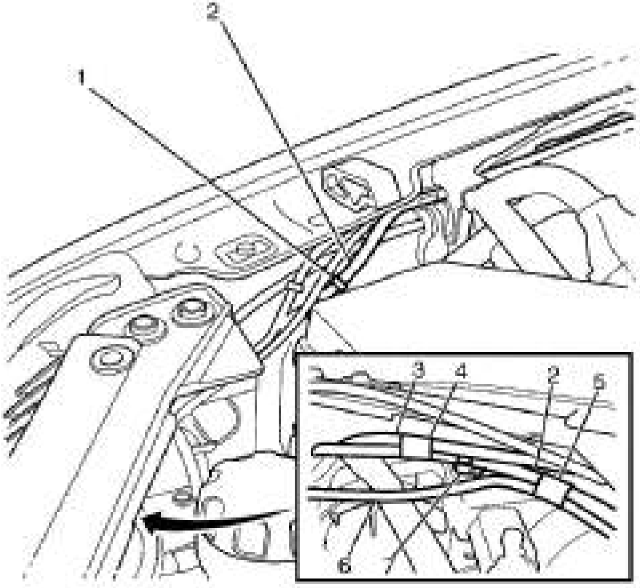
4. Tilt the radiator assembly (2) away from the front end panel (1).
5. Insert a suitable holding device between the front end panel (1) and the radiator assembly (2).



6. Place a suitable container under the windshield washer pump (2).

Important: Take care not to damage the condenser cooling fins when removing the windshield washer hose (1) from the windshield washer pump (3).

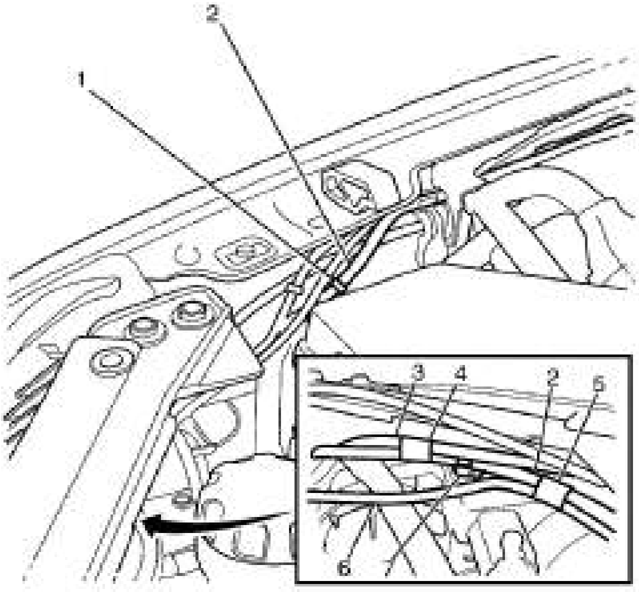
7. Disconnect the windshield washer hose (1) from the windshield washer pump (3).
8. Detach the windshield washer hose (1) from the solvent container (2).



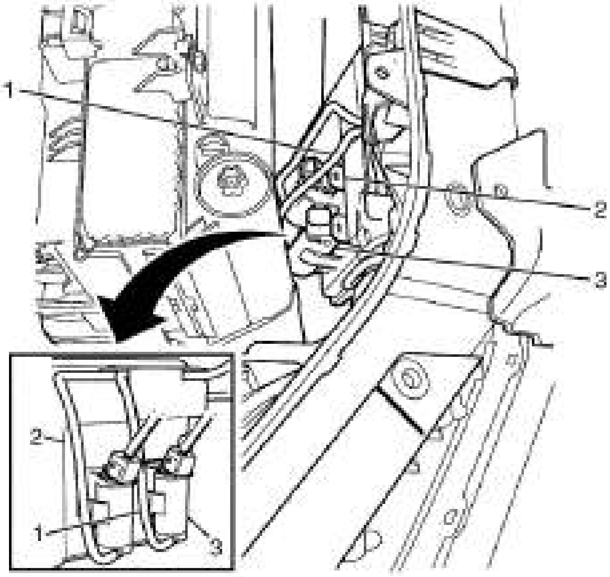
9. Mark the location of the windshield washer hose to solvent container overflow hose retaining tape (4) to the solvent container overflow hose (3).
10. Remove the windshield washer hose to solvent container overflow hose retaining tape (4).
11. Mark the location of the rear window washer hose to windshield washer hose retaining tape (5) to the rear window washer hose (6).
12. Remove the rear window washer hose to windshield washer hose retaining tape (5).
13. Mark the location of the windshield washer hose retaining clip (7) to the windshield washer hose (2).
14. Detach the windshield washer hose (2) from the windshield washer hose retaining clip (7).
15. Disconnect the windshield washer hose (2) from the windshield washer hose front fender connector (1).
16. Remove the windshield washer hose (2).
17. Using the original windshield washer hose retaining clip reference mark as a guide, mark the position of the windshield washer hose retaining clip to the NEW windshield washer hose.

Installation Procedure - Washer Pump to Front Fender Connector

Important: When installing the windshield washer hose make sure it follows the original hose routing.

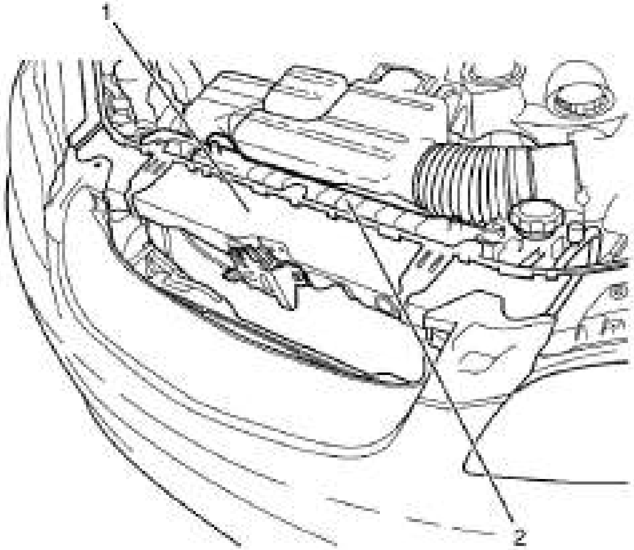


1. Connect the windshield washer hose (2) to the windshield washer hose front fender connector (1).
2. Attach the windshield washer hose (2) to the windshield washer hose retaining clip (7).
3. Attach the rear window washer hose (6) to the marked location on the windshield washer hose (2) with adhesive tape (5).
4. Attach the solvent container overflow hose (3) to the marked location on the windshield washer hose (2) with adhesive tape (4).

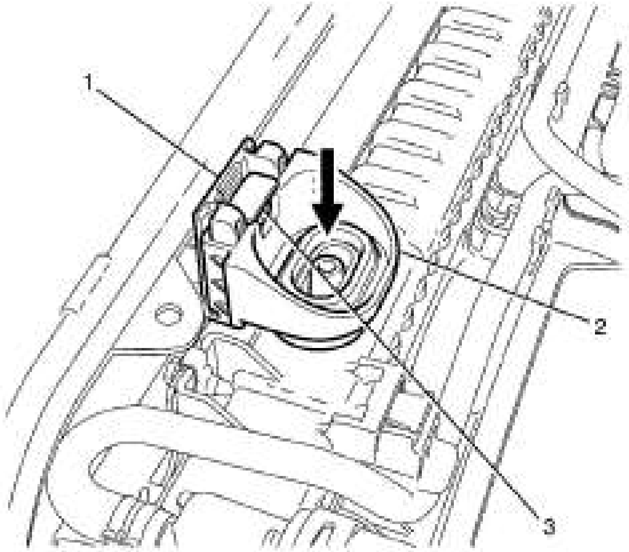


Important: Take care not to damage the condenser cooling fins when installing the rear window washer hose (1) to the rear window washer pump (2).

5. Attach the windshield washer hose (1) to the solvent container (2).
6. Connect the windshield washer hose (1) to the windshield washer pump (3).

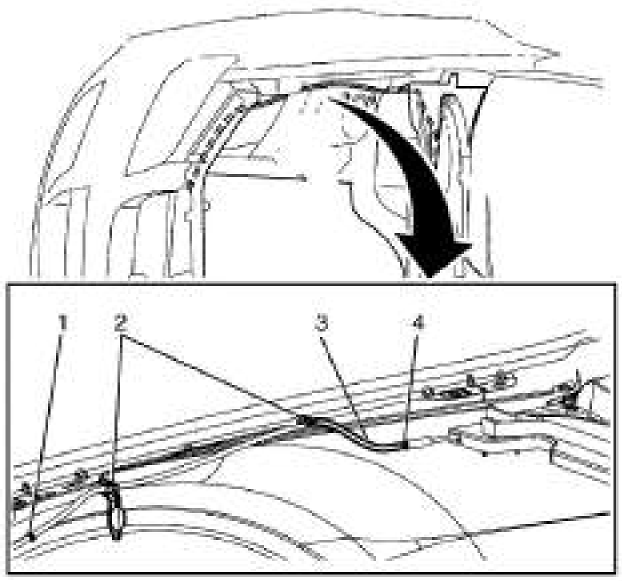


7. Remove the holding device between the radiator assembly (2) and front end panel (1).
8. Position the radiator assembly (2) towards the front end panel (1) to its original position.



9. Install the radiator support bracket (2) to the radiator slide pin assembly (1) on both sides.
10. Push the securing lock (3) into the radiator support bracket (2) making sure it is correctly seated on both sides.
11. Install the radiator grille. Refer to Radiator Grille Replacement.
12. Fill the washer fluid container with solvent.
13. Check the operation of the windshield washer and make sure there are no solvent leaks.

Removal Procedure - Front Fender Connector to Air Inlet Grill Connector

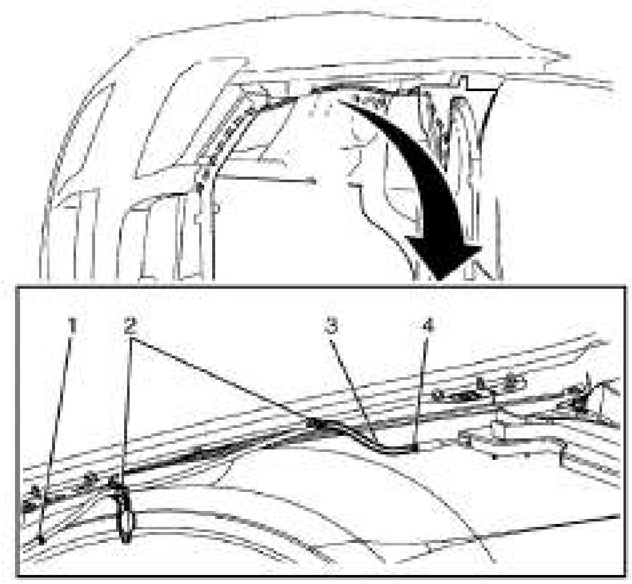


1. Detach the windshield washer hose (3) from the front fender retaining clips (2).
2. Disconnect the windshield washer hose (3) from the windshield washer hose front fender

connector (1).

3. Disconnect the windshield washer hose (3) from the windshield washer hose air inlet grill hose connector (4).
4. Remove the windshield washer hose (3).

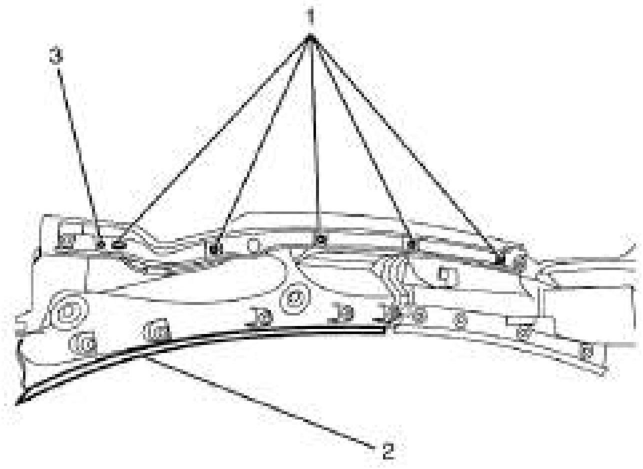
Installation Procedure - Front Fender Connector to Air Inlet Grill Connector



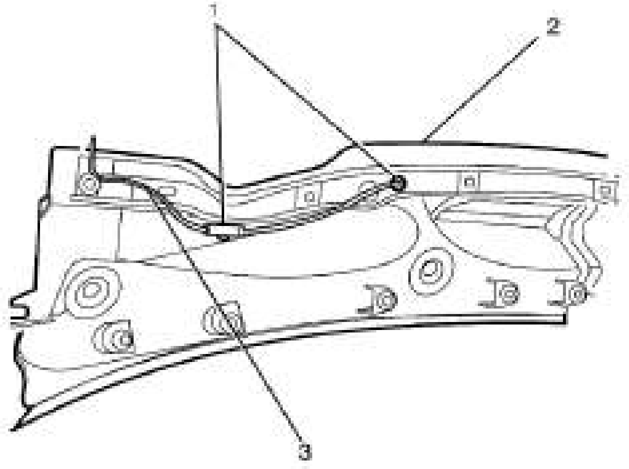
1. Connect the windshield washer hose (3) to the windshield washer hose air inlet grill hose connector (4).
2. Connect the windshield washer hose (3) to the windshield washer hose front fender connector (1).
3. Attach the windshield washer hose (3) to the fender retaining clips (2).
4. Check the operation of the windshield washers and make sure there are no solvent leaks.

Removal Procedure - Air Inlet Grill Hose

1. Remove the windshield wiper arms. Refer to Windshield Wiper Arm Replacement.
2. Remove the air inlet grille. Refer to Air Inlet Grille Panel Replacement.

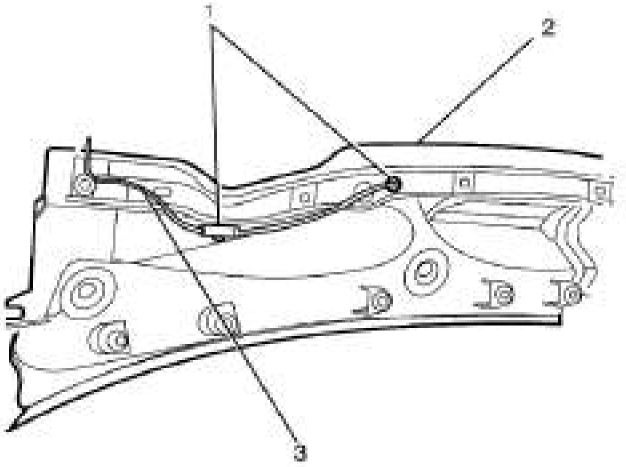


3. Remove the air inlet grille brace retaining screws (1) from air inlet grille brace (3).
4. Remove the air inlet grille brace (3) from the air inlet grille (2).

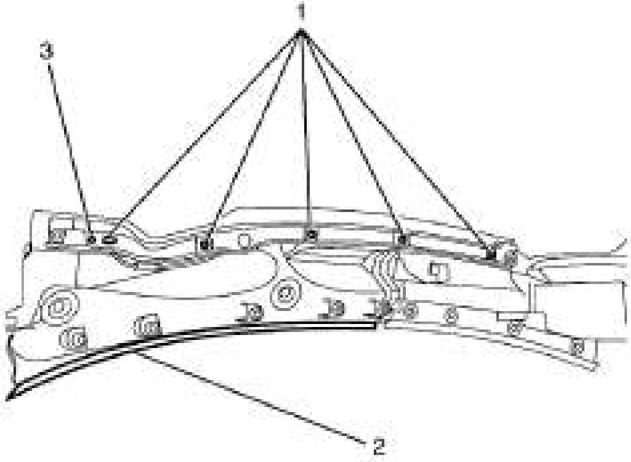


5. Disconnect the windshield washer hose (3) from the windshield washer hose air inlet grille to wiper arm hose connectors (1).
6. Remove the windshield washer hose (3).

Installation Procedure - Air Inlet Grill Hose



1. Connect the windshield washer hose (3) to the windshield washer hose air inlet grille to wiper arm hose connectors (1).



2. Install the air inlet grille brace (3) to the air inlet grille (2).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the air inlet grille brace retaining screws (1) to the air inlet grille brace (3).

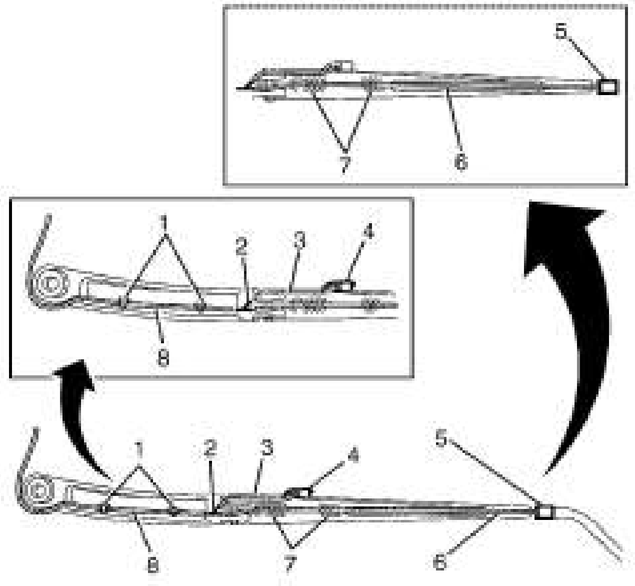
   Tighten
   Tighten the screws to 2 N·m (18 lb in).

4. Install the air inlet grille. Refer to Air Inlet Grille Panel Replacement.
5. Install the wiper arms. Refer to Windshield Wiper Arm Replacement

6. Check the operation of the windshield washers and make sure there are no solvent leaks.

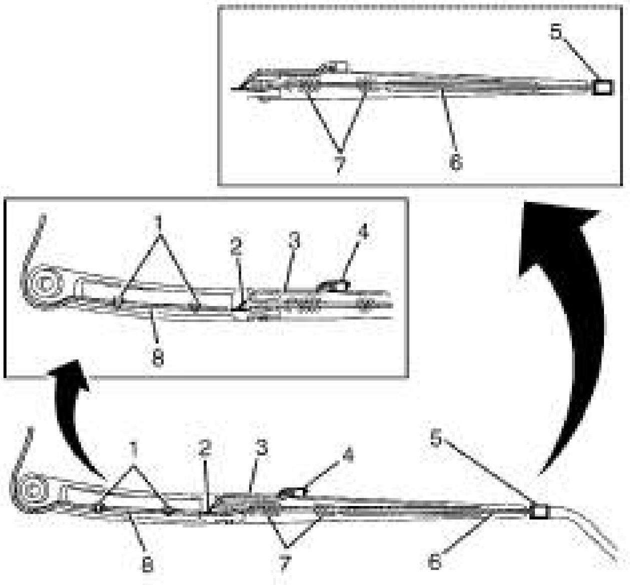
Removal Procedure - Windshield Wiper Arm Hoses

1. Remove the windshield wiper arm. Refer to Windshield Wiper Arm Replacement.



2. Detach the primary windshield washer hose (8) from the primary windshield washer hoses retaining clips (1).
3. Disconnect and remove the primary windshield washer hose (8) from the primary windshield washer hoses to right and left washer nozzle hose connector (2).
4. Disconnect the right windshield washer nozzle hose (3) from the primary windshield washer hoses to right and left washer nozzle hose connector (2).
5. Disconnect and remove the right windshield washer nozzle hose (3) from the right windshield washer nozzle (4).
6. Disconnect and remove the primary windshield washer hoses to right and left washer nozzle hose connector (2) from the left windshield washer nozzle hose (6).
7. Disconnect the left windshield washer nozzle hose (6) from the left windshield washer nozzle (5).
8. Thread and remove the left windshield washer nozzle hose (6) out of the windshield wiper arm tension spring (7).

Installation Procedure - Windshield Wiper Arm Hoses



1. Thread the left windshield washer nozzle hose (6) through the windshield wiper arm tension spring (7) to the left windshield washer nozzle (5).
2. Connect the left windshield washer nozzle hose (6) to the left windshield washer nozzle (5).
3. Connect the primary windshield washer hoses to right and left washer nozzle hose connector (2) to the left windshield washer nozzle hose (6).
4. Connect the right windshield washer nozzle hose (3) to the right windshield washer nozzle (4).
5. Connect the right windshield washer nozzle hose (3) to the primary windshield washer hoses to right and left washer nozzle hose connector (2).
6. Connect the primary windshield washer hose (8) to the primary windshield washer hoses to right and left washer nozzle hose connector (2).
7. Attach the primary windshield washer hose (8) to the primary windshield washer hoses retaining clips (1).
8. Install the wiper arm. Refer to Windshield Wiper Arm Replacement
9. Check the operation of the windshield washers and make sure there are no solvent leaks.

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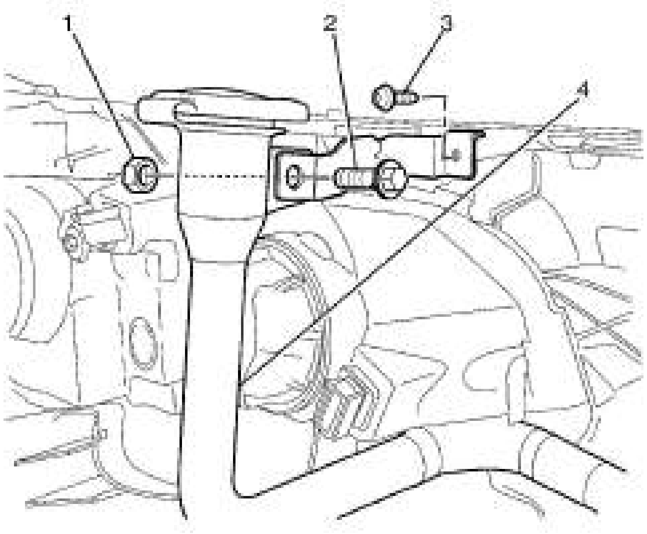
Windshield Washer Solvent Container Filler Tube Replacement

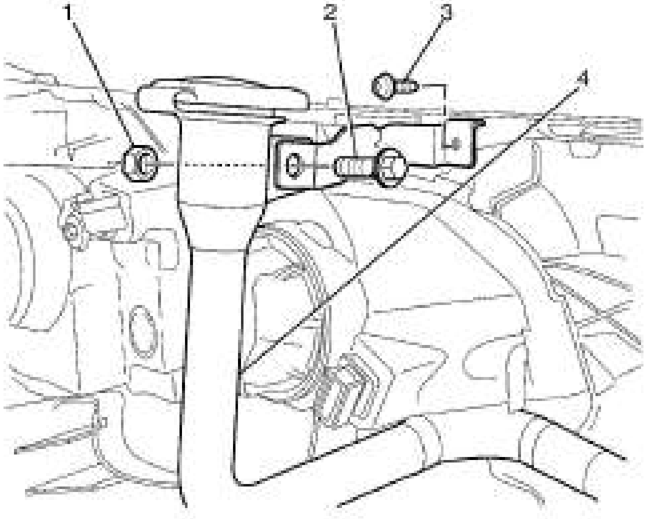
Removal Procedure

1. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.



2. Remove the washer solvent container filler neck (4) to front end module bracket retaining bolt (2) and nut (1).
3. Remove the washer solvent container filler neck (4) to front end module bracket retaining torx screw (3).
4. Remove the washer solvent container filler neck (4) from the washer solvent container.

Installation Procedure



1. Install the washer solvent container filler neck (4) into the washer solvent container.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the washer solvent container filler neck (4) to front end module bracket retaining bolt (2) and nut (1).

   Tighten
   Tighten the washer solvent container filler neck retaining bolt to 5.0 N·m (44 lb in).

3. Install the washer solvent container filler neck (4) to front end module bracket retaining torx screw (3).

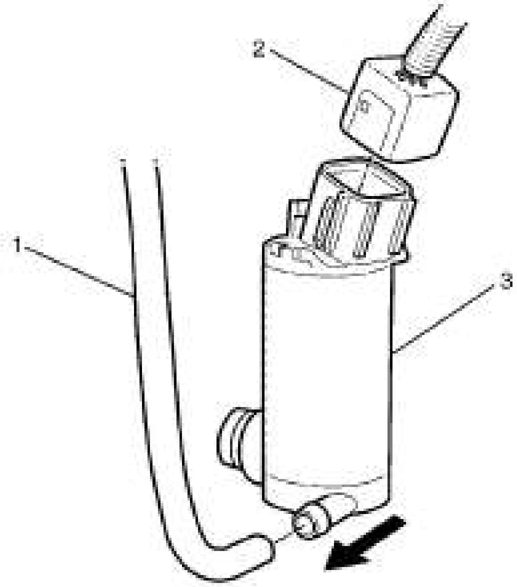
   Tighten
   Tighten the retaining torx screw to (4.0 N·m (35 lb in).

4. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.

Windshield Washer Solvent Container Replacement

Removal Procedure

1. Remove the radiator assembly. Refer to Radiator Replacement.
2. Remove the washer solvent container filler neck. Refer to Windshield Washer Solvent Container Filler Tube Replacement.



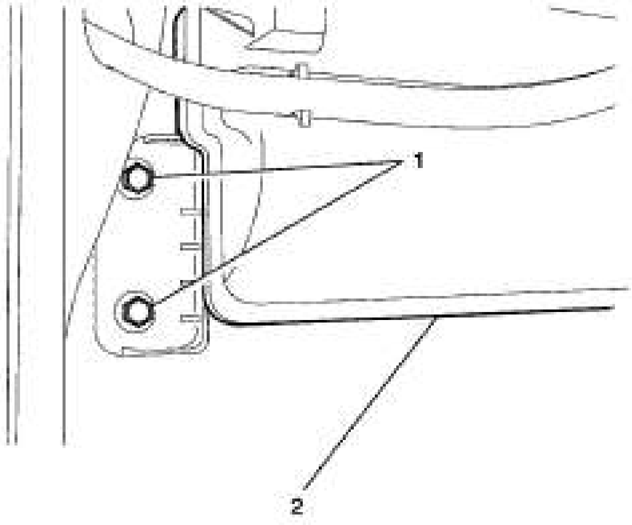
3. If fitted, remove the headlamp washer hose from the headlamp washer pump.

   Disconnect the washer pump electrical connector (2).

4. Place a suitable container under the washer pump (3).
5. Remove the washer pump (3) from the washer solvent container.
6. Drain the washer solvent by directing the flow out of the solvent container into the suitable container.

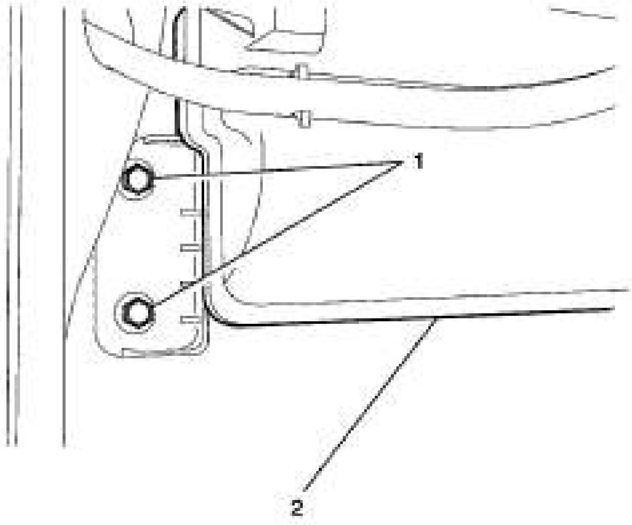
   Important: Inspect the rubber seal for damage, due to perishing and replace as necessary.

7. Use a suitable tool to separate the washer hose (1) from the washer pump (3).



8. Remove the washer solvent container (2) to front end module support retaining bolts (1). Carry out the same procedure for opposite side.
9. Remove the solvent washer container (2).

Installation Procedure

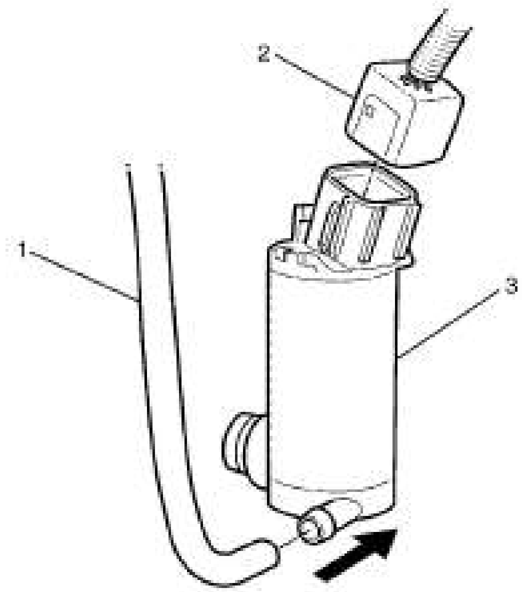


1. Install the washer solvent container (2) to the front end module support.
2. Install the washer solvent container (2) to the front end module support retaining bolts (1).

Notice: Refer to Fastener Notice in the Preface section.

Tighten

Tighten the bolts (1) to (5 N·m (44 lb in).



3. If fitted, install the headlamp washer hose.

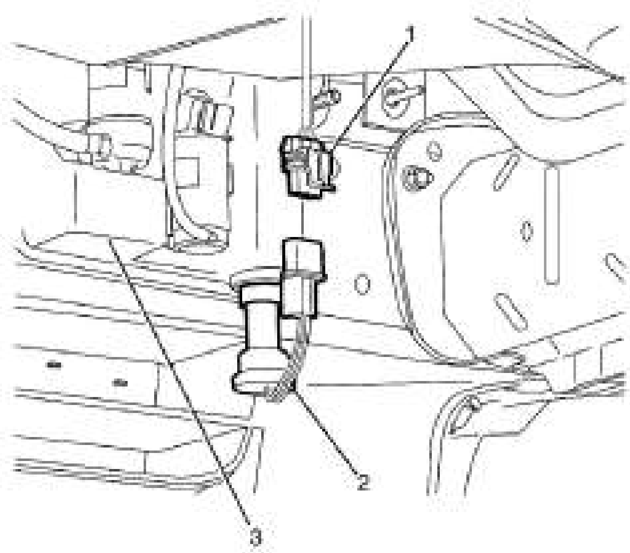
   Connect the washer pump electrical connector (2).

4. Connect the washer pump hose (1) to the washer pump (3)
5. Install the washer solvent container filler neck. Refer to Windshield Washer Solvent Container Filler Tube Replacement.
6. Fill the washer solvent container with washer solvent.
7. Install the radiator assembly. Refer to Radiator Replacement.
8. Test the washer pump for the correct operation.

Windshield Washer Solvent Level Switch Replacement

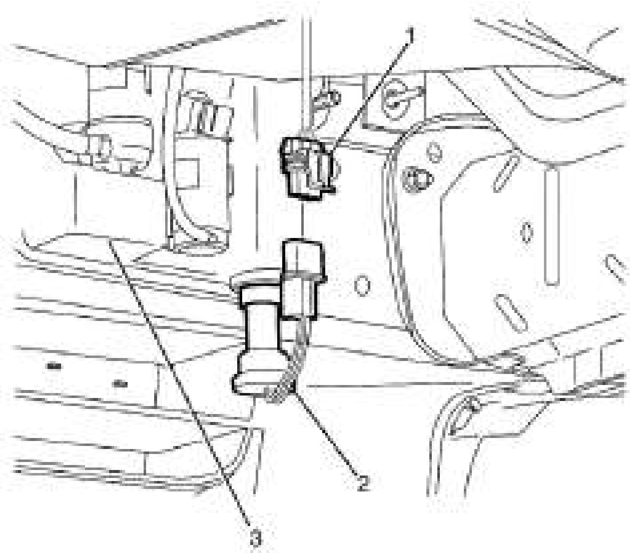
Removal Procedure

1. Remove the radiator assembly. Refer to Radiator Replacement.



2. Disconnect the washer fluid level switch electrical connector (1).
3. Place a suitable container under the washer fluid level switch (2).
4. Remove the washer fluid level switch (2) from the washer fluid container and discard the rubber seal.

Installation Procedure



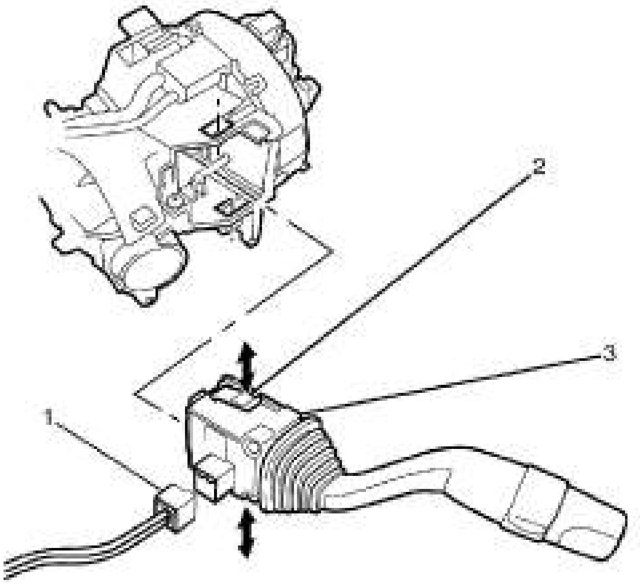
Important: Insert the washer fluid level switch into the washer fluid container until fully seated.

1. Install the washer fluid level switch (2) into the washer fluid container.
2. Connect the washer fluid level switch electrical connector (1).
3. Fill the washer solvent container with washer solvent.
4. Install the radiator assembly. Refer to Radiator Replacement.

Windshield Wiper and Washer Switch Replacement (RHD)

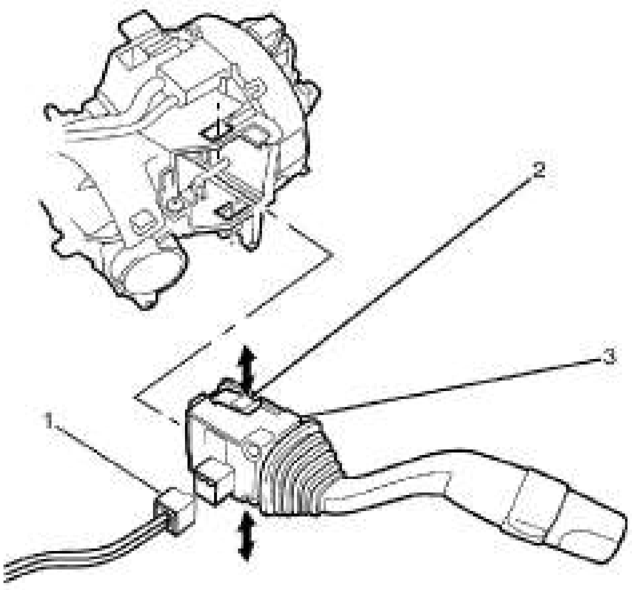
Removal Procedure

1. Remove the steering column trim covers. Refer to Steering Column Trim Covers Replacement.



2. Press the top and bottom retaining tabs (2) in and Pull the wiper/washer switch (3) out if the column assembly.
3. Disconnect the wiper/washer switch electrical connector (1).
4. Remove the wiper/washer switch (1).

Installation Procedure



1. Connect the wiper/washer switch electrical connector (1).
2. Install the Wipers/Washer signal switch (3) to the steering column. Listen for an audible click from the retaining tabs (2) to confirm fitting.
3. Install the steering column trim covers. Refer to Steering Column Trim Covers Replacement.
4. Test wiper and washer system for correct operation.

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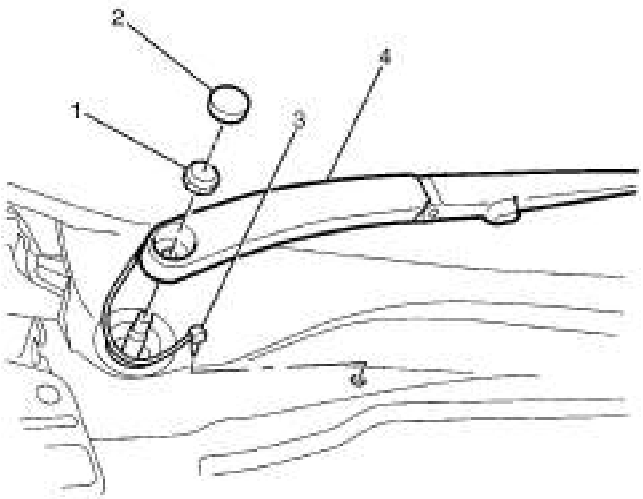
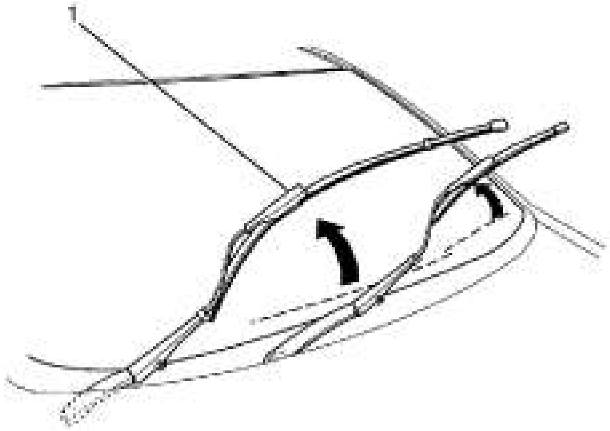
Windshield Wiper Arm Replacement (RHD)

Removal Procedure



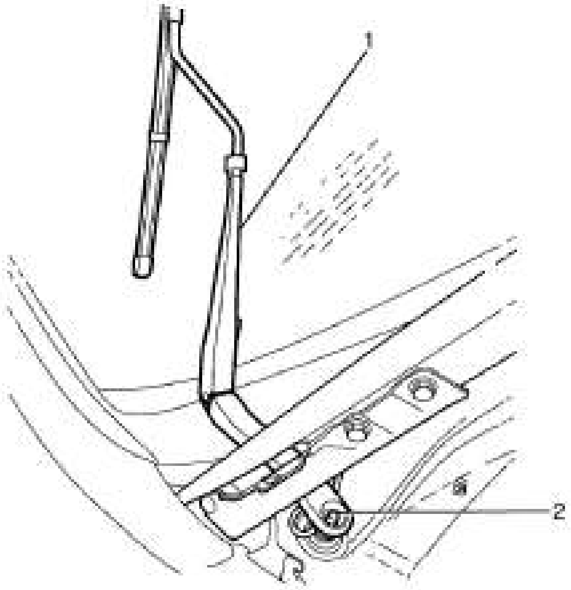
Important: Make sure that the wiper arms do not interfere with the bonnet while being moved away from the windshield otherwise damage to the bonnet may occur.

1. Open the Bonnet
2. Remove the wiper arm to pivot stud retaining nut covers (2).
3. Remove the wiper arm to air inlet grille washer hose connectors (3).
4. Remove the wiper arm to pivot stud retaining nuts (1).



Important: Make sure that the wiper arms do not interfere with the bonnet while being moved away from the windshield otherwise damage to the bonnet may occur.

5. Close the Bonnet
6. Lift the wiper arms (1) away from the windshield to the upright position.
7. Remove the LHS wiper arm (4) from the wiper pivot stud.

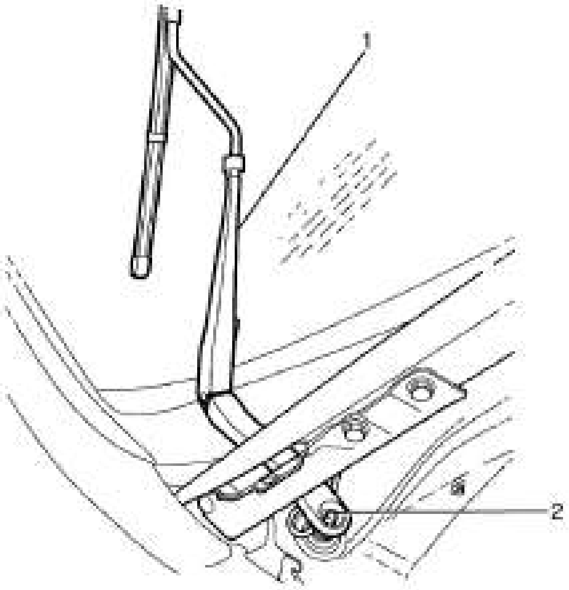


Important: Make sure that the RHS wiper arm does not interfere with the bonnet otherwise damage to the bonnet may occur.

Important: The RHS wiper should be in the vertical position and away from the windshield as shown.

8. Pull the right hand side wiper arm (1) away from the spline
9. Rotate the RHS wiper arm (1) so the bonnet can be opened without hitting the wiper.
10. Open the bonnet.
11. Manoeuvre the RHS wiper arm (1) off the wiper pivot stud and off the vehicle.

Installation Procedure



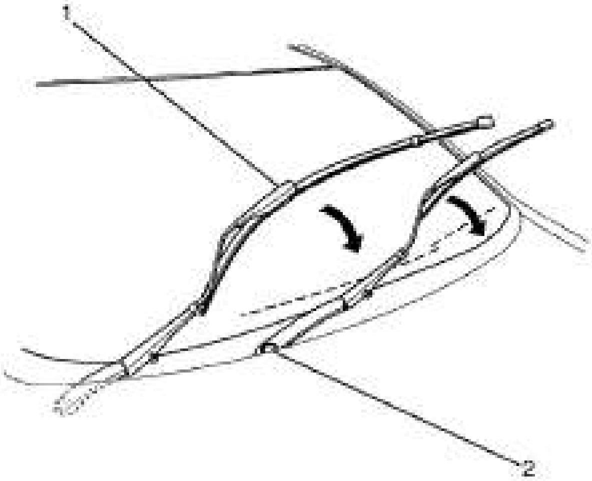
Important: Make sure that the RHS wiper arm does not interfere with the bonnet otherwise damage to the bonnet may occur.

Important: The RHS wiper should be in the vertical position and away from the windshield as shown.

1. Install the RHS wiper arm (1) onto the wiper pivot stud.
2. Install the wiper arm to pivot stud retaining nut (2).

   Do not fully tighten at this stage.

3. Close the bonnet

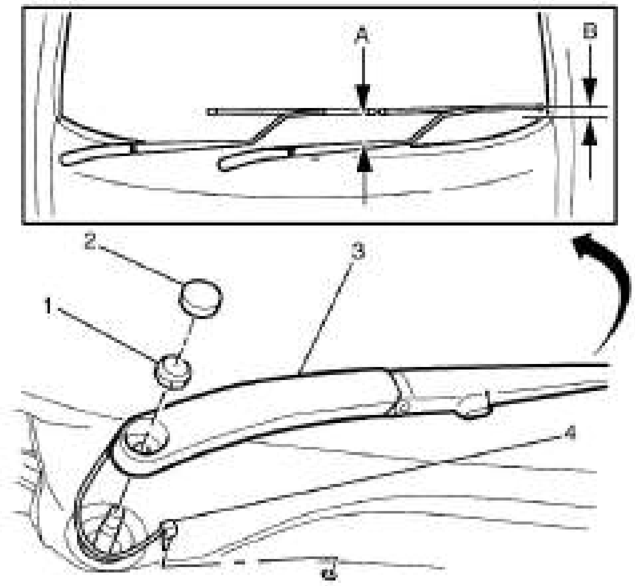


Important: Make sure that the wiper arms do not interfere with the bonnet while being moved away from the windshield otherwise damage to the bonnet may occur.

4. Install the LHS wiper arm (1) to the wiper pivot stud.
5. Install the LHS wiper arm to pivot stud retaining nut (2).

Do not fully tighten at this stage.

6. Lower the wiper arms (1) toward the windshield to the lowered position.



Important: When installing the wiper arm, ensure the installation measurements are adhered to otherwise fouling of the inlet panel may occur.

7. Align the wiper arm blades to the inlet panel using the following measurements :
   - Point ' A' 59 mm
   - Point ' B' 29 mm

Notice: Refer to Fastener Notice in the Preface section.

8. Tighten the LHS wiper arm to pivot stud retaining nut (1).

Tighten
Tighten the nut to 35 N·m (26 lb ft).

9. Open the bonnet.

Notice: Refer to Fastener Notice in the Preface section.

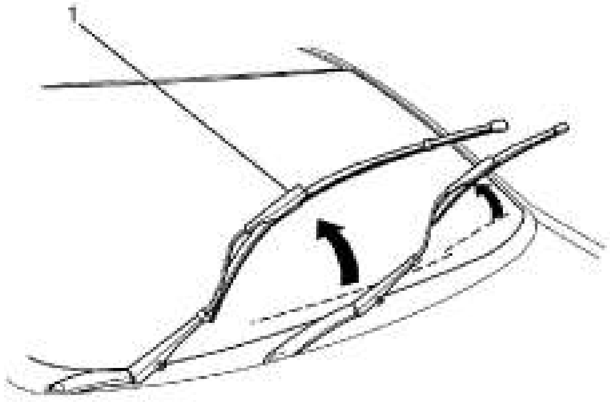
10. Tighten the RHS wiper arm to pivot stud retaining nut (1).

Tighten
Tighten the nut to 35 N·m (26 lb ft).

11. Install the wiper arm to pivot stud retaining nut covers.
12. Connect the wiper arm (3) to the air inlet grille washer hose connectors (4).
13. Close the bonnet.
14. Check the windshield wipers for correct operation.

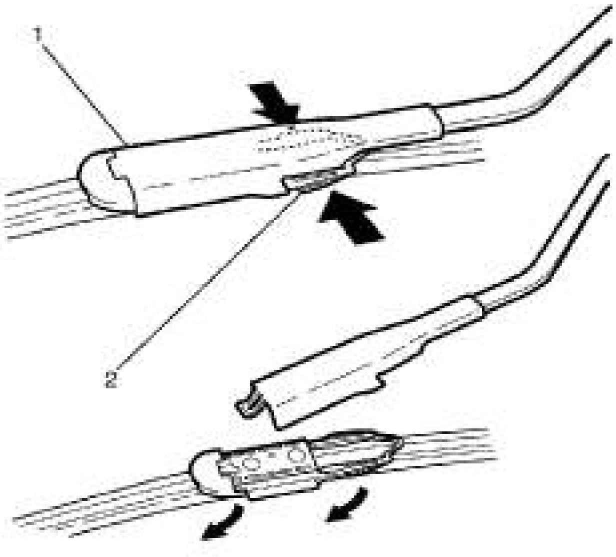
Windshield Wiper Blade Replacement (RHD)

Removal Procedure



Important: Ensure that the wiper arms do not interfere with the hood while being moved away from the windshield.

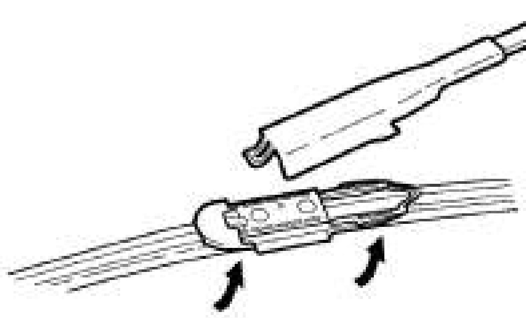
1. Lift the wiper arms (1) away from the windshield to the upright position.



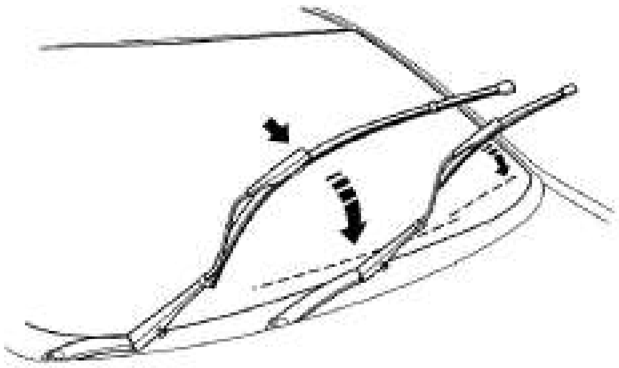
Important: Ensure that the wiper arms remain at rest and Do Not spring back onto the windscreen.

2. Press the wiper arm blade side clip (2) in and unclip the wiper arm (1) blade.
3. Remove the wiper arm blade from the wiper arm (1).

Installation Procedure



1. Clip the wiper arm blade connector onto the wiper arm. Listen for an audible click to confirm fitting.

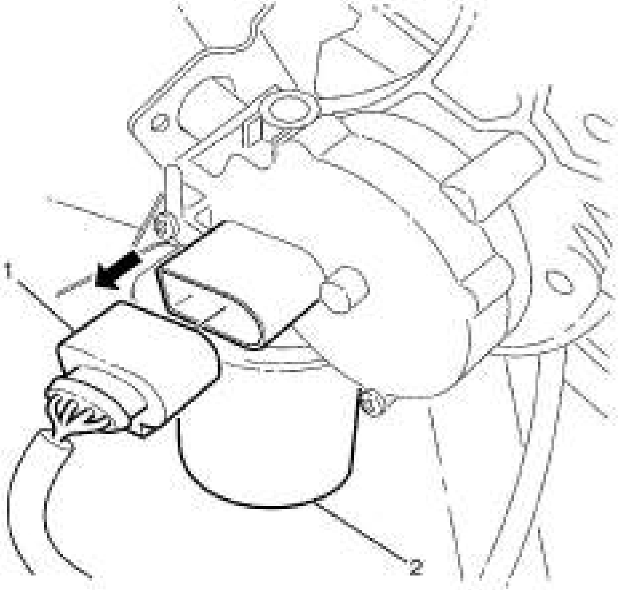


2. Move the wiper arm back to the parked position.
3. Test the windshield wipers and washers for correct operation.

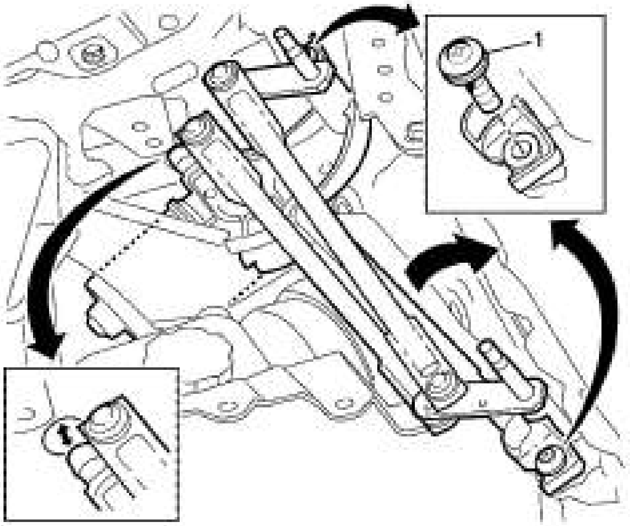
Windshield Wiper System Module Replacement (RHD)

Removal Procedure

1. Remove the wiper arms. Refer to Windshield Wiper Arm Replacement.
2. Remove the air inlet grille. Refer to Air Inlet Grille Panel Replacement.

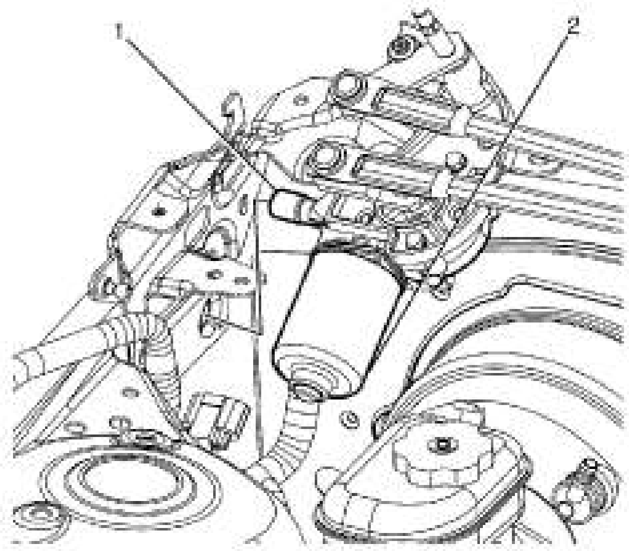


3. Disconnect the electrical connector (1) from the wiper motor (2).



4. Remove the wiper motor module to bulk head retaining bolts (1).
5. Remove the wiper motor module from the bulkhead.

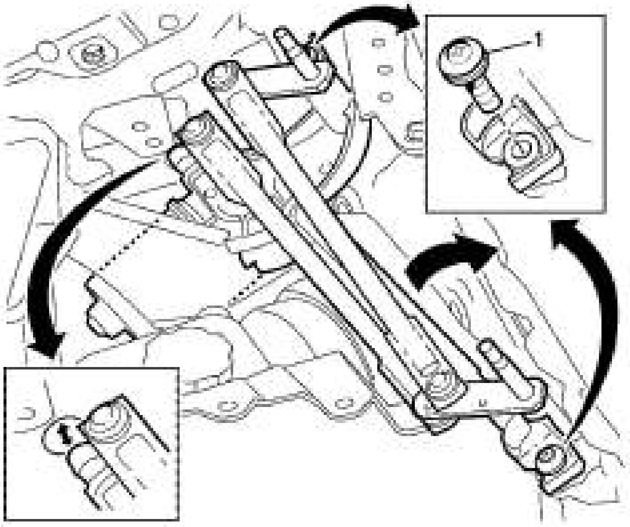
Installation Procedure



Important: Ensure that the locator lug (1) is inserted before attempting to fasten the retaining bolts.

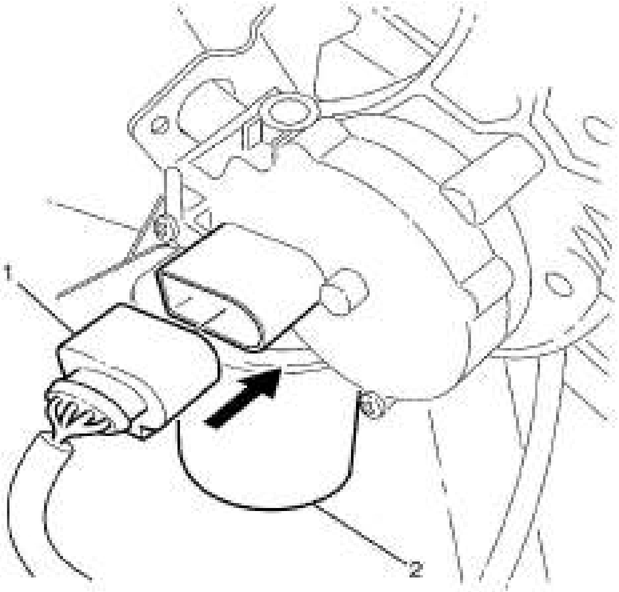
1. Install the wiper motor module (2) onto the bulkhead.

Notice: Refer to Fastener Notice in the Preface section.



2. Install the wiper motor module to bulk head retaining bolts (1).

   Tighten
   Tighten the bolts to 8 N·m (71 lb in).



3. Connect the electrical connector (1) to the wiper motor (2).
4. To ensure the wiper motor module is in the correct position :
   - Turn the ignition ON and wait for the wiper motor module to assume the park position.
   - Turn the ignition OFF.
   - Install the air inlet grille. Refer to Air Inlet Grille Panel Replacement.
   - Install the wiper arms. Refer to Windshield Wiper Arm Replacement.
   - Test the wiper and washer system for correct operation.

Wiper Blade Element Cleaning

Lift each blade assembly off of the windshield and clean the element with a cloth saturated with full strength washer solvent. Rinse the blade assemblies with clear water.

Wiper Chatter Repair

Some vehicles may exhibit a condition where the windshield wipers chatter and/or wipe unevenly. Several items may contribute to this condition. To completely repair this condition, all of the items listed should be tested and repaired as necessary.

- Clean the windshield glass. Refer to Windshield Glass Cleaning.
- Clean the wiper blade elements. Refer to Wiper Blade Element Cleaning.
- Replace the wiper blades, if necessary. Refer to Windshield Wiper Blade Replacement.

Headlamp Washer System Description and Operation

Headlamp Washer System Components

The headlamp washer system consists of the following components:

- Headlamp washer pump
- Headlamp wash relay
- WASH 30A fuse

Headlamp Washer System Controls

Body control module

Headlamp Washer System Operation

The body control module controls the headlamp washer pump using a programmed pulse type wash sequence. The washing sequence is a short wash pulse followed by a delay time to let the water soak which is then followed by another wash cycle for a programmed amount of time. The headlamp washer pump is controlled by the body control module through the headlamp washer relay. The headlamp washer switch signal circuit is supplied a 12-volt reference through a resistor then monitored within the body control module. The headlamp washer switch is open when in an inactive state. When the headlamp washer switch is activated the signal circuit is closed to ground. When the headlamp washer switch signal circuit is closed to ground the reference voltage is dropped across the resistor within the body control module. The low voltage on the headlamp washer switch signal circuit indicates to the body control module the switch status is active. Battery positive voltage is supplied to the coil and switch sides of the headlamp washer relay. When a headlamp wash request is active the body control module energizes the headlamp washer relay by grounding the relay coil through the headlamp washer relay control circuit. When the relay is energized battery positive voltage to the relay switch is supplied to the washer pump control circuit. The headlamp washers activate for one wash-wait-rinse cycle when the front windshield washer button is pressed for the first time after the vehicle is turned on. The headlamps washers then activate automatically for one cycle after every four front windshield washes. The headlamps must be on to be washed. If the headlamps are off, only the front windshield will be washed. The headlamp washers use the same fluid bottle as the windshield washer. However, the headlamp washers will run out of fluid before the windshield washer. If the windshield can be washed, but not the headlamps, check the fluid level.

Wiper / Washer System Description and Operation

Wiper / Washer System Components

The windshield Wiper/Washer system consists of the following components:

- Body Control Module (BCM).
- Washer pump.
- Washer pump relay.
- Washer solvent container.
- Wiper arm and blade assemblies.
- Wiper motor.
- Wiper/washer switch.
- F15 30 A fuse.
- F21 15 A fuse.
- Wiper relay.
- Wiper high relay.
- Moisture Sensor (If Equipped).
- Heated Washer System (If Equipped).

Windshield Wiper / Washer System Power and Ground

With the ignition in the ON position, accessory voltage is supplied through a 30A fuse to the wiper relay and the wiper high relay. Accessory voltage is supplied through a 15A fuse to the washer pump relay when the ignition is in the ON position. All of the above mentioned fuses and relays are located in the underhood fuse block.

Modes Of Operation

- Manual low.
- Mist.
- Intermittent.
- Manual high.
- Wash.

Low Speed Operation

When the wiper switch is in the low speed position, ground is applied through a resistor internal to the switch and the wiper switch low signal circuit to the BCM. In response to this signal, the BCM energizes the wiper relay. Since the wiper high relay is de-energized and its switch contacts are normally closed to the low speed control circuit of the windshield wiper motor, the motor will operate at low speed.

Mist Operation

Windshield wiper/washer system mist operation is identical to wiper low speed operation, except that the mist switch is a press and release type switch. When the wiper switch is moved to the mist position and released, low speed wiper motor operation is started and will continue until 1 wipe cycle is complete. If the wiper switch is moved to the mist position and held, the wiper motor will operate in the low mode until the switch is released.

Intermittent Operation

Windshield wiper intermittent operation is a low speed wiper motor function with a variable delay interval between the wiper motor cycles. The delay interval is determined by a series of 6 resistors within the wiper/washer switch. The BCM monitors the wiper switch low signal circuit to determine the delay interval between the low speed wiper motor wipe cycles.

High Speed Operation

When the wiper switch is in the high speed position, ground is applied through the windshield wiper switch high signal circuit to the BCM indicating the wiper high speed request. In response to this signal, the BCM then energizes the wiper relay, by applying battery voltage through the wiper relay control circuit to the coil side of the relay. This allows battery positive voltage from the F21 15A fuse to flow through the switch input side of the wiper relay and out to the switch input side of the wiper high relay. At the same time, the BCM also energizes the wiper high relay by applying ground through the control circuit to the coil side of the wiper high relay. As the wiper high relay is energized and its switch contacts closed to the high speed control circuit of the wiper motor, the motor will operate at high speed.

Wash Operation

In the wash position windshield wiper/washer switch grounds the control circuit of the windshield washer pump to the BCM. The BCM monitors this voltage input to detect when a wash cycle is requested so it can enable the wipers. The BCM energizes the wiper relay which will operate the windshield wiper motor at low speed.

The windshield washer pump sprays solvent onto the windshield. The windshield wipers operate at low speed for 3-5 wipes and returns to the park position.

Moisture Sensitive Wipers (If Equipped)

The outside moisture sensor monitors moisture accumulation on the windshield and uses a windshield wiper/washer switch status input to provide wipe commands to the body control module (BCM). The DELAY positions on the wiper/washer switch are used to activate the AUTOMATIC rain sensing operating mode. They are also used to adjust the level of sensitivity to moisture accumulation, which determines the dwell time for commanding a wiper motor wipe cycle. Accessory voltage is supplied to the outside moisture sensor through the 10A Fuse, located in the I/P fuse block. The sensor is grounded through the ground circuit .. Whenever the ignition is in the run or accessory positions, the BCM sends the wiper/washer switch status using a pulse width modulation (PWM) signal through the outside moisture sensor signal 1 circuit to the outside moisture sensor. When a wipe cycle is needed, the moisture sensor sends a PWM voltage signal through the moisture sensor signal 2 circuit back to the BCM requesting the wiper operation. The outside moisture sensor uses the moisture sensor signal 2 circuit to command wiper motor wipe cycles and to confirm the moisture sensor signal 1 is being received. If at anytime communication between the outside moisture sensor and BCM is lost, the BCM will use the inputs from the windshield wiper/washer switch in the delay positions to operate the wiper motor at continuous variable delay intervals.

Heated Washer System (If Equipped)

The Heated Washer System consists of the following components:

- Windshield washer fluid heater assembly
- Heated washer fluid switch
- Htd_Wsh_Htr Fuse 60 A
- Htd_Wsh_Ign Fuse 10 A

The heated washer fluid module is located near the brake master cylinder. High current battery voltage is supplied to the windshield washer fluid heater assembly from a 60A inline fuse. The washer fluid heater uses this voltage to power the 3 heater coils. Battery positive voltage from the 10A F38 Fuse located in the underhood fuse block is applied to the windshield washer fluid heater assembly with the ignition in the ON position. This voltage is used to power up the logic in the heater assembly. Approximately 5 seconds after the ignition is turned on the washer fluid heater assembly will enter standby mode. During standby mode the heater assembly turns on 1 of the 3 heater elements to maintain a fluid temperature of 56°C (132°F). When the heated wash switch is pressed, the module detects switch closure and starts heated wash sequence The Instrument Cluster (IPC) will display the HEATED WASHER FLUID INDICATOR while the heater assembly heats the wash fluid to approximately 70°C (160°F). The total duration of the initial heat up cycle may take up to 40 seconds. Once the proper temperature is reached, the heater assembly will request the body control module (BCM) to activate the windshield wash cycle. The heater assembly will maintain an active wash request until the wash fluid temperature drops to 40° C when the wash cycle request will be de-activated allowing the wash fluid to heat up again. The fluid heating and wash application will automatically be repeated 3 more times. Upon completion of the 4 wash cycles, the system will transition to off. The automatic heated wash mode may be terminated at any time by pressing the heated washer fluid switch.

Rear Wiper/Washer System Description and Operation

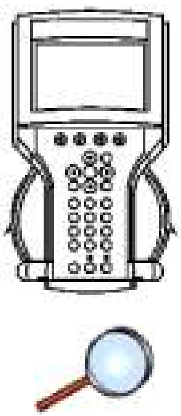
Rear Wiper Description and Operation

The rear wiper is controlled by an input from the rear wiper/washer switch which is located in the instrument panel. When the WIPER portion of the switch is pushed into it's detent the rear wipers are turned on, a voltage signal from the fuse block is applied through the wiper washer switch to the rear wiper motor to command it ON.

Rear Washer System Description and Operation

When the WASHER portion of the switch is pressed the rear washers are turned on, the switch has a momentary contact in the washer position and will continue to spray as long as the switch is being pressed and will stop when it is released.

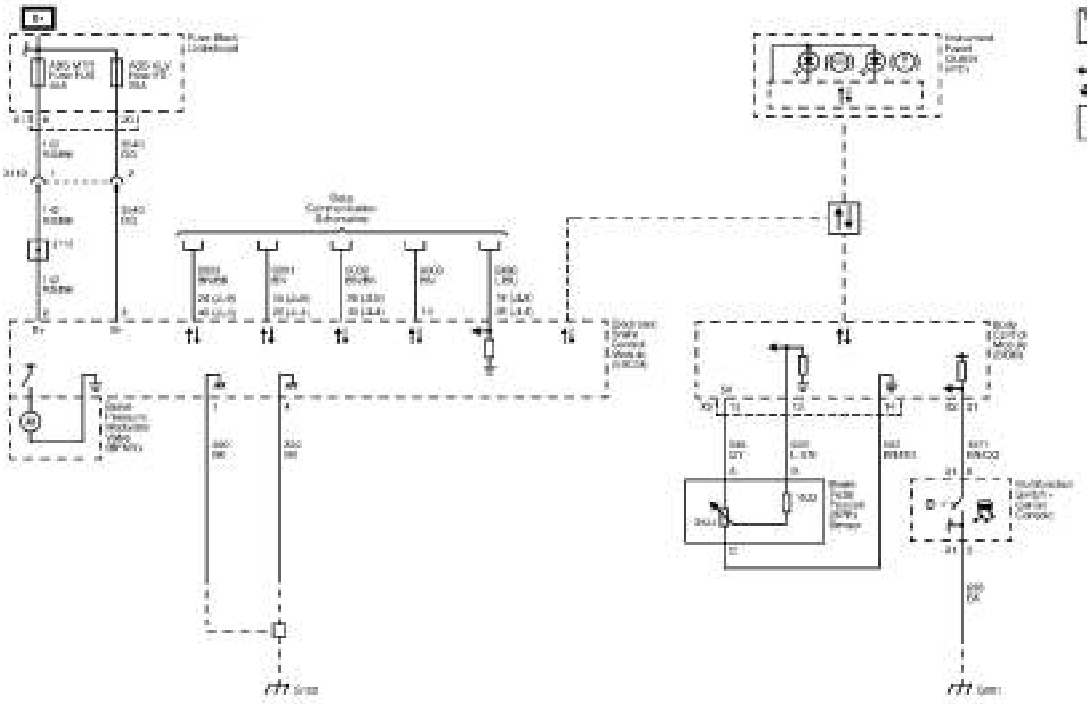
Special Tools

Illustration	Tool Number / Description
	70000861 Scan Tool Used for diagnosis of vehicle electrical system.

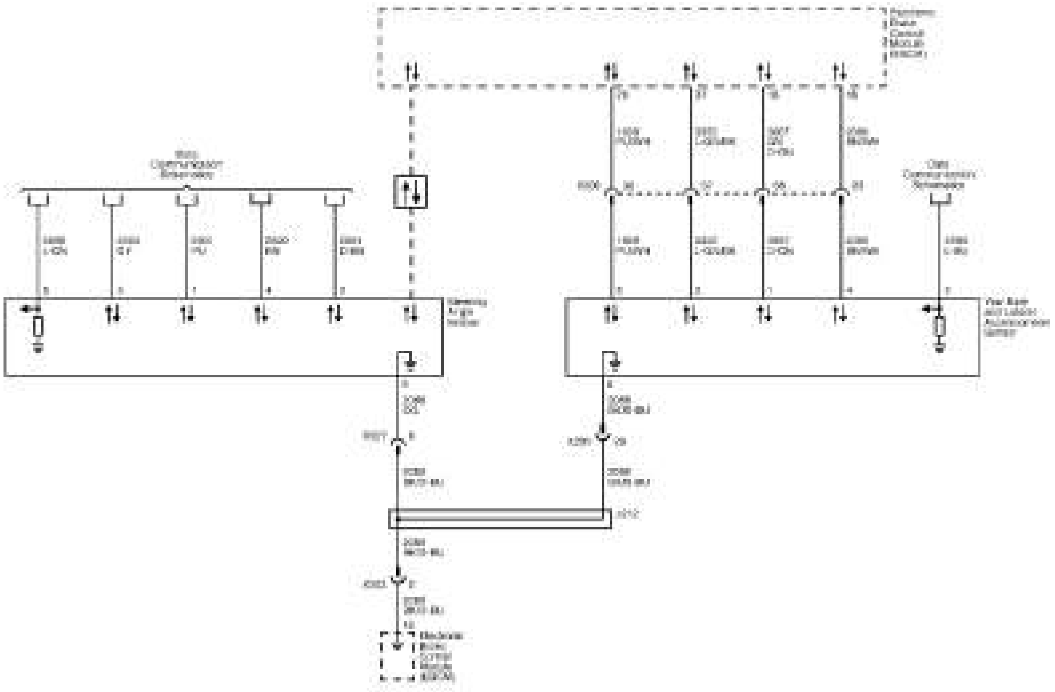
Fastener Tightening Specifications

Application	Specification	
	Metric	English
Brake Pressure Modulator Valve/Electronic Brake Control Module (BPMV/EBCM) Assembly Bracket Mounting Bolts.	12 Nm	8 lb in
BPMV Brake Pipes.	15 Nm	11 lb ft
BPMV/EBCM Assembly to Bracket Mounting Nuts.	8 Nm	70 lb in
EBCM to BPMV Mounting Screws.	First pass 2 Nm Second Pass 3 Nm	First pass 17 lb in Second Pass 26 lb in
Rear Wheel Speed Sensor To Knuckle Retaining Bolt	7 Nm	62 lb in
Yaw Rate Sensor/Lateral Acceleration Sensor Nuts.	9 Nm	79 lb in

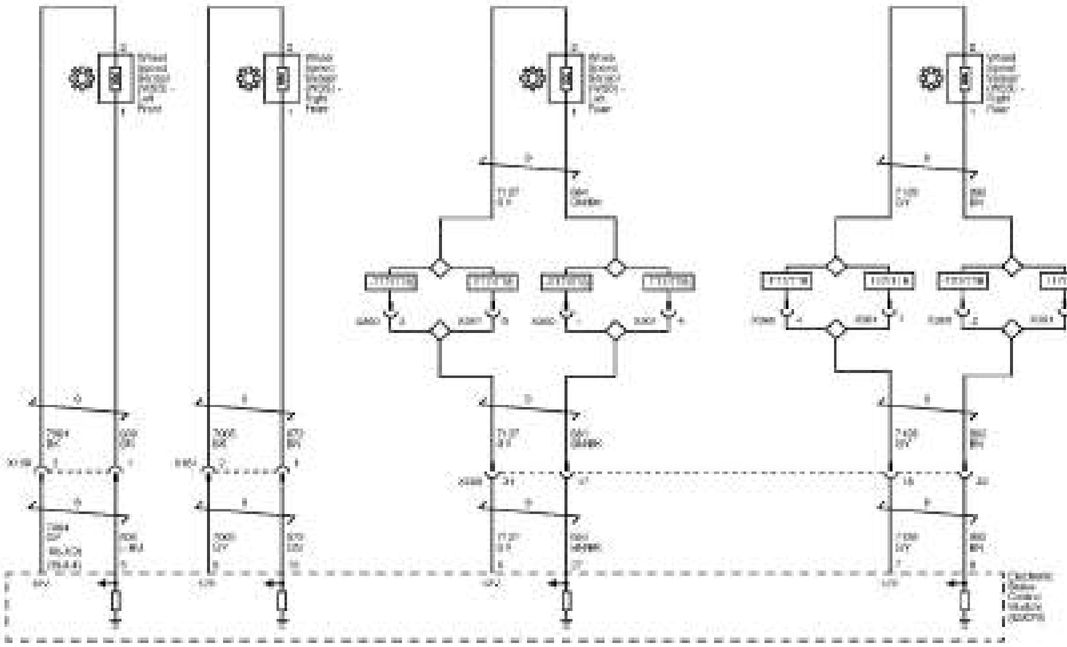
Module Power, Ground, Serial Data, Traction Control, and Brake Pedal Position



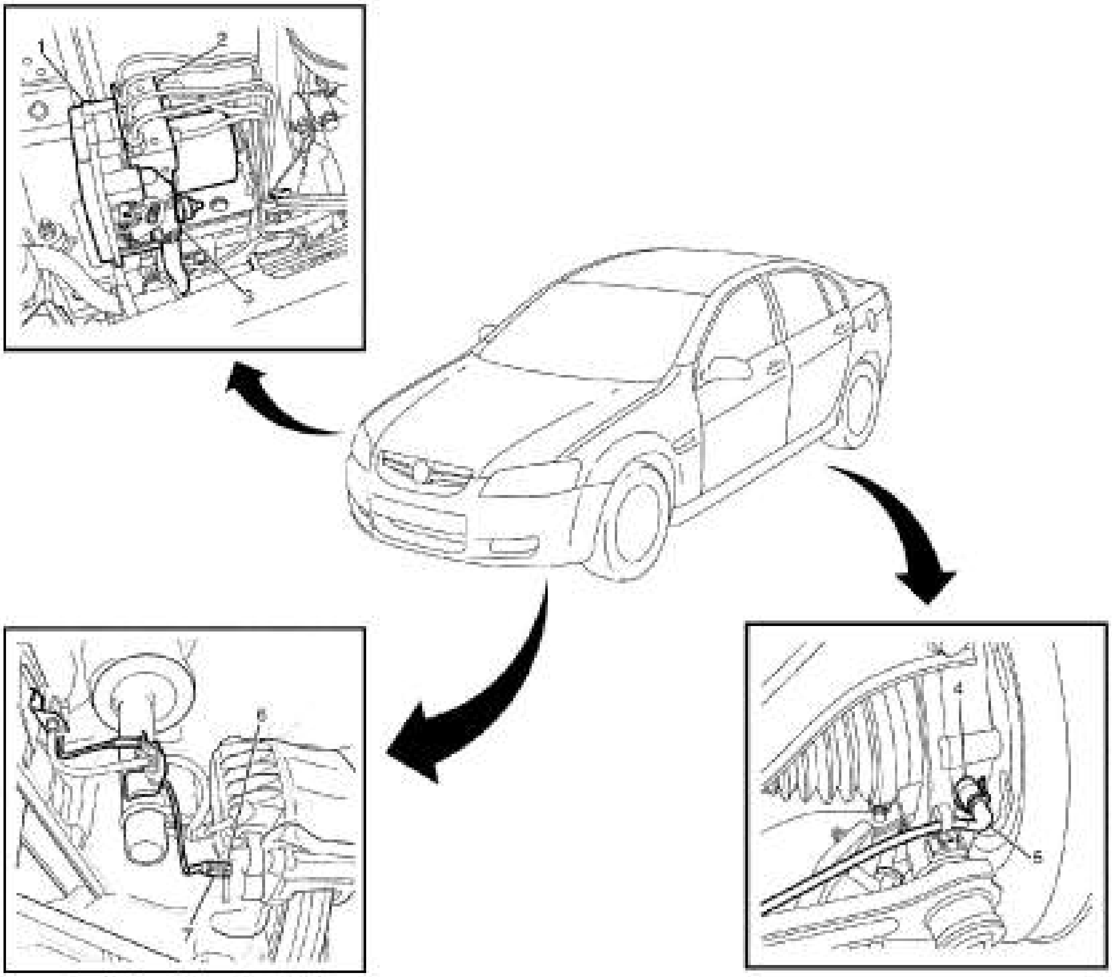
Vehicle Stability (JL4)


Steering Angle Sensor
Yaw Rate and Lateral Acceleration Sensor
Data Communication Schematics
Electronic Brake Control Module (EBCM)

Wheel Speed Sensors

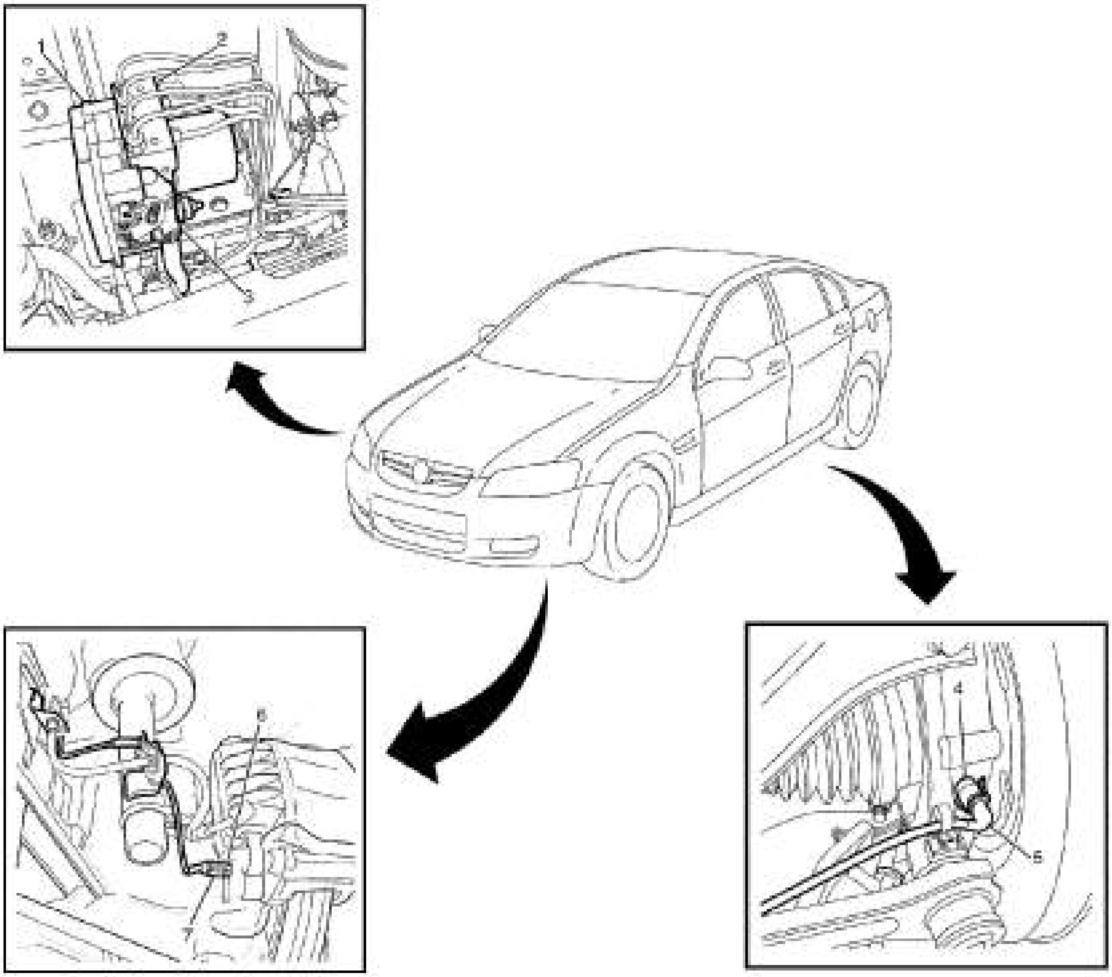

Wheel Speed Sensor - Left Front
Wheel Speed Sensor - Right Front
Wheel Speed Sensor - Left Rear
Wheel Speed Sensor - Right Rear
Electronic Brake Control Module (EBCM)

EBCM / BPMV Assembly and Wheel Speed Sensors



(1) Electronic Brake Control Module (EBCM)
(2) Brake Pressure Modulator Valve (BPMV)
(3) Electronic Brake Control Module (EBCM) Connector
(4) Wheel Speed Sensor (WSS) - Left Rear (Right Rear Same)
(5) Wheel Speed Sensor (WSS) - Left Rear Connector (Right Rear Same)
(6) Wheel Speed Sensor (WSS) - Left Front (Right Front Same)
(7) Wheel Speed Sensor (WSS) - Left Front Connector (Right Front Same)

EBCM / BPMV Assembly and Wheel Speed Sensors



(1) Electronic Brake Control Module (EBCM)
(2) Brake Pressure Modulator Valve (BPMV)
(3) EBCM Connector
(4) Wheel Speed Sensor - LR (RR Same)
(5) Wheel Speed Sensor Connector - LR (RR Same)
(6) Wheel Speed Sensor (WSS) - LF (RF Same)
(7) Wheel Speed Sensor Connector - LF (RF Same)

Diagnostic Starting Point - Antilock Brake System

Begin the system diagnosis with Diagnostic System Check - Vehicle. The Diagnostic System Check will provide the following information:

- The identification of the control modules which command the system
- The ability of the control modules to communicate through the serial data circuit
- The identification of any stored diagnostic trouble codes (DTCs) and their status

The use of the Diagnostic System Check will identify the correct procedure for diagnosing the system and where the procedure is located.

DTC B2745

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B2745 00: Traction Control Switch Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	--	1	B2745	--
Ground	--	1	--	--

Circuit/System Description

The traction control system (TCS) switch is a normally open switch that closes when the switch is activated. When activated, the switch grounds the TCS signal circuit. The body control module (BCM) converts the signal into serial data, which is used by the electronic brake control module (EBCM) to enable/disable the TCS.

Conditions for Running the DTC

- Ignition ON.
- Ignition voltage is greater than 10 volts.

Conditions for Setting the DTC

The BCM detects the TCS switch is activated for 60 seconds or more.

Action Taken When the DTC Sets

- The EBCM disables the ABS/traction control system (TCS)/vehicle stability enhancement system (VSES) for the duration of the ignition cycle.
- A DIC message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The conditions for setting the DTC are no longer present.
- The EBCM clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

ABS Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, with a scan tool command the IPC display test ON and OFF. The StabiliTrak indicator should turn ON and OFF.
   If the indicator does not turn ON and OFF, replace the IPC.
2. Observe the scan tool BCM Traction Control Switch parameter while pressing and releasing the traction control switch. The reading should change between Active and Inactive.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the traction control switch.
2. Test for less than 1 ohm between the ground circuit terminal 2 and ground.
   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Traction Control Switch parameter is Inactive.
   If not the specified value, test the signal circuit terminal 8 for a short to ground.
4. Install a 3A fused jumper wire between the signal circuit terminal 8 and the ground circuit terminal 2. Verify the scan tool Traction Control Switch parameter is Active.
   If not the specified value, test the signal circuit for a short to voltage or an open/high

resistance.

5. If all circuits test normal, test or replace the traction control switch. If the DTC resets, replace the BCM.

Component Testing

1. Ignition OFF, disconnect the harness connector at the traction control switch.
2. Test for infinite resistance between the signal terminal 8 and the ground terminal 2 with the switch in the open position.

   If not the specified value, replace the traction control switch.
3. Test for less than 3 ohms between the signal terminal 8 and the ground terminal 2 with the switch in the closed position.

   If greater than the specified range, replace the traction control switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for BCM replacement, setup, and programming

DTC C0035-C0050

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC C0035 00: Left Front Wheel Speed Sensor Circuit

DTC C0035 5A: Left Front Wheel Speed Sensor Circuit Plausibility Failure

DTC C0040 00: Right Front Wheel Speed Sensor Circuit

DTC C0040 5A: Right Front Wheel Speed Sensor Circuit Plausibility Failure

DTC C0045 00: Left Rear Wheel Speed Sensor Circuit

DTC C0045 5A: Left Rear Wheel Speed Sensor Circuit Plausibility Failure

DTC C0050 00: Right Rear Wheel Speed Sensor Circuit

DTC C0050 5A: Right Rear Wheel Speed Sensor Circuit Plausibility Failure

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Left Front Wheel Speed Sensor 12-Volt Reference	C0035 00	C0035 00	--	C0035 5A
Left Front Wheel Speed Sensor Signal	C0035 00	C0035 00	C0035 00	C0035 5A
Right Front Wheel Speed Sensor 12-Volt Reference	C0040 00	C0040 00	--	C0040 5A
Right Front Wheel Speed Sensor Signal	C0040 00	C0040 00	C0040 00	C0040 5A
Left Rear Wheel Speed Sensor 12-Volt Reference	C0045 00	C0045 00	--	C0045 5A
Left Rear Wheel Speed Sensor Signal	C0045 00	C0045 00	C0045 00	C0045 5A
Right Rear Wheel Speed Sensor 12 Volt Reference	C0050 00	C0050 00	--	C0050 5A
Right Rear Wheel Speed Sensor Signal	C0050 00	C0050 00	C0050 00	C0050 5A

Component	Condition	DTCs
Left Front Wheel Speed Sensor	• Physical damage • Debris on the wheel speed sensor or the encoder ring • Loose or improperly mounted sensor • Loose or worn wheel bearing • Air gap between the wheel speed sensor and the encoder ring too large	C0035 5A
Right Front Wheel Speed Sensor	• Physical damage • Debris on the wheel speed sensor or the encoder ring • Loose or improperly mounted sensor • Loose or worn wheel bearing • Air gap between the wheel speed sensor and the encoder ring too large	C0040 5A
Left Rear Wheel Speed Sensor	• Physical damage • Debris on the wheel speed sensor or the encoder ring • Loose or improperly mounted sensor • Loose or worn wheel bearing • Air gap between the wheel speed sensor and the encoder ring too large	C0045 5A
Right Rear Wheel Speed Sensor	• Physical damage • Debris on the wheel speed sensor or the encoder ring • Loose or improperly mounted sensor • Loose or worn wheel bearing • Air gap between the wheel speed sensor and the encoder ring too large	C0050 5A

Circuit/System Description

The wheel speed sensor (WSS) receives ignition voltage from the electronic brake control module (EBCM) and provides a DC square wave signal back to the module. As the wheel spins, the EBCM uses the frequency of the square wave signal to calculate the wheel speed.

Conditions for Running the DTC

C0035 00-C0050 00

- Ignition ON.
- Ignition voltage is greater than 10 volts.

C0035 5A-C0050 5A

- Ignition ON.
- Ignition voltage is greater than 10 volts.
- The brake pedal is not pressed.
- A DTC is not set for the other wheel speed sensor on the same axle.

Conditions for Setting the DTC

C0035 00-C0050 00

- A short to ground, or an open/high resistance is detected on the wheel speed sensor 12-volt reference circuit.
- A short to voltage, short to ground or an open/high resistance is detected on the signal circuit.
- Wheel speed sensor power supply is less than 7.6 volts.
- A missing wheel speed sensor signal

C0035 5A-C0050 5A

An erratic signal output of the wheel speed sensor is detected.

Action Taken When the DTC Sets

- The EBCM disables the antilock brake system (ABS)/traction control system (TCS) and vehicle stability enhancement system (VSES) for the duration of the ignition cycle.
- A DIC message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- Operate the vehicle at speeds greater than 15 km/h (10 mph) to complete the self test, and the EBCM will turn off the ABS indicator.
- A history DTC clears after 100 consecutive ignition cycles, if no failures are reported by this diagnostic.

Diagnostic Aids

If 2 or more wheel speed sensors are inoperative diagnose each wheel speed sensor individually.

If the customer comments that the ABS indicator is ON only during moist environmental conditions: rain, snow, vehicle wash, etc., inspect the wheel speed sensor wiring for signs of water intrusion. If the DTC is not current, clear all DTCs and simulate the effects of water intrusion by using the following procedure:

1. Spray the suspected area with a 5 percent saltwater solution. To create a 5 percent saltwater solution, add 2 teaspoons of salt to 8 fl oz of water (10 g of salt to 200 ml of water).

2. Test drive the vehicle over various road surfaces: bumps, turns, etc., above 40 km/h (25 mph) for at least 30 seconds.
3. Rinse the area thoroughly when completed.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

ABS Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Observe the scan tool Wheel Speed Sensor parameter. The reading should be the same speed on all sensors when driving in a straight line at a speed greater than 20 km/h (13 mph).

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the EBCM.
2. Ignition ON, test for less than 1 volt between the 12-volt reference circuit terminal of the appropriate sensor listed below and ground:
   - LF Sensor circuit terminal 26
   - RF Sensor circuit terminal 9
   - LR Sensor circuit terminal 6
   - RR Sensor circuit terminal 7

   If greater than the specified range, test the 12-volt reference circuit for a short to voltage.
3. Test for less than 1 volt between the signal circuit terminal of the appropriate sensor listed below and ground:
   - LF Sensor circuit terminal 5

- RF Sensor circuit terminal 10
- LR Sensor circuit terminal 27
- RR Sensor circuit terminal 8

If greater than the specified range, test the signal circuit for a short to voltage.

4. Ignition OFF, test for infinite resistance between the 12- volt reference terminal of the appropriate sensor circuit listed below and ground:
   - LF Sensor circuit terminal 26
   - RF Sensor circuit terminal 9
   - LR Sensor circuit terminal 6
   - RR Sensor circuit terminal 7

   If less than the specified value, test the 12-volt reference circuit for a short to ground.
5. Test for infinite resistance between the following signal circuit terminal of the appropriate sensor circuit listed below and ground:
   - LF Sensor circuit terminal 5
   - RF Sensor circuit terminal 10
   - LR Sensor circuit terminal 27
   - RR Sensor circuit terminal 8

   If less than the specified value, test the signal circuit for a short to ground.
6. Ignition OFF, disconnect the harness connector at the appropriate WSS.
7. Test for less than 2 ohms between the appropriate 12-volt reference circuit terminals listed below:
   - LF Sensor circuit terminal 26 at the EBCM harness connector, and terminal 2 at the WSS harness connector
   - RF Sensor circuit terminal 9 at the EBCM harness connector, and terminal 2 at the WSS harness connector
   - LR Sensor circuit terminal 6 at the EBCM harness connector, and terminal 2 at the WSS harness connector
   - RR Sensor circuit terminal 7 at the EBCM harness connector, and terminal 2 at the WSS harness connector

   If greater than the specified range, test the 12-volt reference circuit for an open or high resistance.
8. Test for less than 2 ohms between the appropriate signal circuit terminals listed below:
   - LF Sensor circuit terminal 5 at the EBCM harness connector, and terminal 1 at the WSS harness connector
   - RF Sensor circuit terminal 10 at the EBCM harness connector, and terminal 1 at the WSS harness connector
   - LR Sensor circuit terminal 27 at the EBCM harness connector, and terminal 1 at the WSS harness connector
   - RR Sensor circuit terminal 8 at the EBCM harness connector, and terminal 1 at the WSS harness connector

   If greater than the specified range, test the signal circuit for an open or high resistance.
9. If all circuits test normal, replace the appropriate wheel speed sensor. If the DTC resets replace the EBCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Front Wheel Speed Sensor Replacement
- Rear Wheel Speed Sensor Replacement
- Control Module References for EBCM replacement, setup, and programming

DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156

Diagnostic Instructions

1. Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
2. Review Strategy Based Diagnosis for an overview of the diagnostic approach.
3. Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC C0060 00: Left Front Antilock Braking System Solenoid Valve Circuit

DTC C0065 00: Left Front Antilock Brake System Solenoid 2 Circuit

DTC C0070 00: Right Front Antilock Braking System Solenoid Valve Circuit

DTC C0075 00: Right Front Antilock Brake System Solenoid 2 Circuit

DTC C0080 00: Left Rear Antilock Braking System Solenoid Valve Circuit

DTC C0085 00: Left Rear Antilock Brake System Solenoid 2 Circuit

DTC C0090 00: Right Rear Antilock Braking System Solenoid Valve Circuit

DTC C0095 00: Right Rear Antilock Brake System Solenoid 2 Circuit

DTC C0100 00: Rear Antilock Brake System Solenoid Circuit

DTC C0105 00: Rear Antilock Brake System Solenoid 2 Circuit

DTC C0121 00: Valve Relay Circuit

DTC C0141 00: Left Traction Control System Solenoid Valve Circuit

DTC C0146 00: Left Traction Control System Solenoid 2 Circuit

DTC C0151 00: Right Traction Control System Solenoid Valve Circuit

DTC C0156 00: Right Traction Control System Solenoid 2 Circuit

Circuit / System Description

The solenoid relay, located within the electronic brake control module (EBCM), supplies battery voltage to all of the valve solenoids when commanded by the EBCM.

Conditions for Running the DTC

- Ignition voltage is greater than 10 volts.

- The solenoid relay is commanded ON.

Conditions for Setting the DTC

- The EBCM detects an open in the B+ circuit to the solenoid valve relay.
- The EBCM detects a valve or valve solenoid malfunction.

Action Taken When the DTC Sets

- The EBCM disables the ABS/traction control system (TCS)/vehicle stability enhancement system (VSES) for the duration of the ignition cycle.
- A DIC message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The EBCM clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

ABS Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, verify that DTC C0060, C0065, C0070, C0075, C0080, C0085, C0090, C0095, C0100, C0105, C0121, C0141, C0146, C0151, C0156 is not set.

If any of the DTCs are set, replace the BPMV. If the DTC resets, replace the EBCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Brake Pressure Modulator Valve Assembly Replacement
- Control Module References for EBCM replacement, setup, and programming

DTC C0110

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC C0110 00: Pump Motor Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	C0110 00	C0110 00	--	--
Ground	--	C0110 00	--	--

Circuit/System Description

The pump motor is an integral part of the brake pressure modulator valve (BPMV), while the pump motor relay is integral to the electronic brake control module (EBCM). The pump motor relay is not engaged during normal system operation. When the antilock brake system (ABS) or traction control system (TCS) operation is required the EBCM activates the pump motor relay and turns the pump motor ON.

Conditions for Running the DTC

- Ignition ON.
- The vehicle speed is greater than 16 km/h (10 mph).

Conditions for Setting the DTC

- The EBCM detects a short to ground or an open/high resistance on the B+ circuit.
- The EBCM detects an open/high resistance on the ground circuit.
- The EBCM detects the pump motor runs continuously.
- The EBCM detects the pump motor is binding or stalled.

Action Taken When the DTC Sets

- The EBCM disables the ABS / traction control system (TCS) / vehicle stability enhancement system (VSES) for the duration of the ignition cycle.

- A DIC message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The EBCM clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

ABS Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the EBCM.
2. Test for less than 1 ohm between the ground circuits listed below and ground.
   - Terminal 4
   - Terminal 1

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify that a test lamp illuminates between the B+ circuits listed below and ground.
   - Terminal 3
   - Terminal 2

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse is open, replace the EBCM/BPMV assembly.

4. If all circuits test normal, replace the EBCM/BPMV assembly.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Brake Pressure Modulator Valve Assembly Replacement
- Control Module References for EBCM replacement, setup, and programming

DTC C0131

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC C0131 00: Antilock Brake System Pressure Circuit

Circuit/System Description

The electronic brake control module (EBCM) uses input from the brake pressure sensor for more accurate control during a vehicle stability enhancement system (VSES) event.

Conditions for Running the DTC

- Ignition ON.
- Ignition voltage is greater than 10 volts.

Conditions for Setting the DTC

- Pressure signal does not correlate to estimated pressure over time.
- Brake Signal does not correlate to pressure signal.
- Signal is erratic and changes faster than physically allowed.

Action Taken When the DTC Sets

- The EBCM disables the ABS/traction control system (TCS)/vehicle stability enhancement system (VSES) for the duration of the ignition cycle.
- A DIC message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The EBCM clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

ABS Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Apply and release brake pedal. Verify brake lamps operate properly.
   If brake lamps do not operate properly, refer to Symptoms - Lighting.
2. Ignition ON, observe the scan tool EBCM BPP signal parameter while applying and releasing the brake pedal. The reading should change between Applied and Released.
   If the parameter does not change between applied and release, replace the BPMV/EBCM assembly.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Brake Pressure Modulator Valve Assembly Replacement
- Control Module References for EBCM replacement, setup, and programming

DTC C0161

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC C0161 00: Antilock Brake System Brake Switch Circuit

DTC C0161 71: Antilock Brake System Invalid Serial Data Received

Circuit/System Description

The electronic brake control module (EBCM) detects inputs from the brake pressure sensor, vehicle speed, and a serial data message from the BCM that the brake pedal is applied. When the vehicle is stopping the EBCM monitors for the brake pedal is pressed, with the brake pressure increasing and the vehicle is slowing down, or when the vehicle is accelerating, the brake pedal is not pressed and brake pressure is not increasing.

Conditions for Running the DTC

- Ignition ON.
- The vehicle speed is greater than 16 km/h (10 mph).
- The ignition voltage is greater than 10 volts.

Conditions for Setting the DTC

- The brake pedal is sensed as applied.
- The vehicle speed is greater than 40 km/h (25 mph).
- The vehicles acceleration exceeds 8 km/h per second (5 mph per second).
- Brake pedal is not applied.
- Master cylinder pressure is greater than 150 psi.
- The vehicle speed is greater than 24 km/h (14 mph).
- The vehicles deceleration exceeds 11.5 km/h per second (7 mph per second).

Action Taken When the DTC Sets

- The EBCM disables the ABS/traction control system (TCS)/vehicle stability enhancement system (VSES) for the duration of the ignition cycle.
- A DIC message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The EBCM clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

ABS Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Apply and release brake pedal. Verify brake lamps operate properly.
   If brake lamps do not operate properly, refer to Symptoms - Lighting.
2. Ignition ON, observe the scan tool EBCM BPP signal parameter while applying and releasing the brake pedal. The reading should change between Applied and Released.
   If the parameter does not change between applied and release, replace the EBCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for EBCM replacement, setup, and programming

DTC C0186 or C0196

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC C0186 00: Lateral Accelerometer Circuit

DTC C0186 5A: Lateral Accelerometer Plausibility Failure

DTC C0196 00: Yaw Rate Circuit

DTC C0196 5A: Yaw Rate Circuit Plausibility Failure

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	C0186 00, C0196 00	C0186 00, C0196 00	--	--
5 Volt Reference	C0186 00, C0196 00,	C0186 00, C0196 00,	C0196 00	--
Yaw Rate Signal	C0196 00	C0196 00	C0196 00	C0186 5A
Yaw Rate Sensor Test Control Signal	C0196 00	C0196 00	C0196 00	C0196 5A
Combined Vehicle Inertial Sensor Signal	C0186 00	C0186 00	C0186 00	--
Low Reference	--	C0186 00. C0196 00	--	--

Circuit/System Description

The lateral accelerometer and the yaw rate sensors are combined into one sensor external to the electronic brake control module (EBCM). The electronic stability program (ESP) uses the lateral accelerometer input when calculating the desired yaw rate.

Conditions for Running the DTC

- Ignition ON.
- Ignition voltage is greater than 10 volts.

Conditions for Setting the DTC

C0186 00

- The EBCM detects a short to voltage, short to ground or an open/high resistance on the combined vehicle inertial sensor signal circuit
- The EBCM detects a short to ground or an open/high resistance on the 5 volt reference circuit, or the ignition voltage circuit.

C0196 00

- The EBCM detects a short to voltage, short to ground or an open/high resistance in the 5 volt reference circuit, yaw rate sensor test control signal circuit, or the yaw rate signal circuit.
- The EBCM detects an open/high resistance in the ignition voltage circuit.
- The EBCM detects an open/high resistance in the low reference circuit.

C0186 5A or C0196 5A

The yaw/lateral combination sensor fails an internal self test.

Action Taken When the DTC Sets

- The EBCM disables the VSES for the duration of the ignition cycle.
- A DIC message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The EBCM clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

ABS Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the yaw/lat sensor.
2. Ignition OFF for 60 seconds, test for less than 5 ohms between the low reference circuit terminal 6 and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance.
3. Ignition ON, test for B+ between the ignition voltage circuit terminal 3 and ground.

   If not the specified value, test the ignition voltage circuit for a short to ground or open/high resistance.
4. Ignition OFF, disconnect the harness connector at the EBCM.
5. Ignition ON, test for less than 1 volt between the 5 volt reference circuit terminal 1 at the yaw/lat sensor and ground.

   If greater than the specified range, test the 5 volt reference circuit for a short to voltage.
6. Ignition OFF, test for infinite resistance between the 5 volt reference circuit terminal 1 at the yaw/lat sensor and ground.

   If less than the specified value, test the 5 volt reference circuit for a short to ground.
7. Ignition OFF, test for less than 2 ohms between the 5 volt reference circuit terminal 1 at the yaw/lat sensor harness connector and terminal 23 at the EBCM harness connector.

   If greater than the specified range, test the 5 volt reference circuit for an open/high resistance.
8. Ignition ON, test for less than 1 volt between the signal circuit listed below and ground.
   - Terminal 2
   - Terminal 4
   - Terminal 5

   If greater than the specified range, test the signal circuit for a short to voltage.
9. Ignition OFF, test for infinite resistance between the signal circuit listed below and ground.
   - Terminal 2
   - Terminal 4
   - Terminal 5

   If less than the specified value, test the signal circuit for a short to ground.
10. Test for less than 2 ohms between the signal circuit terminals listed below.
    - Terminal 2 at the yaw sensor harness connector and terminal 37 at the EBCM harness connector.
    - Terminal 4 at the yaw sensor harness connector and terminal 16 at the EBCM harness connector.
    - Terminal 5 at the yaw sensor harness connector and terminal 38 at the EBCM harness connector.

If greater than the specified range, test the signal circuit for an open/high resistance.

11. If all circuits test normal, replace the yaw/lat sensor. If the DTC resets, replace the EBCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Vehicle Yaw Sensor with Vehicle Lateral Accelerometer Replacement
- Control Module References Control Module References for EBCM replacement, setup, and programming

DTC C0245

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC C0245 00: Wheel Speed Sensor Frequency

Circuit/System Description

The wheel speed sensor receives ignition voltage from the electronic brake control module (EBCM) and provides an output signal to the EBCM. As the wheel spins, the wheel speed sensor sends the EBCM a DC square wave signal, and uses the frequency of the square wave signal to calculate the wheel speed.

Conditions for Running the DTC

- Ignition voltage is greater than 10 volts.
- No wheel speed sensor faults exist.
- Brake is not applied.
- Vehicle is not cornering.

Conditions for Setting the DTC

Wheel speed differences between one wheel and the others is greater than 25 percent.

Action Taken When the DTC Sets

- The EBCM disables the traction control system (TCS) and vehicle stability enhancement system (VSES) for the duration of the ignition cycle.
- A DIC message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The EBCM clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Diagnostic Aids

- Faulty wheel speed sensor will not set this DTC.
- A vehicle using a space saver spare will not set this code.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

ABS Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

Inspect for one tire that has improper air pressure or improper size.

DTC C0252

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC C0252 00: VSES Sensor Uncorrelated

Circuit / System Description

The vehicle stability enhancement system (VSES) is activated by the electronic brake control module (EBCM) and calculates the desired yaw rate and comparing it to the actual yaw rate input. The desired yaw rate is calculated from measured steering wheel position, vehicle speed, and lateral acceleration. The difference between the desired yaw rate and actual yaw rate is the yaw rate error, which is a measurement of oversteer or understeer. If the yaw rate error becomes to large, the EBCM will attempt to correct the vehicle's yaw motion by applying differential braking to the left or right front wheel.

The amount of differential braking applied to the left or right front wheel is based on both the yaw rate error and side slip rate error. The side slip rate error is a function of the lateral acceleration minus the product of the yaw rate and vehicle speed. The yaw rate error and side slip rate error are combined to produce the total delta velocity error. When the delta velocity error becomes too large and the VSES system activates, the drivers steering inputs combined with the differential braking will attempt to bring the delta velocity error toward 0. The VSES activations generally occur during aggressive driving, in the turns or bumpy roads with out much use of the accelerator pedal. When braking during VSES activation, the brake pedal will feel different than the antilock brake system (ABS) pedal pulsation. The brake pedal pulsates at a higher frequency during VSES activation.

Conditions for Running the DTC

- Ignition is ON.
- The ignition voltage is above 9.5 volts.

Conditions for Setting the DTC

There is an incorrect checksum stored in the EEPROM area where the dynamic sensor offsets are saved.

Action Taken When the DTC Sets

- The VSES is disabled.

- A DIC message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The EBCM automatically clears the history DTC when a current DTC is not detected in 50 consecutive drive cycles.

Diagnostic Aids

- An incorrectly calibrated steering angle sensor.
- A loose or incorrectly mounted yaw lateral sensor.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation Reference

ABS Description and Operation

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs
- Connector Repairs

Scan Tool Reference

Control Module References for Scan Tool Information

Circuit/System Verification

1. Perform the Steering Angle Sensor Centering , clear DTCs and operate the vehicle within the conditions for setting the DTC.
2. Verify that DTC C0186, C0196 or C0460 is not set

   If any of the DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.

DTC C0460

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC C0460 00: Steering Position Sensor

DTC C0460 12: Steering Position Sensor Below Minimum Threshold

DTC C0460 42: Steering Position Sensor Calibration Data Set Not Programmed

DTC C0460 71: Steering Position Sensor Invalid Serial Data Received

DTC C0460 5A: Steering Position Sensor Plausibility Failure

Circuit/System Description

The electronic brake control module (EBCM) receives CAN message inputs from the steering wheel position sensor identifying the position and direction of the steering wheel rotation.

Conditions for Running the DTC

- Ignition ON.
- Ignition voltage is greater than 10 volts.

Conditions for Setting the DTC

C0460 00, C0460 12, C0460 5A, or C0460 71

The EBCM detects an internal steering angle sensor failure.

C0460 42

Steering angle sensor not calibrated.

Action Taken When the DTC Sets

- The EBCM disables the ABS/traction control system (TCS)/vehicle stability enhancement system (VSES) for the duration of the ignition cycle.
- A DIC message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The EBCM clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

ABS Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

C0460 00, C0460 12, C0460 5A, or C0460 71

1. Verify that no U codes are set.
   If any of the DTCs are set refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. Replace the steering angle sensor.

C0460 42

Verify that DTC C0460 42 is not set.

If the DTC is set perform the Steering Angle Sensor Centering.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Steering Angle Sensor Replacement

DTC C0550

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC C0550 00: Electronic Control Unit (ECU) Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Electronic Control Unit (ECU) Performance	--	--	--	C0550 00

Circuit/System Description

The electronic brake control module (EBCM) detects an internal malfunction.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

An internal EBCM malfunction exists.

Action Taken When the DTC Sets

- The EBCM disables the Antilock Brake System (ABS)/Traction Control System (TCS)/Electronic Stability Control (ESP) for the duration of the ignition cycle.
- The multi function display (MFD) displays the ABS Fault message.
- The multi function display (MFD) displays the Traction Ctrl Off message.
- The multi function display (MFD) displays the Stability Ctrl Off message.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The EBCM automatically clears the history DTC when a current DTC is not detected in

100 consecutive drive cycles.
- The DTC can be cleared using a scan tool.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Testing

DTC C0550 will set as result of internal EBCM circuit fault.

If the DTC is set to current, replace the EBCM.

Repair Instructions

- Perform the Diagnostic Repair Verification after completing the diagnostic procedure.
- Control Module References for EBCM replacement, setup, and programming

DTC C0558

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC C0558 00: Calibration Data Not Programmed

Diagnostic Fault Information

Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.

Circuit/System Description

The electronic brake control module (EBCM) must be calibrated/programmed or has an internal fault and requires replacement.

Conditions for Running the DTC

- The ignition is ON.
- Ignition voltage is between 9 and 16 volts.

Conditions for Setting the DTC

The EBCM has not been calibrated or has an internal fault.

Action Taken When the DTC Sets

- The EBCM disables the ABS and the TCS for the duration of the ignition cycle
- The ABS fault indicator on the driver information centre (DIC) is activated.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- The EBCM automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.
- The DTC can be cleared using a scan tool.

Reference Information

Schematic Reference

Antilock Brake System Schematics .

Connector End View Reference

Component Connector End Views .

Electrical Information Reference

- Circuit Testing .
- Connector Repairs .
- Testing for Intermittent Conditions and Poor Connections .
- Wiring Repairs .

Scan Tool Reference

Control Module References .

Circuit/System Testing

1. Verify that no other DTCs are not set.
   If any other DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle .
2. Calibrate/programme the EBCM.
3. Ignition ON, using the scan tool view the current DTCs.
   If DTC C0558 is set to current replace EBCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for EBCM replacement, setup and programming

DTC C0561

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC C0561 71: CAN-Bus Invalid Data

Circuit/System Description

The electronic brake control module (EBCM) receives messages from the engine control module (ECM), and the transmission control module (TCM) over GMLAN which are needed to perform ESP or TCS functions.

Conditions for Running the DTC

- Ignition ON.
- Ignition voltage is greater than 8 volts.

Conditions for Setting the DTC

The EBCM receives an invalid message from either the ECM or TCM over GMLAN which causes EBCM to deactivate TCS, ESP and EBD.

Action Taken When the DTC Sets

- The EBCM disables the Traction Control System (TCS)/Electronic Stability Control (ESP) for the duration of the ignition cycle.
- A multi function display (MFD) message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

Verify that no DTCs are set in the ECM or TCM.

If DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

DTC C0565

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC C0565 47: VIN Not Programmed (Vehicle Identification Number)

DTC C0565 71: VIN (Vehicle Identification Number) Invalid Serial Data Received

Circuit/System Description

When the EBCM is replaced, software and calibrations are flash programmed into the EBCM.

Conditions for Running the DTC

- Ignition ON.
- Ignition voltage is greater than 10 volts.

Conditions for Setting the DTC

C0565 47

VIN is not programmed into the EBCM.

C0565 71

Wrong VIN is programmed into the EBCM.

Action Taken When the DTC Sets

- The EBCM disables the Antilock Brake System (ABS)/Traction Control System (TCS)/Electronic Stability Control (ESP) for the duration of the ignition cycle.
- A DIC message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The EBCM clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

ABS Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Verify that DTC C0565 is not set.

If the DTC is set, program the EBCM. If the DTC resets, replace the EBCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Brake Pressure Modulator Valve Assembly Replacement

Control Module References for EBCM replacement, setup, and programming

DTC C0569

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC C0569 00: System Configuration

Circuit/System Description

The electronic brake control module (EBCM) compares its RPO data with the instrument panel cluster (IPC) programmed data.

Conditions for Running the DTC

- Ignition ON.
- Ignition voltage is greater than 10 volts.

Conditions for Setting the DTC

The IPC has been programmed incorrectly.

Action Taken When the DTC Sets

- The EBCM disables the ABS/traction control system (TCS)/vehicle stability enhancement system (VSES) for the duration of the ignition cycle.
- A DIC message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- A current DTC will clear when the IPC is programmed.
- The EBCM clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

ABS Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Verify that DTC C0569 is not set.

If the DTC is set, program the IPC. If the DTC resets, replace the EBCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Brake Pressure Modulator Valve Assembly Replacement

Control Module References for EBCM and/or IPC replacement, setup, and programming

DTC C0899

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC C0899 00: Power Supply Circuit Low Voltage

Circuit Description

The electronic brake control module (EBCM) monitors the voltage level available for system operation. A low voltage condition prevents the system from operating correctly.

Conditions for Running the DTC

- The ignition is ON.
- The vehicle speed is greater than 8 km/h (5 mph).

Conditions for Setting the DTC

One of the following conditions exists for 0.72 seconds:

- During initialization or when the system is inactive, the system voltage is less than 9.6 volts.
- During the system operation, the system voltage is less than 9.3 volts.

Action Taken When the DTC Sets

- The EBCM disables the Antilock Brake System (ABS)/Traction Control System (TCS)/Electronic Stability Control (ESP)/Electronic Brake Distribution (EBD) for the duration of the ignition cycle.
- The multi function display (MFD) displays the ABS Fault message.
- The multi function display (MFD) displays the Traction Ctrl Off message.
- The multi function display (MFD) displays the Stability Ctrl Off message.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The DTC can be cleared using a scan tool.

Diagnostic Aids

- Test the charging system. Refer to Charging System Test .
- Possible causes of this DTC are the following conditions:
  - A charging system malfunction
  - Too much battery draw
  - A weak battery
  - A faulty system ground

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Verification

With scan tool installed, clear the DTCs then drive the vehicle in a straight line at a speed greater than 20 km/h (13 mph).

Circuit/System Testing

1. Measure the voltage at the battery terminals.
2. With a scan tool, observe the Switched System Battery Voltage parameter in the ABS data list. Verify that battery terminal voltage and ignition voltage readings do not differ more than 1 volt.

   If more than 1 volt, test the ground circuit of the EBCM for high resistance. If the circuit test normal, test or replace the EBCM.

Repair Instructions

- Electronic Brake Control Module Replacement .
- Control Module References

DTC C0900

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC C0900 00: Power Supply Circuit High Voltage

Circuit Description

The electronic brake control module (EBCM) monitors the voltage level available for system operation. If the voltage level is too high, damage may result in the system. When the EBCM detects a high voltage condition, the EBCM turns OFF the system relay which removes battery voltage from the solenoid valves and pump motor.

Conditions for Running the DTC

- The ignition is ON.
- The vehicle speed is greater than 8 km/h (5 mph).

Conditions for Setting the DTC

One of the following conditions exists for 0.72 seconds:

- During initialization or when the system is inactive, the system voltage is greater than 16.8 volts.
- During the system operation, the system voltage is greater than 16.7 volts.

Action Taken When the DTC Sets

- The EBCM disables the Antilock Brake System (ABS)/Traction Control System (TCS)/Electronic Stability Control (ESP)/Electronic Brake Distribution (EBD) for the duration of the ignition cycle.
- The multi function display (MFD) displays the ABS Fault message.
- The multi function display (MFD) displays the Traction Ctrl Off message.
- The multi function display (MFD) displays the Stability Ctrl Off message.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The DTC can be cleared using a scan tool.

Diagnostic Aids

- Test the charging system. Refer to Charging System Test .
- Possible causes of this DTC are the following conditions:
  A charging system malfunction

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Verification

With scan tool installed, clear the DTCs then drive the vehicle in a straight line at a speed greater than 20 km/h (13 mph).

Circuit/System Testing

1. Start the engine and allow to idle, using a scan tool check if DTC is set to current.
   If the DTC is set to current, continue.
2. Ignition OFF, disconnect the EBCM harness connector.
3. Test for less than 1.0 ohm of resistance between the ground circuit terminals and ground.
   If greater than the specified range, test the ground circuits for an open/high resistance.
4. Connect a DMM between the supply voltage circuit terminals and the ground circuit terminals.
   If 12 volts is present, replace the EBCM.
   If greater than 116 volts is present, test and repair charging system.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Electronic Brake Control Module Replacement .
- Control Module References .

DTC P0856

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0856: Traction Control Torque Request Signal Message Counter Incorrect

Circuit/System Description

The electronic brake control module (EBCM) and the engine control module (ECM) simultaneously control the traction control. The EBCM sends a serial data message to the ECM requesting torque reduction. When certain ECM DTCs are set, the ECM will not be able to perform the torque reduction for traction control. A serial data message is sent to the EBCM indicating that traction control is not allowed.

Conditions for Running the DTC

- Ignition ON.
- Ignition voltage is greater than 10 volts.

Conditions for Setting the DTC

The ECM detects a fault that prevents it from performing a traction control function and sends a serial data message to the EBCM indicating that torque reduction is not allowed.

Action Taken When the DTC Sets

- The EBCM disables the TCS for the duration of the ignition cycle.
- The ABS remains functional.
- A DIC message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The electronic brake control module (EBCM) clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Diagnostic Aids

These DTCs are an indicator that the ECM receives an invalid message from the EBCM , and does not necessarily indicate a fault is present with the EBCM. This DTC should not be used as a fault indicator, but rather as a symptom to assist in the diagnosis of these other systems.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

ABS Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Verify that no DTCs are set in the ECM.

If DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.

Symptoms - Antilock Brake System

Important: The following steps must be completed before using the symptom tables.

1. Perform the Diagnostic System Check - Vehicle, before using the Symptom Tables in order to verify that all of the following are true:
    - There are no DTCs set.
    - The control module(s) can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to ABS Description and Operation.

Visual/Physical Inspection

- Inspect for aftermarket devices which may affect the operation of the antilock brake system. Refer to Checking Aftermarket Accessories.
- Inspect the easily accessible or visible system components for obvious damage or conditions which may cause the symptom.
- Inspect the master cylinder reservoir for the correct brake fluid level.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- ABS Indicator Malfunction.
- StabiliTrak Indicator Malfunction.

StabiliTrak Indicator Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	--	1	B2745	--
Ground	--	1	--	--
1. Traction Control Indicator Malfunction				

Circuit/System Description

The traction control system (TCS) switch is a normally open switch that closes when the switch is activated. When activated, the switch grounds the TCS signal circuit. The body control module (BCM) converts the signal into serial data, which is used by the electronic brake control module (EBCM) to enable/disable the TCS.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

ABS Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, with a scan tool command the IPC display test ON and OFF. The StabiliTrak indicator should turn ON and OFF.
   - If the indicator does not turn ON and OFF, replace the IPC.
2. Observe the scan tool BCM Traction Control Switch parameter while pressing and releasing the traction control switch. The reading should change between Active and Inactive.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the traction control switch.
2. Test for less than 1 ohm between the ground circuit terminal 2 and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Traction Control Switch parameter is Inactive.
   - If not the specified value, test the signal circuit terminal 8 for a short to ground.
4. Install a 3A fused jumper wire between the signal circuit terminal 8 and the ground circuit terminal 2. Verify the scan tool Traction Control Switch parameter is Active.
   - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance.
5. If all circuits test normal, test or replace the traction control switch. If the DTC resets, replace the BCM.

Component Testing

1. Ignition OFF, disconnect the harness connector at the traction control switch.
2. Test for infinite resistance between the signal terminal 8 and the ground terminal 2 with the switch in the open position.
   - If not the specified value, replace the traction control switch.
3. Test for less than 3 ohms between the signal terminal 8 and the ground terminal 2 with the switch in the closed position.
   - If greater than the specified range, replace the traction control switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for BCM replacement, setup, and programming

ABS Indicator Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit/System Description

The instrument panel cluster (IPC) illuminates the antilock brake system (ABS) indicator during the IPC bulb check or when the electronic brake control module (EBCM) detects a fault and sends a serial data message to the IPC commanding the indicator ON.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

ABS Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, with a scan tool command the IPC display test ON and OFF. The ABS warning indicator should turn ON and OFF.

   If the ABS warning indicator does not turn ON and OFF, replace the IPC.
2. Replace the EBCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for IPC replacement, setup, and programming

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Brakes | Antilock Brake System | Repair Instructions | **Document ID: 1979872**

Antilock Brake System Automated Bleed Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

Important: Before performing the Antilock Brake System Automated Bleed Procedure, first perform a pressure bleed of the base brake system. Refer to Hydraulic Brake System Bleeding . The automated bleed procedure is recommended when one of the following conditions exist:

- Base brake system bleeding does not achieve the desired pedal height or feel.
- Extreme loss of brake fluid has occurred.
- Air ingestion is suspected in the secondary circuits of the hyraulic modulator assembly.

1. The Antilock Brake System Automated Bleed Procedure uses a scan tool to cycle the system solenoid valves and run the pump in order to purge any air from the secondary circuits. These circuits are normally closed off and are only opened during system initialisation at vehicle start up and during ABS operation. The automated bleed procedure opens these secondary circuits and allows any air trapped in these circuits to flow out toward the brake calipers.

Performing the Automated Bleed Procedure

Notice: The Auto Bleed Procedure may be terminated at any time during the process by pressing the EXIT button. No further Scan Tool prompts pertaining to the Auto Bleed procedure will be given. After exiting the bleed procedure, relieve bleed pressure and disconnect bleed equipment per manufacturers instructions. Failure to properly relieve pressure may result in spilled brake fluid causing damage to components and painted surfaces.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove all four wheels. Refer to Tire and Wheel Removal and Installation .
3. Inspect the brake system for leaks and visual damage. Refer to Symptoms - Hydraulic Brakes , repair or replace components as needed.
4. Lower the vehicle.
5. Inspect the battery state of charge. Refer to Battery Inspection/Test .
6. Install a scan tool.
7. Turn the key to the ignition ON, engine OFF position.
8. With the scan tool, establish communications with the ABS system. Select Special Functions. Select Automated Bleed from the Special Functions menu.
9. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
10. Following the directions given on the scan tool, pressure bleed the base brake system. Refer to Hydraulic Brake System Bleeding .

11. Follow the scan tool directions until the desired brake pedal height is achieved.
12. If the bleed procedure is aborted, a malfunction exists. Perform the following steps before resuming the bleed procedure:
    - If a DTC is detected, refer to Diagnostic Trouble Code (DTC) List - Vehicle and diagnose the appropriate DTC.
    - If the brake pedal feels spongy, perform the conventional brake bleed procedure again. Refer to Hydraulic Brake System Bleeding .
13. When the desired pedal height is achieved, press the brake pedal to inspect for firmness.
14. Lower the vehicle.
15. Remove the scan tool.
16. Install the tyre and wheel assemblies. Refer to Tire and Wheel Removal and Installation .
17. Inspect the brake fluid level. Refer to Master Cylinder Reservoir Filling .
18. Road test the vehicle while inspecting that the pedal remains high and firm.

Brake Pressure Modulator Valve Assembly Replacement (RHD)

Removal Procedure

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

Caution: For safety reasons, the brake pressure modulator valve assembly must not be repaired, the complete unit must be replaced. With the exception of the EBCM, no screws on the brake pressure modulator valve assembly may be loosened. If screws are loosened, it will not be possible to get the brake circuits leak-tight and personal injury may result.

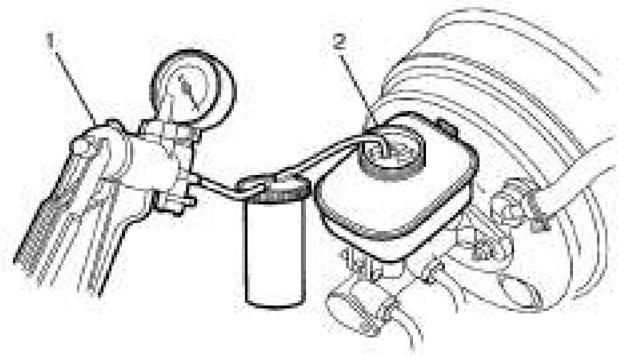
Important: If the electronic brake control module (EBCM) or brake pressure modulator valve (BPMV) is to replaced under manufacturer's warranty, do not disassemble the EBCM/BPMV assembly. If the EBCM or BPMV is faulty, replace the EBCM/BPMV assembly.

Important: The BPMV is not a separate serviceable component. If the BPMV is faulty, replace the EBCM/BPMV as an assembly.

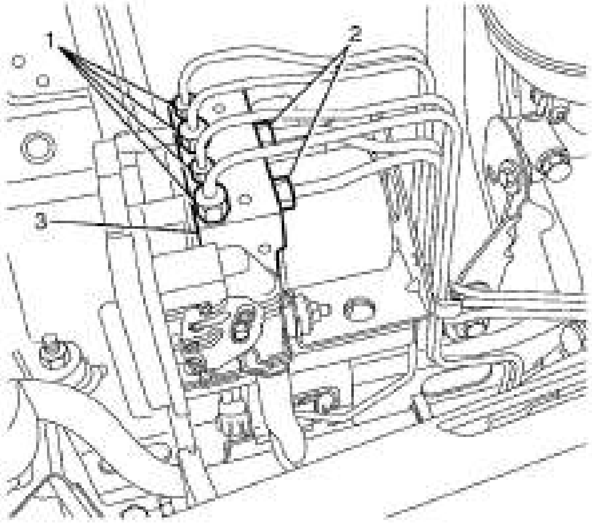
1. Turn the key to the ignition OFF position.

   Important: The area around the EBCM/BPMV assembly must be free from loose dirt to prevent contamination of disassembled ABS components.

2. Clean the BPMV and brake pipes.
3. Place a clean suitable container under the BPMV.
4. Remove the master cylinder reservoir cap.



5. Siphon the brake fluid out of the master cylinder reservoir (2) using a hand vacuum pump (1).



Important: Record the location of all brake pipes to the EBCM/BPMV assembly as an aid during installation.

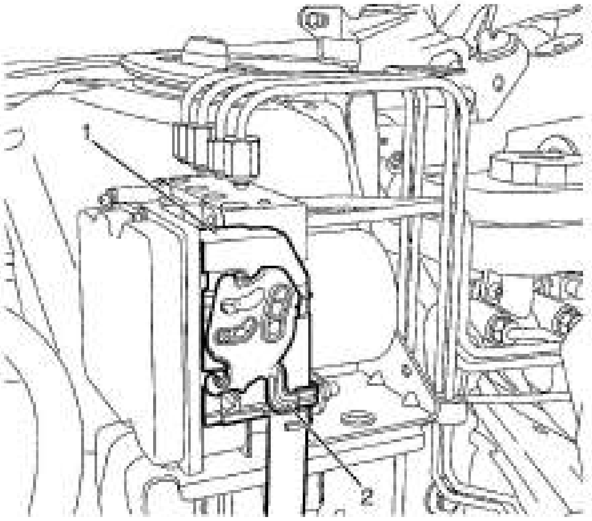
6. Remove the two master cylinder brake pipes (3) from the BPMV (1).

Important: Install a rubber cap or plug to the master cylinder brake pipes (3) in order to prevent fluid loss and contamination.

7. Plug the master cylinder brake pipes (3).
8. Remove the four wheel brake pipes (2) from the BPMV (1).

Important: Install a rubber cap or plug to the wheel brake pipes (2) in order to prevent fluid loss and contamination.

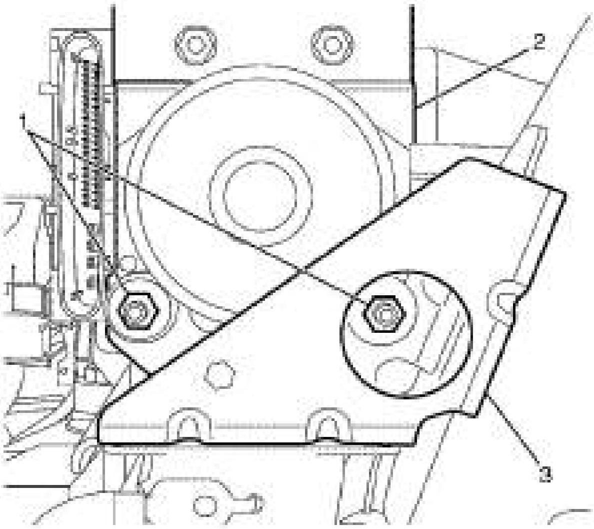
9. Plug the wheel brake pipes (2).
10. Clean any brake fluid spillage from the BPMV (1).



11. Rotate the EBCM connector tab (2) up to the unlocked position.

Notice: To prevent equipment damage, never connect or disconnect the wiring harness connection from the EBCM with the ignition switch in the ON position.

12. Disconnect the EBCM electrical connector (1) and position out of the way.



13. Remove the EBCM/BPMV assembly to EBCM/BPMV assembly bracket retaining nuts (1).
14. Remove the EBCM/BPMV assembly (2) from the EBCM/BPMV assembly bracket (3).

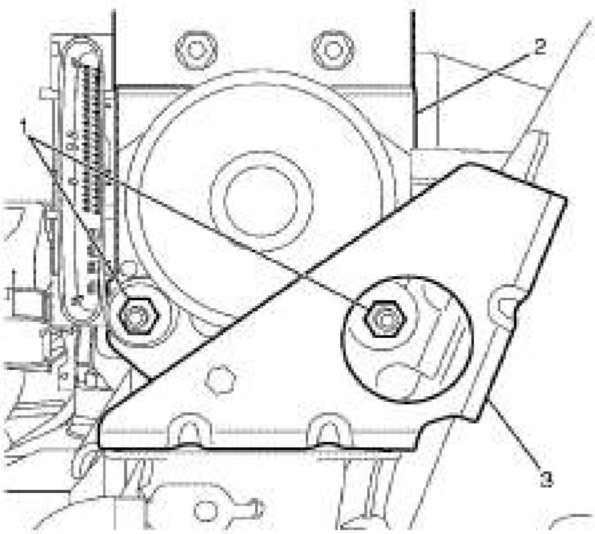
Installation Procedure

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.



Caution: For safety reasons, the brake pressure modulator valve assembly must not be repaired, the complete unit must be replaced. With the exception of the EBCM, no screws on the brake pressure modulator valve assembly may be loosened. If screws are loosened, it will not be possible to get the brake circuits leak-tight and personal injury may result.

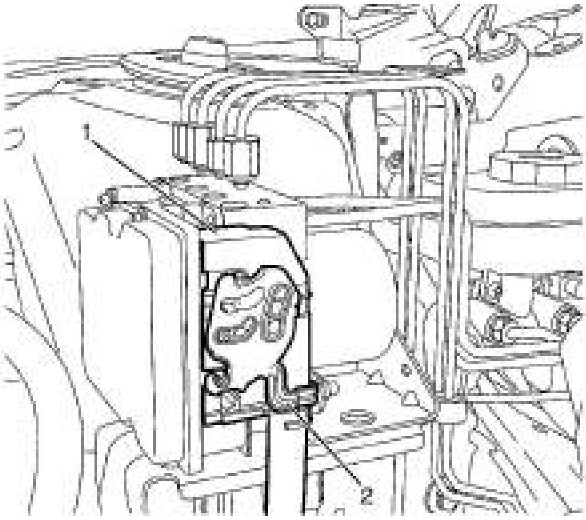
Important: Make sure that the rubber isolators are installed on the EBCM/BPMV assembly (2). The isolators protect the EBCM/BPMV assembly (2) from vehicle vibrations.

1. Install the EBCM/BPMV assembly (2) to the EBCM/BPMV assembly bracket (1).

   Notice: Refer to Fastener Notice in the Preface section.

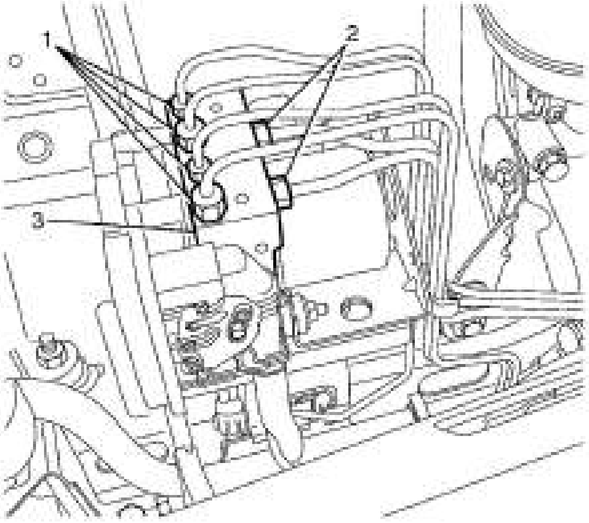
2. Install the EBCM/BPMV assembly to EBCM/BPMV assembly bracket retaining nuts (2).

   Tighten
   Tighten the nuts to 8 N·m (71 lb in).



Notice: To prevent equipment damage, never connect or disconnect the wiring harness connection from the EBCM with the ignition switch in the ON position.

3. Connect the EBCM electrical connector (1) to the EBCM (3).
4. Rotate the EBCM connector tab (2) to the locked position.



Caution: The brake pipes must be fully installed to the brake pipe mounting retainers on the frame. Failure to properly retain the brake pipes may cause the pipes to contact the frame and/or the transmission resulting in possible loss of brake fluid and personal injury.

Caution: Make sure brake pipes are correctly connected to BPMV. If brake pipes are switched by mistake Inlet vs. Outlet, wheel lockup will occur and personal injury may result.

Important: If a new BPMV is being installed, remove the shipping plugs from the valve openings.

5. Remove the cap or plug from the wheel brake pipes (2) and install the wheel brake pipes (2) to the BPMV (1) using the locations recorded during the removal procedure.

   Tighten
   Tighten the wheel brake pipes to 15 Nm (11 lb ft).

6. Remove the cap or plug from the master cylinder brake pipes (3) and install the two master cylinder brake pipes (3) to the BPMV (1) using the locations recorded during the removal procedure.

   Tighten
   Tighten the master cylinder brake pipes to 15 Nm (11 lb ft).

7. Fill and bleed the hydraulic brake system. Refer to Master Cylinder Reservoir Filling and Hydraulic Brake System Bleeding .
8. Perform the Auto Bleed Procedure. Refer to Antilock Brake System Automated Bleed Procedure .
9. Perform the System Check-Vehicle. Refer to Diagnostic System Check - Vehicle .

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Electronic Brake Control Module Replacement (RHD)

Removal Procedure

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

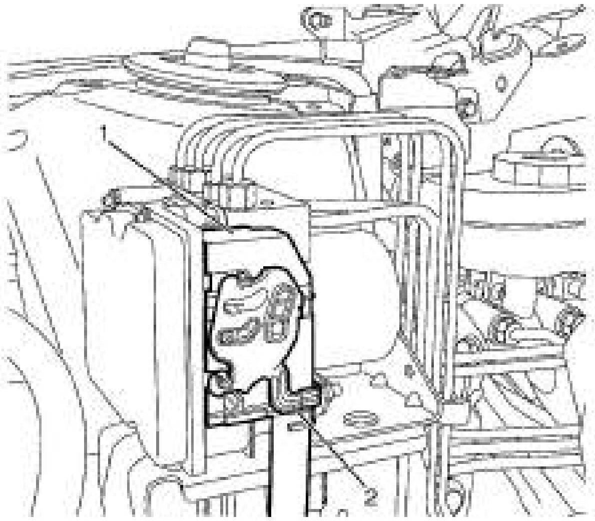
Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

Important: If the electronic brake control module (EBCM) or brake pressure modulator valve (BPMV) is to replaced under manufacturer's warranty, do not disassemble the EBCM/BPMV assembly. If the EBCM or BPMV is faulty, replace the EBCM/BPMV as an assembly.

Important: The area around the electronic brake control module (EBCM) must be free from loose dirt to prevent contamination of dissembled ABS components.

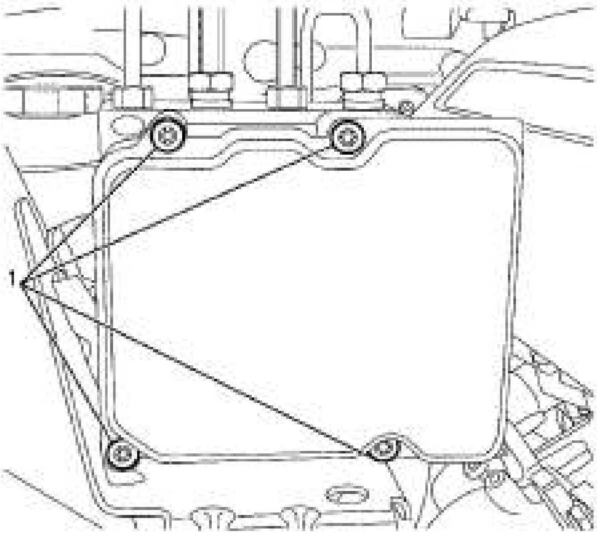
1. Turn the key to the ignition OFF position.



2. Remove the EBCM/BPMV assembly. Refer to Brake Pressure Modulator Valve Assembly Replacement .
3. Clean the EBCM/BPMV assembly.
4. Rotate the EBCM connector tab (2) up to the unlocked position.

Notice: To prevent equipment damage, never connect or disconnect the wiring harness connection from the EBCM with the ignition switch in the ON position.

5. Disconnect the EBCM electrical connector (1) and position out of the way.

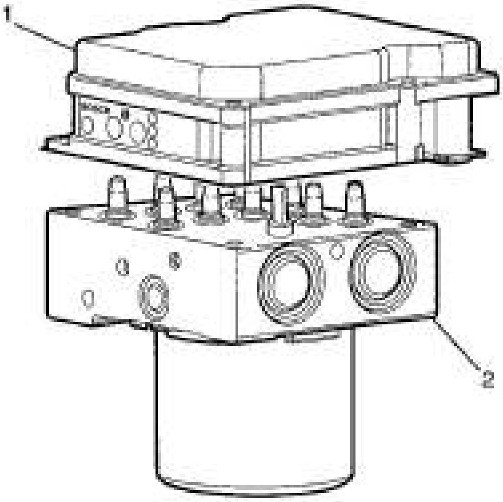


Important: EBCM to BPMV retaining screws are a single use only component. NEW EBCM to BPMV retaining screws must be installed whenever the EBCM to BPMV retaining screws are removed.

6. Remove the EBCM to BPMV retaining screws (1) and discard.

   Discard the screws.

7. Clean the surface of the EBCM/BPMV assembly.



Important: The EBCM (1) cannot be repaired. If faulty, the EBCM (1) must be replaced.

8. Separate the EBCM (1) from the BPMV (2).

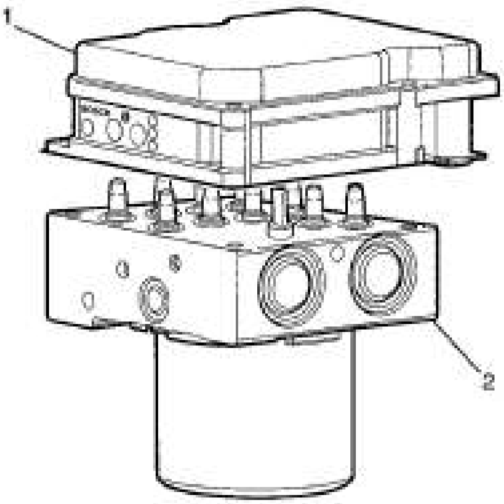
Installation Procedure

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.



Important: The seal is not available as a spare part and the mating surfaces cannot be mechanically reworked. If the seal or mating surfaces are damaged the EBCM/BPMV assembly must be replaced.

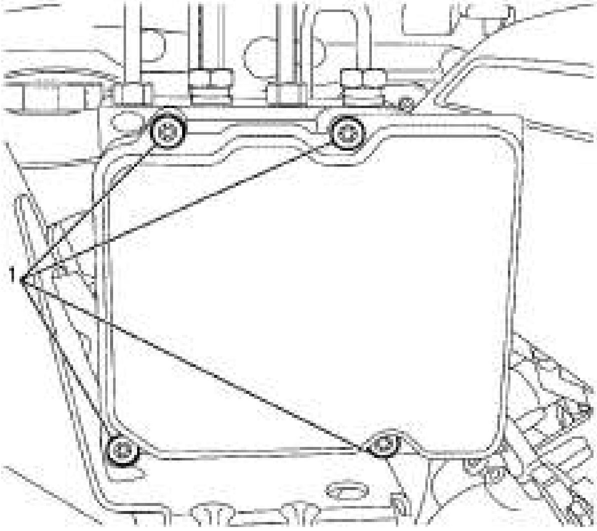
1. Inspect the EBCM (1) to BPMV (2) mating surfaces and seal.
2. Clean the seal surface of the BPMV.

Important: Make sure the coils for the solenoid valves are aligned correctly. If they are not correctly aligned the EBCM (1) must be replaced.

Important: Make sure the contact pins of the hydraulic pump are aligned correctly.

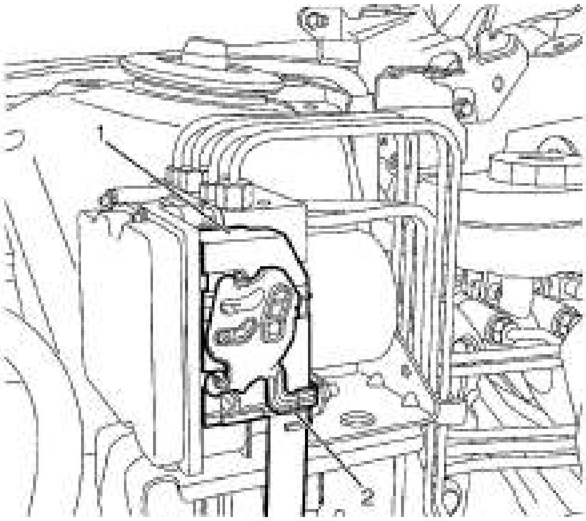
3. Install the EBCM (1) to the BPMV (2).

Notice: Refer to Fastener Notice in the Preface section.



4. Install the NEW EBCM to BPMV retaining screws.

   Tighten
   Tighten the EBCM to BPMV screws in sequence 8 Nm (71 lb in).



Notice: To prevent equipment damage, never connect or disconnect the wiring harness connection from the EBCM with the ignition switch in the ON position.

5. Connect the EBCM electrical connector (1) to the EBCM (3).
6. Rotate the EBCM connector tab (2) to the locked position.
7. Use the scan tool in order to clear any DTCs.

8. Perform the Auto Bleed Procedure. Refer to Antilock Brake System Automated Bleed Procedure .
9. If installing a new EBCM it is necessary to program the EBCM. Refer to Service Programming System (SPS) .
10. Perform the System Check-Vehicle. Refer to Diagnostic System Check - Vehicle .
11. Recalibrate the brake pedal position sensor. Refer to Stop Lamp Switch Adjustment .

Front Wheel Speed Sensor Reluctor Wheel Replacement

The front wheel speed sensor tone wheels are integral with the hub and bearing assemblies. If a front wheel speed sensor tone wheel needs replacement, you must replace the entire hub and bearing assembly. Refer to Front Wheel Bearing and Hub Replacement.

Front Wheel Speed Sensor Replacement

The front wheel speed sensors are integral with the hub and bearing assemblies. If a front wheel speed sensor needs replacement, you must replace the entire hub and bearing assembly. Refer to Front Wheel Bearing and Hub Replacement.

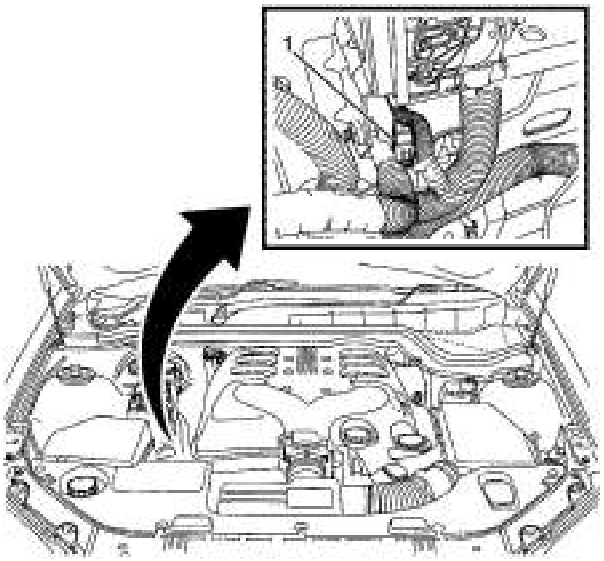
Front Wheel Speed Sensor Wiring Harness Replacement

Removal Procedure - Right

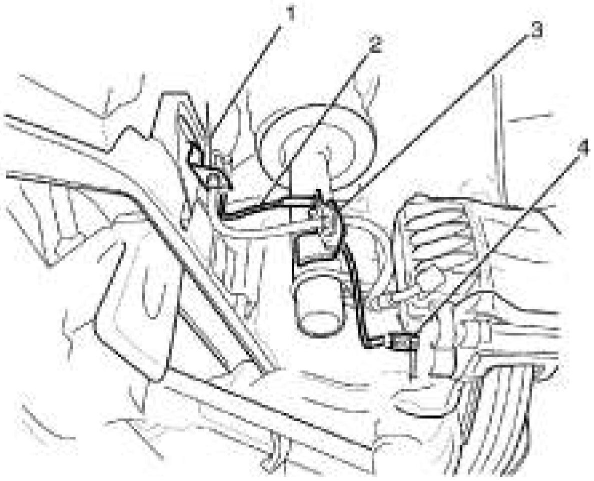
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.



1. Disconnect the wheel speed sensor jumper harness electrical connector (1).
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
3. Remove the right hand front wheel. Refer to Tire and Wheel Removal and Installation .



4. Disconnect the wheel speed sensor jumper harness electrical connector (4).
5. Detach the wheel speed sensor jumper harness (2) from the brake hose/wheel speed sensor jumper harness bracket (1).
6. Detach the wheel speed sensor jumper harness (2) from the front strut mounting bracket (3).

   Important: Note the routing of the wheel speed sensor jumper harness (2).

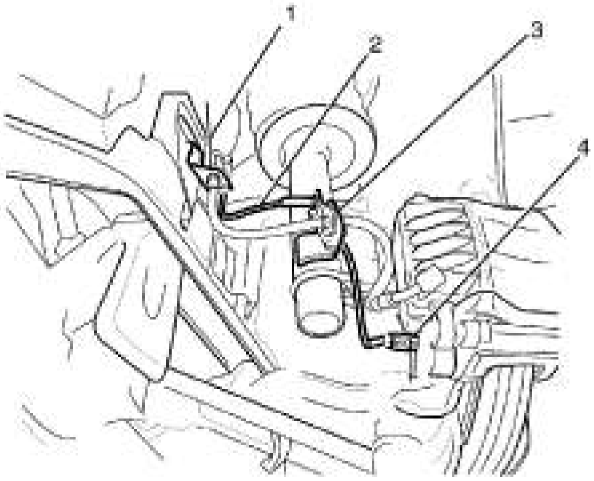
7. Remove the wheel speed sensor jumper harness (2) from the vehicle.

Installation Procedure - Right

Caution: Refer to Safety Glasses Caution in the Preface section.

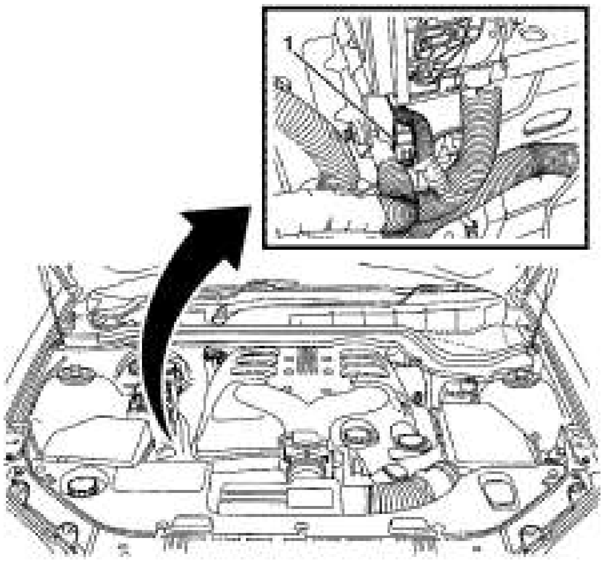
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.



Important: Make sure the routing of the wheel speed sensor jumper harness (2) is secured and routed in its original location.

1. Install the wheel speed sensor jumper harness (2) to the vehicle.
2. Attach the wheel speed sensor jumper harness (2) from the front strut mounting bracket (3).
3. Attach the wheel speed sensor jumper harness (2) to the brake hose/wheel speed sensor jumper harness bracket (1).
4. Connect the wheel speed sensor jumper harness electrical connector (4).
5. Install the right hand front wheel. Refer to Tire and Wheel Removal and Installation .
6. Lower the vehicle.



7. Connect the wheel speed sensor jumper harness electrical connector (1).
8. Use the scan tool in order to clear any DTCs.

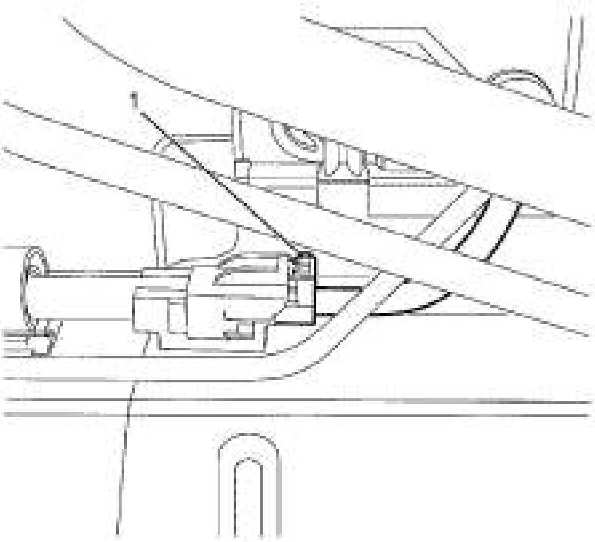
9. Perform the System Check-Vehicle. Refer to Diagnostic System Check - Vehicle .

Removal Procedure - Left

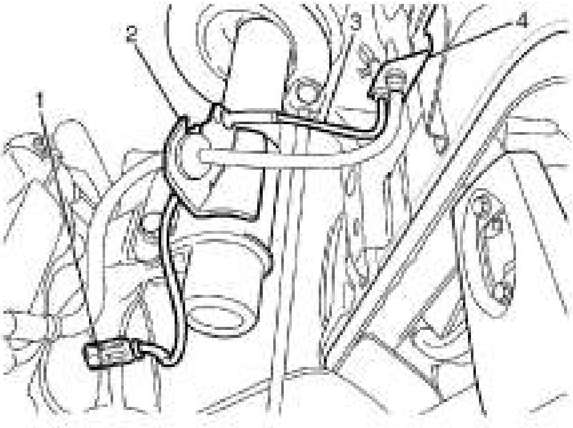
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.



1. Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement for 3.6L engine, or Air Cleaner Assembly Replacement for 6.0L engine.
2. Disconnect the wheel speed sensor jumper harness electrical connector (1).
3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
4. Remove the left hand front wheel. Refer to Tire and Wheel Removal and Installation .



5. Disconnect the wheel speed sensor jumper harness electrical connector (1).
6. Detach the wheel speed sensor jumper harness (3) from the brake hose/wheel speed sensor jumper harness bracket (4).
7. Detach the wheel speed sensor jumper harness (3) from the front strut mounting bracket (2).

   Important: Note the routing of the wheel speed sensor jumper harness (3).

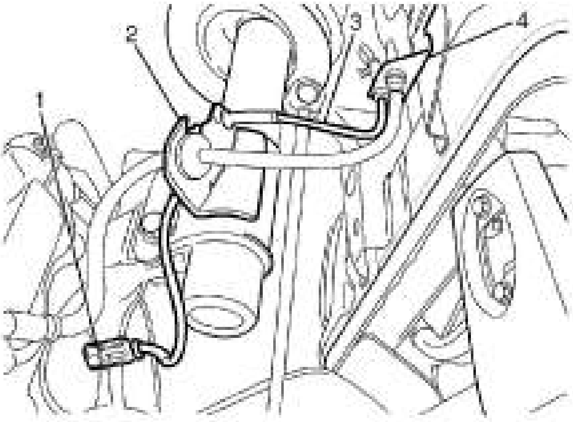
8. Remove the wheel speed sensor jumper harness (3) from the vehicle.

Installation Procedure - Left

Caution: Refer to Safety Glasses Caution in the Preface section.

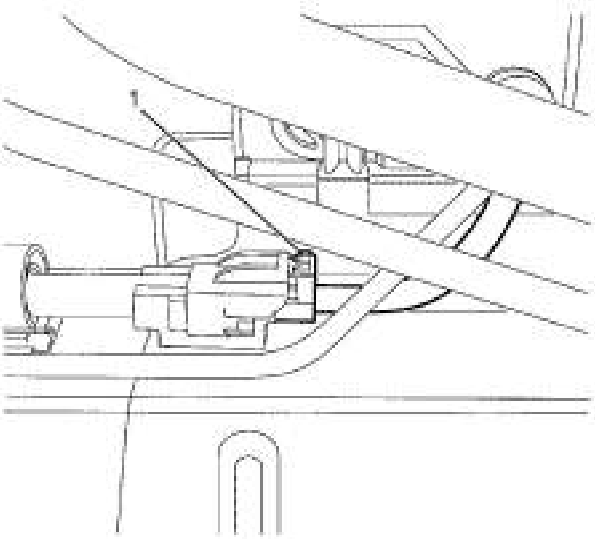
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.



Important: Make sure the routing of the wheel speed sensor jumper harness (3) is secured and routed in its original location.

1. Install the wheel speed sensor jumper harness (3) to the vehicle.
2. Attach the wheel speed sensor jumper harness (3) from the front strut mounting bracket (2).
3. Attach the wheel speed sensor jumper harness (3) to the brake hose/wheel speed sensor jumper harness bracket (4).
4. Connect the wheel speed sensor jumper harness electrical connector (1).
5. Install the left hand front wheel. Refer to Tire and Wheel Removal and Installation .
6. Lower the vehicle.



7. Connect the wheel speed sensor jumper harness electrical connector (1).
8. Install the air cleaner assembly. Refer to Air Cleaner Assembly Replacement for 3.6L engine,

or Air Cleaner Assembly Replacement for 6.0L engine.

9. Use the scan tool in order to clear any DTCs.
10. Perform the System Check-Vehicle. Refer to Diagnostic System Check - Vehicle .

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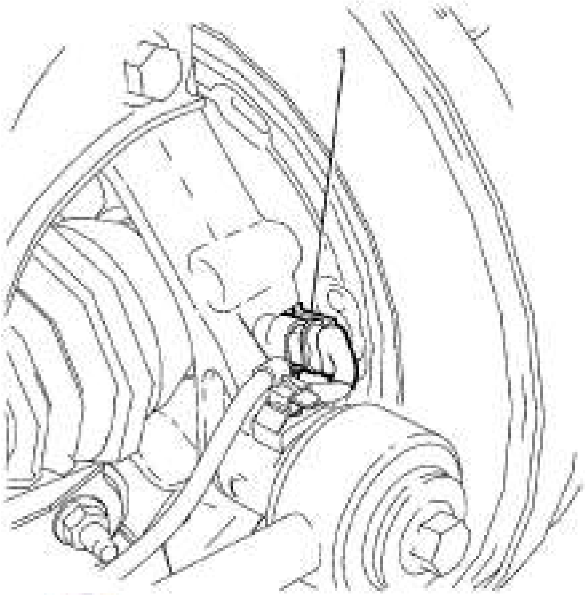
Rear Wheel Speed Sensor Replacement

Removal Procedure

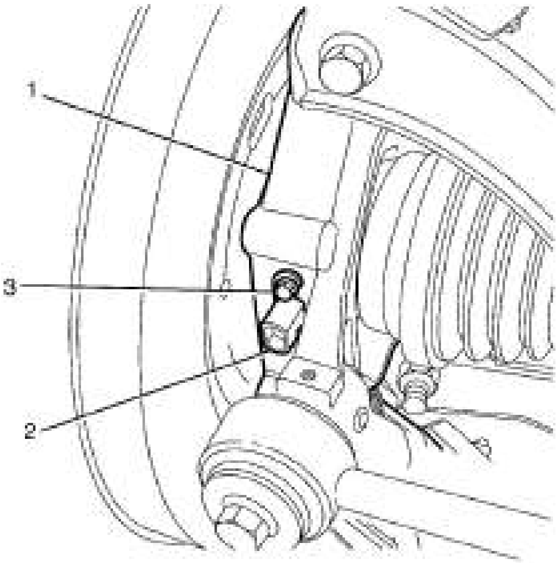
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.



1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the rear wheels. Refer to Tire and Wheel Removal and Installation .
3. Disconnect the wheel speed sensor electrical connector (1).



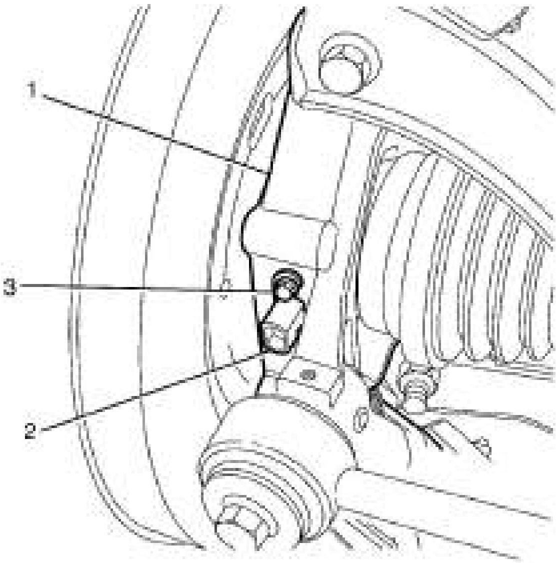
4. Remove the wheel speed sensor to knuckle retaining bolt (3).
5. Remove the wheel speed sensor (2) from the knuckle (1).

Installation Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

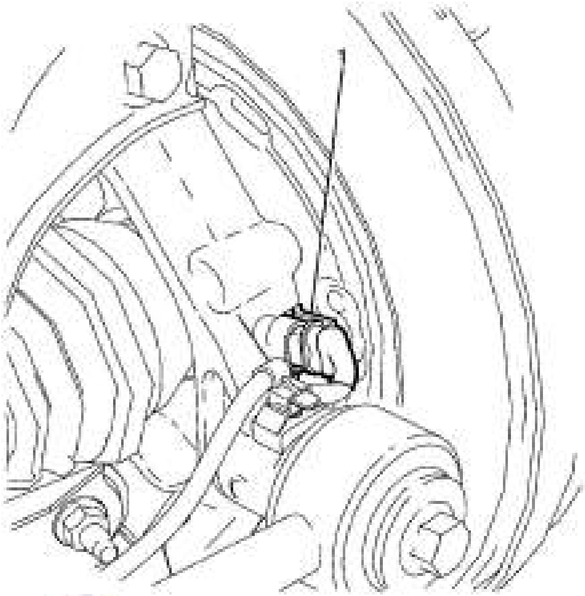


1. Install the wheel speed sensor (2) to the knuckle (1).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the wheel speed sensor to knuckle retaining bolt (3).

   Tighten
   Tighten the bolt to 7 Nm (62 lb in).



3. Connect the wheel speed sensor jumper harness electrical connector (1).
4. Install the rear wheels. Refer to Tire and Wheel Removal and Installation .
5. Lower the vehicle.

Rear Wheel Speed Sensor Ring Replacement

The rear wheel speed sensor tone wheels are integral with the hub and bearing assemblies. If a rear wheel speed sensor tone wheel needs replacement, you must replace the entire hub and bearing assembly. Refer to Rear Wheel Bearing and Hub Replacement .

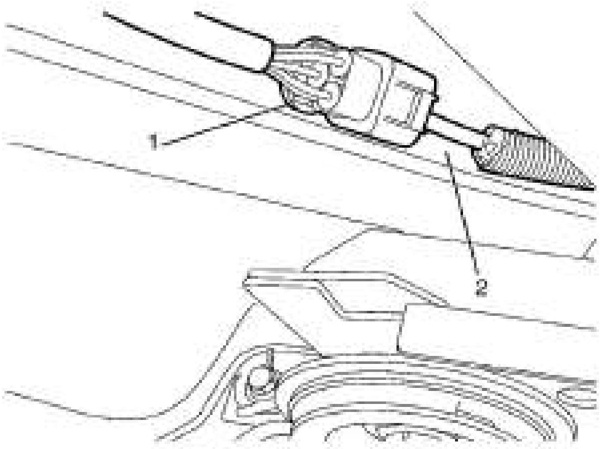
Rear Wheel Speed Sensor Wiring Harness Replacement

Removal Procedure

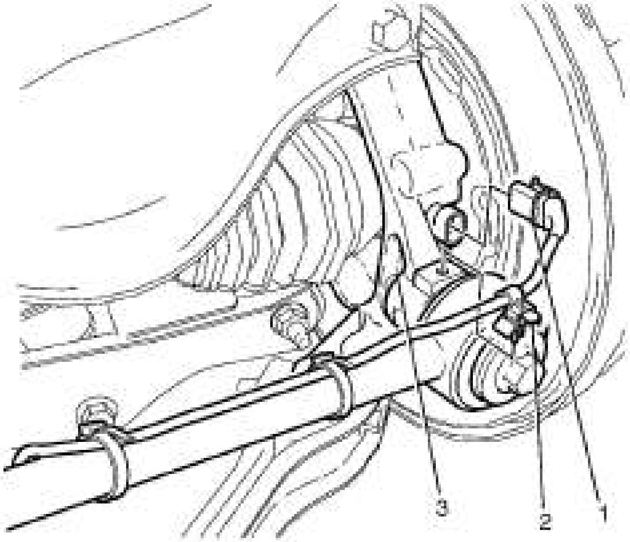
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

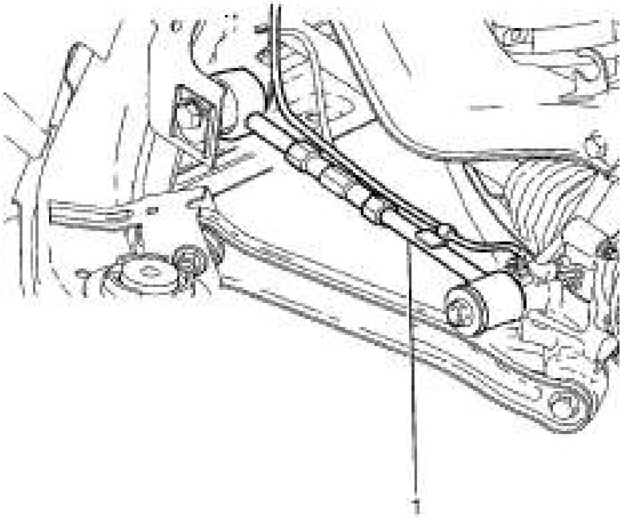
Caution: Refer to Brake Dust Caution in the Preface section.



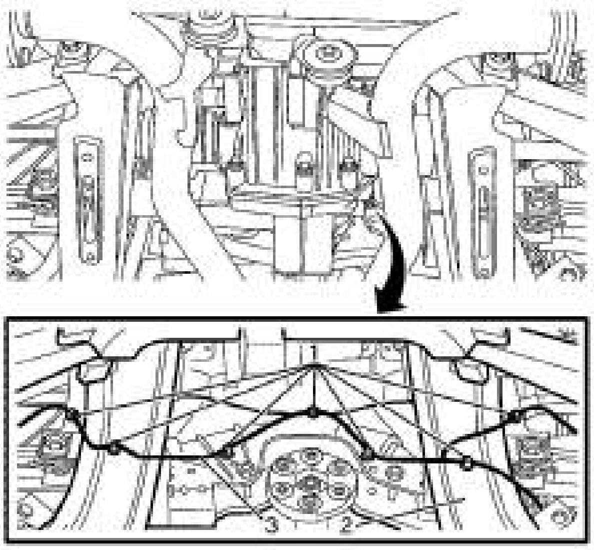
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the rear wheels. Refer to Tire and Wheel Removal and Installation .
3. Disconnect the wheel speed sensor jumper harness electrical connector (1).
4. Detach the electrical connector (1) from the right hand rail (2).



5. Disconnect the left rear and right rear wheel speed sensor electrical connectors (1).
6. Detach the wheel speed sensor wiring harness mounting clip (2) from the left rear and right rear knuckles (3).



7. Detach the wheel speed sensor wiring harness mounting clip (1).



8. Detach the wheel speed sensor wiring harness mounting clips (1) from the rear suspension subframe (2).

   Important: Note the routing of the wheel speed sensor jumper harness (3).

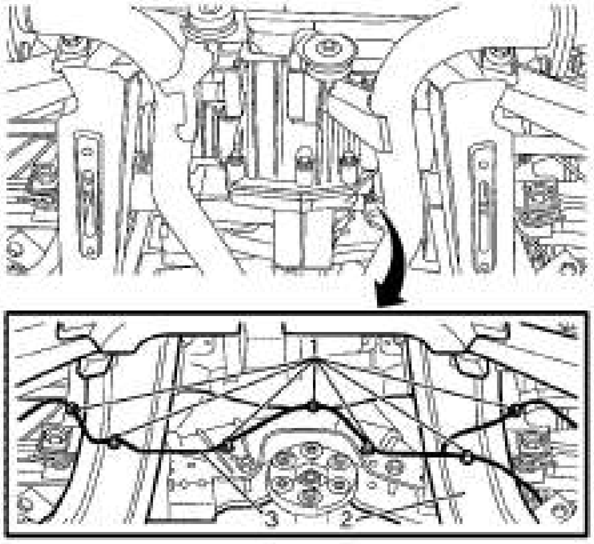
9. Remove the wheel speed sensor jumper harness (2) from the vehicle.

Installation Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

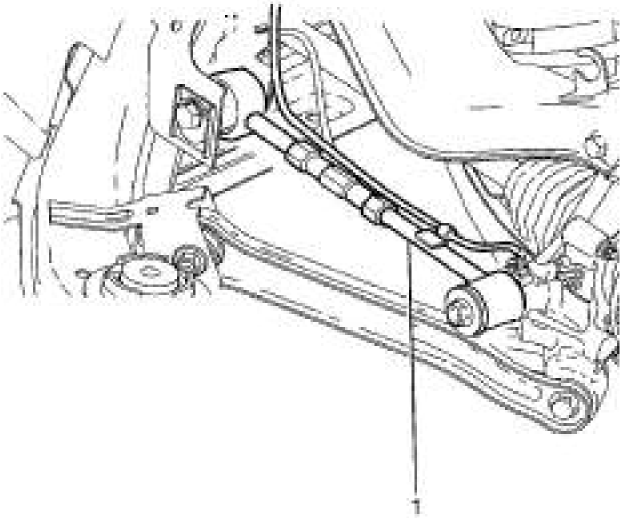
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

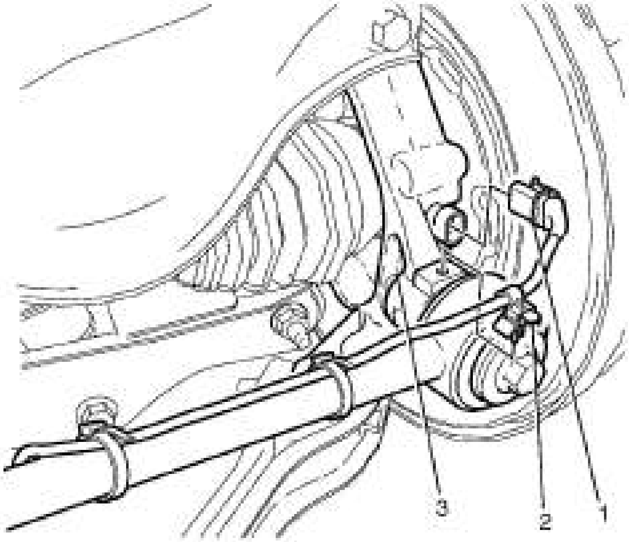


Important: Make sure the routing of the wheel speed sensor jumper harness (3) is routed in its original location.

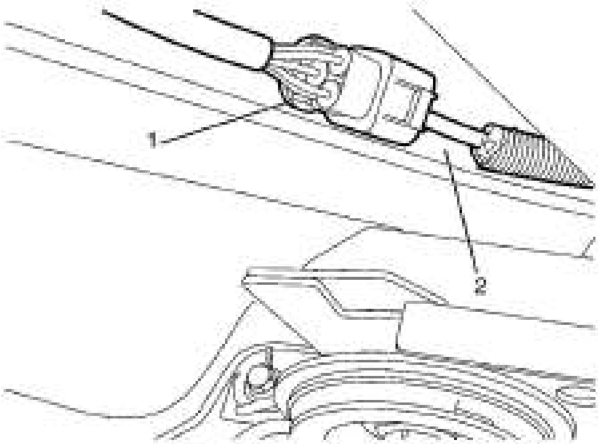
1. Install the wheel speed sensor jumper harness (3) to the vehicle.
2. Attach the wheel speed sensor wiring harness mounting clips (1) to the rear suspension subframe (2).



3. Attach the wheel speed sensor wiring harness mounting clip (1).



4. Connect the left rear and right rear wheel speed sensor electrical connectors (1).
5. Attach the wheel speed sensor wiring harness mounting clip (2) to the left rear and right rear knuckles (3).



6. Attach the electrical connector (1) to the right hand rail (2).
7. Connect the wheel speed sensor jumper harness electrical connector (1).
8. Install the rear wheels. Refer to Tire and Wheel Removal and Installation .
9. Lower the vehicle.
10. Use the scan tool in order to clear any DTCs.
11. Perform the System Check-Vehicle. Refer to Diagnostic System Check - Vehicle ..

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Brakes | Antilock Brake System | Repair Instructions | **Document ID: 1998897**

Steering Angle Sensor Centering

The steering angle sensor does not require centering often. Centering of the steering angle sensor might be required after certain service procedures are performed. Some of these procedures are as follows:

- Steering gear replacement
- Steering column replacement
- Steering angle sensor replacement
- Intermediate shaft replacement
- Electronic brake control module (EBCM) replacement
- Collision or other physical damage

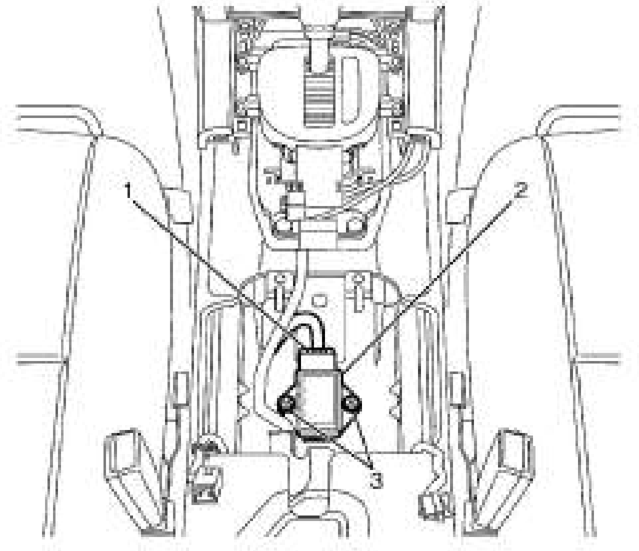
The steering angle sensor centering procedure can be completed with a scan tool using the following steps:

1. Using the steering wheel, align the front wheels forward.
2. Set the transmission in the PARK position.
3. Turn the ignition switch ON, with the engine OFF.
4. Clear any DTCs that may be set.
5. Select Steering Angle Sensor Centering in the EBCM Special Functions list.
6. Follow the scan tool directions to complete the centering procedure.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Brakes | Antilock Brake System | Repair Instructions | **Document ID: 1974849**

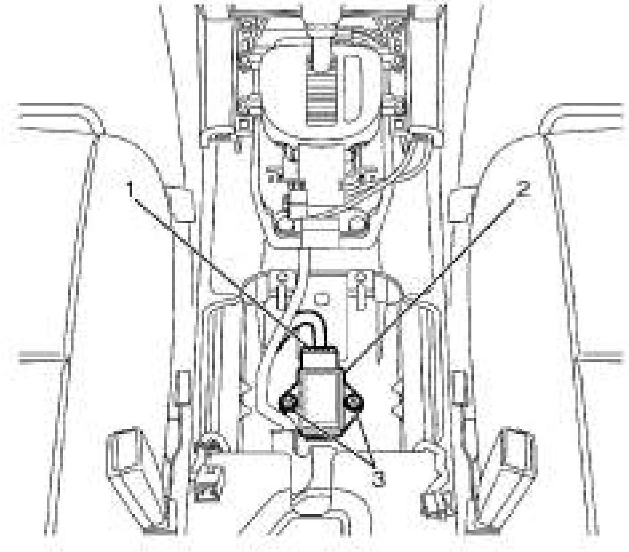
Vehicle Yaw Sensor with Vehicle Lateral Accelerometer Replacement (RHD)

Removal Procedure



1. Turn the key to the ignition OFF position.
2. Remove the center console. Refer to Front Floor Console Replacement .
3. Disconnect the yaw rate sensor/lateral accelerometer sensor electrical connector (1).
4. Remove the yaw rate sensor/lateral accelerometer sensor to yaw rate sensor/lateral accelerometer mounting bracket retaining nuts (3).
5. Remove the yaw rate sensor/lateral accelerometer sensor (2) from the vehicle.

Installation Procedure



1. Install the yaw rate sensor/lateral accelerometer sensor (2) to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the yaw rate sensor/lateral accelerometer sensor to yaw rate sensor/lateral accelerometer mounting bracket retaining nuts (3).

   Tighten
   Tighten the nuts to 9 Nm (80 lb in).

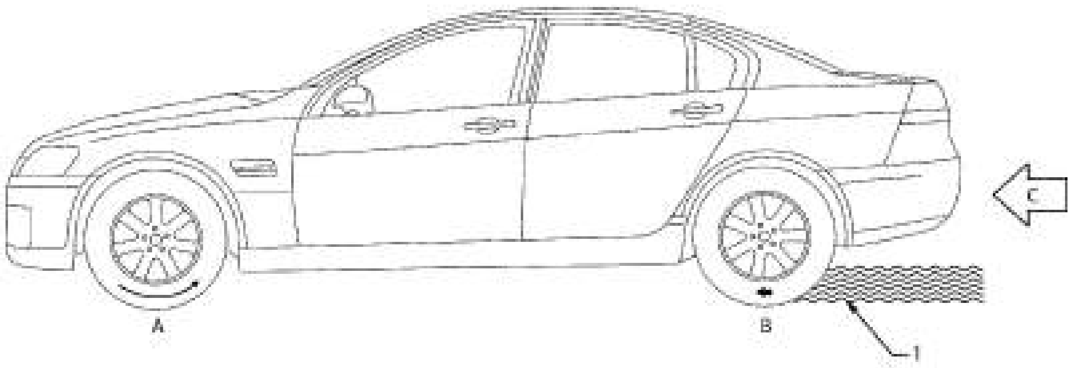
3. Connect the yaw rate sensor/lateral accelerometer sensor electrical connector (1).
4. Install the center console. Refer to Front Floor Console Replacement .

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Brakes | Antilock Brake System | Description and Operation | **Document ID: 1984385**

ABS Description and Operation (SWBRHD)

Definition of Longitudinal Wheel Slip

Longitudinal wheel slip is a loss of adhesion between the tyres and the road surface. This occurs when the vehicle is moving in a straight ahead direction and the braking or acceleration forces applied to a tyre exceeds the amount of adhesion available to that tyre.



- At 0 percent slip, the front tyre rolls freely (A).
- At 100 percent slip, the rear wheel locks-up (B) as the weight of the vehicle pushes the non-rotating tyre along the road surface (C). When the wheels are locked-up, the vehicle's kinetic energy (forward motion) is converted into thermal energy (heat) between the tyre and the road surface (1). This will result in an unstable and inefficient braking due to the effect of the following factors:
  - Asphalt, cement, gravel or dirt road surfaces provide different degree of tyre adhesion.
  - Oil puddles, ice spots or other contaminants that cause a sudden change in the road surface condition.
  - Wet, dry, smooth, rough road surface conditions affect tyre adhesion.

When none of the wheels are locked during braking, the brakes work by converting kinetic energy (forward motion of the vehicle) into thermal energy (heat). The friction between the stationary brake pad and the rotating disc as it slides past the pad convert the motion of the wheel and tyre into heat. The brake disc is designed to work like a heat sink, and absorbs as much as 80% of the heat generated during stopping. The brake disc is cooled as it spins through the air on the way to the next stop. The friction surfaces between the brake pads and the brake disc are designed to provide a stable and controlled braking action. Therefore, a vehicle that is braked without locking the wheel will stop in a shorter distance while maintaining directional stability and steering capability. Maximum braking efficiency is achieved when a wheel lock slip is prevented.

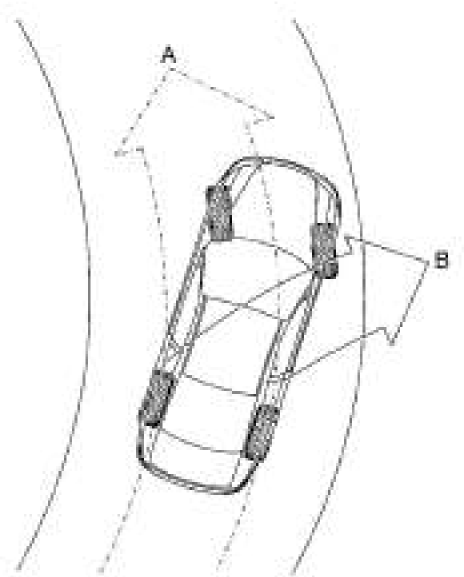
Definition of Lateral Wheel Slip

Lateral wheel slip is the loss of adhesion between the tyres and the road surface, which occurs when the vehicle is cornering or when too much engine torque is applied to the vehicle and the following forces applied to the tyres exceeds the amount of adhesion available to that tyre:

- Cornering forces.
- Acceleration force.
- Braking force.

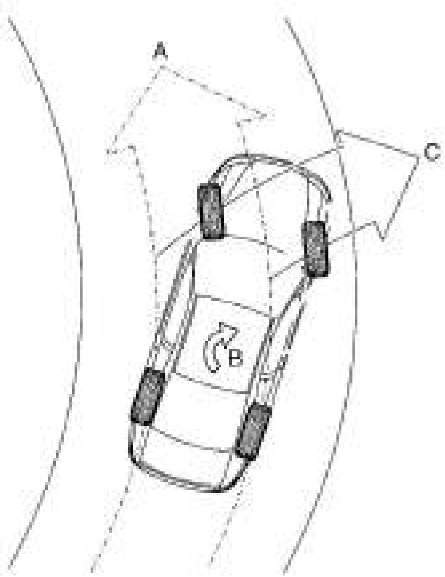
In addition, steering control depends upon tyre adhesion. A locked wheel in a 100 percent slip condition delivers poor braking and directional control.

The front tyre direction (A) has minimal steering effect while the vehicle skids in direction (B). The tyres must regain their adhesion before steering control is restored to the vehicle.



Definition of Understeer

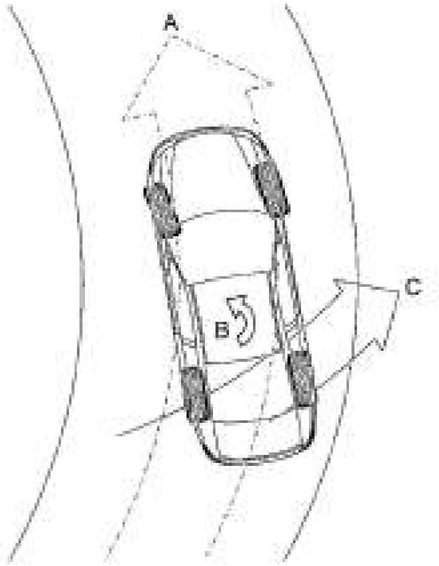
When the vehicle is cornering (A) at high speed or when the vehicle encounters a slippery road surface, the vehicle understeers when the cornering, braking or acceleration forces applied to the tyres exceeds the adhesion available between the tyres and the road surface.



Under this condition, the vehicle spins (B) with the front of the vehicle sliding in direction (C).

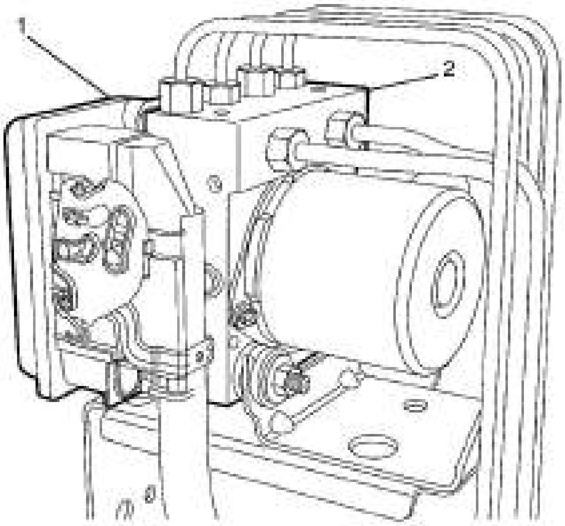
Definition of Oversteer

When the vehicle is cornering (A) at high speed or when the vehicle encounters a slippery road surface, the vehicle oversteers when the cornering, braking or acceleration forces applied to the tyres exceeds the adhesion available between the tyres and the road surface.



Under this condition, the vehicle spins (B) with the rear of the vehicle sliding in direction (C).

Electronic Brake Control Module



The Electronic Brake Control Module (EBCM) (1) is the control centre of the antilock braking system-traction control system with electronic stability program (ABS-TCS/ESP). It is integrated with the Brake Modulator Assembly (2) to form one assembly.

Electronic Brake Control Module Inputs

The EBCM constantly monitors and evaluates input signals from the following:

- Wheel speed sensors.
- Yaw-rate sensors.
- Steering angle sensor.
- Stop lamp switch.
- Ignition on input.
- Battery voltage.
- Serial data communication circuit.

Electronic Brake Control Module Outputs

Based on the inputs received, the EBCM sends output signals to the following:

- Instrument cluster multi-function display (MFD).
- Diagnostic link connector.
- Hydraulic modulator solenoid valves.
- Hydraulic modulator pump motor.

- Serial data communication circuit.

Electronic Brake Control Module Self-test Initialisation Sequence

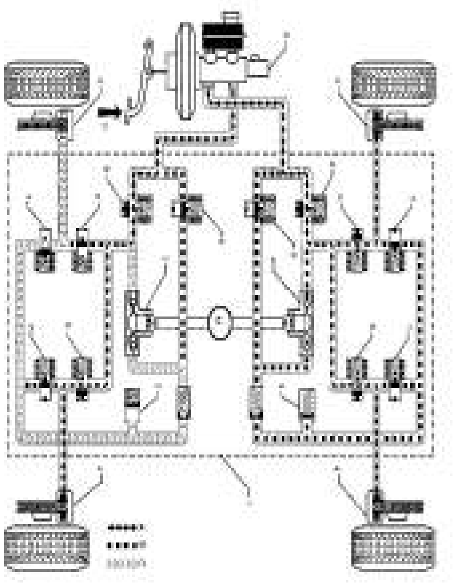
When the ignition is switched on, the EBCM constantly performs a self-test that detects and isolates ABS-TCS/ESP faults. In addition, the EBCM performs on Self-test Initialisation Sequence for each ignition cycle. This Initialisation Sequence commences when the vehicle reaches approximately 15 km/h.

Important: The Initialisation Sequence may be heard and felt while it is taking place, which is considered part of the normal system operation.

During the Initialisation Sequence, the EBCM sends a control signal to the hydraulic modulator to cycle each of the solenoid valves as well as operate the pump motor to check for correct component operation. If the pump or any solenoid valves fail to operate, the EBCM sets a diagnostic trouble code (DTC).

When the vehicle speed exceeds 15 km/h, the EBCM continuously monitors the ABS-TCS/ESP by comparing the logical sequence of input and output signals with the normal operating parameters stored in the EBCM. If any of the input or output signals are outside the normal operating parameters, the EBCM sets the DTC.

Brake Pressure Modulator Valve



(1) Brake pressure modulator valve
(2) Return Pump
(3) Accumulator
(4) Brake Caliper
(5) Brake Master Cylinder
(6) Inlet Valves

(7) Outlet Valves
(8) Isolating Solenoid Valve
(9) Priming Solenoid Valve
(a) Normal (conventional) brake fluid pressure
(b) Stopped brake fluid pressure flow (solenoid valve closed)
(c) Pump generated brake fluid pressure flow
(d) Brake pedal applied
(m) Motor

Important: The illustration shows the brake pressure modulator valve components while in ABS pressure reducing phase. Refer to this illustration for the following hydraulic components.

The brake pressure modulator valve (BPMV) assembly (1) modulates the brake fluid pressure (A) based on the control signal sent by the electronic brake control module (EBCM).

To allow individual control of each wheel brake fluid circuit, a four-channel circuit configuration with a front/rear split is used. Each of the brake fluid circuits are hydraulically isolated, which enables continued braking ability if a leak develops in any of the brake fluid circuits. The BPMV components consist of the following:

- Two return pumps (2) - Each pump draws excess brake fluid from the accumulators (3) and brake calipers (4) allowing the hydraulic modulator to return brake fluid to the brake master cylinder (5) against brake fluid pressure (C) during the ABS-TCS/ESP pressure reducing phase. In addition, the return pump applies pressure to the brake calipers during the ABS brake intervention phase.
- One electric motor (M) - The electric motor drives the return pump.
- Two accumulators - The accumulators store the excess brake fluid during the ABS-TCS/ESP pressure reducing phase that enables the hydraulic modulator to apply instant pressure reduction.
- Four inlet valves (6) - At rest position, each inlet valve allows brake fluid pressure to be applied to the brake callipers. When active, each inlet valve isolates a brake calliper from the brake master cylinder.
- Four outlet valves (7) - At rest position, each outlet valve isolates a brake calliper from the accumulator and return pump. When active, each outlet valve directs excess brake fluid to the accumulator and return pump that allows pressure reduction.
- Two isolating solenoid valves (8) - The isolating solenoid valves isolate the rear brake fluid circuits from the brake master cylinder which prevents the return of the brake fluid to the brake master cylinder during TCS operation.
- Two rear priming valves (9) - Allow brake fluid to be drawn from the brake master cylinder into the hydraulic pump during TCS operation.

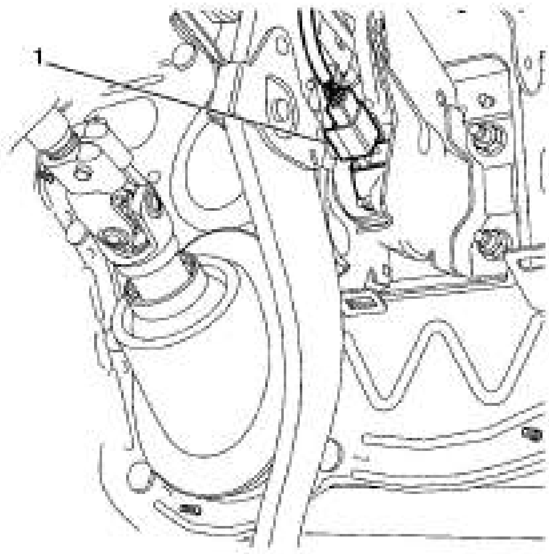
Wheel Speed Sensor

Active wheel speed sensors are fitted to this vehicle. Active wheel speed sensors are direction sensitive.

The wheel speed sensor receives a 12-volt power supply voltage from the electronic brake control module (EBCM). The wheel speed sensor contains an integrated circuit containing a magneto-resistive bridge. Wheel rotation changes the positioning of the tone wheel and the wheel speed sensor's magnetic field and varies the magneto-resistive bridge resistance. The wheel speed sensor's integrated circuit modifies and amplifies the varying resistance into a direct current (DC) square wave signal. Therefore as the wheel spins, the wheel speed sensor changes the voltage and current level output signal to the EBCM. The wheel speed sensor always has a current flow on the output signal circuit to complete the wheel speed sensor's ground path and for EBCM diagnostics. The EBCM uses the frequency of the square wave signal to calculate the wheel speed.

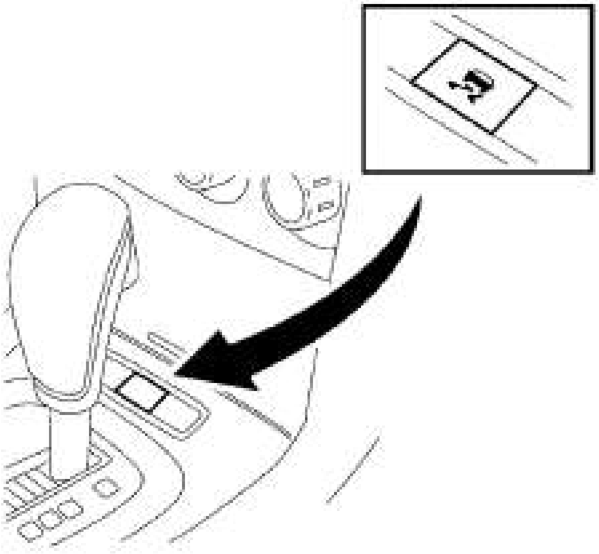
Brake Pedal Position Sensor

The brake pedal position sensor (1) is a normally open switch that closes when the brake pedal is depressed.



The electronic brake control module (EBCM) uses the stop lamp switch signal voltage to determine when the brake pedal is depressed.

Electronic Stability Program (ESP) Switch



The ESP switch incorporates traction control (TCS) which is part of a multi function centre console switch assembly and is located in the console as shown above.

The ESP switch is a momentary contact switch that sends a ground output signal to the body control module (BCM).

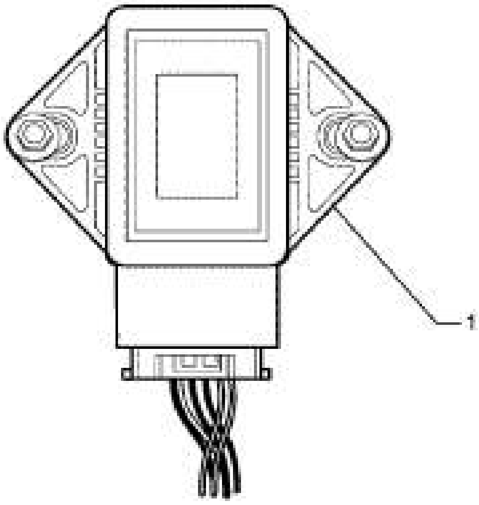
The BCM sends a signal to the EBCM via the serial data bus to perform the following functions:

- Pressing the ESP switch once deactivates both TCS and ESP for the duration of that ignition cycle. ABS will still function normally when the TCS and ESP is deactivated.
- Pressing the ESP switch again when the TCS and ESP is deactivated, activates the TCS and ESP.
- Pressing the ESP switch for more than 60 seconds will be interpreted as a short circuit. Consequently, a DTC will be logged and the TCS and ESP will be deactivated for the duration of that ignition cycle.

If there are no current TCS/ESP DTC's logged, the ESP activates at the next ignition cycle.

Yaw Rate Sensor

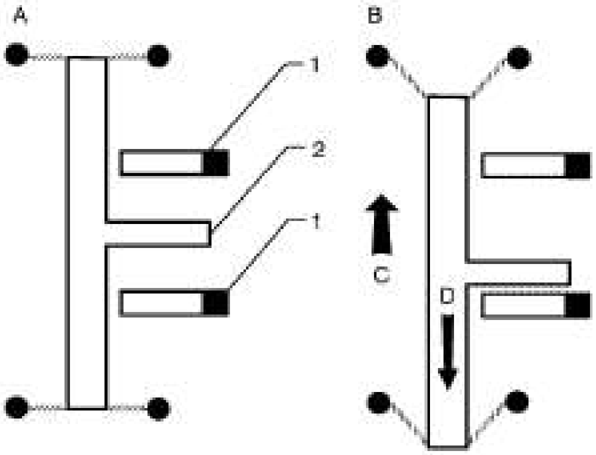
The yaw-rate sensor assembly (1) comprises of a yaw-rate sensor and a lateral acceleration sensor.



- The yaw-rate sensor produces a signal output voltage that corresponds to a vehicle rotation around its vertical axis.
- The lateral acceleration sensor produces a signal output voltage that corresponds to a vehicle lateral acceleration.

The EBCM uses the output signal voltage of the yaw-rate sensor and the acceleration sensor in conjunction with the wheel speed sensor signal output voltage and serial data output signal of the steering angle sensor, to support the calculation of actual vehicle behavior as compared to the driver intended direction.

Lateral Acceleration Sensor



Important: This illustration represents the lateral acceleration sensor in symbolic form, which aims to show the operation of the acceleration sensor in a simplified manner.

The lateral acceleration sensor consists of the following components:

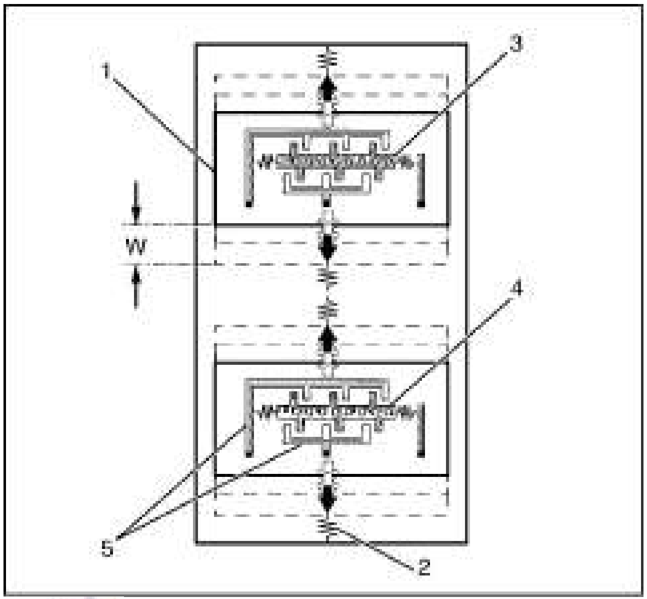
- Differential capacitors connected to the fixed side plates (1).
- Mass plate (2) suspended by springs (3) about its centre of mass, which moves in response to vehicle lateral acceleration.

When the vehicle is stationary (View A), the distance between the mass plate and the 2 side plates are equal. Therefore, the capacitance between the 2 capacitors is the same and the acceleration sensor signal voltage is zero.

As the vehicle accelerates (View B), the side plates move with the vehicle (C) while the mass plate, which is suspended by springs tends to move in the opposite direction. Therefore, the distance between the side plates and the mass plates changes in proportion to the level of acceleration.

This changes the capacitance between the 2 capacitors causing the acceleration sensor to produce a signal voltage with an amplitude proportional to the movement of the mass plates.

Yaw Rate Sensor



Important: This illustration represent the yaw rate sensor in symbolic form, which shows the operation of the yaw rate sensor in a simplified manner.

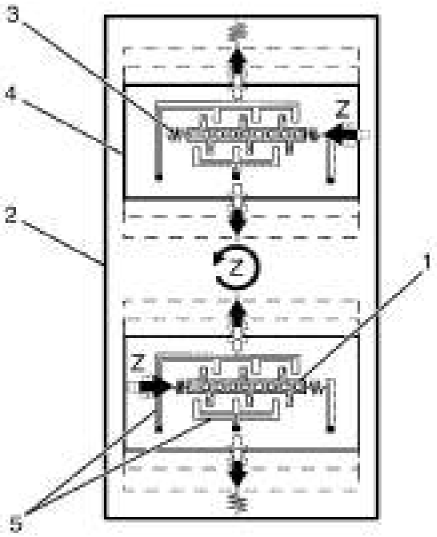
The yaw-rate sensor consists of the following components:

- Two oscillating plates (1) suspended by springs (2) around its center of mass.
- An acceleration sensor (3) incorporated within the oscillating plates.
- Permanent magnets, which project magnetic field to the oscillating plates.

While in the presence of a magnetic field, electric current is applied to the oscillating plates, which causes the plates to move at a constant amplitude (W).

When the vehicle is driving in a straight-ahead direction and there are not lateral forces applied to the acceleration sensors, the distance between the mass plates (4) and the side plates of the acceleration sensors are equal (5). Therefore, the capacitance between the capacitors are the same and the acceleration sensor signal voltage is zero.

When the vehicle rotates around its vertical axis, the following situation occurs.

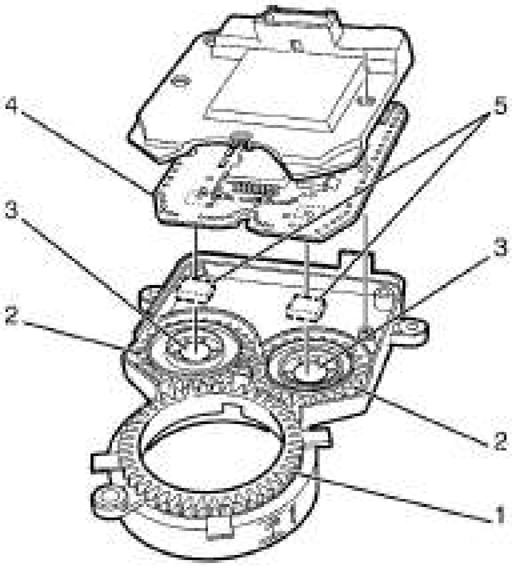


- With the exception of the mass plates (1), the yaw-rate sensor (2), which is firmly attached to the vehicle rotates with the vehicle (Z).
- The mass plates, which are suspended by springs (3) and moves along with the oscillating plates (4), tend to float in its current position while the fixed side plates (5) rotate with the vehicle. Therefore, the distance between the fixed side plates and the mass plates of the acceleration sensor changes in proportion to the level of vehicle rotation around its vertical axis.
- This changes the capacitance between the capacitors causing the acceleration sensor to produce a signal voltage with an amplitude proportional to the movement of the mass plates.

The evaluation circuit of the yaw-rate sensor compares and evaluates the output signal of both acceleration sensors to calculate the level of vehicle rotation around its vertical axis.

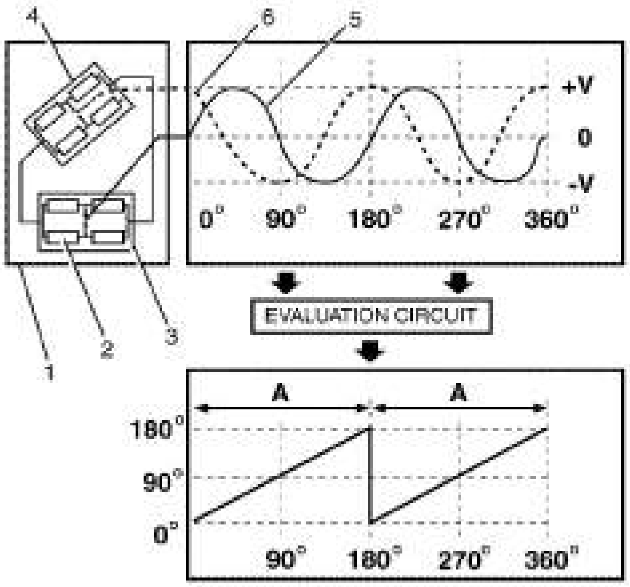
Steering Angle Sensor

The steering angle sensor provides a signal output that represents the steering wheel degree of rotation. The EBCM uses this information to calculate the driver intended driving direction. The steering angle sensor contains:



- Gear Wheel (1).
- Measuring Gears (2).
- Measuring Gear Magnets (3).
- Evaluation Circuit (4).
- Anisotropic Magneto Resistive (AMR) Integrated Circuit (IC) (5).

The anisotropic magneto resistive integrated circuit (AMRIC) (1) comprises of eight AMR elements (2) which are configured to form two Wheatstone bridges (3).


4
6
5
+V
0
-V
0°
90°
180°
270°
360°
EVALUATION CIRCUIT
1
2
3
A
A
180°
90°
0°
90°
180°
270°
360°

One of the Wheatstone bridges (4) is 45 degrees offset from the other to enable the AMR IC to produce sine (5) and cosine (6) output signal.

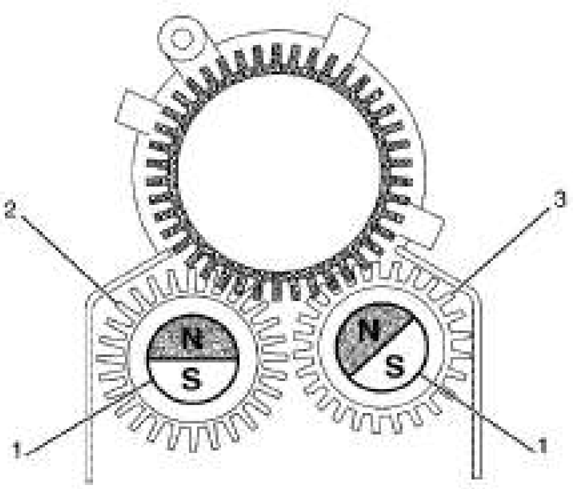
The AMR elements change resistance that corresponds to the changes in the angle of magnetic field projected to the AMR IC, regardless of the polarity of the magnetic field.

The evaluation circuit of the steering angle sensor evaluated and combines the output signal of the AMR IC to produce two identical linear output (A) that represents the 360 degrees angular rotation of the magnetic field.

The omni polarity of the AMR elements limits the signal output range of a single AMR IC from 0-180 degrees.

Steering Angle Sensor Layout

To increase the output signal range of the steering angle sensor, and enable it to produce an output signal that can represent the ±760 degrees of steering wheel rotation, two AMR ICs are fitted to the steering angle sensor.

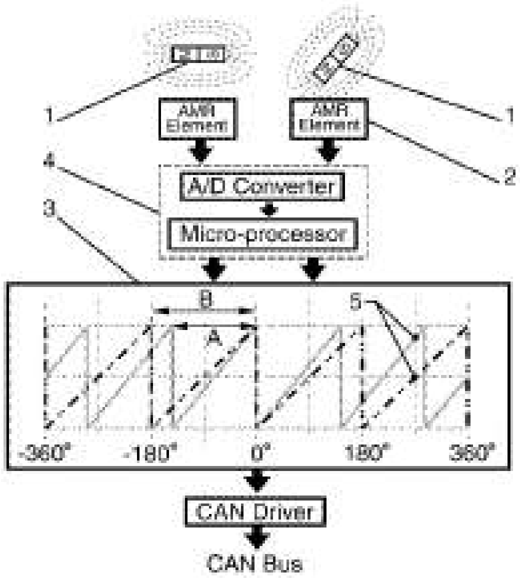


The magnets (1) that project magnetic fields to the AMR ICs are mounted on the primary measuring gear (2) and secondary measuring gear (3).

The secondary gear has two less teeth when compared against the primary measuring gear. This causes the measuring gears to rotate at a different ratio.

Steering Angle Sensor Operation

The angular orientation of the magnetic fields produced by the measuring gear magnets (1) corresponds to the degree of steering wheel angular position.



This magnetic field changes the resistance value of the AMR elements, which enable the AMR ICs (2) to produce a pair of signal outputs (3).

The difference in the rotational ratio between the measuring gears causes the signal output of the second AMR IC (A) to be shorter in range when compared against the signal output of the first AMR IC (B).

The evaluation circuit (4) compares and evaluates this difference, and the rate of change between the output signals of the AMR ICs, at parallel points (5) to calculate that precise steering wheel angular position.

Antilock Brake System Operation

The antilock braking system (ABS) prevents wheel lock-up during hard or emergency braking by modulating the brake fluid pressure applied to the appropriate wheels. The ABS cycles through the following phases when the electronic brake control module (EBCM) detects the beginning of the wheel lock-up:

- Maintaining pressure.
- Reducing pressure.
- Increasing pressure.

Important: The following are conditions that may be experienced when the ABS is active and are considered normal:

- During ABS controlled braking, the braking pressure of the affected wheel is automatically adjusted to prevent wheel lock-up, regardless of pressure applied to the brake pedal.

- A series of rapid pulsations are felt through the brake pedal. These pulsations occur as solenoid valves within the hydraulic modulator changes position to modulate the brake hydraulic pressure.
- A ticking or popping noise in the hydraulic modulator occurs as the hydraulic modulator solenoid valves cycle rapidly to modulate the hydraulic brake pressure.
- Intermittent chirping noises may be heard as the tyres approach slipping on dry pavement.
- Electric motor and pump noise and rapid brake pedal pulsation caused by the operation of the hydraulic modulator pump during the ABS reducing or increasing pressure phase or the EBCM self-test.

ABS Phase - Maintaining Pressure

The EBCM closes the inlet valve and keeps the outlet valve closed in order to isolate the system when wheel slip occurs. This maintains the pressure steady on the brake so that the hydraulic pressure does not increase or decrease.

ABS Phase - Reducing Pressure

The EBCM decreases the pressure to individual wheels during a deceleration when wheel slip occurs. The inlet valve is closed and the outlet valve is opened. The excess fluid is stored in the accumulator until the return pump can return the fluid to the master cylinder.

ABS Phase - Increasing Pressure

The EBCM increases the pressure to individual wheels during a deceleration in order to reduce the speed of the wheel. The inlet valve is opened and the outlet valve is closed. The increased pressure is delivered from the master cylinder.

Electronic Brake-Force Distribution System

The electronic brake-force distribution (EBD) system is part of the ABS software programmed into the electronic brake control module (EBCM). It is designed to replace the rear brake proportioning valve in reducing rear wheel slip during moderate braking.

The EBD system utilises the existing ABS active controls to regulate the vehicle's rear brake fluid pressure. This enables the EBD system to provide dynamic front to rear brake proportioning under various vehicle loads, driving manoeuvres, or road conditions.

In some situations, when the EBD system is activated, a brake pedal height drop of approximately 10 mm will be experienced when the driver varies the brake pedal pressure while performing brake stops. This is caused by the hydraulic modulator performing an adjustment on the rear brake fluid pressure and is considered normal.

EBD System Keep Alive Function

The EBD system plays an important role in vehicle stability during braking. For this reason, the EBD system has a Keep Alive Function integrated in its software. When the EBCM detects a fault in the ABS, depending on the type of fault, certain parts of the system are kept alive. This allows the EBD system to apply some rear wheel brake proportioning even under certain ABS faults.

Traction Control System

The traction control system (TCS) utilises the active braking controls in the ABS and the engine torque reduction function of the engine management system to prevent longitudinal wheel spin during vehicle acceleration.

When drive wheel slip is noted while the brake is not applied, the EBCM will enter traction control mode.

First, the EBCM requests the ECM to reduce the amount of torque to the drive wheels via the requested torque signal circuit. The ECM reduces torque to the drive wheels by retarding spark timing and turning off fuel injectors. The ECM reports the amount torque delivered to the drive wheels via the delivered torque signal circuit.

If the engine torque reduction does not abolish drive wheel slip, the EBCM will actively apply the drive wheel brakes. During traction control braking, hydraulic pressure in each drive wheel circuit is controlled to prevent the drive wheels from slipping. The master cylinder isolation valve closes in order to isolate the master cylinder from the rest of the hydraulic system. The prime valve then opens in order to allow the pump to accumulate brake fluid in order to build hydraulic pressure for braking. The drive wheel inlet and outlet solenoid valves then open and close in order to perform the following functions:

- Pressure increase.
- Pressure hold.
- Pressure decrease.

If at any time during TCS mode the brakes are manually applied, the brake switch sends a signal to the EBCM to exit the TCS brake intervention mode and allow for manual braking.

Electronic Stability Program

The electronic stability program (ESP) is designed to provide optimum vehicle stability and steering control during high speed cornering or when driving on a slippery road surface.

Yaw rate is the rate of rotation about the vehicle's vertical axis. The VSES is activated when the EBCM determines that the desired yaw rate does not match the actual yaw rate as measured by the yaw rate sensor.

The desired yaw rate is calculated from the following parameters:

- The position of the steering wheel.
- The speed of the vehicle.
- The lateral, or sideways acceleration of the vehicle.

The difference between the desired yaw rate and the actual yaw rate is the yaw rate error, which is a measurement of oversteer or understeer. If the yaw rate error becomes too large, the EBCM attempts to correct the vehicle's yaw motion by applying differential braking to the appropriate wheel. The amount of differential braking applied to the left or right front wheel is based on both the yaw rate error and side slip rate error.

The VSES activations generally occur during aggressive driving, in turns or on bumpy roads without much use of the accelerator pedal. When braking during VSES activation, the pedal pulsations feel different than the ABS pedal pulsations. The brake pedal pulsates at a higher frequency during

VSES activation.

The ESP incorporates the following components:

- Steering angle sensor to determine driver steering input, which the EBCM uses to support the calculation of intended vehicle direction.
- Yaw rate sensor to measure vehicle rotation around its vertical axis, which the EBCM uses to support the calculation of actual vehicle behaviour.
- Active braking and engine torque reduction functionality of the TCS to prevent wheel spin.

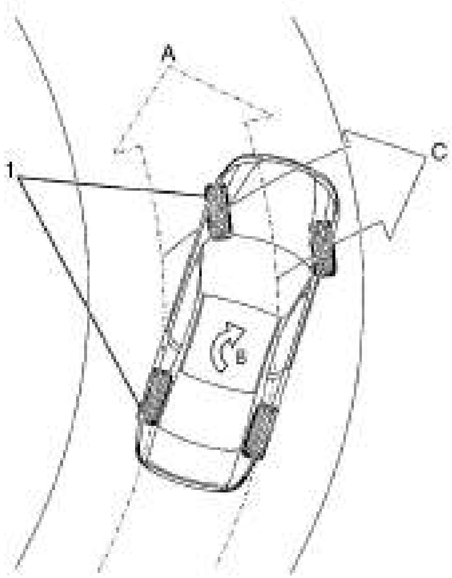
When the ESP detects a lateral wheel slip or when the calculated vehicle direction deviates from the actual vehicle direction, the ESP utilises the engine torque reduction functionality and the active braking controls in the ABS-TCS to stabilise and steer the vehicle to the correct direction.

ESP Engine Torque Reduction

The ESP monitors the wheel speed sensor, yaw-rate sensor and the steering angle sensor to determine lateral wheel slip. When the ESP detects a lateral wheel slip, the ESP initially utilises the torque reduction functionality of the TCS and sends a serial data communication signal to the engine control module (ECM) requesting engine torque reduction. In addition, if the ESP still detects a lateral wheel slip, the ESP applies active brake intervention.

ESP Brake Intervention

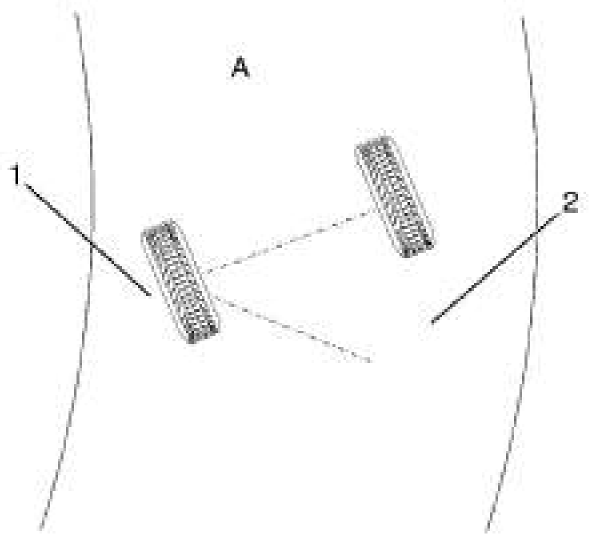
The ESP applies active brake intervention when the EBCM receives the following input signals and determines the vehicle is beginning to understeer.



- The steering angle sensor sends a signal to the EBCM the driver intends to steer in direction (A).
- The yaw rate sensor detects the vehicle begins to spin (B) with the front of the vehicle

beginning to slide in direction (C).

The ESP uses the existing active braking control in the ABS-TCS to apply a calculated braking force to one or both inner wheels (1) of the vehicle to stabilise and steer the vehicle to the intended direction.



Important: Applying brake-force to the inner wheel (1) slows down the inner side of the vehicle, which induces the vehicle to rotate on its vertical axis (A).

The EBCM monitors and compares signals from the yaw-rate sensor, steering angle sensor and each wheel speed sensor to determine wheel slip. If the EBCM detects the beginning of a vehicle understeer condition, the EBCM sends the following signal to the hydraulic modulator to:

- Close the front and rear isolating valves.
- Open the front and rear prime valves.
- Close the front right and rear right inlet valves.
- Operate the hydraulic modulator pump.

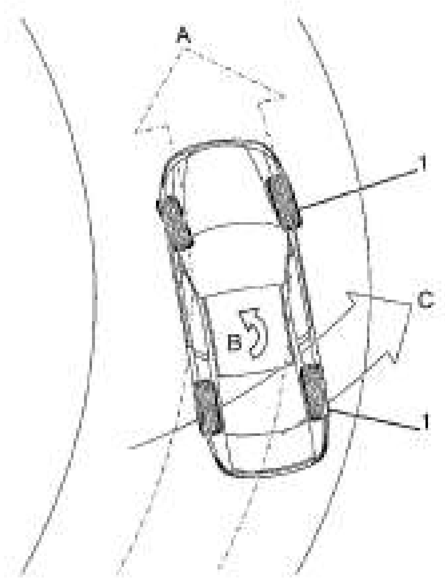
This results in the following actions:

- The rear isolation valve is closed to isolate the rear brake fluid circuits from the master cylinder and prevent the brake fluid returning to the brake master cylinder when the hydraulic pump builds-up the brake fluid pressure.
- The front right and rear right inlet valves are closed to isolate the right wheel hydraulic circuits, allowing the hydraulic modulator to supply brake fluid pressure only to the left wheels.
- The rear priming valve is open to allow fluid to be drawn from the master cylinder into the hydraulic pump.

- The hydraulic pump applies appropriate brake fluid pressure to the left brake callipers to steer the vehicle to the intended direction.
- The hydraulic modulator modulates the front left and rear left inlet valves and outlet valves to assist in obtaining maximum road surface traction in the same manner as in the TCS Mode.

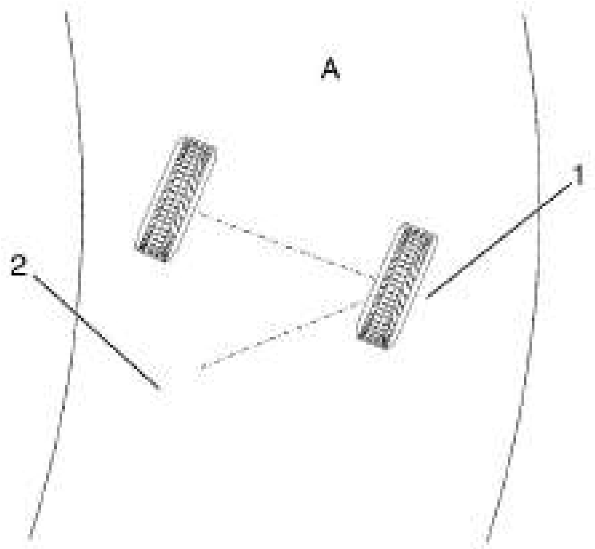
Important: If at any time during the ESP Mode the brakes are manually applied, the brake switch sends a signal to the EBCM to exit the ESP Brake Intervention Mode and allow normal braking.

The ESP applies active brake intervention when the EBCM receives the following input signals and determines the vehicle is beginning to oversteer.



- The steering angle sensor sends a signal to the EBCM the driver intends to steer in direction (A).
- The yaw-rate sensor detects the vehicle begins to spin (B) with the rear of the vehicle beginning to slide in direction (C).

The ESP uses the existing active braking control in the ABS-TCS to apply a calculated braking force to one or both outer wheels (1) of the vehicle to stabilise and steer the vehicle to the intended direction.



Applying brake-force to the outer wheel (1) slows down the outer side of the vehicle, which induces the inner wheel to rotate on its vertical axis (A).

The EBCM monitors and compares signals from the yaw-rate sensor, steering angle sensor and each wheel speed sensor to determine wheel slip. If the EBCM detects the beginning of a vehicle oversteer condition, the EBCM sends the following signal to the hydraulic modulator to:

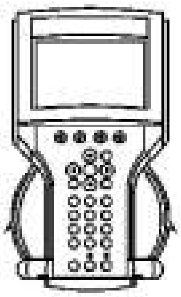
- Close the front and rear isolating valves.
- Open the front and rear prime valves.
- Close the front right and rear right inlet valves.
- Operate the hydraulic modulator pump.

This results in the following actions:

- The rear isolation valve is closed to isolate the rear brake fluid circuits from the master cylinder and prevent the brake fluid returning to the brake master cylinder when the hydraulic pump builds-up the brake fluid pressure.
- The front left and rear left inlet valves are closed to isolate the right wheel hydraulic circuits, allowing the hydraulic modulator to supply brake fluid pressure only to the left wheels.
- The rear priming valves are open to allow fluid to be drawn from the master cylinder to the hydraulic pump.
- The hydraulic pump applies appropriate brake fluid pressure to the left brake callipers to stern the vehicle to the intended direction.
- The hydraulic modulator modulates the front right and rear right inlet valves and outlet valves to assist in obtaining maximum road surface traction in the same manner as in the TCS Mode.

Important: If at any time during the ESP Mode the brakes are manually applied, the brake switch sends a signal to the EBCM to exit the ESP Brake Intervention Mode and allow normal braking.

Special Tools

Illustration	Tool Number / Description
	700086I Scan Tool Used for diagnosis of vehicle electrical system.

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Brake Caliper Bleeder Valve to Brake Caliper, Dry Torque (All except CSV HSV VXR8)	12 N·m	106 lb in
Brake Caliper Bleeder Valve to Brake Caliper, Dry Torque (CSV HSV VXR8)	17 N·m	13 lb ft
Brake Hose to Caliper Banjo Bolt, Dry Torque (All except CSV HSV VXR8)	35 N·m	26 lb ft
Brake Hose to Caliper Banjo Bolt, Dry Torque (CSV HSV VXR8)	33 N·m	24 lb ft
Disc Brake Backing Plate to Knuckle Bolt (Rear, Lower)	130 N·m	96 lb ft
Disc Brake Backing Plate to Knuckle Bolt (Rear, Upper)	60 N·m	44 lb ft
Front Brake Caliper Anchor Plate to Knuckle Retaining Bolt (All except CSV HSV VXR8)		
• First Pass	60 N·m	44 lb ft
• Second Pass	+ 120 degrees	
Front Brake Caliper Anchor Plate to Knuckle Retaining Bolt (CSV HSV VXR8)	130 N·m	96 lb ft
Front Brake Caliper Pin Retaining Bolt	42 N·m	31 lb ft
Front Brake Disc Splash Shield to Steering Knuckle Retaining Bolt	9 N·m	80 lb in
Rear Brake Caliper Pin Retaining Bolt	42 N·m	31 lb ft
Rear Brake Caliper to Knuckle Retaining Bolt	110 N·m	81 lb ft
Steering Knuckle to Strut Assembly Retaining Bolt & Nut		
• First Pass	60 N·m	44 lb ft
• Second Pass	100 N·m	74 lb ft
• Third Pass	+ 90 degrees	

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Brakes | Disc Brakes | Specifications | **Document ID: 1994172**

Disc Brake Component Specifications (LWB SWB)

Application	Specification	
	Metric	**English**
Front Brake Rotors		
Rotor Diameter	298 mm/321 mm	11.7 in/12.6 in
Rotor Discard Thickness	28 mm	1.1 in
Rotor Maximum Allowable Assembled Lateral Runout	0.050 mm	0.002 in
Rotor Maximum Allowable Scoring	1.5 mm	0.060 in
Rotor Maximum Allowable Thickness Variation	0.02 mm	0.001 in
Rotor Minimum Thickness after Refinishing	28.75 mm	1.13 in
Rotor Thickness New	30 mm	1.18 in
Rear Brake Rotors		
Rotor Diameter	302 mm/324 mm	11.90 in/12.75 in
Rotor Discard Thickness	20 mm	0.80 in
Rotor Maximum Allowable Assembled Lateral Runout	0.05 mm	0.002 in
Rotor Maximum Allowable Scoring	1.5 mm	0.060 in
Rotor Maximum Allowable Thickness Variation	0.02 mm	0.001 in
Rotor Minimum Thickness after Refinishing	20.75 mm	0.82 in
Rotor Thickness New	22 mm	0.87 in

Diagnostic Starting Point - Disc Brakes

Begin the disc brake system diagnosis with Diagnostic Starting Point - Hydraulic Brakes in Hydraulic Brakes. The use of the Diagnostic Starting Point will lead to the identification of the correct procedure for diagnosing the system and where the procedure is located.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Brakes | Disc Brakes | Diagnostic Information and Procedures | **Document ID: 1977641**

Brake Caliper Inspection (LWB SWB)

Caution: Refer to Brake Dust Caution in the Preface section.

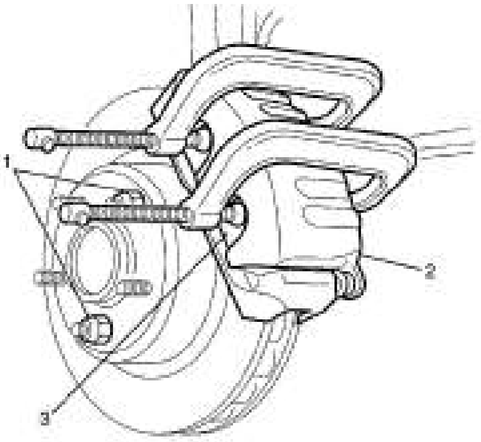
Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

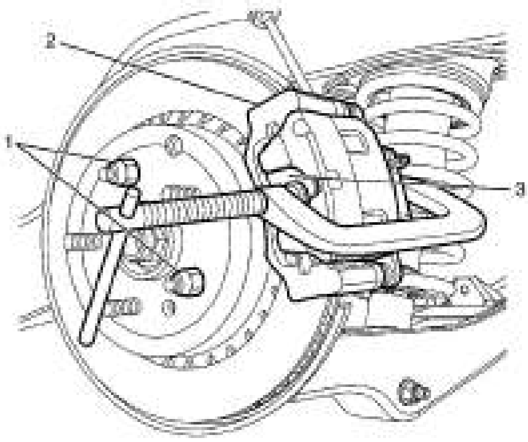
1. Inspect the fluid level in the master cylinder reservoir.
    - If the brake fluid level is midway between the maximum--fill level and the minimum allowable level, no brake fluid needs to be removed from the master cylinder reservoir before proceeding.

      Important: DO NOT completely empty the master cylinder reservoir or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

      Important: DO NOT re use the removed fluid.

    - If the brake fluid level is higher than midway between the maximum--fill level and the minimum allowable level, syphon the brake fluid to the midway point using a hand vacuum pump before proceeding.
2. Remove wheels. Refer to Tire and Wheel Removal and Installation in Tires and Wheels.





3. Install 2 wheel nuts (1) in reverse to opposite wheel studs to retain the brake disc to the hub.

   Important: Position the ends of the G-clamps against the rear of the brake caliper (2) and against the outboard brake pad (3).

4. Install large G-clamps over the body of the brake caliper (3).

   Important: The movement of a brake caliper piston into a brake caliper bore should be smooth and even. If a brake caliper piston is frozen or difficult to bottom out, the brake caliper requires overhaul or replacement.

5. Inspect for smooth and complete travel of the brake caliper piston/s, into the brake caliper bore/s:

   Tighten the G-clamp/s until the brake caliper piston/s bottom out in the brake caliper bore/s.

6. Remove the G-clamp/s from the brake caliper (2).
7. Grasp the brake caliper (2) and try to move the brake caliper (2) up or down.

   The brake caliper (2) should not have too much freeplay.

8. Grasp the brake caliper (2) and try to move the brake caliper in and out.

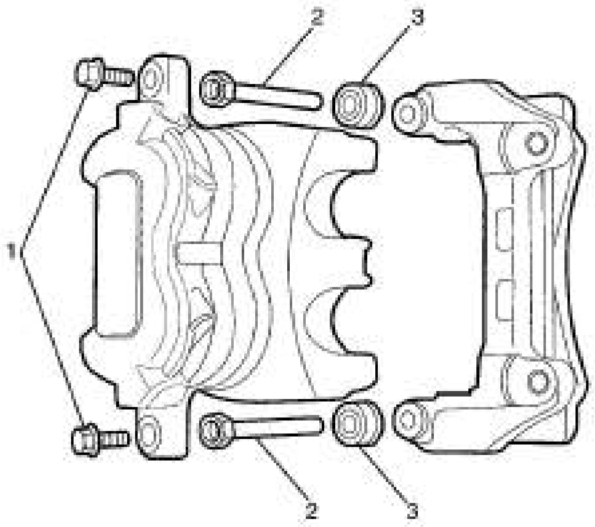
   The brake caliper (2) should slide smoothly with minimal force.

   Important: DO NOT disconnect the hydraulic brake flexible hose from the brake caliper.

9. Remove the brake caliper. Refer to Front Brake Rotor Replacement or Rear Brake Rotor Replacement in Disc Brakes.

   Notice: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

10. Inspect the brake caliper to knuckle retaining bolts for the following:
    - Bent or damaged brake caliper to knuckle retaining bolts.
    - Binding.
    - Corrosion.
    - Seizing in the knuckle.
11. If any of the conditions listed are found, replace the brake caliper to knuckle retaining bolts.

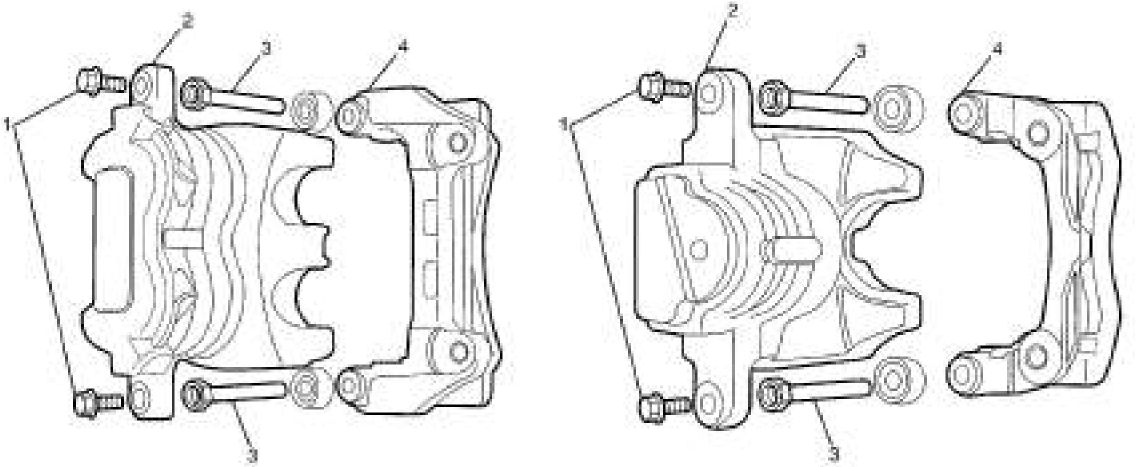


12. Remove the brake caliper lower guide pin retaining bolts (1).
13. Inspect the brake caliper slide pins (2) gently pull the brake caliper slide pins (2) outward

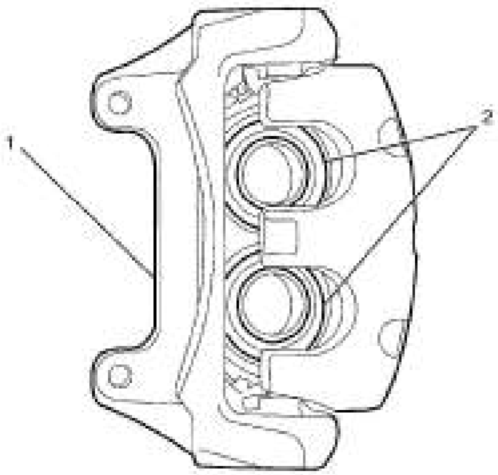
without disengaging the slides from the boot), then push inward, and inspect for the following:

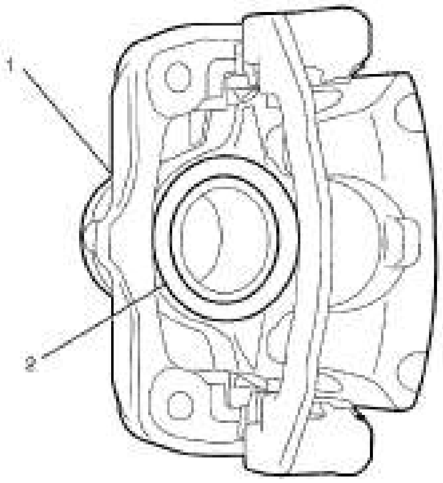
- Bent or damaged brake caliper guide pin retaining bolts (1).
- Bent or damaged brake caliper guide pins (2).
- Binding.
- Corrosion.
- Seizing.

14. If any of the conditions listed are found, replace the brake caliper guide pins (2).
15. Inspect the brake caliper boots (3) for the following:
    - Missing brake caliper boots (3).
    - Cracked or torn brake caliper boots (3).
16. If any of the conditions listed are found, replace the brake caliper boots (3).



17. Inspect the brake caliper (2) and brake caliper anchor plate (4) for the following:
    - Bent or damaged brake caliper anchor plate (4).
    - Too much brake caliper guide pin (3) play in the brake caliper anchor plate (4).
    - Too much brake caliper guide bolt (1) play in the brake caliper (2).
    - Corrosion.
    - Cracks.
    - Damage.
    - Too much Wear.
18. If any of the conditions listed are found, replace the brake caliper (2).





19. Inspect the brake caliper piston dust boot seals (2) for cracks, tears, cuts, deterioration and/or incorrect seating in the brake caliper (1). If any of these conditions are present, the brake caliper requires overhaul or replacement.
20. Inspect for brake fluid leakage around the brake caliper piston dust boot seals (2) and on the brake pads. If there is any evidence of brake fluid leakage, overhaul or replace the brake caliper (1).

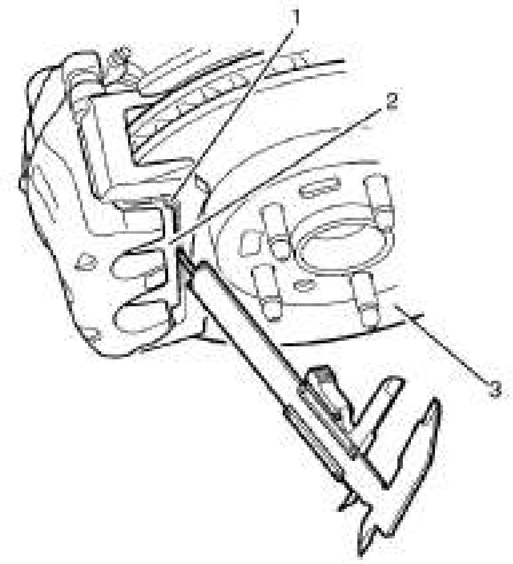
Brake Pad Inspection (LWB SWB)

Caution: Refer to Safety Glasses Caution in the Preface section.

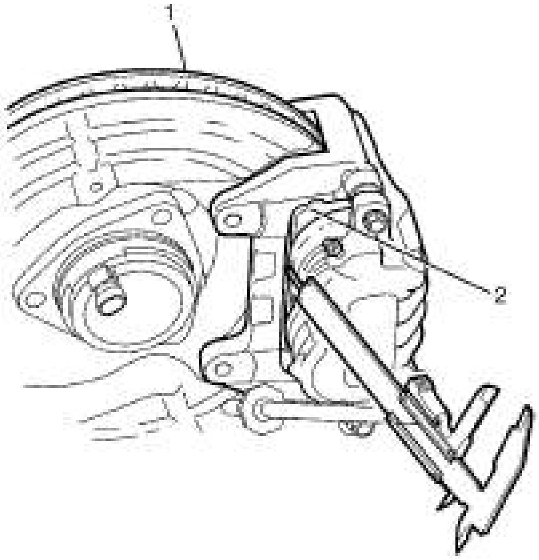
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the front wheels. Refer to Tire and Wheel Removal and Installation .
3. Carry out a visual inspection of the front brake assemblies.
4. With the aid of an assistant or a brake pedal holding bar, apply and hold the foot brake.



5. Using a vernier caliper gauge, on the outer brake pad backing plate (2), take note of the measurement from the brake pad backing plate (2) to the brake disc (1), as shown in the diagram.



6. Using a vernier caliper gauge, on the inner brake pad (2), take note of the measurement from the brake pad backing plate (2) to the brake disc (1), as shown in the diagram
7. Replace the pads if .
   - Either reading is 10 mm or less (this equates to 3 mm lining material remaining on the brake pad).
   - If there is more than 2 mm variation between the inner and outer brake pad reading, this may indicate that the caliper is partially sticking.

Brake Rotor Assembled Lateral Runout Measurement

Tools Required

- J 26900-12 Dial Indicator
- J 26900-13 Magnetic Indicator Base
- J 23738-A Hand Vacuum Pump

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

Important:

- Brake disc assembled lateral runout (LRO) exceeding the maximum allowable specification can cause thickness variation to develop in the brake disc over time, usually between 10,000 [dash] 20,000 km (6,200 [dash] 12,400 mi).
- Brake disc thickness variation MUST be inspected BEFORE inspecting for assembled LRO. Thickness variation exceeding the maximum acceptable level can cause brake pulsation. Refer to Brake Rotor Thickness Variation Measurement .

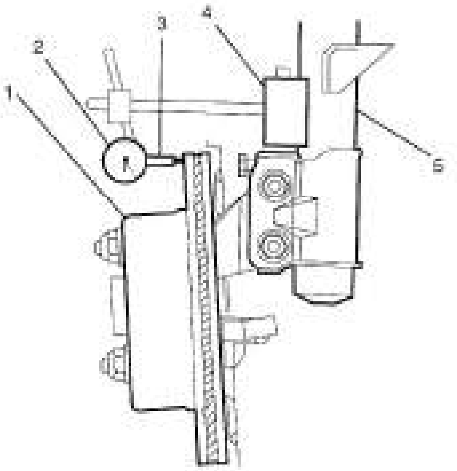
1. Matchmark the position of the brake disc to the wheel studs.

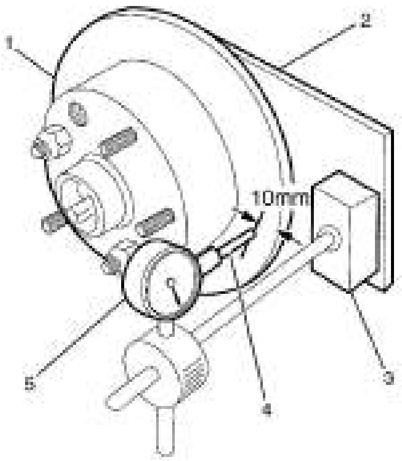
   Important: Whenever the brake disc has been separated from the hub/axle flange, any rust or contaminants should be cleaned from the hub/axle flange and the brake disc mating surfaces. Failure to do this may result in too much assembled LRO of the brake disc, which may lead to brake pulsation.

2. Inspect the mating surface of the hub/axle flange and the brake disc to make sure that there is no corrosion, foreign particles, rust, or debris. If the wheel hub/axle flange and/or brake disc mating surfaces exhibit these conditions, perform the following steps:
   - 2.1. Remove the brake disc from the vehicle. Refer to Front Brake Rotor Replacement or Rear Brake Rotor Replacement .
   - 2.2. Clean any rust or corrosion from the mating surface of the hub/axle flange.
   - 2.3. Clean any rust or corrosion from the mating surface of the brake disc.
   - 2.4. Clean the friction surfaces of the brake disc with denatured alcohol, or an equivalent approved brake cleaner.
3. Install the disc to the hub/axle flange using the matchmark made prior to removal.

   Important: Install the wheel nuts in reverse avoid damage to the tapers.

4. Install 2 wheel nuts in reverse to opposite wheel studs to retain the brake disc to the hub.
5. Mount a dial indicator and position the indicator button so it contacts the brake disc friction surface at a 90 degree angle, approximately 10 mm (3/8 in) from the outer edge of the brake disc.





Important: The dial indicator's magnetic mounting base (4) must be securely mounted to the front strut unit (5).

- To measure the front brake disc assembled LRO (View A), set up a dial indicator (2) on a magnetic mounting base (4) and attach to the front strut unit (5) above the brake disc (1).

Important: The dial indicator's magnetic mounting base (3) must be securely mounted to the dial indicator plate (2).

- To measure the rear brake disc assembled LRO (View B), bolt the dial indicator plate (2) to the brake caliper attaching points on the rear knuckle. Set up a dial indicator (4) on a magnetic mounting base (3) and attach to the dial indicator plate (2). Refer to Dial Indicator Plate in Special Tools for dial indicator plate details.

6. Measure and record the assembled LRO of the brake disc:
   - 6.1. Rotate the brake disc until the lowest reading is displayed on the indicator dial, then set the dial to zero.
   - 6.2. Rotate the brake disc until the highest reading is displayed on the dial.
   - 6.3. Mark the location of the high spot relative to the nearest wheel stud, or studs.
   - 6.4. Measure and record the amount of assembled LRO.
7. Compare the brake disc assembled LRO to the following specification:

   Specification

   - Front brake disc maximum allowable assembled lateral runout: 0.05 mm (0.002 in).
   - Rear brake disc maximum allowable assembled lateral runout: 0.05 mm (0.002 in).
8. If the brake disc assembled LRO measurement exceeds the specification, refer to Brake Rotor Assembled Lateral Runout Correction .
9. If the brake disc assembled LRO measurement is within specification, install the brake caliper and depress the brake pedal several times to secure the brake disc in place before removing the wheel nuts.

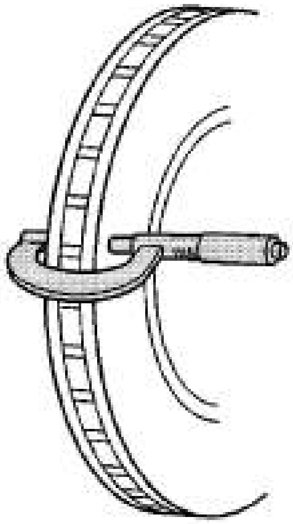
Brake Rotor Surface and Wear Inspection

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle in General Information.
2. Remove the wheels. Refer to Tire and Wheel Removal and Installation in Tires and Wheels.
3. Clean the friction surfaces of the brake disc with denatured alcohol, or an equivalent approved brake cleaner.
4. Inspect the friction surfaces of the brake disc for the following Braking Surface Conditions:
    - Heavy rust and/or pitting
    - Light surface rust can be removed with an abrasive disc. Heavy surface rust and/or pitting must be removed by refinishing the brake disc.
    - Cracks and/or heat spots
    - Too much blueing, discoloration
5. If the friction surfaces of the brake disc exhibit one or more of the Braking Surface Conditions, the brake disc requires refinishing or replacement.



6. Using a micrometer calibrated in thousandths-of-a-millimeter, or ten-thousandths-of-an-inch, measure and record the scoring depth of any grooves present on the brake disc friction surfaces.
7. Compare the groove scoring depth recorded to the following specification:

Specification
Brake disc maximum allowable scoring: 1.50 mm (0.060 in).

8. If the brake disc scoring depth exceeds the specification, or if too much scoring is present,

the brake disc requires refinishing or replacement.

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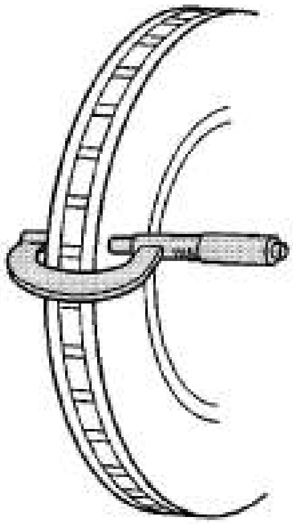
Brake Rotor Thickness Measurement

Caution: Refer to Brake Dust Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle in General Information.
2. Remove the wheels. Refer to Tire and Wheel Removal and Installation in Tires and Wheels.
3. Clean the friction surfaces of the brake disc with denatured alcohol, or an equivalent approved brake cleaner.



4. Using a micrometer calibrated in thousandths-of-a-millimeter, or ten-thousandths-of-an-inch, measure and record the thickness of the brake disc at 4 points, evenly spaced around the brake disc.
5. Make sure that the measurements are only taken within the friction surfaces and that the micrometer is positioned the same distance from the outer edge of the brake disc, about 13 mm (½ in), for each measurement.
6. Compare the lowest thickness measurement recorded to the following specification:

Specification - Front

- Brake disc minimum allowable thickness after refinishing: 28.75 mm (1.13 in).
- Brake disc discard thickness: 28 mm (1.1 in)

Specification - Rear

- Brake disc minimum allowable thickness after refinishing: 20.75 mm (0.82 in)
- Brake disc discard thickness: 20 mm (0.80 in)

7. If the lowest thickness measurement of the brake disc is above the minimum allowable thickness after refinishing specification, the brake disc may be able to be refinished, depending upon surface and wear conditions which may be present.
8. If the lowest thickness measurement of the brake disc is at or below the minimum allowable

thickness after refinishing specification, the brake disc may not be refinished.

9. If the lowest thickness measurement of the brake disc is at or below the discard thickness specification, the brake disc requires replacement.

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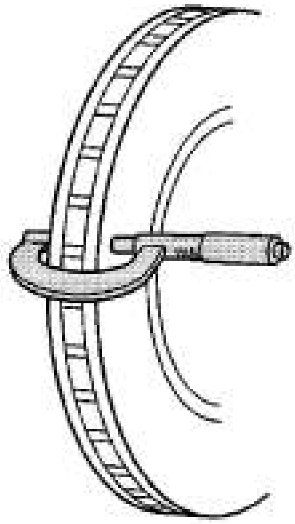
Brake Rotor Thickness Variation Measurement

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle in General Information.
2. Remove the wheels assembly. Refer to Tire and Wheel Removal and Installation in Tires and Wheels.
3. Clean the friction surfaces of the brake disc with denatured alcohol, or an equivalent approved brake cleaner.



4. Using a micrometer calibrated in thousandths-of-a-millimeter, or ten-thousandths-of-an-inch, measure and record the thickness of the brake disc at 4 points, evenly spaced around the brake disc.
5. Make sure that the measurements are only taken within the friction surfaces and that the micrometer is positioned the same distance from the outer edge of the brake disc, about 13 mm (½ in), for each measurement.
6. Calculate the difference between the highest and lowest thickness measurements recorded to obtain the amount of thickness variation.
7. Compare the thickness variation measurement to the following specification:

Specification
Brake disc maximum allowable thickness variation: 0.02 mm (0.001 in).

Important: Whenever a brake disc is refinished or replaced, the assembled lateral runout (LRO) of the brake disc must be measured to make sure optimum performance of the disc brakes.

8. If the brake disc thickness variation measurement exceeds the specification, the brake disc

requires refinishing or replacement.

Brake Pad and Rotor Burnishing

Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.

Important: Burnishing the brake pads and brake discs is necessary whenever the brake discs have been refinished or replaced, and/or whenever the brake pads have been replaced to make sure that the braking surfaces are correctly prepared.

1. Select a smooth road with little or no traffic.
2. Accelerate the vehicle to 70 km/h (43 mph).

Important: Use care to avoid overheating the brakes while performing this step as it may adversely affect the heating characteristics of the NEW brake pad material.

Important: DO NOT allow the brakes to lock.

3. Using moderate pressure, apply the brakes to bring the vehicle to a stop.
4. Repeat steps 2 and 3 until approximately 20 stops have been completed. Allow sufficient cooling periods of no less than 500 metres between stops in order to correctly burnish the brake pads and brake discs.

Brake Rotor Assembled Lateral Runout Correction - Indexing

Important: Brake disc thickness variation MUST be inspected BEFORE inspecting for assembled lateral runout (LRO). Thickness variation exceeding the maximum acceptable level can cause brake pulsation. Refer to Brake Rotor Thickness Variation Measurement.

Important: Brake disc and hub indexing is required so the minimum installed brake disc runout is achieved. Brake disc and hub indexing involves aligning the point of maximum runout on the hub with the point of least runout on the brake disc.

Important: The procedure is to be used when installing NEW brake discs or brake discs that have been removed for any reason and where the brake disc to hub matching is not evident.

The procedure consists of three parts:

- Clean Mating Surfaces.
- Indexing Brake Disc to Hub. If these measurements are not within specification, go to Hub Runout Inspection.
- Hub Runout Inspection.

Clean Mating Surfaces

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

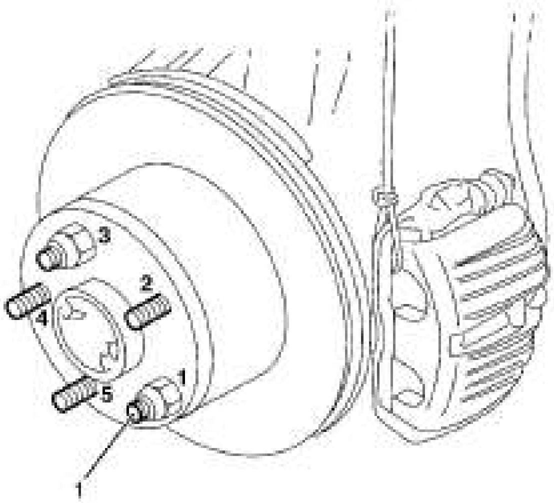
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove wheels. Refer to Tire and Wheel Removal and Installation.
3. Remove the brake caliper. Refer to Front Brake Rotor Replacement or Rear Brake Rotor Replacement.
4. Make sure that brake disc and hub mating surfaces are free from dirt, corrosion, etc. If required, use fine emery paper to clean surfaces.

Indexing Brake Disc to Hub - Front

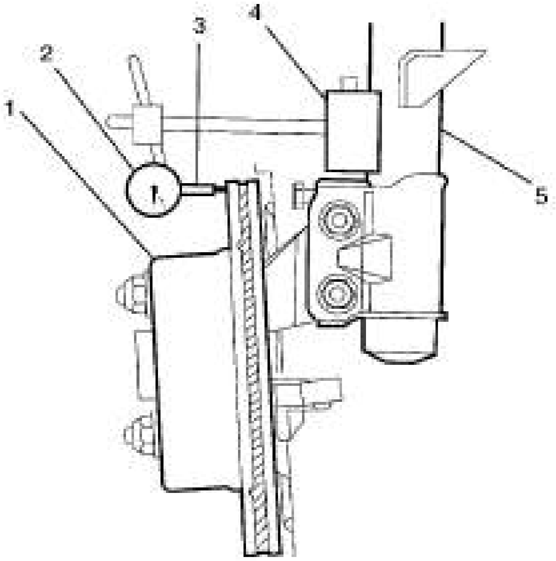
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.



1. Install 2 wheel nuts in reverse to opposite wheel studs to retain the brake disc to the hub.
2. Number each of the wheel stud holes on the front surface of the brake disc from 1 to 5.
3. Place a chalk mark on the end of the wheel stud adjacent to the number "1" hole (1).



4. Set up a dial indicator (2) on a magnetic base (4) and attach to the front strut unit (5) above the brake disc (1).
5. Position the pointer (3) about 10 mm (3/8 in), from the outer edge of the disc.

Important: The number of divisions between the points of minimum and maximum runout on the dial indicator is the total indicated runout.

6. Rotate the brake disc (1) and note the points of minimum and maximum runout on the dial indicator (2).

Important: If the lowest assembled disc runout achieved is more than 0.05 mm (50 micron), then the hub runout should be inspected as detailed in the Hub Runout procedure.

7. Record the figure together with the number on the brake disc aligned with the chalk-marked stud.
8. Remove and reinstall the brake disc with hole number '2' over the marked stud. Repeat Steps 4 to 7. This procedure is to be repeated for all 5 hole positions.

Specification
The maximum assembled brake disc and hub runout at brake disc outer diameter equals 0.05 mm.

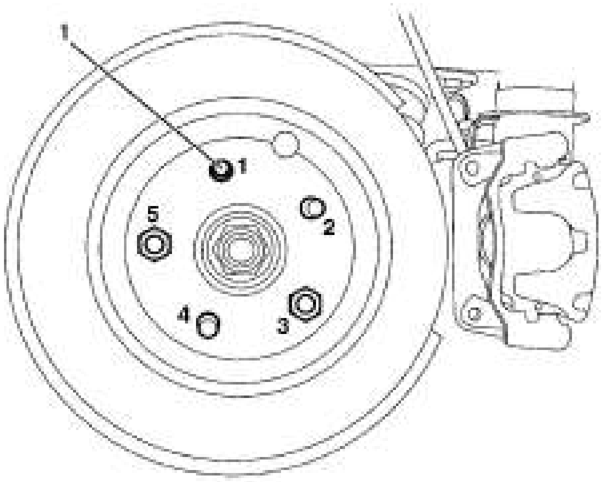
9. Mount the brake disc to the hub in the stud position which recorded the least amount of runout.

Index Brake Disc to Hub - Rear

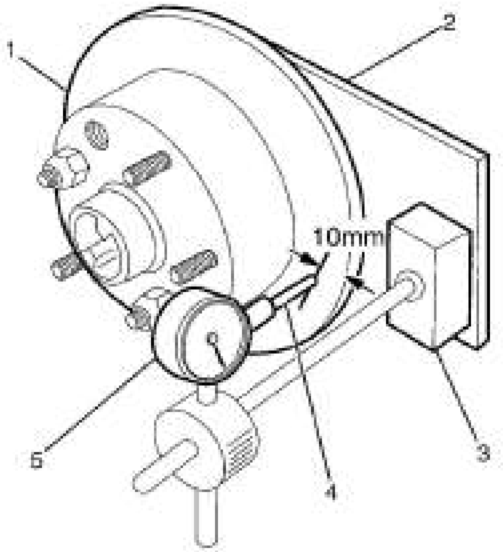
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.



1. Install 2 wheel nuts in reverse to opposite wheel studs to retain the brake disc to the hub.
2. Number each of the wheel stud holes on the front surface of the brake disc from 1 to 5.
3. Place a chalk mark on the end of the wheel stud adjacent to the number "1" hole (1).
4. Bolt the dial indicator plate (3) to the brake caliper attaching points on the rear knuckle. Refer to Dial Indicator Plate in Special Tools for dial indicator plate details.



5. Set up a dial indicator (1) on a magnetic mounting base (2) and attach to the dial indicator plate (3).
6. Position the pointer (4) about 10 mm (3/8 in), from the outer edge of the brake disc (5).

   Important: The number of divisions between the points of minimum and maximum runout on the dial indicator is the total indicated runout.

7. Carefully rotate the brake disc and note the points of minimum and maximum runout on the dial indicator.

   Important: If the lowest assembled brake disc runout achieved is more than 0.05 mm (50 micron), then the trunnion hub runout should be inspected as detailed in the Hub Runout procedure.

8. Record this figure together with the number on the brake disc aligned with the chalk-marked stud.
9. Remove and reinstall brake disc with hole number 2 over the marked stud and repeat Step 4. This procedure is to be repeated for all 5 hole positions.

   Specification
   Maximum assembled brake disc and hub runout at brake disc outer diameter [dash] rear brake disc: 0.05 mm

   Mount the brake disc to the hub in the stud position which recorded the least amount of runout.

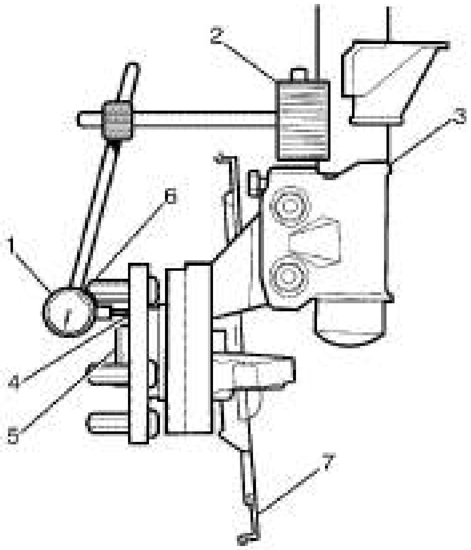
Hub Runout Inspection - Front

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

1. Clean the front hub face with fine emery paper.



2. Locate the dial indicator magnetic base (2) on the front strut unit (3) and position the pointer (4) on the hub face midway between the spigot (5) and the studs (6).

   Important: For this inspection to be performed with 100 percent accuracy, a flat parallel surface plate attached to the hub should be used. However, measuring runout between spigot (5) and the studs (6) should yield adequate results.

   Important: The number of divisions between the points of minimum and maximum runout on the dial indicator (1) is the total indicated runout.

3. Rotate the hub by the hub spigot (5) (to avoid loading the bearing) and note the points of minimum and maximum runout on the dial indicator (1).

   Important: The maximum runout at hub face-front hub is 0.025 mm.

4. If the runout measured in Step 3 exceeds 0.025 mm (25 micron), replace the hub unit. Refer to Front Wheel Bearing and Hub Replacement.

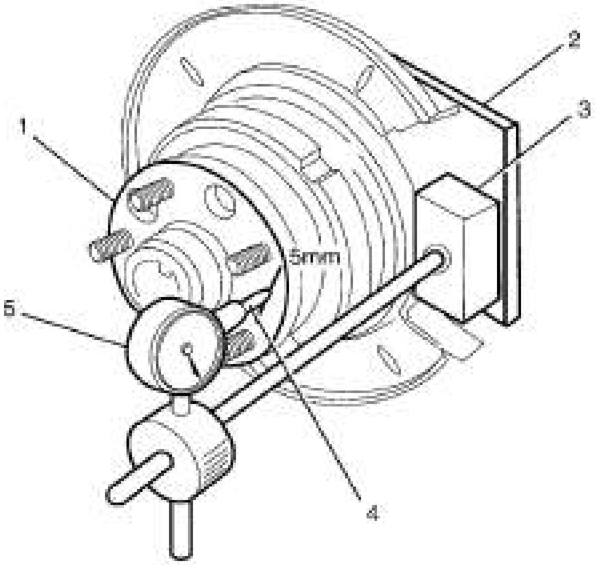
Hub Runout Inspection - Rear

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

1. Clean the hub face by rubbing lightly with fine emery paper.



2. Set up a dial indicator (5) on a magnetic base (3) and attach to the pre-fabricated mounting plate (2).
3. Position the pointer (4) on the hub face 5 mm (0.2 in) from the edge of the hub (1).

Important: For this inspection to be performed with 100 percent accuracy, a flat parallel surface plate attached to the hub should be used. However, measuring runout on the hub face 5 mm (0.2 in) from the edge of the hub (1) should yield adequate results.

Important: The number of divisions between the points of minimum and maximum runout on the dial indicator (5) is the total indicated runout.

4. Rotate the hub by the wheel studs and note the points of minimum and maximum runout on the dial indicator (5).
5. If the runout measured in Step 3 exceeds 0.025 mm (25 micron), replace the hub assembly.

Specification
Maximum hub total indicated runout (TIR): 0.25 mm

Brake Rotor Assembled Lateral Runout Correction

Important:

- Brake disc thickness variation MUST be inspected BEFORE inspecting for assembled lateral runout (LRO). Thickness variation exceeding the maximum acceptable level can cause brake pulsation. Refer to Brake Rotor Thickness Variation Measurement .
- Brake disc assembled lateral runout (LRO) exceeding the maximum allowable specification can cause thickness variation to develop in the brake disc over time, usually between 4 800-11 300 km (3,000-7,000 mi). Refer to Part 2 in Brake Rotor Assembled Lateral Runout Correction - Indexing .

Review the following acceptable methods for bringing the brake disc assembled LRO to within specifications. Determine which method to use for the vehicle being repaired.

- The indexing method of correcting assembled LRO is most effective when the LRO specification is only exceeded by a relatively small amount: 0.025-0.127 mm (0.001-0.005 in). Indexing is used to achieve the best possible match of high spots to low spots between related components. Refer to Brake Rotor Assembled Lateral Runout Correction - Indexing .
- The on-vehicle brake lathe method is used to bring the LRO to within specifications through compensating for LRO while refinishing the brake disc. Refer to Brake Rotor Assembled Lateral Runout Correction - On Vehicle Lathe .

If the assembled LRO cannot be corrected using these methods, then other components must be suspected as causing and/or contributing to the LRO concern.

Brake Rotor Assembled Lateral Runout Correction - On Vehicle Lathe

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

Important:

- Brake disc thickness variation must be inspected before inspecting for assembled lateral runout (LRO). Thickness variation exceeding the maximum acceptable level can cause brake pulsation. Refer to Brake Rotor Thickness Variation Measurement.
- Brake disc assembled LRO exceeding the maximum allowable specification can cause thickness variation to develop in the brake disc over time, usually between 10 000-20 000 km (6,213-12,427 mi). Refer to Brake Rotor Assembled Lateral Runout Measurement.
- Before refinishing a brake disc, the brake disc must first be inspected for adequate thickness to allow the brake disc to be refinished and remain above the minimum allowable thickness after refinish specification. Refer to Brake Rotor Thickness Measurement.

1. Make sure that the brake caliper and brake caliper anchor plate that are already being supported, are clear from contacting any rotating components, such as the brake disc.
2. Remove the dial indicator and the wheel nuts that were installed during the assembled LRO measurement procedure and/or the indexing correction procedure.
3. Inspect the mounting surface of the hub/axle flange and the brake disc to make sure that there are no foreign particles or debris remaining.
4. Set up the lathe, following the manufacturer's instructions.
5. Refinish the brake disc, following the brake lathe manufacturer's instructions.
6. After each successive cut, inspect the brake disc thickness. Refer to Brake Rotor Thickness Measurement.
7. If at any time the brake disc exceeds the minimum allowable thickness after refinish specification, the brake disc must be replaced. After replacing the brake disc, proceed to step 10.
8. After refinishing the brake disc, use the following procedure in order to obtain the desired non-directional finish:
    8.1. Follow the brake lathe manufacturer's recommended speed setting for applying a non-directional finish.

    8.2. Using moderate pressure, apply the non-directional finish:

    - If the lathe is equipped with a non-directional finishing tool, apply the finish with 120 grit aluminum oxide sandpaper.
    - If the lathe is not equipped with a non-directional finishing tool, apply the finish with a sanding block and 150 grit aluminum oxide sandpaper.

    8.3. After applying a non-directional finish, clean each friction surface of the brake disc with denatured alcohol, or an equivalent approved brake cleaner.
9. Remove the lathe from the vehicle.
10. Measure the assembled LRO of the brake disc. Refer to Brake Rotor Assembled Lateral Runout Measurement.
11. If the brake disc assembled LRO measurement still exceeds the maximum allowable

specification, refer to Brake Rotor Assembled Lateral Runout Correction.

12. If the brake disc assembled LRO is within specification, install the brake caliper and depress the brake pedal several times to secure the brake disc in place before removing the dial indicator and the wheel nuts.

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Brake Rotor Refinishing

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

Important:

- The brake discs do not require refinishing as part of routine brake system service. NEW brake discs do not require refinishing.
- DO NOT refinish brake discs in an attempt to correct the following conditions:
  - Brake system noise - squeal, growl, groan
  - Uneven and/or premature brake pad wear
  - Superficial or cosmetic corrosion/rust of the brake disc friction surface
  - Scoring of the brake disc friction surface less than the maximum allowable specification
- Before refinishing a brake disc, the brake disc must first be inspected for adequate thickness to allow the brake disc to be refinished and remain above the minimum allowable thickness after refinish specification. Refer to Brake Rotor Thickness Measurement.
- Brake discs should only be refinished if they have adequate thickness to be refinished and if one or more of the following conditions exist:
  - Thickness variation in excess of the maximum allowable specification.
  - Too much corrosion/rust and/or pitting.
  - Cracks and/or heat spots.
  - Too much blueing, discoloration.
  - Scoring of the brake disc surface in excess of the maximum allowable specification.
- Brake discs may need to be refinished as part of the process for correcting brake disc assembled lateral runout (LRO) that exceeds the maximum allowable specification.

Important: Whenever the brake disc has been separated from the hub/axle flange, clean any rust or contaminants from the hub/axle flange and the brake disc mating surfaces. Failure to do this may result in increased assembled LRO of the brake disc, which may lead to brake pulsation.

1. Clean any rust or corrosion from the mating surface of the hub/axle flange.
2. Clean any rust or corrosion from the mating surface and mounting surface of the brake disc.
3. Inspect the mating surfaces of the hub/axle flange and the brake disc to make sure that there are no foreign particles or debris remaining.
4. Mount the brake disc to the brake lathe according to the lathe manufacturer's instructions, ensuring that all mounting attachments and adapters are clean and free of debris.
5. Make sure that any vibration dampening attachments are securely in place.
6. With the brake lathe running, slowly bring in the cutting tools until they just contact the brake disc friction surfaces.
7. Observe the witness mark on the brake disc. If the witness mark extends approximately three-quarters or more of the way around the brake disc friction surface on each side, the brake disc is correctly mounted to the lathe.
8. If the witness mark does not extend three-quarters or more of the way around the brake

disc, re-mount the brake disc to the lathe.

9. Following the brake lathe manufacturer's instructions, refinish the brake disc.
10. After each successive cut, inspect the brake disc thickness. Refer to Brake Rotor Thickness Measurement.
11. If at any time the brake disc exceeds the minimum allowable thickness after refinish specification, the brake disc must be replaced.
12. After refinishing the brake disc, use the following procedure in order to obtain the desired non-directional finish:
    12.1. Follow the brake lathe manufacturer's recommended speed setting for applying a non-directional finish

    12.2. Using moderate pressure, apply the non-directional finish:

    - If the lathe is equipped with a non-directional finishing tool, apply the finish with 120 grit aluminum oxide sandpaper.
    - If the lathe is not equipped with a non-directional finishing tool, apply the finish with a sanding block and 150 grit aluminum oxide sandpaper.

    12.3. After applying a non-directional finish, clean each friction surface of the brake disc with denatured alcohol, or an equivalent approved brake cleaner.
13. Remove the brake disc from the brake lathe.
14. Measure the assembled LRO of the brake disc to make sure optimum performance of the disc brakes. Refer to Brake Rotor Assembled Lateral Runout Measurement.
15. If the brake disc assembled LRO measurement exceeds the specification, bring the LRO to within specifications. Refer to Brake Rotor Assembled Lateral Runout Correction.

Front Brake Caliper Overhaul (LWB SWB)

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

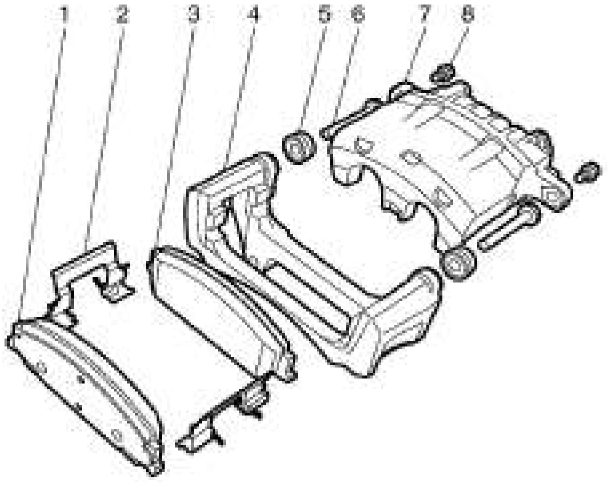
Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

Disassembly Procedure

Important:

- Replace all the components included in the repair kit used to service the brake caliper.
- Lubricate the rubber parts with brake fluid conforming to specification to make assembly easier. Refer to Brake System Specifications for correct brake fluid specification.
- If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
- The torque values specified are for dry, non-lubricated fasteners.
- Perform the service operations on a clean bench, free from all mineral oil materials.

1. Remove the brake caliper from the vehicle. Refer to Front Brake Caliper Replacement.
2. Drain the brake fluid from the brake caliper.



Important: To remove the guide pin bolts (8) use a suitable tool to hold the flat section on the guide pins (6) whilst loosening the guide pin retaining bolts (8).

3. Remove the guide pin retaining bolts (8).
4. Separate the brake caliper housing (7) from the brake caliper anchor plate (4).

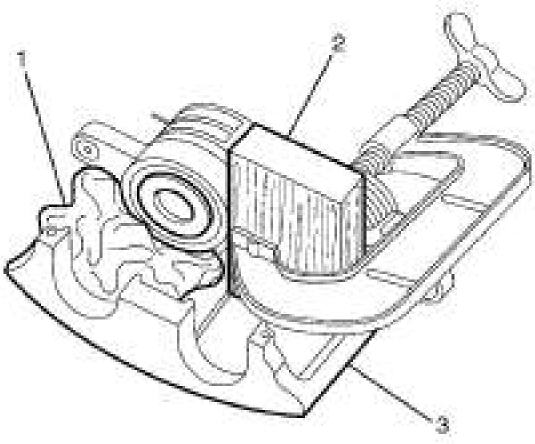
5. Remove the brake pads (1 and 3).
6. Remove the retainer clips (2).
7. Withdraw the guide pins (6) and dust boots (5) from the brake caliper anchor plate (4).

   Separate the dust boots (5) from the guide pins (6).

   Caution: Do not place fingers in front of the caliper piston(s) in an attempt to catch or protect it when applying compressed air. The piston(s) can fly out with force and could result in serious bodily injury.

   Notice: Use clean cloths to pad interior of caliper housing during piston removal. Use just enough air to ease the pistons out of the bores. If the pistons are blown out, even with the padding provided, it may be damaged.

   Important: Observe the pistons coming out of the bores. If one of the pistons appears to be seized, STOP applying air pressure.



8. Remove the brake caliper pistons by directing low pressure compressed air into the brake caliper inlet hole.

   If one of the pistons appears to be seized, perform the following steps:

   8.1. Place a 25 mm (1 in) block of wood between the brake caliper and the brake caliper piston that was moving freely.

   Important: Position the ends of the G-clamp against the rear of the brake caliper and against the 25 mm (1 in) block of wood.

   8.2. Install a large G-clamp over the body of the brake caliper.
   8.3. Remove the brake seized caliper piston by directing low pressure compressed air into the brake caliper inlet hole.

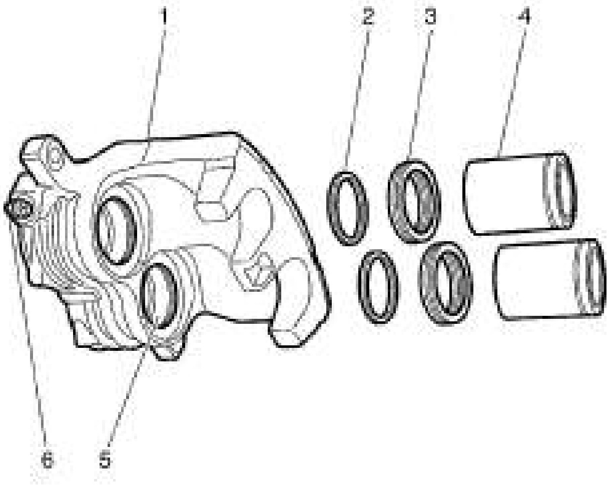
  8.4. Remove the G-clamp from the brake caliper.

  8.5. Remove the block of wood from the brake caliper.

9. Install clean workshop cloths (1) to pad the interior of the brake caliper (3) between the remaining brake caliper piston and the body of the brake caliper (3).
10. To cover the open brake caliper bore place a 25 mm (1 in) block of wood (2) between the body of the brake caliper (3) and the brake caliper dust boot seal.

Important: Position the ends of the G-clamp against the rear of the brake caliper (3) and against the 25 mm (1 in) block of wood (2).

11. Install a large G-clamp over the body of the brake caliper (1).
12. Remove the brake caliper piston by directing low pressure compressed air into the brake caliper inlet hole.
13. Remove the G-clamp form the brake caliper (3).
14. Remove the block of wood (2) from the brake caliper (3).



Important: Use a small wooden or plastic tool to avoid damage to the brake caliper (1).

Important: Brake caliper seals are single use components only and must be discarded after removal.

15. With the brake caliper pistons (4) removed, remove the brake caliper piston dust boot seal (3) from the brake caliper (1).

    Discard the brake caliper piston dust boot seal (3).

16. Remove the brake caliper piston seal (2) from the brake caliper (1).

    Discard the brake caliper piston seal (2).

17. Remove the brake caliper bleeder valve (6).
18. Inspect the brake caliper anchor plate guide surfaces for corrosion and wear.

Replace the brake caliper assembly if damaged or worn.

19. Clean the brake caliper piston bores (5) with denatured alcohol, or equivalent.

Important: DO NOT use abrasives to clean the brake caliper assembly.

20. Clean the brake caliper pistons (4) with denatured alcohol, or equivalent.
21. Clean the brake caliper bleeder valve (6).
22. Dry the brake caliper piston bores (5) with non-lubricated, filtered air.
23. Dry the brake caliper pistons (4) with non-lubricated, filtered air.
24. Dry the brake caliper bleeder valve (6) with non-lubricated, filtered air.
25. Inspect the brake caliper bores (5) for cracks, scoring, pitting, too much corrosion.

If cracks, scoring, pitting, and too much corrosion are present in the brake caliper bores (5), replace the brake caliper assembly.

26. Inspect the brake caliper pistons (4) for cracks, scoring, and/or damage.

If cracks, scoring, and/or damage are present in the brake caliper pistons (4), replace the brake caliper pistons (4) if any of these conditions exist.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

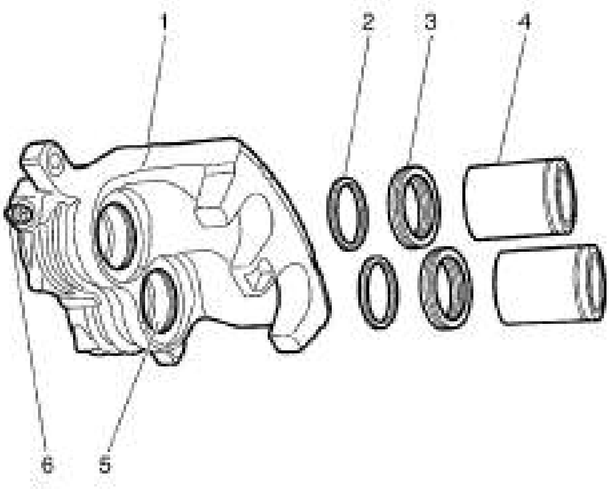
Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

Assembly Procedure

Important:

- Replace all the components included in the repair kit used to service the brake brake caliper.
- Lubricate the rubber parts with brake fluid conforming to specification to make assembly easier. Refer to Brake System Specifications for correct brake fluid specification.
- If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
- The torque values specified are for dry, non-lubricated fasteners.
- Perform the service operations on a clean bench, free from all mineral oil materials.

Notice: Refer to Fastener Notice in the Preface section.



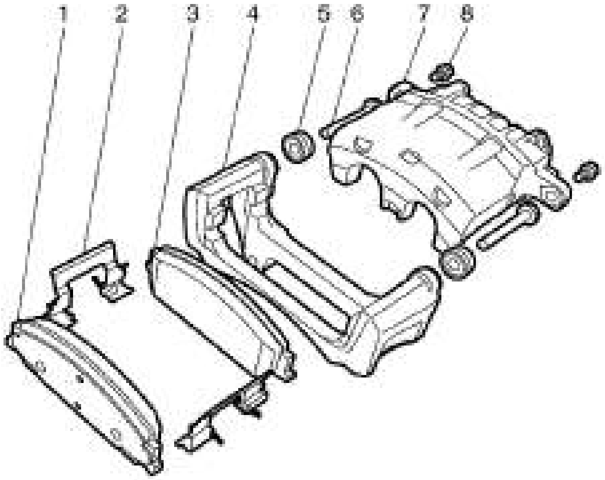
1. Install the brake caliper bleeder valve (6).

   Tighten
   Tighten the bleeder valve to 12 Nm (106 lb in).

2. Lubricate the NEW brake caliper piston seals (2) with brake fluid conforming to specification, from a clean, sealed brake fluid container. Refer to Brake System Specifications for correct brake fluid specification.

   Important: When installing, make sure the brake caliper piston seals (2) are not twisted.

3. Install the brake caliper piston seals (2) into the seal grooves in the brake caliper bores (5).
4. Lubricate the brake caliper bores (5) and pistons (4) with brake fluid.
5. Install the brake caliper pistons (4) into the caliper bores (5).
6. Install the NEW brake caliper piston dust boot seals (3) over the brake caliper pistons (4).
7. Complete the following for both brake caliper piston dust boot seals (3).
   - 7.1. Fully seat the brake caliper piston dust boot seal (4) into the brake caliper (1).
   - 7.2. Make sure the brake caliper piston dust boot seal (4) is correctly seated into the groove in the brake caliper bore (5).



8. Lubricate the guide pins (6) with silicone grease, such as Dow Corning No. 44 or equivalent.
9. Install guide pins (6) into the brake caliper anchor plate (4).

   Do not fit the two guide pin boots (5) at this stage.

   Important: To install the guide pin bolts (8) use an open-end spanner to hold the flat section on the guide pins (6) whilst installing the guide pin bolts (8).

10. Install the brake caliper (7) to the brake caliper anchor plate (4) and install NEW guide pin bolts (8).

    Tighten
    Tighten the guide pin bolts to 42 Nm (31 lb ft).

    Important: Make sure that the brake caliper (7) and guide pins (6) slide in and out easily from the brake caliper anchor plate (4). If any binding is evident, then steps 8 and 9 must be repeated.

11. Detach the brake caliper (7) from the brake caliper anchor plate (4) and install the NEW guide pin boots (5) to the guide pins (6).
12. Install the brake pad retainers (2) to the brake caliper anchor plate (4).

    Important: The brake pads (1 and 3) are marked as inner and outer only. Failure to install the front brake pads (1 and 3) in their correct position will cause the brake pads (1 and 3) not to seat correctly in the brake caliper (7).

13. Install the brake pads (1 and 3) to the brake caliper anchor plate (4).

    Important: Remove all excess air from the guide pin boot (5) and make sure that each guide pin boot (5) is correctly located in the grooves in the guide pin (6) and brake caliper anchor plate (4).

14. Assemble the brake caliper (7) and brake caliper anchor plate (4) together.

15. Install the brake caliper assembly to the vehicle. Refer to Front Brake Caliper Replacement.

Front Brake Caliper Replacement (RHD)

Removal Procedure

Tools Required

J 23738-A Hand Vacuum Pump.

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

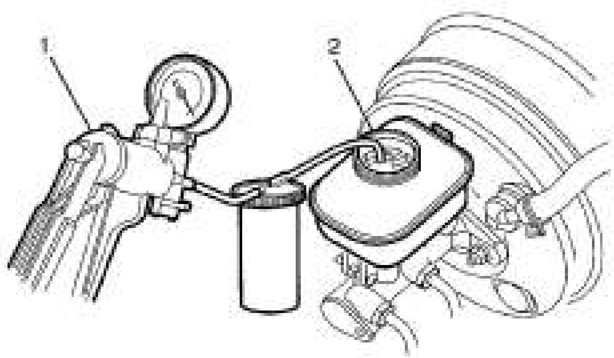
Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.



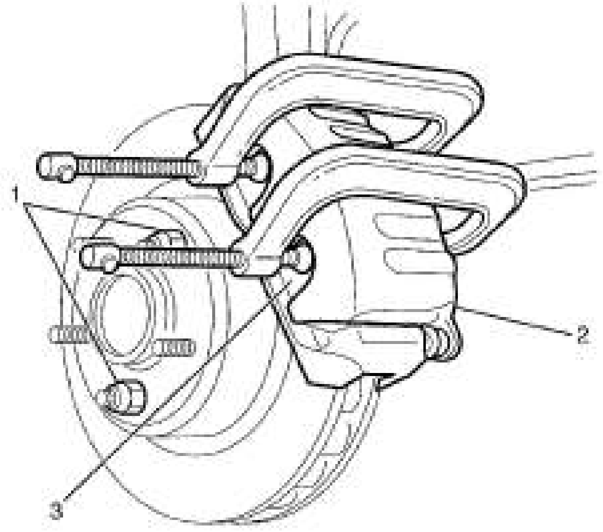
1. Inspect the fluid level in the master cylinder reservoir (2).
   - If the brake fluid level is midway between the maximum fill level and the minimum allowable level, no brake fluid needs to be removed from the master cylinder reservoir (2) before proceeding.

Important: DO NOT completely empty the master cylinder reservoir (2) or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

Important: DO NOT re use the removed fluid.

- If the brake fluid level is higher than midway between the maximum fill level and the minimum allowable level, syphon the brake fluid to the midway point using a hand vacuum pump (1) before proceeding.

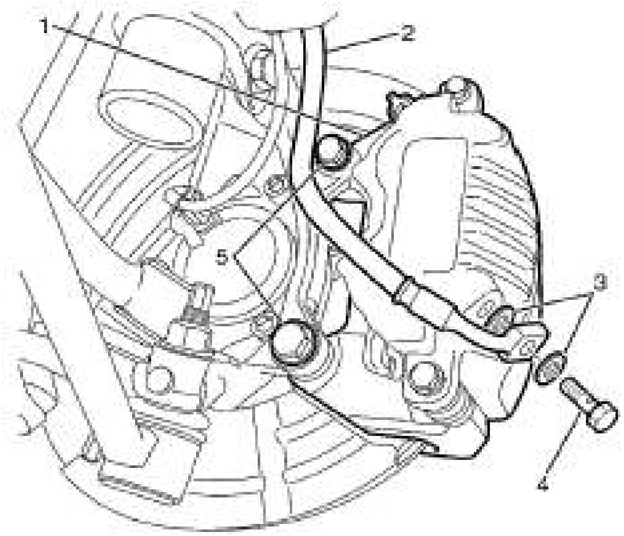
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
3. Remove the front wheels. Refer to Tire and Wheel Removal and Installation .



4. Install two wheel nuts (1) in reverse to opposite wheel studs to retain the brake disc to the hub.

Important: Position the ends of the G-clamps against the rear of the brake caliper (2) and against the outboard brake pad (3).

5. Install large G-clamps over the body of the brake caliper (2).
6. Tighten the G-clamps evenly until the brake caliper pistons bottom in each brake caliper bore.
7. Remove the G-clamps from the brake caliper (2).
8. Place a drain tray beneath the brake caliper assembly.



9. Remove the brake hose to brake caliper banjo retaining bolt (4).

   Important: Install a rubber cap or plug on the exposed brake hose end in order to prevent fluid loss and contamination.

10. Separate the brake hose to brake caliper banjo retaining bolt (4) from the brake hose (2).

    Important: Copper brake hose sealing washers become work hardened due to the heat generated with brake applications and will not reseal. Install NEW copper brake hose sealing washers (3) whenever the brake hose to brake caliper banjo retaining bolt (4) is removed.

11. Remove the two copper brake hose sealing washers (3). The copper brake hose sealing washers (3) may be stuck to the brake caliper (1) and/or the brake hose (2).

    Discard the washers.

    Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

    Important: Make sure all the bolt holes are thoroughly cleaned and all micro-encapsulated thread sealant is removed.

12. Remove the brake caliper anchor plate to knuckle retaining bolts (5)

    Discard the bolts.

    Clean the bolt holes.

13. Remove the brake caliper assembly (1).

Installation Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

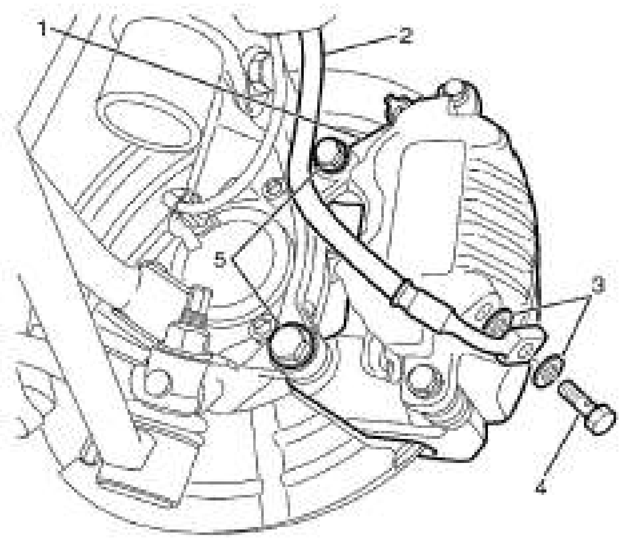
Notice: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

1. Clean the brake caliper anchor plate to steering knuckle mounting surfaces.
2. Check the serviceability of the brake pads. Refer to Brake Pad Inspection .

Important: The brake pads (4) are marked as inner and outer only. Failure to install the brake pads (4) in their correct position will cause the brake pads (4) not to seat correctly in the brake caliper (1).

3. Install the existing or NEW brake pads as required.
4. Press the inner brake pad by using a suitable tool to make sure the brake caliper pistons bottom in each brake caliper bore.
5. Position the brake caliper assembly over the brake disc.

Notice: Refer to Fastener Notice in the Preface section.



6. Install the NEW brake caliper anchor plate to knuckle retaining bolts (5).

Tighten
Tighten the bolts to 60 Nm +120° (44 lb ft +120°).

Notice: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

Important: Install NEW copper brake hose sealing washers (3).

7. Install the brake hose (2) to brake caliper banjo retaining bolt (4) and NEW copper brake hose sealing washers (3) to the brake caliper (1).

   Tighten
   Tighten the banjo bolt to 35 Nm (25 lb ft).

8. Bleed the braking system. Refer to Hydraulic Brake System Bleeding .
9. Remove the wheel nuts retaining the brake disc to the hub.
10. Install the front wheels. Refer to Tire and Wheel Removal and Installation .
11. Lower the vehicle to the ground.
12. With the engine OFF, gradually apply the brake pedal to approximately 2/3 of its travel distance.
13. Slowly release the brake pedal.
14. Repeat steps 12 and 13 until a firm brake pedal apply is obtained. This will correctly seat the brake caliper pistons and brake pads.
15. Fill the master cylinder reservoir to the correct level. Refer to Master Cylinder Reservoir Filling .
16. Burnish (bed in) the brake pads and brake discs if required. Refer to Brake Pad and Rotor Burnishing .

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Brakes | Disc Brakes | Repair Instructions | **Document ID: 1974953**

Front Brake Rotor Replacement (RHD)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

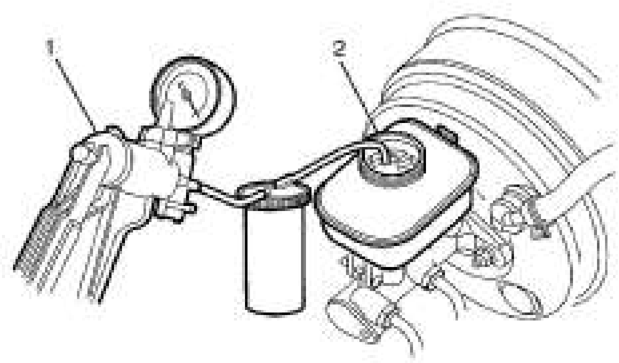
Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.



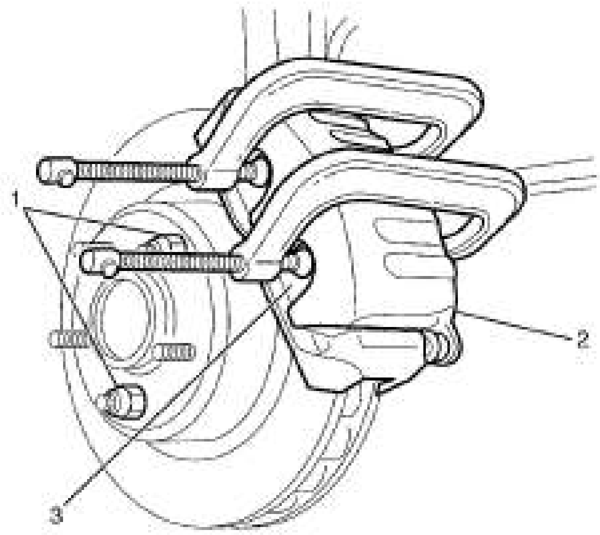
1. Inspect the fluid level in the brake master cylinder reservoir (2).
   - If the brake fluid level is midway between the maximum-fill level and the minimum allowable level, no brake fluid needs to be removed from the master cylinder reservoir (2) before proceeding.

Important: DO NOT completely empty the master cylinder reservoir (2) or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

Important: DO NOT re use the removed fluid.

- If the brake fluid level is higher than midway between the maximum-fill level and the minimum allowable level, syphon the brake fluid to the midway point using a hand vacuum pump (1) before proceeding.

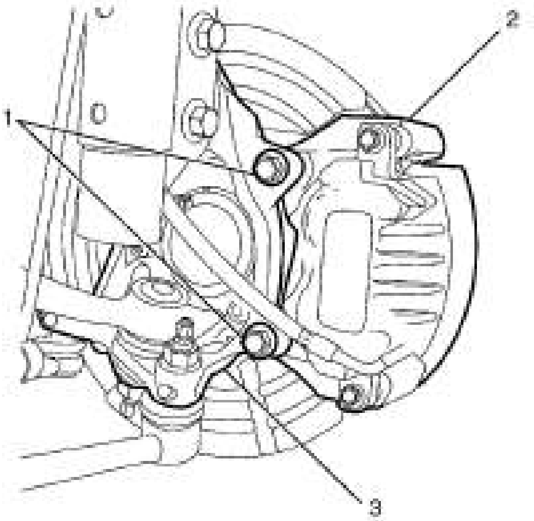
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
3. Remove the front wheels. Refer to Tire and Wheel Removal and Installation .



4. Install two wheel nuts (1) in reverse to opposite wheel studs to retain the brake disc to the hub.

   Important: Position the ends of the G-clamps against the rear of the brake caliper (2) and against the outboard brake pad (3).

5. Install large G-clamps over the body of the brake caliper (2).
6. Tighten the G-clamps evenly until the brake caliper pistons bottom out in each brake caliper bore.
7. Remove the G-clamps from the brake caliper (2).



Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

Important: Make sure all the bolt holes are thoroughly cleaned and all micro-encapsulated thread sealant is removed.

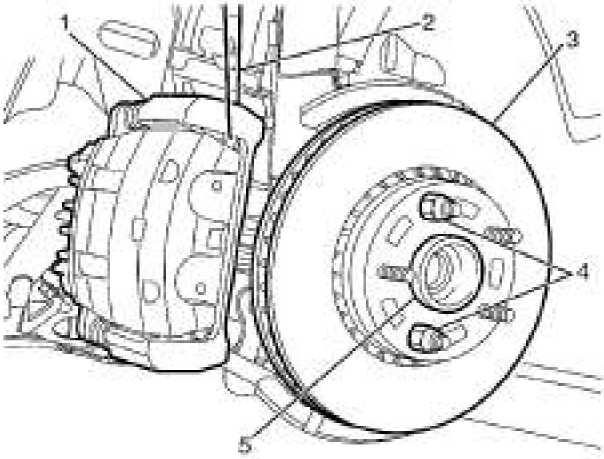
8. Remove the brake caliper anchor plate to knuckle retaining bolts (1).

   Discard the bolts.

   Clean the bolt holes.

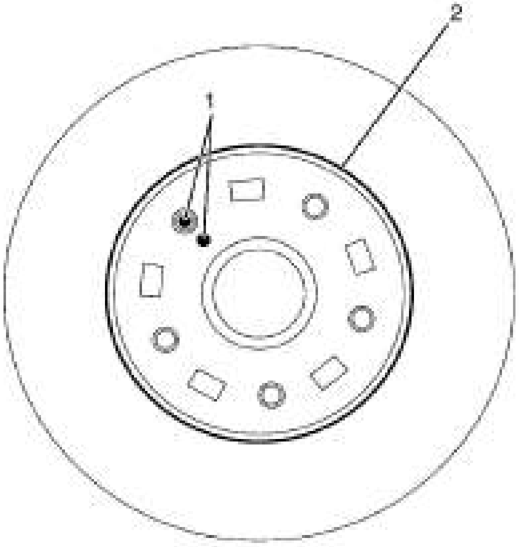
   Important: DO NOT disconnect the hydraulic brake flexible hose from the brake caliper otherwise complete bleeding of the braking system will be necessary.

9. Remove the brake caliper (2) from the steering knuckle (3).



Notice: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

10. Support the brake caliper (1) with heavy mechanic's wire, or equivalent (2).
11. Remove the two wheel nuts (4) retaining the brake disc (3) to the hub (5).



Important: The brake disc to hub relationship is indexed during production. Mark the relationship of the brake disc to a wheel stud end for installation to minimise the potential of brake shudder.

Important: If the brake disc is being removed to be machined or replaced to rectify brake shudder, or if brake disc to hub matching is not evident, the brake disc to the hub must be indexed. Refer to Brake Rotor Assembled Lateral Runout Correction - Indexing .

12. Matchmark the position of the brake disc (2) to the wheel studs (1).
13. Remove the brake disc (2).

Installation Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Caution in the Preface section.

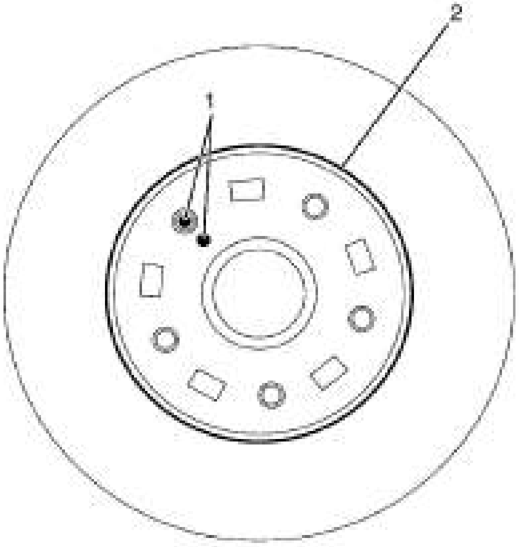
Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

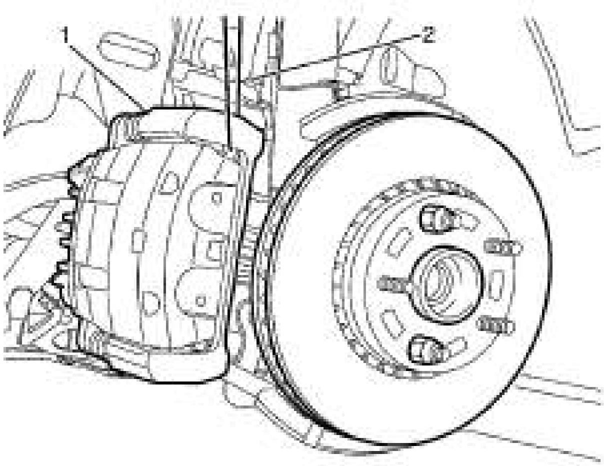
Important: Whenever the brake disc has been separated from the hub/axle flange, any rust or contaminants should be cleaned from the hub/axle flange and the brake disc mating surfaces. Failure to do this may result in too much assembled lateral runout (LRO) of the brake disc, which may lead to brake pulsation.

1. Clean any rust or corrosion from the mating surface of the hub/axle flange and mounting surface of the brake disc.
2. Inspect the mating surfaces of the hub/axle flange and the brake disc to make sure that there are no foreign particles or debris remaining.

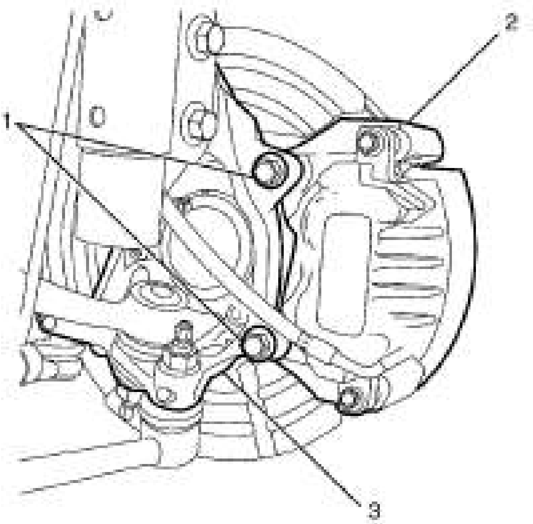


Important: Use the matchmark (1) made prior to removal for correct orientation to the flange.

3. Install the brake disc (2) to the hub/axle flange.
4. If the brake disc (2) was removed and installed as part of a brake system repair, measure the assembled lateral runout (LRO) of the brake disc (2) to make sure optimum performance of the disc brakes. Refer to Brake Rotor Assembled Lateral Runout Measurement .
5. If the brake disc (2) assembled LRO measurement exceeds the specification, bring the LRO to within specifications. Refer to Brake Rotor Assembled Lateral Runout Correction .



6. Remove the heavy mechanic's wire, or equivalent support (2) from the brake caliper (1).



Notice: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

7. Install the brake caliper assembly (2) to the steering knuckle (3).

   Notice: Refer to Fastener Notice in the Preface section.

8. Install the NEW brake caliper anchor plate to knuckle retaining bolts (1).

   Tighten
   Tighten the bolts to 60 Nm +120° (44 lb ft +120°).

9. Install the front wheels. Refer to Tire and Wheel Removal and Installation .
10. Lower the vehicle to the ground.
11. With the engine OFF, gradually apply the brake pedal to approximately 2/3 of its travel distance.
12. Slowly release the brake pedal.
13. Repeat steps 11 and 12 until a firm brake pedal is obtained. This will correctly seat the brake caliper pistons and brake pads.
14. Fill the master cylinder reservoir to the correct level. Refer to Master Cylinder Reservoir Filling .
15. If the brake disc was refinished or replaced, or if new brake pads were installed, burnish the brake pads and brake discs. Refer to Brake Pad and Rotor Burnishing .

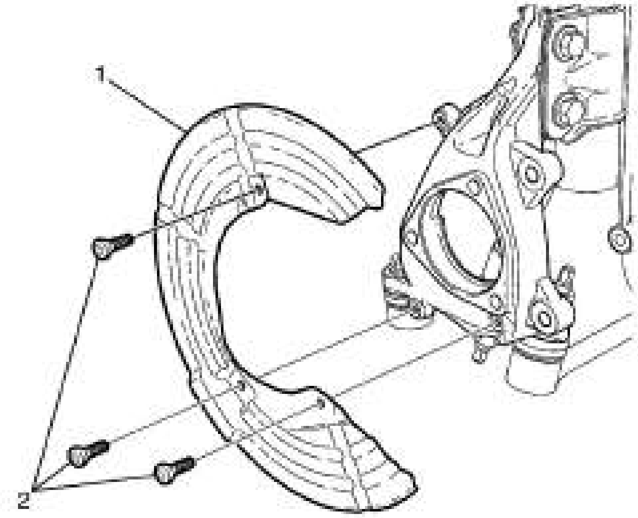
Front Brake Shield Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

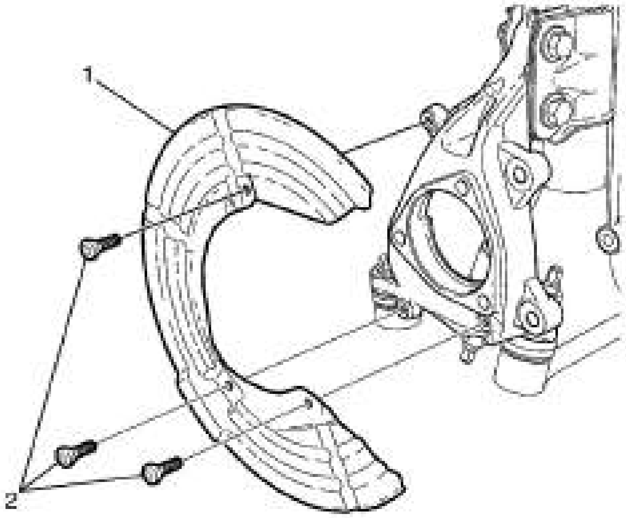
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the front wheel. Refer to Tire and Wheel Removal and Installation .
3. Remove the front wheel hub assembly. Refer to Front Wheel Bearing and Hub Replacement .



4. Remove the brake disc splash shield to steering knuckle retaining bolts (2).
5. Remove the brake disc splash shield (1).

Installation Procedure



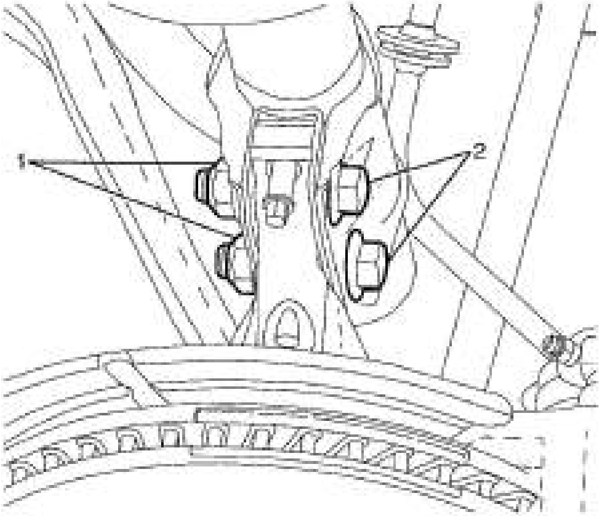
1. Install the brake disc splash shield (1).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the brake disc splash shield to steering knuckle retaining bolts (2).

   Tighten
   Tighten the nut to 9 Nm (89 lb in).

3. Install the front wheel hub assembly. Refer to Front Wheel Bearing and Hub Replacement .



Important: If the steering knuckle has been replaced, the end-float measurement must be inspected.

4. Install the front wheel. Refer to Lifting and Jacking the Vehicle .
5. Remove the safety stands.
6. Lower the vehicle to the ground.
7. Bounce the vehicle several times to settle the suspension.
8. Inspect and adjust the wheel alignment. Refer to Wheel Alignment Measurement .
9. Tighten the strut assembly to steering knuckle retaining bolts (2) and nuts (1).

   Tighten
   Tighten the bolts a first pass to 85 N·m (63 lb in).

   Tighten
   Tighten the bolts a second pass to 100 N·m (74 lb in).

   Tighten
   Tighten the bolts an additional 90 degrees.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Brakes | Disc Brakes | Repair Instructions | Document ID: 1974928

Front Disc Brake Pads Replacement (RHD)

Removal Procedure

Tools Required

J 23738-A Hand Vacuum Pump.

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

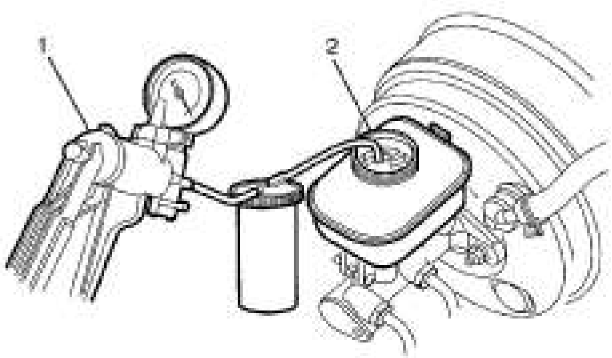
Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.



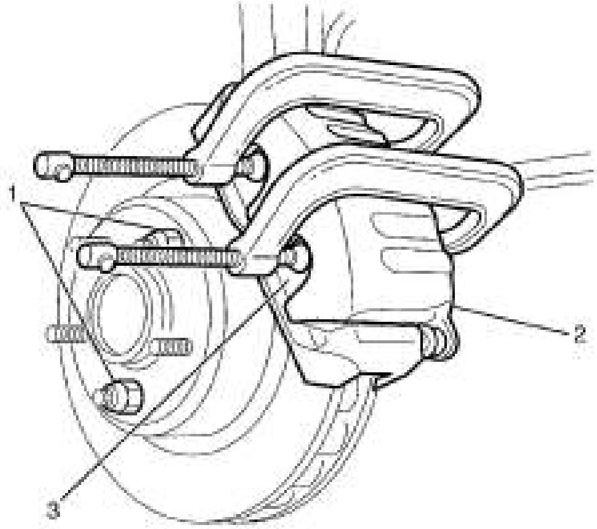
1. Inspect the fluid level in the master cylinder reservoir (2).
   - If the brake fluid level is midway between the maximum fill level and the minimum allowable level, no brake fluid needs to be removed from the master cylinder reservoir (2) before proceeding.

Important: DO NOT completely empty the master cylinder reservoir (2) or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

Important: DO NOT re use the removed fluid.

- If the brake fluid level is higher than midway between the maximum fill level and the minimum allowable level, using a hand vacuum pump (1) syphon the brake fluid to the midway point before proceeding.

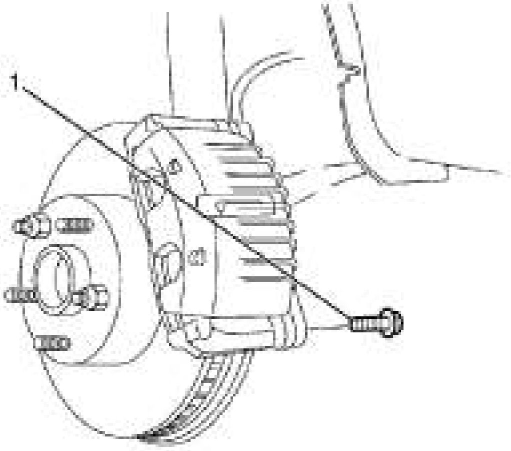
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
3. Remove the front wheels. Refer to Tire and Wheel Removal and Installation .



4. Install two wheel nuts (1) in reverse to opposite wheel studs to retain the brake disc to the hub.

   Important: Position the ends of the G-clamps against the rear of the brake caliper (2) and against the outboard brake pad (3).

5. Install large G-clamps over the body of the brake caliper (2).
6. Tighten the G-clamps evenly until the brake caliper pistons bottom out in each brake caliper bore.
7. Remove the G-clamps from the brake caliper (2).



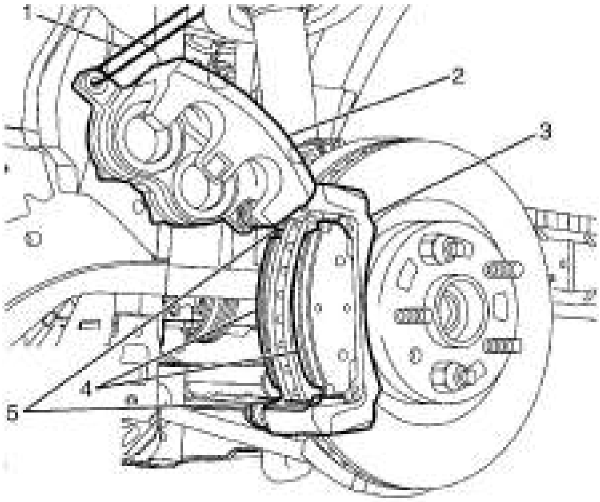
Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

Important: Make sure the bolt hole is thoroughly cleaned and all micro-encapsulated thread sealant is removed.

8. Remove the brake caliper lower guide pin bolt (1).

   Discard the bolt.

   Clean the bolt hole.



Notice: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

Important: DO NOT disconnect the brake hose from the brake caliper (2).

9. Pivot the brake caliper (2) upward and secure with heavy mechanics wire (1), or equivalent.
10. Remove the brake pads (4) from the brake caliper anchor plate (3).
11. Remove the brake pad retainers (5) from the brake caliper anchor plate (3).
12. Clean the brake pad brake pad retainer surfaces of the brake caliper anchor plate (3).

Important: Inspect the brake caliper guide pins for freedom of movement and the condition of the guide pin boots. This is achieved by moving the guide pins inboard and outboard within the brake caliper anchor plate (3) bores, without disengaging the slides from the boots.

13. Inspect the brake caliper guide pins and boots for the following conditions:
    - Restricted brake caliper guide pin movement.
    - Too much brake caliper guide pin play in the brake caliper anchor plate (3).
    - Seized or binding brake caliper guide pins.
    - Split or torn boots.
14. If any of the conditions listed are found, overhaul or replace the brake caliper (2).

Installation Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

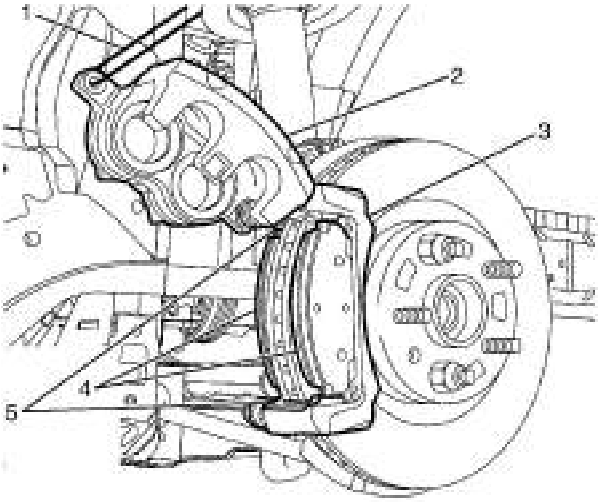
Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

1. Clean the piston to brake pad contact faces as required.



2. Install the new brake pad retainers (5) to the brake caliper anchor plate (3).

   Important: The brake pads (4) are marked as inner and outer only. Failure to install the brake pads (4) in their correct position will cause the brake pads (4) not to seat correctly in the brake caliper (2).

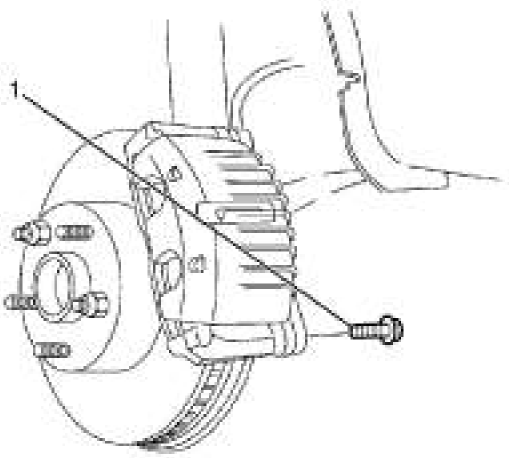
3. Install the brake pads (4) to the brake caliper anchor plate (3).

   Important: Make sure the brake hose is correctly located in its mounting bracket.

   Notice: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

4. Remove the mechanics wire or equivalent (1), and rotate the brake caliper (2) into position over the brake pads (4) and to the brake caliper anchor plate (3).

   Notice: Refer to Fastener Notice in the Preface section.



5. Install the NEW lower brake caliper guide pin to brake caliper anchor plate retaining bolt (1).

   Tighten
   Tighten the bolt to 42 Nm (31 lb ft).

6. Remove the wheel nuts retaining the brake disc to the hub.
7. Install the front wheels. Refer to Tire and Wheel Removal and Installation .
8. Lower the vehicle to the ground.
9. With the engine off, gradually apply the brake pedal approximately 2/3 of its travel distance.
10. Slowly release the brake pedal.
11. Repeat steps 9 and 10 until a firm brake pedal is obtained. This will correctly seat the brake caliper pistons and brake pads.
12. Fill the master cylinder reservoir to the correct level. Refer to Master Cylinder Reservoir Filling .
13. Burnish (bed in) the brake pads and brake discs. Refer to Brake Pad and Rotor Burnishing .

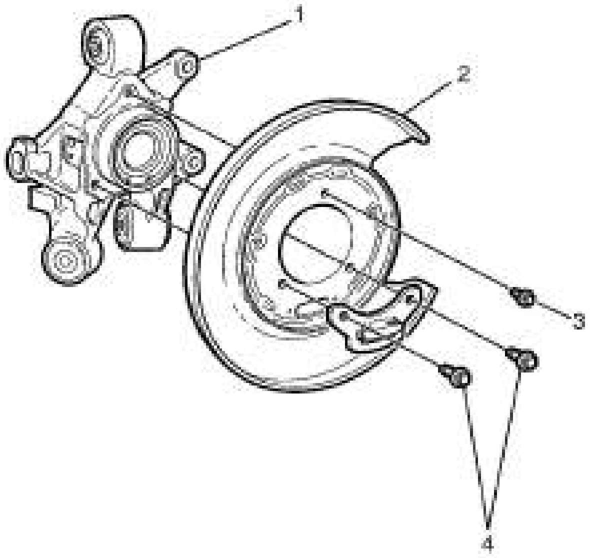
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Brakes | Disc Brakes | Repair Instructions | **Document ID: 1992486**

Rear Disc Brake Backing Plate Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

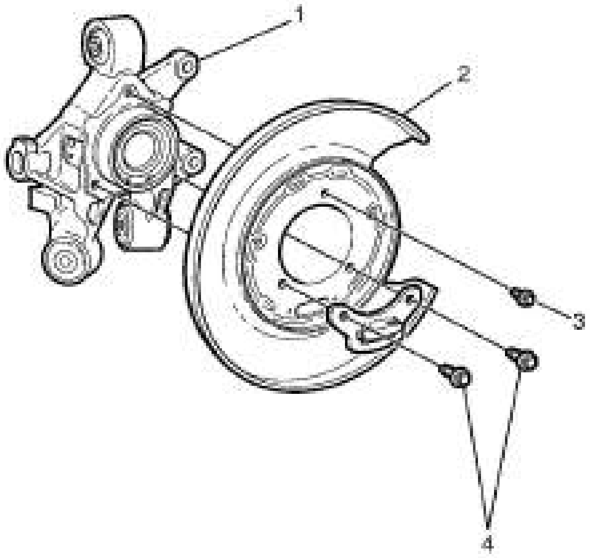
1. Remove the wheel hub and knuckle assembly. Refer to Knuckle Replacement.
2. Remove the wheel hub. Refer to Rear Wheel Bearing and Hub Replacement.



3. Remove the disc brake backing plate to knuckle retaining bolts (3 and 4).
4. Remove the disc brake backing plate (2) from the knuckle (1).

Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



1. Install the disc brake backing plate (2) to the knuckle (1).
2. Install the upper disc brake backing plate to knuckle retaining bolt (3).

   Tighten
   Tighten the bolts to 60 Nm (44 lb ft).

3. Install the lower disc brake backing plate to knuckle retaining bolts (4).

   Tighten
   Tighten the bolts to 130 Nm (96 lb ft).

4. Install the wheel hub. Refer to Rear Wheel Bearing and Hub Replacement.
5. Install the wheel hub and knuckle assembly. Refer to Knuckle Replacement.

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Rear Brake Caliper Overhaul (LWB SWB)

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

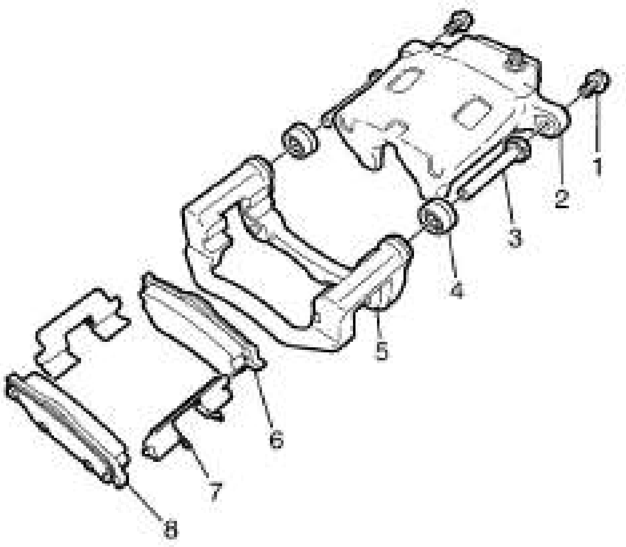
Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

Disassembly Procedure

Important:

- Replace all the components included in the repair kit used to service the brake caliper.
- Lubricate the rubber parts with brake fluid conforming to specification to make assembly easier. Refer to Brake System Specifications for correct brake fluid specification.
- If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
- The torque values specified are for dry, non-lubricated fasteners.
- Perform the service operations on a clean bench, free from all mineral oil materials.

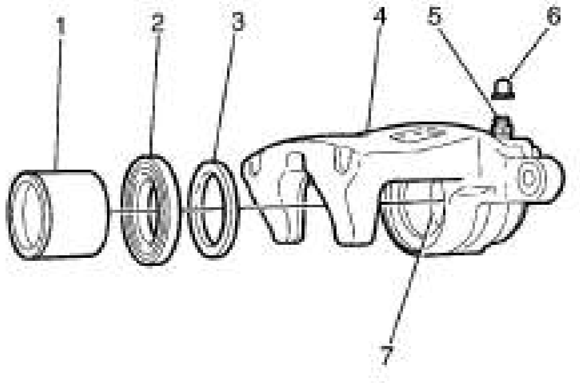
1. Remove the brake caliper from the vehicle. Refer to Rear Brake Caliper Replacement.
2. Drain the brake fluid from the brake caliper.



Important: To remove the guide pin bolts (1) use a suitable tool to hold the flat section on the guide pins (3) whilst loosening the guide pin bolts (1).

3. Remove the guide pin retaining bolts (1).
4. Separate the brake caliper housing (2) from the brake caliper anchor plate (5).

5. Remove the brake pads (6 and 8).
6. Remove the retainer clips (7)
7. Withdraw the guide pins (3) and dust boots (4) from the brake caliper anchor plate (5).
8. Separate the dust boots (4) from the guide pins (3).



Caution: Do not place fingers in front of the caliper piston(s) in an attempt to catch or protect it when applying compressed air. The piston(s) can fly out with force and could result in serious bodily injury.

Notice: Use clean cloths to pad interior of caliper housing during piston removal. Use just enough air to ease the pistons out of the bores. If the pistons are blown out, even with the padding provided, it may be damaged.

9. Install clean cloths to pad the interior of the caliper (4) between the caliper piston (1) and the caliper (4).
10. Carefully remove the brake caliper piston (1) by directing low pressure compressed air into the brake caliper (1) inlet hole.

Important: Use a small wooden or plastic tool to avoid damage to the brake caliper (4).

Important: Brake caliper seals are single use components only and must be discarded after removal.

11. With the brake caliper piston (1) removed, remove the brake caliper piston dust boot seal (2) from the brake caliper (4).

    Discard the brake caliper piston dust boot seal (2).

12. Remove the brake caliper piston seal (3) from the brake caliper (4) and discard the brake caliper piston seal (3).

    Discard the brake caliper piston seal (3).

13. Remove the brake caliper bleeder valve cap (6).
14. Remove the brake caliper bleeder valve (5).
15. Inspect the brake caliper anchor plate guide surfaces for corrosion and wear. Replace the brake caliper assembly if damaged or worn.
16. Clean the brake caliper piston bore (7) with denatured alcohol, or equivalent.

    Important: DO NOT use abrasives to clean the brake caliper piston (1).

17. Clean the brake caliper piston (1) with denatured alcohol, or equivalent.
18. Clean the brake caliper bleeder valve (5)
19. Dry the brake caliper piston bore (7) with non-lubricated, filtered air.
20. Dry the brake caliper piston (1) with non-lubricated, filtered air.
21. Dry the brake caliper bleeder valve (5) with non-lubricated, filtered air.
22. Inspect the brake caliper bore (7) for cracks, scoring, pitting, too much corrosion.
23. If light corrosion is present in the brake caliper bore (7), attempt to remove the imperfection with a fine emery paper. If the imperfection cannot be removed, replace the brake caliper assembly.
24. If cracks, scoring, pitting, and too much corrosion are present in the brake caliper bore (7), replace the brake caliper assembly.
25. Inspect the brake caliper piston (1) for cracks, scoring, and/or damage, replace the brake caliper piston (1) if any of these conditions exist.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

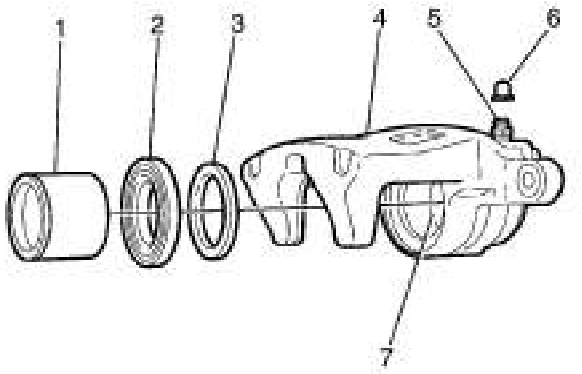
Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

Assembly Procedure

Important:

- Replace all the components included in the repair kit used to service the brake caliper.
- Lubricate the rubber parts with brake fluid conforming to specification to make assembly easier. Refer to Brake System Specifications for correct brake fluid specification.
- If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
- The torque values specified are for dry, non-lubricated fasteners.
- Perform the service operations on a clean bench, free from all mineral oil materials.

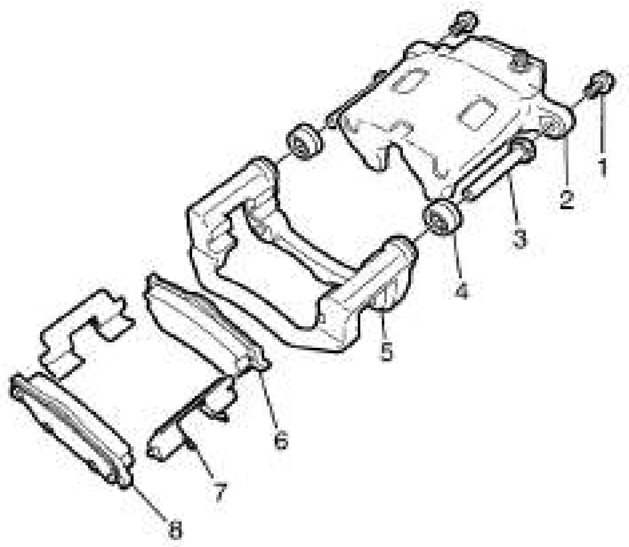
Notice: Refer to Fastener Notice in the Preface section.



1. Install the brake caliper bleeder valve (6) to the brake caliper (4).

   Tighten
   Tighten the brake caliper bleeder valve when dry 12 Nm (106 lb in).

2. Install the brake caliper bleeder valve cap (7) to the brake caliper bleeder valve (6).
3. Lubricate the NEW brake caliper piston seal (3) with brake fluid conforming to specification, from a clean, sealed brake fluid container. Refer to Brake System Specifications for correct brake fluid specification.
4. Install the lubricated brake caliper piston seal (3) into the seal groove in the brake caliper bore (7). Make sure the brake caliper piston seal (3) is not twisted.
5. Lubricate the brake caliper bore (7) and the brake caliper piston (1) with brake fluid.
6. Install the brake caliper piston (1) into the brake caliper bore (7).
7. Install the NEW brake caliper piston dust boot seal (2) over the brake caliper piston (1).
8. Complete the following for the brake caliper piston dust boot seal (2).
   - 8.1. Fully seat the brake caliper piston dust boot seal (2) into the brake caliper (4).
   - 8.2. Make sure the brake caliper piston dust boot seal (2) is correctly seated into the groove in the brake caliper bore (7).



9. Lubricate the guide pins (1) with silicone grease, such as Dow Corning No. 44 or equivalent.
10. Install guide pins (1) into the brake caliper anchor plate (5).

    Do not fit the two guide pin boots (2) at this stage.

11. Install the brake caliper (4) to the brake caliper anchor plate (5) and install NEW guide pin bolts (3).
12. Use an open-end spanner to hold the guide pin flat section, tighten the NEW guide pin bolts (3) to the correct torque.

    Tighten
    Tighten the guide pin bolt to 42 Nm (31 lb ft).

    Important: Make sure that the brake caliper and guide pins slide in and out easily from the brake caliper anchor plate. If any binding is evident, then steps 9-12 must be repeated.

13. Detach the brake caliper (4) from the brake caliper anchor plate (5) and install the NEW guide pin boots (4) to the guide pins (3).

    Important: Remove all excess air from the guide pin boot and make sure that each guide pin boot is correctly located in the guide pin and brake caliper anchor plate grooves.

14. Assemble the brake caliper (4) and brake caliper anchor plate (5) together.
15. Install the brake pads. Refer to Rear Disc Brake Pads Replacement.
16. Install the brake caliper to the vehicle. Refer to Rear Brake Caliper Replacement.

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Rear Brake Caliper Replacement (RHD)

Removal Procedure

Tools Required

J 23738-A Hand Vacuum Pump.

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

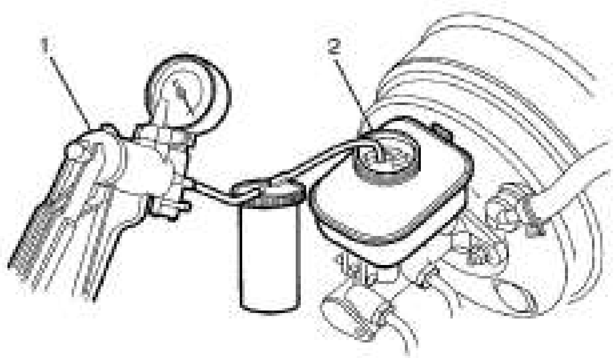
Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.



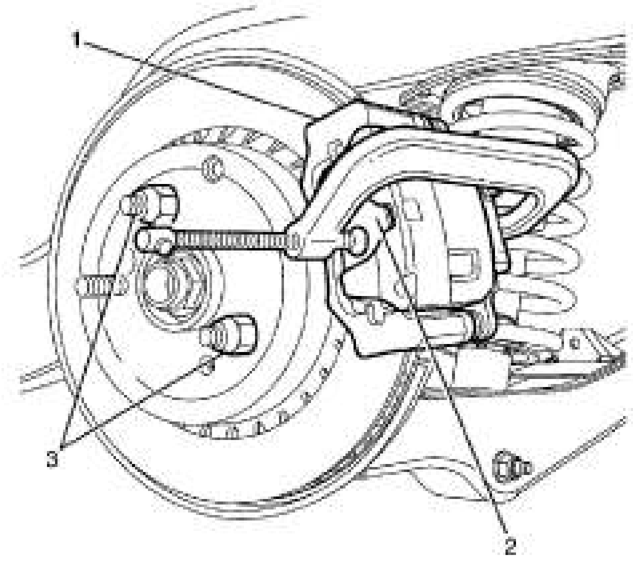
1. Inspect the fluid level in the brake master cylinder reservoir (2).
    - If the brake fluid level is midway between the maximum [dash] fill level and the minimum allowable level, no brake fluid needs to be removed from the master cylinder reservoir (2) before proceeding.

Important: DO NOT completely empty the master cylinder reservoir (2) or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

Important: DO NOT re use the removed fluid.

- If the brake fluid level is higher than midway between the maximum [dash] fill level and the minimum allowable level, using a hand vacuum pump (1) syphon the brake fluid to the midway point before proceeding.

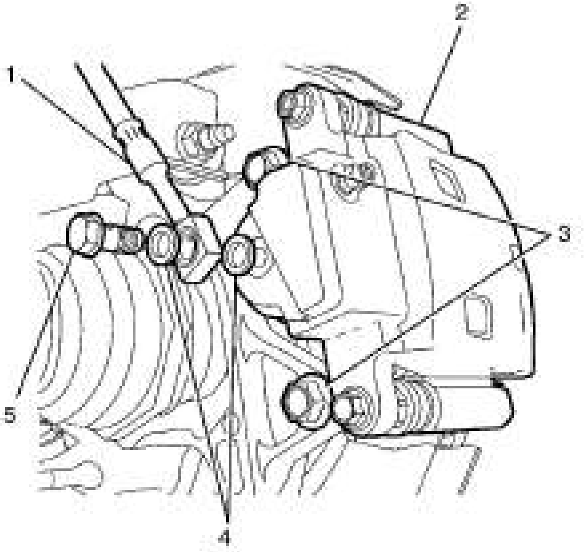
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
3. Remove the front wheels. Refer to Tire and Wheel Removal and Installation .



4. Install two wheel nuts (3) in reverse to opposite wheel studs to retain the brake disc to the hub.

Important: Position the ends of the G-clamp against the rear of the brake caliper (1) and against the outboard brake pad (2).

5. Install a large G-clamp over the body of the brake caliper (1).
6. Tighten the G-clamp until the brake caliper piston bottoms out in the brake caliper bore.
7. Remove the G-clamps from the brake caliper (1).
8. Place a drain tray beneath the brake caliper assembly.



9. Remove the brake hose to brake caliper banjo retaining bolt (5).

   Important: Install a rubber cap or plug on the exposed brake hose end in order to prevent fluid loss and contamination.

10. Separate the brake hose to brake caliper banjo retaining bolt (5) from the brake hose (1).

    Important: Copper brake hose sealing washers become work hardened due to the heat generated with brake applications and will not reseal. Install NEW copper brake hose sealing washers (4) whenever the brake hose to brake caliper banjo retaining bolt (5) is removed.

11. Remove the two copper brake hose sealing washers (4). The copper brake hose sealing washers (4) may be stuck to the brake caliper (2) and/or the brake hose (1).

    Discard the sealing washers.

    Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

    Important: Make sure all the bolt holes are thoroughly cleaned and all micro-encapsulated thread sealant is removed.

12. Remove the brake caliper anchor plate to knuckle retaining bolts (3).

    Discard the bolts.

    Clean the bolt holes.

13. Remove the brake caliper assembly (2) from the vehicle.

Installation Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

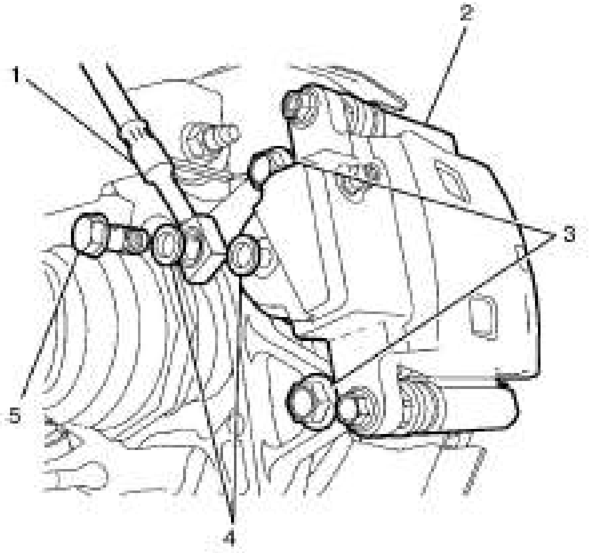
Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

1. Clean the brake caliper anchor plate to steering knuckle mounting surfaces.
2. Check the serviceability of the brake pads. Refer to Brake Pad Inspection .

Important: The inner brake pads are marked as left and right side only.

3. Install the existing or NEW brake pads as required.
4. Press the inner brake pad by using a suitable tool to make sure the brake caliper piston bottoms out in the brake caliper bore.
5. Position the brake caliper assembly over the brake disc.

Notice: Refer to Fastener Notice in the Preface section.



6. Install the NEW brake caliper anchor plate to knuckle retaining bolts (3).

Tighten
Tighten the bolt to 110 Nm (81 lb ft).

Notice: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

7. Install the brake hose (1) to brake caliper banjo retaining bolt (5) and NEW copper sealing washers (4) to the brake caliper (2).

   Tighten
   Tighten the banjo bolt to 35 Nm (26 lb ft).

8. Bleed the braking system. Refer to Hydraulic Brake System Bleeding .
9. Remove the wheel nuts retaining the brake disc to the hub.
10. Install the rear wheels. Refer to Tire and Wheel Removal and Installation .
11. Lower the vehicle to the ground.
12. With the engine OFF, gradually apply the brake pedal to approximately 2/3 of its travel distance.
13. Slowly release the brake pedal.
14. Repeat steps 12 and 13 until a firm brake pedal is obtained. This will correctly seat the brake caliper pistons and brake pads.
15. Fill the master cylinder reservoir to the correct level. Refer to Master Cylinder Reservoir Filling .
16. Burnish (bed in) the brake pads and brake discs if required. Refer to Brake Pad and Rotor Burnishing .

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Rear Brake Rotor Replacement (RHD)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

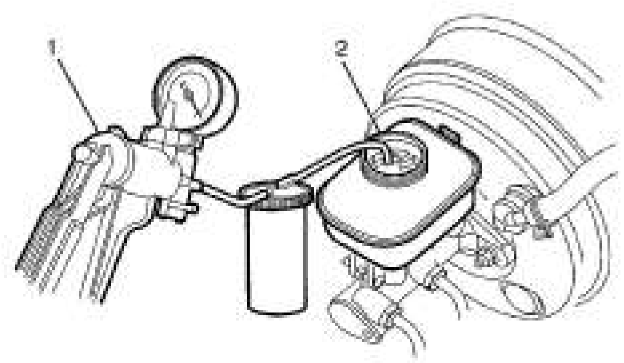
Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.



1. Inspect the fluid level in the brake master cylinder reservoir (2).
    - If the brake fluid level is midway between the maximum fill level and the minimum allowable level, no brake fluid needs to be removed from the master cylinder reservoir (2) before proceeding.

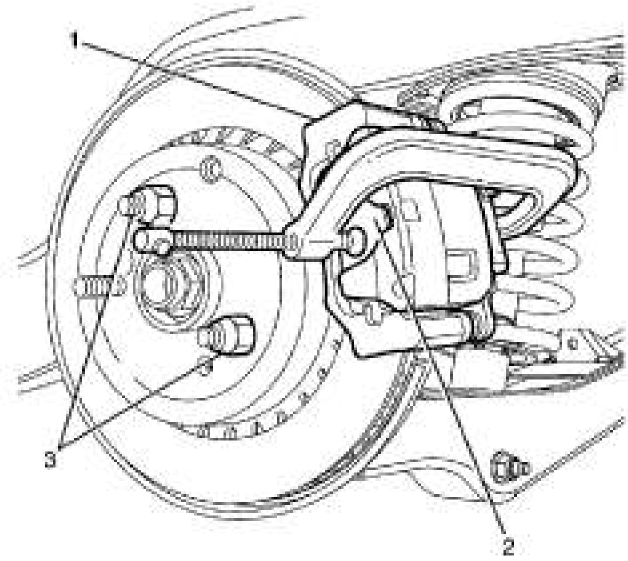
Important: DO NOT completely empty the master cylinder reservoir (2) or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

Important: DO NOT re use the removed fluid.

- If the brake fluid level is higher than midway between the maximum fill level and the minimum allowable level, syphon the brake fluid to the midway point using a hand vacuum pump (1) before proceeding.

Important: Make sure the park brake is fully released.

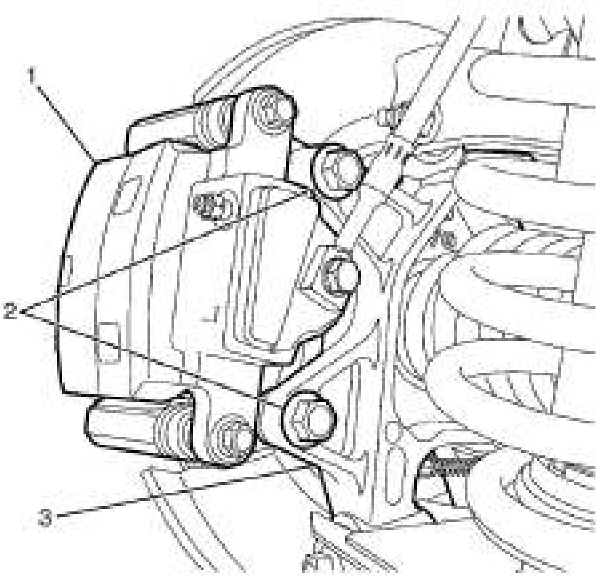
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
3. Remove the rear wheels. Refer to Tire and Wheel Removal and Installation .



4. Install two wheel nuts in reverse (3) to opposite wheel studs to retain the brake disc to the hub.

Important: Position the ends of the G-clamp against the rear of the brake caliper (1) and against the outboard brake pad (2).

5. Install large G-clamp over the body of the brake caliper (1).
6. Tighten the G-clamp until the brake caliper piston bottoms out in the brake caliper bore.
7. Remove the G-clamp from the brake caliper (1).



Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

Important: Make sure all the bolt holes are thoroughly cleaned and all micro-encapsulated thread sealant is removed.

8. Remove the brake caliper anchor plate to knuckle retaining bolts (1).

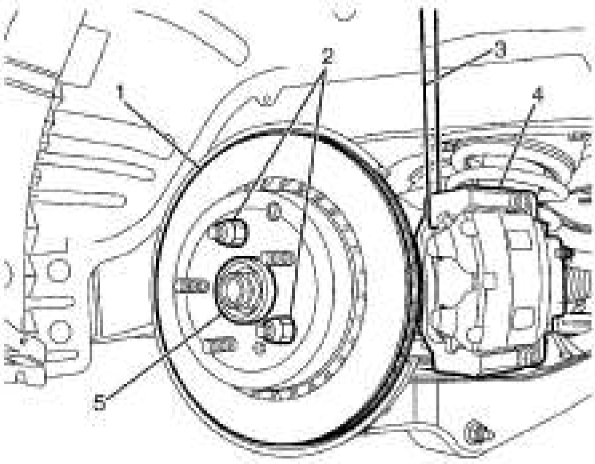
   Discard the bolts.

   Clean the bolt holes.

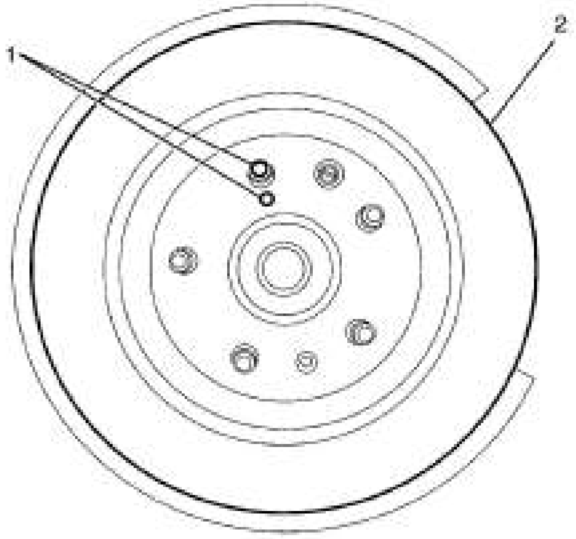
   Important: DO NOT disconnect the hydraulic brake flexible hose from the brake caliper otherwise complete bleeding of the braking system will be necessary.

9. Remove the brake caliper (2) from the knuckle (3).

   Notice: Refer to Brake Caliper Notice in the Preface section.



10. Support the brake caliper (1) with heavy mechanic's wire, or equivalent (2).
11. Remove the two wheel nuts (4) retaining the brake disc (3) to the hub (5).



Important: The brake disc to hub relationship is indexed during production. Mark the relationship of the brake disc to a wheel stud end for installation to minimise the potential of brake shudder.

Important: If the brake disc is being removed to be machined or replaced to rectify brake shudder, or if brake disc to hub matching is not evident, the brake disc to the hub must be indexed. Refer to Brake Rotor Assembled Lateral Runout Correction - Indexing .

12. Matchmark the position of the brake disc (2) to the wheel studs (1).
13. Remove the brake disc (2).

Installation Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Caution in the Preface section.

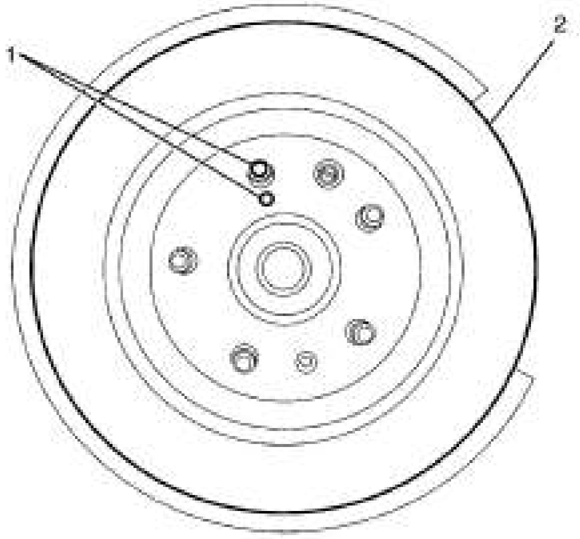
Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

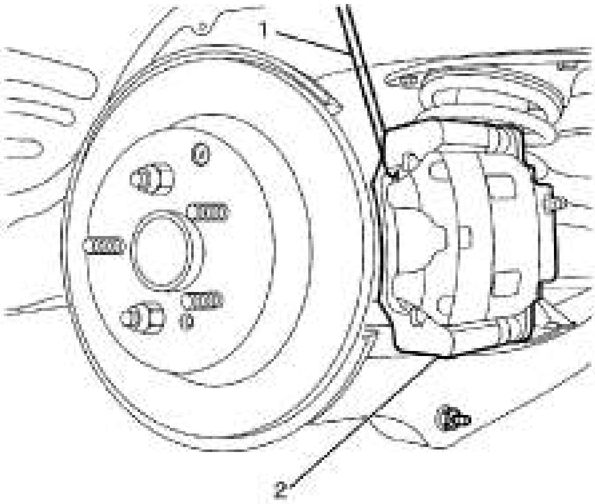
Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

Important: Whenever the brake disc has been separated from the hub/axle flange, any rust or contaminants should be cleaned from the hub/axle flange and the brake disc mating surfaces. Failure to do this may result in too much assembled lateral runout (LRO) of the brake disc, which may lead to brake pulsation.

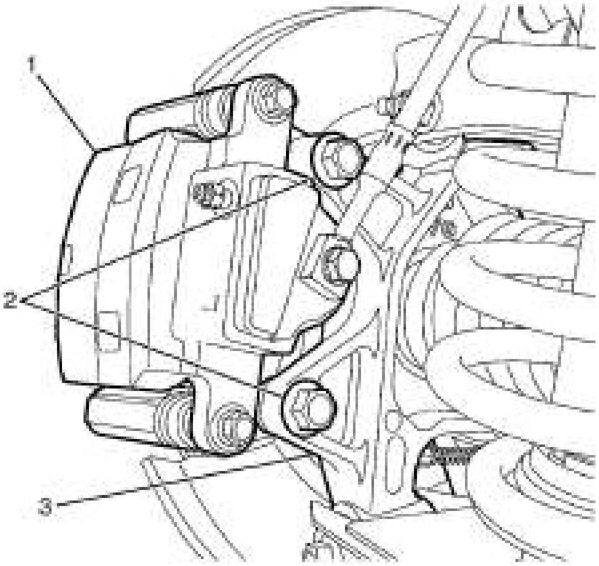
1. Clean any rust or corrosion from the mating surface of the hub/axle flange and mounting surface of the brake disc.
2. Inspect the mating surfaces of the hub/axle flange and the brake disc to make sure that there are no foreign particles or debris remaining.



3. Install the brake disc (2) to the hub/axle flange. Use the matchmark (1) made prior to removal for correct orientation to the flange.
4. If the brake disc was removed and installed as part of a brake system repair, measure the assembled lateral runout (LRO) of the brake disc to make sure optimum performance of the disc brakes. Refer to Brake Rotor Assembled Lateral Runout Measurement .
5. If the brake disc assembled LRO measurement exceeds the specification, bring the LRO to within specifications. Refer to Brake Rotor Assembled Lateral Runout Correction .



6. Remove the heavy mechanic's wire or equivalent support (2) from the brake caliper (1).



Notice: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

7. Install the brake caliper assembly (1) to the knuckle (3).

Notice: Refer to Fastener Notice in the Preface section.

8. Install the NEW brake caliper anchor plate to knuckle retaining bolts (2).

Tighten
Tighten the bolts to 110 Nm (82 lb ft).

9. Install the rear wheels. Refer to Tire and Wheel Removal and Installation .
10. Lower the vehicle to the ground.
11. With the engine OFF, gradually apply the brake pedal to approximately 2/3 of its travel distance.
12. Slowly release the brake pedal.
13. Repeat steps 11 and 12 until a firm brake pedal is obtained. This will correctly seat the brake caliper pistons and brake pads.
14. Fill the master cylinder reservoir to the correct level. Refer to Master Cylinder Reservoir Filling .
15. If the brake disc was refinished or replaced, or if new brake pads were installed, burnish the brake pads and brake discs. Refer to Brake Pad and Rotor Burnishing .

Rear Disc Brake Pads Replacement (RHD)

Removal Procedure

Tools Required

J 23738-A Hand Vacuum Pump.

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

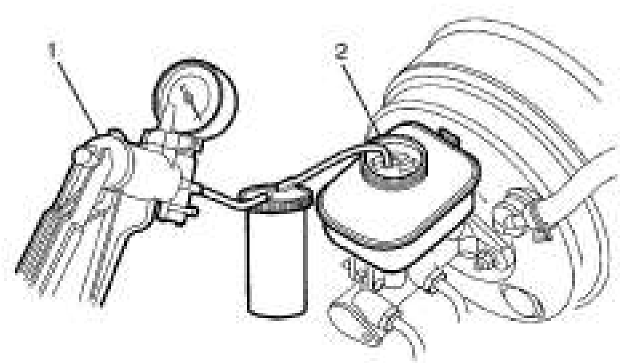
Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.



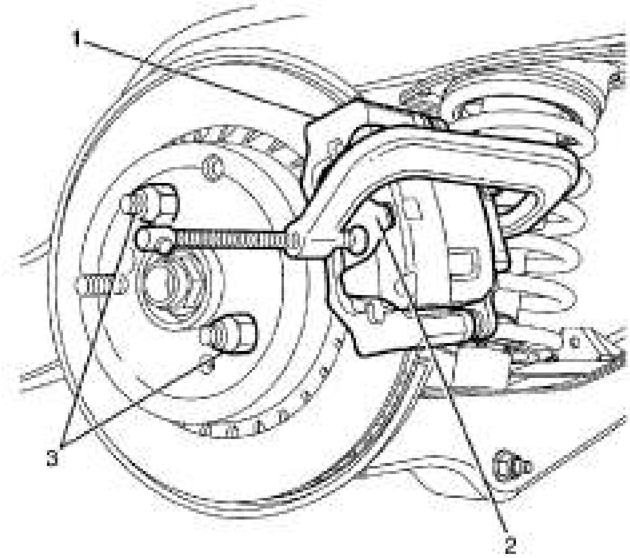
1. Inspect the fluid level in the master cylinder reservoir (2).
    - If the brake fluid level is midway between the maximum fill level and the minimum allowable level, no brake fluid needs to be removed from the master cylinder reservoir (2) before proceeding.

Important: DO NOT completely empty the master cylinder reservoir (2) or remove any brake lines otherwise complete bleeding of the braking system will be necessary.

Important: DO NOT re use the removed fluid.

- If the brake fluid level is higher than midway between the maximum fill level and the minimum allowable level, syphon the brake fluid to the midway point using a hand vacuum pump (1) before proceeding.

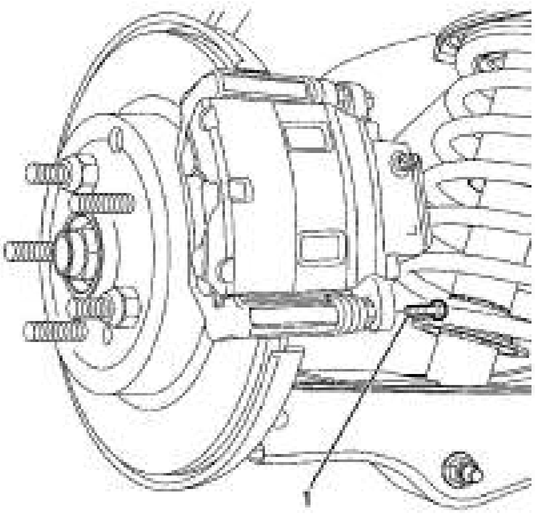
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
3. Remove rear wheels. Refer to Tire and Wheel Removal and Installation .



4. Install two wheel nuts (3) in reverse to opposite wheel studs to retain the brake disc to the hub.

Important: Position the ends of the G-clamp against the rear of the brake caliper (1) and against the outboard brake pad (2).

5. Install a large G-clamp over the body of the brake caliper (1).
6. Tighten the G-clamp until the brake caliper piston bottoms out in the brake caliper bore.
7. Remove the G-clamp from the brake caliper (1).



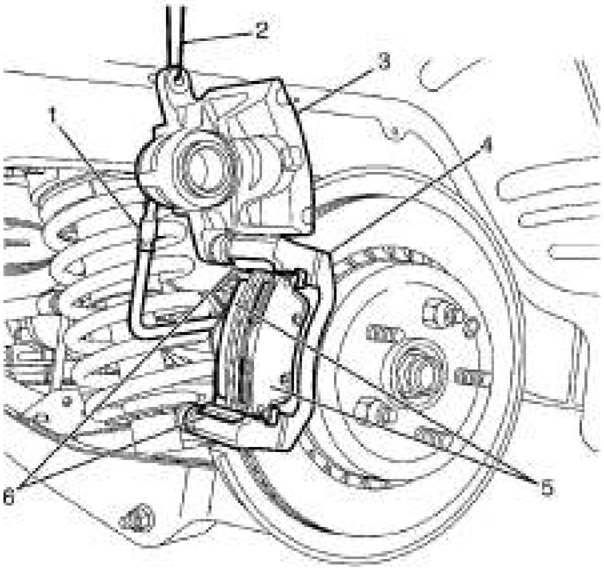
Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

Important: Make sure the bolt hole is thoroughly cleaned and all micro-encapsulated thread sealant is removed.

8. Remove the brake caliper lower guide pin bolt (1).

   Discard the bolt.

   Clean the bolt hole.



Notice: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

Important: DO NOT disconnect the brake hose (1) from the brake caliper (3).

9. Pivot the brake caliper (3) upward and secure with heavy mechanics wire (2), or equivalent.
10. Remove the brake pads (5) from the brake caliper anchor plate (4).
11. Remove the brake pad retainers (6) from the brake caliper anchor plate (4).
12. Clean the brake pad retainer mating surfaces of the brake caliper anchor plate (4).

Important: Inspect the brake caliper guide pins for freedom of movement and the condition of the guide pin boots. This is achieved by moving the guide pins inboard and outboard within the brake caliper anchor plate (4) bores, without disengaging the slides from the boots.

13. Inspect the brake caliper guide pins and boots for the following conditions:
    - Restricted brake caliper guide pin movement.
    - Too much brake caliper guide pin play in the brake caliper anchor plate (4).
    - Seized or binding brake caliper guide pins.
    - Split or torn boots.
14. If any of the conditions listed are found, overhaul or replace the brake caliper (3).

Installation Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

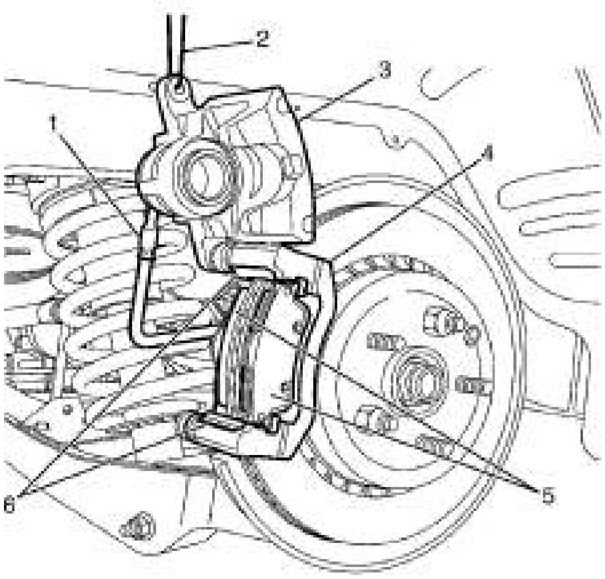
Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

1. Thoroughly clean both piston to brake pad contact faces as required.



2. Install the brake pad retainers (6) to the brake caliper anchor plate (4).

   Important: The brake pads (5) are marked as left hand inner and right hand inner and must only be fitted to their respective positions to optimise brake pad life and performance.

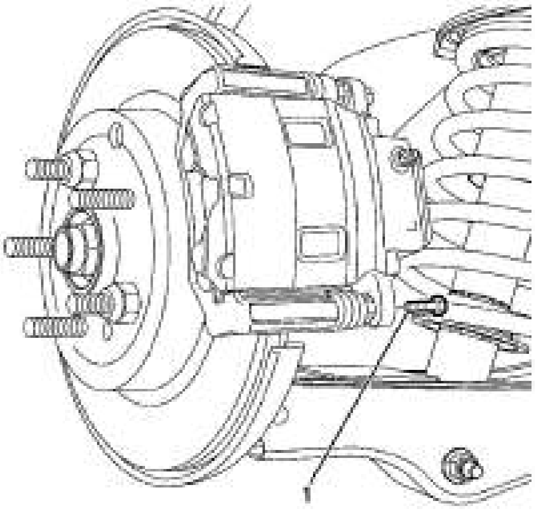
3. Install the brake pads (5) to the brake caliper anchor plate (4).

   Notice: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

4. Remove the mechanics wire or equivalent (2), and rotate the brake caliper (3) into position over the brake pads (5) and to the brake caliper anchor plate (4).

   Make sure the brake hose (1) is correctly located in its mounting bracket.

   Notice: Refer to Fastener Notice in the Preface section.



5. Install the NEW lower brake caliper guide pin bolt (1).

   Tighten
   Tighten the bolt to 42 Nm (31 lb ft).

6. Remove the wheel nuts retaining the brake disc to the hub.
7. Install the rear wheels. Refer to Tire and Wheel Removal and Installation .
8. Lower the vehicle to the ground.
9. With the engine off, gradually apply the brake pedal approximately 2/3 of its travel distance.
10. Slowly release the brake pedal.
11. Repeat steps 9 and 10 until a firm brake pedal is obtained. This will correctly seat the brake caliper pistons and brake pads.
12. Fill the master cylinder reservoir to the correct level. Refer to Master Cylinder Reservoir Filling .
13. Burnish (bed in) the brake pads and brake discs. Refer to Brake Pad and Rotor Burnishing .

Disc Brake System Description and Operation (LWB SWB)

System Component Description

The disc brake system consists of the following components:

Brake Pads: Applies mechanical output force from the hydraulic brake calipers to friction surfaces of brake discs.

Brake Discs: Uses mechanical output force applied to friction surfaces from the brake pads to slow speed of tyre and wheel assembly rotation.

Brake Caliper Anchor Plate: Provides mounting for the hydraulic brake caliper and secures the brake caliper firmly in correct relationship to the brake disc. Enables a sliding motion of the brake caliper to the brake pads when mechanical output force is applied and the reaction of the brake caliper anchor plate pulls the outer pad against the disc. The forces of the pads on each side of the disc are therefore equal.

Brake Caliper: The brake caliper incorporates either twin (front) or a single hydraulic piston (rear), each with a fluid seal. When hydraulic pressure is applied, a mechanical output force on the piston applies the inner pad against the disc. When the hydraulic pressure is released, the piston fluid seal/s retracts the piston/s a small amount, allowing the moving parts to relax sufficiently for the pads to remain in close proximity to the disc without dragging. Adjustment for wear is automatic.

System Operation

Mechanical output force is applied from the hydraulic brake caliper pistons to the inner brake pads. As the pistons press the inner brake pads outward, the brake calipers draw the outer brake pads inward. This allows the output force to be equally distributed. The brake pads apply the output force to the friction surfaces on both sides of the brake discs, which slows the rotation of the tyre and wheel assemblies. The correct function of both the brake pad and brake anchor plate is essential for even distribution of braking force.

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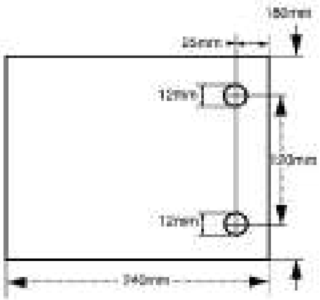
Special Tools

Illustration	Tool Number / Description
 	Pre Fabricated Mounting Plate

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Brake Hose to Caliper Banjo Bolt	35 Nm	26 lb ft
Brake Master Cylinder Reservoir to Brake Master Cylinder Retaining Screw	2 Nm	18 lb in
Brake Master Cylinder to Vacuum Brake Booster Retaining Nut	15 Nm	11 lb ft
Brake Pedal Assembly to Bulkhead Retaining Nut	22 Nm	16 lb ft
Brake Pedal Bracket Assembly to I/P Crossmember Retaining Bolt	22 Nm	16 lb ft
Brake Pedal Position Sensor to Brake Pedal Bracket Retaining Bolt	2 Nm	18 lb in
Brake Pipe Fitting at Brake Pressure Modulator Valve (BPNV)	16 Nm	12 lb ft
Brake Pipe Fitting at Master Cylinder	16 Nm	12 lb ft
Brake Pipe Fitting at Brake Hose	16 Nm	12 lb ft
Front Brake Hose Inner Wheel House to Frame Retaining Bolt	9 Nm	80 lb in
Front Brake Caliper Anchor Plate to Steering Knuckle Retaining Bolt	60 Nm +120°	44 lb ft +120°
Intermediate Brake Pipe to Brake Pipe Union	15 Nm	11 lb ft
Rear Brake Caliper to Knuckle Retaining Bolt	110 Nm	81 lb ft
Vacuum Brake Booster to Bulkhead Retaining Nuts	22 Nm	16 lb ft

Brake Component Specifications (LWB SWB)

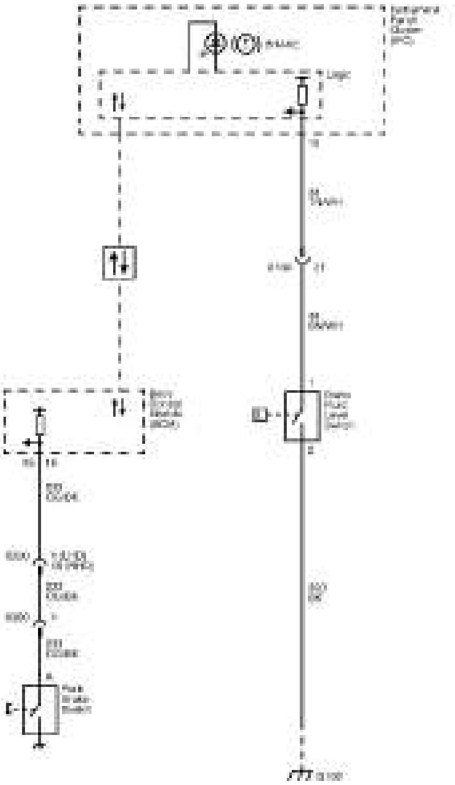
Application	Specification	
	Metric	English
Brake Caliper Bleeder Valve	12 N·m	106 lb in

Brake System Specifications (RHD)

Component	Application	Specification
Brake Fluid	Type	DOT 4 or Super DOT 4 (Up to BSI) Brake fluid conforming to SAE 1704 (As of BSI)
	Capacity	0.9 Litres (0.791 quarts)
Brake Booster	Make	Mando Corporation
	Type	Tandem Vacuum Suspended
	Size	203 mm (8 in) or 229 mm (9 in)
Master Cylinder	Type	Fore/aft split
	Bore Size	26 mm (1.023 in)
	Nominal Stroke	37 mm (1.456 in)
Brake Pedal Travel	Maximum Specification with 445 Nm (100 lbs) of force applied to the pedal with the ignition OFF and the booster power reserve depleted.	90 mm (3.54 in)

Hydraulic Brake Schematics

Hydraulic Brake Schematics


Instrument Panel Cluster (IPC)
Logic
Body Control Module (BCM)
Brake Fluid Level Switch
Park Brake Switch

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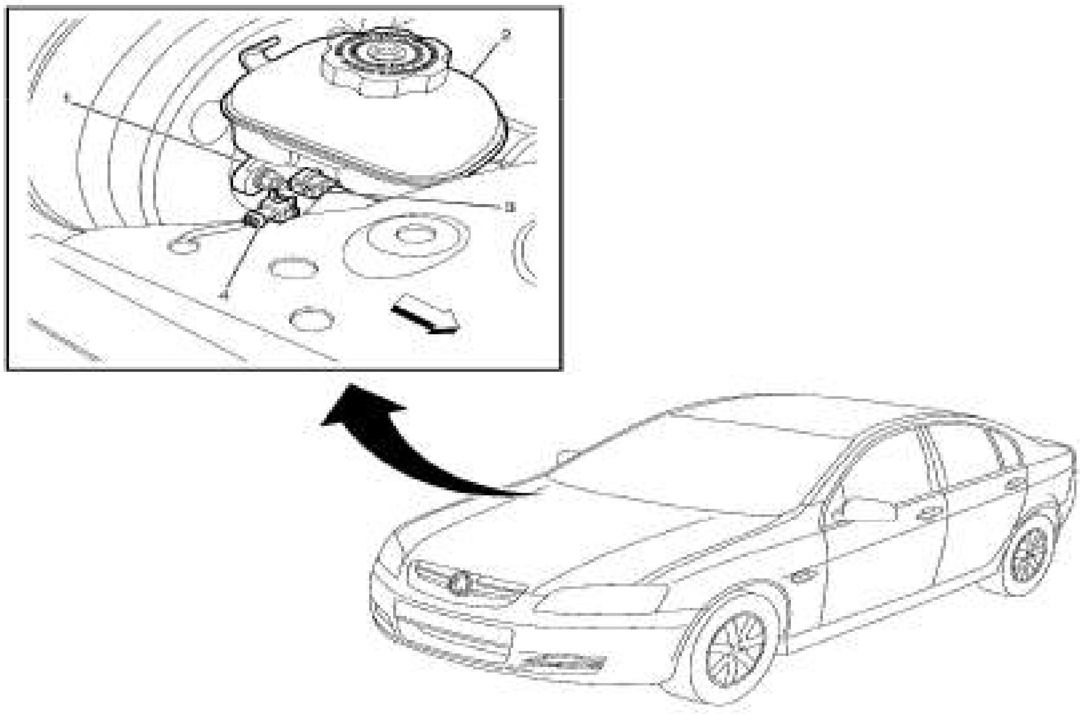
Hydraulic Brake Component Views (SWBRHD)

Brake Fluid Level Switch



(1) Master Cylinder Assembly
(2) Master Cylinder Reservoir
(3) Brake Fluid level Switch
(4) Brake Fluid level Switch Electrical Connector

Diagnostic Starting Point - Hydraulic Brakes

Begin the hydraulic brake system diagnosis with the Diagnostic System Check - Vehicle. The Diagnostic System Check will provide the following information:

- The identification of the control modules which command the system.
- The ability of the control modules to communicate through the serial data circuit.
- The identification of any stored diagnostic trouble codes (DTCs) and their status.

The use of the Diagnostic System Check will identify the correct procedure for diagnosing the system and where the procedure is located.

DTC C0126

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC C0126 00: Low Brake Fluid Indicated

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Brake Fluid Level Signal	C0126 00	1	1	--
Park Brake Signal	1	1	1	--
Ground	--	1	--	--
1. Brake Warning Indicator Malfunction				

Circuit/System Description

The brake fluid level switch monitors the level of brake fluid in the master cylinder. When the instrument panel cluster (IPC) sees the brake fluid level switch input closed, it turns ON the Red Brake Warning indicator and sends a serial data message to the electronic brake control module (EBCM) that the brake fluid level is low.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

- Low brake fluid is detected.
- A short to ground exists on the signal circuit.

Action Taken When the DTC Sets

- The EBCM disables the antilock brake system (ABS)/traction control system (TCS) dynamic rear proportion (DRP) and vehicle stability enhancement system (VSES).
- A DIC message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The EBCM clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Brake Warning System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Inspect for proper brake fluid level, the fluid level should be at or above the proper level.
   If low, refer to Brake Fluid Loss.
2. Ignition ON, observe the scan tool IPC Brake Fluid Level Switch parameter. The reading should be OFF.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the brake fluid level switch.
2. Test for less than 5 ohms between the ground circuit terminal 2 and ground.
   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, test for 4.8 - 5.2 volts between the 5 volt reference circuit terminal 1 and ground.
   If less than the specified range, test the 5 volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the IPC.

If greater than the specified range, test the 5 volt reference circuit for a short to voltage. If the circuit tests normal, replace the IPC.

4. If all circuits test normal, test or replace the brake fluid level switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Brake Fluid Level Indicator Switch Replacement
- Control Module References for IPC replacement, setup, and programming

Brake Warning Indicator Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Brake Fluid Level Signal	C0126 00	1	1	--
Park Brake Signal	1	1	1	--
Ground	--	1	--	--
1. Brake Warning Indicator Malfunction				

Circuit/System Description

The instrument panel cluster (IPC) sees the brake fluid level switch input opens and illuminates the Red Brake Warning indicator. The body control module (BCM) sees the park brake switch input grounded, it sends a serial data message to the IPC requesting illumination of the Red Brake Warning indicator.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Brake Warning System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections

- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the park brake is released and the brake fluid is at or above the proper level.

   If low, refer to Brake Fluid Loss.
2. Command the IPC display test with a scan tool, the warning indicator should turn ON.

   If the red brake warning indicator does not illuminate, replace the IPC.
3. Ignition ON, observe the scan tool BCM Park Brake Switch parameter while applying and releasing the park brake. The parameter should cycle between Active and Inactive.

   If the parameter does not cycle between the specified values, refer to Park Brake Switch Malfunction.
4. Observe the scan tool IPC Brake Fluid Level Switch parameter. The reading should be OFF.

   If not the specified value, refer to Brake Fluid Level Switch Malfunction.

Circuit/System Testing

Park Brake Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the park brake switch.
2. Ignition ON, verify the scan tool BCM Park Brake Switch parameter is Inactive.

   If not the specified value, test the signal circuit terminal A for a short to ground. If the circuit tests normal, replace the BCM.
3. Install a 3A fused jumper wire between the signal circuit terminal A and ground. Verify the scan tool BCM Park Brake Switch parameter is Active.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance.
4. If all circuits test normal, test or replace the park brake switch.

Brake Fluid Level Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the brake fluid level switch.
2. Test for less than 5 ohms between the ground circuit terminal 2 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, test for 4.8 - 5.2 volts between the 5 volt reference circuit terminal 1 and ground.

   If less than the specified range, test the 5 volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the IPC.

   If greater than the specified range, test the 5 volt reference circuit for a short to voltage. If the circuit tests normal, replace the IPC.
4. If all circuits test normal, test or replace the brake fluid level switch.

Component Testing

Park Brake Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the park brake switch.
2. Test for infinite resistance between the signal terminal A and ground with the park brake released.

   If less than the specified value, replace the park brake switch.
3. Test for less than 1 ohm between the signal terminal A and ground with the park brake applied.

   If greater than the specified range, replace the park brake switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Brake Fluid Level Indicator Switch Replacement
- Parking Brake Indicator Switch Replacement
- Control Module References for BCM and IPC replacement, setup, and programming

Brake Fluid Loss

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes s
2	Inspect the hydraulic brake system for correct operation. Refer to Hydraulic Brake System Diagnosis . Did you find and correct a condition?	Go to Step 6	Go to Step 3
3	Inspect the disc brake system for correct operation. Refer to Disc Brake System Diagnosis . Did you find and correct a condition?	Go to Step 6	Go to Step 4
4	1. Separate the master cylinder from the vacuum brake booster. DO NOT disconnect any brake pipes. Refer to Master Cylinder Replacement . 2. Inspect the rear of the master cylinder for a brake fluid leak. 3. Inspect for brake fluid in the vacuum brake booster. Did you find a brake fluid leak?	Go to Step 5	Go to Diagnostic Starting Point - Hydraulic Brakes
5	Replace the brake master cylinder and the vacuum brake booster. Refer to Master Cylinder Replacement and Power Vacuum Brake Booster Replacement Hydraulic Brakes. Did you complete the replacement?	Go to Step 6	--
6	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle to confirm correct operation. Refer to Brake System Vehicle Road Test . Is the condition still present?	Go to Step 2	System OK

Brake Pedal Excessive Effort

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	Inspect the hydraulic brake system for correct operation. Refer to Hydraulic Brake System Diagnosis. Did you find and correct a condition?	Go to Step 4	Go to Step 3
3	Inspect the disc brake system for correct operation. Refer to Disc Brake System Diagnosis. Did you find and correct a condition?	Go to Step 4	Go to Diagnostic Starting Point - Hydraulic Brakes
4	Road test the vehicle to confirm correct operation. Refer to Brake System Vehicle Road Test. Is the condition still present?	Go to Step 2	System OK

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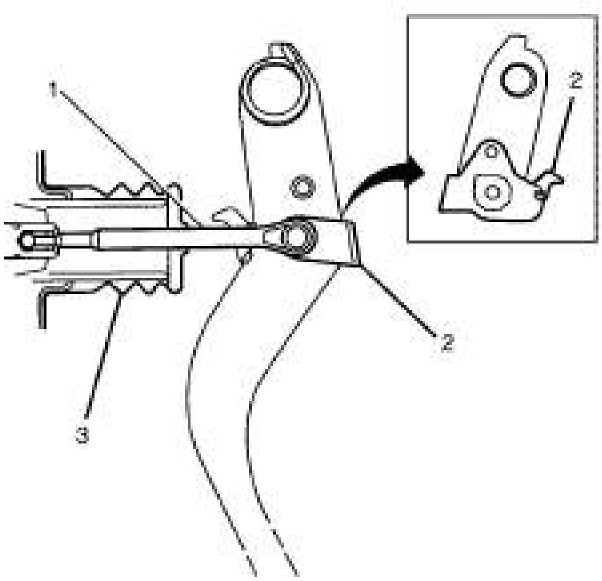
Brake Pedal Excessive Travel

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	Inspect for correct brake pedal travel. Refer to Brake Pedal Travel Measurement and Inspection . Is the brake pedal travel distance within the acceptable limits?	Go to Step 5	Go to Step 3
3	1. Inspect for worn, missing, misaligned, bent or damaged brake pedal system components. • For the brake pedal pushrod component inspection, refer to Brake Pedal Pushrod Inspection . • Inspect the brake pedal bushings for greater than desired wear and/or damage and inspect the brake pedal for a misaligned, bent, and/or damaged condition. 2. Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged. Refer to the following procedures as necessary. • Brake Pedal Assembly Replacement • Power Vacuum Brake Booster Replacement . Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?	Go to Step 4	Go to Step 5
4	Inspect for correct brake pedal travel. Refer to Brake Pedal Travel Measurement and Inspection . Is the brake pedal travel distance within the acceptable limits?	Go to Step 8	Go to Step 5
5	Inspect the hydraulic brake system for correct operation. Refer to Hydraulic Brake System Diagnosis . Did you find and correct a condition?	Go to Step 8	Go to Step 6
6	Inspect the disc brake system for correct operation. Refer to Disc Brake System Diagnosis . Did you find and correct a condition?	Go to Step 8	Go to Step 7
7	Inspect the brake assist system for correct operation. Refer to Symptoms - Hydraulic Brakes . Did you find and correct a condition?	Go to Step 8	Go to Diagnostic Starting Point - Hydraulic Brakes
	Road test the vehicle to confirm correct operation. Refer to Brake System Vehicle Road Test .		

8	Is the condition still present?	Go to Step 2	System OK

Brake Pedal Pushrod Inspection (RHD)



1. Disconnect the brake pedal pushrod (1) from the brake pedal. Refer to Brake Pedal Assembly Replacement.
2. Inspect the brake pedal pushrod eyelet bushing (2), for cracks and/or greater than desired wear.
3. Reposition the pedal pushrod boot (3) toward the front of the vehicle to expose as much of the pedal pushrod (1) as possible.
4. Inspect the brake pedal pushrod (1) for straightness.
5. If the brake pedal pushrod eyelet bushing (2) exhibited cracks and/or greater than desired wear, then the bushing requires replacement.
6. If the brake pedal pushrod (1) is not straight, then the pushrod requires replacement.
7. Return the pedal pushrod boot (3) to its original position on the pedal pushrod (1).
8. Connect the brake pedal pushrod (1) to the brake pedal. Refer to Brake Pedal Assembly Replacement.

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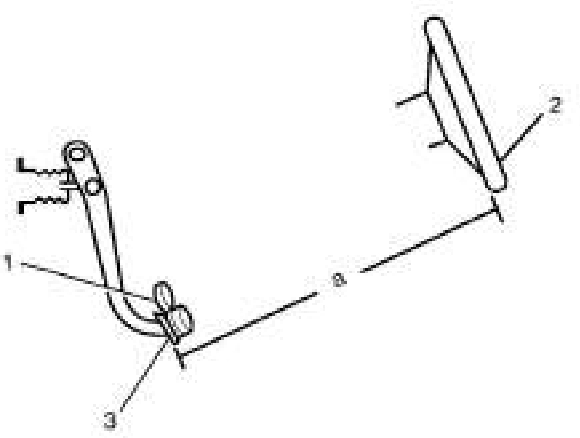
Brake Pedal Travel Measurement and Inspection

Tools Required

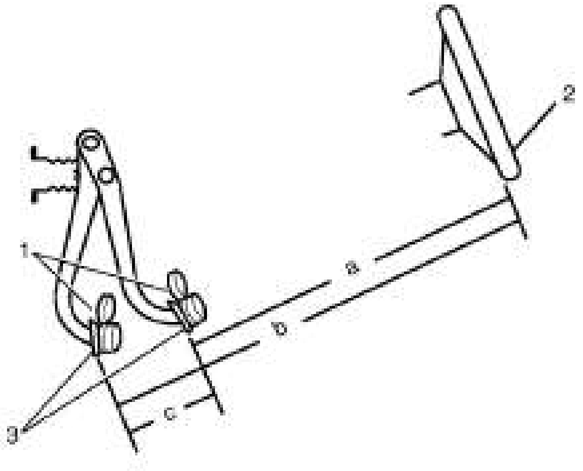
J 28662 Brake Pedal Effort Gauge.

> **Important:** With the ignition OFF and the brakes cool, apply the brakes three to five times or until the brake pedal effort increases significantly, in order to deplete the vacuum brake booster power reserve.

1. Deplete the vacuum brake booster power reserve.



2. Install the J 28662 (1) to the brake pedal (3).
3. Measure and record the distance (a) from the brake pedal (3) to the rim of the steering wheel (2); note the points of measurement.



4. Apply and maintain a force of 445 N (100 lb) to the brake pedal, as indicated on the J 28662 (1).
5. While maintaining 445 N (100 lb) of force to the brake pedal (3), measure and record the distance (b) from the same point on the brake pedal (3) to the same point on the rim of the steering wheel (2).
6. Release the brake pedal (3) and repeat steps 4 and 5 to obtain a second measurement.
7. Average the first and second measurements recorded for the two braking applications.
8. Subtract the initial unapplied distance (a), from the average applied distance (b) to obtain the brake pedal travel measurement (c).

   Specification
   Maximum brake pedal travel[dash]measured with the ignition OFF, vacuum brake booster power assist depleted, and the brakes cool: 90 mm (3.54 in).

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Brake Pipe and Hose Inspection

Caution: Refer to Safety Glasses Caution in the Preface section.

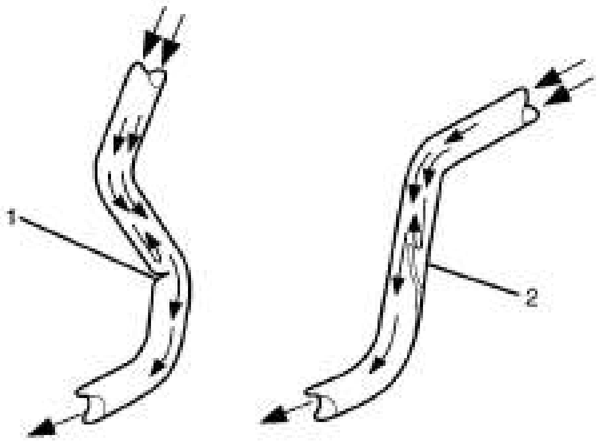
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

1. Visually inspect all of the brake pipes for the following conditions:
   - Kinks, incorrect routing, missing or damaged retainers
   - Leaking fittings, greater than desired corrosion
2. If any of the brake pipes exhibited any of the conditions listed, then the identified pipe, or pipes, require replacement.
3. Make sure that the vehicle axles are correctly supported at ride height in order to maintain the correct relationship of the flexible brake hoses to the chassis.



4. Visually inspect all of the flexible brake hoses for the following conditions:
   - Kinks (1), incorrect routing, twists, chafing, missing or damaged retainers
   - Leaking connections, perished, cracked, blistered, brittle or bulging hoses
5. If any of the flexible brake hoses exhibited any of the conditions listed, then the identified flexible brake hose, or hoses require replacement.
6. Squeeze the flexible brake hoses with firm finger pressure to inspect for soft spots (2), indicating an internal restriction. Inspect the entire length of each flexible brake hose.
7. If any of the flexible brake hoses were found to have soft spots (2), then the identified flexible brake hose, or hoses require replacement.

Brake Pulsation

Test Description

The numbers below refer to the step numbers on the diagnostic table:

2. Suspension components that are not operating correctly may cause a disturbance to the vehicle during application of the brake system.

3. Antilock brake system operation may produce feedback through the brake pedal during application of the brake system.

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	Inspect the suspension system for correct operation. Refer to Diagnostic Starting Point - Suspension General Diagnosis . Did you find and correct a condition?	Go to Step 6	Go to Step 3
3	Inspect the antilock brake system for correct operation. Refer to Diagnostic Starting Point - Antilock Brake System . Did you find and correct a condition?	Go to Step 6	Go to Step 4
4	Inspect the disc brake system for correct operation. Refer to Disc Brake System Diagnosis . Did you find and correct a condition?	Go to Step 6	Go to Step 5
5	Inspect the hydraulic brake system for correct operation. Refer to Hydraulic Brake System Diagnosis . Did you find and correct a condition?	Go to Step 6	Go to Diagnostic Starting Point - Hydraulic Brakes
6	Road test the vehicle in order to confirm correct operation. Refer to Brake System Vehicle Road Test . Is the condition still present?	Go to Step 2	System OK

Brake System External Leak Inspection

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

1. In order to inspect for external brake fluid leaks, first inspect the fluid level in the master cylinder.

   While a slight brake fluid level drop can be considered a normal condition due to brake lining wear, a very low level may indicate a brake fluid leak in the hydraulic system.

2. If the fluid level is abnormally low, adjust the brake fluid level. Refer to Master Cylinder Reservoir Filling.
3. Start the engine and allow it to idle.
4. Apply constant, moderate foot pressure to the brake pedal.

   If the brake pedal gradually falls away while under foot pressure, there may be a brake fluid leak.

5. Turn the ignition OFF .
6. Visually inspect the following brake system components for brake fluid leaks, greater than desired corrosion, and damage. Give particular attention to all brake pipe and flexible hose connections to make sure that there are not any slight brake fluid leaks [dash] even though the brake pedal may feel firm and hold steady:
   - Master cylinder brake pipe fittings.
   - All brake pipe connections.
   - Brake pipes.
   - Brake hoses and connections.
   - Brake calipers.
7. While slight dampness around the master cylinder reservoir can be considered acceptable, brake fluid leaking from any of the brake system components requires immediate attention. If any of these components exhibit signs of brake fluid leakage, repair or replace those components. After the repair or replacement, inspect the hydraulic brake system to make sure of correct function.

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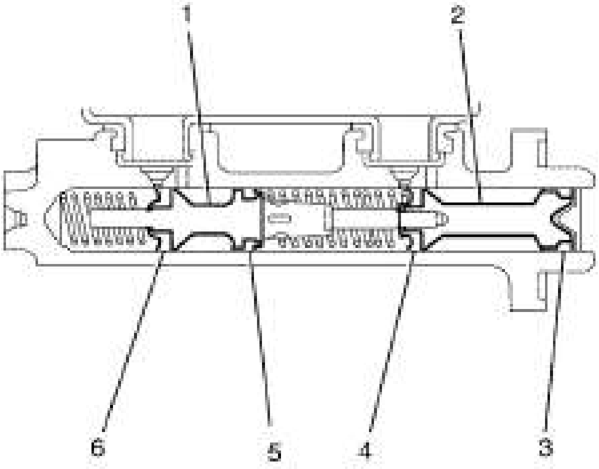
Brake System Internal Leak Test

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

1. Start the engine and allow it to idle.
2. Apply light, steady pressure to the brake pedal. Observe both the brake pedal feel and travel.
3. Release the brakes and turn the ignition OFF .
4. If the brake pedal apply felt spongy, but the brake pedal travel was not greater than desired, perform the following steps:
    - 4.1. Inspect the brake system for external leaks. Refer to Brake System External Leak Inspection .
    - 4.2. Pressure bleed the brake system in order to purge any air that may be trapped in the system. Refer to Hydraulic Brake System Bleeding .



5. If the brake pedal apply did not feel spongy, but the brake pedal travel was greater than desired, perform the following steps:
    - 5.1. Loosen the master cylinder to vacuum brake booster retaining nuts.
    - 5.2. Carefully pull the master cylinder away from the vacuum brake booster just enough to inspect the mounting surface of the master cylinder.
    - 5.3. Inspect the master cylinder mounting surface at the primary piston (2) for brake fluid leaks.
6. If the master cylinder exhibits any leakage around the primary piston (2), then the primary piston primary seal (4) and/or secondary seal (3) is leaking and the master cylinder requires replacement.
7. If the master cylinder primary piston (2) does not exhibit any leakage, pressure bleed the brake system. Refer to Hydraulic Brake System Bleeding .

8. If the brake pedal apply did not feel spongy, and the brake pedal travel was initially steady and not greater than desired, but then gradually fell, then the master cylinder requires overhaul or replacement due to an internal leak past the secondary piston (1) from the secondary piston primary seal (6) or secondary seal (5).
9. If the brake pedal apply did not feel spongy, and the brake pedal travel was initially steady and not greater than desired, then fell slightly, then became steady again, then the brake pressure modulator valve (BPMV) may be leaking internally, and may require replacement.

Brake System Noise

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	Inspect the disc brake system for correct operation. Refer to Disc Brake System Diagnosis . Did you find and correct a condition?	Go to Step 7	Go to Step 3
3	Inspect the hydraulic brake system for correct operation. Refer to Hydraulic Brake System Diagnosis . Did you find and correct a condition?	Go to Step 7	Go to Step 4
4	Make sure the park brake shoes are not adjusted too tightly, possibly causing a noise under certain conditions. Are the park brake shoes adjusted too tightly?	Go to Step 5	Go to Step 6
5	1. Clean and inspect the park brake shoes for greater than desired wear and/or damage. 2. Inspect the drum portion of the brake discs for greater than desired wear, blueing discoloration, heat spots, and greater than desired radial run out. 3. If any of these conditions are present, replace the affected components. 4. Adjust the park brake system. Did you find and correct a condition?	Go to Step 7	Go to Step 6
6	Inspect the park brake system for correct operation. Refer to Park Brake System Diagnosis . Did you find and correct a condition?	Go to Step 7	Go to Diagnostic Starting Point - Hydraulic Brakes
7	Road test the vehicle in order to confirm correct operation. Refer to Brake System Vehicle Road Test . Is the condition still present?	Go to Step 2	System OK

Brake System Slow Release

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	Inspect the hydraulic brake system for correct operation. Refer to Hydraulic Brake System Diagnosis. Did you find and correct a condition?	Go to Step 4	Go to Step 3
3	Inspect the disc brake system for correct operation. Refer to Disc Brake System Diagnosis. Did you find and correct a condition?	Go to Step 4	Go to Diagnostic Starting Point - Hydraulic Brakes
4	Road test the vehicle to confirm correct operation. Refer to Brake System Vehicle Road Test. Is the condition still present?	Go to Step 2	System OK

Brake System Vacuum Source Test

Important:

- Engine temperature, accessory load, and elevation level will affect engine vacuum.
- Vacuum readings will decrease by approximately 2.7 kPa (0.8 in Hg) for every 305 m (1000 ft) of elevation above sea level.

1. Disconnect the engine vacuum hose from the vacuum brake booster check valve.
2. Install a vacuum gauge to the engine vacuum hose.
3. Start the engine and allow the engine to idle until normal operating temperatures are reached.
4. With the vehicle in PARK or NEUTRAL with the park brake on, the engine idling, and the air conditioning (A/C) system OFF, check to see if the engine vacuum reading is within the specified normal engine vacuum range.

   Specification
   47-68 kPa (14-20 in Hg)

5. Turn the ignition OFF.
6. If the engine vacuum reading is within the specified normal range, proceed to step 10.
7. If the engine vacuum reading is NOT within the specified normal range, inspect the engine vacuum hose for the following conditions.
   - Loose connection to the engine.
   - Collapse, deformation or contamination.
   - Cracks, cuts, or brittleness.
8. If any of these conditions were found with the engine vacuum hose, replace the hose, then repeat steps 2 [dash] 4.
9. If none of these conditions were found with the engine vacuum hose, then there is an engine vacuum source condition, check the engine vacuum system.
10. Remove the vacuum brake booster check valve from the booster.
11. Install the check valve to the engine vacuum hose.
12. Install the vacuum gauge to the check valve.
13. Start the engine and allow the engine to idle in park or neutral with the park brake on and with the A/C system OFF, until normal operating temperatures are reached.
14. Turn the ignition OFF.
15. Visually inspect the engine vacuum reading is maintained within the specified normal engine vacuum range.

    Specification
    47-68 kPa (14-20 in Hg)

16. If the engine vacuum reading is maintained within the specified normal range, proceed to step 18.
17. If the engine vacuum reading is NOT maintained within the specified normal range, replace the vacuum brake booster check valve, then repeat steps 11 15.
18. Inspect the vacuum brake booster check valve grommet for the following conditions:
    - Loose connection to the vacuum brake booster.
    - Deformation or contamination.
    - Cracks, cuts or brittleness.

19. If any of these conditions were found with the check valve grommet, replace the grommet.

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Brake System Vehicle Road Test

Preliminary Inspections

1. Visually inspect easily accessible brake system components for obvious damage and/or leaks which may indicate that the vehicle should not be driven until further inspections have been completed.
2. Inspect the brake fluid level in the master cylinder reservoir and top up only if necessary for brake system road testing. Refer to Master Cylinder Reservoir Filling .
3. Inspect the tyre inflation pressures and adjust as necessary.
4. Inspect the tyre tread patterns to make sure that they are the same or very similar, especially per axle.
5. Make sure that the vehicle is not loaded unevenly prior to brake system road testing.

Road Testing Procedure

Caution: Refer to Road Test Caution in the Preface section.

1. Start the engine and allow it to idle.
2. Visually inspect if the brake warning indicator remains illuminated.
3. If the brake system warning lamp remains illuminated, DO NOT proceed to test drive the vehicle until it is diagnosed and repaired. Refer to Symptoms - Hydraulic Brakes .
4. Select a smooth, dry, clean and level road or large allotment that is as free of traffic and obstacles as possible for brake system low speed road testing.
5. On a level surface, put the transmission in Park or Neutral and lightly apply the brake pedal. Observe both the pedal feel and the pedal travel.
   - If the brake pedal application felt spongy, or the pedal travel was greater than desired, DO NOT drive the vehicle until it is repaired.
   - If the brake pedal application did not feel spongy and the pedal travel was not greater than desired, proceed to step 6.
6. Release and apply the brakes.
7. While continuing to apply the brakes, shift the transmission into DRIVE or 1st, release the brakes and allow the engine to idle the vehicle away from the stopped position. Observe for a slow release of the brake system.
8. With the aid of an assistant to observe the vehicle's performance from outside of the vehicle, drive the vehicle at a low speed and lightly apply the brakes while driving past the assistant. Have the assistant observe for brake system noise from the side of the vehicle closest to them, while you observe both the pedal effort and the pedal travel.
   - If the brake pedal application effort was greater than desired, or the pedal travel was greater than desired, DO NOT continue to test drive the vehicle until it is repaired.
   - If the brake pedal application effort was not greater than desired and the pedal travel was not greater than desired, proceed to step 9.
9. Drive the vehicle in the opposite direction, at the same low speed and lightly apply the brakes while driving past the assistant. Have the assistant observe for brake system noise from the side of the vehicle closest to the assistant.
10. Drive the vehicle at a low speed and shift the transmission into NEUTRAL without applying the brakes. Observe for a rapid deceleration in vehicle speed, indicating possible brake drag.
11. Select a smooth, dry, clean and level road that is as free of heavy traffic as possible for brake system moderate speed road testing.
12. Drive the vehicle at a moderate speed. Observe for a pull and/or incorrect tracking of the

vehicle without the brakes applied.

13. While continuing to drive the vehicle at a moderate speed, perform several light brake applications. Observe the pedal effort and the pedal travel, observe for brake system noise, pulsation and/or brake drag.
    - If the brake pedal application effort was greater than desired, or the pedal travel was greater than desired, DO NOT continue to test drive the vehicle until it is repaired.
    - If the brake pedal application effort was not greater than desired and the pedal travel was not greater than desired, proceed to step 14.
14. While continuing to drive the vehicle at a moderate speed, perform several moderate brake applications. Observe the pedal effort and the pedal travel, observe for brake system pulsation and/or uneven braking action [dash] either side to side, or front to rear.

    A small amount of vehicle front end dip is expected during a moderate brake application.

15. If the brake pedal apply effort was greater than desired, or the pedal travel was greater than desired, DO NOT continue to test drive the vehicle until it is repaired.

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Brakes Drag

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	Inspect the brake pedal position sensor for correct adjustment to make sure that the brake pedal is fully releasing. Refer to Brake Pedal Travel Measurement and Inspection Did you find and correct a condition?	Go to Step 10	Go to Step 3
3	Inspect the park brake system for correct operation. Refer to Park Brake System Diagnosis . Did you find and correct a condition?	Go to Step 10	Go to Step 4
4	Inspect the disc brake system for correct operation. Refer to Disc Brake System Diagnosis . Did you find and correct a condition?	Go to Step 10	Go to Step 5
5	1. Separate the vacuum brake booster pushrod from the brake pedal. Refer to Brake Pedal Assembly Replacement in Hydraulic Brakes. 2. Inspect each brake assembly to determine if the brake drag condition is still present. Do any brake assemblies still exhibit the brake drag condition?	Go to Step 7	Go to Step 6
6	Replace the brake pedal assembly. Refer to Brake Pedal Assembly Replacement . Did you complete the replacement?	Go to Step 10	--
7	1. Separate the master cylinder from the vacuum brake booster. DO NOT disconnect any brake pipes. Refer to Master Cylinder Replacement . 2. Inspect the brake assemblies to determine if the brake drag condition is still present. Do any brake assemblies still exhibit the brake drag condition?	Go to Step 10	Go to Step 8
8	Replace the vacuum brake booster. Refer to Power Vacuum Brake Booster Replacement . Did you complete the replacement?	Go to Step 10	--
9	Inspect the hydraulic brake system for correct operation. Refer to Hydraulic Brake System Diagnosis	Go to	Go to Diagnostic Starting Point -

	Did you find and correct a condition?	Step 10	Hydraulic Brakes
10	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle to confirm correct operation. Refer to Brake System Vehicle Road Test . Is the condition still present?	Go to Step 2	System OK

Braking Action Uneven - Front to Rear

Test Description

The number below refer to the step number on the diagnostic table:

2. Suspension components that are not operating correctly may cause a disturbance to the vehicle during application of the brake system.

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	Inspect the suspension system for correct operation. Refer to Diagnostic Starting Point - Suspension General Diagnosis. Did you find and correct a condition?	Go to Step 5	Go to Step 3
3	Inspect the hydraulic brake system for correct operation. Refer to Hydraulic Brake System Diagnosis. Did you find and correct a condition?	Go to Step 5	Go to Step 4
4	Inspect the disc brake system for correct operation. Refer to Disc Brake System Diagnosis. Did you find and correct a condition?	Go to Step 5	Go to Diagnostic Starting Point - Hydraulic Brakes
5	Road test the vehicle in order to confirm correct operation. Refer to Brake System Vehicle Road Test. Is the condition still present?	Go to Step 2	System OK

Braking Action Uneven - Pulls to One Side

Test Description

The numbers below refer to the step numbers on the diagnostic table:

2. Suspension components that are not operating correctly may cause a disturbance to the vehicle during application of the brake system.

3. Steering components that are not operating correctly may cause a disturbance to the vehicle during application of the brake system.

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	Inspect the suspension system for correct operation. Refer to Diagnostic Starting Point - Suspension General Diagnosis. Did you find and correct a condition?	Go to Step 6	Go to Step 3
3	Inspect the steering system for correct operation. Refer to Diagnostic Starting Point - Power Steering System. Did you find and correct a condition?	Go to Step 6	Go to Step 4
4	Inspect the hydraulic brake system for correct operation. Refer to Hydraulic Brake System Diagnosis. Did you find and correct a condition?	Go to Step 6	Go to Step 5
5	Inspect the disc brake system for correct operation. Refer to Disc Brake System Diagnosis. Did you find and correct a condition?	Go to Step 6	Go to Diagnostic Starting Point - Hydraulic Brakes
6	Road test the vehicle in order to confirm correct operation. Refer to Brake System Vehicle Road Test. Is the condition still present?	Go to Step 2	System OK

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Disc Brake System Diagnosis

Test Description

The numbers below refer to the step numbers on the diagnostic table:

9. Lubricant leaks from non-brake system components may come in contact with and contaminate brake system components.

10. Lubricant leaks from non-brake system components may come in contact with and contaminate brake system components.

12. Disc brake disc shields/backing plates that come in contact with disc brake discs may cause brake system noise.

15. Disc brake disc thickness variation that exceeds the maximum acceptable level can cause brake pulsation.

19. Disc brake disc thickness variation that exceeds the maximum acceptable level can cause brake pulsation.

22. Disc brake disc assembled lateral runout (LRO) that exceeds the maximum acceptable level can lead to thickness variation.

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the DISC brake system in order to determine if the DISC brake system is operating correctly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	Visually inspect the brake pads for the following conditions: Refer to Brake Pad Inspection . • Lining thickness below specifications • Uneven and/or abnormal wear edge-to-edge and/or side-to-side • Looseness or damage including brake pad hardware • Evidence of contamination from an external substance Did you find any conditions to indicate a concern with any of the front and/or rear brake pad?	Go to Step 3	Go to Step 12

3	Are any of the front and/or rear brake pads contaminated?	Go to Step 8	Go to Step 4
4	Are any of the front and/or rear brake pads worn unevenly?	Go to Step 7	Go to Step 5
5	Are any of the front and/or rear brake pads and/or brake pad hardware loose or damaged?	Go to Step 7	Go to Step 6
6	1. Remove and inspect the worn brake pads for glazing, looseness, heat spots or damage. 2. Replace the worn brake pads as a complete axle set. Refer to Front Disc Brake Pads Replacement and/or Rear Disc Brake Pads Replacement . Did you complete the inspection and replacement?	Go to Step 12	--
7	**Notice:** Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak. **Important:** Do NOT disconnect the hydraulic brake flex hoses from the brake calipers. 1. Remove the front and/or rear brake calipers, as appropriate, from the brake caliper anchor plates and support the brake calipers. Refer to Front Brake Rotor Replacement or Rear Brake Rotor Replacement . 2. Inspect the brake caliper anchor plate and the mounting/sliding hardware for the following conditions: • Binding or seized brake caliper slides • Worn, damaged or missing components • Loose, bent, cracked, or damaged brake caliper anchor plate 3. Replace components as required. Refer to the following procedures as required: • Front Brake Caliper Replacement . • Rear Brake Caliper Replacement . 4. Replace the unevenly-worn, loose or damaged brake pads as a complete axle set. Refer to Front Disc Brake Pads Replacement and/or Rear Disc Brake Pads Replacement . Did you complete the inspection and replacement?	Go to Step 12	--
	1. Inspect the brake calipers, brake hoses and brake pipes for evidence of an external brake fluid leak. 2. Replace any components found to be leaking brake fluid. Refer to the following procedures as required:		

8	- Front Brake Caliper Overhaul or Front Brake Caliper Replacement . - Rear Brake Caliper Overhaul or Rear Brake Caliper Replacement . - Front Brake Hose Replacement . - Rear Brake Hose Replacement . - Brake Pipe Replacement Caution . Did you find and correct the source of the leak causing contamination of the brake pads?	Go to Step 11	Go to Step 9
9	1. Inspect the wheel drive shaft outer seals for damage and evidence of a grease leak. 2. Replace any wheel drive shaft seal that is found to be leaking grease which may be the source of the contamination to the brake pads. Refer to Wheel Drive Shaft Outer Joint and Boot Replacement . Did you find and correct the source of the leak causing contamination of the brake pads?	Go to Step 11	Go to Step 10
10	1. Clean the remaining disc brake system components to remove any traces of the contaminant. **Notice:** Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak. **Important:** DO NOT disconnect the hydraulic brake flex hoses from the brake calipers. 2. Remove the front and/or rear brake calipers, as appropriate, from the brake caliper anchor plates and support the brake calipers. Refer to Front Brake Rotor Replacement and/or Rear Brake Rotor Replacement . 3. Inspect the brake caliper anchor plate/sliding hardware for the following conditions: - Binding or seized hardware - Distorted, worn, damaged or missing hardware components 4. Replace the brake calipers as required. Refer to Front Brake Caliper Replacement or Rear Brake Caliper Replacement . 5. Replace the contaminated brake pads as a complete axle set. Refer to Front Disc Brake Pads Replacement and/or Rear Disc Brake Pads Replacement . Did you complete the cleaning, inspection and	Go to	--

	replacement?	Step 11	
11	Visually inspect each of the rear disc brake disc shields/backing plates for evidence of contact with the brake discs. Are any of the brake disc shields/backing plates contacting the brake discs?	Go to Step 12	Go to Step 13
12	Repair or replace the disc brake disc shields/backing plates as required. Refer to Rear Disc Brake Backing Plate Replacement . Did you complete the repair or replacement?	Go to Step 13	--
13	1. Inspect the thickness of each of the brake discs. **Important:** Make the following determination AND ANSWER the question INDIVIDUALLY for EACH brake disc. 2. Make a determination for each brake disc if the brake disc can be REFINISHED and REMAIN ABOVE the minimum requirements. Refer to Brake Rotor Thickness Measurement . Does the brake disc meet the minimum requirements for REFINISHING?	Go to Step 14	Go to Step 17
14	**Important:** Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH brake disc. Inspect each of the brake discs for thickness variation that exceeds the maximum acceptable level. Refer to Brake Rotor Thickness Variation Measurement . Does the brake disc exhibit thickness variation that exceeds the maximum acceptable level?	Go to Step 16	Go to Step 15
15	1. Inspect each of the brake discs for the following surface and wear conditions: Refer to Brake Rotor Surface and Wear Inspection . • Heavy rust and/or pitting • Cracks and/or heat spots • Too much blueing, discoloration • Deep or greater than desired scoring beyond maximum acceptable level **Important:** Make the following determination AND ANSWER the question INDIVIDUALLY for EACH brake disc.		

	2. Make a determination for each brake disc if the brake disc requires refinishing based upon the results of the inspection. If the brake disc exhibits any of the conditions listed previously, it requires refinishing. Does the brake disc require REFINISHING?	Go to Step 16	Go to Step 21
16	1. Refinish the brake disc. Refer to Brake Rotor Refinishing . 2. Inspect the brake disc thickness. Refer to Brake Rotor Thickness Measurement . Were you able to REFINISH the brake disc within the minimum requirements?	Go to Step 21	Go to Step 20
17	Is the brake disc at or below the DISCARD requirements?	Go to Step 20	Go to Step 18
18	**Important:** Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH brake disc. Inspect each of the brake discs for thickness variation that exceeds the maximum acceptable level. Refer to Brake Rotor Thickness Variation Measurement . Does the brake disc exhibit thickness variation that exceeds the maximum acceptable level?	Go to Step 20	Go to Step 19
19	1. Inspect each of the brake discs for the following surface and wear conditions: Refer to Brake Rotor Surface and Wear Inspection . • Heavy rust and/or pitting • Cracks and/or heat spots • Too much blueing, discoloration • Deep or greater than desired scoring beyond maximum acceptable level **Important:** Make the following determination AND ANSWER the question INDIVIDUALLY for EACH brake disc. 2. Make a determination for each brake disc if the brake disc requires replacement based upon the results of the inspection. If the brake disc exhibits any of the conditions listed previously, it requires replacement. Does the brake disc require REPLACEMENT?	Go to Step 20	Go to Step 21
	Important: Whenever a brake disc is replaced, the		

20	assembled lateral runout (LRO) of the brake disc must be measured to make sure optimum performance of the disc brakes. Replace the brake disc. Refer to Front Brake Rotor Replacement or Rear Brake Rotor Replacement . Did you complete the replacement?	Go to Step 23	--
21	**Important:** Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH brake disc. Inspect each of the brake discs for assembled lateral runout (LRO) that exceeds the maximum acceptable level. Refer to Brake Rotor Assembled Lateral Runout Measurement . Does the brake disc exhibit assembled LRO that exceeds the maximum acceptable level?	Go to Step 22	Go to Step 23
22	Correct the LRO for each brake disc that was determined to have LRO exceeding the maximum acceptable level. Refer to Brake Rotor Assembled Lateral Runout Correction . Did you complete the operation?	Go to Step 23	--
23	Install or connect components that were removed or disconnected during diagnosis. Did you complete the operation?	Disc Brake System OK Return to Symptom Table	--

Hydraulic Brake Component Operation Visual Inspection

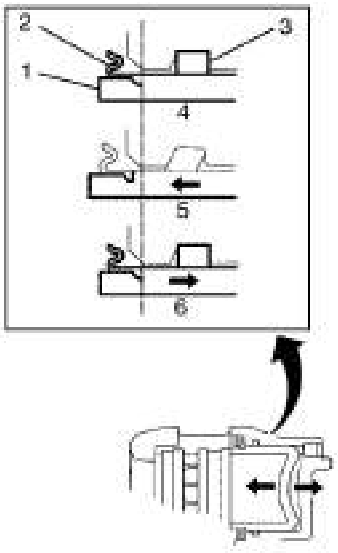
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.



1. With the tyre and wheel assemblies removed and the brake rotors retained by wheel nuts, visually inspect the brake caliper piston dust boot (2) sealing area to make sure that there are no brake fluid leaks.
2. If any evidence of a brake fluid leak is present, the brake caliper requires overhaul or replacement.
3. While the brake system is at rest (4), observe the position of the brake caliper piston (1) in relation to the brake caliper housing.
4. Have an assistant apply and release the brake pedal several times while you observe the operation of the hydraulic brake caliper.
   - 4.1. Observe the brake caliper piston (1) for unrestricted and even movement during each apply of the brake system (5).
   - 4.2. Observe the brake caliper piston (1) for an unrestricted and even return motion during each release of the brake system (6).
5. If the brake caliper piston (1) did not exhibit unrestricted and even movement during brake

system apply and/or release, the piston square seal (3) may be worn or damaged and the brake caliper may require overhaul or replacement.

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Hydraulic Brake System Diagnosis

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the HYDRAULIC brake system in order to determine if the HYDRAULIC brake system is operating correctly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	Inspect and adjust the brake fluid level in the brake master cylinder. Refer to Master Cylinder Reservoir Filling. Was the brake fluid level low?	Go to Step 3	Go to Step 4
3	1. Inspect the brake fluid for the following conditions, indicating brake fluid contamination: • Fluid separation, indicating two types of fluid are present - Swirled appearance - oil-based substance - Layered appearance - silicone-based substance • Fluid discoloration - Cloudy appearance - moisture - Dark appearance/suspended particles in fluid - dirt, rust, corrosion, brake dust 2. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating fluid contamination. Do any of the above conditions exist?	Go to Step 5	Go to Step 6
4	1. Inspect the brake fluid for the following conditions, indicating brake fluid contamination: • Fluid separation, indicating two types of fluid are present - Swirled appearance - oil-based substance - Layered appearance - silicone-based substance • Fluid discoloration - Cloudy appearance - moisture - Dark appearance/suspended particles in fluid - dirt, rust, corrosion, brake dust 2. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating fluid contamination.	Go to	

	Do any of the above conditions exist?	Step 5	Go to Step 12
5	1. Flush the hydraulic brake system. Refer to Hydraulic Brake System Flushing. 2. If the brake fluid WAS contaminated with an oil-based or a silicone-based fluid, indicated by fluid separation and/or a swollen master cylinder reservoir cap diaphragm and/or swollen reservoir-to-master cylinder grommets, perform the following steps. Refer to the procedures indicated. 2.1. Remove ALL of the following components listed. Each component contains internal rubber seals/linings which have been contaminated. 2.2. Clean out the hydraulic brake pipes using denatured alcohol, or equivalent. 2.3. Dry the brake pipes using non-lubricated, filtered air. 2.4. Repair or replace ALL of the following components listed. Each component contains internal rubber seals/linings which have been contaminated. • Replace the brake master cylinder reservoir cap diaphragm. • Master Cylinder Replacement • Brake master cylinder reservoir: Clean the brake master cylinder reservoir using denatured alcohol, or equivalent, then dry the reservoir using non-lubricated, filtered air, or if necessary, replace the brake master cylinder reservoir. • Front Brake Hose Replacement • Rear Brake Hose Replacement • Front Brake Caliper Overhaul or Front Brake Caliper Replacement • Rear Brake Caliper Overhaull or Rear Brake Caliper Replacement • Brake Pressure Modulator Valve Assembly Replacement 3. If the brake fluid was NOT contaminated with an oil-based fluid, but WAS contaminated with water or dirt, rust, corrosion, and/or brake dust, replace the brake master cylinder reservoir cap diaphragm which may have allowed moisture or dirt to enter the system. 4. Refill and bleed the hydraulic brake system. Refer to Hydraulic Brake System Bleeding or Hydraulic Brake System Bleeding. Did you complete the operation and any required repairs and/or replacements?	Go to Step 9	--

6	1. Inspect the following hydraulic brake system components for external fluid leaks. Repair or replace any of the components found to be leaking brake fluid. Refer to the appropriate procedures: - Brake master cylinder reservoir cap diaphragm - Master Cylinder Replacement - Front Brake Hose Replacement - Rear Brake Hose Replacement - Brake Pipe Replacement - Front Brake Caliper Overhaul or Front Brake Caliper Replacement - Rear Brake Caliper Overhaul or Rear Brake Caliper Replacement - Brake Pressure Modulator Valve Assembly Replacement 2. If you repaired or replaced any of the brake system components listed, bleed the hydraulic brake system. Refer to Hydraulic Brake System Bleeding or Hydraulic Brake System Bleeding. While bleeding the hydraulic brake system, observe for the following conditions: - The presence of air in the system at a bleeder valve location other than at the repair location, except if the brake master cylinder was replaced - An unrestricted and even flow of brake fluid per axle during the bleeding procedure Did you find and correct a condition?	Go to Step 7	Go to Step 12
7	Was there air in the system at a bleeder valve location other than at the repair location, except if the brake master cylinder was replaced?	Go to Step 19	Go to Step 8
8	Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?	Go to Step 9	Go to Step 10
9	Inspect the hydraulic function of the brake calipers for correct operation. Refer to Hydraulic Brake Component Operation Visual Inspection. Was the hydraulic function of the brake calipers operating correctly?	Go to Step 21	Go to Step 14
10	Was the flow of brake fluid restricted or uneven through front axle hydraulic components during the bleeding procedure?	Go to Step 13	Go to Step 11
11	Was the flow of brake fluid restricted or uneven through rear axle hydraulic components during the bleeding procedure?	Go to Step 17	--
12	Inspect the hydraulic function of the brake calipers/wheel cylinders for correct operation. Refer to Hydraulic Brake Component Operation Visual Inspection.		

	Was the hydraulic function of the brake calipers/wheel cylinders operating correctly?	Go to Step 15	Go to Step 13
13	Determine if the brake caliper is restricting the flow of brake fluid and/or not operating correctly: 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle. 2. Remove the tyre and wheel assemblies. Refer to Tire and Wheel Removal and Installation. 3. Open the suspected brake caliper bleeder valve. 4. Using a large G-clamp, compress the brake caliper piston and observe for an unrestricted flow of brake fluid and for free movement of the brake caliper piston. 5. Close the brake caliper bleeder valve. Was the flow of brake fluid unrestricted and did the brake caliper piston move freely?	Go to Step 17	Go to Step 14
14	Repair or replace any brake caliper that was not operating correctly. Refer to the appropriate procedure. • Front Brake Caliper Overhaul or Front Brake Caliper Replacement • Rear Brake Caliper Overhaul or Rear Brake Caliper Replacement Did you complete the repair and/or replacement?	Go to Step 21	--
15	Bleed the hydraulic brake system to observe for the presence of air in the system and to observe for an unrestricted and even flow of brake fluid per axle during the bleeding procedure. Refer to Hydraulic Brake System Bleeding or Hydraulic Brake System Bleeding. Was there air in the system?	Go to Step 19	Go to Step 16
16	Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?	Go to Step 21	Go to Step 17
17	1. Inspect the hydraulic brake pipes and flexible brake hoses for signs of a fluid restriction; such as being bent, kinked, pinched or damaged. Refer to Brake Pipe and Hose Inspection. 2. Replace any of the hydraulic brake pipes and/or flexible brake hoses found to be bent, kinked, pinched, or damaged. Refer to the following procedures as necessary: • Front Brake Hose Replacement • Rear Brake Hose Replacement • Brake Pipe Replacement Caution 3. If none of the hydraulic brake pipes or flexible brake hoses were visibly bent, kinked, pinched, or damaged, replace the hydraulic brake flex hose at the restricted location.		

	Did you find and correct a condition?	Go to Step 21	Go to Step 18
18	Replace the ABS brake modulator assembly, in order to correct the hydraulic brake dynamic rear proportioning mechanical operation. Refer to Brake Pressure Modulator Valve Assembly Replacement. Did you complete the replacement?	Go to Step 21	--
19	1. Inspect the hydraulic brake system components for brake fluid seepage at a seal and/or fitting location, which may have drawn air into the system. 2. Inspect the hydraulic brake system components for evidence of a recent repair, which may have introduced air into the system. 3. Repair or replace any of the components found to be installed incorrectly or seeping brake fluid. Did you find and correct a condition?	Go to Step 21	Go to Step 20
20	1. Inspect the brake master cylinder for internal fluid leaks. Refer to Brake System Internal Leak Test. 2. Repair or replace the brake master cylinder if it is found to be leaking brake fluid internally. Refer to Master Cylinder Replacement. Did you find and correct a condition?	Go to Step 21	Return to Symptom Table
21	Install or connect components that were removed or disconnected during diagnosis. Did you complete the operation?	Hydraulic Brake System OK Return to Symptom Table	--

Symptoms - Hydraulic Brakes

Important: The following steps must be completed before using the symptom tables.

1. Perform Diagnostic System Check - Vehicle before using the brake indicator symptom tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control module(s) can communicate via the serial data link.
2. Perform the Brake System Vehicle Road Test before using the hydraulic brake symptom tables in order to duplicate the customer's concern.
3. Review the system operation in order to familiarize yourself with the system functions. Refer to the following:
   - Brake Warning System Description and Operation
   - Hydraulic Brake System Description and Operation
   - Brake Assist System Description and Operation
   - Disc Brake System Description and Operation

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the brake warning system. Refer to Checking Aftermarket Accessories.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Brake Warning Indicator Malfunction
- Brake Pulsation
- Brake System Noise
- Braking Action Uneven - Pulls to One Side
- Braking Action Uneven - Front to Rear
- Brake Pedal Excessive Travel
- Brake Pedal Excessive Effort
- Brakes Drag
- Brake System Slow Release
- Brake Fluid Loss

Brake Fluid Level Indicator Switch Replacement

The master cylinder fluid level sensor is moulded into the master cylinder reservoir and is not serviced separately. The master cylinder fluid level sensor must be replaced with the master cylinder reservoir as an assembly. Refer to Master Cylinder Reservoir Replacement.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Brakes | Hydraulic Brakes | Repair Instructions | Document ID: 1967135

Brake Pedal Assembly Replacement (RHD)

Removal Procedure

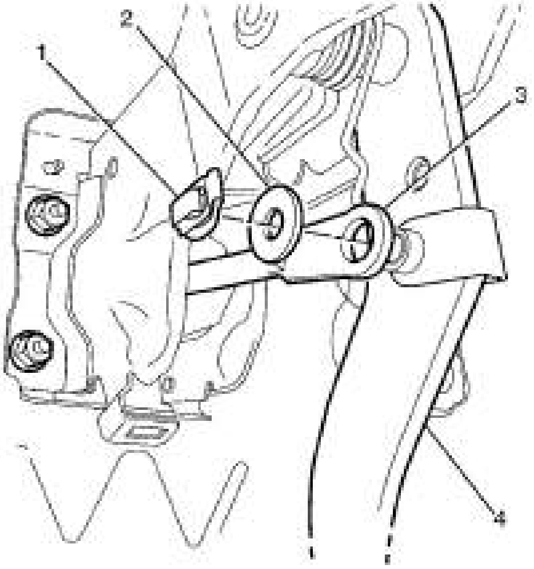
Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

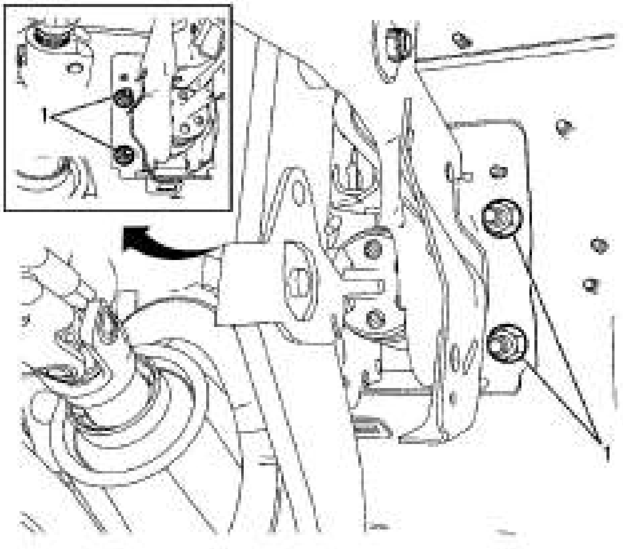
Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

1. Remove the instrument panel lower trim panel assembly. Refer to Knee Bolster Replacement.
2. Remove the instrument panel lower right trim plate assembly. Refer to Instrument Panel Insulator Panel Replacement - Right Side.
3. Remove the instrument panel lower trim panel retainer. Refer to Instrument Panel Retainer Replacement.
4. Remove the master cylinder from the vehicle. Refer to Master Cylinder Replacement.
5. Remove the vacuum hose and check valve from the vacuum brake booster. Refer to Power Brake Booster Inlet Hose Replacement.
6. Remove the brake pedal position sensor. Refer to Stop Lamp Switch Replacement.



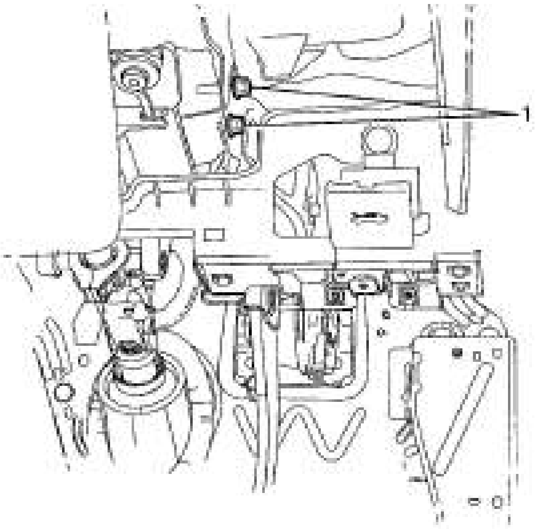
7. Remove the brake pedal pushrod retaining clip (1), washer (2) and the brake pedal pushrod (3) from the brake pedal (4).



8. Remove the vacuum brake booster to brake pedal support bracket retaining nuts (1).

Important: From the engine compartment, pull the vacuum brake booster forward to release the four studs from the bulkhead and brake pedal support bracket.

9. Remove the vacuum brake booster from the vehicle.



10. Remove the two brake pedal bracket assembly to instrument panel crossmember retaining bolts (1).

Important: Lower the brake pedal assembly rear end first to aid in removal.

11. Remove the brake pedal assembly from under the instrument panel.

Installation Procedure

Caution: Refer to Brake Fluid Caution in the Preface section.

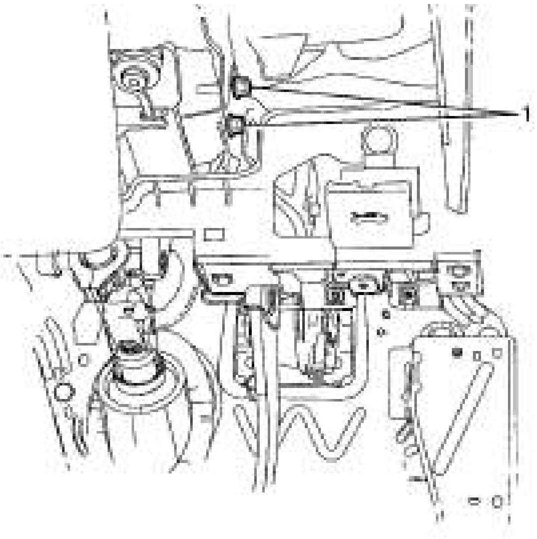
Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

Important: Raise the brake pedal assembly front end first to aid in installation.

1. Install the brake pedal assembly to the instrument panel crossmember.



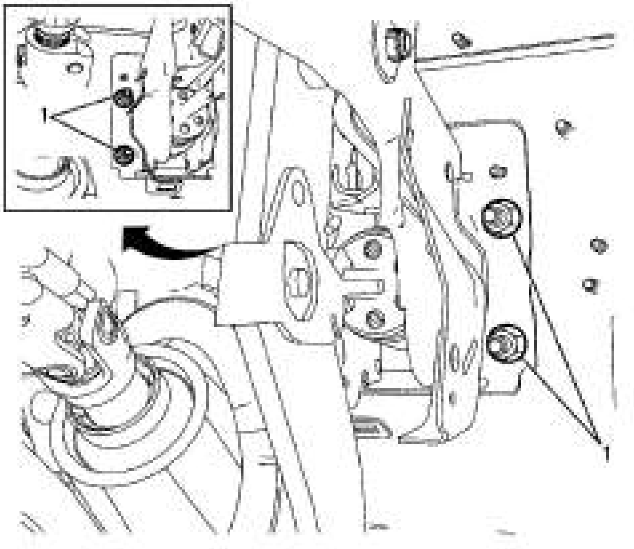
2. Install the two brake pedal bracket assembly to instrument panel crossmember retaining bolts (1).

   DO NOT fully tighten at this stage.

   Important: Make sure the vacuum brake booster's four studs are correctly located in the bulkhead and brake pedal support bracket.

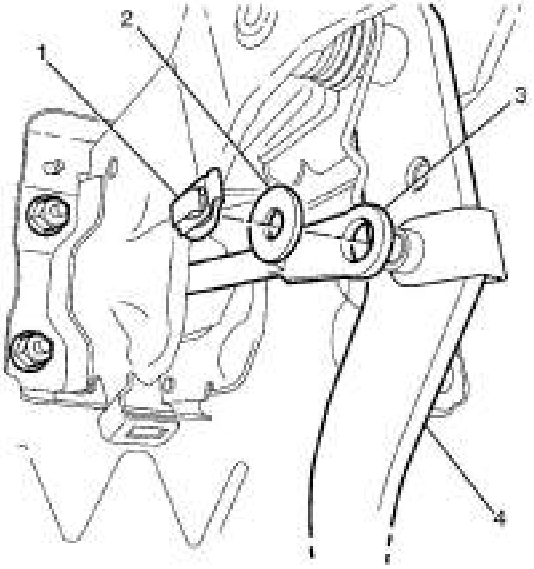
3. With the aid of an assistant install the vacuum brake booster from the engine compartment.

   Notice: Refer to Fastener Notice in the Preface section.

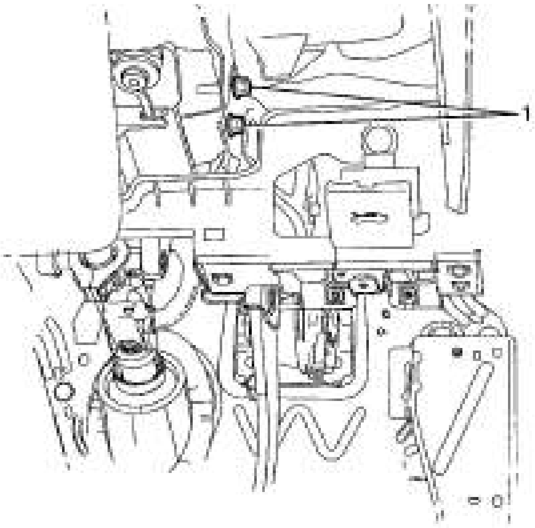


4. Install the vacuum brake booster to brake pedal support bracket retaining nuts (1).

   Tighten
   Tighten the nuts to 22 Nm (16 lb ft).



5. Install the push rod (3), washer (2) and retaining clip (1) to the brake pedal assembly (4).



6. Tighten the two brake pedal bracket assembly to cross car beam retaining bolts (1).

   Tighten
   Tighten the bolts to 23 Nm (17 lb ft).

7. Install the brake pedal position sensor. Refer to Stop Lamp Switch Replacement.
8. Install the vacuum hose and check valve to the vacuum brake booster. Refer to Power Brake Booster Inlet Hose Replacement.
9. Install the master cylinder. Refer to Master Cylinder Replacement.
10. Bleed the braking system. Refer to Hydraulic Brake System Bleeding.
11. Install the instrument panel lower trim panel retainer. Refer to Instrument Panel Insulator Panel Replacement - Right Side.
12. Install the instrument panel lower trim panel assembly. Refer to Knee Bolster Replacement.
13. Road test the vehicle to inspect correct brake, stop lamp and cruise control operation.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Brakes | Hydraulic Brakes | Repair Instructions | Document ID: 2194827

Brake Pipe Replacement (RHD)

Tools Required

J 23738-A J 23738-A Mityvac

Master Cylinder to Brake Pressure Modulator Valve (BPMV) Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

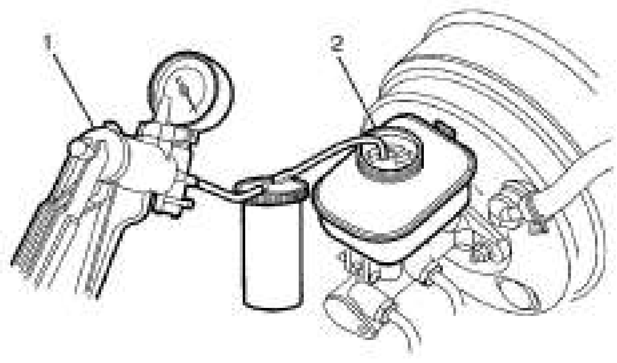
Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

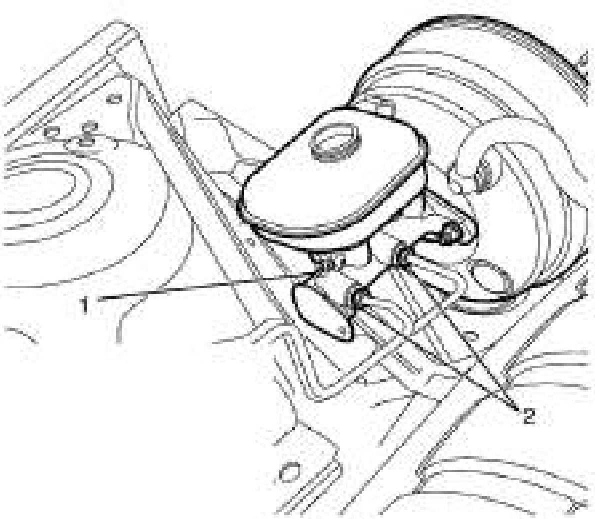
Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

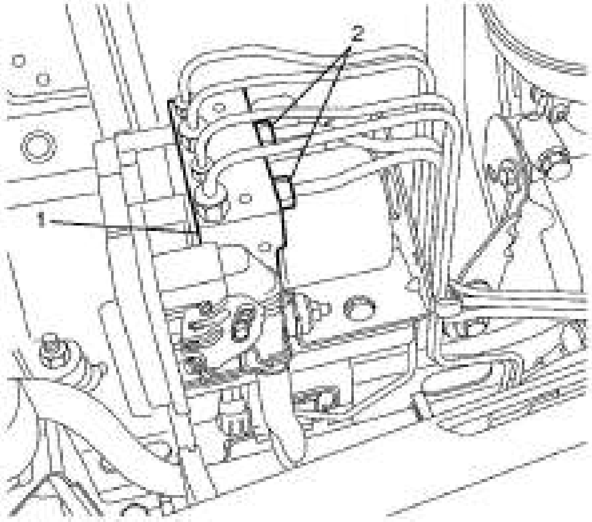
1. Clean the master cylinder, especially around the brake lines and reservoir cap.
2. Place a clean suitable container under the BPMV and master cylinder.
3. Remove the master cylinder reservoir cap.



4. Siphon the brake fluid out of the master cylinder reservoir (2) using the J 23738-A J 23738-A (1)



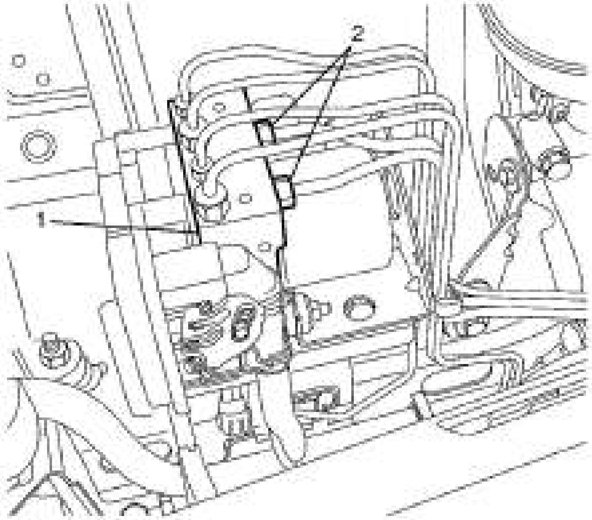
5. Remove the brake pipes (2) from the master cylinder (1).



Important: Record the location of all brake pipes to the BPMV assembly for use as an aid during installation.

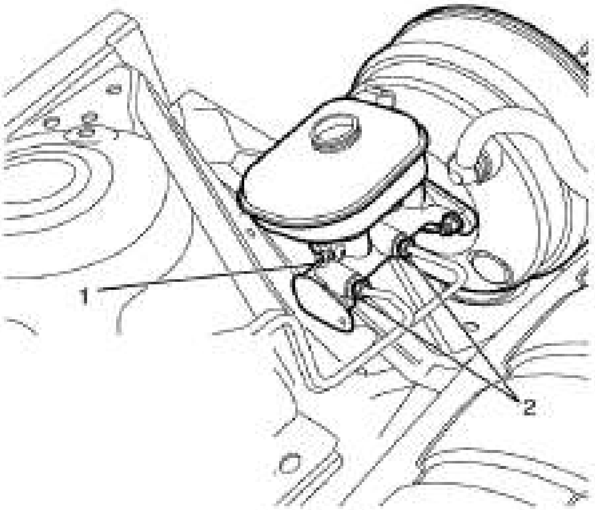
6. Remove the master cylinder brake pipes (2) from the BPMV (1).

Master Cylinder to Brake Pressure Modulator Valve (BPMV) Installation Procedure



1. Install the wheel brake pipes (2) to the BPMV (1) using the locations recorded during the removal procedure.

   Tighten
   Tighten the wheel brake pipes to 16 Nm (12 lb ft).



2. Install the brake pipes (2) to the master cylinder (1).

   Tighten
   Tighten the pipe fittings to 16 Nm (12 lb ft).

3. Bleed the hydraulic brake system. Refer to Hydraulic Brake System BleedingHydraulic Brake

System Bleeding

Front Brake Pipe Removal Procedure - Right

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

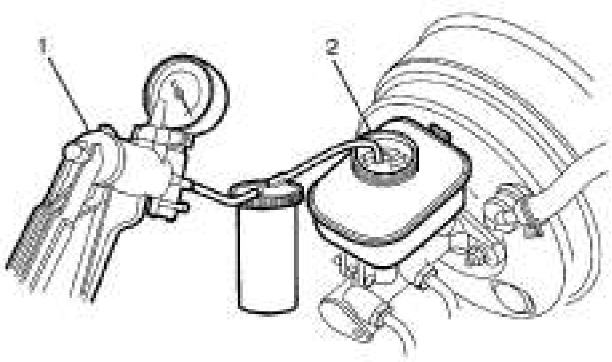
Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

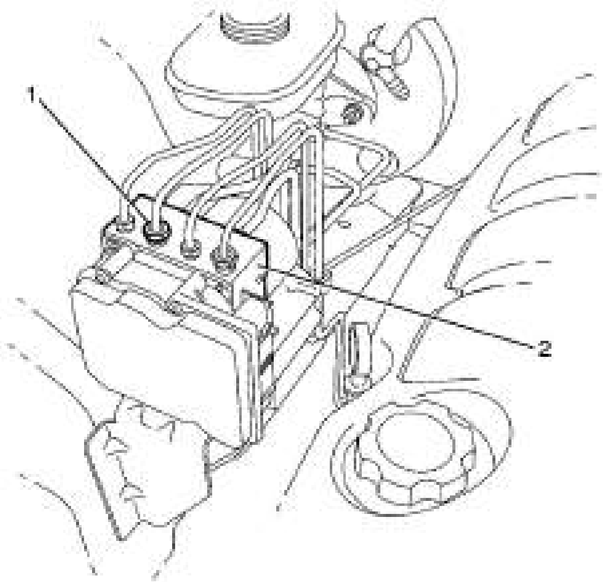
Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

1. Clean the master cylinder, especially around the brake lines and reservoir cap.
2. Place a clean suitable container under the BPMV.
3. Remove the master cylinder reservoir cap.



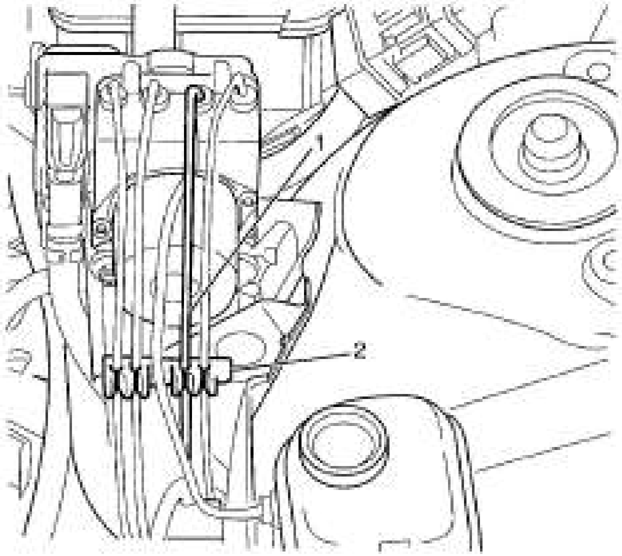
4. Siphon the brake fluid out of the master cylinder reservoir (2) using the J 23738-A J 23738-A (1)



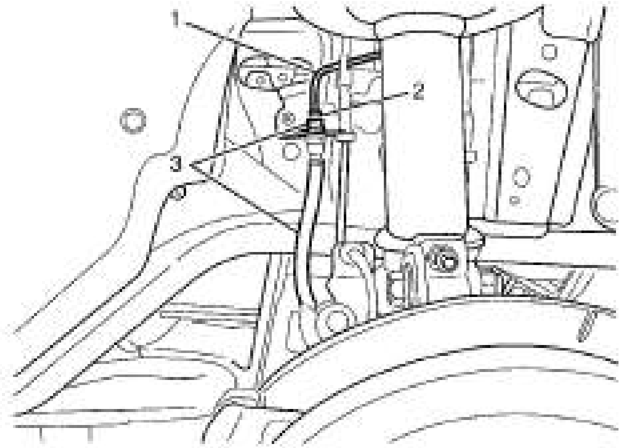
5. Disconnect the brake pipe (1) from the BPMV (2).

   Important: Install a rubber cap or plug to the BPMV (2) in order to prevent fluid loss and contamination.

6. Plug the BPMV (2).



7. Detach the brake pipe (1) from the locating clip (2).
8. Raise and support the vehicle. Refer to Lifting and Jacking the VehicleLifting and Jacking the Vehicle
9. Remove the right front wheel. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation
10. Remove the right splash guard. Refer to Wheelhouse Splash Shield ReplacementWheelhouse Splash Shield Replacement



11. Clean all dirt and foreign material from the brake hose and the brake pipe fittings (2 and 3).

    Important: Hold the brake hose (3) with a suitable tool whilst disconnecting the brake pipe fitting (2) to prevent damage to the brake pipe (1).

12. Disconnect the brake pipe fitting (2) from the brake hose (3).

    Important: Install a rubber cap or plug to the exposed brake hose fitting end in order to prevent brake fluid loss and contamination.

13. Plug the brake hose (3).
14. Remove the brake pipe (1).

Front Brake Pipe Installation Procedure - Right

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

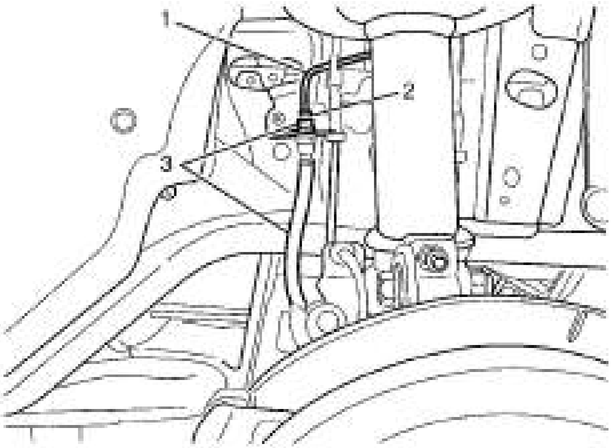
Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

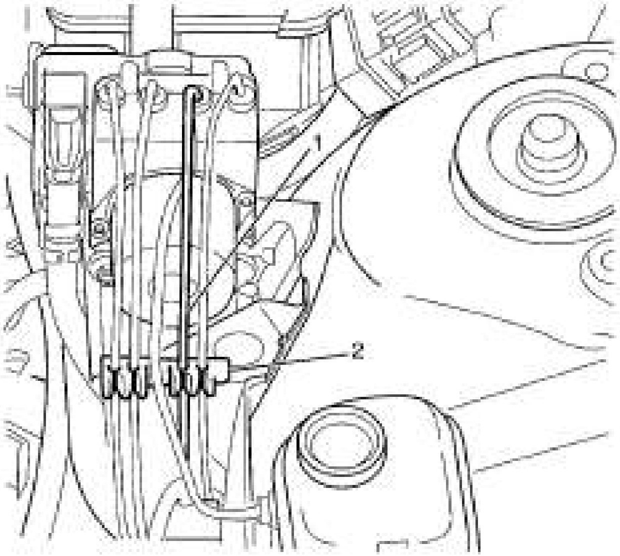
Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.



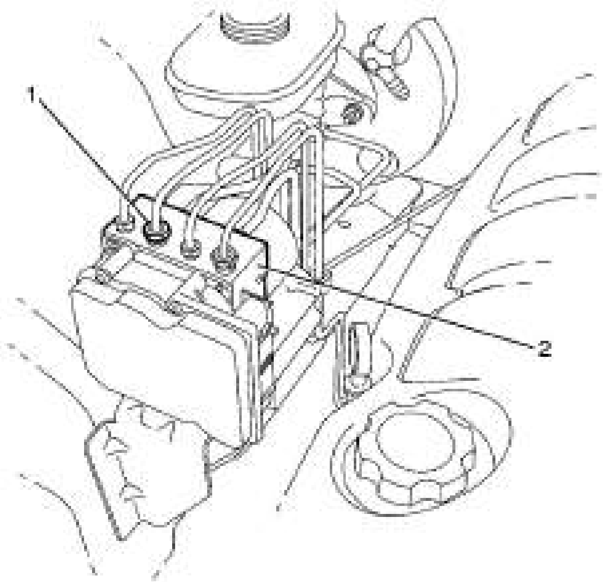
1. Install the brake pipe (1) to the vehicle.
2. Remove the rubber cap or plug from the brake hose (3).
3. Connect the brake pipe fitting (2) to the brake hose (3).

   Do not fully tighten at this stage.

4. Lower the vehicle.



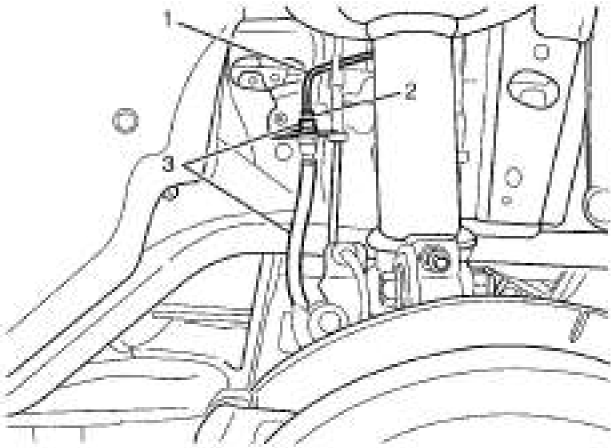
5. Attach the brake pipe (1) to the locating clip (2).



6. Remove the rubber cap or plug from the BPMV (2).
7. Install the brake pipe (1) to the BPMV (2).

   Do not fully tighten at this stage.

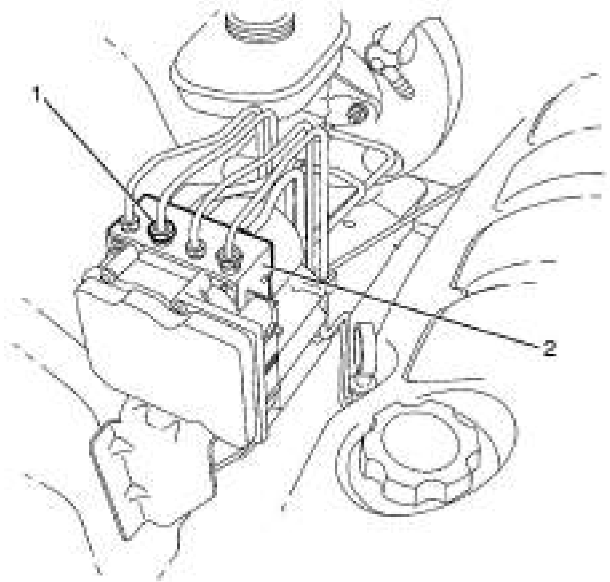
   Notice: Refer to Fastener Notice in the Preface section.



Important: Hold the brake hose (3) with a suitable tool whilst connecting the brake pipe fitting (2) to prevent damage to the brake pipe (1).

8. Tighten the brake pipe fitting (2) to the brake hose (3)

Tighten
Tighten the brake pipe fitting to 16 Nm (12 lb ft).



9. Tighten the brake pipe fitting (1) to the BPMV (2).

   Tighten
   Tighten the brake pipe fitting to 16 Nm (12 lb ft).

10. Install the right splash guard. Refer to Wheelhouse Splash Shield ReplacementWheelhouse Splash Shield Replacement
11. Bleed the hydraulic brake system. Refer to Hydraulic Brake System BleedingHydraulic Brake System Bleeding

Front Brake Pipe Removal Procedure - Left

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Caution in the Preface section.

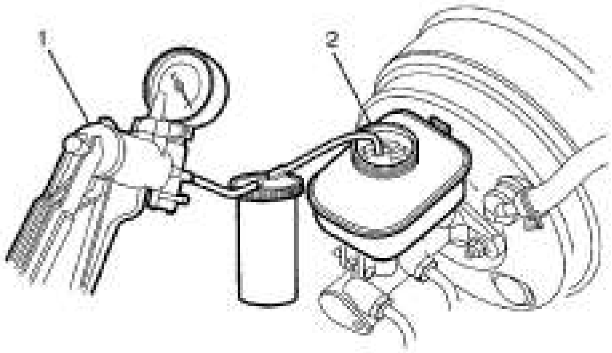
Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

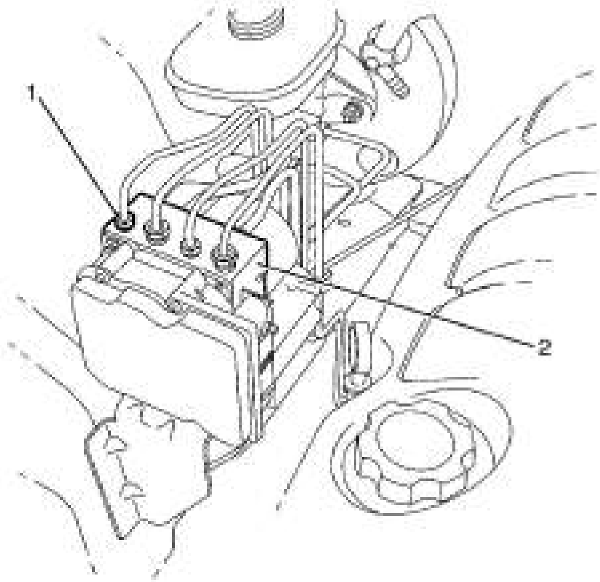
Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

1. Clean the master cylinder, brake lines and reservoir cap.

2. Place a clean suitable container under the Brake Pressure Modulator Valve (BPMV).
3. Remove the master cylinder reservoir cap.



4. Siphon the brake fluid out of the master cylinder reservoir (2) using the J 23738-A J 23738-A (1)



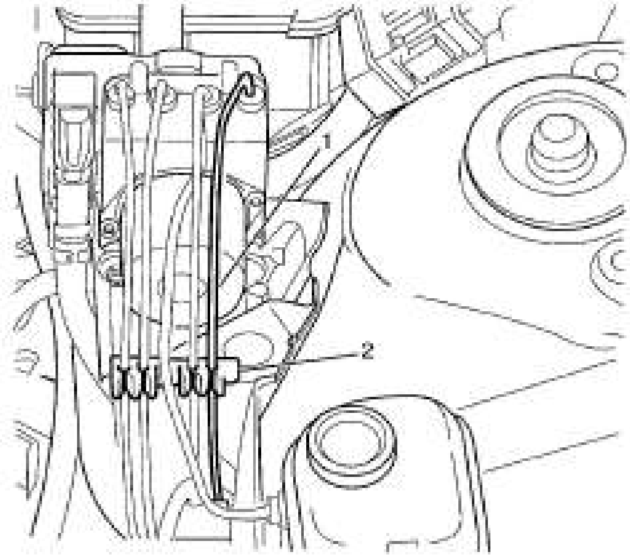
5. Disconnect the brake pipe (1) from the BPMV (2).

   Important: Install a rubber cap or plug to the BPMV (2) in order to prevent fluid loss and contamination.

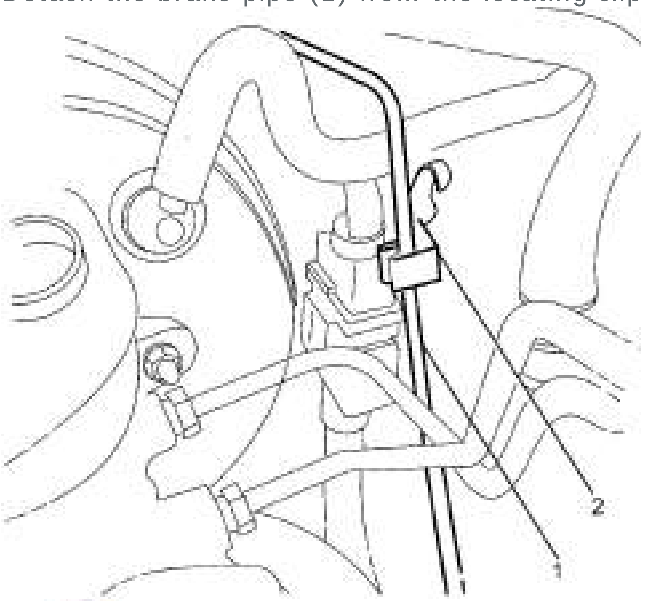
6. Plug the BPMV (2).
7. Raise and support the vehicle. Refer to Lifting and Jacking the VehicleLifting and Jacking the Vehicle
8. Remove the engine. Refer to Engine ReplacementEngine Replacement for 3.6L or Engine

ReplacementEngine Replacement for 6.0L.

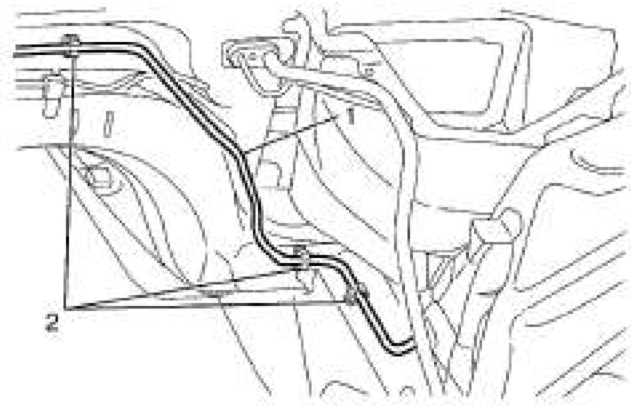
9. Remove the heat shields in the engine bay.
10. Remove the sound proofing trim from the bulkhead.



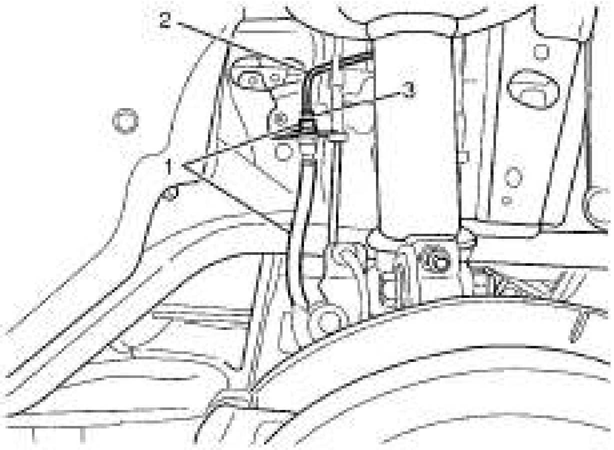
11. Detach the brake pipe (1) from the locating clip (2).



12. Detach the brake pipe (1) from the locating clip (2).



13. Detach the brake pipe (1) from the locating clips (2).



14. Clean all dirt and foreign material from the brake hose and the brake pipe fittings (1 and 3).

Important: Hold the brake hose (1) with a suitable tool whilst disconnecting the brake pipe fitting (3) to prevent damage to the brake pipe (2).

15. Disconnect the brake pipe fitting (3) from the brake hose (1).

Important: Install a rubber cap or plug to the exposed brake hose (1) in order to prevent brake fluid loss and contamination.

16. Plug the brake hose (1).
17. Remove the left splash guard. Refer to Wheelhouse Splash Shield ReplacementWheelhouse

Splash Shield Replacement

18. Remove the brake pipe (2) from the vehicle.

Front Brake Pipe Installation Procedure - Left

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

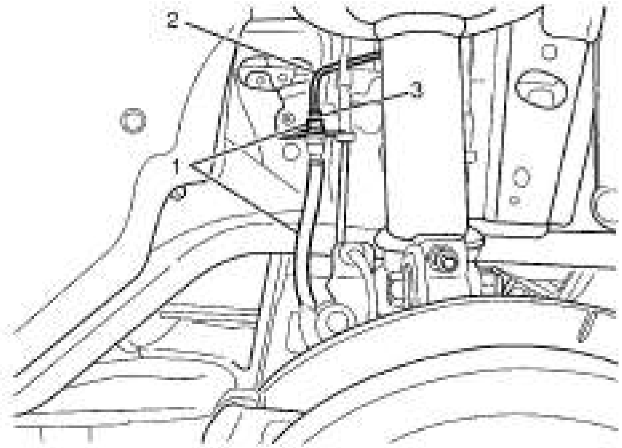
Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Caution in the Preface section.

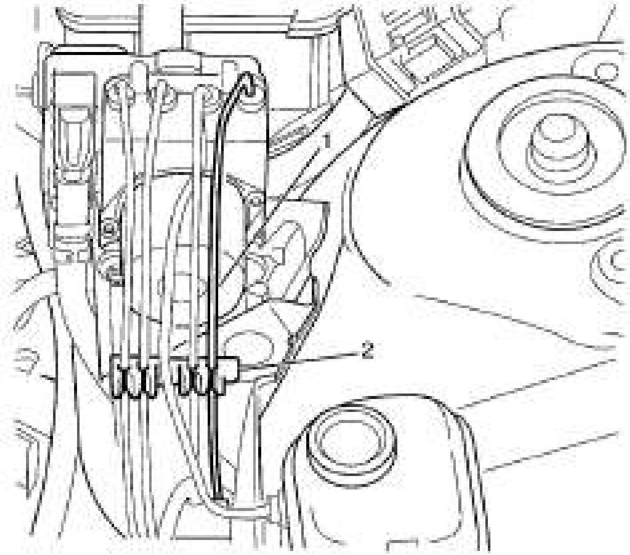
Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

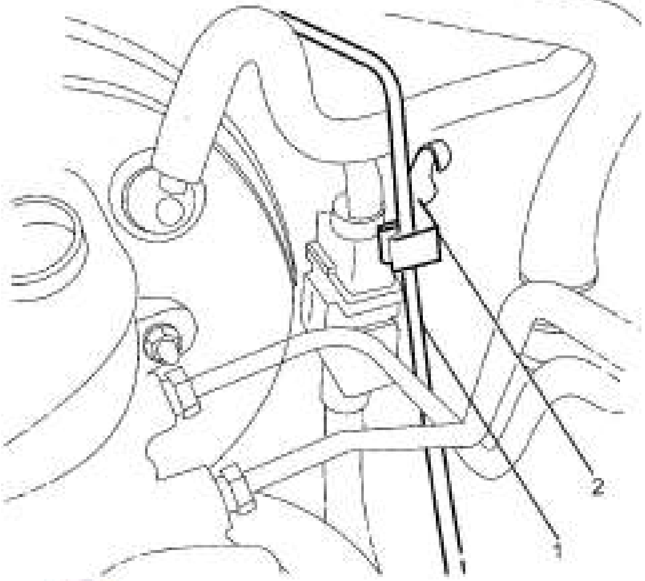
Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.



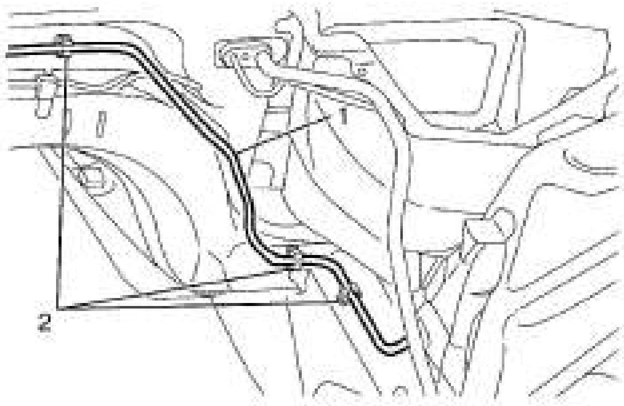
1. Install the brake pipe (2) to the vehicle.
2. Remove the rubber cap or plug from the brake hose (1).
3. Connect the brake pipe (2) to the brake hose (1).
4. Lower the vehicle.



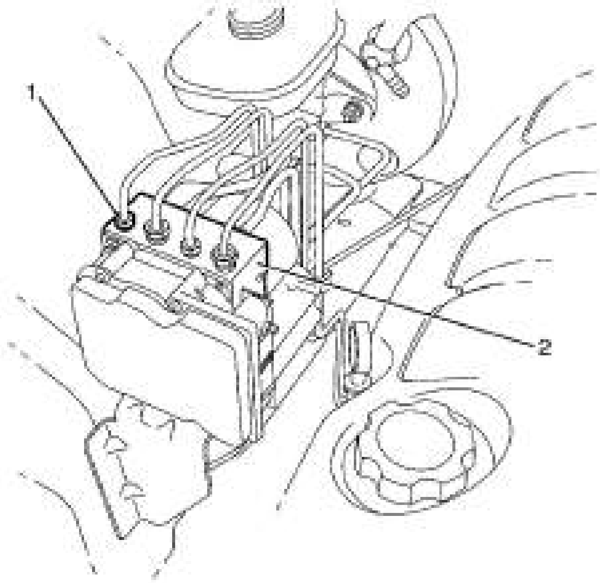
5. Attach the brake pipe (1) to the locating clip (2).



6. Attach the brake pipe (1) to the locating clip (2).



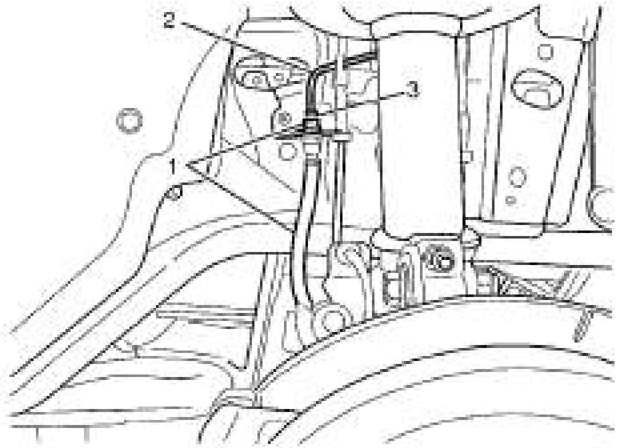
7. Attach the brake pipe (1) to the locating clips (2).



8. Remove the rubber cap or plug from the BPMV (2).
9. Install the brake pipe (1) to the BPMV (2).

   Do not fully tighten at this stage.

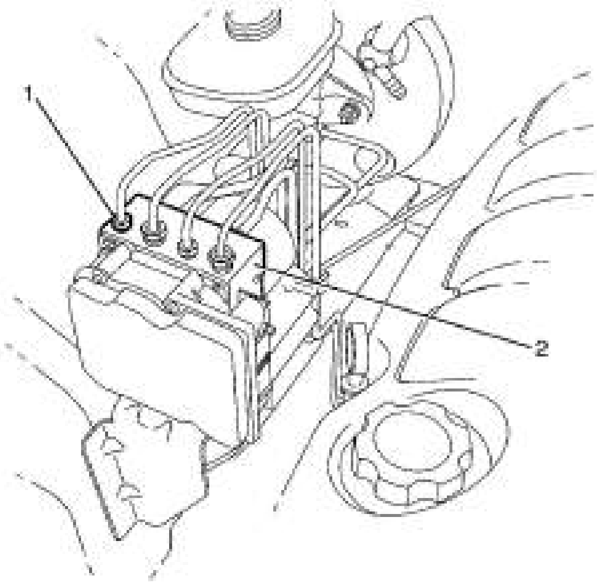
   Notice: Refer to Fastener Notice in the Preface section.



Important: Hold the brake hose (1) with a suitable tool whilst connecting the brake pipe fitting (3) to prevent damage to the brake pipe (2).

10. Tighten the brake pipe fitting (3) to the brake hose (1)

Tighten
Tighten the brake pipe fitting to 16 Nm (12 lb ft).



11. Tighten the brake pipe fitting (1) to the BPMV (2)

Tighten

Tighten the brake pipe fitting to 16 Nm (12 lb ft).

12. Install the sound proofing trim to the bulkhead.
13. Install the heat shields to the engine bay.
14. Install the engine. Refer to Engine ReplacementEngine Replacement for 3.6L or Engine ReplacementEngine Replacement for 6.0L.
15. Install the left splash guard. Refer to Wheelhouse Splash Shield ReplacementWheelhouse Splash Shield Replacement
16. Bleed the hydraulic brake system. Refer to Hydraulic Brake System BleedingHydraulic Brake System Bleeding

Intermediate Brake Pipe Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

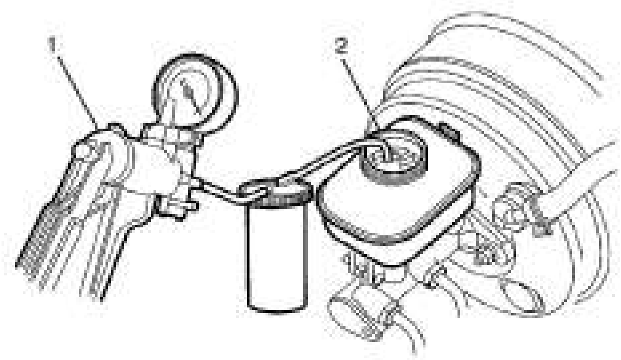
Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

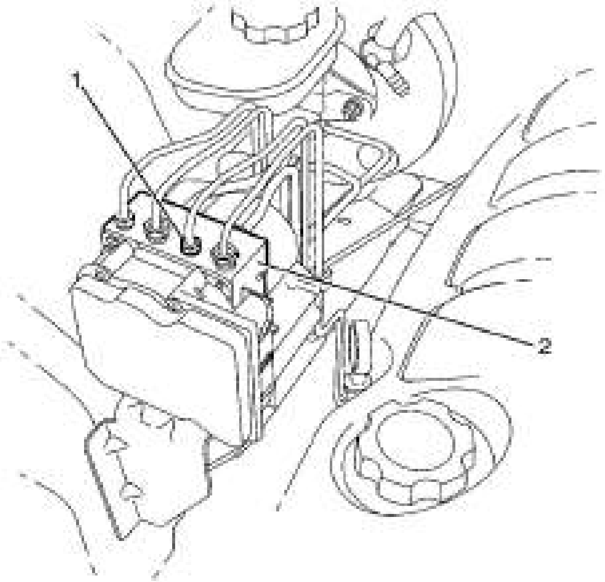
Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

1. Clean the master cylinder, brake lines and reservoir cap.
2. Place a clean suitable container under the Brake Pressure Modulator Valve (BPMV).
3. Remove the master cylinder reservoir cap.



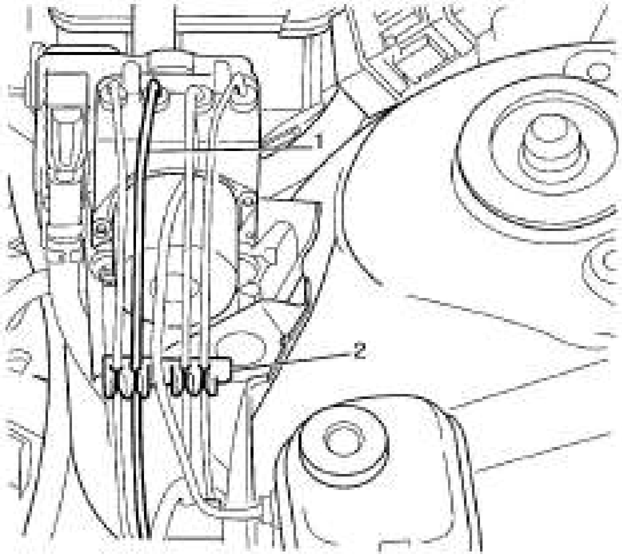
4. Siphon the brake fluid out of the master cylinder reservoir (2) using the J 23738-A J 23738-A (1)



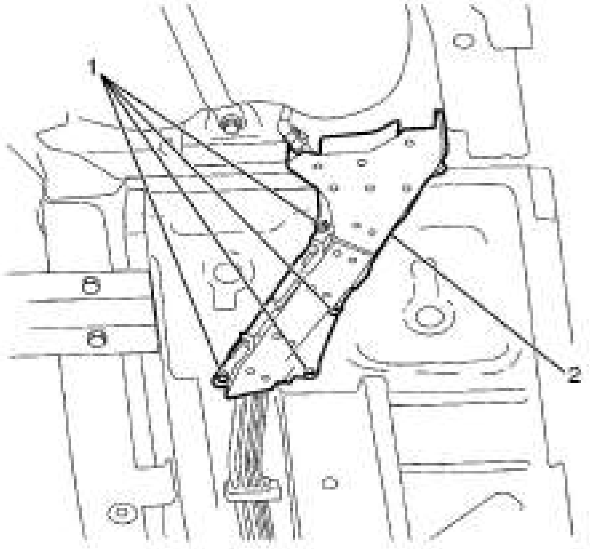
5. Disconnect the brake pipe (1) from the BPMV (2).

Important: Install a rubber cap or plug to the BPMV (2) in order to prevent fluid loss and contamination.

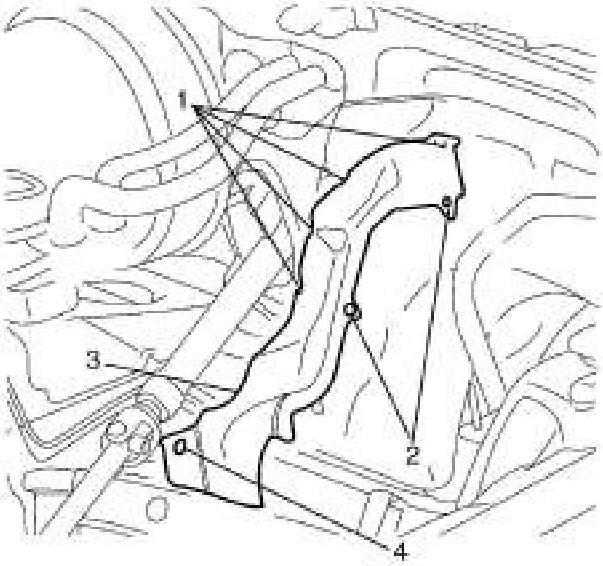
6. Plug the BPMV (2).



7. Detach the brake pipe (1) to the locating clip (2).
8. Raise and support the vehicle. Refer to Lifting and Jacking the VehicleLifting and Jacking the Vehicle



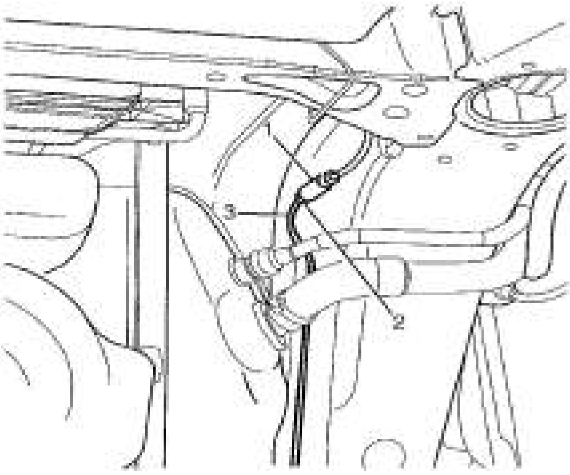
9. Remove the brake and fuel pipe splash shield to chassis retaining nuts (1).
10. Remove the brake and fuel pipe splash shield (2).
11. Remove the front heat shield. Refer to Exhaust Front Heat Shield ReplacementExhaust Front Heat Shield Replacement
12. Remove the engine. Refer to Engine ReplacementEngine Replacement for 3.6L or Engine ReplacementEngine Replacement for 6.0L.



Important: The brake and fuel pipe protector shield (3) is retained by rivets (2). These rivets (2) must be drilled out during removal and replaced as per the installation procedure.

13. Remove the brake and fuel pipe heat shield to bulkhead retaining rivets (2).
14. Remove the brake and fuel pipe heat shield to bulkhead retaining bolt (4).
15. Detach the brake and fuel pipe heat shield clips (1).

16. Remove the brake and fuel pipe protector shield (2).
17. Remove the rear subframe. Refer to Rear Frame ReplacementRear Frame Replacement

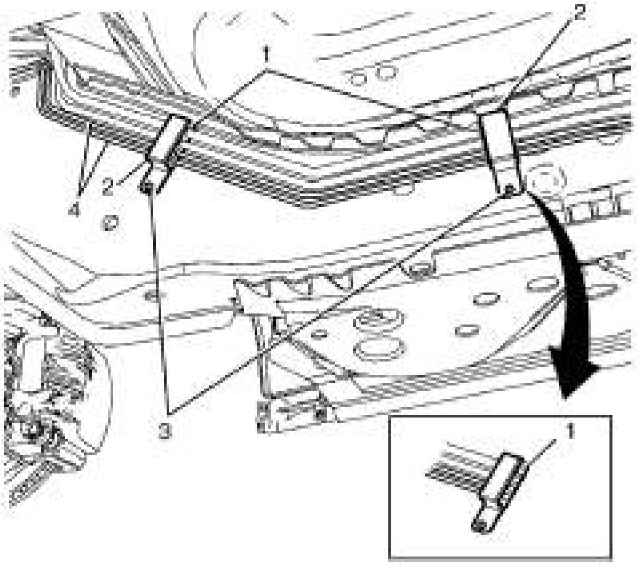


Important: Hold the brake pipe union (1) with a suitable tool whilst disconnecting the brake pipe fitting (2) to prevent damage to the intermediate brake pipe (3).

18. Disconnect the intermediate brake pipe (3) from the brake pipe union (1).

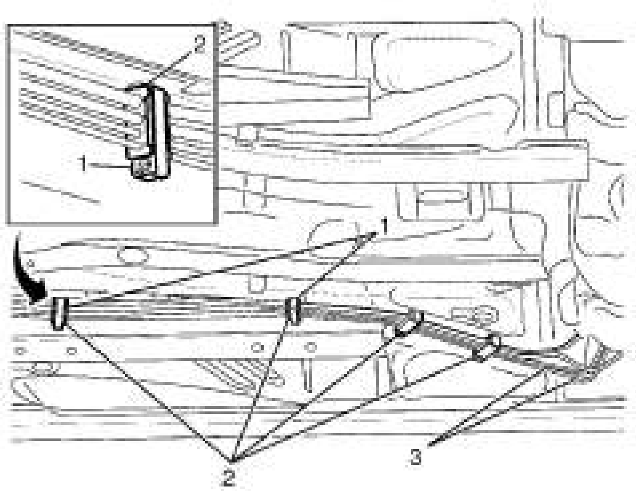
Important: Install a rubber cap or plug to the brake pipe union (1) in order to prevent brake fluid loss and/or contamination.

19. Plug the brake pipe union (1).



Important: The brake and fuel pipe retaining brackets (2) are retained by rivets (3). These rivets (3) must be drilled out during removal and replaced as per the installation procedure.

20. Remove the brake and fuel pipe retaining bracket to chassis retaining rivets (3).
21. Remove the brake and fuel pipe retaining brackets (2).
22. Remove the brake pipes (4) from the brake and fuel pipe retaining bracket rubber insulators (1).



Important: Use a suitable tool to open the brake and fuel pipe retaining brackets (2) by detaching the brake and fuel pipe retaining bracket (2) clip.

23. Open the brake and fuel pipe retaining brackets (2).
24. Remove the brake pipe (1) from the brake and fuel pipe retaining bracket rubber insulators (3).

Intermediate Brake Pipe Installation Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

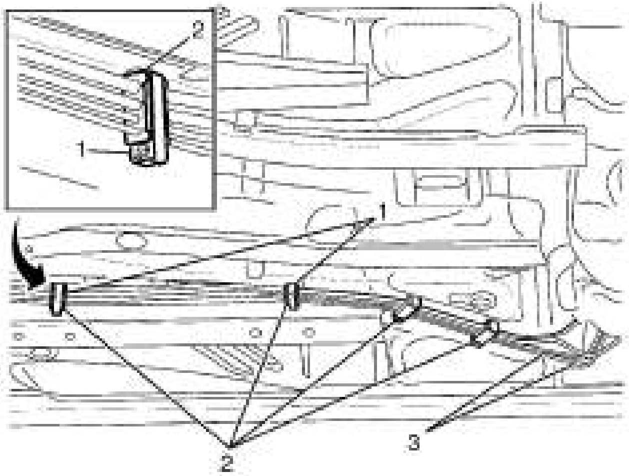
Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Caution in the Preface section.

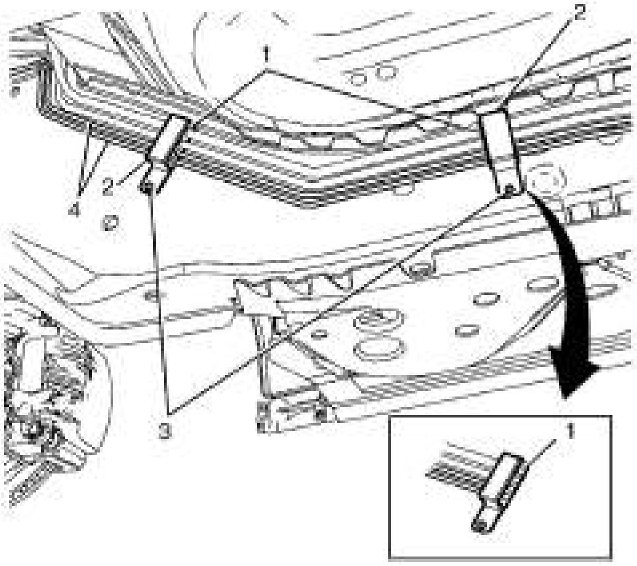
Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

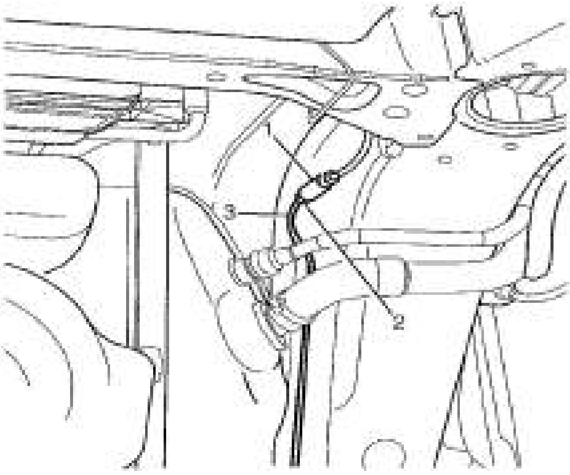
Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.



1. Install the brake pipes (3) to the brake and fuel pipe retaining bracket rubber insulators (2).
2. Close the brake and fuel pipe retaining brackets (1).

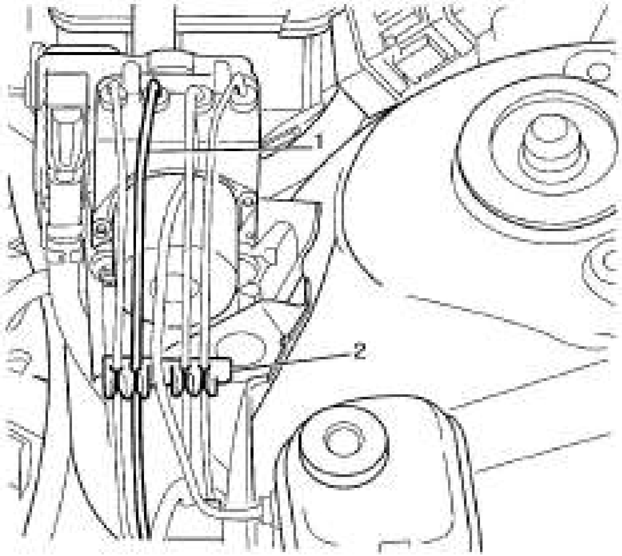


3. Install the brake pipes (4) to the two brake and fuel pipe retaining bracket rubber insulators (1).
4. Install the two brake and fuel pipe retaining brackets (2).
5. Install the NEW brake and fuel pipe retaining bracket to chassis retaining rivets (3).
6. Remove the rubber cap or plug from the brake pipe union.

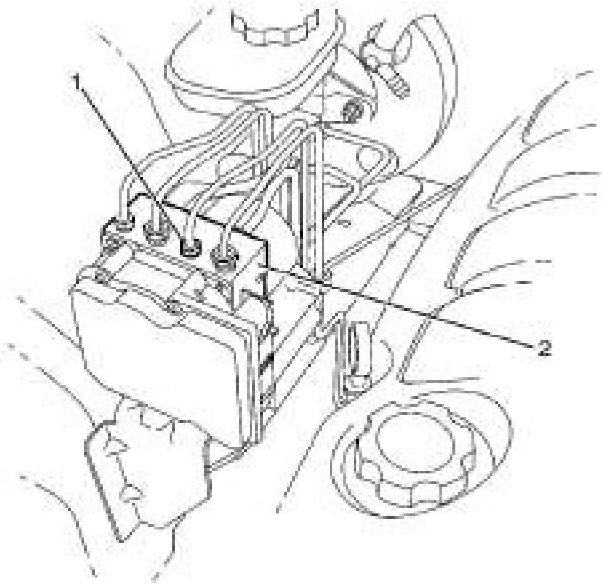


Important: Hold the brake pipe union (1) with a spanner whilst connecting the brake pipe fitting (2) to prevent damage to the brake pipe (3).

7. Connect the brake pipe (1) to the brake pipe union (2).

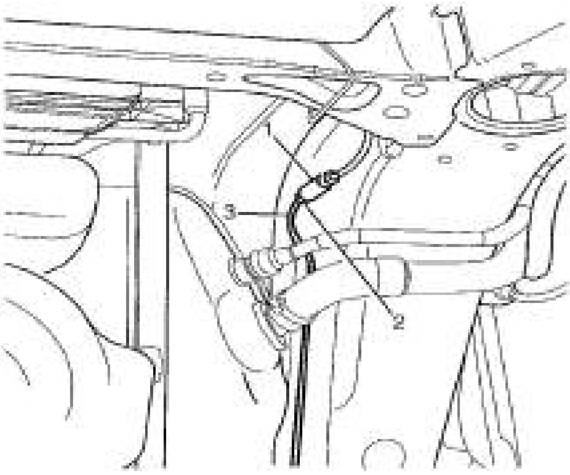


8. Attach the brake pipe (1) to the locating clip (2).



9. Remove the rubber cap or plug from the BPMV (2).
10. Install the brake pipe (1) to the BPMV (2).

Notice: Refer to Fastener Notice in the Preface section.

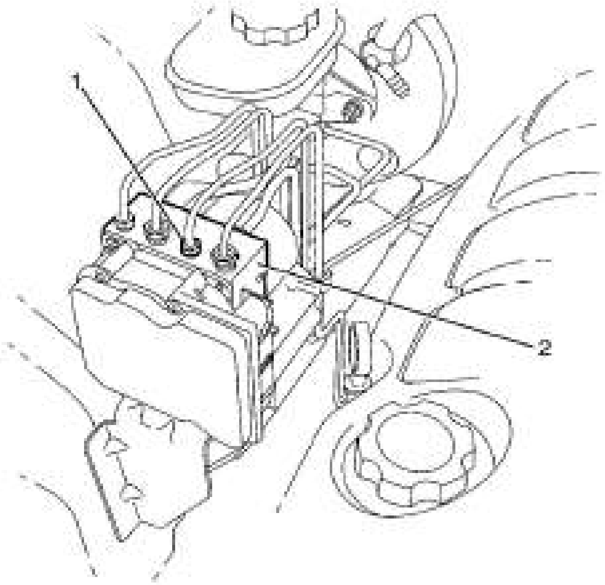


Important: Hold the brake pipe union (1) with a suitable tool whilst connecting the brake pipe fitting (2) to prevent damage to the brake pipe (3).

11. Tighten the brake pipe (1) to the brake pipe union (2).

Tighten

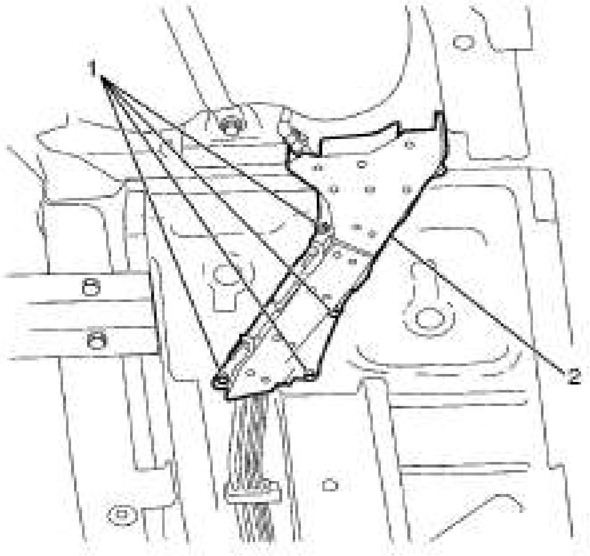
Tighten the brake pipe fitting to 15 N·m (11 lb ft).



12. Tighten the brake pipe (1) to the BPMV (2).

    Tighten
    Tighten the brake pipe fitting to 16 N·m (12 lb ft).

13. Install the rear subframe. Refer to Rear Frame ReplacementRear Frame Replacement

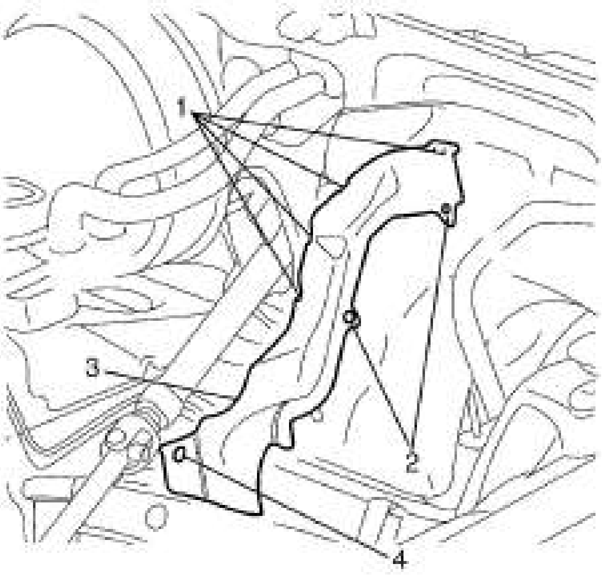


14. Install the brake and fuel pipe splash shield (2) to the underbody.
15. Install the brake and fuel pipe splash shield to chassis retaining nuts (1).

    Tighten

Tighten the nuts to 5 N·m (43 lb in).

16. Lower the vehicle.



17. Install the brake and fuel pipe heat shield (3).
18. Attach the brake and fuel pipe heat shield clips (1).
19. Install NEW brake and fuel pipe protector shield to bulkhead retaining rivets (2).
20. Install the brake and fuel pipe protector shield to bulkhead retaining bolt (4).
21. Install the engine. Refer to Engine ReplacementEngine Replacement for 3.6L or Engine ReplacementEngine Replacement for 6.0L.
22. Install the front heat shield. Refer to Exhaust Front Heat Shield ReplacementExhaust Front Heat Shield Replacement
23. Bleed the hydraulic brake system. Refer to Hydraulic Brake System BleedingHydraulic Brake System Bleeding

Rear Brake Pipe Removal Procedure - Right

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Caution in the Preface section.

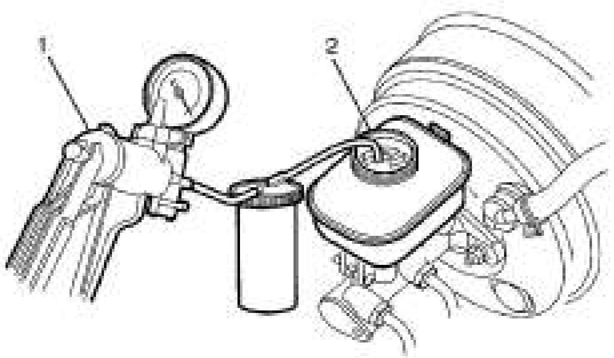
Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

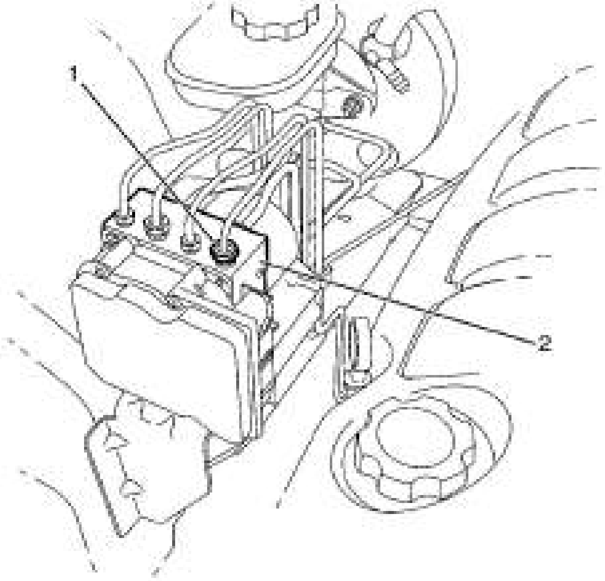
Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

1. Clean the master cylinder, brake lines and reservoir cap.
2. Place a clean suitable container under the BPMV and master cylinder.

3. Remove the master cylinder reservoir cap.



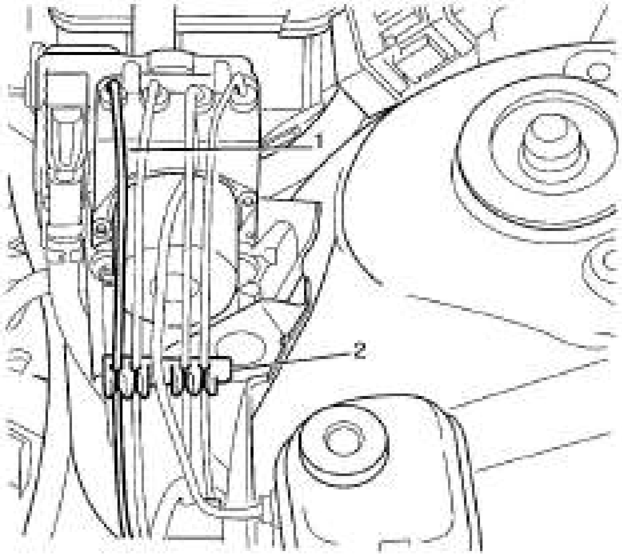
4. Siphon the brake fluid out of the master cylinder reservoir (2) using the J 23738-A J 23738-A (1)



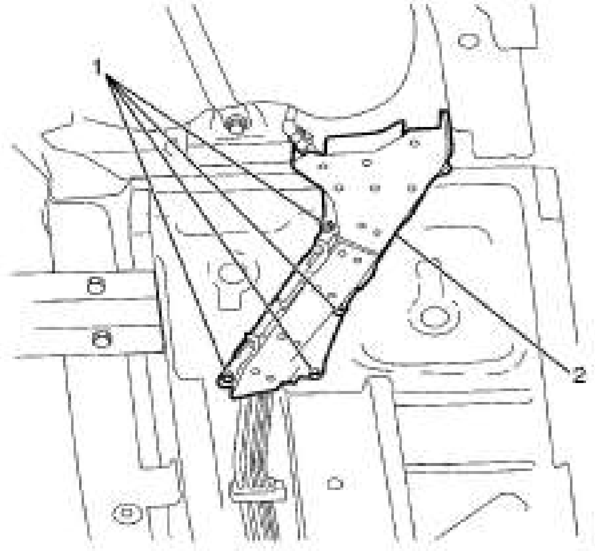
5. Disconnect the brake pipe (1) from the BPMV (2).

   Important: Install a rubber cap or plug to the BPMV (2) in order to prevent fluid loss and contamination.

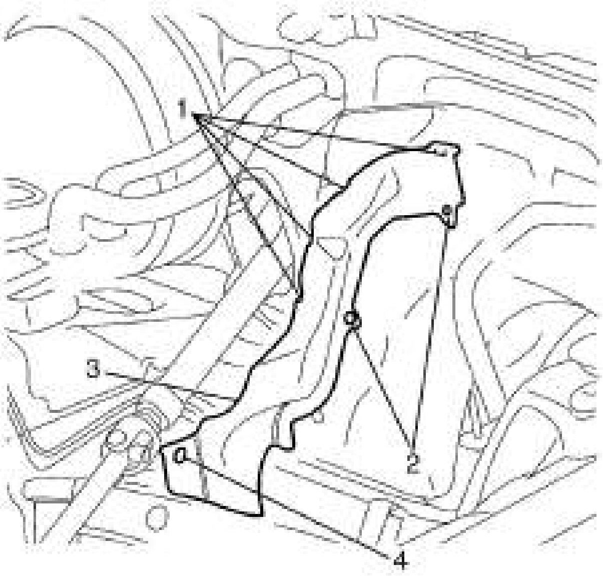
6. Plug the BPMV (2).



7. Detach the brake pipe (1) from the locating clip (2).
8. Raise and support the vehicle. Refer to Lifting and Jacking the VehicleLifting and Jacking the Vehicle

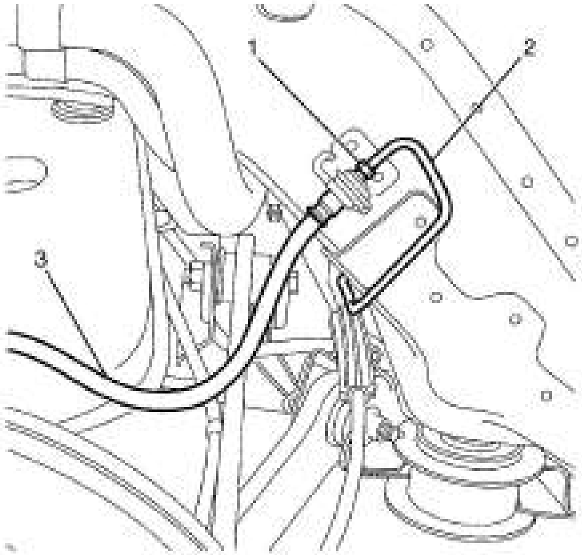


9. Remove the brake and fuel pipe splash shield to chassis retaining nuts (1).
10. Remove the brake and fuel pipe splash shield (2).
11. Remove the front heat shield. Refer to Exhaust Front Heat Shield ReplacementExhaust Front Heat Shield Replacement
12. Remove the engine. Refer to Engine ReplacementEngine Replacement for 3.6L or Engine ReplacementEngine Replacement for 6.0L.



Important: The brake and fuel pipe heat shield (3) is retained by rivets (2). These rivets (2) must be drilled out during removal and replaced as per the installation procedure.

13. Remove the brake and fuel pipe heat shield to bulkhead retaining rivets (2).
14. Remove the brake and fuel pipe heat shield to bulkhead retaining bolt (4).
15. Detach the brake and fuel pipe heat shield clips (1).
16. Remove the brake and fuel pipe heat shield (2).

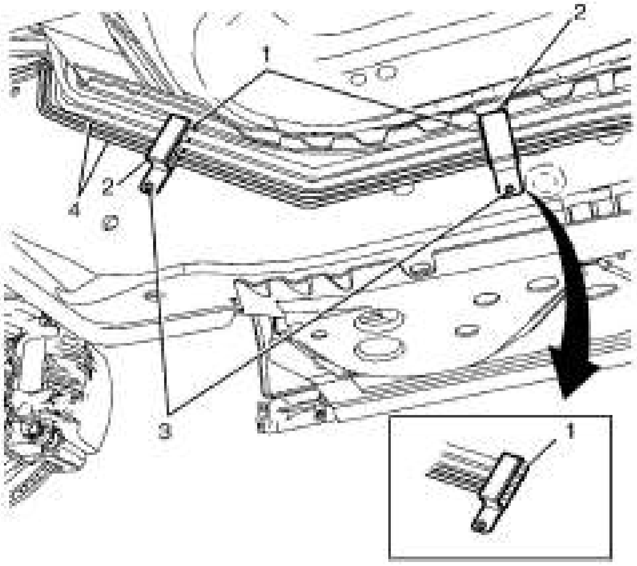


Important: Hold the brake hose (3) with a suitable whilst disconnecting the brake pipe fitting (1) to prevent damage to the brake pipe (2).

17. Disconnect the brake pipe fitting (1) from the brake hose (3).

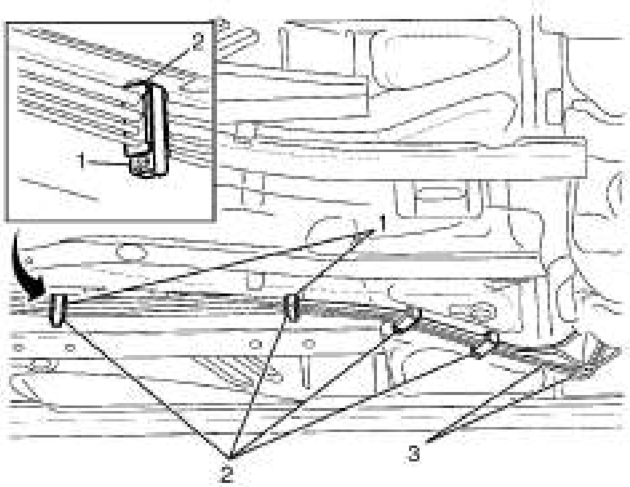
Important: Install a rubber cap or plug to the brake hose (3) in order to prevent brake fluid loss and contamination.

18. Plug the brake hose (3).



Important: The brake and fuel pipe retaining brackets (2) are retained by rivets (3). These rivets (3) must be drilled out during removal and replaced as per the installation procedure.

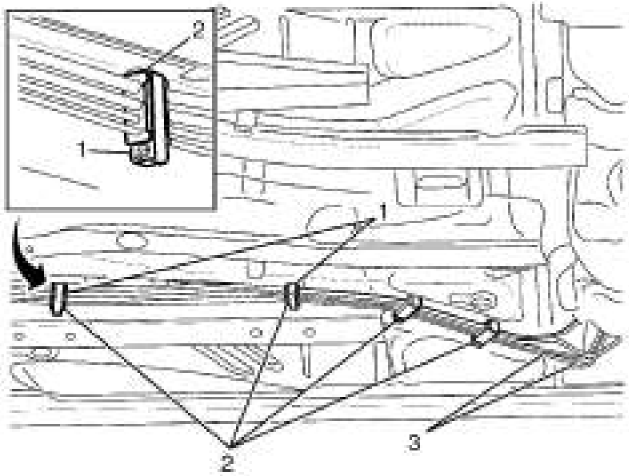
19. Remove the brake and fuel pipe retaining bracket to chassis retaining rivets (3).
20. Remove the brake and fuel pipe retaining brackets (2).
21. Remove the brake pipes (4) from the brake and fuel pipe retaining bracket rubber insulators (1).



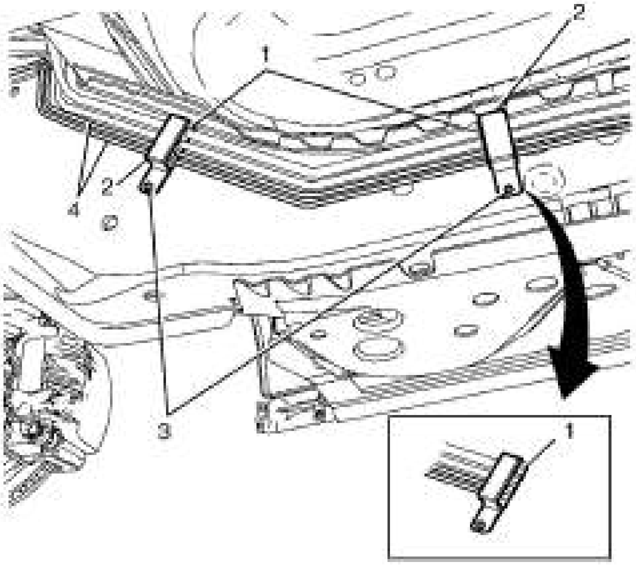
Important: Use a suitable tool to open the brake and fuel pipe retaining brackets (1) by detaching the brake and fuel pipe retaining bracket (1) clip.

22. Open the brake and fuel pipe retaining brackets (1).
23. Remove the brake pipes (3) from the brake and fuel pipe retaining bracket rubber insulators (2).
24. Remove the brake pipe from the vehicle.

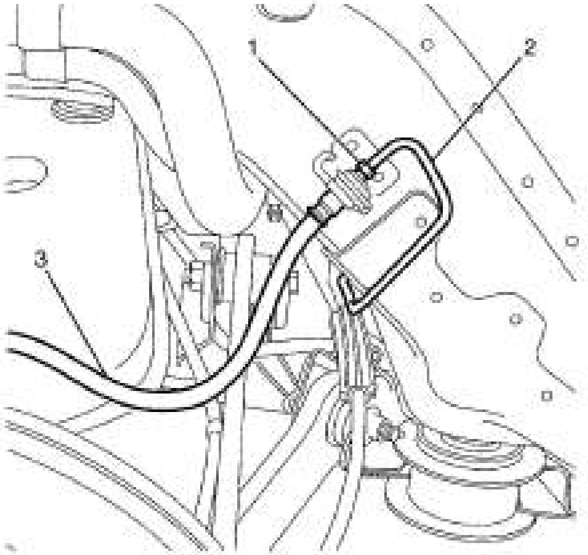
Rear Brake Pipe Installation Procedure - Right



1. Install the brake pipes (3) to the brake and fuel pipe retaining bracket rubber insulators (2).
2. Close the brake and fuel pipe retaining brackets (1).



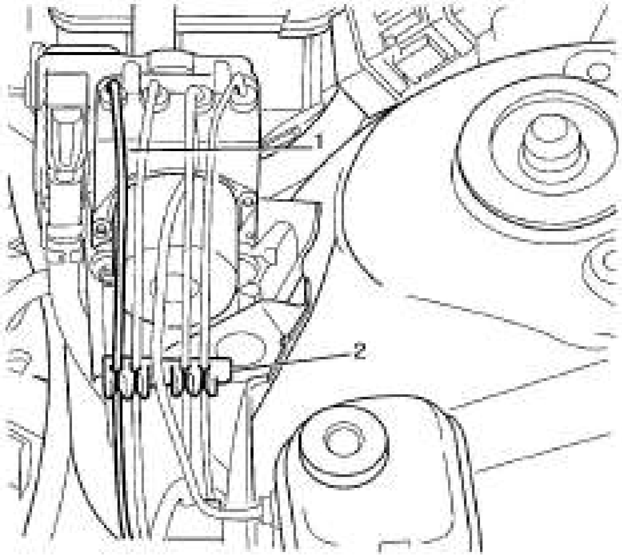
3. Install the brake pipes (4) to the two brake and fuel pipe retaining bracket rubber insulators (1).
4. Install the two brake and fuel pipe retaining brackets (2).
5. Install the NEW brake and fuel pipe retaining bracket to chassis retaining rivets (3).



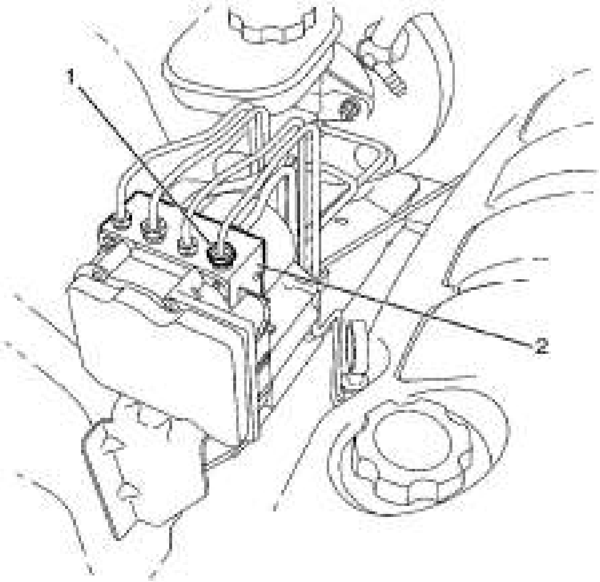
6. Remove the rubber cap or plug from the brake hose (3).
7. Connect the brake pipe fitting (1) to the brake hose (3).

   Do not fully tighten at this stage.

8. Lower the vehicle.



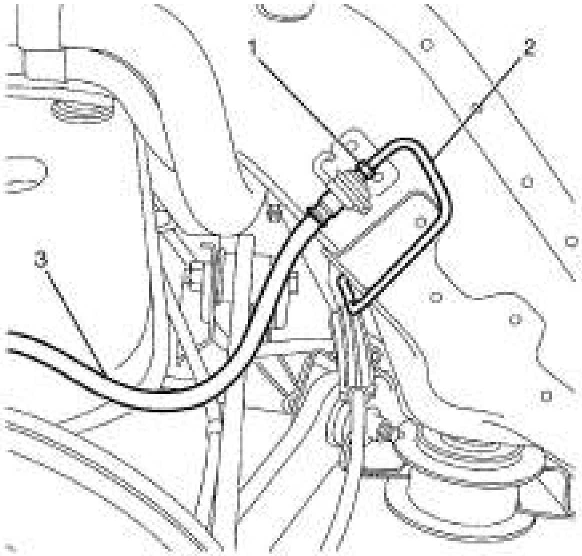
9. Attach the brake pipe (1) to the locating clip (2).



10. Remove the rubber cap or plug from the BPMV (2).
11. Install the brake pipe (1) to the BPMV (2).

    Do not fully tighten at this stage.

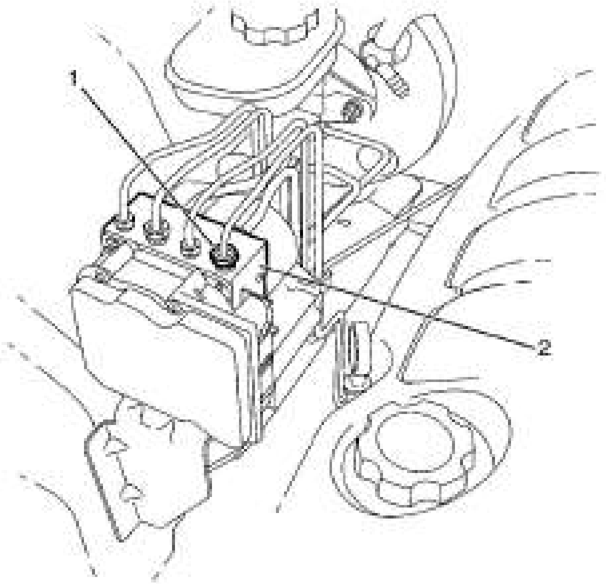
    Notice: Refer to Fastener Notice in the Preface section.



Important: Hold the brake hose (3) with a suitable tool whilst connecting the brake pipe fitting (1) to prevent damage to the brake pipe (2).

12. Tighten the brake pipe fitting (1) to the brake hose (3).

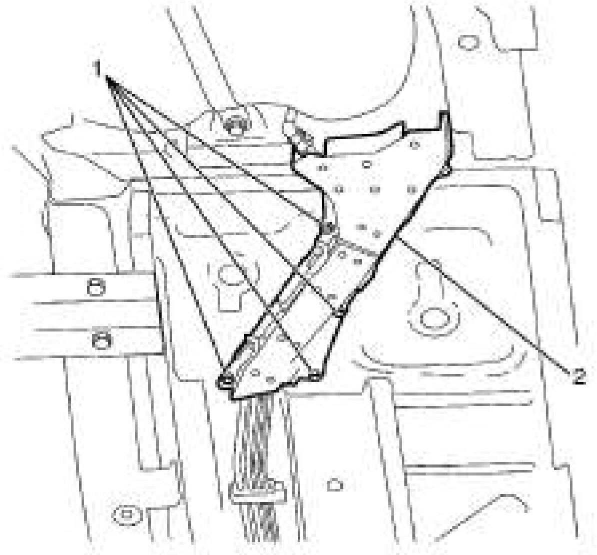
Tighten
Tighten the brake pipe fitting to 16 Nm (12 lb ft).



13. Tighten the brake pipe (1) to the BPMV (2).

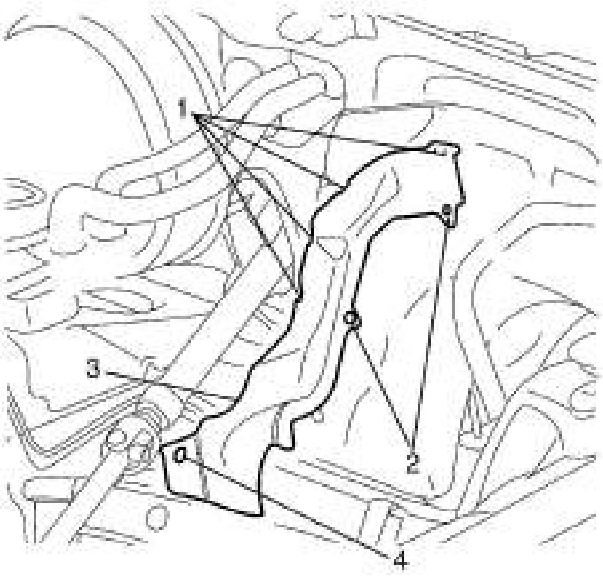
    Tighten
    Tighten the brake pipe fitting to 16 Nm (12 lb ft).

14. Raise the vehicle.

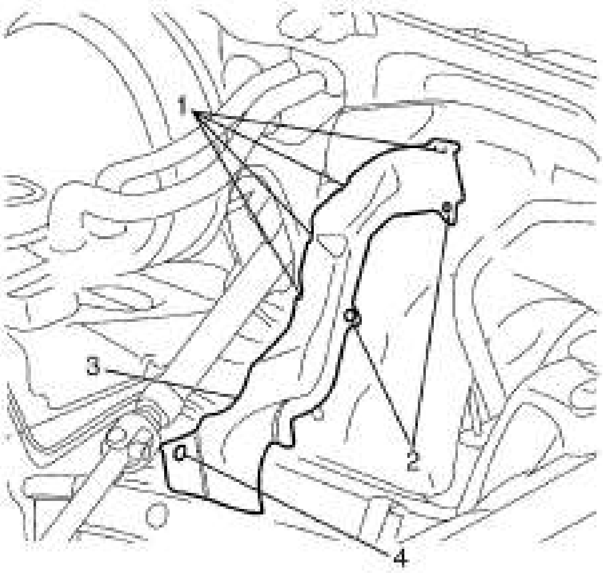


15. Install the brake and fuel pipe splash shield (2) to the underbody.
16. Install the brake and fuel pipe splash shield to chassis retaining nuts (1).

Tighten
Tighten the nuts to 5 Nm (43 lb in).



17. Install the brake and fuel pipe heat shield (3).
18. Attach the brake and fuel pipe heat shield clips (1).
19. Install NEW brake and fuel pipe heat shield to bulkhead retaining rivets (2).
20. Install the brake and fuel pipe heat shield to bulkhead retaining bolt (4).
21. Install the engine. Refer to Engine ReplacementEngine Replacement for 3.6L or Engine ReplacementEngine Replacement for 6.0L.
22. Install the front heat shield. Refer to Exhaust Front Heat Shield ReplacementExhaust Front Heat Shield Replacement
23. Lower the vehicle.



24. Install the brake and fuel pipe heat shield (3).

25. Attach the brake and fuel pipe heat shield clips (1).
26. Install NEW brake and fuel pipe heat shield to bulkhead retaining rivets (2).
27. Install the brake and fuel pipe heat shield to bulkhead retaining bolt (4).
28. Bleed the hydraulic brake system. Refer to Hydraulic Brake System BleedingHydraulic Brake System Bleeding

Rear Brake Pipe Removal Procedure - Left

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

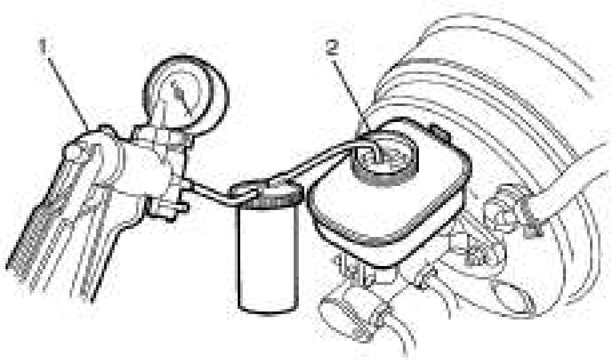
Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

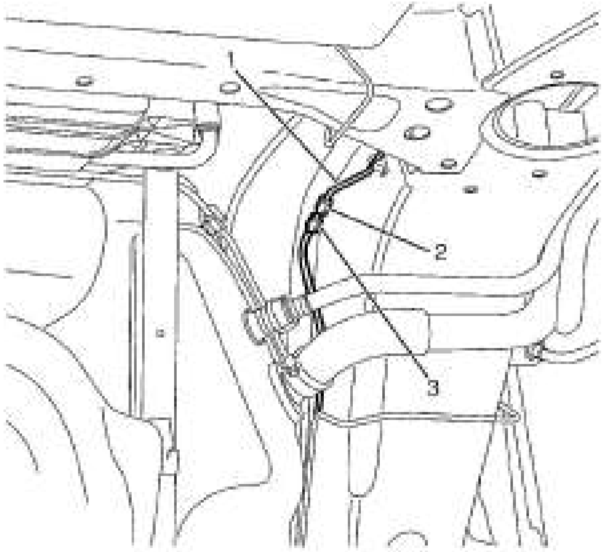
Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

1. Clean the master cylinder, brake lines and reservoir cap.
2. Remove the master cylinder reservoir cap.



3. Siphon the brake fluid out of the master cylinder reservoir (2) using the J 23738-A J 23738-A (1)
4. Remove the rear suspension sub frame assembly. Refer to Rear Frame ReplacementRear Frame Replacement



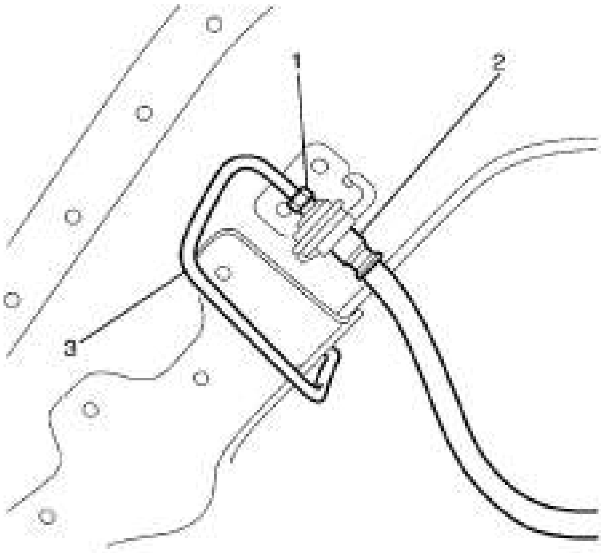
5. Place a clean suitable container under the brake pipe union (3).

   Important: Hold the brake pipe union (3) with a suitable tool whilst disconnecting the brake pipe fitting (2) to prevent damage to the brake pipe (1).

6. Disconnect the intermediate brake pipe (1) from the brake pipe union (3).

   Important: Install a rubber cap or plug to the brake pipe union (3) in order to prevent brake fluid loss and/or contamination.

7. Plug the brake pipe union (3).

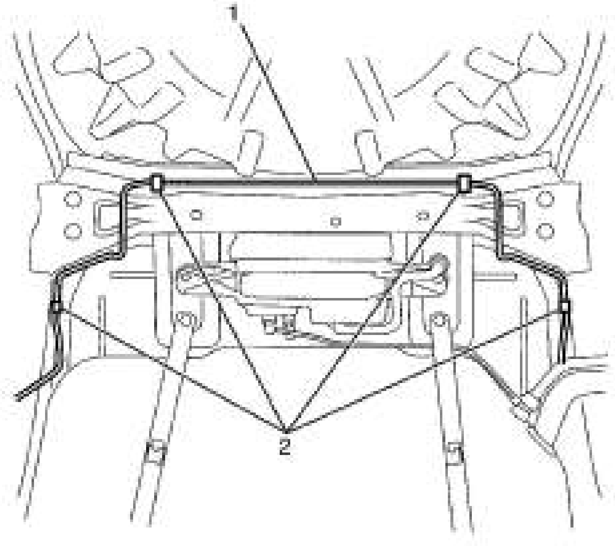


Important: Hold the brake hose (2) with a suitable tool whilst disconnecting the brake pipe fitting (1) to prevent damage to the brake pipe (3).

8. Disconnect the brake pipe fitting (1) from the brake hose (2).

   Important: Install a rubber cap or plug to the brake hose fitting end in order to prevent brake fluid loss and contamination.

9. Plug the brake hose (2).



10. Remove the brake pipe (1) from the brake pipe retaining clips (2).

Rear Brake Pipe Installation Procedure - Left

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

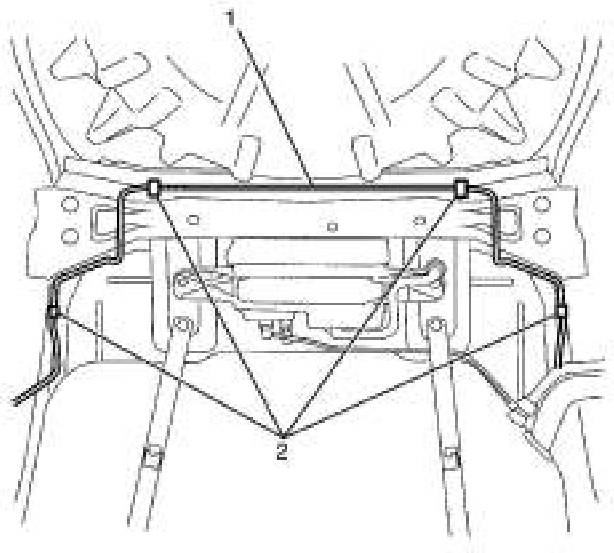
Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Caution in the Preface section.

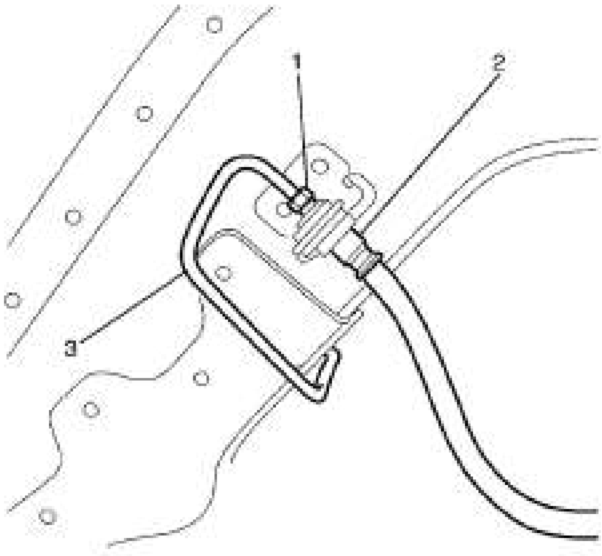
Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

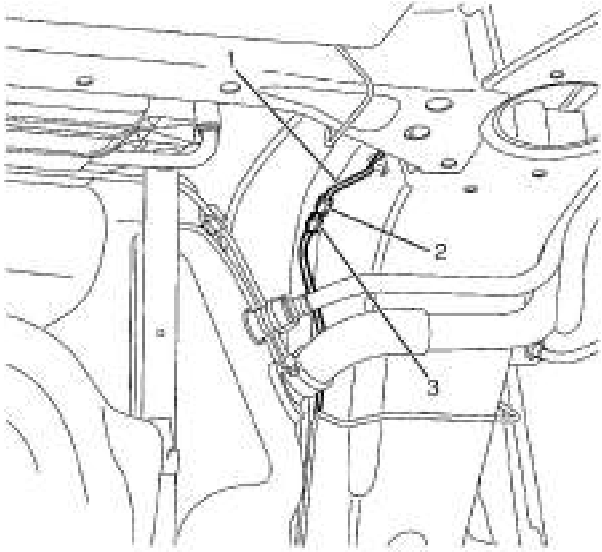


1. Install the brake pipe (1) to the brake pipe retaining clips (2).



2. Remove the rubber cap or plug from the brake hose (2).
3. Connect the brake pipe fitting (1) to the brake hose (3).

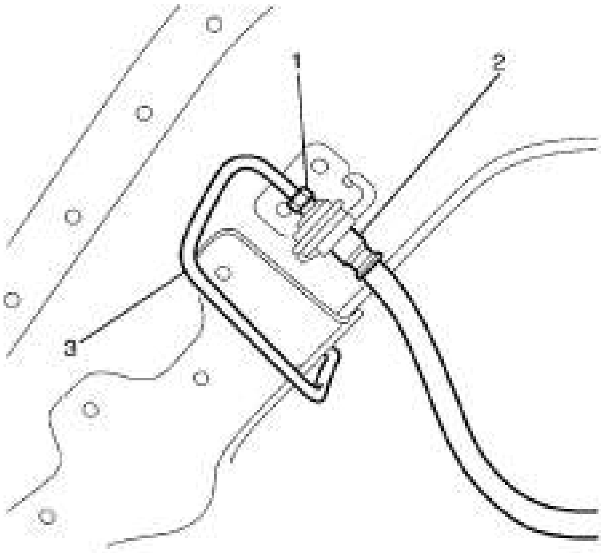
   Do not fully tighten at this stage.



4. Remove the rubber cap or plug from the brake pipe union (2).
5. Connect the brake pipe (1) to the brake pipe union (2).

   Do not fully tighten at this stage.

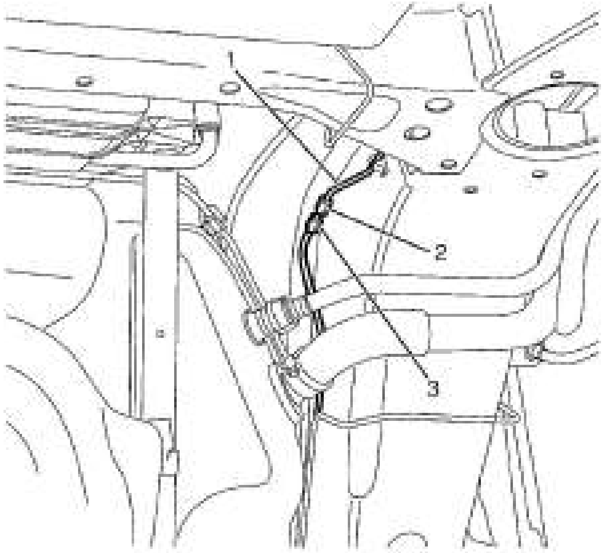
   Notice: Refer to Fastener Notice in the Preface section.



Important: Hold the brake hose (2) with a suitable tool whilst connecting the brake pipe fitting (1) to prevent damage to the brake pipe (3).

6. Tighten the brake pipe fitting (1) to the brake hose (3).

Tighten
Tighten the brake pipe fitting to 16 Nm (12 lb ft).



Important: Hold the brake pipe union (2) with a suitable tool whilst connecting the brake pipe fitting (3) to prevent damage to the brake pipe (2).

7. Tighten the brake pipe (1) to the brake pipe union (2).

   Tighten
   Tighten the brake pipe fitting to 15 Nm (11 lb ft).

8. Install the rear suspension sub frame assembly. Refer to Rear Frame ReplacementRear Frame Replacement
9. Bleed the hydraulic brake system. Refer to Hydraulic Brake System BleedingHydraulic Brake System Bleeding

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Brakes | Hydraulic Brakes | Repair Instructions | **Document ID: 2194830**

Front Brake Hose Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

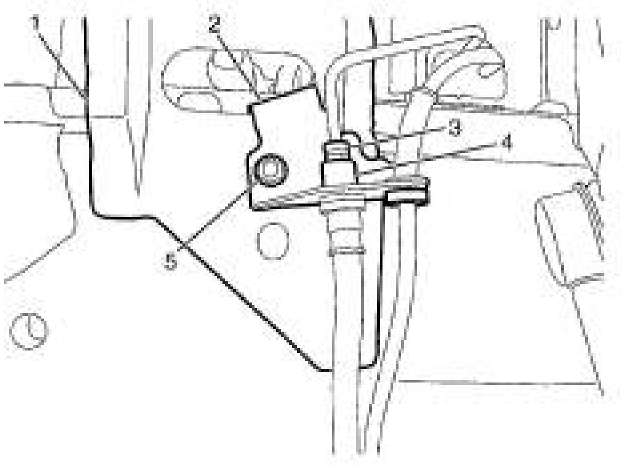
Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the VehicleLifting and Jacking the Vehicle.
2. Remove the front wheels. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation.
3. Clean all dirt and foreign material from the brake hose and the brake pipe fittings.



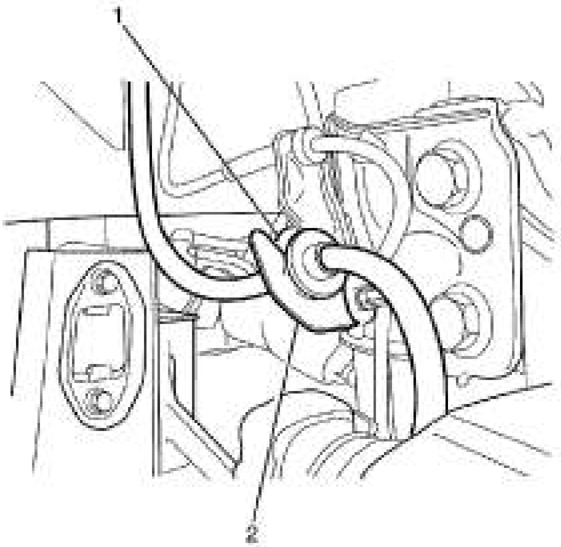
4. Detach the ABS wheel speed sensor wiring harness (5) from the brake hose retaining bracket (2).
5. Place a clean suitable container under the brake pipe fitting (3).

Important: Hold the brake hose (4) with a suitable tool whilst disconnecting the brake pipe fitting (3) to prevent damage to the brake pipe fitting (3).

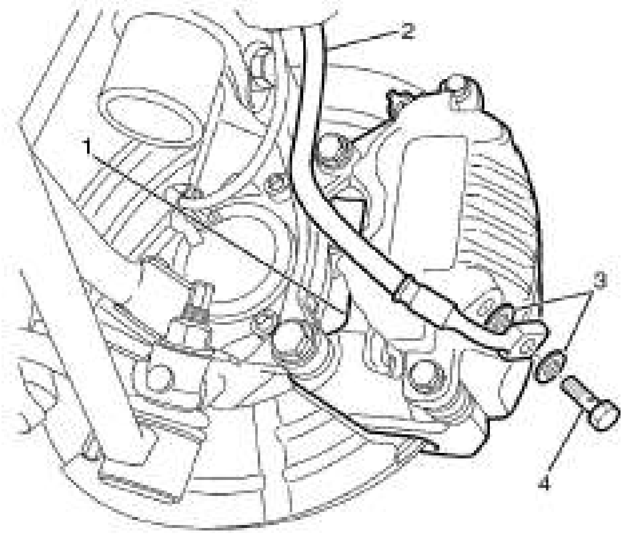
6. Disconnect the brake pipe fitting (3) from the brake hose (4).

   Important: Install a rubber cap or plug to the brake pipe fitting (3) in order to prevent brake fluid loss and contamination.

7. Plug the brake pipe fitting (3).
8. Remove the brake hose retaining bracket to wheel house retaining nut (6).
9. Remove the brake hose retaining bracket (2) from the wheel house (1).



10. Detach the brake hose (1) from the strut mounted brake hose retaining bracket (2).



11. Remove the brake hose to brake caliper banjo retaining bolt (4).
12. Remove the brake hose (2) from the brake caliper (1).

    Important: Install a rubber cap or plug to the brake caliper (1) in order to prevent brake fluid loss and/or contamination.

13. Plug the brake hose to brake caliper banjo retaining bolt hole in the brake caliper (1).
14. Place a shop towel on a hard surface.

Important: The copper brake hose sealing washers (3) may be stuck to the brake caliper (1) and/or the brake hose (2).

15. Tap the threaded end of the brake hose to brake caliper banjo retaining bolt (4) on the shop towel to remove the copper brake hose sealing washers (3) from the brake hose to brake caliper banjo retaining bolt (4).

Important: Copper brake hose sealing washers become work hardened due to the heat generated with brake applications and will not reseal. Install NEW copper brake hose sealing washers (4) whenever the brake hose to brake caliper banjo retaining bolt (3) is removed.

16. Remove the two copper brake hose sealing washers (3).

Discard the two copper brake hose sealing washers (3).

Installation Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

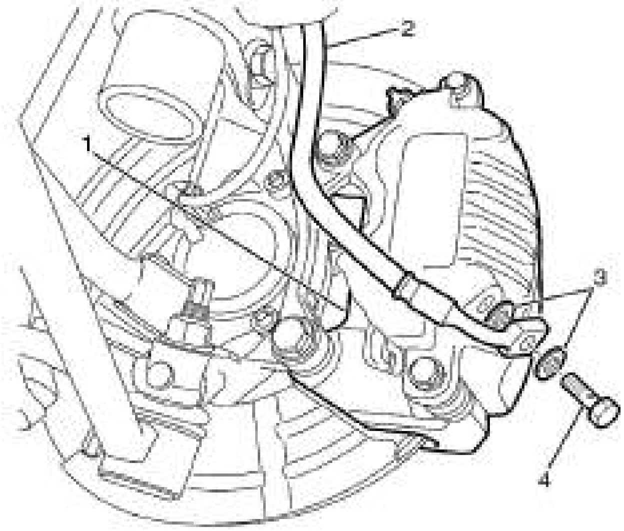
Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

1. Remove the rubber plug from the brake hose to brake caliper banjo retaining bolt hole in the brake caliper.

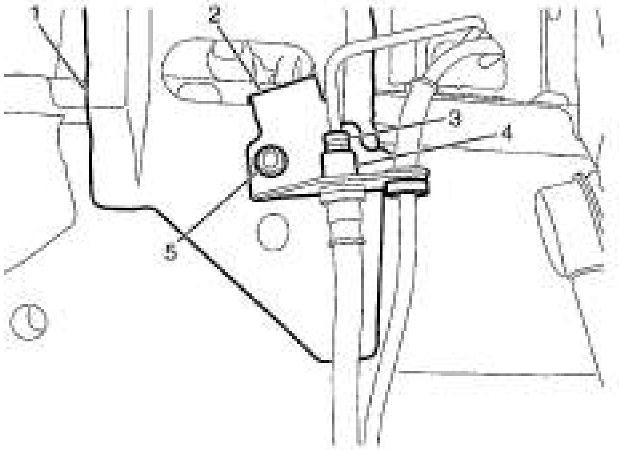


2. Assemble the NEW copper brake hose sealing washers (3), and the brake hose to brake caliper banjo retaining bolt (4) to the brake hose (2).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the brake hose (2) and brake hose to brake caliper banjo retaining bolt (4) to the brake caliper (1).

   Tighten
   Tighten the brake hose to brake caliper banjo retaining bolt to 35 Nm (26 lb ft).



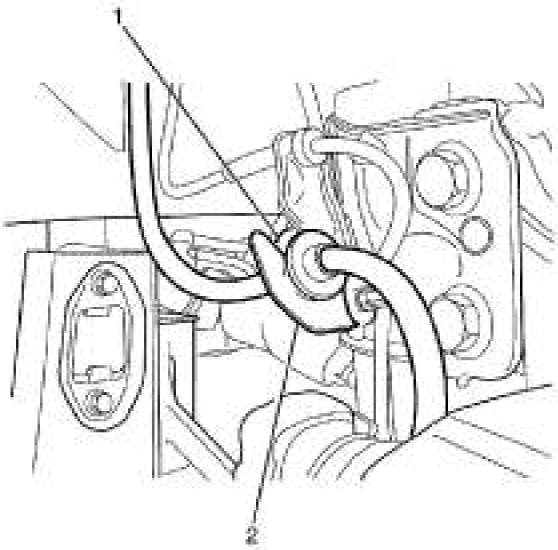
4. Position the brake hose retaining bracket (2) to the inner skirt panel (1).

5. Install the brake hose retaining bracket to inner skirt panel retaining nut (5).
6. Remove the rubber cap or plug from the brake pipe fitting (3).

    Important: Hold the brake hose (4) with a back up spanner whilst connecting the brake pipe fitting (3) to prevent damage to the brake pipe fitting (3).

7. Connect the brake pipe fitting (3) to the brake hose (4).

    Tighten
    Tighten the brake pipe fitting to 16 Nm (12 lb ft).



Important: Slightly twist the brake hose (1) to enable the slot in the brake hose retaining bracket (2) to line up with the flat in the brake hose (1). Slide the brake hose (1) down the brake hose retaining bracket (2) and allow the brake hose to return to its untwisted position for positive engagement in the brake hose retaining bracket (2)

8. Install the brake hose (1) to the strut mounted brake hose retaining bracket (2).
9. Bleed the hydraulic brake system. Refer to Hydraulic Brake System BleedingHydraulic Brake System Bleeding.
10. Install the front wheel assembly. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation.
11. Lower the vehicle.

Hydraulic Brake System Bleeding (Manual)

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

1. Place a clean suitable container beneath the brake master cylinder to catch brake fluid spills.

Important: With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal effort increases significantly, in order to deplete the brake booster power reserve.

2. Deplete the brake booster power reserve.
3. If you have performed a brake master cylinder bench bleed, disconnected the brake pipes from the master cylinder or the hydraulic modulator assembly, you MUST perform the following steps to bleed air at the ports of the hydraulic component:
   - 3.1. Clean the outside of the reservoir on and around the reservoir cap prior to removal.
   - 3.2. With the brake pipes installed securely to the master cylinder or hydraulic modulator assembly, loosen and separate one of the brake pipes from the port of the component:

For the hydraulic modulator assembly, perform these steps in the sequence of system flow; begin with the fluid feed pipes from the master cylinder.

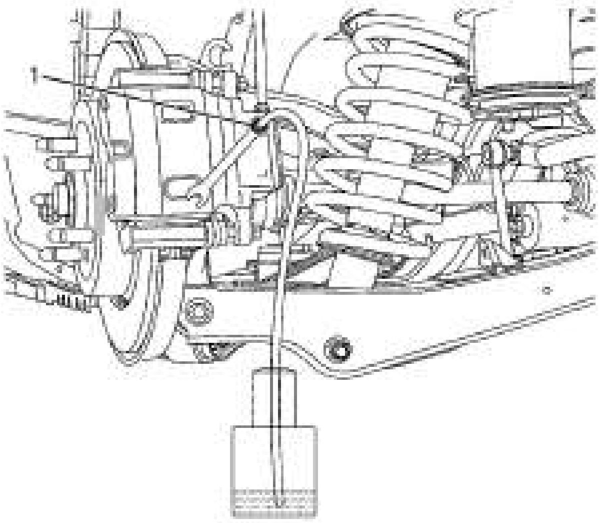
   - 3.3. Allow a small amount of brake fluid to gravity bleed from the open port of the component.
   - 3.4. Reconnect the brake pipe to the component and tighten securely.
   - 3.5. With the aid of an assistant slowly depress the brake pedal fully and maintain steady pressure on the pedal.
   - 3.6. Loosen the same brake pipe to purge air from the open port of the component.
   - 3.7. Tighten the brake pipe, then have the assistant slowly release the brake pedal.
   - 3.8. Wait 15 seconds, then repeat steps 3.3-3.7 until all air is purged from the same port of each component.
   - 3.9. With the brake pipe installed securely to the master cylinder or hydraulic modulator assembly, and after all air has been purged from the first port of the component that was bled, loosen and separate the next brake pipe from the component, then repeat steps 3.3-3.8 until each of the ports on the component has been bled.

    3.10. After completing the final component port bleeding procedure, make sure that each of the brake pipe to component fittings is correctly tightened.

4. Clean the outside of the brake master cylinder reservoir on and around the reservoir cap.

Important: Make sure the brake master cylinder reservoir remains at least half-full during this bleeding procedure. Add fluid as needed to maintain the correct level.

5. Remove the master cylinder reservoir cap.
6. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
7. Remove the wheels. Refer to Tire and Wheel Removal and Installation.



8. Fit a correct sized ring spanner onto the LEFT REAR wheel hydraulic circuit bleeder valve (1).
9. Install a transparent hose over the end of the LEFT REAR wheel hydraulic circuit bleeder valve (1).
10. Submerge the open end of the transparent hose into a container partially filled with brake fluid conforming to specification, from a clean, sealed brake fluid container. Refer to Brake System Specifications for correct brake fluid specification.
11. Have an assistant slowly depress the brake pedal fully and maintain steady pressure on the pedal.
12. Loosen the bleeder valve to purge air from the wheel hydraulic circuit.
13. Tighten the bleeder valve, then have the assistant slowly release the brake pedal.
14. Wait 15 seconds, then repeat steps 11-13 until all air is purged from the wheel hydraulic circuit.
15. Tighten the wheel circuit bleeder valve securely.
16. Fit a correct sized ring spanner onto the RIGHT REAR wheel hydraulic circuit bleeder valve.
17. Repeat steps 9-15.
18. Fit a correct sized ring spanner onto the LEFT FRONT wheel hydraulic circuit bleeder valve.
19. Repeat steps 9-15.
20. Fit a correct sized ring spanner onto the RIGHT FRONT wheel hydraulic circuit bleeder valve.
21. Repeat steps 9-15.
22. After completing the final wheel hydraulic circuit bleeding procedure, make sure that each of the 4 wheel hydraulic circuit bleeder valves is correctly tightened.
23. Install the wheels. Refer to Tire and Wheel Removal and Installation.
24. Lower the vehicle.
25. Fill the brake master cylinder reservoir to the maximum-fill level with brake fluid conforming

to specification, from a clean, sealed brake fluid container. Refer to Brake System Specifications for correct brake fluid specification.

26. Slowly depress and release the brake pedal. Observe the feel of the brake pedal.

    Important: If it is determined that air was induced into the system upstream of the hydraulic modulator assembly prior to servicing, the Antilock Brake System Automated Bleed Procedure must be performed. Refer to Antilock Brake System Automated Bleed Procedure.

27. If the brake pedal feels spongy, repeat the bleeding procedure again. If the brake pedal still feels spongy after repeating the bleeding procedure, perform the following steps:
    27.1. Inspect the brake system for external leaks. Refer to Brake System External Leak Inspection.
    27.2. Pressure bleed the hydraulic brake system in order to purge any air that may still be trapped in the system.
28. Turn the ignition ON, engine OFF. Check to see if the brake system warning lamp is illuminated.

    Important: DO NOT allow the vehicle to be driven until it is diagnosed and repaired.

29. If the brake system warning lamp is illuminated, refer to Symptoms - Hydraulic Brakes.

Hydraulic Brake System Bleeding (Pressure)

Tools Required

- J 29532 Diaphragm Pressure Bleeder
- J 35589-A Brake Pressure Bleeder Adapter

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

1. Place a clean suitable container beneath the brake master cylinder to catch brake fluid spills.

   Important: With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal becomes firm, in order to deplete the vacuum brake booster power reserve.

2. Deplete the vacuum brake booster power reserve.
3. If you have performed a brake master cylinder bench bleed, disconnected the brake pipes from the master cylinder or the Brake Pressure Modulator Valve (BPMV), you MUST perform the following steps to bleed air at the ports of the hydraulic component:
   - 3.1. Clean the outside of the reservoir on and around the reservoir cap prior to removal.
   - 3.2. With the brake pipes installed securely to the master cylinder or BPMV, loosen and separate one of the brake pipes from the port of the component:

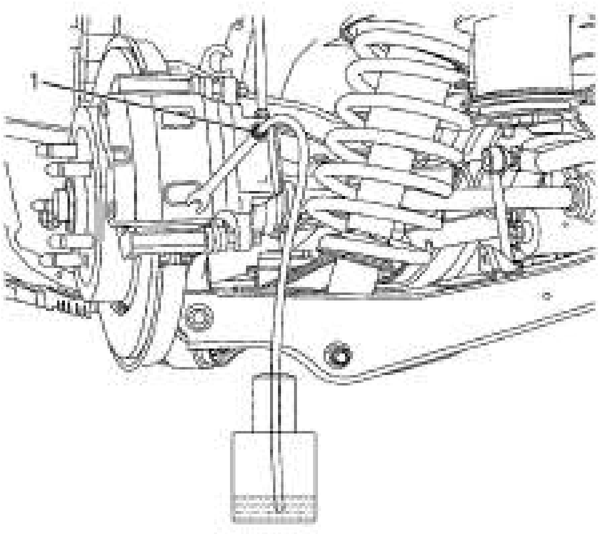
   For the BPMV, perform these steps in the sequence of system flow; begin with the fluid feed pipes from the master cylinder.

   - 3.3. Allow a small amount of brake fluid to gravity bleed from the open port of the component.
   - 3.4. Reconnect the brake pipe to the component and tighten securely.
   - 3.5. With the aid of an assistant slowly depress the brake pedal fully and maintain steady pressure on the pedal.
   - 3.6. Loosen the same brake pipe to purge air from the open port of the component.
   - 3.7. Tighten the brake pipe, then have the assistant slowly release the brake pedal.
   - 3.8. Wait 15 seconds, then repeat steps 3.3-3.7 until all air is purged from the same port of each component.

   3.9. With the brake pipe installed securely to the master cylinder or BPMV, and after all air has been purged from the first port of the component that was bled, loosen and separate the next brake pipe from the component, then repeat steps 3.3-3.8 until each of the ports on the component has been bled.
   3.10. After completing the final component port bleeding procedure, make sure that each of the brake pipe to component fittings is correctly tightened.
4. Clean the outside of the reservoir on and around the reservoir cap.
5. Remove the master cylinder reservoir cap and diaphragm.
6. Fill the brake master cylinder reservoir to the maximum-fill level with brake fluid conforming to specification, from a clean, sealed brake fluid container. Refer to Brake System Specifications for correct brake fluid specification.
7. Set up the brake pressure bleeder following the manufacturer's instructions.
8. Open the brake pressure bleeder fluid valve to allow pressurised brake fluid to enter the brake system.

Important: Any brake fluid leaks identified require repair prior to completing this procedure.

9. Wait approximately 30 seconds, then inspect the entire hydraulic brake system in order to make sure that there are no existing external brake fluid leaks.
10. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
11. Remove the wheels. Refer to Tire and Wheel Removal and Installation.



Important: Make sure the brake master cylinder reservoir remains at least half-full during this bleeding procedure. Add fluid as needed to maintain the correct level.

12. Fit a suitable tool onto the LEFT REAR wheel hydraulic circuit bleeder valve (1).
13. Install a transparent hose over the end of the LEFT REAR wheel hydraulic circuit bleeder valve (1).
14. Submerge the open end of the transparent hose into a container partially filled with brake fluid (3) conforming to specification, from a clean, sealed brake fluid container. Refer to Brake System Specifications for correct brake fluid specification.
15. Loosen the bleeder valve to purge air from the wheel hydraulic circuit. Allow fluid to flow until air bubbles stop flowing from the bleeder, then tighten the bleeder valve.

16. Tighten the wheel circuit bleeder valve securely.
17. Fit a suitable tool onto the RIGHT REAR wheel hydraulic circuit bleeder valve.
18. Repeat steps 13-15.
19. Tighten the wheel circuit bleeder valve securely.
20. Fit a suitable tool onto the LEFT FRONT wheel hydraulic circuit bleeder valve.
21. Repeat steps 13-15.
22. Tighten the wheel circuit bleeder valve securely.
23. Fit a suitable tool onto the RIGHT FRONT wheel hydraulic circuit bleeder valve.
24. Repeat steps 13-15.
25. After completing the final wheel hydraulic circuit bleeding procedure, make sure that each wheel hydraulic circuit bleeder valve is correctly tightened.
26. Close the brake pressure bleeder fluid valve.
27. Install the wheels. Refer to Tire and Wheel Removal and Installation.
28. Lower the vehicle.
29. Remove the brake pressure bleeder from the brake master cylinder reservoir.
30. Fill the brake master cylinder reservoir to the maximum-fill level with brake fluid conforming to specification, from a clean, sealed brake fluid container. Refer to Brake System Specifications for correct brake fluid specification.
31. Slowly depress and release the brake pedal. Observe the feel of the brake pedal.

    Important: If it is determined that air was induced into the system upstream of the BPMV prior to servicing, the Antilock Brake System Automated Bleed Procedure must be performed. Refer to Antilock Brake System Automated Bleed Procedure.

32. If the brake pedal feels spongy, repeat the bleeding procedure again. If the brake pedal still feels spongy after repeating the bleeding procedure, perform the following step:

    Inspect the brake system for external leaks. Refer to Brake System External Leak Inspection.

33. Turn the ignition ON, engine OFF. Check to see if the brake system warning lamp is illuminated.

    Important: DO NOT allow the vehicle to be driven until it is diagnosed and repaired.

34. If the brake system warning lamp is illuminated, refer to Symptoms - Hydraulic Brakes.

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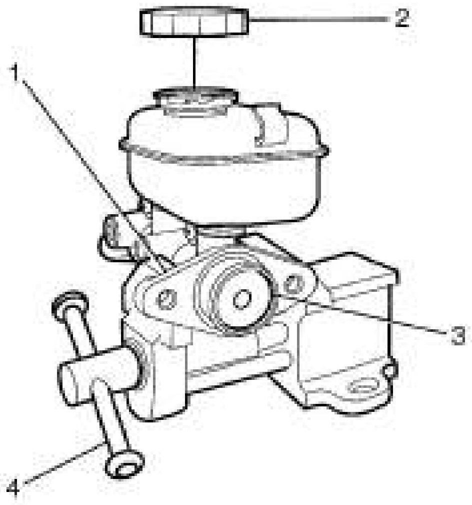
Master Cylinder Bench Bleeding (RHD)

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

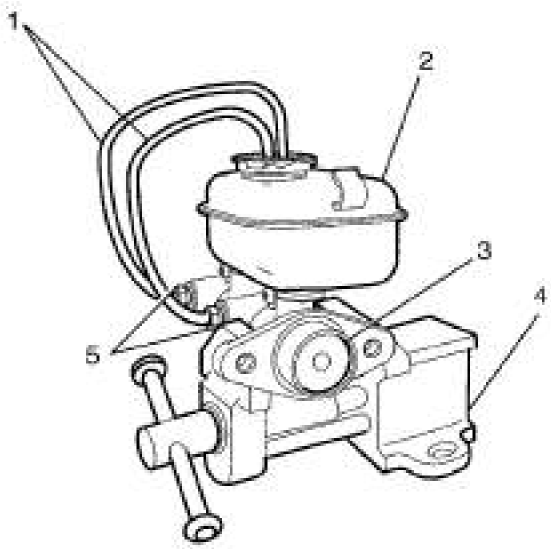
Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.



Important: The rear of the primary piston (3) must be accessible.

1. Secure the mounting flange of the brake master cylinder (1) in a suitable bench vise (4).
2. Remove the master cylinder reservoir cap (2).



Important: Install suitable fittings to the master cylinder ports (5) that match the type of flare seat required and also provide for hose attachment.

3. Install suitable fittings to the master cylinder ports (5).
4. Install transparent hoses (1) to the fittings installed to the master cylinder ports (5).

   Route the hoses into the master cylinder reservoir (2).

   Important: Brake fluid from a clean, sealed brake fluid container must be used when topping up the brake fluid level.

5. Fill the master cylinder reservoir (2) to the maximum fill level.

   Important: Make sure that the ends of the transparent hoses (1) running into the master cylinder reservoir (2) are fully submerged in the brake fluid.

   Important: As air is bled from the primary and secondary pistons, the effort required to depress the primary piston (3) will increase and the amount of travel will decrease.

   Important: Use a suitable smooth, round-ended tool to depress and release the primary piston (3) as far as it will travel. Observe the flow of fluid coming from the ports.

6. Depress and release the primary piston (3).
7. Continue to depress and release the primary piston (3) until fluid flows freely from the ports with no evidence of air bubbles.
8. Remove the fittings installed to the master cylinder ports (5) and transparent hoses (1).

   Wrap the master cylinder with a clean shop cloth to prevent brake fluid spills.

9. Install the master cylinder reservoir cap.
10. Remove the master cylinder from the suitable bench vise (4).

Master Cylinder Replacement (RHD)

Tools Required

J 23738-A J 23738-A Hand Vacuum Pump

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and ConnectionBattery Negative Cable Disconnection and Connection l.

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

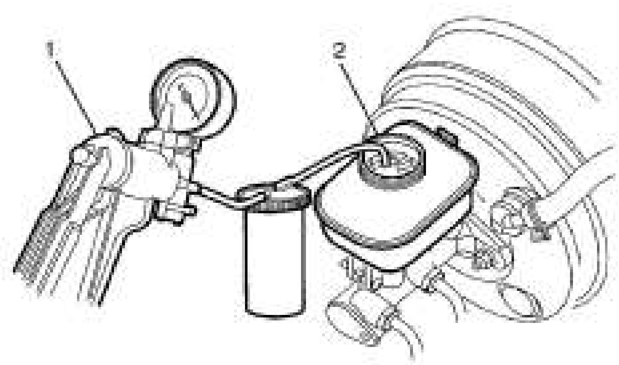
Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

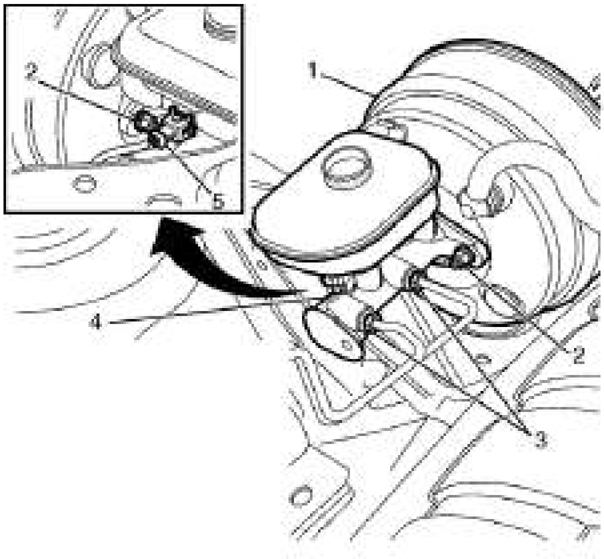
2. Apply the park brake and chock the wheels.

Important: With the ignition OFF and the brakes cool, apply the brakes three to five times, or until the brake pedal effort increases significantly, in order to deplete the vacuum brake booster power reserve.

3. Deplete the vacuum brake booster power reserve.
4. Clean the master cylinder, around the brake lines and the reservoir cap.
5. Place a clean suitable container under the master cylinder.
6. Remove the master cylinder reservoir cap.



7. Siphon the brake fluid out of the master cylinder reservoir (2) using J 23738-A J 23738-A (1).

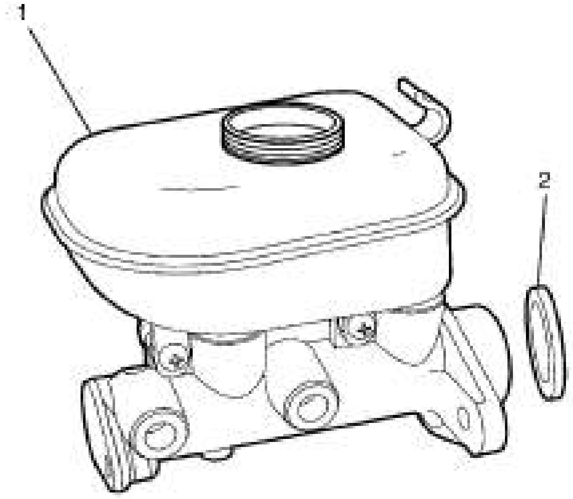


Important: Using a suitable tool lift the connector security clip to release the brake fluid level switch electrical connector (8) from the brake fluid level switch.

8. Disconnect the brake fluid level switch electrical connector (8).
9. Disconnect the brake pipes (3) from the master cylinder (7).

Important: Install a suitable rubber cap or plug on the exposed brake pipes (3) in order to prevent fluid loss and contamination.

10. Plug both the exposed brake pipes (3).
11. Remove the strut tower to master cylinder support bracket retaining nuts (4).
12. Remove the master cylinder support bracket to master cylinder retaining bolt (6).
13. Remove the master cylinder support bracket (5).
14. Remove the master cylinder to vacuum brake booster retaining nuts (2).
15. Remove the master cylinder (7) from the vacuum brake booster (1).



Important: The vacuum brake booster to master cylinder sealing O-ring (2) is a single use only component and will not reseal. Install a NEW master cylinder sealing O-ring (2) whenever the master cylinder (1) is removed from the vacuum brake booster.

16. Remove the vacuum brake booster to master cylinder sealing O-ring (2) from the master cylinder (1).

    Discard the master cylinder sealing O-ring (2).

Installation Procedure

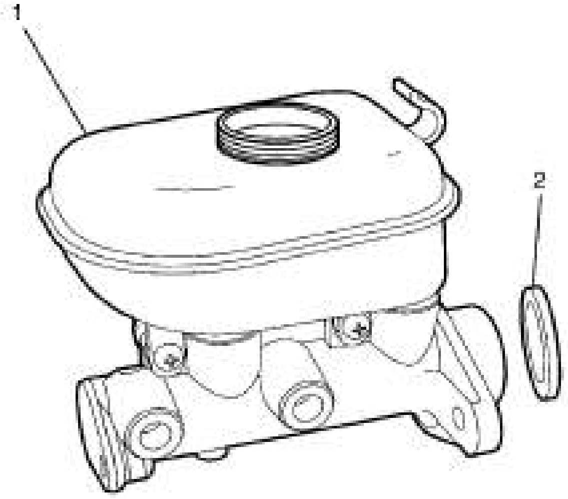
Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

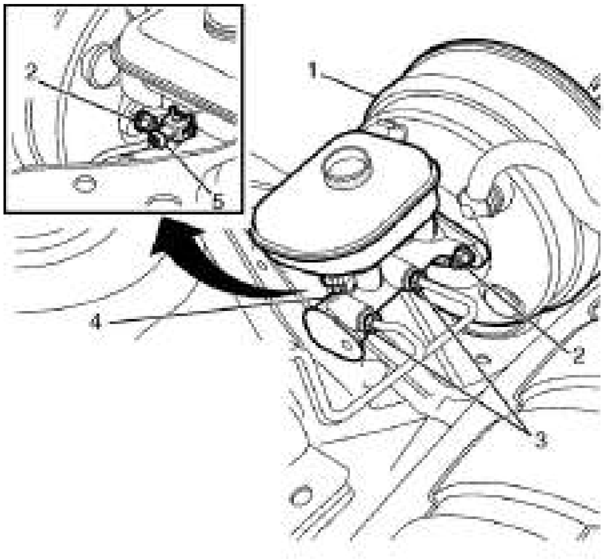
Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

1. Install the master cylinder reservoir. Refer to Master Cylinder Reservoir ReplacementMaster Cylinder Reservoir Replacement .
2. Bench bleed the master cylinder. Refer to Master Cylinder Bench BleedingMaster Cylinder Bench Bleeding.



3. Install a NEW vacuum brake booster to master cylinder sealing O-ring (2) to the master cylinder (1).
4. Place a clean suitable container under the master cylinder (1).



5. Install the master cylinder (7) to the vacuum brake booster (1).

   Notice: Refer to Fastener Notice in the Preface section.

6. Install the master cylinder to vacuum brake booster retaining nuts (2).

   Tighten
   Tighten the nuts to 15 Nm (11 lb ft).

7. Install the master cylinder support bracket (5).

8. Install the master cylinder support bracket to strut tower retaining nuts (4).

   Tighten
   Tighten the nuts to 22 Nm (16 lb ft).

9. Install the master cylinder support bracket to master cylinder retaining bolt (6).

   Tighten
   Tighten the bolt to 17 Nm (13 lb ft).

10. Remove the rubber caps from the exposed brake pipes (3).
11. Connect the brake pipes (3) to the master cylinder (7).

    Tighten
    Tighten the pipe fittings to 16 Nm (12 lb ft).

12. Connect brake fluid level switch electrical connector (8).

    Make sure the security clip is correctly installed.

13. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and ConnectionBattery Negative Cable Disconnection and Connection.
14. Release the park brake and remove the wheel chocks.
15. Bleed the braking system. Refer to Hydraulic Brake System BleedingHydraulic Brake System Bleeding.

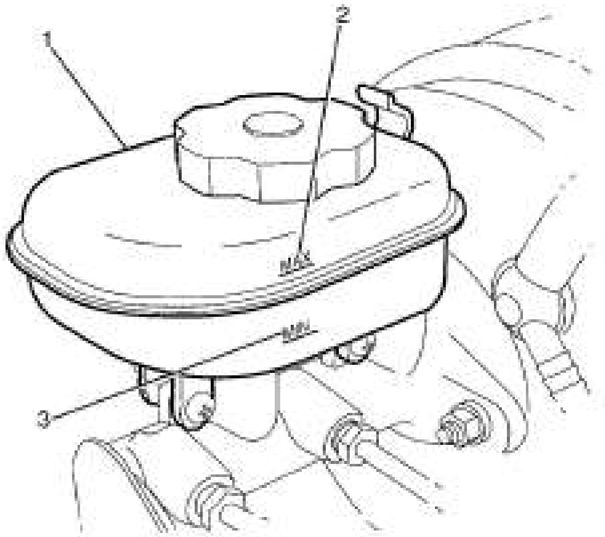
Master Cylinder Reservoir Filling (RHD)

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.



1. Visually inspect the brake fluid level in the master cylinder reservoir (1).
2. If the brake fluid level is at or below the minimum allowable level (3) during routine fluid inspections, the brake system should be inspected for wear and possible brake fluid leaks.
3. If the brake fluid level is at or below the minimum allowable level (3) and an inspection of the brake system did not reveal wear or brake fluid leaks, the brake fluid may be topped up to the maximum fill level (2).

Important: If brake fluid is to be added to the master cylinder reservoir (1), clean the outside and around the reservoir cap prior to removal.

4. If a brake system service was just completed, the brake fluid may be topped up to the maximum fill level (2).
5. If the brake fluid level is above the minimum allowable level (3), adding brake fluid is not recommended under normal conditions.

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Master Cylinder Reservoir Replacement (RHD)

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

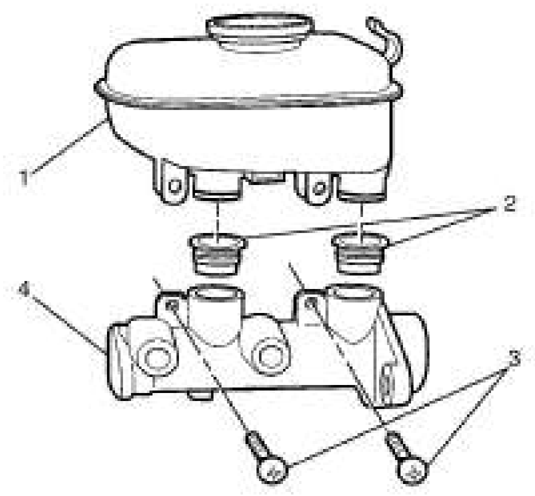
Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

2. Apply the park brake and chock the wheels.

Important: With the ignition OFF and the brakes cool, apply the brakes three to five times, or until the brake pedal effort increases significantly, in order to deplete the vacuum brake booster power reserve.

3. Deplete the vacuum brake booster power reserve.
4. Remove the master cylinder. Refer to Master Cylinder Replacement.



5. Clean the master cylinder reservoir (1), and master cylinder (5).
6. Remove the master cylinder reservoir cap (2).
7. Remove the master cylinder reservoir to master cylinder retaining screws (4).

Important: To remove the master cylinder reservoir (1) grasp the master cylinder (5) then pull up on the master cylinder reservoir (1).

8. Remove the master cylinder reservoir (1) from the master cylinder (5).

Important: Master cylinder reservoir seals (3) are single use only components and will not reseal. Install NEW master cylinder reservoir seals (3) whenever the master cylinder reservoir (1) is removed from the master cylinder (5).

9. Remove the two master cylinder reservoir seals (3) from the master cylinder (5).

Discard the two master cylinder reservoir seals (3).

Installation Procedure

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

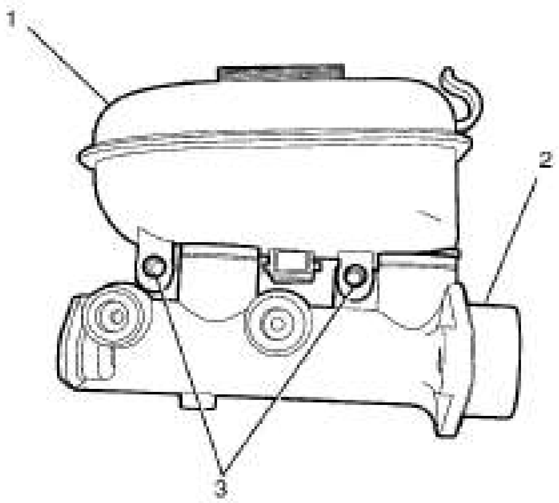
Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

Important: Lubricate the NEW master cylinder reservoir seals and the outer surface of the NEW master cylinder reservoir to housing barrels with brake fluid conforming to specification, from a clean, sealed brake fluid container in order to prevent tearing on installation. Refer to Brake System Specifications for correct brake fluid specification.

1. Install the NEW master cylinder reservoir seals to the master cylinder body.

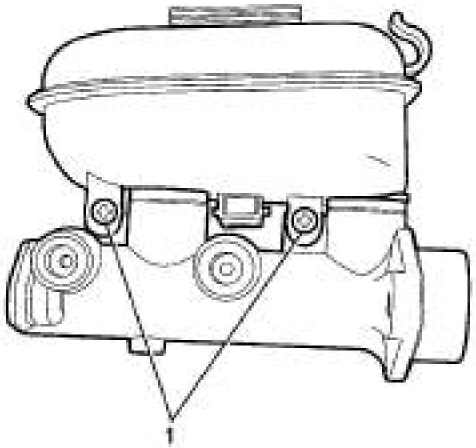
Make sure they are fully seated.



Important: Press down on the master cylinder reservoir (1) until the master cylinder reservoir to master cylinder retaining screw holes in the master cylinder body (3) are aligned.

2. Install the master cylinder reservoir (1) to the master cylinder body (2).

Notice: Refer to Fastener Notice in the Preface section.



3. Install the master cylinder reservoir to master cylinder retaining screws (1).

Tighten
Tighten the screws to 2.5 N·m (22 lb in).

4. Install the master cylinder. Refer to Master Cylinder Replacement.
5. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

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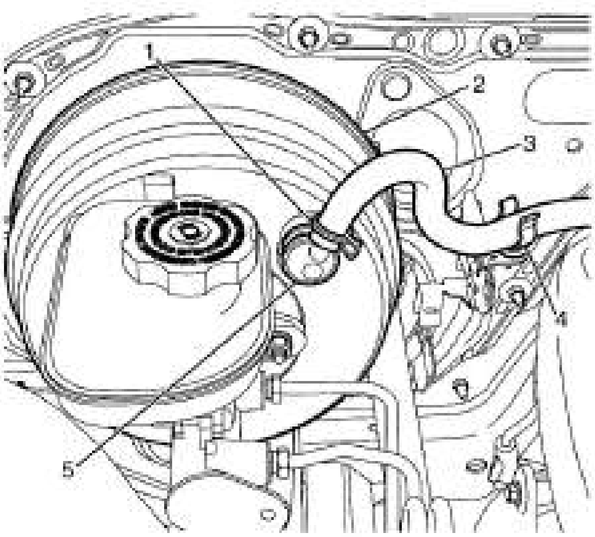
Power Brake Booster Inlet Hose Replacement (3.6L Engine RHD)

Removal Procedure

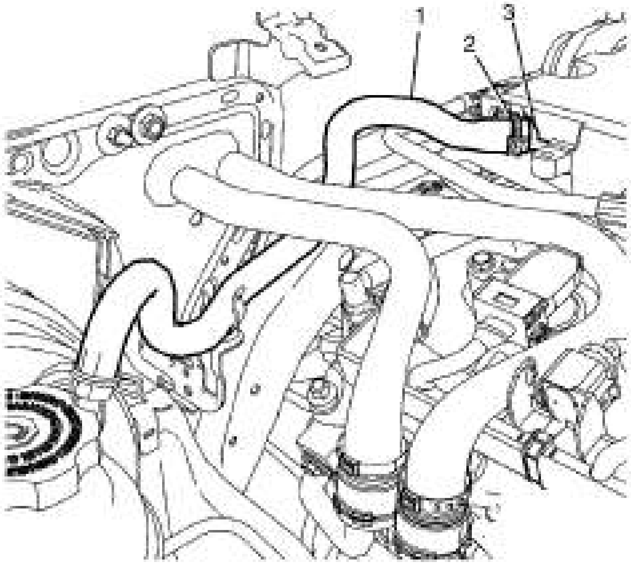
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .

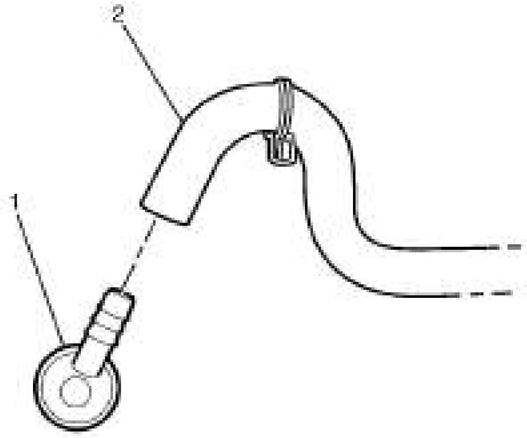


Important: With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal becomes firm, in order to deplete the vacuum brake booster power reserve.

2. Deplete the vacuum brake booster power reserve.
3. Remove the engine dress cover. Refer to Engine Cover Replacement
4. Compress the vacuum hose retaining clamp (1) at the vacuum brake booster (2) end and slide 50 mm (2 in) along the vacuum hose (3).
5. Disconnect the vacuum hose (3) and the vacuum brake booster check valve (5) from vacuum brake booster (2).
6. Detach the vacuum hose (3) from the bulkhead mounted vacuum hose retaining bracket (4).

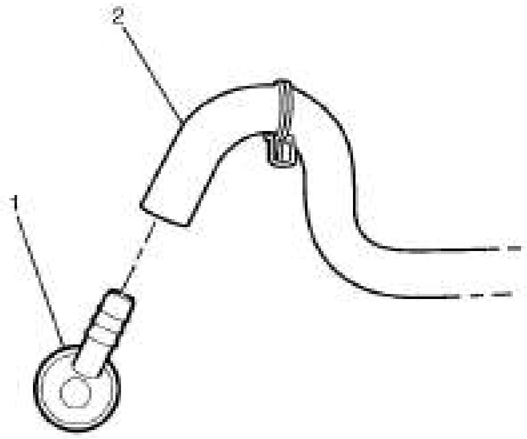


7. Compress the vacuum hose retaining clamp (2) at the intake manifold vacuum port (3) and slide 50 mm (2 in) along the vacuum hose (1).
8. Disconnect the vacuum hose (1) from the intake manifold vacuum port (3).

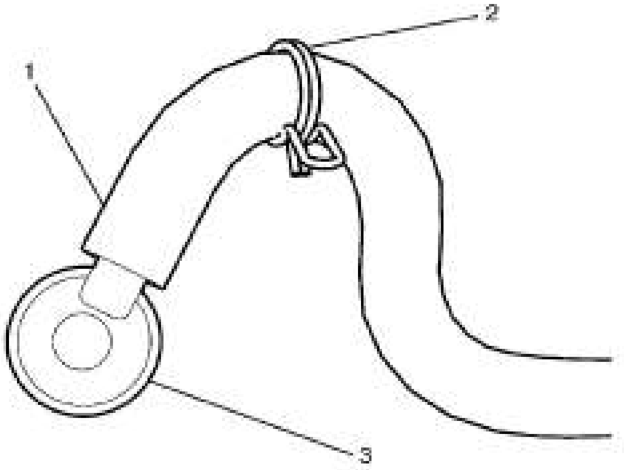


9. Remove the vacuum brake booster check valve (1) from the vacuum hose (2).

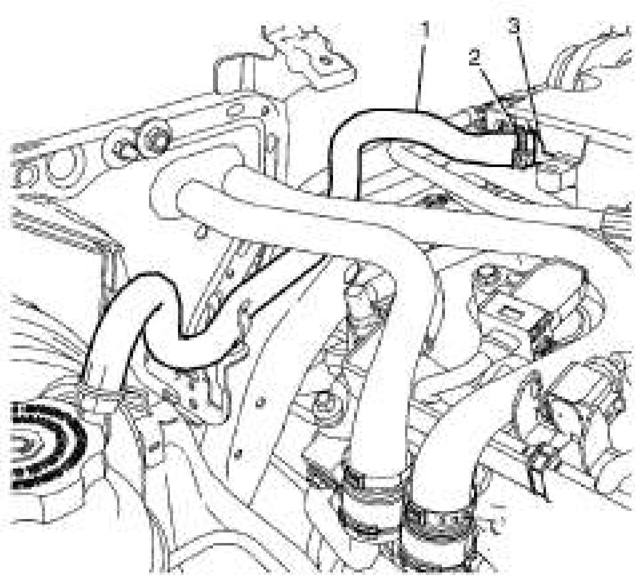
Installation Procedure



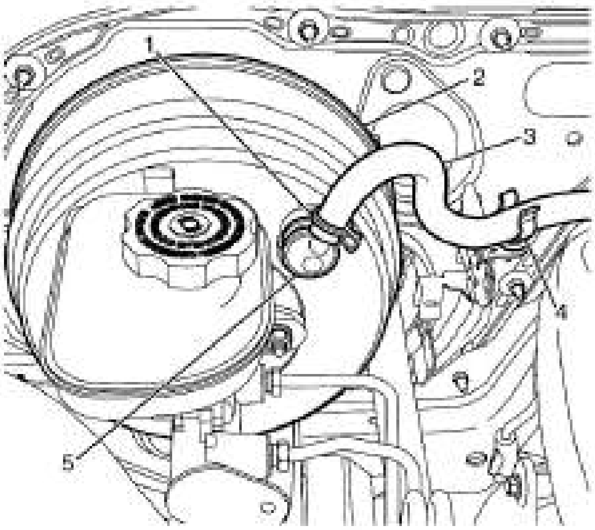
1. Install the vacuum brake booster check valve (1) to the vacuum hose (2).



2. Install the vacuum hose retaining clamp (2) to the correct location on the vacuum hose (1) to secure the vacuum brake booster check valve (3).



3. Connect the vacuum hose (1) to the intake manifold vacuum port (3).
4. Compress the vacuum hose retaining clamp (2) and slide along the vacuum hose (1) to the correct location to secure the vacuum hose (1) to the intake manifold vacuum port (3).



Important: Make sure the vacuum hose (3) is not twisted. Compress the vacuum hose retaining clamp (1) and rotate the vacuum brake booster check valve (5) as required.

5. Connect the vacuum hose (3) and vacuum brake booster check valve (5) to vacuum brake booster (2).
6. Attach the vacuum hose (3) to the bulkhead mounted vacuum hose retaining bracket (4).
7. Install the engine dress cover. Refer to Engine Cover Replacement
8. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .

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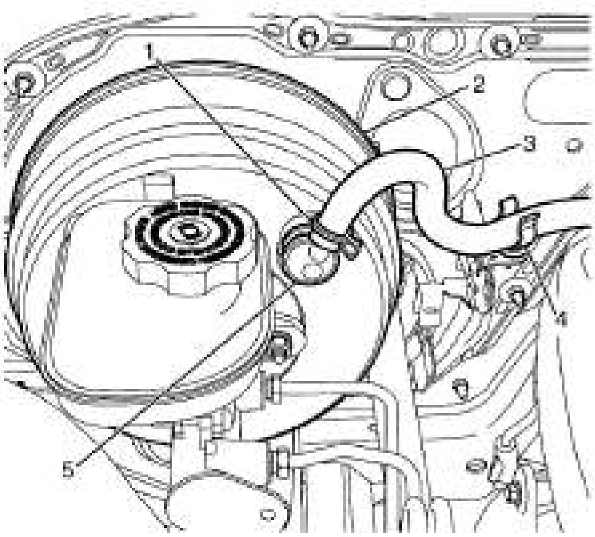
Power Brake Booster Inlet Hose Replacement (6.0L Engine RHD)

Removal Procedure

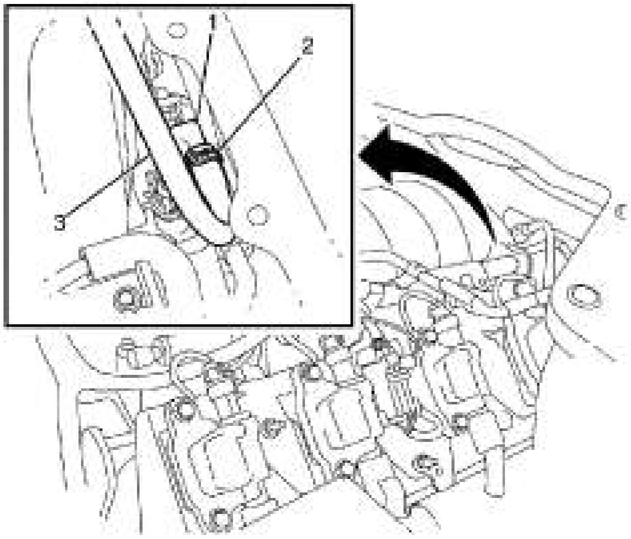
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

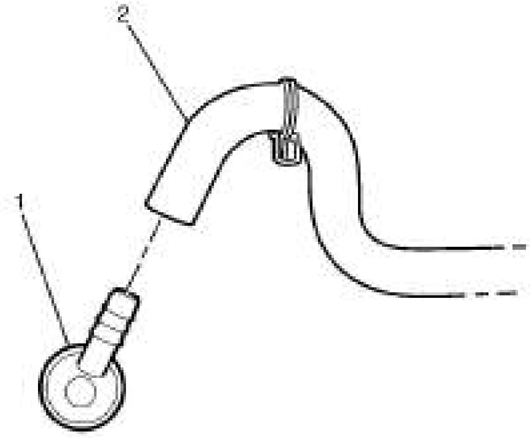


Important: With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal becomes firm, in order to deplete the vacuum brake booster power reserve.

2. Deplete the vacuum brake booster power reserve.
3. Remove the engine dress cover. Refer to Engine Cover Replacement.
4. Compress the vacuum hose retaining clamp (1) at the vacuum brake booster (2) end and slide 50 mm (2 in) back along the vacuum hose (3).
5. Disconnect the vacuum hose (3) and the vacuum brake booster check valve (5) from vacuum brake booster (2).
6. Detach the vacuum hose (3) from the bulkhead mounted vacuum hose retaining bracket (4)

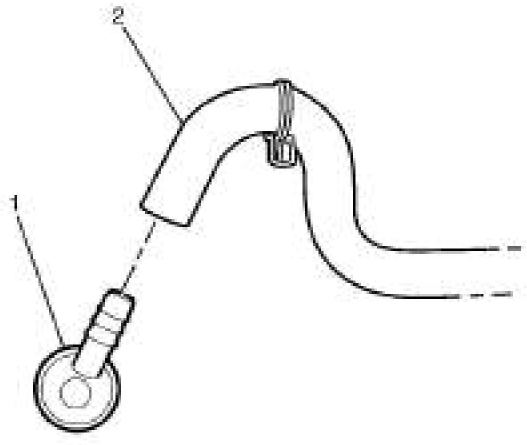


7. Compress the vacuum hose retaining clamp (2) at the intake manifold vacuum port (1) and slide 50 mm (2 in) back along the vacuum hose (3).
8. Disconnect the vacuum hose (3) from the intake manifold vacuum port (1).

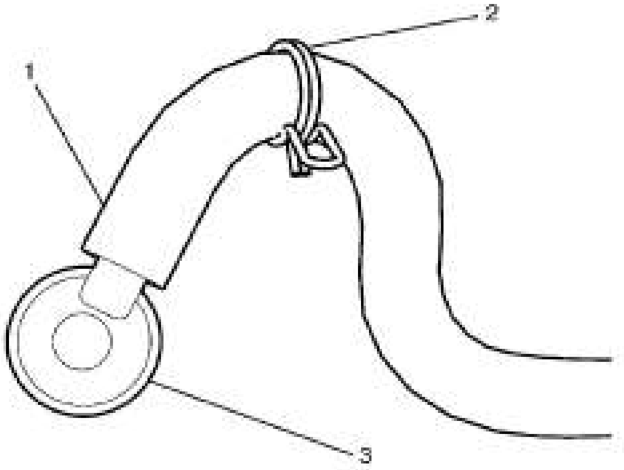


9. Remove the vacuum brake booster check valve (1) from the vacuum hose (2).

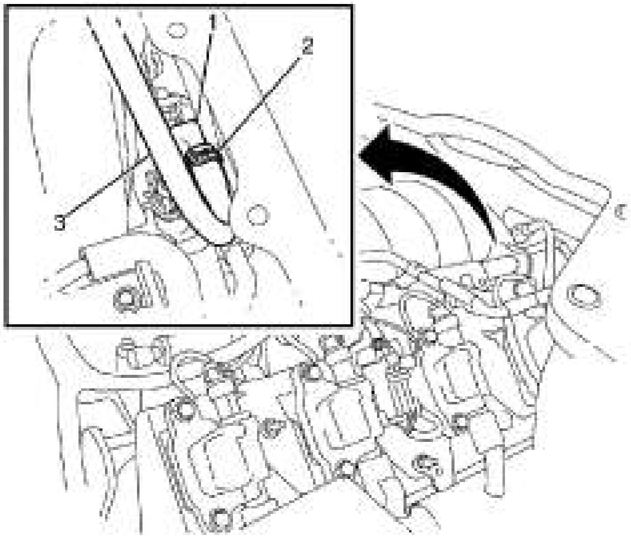
Installation Procedure



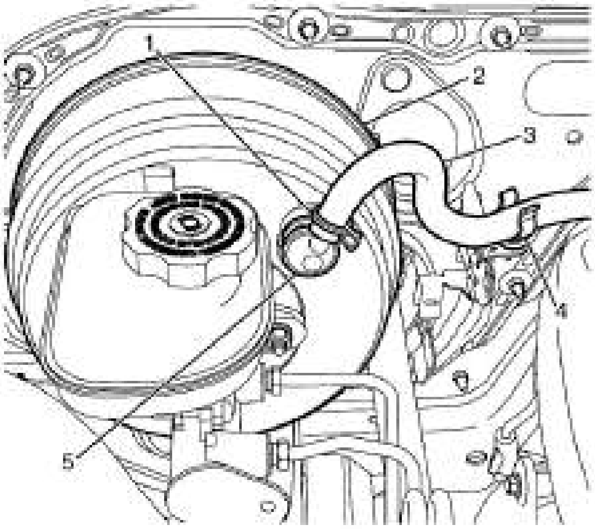
1. Install the vacuum brake booster check valve (2) to the vacuum hose (1).



2. Install the vacuum hose retaining clamp (1) to the correct location on the vacuum hose (2) to secure the vacuum brake booster check valve (3).



3. Connect the vacuum hose (3) to the intake manifold vacuum port (1).
4. Compress the vacuum hose retaining clamp (2) and slide along the vacuum hose (3) to the correct location to secure the vacuum hose (3) to the intake manifold vacuum port (1).



Important: Make sure the vacuum hose (3) is not twisted. Compress the vacuum hose retaining clamp (1) and rotate the vacuum brake booster check valve (5) as required.

5. Connect the vacuum hose (3) and vacuum brake booster check valve (5) to vacuum brake booster (2).
6. Attach the vacuum hose (3) to the bulkhead mounted vacuum hose retaining bracket (4).
7. Install the engine dress cover. Refer to Engine Cover Replacement.
8. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

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Power Vacuum Brake Booster Replacement (RHD)

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

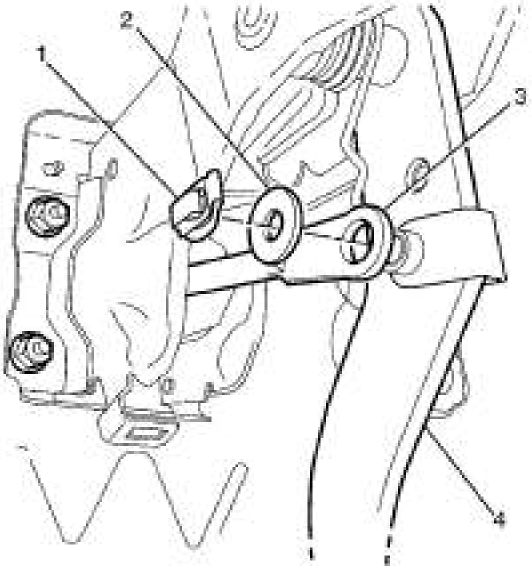
   Caution: Refer to Brake Fluid Caution in the Preface section.

   Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

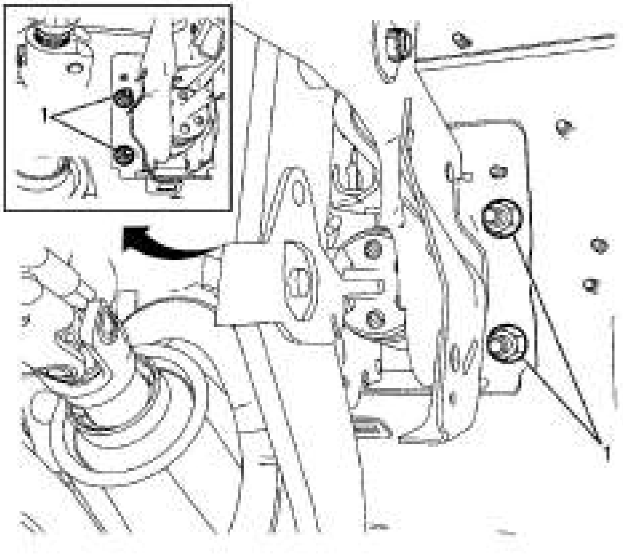
   Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

   Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

2. Remove the instrument panel lower trim panel assembly. Refer to Knee Bolster Replacement.
3. Remove the instrument panel lower trim panel retainer. Refer to Instrument Panel Insulator Panel Replacement - Right Side.
4. Remove the master cylinder from the vehicle. Refer to Master Cylinder Replacement.
5. Remove the vacuum hose and check valve from the vacuum brake booster. Refer to Power Brake Booster Inlet Hose Replacement



6. Remove the brake pedal pushrod retaining clip (1), washer (2) and the brake pedal pushrod (3) from the brake pedal (4).



7. Remove the vacuum brake booster to brake pedal support bracket retaining nuts (1).

   Important: From the engine compartment, pull the vacuum brake booster forward to release the four studs from the bulkhead and brake pedal support bracket.

8. Remove the vacuum brake booster from the vehicle.

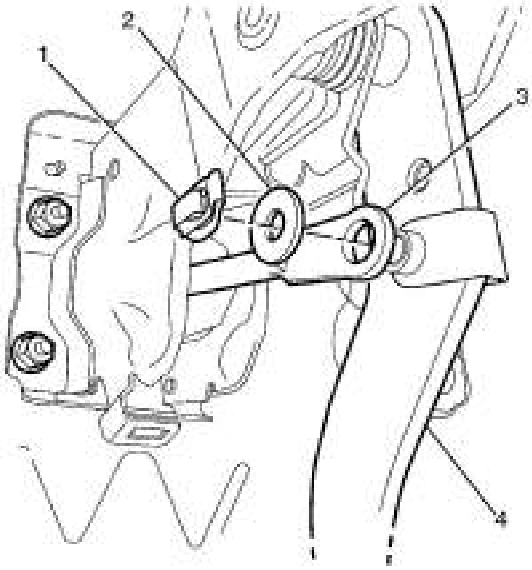
Installation Procedure

Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

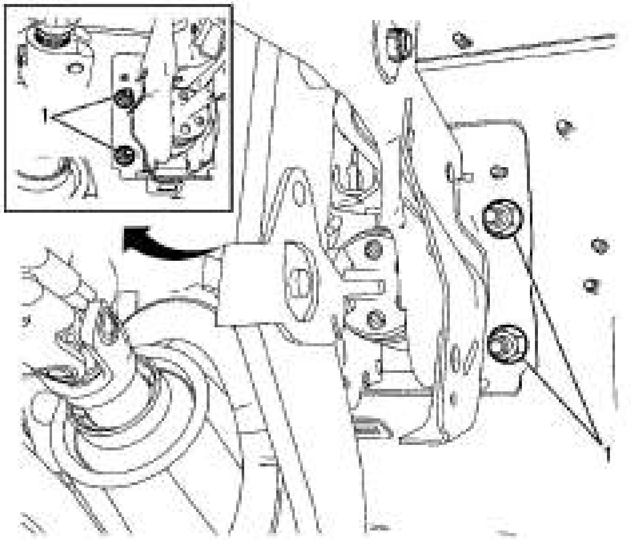
Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

1. With the aid of an assistant, install the vacuum brake booster from the engine compartment. Make sure the vacuum brake booster's four studs are correctly located in the bulkhead and brake pedal support bracket.



2. Install the push rod (3), washer (2) and retaining clip (1) to the brake pedal assembly (4).

   Notice: Refer to Fastener Notice in the Preface section.



3. Install the vacuum brake booster to brake pedal support bracket retaining nuts (1).

   Tighten
   Tighten the nuts to 23 N·m (17 lb ft).

4. Install the vacuum hose and check valve to the vacuum brake booster. Refer to Power Brake Booster Inlet Hose Replacement
5. Install the master cylinder to the vacuum brake booster. Refer to Master Cylinder

Replacements.

6. Bleed the braking system. Refer to Hydraulic Brake System Bleeding.
7. Install the instrument panel lower trim panel retainer. Refer to Instrument Panel Insulator Panel Replacement - Right Side.
8. Install the instrument panel lower trim panel assembly. Refer to Knee Bolster Replacement.
9. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

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Rear Brake Hose Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

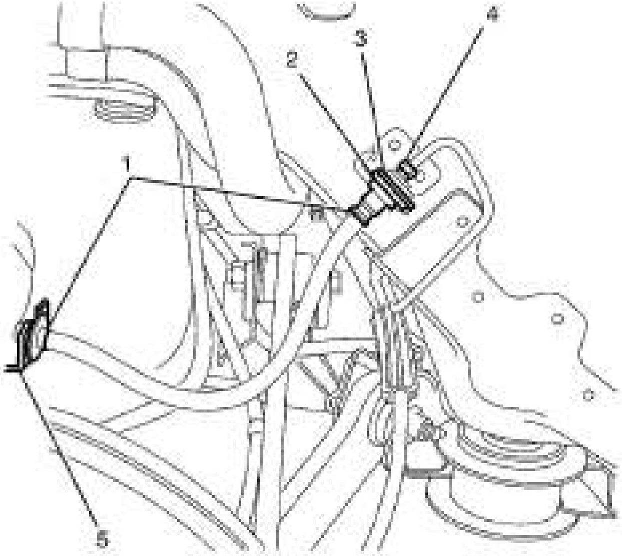
Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the VehicleLifting and Jacking the Vehicle.
2. Remove the rear wheel. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation.
3. Clean all dirt and foreign material from the brake hose and the brake pipe fittings.



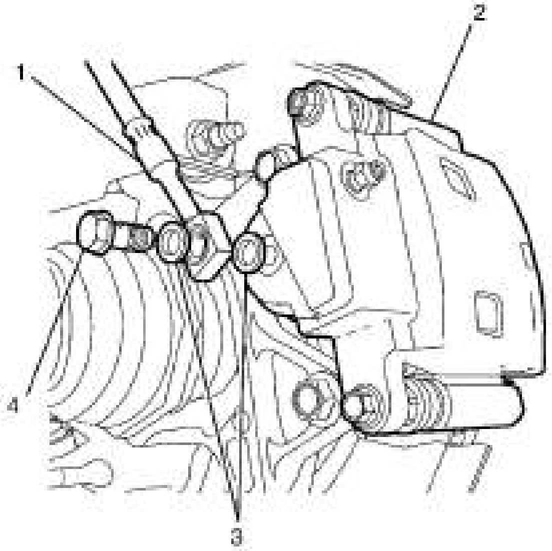
4. Place a clean suitable container under the brake pipe fitting (4).

Important: Hold the brake hose (1) with a suitable tool whilst disconnecting the brake pipe fitting (4) to prevent damage to the brake pipe fitting (4).

5. Disconnect the brake pipe fitting (4) from the brake hose (1).

Important: Install a rubber cap or plug to the brake pipe fitting (4) in order to prevent brake fluid loss and contamination.

6. Plug the brake pipe fitting (4).
7. Remove the brake hose retaining clip (2) from brake hose (1) and remove from the brake hose retaining bracket (3).
8. Detach the brake hose (1) from the upper control arm mounted brake hose retaining bracket (5).



9. Remove the brake hose to brake caliper banjo retaining bolt (4) from the brake caliper (2).
10. Remove the brake hose (1) from the brake caliper (2).

Important: Install a rubber cap or plug to the exposed brake caliper (2) in order to prevent brake fluid loss and/or contamination.

11. Plug the brake hose to brake caliper banjo retaining bolt hole in the brake caliper (2).
12. Place a shop towel on a hard surface.

Important: The copper brake hose sealing washers (3) may be stuck to the brake caliper (2) and/or the brake hose (1).

13. Tap the threaded end of the brake hose to brake caliper banjo retaining bolt (4) on the shop towel to remove the copper brake hose sealing washers (3) from the brake hose to brake caliper banjo retaining bolt (4)

Important: Copper brake hose sealing washers (3) become work hardened due to the heat generated with brake applications and will not reseal. Install NEW copper brake hose sealing washers (3) whenever the brake hose to brake caliper banjo retaining bolt (4) is removed.

14. Remove the two copper brake hose sealing washers (3).

Discard the two copper brake hose sealing washers (3).

Installation Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

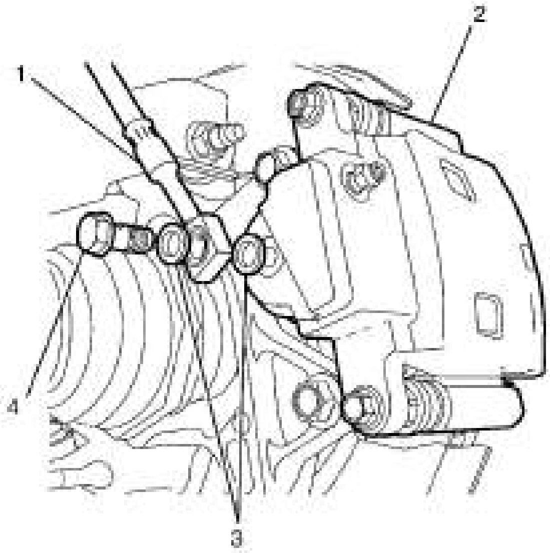
Caution: Refer to Brake Fluid Caution in the Preface section.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Adding Fluid to the Brake System Notice in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

1. Remove the rubber cap or plug from the brake hose to brake caliper banjo retaining bolt hole in the brake caliper.



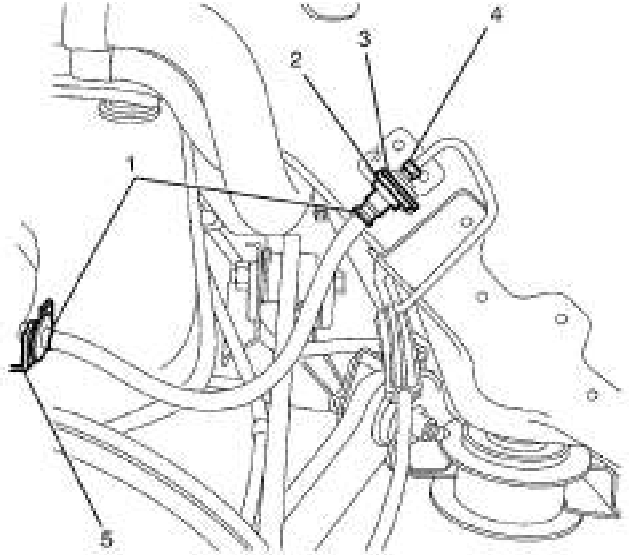
2. Assemble the NEW copper brake hose sealing washers (3), and the brake hose to brake caliper banjo retaining bolt (4) to the brake hose (1).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the brake hose to brake caliper banjo retaining bolt (4) to the brake caliper (2).

   Tighten
   Tighten the brake hose to brake caliper banjo retaining bolt to 35 Nm (26 lb ft).

4. Remove the rubber cap or plug from the brake pipe fitting end.



5. Install the brake pipe fitting (3) to the brake hose (1) through brake hose retaining bracket (4).

   Tighten
   Tighten the brake pipe fitting to 16 Nm (12 lb ft).

6. Install the bracket retainer clip (2).

   Important: Slightly twist the brake hose (1) to enable the slot in the brake hose retaining bracket (5) to line up with the flat in the brake hose (1). Slide the brake hose (1) down the brake hose retaining bracket (5) and allow the brake hose to return to its untwisted position for positive engagement in the brake hose retaining bracket (5)

7. Attach the brake hose (1) to the upper control arm mounted brake hose retaining bracket (5).
8. Bleed the hydraulic brake system. Refer to Hydraulic Brake System BleedingHydraulic Brake System Bleeding.
9. Install the rear wheel. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation.
10. Lower the vehicle.

Brake Warning System Description and Operation

The purpose of the brake warning system is to warn the driver of the park brake being applied whilst the vehicle is being driven, a brake Electronic Brake Differential (EBD) failure and/or a low brake fluid level condition.

- The Park Brake Warning is active when the park brake signal is active and the vehicle speed is greater than 10 km/h (6 mph).

  A red telltale illuminates whilst the park brake signal is active, regardless of the vehicle speed.

  The Park Brake Warning is displayed both as an animation on the Multi Function Display (MFD) and as a telltale. The General Warning Chime sounds when the animated warning activates. The chime will not repeat whilst the warning remains active.

  The Park Brake Warning remains on the Multi Function Display (MFD) until:

  - The ENTER switch is pressed.
  - The TRIP button is pressed.
  - The condition is rectified.
  - The speed is reduced to less than 10 km/h (6 mph).
- A brake EBD fail warning is active when the brake fail signal is active.

  A red telltale illuminates whilst the brake fail signal is active.

  A brake EBD Fail Warning is displayed both as an animation on the MFD and as a telltale. The General Warning Chime sounds when the animated warning activates. The chime will not repeat whilst the warning remains active.

  The brake EBD fail warning remains on the MFD until:

  - The ENTER switch is pressed.
  - The TRIP button is pressed.
  - The condition is rectified.
- A brake fluid level warning is active when the Instrument Panel Cluster (IPC) detects an increase in resistance in the Brake Fluid Level Switch circuit.

  A red telltale illuminates continuously with the ignition in the ON position and the resistance of the Brake Fluid Level Switch circuit above a predetermined value.

  The brake fluid level warning is displayed both as an animation on the MFD and as a telltale. The General Warning Chime sounds when the animated warning activates. The chime will not repeat whilst the warning remains active.

  The brake fluid level warning remains on the MFD until:

  - The ENTER switch is pressed.
  - The TRIP button is pressed.
  - The condition is rectified.

Hydraulic Brake System Description and Operation

System Component Description

The hydraulic brake system consists of the following:

Hydraulic Brake Master Cylinder Reservoir: Contains a supply of brake fluid for the hydraulic brake system.

Hydraulic Brake Master Cylinder: Converts mechanical input force into hydraulic output pressure. Hydraulic output pressure is distributed from the master cylinder through two hydraulic circuits to the Brake Modulator Assembly. Under normal braking the Brake Modulator Assembly allows fluid pressure to be distributed through out the hydraulic brake system.

Hydraulic Brake Pressure Balance Control System: Regulates brake fluid pressure delivered to hydraulic brake wheel circuits, in order to control the distribution of braking force. Pressure balance control is achieved through Electronic Brake Differential (EBD), which is a function of the ABS modulator. For specific information on the operation of Electronic Brake Differential (EBD) refer to ABS Description and Operation.

Hydraulic Brake Pipes and Flexible Brake Hoses: Carries brake fluid to and from hydraulic brake system components.

Hydraulic Brake Wheel Apply Components: Converts hydraulic input pressure into mechanical output force.

System Operation

Mechanical force is converted into hydraulic pressure by the master cylinder, regulated to meet braking system demands by the pressure balance control system and delivered to the hydraulic brake wheel circuits by the pipes and flexible hoses. The wheel apply components then convert the hydraulic pressure back into mechanical force which presses brake linings against rotating brake system components.

Brake Assist System Description and Operation

System Component Description

The brake assist system consists of the following:

Brake Pedal: Multiplies the braking effort applied by the driver.

Brake Pedal Pushrod: Transfers multiplied input force received from the brake pedal to the vacuum brake booster.

Vacuum Brake Booster: Uses source vacuum to decrease effort required by the driver when applying the brakes.

Vacuum Source: The source vacuum for a spark ignition engine is normally derived from the Intake Manifold.

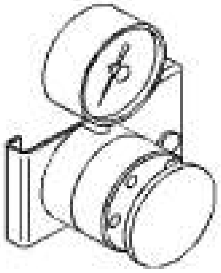
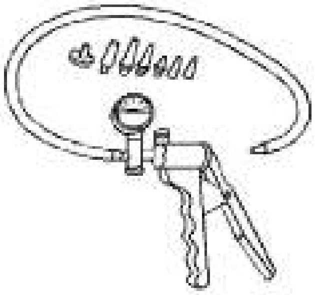
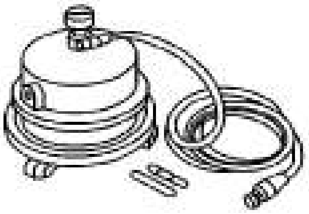
Vacuum Source Delivery System: Enables delivery and retention of source vacuum for vacuum brake booster.

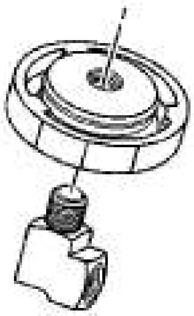
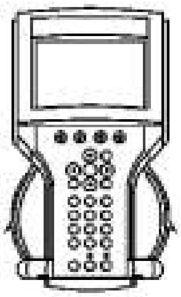
System Operation

Under normal driving conditions, without the brakes applied, vacuum is allowed to act on both sides of the diaphragm within the vacuum brake booster. When the brake pedal is applied, the effort by the driver is multiplied due to the relative length of the brake pedal in relationship to its pivot point and the point at which the push rod to the Vacuum Brake Booster is attached. Movement of the push rod causes a valve within the Vacuum Brake Booster to close between the two sides of the diaphragm, thus isolating each side. It also allows a valve to open that allows atmospheric pressure to act on the pedal side of the Vacuum Brake Booster whilst maintaining vacuum on the vacuum source side of the diaphragm. The movement of the Brake Pedal Pushrod is transferred to the Hydraulic Brake Master Cylinder via the Vacuum Brake Booster. The pressure differential within the Vacuum Brake Booster reduces the effort required by the driver in applying the brakes.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Brakes | Hydraulic Brakes | Special Tools and Equipment | **Document ID: 1989394**

Special Tools

Illustration	Tool Number / Description
	J 28662 Brake Pedal Effort Gauge
	J 23728-A Hand Vacuum Pump
	J 29532 Diaphragm Pressure Bleeder
	J 35589-A

	Brake Pressure Bleeder Adapter
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

Fastener Tightening Specifications

Up to - 05 Mar 2007

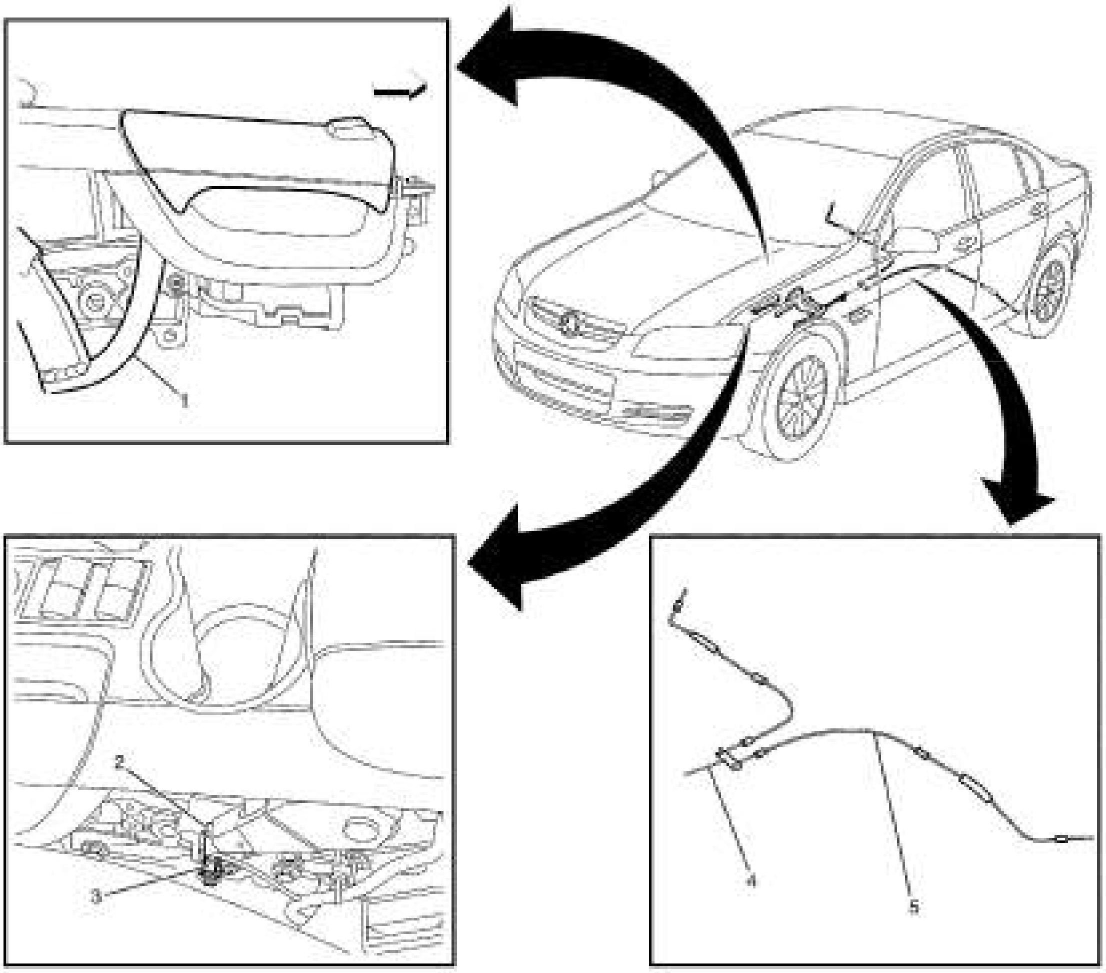
Application	Specification	
	Metric	English
Park Brake Cable Guide Bolt	22 Nm	18 lb ft
Park Brake Cable Guide Nut	9 Nm	80 lb in
Park Brake Cable Mounting Bracket Bolt	22 Nm	16 lb ft
Park Brake Handle Assembly Mounting Nuts	1.5 Nm	18 lb in
Park Brake Warning Lamp Switch Bolt	1.5 Nm	18 lb in

From - 05 Mar 2007

Application	Specification	
	Metric	English
Park Brake Cable Guide Bolt	22 Nm	18 lb ft
Park Brake Cable Guide Nut	11 Nm	97 lb in
Park Brake Cable Mounting Bracket Bolt	22 Nm	16 lb ft
Park Brake Handle Assembly Mounting Nuts	1.5 Nm	18 lb in
Park Brake Warning Lamp Switch Bolt	1.5 Nm	18 lb in

Park Brake System Component Views (SWBRHD)

Park Brake Subsystem Components



(1) Park Brake Lever Assembly

(2) Park Brake Switch

(3) Park Brake Switch Electrical Connector

(4) Park Brake Cable Assembly (Front)

(5) Park Brake Cable Assembly (Rear)

Diagnostic Starting Point - Park Brake

Begin the system diagnosis by reviewing the system description and operation. Reviewing the description and operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the description and operation information will also help you determine if the condition described by the customer is normal operation. Refer to Symptoms - Park Brake, order to identify the correct procedure for diagnosing the system and where the procedure is located.

Symptoms - Park Brake

Important: Review the system operation in order to familiarise yourself with the system functions.

Refer to Park Brake System Description and Operation.

Visual / Physical Inspection

- Inspect for aftermarket devices which may affect the operation of the park brake system.
- Inspect the easily accessible or visible system components for obvious damage or conditions which may cause the symptom.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

Park Brake Will Not Hold or Release.

Park Brake System Diagnosis.

Park Brake Will Not Hold or Release

Step	Action	Yes	No
1	Were you sent here from the Park Brake Symptom List?	Go to Step 2	Go to Diagnostic Starting Point - Park Brake.
2	Inspect the park brake system for correct operation. Refer to Park Brake System Diagnosis. Did you find and correct a condition?	Go to Step 5	Go to Step 3
3	Inspect the disc brake system for correct operation. Refer to Disc Brake System Diagnosis. Did you find and correct a condition?	Go to Step 5	Go to Step 4
4	Inspect the hydraulic brake system for correct operation. Refer to Hydraulic Brake System Diagnosis. Did you find and correct a condition?	Go to Step 5	Go to Diagnostic Starting Point - Park Brake.
5	Road test the vehicle in order to confirm correct operation. Refer to Brake System Vehicle Road Test. Is the condition still present?	Go to Step 2	System OK

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Brakes | Park Brake | Diagnostic Information and Procedures | **Document ID: 1982155**

Park Brake System Diagnosis

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the PARK brake system in order to determine if the PARK brake system is operating correctly. You will be directed by the appropriate Symptom Table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Hydraulic Brake Symptom Table?	Go to Step 4	Go to Step 2
2	Were you sent here from a Park Brake Symptom List?	Go to Step 4	Go to Step 3
3	Is the symptom related to the ability of the park brake system to hold and/or release?	Go to Park Brake Will Not Hold or Release	Go to Diagnostic Starting Point - Hydraulic Brakes
4	1. Raise and support the vehicle with the rear axle supported by jack stands. Refer to Lifting and Jacking the Vehicle . 2. Shift the transmission into NEUTRAL. 3. With the park brake RELEASED, attempt to rotate the rear wheels to inspect the rear brakes for a significant amount of drag. Do the rear brakes have a substantial amount of drag?	Go to Step 11	Go to Step 5
5	1. With the transmission still in NEUTRAL, apply the park brake. 2. Attempt to rotate the rear wheels to inspect the rear brakes for a significant amount of drag. Do the rear brakes have a significant amount of drag?	Go to Step 6	Go to Step 7
6	1. Release the park brake. 2. Rotate the rear wheels to inspect the rear brakes for a significant reduction in the amount of drag. Did the rear brakes exhibit a significant reduction in the amount of drag?	Go to Step 21	Go to Step 11
7	Visually inspect the park brake cable connections and the cables that are accessible on the UNDERSIDE of the vehicle for disconnections and/or damage. Were any of the park brake cables disconnected and/or damaged?	Go to Step 8	Go to Step 9
	Reconnect or replace the park brake cables as		

8	necessary. Refer to the following procedures as necessary: Parking Brake Front Cable Replacement . Did you complete the repair and/or replacement?	Go to Step 9	--
9	Inspect the adjustment of the park brake. Refer to Park Brake Adjustment . Was the park brake adjusted correctly?	Go to Step 11	Go to Step 10
10	Adjust the park brake. Refer to Park Brake Adjustment . Were you able to attain adjustment of the park brake?	Go to Step 16	Go to Step 11
11	**Notice:** Do not depress the brake pedal with the brake rotors and/or the brake drums removed, or with the brake calipers repositioned away from the brake rotors, or damage to the brake system may result. 1. Remove the rear brake discs. Refer to Rear Brake Rotor Replacement . 2. Inspect the park brake shoe assembly for play, damaged, broken or missing components. 3. Inspect the park brake actuators for a seized condition. Does the park brake assembly and/or park brake actuators require replacement?	Go to Step 12	Go to Step 13
12	1. Replace park brake hardware components as necessary. Refer to Parking Brake Shoe Replacement in Park Brake. 2. Replace the park brake actuators as necessary. Refer to Parking Brake Actuator Replacement . Did you complete the replacement?	Go to Step 13	--
13	Have an assistant apply and release the park brake, while you observe the park brake cables for free movement. Do the park brake cables move freely?	Go to Step 14	Go to Step 17
14	Inspect the adjustment of the park brake. Refer to Park Brake Adjustment . Was the park brake adjusted correctly?	Go to Step 16	Go to Step 15
15	Adjust the park brake. Refer to Park Brake Adjustment . Were you able to attain adjustment of the park		

	brake?	Go to Step 16	Go to Step 24
16	1. With the transmission still in NEUTRAL, apply the park brake. 2. Attempt to rotate the rear wheels to inspect the rear brakes for a significant amount of drag. 3. Release the park brake. 4. Rotate the rear wheels to inspect the rear brakes for a significant reduction of drag. Does the park brake apply and release correctly?	Go to Step 23	Return to Symptom Table
17	Disconnect the park brake cable connections that are accessible on the UNDERSIDE of the vehicle one at a time and inspect each cable for free movement. Do any of the park brake cables accessible on the underside of the vehicle require replacement?	Go to Step 18	Go to Step 19
18	Replace any of the park brake cables that do not have free movement (do not release correctly). Refer to the following procedures as necessary: - Parking Brake Front Cable Replacement . - Parking Brake Rear Cable Replacement . Did you complete the replacement?	Go to Step 23	--
19	Replace the park brake lever assembly. Refer to Parking Brake Release Handle Assembly Replacement . Did you complete the replacement?	Go to Step 23	--
20	Inspect the adjustment of the park brake. Refer to Park Brake Adjustment . Is the park brake adjusted correctly?	Park Brake System OK	Go to Step 21
21	Adjust the park brake. Refer to Park Brake Adjustment . Were you able to attain adjustment of the park brake system?	Go to Step 25	Go to Step 22
22	1. Remove the rear brake discs if they have not yet been removed. Refer to Rear Brake Rotor Replacement . 2. Inspect the park brake actuators for a seized condition. 3. Replace the park brake actuators as necessary. Refer to Parking Brake Actuator Replacement . Did you find and correct a condition?	Go to Step 23	Go to Step 24
	Adjust the park brake. Refer to Park Brake		

23	Adjustment . Were you able to attain adjustment of the park brake system?	Go to Step 25	Go to Step 24
24	1. Replace the component that is used to adjust the park brake system. Refer to Parking Brake Release Handle Assembly Replacement . 2. Adjust the park brake. Refer to Park Brake Adjustment . Did you complete the replacement and adjustment?	Go to Step 25	Return to Symptom Table
25	1. With the transmission still in NEUTRAL, apply the park brake. 2. Attempt to rotate the rear wheels to inspect the rear brakes for a significant amount of drag. 3. Release the park brake. 4. Rotate the rear wheels to inspect the rear brakes for a significant reduction of drag. Did the park brake apply and release correctly?	Go to Step 26	Return to Symptom Table
26	Install or connect any components that were removed or disconnected during diagnosis. Did you complete the operation?	Park Brake System OK Return to Symptom Table	--

Parking Brake Shoe Inspection

Caution: Refer to Brake Dust Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear wheels. Refer to Tire and Wheel Removal and Installation.
3. Remove the rear brake caliper and brake disc. Refer to Rear Brake Rotor Replacement.
4. Inspect the park brake shoe and lining for the following conditions:
   - Substantial wear indicated by the park brake lining being worn down to the shoe
   - Brake lining cracking
   - Oil or fluid contamination of the brake lining
5. If any of the conditions listed are found, replace the park brake shoes. Refer to Parking Brake Shoe Replacement.
6. Adjust the park brake shoe. Refer to Park Brake Adjustment.
7. Install the rear brake disc. Refer to Rear Brake Rotor Replacement.
8. Install the rear brake caliper. Refer to Rear Brake Caliper Replacement.
9. Install the rear wheels. Refer to Tire and Wheel Removal and Installation.
10. Lower the vehicle.

Parking Brake Actuator Replacement

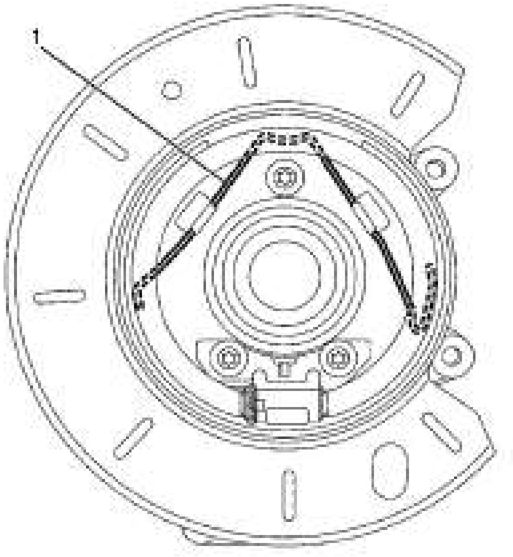
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

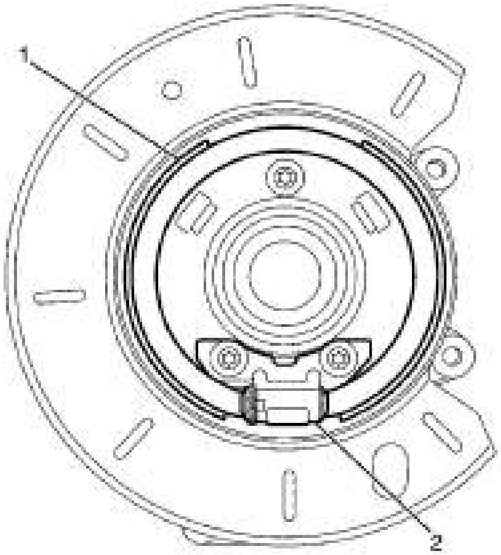
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the rear wheels. Refer to Tire and Wheel Removal and Installation .
3. Remove the rear brake caliper and brake disc. Refer to Rear Brake Rotor Replacement .
4. Remove the rear wheel hub and bearing assembly. Refer to Rear Wheel Bearing and Hub Replacement .
5. Rotate the park brake adjusting nut until all park brake shoe adjustment has been removed.

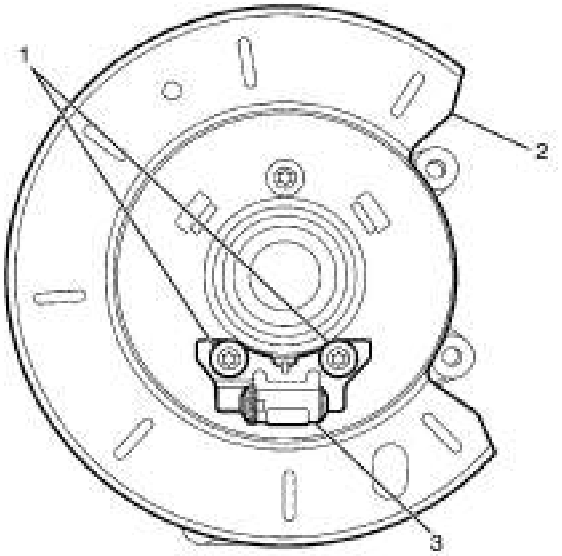


6. Remove the park brake shoe retaining spring (1).



Important: Detach the park brake shoe (1) from the actuator assembly (2) by grasping the shoe and pushing upwards.

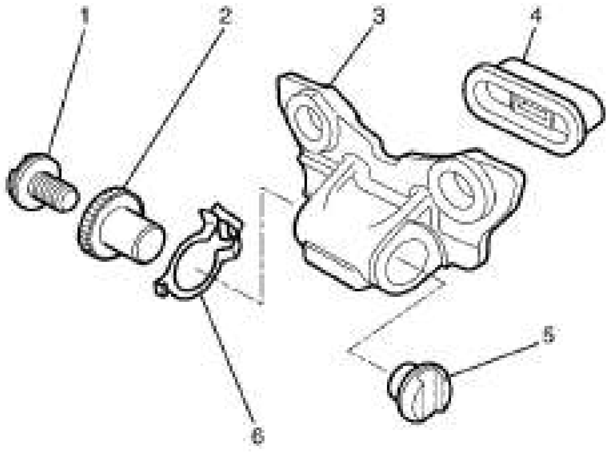
7. Detach the park brake shoe (1) from the actuator assembly (2).
8. Remove the park brake shoe (1).



9. Remove the actuator assembly / backing plate to knuckle retaining bolts (1).

Important: Slide the actuator assembly (3) downwards to detach the actuator assembly (3) from the locating tab on the backing plate (2).

10. Remove the actuator assembly (3) from the backing plate (2).



Important: Using a flat blade screwdriver remove the adjuster nut (2) from the abutment plate (3).

11. Remove the adjuster nut (2) from the abutment plate (3).
12. Remove the adjustment screw (1) from the adjuster nut (2).

Important: Using a flat blade screwdriver remove the tappet (5) from the abutment plate (3).

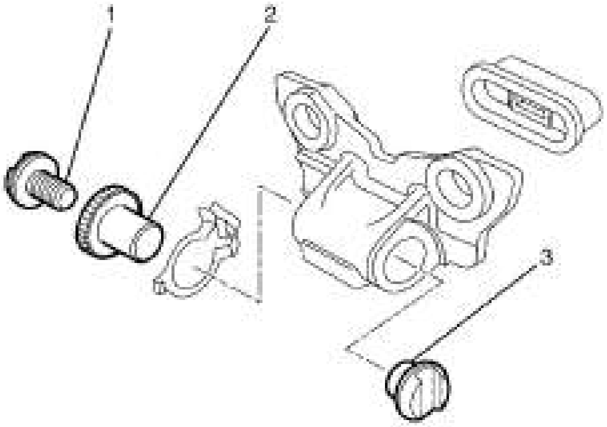
13. Remove the tappet (5) from the abutment plate (3).
14. Remove the adjustment pawl (6).
15. Remove the dust cover (4) from the abutment plate (3).

Installation Procedure

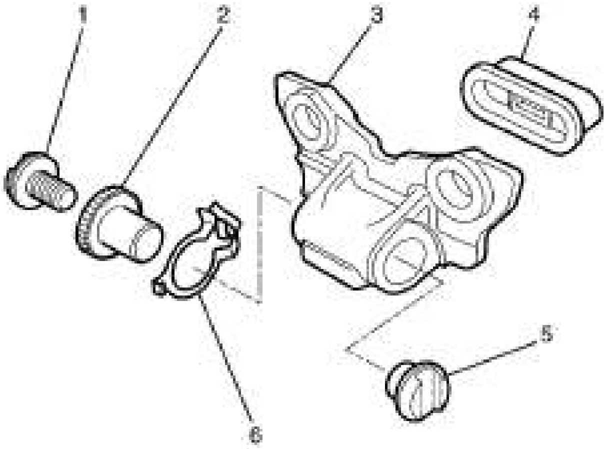
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

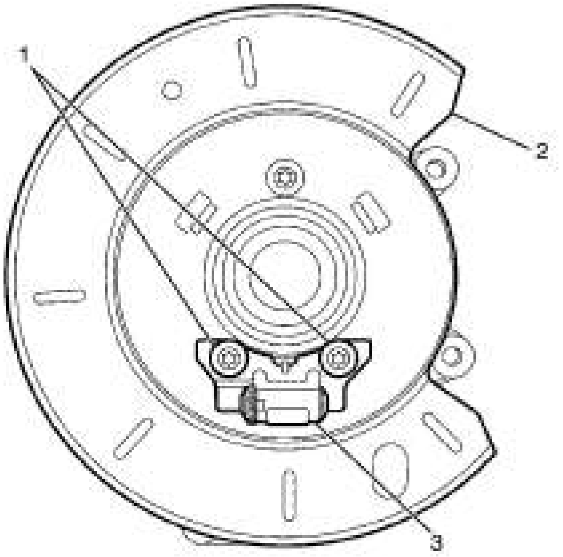
Caution: Refer to Brake Dust Caution in the Preface section.



1. Apply a small amount of GM approved silicone grease to positions (2, 3). DO NOT apply grease to the bolt threads (1).



2. Install the dust cover (4) to the abutment plate (3).
3. Install the adjustment pawl (6).
4. Install the tappet (5) to the abutment plate (3).
5. Install the adjustment screw (1) to the adjuster nut (2).
6. Install the adjuster nut (2) to the abutment plate (3).



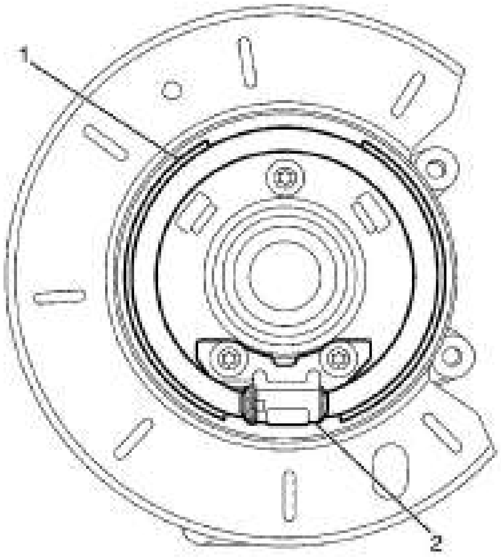
Important: Slide the actuator assembly (3) upwards to attach the actuator assembly (3) to the locating tab on the backing plate (2).

7. Install the actuator assembly (3) to the backing plate (2).

   Notice: Refer to Fastener Notice in the Preface section.

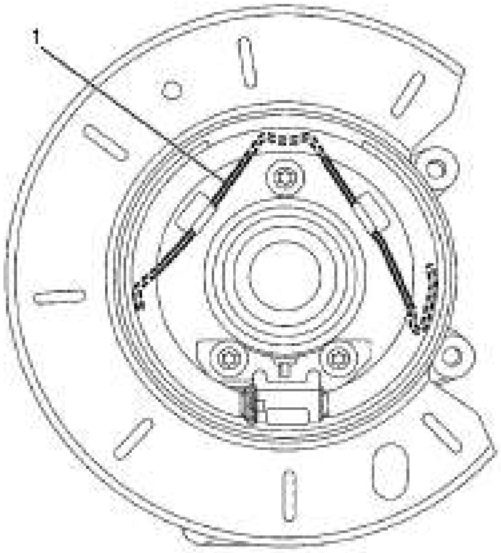
8. Install the actuator assembly/backing plate to knuckle retaining bolts (1).

   Tighten
   Tighten the bolt to 130 Nm (96 lb ft).



Important: Install the park brake shoe assembly (1) by grasping the shoe and spreading slightly while pulling the shoe over the actuator assembly (2).

9. Install the park brake shoe assembly (1) to the actuator assembly (2).



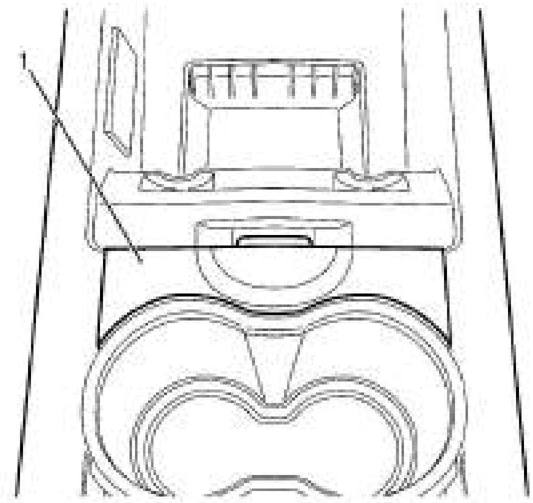
10. Install the park brake shoe retaining spring (1).
11. Install the rear wheel hub and bearing assembly. Refer to Rear Wheel Bearing and Hub Replacement .
12. Install the rear brake disc and rear brake caliper. Refer to Rear Brake Rotor Replacement .
13. Adjust the park brake. Refer to Park Brake Adjustment .
14. Install the rear wheels. Refer to Tire and Wheel Removal and Installation .
15. Lower the vehicle.

Parking Brake Adjustment

Caution: Refer to Safety Glasses Caution in the Preface section.

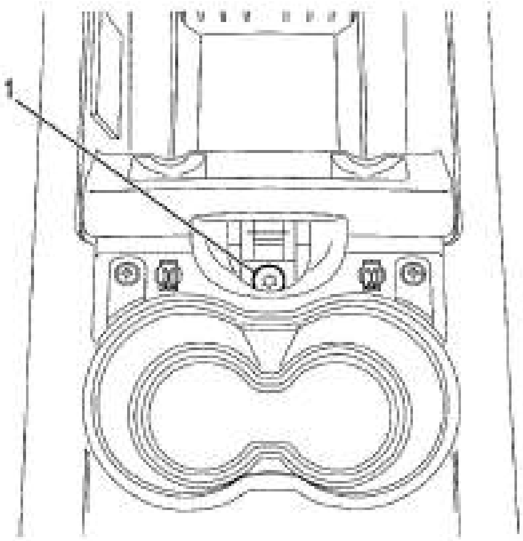
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

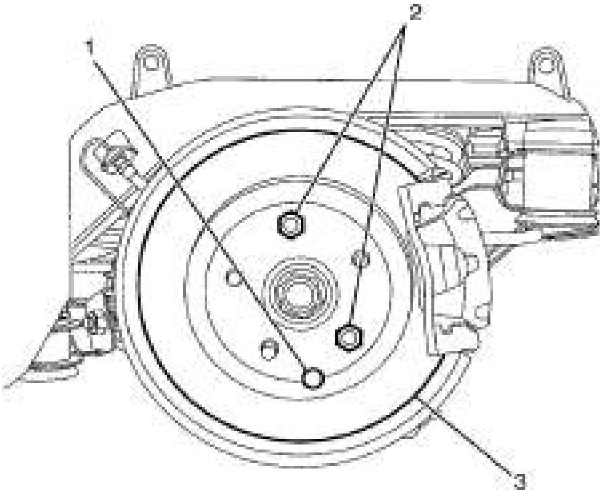


Important: The park brake cable adjustment bolt cover trim (1) is retained by two clips. Gently pry upwards with fingers at the front floor console armrest latch to remove.

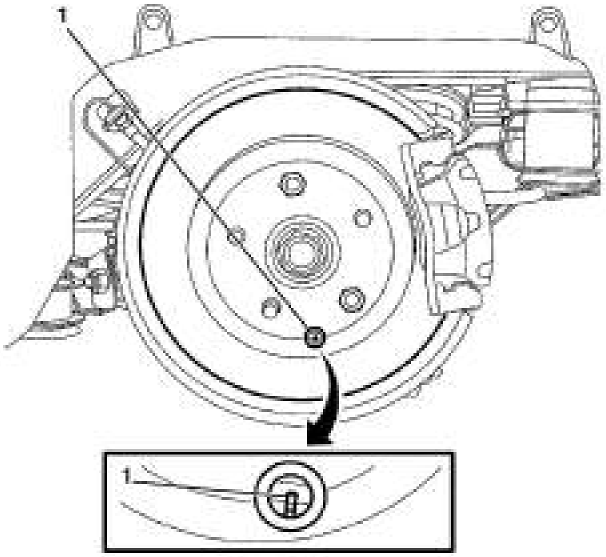
1. Remove the park brake cable adjustment bolt cover trim (1).



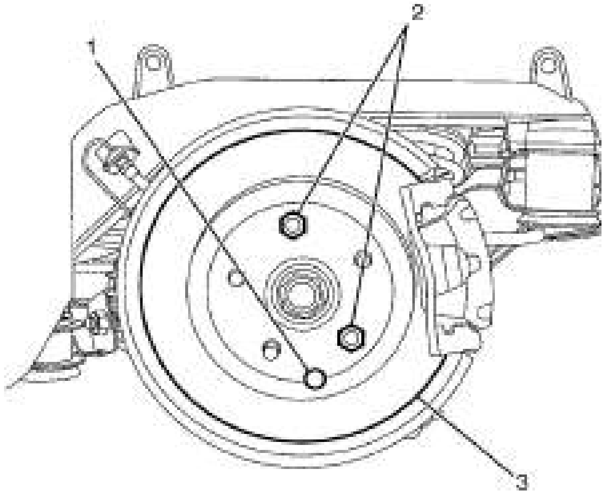
2. Loosen the park brake cable adjustment bolt (1) several turns to allow slack in the park brake rear cables.
3. Make sure that the park brake actuator arms have fully retracted.
4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
5. Remove the rear wheels. Refer to Tire and Wheel Removal and Installation.



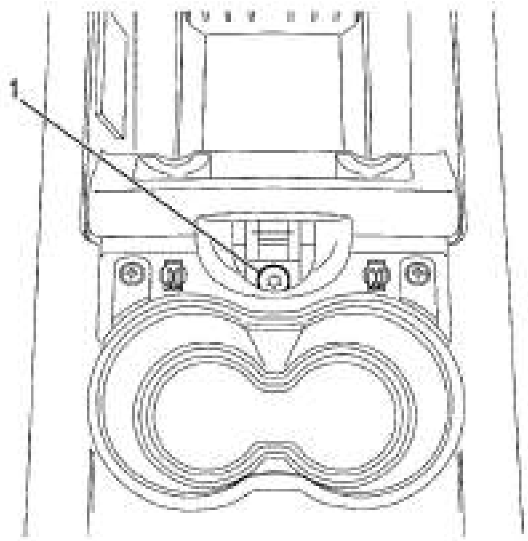
6. Install 2 wheel nuts (2) in reverse to opposite wheel studs to retain the brake disc (3) to the hub.
7. Make sure that the brake disc (3) is free and does not bind. If the brake disc (3) is binding refer to the following procedures.
   - Brake Rotor Thickness Variation Measurement.
   - Brake Rotor Assembled Lateral Runout Measurement.
   - Brake Caliper Inspection.
8. Remove the access hole plug (1) from the brake disc (3).



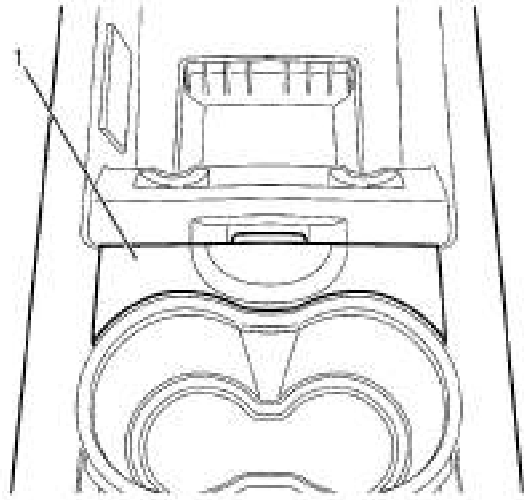
9. Using a suitable lever such as a screwdriver, tighten the adjuster nut (1), until the brake disc is locked.
10. Loosen the adjuster nut (1) 3-5 clicks. Make sure that the brake disc is free and does not bind.



11. Install the access hole plug (1).
12. Remove the 2 wheel nuts (2) retaining the brake disc (3) to the hub
13. Install the rear wheels. Refer to Tire and Wheel Removal and Installation.
14. Lower the vehicle.



15. Apply the park brake until the lever is extended 4-6 clicks.
16. Tighten the park brake cable adjustment bolt (1) to remove any excess slack from the park brake cable.
17. Make sure that this adjustment applies the park brake shoes by attempting to turn each rear wheel.
18. Release the park brake and inspect that each rear wheel is free and does not bind.
19. Lower the vehicle to the ground.



20. Install the park brake cable adjustment bolt cover trim (1).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Brakes | Park Brake | Repair Instructions | **Document ID: 1964709**

Parking Brake Front Cable Replacement

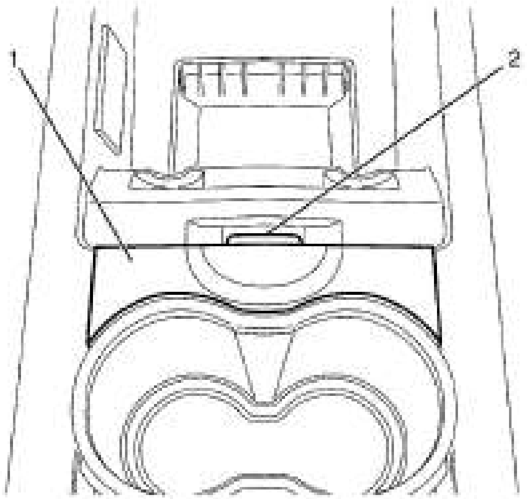
Removal Procedure Up to - 05 Mar 2007

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

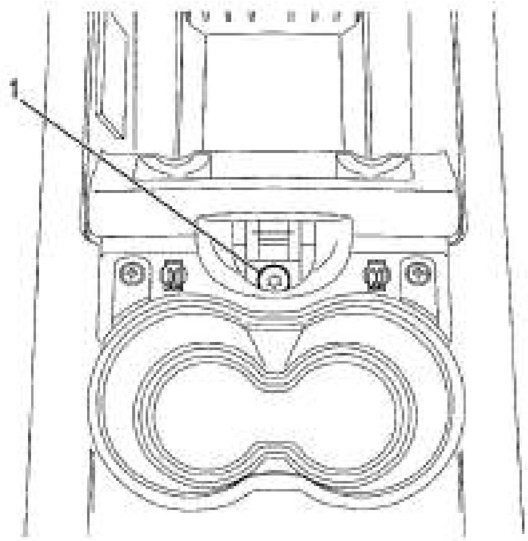
Caution: Refer to Brake Dust Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the rear wheels. Refer to Tire and Wheel Removal and Installation .
3. Remove the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement .
4. Remove the propeller shaft heat shield. Refer to Exhaust Heat Shield Replacement - Center .
5. Remove the propeller shaft. Refer to Propeller Shaft Replacement .
6. Remove the fuel tank heat shield. Refer to Fuel Tank Heat Shield Replacement .
7. Lower the vehicle.

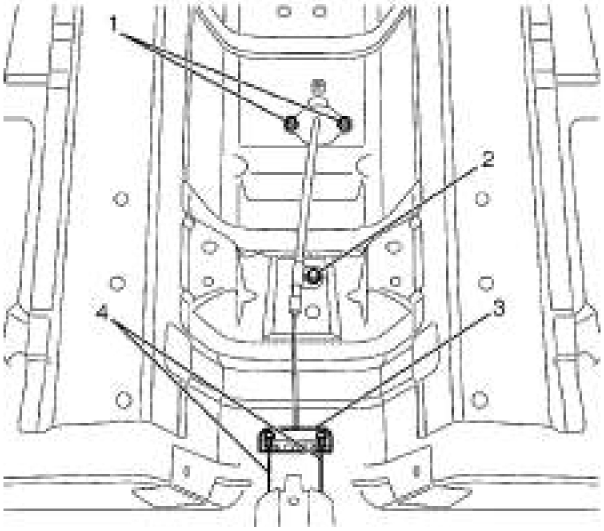


Important: The park brake cable adjustment bolt cover trim (1) is retained by two clips. Gently pry upwards with fingers at the front floor console armrest latch (2) to remove.

8. Remove the park brake cable adjustment bolt cover trim (1).



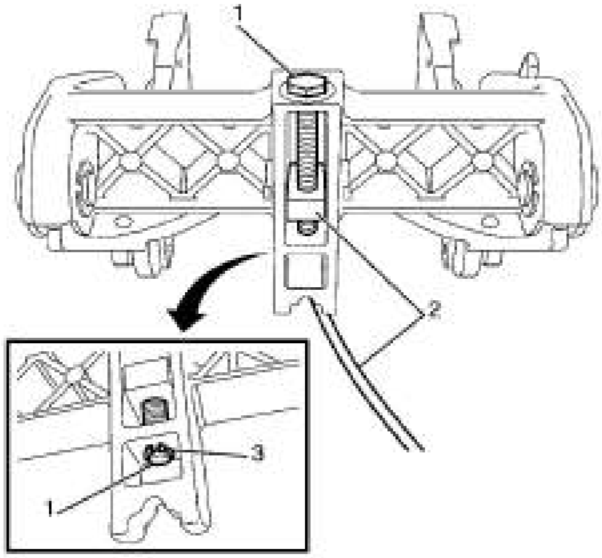
9. Loosen the park brake cable adjustment bolt (1) all the way to allow maximum slack in the rear park brake cables.
10. Raise the vehicle.



Important: Wrap a workshop cloth around the rear inner cable (4) to protect it from damage. Using pliers, pull the rear inner cable (4) forward and upwards to release the ball nipple from the front park brake cable and equaliser bracket assembly (3).

11. Remove the rear inner cables (4) from the front park brake cable and equaliser bracket assembly (3).
12. Remove the front park brake cable forward bracket to vehicle underbody retaining (1) nuts.
13. Remove the front park brake cable rear bracket to vehicle underbody retaining bolt (2).
14. Lower the vehicle.

15. Remove the park brake lever assembly from the front floor console. Refer to Parking Brake Release Handle Assembly Replacement .



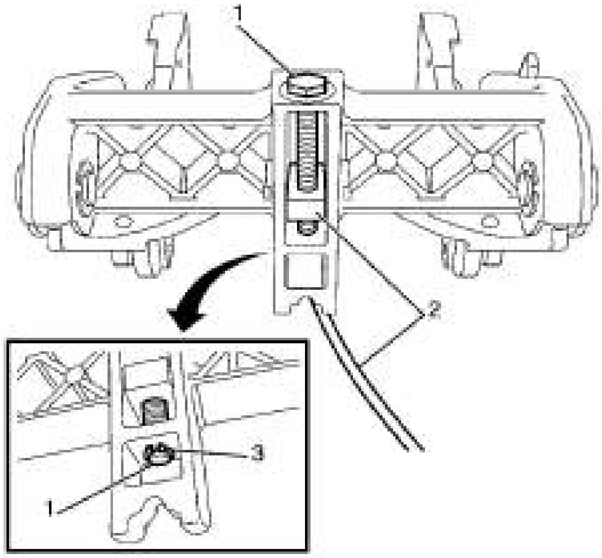
16. Remove the park brake cable adjustment bolt to park brake assembly retaining circlip (3).
17. Remove the park brake cable adjustment bolt (1).
18. Remove the front park brake cable (2).

Installation Procedure - Up to 05 Mar 2007

Caution: Refer to Safety Glasses Caution in the Preface section.

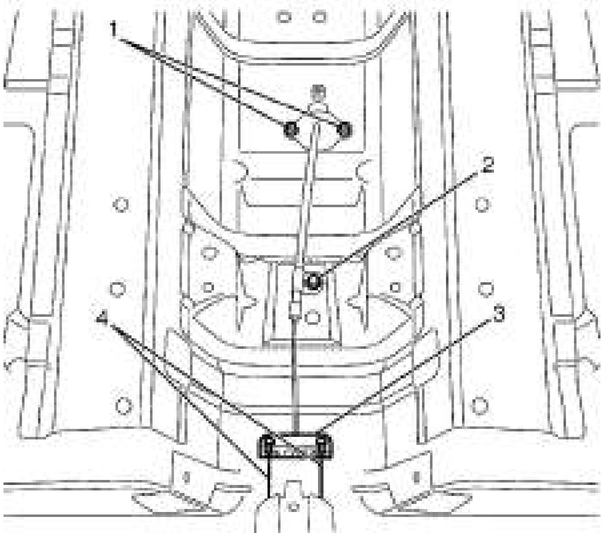
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.



1. Install the front park brake cable (2) into position.
2. Install the park brake cable adjustment bolt (1).
3. Install the park brake cable adjustment bolt to park brake assembly retaining circlip (3).
4. Install the park brake lever assembly and front floor console. Refer to Parking Brake Release Handle Assembly Replacement .
5. Raise the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.



6. Install the front park brake cable rear bracket to vehicle underbody retaining bolt (2).

   Tighten
   Tighten the bolt to 22 Nm (16 lb ft).

7. Install the front park brake cable forward bracket to vehicle underbody retaining (1) nuts.

   Tighten
   Tighten the nuts to 9 Nm (80 lb in).

   Important: Wrap a workshop cloth around the rear inner cable (4) to protect it from damage. Using pliers, pull the rear inner cable (4) forward and downwards to install the ball nipple to the front park brake cable and equaliser bracket assembly (3).

8. Install the rear inner cables (4) to the front park brake cable and equaliser bracket assembly (3).

   Make sure that the rear cables are properly seated.

9. Adjust the park brake. Refer to Parking Brake Release Handle Assembly Replacement .

10. Cycle the park brake pedal 2-3 times to make sure that the park brake cable retainers are seated.
11. Install the fuel tank heat shield. Refer to Fuel Tank Heat Shield Replacement .
12. Install the propeller shaft. Refer to Propeller Shaft Replacement .
13. Install the propeller shaft heat shield. Refer to Exhaust Heat Shield Replacement - Center .
14. Install the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement .
15. Install the rear wheels. Refer to Tire and Wheel Removal and Installation .
16. Lower the vehicle.

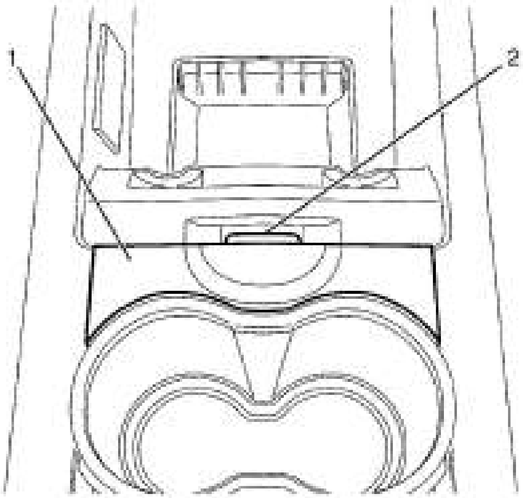
Removal Procedure - From 05 Mar 2007

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

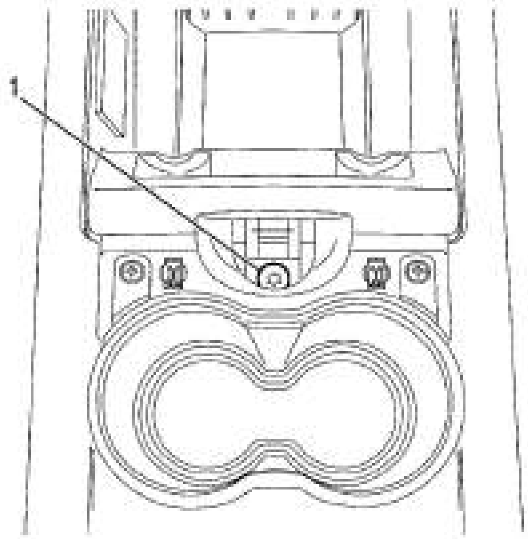
Caution: Refer to Brake Dust Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the rear wheels. Refer to Tire and Wheel Removal and Installation .
3. Remove the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement .
4. Remove the propeller shaft heat shield. Refer to Exhaust Heat Shield Replacement - Center .
5. Remove the propeller shaft. Refer to Propeller Shaft Replacement .
6. Remove the fuel tank heat shield. Refer to Fuel Tank Heat Shield Replacement .
7. Lower the vehicle.

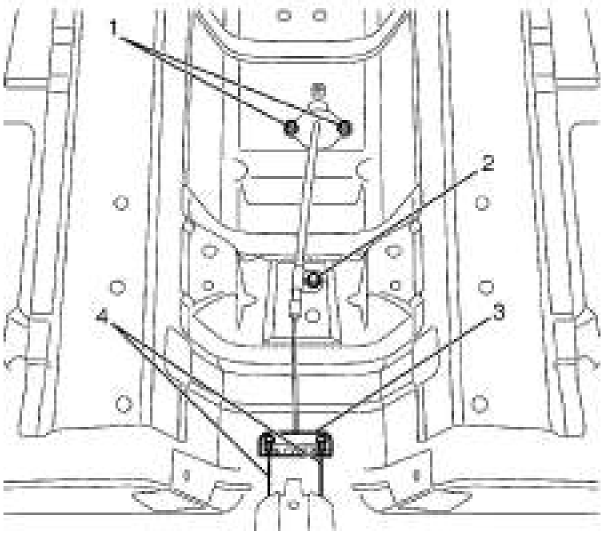


Important: The park brake cable adjustment bolt cover trim (1) is retained by two clips. Gently pry upwards with fingers at the front floor console armrest latch (2) to remove.

8. Remove the park brake cable adjustment bolt cover trim (1).



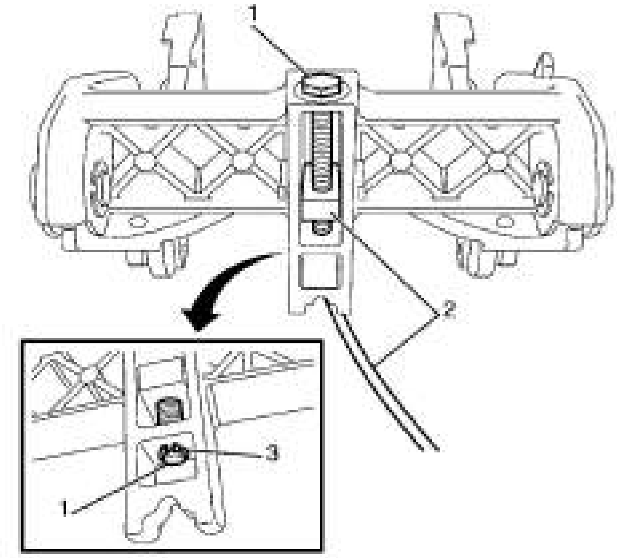
9. Loosen the park brake cable adjustment bolt (1) all the way to allow maximum slack in the rear park brake cables.
10. Raise the vehicle.



Important: Wrap a workshop cloth around the rear inner cable (4) to protect it from damage. Using pliers, pull the rear inner cable (4) forward and upwards to release the ball nipple from the front park brake cable and equaliser bracket assembly (3).

11. Remove the rear inner cables (4) from the front park brake cable and equaliser bracket assembly (3).
12. Remove the front park brake cable forward bracket to vehicle underbody retaining (1) nuts.
13. Remove the front park brake cable rear bracket to vehicle underbody retaining bolt (2).
14. Lower the vehicle.

15. Remove the park brake lever assembly from the front floor console. Refer to Parking Brake Release Handle Assembly Replacement .



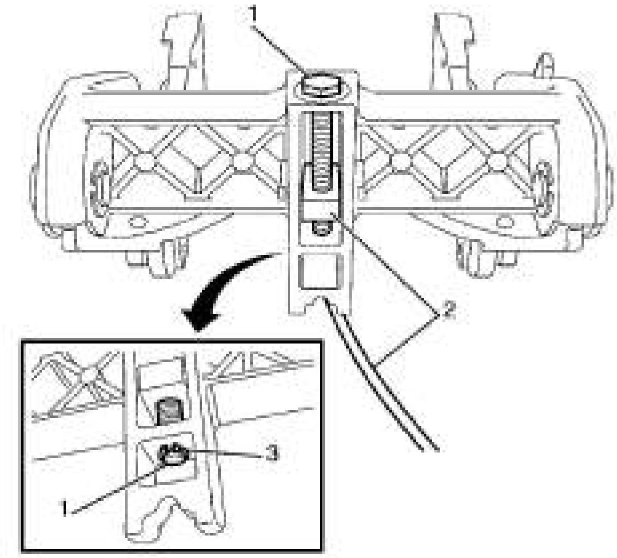
16. Remove the park brake cable adjustment bolt to park brake assembly retaining circlip (3).
17. Remove the park brake cable adjustment bolt (1).
18. Remove the front park brake cable (2).

Installation Procedure - From 05 Mar 2007

Caution: Refer to Safety Glasses Caution in the Preface section.

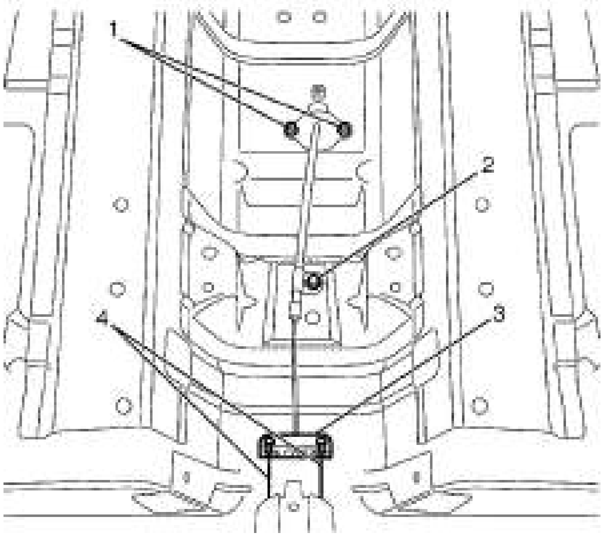
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.



1. Install the front park brake cable (2) into position.
2. Install the park brake cable adjustment bolt (1).
3. Install the park brake cable adjustment bolt to park brake assembly retaining circlip (3).
4. Install the park brake lever assembly and front floor console. Refer to Parking Brake Release Handle Assembly Replacement .
5. Raise the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.



6. Install the front park brake cable rear bracket to vehicle underbody retaining bolt (2).

   Tighten
   Tighten the bolt to 22 Nm (16 lb ft).

7. Install the front park brake cable forward bracket to vehicle underbody retaining (1) nuts.

   Tighten
   Tighten the nuts to 11 Nm (97 lb in).

   Important: Wrap a workshop cloth around the rear inner cable (4) to protect it from damage. Using pliers, pull the rear inner cable (4) forward and downwards to install the ball nipple to the front park brake cable and equaliser bracket assembly (3).

8. Install the rear inner cables (4) to the front park brake cable and equaliser bracket assembly (3).

   Make sure that the rear cables are properly seated.

9. Adjust the park brake. Refer to Parking Brake Release Handle Assembly Replacement .

10. Cycle the park brake pedal 2-3 times to make sure that the park brake cable retainers are seated.
11. Install the fuel tank heat shield. Refer to Fuel Tank Heat Shield Replacement .
12. Install the propeller shaft. Refer to Propeller Shaft Replacement .
13. Install the propeller shaft heat shield. Refer to Exhaust Heat Shield Replacement - Center .
14. Install the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement .
15. Install the rear wheels. Refer to Tire and Wheel Removal and Installation .
16. Lower the vehicle.

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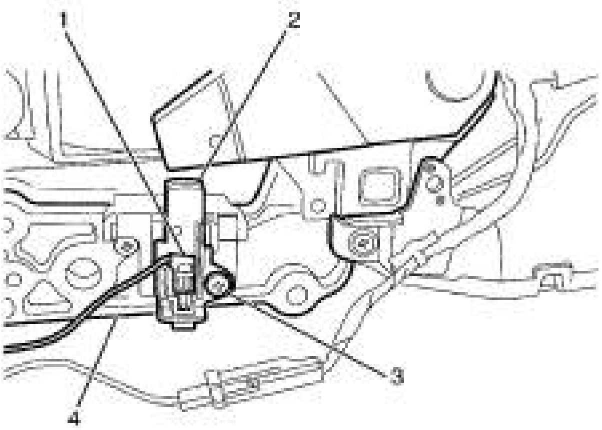
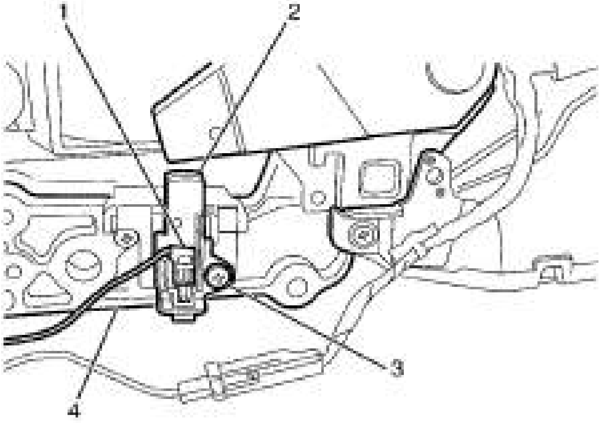
Parking Brake Indicator Switch Replacement (RHD)

Removal Procedure



1. Remove the front floor console left side panel. Refer to Console Trim Plate Replacement.
2. Disconnect the park brake warning lamp switch electrical connector (1).
3. Remove the park brake warning lamp switch to park brake lever assembly retaining screw (3).
4. Remove the park brake warning lamp switch (2) from the park brake lever assembly (4).

Installation Procedure



1. Connect the park brake warning lamp switch electrical connector (1).
2. Install the park brake warning lamp switch (2) to the park brake lever assembly (4).
3. Install the park brake warning lamp switch to park brake lever assembly retaining screw (3).

   Tighten
   Tighten the bolt to 2 Nm (18 lb in).

4. Install the front floor console left side panel. Refer to Console Trim Plate Replacement.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Brakes | Park Brake | Repair Instructions | Document ID: 1964723

Parking Brake Rear Cable Replacement

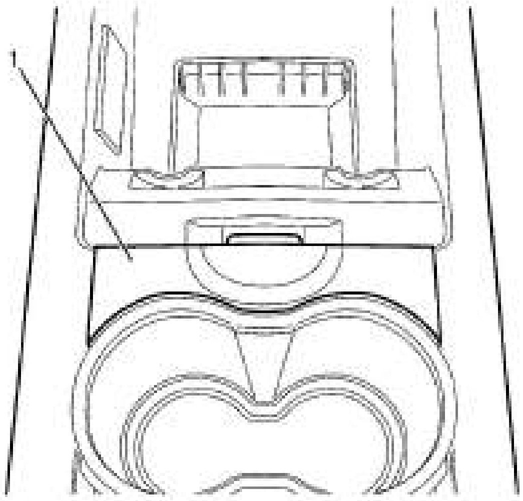
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

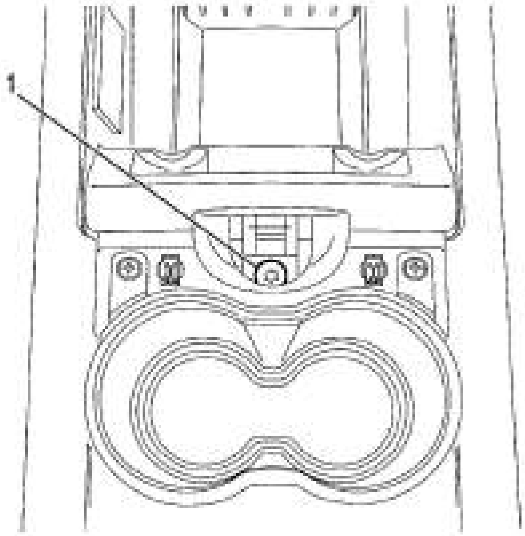
Caution: Refer to Brake Dust Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear wheels. Refer to Tire and Wheel Removal and Installation.
3. Remove the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement.
4. Remove the propeller shaft heat shield. Refer to Exhaust Heat Shield Replacement - Center .
5. Remove the propeller shaft. Refer to Propeller Shaft Replacement.
6. Remove the fuel tank heat shield. Refer to Fuel Tank Heat Shield Replacement.
7. Lower the vehicle to the ground.

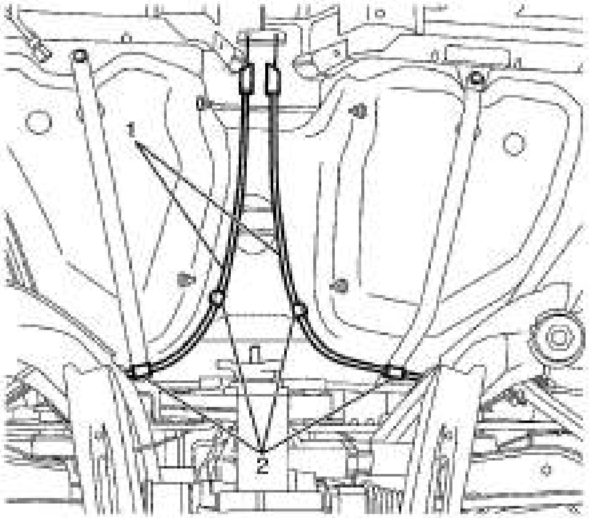


Important: The park brake cable adjustment bolt cover trim (1) is retained by two clips. Gently pry upwards with fingers at the front floor console armrest latch to remove.

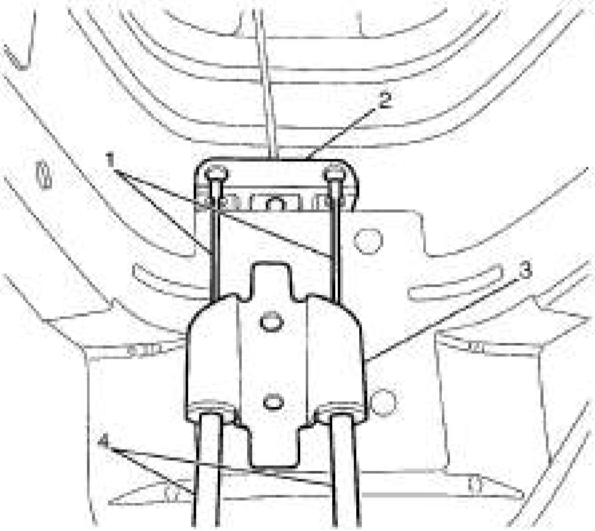
8. Remove the park brake cable adjustment bolt cover trim (1).



9. Loosen the park brake cable adjustment bolt (1) all the way to allow maximum slack in the rear park brake cables.
10. Raise the vehicle.



11. Detach the park brake cables (1) from the underbody park brake cable retaining clips (2).

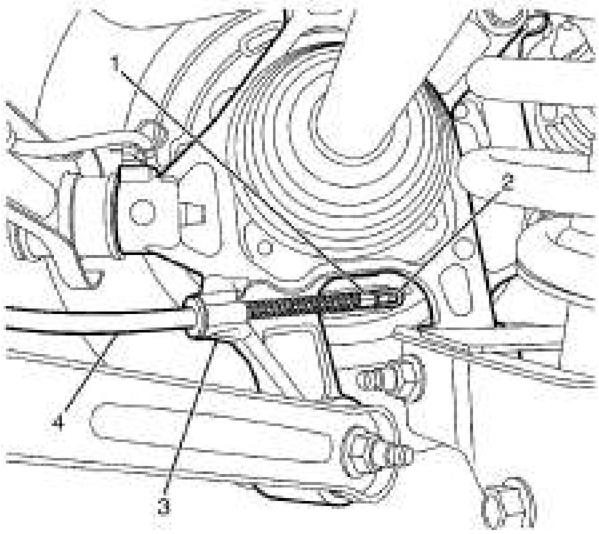


Important: Wrap a workshop cloth around the rear inner cable (1) to protect it from damage. Using pliers, pull the rear inner cable (1) forward and upwards to release the ball nipple from the front park brake cable and equaliser bracket assembly (2).

12. Remove the rear inner cables (1) from the front park brake cable and equaliser bracket assembly (2).

Important: Remove the outer cable (4) from the vehicle underbody bracket (3) by pulling the outer cable (4) rearward.

13. Remove the outer cable (4) from the vehicle underbody bracket (3).



Important: Remove the outer cable (4) from the rear knuckle (3) by pulling the outer cable (4) forward.

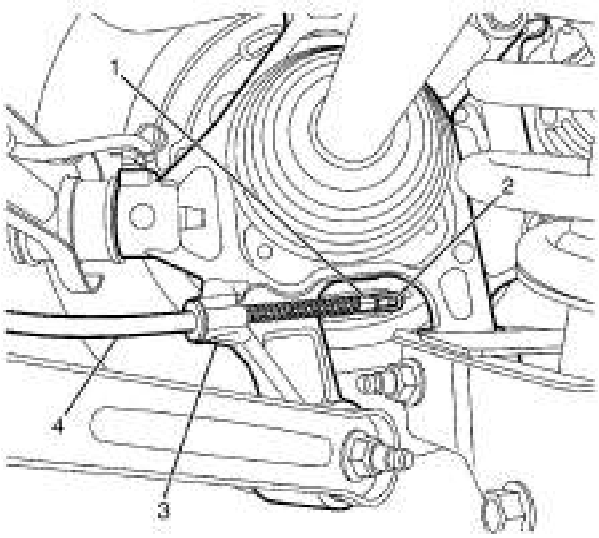
14. Remove the outer cable (4) from the rear knuckle (3).
15. Detach the rear park brake cable and clevis (1) from the park brake actuator (2).

Installation Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

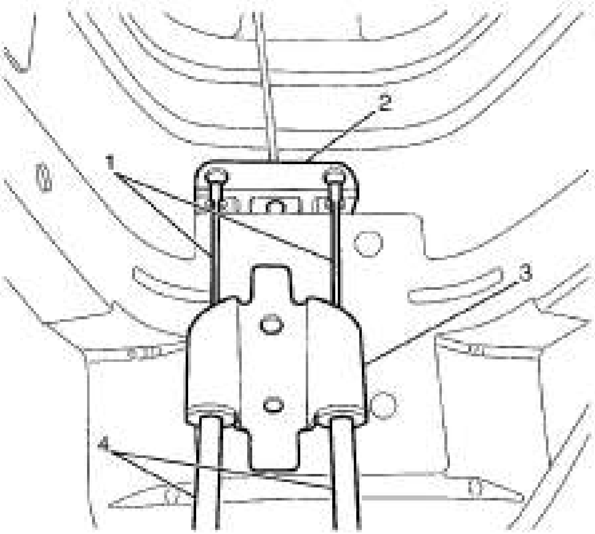
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.



1. Attach the rear park brake cable and clevis (1) to the park brake actuator (2).
2. Install the rear park brake cable (4) into the rear knuckle (3).

   Make sure that the rear park brake cables (4) are properly seated.

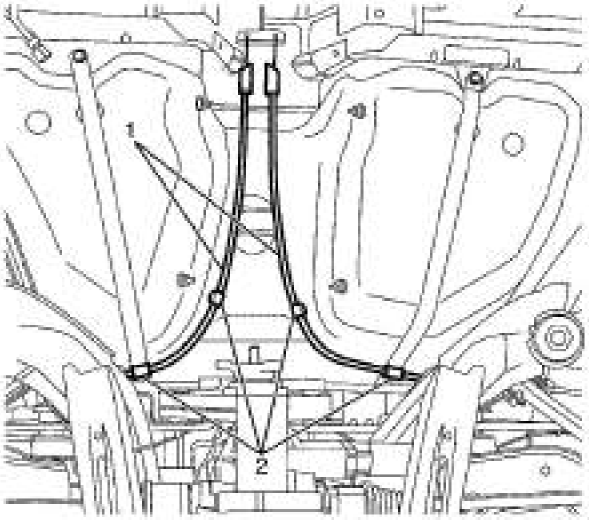


3. Install the outer cable (4) to the vehicle underbody bracket (3).

   Make sure that the outer cables (4) are properly seated in the vehicle underbody bracket (3).

   Important: Wrap a workshop cloth around the rear inner cable (1) to protect it from damage. Using pliers, pull the rear inner cable (1) forward and downwards to install the ball nipple to the front park brake cable and equaliser bracket assembly (2).

4. Install the rear inner cables (1) to the front park brake cable and equaliser bracket assembly (2).



5. Attach the park brake cables (1) to the underbody park brake cable retaining clips (2).
6. Adjust the park brake. Refer to Park Brake Adjustment.
7. Cycle the park brake lever 2-3 times to make sure that the park brake cable retainers are

seated.

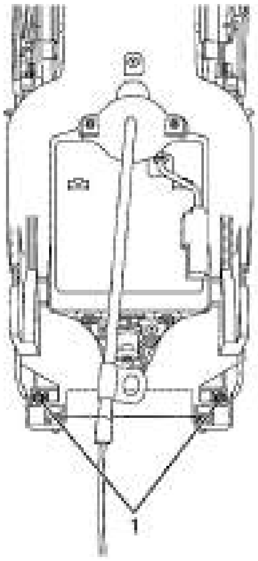
8. Install the fuel tank heat shield. Refer to Fuel Tank Heat Shield Replacement.
9. Install the propeller shaft. Refer to Propeller Shaft Replacement.
10. Install the propeller shaft heat shield. Refer to Exhaust Heat Shield Replacement - Center.
11. Install the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement.
12. Install the rear wheels. Refer to Tire and Wheel Removal and Installation.
13. Lower the vehicle to the ground.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Brakes | Park Brake | Repair Instructions | Document ID: 1964626

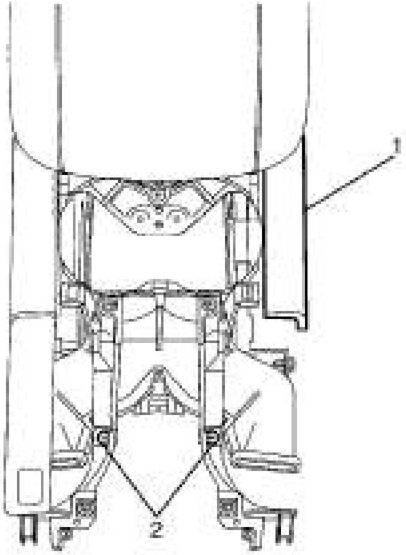
Parking Brake Release Handle Assembly Replacement (RHD)

Removal Procedure

1. Remove the front floor console assembly. Refer to Front Floor Console Replacement .



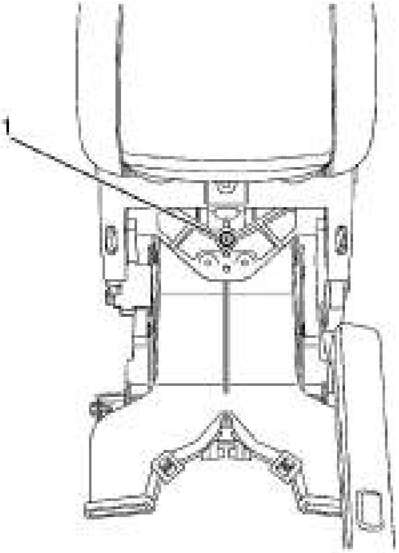
2. Remove the rear front floor console cover assembly to rear floor air outlet duct retaining screws (1).



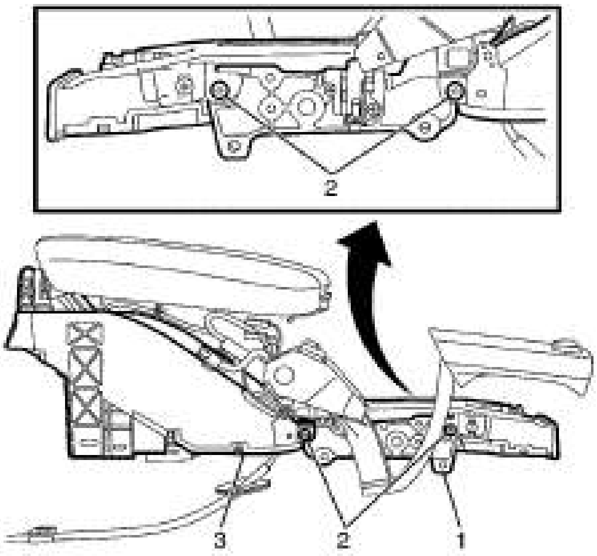
3. Remove the front floor console cover assembly to rear floor air outlet duct retaining

screws (2).

4. Remove the front floor console cover assembly (1).

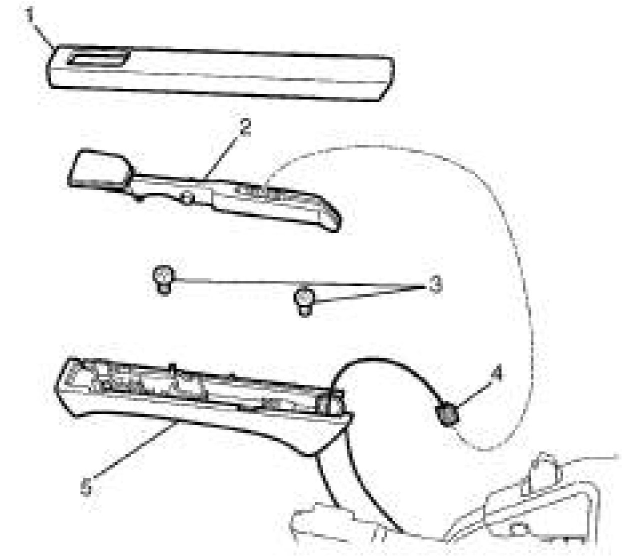


5. Remove the rear floor air outlet duct to park brake assembly retaining screw (1).



6. Remove the rear floor air outlet duct to park brake assembly retaining screw (2).
7. Remove the park brake assembly (1) from the rear floor air outlet duct (3).

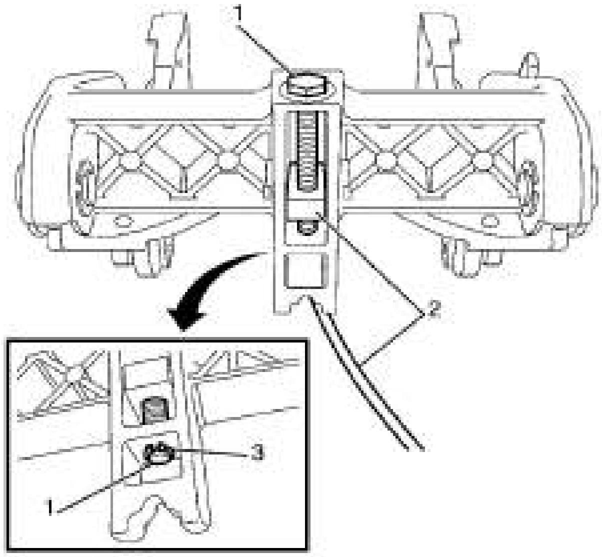
Disassembly Procedure



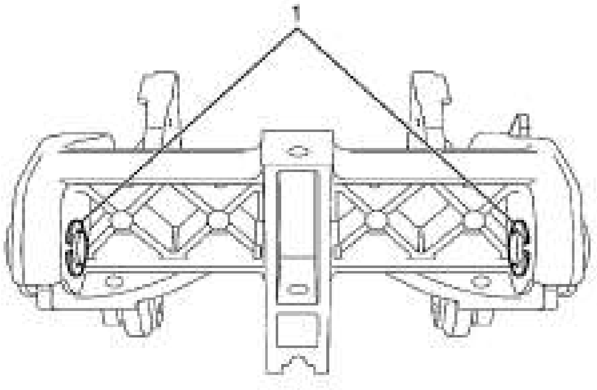
Important: The park brake lever upper grip (1) is retained by clips and glue. Lift the park brake lever upper grip (1) upwards with your fingers to detach the clips from the park brake lever lower grip (5).

Important: Due to the glue holding them together, the park brake lever upper and lower grips will need replacing once disassembled.

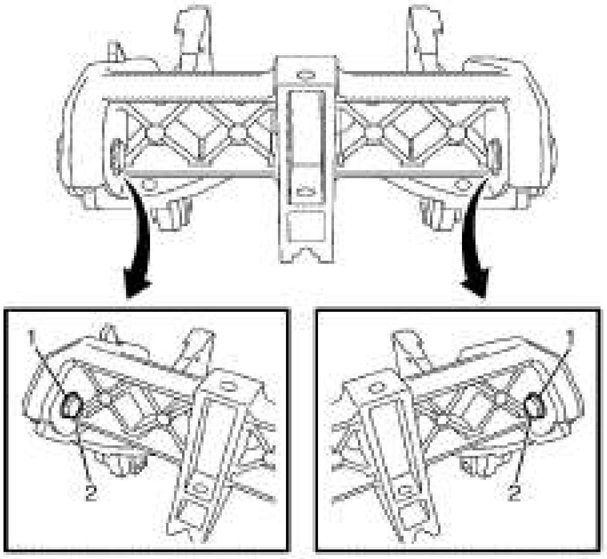
1. Remove the park brake lever upper grip (1) and discard.
2. Detach the park brake lever cable (4) from the park brake lever button (2).
3. Remove the park brake lever button (2) and the park brake lever spring.
4. Remove the park brake lever to park brake lever lower grip retaining screws (3).
5. Remove the park brake lever lower grip (5) and discard.



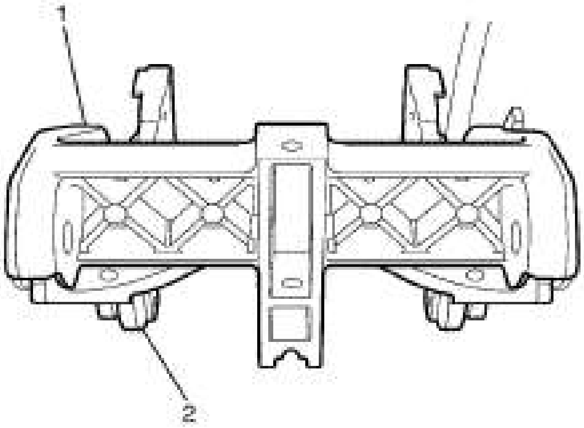
6. Remove the park brake cable adjustment bolt to park brake assembly retaining circlip (3).
7. Remove the park brake cable adjustment bolt (1).
8. Remove the front park brake cable (2).



9. Remove the pivot pin to park brake assembly retaining circlips (1).

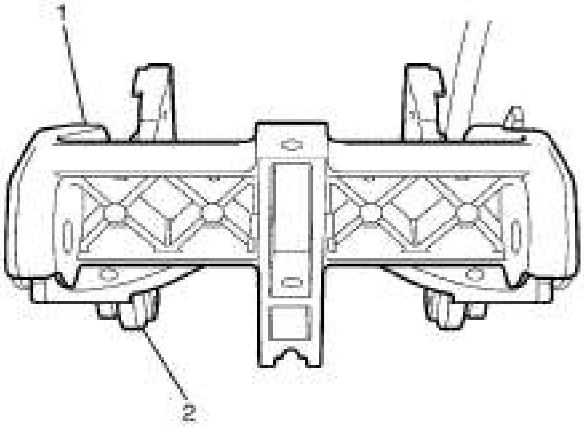


10. Remove the pivot pins (1) and bushes (2) from the park brake base.

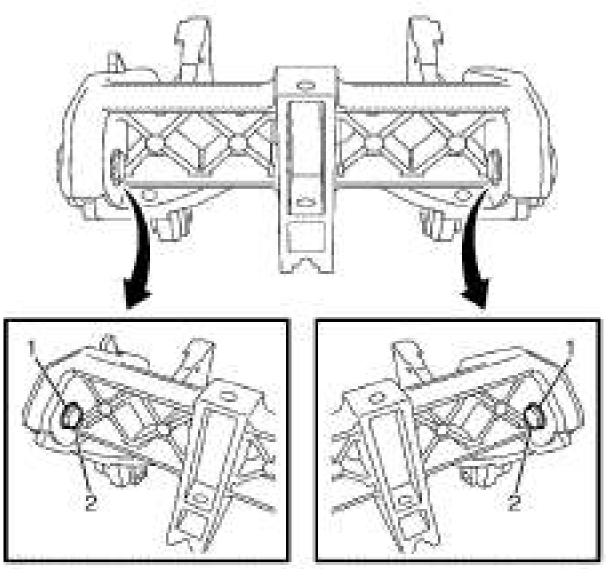


11. Separate the park brake lever assembly (1) from the park brake base (2).

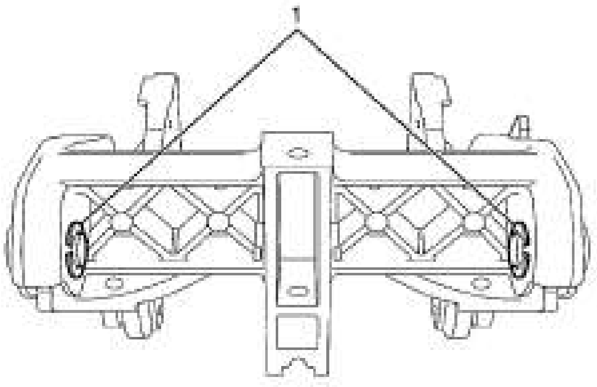
Assembly Procedure



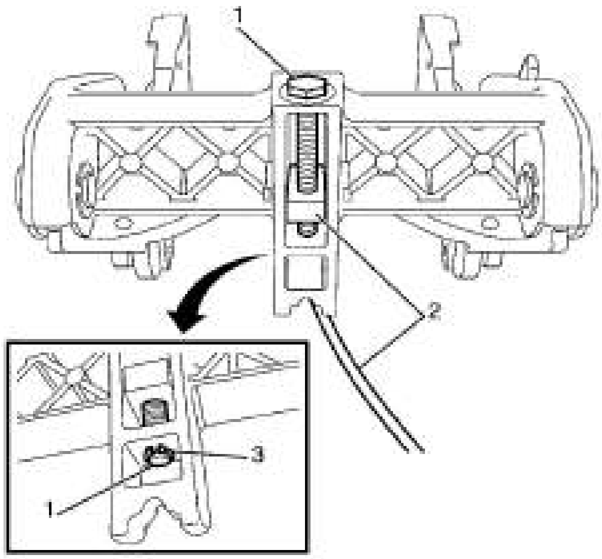
1. Install the park brake lever assembly (1) to the park brake base (2).



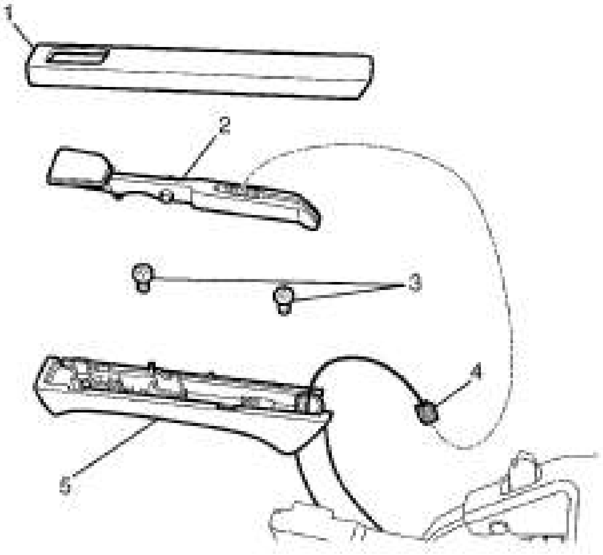
2. Install the pivot pins (1) and bushes (2) to the park brake base.



3. Install the pivot pin to park brake assembly retaining circlips (3).



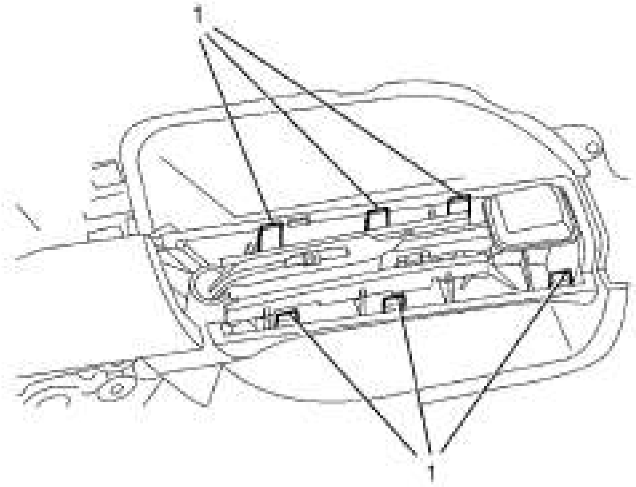
4. Install the front park brake cable (2) into position.
5. Install the park brake cable adjustment bolt (1).
6. Install the park brake cable adjustment bolt to park brake assembly retaining circlip (3).



7. Install NEW park brake lever lower grip (5).
8. Install the park brake lever to park brake lever lower grip retaining screws (3).
9. Install the park brake lever spring and the park brake lever button (2).

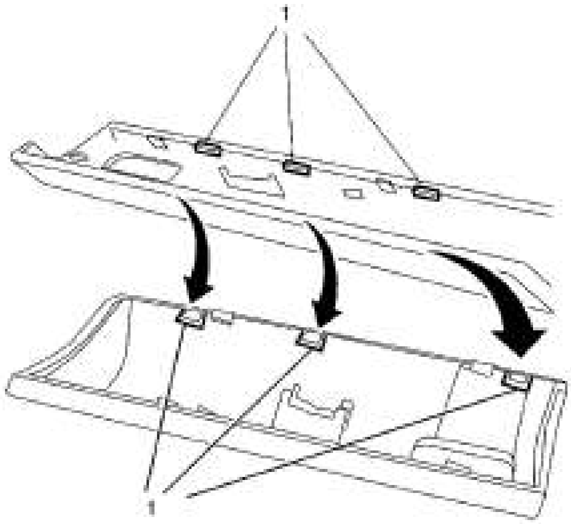
Important: Make sure there is not preload on the button release cable, this cable adjustment affects the release of the park brake, and could result in accidental release of the park brake.

10. Attach NEW park brake lever cable (4) to the park brake lever button (2).



Important: Apply 3M Scotch-Weld Acrylic Structural Plastic Adhesive DP-8005 or super glue (Loctite 406) to the six clips to ensure the park brake lever upper grip is retained. Glue should be applied under the barb of clip.

11. Apply Glue to the six clips on the park brake lever lower grip (1).



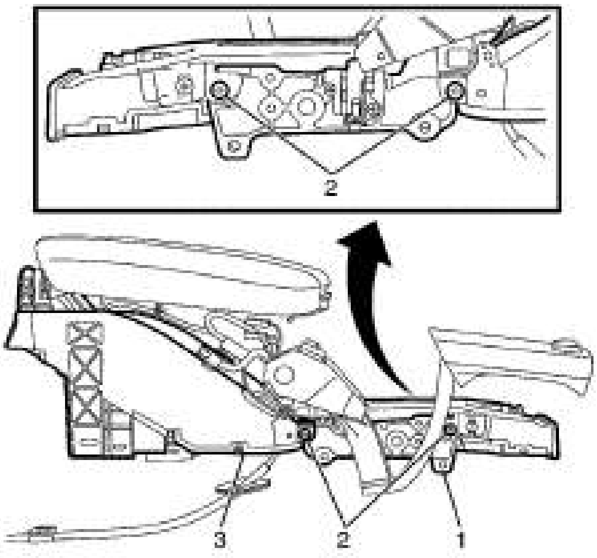
Important: Apply 3M Scotch-Weld Acrylic Structural Plastic Adhesive DP-8005 or super glue (Loctite 406) to the six clips to ensure the park brake lever upper grip (1) is retained.

12. Apply Glue to the six clips on the park brake lever upper grip (1).

Important: The park brake lever upper grip (1) is retained by clips. Fit the top cover by clipping inboard side first, and rolling over. Hold top down tight while glue sets. Make sure all the clips are aligned with the park brake lever lower grip and are engaged to avoid an induced rattle condition.

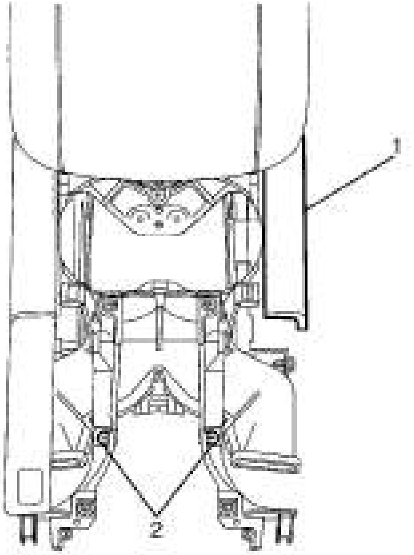
13. Install the park brake lever upper grip (1).

Installation Procedure



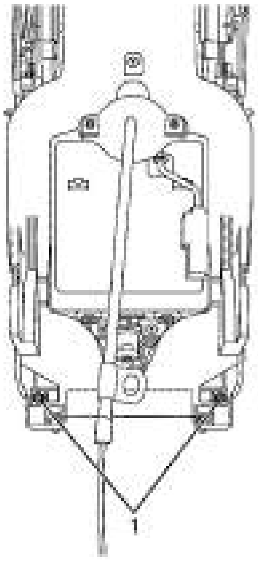
1. Install the park brake assembly (1) to the rear floor air outlet duct (3).
2. Install the rear floor air outlet duct to park brake assembly retaining screw (2)

   Tighten
   Tighten the bolt to 2 Nm (18 lb in).



3. Install the front floor console cover assembly (1).
4. Install the front floor console cover assembly to rear floor air outlet duct retaining screws (2).

Tighten
Tighten the bolt to 2 Nm (18 lb in).



5. Install the rear front floor console cover assembly to rear floor air outlet duct retaining screws (1).

Tighten
Tighten the bolt to 2 Nm (18 lb in).

6. Install the front floor console assembly. Refer to Front Floor Console Replacement .
7. Adjust the park brake. Refer to Park Brake Adjustment .

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Parking Brake Shoe Replacement

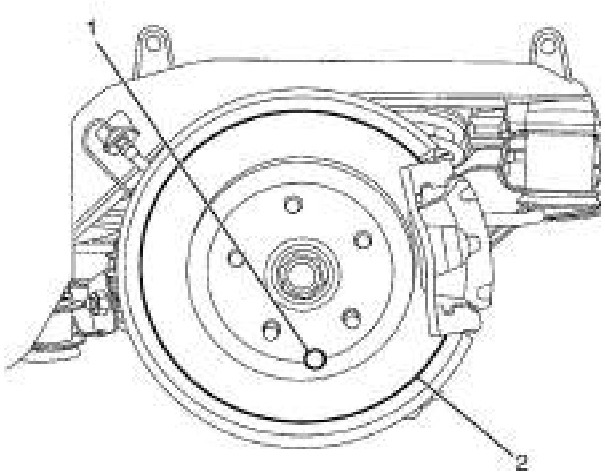
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

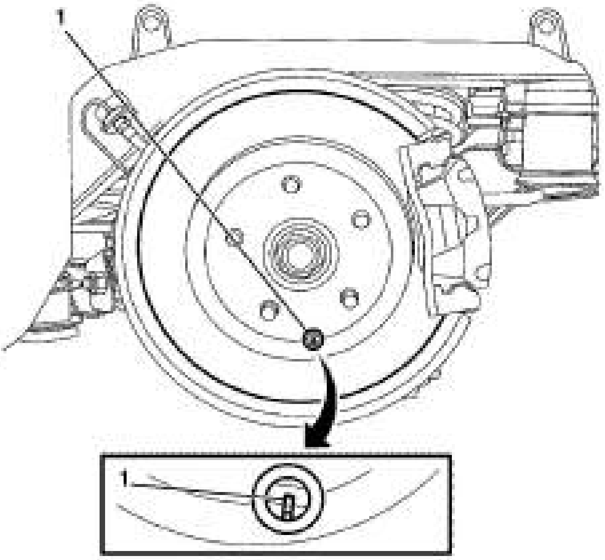
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.

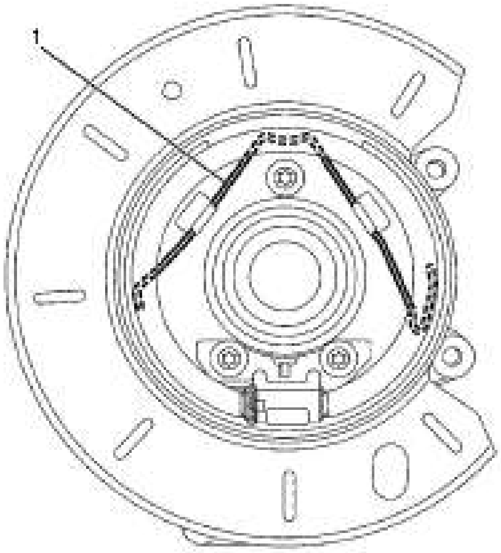
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear tire and wheel assembly. Refer to Tire and Wheel Removal and Installation.



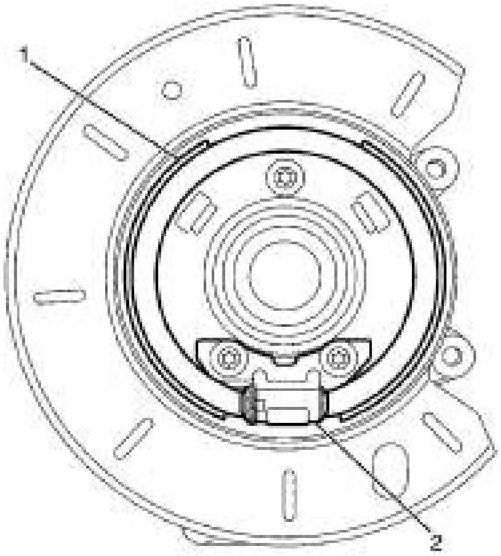
3. Remove the park brake adjustment access hole plug (1) from the brake disc (2).



4. Rotate the park brake adjuster nut (1) until all park brake shoe adjustment has been removed.
5. Remove the rear brake caliper and brake disc. Refer to Rear Brake Rotor Replacement.
6. Remove the wheel bearing and hub assembly. Refer to Rear Wheel Bearing and Hub Replacement.



7. Remove the park brake shoe retaining spring (1).



Important: Detach the park brake shoe (1) from the actuator assembly (2) by grasping the park brake shoe assembly (1) and pushing upwards.

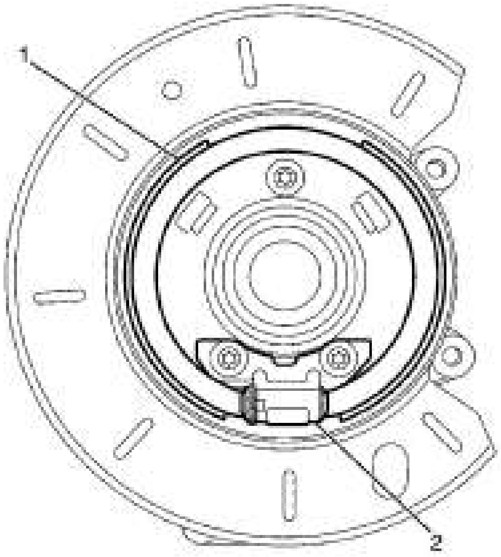
8. Detach the park brake shoe (1) from the actuator assembly (2).
9. Remove the park brake shoe (1).

Installation Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

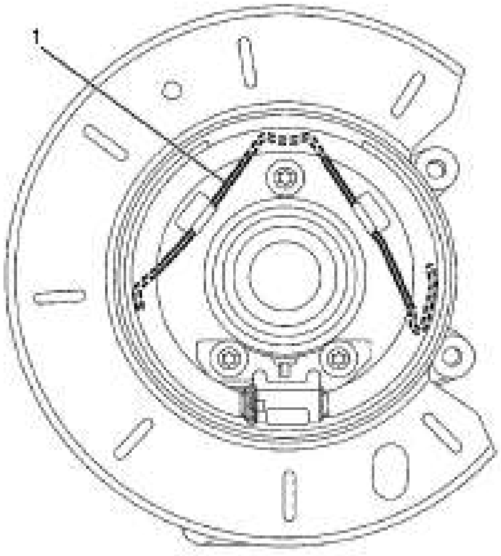
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Brake Dust Caution in the Preface section.



Important: Attach the park brake shoe assembly (1) to the actuator assembly (2) by grasping the park brake shoe assembly (1) and spreading slightly while pulling the shoe over the actuator assembly (2).

1. Attach the park brake shoe assembly (1) to the actuator assembly (2).



2. Install the parking brake shoe retaining spring (1).
3. Install the wheel bearing and hub assembly. Refer to Rear Wheel Bearing and Hub Replacement.
4. Install the rear brake disc and rear brake caliper. Refer to Rear Brake Rotor Replacement.
5. Adjust the park brake. Refer to Park Brake Adjustment.
6. Install the rear tire and wheel assembly. Refer to Tire and Wheel Removal and Installation.
7. Lower the vehicle.

Park Brake System Description and Operation

System Component Description

The park brake system consists of the following:

Park Brake Handle Assembly: When pulled upward applies the park brake system and engages a ratchet assembly to hold the park brake on. A button on the top of the park brake handle releases the ratchet assembly and allows the park brake handle assembly to be lowered which releases the application of the park brake system.

Park Brake Cables: Transfers input force received from park brake handle assembly through park brake cable equalizer, to park brake apply lever.

Park Brake Cable Equalizer: Evenly distributes input force to both the left and right park brake units.

Park Brake Apply Lever: Multiplies and transfers input force to park brake actuator.

Park Brake Actuator / Adjuster: Uses multiplied input force from apply lever to expand park brake shoe toward the friction surface of the drum portion of the rear brake disc. Threaded park brake actuators are also used to control clearance between the park brake shoe and the friction surface of the drum portion of the rear brake disc.

Park Brake Shoe: Applies mechanical output force from park brake actuator to friction surface of the drum portion of the rear brake disc.

System Operation

Park brake application is achieved by the park brake handle assembly being pulled upward. This also engages a ratchet assembly in the park brake handle assembly which holds the park brake on. Park brake apply input force is transferred and evenly distributed through the park brake cables and park brake cable equalizer to the left and right park brake apply levers. The park brake apply levers multiply and transfer the apply input force to the park brake actuators. The park brake actuators expand the park brake shoe toward the friction surface of the drum portion of the rear brake disc preventing the rotation of the rear tyre and wheel assemblies. The park brake handle assembly has a release button on the top of the handle which releases the ratchet assembly when depressed. This allows the park brake handle assembly to be lowered which releases the application of the park brake system.

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Document ID: 2171186

Control Module References

Control Module	Schematic	Repair Instruction	Programming and Setup
• Diagnostic System Check - Vehicle. • Diagnostic Trouble Code (DTC) List - Vehicle. • DTC Symptom Description. • Symptoms - Vehicle.			
Audio/Video Interface Module	Video System Schematics	Audio/Video Interface Module Replacement	Audio/Video Interface Module Programming and Setup
Bluetooth Module	Cellular Telephone Schematics	Bluetooth Module Replacement	This device requires no programming or setup.
Body Control Module Scan Tool Information	Body Control System Schematics	Body Control Module Replacement	Body Control Module Programming and Setup
Door Module (Front)	Door Lock/Indicator Schematics	Front Door Module Replacement	This device requires no programming or setup.
Driver Information Display Control Module	Driver Information System Schematics	Driver Information Display Replacement	Driver Information Display Control Module Programming and Setup
Electronic Brake Control Module Scan Tool Information	Antilock Brake System Schematics	Electronic Brake Control Module Replacement	Electronic Brake Control Module Programming and Setup
Engine Control Module Scan Tool Information	Engine Controls Schematics or Engine Controls Schematics	Engine Control Module Replacement or Engine Control Module Replacement	Engine Control Module Programming and Setup
Heating, Ventilation and Air Conditioning Control Module Scan Tool Information	HVAC Schematics or HVAC Schematics	HVAC Control Module Replacement or HVAC Control Module Replacement	HVAC Control Module Programming and Setup
		Inflatable Restraint Sensing and Diagnostic Module Programming and Setup	

Inflatable Restraint Sensing and Diagnostic Module Scan Tool Information	SIR Schematics	Instrument Panel Inflatable Restraint Module Replacement Driver or Passenger Seat Side Inflatable Restraint Module Replacement Steering Wheel Inflatable Restraint Module Coil Replacement Steering Wheel Inflatable Restraint Module Replacement	Inflatable Restraint Sensing and Diagnostic Module Programming and Setup
Instrument Cluster Scan Tool Information	Instrument Cluster Schematics	Instrument Cluster Replacement	Instrument Cluster Programming and Setup
Liquefied Petroleum Gas Control Module	Engine Controls Schematics Engine Controls Schematics	Liquefied Petroleum Gas Control Module Replacement	This device requires no programming or setup.
Memory Seat Control Module	Driver Seat Schematics	Memory Seat Control Module Replacement	This device requires no programming or setup.
Navigation Interface Module	Radio/Navigation System Schematics	Navigation Interface Module Replacement	This device requires no programming or setup.
Object Alarm Module (Rear)	Object Detection Schematics	Front and Rear Object Alarm Module Replacement	Service Programming System (SPS) Notice
Power Steering Control Module	Power Steering Schematics	Power Steering Control Module Replacement	Power Steering Control Module Programming and Setup
Power Window Module	Moveable Window Schematics	Power Mirror Switch Replacement	Window Motor Programming - Express Function
Radio Scan Tool Information	Radio/Navigation System Schematics	Radio Replacement	Radio Programming and Setup
Rearview Camera Image Display Module	Object Detection Schematics	Rearview Camera Image Display Module Replacement	Rearview Camera Image Display Module Programming and Setup
Remote Control Door Lock Receiver Scan Tool Information	Remote Function Schematics	Remote Control Door Lock Receiver and Theft Deterrent Module Replacement	Remote Control Door Lock Receiver and Theft Deterrent Module Programming and Setup
Seat Interface	Driver Seat	Memory Seat Control	Seat Adjuster Control

Module	Schematics	Module Replacement	Module Programming and Setup
Secondary Information Center	Instrument Cluster Schematics	Secondary Driver Information Display Replacement	Driver Information Display Control Module Programming and Setup
Steering Angle Sensor	Antilock Brake System Schematics	Steering Angle Sensor Replacement	Power Steering Control Module Programming and Setup
Theft Deterrent Module Scan Tool Information	Theft Deterrent System Schematics	Theft Deterrent Module Replacement	Theft Deterrent Control Module Programming and Setup
Transmission Control Module Scan Tool Information	• Automatic Transmission Controls Schematics • Automatic Transmission Controls Schematics • Automatic Transmission Controls Schematics	• Transmission Control Module Replacement for 4L60-E/4L65-E/4L70-E. • Transmission Control Module Replacement for 5L40-E/5L50-E. • Control Solenoid Valve and Transmission Control Module Assembly Replacement for 6L50-E/6L80-E/6L90-E.	Service Programming System (SPS) Notice

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Document ID: 1995371

Obtaining TIS Approval (RHD)

General Information

Certain programming functions performed with the scan tool are prohibited without TIS approval. TIS approval can be obtained by clicking on the Security Access icon on the TIS 2000 Application Selection Screen

Security Access

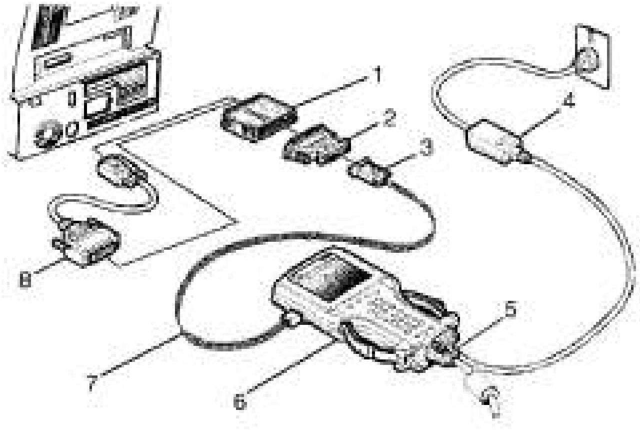
Security Access is used in order to prevent unauthorised persons from programming certain security functions.

After a scan tool security programming function has been selected, the scan tool will display: Please get programming approval from TIS!

To enable these programming procedures they must be approved by the TIS 2000 Security Access function and scan tool must be connected to TIS 2000 using the RS232 interface and a registered security hardware key. Without this security hardware key, an error message is given by TIS 2000.

Security Access Procedure

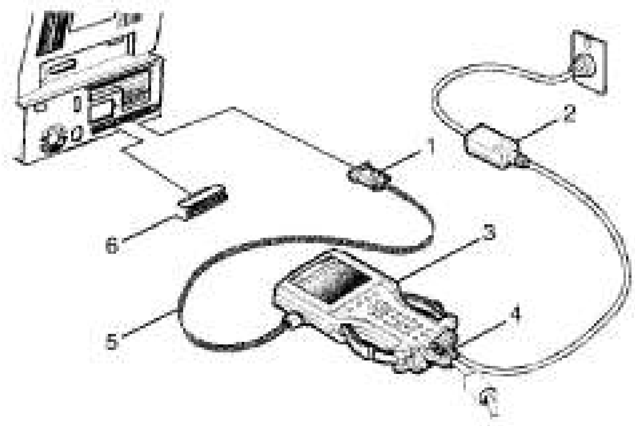
1. If your security hardware key is the serial type, go to step 2. If your hardware key is the parallel type, go to step 7. If your hardware key is the USB type, go to step 12.



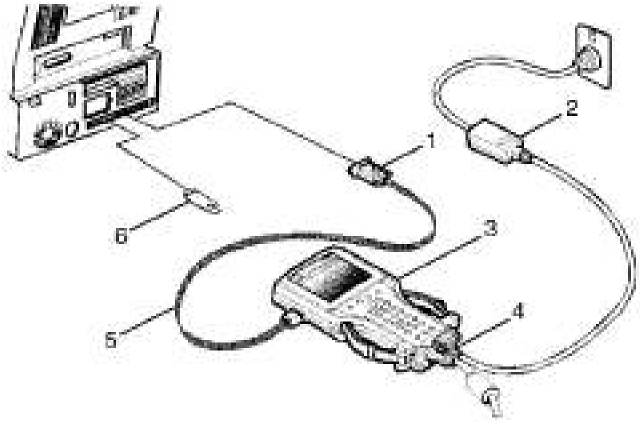
2. Connect the RS-232 cable (7) to the scan tool (6) RS-232 communication port.
3. Connect the other end of the RS-232 cable to the DB-9 adapter (3) and then connect the DB-9 adapter to the 25/9 pin adapter (2).

Important: If your PC has a 9 pin serial communication port you will need to fit the 9/25 pin adapter (8) between the hardware key and the serial port of the TIS 2000 PC.

4. Connect the 25/9 pin adapter to the Serial Security Hardware Key (1) and then connect the Serial Security Hardware Key to the serial port of a Personal Computer (PC) with TIS 2000 installed.
5. Connect the power supply (4) to the scan tool power supply jack (5). Press the PWR button to turn on the scan tool. The scan tool should now be at the title display screen.
6. Now go to step 16.



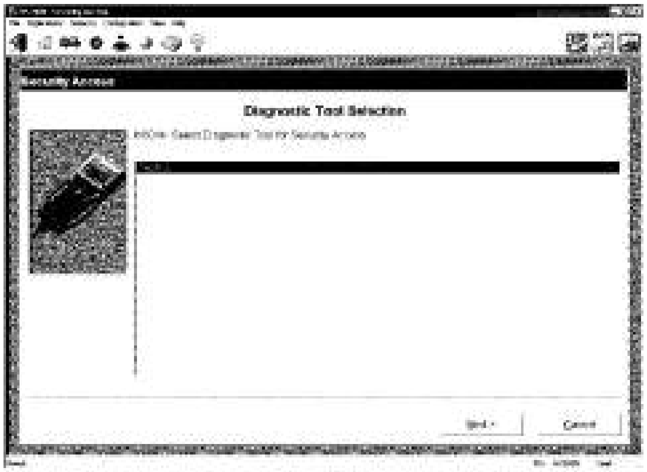
7. Connect the RS-232 cable (5) to the scan tool (3) RS-232 communication port.
8. Connect the other end of the RS-232 cable to the DB-9 adapter (1) and then connect the DB-9 adapter to the Comms port of the Personal Computer (PC) with TIS 2000 installed.
9. Connect the Parallel Security Hardware Key (6) to the serial port of the Personal Computer (PC) with TIS 2000 installed.
10. Connect the power supply (2) to the scan tool power supply jack (4). Press the PWR button to turn on the scan tool. The scan tool should now be at the title display screen.
11. Now go to step 16.



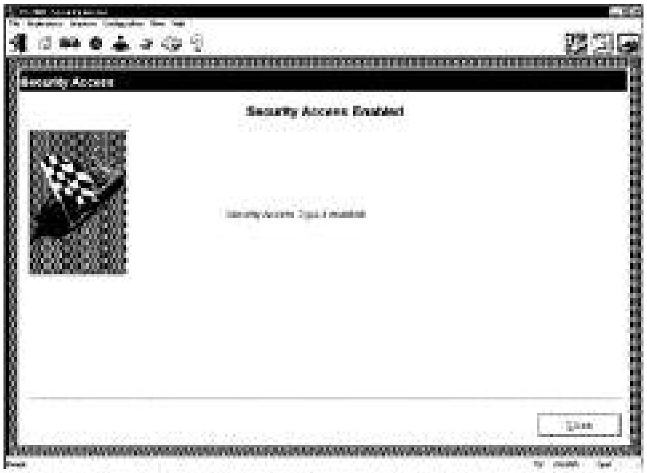
12. Connect the RS-232 cable (5) to the scan tool (3) RS-232 communication port.
13. Connect the other end of the RS-232 cable to the DB-9 adapter (1) and then connect the DB-9 adapter to the Comms port of the Personal Computer (PC) with TIS 2000 installed.
14. Connect the USB Security Hardware Key (6) to the USB port of the Personal Computer (PC) with TIS 2000 installed.
15. Connect the power supply (2) to the scan tool power supply jack (4). Press the PWR button to turn on the scan tool. The scan tool should now be at the title display screen.

Object Number: 1954313 Size: SH

16. From the TIS 2000 main menu, click on the Security Access icon to start the application.


Security Access
Diagnostic Tool Selection

17. Select diagnostic tool (Tech 2) for Security Access.
18. Select Next> to continue.


Security Access
Security Access Enabled

19. When the process is complete, a Security Access Enabled, Security Access Type 2 and or 3 enabled screen appears. Click on the Close button to close the application.
20. Reconnect the scan tool to the vehicle DLC and reselect the programming function, you will now be permitted to complete the programming function.

Audio/Video Interface Module Programming and Setup

Rear Seat Entertainment (RSE) Interface Module Replacement

Important: If the RSE interface module vehicle identification number (VIN) does not match the VIN transmitted by the body control module (BCM) the system will enter theft mode and will be locked. After the installation of a new RSE interface module, the RSE interface module will auto-learn the VIN that is transmitted by the BCM.

If the RSE interface module is replaced, the following procedures must be performed:

1. RSE interface module reprogramming - Refer to Service Programming System (SPS) .
2. Link RSE Components procedure.
3. Program Region Code to the RSE interface module.

Link RSE Components

Important: Performing the Link RSE Components procedure is prohibited without TIS approval. Refer to Obtaining TIS Approval for more information.

Important: If the Link RSE Components procedure is not performed the RSE system will not function correctly. If either the RSE interface module or any of the RSE system components are independently replaced it will be necessary to perform the "Link RSE Components" procedure. If all RSE components are replaced together they will auto-link.

1. Install a diagnostic scan tool.
2. Select Infotainment System.
3. Select RSE (Rear Seat Entertainment).
4. Select Programming.
5. Select the Link RSE Components procedure and follow the directions displayed on the screen.
6. Obtain TIS approval then repeat steps 1-5.

Program Region Code

Important: Performing the program region code procedure is prohibited without TIS approval. Refer to Obtaining TIS Approval for more information.

Important: The region code can only be set ONCE. Once the region code has been set it cannot be reprogrammed again.

1. Install a diagnostic scan tool.
2. Select Infotainment System.
3. Select RSE (Rear Seat Entertainment).
4. Select Programming.
5. Select the Program Region Code procedure and follow the directions displayed on the screen.
6. Obtain TIS approval then repeat steps 1-5.

Perform the Diagnostic Repair Verification after completing the proceeding procedures.

Body Control Module Programming and Setup

Introduction

A new body control module (BCM) must be programmed with the latest operating software and vehicle calibrations. Ensure that the following conditions exist in order to prepare for BCM programming:

- The battery is fully charged.
- The ignition switch is in the ON position.
- The data link connector (DLC) is accessible.
- All disconnected modules and devices are connected.

Programming the BCM

Important: The vehicle will not start and many other functions may not operate correctly if a replacement BCM is not correctly set up. The following procedures must be followed:

1. The BCM reprogramming - Refer to Service Programming System (SPS) Notice .
2. Brake pedal position sensor (BPPS) learn.
3. Program SDM primary key to BCM

Important: After the procedure is completed, the personalization settings of the BCM are set to default settings. Inform the customer that the personalization must be set again.

Brake Pedal Position Sensor (BPPS) Learn

1. *Calibration Criteria* DO NOT apply the brake pedal during the brake pedal position sensor calibration procedure. Any movement of the brake pedal during this procedure will cause the calibration procedure to fail. If this occurs, the BPPS calibration must be repeated. BPPS calibration must be performed after the BPPS or body control module (BCM) have been serviced. The calibration procedure will set the BPPS home value. This value is used by the BCM to determine the action of the driver applying the brake system and to provide this information to the vehicle subsystems via the serial data communication bus.

   Apply the parking brake.

2. Place the transmission in the PARK position for automatic transmission or NEUTRAL for manual transmission.
3. Install a diagnostic scan tool.
4. Key ON, engine OFF, select Body.
5. Select BCM (Body Control Module).
6. Select Programming.
7. Select the Brake Pedal Position Sensor Learn procedure and follow the directions displayed on the screen.
8. Check all vehicle lights for correct operation.

Program SDM Primary Key to BCM

1. Install a diagnostic scan tool.
2. Key ON, engine OFF, select Body.
3. Select BCM (Body Control Module).
4. Select Programming.
5. Select the Program SDM primary key to BCM procedure and follow the directions displayed on the screen.

Perform the Diagnostic Repair Verification after completing the proceeding procedures.

Clutch Pedal Position Sensor Learn

Important: The clutch pedal position (CPP) sensor learn procedure is required when the following service procedures have been performed regardless of whether DTC P080A is set:

- An engine control module (ECM) replacement
- A CPP sensor replacement
- Any repairs which affect the CPP sensor relationship

1. Install a scan tool.
2. Monitor the ECM for DTCs with a scan tool. If other DTCs are set, except DTC P080A, refer to Diagnostic Trouble Code (DTC) List - Vehicle for the applicable DTC that set.
3. With a scan tool, select Clutch Pedal Position Learn under Module Setup in Manual Transmission, and perform the following instructions displayed on the scan tool screen.

   Important: The CPP sensor learn procedure cannot be performed more than once per ignition cycle. The clutch pedal needs to be fully depressed and held steady throughout this procedure in order to perform a correct learning.

4. The scan tool will display under CPP Learn Status: Not Learned, In Process, Complete, Fail - Low Volt, Fail - High Volt, or Fail Moving. The scan tool will display under CPP Learn Status Complete if the process was successful.
5. If the scan tool indicates that DTC P080A ran and passed this ignition the CPP sensor learn procedure is complete. If the scan tool indicates DTC P080A failed or did not run this ignition, refer to DTC P080A. If any other DTC is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle for the applicable DTC.
6. Turn OFF the ignition for 30 seconds after the learn procedure has successfully completed in order to store the CPP sensor variation values in ECM history.

Diagnostic Repair Verification

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming or setup procedures that are required when a component or module is removed or replaced.
3. Clear the DTCs.
4. Turn OFF the ignition for 60 seconds.
5. If the repair was related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not reset. If the DTC resets or another DTC is present, refer to the Diagnostic Trouble Code (DTC) List - Vehicle and perform the appropriate diagnostic procedure.

   Or

   If the repair was symptom related, duplicate the conditions under which the customer concern occurred to verify the repair. If the customer concern reoccurs or another symptom is present, return to Symptoms - Vehicle and perform the appropriate symptom diagnostic.

Driver Information Display Control Module Programming and Setup

Important: There are two display types available for this vehicle - standard and sports, the standard has one programming option for audio display. The sports has two programming options, one for audio display, one for voltage/oil pressure depending on the vehicle option level.

If the standard secondary information centre (SIC) is removed or replaced the following procedures must be performed:

Standard Installation

1. Install a diagnostic scan tool.
2. Key ON, engine OFF, select Infotainment System.
3. Select SIC (Secondary Information Centre).
4. Select Programming.

   Important: The VIN will automatically program to the SIC once this process is selected. No further steps are required.

5. Select Learn Vehicle Identification Number (VIN).

If the standard secondary information centre (SIC) is removed or replaced the following procedures must be performed:

Sports Installation

1. Install a diagnostic scan tool.
2. Key ON, engine OFF, select Infotainment System.
3. Select SIC (Secondary Information Centre).
4. Select Programming.
5. Select Display Type.
6. Select Standard or Sports - standard will provide audio display, sports will provide voltage/oil pressure gauges.

   Important: The VIN will automatically program to the SIC once the following process is selected.

7. Select Learn Vehicle Identification Number (VIN).

Perform the Diagnostic Repair Verification after completing the proceeding procedures.

Electronic Brake Control Module Programming and Setup

EBCM Replacement

If the electronic brake control module (EBCM) is replaced it must be programmed. The following must be performed in the specified order to program the EBCM:

1. Service Programming System (SPS)
2. Steering Angle Sensor Centering

Service Programming System (SPS)

For step-by-step programming instructions, please refer to the techline information system (TIS) terminal.

Review the information below to ensure proper programming protocol.

Important:

- DO NOT program a control module unless you are directed by a service procedure or you are directed by a General Motors Corporation service bulletin. Programming a control module at any other time will not permanently correct a customers concern.
- It is essential that the Tech 2, MDI and the TIS terminal are all equipped with the latest software before performing service programming.
- Due to the time requirements of programming a controller, it is recommended that an external power source be used to maintain system voltage. Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. To ensure trouble-free programming, GM recommends using one of the following external power sources:
  - A Midtronics PSC charger
  - A fully charged 12V jumper or booster pack disconnected from the AC voltage supply
- Some modules will require additional programming/setup events performed before or after programming.
- Some vehicles may require the use of a CANDi or MDI module for programming.
- Review the appropriate service information for these procedures.
- DTCs may set during programming. Clear DTCs after programming is complete.
- Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.

Ensure the following conditions are met before programming a control module:

- Vehicle system voltage:
  - There is not a charging system concern. All charging system concerns must be repaired before programming a control module.
  - Battery voltage is greater than 12 volts but less than 16 volts. The battery must be fully charged before programming the control module.
  - Turn OFF or disable any system that may put a load on the vehicles battery, such as the following components:
    - Twilight sentinel
    - Interior lights
    - Daytime running lights (DRL)--Applying the parking brake, on most vehicles, disables the DRL system
    - Heating, ventilation, and air conditioning (HVAC) systems
    - Engine cooling fans, radio, etc.
- The ignition switch must be in the proper position. SPS prompts you to turn ON the ignition, with the engine OFF. DO NOT change the position of the ignition switch during the

programming procedure, unless instructed to do so.

- Make certain all tool connections are secure, including the following components and circuits:
  - Tech 2
    - The RS-232 communication cable port
    - The connection at the data link connector (DLC)
    - The voltage supply circuits
  - MDI
    - The USB, Ethernet or Wireless communication port
    - The connection at the data link connector (DLC)
- DO NOT disturb the tool harnesses while programming. If an interruption occurs during the programming procedure, programming failure or control module damage may occur.
- DO NOT turn OFF the ignition if the programming procedure is interrupted or unsuccessful. Ensure that all control module and DLC connections are secure and the TIS terminal operating software is up to date. Attempt to reprogram the control module. If the control module cannot be programmed, replace the control module.

Steering Angle Sensor Centering

The steering angle sensor does not require centering often. Centering of the steering angle sensor might be required after certain service procedures are performed. Some of these procedures are as follows:

- Steering gear replacement
- Steering column replacement
- Steering angle sensor replacement
- Intermediate shaft replacement
- Electronic brake control module (EBCM) replacement
- Collision or other physical damage

The steering angle sensor centering procedure can be completed with a scan tool using the following steps:

1. Using the steering wheel, align the front wheels forward.
2. Set the transmission in the PARK position.
3. Turn the ignition switch ON, with the engine OFF.
4. Clear any DTCs that may be set.
5. Select Steering Angle Sensor Centering in the EBCM Special Functions list.
6. Follow the scan tool directions to complete the centering procedure.

Engine Control Module Programming and Setup (3.6L)

The following service procedures require either a programming or a setup event performed for a complete repair.

Warning: Replacement or reprogramming of the ECM, or replacement of the clutch pedal position sensor (CPPS) or clutch pedal requires that a CPPS learn procedure be performed. Failure to perform the CPPS learn procedure may result in personal injury or damage to the vehicle or its components if the vehicle is in gear and the starter motor is accidentally engaged.

ECM Replacement and Reprogramming

If the engine control module (ECM) is replaced or reprogrammed, the following procedures must be performed:

1. ECM Reprogramming--Refer to Service Programming System (SPS) .
2. Clutch pedal position sensor learn, if equipped--Refer to Clutch Pedal Position Sensor Learn .
3. Idle Learn Procedure--Refer to Idle Learn
4. Theft Deterrent--Refer to Theft Deterrent Control Module Programming and Setup . The ECM will learn the incoming fuel continue password immediately upon receipt of a password message. Once a password message is received, and a password is learned, a learn procedure must be performed to change this password again. An ECM which has been previously installed in another vehicle will have learned the other vehicle's fuel continue password, and will require a learn procedure after programming to learn the current vehicle's password.
5. Engine Oil Life Remaining--When available, use a scan tool to reset the Engine Oil Life Remaining back to the original percentage recorded before the module was replaced.

Setup for Component Replacement

The replacement of some components will require a setup procedure for complete repair.

- If any of the following components are replaced, an Idle Learn Procedure must be performed. Refer to Idle Learn .
  - Throttle body assembly
  - ECM
- If any of the following components are replaced, a Clutch Pedal Position Sensor Learn Procedure must be performed. Refer to Clutch Pedal Position Sensor Learn .
  - Clutch pedal
  - Clutch pedal position sensor

Engine Control Module Programming and Setup (6.0L)

The following service procedures require either a programming or a setup event performed for a complete repair.

ECM Replacement

Warning: Replacement or reprogramming of the ECM, or replacement of the clutch pedal position sensor (CPPS) or clutch pedal requires that a CPPS learn procedure be performed. Failure to perform the CPPS learn procedure may result in personal injury or damage to the vehicle or its components if the vehicle is in gear and the starter motor is accidentally engaged.

If the engine control module (ECM) is replaced, the following procedures must be performed:

> **Note:** When replacing the ECM, the ECM must be reset prior to removal. Failure to perform this procedure will result in the inability to:
> - Test the ECM for warranty purposes.
> - Install the ECM into other vehicles.

1. ECM reset procedure
2. ECM reprogramming--Refer to Service Programming System (SPS) .
3. The Throttle Learn procedure--Refer to Throttle Learn .
4. The CKP Variation Learn/CASE-Crank Angle Sensing Error procedure--Refer to Customer Concern Verification Sheets .
5. The Theft Deterrent Programming--Refer to Theft Deterrent Control Module Programming and Setup .
6. The Clutch Pedal Position Sensor Learn--Refer to Clutch Pedal Position Sensor Learn .

ECM Reprogramming

Warning: Replacement or reprogramming of the ECM, or replacement of the clutch pedal position sensor (CPPS) or clutch pedal requires that a CPPS learn procedure be performed. Failure to perform the CPPS learn procedure may result in personal injury or damage to the vehicle or its components if the vehicle is in gear and the starter motor is accidentally engaged.

- If the ECM needs to be reprogrammed, refer to Service Programming System (SPS) .
- The Clutch Pedal Position Sensor Learn--Refer to Clutch Pedal Position Sensor Learn .
- Engine Oil Life Remaining - When available, use a scan tool to reset the Engine Oil Life Remaining back to the original percentage recorded before the module was reprogrammed.

Setup for Component Replacement

The replacement of some components will require a setup procedure for complete repair.

If any of the following components are replaced, a CKP Variation Learn Procedure must be performed. Refer to Customer Concern Verification Sheets .

- Engine replacement
- Any engine repair that disturbs the crankshaft position (CKP) sensor or its relationship with the crankshaft reluctor wheel.
- CKP sensor

If the throttle body is replaced, a Throttle Learn procedure must be performed. Refer to Throttle Learn .

Perform the Diagnostic Repair Verification after completing the proceeding procedures.

HVAC Control Module Programming and Setup

Each of the following service procedures may require programming or setup procedures to be performed on the HVAC control module or HVAC actuators.

HVAC Control Module Replacement

If the HVAC manual or HVAC automatic control modules are replaced, an automatic re-calibration of all the actuators will occur. For the best re-calibration results, start and run the engine for at least one minute after installing the new module . Do not adjust any controls on the HVAC control module during the re-calibration procedure. If interrupted, improper HVAC performance may result. No additional procedures are necessary.

HVAC Control Module Reprogramming

Do not reprogram the HVAC control module unless directed by a service procedure or a service bulletin.

Reprogram HVAC Control Module--Refer to Service Programming System (SPS) .

Inflatable Restraint Sensing and Diagnostic Module Programming and Setup

Important: After installing and one cycle of the ignition, the inflatable restraint sensing and diagnostic module (SDM) is locked to the vehicle and it will not be possible to swap between other vehicles.

Program SDM Primary Key to BCM

Important: Performing the SDM primary key to BCM programming is prohibited without TIS approval. Refer to Obtaining TIS Approval for more information.

1. Install a diagnostic scan tool.
2. Key ON, engine OFF, select Body.
3. Select SDM (Sensory Diagnostic Module).
4. Select Programming.
5. Select the Program SDM primary key to BCM procedure and follow the directions displayed on the screen.

Perform the Diagnostic Repair Verification after completing the proceeding procedures.

Instrument Cluster Programming and Setup

IPC Replacement

Important: The original odometer reading, together with other important vehicle parameters, must be programmed into the replacement instrument cluster. If a replacement cluster has been fitted to a vehicle it will require programming, the vehicle type must be selected followed by the country and then the engine type. The engine type is required only for some countries and this is highlighted below.

If the instrument panel cluster (IPC) is replaced, the following procedures must be performed in the order shown:

1. Odometer reprogramming.

   Important: The IPC variant configuration must be correct or the performance of the EBCM will be reduced.

2. Variant configuration.
3. IPC reprogramming - Refer to Service Programming System (SPS) .

Program Odometer

Important: It is only possible to reset the odometer reading if no more than 100 km has been registered on the odometer. It is essential to enter the correct odometer value, as the programming of the odometer can only be performed once.

Important: Programming the odometer is prohibited without TIS approval. Refer to Obtaining TIS Approval for more information.

1. Install a diagnostic scan tool.
2. Select Body.
3. Select IPC (Instrument Panel Cluster).
4. Select Programming.
5. Select the Program Odometer procedure and follow the directions displayed on the screen.
6. Obtain TIS approval then repeat steps 1-5.

Program Variant Configuration

This option allows you to reconfigure the instrument panel cluster (IPC) from the default factory settings.

Important: Regular production options (RPOs) are located on the vehicle security card.

Prior to removal use a scan tool to identify the existing RPOs that are programmed into the IPC.

The following options are available:

1. Car Body Style.

- 4 Door Short Wheel Base Sedan.
- 4 Door Long Wheel Base Sedan.

2. Engine Type.
   - 3.6 L V6 (LE0)
   - 3.6 L V6 (LY7)
   - 3.6 L V6 LPG (LW2)
   - 6.0 L V8 (L76/L98)
   - 6.0 L V8 HSV (LS2)
3. Transmission Type.
   - 6 Speed Manual (D173) MV5
   - 6 Speed Manual (T56) M10
   - 4 Speed Automatic RWD (4L60E) M30
   - 4 Speed Automatic RWD (4L65E) M32
   - 5 Speed Automatic RWD (5L40E) M82
   - 6 Speed Automatic RWD (6L80E) MYC
4. Suspension Type.
   - Unknown
   - Standard FE1
   - Sports FE2
   - Country FR1
5. Country.
   - Australia (B13)
   - New Zealand (E13)
   - Middle East (E05)
   - Brazil (B08)
   - South Africa (B02)
   - Indonesia (B00)
6. Tyre Pressure Monitoring.
   - Not Fitted
   - Fitted
7. Police Mode.
   - Disabled
   - Enabled
8. Navigation.
   - Not Fitted
   - TBT Nav (UY4)
   - Full Nav (UV9)
9. Fleet Telematics (U86).
   - Not Fitted
   - Fitted
10. LPG.
    - Not Fitted
    - Fitted

11. AHL (Automatic Headlamp Levelling).
    - Not Fitted
    - Fitted

Programming

1. Install a diagnostic scan tool.
2. Select Body.
3. Select IPC (Instrument Panel Cluster).
4. Select Programming.
5. Select the Program Variant Configuration procedure and follow the directions displayed on the screen.
6. Obtain TIS approval then repeat steps 1-5.

Perform the Diagnostic Repair Verification after completing the proceeding procedures.

Object Alarm Module Programming and Setup

If the object alarm module is replaced it must be programmed. Refer to Service Programming System (SPS) .

Power Steering Control Module Programming and Setup

If the steering angle sensor is removed or replaced it must be recalibrated.

1. Install a diagnostic scan tool.
2. Key ON, engine OFF, select Chassis.
3. Select EBCM (Electronic Brake Control Module).
4. Select Programming.
5. Select the Calibrate Steering Angle Sensor procedure and follow the directions displayed on the screen.

Perform the Diagnostic Repair Verification after completing the proceeding procedures.

Radio Programming and Setup

Infotainment Unit Replacement

Important: If the infotainment unit vehicle identification number (VIN) does not match the VIN transmitted by the body control module (BCM) the system will enter theft mode and will be locked. After the installation of a new infotainment unit, the infotainment unit will auto-learn the VIN that is transmitted by the BCM.

Important: If either the infotainment unit or infotainment facia is being independently replaced it will be necessary to perform the "Facia link to IRC" procedure. If both infotainment facia and infotainment unit are new and are replaced together they will auto-link.

Important: If the vehicle has a rear seat entertainment (RSE) system installed it will be necessary to enable the rear auxiliary input to allow RSE video to play through the infotainment unit display. The default setting is Rear Auxiliary Off.

If the infotainment unit is replaced, the following procedures must be performed:

1. Audio system reprogramming - Refer to Service Programming System (SPS) .
2. Facia link to IRC procedure.

Facia Link to IRC

> **Important:** Performing the facia link to IRC procedure is prohibited without TIS approval. Refer to Obtaining TIS Approval for more information.

1. Install a diagnostic scan tool.
2. Select Infotainment System.
3. Select Audio System.
4. Select Programming.
5. Select the Facia Link to IRC procedure and follow the directions displayed on the screen.
6. Obtain TIS approval then repeat steps 1-5.

Perform the Diagnostic Repair Verification after completing the proceeding procedures.

Remote Control Door Lock Receiver and Theft Deterrent Module Programming and Setup

Tools Required

- EL-47826 TPMS Activation and Test Tool.
- EL-49310 TPMS Activation and Test Tool.

Remote Function Actuator (RFA) Replacement

If the RFA is replaced, the following procedures must be performed:

Important: When the RFA is programmed via the service programming system (SPS) the remote key and TPMS pressure sensor data will be erased. Remote keys and TPMS pressure sensors (where installed) must be programmed whenever a RFA is replaced.

1. RFA reprogramming - Refer to Service Programming System (SPS).
2. Select Body.
3. Select RFA (Remote Function Actuator).
4. Select Programming.

Important: Performing the Erase All and Program Remotes procedure is prohibited without TIS approval. Refer to Obtaining TIS Approval for more information.

Important: Remote keys must be programmed to the RFA. Remote keys can be reused, a maximum of 4 remote keys may be reprogrammed.

5. Select Erase All and Program Remotes.
6. Obtain TIS approval then repeat steps 1-5.

Important: The scan tool must stay connected until all of the remote keys are programmed.

7. Press and hold the LOCK button and the UNLOCK button simultaneously on one remote key. After a delay of 5-10 seconds, the scan tool will indicate that the remote key is programmed.
8. Repeat the previous step in order to program up to 4 remote keys.

Important: The following procedures are only required on vehicles where the tyre pressure monitoring system (TPMS) is installed.

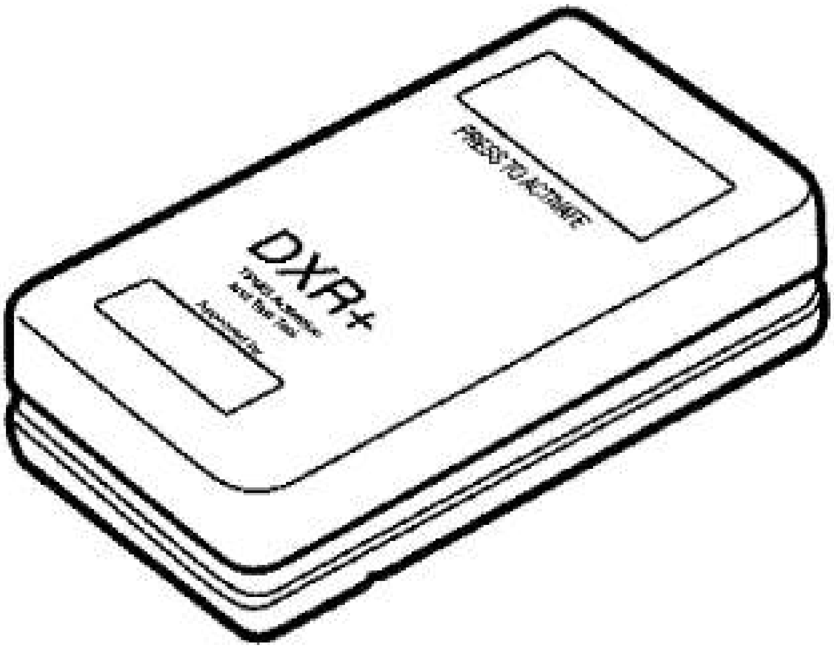
9. Select Tire Type/Pressure selection.
10. Select TPM Learn mode.
11. Activate each TPMS pressure sensor in the order displayed on the scan tool display and follow the instructions below:

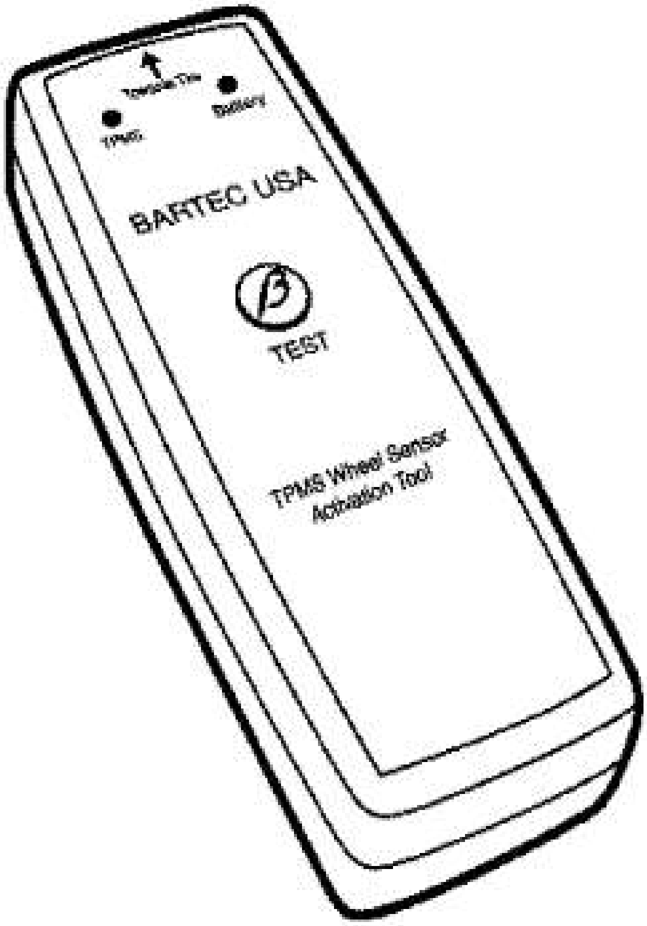
Important: To program each TPMS pressure sensor ID into the RFA and/or to activate a sensor, the mandatory TPMS Activation and Test Tool EL-47826 or EL-49310 is required.

Important: For this vehicle, the TPMS Activation and Test Tool LED and audible tone do not operate during the program procedure, activation of each TPMS pressure sensor is confirmed using the scan tool.

12. Hold the Activation and Test Tool EL-47826 or EL-49310 against the tyre sidewall, with the end of the tool at the valve location and perpendicular to the tyre wall.
13. Press the activation button once, then release. This begins the sensor activation process.
14. Following activation of each TPMS pressure sensor, the vehicle horn will sound, the indicators will flash once and confirmation will be displayed on the scan tool display.

Perform the Diagnostic Repair Verification after completing the proceeding procedures.


DXR+
PRESS TO ACTIVATE


TPMS
Battery
BARTEC USA
TEST
TPMS Wheel Sensor
Activation Tool

Seat Adjuster Control Module Programming and Setup

If the seat interface module (SIM) is removed or replaced it must the vehicle identification number (VIN) must be relearned.

1. Install a diagnostic scan tool.
2. Key ON, engine OFF, select Body.
3. Select Memory Seats and Mirrors.
4. Select Programming.

   Important: The VIN will automatically program to the SIM once the following process is selected.

5. Select Learn Vehicle Identification Number (VIN).

Perform the Diagnostic Repair Verification after completing the proceeding procedures.

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Service Programming System (SPS)

For step-by-step programming instructions, please refer to the techline information system (TIS) terminal.

Review the information below to ensure proper programming protocol.

Important:

- DO NOT program a control module unless you are directed by a service procedure or you are directed by a General Motors Corporation service bulletin. Programming a control module at any other time will not permanently correct a customers concern.
- It is essential that the Tech 2, MDI and the TIS terminal are all equipped with the latest software before performing service programming.
- Due to the time requirements of programming a controller, it is recommended that an external power source be used to maintain system voltage. Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. To ensure trouble-free programming, GM recommends using one of the following external power sources:
  - A Midtronics PSC charger
  - A fully charged 12V jumper or booster pack disconnected from the AC voltage supply
- Some modules will require additional programming/setup events performed before or after programming.
- Some vehicles may require the use of a CANDi or MDI module for programming.
- Review the appropriate service information for these procedures.
- DTCs may set during programming. Clear DTCs after programming is complete.
- Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.

Ensure the following conditions are met before programming a control module:

- Vehicle system voltage:
  - There is not a charging system concern. All charging system concerns must be repaired before programming a control module.
  - Battery voltage is greater than 12 volts but less than 16 volts. The battery must be fully charged before programming the control module.
  - Turn OFF or disable any system that may put a load on the vehicles battery, such as the following components:
    - Twilight sentinel
    - Interior lights
    - Daytime running lights (DRL)--Applying the parking brake, on most vehicles, disables the DRL system
    - Heating, ventilation, and air conditioning (HVAC) systems
    - Engine cooling fans, radio, etc.
- The ignition switch must be in the proper position. SPS prompts you to turn ON the ignition, with the engine OFF. DO NOT change the position of the ignition switch during the

programming procedure, unless instructed to do so.

- Make certain all tool connections are secure, including the following components and circuits:
  - Tech 2
    - The RS-232 communication cable port
    - The connection at the data link connector (DLC)
    - The voltage supply circuits
  - MDI
    - The USB, Ethernet or Wireless communication port
    - The connection at the data link connector (DLC)
- DO NOT disturb the tool harnesses while programming. If an interruption occurs during the programming procedure, programming failure or control module damage may occur.
- DO NOT turn OFF the ignition if the programming procedure is interrupted or unsuccessful. Ensure that all control module and DLC connections are secure and the TIS terminal operating software is up to date. Attempt to reprogram the control module. If the control module cannot be programmed, replace the control module.

Steering Angle Sensor Centering

The steering angle sensor does not require centering often. Centering of the steering angle sensor might be required after certain service procedures are performed. Some of these procedures are as follows:

- Steering gear replacement
- Steering column replacement
- Steering angle sensor replacement
- Intermediate shaft replacement
- Electronic brake control module (EBCM) replacement
- Collision or other physical damage

The steering angle sensor centering procedure can be completed with a scan tool using the following steps:

1. Using the steering wheel, align the front wheels forward.
2. Set the transmission in the PARK position.
3. Turn the ignition switch ON, with the engine OFF.
4. Clear any DTCs that may be set.
5. Select Steering Angle Sensor Centering in the EBCM Special Functions list.
6. Follow the scan tool directions to complete the centering procedure.

Theft Deterrent Control Module Programming and Setup

There are three programming routines available for the theft deterrent system:

- Theft deterrent link to ECM.
- Reprogram all transponder keys.
- Program additional transponder keys.

Theft deterrent link to ECM

The theft deterrent link to ECM will be required for three different scenarios, when replacing the theft deterrent module (TDM), when replacing of the engine control module (ECM) or when replacing both TDM and ECM together.

Theft Deterrent Module (TDM) Replacement

If the TDM is replaced, the following procedures must be performed:

1. TDM reprogramming - Refer to Service Programming System (SPS) .
2. TDM Link to ECM.
3. Program transponder keys.

Engine Control Module (ECM) Replacement

If the ECM is replaced, the following procedures must be performed:

1. ECM reprogramming - Refer to Engine Control Module Programming and Setup .
2. TDM Link to ECM.

Theft Deterrent Module (TDM) and Engine Control Module (ECM) Replacement

If the TDM and ECM are replaced, the following procedures must be performed:

1. ECM reprogramming - Refer to Engine Control Module Programming and Setup .
2. TDM reprogramming - Refer to Service Programming System (SPS) .
3. TDM Link to ECM.
4. Program transponder keys.

TDM Link to ECM

Important: Performing the TDM link to ECM procedure may require TIS approval. Refer to Obtaining TIS Approval for more information.

Important: A new TDM is already unlocked and in learn mode, for new TDMs the 10 minute wait to enter learn mode will not be required.

When linking a previously programmed TDM or ECM, or reprogramming all transponder keys, there will be a 10 minute wait while the TDM enters learn mode. There are two types of learn mode:

- When linking an ECM to an existing TDM, the TDM must be unlocked in order to transmit the security data; this does not erase transponder keys. There is no timer displayed for this type of learn.
- When a TDM is linked to an existing ECM or all transponder keys are programmed the TDM must be unlocked in order to transmit the security data and existing transponder keys will be erased. There is a timer displayed for this type of learn. Once the first two keys are programmed, the TDM exits learn mode and allows additional transponder keys to be reprogrammed.

1. Install a diagnostic scan tool.
2. Key ON, engine OFF, select Body.
3. Select Theft Deterrent.
4. Select Programming.
5. Select V6 or V8 engine, depending on the vehicle being reprogrammed.
6. Select Theft Deterrent link to ECM.
7. Obtain TIS approval then repeat steps 1-6.

   Important: The Security Code is a four digit code that is located on the vehicle security card supplied with the vehicle. For more details on the vehicle security card refer to the owner handbook.

8. Enter Security Code and follow the directions displayed on the screen.

   Important: To perform the TDM Link to ECM as a security measure two pre-programmed transponder keys must be present. The TDM will unlock and learn the first of the transponder keys, the second transponder key must then be inserted and accepted by the TDM. When the TDM has recognized both valid transmitter keys it will then move to link to the ECM.

   Important: If two transponder keys are not present at the time of reprogramming a possible vehicle non-start event can occur.

Reprogram all transponder keys

If the TDM is replaced, the following procedures must be performed:

1. Install a diagnostic scan tool.
2. Key ON, engine OFF, select Body.
3. Select Theft Deterrent.
4. Select Programming.
5. Select V6 or V8 engine, depending on the vehicle being reprogrammed.
6. Reprogram all transponder keys.
7. Obtain TIS approval then repeat steps 1-6.

   Important: The Security Code is a four digit code that is located on the vehicle security card supplied with the vehicle. For more details on the vehicle security card refer to the owner handbook.

8. Enter Security Code and follow the directions displayed on the screen.

Important: When programming transponder keys ensure that no other transponder keys are within 50cm of the TDM.

Important: If two transponder keys are not present at the time of reprogramming a possible vehicle non-start event can occur.

Program additional transponder keys

Important: Up to four transponder keys can be programmed for use at one time.

1. Install a diagnostic scan tool.
2. Key ON, engine OFF, select Body.
3. Select Theft Deterrent.
4. Select Programming.
5. Select V6 or V8 engine, depending on the vehicle being reprogrammed.
6. Program additional transponder keys.
7. Obtain TIS approval then repeat steps 1-6.

    Important: The Security Code is a four digit code that is located on the vehicle security card supplied with the vehicle. For more details on the vehicle security card refer to the owner handbook.

8. Enter Security Code and follow the directions displayed on the screen.

    Important: When programming transponder keys ensure that no other transponder keys are within 50cm of the TDM.

    Important: If two transponder keys are not present at the time of reprogramming a possible vehicle non-start event can occur.

Perform the Diagnostic Repair Verification after completing the proceeding procedures.

Transmission Control Module Programming and Setup (4L60-E/4L65-E/4L70-E)

The following service procedures require either a programming or a setup event be performed for a complete repair.

Transmission Control Module (TCM) Replacement

If the TCM is replaced, TCM Reprogramming must be performed. Refer to Service Programming System (SPS).

TCM Reprogramming

If the TCM is reprogrammed, TCM Reprogramming must be performed. Refer to Service Programming System (SPS).

Ensure the following conditions exist in order to prepare for TCM programming or reprogramming:

- The battery is fully charged.
- The ignition switch is in the RUN position.
- The Techline equipment cable connection at the data link connector (DLC) is secure.

Program the TCM using the latest software matching the vehicle. Refer to up-to-date Techline equipment user instructions.

If the TCM fails to program, proceed as follows:

- Ensure the TCM connection is good.
- Inspect the Techline equipment for the latest software version.
- Attempt to program the TCM. If the TCM still cannot be programmed properly, replace the TCM.

TCM Setup

This device requires no setup.

Window Regulator Motor Programming and Setup

Window Motor Programming and Setup

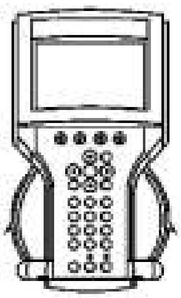
If the battery has been disconnected, recharged or replaced, it will be necessary to reprogram each power window for the express-up and express-down feature.

To program each front window, follow these steps:

1. With the ignition in ACCESSORY, RUN, or in the retained accessory power (RAP) mode.
2. Close all doors.
3. Press and hold the power window switch until the window is fully open and continue holding the switch up for approximately two seconds after the window is completely open.
4. Pull the power window switch up until the window is fully closed and continue holding the switch up for approximately 2 seconds after the window is completely closed.

The window is now reprogrammed. Repeat the process for the remaining windows.

Special Tools

Illustration	Tool Number/Description
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

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Body Control Module Scan Tool Information

Use the scan tool data display values and definitions information in order to assist in diagnosing vehicle malfunctions. Compare the vehicles actual scan tool data with the typical data display value table information. Use the information in order to aid in understanding the nature of the concern when the vehicle data does not match the typical data display values.

The scan tool data values were taken from a known good vehicle under the following conditions:

- The ignition switch is in the Run position.
- The engine is not running.
- The vehicle is in PARK.

Parameter	Operating Conditions	Expected Value	Definition
Ignition is ON, engine OFF, and vehicle is stationary			
Accessory Relay Command	Ignition is in ACC/RUN position	On	The scan tool displays On or Off. This is the state of the accessory relay.
	Ignition is in OFF position	Off	
Acc./RAP Relay Command	Acc./RAP relay switch activated	On	The scan tool displays On or Off. This is the state of the Acc./RAP relay.
	Acc./RAP relay switch deactivated	Off	
All Door Lock Command	All door lock switch activated	Active	The scan tool displays Active or Inactive. This is the state of the all door lock switch.
	All door lock switch deactivated	Inactive	
Ambient Light Sensor	--	4.6 Volts	The scan tool displays the ambient light level as detected by the sensor as a voltage.
Ambient Light Status	--	Night	The scan tool displays Night, Day, Unknown or Invalid. This is the state of the ambient light sensor.
	--	Day	
	--	Unknown	
	--	Invalid	
Anti Theft Warning System	Anti theft warning system activated	Armed	This parameter displays whether the anti theft warning system is Armed or Disarmed.
	Anti theft warning system deactivated	Disarmed	
ATWS LED (Anti-Theft Warn.)	--	On	The scan tool displays On or Off. This is the current state of the ATWS indicator.
	--	Fast Flash	
	--	Off	
	Auto headlamp disable switch	Active	

Auto Headlamp Disable Switch	activated		This parameter displays the status of the auto headlamp disable switch.
	Auto headlamp disable switch idle position	Inactive	
Battery Current	--	0 - 4 amps	The scan tool displays amperes. This numeric value is the battery amperage.
Battery Low at Start Up	Battery voltage below 11 Volts	Yes	The scan tool displays Yes if the voltage is below 11 Volts or No if the voltage is above 12 Volts.
	Battery voltage above 12 Volts	No	
Battery Open Circuit Volts	--	12 Volts	This parameter displays the Voltage of the battery open charge.
Battery Open Circuit Tested	Battery circuit open	Yes	The scan tool will display Yes, if the battery has an open circuit.
	Battery circuit closed	No	
Battery Sulfation Mode	--	Active	This parameter displays Active if the regulated voltage has been low for some time the BCM will command a higher regulated voltage to prevent sulfation.
	--	Inactive	
Battery Voltage	--	12 Volts	The scan tool displays 0-14 Volts. The scan tool displays approximately 12 Volts when the ignition is On.
Battery Voltage High Resolution	--	12 Volts	The scan tool displays 0-14 Volts. The scan tool displays approximately 12 Volts when the ignition is On.
Boost Level 2 Counter	--	0 Counts	The scan tool displays a numeric value. This is the number of level 2 idle boosts.
Boost Level 3 Counter	--	0 Counts	The scan tool displays a numeric value. This is the number of level 3 idle boosts.
BPPS High During Learn	--	Yes	The scan tool displays Yes or No. Yes is displayed if the BPPS was high during BPP calibration.
	--	No	
BPPS Learned Home Position	--	219 Counts	The scan tool displays Counts. This numeric value is the BPPS learned home position.
BPPS Low During Learn	--	Yes	The scan tool displays Yes or No. Yes is displayed if the BPPS was low during BPP calibration.
	--	No	
BPPS Move During Learn	--	Yes	The scan tool displays Yes or No. Yes is displayed if the BPPS was moved during BPP calibration.
	--	No	
BPPS Reference	--	792 Counts	The scan tool displays Counts. This numeric value is the BPPS reference.
BPPS Status (Brake Pedal)	--	Learned	The scan tool displays Invalid, Learned, Undecided and Learning. This is the state of the BPPS calibration in the BCM.
	Brake pedal		

Brake Lamps	applied	On	The scan tool will display On or Off depending on the position of the brake pedal.
	Brake pedal not applied	Off	
Brake Pedal Position (BPP) Sensor	--	174 Counts	The scan tool displays counts. The numerical value is the location of the BPP as interpreted by the BCM
Brake Status	Brakes applied	On	The scan tool displays On or Off. This is the state of the brakes.
	Brakes not applied	Off	
Central Door Lock Switch	Centre console door lock button pressed	Active	This parameter displays Active if the central door lock switch has been activated.
	Centre console door lock button in idle position	Inactive	
Central Door Unlock Switch	Centre console door unlock button pressed	Active	This parameter displays Active if the central door lock switch has been deactivated.
	Centre console door unlock button in idle position	Inactive	
Cruise Control Switch	Cruise control switched Off	Off	The scan tool displays Off, On, Resume, Set, Error or Cancel. This is the current state of the cruise control switch.
	Cruise control switched On	On	
	Resume/Accel cruise button pressed	Resume	
	Set/Decel cruise button pressed	Set	
	--	Error	
	Brake pedal applied	Cancel	
Current Anti-Theft Warning	No Anti Theft Warnings	None	The scan tool displays None, Driver Door, Passenger Door, Hood, Ignition, Intrusion, Inclination, Remote, Battery Reconnect, Power Mode or Tamper. These parameters are the possible current anti-theft warnings
	--	Driver Door	
	--	Passenger Door	
	--	Hood	
	--	Ignition	
	--	Intrusion	
	--	Inclination	
	--	Remote	
	--	Battery Reconnect	
	--	Power Mode	

	--	Tamper	
Daytime Running Lamps	Daytime running lamps activated	On	This parameter displays whether the daytime running lamps are On or Off. If fitted
	Daytime running lamps deactivated	Off	
Desired Voltage	--	12 Volts	The scan tool displays 0-14 Volts. The scan tool displays approximately 12 Volts when the ignition is On.
Dimming Control Switch	Dimming control increase switch activated	Up	This parameter displays the status of the dimming control switch.
	Dimming control decrease switch activated	Down	
	Dimming control switch idle position	Inactive	
Door Key Cylinder Lock Switch	Door key cylinder in the lock position	Active	The scan tool displays Active or Inactive. This is the state of the door key cylinder lock switch.
	Door key cylinder in the idle position	Inactive	
Door Key Cylinder Unlock Switch	Door key cylinder in the unlock position	Active	The scan tool displays Active or Inactive. This is the state of the door key cylinder unlock switch.
	Door key cylinder in the idle position	Inactive	
Door Lock Request	Centre console door lock button pressed	Power lock	The scan tool displays Power Lock, Door Key Cyl. Keyless Entry, or Auto Locks. This is the current state of the door lock request as monitored by the BCM.
	Door locked by key in door lock cylinder	Door Key Cyl.	
	Remote key door lock button pressed	Keyless Entry	
	Key removed from ignition	Auto locks	
Driver Door Unlock Command	Driver door unlock switch activated	Active	The scan tool displays Active or Inactive. This is the state of the driver door unlock switch.
	Driver door unlock switch deactivated	Inactive	
Driver Identification	Driver key 1/2/3 in ignition	Driver 1	This parameter identifies the current key in the ignition.
		Driver 2	
		Driver 3	
Drivers Door Ajar Switch	With door open	Door Ajar	The scan tool displays the current status of the drivers door ajar switch
	With door closed	Door Closed	

Engine Hood Open Switch	Engine hood open	Active	This parameter displays the status of the engine hood open switch.
	Engine hood closed	Inactive	
Estimated Battery Temperture	--	12 °C	This parameter displays the current temperature of the battery.
Flash to Pass Switch	Flash to pass switch activated	Active	The scan tool displays Active or Inactive. This is the state of the flash to pass switch.
	Flash to pass switch in idle position	Inactive	
Fog Lamp Front	Front fog lamps activated	On	This parameter displays On, when you activate the front fog lamp switch.
	Front fog lamps deactivated	Off	
Front Fog Lamp Switch	Front fog lamp switch activated	Active	This parameter displays if the front fog lamp switch is Active or Inactive. This determines whether the switch is receiving voltage.
	Front fog lamp switch deactivated	Inactive	
Fuel Economy Mode	--	Active	If the battery is over 80% charged the BCM may reduce regulated voltage to as low as 12.8 volts.
	--	Inactive	
Headlamp Switch	Headlamp switch activated	On	The scan tool displays On or Off. This is the state of the headlamp switch.
	Headlamp switch deactivated	Off	
Headlamp Washer Relay Command	Headlamp washer relay activated	On	This parameter displays On or Off. This is the state of the headlamp washer relay.
	Headlamp washer relay activated	Off	
High Beam	High beam activated	On	The scan tool displays if the high beam lamps are On or Off.
	High beam deactivated	Off	
High Beam Switch	High beam switch activated	Active	This parameter displays if the high beam switch is active or inactive.
	High beam switch deactivated	Inactive	
Hood Close Switch	Hood closed	Active	This parameter displays the status of the hood close switch.
	Hood open	Inactive	
HS Communication Command	HS communication activated	Active	The scan tool displays On or Off. This is the state of the high speed communications command of the BCM.
	HS communication deactivated	Inactive	
Ignition Accessory/Run	Ignition is in ACC/RUN position	Active	The scan tool displays Active or Inactive. This is the state of the ignition
	Ignition is in OFF		

	position	Inactive	Accessory/Run.
Ignition Off/Run/Crank	Ignition is in OFF position	Key In	This parameter displays the current status of the ignition Off/Run/Crank.
	Ignition is in ACC position	Key Off	
	Ignition is in RUN position	Run	
	Ignition is in CRANK position	Crank	
Ignition Run/Crank	Ignition is in RUN/CRANK position	Active	The scan tool displays Active or Inactive. This is the state of the ignition Run/Crank.
	Ignition is in OFF/ACC position	Inactive	
Incand Dimming PWM Command	0 - 100	%	This scan tool displays a percentage. This is the current incandescent dimming percentage.
Interior Lamp Door Switch	Interior lamp door switch activated	Active	This parameter displays the status of the interior lamp door switch.
	Interior lamp door switch deactivated	Inactive	
Interior Lamp Activation Reason	--	Off	This parameter displays the interior lamp activation reason.
	--	Door Open	
	--	Manual Defeat	
Interior Lamp On/Off Switch	Interior lamp On/Off switch activated	On	This parameter displays if the interior lamp is turned On or Off.
	Interior lamp On/Off switch deactivated	Off	
Interior Lamp PWM Command	0 -100	%	This parameter displays the interior lamp dimming percentage.
Key In Status	Key in ignition	Key In	This parameter displays if the ignition key is in or out of the ignition barrel
	Key not in ignition	Key Out	
LED Dimming PWM Command	0 - 100	%	The scan tool displays a percentage. This is the current LED dimming percentage.
Left Front Turn Signal	Left front turn signal activated	On	This parameter displays whether the left front turn signal is Active or Inactive.
	Left front turn signal deactivated	Off	
Left Rear Turn Signal	Left rear turn signal activated	On	This parameter displays whether the left rear turn signal is Active or Inactive.
	Left rear turn signal deactivated	Off	
	Left turn signal switch activated	Active	

Left Turn Signal Switch	Left turn signal switch in the idle position	Inactive	This parameter displays Active or Inactive. This is the status of the left turn signal switch.
Load Shed Level 2 Counter	--	0 Counts	
Load Shed Level 3 Counter	--	0 Counts	
Low Beam	Low beams activated	On	This parameter displays the status of the low beam headlamps.
	Low beams deactivated	Off	
Off/Run/Crank Reference	--	5.4 Volts	The scan tool displays volts. This is the current Off/Run/Crank reference voltage.
Off/Run/Crank Signal	--	4.4 Volts	The scan tool displays volts. This is the current Off/Run/Crank signal voltage.
Parasitic Current	--	0 Amps	The scan tool displays amperes. This is the state of the parasitic draw on the battery.
Park Brake Switch	Park brake engaged	Active	This parameter displays the current position of the park brake switch.
	Park brake disengaged	Inactive	
Park Lamp Switch	Park lamp switch activated	On	This parameter displays the status of the park lamp switch.
	Park lamp switch deactivated	Off	
Park Lamps	Park lamps activated	On	This parameter displays On when the park lamps are in the on position.
	Park lamps deactivated	Off	
Passenger Door Ajar Switch	With door open	Door Ajar	The scan tool displays the current status of the passenger door ajar switch.
	With door closed	Door Closed	
Passenger Door Unlock Command	Passenger door unlock switch activated	Active	The scan tool displays Active or Inactive. This is the state of the passenger doors unlock system.
	Passenger door unlock switch deactivated	Inactive	
Powertrain HS Communication	Powertrain HS communication activated	Active	The scan tool displays Active or Inactive. This is the state of the powertrain high speed communications command.
	Powertrain HS communication deactivated	Inactive	
Previous State of Charge	0 - 100	%	The scan tool displays a percentage. This was the previous state of charge of the battery at start up.

Puddle Lamps	Puddle lamps activated	On	This parameter displays On when the puddle lamps are active.
	Puddle lamps deactivated	Off	
Rain Sensor Mode	--	Off Parked	
Rain Sensor Signal	--	Volts	
Rain Sensor Wiper Request	--	Valid	
	--	Invalid	
Rear Fog Light Status	Rear fog lights activated	On	The scan tool displays On or Off. This is the state of the rear fog light.
	Rear fog lights deactivated	Off	
Rear Fog Light Switch	Rear fog light switch activated	Active	This parameter displays the status of the rear fog light switch.
	Rear fog light switch deactivated	Inactive	
Rear Lamp Flasher Switch	Rear lamp flasher switch activated	Active	This parameter displays the status of the rear lamp flasher switch.
	Rear lamp flasher switch deactivated	Inactive	
Regulator Setpoint	0 - 100	%	The scan tool displays a percentage. This is the set point of the voltage regulator.
Reverse Lamps	Reverse gear selected	On	This parameter displays whether the reverse lamps are On or Off.
	Reverse gear not selected	Off	
Right Front Turn Signal	Right front turn signal activated	On	This parameter displays the status of the right front turn signal.
	Right front turn signal deactivated	Off	
Right Rear Turn Signal	Right rear turn signal activated	On	This parameter displays the status of the right rear turn signal.
	Right rear turn signal deactivated	Off	
Right Turn Signal Switch	Right turn signal switch activated	Active	This parameter displays the status of the right turn signal switch.
	Right turn signal switch in idle position	Inactive	
Run/Crank Relay Command	Ignition is in RUN/CRANK position	On	The scan tool displays On or Off. This is the state of the Run/Crank relay.
	Ignition is in OFF/ACC position	Off	
	Shift lock solenoid		

Shift Lock Solenoid Command	activated	Lock	The scan tool displays Lock or Unlock. This is the state of the shift lock solenoid.
	Shift lock solenoid deactivated	Unlock	
Shift Mode Switch	Shift mode switch is activated	Active	This parameter displays the status of the shift mode switch.
	Shift mode switch is deactivated	Inactive	
Shifter Unlock Command	Shifter unlock command activated	On	The scan tool displays On or Off. This is the state of the shifter unlock command
	Shifter unlock command deactivated	Off	
Start Up State of Charge	0 - 100	%	The scan tool displays a percentage. This was the last state of charge of the battery at start up.
State of Charge	0 - 100	%	The scan tool displays a percentage. This is the current state of charge of the battery.
Surveillance Mode Switch	Surveillance mode switch activated	Active	This parameter displays the status of the surveillance mode switch.
	Surveillance mode switch deactivated	Inactive	
System Power Mode	Ignition is in OFF position	Off	This parameter displays Accessory/Run/Crank. This is the status of the system power mode dependent on the ignition position.
	Ignition is in ACC position	Accessory	
	Ignition is in RUN position	Run	
	Ignition is in CRANK position	Crank	
TC/ESP Switch (Traction Control)	Traction control turned ON	Active	This parameter displays the status of the TC/ESP switch (traction control).
	Traction control turned OFF	Inactive	
Theft Horn Relay Command	Security system activated	On	The scan tool displays On or Off. This is the state of the theft horn relay.
	Security system deactivated	Off	
Trunk Release Command	Trunk release button is pressed	Active	The scan tool displays Active or Inactive. This is the state of the trunk release relay.
	Trunk release button not pressed	Inactive	
Trunk Switch	Trunk switch activated	Active	This parameter displays the status of the trunk switch.
	Trunk switch	Inactive	

	deactivated		
Up and Down Shift Switch	Active select shift up	Up	This parameter displays the status of the up and down shift switch.
	Active select shift down	Down	
	Active select idle position	Inactive	
Washer Relay Command	Washer relay command activated	On	The scan tool displays On or Off. This is the state of the washer relay.
	Washer relay command idle position	Off	
Windscreen Washer Switch	Windscreen washer switch activated	Active	This parameter displays the status of the windscreen washer switch.
	Windscreen washer switch in idle position	Inactive	
Windscreen Wiper Switch	User dependent	Off	The scan tool displays Off, Single wipe, Low, High or Switch Fault. This is the state of the windscreen wiper switch.
		Single wipe	
		Low	
		High	
Wiper Delay Setting	User dependent	1 - 5	The scan tool displays a numeric value. This is the wiper delay setting.
Wiper High Speed Relay	Wiper high speed relay activated	On	The scan tool displays On or Off. This is the state of the wiper high speed relay.
	Wiper high speed relay deactivated	Off	
Wiper High Speed Switch	Wiper high speed switch activated	Active	This parameter displays the status of the wiper high speed switch.
	Wiper high speed switch deactivated	Inactive	
Wiper Park Switch	Wiper park switch activated	On	This parameter displays the status of the wiper park switch.
	Wiper park switch in idle position	Off	
Wiper Relay Command	Wiper relay activated	On	This parameter displays whether the wiper relay is receiving power. The wiper function is controlled via the BCM.
	Wiper relay deactivated	Off	

Body Control Module Scan Tool Output Controls

Scan Tool	Additional Menu Selection	

Output Control	(s)	Description
Backup Lamps	Exterior Lighting	The BCM activates the backup lamp relay when you select ON. The backup lamps illuminate for 5 seconds or until commanded OFF.
Fog Lamps	Exterior Lighting	The BCM activates the fog lamps relay when you select ON. The fog lamps illuminate for 5 seconds or until commanded OFF.
High Beams	Exterior Lighting	The BCM activates the high beam relay when you select ON. The high beam headlamps illuminate for 5 seconds or until commanded OFF.
LF Turn Signal	Exterior Lighting	The BCM activates the left front turn signal lamps when you select ON. The turn signal lamps illuminate for 5 seconds or until commanded OFF.
Low Beams	Exterior Lighting	The BCM activates the low beam relay when you select ON. The low beam headlamps illuminate for 5 seconds or until commanded OFF.
LR Turn Signal	Exterior Lighting	The BCM activates the left rear turn signal lamps when you select ON. The lamp illuminates for 5 seconds or until commanded OFF.
Parking Lamps	Exterior Lighting	The BCM activates the park lamp relay when you select ON. The park lamps illuminate for 5 seconds or until commanded OFF.
RF Turn Signal	Exterior Lighting	The BCM activates the right front turn signal lamps when you select ON. The turn signal lamps illuminate for 5 seconds or until commanded OFF.
RR Turn Signal	Exterior Lighting	The BCM activates the right rear turn signal lamps when you select ON. The lamp illuminates for 5 seconds or until commanded OFF.
Courtesy Lamp	Interior Lighting	The BCM activates the interior lamps outputs for 5 seconds when you select ON. The dome, footwell, and courtesy lamps illuminate for 5 seconds or until commanded OFF.
Incandescent Dimming	Interior Lighting	The BCM activates the interior incandescent type component lamps from full dim to full bright for 5 seconds or until commanded OFF.
LED Dimming	Interior Lighting	The BCM activates the interior LED type component lamps from full dim to full bright for 5 seconds or until commanded OFF.
Wiper	Miscellaneous Test	The Wiper/Washer switch has to be in the off position for this output control to function. The BCM actuates the Wiper relay when you select ON. The front wipers should operate in intermittent mode.
Horn	Miscellaneous Test	The BCM Energizes the horn relay for 5 seconds when you select On or until you select Off.

The Transmission Scan Tool Data Definitions contain a brief description of manual transmission related parameters available on the scan tool. The list is in alphabetical order. A given parameter may appear in any one of the data lists. In some cases, the parameter appears more than once or in more than one data list in order to group certain related parameters together.

CPP Switch: This parameter displays the state of the clutch pedal switch circuit input. The scan tool will display APPLIED when the clutch pedal is depressed, and RELEASED when the clutch pedal is released.

Vehicle Speed Sensor: This parameter displays the speed at which the vehicle is traveling. The scan tool displays vehicle speed as kilometers per hour (km/h), miles per hour (mph). The vehicle speed is calculated based on the input signal from the vehicle speed sensor.

Wheel Speed Sensor: This parameter displays the speed at which the vehicle is travelling. The scan tool displays vehicle speed as kilometres per hour (km/h), miles per hour (m.p.h.). The vehicle speed is calculated based on the input signal from the wheel speed sensor.

The Transmission Scan Tool Data List contains manual transmission related parameters that are available on the scan tool. The list is arranged in alphabetical order. A given parameter may appear in any one of the data lists, and in some cases may appear more than once, or in more than one data list in order to group certain related parameters together.

Use the Transmission Scan Tool Data List only after the following is determined:

- The Diagnostic System Check - Vehicle in Vehicle DTC Information, is completed.
- There are no diagnostic trouble codes (DTCs) shown.
- The on-board diagnostics are functioning properly.

Scan tool values from a properly functioning vehicle may be used for comparison with the vehicle you are diagnosing.

Important: A scan tool that displays faulty data should not be used. The scan tool concern should be reported to the manufacturer. Use of a faulty scan tool can result in misdiagnosis and unnecessary parts replacement.

Only the parameters listed below are referenced in this service manual for use in diagnosis. If all values are within the typical range described below, refer to Symptoms - Manual Transmission in Manual Transmission - Aisin AY6.

The column labelled Data List indicates where a parameter can be located on the scan tool. Refer to the scan tool operating manual for the exact locations of the data lists. The following is a description of each term listed:

Engine Data 1: (1)

Engine Data 2: (2)

EVAP Data: (3)

Fuel Trim Data: (4)

HO2S Data: (5)

Misfire Data: (6)

TAC Data: (7)

CMP Actuator Data: (8)

Cooling / HVAC Data: (9)

Cruise / Traction Data: (10)

Electrical / Theft Data: (11)

IPC Data: (12)

ODM Data: (13)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Engine Idling / Radiator Hose Hot / Closed Throttle / Park or Neutral / Closed Loop / Accessories Off / Brake Pedal Released			
CPP Switch (If Equipped)	1	APPLIED/RELEASED	RELEASED
Wheel Speed Sensor	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12	km/h (mph)	0

Use the scan tool data values under the following conditions:

- The Diagnostic System Check - Vehicle in Vehicle DTC Information is complete.
- The on-board diagnostics are functioning properly.
- No diagnostic trouble codes (DTCs) are present.

The values below represent a typical display recorded from a properly functioning system.

Important: Do not use a scan tool that displays faulty data. Report the condition to the scan tool manufacturer. The use of a faulty scan tool can result in misdiagnosis and the unnecessary replacement of parts.

Only the parameters listed below are used in this manual for diagnosing. If a scan tool displays other parameters, the values are not recommended by General Motors for use in diagnosis.

Scan tool values below were recorded under the following conditions:

- Engine at idle
- Upper radiator hose hot
- Closed throttle
- Transmission in Neutral
- Closed Loop operation
- Accessories OFF
- Brake pedal not applied

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Clutch Pedal Switch	F0, F3	applied/released	released
Reverse Inhibit Solenoid Command	F0	INHIBIT/OFF	OFF

Wheel Speed Sensor	ALL	km/h (mph)	0
*Data List Legend • F0: Engine Data 1 • F1: Engine Data 2 • F2: Engine Data 3 • F3: Cruise Control Data • F4: Enhanced EVAP Data • F5: Fuel Trim Data • F6: Misfire Data • F7: TAC Data • F8: H02S Data			

Clutch Pedal Switch: This parameter displays the state of the clutch pedal switch circuit input. The scan tool will display APPLIED when the clutch pedal is depressed, and RELEASED when the clutch pedal is released.

Reverse Inhibit Solenoid Command: This parameter displays the commanded state of the reverse inhibit solenoid. When the vehicle speed is greater than 5 km/h (3 mph), the solenoid is commanded ON, inhibiting shifts to Reverse. When the vehicle speed is less than 5 km/h (3 mph), the solenoid is commanded OFF, allowing shifts to Reverse. The scan tool will display ON/OFF.

Reverse Inhibit Solenoid Command: This parameter displays the commanded state of the reverse inhibit solenoid. When the vehicle speed is greater than 5 km/h (3 mph), the solenoid is commanded ON, inhibiting shifts to Reverse. When the vehicle speed is less than 5 km/h (3 mph), the solenoid is commanded OFF, allowing shifts to Reverse. The scan tool will display ON/OFF.

Vehicle Speed: This parameter displays the speed at which the vehicle is traveling. The scan tool displays vehicle speed as kilometers per hour (km/h), miles per hour (MPH). The vehicle speed is calculated based on the input signal from the vehicle speed sensor.

Scan Tool Output Control	Additional Menu Selection(s)	Description
Reverse Inhibit	Special Functions - Engine Output Controls	Command grounds the reverse lockout solenoid control circuit. Turns the reverse inhibit solenoid ON and OFF.

Diagnostic System Check - Vehicle

Diagnostic Instructions

- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Continue through the Diagnostic System Check until you are directed to follow a particular diagnostic or repair procedure. Once a repair has been completed, perform the Diagnostic Repair Verification and verify the customer concern has been corrected.

The diagnostic procedures within this manual are developed on the assumption that the following areas function as designed:

- The 12V battery is fully charged and cables are clean and tight. Refer to Battery Inspection/Test.
- Fuses are not open. Refer to Power Distribution Schematics and Electrical Center Identification Views.
- Ground circuits for the area of customer concern are clean, tight, and in the correct location. Refer to Ground Distribution Schematics and Harness Routing Views.
- All connections/connectors for the area of concern are fully seated. Refer to Component Connector End Views.
- There are no aftermarket devices that affect the operation of the system. Refer to Checking Aftermarket Accessories.
- The scan tool powers up. Refer to Scan Tool Does Not Power Up.

Diagnostic System Check

1. *VERIFY CUSTOMER CONCERN* -- Understand and validate the customer concern. Inspect the visible system components for obvious damage or conditions that may cause the concern.
2. *BULLETIN SEARCH* -- Check for related bulletins, recall/field actions and preliminary information.
3. *MECHANICAL CONCERNS* -- Verify the symptom is not exclusively a mechanical concern.

   If the symptom is exclusively a mechanical concern, refer to Symptoms - Vehicle.

   Note: Do not clear any DTCs unless instructed to do so by a diagnostic procedure. If any DTC is Powertrain related, select Capture Info to store DTC and Freeze Frame/Failure Records to the Scan Tool.

4. *CONTROL MODULE COMMUNICATION and DTC CHECK* -- Using a scan tool, perform the Vehicle DTC Information function and verify at least one control module communicates with the scan tool. Record on the Repair Order the following information:
   - Any control module that is not communicating.
   - Any DTC, including symptom byte, and the control module that has set the DTC.

   If the scan tool does not communicate with any control module on the vehicle, refer to Power Mode Mismatch.
5. *CONTROL MODULE INTERNAL PERFORMANCE FAULTS* -- Verify there are no current control module Internal Hardware Performance DTCs set.

If any DTC of this type is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.

6. *CONTROL MODULE COMMUNICATION VERIFICATION* -- Verify the vehicle is built with any control module listed as not communicating, refer to Data Link References. All control modules should be communicating, as equipped.

   If the scan tool does not communicate with one or more control modules refer to Data Link References.

7. *COMMUNICATION and POWERMODE FAULTS* -- Verify there are no current control module Power Mode or Communication DTCs set..

   If any DTC of this type is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.

   Note: The engine may start during this test. Ensure the vehicle is out of gear and the parking brake is applied. Turn the engine OFF as soon as the crank power mode parameter has been observed.

8. *POWER MODE VERIFICATION* -- Driver door open, observe the scan tool Power Mode parameter while cycling the ignition switch through all the power modes. Verify the current Power Mode parameter matches the actual ignition switch positions.

   If the Power Mode parameter does not match the actual ignition switch positions, refer to Power Mode Mismatch.

9. *ENGINE CRANK and RUN VERIFICATION* -- Verify that the engine cranks and runs.

   If the engine does not crank, refer to Symptoms - Engine Electrical.

   If the engine does not run, refer to Engine Cranks But Does Not Runfor the 2.8L, 3.0L, 3.2L, or 3.6L engine or Engine Cranks But Does Not Runfor the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine.

10. *REMAINING DTC REVIEW* -- Verify there are no other DTCs set.

    If other DTCs are set, diagnose them in the order listed below. Refer to Diagnostic Trouble Code (DTC) List - Vehicle.

    10.1. Voltage DTCs

    10.2. Programming, Setup, Configuration or Software Performance DTCs

    10.3. Component related DTCs

    10.4. System related DTCs

    10.5. Any remaining DTCs

11. *SYMPTOM DIAGNOSIS* -- Diagnose any remaining customer concern. Refer to Symptoms - Vehicle.

Driver Seat Adjuster and Mirror Memory Module Scan Tool Information

Table 1: Memory Seat Module Scan Tool Data Display
Table 2: Memory Seat Module Scan Tool Actuator Test

Memory Seat Module Scan Tool Data Display

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON			
Able to Move	--	Yes	The scan tool displays Yes or No. When the seat is requested to move, the seat memory module monitors the amount of Steps that a position sensor has taken during that movement. This inability to move at all or quickly enough may be due to a physical restriction in that movement, or the battery not having enough charge to power the particular motor adequately.
Able To Recall	--	Yes	The scan tool displays Yes or NO. This is if the seat assembly has the ability to recall a memory position.
Button 1 Input Status	--	Active	The scan tool displays Active or Inactive. This is the state of button 1 on the memory position switch.
Button 1 Output Status	--	Active	The scan tool displays Active or Inactive. This is the state of the button 1 signal from the SIM to the MSM indicating the memory request.
Button 2 Input Status	--	Active	The scan tool displays Active or Inactive. This is the state of button 2 on the memory position switch.
Button 2 Output Status	--	Active	The scan tool displays Active or Inactive. This is the state of button 2 on the memory position switch.
Button 3 Input Status	--	Active	The scan tool displays Active or Inactive. This is the state of button 3 on the memory position switch.
Button 3 Output Status	--	Active	The scan tool displays Active or Inactive. This is the state of button 3 on the memory position switch.
Button M Input Status	--	Active	The scan tool displays Active or Inactive. This is the state of button M on the memory position switch.
Button M Output Status	--	Active	The scan tool displays Active or Inactive. This is the state of button M on the memory position switch.

Button Pack Communication	--	Okay	The scan tool displays Okay or Not Okay. This is whether there is serial data communication with the mirror control switch, right hand or left hand rear-view mirrors. If there is communication with at least one of these components, the scan tool will display Okay. If there is no communications with all of the components, the scan tool will display Not Okay.
Current Priority	--	Priority 1	The scan tool displays Priority 1, Priority 2, No Memory, or Invalid. This is the current priority that is set when the vehicle is unlocked with either priority key 1 or 2.
Demist Request	--	Yes	The scan tool displays Yes or No. This is the status of the rear demist system.
Driver Identification	--	Driver 1	The scan tool displays Driver 1, Driver 2, or Driver 3. This is the current User selection based from the ignition key.
Front Vertical Position Maximum Limit	--	Steps	The scan tool displays 0 - 65635 Steps. This is the maximum limit of seat front vertical upward travel displayed in Steps. This value should be high but never reach 65535 Steps. If the value displayed is 65535, the seat has not been calibrated.
Front Vertical Position Minimum Limit	--	Steps	The scan tool displays 0 - 65635 Steps. This is the minimum limit of the seat front vertical downward travel displayed in Steps. This value should be low but never reach 0 Steps. If the value displayed is 0, the seat has not been calibrated.
Front Vertical Position Sensor	--	Connected	The scan tool displays Connected or Not Connected. This parameter confirms if the front vertical motor position sensor is connected.
Front Vertical Position Sensor	--	Steps	The scan tool displays 0 - 65635 Steps. This value represents the current position of the front vertical motor. High scan tool step values indicate an up position while low step values indicate a down position.
Front Vertical Switch	--	Inactive	The scan tool displays Inactive, Up, Down, or Invalid. This is the state of the front vertical switch.
Horizontal Position Maximum Limit	--	Steps	The scan tool displays 0 - 65635 Steps. This is the maximum limit of seat horizontal forward travel displayed in Steps. This value should be high but never reach 65535 Steps. If the value displayed is 65535, the seat has not been calibrated.
Horizontal Position	--	0 Steps	The scan tool displays 0 - 65635 Steps. This is the minimum limit of seat horizontal rearward travel displayed in Steps. This

Minimum Limit			value should be low but never reach 0 Steps. If the value displayed is 0, the seat has not been calibrated
Horizontal Position Sensor	--	Connected	The scan tool displays Connected or Not Connected. This parameter confirms if the seat horizontal motor position sensor is connected.
Horizontal Position Sensor	--	Steps	The scan tool displays 0 - 65635 Steps. This value represents the current position of the seat horizontal motor. High scan tool step values indicate a forward position while low step values indicate a rearward position.
Horizontal Switch	--	Inactive	The scan tool displays Inactive, Forward, Backward, or Invalid. This is the state of the horizontal switch.
Ignition Accessory Signal	--	On/Off	This parameter indicates the status of the ignition switch.
Ignition On Signal	--	On/Off	This parameter indicates the status of the ignition switch.
Ignition Switch	--	On/Off/Accessory	This parameter indicates the status of the ignition switch.
Left Exterior Mirror Communication	--	Okay	The scan tool display Okay or Not Okay. This parameter confirms if the scan tool can communicate with the left hand exterior rear-view mirror.
Left Exterior Mirror Switch	--	Inactive	The scan tool displays Up, Down, Left, Right, or Inactive. When the mirror switch is pressed, this parameter displays the selected mirror direction.
Lumbar Switch	--	Inactive	The scan tool displays Inactive, Forward, Backward, or Invalid. This is the state of the lumbar switch.
Memory 1 Button	--	Not Pressed	The scan tool displays Pressed or Not Pressed. This parameter displays the state of button 1 on the memory seat switch.
Memory 2 Button	--	Not Pressed	The scan tool displays Pressed or Not Pressed. This parameter displays the state of button 2 on the memory seat switch.
Memory 3 Button	--	Not Pressed	The scan tool displays Pressed or Not Pressed. This is the state of button 3 on the memory seat switch.
Memory Recall Position in Use	--	No Active Memory	The scan tool displays Memory 1, Memory 2, Memory 3. Priority 1, Priority 2 or No Active Memory. This parameter displays the status of the current memory recall of the seat assembly.
Mirror DIP Button	--	Not Pressed	The scan tool displays Pressed or Not Pressed. This is the state of the mirror dip / memory store (M) button on the memory position switch.

MSM Power Output	--	Active	The scan tool displays Active or Inactive. This is the Power Output state of the Memory Seat Module.
MSM UART Bus Status	--	On	The scan tool displays On or Off. This is the Status of the Memory Seat Module UART Bus.
MSM Wake-Up Output	--	Active	The scan tool displays Active or Inactive. This is the Wake-Up Output state of the Memory Seat Module.
Rear Vertical Position Maximum Limit	--	Steps	The scan tool displays 0 - 65635 Steps. This is the maximum limit of seat rear vertical upward travel displayed in Steps. This value should be high but never reach 65535 Steps. If the value displayed is 65535, the seat has not been calibrated.
Rear Vertical Position Minimum Limit	--	Steps	The scan tool displays 0 - 65635 Steps. This is the minimum limit of the seat rear vertical downward travel displayed in Steps. This value should be low but never reach 0 Steps. If the value displayed is 0, the seat has not been calibrated.
Rear Vertical Position Sensor	--	Connected	The scan tool displays Connected or Not Connected. This parameter confirms if the rear vertical motor position sensor is connected.
Rear Vertical Position Sensor	--	Steps	The scan tool displays 0 - 65635 Steps. This value represents the current position of the rear vertical motor. High scan tool step values indicate an up position while low step values indicate a down position.
Rear Vertical Switch	--	Inactive	The scan tool displays Inactive, Up, Down, or Invalid. This is the state of the rear vertical switch.
Recline Position Sensor	--	Connected	The scan tool displays Connected or Not Connected. This parameter confirms if the seat back recline motor position sensor is connected.
Recline Position Sensor	--	Steps	The scan tool displays 0 - 65635 Steps. This value represents the current position of the seat back recline motor. High scan tool step values indicate a forward position while low step values indicate a rearward position.
Recline Switch	--	Inactive	The scan tool displays Inactive, Forward, Backward, or Invalid. This is the state of the seat back recline switch.
Reverse Gear	--	Inactive	The scan tool displays Active or Inactive. This parameter displays if the vehicle is in reverse gear.
Right Exterior Mirror	--	Okay	The scan tool display Okay or Not Okay. This parameter confirms if the scan tool can communicate with the right hand exterior

Communication			rear-view mirror.
Right Exterior Mirror Switch	--	Inactive	The scan tool displays Up, Down, Left, Right, or Inactive. When the mirror switch is pressed, this parameter displays the selected mirror direction.
Shift Lever Position	User Dependant	P	The scan tool displays P, R, N, D, 3, 2, or 1. This parameter displays the position of the transmission selector.
Start Wait Active	--	No	The scan tool displays Yes or No. Only when there has been a cold-start reset will the scan tool display No. A cold-start reset will occur when module detects too much electromagnetic interference (EMI) in the system. If the Start Wait Active displays No, the system will still be operational.
System Power Mode	--	Run	The scan tool displays Off, Accessory, Run, Crank, Invalid. This is the Power Mode required for the System to run.
Vehicle Speed	--	km/h	This parameter indicates the vehicle speed calculated by the control module based on an input from the vehicle speed sensor (VSS). The scan tool will display a high value at higher vehicle speeds, and a low value at lower vehicle speeds.

Memory Seat Module Scan Tool Actuator Test

Output Control	Description
Chime	This output control is used to command the chime ON and OFF.
Button 1 Output	This output control is used to command the driver seat to move to the driver 1 memory position.
Button 2 Output	This output control is used to command the driver seat to move to the driver 2 memory position.
Button 3 Output	This output control is used to command the driver seat to move to the driver 3 memory position.
Front Vertical Motor	This output control is used to command the driver seat front vertical motor Up and Down.
Horizontal Motor	This output control is used to command the driver seat forward and rearward.
Lumbar Motor	This output control is used to command the driver seat lumbar support motor forward and rearward.
Rear Vertical Motor	This output control is used to command the driver seat rear vertical motor Up and Down.
Recline Motor	This output control is used to command the driver seat back recline motor forward and rearward.

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Electronic Suspension Control Module Scan Tool Information

Table 1: Electronic Suspension Control Scan Tool Data Parameters
Table 2: Electronic Suspension Control Scan Tool Output Controls

Electronic Suspension Control Scan Tool Data Parameters

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON, Suspension control select switch ON			
Battery Voltage	--	Varies	This displays volts. This is the voltage input supplied to the module.
Ignition Voltage Status	--	Active	This displays Active. This indicates that ignition voltage is supplied to the module.
Suspension Control Select Switch Status	--	ON	This displays ON. This indicates the state of the switch.
Suspension Control Selection Indicator Status	--	ON	This displays ON. This indicates the state of the indicator.
Service Suspension Control Indicator	--	OFF	This displays OFF. This indicates the state of the Service Suspension Control indicator.
Vehicle Speed	--	0 km/h (0 mph)	This displays km/h (mph). This is the current vehicle speed.
Right Front Position Sensor	--	Volts	This displays Volts. This is the current right front position sensor voltage.
Right Front Damper Actuator Command	--	Varies	This displays %. This is the current right front damper actuator command percentage.
Left Front Position Sensor	--	Volts	This displays Volts. This is the current left front position sensor voltage.
Left Front Damper Actuator Command	--	Varies	This displays %. This is the current left front damper actuator command percentage.
Right Rear Position Sensor	--	Volts	This displays Volts. This is the current right rear position sensor voltage.
Right Rear Damper Actuator Command	--	Varies	This displays %. This is the current right rear damper actuator command percentage.
Left Rear Position Sensor	--	Volts	This displays Volts. This is the current left rear position sensor voltage.
Left Rear Damper Actuator Command	--	Varies	This displays %. This is the current left rear damper actuator command percentage.
Lift/Dive Status	--	Neutral	This displays Neutral. This indicates the state of the vehicle position.
			This displays Unchanged. This indicates if

Lift/Dive Change	--	Unchanged	the vehicle position has changed since the last sensor update.
Test Normal Force Left Rear	--	ON	This displays ON. This the state of the left rear damper actuator.
Test Normal Force Right Rear	--	ON	This displays ON. This the state of the right rear damper actuator.
Test Normal Force Left Front	--	ON	This displays ON. This the state of the left front damper actuator.
Test Normal Force Right Front	--	ON	This displays ON. This the state of the right front damper actuator.
Normal Force Left Front	--	20%	This displays 0-100%. This indicates the applied duty cycle of the left front damper actuator.
Normal Force Right Front	--	Varies	This displays 0-100%. This indicates the applied duty cycle of the right front damper actuator.
Normal Force Left Rear	--	Varies	This displays 0-100%. This indicates the applied duty cycle of the left rear damper actuator.
Normal Force Right Rear	--	Varies	This displays 0-100%. This indicates the applied duty cycle of the right rear damper actuator.

Electronic Suspension Control Scan Tool Output Controls

Output Control	Description
Static Test Damper Front	When commanded ON, both front shock damper actuators activate until commanded OFF.
Static Test Damper Rear	When commanded ON, both rear shock damper actuators activate until commanded OFF.
Cycle Test Damper Front	When commanded ON, both front shock damper actuators cycle between ON and OFF until commanded OFF.
Cycle Test Damper Rear	When commanded ON, both rear shock damper actuators cycle between ON and OFF until commanded OFF.

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Engine Control Module Scan Tool Information (3.6L Engine)

Table 1: ECM Control Module Scan Tool Output Controls

The Engine Scan Tool Data List contains all engine related parameters that are available on the scan tool. The list is arranged in alphabetical order. A parameter may appear in any one of the data lists and in some cases may appear more than once or in more than one data list in order to group certain related parameters together.

Use the Engine Scan Tool Data List only after the following conditions are determined:

- The Diagnostic System Check - Vehicle is completed.
- There are no diagnostic trouble codes (DTCs).
- The on-board diagnostics are functioning correctly.

Scan tool values from an engine that is operating correctly may be used for comparison with the engine you are diagnosing. The Engine Scan Tool Data List represents the values that would be seen on a normal operating engine.

Important: Do not use a scan tool that displays faulty data. The scan tool concern should be reported to the manufacturer. Use of a faulty scan tool may result in mis-diagnosis and unnecessary parts replacement.

Only the parameters listed below are referenced in this service information for use in diagnosis. If all values are within the typical range described below, refer to Symptoms - Engine Controls , for diagnosis.

ECM Control Module Scan Tool Data Parameters

Parameter	Operating Conditions	Expected Value	Definition
Ignition is ON, engine OFF, and vehicle is stationary			
5V Reference Voltage Circuit 1 Status	--	Valid	This parameter displays the voltage sensed on the 5-volt reference 1 circuit at the engine control module.
	--	Invalid	
5V Reference Voltage Circuit 2 Status	--	Valid	This parameter displays the voltage sensed on the 5-volt reference 2 circuit at the engine control module.
	--	Invalid	
5V Reference Voltage Circuit 3 Status	--	Valid	This parameter displays the voltage sensed on the 5-volt reference 3 circuit at the engine control module.
	--	Invalid	
	--	Inactive	This parameter displays whether

A/C Cutoff Mode (Air Conditioning)	--	Pressure	the engine control module (ECM) is commanding the Air Conditioning (A/C) compressor clutch relay Off for max acceleration or pressure issues.
	--	Max. Acceleration	
	--	Active	
A/C Disengagement 1st History	--	Present	This parameter displays the last 8 A/C compressor disengagements in order from 1 to 8 with 8 being the most recent. There are about 8 possible causes for the A/C compressor to disengage.
	--	Not Present	
A/C Disengagement 2nd History	--	Present	
	--	Not Present	
A/C Disengagement 3rd History	--	Present	
	--	Not Present	
A/C Disengagement 4th History	--	Present	
	--	Not Present	
A/C Disengagement 5th History	--	Present	
	--	Not Present	
A/C Disengagement 6th History	--	Present	
	--	Not Present	
A/C Disengagement 7th History	--	Present	
	--	Not Present	
A/C Disengagement 8th History	--	Present	
	--	Not Present	
A/C Pressure Sensor	--	0 - 3,450 kPa	This parameter displays the pressure from the A/C high side pressure sensor signal circuit to the ECM.
A/C Pressure Sensor	--	0 - 5 Volts	The scan tool displays 0-5 Volts. The displayed voltage varies depending on the conditions prior to A/C shutdown.
A/C Request (Air Conditioning)	A/C button pressed	On	This parameter displays the state of the A/C request input to the ECM from the heating, ventilation and air conditioning (HVAC) controls.
	A/C button depressed	Off	
Actual Air/Flow Ratio	--	0.00 :1 Ratio	This parameter displays the ratio of air to fuel as calculated by the ECM based on various sensor inputs. The scan tool will display a lower air fuel ratio when a richer air to fuel mixture is commanded. The scan tool will display a higher air fuel ratio when a leaner air to fuel mixture is commanded. In closed loop operation the air fuel ratio should normally be around 14.2-14.7 to 1.
	Gear selector in park position	P/N	

Actual Gear	Gear selector in reverse position	R	The scan tool will display the gear that is currently selected as determined by the ECM from the information received from the TR switch.
	Gear selector in neutral position	P/N	
	Gear selector in drive position	D	
Actual Torque	--	0 - 100 %	This parameter indicates the percentage of available torque requested from the engine to the transmission as calculated by the ECM. The scan tool will display a high value for higher torque or a low value for lower torque.
Alternator F Terminal	--	0 - 100 %	This parameter displays the commanded state of the generator by the ECM. A High value indicates a high charging command, and a low value indicates a low charging command.
Alternator L Terminal Circuit Status	--	Complete	This parameter displays if the ECM is allowing the generator to operate. The scan tool displays Complete if the ECM is allowing the generator to operate, or Incomplete if the ECM is disabling the generator.
	--	Incomplete	
Alternator L Terminal Duty Cycle	--	0 - 100%	This parameter displays the control signal from the ECM to the alternator. This controls the load on the alternator.
Ambient Temperature	--	° C	This parameter displays the ambient, outside, air temperature as calculated by the ECM.
APP Sensors (Accelerator Pedal Position)	--	0 - 100 %	This parameter displays the angle of the accelerator pedal position (APP) sensors as a percentage calculated by the ECM using the signal from the APP sensors. APP sensors have a range of values indicating a low percentage when the accelerator pedal is not pressed to a high percentage when the accelerator pedal is fully pressed.
APP Sensor 1	--	Volts	The scan tool displays 0-5 Volts. The scan tool displays approximately 1 - 1.15 Volts when in the idle position.
APP Sensor 1 - 2 Correlation	--	OK	The scan tool displays Fault if the ECM detects the signal voltage from APP sensor 1 is not in correct relationship to APP sensor 2. The

	--	Fault	scan tool displays OK under the normal operating conditions.
APP Sensor 2	--	Volts	The scan tool displays 0-5 Volts. The scan tool displays approximately 0.5 - 0.6 Volts when in the idle position.
B1 Actual Exhaust Camshaft Position	--	° CA	This parameter displays the actual bank 1 exhaust camshaft position in degrees.
B1 Actual Intake Camshaft Position	--	° CA	This parameter displays the actual bank 1 intake camshaft position in degrees.
B1 Catalyst Temperature	--	° C	The scan tool displays the B1 catalytic converter temperature as calculated by the ECM.
B1 Commanded Exhaust Camshaft Position	--	0 - 100 %	This parameter displays the exhaust camshaft position as a percentage of the range as commanded by the ECM.
B1 Commanded Exhaust Camshaft Position	--	° CA	This parameter displays the actual exhaust camshaft position in degrees.
B1 Commanded Intake Camshaft Position	--	0 - 100 %	This parameter displays the intake camshaft position as percentage of the range as commanded by the ECM.
B1 Commanded Intake Camshaft Position	--	° CA	This parameter displays the actual intake camshaft position in degrees.
B1 Exhaust Camshaft Position Sensor Active Counter	--	Counts	This parameter displays the B1 exhaust camshaft position counters count as the active edge of the camshaft wheel passes the camshaft sensor. With the engine stopped this counter should not increment.
B1 Exhaust Camshaft Position Solenoid Circuit Status	--	OK	This parameter displays the state of the exhaust camshaft actuator solenoid control circuit. The parameter displays Fault if the camshaft actuator solenoid control circuit is open, short to ground, or a short to voltage on the circuit.
	--	Fault	
	--	Undefined	
B1 Intake Camshaft Position Sensor Active Counter	--	Counts	This parameter displays the B1 intake camshaft position counters count as the active edge of the camshaft wheel passes the camshaft sensor. With the engine stopped this counter should not increment.

B1 Intake Camshaft Position Solenoid Valve Circuit Status	--	OK	This parameter displays the state of the intake camshaft actuator solenoid control circuit. The parameter displays Fault if the camshaft actuator solenoid control circuit is open, short to ground, or a short to voltage on the circuit.
	--	Fault	
	--	Undefined	
B1 LTFT Cruise/Acceleration	--	0 - 100 %	The scan tool displays in %. This parameter is the long term fuel trim for this bank as calculated by the ECM. The scan tool will display more than 0 percent indicating that time is being added to the injector pulse width, increasing the amount of fuel to this bank of the engine. The scan tool will display a value less than 0 indicating time is being subtracted from the injector pulse width, reducing the amount fuel to this bank of the engine. A value of 0 percent indicates no compensation is required to operate the engine at the desired air/fuel ratio.
B1 LTFT Idle/Deceleration	--	0 - 100 %	The scan tool displays in %. This parameter is the long term fuel trim for this bank as calculated by the ECM. The scan tool will display more than 0 percent indicating that time is being added to the injector pulse width, increasing the amount of fuel to this bank of the engine. The scan tool will display a value less than 0 indicating time is being subtracted from the injector pulse width, reducing the amount fuel to this bank of the engine. A value of 0 percent indicates no compensation is required to operate the engine at the desired air/fuel ratio.
B1 Short Term Fuel Trim	--	0 - 100 %	The scan tool displays percentage. This parameter indicates the current short term fuel trim for this bank. The scan tool will display a value higher than 0 if the time is being added to the injector pulse width, increasing the amount of fuel to that bank of the engine to compensate for a lean condition sensed by the oxygen sensors on that bank. The scan tool will display a value lower than 0 if time is being subtracted from the injector pulse

			width, reducing the amount of fuel to the engine to compensate for a rich condition sensed by the oxygen sensors on that bank. A value of 0 percent indicates no compensation is required to operate the engine at the desired air/fuel ratio.
B1 Total Fuel Trim	--	0 - 100 %	This parameter displays the total fuel trim from the long term idle/decel parameter and the long term fuel trim cell.
B1S1 o2 Sensor - Bank 1 Sensor 1	--	mVolts	This parameter displays the voltage from the signal produced by the heated oxygen sensor (HO2S) used to monitor catalyst efficiency for cylinder bank 1. The scan tool will display a low voltage reading when that cylinder bank is running lean. The scan tool will display a high voltage reading when that cylinder bank is running rich.
B1S1 o2 Sensor Heater	--	Ohms	This parameter displays the resistance of the sensing element within the ECM.
B1S1 o2 Sensor Heater	--	Active	This parameter displays the status of the O2 sensor heater. If the scan tool displays Active the O2 sensor heater has been activated.
	--	Inactive	
B1S1 o2 Sensor Heater Circuit Status	--	OK	This parameter displays the state of the oxygen sensor heater control circuit. The parameter displays Fault if the oxygen sensor heater control circuit is open, short to ground, or a short to voltage on the circuit.
	--	Fault	
	--	Undefined	
B1S2 o2 Sensor - Bank 1 Sensor 2	--	mVolts	This parameter displays the voltage from the signal produced by the HO2S used to monitor catalyst efficiency for cylinder bank 1. The scan tool will display a low voltage reading when that cylinder bank is running lean. The scan tool will display a high voltage reading when that cylinder bank is running rich.
B1S2 o2 Sensor Heater	--	Active	This parameter displays the status of the O2 sensor heater. If the scan tool displays Active the O2 sensor heater has been activated.
	--	Inactive	
	--	OK	This parameter displays the state of the oxygen sensor heater control circuit. The parameter displays

B1S2 o2 Sensor Heater Circuit Status	--	Fault	Fault if the oxygen sensor heater control circuit is open, short to ground, or a short to voltage on the circuit.
	--	Undefined	
B2 Actual Exhaust Camshaft Position	--	° CA	This parameter displays the actual bank 2 exhaust camshaft position in degrees.
B2 Actual Intake Camshaft Position	--	° CA	This parameter displays the actual bank 2 intake camshaft position in degrees.
B2 Catalyst Temperature	--	° C	This parameter displays the B2 catalytic converter temperature as calculated by the ECM.
B2 Commanded Exhaust Camshaft Position	--	0 - 100 %	This parameter displays the exhaust camshaft position as a percentage of the range as commanded by the ECM.
B2 Commanded Exhaust Camshaft Position	--	° CA	This parameter displays the actual exhaust camshaft position in degrees.
B2 Command Intake Camshaft Position	--	0 - 100 %	This parameter displays the intake camshaft position as a percentage of range as commanded by the ECM.
B2 Command Intake Camshaft Position	--	° CA	This parameter displays the actual intake camshaft position in degrees.
B2 Exhaust Camshaft Position Sensor Active Counter	--	Counts	This parameter displays the B2 exhaust camshaft position counters count as the active edge of the camshaft wheel passes the camshaft sensor. With the engine stopped this counter should not increment.
B2 Exhaust Camshaft Position Solenoid Circuit Status	--	OK	This parameter displays the state of the exhaust camshaft actuator solenoid control circuit. The parameter displays Fault if the camshaft actuator solenoid control circuit is open, short to ground, or a short to voltage on the circuit.
	--	Fault	
	--	Undefined	
B2 Intake Camshaft Position Sensor Active Counter	--	Counts	This parameter displays the B2 intake camshaft position counters count as the active edge of the camshaft wheel passes the camshaft sensor. With the engine stopped this counter should not increment.
B2 Intake Camshaft	--	OK	This parameter displays the state of the intake camshaft actuator solenoid control circuit. The

Position Solenoid Circuit Status	--	Fault	parameter displays Fault if the camshaft actuator solenoid control circuit is open, short to ground, or a short to voltage on the circuit.
	--	Undefined	
B2 LTFT Cruise/Acceleration	--	0 - 100 %	The scan tool displays in %. This parameter is the long term fuel trim for this bank as calculated by the ECM. The scan tool will display more than 0 percent indicating that time is being added to the injector pulse width, increasing the amount of fuel to this bank of the engine. The scan tool will display a value less than 0 indicating time is being subtracted from the injector pulse width, reducing the amount fuel to this bank of the engine. A value of 0 percent indicates no compensation is required to operate the engine at the desired air/fuel ratio.
B2 LTFT Idle/Deceleration	--	0 - 100 %	The scan tool displays in %. This parameter is the long term fuel trim for this bank as calculated by the ECM. The scan tool will display more than 0 percent indicating that time is being added to the injector pulse width, increasing the amount of fuel to this bank of the engine. The scan tool will display a value less than 0 indicating time is being subtracted from the injector pulse width, reducing the amount fuel to this bank of the engine. A value of 0 percent indicates no compensation is required to operate the engine at the desired air/fuel ratio.
B2 Short Term Fuel Trim	--	0 - 100 %	The scan tool displays percentage. This parameter indicates the current short term fuel trim for this bank. The scan tool will display a value higher than 0 if the time is being added to the injector pulse width, increasing the amount of fuel to that bank of the engine to compensate for a lean condition sensed by the oxygen sensors on that bank. The scan tool will display a value lower than 0 if time is being subtracted from the injector pulse width, reducing the amount of fuel to the engine to compensate for a rich condition sensed by the oxygen

			sensors on that bank. A value of 0 percent indicates no compensation is required to operate the engine at the desired air/fuel ratio.
B2 Total Fuel Trim	--	0 - 100 %	This parameter displays the total fuel trim from the long term idle/decel parameter and the long term fuel trim cell.
B2S1 o2 Sensor - Bank 2 Sensor 1	--	mVolts	This parameter displays the voltage from the signal produced by the HO2S used to monitor catalyst efficiency for cylinder bank 2. The scan tool will display a low voltage reading when that cylinder bank is running lean. The scan tool will display a high voltage reading when that cylinder bank is running rich.
B2S1 o2 Sensor Heater - Bank 2 Sensor 1	--	Ohm	This parameter displays the resistance of the sensing element within the ECM.
B2S1 o2 Sensor Heater - Bank 2 Sensor 1	--	Active	This parameter displays the status of the O2 sensor heater. If the scan tool displays Active the O2 sensor heater has been activated.
	--	Inactive	
B2S1 o2 Sensor Heater Circuit Status	--	OK	This parameter displays the state of the intake camshaft actuator solenoid control circuit. The parameter displays Fault if the camshaft actuator solenoid control circuit is open, short to ground, or a short to voltage on the circuit.
	--	Fault	
	--	Undefined	
B2S2 o2 Sensor - Bank 2 Sensor 2	--	mVolts	This parameter displays the voltage from the signal produced by the HO2S used to monitor catalyst efficiency for cylinder bank 2. The scan tool will display a low voltage reading when that cylinder bank is running lean. The scan tool will display a high voltage reading when that cylinder bank is running rich.
B2S2 o2 Sensor Heater	--	Active	This parameter displays the status of the O2 sensor heater. If the scan tool displays Active the O2 sensor heater has been activated.
	--	Inactive	
B2S2 o2 Sensor Heater Circuit Status	--	OK	This parameter displays the state of the intake camshaft actuator solenoid control circuit. The parameter displays Fault if the camshaft actuator solenoid control circuit is open, short to ground, or
	--	Fault	

	--	Undefined	a short to voltage on the circuit.
Barometric Pressure	--	kPa	This parameter displays the barometric pressure as calculated by the ECM using the signal from the manifold absolute pressure (MAP) sensor measured when the ignition is turned on with the engine not running. The ECM will update the barometric pressure during wide-open throttle (WOT) conditions. The scan tool will display a low value when the barometric pressure is low, and a high value when the barometric pressure is high.
Barometric Pressure	--	Volts	The scan tool displays 0-?? Volts. The scan tool displayed Voltage varies depending on the atmospheric pressure and the altitude.
Brake Lamp Switch	Brake pedal depressed	Active	This parameter displays the state of the brake pedal position switch as determined by the brake pedal switch. The scan tool will display Active when the brake pedal is depressed, and Inactive when the brake pedal is not depressed.
	Brake pedal not depressed	Inactive	
Calculated Air Flow	--	g/s	This parameter displays the air flow of the engine as calculated by the ECM using information from the MAP sensor. The scan tool will display a range of values indicating a high air flow when MAP pressure is high and a low air flow when MAP pressure is low. This value is listed in grams per second (g/s).
Calculated ECT - Closed	--	° C	This parameter displays the modeled temperature that the ECM calculates from air entering the engine, coolant temperature, and ambient air temperature. If the actual engine coolant temperature does not reach this calculated temperature within a predetermined amount of time, a DTC will be set.
Calculated ECT - Thermostat	--	° C	This parameter displays the modeled temperature that the ECM calculates from air entering the engine, coolant temperature, and ambient air temperature. If the actual engine coolant temperature does not reach this calculated

			temperature within a predetermined amount of time, a DTC will be set.
Calculated Pedal Position	--	0 - 100 %	This parameter displays the angle of the accelerator pedal as calculated by the ECM using the signals from the APP sensors. The APP indicated angle is a range of values indicating a low percentage when the accelerator pedal is not pressed to a high percentage when the accelerator pedal is fully pressed.
Calculated Throttle Position	--	0 - 100 %	This parameter displays the angle of the throttle position (TP) sensor as a percentage. This information is calculated by the engine control module using the signal from the throttle position sensor. The scan tool will display a low percentage when the throttle plates are closed. The scan tool will display a high percentage when the throttle plates are fully open.
Camshaft Active Counter	--	Counts	This parameter displays an incrementing counter when the engine control module receives a signal form the camshaft position (CMP) sensor.
CC Disengagement 1st History	--	On	The parameter displays the last 8 cruise control (CC) disengagements in order from 1 to 8, with 8 being the most recent. There are about 33 possible causes for the CC to disengage.
	--	Off	
CC Disengagement 2nd History	--	On	
	--	Off	
CC Disengagement 3rd History	--	On	
	--	Off	
CC Disengagement 4th History	--	On	
	--	Off	
CC Disengagement 5th History	--	On	
	--	Off	
CC Disengagement 6th History	--	On	
	--	Off	
CC Disengagement 7th History	--	On	
	--	Off	
CC Disengagement 8th History	--	On	
	--	Off	
			This parameter indicates whether the engine meets the conditions for a cold start-up during the present

Cold Startup	--	Yes	ignition cycle. The scan tool displays Yes when the conditions for a cold start-up are met during this ignition cycle. The scan tool displays No when the conditions for a cold start-up are not met during the present ignition cycle. Conditions for a cold start-up require the coolant temperature and the intake air temperature to be below a predetermined temperature and within a certain range of each other. These conditions must occur after the engine was warmed up to a specific temperature during the previous ignition cycle.
	--	No	
Commanded B1S1 o2 Sensor Heater	--	0 - 100 %	This parameter displays the commanded state of the bank 1 sensor 1 heater by the ECM. The scan tool will display 100% when the heater command is at the maximum, and a 0% value if the heater command is Off.
Commanded B1S1 o2 Sensor Valve	--	Ratio	
Commanded B1S2 o2 Sensor Heater	--	0 - 100 %	This parameter displays the commanded state of the bank 1 sensor 2 heater by the ECM. The scan tool will display 100% when the heater command is at the maximum, and a 0% value if the heater command is Off.
Commanded B1S2 o2 Sensor Valve	--	Ratio	
Commanded B2S1 o2 Sensor Heater	--	0 - 100 %	This parameter displays the commanded state of the bank 2 sensor 1 heater by the ECM. The scan tool will display 100% when the heater command is at the maximum, and a 0% value if the heater command is Off.
Commanded B2S2 o2 Sensor Heater	--	0 - 100%	This parameter displays the commanded state of the bank 2 sensor 2 heater by the ECM. The scan tool will display 100% when the heater command is at the maximum, and a 0% value if the heater command is Off.
Coolant Temperature	--	° C	This parameter displays the temperature of the engine coolant based on a voltage input from the

			engine coolant temperature (ECT) sensor to the ECM.
Crank Request	--	Active	This parameter displays whether the ignition switch has been cycled to the crank position requesting the ECM to activate the starter relay.
	--	Inactive	
Crankshaft Active Counter	--	Counts	This parameter displays an incrementing counter when the engine control module receives a signal from the crankshaft position (CKP) sensor.
Crankshaft Resynchronis Counter	--	Counts	This parameter displays the number of times the ECM re-syncs with the CKP sensor.
Cruise Control Active	--	Yes	This parameter displays the status of the cruise control system as determined by the ECM. The scan tool will display Yes when the cruise control system is in control of the vehicle speed, or No when the cruise control system is not operating.
	--	No	
Cruise Control Disengagement Reason	--	Off	This parameter displays the reason for the last cruise control disengagement.
	--	Brake Applied	
Cruise Control Switch	Cruise control switch activate	Active	This parameter displays the status of the cruise control switch.
	Cruise control switch deactivated	Inactive	
Cruise Resume/Acceleration Switch	Cruise resume/accel button pressed	Active	This parameter displays the status of the cruise resume/acceleration switch.
	Cruise resume/accel button in idle position	Inactive	
Cruise Set/Deceleration Switch	Cruise set/decel button pressed	Active	This parameter displays the status of the cruise set/deceleration switch.
	Cruise set/decel button in idle position	Inactive	
Cycles of Misfire	--	Number	This parameter displays the number of cylinder firing events that were recorded as misfires as determined by the ECM.
Cylinder 1 Ignition	--	OK	This parameter displays the state of the ignition control circuit. The parameter displays Fault if the ignition control circuit is open,
	--	Fault	

Circuit Status	--	Indeterminate	shorted to ground, or shorted to voltage. The parameter displays indeterminate until the control circuit has been commanded On.
Cylinder 1 Injector Circuit Status	--	OK	This parameter displays the status of the output driver for the injector control circuit. The scan tool displays OK, Incomplete, Short B+, Short Gnd/Open. The scan tool will display OK if the circuit is operating correctly. The scan tool will display a fault if there is an open, short to ground, or a short to voltage on the circuit.
	--	Fault	
	--	Incomplete	
Cylinder 1 Knock Detected	--	Yes	This parameter displays the knock retard as commanded by the ECM for cylinders 1-6. Each cylinder is controlled individually based on both knock sensor signal inputs.
	--	No	
Cylinder 2 Ignition Circuit Status	--	OK	This parameter displays the state of the ignition control circuit. The parameter displays Fault if the ignition control circuit is open, shorted to ground, or shorted to voltage. The parameter displays indeterminate until the control circuit has been commanded On.
	--	Fault	
	--	Indeterminate	
Cylinder 2 Injector Circuit Status	--	OK	This parameter displays the status of the output driver for the injector control circuit. The scan tool displays OK, Incomplete, Short B+, Short Gnd/Open. The scan tool will display OK if the circuit is operating correctly. The scan tool will display a fault if there is an open, short to ground, or a short to voltage on the circuit.
	--	Fault	
	--	Incomplete	
Cylinder 2 Knock Detected	--	Yes	This parameter displays the knock retard as commanded by the ECM for cylinders 1-6. Each cylinder is controlled individually based on both knock sensor signal inputs.
	--	No	
Cylinder 3 Ignition Circuit Status	--	OK	This parameter displays the state of the ignition control circuit. The parameter displays Fault if the ignition control circuit is open, shorted to ground, or shorted to voltage. The parameter displays indeterminate until the control circuit has been commanded On.
	--	Fault	
	--	Indeterminate	
			This parameter displays the status

Cylinder 3 Injector Circuit Status	--	OK	of the output driver for the injector control circuit. The scan tool displays OK, Incomplete, Short B+, Short Gnd/Open. The scan tool will display OK if the circuit is operating correctly. The scan tool will display a fault if there is an open, short to ground, or a short to voltage on the circuit.
	--	Fault	
	--	Incomplete	
Cylinder 3 Knock Detected	--	Yes	This parameter displays the knock retard as commanded by the ECM for cylinders 1-6. Each cylinder is controlled individually based on both knock sensor signal inputs.
	--	No	
Cylinder 4 Ignition Circuit Status	--	OK	This parameter displays the state of the ignition control circuit. The parameter displays Fault if the ignition control circuit is open, shorted to ground, or shorted to voltage. The parameter displays indeterminate until the control circuit has been commanded On.
	--	Fault	
	--	Indeterminate	
Cylinder 4 Injector Circuit Status	--	OK	This parameter displays the status of the output driver for the injector control circuit. The scan tool displays OK, Incomplete, Short B+, Short Gnd/Open. The scan tool will display OK if the circuit is operating correctly. The scan tool will display a fault if there is an open, short to ground, or a short to voltage on the circuit.
	--	Fault	
	--	Incomplete	
Cylinder 4 Knock Detected	--	Yes	This parameter displays the knock retard as commanded by the ECM for cylinders 1-6. Each cylinder is controlled individually based on both knock sensor signal inputs..
	--	No	
Cylinder 5 Ignition Circuit Status	--	OK	This parameter displays the state of the ignition control circuit. The parameter displays Fault if the ignition control circuit is open, shorted to ground, or shorted to voltage. The parameter displays indeterminate until the control circuit has been commanded On.
	--	Fault	
	--	Indeterminate	
Cylinder 5 Injector Circuit Status	--	OK	This parameter displays the status of the output driver for the injector control circuit. The scan tool displays OK, Incomplete, Short B+, Short Gnd/Open. The scan tool will display OK if the circuit is operating correctly. The scan tool will display
	--	Fault	

	--	Incomplete	a fault if there is an open, short to ground, or a short to voltage on the circuit.
Cylinder 5 Knock Detected	--	Yes	This parameter displays the knock retard as commanded by the ECM for cylinders 1-6. Each cylinder is controlled individually based on both knock sensor signal inputs.
	--	No	
Cylinder 6 Ignition Circuit Status	--	OK	This parameter displays the state of the ignition control circuit. The parameter displays Fault if the ignition control circuit is open, shorted to ground, or shorted to voltage. The parameter displays indeterminate until the control circuit has been commanded On.
	--	Fault	
	--	Indeterminate	
Cylinder 6 Injector Circuit Status	--	OK	This parameter displays the status of the output driver for the injector control circuit. The scan tool displays OK, Incomplete, Short B+, Short Gnd/Open. The scan tool will display OK if the circuit is operating correctly. The scan tool will display a fault if there is an open, short to ground, or a short to voltage on the circuit.
	--	Fault	
	--	Incomplete	
Cylinder 6 Knock Detected	--	Yes	This parameter displays the knock retard as commanded by the ECM for cylinders 1-6. Each cylinder is controlled individually based on both knock sensor signal inputs.
	--	No	
Dec. Fuel Cutoff (Deceleration)	--	Active	This parameter displays the status of the operating mode of the engine control module used to turn off the fuel injectors and the evaporative emission (EVAP) canister purge valve during certain deceleration conditions.
	--	Inactive	
Desired Engine Idle Speed	--	744 RPM	This parameter displays the desired engine idle speed as commanded by the ECM.
Desired Throttle Position	--	0 - 100 %	This parameter displays the angle of the TP as a percentage. This information is calculated by the ECM using the signals from the TP sensors. The scan tool will display a low percentage when the throttle plates are closed. The scan tool will display a high percentage when the throttle plates are fully open.
			This parameter displays the

Distance Since DTC Cleared	--	Km	distance accumulated since an emission diagnostic trouble code was cleared. The scan tool will display increasing distance as the vehicle is driven.
Electronic Throttle Control Learn Counter	--	Counts	This parameter displays the stage of learning the throttle positions are at. The electronic throttle control learn counter will display 0 - 11 counts. When 11 is displayed this indicates that the learning is complete.
Engine Control Ignition Relay	--	On	This parameter displays the state of the control circuit ECM power relay as commanded by the ECM. The scan tool displays On with the engine running.
	--	Off	
Engine Control Ignition Relay Circuit Status	--	Complete	This parameter displays the status of the output driver for the EC Ignition Relay control circuit. The scan tool will display Complete, Incomplete. The scan tool will display Complete if the circuit is operating correctly. The scan tool will display Incomplete if there is an open, short to ground, or a short to voltage on the circuit.
	--	Incomplete	
Engine Control Ignition Relay Feedback	--	Volts	The scan tool displays 0-13 Volts. The scan tool displays approximately 12 Volts when the ignition is On.
Engine Load	--	0 - 100 %	This parameter displays the calculated engine load as a percentage based on inputs to the ECM from various engine sensors.
Engine Oil Level Switch	Normal engine oil level	Ok	This parameter displays if the level of the engine oil is within range as determined by the ECM from information received from the engine oil level switch.
	Low engine oil level	Low	
Engine Oil Life Remaining	--	0 - 100 %	This parameter displays the percent of engine oil life remaining. The controller calculates the engine oil life by monitoring engine load, coolant temperature, and engine speed.
Engine Oil Pressure	--	kPa	This parameter displays the engine oil pressure.
Engine Oil Pressure Sensor	--	Volts	The scan tool displays 0-?? Volts. The scan tool displayed Voltage varies depending on the engine oil

			pressure.
Engine Oil Pressure Sensor	Normal engine oil pressure	Ok	This parameter displays Ok if the engine oil pressure is within the correct range. If the engine control module detects that the engine oil pressure is not within the correct range, the scan tool displays Low.
	Low engine oil pressure	Low	
Engine Oil Temperature	--	° C	This parameter displays the temperature of the engine oil.
Engine Oil Temperature Calculated	--	° C	This parameter displays the engine oil temperature as calculated by the ECM.
Engine Run Time	--	hh:mm:ss	This parameter displays the time elapsed since the engine was started. The scan tool will display the time in hours, minutes and seconds. The engine run time will reset to zero as soon as the engine stops running.
Engine Speed	--	RPM	This parameter displays the speed of the crankshaft as calculated by the ECM based on inputs from the CKP Sensor. The scan tool will display the engine speed in RPM.
EVAP Purge Solenoid (Evaporative Emission)	--	0 - 100 %	This parameter displays the on-time or duty cycle of the EVAP canister purge solenoid commanded by the engine control module. Zero percent indicates no purge. One hundred percent indicates full purge.
EVAP Purge Solenoid Valve Circuit Status	--	Okay	This parameter displays the state of the EVAP purge solenoid valve control circuit. The parameter displays Fault if the EVAP purge solenoid valve control circuit is shorted to voltage. This parameter may not change if the scan tool is used to command the EVAP purge solenoid valve on.
	--	Fault	
	--	Undefined	
Fan 1 Relay	--	Okay	This parameter displays the state of the fan relay control circuit. The parameter displays Fault if the fan relay control circuit is open, shorted to ground, or shorted to voltage. The parameter displays Indeterminate until the circuit has been commanded on.
	--	Fault	
	--	Indeterminate	
Fan 1 Relay Circuit	--	Okay	This parameter displays the state of the fan relay control circuit. The parameter displays Fault if the fan
	--	Fault	

Status	--	Undefined	relay control circuit has an open, short to ground, or a short to voltage on the circuit
Fan 2 and 3 Relay	--	On	This parameter displays the engine control module commanded state of the fan relay control circuit.
	--	Off	
Fan 2 and 3 Relay Circuit Status	--	Okay	This parameter displays the state of the fan relay control circuit. The parameter displays Fault if the fan relay control circuit is open, short to ground, or a short to voltage on the circuit
	--	Fault	
	--	Undefined	
Fuel Level	--	0 - 100 %	This parameter displays the amount of fuel remaining in all of the fuel tanks of the vehicle as a percentage. The ECM calculates this level using the signals from the sensors used to monitor the fuel level in the fuel tanks. The scan tool will display a low reading when the total fuel level in the vehicle is low or near empty. The scan tool will display a high reading when the fuel level in the tank is high or near full.
Fuel Level	--	Litres	This parameter displays the amount of fuel remaining in all fuel tanks of the vehicle as measured in litres or gallons. The ECM calculates the amount of fuel remaining in the tank by using information from the fuel level sensors.
Fuel Level Sensor 1	--	Volts	The scan tool displays 0-?? Volts. The scan tool displayed Voltage varies depending on the fuel level in the fuel tank.
Fuel Level Sensor 2	--	Volts	The scan tool displays 0-?? Volts. The scan tool displayed Voltage varies depending on the fuel level in the fuel tank.
Fuel Pump Relay	--	On	This parameter displays the commanded state of the fuel pump relay control circuit. The fuel pump relay should be On when the scan tool indicates the fuel pump relay command is On. The fuel pump relay should be Off when the scan tool indicates the fuel pump relay command is Off.
	--	Off	
Fuel Pump Relay	--	Okay	This parameter displays the state of the fuel pump relay control circuit. The parameter displays Fault if the

Circuit Status	--	Fault	fuel pump relay control circuit is open, short to ground, or a short to voltage on the circuit
	--	Undefined	
Fuel System Status	--	Open Loop	The scan tool displays Closed Loop if the ECM is controlling the fuel delivery according to the HO2S voltages. The scan tool displays Open Loop if the engine control module is not adjusting for HO2S inputs. In Open Loop the engine control module bases fuel deliver on throttle position, engine coolant temperature, and mass airflow sensor inputs.
	--	Closed Loop	
Fuel Trim Learn	--	Enable	The scan tool displays Enabled when conditions are appropriate for enabling long term fuel trim corrections. If the scan tool displays Disabled, then long term fuel trim will not respond to changes in short term fuel trim.
	--	Disable	
Ignition Accessory Signal	Ignition is in ACC position	On	This parameter displays the state of the ignition input to the ECM from the ignition switch. The scan tool will display On when the ignition switch is in the ignition accessory position. The scan tool will display Off when the ignition switch is in any other position.
	Ignition is in OFF/RUN/CRANK positions	Off	
Ignition Off Time	--	hh:mm:ss	This parameter displays the time which the ignition has been switched off.
Ignition Voltage	--	Volts	The scan tool displays 0-13 Volts. The scan tool displays approximately 11-13 Volts when the ignition is On.
IMRC Solenoid (Intake Manifold Runner Control)	--	On	This parameter displays the ECM commanded state of the IMRC solenoid.
	--	Off	
IMRC Solenoid Circuit Status	--	OK	This parameter displays the state of the IMRC circuit. The parameter displays Fault if the IMRC circuit is open, shorted to ground, or shorted to voltage. The parameter displays Indeterminate until the circuit has been commanded on. This parameter may not change if the scan tool is used to command the IMRC solenoid on.
	--	Fault	
	--	Indeterminate	
Injection Time Cylinder 1	--	milliseconds	

Injection Time Cylinder 2	--	milliseconds	This parameter displays the amount of fuel injector on time or pulse width as commanded by the ECM.
Injection Time Cylinder 3	--	milliseconds	
Injection Time Cylinder 4	--	milliseconds	
Injection Time Cylinder 5	--	milliseconds	
Injection Time Cylinder 6	--	milliseconds	
Injector 1 Disabled Due to Misfire	--	Yes	This parameter displays the status of the fuel injector driver by the ECM. The scan tool will display Yes if the fuel injector is being disabled due to a misfire detection. The scan tool will display No if the fuel injector is not being disabled by the ECM due to a misfire.
	--	No	
Injector 2 Disabled Due to Misfire	--	Yes	
	--	No	
Injector 3 Disabled Due to Misfire	--	Yes	
	--	No	
Injector 4 Disabled Due to Misfire	--	Yes	
	--	No	
Injector 5 Disabled Due to Misfire	--	Yes	
	--	No	
Injector 6 Disabled Due to Misfire	--	Yes	
	--	No	
Intake Air Temperature	--	° C	This parameter displays the temperature of the intake air calculated by the ECM based on the input from the intake air temperature (IAT). The scan tool will display a low value for a low intake air temperature, and a high value for a high intake air temperature.
Knock Retard	--	° CA	This parameter indicates the amount of timing retard commanded by the ECM. The scan tool will display a lower value if no knock is detected, and a higher value as more knock is detected.
Knock Retard Cylinder 1	--	° CA	This parameter indicates the amount of timing retard commanded by the ECM. The scan tool will display a lower value if no knock is detected, and a higher value as more knock is detected and the ECM retards the ignition timing.
Knock Retard Cylinder 2	--	° CA	
Knock Retard Cylinder 3	--	° CA	
Knock Retard Cylinder 4	--	° CA	
Knock Retard Cylinder 5	--	° CA	

Knock Retard Cylinder 6	--	° CA	
Knock Sensor 1 Test Status	--	Complete	This parameter displays the knock sensor 1 test status. The scan tool displays Complete if the knock sensor 1 test is completed and operating normally.
	--	Incomplete	
Knock Sensor 2 Test Status	--	Complete	This parameter displays the knock sensor 2 test status. The scan tool displays Complete if the knock sensor 2 test is completed and operating normally.
	--	Incomplete	
Knock Sensor Circuit Test Status	--	Complete	This parameter displays the knock sensor circuit test status. The parameter displays Complete if the knock sensor circuit test is completed and operating normally.
	--	Incomplete	
Loop Status Bank 1 Sensor 1	--	Open Loop	This parameter displays the state of the fuel control system as commanded by the ECM. Closed Loop operation indicates that the ECM is controlling the fuel delivery based off the oxygen sensors input signal. In Open Loop operation the ECM ignores the oxygen sensor input signal and bases the amount of fuel to be delivered on other sensor inputs.
	--	Closed Loop	
Loop Status Bank 2 Sensor 1	--	Open Loop	This parameter displays the state of the fuel control system as commanded by the ECM. Closed Loop operation indicates that the ECM is controlling the fuel delivery based off the oxygen sensors input signal. In Open Loop operation the ECM ignores the oxygen sensor input signal and bases the amount of fuel to be delivered on other sensor inputs.
	--	Closed Loop	
Malfunction Indicator	--	On	This parameter displays the commanded state of the malfunction indicator lamp (MIL) control circuit by the ECM.
	--	Off	
Mass Air Flow	--	g/s	This parameter indicates the airflow into the engine as calculated by the ECM based on mass airflow (MAF) sensor inputs. The scan tool will display a high value at higher engine speeds, and a low value at idle.
			This parameter indicates the

Mass Air Flow Sensor	--	Hz	frequency signal sent from the MAF sensor to the ECM. The scan tool will display a high value indicates a higher engine speed. The scan tool will display a low value at idle.
Misfire Current Cylinder 1	--	Counts	This parameter indicates the number of cylinder firing events detected as possible misfires on each cylinder during the last 200 crankshaft revolutions as calculated by the ECM.
Misfire Current Cylinder 2	--	Counts	
Misfire Current Cylinder 3	--	Counts	
Misfire Current Cylinder 4	--	Counts	
Misfire Current Cylinder 5	--	Counts	
Misfire Current Cylinder 6	--	Counts	
Misfire History Cylinder 1	--	Counts	The scan tool displays in counts. This parameter displays the total level of cylinder misfires that have been calculated for each cylinder by the ECM. This parameter will not update or show activity until a misfire DTC has become active. The misfire history counters will update every 200 cylinder firing events.
Misfire History Cylinder 2	--	Counts	
Misfire History Cylinder 3	--	Counts	
Misfire History Cylinder 4	--	Counts	
Misfire History Cylinder 5	--	Counts	
Misfire History Cylinder 6	--	Counts	
Number of Warm Ups Since DTCs Cleared	--	(#)	This parameter indicates the number of warm up cycles that have occurred since DTCs were cleared. The scan tool will display a higher counts as more warm up cycles have occurred since the DTCs were cleared.
Oil Level	--	Normal	This parameter displays if the level of the engine oil is within range as determined by the ECM from information received from the engine oil level switch.
	--	Low	
Power Enrichment	--	Yes	Scan tool displays Yes or No. Yes displayed indicates that the ECM has detected conditions appropriate to operate in power enrichment mode. The ECM commands power enrichment mode when a large increase in throttle position and load is detected. While in power

	--	No	enrichment, the ECM will increase the amount of fuel delivered by entering open loop and increasing the injector pulse width.
Powertrain Immobiliser	--	Standby	This parameter displays the current status of the powertrain immobiliser as Active, Inactive or Standby
	--	Active	
	--	Inactive	
Reduced Engine Power	--	Active	The scan tool displays Active when the ECM receives a signal from the throttle actuator control (TAC) module that a TAC system fault is occurring. The scan tool displays Inactive when the engine is operating normally.
	--	Inactive	
Requested Torque	--	0 - 100 %	This parameter displays the calculated amount torque requested of the controller.
RVC (Regulated Voltage Control) Override Command	--	On	This parameter displays whether the ECM has command the alternator On or Off to maintain a regulated voltage.
	--	Off	
Spark Advance	--	° CA	This parameter displays the amount of spark advance the engine control module is commanding on the ignition control circuits. The ECM determines the desired advance.
Starter Relay	--	On	This parameter displays the ECM commanded state of the starter motor relay control circuit.
	--	Off	
Starter Relay Circuit Status	--	Okay	This parameter displays the state of the starter relay control circuit. The parameter displays Fault if the starter relay control circuit is open, short to ground, or a short to voltage on the circuit
	--	Fault	
	--	Undefined	
Start-Up ECT	--	° C	This parameter indicates the engine coolant temperature at start-up, as calculated by the ECM based on the input from the engine coolant temperature sensor. The scan tool will display a higher value at higher engine start-up temperatures, and a lower value at lower start-up temperatures.
Start-Up IAT	--	° C	This parameter indicates the intake air temperature (IAT) at the time that the vehicle was started. Used to determine if the last start-up was a cold start. The scan tool

			range is -39 to +140°C (-38 to +284°F). This parameter indicates the ambient air temperature at start-up.
System Power Mode	Ignition is in OFF position	Off	This parameter displays Off/Accessory/Run/Crank. This is the status of the system power mode dependant on the ignition position
	Ignition is in ACC position	Accessory	
	Ignition is in RUN position	Run	
	Ignition is in CRANK position	Crank	
TAC Motor PWM Command	--	0 - 100 %	This parameter indicates the commanded state of the TAC PWM Solenoid by the ECM. The scan tool displays as a percentage. The scan tool displays 0% when the solenoid is Off.
Throttle Position	--	0 - 100 %	This parameter displays the throttle position as a percentage as calculated by the ECM using information from the two TP sensors.
Total Knock Retard	--	° CA	This parameter indicates how much ignition spark timing is being retarded due to all control systems monitored by the ECM. The scan tool will display a high value during extreme conditions such as high temperatures and antilock braking. The scan tool will display a lower value during lighter driving conditions.
Total Misfire	--	(#)	The scan tool range is 0-255 counts. This parameter indicates the total level of misfire that has been detected on each cylinder. The misfire history counters will not update or show any activity until a misfire or DTC P0300 has become active. The misfire history counter will update every 200 cylinder firing events.
TP Sensor 1	--	0 - 100 %	This parameter displays the angle of the TP sensor 1 as a percentage. This information is calculated by the ECM using the signal from the TP sensor 1. The scan tool will display a low percentage when the throttle plates are closed. The scan tool will display a high percentage when the throttle plates are fully

			open.
TP Sensor 1	--	Volts	The scan tool displays 0-5 Volts. The scan tool displays approximately 3-3.6 Volts when the ignition is On.
TP Sensor 1 Learned Lower Position	--	Volts	This parameter displays the learned minimum value of TP sensor 1 as recorded by the ECM during the last learn procedure.
TP Sensor 1-2 Correlation	--	OK	This parameter displays the results of a ECM test that compares signals from the TP sensors 1 and 2. The scan tool will display OK when the signal from TP sensor 1 corresponds with the signal from TP sensor 2. The scan tool will display Fault when the signal from TP sensor 1 conflicts with the signal from TP sensor 2.
	--	Fault	
TP Sensor 2	--	0 - 100 %	This parameter displays the angle of the TP sensor 2 as a percentage. This information is calculated by the ECM using the signal from the TP sensor 2. The scan tool will display a low percentage when the throttle plates are closed. The scan tool will display a high percentage when the throttle plates are fully open.
TP Sensor 2	--	Volts	The scan tool displays 0-5 Volts. The scan tool displays approximately 1.5-1.9 Volts when the ignition is On.
TP Sensor 2 Learned Lower Position	--	Volts	This parameter displays the learned minimum value of TP sensor 2 as recorded by the ECM during the last learn procedure.
Traction Control	--	Active	This parameter displays Active if the EBCM is commanding traction control.
	--	Inactive	
Transmission Gear	Gear selector in Park position	P/N	This parameter indicates the current state of the gear select switch on the transmission/transaxle as calculated by the ECM based on the TR switch.
	Gear selector in Reverse position	R	
	Gear selector in Neutral position	P/N	
	Gear selector in Drive position	D	
	--	OK	This parameter displays the status of the vehicle speed circuit. The

Vehicle Speed Circuit Status	--	Fault	parameter displays Fault if the vehicle speed circuit is open, shorted to ground, or shorted to voltage. The parameter displays Incomplete until the circuit has been commanded On. The scan tool will display OK if the circuit is operating correctly.
	--	Incomplete	
Vehicle Speed	--	Km/h	This parameter indicates the vehicle speed calculated by the ECM based on an input from the vehicle speed sensor (VSS). The scan tool will display a high value at higher vehicle speeds, and a low value at lower vehicle speeds.
Volumetric Efficiency	--	5 - 25 %	This parameter displays the calculated volumetric efficiency of the engine as calculated by the ECM.

ECM Control Module Scan Tool Output Controls

Scan Tool Output Control	Additional Menu Selection(s)	Description
Camshaft Actuator	Special Functions/Engine Output Controls/CMP Actuator System	This function controls the selected camshaft actuator. The normal commanded state is NONE. The system will increase or decrease the angle of the selected camshaft in 5 degree increments up to 40 crankshaft degrees. The scan tool initiates the test when the following conditions are met: • The vehicle speed is 0 km/h (0 mph). • The transmission is in park or neutral. • The engine speed is between 1,000-1,400 RPM. The system remains in the commanded state until cancelled by the scan tool.
Camshaft Actuator Solenoid	Special Functions/Engine Output Controls/CMP Actuator System	This function controls the selected camshaft actuator solenoid. The normal commanded state is NONE. When commanded ON/OFF, the ECM turns the camshaft actuator solenoid ON/OFF. The scan tool initiates the test when the following conditions are met: • The ignition is ON with the engine OFF. • No engine speed is detected. The system remains in the commanded state until cancelled by the scan tool.
		Important: The Misfire Current and Misfire History parameters may not increment when using this

Cylinder Power Balance	Special Functions/Fuel System	function. This function disables the selected fuel injector. The normal commanded state is None. The scan tool initiates the test when the following conditions are met: • The engine is operating and the engine idle is stable. • The vehicle speed is 0 km/h (0 mph). • There are no DTCs set for the vehicle speed sensor. If the fuel injector was disabled for 30 seconds, fuel injector control is not allowed again on the same fuel injector for 60 seconds.
Engine Speed Control	Special Functions/TAC System	This function controls the idle speed override in 25 RPM, 100 RPM, and 500 RPM increments, from the base idle speed to 1,400 RPM. The scan tool initiates the test when the following conditions are met: • The transmission is in park or neutral. • The engine speed is less than 1,000 RPM. The engine speed will remain in the commanded state until cancelled by the scan tool.
EVAP Purge Solenoid	Special Functions/Engine Output Controls/EVAP System	**Important:** The EVAP Purge Solenoid Command parameter may not change states when using this output control. This function controls the EVAP purge solenoid valve. The normal commanded state is NONE. The system will increase or decrease the amount of purge by changing the duty cycle of the purge valve in 10 percent increments within a range of 0-100 percent. The system remains in the commanded state until cancelled by the scan tool or the fuel tank pressure (FTP) sensor exceeds -24 mm Hg (-12 inch H20).
EVAP Purge/Seal	Special Functions/Engine Output Controls/EVAP System	**Important:** The EVAP Purge and Vent Solenoid Command parameters may not change states when using this output control. This function activates both the EVAP purge solenoid valve and EVAP vent solenoid to seal the EVAP system. When activated, the purge valve is commanded to 0 percent and the vent valve is commanded ON, Not-venting. The normal commanded state for both solenoids is None. Both of the solenoids remain in the commanded state until

		cancelled by the scan tool or the FTP sensor exceeds -24 mm Hg (-12 inch H20).
EVAP Test	Service Bay Test	This function activates the Service Bay Test to verify the integrity of the EVAP system. The scan tool initiates the test when the following conditions are met: • All instructions on the scan tool have been completed. • ECT is less than a specified value. • No EVAP DTCs are set.
EVAP Vent Solenoid	Special Functions/Engine Output Controls/EVAP System	**Important:** The EVAP Vent Solenoid Command parameter may not change states when using this output control. This function controls the EVAP vent solenoid. The normal commanded state is NONE. When commanded ON, the vent valve switches to Not-venting. The system remains in the commanded state unless one of the following conditions occur: • Cancelled by the scan tool • The EVAP canister purge solenoid is more than 0 percent, and the FTP sensor exceeds -24 mm Hg (-12 inch H20).
Fuel Injector Balance	Special Functions/Fuel System	This function enables the fuel injector in order to verify the correct fuel injector flow. The ECM will pulse the selected fuel injector when the following conditions are met: • All instruction on the scan tool is complete. • A fuel injector is selected. • The ignition is ON with the engine OFF. The selected fuel injector can only be flowed/pulsed once per ignition cycle.
Fuel Pump	Special Functions/Engine Output Controls	This function controls the fuel pump relay. The normal commanded state is NONE. The scan tool initiates the test when the following conditions are met: • There are no vehicle speed sensor DTCs set. • The vehicle speed is 0 km/h (0 mph). When commanded ON/OFF, the engine Control Module (ECM) turns the fuel pump relay ON/OFF. If the engine is running and the fuel pump relay is commanded OFF, the engine will stall. The system remains in the commanded state for about

		2 seconds or until cancelled by the scan tool or the ECM detects a vehicle speed.
Fuel Trim Reset	Special Functions/Fuel System	This function resets the fuel trim data and the learned values for the rear heated oxygen sensors.
Idle Learn Reset	Special Functions/TAC System	This function allows the throttle position and the idle speed to be relearned by the ECM, once the following conditions have been met. • The ignition is ON with the engine OFF. • The engine coolant temperature (ECT) is between 5-85°C (41-185°F). • No TAC system DTCs are set.
IMRC Solenoid	Special Functions/Engine Output Controls	This function controls the intake manifold runner control (IMRC) solenoid. The normal commanded state is NONE. When commanded ON/OFF, the ECM turns the IMRC solenoid ON/OFF. The scan tool initiates the test when the following conditions are met: • There are no vehicle speed sensor DTCs set. • The vehicle speed is 0 km/h (0 mph). The system remains in the commanded state until cancelled by the scan tool.
Loop Status	Special Functions/Engine Output Controls	This function controls the heated oxygen sensor (HO2S) loop status. The commanded states include NONE, OPEN, and CLOSED. The normal commanded state is NONE. The loop status changes as commanded, OPEN or CLOSED. The system remains in the commanded state until cancelled by the scan tool.
Malfunction Indicator Lamp	Special Functions/Engine Output Controls	This function controls the malfunction indicator lamp (MIL). The normal commanded state is NONE. When commanded ON/OFF, the ECM turns the MIL ON/OFF. The system remains in the commanded state until cancelled by the scan tool.
Throttle Position	Special Functions/TAC System	This function controls the throttle valve in 10 percent increments. The scan tool initiates the test when the following conditions are met: • There are no vehicle speed sensor DTCs set. • The vehicle speed is 0 km/h (0 mph). • The ignition is ON, with the engine OFF. • The ECM is not commanding a throttle learn. The system remains in the commanded state until cancelled by the scan tool.

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Engine Control Module Scan Tool Information (V8 Gasoline)

Table 1: Engine Control Module Scan Tool Data
Table 2: Output Control

The Engine Control Module Scan Tool Data List contains all engine-related parameters that are available on the scan tool. The list is arranged in alphabetical order. A given parameter may appear in any one of the data lists, and in some cases may appear more than once, or in more than one data list in order to group certain related parameters together.

Use the Engine Scan Tool Data List only after the following is determined:

- The Diagnostic System Check - Vehicle is completed.
- No DTCs are set
- The on-board diagnostics are functioning properly

The scan tool values from a properly running engine may be used for comparison with the engine you are diagnosing. The engine scan tool data list represents values that would be seen on a normally running engine.

Important: A scan tool that displays faulty data should not be used. The scan tool concern should be reported to the manufacturer. Use of a faulty scan tool can result in misdiagnosis and unnecessary parts replacement.

Only the parameters listed below are referenced in this service manual for use in diagnosis.

Engine Control Module Scan Tool Data

Parameter	System State	Expected Value	Description
Base Operating Conditions: Engine Idling/Radiator Hose Hot/Park or Neutral/Closed Loop/Accessories OFF			
5-volt Reference 1	--	5 Volts	This parameter displays the voltage sensed on the 5-volt reference 1 circuit at the control module. The scan tool will display a higher value at higher voltage. The scan tool will display a lower value at lower voltage.
5-volt Reference 1 Circuit Status	--	OK	This parameter will display OK if the circuit is good or Fault if a short to ground, short to B+ or open circuit is present.
5-volt Reference 2	--	5 Volts	This parameter displays the voltage sensed on the 5-volt reference 2 circuit at the control module. The scan tool will display a higher value at higher voltage. The scan tool will display a lower value at lower voltage.
5-volt			This parameter will display OK if the circuit is

Reference 2 Circuit Status	--	OK	good or Fault if a short to ground, short to B+ or open circuit is present.
A/C Request Signal	--	NO	The scan tool displays YES/NO. The HVAC module receives an input request when the HVAC module is turned ON.
A/C Relay Command	--	OFF	This parameter displays the commanded state of the air conditioning (A/C) clutch relay control circuit. The scan tool will display ON or OFF. ON indicates the A/C clutch relay control circuit is being grounded by the control module, allowing voltage to the A/C compressor clutch. OFF indicates the A/C clutch relay is not being commanded ON by the control module.
A/C Relay Ckt Short Gnd Test Status	--	OK	This displays the status of the relay control circuit. It can display OK, Fault or Not Run.
A/C Relay Ckt Open Test Status	--	OK	This displays the status of the relay control circuit. It can display OK, Fault or Not Run.
A/C Relay Ckt Short Volts Test Status	--	Not Run	This displays the status of the relay control circuit. It can display OK, Fault or Not Run.
A/C High side Pressure Sensor	A/C OFF	1.43 Volts	The scan tool displays 0-5 volts. The voltage applied to the ECM input for the A/C refrigerant pressure sensor.
	A/C ON	2.39 Volts	
A/C High side Pressure Sensor	A/C OFF	500-2,220 kPa (72-319 psi)	The scan tool displays 0-3450 kPa (0-500 psi). The voltage applied to the ECM input from the A/C refrigerant pressure sensor is converted to a pressure value.
	A/C ON	300-1,220 kPa (43-174 psi)	
A/C OFF for WOT	A/C ON	NO	The scan tool displays YES/NO. The state of the A/C request related to wide open throttle.
A/C Pressure Disable	--	NO	The scan tool displays YES/NO. The state of the A/C refrigerant pressure sensor and circuitry.
A/C Disengage 1-8 History	A/C ON	Reason for A/C Disengagement	The scan tool displays None, A/C Pressure, Engine Speed, Battery Voltage, Stall Prevention, RPM Unstable, WOT, Launch Performance or Coolant Hot. The scan tool displays None if OK.
Air Flow Calculated	--	3-7 g/s	This parameter displays the air flow of the engine as calculated by the control module using information from the manifold absolute pressure (MAP) sensor. The scan tool will display a range of values indicating a high air flow when MAP pressure is high and a low air flow when MAP pressure is low. This value is listed in grams per second (g/s).
Ambient Air Temperature	--	Varies	Outside temperature at any given altitude expressed in degrees

APP Indicated Angle	Accelerator pedal not applied	0%	This parameter displays the angle of the accelerator pedal as calculated by the control module using the signals from the accelerator pedal position sensors. The accelerator pedal position (APP) indicated angle is a range of values indicating a low percentage when the accelerator pedal is not depressed to a high percentage when the accelerator pedal is fully depressed.
	Accelerator pedal WOT	100%	
APP Sensor	--	Varies	This parameter displays the average of the APP sensors as calculated by the throttle actuator control (TAC) module. The APP average is a range of values indicating a low number when the accelerator pedal is not depressed to a high number when the accelerator pedal is fully depressed. This value is listed in counts.
APP Sensor 1	Accelerator pedal not actuated	0.7-1.2 Volts	This parameter displays the voltage signal sent to the control module from APP sensor 1 of the APP sensor assembly. APP sensor 1 is a range of values indicating a low voltage when the accelerator pedal is not depressed to a high voltage when the accelerator pedal is fully depressed.
	Accelerator pedal fully actuated	4.2-4.5 Volts	
APP Sensor 1 Indicated Position	Accelerator pedal not actuated	0%	This parameter displays the angle of the APP sensor 1 as calculated by the control module using the signal from the APP sensor 1. APP sensor 1 is a range of values indicating a low percentage when the accelerator pedal is not depressed to a high percentage when the accelerator pedal is fully depressed.
	Accelerator pedal fully actuated	100%	
APP Sensor 2	Accelerator pedal not actuated	0.3-0.5 Volts	This parameter displays the voltage signal sent to the control module from APP sensor 2 of the APP sensor assembly. APP sensor 2 is a range of values indicating a low voltage when the accelerator pedal is not depressed to a high voltage when the accelerator pedal is fully depressed.
	Accelerator pedal fully actuated	2.2-2.5 Volts	
APP Sensor 2 Indicated Position	Accelerator pedal not actuated	0%	This parameter displays the angle of the APP sensor 2 as calculated by the control module using the signal from the APP sensor 2. APP sensor 2 is a range of values indicating a low percentage when the accelerator pedal is not depressed to a high percentage when the accelerator pedal is fully depressed.
	Accelerator pedal fully actuated	100%	
APP Sensor 1 and 2	--	Agree	This parameter displays the results of a control module test that compares the signals from the APP sensors 1 and 2. The scan tool will display Agree or Disagree. Agree indicates that APP sensor 1 and APP sensor 2 voltages correspond to the same accelerator pedal position. Disagree indicates that APP

			sensor 1 and APP sensor 2 voltages correspond to different accelerator pedal positions.
BARO	--	Varies with altitude	This parameter displays the barometric pressure as calculated by the control module using the signal from the MAP sensor measured when the ignition is turned ON with the engine not running. The control module will update the barometric pressure during wide-open throttle (WOT) conditions.
BPP Signal	--	Released	This parameter displays the state of the brake pedal position switch as determined by the brake pedal switch. The scan tool will display Applied when the brake pedal is depressed, and Released when the brake pedal is not depressed.
BPP Circuit Signal	--	Released	The BCM uses the Brake Pedal Position sensor as an indication that the brake pedal is applied or released.
Catalytic Converter Protection Active	--	No	This parameter indicates the status of the control module control for catalytic converter protection. The scan tool will indicate YES if the control module is adjusting fuel and ignition quantity and timing to protect the catalytic converter from damage. The scan tool will indicate NO if the control module is in a normal fuel and ignition control mode.
Calc. TWC Temp.	--	Varies	This parameter displays the catalytic converter temperature as calculated by the control module.
Calc. TWC Temp. Bank 1 and Bank 2	--	Varies	This parameter displays the catalytic converter temperature as calculated by the control module.
Change Engine Oil Indicator Command	--	No	This parameter displays the state of the change engine oil lamp control circuit as commanded by the control module.
CKP Resync Counter	--	Varies	This parameter displays the number of times the control module has to synchronize the CKP sensor.
CKP Sensor	--	Engine Idle Speed	This parameter displays the engine speed as calculated by the control module using the signal from the CKP sensor.
CKP Active Counter	--	Incrementing	This parameter displays an incrementing counter when the control module receives a signal from the crankshaft position (CKP) sensor.
Cmmd. A/F Equivalence Ratio	--	1	Equivalence numbers greater than one represent excess fuel in the fuel air mix. Equivalence numbers less than one represent a deficiency of fuel in the fuel air mix for complete combustion. The equivalence ratio

			will be reported as one when the vehicle is in Closed Loop.
CMP Sensor	--	Engine Idle Speed	This parameter displays the engine speed as calculated by the control module using the signal from the CMP sensor.
Cold Startup	--	Varies	This parameter displays whether the engine meets the conditions for a cold startup during the present ignition cycle. The scan tool displays Yes when the conditions for a cold startup are met during this ignition cycle. The scan tool displays No when the conditions for a cold startup are not met during the present ignition cycle. Conditions for a cold startup require the coolant temperature and the intake air temperature to be below a predetermined temperature and within a certain range of each other. These conditions must occur after the engine was warmed up to a specific temperature during the previous ignition cycle.
Crank Request Signal	--	No	This parameter displays the state of the crank request input to the control module from the ignition switch. The scan tool will display Yes when the ignition switch is in the Crank position. The scan tool will display No when the ignition switch is in any other position.
Cruise Control Active	--	Inactive	This parameter displays the status of the cruise control system as determined by the control module. The scan tool will display Yes when the cruise control system is in control of vehicle speed. The scan tool will display No when the cruise control system is not operating.
Cruise Disengage 1-8 History	Cruise ON	None	The Scan tool displays the last 8 cruise control disengages in order from 1 to 8. There are 20 possible causes for the cruise control to disengage.
Cruise ON/OFF Switch	--	ON	This parameter displays the state of the ON/OFF switch input to the control module. The scan tool will display ON when the cruise ON/OFF switch is ON. The scan tool will display OFF when the cruise ON/OFF switch is OFF.
Cruise Resume/Accel Switch	--	Invalid	This parameter displays the state of the Resume/Accel switch input to the control module When the cruise control switch is in the ON position and the Resume/Accel switch is activated, the scan tool displays ON. When the Resume/Accel switch is released the scan tool displays OFF.
			This parameter displays the state of the Set/Coast switch input to the control module

Cruise Set/Coast Switch	--	Invalid	from the cruise control system. When the cruise control switch is in the ON position and the Set/Coast switch is activated, the scan tool displays ON. When the Set/Coast switch is released the scan tool displays OFF.
Cruise Control Cancel Switch	--	Off	This parameter displays the status of the cruise control cancel switch as determined by the control module. The scan tool will display On when the cruise control cancel switch is on. The scan tool will display Off when the cruise control cancel switch is off.
Cycles of Misfire Data	--	Incrementing 0-100	This parameter displays the number of cylinder firing events recorded by the control module
Cyl. 1-8 IC Ckt Short Gnd Test Status	--	OK	This parameter displays the status of the output driver for the ignition control circuits. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Cyl. 1-8 IC Ckt Open Test Status	--	OK	This parameter displays the status of the output driver for the ignition control circuits. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Cyl. 1-8 IC Ckt Short Volts Test Status	--	OK	This parameter displays the status of the output driver for the ignition control circuits. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Cyl. 1-8 Inj. Ckt Short Gnd Test Status	--	OK	This parameter displays the status of the output driver for the ignition control circuits. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Cyl. 1-8 Inj. Ckt Open Test Status	--	OK	This parameter displays the status of the output driver for the ignition control circuits. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Cyl. 1-8 Inj. Ckt Short Volts Test Status	--	OK	This parameter displays the status of the output driver for the ignition control circuits. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Decel. Fuel Cut-off	--	Inactive	This parameter displays the status of the operating mode used to turn OFF the fuel injectors during certain deceleration conditions. When the scan tool displays Active, the control module has turned OFF the fuel injectors. When the scan tool displays Inactive, the fuel system is operating normally.

Desired EGR Position	--	0%	This parameter displays the position of the exhaust gas recirculation (EGR) valve commanded by the control module. The scan tool will display 0 percent when the control module is commanding the EGR valve closed. The scan tool will display a higher percentage when the EGR valve is commanded open.
Desired Exh CMP Bank 1 or 2	--	Varies in degrees	This parameter displays the desired exhaust camshaft position for Bank 1 or 2, as determined by the control module. The scan tool will display a higher value for more advanced exhaust valve timing, such as at high load or speed conditions. The scan tool will display a lower value for a less advanced exhaust valve timing, such as at idle.
Desired Idle Speed	--	650-700	This parameter displays the engine idle speed in RPM as commanded by the control module. The control module compensates for various engine loads in order to maintain the desired engine speed at idle. This parameter is not valid unless the engine is running
Desired Int. CMP Bank 1 or 2	--	Varies in degrees	This parameter displays the desired exhaust camshaft position for Bank 1 or 2, as determined by the control module. The scan tool will display a higher value for more advanced intake valve timing, such as at high load or speed conditions. The scan tool will display a lower value for a less advanced intake valve timing, such as at idle.
Distance Since DTC Cleared	--	Varies	This parameter displays the distance accumulated since an emission diagnostic trouble code was cleared. The scan tool will display increasing distance as the vehicle is driven.
Distance Since First Failure	--	Varies	This parameter displays the distance accumulated when the emission diagnostic trouble code first failed.
Distance Since Last Failure	--	Varies	This parameter displays the distance accumulated when the emission diagnostic trouble code last failed.
Drag Control Status	--	Inactive	Drop Throttle Control Mode is active when the Requested Torque Signal indicates greater than 90 percent duty cycle while the Traction Control System Data Control Signal input is active.
Drop Throttle Status	--	Inactive	Drop Throttle Control Mode is active when the Requested Torque Signal indicates greater than 90 percent duty cycle while the Traction Control System Data Control Signal input is active.
			This parameter displays the status of the output driver for the engine control (EC)

EC Ignition Relay Ckt Short Gnd Test Status	--	Not Run	Ignition Relay control circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
EC Ignition Relay Ckt Open Test Status	--	Not Run	This parameter displays the status of the output driver for the engine control (EC) Ignition Relay control circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
EC Ignition Relay Ckt Short Volts Test Status	--	OK	This parameter displays the status of the output driver for the engine control (EC) Ignition Relay control circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
EC Ignition Relay Command	--	ON	This parameter displays the commanded state of the EC Ignition relay control circuit. The scan tool will display ON or OFF. ON indicates the EC ignition relay control circuit is being grounded by the control module, allowing voltage to other control module circuits and systems. OFF indicates the EC ignition relay is not being commanded ON by the control module.
EC Ignition Relay Feedback Signal	--	Battery Voltage	This parameter displays the voltage signal sent to the control module from the engine control ignition relay. The scan tool will display battery voltage when the engine is running. The scan tool will display no voltage when the relay is OFF.
ECM Authentication Status	--	Valid	This parameter indicates the result of the comparison between the last received immobilizer system response and the expected response calculated by the ECM.
ECM Challenge Status	--	Invalid	This parameter shows the immobilizer system status of the ECM challenge. This indicates whether the currently calculated ECM challenge is valid.
ECM Response Source	--	Normal	The parameter indicates the source used to calculate the ECM response. The sources include Normal Start, Remote Vehicle Start, PTO Remote Start.
ECT Sensor	--	85-105°C (185-220°F)	This parameter displays the temperature of the engine coolant based on the input from the engine coolant temperature (ECT) sensor. When the coolant temperature is low, the scan tool will display a low temperature. When the coolant temperature is high, the scan tool will display a high temperature.
			This parameter displays the engine load in percent based on inputs to the control module

Engine Load	--	25-30%	from various engine sensors. The scan tool will display a low percentage when the engine is at idle with little or no load. The scan tool will display a high percentage when the engine is running at a high RPM under a heavy load.
Engine OFF Time	--	Varies	This parameter displays the time elapsed since the engine turned OFF. The scan tool will display the time in hours, minutes and seconds. The engine OFF time will reset to zero when the engine starts.
Engine Oil Level Switch	--	OK	This parameter displays the status of the engine oil level switch as determined by the control module. The control module uses this information to turn ON the low engine oil lamp if the engine oil level remains approximately 1 quart low for a sufficient amount of time. The scan tool will display Low when the engine oil level is low. The scan tool will display OK when the engine oil level is correct.
Engine Oil Life Remaining	--	Varies	This parameter displays the amount engine oil life remaining before requiring an oil change based on calculations by the control module. The scan tool will display lower values as the engine oil life approaches 0 miles.
Engine Oil Pressure Switch	--	OK	This parameter displays the state of the EOP as determined by the control module. The control module monitors the EOP switch to determine if the EOP is sufficient. The scan tool will display low when the EOP is below a predetermined value.
Engine Oil Temperature Calculated	--	Varies °C/°F	This parameter displays the temperature of the engine oil as calculated by the control module using various sensor inputs. The engine oil temperature calculated has a range of values indicating a low value when the oil temperature is low to a high value when the oil temperature is high.
Engine Run Time	--	Varies	This parameter displays the time elapsed since the engine was started. The scan tool will display the time in hours, minutes and seconds. The engine run time will reset to zero when the engine stops running.
Engine Speed	--	650 RPM	This parameter displays the speed of the crankshaft as determined by the control module using an input from the CKP sensor. The scan tool will display a high value at high engine speeds and a low value at low engine speeds.
			This parameter displays the reason for the

EPM Inhibit Reason	--	None	regulated voltage control (RVC) override command. RVC lowers system operating voltage to reduce the system electrical load and improve fuel economy performance. The RVC command will be overridden if the voltage commanded is below the minimum system voltage required to ensure that the fuel demand, powertrain OBD diagnostics, airflow measurement, cylinder deactivation, or transmission control module functions will execute properly. Reasons include the following: None, Device Control, Fuel Demand, OBD Diagnostics, Airflow Measurement, Cylinder Deactivation, Transmission Control Module Request.
EVAP Fault History	--	No Fault	This parameter displays the result of the evaporative emission (EVAP) system diagnostic as determined by the control module. The scan tool will display various messages, depending on the result of the test.
EVAP Purge Solenoid Command	--	15%	This parameter displays the on-time or duty cycle of the EVAP purge solenoid commanded by the control module expressed as a percent. The scan tool will display a high percentage when the control module is commanding the EVAP purge solenoid to be open a large amount. The scan tool will display a low percentage when the control module is commanding the EVAP purge solenoid to be open a small amount. The scan tool will display 0 when the control module is commanding the EVAP purge solenoid closed.
EVAP Purge Solenoid Ckt Short Gnd Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the evaporative emission purge solenoid control circuit as determined by the control module. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
EVAP Purge Solenoid Ckt Open Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the evaporative emission purge solenoid control circuit as determined by the control module. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
EVAP Purge Solenoid Ckt Short Volts Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the evaporative emission purge solenoid control circuit as determined by the control module. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is

			operating correctly.
EVAP Vent Solenoid Command	--	Venting	This parameter displays the state of the EVAP vent solenoid commanded by the control module. The scan tool will display venting when the control module is commanding the EVAP vent solenoid to be open. The scan tool will display a not venting when the control module is commanding the EVAP vent solenoid to be closed.
EVAP Vent Solenoid Ckt Short Gnd Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the evaporative emission vent solenoid control circuit as determined by the control module. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
EVAP Vent Solenoid Ckt Open Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the evaporative emission vent solenoid control circuit as determined by the control module. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
EVAP Vent Solenoid Ckt Short Volts Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the evaporative emission vent solenoid control circuit as determined by the control module. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Exh CMP Angle Bank 1 or 2	--	0 Degrees	This parameter displays the actual exhaust camshaft position in degrees.
Exh CMP Bank 1 or 2 Command	--	0 Degrees	This parameter displays the degrees of advanced exhaust camshaft angle related to crankshaft position as commanded by the control module. The scan tool will display a higher value for a more advanced exhaust camshaft position. The scan tool will display a lower value when the exhaust camshaft is not being advanced, such as at idle.
Exh CMP Bank 1 or 2 Variance	--	0 Degrees	This parameter displays in degrees, the difference between the desired exhaust camshaft position and the actual exhaust camshaft position.
Exh CMP Bank 1 or Bank 2 Active Counter	--	Varies in counts	This parameter displays an incrementing counter when the control module receives a signal from the exhaust camshaft position (CMP) sensor.
Exh CMP Sol Bn 1 Ckt Short Volts Test	--	OK	This parameter displays the diagnostic state of the output driver for the Exh CMP solenoid Bn 1 control circuit as determined by the control module. The scan tool will display OK,

Status			Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Exh CMP Sol Bn 1 Ckt Open Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the Exh CMP solenoid Bn 1 control circuit as determined by the control module. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Exh CMP Sol Bn 1 Ckt Short Gnd Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the Exh CMP solenoid Bn 1 control circuit as determined by the control module. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Exh CMP Sol Bn 2 Ckt Short Volts Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the Exh CMP solenoid Bn 2 control circuit as determined by the control module. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Exh CMP Sol Bn 2 Ckt Open Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the Exh CMP solenoid Bn 2 control circuit as determined by the control module. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Exh CMP Sol Bn 2 Ckt Short Gnd Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the Exh CMP solenoid Bn 2 control circuit as determined by the control module. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Ext. Travel BPP Signal	--	Released	This parameter will display the state of the brake pedal, applied or released.
Fail Counter	--	Varies Counts	This parameter displays the number of times a specific diagnostic has run and failed.
FC Relay 1 Ckt Short Gnd Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the cooling fan relay 1 control circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
FC Relay 1 Ckt Open Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the cooling fan relay 1 control circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
FC Relay 1 Ckt Short Volts Test Status	--	Not Run	This parameter displays the diagnostic state of the output driver for the cooling fan relay 1 control circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.

FC Relay 1 Command	--	Varies ON/OFF	This parameter displays the commanded state of the cooling fan relay 1 control circuit. The cooling fan relay 1 should be ON when the scan tool indicates the FC relay 1 command is ON. The cooling fan relay 1 should be OFF when the scan tool indicates the FC Relay 1 Command is OFF.
FC Relays 2 and 3 Ckt Short Gnd Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the cooling fan relays 2 and 3 control circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
FC Relays 2 and 3 Ckt Open Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the cooling fan relays 2 and 3 control circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
FC Relays 2 and 3 Ckt Short Volts Test Status	--	Not Run	This parameter displays the diagnostic state of the output driver for the cooling fan relays 2 and 3 control circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
FC Relays 2 and 3 Command	--	Varies ON/OFF	This parameter displays the commanded state of the cooling fan relays 2 and 3 control circuit. The cooling fan relays 2 and 3 should be ON when the scan tool indicates the FC Relay 2 and 3 command is ON. The cooling fan relays 2 and 3 should be OFF when the scan tool indicates the FC Relay 2 and 3 command is OFF.
Fuel Level Sensor	--	Varies	This parameter displays the voltage from the sensor used to monitor the fuel level inside the fuel tank. The scan tool will display a low voltage reading when that the fuel level in the tank is low or near empty. The scan tool will display a high voltage reading when the fuel level in the tank is high or near full.
Fuel Level Sensor Left or Right Tank	--	0-5 Volts	This parameter displays the voltage signal received by the control module from the fuel level sensors.
Fuel Pump Relay Ckt Short Volts Test Status	--	OK	This parameter displays the diagnostic state of the Fuel Pump Relay circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Fuel Pump Relay Ckt Open Test Status	--	OK	This parameter displays the diagnostic state of the Fuel Pump Relay circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating

			correctly.
Fuel Pump Relay Ckt Short Gnd Test Status	--	OK	This parameter displays the diagnostic state of the Fuel Pump Relay circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Fuel Pump Relay Command	--	ON	This parameter displays the commanded state of the Fuel Pump Relay control circuit. The fuel pump relay should be ON when the scan tool indicates the Fuel Pump Relay command is ON. The fuel pump relay should be OFF when the scan tool indicates the Fuel Pump Relay Command is OFF.
Fuel Pump Relay Circuit Status	--	OK/Incomplete	This parameter displays the diagnostic state of the output driver for the Fuel Pump Relay control circuit. The scan tool will display OK if the circuit is operating correctly. The scan tool will display the appropriate fault if there is an open, short to ground or a short to voltage on the circuit.
Fuel Tank Level Remaining	--	Varies	This parameter displays the amount of fuel remaining in the fuel tank as measured in percentage. The control module determines the amount of fuel remaining in the tank by using information from the fuel level sensors. The scan tool will display a higher value with a full fuel tank, and a lower value with an empty fuel tank.
Fuel Tank Pressure Sensor	--	1.5 Volts	This parameter displays the voltage signal sent to the control module from the sensor used to monitor the pressure inside the fuel tank. The scan tool will display a low voltage when the pressure in the fuel tank is high. The scan tool will display a high voltage when the pressure in the fuel tank is low or in a vacuum.
Fuel Tank Pressure Sensor	--	0 inches H2O (0 mm Hg)	This parameter displays the fuel tank pressure as calculated based on a signal sent to the control module from the fuel tank pressure (FTP) sensor. The scan tool will display a low value when the pressure in the fuel tank is low or a vacuum. The scan tool will display a high value when the pressure in the fuel tank is high.
Fuel Tank Rated Capacity	--	17.5-20 gals (66.24-75.7 liter)	This parameter displays the rated maximum quantity of fuel the fuel tank will hold. This is calibrated in the control module to match the vehicle. See Owner's Manual-Capacities and Specifications.
			This parameter displays the fuel trim cell number as calculated by the control module based on engine speed and load inputs. The

Fuel Trim Cell	--	Varies	scan tool will display a lower number as conditions are nearer to idle, and a higher value as conditions approach maximum engine speed and maximum load.
Fuel Trim Learn	--	Enabled	This parameter indicated if the control module is adjusting long term fuel trim in response to the short term fuel trim. The scan tool displays Enabled or Disabled. When conditions are appropriate for enabling long term fuel trim corrections, the scan tool displays Enabled.
Fuel Trim System Test State	--	Monitoring	This parameter indicates the status of the Fuel Trim System Test. The scan tool will display Disabled, Enabled, Monitoring, or Run Purge Test.
Fuel Volatility	--	Varies	This parameter indicates the rate the fuel can be vaporized in the cylinder as calculated by the control module. The scan tool displays Low, Moderate, or High. The scan tool will display HIGH when the fuel volatility is high. The scan tool will display LOW when the fuel volatility is low.
GEN F-Terminal Signal	--	0-100%	This parameter indicates the generator field duty cycle as commanded by the voltage regulator or control module. The scan tool will display a higher value for a higher commanded generator output, and a lower value for a lower commanded generator output.
GEN L-Terminal Ckt Short Volts Test Status	--	OK	This parameter displays the diagnostic state of the Gen- L Terminal circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
GEN L-Terminal Ckt Open Test Status	--	OK	This parameter displays the diagnostic state of the Gen- L Terminal circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
GEN L-Terminal Ckt Short Gnd Test Status	--	OK	This parameter displays the diagnostic state of the Gen- L Terminal circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
GEN L-Terminal Command	--	0-100%	This parameter displays the control modules commanded state of the voltage regulator on the generator.
HO2S Bank 1 or 2 Sensor 1	--	80-850 mV	This parameter indicates the heated oxygen sensor (HO2S) bank 1 or bank 2, sensor 1 output voltage as measured by the control module. The scan tool value fluctuates constantly while operating in Closed Loop.

			The scan tool will display a higher value during rich running conditions, and a lower value during leaner running conditions.
HO2S Bank 1 or 2 Sensor 1 Heater	--	0.60-0.80 amps	This parameter displays the current through the control module when the bank 1 or bank 2, sensor 1 HO2S heater is commanded ON by the control module. HO2S Heater Bank 1 Sen. 1 is a range of values indicating a low current when the heater circuit resistance is high to a high current when the heater circuit resistance is low.
HO2S Bn 1 or 2 Sen 1 Heater Ckt Short Gnd Test Status	--	OK	This parameter displays the status of the output driver for the HO2S Heater Bank 1 or Bank 2 Senor 1. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
HO2S Bn 1 or 2 Sen 1 Heater Ckt Open Test Status	--	OK	This parameter displays the status of the output driver for the HO2S Heater Bank 1 or Bank 2 Senor 1. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
HO2S Bn 1 or 2 Sen 1 Heater Ckt Short Volts Test Status	--	OK	This parameter displays the status of the output driver for the HO2S Heater Bank 1 or Bank 2 Senor 1. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
HO2S Bn 1 or 2 Sen 1 Heater Command	--	0-99%	This parameter displays the commanded state of the Bank 1 or Bank 2 Sensor 1 heater by the control module. The scan tool will display a higher value as the heater command is increased, and a lower value if the heater is not commanded ON.
HO2S Bn 1 or 2 Sen 1 Heater Command	--	ON	This parameter displays the commanded state of the Bank 1 or Bank 2 Sensor 1 heater by the control module. The scan tool will display ON when the heater is commanded ON. The scan tool will display OFF when the heater is commanded OFF.
HO2S Bank 1 or 2 Sensor 2	--	80-850 mV	This parameter indicates the heated oxygen sensor (HO2S) bank 1 sensor 2 output voltage as measured by the control module. The scan tool value fluctuates constantly while operating in Closed Loop. The scan tool will display a higher value during rich running conditions, and a lower value during leaner running conditions.
HO2S Bank 1 or 2 Sensor 2 Heater		0.60-0.80 amps	This parameter displays the current through the control module when the bank 1 sensor 2 HO2S heater is commanded ON by the control module. HO2S Heater Bank 1 Sensor 2 is a range of values indicating a low current when the heater circuit resistance is

			high to a high current when the heater circuit resistance is low.
HO2S Bn 1 Sen 2 Heater Ckt Short Gnd Test Status	--	OK	This parameter displays the status of the output driver for the HO2S Heater Bank 1 Sen. 2. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
HO2S Bn 1 Sen 2 Heater Ckt Open Test Status	--	OK	This parameter displays the status of the output driver for the HO2S Heater Bank 1 Sen. 2. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
HO2S Bn 1 Sen 2 Heater Ckt Short Volts Test Status	--	OK	This parameter displays the status of the output driver for the HO2S Heater Bank 1 Sen. 2. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
HO2S Bn 1 or 2 Sen 2 Heater Command	--	0-99%	This parameter displays the commanded state of the Bank 1 Sensor 2 heater by the control module. The scan tool will display a higher value as the heater command is increased, and a lower value if the heater is not commanded ON.
HO2S Bn 1 or 2 Sen 2 Heater Command	--	ON	This parameter displays the commanded state of the Bank 1 Sensor 2 heater by the control module. The scan tool will display ON when the heater is commanded ON. The scan tool will display OFF when the heater is commanded OFF.
Hot Open Loop	--	Inactive	This parameter indicates the status of the fuel delivery system. The scan tool will display Active if the fuel system is running in open loop due to a temperature concern. The scan tool will display Inactive if the fuel system is operating normally.
IAT Sensor		Varies	This parameter displays the temperature of the air entering the engine as calculated by the control module based on the input from the intake air temperature (IAT) sensor. The scan tool will display a low value when the air temperature is low, and a high value when the air temperature is high.
IAT Sensor 2	--	Varies	This parameter displays the temperature of the air entering the engine as calculated by the control module based on the input from the IAT sensor 2. The scan tool will display a low value when the air temperature is low, and a high value when the air temperature is high.
Ignition			This parameter displays the state of the ignition 0 input to the control module from the ignition switch. The scan tool will display

Accessory Signal	--	OFF	ON when the ignition switch is in the ignition accessory position. The scan tool will display OFF when the ignition switch is in any other position.
Ignition 1 Signal	--	Battery Voltage	This parameter displays the voltage measured at the ignition 1 circuit of the control module. Voltage is applied to the control module when the ignition switch is in the ignition 1 position. The scan tool will display a low value when the voltage is low. The scan tool will display a high value, such as battery voltage, when the voltage is higher.
Ignition OFF Time	--	Varies	This parameter displays the time elapsed since the ignition was last turned OFF. The scan tool will display the time in hours, minutes and seconds. The ignition OFF time will reset to zero when the ignition is turned ON.
Injector PWM Bank 1 or Bank 2	--	2.0-5.4 ms	This parameter indicates the average commanded ON time for each injector on Bank 1 or Bank 2 by the control module. The scan tool will display a larger value for a longer injector commanded ON time, causing more fuel to be delivered to the cylinders. The scan tool will display a smaller value for a shorter injector commanded ON time, causing less fuel to be delivered to the cylinders.
Injector 1-8 Disabled Due To Misfire	--	No	This parameter displays the status of the fuel injector driver by the control module. The scan tool will display YES if the fuel injector is being disabled due to a misfire detection. The scan tool will display NO if the fuel injector is not being disabled by the control module due to a misfire.
Int. CMP Angle Bank 1 or 2	--	0 Degrees	This parameter displays the degrees of advanced intake camshaft angle related to crankshaft position as determined by the control module based on input from the intake CMP sensors. The scan tool will display a higher value for a more advanced intake camshaft position. The scan tool will display a lower value when the intake camshaft is not being advanced, such as at idle.
Int. CMP Bank 1 or 2 Command	--	0 Degrees	This parameter displays the degrees of advanced intake camshaft angle related to crankshaft position as commanded by the control module. The scan tool will display a higher value for a more advanced intake camshaft position. The scan tool will display a lower value when the intake camshaft is not being advanced, such as at idle.
			This parameter indicates the difference

Int. CMP Bank 1 or 2 Variance	--	0 Degrees	between the actual camshaft angle and the commanded camshaft angle as determined by the control module. The scan tool will display a higher value for larger differences, or a lower value if there is only a small difference.
Int. CMP Bank 1 or 2 Active Counter	--	Varies in counts	This parameter displays an incrementing counter when the control module receives a signal from the intake camshaft position (CMP) sensor.
Int CMP Sol Bn 1 Ckt Short Volts Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the Int CMP solenoid Bn 1 control circuit as determined by the control module. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Int CMP Sol Bn 1 Ckt Open Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the Int CMP solenoid Bn 1 control circuit as determined by the control module. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Int CMP Sol Bn 1 Ckt Short Gnd Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the Int CMP solenoid Bn 1 control circuit as determined by the control module. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Int CMP Sol Bn 2 Ckt Short Volts Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the Int CMP solenoid Bn 2 control circuit as determined by the control module. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Int CMP Sol Bn 2 Ckt Open Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the Int CMP solenoid Bn 2 control circuit as determined by the control module. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Int CMP Sol Bn 2 Ckt Short Gnd Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the Int CMP solenoid Bn 2 control circuit as determined by the control module. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Intake Manifold Pressure	--	70-75 kPa	This parameter displays the pressure difference between the MAP and the barometric pressure (BARO) as calculated by the control module. The scan tool will display a higher value during high vacuum conditions, such as idle or deceleration. The scan tool will display a lower value during low

			vacuum conditions, such as wide open throttle or low load cruising.
Knock Detected Cyl. 1-8	--	NO	This parameter displays the status of each cylinder for knock detection by the control module. The scan tool will display YES if a knock condition has been detected related to that cylinder combustion event. The scan tool will display NO if there is no knock condition detected related to that cylinder combustion event.
Knock Retard	--	0	This parameter indicates the amount of spark advance the control module removes from the ignition control (IC) spark advance in response to the signal from the knock sensors. The scan tool displays a high value for a large amount of spark retard, and a low value for a small amount of spark retard.
Long Term FT Bank 1 or Bank 2	--	0% ± 10%	This parameter is calculated by the control module based on the Short Term FT value. The Long Term FT bank 1 is used for the long term correction of the fuel delivery in bank or bank 2. The scan tool will a high value for a large amount of long term fuel correction, and 0 percent for no long term fuel trim correction. The scan tool will display a negative value when fuel system is running too rich and fuel is being removed from the combustion event. The scan tool will display a positive value if the fuel system is running lean and fuel is being added to the combustion event.
LT FT Test Avg. Bank 1 or Bank 2	--	1%	This parameter is calculated by the control module based on an intrusive test by the control module. The Long Term FT test average used for the long term correction of the fuel delivery in each bank. The scan tool will a high value for a large amount of long term fuel correction, and 0 percent for no long term fuel trim correction. The scan tool will display a negative value when fuel system is running too rich and fuel is being removed from the combustion event. The scan tool will display a positive value if the fuel system is running lean and fuel is being added to the combustion event.
LT FT Avg. Bank 1 or Bank 2 w/o	--	1%	This parameter is calculated by the control module based on the Short Term FT value. The Long Term FT bank 1 is used for the long term correction of the fuel delivery in bank 1. The scan tool will display a high value for a large amount of long term fuel correction, and 0 percent for no long term fuel trim correction. The scan tool will display a

Purge			negative value when fuel system is running too rich and fuel is being removed from the combustion event. The scan tool will display a positive value if the fuel system is running lean and fuel is being added to the combustion event.
Loop Status	--	Closed	This parameter displays the state of the fuel control system as commanded by the control module. Closed Loop operation indicates that the control module is controlling the fuel delivery based off the oxygen sensors input signal. In Open Loop operation the control module ignores the oxygen sensor input signal and bases the amount of fuel to be delivered on other sensor inputs.
Low EOP Indicator Command	--	OFF	• This parameter displays the commanded state of the low oil lamp control circuit. The low oil lamp should be ON when the scan tool indicates the Low Oil Lamp Command is ON. The low oil lamp should be OFF when the scan tool indicates the Low Oil Lamp Command is OFF. • The scan tool displays ON/OFF • The scan tool displays ON or OFF. The scan tool displays ON when the ECM detects that there is a low oil level condition. The low oil lamp is then commanded ON by the ECM. • Scan tool displays ON or OFF. Represents the commanded state of the Low Oil Lamp indicator control circuit.
MAF Performance Test	--	OK	This parameter displays the status of the mass air flow (MAF) performance test by the control module. The scan tool will display OK if no fault is found. The scan tool will display Fault if the control module detects a fault during the test.
MAF Sensor	Engine Idling	3.4-6.5 g/s	This parameter indicates the quantity calculated by the control module based on a signal from the MAF sensor. The scan tool will display a high value at high engine speeds, and a low value at low engine speeds.
	Engine speed at 2,500 RPM	11.88 g/s	
MAF Sensor	--	1510-3224 Hz	This parameter indicates the frequency signal received from the MAF sensor by the control module. The scan tool will display a high value at high engine speeds, and a low value at low engine speeds.
MAP Performance	--	OK	This parameter displays the status of the MAP performance test 1 by the control module. The scan tool will display OK if no fault is

Test 1			found. The scan tool will display Fault if the control module detects a fault during the test.
MAP Performance Test 2	--	OK	This parameter displays the status of the MAP performance test 2 by the control module. The scan tool will display OK if no fault is found. The scan tool will display Fault if the control module detects a fault during the test.
MAP Sensor	--	30-38 kPa	This parameter indicates the manifold absolute pressure inside the engine as calculated by the control module based on the signal from the MAP sensor. The scan tool will display a higher value wide open throttle, and a lower value at idle.
MAP Sensor	--	0.75-1.40 Volts	This parameter indicates the voltage signal received by the control module from the MAP sensor. The scan tool displays a low voltage at idle, and a high voltage at wide open throttle. Barometric pressure and altitude can effect these values.
MIL Ckt Short Gnd Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the malfunction indicator lamp control (MIL) circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
MIL Ckt Open Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the malfunction indicator lamp control (MIL) circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
MIL Ckt Short Volts Test Status	--	Not Run	This parameter displays the diagnostic state of the output driver for the malfunction indicator lamp control (MIL) circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
MIL Command	--	OFF	This parameter displays the commanded state of the MIL control circuit. The MIL should be ON when the scan tool indicates the MIL Command is ON. The malfunction indicator lamp should be OFF when the scan tool indicates the MIL Command is OFF. The control module will command the MIL ON when the ignition is ON with the engine OFF in order to perform a bulb check.
MIL Requested by DTC	--	NO	This parameter indicates the reason the control module illuminated the MIL. The scan tool will display YES when the MIL is requested as a result of an A or B type DTC. The scan tool will display NO if the MIL is illuminated for another reason, such as

			transmission DTCs.
Misfire Current Cyl. 1-8	--	0	This parameter displays the number of possible misfires during the last 200 cylinder firing events detected on Cylinders 1-8 as calculated by the control module. The misfires are calculated based on engine crankshaft rotation speed variations. The scan tool displays an incrementing counter. This counter should display some activity, but the activity should be the same for all cylinders.
Misfire History Cyl. 1-8	--	0	This parameter displays the number of possible misfires that have occurred after 195 current misfires have been counted on Cylinders 1-8 as calculated by the control module. The misfires are calculated based on engine crankshaft rotation speed variations. The scan tool displays an incrementing counter. This counter should display some activity, but the activity should be the same for all cylinders.
Not Run Counter	--	Varies	This parameter displays the number of ignition cycles that a DTC has not run. The scan tool display will increment as the number of ignition cycles increase without a DTC pass or Fail.
Pass Counter	--	Counts	The scan tool displays the number of times a DTC has run and passed.
PNP Switch	--	P/N	This parameter indicates the range selection of the automatic transmission as calculated by the control module based on input from the PNP switch. The scan tool will display, In Gear, Park, or Neutral depending on the PNP switch position.
Power Enrichment	--	Inactive	This parameter indicates if the control module has detected conditions appropriate to operate in Power Enrichment mode. The scan tool will display Active if the mode is in operation, and Inactive if the mode is not in operation. The control module enters Open Loop operation and increases injector pulse width when in power enrichment mode.
Reduced Engine Power	--	Inactive	This parameter indicates if the control module has detected that a TAC system fault has occurred. The scan tool will display Active if the mode is in operation, and Inactive if the mode is not in operation. The control module limits engine power when this mode is Active.
Reverse Inhibit Command	--	OFF	This parameter displays the commanded state of the reverse inhibit solenoid control circuit. The reverse inhibit solenoid should be ON when the scan tool indicates the Reverse Inhibit Solenoid Command is ON. The reverse

			inhibit solenoid should be OFF when the scan tool indicates the Reverse Inhibit Solenoid Command is OFF.
Reverse Inhibit Solenoid Command	--	OFF	This parameter displays the commanded state of the reverse inhibit solenoid control circuit. The reverse inhibit solenoid should be ON when the scan tool indicates the Reverse Inhibit Solenoid Command is ON. The reverse inhibit solenoid should be OFF when the scan tool indicates the Reverse Inhibit Solenoid Command is OFF.
Rev. Inhibit Solenoid Ckt Short Gnd Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the Reverse Inhibit Solenoid circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Rev. Inhibit Solenoid Ckt Open Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the Reverse Inhibit Solenoid circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Rev. Inhibit Solenoid Ckt Short Volts Test Status	--	OK	This parameter displays the diagnostic state of the output driver for the Reverse Inhibit Solenoid circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
RVS Disable 1-8 History	--	None	This parameter displays one of the last eight reasons that powertrain has disabled remote vehicle start (RVS).
RVS Request Signal	--	ON/OFF	This parameter indicates the state of the request received over serial communication from the remote vehicle start (RVS) system to start the vehicle in remote mode.
Short Term FT Bank 1 or Bank 2	--	0% ± 10%	This parameter displays the short term correction to fuel delivery for bank 1 or bank 2 by the control module in response to the amount of time the oxygen sensor voltage spends above or below the 450 mV threshold. The scan tool will display 0 percent if no adjustments are required. The scan tool will display a higher positive value if fuel has to be added, and a higher negative value if fuel has to be removed.
Spark	--	9-11°	This parameter displays the spark timing being commanded by the control module ON the IC circuit. The scan tool will display a negative value if the spark timing is before top dead center (BTDC) or spark advance; the scan tool will display a positive value if the spark timing is after top dead center (ATDC) or spark retard. Because the ignition control module sets spark advance at a fixed

			value BTDC while operating in bypass mode, the displayed spark advance only reflects true spark timing when the PCM has commanded IC mode.
Start Up ECT	--	Varies	This parameter Indicates the engine coolant temperature at engine start up as calculated by the control module based on the signal from the ECT sensor. The scan tool will display a higher value on a warmer engine, and a lower value on a colder engine.
Start Up IAT	--	Varies	This parameter Indicates the intake air temperature at engine start up as calculated by the control module based on the signal from the IAT sensor. The scan tool will display a higher value during warmer under hood temperatures, and a lower value during colder under hood temperatures.
ST FT Test Avg. Bank 1 or Bank 2	--	1%	This parameter is calculated by the control module based on an intrusive test by the control module. The Short Term FT Test Average used for the short term correction of the fuel delivery in each bank. The scan tool will display a high value for a large amount of short term fuel correction, and 0% for no short term fuel trim correction. The scan tool will display a negative value when fuel system is running too rich and fuel is being removed from the combustion event. The scan tool will display a positive value if the fuel system is running lean and fuel is being added to the combustion event.
Starter Relay Ckt Short Gnd Test Status	--	OK	The scan tool displays OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Starter Relay Ckt Open Test Status	--	OK	The scan tool displays OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Starter Relay Ckt Short Volts Test Status	--	Not Run	The scan tool displays OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Starter Relay Command	--	OFF	The scan tool displays ON/OFF. The scan tool displays OFF until the ignition is placed into the CRANK position, then it reads ON.
TAC Forced Engine Shutdown	--	NO	This parameter indicates the status of TAC control by the control module. The scan tool will display YES if the engine has been shut down due to a throttle control fault. The scan tool will display NO if the engine has not been shut down by a throttle control fault.
TAC Motor	--	Enabled	This parameter indicates the status of the TAC motor driver by the ECM. The scan tool will display Enabled if TAC motor operation is

			allowed. The scan tool will display disabled if the TAC motor is disabled.
TAC Motor Command	--	15-25%	This parameter indicates the required duty cycle to maintain a desired throttle position. The scan tool will display a higher value if more effort is required to move the throttle to the desired position, such as physical resistance. The scan tool will display a lower value if less effort is required to move the throttle to the desired position.
TCS and Drop Throttle Status	--	Inactive	TCS Active and Drop Throttle Control Mode is active when the Requested Torque Signal is within the TCS region, 40-90 percent duty cycle, while the Traction Control System Data Control Signal input is Active.
TCS Torque Request Signal	--	3 N·m (2 lbs ft)	This parameter indicates the percentage of available torque requested from the engine to the transmission as calculated by the control module. The scan tool will display a higher value for higher torque, and a lower value for lower torque.
TCS Torque Request Signal	--	100%	This parameter indicates the torque requested from the engine to the transmission as calculated by the control module. The scan tool will display a higher value for higher torque, and a lower value for lower torque.
TCS Torque Delivered Signal	--	1%	This parameter indicates the torque delivered from the engine to the transmission as calculated by the control module. The scan tool will display a higher value for higher torque, and a lower value for lower torque.
TFT Sensor	--	Varies °C/°F	• The scan tool displays °C (°F). This value represents the input signal of the transmission fluid temperature sensor. • The scan tool range is -40 to +150°C (-40 to +302°F). This display indicates the temperature of the transmission fluid. • Scan Tool Range -39 to +140°C (-38 to +284°F). The Trans Fluid Temp. sensor parameter displays the temperature of the manual transmission.
Torque Management Spark Retard	--	0°	This parameter indicates how much the ignition spark timing is being retarded to control torque by the control module. The scan tool will display a higher value under extreme torque control conditions such as spinning wheels. The scan tool will display a lower value under low torque control conditions such as light driving.

Total Knock Retard	--	0°	This parameter indicates how much ignition spark timing is being retarded due to all control systems monitored by the control module. The scan tool will display a high value during extreme conditions such as high temperatures and antilock braking. The scan tool will display a lower value during lighter driving conditions.
Total Misfire	--	0	This parameter displays the number of possible misfires during the last 200 cylinder firing events detected on all cylinders as calculated by the control module. The misfires are calculated based on engine crankshaft rotation speed variations. The scan tool displays an incrementing counter.
TP Desired Angle	--	2-6%	This parameter indicates the desired throttle angle calculated by the TAC module as commanded by the vehicle operator. The scan tool will display a higher value when the accelerator pedal is depressed, and a lower value as the accelerator pedal is released.
TP Indicated Angle	--	2-6%	This parameter displays the angle of the throttle plate as calculated by the control module using the signals from the throttle position (TP) sensors. The TP indicated angle is a range of values indicating a low percentage when the throttle is closed to a high percentage when the throttle is wide open.
TP Performance Test	--	OK	This parameter displays the status of the TP performance test by the control module. The scan tool will display OK if no fault is found. The scan tool will display Fault if the control module detects a fault during the test.
TP Sensor 1	--	4.1-4.5 Volts	This parameter displays the voltage signal sent to the control module from TP sensor 1 of the throttle assembly. The TP sensor 1 is a range of values indicating a high voltage when the throttle is closed to a low voltage when the throttle plate is fully open.
TP Sensor 1 Indicated Position	--	2%	This parameter displays the angle of the throttle position (TP) sensor 1 as calculated by the control module using the signal from the TP sensor 1. The TP sensor 1 is a range of values indicating a low percentage when the throttle is closed to a high percentage when the throttle is fully open.
TP Sensors 1 and 2	--	Agree	This parameter displays the results of a control module test that compares the signals from the TP sensors 1 and 2. The scan tool will display Agree or Disagree. Agree indicates that TP sensor 1 and TP sensor 2 voltages correspond to the same throttle

			position. Disagree indicates that TP sensor 1 and TP sensor 2 voltages correspond to different throttle positions.
TP Sensor 2	--	0.5-0.8 Volts	This parameter displays the voltage signal sent to the control module from TP sensor 2 of the throttle assembly. The TP sensor 2 is a range of values indicating a low voltage when the throttle is closed to a high voltage when the throttle plate is fully open.
TP Sensor 2 Indicated Position	--	2%	This parameter displays the angle of the TP sensor 2 as calculated by the control module using the signal from the TP sensor 2. The TP sensor 2 is a range of values indicating a low percentage when the throttle is closed to a high percentage when the throttle is fully open.
Torque Delivered Signal	--	N·m (lbs ft) Varies	• This parameter indicates the amount of available engine torque. • Scan tool range 0-100 percent. Represents the PWM signal which indicates the percent of available torque the engine is delivering to the drive wheels. The EBTCM monitors the Traction Control Torque signal to ensure that the PCM is responding properly to the Traction Control Desired Torque signal. • The scan tool displays -473 to +473 N·m/-349 to 349 lbs ft This is the calculated torque output from the engine to the transaxle used by the EBTCM for the traction control system operation.
Traction Control Status	--	Inactive	This parameter indicates the status of the traction control system as reported by the control module. The scan tool will display ACTIVE if the traction control system is taking action to reduce drive wheel slippage. The scan tool will display INACTIVE if the traction control system is not being required to take action to reduce drive wheel slippage.
Vehicle Speed Ckt Short Volts Test Status	--	OK	This parameter displays the diagnostic state of the Vehicle Speed Sensor circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Vehicle Speed Ckt Open Test Status	--	OK	This parameter displays the diagnostic state of the Vehicle Speed Sensor circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.

Vehicle Speed Ckt Short Gnd Test Status	--	OK	This parameter displays the diagnostic state of the Vehicle Speed Sensor circuit. The scan tool will display OK, Fault or Not Run. The scan tool will display OK if the circuit is operating correctly.
Vehicle Speed Sensor	--	0 km/mi	This parameter indicates the vehicle speed as calculated by the control module based on a signal from the vehicle speed sensor (VSS). The scan tool will display a higher value at higher vehicle speeds, and a lower value at lower vehicle speeds.
VTD Auto. Learn Counter	--	Counts	The scan tool displays the count value when using the 30-minute reprogramming procedure. Three 10-minute cycles, or three counts, are required to complete the 30-minute auto learn reprogramming procedure.
VTD Auto. Learn Timer	--	Inactive	This parameter indicates that either the auto learn timer (used in the auto learn procedure to enable VTD password learning) or the seed and key timer (used in the seed and key procedure to enable VTD password learning) is active.
VTD Fuel Disable	--	Inactive	This parameter indicates the VTD system has disabled fuel.
VTD Fuel Disable Until Ign. OFF	--	NO	This parameter indicates the VTD system has disabled fuel for the remainder of the ignition cycle.
VTD Fuel Enabled	--	Yes	This parameter indicates the VTD system has enabled fuel.
VTD Password Learn Enabled	--	No	The scan tool will display Yes when a valid theft password has been learned.
VTD Password Learned	--	No	This indicates learning of the VTD password received from the platform electronics is enabled. VTD password learning is first enabled in assembly plant (prior to the manufacturer’s enable counter being set to zero) may be re-enabled using 1 of 2 procedures.
VTD Security Code Accepted	--	No	This parameter indicates that the received immobilizer system security code is correct.
VTD Security Code Lockout	--	Inactive	This parameter displays Active or Inactive. Security Code Lockout Active indicates that the security code has not passed and lockout is active.
VTD Security Code Programmed	--	No	This parameter indicates if the immobilizer system security code has been programmed.
VTD Security Info. Programmed	--	Yes	This parameter indicates if the immobilizer secret information, e.g. powertrain pre-release password, powertrain secret key, has been programmed.

VTD System Status	--	Dis. Neg. Resp.	This parameter indicates the current state of the immobilizer algorithm. The states include the following: Standby, Disabled at Startup, Disabled Due to No Response, Disabled Due to Negative Response, Disabled Due to Incorrect Response, Post Release, Pre-Release, Released.
Warm-ups Since DTC Cleared	--	Varies	This parameter indicates the number of warm up cycles that have occurred Since DTCs were cleared. The scan tool will display a higher counts as more warm up cycles have occurred since the DTCs were cleared.
Warm-ups w/o Emission Faults	--	Varies	This parameter indicates the number of warm up cycles that have occurred without an emission fault present. The scan tool will display a 0 if a fault has occurred. The scan tool will display a higher count if a number of warm up cycles have occurred without an emission fault.
Warm-ups w/o Non-emission Faults	--	Varies	This parameter indicates the number of warm up cycles that have occurred without a non-emission fault present. The scan tool will display a 0 if a fault has occurred. The scan tool will display a higher count if a number of warm up cycles have occurred without a non-emission fault.
Wide Open Throttle	--	NO	This parameter indicates the throttle status commanded by the control module. The scan tool will display YES is the vehicle throttle is commanded to wide open. The scan tool will display NO if the vehicle throttle is commanded to an amount less than 100%.

Output Control

Parameter	Description
A/C Relay	The engine must be running and the ECM must receive an A/C request from the HVAC control module in order to enable the output control. The ECM de-energizes the A/C compressor clutch relay when you select OFF. The relay remains de-energized until you select ON.
CMP Actuator	This function controls the camshaft actuator Ssolenoid. The normal commanded state is NONE. The system will increase or decrease the angle of the selected camshaft in 5 degree increments up to 25 crankshaft degrees. The scan tool initiates the test when the following conditions are met: • The vehicle speed is 0 km/h (0 mph). • The transmission is in Park or Neutral. • The engine speed is between 1,000-1,400 RPM. The system remains in the commanded state until cancelled by the scan tool.
CMP Actuator Solenoid	This function controls the camshaft actuator. The normal commanded state is NONE. The system will increase or decrease the angle of the camshaft in 5

	degree increments up to 20 crankshaft degrees. The engine must be OFF.
Cylinder Power Balance	Enables/disables a cylinder by turning OFF the fuel injector to the cylinder. The fuel injector is normally enabled. The control module disables the fuel injector when the following conditions are met: • The engine speed has stabilized. • The fuel injector has been selected. When DISABLE is selected, the control module turns the injector OFF for 30 seconds.
Dash Lamps	Malfunction Indicator Lamp--Controls the malfunction indicator lamp (MIL). The commanded states include NONE, ON, and OFF. When commanded ON or OFF, the system remains in the commanded state until cancelled by the scan tool.
Engine Controls Ignition Relay	This function activates the engine control (EC) ignition relay. The normal commanded state is NONE. When commanded ON or OFF, the engine control module (ECM) turns the relay ON or OFF. The system remains in the commanded state until cancelled by the scan tool.
Engine Speed Control	Activates the idle air control (IAC) valve to change engine RPM. The normal commanded state is NONE. To enable the RPM control, all instruction on the scan tool must be completed. The system will INCREASE or DECREASE the engine speed. The SET STEP VALUE changes the engine speed by increments of 25 RPM, 100 RPM, and 500 RPM. The system remains in the commanded state until cancelled by the tool.
EVAP Purge Solenoid	Activates the EVAP Purge Valve. The normal commanded state is NONE. The system will INCREASE or DECREASE the amount of EVAP purge valve opening by 10 percent increments within a range of 0-100 percent. The system remains in the commanded state until cancelled by the tool or the fuel tank pressure exceeds 24 mm Hg (12 in H2O).
EVAP Service Test	Activates the on-board EVAP diagnostic test.
EVAP Vent Solenoid	Activates the EVAP vent solenoid. The normal commanded state is NONE. When commanded ON, the vent valve switches to non-venting. The system remains in the commanded state unless one of the following conditions occurs: • Cancelled by the tool • Purge is greater than 0 percent, and the fuel tank pressure exceeds 24 mm Hg (12 in H2O).
EVAP Purge/Seal	This control enables 2 functions. One function increases or decreases the amount of purge by changing the duty cycle of the purge valve and commanding the vent ON (non-venting). The normal commanded state of both valves is NONE. The system will INCREASE or DECREASE the amount of EVAP purge valve opening by 10 percent increments within a range of 0-100 percent. The second function seals the system after using the purge function to obtain a specific amount of fuel tank pressure (FTP). When activated the purge valve is commanded to 0 percent and the vent valve is commanded ON (non-venting). Both functions remain in the commanded state until cancelled by the tool or the FTP exceeds 24 mm Hg (12 in H2O).
	This function controls the exhaust camshaft actuator for bank 1. The normal

Exhaust CMP Actuator Bank 1	commanded state is NONE. The system will increase or decrease the angle of the selected camshaft in 5 degree increments up to 25 crankshaft degrees. The scan tool initiates the test when the following conditions are met: • The vehicle speed is 0 km/h (0 mph). • The transmission is in Park or Neutral. • The engine speed is between 1,000-1,400 RPM. The system remains in the commanded state until cancelled by the scan tool.
Exhaust CMP Actuator Bank 2	This function controls the exhaust camshaft actuator for bank 2. The normal commanded state is NONE. The system will increase or decrease the angle of the selected camshaft in 5 degree increments up to 25 crankshaft degrees. The scan tool initiates the test when the following conditions are met: • The vehicle speed is 0 km/h (0 mph). • The transmission is in Park or Neutral. • The engine speed is between 1,000-1,400 RPM. The system remains in the commanded state until cancelled by the scan tool.
Exhaust CMP Actuator Sol. Bank 1	This function controls the exhaust camshaft actuator solenoid for bank 1. The normal commanded state is NONE. When commanded ON/OFF, the ECM turns the camshaft actuator solenoid ON/OFF. The scan tool initiates the test when the following conditions are met: • The ignition is ON with the engine OFF. • No engine speed is detected. The system remains in the commanded state until cancelled by the scan tool.
Exhaust CMP Actuator Sol. Bank 2	This function controls the exhaust camshaft actuator solenoid for bank 2. The normal commanded state is NONE. When commanded ON/OFF, the ECM turns the camshaft actuator solenoid ON/OFF. The scan tool initiates the test when the following conditions are met: • The ignition is ON with the engine OFF. • No engine speed is detected. The system remains in the commanded state until cancelled by the scan tool.
Fan Relay 1	Commands the low speed fan relay ON and OFF. Both cooling fans will activate on low speed
Fan Relays 2 and 3	Commands the series parallel and high speed fan relays ON and OFF. The driver side fan will be OFF. The passenger side fan will activate on high speed.
Fan Relays 1, 2 and 3	Commands the low speed fan , high speed fan, and series parallel relays ON and OFF. Both fans will activate on high speed.
	Enables the fuel injector in order to verify proper fuel injector flow. The ECM will pulse the selected injector when the following conditions are met:

Fuel Injector Balance	• All instruction on the scan tool completed • Fuel injector selected • Key ON, engine OFF The selected fuel injector can only be flowed/pulsed once per ignition cycle.
Fuel Pump Relay	Controls the fuel pump relay. The normal commanded state is NONE. When commanded ON/OFF, the PCM turns the fuel pump ON/OFF. If the engine is running, and the fuel pump is commanded OFF, the engine will stall. The system remains in the commanded state until cancelled by the scan tool.
Fuel Trim Enable	Disables the ECM ability to learn new fuel trim parameters. The commanded states are NONE, ENABLED, DISABLED. The normal commanded state is NONE. The system remains in the commanded state until cancelled by the scan tool.
Fuel Trim Reset	Activates the reset of fuel trim data in all fuel trim cells.
GEN L-Terminal	The commanded states are ON and OFF. Selecting OFF commands the ECM to turn OFF the generator and stop generating an output voltage.
HO2S Heater Bank 1 Sensor 1 Command	Activates the HO2S bank 1 sensor 1 heater. The commanded states include NONE, ON, and OFF. The normal commanded state is NONE. Commanding the HO2S bank 1 sensor 1 heater ON turns on the heater driver. The system remains in the commanded state until cancelled by the tool.
HO2S Heater Bank 1 Sensor 2 Command	Activates the HO2S bank 1 sensor 2 heater. The commanded states include NONE, ON, and OFF. The normal commanded state is NONE. Commanding the HO2S bank 1 sensor 2 heater ON turns on the heater driver. The system remains in the commanded state until cancelled by the tool.
HO2S Heater Bank 2 Sensor 1 Command	Activates the HO2S bank 2 sensor 1 heater. The commanded states include NONE, ON, and OFF. The normal commanded state is NONE. Commanding the HO2S bank 2 sensor 1 heater ON turns on the heater driver. The system remains in the commanded state until cancelled by the tool.
HO2S Heater Learn	his output control is used to trigger the reset of the learned resistances for the oxygen sensor heaters following a replacement in service. The learned resistances are reset to a calibration used to prevent overheating of the sensors until more accurate resistances may be learned following an extended engine OFF time, typically 12 or more hours.
Idle Spark	Disables and enables idle spark advance with the engine running.
Intake CMP Actuator Bank 1	This function controls the intake camshaft actuator for bank 1. The normal commanded state is NONE. The system will increase or decrease the angle of the selected camshaft in 5 degree increments up to 20 crankshaft degrees. The scan tool initiates the test when the following conditions are met: • The vehicle speed is 0 km/h (0 mph). • The transmission is in Park or Neutral. • The engine speed is between 1,000-1,400 RPM. The system remains in the commanded state until cancelled by the scan tool.
	This function controls the intake camshaft actuator for bank 2. The normal commanded state is NONE. The system will increase or decrease the angle of the selected camshaft in 5 degree increments up to 20 crankshaft degrees.

Intake CMP Actuator Bank 2	The scan tool initiates the test when the following conditions are met: • The vehicle speed is 0 km/h (0 mph). • The transmission is in Park or Neutral. • The engine speed is between 1,000-1,400 RPM. The system remains in the commanded state until cancelled by the scan tool.
Intake CMP Actuator Sol. Bank 1	This function controls the intake camshaft actuator solenoid for bank 1. The normal commanded state is NONE. When commanded ON/OFF, the ECM turns the camshaft actuator solenoid ON/OFF. The scan tool initiates the test when the following conditions are met: • The ignition is ON with the engine OFF. • No engine speed is detected. The system remains in the commanded state until cancelled by the scan tool.
Intake CMP Actuator Sol. Bank 2	This function controls the intake camshaft actuator solenoid for bank 2. The normal commanded state is NONE. When commanded ON/OFF, the ECM turns the camshaft actuator solenoid ON/OFF. The scan tool initiates the test when the following conditions are met: • The ignition is ON with the engine OFF. • No engine speed is detected. The system remains in the commanded state until cancelled by the scan tool.
Loop Status	Controls the system loop status. The commanded states include NONE, OPEN, or CLOSED. The normal commanded state is NONE. When commanded OPEN or CLOSED, the system remains in the commanded state until cancelled by the scan tool.
Malfunction Indicator Lamp	Controls the malfunction indicator lamp (MIL). The commanded states include NONE, ON, and OFF. When commanded ON or OFF, the system remains in the commanded state until cancelled by the scan tool.
Misfire Graphic	Graphs the accumulated misfires occurring in each cylinder. The scan tool allows for a reset of the misfire graph.
Reverse Inhibit	This device control is used to override the state of the Reverse Inhibit output.
RVS Disable History Reset	This output control is used to trigger the reset of the last 8 reasons the ECM has disabled remote vehicle start (RVS).
Spark Retard	Controls the amount of spark retard. The normal commanded state is NONE. The system will INCREASE or DECREASE the amount of spark retard by 1 degree increments within a range of 0-10 degrees maximum retard. The system remains in the commanded state until cancelled by the tool.
Starter Relay	This output control is used to override the state of the Starter Relay output. Fuel and spark are disabled to prevent the engine from starting if the starter relay output is commanded ON.
	This function opens the throttle plate in 10 percent increments. The scan tool initiates the test when the following conditions are met:

Throttle Position	- The ignition is ON, with the engine OFF. - The vehicle speed is 0 km/h (mph). The system remains in the commanded state until cancelled by the scan tool.

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Inflatable Restraint Sensing and Diagnostic Module Scan Tool Information

The sensing and diagnostic module (SDM) scan tool data list contains all the restraint system related parameters that are available on the scan tool. The parameters in the list are arranged in alphabetical order.

Use the SDM scan tool data list as directed by a diagnostic table or in order to supplement the diagnostic procedures. Begin all of the diagnostic procedures with the Diagnostic System Check - SIR. Use the SDM scan tool data list after the following is determined:

- There is no published diagnostic trouble code (DTC) procedure nor published symptom procedure for the customer concern
- The DTC or symptom diagnostic procedure indicated by the diagnostic system check does not resolve the customer concern

The typical data values are obtained from a properly operating vehicle under the conditions specified in the second row of the scan tool data list table. Comparison of the parameter values from the suspect vehicle with the typical data values may reveal the source of the customer concern.

Parameter	Operating Conditions	Expected Value	Definition
Ignition is ON, engine OFF, and vehicle is stationary			
Backup System Power Mode	Backup system power mode activated	Enable	This parameter displays the status of the Backup System Power Mode
	Backup system power mode deactivated	Disable	
Driver Air Bag Stage 1 Squib	--	2.6 - 3.3 Ohms	The scan tool displays 2.6 - 3.3 Ohms. This is the resistance of the driver air bag stage 1 squib circuit as interpreted by the Sensing and Diagnostic Module.
Driver Air Bag Stage 2 Squib	--	2.6 - 3.3 Ohms	The scan tool displays 2.6 - 3.3 Ohms. This is the resistance of the driver air bag stage 2 squib circuit as interpreted by the Sensing and Diagnostic Module.
Driver EFS Status	--	Okay	The scan tool displays Okay or Not Okay. This is the current status of the Driver EFS.
	--	Not Okay	
Driver Seat Position Sensor Status	--	Okay	The scan tool displays Okay or Not Okay. This is the current status of the Driver Seat Position Sensor.
	--	Not Okay	
Driver Curtain Air Bag Squib	--	1.9 - 2.6 Ohms	The scan tool displays 1.9 - 2.6 Ohms. This is the resistance of the driver curtain air bag squib circuit as interpreted by the

			Sensing and Diagnostic Module.
Driver Pretensioner Circuit	--	2.6 - 3.3 Ohms	The scan tool displays 2.6 - 3.3 Ohms. This is the resistance of the driver pretensioner circuit as interpreted by the Sensing and Diagnostic Module.
Driver Seat Belt Status	Seat belt buckled	Buckled	The scan tool displays whether the driver seat belt is Buckled or Not Buckled.
	Seat belt unbuckled	Not Buckled	
Driver Side Air Bag Squib	--	2.6 - 3.3 Ohms	The scan tool displays 2.6 - 3.3 Ohms. This is the resistance of the driver side air bag squib circuit as interpreted by the Sensing and Diagnostic Module.
Driver SIS Status	--	Okay	The scan tool displays Okay or Not Okay. This is the current status of the Driver SIS.
	--	Not Okay	
Passenger Air Bag Stage 1 Squib	--	1.9 - 2.6 Ohms	The scan tool displays 1.9 - 2.6 Ohms. This is the resistance of the passenger air bag stage 1 squib circuit as interpreted by the Sensing and Diagnostic Module.
Passenger Air Bag Stage 2 Squib	--	1.9 - 2.6 Ohms	The scan tool displays 1.9 - 2.6 Ohms. This is the resistance of the passenger air bag stage 2 squib circuit as interpreted by the Sensing and Diagnostic Module.
Passenger Curtain Air Bag Squib	--	2.6 - 3.3 Ohms	The scan tool displays 2.6 - 3.3 Ohms. This is the resistance of the passenger curtain air bag squib circuit as interpreted by the Sensing and Diagnostic Module.
Passenger EFS Status	--	Okay	The scan tool displays Okay or Not Okay. This is the current status of the Passenger EFS.
	--	Not Okay	
Passenger Pretensioner Circuit	--	1.9 - 2.6 Ohms	The scan tool displays 1.9 - 2.6 Ohms. This is the resistance of the passenger pretensioner circuit as interpreted by the Sensing and Diagnostic Module.
Passenger Side Air Bag Squib	--	1.9 - 2.6 Ohms	The scan tool displays 1.9 - 2.6 Ohms. This is the resistance of the passenger side air bag squib ciruit as interpreted by the Sensing and Diagnostic Module.
Passenger SIS Status	--	Okay	The scan tool displays Okay or Not Okay. This is the current status of the Passenger SIS.
	--	Not Okay	
Primary Key Status	--	Valid	The scan tool displays if there is a passenger airbag suppression device used on this vehicle and if so, whether it is has an automatic, manual key switch or both.
	--	Invalid	
Received Primary Key	--	4711	The scan tool displays what the BCM is sending out as the primary key. The SDM then compares it to what it has stored. This should match the SDM Primary Key.

Run/Crank Signal	Ignition is in RUN/CRANK position	Active	The scan tool displays the current power mode of the SDM.
	Ignition is in OFF/ACC position	Inactive	
Seat Position Driver	Seat positioned toward the rear of the cabin	Rearward	The scan tool displays Rearward or Forward. This is the positional state of the drive seat.
	Seat positioned close to the steering wheel	Forward	
Secondary Key Status	--	Valid	The scan tool displays whether the Secondary Key is valid or invalid. This determines if the VIN stored in SDM memory matches what is stored in the BCM.
	--	Invalid	
System Power Mode	Ignition is in OFF position	Off	This scan tool displays the current position of the ignition cycle.
	Ignition is in ACC position	Accessory	
	Ignition is in RUN position	Run	
	Ignition is in CRANK position	Crank	
VIN Digit 2 - 5	--	Vehicle Dependant	The scan tool displays the Secondary Key which includes digits 2 though 5 of the VIN that the BCM sends to the SDM.
VIN Digit 6 - 8	--	Vehicle Dependant	The scan tool displays the Secondary Key which includes digits 6 through 8 of the VIN that the BCM sends to the SDM.
VIN Digit 9 - 12	--	Vehicle Dependant	The scan tool displays the Secondary Key which includes digits 9 through 12 of the VIN that the BCM sends to the SDM.
VIN Digit 13 - 15	--	Vehicle Dependant	The scan tool displays the Secondary Key which includes digits 13 through 15 of the VIN that the BCM sends to the SDM.
VIN Digit 16 - 17	--	Vehicle Dependant	The scan tool displays the Secondary Key which includes digits 16 and 17 of the VIN that the BCM sends to the SDM.
Warning Indicator	SRS warning indicator activated	On	The scan tool displays whether the SRS warning indicator has been requested ON or OFF
	SRS warning indicator deactivated	Off	

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Instrument Cluster Scan Tool Information

The scan tool data lists contain all the instrument panel, gages, and console related parameters that are available on the scan tool. The parameters in the list are arranged in alphabetical order. The data list column indicates the location of the parameter within the scan tool menu selections.

Use the scan tool data lists as directed by a diagnostic table or in order to supplement the diagnostic procedures. Begin all of the diagnostic procedures with the Diagnostic System Check - Vehicle.

Use the scan tool data lists only after the following is determined:

- There is no published DTC procedure nor published symptom procedure for the customer concern.
- The DTC or symptom procedure indicated by the diagnostic system check does not resolve the customer concern.

The typical data values are obtained from a correctly operating vehicle under the conditions specified in the first row of the scan tool data list table. Comparison of the parameter values from the suspect vehicle with the typical data values may reveal the source of the customer concern.

Parameter	**Operating Conditions**	**Expected Value**	**Definition**
Ignition is ON, engine OFF, and vehicle is stationary			
ABS Telltail	Systems check or fault with the system	On	This parameter displays On, which will command the telltail lamp on the instrument cluster to illuminate when doing a systems check or a fault is logged.
	Systems are normal	Off	
Alternator Telltail	Fault with the system	On	This parameter displays On, which will command the telltail lamp on the instrument cluster to illuminate when there is a fault with the system.
	Systems are normal	Off	
Backup System Power Mode	Back up power system activated	Enabled	This parameter displays the status of the backup system power mode.
	Back up power system deactivated	Disabled	
Battery Voltage	--	12 Volts	The scan tool displays 0-14 Volts. The scan tool displays approximately 12 Volts when the ignition is on
Brake Fluid Level Switch	Low brake fluid level	On	This parameter displays On, which will command the telltail lamp on the instrument cluster to illuminate when
	Normal brake		

	fluid level	Off	there is a fault with the system.
Brake System Telltail	Systems check or fault with the system	On	This parameter displays On, which will command the telltail lamp on the instrument cluster to illuminate when doing a systems check or a fault is logged.
	Systems are normal	Off	
Current Trip Display	--	Km	This parameter displays the total distance travelled so far.
Distance To Arrival	--	Km	This parameter displays the remaining distance till arrival, based off the user's selection.
Door Open Telltail	Door open or ajar	On	This parameter displays On, which will command the telltail lamp on the instrument cluster to illuminate when a door is open or not closed correctly.
	Door closed correctly	Off	
Drivers Side Seat Belt Telltail	Seat belt not being worn	On	This parameter displays On, which will command the telltail lamp on the instrument cluster to illuminate when doing a systems check or a fault is logged.
	Seat belt being worn	Off	
Engine Coolant Temperature	--	[ordm] C	This parameter displays the current temperature of the coolant in the vehicle in degrees.
Engine Speed	--	RPM	This parameter displays the speed of the crankshaft as calculated by the control module based on inputs from the crankshaft position (CKP) sensor. The scan tool will display the engine speed in revolutions per minute (RPM).
Fr. Fog Light Telltail	Front fog lamps activated	On	This parameter displays On, which will command the telltail lamp on the instrument cluster to illuminate when turned on.
	Front fog lamps deactivated	Off	
Fuel Used A	--	Litres	This parameter displays the total litres of fuel used since the trip computer was reset.
Fuel Used B	--	Litres	This parameter displays the total litres of fuel used since the trip computer was reset.
High Beam Telltail	High beam activated	On	This parameter displays On, which will command the telltail lamp on the instrument cluster to illuminate when turned on.
	High beam deactivated	Off	
	Ignition is in	Off	

Ignition Switch	OFF position		This parameter displays the current status of the ignition switch.
	Ignition is in ACC position	Off	
	Ignition is in RUN position	On	
	Ignition is in CRANK position	On	
Left Scroll Switch	--	Counts	This parameter displays the position of the left scroll switch.
Odometer	--	Km	This parameter displays the odometer reading which calculates the distance travelled based on information from the ECM.
Phone	Phone activated	On	This parameter displays the commanded state of a connected mobile phone.
	Phone deactivated	Off	
Rear Fog Light Telltail	Rear fog lights activated	On	This parameter displays On, which will command the telltail lamp on the instrument cluster to illuminate when turned on.
	Rear fog lights deactivated	Off	
Remaining Fuel	--	%/ L	This parameter displays the remaining fuel as either a percentage or in litres.
Right Scroll Switch	--	Counts	This parameter displays the position of the right scroll switch.
Shift Up Indicator	Shift up indicator activated	On	This parameter displays the status of the shift up light.
	Shift up indicated deactivated	Off	
SRS Air Bag Telltail	Systems check or fault with the system	On	This parameter displays On, which will command the telltail lamp on the instrument cluster to illuminate when doing a systems check or a fault is logged.
	Systems are normal	Off	
Steering Wheel Switch	Left scroll pressed	Menu Enter	This parameter displays the position of the steering wheel switch.
	Left scroll in idle position	Off	
System Power	Ignition is in OFF position	Off	This parameter displays the system power mode which is dependant on
	Ignition is in ACC position	ACC	

Mode	Ignition is in RUN position	Run	ignition position.
	Ignition is in CRANK position	Crank	
Time To Arrival	--	day(s)	This parameter displays the total days remaining till arrival.
Time To Arrival	--	00:00:00 (hh:mm:ss)	This parameter displays the time to arrival at a programmed destination.
Tyre Pressure Monitoring Telltail	Systems check or fault with the system	On	This parameter displays On, which will command the telltail lamp on the Instrument Cluster to illuminate when doing a systems check or a fault is logged.
	System is normal	Off	
Trip A Distance	--	Km	This parameter displays the total kilometers travelled since last reset.
Trip A Time	--	day(s)	This parameter will display the total days remaining till arrival.
Trip A Time	--	00:00:00 (hh:mm:ss)	This parameter will display the engine running time during this ignition cycle.
Trip B Distance	--	Km	This parameter displays the total kilometres travelled since last reset.
Trip B Time	--	day(s)	This parameter displays the total days remaining till arrival.
Trip B Time	--	00:00:00 (hh:mm:ss)	This parameter will display the engine running time during this ignition cycle.
Turn Left Signal Telltail	Turn left signal activated	On	This parameter displays On, which will command the telltail lamp on the instrument cluster to illuminate when the turn signal switch is activated.
	Turn left signal deactivated	Off	
Turn Right Signal Telltail	Turn right signal activated	On	This parameter displays On, which will command the telltail lamp on the instrument cluster to illuminate when the turn signal switch is activated.
	Turn left signal deactivated	Off	
Vehicle Speed	--	Km/h	This parameter indicates the vehicle speed calculated by the control module based on an input from the vehicle speed sensor (VSS). The scan tool will display a high value at higher vehicle speeds, and a low value at lower vehicle speeds.
	Low washer		

Washer Level Switch	level	On	This parameter displays the position of the washer level switch.
	Normal washer level	Off	

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Radio Scan Tool Information

Parameter	Operating Conditions	Expected Value	Definition
Ignition is ON, engine OFF, and vehicle is stationary			
Antenna	--	Main	
Audio Source	CD Mode Selected	CD	This parameter determines which mode the Infotainment is currently using.
	Tuner Mode Selected	Tuner	
Audio System	System On	On	This parameter determines if the Audio System is On or Off.
	System Off	Off	
Auxiliary Input	External Device Connected	Active	This parameter displays if their is an external device connected to the Infotainment unit.
	External Device Not Connected	Inactive	
Balance	Left 1 to 6	User Dependent	This parameter displays the current balance of the speaker on the left or right sides.
	Right 1 to 6	User Dependent	
Band	FM 1	FM 1	This parameter displays the currently selected Band.
	FM 2	FM 2	
	FM ASM	FM ASM	
	AM	AM	
	AM ASM	AM ASM	
Bass	STD	User Dependent	This parameter displays the current bass setting based off the user's selection.
	+1 to +6	User Dependent	
Battery Voltage	--	12 Volts	The scan tool displays 0-14 Volts. The scan tool displays approximately 12 Volts when the ignition is On.
Beeps	Beeps activated	On	This parameter displays if the audio unit will beep when buttons are pressed.
	Beeps deactivated	Off	
Brightness	STD	User Dependent	This parameter displays the currently selected brightness based off the users selection.
	-5 to +5	User Dependent	
CD Error	Problem with Unit	Yes	This parameter displays if there is a current error with the audio unit.
	No Problem with Unit	No	

CD Player Status	Pause button pressed while CD paused	Play	This parameter displays the status of the CD Player.
	Pause button pressed while CD playing	Pause	
	Audio system turned off or change of audio source	Stop	
	Track up button pressed	Track Up	
	Track down button pressed	Track Down	
	Reverse button pressed	Reverse	
	Cue button pressed	Cue	
CD Special Play Mode	Repeat button pressed	Repeat Track	This parameter displays the last CD special play mode that was selected by the user.
	Random button pressed	Random Track	
Colour	--	Vehicle Dependent	This parameter displays a numeric value. This number corresponds to the colour of the infotainment unit display.
Contrast	STD	User Dependent	This parameter displays the current contract setting, based off the user's selection.
	-5 to +5	User Dependent	
Current CD	--	Audio CD	This parameter displays the type of disc inserted into the CD Player.
	--	MP3	
Current CD Type	CDDA	User Dependent	This parameter displays whether the compact disc is CDDA or MP3.
	MP3	User Dependent	
Current Track	1 to 30	--	This parameter displays the current track on the CD been played.
Date	1 to 31	--	This parameter displays the current date stored in the infotainment unit.
Day	Monday - Sunday	--	This parameter displays the current day of the week stored in the unit.
DDL Bass Attenuation	0 to 60 dB	User Dependent	This parameter displays the current dynamic distortion bass level.
DDL Setting	Default Setting	Off	
	User dependent	Cur 1 to Cur 3	
			This parameter displays the current

DDL Volume	0 to 60 dB	0 dB	dynamic distortion volume level.
Dial Turns	Counts	1 Counts	This parameter displays the numbers of counts the dial has been turned.
Dial Type	Mode dial used	Mode	This parameter displays the last dial type to be used by the user.
	Multi-function dial used	Multi-function	
	Fan speed dial used	Fan Speed	
	Driver temp dial used	Driver Temp	
Display Format	--	12 Hour	This parameter displays the time format based on 12 hour or 24 hour format.
	--	24 Hour	
Display Illumination	1 to 100 %	User Dependent	This parameter displays the current illumination level based from the user's selection.
Drive Type	--	Single CD	This parameter displays the current drive type as selected by the user
Driver Identification	Programmed Key	Driver 1	This parameter displays the status of the current ignition key.
	Programmed Key	Driver 2	
Equalizer	On	User Dependent	This parameter displays if the user has turned On or Off the equalizer settings in the audio unit.
	Off	User Dependent	
Equalizer Boost	--	0	
Equalizer Preset	--	On	This parameter displays the current preset for the equalizer.
	--	Off	
Fader	STD	User Dependent	This parameter displays the current settings for the fader based off the user's selection.
	Front 1 to 6	User Dependent	
	Rear 1 to 6	User Dependent	
Fascia Button	Depends on Last button pressed.	--	This parameter displays the last fascia button pressed during the last ignition cycle.
Field Intensity	--	0-300 dBuV	The scan tool displays 0-300 dBuV. The signal from the antenna is measured in dBuV.
Frequency	87.5 to 108.00 FM	User Dependent	This parameter displays the currently selected radio frequency.
	522 to 1710 AM	User Dependent	
Hazards	Hazard button pressed	Active	This parameter displays whether the hazard lamps have been activated.
	Hazard button		

	depressed	Inactive	
Illumination	--	0-100%	
Illumination Mode	--	Auto	
Interior Illumination	--	0-100%	This parameter displays the interior illumination as a percentage. The highest percentage will have the interior lamps at their brightest.
Key Stuck	--	None	This parameter displays if their is currently a button stuck on the fascia plate.
Loudness	Loudness activated	On	This parameter displays if the loudness function has be turned On or Off by the user.
	Loudness deactivated	Off	
Month	--	Varies	This parameter displays the current month
Multipath	--	%	
Multipath	--	Yes	
	--	No	
Mute	Mute button pressed	On	This parameter displays if the audio unit mute button has been activated or deactivated.
	Mute button depressed	Off	
Navigation Audio Channel	--	Varies	This parameter displays the audio channel that is utilised for the navigation audio
Navigation	--	Activated	This parameter displays if the navigation is Activated or Not Activated.
	--	Not Activated	
Navigation Volume	--	dB	This parameter displays the correctly selected volume setting for the navigation system through the audio unit.
Play Time	--	hh:mm:ss	This parameter displays the play time of the CDDA/MP3.
Preset	1 to 6	User Dependent	This parameter displays the currently selected preset radio station.
Rear Aux	Rear aux activated	On	This parameter displays if the rear aux is On or Off
	Rear aux deactivated	Off	
Rear Controls	Rear controls activated	Active	This parameter displays if the rear seat controls are working correctly.
	Rear controls deactivated	Inactive	
Search Sensitivity	Local	User Dependent	This parameter displays the currently selected search sensitivity signal strength.
	Distant	User Dependent	

	Auto	User Dependent	
Single CD Loaded	CD Loaded into Unit	Yes	The scan tool will display whether their is a compact disc loading or not.
	No CD Laded into Unit	No	
Speed Dependent Volume	--	dB	This parameter displays the volume in dB of the infotainment unit dependent on the speed of the vehicle.
Speed Volume Curve	Default Setting	Off	This parameter displays the speed volume curve as defined by the user
	User Settings	Cur 1 to Cur 5	
Stereo Status	User dependent	Mono	This parameter displays if the audio system on stereo or mono mode based on the user's selection.
	User dependent	Stereo	
System Power Mode	Ignition is in OFF position	Off	This parameter displays the current ignition cycle the key is on.
	Ignition is in ACC position	Accessory	
	Ignition is in RUN position	Run	
	Ignition is in CRANK position	Crank	
Time	--	hh:mm:ss	This parameter displays the current time.
Total Track Time	--	hh:mm:ss	The scan tool will display the total time of the current song.
Treble	STD	User dependent	The scan tool will show the current treble setting as selected by the user.
	-6 to +6	User dependent	
Vehicle Speed	--	km/h	This parameter indicates the vehicle speed calculated by the control module based on an input from the vehicle speed sensor (VSS). The scan tool will display a high value at higher vehicle speeds, and a low value at lower vehicle speeds.
Voice In	Voice in activated	Active	
	Voice in deactivated	Inactive	
Volume	0 to 40	User dependent	The scan tool will show the current user selection.
Year	2000 to 2099	--	The scan tool will show the current year.

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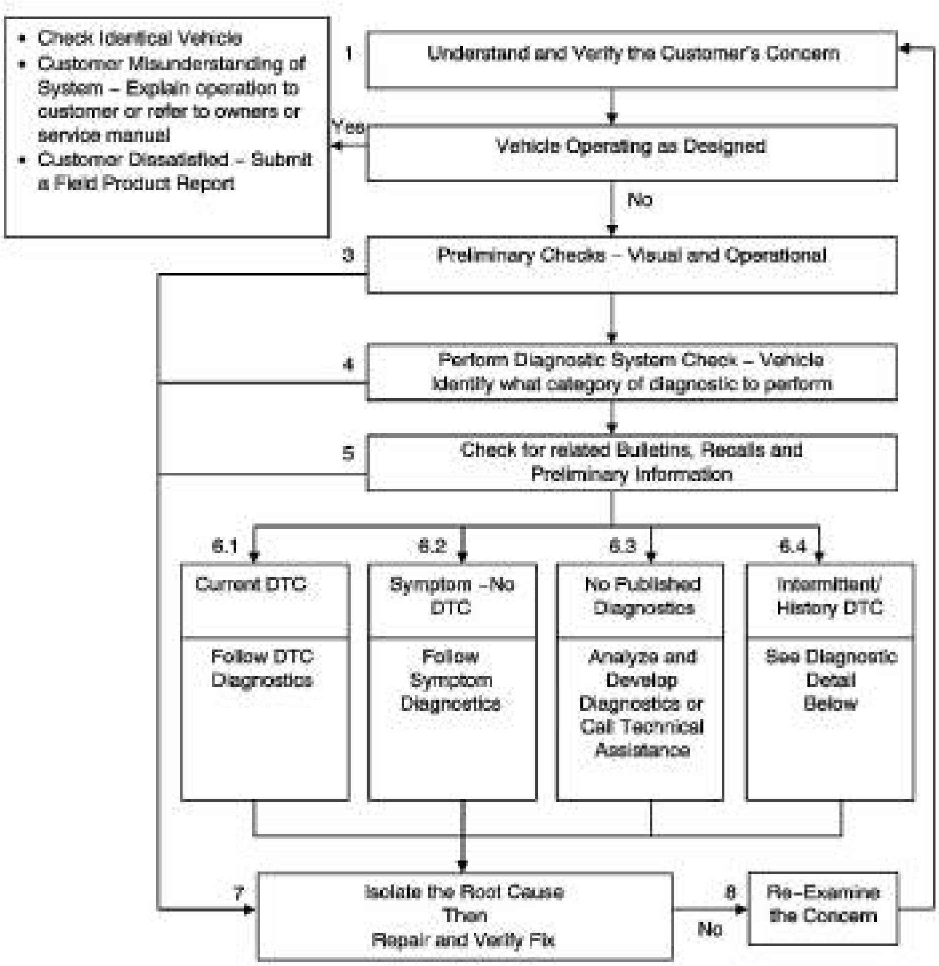
Strategy Based Diagnosis

The goal of Strategy Based Diagnosis is to provide guidance when you create a plan of action for each specific diagnostic situation. Following a similar plan for each diagnostic situation, you will achieve maximum efficiency when you diagnose and repair vehicles. Although each of the Strategy Based Diagnosis boxes is numbered, you are not required to complete every box in order to successfully diagnose a customer concern. The first step of your diagnostic process should always be Understand and Verify the Customer's Concern. The final step of your diagnostic process should be Repair and verify the Fix. Refer to the following chart for the correct Strategy Based Diagnosis.


2
• Check Identical Vehicle
• Customer Misunderstanding of System – Explain operation to customer or refer to owners or service manual
• Customer Dissatisfied – Submit a Field Product Report
1
Understand and Verify the Customer's Concern
Yes
Vehicle Operating as Designed
No
3
Preliminary Checks – Visual and Operational
4
Perform Diagnostic System Check – Vehicle
Identify what category of diagnostic to perform
5
Check for related Bulletins, Recalls and Preliminary Information
6.1
Current DTC
Follow DTC Diagnostics
6.2
Symptom –No DTC
Follow Symptom Diagnostics
6.3
No Published Diagnostics
Analyze and Develop Diagnostics or Call Technical Assistance
6.4
Intermittent/ History DTC
See Diagnostic Detail Below
7
Isolate the Root Cause Then Repair and Verify Fix
No
8
Re-Examine the Concern

1. Understand and Verify the Customer's Concern: The first part of this step is to obtain as much information as possible from the customer. Are there aftermarket accessories on the vehicle? When does the condition occur? Where does the condition occur? How long does the condition last? How often does the condition occur? In order to verify the concern, the technician should be familiar with the normal operation of the system and refer to the owner

or service manual for any information needed.

2. Vehicle Operating as Designed: This condition exists when the vehicle is found to operate normally. The condition described by the customer may be normal. Compare with another like vehicle that is operating normally under the same conditions described by the customer. Explain your findings and the operation of the system to the customer. If the customer is dissatisfied submit a Field Product Report.
3. Preliminary Checks: Conduct a thorough visual inspection. Review the service history. Detect unusual sounds or odors. Gather diagnostic trouble code (DTC) information in order to achieve an effective repair.
4. Perform Published Diagnostic System Check- Vehicle: The Diagnostic System Check - Vehicle verifies the proper operation of the system. This will lead the technician in an organized approach to diagnostics and identify what category of diagnostic to perform.
5. Check for related Bulletins, Recalls and Preliminary Information (PI).
6. Diagnostic categories:
    - 6.1. Current DTC: Follow the designated DTC diagnostic in order to make an effective repair. Refer to Diagnostic Trouble Code (DTC) List - Vehicle.
    - 6.2. Symptom - No DTC: Select the appropriate symptom diagnostic. Follow the diagnostic steps or suggestions in order to complete the repair. Refer to Symptoms - Vehicle.
    - 6.3. No Published Diagnostics: Analyze the Concern. Develop a plan for the diagnostics. The service manual schematics will help you to see system power, ground, input, and output circuits. You can also identify splices and other areas where multiple circuits are tied together. Look at component locations to see if components, connectors or harnesses may be exposed to extreme temperature, moisture, or corrosives (road salt, battery acid, oil or other fluids). Utilize the wiring diagrams, system description and operation, and system circuit description.
    - 6.4. Intermittent/History DTC: An intermittent condition is one that does not occur continuously, may be difficult to duplicate, and will only occur when certain conditions are met. Generally, an intermittent is caused by faulty electrical connections and wiring, malfunctioning components, electromagnetic/radio frequency interference, driving conditions, or aftermarket equipment. The following approaches/tools may prove to be beneficial in locating and repairing an intermittent condition or history DTC.
        - Combining technicians knowledge with the available service information.
        - Evaluate the symptoms and conditions described by the customer on the Customer Concern Verification Sheets.
        - Follow the suggestions on Testing for Intermittent Conditions and Poor Connections.
        - Use the available scan tool, digital multi-meter, or J 42598 with data capturing capabilities.
7. Isolate the Root Cause then Repair and Verify Fix: After isolating the root cause, make the repairs and validate for the correct operation by performing the Diagnostic Repair Verification. Verifying that the DTC or symptom has been corrected may involve road testing the vehicle.
8. Re-examine the Concern: If a technician cannot successfully find or isolate the concern, a re-evaluation is necessary. Re-verify the concern. The concern could be an intermittent or normal condition.

Diagnostic System Check - Vehicle

Diagnostic Instructions

- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Continue through the Diagnostic System Check until you are directed to follow a particular diagnostic or repair procedure. Once a repair has been completed, perform the Diagnostic Repair Verification and verify the customer concern has been corrected.

The diagnostic procedures within this manual are developed on the assumption that the following areas function as designed:

- The 12V battery is fully charged and cables are clean and tight. Refer to Battery Inspection/Test.
- Fuses are not open. Refer to Power Distribution Schematics and Electrical Center Identification Views.
- Ground circuits for the area of customer concern are clean, tight, and in the correct location. Refer to Ground Distribution Schematics and Harness Routing Views.
- All connections/connectors for the area of concern are fully seated. Refer to Component Connector End Views.
- There are no aftermarket devices that affect the operation of the system. Refer to Checking Aftermarket Accessories.
- The scan tool powers up. Refer to Scan Tool Does Not Power Up.

Diagnostic System Check

1. *VERIFY CUSTOMER CONCERN* -- Understand and validate the customer concern. Inspect the visible system components for obvious damage or conditions that may cause the concern.
2. *BULLETIN SEARCH* -- Check for related bulletins, recall/field actions and preliminary information.
3. *MECHANICAL CONCERNS* -- Verify the symptom is not exclusively a mechanical concern.

   If the symptom is exclusively a mechanical concern, refer to Symptoms - Vehicle.

   Note: Do not clear any DTCs unless instructed to do so by a diagnostic procedure. If any DTC is Powertrain related, select Capture Info to store DTC and Freeze Frame/Failure Records to the Scan Tool.

4. *CONTROL MODULE COMMUNICATION and DTC CHECK* -- Using a scan tool, perform the Vehicle DTC Information function and verify at least one control module communicates with the scan tool. Record on the Repair Order the following information:
   - Any control module that is not communicating.
   - Any DTC, including symptom byte, and the control module that has set the DTC.

   If the scan tool does not communicate with any control module on the vehicle, refer to Power Mode Mismatch.
5. *CONTROL MODULE INTERNAL PERFORMANCE FAULTS* -- Verify there are no current control

module Internal Hardware Performance DTCs set.

If any DTC of this type is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.

6. *CONTROL MODULE COMMUNICATION VERIFICATION* -- Verify the vehicle is built with any control module listed as not communicating, refer to Data Link References. All control modules should be communicating, as equipped.

   If the scan tool does not communicate with one or more control modules refer to Data Link References.

7. *COMMUNICATION and POWERMODE FAULTS* -- Verify there are no current control module Power Mode or Communication DTCs set..

   If any DTC of this type is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.

Note: The engine may start during this test. Ensure the vehicle is out of gear and the parking brake is applied. Turn the engine OFF as soon as the crank power mode parameter has been observed.

8. *POWER MODE VERIFICATION* -- Driver door open, observe the scan tool Power Mode parameter while cycling the ignition switch through all the power modes. Verify the current Power Mode parameter matches the actual ignition switch positions.

   If the Power Mode parameter does not match the actual ignition switch positions, refer to Power Mode Mismatch.

9. *ENGINE CRANK and RUN VERIFICATION* -- Verify that the engine cranks and runs.

   If the engine does not crank, refer to Symptoms - Engine Electrical.

   If the engine does not run, refer to Engine Cranks But Does Not Runfor the 2.8L, 3.0L, 3.2L, or 3.6L engine or Engine Cranks But Does Not Runfor the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine.

10. *REMAINING DTC REVIEW* -- Verify there are no other DTCs set.

    If other DTCs are set, diagnose them in the order listed below. Refer to Diagnostic Trouble Code (DTC) List - Vehicle.

    10.1. Voltage DTCs

    10.2. Programming, Setup, Configuration or Software Performance DTCs

    10.3. Component related DTCs

    10.4. System related DTCs

    10.5. Any remaining DTCs

11. *SYMPTOM DIAGNOSIS* -- Diagnose any remaining customer concern. Refer to Symptoms - Vehicle.

Diagnostic Repair Verification

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming or setup procedures that are required when a component or module is removed or replaced.
3. Clear the DTCs.
4. Turn OFF the ignition for 60 seconds.
5. If the repair was related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not reset. If the DTC resets or another DTC is present, refer to the Diagnostic Trouble Code (DTC) List - Vehicle and perform the appropriate diagnostic procedure.

   Or

   If the repair was symptom related, duplicate the conditions under which the customer concern occurred to verify the repair. If the customer concern reoccurs or another symptom is present, return to Symptoms - Vehicle and perform the appropriate symptom diagnostic.

Diagnostic Starting Point - Vehicle

Begin the system diagnosis with Diagnostic System Check - Vehicle. The Diagnostic System Check - Vehicle will provide the following information:

- The identification of the control modules which are not communicating through the serial data circuit.
- The identification of any stored diagnostic trouble codes (DTCs) and their status.

The use of the Diagnostic System Check - Vehicle will identify the correct procedures to begin vehicle diagnosis. These must be performed before system DTC or symptom diagnosis.

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Diagnostic Trouble Code (DTC) List - Vehicle

This master DTC list includes all applicable DTCs in alphanumeric order with descriptors.

DTC	DTC Descriptor	Module That Sets the DTC	Diagnostic Procedure
B0012	Driver Frontal Deployment Loop Stage 1	SDM	DTC B0012 or B0013
B0013	Driver Frontal Deployment Loop Stage 2	SDM	DTC B0012 or B0013
B0014	Driver Side Deployment Loop	SDM	DTC B0014
B0015	Driver Pretensioner Deployment Stage 1 Loop	SDM	DTC B0015
B0016	Driver Curtain Deployment Loop Initiator	SDM	DTC B0016
B0019	Passenger Frontal Deployment Loop Stage 1	SDM	DTC B0019 or B0020
B0020	Passenger Frontal Deployment Loop Stage 2	SDM	DTC B0019 or B0020
B0021	Passenger Side Deployment Loop Stage 1	SDM	DTC B0021
B0022	Passenger Pretensioner Deployment Stage 1 Loop	SDM	DTC B0022
B0023	Passenger Curtain Deployment Loop Initiator	SDM	DTC B0023
B0052	Deployment Commanded	SDM	DTC B0052 or B0053
B0053	Deployment Commanded with Loop DTCs Present	SDM	DTC B0052 or B0053
B0055	Side Airbag Deployment Commanded	SDM	DTC B0055
B0072	Driver Seat Belt Sensor Circuit	SDM	DTC B0072
B0079	Driver Seat Position Sensor Circuit	SDM	DTC B0079
B0083	Front End Sensor 1	SDM	DTC B0083 or B0084
B0084	Front End Sensor 2	SDM	DTC B0083 or B0084
B0085	Left Front Side Impact Circuit	SDM	DTC B0085 or B0086
B0086	Right Front Side Impact Sensor Circuit	SDM	DTC B0085 or B0086
B013B	Coil Compressor Stroke Control Circuit	HVAC	DTC B013B
B0158	Outside Air Temperature Sensor Circuit	HVAC	DTC B0158 or B0168
	Passenger Compartment		

B0168	Temperature Sensor Circuit	HVAC	DTC B0158 or B0168
B0183	Left Solar Load Sensor 1 Circuit	HVAC	DTC B0183 or B0188
B0188	Right Solar Load Sensor 2 Circuit	HVAC	DTC B0183 or B0188
B0193	Blower Motor Feedback Circuit	HVAC	DTC B0193
B0198	Blower Motor Feedback Circuit	HVAC	DTC B0198 2
B0228	Air Intake Flow Actuator Fault (LHD) or Recirculation Door Motor Circuit (RHD)	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531
B0238	Demist Actuator Fault (LHD) or Defogger Door Motor Circuit (RHD)	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531
B0253	Face/Floor Actuator Fault (LHD) or Vent/Floor Door Motor Circuit (RHD)	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531
B0283	Electric Rear Defrost Circuit	HVAC	DTC B0283
B0408	Drivers Side Air Mix Actuator (LHD) or Drivers Air Mix Door Motor Circuit (RHD)	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531
B0418	Passenger Side Air Mix Actuator (LHD) or Passengers Air Mix Door Motor Circuit (RHD)	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531
B0428	Rear Air Mix Door Motor Circuit	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531
B0946	Suspension Control Selection Indicator Circuit	ESCM	DTC B0946
B094A	Service Suspension Control Indicator Circuit	ESCM	DTC B094A

B0954	Park Assist Sensor Front Left Outer Circuit	UPA	DTC B0954, B0955, B0956, or B0957
B0955	Park Assist Sensor Front Left Middle Circuit	UPA	DTC B0954, B0955, B0956, or B0957
B0956	Park Assist Sensor Front Right Middle Circuit	UPA	DTC B0954, B0955, B0956, or B0957
B0957	Park Assist Sensor Front Right Outer Circuit	UPA	DTC B0954, B0955, B0956, or B0957
B0958	Park Assist Sensor Rear Left Outer Circuit	UPA	DTC B0958, B0959, B0960, or B0961
B0959	Park Assist Sensor Rear Left Middle Circuit	UPA	DTC B0958, B0959, B0960, or B0961
B0960	Park Assist Sensor Rear Right Middle Circuit	UPA	DTC B0958, B0959, B0960, or B0961
B0961	Park Assist Sensor Rear Right Outer Circuit	UPA	DTC B0958, B0959, B0960, or B0961
B0967	Park Assist Switch Circuit	UPA	DTC B0967
B0968	Park Assist Indicator Circuit Malfunction	UPA	DTC B0968
B0970	Hazard Warning Switch Stuck	BCM	DTC B0970
B0983	Security System Indicator 2 Circuit	BCM	DTC B0983
B0996	Vehicle Identification Number Mismatch	Radio, RSE	DTC B0996, 1016, or B1271
B0997	Auxiliary Electronic Control Unit (ECU) 2 Performance	Radio	DTC B0997
	Memory Seat and Mirror Module Checksum Error	MSM	DTC B0997
B0998	Screen 1 EEPROM Failure	RSE	DTC B0998 or B0999
B0999	Screen 2 EEPROM Failure	RSE	DTC B0998 or B0999
B1000	Electronic Control Unit (ECU) Performance	BCM, IPC, MSM, RFA, SDM, TDM, Telematics, UPA	DTC B1000
B1001	Option Configuration Error	BCM, IPC	DTC B1001
		SDM	DTC B1001
B1008	Calibration Data Not Programmed	Telematics	DTC B1008
		UPA	DTC B1008
B1009	EEPROM Failure	RSE	DTC B1009
B1010	System Sensor Data Mismatch Invalid Odometer Signal	NIM	DTC B1010
B1011	System Disabled Over Temperature	NIM	DTC B1011
B1015	Vehicle Identification Number (VIN) Information Error	Telematics	DTC B1015 or DTC B1016

B1016	Vehicle Identification Number (VIN) Not Programmed	BCM	DTC B1016
		Radio	DTC B0996, 1016, or B1271
		SDM	DTC B1016
		Telematics	DTC B1015 or DTC B1016
B1019	System Configuration Error	Radio	DTC B1019
B101D	ECU Hardware Performance	NIM, Radio, RSE,	DTC B101D
B101E	ECU Software Performance	Radio	DTC B101E
B1020	Auxiliary Electronic Unit (ECU) Performance	NIM	DTC B1020
B1021	SIM Mismatch	Telematics	DTC B1021
B1023	Integral Switch Performance	Radio	DTC B1023
B1024	Printed Circuit Board (PCB) Temperature Sensor Fault	IPC	DTC B1024
B1025	Audio Output 1 Left Front Circuit	Radio	DTC B1025, B1035, B1045, or B1055
B1035	Audio Output 2 Right Front Circuit	Radio	DTC B1025, B1035, B1045, or B1055
B1045	Audio Output 3 Left Rear Circuit	Radio	DTC B1025, B1035, B1045, or B1055
B1055	Audio Output 4 Right Rear Circuit	Radio	DTC B1025, B1035, B1045, or B1055
B1240	CD-Player Malfunction	Radio	DTC B1240 or B1245
B1243	CD-Player Load or Eject Malfunction	Radio	DTC B1243 or B1248
		RSE	DTC B1243
B1244	CD-Player, Disc Upside Down	Radio	DTC B1244 or B1249
B1245	CD-Changer Malfunction	Radio	DTC B1240 or B1245
B1248	CD Changer Load/Unload Performance	Radio	DTC B1243 or B1248
B1249	CD-Changer, Disc Upside Down	Radio	DTC B1244 or B1249
B1271	Theft Locked	Radio	DTC B0996, 1016, or B1271
B1277	Microphone Circuit	Telematics	DTC B1277
B1287	Radio Mute Circuit	Telematics	DTC B1287
B1325	Device Power Circuit	HVAC	DTC B1325
		RSE	DTC B1325, B1330, or B1423
	System Voltage	SDM	DTC B1325
B1330	RSE Control Panel Supplied Power	RSE	DTC B1325, B1330, or B1423
B1335	Screen 1 Power Supply Voltage Circuit	RSE	DTC B1335 or B1340
B1340	Screen 2 Power Supply Voltage Circui	RSE	DTC B1335 or B1340
		BCM	DTC B1370-B1379, B1380-B1389, or B1440-B1443

B1370	Device Ignition 1 Circuit	SDM	DTC B1370
	Wake Up Circuit	MSM	DTC B1370
B1380	Device Ignition ACCESSORY Circuit	BCM	DTC B1370-B1379, B1380-B1389, or B1440-B1443
B138A	Device Voltage Reference Group 1 Outputs	UPA	DTC B138A
B1390	Button 1 Circuit Short to Battery	MSM	DTC B1390, B1400, B1410, or B2765
B1400	Button 2 Circuit Short to Battery	MSM	DTC B1390, B1400, B1410, or B2765
B1410	Button 3 Circuit Short to Battery	MSM	DTC B1390, B1400, B1410, or B2765
B1423	Supply Voltage Circuit	RSE	DTC B1325, B1330, or B1423
B1428	Ignition Switched Power Relay 1 Circuit	BCM	DTC B1428
B1433	Ignition Switched Power Relay 2 Circuit	BCM	DTC B1433
B1440	Power Mode Master Input Circuit Malfunction	BCM	DTC B1370-B1379, B1380-B1389, or B1440-B1443
B1441	Device Ignition OFF, RUN, and CRANK Circuit	BCM	DTC B1370-B1379, B1380-B1389, or B1440-B1443
B1446	Backup Battery Timer Expired	Telematics	DTC B1446
B1447	Backup Battery Circuit	Telematics	DTC B1447
B1475	Retained Accessory Power Circuit	BCM	DTC B1475
B1516	Battery Current Sensor Performance	BCM	DTC B1516
B1517	Battery Voltage	BCM	DTC B1517
		Telematics	DTC B1517
B1527	High Parasitic Load Detected	BCM	DTC B1527
B1529	Control Module Voltage Reference Output 5 Circuit	BCM	DTC B1529
B1565	Mirror DIP Button Stuck	MSM	DTC B1565, B2755, B2760, or B3599
B1735	Front Vertical Up Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1740	Front Vertical Down Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1745	Rear Vertical Up Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1750	Rear Vertical Down Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1755	Horizontal Forward Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1760	Horizontal Back Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820

B1815	Recline Up Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1820	Recline Down Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1825	Recline Position Sensor Fault	MSM	DTC B1825, B2355, B2365, or B2375
B1831	Lumbar Forward Switch Stuck	MSM	DTC B1831 or B1836
B1836	Lumbar Rearward Switch Stuck	MSM	DTC B1831 or B1836
B1851	Lumbar Position Sensor Fault	MSM	DTC B1851
B2355	Front Vertical Position Sensor Fault	MSM	DTC B1825, B2355, B2365, or B2375
B2365	Rear Vertical Position Sensor Fault	MSM	DTC B1825, B2355, B2365, or B2375
B2375	Horizontal Position Sensor Fault	MSM	DTC B1825, B2355, B2365, or B2375
B245A	Telematics Indicator 1 Circuit	Telematics	DTC B245A
B245B	Telematics Indicator 2 Circuit	Telematics	DTC B245B
B2461	Navigation Electronic Control Unit (ECU) Synchronous Signal Error	NIM	DTC B2461
B2462	Global Positioning System (GPS) Antenna Circuit	NIM, Telematics	DTC B2462
B2464	Navigation Player Decoding Error	Radio	DTC B2464
B2469	SIM Card Invalid	Telematics	DTC B2469
B2471	Telephone Number Error	Telematics	DTC B2471
B2476	Keypad Circuit	Telematics	DTC B2476
B2484	Global Positioning System Sensor Open Circuit	NIM	DTC B2484
B2530	Front Foglamps Control Circuit	BCM	DTC B2530
B2545	Backup Lamps Circuit	BCM	DTC B2545
B2555	Passenger Compartment Lamp Control Circuit	BCM	DTC B2555
B2575	Headlamp Low Beam Control Circuit	BCM	DTC B2575
B257A	Headlamp Switch Input Signals Mismatch	BCM	DTC B257A
B2580	Headlamp High Beam Control Circuit	BCM	DTC B2580
B2585	Parklamp Control Circuit	BCM	DTC B2585
B2610	Passenger Compartment Dimming 1 Circuit	BCM	DTC B2610
B2615	Passenger Compartment Dimming 2 Circuit	BCM	DTC B2615
	Display Dimming Pulse Width		

B2625	Modulation (PWM) Output Circuit	BCM	DTC B2625
B2645	Ambient Light Sensor Circuit	BCM	DTC B2645
B2652	Passenger Compartment Dimming 3 Circuit	BCM	DTC B2652
B2705	Gearshift Unlock Circuit	BCM	DTC B2705
B2730	Interior Trunk/Liftglass/Hatch Release Switch Circuit	BCM	DTC B2730
B2745	Traction Control Switch Circuit	BCM	DTC B2745
B2750	Horn Relay Coil Circuit	BCM	DTC B2750
B2755	Memory Button 1 Stuck	MSM	DTC B1565, B2755, B2760, or B3599
B2760	Memory Button 2 Stuck	MSM	DTC B1565, B2755, B2760, or B3599
B2765	Button M Circuit Short to Battery	MSM	DTC B1390, B1400, B1410, or B2765
B2795	Suspension Control Select Switch Circuit	ESCM	DTC B2795
B2815	Steering Wheel Switch Circuit	IPC	DTC B2815
B2976	Driver Door Ajar Circuit	BCM	DTC B2976
B2991	Passenger Door Ajar Circuit	BCM	DTC B2991
B3006	Hood Ajar Circuit Plausability Failure	BCM	DTC B3006
B3055	No Transponder Modulation or No Transponder	TDM	DTC B3055
B3060	Unprogrammed Transponder Key Identification Code Received	TDM	DTC B3060
B3105	Keyless Entry System Key Not Programmed	RFA	DTC B3105
B3109	Keyless Entry Transmitter 1 Battery Low Voltage	RFA	DTC B3109
B3110	Keyless Entry Transmitter 2 Battery Low Voltage	RFA	DTC B3110
B3111	Keyless Entry Transmitter 3 Battery Low Voltage	RFA	DTC B3111
B3112	Keyless Entry Transmitter 4 Battery Low Voltage	RFA	DTC B3112
B3125	Left Front/Driver Door Only Unlock Circuit	BCM	DTC B3125, B3130, or B3135
B3130	All Door Unlock Circuit	BCM	DTC B3125, B3130, or B3135
B3135	All Door Lock Circuit	BCM	DTC B3125, B3130, or B3135
B3140	Driver Unlock Switch Circuit	BCM	DTC B3140 or B3150
B3150	Driver Lock Switch Circuit	BCM	DTC B3140 or B3150
B3265	Trunk/Hatch/Liftglass Release	BCM	DTC B3265

	Output Circuit		
B3410	AHLD Front Axle Sensor Signal Circuit	Headlamp Control Module	DTC B3410 or B3420
B3415	AHLD Front Axle Sensor Supply Circuit	Headlamp Control Module	DTC B3415
B3420	AHLD Rear Axle Sensor Signal Circuit	Headlamp Control Module	DTC B3410 or B3420
B3435	AHLD Left Servo Driver Circuit	Headlamp Control Module	DTC B3435 or B3440
B3440	AHLD Right Servo Driver Circuit	Headlamp Control Module	DTC B3435 or B3440
B3445	Stop Lamp Circuit	BCM	DTC B3445
B3531	Rear Air Mode Door Motor Circuit	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531
B3599	Memory Button 3 Stuck	MSM	DTC B1565, B2755, B2760, or B3599
B370C	Rain Sensor Intensity Signal Circuit	BCM	DTC B370C or B370D
B370D	Rain Sensor Mode Control Circuit	BCM	DTC B370C or B370D
B3715	Front Wiper Relay Drive Circuit	BCM	DTC B3715
B3794	Cruise Control Function Request Circuit	BCM	DTC B3794
B3873	Front Washer Relay Circuit	BCM	DTC B3873
B3875	Wiper High Speed Relay Circuit	BCM	DTC B3875
B3907	Button Assembly Short to Battery	MSM	DTC B3907
B3922	Front Wiper Function Select Circuit	BCM	DTC B3922
B3924	DVD Player Theft Locked	RSE	DTC B3924
B3926	Screen 1 Theft Locked	RSE	DTC B3926 or B3927
B3927	Screen 2 Theft Locked	RSE	DTC B3926 or B3927
B3933	Evaporator Temperature Sensor Circuit	HVAC	DTC B3933
B3935	Transponder Key Identification Error	TDM	DTC B3935
B3976	Unconfigured Transponder Key	TDM	DTC B3976
C0035	Front Left Wheel Speed Sensor Circuit	EBCM	DTC C0035-C0050
C0040	Front Right Wheel Speed Sensor Circuit	EBCM	DTC C0035-C0050

C0045	Rear Left Wheel Speed Sensor Circuit	EBCM	DTC C0035-C0050
C0050	Rear Right Wheel Speed Sensor Circuit	EBCM	DTC C0035-C0050
C0060	Left Front Antilock Braking System Solenoid Valve Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0065	Left Front Antilock Brake System Solenoid 2 Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0070	Right Front Antilock Braking System Solenoid Valve Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0075	Right Front Antilock Brake System Solenoid 2 Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0080	Left Rear Antilock Brake System Solenoid Valve Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0085	Left Rear Antilock Brake System Solenoid 2 Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0090	Right Rear Antilock Braking System Solenoid Valve Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0095	Right Rear Antilock Braking System Solenoid 2 Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0100	Rear Antilock Brake System Solenoid Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0105	Rear Antilock Brake System Solenoid 2 Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0110	Return Pump Circuit Malfunction	EBCM	DTC C0110
C0121	Valve Relay Circuit Malfunction	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0126	Low Brake Fluid Indicated	EBCM	DTC C0126
C0131	Antilock Brake System Pressure Circuit	EBCM	DTC C0131
C0141	Front Left/Front Right TC/ESP Priming Valve Circuit Malfunction	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0146	Front Left/Front Right TC/ESP Switch Over Valve Circuit Malfunction	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156

C0151	Rear Left/Rear Right TC/ESP Priming Valve Circuit Malfunction	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0156	Rear Left/Rear Right TC/ESP Switch Over Valve Circuit Malfunction	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0161	Brake Switch Circuit	EBCM	DTC C0161
C0186	Lateral Acceleration Sensor	EBCM	DTC C0186 or C0196
C0196	Yaw Rate Sensor	EBCM	DTC C0186 or C0196
C0245	Wheel Speed Sensor Frequency	EBCM	DTC C0245
C0252	Implausible Control	EBCM	DTC C0252
C0277	Brake Pedal Position Sensor Circuit	BCM	DTC C0277 or C0890
C0297	Brake Applied Output Circuit	BCM	DTC C0297
C0460	Steering Angle Sensor Circuit	EBCM	DTC C0460
C0550	Electronic Control Unit (ECU) Performance	EBCM	DTC C0550
C0558	Calibration Data Not Programmed	ESCM	DTC C0558
C0561	CAN-Bus Invalid Data	EBCM	DTC C0561
C0565	Vehicle Identification Number (VIN) Not Programmed/Mismatch	EBCM	DTC C0565
C0569	System Configuration Error	EBCM	DTC C0569
		RFA	DTC C0569
C0575	Left Front Solenoid/Motor/Actuator Circuit	ESCM	DTC C0575, C0580, C0585, or C0590
C0580	Right Front Solenoid/Motor/Actuator Circuit	ESCM	DTC C0575, C0580, C0585, or C0590
C0585	Left Rear Solenoid/Motor/Actuator Circuit	ESCM	DTC C0575, C0580, C0585, or C0590
C0590	Right Rear Solenoid/Motor/Actuator Circuit	ESCM	DTC C0575, C0580, C0585, or C0590
C0615	Left Front Position Sensor Circuit	ESCM	DTC C0615, C0620, C0625, or C0630
C0620	Right Front Position Sensor Circuit	ESCM	DTC C0615, C0620, C0625, or C0630
C0625	Left Rear Position Sensor Circuit	ESCM	DTC C0615, C0620, C0625, or C0630
C0630	Right Rear Position Sensor Circuit	ESCM	DTC C0615, C0620, C0625, or C0630

C0696	Position Sensor Overcurrent 5-Volt Supply	ESCM	DTC C0696
C0750	Left Front Tire Pressure Sensor	RCDLR	DTC C0750, C0755, C0760, or C0765
C0755	Right Front Tire Pressure Sensor	RCDLR	DTC C0750, C0755, C0760, or C0765
C0760	Left Rear Tire Pressure Sensor	RCDLR	DTC C0750, C0755, C0760, or C0765
C0765	Right Rear Tire Pressure Sensor	RCDLR	DTC C0750, C0755, C0760, or C0765
C0890	Device Voltage Reference Output 3 Circuit	BCM	DTC C0277 or C0890
C0899	Power Supply Circuit Low Voltage	EBCM	DTC C0899
C0900	Power Supply Circuit High Voltage	EBCM	DTC C0900
C1209	Left Rear Wheel Speed Sensor Circuit High	EBCM, ECM	DTC C1209, C1223, C1227, or C1234
C1210	Right Rear Wheel Speed Sensor Circuit High	EBCM, ECM	DTC C1210, C1224, C1228, or C1235
C1223	Left Rear Wheel Speed Sensor Circuit	EBCM, ECM	DTC C1209, C1223, C1227, or C1234
C1224	Right Rear Wheel Speed Sensor Circuit	EBCM, ECM	DTC C1210, C1224, C1228, or C1235
C1227	Left Rear Wheel Speed Sensor Circuit Range/Performance	EBCM, ECM	DTC C1209, C1223, C1227, or C1234
C1228	Right Rear Wheel Speed Sensor Circuit Range/Performance	EBCM, ECM	DTC C1210, C1224, C1228, or C1235
C1234	Left Rear Wheel Speed Sensor Circuit Low	EBCM, ECM	DTC C1209, C1223, C1227, or C1234
C1235	Right Rear Wheel Speed Sensor Circuit Low	EBCM, ECM	DTC C1210, C1224, C1228, or C1235
P0008	Engine Position System Performance Bank 1	ECM	DTC P0008 or P0009
P0009	Engine Position System Performance Bank 2	ECM	DTC P0008 or P0009
P0010	Intake Camshaft Position Control Solenoid Circuit Malfunction Bank 1	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P0011	Intake Camshaft Position Range/Performance Bank 1	ECM	DTC P0011, P0014, P0021, or P0024
P0013	Exhaust Camshaft Position Control Solenoid Circuit Malfunction Bank 1	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P0014	Exhaust Camshaft Position Range/Performance Bank 1	ECM	DTC P0011, P0014, P0021, or P0024

P0016	Crankshaft/Intake Camshaft Position not Plausible Bank 1	ECM	DTC P0016, P0017, P0018, or P0019 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Crankshaft Position (CKP) Camshaft Position (CMP) Correlation		DTC P0016 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0017	Crankshaft/Exhaust Camshaft Position not Plausible Bank 1	ECM	DTC P0016, P0017, P0018, or P0019
P0018	Crankshaft/Intake Camshaft Position not Plausible Bank 2	ECM	DTC P0016, P0017, P0018, or P0019
P0019	Crankshaft/Exhaust Camshaft Position not Plausible Bank 2	ECM	DTC P0016, P0017, P0018, or P0019
P0020	Intake Camshaft Position Control Solenoid Circuit Malfunction Bank 2	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P0021	Intake Camshaft Position Range/Performance Bank 2	ECM	DTC P0011, P0014, P0021, or P0024
P0023	Exhaust Camshaft Position Control Solenoid Circuit Malfunction Bank 2	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P0024	Exhaust Camshaft Position Range/Performance Bank 2	ECM	DTC P0011, P0014, P0021, or P0024
P0030	O2 Sensor Heater Circuit Malfunction Bank 1 Sensor 1	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Control Circuit Bank 1 Sensor 1		DTC P0030, P0036, P0053, P0054, P0135, or P0141 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0031	O2 Sensor Heater Circuit Low Voltage Bank 1 Sensor 1	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0032	O2 Sensor Heater Circuit High Voltage Bank 1 Sensor 1	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0036	O2 Sensor Heater Circuit Malfunction Bank 1 Sensor 2	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Control Circuit Bank 2		DTC P0030, P0036, P0053, P0054, P0135, or P0141 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0037	O2 Sensor Heater Circuit Low Voltage Bank 1 Sensor 2	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0038	O2 Sensor Heater Circuit High Voltage Bank 1 Sensor 2	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
	O2 Sensor Signals not		

P0040	Plausible Bank 1 Sensor 1 & Bank 2 Sensor 1	ECM	DTC P0040 or P0041
P0041	O2 Sensor Signals not Plausible Bank 1 Sensor 2 & Bank 2 Sensor 2	ECM	DTC P0040 or P0041
P0050	O2 Sensor Heater Circuit Malfunction Bank 2 Sensor 1	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Control Bank 2 Sensor 1		DTC P0050, P0056, P0059, P0060, P0155, or P0161 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0051	O2 Sensor Heater Circuit Low Voltage Bank 2 Sensor 1	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0052	O2 Sensor Heater Circuit High Voltage Bank 2 Sensor 1	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0053	O2 Sensor Heater Resistance Range/Performance Bank 1 Sensor 1	ECM	DTC P0053 or P0059 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Resistance Circuit Bank 1 Sensor 1		DTC P0030, P0036, P0053, P0054, P0135, or P0141 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0054	HO2S Heater Resistance Circuit Bank 1 Sensor 2	ECM	DTC P0030, P0036, P0053, P0054, P0135, or P0141
P0056	O2 Sensor Heater Circuit Malfunction Bank 2 Sensor 2	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Control Bank 2 Sensor 2		DTC P0050, P0056, P0059, P0060, P0155, or P0161 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0057	O2 Sensor Heater Circuit Low Voltage Bank 2 Sensor 2	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0058	O2 Sensor Heater Circuit High Voltage Bank 2 Sensor 2	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0059	O2 Sensor Heater Resistance Range/Performance Bank 2 Sensor 1	ECM	DTC P0053 or P0059 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Resistance Bank 2 Sensor 1		DTC P0050, P0056, P0059, P0060, P0155, or P0161 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0060	HO2S Heater Resistance Bank 2 Sensor 2	ECM	DTC P0050, P0056, P0059, P0060, P0155, or P0161
P0068	Throttle Body Airflow Performance	ECM	DTC P0068 or P0121

P0100	Mass Air Flow Sensor Circuit Malfunction	ECM	DTC P0100, P0102, or P0103
P0101	Mass Air Flow Sensor Circuit Range/Performance	ECM	DTC P0101 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Mass Air Flow (MAF) Sensor Performance	ECM	DTC P0101 or P1101 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0102	Mass Air Flow Sensor Voltage Low	ECM	DTC P0100, P0102, or P0103 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Mass Air Flow (MAF) Sensor Circuit Low Frequency	ECM	DTC P0102 or P0103 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0103	Mass Air Flow Sensor Voltage High	ECM	DTC P0100, P0102, or P0103 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Mass Air Flow (MAF) Sensor Circuit High Frequency	ECM	DTC P0102 or P0103 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0106	Manifold Absolute Pressure (MAP) Sensor Performance	ECM	DTC P0106
P0107	Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage	ECM	DTC P0107 or P0108
P0108	Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage	ECM	DTC P0107 or P0108
P0111	Intake Air Temperature Sensor Circuit Range/Performance	ECM	DTC P0111-P0113
P0112	Intake Air Temperature Sensor Circuit Low Voltage	ECM	DTC P0111-P0113 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
			DTC P0112 or P0113 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0113	Intake Air Temperature Sensor Circuit High Voltage	ECM	DTC P0111-P0113 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
			DTC P0112 or P0113 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0115	Engine Coolant Temperature (ECT) Sensor Circuit	TCM	DTC P0115
P0116	Engine Coolant Temperature (ECT) Sensor Performance	ECM	DTC P0116 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0116 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0117	Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage	ECM	DTC P0117 or P0118 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0117 or P0118 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine

P0118	Engine Coolant Temperature (ECT) Sensor Circuit High Voltage	ECM	DTC P0117 or P0118 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0117 or P0118 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0119	Engine Coolant Temperature Sensor Circuit Intermittent	ECM	DTC P0119
P0120	Throttle Position Sensor 1 Circuit	ECM	DTC P0120, P0122, P0123, P0220, P0222, P0223, or P2135 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
	Throttle Position (TP) Sensor Circuit	TCM	DTC P0120
P0121	Throttle Position Sensor 1 Circuit Range/Performance	ECM	DTC P0121, P0122, P0123, P0221, P0222, or P0223 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Throttle Position (TP) Sensor 1 Performance	ECM	DTC P0068 or P0121 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0122	Throttle Position Sensor 1 Circuit Low Voltage	ECM	DTC P0121, P0122, P0123, P0221, P0222, or P0223 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0120, P0122, P0123, P0220, P0222, P0223, or P2135 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0123	Throttle Position Sensor 1 Circuit High Voltage	ECM	DTC P0121, P0122, P0123, P0221, P0222, or P0223 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0120, P0122, P0123, P0220, P0222, P0223, or P2135 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0128	Engine Coolant Temperature Below Thermostat Regulating Temperature	ECM	DTC P0128 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0128 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0130	O2 Sensor Circuit Malfunction Bank 1 Sensor 1	ECM	DTC P0130 or P0150
	O2 Sensor Circuit Low Voltage		DTC P0131 or P0151 for the 2.8L,

P0131	Bank 1 Sensor 1	ECM	3.0L, 3.2L, or 3.6L engine
	HO2S Circuit Low Voltage Bank 1 Sensor 1		DTC P0131, P0132, P0137, or P0138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0132	O2 Sensor Circuit High Voltage Bank 1 Sensor 1	ECM	DTC P0132 or P0152 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit High Voltage Bank 1 Sensor 1		DTC P0131, P0132, P0137, or P0138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0133	O2 Sensor Circuit Slow Response Bank 1 Sensor 1	ECM	DTC P0133 or P0153 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Slow Response Bank 1 Sensor 1		DTC P0133, P0134, P0140, P1133, P2270, or P2271 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0134	HO2S Circuit Insufficient Activity Bank 1 Sensor 1	ECM	DTC P0134 or P0154 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0133, P0134, P0140, P1133, P2270, or P2271 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0135	O2 Sensor Heater Circuit Range/Performance Bank 1 Sensor 1	ECM	DTC P0135, P0141, P0155, or P0161 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Performance Bank 1 Sensor 1		DTC P0030, P0036, P0053, P0054, P0135, or P0141 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0137	O2 Sensor Circuit Low Voltage Bank 1 Sensor 2	ECM	DTC P0137, P0138, P0140, P0157, P0158, or P0160 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit Low Voltage Bank 1 Sensor 2		DTC P0131, P0132, P0137, or P0138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0138	O2 Sensor Circuit High Voltage Bank 1 Sensor 2	ECM	DTC P0137, P0138, P0140, P0157, P0158, or P0160 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit High Voltage Bank 1 Sensor 2	ECM	DTC P0131, P0132, P0137, or P0138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P013A	HO2S Slow Response Rich to Lean Bank 1 Sensor 2	ECM	DTC P013A, P013C, P013E, or P014A
P013C	HO2S Slow Response Rich to Lean Bank 2 Sensor 2	ECM	DTC P013A, P013C, P013E, or P014A
P013E	HO2S Delayed Response Rich to Lean Bank 1 Sensor 2	ECM	DTC P013A, P013C, P013E, or P014A
	O2 Sensor Circuit No Activity Detected Bank 1 Sensor 2	ECM	DTC P0137, P0138, P0140, P0157, P0158, or P0160 for the 2.8L, 3.0L, 3.2L, or 3.6L engine

P0140	HO2S Circuit Insufficient Activity Bank 1 Sensor 2	ECM	DTC P0133, P0134, P0140, P1133, P2270, or P2271 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0141	O2 Sensor Heater Circuit Range/Performance Bank 1 Sensor 2	ECM	DTC P0135, P0141, P0155, or P0161 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Performance Bank 1 Sensor 2	ECM	DTC P0030, P0036, P0053, P0054, P0135, or P0141 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P014A	HO2S Delayed Response Rich to Lean Bank 2 Sensor 2	ECM	DTC P013A, P013C, P013E, or P014A
P0150	O2 Sensor Circuit Malfunction Bank 2 Sensor 1	ECM	DTC P0130 or P0150
P0151	O2 Sensor Circuit Low Voltage Bank 2 Sensor 1	ECM	DTC P0131 or P0151 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit Low Voltage Bank 2 Sensor 1		DTC P0151, P0152, P0157, or P0158 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0152	O2 Sensor Circuit High Voltage Bank 2 Sensor 1	ECM	DTC P0132 or P0152 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit High Voltage Bank 2 Sensor 1		DTC P0151, P0152, P0157, or P0158 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0153	O2 Sensor Circuit Slow Response Bank 2 Sensor 1	ECM	DTC P0133 or P0153 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Slow Response Bank 2 Sensor 1		DTC P0153, P0154, P0160, P1153, P2272, or P2273 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0154	HO2S Circuit Insufficient Activity Bank 2 Sensor 1	ECM	DTC P0134 or P0154 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
			DTC P0153, P0154, P0160, P1153, P2272, or P2273 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0155	O2 Sensor Heater Circuit Range/Performance Bank 2 Sensor 1	ECM	DTC P0135, P0141, P0155, or P0161 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Performance Bank 2 Sensor 1		DTC P0050, P0056, P0059, P0060, P0155, or P0161 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0157	O2 Sensor Circuit Low Voltage Bank 2 Sensor 2	ECM	DTC P0137, P0138, P0140, P0157, P0158, or P0160 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit Low Voltage Bank 2 Sensor 2		DTC P0151, P0152, P0157, or P0158 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0158	O2 Sensor Circuit High Voltage Bank 2 Sensor 2	ECM	DTC P0137, P0138, P0140, P0157, P0158, or P0160 for the 2.8L, 3.0L, 3.2L, or 3.6L engine

	HO2S Circuit High Voltage Bank 2 Sensor 2		DTC P0151, P0152, P0157, or P0158 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0160	O2 Sensor Circuit No Activity Detected Bank 2 Sensor 2	ECM	DTC P0137, P0138, P0140, P0157, P0158, or P0160 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit Insufficient Activity Bank 2 Sensor 2		DTC P0153, P0154, P0160, P1153, P2272, or P2273 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0161	O2 Sensor Heater Circuit Range/Performance Bank 2 Sensor 2	ECM	DTC P0135, P0141, P0155, or P0161 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Performance Bank 2 Sensor 2	ECM	DTC P0050, P0056, P0059, P0060, P0155, or P0161 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0171	Fuel Trim System Lean Bank 1	ECM	DTC P0171, P0172, P0174, or P0175
P0172	Fuel Trim System Rich Bank 1	ECM	DTC P0171, P0172, P0174, or P0175
P0174	Fuel Trim System Lean Bank 2	ECM	DTC P0171, P0172, P0174, or P0175
P0175	Fuel Trim System Rich Bank 2	ECM	DTC P0171, P0172, P0174, or P0175
P0196	Engine Oil Temperature Sensor Range/Performance	ECM	DTC P0196, P0197, or P0198 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Engine Oil Temperature Sensor Circuit Range/Performance	ECM	DTC P0196, P0197, or P0198 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0197	Engine Oil Temperature Voltage Low	ECM	DTC P0196, P0197, or P0198 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Engine Oil Temperature Sensor Circuit Low Input	ECM	DTC P0196, P0197, or P0198 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0198	Engine Oil Temperature Voltage High	ECM	DTC P0196, P0197, or P0198 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Engine Oil Temperature Sensor Circuit High Input	ECM	DTC P0196, P0197, or P0198 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0201	Injector 1 Control Circuit	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
			DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262,

P0202	Injector 2 Control Circuit	ECM	P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0203	Injector 3 Control Circuit	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0204	Injector 4 Control Circuit	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0205	Injector 5 Control Circuit	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
			DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262,

P0206	Injector 6 Control Circuit	ECM	P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0207	Injector 7 Control Circuit	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208
P0208	Injector 8 Control Circuit	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208
P0218	Transmission Fluid Overtemperature	TCM	• DTC P0218 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0218 for the 5L40-E/5L50-E transmission • DTC P0218 for the 6L50/6L80/6L90 transmission
P0219	Engine Overspeed Condition	ECM	DTC P0219
P0220	Throttle Position Sensor 2 Circuit	ECM	DTC P0120, P0122, P0123, P0220, P0222, P0223, or P2135
P0221	Throttle Position Sensor 2 Circuit Range/Performance	ECM	DTC P0121, P0122, P0123, P0221, P0222, or P0223
P0222	Throttle Position Sensor 2 Circuit Low Voltage	ECM	DTC P0121, P0122, P0123, P0221, P0222, or P0223 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0120, P0122, P0123, P0220, P0222, P0223, or P2135 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0223	Throttle Position Sensor 2 Circuit High Voltage	ECM	DTC P0121, P0122, P0123, P0221, P0222, or P0223 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0120, P0122, P0123, P0220, P0222, P0223, or P2135 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0230	Fuel Pump Relay Control Circuit	ECM	DTC P0230
			DTC P0201, P0202, P0203, P0204,

P0261	Injector 1 Control Circuit Low Voltage	ECM	P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0262	Injector 1 Control Circuit High Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0264	Injector 2 Control Circuit Low Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0265	Injector 2 Control Circuit High Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0267	Injector 3 Control Circuit Low Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0268	Injector 3 Control Circuit High Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0270	Injector 4 Control Circuit Low Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0271	Injector 4 Control Circuit High Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0273	Injector 5 Control Circuit Low Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0274	Injector 5 Control Circuit High Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
	Injector 6 Control Circuit Low		DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262,

P0276	Voltage	ECM	P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0277	Injector 6 Control Circuit High Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0300	Engine Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0301	Cylinder 1 Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0302	Cylinder 2 Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0303	Cylinder 3 Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0304	Cylinder 4 Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0305	Cylinder 5 Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine

P0306	Cylinder 6 Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0307	Cylinder 7 Misfire Detected	ECM	DTC P0300-P0308
P0308	Cylinder 8 Misfire Detected	ECM	DTC P0300-P0308
P0315	Crankshaft Position System Variation Not Learned	ECM	DTC P0315
P0324	Knock Sensor Module Performance	ECM	DTC P0324 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0325	Knock Sensor (KS) Circuit Bank 1	ECM	DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333
P0326	Knock Sensor (KS) Performance Bank 1	ECM	DTC P0326, P0327, P0328, P0331, P0332, or P0333 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Knock Sensor (KS) Performance	ECM	DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0327	Knock Sensor (KS) Circuit Low Voltage Bank 1	ECM	DTC P0326, P0327, P0328, P0331, P0332, or P0333 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0328	Knock Sensor (KS) Circuit High Voltage Bank 1	ECM	DTC P0326, P0327, P0328, P0331, P0332, or P0333 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0330	Knock Sensor (KS) Circuit	ECM	DTC P0324, P0325, P0326, P0327,

	Bank 2		P0328, P0330, P0332, or P0333
P0331	Knock Sensor (KS) System Performance Bank 2	ECM	DTC P0326, P0327, P0328, P0331, P0332, or P0333
P0332	Knock Sensor (KS) Circuit Low Voltage Bank 2	ECM	DTC P0326, P0327, P0328, P0331, P0332, or P0333 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0333	Knock Sensor (KS) Circuit High Voltage Bank 2	ECM	DTC P0326, P0327, P0328, P0331, P0332, or P0333 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0335	Crankshaft Position Sensor Circuit Malfunction	ECM	DTC P0335, P0336, or P0338 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Crankshaft Position (CKP) Sensor Circuit		DTC P0335 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0336	Crankshaft Position Sensor Signal Range/Performance	ECM	DTC P0335, P0336, or P0338 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Crankshaft Position (CKP) Sensor Performance		DTC P0336 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0338	Crankshaft Position Sensor Circuit High Duty Cycle	ECM	DTC P0335, P0336, or P0338 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
P0340	Camshaft Position (CMP) Sensor Circuit	ECM	DTC P0340
P0341	Intake Camshaft Position Sensor Range/Performance Bank 1	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Camshaft Position (CMP) Sensor Performance	ECM	DTC P0341 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0342	Intake Camshaft Position Sensor Low Voltage Bank 1	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0343	Intake Camshaft Position Sensor High Voltage Bank 1	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0346	Intake Camshaft Position Sensor Range/Performance	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367,

	Bank 2		P0368, P0391, P0392, or P0393
P0347	Intake Camshaft Position Sensor Low Voltage Bank 2	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0348	Intake Camshaft Position Sensor High Voltage Bank 2	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0351	Ignition Coil Cylinder 1 Control Circuit	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0351-P0358 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0352	Ignition Coil Cylinder 2 Control Circuit	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0351-P0358 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0353	Ignition Coil Cylinder 3 Control Circuit	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0351-P0358 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0354	Ignition Coil Cylinder 4 Control Circuit	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0351-P0358 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
			DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 for the 2.8L, 3.0L,

P0355	Ignition Coil Cylinder 5 Control Circuit	ECM	3.2L, or 3.6L engine or DTC P0351-P0358 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0356	Ignition Coil Cylinder 6 Control Circuit	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0351-P0358 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0357	Ignition Coil Cylinder 7 Control Circuit	ECM	DTC P0351-P0358
P0358	Ignition Coil Cylinder 8 Control Circuit	ECM	DTC P0351-P0358
P0366	Exhaust Camshaft Position Sensor Range/Performance Bank 1	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0367	Exhaust Camshaft Position Sensor Low Voltage Bank 1	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0368	Exhaust Camshaft Position Sensor High Voltage Bank 1	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0391	Exhaust Camshaft Position Sensor Range/Performance Bank 2	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0392	Exhaust Camshaft Position Sensor Low Voltage Bank 2	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0393	Exhaust Camshaft Position Sensor High Voltage Bank 2	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0420	Catalyst System Low EfficiencyBank 1	ECM	DTC P0420 or P0430 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0420 or P0430 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0430	Catalyst System Low Efficiency Bank 2	ECM	DTC P0420 or P0430 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or

			DTC P0420 or P0430 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0443	Evaporative Emission Control System Purge Solenoid Circuit Malfunction	ECM	DTC P0443, P0458, or P0459 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0443 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0458	Evaporative Emission Control System Purge Solenoid Circuit Low Voltage	ECM	DTC P0443, P0458, or P0459
P0459	Evaporative Emission Control System Purge Solenoid Circuit High Voltage	ECM	DTC P0443, P0458, or P0459
P0461	Fuel Level Sensor 1 Performance	ECM	DTC P0461
P0462	Fuel Level Sensor 1 Circuit Low Voltage	ECM	DTC P0462
P0463	Fuel Level Sensor 1 Circuit HighVoltage	ECM	DTC P0463
P0480	Cooling Fan Relay 1 Control Circuit	ECM	DTC P0480, P0481, P0691, P0692, P0693, or P0694 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0480 or P0481 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0481	Cooling Fan Relay 2 Control Circuit	ECM	DTC P0480, P0481, P0691, P0692, P0693, or P0694 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0480 or P0481 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0500	Vehicle Speed Sensor Circuit Malfunction	ECM	DTC P0500
P0501	Vehicle Speed Sensor (VSS) Performance	ECM	DTC P0501 or P0502
P0502	Vehicle Speed Sensor (VSS) Circuit Low Voltage	ECM	DTC P0501 or P0502 for the Aisin AY6 transmission or DTC P0502 or P0503 for the Tremec 6-Speed transmission
P0503	Vehicle Speed Sensor (VSS)	ECM	DTC P0502 or P0503

	Circuit Intermittent		
P0506	Idle Speed Low	ECM	DTC P0506, P0507, or P050A for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0506 or P0507 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0507	Idle Speed High	ECM	DTC P0506, P0507, or P050A for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0506 or P0507 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P050A	Cold Start Idle Air Control (IAC) System Performance	ECM	DTC P0506, P0507, or P050A
P0521	Engine Oil Pressure (EOP) Sensor Performance	ECM	DTC P0521, P0522, or P0523
P0522	Engine Oil Pressure (EOP) Sensor Circuit Low Voltage	ECM	DTC P0521, P0522, or P0523
P0523	Engine Oil Pressure (EOP) Sensor Circuit High Voltage	ECM	DTC P0521, P0522, or P0523
P0532	Air Conditioning (A/C) Refrigerant Pressure Sensor Circuit	ECM	DTC P0532 or P0533
P0533	Air Conditioning (A/C) Refrigerant Pressure Sensor Circuit Low Voltage	ECM	DTC P0532 or P0533
P0560	System Voltage Malfunction	ECM	DTC P0560
P0562	System Voltage Low	ECM	DTC P0562
		TCM	• DTC P0562 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0562 for the 5L40-E/5L50-E transmission • DTC P0562 or P0563 for the 6L50/6L80/6L90 transmission
P0563	System Voltage High	ECM	DTC P0563
		TCM	• DTC P0563 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0563 for the 5L40-E/5L50-E transmission • DTC P0562 or P0563 for the 6L50/6L80/6L90 transmission
P0571	Cruise Control Brake Switch Circuit	ECM	DTC P0571
	Brake Switch Circuit 1 Low		

P0572	Voltage	ECM	DTC P0572
P0573	Brake Switch Circuit 1 High Voltage	ECM	DTC P0573
P0575	Cruise Control Enable Circuit Malfunction	ECM	DTC P0575
P0601	Control Module Read Only Memory (ROM) Error	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
	Transmission Control Module (TCM) Read Only Memory (ROM)	TCM	• DTC P0601-P0604 or P062F for the 4L60-E/4L65-E/4L70-E transmission • DTC P0601 for the 5L40-E/5L50-E transmission • DTC P0601-P0604 or P062F for the 6L50/6L80/6L90 transmission
P0602	Control Module Not Programmed	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
	Transmission Control Module (TCM) Not Programmed	TCM	• DTC P0601-P0604 or P062F for the 4L60-E/4L65-E/4L70-E transmission • DTC P0602 for the 5L40-E/5L50-E transmission • DTC P0601-P0604 or P062F for the 6L50/6L80/6L90 transmission
	Control Module Long Term Memory Reset	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or

			P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0603	Transmission Control Module (TCM) Long Term Memory Reset	TCM	• DTC P0601-P0604 or P062F for the 4L60-E/4L65-E/4L70-E transmission • DTC P0603 for the 5L40-E/5L50-E transmission • DTC P0601-P0604 or P062F for the 6L50/6L80/6L90 transmission
P0604	Control Module Random Access Memory (RAM)	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
	Transmission Control Module (TCM) Random Access Memory (RAM)	TCM	• DTC P0601-P0604 or P062F for the 4L60-E/4L65-E/4L70-E transmission • DTC P0604 for the 5L40-E/5L50-E transmission • DTC P0601-P0604 or P062F for the 6L50/6L80/6L90 transmission
P0606	Control Module Internal Performance	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0607	Control Module Performance	ECM	DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610
P060D	Control Module Accelerator Pedal Position (APP) System Performance	ECM	DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610
P0615	Starter Relay Circuit Malfunction	ECM	DTC P0615
P0616	Starter Relay Control Circuit Low Voltage	ECM	DTC P0616 or P0617
	Starter Relay Control Circuit		

P0617	High Voltage	ECM	DTC P0616 or P0617
P0621	Alternator L-Terminal Circuit Malfunction	ECM	DTC P0621
P0622	Generator F-Terminal Circuit	ECM	DTC P0622
P0625	Generator F-Terminal Low Voltage	ECM	DTC P0625 or P0626
P0626	Generator F-Terminal High Voltage	ECM	DTC P0625 or P0626
P0627	Fuel Pump Relay Control Circuit	ECM	DTC P0627, P0628, or P0629
P0628	Fuel Pump Relay Control Circuit Low Voltage	ECM	DTC P0627, P0628, or P0629
P0629	Fuel Pump Relay Control Circuit High Voltage	ECM	DTC P0627, P0628, or P0629
P062F	Control Module Long Term Memory Performance	ECM	DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
	Transmission Control Module (TCM) Long Term Memory Performance	TCM	• DTC P0601-P0604 or P062F for the 4L60-E/4L65-E/4L70-E transmission • DTC P062F for the 5L40-E/5L50-E transmission • DTC P0601-P0604 or P062F for the 6L50/6L80/6L90 transmission
P0633	Theft Deterrent Key Not Programmed	ECM	DTC P0633
P0634	Transmission Control Module (TCM) Overtemperature	TCM	DTC P0634
P0638	Commanded versus Actual Throttle Position Correlation	ECM	DTC P0638, P2100, P2101, or P2119
P0641	5-Volt Reference 1 Circuit	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	5V Reference Circuit 1 Malfunction		DTC P0641 or P0651 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0642	5-Volt Reference 1 Circuit Low Voltage	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P0643	5-Volt Reference 1 Circuit High Voltage	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P0650	Malfunction Indicator (MI) Circuit Malfunction	ECM	DTC P0650 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0650 for the 4.8L, 5.3L, 6.0L,

			6.2L, or 7.0L engine
P0651	5-Volt Reference 2 Circuit	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	5V Reference Circuit 2 Malfunction	ECM	DTC P0641 or P0651 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0652	5-Volt Reference 2 Circuit Low Voltage	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P0653	5-Volt Reference 2 Circuit High Voltage	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P0658	Solenoid High Control Circuit Group 1 Low Voltage	TCM	DTC P0658 or P0659 for the 5L40-E/5L50-E transmission or DTC P0658 or P0659 for the 6L50/6L80/6L90 transmission
P0659	Solenoid High Control Circuit Group 1 High Voltage	TCM	DTC P0658 or P0659 for the 5L40-E/5L50-E transmission or DTC P0658 or P0659 for the 6L50/6L80/6L90 transmission
P0660	Intake Manifold Tuning (IMT) Valve Solenoid Control Circuit	ECM	DTC P0660, P0661, or P0662
P0661	Intake Manifold Tuning (IMT) Solenoid Control Circuit Low Voltage	ECM	DTC P0660, P0661, or P0662
P0662	Intake Manifold Tuning (IMT) Solenoid Control Circuit High Voltage	ECM	DTC P0660, P0661, or P0662
P0667	Transmission Control Module (TCM) Temperature Sensor Performance	TCM	DTC P0667, P0668, or P0669
P0668	Transmission Control Module (TCM) Temperature Sensor Circuit Low Voltage	TCM	DTC P0667, P0668, or P0669
P0669	Transmission Control Module (TCM) Temperature Sensor Circuit High Voltage	TCM	DTC P0667, P0668, or P0669
P0685	Engine Control Ignition Relay Circuit Malfunction	ECM	DTC P0685, P0686, P0687, P0689, or P0690 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Engine Controls Ignition Relay Control Circuit	ECM	DTC P0685, P0689, or P0690 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0686	Engine Control Ignition Relay Circuit Low Voltage	ECM	DTC P0685, P0686, P0687, P0689, or P0690

P0687	Engine Control Ignition Relay Circuit High Voltage	ECM	DTC P0685, P0686, P0687, P0689, or P0690
P0689	Engine Control Ignition Relay Feedback Circuit Low Voltage	ECM	DTC P0685, P0686, P0687, P0689, or P0690 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Engine Controls Relay Feedback Circuit Low Voltage		DTC P0685, P0689, or P0690 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0690	Engine Control Ignition Relay Feedback Circuit High Voltage	ECM	DTC P0685, P0686, P0687, P0689, or P0690 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Engine Controls Relay Feedback Circuit High Voltage		DTC P0685, P0689, or P0690 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0691	Cooling Fan Relay 1 Control Circuit Low Voltage	ECM	DTC P0480, P0481, P0691, P0692, P0693, or P0694
P0692	Cooling Fan Relay 2 Control Circuit High Voltage	ECM	DTC P0480, P0481, P0691, P0692, P0693, or P0694
P0693	Cooling Fan Relay 2 Control Circuit Low Voltage	ECM	DTC P0480, P0481, P0691, P0692, P0693, or P0694
P0694	Cooling Fan Relay 1 Control Circuit High Voltage	ECM	DTC P0480, P0481, P0691, P0692, P0693, or P0694
P0697	5-Volt Reference 3 Circuit	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P0698	5-Volt Reference 3 Circuit Low Voltage	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P0699	5-Volt Reference 3 Circuit High Voltage	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P06AC	Transmission Control Module (TCM) Power Up Temperature Sensor Performance	TCM	DTC P06AC, P06AD, or P06AE
P06AD	Transmission Control Module (TCM) Power Up Temperature Sensor Circuit Low Voltage	TCM	DTC P06AC, P06AD, or P06AE
P06AE	Transmission Control Module (TCM) Power Up Temperature Sensor Circuit High Voltage	TCM	DTC P06AC, P06AD, or P06AE
P0700	Transmission Control Module (TCM) Requested MIL Illumination	ECM	DTC P0700 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0700 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0703	Torque Converter / Brake Switch Circuit Malfunction	ECM	DTC P0703
P0704	Clutch Switch Circuit	ECM	DTC P0704
			• DTC P0711 for the 4L60-

P0711	Transmission Fluid Temperature (TFT) Sensor Performance	TCM	E/4L65-E/4L70-E transmission • DTC P0711 for the 5L40-E/5L50-E transmission • DTC P0711, P0712, or P0713 for the 6L50/6L80/6L90 transmission
P0712	Transmission Fluid Temperature (TFT) Sensor Circuit Low Voltage	ECM	DTC P0712 or P0713 for the Tremec 6-Speed transmission
		TCM	• DTC P0712 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0712 for the 5L40-E/5L50-E transmission • DTC P0711, P0712, or P0713 for the 6L50/6L80/6L90 transmission
P0713	Transmission Fluid Temperature (TFT) Sensor Circuit High Voltage	ECM	DTC P0712 or P0713 for the Tremec 6-Speed transmission
		TCM	• DTC P0713 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0713 for the 5L40-E/5L50-E transmission • DTC P0711, P0712, or P0713 for the 6L50/6L80/6L90 transmission
P0716	Input Speed Sensor Performance	TCM	• DTC P0716 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0716 for the 5L40-E/5L50-E transmission • DTC P0716 or P0717 for the 6L50/6L80/6L90 transmission
P0717	Input Speed Sensor Circuit Low Voltage	TCM	• DTC P0717 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0717 for the 5L40-E/5L50-E transmission • DTC P0716 or P0717 for the 6L50/6L80/6L90 transmission
P0719	Brake Switch Circuit Low Voltage	TCM	DTC P0719
P0722	Output Speed Sensor Circuit Low Voltage	TCM	• DTC P0722 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0722 for the 5L40-E/5L50-E transmission • DTC P0722 or P0723 for the 6L50/6L80/6L90 transmission
			• DTC P0723 for the 4L60-

P0723	Output Speed Sensor Circuit Intermittent	TCM	E/4L65-E/4L70-E transmission • DTC P0723 for the 5L40-E/5L50-E transmission • DTC P0722 or P0723 for the 6L50/6L80/6L90 transmission
P0724	Brake Switch Circuit High Voltage	TCM	DTC P0724
P0727	Engine Speed No Signal	TCM	DTC P0727
P0741	Torque Converter Clutch (TCC) System - Stuck Off	TCM	• DTC P0741 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0741 for the 5L40-E/5L50-E transmission • DTC P0741 or P0742 for the 6L50/6L80/6L90 transmission
P0742	Torque Converter Clutch (TCC) System - Stuck On	TCM	• DTC P0742 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0742 for the 5L40-E/5L50-E transmission • DTC P0741 or P0742 for the 6L50/6L80/6L90 transmission
P0748	Pressure Control (PC) Solenoid Control Circuit	TCM	DTC P0748
P0751	1-2 Shift Solenoid (SS) Valve Performance - No First, Fourth or Fifth Gear	TCM	DTC P0751 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0751 for the 5L40-E/5L50-E transmission
	Shift Solenoid (SS) 1 Valve Performance - Stuck Off		DTC P0751 for the 6L50/6L80/6L90 transmission
P0752	1-2 Shift Solenoid (SS) Valve Performance - No Second or Third Gear	TCM	DTC P0752 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0752 for the 5L40-E/5L50-E transmission
	Shift Solenoid (SS) 1 Valve Performance - Stuck On		DTC P0752 for the 6L50/6L80/6L90 transmission
P0756	2-3 Shift Solenoid (SS) Valve Performance - No First or Second Gear	TCM	DTC P0756 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0756 for the 5L40-E/5L50-E transmission

	Shift Solenoid (SS) 2 Valve Performance - Stuck Off		DTC P0756 for the 6L50/6L80/6L90 transmission
P0757	2-3 Shift Solenoid (SS) Valve Performance - No Third, Fourth or Fifth Gear	TCM	DTC P0757 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0757 for the 5L40-E/5L50-E transmission
P0761	4-5 Shift Solenoid (SS) Valve Performance - No Fourth Gear	TCM	DTC P0761
P0762	4-5 Shift Solenoid (SS) Valve Performance - No Fifth Gear	TCM	DTC P0762
P0776	Clutch Pressure Control (PC) Solenoid 2 - Stuck Off	TCM	DTC P0776 or P0777
P0777	Clutch Pressure Control (PC) Solenoid 2 - Stuck On	TCM	DTC P0776 or P0777
P0787	3-2 Shift Solenoid (SS) Control Circuit Low Voltage	TCM	DTC P0787
P0788	3-2 Shift Solenoid (SS) Control Circuit High Voltage	TCM	DTC P0788
P0796	Clutch Pressure Control (PC) Solenoid 3 - Stuck Off	TCM	DTC P0796 or P0797
P0797	Clutch Pressure Control (PC) Solenoid 3 - Stuck On	TCM	DTC P0796 or P0797
P0801	Reverse Lockout Solenoid Control Circuit	ECM	DTC P0801
P0803	Skip Shift Solenoid Control Circuit	ECM	DTC P0803
P0806	Clutch Pedal Position (CPP) Sensor Circuit Performance	ECM	DTC P0806 for the Aisin AY6 transmission or DTC P0806 for the Tremec 6-Speed transmission
P0807	Clutch Pedal Position (CPP) Sensor Circuit Low Voltage	ECM	DTC P0807 or P0808 for the Aisin AY6 transmission or DTC P0807 or P0808 for the Tremec 6-Speed transmission
P0808	Clutch Pedal Position (CPP) Sensor Circuit High Voltage	ECM	DTC P0807 or P0808 for the Aisin AY6 transmission or DTC P0807 or P0808 for the Tremec

			6-Speed transmission
P080A	Clutch Pedal Position (CPP) Sensor Circuit High Voltage	ECM	DTC P080A for the Aisin AY6 transmission or DTC P080A for the Tremec 6-Speed transmission
P0815	Upshift Switch Circuit	TCM	DTC P0815, P0816, or P0826 for the 5L40-E/5L50-E transmission or DTC P0815, P0816, or P0826 for the 6L50/6L80/6L90 transmission
P0816	Downshift Switch Circuit	TCM	DTC P0815, P0816, or P0826 for the 5L40-E/5L50-E transmission or DTC P0815, P0816, or P0826 for the 6L50/6L80/6L90 transmission
P0826	Up and Down Shift Switch Circuit	TCM	DTC P0815, P0816, or P0826 for the 5L40-E/5L50-E transmission or DTC P0815, P0816, or P0826 for the 6L50/6L80/6L90 transmission
P0842	Transmission Fluid Pressure (TFP) Switch 1 Circuit Low Voltage	TCM	DTC P0842 or P0843
P0843	Transmission Fluid Pressure (TFP) Switch 1 Circuit High Voltage	TCM	DTC P0842 or P0843
P0850	Park/Neutral Position (PNP) Switch Circuit	TCM	DTC P0850 for the 5L40-E/5L50-E transmission or DTC P0850-P0852 for the 6L50/6L80/6L90 transmission
P0851	Park/Neutral Position (PNP) Switch Circuit Low Voltage	ECM	DTC P0850-P0852 for the 6L50/6L80/6L90 transmission
P0852	Park/Neutral Position (PNP) Switch Circuit High Voltage	ECM	DTC P0850-P0852 for the 6L50/6L80/6L90 transmission
P0856	Engine Control Module (ECM) Traction Control Torque Request Circuit	ECM	DTC P0856

P0872	Transmission Fluid Pressure (TFP) Switch 3 Circuit Low Voltage	TCM	DTC P0872 or P0873
P0873	Transmission Fluid Pressure (TFP) Switch 3 Circuit High Voltage	TCM	DTC P0872 or P0873
P0877	Transmission Fluid Pressure (TFP) Switch 4 Circuit Low Voltage	TCM	DTC P0877 or P0878
P0878	Transmission Fluid Pressure (TFP) Switch 4 Circuit High Voltage	TCM	DTC P0877 or P0878
P0897	Transmission Fluid Life	TCM	DTC P0897
P0961	Line Pressure Control (PC) Solenoid System Performance	TCM	DTC P0961 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0961-P0963 for the 6L50/6L80/6L90 transmission
P0962	Line Pressure Control (PC) Solenoid Control Circuit Low Voltage	TCM	DTC P0961-P0963
P0963	Line Pressure Control (PC) Solenoid Control Circuit High Voltage	TCM	DTC P0961-P0963
P0965	Clutch Pressure Control (PC) Solenoid 2 System Performance	TCM	DTC P0965-P0967
P0966	Clutch Pressure Control (PC) Solenoid 2 Control Circuit Low Voltage	TCM	DTC P0965-P0967
P0967	Clutch Pressure Control (PC) Solenoid 2 Control Circuit High Voltage	TCM	DTC P0965-P0967
P0969	Clutch Pressure Control (PC) Solenoid 3 System Performance	TCM	DTC P0969-P0971
P0970	Clutch Pressure Control (PC) Solenoid 3 Control Circuit Low Voltage	TCM	DTC P0969-P0971
P0971	Clutch Pressure Control (PC) Solenoid 3 Control Circuit High Voltage	TCM	DTC P0969-P0971
P0973	1-2 Shift Solenoid (SS) Control Circuit Low Voltage	TCM	DTC P0973 for the 4L60-E/4L65-E/4L70-E transmission or

			DTC P0973 for the 5L40-E/5L50-E transmission
	Shift Solenoid (SS) 1 Control Circuit Low Voltage		DTC P0973 or P0974 for the 6L50/6L80/6L90 transmission
P0974	1-2 Shift Solenoid (SS) Control Circuit High Voltage	TCM	DTC P0974 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0974 for the 5L40-E/5L50-E transmission
	Shift Solenoid (SS) 1 Control Circuit High Voltage		DTC P0973 or P0974 for the 6L50/6L80/6L90 transmission
P0976	2-3 Shift Solenoid (SS) Control Circuit Low Voltage	TCM	DTC P0976 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0976 for the 5L40-E/5L50-E transmission
	Shift Solenoid (SS) 2 Control Circuit Low Voltage		DTC P0976 or P0977 for the 6L50/6L80/6L90 transmission
P0977	2-3 Shift Solenoid (SS) Control Circuit High Voltage	TCM	DTC P0977 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0977 for the 5L40-E/5L50-E transmission
	Shift Solenoid (SS) 2 Control Circuit High Voltage		DTC P0976 or P0977 for the 6L50/6L80/6L90 transmission
P0979	4-5 Shift Solenoid (SS) Control Circuit Low Voltage	TCM	DTC P0979
P0980	4-5 Shift Solenoid (SS) Control Circuit High Voltage	TCM	DTC P0980
P0989	Transmission Fluid Pressure (TFP) Switch 5 Circuit Low Voltage	TCM	DTC P0989 or P0990
P0990	Transmission Fluid Pressure (TFP) Switch 5 Circuit High Voltage	TCM	DTC P0989 or P0990
P1011	Intake Camshaft Actuator Park Position Bank 1	ECM	DTC P1011-P1014
P1012	Exhaust Camshaft Actuator Park Position Bank 1	ECM	DTC P1011-P1014
P1013	Intake Camshaft Actuator Park Position Bank 2	ECM	DTC P1011-P1014
P1014	Exhaust Camshaft Actuator Park Position Bank 2	ECM	DTC P1011-P1014

P1101	Intake Air Flow System Performance	ECM	DTC P0101 or P1101
P1133	HO2S Insufficient Switching Bank 1 Sensor 1	ECM	DTC P0133, P0134, P0140, P1133, P2270, or P2271
P1153	HO2S Insufficient Switching Bank 2 Sensor 1	ECM	DTC P0153, P0154, P0160, P1153, P2272, or P2273
P1174	Fuel Trim Cylinder Balance Bank 1	ECM	DTC P1174 or P1175
P1175	Fuel Trim Cylinder Balance Bank 2	ECM	DTC P1174 or P1175
P1258	Engine Coolant Over Temperature - Protection Mode Active	ECM	DTC P1258
P1380	Misfire Detected - Rough Road Data Not Available	ECM	DTC P1380 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P1380 or P1381 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P1381	Misfire Detected - No Communication with Brake Control Module	ECM	DTC P1380 or P1381
P1400	Cold Start Emission Reduction Control System	ECM	DTC P1400
P1516	Throttle Actuator Control (TAC) Module Throttle Actuator Position Performance	ECM	DTC P1516, P2101, P2119, or P2176
P1551	Throttle Control Lower Position not Reached during Learning Mode	ECM	DTC P1551
P1631	Theft Deterrent Fuel Enable Signal Not Correct	ECM	DTC P1631
P1668	Generator L-Terminal Control Circuit	ECM	DTC P1668, P2500, or P2501
P167D	Control Module Ignition Coil Internal Circuit	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610
P1682	Ignition 1 Switch Circuit 2	ECM	DTC P1682
P1751	Shift Valve 1 Performance	TCM	DTC P1751
P1761	Up and Down Shift Switch Signal Circuit	TCM	DTC P1761
P1793	Wheel Speed Signal	TCM	DTC P1793
P1810	Transmission Fluid Pressure (TFP) Position Switch Circuit	TCM	DTC P1810
P1815	Transmission Fluid Pressure (TFP) Valve Position Switch -	TCM	DTC P1815 for the 4L60-E/4L65-E/4L70-E transmission or

	Start in Wrong Range		DTC P1815 for the 5L40-E/5L50-E transmission
P1816	Transmission Fluid Pressure (TFP) Valve Position Switch Indicates Park/Neutral (P/N) with Drive Ratio	TCM	DTC P1816
P1818	Transmission Fluid Pressure (TFP) Valve Position Switch Indicates Drive without Drive Ratio	TCM	DTC P1818
P1820	Internal Mode Switch A Circuit Low Voltage	TCM	DTC P1820
P1822	Internal Mode Switch B Circuit High Voltage	TCM	DTC P1822
P1823	Internal Mode Switch P Circuit Low Voltage	TCM	DTC P1823
P1825	Internal Mode Switch - Invalid Range	TCM	DTC P1825 or P1915
P1826	Internal Mode Switch C Circuit High Voltage	TCM	DTC P1826
P182E	Internal Mode Switch - Invalid Range	TCM	DTC P182E or P1915
P1831	Pressure Control (PC)/Shift Lock Solenoid Control Circuit Low Voltage	TCM	DTC P1831 for the 5L40-E/5L50-E transmission
P1832	Pressure Control (PC)/Shift Lock Solenoid Control Circuit High Voltage	TCM	DTC P1832 for the 5L40-E/5L50-E transmission
P1833	Torque Converter Clutch (TCC)/Shift Solenoid (SS) Control Circuit Low Voltage	TCM	DTC P1833
P1834	Torque Converter Clutch (TCC)/Shift Solenoid (SS) Control Circuit High Voltage	TCM	DTC P1834
P1876	Up and Down Shift Switch Performance - Range Switch Not in D3	TCM	DTC P1876 for the 5L40-E/5L50-E transmission or DTC P1876 for the 6L50/6L80/6L90 transmission
P1915	Internal Mode Switch Does Not Indicate Park/Neutral (P/N) During Start	TCM	DTC P1825 or P1915 for the 5L40-E/5L50-E transmission
	Internal Mode Switch Start/Wrong Range		DTC P182E or P1915 for the 6L50/6L80/6L90 transmission
P2066	Fuel Level Sensor 2 Performance	ECM	DTC P2066

P2067	Fuel Level Sensor 2 Low Voltage	ECM	DTC P2067
P2068	Fuel Level Sensor 2 High Voltage	ECM	DTC P2068
P2072	Throttle Actuator Control System - Ice Blockage	ECM	DTC P2072
P2088	Intake Camshaft Position Control Solenoid Circuit Low Voltage Bank 1	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2089	Intake Camshaft Position Control Solenoid Circuit High Voltage Bank 1	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2090	Exhaust Camshaft Position Control Solenoid Circuit Low Voltage Bank 1	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2091	Exhaust Camshaft Position Control Solenoid Circuit High Voltage Bank 1	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2092	Intake Camshaft Position Control Solenoid Circuit Low Voltage Bank 2	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2093	Intake Camshaft Position Control Solenoid Circuit High Voltage Bank 2	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2094	Exhaust Camshaft Position Control Solenoid Circuit Low Voltage Bank 2	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2095	Exhaust Camshaft Position Control Solenoid Circuit High Voltage Bank 2	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2096	Post Catalyst O2 Sensor Fuel Trim Below Lower Limit Bank 1	ECM	DTC P2096 or P2098
P2097	Post Catalyst O2 Sensor Fuel Trim Above Upper Limit Bank 1	ECM	DTC P2097 or P2099
P2098	Post Catalyst O2 Sensor Fuel Trim Below Lower Limit Bank 2	ECM	DTC P2096 or P2098
P2099	Post Catalyst O2 Sensor Fuel Trim Above Upper Limit Bank 2	ECM	DTC P2097 or P2099
P2100	Throttle Control Motor Malfunction	ECM	DTC P0638, P2100, P2101, or P2119
P2101	Throttle Control Position Range/Performance	ECM	DTC P0638, P2100, P2101, or P2119 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Throttle Actuator Position Performance		DTC P1516, P2101, P2119, or P2176 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2105	Throttle Control Forced Engine Shutdown	ECM	DTC P2105

P2119	Closed Throttle Position Range/Performance	ECM	DTC P0638, P2100, P2101, or P2119 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Throttle Closed Position Performance		DTC P1516, P2101, P2119, or P2176 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2120	Accelerator Pedal Position Sensor 1 Circuit	ECM	DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138
P2122	Accelerator Pedal Position Sensor 1 Low Voltage	ECM	DTC P2122, P2123, P2127, P2128, or P2138 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2123	Accelerator Pedal Position Sensor 1 High Voltage	ECM	DTC P2122, P2123, P2127, P2128, or P2138 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2125	Accelerator Pedal Position Sensor 2 Circuit	ECM	DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138
P2127	Accelerator Pedal Position Sensor 2Low Voltage	ECM	DTC P2122, P2123, P2127, P2128, or P2138 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2128	Accelerator Pedal Position Sensor 2 High Voltage	ECM	DTC P2122, P2123, P2127, P2128, or P2138 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
	Throttle Position Sensor 1-2		DTC P0120, P0122, P0123, P0220,

P2135	Correlation	ECM	P0222, P0223, or P2135
P2138	Accelerator Pedal Position Sensor 1-2 Correlation	ECM	DTC P2122, P2123, P2127, P2128, or P2138 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2176	Throttle Actuator Control Lower Position Not Learned	ECM	DTC P2176 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Minimum Throttle Position Not Learned		DTC P1516, P2101, P2119, or P2176 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2177	Fuel Trim Lean during Cruising/Acceleration Bank 1	ECM	DTC P2177, P2179, P2187, or P2189
P2178	Fuel Trim Rich during Cruising/Acceleration Bank 1	ECM	DTC P2178, P2180, P2188, or P2190
P2179	Fuel Trim Lean during Cruising/Acceleration Bank 2	ECM	DTC P2177, P2179, P2187, or P2189
P2180	Fuel Trim Rich during Cruising/Acceleration Bank 2	ECM	DTC P2178, P2180, P2188, or P2190
P2187	Fuel Trim Lean during Idling/Deceleration Bank 1	ECM	DTC P2177, P2179, P2187, or P2189
P2188	Fuel Trim Rich during Idling/Deceleration Bank 1	ECM	DTC P2178, P2180, P2188, or P2190
P2189	Fuel Trim Lean during Idling/Deceleration Bank 2	ECM	DTC P2177, P2179, P2187, or P2189
P2190	Fuel Trim Rich during Idling/Deceleration Bank 2	ECM	DTC P2178, P2180, P2188, or P2190
P2227	Barometric Pressure Sensor Range/Performance	ECM	DTC P2227, P2228, or P2229
P2228	Barometric Pressure Sensor Voltage Low	ECM	DTC P2227, P2228, or P2229
P2229	Barometric Pressure Sensor Voltage High	ECM	DTC P2227, P2228, or P2229
P2232	HO2S Signal Circuit Shorted to Heater Circuit Bank 1 Sensor 2	ECM	DTC P2232 or P2235
P2235	HO2S Signal Circuit Shorted to Heater Circuit Bank 2 Sensor 2	ECM	DTC P2232 or P2235
P2270	O2 Sensor Lean/Rich Switch Signal Malfunction Bank 1 Sensor 2	ECM	DTC P2270 or P2272 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Signal Stuck Lean Bank 1 Sensor 2		DTC P0133, P0134, P0140, P1133, P2270, or P2271 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine

P2271	O2 Sensor Rich/Lean Switch Signal Malfunction Bank 1 Sensor 2	ECM	DTC P2271 or P2273 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Signal Stuck Rich Bank 1 Sensor 2		DTC P0133, P0134, P0140, P1133, P2270, or P2271 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2272	O2 Sensor Lean/Rich Switch Signal Malfunction Bank 2 Sensor 2	ECM	DTC P2270 or P2272 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Signal Stuck Lean Bank 2 Sensor 2		DTC P0153, P0154, P0160, P1153, P2272, or P2273 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2273	O2 Sensor Rich/Lean Switch Signal Malfunction Bank 2 Sensor 2	ECM	DTC P2271 or P2273 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Signal Stuck Rich Bank 2 Sensor 2		DTC P0153, P0154, P0160, P1153, P2272, or P2273 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2300	Ignition Coil Cylinder 1 Circuit Low Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2301	Ignition Coil Cylinder 1 Circuit High Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2303	Ignition Coil Cylinder 2 Circuit Low Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2304	Ignition Coil Cylinder 2 Circuit High Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2306	Ignition Coil Cylinder 3 Circuit Low Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2307	Ignition Coil Cylinder 3 Circuit High Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2309	Ignition Coil Cylinder 4 Circuit Low Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2310	Ignition Coil Cylinder 4 Circuit High Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316

P2312	Ignition Coil Cylinder 5 Circuit Low Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2313	Ignition Coil Cylinder 5 Circuit High Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2315	Ignition Coil Cylinder 6 Circuit Low Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2316	Ignition Coil Cylinder 6 Circuit High Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2500	Generator L-Terminal Circuit Low Voltage	ECM	DTC P1668, P2500, or P2501
P2501	Generator L-Terminal Circuit High Voltage	ECM	DTC P1668, P2500, or P2501
P250A	Engine Oil Level Sensor Circuit	ECM	DTC P250A
P2534	Ignition 1 Switch Circuit Low Voltage	TCM	• DTC P2534 for the 4L60-E/4L65-E/4L70-E transmission • DTC P2534 for the 5L40-E/5L50-E transmission • DTC P2534 for the 6L50/6L80/6L90 transmission
P2544	Transmission Torque Request Circuit	ECM	DTC P2544 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P2544 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
		TCM	DTC P2544 for the 5L40-E/5L50-E transmission
P2610	Control Module Ignition Off Timer Performance	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2636	Fuel Transfer Pump Flow Insufficient	ECM	DTC P2636
	Transmission Torque Delivered		

P2637	Circuit	TCM	DTC P2637
P2670	Solenoid High Control Circuit Group 2 Low Voltage	TCM	DTC P2670 or P2671
P2671	Solenoid High Control Circuit Group 2 High Voltage	TCM	DTC P2670 or P2671
P2714	Clutch Pressure Control (PC) Solenoid 4 - Stuck Off	TCM	DTC P2714 or P2715
P2715	Clutch Pressure Control (PC) Solenoid 4 - Stuck On	TCM	DTC P2714 or P2715
P2719	Clutch Pressure Control (PC) Solenoid 4 System Performance	TCM	DTC P2719-P2721
P2720	Clutch Pressure Control (PC) Solenoid 4 Control Circuit Low Voltage	TCM	DTC P2719-P2721
P2721	Clutch Pressure Control (PC) Solenoid 4 Control Circuit High Voltage	TCM	DTC P2719-P2721
P2723	Clutch Pressure Control (PC) Solenoid 5 - Stuck Off	TCM	DTC P2723 or P2724
P2724	Clutch Pressure Control (PC) Solenoid 5 - Stuck On	TCM	DTC P2723 or P2724
P2728	Clutch Pressure Control (PC) Solenoid 5 System Performance	TCM	DTC P2728-P2730
P2729	Clutch Pressure Control (PC) Solenoid 5 Control Circuit Low Voltage	TCM	DTC P2728-P2730
P2730	Clutch Pressure Control (PC) Solenoid 5 Control Circuit High Voltage	TCM	DTC P2728-P2730
P2762	Torque Converter Clutch (TCC) Pressure Control Solenoid System Performance	TCM	DTC P2762, P2763, or P2764
P2763	Torque Converter Clutch (TCC) Pressure Control (PC) Solenoid Control Circuit High Voltage	TCM	DTC P2763 for the 4L60-E/4L65-E/4L70-E transmission or DTC P2763 for the 5L40-E/5L50-E transmission
	Torque Converter Clutch (TCC) Pressure Control Solenoid Control Circuit Low Voltage		DTC P2762, P2763, or P2764 for the 6L50/6L80/6L90 transmission
	Torque Converter Clutch (TCC) Pressure Control (PC) Solenoid Control Circuit Low Voltage		DTC P2764 for the 4L60-E/4L65-E/4L70-E transmission or

P2764		TCM	DTC P2764 for the 5L40-E/5L50-E transmission
	Torque Converter Clutch (TCC) Pressure Control Solenoid Control Circuit High Voltage		DTC P2762, P2763, or P2764 for the 6L50/6L80/6L90 transmission
P2769	Torque Converter Clutch (TCC) Enable Solenoid Control Circuit Low Voltage	TCM	DTC P2769
P2770	Torque Converter Clutch (TCC) Enable Solenoid Control Circuit High Voltage	TCM	DTC P2770
P3400	Cylinder Deactivation System Performance	ECM	DTC P3400
P3401	Cylinder 1 Deactivation Solenoid Control Circuit	ECM	DTC P3401, P3425, P3441, or P3449
P3425	Cylinder 4 Deactivation Solenoid Control Circuit	ECM	DTC P3401, P3425, P3441, or P3449
P3441	Cylinder 6 Deactivation Solenoid Control Circuit	ECM	DTC P3401, P3425, P3441, or P3449
P3449	Cylinder 7 Deactivation Solenoid Control Circuit	ECM	DTC P3401, P3425, P3441, or P3449
U0073	High Speed Communication Bus	--	DTC U0073
U0100 - U0249	CAN-Bus No Communication with XXX Control Module	--	DTC U0100-U0249
U1304	CAN-Bus No Communication with SIM (Seat Interface Module)	SIM	DTC U1304
U1401	No Communication with MSM (Memory Seat and Mirror Module)	SIM	DTC U1401
	Lost Communications Between AD and ADG	NIM	DTC U1401
U1814	Powertrain High Speed Communication Enable Circuit	BCM	DTC U1814
U2099	High Speed Communication Enable Circuit	BCM	DTC U2099
U2100	CAN-Bus Circuit Malfunction	--	DTC U2100
U2121	No Communication with Radio Display	Radio	DTC U2121
U2136	No Exterior Mirror Communication	MSM	DTC U2136
U2201	No Communication With DVD Player	RSE	DTC U2201
U2202	No Communication With Rear Control Panel	RSE	DTC U2202

U2203	No Communication With Screen 1	RSE	DTC U2203 or U2204
U2204	No Communication With Screen 2	RSE	DTC U2203 or U2204

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Emissions Related DTCs

Action Taken When the DTC Sets - Type A

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Action Taken When the DTC Sets - Type B

- The control module illuminates the MIL on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.
- The following applies to misfire DTCs:
  - If the control module detects a low level or an emission level misfire condition during 2 consecutive trips, the control module illuminates the MIL.
  - If the control module detects a high level or catalyst damaging misfire, the control module flashes the MIL at a rate of once per second.
  - If the control module detects a misfire during 2 non-consecutive trips, the stored conditions are compared with the current conditions. The control module illuminates the MIL when the following conditions occur:
    - The engine load is within 20 percent of the previous test that failed.
    - The engine speed is within 375 RPM of the previous test that failed.
    - The engine coolant temperature is in the same range of the previous test that failed.
- The following applies to fuel trim DTCs:
  - If the control module detects a fuel trim condition during 2 consecutive trips, the control module illuminates the MIL.
  - If the control module detects a fuel trim condition during 2 non-consecutive trips, the stored conditions are compared with the current conditions. The control module illuminates the MIL when the following conditions occur:
    - The engine load is within 20 percent of the previous test that failed.
    - The engine speed is within 375 RPM of the previous test that failed.
    - The engine coolant temperature is in the same range of the previous test that failed.

Conditions for Clearing the MIL/DTC - Type A or Type B

- The control module turns OFF the MIL after 4 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Non-Emissions Related DTCs

Action Taken When the DTC Sets - Type C

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The MIL will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- The driver information center, if equipped, may display a message.

Conditions for Clearing the DTC - Type C

- A current DTC Last Test Failed clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.
- Clear the DTC with a scan tool.

Action Taken When the DTC Sets - Type D

- The control module will take default actions but no DTC will be stored in Failure Records.
- The MIL or SVS will not illuminate.

Conditions for Clearing the DTC - Type D

Clear the DTC with a scan tool.

Diagnostic System Check - Vehicle

Diagnostic Instructions

- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Continue through the Diagnostic System Check until you are directed to follow a particular diagnostic or repair procedure. Once a repair has been completed, perform the Diagnostic Repair Verification and verify the customer concern has been corrected.

The diagnostic procedures within this manual are developed on the assumption that the following areas function as designed:

- The 12V battery is fully charged and cables are clean and tight. Refer to Battery Inspection/Test.
- Fuses are not open. Refer to Power Distribution Schematics and Electrical Center Identification Views.
- Ground circuits for the area of customer concern are clean, tight, and in the correct location. Refer to Ground Distribution Schematics and Harness Routing Views.
- All connections/connectors for the area of concern are fully seated. Refer to Component Connector End Views.
- There are no aftermarket devices that affect the operation of the system. Refer to Checking Aftermarket Accessories.
- The scan tool powers up. Refer to Scan Tool Does Not Power Up.

Diagnostic System Check

1. *VERIFY CUSTOMER CONCERN* -- Understand and validate the customer concern. Inspect the visible system components for obvious damage or conditions that may cause the concern.
2. *BULLETIN SEARCH* -- Check for related bulletins, recall/field actions and preliminary information.
3. *MECHANICAL CONCERNS* -- Verify the symptom is not exclusively a mechanical concern.

   If the symptom is exclusively a mechanical concern, refer to Symptoms - Vehicle.

   Note: Do not clear any DTCs unless instructed to do so by a diagnostic procedure. If any DTC is Powertrain related, select Capture Info to store DTC and Freeze Frame/Failure Records to the Scan Tool.

4. *CONTROL MODULE COMMUNICATION and DTC CHECK* -- Using a scan tool, perform the Vehicle DTC Information function and verify at least one control module communicates with the scan tool. Record on the Repair Order the following information:
   - Any control module that is not communicating.
   - Any DTC, including symptom byte, and the control module that has set the DTC.

   If the scan tool does not communicate with any control module on the vehicle, refer to Power Mode Mismatch.
5. *CONTROL MODULE INTERNAL PERFORMANCE FAULTS* -- Verify there are no current control

module Internal Hardware Performance DTCs set.

If any DTC of this type is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.

6. *CONTROL MODULE COMMUNICATION VERIFICATION* -- Verify the vehicle is built with any control module listed as not communicating, refer to Data Link References. All control modules should be communicating, as equipped.

   If the scan tool does not communicate with one or more control modules refer to Data Link References.

7. *COMMUNICATION and POWERMODE FAULTS* -- Verify there are no current control module Power Mode or Communication DTCs set..

   If any DTC of this type is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.

Note: The engine may start during this test. Ensure the vehicle is out of gear and the parking brake is applied. Turn the engine OFF as soon as the crank power mode parameter has been observed.

8. *POWER MODE VERIFICATION* -- Driver door open, observe the scan tool Power Mode parameter while cycling the ignition switch through all the power modes. Verify the current Power Mode parameter matches the actual ignition switch positions.

   If the Power Mode parameter does not match the actual ignition switch positions, refer to Power Mode Mismatch.

9. *ENGINE CRANK and RUN VERIFICATION* -- Verify that the engine cranks and runs.

   If the engine does not crank, refer to Symptoms - Engine Electrical.

   If the engine does not run, refer to Engine Cranks But Does Not Runfor the 2.8L, 3.0L, 3.2L, or 3.6L engine or Engine Cranks But Does Not Runfor the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine.

10. *REMAINING DTC REVIEW* -- Verify there are no other DTCs set.

    If other DTCs are set, diagnose them in the order listed below. Refer to Diagnostic Trouble Code (DTC) List - Vehicle.

    10.1. Voltage DTCs
    10.2. Programming, Setup, Configuration or Software Performance DTCs
    10.3. Component related DTCs
    10.4. System related DTCs
    10.5. Any remaining DTCs

11. *SYMPTOM DIAGNOSIS* -- Diagnose any remaining customer concern. Refer to Symptoms - Vehicle.

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Diagnostic Trouble Code (DTC) List - Vehicle

This master DTC list includes all applicable DTCs in alphanumeric order with descriptors.

DTC	DTC Descriptor	Module That Sets the DTC	Diagnostic Procedure
B0012	Driver Frontal Deployment Loop Stage 1	SDM	DTC B0012 or B0013
B0013	Driver Frontal Deployment Loop Stage 2	SDM	DTC B0012 or B0013
B0014	Driver Side Deployment Loop	SDM	DTC B0014
B0015	Driver Pretensioner Deployment Stage 1 Loop	SDM	DTC B0015
B0016	Driver Curtain Deployment Loop Initiator	SDM	DTC B0016
B0019	Passenger Frontal Deployment Loop Stage 1	SDM	DTC B0019 or B0020
B0020	Passenger Frontal Deployment Loop Stage 2	SDM	DTC B0019 or B0020
B0021	Passenger Side Deployment Loop Stage 1	SDM	DTC B0021
B0022	Passenger Pretensioner Deployment Stage 1 Loop	SDM	DTC B0022
B0023	Passenger Curtain Deployment Loop Initiator	SDM	DTC B0023
B0052	Deployment Commanded	SDM	DTC B0052 or B0053
B0053	Deployment Commanded with Loop DTCs Present	SDM	DTC B0052 or B0053
B0055	Side Airbag Deployment Commanded	SDM	DTC B0055
B0072	Driver Seat Belt Sensor Circuit	SDM	DTC B0072
B0079	Driver Seat Position Sensor Circuit	SDM	DTC B0079
B0083	Front End Sensor 1	SDM	DTC B0083 or B0084
B0084	Front End Sensor 2	SDM	DTC B0083 or B0084
B0085	Left Front Side Impact Circuit	SDM	DTC B0085 or B0086
B0086	Right Front Side Impact Sensor Circuit	SDM	DTC B0085 or B0086
B013B	Coil Compressor Stroke Control Circuit	HVAC	DTC B013B
B0158	Outside Air Temperature Sensor Circuit	HVAC	DTC B0158 or B0168
	Passenger Compartment		

B0168	Temperature Sensor Circuit	HVAC	DTC B0158 or B0168
B0183	Left Solar Load Sensor 1 Circuit	HVAC	DTC B0183 or B0188
B0188	Right Solar Load Sensor 2 Circuit	HVAC	DTC B0183 or B0188
B0193	Blower Motor Feedback Circuit	HVAC	DTC B0193
B0198	Blower Motor Feedback Circuit	HVAC	DTC B0198 2
B0228	Air Intake Flow Actuator Fault (LHD) or Recirculation Door Motor Circuit (RHD)	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531
B0238	Demist Actuator Fault (LHD) or Defogger Door Motor Circuit (RHD)	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531
B0253	Face/Floor Actuator Fault (LHD) or Vent/Floor Door Motor Circuit (RHD)	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531
B0283	Electric Rear Defrost Circuit	HVAC	DTC B0283
B0408	Drivers Side Air Mix Actuator (LHD) or Drivers Air Mix Door Motor Circuit (RHD)	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531
B0418	Passenger Side Air Mix Actuator (LHD) or Passengers Air Mix Door Motor Circuit (RHD)	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531
B0428	Rear Air Mix Door Motor Circuit	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531
B0946	Suspension Control Selection Indicator Circuit	ESCM	DTC B0946
B094A	Service Suspension Control Indicator Circuit	ESCM	DTC B094A

B0954	Park Assist Sensor Front Left Outer Circuit	UPA	DTC B0954, B0955, B0956, or B0957
B0955	Park Assist Sensor Front Left Middle Circuit	UPA	DTC B0954, B0955, B0956, or B0957
B0956	Park Assist Sensor Front Right Middle Circuit	UPA	DTC B0954, B0955, B0956, or B0957
B0957	Park Assist Sensor Front Right Outer Circuit	UPA	DTC B0954, B0955, B0956, or B0957
B0958	Park Assist Sensor Rear Left Outer Circuit	UPA	DTC B0958, B0959, B0960, or B0961
B0959	Park Assist Sensor Rear Left Middle Circuit	UPA	DTC B0958, B0959, B0960, or B0961
B0960	Park Assist Sensor Rear Right Middle Circuit	UPA	DTC B0958, B0959, B0960, or B0961
B0961	Park Assist Sensor Rear Right Outer Circuit	UPA	DTC B0958, B0959, B0960, or B0961
B0967	Park Assist Switch Circuit	UPA	DTC B0967
B0968	Park Assist Indicator Circuit Malfunction	UPA	DTC B0968
B0970	Hazard Warning Switch Stuck	BCM	DTC B0970
B0983	Security System Indicator 2 Circuit	BCM	DTC B0983
B0996	Vehicle Identification Number Mismatch	Radio, RSE	DTC B0996, 1016, or B1271
B0997	Auxiliary Electronic Control Unit (ECU) 2 Performance	Radio	DTC B0997
	Memory Seat and Mirror Module Checksum Error	MSM	DTC B0997
B0998	Screen 1 EEPROM Failure	RSE	DTC B0998 or B0999
B0999	Screen 2 EEPROM Failure	RSE	DTC B0998 or B0999
B1000	Electronic Control Unit (ECU) Performance	BCM, IPC, MSM, RFA, SDM, TDM, Telematics, UPA	DTC B1000
B1001	Option Configuration Error	BCM, IPC	DTC B1001
		SDM	DTC B1001
B1008	Calibration Data Not Programmed	Telematics	DTC B1008
		UPA	DTC B1008
B1009	EEPROM Failure	RSE	DTC B1009
B1010	System Sensor Data Mismatch Invalid Odometer Signal	NIM	DTC B1010
B1011	System Disabled Over Temperature	NIM	DTC B1011
B1015	Vehicle Identification Number (VIN) Information Error	Telematics	DTC B1015 or DTC B1016

B1016	Vehicle Identification Number (VIN) Not Programmed	BCM	DTC B1016
		Radio	DTC B0996, 1016, or B1271
		SDM	DTC B1016
		Telematics	DTC B1015 or DTC B1016
B1019	System Configuration Error	Radio	DTC B1019
B101D	ECU Hardware Performance	NIM, Radio, RSE,	DTC B101D
B101E	ECU Software Performance	Radio	DTC B101E
B1020	Auxiliary Electronic Unit (ECU) Performance	NIM	DTC B1020
B1021	SIM Mismatch	Telematics	DTC B1021
B1023	Integral Switch Performance	Radio	DTC B1023
B1024	Printed Circuit Board (PCB) Temperature Sensor Fault	IPC	DTC B1024
B1025	Audio Output 1 Left Front Circuit	Radio	DTC B1025, B1035, B1045, or B1055
B1035	Audio Output 2 Right Front Circuit	Radio	DTC B1025, B1035, B1045, or B1055
B1045	Audio Output 3 Left Rear Circuit	Radio	DTC B1025, B1035, B1045, or B1055
B1055	Audio Output 4 Right Rear Circuit	Radio	DTC B1025, B1035, B1045, or B1055
B1240	CD-Player Malfunction	Radio	DTC B1240 or B1245
B1243	CD-Player Load or Eject Malfunction	Radio	DTC B1243 or B1248
		RSE	DTC B1243
B1244	CD-Player, Disc Upside Down	Radio	DTC B1244 or B1249
B1245	CD-Changer Malfunction	Radio	DTC B1240 or B1245
B1248	CD Changer Load/Unload Performance	Radio	DTC B1243 or B1248
B1249	CD-Changer, Disc Upside Down	Radio	DTC B1244 or B1249
B1271	Theft Locked	Radio	DTC B0996, 1016, or B1271
B1277	Microphone Circuit	Telematics	DTC B1277
B1287	Radio Mute Circuit	Telematics	DTC B1287
B1325	Device Power Circuit	HVAC	DTC B1325
		RSE	DTC B1325, B1330, or B1423
	System Voltage	SDM	DTC B1325
B1330	RSE Control Panel Supplied Power	RSE	DTC B1325, B1330, or B1423
B1335	Screen 1 Power Supply Voltage Circuit	RSE	DTC B1335 or B1340
B1340	Screen 2 Power Supply Voltage Circui	RSE	DTC B1335 or B1340
		BCM	DTC B1370-B1379, B1380-B1389, or B1440-B1443

B1370	Device Ignition 1 Circuit	SDM	DTC B1370
	Wake Up Circuit	MSM	DTC B1370
B1380	Device Ignition ACCESSORY Circuit	BCM	DTC B1370-B1379, B1380-B1389, or B1440-B1443
B138A	Device Voltage Reference Group 1 Outputs	UPA	DTC B138A
B1390	Button 1 Circuit Short to Battery	MSM	DTC B1390, B1400, B1410, or B2765
B1400	Button 2 Circuit Short to Battery	MSM	DTC B1390, B1400, B1410, or B2765
B1410	Button 3 Circuit Short to Battery	MSM	DTC B1390, B1400, B1410, or B2765
B1423	Supply Voltage Circuit	RSE	DTC B1325, B1330, or B1423
B1428	Ignition Switched Power Relay 1 Circuit	BCM	DTC B1428
B1433	Ignition Switched Power Relay 2 Circuit	BCM	DTC B1433
B1440	Power Mode Master Input Circuit Malfunction	BCM	DTC B1370-B1379, B1380-B1389, or B1440-B1443
B1441	Device Ignition OFF, RUN, and CRANK Circuit	BCM	DTC B1370-B1379, B1380-B1389, or B1440-B1443
B1446	Backup Battery Timer Expired	Telematics	DTC B1446
B1447	Backup Battery Circuit	Telematics	DTC B1447
B1475	Retained Accessory Power Circuit	BCM	DTC B1475
B1516	Battery Current Sensor Performance	BCM	DTC B1516
B1517	Battery Voltage	BCM	DTC B1517
		Telematics	DTC B1517
B1527	High Parasitic Load Detected	BCM	DTC B1527
B1529	Control Module Voltage Reference Output 5 Circuit	BCM	DTC B1529
B1565	Mirror DIP Button Stuck	MSM	DTC B1565, B2755, B2760, or B3599
B1735	Front Vertical Up Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1740	Front Vertical Down Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1745	Rear Vertical Up Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1750	Rear Vertical Down Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1755	Horizontal Forward Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1760	Horizontal Back Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820

B1815	Recline Up Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1820	Recline Down Switch Stuck	MSM	DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820
B1825	Recline Position Sensor Fault	MSM	DTC B1825, B2355, B2365, or B2375
B1831	Lumbar Forward Switch Stuck	MSM	DTC B1831 or B1836
B1836	Lumbar Rearward Switch Stuck	MSM	DTC B1831 or B1836
B1851	Lumbar Position Sensor Fault	MSM	DTC B1851
B2355	Front Vertical Position Sensor Fault	MSM	DTC B1825, B2355, B2365, or B2375
B2365	Rear Vertical Position Sensor Fault	MSM	DTC B1825, B2355, B2365, or B2375
B2375	Horizontal Position Sensor Fault	MSM	DTC B1825, B2355, B2365, or B2375
B245A	Telematics Indicator 1 Circuit	Telematics	DTC B245A
B245B	Telematics Indicator 2 Circuit	Telematics	DTC B245B
B2461	Navigation Electronic Control Unit (ECU) Synchronous Signal Error	NIM	DTC B2461
B2462	Global Positioning System (GPS) Antenna Circuit	NIM, Telematics	DTC B2462
B2464	Navigation Player Decoding Error	Radio	DTC B2464
B2469	SIM Card Invalid	Telematics	DTC B2469
B2471	Telephone Number Error	Telematics	DTC B2471
B2476	Keypad Circuit	Telematics	DTC B2476
B2484	Global Positioning System Sensor Open Circuit	NIM	DTC B2484
B2530	Front Foglamps Control Circuit	BCM	DTC B2530
B2545	Backup Lamps Circuit	BCM	DTC B2545
B2555	Passenger Compartment Lamp Control Circuit	BCM	DTC B2555
B2575	Headlamp Low Beam Control Circuit	BCM	DTC B2575
B257A	Headlamp Switch Input Signals Mismatch	BCM	DTC B257A
B2580	Headlamp High Beam Control Circuit	BCM	DTC B2580
B2585	Parklamp Control Circuit	BCM	DTC B2585
B2610	Passenger Compartment Dimming 1 Circuit	BCM	DTC B2610
B2615	Passenger Compartment Dimming 2 Circuit	BCM	DTC B2615
	Display Dimming Pulse Width		

B2625	Modulation (PWM) Output Circuit	BCM	DTC B2625
B2645	Ambient Light Sensor Circuit	BCM	DTC B2645
B2652	Passenger Compartment Dimming 3 Circuit	BCM	DTC B2652
B2705	Gearshift Unlock Circuit	BCM	DTC B2705
B2730	Interior Trunk/Liftglass/Hatch Release Switch Circuit	BCM	DTC B2730
B2745	Traction Control Switch Circuit	BCM	DTC B2745
B2750	Horn Relay Coil Circuit	BCM	DTC B2750
B2755	Memory Button 1 Stuck	MSM	DTC B1565, B2755, B2760, or B3599
B2760	Memory Button 2 Stuck	MSM	DTC B1565, B2755, B2760, or B3599
B2765	Button M Circuit Short to Battery	MSM	DTC B1390, B1400, B1410, or B2765
B2795	Suspension Control Select Switch Circuit	ESCM	DTC B2795
B2815	Steering Wheel Switch Circuit	IPC	DTC B2815
B2976	Driver Door Ajar Circuit	BCM	DTC B2976
B2991	Passenger Door Ajar Circuit	BCM	DTC B2991
B3006	Hood Ajar Circuit Plausability Failure	BCM	DTC B3006
B3055	No Transponder Modulation or No Transponder	TDM	DTC B3055
B3060	Unprogrammed Transponder Key Identification Code Received	TDM	DTC B3060
B3105	Keyless Entry System Key Not Programmed	RFA	DTC B3105
B3109	Keyless Entry Transmitter 1 Battery Low Voltage	RFA	DTC B3109
B3110	Keyless Entry Transmitter 2 Battery Low Voltage	RFA	DTC B3110
B3111	Keyless Entry Transmitter 3 Battery Low Voltage	RFA	DTC B3111
B3112	Keyless Entry Transmitter 4 Battery Low Voltage	RFA	DTC B3112
B3125	Left Front/Driver Door Only Unlock Circuit	BCM	DTC B3125, B3130, or B3135
B3130	All Door Unlock Circuit	BCM	DTC B3125, B3130, or B3135
B3135	All Door Lock Circuit	BCM	DTC B3125, B3130, or B3135
B3140	Driver Unlock Switch Circuit	BCM	DTC B3140 or B3150
B3150	Driver Lock Switch Circuit	BCM	DTC B3140 or B3150
B3265	Trunk/Hatch/Liftglass Release	BCM	DTC B3265

	Output Circuit		
B3410	AHLD Front Axle Sensor Signal Circuit	Headlamp Control Module	DTC B3410 or B3420
B3415	AHLD Front Axle Sensor Supply Circuit	Headlamp Control Module	DTC B3415
B3420	AHLD Rear Axle Sensor Signal Circuit	Headlamp Control Module	DTC B3410 or B3420
B3435	AHLD Left Servo Driver Circuit	Headlamp Control Module	DTC B3435 or B3440
B3440	AHLD Right Servo Driver Circuit	Headlamp Control Module	DTC B3435 or B3440
B3445	Stop Lamp Circuit	BCM	DTC B3445
B3531	Rear Air Mode Door Motor Circuit	HVAC	DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531
B3599	Memory Button 3 Stuck	MSM	DTC B1565, B2755, B2760, or B3599
B370C	Rain Sensor Intensity Signal Circuit	BCM	DTC B370C or B370D
B370D	Rain Sensor Mode Control Circuit	BCM	DTC B370C or B370D
B3715	Front Wiper Relay Drive Circuit	BCM	DTC B3715
B3794	Cruise Control Function Request Circuit	BCM	DTC B3794
B3873	Front Washer Relay Circuit	BCM	DTC B3873
B3875	Wiper High Speed Relay Circuit	BCM	DTC B3875
B3907	Button Assembly Short to Battery	MSM	DTC B3907
B3922	Front Wiper Function Select Circuit	BCM	DTC B3922
B3924	DVD Player Theft Locked	RSE	DTC B3924
B3926	Screen 1 Theft Locked	RSE	DTC B3926 or B3927
B3927	Screen 2 Theft Locked	RSE	DTC B3926 or B3927
B3933	Evaporator Temperature Sensor Circuit	HVAC	DTC B3933
B3935	Transponder Key Identification Error	TDM	DTC B3935
B3976	Unconfigured Transponder Key	TDM	DTC B3976
C0035	Front Left Wheel Speed Sensor Circuit	EBCM	DTC C0035-C0050
C0040	Front Right Wheel Speed Sensor Circuit	EBCM	DTC C0035-C0050

C0045	Rear Left Wheel Speed Sensor Circuit	EBCM	DTC C0035-C0050
C0050	Rear Right Wheel Speed Sensor Circuit	EBCM	DTC C0035-C0050
C0060	Left Front Antilock Braking System Solenoid Valve Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0065	Left Front Antilock Brake System Solenoid 2 Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0070	Right Front Antilock Braking System Solenoid Valve Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0075	Right Front Antilock Brake System Solenoid 2 Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0080	Left Rear Antilock Brake System Solenoid Valve Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0085	Left Rear Antilock Brake System Solenoid 2 Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0090	Right Rear Antilock Braking System Solenoid Valve Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0095	Right Rear Antilock Braking System Solenoid 2 Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0100	Rear Antilock Brake System Solenoid Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0105	Rear Antilock Brake System Solenoid 2 Circuit	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0110	Return Pump Circuit Malfunction	EBCM	DTC C0110
C0121	Valve Relay Circuit Malfunction	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0126	Low Brake Fluid Indicated	EBCM	DTC C0126
C0131	Antilock Brake System Pressure Circuit	EBCM	DTC C0131
C0141	Front Left/Front Right TC/ESP Priming Valve Circuit Malfunction	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0146	Front Left/Front Right TC/ESP Switch Over Valve Circuit Malfunction	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156

C0151	Rear Left/Rear Right TC/ESP Priming Valve Circuit Malfunction	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0156	Rear Left/Rear Right TC/ESP Switch Over Valve Circuit Malfunction	EBCM	DTC C0060-C0095, C0100, C0105, C0121, C0141, C0146, C0151, or C0156
C0161	Brake Switch Circuit	EBCM	DTC C0161
C0186	Lateral Acceleration Sensor	EBCM	DTC C0186 or C0196
C0196	Yaw Rate Sensor	EBCM	DTC C0186 or C0196
C0245	Wheel Speed Sensor Frequency	EBCM	DTC C0245
C0252	Implausible Control	EBCM	DTC C0252
C0277	Brake Pedal Position Sensor Circuit	BCM	DTC C0277 or C0890
C0297	Brake Applied Output Circuit	BCM	DTC C0297
C0460	Steering Angle Sensor Circuit	EBCM	DTC C0460
C0550	Electronic Control Unit (ECU) Performance	EBCM	DTC C0550
C0558	Calibration Data Not Programmed	ESCM	DTC C0558
C0561	CAN-Bus Invalid Data	EBCM	DTC C0561
C0565	Vehicle Identification Number (VIN) Not Programmed/Mismatch	EBCM	DTC C0565
C0569	System Configuration Error	EBCM	DTC C0569
		RFA	DTC C0569
C0575	Left Front Solenoid/Motor/Actuator Circuit	ESCM	DTC C0575, C0580, C0585, or C0590
C0580	Right Front Solenoid/Motor/Actuator Circuit	ESCM	DTC C0575, C0580, C0585, or C0590
C0585	Left Rear Solenoid/Motor/Actuator Circuit	ESCM	DTC C0575, C0580, C0585, or C0590
C0590	Right Rear Solenoid/Motor/Actuator Circuit	ESCM	DTC C0575, C0580, C0585, or C0590
C0615	Left Front Position Sensor Circuit	ESCM	DTC C0615, C0620, C0625, or C0630
C0620	Right Front Position Sensor Circuit	ESCM	DTC C0615, C0620, C0625, or C0630
C0625	Left Rear Position Sensor Circuit	ESCM	DTC C0615, C0620, C0625, or C0630
C0630	Right Rear Position Sensor Circuit	ESCM	DTC C0615, C0620, C0625, or C0630

C0696	Position Sensor Overcurrent 5-Volt Supply	ESCM	DTC C0696
C0750	Left Front Tire Pressure Sensor	RCDLR	DTC C0750, C0755, C0760, or C0765
C0755	Right Front Tire Pressure Sensor	RCDLR	DTC C0750, C0755, C0760, or C0765
C0760	Left Rear Tire Pressure Sensor	RCDLR	DTC C0750, C0755, C0760, or C0765
C0765	Right Rear Tire Pressure Sensor	RCDLR	DTC C0750, C0755, C0760, or C0765
C0890	Device Voltage Reference Output 3 Circuit	BCM	DTC C0277 or C0890
C0899	Power Supply Circuit Low Voltage	EBCM	DTC C0899
C0900	Power Supply Circuit High Voltage	EBCM	DTC C0900
C1209	Left Rear Wheel Speed Sensor Circuit High	EBCM, ECM	DTC C1209, C1223, C1227, or C1234
C1210	Right Rear Wheel Speed Sensor Circuit High	EBCM, ECM	DTC C1210, C1224, C1228, or C1235
C1223	Left Rear Wheel Speed Sensor Circuit	EBCM, ECM	DTC C1209, C1223, C1227, or C1234
C1224	Right Rear Wheel Speed Sensor Circuit	EBCM, ECM	DTC C1210, C1224, C1228, or C1235
C1227	Left Rear Wheel Speed Sensor Circuit Range/Performance	EBCM, ECM	DTC C1209, C1223, C1227, or C1234
C1228	Right Rear Wheel Speed Sensor Circuit Range/Performance	EBCM, ECM	DTC C1210, C1224, C1228, or C1235
C1234	Left Rear Wheel Speed Sensor Circuit Low	EBCM, ECM	DTC C1209, C1223, C1227, or C1234
C1235	Right Rear Wheel Speed Sensor Circuit Low	EBCM, ECM	DTC C1210, C1224, C1228, or C1235
P0008	Engine Position System Performance Bank 1	ECM	DTC P0008 or P0009
P0009	Engine Position System Performance Bank 2	ECM	DTC P0008 or P0009
P0010	Intake Camshaft Position Control Solenoid Circuit Malfunction Bank 1	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P0011	Intake Camshaft Position Range/Performance Bank 1	ECM	DTC P0011, P0014, P0021, or P0024
P0013	Exhaust Camshaft Position Control Solenoid Circuit Malfunction Bank 1	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P0014	Exhaust Camshaft Position Range/Performance Bank 1	ECM	DTC P0011, P0014, P0021, or P0024

P0016	Crankshaft/Intake Camshaft Position not Plausible Bank 1	ECM	DTC P0016, P0017, P0018, or P0019 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Crankshaft Position (CKP) Camshaft Position (CMP) Correlation		DTC P0016 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0017	Crankshaft/Exhaust Camshaft Position not Plausible Bank 1	ECM	DTC P0016, P0017, P0018, or P0019
P0018	Crankshaft/Intake Camshaft Position not Plausible Bank 2	ECM	DTC P0016, P0017, P0018, or P0019
P0019	Crankshaft/Exhaust Camshaft Position not Plausible Bank 2	ECM	DTC P0016, P0017, P0018, or P0019
P0020	Intake Camshaft Position Control Solenoid Circuit Malfunction Bank 2	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P0021	Intake Camshaft Position Range/Performance Bank 2	ECM	DTC P0011, P0014, P0021, or P0024
P0023	Exhaust Camshaft Position Control Solenoid Circuit Malfunction Bank 2	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P0024	Exhaust Camshaft Position Range/Performance Bank 2	ECM	DTC P0011, P0014, P0021, or P0024
P0030	O2 Sensor Heater Circuit Malfunction Bank 1 Sensor 1	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Control Circuit Bank 1 Sensor 1		DTC P0030, P0036, P0053, P0054, P0135, or P0141 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0031	O2 Sensor Heater Circuit Low Voltage Bank 1 Sensor 1	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0032	O2 Sensor Heater Circuit High Voltage Bank 1 Sensor 1	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0036	O2 Sensor Heater Circuit Malfunction Bank 1 Sensor 2	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Control Circuit Bank 2		DTC P0030, P0036, P0053, P0054, P0135, or P0141 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0037	O2 Sensor Heater Circuit Low Voltage Bank 1 Sensor 2	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0038	O2 Sensor Heater Circuit High Voltage Bank 1 Sensor 2	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
	O2 Sensor Signals not		

P0040	Plausible Bank 1 Sensor 1 & Bank 2 Sensor 1	ECM	DTC P0040 or P0041
P0041	O2 Sensor Signals not Plausible Bank 1 Sensor 2 & Bank 2 Sensor 2	ECM	DTC P0040 or P0041
P0050	O2 Sensor Heater Circuit Malfunction Bank 2 Sensor 1	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Control Bank 2 Sensor 1		DTC P0050, P0056, P0059, P0060, P0155, or P0161 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0051	O2 Sensor Heater Circuit Low Voltage Bank 2 Sensor 1	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0052	O2 Sensor Heater Circuit High Voltage Bank 2 Sensor 1	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0053	O2 Sensor Heater Resistance Range/Performance Bank 1 Sensor 1	ECM	DTC P0053 or P0059 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Resistance Circuit Bank 1 Sensor 1		DTC P0030, P0036, P0053, P0054, P0135, or P0141 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0054	HO2S Heater Resistance Circuit Bank 1 Sensor 2	ECM	DTC P0030, P0036, P0053, P0054, P0135, or P0141
P0056	O2 Sensor Heater Circuit Malfunction Bank 2 Sensor 2	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Control Bank 2 Sensor 2		DTC P0050, P0056, P0059, P0060, P0155, or P0161 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0057	O2 Sensor Heater Circuit Low Voltage Bank 2 Sensor 2	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0058	O2 Sensor Heater Circuit High Voltage Bank 2 Sensor 2	ECM	DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058
P0059	O2 Sensor Heater Resistance Range/Performance Bank 2 Sensor 1	ECM	DTC P0053 or P0059 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Resistance Bank 2 Sensor 1		DTC P0050, P0056, P0059, P0060, P0155, or P0161 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0060	HO2S Heater Resistance Bank 2 Sensor 2	ECM	DTC P0050, P0056, P0059, P0060, P0155, or P0161
P0068	Throttle Body Airflow Performance	ECM	DTC P0068 or P0121

P0100	Mass Air Flow Sensor Circuit Malfunction	ECM	DTC P0100, P0102, or P0103
P0101	Mass Air Flow Sensor Circuit Range/Performance	ECM	DTC P0101 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Mass Air Flow (MAF) Sensor Performance	ECM	DTC P0101 or P1101 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0102	Mass Air Flow Sensor Voltage Low	ECM	DTC P0100, P0102, or P0103 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Mass Air Flow (MAF) Sensor Circuit Low Frequency	ECM	DTC P0102 or P0103 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0103	Mass Air Flow Sensor Voltage High	ECM	DTC P0100, P0102, or P0103 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Mass Air Flow (MAF) Sensor Circuit High Frequency	ECM	DTC P0102 or P0103 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0106	Manifold Absolute Pressure (MAP) Sensor Performance	ECM	DTC P0106
P0107	Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage	ECM	DTC P0107 or P0108
P0108	Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage	ECM	DTC P0107 or P0108
P0111	Intake Air Temperature Sensor Circuit Range/Performance	ECM	DTC P0111-P0113
P0112	Intake Air Temperature Sensor Circuit Low Voltage	ECM	DTC P0111-P0113 for the 2.8L, 3.0L, 3.2L, or 3.6L engine DTC P0112 or P0113 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0113	Intake Air Temperature Sensor Circuit High Voltage	ECM	DTC P0111-P0113 for the 2.8L, 3.0L, 3.2L, or 3.6L engine DTC P0112 or P0113 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0115	Engine Coolant Temperature (ECT) Sensor Circuit	TCM	DTC P0115
P0116	Engine Coolant Temperature (ECT) Sensor Performance	ECM	DTC P0116 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0116 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0117	Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage	ECM	DTC P0117 or P0118 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0117 or P0118 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine

P0118	Engine Coolant Temperature (ECT) Sensor Circuit High Voltage	ECM	DTC P0117 or P0118 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0117 or P0118 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0119	Engine Coolant Temperature Sensor Circuit Intermittent	ECM	DTC P0119
P0120	Throttle Position Sensor 1 Circuit	ECM	DTC P0120, P0122, P0123, P0220, P0222, P0223, or P2135 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
	Throttle Position (TP) Sensor Circuit	TCM	DTC P0120
P0121	Throttle Position Sensor 1 Circuit Range/Performance	ECM	DTC P0121, P0122, P0123, P0221, P0222, or P0223 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Throttle Position (TP) Sensor 1 Performance	ECM	DTC P0068 or P0121 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0122	Throttle Position Sensor 1 Circuit Low Voltage	ECM	DTC P0121, P0122, P0123, P0221, P0222, or P0223 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0120, P0122, P0123, P0220, P0222, P0223, or P2135 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0123	Throttle Position Sensor 1 Circuit High Voltage	ECM	DTC P0121, P0122, P0123, P0221, P0222, or P0223 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0120, P0122, P0123, P0220, P0222, P0223, or P2135 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0128	Engine Coolant Temperature Below Thermostat Regulating Temperature	ECM	DTC P0128 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0128 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0130	O2 Sensor Circuit Malfunction Bank 1 Sensor 1	ECM	DTC P0130 or P0150
	O2 Sensor Circuit Low Voltage		DTC P0131 or P0151 for the 2.8L,

P0131	Bank 1 Sensor 1	ECM	3.0L, 3.2L, or 3.6L engine
	HO2S Circuit Low Voltage Bank 1 Sensor 1		DTC P0131, P0132, P0137, or P0138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0132	O2 Sensor Circuit High Voltage Bank 1 Sensor 1	ECM	DTC P0132 or P0152 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit High Voltage Bank 1 Sensor 1		DTC P0131, P0132, P0137, or P0138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0133	O2 Sensor Circuit Slow Response Bank 1 Sensor 1	ECM	DTC P0133 or P0153 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Slow Response Bank 1 Sensor 1		DTC P0133, P0134, P0140, P1133, P2270, or P2271 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0134	HO2S Circuit Insufficient Activity Bank 1 Sensor 1	ECM	DTC P0134 or P0154 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0133, P0134, P0140, P1133, P2270, or P2271 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0135	O2 Sensor Heater Circuit Range/Performance Bank 1 Sensor 1	ECM	DTC P0135, P0141, P0155, or P0161 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Performance Bank 1 Sensor 1		DTC P0030, P0036, P0053, P0054, P0135, or P0141 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0137	O2 Sensor Circuit Low Voltage Bank 1 Sensor 2	ECM	DTC P0137, P0138, P0140, P0157, P0158, or P0160 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit Low Voltage Bank 1 Sensor 2		DTC P0131, P0132, P0137, or P0138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0138	O2 Sensor Circuit High Voltage Bank 1 Sensor 2	ECM	DTC P0137, P0138, P0140, P0157, P0158, or P0160 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit High Voltage Bank 1 Sensor 2	ECM	DTC P0131, P0132, P0137, or P0138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P013A	HO2S Slow Response Rich to Lean Bank 1 Sensor 2	ECM	DTC P013A, P013C, P013E, or P014A
P013C	HO2S Slow Response Rich to Lean Bank 2 Sensor 2	ECM	DTC P013A, P013C, P013E, or P014A
P013E	HO2S Delayed Response Rich to Lean Bank 1 Sensor 2	ECM	DTC P013A, P013C, P013E, or P014A
	O2 Sensor Circuit No Activity Detected Bank 1 Sensor 2	ECM	DTC P0137, P0138, P0140, P0157, P0158, or P0160 for the 2.8L, 3.0L, 3.2L, or 3.6L engine

P0140	HO2S Circuit Insufficient Activity Bank 1 Sensor 2	ECM	DTC P0133, P0134, P0140, P1133, P2270, or P2271 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0141	O2 Sensor Heater Circuit Range/Performance Bank 1 Sensor 2	ECM	DTC P0135, P0141, P0155, or P0161 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Performance Bank 1 Sensor 2	ECM	DTC P0030, P0036, P0053, P0054, P0135, or P0141 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P014A	HO2S Delayed Response Rich to Lean Bank 2 Sensor 2	ECM	DTC P013A, P013C, P013E, or P014A
P0150	O2 Sensor Circuit Malfunction Bank 2 Sensor 1	ECM	DTC P0130 or P0150
P0151	O2 Sensor Circuit Low Voltage Bank 2 Sensor 1	ECM	DTC P0131 or P0151 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit Low Voltage Bank 2 Sensor 1		DTC P0151, P0152, P0157, or P0158 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0152	O2 Sensor Circuit High Voltage Bank 2 Sensor 1	ECM	DTC P0132 or P0152 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit High Voltage Bank 2 Sensor 1		DTC P0151, P0152, P0157, or P0158 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0153	O2 Sensor Circuit Slow Response Bank 2 Sensor 1	ECM	DTC P0133 or P0153 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Slow Response Bank 2 Sensor 1		DTC P0153, P0154, P0160, P1153, P2272, or P2273 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0154	HO2S Circuit Insufficient Activity Bank 2 Sensor 1	ECM	DTC P0134 or P0154 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
			DTC P0153, P0154, P0160, P1153, P2272, or P2273 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0155	O2 Sensor Heater Circuit Range/Performance Bank 2 Sensor 1	ECM	DTC P0135, P0141, P0155, or P0161 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Performance Bank 2 Sensor 1		DTC P0050, P0056, P0059, P0060, P0155, or P0161 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0157	O2 Sensor Circuit Low Voltage Bank 2 Sensor 2	ECM	DTC P0137, P0138, P0140, P0157, P0158, or P0160 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit Low Voltage Bank 2 Sensor 2		DTC P0151, P0152, P0157, or P0158 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0158	O2 Sensor Circuit High Voltage Bank 2 Sensor 2	ECM	DTC P0137, P0138, P0140, P0157, P0158, or P0160 for the 2.8L, 3.0L, 3.2L, or 3.6L engine

	HO2S Circuit High Voltage Bank 2 Sensor 2		DTC P0151, P0152, P0157, or P0158 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0160	O2 Sensor Circuit No Activity Detected Bank 2 Sensor 2	ECM	DTC P0137, P0138, P0140, P0157, P0158, or P0160 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Circuit Insufficient Activity Bank 2 Sensor 2		DTC P0153, P0154, P0160, P1153, P2272, or P2273 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0161	O2 Sensor Heater Circuit Range/Performance Bank 2 Sensor 2	ECM	DTC P0135, P0141, P0155, or P0161 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Heater Performance Bank 2 Sensor 2	ECM	DTC P0050, P0056, P0059, P0060, P0155, or P0161 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0171	Fuel Trim System Lean Bank 1	ECM	DTC P0171, P0172, P0174, or P0175
P0172	Fuel Trim System Rich Bank 1	ECM	DTC P0171, P0172, P0174, or P0175
P0174	Fuel Trim System Lean Bank 2	ECM	DTC P0171, P0172, P0174, or P0175
P0175	Fuel Trim System Rich Bank 2	ECM	DTC P0171, P0172, P0174, or P0175
P0196	Engine Oil Temperature Sensor Range/Performance	ECM	DTC P0196, P0197, or P0198 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Engine Oil Temperature Sensor Circuit Range/Performance	ECM	DTC P0196, P0197, or P0198 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0197	Engine Oil Temperature Voltage Low	ECM	DTC P0196, P0197, or P0198 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Engine Oil Temperature Sensor Circuit Low Input	ECM	DTC P0196, P0197, or P0198 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0198	Engine Oil Temperature Voltage High	ECM	DTC P0196, P0197, or P0198 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Engine Oil Temperature Sensor Circuit High Input	ECM	DTC P0196, P0197, or P0198 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0201	Injector 1 Control Circuit	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
			DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262,

P0202	Injector 2 Control Circuit	ECM	P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0203	Injector 3 Control Circuit	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0204	Injector 4 Control Circuit	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0205	Injector 5 Control Circuit	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
			DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262,

P0206	Injector 6 Control Circuit	ECM	P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0207	Injector 7 Control Circuit	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208
P0208	Injector 8 Control Circuit	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208
P0218	Transmission Fluid Overtemperature	TCM	• DTC P0218 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0218 for the 5L40-E/5L50-E transmission • DTC P0218 for the 6L50/6L80/6L90 transmission
P0219	Engine Overspeed Condition	ECM	DTC P0219
P0220	Throttle Position Sensor 2 Circuit	ECM	DTC P0120, P0122, P0123, P0220, P0222, P0223, or P2135
P0221	Throttle Position Sensor 2 Circuit Range/Performance	ECM	DTC P0121, P0122, P0123, P0221, P0222, or P0223
P0222	Throttle Position Sensor 2 Circuit Low Voltage	ECM	DTC P0121, P0122, P0123, P0221, P0222, or P0223 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0120, P0122, P0123, P0220, P0222, P0223, or P2135 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0223	Throttle Position Sensor 2 Circuit High Voltage	ECM	DTC P0121, P0122, P0123, P0221, P0222, or P0223 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0120, P0122, P0123, P0220, P0222, P0223, or P2135 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0230	Fuel Pump Relay Control Circuit	ECM	DTC P0230
			DTC P0201, P0202, P0203, P0204,

P0261	Injector 1 Control Circuit Low Voltage	ECM	P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0262	Injector 1 Control Circuit High Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0264	Injector 2 Control Circuit Low Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0265	Injector 2 Control Circuit High Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0267	Injector 3 Control Circuit Low Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0268	Injector 3 Control Circuit High Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0270	Injector 4 Control Circuit Low Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0271	Injector 4 Control Circuit High Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0273	Injector 5 Control Circuit Low Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0274	Injector 5 Control Circuit High Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
	Injector 6 Control Circuit Low		DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262,

P0276	Voltage	ECM	P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0277	Injector 6 Control Circuit High Voltage	ECM	DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277
P0300	Engine Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0301	Cylinder 1 Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0302	Cylinder 2 Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0303	Cylinder 3 Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0304	Cylinder 4 Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0305	Cylinder 5 Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine

P0306	Cylinder 6 Misfire Detected	ECM	DTC P0300-P0306 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0300-P0308 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0307	Cylinder 7 Misfire Detected	ECM	DTC P0300-P0308
P0308	Cylinder 8 Misfire Detected	ECM	DTC P0300-P0308
P0315	Crankshaft Position System Variation Not Learned	ECM	DTC P0315
P0324	Knock Sensor Module Performance	ECM	DTC P0324 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0325	Knock Sensor (KS) Circuit Bank 1	ECM	DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333
P0326	Knock Sensor (KS) Performance Bank 1	ECM	DTC P0326, P0327, P0328, P0331, P0332, or P0333 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Knock Sensor (KS) Performance	ECM	DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0327	Knock Sensor (KS) Circuit Low Voltage Bank 1	ECM	DTC P0326, P0327, P0328, P0331, P0332, or P0333 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0328	Knock Sensor (KS) Circuit High Voltage Bank 1	ECM	DTC P0326, P0327, P0328, P0331, P0332, or P0333 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0330	Knock Sensor (KS) Circuit	ECM	DTC P0324, P0325, P0326, P0327,

	Bank 2		P0328, P0330, P0332, or P0333
P0331	Knock Sensor (KS) System Performance Bank 2	ECM	DTC P0326, P0327, P0328, P0331, P0332, or P0333
P0332	Knock Sensor (KS) Circuit Low Voltage Bank 2	ECM	DTC P0326, P0327, P0328, P0331, P0332, or P0333 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0333	Knock Sensor (KS) Circuit High Voltage Bank 2	ECM	DTC P0326, P0327, P0328, P0331, P0332, or P0333 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0335	Crankshaft Position Sensor Circuit Malfunction	ECM	DTC P0335, P0336, or P0338 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Crankshaft Position (CKP) Sensor Circuit		DTC P0335 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0336	Crankshaft Position Sensor Signal Range/Performance	ECM	DTC P0335, P0336, or P0338 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Crankshaft Position (CKP) Sensor Performance		DTC P0336 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0338	Crankshaft Position Sensor Circuit High Duty Cycle	ECM	DTC P0335, P0336, or P0338 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
P0340	Camshaft Position (CMP) Sensor Circuit	ECM	DTC P0340
P0341	Intake Camshaft Position Sensor Range/Performance Bank 1	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Camshaft Position (CMP) Sensor Performance	ECM	DTC P0341 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0342	Intake Camshaft Position Sensor Low Voltage Bank 1	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0343	Intake Camshaft Position Sensor High Voltage Bank 1	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0346	Intake Camshaft Position Sensor Range/Performance	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367,

	Bank 2		P0368, P0391, P0392, or P0393
P0347	Intake Camshaft Position Sensor Low Voltage Bank 2	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0348	Intake Camshaft Position Sensor High Voltage Bank 2	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0351	Ignition Coil Cylinder 1 Control Circuit	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0351-P0358 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0352	Ignition Coil Cylinder 2 Control Circuit	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0351-P0358 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0353	Ignition Coil Cylinder 3 Control Circuit	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0351-P0358 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0354	Ignition Coil Cylinder 4 Control Circuit	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0351-P0358 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
			DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 for the 2.8L, 3.0L,

P0355	Ignition Coil Cylinder 5 Control Circuit	ECM	3.2L, or 3.6L engine or DTC P0351-P0358 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0356	Ignition Coil Cylinder 6 Control Circuit	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0351-P0358 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0357	Ignition Coil Cylinder 7 Control Circuit	ECM	DTC P0351-P0358
P0358	Ignition Coil Cylinder 8 Control Circuit	ECM	DTC P0351-P0358
P0366	Exhaust Camshaft Position Sensor Range/Performance Bank 1	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0367	Exhaust Camshaft Position Sensor Low Voltage Bank 1	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0368	Exhaust Camshaft Position Sensor High Voltage Bank 1	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0391	Exhaust Camshaft Position Sensor Range/Performance Bank 2	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0392	Exhaust Camshaft Position Sensor Low Voltage Bank 2	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0393	Exhaust Camshaft Position Sensor High Voltage Bank 2	ECM	DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393
P0420	Catalyst System Low EfficiencyBank 1	ECM	DTC P0420 or P0430 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0420 or P0430 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0430	Catalyst System Low Efficiency Bank 2	ECM	DTC P0420 or P0430 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or

			DTC P0420 or P0430 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0443	Evaporative Emission Control System Purge Solenoid Circuit Malfunction	ECM	DTC P0443, P0458, or P0459 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0443 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0458	Evaporative Emission Control System Purge Solenoid Circuit Low Voltage	ECM	DTC P0443, P0458, or P0459
P0459	Evaporative Emission Control System Purge Solenoid Circuit High Voltage	ECM	DTC P0443, P0458, or P0459
P0461	Fuel Level Sensor 1 Performance	ECM	DTC P0461
P0462	Fuel Level Sensor 1 Circuit Low Voltage	ECM	DTC P0462
P0463	Fuel Level Sensor 1 Circuit HighVoltage	ECM	DTC P0463
P0480	Cooling Fan Relay 1 Control Circuit	ECM	DTC P0480, P0481, P0691, P0692, P0693, or P0694 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0480 or P0481 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0481	Cooling Fan Relay 2 Control Circuit	ECM	DTC P0480, P0481, P0691, P0692, P0693, or P0694 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0480 or P0481 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0500	Vehicle Speed Sensor Circuit Malfunction	ECM	DTC P0500
P0501	Vehicle Speed Sensor (VSS) Performance	ECM	DTC P0501 or P0502
P0502	Vehicle Speed Sensor (VSS) Circuit Low Voltage	ECM	DTC P0501 or P0502 for the Aisin AY6 transmission or DTC P0502 or P0503 for the Tremec 6-Speed transmission
P0503	Vehicle Speed Sensor (VSS)	ECM	DTC P0502 or P0503

	Circuit Intermittent		
P0506	Idle Speed Low	ECM	DTC P0506, P0507, or P050A for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0506 or P0507 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0507	Idle Speed High	ECM	DTC P0506, P0507, or P050A for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0506 or P0507 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P050A	Cold Start Idle Air Control (IAC) System Performance	ECM	DTC P0506, P0507, or P050A
P0521	Engine Oil Pressure (EOP) Sensor Performance	ECM	DTC P0521, P0522, or P0523
P0522	Engine Oil Pressure (EOP) Sensor Circuit Low Voltage	ECM	DTC P0521, P0522, or P0523
P0523	Engine Oil Pressure (EOP) Sensor Circuit High Voltage	ECM	DTC P0521, P0522, or P0523
P0532	Air Conditioning (A/C) Refrigerant Pressure Sensor Circuit	ECM	DTC P0532 or P0533
P0533	Air Conditioning (A/C) Refrigerant Pressure Sensor Circuit Low Voltage	ECM	DTC P0532 or P0533
P0560	System Voltage Malfunction	ECM	DTC P0560
P0562	System Voltage Low	ECM	DTC P0562
		TCM	• DTC P0562 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0562 for the 5L40-E/5L50-E transmission • DTC P0562 or P0563 for the 6L50/6L80/6L90 transmission
P0563	System Voltage High	ECM	DTC P0563
		TCM	• DTC P0563 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0563 for the 5L40-E/5L50-E transmission • DTC P0562 or P0563 for the 6L50/6L80/6L90 transmission
P0571	Cruise Control Brake Switch Circuit	ECM	DTC P0571
	Brake Switch Circuit 1 Low		

P0572	Voltage	ECM	DTC P0572
P0573	Brake Switch Circuit 1 High Voltage	ECM	DTC P0573
P0575	Cruise Control Enable Circuit Malfunction	ECM	DTC P0575
P0601	Control Module Read Only Memory (ROM) Error	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
	Transmission Control Module (TCM) Read Only Memory (ROM)	TCM	• DTC P0601-P0604 or P062F for the 4L60-E/4L65-E/4L70-E transmission • DTC P0601 for the 5L40-E/5L50-E transmission • DTC P0601-P0604 or P062F for the 6L50/6L80/6L90 transmission
P0602	Control Module Not Programmed	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
	Transmission Control Module (TCM) Not Programmed	TCM	• DTC P0601-P0604 or P062F for the 4L60-E/4L65-E/4L70-E transmission • DTC P0602 for the 5L40-E/5L50-E transmission • DTC P0601-P0604 or P062F for the 6L50/6L80/6L90 transmission
	Control Module Long Term Memory Reset	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or

P0603			P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
	Transmission Control Module (TCM) Long Term Memory Reset	TCM	• DTC P0601-P0604 or P062F for the 4L60-E/4L65-E/4L70-E transmission • DTC P0603 for the 5L40-E/5L50-E transmission • DTC P0601-P0604 or P062F for the 6L50/6L80/6L90 transmission
P0604	Control Module Random Access Memory (RAM)	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
	Transmission Control Module (TCM) Random Access Memory (RAM)	TCM	• DTC P0601-P0604 or P062F for the 4L60-E/4L65-E/4L70-E transmission • DTC P0604 for the 5L40-E/5L50-E transmission • DTC P0601-P0604 or P062F for the 6L50/6L80/6L90 transmission
P0606	Control Module Internal Performance	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0607	Control Module Performance	ECM	DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610
P060D	Control Module Accelerator Pedal Position (APP) System Performance	ECM	DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610
P0615	Starter Relay Circuit Malfunction	ECM	DTC P0615
P0616	Starter Relay Control Circuit Low Voltage	ECM	DTC P0616 or P0617
	Starter Relay Control Circuit		

P0617	High Voltage	ECM	DTC P0616 or P0617
P0621	Alternator L-Terminal Circuit Malfunction	ECM	DTC P0621
P0622	Generator F-Terminal Circuit	ECM	DTC P0622
P0625	Generator F-Terminal Low Voltage	ECM	DTC P0625 or P0626
P0626	Generator F-Terminal High Voltage	ECM	DTC P0625 or P0626
P0627	Fuel Pump Relay Control Circuit	ECM	DTC P0627, P0628, or P0629
P0628	Fuel Pump Relay Control Circuit Low Voltage	ECM	DTC P0627, P0628, or P0629
P0629	Fuel Pump Relay Control Circuit High Voltage	ECM	DTC P0627, P0628, or P0629
P062F	Control Module Long Term Memory Performance	ECM	DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
	Transmission Control Module (TCM) Long Term Memory Performance	TCM	• DTC P0601-P0604 or P062F for the 4L60-E/4L65-E/4L70-E transmission • DTC P062F for the 5L40-E/5L50-E transmission • DTC P0601-P0604 or P062F for the 6L50/6L80/6L90 transmission
P0633	Theft Deterrent Key Not Programmed	ECM	DTC P0633
P0634	Transmission Control Module (TCM) Overtemperature	TCM	DTC P0634
P0638	Commanded versus Actual Throttle Position Correlation	ECM	DTC P0638, P2100, P2101, or P2119
P0641	5-Volt Reference 1 Circuit	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	5V Reference Circuit 1 Malfunction		DTC P0641 or P0651 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0642	5-Volt Reference 1 Circuit Low Voltage	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P0643	5-Volt Reference 1 Circuit High Voltage	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P0650	Malfunction Indicator (MI) Circuit Malfunction	ECM	DTC P0650 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0650 for the 4.8L, 5.3L, 6.0L,

			6.2L, or 7.0L engine
P0651	5-Volt Reference 2 Circuit	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	5V Reference Circuit 2 Malfunction	ECM	DTC P0641 or P0651 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0652	5-Volt Reference 2 Circuit Low Voltage	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P0653	5-Volt Reference 2 Circuit High Voltage	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P0658	Solenoid High Control Circuit Group 1 Low Voltage	TCM	DTC P0658 or P0659 for the 5L40-E/5L50-E transmission or DTC P0658 or P0659 for the 6L50/6L80/6L90 transmission
P0659	Solenoid High Control Circuit Group 1 High Voltage	TCM	DTC P0658 or P0659 for the 5L40-E/5L50-E transmission or DTC P0658 or P0659 for the 6L50/6L80/6L90 transmission
P0660	Intake Manifold Tuning (IMT) Valve Solenoid Control Circuit	ECM	DTC P0660, P0661, or P0662
P0661	Intake Manifold Tuning (IMT) Solenoid Control Circuit Low Voltage	ECM	DTC P0660, P0661, or P0662
P0662	Intake Manifold Tuning (IMT) Solenoid Control Circuit High Voltage	ECM	DTC P0660, P0661, or P0662
P0667	Transmission Control Module (TCM) Temperature Sensor Performance	TCM	DTC P0667, P0668, or P0669
P0668	Transmission Control Module (TCM) Temperature Sensor Circuit Low Voltage	TCM	DTC P0667, P0668, or P0669
P0669	Transmission Control Module (TCM) Temperature Sensor Circuit High Voltage	TCM	DTC P0667, P0668, or P0669
P0685	Engine Control Ignition Relay Circuit Malfunction	ECM	DTC P0685, P0686, P0687, P0689, or P0690 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Engine Controls Ignition Relay Control Circuit	ECM	DTC P0685, P0689, or P0690 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0686	Engine Control Ignition Relay Circuit Low Voltage	ECM	DTC P0685, P0686, P0687, P0689, or P0690

P0687	Engine Control Ignition Relay Circuit High Voltage	ECM	DTC P0685, P0686, P0687, P0689, or P0690
P0689	Engine Control Ignition Relay Feedback Circuit Low Voltage	ECM	DTC P0685, P0686, P0687, P0689, or P0690 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Engine Controls Relay Feedback Circuit Low Voltage		DTC P0685, P0689, or P0690 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0690	Engine Control Ignition Relay Feedback Circuit High Voltage	ECM	DTC P0685, P0686, P0687, P0689, or P0690 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Engine Controls Relay Feedback Circuit High Voltage		DTC P0685, P0689, or P0690 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0691	Cooling Fan Relay 1 Control Circuit Low Voltage	ECM	DTC P0480, P0481, P0691, P0692, P0693, or P0694
P0692	Cooling Fan Relay 2 Control Circuit High Voltage	ECM	DTC P0480, P0481, P0691, P0692, P0693, or P0694
P0693	Cooling Fan Relay 2 Control Circuit Low Voltage	ECM	DTC P0480, P0481, P0691, P0692, P0693, or P0694
P0694	Cooling Fan Relay 1 Control Circuit High Voltage	ECM	DTC P0480, P0481, P0691, P0692, P0693, or P0694
P0697	5-Volt Reference 3 Circuit	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P0698	5-Volt Reference 3 Circuit Low Voltage	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P0699	5-Volt Reference 3 Circuit High Voltage	ECM	DTC P0641-P0643, P0651-P0653, or P0697-P0699
P06AC	Transmission Control Module (TCM) Power Up Temperature Sensor Performance	TCM	DTC P06AC, P06AD, or P06AE
P06AD	Transmission Control Module (TCM) Power Up Temperature Sensor Circuit Low Voltage	TCM	DTC P06AC, P06AD, or P06AE
P06AE	Transmission Control Module (TCM) Power Up Temperature Sensor Circuit High Voltage	TCM	DTC P06AC, P06AD, or P06AE
P0700	Transmission Control Module (TCM) Requested MIL Illumination	ECM	DTC P0700 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0700 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P0703	Torque Converter / Brake Switch Circuit Malfunction	ECM	DTC P0703
P0704	Clutch Switch Circuit	ECM	DTC P0704
			• DTC P0711 for the 4L60-

P0711	Transmission Fluid Temperature (TFT) Sensor Performance	TCM	E/4L65-E/4L70-E transmission • DTC P0711 for the 5L40-E/5L50-E transmission • DTC P0711, P0712, or P0713 for the 6L50/6L80/6L90 transmission
P0712	Transmission Fluid Temperature (TFT) Sensor Circuit Low Voltage	ECM	DTC P0712 or P0713 for the Tremec 6-Speed transmission
		TCM	• DTC P0712 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0712 for the 5L40-E/5L50-E transmission • DTC P0711, P0712, or P0713 for the 6L50/6L80/6L90 transmission
P0713	Transmission Fluid Temperature (TFT) Sensor Circuit High Voltage	ECM	DTC P0712 or P0713 for the Tremec 6-Speed transmission
		TCM	• DTC P0713 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0713 for the 5L40-E/5L50-E transmission • DTC P0711, P0712, or P0713 for the 6L50/6L80/6L90 transmission
P0716	Input Speed Sensor Performance	TCM	• DTC P0716 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0716 for the 5L40-E/5L50-E transmission • DTC P0716 or P0717 for the 6L50/6L80/6L90 transmission
P0717	Input Speed Sensor Circuit Low Voltage	TCM	• DTC P0717 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0717 for the 5L40-E/5L50-E transmission • DTC P0716 or P0717 for the 6L50/6L80/6L90 transmission
P0719	Brake Switch Circuit Low Voltage	TCM	DTC P0719
P0722	Output Speed Sensor Circuit Low Voltage	TCM	• DTC P0722 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0722 for the 5L40-E/5L50-E transmission • DTC P0722 or P0723 for the 6L50/6L80/6L90 transmission
			• DTC P0723 for the 4L60-

P0723	Output Speed Sensor Circuit Intermittent	TCM	E/4L65-E/4L70-E transmission • DTC P0723 for the 5L40-E/5L50-E transmission • DTC P0722 or P0723 for the 6L50/6L80/6L90 transmission
P0724	Brake Switch Circuit High Voltage	TCM	DTC P0724
P0727	Engine Speed No Signal	TCM	DTC P0727
P0741	Torque Converter Clutch (TCC) System - Stuck Off	TCM	• DTC P0741 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0741 for the 5L40-E/5L50-E transmission • DTC P0741 or P0742 for the 6L50/6L80/6L90 transmission
P0742	Torque Converter Clutch (TCC) System - Stuck On	TCM	• DTC P0742 for the 4L60-E/4L65-E/4L70-E transmission • DTC P0742 for the 5L40-E/5L50-E transmission • DTC P0741 or P0742 for the 6L50/6L80/6L90 transmission
P0748	Pressure Control (PC) Solenoid Control Circuit	TCM	DTC P0748
P0751	1-2 Shift Solenoid (SS) Valve Performance - No First, Fourth or Fifth Gear	TCM	DTC P0751 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0751 for the 5L40-E/5L50-E transmission
	Shift Solenoid (SS) 1 Valve Performance - Stuck Off		DTC P0751 for the 6L50/6L80/6L90 transmission
P0752	1-2 Shift Solenoid (SS) Valve Performance - No Second or Third Gear	TCM	DTC P0752 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0752 for the 5L40-E/5L50-E transmission
	Shift Solenoid (SS) 1 Valve Performance - Stuck On		DTC P0752 for the 6L50/6L80/6L90 transmission
P0756	2-3 Shift Solenoid (SS) Valve Performance - No First or Second Gear	TCM	DTC P0756 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0756 for the 5L40-E/5L50-E transmission

	Shift Solenoid (SS) 2 Valve Performance - Stuck Off		DTC P0756 for the 6L50/6L80/6L90 transmission
P0757	2-3 Shift Solenoid (SS) Valve Performance - No Third, Fourth or Fifth Gear	TCM	DTC P0757 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0757 for the 5L40-E/5L50-E transmission
P0761	4-5 Shift Solenoid (SS) Valve Performance - No Fourth Gear	TCM	DTC P0761
P0762	4-5 Shift Solenoid (SS) Valve Performance - No Fifth Gear	TCM	DTC P0762
P0776	Clutch Pressure Control (PC) Solenoid 2 - Stuck Off	TCM	DTC P0776 or P0777
P0777	Clutch Pressure Control (PC) Solenoid 2 - Stuck On	TCM	DTC P0776 or P0777
P0787	3-2 Shift Solenoid (SS) Control Circuit Low Voltage	TCM	DTC P0787
P0788	3-2 Shift Solenoid (SS) Control Circuit High Voltage	TCM	DTC P0788
P0796	Clutch Pressure Control (PC) Solenoid 3 - Stuck Off	TCM	DTC P0796 or P0797
P0797	Clutch Pressure Control (PC) Solenoid 3 - Stuck On	TCM	DTC P0796 or P0797
P0801	Reverse Lockout Solenoid Control Circuit	ECM	DTC P0801
P0803	Skip Shift Solenoid Control Circuit	ECM	DTC P0803
P0806	Clutch Pedal Position (CPP) Sensor Circuit Performance	ECM	DTC P0806 for the Aisin AY6 transmission or DTC P0806 for the Tremec 6-Speed transmission
P0807	Clutch Pedal Position (CPP) Sensor Circuit Low Voltage	ECM	DTC P0807 or P0808 for the Aisin AY6 transmission or DTC P0807 or P0808 for the Tremec 6-Speed transmission
P0808	Clutch Pedal Position (CPP) Sensor Circuit High Voltage	ECM	DTC P0807 or P0808 for the Aisin AY6 transmission or DTC P0807 or P0808 for the Tremec

			6-Speed transmission
P080A	Clutch Pedal Position (CPP) Sensor Circuit High Voltage	ECM	DTC P080A for the Aisin AY6 transmission or DTC P080A for the Tremec 6-Speed transmission
P0815	Upshift Switch Circuit	TCM	DTC P0815, P0816, or P0826 for the 5L40-E/5L50-E transmission or DTC P0815, P0816, or P0826 for the 6L50/6L80/6L90 transmission
P0816	Downshift Switch Circuit	TCM	DTC P0815, P0816, or P0826 for the 5L40-E/5L50-E transmission or DTC P0815, P0816, or P0826 for the 6L50/6L80/6L90 transmission
P0826	Up and Down Shift Switch Circuit	TCM	DTC P0815, P0816, or P0826 for the 5L40-E/5L50-E transmission or DTC P0815, P0816, or P0826 for the 6L50/6L80/6L90 transmission
P0842	Transmission Fluid Pressure (TFP) Switch 1 Circuit Low Voltage	TCM	DTC P0842 or P0843
P0843	Transmission Fluid Pressure (TFP) Switch 1 Circuit High Voltage	TCM	DTC P0842 or P0843
P0850	Park/Neutral Position (PNP) Switch Circuit	TCM	DTC P0850 for the 5L40-E/5L50-E transmission or DTC P0850-P0852 for the 6L50/6L80/6L90 transmission
P0851	Park/Neutral Position (PNP) Switch Circuit Low Voltage	ECM	DTC P0850-P0852 for the 6L50/6L80/6L90 transmission
P0852	Park/Neutral Position (PNP) Switch Circuit High Voltage	ECM	DTC P0850-P0852 for the 6L50/6L80/6L90 transmission
P0856	Engine Control Module (ECM) Traction Control Torque Request Circuit	ECM	DTC P0856

P0872	Transmission Fluid Pressure (TFP) Switch 3 Circuit Low Voltage	TCM	DTC P0872 or P0873
P0873	Transmission Fluid Pressure (TFP) Switch 3 Circuit High Voltage	TCM	DTC P0872 or P0873
P0877	Transmission Fluid Pressure (TFP) Switch 4 Circuit Low Voltage	TCM	DTC P0877 or P0878
P0878	Transmission Fluid Pressure (TFP) Switch 4 Circuit High Voltage	TCM	DTC P0877 or P0878
P0897	Transmission Fluid Life	TCM	DTC P0897
P0961	Line Pressure Control (PC) Solenoid System Performance	TCM	DTC P0961 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0961-P0963 for the 6L50/6L80/6L90 transmission
P0962	Line Pressure Control (PC) Solenoid Control Circuit Low Voltage	TCM	DTC P0961-P0963
P0963	Line Pressure Control (PC) Solenoid Control Circuit High Voltage	TCM	DTC P0961-P0963
P0965	Clutch Pressure Control (PC) Solenoid 2 System Performance	TCM	DTC P0965-P0967
P0966	Clutch Pressure Control (PC) Solenoid 2 Control Circuit Low Voltage	TCM	DTC P0965-P0967
P0967	Clutch Pressure Control (PC) Solenoid 2 Control Circuit High Voltage	TCM	DTC P0965-P0967
P0969	Clutch Pressure Control (PC) Solenoid 3 System Performance	TCM	DTC P0969-P0971
P0970	Clutch Pressure Control (PC) Solenoid 3 Control Circuit Low Voltage	TCM	DTC P0969-P0971
P0971	Clutch Pressure Control (PC) Solenoid 3 Control Circuit High Voltage	TCM	DTC P0969-P0971
P0973	1-2 Shift Solenoid (SS) Control Circuit Low Voltage	TCM	DTC P0973 for the 4L60-E/4L65-E/4L70-E transmission or

			DTC P0973 for the 5L40-E/5L50-E transmission
	Shift Solenoid (SS) 1 Control Circuit Low Voltage		DTC P0973 or P0974 for the 6L50/6L80/6L90 transmission
P0974	1-2 Shift Solenoid (SS) Control Circuit High Voltage	TCM	DTC P0974 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0974 for the 5L40-E/5L50-E transmission
	Shift Solenoid (SS) 1 Control Circuit High Voltage		DTC P0973 or P0974 for the 6L50/6L80/6L90 transmission
P0976	2-3 Shift Solenoid (SS) Control Circuit Low Voltage	TCM	DTC P0976 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0976 for the 5L40-E/5L50-E transmission
	Shift Solenoid (SS) 2 Control Circuit Low Voltage		DTC P0976 or P0977 for the 6L50/6L80/6L90 transmission
P0977	2-3 Shift Solenoid (SS) Control Circuit High Voltage	TCM	DTC P0977 for the 4L60-E/4L65-E/4L70-E transmission or DTC P0977 for the 5L40-E/5L50-E transmission
	Shift Solenoid (SS) 2 Control Circuit High Voltage		DTC P0976 or P0977 for the 6L50/6L80/6L90 transmission
P0979	4-5 Shift Solenoid (SS) Control Circuit Low Voltage	TCM	DTC P0979
P0980	4-5 Shift Solenoid (SS) Control Circuit High Voltage	TCM	DTC P0980
P0989	Transmission Fluid Pressure (TFP) Switch 5 Circuit Low Voltage	TCM	DTC P0989 or P0990
P0990	Transmission Fluid Pressure (TFP) Switch 5 Circuit High Voltage	TCM	DTC P0989 or P0990
P1011	Intake Camshaft Actuator Park Position Bank 1	ECM	DTC P1011-P1014
P1012	Exhaust Camshaft Actuator Park Position Bank 1	ECM	DTC P1011-P1014
P1013	Intake Camshaft Actuator Park Position Bank 2	ECM	DTC P1011-P1014
P1014	Exhaust Camshaft Actuator Park Position Bank 2	ECM	DTC P1011-P1014

P1101	Intake Air Flow System Performance	ECM	DTC P0101 or P1101
P1133	HO2S Insufficient Switching Bank 1 Sensor 1	ECM	DTC P0133, P0134, P0140, P1133, P2270, or P2271
P1153	HO2S Insufficient Switching Bank 2 Sensor 1	ECM	DTC P0153, P0154, P0160, P1153, P2272, or P2273
P1174	Fuel Trim Cylinder Balance Bank 1	ECM	DTC P1174 or P1175
P1175	Fuel Trim Cylinder Balance Bank 2	ECM	DTC P1174 or P1175
P1258	Engine Coolant Over Temperature - Protection Mode Active	ECM	DTC P1258
P1380	Misfire Detected - Rough Road Data Not Available	ECM	DTC P1380 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P1380 or P1381 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P1381	Misfire Detected - No Communication with Brake Control Module	ECM	DTC P1380 or P1381
P1400	Cold Start Emission Reduction Control System	ECM	DTC P1400
P1516	Throttle Actuator Control (TAC) Module Throttle Actuator Position Performance	ECM	DTC P1516, P2101, P2119, or P2176
P1551	Throttle Control Lower Position not Reached during Learning Mode	ECM	DTC P1551
P1631	Theft Deterrent Fuel Enable Signal Not Correct	ECM	DTC P1631
P1668	Generator L-Terminal Control Circuit	ECM	DTC P1668, P2500, or P2501
P167D	Control Module Ignition Coil Internal Circuit	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610
P1682	Ignition 1 Switch Circuit 2	ECM	DTC P1682
P1751	Shift Valve 1 Performance	TCM	DTC P1751
P1761	Up and Down Shift Switch Signal Circuit	TCM	DTC P1761
P1793	Wheel Speed Signal	TCM	DTC P1793
P1810	Transmission Fluid Pressure (TFP) Position Switch Circuit	TCM	DTC P1810
P1815	Transmission Fluid Pressure (TFP) Valve Position Switch -	TCM	DTC P1815 for the 4L60-E/4L65-E/4L70-E transmission or

	Start in Wrong Range		DTC P1815 for the 5L40-E/5L50-E transmission
P1816	Transmission Fluid Pressure (TFP) Valve Position Switch Indicates Park/Neutral (P/N) with Drive Ratio	TCM	DTC P1816
P1818	Transmission Fluid Pressure (TFP) Valve Position Switch Indicates Drive without Drive Ratio	TCM	DTC P1818
P1820	Internal Mode Switch A Circuit Low Voltage	TCM	DTC P1820
P1822	Internal Mode Switch B Circuit High Voltage	TCM	DTC P1822
P1823	Internal Mode Switch P Circuit Low Voltage	TCM	DTC P1823
P1825	Internal Mode Switch - Invalid Range	TCM	DTC P1825 or P1915
P1826	Internal Mode Switch C Circuit High Voltage	TCM	DTC P1826
P182E	Internal Mode Switch - Invalid Range	TCM	DTC P182E or P1915
P1831	Pressure Control (PC)/Shift Lock Solenoid Control Circuit Low Voltage	TCM	DTC P1831 for the 5L40-E/5L50-E transmission
P1832	Pressure Control (PC)/Shift Lock Solenoid Control Circuit High Voltage	TCM	DTC P1832 for the 5L40-E/5L50-E transmission
P1833	Torque Converter Clutch (TCC)/Shift Solenoid (SS) Control Circuit Low Voltage	TCM	DTC P1833
P1834	Torque Converter Clutch (TCC)/Shift Solenoid (SS) Control Circuit High Voltage	TCM	DTC P1834
P1876	Up and Down Shift Switch Performance - Range Switch Not in D3	TCM	DTC P1876 for the 5L40-E/5L50-E transmission or DTC P1876 for the 6L50/6L80/6L90 transmission
P1915	Internal Mode Switch Does Not Indicate Park/Neutral (P/N) During Start	TCM	DTC P1825 or P1915 for the 5L40-E/5L50-E transmission
	Internal Mode Switch Start/Wrong Range		DTC P182E or P1915 for the 6L50/6L80/6L90 transmission
P2066	Fuel Level Sensor 2 Performance	ECM	DTC P2066

P2067	Fuel Level Sensor 2 Low Voltage	ECM	DTC P2067
P2068	Fuel Level Sensor 2 High Voltage	ECM	DTC P2068
P2072	Throttle Actuator Control System - Ice Blockage	ECM	DTC P2072
P2088	Intake Camshaft Position Control Solenoid Circuit Low Voltage Bank 1	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2089	Intake Camshaft Position Control Solenoid Circuit High Voltage Bank 1	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2090	Exhaust Camshaft Position Control Solenoid Circuit Low Voltage Bank 1	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2091	Exhaust Camshaft Position Control Solenoid Circuit High Voltage Bank 1	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2092	Intake Camshaft Position Control Solenoid Circuit Low Voltage Bank 2	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2093	Intake Camshaft Position Control Solenoid Circuit High Voltage Bank 2	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2094	Exhaust Camshaft Position Control Solenoid Circuit Low Voltage Bank 2	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2095	Exhaust Camshaft Position Control Solenoid Circuit High Voltage Bank 2	ECM	DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095
P2096	Post Catalyst O2 Sensor Fuel Trim Below Lower Limit Bank 1	ECM	DTC P2096 or P2098
P2097	Post Catalyst O2 Sensor Fuel Trim Above Upper Limit Bank 1	ECM	DTC P2097 or P2099
P2098	Post Catalyst O2 Sensor Fuel Trim Below Lower Limit Bank 2	ECM	DTC P2096 or P2098
P2099	Post Catalyst O2 Sensor Fuel Trim Above Upper Limit Bank 2	ECM	DTC P2097 or P2099
P2100	Throttle Control Motor Malfunction	ECM	DTC P0638, P2100, P2101, or P2119
P2101	Throttle Control Position Range/Performance	ECM	DTC P0638, P2100, P2101, or P2119 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Throttle Actuator Position Performance		DTC P1516, P2101, P2119, or P2176 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2105	Throttle Control Forced Engine Shutdown	ECM	DTC P2105

P2119	Closed Throttle Position Range/Performance	ECM	DTC P0638, P2100, P2101, or P2119 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Throttle Closed Position Performance		DTC P1516, P2101, P2119, or P2176 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2120	Accelerator Pedal Position Sensor 1 Circuit	ECM	DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138
P2122	Accelerator Pedal Position Sensor 1 Low Voltage	ECM	DTC P2122, P2123, P2127, P2128, or P2138 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2123	Accelerator Pedal Position Sensor 1 High Voltage	ECM	DTC P2122, P2123, P2127, P2128, or P2138 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2125	Accelerator Pedal Position Sensor 2 Circuit	ECM	DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138
P2127	Accelerator Pedal Position Sensor 2Low Voltage	ECM	DTC P2122, P2123, P2127, P2128, or P2138 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2128	Accelerator Pedal Position Sensor 2 High Voltage	ECM	DTC P2122, P2123, P2127, P2128, or P2138 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
	Throttle Position Sensor 1-2		DTC P0120, P0122, P0123, P0220,

P2135	Correlation	ECM	P0222, P0223, or P2135
P2138	Accelerator Pedal Position Sensor 1-2 Correlation	ECM	DTC P2122, P2123, P2127, P2128, or P2138 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2176	Throttle Actuator Control Lower Position Not Learned	ECM	DTC P2176 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	Minimum Throttle Position Not Learned		DTC P1516, P2101, P2119, or P2176 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2177	Fuel Trim Lean during Cruising/Acceleration Bank 1	ECM	DTC P2177, P2179, P2187, or P2189
P2178	Fuel Trim Rich during Cruising/Acceleration Bank 1	ECM	DTC P2178, P2180, P2188, or P2190
P2179	Fuel Trim Lean during Cruising/Acceleration Bank 2	ECM	DTC P2177, P2179, P2187, or P2189
P2180	Fuel Trim Rich during Cruising/Acceleration Bank 2	ECM	DTC P2178, P2180, P2188, or P2190
P2187	Fuel Trim Lean during Idling/Deceleration Bank 1	ECM	DTC P2177, P2179, P2187, or P2189
P2188	Fuel Trim Rich during Idling/Deceleration Bank 1	ECM	DTC P2178, P2180, P2188, or P2190
P2189	Fuel Trim Lean during Idling/Deceleration Bank 2	ECM	DTC P2177, P2179, P2187, or P2189
P2190	Fuel Trim Rich during Idling/Deceleration Bank 2	ECM	DTC P2178, P2180, P2188, or P2190
P2227	Barometric Pressure Sensor Range/Performance	ECM	DTC P2227, P2228, or P2229
P2228	Barometric Pressure Sensor Voltage Low	ECM	DTC P2227, P2228, or P2229
P2229	Barometric Pressure Sensor Voltage High	ECM	DTC P2227, P2228, or P2229
P2232	HO2S Signal Circuit Shorted to Heater Circuit Bank 1 Sensor 2	ECM	DTC P2232 or P2235
P2235	HO2S Signal Circuit Shorted to Heater Circuit Bank 2 Sensor 2	ECM	DTC P2232 or P2235
P2270	O2 Sensor Lean/Rich Switch Signal Malfunction Bank 1 Sensor 2	ECM	DTC P2270 or P2272 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Signal Stuck Lean Bank 1 Sensor 2		DTC P0133, P0134, P0140, P1133, P2270, or P2271 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine

P2271	O2 Sensor Rich/Lean Switch Signal Malfunction Bank 1 Sensor 2	ECM	DTC P2271 or P2273 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Signal Stuck Rich Bank 1 Sensor 2		DTC P0133, P0134, P0140, P1133, P2270, or P2271 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2272	O2 Sensor Lean/Rich Switch Signal Malfunction Bank 2 Sensor 2	ECM	DTC P2270 or P2272 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Signal Stuck Lean Bank 2 Sensor 2		DTC P0153, P0154, P0160, P1153, P2272, or P2273 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2273	O2 Sensor Rich/Lean Switch Signal Malfunction Bank 2 Sensor 2	ECM	DTC P2271 or P2273 for the 2.8L, 3.0L, 3.2L, or 3.6L engine
	HO2S Signal Stuck Rich Bank 2 Sensor 2		DTC P0153, P0154, P0160, P1153, P2272, or P2273 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2300	Ignition Coil Cylinder 1 Circuit Low Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2301	Ignition Coil Cylinder 1 Circuit High Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2303	Ignition Coil Cylinder 2 Circuit Low Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2304	Ignition Coil Cylinder 2 Circuit High Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2306	Ignition Coil Cylinder 3 Circuit Low Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2307	Ignition Coil Cylinder 3 Circuit High Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2309	Ignition Coil Cylinder 4 Circuit Low Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2310	Ignition Coil Cylinder 4 Circuit High Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316

P2312	Ignition Coil Cylinder 5 Circuit Low Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2313	Ignition Coil Cylinder 5 Circuit High Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2315	Ignition Coil Cylinder 6 Circuit Low Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2316	Ignition Coil Cylinder 6 Circuit High Voltage	ECM	DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316
P2500	Generator L-Terminal Circuit Low Voltage	ECM	DTC P1668, P2500, or P2501
P2501	Generator L-Terminal Circuit High Voltage	ECM	DTC P1668, P2500, or P2501
P250A	Engine Oil Level Sensor Circuit	ECM	DTC P250A
P2534	Ignition 1 Switch Circuit Low Voltage	TCM	• DTC P2534 for the 4L60-E/4L65-E/4L70-E transmission • DTC P2534 for the 5L40-E/5L50-E transmission • DTC P2534 for the 6L50/6L80/6L90 transmission
P2544	Transmission Torque Request Circuit	ECM	DTC P2544 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P2544 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
		TCM	DTC P2544 for the 5L40-E/5L50-E transmission
P2610	Control Module Ignition Off Timer Performance	ECM	DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610 for the 2.8L, 3.0L, 3.2L, or 3.6L engine or DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
P2636	Fuel Transfer Pump Flow Insufficient	ECM	DTC P2636
	Transmission Torque Delivered		

P2637	Circuit	TCM	DTC P2637
P2670	Solenoid High Control Circuit Group 2 Low Voltage	TCM	DTC P2670 or P2671
P2671	Solenoid High Control Circuit Group 2 High Voltage	TCM	DTC P2670 or P2671
P2714	Clutch Pressure Control (PC) Solenoid 4 - Stuck Off	TCM	DTC P2714 or P2715
P2715	Clutch Pressure Control (PC) Solenoid 4 - Stuck On	TCM	DTC P2714 or P2715
P2719	Clutch Pressure Control (PC) Solenoid 4 System Performance	TCM	DTC P2719-P2721
P2720	Clutch Pressure Control (PC) Solenoid 4 Control Circuit Low Voltage	TCM	DTC P2719-P2721
P2721	Clutch Pressure Control (PC) Solenoid 4 Control Circuit High Voltage	TCM	DTC P2719-P2721
P2723	Clutch Pressure Control (PC) Solenoid 5 - Stuck Off	TCM	DTC P2723 or P2724
P2724	Clutch Pressure Control (PC) Solenoid 5 - Stuck On	TCM	DTC P2723 or P2724
P2728	Clutch Pressure Control (PC) Solenoid 5 System Performance	TCM	DTC P2728-P2730
P2729	Clutch Pressure Control (PC) Solenoid 5 Control Circuit Low Voltage	TCM	DTC P2728-P2730
P2730	Clutch Pressure Control (PC) Solenoid 5 Control Circuit High Voltage	TCM	DTC P2728-P2730
P2762	Torque Converter Clutch (TCC) Pressure Control Solenoid System Performance	TCM	DTC P2762, P2763, or P2764
P2763	Torque Converter Clutch (TCC) Pressure Control (PC) Solenoid Control Circuit High Voltage	TCM	DTC P2763 for the 4L60-E/4L65-E/4L70-E transmission or DTC P2763 for the 5L40-E/5L50-E transmission
	Torque Converter Clutch (TCC) Pressure Control Solenoid Control Circuit Low Voltage		DTC P2762, P2763, or P2764 for the 6L50/6L80/6L90 transmission
	Torque Converter Clutch (TCC) Pressure Control (PC) Solenoid Control Circuit Low Voltage		DTC P2764 for the 4L60-E/4L65-E/4L70-E transmission or

P2764		TCM	DTC P2764 for the 5L40-E/5L50-E transmission
	Torque Converter Clutch (TCC) Pressure Control Solenoid Control Circuit High Voltage		DTC P2762, P2763, or P2764 for the 6L50/6L80/6L90 transmission
P2769	Torque Converter Clutch (TCC) Enable Solenoid Control Circuit Low Voltage	TCM	DTC P2769
P2770	Torque Converter Clutch (TCC) Enable Solenoid Control Circuit High Voltage	TCM	DTC P2770
P3400	Cylinder Deactivation System Performance	ECM	DTC P3400
P3401	Cylinder 1 Deactivation Solenoid Control Circuit	ECM	DTC P3401, P3425, P3441, or P3449
P3425	Cylinder 4 Deactivation Solenoid Control Circuit	ECM	DTC P3401, P3425, P3441, or P3449
P3441	Cylinder 6 Deactivation Solenoid Control Circuit	ECM	DTC P3401, P3425, P3441, or P3449
P3449	Cylinder 7 Deactivation Solenoid Control Circuit	ECM	DTC P3401, P3425, P3441, or P3449
U0073	High Speed Communication Bus	--	DTC U0073
U0100 - U0249	CAN-Bus No Communication with XXX Control Module	--	DTC U0100-U0249
U1304	CAN-Bus No Communication with SIM (Seat Interface Module)	SIM	DTC U1304
U1401	No Communication with MSM (Memory Seat and Mirror Module)	SIM	DTC U1401
	Lost Communications Between AD and ADG	NIM	DTC U1401
U1814	Powertrain High Speed Communication Enable Circuit	BCM	DTC U1814
U2099	High Speed Communication Enable Circuit	BCM	DTC U2099
U2100	CAN-Bus Circuit Malfunction	--	DTC U2100
U2121	No Communication with Radio Display	Radio	DTC U2121
U2136	No Exterior Mirror Communication	MSM	DTC U2136
U2201	No Communication With DVD Player	RSE	DTC U2201
U2202	No Communication With Rear Control Panel	RSE	DTC U2202

U2203	No Communication With Screen 1	RSE	DTC U2203 or U2204
U2204	No Communication With Screen 2	RSE	DTC U2203 or U2204

Symptoms - Vehicle

Body Systems

- Symptoms - Fixed and Moveable Windows
- Symptoms - Horns
- Symptoms - Lighting
- Symptoms - Mirrors
- Symptoms - Stationary Windows
- Symptoms - Vehicle Access
- Symptoms - Wiper/Washer Systems

Brakes

- Symptoms - Antilock Brake System
- Symptoms - Hydraulic Brakes
- Symptoms - Park Brake

Driveline / Axle

- Symptoms - Propeller Shaft
- Symptoms - Rear Drive Axle
- Symptoms - Wheel Drive Shafts

Driver Information and Entertainment

- Symptoms - Cellular Communication
- Symptoms - Entertainment
- Symptoms - Displays and Gages
- Symptoms - Secondary and Configurable Customer Controls
- Symptoms - Telematics

Engine

- Symptoms - Cruise Control
- Symptoms - Engine Controls for the 2.8L, 3.0L, 3.2L, or 3.6L engine
- Symptoms - Engine Controls for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
- Symptoms - Engine Cooling
- Symptoms - Engine Electrical

- Symptoms - Engine Exhaust
- Symptoms - Engine Mechanical for the 2.8L, 3.0L, 3.2L, or 3.6L engine
- Symptoms - Engine Mechanical for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine

HVAC

- Symptoms - Heating, Ventilation, and Air Conditioning
- Symptoms - HVAC Systems - Automatic
- Symptoms - HVAC Systems - Manual

Power and Signal Distribution

- Symptoms - Data Communications
- Symptoms - Power Outlets
- Symptoms - Wiring Systems

Roof

Symptoms - Roof

Safety and Security

- Symptoms - Keyless Entry
- Symptoms - Object Detection
- Symptoms - Seat Belts
- Symptoms - SIR
- Symptoms - Theft Deterrent

Seats

Symptoms - Seats

Steering

- Symptoms - Power Steering System
- Symptoms - Steering Wheel and Column

Suspension

Symptoms - Suspension General Diagnosis

Transmission

- Symptoms - Automatic Transmission for the 4L60-E/4L65-E/4L70-E transmission

- Symptoms - Automatic Transmission for the 5L40-E/5L50-E transmission
- Symptoms - Automatic Transmission for the 6L50/6L80/6L90 transmission
- Symptoms - Automatic Transmission Shift Lock Control
- Symptoms - Clutch
- Symptoms - Manual Transmission for the Aisin AY6 transmission
- Symptoms - Manual Transmission for the Temec 6-Speed transmission

DTC Symptom Description

A DTC symptom is a 2-digit number which adds additional detail to a DTC. The DTC symptom provides additional information without requiring a large increase in the number of new DTCs.

DTC Symptom Categories

The DTC symptom is made up of 2 alphanumeric digits. The first digit following the DTC indicates the DTC symptom category. There are 16 possible categories available in the range of 0 through the letter F. Currently there are 8 categories in use, 0 through 7. These 8 categories together with their definitions are given below.

Category Number	Category Name	Category Description
0	General Electrical Failures	This category includes standard wiring failure modes, direct current quantities related by Ohm's Law and quantities related to amplitude, frequency or rate of change, and wave shape.
1	Additional General Electrical Failures	This category includes the overflow from the previous category.
2	FM/PWM (Frequency/Pulse Width Modulated) Failures	This category includes faults related to frequency modulated and pulse width modulated inputs and outputs of the electronic control module (ECU). This category also includes faults where position is determined by counts.
3	ECU Internal Failures	This category includes faults related to memory, software, and internal electrical circuitry; requiring ECU replacement.
4	ECU Programming Failures	This category includes faults related to operational software, calibrations, and options, remedied by programming the ECU.
5	Algorithm Based Failures	This category includes faults based on comparing two or more input parameters for plausibility or comparing a single parameter to itself with respect to time.
6	Mechanical Failures	This category includes faults detected by inappropriate motion in response to an ECU controlled output.
7	Bus Signal/Message Failures	This category includes faults related to bus hardware and signal integrity. This category is also used when the physical input for a signal is located in one ECU and another ECU diagnoses the circuit.
8-F	Reserved by Document	Not in use at this time.

DTC Symptom Subtypes

The second digit of the DTC symptom is the subtype of the DTC symptom. These subtypes and their categories, together with their definitions, are given in the following table. DTC symptom 00 is a special case. If 00 is displayed, only the base code number and its description apply.

Information regarding the fault will be provided in the code setting criteria.

Example

The DTC symptoms associated with each DTC provide more information about the fault that caused that DTC. An example of a DTC displayed can be B1451 05 where the B1451 is the DTC, and 05 after the space represents the DTC symptom. While the DTC indicates that the fault is in the accessory power circuit, this DTC symptom indicates the circuit is shorted to battery or open. Another possible symptom for this code is B1451 02, where B1451 indicates the accessory power circuit, and 02 indicates the circuit is shorted to ground.

DTC Symptom	DTC Symptom Description
00	No Additional Information
01	Short to Battery
02	Short to Ground
03	Voltage Below Threshold
04	Open Circuit
05	Short to Battery or Open
06	Short to Ground or Open
07	Voltage Above Threshold
08	Signal Invalid
09	Rate of Change Above Threshold
0A	Rate of Change Below Threshold
0B	Current Above Threshold
0C	Current Below Threshold
0D	Resistance Above Threshold
0E	Resistance Below Threshold
0F	Erratic
10	Reserved
11	Above Maximum Threshold
12	Below Minimum Threshold
13	Voltage Low/High Temperature
14	Voltage High/Low Temperature
15	Signal Rising Time Failure
16	Signal Falling Time Failure
17	Signal Shape/Waveform Failure
18	Signal Amplitude Less Than Minimum
19	Signal Amplitude Greater Than Maximum
1A	Bias Level Out of Range
1F	Intermittent
21	Incorrect Period
22	Low Time Less Than Minimum
23	Low Time Greater Than Maximum

24	High Time Less Than Minimum
25	High Time Greater Than Maximum
26	Frequency Too Low
27	Frequency Too High
28	Incorrect Frequency
29	Too Few Pulses
2A	Too Many Pulses
2B	Missing Reference
2C	Reference Compare Error
31	General Checksum Failure
32	General Memory Failure
33	Special Memory Failure
34	RAM Failure
35	ROM Failure
36	EEPROM Failure
37	Watchdog/Safety Processor Failure
38	Supervision Software Failure
39	Internal Electronic Failure
41	Operational Software/Calibration Data Set Not Programmed
42	Calibration Data Set Not Programmed
43	EEPROM Error
44	Security Access Not Activated
45	Variant Not Programmed
46	Vehicle Configuration Not Programmed
47	VIN Not Programmed
48	Theft/Security Data Not Programmed
49	RAM Error
4A	Checksum Error
4B	Calibration Not Learned
51	Calculation Failure
52	Compare Failure
53	Temperature Low
54	Temperature High
55	Expected Number of Transitions/Events Not Reached
56	Allowable Number of Transitions/Events Exceeded
57	Expected Reaction After Event Did Not Occur
58	Incorrect Reaction After Event
59	Circuit/Component Protection Time-Out
61	Actuator Stuck
62	Actuator Stuck Open

63	Actuator Stuck Closed
64	Actuator Slipping
65	Emergency Position Not Reachable
71	Invalid Serial Data Received (Signal Validity Bit Indicates Failure)
72	Alive Counter Incorrect/Not Updated
73	Parity Error
74	Value of Signal Protection Calculation Incorrect
75	Signal Above Allowable Range
76	Signal Below Allowable Range
7F	Erratic

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Propeller Shaft Rubber Coupling to Propeller Shaft Retaining Bolts and Nuts.	20 N-m +55°	15 lb ft +55°
Centre Bearing to Body Retaining Bolts.	22 N-m	16 lb ft
Propeller Shaft Rubber Coupling to Propeller Shaft Yoke Retaining Bolts and Nuts.	20 N-m +55°	15 lb ft +55°
Propeller Shaft Coupling to Differential Flange Retaining Bolts.	115 N-m	85 lb ft
Propeller Shaft Rubber Coupling to Transmission Flange Retaining Bolts and Nuts (torque bolt, hold nut).	100 N-m	72 lb ft

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material
Slip Yoke Splines	Molybdenum Disulphide Grease

Diagnostic Starting Point - Propeller Shaft

Begin the system diagnosis by reviewing Propeller Shaft Description and Operation. Reviewing the description and operation information will help you determine the correct symptom and diagnostic procedure when a malfunction exists. Reviewing the description and operation information will also help you determine if the condition described by the customer is normal operation. Refer to Symptoms - Propeller Shaft, in order to identify the correct procedure for diagnosing the system and where the procedure is located.

Knock or Clunk Noise

Checks	Action
DEFINITION: Knocking or clunking noise occurs when operating the vehicle in high gear or coasting in neutral at 16 km/h (10 mph).	
The universal joint is worn or damaged.	Replace the complete propeller shaft. Refer to Propeller Shaft Replacement .
The rubber coupling is damaged.	Replace the rubber coupling. Refer to Rear Propeller Shaft Coupling Replacement .
The rubber coupling to propeller shaft retaining bolts and nuts are loose.	Tighten the bolts to specifications. Refer to Fastener Tightening Specifications .
The rubber coupling is damaged.	Replace the rubber coupling. Refer to Rear Propeller Shaft Coupling Replacement .
The center bearing is damaged.	Replace the center bearing. Refer to Propeller Shaft Center Support Bearing Replacement .
The side gear in the differential is worn or oversize.	Replace the differential case and/or the side gears. Refer to Differential Replacement .

Scraping Noise

Checks	Action
DEFINITION: A scraping noise occurs when driving the vehicle at various speeds.	
The heat shield, exhaust or other part is touching the propeller shaft.	Correct the interference as necessary.
The pinion flange slinger or the centre bearing is rubbing.	Correct the interference as necessary.

Shudder on Acceleration at Low Speed

Checks	Action
DEFINITION: When the vehicle is accelerating at low speed a shudder occurs.	
The centre bearing rubber cushion is worn or damaged.	Replace the centre bearing assembly. Refer to Rear Propeller Shaft Coupling Replacement .
The universal joint is worn, damaged or too stiff.	Replace the centre bearing assembly. Refer to Universal Joint Replacement .
The rubber coupling to propeller shaft retaining nuts and bolts are loose.	Tighten the rubber coupling to propeller shaft retaining nuts and bolts to specifications. Refer to Fastener Tightening Specifications .
The angle across the universal joints is too high.	Determine the cause of the excessive driveline angle. Check engine and transmission mounts, centre bearing mounting bracket, subframe and differential mounts.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Driveline/Axle | Propeller Shaft | Diagnostic Information and Procedures | **Document ID: 1987141**

Squeak Noise

Checks	Action
DEFINITION: When driving the vehicle at various speeds a squeaking sound occurs.	
The universal joint is worn or damaged.	Replace the complete propeller shaft. Refer to Propeller Shaft Replacement.

Symptoms - Propeller Shaft

Before beginning diagnosis, review the system Description and Operation in order to familiarise yourself with the system function. Refer to Propeller Shaft Description and Operation.

Classifying the Symptom

Propeller Shaft symptoms can usually be classified into the following categories:

- Noises.
- Vibrations.

Visual/Physical Inspection

- Inspect the system for aftermarket devices which could affect the operation of the propeller shaft.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Universal Joint Noise.
- Ping, Snap, or Click Noise.
- Knock or Clunk Noise.
- Scraping Noise.
- Squeak Noise.

Universal Joint Noise

Problem	Action
The universal joint is worn or damaged.	Replace the complete propeller shaft. Refer to Propeller Shaft Replacement.
The universal joint has lost lubricant.	Replace the complete propeller shaft. Refer to Propeller Shaft Replacement.
The rubber coupling to transmission or differential flange retaining bolts and/or nuts are loose.	Tighten the bolts to specifications. Refer to Fastener Tightening Specifications.

Propeller Shaft Replacement

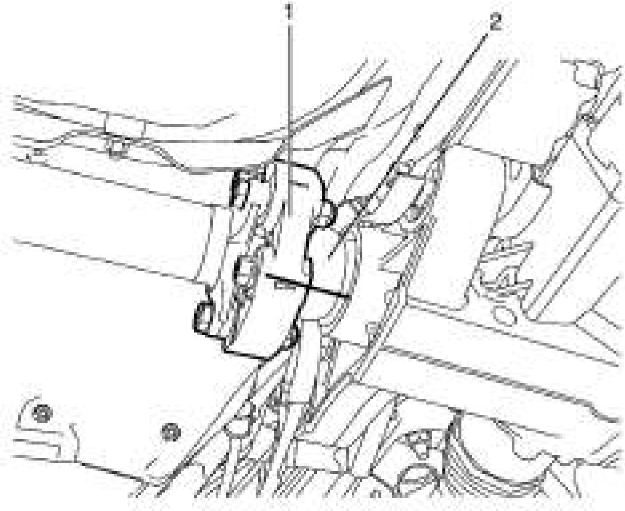
Removal Procedure

1. Select park/1st gear position in the transmission and apply the park brake.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

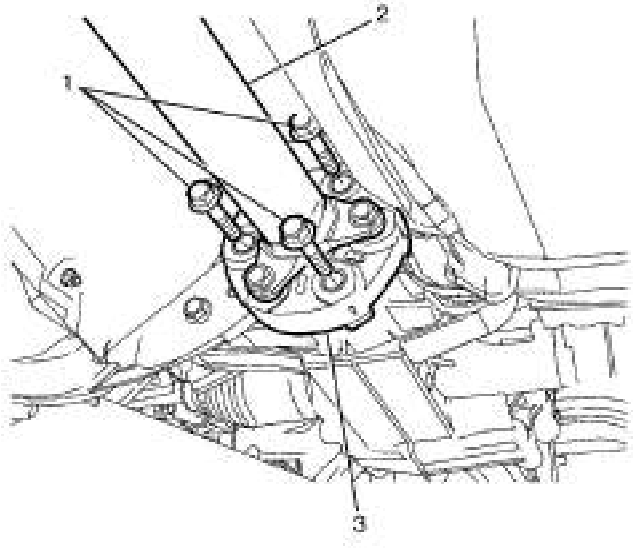
   Caution: Refer to Safety Glasses Caution in the Preface section.

2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
3. Remove the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement .
4. Remove the propeller shaft heat shield. Refer to Exhaust Heat Shield Replacement - Center .



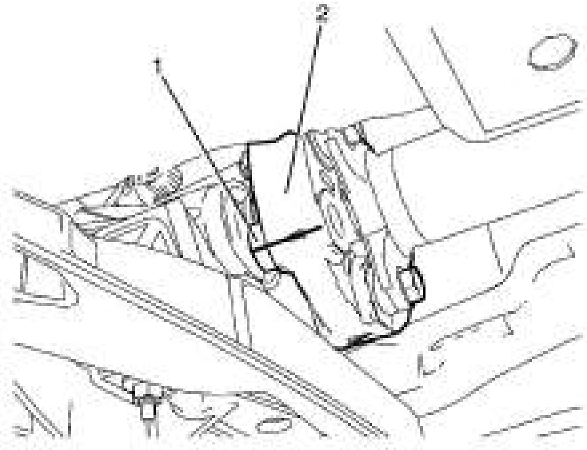
Important: Observe the orientation of the rubber couplings with reference to the differential flange and the transmission flange. This will minimise the potential of incorrect propeller shaft installation.

5. Mark the rubber coupling (1) in relation to the differential flange (2).



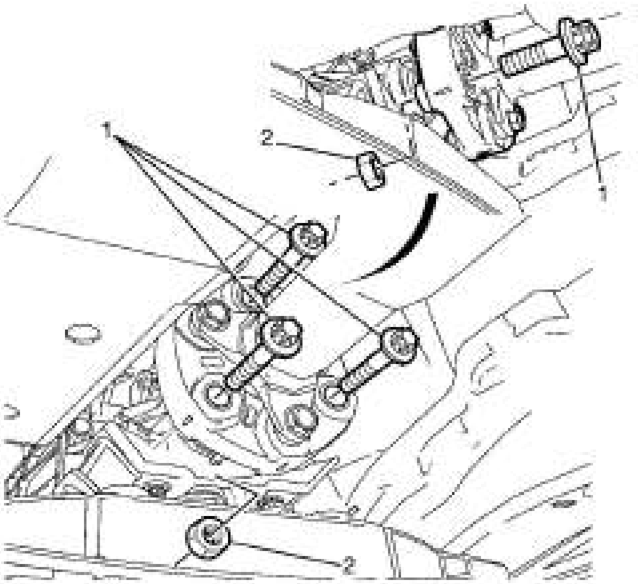
Important: With the aid of an assistant or suitable jack support the propeller shaft (2).

6. Remove the rubber coupling to differential flange retaining bolts (1).



Important: Observe the orientation of the rubber couplings with reference to the differential flange and the transmission flange. This recommendation will minimise the potential of incorrect propeller shaft installation.

7. Mark the rubber coupling (2) in relation to the transmission flange (1).

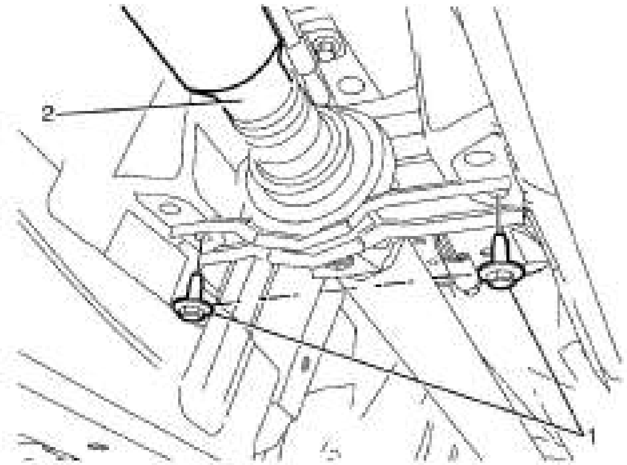


Important: With the aid of an assistant or suitable jack support the propeller shaft.

Important: Torque prevailing nuts with are single use parts and must be discarded after removal.

8. Remove the rubber coupling to transmission flange retaining bolts (1) and torque prevailing nuts (2).

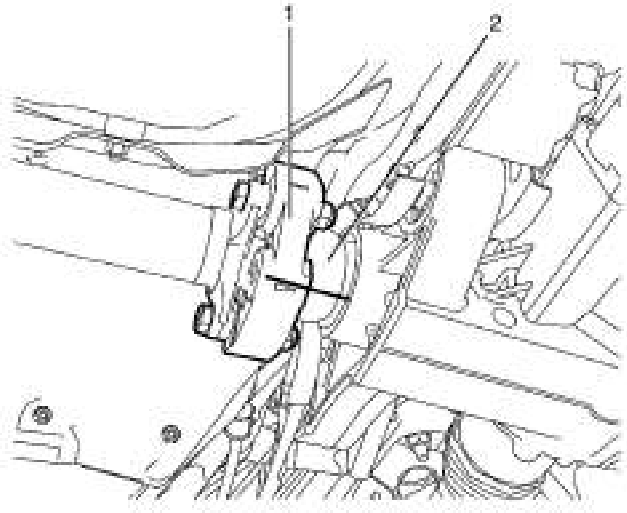
   Discard the nuts.



Important: With the aid of an assistant or suitable jack support the propeller shaft (2).

9. Remove the centre bearing to body retaining bolts (1).
10. Disconnect the propeller shaft (2) from the differential flange.
11. Remove the propeller shaft (2) from the vehicle.
12. Inspect the propeller shaft (2) assembly for excessive wear and/or damage. Inspect the following:
    - Propeller shaft. For replacement refer to Propeller Shaft Replacement .
    - Rubber coupling. For replacement refer to Rear Propeller Shaft Coupling Replacement .
    - Centre bearing. For replacement refer to Propeller Shaft Center Support Bearing Replacement .
    - Universal joint. For replacement refer to Universal Joint Replacement .

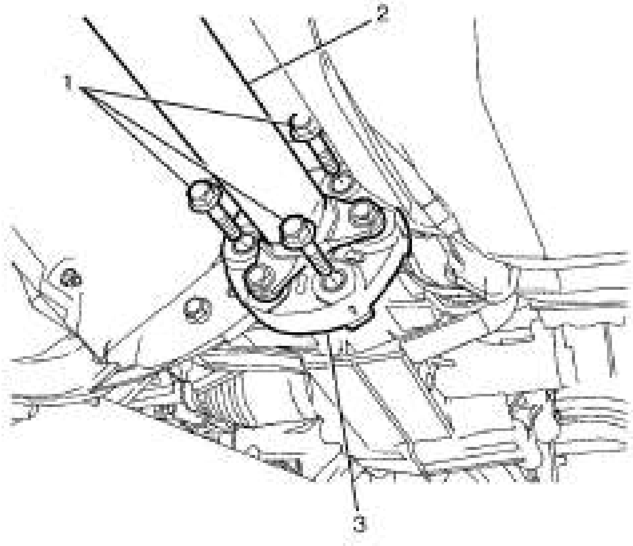
Installation Procedure



Important: Align the marks on the rubber coupling (1) to differential flange (2) made prior to removal.

1. Connect the rubber coupling (1) to the differential flange (2).

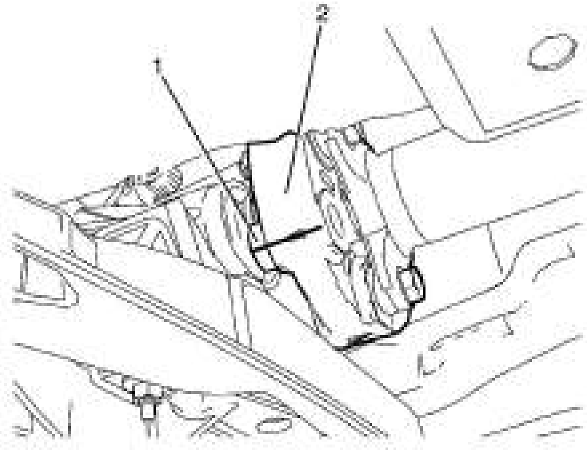
Notice: Refer to Fastener Notice in the Preface section.



Important: With the aid of an assistant or suitable jack support the propeller shaft (2) to the differential flange (3).

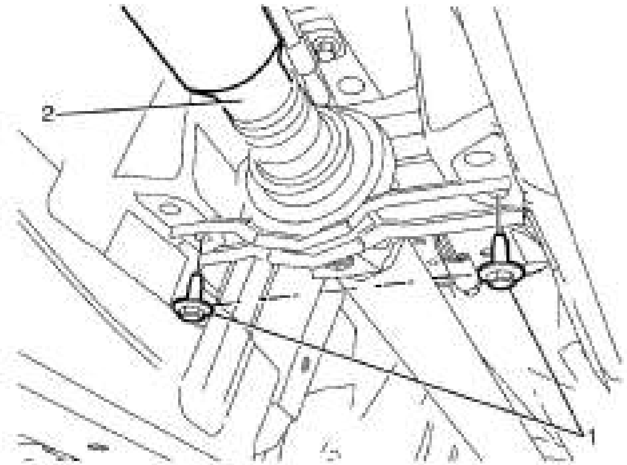
2. Install the rubber coupling to differential flange retaining bolts (1).

Tighten
Tighten the bolts to 115 N-m (85 lb ft).



Important: Align the marks on the rubber coupling (2) to transmission flange (1) made prior to removal.

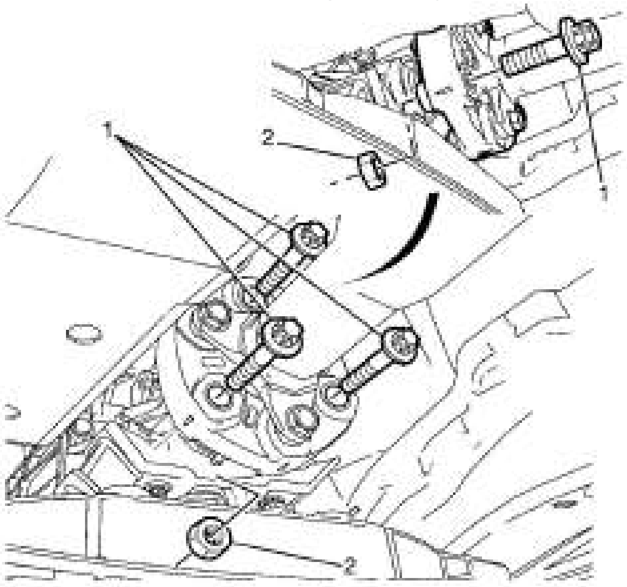
3. Connect the rubber coupling (2) to transmission flange (1).



Important: With the aid of an assistant or suitable jack support the propeller shaft (2).

Important: The centre bearing to body retaining bolts (1) must not be fully tightened at this stage.

4. Install the centre bearing to body retaining bolts (1).

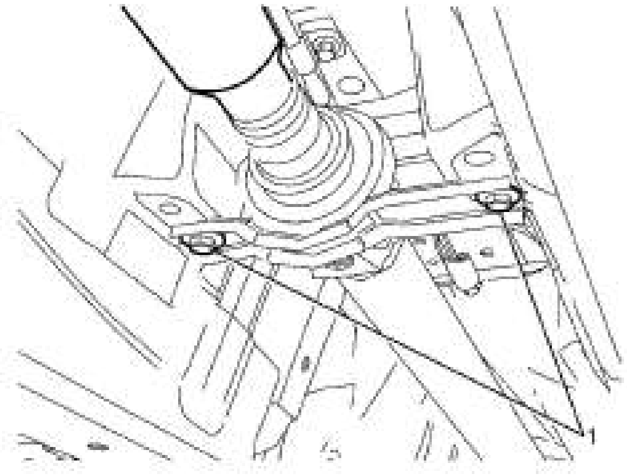


Important: With the aid of an assistant or suitable jack support the propeller shaft.

5. Install the rubber coupling to transmission flange bolts (1) and NEW torque prevailing nuts (2).

Tighten

Tighten the bolts and nuts to 100 N-m (72 lb ft).



6. Tighten the centre bearing to body retaining bolts (1).

   Tighten

   Tighten the bolts to 22 N-m (16 lb ft).

7. Install the propeller shaft heat shield. Refer to Exhaust Heat Shield Replacement - Center .
8. Install the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement .
9. Remove the safety stands.
10. Lower the vehicle to the ground.

Two-Piece Propeller Shaft Replacement

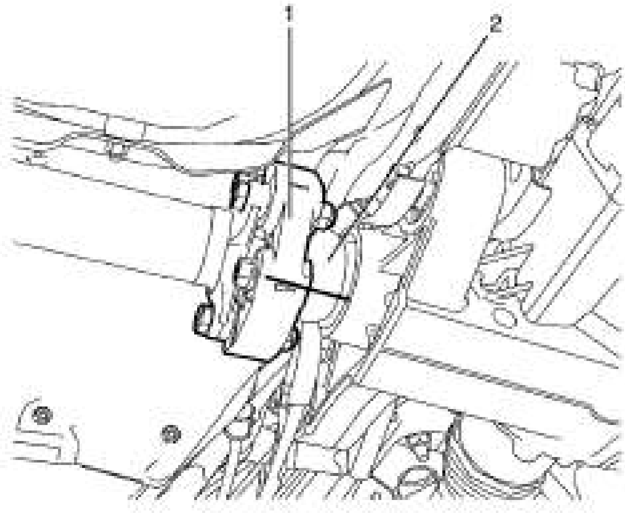
Removal Procedure

1. Select park/1st gear position in the transmission and apply the park brake.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

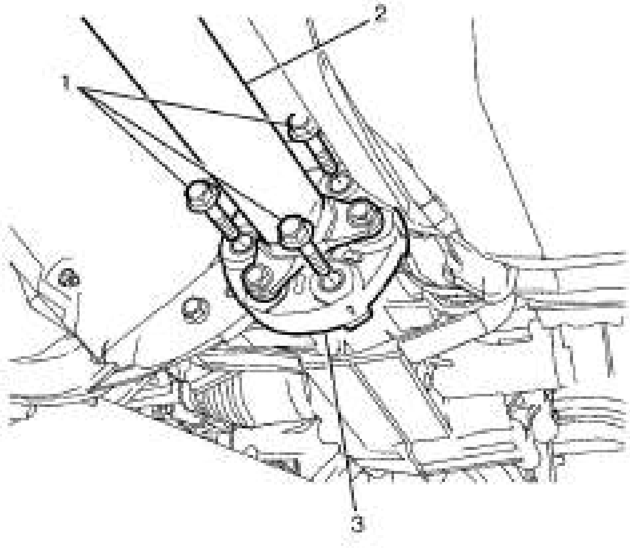
   Caution: Refer to Safety Glasses Caution in the Preface section.

2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Remove the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement.
4. Remove the propeller shaft heat shield. Refer to Exhaust Heat Shield Replacement - Center.



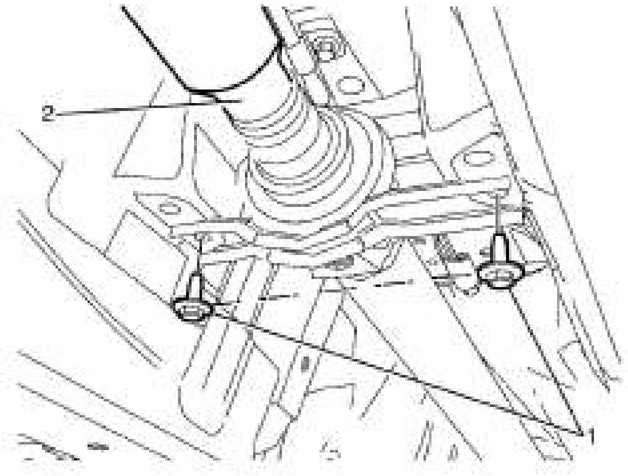
Important: Observe the orientation of the rubber couplings with reference to the differential flange and the transmission flange. This will minimise the potential of incorrect propeller shaft installation.

5. Mark the rubber coupling (1) in relation to the differential flange (2).



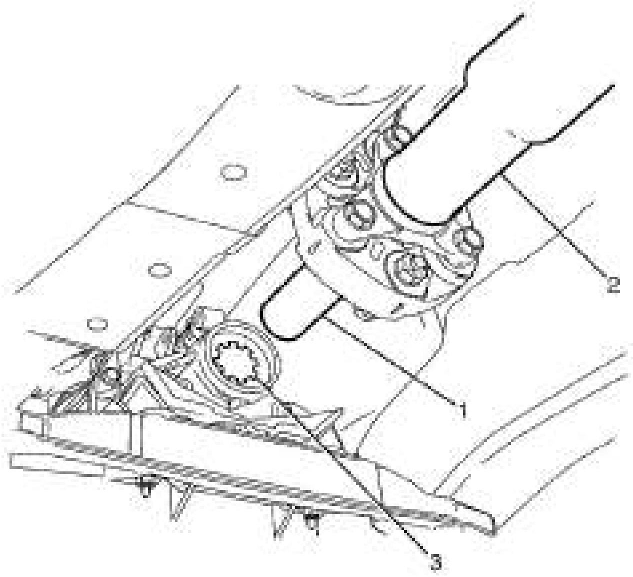
Important: With the aid of an assistant or suitable jack support the propeller shaft (2).

6. Remove the rubber coupling to differential bolts (1).



Important: With the aid of an assistant or suitable jack support the propeller shaft (2).

7. Remove the centre bearing to body retaining bolts (1).
8. Disconnect the propeller shaft (2) from the differential flange.
9. Place a suitable container under the transmission in order to collect draining fluid.



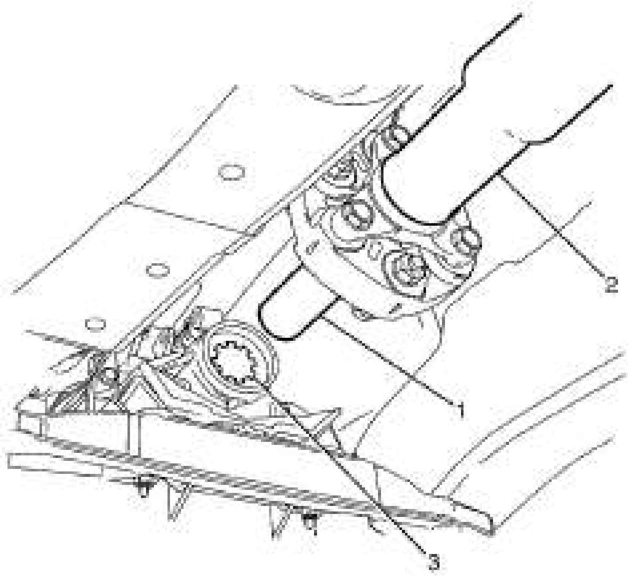
Important: Do not damage the oil seal when disconnecting the propeller shaft (2) from the transmission. Cuts or abrasions will damage the oil seal and result in lubricant leakage from this area.

Important: Support the propeller shaft front yoke (1) and move the propeller shaft (2) rearward to disconnect the propeller shaft front yoke (1) from the transmission shaft splines (3).

10. With the aid of an assistant remove the propeller shaft (2) from the vehicle.
11. Insert a suitable plug to the transmission shaft splines (3) to prevent loss of transmission lubricant.
12. Inspect the propeller shaft (2) for excessive wear and/or damage. Inspect the following:
    - Propeller shaft. For replacement refer to Propeller Shaft Replacement.
    - Rubber coupling. For replacement refer to Rear Propeller Shaft Coupling Replacement.
    - Centre Bearing. For replacement refer to Propeller Shaft Center Support Bearing Replacement.
    - Universal joint. For replacement refer to Universal Joint Replacement.

Installation Procedure

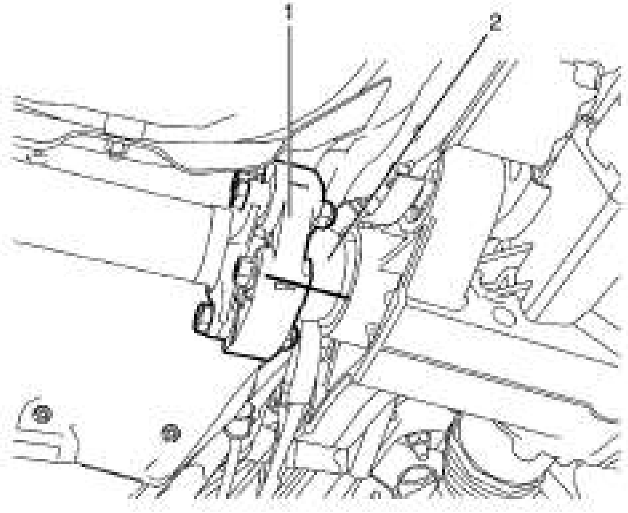
1. Remove the transmission plug installed prior to prevent loss of lubricant.



Important: Do not to damage the oil seal when installing the propeller shaft (2) to the transmission. Cuts or abrasions will damage the oil seal and result in lubricant leakage from this area.

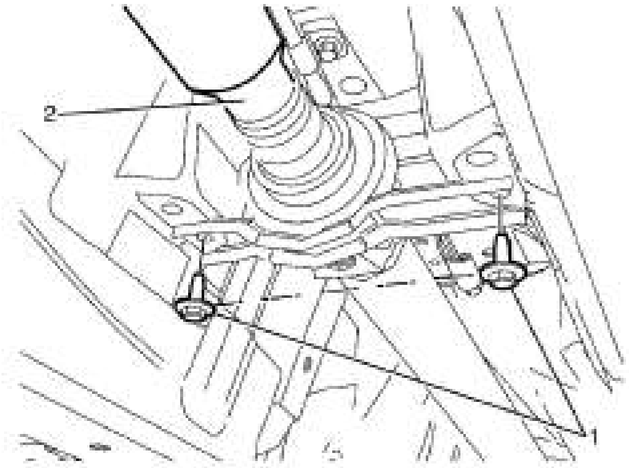
Important: Support the propeller shaft yoke (1) and install the propeller shaft (2) forward to connect the propeller shaft yoke (1) to the transmission output shaft splines (3).

2. With the aid of an assistant install the propeller shaft (2) to the transmission.



Important: Align the marks on rubber coupling (1) to the differential flange (2) made prior to removal.

3. Connect the rubber coupling (1) to the differential flange (2).

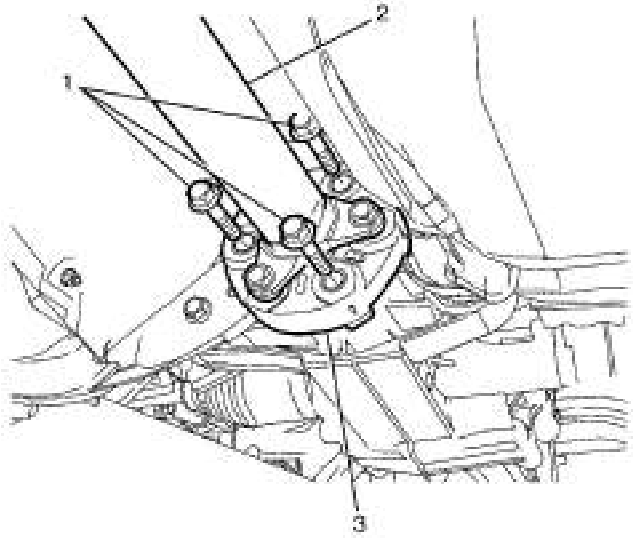


Important: With the aid of an assistant or suitable jack support the propeller shaft (2).

Important: The centre bearing to body retaining bolts (1) must not be fully tightened at this stage.

4. Install the centre bearing to body retaining bolts (1).

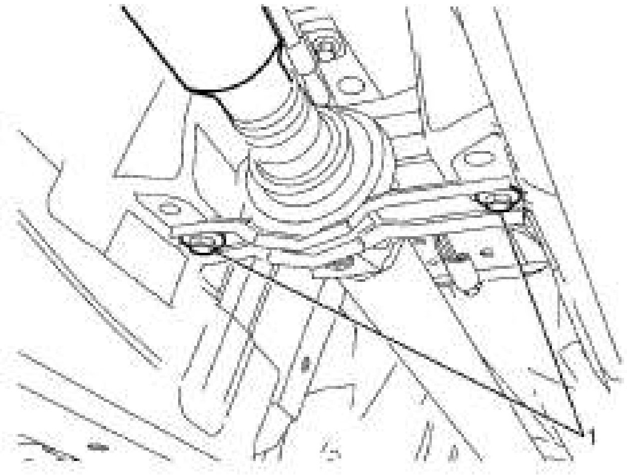
Notice: Refer to Fastener Notice in the Preface section.



Important: With the aid of an assistant or suitable jack support the propeller shaft (2) to the differential flange (3).

5. Install the rubber coupling to differential flange retaining bolts (1).

   Tighten
   Tighten the bolts to 115 N-m (85 lb ft).



6. Tighten the centre bearing to body retaining bolts (1).

   Tighten
   Tighten the bolts to 22 N-m (15 lb ft).

7. Install the propeller shaft heat shield. Refer to Exhaust Heat Shield Replacement - Center.
8. Install the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement.
9. Remove the safety stands.
10. Lower the vehicle to the ground.

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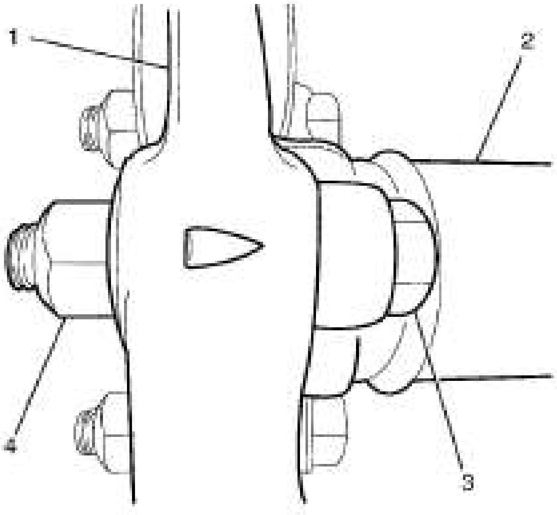
Rear Propeller Shaft Coupling Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the propeller shaft from the vehicle. Refer to Propeller Shaft Replacement.



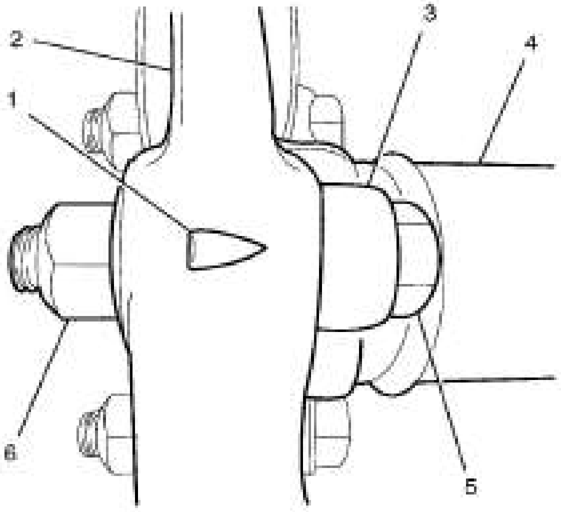
Important: Torque prevailing nuts with are single use parts and must be discarded after removal.

3. Remove the rubber coupling to propeller shaft retaining bolts (3) and torque prevailing nuts (4).

   Discard the nuts.

4. Remove the rubber coupling (1) from the propeller shaft (2).

Installation Procedure



Important: The triangular mark (1) on the rubber coupling (2) must face towards the propeller shaft flange lug (3).

1. Install the rubber coupling (2) to the propeller shaft (4).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the rubber coupling to propeller shaft retaining bolts (5) and NEW torque prevailing nuts (6).

   Tighten
   Tighten the bolts and nuts to 20 N-m +55° (15 lb ft +55°).

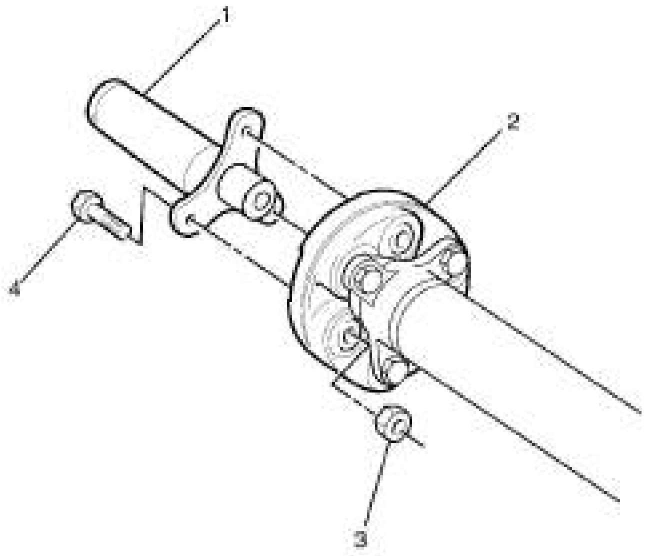
3. Install the propeller shaft to the vehicle. Refer to Propeller Shaft Replacement.
4. Remove the safety stands.
5. Lower the vehicle to the ground.

Removal Procedure - Front Slip Joint

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the propeller shaft from the vehicle. Refer to Propeller Shaft Replacement.

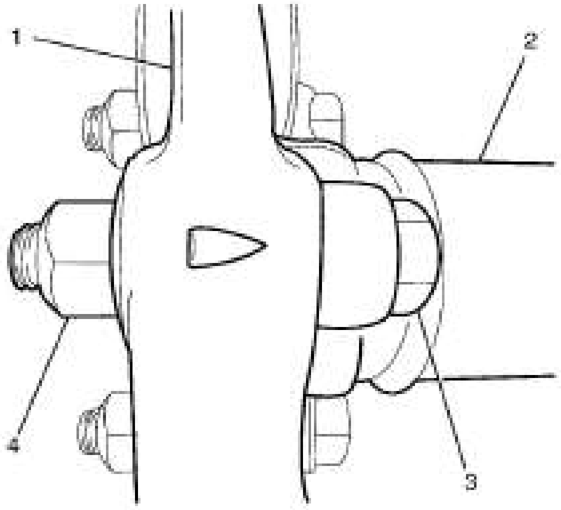


Important: Torque prevailing nuts with are single use parts and must be discarded after removal.

3. Remove the rubber coupling to propeller shaft yoke retaining bolts (4) and torque prevailing nuts (3).

   Discard the nuts.

4. Remove the propeller shaft yoke (1) from the rubber coupling (2).



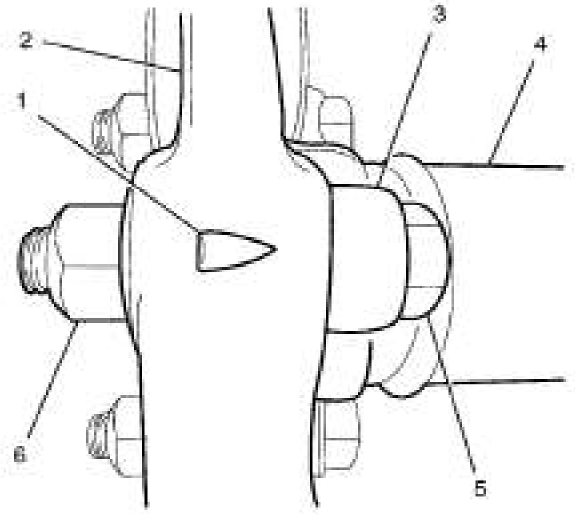
Important: Torque prevailing nuts with are single use parts and must be discarded after removal.

5. Remove the rubber coupling to propeller shaft retaining bolts (3) and torque prevailing nuts (4).

   Discard the nuts.

6. Remove the rubber coupling (1) from the propeller shaft (2).

Installation Procedure - Front Slip Joint



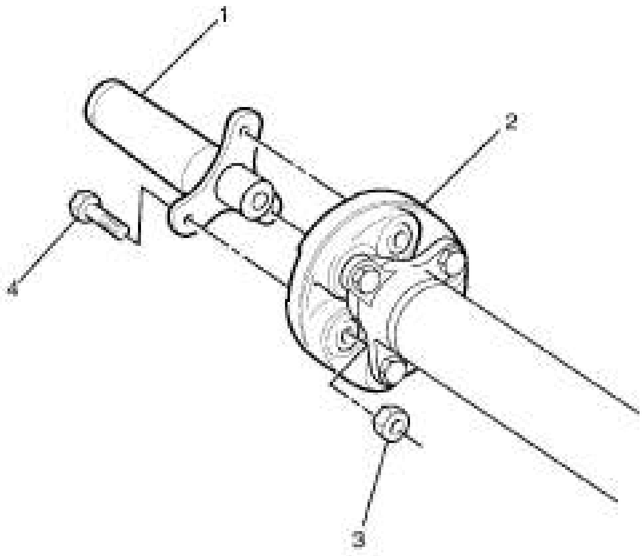
Important: The triangular mark (1) on the propeller shaft rubber coupling (2) must align with the propeller shaft flange lug (3).

1. Install the rubber coupling (2) to the propeller shaft (4).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the rubber coupling to propeller shaft retaining bolts (5) and NEW torque prevailing nuts (6).

   Tighten
   Tighten the bolts and nuts to 20 N-m +55° (15 lb ft +55°).



3. Install the propeller shaft yoke (1) to the rubber coupling (2).
4. Install the propeller shaft yoke to rubber coupling retaining bolts (4) and NEW torque prevailing nuts (3).

   Tighten
   Tighten the bolts and nuts to 20 N-m +55° (15 lb ft +55°).

5. Install the propeller shaft to the vehicle. Refer to Propeller Shaft Replacement.
6. Remove the safety stands.
7. Lower the vehicle to the ground.

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Propeller Shaft Center Support Bearing Replacement

Tools Required

- J 21426 Installer.
- J-22912-01 Press Plates.
- J 22610 Keystone Pliers.
- J 5590 Bearing and Seal Driver.

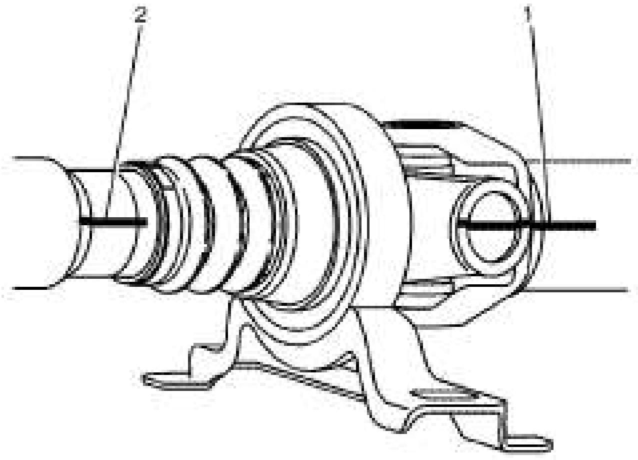
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the propeller shaft from the vehicle. Refer to Propeller Shaft Replacement .

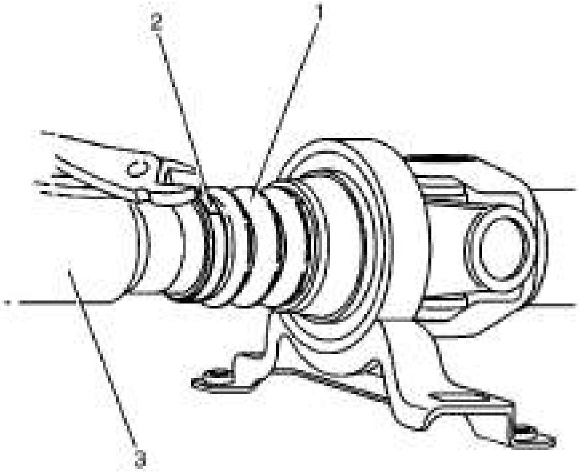
Notice: Refer to General Repair Instructions in the Preface section.



Important: Correct alignment during assembly is critical in order to maintain correct balance.

Important: The propeller shaft splines are not keyed, therefore, alignment marks are necessary for assembly.

3. Mark the position of the propeller shaft rear section (1) in relation to the propeller shaft front section (2).

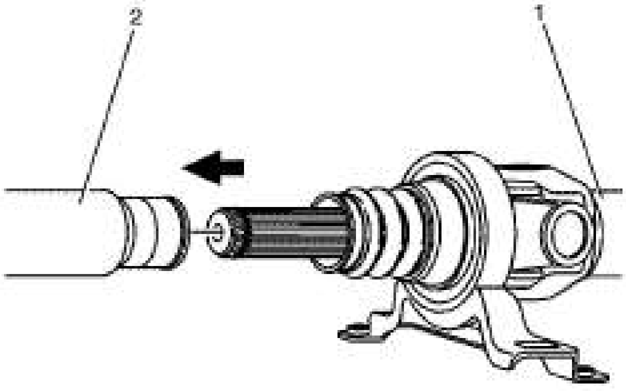


Important: The dust boot clamp is a single use part and must be discarded after use.

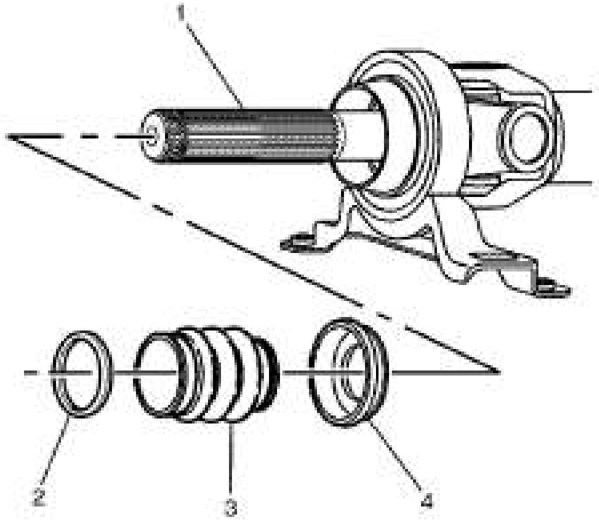
4. Remove the dust boot to propeller shaft front section clamp (2).

   Discard the dust boot clamp.

5. Detach the dust boot (1) from the propeller shaft (3).



6. Separate the propeller shaft rear section (1) from the propeller shaft front section (2).



Important: The spline retention O-ring (2) is a single use part and must be discarded after use.

7. Remove the spline retention O-ring (2) from the propeller shaft (1).

   Discard the spline retention O-ring.

   Important: The dust boot (3) is a single use part and must be discarded after use.

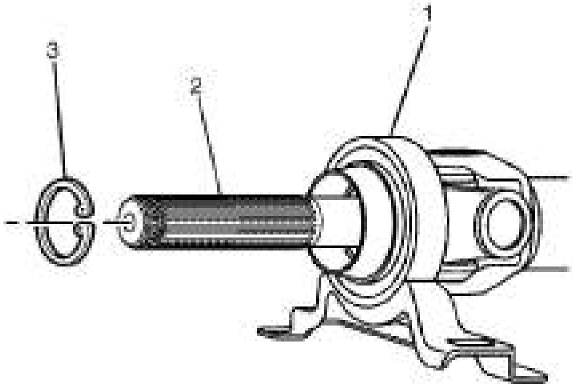
8. Remove the dust boot (3) from the propeller shaft (1).

   Discard the dust boot.

   Important: The centre bearing slinger (4) is a single use part and must be discarded after use.

9. Remove the centre bearing slinger (4) from the propeller shaft (1).

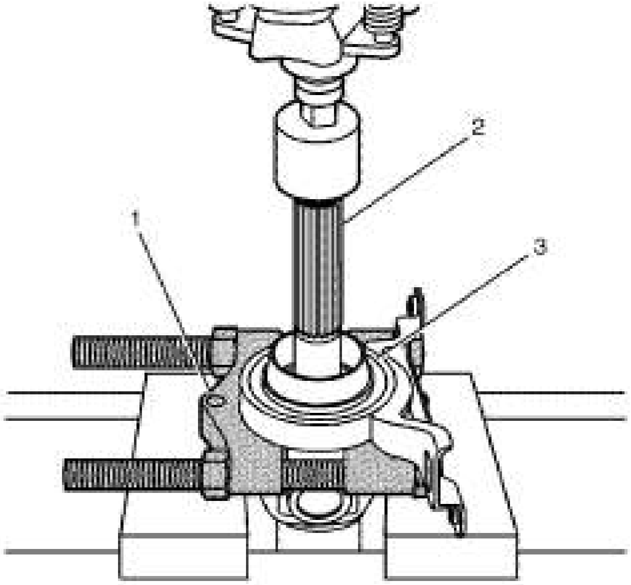
   Discard the centre bearing slinger.



Important: The circlip (3) is a single use part and must be discarded after use.

10. Remove the propeller shaft (2) to centre bearing (1) retaining circlip (3).

    Discard the circlip.

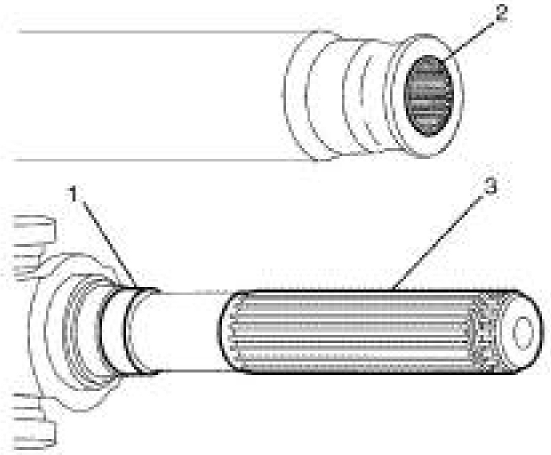


Important: Observe the orientation and depth of the centre bearing (3) in relation to the propeller shaft (2).

Important: Install the J-22912-01 (1) to the rear propeller shaft (2) behind the centre bearing (3). Place the rear propeller shaft (2) in a suitable press and remove the centre bearing (3).

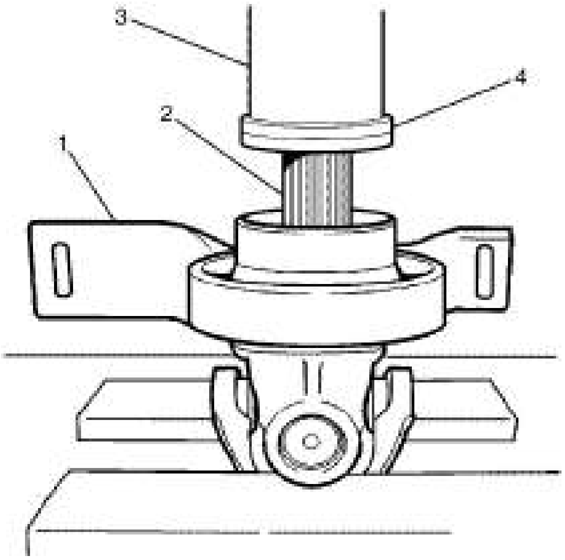
11. Remove the centre bearing (3) from the propeller shaft (2).

Clean and Inspect



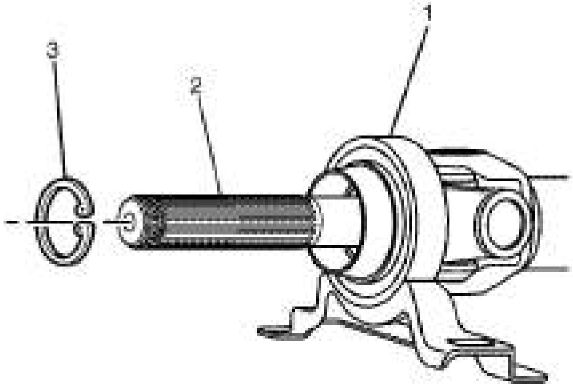
1. Clean the grease from the front propeller shaft spline (2) and rear propeller shaft spline (3).
2. Check the front propeller shaft spline (2) and rear propeller shaft spline (3) for damage and/or wear.
3. Remove any corrosion or debris from the bearing area (1).

Installation Procedure

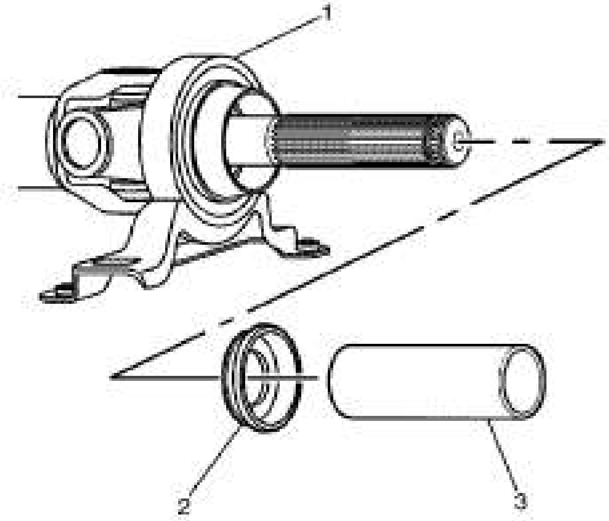


Important: Use a suitable press to install the centre bearing (1) with J 5590 Bearing and Seal Driver (3) and adaptor (4) until it seats and the circlip groove is visible.

1. Install the centre bearing (1) to the propeller shaft (2).

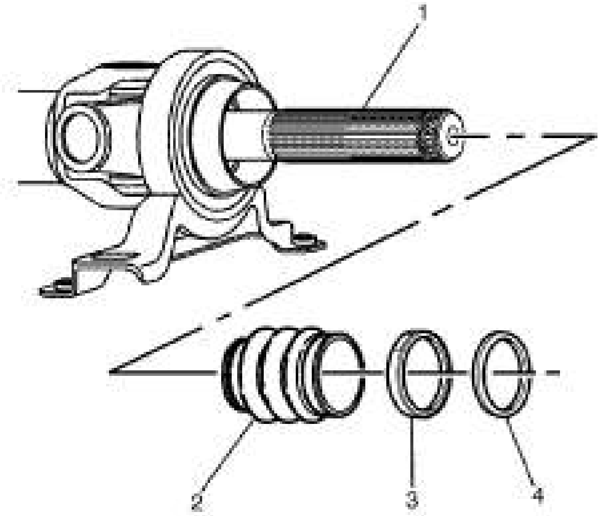


2. Install the propeller shaft (2) to centre bearing (1) NEW retaining circlip (3).



Important: Install the centre bearing slinger (1) with J 21426 (3) until it seats fully onto the centre bearing (1).

3. Install the NEW centre bearing slinger (2).



Important: Lubricate the propeller shaft splines (1) with 1-2 grams of molybdenum disulphide grease. Refer to Adhesives, Fluids, Lubricants, and Sealers .

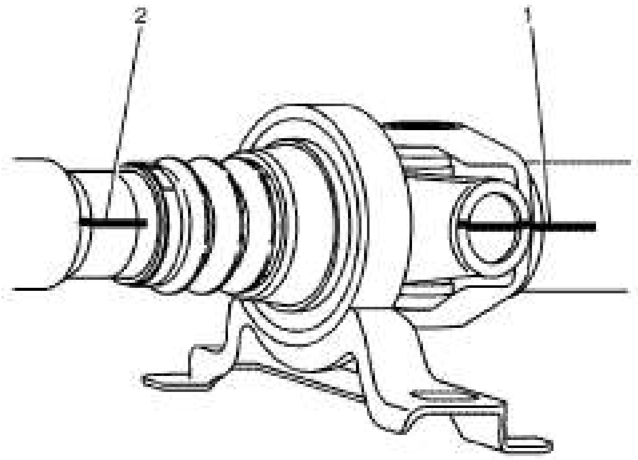
4. Lubricate the propeller shaft splines (1).

Important: The NEW dust boot clamp (3) must not to be fully tightened at this stage.

5. Install the NEW dust boot (2) and NEW dust boot clamp (3) to propeller shaft rear section (1). Do not fully tighten the dust boot clamp.

Important: The O-ring must be located into the groove on the spline.

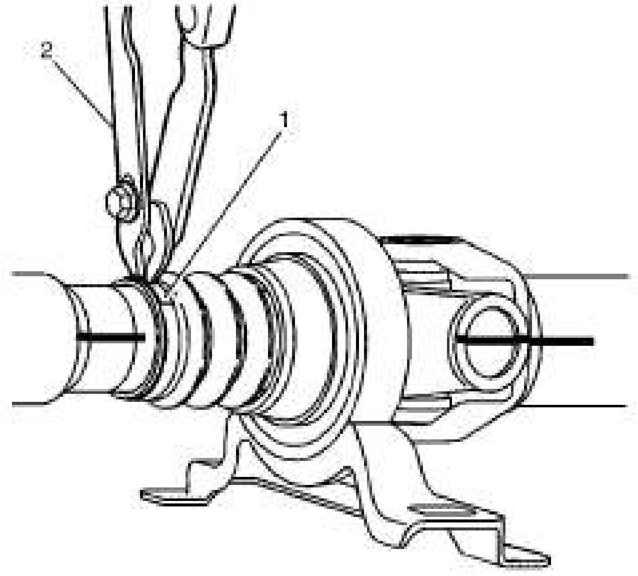
6. Install the NEW spline sealing O-ring (4) to the propeller shaft (1).



Important: Correct alignment during assembly is critical in order to maintain correct balance.

Important: Align the marks on the rear propeller shaft (1) and the front propeller shaft (2) made prior to ensure correct assembly balance.

7. Connect the propeller shaft rear section (1) to the propeller shaft front section (2).
8. Attach the NEW dust boot (3) to the propeller shaft front section (2).



9. Tighten the NEW dust boot clamp (1) using J 22610 keystone pliers (2).
10. Install the propeller shaft to the vehicle. Refer to Propeller Shaft Replacement .
11. Remove the safety stands.
12. Lower the vehicle to the ground.

Universal Joint Replacement

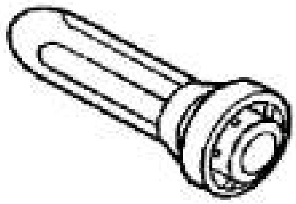
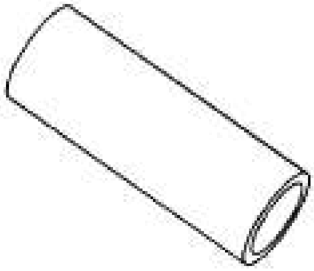
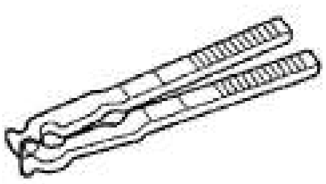
The cross type universal joint type is non-serviceable, as the bearing cups are set and retained by staking. This requires sophisticated equipment to make sure of concentricity of the installed universal joint. If the universal joint is worn or damaged replace complete propeller shaft. Refer to Propeller Shaft Replacement.

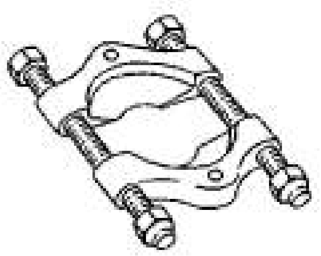
Propeller Shaft Description and Operation

The propeller shaft is a two piece tube supported by a sealed for life centre bearing and non-servicable universal joint. Only vehicles fitted with 4-speed transmissions have a splined slip yoke at the front of the propeller shaft which slides directly into the transmission. The splined slip yoke type propeller shaft has a sealed for life centre bearing and non-servicable universal joint. It has a rubber coupling at each end joining the propeller shaft to the transmission and the differential. All propeller shafts are fixed to the rubber couplings by 3 bolts and 3 torque prevailing nuts which are discarded when removed. Torque prevailing nuts have a low friction coating to ensure no damage to the coupling when assembled, correct nuts must be used. The rubber couplings are then mounted to the differential with 3 bolts and the transmission with 3 bolts and 3 torque prevailing nuts which are also discarded when removed. The centre bearing assembly is fixed to the body with 2 bolts. The two-piece propeller shaft is used to transmit power from the transmission to the differential. The centre bearing and rubber couplings are used to support and connect the propeller shaft and decrease vibration, noise and harshness.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Driveline/Axle | Propeller Shaft | Special Tools and Equipment | **Document ID: 2008309**

Special Tools

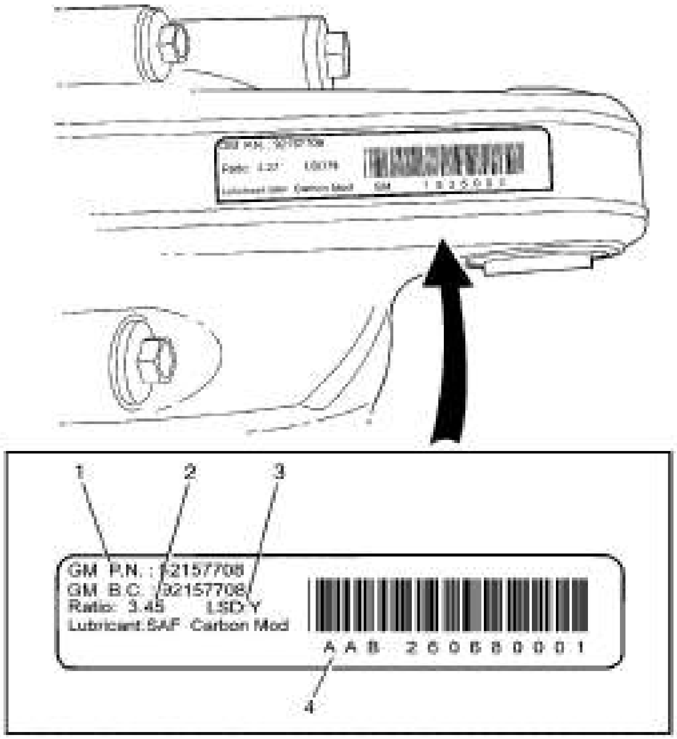
Illustration	Tool Number / Description
	J 21426 Installer
	J 5590 Press Tube
	J 22610 Keystone Clamp Pliers
	J 22912-01

	Press Plates

Fastener Tightening Specifications

Application	Specification	
	Metric	English
2 Bearing Retaining Bolts M14x135 (2x)	153 N-m	112 lb ft
2 Bearing Retaining Bolts M14x100 (2x)	153 N-m	112 lb ft
6 Differential Housing Retaining Bolts M10x1.5x75 (6x)	53 N-m	39 lb ft
10 Ring Gear Retaining Bolts M12 (10x)	125 N-m	92 lb ft
Pinion Flange Nut (In Vehicle)	Record pinion drag torque before removal and torque to the same value on installation.	Record pinion drag torque before removal and torque to the same value on installation.
Pinion Flange Nut (Out of Vehicle)	2.5 N-m	23 Ib in
Differential Fill Plug	35 N-m	26 lb ft
Differential Drain Plug	35 N-m	26 lb ft
Breather Fitting	15 N-m	11 lb ft
Differential to Subframe Retaining Nuts	80 N-m	59 lb ft

Rear Axle Usage


1
2
3
GM P.N.: 92157708
GM B.C.: 92157708
Ratio: 3.45 LSD Y
Lubricant:SAF Carbon Mod
AAB 260680001
4

(1) GM Part Number

(2) Differential Ratio

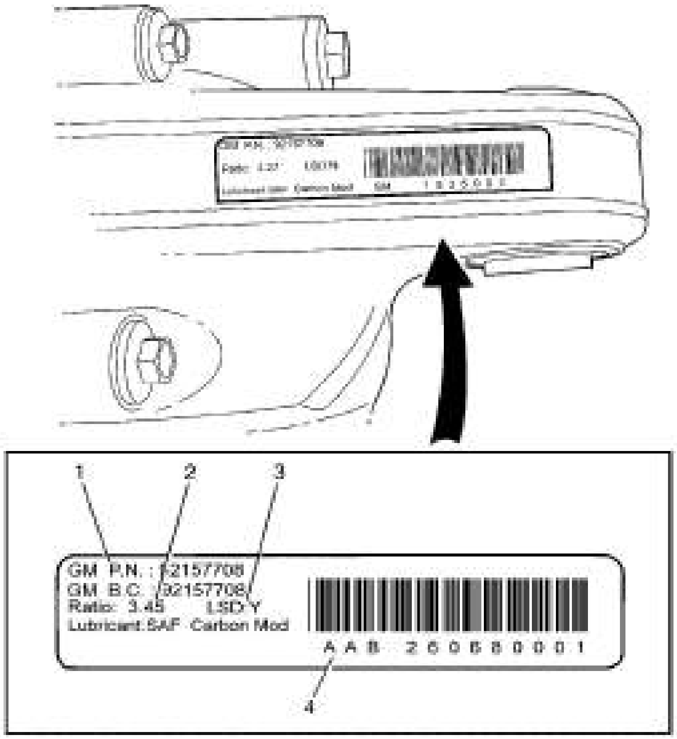
(3) L.S.D Yes or L.S.D No

(4) GM Broadcast Code

Available Axle Ratios

Axle Ratio	LSD	Drive/Engine	Flange PCD
2.92	No	V6 5 speed auto & 6 speed manual	96mm
2.92	Yes	V6 5 speed auto & 6 speed manual	96mm
3.27	No	V6 4 speed auto	96mm
3.27	Yes	V6 4 speed auto	96mm
3.45	No	V8 6 speed manual	110mm
3.45	Yes	V8 6 speed manual	110mm
3.70	Yes	HSV only V8 6 speed manual	110mm
3.27	No	V8 4 speed auto	110mm
3.27	Yes	V8 4 speed auto & HSV V8 6 speed auto	110mm
2.92	No	V8 6 speed auto	110mm
2.92	Yes	V8 6 speed auto	110mm

Rear Axle Usage


1
2
3
GM P.N. : 92157708
GM B.C. : 92157708
Ratio: 3.45 LSD Y
Lubricant:SAF Carbon Mod
AAB 260680001
4

(1) GM Part Number

(2) Differential Ratio

(3) L.S.D Yes or L.S.D No

(4) GM Broadcast Code

Available Axle Ratios

Axle Ratio	LSD	Drive/Engine	Flange PCD
2.92	No	V6 5 speed auto & 6 speed manual	96mm
2.92	Yes	V6 5 speed auto & 6 speed manual	96mm
3.27	No	V6 4 speed auto	96mm
3.27	Yes	V6 4 speed auto	96mm
3.45	No	V8 6 speed manual	110mm
3.45	Yes	V8 6 speed manual	110mm
3.70	Yes	HSV only V8 6 speed manual	110mm
3.27	No	V8 4 speed auto	110mm
3.27	Yes	V8 4 speed auto & HSV V8 6 speed auto	110mm
2.92	No	V8 6 speed auto	110mm
2.92	Yes	V8 6 speed auto	110mm

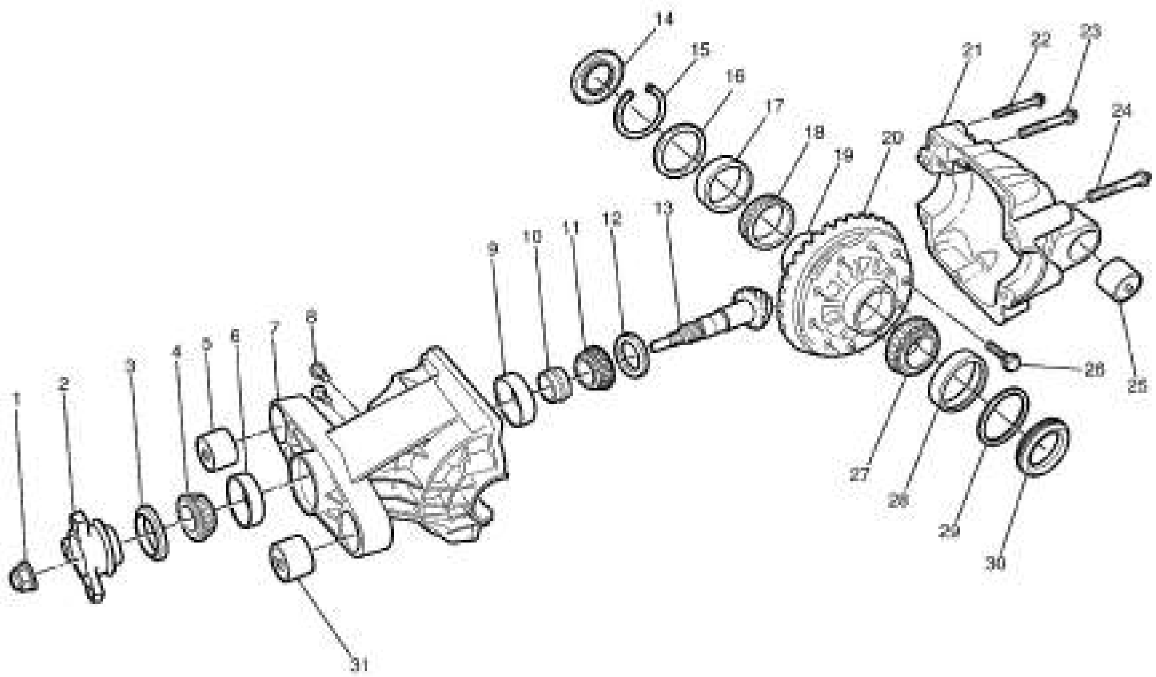
Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	Description
Prevailing Torque Pinion Flange Nut	Thread Locker	Loctite 2701 (Alternative Loctite 648)
Input and Output Seals	Grease	Mobil Grease XHD 222
Differential Housing	Sealant	Loctite 5910

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Driveline/Axle | Rear Drive Axle | Component Locator | **Document ID: 1982171**

Rear Axle Disassembled Views

Differential



(1) Prevailing Torque Pinion Flange Nut
(2) Pinion Flange
(3) Pinion Flange Oil Seal
(4) Pinion Tail Bearing
(5) Right Front Bushing
(6) Pinion Tail Bearing Cup
(7) Differential Housing
(8) Drain/Fill Plugs
(9) Pinion Head Bearing Cup
(10) Collapsible Spacer
(11) Pinion Head Bearing
(12) Pinion Shim
(13) Pinion Gear
(14) Right Axle Shaft Seal
(15) Circlip
(16) Right Shim
(17) Differential Bearing Cup

(18) Differential Bearing
(19) Differential Assembly
(20) Ring Gear
(21) Differential Housing Cover
(22) Differential Retaining Bolt M10 (6x)
(23) Differential Housing Bolt M14 x 135mm (2x)
(24) Differential Housing Bolt M14 x 100mm (2x)
(25) Rear Bushing
(26) Ring Gear Bolts M12 (10x)
(27) Differential Bearing
(28) Differential Bearing Cup
(29) Left Shim
(30) Axle Shaft Seal
(31) Left Front Bushing

Diagnostic Starting Point - Rear Drive Axle

Begin the system diagnosis by reviewing Rear Drive Axle Description and Operation. Reviewing the description and operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the description and operation information will also help you determine if the condition described by the customer is normal operation. Refer to Symptoms - Rear Drive Axle. In order to identify the correct procedure for diagnosing the system and where the procedure is located.

Symptoms - Rear Drive Axle

Before beginning diagnosis, review the system Description and Operation in order to familiarise yourself with the system function. Refer to Rear Drive Axle Description and Operation .

Symptom Identification

Important: Guide to typical rear axle noises, and common sources that are often confused with rear axle noise

- Rear Drive Axle Gears - typically a whine type noise occurs with drivetrain under load, and varies with vehicle and engine speed, and amount of throttle application. Other typical type of noise is a clunk which is most pronounced when the foot is abruptly lifted from the accelerator pedal, or when the pedal is abruptly depressed from its free position while driving at relatively low speeds.
- Rear Drive Axle Bearings - typically a grinding/growl type noise that does not vary with vehicle speed, but does vary with drivetrain load. Will also be apparent during coast, but will not if allowed to coast with transmission in neutral.
- Transmission Gears - whine type noise that typically does not occur when transmission gear is selected achieves a 1:1 ratio during driving.
- Transmission Bearings - typically a grinding/growl type noise that does not vary with vehicle speed, but does vary with drivetrain load. Will also be apparent during coast, but will not if allowed to coast with transmission in neutral.
- Tyres - typically a roar type noise, but can also present itself as a whine that varies with inflation pressure, tread condition and road surfac. Does not vary with vehicle speed, engine speed, or drivetrain load.
- Engine - typically a whine type noise, that is apparent at certain engine speeds regardless of whether driving vehicle or revving engine whilst vehicle is stationary.
- Wheel Bearing or Wheel Drive Shafts - typically a grinding/growl type noise and will be heard across entire vehicle speed range regardless of whether accelerating, decelerating. If vehicle is allowed to coast with transmission in neutral, and noise is still apparent then this is typically the cause.

Classifying the Symptom

Important: Very often, rear drive axles are considered noisy, when in reality, the noise is emanating from some other source, such as tyres, front wheel bearings, rear wheel bearings, manual transmission rear bearings, engine noises, muffler roar, automatic transmission or power steering pumps.

All rear drive axles have some slight humming noise. This will vary with the type of body construction, load and tyre pressure.

Noise which emanates from any one of these can quite easily be confused with a rear drive axle noise and unless a series of elimination tests are carried out to definately confirm the real source of the noise, differential assemblies may be, and often are replaced or repaired unnecessarily.

Differential symptoms can be classified into the following categories:

- Gear related noises.
- Bearing related noises.
- Fluid leaks.

Visual / Physical Inspection

- Inspect the system for aftermarket devices which could affect the operation of the differential.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Check for the correct lubricant level and the correct specification.
- Verify the exact operating conditions under which the concern exists. Note factors such as vehicle speed, road conditions, ambient temperature, and other specifics.
- Compare the driving characteristics or sounds, if applicable, to a known good vehicle and make sure you are not trying to correct a normal condition.

System Testing

1. Check the rear drive axle oil level.
2. If oil level is correct then check oil condition.

   Drain and fill as required.
3. If oil is in good condition check for foreign particle contamination.

   Drain and fill as required.
4. If oil is not contaminated with foreign particles then check oil for water contamination.

   Drain and fill as required.
5. If the oil is not contaminated with water, or if noise continues, then road test the vehicle.
6. Pre test: drive at low speed until thoroughly familiar with vehicle noises by which time the rear drive axle should have reached normal operating tempreture.
7. Determine driving conditions at which noise occurs: Accelerate with a light throttle from a low speed (use highest gear possible so as to avoid gear changes during the road test) to the maximum speed allowable (110km/h if possible). Release foot from accelerator and allow vehicle to coast to a stop. Listen and note any noises/issues heard/felt, and also record vehicle and engine speed, and whether accelerating or coasting when the condition occurs.
8. Eliminate transmission gear noise: Accelerate with a light throttle from the lowest speed possible whilst maintaining a 1:1 direct ratio to maximum speed allowable (110km/h if possible). Release foot from accelerator and coast to a stop. Listen and note any noises/issues heard/felt, and also record vehicle and engine speed, and whether accelerating or coasting when the condition occurs.
9. Investigate if noise if responsive to drive train load: Accelerate with a moderate throttle (load) from the lowest speed possible whilst maintaining a 1:1 direct ratio to a maximum speed allowable (110km/h if possible). Release foot from accelerator and coast with the transmission in neutral (this removes load from the rear drive axle) to a stop. Listen and note any noises/issues heard/felt, and also record vehicle and engine speed, and whether accelerating or coasting when the condition occurs.
10. Investigate if noise is related to tyres: Drive at same conditions on varying road surfaces, and safe to do so repeat with elevated tyre pressures.
11. Investigate if noise is related to engine: Note the vehicle RPM and speed where the condition occurs, when reaching the correct conditions, shift gears in order to change the engine RPM. note if noise is still evident, if it is not then generally not engine related.
12. If road test confirms likely rear drive axle noise, then repair or replace the unit as required.

Repair Instructions

- Rear Axle Lubricant Level Inspection
- Differential Oil Replacement
- Differential Replacement

Noisy in Drive

Cause	Correction
Important: Inspect the differential oil level prior to performing system diagnosis. Refer to Rear Axle Lubricant Level Inspection.	
Gear whine within Rear Drive Axle.	1. If oil level is correct then check the condition of the oil. Drain and fill as required. 2. If the oil is in good condition check for foreign particle contamination. Drain and fill as required. 3. If the oil is not contaminated with foreign particles then check for water contamination. Drain and fill as required. 4. If the oil is not contaminated with water, or if the noise continues, then road test the vehicle. 5. If result of the road test confirms likely Rear Drive Axle noise, then repair or replace the unit as required. If result of a road test confirms likely that noise is not related to the Rear Drive Axle, then refer to relevant component subsection for further diagnosis.
Bearing noise within Rear Drive Axle.	1. If oil level is correct then check the condition of the oil. Drain and fill as required. 2. If the oil is in good condition check for foreign particle contamination. Drain and fill as required. 3. If the oil is not contaminated with foreign particles then check for water contamination. Drain and fill as required. 4. If the oil is not contaminated with water, or if the noise continues, then road test the vehicle. 5. If result of the road test confirms likely Rear Drive Axle noise, then repair or replace the unit as required. If result of a road test confirms likely that noise is not related to the Rear Drive Axle, then refer to relevant component subsection for further diagnosis.

Intermittent Noise

Cause	Correction
Important: Inspect the differential oil level prior to performing system diagnosis. Refer to Rear Axle Lubricant Level Inspection .	
Worn or damaged differential mount and/or mounts.	Replace the differential mount and/or mounts as required. Refer to Differential Carrier Bushing Replacement - Rear in Rear Drive Axle.
Incorrect differential oil.	Replace with the correct differential oil. Refer to Lubrication Specifications .

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Noisy When Coasting

Cause	Correction
Important: Inspect the differential oil level prior to performing system diagnosis. Refer to Rear Axle Lubricant Level Inspection.	
Gear whine noise within Rear Drive Axle.	1. If oil level is correct then check the condition of the oil. Drain and fill as required. 2. If the oil is in good condition check for foreign particle contamination. Drain and fill as required. 3. If the oil is not contaminated with foreign particles then check for water contamination. Drain and fill as required. 4. If the oil is not contaminated with water, or if the noise continues, then road test the vehicle. 5. If result of the road test confirms likely Rear Drive Axle noise, then repair or replace the unit as required. If result of a road test confirms likely that noise is not related to the Rear Drive Axle, then refer to relevant component subsection for further diagnosis.
Bearing noise within Rear Drive Axle.	1. If oil level is correct then check the condition of the oil. Drain and fill as required. 2. If the oil is in good condition check for foreign particle contamination. Drain and fill as required. 3. If the oil is not contaminated with foreign particles then check for water contamination. Drain and fill as required. 4. If the oil is not contaminated with water, or if the noise continues, then road test the vehicle. 5. If result of the road test confirms likely Rear Drive Axle noise, then repair or replace the unit as required. If result of a road test confirms likely that noise is not related to the Rear Drive Axle, then refer to relevant component subsection for further diagnosis.

Noisy on Turns

Cause	Correction
Important: Inspect the differential oil level prior to performing system diagnosis. Refer to Rear Axle Lubricant Level Inspection .	
Worn differential mount and/or mounts.	Replace the differential mounts and/or mounts as required. Refer to Differential Carrier Bushing Replacement - Rear .
Worn wheel drive shaft constant velocity joints.	Replace the constant velocity joints as required. Refer to Wheel Drive Shaft Inner Joint and Boot Replacement and Wheel Drive Shaft Outer Joint and Boot Replacement .
Worn wheel bearings.	Replace the wheel bearings as required. Refer to Wheel Bearings Diagnosis .
Incorrect differential oil.	Fill to the correct level with the correct differential oil. Refer to Lubrication Specifications and Rear Axle Lubricant Level Inspection .

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Differential Carrier Bushing Replacement - Rear

Tools Required

AU-592 Bushing Remover/Installer.

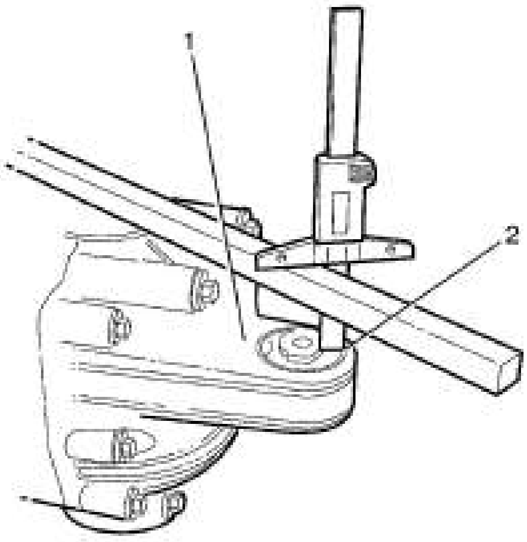
Important: All three bushings of the differential are different although they appear the same. Make sure that the correct part number is used. Mount orientation is critical for noise and vibration performance.

Removal Procedure-Rear Differential Carrier Assembly Bushing

Caution: Refer to Vehicle Lifting Caution in the Preface section.

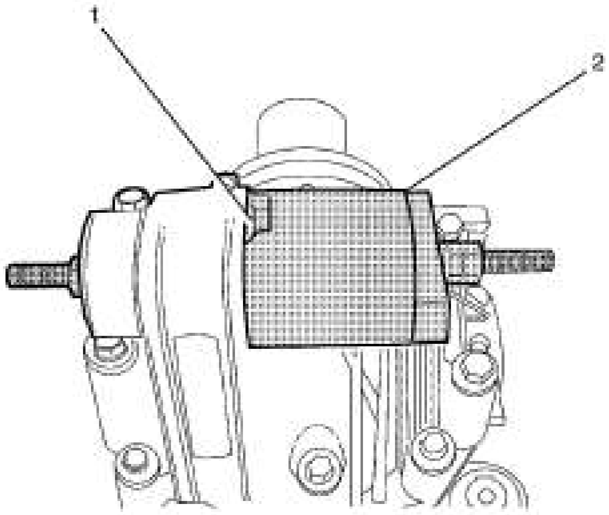
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove both rear wheel assemblies. Refer to Tire and Wheel Removal and Installation .
3. Disconnect the propeller shaft and rubber coupling from the differential flange. Refer to Propeller Shaft Replacement .
4. Remove the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement .
5. Remove both wheel drive shaft assemblies. Refer to Wheel Drive Shaft Replacement .
6. Remove the differential assembly. Refer to Differential Replacement .



Important: Observe and mark the orientation of the rear bushing (1) with reference to the original position. This recommendation will minimise the potential of incorrect rear bushing installation.

7. Measure the installation depth of the rear bushing (2) in relation to the differential (1).

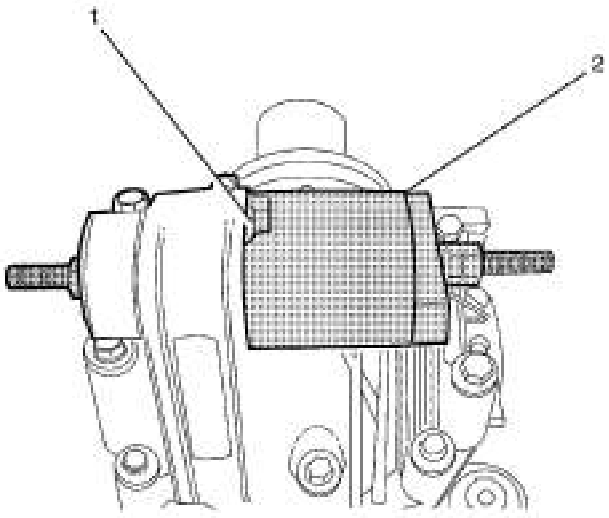


Important: The rear bushing (1) is a single use part and must be discarded after use.

8. Remove the rear bushing (1) from the differential using AU-592 (2).

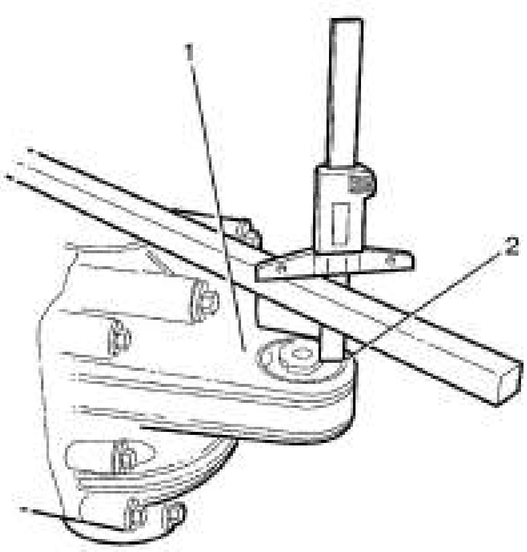
   Discard the rear bushing.

Installation Procedure-Rear Differential Carrier Assembly Bushing



Important: Before installing, the rear bushing (1) must be correctly aligned and oriented. Mount orientation is critical for noise and vibration performance. The depth to which the bushing is going to travel must also be maintained.

1. Pull the rear bushing (1) into the differential using the AU-592 (2).



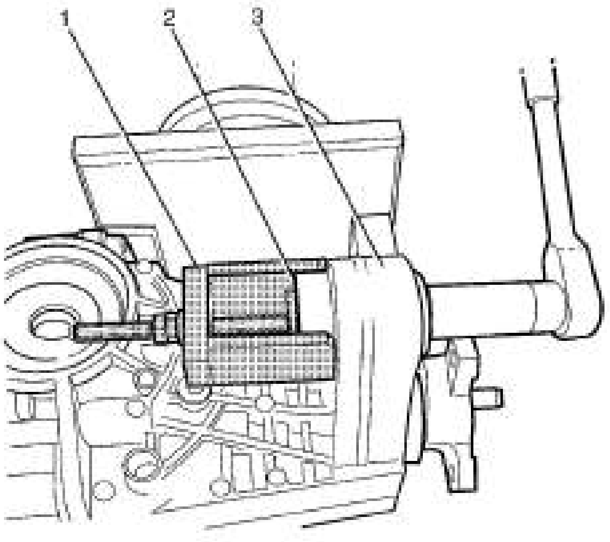
2. Pull the rear bushing (2) into the differential (1) until the measured installation depth is reached.
3. Install the differential assembly. Refer to Differential Replacement .
4. Connect the propeller shaft and rubber coupling to the differential flange. Refer to Propeller Shaft Replacement .
5. Install the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement .
6. Install both wheel drive shaft assemblies. Refer to Wheel Drive Shaft Replacement .
7. Install both rear wheel assemblies. Refer to Tire and Wheel Removal and Installation .
8. Remove the safety stands.
9. Lower the vehicle to the ground.

Removal Procedure-Front Right Differential Carrier Assembly Bushing

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove both rear wheel assemblies. Refer to Tire and Wheel Removal and Installation .
3. Disconnect the propeller shaft and rubber coupling from the differential flange. Refer to Propeller Shaft Replacement .
4. Remove the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement .
5. Remove both wheel drive shaft assemblies. Refer to Wheel Drive Shaft Replacement .
6. Remove the differential assembly. Refer to Differential Replacement .



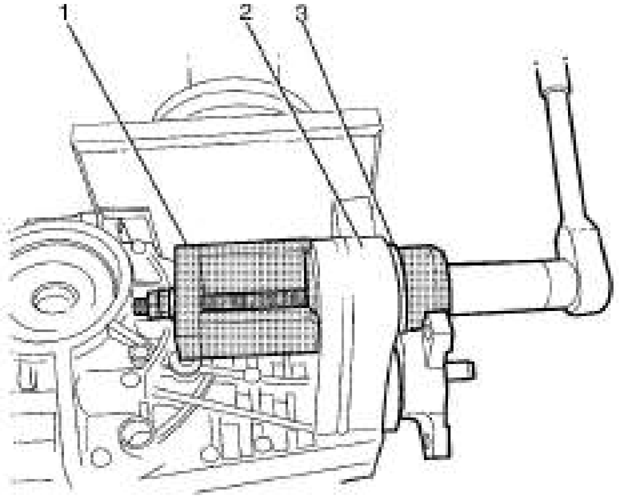
Important: Observe and mark the orientation of the bushing with reference to the original position. This will minimise the potential of incorrect bushing installation.

Important: The front right bushing (2) is a single use part and must be discarded after use.

7. Remove the front right bushing (2) from the differential (3) using AU-592 (1).

   Discard the bushing.

Installation Procedure-Front Right Differential Carrier Assembly Bushing



Important: Before installing, the front right bushing (3) must be correctly aligned and oriented. Mount orientation is critical for noise and vibration performance.

1. Pull the front right bushing (3) to the differential (2) using AU-592 (1).
2. Pull the front right bushing (3) until it is flush fitted.
3. Install the differential assembly. Refer to Differential Replacement .
4. Connect the propeller shaft and rubber coupling to the differential flange. Refer to Propeller Shaft Replacement .
5. Install the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement .
6. Install the wheel drive shaft assemblies. Refer to Wheel Drive Shaft Replacement .
7. Install the rear wheel assemblies. Refer to Tire and Wheel Removal and Installation .
8. Remove the safety stands.
9. Lower the vehicle to the ground.

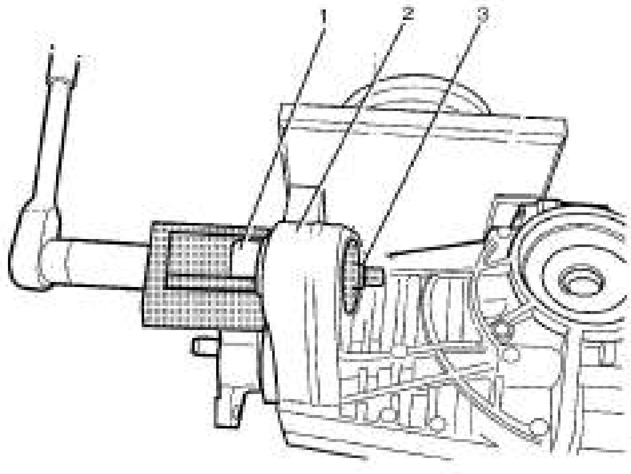
Removal Procedure-Front Left Differential Carrier Assembly Bushing

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

Important: The left differential carrier bushing has to be pressed in the opposite direction to the right due to clearance.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the rear wheel assemblies. Refer to Tire and Wheel Removal and Installation .
3. Disconnect the propeller shaft and rubber coupling from the differential flange. Refer to Propeller Shaft Replacement .
4. Remove the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement .
5. Remove the wheel drive shaft assemblies. Refer to Wheel Drive Shaft Replacement .
6. Remove the differential assembly. Refer to Differential Replacement .



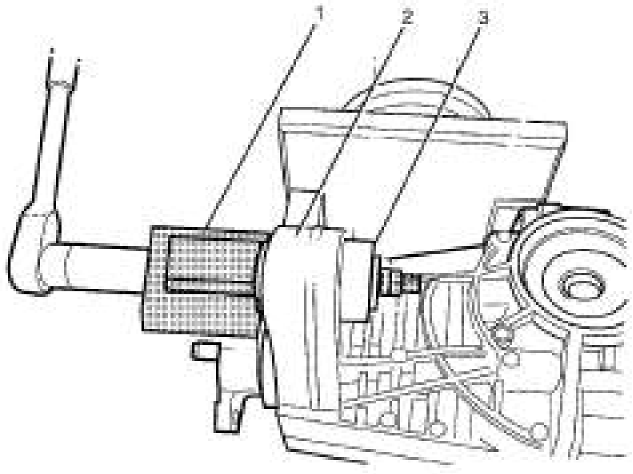
Important: Observe and mark the orientation of the bushing with reference to the original position. This will minimise the potential of incorrect bushing installation.

Important: The front left front bushing (1) is a single use part and must be discarded after use.

7. Remove the front left bushing (1) from the differential (2) using AU-592 (3).

   Discard the bushing.

Installation Procedure-Front Left Differential Carrier Assembly Bushing



Important: Before installing, the bushing (1) must be correctly aligned and oriented. Mount orientation is critical for noise and vibration performance.

1. Pull the front left bushing (3) to the differential (2) using AU-592 (1).
2. Pull the front left bushing (3) until it is flush fitted.
3. Install the differential assembly. Refer to Differential Replacement .
4. Connect the propeller shaft and rubber coupling to the differential flange. Refer to Propeller Shaft Replacement .
5. Install the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement .
6. Install the wheel drive shaft assemblies. Refer to Wheel Drive Shaft Replacement .
7. Install the rear wheel assemblies. Refer to Tire and Wheel Removal and Installation .
8. Remove the safety stands.
9. Lower the vehicle to the ground.

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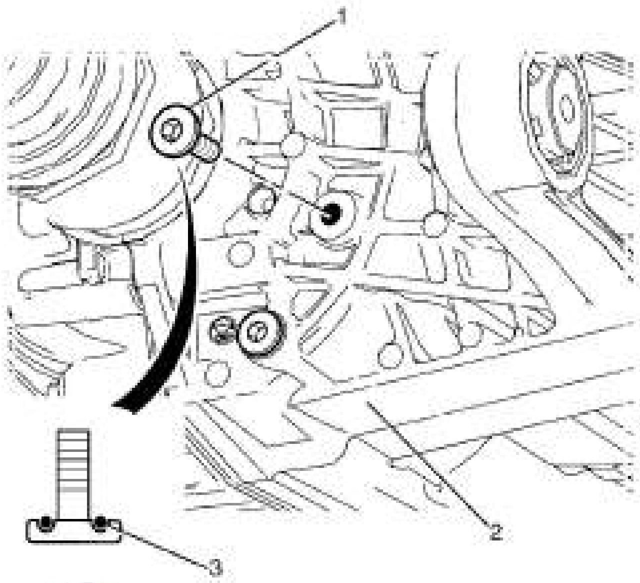
Differential Oil Replacement

Draining Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

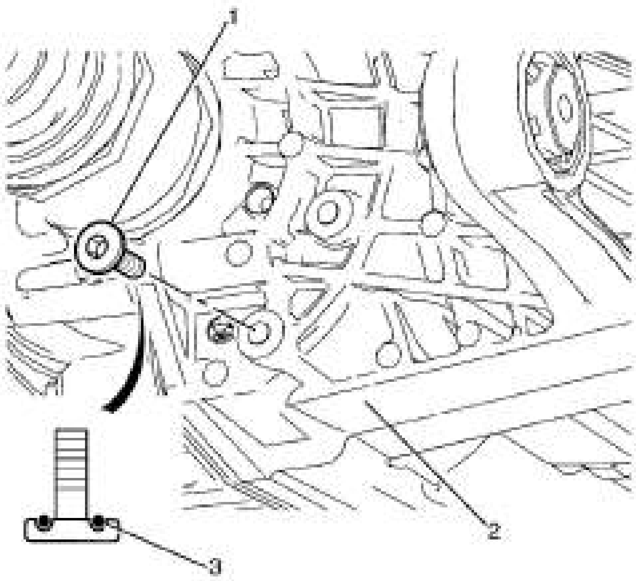
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Place a large suitable container under the differential in order to collect draining differential fluid.



Important: Clean the area around the differential plug (1) to prevent the entry of foreign particles into the differential (2).

Important: The differential fill plug (1) and O-ring (3) come as an assembly, the O-ring (3) cannot be replaced separately.

3. Remove the differential fill plug (1) from the differential (2).
4. Inspect the differential fill plug (1) and O-ring (3) for excessive wear and/or damage. Replace as necessary.



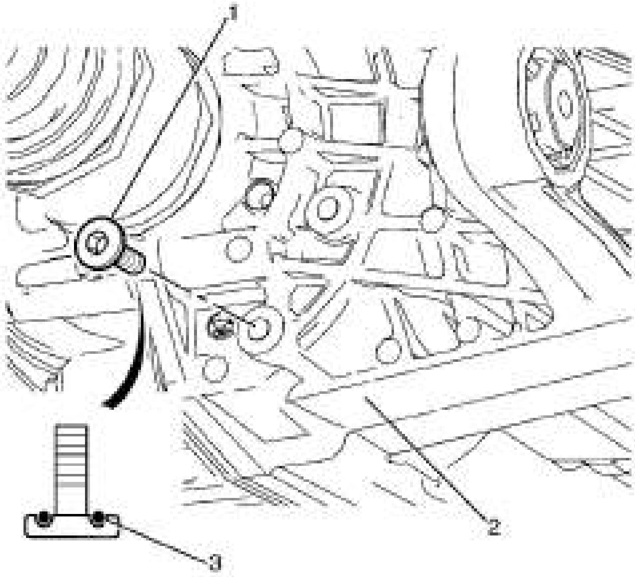
Important: Clean the area around the differential plug (1) to prevent the entry of foreign particles into the differential (2).

Important: The differential drain plug (1) and O-ring (3) come as an assembly, the O-ring (3) cannot be replaced separately.

5. Remove the differential drain plug (1) from the differential (2).
6. Inspect the differential drain plug (1) and O-ring (3) for excessive wear and/or damage. Replace as necessary.
7. Allow the differential fluid to drain completely.

Filling Procedure

Notice: Refer to Fastener Notice in the Preface section.



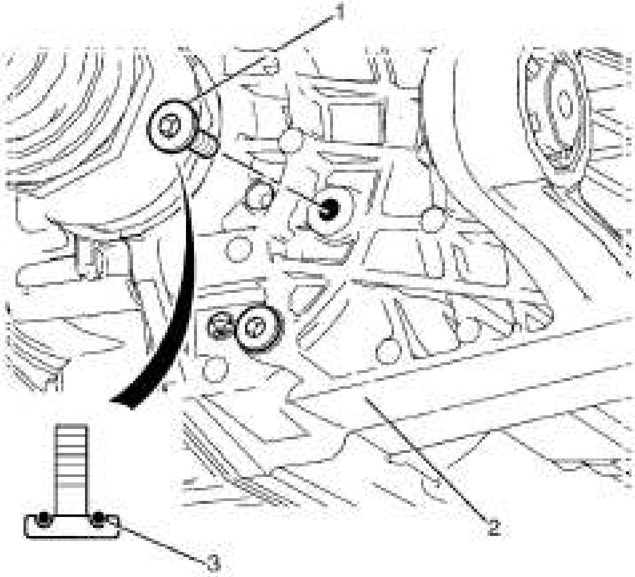
1. Install the differential drain plug (1) and O-ring (3) to the differential (2).

   Tighten
   Tighten the differential drain plug to 35 N-m (26 lb ft).

   Important: When adding fluid or making a complete fluid change, always use the correct differential fluid. Failure to use the correct fluid may cause gear damage and/or fluid leaks. For fluid specifications refer to Lubrication Specifications .

   Important: The differential fluid level must be level with the bottom of the fill plug hole to no lower than 6 mm (0.25 in) below the opening.

2. Fill the differential to the correct level.



3. Install the differential fill plug (1) and O-ring (3) to the differential (2).

   Tighten
   Tighten the differential fill plug to 35 N-m (26 lb ft).

4. Remove safety stands.
5. Lower the vehicle to the ground.

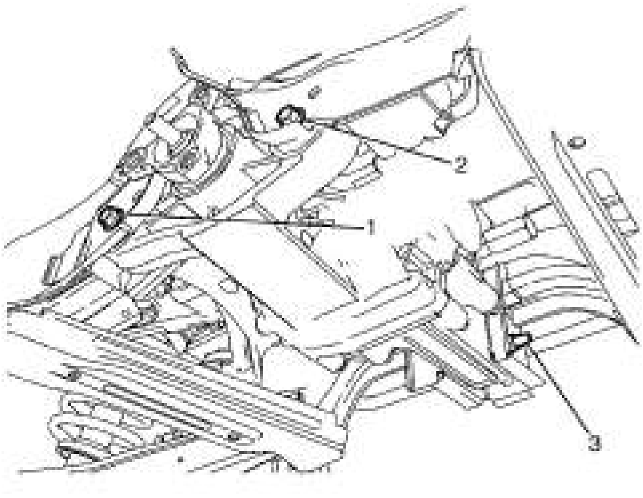
Differential Replacement

Removal Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear tyre and wheel assemblies. Refer to Tire and Wheel Removal and Installation.
3. Drain differential oil. Refer to Differential Oil Replacement.
4. Remove the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement.
5. Remove the propeller shaft and rubber coupling from differential flange. Refer to Propeller Shaft Replacement.
6. Remove the wheel drive shaft assemblies. Refer to Wheel Drive Shaft Replacement.
7. Support the differential with a suitable jack.



Important: Nuts with micro-encapsulated thread sealant are single use parts and must be discarded after removal.

8. Remove the differential retaining bolts and nuts (1), (2) and (3) from the rear suspension.

Important: With a suitable jack support the differential.

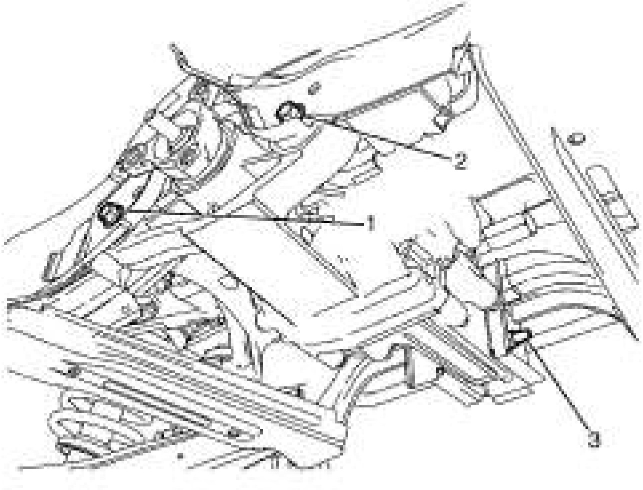
9. Remove the differential from the vehicle.

Installation Procedure

Important: With a suitable jack raise and support the differential.

1. Position the differential to the vehicle.

Notice: Refer to Fastener Notice in the Preface section.



Important: With a suitable jack support the differential.

2. Install the differential retaining bolts and nuts (1), (2) and (3) to the rear suspension.

   Tighten
   Tighten the differential to body retaining bolts and nuts (1) to 80 N-m (59 lb ft).

   Tighten
   Tighten the differential to body retaining bolts and nuts (2) to 100 N-m (74 lb ft).

   Tighten
   Tighten the differential to body retaining bolts and nuts (3) to 100 N-m (74 lb ft).

3. Install the propeller shaft and rubber coupling to the differential flange. Refer to Propeller Shaft Replacement.
4. Install the wheel drive shaft assemblies. Refer to Wheel Drive Shaft Replacement.
5. Install the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement.
6. Install the rear wheel assemblies. Refer to Tire and Wheel Removal and Installation.
7. Fill differential oil. Refer to Differential Oil Replacement.
8. Remove the safety stands.
9. Lower the vehicle to the ground.

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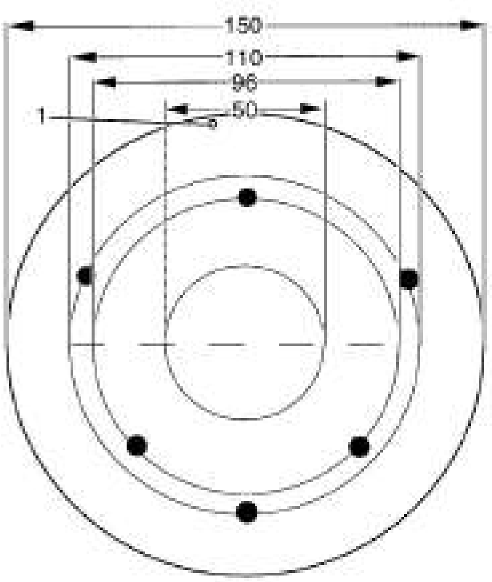
Drive Pinion Flange / Yoke and / or Oil Seal Replacement

Tools Required

- E-308 Seal Remover.
- DT-48727 Seal Installer.
- 6613 Universal Pulley Holder OTC.

Removal Procedure -- Pinion Flange



1. A pre-fabricated tool will need to made prior to starting this procedure. Follow the steps below:
   - Make from a 13mm piece of wood.
   - Drill a hole at (1) and attach a one metre length of string at this point, knotted at one end.
   - Drill three 8.5mm holes at a PCD of 96mm and 120 degrees apart.
   - Drill three 8.5mm holes at a PCD of 110mm and 120 degrees apart.
   - Drill a 50mm hole in the centre of the tool.

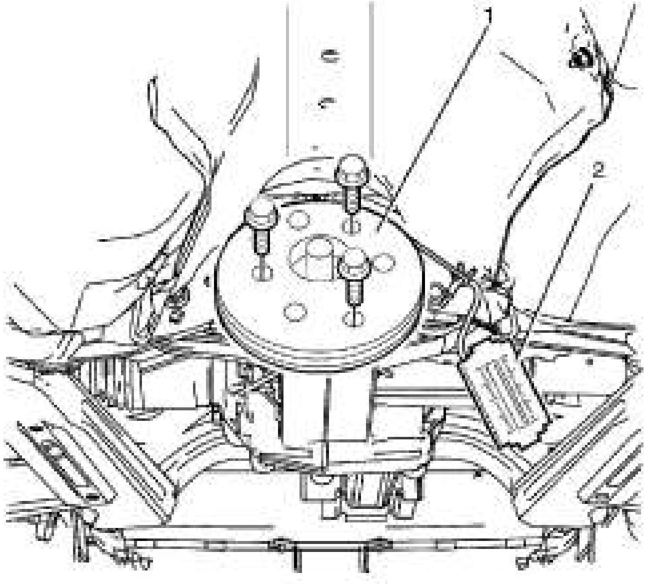
   Caution: Refer to Vehicle Lifting Caution in the Preface section.

   Caution: Refer to Safety Glasses Caution in the Preface section.

2. Raise and support vehicle. Refer to Lifting and Jacking the Vehicle .
3. Remove the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement .
4. Remove the rear tyre and wheel assemblies. Refer to Tire and Wheel Removal and

Installation .

5. Disconnect the propeller shaft and rubber coupling from the differential pinion flange. Refer to Propeller Shaft Replacement .
6. Secure the propeller shaft with a wire to protect it from damage.



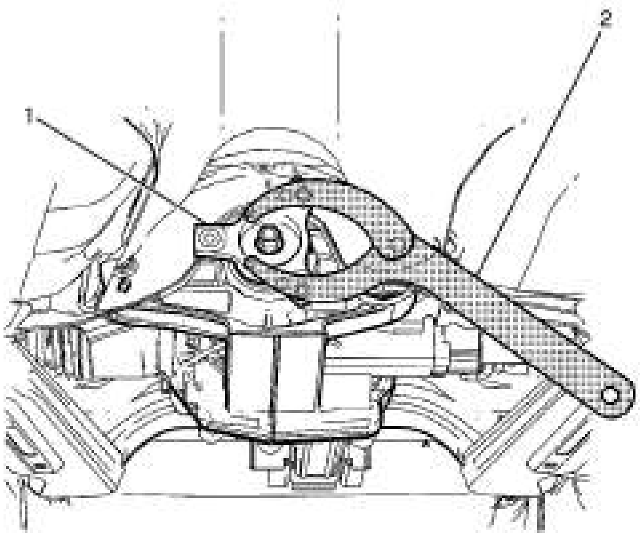
Important: Make sure that the hand brake is off and the brake rotors freely rotate.

7. Install the pre-fabricated tool (1) to the pinion flange.
8. Attach the spring balance (2) to the string of the pre-fabricated tool (1).

Important: The torque reading will different for in and out of the vehicle measurement.

Important: The torque reading is required to correctly reset pinion pre-load on assembly.

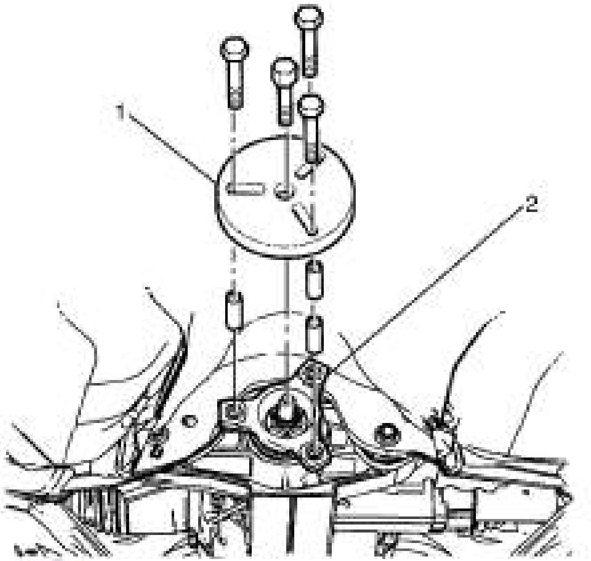
9. Pull the spring balance (2) and record the reading.
   - Example:
   - With a pulley diameter of 150 mm, the radius is 75 mm, which equals .075 m. With a spring balance reading of 25 N, the pre-load equals .075 m x 25 N = 1.875 N.m.



10. Install the 6613 (2) to the pinion flange (1).
11. While holding the 6613 (2) remove the prevailing torque pinion flange retaining nut from the differential.

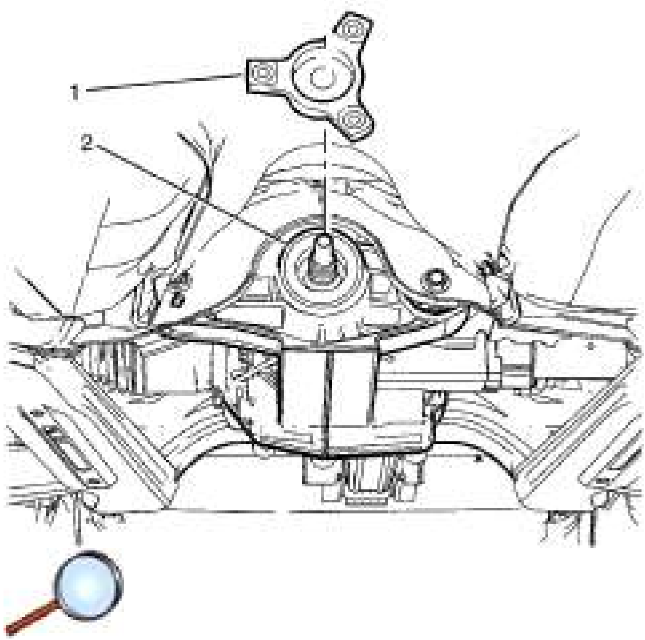
    Discard the prevailing torque pinion flange retaining nut.

12. Remove the 6613 (2) from the pinion flange (1).



Important: Use a suitable puller (1) to remove the pinion flange (2).

13. Install the puller (1) to the pinion flange (2).
14. Place a large suitable container under the differential in order to collect draining fluid.
15. Use the puller (1) to remove the pinion flange (2).



16. Remove the pinion flange (1) from the differential (2).

Important: The pinion flange oil seal should be replaced when replacing the pinion flange.

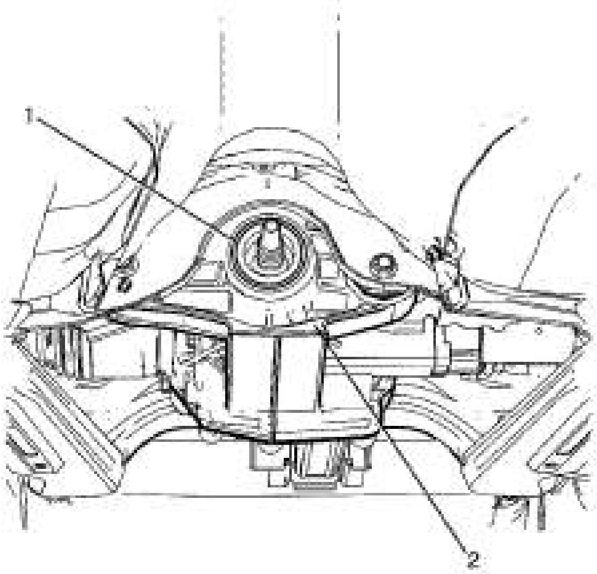
17. Check the pinion flange oil seal for wear and/or damage. Replace if necessary.

Removal Procedure -- Oil Seal

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Raise and support vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement .
3. Disconnect the propeller shaft and rubber coupling from the differential flange. Refer to Propeller Shaft Replacement .
4. Remove the differential pinion flange. Refer to Drive Pinion Flange/Yoke and/or Oil Seal Replacement .



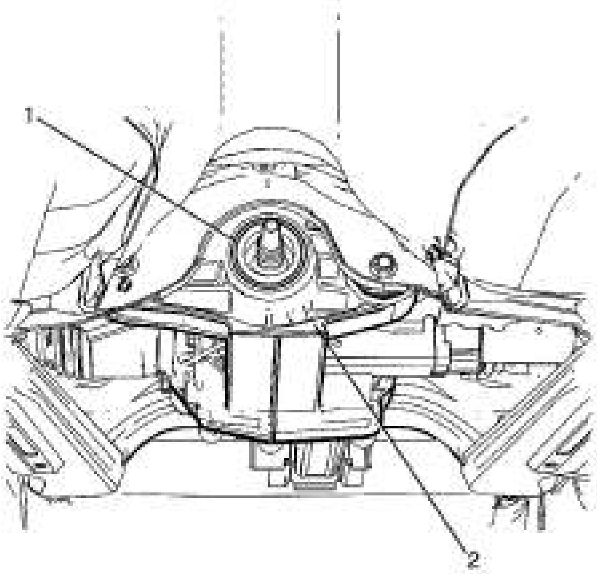
Important: Do not damage any sealing surfaces when removing the pinion flange oil seal (1). Cuts or abrasions will damage the assembly and result in lubricant leakage from this area.

Important: The pinion flange oil seal (1) is a single use part and must be discarded after use.

5. Use E-308 to remove the pinion flange oil seal (1) from the differential (2).

   Discard the pinion flange oil seal.

Installation Procedure -- Oil Seal



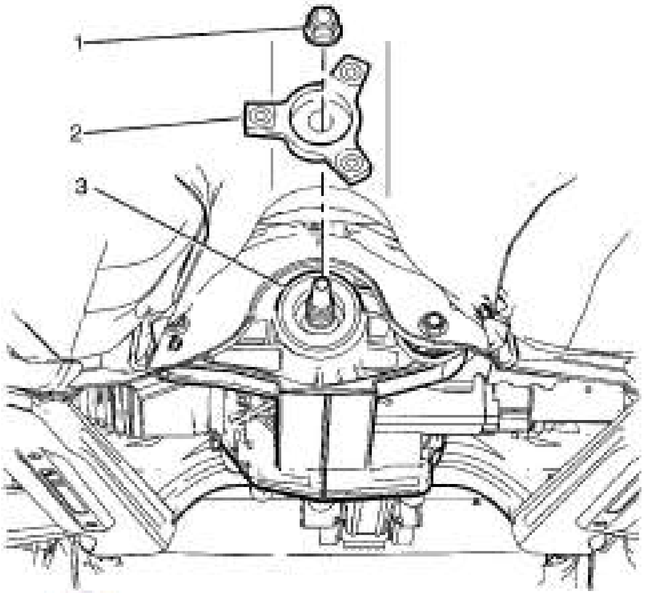
1. Lubricate the NEW pinion flange oil seal (1) with the correct grease. Refer to Adhesives, Fluids, Lubricants, and Sealers .

Important: Do not damage any sealing surfaces when fitting the pinion flange oil seal. Cuts or abrasions will damage the assembly and result in lubricant leakage from this area.

Important: Use DT-48727 to obtain correct seal depth.

2. Install the NEW pinion flange oil seal (1) to the differential (2) with DT-48727 .
3. Install the pinion flange. Refer to Drive Pinion Flange/Yoke and/or Oil Seal Replacement .
4. Connect the propeller shaft and rubber coupling to the differential flange. Refer to Propeller Shaft Replacement .
5. Install the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement .
6. Check differential fluid. Refer to Rear Axle Lubricant Level Inspection .
7. Remove safety stands.
8. Lower the vehicle to the ground.

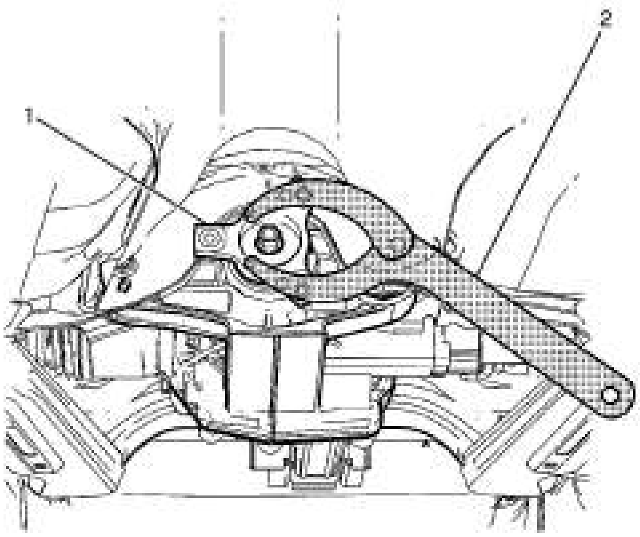
Installation Procedure -- Pinion Flange



1. Position the pinion flange (2) to the differential (3).
2. Lubricate the contact surface of the NEW prevailing torque pinion flange retaining nut (1) with correct grease. Refer to Adhesives, Fluids, Lubricants, and Sealers .
3. Apply loctite 2701 (alternative loctite 648) to the thread of the NEW prevailing torque pinion flange retaining nut (1).

Important: Do not fully tighten the NEW prevailing torque pinion flange retaining nut at this stage.

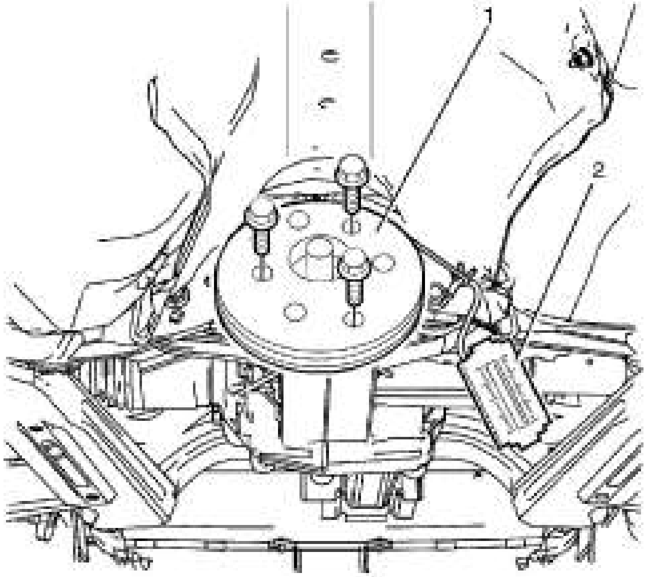
4. Install the NEW prevailing torque pinion flange retaining nut (1) to the differential (3).



5. Install the 6613 (2) to the pinion flange (1).

Important: Do NOT over tighten the NEW prevailing torque pinion flange retaining nut. If the prevailing torque pinion flange retaining nut is over tightened the differential will have to be disassembled.

6. Tighten the NEW prevailing torque pinion flange retaining nut carefully until the pinion flange has no play.
7. Remove the 6613 (2) from the pinion flange (1).



Important: The torque reading will different for in and out of the vehicle measurement.

8. Install the pre-fabricated tool (1) to the pinion flange.

9. Attach the spring balance (2) to the string of the pre-fabricated tool (1).
10. Turning torque must be equal to the value recorded in the removal procedure.

    Important: Do NOT over tighten the prevailing torque pinion flange retaining nut. If the prevailing torque pinion flange retaining nut is over tightened the differential will have to be disassembled.

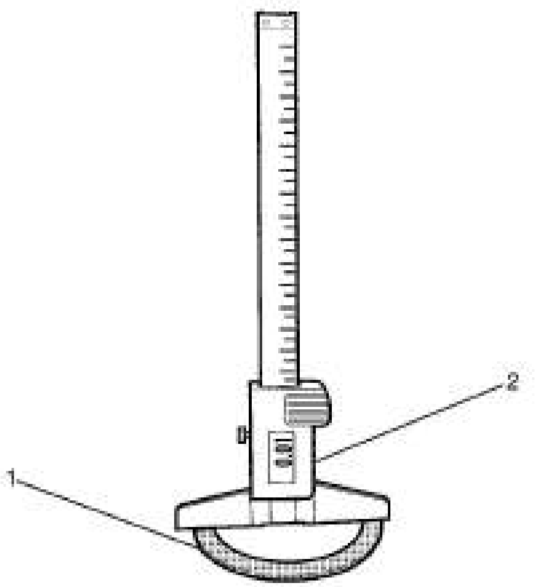
11. If the turning torque is below the value recorded in the removal procedure, tighten the NEW prevailing torque pinion flange retaining nut in small steps and check turning torque until specified turning torque is reached.
12. If the turning torque is above the value recorded in the removal procedure a NEW collapsible spacer must be fitted. Refer to Rear Axle Disassembled Views .
13. Make sure the pinion gear is free from excessive Loctite.
14. Install the propeller shaft and rubber coupling to differential flange retaining bolts. Refer to Propeller Shaft Replacement
15. Install the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement .
16. Check differential fluid level. Refer to Rear Axle Lubricant Level Inspection .
17. Remove safety stands.
18. Lower the vehicle to the ground.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Driveline/Axle | Rear Drive Axle | Repair Instructions | **Document ID: 1995635**

Rear Axle Assemble

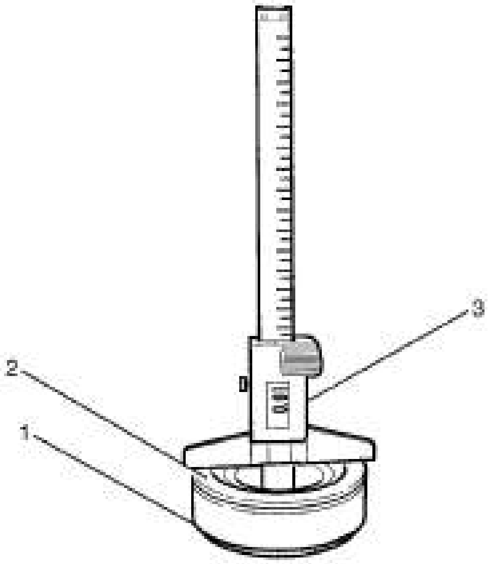
Tools Required

- DT-48723 Pinion Head Bearing Cup Installer.
- DT-48725 Pinion Tail Bearing Cup Installer.
- DT-48722 Left Axle Seal Installer.
- DT-48721 Right Axle Seal Installer.
- DT-48727 Pinion Seal Installer.
- DT-48728 Differential Bearing Installer.
- DT-48806 Pinion Bearing Measurement Spacer.
- DT-48807 Pinion Head Bearing Installer.



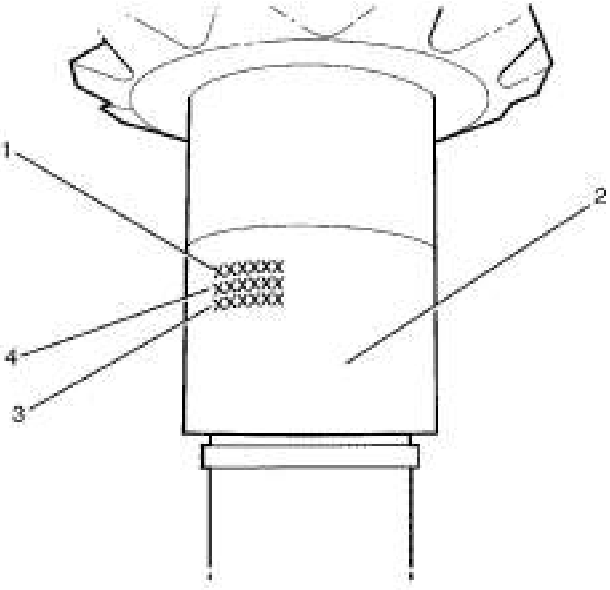
Important: Use DT-48806 otherwise bearing height cannot be measured correctly.

1. Measure the thickness of DT-48806 (1) using a depth gauge (2).(e.g - 3.67mm).
2. Record the thickness of the DT-48806 (1).



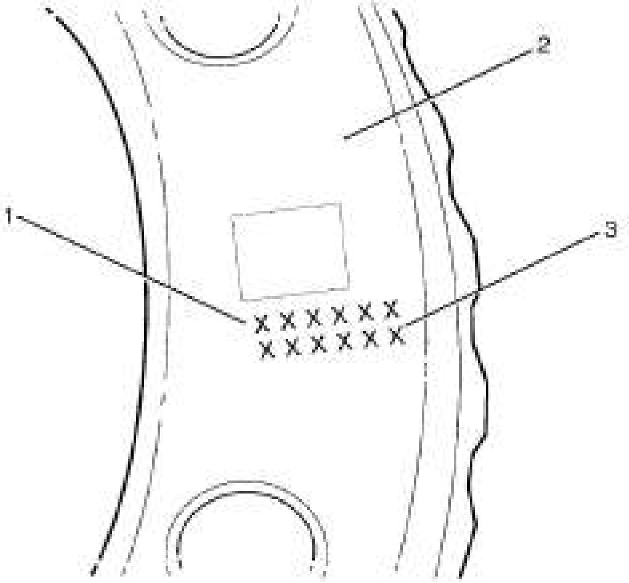
Important: Rotate the pinion head bearing (2) to settle for correct measurement.

3. Measure the thickness of the DT-48806 (1) and the pinion head bearing (2) with the depth gauge (3) (e.g - 33.925mm).
4. Record the thickness of the DT-48806 (1) and pinion head bearing (2).
5. Subtract the thickness of DT-48806 (1) 3.67mm from the total thickness of the pinion bearing measurement spacer (1) and the pinion bearing (2) 33.925mm to determine the pinion head bearing (2) thickness.
6. Example - The pinion head bearing (2) thickness is 33.925mm - 3.67mm = 30.255mm

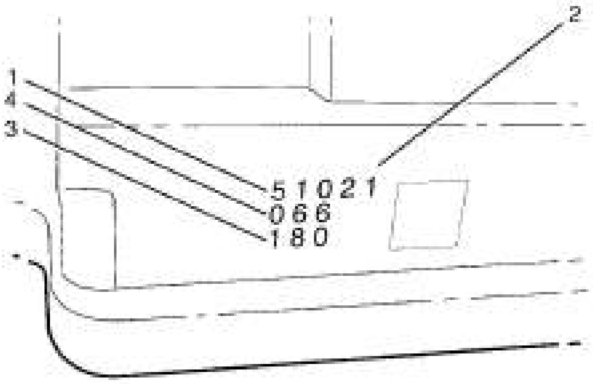


7. Record the serial number (1), set number (3) and size (4) which are stamped into the pinion gear (2).
8. Example:

- Serial Number A0200008 (1)
- Pinion Size 106.475mm (4)
- Set Number 260125 (3)



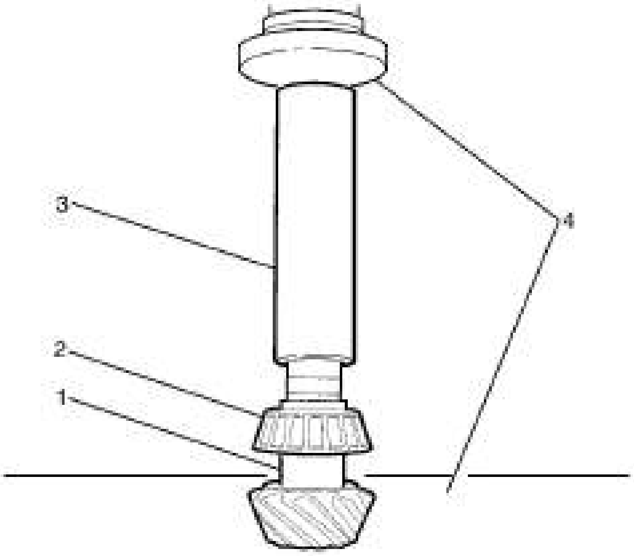
9. Check that the serial number (1) and set number (3) which are stamped into the ring gear (2) match those of the pinion set in step 7.
10. Example:
    - Serial Number A0200008 (1)
    - Set Number 260125 (3)



Important: The identification number (1, 3, and 4) is stamped into the differential housing

(2).

11. Identify the differential housing.
    - Manufacturing date (1).
    - Item number (4).
    - Size equals 138 plus the number on the housing. Example - 138.180mm (3).
12. Record the differential housing size. Example - 138.180mm
13. Determine the thickness of the pinion shim.
    - Add the pinion plus the bearing Example - 106.475mm + 30.255mm = 136.730mm.
    - Subtract the pinion plus the head bearing from the housing size, also subtract the correction factor. The correction factor is .05mm. Example 138.180 - 136.730 - 0.05 = 1.40mm thickness shim required.
14. Position the correct shim onto the pinion head.



Important: Use DT-48807 (3) to aid in pinion bearing (2) installation.

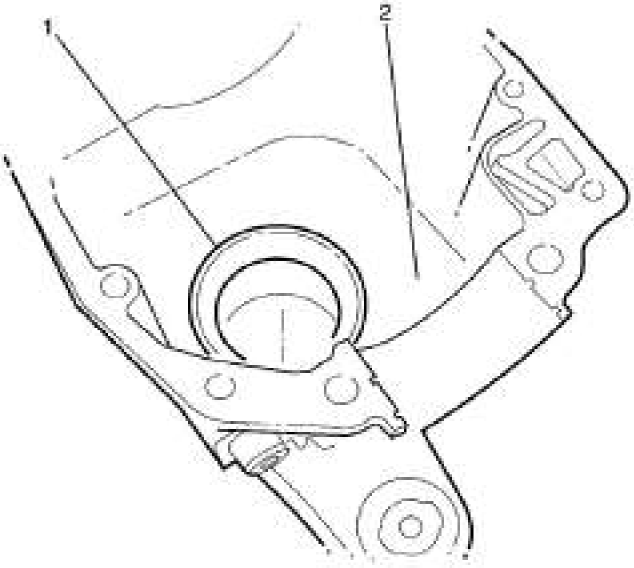
Important: Position the pinion gear (1) onto an aluminium plate in suitable press (4) before pressing the pinion head bearing (2) to prevent damage to the pinion (1).

15. Position the NEW pinion head bearing (2) onto the pinion gear (1).

Important: Use a suitable press (4) to install the NEW differential pinion head bearing (2).

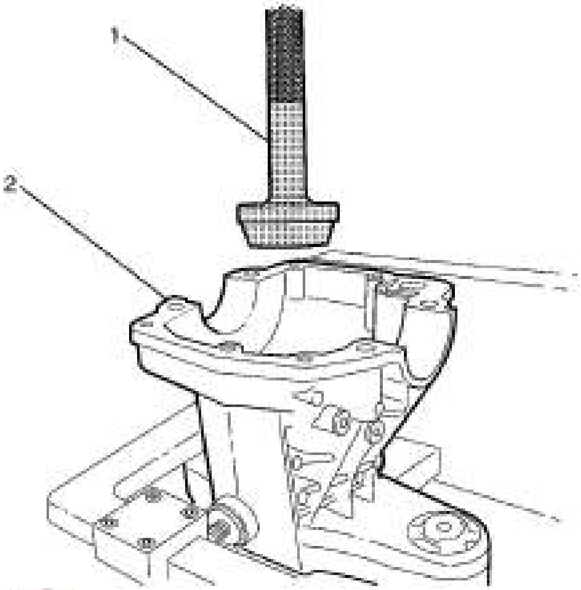
16. Press the NEW pinion head bearing (2) onto the pinion gear using DT-48807 (3).
17. Clean the ring gear and the contact area of the differential.

Caution: Refer to Safety Glasses Caution in the Preface section.

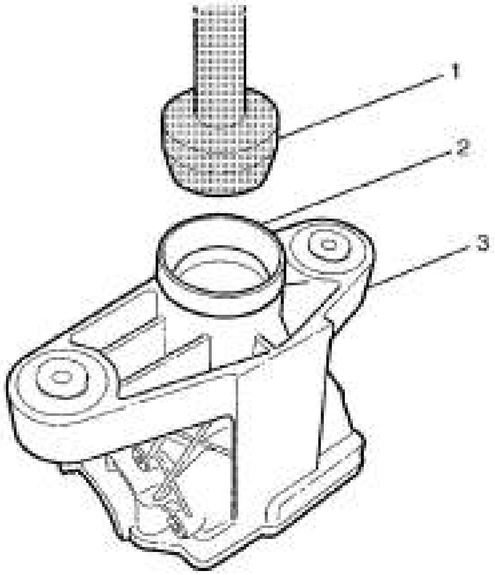


Important: To make fitting easier cool the bearing cups (2).

18. Position the NEW head bearing cup (1) into the differential housing (2).

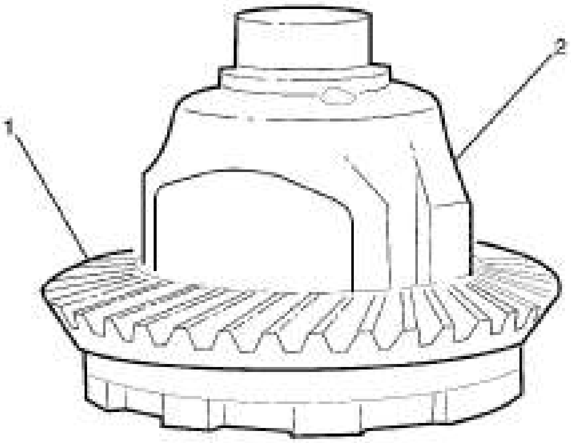


19. Press the NEW head bearing cup in with DT-48723 (1) and rotate until it fits tightly in the front differential housing (2).
20. Use a feeler gauge to make sure the NEW head bearing cup is seated correctly.



Important: To make fitting easier cool the bearing cup (2).

21. Position the NEW tail bearing cup (2) to the differential housing (3).
22. Press the NEW tail bearing cup in with DT-48725 (1) and rotate until it fits tightly in the front differential housing (2).
23. Use a feeler gauge to make sure the NEW tail bearing cup is seated correctly.



Important: Warm the ring gear (1) evenly using a hotplate until it fits over the differential (2).

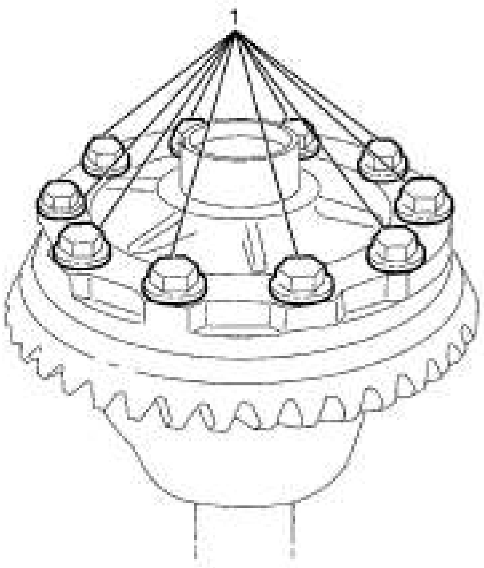
24. Position the ring gear (1) to the differential (2).

Important: Do not fully tighten the NEW ring gear to differential retaining bolts at this stage.

Important: The ring gear has to cool before the ring gear to differential retaining bolts can be tightened.

25. Install two NEW ring gear to differential retaining bolts.

Notice: Refer to Fastener Notice in the Preface section.

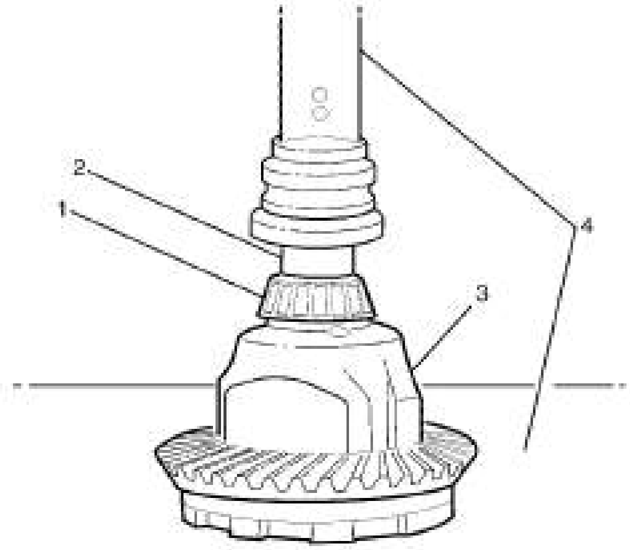


Important: The ring gear has to cool before the ring gear to differential retaining bolts (1) can be tightened.

Important: Tighten the ring gear to differential retaining bolts (1) working diagonally.

26. Install the remaining NEW ring gear to differential retaining bolts (1).

Tighten
Tighten the bolts to 125 N-m (96 lb ft).

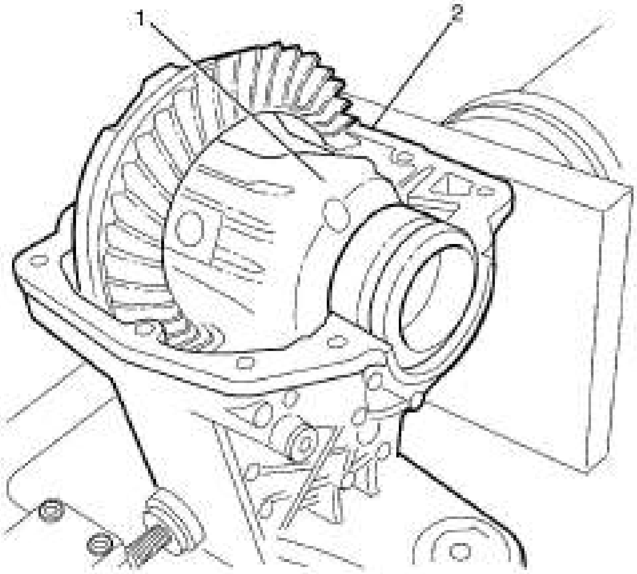


Important: Use a suitable press (4) to install the right differential bearing (1).

27. Press the right differential bearing (1) to the differential (3) with DT-48728 (2).

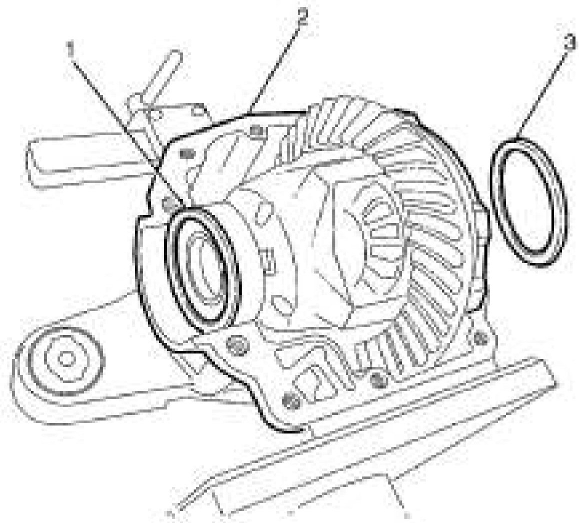
Important: Use a suitable press (4) to install the left differential bearing.

28. Rotate and press the left bearing to the differential with DT-48728 (2).

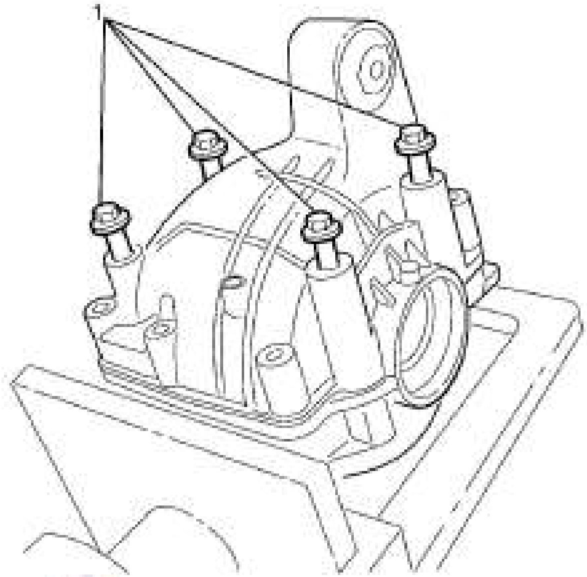


Important: Position the differential (1) to the differential housing (2) using a suitable tool or with the aid of an assistant.

29. Position the differential (1) to the differential housing (2).

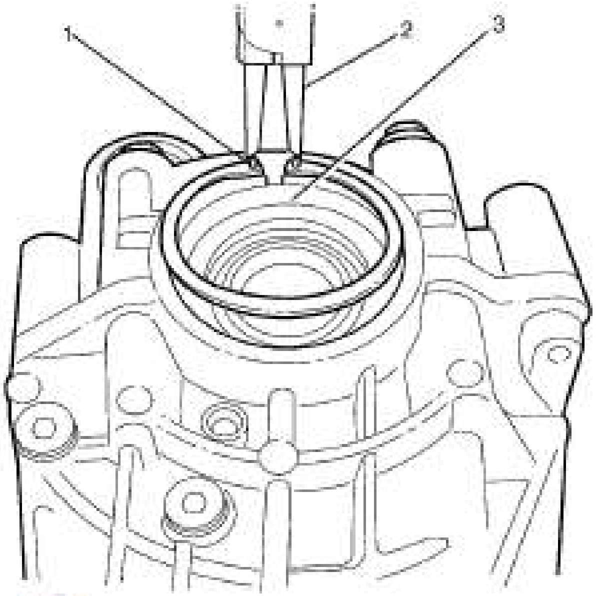


30. Position the left shim (3) and right shim (1) to the original position in the differential housing (2).



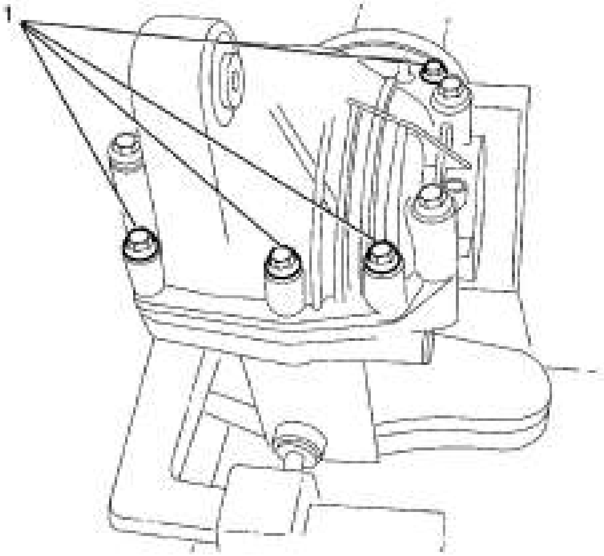
Important: Do not fully tighten the bearing bolts (1) is stage. The differential has to be able to move freely within the differential housing to allow fitment of the circlip.

31. Position the differential housing cover to the differential housing and retain with the 4 bearing bolts (1).
32. Turn the differential assembly left through 90° for the differential to slide down in the housing.



Important: Align the opening of the circlip (1) with the opening on the differential housing.

33. Install the circlip (1) to the differential (3) with circlip pliars (2).
34. Make sure the circlip (1) is fitted correctly.

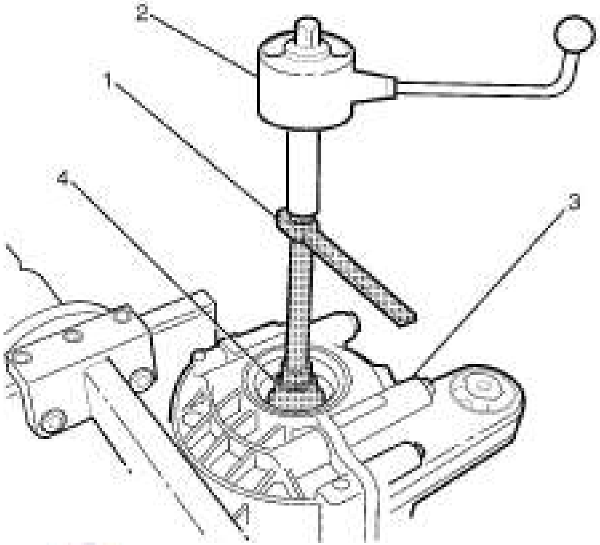


Important: Tighten the differential housing cover to differential housing retaining bolts (1) working diagonally.

35. Install the remaining differential housing cover to differential housing retaining bolts (1).

Tighten
Tighten the housing bolts to 53 N-m (39 lb ft).

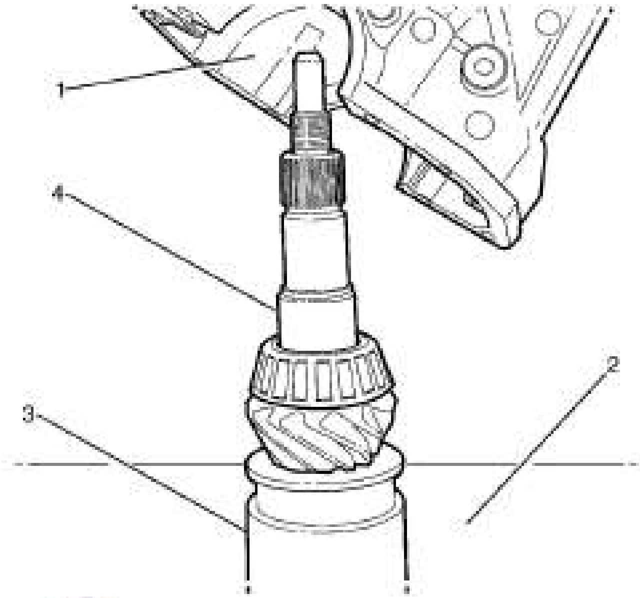
Tighten
Tighten the bearing bolts to 153 N-m (112 lb ft).



36. Position the backlash tool (1, 4) to the differential assembly (3).
37. Secure the backlash tool (1) to the differential assembly (3) by adjusting the spreading nut (4).
38. Mount the turning torque gauge (2) to the backlash tool (1).
39. Rotate the turning torque gauge (2) clockwise and record reading.

Important: This figure is for NEW bearings only.

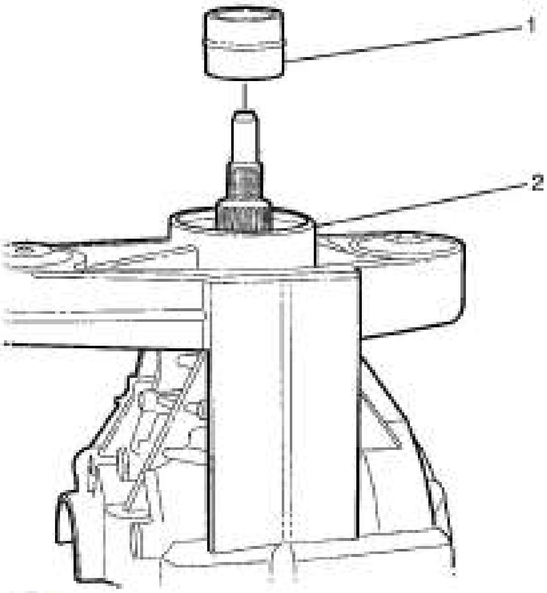
40. Turning torque should be between 2.0 to 3.3 Nm (27 lb in).
41. If the measured turning torque is outside the tolerance:
    - Remove the rear differential housing.
    - If turning torque is too high or too low, fit a thinner or thicker shim respectively.
    - Repeat from steps 5-11 from the disassembly procedure then from step 27 onwards in the assembly procedure.
    - Check turning torque. Repeat until the turning torque is correct.
42. Remove differential assembly. Repeat steps 5 through 11 from the disassembly procedure.



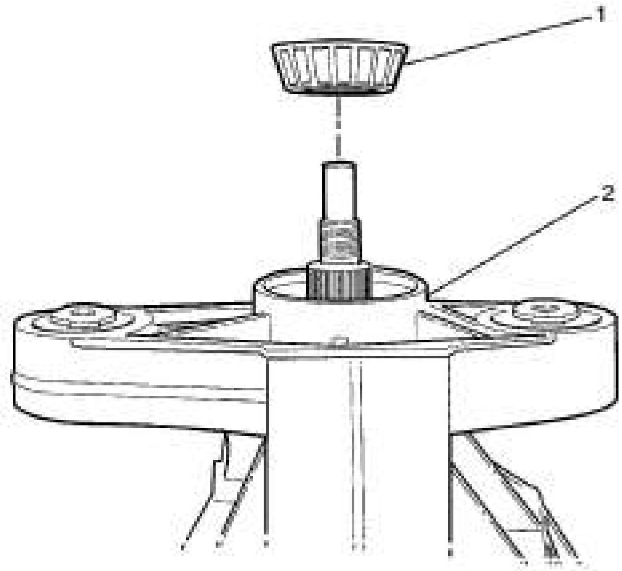
43. Position the pinion (4) on DT-48728 (3) in a suitable press (2).

    Important: The differential housing (1) must not rest on the press (2). Use a suitable supporting tool (3) to elevate pinion (4).

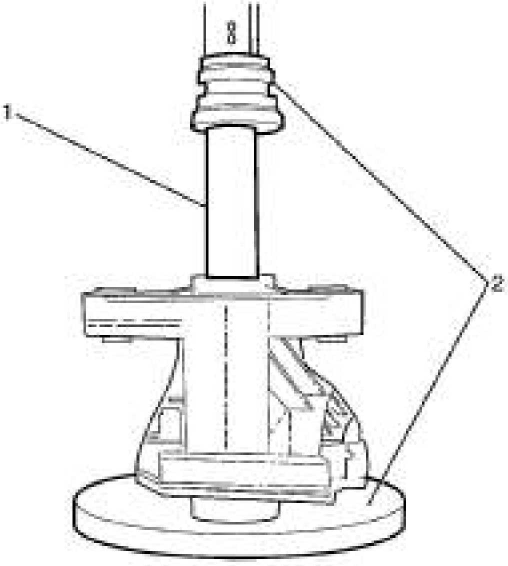
44. Position the differential housing (1) over the pinion gear (4).



45. Position a NEW collapsible spacer (1) to the differential (2).

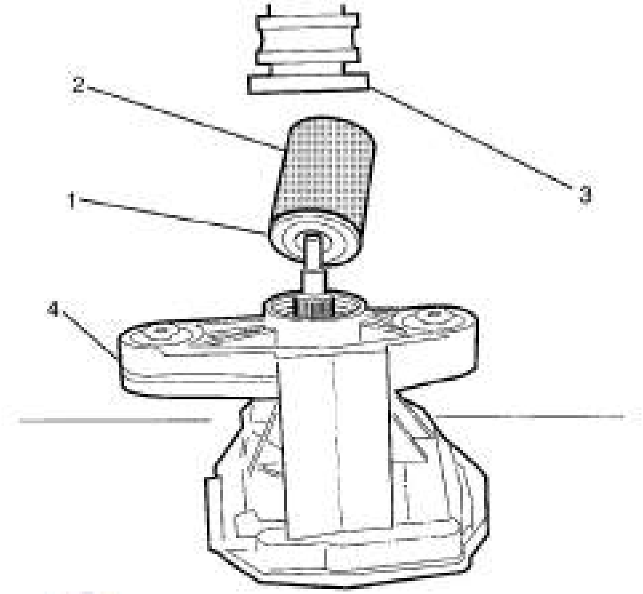


46. Position the pinion tail bearing (1) to the differential housing (2).



Important: Take care to only press the tail bearing until it rests on the collapsible spacer so that it is not damaged.

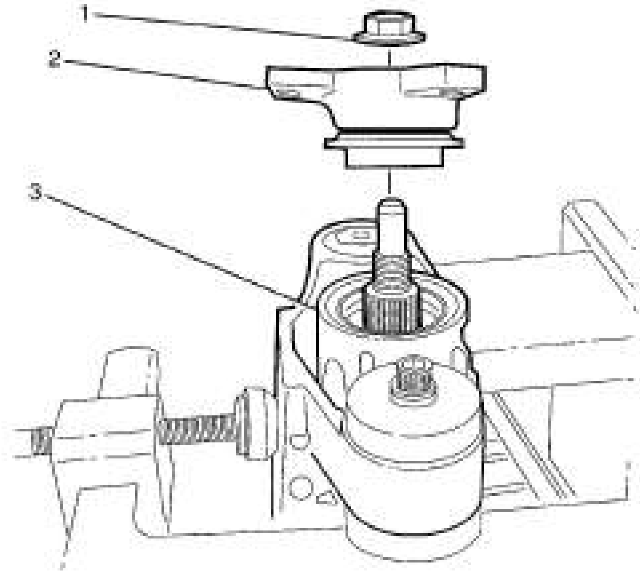
47. Use a suitable press (2) and DT-48723 (1) to press the tail bearing until it rests against the collapsible spacer.
48. Remove the supporting tool so that the differential housing rests on the table.



49. Lubricate the NEW pinion flange seal (1) with correct grease. Refer to Adhesives, Fluids, Lubricants, and Sealers .

Important: Use DT-48727 to install the seals to correct depth.

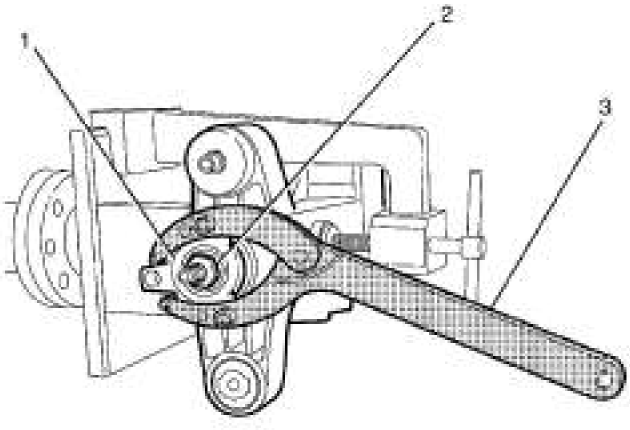
50. Install the pinion flange seal (1) to the differential housing (4) with DT-48727 (2) in a suitable press (3).
51. Mount the differential housing (4) on a suitable holding device.



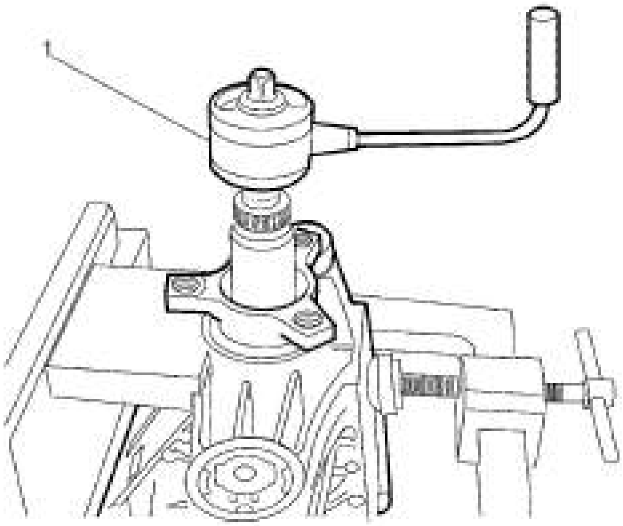
52. Position the pinion flange (2) to the differential (3).
53. Lubricate the contact surface of the prevailing torque pinion flange retaining nut (1) with correct grease. Refer to Adhesives, Fluids, Lubricants, and Sealers .
54. Apply correct loctite to the thread of the NEW prevailing torque pinion flange retaining nut (1).

Important: Do not fully tighten the NEW prevailing torque pinion flange retaining nut at this stage. Overtightening will require disassembly and fitment of a new collapsible spacer and possibly bearings.

55. Install the NEW prevailing torque pinion flange retaining nut (1) to the differential (3).



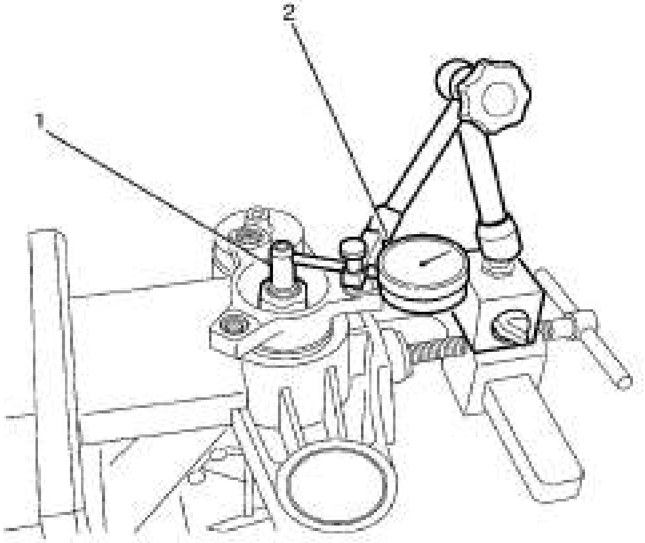
56. Install the universal pulley holder (3) to the pinion flange (1).
57. Tighten the prevailing torque pinion flange retaining nut (2) carefully until it has no play.
58. Remove the universal pulley holder from the pinion flange (1).
59. Turn the differential assembly through 90°.



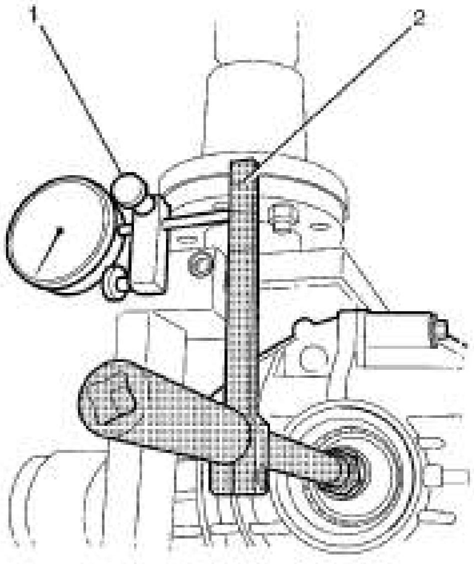
60. Position the turning torque gauge (1) to the prevailing torque pinion flange nut.
61. Turn the turning torque gauge (1) in a clockwise direction and record reading.

Important: This torque figure is for NEW bearings only.

62. Turning torque should be between 2.2 and 2.7 Nm (20-25 lb in).
63. If the turning torque is below specified tolerance, tighten the prevailing torque pinion flange retaining nut in small steps and check turning torque until specified turning torque is reached.
64. If the turning torque is above specified tolerance disassemble, fit new collapsible spacer and repeat until correct specification is achieved.



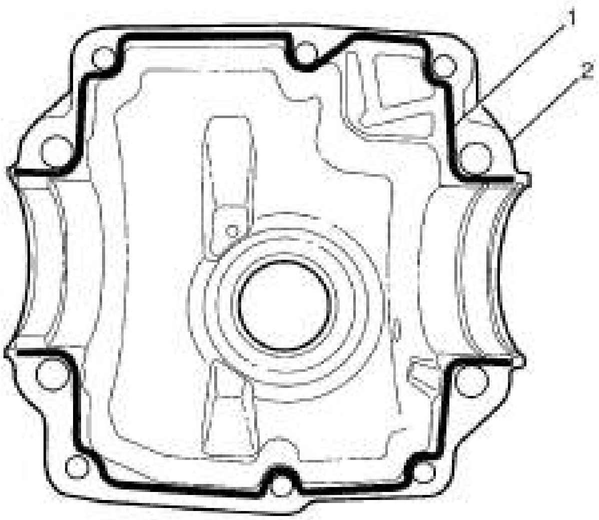
65. Position a dial gauge (2) to measure the concentric running on centering while turning the pinion (1).
66. If the measured value is above .1mm remove the pinion flange and re-install at a different angle. Repeat steps 52-66 in the assembly procedure. Make sure the turning torque is .1-.2 N-m higher than recorded in step 63 but not higher than 2.7 N-m.



67. Position the backlash tool (2) to the differential assembly.

Important: The location of the dial gauge on the backlash tool (2) arm corresponds to the edge of the ring gear (210mm)

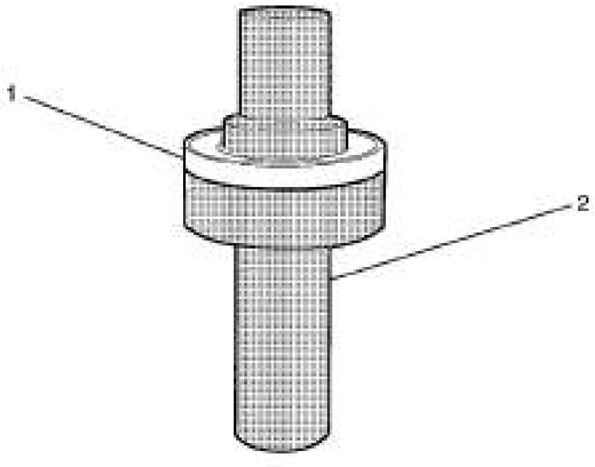
68. Position the dial gauge (1) to the backlash tool (2).
69. Use a suitable tool to move the backlash tool (2) within the backlash and record the reading.
70. Backlash must be between .07 and .18 mm.
71. If the backlash is not between the specified tolerance, it must be adjusted with differential shims otherwise turning torque set during steps 38-43 will be changed.
72. If a .05 mm thinner shim is used on the right a .05 mm thicker shim has to be added to the left.
73. Remove the rear differential housing. Refer to steps 5 and 6 in the disassembly procedure.



74. Clean the mating faces of the differential housings (2).

Important: Apply a 1mm liquid seal bead (1) to the differential housing. Use the graphic as a template.

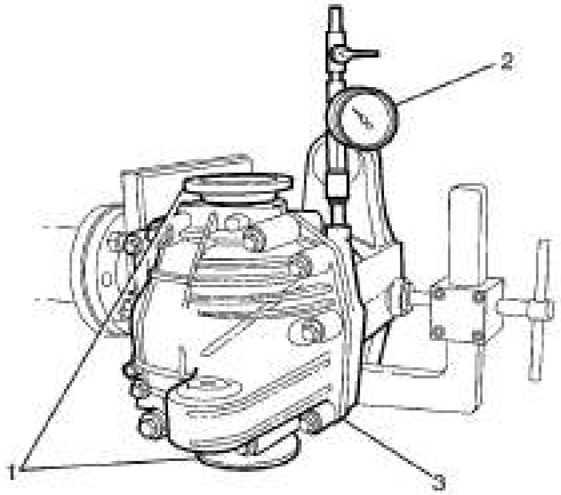
75. Apply a 1mm liquid seal bead (loctite 5910).(1) to the mating face of the differential housing. Refer to Adhesives, Fluids, Lubricants, and Sealers .
76. Install the differential housing cover to the differential housing. Refer to steps 26 through 33.



Important: The left and right rear axle shaft seals are different sizes so there are 2 different size installers. Make sure that the correct seal installer is used for the correct seal.

Important: Fill the space between the dust lip and the seal lip with the correct grease.

77. Install the left and right rear axle shaft seals (1) using DT-48722 and DT-48721 (2).



78. Install two rear axle flanges or two sealing plugs (1) to seal the differential (3).

Important: Set the air pressure regulator to .4 bar before connecting.

79. Remove the oil drain plug and install the air pressure regulator (2).
80. Connect the air supply to the regulator (2) and pressurise the differential (3) to .4 bar.

81. Disconnect the air supply from the regulator (2).
82. The pressure should not decrease from .4 bar within 3 minutes. If the pressure decreases, locate and repair leakage.
83. Install the differential (3) to the vehicle. Refer to Differential Replacement .
84. Fill the differential fluid. Refer to the filling procedure in Differential Oil Replacement .

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Rear Axle Disassemble

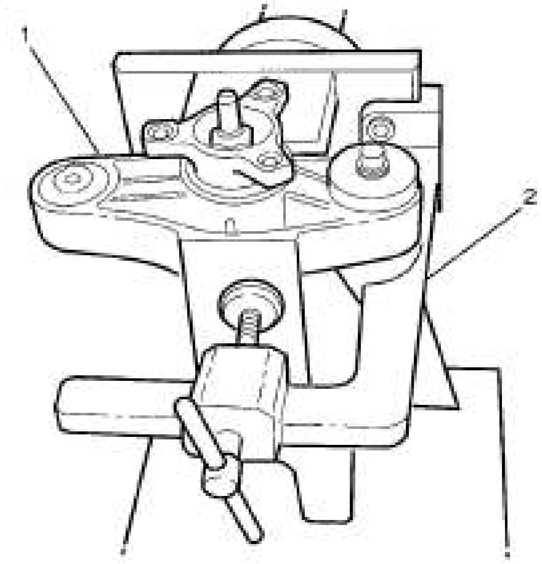
Tools Required

- E-308 Seal Remover.
- 205-116 Carrier Bearing Puller Including Plug.
- DT-48805 Pinion Tail Bearing Cup Remover.
- DT-48725 Pinion Head Bearing Cup Removal Kit.
- DT-48726 Pinion Head Bearing Cup Remover.

Caution: Refer to Safety Glasses Caution in the Preface section.

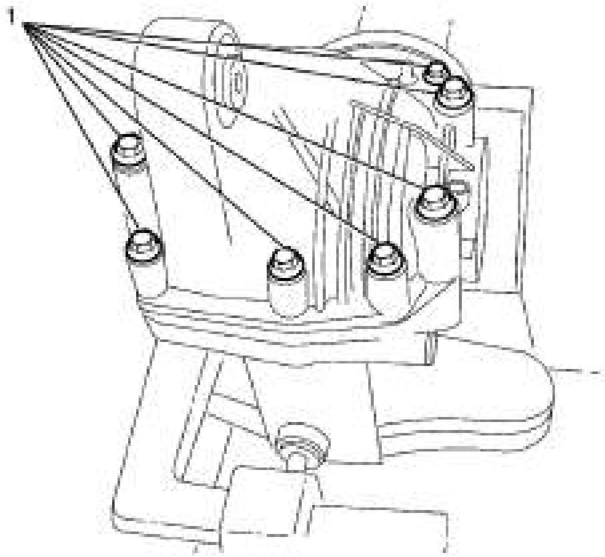
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Drain the differential fluid. Refer to the draining procedure in Differential Oil Replacement .
3. Remove the differential from the vehicle. Refer to Differential Replacement .

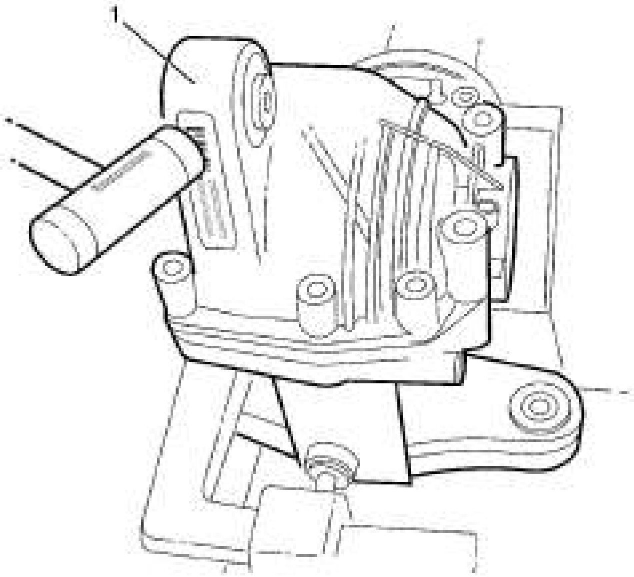


Important: The holding device must be able to rotate.

4. Mount the differential assembly (1) to a suitable holding device (2).

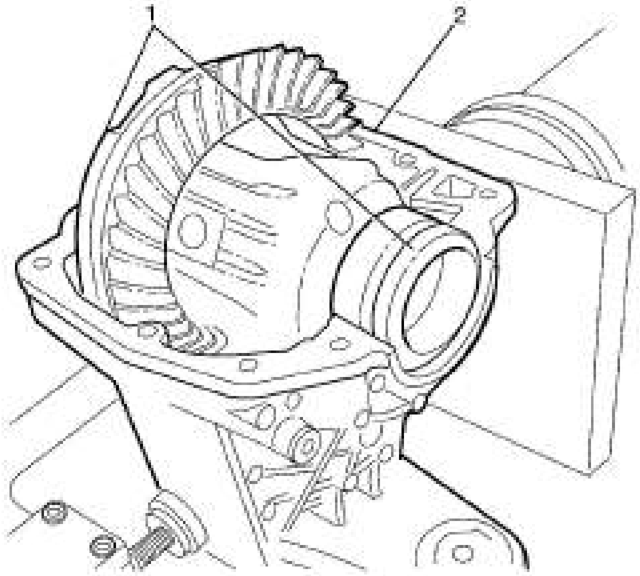


5. Remove the differential housing cover to differential housing retaining bolts (1).



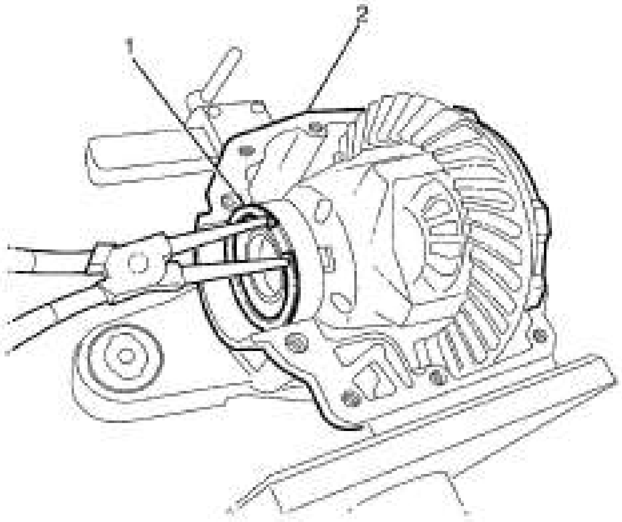
Important: Use a soft faced hammer to aid in separating the differential housing cover from the rear differential housing (1).

6. Remove the rear differential housing cover (1).

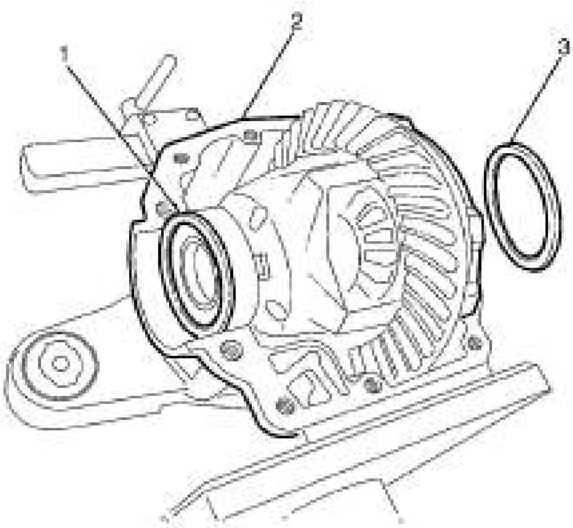


7. Remove the left and right axle shaft seals (1) from the differential (2).

   Discard the axle shaft seals.

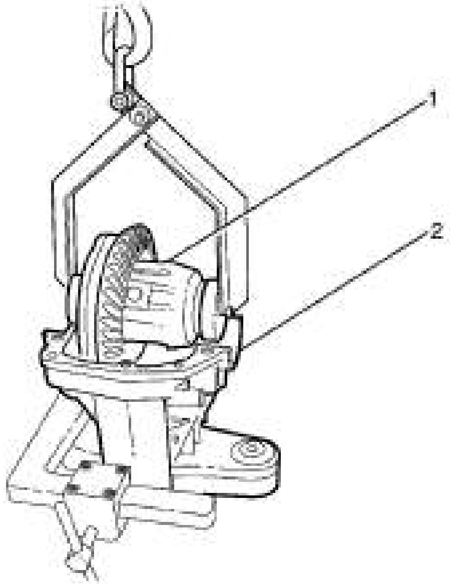


8. Remove the circlip (1) from the differential (2).



Important: Mark the left shim (3) and right shim (1) before removing for correct refitting.

9. Remove the left shim (3) and right shim (1) from the differential (2).

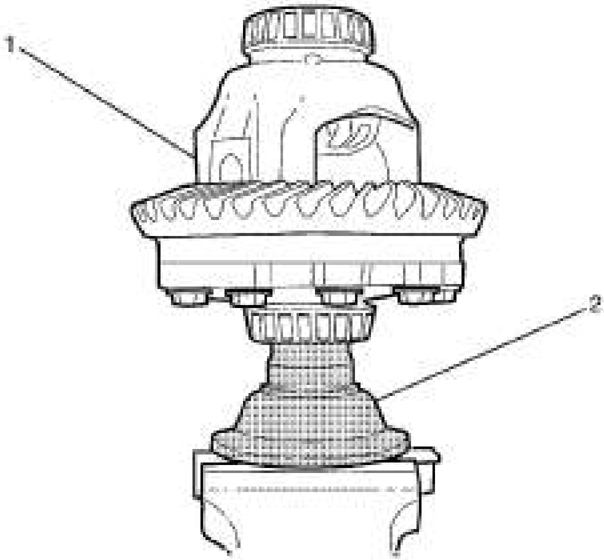


Important: Remove the differential (1) using a suitable tool or with the aid of an assistant.

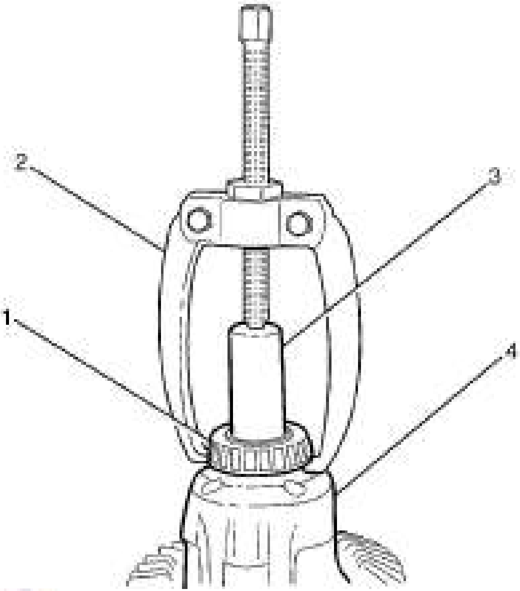
10. Remove the differential (1) from the differential housing (2).

Important: Place a suitable container to catch remaining differential fluid.

11. Allow remaining differential fluid to drain.



12. Position the differential (1) onto a suitable holding device (2).



Important: Use a suitable puller (2) and 205-116 (3) to remove the right bearing (1).

13. Remove the right bearing (1) from the differential (4).

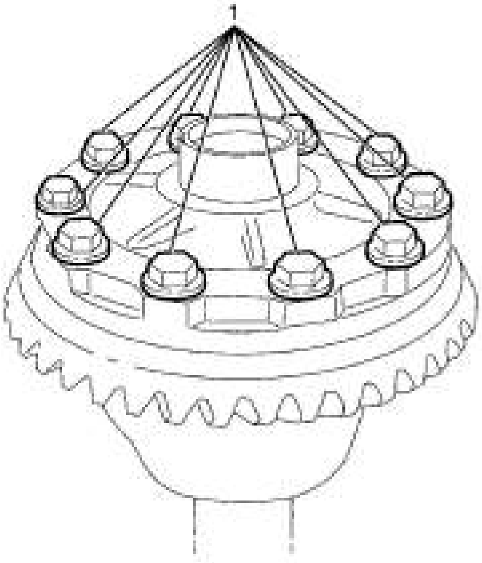
    Discard the right bearing.

14. Turn the differential (4) over on the holding tool with the aid of an assistant.

    Important: Use a suitable puller (2) and 205-116 (3) to remove the left bearing.

15. Remove the left bearing from the differential (4).

Discard the left bearing.



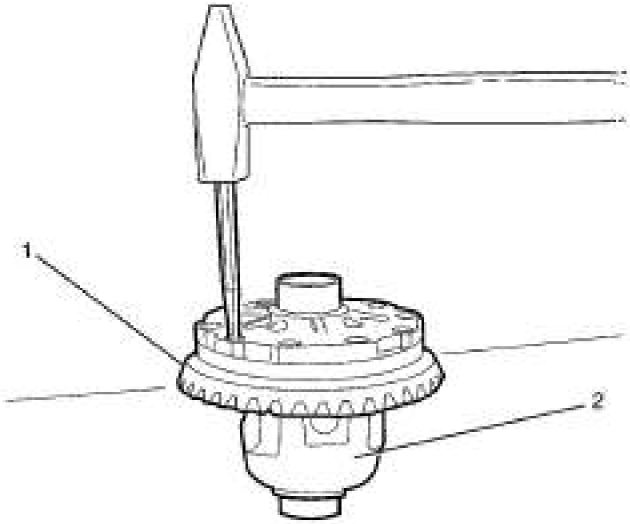
16. Remove the ring gear to differential retaining bolts (1).

    Discard ring gear to differential retaining bolts.

17. Remove the differential from the holding device.

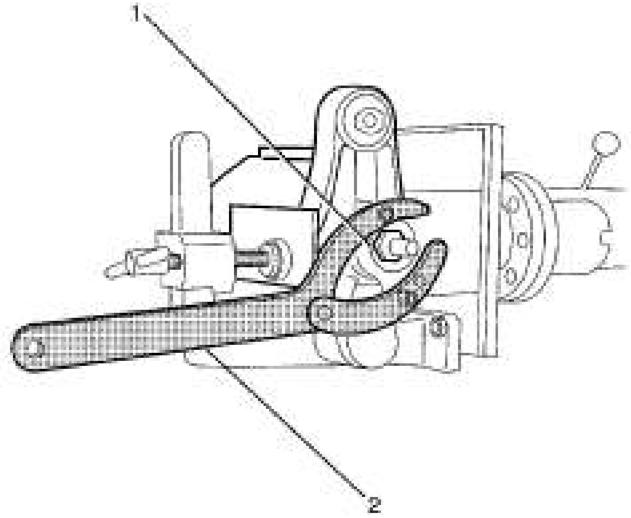
    Important: Make sure there is soft material between the differential and the bench top.

18. Place the differential onto a bench top.



Important: Use suitable tools or a suitable press to remove the ring gear (1) from the differential (2). Take care not to damage the ring gear retaining bolt hole threads.

19. Remove the ring gear (1) from the differential (2).



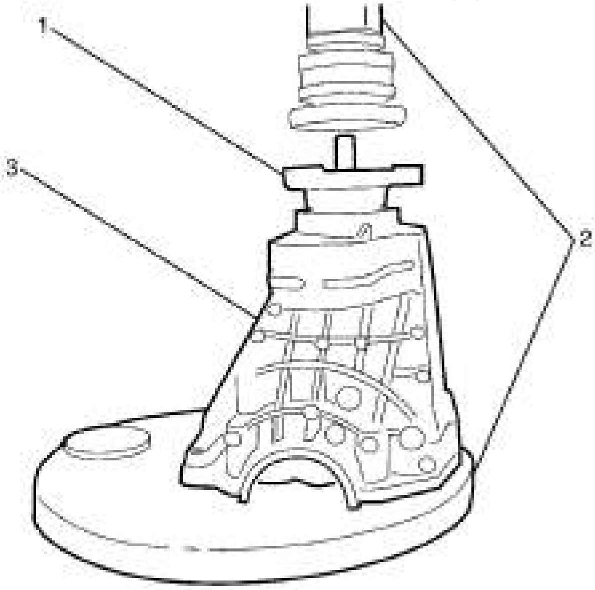
20. Install the universal holding tool (2) to the pinion flange (1).

Important: Hold the pinion flange with universal holding tool (2).

21. Remove the pinion flange to prevailing torque pinion flange retaining nut (1).

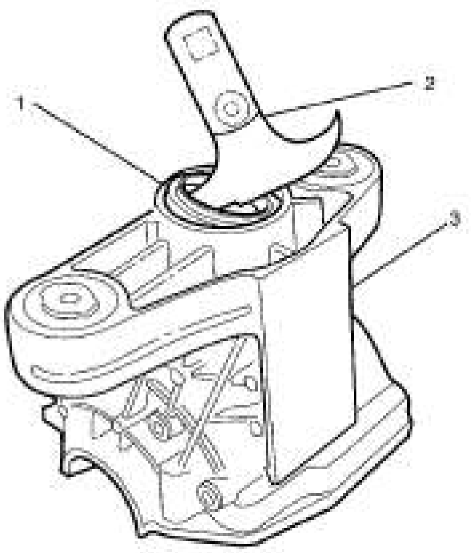
Discard the prevailing torque pinion flange retaining nut.

22. Remove the universal holding tool (2) from the pinion flange (1).



Important: The pinion flange (1) can be removed with a suitable puller or with a press (2). Support the pinion or place a soft cloth under the pinion to prevent damage when removing.

23. Remove the pinion flange (1) from the differential housing (3).
24. Remove the pinion from the differential housing (3).



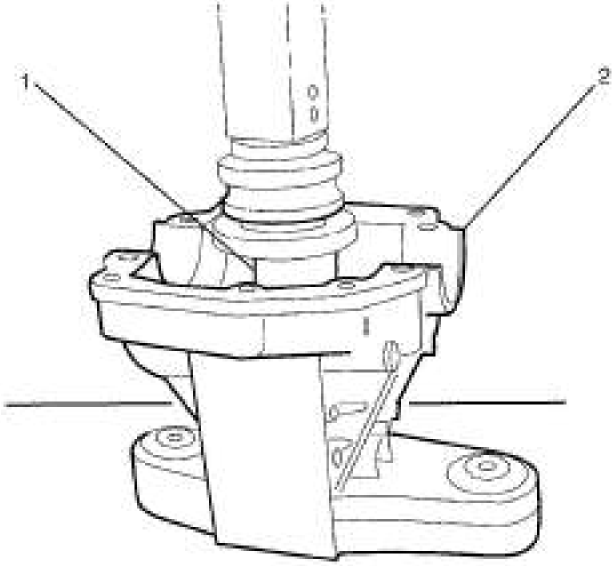
Important: Do not damage any sealing surfaces when removing the axle shaft oil seal (1). Cuts or abrasions will damage the assembly and result in lubricant leakage from this area.

25. Using a E-308 (2), remove the pinion flange oil seal (1) from the differential housing (3).

    Discard the pinion flange oil seal.

26. Remove the tail bearing from the differential housing (3).

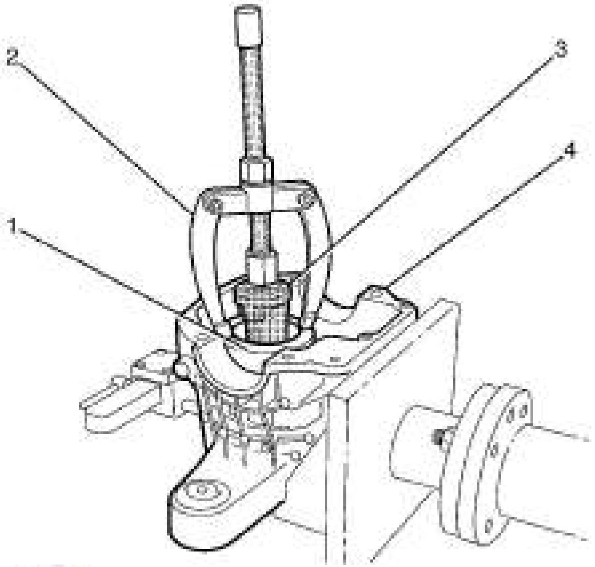
    Discard the tail bearing.



Important: Use a suitable press and DT-48805 to remove the tail bearing cup.

27. Position the DT-48805 (1) to the differential housing (2) and press out the tail bearing cup.
28. Remove the tail bearing cup from the differential housing (2).

    Discard the tail bearing cup.

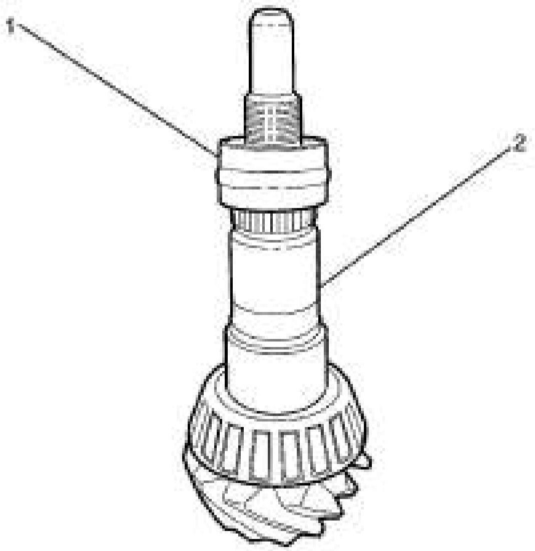


Important: Use DT-48725 (1, 2) and DT-48726 (3) to remove the head bearing cup.

29. Position DT-48726 (3) to the differential housing (4) and pull out the head bearing cup.

30. Remove the head bearing cup from the differential housing (4).

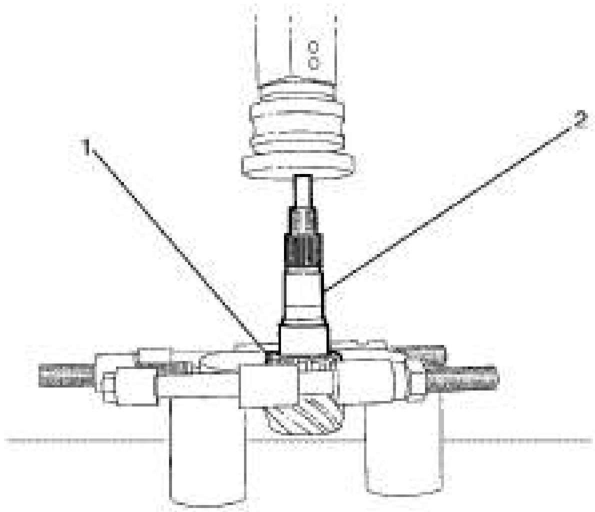
    Discard the head bearing cup.



Important: Do not reuse the collapsible spacer (1).

31. Remove the collapsible spacer (1) from the pinion gear (2).

    Discard the collapsible spacer.



Important: Use a suitable press and press plates to remove the pinion head bearing (1).

32. Remove the pinion head bearing (1) from the pinion gear (2).

    Discard the pinion head bearing.

33. Remove the pinion shim from the pinion gear (2).
34. Clean loctite from the pinion gear thread.

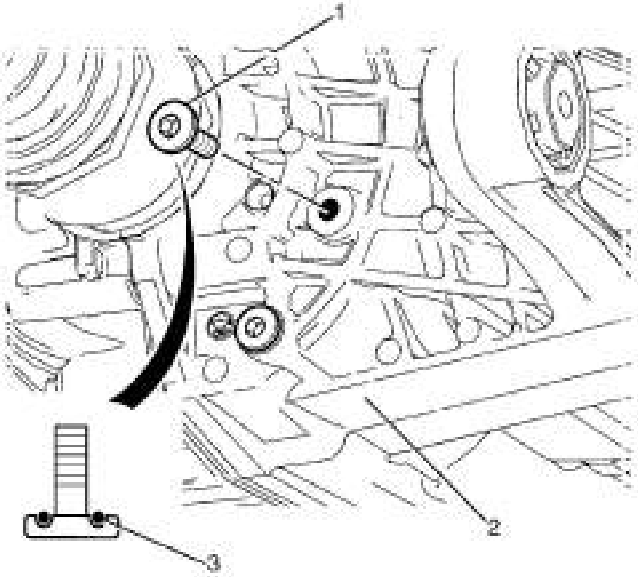
Rear Axle Lubricant Level Inspection

Inspection Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



Important: The differential fill plug (1) and O-ring (3) come as an assembly, the O-ring (3) cannot be replaced separately.

Important: Clean the area around the differential fill plug (1) to prevent the entry of foreign particles into the differential (2).

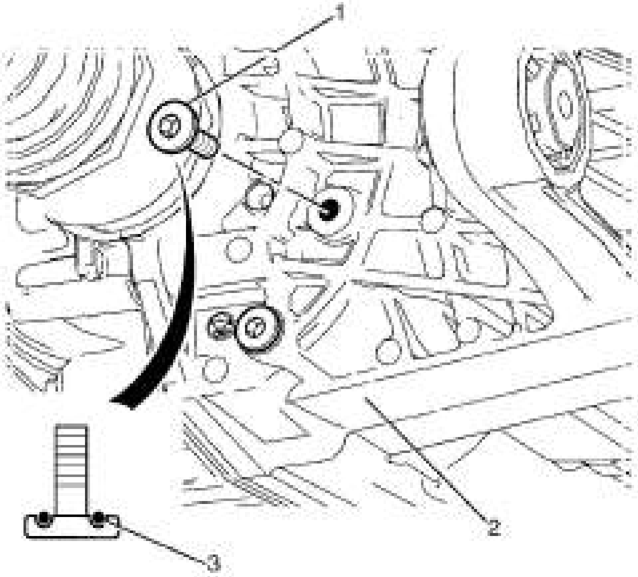
2. Remove the differential fill plug (1) from the differential (2).
3. Inspect the differential fill plug (1) and O-ring (3) for excessive wear and/or damage. Replace as necessary.

Important: The differential fluid level must be level with the bottom of the differential fill plug hole to no lower than 6 mm (0.25 in) below the opening.

Important: When adding differential fluid or making a complete differential fluid change, always use the correct differential fluid. Failure to use the correct differential fluid may cause gear damage and/or differential fluid leaks. For differential fluid specifications refer to Lubrication Specifications .

4. Check the differential fluid level.
5. Add new differential fluid if necessary.

Notice: Refer to Fastener Notice in the Preface section.



6. Install the differential fill plug (1) and O-ring (3) to the differential (2).

   Tighten
   Tighten the differential fill plug to 35 N-m (26 lb ft).

7. Remove the safety stands.
8. Lower the vehicle to the ground.

Limited Slip Differential Description and Operation

The limited slip differential performs the same functions as the conventional type differential. However, should the one wheel begin to spin, it transfers driving force to the wheel with traction. It does this with a 5 plate clutch set up in the differential.

Rear Drive Axle Description and Operation

The differential assembly is a cast aluminium two-piece housing design. The differential is mounted to the rear suspension assembly by three rubber mounts, one either side of the pinion flange at the front and the third at the rear of the housing. The differential housing retaining bolts are located around the outside of the housing with the four larger bolts are also bearing retaining bolts. The internal components incorporate a hypoid gear set, ring gear and pinion, carrier assembly and pinion housing assembly. Pinion bearing pre-load is created through a collapsible spacer. Torque is transferred from the propeller shaft to the differential via the pinion flange which is splined to the hypoid pinion. The torque is then transferred from the pinion through the ring gear, differential case, differential pinions, side gears, and then via splines to the wheel drive shafts.

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Fastener Tightening Specifications

Application	**Specification**	
	Metric	**English**
Rear Drive Shaft to Rear Hub Retaining Nut		
There are two alternate methods of achieving the required Rear Hub Retaining Nut torque. **Important: DO NOT EXCEED THE SPECIFIED TIGHTENING VALUES, otherwise premature bearing failure may result.**		
Preferred Method		
• First Pass	150 N·m	110 lb ft
• Loosen	-180 Degrees	
• Final Pass	425 N·m	313 lb ft
Alternate Method		
• First Pass	150 N·m	110 lb ft
• Loosen	-180 Degrees	
• Second Pass	50 N·m	37 lb ft
• Final Pass	45 Degrees	

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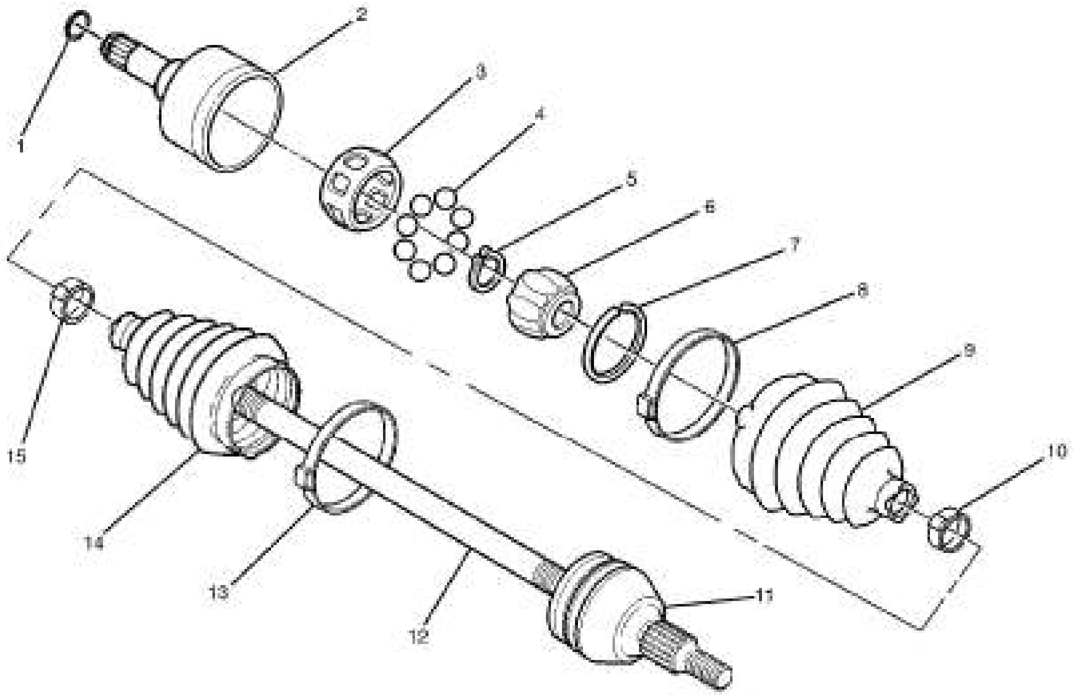
Wheel Drive Shafts Disassembled Views



(1) Snap Ring
(2) Inner Constant Velocity Joint Outer Race
(3) Inner Constant Velocity Joint Cage
(4) Inner Constant Velocity Balls
(5) Inner Race Circlip
(6) Inner Constant Velocity Joint Inner Race
(7) Inner Constant Velocity Joint Outer Race Circlip
(8) Inner Joint Boot Large Retaining Clamp
(9) Inner Joint Boot
(10) Inner Joint Boot Small Retaining Clamp
(11) Outer Constant Velocity Joint
(12) Interconnecting Shaft
(13) Outer Joint Boot Large Retaining Clamp
(14) Outer joint Boot
(15) Outer Joint Boot Small Retaining Clamp

Diagnostic Starting Point - Wheel Drive Shafts

Begin the system diagnosis by reviewing Wheel Drive Shafts Description and Operation. Reviewing the description and operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the description and operation information will also help you determine if the condition described by the customer is normal operation. Refer to Symptoms - Wheel Drive Shafts. In order to identify the correct procedure for diagnosing the system and where the procedure is located.

Symptoms - Wheel Drive Shafts

Before beginning diagnosis, review the system description and operation in order to familiarise yourself with the system function. Refer to Wheel Drive Shafts Description and Operation.

Classifying the Symptom

Wheel drive shaft symptoms can usually be classified into the following categories:

- Noises.
- Vibrations.

Visual/Physical Inspection

- Inspect the system components for obvious damage or conditions which could cause the symptom.
- Inspect the system for aftermarket devices which could affect the operation of the wheel drive shaft.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Clunk When Accelerating from Coast.
- Shudder or Vibration During Acceleration.

Clunk When Accelerating from Coast

A clunk noise when accelerating from coast or a standing start may be caused by a worn or damaged constant velocity joint. The common cause of constant velocity joint damage is the loss of lubricating grease and/or the presence of foreign material and contaminates in the constant velocity joint. This usually occurs as a result of a torn or damaged joint boot.

Carefully inspect the joint boot for cuts, tears or other signs of damage that may allow the loss of the lubricating grease and/or the entry of contaminates. If there is no damage to the joint boots, remove the wheel drive shaft from the vehicle and inspect the constant velocity joints. Rotate the constant velocity joints in a circular motion. Do not allow the constant velocity joint inner races to become disengaged from the outer race housings, or damage to the constant velocity joints will occur. The movement of the constant velocity joints should be smooth and even. If any binding or impeded motion is felt, the constant joint requires replacement.

Shudder or Vibration During Acceleration

A shudder/vibration, or a groan/scraping noise during acceleration may be caused by a worn or damaged constant velocity joint. The common cause of constant velocity joint damage is the loss of lubricating grease and/or the presence of foreign material and contaminates in the constant velocity joint. This usually occurs as a result of a torn or damaged constant velocity joint boot.

Carefully inspect the joint boot for cuts, tears or other signs of damage that may allow the loss of the lubricating grease and/or the entry of contaminates. If the boot is torn check for contact with foreign matter or other parts in the surrounding area. If there is no damage to the joint boots, remove the wheel drive shaft from the vehicle and inspect the constant velocity joints. Rotate the constant velocity joints in a circular motion. Do not allow the constant velocity joint inner races to become disengaged from the outer race housings, or damage to the constant velocity joints will occur. The movement of the constant velocity joints should be smooth and even. If any binding or impeded motion is felt, the constant velocity joint requires replacement.

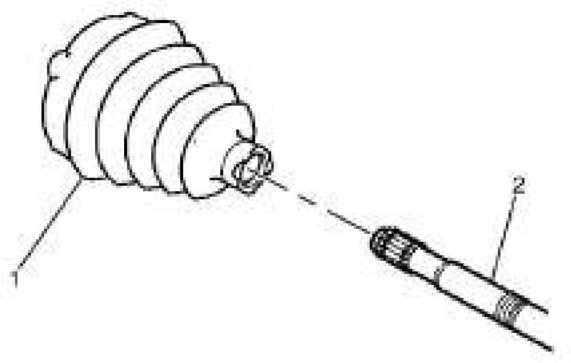
Rear Wheel Drive Shaft Inner Joint Boot Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the wheel drive shaft from the vehicle. Refer to Wheel Drive Shaft Replacement.
3. Remove the inner constant velocity joint. Refer to Wheel Drive Shaft Inner Joint and Boot Replacement.



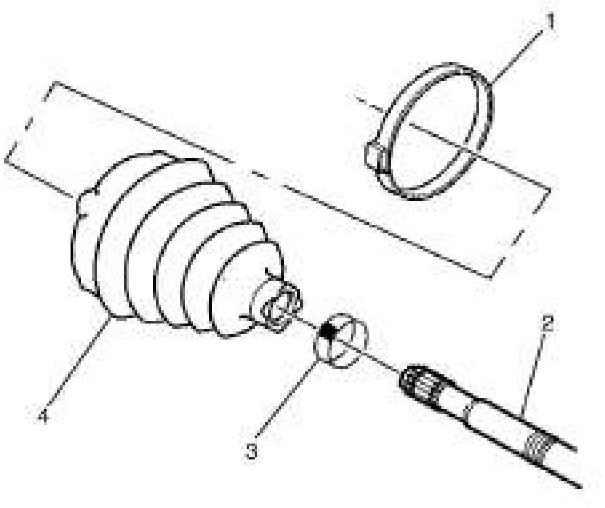
4. Remove the inner joint boot (1) from the interconnecting shaft (2).

   Discard the inner joint boot.

   Important: All traces of old grease and any contaminates must be removed.

5. Clean the grease from the interconnecting shaft (2).

Installation Procedure



Important: The inner constant velocity joint NEW small retaining clamp (3) and NEW large retaining clamp (1) must not be fully tightened at this stage.

1. Install the NEW large retaining clamp (1) and the NEW small retaining clamp (3) to the NEW inner joint boot (4).

   Do not fully tighten clamp.

2. Install the NEW inner joint boot (4) along the interconnecting shaft (2).
3. Install the inner constant velocity joint. Refer to Wheel Drive Shaft Inner Joint and Boot Replacement.
4. Install the wheel drive shaft to the vehicle. Refer to Wheel Drive Shaft Replacement.
5. Remove the safety stands.
6. Lower the vehicle to the ground.

Rear Wheel Drive Shaft Outer Joint Boot Replacement

Tool Required

J 22610 Keystone Pliers.

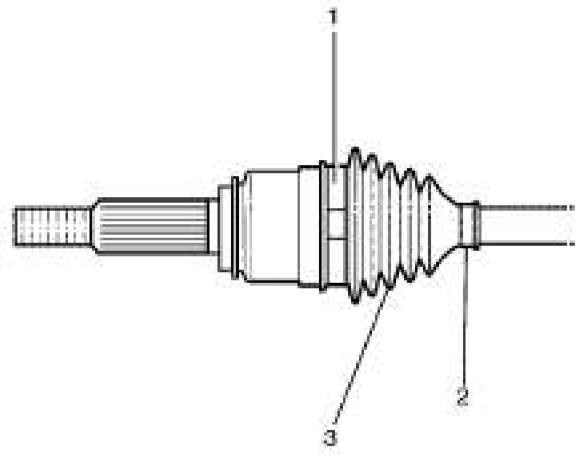
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Important: When the outer joint boot is replaced the inner joint boot must always be replaced.

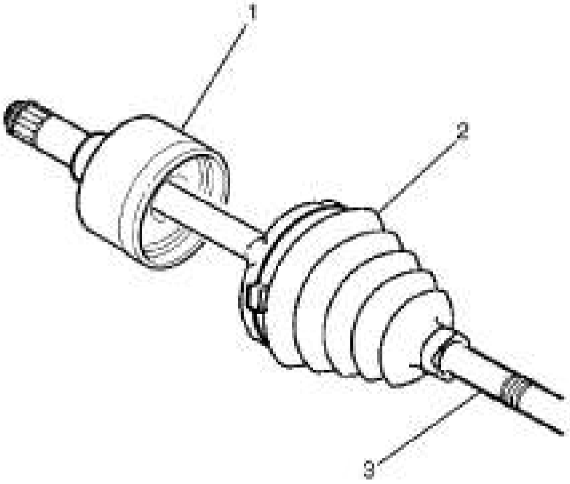
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the wheel drive shaft from the vehicle. Refer to Wheel Drive Shaft Replacement .
3. Remove inner constant velocity joint and joint boot. Refer to Wheel Drive Shaft Inner Joint and Boot Replacement .



Important: The outer joint boot small retaining clamp (2) and outer joint boot large retaining clamp (1) are single use parts and must be discarded after use.

4. Remove the outer joint boot large retaining clamp (1) and the outer joint boot small retaining clamp (2) from the outer joint boot (3).

   Discard the clamps.



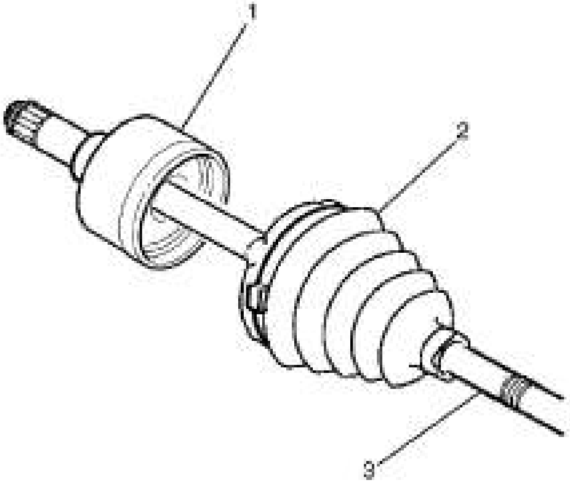
5. Remove the outer joint boot (2) from the outer constant velocity joint (1) along the interconnecting shaft (3).

   Discard the outer joint boot.

   Important: All traces of old grease and any contaminates must be removed.

6. Clean the grease from the interconnecting shaft (3) and outer constant velocity joint (1).

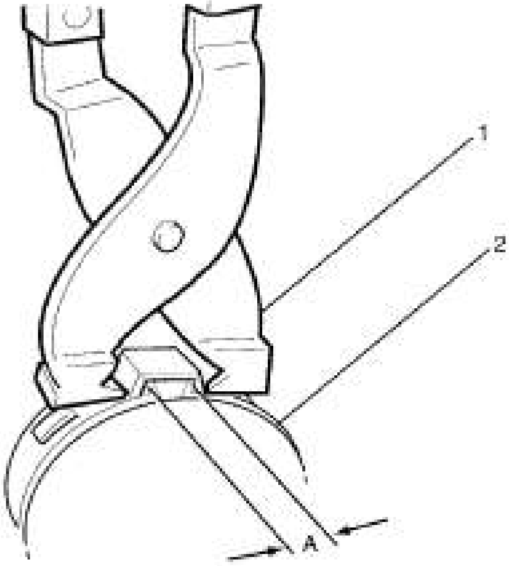
Installation Procedure



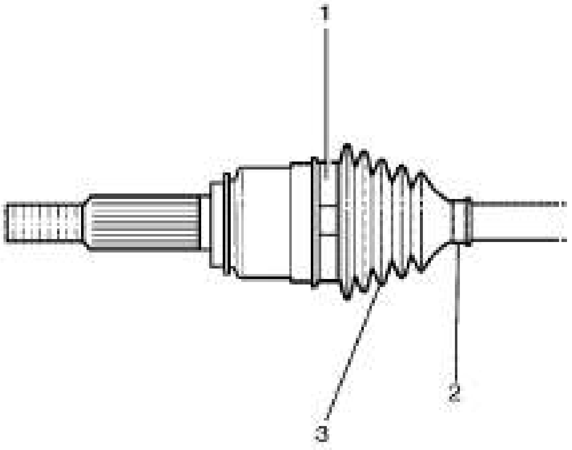
1. Install the NEW outer joint boot (2) along the interconnecting shaft (3).

   Important: Install grease into the outer constant velocity joint (1) and the NEW outer joint boot (2). Refer to Adhesives, Fluids, Lubricants, and Sealers .

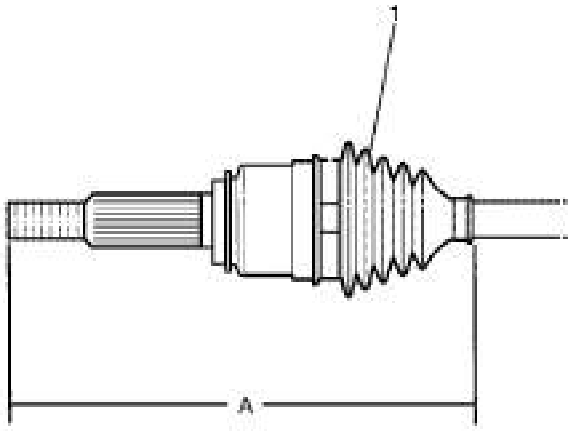
2. Install the NEW outer joint boot (2) to the outer constant velocity joint (1).



3. Use J 22610 (1) to crimp retaining clamp (2). The crimped distance (A) must be between 1.2 - 4mm.



4. Position the NEW outer joint boot large retaining clamp (1) and the NEW outer joint boot small retaining clamp (2) to the NEW outer joint boot (3).
5. Crimp the NEW outer joint boot large retaining clamp (1) and NEW outer joint boot small retaining clamp (2) to the NEW outer joint boot (3).



Important: The NEW outer joint boot (1) must not be dimpled, stretched, or deformed. Always equalise the air pressure in the NEW outer joint boot with the joint in the centre of its plunge position and shape properly by hand.

6. The outer constant velocity joint dimension A is 248 mm (9.8 in) for V6 and 254.3 mm (10 in) for V8.
7. Fully cycle the outer constant velocity joint several times to disperse grease throughout the outer constant velocity joint.
8. Install the inner constant velocity joint and joint boot. Refer to Wheel Drive Shaft Inner Joint and Boot Replacement .
9. Install the wheel drive shaft to the vehicle. Refer to Wheel Drive Shaft Replacement .
10. Remove the safety stands.
11. Lower the vehicle to the ground.

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Wheel Drive Shaft Inner Joint and Boot Replacement

Tools Required

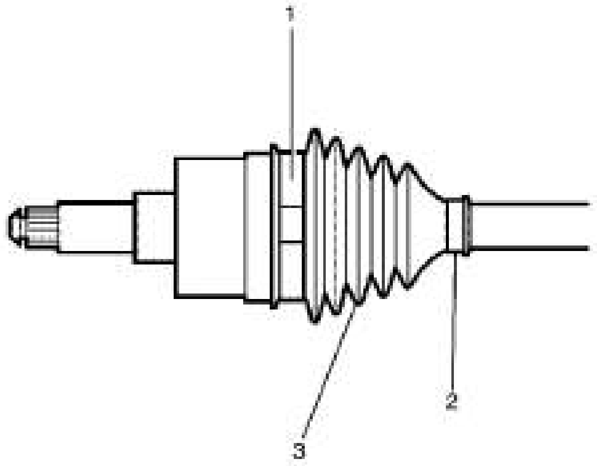
J 22610 Keystone Pliers.

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

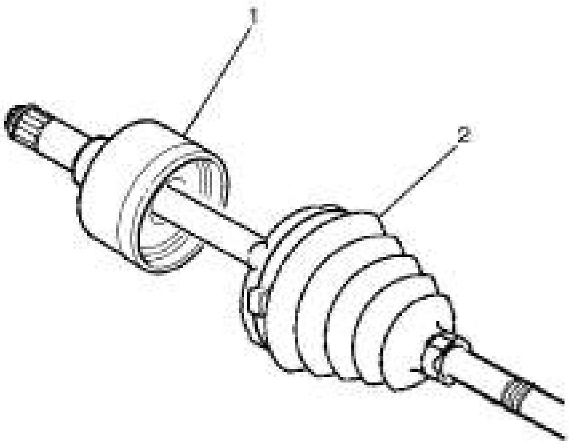
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the wheel drive shaft from the vehicle. Refer to Wheel Drive Shaft Replacement .



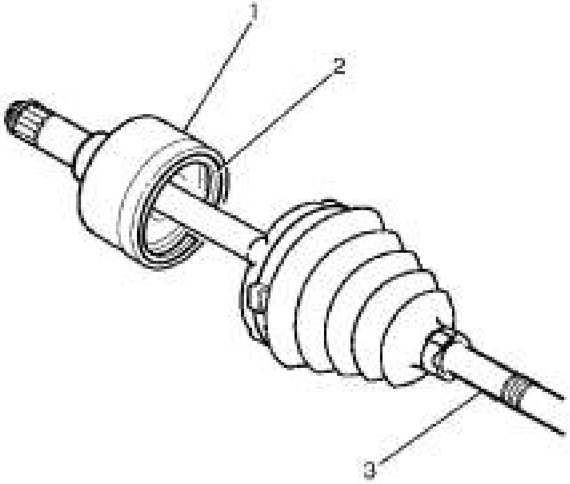
Important: The inner joint boot small retaining clamp (2) and the inner joint boot large retaining clamp (1) are single use parts and must be discarded after use.

3. Remove the inner joint boot small retaining clamp (1) and the large retaining clamp (2) from the inner joint boot (3).

   Discard the clamps.



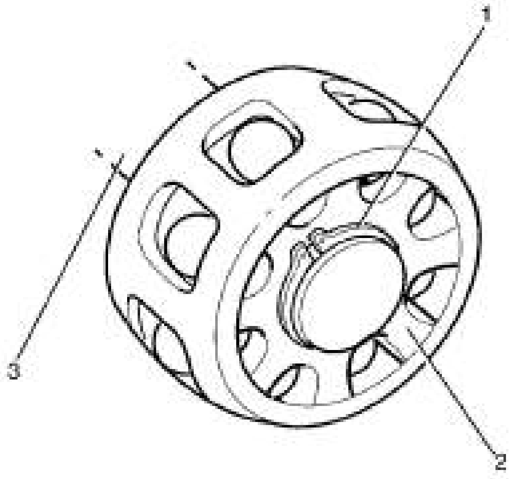
4. Move the inner joint boot (2) from the inner constant velocity joint (1) along the interconnecting shaft (3).



5. Remove the circlip (2) from the outer race of the inner constant velocity joint (1).

   Important: Take care as inner constant velocity balls can fall out when the inner constant velocity joint outer race (1) is removed.

6. Remove the inner constant velocity joint outer race (1) from the interconnecting shaft (3).

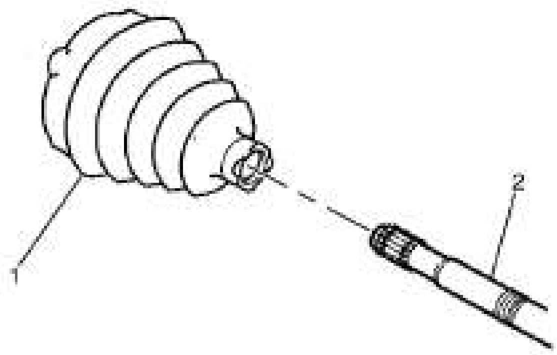


Important: The circlip (1) is a single use part and must be discarded after use.

7. Remove the circlip (1) from the inner constant velocity joint inner race (2).

   Discard the circlip.

8. Remove the inner constant velocity joint inner race (2) from the interconnecting shaft (3).

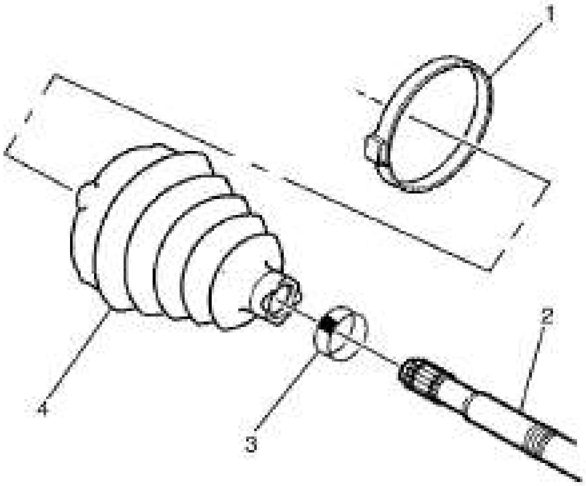


9. Remove the inner joint boot (1) from the interconnecting shaft (2).

   Important: All traces of old grease and any contaminates must be removed.

10. Clean the grease from the interconnecting shaft (2).

Installation Procedure

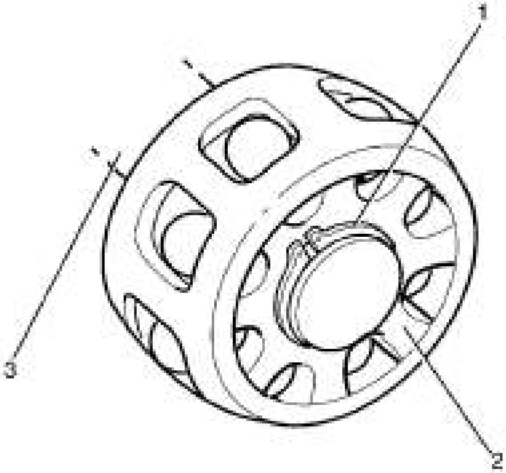


Important: The NEW inner joint boot large retaining clamp (1) and the NEW inner joint boot small retaining clamp (3) must not be fully tightened at this stage.

1. Install the NEW inner joint boot large retaining clamp (1) and the NEW inner joint boot small retaining clamp (3) to the NEW inner joint boot (4).

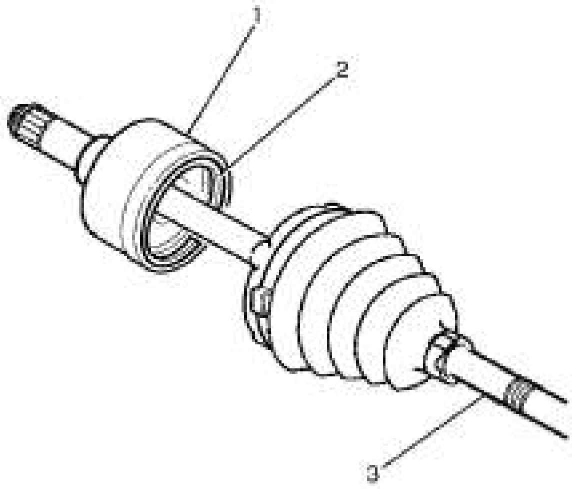
   Do not fully tighten clamps.

2. Install the NEW inner joint boot (4) along the interconnecting shaft (2).

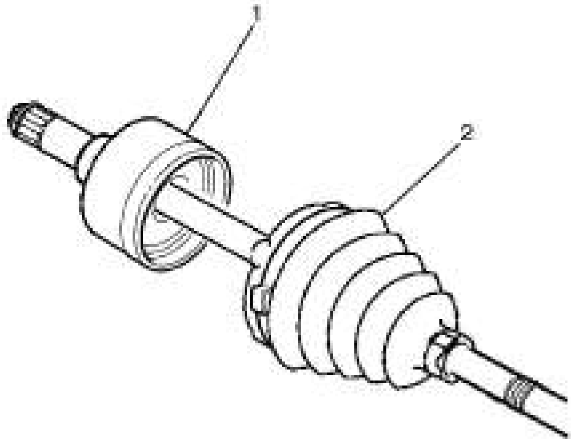


Important: Pack grease around the inner constant velocity balls to aid in holding in place. Refer to Adhesives, Fluids, Lubricants, and Sealers .

3. Install the inner race (2) to the interconnecting shaft (3).
4. Install the NEW inner race snap ring (1) to the interconnecting shaft (3).

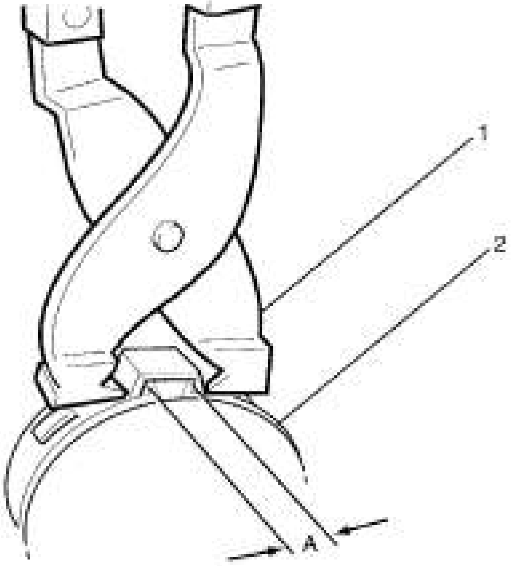


5. Install the inner constant velocity joint outer race (1) to the interconnecting shaft (3).
6. Install the NEW inner constant velocity joint outer race circlip (2) to the outer race of the inner constant velocity joint (1).



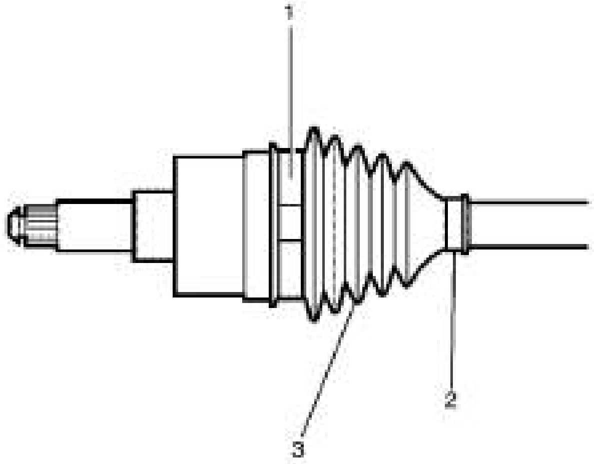
Important: Install grease into the inner constant velocity joint (1) and the NEW inner joint boot (2). Refer to Adhesives, Fluids, Lubricants, and Sealers .

7. Install the NEW inner joint boot (2) to the constant velocity joint (1).

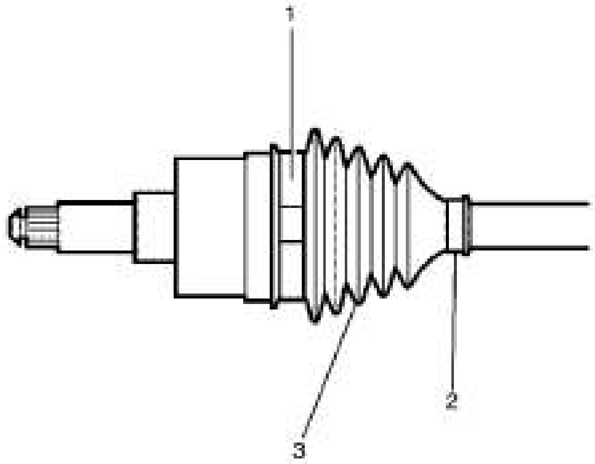


8. Use J 22610 (1) to crimp retaining clamp (2). The crimped distance (A) must be between 1.2 - 4mm.

Notice: Refer to Fastener Notice in the Preface section.

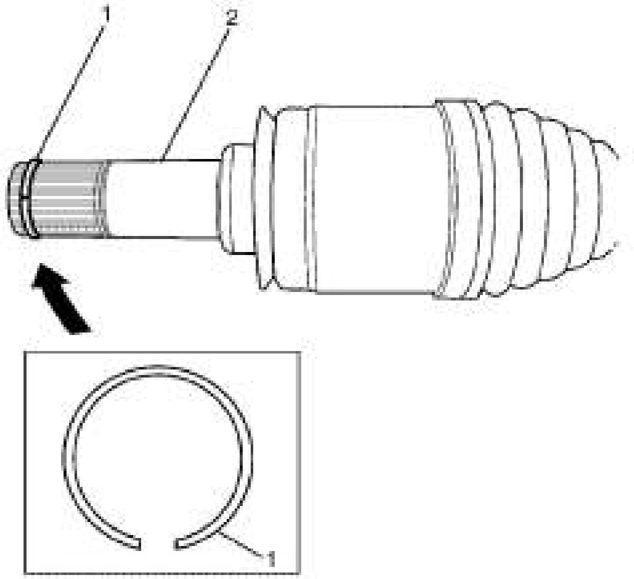


9. Crimp the NEW inner joint boot large retaining clamp (1) and NEW inner joint boot small retaining clamp (2) to the NEW inner joint boot (3).



Important: The NEW inner joint boot (1) must not be dimpled, stretched, or deformed. Always equalise the air pressure in the NEW inner boot with the joint in the centre of its plunge position and shape correctly by hand.

10. The inner constant velocity joint dimension A is 280.3 mm (11.04 in) for V8 and 281.8 mm (11.09 in) for V6.



11. Install the NEW snap ring (1) to the inner constant velocity joint (2).
12. Fully cycle the inner constant velocity joint (2) several times to disperse grease throughout the inner constant velocity joint (2).
13. Install the wheel drive shaft to the vehicle. Refer to Wheel Drive Shaft Replacement .
14. Remove the safety stands.
15. Lower the vehicle to the ground.

Wheel Drive Shaft Outer Joint and Boot Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Important: Outer constant velocity joint and axle shaft can not be separated and are replaced as a complete assembly.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the wheel drive shaft from the vehicle. Refer to Wheel Drive Shaft Replacement.
3. Remove inner constant velocity joint and joint boot. Refer to Wheel Drive Shaft Inner Joint and Boot Replacement.
4. Discard wheel drive shaft assembly.

Installation Procedure

1. Install outer joint boot to NEW outer constant velocity joint and axle shaft assembly. Refer to Rear Wheel Drive Shaft Outer Joint Boot Replacement.
2. Install the inner constant velocity joint and joint boot. Refer to Wheel Drive Shaft Inner Joint and Boot Replacement.
3. Install the wheel drive shaft to the vehicle. Refer to Wheel Drive Shaft Replacement.
4. Remove the safety stands.
5. Lower the vehicle to the ground.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Driveline/Axle | Wheel Drive Shafts | Repair Instructions | **Document ID: 1992446**

Wheel Drive Shaft Replacement

Tools Required

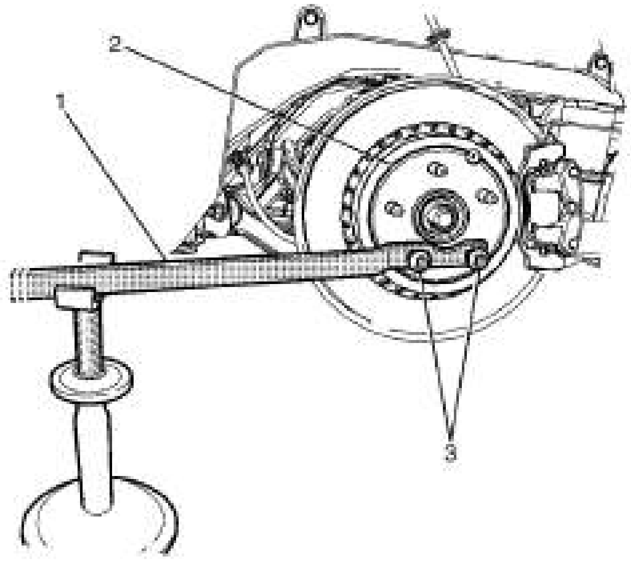
- KM-468 Holding Tool.
- J-22912-01 Press Plates.
- J 22610 Keystone Pliars.
- 7208 Rear Axle Remover.

Removal Procedure

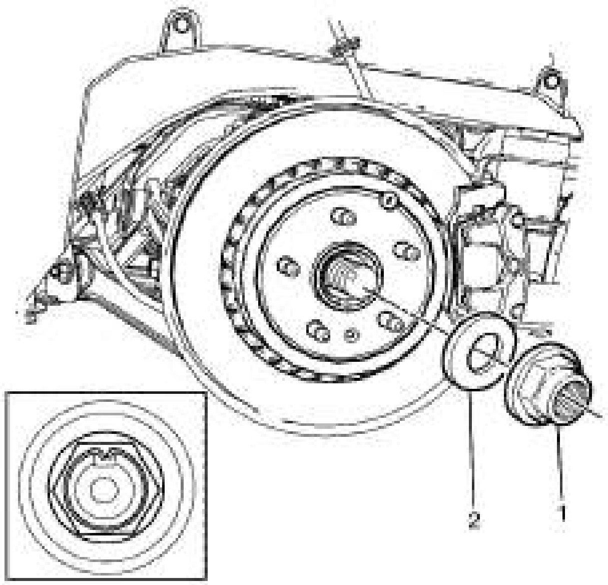
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear tyre and wheel assemblies. Refer to Tire and Wheel Removal and Installation.



3. Install the KM-468 (1) to the wheel hub (2) with two inverted wheel nuts (3).
4. Support the KM-468 (1) outer end on a safety stand.



Important: Use a suitable tool to release the crimping on the wheel drive shaft retaining nut.

Important: The wheel drive shaft retaining nut (1) must be discarded after removal.

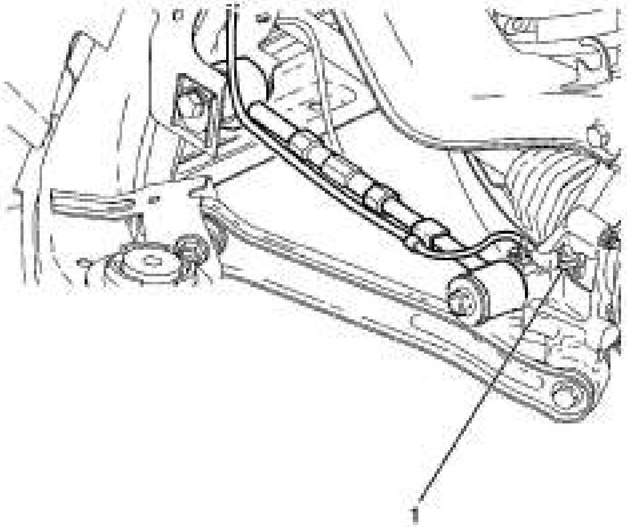
5. Remove the wheel drive shaft retaining nut (1).

   Discard the nut.

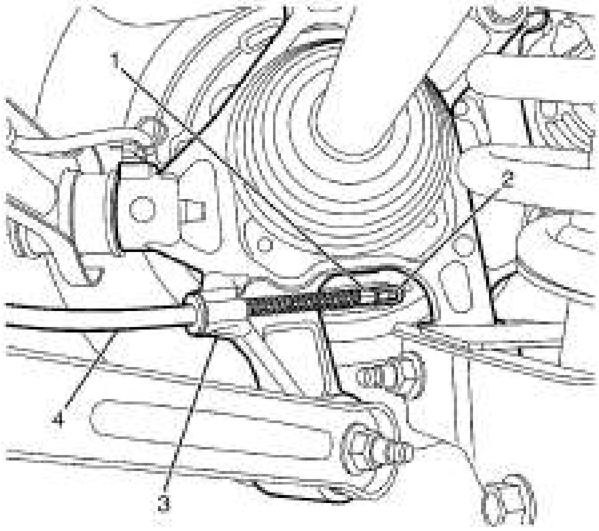
6. Remove the wheel drive shaft washer (2).

   Discard the washer.

7. Remove the KM-468 from the wheel hub.



8. Disconnect the wheel speed sensor electrical connector (1).
9. Detach the wheel speed sensor wiring harness mounting clip (2) from the knuckle (3).

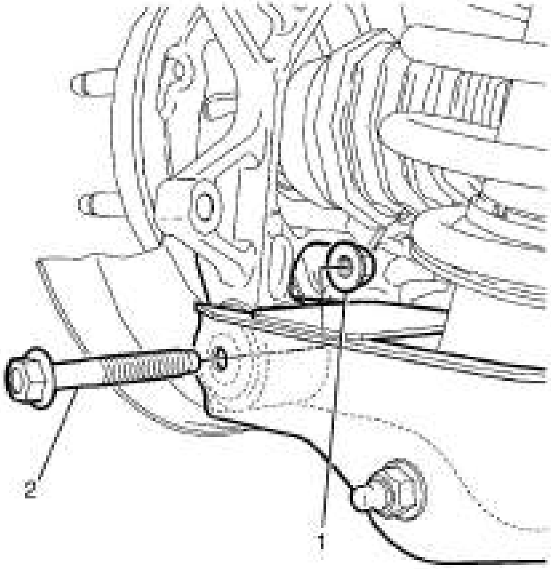


Important: Using a suitable tool, detach the rear park brake cable and clevis (1) from the park brake actuator (2) by pivoting the rear park brake cable and clevis (1) rearward.

10. Detach the rear park brake cable and clevis (1) from the park brake actuator (2).

Important: Remove the outer cable (4) from the rear knuckle (3) by pulling the outer cable (4) forward.

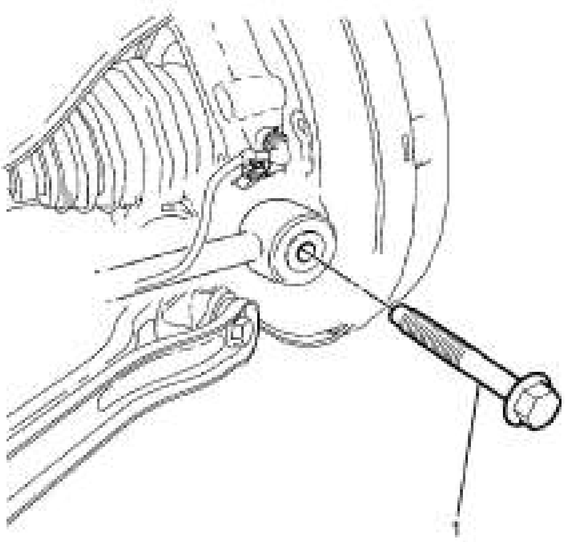
11. Remove the outer cable (4) from the rear knuckle (3).



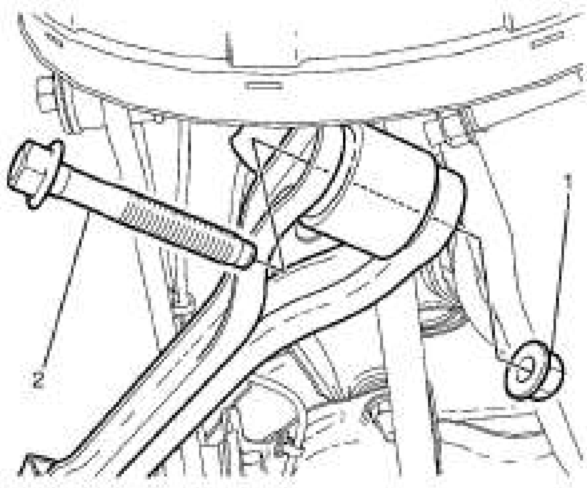
Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

12. Remove the lower control arm to knuckle retaining bolt (2) and nut (1).

    Discard the nut.

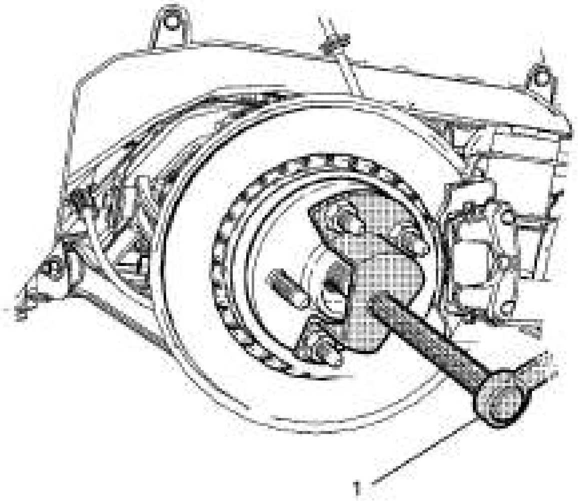


13. Remove the I-Link to knuckle retaining bolt (1) and washer (2).



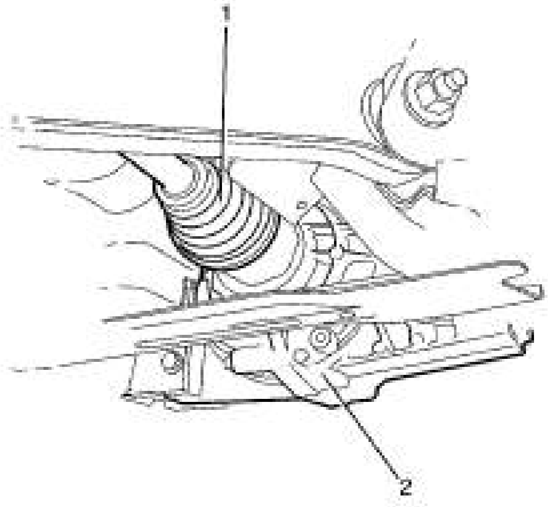
14. Remove the Y-Link to the knuckle retaining bolt (2) and nut (1).

Discard the nut.



Important: Do not hammer the end of the wheel drive shaft to remove use 7208 .

15. Use 7208 to remove the wheel drive shaft (1) from the wheel hub assembly (2).
16. Place a suitable container under the differential in order to collect draining fluid.



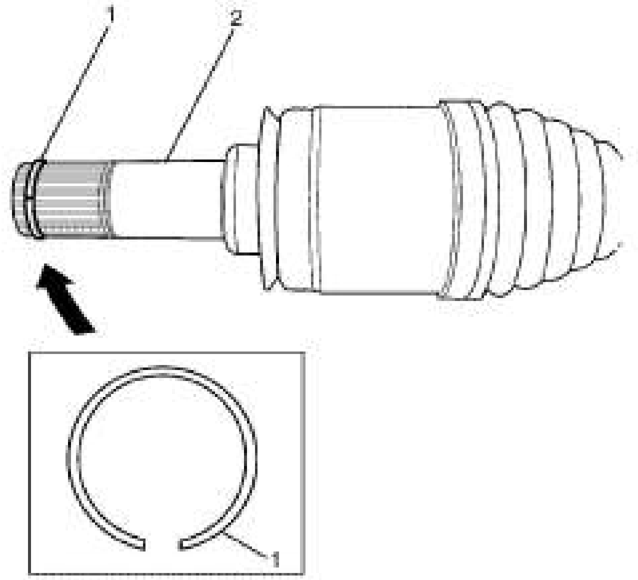
Important: Do not pull on the interconnecting shaft as it will pull apart the inboard joint.

Important: Do not damage the axle seal when disconnecting the wheel drive shaft (1) from the differential (2). Cuts or abrasions will damage the axle seal and result in lubricant leakage from this area.

Important: Use a suitable tool to pry the inner constant velocity joint out of the differential to release the snap ring.

Important: Support the wheel drive shaft when removing as the rear subframe may cut the inner constant velocity boot.

17. Disconnect the wheel drive shaft (1) from the differential (2).
18. Remove the wheel drive shaft (1) from the vehicle.



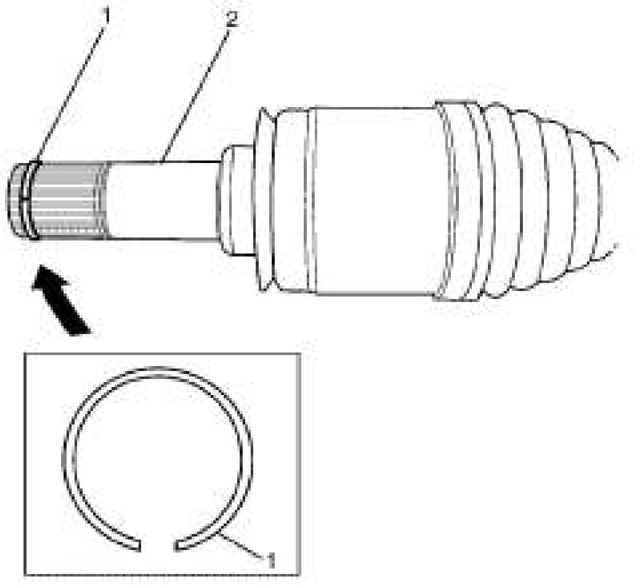
Important: The snap ring (1) is a single use part and must be discarded after removal.

19. Remove the snap ring (1) from the inner constant velocity joint (2).

    Discard the snap ring.

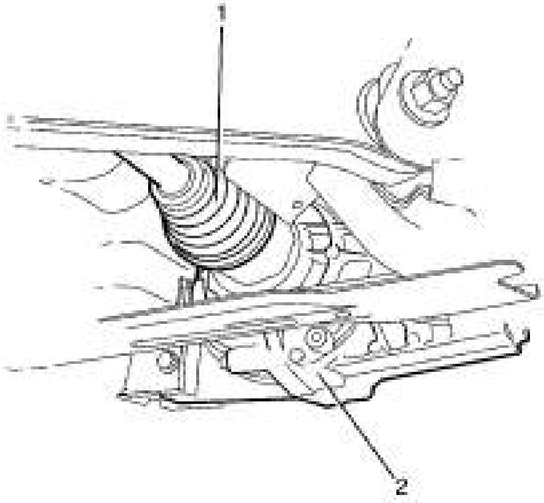
20. Inspect the wheel drive shaft assembly for excessive wear and/or damage. Inspect the following:
    - Wheel Drive Shaft.
    - Inner Joint Boot. For replacement refer to Rear Wheel Drive Shaft Inner Joint Boot Replacement.
    - Inner Constant Velocity Joint. For replacement refer to Wheel Drive Shaft Inner Joint and Boot Replacement.
    - Outer Joint Boot. For replacement refer to Rear Wheel Drive Shaft Outer Joint Boot Replacement.
    - Outer Constant Velocity Joint. For replacement refer to Wheel Drive Shaft Outer Joint and Boot Replacement.

Installation Procedure



Important: The gap in the snap ring (1) must be at the bottom.

1. Install the NEW snap ring (1) to the wheel drive inner constant velocity joint (2).



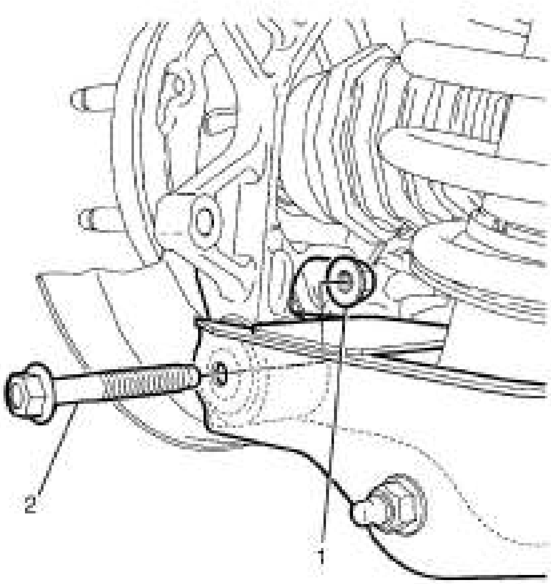
Important: Do not damage the axle seal when installing the wheel drive shaft (1) to the differential (2). Cuts or abrasions will damage the axle seal and result in subsequent lubricant leakage from this area.

2. Install the wheel drive shaft (1) to the differential (2).

Important: Pull the wheel hub assembly outwards to position the wheel drive shaft through the wheel hub assembly.

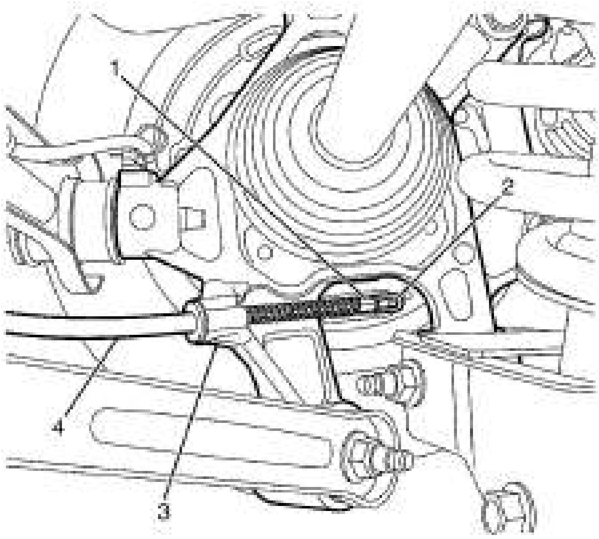
3. Position the wheel drive shaft through the wheel hub assembly.

Notice: Refer to Fastener Notice in the Preface section.



4. Install the lower control arm to knuckle retaining bolt (2) and NEW nut (1).

Tighten
Tighten the bolt and nut to 105 N·m (77 lb ft).

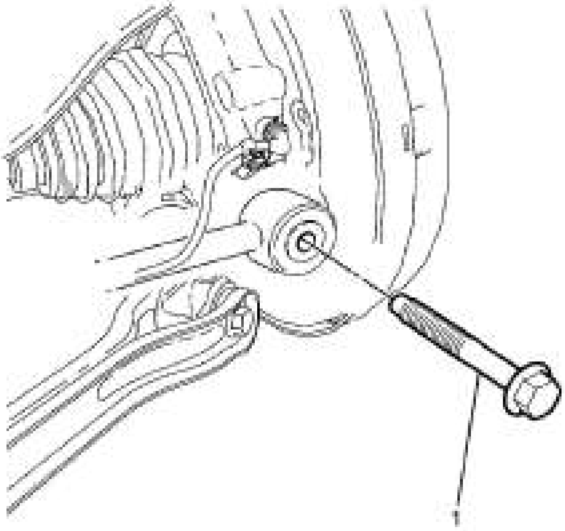


5. Install the rear park brake cable (4) into the rear knuckle (3).

   Make sure that the rear park brake cables (4) are properly seated.

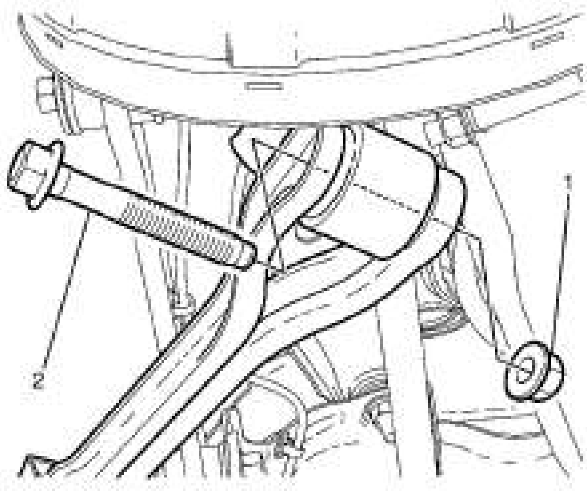
   Important: Attach the rear park brake cable and clevis (1) to the park brake actuator (2) by pivoting the rear park brake cable and clevis (1) rearward using pliers.

6. Attach the rear park brake cable and clevis (1) to the park brake actuator (2).



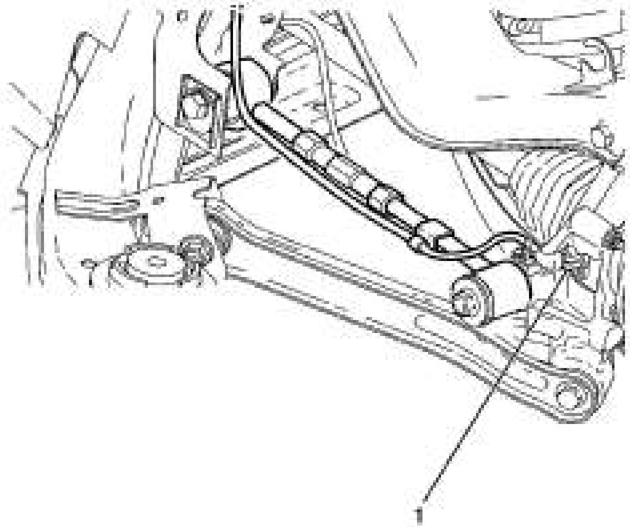
7. Install the I-Link to knuckle retaining bolt (1) and washer (2).

   Tighten
   Tighten the bolt to 105 N·m (77 lb ft).



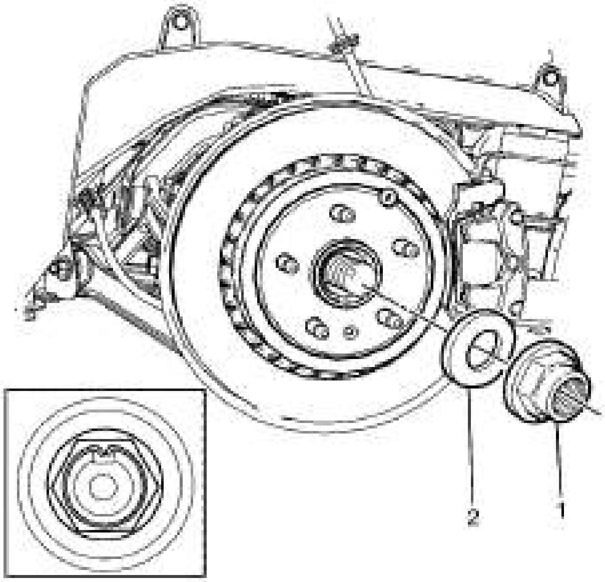
8. Install the Y-Link to the knuckle retaining bolt (2) and NEW nut (1).

   Tighten
   Tighten the bolt and nut to 170 N·m (126 lb ft).

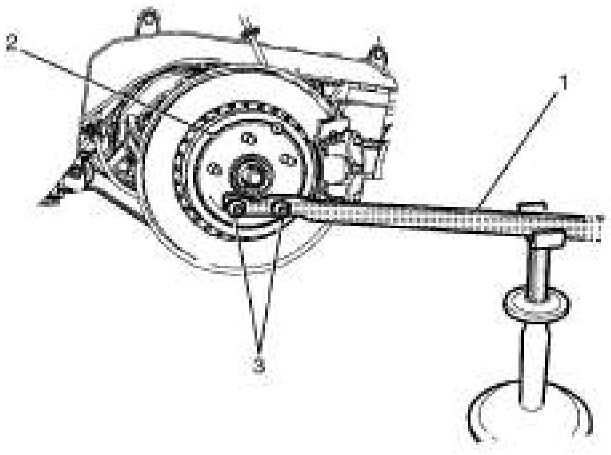


Important: The wheel speed sensor cable must be secured to protect it from damage.

9. Connect the wheel speed sensor electrical connector (1).



10. Install the NEW wheel drive shaft washer (2) to the wheel hub assembly.
11. Install the NEW wheel drive shaft nut (1) to the wheel hub assembly.



12. Install the KM-468 (1) to the wheel hub assembly (2) with two inverted wheel nuts (3).
13. Support the KM-468 (1) outer end on a safety stand.

Notice: Refer to Fastener Notice in the Preface section.

Important: There are two suitable methods of tightening the wheel drive shaft retaining nut. DO NOT EXCEED THE SPECIFIED TIGHTENING VALUES, otherwise premature bearing failure may result.

14. Preferred Method

Tighten
Tighten the nut on first pass to 150 N·m (111 lb ft).

Loosen
Loosen the nut on second pass by 180 Degrees.

Tighten
Tighten the nut on third pass to 425 N·m (313 lb ft)

Crimp nut.

Alternate Method

Tighten
Tighten the nut on first pass to 150 N·m (111 lb ft).

Loosen
Loosen the nut on second pass by 180 Degrees.

Tighten

Tighten the nut on the third pass to 50 N·m (37 lb ft)

Tighten
Tighten the nut on the forth pass by 45 Degrees

Crimp nut.

15. Remove the KM-468 (1).
16. Use a suitable tool to crimp the NEW wheel drive shaft nut to the wheel drive shaft keyway.
17. Install the rear wheel. Refer to Tire and Wheel Removal and Installation.
18. Check the differential fluid level. Refer to Rear Axle Lubricant Level Inspection.
19. Remove the safety stands.
20. Lower the vehicle to the ground.

Wheel Drive Shafts Description and Operation

The wheel drive shaft assemblies are flexible assemblies consisting of an inner and outer constant velocity joint connected by a interconnecting shaft. The inner constant velocity joint is flexible and can move in and out. The inner constant velocity joint is replaceable. The outer constant velocity joint is flexible, but cannot move in or out. The outer constant velocity joint is pressed onto the interconnecting shaft and is replaced as a complete outer constant velocity joint and interconnecting shaft assembly. Both constant velocity joints use rubber joint boots to protect and seal the constant velocity joints from dirt, water, and atmospheric conditions. The joint boots also contain lubricating grease required by the constant velocity joints for lubrication and quiet operation. Inner and outer joint boot kits are available and can be replaced individually as required. The inner constant velocity joints incorporate a male spline and interlock with the differential gears using barrel type snap rings. The snap rings are replaced after removal. The outer constant velocity joint is secured to the wheel/hub assembly with a locking nut and washer. The nut must be peened over into the keyway of the outer constant velocity joint stem to secure. The nut is discarded after removal. The wheel drive shafts transmit power from the differential to the wheel hubs. The constant velocity joints enable the wheel drive shafts to transmit the power with a flexible and quiet operation.

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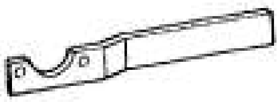
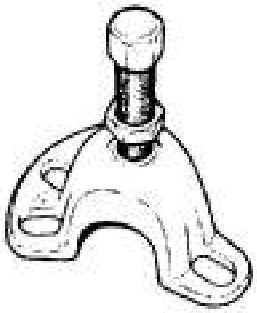
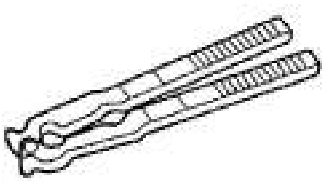
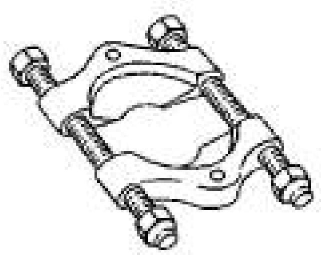
Special Tools

Illustration	Descripton	Tool Classification
	KM 468 Holding Bar	Desirable
	7208 Rear Axle Removal	Unique
	J 22610 Keystone Pliers	Desirable
	J 22912-01	

	Press Plates	Desirable

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Driver Information and Entertainment | Preliminary Information | **Document ID: 2155348**

#PIC3011E: OnStar Voice Recognition Operation Issues - keywords information intermittent microphone performance voice - (Jun 18, 2008)

Subject: OnStar® Voice Recognition Operation Issues

Models: All 2000-2009 OnStar® Equipped vehicles

This PI was superseded to update model year and diagnostic information. Please discard PIC3011D.

The following diagnosis might be helpful if the vehicle exhibits the symptom(s) described in this PI.

Condition/Concern:

When using the OnStar® voice recognition dialing, the customer may report that the system does not respond properly to some numbers and/or commands.

Recommendation/Instructions:

Dealers should test the OnStar® voice recognition (VR) system with the customer in the vehicle to verify the condition. It is helpful for the technician to also operate the VR to confirm that the system does respond with the customer present. If available, the dealer should also have the customer try the voice recognition in an identical vehicle. If the OnStar® system properly responds to any command for the user, the hardware is assumed to be good. In rare instances a specific command or number may not respond properly for any user. Only in these rare occasions would hardware be suspect.

The customer should be directed to the operational characteristics in the OnStar® Users Guide. They may also be directed to contact OnStar® Customer Assistance, who can provide additional guidance with system operation and voice recognition tips. Dealers may also refer to OnStar Description and Operation in service information (eSI) and go to the section labeled "General Tips for Better Speech Recognition". This information is available in eSI for most vehicles and can be useful when working through the concern with some customers.

Please follow this diagnostic or repair process thoroughly and complete each step. If the condition exhibited is resolved without completing every step, the remaining steps do not need to be performed.

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""do-it-yourselfer"". They are written to inform these technicians of conditions that may occur on some vehicles, or to provide information that could assist in the proper service of a vehicle. Properly trained technicians have the equipment, tools, safety instructions, and know-how to do a job properly and safely. If a condition is described, DO NOT assume that the bulletin applies to your vehicle, or that your vehicle will have that condition. See your GM dealer for information on whether your vehicle may benefit from the information.

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2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Driver Information and Entertainment | Preliminary Information | **Document ID: 2171633**

#PIC3597F: Disabled OnStar System Identification - keywords blue button communication deactivated digital disabled information led no operation red - (Jul 23, 2008)

Subject: **Disabled OnStar® system identification**

Models: **All OnStar® equipped vehicles**

This PI was superseded to update text referenceing Bulletin. Please discard PIC3597E.

The following diagnosis might be helpful if the vehicle exhibits the symptom(s) described in this PI.

Condition / Concern:

A customer may report that the OnStar® does not connect, status LED is not illuminated or a disabled system message is heard. This may be due to the OnStar® system being disabled.

Recommendation / Instructions:

OnStar® will deactivate vehicles where the customer has chosen not to renew their OnStar® subscription after expiration, when the initial activation has never taken place or the vehicle has an analog only system that was disabled due to the analog sunset (see the current version of service bulletin 05-08-46-006). As a part of the OnStar® renewal communications, customers are notified that the OnStar® system in their vehicle will be deactivated unless they elect to renew the account. Customers who had an analog only system were notified that their systems would be disabled once the analog sunset (February 2008) was reached.

In most cases a check with the Tech 2 will find no current or history DTCs as well a MIN of 1234567890 or 7348436002 (after 2/3/08) may be listed.

After the vehicle has been successfully deactivated, customers will experience the following when attempting to contact OnStar® from their vehicle:

Blue OnStar® key: depending on vehicle hardware, the customer will either connect to a sales advisor or will hear an automated demonstration message. If the demonstration message is heard the customer needs to press the OnStar® button again to make a call for activation.

Gen 6 and newer systems may not have the OnStar® LED illuminated. The technician may not be able to activate the green LED with the "Green LED" test option in the Tech 2. This is a normal condition for a deactivated version 6.0 and newer system. No further action is needed unless the customer has or wants to renew their OnStar® account.

Note: If the customer wants to activate OnStar®, press the OnStar blue button. The LED will illuminate and start flashing, Allow the call to complete (this may take several minutes). Once the call completes request a unit configuration and retest the system.

Emergency key: A demo message will be played indicating the service has been deactivated. (on 1999 models, the operation of this key does not change with deactivation.)

Note: When successfully deactivated, the OnStar® system will not attempt to connect to the OnStar center if the vehicle's airbags deploy.

Certain vehicles that have never had an active OnStar® account may mimic the symptoms of a cellular or vehicle hardware concern, once they have been deactivated as they may not be able to establish a connection to the OnStar® center.

Please follow this diagnostic or repair process thoroughly and complete each step. If the condition exhibited is resolved without completing every step, the remaining steps do not need to be performed.

GM bulletins are intended for use by professional technicians, NOT a ""do-it-yourselfer"". They are written to inform these technicians of conditions that may occur on some vehicles, or to provide information that could assist in the proper service of a vehicle. Properly trained technicians have the equipment, tools, safety instructions, and know-how to do a job properly and safely. If a condition is described, DO NOT assume that the bulletin applies to your vehicle, or that your vehicle will have that condition. See your GM dealer for information on whether your vehicle may benefit from the information.

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#PIC4310C: Unable To Connect To OnStar Handsfree Calling Digital Hardware - keywords cellt cellular communication droppedcall failedtovoice information intermittent OPC operation no noconnect performance region - (Jun 18, 2008)

Subject:	**Unable to connect to OnStar or use OnStar handsfree calling Digital Hardware**
Models:	**All OnStar equipped vehicles**

This PI was superseded to update Recommendation/Instructions. Please discard PIC4310B.

The following diagnosis might be helpful if the vehicle exhibits the symptom(s) described in this PI.

Condition/Concern:

The OnStar Blue button, emergency -red button or/and HFC (call answer/end button) key press results in: Cell messages, progression tones (1 every 6 seconds), dropped calls or failed to voice call. A possible cause could be a lack/limited cellular coverage or outage in the area. Incorrect PRL or incorrect home SID may cause this concern.

Recommendation/Instructions:

The following information is to be retrieved with the Tech2 before calling General Motors Technical Assistance.

It is imperative that when retrieving ALL following information the vehicle is Outside in an Open Area

Module ID 2

8 Digit GM part number:

Electronic Serial Number:

VCI Module Station ID:

Module ID:

Data Display

Signal Strength:

Signal Type:

Trans ID:

Cellular Information

Call mode:

Current System ID:

Digital Home NID:

Digital Home SID:

PRL Outdated Status:

PRL Version Number:

Off Board Navigation (Gen 7):

> Module Set Up >Program Phone Number

MIN:

MDN:

Perform an outbound OnStar personal call:

Results:

OnStar key press

Results:

Can the vehicle receive a call?

Results:

Test the Emergency Button:

If answered tell adviser you have no Emergency and you are testing the OnStar

After retrieving the above information with tech 2 with the vehicle outside please look at the following information.

If Current SID reads 40000 or 03353, Call Mode 0, 13, 60, and Signal Strength of 0 or 106 the Cell Antenna Circuit need to be tested.

When testing a Fluke Meter is preferred (J 39200) and have set on an Auto Ranging Scale. When making note of value also note the scale the meter is displaying. When testing the Cell Antenna circuit to disconnect antenna from VCIM and measure pin/shield. Note: Blue is always GPS and the Screw On Connector or Violet or White is the Cellular. Please document if you connect to the OnStar center with no data (failed to Voice) at any time.

Please follow this diagnostic or repair process thoroughly and complete each step. If the condition exhibited is resolved without completing every step, the remaining steps do not need to be performed.

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#PIC4564A: Handsfree Calling Inop With Demo Message On OnStar Keypress - keywords 05-08-46-006N blue button communication digital disabled message no OPC operation vs3bgen6 vs3bgen7 - (Apr 10, 2008)

Subject: **Handsfree Calling inop with demo message on OnStar® keypress**

Models: **All 2000 - 2009 OnStar® equipped vehicles with GEN 6 or GEN 7 hardware**

This PI was superseded to update model years and bulletin reference information. Please discard PIC4564.

The following diagnosis might be helpful if the vehicle exhibits the symptom(s) described in this PI.

Condition/Concern:

It has been determined that all vehicles that have Gen 6.X (Gen 6.0, 6.05, 6.06, 6.05R, 6.11, 6.15, 6.4) or 7.X (7.0, 7.04, 7.045, 7.0L, 7.1L) could have a concern where the OnStar® Handsfree Calling (OHFC) may be inoperative as well as the demo message being heard when the OnStar® blue button is pressed.

This is due to the module being reset to its default configuration through an internal trigger in the VCIM or by a call into the vehicle by OnStar® to disable the system for an identified concern.

Recommendation/Instructions:

Important: Do not perform a Set-up new OnStar®/VCIM setup on this vehicle as they may cause the concern. If a Set-up new OnStar®/VCIM setup was not performed, perform the following diagnostics:

1. Verify that the OnStar® account was not canceled/deactivated where this may be a normal condition.
2. Check to see if the customer received a letter referencing B02-08-46-007C. If so, follow bulletin directions.
3. If neither step 1 or 2 applies, contact the General Motors Technical Assistance Center (GMTAC) for further assistance.

Please follow this diagnostic or repair process thoroughly and complete each step. If the condition exhibited is resolved without completing every step, the remaining steps do not need to be performed.

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#PIC4600A: Information Required Before Ordering A New OnStar VCIM For A DTC B1000 - keywords blue button communication message no noconnect operation - (Sep 19, 2008)

Subject:	**Information required before ordering a new OnStar® VCIM for a DTC B1000**
Models:	**2002 through 2009 OnStar® equipped vehicles**

This PI was superseded to update model years and text. Please discard PIC4600.

The following diagnosis might be helpful if the vehicle exhibits the symptom(s) described in this PI.

Condition/Concern:

Before ordering a VCIM for a DTC B1000, GMTAC has been requested to document specific information about the DTC. Dealer technicians will find most of this information using the TECH2.

Recommendation/Instructions:

GM TAC will need to verify the original customer concern that led to the discovery of the DTC B1000 with the technician. Some of the questions GM TAC may ask are "What happens when an OnStar® key press is made?", "Does the system connect on a key press?", "Does OnStar® have a current GPS location on a key press?"

On GM LAN vehicles the sub code must be recorded. example B1000 SYM00

If available on the TECH2 for the vehicle, technicians should select the following menu and record the data from the VCIM:

(Will not be available on the Chevrolet Colorado and Trailblazer; GMC Canyon and Envoy, Hummer H3)

Body/Vehicle Communications Interface Module/Special Functions/ B1000 Data

DPID 11 Byte1:

DPID 11 Byte2:

DPID 11 Byte3:

Dealers should also review service bulletin 03-08-46-004D and record all relevant module information to expedite the order process.

Please follow this diagnostic or repair process thoroughly and complete each step. If the condition exhibited is resolved without completing every step, the remaining steps do not need to be performed.

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#PIC4801A: OnStar Turn By Turn / TBT Feature Inoperative - keywords blue button calibration call cellular communication data digital navigation operation performance - (Aug 1, 2008)

Subject: OnStar® Turn By Turn / TBT Feature Inoperative

Models: All 2006-2009 OnStar Gen 7 and Gen 8 equipped vehicles with TBT

This PI was superseded to update model years and text. Please discard PIC4801.

The following diagnosis might be helpful if the vehicle exhibits the symptom(s) described in this PI.

Condition/Concern:

OnStar Center is unable to provide Turn by Turn services

Recommendation/Instructions:

Turn by Turn inop Diagnostic information:

Turn by Turn feature only available on Gen 7 or higher VCIM

OnStar system must be activated and configured in order to have Turn by Turn services.

Vehicle must have Anti-Lock Brakes System to have Turn by Turn feature.

Vehicle must be in a cellular market that supports Turn by Turn, Packet Data market.

Vehicle must be able to get a GPS location.

Verify no DTCs are present in vehicle ABS and VCIM.

The following information is to be retrieved with the Tech 2 before calling General Motors Technical Assistance.

Module ID 2

8 Digit GM part number:

Electronic Serial Number:

VCI Module Station ID:

Module ID:

Data Display

Signal Strength:

Signal Type:

Trans ID:

Cellular Information

Call mode:

Current System ID:

Digital Home NID:

Digital Home SID:

PRL Outdated Status:

PRL Version Number:

Off Board Navigation (Gen 7):

Network Access:

Username:

Program Phone Number

MIN:

MDN:

Perform an outbound and inbound OnStar personal call:

Results:

OnStar key press

Results:

Can the vehicle receive a call?

Results:

Vehicle must be driven 5-10 miles with an open sky condition to calibrate Dead Reckoning for Turn by Turn, Tech 2 Off-Board Navigation OBN flag will read YES when calibrated.

Perform an OnStar blue button press, ask the adviser for a Turn by Turn route. Is the adviser able to give TBT route?

Making an outgoing call and one incoming call to and from the vehicle, (this helps with any cellular diagnostic that may preformed by the cellular carrier).

If normal Diagnostic does not lead to a resolution contact GM Technical Assistance.

Please follow this diagnostic or repair process thoroughly and complete each step. If the condition exhibited is resolved without completing every step, the remaining steps do not need to be performed.

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#PIC4889: OnStar Deactivated Returned To Stock New Vehicle Inventory - keywords activation button deactivated disabled inventory keypress letter - (Jun 5, 2008)

Subject:	**OnStar® deactivated Returned to Stock New Vehicle Inventory.**
Models:	**All GM Vehicles Returned to Stock & Equipped with OnStar® (RPO UE1)**

The following diagnosis might be helpful if the vehicle exhibits the symptom(s) described in this PI.

Condition/Concern:

OnStar® has recently discovered a software anomaly affecting vehicles that have been returned to dealer stock, following an incomplete sale of the vehicle. If a customer delivery record was created and the vehicle subsequently returned to stock, the OnStar® system may have been inadvertently disabled. Records indicate many of these returned to stock (RTS) vehicles still remain in dealer inventories. Due to the nature of disablement, these vehicles cannot be contacted by OnStar® and will require a blue OnStar® button press to enable the necessary actions to take place will correct this condition.

Recommendation/Instructions:

OnStar® will notify, by mail, affected customers who may have since purchased one these previously returned to stock vehicles with directions to perform a blue button press to complete the vehicle and account configuration process.

Dealers are requested to perform a blue button press on inventoried vehicles. A list of affected vehicles is going out to dealers VIA DCS messaging. Additional information is forthcoming.

To check the OnStar system simply perform a blue button press. If the "Connecting to Onstar" message is immediately heard the system is fully configured and no further action is required. If an automated message is heard when the button is pressed, the vehicle requires a reconfiguration and a second button press will connect the vehicle to an advisor at the OnStar Center. You will be transferred to the technical support group, who will assist you in the configuration of the customer's vehicle.

No part replacement is required and the configuration process will complete the vehicle and account set-up process.

Please follow this diagnostic or repair process thoroughly and complete each step. If the condition exhibited is resolved without completing every step, the remaining steps do not need to be performed.

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#PIC4935: OnStar Power Consumption - keywords battery digital discharge drain draw parasitic VCIM - (Jul 23, 2008)

Subject: OnStar® Power Consumption

Models: 2000 - 2009 OnStar Equipped vehicles with Digital Hardware

The following diagnosis might be helpful if the vehicle exhibits the symptom(s) described in this PI.

Condition / Concern:

During battery parasitic drain testing, there may be some confusion as to the normal power consumption reading from the OnStar® system.

Recommendation / Instructions:

When performing current draw tests it is important to understand the power cycles of the various OnStar® systems. All OnStar® customers with currently active vehicles have digital/analog cellular capability. A green status LED on the OnStar® keypad normally indicates an active OnStar® account. A red LED indicates a system DTC. On Gen 6 and later systems, a clear, or "dark" LED may indicated the OnStar® system has been deactivated or may possibly have a no power concern/no communication.

The OnStar® system will stay powered up after ignition off for an extended time in order to allow for remote services like door unlock, horn honk, light flash, etc to take place as requested by the customer. Power cycle (also referred to as DRX) times vary depending on the generation of the OnStar® system. Technicians may identify the system generation by using a Tech 2 (Body>VCIM>Module ID Information>Module Information 2) or by using www.onstarenrollment.com.

All Gen 6, Gen 7, and 8 systems are powered up continuously for 48 hours from ignition off. After the 48 hours the Gen 6 and some Gen 7 power off; Gen 7.xxL, and all Gen 8 systems will enter a 9 minute OFF 1 minute ON power cycle for an additional 72 hours. At the beginning and end of the 1 minute ON stage, you may or may not experience a short spike of current at the beginning and at the end. This allows for calls from OnStar to be received by the system. After 120 hours from ignition off, these systems then completely power off.

The expected current draw of the OnStar® module is:

- IGN ON - 240 to 400 mA
- IGN OFF - 3 to 20 mA for 48 hours
- IGN OFF - after 48 hours (120 hours on specified VCPs) - 0.2 to 0.8 mA

- During extended voltage monitoring for platform battery parasitic it is possible that you may see a voltage spike caused by a cellular registration call that was triggered by the local cellular system, or that OnStar® has set a monthly trigger for a vehicle data upload call for the OnStar® Vehicle Diagnostic email upload. Note that in analog cellular markets all module generations completely power down after 48 hours. You can contact Technical Assistance to find out if your dealership cellular market or the customer's home cellular market still has analog service.

Please follow this diagnostic or repair process thoroughly and complete each step. If the condition exhibited is resolved without completing every step, the remaining steps do not need to be performed.

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#PIC4944: Unable To Program Replacement VCIM - keywords module ogen8 onstar programming service sps tech2 techline tis2web UE1 vs3bgen7 - (Aug 1, 2008)

Subject:	**Unable to program replacement VCIM**
Models:	**All 2009 MY vehicles with OnStar® (UE1)**

The following diagnosis might be helpful if the vehicle exhibits the symptom(s) described in this PI.

Condition / Concern:

After replacement of an OnStar® VCIM on any 2009 MY vehicle the technician may find they cannot perform the module setup (SPS) through TIS2WEB. They may also find no VCIM setup in the TECH2.

Recommendation / Instructions:

The software calibration for the VCIM is currently not loaded in TIS2WEB for most 2009 MY vehicles. This calibration is expected to be loaded by mid August 2008.

If after a VCIM is replaced the calibration is not available in TIS2WEB, dealers are to contact TECHLINE for assistance with this issue.

Please follow this diagnostic or repair process thoroughly and complete each step. If the condition exhibited is resolved without completing every step, the remaining steps do not need to be performed.

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#PIT4720: Odometer Servicing When The Odometer Cannot be Set to the Actual Mileage - keywords cluster ipc mile program - (Sep 26, 2008)

Subject: **Odometer Servicing When the Odometer Cannot be Set to the Actual Mileage - keywords Cluster IPC Mile Program**

Models: **2009 and Prior Passenger Cars and Trucks**

The following diagnosis might be helpful if the vehicle exhibits the symptom(s) described in this PI.

Condition/Concern:

When replacing or servicing the IPC/odometer the exchange center is unable to program the actual mileage on the odometer or the actual mileage is unknown.

Recommendation/Instructions:

Refer the dealer to the GM SERVICE POLICIES AND PROCEDURES MANUAL section 3.2.4 ODOMETER SERVICING

3.2.4 ODOMETER SERVICING

Various laws require that when an odometer is serviced, repaired or replaced, the mileage indicated is to remain the same as before this service, repair, or replacement. Where the odometer can not register the same mileage as before, the odometer shall be adjusted to read zero and a notice in writing shall be attached to the driver's door frame of the vehicle.

It is the general practice of ACDelco Service Centers to return repaired speedometers to their customers showing the original mileage reading on the odometer as received. This practice will apply whether or not the odometer unit is replaced. Therefore, a notice for the vehicle door frame indicating that an odometer has been set to zero normally will not be required.

In those unusual instances when the odometer cannot be set to the actual vehicle mileage, it must be set at zero and a label such as indicated below, must be affixed to the driver's door frame or the vehicle by dealer. Odometer Repair Notice Label may be obtained through GMSPO (Catalog Group 8.808).

Note: The above applies to GM Vehicles and Saab 9-7X only. For all other Saab vehicles, parts are available through normal spare parts.

ODOMETER REPAIR/REPLACEMENT

THE ODOMETER ON THIS VEHICLE WAS

REPAIRED AND TURNED BACK TO ZERO,

OR WAS REPLACED WITH AN ODOMETER

SET AT ZERO. MILEAGE PRIOR TO

REPAIR/REPLACEMENT WAS

_______________________MILES OR

_______________________KILOMETERS.

DATE REPAIRED/REPLACED:__________

BY: ________________________________

____

FEDERAL LAW PROHIBITS REMOVAL

OR ALTERATION OF THIS LABEL

PT. NO. 10443718

ODOMETER REPAIR NOTICE

Please follow this diagnostic or repair process thoroughly and complete each step. If the condition exhibited is resolved without completing every step, the remaining steps do not need to be performed.

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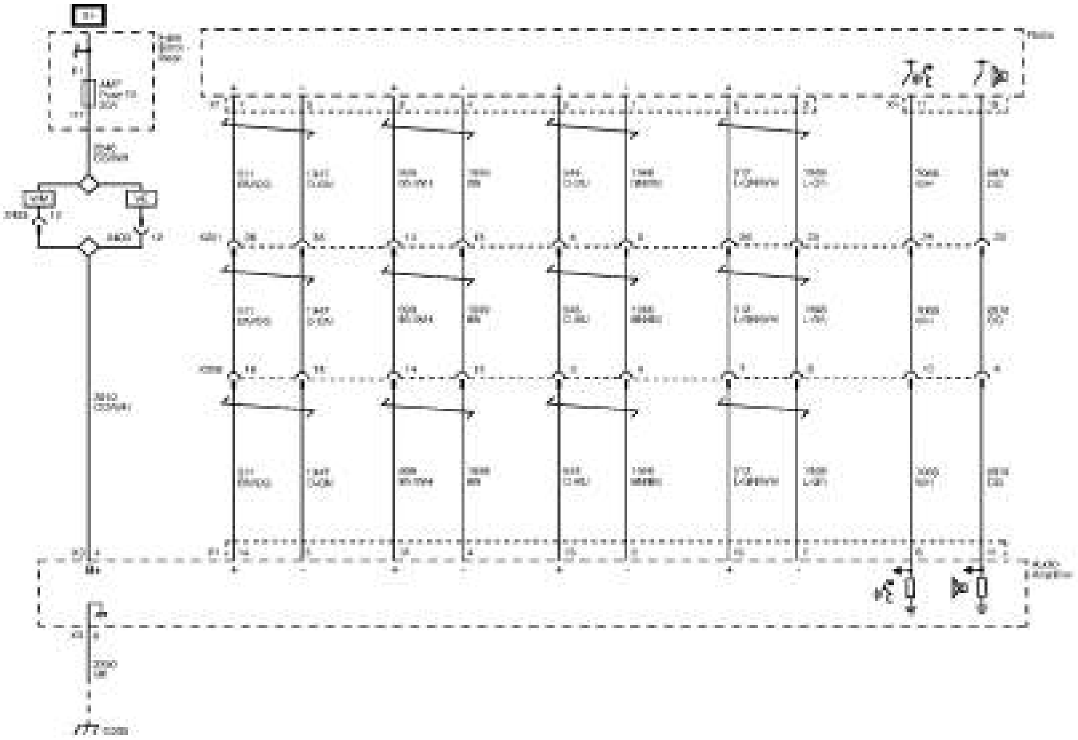
Fastener Tightening Specifications

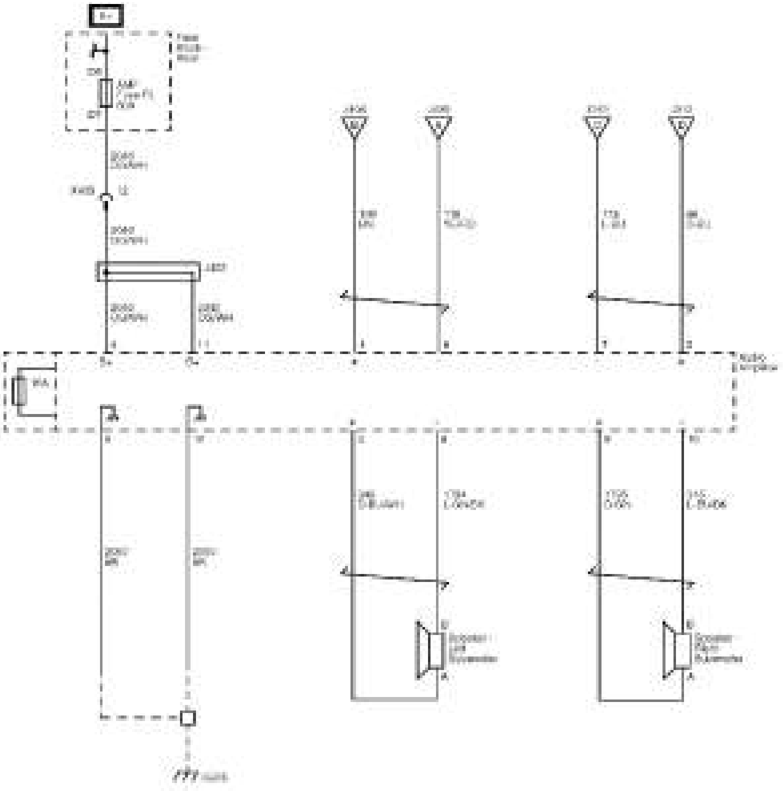
Application	Specification	
	Metric	English
Amplifier Mounting Bracket to Vehicle Retaining Bolts	22 N·m	16 lb ft
Amplifier to Mounting Bracket Retaining Screws	2 N·m	18 lb in
Antenna Module Ground Point to Roof Panel Retaining Bolt (RHD)	2 N·m	18 lb in
Antenna Module to Roof Panel Retaining Bolt	4 N·m	35 lb in
Backup Battery Cover to Telematics Module Retaining Screws (RHD)	2 N·m	18 lb in
Centre Speaker to Insulation Panel (I/P) Attaching Screws	2 N·m	18 lb in
Diversity Antenna Module to Rear Upper Quarter Panel Retaining Bolt	10 N·m	89 lb in
DVD Player Surround to Roof Panel Retaining Screw	1 N·m	9 lb in
DVD Screen Assembly to Head Restraint Assembly Retaining Screws	2 N·m	18 lb in
DVD Screen Surround to Roof Panel Retaining Screw	1 N·m	9 lb in
DVD Screen to Mounting Plate Retaining Screws	2 N·m	18 lb in
DVD Screen to RSE Assembly Bracket Retaining Screws	1 N·m	9 lb in
Front Speaker Assembly to Door Frame Attaching Screws	2 N·m	18 lb in
Grounding Point to RSE Assembly Bracket Retaining Screws (LHD)	1 N·m	9 lb in
Headliner Audio Controls to RSE Assembly Bracket Retaining Screws (LHD)	1 N·m	9 lb in
Infotainment Unit to Instrument Panel Retaining Screws	2 N·m	18 lb in
I/P Compartment Lower Retaining Screws (RHD)	2 N·m	18 lb in
I/P Compartment Upper Retaining Screws (RHD)	2 N·m	18 lb in
Navigation Interface Module (NIM) to I/P Assembly Retaining Screws (RHD)	2 N·m	18 lb in
Pivot Hinge to Mounting Plate Retaining Screws	2 N·m	18 lb in
Radio Antenna Module Ground Point to Roof Panel Retaining Bolt (Sportwagon)	2 N·m	18 lb in
Radio Antenna Module to Roof Panel Retaining Bolt (Sportwagon)	4 N·m	35 lb in
Rear Speaker Assembly to Door Frame Attaching Screws	2 N·m	18 lb in
RSE Circuit Board to Head Restraint Assembly Retaining Screws	2 N·m	18 lb in
RSE Head Restraint Escutcheon to Head Restraint Assembly Retaining Screws	2 N·m	18 lb in
RSE Interface Module to RSE Assembly Bracket Retaining Screws (LHD)	1 N·m	9 lb in
Secondary Information Centre (SIC) Display to I/P Upper Trim Panel Assembly Retaining Screws	2 N·m	18 lb in
Steering Wheel Audio Control Switch Assembly Ground Retaining Screw (SWBLHD)	1 N·m	9 lb in
Steering Wheel Hub to Rear Cover Retaining Screws	1 N·m	9 lb in
Steering Wheel Hub to Steering Wheel Audio Control Switch Assembly Retaining Screws (LHD)	2 N·m	18 lb in

Subwoofer Assembly to Rear Shelf Attaching Screws	2 N·m	18 lb in
Telematics Module to Retaining Bracket Retaining Screw (RHD)	2 N·m	18 lb in
Tweeter Speaker to I/P Attaching Screw	2 N·m	18 lb in

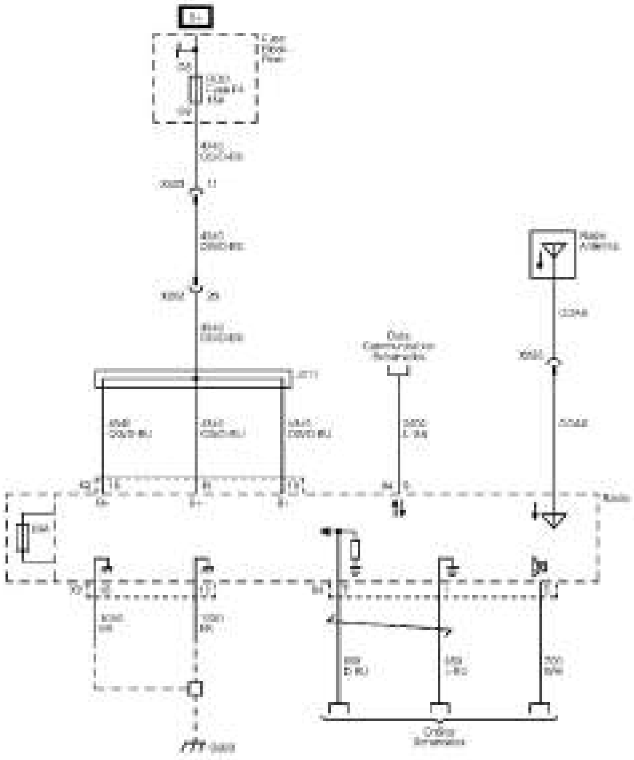
Amplifier (UQ7)



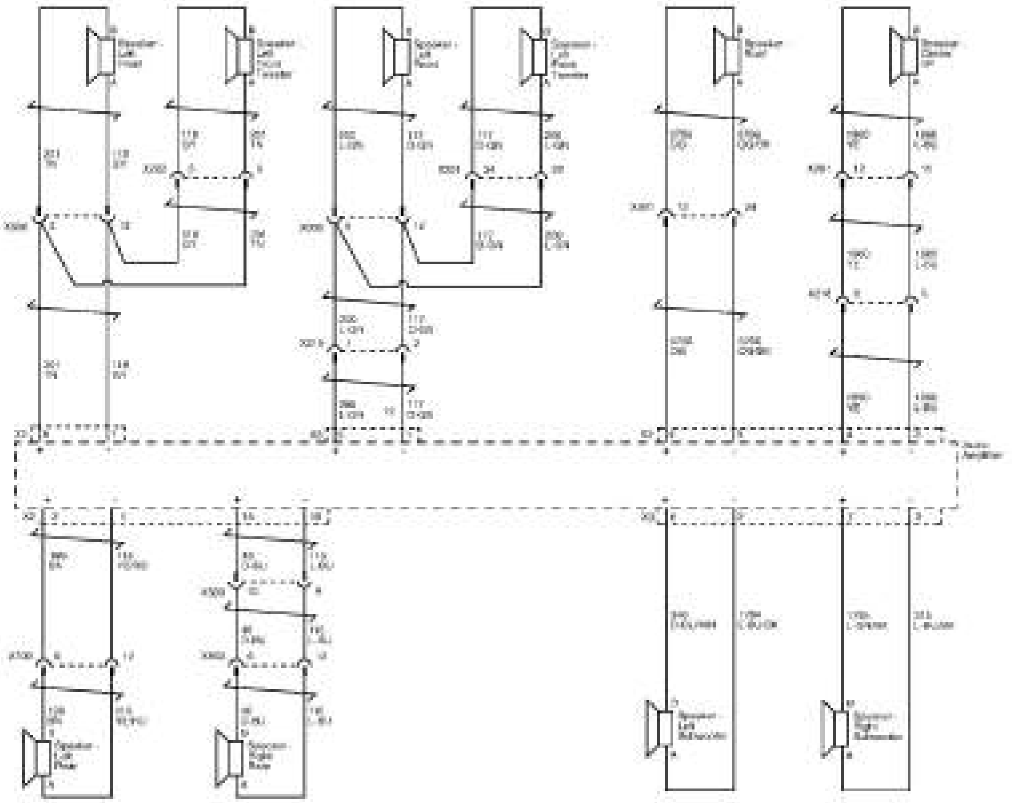
Amplifier (UWP)


B+
Audio Amplifier
Speaker - Left Subwoofer
Speaker - Right Subwoofer

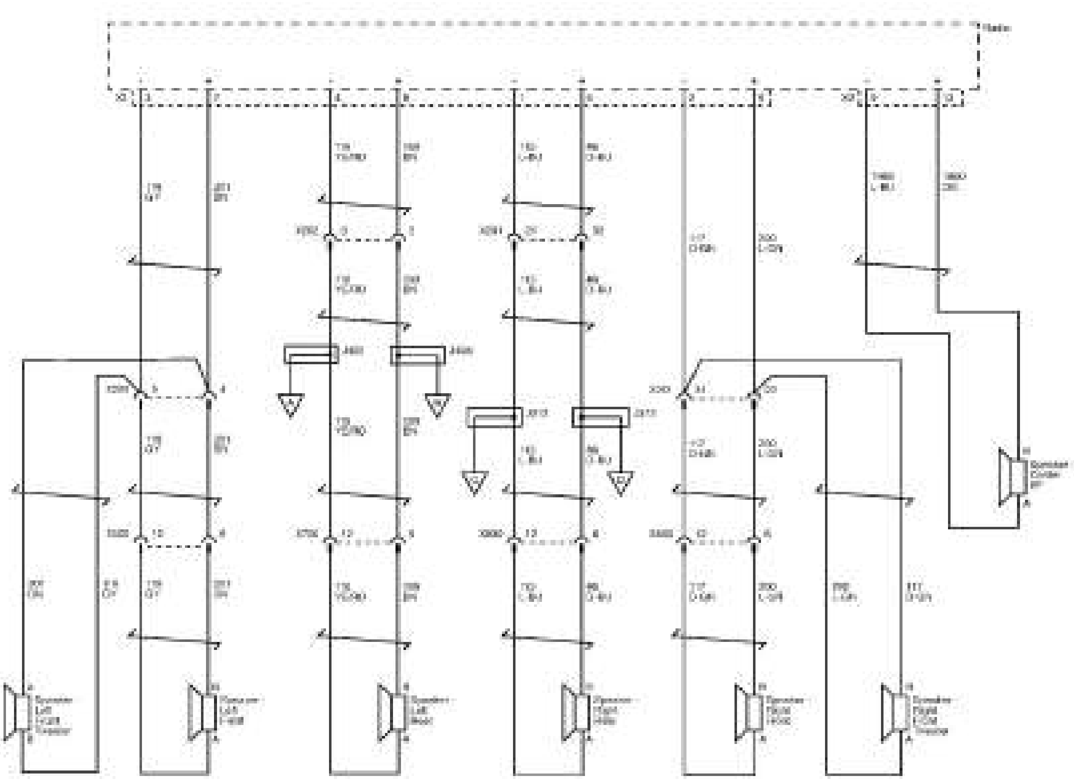
Radio Power, Ground, and Serial Data


B+
11
25
Radio Antenna
Data Communication Schematics
Radio

Speakers (UQ7)



Speakers (UWP)



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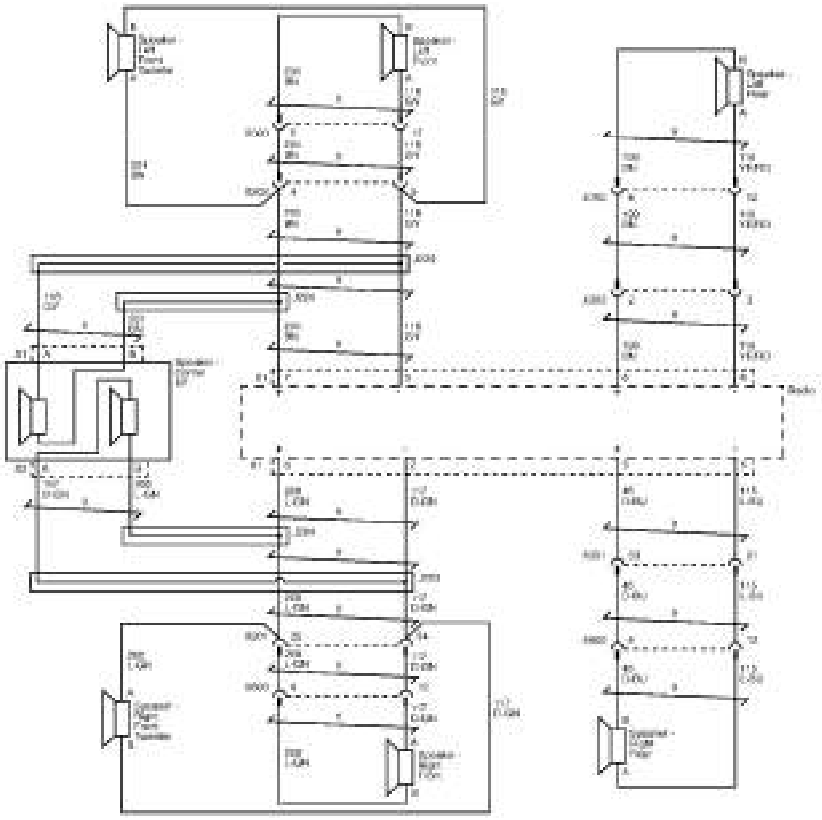
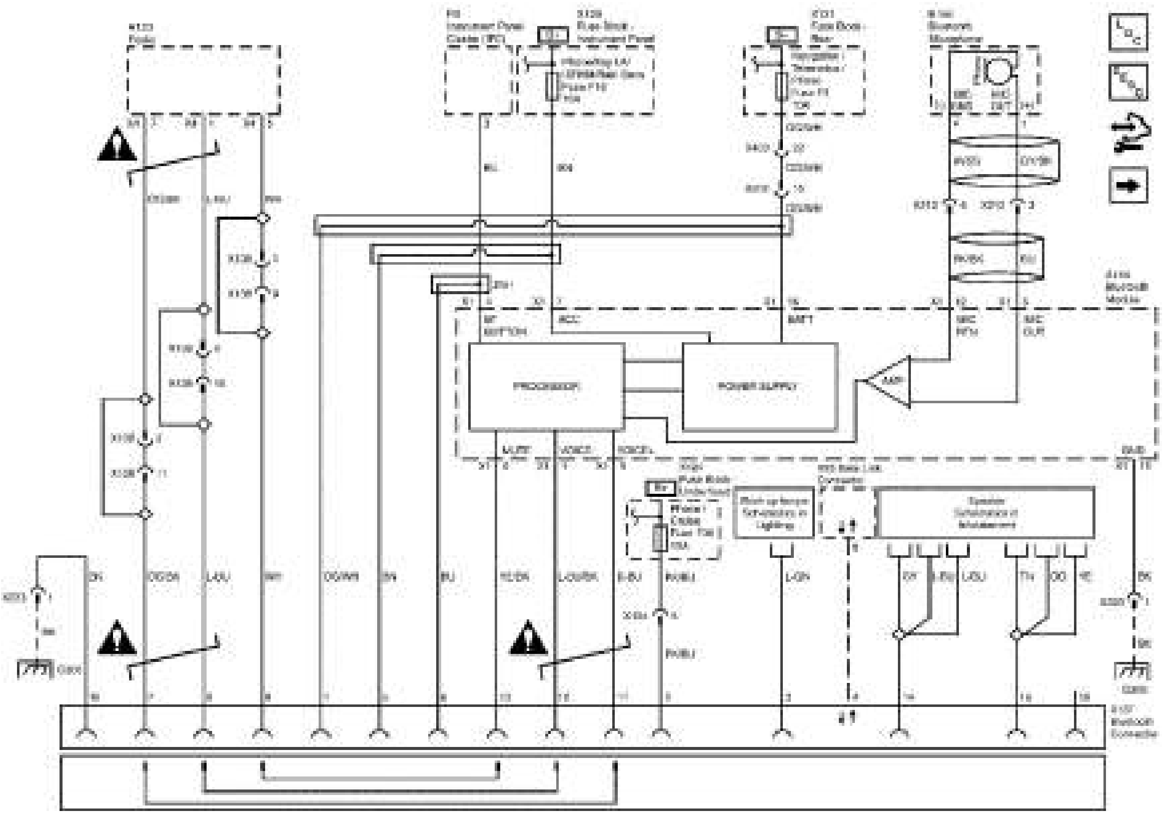
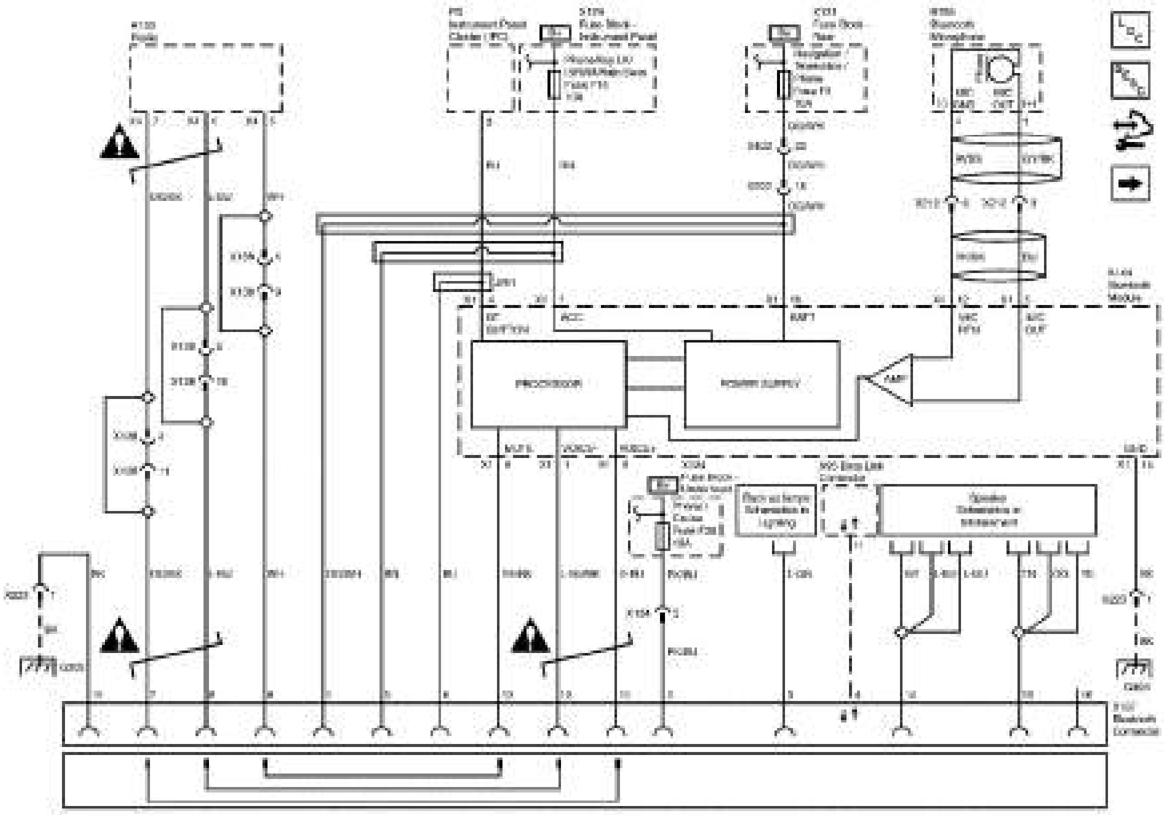
Speakers (except UWP)



Bluetooth System -- BRL


PROCESSOR
POWER SUPPLY
AMP
ACC
BATT
MIC
Fuse Block - Underhood

Bluetooth System - Except BRL


PROCESSOR
POWER SUPPLY
AMP
ACC
BATT
MIC
MIC
Bluetooth Module
Bluetooth Microphone
Instrument Panel Cluster (IPC)
Fuse Block - Instrument Panel
Speaker Schematics in Infotainment
Bluetooth Connector

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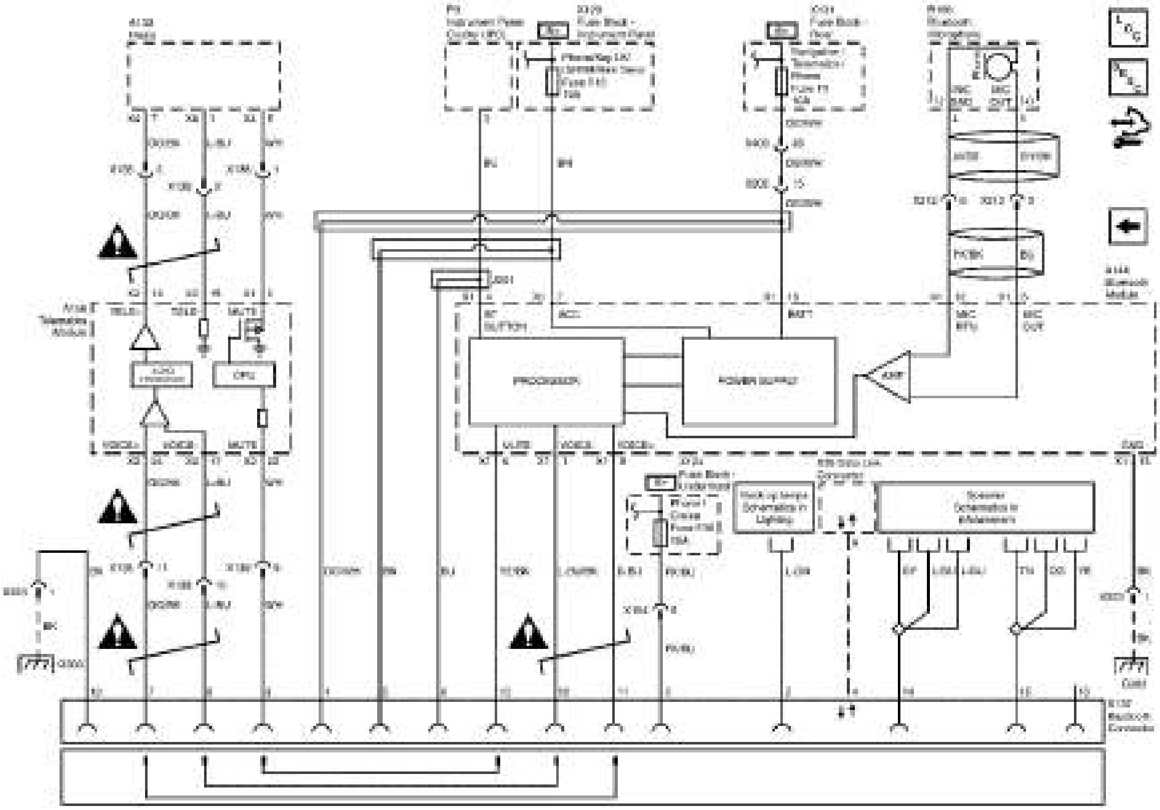
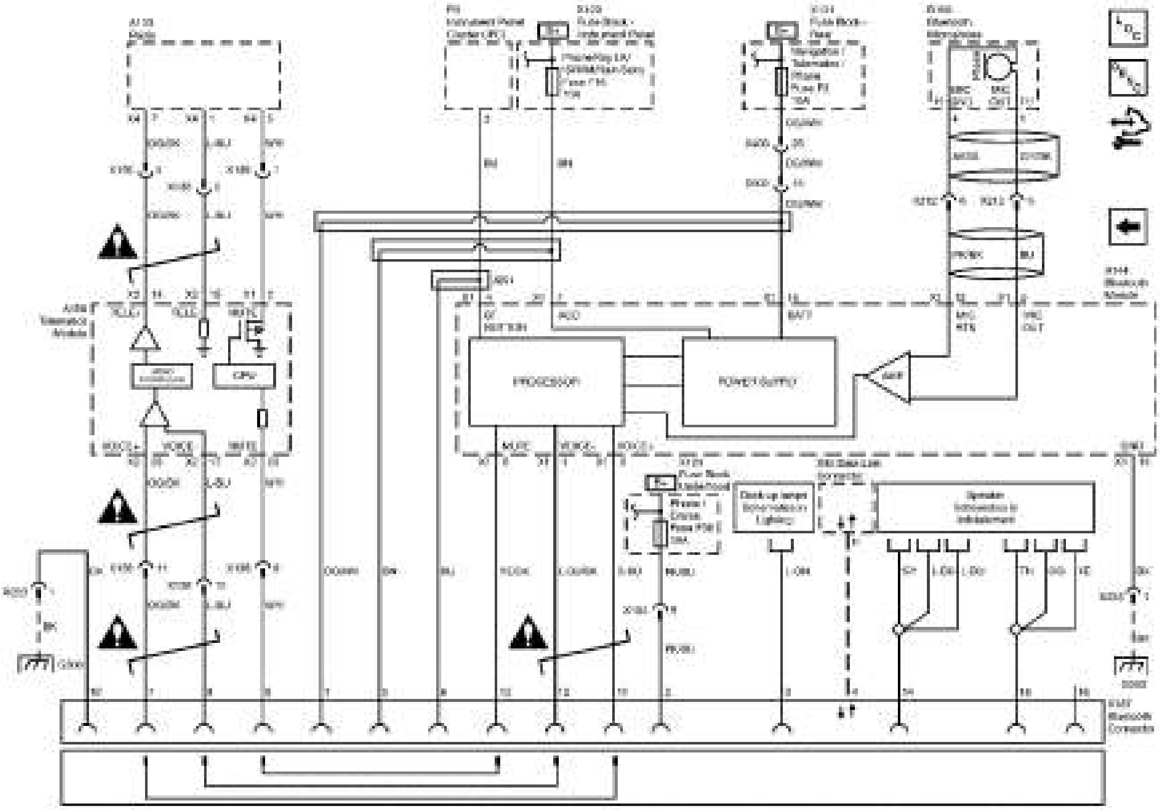
Document ID: 2032331

Bluetooth System (with Telematics) -- BRL


PROCESSOR
POWER SUPPLY
AMP
CPU
MUTE
ACC
BATT
MIC OUT

Bluetooth System (with Telematics) - Except BRL


PROCESSOR
POWER SUPPLY
CPU
AMP
MUTE
VOICE
BATT
ACC
MIC RTN
MIC OUT

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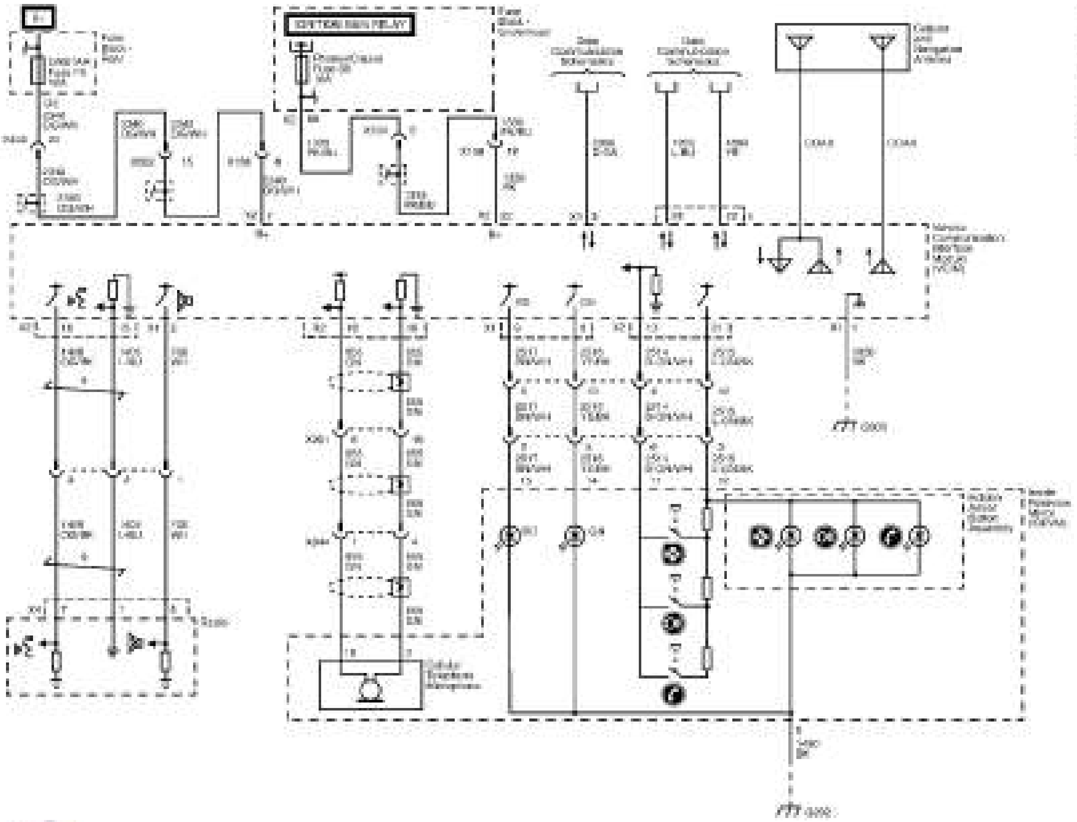
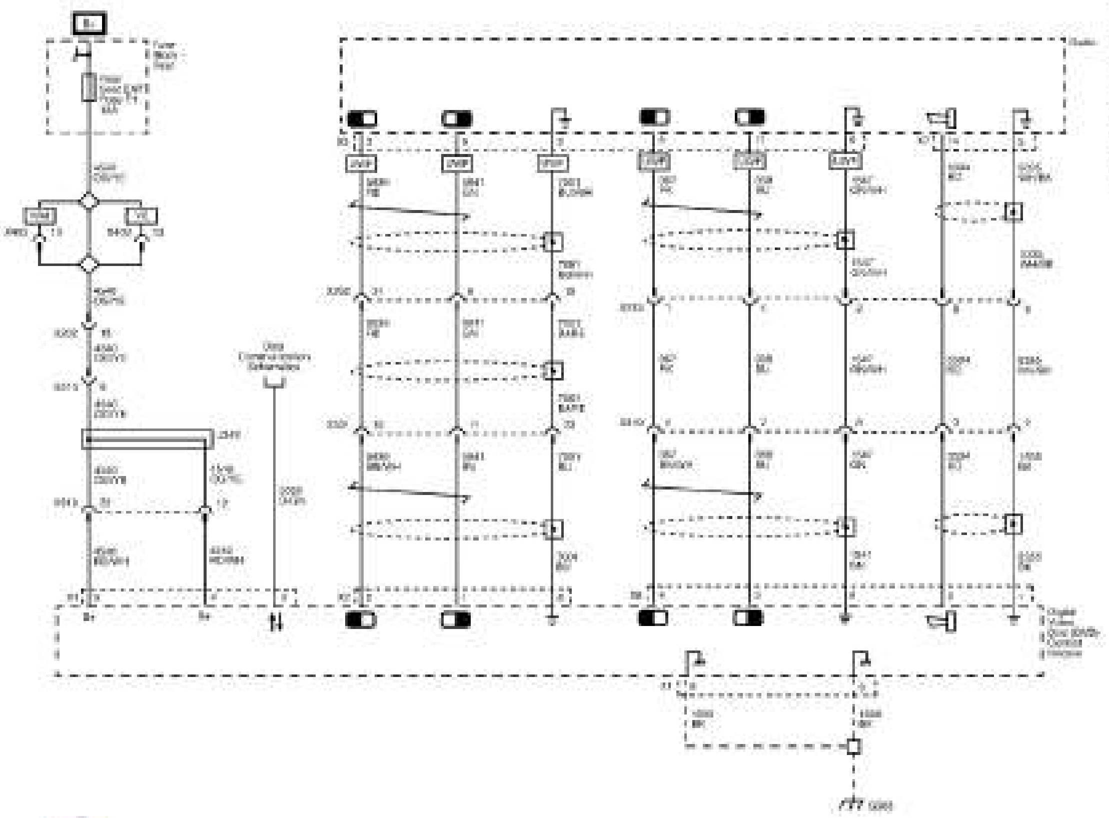
Telematics Schematics

Holden Assist (U5J)



2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Driver Information and Entertainment | Cellular, Entertainment, and Navigation | Schematic and Routing Diagrams | **Document ID: 2154653**

Module Power, Ground, Serial Data, and Radio Inputs



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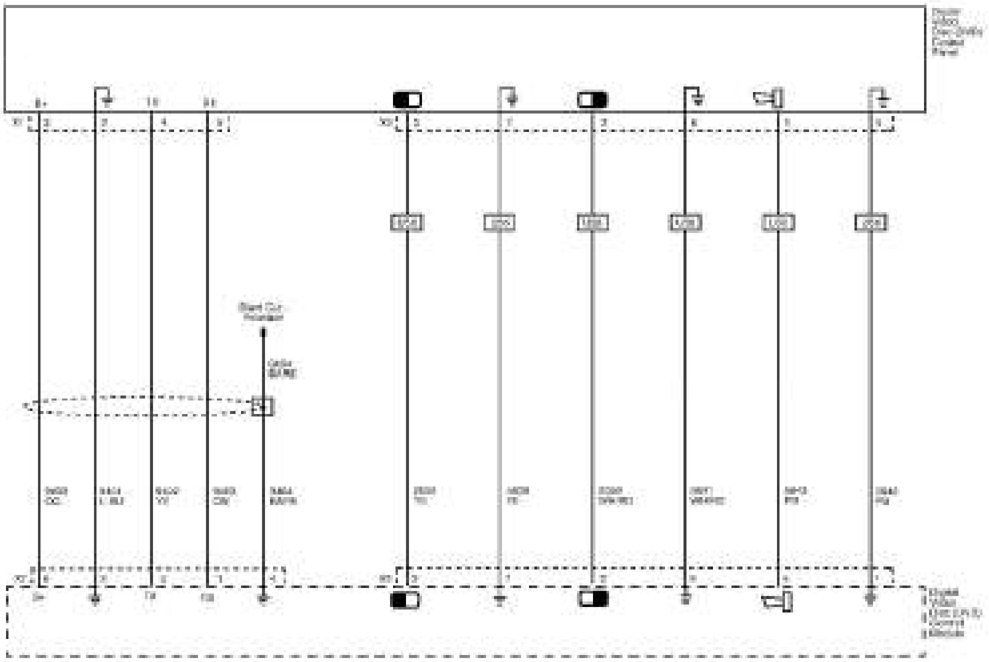
Document ID: 2154655

DVD Controls



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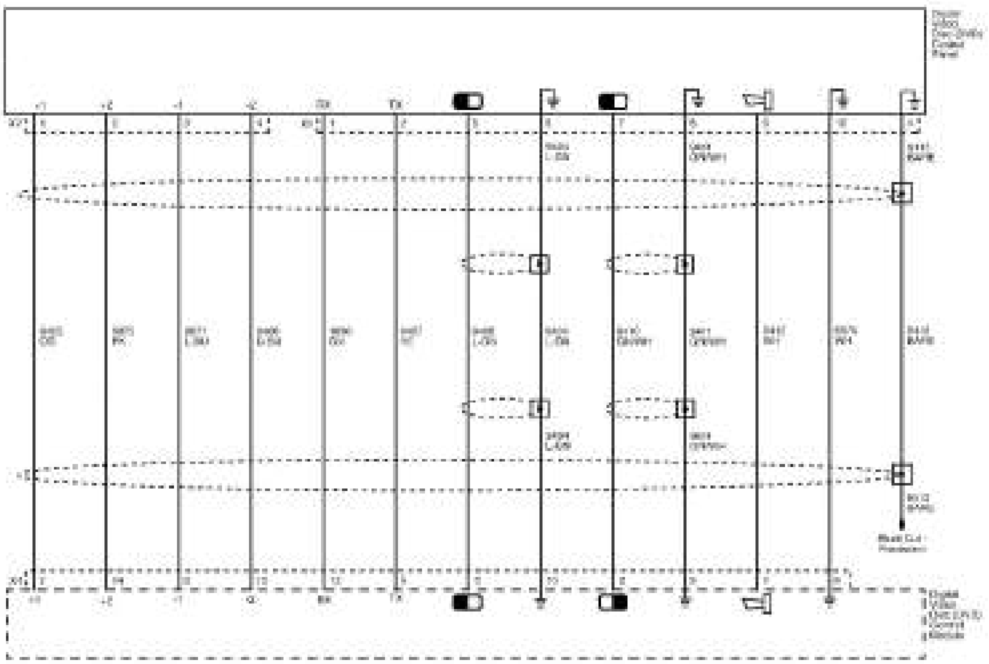
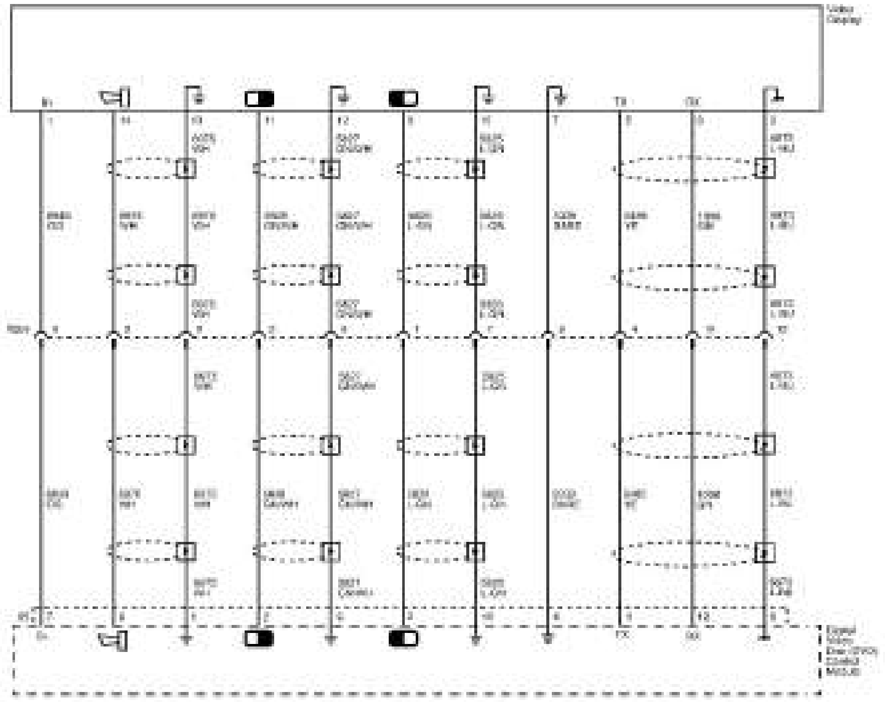
Document ID: 2154657

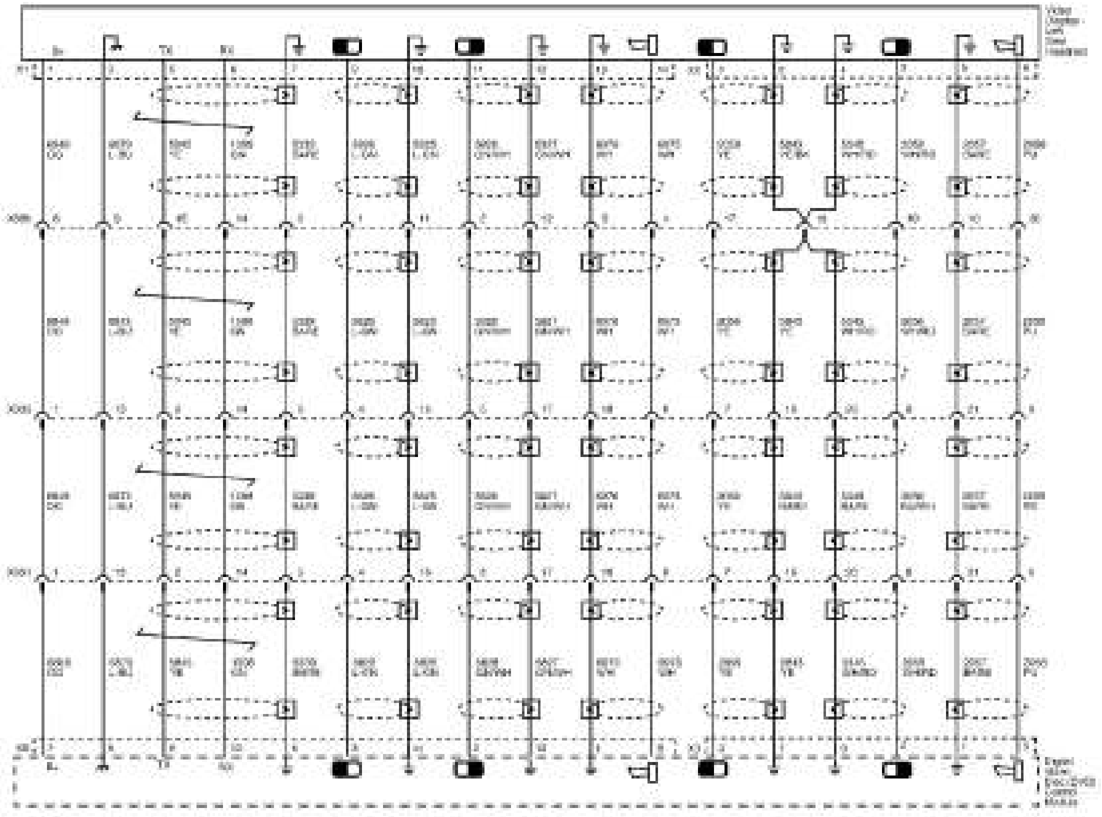
DVD Player Signals



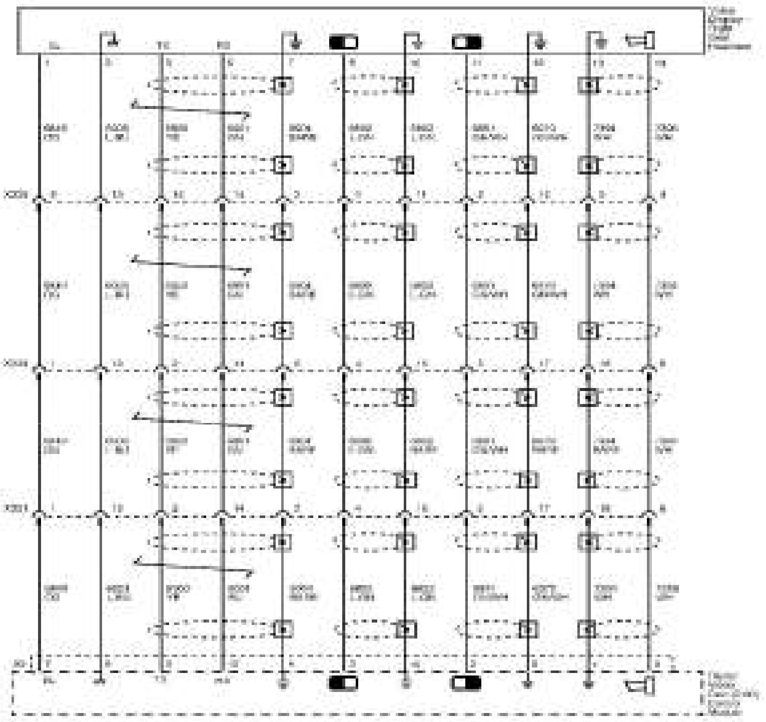
Video Display (U56)


Video Display
Digital Video Disc (DVD) Control Module

Left Display (UWF)



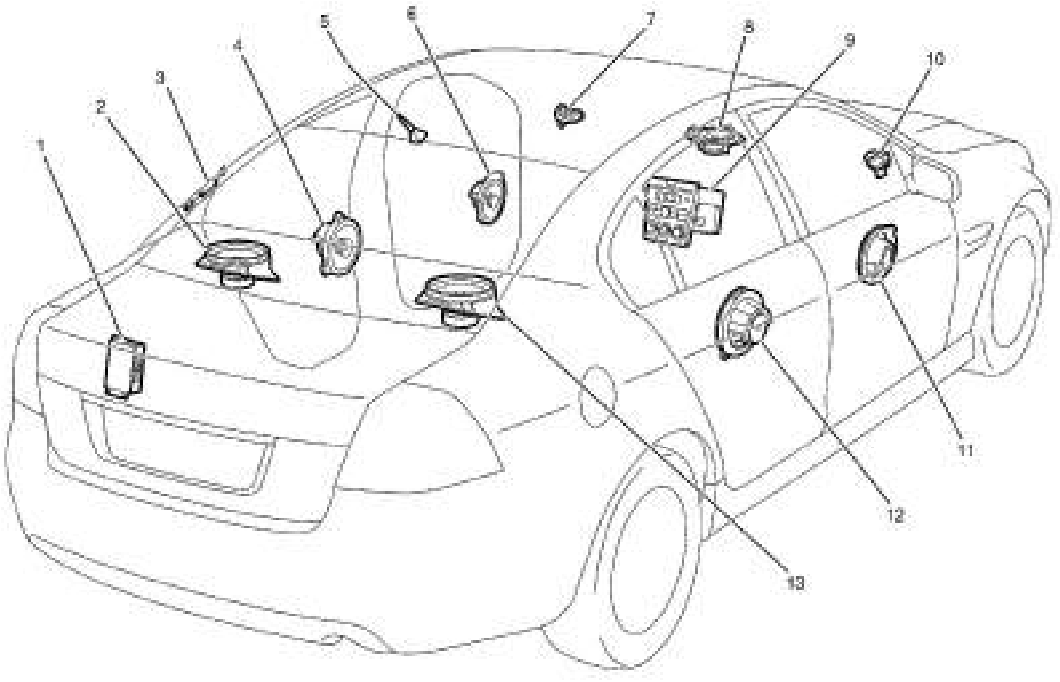
Right Display (UWF)



2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Driver Information and Entertainment | Cellular, Entertainment, and Navigation | Component Locator |

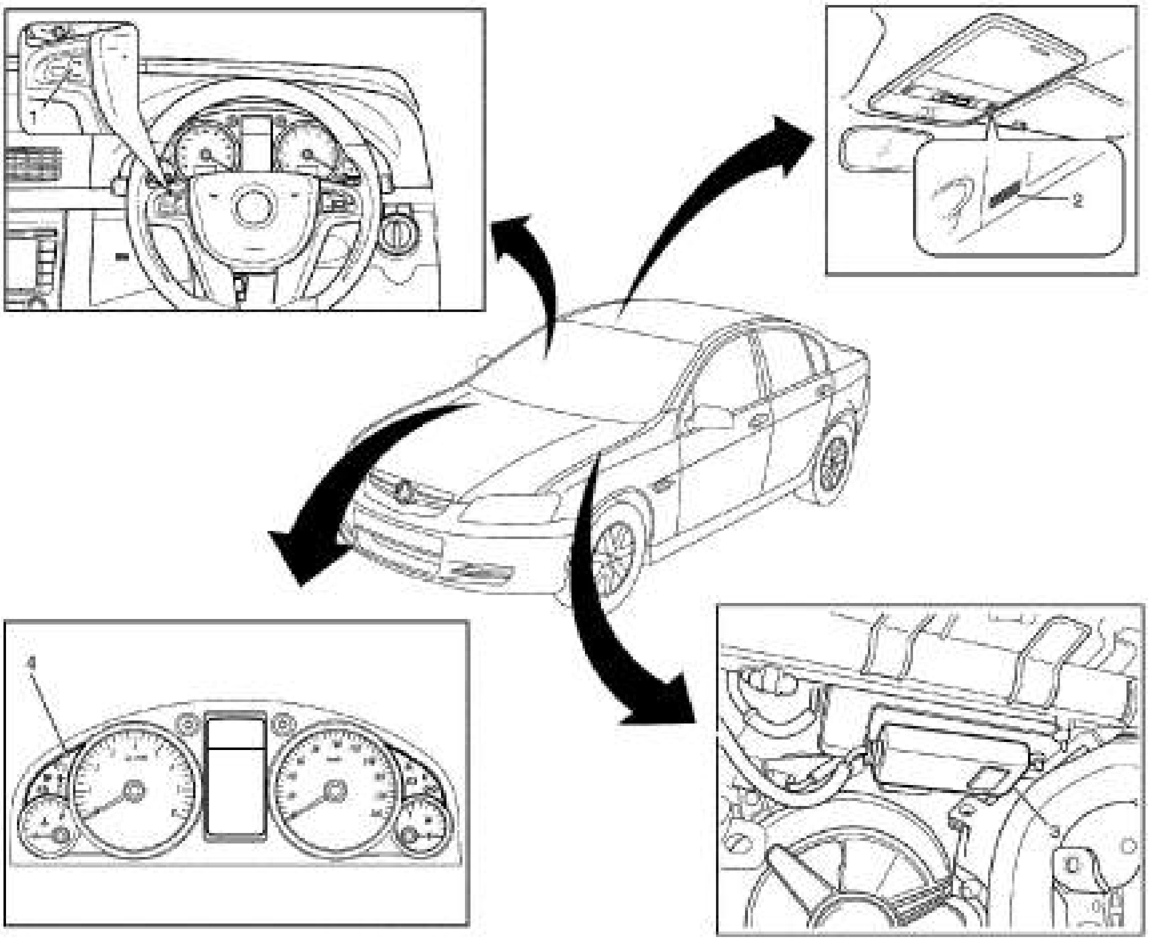
Document ID: 1973335

Infotainment Unit, Amplifier, Antenna and Speakers



(1) Subwoofer Amplifier
(2) Speaker - LR Subwoofer
(3) Diversity Antenna Module
(4) Speaker - LR Door
(5) Roof Antenna
(6) Speaker - LF Door
(7) Speaker - LF I/P Tweeter
(8) Speaker - I/P Centre
(9) Infotainment Assembly
(10) Speaker - RF I/P Tweeter
(11) Speaker - RF Door
(12) Speaker - RR Door
(13) Speaker - RR Subwoofer

Bluetooth Button, Bluetooth Microphone, Bluetooth Module and Instrument Panel Cluster (IPC).



(1) Bluetooth Button
(2) Bluetooth Microphone
(3) Bluetooth Module
(4) Instrument Panel Cluster (IPC)

Diagnostic Starting Point - Cellular, Entertainment, and Navigation

Begin the system diagnosis with the Diagnostic System Check - Vehicle. The Diagnostic System Check - Vehicle will provide the following information:

- The identification of the control modules which command the system
- The ability of the control modules to communicate through the serial data circuit
- The identification of any stored DTCs and their status

The use of the Diagnostic System Check - Vehicle will identify the correct procedure for diagnosing the system and where the procedure is located.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Driver Information and Entertainment | Cellular, Entertainment, and Navigation | Diagnostic Information and Procedures | **Document ID: 2195023**

Bluetooth Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provide an overview of each diagnostic category.

Circuit / System Description

The Bluetooth Module is a cellular device that is powered by a fused, battery positive, voltage circuit and allows a cordless link between a cellular phone and the Bluetooth car kit. The Bluetooth Module is not connected to serial data. It communicates with the cellular telephone via low-power radio waves. Due to the low power of the signal, approximately 1 milliwatt, a cellular telephone must be within 10 meters (32 feet) of the vehicle's Bluetooth Module to identify it and so that pairing between the cellular telephone and the Bluetooth car kit can take place.

In order to use hands-free calling, the cellular phone must be paired to the vehicle. Up to five devices can be paired to the vehicle at one time, but only one can be connected at any given time. To pair a phone, the customer must know how to operate the Bluetooth ® functionality of their phone.

Diagnostic Aids

- The purpose of this diagnostic is to verify the ability of the Bluetooth module to pair and connect to a Bluetooth ® device.
- The Bluetooth system cannot be diagnosed using Tech 2, however it is possible to carry out a self-test on the system. To carry out the test press the Phone button on the steering wheel remote control 4 times consecutively with the ignition on. If the Blue tooth module is functioning correctly a series of notes will be played through the audio system. This tests that the Blue Tooth module is present and functioning and tests the output of the Blue Tooth module through the audio system. This test cannot be performed while a Blue Tooth phone is paired with the vehicle

Schematic Reference

Cellular Telephone Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cellular Telephone Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Turn OFF bluetooth on all of the cell phones that are paired with the vehicle.
2. Ignition ON, press the bluetooth button 4 times consecutively. Verify that a series of chimes are heard clearly through the radio.

   If there was no audible tone heard, refer to Circuit/System Testing - Button Malfunction

   If the audio was distorted, refer to Circuit/System Testing - Audio Distortion
3. Turn ON the bluetooth function for the cell phone that will be paired with the vehicle.
4. Follow the instructions provided in the Vehicle Owners Manual and cell phones manual for pairing. Verify successful pairing with the cell phone.

   If pairing is not successful, repeat the pairing process. If pairing is still not successful, replace the Bluetooth module.
5. Refer to Diagnostic Aids.

Circuit/System Testing

Button Malfunction

1. Ignition ON, while depressing the Bluetooth button on the steering wheel control switches, observe the Instrument Panel Cluster (IPC) and verify the illumination of the phone symbol.

   If the symbol does not illuminate, refer to Steering Wheel Controls Malfunction
2. Ignition OFF, disconnect the harness connector at the Bluetooth module.
3. Test for less than 10 Ω between the ground circuit terminal 15 and ground.

   If greater than specified range, test the circuit for an open/high resistance.
4. Test for B+ between the B+ circuit terminal 16 and ground.

   If less than specified range, test the circuit for a short to ground or an open/high resistance.
5. Ignition ON, test for less than 1V between the bluetooth signal circuit terminal 6 and ground.

   If greater than the specified value, test the circuit for a short to voltage. If the circuit tests normal, replace the IPC.
6. Ignition ON, test for infinite resistance between the bluetooth signal circuit terminal 6 and ground.

   If less than the specified value, test the circuit for a short to ground. If the circuit tests normal, replace the IPC.
7. Ignition ON, while pressing the bluetooth button on the steering wheel, test for less than 10 Ω between the bluetooth signal circuit terminal 6 and ground.

   If greater than the specified value, test the circuit for an open/high resistance. If the circuit tests normal, replace the IPC.

8. If all circuits test normal, replace the Bluetooth module.

Audio Distortion

1. Ignition OFF, disconnect the X4 harness connector at the radio.
2. Ignition ON, press the bluetooth button 4 times consecutively and test for a varying mV A/C voltage between the following signal circuit terminals listed below and ground.
   - telephone audio signal (+) circuit terminal 9
   - telephone audio signal (-) circuit terminal 1

   If the varying mV A/C voltage is not present, test the circuit for a short to voltage, short to ground, or for an open/high resistance. If the circuits test normal, replace the bluetooth module.
3. Ignition ON, press the bluetooth button 4 times consecutively and test for less than 10 Ω between the mute signal circuit terminal 10 and ground.

   If greater then specified value, test the circuit for an open/high resistance. If the circuit tests normal, replace the bluetooth module.
4. If all circuits test normal, replace the radio.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for Bluetooth module replacement, setup, and programming

Cellular Telephone Will Not Connect To Bluetooth Car Kit

Diagnostic Fault Information

Important: Always perform the Diagnostic System Check - Vehicle. Refer to Diagnostic System Check - Vehicle , prior to using this diagnostic procedure.

Circuit / System Description

The Bluetooth Module is a cellular device that is powered by a fused, battery positive, voltage circuit and allows a cordless link between a cellular telephone and the Bluetooth car kit. The Bluetooth Module is not connected to the GMLAN system. It communicates with the cellular telephone via low-power radio waves. Due to the low power of the signal, approximately 1 milliwatt, a cellular telephone must be within 10 meters (32 feet) of the vehicle's Blue Tooth Module to identify the Bluetooth Module.. When a paired cellular telephone and the Bluetooth car kit come within range of one another and the ignition is turned to the ON position and/or the bluetooth button is pressed, an electronic conversation automatically takes place and the devices form a personal-area network (PAN), or piconet, in the vehicle.

Reference Information

Schematic Reference

Cellular Telephone Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cellular Telephone Description and Operation

Electrical Information Reference

Circuit / System Verification

Important: Perform this diagnostic if the paired cellular telephone and the Bluetooth Module cannot be connected.

Ignition ON, get in the vehicle with the paired cellular telephone and activate Bluetooth function on the cellular telephone and press the Bluetooth button on the steering wheel. Verify that the paired cellular telephone is not connected to the Bluetooth car kit.

Circuit / System Testing

1. Drive the vehicle to a location where there is minimal traffic. Make sure there are no other paired cellular telephones in the vehicle or in the 10 meter (32 feet) vicinity of the vehicle.
2. Pair and connect a cellular telephone that has previously worked in a Bluetooth car kit. Refer to Cellular Telephone Description and Operation .

   If pairing and connection takes place, Refer to the cellular telephone's owner manual to allow authorised automatic connection.

   If pairing is unsuccessful, refer to Cellular Telephone Will Not Pair Up With Bluetooth Car Kit

Repair Instructions

Perform the Diagnostic Repair Verification .

Cellular Telephone Will Not Pair Up With Bluetooth Car Kit

Diagnostic Fault Information

Important: Always perform the Diagnostic System Check - Vehicle. Refer to Diagnostic System Check - Vehicle in Vehicle Diagnostic Information, prior to using this diagnostic procedure.

Circuit/System Description

The Bluetooth Module is a cellular device that is powered by a fused, battery positive, voltage circuit and allows a cordless link between a cellular telephone and the Bluetooth car kit. The Bluetooth Module is not connected to the GMLAN system. It communicates with the cellular telephone via low-power radio waves. Due to the low power of the signal, approximately 1 milliwatt, a cellular telephone must be within 10 meters (32 feet) of the vehicle's Blue Tooth Module to identify the Bluetooth Module so that pairing between the cellular telephone and the Bluetooth car kit can take place.

Reference Information

Schematic Reference

Cellular Telephone Schematics .

Connector End View Reference

Component Connector End Views

Description and Operation

Cellular Telephone Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Circuit/System Verification

Important: Perform this diagnostic if the cellular telephone and the Bluetooth Module cannot be paired.

Ignition ON, get in the vehicle with the cellular telephone and activate Bluetooth function on the cellular telephone and search for Bluetooth devices. Verify that the cellular telephone cannot pick up a device labelled Vehicle BT.

Circuit/System Testing

1. Drive the vehicle to a location where there is minimal traffic. Make sure there are no other paired cellular telephones in the vehicle or in the 10 meter (32 feet) vicinity of the vehicle.
2. Ignition ON, activate Bluetooth function on a cellular telephone, with a known to be operating Bluetooth function, and search for Bluetooth devices.

   If no Bluetooth devices are found, continue.
3. Press the Bluetooth button 4 times and listen for a series of chimes through the speakers.

   If a series of chimes was heard through the speakers, replace the Bluetooth module.
4. Connect a DMM between the supply voltage circuit terminals and the ground circuit terminals.

   If 12 volts is present, replace the Bluetooth module.

Repair Instructions

Perform the Diagnostic Repair Verification .

- Control Module References
- Bluetooth Module Replacement

DTC B0996, B1016, or B1271

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC B0996: Vehicle Identification Number Mismatch

DTC B1016: Vehicle Identification Number Not Programmed

DTC B1271: Theft Locked

Circuit Description

This DTC is generated by the module when the Theft Lock is activated. This occurs when the VIN as received over the data communication circuit and the VIN as stored in the module memory do not match. This also occurs when no VIN is received over the data communication circuit. The only circuit required is the communication line.

Conditions for Running the DTC

This DTC test runs when the radio changes from OFF to ON.

Conditions for Setting the DTC

This DTC is generated by the module when the VIN as received over the data communication circuit and the VIN as stored in the module memory do not match. This also occurs if no VIN is received over the data communication circuit.

Action Taken When the DTC Sets

The radio does not function. The radio display will indicate that Theftlock is active.

Conditions for Clearing the DTC

Re-calibration with the correct calibrations for the vehicle and cycling the radio to OFF then to ON will clear the DTC if there is no damage to the radio.

Diagnostic Aids

This DTC may be an indication that an incorrect radio is installed in the vehicle, or that the radio was replaced without reprogramming with the new information.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify DTC B0996, B1016, or B1271 is not set.

   If any DTCs are set, program the radio. If the DTC resets, replace the radio.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for radio replacement, setup, and programming

DTC B0997

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B0997 3A: Auxiliary Electronic Control Unit (ECU) 2 Performance Incorrect Component

DTC B0997 33: Auxiliary Electronic Control Unit (ECU) 2 Performance Special Memory Failure

DTC B0997 36: Auxiliary Electronic Control Unit (ECU) 2 Performance, EEPROM Failure

DTC B0997 42: Auxiliary Electronic Control Unit (ECU) 2 Performance Calibration Data Set Not Programmed

DTC B0997 45: Auxiliary Electronic Control Unit (ECU) 2 Performance Variant Not Programmed

Circuit / System Description

The EEPROM (Electrically Erasable Programmable Read Only Memory) is part of the printed circuit board housed within the radio display. It stores variables required for the operation of the entertainment system.

Conditions for Running DTC

The radio display runs the program to detect an internal fault or compatibility concern when the radio changes from OFF to ON.

Conditions for Setting the DTC

- The radio display internal EEPROM has failed or is corrupt.
- An incompatible radio display is installed to the radio.
- The radio display that is installed is compatible but a different type of radio display from the current learned type.

Action Taken When DTC Sets

The system will set the DTC and not function.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Diagnostic Aids

This DTC may be an indication that the radio display was installed in the vehicle, or that the radio display was replaced without reprogramming with the new information.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Verify that DTC B0997 is not set.
   If the DTC is set, reprogram the radio. If the DTC resets, replace the radio display.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for radio display replacement, and for radio setup, and programming

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DTC B0998 or B0999

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B0998: Screen 1 EEPROM Failure

DTC B0999: Screen 2 EEPROM Failure

Circuit / System Description

The EEPROM (Electrically Erasable Programmable Read Only Memory) is part of the printed circuit board housed within the DVD screen. It stores variables required for the operation of the rear seat entertainment system.

Conditions for Running DTC

The DVD screen runs the program to detect an internal fault or compatibility concern when power up is commanded. The only requirements are voltage and ground. This program runs even if the voltage is out of the valid operating range.

Conditions for Setting the DTC

DTCs B0998 and B0999 will set if the EEPROM checksum is incorrect. The testing of the EEPROM checksum occurs every time the ignition is turned on. The DTC is reset when the EEPROM checksum is tested as being correct. The DTC is logged as a History DTC.

DTC B0999 is only applicable to level 5 vehicles with DVD screens mounted within the rear seats and applies to the second of the two screens.

Action Taken When DTC Sets

The system will set the DTC and disable itself.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Verify that DTC B0998 or B0999 is not set.
   If either DTC B0998 or B0999 is set to current, replace the appropriate DVD screen.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Video Display Replacement

DTC B1008 (RHD)

DTC Descriptor

DTC B1008: Calibration Data Not Programmed

Diagnostic Fault Information

Perform the Diagnostic System Check - Vehicle in Vehicle DTC Information, prior to using this diagnostic procedure.

Circuit/System Description

The telematics module requires initial programming when installed for a valid calibration data set, if no valid calibration set is found the telematics module will set a DTC and commands the red LED ON.

Conditions for Running the DTC

The only requirements are battery positive voltage and ground.

Conditions for Setting the DTC

This code shall set as current when the calibration set does not exist in the telematics module.

Action Taken When the DTC Sets

- The telematics module sets a DTC.
- The telematics module commands the red LED ON.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.
- The DTC can be cleared using a scan tool.

Reference Information

Schematic Reference

Telematics Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing .
- Connector Repairs .
- Testing for Intermittent Conditions and Poor Connections .
- Wiring Repairs .

Scan Tool Reference

Control Module References

Circuit / System Testing

1. Ignition ON, use the scan tool to request DTCs. Verify that DTC B1008 is set as current.
   If DTC B1008 is current perform the programming setup. If programming fails, replace the telematics module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for telematics module replacement, setup and programming.

DTC B1009 (RHD)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B1009 36: EEPROM Failure

Circuit/System Description

The electrically erasable programmable read-only memory (EEPROM) check sum error detection is handled inside the Audio/Video Interface Module. No external circuits are involved.

Conditions for Running DTC

The Audio/Video Interface Module runs the program to detect an EEPROM checksum error after each wake-up. The only requirements are battery positive voltage and ground. This program runs even if the voltage is out of the valid operating range.

Conditions for Setting the DTCs

The Audio/Video Interface Module retains an inverse copy of the digital value stored in certain blocks of memory in the EEPROM. The Audio/Video Interface Module then reads the information from those certain blocks and adds the stored inverse value to the current value. If they do not equal 0, the module sets the DTC.

Action Taken When the DTC Sets

The Audio/Video Interface Module reverts to base operation values programmed for those blocks of data that have failed the check sum test. The blocks of data that have not failed the check sum test are not affected.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.
- The DTC can be cleared using a scan tool.

Diagnostic Aids

This DTC may be stored as a history DTC without affecting the operation of the Audio/Video Interface Module. If stored only as a history DTC and not retrieved as a current DTC, do not replace the Audio/Video Interface Module.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Verify DTC B1009 36 is not set.
   If the DTC is set, replace the Audio/Video Interface Module.

Repair Instructions

Perform the Diagnostic Repair Verification.

Audio/Video Interface Module Replacement

DTC B1011 (RHD)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B1011: System Disabled Over Temperature

Circuit/System Description

The internal diagnostics of the navigation module periodically test the DVD drive temperature. If the DVD drive temperature is excessive DTC B1011 will set.

Conditions for Running the DTC

The radio must detect one of the following power modes:

- The navigation module is in the ACCESSORY, RUN, or RAP power mode.
- The system voltage is at least 9 volts and no more than 16 volts.

Conditions for Setting the DTC

Temperature of the DVD drive increases due to continuous operation/abnormal operating circumstances.

Action Taken When the DTC Sets

The navigation system will display either of the following messages: "Temperature High" and/or "DVD drive over temperature".

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC clears after 50 fault-free ignition cycles.
- The DTC can be cleared using a scan tool.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Navigation System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

Note: Allow the entertainment system to cool if the ambient temperature inside the vehicle is in excess before proceeding with this diagnostic procedure.

1. Verify that DTC B1011 is not set.
   If the DTC is set, replace the navigation module.

Repair Instructions

Perform the Diagnostic Repair Verification.

Control Module References.

DTC B1015 or DTC B1016 (RHD)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B1015 00: Vehicle Identification Number (VIN) Information Error

DTC B1016 00: VIN Not Programmed (Vehicle Identification Number)

Circuit / System Description

When the telematics module receives Over-The-Air messages, it will compare the information received to the data stored in memory. If the VIN stored in memory does not match the VIN received via Over-The-Air messages, the telematics module will set a DTC and commands the red LED on the electrochromatic mirror ON.

Conditions for Running the DTC

The system voltage is at least 9 volts and no more than 16 volts.

Conditions for Setting the DTC

B1015

- The telematics module stored VIN digits does not match the digits stored in the BCM.
- The VIN stored in memory does not match the VIN received via an Over-The-Air message.

B1016

The telematics module stored VIN digits are not programmed.

Action Taken When the DTC Sets

- The telematics module sets a DTC.
- The telematics module commands the red LED ON.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Verify that either DTC B1015 or DTC B1016 are not set.

   If either DTC is set, reprogram the telematics module. If either DTC resets, replace the telematics module

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for telematics module replacement, setup and programming.

DTC B1019

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B1019 45: System Configuration Error

Circuit / System Description

When the ignition is turned ON, the radio performs a self test to verify proper calibration exists within the system.

Conditions for Running the DTC

This DTC test runs when the radio changes from OFF to ON.

Conditions for Setting the DTC

The radio calibration has failed or is corrupt.

Action Taken When DTC Sets

The system will set the DTC and disable itself.

Conditions for Clearing the DTC

Re-calibration with the correct calibrations for the vehicle and cycling the radio to OFF then to ON will clear the DTC if there is no damage to the radio.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Verify DTC 1019 45 is not set.

   If the DTC is set, program the radio. If the DTC resets, replace the radio.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for radio replacement, setup, and programming

DTC B101D (Navigation Module)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B101D 33: ECU Hardware Performance Special Memory Failure

DTC B101D 34: ECU Hardware Performance RAM Failure

DTC B101D 36: ECU Hardware Performance EEPROM Failure

Circuit/System Description

When the ignition is turned ON, the navigation interface module (NIM) performs a self test to verify if any critical malfunction exists within the system.

Conditions for Running the DTC

This DTC runs continuously

Conditions for Setting the DTC

The module has detected an internal electrical malfunction.

Action Taken When the DTC Sets

This code will set as current when the NIM recognises an internal fault or fails to communicate with the BCM.

Conditions for Clearing the DTC

- A current DTC clears when the conditions for setting the DTC are no longer present.
- A history DTC clears after 50 malfunction-free ignition cycles.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Navigation System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Verify that DTC B101D is not set.

If the DTC is set, replace the navigation interface module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for navigation interface module replacement, setup, and programming

DTC B101D (Radio)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B101D 33: ECU Hardware Performance Special Memory Failure

DTC B101D 34: ECU Hardware Performance RAM Failure

DTC B101D 36: ECU Hardware Performance EEPROM Failure

Circuit/System Description

When the ignition is turned ON, the radio performs a self test to verify if any critical malfunction exists within the system.

Conditions for Running the DTC

This DTC runs continuously

Conditions for Setting the DTC

The module has detected an internal electrical malfunction.

Action Taken When the DTC Sets

Radio functions are disabled

Conditions for Clearing the DTC

- A current DTC clears when the conditions for setting the DTC are no longer present.
- A history DTC clears after 50 malfunction-free ignition cycles.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Verify that DTC B101D is not set.

If the DTC is set, replace the radio.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for radio replacement, setup, and programming

DTC B101D (RSE)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B101D 00: ECU Hardware Performance, Internal Communications Failure

Circuit/System Description

The rear seat entertainment (RSE) interface module is used to communicate between all the infotainment units equipped on the vehicle.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

When the RSE interface module has recognised an internal fault.

Action Taken When the DTC Sets

This code will set as current when the RSE interface module recognises an internal fault or fails to communicate with the BCM. DTC B101D indicates that the RSE interface module has had an internal fault and is not affected by any external circuits.

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 fault-free ignition cycles.
- The DTC can be cleared using the scan tool.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Verify that DTC B101D is not set.

If the DTC is set, replace the Audio/Video interface module.

Repair Instructions

Perform the Diagnostic Repair Verification

Audio/Video Interface Module Replacement

DTC B1020

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B1020 00: Auxiliary Electronic Unit (ECU) Performance

DTC B1020 39:: Auxiliary Electronic Unit (ECU) Performance Internal Electronic Failure

Circuit/System Description

The navigation module performs a self test to detect an internal malfunction.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

An internal navigation module malfunction exists.

Action Taken When the DTC Sets

Navigation system fails to operate.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Navigation System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC clears after 50 fault-free ignition cycles.

Circuit / System Verification

1. Verify DTC B1020 is not set.

   If the DTC is set, replace the navigation module.

Repair Instructions

Perform the Diagnostic Repair Verification.

Control Module References for navigation module replacement, setup, and programming.

DTC B1021 (RHD)

DTC Descriptor

DTC B1021: SIM Mismatch

Diagnostic Fault Information

Perform the Diagnostic System Check - Vehicle in Vehicle DTC Information, prior to using this diagnostic procedure.

Circuit/System Description

The telematics module is programmed to match a SIM card. SIM cards have each been assigned a unique SIM card number. If the SIM card number programmed into the telematics module does not match the SIM card or if the SIM card has been swapped from another telematics module, the telematics module will set a DTC.

Conditions for Running the DTC

The SIM card number programmed into the telematics module does not match the SIM card.

Conditions for Setting the DTC

This code shall set as current when the SIM card number programmed into the telematics module does not match the SIM card.

Action Taken When the DTC Sets

- The telematics module sets a DTC.
- The telematics module commands the red LED ON.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.
- The DTC can be cleared using a scan tool.

Reference Information

Schematic Reference

Telematics Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing .
- Connector Repairs .
- Testing for Intermittent Conditions and Poor Connections .
- Wiring Repairs .

Scan Tool Reference

Control Module References

Circuit/System Testing

1. Verify that the SIM card present is correct for the original unit and has not been swapped from another telematics module.
2. Ignition ON, use the scan tool to request DTCs. Verify that DTC B1021 is set as current.

   If DTC B1021 is historical, clear the DTC.

   If DTC B1021 is current replace the telematics module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for telematics module replacement, setup and programming.

DTC B1023

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B1023 00: Integral Switch Performance

Circuit / System Description

The radio monitors the button presses on the radio display. The radio will ignore any stuck buttons and allow full functionality of the working buttons. The only circuit required is the serial data line between the radio and the radio display.

Conditions for Running DTC

- System voltage is between 9-16 volts.
- Ignition switch is in the ON position.

Conditions for Setting DTC

This DTC is generated by the radio if a button is active for a period greater than 60 seconds.

Action Taken When DTC Sets

- The radio ignores continuous inputs from the button.
- The radio will respond to all other valid button inputs.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

1. Inspect the radio display buttons for signs of damage or foreign objects. Operate each of the radio display buttons and verify that the buttons have a smooth operation.
   If the buttons do not have a smooth operation, replace the radio display.
2. Verify DTC 1023 is not set.
   If the DTC is set, clear the DTC. If the DTC resets, replace the driver information display.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for Radio Display and Radio replacement, setup, and programming

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Driver Information and Entertainment | Cellular, Entertainment, and Navigation | Diagnostic Information and Procedures |
Document ID: 2155428

DTC B1025, B1035, B1045, or B1055

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC B1025 01: Audio Output 1 Left Front Circuit Short to Battery

DTC B1025 02: Audio Output 1 Left Front Circuit Short to Ground

DTC B1025 04: Audio Output 1 Left Front Circuit Open

DTC B1035 01: Audio Output 2 Right Front Circuit Short to Battery

DTC B1035 02: Audio Output 2 Right Front Circuit Short to Ground

DTC B1035 04: Audio Output 2 Left Front Circuit Open

DTC B1045 01: Audio Output 3 Left Rear Circuit Short to Battery

DTC B1045 02: Audio Output 3 Left Rear Circuit Short to Ground

DTC B1045 04: Audio Output 3 Left Front Circuit Open

DTC B1055 01: Audio Output 4 Right Rear Circuit Short to Battery

DTC B1055 02: Audio Output 4 Right Rear Circuit Short to Ground

DTC B1055 04: Audio Output 4 Left Front Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Amplifier B+	--	1	--	--
Left Front Speaker Output (+) Signal	B1025 02, *	B1025 04, *	B1025 01, *	--
Left Front Speaker Output (-) Signal	B1025 02, *	B1025 04, *	B1025 01, *	--
Right Front Speaker Output (+) Signal	B1035 02, *	B1035 04, *	B1035 01, *	--
Right Front Speaker	B1035 02, *	B1035 04, *	B1035 01, *	--

Output (-) Signal				
Left Rear Speaker Output (+) Signal	B1045 02, *	B1045 04, *	B1045 01, *	--
Left Rear Speaker Output (-) Signal	B1045 02, *	B1045 04, *	B1045 01, *	--
Right Rear Speaker Output (+) Signal	B1055 02*	B1055 04*	B1055 01, *	--
Right Rear Speaker Output (-) Signal	B1055 02*	B1055 04*	B1055 01, *	--
Rear Subwoofer Speaker Outputs (+) Signal	2	2	2	--
Rear Subwoofer Speaker Outputs (-) Signal	2	2	2	--
Center Speaker Output Signal (+)	3	3	3	--
Center Speaker Output Signal (-)	3	3	3	--
Amplifier Ground	--	1	--	--

1. Amplifier inoperative/no sound from speakers.

2. No or reduced sound from subwoofer.

3. No sound from center speaker.

* Noticeable audio distortion possible.

Circuit/System Description

Each of the audio output channel circuits (+) and (-), at the radio and audio amplifier have a DC bias voltage that is one half of the battery voltage. When using a DMM, each of the audio output channel circuits will measure approximately 6.5V DC. The audio being played on the system is produced by a varying AC voltage that is centered around the DC bias voltage on the same circuit. The AC voltage is what causes the speaker cone to move and produce sound. This voltage will vary depending on what type of audio is being listened to, talk or music, and type of music, as well as the volume setting of the system. Low volume and talk settings will measure around 1V AC and less, where constant music may measure 3V AC and slightly higher. The amplifier may only supplied an amplified signal to the subwoofers, or on the premium audio systems, the amplifier will amplify all of the audio signals. The amplifier can not set DTCs.

Conditions for Running the DTC

- The radio is ON.
- Battery voltage must be between 9-16 volts.

Conditions for Setting the DTC

B1025 01, B1035 01, B1045 01, B1055 01

A short to voltage is detected on the specified (+) or (-) signal circuit.

B1025 02, B1035 02, B1045 02, B1055 02

A short to ground is detected on the specified (+) or (-) signal circuit.

B1025 04, B1035 04, B1045 04, B1055 04

An open/high resistance is detected on the specified (+) or (-) signal circuit.

Action Taken When the DTC Sets

No sound is present from one or more of the speakers.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

Without Amplifier

1. Ignition OFF, disconnect the harness connector at the appropriate speaker.
2. Radio ON, test for 5.0-7.5 volts between the signal circuit terminal A and ground.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the radio.
3. Test for 5.0-7.5 volts between the signal circuit terminal B and ground.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the radio.
4. If all circuits test normal, replace the speaker.

With Amplifier -- Front Speaker Testing UQG

1. Ignition OFF, disconnect the harness connector at the appropriate speaker.
2. Radio ON, test for 5.0-7.5 V between the signal circuit terminal A and ground.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the radio.
3. Test for 5.0-7.5 V between the signal circuit terminal B and ground.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the radio.
4. If all circuits test normal, replace the speaker.

With Amplifier -- Rear Speaker Testing UQG

1. Ignition OFF, disconnect the amplifier and the appropriate speaker harness connectors.
2. Radio ON, test for 5.0-7.5 V between the signal circuit terminal A and ground.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the radio.
3. Test for 5.0-7.5 V between the signal circuit terminal B and ground.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the radio.
4. Ignition OFF, reconnect the harness connector at the audio amplifier.
5. Radio ON, test for 5.0-7.5 V between the signal circuit terminal A and ground at the appropriate speaker.

   If not within the specified range, replace the amplifier.
6. Radio ON, test for 5.0-7.5 V between the signal circuit terminal B and ground at the appropriate speaker.

   If not within the specified range, replace the amplifier.
7. If all circuits test normal, replace the speaker.

With Amplifier -- Speaker Testing RHD -- UQA

1. Ignition OFF, disconnect the X1 harness connector at the amplifier.
2. Radio ON, test for 5.0-7.5 V between the terminals listed below and ground.
   - Left front low level audio signal (+) - terminal 15
   - Left front low level audio signal (-) - terminal 7
   - Right front low level audio signal (+) - terminal 14
   - Right front low level audio signal (-) - terminal 6
   - Left rear low level audio signal (+) - terminal 13
   - Left rear low level audio signal (-) - terminal 5
   - Right rear low level audio signal (+) - terminal 12
   - Right rear low level audio signal (-) - terminal 4

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the radio.
3. If all circuits test normal, replace the amplifier.

With Amplifier -- Speaker Testing LHD -- UQA

1. Ignition OFF, disconnect the X1 harness connector at the amplifier.
2. Radio ON, test for 5.0-7.5 V between the terminals listed below and ground.
   - Left front low level audio signal (+) - terminal 14
   - Left front low level audio signal (-) - terminal 6
   - Right front low level audio signal (+) - terminal 15
   - Right front low level audio signal (-) - terminal 7
   - Left rear low level audio signal (+) - terminal 12
   - Left rear low level audio signal (-) - terminal 4
   - Right rear low level audio signal (+) - terminal 13
   - Right rear low level audio signal (-) - terminal 5

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the radio.
3. If all circuits test normal, replace the amplifier.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Speaker Replacement Reference
- Control Module References for audio amplifier and radio replacement, setup, and programming

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DTC B1240 or B1245

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B1240 59: CD-Player Not Responding

DTC B1245 54: CD-Changer High Temperature

DTC B1245 59: CD-Changer Not Responding

Circuit/System Description

When the ignition is turned ON, the radio performs a self test to verify if any critical malfunction exists within the system.

Conditions for Running the DTC

This DTC test runs when the radio changes from OFF to ON.

Conditions for Setting the DTC

DTC B1240 59, DTC B1245 59

The CD player mechanism does not respond when requested and internal communication attempts time out.

DTC B1245 54

The CD player changer reports that the mechanism is overheating.

Action Taken When the DTC Sets

DTC B1240 59, DTC B1245 59

- The radio displays a "CD Error" message temporarily.
- The radio will attempt a communication reset with the CD player mechanism, this will be attempted each time there is an infotainment system source change request.

DTC B1245 54

- The radio displays a "Mechanism Overheat" message temporarily.
- The radio will attempt a communication reset with the CD player mechanism, this will be attempted each time there is an radio source change request.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.

Diagnostic Aids

Extended use the CD player, especially in warm weather conditions, may cause this DTC to set in the radio. Under these conditions, it may be normal for this DTC to set to prevent permanent damage to the radio circuitry and no repair should be attempted.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Note: Allow the entertainment system to cool if the ambient temperature inside the vehicle is in excess before proceeding with this diagnostic procedure.

1. Ignition ON, with a scan tool clear all DTCs.
2. Radio ON, play a known good CD and verify B1240 or B1245 does not reset.
   If the DTC resets, replace the radio.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for radio replacement, setup, and programming

DTC B1243 (RSE)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B1243 00: CD-Player Load or Unload Performance

Circuit/System Description

The DVD player monitors loading/ejecting disc performance.

Conditions for Running the DTC

The DVD player recovers from loading/ejecting error.

Conditions for Setting the DTCs

The DVD player experiences a loading/ejecting error.

Action Taken When the DTC Sets

None.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, with a scan tool clear all DTCs.
2. Radio ON, play a known good CD. Eject and reinsert the CD several times.
   If the DTC resets, replace the DVD Player.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Video Disc Player Replacement

DTC B1243 or B1248

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B1243 00: CD-Player Load or Unload Performance

DTC B1248 00: CD Changer Load/Unload mechanism Performance

Circuit/System Description

When the ignition is turned ON, the radio performs a self test to verify if any critical malfunction exists within the system.

Conditions for Running the DTC

The CD player/changer recovers from loading/ejecting error.

Conditions for Setting the DTC

The CD player/changer experiences a loading/ejecting error.

Action Taken When the DTC Sets

The radio displays a "Mechanism Error" message temporarily.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, with a scan tool clear all DTCs.
2. Radio ON, play a known good CD. Eject and reinsert the CD several times and verify B1243 or B1248 does not reset.
   If the DTC resets, replace the radio.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for radio replacement, setup, and programming

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DTC B1244 or B1249

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B1244 00: CD-Player Disc Upside Down

DTC B1249 00: CD-Changer Disc Upside Down

Circuit/System Description

The radio performs a self test to verify if any problems exist in reading the CD.

Conditions for Running the DTC

The CD player/changer recovers from loading/ejecting error.

Conditions for Setting the DTC

The CD player/changer experiences a loading/ejecting error.

Action Taken When the DTC Sets

- The radio displays a "Error Check Disc" message temporarily.
- Disc is ejected and radio source is changed to tuner.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.

Diagnostic Aids

Visually inspect the CD for physical damage or signs of abnormal wear, scratches etc.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, with a scan tool clear all DTCs.
2. Radio ON, play a known good CD. Eject and reinsert the CD several times and verify B1244 or B1249 does not reset.

   If the DTC resets, replace the radio.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for radio replacement, setup, and programming

DTC B1277 (RHD)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B1277: Microphone Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Cellular Microphone Signal	B1277 02	B1277 04	B1277 01	--
Cellular Microphone Drain	--	B1277 04	1	--
1. Microphone Inoperative - Caller Cannot Be Heard				

Circuit/System Description

The communication interface module provides the cellular microphone with a supplied voltage on the cellular microphone signal circuit. When the microphone is in use, voice data from the user is sent back to the communication interface module on the signal circuit. The communication interface module provides a ground for the microphone via the drain wire.

Conditions for Running the DTC

- The ignition must be in the RUN or ACC position.
- The system voltage is at least 9.5 volts and no more than 15.5 volts.
- All the above conditions are present for greater than 10 seconds.

Conditions for Setting the DTC

- The CIM detects an open, short to ground or short to voltage in the cellular microphone signal circuit for 10 seconds or greater.
- The CIM detects an open/high resistance in the drain wire circuit for 10 seconds or greater.

Action Taken When the DTC Sets

- The communication interface module will not receive a signal from the microphone.
- Calls can be placed but the caller cannot be heard.
- The communication interface module commands the red LED ON.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the inside rearview mirror.
2. Test for less than 10 Ω between the drain circuit terminal 2 and ground.

   If greater than the specified range, test the circuit for an open/high resistance.
3. Ignition ON, test for 9.5-10.5 V between the signal circuit terminal 10 and ground.

   If less than the specified range, test the circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the communication interface module.

   If greater than the specified range, test the circuit for a short to voltage. If the circuit tests normal, replace the communication interface module.
4. If all circuit test normal, replace the cellular microphone.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Communication Interface Module Microphone Replacement
- Control Module References for telematics module replacement, setup and programming.

DTC B1287 (RHD)

DTC Descriptor

DTC B1287: Radio Mute Circuit

Diagnostic Fault Information

Perform the Diagnostic System Check - Vehicle in Vehicle DTC Information, prior to using this diagnostic procedure.

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Radio Mute Circuit	B1277 02	B1277 0B	B1277 01	--

Circuit/System Description

The telematics module is connected to the drivers side radio speaker via an internal relay. When the Emergency, Holden Assist or Information/End Call button is pressed, the telematics module sends a signal to the infotainment unit via the auxiliary Infotainment unit inputs selected with the aid of the radio mute line. The Infotainment unit will then mute the radio and allow only the telematics audio and tones to sound through the speaker.

Conditions for Running the DTC

The radio mute output circuit has a malfunction.

Conditions for Setting the DTC

This code shall set as current when the telematics module detects the radio mute output circuit is short to ground, battery or is over loaded.

Action Taken When the DTC Sets

- The telematics module sets a DTC.
- The telematics module commands the red LED ON.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.
- The DTC can be cleared using a scan tool.

Reference Information

Schematic Reference

Telematics Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing .
- Connector Repairs .
- Testing for Intermittent Conditions and Poor Connections .
- Wiring Repairs .

Scan Tool Reference

Control Module References

Circuit/System Testing

1. Ignition ON, use the scan tool to request DTCs. Verify that DTC B1287 is set as current.
   If DTC B1287 is historical, Clear the DTC.
2. Check the infotainment unit is functioning correctly.
   If the infotainment unit is not functioning correctly, refer to infotainment unit system diagnostics.
3. Ignition OFF, disconnect the harness connector at the telematics module.
4. Test the radio mute circuit for short to ground, short to voltage or an open/high resistance.
   If all circuits do not test normal, repair or replace the affected circuit(s).

   Important: Other infotainment related DTC's will set when the infotainment unit is disconnected.

5. Disconnect the Infotainment unit.
   If the DTC is still current, replace the telematics module.

   If the DTC is not current, replace the infotainment unit.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for the infotainment unit and telematics module replacement, setup and programming.

DTC B1325, B1330, or B1423

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B1325 03: DVD Player Power Supply Voltage Below Threshold

DTC B1325 07: DVD Player Power Supply Voltage Above Threshold

DTC B1330 03: RSE Control Panel Supplied Power Below Voltage Threshold

DTC B1330 07: Rear Control Panel Power Supply Voltage Above Threshold

DTC B1423 03: Supply Voltage Below Threshold

DTC B1423 07: Supply Voltage Above Threshold

Circuit/System Description

With the ignition in either the ACC or ON positions, the DVD player, rear seat entertainment (RSE) control panel and rear seat entertainment interface module receives an individual 12V power supply. The DVD player and RSE control panel power supply is distributed via the rear seat entertainment interface module.

Conditions for Running the DTC

- The rear seat entertainment is ON.
- Battery voltage must be between 9-16 volts.

Conditions for Setting the DTCs

B1325 03, B1325 07

- DTC B1325 03 will set to indicate the B+ positive supplied to the DVD Player is below the threshold.
- DTC B1325 07 will set to indicate the B+ positive supplied to the DVD Player is above the threshold.

B1330 03, B1330 07

- DTC B1330 03 will set to indicate the B+ positive supplied to the RSE control panel is below the threshold.
- DTC B1330 07 will set to indicate the B+ positive supplied to the RSE control panel is above the threshold.

B1423 03, B1423 07

- DTC B1423 03 will set to indicate the B+ positive supplied to the rear seat entertainment interface module is below the threshold.
- DTC B1423 07 will set to indicate the B+ positive supplied to the rear seat entertainment interface module is above the threshold.

Action Taken When the DTC Sets

B1325 03, B1325 07

When DTC B1325 03 or DTC B1325 07 are set, the DVD player will not turn ON.

B1330 03, B1330 07

When DTC B1330 03 or DTC B1330 07 are set, the video disc player control will not turn ON.

B1423 03, B1423 07

When DTC B1423 03 or DTC B1423 07 are set, the DVD player and video disc player control will not turn ON.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.

Reference Information

Schematic Reference

Video System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Video Entertainment System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Diagnostic Aids

The DVD player and RSE control panel power supply is distributed via the rear seat entertainment interface module. DTC B1325 03 or DTC B1330 03 could set concurrently with DTC B1423 03 as a result of the B+ positive supplied to the rear seat entertainment interface module being below the threshold. DTC B1325 07 or DTC B1330 07 could set concurrently with DTC B1423 07 as a result of the B+ positive supplied to the rear seat entertainment interface module being above the threshold. In the event of these DTCs setting together either DTC B1423 03 or DTC B1423 07 should be diagnosed first. If either DTC B1423 03 or DTC B1423 07 is not set it would suggest that the fault exists after the rear seat entertainment interface module and is within either of the B+ positive supplies to the DVD player or video disc player control or a fault within one of these components.

Circuit/System Testing

B1423 03, B1423 07

1. Ignition OFF, disconnect the rear seat entertainment interface module harness connector.
2. Ignition OFF, test for less than 3 Ω between the ground circuit at the rear seat entertainment interface module harness connector and a ground.

   If greater than the specified range, test the circuti for an open/high resistance.
3. Ignition ON, test for B+ between the battery positive voltage circuit at the rear seat entertainment interface module harness connector and a ground.

   If not within specified range, test the circuit for a short to ground or an open/high resistance.
4. If all circuits test normal, replace the Audio/Video Interface Module.

B1325 03, B1325 07

1. Ignition OFF, disconnect the DVD player harness connector.
2. Ignition OFF, test for less than 3 Ω between the ground circuit at the DVD player harness connector and a ground.

   If greater than the specified range, test the circuit for a short to ground or an open/high resistance.
3. Ignition ON, test for B+ between the battery positive voltage circuit at the DVD player harness connector and ground.

   If not within specified range, test the battery positive voltage circuit for an open/high resistance. If the circuit tests normal replace the rear seat entertainment interface module.
4. If all circuits test normal, replace the DVD player.

B1330 03, B1330 07

1. Ignition OFF, disconnect the Video Disc Player Control harness connector.
2. Ignition OFF, test for less than 3 Ω between the ground circuit at the rear seat entertainment interface module harness connector and a ground.

   If greater than the specified range, test the circuit for a short to ground or an open/high resistance.
3. Ignition ON, test for B+ between the battery positive voltage circuit at the Video Disc Player Control harness connector and ground.

   If not within specified range, test the battery positive voltage circuit for an open/high resistance. If the circuit tests normal replace the rear seat entertainment interface module.
4. If all circuits test normal, replace the Video Disc Player Control.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Video Disc Player Replacement
- Audio/Video Interface Module Replacement
- Video Disc Player Control Replacement

DTC B1335 or B1340

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B1335 03: Screen 1 Power Supply Voltage Below Threshold

DTC B1335 07: Screen 1 Power Supply Voltage Above Threshold

DTC B1340 03: Screen 2 Power Supply Voltage Below Threshold

DTC B1340 07: Screen 2 Power Supply Voltage Above Threshold

Circuit/System Description

With the ignition in either the ACC or ON positions, the DVD screens each receive an individual 12V power supply. The DVD screen power supply is distributed via the Audio/Video Interface Module. DTCs B1335 03 and B1335 07 relate to the headlining DVD screen installed to lower level vehicles and the right front head restraint DVD screen on higher level vehicles. DTCs B1340 03 and B1340 07 relate to the left front head restraint DVD screen on higher level vehicles.

Conditions for Running DTC

B1335 03, B1340 03

DTC B1335 03 or B1340 03 will set to indicate the B+ positive supplied to the DVD screen is below the threshold.

B1335 07, B1340 07

DTC B1335 07 or B1340 07 will set to indicate the B+ positive supplied to the DVD screen is above the threshold.

Conditions for Setting the DTCs

These DTCs run continuously once the following condition is met:

The supplied power to the DVD screen is between 9 - 16V.

Action Taken When the DTC Sets

When DTC B1335 or B1340 is set, the DVD screen will not turn ON.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.

Reference Information

Schematic Reference

Video System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Video Entertainment System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Diagnostic Aids

The DVD screen power supply is distributed via the rear seat entertainment interface module. DTC B1335 03 or DTC B1340 03 could set concurrently with DTC B1423 03 as a result of the B+ positive supplied to the Audio/Video Interface Module being below the threshold. DTC B1335 07 or DTC B1340 07 could set concurrently with DTC B1423 07 as a result of the B+ positive supplied to the Audio/Video Interface Module being above the threshold. In the event of these DTCs setting together either DTC B1423 03 or DTC B1423 07 should be diagnosed first. If either DTC B1423 03 or DTC B1423 07 is not set it would suggest that the fault exists after the Audio/Video Interface Module and is within the B+ positive supply to the DVD screen or a fault within the component.

Circuit/System Testing

1. Ignition OFF, disconnect the DVD screen harness connector.
2. Ignition OFF, test for less than 3 Ω between the ground circuit at the rear seat entertainment interface module harness connector and a ground.

If greater than the specified range, test the circuti for an open/high resistance.

3. Ignition ON, test for B+ between the battery positive voltage circuit at the DVD screen harness connector and ground.

   If not within specified range, test the battery positive voltage circuit for an open/high resistance. If the circuit tests normal replace the Audio/Video Interface Module.

4. If all circuits test normal, replace the DVD screen.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Video Display Replacement
- Audio/Video Interface Module Replacement

DTC B1446 (RHD)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B1446: Backup Battery Timer Expired

Circuit/System Description

The Back-up Battery provides voltage to the communication interface module , to be able to successfully place a call in the event of a main battery disconnect during a collision event.

Conditions for Running the DTC

- Ignition is in the RUN or ACC position.
- System voltage is between 9.5 and 15.5 volts.
- DTC B1447 is not set.

Conditions for Setting the DTC

The communication interface module detects that the back-up battery voltage has dropped below the minimum threshold value.

Action Taken When the DTC Sets

The communication interface module commands the red LED ON.

Conditions for Clearing the DTC

- When the CIM detects the voltage of the back-up battery is above the minimum threshold value.
- The history DTC will clear after 50 fault-free ignition cycles.

Diagnostic Aids

Note: Shorting the back-up battery positive voltage circuit to the back-up battery ground circuit or chassis ground will activate the internal circuit protection of the back-up battery , rendering the back-up battery inoperable.

Reference Information

Schematic Reference

Telematics Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Telematics Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector X1 at the comunication interface module.
2. Test for greater than 15.5 volts between terminals 13 and 14.

   If less than specified value, test the battery backup supply voltage circuit and battery backup low reference circuit for an open/high resistance, short to ground or short to voltage. If the circuits test normal, replace the back-up battery.
3. If all circuits test normal, replace the comunication interface module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Communication Interface Module Battery Replacement
- Control Module References for communication interface module replacement, setup and programming.

DTC B1447 (RHD)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B1447 03: Backup Battery Voltage Too Low

DTC B1447 04: Backup Battery Circuit Open

DTC B1447 07: Backup Battery Voltage Too High

Circuit/System Description

The Back-up Battery provides voltage to the communication interface module , to be able to successfully place a call in the event of a main battery disconnect during a collision event.

Conditions for Running the DTC

- Ignition is in the RUN or ACC position.
- System voltage is between 9.5 and 15.5 volts.
- The above conditions are present for greater than 10 seconds.

Conditions for Setting the DTC

The communication interface module detects no voltage from the back-up battery.

Action Taken When the DTC Sets

- The communication interface module module will be unable to place a call in the event of a main battery disconnect during a collision event.
- The communication interface module module commands the red LED ON.

Conditions for Clearing the DTC

- A current DTC B1447 will clear when the CIM detects voltage from the back-up battery.
- The history DTC will clear after 50 fault-free ignition cycles.

Diagnostic Aids

Note: DTC B1447 may set if the communication interface module has been incorrectly disconnected or serviced. When disconnecting the communication interface module, disconnect the harness connector X1 at the communication interface module prior to disconnecting any other harness connectors. This will ensure the back-up battery is preserved when voltage is removed from the communication interface module.

Reference Information

Schematic Reference

Telematics Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Telematics Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector X1 at the comunication interface module.
2. Test for greater than 15.5 volts between terminals 13 and 14.

   If less than specified value, test the battery backup supply voltage circuit and battery backup low reference circuit for an open/high resistance, short to ground or short to voltage. If the circuits test normal, replace the back-up battery.
3. If all circuits test normal, replace the comunication interface module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Communication Interface Module Battery Replacement
- Control Module References for communication interface module replacement, setup and programming.

DTC B1517 (RHD)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B1517 00: Battery Voltage Below/Above Threshold

Circuit/System Description

The body control module (BCM) has designated circuits for monitoring vehicle system voltage. The BCM monitors the system voltage to ensure that the voltage stays within a correct range. Damage to components and incorrect data may occur when the voltage is out of range. The BCM monitors the system voltage over an extended length of time. If the BCM detects the system voltage is outside an expected range for the calibrated length of time, or the BCM battery sense circuits differ by 1 volt, DTC B1517 will set. Other modules also monitor system voltage. The system voltage message is sent to the other modules and will default to 12.9 volts.

Conditions for Running the DTC

This DTC shall run only if the telematics module has power, ground, and the ignition is not in START mode. This DTC shall execute regardless of the battery voltage.

Conditions for Setting the DTC

The battery voltage measured by the telematics module is:

- Less than 11.8 V for greater than 30 minutes
- Less than 11.6 V for greater than 20 minutes
- Less than 11 V for greater than 90 seconds

Action Taken When the DTC Sets

- The telematics module contacts the Telematics Call Centre alerting them of a low battery concern.
- The telematics module sets a DTC.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The battery voltage measured by the telematics module is above 11.8 V.

Reference Information

Schematic Reference

Power Distribution Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing .
- Connector Repairs .
- Testing for Intermittent Conditions and Poor Connections .
- Wiring Repairs .

Scan Tool Reference

Control Module References

Circuit / System Testing

1. Measure and record the battery voltage.
2. Ignition OFF, disconnect the harness connector at the telematics module.
3. Ignition OFF, measure for battery voltage from the telematics module power circuit to a known ground.

   If more than 1 volt difference between battery voltage and the power circuit then test the applicable circuit for a short to ground or an open/high resistance. If the circuits/connections test normal, replace the telematics module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for telematics module replacement, setup, and programming

DTC B245A (RHD)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B245A: Telematics Indicator 1 (Green) Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Telematics Indicator 1 (Green) Circuit	B245A 02	B245A 04	B245A 01	--

Circuit/System Description

The communication interface module button assembly on the inside rearview mirror assembly consists of 3 buttons, Information/End Call, Holden Assist and Emergency. The button assembly on the inside rearview mirror assembly also has three status Light Emitting Diodes (LED), Green, Red and Orange. The function of each is as follows:

- Flashing Green: Call is in progress.
- Steady Green: System is on and self test has been completed.
- Steady Red: System is on and self test has detected a malfuntion.
- Steady Orange: Vehicle is not in the coverage area. This is emphasised by 5 beeps when the ignition is switched off to inform the driver that the vehicle is about to be left in a "shadow" location that is untraceable by the Telematics Call Center.
- Red and Green Lights Flashing: telematics is in Service mode. Press the Holden Assist button to request this mode be disabled.

Conditions for Running the DTC

- Ignition is in the RUN or ACC position.
- System voltage is between 9 and 16 volts.

Conditions for Setting the DTC

The communication interface module detects a short to voltage, short to ground, or an open/high resistance on the Green LED circuit.

Action Taken When the DTC Sets

- The communication interface module sets a DTC.
- The communication interface module commands the red LED ON.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.

Reference Information

Schematic Reference

Telematics Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Telematics Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the mirror assembly keypad and the harness connector at the telematics module.
2. Test for less than 5 Ω between terminal 14 on the inside rearview mirror harness connector and terminal 3 on the vehicle comunication interface module X2 harness connector.

   If greater than specified range, test the circuit for a short to voltage, short to ground, or an open/high resistance.
3. If all circuits test normal, replace the inside rearview mirror.
4. If the DTC resets, replace the communication interface module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Inside Rearview Mirror Replacement.
- Control Module References for communication interface module replacement, setup and programming.

DTC B245B (RHD)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B245A 01: Telematics Indicator 2 (Red) Circuit

Diagnostic Fault Information

Perform the Diagnostic System Check - Vehicle in Vehicle DTC Information, prior to using this diagnostic procedure.

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Telematics Indicator 1 (Red) Circuit	B245B 02	B245B 04	B245B 01	--

Circuit/System Description

The communication interface module button assembly on the inside rearview mirror assembly consists of 3 buttons, Information/End Call, Holden Assist and Emergency. The button assembly on the inside rearview mirror assembly also has three status Light Emitting Diodes (LED), Green, Red and Orange. The function of each is as follows:

- Flashing Green: Call is in progress.
- Steady Green: System is on and self test has been completed.
- Steady Red: System is on and self test has detected a malfuntion.
- Steady Orange: Vehicle is not in the coverage area. This is emphasised by 5 beeps when the ignition is switched off to inform the driver that the vehicle is about to be left in a "shadow" location that is untraceable by the Telematics Call Center.
- Red and Green Lights Flashing: telematics is in Service mode. Press the Holden Assist button to request this mode be disabled.

Conditions for Running the DTC

- Ignition is in the RUN or ACC position.
- System voltage is between 9 and 16 volts.

Action Taken When the DTC Sets

The communication interface module sets a DTC.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.

Reference Information

Schematic Reference

Telematics Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Telematics Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the mirror assembly keypad and the harness connector at the telematics module.
2. Test for less than 5 Ω between terminal 15 on the inside rearview mirror harness connector and terminal 2 on the vehicle comunication interface module X2 harness connector.

   If greater than specified range, test the circuit for a short to voltage, short to ground, or an open/high resistance.
3. If all circuits test normal, replace the inside rearview mirror.
4. If the DTC resets, replace the communication interface module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Inside Rearview Mirror Replacement.
- Control Module References for communication interface module replacement, setup and programming.

DTC B2461 (RHD)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B2461 00: Navigation Electronic Control Unit (ECU) Synchronous Signal Error

Circuit Description

The navigation interface module (NIM) communicates with the navigation module via serial data. The NIM can request diagnostic information from the navigation module, if the NIM does not receive a response from the navigation module a DTC will set.

Conditions for Running the DTC

The ignition or the infotainment unit is ON.

Conditions for Setting the DTC

When diagnostic information is requested from the navigation module by the navigation interface module (NIM) and a response is not received.

Conditions for Clearing the DTC

A history DTC clears after 50 fault-free ignition cycles.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Navigation System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Disconnect the navigation gateway module and the navigation module X3 harness connectors.
2. Test for less than 5 Ω between the following pin locations:
   - navigation gateway module terminal 1 and navigation module terminal C7
   - navigation gateway module terminal 7 and navigation module terminal C8

   If greater than the specified range, test the circuit for a short to ground or an open/high resistance..
3. If all circuits test normal, replace the navigation module.

Repair Instructions

Perform the Diagnostic Repair Verification.

- Navigation Map Disc Player Replacement
- Control Module References.

DTC B2462 (RHD Entertainment)

DTC Descriptor

DTC B2462: GPS Antenna Circuit

Diagnostic Fault Information

Perform the Diagnostic System Check - Vehicle in Vehicle DTC Information, prior to using this diagnostic procedure.

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Telematics Indicator 1 (Green) Circuit	B2462 02	B2462 04	B2462 01	--

Circuit Description

The Global Positioning System (GPS) antenna is connected to the telematics module with a coax cable. The telematics module polls the data from the GPS antenna once every second.

Conditions for Running the DTC

- System voltage is between 9-16 volts.
- Ignition switch is in the ON position.

Conditions for Setting the DTC

- GPS antenna output above threshold.
- General GPS receiver error during test.

Conditions for Clearing the DTC

A history DTC clears after 50 fault-free ignition cycles.

Diagnostic Aids

An intermittent condition may be caused by the following:

- Mis-routed harness
- Rubbed through wire insulation
- Broken wire inside the insulation

Reference Information

Schematic Reference

Telematics Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit / System Testing

1. Ignition ON, disconnect the GPS coaxial cable from the GPS antenna. Verify there is 4 to 5.5 volts between the centre conductor and the shield of the coaxial cable.

   If 4 to 5.5 volts are present, replace the GPS antenna.
2. Ignition OFF, disconnect the GPS coaxial cable from the telematics module. Test the resistance of the GPS coaxial cable centre conductor from end to end. Verify the resistance is less than 5 ohms.

   If the resistance greater than 5 ohms, replace the GPS coaxial cable
3. Test the resistance of the GPS coaxial cable between the centre conductor and the outer conductor. Verify there is infinite resistance between both conductors.

   If there is less than infinite resistance between the inner conductor and the outer conductor of the GPS coaxial cable, replace the GPS coaxial cable. If the GPS coaxial cable tests normal, replace the telematics module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Communication Module Antenna Replacement
- Control Module References for telematics module replacement, setup, and programming.

DTC B2462 (RHD Navigation)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B2462 00: Global Positioning System Sensor Receiver Failure

DTC B2462 08: Global Positioning System Sensor Signal Invalid

Circuit Description

The navigation antenna is connected to the navigation module with a coax cable. The navigation module polls the data from the navigation antenna once every second.

Conditions for Running the DTC

- The ignition ON
- The system voltage is at least 9.5 volts and no more than 15.5 volts.

Conditions for Setting the DTC

- GPS antenna output above threshold.
- General GPS receiver error during test.

Conditions for Clearing the DTC

- The navigation module detects a proper signal from the GPS antenna.
- A history DTC clears after 50 fault-free ignition cycles.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Navigation System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Circuit / System Testing

1. Ignition OFF, disconnect the GPS coaxial cable from the navigation module.
2. Ignition ON, test for 4-5.5 volts between the center conductor and the shield of the coaxial cable.

   If not within the specified range, replace the navigation module.
3. If all circuits test normal, replace the GPS antenna.

Repair Instructions

Perform the Diagnostic Repair Verification.

- Electronic Navigation Antenna Replacement
- Control Module References for navigation module replacement, setup, and programming.

DTC B2464

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B2464 00: Navigation Player Decoding Error

Circuit / System Description

The circuitry is internal to the navigation radio. The system does not function when the internal temperature reaches 70°C (158°F) or above. This feature prevents heat damage to internal components.

Conditions for Running the DTC

The radio must detect one of the following power modes:

- The ignition ON.
- Battery voltage must be between 9-16 volts.
- The navigation module detects a power mode transition from OFF to ON.

Conditions for Setting the DTC

- Error found with the inserted DVD disc after 4 attempts at reading.
- The navigation module is unable to read the DVD due to laser focus error, there is a table of contents error or the DVD laser head temperature is above 70°C (158°F).

Action Taken When the DTC Sets

- No map or blue screen appears on the display and index is not usable.
- Navigation buttons do not function.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.

Diagnostic Aids

- Cycle the ignition after a successful inspection with a scan tool so initialization will occur.
- Make sure the map DVD is the correct one for this system.
- Occasionally it is possible to overheat the navigation system due to excessive ambient heat inside the vehicle. In this instance it may be necessary to allow time for the navigation system to cool.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Navigation System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Circuit/System Verification

Note: Allow the navigation system to cool if the ambient temperature inside the vehicle is excessive and the radio is hot to the touch before proceeding with this diagnostic procedure.

1. Ignition ON, with a scan tool clear all DTCs.
2. Ignition ON, install a known good MAP DVD and operate the system within the Condition for Running the DTC.

   If B2464 resets, replace the radio.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for Navigation Module replacement, setup, and programming

DTC B2469 (RHD)

DTC Descriptor

DTC B2469: SIM Card Invalid

Diagnostic Fault Information

Perform the Diagnostic System Check - Vehicle in Vehicle DTC Information, prior to using this diagnostic procedure.

Circuit/System Description

The telematics module is programmed to match a SIM card. SIM cards have each been assigned a unique SIM card number. If the SIM card number programmed into the telematics module does not match the SIM card or if the SIM card has been swapped from another telematics module, the telematics module will set a DTC.

Conditions for Running the DTC

The SIM card is no longer valid or is barred from the network.

Conditions for Setting the DTC

This code shall set as current when the SIM card number programmed into the telematics module does not match the SIM card.

Action Taken When the DTC Sets

- The telematics module sets a DTC.
- The telematics module commands the red LED ON.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.
- The DTC can be cleared using a scan tool.

Reference Information

Schematic Reference

Telematics Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit / System Testing

1. Ignition ON, use the scan tool to request DTCs. Verify that DTC B2469 is set as current.
   If DTC B2469 is historical, clear the DTC.
2. Contact the Telematics Call Centre to verify if the SIM Card is valid.
   If the SIM card is valid replace the telematics module.
3. Request activation of the SIM card and wait for confirmation with the Telematics Call Centre.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for telematics module replacement, setup and programming.

DTC B2471 (RHD)

DTC Descriptor

DTC B2471: Telephone Number Error

Diagnostic Fault Information

Perform the Diagnostic System Check - Vehicle in Vehicle DTC Information, prior to using this diagnostic procedure.

Circuit/System Description

The telematics module is programmed with the phone numbers for information services, Holden assist and emergency. If any one of their respective buttons are pushed, the telematics module will attempt to establish a voice call to an information services operator. If an incorrect phone number is programmed into the telematics module, the telematics module will set a DTC.

Conditions for Running the DTC

The phone number automatically dialled is invalid.

Conditions for Setting the DTC

This code shall set as current when an incorrect phone number is programmed into the telematics module.

Action Taken When the DTC Sets

- The telematics module sets a DTC.
- The telematics module commands the red LED ON.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.
- The DTC can be cleared using a scan tool.

Reference Information

Schematic Reference

Telematics Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Testing

1. Ignition ON, use the scan tool to request DTCs. Verify that DTC B2471 is set as current.
   If DTC B2471 is historical, clear the DTC.
   If DTC B2471 is current replace the telematics module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for telematics module replacement, setup and programming.

DTC B2476 (RHD)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B2476 00: Cellular Phone Select Switch

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Keypad Supply Voltage	B2476 00	B2476 00	B2476 00	--

Circuit/System Description

The telematics button assembly on the inside rearview mirror assembly consists of 3 buttons, Information/End Call, Holden Assist and Emergency. Ten volts is supplied to the button assembly on the keypad supply voltage circuit. Each of the buttons, when pressed, completes the circuit across a resistor allowing a specific voltage to be returned to the telematics module on the keypad signal circuit. Depending upon the voltage range returned, the telematics module is able to identify which button has been pressed.

Conditions for Running the DTC

- The radio is ON.
- Battery voltage must be between 9-16 volts.

Conditions for Setting the DTC

The communication interface module detects a short to voltage, short to ground, or an open/high resistance on the keypad supply voltage circuit.

Action Taken When the DTC Sets

- No calls can be placed.
- The communication interface module commands the red LED ON.
- The communication interface module will ignore all inputs from the button assembly.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 100 fault-free ignition cycles.

Reference Information

Schematic Reference

Telematics Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Telematics Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the inside rearview mirror.
2. Test for less than 5 Ω between the mirror ground circuit terminal 8 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, test for less than 1 V between the keypad signal circuit terminal 11 and ground.

   If greater than the specified range, test the keypad signal circuit for a short to voltage. If the circuit tests normal, replace the communication interface module.
4. Ignition OFF, test for 600 K - 700 K Ω between the keypad signal circuit terminal 11 and ground.

   If less than the specified range, test the keypad signal circuit for a short to ground. If the circuit tests normal, replace the communication interface module.

   If greater than the specified range, test the ground circuit for an open/high resistance. If the circuit tests normal, replace the communication interface module.
5. Ignition ON, test for 9.8-10.2 V between the keypad supply voltage circuit terminal 12 and ground.

   If less than the specified range, test the supply voltage circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the communication interface module.

If greater than the specified range, test the supply voltage circuit for a short to voltage. If the circuit tests normal, replace the communication interface module.

6. If all circuits test normal, test or replace the button assembly.

Component Testing

1. Ignition OFF, disconnect the harness connector at the inside rearview mirror.
2. Test for infinite resistance between the keypad supply voltage terminal 12 and the keypad signal terminal 11.

   If less than the specified range, replace the inside rearview mirror.
3. Test for 1.4 K - 1.6 K Ω between the keypad supply voltage terminal 12 and the keypad signal terminal 11 while pressing the black phone button.

   If not within the specified range, replace the inside rearview mirror.
4. Test for 2.7 K - 3.3 K Ω between the keypad supply voltage terminal 12 and the keypad signal terminal 11 while pressing the blue Holden Assist® button.

   If not within the specified range, replace the inside rearview mirror.
5. Test for 2.7 K - 3.3 K Ω between the keypad supply voltage terminal 12 and the keypad signal terminal 11 while pressing the red emergency button.

   If not within the specified range, replace the inside rearview mirror.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Inside Rearview Mirror Replacement in Stationary Windows.
- Control Module References for communication interface module replacement, setup and programming.

DTC B2484

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B2484 00: Global Positioning System Sensor Open Circuit

Circuit Description

The GPS antenna is connected to the navigation module with a coaxial cable. The navigation module polls the data from the GPS antenna once every second. The GPS antenna is powerd a 5 volt reference from the radio via the coaxial cable.

Conditions for Running the DTC

- The ignition must be in the RUN or ACC position.
- The system voltage is at least 9.5 volts and no more than 15.5 volts.
- All the above conditions are present for greater than 1 second.

Conditions for Setting the DTC

- The navigation module determines there is an open in the GPS antenna.
- All the above conditions are present for greater than 1 second.

Actions Taken When the DTC Sets

- Unable to get GPS location updated, the radio uses the last reported position and the vehicle speed signal to calculate the vehicle position.
- Route guidance may be inaccurate.
- This failure has no effect outside the navigation system.

Conditions for Clearing the DTC

- The navigation module detects the presence of a GPS antenna.
- A history DTC clears after 50 fault-free ignition cycles.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Navigation System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Circuit/System Testing

Note: The global positioning system (GPS) requires a clear line of sight to the sky to operate properly. In most cases the GPS will not have reception near tall buildings or inside structures.

1. Turn ON the ignition. Disconnect the GPS coaxial cable from the navigation module. Verify there is 4-5.5 volts between the center conductor and the shield of the coaxial cable.
   If 4-5.5 volts is not present, replace the navigation module.
2. If all circuits test normal, replace the GPS antenna.

Repair Instructions

Perform the Diagnostic Repair Verification.

- Electronic Navigation Antenna Replacement
- Control Module References for navigation module replacement, setup, and programming.

DTC B3924

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B3924: DVD Player Theft Locked

Circuit/System Description

This DTC will set when the rear seat entertainment (RSE) system is switched from the OFF to ON position. The DVD player and audio/video interface module communicate with each other to verify that a security code relayed between the two components is valid. The DTC will pass when the both components acknowledge a matching code.

Conditions for Running the DTC

- The radio is ON.
- Battery voltage must be between 9-16 volts.

Conditions for Setting the DTC

- The RSE system transitions from OFF to ON.
- This DTCs will set when there is a security code mismatch.

Action Taken When the DTC Sets

The system will enter the Theft Detected Mode and "Security Error" is displayed on the screen.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.

Reference Information

Schematic Reference

Video System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Video Entertainment System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Testing

1. Verify that DTC B3924 is not set and/or "Security Error" is not displayed on the screen.
   If the DTC is set and/or "Security Error" is displayed on the screen attempt DVD player to rear seat entertainment interface module auto-learn procedure.
2. Ignition ON, RSE system ON, select the DVD function for the system, verify that DVD player functions correctly.
   If the RSE system fails to function correctly, replace the DVD player.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Video Disc Player Replacement

DTC B3926 or B3927

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B3926: Screen 1 Theft Locked

DTC B3927: Screen 2 Theft Locked

Circuit/System Description

The DVD screen and rear seat entertainment interface module communicate with each other to verify that a security code relayed between the two components is valid. The DTC will pass when the both components acknowledge a matching code.

Conditions for Setting the DTC

- The RSE system transitions from OFF to ON. This may be in response to the RSE system power switch or an ignition key cycle.
- This DTCs will set when there is a security code mismatch.
- Battery voltage must be between 9-16 volts.

Action Taken When the DTC Sets

The system will enter the Theft Detected Mode.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.
- The DTC can be cleared using a scan tool.

Reference Information

Schematic Reference

Video System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Video Entertainment System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Testing

1. Verify that DTC B3926 or B3927 is set to current.
   If DTC B3926 or B3927 is set to current and "Security Error" is displayed on the screen attempt DVD screen to rear seat entertainment interface module auto-learn procedure.
2. RSE system OFF, ignition OFF, wait for 30 seconds.
3. Ignition ON, RSE system ON, select the DVD function for the system, verify that DVD screen functions correctly.
   If the RSE system fails to function correctly, replace the appropriate DVD screen.

Repair Instructions

Perform the Diagnostic Repair Verification.

Video Display Replacement

DTC U1401

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC U1401: Lost Communications Between AD and ADG

Circuit/System Description

The navigation interface module (NIM) continuously sends a communication signal to the navigation module. Upon receiving the signal, the navigation module sends a reply signal, confirming that it can communicate.

Conditions for Running the DTC

- The ignition ON
- The system voltage is at least 9.5 volts and no more than 15.5 volts.

Conditions for Setting the DTC

The NIM does not receive a response from the navigation module for 5 or more consecutive seconds.

Action Taken When the DTC Sets

The navigation system is disabled.

Conditions for Clearing the DTC

- The current DTC will clear when the NIM receives a communication reply from the navigation module.
- The history DTC will clear after 50 fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Navigation System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Testing

1. Disconnect the X1 harness connector at the Navigation Module.
2. Ignition OFF, test for less than 10 Ω between the ground circuit terminal A8 and ground

   If greater than specified range, test the ground circuit for an open/high resistance.
3. Ignition On, test for B+ between the B+ circuit terminal A4 and ground.

   If less than the specified value, test the circuit for a short to ground or an open/high resistance.
4. Ignition ON, Navigation ON, test for B+ between the control circuit terminal A7 and ground.

   If less than the specified value, test the circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the Navigation Interface Module.
5. Ignition OFF, disconnect the harness connector at the Navigation Interface Module and the X3 harness connector at the Navigation Module.
6. Test for less than 1 Ω between the serial data terminals listed below:
   - Terminal 1 at the Navigation Interface Module and terminal C7 X3 at the Navigation Module.
   - Terminal 7 at the Navigation Interface Module and terminal C8 X3 at the Navigation Module.

   If greater than the specified range, test the circuit for an open/high resistance.
7. Test for infinite resistance between the serial data terminals listed below and ground:
   - Terminal 1 at the Navigation Interface Module.
   - Terminal 7 at the Navigation Interface Module.

   If less than the specified value, test the circuit for a short to ground.
8. Test for less than 1 V between the serial data terminals listed below and ground:
   - Terminal 1 at the Navigation Interface Module.
   - Terminal 7 at the Navigation Interface Module.

   If greater than the specified range, test the circuit for a short to voltage.
9. If all circuits test normal, replace the Navigation Module.

Repair Instructions

Perform the Diagnostic Repair Verification.

Control Module References for Navigation Interface module and Navigation Module replacement, setup, and programming.

DTC U2121

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC U2121: No Communication with Radio Display

Circuit/System Description

The radio continuously sends a communication signal to the driver information display. Upon receiving the signal, the display sends a reply signal, confirming that it can communicate. The display is directly connects to the radio with no external circuits involved.

Conditions for Running the DTC

The radio is active.

Conditions for Setting the DTC

The radio does not receive a response from the radio display for 10 or more consecutive seconds.

Action Taken When the DTC Sets

The system will set the DTC and disable itself.

Conditions for Clearing the DTC

- The current DTC will clear when the radio receives a communication reply from the driver information display.
- The history DTC will clear after 50 fault-free ignition cycles have occurred.

Diagnostic Aids

Physically check that the driver information display is correctly mounted to the radio.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC U2121 is not set.

   If the DTC is set, replace the driver information display. If the DTC resets, replace the radio.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for radio and driver information display replacement, setup, and programming

DTC U2201

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit/System Description

With the ignition in either the ACC position or the ON position the rear seat entertainment (RSE) interface module continuously sends a communication signal to the DVD player. Upon receiving the signal, the DVD player sends a reply signal, confirming that it can communicate. DTC U2201 will set to indicate the DVD Player has not received a communication signal or replied when the RSE interface module has requested operation.

Conditions for Running the DTC

DTC U2201 runs continuously once a valid DVD player response occurs.

Conditions for Setting the DTC

The RSE interface module does not receive a response from the DVD player after 3 consecutive communication attempts.

Action Taken When the DTC Sets

The rear seat entertainment system fails to operate.

Conditions for Clearing the DTC

- The current DTC will clear when the RSE interface module receives a communication reply from the DVD player.
- The history DTC will clear after 50 fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Video System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Video Entertainment System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Using the scan tool, select the DTC display function. Verify that DTC U2201 is set.
2. If DTC U2201 is set, turn OFF the RSE system for 30 seconds.
3. Ignition ON, RSE system ON, select the DVD function for the system. Using the scan tool, select the DTC display function and verify that DTC U2201 is set to current.
4. Press the eject button on the DVD player and audibly verify that the DVD player has eject/load capability.

   If the DVD player fails to eject verify that DTC B1325 is not set to current.
5. Ignition OFF, disconnect the RSE interface module and DVD player harness connectors.
6. Using a DMM test the RSE interface module and DVD player; communication, power and ground circuits for short to ground or an open/high resistance.

   If the circuits do not test normal, repair or replace the effected circuit(s).

   If the circuits test normal, replace the DVD player.
7. Using the scan tool, select the DTC display function. If DTC U2201 resets, replace the audio video interface module.

Repair Instructions

Perform the Diagnostic Repair Verification.

- Audio/Video Interface Module Replacement
- Video Disc Player Replacement

DTC U2202

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC U2202: No Communication With Rear Control Panel

Circuit/System Description

With the ignition in either the ACC position or the ON position the rear seat entertainment (RSE) interface module continuously sends a communication signal to the rear seat entertainment (RSE) control panel. Upon receiving the signal, the RSE control panel sends a reply signal, confirming that it can communicate. DTC U2202 will set to indicate the RSE control panel has not received a communication signal or replied when the RSE interface module has requested operation.

Conditions for Running the DTC

DTC U2202 runs continuously once a valid RSE control panel response occurs.

Conditions for Setting the DTC

The RSE interface module does not receive a response from the RSE control panel after 3 consecutive communication attempts.

Action Taken When the DTC Sets

The rear seat entertainment system fails to operate.

Conditions for Clearing the DTC

- The current DTC will clear when the RSE interface module receives a communication reply from the RSE control panel.
- The history DTC will clear after 50 fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Video System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Video Entertainment System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Verify that DTC U2202 is set.
2. Ignition OFF, disconnect the audio/video interface module and RSE control panel harness connectors.
3. Test the RSE interface module and RSE control panel; communication, power and ground circuits for short to ground or an open/high resistance.

   If the circuits do not test normal, repair or replace the effected circuit(s).

   If the circuits test normal, replace the RSE control panel.
4. Using the scan tool, select the DTC display function. If DTC U2202 resets, replace the audio/video interface module.

Repair Instructions

Perform the Diagnostic Repair Verification.

- Video Disc Player Control Replacement
- Audio/Video Interface Module Replacement

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DTC U2203 or U2204

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC U2203: No Communication With Screen 1

DTC U2204: No Communication With Screen 2

Circuit/System Description

With the ignition in either the ACC position or the ON position the rear seat entertainment (RSE) interface module continuously sends a communication signal to the DVD screen/s. Upon receiving the signal, the DVD screen/s send a reply signal, confirming that they can communicate. DTC U2201 will set to indicate the DVD screen/s have not received a communication signal or replied when the RSE interface module has requested operation.

Conditions for Running the DTC

DTC U2203 and U2204 run continuously once a valid DVD screen response occurs.

Conditions for Setting the DTC

The RSE interface module does not receive a response from the DVD screen/s after 3 consecutive communication attempts.

Action Taken When the DTC Sets

The rear seat entertainment system fails to operate.

Conditions for Clearing the DTC

- The current DTC will clear when the RSE interface module receives a communication reply from the DVD screen/s.
- The history DTC will clear after 50 fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Video System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Video Entertainment System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the audio/video interface module and DVD screen harness connectors.
2. Test the audio/video interface module and DVD screen; communication, power and ground circuits for short to ground or an open/high resistance.

   If the circuits test normal, repair or replace the effected circuit(s).
3. If the circuits test normal, replace the appropriate DVD screen.
4. If either DTC U2203 or U2204 resets, replace the Audio Video interface module.

Repair Instructions

Perform the Diagnostic Repair Verification.

- Video Display Replacement
- Audio/Video Interface Module Replacement

Global Positioning System (GPS) Data Not Current or Inaccurate

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit / System Description

The communication interface module (CIM) receives information from a specific navigation antenna located on the outside of the vehicle. The navigation antenna is connected to the CIM via a shielded coaxial cable. The antenna cable also provides a path for DC current for powering the antenna.

Diagnostic Aids

- The GPS signal title on the scan tool will display a Yes or No dependant upon whether or not the module sees an increment of the seconds transmitted by GPS signals to the vehicle communication interface module. Upon entering this screen, the GPS signal title will automatically display Yes, regardless of the presence of time increment, for at least 2 seconds, while the algorithm in the scan tool determines the status of the clock. If increment is found, Yes is continually displayed. If the clock remains static, No is displayed. The scan tool looks for increment every second, regardless of current display.
- Inaccurate or aged GPS position concerns which are no longer present may have been due to the temporary loss of GPS signal reception by the vehicle. Conditions such as driving through tunnels or parking structures while making an Holden Assist® keypress will restrict the navigation antenna from a clear view of the satellites in the sky and may have caused this temporary data loss.

Reference Information

Schematic Reference

Telematics Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Telematics Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Note: It is important to have the vehicle in an open outside area where a cellular call can be successfully placed and GPS data can be received from the satellites. It is also necessary to inform the Holden Assist® Call Center advisor that this call is for vehicle diagnostic purposes.

1. Ignition ON, observe the GPS signal status indicator for at least 10 seconds with a scan tool. The indicator should display Yes.

   If the indicator does not display Yes, refer to Circuit/System Testing.
2. Call and verify the Holden Assist advisor has received the GPS data.

   If the advisor did not receive the GPS data and the call was a "fail to voice", contact the GM Technical Assistance Center.

   If the advisor did not receive the GPS data and the call was not a "fail to voice", refer to Circuit/System Testing.
3. Verify with the Holden Assit Call Center advisor that your actual position is within a reasonable distance from the actual location of the vehicle.

   If your actual position is not within a reasonable distance from the actual location of the vehicle, replace the CIM.

Circuit/System Testing

1. Disconnect the navigation antenna coax cable from the CIM.
2. Ignition ON, test for 4.5-5.5 V between the CIM coax cable center conductor terminal at the module and ground.

   If not within the specified range, replace the CIM.
3. Reconnect the coax cable to the CIM. Disconnect the coax cable from the navigation antenna.
4. Test for 4.5-5.5 V between the coax cable center conductor and the outer shield.

   If not within the specified range, replace the coax cable.
5. If all circuits test normal, replace the navigation antenna.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Communication Module Antenna Replacement
- Control Module References for CIM replacement, setup, and programming.

Microphone Malfunction - Caller Cannot Be Heard

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Cellular Microphone Signal	1	1	1	--
Cellular Microphone Drain	--	1	--	--
1. Microphone Inoperative - Caller Cannot Be Heard				

Circuit/System Description

Bluetooth ® wireless technology is a short-range communications technology intended to replace the cables connecting portable and/or fixed devices while maintaining high levels of security. Only vehicles with steering wheel controls will have Bluetooth ® functionality. In order to utilize the vehicle's Bluetooth ® system, a Bluetooth ® equipped cellular phone is required. The bluetooth module is not connected to serial data and will not set DTCs. When a Bluetooth button keypress is made, the bluetooth module pulls the celular telephone signal to ground to mute all radio functions and transmit cellular telephone originated audio. After the audio system is muted, the cellular telephone signals are transmitted to the audio system on the cellular telephone voice signal circuit, and returned to the module on the cellular telephone voice low reference circuit.

Reference Information

Schematic Reference

Cellular Telephone Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cellular Telephone Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the Bluetooth microphone.
2. Test for less than 10 Ω between the drain circuit terminal 4 and ground.

   If greater than the specified range, test the circuit for an open/high resistance.
3. Ignition ON, test for 7.2-9.2 V between the signal circuit terminal 1 and ground.

   If less than the specified range, test the circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the Bluetooth module.

   If greater than the specified range, test the circuit for a short to voltage. If the circuit tests normal, replace the Bluetooth module.
4. If all circuit test normal, replace the Bluetooth microphone assembly.

Repair Instructions

Perform the Diagnostic Repair Verification.

- Bluetooth Microphone Replacement
- Control Module References for Bluetooth module replacement, setup, and programming.

Radio Poor Reception

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit/System Description

AM and FM radio reception is dependent on the following components:

- Radio antenna
- Coax cable between the radio antenna and the radio
- Radio

Diagnostic Aids

Poor AM and FM radio reception is dependent on multiple influences, some of which may not be vehicle related. Areas which have high RF traffic or block the signal path may cause a degradation in radio reception. Radio reception may also be influenced by items within the vehicle, but not part of the radio system. Such examples are aftermarket electrical accessories or other items which may generated noise in the vehicle electrical system.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections

- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Inspect the antenna for proper mounting or physical damage.
   If damage is found, repair or replace as necessary
2. Radio ON, tune to several known AM and FM stations, and play a known good CD.
   If audio output is poor from all sources, refer to Speaker Malfunction.

Circuit/System Testing

1. Ignition OFF, disconnect the coax cable from the radio and radio antenna.
2. Verify the coax connectors are properly secured and free of any damage.
   If damage is found, repair or replace as necessary.
3. Test for infinite resistance between the antenna coax center terminal and ground.
   If less than the specified value, replace the antenna coax.
4. Test for less than 5 ohms on the antenna coax center terminal from end to end.
   If greater than the specified range, replace the antenna coax.
5. Test for less than 5 ohms on the antenna coax outer shield from end to end.
   If greater than the specified range, replace the antenna coax.
6. Test for infinite resistance between the coax center terminal and the outer shield.
   If less than the specified value, replace the antenna coax.
7. If all circuits test normal, replace the antenna.
8. Ignition ON, radio ON, verify radio reception has improved.
   If there is still poor reception, replace the radio.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for Radio replacement, setup, and programming

Speaker Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Amplifier B+	--	1	--	--
Left Front Speaker Output (+) Signal	B1025 02, *	B1025 04, *	B1025 01, *	--
Left Front Speaker Output (-) Signal	B1025 02, *	B1025 04, *	B1025 01, *	--
Right Front Speaker Output (+) Signal	B1035 02, *	B1035 04, *	B1035 01, *	--
Right Front Speaker Output (-) Signal	B1035 02, *	B1035 04, *	B1035 01, *	--
Left Rear Speaker Output (+) Signal	B1045 02, *	B1045 04, *	B1045 01, *	--
Left Rear Speaker Output (-) Signal	B1045 02, *	B1045 04, *	B1045 01, *	--
Right Rear Speaker Output (+) Signal	B1055 02*	B1055 04*	B1055 01, *	--
Right Rear Speaker Output (-) Signal	B1055 02*	B1055 04*	B1055 01, *	--
Rear Subwoofer Speaker Outputs (+) Signal	2	2	2	--
Rear Subwoofer Speaker Outputs (-) Signal	2	2	2	--
Center Speaker Output Signal (+)	3	3	3	--
Center Speaker Output Signal (-)	3	3	3	--
Amplifier Ground	--	1	--	--

1. Amplifier inoperative/no sound from speakers.

2. No or reduced sound from subwoofer.

3. No sound from center speaker

* Noticeable audio distortion possible.

Circuit / System Description

Each of the audio output channel circuits (+) and (-), at the radio and audio amplifier have a DC bias voltage that is one half of the battery voltage. When using a DMM, each of the audio output channel circuits will measure approximately 6.5V DC. The audio being played on the system is produced by a varying AC voltage that is centered around the DC bias voltage on the same circuit. The AC voltage is what causes the speaker cone to move and produce sound. This voltage will vary depending on what type of audio is being listened to, talk or music, and type of music, as well as the volume setting of the system. Low volume and talk settings will measure around 1V AC and less, where constant music may measure 3V AC and slightly higher. The amplifier may only supplied an amplified signal to the subwoofers, or on the premium audio systems, the amplifier will amplify all of the audio signals. The amplifier can not set DTCs. The amplifier mute circuit from the radio to the amplifier sends a 4V signal to disable the rear speakers, and is 2V when the mute is OFF.

Diagnostic Aids

- Improper speaker mounting or loose trim may cause an audible buzz or distortion. Inspect the appropriate speaker and the surrounding interior trim for proper and secure mounting. If the speaker or surrounding interior trim is found to be loose or improperly secured, correctly secure the item.
- When equipped with an amplifier, it is possible for some individual circuit faults to affect more than one speakers operation. Perform diagnostic tests in the sequence listed to avoid misdiagnosis.
- The front tweeter speakers are connected to the same channel as the front door speakers.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Radio ON, adjust the fade and balance controls on the radio to test all four channels individually. Each channel should produce clear and even sound.

Without Amplifier

Radio ON, verify clear audio is heard from each audio speaker.

If audio is inoperative from all speakers, replace the radio.

If audio is inoperative from one or more, but not all, speakers or the audio emitted from the speakers is not clear, refer to Speaker Circuit Malfunction - without Amplifier.

With Amplifier -- UQG

Radio ON, verify clear audio is heard from each audio speaker.

If audio is inoperative from one or both subwoofers, refer to Amplifier Circuit Malfunction.

If audio is inoperative from one or more rear speakers or the audio emitted from the speakers is not clear, refer to Speaker Circuit Malfunction - with Amplifier.

With Amplifier -- UQA

Radio ON, verify clear audio is heard from each audio speaker.

If audio is inoperative from all speakers, or just the rear speakers, refer to Amplifier Circuit Malfunction.

If audio is inoperative from one or more, but not all, speakers or the audio emitted from the speakers is not clear, refer to Speaker Circuit Malfunction - with Amplifier.

Circuit/System Testing

Speaker Circuit Malfunction - without Amplifier

1. Ignition OFF, disconnect the harness connector at the appropriate speaker.
2. Radio ON, test for 5.0-7.5 volts between the signal circuit terminal A and ground.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the radio.
3. Test for 5.0-7.5 V between the signal circuit terminal B and ground.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the radio.

4. If all circuits test normal, replace the speaker.

Amplifier Circuit Malfunction -- UQG

1. Ignition OFF, disconnect the harness connector at the audio amplifier.
2. Ignition OFF, test for less than 10 Ω between the ground circuit terminals listed below and ground.
   - Terminal 5
   - Terminal 12

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, test for B+ on the B+ circuit terminals listed below and ground.
   - Terminal 4
   - Terminal 11

   If less than the specified value, test the B+ circuit for a short to ground or an open/high resistance.
4. Radio ON, test for 5.0-7.5 V between the appropriate signal circuit terminal listed below and ground.
   - Left rear speaker output (+) terminal 1
   - Left rear speaker output (-) terminal 6
   - Right rear speaker output (+) terminal 2
   - Right rear speaker output (-) terminal 7

   If less than the specified range, test the appropriate signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.

   If greater than the specified range, test the appropriate signal circuit for a short to voltage. If the circuit tests normal, replace the radio.
5. Ignition OFF, reconnect the amplifier and disconnect the appropriate subwoofer harness connectors.
6. Radio ON, test for 5.0-7.5 V between the signal circuit terminal 1 and ground.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the amplifier.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the amplifier.
7. Test for 5.0-7.5 V between the signal circuit terminal 2 and ground.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the amplifier.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the amplifier.
8. If all circuits test normal, replace the appropriate subwoofer.

Amplifier Circuit Malfunction UQA

1. Ignition OFF, disconnect the X3 harness connector at the audio amplifier.
2. Ignition OFF, test for less than 10 ohms between the ground circuit terminal 8 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Reconnect the X3 harness connector and disconnect the X1 harness connector.
4. Ignition ON, test for B+ between the B+ circuit terminal 4 and ground.

   If less then specified value, test the circuit for a short to ground, or an open/high resistance.

5. Test for B+ between the remote enable signal circuit terminal 8

   If less then the specified value, test the circuit for a short to ground, or an open/high resistance. If the circuit tests normal, replace the radio.
6. Radio ON, Mute OFF, test for 1.5 - 2.5 V between the amplifier mute signal circuit terminal 11 and ground.

   If less then the specified range, test the circuit for a short to ground, or an open/high resistance. If the circuit tests normal, replace the radio.

   If greater then the specified range, test the circuit for a short to voltage. If the circuit tests normal, replace the radio.
7. If all circuits test normal, replace the audio amplifier.

Speaker Circuit Malfunction -- With Amplifier UQG -- Front Speaker Testing

1. Ignition OFF, disconnect the harness connector at the appropriate speaker.
2. Radio ON, test for 5.0-7.5 V between the signal circuit terminal A and ground.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the radio.
3. Test for 5.0-7.5 V between the signal circuit terminal B and ground.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the radio.
4. If all circuits test normal, replace the speaker.

Speaker Circuit Malfunction - with Amplifier UQG -- Rear Speaker Testing

1. Ignition OFF, disconnect the amplifier and the appropriate speaker harness connectors.
2. Radio ON, test for 5.0-7.5 V between the signal circuit terminal A and ground.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the radio.
3. Test for 5.0-7.5 V between the signal circuit terminal B and ground.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the radio.
4. Ignition OFF, reconnect the harness connector at the audio amplifier.
5. Radio ON, test for 5.0-7.5 V between the signal circuit terminal A and ground at the appropriate speaker.

   If not within the specified range, replace the amplifier.
6. Radio ON, test for 5.0-7.5 V between the signal circuit terminal B and ground at the appropriate speaker.

   If not within the specified range, replace the amplifier.
7. If all circuits test normal, replace the speaker.

Speaker Malfunction Radio Output Testing -- RHD -- UQA

1. Ignition OFF, disconnect the X1 connector at the amplifier.
2. Ignition ON, radio ON, test for 5.0-7.5 volts between the appropriate signal circuit terminal listed below and ground.
   - Left front low level audio signal (+) - terminal 15
   - Left front low level audio signal (-) - terminal 7
   - Right front low level audio signal (+) - terminal 14
   - Right front low level audio signal (-) - terminal 6
   - Left rear low level audio signal (+) - terminal 13
   - Left rear low level audio signal (-) - terminal 5
   - Right rear low level audio signal (+) - terminal 12
   - Right rear low level audio signal (-) - terminal 4

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the radio.
3. If all circuits test normal, replace the amplifier.

Speaker Malfunction Radio Output Testing -- LHD -- UQA

1. Ignition OFF, disconnect the X1 connector at the amplifier.
2. Ignition ON, radio ON, test for 5.0-7.5 volts between the appropriate signal circuit terminal listed below and ground.
   - Left front low level audio signal (+) - terminal 14
   - Left front low level audio signal (-) - terminal 6
   - Right front low level audio signal (+) - terminal 15
   - Right front low level audio signal (-) - terminal 7
   - Left rear low level audio signal (+) - terminal 12
   - Left rear low level audio signal (-) - terminal 4
   - Right rear low level audio signal (+) - terminal 13
   - Right rear low level audio signal (-) - terminal 5

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the radio.
3. If all circuits test normal, replace the amplifier.

Speaker Malfunction Amplifier Output Testing -- RHD --UQA

1. Ignition OFF, disconnect the X2 and X3 connectors at the amplifier.
2. Radio ON, test for less than 1 volt between the appropriate signal circuit terminal listed below and ground:
   - Left front speaker output (+) - terminal 5 X3
   - Left front speaker output (-) - terminal 1 X3
   - Right front speaker output (+) - terminal 8 X2

- Right front low speaker output (-) - terminal 7 X2
- Left rear speaker output (+) - terminal 15 X2
- Left rear speaker output (-) - terminal 16 X2
- Right rear speaker output (+) - terminal 2 X2
- Right rear speaker output (-) - terminal 1 X2
- Left subwoofer speaker output (+) - terminal 7 X3
- Left subwoofer speaker output (-) - terminal 3 X3
- Right subwoofer speaker output (+) - terminal 6 X3
- Right subwoofer speaker output (-) - terminal 2 X3
- Center speaker output (+) - terminal 4 X2
- Center speaker output (-) - terminal 3 X2
- Roof speaker output (+) - terminal 6 X2
- Roof speaker output (-) - terminal 5 X2

  If greater than the specified range, test both circuits of the affected speaker for a short to voltage.

3. Radio OFF, test for infinite resistance between the appropriate signal circuit terminal listed below and ground:
   - Left front speaker output (+) - terminal 5 X3
   - Left front speaker output (-) - terminal 1 X3
   - Right front speaker output (+) - terminal 8 X2
   - Right front low speaker output (-) - terminal 7 X2
   - Left rear speaker output (+) - terminal 15 X2
   - Left rear speaker output (-) - terminal 16 X2
   - Right rear speaker output (+) - terminal 2 X2
   - Right rear speaker output (-) - terminal 1 X2
   - Left subwoofer speaker output (+) - terminal 7 X3
   - Left subwoofer speaker output (-) - terminal 3 X3
   - Right subwoofer speaker output (+) - terminal 6 X3
   - Right subwoofer speaker output (-) - terminal 2 X3
   - Center speaker output (+) - terminal 4 X2
   - Center speaker output (-) - terminal 3 X2
   - Roof speaker output (+) - terminal 6 X2
   - Roof speaker output (-) - terminal 5 X2

   If less than the specified value, test both circuits of the affected speaker for a short to ground.
4. If all circuits test normal, reconnect all harness connectors at the amplifier.
5. Radio ON, disconnect the appropriate speaker.
6. Test for 5.0-7.5 volts between the signal circuit terminals and ground.

   If less then the specified range test the circuit for an open/high resistance. If the circuit tests normal, replace the amplifier.

   If greater then the specified range test the circuit for a short to voltage. If the circuit tests normal, replace the amplifier.
7. If the circuit tests normal, replace the appropriate speaker.

Speaker Malfunction Amplifier Output Testing -- LHD --UQA

1. Ignition OFF, disconnect the X2 and X3 connectors at the amplifier.
2. Radio ON, test for less than 1 volt between the appropriate signal circuit terminal listed below and ground:
   - Left front speaker output (+) - terminal 8 X2
   - Left front speaker output (-) - terminal 7 X2
   - Right front speaker output (+) - terminal 5 X3
   - Right front low speaker output (-) - terminal 1 X3
   - Left rear speaker output (+) - terminal 2 X2
   - Left rear speaker output (-) - terminal 1 X2
   - Right rear speaker output (+) - terminal 15 X2
   - Right rear speaker output (-) - terminal 16 X2
   - Left subwoofer speaker output (+) - terminal 6 X3
   - Left subwoofer speaker output (-) - terminal 2 X3
   - Right subwoofer speaker output (+) - terminal 3 X3
   - Right subwoofer speaker output (-) - terminal 7 X3
   - Center speaker output (+) - terminal 4 X2
   - Center speaker output (-) - terminal 3 X2
   - Roof speaker output (+) - terminal 6 X2
   - Roof speaker output (-) - terminal 5 X2

   If greater than the specified range, test both circuits of the affected speaker for a short to voltage.
3. Radio OFF, test for infinite resistance between the appropriate signal circuit terminal listed below and ground:
   - Left front speaker output (+) - terminal 8 X2
   - Left front speaker output (-) - terminal 7 X2
   - Right front speaker output (+) - terminal 5 X3
   - Right front low speaker output (-) - terminal 1 X3
   - Left rear speaker output (+) - terminal 2 X2
   - Left rear speaker output (-) - terminal 1 X2
   - Right rear speaker output (+) - terminal 15 X2
   - Right rear speaker output (-) - terminal 16 X2
   - Left subwoofer speaker output (+) - terminal 6 X3
   - Left subwoofer speaker output (-) - terminal 2 X3
   - Right subwoofer speaker output (+) - terminal 3 X3
   - Right subwoofer speaker output (-) - terminal 7 X3
   - Center speaker output (+) - terminal 4 X2
   - Center speaker output (-) - terminal 3 X2
   - Roof speaker output (+) - terminal 6 X2
   - Roof speaker output (-) - terminal 5 X2

   If less than the specified value, test both circuits of the affected speaker for a short to ground.

4. If all circuits test normal, reconnect all harness connectors at the amplifier.
5. Radio ON, disconnect the appropriate speaker.
6. Test for 5.0-7.5 volts between the signal circuit terminals and ground.

   If less then the specified range test the circuit for an open/high resistance. If the circuit tests normal, replace the amplifier.

   If greater then the specified range test the circuit for a short to voltage. If the circuit tests normal, replace the amplifier.
7. If the circuit tests normal, replace the appropriate speaker.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Speaker Replacement Reference
- Control Module References for audio amplifier and radio replacement, setup, and programming

Speaker Replacement Reference

Component	Repair Instruction
Front Side Door Speaker Replacement	Refer to Radio Front Side Door Lower Speaker Replacement
Front Speaker (Tweeter)	Refer to Radio Front Speaker Replacement
Rear Side Door Speaker Replacement	Refer to Radio Rear Side Door Speaker Replacement
Rear Shelf Speaker Replacement	Refer to Radio Rear Speaker Replacement

Symptoms - Cellular Communication

Important: The following steps must be completed before using the symptom table.

Important: The Bluetooth Module is not connected to the GMLAN system.

1. Perform the Diagnostic System Check - Vehicle , before using the Symptom Tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarise yourself with the system functions. Refer to Cellular Telephone Description and Operation in Cellular Communication.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the Radio/Audio System. Refer to Checking Aftermarket Accessories .
- Inspect for easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Microphone Inoperative - Caller Cannot Be Heard
- Cellular Telephone Will Not Pair Up With Bluetooth Car Kit
- Cellular Telephone Will Not Connect To Bluetooth Car Kit
- Voice Recognition Inoperative

Symptoms - Entertainment

Important: The following steps must be completed before using the symptom table.

1. Perform the Diagnostic System Check - Vehicle before using the Symptom Tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to Radio/Audio System Description and Operation.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the Radio/Audio System. Refer to Checking Aftermarket Accessories.
- Inspect for easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Radio Poor Reception
- Speaker Malfunction

Symptoms - Telematics

Important: The following steps must be completed before using the symptom table.

1. Perform the Diagnostic System Check - Vehicle , before using the Symptom Tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarise yourself with the system functions. Refer to Telematics Description and Operation .
3. Refer to the following symptom list, this list will enable the user to verify the customer complaint and narrow it to its source.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the Radio/Audio System. Refer to Checking Aftermarket Accessories .
- Inspect for easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Telematics Call Center Remote Function Requests Inoperative
- Unable to Contact Telematics Call Center
- No or Noisy Telematics Audio
- Global Positioning System (GPS) Data Not Current or Inaccurate

Telematics Audio Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Telephone Audio Signal (+)	1	1	1	--
Telephone Audio Signal (-)	--	1	--	--
1. No (or Noisy) Holden Assist® Audio				

Circuit/System Description

When a Holden Assist® keypress is made, a serial data message is sent to the audio system to mute all radio functions and output Holden Assist® originated audio. After the audio system is muted, the telematics module transmits signals to the audio system on the audio signal circuit, and returned to the module on the audio common circuit.

Reference Information

Schematic Reference

- Radio/Navigation System Schematics
- Telematics Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

- Radio/Audio System Description and Operation
- Telematics Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Tune radio to a known good station and verify the audio is heard clearly through all speaker channels.

   If audio is not heard clearly, refer to Speaker Malfunction.
2. Ignition ON, radio ON, set volume to comfortable level and press Holden Assist® Call Center button. Verify Connecting to Holden Assist® message is heard clearly through the audio system.

   If Holden Assist® message is noisy or distorted, refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition OFF, disconnect the X2 harness connector at the telematics module.
2. Test for less than 5 Ω between terminal 2 and ground.

   If greater than the specified range, test the circuit for an open or high resistance. If the circuit tests normal, replace the radio.
3. Disconnect the X4 harness connector at the radio.
4. Ignition OFF, test for less than 5 Ω of resistance between the Telephone Audio Signal (+) terminal 7 at the radio and the Telephone Audio Signal (+) terminal 15 at the telematics module.

   If greater than the specified range, test the circuit for a short to voltage, short to ground, or an open/high resistance.
5. If all circuits test normal, replace the telematics module.
6. Ignition ON, radio ON, verify Holden Assist® audio has improved.

   If the audio is still poor, replace the radio.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for radio or telematics module replacement, setup, and programming.

Telematics Call Center Remote Function Requests Inoperative

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit/System Description

The communication interface module has the capability of commanding the horn, initiating door lock/unlock, or operating the exterior lamps using the serial data circuits. These functions are commanded by the Call Center per a customer request.

Diagnostic Aids

The customer concern may have been due to a lack of cellular service in a given area. A failure in the Cellular Network infrastructure that has since been corrected.

Reference Information

Schematic Reference

Telematics Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Telematics Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Important:

- It is necessary to inform the Call Center advisor that this call is for vehicle diagnostic purposes.
- It is necessary to have the vehicle in an open outside area where a cellular call can be successfully placed and GPS data can be received from satellites.

1. Verify that the horn, lights, and the doors locks on the vehicle operate properly.

   If the applicable system does not operate properly, refer to Diagnostic System Check - Vehicle .
2. Contact the Call Center by pressing the blue button. Verify with the call center advisor that all of the remote functions (door locks, lights, or horn) work.

   If unable to connect with the call center, refer to Unable to Contact Telematics Call Center .

   If the remote functions do not operate when requested, replace the communication interface module.

Repair Instructions

Perform the Diagnostic Repair Verification .

Control Module References for Communication Interface module replacement, setup, and programming

Unable to Contact Telematics Call Center

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit / System Description

The communication interface module is a cellular device that allows the user to communicate data and voice signals over the national cellular network. When a blue button keypress is made, the communication interface module activates and connects the system to the cellular carriers communication system by interacting with the national cellular infrastructure. The module sends and receives all cellular communications over the cellular antenna and cellular antenna coax.

Diagnostic Aids

- The customer concern may have been due to a lack of cellular service in a given area. A failure in the National Cellular Network infrastructure at the time of the customers failed connection that has since been repaired may also have been the cause.
- If an emergency call is able to successfully connect the vehicle to the Call Center when a Call Center button press is not, there may be a failure in the ability of the system in the vehicle to be recognized by the local cellular carrier.
- If the prompt "Request Ended" is heard, without pressing the white dot button at the end of the keypress, the system at one time has made a successful cellular connection, but was unable to complete the call.
- It is important to have the vehicle in an open outside area where a cellular call can be successfully placed and GPS data can be received from satellites.

Reference Information

Schematic Reference

Telematics Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Telematics Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Verify that the cellular antenna and cellular antenna coupling assembly are not damaged.
   If damage is found, repair or replace as necessary.
2. If the system activates but does not connect with the call center, refer to Circuit/System testing.

Circuit / System Testing

1. Ignition OFF, disconnect the cellular antenna coax from the communication interface module and the cellular antenna.
2. Ignition ON, test for less than 1V between the antenna coax center terminal and ground.
   If greater than the specified range, replace the antenna coax.
3. Ignition ON, test for less than 1 V between the antenna coax outer shield and ground.
   If greater than the specified range, replace the antenna coax.
4. Test for infinite resistance between the antenna coax center terminal and ground.
   If less than the specified value, replace the antenna coax.
5. Test for infinite resistance between the antenna coax outer shield and ground.
   If less than the specified value, replace the antenna coax.
6. Test for less than 5 Ω at the cellular antenna coax center terminal from end to end.
   If greater than specified value, replace the cellular antenna coax cable.
7. Test for less than 5 Ω at the cellular antenna coax outer shield from end to end.
   If greater than specified value, replace the cellular antenna coax cable.
8. Test for infinite resistance between the antenna coax center terminal and the outer shield.
   If less than specified value, replace the cellular antenna coax cable.
9. If coax cable tests normal, replace the cellular antenna.
10. Press the Call Center button. Verify the system connects to call center.
    If a connection is not made to the call center, replace the comunication interface module.

Repair Instructions

Perform the Diagnostic Repair Verification .

Control Module References for Communication Interface module replacement, setup, and programming

Voice Recognition Inoperative

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit/System Description

Bluetooth ® wireless technology is a short-range communications technology intended to replace the cables connecting portable and/or fixed devices while maintaining high levels of security. Only vehicles with steering wheel controls will have Bluetooth ® functionality. In order to utilize the vehicle's Bluetooth ® system, a Bluetooth ® equipped cellular phone is required. The bluetooth module is not connected to serial data and will not set DTCs. When a Bluetooth button keypress is made, the bluetooth module pulls the celular telephone signal to ground to mute all radio functions and transmit cellular telephone originated audio. After the audio system is muted, the cellular telephone signals are transmitted to the audio system on the cellular telephone voice signal circuit, and returned to the module on the cellular telephone voice low reference circuit.

Reference Information

Schematic Reference

Cellular Telephone Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cellular Telephone Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Ignition ON, press Bluetooth button and make a phone call. Verify that your voice cannot be heard clearly by the person called.

   If your voice can not be heard clearly, refer to Microphone Inoperative - Caller Cannot Be Heard
2. Make sure the background noise is minimal. Press the Bluetooth button. Attempt to operate the bluetooth system using multiple different voice commands. Verify the system responds appropriately to all voice commands.

   If the Bluetooth system does not respond to any voice commands, replace the Bluetooth module.
3. Record voice commands via the Bluetooth car kit. Refer the cellular telephone's owner handbook.

   If voice commands cannot be recorded via the Bluetooth car kit, the cellular telephone may not be fully compatible with the Bluetooth car kit.

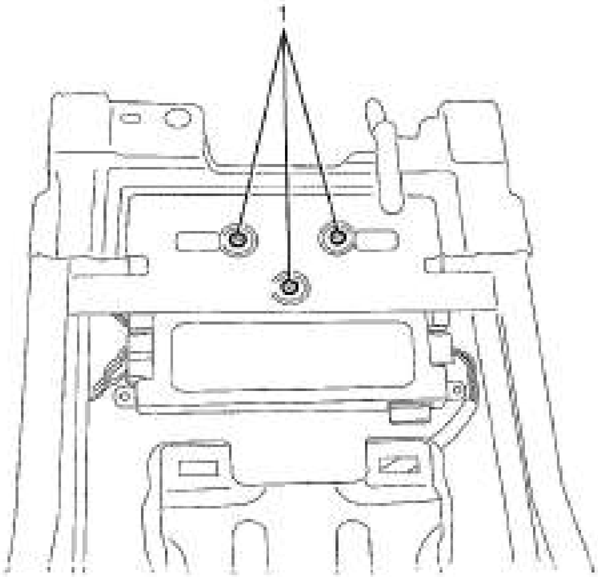
Repair Instructions

Perform the Diagnostic Repair Verification.

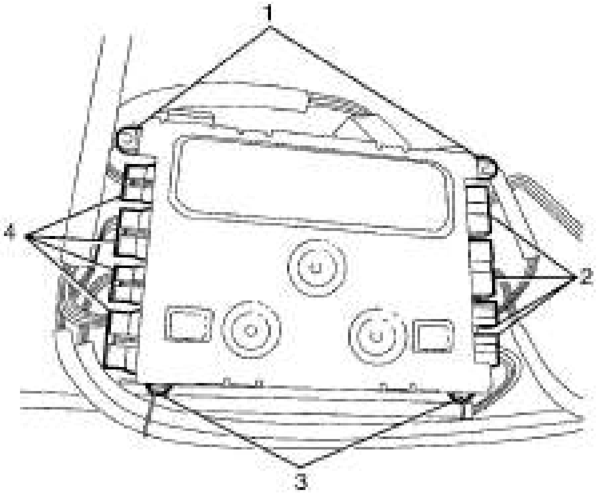
Control Module References for Bluetooth module replacement, setup, and programming.

Audio/Video Interface Module Replacement

Removal Procedure



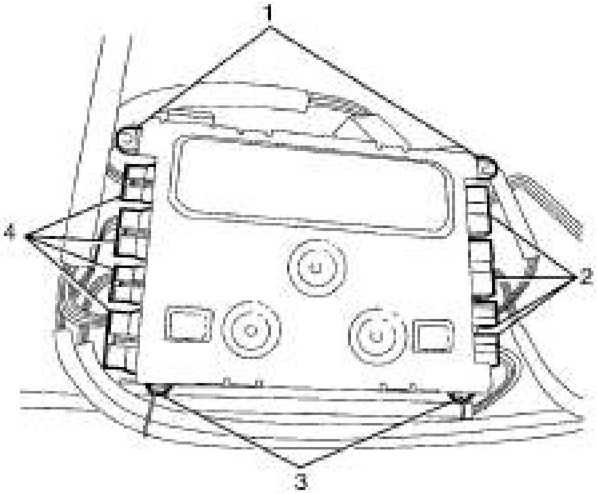
1. Remove the rear seat entertainment (RSE) assembly. Refer to Video Disc Player Bracket Replacement .
2. Remove the RSE interface module to rear seat entertainment assembly bracket screws (1).



Important: Make sure to label the connectors configuration for easy re-assembly.

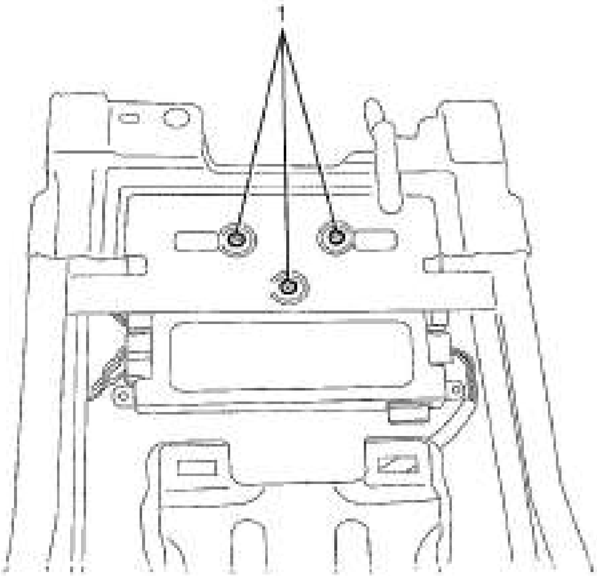
3. Disconnect the RSE interface module connectors (2 and 4, where fitted)
4. Cut the retaining ties (1 and 3) securing the RSE assembly harnesses to the RSE interface module.
5. Remove the RSE interface module from the RSE assembly bracket.

Installation Procedure



1. Install the RSE interface module to the RSE assembly bracket.
2. Connect the RSE interface module electrical connectors (2 and 4, where fitted).
3. Appropriately fasten the RSE harnesses to the RSE interface module assembly (1 and 3) with retaining ties.

Notice: Refer to Fastener Notice in the Preface section.



4. Install the RSE interface module to RSE assembly bracket retaining screws (1).

   Tighten
   Tighten the screws to 1.5 N·m (13 lb in).

5. Install the RSE assembly. Refer to Video Disc Player Bracket Replacement .
6. Refer to Control Module References for RSE interface module programming and setup.

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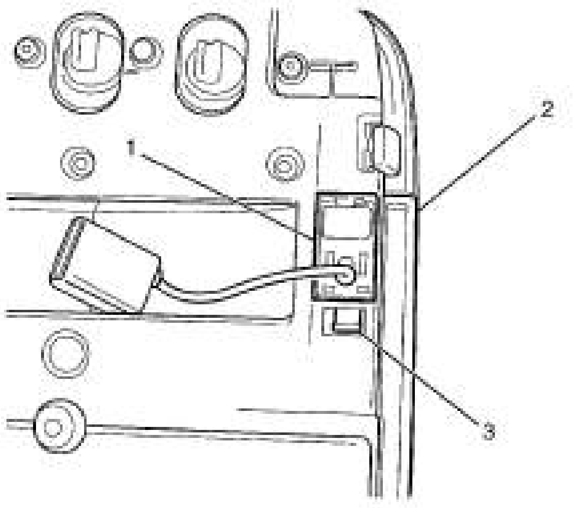
Bluetooth Microphone Replacement

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

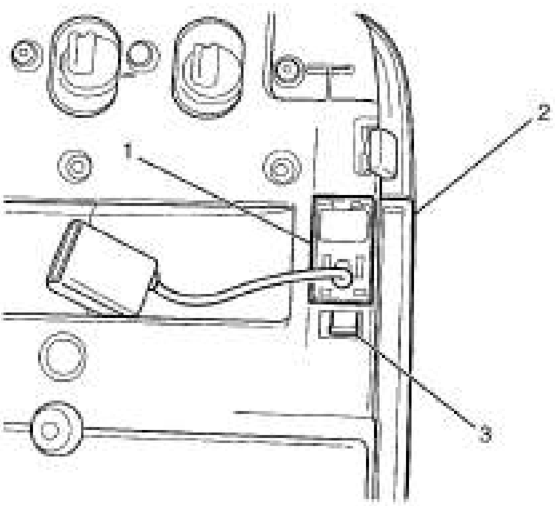
1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the front dome lamp assembly. Refer to Dome Lamp Replacement.



Important: Use a suitable tool to release the bluetooth microphone to dome lamp retaining clip (3) .

3. Remove the bluetooth microphone (1) from the dome lamp (2).

Installation Procedure



Important: Listen for an audible click to make sure the bluetooth microphone to dome lamp retaining clip (3) engages to avoid an induced rattle condition.

1. Install the bluetooth microphone (1) to the dome lamp (2).
2. Install the front dome lamp assembly. Refer to Dome Lamp Replacement in Lighting Systems.
3. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

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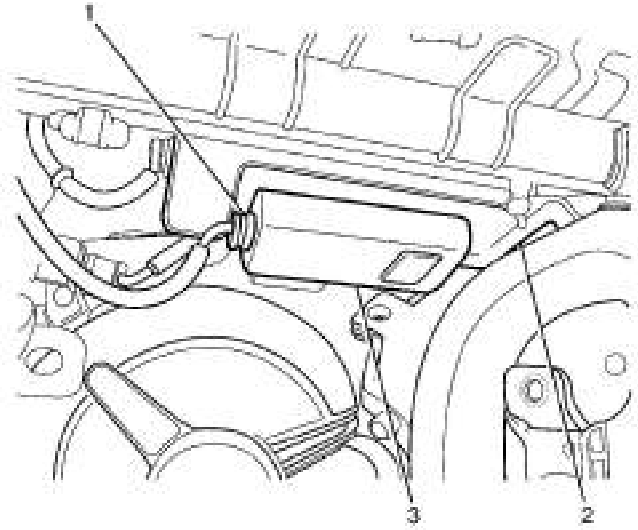
Bluetooth Module Replacement

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the insulator panel. Refer to Instrument Panel Insulator Panel Replacement - Left Side.
3. Remove the instrument panel outer trim cover. Refer to Instrument Panel Outer Trim Cover Replacement.
4. Remove the instrument panel compartment. Refer to Instrument Panel Compartment Replacement.

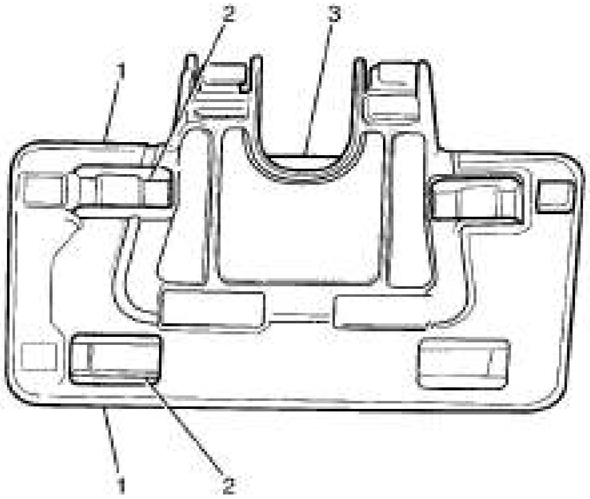


5. Disconnect the bluetooth module electrical connector (1).

Important: Push the bluetooth module assembly (3) towards the front of the vehicle and pull downward to disengage the bluetooth module assembly retaining clips from the I/P carrier (2).

6. Remove the bluetooth module assembly (3) from the I/P carrier (2).

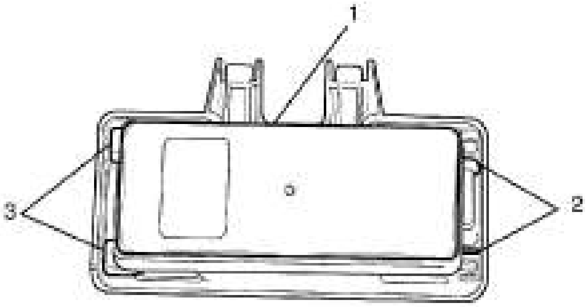
Disassembly Procedure



Important: To remove the bluetooth module bracket (1) from the bluetooth module (3), grasp the outside of the bluetooth module bracket with your fingers and disengage the bluetooth module bracket retaining tangs (2) with your thumbs.

Remove the bluetooth module (3) from the bluetooth module bracket (1).

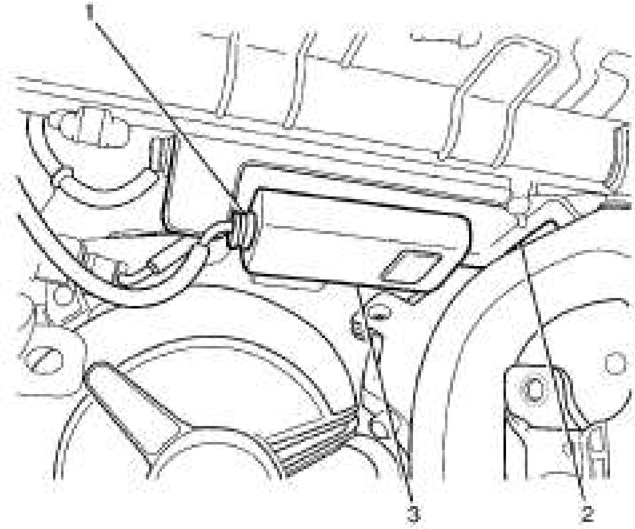
Assembly Procedure



Important: Guide the bluetooth module (1) into the bluetooth module bracket (2), make sure retaining clips (3) engage.

Install the bluetooth module (1) to the bluetooth module bracket (2 and 3).

Installation Procedure



Important: Push the bluetooth module assembly (1) toward the rear of the vehicle, making sure to engage the bluetooth module assembly retaining clips to the I/P carrier (2).

1. Install the bluetooth module assembly (1) to the I/P carrier (2).
2. Connect the bluetooth module electrical connector (1).
3. Install the Instrument Panel Outer Trim Cover. Refer to Instrument Panel Outer Trim Cover Replacement.
4. Install the insulator panel. Refer to Instrument Panel Insulator Panel Replacement - Left Side.
5. Install the instrument panel compartment. Refer to Instrument Panel Compartment Replacement.
6. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
7. If re-programming is required. Refer to Control Module References.

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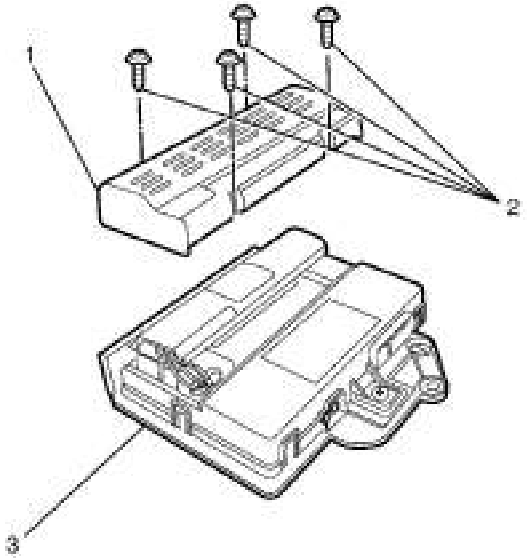
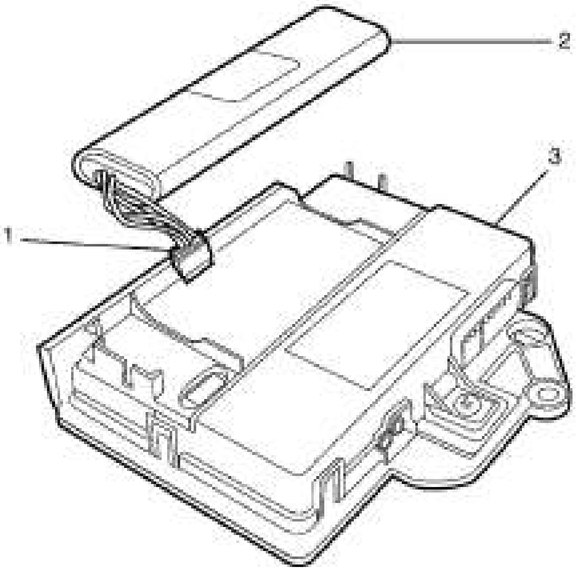
Communication Interface Module Battery Replacement

Removal Procedure

1. Using a scan tool, select service mode to disable the telematics module. Refer to Communication Interface Module Mode Selection.
2. Remove the telematics module. Refer to Communication Interface Module Replacement.



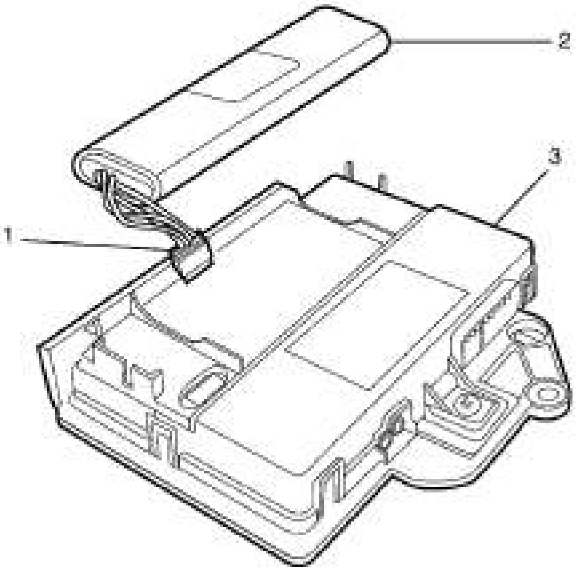
3. Remove the backup battery cover to telematics module retaining torx screws (2).
4. Remove the battery back up cover (1) from the telematics module (3).



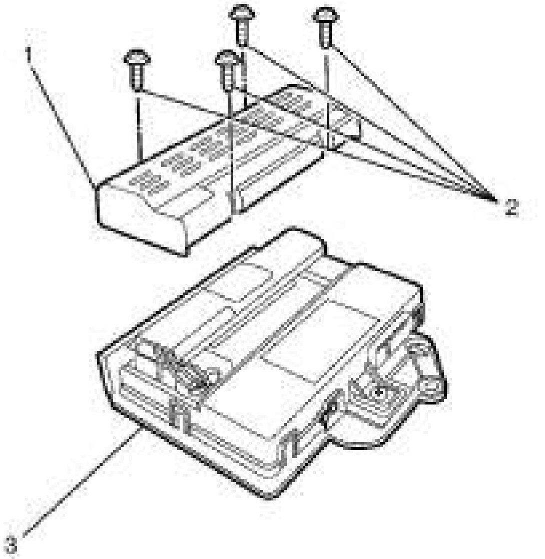
Important: If replacing the battery, dispose of it in an environmentally sound/personally safe manner.

5. Disconnect the backup battery electrical connector (1) from the telematics module (3).
6. Remove the backup battery (2).

Installation Procedure



1. Connect the backup battery electrical connector (1) to the telematics module (3).
2. Install the backup battery (2) into the telematics module (3).



3. Install the backup battery cover (1) to the telematics module (3).

Notice: Refer to Fastener Notice in the Preface section.

4. Install the backup battery cover to telematics module retaining torx screws (2).

   Tighten
   Tighten the screws to 2.0 N·m (18 lb in).

5. Using a scan tool reset the backup battery timer.
6. Install the telematics module. Refer to Communication Interface Module Replacement.

   Important: If the telematics module service mode remains enabled, the telematics system does not have full functionality.

7. Using a scan tool, select active mode to enable the telematics module. Refer to Communication Interface Module Mode Selection.

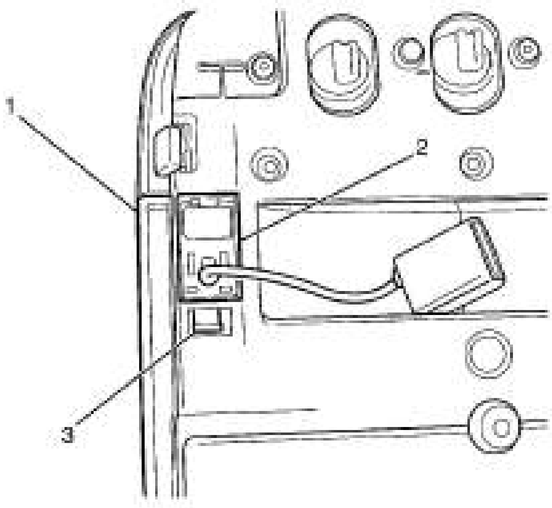
Communication Interface Module Microphone Replacement

Removal Procedure

1. Using a scan tool, select service mode to disable the telematics module. Refer to Communication Interface Module Mode Selection.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

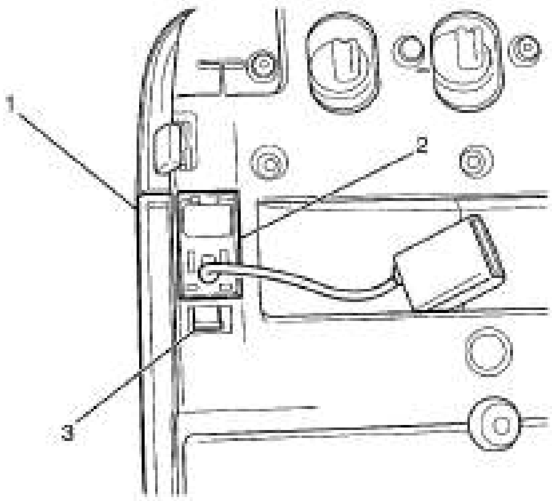
2. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the front dome lamp assembly. Refer to Dome Lamp Replacement.



   Important: Use a suitable tool to release the telematics (secure) microphone to dome lamp retaining clip (3).

4. Remove the telematics (secure) microphone (1) from the dome lamp (2).

Installation Procedure



Important: Listen for an audible click to make sure the telematics (secure) microphone to dome lamp retaining clips (3) are engaged to avoid an induced rattle condition.

1. Install the telematics (secure) microphone (1) to the dome lamp (2).
2. Install the front dome lamp assembly. Refer to Dome Lamp Replacement.
3. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

Important: If the telematics module service mode remains enabled, the telematics system does not have full functionality.

4. Using a scan tool, select active mode to enable the telematics module. Refer to Communication Interface Module Mode Selection.

Communication Interface Module Mode Selection

Important: New telematics modules and vehicles that require telematics activation will be delivered in Pre-Delivery mode. Before a system can be activated or once a telematics module has been installed the telematics module must be removed from Pre-Delivery mode.

The telematics module has four operational modes:

- Service - Used to temporarily deactivate the system so as service procedures can be performed.
- Active - When selected will enable the telematics system to function.
- Sleep - Periodic mode of telematics module used to limit battery current draw.
- Pre-Delivery - Initial mode of telematics module when supplied from production.

To select a mode follow the steps below:

1. Install a diagnostic scan tool.
2. Select Infotainment System.
3. Select Telematics.
4. Select Programming.
5. Select the one of the following four options:
    - Service
    - Active
    - Sleep
    - Pre-Delivery

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Communication Interface Module Registration

Software Selection

If a new telematics module has been installed or a vehicle has had the telematics system activated, the correct system software level must be selected (GM Fleetview, Secure or Assist Ultra). This process is incorporated into the initial programming of the telematics module.

Registration

If a new telematics module has been installed or a vehicle has had the telematics system activated, it must be registered with the Telematics Call Centre:

GM Fleetview

1. After the new telematics module has been installed, turn on the ignition and make a call to the Telematics Call Centre using the following telephone number: 1 300 725 330.
2. When the Telematics Call Centre operator answers, inform the operator who you are and what retail outlet you are from, and that you have just installed a new telematics module into the vehicle. You will also be required to provide the operator with the complete VIN and, if the vehicle is registered, the registration number of the vehicle.
3. The new telematics module is now registered to this vehicle.

Secure

1. After the new telematics module has been installed, turn on the ignition and make a call to the Telematics Call Centre using the following telephone number: 1 300 880 088.
2. When the Telematics Call Centre operator answers, inform the operator who you are and what retail outlet you are from, and that you have just installed a new telematics module into the vehicle. You will also be required to provide the operator with the complete VIN and, if the vehicle is registered, the registration number of the vehicle.
3. The new telematics module is now registered to this vehicle.

Assist Ultra

1. After the new telematics module has been installed, turn on the ignition and press the Holden Assist button to make a call to the Telematics Call Centre.
2. When the Telematics Call Centre operator answers, inform the operator who you are and what retail outlet you are from, and that you have just installed a new telematics module into the vehicle. You will also be required to provide the operator with the complete VIN and, if the vehicle is registered, the registration number of the vehicle.
3. The new telematics module is now registered to this vehicle.

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Communication Interface Module Replacement

Service Operations

Caution: Refer to Service Programming System (SPS) Notice in the Preface section.

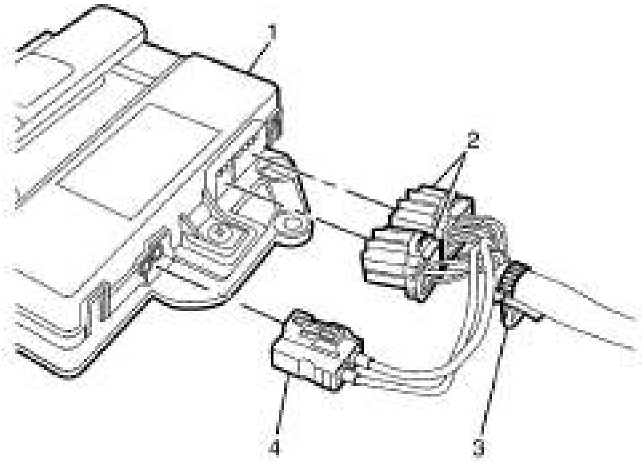
If the telematics module is not enabled:

A low battery voltage alert (when the battery voltage is low) is transmitted to the Telematics Call Centre.

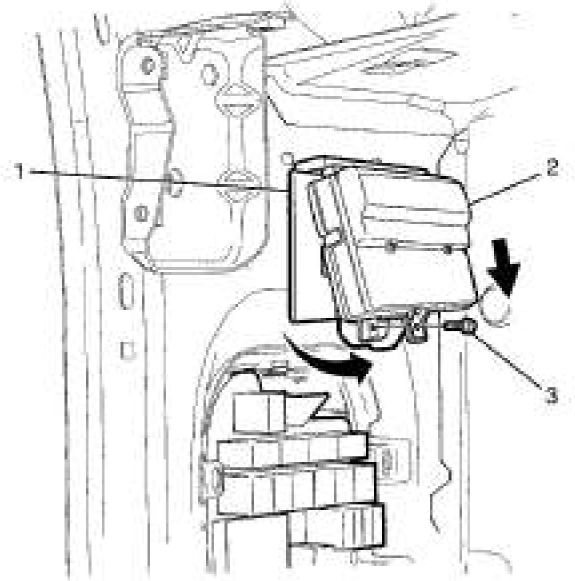
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Using a scan tool, select service mode to disable the telematics module. Refer to Service Programming System (SPS).
2. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the I/P compartment. Refer to Instrument Panel Compartment Replacement.

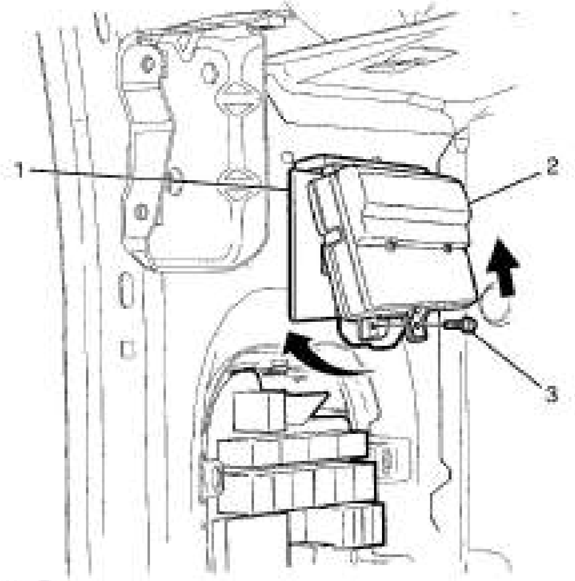


4. Detach the electrical wiring harness cable tie (3) from the telematics module (1).
5. Disconnect the GPS antenna connector (4) and the telematics module connectors (2) from the telematics module (1).



6. Remove the telematics module to retaining bracket retaining screw (3).
7. Remove the telematics module (2), by manoeuvring it forward and sliding it out of the retaining bracket (1).

Installation procedure

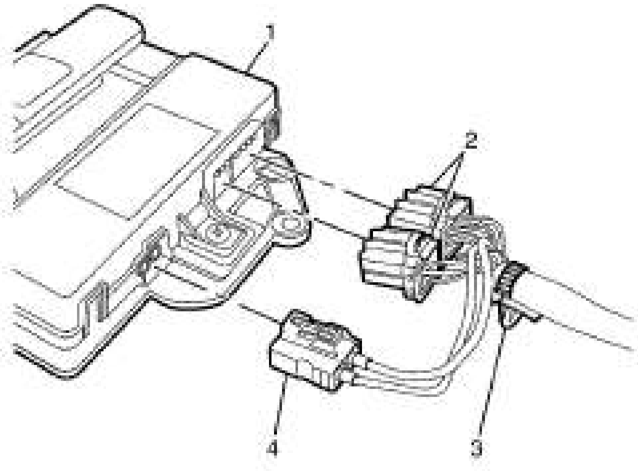


1. Install the top of the telematics module (2) into the retaining bracket (1) and locate the bottom end of the telematics module (2) into the bottom end of the retaining bracket (1).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the telematics module to retaining bracket retaining screw (3).

Tighten
Tighten the screw to 2.0 N·m (18 lb in).



3. Connect the GPS antenna connector (4) and the telematics module connectors (2) to the telematics module (1).
4. Attach the electrical wiring harness cable tie (3) to the telematics module (1).
5. Install the I/P compartment. Refer to Instrument Panel Compartment Replacement.
6. Install the I/P compartment. Refer to Instrument Panel Compartment Replacement.
7. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.

   Important: If replacing a telematics module, the new module will require the programming of the correct system software level.

8. Reprogram the telematics module and select the system software required (GM Fleetview, Secure or Assist Ultra). Refer to Service Programming System (SPS).

   Important: If replacing a telematics module, the new module will require registration.

9. Register the telematics module. Refer to Communication Interface Module Registration.

   Important: If the telematics module service mode remains enabled, the telematics system does not have full functionality.

10. Using a scan tool, select active mode to enable the telematics module. Refer to Service Programming System (SPS).

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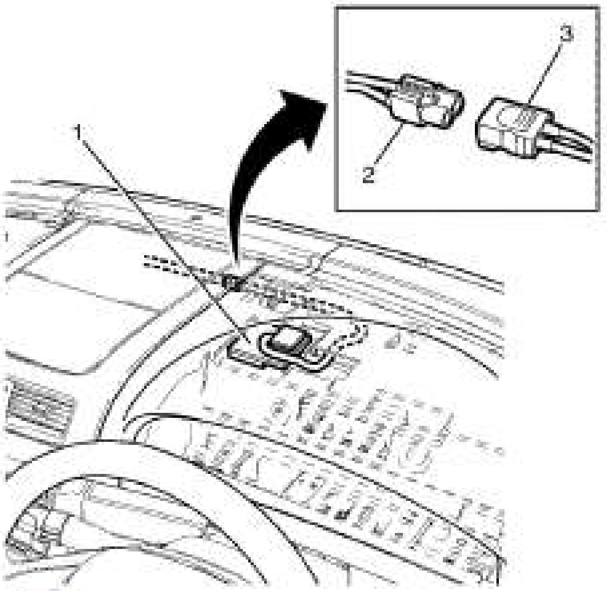
Communication Module Antenna Replacement

Removal Procedure

1. Using a scan tool, select service mode to disable the telematics module. Refer to Communication Interface Module Mode Selection.

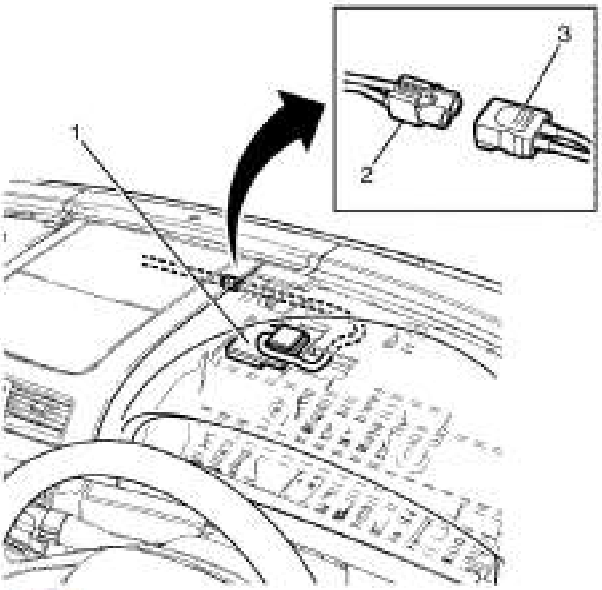
   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the I/P cluster. Refer to Instrument Cluster Replacement.

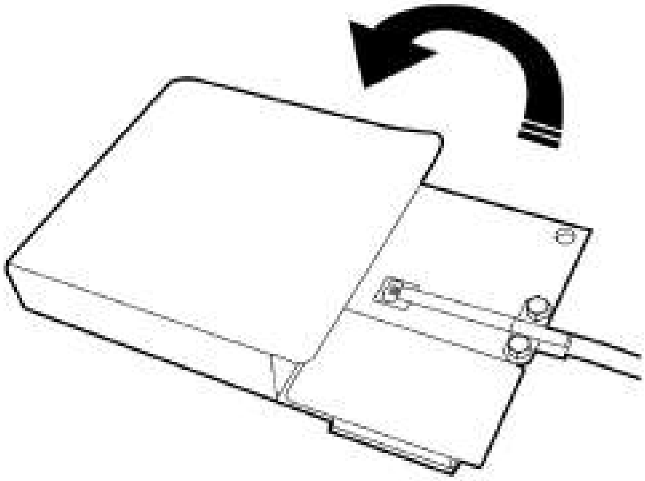


4. Using a flat blade tool, detach the GPS antenna (1) from the I/P pad.
5. Disconnect the GPS antenna electrical connector (2) from the extension wiring harness (3).
6. Remove the GPS antenna (1) from the I/P pad.

Installation Procedure



1. Feed the GPS antenna (1) electrical connector (2) through the hole in the I/P pad.
2. Connect the GPS antenna (1) electrical connector (2) to the extension wiring harness (3).



3. Peel off the paper from the bottom of the GPS antenna.
4. Install the GPS antenna into the I/P pad, by firmly pressing it down into it's location in the I/P pad.
5. Install the I/P cluster. Refer to Instrument Cluster Replacement.
6. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.

   Important: If the telematics module service mode remains enabled, the telematics system does not have full functionality.

7. Using a scan tool, select active mode to enable the telematics module. Refer to

Communication Interface Module Mode Selection.

8. Re-programme the instrument cluster. Refer to Instrument Cluster Programming and Setup.

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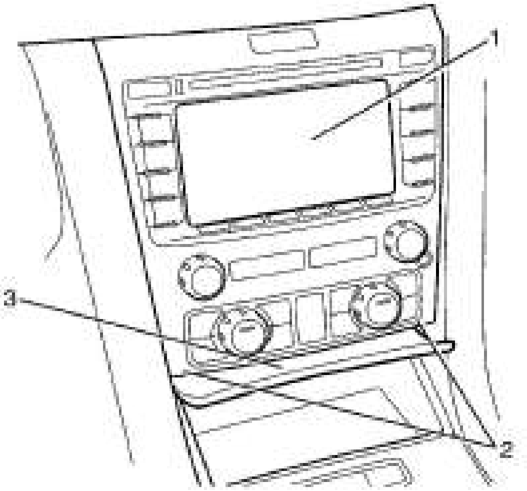
Driver Information Display Replacement

Removal Procedure -- Type A, D and E Infotainment System

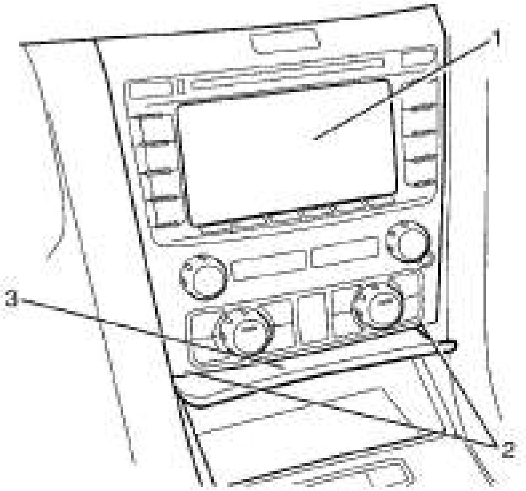


1. Where fitted, open the console storage compartment lid (3) approximately half way.

   Important: Grasp the bottom of the infotainment fascia (1) with two hands at points (2) and pull away from the instrument panel, disconnecting the fascia retainers.

2. Remove the infotainment fascia (1) from the Infotainment Unit.

Installation Procedure -- Type A, D and E Infotainment System

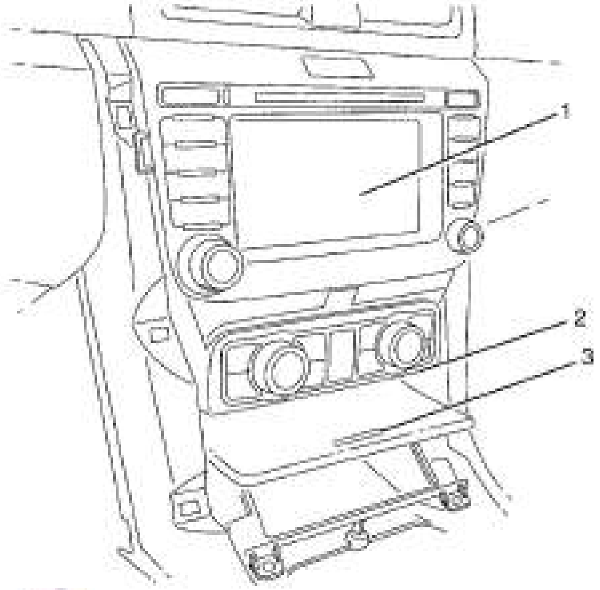


Important: Align the infotainment fascia retainers with the infotainment unit.

1. Install the infotainment fascia (1) to the infotainment unit.
2. Refer to Control Module References.

Removal Procedure -- Type F Infotainment System

1. Remove the console centre trim plate. Refer to Console Trim Plate Replacement.
2. Remove the instrument panel centre trim plate. Refer to Instrument Panel Center Trim Panel Replacement.

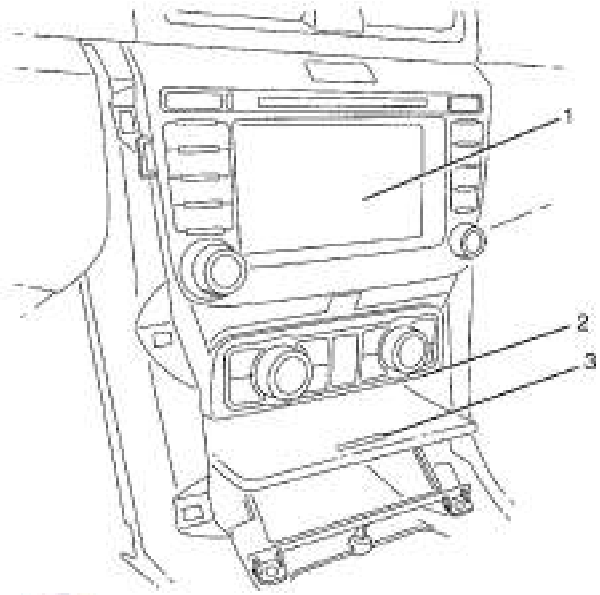


3. Where fitted, open the console storage compartment lid (3) approximately half way.

Important: Grasp the bottom of the infotainment fascia (1) with two hands at points (2) and pull away from the instrument panel, disconnecting the fascia retainers.

4. Remove the infotainment fascia (1) from the Infotainment Unit.

Installation Procedure -- Type F Infotainment System



Important: Align the infotainment fascia retainers with the infotainment unit.

1. Install the infotainment fascia (1) to the infotainment unit.
2. Install the console centre trim plate. Refer to Console Trim Plate Replacement.
3. Install the intrument panel centre trim plate. Refer to Instrument Panel Center Trim Panel Replacement.
4. Refer to Control Module References.

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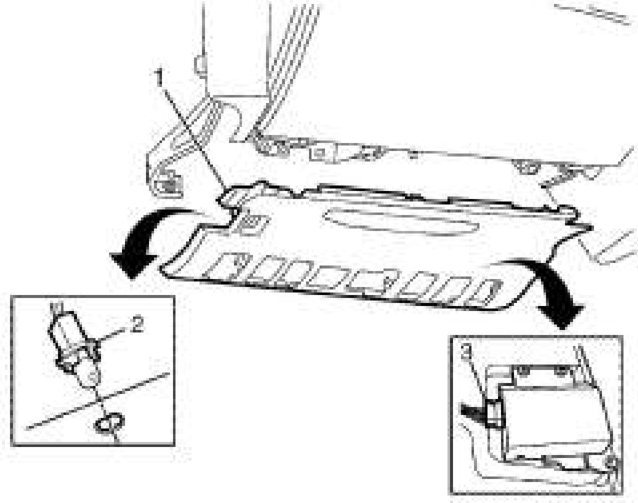
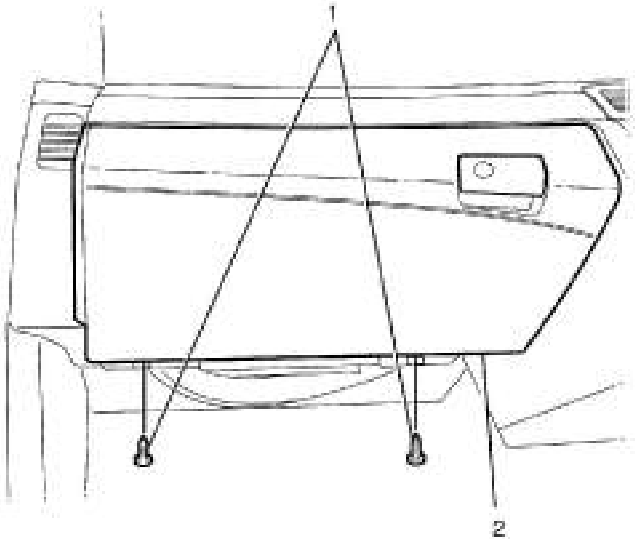
Electronic Navigation Antenna Replacement (RHD)

Removal Procedure

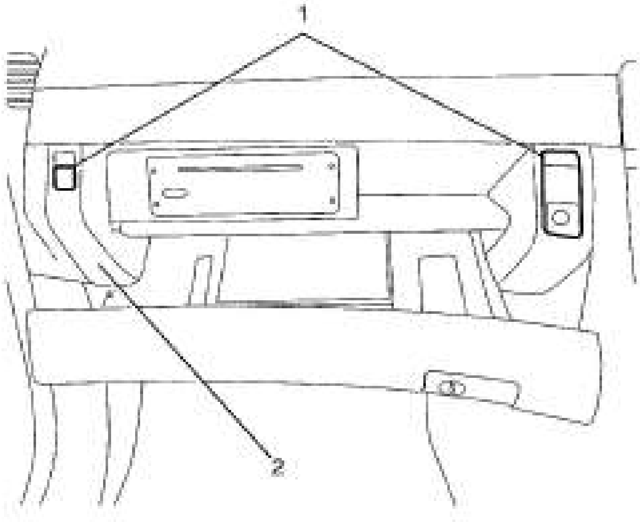
1. Remove the windshield demister grille. Refer to Defroster Grille Replacement in Instrument Panel, Gages, and Console.
2. Remove the instrument panel (I/P) outer trim cover. Refer to Instrument Panel Outer Trim Cover Replacement in Instrument Panel, Gages, and Console.



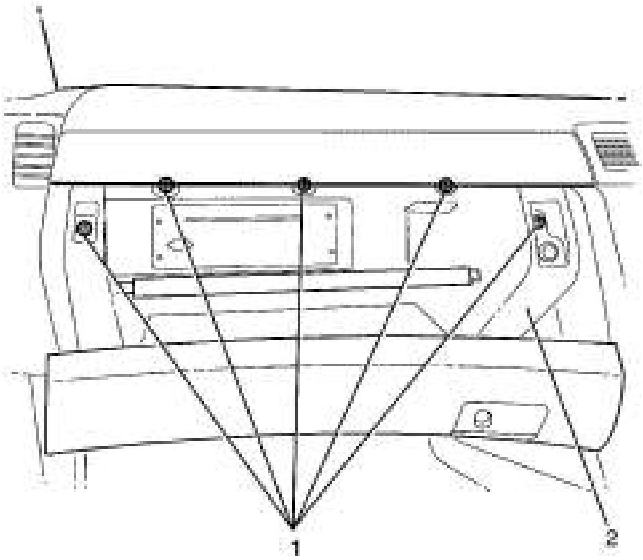
3. Grasp the I/P insulation panel assembly (1) and carefully pull downward to disengage the retaining clips.
4. Remove the courtesy lamp socket (2) from the I/P insulation panel assembly (1) by rotating counter-clockwise.
5. Disconnect the navigation interface module (NIM) electrical connector (3).
6. Remove the I/P insulation panel assembly (1).



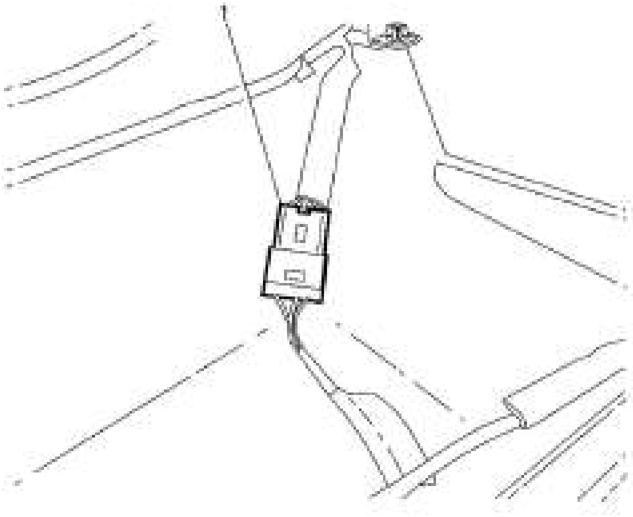
7. Remove the I/P compartment lower retaining screws (1).
8. Open the I/P compartment door (2).



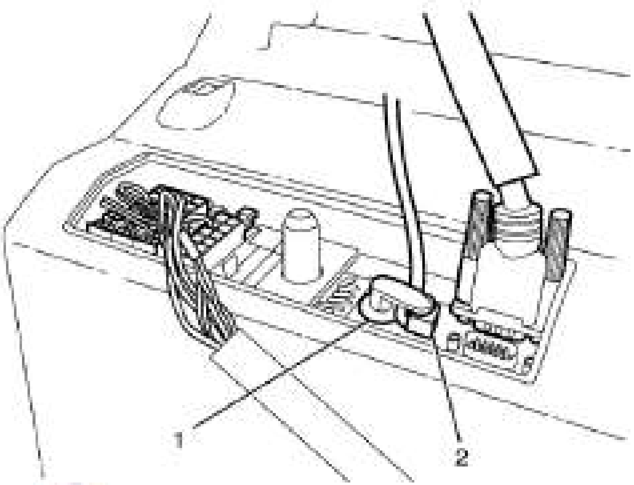
9. Remove the I/P compartment retaining screw covers (1) from the I/P compartment (2)



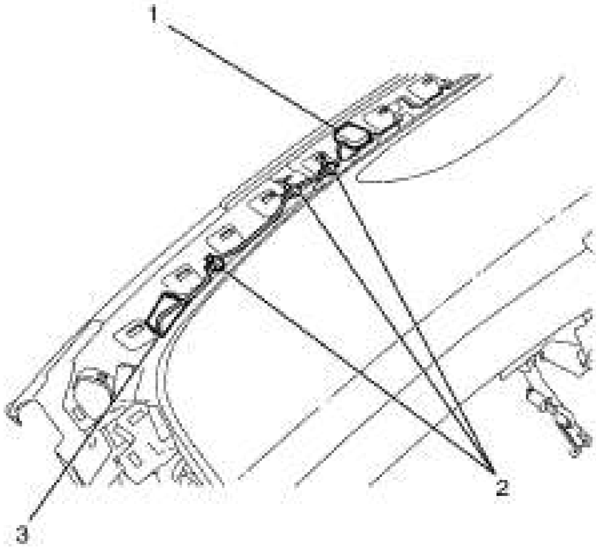
10. Remove the I/P compartment upper retaining screws (1).
11. Detach the I/P compartment (2) from the I/P.



12. Disconnect the I/P compartment electrical connector (1).



13. Rotate the navigation module aerial connector lock (1) clockwise and disconnect the navigation module aerial connector (2).

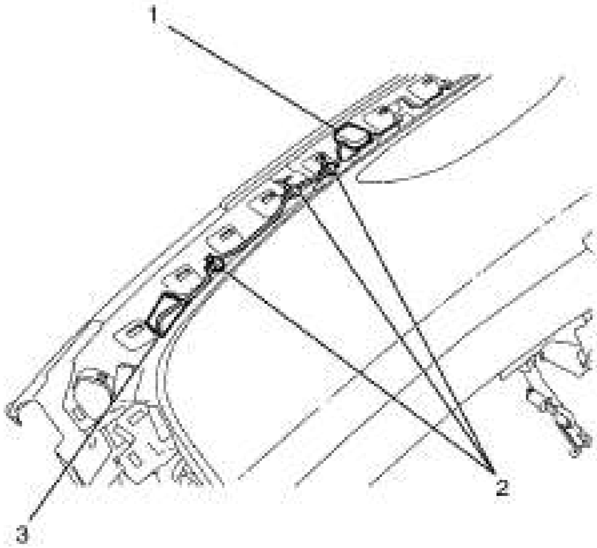


14. Detach the GPS antenna cable retaining clips (2) from the I/P.

Important: The GPS antenna (1) is secured in position with double sided tape.

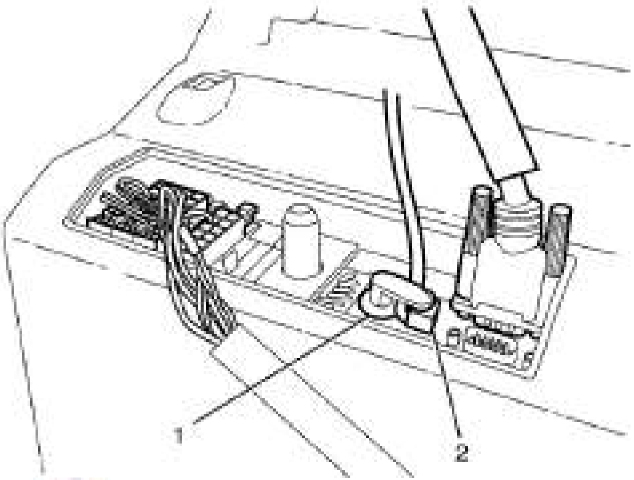
15. Detach the GPS antenna (1) from the I/P.
16. Pull the GPS antenna cable through the hole (3) in the I/P and remove the GPS antenna (1).

Installation Procedure

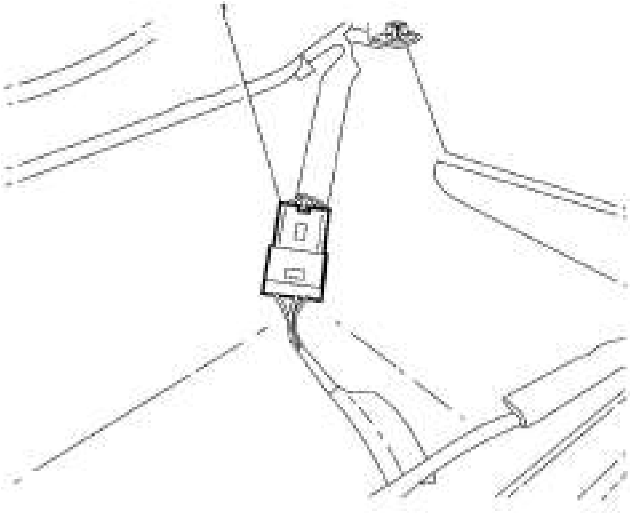


Important: The GPS antenna (1) is secured in position with double sided tape.

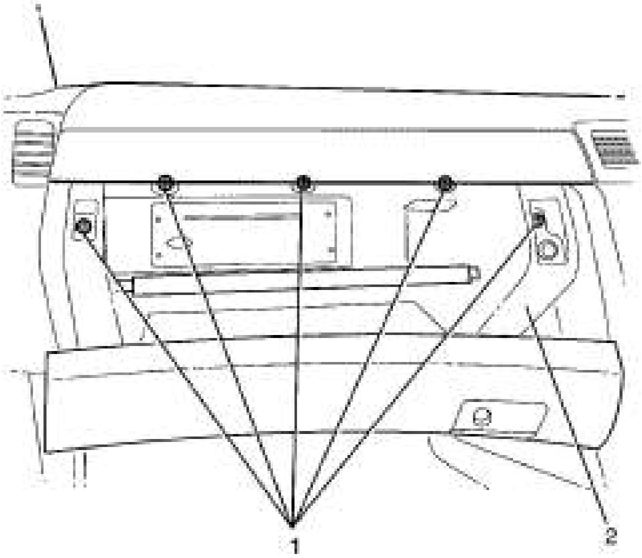
1. Install the GPS antenna (1) to the I/P.
2. Feed the GPS antenna cable through the hole (3) in the I/P.
3. Install the GPS antenna cable retaining clips (2) to the I/P.



4. Connect the navigation module aerial connector (2) and rotate the navigation module aerial connector lock (1) counter-clockwise.



5. Connect the I/P compartment electrical connector (1).

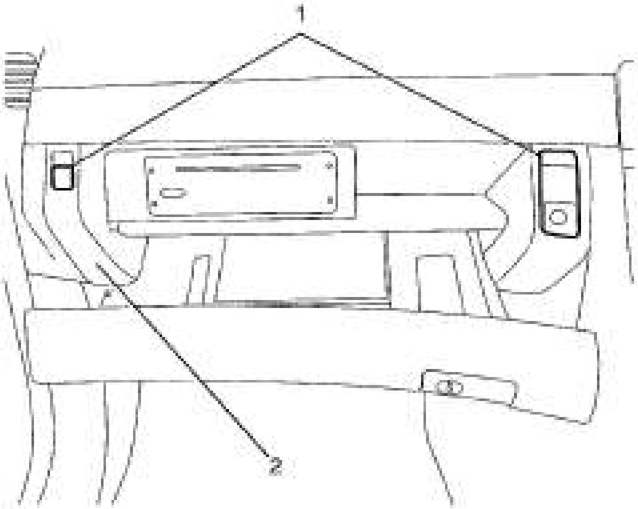


6. Install the I/P compartment (2) to the I/P.

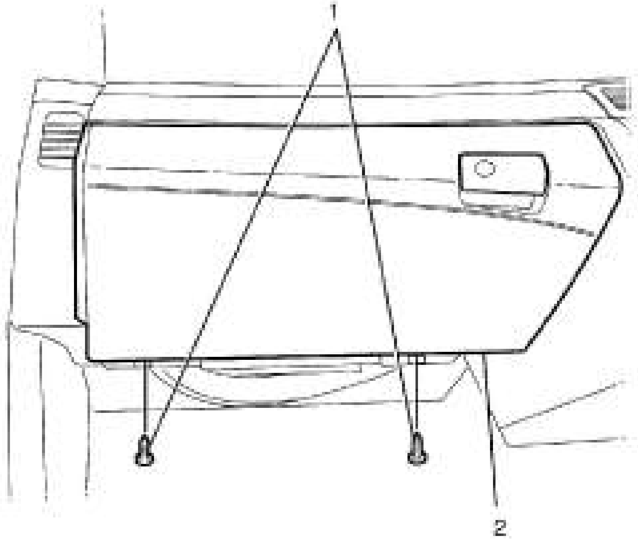
   Notice: Refer to Fastener Notice in the Preface section.

7. Install the I/P compartment upper retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).

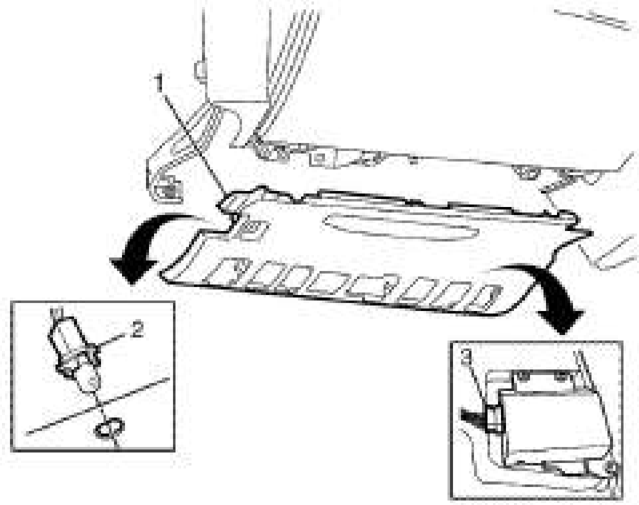


8. Install the I/P compartment retaining screw covers (1) into the I/P compartment (2).



9. Close the I/P compartment door (2).
10. Install the I/P compartment lower retaining screws (1).

Tighten
Tighten the screws to 2 N·m (18 lb in).



11. Install the courtesy lamp socket (2) to the I/P insulation panel assembly (1) by rotating clockwise.
12. Connect the NIM electrical connector (3).
13. Install the I/P insulation panel assembly (1) to the I/P by engaging the retaining clips.
14. Make sure all the clips are located correctly.
15. Install the I/P outer trim cover. Refer to Instrument Panel Outer Trim Cover Replacement in Instrument Panel, Gages, and Console.
16. Install the windshield demister grille. Refer to Defroster Grille Replacement in Instrument Panel, Gages, and Console.

Navigation Interface Module Calibration

Important: Before the navigation system can be used, a calibration of the navigation module is required.

The navigation system would require calibration under the following conditions:

- New tyres installed
- New navigation module installed

The navigation module calibration is carried out on vehicle and requires an 8 - 15 Km road test. For further details on the calibration procedure, refer to the Navigation System Handbook.

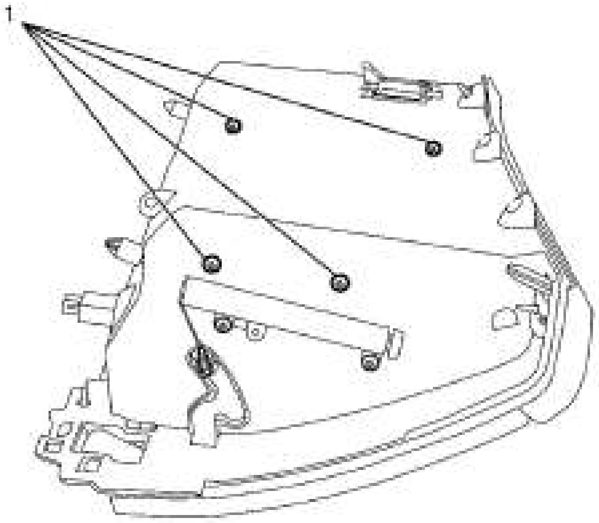
Navigation Interface Module Cradle Replacement

Tools Required

KM6067 Radio Removal Tool

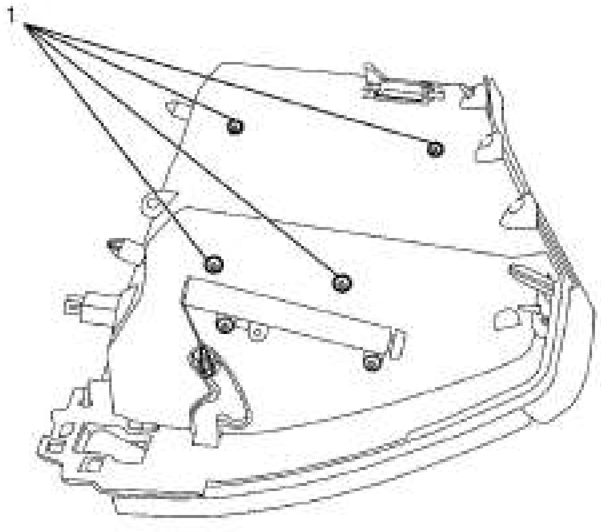
Removal Procedure

1. Remove the navigation module. Refer to Navigation Module Replacement.



2. Remove the navigation module assembly retaining screws (1).
3. Remove the navigation module carrier from the I/P compartment.

Installation Procedure



1. Install the navigation module carrier into the I/P compartment.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the navigation module assembly retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).

3. Install the navigation module. Refer to Navigation Module Replacement.

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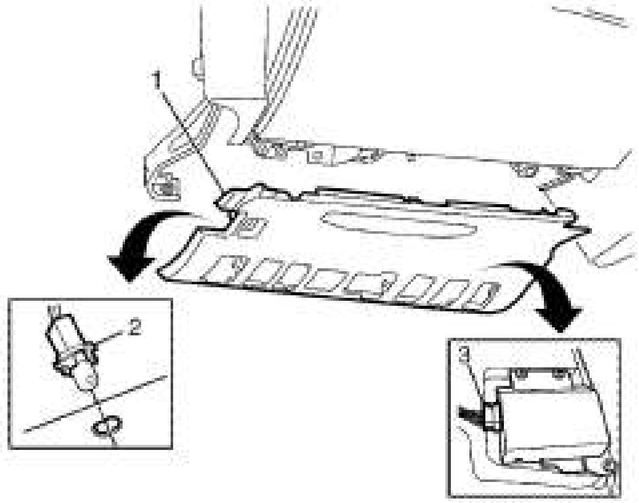
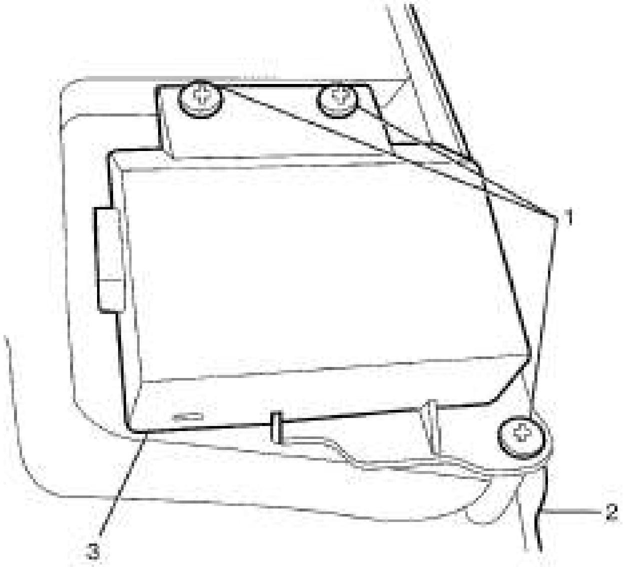
Navigation Interface Module Replacement

Removal Procedure

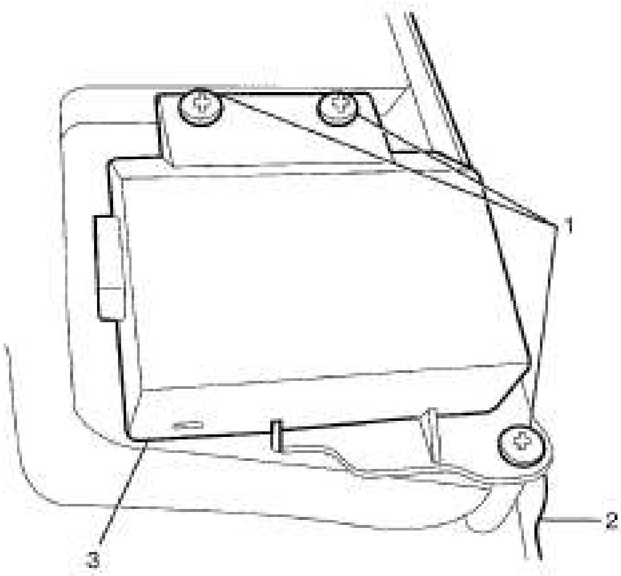


1. Grasp the instrument panel (I/P) insulation panel assembly (1) and carefully pull downward to disengage the retaining clips.
2. Remove the courtesy lamp socket (2) from the I/P insulation panel assembly (1) by rotating counter-clockwise.
3. Disconnect the navigation interface module (NIM) electrical connector (3).
4. Remove the I/P insulation panel assembly (1).



5. Remove the NIM retaining screws (1).
6. Remove the NIM (3) from the I/P insulation panel assembly (2).

Installation Procedure

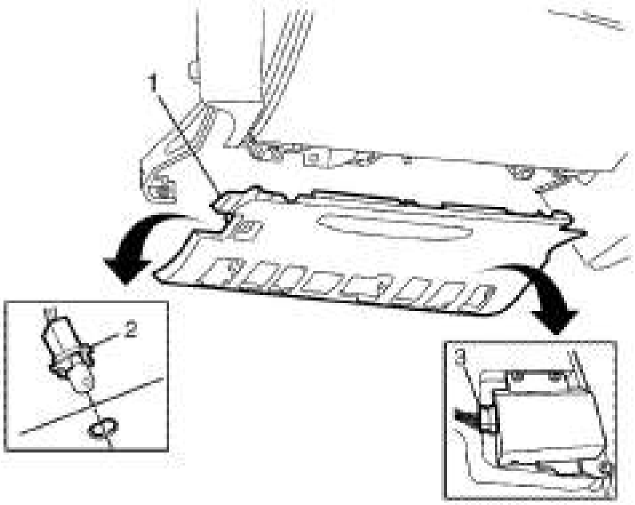


1. Install the NIM (3) to the I/P insulation panel assembly (2).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the NIM retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).



3. Install the courtesy lamp socket (2) to the I/P insulation panel assembly (1) by rotating clockwise.
4. Connect the NIM electrical connector (3).
5. Install the I/P insulation panel assembly (1) to the I/P by engaging the retaining clips.
6. Make sure all the clips are located correctly.

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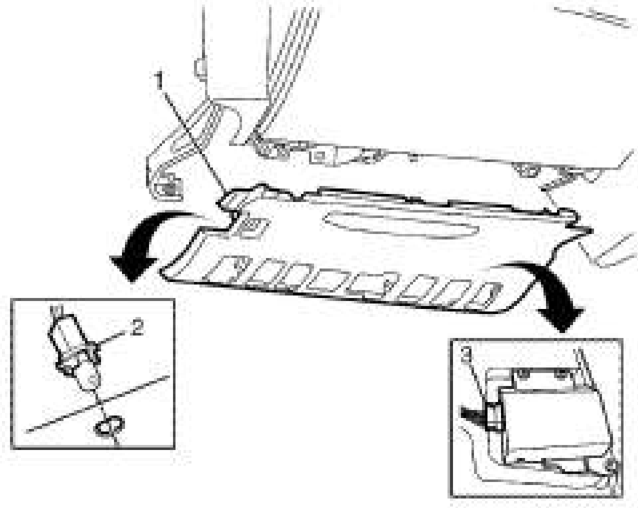
Navigation Map Disc Player Replacement

Tools Required

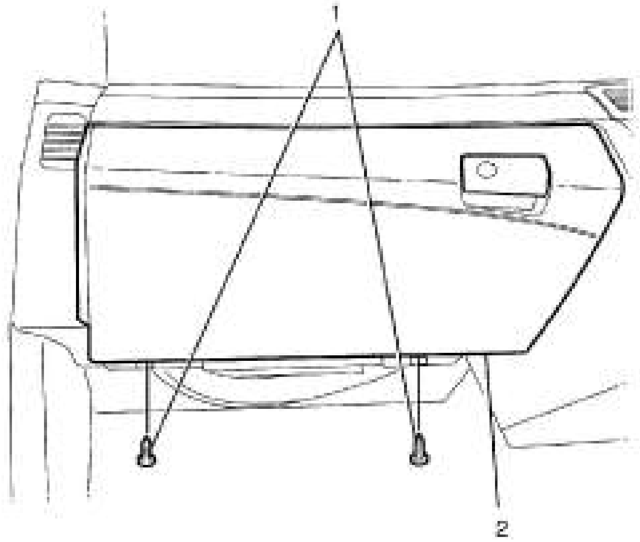
AU-464 Radio Removal Tool

Removal Procedure

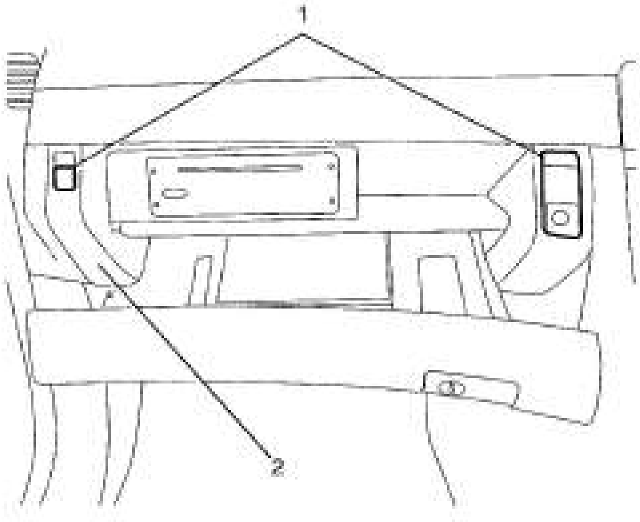
1. Remove the instrument panel (I/P) outer trim cover. Refer to Instrument Panel Outer Trim Cover Replacement.



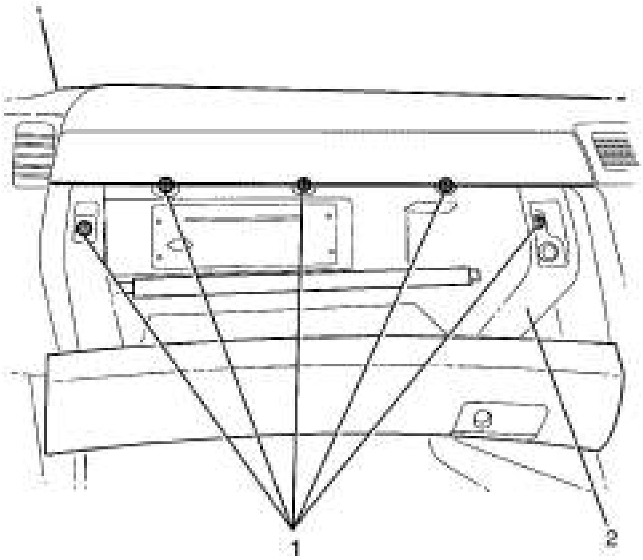
2. Grasp the I/P insulation panel assembly (1) and carefully pull downward to disengage the retaining clips.
3. Remove the courtesy lamp socket (2) from the I/P insulation panel assembly (1) by rotating counter-clockwise.
4. Disconnect the navigation interface module (NIM) electrical connector (3).
5. Remove the I/P insulation panel assembly (1).



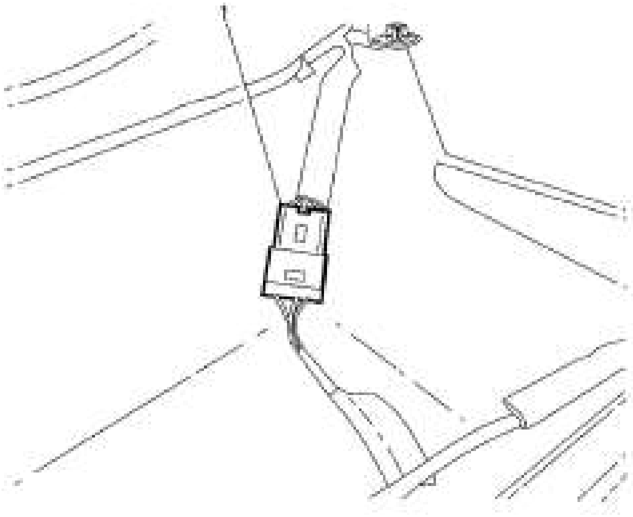
6. Remove the I/P compartment lower retaining screws (1).
7. Open the I/P compartment door (2).



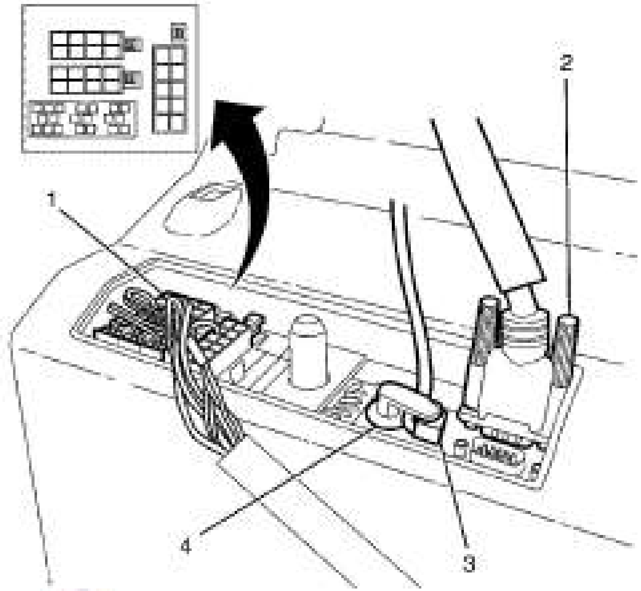
8. Remove the I/P compartment retaining screw covers (1) from the I/P compartment (2).



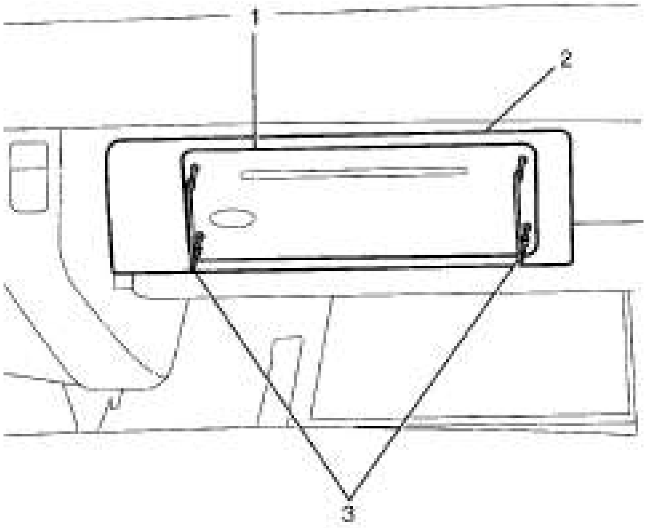
9. Remove the I/P compartment upper retaining screws (1).
10. Detach the I/P compartment (2) from the I/P.



11. Disconnect the I/P compartment electrical connector (1).

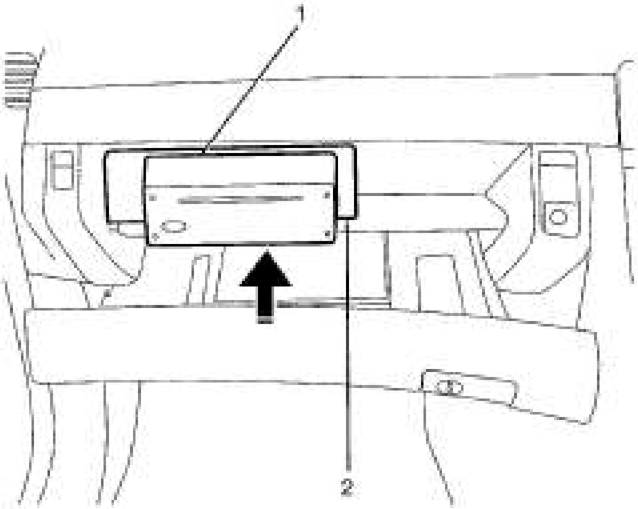


12. Disconnect the navigation module electrical connectors (1).
13. Disconnect the navigation module to audio unit electrical connector (2), where fitted.
14. Rotate the global positioning system (GPS) antenna connector lock (4) clockwise and disconnect the GPS antenna connector (3).
15. Remove the I/P compartment and navigation module assembly.

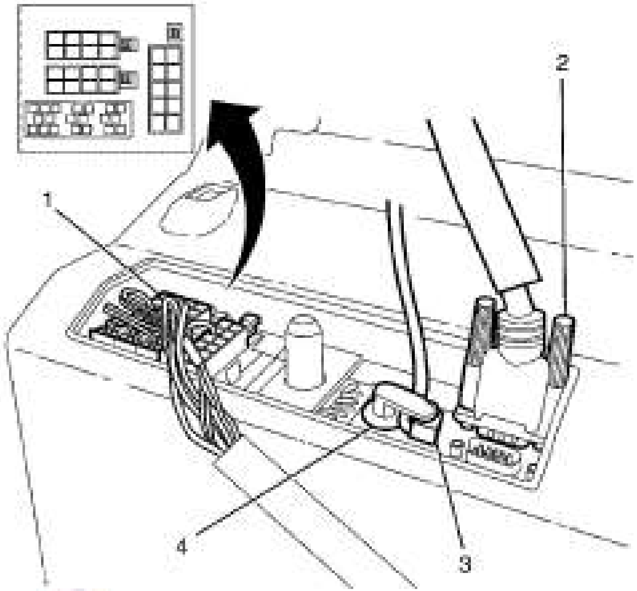


16. Using the tool AU-464 Radio Removal Tool (3), remove the navigation module (1) from the navigation module carrier (2).
17. Remove the navigation module (1) from the navigation module carrier (2).

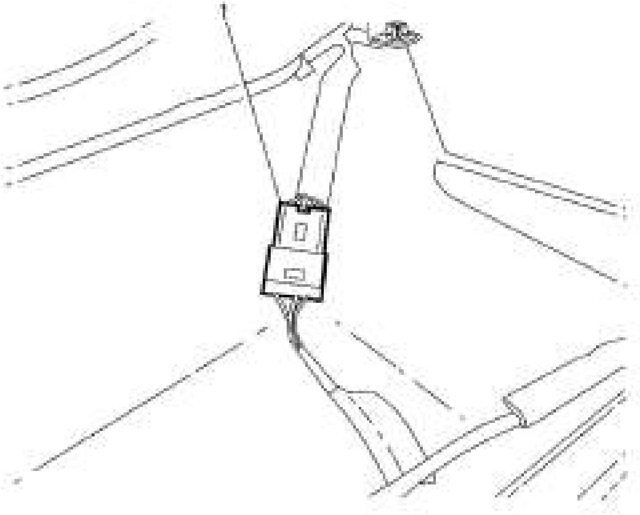
Installation Procedure



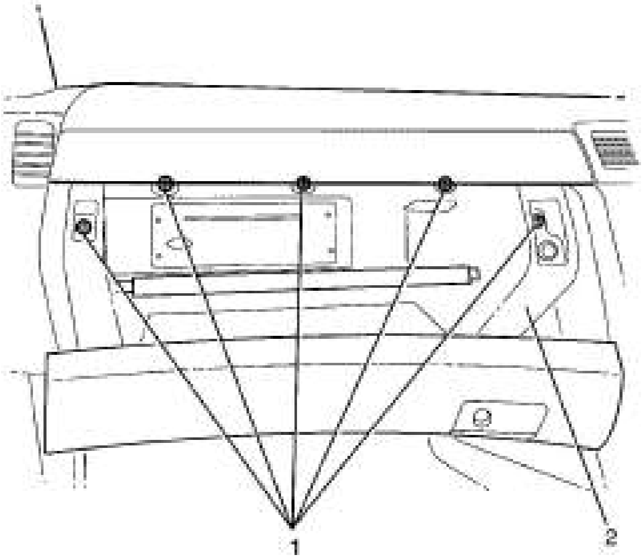
1. Install the navigation module (1) into the navigation module carrier (2).



2. Connect the navigation module electrical connectors (1).
3. Connect the navigation module to audio unit electrical connector (2, where fitted).
4. Connect the GPS antenna connector (3) and rotate the GPS antenna connector lock (4) counter-clockwise.

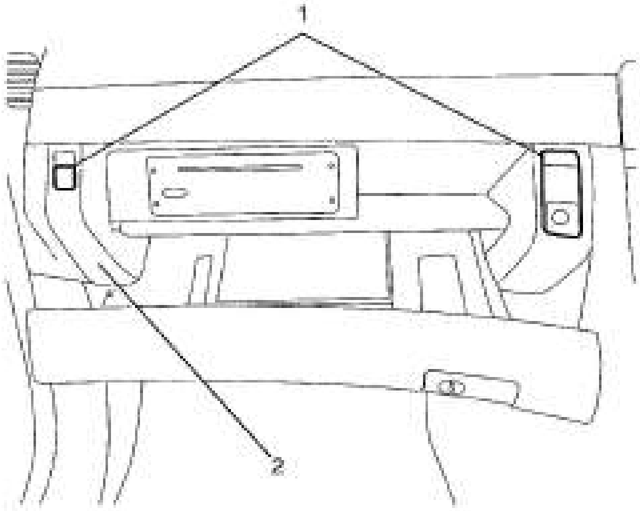


5. Connect the I/P compartment electrical connector (1).

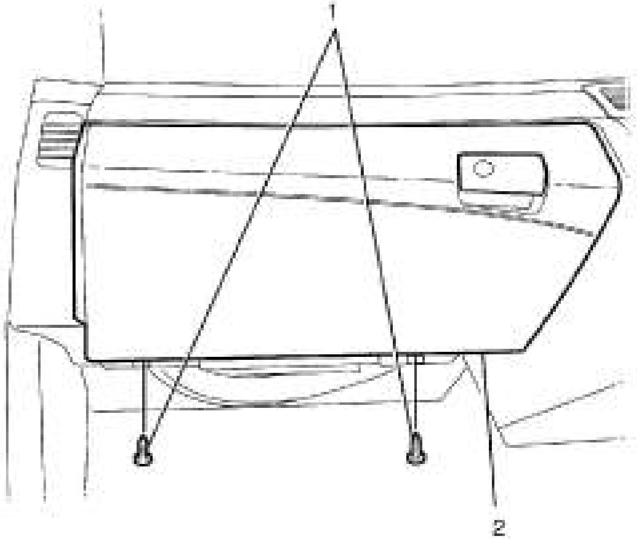


6. Install the I/P compartment (2) to the I/P.
7. Install the I/P compartment upper retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).

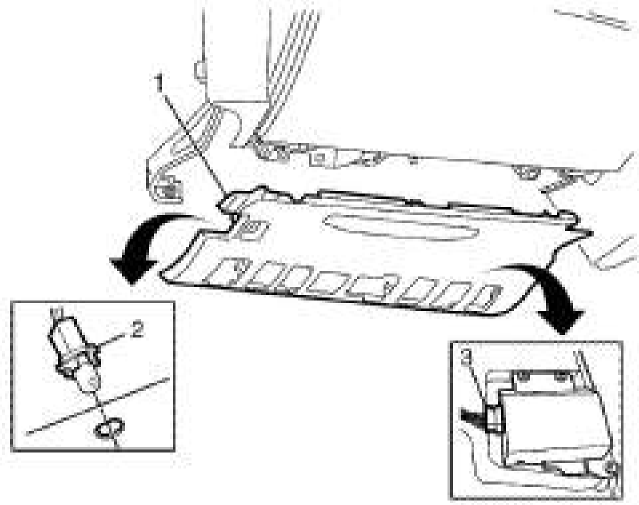


8. Install the I/P compartment retaining screw covers (1) into the I/P compartment (2).



9. Close the I/P compartment door (2).
10. Install the I/P compartment lower retaining screws (1).

    Tighten
    Tighten the screws to 2 N·m (18 lb in).



11. Install the courtesy lamp socket (2) to the I/P insulation panel assembly (1) by rotating clockwise.
12. Connect the navigation interface module (NIM) electrical connector (3).
13. Install the I/P insulation panel assembly (1) to the I/P by engaging the retaining clips.
14. Make sure all the clips are located correctly.
15. Install the I/P outer trim cover. Refer to Instrument Panel Outer Trim Cover Replacement.
16. If a new navigation module is being installed, calibrate the navigation module. Refer to Navigation Interface Module Cradle Replacement.
17. If re-programming is required. Refer to Control Module References.

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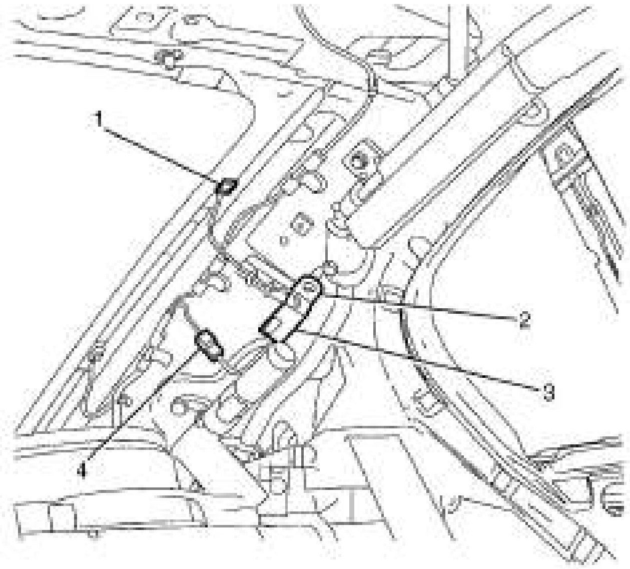
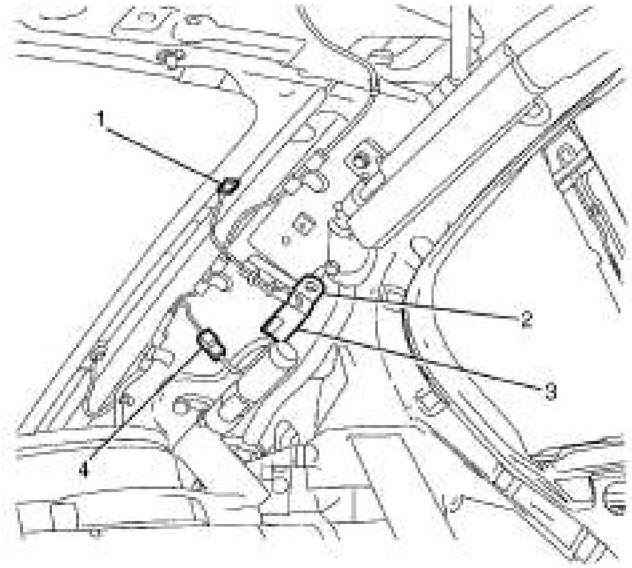
Radio Antenna Diversity Module Replacement

Removal Procedure



1. Turn the infotainment system OFF.
2. Remove the left hand side rear quarter upper trim panel. Refer to Quarter Upper Trim Panel Replacement.
3. Disconnect the rear glass electrical connector (1).
4. Disconnect the diversity antenna amplifier module connector (4).
5. Remove the diversity antenna module to upper body bolt (2).
6. Remove the diversity antenna module (3) from the rear upper quarter panel.

Installation Procedure



1. Install the diversity antenna module (3) to the rear upper quarter.

   Notice: Refer to Fastener Notice in the Preface section.

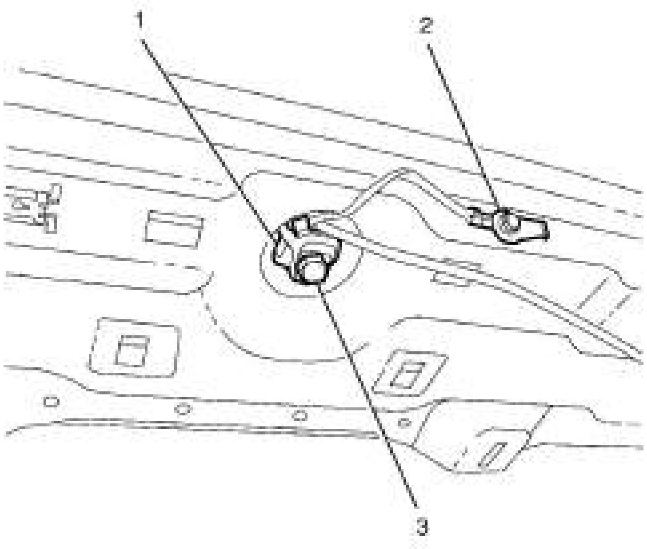
2. Install the diversity antenna module to rear upper quarter panel retaining bolt (2).

   Tighten
   Tighten the bolt to 10 N·m (89 lb in).

3. Connect the diversity antenna amplifier module connector (4).
4. Connect the rear glass electrical connector (1).
5. Install the left hand side rear quarter upper trim panel. Refer to Quarter Upper Trim Panel Replacement.
6. If re-programming is required. Refer to Control Module References.

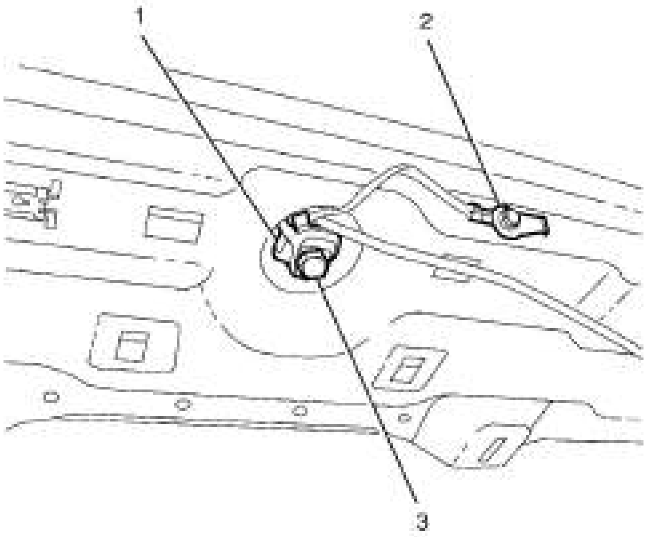
Radio Antenna Replacement (Sedan)

Removal Procedure



1. Remove the headlining trim assembly. Refer to Headlining Trim Panel Replacement.
2. Remove the antenna module ground point to roof panel retaining bolt (2).
3. Remove the antenna module to roof panel retaining bolt (3).
4. Remove the retaining clip (1) securing the antenna module to the roof.
5. Disconnect the electrical connectors.
6. From outside the vehicle, remove the antenna module and harness from the vehicle.

Installation Procedure



1. From outside the vehicle, install the antenna module and harness to the vehicle threading the harness through the cavity.
2. Connect the electrical connector.
3. Install the retaining clip (1) securing the antenna module to the roof.

   Notice: Refer to Fastener Notice in the Preface section.

4. Install the antenna module to roof panel retaining bolt (3).

   Tighten
   Tighten the bolt to 4 N·m (35 lb in).

   Notice: Refer to Fastener Notice in the Preface section.

5. Install the antenna module ground point to roof panel retaining bolt (2).

   Tighten
   Tighten the bolt to 2 N·m (18 lb in).

6. Install the headlining trim assembly. Refer to Headlining Trim Panel Replacement

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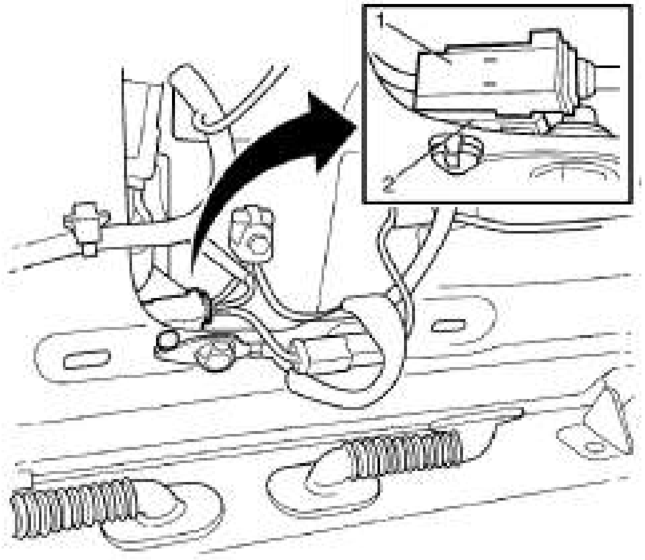
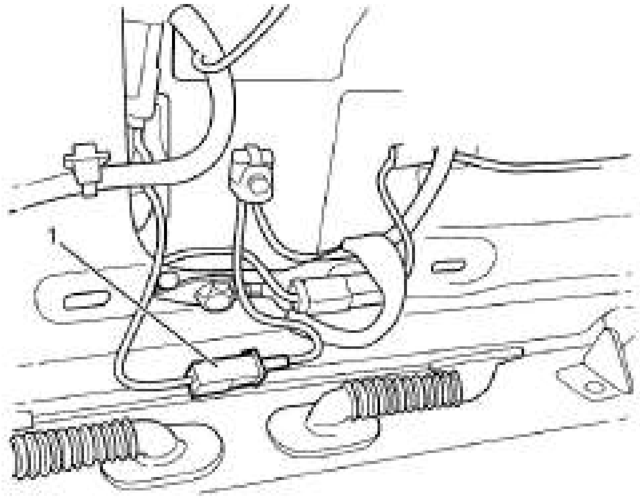
Radio Antenna Replacement (Sportwagon)

Removal Procedure

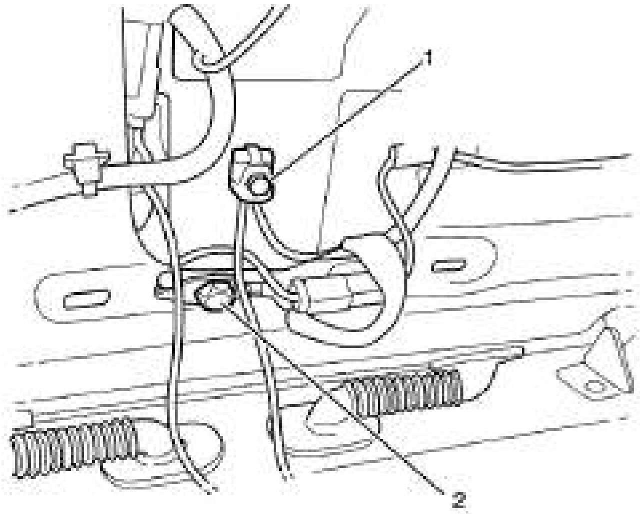
1. Remove the liftgate window upper garnish moulding. Refer to Liftgate Window Upper Garnish Molding Replacement.



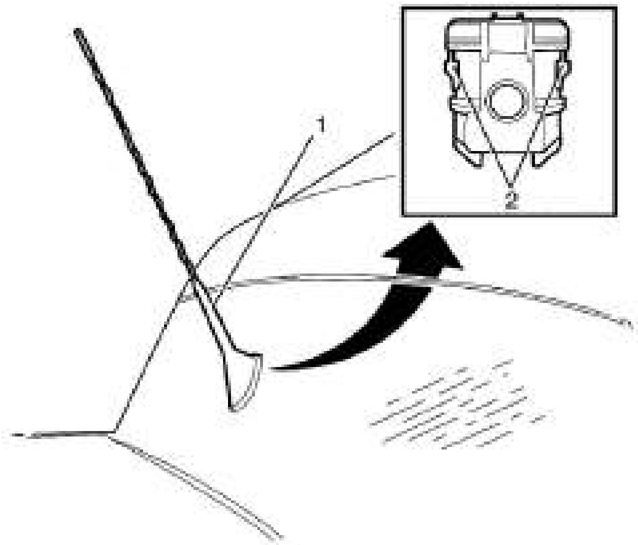
2. Detach the radio antenna module electrical connector (1) by depressing the retaining clip (2).



3. Disconnect the radio antenna module electrical connector (1).

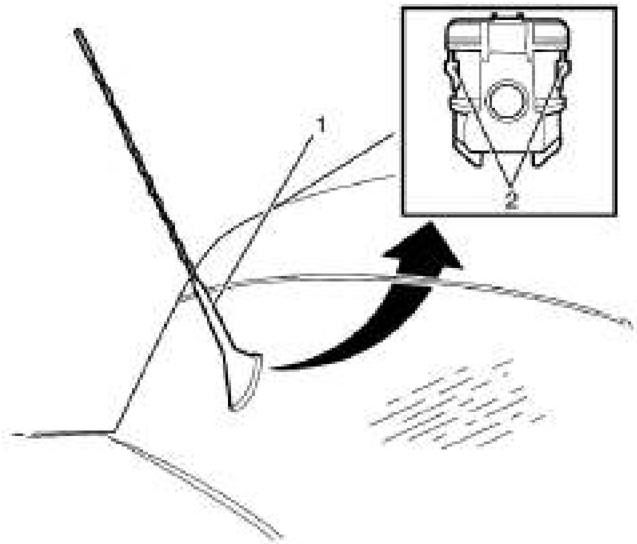


4. Remove the radio antenna module ground point to roof panel retaining bolt (2).
5. Remove the radio antenna module to roof panel retaining bolt (1).



6. From outside the vehicle, hold the radio antenna (1) to prevent from damaging paintwork when released.
7. Release the radio antenna module to liftgate retaining clips (2) .
8. Remove the radio antenna (1) from the vehicle.

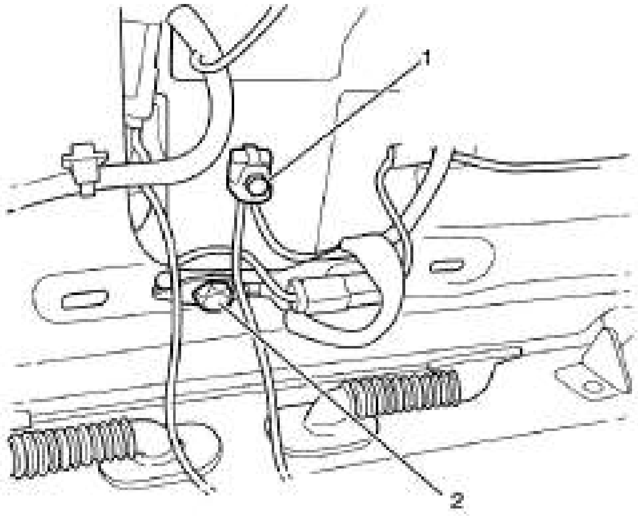
Installation Procedure



1. From outside the vehicle, hold the radio antenna (1).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the radio antenna module to liftgate retaining clips (2) by threading through the cavity.



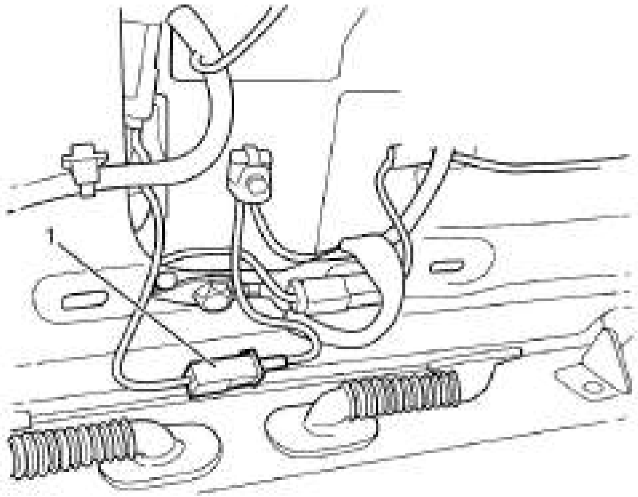
3. Install the radio antenna module to roof panel retaining bolt (1).

   Tighten
   Tighten the bolt to 4 N·m (35 lb in).

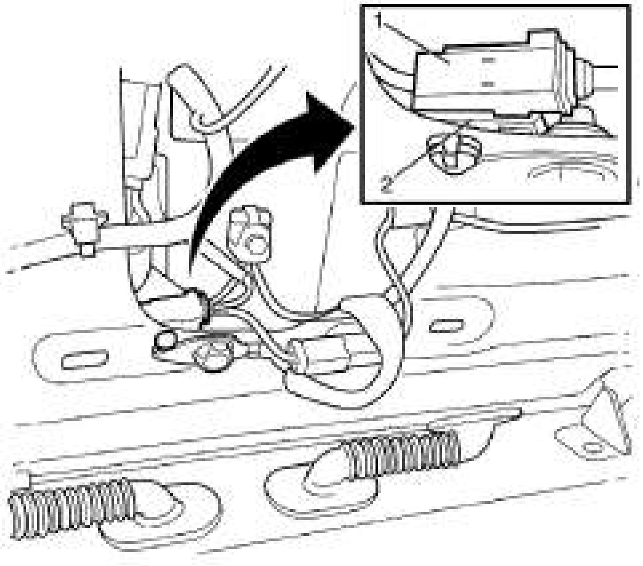
   Notice: Refer to Fastener Notice in the Preface section.

4. Install the radio antenna module ground point to roof panel retaining bolt (2).

   Tighten
   Tighten the bolt to 2 N·m (18 lb in).



5. Connect the radio antenna module electrical connector (1).



6. Install the radio antenna module electrical connector (1) onto the retaining clip (2).
7. Install the liftgate window upper garnish moulding. Refer to Liftgate Window Upper Garnish Molding Replacement.

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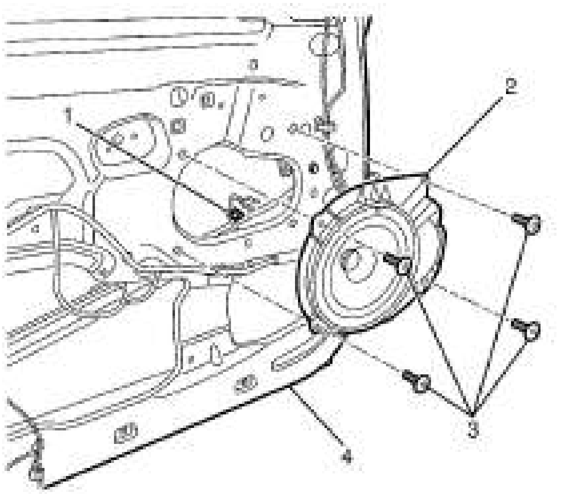
Document ID: 1977439

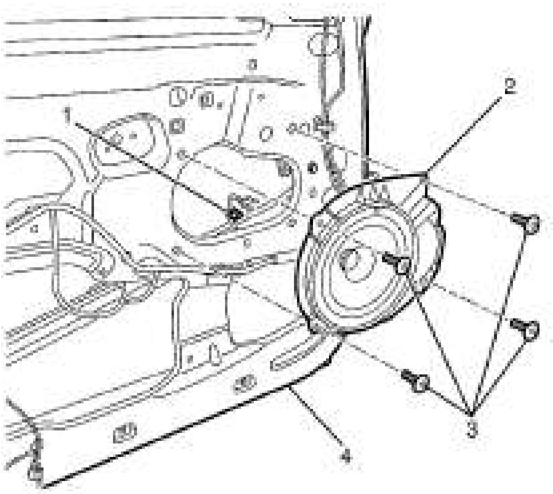
Radio Front Side Door Lower Speaker Replacement

Removal Procedure



1. Remove the front door trim panel. Refer to Front Side Door Trim Panel Replacement.
2. Remove the speaker assembly to door frame retaining screws (3).
3. Disconnect the electrical connector(s) (1).
4. Remove the speaker assembly (2) from the door frame (4).

Installation Procedure



1. Connect the electrical connector(s) (1).

   Notice: Refer to Fastener Notice in the Preface section.

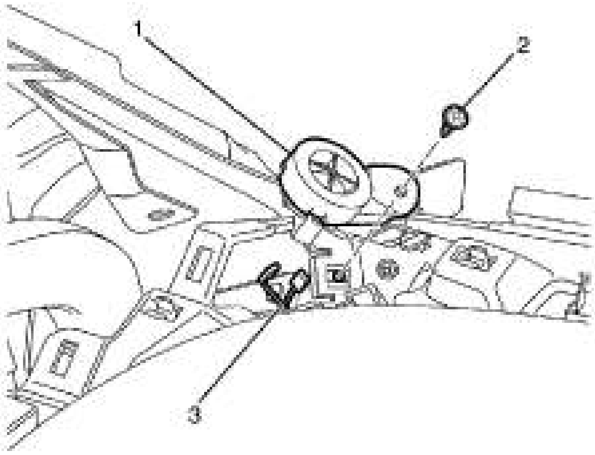
2. Install the speaker assembly (2) to the door frame (4).
3. Install the front speaker assembly to door frame attaching screws (3).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).

4. Install the front door trim panel. Refer to Front Side Door Trim Panel Replacement.

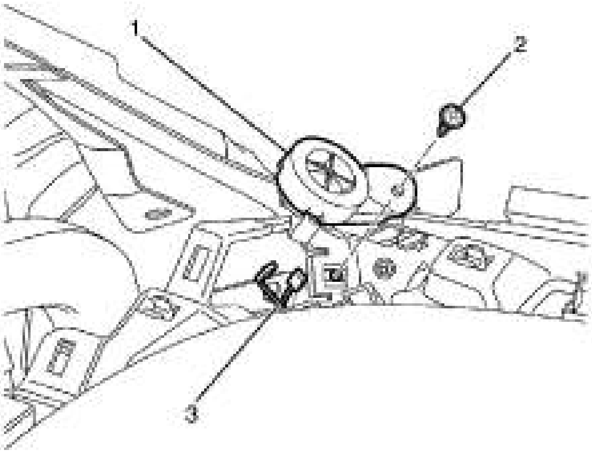
Radio Front Speaker Replacement (RHD)

Removal Procedure - Tweeter



1. Remove the left instrument panel (I/P) defroster grille. Refer to Defroster Grille Replacement .
2. Remove the tweeter speaker to I/P attaching screw (2).
3. Disconnect the electrical connector (3).

Installation Procedure - Tweeter



1. Connect the electrical connector (3).

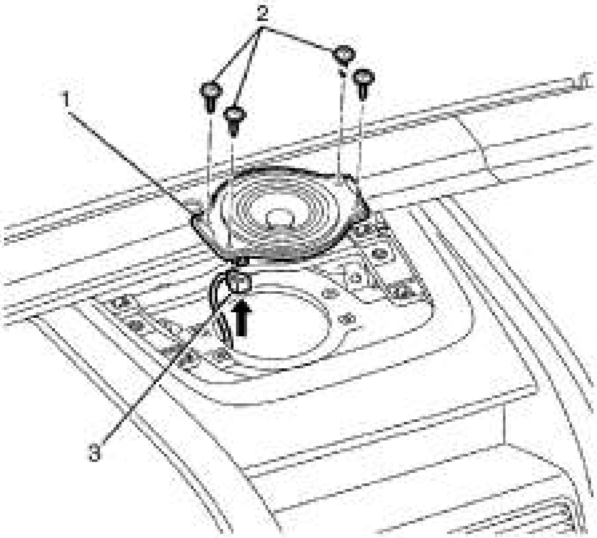
   Notice: Refer to Fastener Notice in the Preface section.

2. Install the tweeter speaker to I/P attaching screw (2).

   Tighten
   Tighten the screw to 2 N·m (18 lb in).

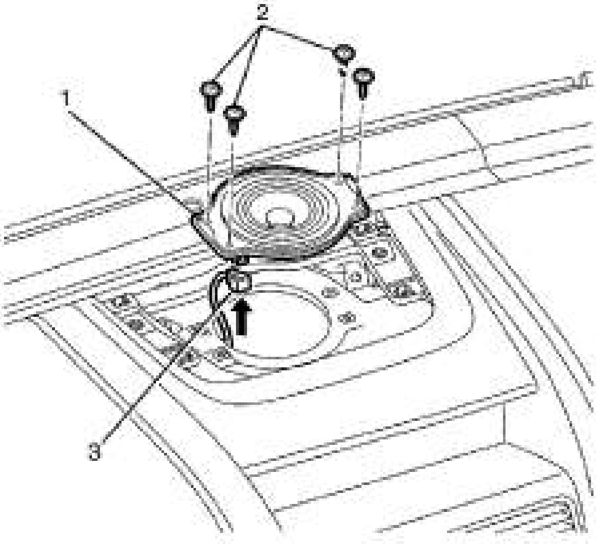
3. Install the left instrument panel defroster grille. Refer to Defroster Grille Replacement .

Removal Procedure - Center



1. Remove the instrument panel (I/P) defroster grilles. Refer to Defroster Grille Replacement .
2. Remove the upper instrument panel (I/P) center trim. Refer to Instrument Panel Upper Trim Panel Replacement
3. Remove the centre speaker to instrument panel attaching screws (2).
4. Disconnect the electrical connector (3).

Installation Procedure - Center



1. Connect the electrical connector (3).

   Notice: Refer to Fastener Notice in the Preface section.

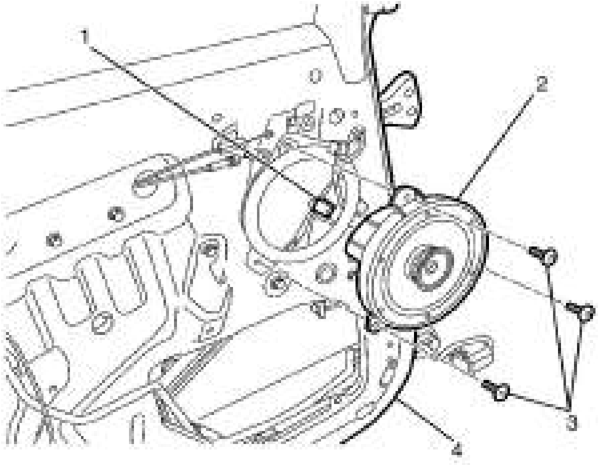
2. Install the centre speaker to instrument panel attaching screws (2).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).

3. Install the upper instrument panel (I/P) centre trim. Refer to Instrument Panel Upper Trim Panel Replacement
4. Install the instrument panel defroster grilles. Refer to Defroster Grille Replacement .

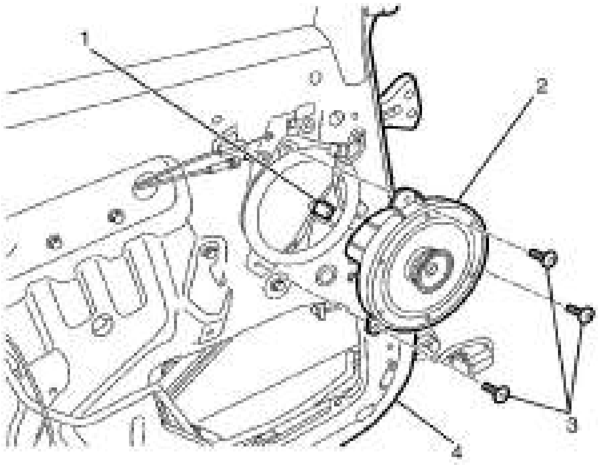
Radio Rear Side Door Speaker Replacement

Removal Procedure



1. Remove the rear door trim panel. Refer to Rear Side Door Trim Panel Replacement.
2. Remove the speaker assembly to door frame attaching screws (3).
3. Disconnect the electrical connector(s) (1).
4. Remove the speaker assembly (2) from the door frame (4).

Installation Procedure



1. Connect the electrical connector(s) (1).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the speaker assembly (2) to the door frame (4).
3. Install the rear speaker assembly to door frame attaching screws (3).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).

4. Install the rear door trim panel. Refer to Rear Side Door Trim Panel Replacement.

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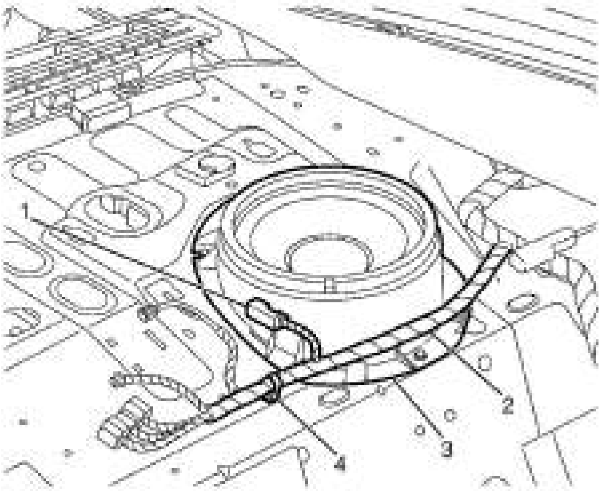
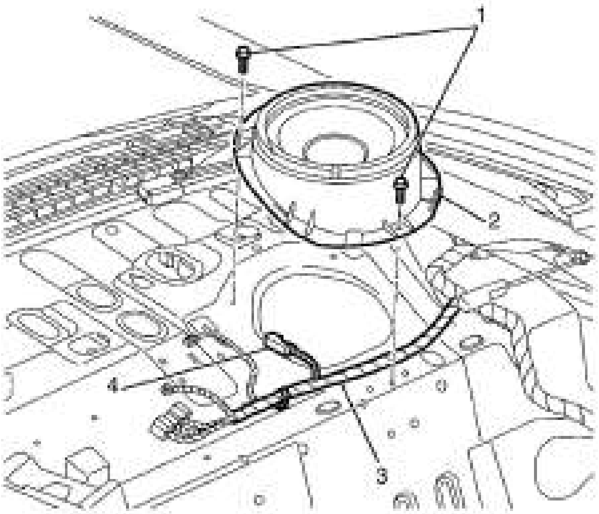
Radio Rear Speaker Replacement

Removal Procedure



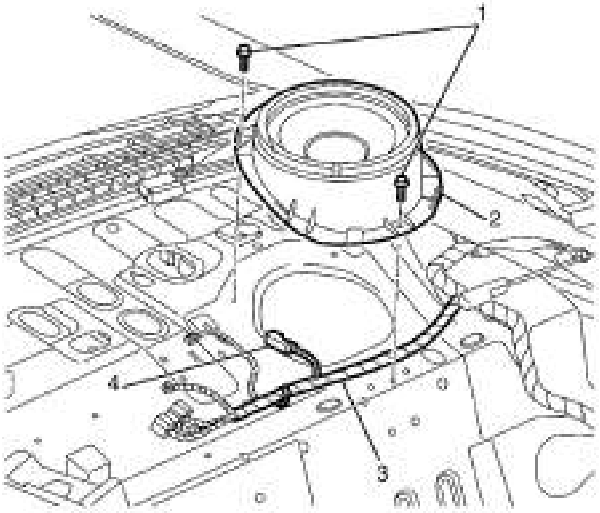
1. Remove the rear shelf trim panel. Refer to Rear Window Shelf Trim Panel Replacement.
2. Disconnect the subwoofer electrical connector (3).
3. Remove the retainer (1) securing the harness (3) to the shelf.



4. Remove the subwoofer assembly to rear shelf attaching screws (1).

5. Slide the harness (3) away from the subwoofer assembly (2).
6. Remove the subwoofer assembly (2) from the rear shelf.

Installation Procedure

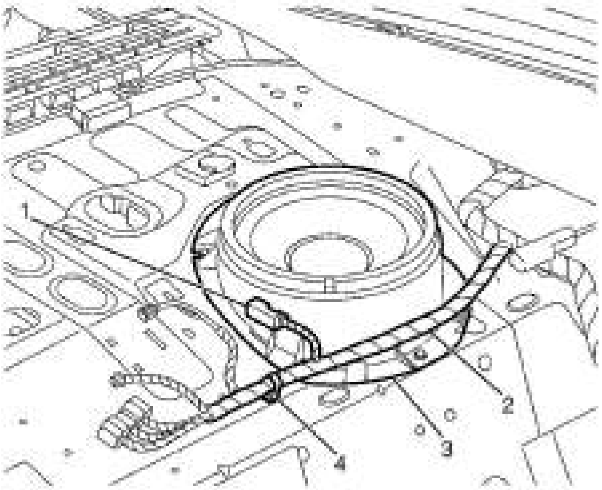


1. Install the subwoofer assembly (2) to the rear shelf.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the subwoofer assembly to rear shelf attaching screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).



3. Secure the electrical harness retainer (1) to the shelf.
4. Connect the subwoofer electrical connector (2).
5. Install the rear shelf trim panel. Refer to Rear Window Shelf Trim Panel Replacement.

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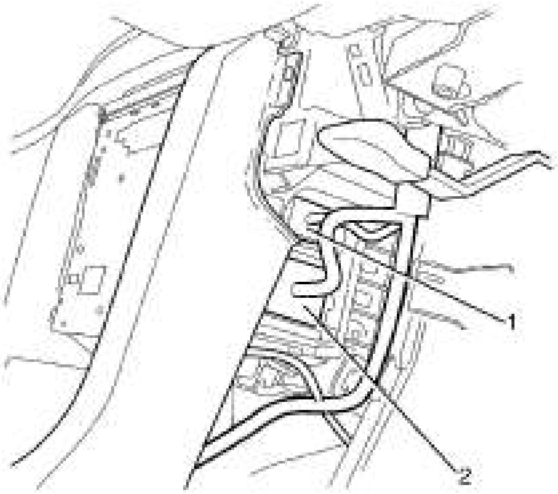
Radio Replacement

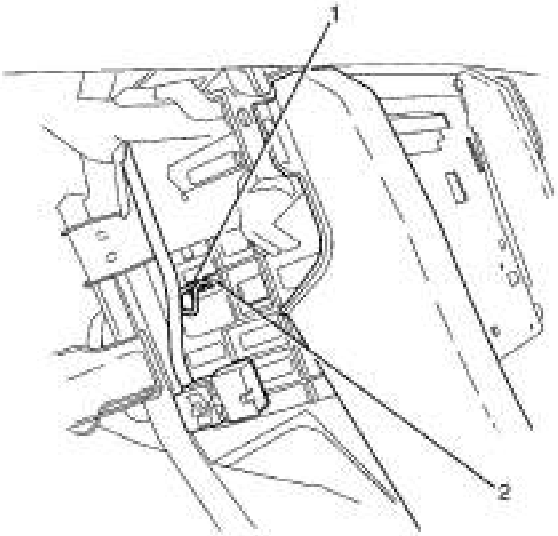
Removal Procedure

1. Remove the infotainment fascia. Refer to Driver Information Display Replacement.
2. Remove the instrument panel compartment assembly. Refer to Instrument Panel Compartment Replacement.
3. Remove the driver side instrument panel lower trim panel assembly. Refer to Knee Bolster Replacement.
4. Remove the left and right side instrument panel lower extension panels. Refer to Instrument Panel Extension Replacement.



Important: Make sure to release the retaining lever on the infotainment electrical connector (2) before disconnecting.

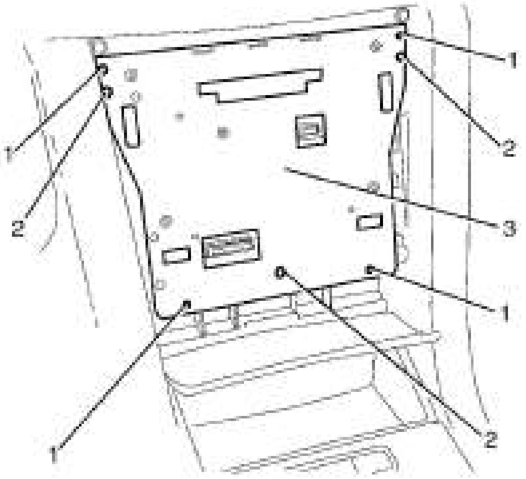
5. Disconnect the connector(s) (1 and 2 where applicable) from the right side of the infotainment unit.



Important: To disconnect coaxial connections, pinch down on the retaining clip near connection side of unit and push connector into the unit and slide connector away from the infotainment unit.

Important: Do not remove by pulling on the coaxial cables as they will be dislodged from the connector.

6. Disconnect the connector(s) (1 and 2 where applicable) from the left side of the infotainment unit.

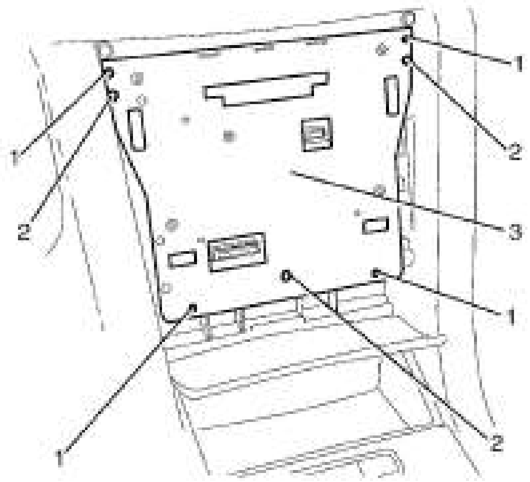


7. Remove the infotainment unit to instrument panel retaining screws (1).

Important: Observe position of aligning lugs (2).

8. Remove the infotainment unit (3) from the instrument panel.

Installation Procedure



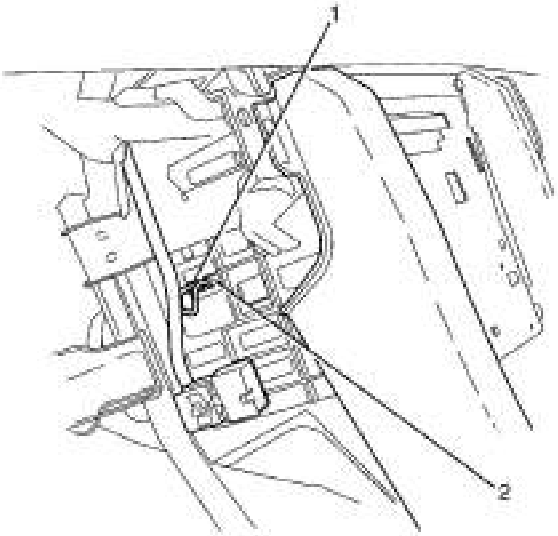
Important: Make sure to guide the infotainment unit (3) over the aligning lugs (2).

1. Install the infotainment unit (3).

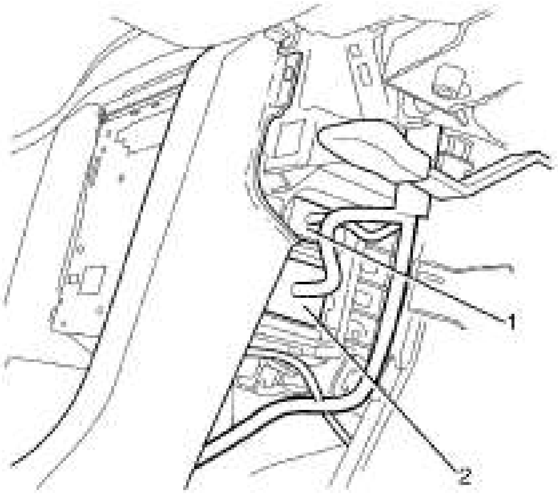
   Notice: Refer to Fastener Notice in the Preface section.

2. Install the infotainment unit to instrument panel retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).



3. Connect the left side infotainment unit electrical connector(s) (1 and 2 where applicable).



Important: Make sure to close the retaining lever on the infotainment electrical connector (2) once connected.

4. Connect the right side infotainment unit electrical connector(s) (1 and 2 where applicable).
5. Install the left and right side instrument panel lower extension panels. Refer to Instrument Panel Extension Replacement.
6. Install the driver side instrument panel lower trim panel assembly. Refer to Knee Bolster Replacement.
7. Install the instrument panel compartment assembly. Refer to Instrument Panel Compartment Replacement.
8. Install the infotainment fascia. Refer to Driver Information Display Replacement.

9. Refer to Control Module References.

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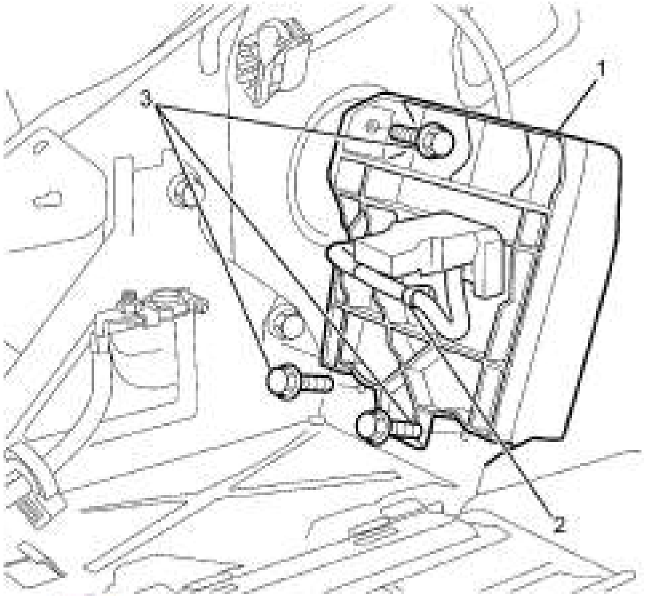
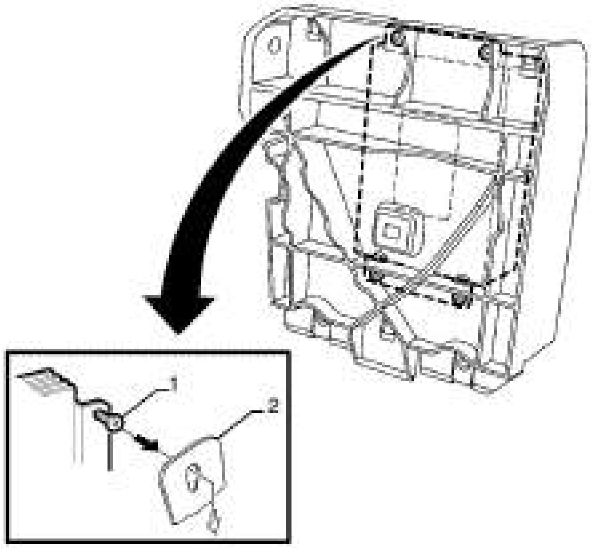
Radio Speaker Amplifier Replacement (SWB)

Removal Procedure



1. Remove the left-hand side carpet trim. Refer to Rear Corner Trim Panel Carpet Replacement
2. Remove the battery. Refer to Battery Replacement .
3. Disengage the battery harness retainer (2) securing the harness to the amplifier mounting bracket (1).
4. Remove the bolts (3) securing the amplifier mounting bracket to the vehicle.
5. Disconnect the electrical connector from the amplifier.
6. Remove the amplifier and bracket assembly.

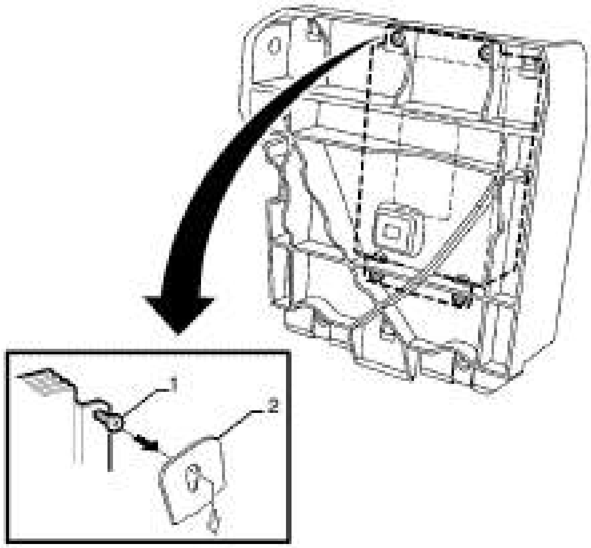


7. Loosen the screws (1) holding the amplifier to the mounting bracket.

   Important: Slide the amplifier upward to release the screw heads from the slots in the mounting bracket.

8. Remove the amplifier from the mounting bracket.

Installation Procedure



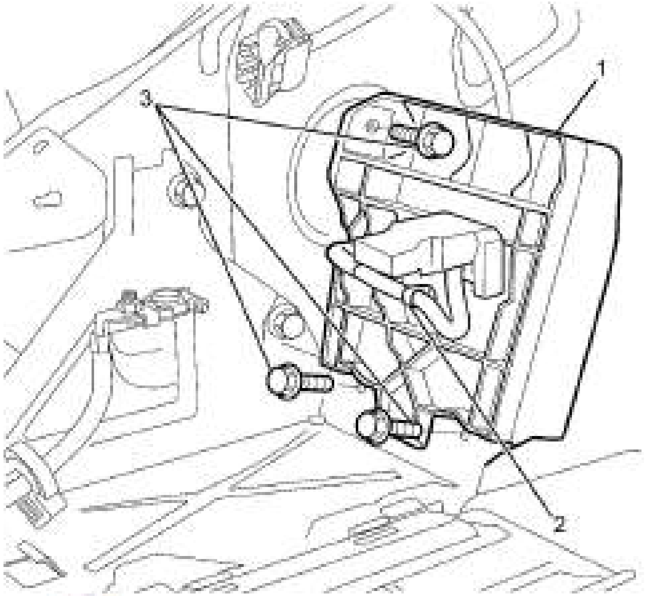
Important: Insert the amplifier screw heads (1) into the mounting bracket slots and slide the amplifier downward to secure the screw heads into the slots in the mounting bracket.

1. Install the amplifier to the mounting bracket.

   Notice: Refer to Fastener Notice in the Preface section.

2. Tighten the amplifier to mounting bracket retaining screws (1).

   Tighten
   Tighten the screws to 2.5 N·m (22 lb in).



3. Install the amplifier and bracket assembly (1).
4. Connect the electrical connector to the amplifier.

Notice: Refer to Fastener Notice in the Preface section.

5. Install the amplifier mounting bracket to vehicle retaining bolts (3).

Tighten
Tighten the bolts to 22 N·m (16 lb ft).

Important: Make sure the retainer (2) securing the harness to the amplifier mounting bracket (1) engages correctly.

6. Connect the battery harness to the amplifier bracket assembly.
7. Install the battery. Refer to Battery Replacement .
8. Install the left-hand side carpet trim. Refer to Rear Corner Trim Panel Carpet Replacement
9. Refer to Control Module References .

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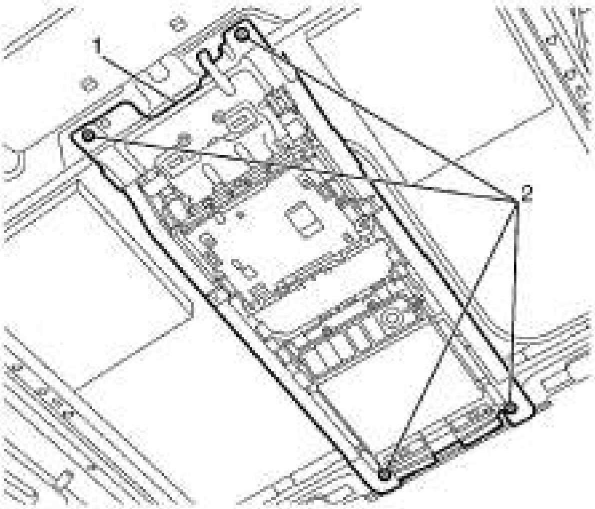
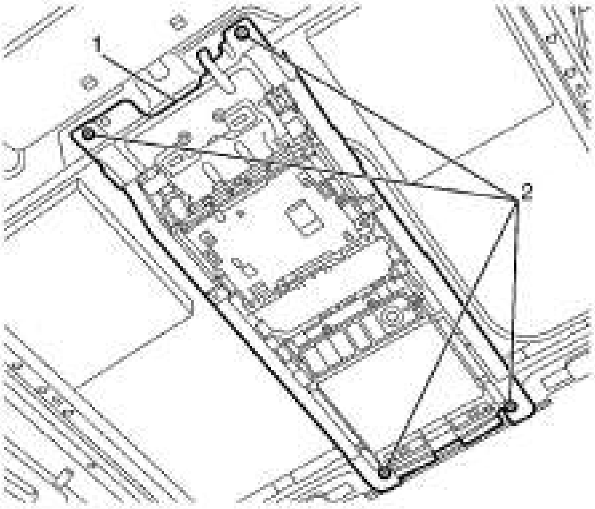
Video Disc Player Bracket Replacement

Removal Procedure



1. Remove the headlining trim assembly. Refer to Headlining Trim Panel Replacement.
2. Remove the rear seat entertainment assembly to roof panel screws (2).
3. Carefully lower the front of the rear seat entertainment assembly (1) from the roof panel followed by the rear.
4. Disconnect the connector from the rear seat entertainment assembly
5. Remove the rear seat entertainment assembly (1) from the roof panel.

Installation Procedure



1. Connect the rear seat entertainment assembly electrical connector.
2. Install the rear seat entertainment assembly (1) to the roof panel.

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the rear seat entertainment assembly to roof panel retaining screws (2).

   Tighten
   Tighten the screws to 1 N·m (9 lb in).

4. Install the headlining trim assembly. Refer to Headlining Trim Panel Replacement.

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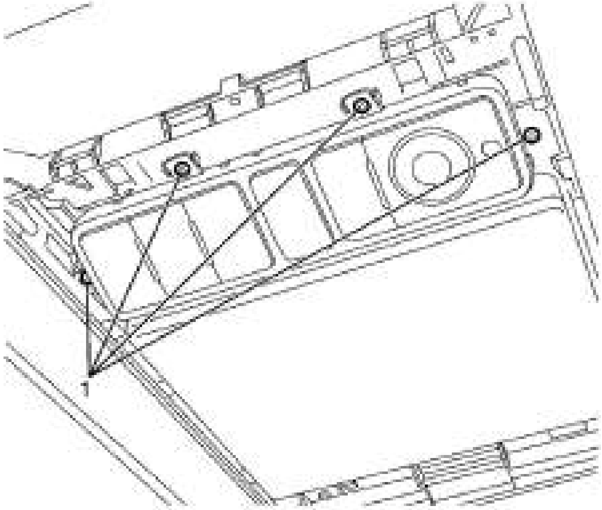
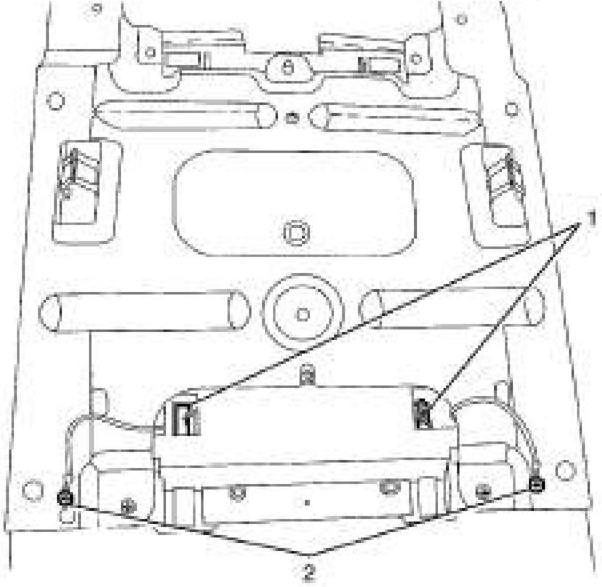
Video Disc Player Control Replacement (SWB)

Removal Procedure



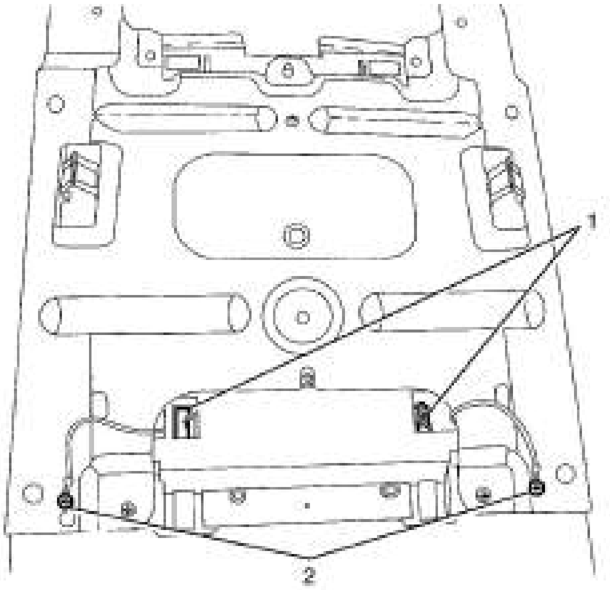
1. Remove the RSE assembly. Refer to Video Disc Player Bracket Replacement .
2. Remove the audio control to RSE assembly bracket screws (1).



3. Disconnect the headliner audio control connectors (1).
4. Remove the grounding point to RSE assembly bracket screws (2).

5. Remove the headliner audio controls from the RSE assembly bracket.

Installation Procedure



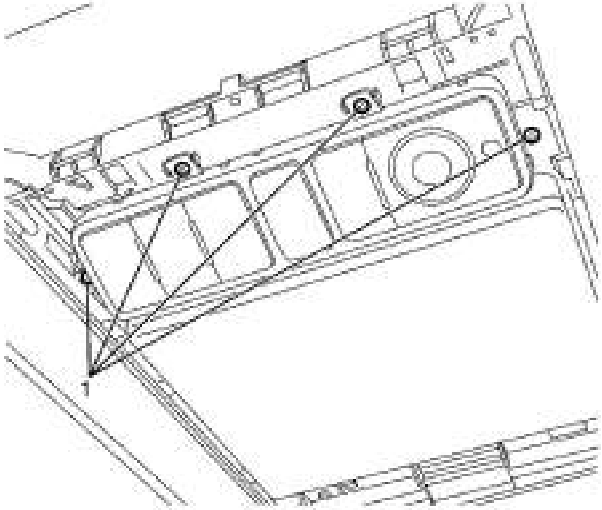
1. Install the headliner audio controls to the headliner.
2. Connect the headliner audio controls electrical connectors (1).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the grounding point to RSE assembly bracket retaining screws (2).

   Tighten
   Tighten the screws to 1 N·m (9 lb in).

   Notice: Refer to Fastener Notice in the Preface section.



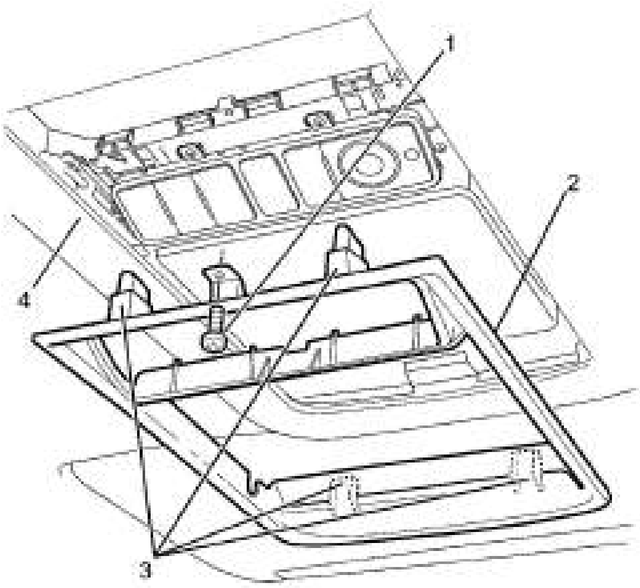
4. Install the headliner audio controls to RSE assembly bracket retaining screws (1).

   Tighten
   Tighten the screws to 1 N·m (9 lb in).

5. Install the rear seat entertainment assembly. Refer to Video Disc Player Bracket Replacement .

Video Disc Player Display Bezel Replacement (Display)

Removal Procedure

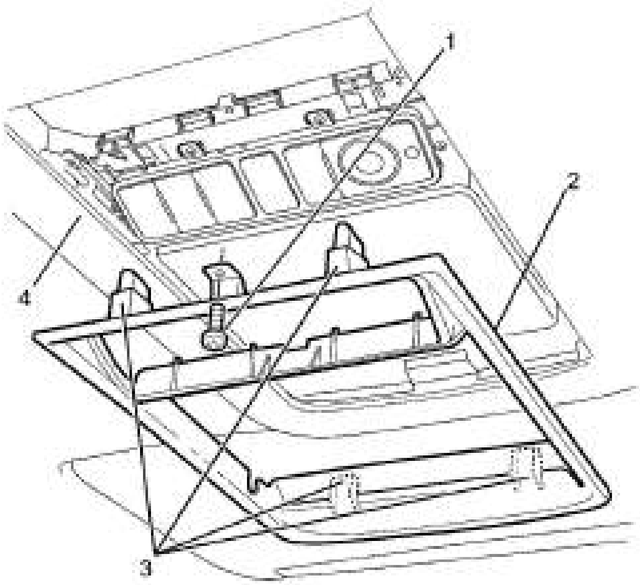


1. Remove the rear dome lamp assembly. Refer to Dome Lamp Replacement.
2. Remove the DVD screen surround to roof panel screw (1).

   Important: Using a suitable tool disengage the retainers (3).

3. Remove the DVD screen surround (2) from the headlining trim (4).

Installation Procedure



Important: Make sure all the retainers (3) engage the headlining trim (3).

1. Install the DVD screen surround (2) to the headlining trim (4).

   Notice: Refer to Fastener Notice in the Preface section.

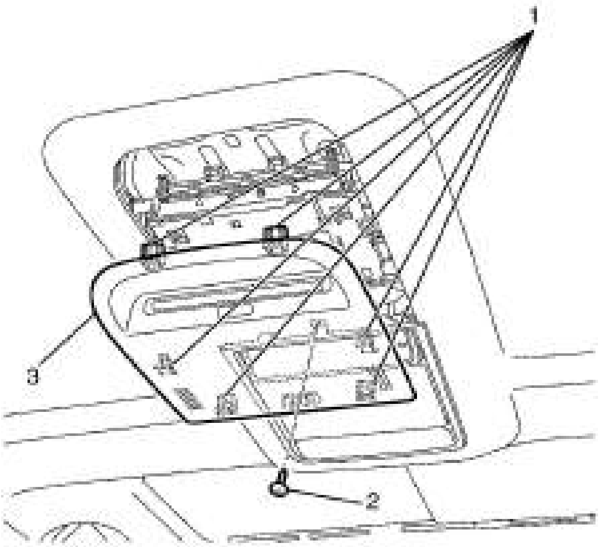
2. Install the DVD screen surround to roof panel retaining screw (1).

   Tighten
   Tighten the screws to 1 N·m (18 lb in).

3. Install the rear dome lamp assembly. Refer to Dome Lamp Replacement.

Video Disc Player Display Bezel Replacement (Player)

Removal Procedure

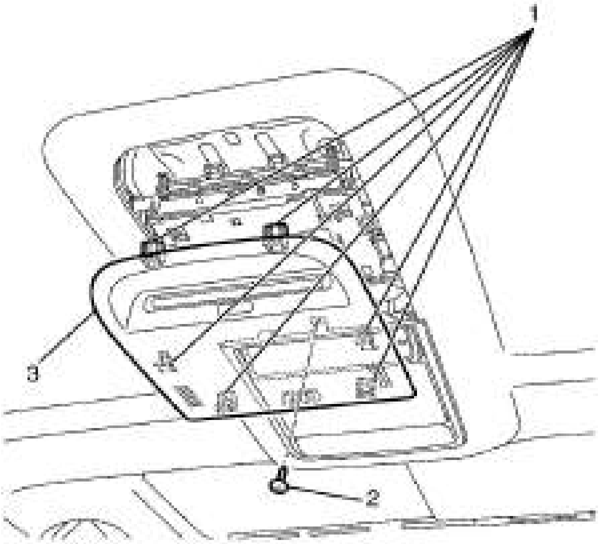


1. Remove the rear dome lamp assembly. Refer to Dome Lamp Replacement.
2. Remove the DVD player surround to roof panel screw (2).

   Important: Using a suitable tool disengage the retainers (1).

3. Remove the DVD player surround (2) from the headlining trim (3).

Installation Procedure



Important: Make sure all the retainers (1) engage through the headlining trim (3).

1. Install the DVD player surround (2) to the headlining trim (3).

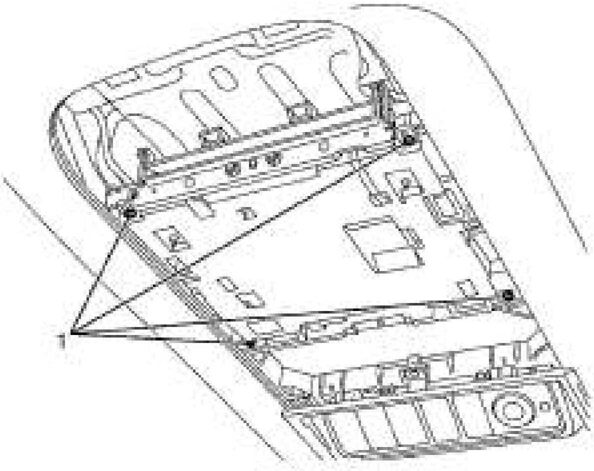
   Notice: Refer to Fastener Notice in the Preface section.

2. Install the DVD player surround to roof panel retaining screw (2).

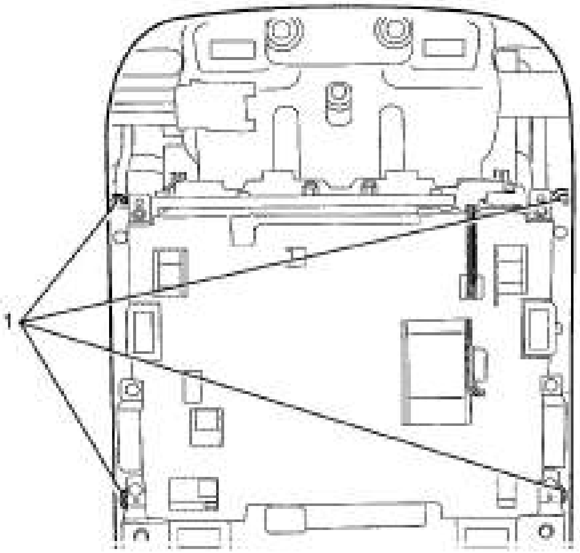
   Tighten
   Tighten the screws to 1 N·m (9 lb in).

3. Install the rear dome lamp assembly. Refer to Dome Lamp Replacement.

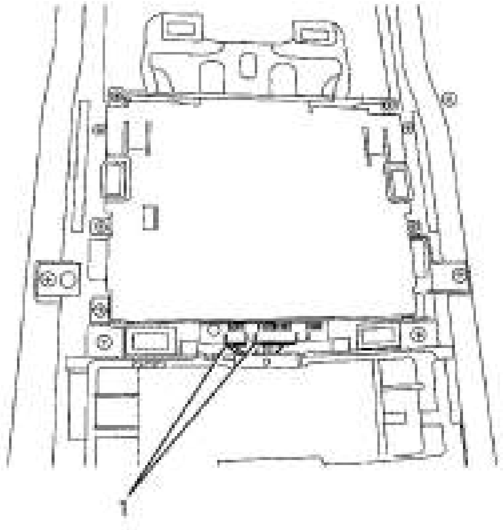
Video Disc Player Replacement



1. Remove the rear dome lamp assembly. Refer to Dome Lamp Replacement.
2. Remove the DVD player surround trim. Refer to Video Disc Player Bezel Replacement.
3. Remove the DVD player to rear seat entertainment (RSE) assembly bracket screws (1).

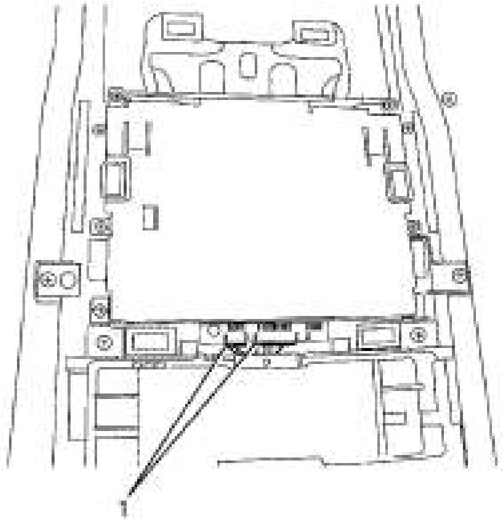


4. Cut the retaining ties (1) securing the RSE assembly harnesses to the DVD player.

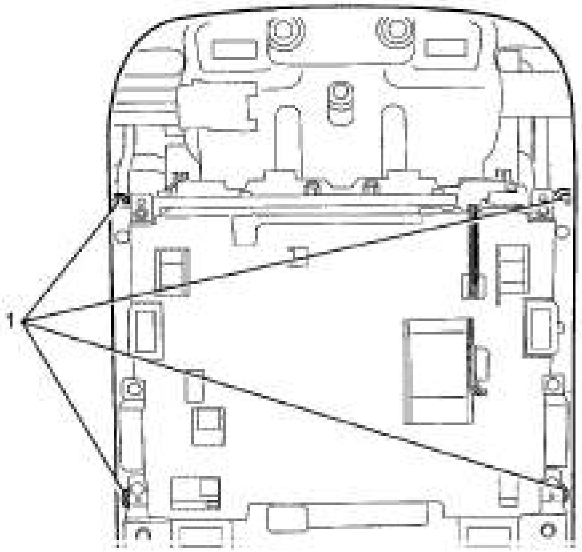


5. Disconnect the DVD player connectors (1).
6. Remove the DVD player from the RSE assembly bracket.

Installation Procedure

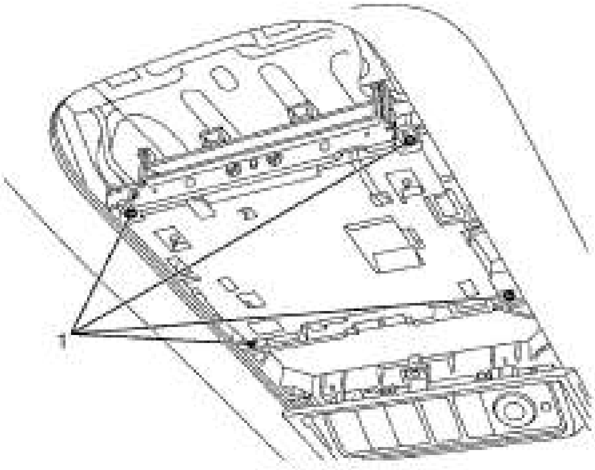


1. Connect the DVD player electrical connector.
2. Install the DVD player to the RSE assembly bracket.



3. Appropriately fasten the RSE harnesses to the DVD player assembly (1) with retaining ties.

   Notice: Refer to Fastener Notice in the Preface section.



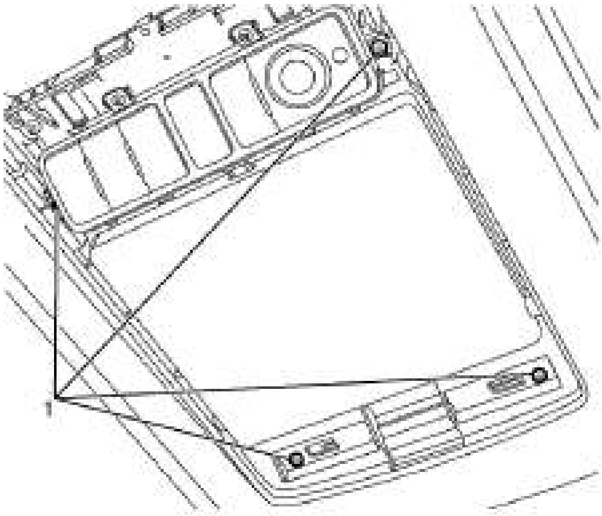
4. Install the DVD player to RSE assembly bracket retaining screws (1).

   Tighten
   Tighten the screws to 2.5 N·m (22 lb in).

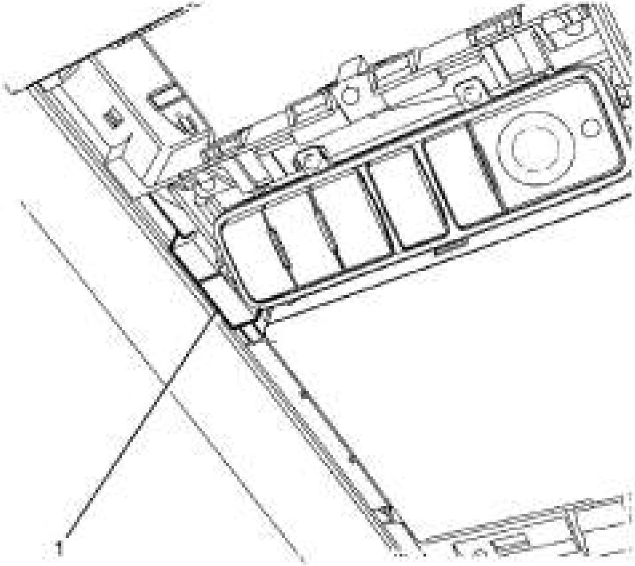
5. Install the DVD player surround trim. Refer to Video Disc Player Bezel Replacement.
6. Install the rear dome lamp assembly. Refer to Dome Lamp Replacement.

Video Display Replacement (Headliner LWB SWB)

Removal Procedure



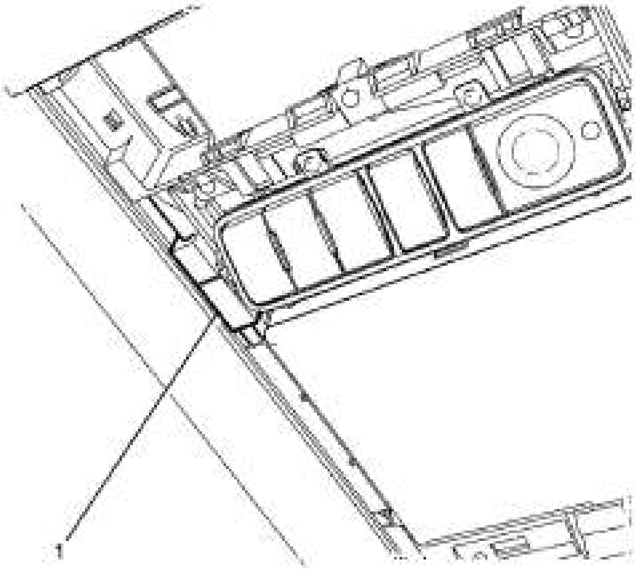
1. Remove the rear dome lamp assembly. Refer to Dome Lamp Replacement .
2. Remove the DVD screen surround trim. Refer to Video Disc Player Display Bezel Replacement
3. Remove the DVD screen to rear seat entertainment (RSE) assembly bracket screws (1).



4. Disconnect the DVD screen connector (1).

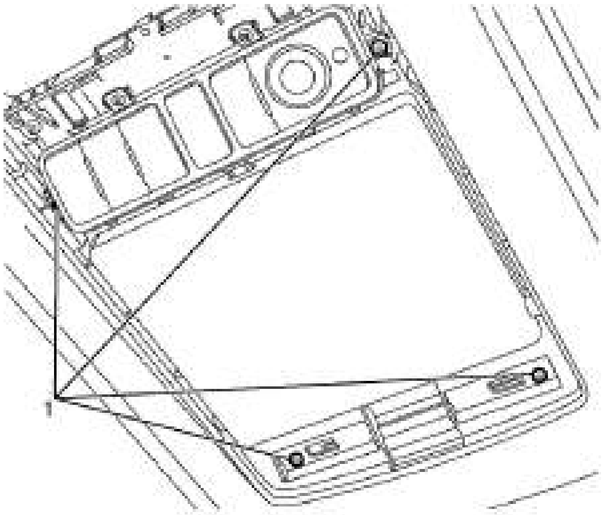
5. Remove the DVD screen from the RSE assembly bracket.

Installation Procedure



1. Install the DVD screen to the RSE assembly bracket.
2. Connect the DVD screen electrical connector (1).

Notice: Refer to Fastener Notice in the Preface section.



3. Install the DVD screen to RSE assembly bracket retaining screws (1).

Tighten
Tighten the screws to 1.5 N·m (13 lb in).

4. Install the DVD screen surround trim.Refer to Video Disc Player Display Bezel Replacement
5. Install the rear dome lamp assembly. Refer to Dome Lamp Replacement .

Cellular Telephone Description and Operation

Bluetooth Wireless Technology

Bluetooth Wireless Technology is a cordless link between two devices, in this case, a cellular telephone and the Bluetooth car kit. Bluetooth devices communicate via low-power radio waves. Bluetooth communicates on a frequency of 2.45 gigahertz which has been reserved by international agreement for the use of industrial, scientific and medical devices (ISM).

Due to the low power of the signal, approximately 1 milliwatt, a cellular telephone must be within 10 meters (32 feet) of the vehicle's Blue Tooth Module to connect and operate. However the cellular telephone and the Bluetooth module do not need to be in a direct line of sight. For example the cellular telephone can be in the centre console or in a bag whilst connected to the Bluetooth car kit.

When a paired cellular telephone and the Bluetooth car kit come within range of one another, an electronic conversation automatically takes place and the devices form a personal-area network (PAN), or piconet, in the vehicle. To avoid interference from other Bluetooth devices, the paired cellular telephone and the Bluetooth car kit, once a piconet is established, randomly hop frequencies in unison so they stay in touch with one another and avoid other piconets that may be operating in the same area.

Bluetooth Definitions

Paired: The Bluetooth module and the cellular telephone have stored each other's ID in memory and are available to be connected when they are within 10 meters (32 feet) of each other.

Connected: The cellular telephone handset is currently linked with the Bluetooth car kit. All functions on the Bluetooth car kit are active.

Pairing a Cellular Telephone

The pairing between a cellular telephone with Bluetooth capability and the Bluetooth car kit can be established using the following procedure.

Important: If a Blackberry/PDA device is being used, the pairing action may take several seconds longer to complete. Do not interrupt during this process or the pairing will not be successful.

1. Switch the cellular telephone ON.
2. Turn the ignition to the ON position.
3. Perform the following steps on the cellular telephone:
   - 3.1. Enter the Bluetooth menu.
   - 3.2. Activate the Bluetooth function.
   - 3.3. Search for Bluetooth devices.
   - 3.4. Select the device labelled 'Vehicle BT'.
   - 3.5. Enter the following PIN: 1234.

This establishes the connection between the cellular telephone and the Bluetooth car kit.

3.6. Set the cellular telephone to accept Bluetooth connection requests automatically without permission (if required).

Pairing multiple cellular telephones

The Bluetooth car kit can be paired with up to six cellular telephones, but can only be connected to one cellular telephone at a time. If a seventh cellular telephone is paired with the Bluetooth car kit, the first or least recent cellular telephone paired with the Bluetooth car kit ID will be over written and will no longer be paired with the Bluetooth car kit.

When the ignition is switched on, the Bluetooth car kit searches for the most recently paired cellular telephone.

Connecting a Cellular Telephone

Important: Make sure the cellular telephone being connected has been paired with the Bluetooth car kit or the connection will not be successful.

Connection between a paired cellular telephone and the Bluetooth car kit can be established using the following procedure.

1. Move the cellular telephone to within 10 meters (32 feet) of the vehicle's Blue Tooth Module, preferably inside the vehicle.
2. Make sure the cellular telephone is switched on and the Bluetooth function has been activated.
3. Turn the ignition to the ON position.
4. Press the Bluetooth button on the steering wheel (if required). A phone symbol will appear in the instrument panel centre display for a few seconds.

Bluetooth Call Options

After connection between a cellular telephone and the Bluetooth car kit has been established, the following call options may be selected. Refer to the owner handbook for specific detail on each call option.

- Dial normally on the cellular telephone handset.
- Make a call by voice dialling.
- Answer a call.
- Automatic answer.
- Reject a call.
- Place call on hold.
- End a call.
- Redial the last number.

Cancelling the Bluetooth Connection

To cancel the Bluetooth connection, perform any of the following:

- Turn the ignition to the OFF position and open the drivers door.
- If no call is in progress, press and hold the Bluetooth button on the steering wheel for three seconds.
- Deactivate the Bluetooth function on the cellular telephone.
- Move the cellular telephone outside of the reception range of the Bluetooth car kit (approximately 10 meters).
- Switch off the cellular telephone

Vehicle Audio System

When making or receiving a call, the vehicle's audio system is automatically set to silent. The voice of the caller is heard through the audio systems speakers and VOICE IN is shown on the audio system display.

Setting Up The Audio System

The volume, bass, treble, fader and balance can be adjusted in the audio system's Bluetooth mode without affecting radio or CD settings.

Set up the audio system for Bluetooth by performing the following procedure:

1. Make a call using the Bluetooth car kit.
2. Adjust the volume, balance and fader settings for Bluetooth.
3. End the call.

Navigation System Description and Operation (SWB)

Navigation System Components

The navigation system contains the following components:

- The navigation module
- The navigation interface module (NIM)
- The global positioning system (GPS) antenna

These components then integrate and communicate with the following components:

- The infotainment module
- The steering wheel controls
- The body control module (BCM)
- The instrument cluster

Navigation Module

The navigation module is available in 2 different variants. Both are single DIN units designed as external components which can be installed as part of the infotainment system. The navigation module is mounted in the instrument panel compartment and contains all the navigation engines and gyroscope used to detect movement of the vehicle.

Type A Navigation Module

This navigation module features 'Turn by Turn' directions. The navigation module is an optional accessory to low level vehicles fitted with Type A or C infotainment systems. The navigation module transmits 'Turn by Turn' direction symbols to the instrument cluster display, via serial data to the navigation interface module (NIM) before being translated and re-transmitted via GMLAN. The navigation module also sends audible verbal direction to the speakers through the infotainment unit via the NIM. Key entries are entered via the steering wheel remote control.

Type B Navigation Module

This navigation module features 'Turn by Turn' directions as well as displaying full map and routing information on the infotainment unit display. The navigation module is an optional accessory to high level vehicles fitted with Type D infotainment systems featuring 6.5" colour LCDs. The navigation module transmits 'Turn by Turn' direction symbols to the instrument cluster display, via serial data to the navigation interface module (NIM) before being translated and re-transmitted via GMLAN. The navigation module also sends audible verbal direction to the speakers through the infotainment unit via the NIM. Map based navigation routing information is also channelled directly to the infotainment unit display from the navigation module. Key entries are entered via the infotainment unit fascia. The INFO button on the steering wheel is used to recall the last audible direction, and also displays the function on the instrument clusters centre multi-function display.

Navigation Interface Module (NIM)

The navigation interface module (NIM) is used to communicate data between the navigation module and the vehicle body control module (BCM), the instrument cluster and the infotainment unit. The illumination signal and ignition signal messages are sent from the BCM to the NIM via GMLAN, the NIM then translates these signals and re-transmits the data to the navigation module. The odometer and reverse signals are also transmitted to the navigation module via the NIM. The NIM also translates and re-transmits the mute signal from the navigation module via serial data to the infotainment unit. The NIM is mounted to the inside edge of the instrument panel insulation panel, directly beneath the I/P compartment.

Global Positioning System (GPS) Antenna

The global positioning system (GPS) locates the current position of the vehicle using signals sent by GPS satellites. The GPS antenna is attached to the instrument panel (I/P) carrier and can be accessed by removing the I/P centre air outlet grille assembly. The GPS antenna is powered through the same coaxial cable used to send the signals to the navigation module. Interference to the system may occur if any of the following exist:

- Signal shadowing, when signals are obstructed by objects such as tall trees or buildings.
- Metallic objects located on the dashboard.
- Aftermarket glass tinting has been applied to the vehicles windshield.
- Ionospheric disturbance (caused by solar activity, which results in greatly increased radio wave absorption).
- Atmospheric disturbances caused by stormy weather.
- Proximity to high power distribution locations, i.e. sub-stations, power stations.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Driver Information and Entertainment | Cellular, Entertainment, and Navigation | Description and Operation |
Document ID: 1995864

Radio / Audio System Description and Operation (SWBRHD)

Contents

- Infotainment Options
- Option Level Recognition
- Circuit description
- Component description
- AM/FM Reception
- Customer tips

Infotainment Options

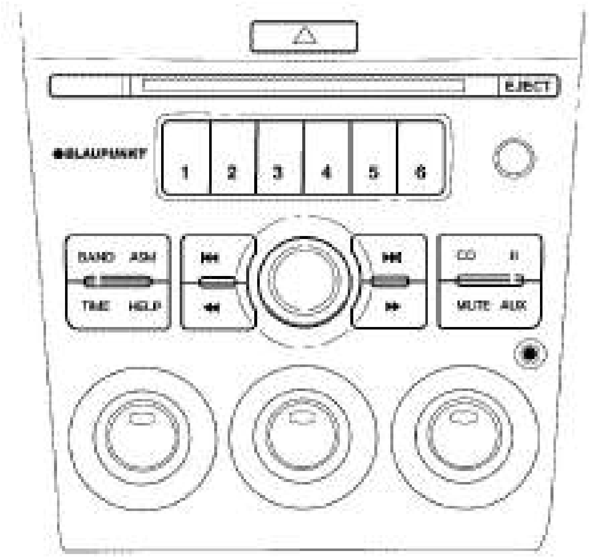
There are 4 Infotainment System options available.

Component(s)	Type A	Type B	Type C	Type D
Single CD (80W) 4 Channel	X	X		
6-Disc CD Changer (80W) 4 Channel with 5.5" Dot Matrix Display		X (SS)	X	
6-Disc CD Changer (150W) 5 Channel with 6.5" Colour LCD				X
4.5" Dot Matrix Remote Display Screen	X			
Wide Red Dot Matrix Remote Display Screen		X		X (SS-V SPORTS GAUGES)
Manual HVAC Controls	X	X		
Automatic Dual Zone HVAC Controls			X	X
Preset Equaliser		X	X	X
Fixed Mast Roof Antenna	X	X	X	X
Diversity Antenna				X (CALAIS & CALAIS-V ONLY)
Steering Wheel Audio Control Assembly	X	X	X	X
Rear Seat Entertainment Controls				X (CALAIS-V ONLY)
Instrument Panel Speakers (Left and Right)	X	X	X	X
Instrument Panel Speaker (Centre)		X	X	X
Front Door Speakers	X	X	X	X
Rear Door Speakers	X	X	X	X
Sub Woofers				X (CALAIS-V & SS-V ONLY)

Sub Woofer Amplifier (80W) 2 Channel				X (CALAIS-V & SS-V ONLY)
DVD Player with Roof Mounted Screen				X (CALAIS-V ONLY)

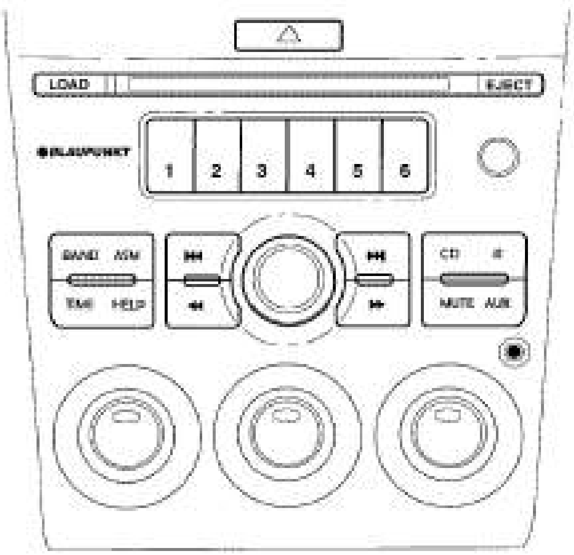
Option Level Recognition

Type A



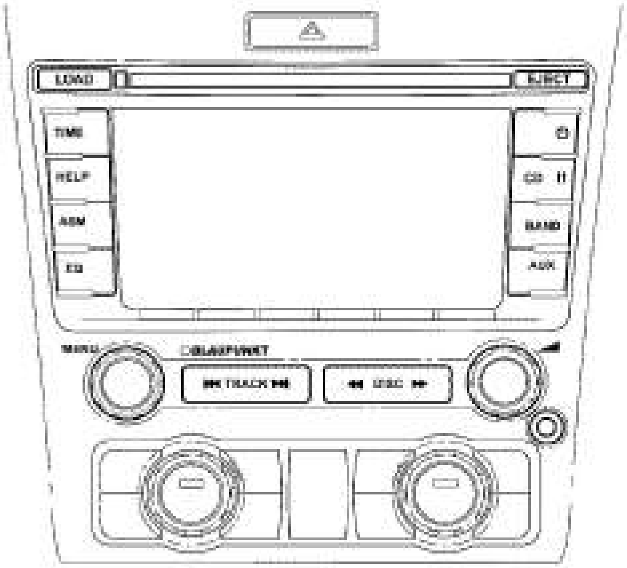
Type A Infotainment Systems incorporate manual HVAC controls in the fascia and feature a 4.5" remote dot matrix display mounted above the infotainment fascia. This system includes 4 X 20W power output, Dynamic Distortion Limiting (DDL), a single disc CD player with AM/FM radio and 2 X auxiliary audio inputs.

Type B


LOAD
EJECT
BLAUPUNKT
1
2
3
4
5
6
BAND
ASM
TIME
HELP
CD
MUTE
AUX

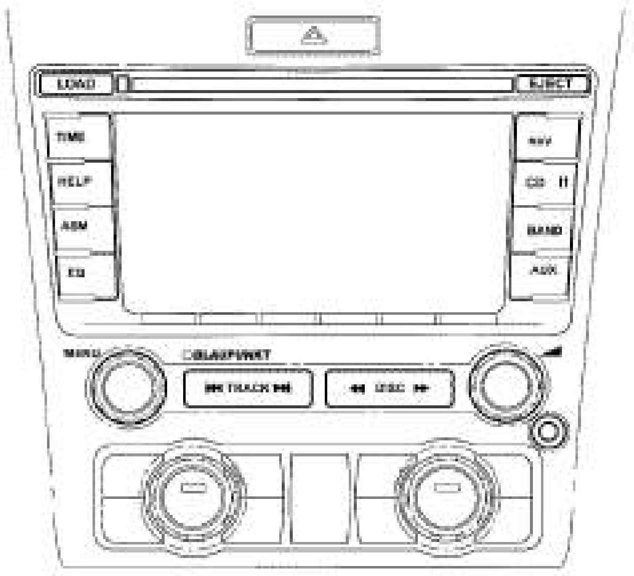
Type B Infotainment Systems incorporate manual HVAC controls in the fascia and feature a wide red remote dot matrix display mounted above the infotainment fascia. This system includes 4 X 20W power output, Dynamic Distortion Limiting (DDL), preset equaliser, a single disc CD player, or 6 disc CD player for SS vehicles, as well as AM/FM radio and 2 X auxiliary audio inputs.

Type C


LOAD
EJECT
TIME
HELP
ASM
EQ
CD
BAND
AUX
MENU
BLAUPUNKT
TRACK
DISC

Type C Infotainment Systems incorporate dual zone automatic HVAC controls and a 5.5" dot matrix reversible display in the fascia. This system includes 4 X 20W power output, Dynamic Distortion Limiting (DDL), preset equaliser, 6 disc CD player with AM/FM radio, MP3 compatible and 2 X auxiliary audio inputs.

Type D



Type D Infotainment Systems incorporate dual zone automatic HVAC controls and a 6.5" colour LCD screen in the fascia. This system includes 5 X 30W power output, Dynamic Distortion Limiting (DDL), pre-programmed 5 band equalisation / effects, 6 disc CD player with AM/FM radio and diversity antenna, MP3 compatible, 2 X auxiliary audio inputs, 1 X auxiliary video input (for optional rear seat entertainment display),1 X auxiliary video and audio inputs (for optional Navigation display and audio), and parking aid display.

Circuit Description

Infotainment Unit Power

The main infotainment unit power is supplied by a 15A fuse located in the rear fuse block. The infotainment system does not require a discrete ignition feed circuit for power moding. The power moding is accomplished using a structure of Virtual Networks (VN). The Power Mode Master (PMM) transmits the GMLAN power mode signals.

The infotainment unit supports the following signals:

- System Power Mode
- Infotainment Operation Allowed

The infotainment unit also supports the following GMLAN Vehicle Power Modes:

- OFF
- ACCESSORY

- RUN
- CRANK REQUEST

Infotainment Unit Ground

A wire in the main radio connector that is connected to battery negative at all times provides the main radio ground. Resistance between the ground pin and the vehicle battery negative terminal must not exceed 0.05 ohms.

Infotainment Speaker Outputs

At low volume, the plus (+) and minus (-) speaker outputs circuits measure approximately 5-6 volts. If a plus or minus circuit for any speaker output is shorted to ground or voltage, the infotainment unit disables the circuit for component protection and sets a diagnostic trouble code (DTC). The radio sets the speaker circuit DTC on non-amplified systems only. As the radio volume increases the voltage on the plus and minus circuits change to create a voltage difference between each other. The difference in voltage is what drives the voice coil of the speaker producing sound.

Infotainment Unit Dimming

GMLAN signal data received by the infotainment unit determines the fascias dimming and backlighting levels. The infotainment unit sets the backlight and VF display dimming to the value indicated by the interior dimming level and interior dimming display level signals in the GMLAN dimming information frame. The infotainment unit provides fascia and control/graphics backlighting in the OFF (RAP inactive) when the exterior lighting virtual network (VN) is activated. The infotainment fascia display is consistent then with the surrounding devices that use PWM dimming to backlight their control/graphics when the power mode is OFF and the park lights are ON.

Sub Woofer Amplifier Speaker Inputs

The low-level audio signals (LR, and RR) from the infotainment unit are the inputs to the amplifier. The amplifier boosts these inputs and outputs them to the rear sub woofer speakers. If one speaker plus or minus low level audio signal circuit is open between the radio and the amplifier, the input to the amplifier is approximately half. The speakers for that channel then operate at approximately half the normal volume or in some cases no volume.

The low level audio signals from the radio to the amplifier typically measure in the 4-5 volts range.

Amplifier Speaker Outputs

At a low volume, the plus (+) and minus (-) speaker outputs circuits measure approximately 2-7 V AC or 7-8 V DC at the speaker connector when testing a normal working system. If a plus (+) or minus (-) for any speaker output is shorted to ground or voltage, the amplifier circuitry will turn OFF the front outputs or rear outputs for component protection.

Repeat speaker malfunction can be caused by a damaged amplifier. Test for a damaged quad bridge output in the amplifier if the wiring between the amplifier and speaker test negative for a short to voltage. Prolonged exposure to DC voltage can cause a speaker coil to short. An early indication of a shorted speaker coil is distortion/noise and eventual malfunction.

Cellular Telephone Mute

The telematics communications module uses the cellular telephone mute signal circuit to over-ride the infotainment unit for telematics communication. When cellular telephone mute is not active, this circuit is held at 1-volt by the radio. When the cellular telephone mute signal is pulled to ground, the radio over-rides any other audio signal and uses the remote audio signals as the source for output to the speakers. If the infotainment unit was OFF when this circuit is pulled low, the infotainment unit will turn ON. Additionally, the radio fades the speakers to full front, adjusts the volume to an initial audible level, and sets an Auto Tone designed for optimal use with telematics. When the mute signal is no longer pulled to ground, the radio returns to the mode it was in previously.

Component Description

Antenna System

The antenna system receives broadcast AM or FM stereo signals from free space and sends the signals to the radio receiver for processing via a coaxial antenna cable. Good antenna grounding is important for good radio reception.

Infotainment Unit

The operator interfaces with the Infotainment unit through the infotainment fascia and steering wheel controls. Through these controls the operator is able to control system power, volume, fade, balance, bass, and treble equalisations. Control on the integrated CD, MP3, or DVD (where fitted). Either a remote display or fascia equipped screen provides system feedback to the operator.

The infotainment unit processes the AM and FM signals from the antenna system or the information from the CD media, amplifies that information and sends the output to the speaker system.

The infotainment unit is located in the instrument panel centre stack area and is fastened to the instrument panel by four screws. The unit features a detachable fascia. Three rear bullet type guide pins are provided to aid in aligning the infotainment fascia to the unit. An electrical connection to the infotainment unit is a 40-way connector that is part of the I/P harness, antenna lead connector, auxiliary audio and video inputs for optional RSE DVD video input, and an additional 8-way harness connector is present on navigation equipped vehicles.

Radio amplifier outputs to the speakers are protected from damage should speaker leads become shorted to ground or shorted to vehicle power. The radio will sense these conditions and shut down the amplifier outputs in a non-destructive manner. After the short condition is removed, the radio will return to normal operation.

Speakers

The Type A speaker system consists of six speakers. Two 6.5" speakers are mounted in each of the front doors. Two 5 1/4" speakers are mounted in each of the rear doors. Two 1" tweeter speakers are mounted in the instrument panel (I/P). Type B and C speaker system adds a 3" speaker mounted in the top centre of the I/P. Type D speaker systems can include two 8" subwoofers mounted to the rear parcel shelf and include a 2 channel 80W amplifier.

Auxiliary Jack Socket

The AM/FM Stereo CD radio shall provide a 3.5 mm Auxiliary stereo jack that will allow playback of audio signals from remote devices (e.g. portable tape player, portable CD player or MP3 playback device, etc.).

Theft Deterrent

The infotainment theft deterrent system is intended to disable infotainment functionality if incorrect vehicle information is received by the infotainment unit. The infotainment unit disables functionality if the VIN information received by the infotainment unit does not match the VIN information that has been learned by the infotainment unit. A VIN sequence is the last 6 digits of the VIN. The infotainment unit receives this information in a GMLAN frame form.

The infotainment unit shall provide the following theft operating modes as part of the infotainment theft deterrent system:

- No VIN Mode - An infotainment unit that has not received or learned a VIN. In this mode the infotainment unit has limited functionality.
- Normal Mode - An infotainment unit has received a VIN sequence. The infotainment unit only learns the VIN sequence if the VIN sequence contained all 6 digits. In this mode the infotainment unit has full functionality.
- Theft Detected Mode - An infotainment unit that had previously learned a VIN sequence and subsequently received a VIN sequence not matching the learned sequence. In this mode the infotainment unit has limited functionality.

AM / FM Reception

Radio Signal

The radio signal is sent from a broadcast station and is then received by an antenna. The strength of the signal received depends on the following:

- The power output, or wattage, of the broadcasting station
- The location of the vehicle, or receiver, relative to the broadcast tower.
- Obstacles between the tower and the receiver
- Atmospheric conditions
- Which band, AM or FM, the station is broadcasting
- Type of antenna and the ground plane

AM Reception

The AM band has a lower frequency range than the FM band. These longer wavelengths:

- Bend around obstacles
- Follow the curvature of the earth
- May reflect, or skip, off of the ionosphere

The AM frequencies have longer range due to the ground wave. The ground wave follows the curvature of the earth and is affected by its conductivity. Greater conductivity equates to less signal loss, thus transmission over water is better than over land. The AM band has a range of 80-320 km (50-200 mi).

FM Reception

The shorter wavelengths of the higher frequency FM band:

- Reflect off obstacles
- Are absorbed by the ground
- Penetrate the ionosphere

Broadcasts in the FM band are limited to "line of sight" reception which is typically 40 km (25 mi). Even when out of a direct line of sight, the signal may be reflected into areas that would be in a "shadow" otherwise. Factors which affect the line of sight include:

- Height of the broadcast antenna
- Height of the receiving antenna
- Terrain and buildings in the broadcast path

Customer Tips

Radio Reception FM

- The Best FM fidelity will be obtained from stations within 16-64 km (10-40 mile) range. Noise or distortion may become apparent when attempting to receive stations at distances greater than this range. *Suggestion:* Reduce treble response when attempting to receive fringe stations.
- Tall buildings or hills may cause a degraded or lost signal. FM signals tend to travel "line of sight". *Suggestion:* Reduce treble response around tall buildings.
- Although receiver circuits are among the most advanced type available, there are instances where one radio station can interfere with another station. *Suggestion:* Select another station or switch to a CD.

Radio Reception AM

AM reception is sensitive to storm disturbances such as lightning. *Suggestion:* Reduce treble response or switch to FM.

Care of Compact Discs

- Handle compact discs (CDs) carefully. Touch only the outer edges of the CD or the edge of the hole in the center of the CD. Never touch the glossy side of the CD. Fingerprints and scratches will interrupt the "reading" of the information on the disc.
- Store CDs in their protective cases. Store CDs away from sunlight, dirt, dust, and debris.
- Do not attach a label or tape to a CD.
- Always check for scratches and signs of wear on both sides of the CD.
- Never place any marks on the CD with a marker.
- If a CD becomes contaminated, clean it with a clean, damp, soft, lint-free cloth and mild detergent. Wipe the CD in a straight line from the center hole outward. Do not use cleaning solutions which may damage the CD, such as chemically treated cleaning cloths, benzene, or paint thinners.

Compact Discs Not Appropriate to Use

These CD players were designed to be compatible with round digital audio CDs with the "Compact Disc Digital Audio" label. Other CDs may be incompatible, causing a no-play condition, skips more than the customer would desire, and "ERR" shown on the radio display or a jam in the loading mechanism. Some incompatible CD types are:

- Special-shaped CDs (any that are not round).
- Re-Writeable CDs (CD-RW type are incompatible).
- Recordable CDs (CD-R type are incompatible, except with Type C or D infotainment units).
- Library CDs (with thick bar code labels).
- CD with User-applied labels.

Technical Information for the MP3/CD Radios (Type B, C or D Infotainment Units)

The Types B, C or D infotainment units will play both standard audio CDs and CD-Rs. The CD-Rs may contain either standard audio (*.cda) or compressed audio (*.mp3). Customers who record their own music CD-Rs should be aware of the following:

- The files can be recorded on a CD-R disc with a maximum capacity of 700 MB.
- The infotainment unit will play only compressed audio files recorded in the *.mp3 format. It also supports playlists that can be made and saved with popular MP3 software (in the *.m3u format). A playlist name must be no more than 32 characters in length. If the name of a playlist is longer than 32 characters, the radio will ignore the playlist.
- The infotainment unit will only play audio from a CD-R, it cannot record audio.
- The infotainment unit will play a mixed mode CD-R/RW (one recorded with both *.cda and *.mp3 files). If a mixed mode CD is inserted in the radio, the radio will assign the standard CD audio to a directory which is listed as ROM audio directory.
- The infotainment unit supports multi-session discs, but only the files from the last session will be played.
- There are a total of 20 directories (folders) allowed on a disc. The file structure can be 0-4 directories deep (a folder within a folder, within a folder, etc). Anything more than 20 directories will be ignored. Each directory may have up to 99 files contained within it. Files not having the *.mp3 extension will not be played, but still count toward the maximum. Anything more than the first 99 files within a directory will be ignored. A single disc may have up to 254 files and directories. Anything beyond the 254 limit will be ignored.
- MP3 files must be written to a CD-R/RW in one of the following industry-standard formats:
  - ISO 9660 Level 1
  - ISO 9660 Level 2
  - Joliet
  - Romeo
- ID3 tag information is displayed by the infotainment unit, if available. The ID3 tag information can either be version 1 or 2. The radio will display the filename, song name, artist name, album name, directory name, and playlist name, etc.

If the customer does not follow these guidelines when recording a CD-R/RW, the disc may not play in the MP3 compatible infotainment units.

Telematics Description and Operation

Available Options

The telematics system is available in three varying option levels, Assist Ultra, Secure and GM Fleetview.

Assist Ultra

Assist Ultra is the highest level of telematics available and has the following functionality/features:

- Air bag deployment notification with Telematics Call Centre assistance.
- Track and recover stolen vehicle.
- Unauthorised entry alert.
- Emergency assistance.
- Remote door unlock.
- Low battery / battery disconnect alert.
- Holden messaging service.
- In vehicle communications, assist rear view mirror.

Secure

Secure is the intermediate level of telematics available and has the following functionality/features:

- Track and recover stolen vehicle.
- Unauthorised entry alert.
- Remote door unlock.
- Low battery alert.

GM Fleetview

GM Fleetview is the basic, fleet customized level of telematics available and has the following functionality/features:

- Track and recover stolen vehicle.
- Remote door unlock.
- Low battery alert.
- Fleet reporting.

These systems consist of the following components:

- Telematics module

- Telematics button assembly (Assist Ultra)
- Microphone (Assist Ultra/Secure)
- Cellular/GPS antenna

This system also interfaces with the factory installed vehicle audio system.

Telematics Module

The telematics module is a 3-watt cellular device that allows the user to communicate data and voice signals over the national cellular network. It is powered by a fused, battery positive, voltage circuit connected through the vehicle wiring to the 3-button assembly (Assist Ultra) and the radio, and attached by means of coax cables to the cellular and navigation antennas. In the event of the battery power not being available, such as after a crash, a flat battery or unauthorised disconnection, an integral Nikel Metal Hydride battery pack provides backup power. Ground for the module is accomplished by means of dedicated circuits that are routed via the body wiring systems to chassis ground points. The module houses 2 modems, one to process global positioning system (GPS) data, and the other for cellular information. Satellites orbiting earth are constantly transmitting signals of their current location, from which the telematics system is able to pinpoint its own location. The navigation antenna receives these GPS signals and provides the data to the telematics module to be processed. The telematics module communicates with the rest of the vehicle through the GMLAN system. The ignition state is determined by the telematics module through GMLAN data system. The telematics module also has the capability of commanding the horn, initiating door lock/unlock and operating the exterior lamps using the GMLAN data system. When a telematics keypress is made, the GMLAN system sends a message, which is sent to the audio system to mute all radio functions and transmit telematics originated audio. After the audio system is muted, the telematics signals are transmitted to the audio system on the cellular telephone voice signal circuit, and returned to the module on the cellular telephone voice low reference circuit. The cellular modem connects the telematics system to the cellular carrier's communication system by interacting with the national cellular infrastructure. The module sends and receives all cellular communications over the cellular antenna and cellular antenna coax.

Telematics Button Assembly (Assist Ultra)

The telematics button assembly is located in the rearview mirror. The button assembly comprises of 3 buttons and a status LED. The buttons are defined as follows:

- The information/end call button, which is black with a white telephone symbol allows the user to answer and end calls.
- The blue Telematics Call Centre button, which displays the Holden Assist logo, allows the user to connect to the Telematics Call Centre.
- The emergency button, which is a white cross on a red background, sends a high priority emergency call to the Telematics Call Centre when pressed.

If any button is pressed for more than 10 seconds the "Button Stuck" DTC will be set. In the event of multiple button presses at the same time, the telematics module will accept the higher ranked button. Button ranking is as follows:

1. Emergency.
2. Holden Assist.
3. Information/end call.

Status Light and Beep

The telematics system also has audible and visual displays to notify the user of system status, they are as follows:

- Flashing green light: call is in progress.
- Steady green light: system is on and self-test has been successfully completed.
- Steady red light: system is ON, however a malfunction has been detected and should be checked by a Holden dealer.
- Steady orange light: car is not within coverage area. This is emphasised by 5 beeps when turning the ignition OFF, to highlight the message to the driver that they are about to leave the car in a 'shadow' location which is untraceable. In an area, such as the basement of a car park, another car park space may be a better option.
- When turning the ignition ON, if the red and green lights flash for 30 seconds accompanied by 5 audible beeps: the telematics system is in service mode. Varying modes can be selected using a scan tool, refer to Communication Interface Module Mode Selection.

Telematics Microphone (Assist Ultra / Secure)

Assist Ultra

The telematics microphone is a cellular device that allows the user to communicate data and voice signals over the national cellular network. It is powered by a fused, battery positive, voltage circuit connected to the telematics button assembly where it is located and interfaces directly with the Infotainment unit. The telematics microphone is not connected to the GMLAN system. When a telematics button keypress is made, a serial data message is sent to the infotainment unit to mute all radio functions and transmit cellular telephone originated audio. After the audio system is muted, the cellular telephone signals are transmitted to the audio system on the cellular telephone voice signal circuit, and returned to the module on the cellular telephone voice low reference circuit.

Secure

The telematics microphone is a cellular device that allows the user to communicate data and voice signals over the national cellular network. It is located in the passenger side of the overhead console, is powered directly by the telematics module which interfaces with the Infotainment unit. The telematics microphone is not connected to the GMLAN system. In the event of the Telematics Call Centre communicating with the user a serial data message is sent to the infotainment to mute all radio functions and transmit cellular telephone originated audio.

Cellular and Navigation Antennas

This vehicle will be equipped with the following types of antenna:

A combination cellular and navigation antenna, which brings the functions of both into a single part.

The cellular antenna is the component that allows the telematics system to send and receive data over airwaves by means of cellular technology. This antenna is connected at the base to a coax cable that plugs directly into the telematics module. The navigation antenna is used to collect the constant signals of the orbiting satellites. A low noise amplifier is housed within the antenna, that allows for a broad and precise reception of this data. The current global positioning system (GPS) location is collected by the module every time a keypress is made. The Telematics Call Centre also has the capability of pinging the vehicle during a telematics call, which commands the module to retrieve the latest GPS location and transmit it to the Telematics Call Centre. A history location of the last recorded position of the vehicle is also stored in the module. In the event the telematics module loses power, or is removed from power, this history location is used by the Telematics Call Centre as a default. Actual GPS location may take up to 10 minutes to register in the event of a loss of power. This antenna requires a clear and unobstructed path to the satellites in the sky. Window tinting on vehicles may interfere with the GPS sensor functions, depending upon the location of the GPS antenna and the amount of darkening and/or metallic particles that are embedded in the film of the tinting material.

Telematics Sleep Cycle

The telematics system uses a digital system to allow the system to receive cellular calls while the ignition is in the OFF position. This cycle enables the telematics module to perform remote functions, such as door unlock, as commanded over the air by the Telematics Call Centre, when requested by the customer, and to continue to maintain an acceptable level of battery electrical drain.

The telematics system uses the following 3 power modes when the vehicle is turned off:

- High Power
- Digital Stand by
- Sleep

The high power state is in effect whenever the ignition is in the ON or RUN position, and enables the telematics system to send and receive cellular calls and perform all remote functions. The digital stand by power state is in effect after the vehicle has been shut off and the retained accessory power (RAP) has timed out. When in digital stand by mode, the telematics module is able to perform all remote functions as commanded by a telematics advisor at any time, for a continuous 8 hours. After 8 hours, the telematics module will follow the standard sleep state of 9 minutes off, 1 minute of digital stand by, based on the time of the GPS signals.

In the event the telematics system loses, or is temporarily removed from battery power, the system will remain in the sleep state while the key is in the OFF position. It will not begin to cycle until the vehicle passes into an open outside area with the ignition ON, where a global positioning system (GPS) signal can be acquired, providing a reference for time. The Telematics Call Centre is able to maintain a record of exactly what time each vehicle will enter the one minute low power state by synchronizing their clocks with those of the vehicle, based on GPS signals.

Deactivated Telematics Accounts

In the event a customer has not renewed their telematics account after expiration or the account was never activated, telematics will make a discrete cellular call to the vehicle to deactivate the telematics system. Before taking this action, customers are notified that the telematics system in their vehicle will be deactivated unless they elect to renew the account. After the vehicle has been successfully deactivated, customers will experience the following when attempting to contact telematics from their vehicle:

- During a Telematics Call Centre button press, the customer will be connected to a dedicated sales team who can sell a telematics subscription and reactivate the vehicle. Depending on the type of telematics hardware in the vehicle, the customer may first hear a demonstration message stating there is no current telematics subscription for the vehicle, and directing the customer what to do to activate services.

- During an emergency button press, a demo message will be played indicating the service has been deactivated.

It is of particular note, that when a telematics system is successfully deactivated, it will NOT attempt to connect to the Telematics Call Centre in the event of a collision or if the vehicles front air bags deploy for any other reason.

Certain vehicles that have never had an active telematics account, that have been deactivated, may be unable to establish a connection with the Telematics Call Centre. When normal published diagnostic procedures do not indicate a possible cause for the no connect concern, the vehicle may have been deactivated. For deactivated vehicles, a no connect response should be considered normal operation. Further diagnosis and subsequent repair is only necessary should the customer elect to become an active telematics subscriber.

Video Entertainment System Description and Operation (SWBRHD)

Display Screen

The rear display screen shows video from either DVD movies, or an AUX input device, such as a video game console or camera. The display screen will turn on when pulled down, and automatically turn off when pushed up and closed. Each video screen has a dedicated video signal circuit to the radio.

AUX Inputs

The auxiliary input jack, located in the DVD control panel in the roof pod, contains the socket for the 3.5 mm type AV auxiliary input plug. A number of devices may be plugged into the AUX jacks, including, but not limited to video game consoles, digital cameras, camcorders, or other devices. Audio only devices can also be played through the 3.5 mm auxiliary jack.

3.5 mm type AV cables are needed to connect the auxiliary device to the Auxiliary Input jacks. Refer to the manufacturers instructions for proper connection of your auxiliary device.

To use the auxiliary inputs on the DVD player, connect an external auxiliary device to the 3.5 mm auxiliary input jack and turn both the auxiliary input jack and DVD player power on. If the DVD player was previously in the DVD player mode, you will need to press the MODE button on the DVD player or the DVD remote control. The display will appear on the Video Screen. Pressing the MODE button will toggle the Rear Entertainment between the auxiliary device and the DVD player.

The auxiliary input video format is preset to NTSC. In some cases, the video format may be in PAL system. The DVD player will detect the video format and set the Video Screen automatically.

Rear Seat Entertainment (RSE) (Type D Infotainment System)

The rear seat entertainment (RSE) is integrated into the rear HVAC control module. Audio, video source and speaker control are controlled by the amplifier and infotainment unit through serial data communication. The rear seat entertainment (RSE) system includes an RSE interface module, a DVD player, a video display screen, a DVD control panel, 2 wireless headphones, and a remote control.

Wireless Headphones (Type D Infotainment System)

Wireless headphones are optional and allow for rear seat passengers to use the rear seat entertainment (RSE) functions without disturbing the listening of front seat passengers. The wireless headphones receive audio signals from the infrared (IR) transmitters on the overhead console. This transmission is line of sight only, so audio quality will be degraded if anything blocks the transmitter signal from reaching the headphones.

To use wireless headphones, turn them on using the power button on the headphone earpiece. Adjust volume using the rotary dial.

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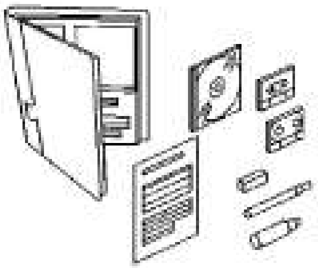
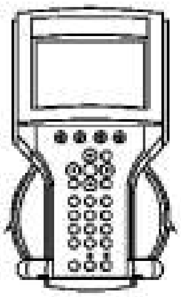
Document ID: 1990014

Special Tools

Illustration	Tool Number / Description
	J 39916-A CD and Cassette Diagnostic Audio Kit
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

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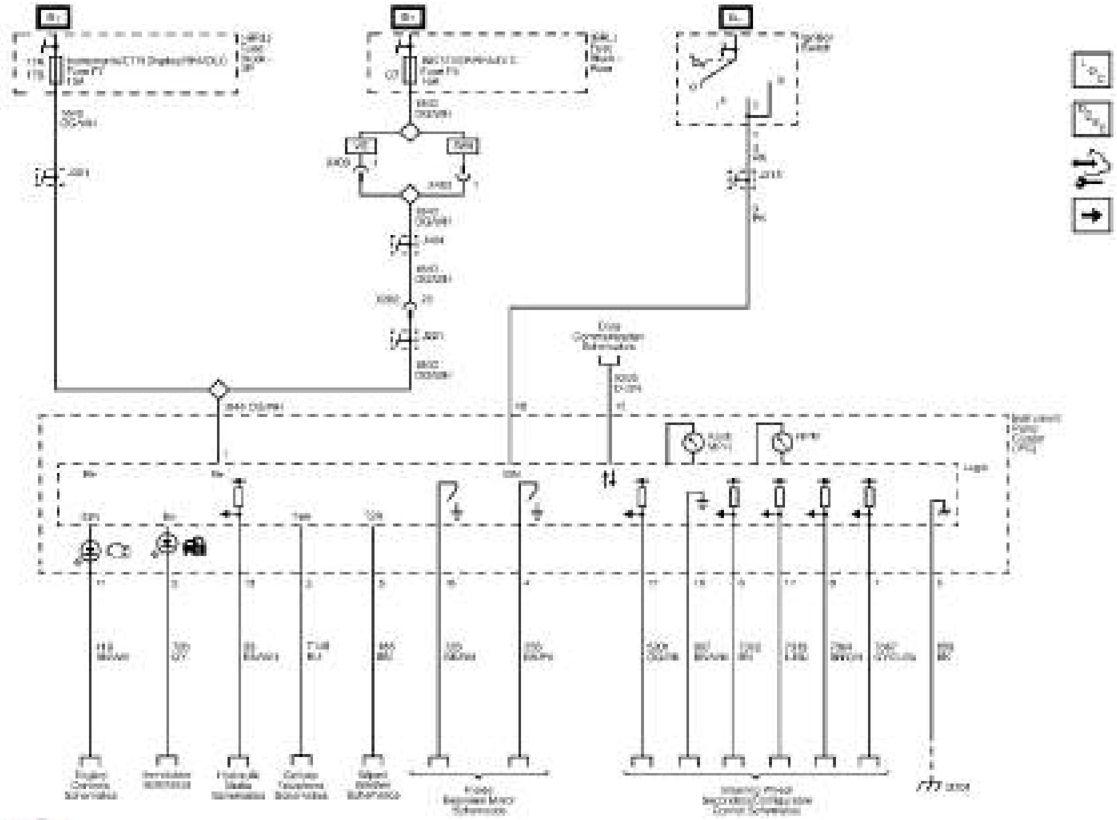
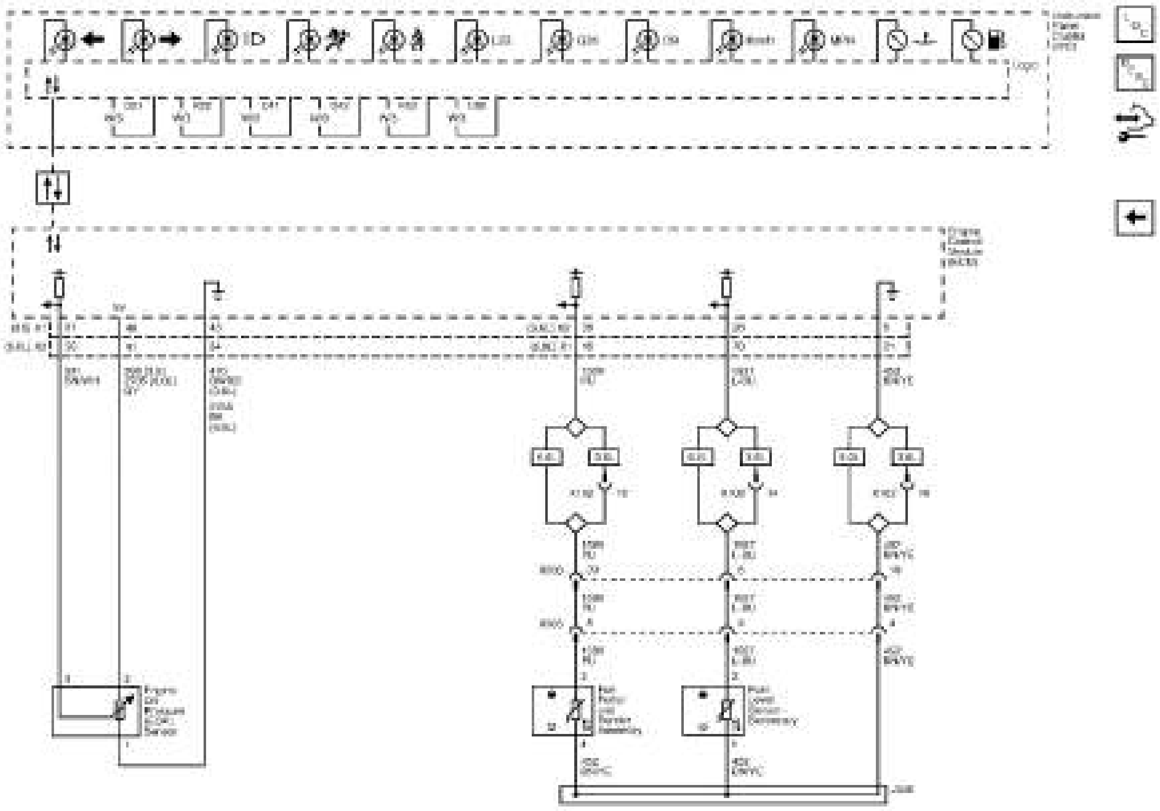
Document ID: 2153519

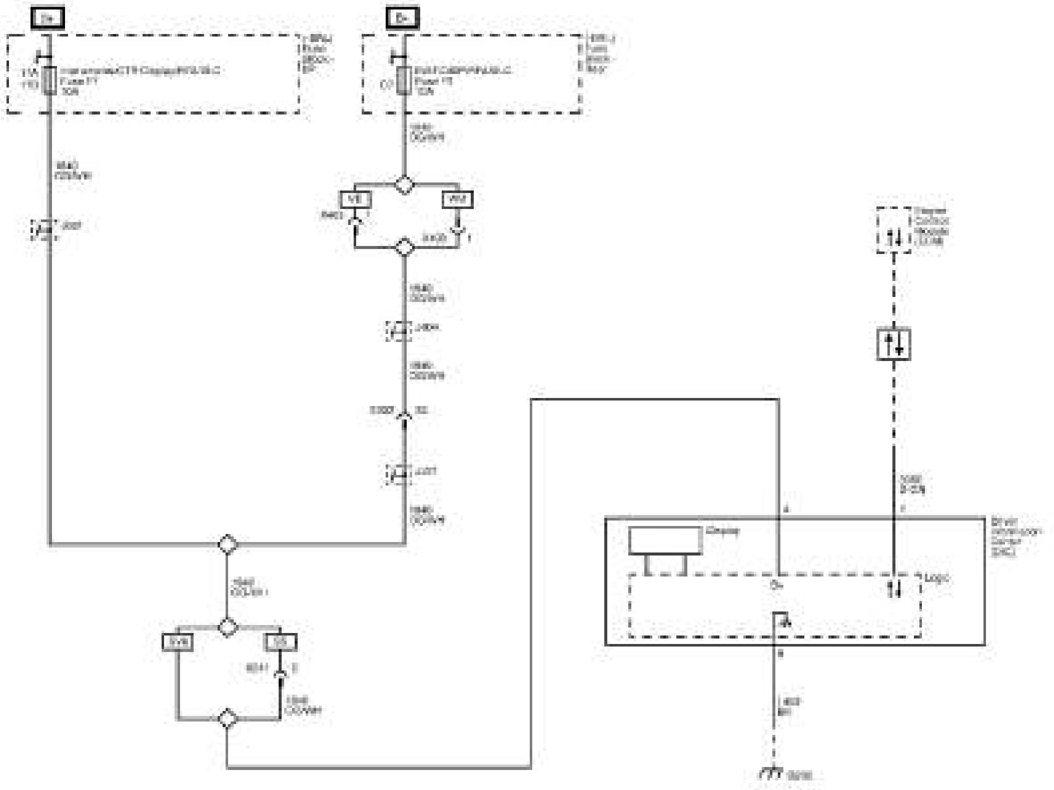
Power, Ground, and System References



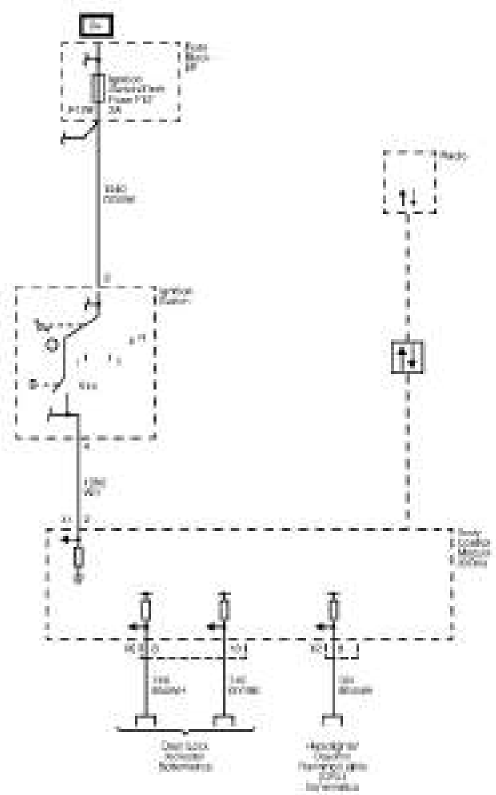
Indicators and Gages


Instrument Panel Cluster (IPC)
Logic
Engine Control Module (ECM)
5V
Engine Oil Pressure (EOP) Sensor

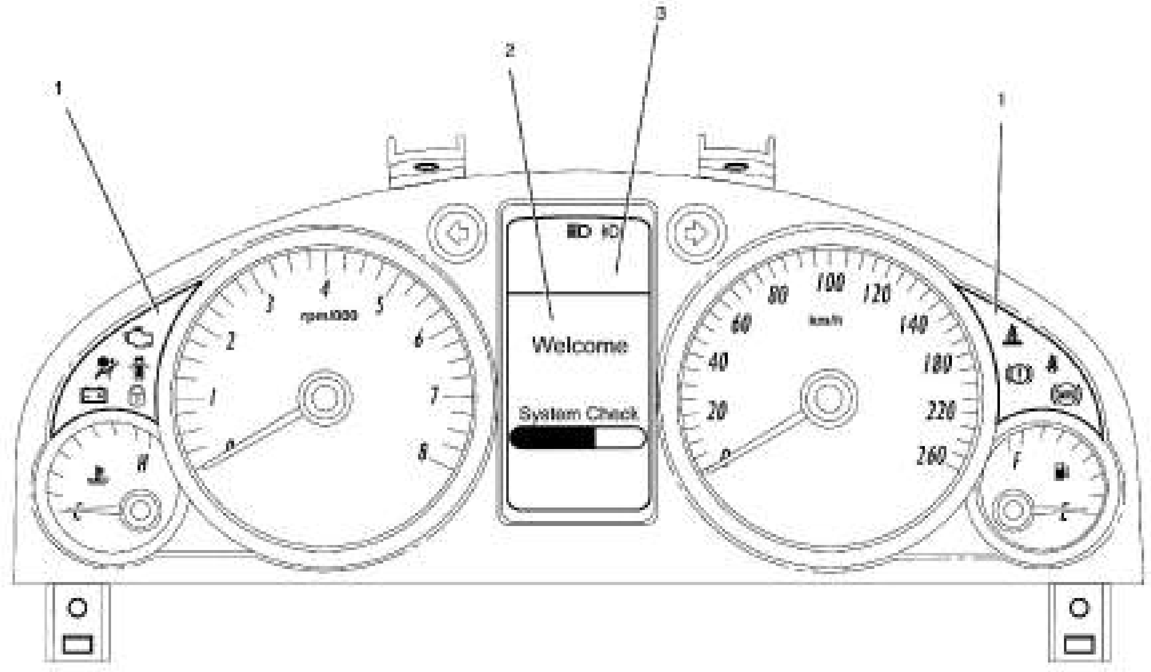
Driver Information System Schematics


B+
B+
VE
WM
Display
Logic
Driver Information Center (DIC)

Audible Warnings Schematics

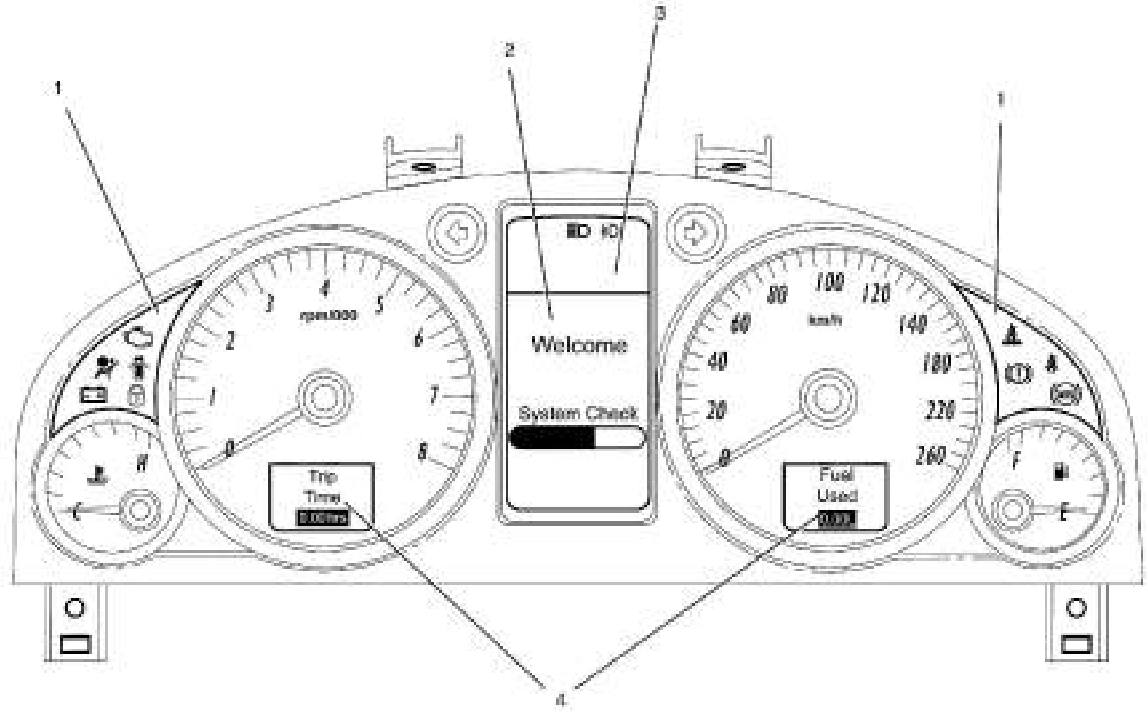


Type A - Instrument Cluster


1
2
3
1
rpmx1000
0
1
2
3
4
5
6
7
8
Welcome
System Check
km/h
0
20
40
60
80
100
120
140
180
220
260
C
H
F
E

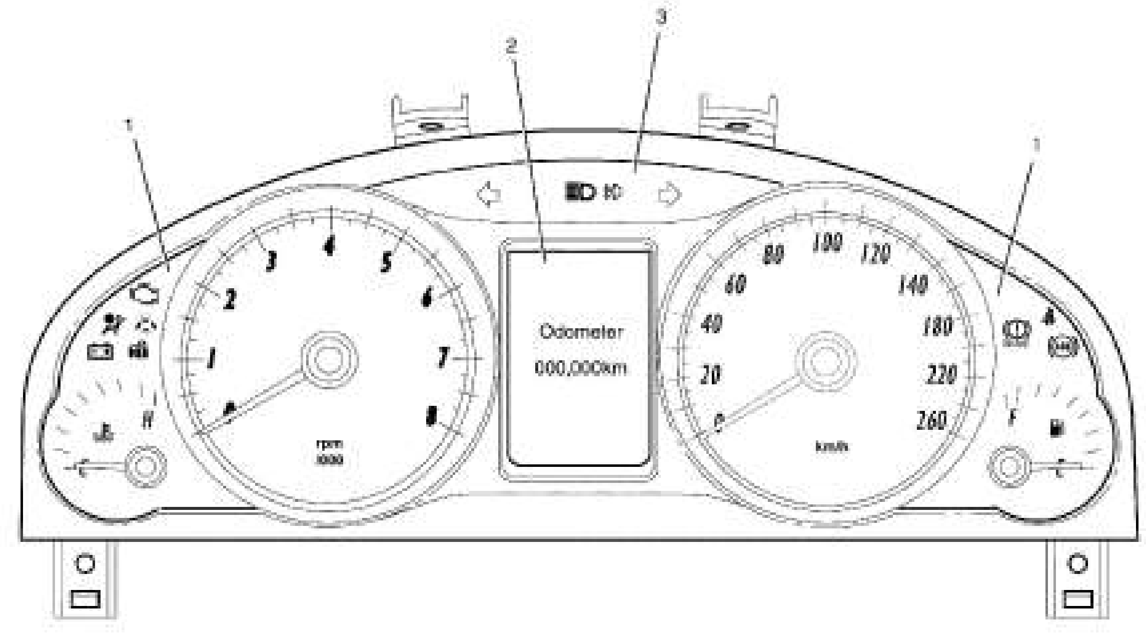
(1) Warning Indicators
(2) High Beam Headlamp Indicator
(3) Driver Information Center (DIC)

Type B - Instrument Cluster


1
2
3
1
Welcome
System Check
rpm/1000
km/h
Trip
Time
Fuel
Used
4

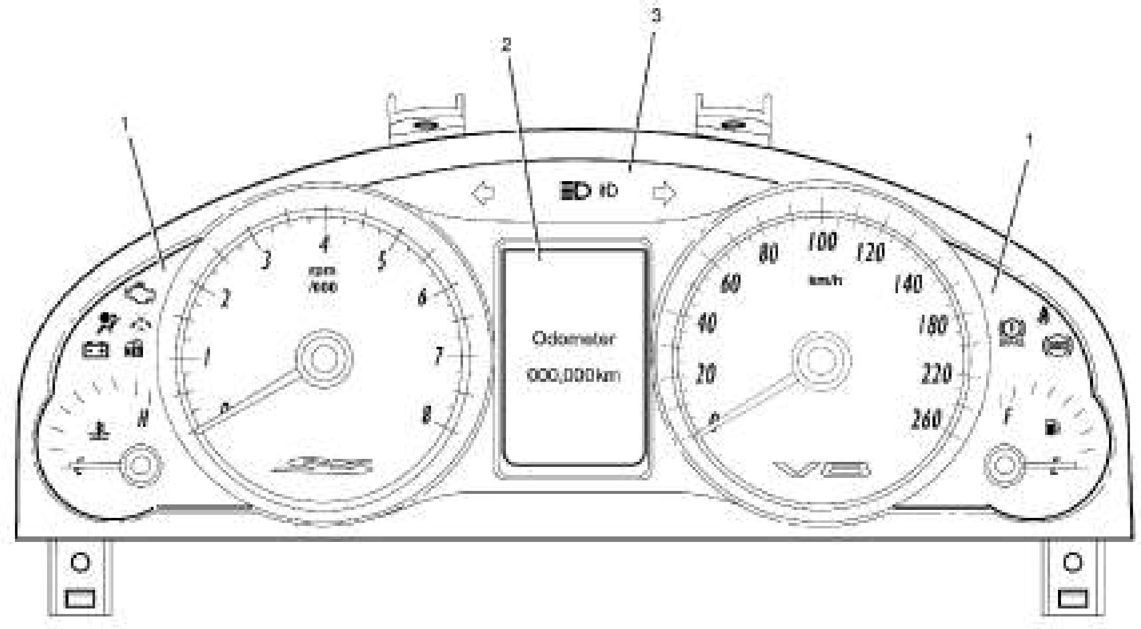
(1) Warning Indicators
(2) Driver Information Center (DIC)
(3) High Beam Headlamp Indicator
(4) Secondary Driver Information Screens

Type C - Instrument Cluster


1
2
3
1
1
2
3
4
5
6
7
8
rpm
1000
Odometer
000,000km
0
20
40
60
80
100
120
140
180
220
260
km/h
H
F

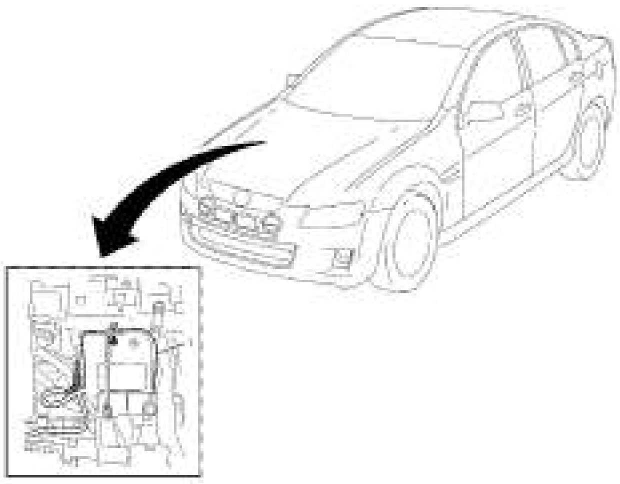
(1) Warning Indicators
(2) Driver Information Center (DIC)
(3) High Beam Headlamp Indicator
(4) Secondary Driver Information Screens

Type D - Instrument Cluster


3
2
1
1
4
3
5
2
rpm
/1000
6
1
7
0
8
H
Odometer
000,000km
80
100
120
60
km/h
140
40
180
20
220
0
260
F
V8

(1) Warning Indicators
(2) Driver Information Center (DIC)
(3) High Beam Headlamp Indicator
(4) Secondary Driver Information Screens

Police Pack Component Views



(1) Vehicle Speed Interface Module (VSIM)

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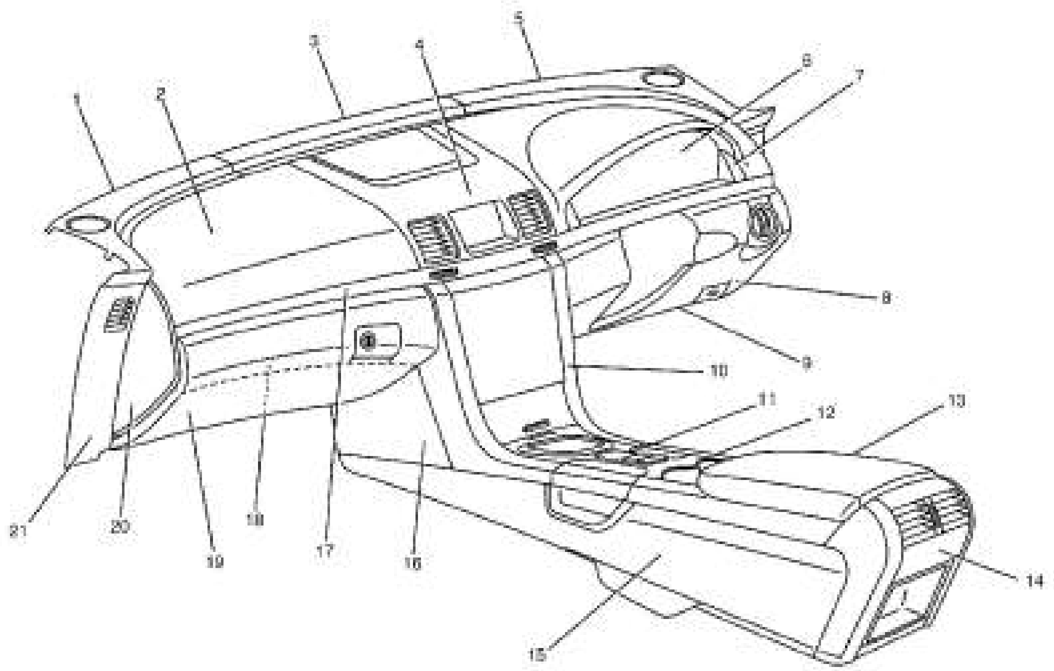
Type A



(1) Defroster Grille (Left)
(2) Trim Pad - Instrument Panel Upper
(3) Defroster Grille (Centre)
(4) Trim Panel - Instrument Panel Upper
(5) Defroster Grille (Right)
(6) Instrument Cluster
(7) Instrument Cluster Trim Panel
(8) Instrument Panel Outer Trim Cover (Right)
(9) Knee Bolster
(10) Trim Panel - Instrument Panel Center
(11) Trim Plate - Console
(12) Centre Console
(13) Armrest Assembly
(14) End Panel
(15) Trim Plate - Console Side
(16) Instrument Panel Extension
(17) Instrument Panel Trim Panel
(18) Compartment - Instrument Panel

(19) Insulator Close Out Panel
(20) Instrument Panel Outer Trim Cover (Left)
(21) Centre A - Pillar Ventilation Trim Panel

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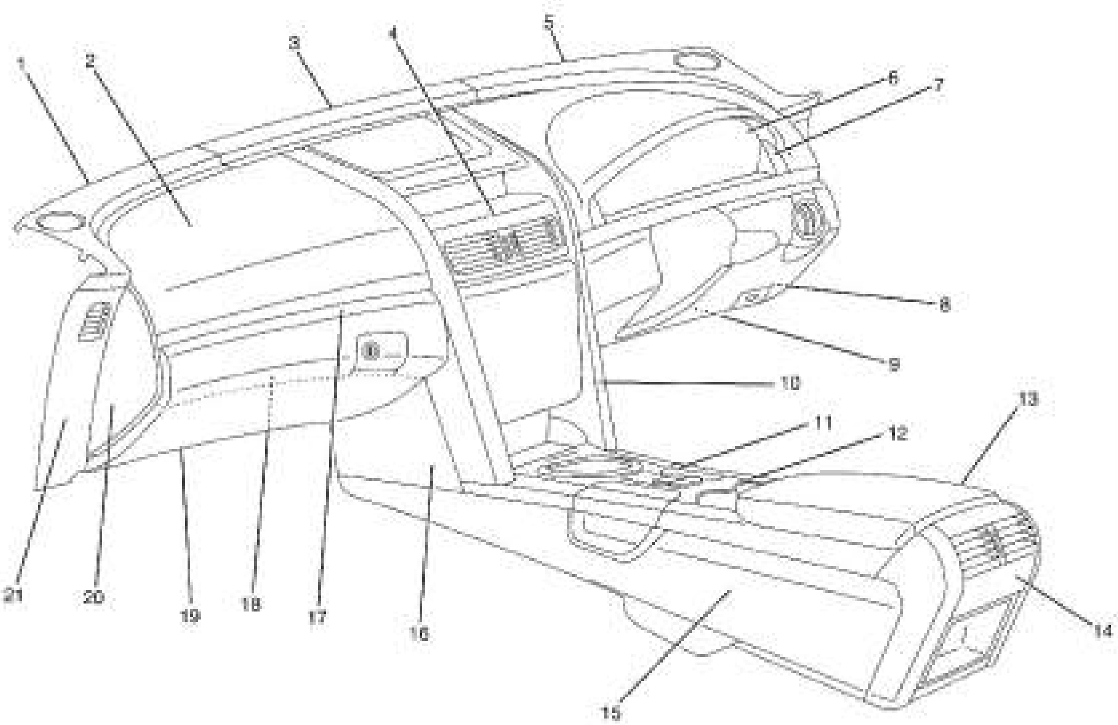
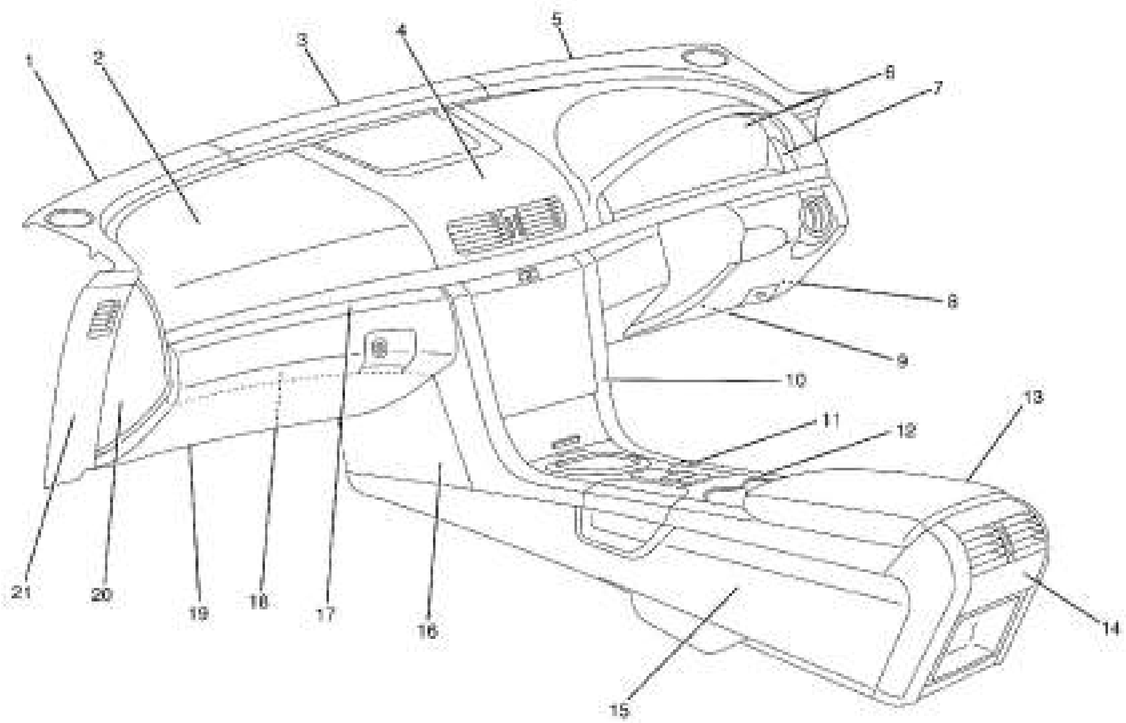
Type B



(1) Defroster Grille (Left)
(2) Trim Pad - Instrument Panel (Ip) Upper
(3) Defroster Grille (Centre)
(4) Trim Panel - Instrument Panel (I/P) Upper
(5) Defroster Grille (Right)
(6) Instrument Cluster
(7) Instrument Cluster Trim Panel
(8) Instrument Panel Outer Trim Cover (Right)
(9) Knee Bolster
(10) Trim Panel - (I/P) Center
(11) Trim Plate - Console
(12) Centre Console
(13) Armrest Assembly
(14) End Panel
(15) Trim Plate - Console Side
(16) Instrument Panel Extension
(17) Instrument Panel Trim Panel
(18) Compartment - (I/P)

(19) Insulator Close Out Panel
(20) Instrument Panel Outer Trim Cover (Left)
(21) Center A - Pillar Ventilation Trim Panel

Type C



(1) Defroster Grille (Left)
(2) Trim Pad - Instrument Panel (Ip) Upper
(3) Defroster Grille (Centre)
(4) Trim Panel - Instrument Panel (I/P) Upper
(5) Defroster Grille (Right)
(6) Instrument Cluster
(7) Instrument Cluster Trim Panel
(8) Instrument Panel Outer Trim Cover (Right)
(9) Knee Bolster
(10) Trim Panel - (I/P) Center
(11) Trim Plate - Console
(12) Centre Console
(13) Armrest Assembly
(14) End Panel
(15) Trim Plate - Console Side
(16) Instrument Panel Extension
(17) Instrument Panel Trim Panel
(18) Compartment - (I/P)

(19) Insulator Close Out Panel
(20) Instrument Panel Outer Trim Cover (Left)
(21) Center A - Pillar Ventilation Trim Panel

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Document ID: 2168661

DTC B1024

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC B1024 00: Printed Circuit Board (PCB) Temperature Sensor Fault

Circuit/System Description

When the "Service Error/Contact Dealer" indicator illuminates in the DIC, it indicates a fault in the instrument panel cluster (IPC). The "Service Error/Contact Dealer" indicator is displayed until you press the TRIP/RESET switch. The indicator symbol then reverts to the original trip computer display.

"X Service" appears at the bottom of the DIC and remains illuminated until the problem has been rectified.

Conditions for Running DTC

- System voltage is between 9-16 volts.
- Ignition switch is in the ON position.

Conditions for Setting the DTC

- The instrument panel cluster (IPC) operating temperature is below 40 °C or above 85°C
- The IPC has a shorted or open circuit.
- The IPC internal temperature has exceeded the specified operating range.

Action Taken When the DTC Sets

The IPC shuts down or fails to display the correct information.

Conditions for Clearing the DTC

- The DTC becomes history when the condition for setting the DTC is no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition ON, with the scan tool, verify that DTC B1024 is not set.
   If DTC B1024 is set as current, attempt to re-calibrate the IPC.
2. Clear all DTCs using the scan tool, verify that DTC B1024 does not reset.
   If the DTC B1024 is set as current, replace the IPC.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for IPC replacement, setup, and programming

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Document ID: 2157560

DTC P0461

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0461: Fuel Level Sensor 1 Performance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Fuel Level Sensor 1 Signal	P0462	1	P0463	P0463	P0461
Fuel Level Sensor 2 Signal	P2067	1	P2068	P2068	P2066
Fuel Level Sensor Low Reference	--	1	P0463, P2068	P0463, P2068	P0461, P2066
1. Fuel Gage Inaccurate or Inoperative					

Circuit/System Description

The primary fuel level sender and the secondary fuel level sender changes resistance based on fuel level. The engine control module (ECM) monitors the signal circuits of the primary fuel level sender and the secondary fuel level sender in order to determine the fuel level. When the fuel tank is full, the resistances of both fuel level senders are low and the ECM senses a low signal voltage on both the signal circuits of the primary fuel level sender and the secondary fuel level sender. When the fuel tanks are empty, the resistances of the fuel level senders are high and the ECM senses a high signal voltage. The ECM uses the signal circuits of the primary fuel level sender and the secondary fuel level sender in order to calculate the percentage of remaining fuel in the tank. The ECM sends the fuel level percentage via serial data circuit to the instrument cluster in order to control the fuel gage.

Conditions for Running the DTC

- The engine is running.
- No fuel level sensor signal failure present.
- The system voltage is between 10-18 volts.

Conditions for Setting the DTC

- The ECM does not detect a change in fuel level in the primary fuel tank of at least 45 percent over a distance of 120 km (75 miles).
- The above condition is present for about 30 seconds.

Action Taken When the DTC Sets

- The fuel gage defaults to empty.
- The low fuel indicator illuminates.
- The ECM records the operating conditions at the time that the diagnostic test fails. The ECM displays the failure information in the Failure Records on the scan tool.

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

Reference Information

Schematic Reference

Instrument Cluster Schematics.

Connector End View Reference

Component Connector End Views

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Component Testing

1. Ignition OFF, remove the primary fuel level sender and verify there are no obstructions interfering with the fuel level sender.

   If any interference is present, repair the fuel sender interference.

2. Ignition OFF, disconnect the harness connector at the fuel level sensor.
3. While sweeping the primary fuel level sensor through its full range of motion, test for a minimum value less than 41 ohms and a maximum value greater than 119 ohms between signal terminal 2 and the low reference terminal 4.

   If not within the specified range, replace the fuel level sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Primary Fuel Level Sensor Replacement
- Control Module References for ECM replacement, setup, and programming

DTC P0462

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0462: Fuel Level Sensor 1 Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Fuel Level Sensor 1 Signal	P0462	1	P0463	P0463	P0461
Fuel Level Sensor 2 Signal	P2067	1	P2068	P2068	P2066
Fuel Level Sensor Low Reference	--	1	P0463 P2068	P0463 P2068	P0461 P2066
1. Fuel Gage Inaccurate or Inoperative					

Circuit/System Description

The primary fuel level sender and the secondary fuel level sender changes resistance based on fuel level. The engine control module (ECM) monitors the signal circuits of the primary fuel level sender and the secondary fuel level sender in order to determine the fuel level. When the fuel tank is full, the resistances of both fuel level senders are low and the ECM senses a low signal voltage on both the signal circuits of the primary fuel level sender and the secondary fuel level sender. When the fuel tanks are empty, the resistances of the fuel level senders are high and the ECM senses a high signal voltage. The ECM uses the signal circuits of the primary fuel level sender and the secondary fuel level sender in order to calculate the percentage of remaining fuel in the tank. The ECM sends the fuel level percentage via serial data circuit to the instrument cluster in order to control the fuel gage.

Conditions for Running the DTC

- The ignition is ON, with the engine running.
- The system voltage is between 10-18 volts.

Conditions for Setting the DTC

- The primary fuel level signal is about 0.25 volt.
- The above condition is present for about 60 seconds.

Action Taken When the DTC Sets

- The fuel gage defaults to empty.
- The low fuel indicator displays in the IPC.
- The ECM records the operating conditions at the time that the diagnostic test fails. The ECM displays the failure information in the Failure Records on the scan tool.

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Fuel Level Sensor parameter. The reading should be between 0.9 - 2.5 volts.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the primary fuel level sensor.
2. Ignition ON, verify that the scan tool Fuel Level Sensor Right Tank parameter is greater than 4.5 volts.

   If less than the specified range, test the primary signal circuit terminal 2 for a short to ground. If the circuit tests normal, replace the ECM.
3. If all circuits test normal, perform the fuel level sensor component test before replacing the primary fuel level sensor.

Component Testing

1. Ignition OFF, remove the primary fuel level sender.
2. While sweeping the primary fuel level sensor through its full range of motion, test for a minimum value less than 41 ohms and a maximum value greater than 119 ohms between signal terminal 2 and the low reference terminal 4.

   If not within the specified range, replace the primary fuel level sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Primary Fuel Level Sensor Replacement
- Control Module References for the ECM replacement, setup, and programming

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DTC P0463

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0463: Fuel Level Sensor 1 High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Fuel Level Sensor 1 Signal	P0462	1	P0463	P0463	P0461
Fuel Level Sensor 2 Signal	P2067	1	P2068	P2068	P2066
Fuel Level Sensor Low Reference	--	1	P0463 P2068	P0463 P2068	P0461 P2066
1. Fuel Gage Inaccurate or Inoperative					

Circuit/System Description

The primary fuel level sender and the secondary fuel level sender changes resistance based on fuel level. The engine control module (ECM) monitors the signal circuits of the primary fuel level sender and the secondary fuel level sender in order to determine the fuel level. When the fuel tank is full, the resistances of both fuel level senders are low and the ECM senses a low signal voltage on both the signal circuits of the primary fuel level sender and the secondary fuel level sender. When the fuel tanks are empty, the resistances of the fuel level senders are high and the ECM senses a high signal voltage. The ECM uses the signal circuits of the primary fuel level sender and the secondary fuel level sender in order to calculate the percentage of remaining fuel in the tank. The ECM sends the fuel level percentage via serial data circuit to the instrument cluster in order to control the fuel gage.

Conditions for Running the DTC

- The engine is running.
- The system voltage is between 10-18 volts.

Conditions for Setting the DTC

- The primary fuel level signal is about 3.2 volts.
- The above condition is present for about 60 seconds.

Action Taken When the DTC Sets

- The fuel gage defaults to empty.
- The low fuel indicator illuminates.
- The ECM records the operating conditions at the time that the diagnostic test fails. The ECM displays the failure information in the Failure Records on the scan tool.

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Fuel Level Sensor parameter. The reading should be between 0.9 - 2.5 volts.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the primary fuel level sensor.
2. Ignition OFF, test for less than 1 ohm between the low reference circuit terminal 4 and ground.

   If greater than the specified range, test the low reference circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, install a 3A fused jumper between the primary signal circuit terminal 2 and the low reference circuit terminal 4. Verify the scan tool Fuel Level Sensor Right Tank parameter is less than 0.4 volts.

   If greater than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
4. If all circuits test normal, perform the fuel level sensor component test before replacing the primary fuel level sensor.

Component Testing

1. Ignition OFF, remove the primary fuel level sensor.
2. While sweeping the primary fuel level sensor through its full range of motion, test for a minimum value less than 41 ohms and a maximum value greater than 119 ohms between signal terminal 2 and the low reference terminal 4.

   If not within the specified range, replace the primary fuel level sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Primary Fuel Level Sensor Replacement
- Control Module References for the ECM replacement, setup, and programming

DTC P0521, P0522, or P0523

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0521: Engine Oil Pressure (EOP) Sensor Performance

DTC P0522: Engine Oil Pressure (EOP) Sensor Circuit Low Voltage.

DTC P0523: Engine Oil Pressure (EOP) Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Engine Oil Pressure 5-Volt Reference	P0522	1	P0522	P0523	P0521
Engine Oil Pressure Sensor Signal	P0522	1	P0522	P0523	P0521
Low Reference	--	1	P0523	--	P0521
1. Engine Oil Pressure Gage Inaccurate or Inoperative.					

Circuit/System Description

The engine oil pressure (EOP) sensor changes voltage based on the engine oil pressure. The EOP sensor is a 3-wire sensor comprising of the signal circuit, the low reference circuit and the 5-volt reference circuit. The engine control module (ECM) supplies 5 volts to the EOP sensor via the 5-volt reference circuit and provides ground via the EOP low reference circuit. The ECM monitors the signal circuit of the EOP sensor to determine the engine oil pressure sensor voltage is within the normal operating range of approximately 1-4 volts. When the engine oil pressure is high, the EOP sensor voltage is high and the ECM senses a high signal voltage. When the engine oil pressure is low, the EOP sensor voltage is low and the ECM senses a low signal voltage. The ECM sends the EOP information to the instrument panel cluster (IPC) via the serial data circuit.

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

P0521

- The engine oil pressure is greater than 880 kPa (127.6 psi) and the engine speed is less than 640 RPM.
- The engine oil pressure is less than 8 kPa (1.16 psi) with the engine speed greater than 1520 RPM, engine oil temperature is between 80°C (176°F) and 110°C (230°F).
- The above condition is present is present for greater than 4 seconds.

P0522

- The ECM detects that the EOP sensor signal circuit is less than 0.2 volt with the engine oil temperature range is between 80°C (176°F) and 110°C (230°F).
- The above condition is present for greater than 10 seconds.

P0523

- The ECM detects that the EOP sensor signal circuit is greater than 4.8 volts with the engine oil temperature range is between 80°C (176°F) and 110°C (230°F).
- The above condition is present for greater than 10 seconds.

Action Taken When the DTC Sets

- The ECM records the operating conditions at the time the diagnostics test fails. The ECM displays this information in the Failure Records on the scan tool.
- The IPC illuminates the EOP indicator.

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

- Indicator/Warning Message Description and Operation
- Instrument Cluster Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, observe the scan tool Engine Oil Pressure Sensor parameter. The reading should be between 0.2-4.8 volts.
2. Verify the engine oil pressure, refer to Oil Pressure Diagnosis and Testing for the 3.6L engine or Oil Pressure Diagnosis and Testing for the 4.8L, 5.3L, and 6.0L engines.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the engine oil pressure (EOP) sensor.
2. Ignition OFF, test for less than 1 ohm between the low reference circuit terminal 1 and ground.

   If greater than the specified range, test the circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8-5.2 volts between the 5-volt reference circuit terminal 2 and ground.

   If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

   If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Verify the scan tool Engine Oil Pressure Sensor parameter is less than 0.2 volt.

   If greater than the specified range, test the signal circuit terminal 3 for a short to voltage. If the circuit tests normal, replace the ECM.
5. Install a 3A fused jumper wire between the signal circuit terminal 3 and the 5-volt reference circuit terminal 2. Verify the scan tool Engine Oil Pressure Sensor parameter is greater than 4.8 volts.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
6. If all circuits test normal, test or replace the EOP sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Engine Oil Pressure Sensor and/or Switch Replacement for 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engines
- Engine Oil Pressure Sensor and/or Switch Replacement for 3.6L engine
- Control Module References for ECM replacement, setup and programming

DTC P2066

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P2066: Fuel Level Sensor 2 Performance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Fuel Level Sensor 1 Signal	P0462	1	P0463	P0463	P0461
Fuel Level Sensor 2 Signal	P2067	1	P2068	P2068	P2066
Fuel Level Sensor Low Reference	--	1	P0463, P2068	P0463, P2068	P0461, P2066
1. Fuel Gage Inaccurate or Inoperative					

Circuit / System Description

The primary fuel level sender and the secondary fuel level sender changes resistance based on fuel level. The engine control module (ECM) monitors the signal circuits of the primary fuel level sender and the secondary fuel level sender in order to determine the fuel level. When the fuel tank is full, the resistances of both fuel level senders are low and the ECM senses a low signal voltage on both the signal circuits of the primary fuel level sender and the secondary fuel level sender. When the fuel tanks are empty, the resistances of the fuel level senders are high and the ECM senses a high signal voltage. The ECM uses the signal circuits of the primary fuel level sender and the secondary fuel level sender in order to calculate the percentage of remaining fuel in the tank. The ECM sends the fuel level percentage via serial data circuit to the instrument cluster in order to control the fuel gage.

Conditions for Running the DTC

- The engine is running.
- No fuel level sensor signal failure present.
- The system voltage is between 10-18 volts.

Conditions for Setting the DTC

- The ECM does not detect a change in fuel level in the secondary fuel tank of at least 45 percent over a distance of 120 km (75 miles).
- The above condition is present for about 30 seconds.

Action Taken When the DTC Sets

- The fuel gage defaults to empty.
- The low fuel indicator illuminates.
- The ECM records the operating conditions at the time that the diagnostic test fails. The ECM displays the failure information in the Failure Records on the scan tool.

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

Reference Information

Schematic Reference

Instrument Cluster Schematics.

Connector End View Reference

Component Connector End Views

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Component Testing

1. Ignition OFF, remove the secondary fuel level sender and verify there are no obstructions interfering with the fuel level sender.

   If any interference is present, repair the fuel sender interference.

2. Ignition OFF, disconnect the harness connector at the secondary fuel level sensor.
3. While sweeping the secondary fuel level sensor through its full range of motion, test for a minimum value less than 41 ohms and a maximum value greater than 119 ohms between signal terminal 2 and the low reference terminal 1.

   If not within the specified range, replace the fuel level sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Secondary Fuel Tank Module Replacement
- Control Module References for the ECM replacement, setup, and programming

DTC P2067

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P2067: Fuel Level Sensor 2 Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Fuel Level Sensor 1 Signal	P0462	1	P0463	P0463	P0461
Fuel Level Sensor 2 Signal	P2067	1	P2068	P2068	P2066
Fuel Level Sensor Low Reference	--	1	P0463, P2068	P0463, P2068	P0461, P2066
1. Fuel Gage Inaccurate or Inoperative					

Circuit/System Description

The primary fuel level sender and the secondary fuel level sender changes resistance based on fuel level. The engine control module (ECM) monitors the signal circuits of the primary fuel level sender and the secondary fuel level sender in order to determine the fuel level. When the fuel tank is full, the resistances of both fuel level senders are low and the ECM senses a low signal voltage on both the signal circuits of the primary fuel level sender and the secondary fuel level sender. When the fuel tanks are empty, the resistances of the fuel level senders are high and the ECM senses a high signal voltage. The ECM uses the signal circuits of the primary fuel level sender and the secondary fuel level sender in order to calculate the percentage of remaining fuel in the tank. The ECM sends the fuel level percentage via serial data circuit to the instrument cluster in order to control the fuel gage.

Conditions for Running the DTC

- The engine is running.
- The system voltage is between 10-18 volts.

Conditions for Setting the DTC

- The secondary fuel level sensor signal is less than 0.25 volt.
- The above condition is present for about 60 seconds.

Action Taken When the DTC Sets

- The fuel gage defaults to empty.
- The low fuel indicator illuminates.
- The ECM records the operating conditions at the time that the diagnostic test fails. The ECM displays the failure information in the Failure Records on the scan tool.

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

Reference Information

Schematic Reference

Instrument Cluster Schematics.

Connector End View Reference

Component Connector End Views

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Fuel Level Sensor parameter. The reading should be between 0.9 - 2.5 volts.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the secondary fuel level sensor.
2. Ignition ON, scan tool installed, verify that the scan tool Fuel Level Sensor Left Tank parameter is greater than 4.5 volts.

   If less than the specified range, test the secondary signal circuit terminal 2 for a short to ground. If the circuit tests normal, replace the ECM.
3. If all circuits test normal, perform the fuel level sensor component test before replacing the secondary fuel level sensor.

Component Testing

1. Ignition OFF, remove the secondary fuel level sensor.
2. While sweeping the secondary fuel level sensor through its full range of motion, test for a minimum value less than 41 ohms and a maximum value greater than 119 ohms between signal terminal 2 and the low reference terminal 1.

   If not within the specified range, replace the secondary fuel level sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Secondary Fuel Tank Module Replacement
- Control Module References for the ECM replacement, setup, and programming

DTC P2068

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P2068: Fuel Level Sensor 2 High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Fuel Level Sensor 1 Signal	P0462	1	P0463	P0463	P0461
Fuel Level Sensor 2 Signal	P2067	1	P2068	P2068	P2066
Fuel Level Sensor Low Reference	--	1	P0463, P2068	P0463, P2068	P0461, P2066
1. Fuel Gage Inaccurate or Inoperative					

Circuit/System Description

The primary fuel level sender and the secondary fuel level sender changes resistance based on fuel level. The engine control module (ECM) monitors the signal circuits of the primary fuel level sender and the secondary fuel level sender in order to determine the fuel level. When the fuel tank is full, the resistances of both fuel level senders are low and the ECM senses a low signal voltage on both the signal circuits of the primary fuel level sender and the secondary fuel level sender. When the fuel tanks are empty, the resistances of the fuel level senders are high and the ECM senses a high signal voltage. The ECM uses the signal circuits of the primary fuel level sender and the secondary fuel level sender in order to calculate the percentage of remaining fuel in the tank. The ECM sends the fuel level percentage via serial data circuit to the instrument cluster in order to control the fuel gage.

Conditions for Running the DTC

- The engine is running.
- The system voltage is between 10-18 volts.

Conditions for Setting the DTC

- The secondary fuel level signal is about 3.2 volts.
- The above condition is present for about 60 seconds.

Action Taken When the DTC Sets

- The fuel gage defaults to empty.
- The low fuel indicator illuminates.
- The ECM records the operating conditions at the time that the diagnostic test fails. The ECM displays the failure information in the Failure Records on the scan tool.

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

Reference Information

Schematic Reference

Instrument Cluster Schematics.

Connector End View Reference

Component Connector End Views

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Fuel Level Sensor parameter. The reading should be between 0.9 - 2.5 volts.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the secondary fuel level sensor.
2. Ignition OFF, test for less than 1 ohm between the low reference circuit terminal 1 and ground.

   If greater than the specified range, test the low reference circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, install a 3A fused jumper between the secondary signal circuit terminal 2 and the low reference circuit terminal 1. Verify the scan tool Fuel Level Sensor Left Tank parameter is less than 0.4 volt.

   If greater than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
4. If all circuits test normal, perform the fuel level sensor component test before replacing the secondary fuel level sensor.

Component Testing

1. Ignition OFF, remove the secondary fuel level sensor.
2. While sweeping the secondary fuel level sensor through its full range of motion, test for a minimum value less than 41 ohms and a maximum value greater than 119 ohms between signal terminal 2 and the low reference terminal 1.

   If not within the specified range, replace the secondary fuel level sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Secondary Fuel Tank Module Replacement
- Control Module References for the ECM replacement, setup, and programming

Charge Indicator Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit / System Description

The engine control module (ECM) uses the generator turn ON signal circuit to control the load of the generator on the engine. A high side driver in the ECM applies voltage to the voltage regulator. This signals the voltage regulator to turn the field circuit ON and OFF. The ECM monitors the state of the generator turn ON signal circuit. The ECM should detect low voltage on the generator turn on signal circuit when the ignition is ON and the engine is OFF, or when the charging system malfunctions. With the engine running, the ECM should detect high voltage on the generator turn on signal circuit. The ECM performs key ON and RUN tests to determine the status of the generator turn on signal circuit. If a malfunction is detected the ECM will illuminate the charge indicator in the instrument panel cluster (IPC).

Reference Information

Schematic Reference

- Instrument Cluster Schematics
- Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

- Indicator/Warning Message Description and Operation
- Charging System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, engine running, verify the scan tool Battery Voltage parameter is between 12.5 and 15.5 volts.
   If not within the specified range, refer to Charging System Test.
2. Ignition ON, perform the display test with the scan tool. The charge indicator should turn ON and OFF when changing between the commanded states.
   If the indicator does not turn ON and OFF between commanded states, replace the IPC.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for the BCM, ECM, and IPC replacement, setup, and programming

Chime Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Key In Ignition B+	1	1	--	--
Key In Ignition Signal	1	1	1	--
1. Chime Malfunction				

Circuit/System Description

The radio generates the audible warning through the left speaker. The radio receives audible warning requests via the serial data circuit from the instrument panel cluster (IPC) or the body control module (BCM). The vehicle may be equipped with a chime module. The chime module receives audible warning requests via the serial data circuit. the chime producer is either the radio or the chime module.

Reference Information

Schematic Reference

Audible Warnings Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Audible Warnings Description and Operation

Electrical Information Reference

- Circuit Testing

- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Important: Before performing this diagnostics, make sure no indicators are illuminated after the IPC performs a lamp test. If any indicators are illuminated after the bulb test, perform the indicator diagnostics before this diagnostics.

1. Ignition ON, headlamp switch OFF, verify the scan tool Headlamp Switch parameter is Inactive.
   If not Inactive, refer to Headlamps Malfunction.
2. Ignition ON, doors closed, verify the scan tool Door Ajar Switch parameter is Door Closed.
   If not Door Closed, refer to Courtesy Lamps Malfunction.
3. Verify that the Key In Ignition Cylinder Switch parameter is Key In when the key is in the ignition and Key Out when the key is out of the ignition.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the key in ignition switch.
2. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 2 and ground.
   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition switch fuse is open, test the signal circuit terminal 4 for a short to ground.
3. Verify the BCM scan tool Key In Ignition Cylinder Switch parameter is Key Out.
   If not the specified value, test the signal circuit terminal 4 for a short to voltage. If the circuit tests normal, replace the BCM.
4. Install a 3A fused jumper wire between the signal circuit terminal 4 and the B+ circuit terminal 2. Verify the BCM scan tool Key In Ignition Cylinder Switch parameter is Key In.
   If not the specified value, test the signal circuit for an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the ignition switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Ignition and Start Switch Replacement
- Control Module References for the BCM replacement, setup, and programming

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Engine Oil Pressure Indicator Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0521: Engine Oil Pressure (EOP) Sensor Performance

DTC P0522: Engine Oil Pressure (EOP) Sensor Circuit Low Voltage.

DTC P0523: Engine Oil Pressure (EOP) Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Engine Oil Pressure 5-Volt Reference	P0522	1	P0522	P0523	P0521
Engine Oil Pressure Sensor Signal	P0522	1	P0522	P0523	P0521
Low Reference	--	1	P0523	--	P0521
1. Engine Oil Pressure Gage Inaccurate or Inoperative.					

Circuit/System Description

The engine oil pressure (EOP) sensor changes voltage based on the engine oil pressure. The EOP sensor is a 3-wire sensor comprising of the signal circuit, the low reference circuit and the 5-volt reference circuit. The engine control module (ECM) supplies 5 volts to the EOP sensor via the 5-volt reference circuit and provides ground via the EOP low reference circuit. The ECM monitors the signal circuit of the EOP sensor to determine the engine oil pressure sensor voltage is within the normal operating range of approximately 1-4 volts. When the engine oil pressure is high, the EOP sensor voltage is high and the ECM senses a high signal voltage. When the engine oil pressure is low, the EOP sensor voltage is low and the ECM senses a low signal voltage. The ECM sends the EOP information to the instrument panel cluster (IPC) via the serial data circuit.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

- Indicator/Warning Message Description and Operation
- Instrument Cluster Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, observe the scan tool Engine Oil Pressure Sensor parameter. The reading should be between 0.2-4.8 volts.
2. Verify the engine oil pressure, refer to:
   - Oil Pressure Diagnosis and Testing for the 2.8L, 3.0L, 3.2L or 3.6L engine
   - Oil Pressure Diagnosis and Testing for the 4.8L, 5.3L, and 6.0L engines.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the engine oil pressure (EOP) sensor.
2. Ignition OFF, test for less than 1 ohm between the low reference circuit terminal 1 and ground.

   If greater than the specified range, test the circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8-5.2 volts between the 5-volt reference circuit terminal 2 and ground.

   If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

   If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Verify the scan tool Engine Oil Pressure Sensor parameter is less than 0.2 volt.

   If greater than the specified range, test the signal circuit terminal 3 for a short to voltage. If the circuit tests normal, replace the ECM.
5. Install a 3A fused jumper wire between the signal circuit terminal 3 and the 5-volt reference circuit terminal 2. Verify the scan tool Engine Oil Pressure Sensor parameter is greater than 4.8 volts.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

6. Ignition ON, perform the IPC displays test with the scan tool and verify the EOP indicator turns OFF when commanded.

   If the EOP indicator does not turn OFF, replace the IPC.
7. If all circuits test normal, test or replace the EOP sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Engine Oil Pressure Sensor and/or Switch Replacement for 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engines
- Engine Oil Pressure Sensor and/or Switch Replacement for 3.6L engine
- Control Module References for ECM replacement, setup and programming

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Document ID: 2157699

Fuel Gage Inaccurate or Inoperative

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Fuel Level Sensor 1 Signal	P0462	1	P0463	P0463	P0461
Fuel Level Sensor 2 Signal	P2067	1	P2068	P2068	P2066
Fuel Level Sensor Low Reference	--	1	P0463 P2068	P0463 P2068	P0461 P2066
1. Fuel Gage Inaccurate or Inoperative					

Circuit/System Description

The primary fuel level sender and the secondary fuel level sender changes resistance based on fuel level. The engine control module (ECM) monitors the signal circuits of the primary fuel level sender and the secondary fuel level sender in order to determine the fuel level. When the fuel tank is full, the resistances of both fuel level senders are low and the ECM senses a low signal voltage on both the signal circuits of the primary fuel level sender and the secondary fuel level sender. When the fuel tanks are empty, the resistances of the fuel level senders are high and the ECM senses a high signal voltage. The ECM uses the signal circuits of the primary fuel level sender and the secondary fuel level sender in order to calculate the percentage of remaining fuel in the tank. The ECM sends the fuel level percentage via serial data circuit to the instrument cluster in order to control the fuel gage.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 33431-C Instrument Panel Tester

Circuit/System Verification

Ignition ON, observe the scan tool Fuel Level Sensor parameter. The reading should be between 0.9 - 2.5 volts.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the primary and secondary fuel level sensors.
2. Ignition OFF, test for less than 1 ohm between the primary low reference circuit terminal 4 and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuits tests normal, replace the ECM.
3. Ignition OFF, test for less than 1 ohm between the secondary low reference circuit terminal 1 and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuits tests normal, replace the ECM.
4. Jumper the primary signal circuit terminal 2 to the secondary signal circuit terminal 2. Install a Signal Generator and Instrument Panel Tester between the jumped signal circuits and the low reference circuit terminal.
5. Ignition ON, vary the signal generator resistance between 40 and 250 ohms. Verify that the scan tool Fuel Tank Level Remaining parameter displays a range that varies between 5 and 95 percent as the signal generator resistance changes.

   If not displaying the specified range, test both signal circuits for an open/high resistance. If the circuits test normal, replace the ECM.
6. Vary the signal generator resistance between 40 and 250 ohms. Verify that the fuel gage displays a range that varies between empty and full as the signal generator resistance changes.

   If the fuel gage is incorrect, replace the IPC.
7. If all circuits test normal, perform the fuel level sensor component test before replacing

either the primary or secondary fuel level sensor.

Component Testing

1. Ignition OFF, remove primary and secondary fuel level senders.
2. While sweeping the primary fuel level sensor through its full range of motion, test for a minimum value less than 41 ohms and a maximum value greater than 119 ohms between signal terminal 2 and the low reference terminal 4.

   If not within the specified range, replace the primary fuel level sensor.
3. While sweeping the secondary fuel level sensor through its full range of motion, test for a minimum value less than 41 ohms and a maximum value greater than 119 ohms between signal terminal 2 and the low reference terminal 1.

   If not within the specified range, replace the secondary fuel level sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Primary Fuel Level Sensor Replacement
- Secondary Fuel Tank Module Replacement
- Control Module References for ECM and IPC replacement, setup, and programming

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Instrument Cluster Gages Inoperative

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit/System Description

This diagnostic procedure applies to serial data gages located in the instrument panel cluster (IPC) which includes the speedometer, tachometer, engine coolant temperature gage.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Important: If the suspect gage is the speedometer, the drive wheels of the vehicle must be raised and the transmission must be placed in drive or first gear. Refer to Lifting and Jacking the Vehicle.

1. Ignition ON and the scan tool installed, perform the IPC Gage Sweep Test in the IPC Output

Controls. Verify that all gage dials move from minimum to the maximum value and back to the gage minimum value.

If the gages do not perform the IPC Gage Sweep Test, replace the IPC.

2. Start the engine with the vehicle drive wheels raised and place the transmission in drive or first gear. Verify that the speedometer value matches the scan tool Vehicle Speed parameter in the ECM Engine Data List.

   If the speedometer is incorrect, test or replace the IPC.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for the IPC replacement, setup and programming

Symptoms - Displays and Gages

Important: The following steps must be completed before using the symptom tables.

1. Perform the Diagnostic System Check - Vehicle , before using the Symptom Tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data circuit.
2. Review the system operation in order to familiarise yourself with the system functions. Refer to the following procedures:
   - Instrument Cluster Description and Operation.
   - Indicator/Warning Message Description and Operation.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the instrument panel cluster (IPC). Refer to Checking Aftermarket Accessories.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect for the correct fluid levels.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to a symptom diagnostic procedure from the following lists in order to diagnose the symptom:

Gauges and Odometer

- Fuel Gage Inaccurate or Inoperative
- Instrument Cluster Gages Inoperative

Indicators

- ABS Indicator Malfunction
- Air Bag Indicator Circuit Malfunction
- Brake Warning Indicator Malfunction
- Charge Indicator Malfunction
- Courtesy Lamps Malfunction

- Cruise Control Indicator Inoperative
- Door Ajar Indicator Malfunction
- Daytime Running Lamps Malfunction
- Engine Oil Pressure Indicator Malfunction
- Front Fog Lamps Malfunction
- Headlamps Malfunction
- Malfunction Indicator Lamp (MIL) Diagnosis for the 4.8L, 5.3L, 6.0L, 6.2L or 7.0L engine
- Park, License, and/or Tail Lamps Malfunction
- Rear Fog Lamps Malfunction
- Seat Belt Indicator Circuit Malfunction
- Security Indicator Malfunction
- StabiliTrak Indicator Malfunction
- Trailer Lamps Malfunction
- Turn Signal Lamps and/or Indicators Malfunction

Audible Warnings

Chime Malfunction

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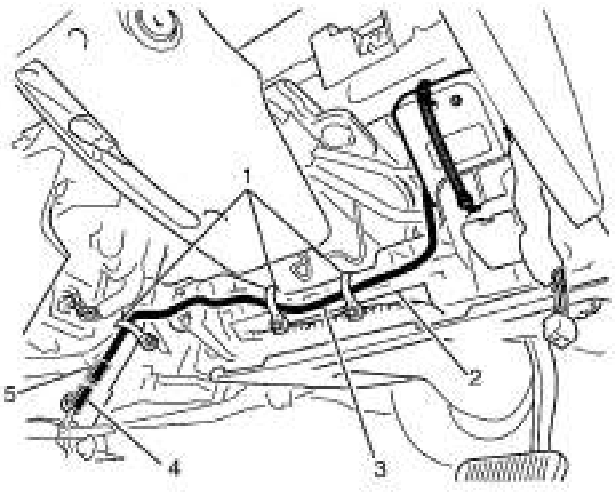
Speedometer Adapter Replacement

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

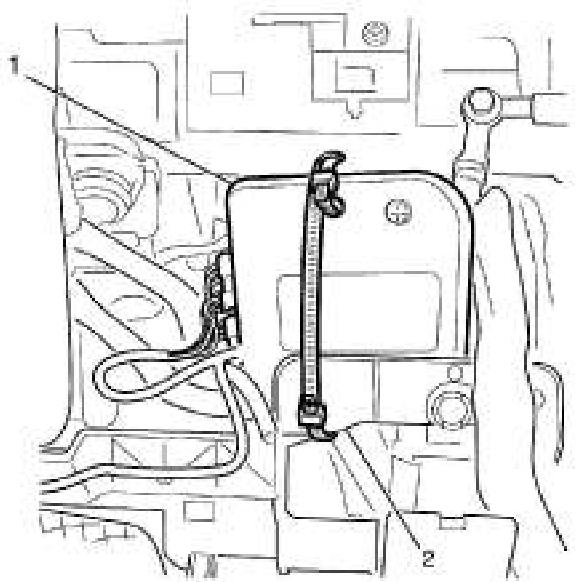
1. Disconnect the battery negative cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the instrument panel (I/P) outer trim cover Refer to Instrument Panel Outer Trim Cover Replacement.
3. Remove the knee bolster. Refer to Knee Bolster Replacement.
4. Remove the instrument panel extension. Refer to Instrument Panel Extension Replacement.



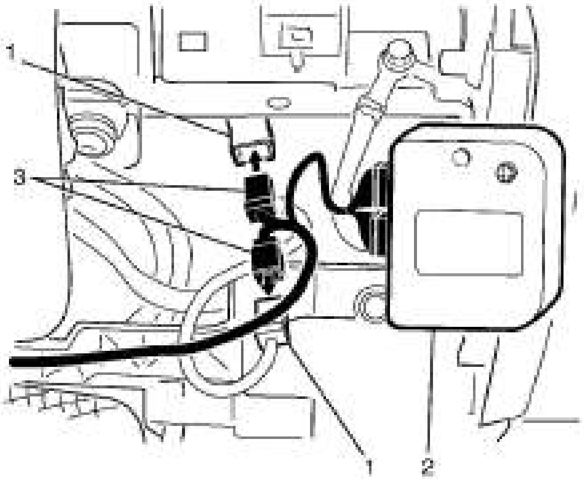
Important: Using a suitable tool, remove the cable ties (1) from the from the I/P lower support brace (2).

Important: Cable ties are a single use item.

5. Detach the vehicle speed interface module (VSIM) wiring harness (3).
6. Disconnect the vehicle speed interface module (VSIM) electrical connector (5) from the main wiring harness connector (4).

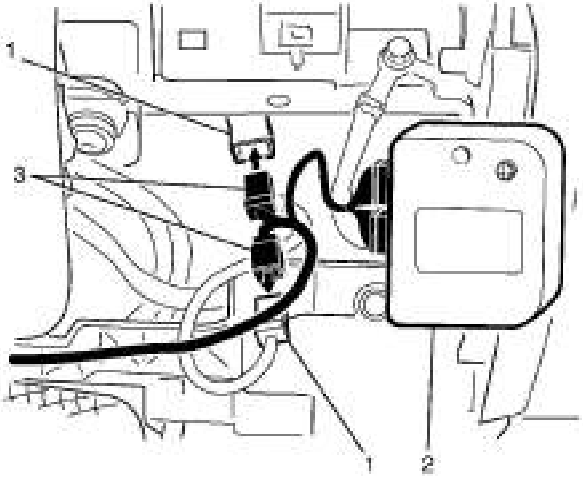


7. Remove the vehicle speed interface module (VSIM) (1) from the I/P beam and the lower fascia support (2).

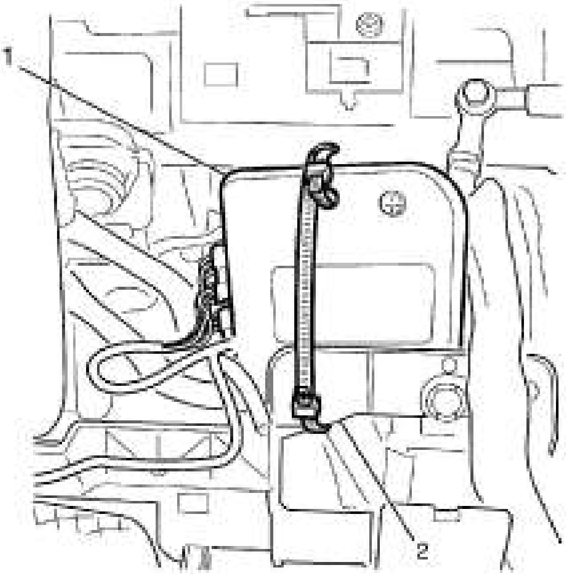


8. Disconnect the vehicle speed interface module (VSIM) (2) electrical connectors (3) from the steering wheel angle sensor (1).
9. Remove the vehicle speed interface module (VSIM) (2) from the vehicle.

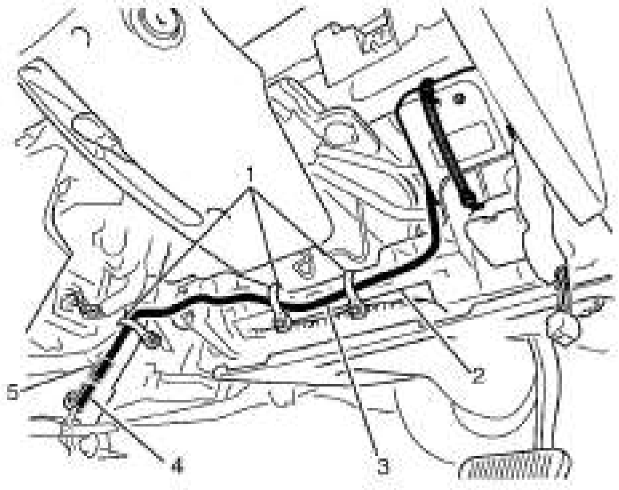
Installation Procedure



1. Connect the vehicle speed interface module (VSIM) (2) electrical connectors (3) to the steering wheel angle sensor (1).



2. Install and secure the vehicle speed interface module (VSIM) (1) to the I/P beam and the lower fascia support (2), using NEW cable ties.



3. Connect the vehicle speed interface module (VSIM) electrical connector (5) to the main wiring harness connector (4).

   Important: Cable ties are a single use item.

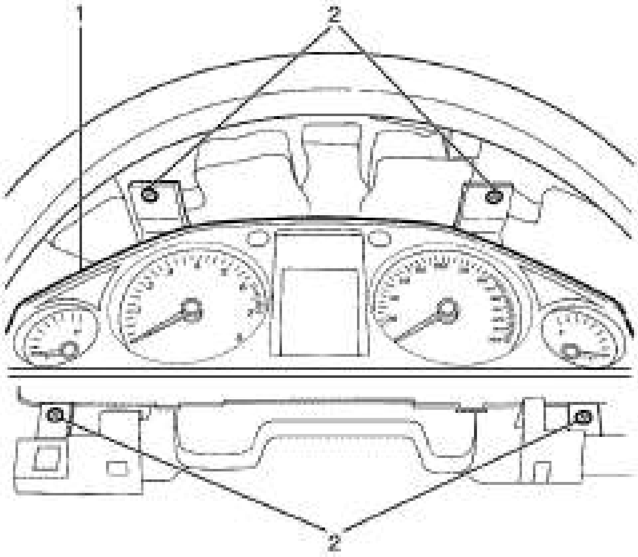
4. Attach the vehicle speed interface module (VSIM) wiring harness (3) to the I/P lower support brace (2), using NEW cable ties (1).
5. Install the instrument panel extension. Refer to Instrument Panel Extension Replacement.
6. Install the knee bolster. Refer to Knee Bolster Replacement.
7. Install the instrument panel (I/P) outer trim cover Refer to Instrument Panel Outer Trim Cover Replacement.
8. Connect the battery negative cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.

Instrument Cluster Replacement (SWB)

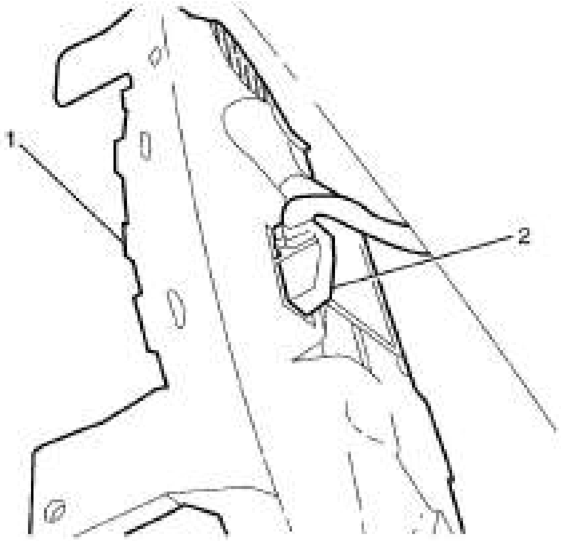
Removal Procedure

Important: If the IPC is being replaced due to mechanical damage only, store the data on Tech 2 so the new IPC can be relearned using the stored info on the Tech 2.

1. Remove the knee Bolster. Refer to Knee Bolster Replacement.
2. Remove the upper steering wheel cover. Refer to Steering Column Trim Covers Replacement.
3. Remove the instrument cluster trim panel. Refer to Instrument Cluster Trim Panel Replacement.
4. Lower the steering column.



5. Remove the instrument cluster (1) to I/P trim pad retaining screws (2).
6. Carefully remove the instrument cluster (1) from the instrument panel trim pad.

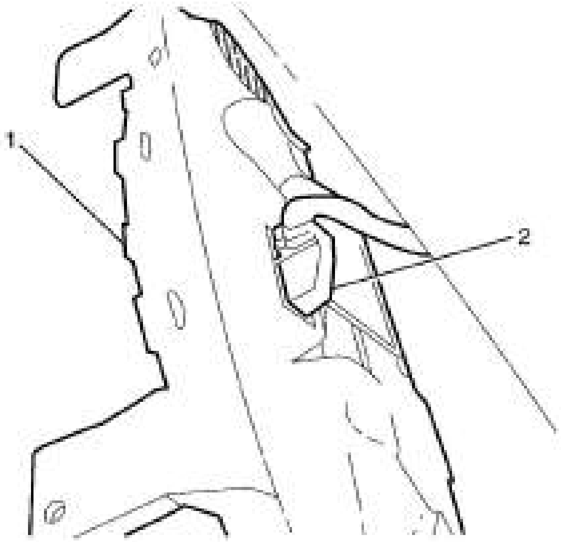


7. Disconnect the instrument cluster (1) electrical connector (2).

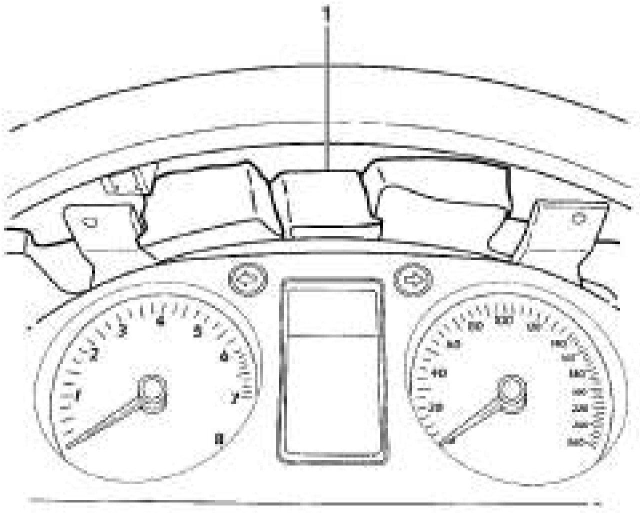
   Important: When removing the instrument cluster, take care not scratch or damage the instrument cluster screen.

8. Remove the instrument cluster (1).

Installation Procedure



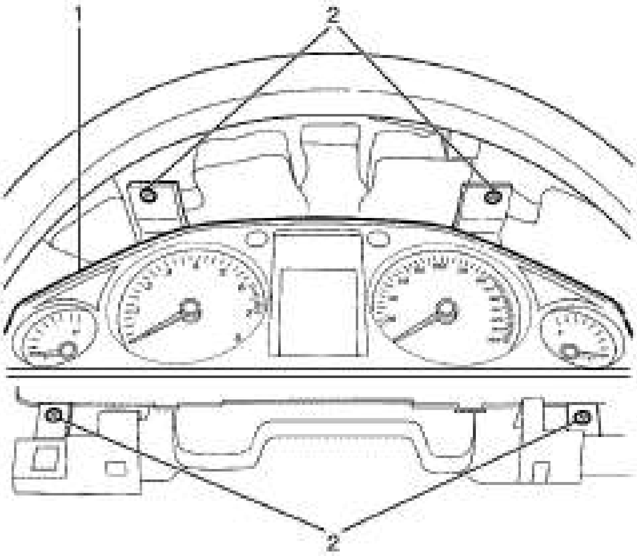
1. Connect the electrical connector (2) to the Instrument cluster (1).



Important: When installing the instrument cluster, make sure the anti-rattle foam (1) is between the I/P trim pad and instrument cluster.

2. Install the instrument cluster.

Notice: Refer to Fastener Notice in the Preface section.



3. Install the instrument cluster (1) retaining screws (2).

Tighten
Tighten the screws (2) to 2 N·m (18 lb in).

4. Install the instrument panel (I/P) trim panel. Refer to Instrument Cluster Trim Panel Replacement.
5. Install the steering wheel upper trim cover. Refer to Steering Column Trim Covers Replacement.
6. Install the knee bolster. Refer to Knee Bolster Replacement.
7. Re-programme the instrument cluster. Refer to Instrument Cluster Programming and Setup.

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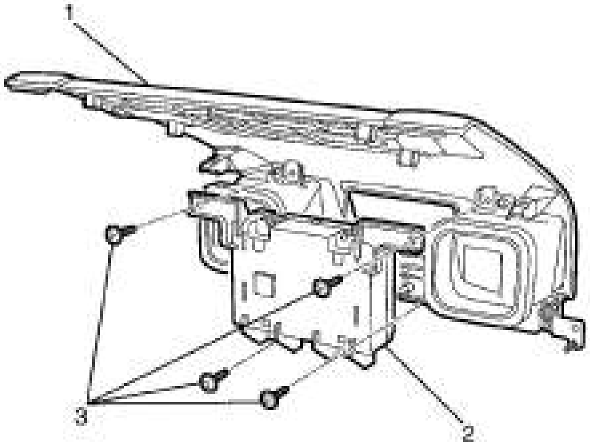
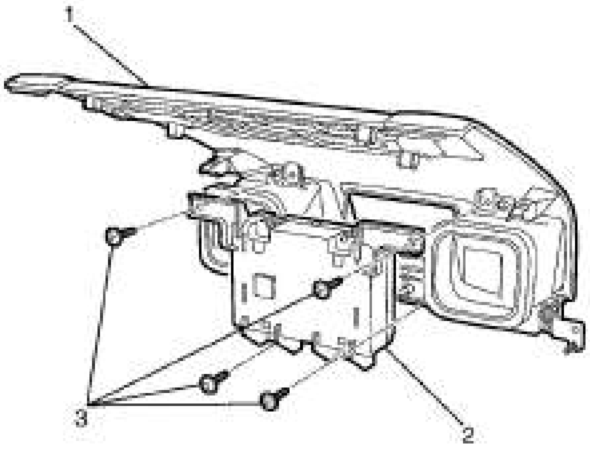
Secondary Driver Information Display Replacement (Base)

Removal Procedure



1. Remove the instrument panel (I/P) upper trim panel assembly. Refer to Instrument Panel Center Trim Panel Replacement.
2. Remove the secondary information centre (SIC) display to I/P upper trim panel assembly retaining screws (3).
3. Remove the SIC display (2) from the I/P upper trim panel assembly (1).

Installation Procedure



1. Install the SIC display (2) to the I/P upper trim panel assembly (1).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the SIC display to I/P upper trim panel assembly retaining screws (3).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).

3. Install the I/P upper trim panel assembly. Refer to Instrument Panel Center Trim Panel Replacement.
4. For programming and setup, refer to Control Module References.

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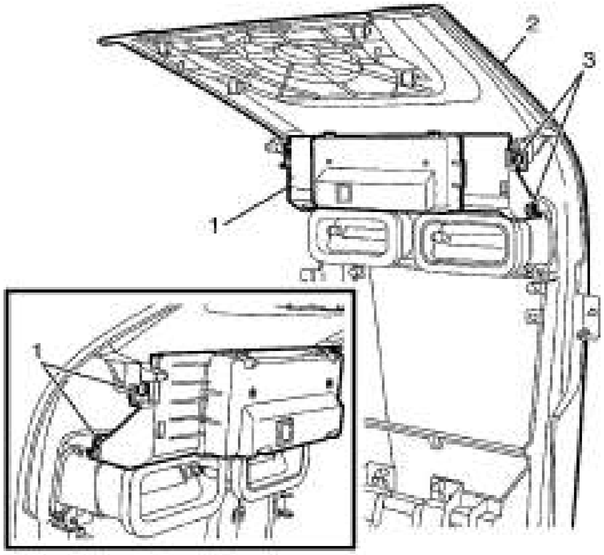
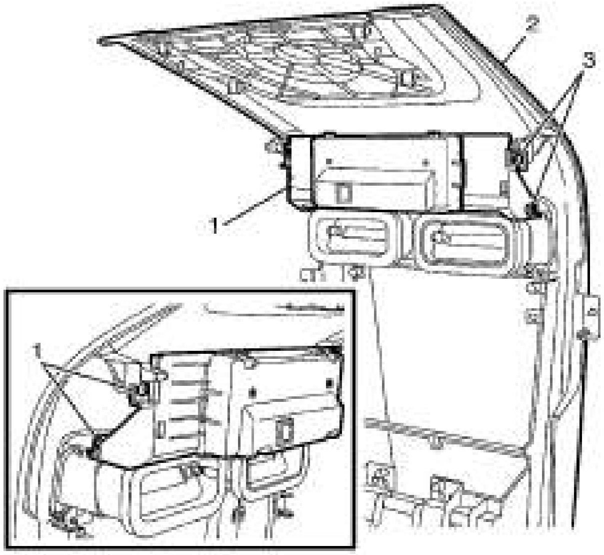
Secondary Driver Information Display Replacement (Sport)

Removal Procedure



1. Remove the instrument panel (I/P) centre trim panel assembly. Refer to Instrument Panel Center Trim Panel Replacement.
2. Remove the secondary information centre (SIC) display to I/P centre trim panel assembly retaining screws (1).
3. Remove the SIC display (2) from the I/P centre trim panel assembly (3).

Installation Procedure



1. Install the SIC display (2) to the I/P centre trim panel assembly (3).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the SIC display to I/P upper trim panel assembly retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).

3. Install the I/P centre trim panel assembly. Refer to Instrument Panel Center Trim Panel Replacement.
4. For programming and setup, refer to Control Module References.

Audible Warnings Description and Operation

Audible warnings alert the driver of a vehicle to a fault or failure in the vehicle operating systems. Audible warnings are also used to reinforce functions performed and information displayed in the multi function display (MFD) of the Instrument Panel Cluster (IPC). The audible warnings are generated by the (IPC) and sound via an internal speaker. The IPC receives requests for audible warnings from various control systems in the vehicle over the GMLAN network. If the IPC receives multiple audible warning requests, the audible warning with the highest priority will sound. The IPC issues audible warnings to reinforce the following conditions:

- A warning indicator or multi function display (MFD) animation is present on the IPC
- A MFD menu selection is made
- Reminder or programmed threshold is confirmed
- A system function check is performed

Each audible warning has a defined frequency, duration, decay and cycle repeat. The following lists the types of audible warnings:

- Overspeed Chime
- Underspeed Chime
- Reminder Chime
- General Warning Chime
- Confirmation Beep Chime

There are two types of audible warning chimes:

- Internal audible warnings which the IPC generates in order to reinforce a certain vehicle condition associated with an IPC indicator or MFD display.
- External Chimes which the IPC generates in response to a requests received via the GMLAN network from other control systems in the vehicle.

The following IPC indicators and MFD displays will generate an audible warning:

- Low fuel
- Very low fuel
- Low oil level
- Low oil pressure
- Low coolant
- Brake fail (low fluid)
- Park brake reminder
- ABS fault
- MIL (malfunction indicator lamp)
- Alternator fault

- Battery saver mode ON
- Reset service reminder
- Airbag fault
- Seat belt reminder (Driver)
- Safety mode active
- Turn Indicator (click-clack sound)
- Hazard (click-clack sound)
- Reduced engine power
- Overspeed warning
- Service vehicle soon
- Engine temperature hot
- Engine immobilised
- Transmission hot - idle engine
- Contact dealer
- Replace battery in remote
- Check engine
- Service reminder
- Front park assist
- Tyre pressure system fault
- Check tyre pressure
- Automatic headlight levelling failed
- Low washer fluid (Caprice only)

Driver Information Center (DIC) Description and Operation

The driver information center (DIC) displays the DIC Welcome message for 5 seconds when it first powers up. The DIC then returns to the last display status before no power condition.

There are 3 button functions for the DIC.

- Customisation
- Set/Reset
- Trip/Fuel

Trip / Fuel

Cycle through the following vehicle parameters by pressing the TRIP button.

- Average Fuel Economy (AFE)
- Average Vehicle Speed (AVS)
- Fuel Range
- Fuel Used
- Instantaneous Fuel Economy (IFE)
- Odometer
- Trip A
- Trip B
- Trip Time

Customisation

The Customisation Menu is used to set features for both the vehicle and the driver. Many of the parameters in the Trip/Fuel menu can be programmed.

- Security
- Lighting
- Trip Computer
- Radio Display
- TPMS
- Language
- Park Assist
- Navigation

Average Fuel Economy

Average fuel economy is calculated using the equation: AFE = Distance/Fuel

- Distance = The accumulated distance travelled since the last reset of this value
- Fuel = The accumulated fuel consumption since the last reset of this value

The engine control module (ECM) sends the average fuel economy GMLAN message to the instrument panel cluster (IPC). The value of this mode is retained during ignition OFF.

Average Speed

Average speed is calculated using the equation: Average Speed = AVS Distance/AVS Time

- Distance = The accumulated distance travelled since the last reset of this value
- Ignition On = The accumulated ignition on time since the last reset of this value

Fuel Range

This message indicates the estimated distance that the vehicle can travel under the current fuel economy and fuel level conditions since the last battery connection to the IPC. Fuel Range is calculated using the equation: Fuel Range = Range Distance/Range Fuel Used.

- Range Distance = The accumulated distance travelled since the last reset of this value.
- Fuel Used = The accumulated fuel delivered since the last reset of this value

The ECM sends the fuel range value to the IPC. The IPC receives a GMLAN message with fuel information. The fuel range value is retained during ignition OFF. The Fuel Range display cannot be reset. LOW is displayed when fuel range is below a predetermined value.

Fuel Used

The DIC calculates and displays the total amount of fuel used since the last reset operation. You can reset the fuel used mode by depressing and holding the ENTER button for more than 3 seconds. The value of this mode is retained during ignition OFF.

Instantaneous Fuel Economy (IFE)

Instantaneous fuel economy (IFE) is calculated using the equation: IFE = Distance/Fuel Used.

- Distance = The accumulated distance travelled for the last 2 seconds
- Fuel = The accumulated fuel delivered for the last 2 seconds

The IPC receives a GMLAN message from the ECM. The distance information is calculated by the IPC using the vehicle speed information from the ECM. These values are retained during ignition OFF. The IFE display cannot be reset.

Tire Pressure Monitoring System

The IPC receives a GMLAN message from the tire pressure monitoring system (TPMS) for front and rear tire pressure data. The DIC will display the pressure for each of the front and rear tires. When a tire with low air pressure is present, the DIC displays XXXX XXXX TIRE PRESSURE LOW.

Trip Time

The timer records elapsed time starting from activation. When the DIC displays the timer, pressing the ENTER button for 1 second on the DIC resets the timer. Pressing the ENTER button on the DIC switch for approximately 1 second starts and stops the timer. The DIC displays the timer in one of the following formats:

The DIC displays the timer in the following format: HH: MM:SS

The (HH) represents hours elapsed, (MM) represents minutes elapsed, and (SS) represents seconds elapsed. The maximum range of the timer is 99 hours, 59 minutes, and 59 seconds. After the maximum range is reached, the timer displays all zeros (00:00:00).

Fuel Display

Parameter	Update Rate	Range	Reset Value	Units
Average Fuel Economy	1 second	0.0-99.9	99.9	L/100 KM
Instant Fuel Economy	2 seconds	0-70	N/A	L/100 KM
Fuel Range	1 second	0-999	N/A	KM
Fuel Used	1 second	0-999.9	0.0	L

Language

The driver information centre (DIC) is capable of displaying in 2 languages

- English
- Portuguese

Driver Information Display Description and Operation

Driver Information Display Description and Operation

The driver information display processes various input signals and displays the relative information on the driver information display screen.

Vehicles equipped with UT3 Audio System

The driver information display provides several on-screen menus, which may be used to select preferences or to make adjustments. Under normal operating conditions the driver information display will display:

- A digital clock displaying the time.
- The current radio station frequency selected.
- Whether or not a CD is inserted in the audio system.

The following audio system messages may be displayed on the driver information display screen:

- Security Lockout Active: This message is displayed when the coded security system has been activated.
- ERR: This message is displayed when the audio system is unable to play the inserted cassette or CD.
- LOC: This message is displayed when the audio system has entered theft mode.
- CAL/CAL ERR: This message is displayed when the audio system has detected an invalid calibration.
- CHECK CD: This message is displayed when the audio system encounters a tracking error.
- NO DISC: This message is displayed when there is no CD discs inserted in the audio system.
- NONE: This message is displayed when the audio system cannot detect the vehicle speed data from GMLAN.

Perform the appropriate diagnostic procedures when an error message is displayed.

Vehicles equipped with UWP Audio System

The driver information display, displays a digital voltage gauge and a digital oil pressure gauge on the display screen.

Voltage Gauge Display

The driver information display processes input signals and displays the current vehicle's electrical system voltage value in the form of a bar graph on the driver information display screen. Under normal operating conditions, the voltage gauge should display between 13.8 - 15.4 volts.

Oil Pressure Gauge Display

The driver information display processes input signals and displays the current vehicle's engine oil pressure value in the form of a bar graph on the driver information display screen. Under normal operating conditions, the oil pressure gauge should display a minimum oil pressure of 74 kPa/10 psi at idle speed and a maximum oil pressure of 377 kPa/54 psi at 2,000 RPM.

Engineering Mode Description and Operation

Engineering Mode enables some instrument identification and current status information to be displayed on the Mutli-function Display (MFD). It also provides an Instrument Self Test function. Engineering mode is entered, by switching the ignition on while pressing the ENTER button.

Engineering Mode is exited by switching off the ignition or pressing the TRIP button.

While in Engineering Mode, if one or more warnings occur they will interrupt the current display.

After all warnings have been acknowledged with the ENTER button, the previous Diagnostic Display screen is restored. Minimised Warning icons will not be shown whilst Engineering Mode is active.

Navigation through the Engineering Mode menu items is via the Up/Down scroll wheel on the steering wheel.

The sequence of displays is as follows:

- Software Version
- GM Part Number
- Battery Voltage
- Remaining Fuel (Lts)
- Instantaneous Fuel (Lts)
- Coolant Temperature
- Speed (km/h)
- Tacho (rpm)
- Tyre Pressure
- Engine Oil Life (%)
- Park Lamps (on/off)
- Steering Wheel Switch Voltage
- Display of Gears (commanded)
- Throttle Position Requested (pedal %)
- Transmission Sump Temperature (°C)
- Self Test

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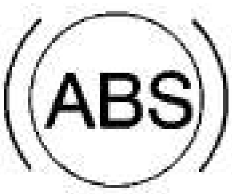
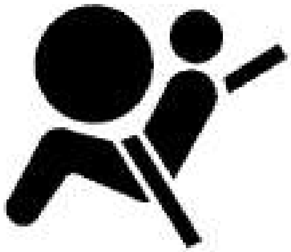
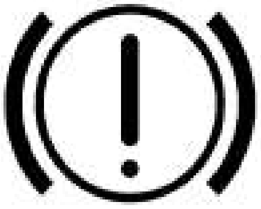
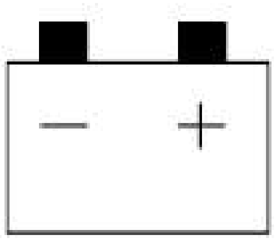
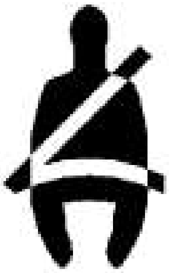
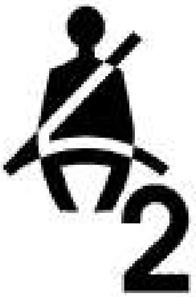
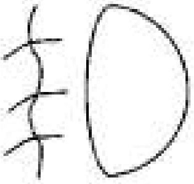
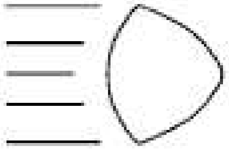
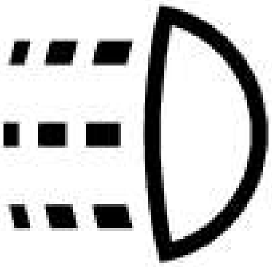
Indicator / Warning Message Description and Operation

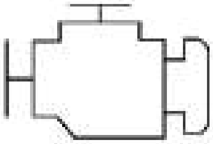
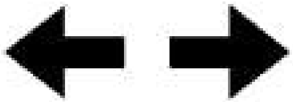
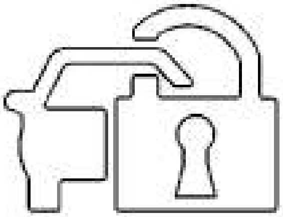
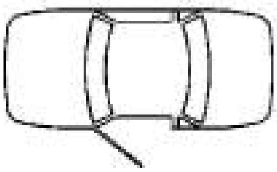
Table 1: Instrument Cluster Panel Indicators
Table 2: Driver Information Centre Warning Messages

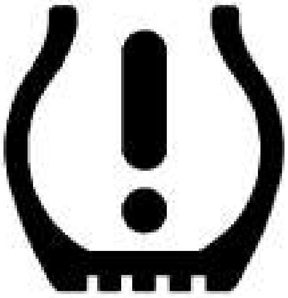
Instrument Cluster Panel Indicators

Symbol	Description
	ABS: ABS Description and Operation
	Air Bag: SIR System Description and Operation
	Brake Warning Lamp: Brake Warning System Description and Operation

BRAKE	
	Alternator or Charging System: Charging System Description and Operation
	Driver Seat Belt Warning: Seat Belt System Description and Operation
	Passenger Seat Belt Warning: Seat Belt System Description and Operation
	Fog Lamps: Exterior Lighting Systems Description and Operation

	
	High Beam: Exterior Lighting Systems Description and Operation
	Daytime Running Lamps: Exterior Lighting Systems Description and Operation
MPH	The IPC displays the MPH indicator when the IPC detects that English units have been requested by the driver.
KM/H	The IPC displays the km/h indicator when the IPC detects that Metric units have been requested by the driver.
	Malfunction Indicator Lamp (MIL):

	• Engine Control Module Description for the 2.8L, 3.0L, 3.2L or 3.6L engine • Engine Control Module Description for the 4.8L, 5.3L, 6.0L, 6.2L or 7.0L engine
	Turn Signals: Exterior Lighting Systems Description and Operation
	Security Warning: Content Theft Deterrent (CTD) Description and Operation
	Door Ajar: Door Ajar Indicator Description and Operation

	Tire Pressure Monitoring System: Tire Pressure Monitor Description and Operation

Driver Information Centre Warning Messages

Symbol	Description
ABS FAULT	ABS Description and Operation
BRAKE	Brake Warning System Description and Operation
PARK BRAKE	Brake Warning System Description and Operation
ALTERNATOR/CHARGING SYSTEM	Charging System Description and Operation
CHECK OIL PRESSURE/OIL LEVEL	The low oil pressure/oil level warning occurs when a low engine oil pressure and/or a low engine oil level concern is detected by the ECM.
ENGINE TEMP (Temperature) HOT	Cooling System Description and Operation
AIR BAG FAULT	SIR System Description and Operation
OVER SPEED	The overspeed warning displays when the BCM detects that the vehicle speed has exceeded the selected value the driver had preset. The IPC then displays the overspeed warning on the DIC. The general warning chime sounds when active.
STABILITY CONTROL ASSISTANCE/STABILITY CONTROL OFF	ABS Description and Operation
LOW FUEL	The low fuel message displays when the IPC determines that the fuel level is less than 12 percent.
VERY LOW FUEL	The very low fuel message displays when the IPC determines that the fuel level is less than 0 percent. This occurs when the fuel level in the tank is lower than the minimum level the sender can read. The IPC receives a message indicating the fuel level from the ECM and displays the very low fuel message on the DIC.
SPORT SHIFT	The sport shift message displays when the BCM detects that the shifter assembly has been moved to enable sport shift mode. The BCM sends this information to the IPC via a serial

	data message.
NORMAL SHIFT	The normal shift message displays when the BCM detects that the shifter assembly has been returned to D. The BCM sends this information to the IPC via a serial data message.
SERVICE	The service error message displays when an IPC concern usually relating to a loss of communications is present.
SERVICE CHARGING SYSTEM	Charging System Description and Operation
REPLACE BATTERY IN REMOTE KEY	Keyless Entry System Description and Operation
CHECK ENGINE	• Engine Control Module Description for the 2.8L, 3.0L, 3.2L or 3.6L engine • Engine Control Module Description for the 4.8L, 5.3L, 6.0L, 6.2L or 7.0L engine
SAFETY MODE ACTIVE AND POWER REDUCED	• Transmission Indicators and Messages • Transmission Indicators and Messages
SERVICE VEHICLE SOON	The service vehicle soon message displays when a non emissions related concern is detected by the BCM. The IPC displays the service vehicle soon message on the DIC. The general warning chime sounds when the warning is active.
SERVICE ENGINE OIL	This message displays when the ECM determines that the engine oil life is below 5 percent. The ECM sends the information to the IPC via a serial data message. After the oil is changed, reset the engine oil monitor. Refer to GM Oil Life System Resetting
CRUISE CONTROL ON/ACTIVE/INACTIVE/OFF	Cruise Control Description and Operation
ENGINE IMMOBILISED	Refer to the Owner's Manual
BATTERY SAVER MODE ON	Charging System Description and Operation
REST REMINDER	The rest reminder message displays after two hours of continuous driving. When the ignition is switched to the ON position, a timer in the IPC starts counting. After two hours of continuous driving, the IPC displays the rest reminder message on the DIC.
TIRE PRESSURE SYSTEM FAULT	Tire Pressure Monitor Description and Operation

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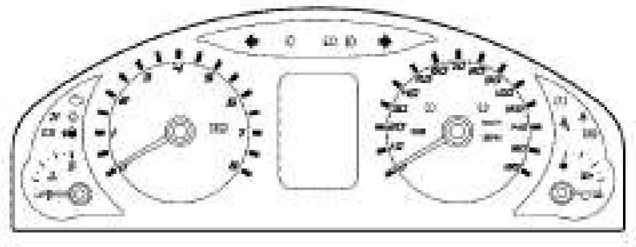
Instrument Cluster Description and Operation

System Overview



The Instrument Panel Cluster (IPC) contains one driver information center (DIC) and provides visual information to the driver for a number of vehicle functions such as trip computer, audio functions, warnings and reminders.

When the ignition is switched to the ON position, a vehicle system check is performed and the status is shown on the DIC.

A number of IPC features will be tested in order to verify the features are working correctly. The following occurs at key ON.

- The supplementary restraint system warning lamp illuminates briefly (not IPC controlled).
- The anti-lock brake system (ABS) warning lamp illuminates briefly.
- The charging system warning lamp illuminates briefly.
- The brake warning lamp illuminates briefly.
- The malfunction indicator lamp (MIL) illuminates until the engine is running (not IPC controlled).
- The seat belt warning lamp will stay illuminated until the driver seat belt is latched (not IPC controlled).

If there are no warnings or service reminders the DIC shows a series of welcome screens. If the system check detects a problem, the DIC displays the appropriate warning immediately. If a warning is displayed, press the TRIP button to acknowledge it (once for each warning). The DIC then reverts to the original trip computer display.

- Pressing the TRIP button any time during the system check causes the DIC to jump ahead to the last trip computer screen displayed before the ignition was last switched off. The system check continues to run in the background
- To display the odometer screen, if not already displayed on the DIC, press the TRIP button until the screen appears

When the ignition is in the OFF position, the odometer appears on the DIC, unless a service reminder is active. Active service reminders will be displayed on the DIC for 10 seconds before reverting back to the odometer for a short period of time and then turning off completely. The odometer will be displayed on the DIC again when the drivers door is opened.

Engine Coolant Temperature Gauge

The IPC displays the engine coolant temperature as determined by the engine control module (ECM). The IPC receives a GMLAN message from the ECM indicating the engine coolant temperature. The IPC engine coolant temperature gauge only displays coolant temperatures greater than 60°C. The engine coolant temperature gauge defaults to 60°C or below if:

- The ECM detects a malfunction in the engine coolant temperature sensor circuit.
- The IPC detects a loss of GMLAN communications with the ECM.
- The body control module (BCM) detects a loss of GMLAN communications with the ECM.

Fuel Gauge

The IPC displays the fuel level as determined by the ECM. The IPC receives a GMLAN message from the ECM indicating the fuel level percent. The fuel gauge defaults to empty if:

- The ECM detects a malfunction in the fuel level sensor circuit.
- The IPC detects a loss of GMLAN communications with the ECM.
- When there is little or no fuel in the tank.

When the fuel level is less than a pre-determined value, the low fuel or very low fuel indicators illuminate on the DIC.

Odometer

The IPC contains an odometer and trip odometer. Momentarily press the TRIP button on the steering wheel in order to toggle between the odometer and the trip odometer. Press the ENTER button for approximately 4 seconds, while the trip odometer is displayed on the DIC, in order to reset the trip odometer. If the ENTER button is pressed for less than 4 seconds, all trip information is cleared. The IPC calculates the distance travelled based on the GMLAN vehicle speed information from the ECM. The DIC will display 'error' if an internal IPC memory failure is detected.

PRNDL Display

The IPC displays the selected gear position as determined by the ECM.The IPC receives a GMLAN message from the BCM indicating the gear position. If the BCM detects a malfunction in the transmission range switch where vehicle speed is continually greater than the indicated gear position's capability, the PRNDL display on the DIC will display the letter P. The PRNDL display on the DIC can also blank if:

- The IPC detects a loss of GMLAN communications with the BCM or ECM.
- The ECM detects a malfunction in the transmission range switch circuit.

Speedometer

The IPC displays the vehicle speed as determined by the ECM. The IPC calculates the kilometres based on the GMLAN vehicle speed information from the BCM. The speedometer defaults to 0 km/h if the IPC detects a loss of GMLAN communications with both the ECM.

- The ECM detects a mulfunction in the vehicle speed sensor.
- The IPC detects a loss of GMLAN communications from the BCM or ECM.

Tachometer

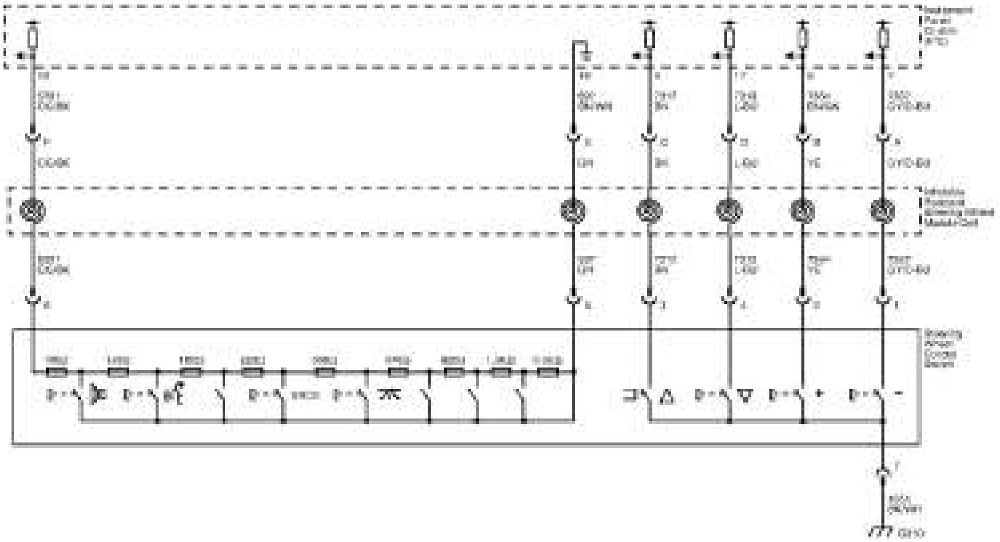
The IPC displays the engine speed as determined by the ECM. The IPC receives a GMLAN message from the BCM indicating the engine speed. The tachometer will default to 0 RPM if:

- The ECM detects a malfunction in the engine speed sensor.
- The IPC detects a loss of GMLAN communications from the BCM or ECM.

Special Tools

Illustration	Tool Number / Description
	J 33431-C Signal Generator and Instrument Panel Tester

Steering Wheel Secondary/Configurable Control Schematics


Instrument Panel Cluster (IPC)
Inflatable Restraint Steering Wheel Module Coil
YE

Diagnostic Starting Point - Secondary and Configurable Customer Controls

Begin the system diagnosis with the Diagnostic System Check - Vehicle . The Diagnostic System Check - Vehicle will provide the following information:

- The identification of the control modules which command the system
- The ability of the control modules to communicate through the serial data circuit
- The identification of any stored DTCs and their status

The use of the Diagnostic System Check - Vehicle will identify the correct procedure for diagnosing the system and where the procedure is located.

DTC B1529

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B1529 00: Control Module Voltage Reference Output 5 Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
BCM B+ Terminal 3	B1529 00, B3794 08, B3922 00	B1529 00, B3794 08, B3922 00	--	--
BCM B+ Terminal 17	B1529 00, B3794 08, B3922 00	B1529 00, B3794 08, B3922 00	--	--

Circuit/System Description

The body control module (BCM) provides battery voltage to the cruise control switch and the automatic transmission shift lever.

Conditions for Running the DTC

- The ignition is ON.
- The battery voltage is between 9 - 16 volts.

Conditions for Setting the DTC

- The BCM detects a short to ground or an open on the B+ circuit.
- The above condition is met for 5 seconds.

Action Taken When the DTC Sets

The BCM stores the DTC information into memory when the diagnostic runs and fails.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC clears after 40 fault-free ignition cycles.

Reference Information

Schematic Reference

- Cruise Control Schematics
- Body Control System Schematics
- Automatic Transmission Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Steering Wheel Controls Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X3 harness connector at the BCM.
2. Verify that a test lamp illuminates between the BCM F9 fuse B+ circuit terminal 3 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Ignition OFF, connect the X3 harness connector at the BCM.
4. Disconnect the harness connector at the turn signal/multifunction switch.
5. Ignition ON, test for B+ between the B+ circuit terminal 6 and ground.

   If less than the specified value, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
6. If all circuits test normal, test or replace the turn signal/multifunction switch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the steering wheel switch assembly.

2. Test for 0.5-O.L. ohms between the scroll wheel terminals listed below, while rotating each steering wheel scroll wheel several times through its full range of motion.
   - right steering wheel scroll wheel terminal 1 and terminal 2.
   - left steering wheel scroll wheel terminal 3 and terminal 4.

   If not within the specified range or is erratic, replace the steering wheel switch.
3. Test the resistance between the signal terminal 6 and the low reference terminal 5 while depressing the appropriate steering wheel controls switch button listed below.

   If not the specified value, replace the steering wheel switch.

Function Switch	**Minimum Resistance Value**	**Maximum Resistance Value**
Mute	98 Ohm	104 Ohm
Phone/Talk	247 Ohm	253 Ohm
Disc Change	426 Ohm	434 Ohm
Audio	646 Ohm	653 Ohm
Trip	975 Ohm	983 Ohm
Call End	3.73k Ohm	3.79k Ohm
No Switch Pressed	7.01k Ohm.	7.30k Ohm.

Repair Instructions

Perform the Diagnostic Repair Verification.

Control Module References for BCM replacement, setup, and programming

DTC B2815

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B2815 04: Steering Wheel Switch Open Circuit

DTC B2815 59: Steering Wheel Switch Stuck

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Steering Wheel Controls Signal	1	1	--	--
Right Steering Wheel Scroll 1 Signal	1	B2815 04	--	--
Right Steering Wheel Scroll 2 Signal	1	B2815 04	--	--
Left Steering Wheel Scroll 1 Signal	1	B2815 04	--	--
Left Steering Wheel Scroll 2 Signal	1	B2815 04	--	--
Steering Wheel Controls Low Reference	1	B2815 04	--	--
1. Steering wheel controls inoperative.				

Circuit/System Description

The instrument panel cluster (IPC) supplies a regulated voltage supply to the steering wheel control switches and monitors the return signal. Each switch state is associated with a specific resistance value. When a switch is depressed a specific voltage drop occurs across the resistor unique to that switch. The IPC is able to identify which switch was depressed by recognising the voltage drop associated with that switch and responds to the selected request.

Conditions for Running the DTC

- The system voltage is between 9-16 volts.

- The ignition is ON.

Conditions for Setting the DTC

DTC B2815 04

The IPC detects an open in the steering wheel circuits for more than 5 seconds.

DTC B2815 59

The IPC detects a stuck steering wheel switch for more than 3 minutes.

Action Taken When the DTC Sets

- The IPC will not acknowledge driver requested inputs from the steering wheel switch.
- A stuck steering wheel switch will be unable to send driver requests to the IPC.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The DTC can be cleared using a scan tool.

Reference Information

Schematic Reference

Steering Wheel Secondary/Configurable Control Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Steering Wheel Controls Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, while depressing the individual push button steering wheel control switches, observe the scan tool and verify the status of the individual steering wheel control switches. The following values should display depending on which switch is depressed.

Depressed	Displayed	
Right Scroll Wheel	Mute	
Phone/Talk	Phone A	
Call End	Phone B	
Source	Mode	
Trip	Trip time	

- While rotating the individual scroll wheel control switches UP multiple times, the value of the Left Source Button or the Right Source Button parameter starts counting until a maximum value of 127 counts are shown. When the switch is released, the Left Source Button or the Right Source Button parameter restarts from 0.
- While rotating the individual scroll wheel control switches DOWN multiple times, the value of the Left Source Button or the Right Source Button parameter starts counting until a minimum value of -127 counts are shown. When the switch is released, the Left Source Button or the Right Source Button parameter restarts from 0.

Circuit/System Testing

Note: If DTC B2815 59 is set the steering wheel switch component test should be performed prior to continuing with component testing below.

1. Ignition OFF, disconnect the harness connector at the steering wheel switch assembly.
2. Test for less than 5 ohms between the low reference circuit terminal 5 and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the IPC.
3. Ignition ON, test for 4.8-5.2 volts between the signal circuit terminal 6 and ground.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the IPC.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the IPC.
4. Test for 4.8-5.2 volts between the signal circuit terminals listed below and ground.
   - Right Steering Wheel Scroll 2 terminal 1.
   - Right Steering Wheel Scroll 1 terminal 2.
   - Left Steering Wheel Scroll 1 terminal 3.
   - Left Steering Wheel Scroll 2 terminal 4.

   If less than the specified range, test the appropriate signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the IPC.

   If greater than the specified range, test the appropriate signal circuit for a short to voltage. If the circuit tests normal, replace the IPC.
5. If all circuits test normal, replace the steering wheel control switch assembly.

Component Testing

1. Ignition OFF, disconnect the harness connector at the steering wheel switch assembly.
2. Test for 0.5-O.L. ohms between the scroll wheel terminals listed below, while rotating each steering wheel scroll wheel several times through its full range of motion.
   - right steering wheel scroll wheel terminal 1 and terminal 2.
   - left steering wheel scroll wheel terminal 3 and terminal 4.

   If not within the specified range or is erratic, replace the steering wheel switch.
3. Test the resistance between the signal terminal 6 and the low reference terminal 5 while depressing the appropriate steering wheel controls switch button listed below.

   If not the specified value, replace the steering wheel switch.

Function Switch	Minimum Resistance Value	Maximum Resistance Value
Mute	98 Ohm	104 Ohm
Phone/Talk	247 Ohm	253 Ohm
Disc Change	426 Ohm	434 Ohm
Audio	646 Ohm	653 Ohm
Trip	975 Ohm	983 Ohm
Call End	3.73k Ohm	3.79k Ohm
No Switch Pressed	7.01k Ohm.	7.30k Ohm.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Steering Wheel Control Switch Assembly Replacement
- Control Module References for BCM replacement, setup, and programming

Symptoms - Secondary and Configurable Customer Controls

Important:

- Perform the Diagnostic System Check - Vehicle before using the Symptom Tables in order to verify that all of the following conditions are true:
  - There are no DTCs set.
  - The control modules can communicate via the serial data link.
- Review the system operation in order to familiarize yourself with the system functions. Refer to Steering Wheel Controls Description and Operation.

Visual/Physical Inspection

- Inspect for aftermarket devices which may affect the operation of the Steering Wheel Controls System. Refer to Checking Aftermarket Accessories.
- Inspect for easily accessible or visible system components for obvious damage or conditions which may cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to Steering Wheel Controls Malfunction in order to diagnose the symptom.

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Steering Wheel Controls Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Steering Wheel Controls Signal	1	1	--	--
Right Steering Wheel Scroll 1 Signal	1	B2815 04	--	--
Right Steering Wheel Scroll 2 Signal	1	B2815 04	--	--
Left Steering Wheel Scroll 1 Signal	1	B2815 04	--	--
Left Steering Wheel Scroll 2 Signal	1	B2815 04	--	--
Steering Wheel Controls Low Reference	1	B2815 04	--	--
1. Steering wheel controls inoperative.				

Circuit/System Description

The instrument panel cluster (IPC) supplies a regulated voltage supply to the steering wheel control switches and monitors the return signal. Each switch state is associated with a specific resistance value. When a switch is depressed a specific voltage drop occurs across the resistor unique to that switch. The IPC is able to identify which switch was depressed by recognising the voltage drop associated with that switch and responds to the selected request.

Reference Information

Schematic Reference

Steering Wheel Secondary/Configurable Control Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Steering Wheel Controls Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, while depressing the individual push button steering wheel control switches, observe the scan tool and verify the status of the individual steering wheel control switches. The following values should display depending on which switch is depressed.

Depressed	Displayed
Right Scroll Wheel	Mute
Phone/Talk	Phone A
Call End	Phone B
Source	Mode
Trip	Trip time

- While rotating the individual scroll wheel control switches UP multiple times, the value of the Left Source Button or the Right Source Button parameter starts counting until a maximum value of 127 counts are shown. When the switch is released, the Left Source Button or the Right Source Button parameter restarts from 0.
- While rotating the individual scroll wheel control switches DOWN multiple times, the value of the Left Source Button or the Right Source Button parameter starts counting until a minimum value of -127 counts are shown. When the switch is released, the Left Source Button or the Right Source Button parameter restarts from 0.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the steering wheel switch assembly.
2. Test for less than 5 ohms between the low reference circuit terminal 5 and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the IPC.
3. Ignition ON, test for 4.8-5.2 volts between the signal circuit terminal 6 and ground.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the IPC.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the IPC.

4. Test for 4.8-5.2 volts between the signal circuit terminals listed below and ground.
   - Right Steering Wheel Scroll 2 terminal 1.
   - Right Steering Wheel Scroll 1 terminal 2.
   - Left Steering Wheel Scroll 1 terminal 3.
   - Left Steering Wheel Scroll 2 terminal 4.

   If less than the specified range, test the appropriate signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the IPC.

   If greater than the specified range, test the appropriate signal circuit for a short to voltage. If the circuit tests normal, replace the IPC.
5. If all circuits test normal, replace the steering wheel control switch assembly.

Component Testing

1. Ignition OFF, disconnect the harness connector at the steering wheel switch assembly.
2. Test for 0.5-O.L. ohms between the scroll wheel terminals listed below, while rotating each steering wheel scroll wheel several times through its full range of motion.
   - right steering wheel scroll wheel terminal 1 and terminal 2.
   - left steering wheel scroll wheel terminal 3 and terminal 4.

   If not within the specified range or is erratic, replace the steering wheel switch.
3. Test the resistance between the signal terminal 6 and the low reference terminal 5 while depressing the appropriate steering wheel controls switch button listed below.

   If not the specified value, replace the steering wheel switch.

Function Switch	Minimum Resistance Value	Maximum Resistance Value
Mute	98 Ohm	104 Ohm
Phone/Talk	247 Ohm	253 Ohm
Disc Change	426 Ohm	434 Ohm
Audio	646 Ohm	653 Ohm
Trip	975 Ohm	983 Ohm
Call End	3.73k Ohm	3.79k Ohm
No Switch Pressed	7.01k Ohm.	7.30k Ohm.

Repair Instructions

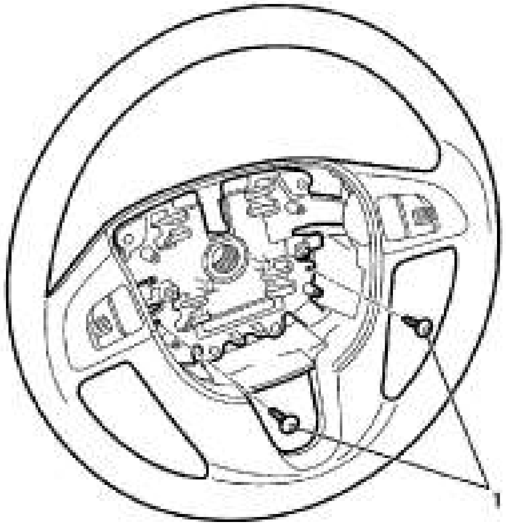
Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Steering Wheel Control Switch Assembly Replacement
- Control Module References for BCM replacement, setup, and programming

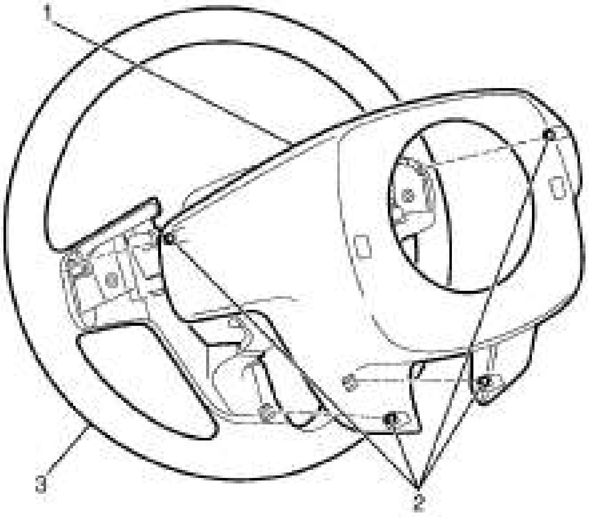
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Driver Information and Entertainment | Secondary and Configurable Customer Controls | Repair Instructions | Document ID: 2137003

Steering Wheel Control Switch Assembly Replacement

Removal Procedure

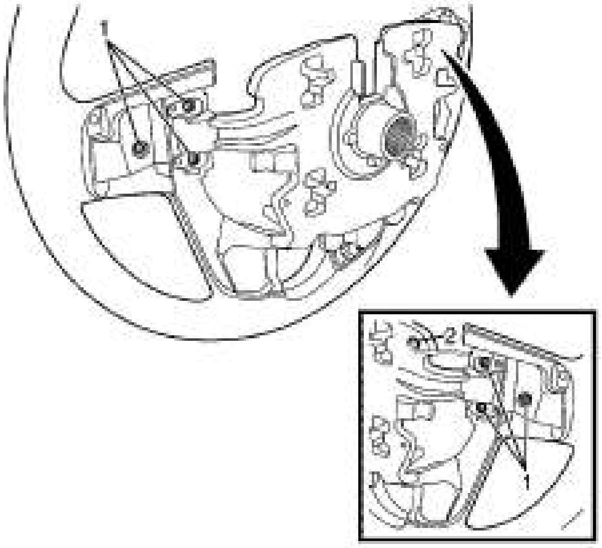


1. Disable the occupant protection system. Refer to SIR Disabling and Enabling.
2. Remove the steering wheel inflatable restraint. Refer to Inflatable Restraint Steering Wheel Module Replacement.
3. Remove the steering wheel. Refer to Steering Wheel Replacement.
4. Remove the steering wheel hub to rear cover screws (1).

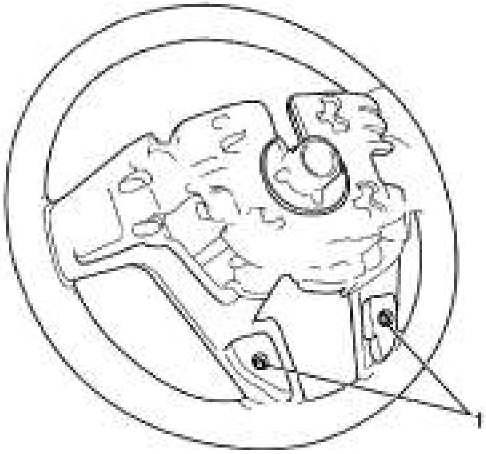


Important: Make sure to disengage the retaining lugs (2).

5. Remove the rear cover (1) from the steering wheel hub (3).

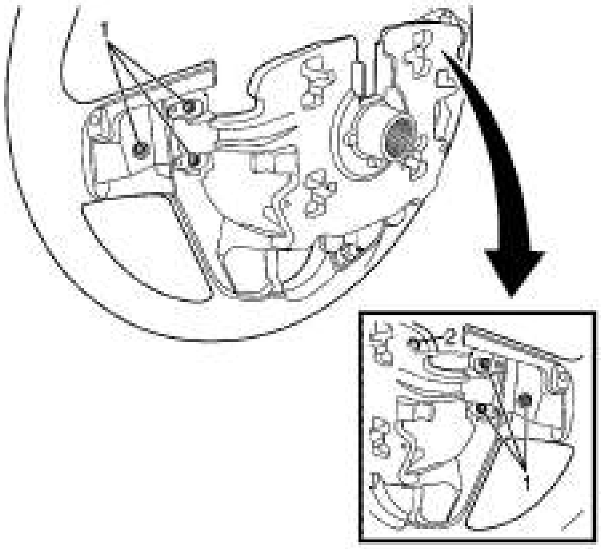


6. Remove the steering wheel hub to steering wheel audio control switch assembly screws (1).
7. Remove the steering wheel audio control switch assembly harness grounding screw (2).



8. Remove the steering wheel hub to steering wheel spoke trim retaining screws (1).
9. Remove the steering wheel audio control switches from the steering wheel hub assembly.

Installation Procedure



1. Install the steering wheel audio control switches from the steering wheel hub assembly.

   Notice: Refer to Fastener Notice in the Preface section.

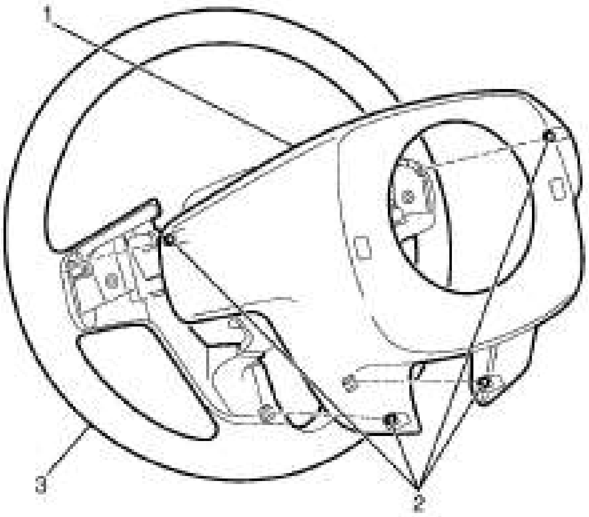
2. Install the steering wheel audio control switch assembly harness grounding screw (2).

   Tighten
   Tighten the screws to 1 N·m (9 lb in).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the steering wheel hub to steering wheel audio control switch assembly retaining screws (1).

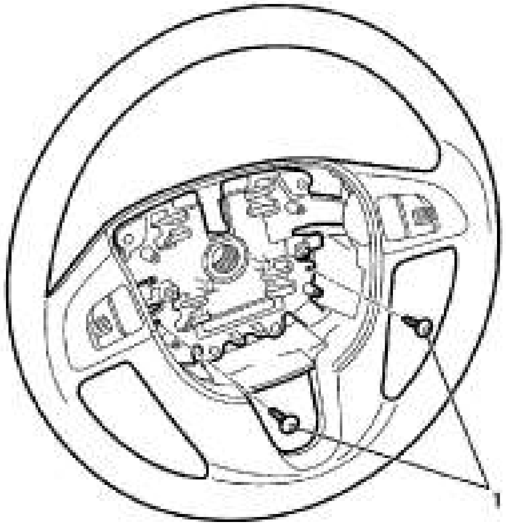
   Tighten
   Tighten the screws to 1 N·m (9 lb in).



Important: Make sure that all the retainers (2) engage.

4. Install the rear cover (1) to the steering wheel hub (3).

   Notice: Refer to Fastener Notice in the Preface section.



5. Install the steering wheel hub to rear cover retaining screws (1).

   Tighten
   Tighten the screws to 1 N·m (9 lb in).

6. Install the steering wheel. Refer to Steering Wheel Replacement.
7. Install the steering wheel inflatable restraint. Refer to Inflatable Restraint Steering Wheel Module Replacement.
8. Enable the occupant protection system. Refer to SIR Disabling and Enabling.

Steering Wheel Controls Description and Operation

The steering wheel control switches duplicate the function of the primary controls of the associated component through a network of multiple momentary contact switches and a series of resistors. The instrument panel cluster (IPC) supplies voltage to the switches and monitors the return signal. When a switch is pressed, a specific voltage drop across the resistors. The IPC identifies the switch selected, sends a serial data message to the component controlled by the switch and activates the feature.

This section is intended to diagnosis the circuits between the IPC and the steering wheel control switches. If the primary control for the device is inoperative, refer to the appropriate section for the component the steering wheel control switch is used for.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Preliminary Information | **Document ID: 2182574**

#PIP4462: SES Light and DTC P0230 - (Aug 26, 2008)

Subject: SES Light and DTC P0230

Models: 2004 - 2009 Passenger Cars and Light Duty Trucks
Equipped with gasoline engines

The following diagnosis might be helpful if the vehicle exhibits the symptom(s) described in this PI.

Condition/Concern:

Some owners may comment that the Service Engine Soon (SES) light has illuminated. Upon closer inspection using a Tech 2, DTC P0230 (Fuel Pump Relay Control Circuit) may have been found stored in the PCM

Recommendation/Instructions:

Follow the appropriate diagnostic information in SI. If no cause for the DTC can be found, inspect the vehicle for installation of an aftermarket anti-theft system. Some aftermarket anti-theft systems may have features that take control of or override the fuel pump relay circuit. Anti-theft systems that have such features may cause the diagnostic code to set if an attempt is made to start the vehicle without first disabling (turning off) the aftermarket system.

If such an aftermarket system is found on the vehicle and the condition (setting the DTC) can be duplicated by not disabling the system prior to starting the vehicle, advise the vehicle owner that the cause of the SES light being illuminated is the aftermarket anti-theft system.

Please follow this diagnostic or repair process thoroughly and complete each step. If the condition exhibited is resolved without completing every step, the remaining steps do not need to be performed.

GM bulletins are intended for use by professional technicians, NOT a ""do-it-yourselfer"". They are written to inform these technicians of conditions that may occur on some vehicles, or to provide information that could assist in the proper service of a vehicle. Properly trained technicians have the equipment, tools, safety instructions, and know-how to do a job properly and safely. If a condition is described, DO NOT assume that the bulletin applies to your vehicle, or that your vehicle will have that condition. See your GM dealer for information on whether your vehicle may benefit from the information.

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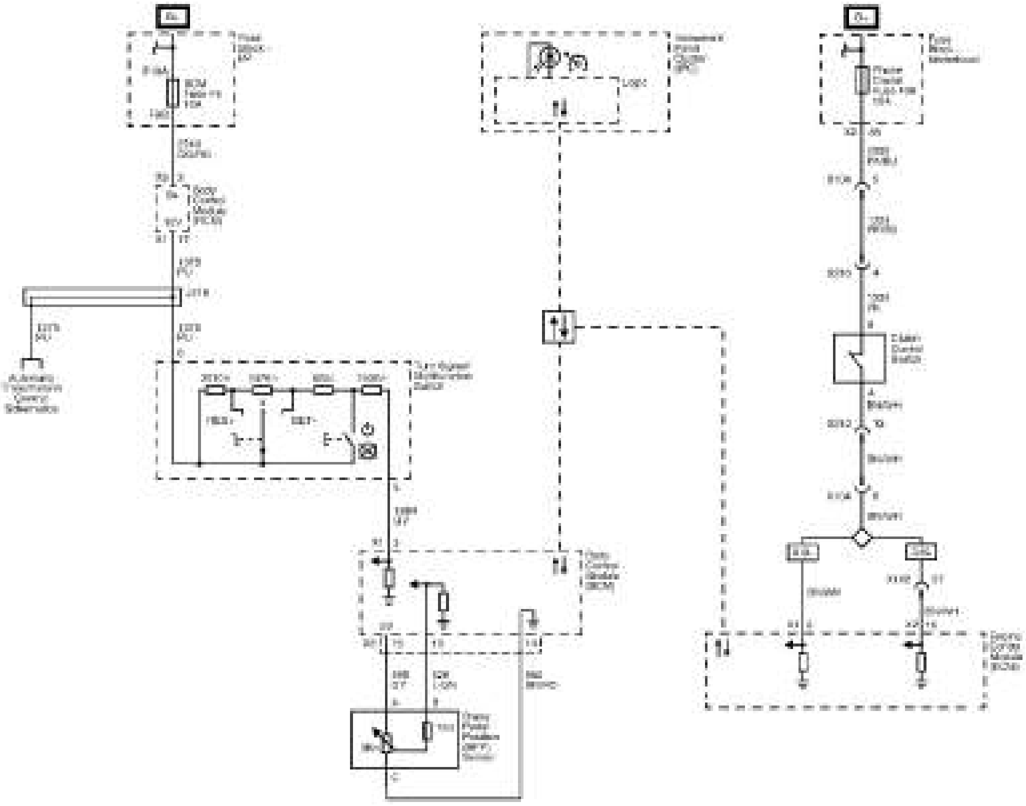
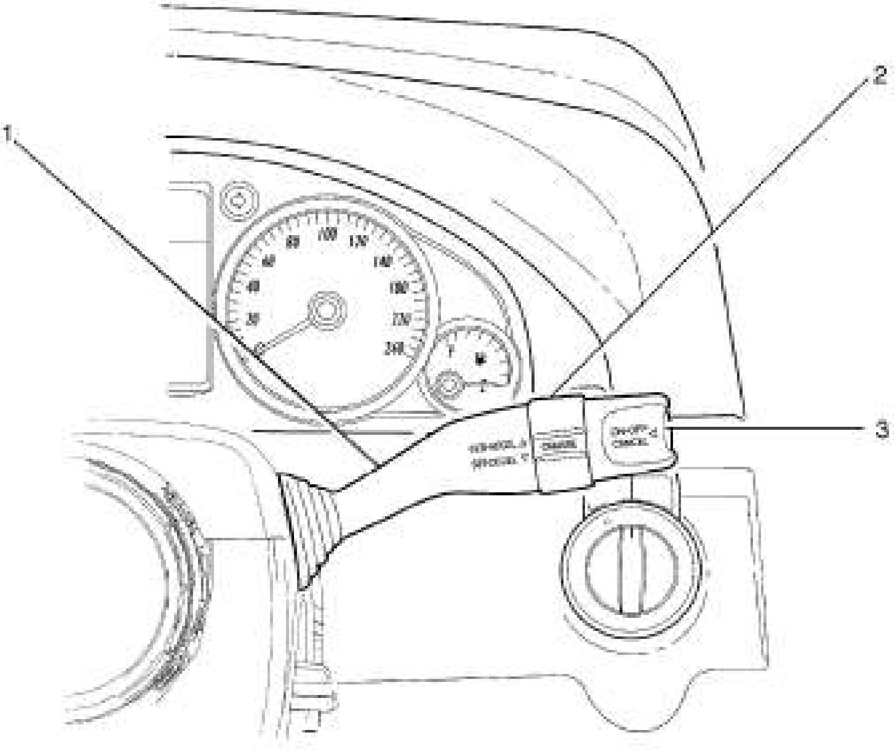
Cruise Control Schematics

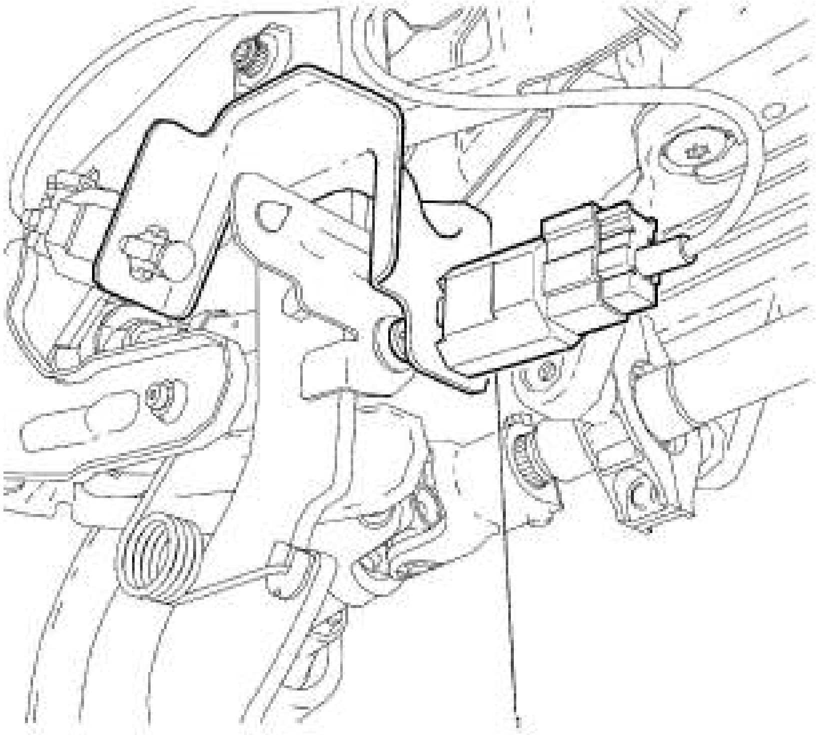


Cruise Control Stalk



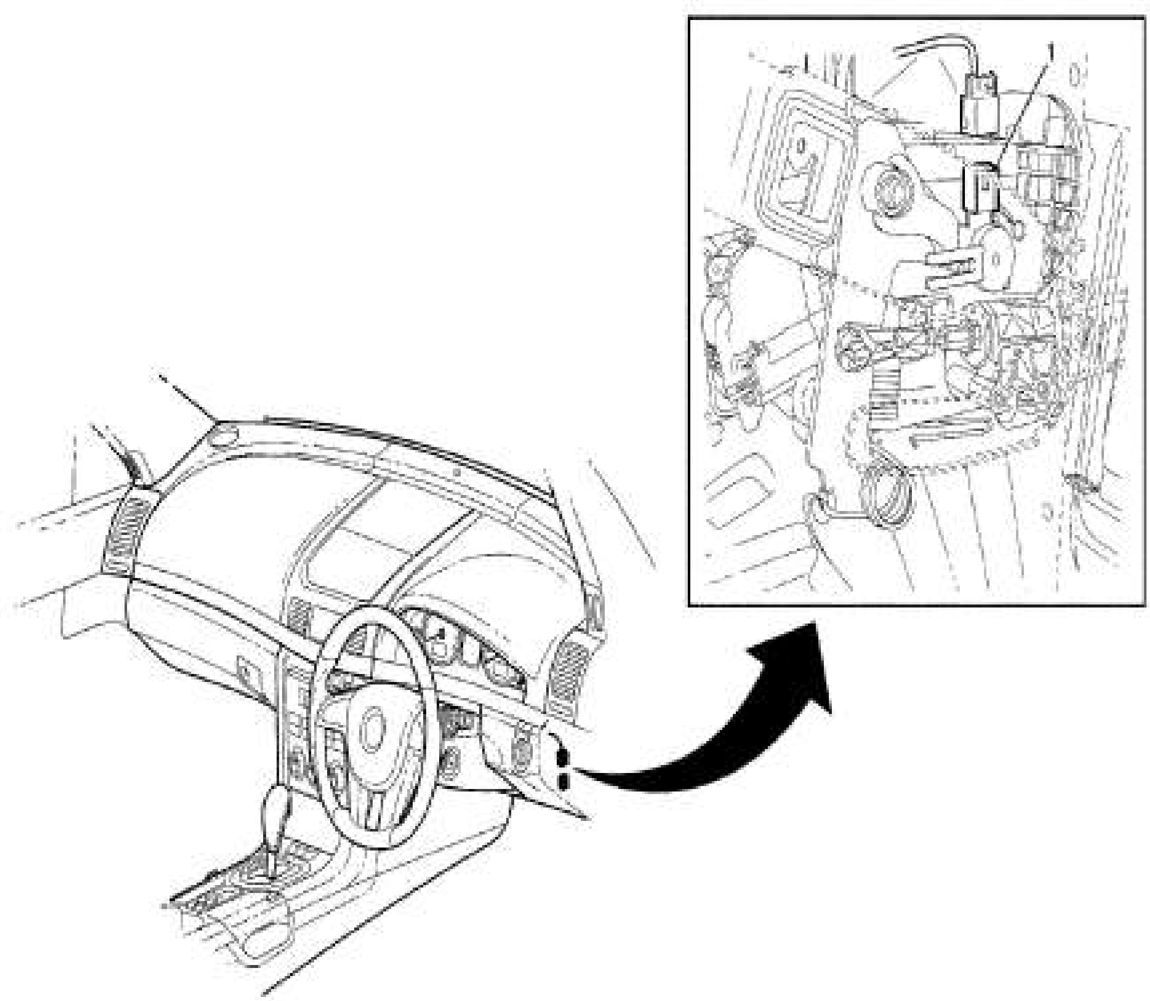
(1) Cruise Control Stalk
(2) Increase/Decrease Speed Selector
(3) On/Off Cruise Control Button

Clutch Switch - Up to 17 Sep 2007



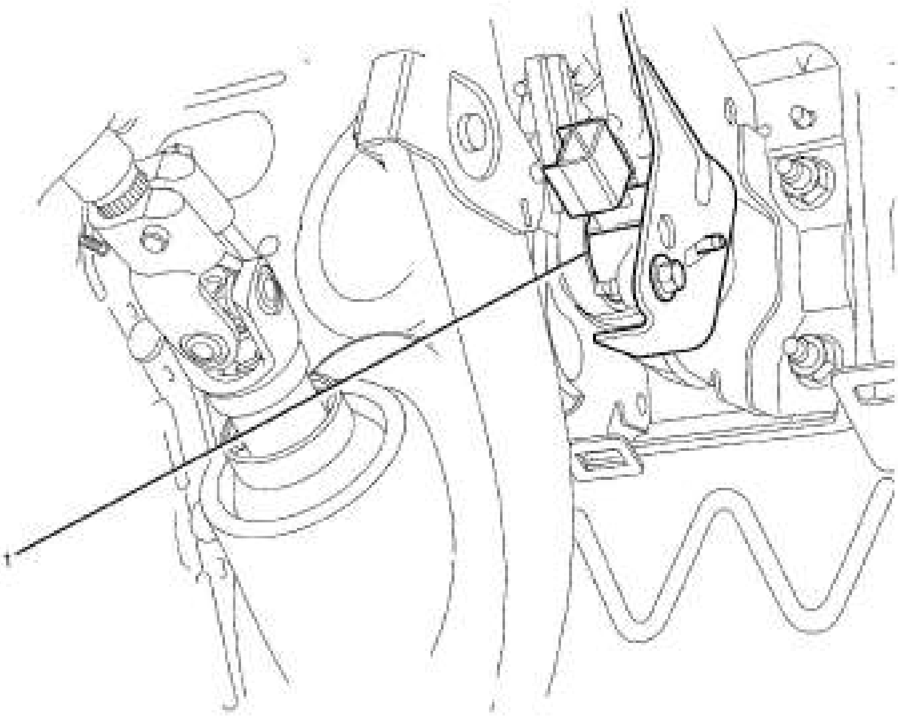
(1) Clutch Switch

Clutch Pedal Position Sensor - After 17 Sept 2007



(1) Clutch Pedal Position Sensor

Brake Pedal Position Sensor



(1) Brake pedal position sensor

Diagnostic Starting Point - Cruise Control

Begin the system diagnosis with the Diagnostic System Check - Vehicle. The Diagnostic System Check will provide the following information:

- The identification of the control modules which command the system.
- The ability of the control modules to communicate through the serial data circuit.
- The identification of any stored diagnostic trouble codes (DTC's) and their status.

The use of the Diagnostic System Check will identify the correct procedure for diagnosing the system and where the procedure is located.

DTC B3794

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B3794 08: Cruise Control Function Request Circuit Signal Invalid

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
BCM B+ Terminal 3	B3794 08, B1529 00, B3922 00	B3794 08, B1529 00, B3922 00	--	--
BCM B+ Terminal 17	B3794 08 B1529 00, B3922 00	B3794 08 B1529 00, B3922 00	--	--
Cruise Control Switch Signal	B3794 08	B3794 08	B3794 08	--

Circuit/System Description

The cruise control switch is an input to the body control module (BCM). The BCM monitors the cruise control on/off, set/coast, resume/accelerate and cancel switches via the cruise control switch signal circuit in order to detect when the driver has requested to perform a cruise control function. The BCM detects a specific voltage signal on the cruise control switch signal circuit when a switch is applied. The BCM sends a serial data message to the ECM indicating the status of the cruise control switches.

Conditions for Running the DTC

- Ignition ON.
- Battery Voltage Must be Between 9 - 16 volts.

Conditions for Setting the DTC

- The BCM detects a short to ground or open on the BCM B+ circuit.
- The BCM detects a short to ground or short to voltage on the cruise control switch signal circuit.

- The BCM detects an invalid voltage signal on the cruise control switch signal circuit.

Actions Taken When the DTC Sets

- The malfunction indicator lamp (MIL) will not illuminate.
- The cruise control system is disabled.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear after 40 malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cruise Control Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

Engine ON, observe the scan tool Cruise Control Switch parameter while pressing each of the cruise control switches. The parameter should toggle between On, Off, Resume and Set as the applicable switch is pressed.

Circuit / System Testing

1. Ignition OFF, disconnect the X3 harness connector at the BCM.

2. Verify that a test lamp illuminates between the BCM F9 fuse B+ circuit terminal 3 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Ignition OFF, connect the X3 harness connector at the BCM.
4. Disconnect the harness connector at the turn signal/multifunction switch.
5. Ignition ON, test for B+ between the B+ circuit terminal 6 and ground.

   If less than the specified value, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
6. Ignition ON, test for B+ between the B+ circuit terminal 6 and the signal circuit terminal 5.

   If less than the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
7. Ignition ON, verify that a test lamp does not illuminate between B+ and the signal circuit terminal 5.

   If the test lamp illuminates, test the signal circuit for a short to ground. If the circuit test normal, replace the BCM.
8. If all circuits test normal, test or replace the turn signal/multifunction switch.

Component Testing

1. Disconnect the harness connector at the turn signal/multifunction switch.
2. Cruise control switch ON, measure the resistance between terminal 5 and terminal 6 while individually activating and holding each cruise control function switch and compare the resistance reading to the values in the table below.

   If not within the specified resistance range, replace the turn signal/multifunction switch.

Function Switch	Minimum Resistance Value	Maximum Resistance Value
Off	6.7k Ohms	6.9k Ohms
On	1.4k Ohms	1.6k Ohms
- SET	2.2k Ohms	2.4k Ohms
+ RES	3.6k Ohms	3.9k Ohms

Repair Instructions

Perform the Diagnostic Repair Verification.

- Turn Signal Switch Replacement
- Control Module References for BCM replacement, setup, and programming.

DTC P0571

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0571: Cruise Control Brake Switch Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open or High Resistance	Short to Voltage	Signal Performance
Stop Lamp Switch Signal	P0571	P0571	P0571	--

Circuit/System Description

The brake applied signal circuit is a high voltage input from the body control module (BCM) to the engine control module (ECM) and transmission control module (TCM). The ECM monitors the stop lamp switch circuit to detect when the brake pedal has been applied. The BCM monitors the brake pedal position sensor to determine when the brake pedal is applied. When the brake pedal is applied, the BCM supplies a high voltage signal on the brake applied signal circuit and also sends a serial data message to the ECM indicating that the brake pedal has been applied. The ECM senses a high voltage signal on the brake applied signal circuit when the brake pedal has been applied.

Conditions for Running the DTC

- The vehicle has cycled from 0-60 km/h (0-37 mph) 3 times in 1 ignition cycle.
- Continuous once the previous criteria have been met.

Conditions for Setting the DTC

The ECM detects either a low voltage signal on the stop lamp switch signal circuit when the serial data message from the BCM indicates the brakes are applied, or a high voltage signal on the stop lamp switch signal circuit when the serial data message from the BCM indicates the brakes are not applied.

Actions Taken When the DTC Sets

- The malfunction indicator lamp (MIL) will not illuminate.

- The cruise control system becomes disabled.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear after 40 malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cruise Control Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the Stoplamp Pedal Switch parameter while applying and releasing the brake pedal. The reading should change between Applied/Released, and all brake lights should turn ON and OFF accordingly. Refer to Exterior Lighting Systems Description and Operation

Circuit/System Testing

1. Ignition OFF, disconnect the harness connectors at the appropriate control modules listed below.
   - ECM X1 (L76)
   - ECM X2 (LY7)
   - TCM
2. Connect a test lamp between the appropriate signal circuit terminal listed below and ground.

  - ECM terminal 9 (L76)
  - ECM terminal 52 (LY7)
  - TCM terminal 6 (L76)
  - TCM terminal 38 (LY7)
3. Ignition ON, press and release the brake pedal. Verify the test lamp turns ON and OFF when pressing and releasing the brake pedal.

   If the test lamp is always ON, test the signal circuit for a short to voltage. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
4. Ignition OFF, connect the harness connector at the TCM.
5. Connect a test lamp between the appropriate signal circuit terminal listed below and ground.
   - ECM X1 terminal 9 (L76)
   - ECM X2 terminal 52 (LY7)
6. Ignition ON, press and release the brake pedal. Verify the test lamp turns ON and OFF when pressing and releasing the brake pedal.

   If the test lamp is always ON, test the signal circuit for a short to voltage. If the circuit tests normal, replace the TCM.

   If the test lamp is always OFF, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the TCM.
7. If all circuits test normal, replace the ECM.

Repair Instructions

Perform the Diagnostic Repair Verification.

- Stop Lamp Switch Replacement
- Control Module References for BCM, ECM, TCM or automatic transmission control replacement, setup, and programming

DTC P0575

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0575 : Cruise Control Enable Circuit Malfunction

Circuit/System Description

When a cruise control function switch is activated the body control module (BCM) detects a predetermined voltage signal. The BCM sends a GMLAN serial data message to the engine control module (ECM) indicating the function that has been requested.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

- The ECM receives an invalid cruise control switch status GMLAN serial data message from the BCM.
- This diagnostic runs continuously.

Action Taken when the DTC Sets

DTC P0575 is a type A DTC.

Conditions for Clearing the MIL/DTC

DTC P0575 is a type A DTC.

Diagnostic Aids

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

Reference Information

Schematic Reference

- Cruise Control Schematics
- Body Control System Schematics
- Steering Wheel Secondary/Configurable Control Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Verification

Ignition ON, observe the scan tool Cruise Control Switch parameter while pressing the cruise control switch ON and OFF. The reading should change between ON and OFF.

Circuit/System Testing

Ignition ON, verify that DTC P0575 is current in the ECM.

- If the DTC is stored as a current DTC, replace the BCM.
- If the DTC is stored only as a history DTC, refer to Diagnostic Aids. Do not replace the BCM.

Repair Instructions

Perform the Diagnostic Repair Verification .

Control Module References .

DTC P0703

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0703: Torque Converter / Brake Switch Circuit Malfunction

Circuit/System Description

The body control module (BCM) monitors the stop lamp switch mounted on the brake pedal. The BCM sends a GMLAN serial data message to the engine control module (ECM) indicating the status of the stop lamp switch.

Conditions for Running the DTC

The engine is ON.

Conditions for Setting the DTC

- The ECM receives an invalid brake pedal status GMLAN serial data message from the BCM.
- This diagnostic runs continuously.

Action Taken when the DTC Sets

DTC P0703 is a type C Store Only DTC.

Conditions for Clearing the MIL/DTC

DTC P0703 is a type C Store Only DTC.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Circuit/System Testing

Important: Fix any Brake System related DTCs before using this diagnostic.

Note: This DTC may be stored as a history DTC without affecting the operation of the BCM. Do not replace the BCM if this DTC is stored only as a history DTC and is not retrieved as a current DTC.

Using a scan tool is DTC P0703 current in the ECM?

If DTC P0703 is current in the ECM, replace the BCM.

If DTC P0703 is not current in the ECM, the system is OK.

Repair Instructions

Perform the Diagnostic Repair Verification .

Control Module References

Symptoms - Cruise Control

Important: The following steps must be completed before using the symptom tables.

1. Perform the Diagnostic System Check - Vehicle:
    - There are no DTCs set.
    - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to Cruise Control Description and Operation.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the Cruise Control System. Refer to Checking Aftermarket Accessories.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to Cruise Control Inoperative/Malfunctioning.

Cruise Control Indicator Inoperative

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit/System Description

The body control module (BCM) monitors the cruise control indicator switch. When the cruise on/off switch is pressed ON, the cruise control switch is closed and the signal circuit is low. The BCM sends a serial data message to the instrument panel cluster (IPC) indicating the status of the cruise control switch.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cruise Control Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, perform the Display Test. Verify the cruise control indicator illuminated.
   If the indicator does not illuminate, replace the IPC.
2. Replace the BCM.

Repair Instructions

Perform the Diagnostic Repair Verification.

- Instrument Cluster Replacement.
- Control Module References for ECM or IPC replacement, setup, and programming.

Cruise Control Inoperative/Malfunctioning

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
BCM B+ Terminal 3	B3794 08, B1529 00, B3922 00	B3794 08, B1529 00, B3922 00	--	--
BCM B+ Terminal 17	B3794 08, B1529 00, B3922 00	B3794 08, 1529 00, B3922 00	--	--
Cruise Control Switch Signal	B3794 08	B3794 08	B3794 08	--

Circuit/System Description

The cruise control switch is an input to the body control module (BCM). The BCM monitors the cruise control on/off, set/coast, resume/accelerate and cancel switches via the cruise control switch signal circuit in order to detect when the driver has requested to perform a cruise control function. The BCM detects a specific voltage signal on the cruise control switch signal circuit when a switch is applied. The BCM sends a serial data message to the ECM indicating the status of the cruise control switches.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cruise Control Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Engine ON, observe the scan tool Cruise Control Switch parameter while pressing each of the cruise control switches. The parameter should toggle between On, Off, Resume and Set as the applicable switch is pressed.

Circuit/System Testing

1. Ignition OFF, disconnect the X3 harness connector at the BCM.
2. Verify that a test lamp illuminates between the BCM F9 fuse B+ circuit terminal 3 and ground.
   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Ignition OFF, connect the X3 harness connector at the BCM.
4. Disconnect the harness connector at the turn signal/multifunction switch.
5. Ignition ON, test for B+ between the B+ circuit terminal 6 and ground.
   If less than the specified value, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
6. Ignition ON, test for B+ between the B+ circuit terminal 6 and the signal circuit terminal 5.
   If less than the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
7. Ignition ON, verify that a test lamp does not illuminate between B+ and the signal circuit terminal 5.
   If the test lamp illuminates, test the signal circuit for a short to ground. If the circuit test normal, replace the BCM.
8. If all circuits test normal, test or replace the turn signal/multifunction switch.

Component Testing

1. Disconnect the harness connector at the turn signal/multifunction switch.
2. Cruise control switch ON, measure the resistance between terminal 5 and terminal 6 while individually activating and holding each cruise control function switch and compare the resistance reading to the values in the table below.
   If not within the specified resistance range, replace the turn signal/multifunction switch.

Function Switch	Minimum Resistance Value	Maximum Resistance Value
Off	6.7k Ohms	6.9k Ohms
On	1.4k Ohms	1.6k Ohms
- SET	2.2k Ohms	2.4k Ohms

+ RES	3.6k Ohms	3.9k Ohms

Repair Instructions

Perform the Diagnostic Repair Verification.

- Turn Signal Switch Replacement
- Control Module References for BCM replacement, setup, and programming.

Cruise Control Description and Operation

Cruise control is a speed control system that maintains a desired vehicle speed under normal driving conditions at speeds above 33 km/h for V6 and 38 km/h for V8. Steep grades may cause variations in the selected vehicle speeds.

The following are the main components of the Cruise Control System:

- The accelerator pedal.
- The stop lamp switch.
- The body control module (BCM).
- The cruise control switches.
- The engine control module (ECM).
- The throttle actuator control (TAC) motor.
- The vehicle speed sensor (VSS).

Cruise Control Engaged

The Cruise Control System will engage and adjust vehicle speeds, based on the activation of the following cruise control switches, which are located in the cruise control stalk.

- On/Off cancel switch
- RES/ACCEL switch.
- SET/DECEL switch.

The body control module (BCM) monitors the signal circuit of the cruise control switches. The BCM relays the cruise control switch status to the engine control module (ECM) via the serial data circuit. The ECM uses the status of the cruise control switch to determine when to capture and maintain the vehicle speed. The ECM monitors the vehicle speed signal circuit in order to determine the desired vehicle speed. The ECM uses the throttle actuator control (TAC) motor in order to maintain the vehicle speed. For further information on the TAC System, refer to Throttle Actuator Control (TAC) System Description.

Voltage is supplied to the cruise control switch via reference voltage circuit supplied by the BCM. The cruise control function switches are arranged in a resistive ladder design, with each cruise control function switch having a different resistance value. The BCM detects a specific voltage value that is associated with the cruise control function switch being activated. When the normally open cruise control on/off switch is turned ON, the switch closes and the BCM supplies a ground to the cruise control switch.

The BCM sends a serial data message to the ECM indicating that the on/off switch is active. Similarly, when the normally open + RES switch or the normally open - SET switch are pressed, the switch closes and the BCM detects the predetermined voltage signal on the cruise control set/coast and resume/accel switch signal circuit. The BCM sends a serial data message to the ECM indicating that the + RES switch or the - SET switch is active. To engage the Cruise Control System, make sure that the vehicle speed is above 33 km/h for a V6 and 38 km/h for a V8, turn the cruise On/Off switch ON and momentarily press the - SET switch. The Cruise Control System has a maximum engaging speed of 110 km/h.

The ECM will engage the Cruise Control System and record the vehicle speed. The ECM sends a serial data message to the driver information center (DIC) in order to illuminate the CRUISE SET TO ### message. The ECM sends a serial data message to the instrument panel cluster (IPC) in order to illuminate the Cruise Engaged indicator in the IPC. The - SET switch and the + RES switch will remain inactive when the BCM has not received the predetermined voltage signal from the on/off switch.

Pressing the accelerator pedal, while the Cruise Control System is engaged, will allow the driver to override the Cruise Control System in order to accelerate the vehicle beyond the current set vehicle speed. When the accelerator pedal is released, the vehicle will decelerate and resume the current set vehicle speed. The driver can also override the current set vehicle speed via the - SET switch and the + RES switch. When the Cruise Control System is engaged, pressing and holding the - SET switch will allow the vehicle to decelerate from the current set vehicle speed without deactivating the Cruise Control System. When the - SET switch is released, the ECM will record the vehicle speed and maintain the vehicle speed as the new set vehicle speed.

When the Cruise Control System is engaged, momentarily pressing the - SET switch will allow the vehicle to decelerate at 1 km/h increments for each time that the - SET is momentarily pressed, with a minimum vehicle speed of 38 km/h. Pressing and holding the + RES switch, when the Cruise Control System is engaged, will allow the vehicle to accelerate to a greater vehicle speed than the current set vehicle speed. When the + RES switch is released, the ECM will record the vehicle speed and maintain the vehicle speed as the new set vehicle speed.

When the Cruise Control System is engaged, momentarily pressing the + RES switch will allow the vehicle to accelerate at 1 km/h increments for each time that the + RES switch is momentarily pressed, with the maximum acceleration total of 16 km/h over the current set vehicle speed. Momentarily activating the + RES switch will recall the previous vehicle speed, after the cruise control system is disengaged by pressing the brake pedal or by activating the CANCEL switch.

Cruise Control Disengaged

The engine control module (ECM) disengages the cruise control operation based on the signals from the following switches:

- The stop lamp switch.
- The cruise control On/Off switch.

The body control module (BCM) determines when the cruise control cancel switch is activated. When the normally open cancel switch is closed, the BCM detects the predetermined voltage signal on the cruise control function switch circuit. The BCM sends a serial data message to the ECM in order to disengage the cruise control system.

The stop lamp switch is mounted on the brake pedal bracket. When the brake pedal is applied, the normally open stop lamp switch closes. The ECM monitors the stop lamp signal circuit through a discrete input and a serial data message signal from the BCM indicating the brake status. When both signals indicate the brake pedal is applied, the ECM will disengage the cruise control system.

The Cruise Control System will disengage when the cruise control On/Off switch is switched OFF. The vehicle speed stored in the memory of the engine control module will be erased when the cruise control On/Off switch is turned OFF, or the ignition switch is turned OFF.

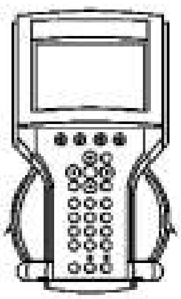
The Cruise Control System will disengage when the ECM detects that a driver override function has been active for approximately 60 seconds. When the Cruise Control System has been disengaged, the ECM sends a serial message to the instrument panel cluster (IPC) in order to turn OFF the Cruise Engaged indicator, and to the driver information center (DIC) in order to turn OFF the CRUISE SET TO ### message.

Cruise Control Inhibited

The engine control module (ECM) inhibits the cruise control operation when any of the following conditions exist:

- The ECM has not detected a brake pedal activation from the body control module (BCM).
- A Cruise Control System DTC has been set.
- The vehicle speed is less than 38 km/h.
- The vehicle speed is too high.
- The vehicle is in PARK, REVERSE, NEUTRAL, or 1st gear.
- The engine RPM is too low.
- The engine RPM is too high.
- The system voltage is not between 9-16 volts.
- The Antilock Brake System (ABS)/Traction Control System (TCS) is active for more than 2 seconds.

Special Tools

Illustration	Tool Number / Description
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

Altitude Versus Barometric Pressure

Altitude Measured in Meters (m)	Altitude Measured in Feet (ft)	Barometric Pressure Measured in Kilopascals (kPa)
Determine your altitude by contacting a local weather station or by using another reference source.		
4 267	14,000	56-64
3 962	13,000	58-66
3 658	12,000	61-69
3 353	11,000	64-72
3 048	10,000	66-74
2 743	9,000	69-77
2 438	8,000	71-79
2 134	7,000	74-82
1 829	6,000	77-85
1 524	5,000	80-88
1 219	4,000	83-91
914	3,000	87-95
610	2,000	90-98
305	1,000	94-102
0	0 Sea Level	96-104
-305	-1,000	101-105

Fastener Tightening Specifications (Petrol)

Application	Specification	
	Metric	English
Accelerator Pedal Position (APP) Sensor Bolt	9 N·m	80 lb in
Air Cleaner Bolt	9 N·m	80 lb in
Camshaft Position (CMP) Actuator Solenoid Valve to Engine Front Cover Retaining Bolt	10 N·m	89 lb in
Camshaft Position (CMP) Sensor to Engine Front Cover Retaining Bolt	10 N·m	89 lb in
Crankshaft Position (CKP) Sensor Bolt	10 N·m	89 lb in
Engine Control Module (ECM) Bracket to chassis Bolt	10 N·m	89 lb in
Engine Coolant Temperature (ECT) Sensor	22 N·m	16 lb ft
Evaporative Emission (EVAP) Canister Bolt	6 N·m	53 lb in
Fuel Filler Tube Brace Bolt	9 N·m	80 lb in
Fuel Filler Tube Hose Clamp	4 N·m	31 lb in
Fuel Tank Strap Bolt	50 N·m	37 lb ft
Heated Oxygen Sensor (HO2S)	40 N·m	30 lb ft
Ignition Coil Bolt	10 N·m	89 lb in
Intake Manifold Runner Control Solenoid Bolt	10 N·m	89 lb in
Knock Sensor Bolt	23 N·m	17 lb ft
MAF Sensor Screw	4 N·m	35 lb in
Rear Frame Bolt		
First pass	65 N·m	48 lb ft
Second pass	120 degrees	
Spark Plugs		
Fit New Spark Plug	20 N·m	15 lb ft
Refit Existing Spark Plug	18 N·m	13 lb ft
Throttle Body Bolts to Upper Intake Manifold Retaining Bolts	10 N·m	89 lb in

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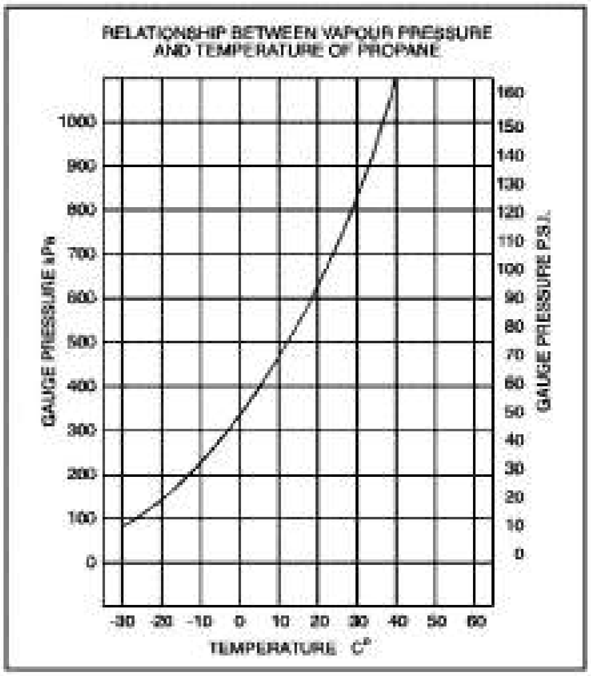
Fuel System Specifications

Fuel Pump Specification

Application	Specification	
	Nominal	Maximum
Fuel Pump Current Draw at Fuel Pump	8.6 Amps	10 Amps

LPG Tank Pressure Relationship Table



Ignition System Specifications

Application	Specification	
	Metric	English
Firing Order	1-2-3-4-5-6	
Spark Plug Gap (non-adjustable)	1.10 mm	0.044 in
Spark Plug Torque	20 N·m	15 lb ft
Spark Plug Type	AC 41-988	

Temperature Versus Resistance - Engine Coolant Temperature Sensor

Temperature C° / F°	Resistance Minimum Ohms	Resistance Maximum Ohms
Engine Coolant Temperature (ECT)		
-40/-40	40,490	50,136
-20/-4	14,096	16,827
-10/14	8,642	10,152
0/32	5,466	6,326
20/68	2,351	2,649
25/77	1,941	2,173
40/104	1,118	1,231
60/140	573	618
80/176	313	332
100/212	182	191
120/248	109	116
140/284	068	074

Temperature Versus Resistance - Intake Air Temperature Sensor

Temperature C°/F°	Resistance Minimum Ohms	Resistance Maximum Ohms
Intake Air Temperature (IAT) Sensor		
-40/-40	35,140	43,760
-20/-4	12,660	15,120
-10/14	7,943	9,307
0/32	5,119	5,892
20/68	2,290	2,551
25/77	1,900	2,100
40/104	1,096	1,238
60/140	565	654
80/176	312	370
100/212	184	222
120/248	114	141
140/284	74	93

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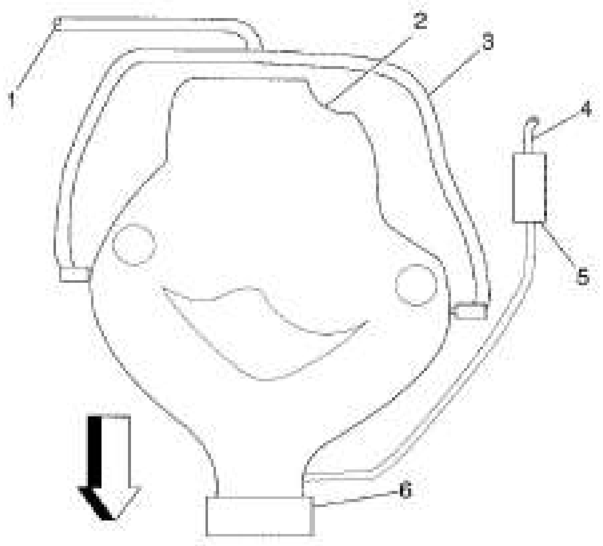
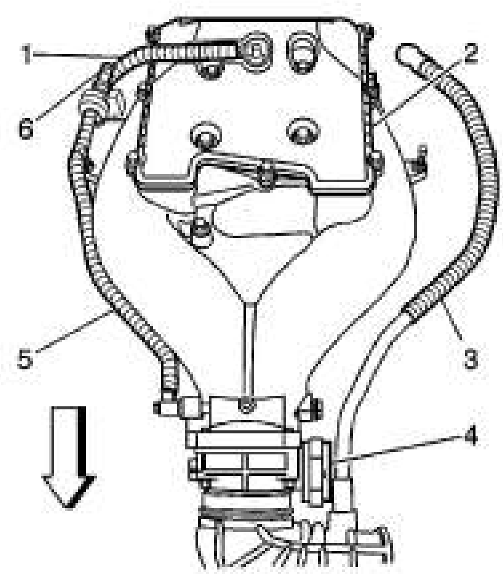
Emission Hose Routing Diagram



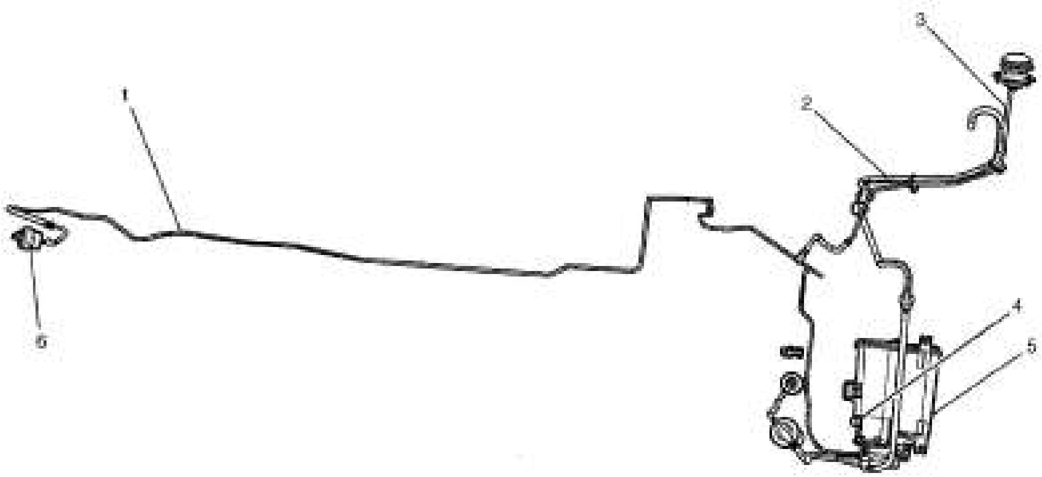
(1) Positive Crankcase Ventilation (PCV) Hose to Cam Cover
(2) Upper Intake Manifold
(3) PCV Hose to Intake Manifold
(4) Emissions Hose to EVAP Canister
(5) Evaporative Emissions (EVAP) Canister Purge Solenoid
(6) Throttle Body Assembly

Emission Hose Routing Diagram (with LLT)

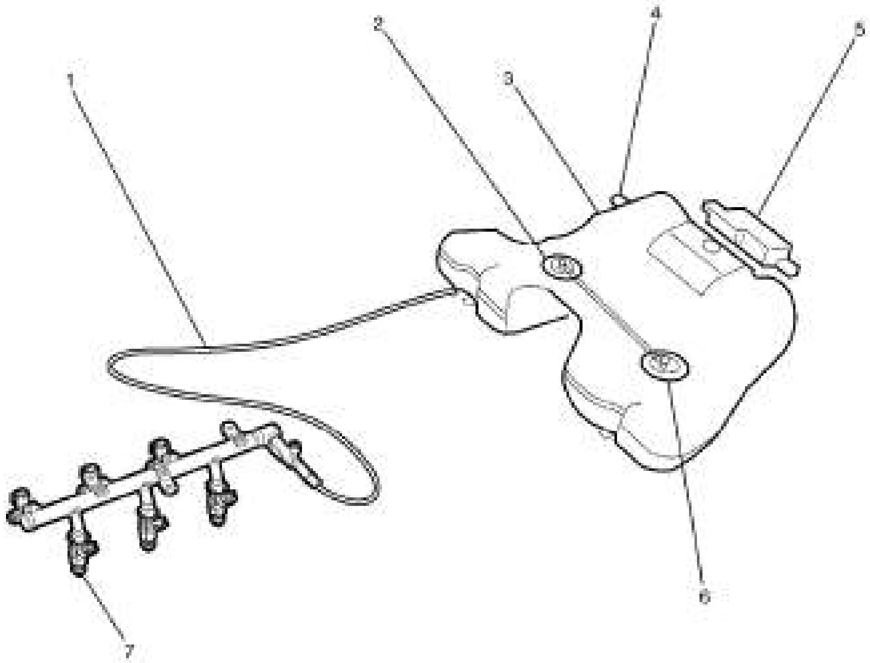


(1) Positive Crankcase Ventilation (PCV) Hose
(2) Upper Intake Manifold Plenum
(3) Fresh Air Breather Hose
(4) Throttle Body Assembly
(5) Evaporative Emissions (EVAP) Canister Purge Solenoid Vacuum Supply Hose
(6) Evaporative Emissions (EVAP) Canister Purge Solenoid

Evaporative Emissions Hose Routing Diagram

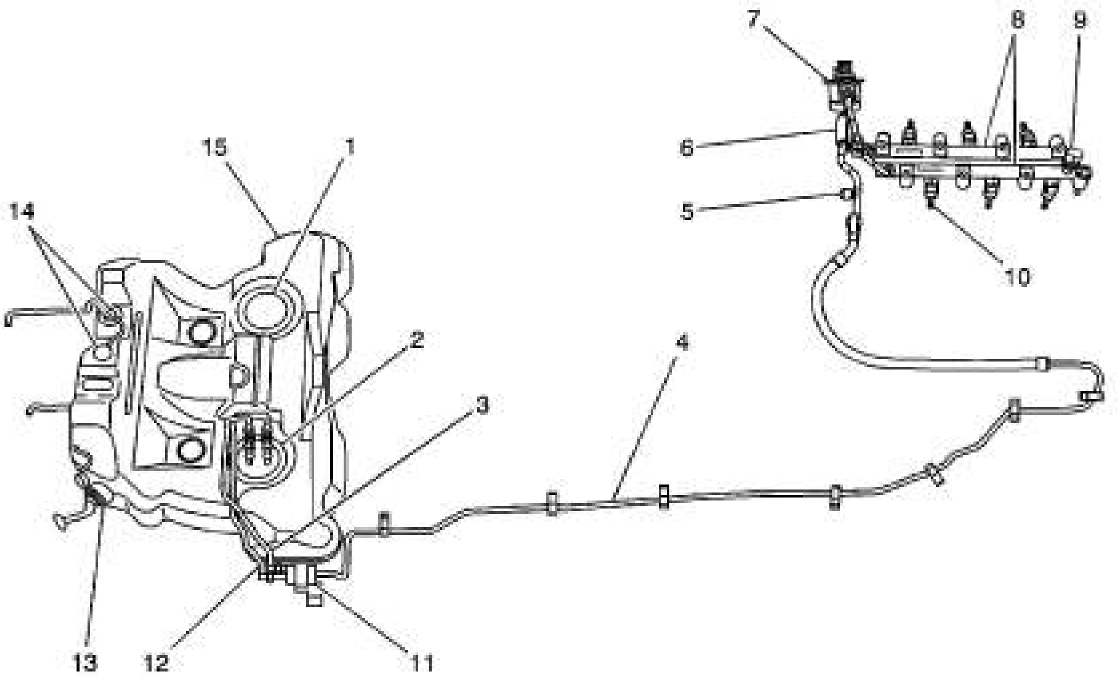


(1) Evaporative Emission (EVAP) Purge Hose/Pipe
(2) EVAP Vent Valve Fresh Air Inlet Tube
(3) Fuel Filler Pipe Vapour Re-circulation Line
(4) EVAP Vent Valve Solenoid
(5) EVAP Canister
(6) EVAP Purge Solenoid



(1) Fuel supply tube
(2) Primary Fuel module
(3) Fuel tank
(4) Filler tube
(5) EVAP canister
(6) Secondary fuel module
(7) Injectors and fuel rail

Fuel Hose / Pipes Routing Diagram (with LLT)



(1) Secondary Fuel Sender Assembly - Left
(2) Primary Fuel Sender Assembly - Right
(3) Fuel Feed Hose
(4) Fuel Feed Pipe
(5) Fuel Pressure Test Connection
(6) Fuel Pulse Dampener
(7) High Pressure Fuel Pump
(8) Fuel Rail
(9) Fuel Rail Pressure Sensor
(10) Fuel Injector
(11) Fuel Filter - if equipped
(12) Fuel Return Hose - if equipped
(13) Fuel Filler Tube
(14) Fill Limit Vent Valve (FLVV)
(15) Fuel Tank

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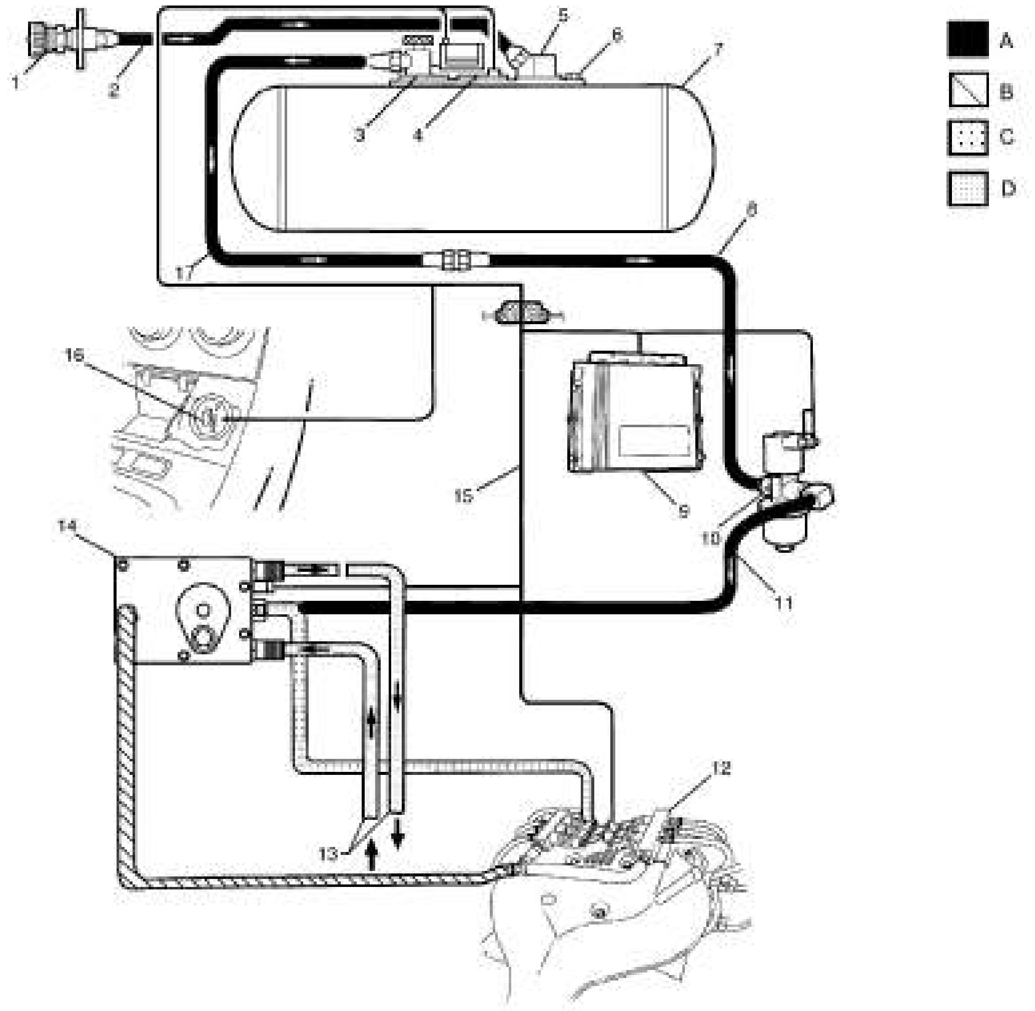
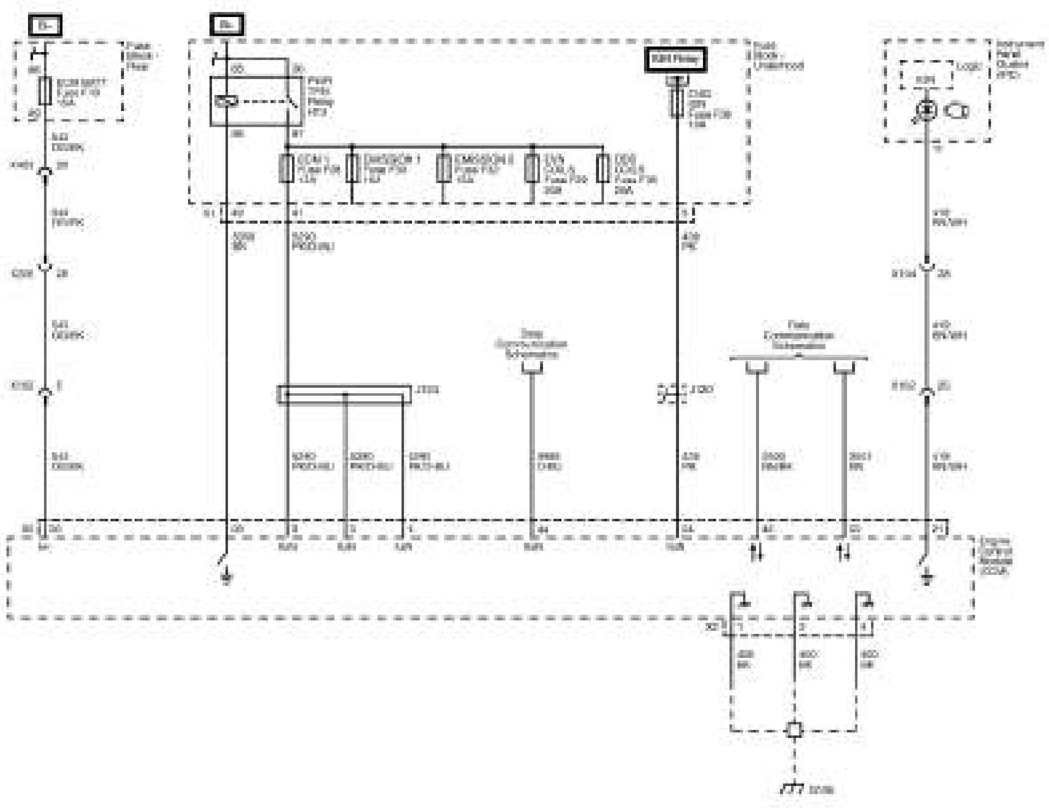
LPG System Schematic



(1) LPG Filler Valve
(2) Filler Line
(3) Rear Lock Off/Service Solenoid Valve Assembly
(4) LPG Tank Assembly
(5) AFL
(6) Fuel Contents Gauge / Sender
(7) LPG Tank
(8) Intermediate Service Line
(9) LPG Control Module
(10) Front LPG Lock-Off (including filter)
(11) Front Service Line

(12) LPG Fuel Injectors and Manifold (2 of)
(13) Coolant Hoses to and from Engine
(14) Reducer
(15) Wiring Harness
(16) Fuel Mode Switch and Fuel Level
(17) Rear Service Line
(18) LPG Filter
(a) Liquid
(b) Vapour
(c) Vacuum
(d) Coolant

Module Power, Ground and Serial Data



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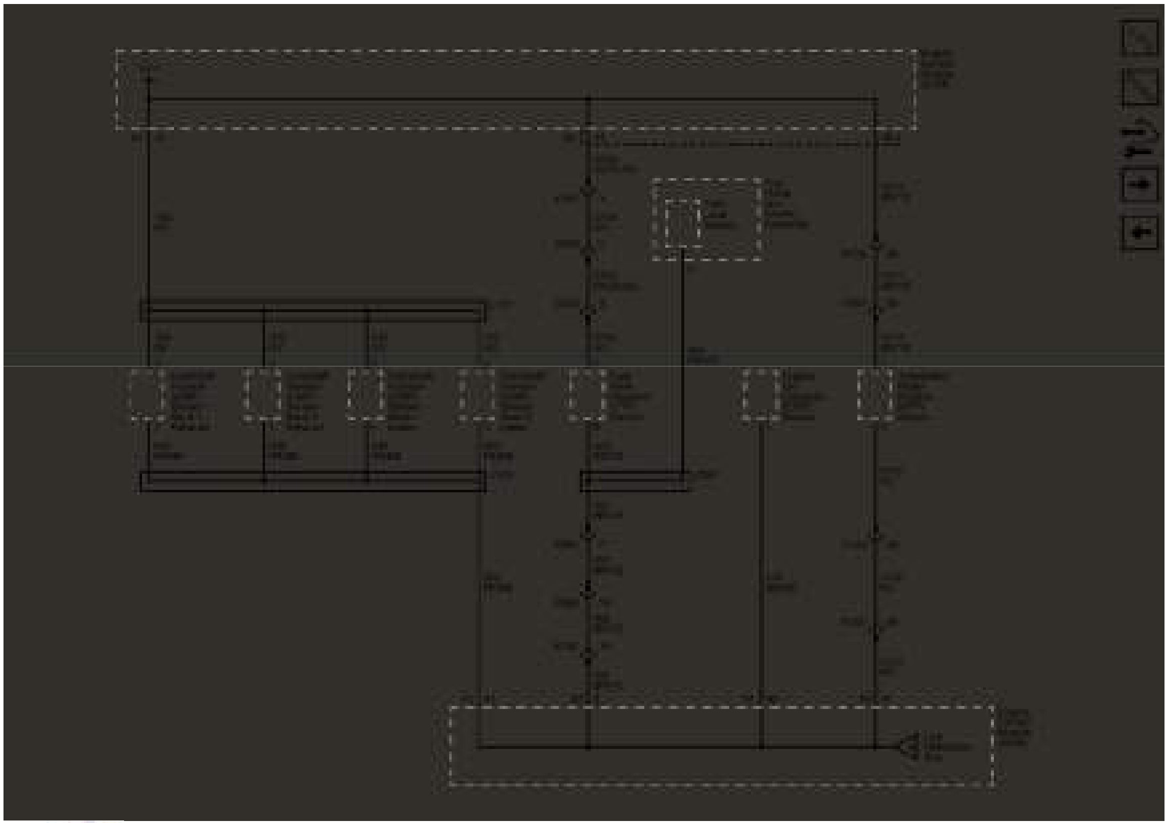
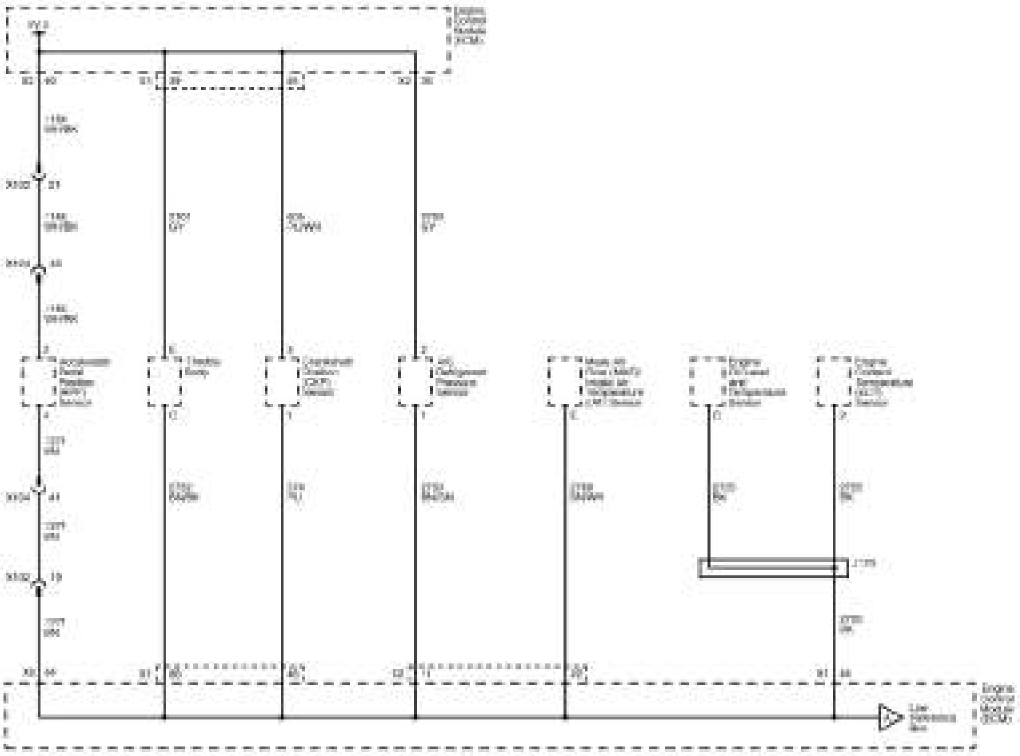
Engine Data Sensors - 5-Volt and Low Reference 1 of 2



Engine Data Sensors - 5-Volt and Low Reference 2 of 2


Engine Control Module (ECM)
5V
X102
X104
Accelerator Pedal Position (APP) Sensor
Throttle Body
Crankshaft Position (CKP) Sensor
A/C Refrigerant Pressure Sensor
Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor
Engine Oil Level and Temperature Sensor
Engine Coolant Temperature (ECT) Sensor
Low Reference
Engine Control Module (ECM)

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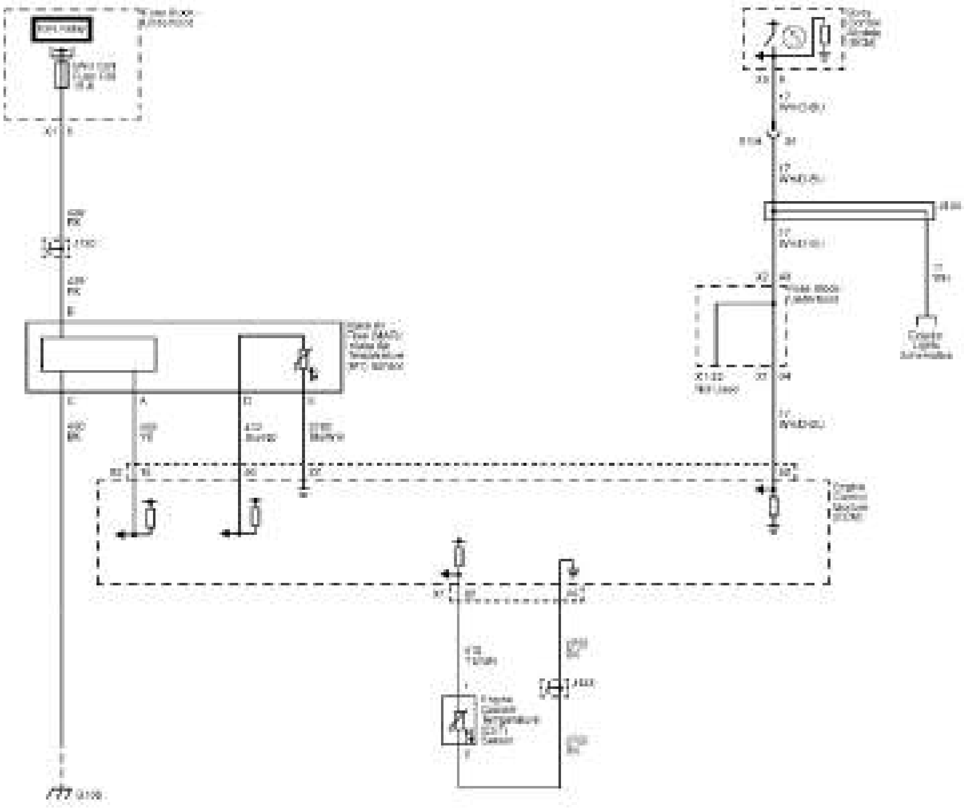
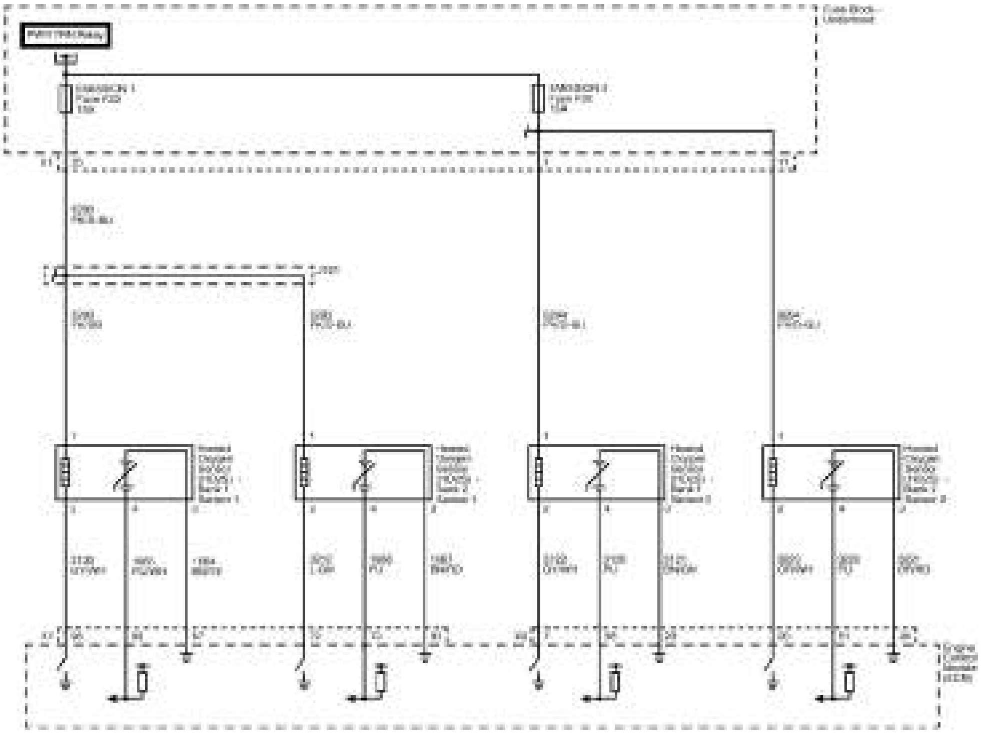
Engine Data Sensors - Pressure and Temperature



2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Schematic and Routing Diagrams | **Document ID: 2153909**

Engine Data Sensors - Oxygen Sensors


Fuse Block - Underhood
EMISSION 1
EMISSION 2
Heated Oxygen Sensor (HO2S) Bank 1 Sensor 1
Heated Oxygen Sensor (HO2S) Bank 2 Sensor 1
Heated Oxygen Sensor (HO2S) Bank 1 Sensor 2
Heated Oxygen Sensor (HO2S) Bank 2 Sensor 2
Engine Control Module (ECM)

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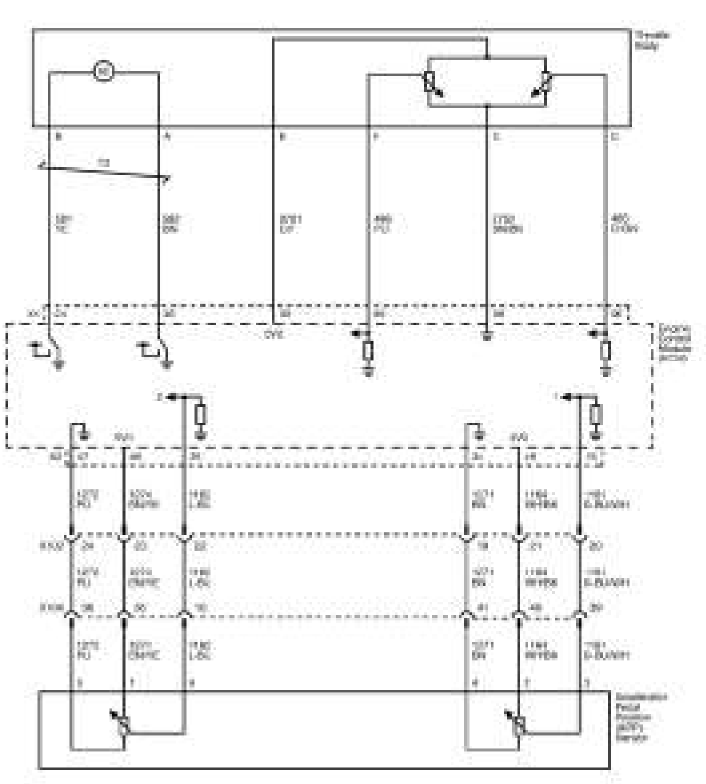
Engine Data Sensors - Throttle Controls



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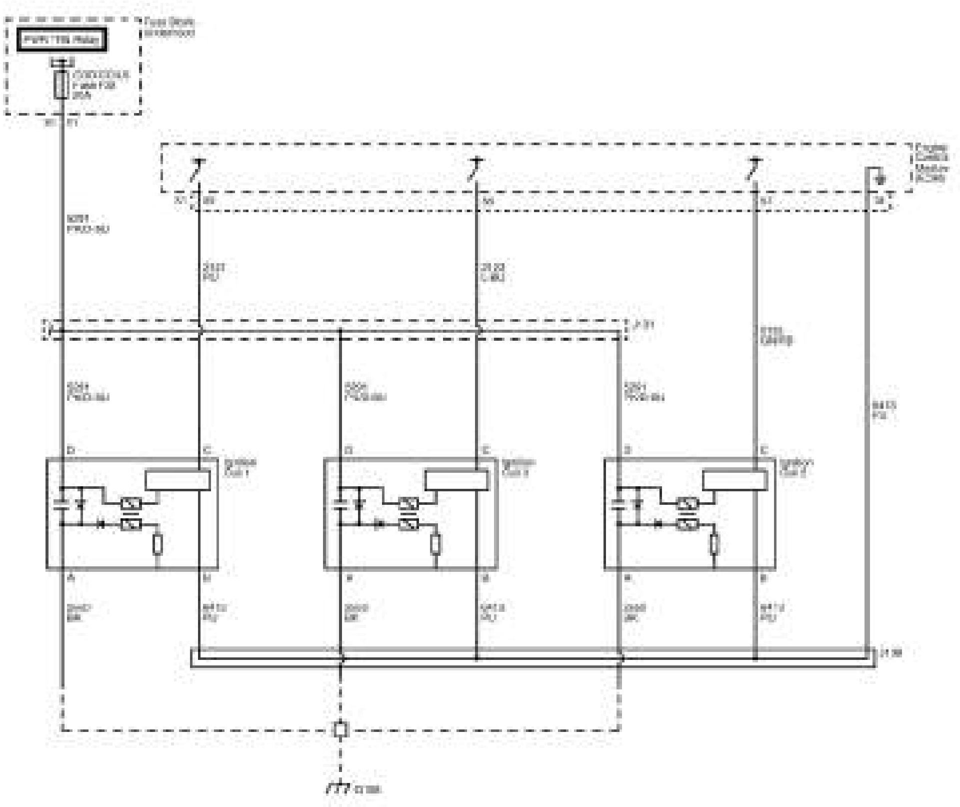
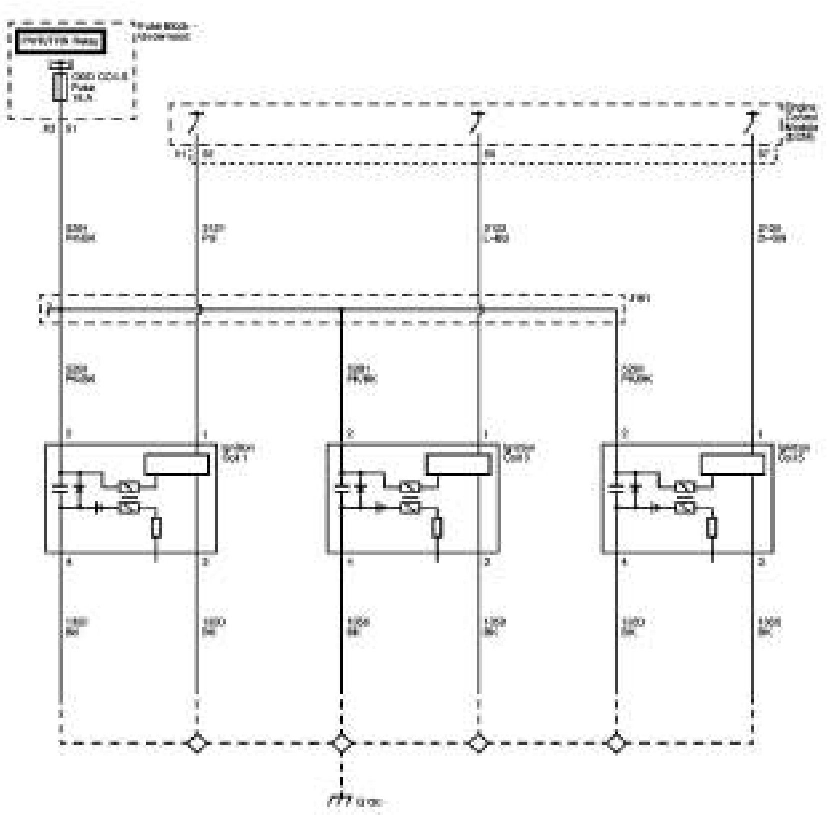
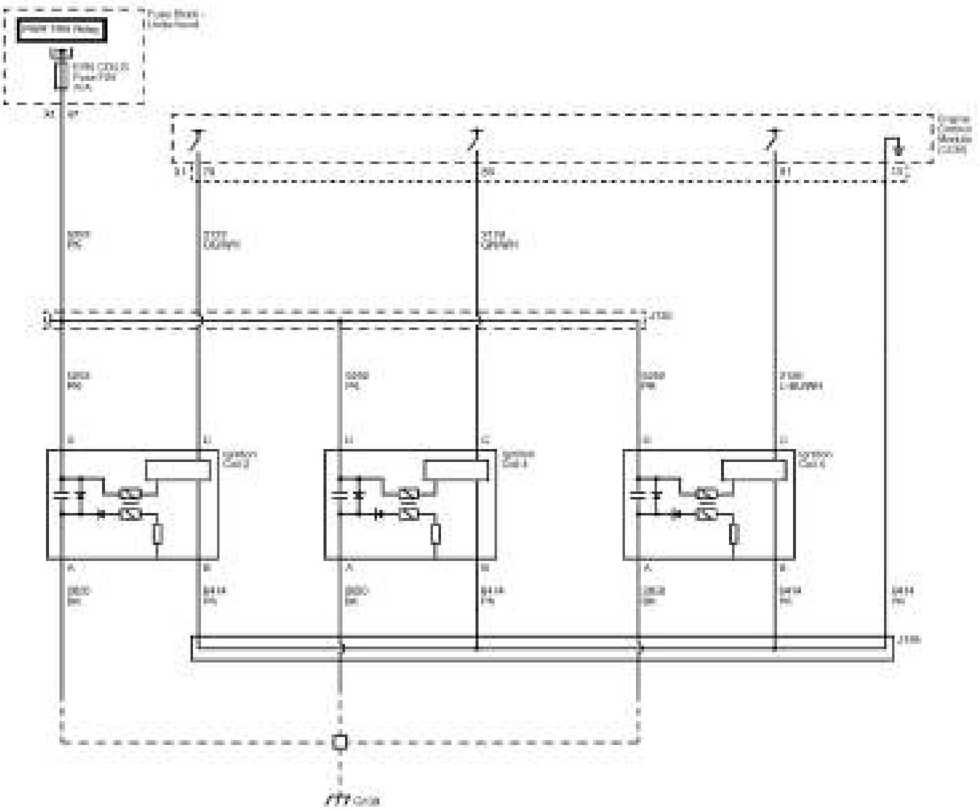
Ignition Controls - Ignition System Coils 1, 3, and 5



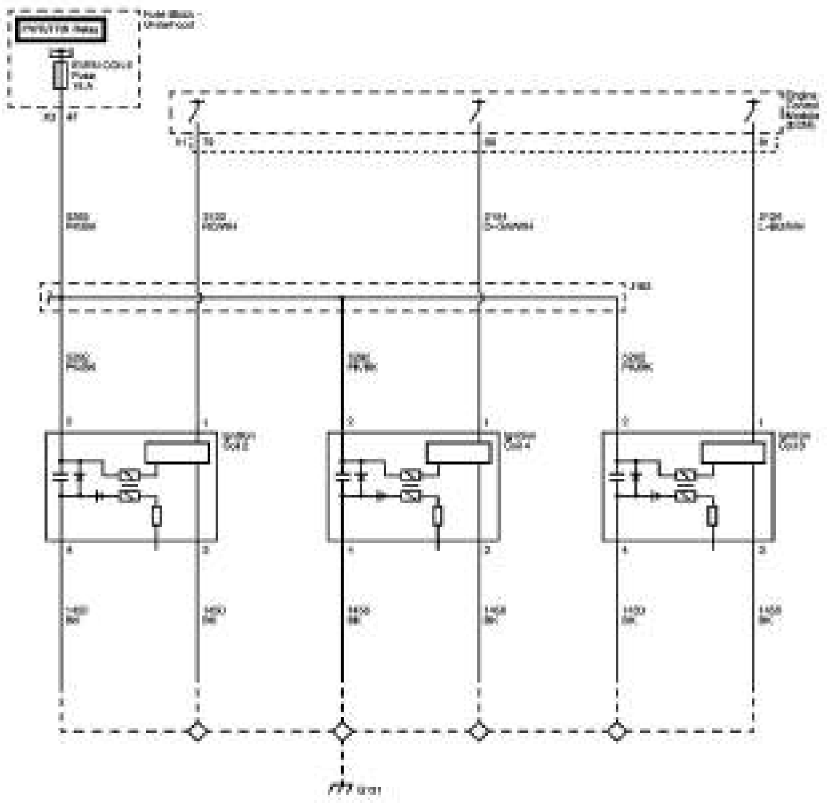
Ignition Controls - Ignition System Coils 1, 3, and 5 - LLT



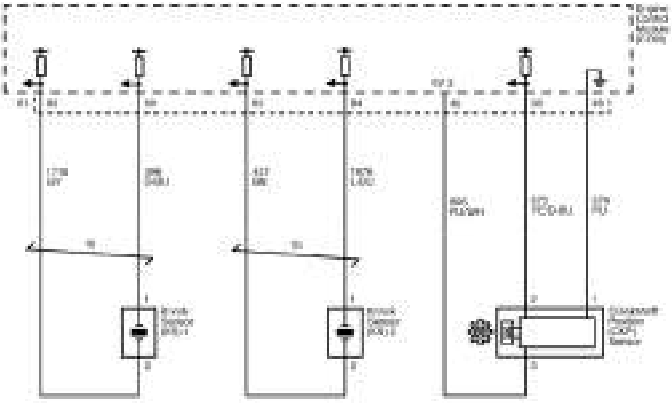
Ignition Controls - Ignition System Coils 2, 4, and 6


Fuse Block - Underhood
Engine Control Module (ECM)
Ignition Coil 2
Ignition Coil 4
Ignition Coil 6
A
B
C
D

Ignition Controls - Ignition System Coils 2, 4, and 6 - LLT



Ignition Controls - Sensors 1 of 2


Engine Control Module
Knock Sensor (KS) 1
Knock Sensor (KS) 2
Crankshaft Position (CKP) Sensor

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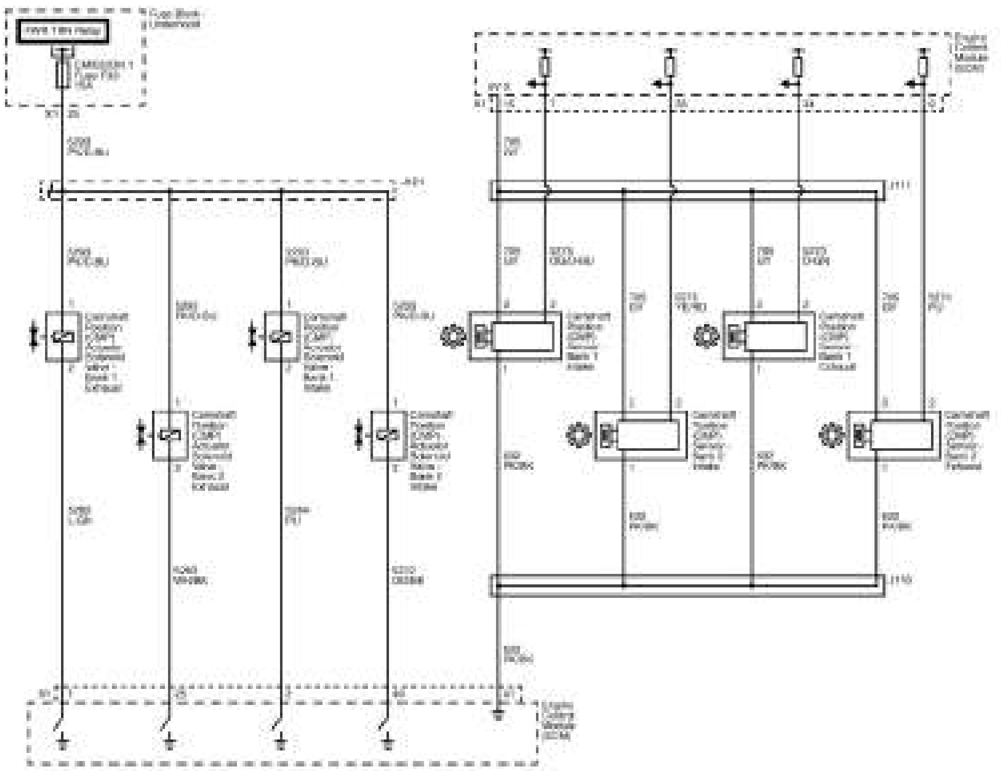
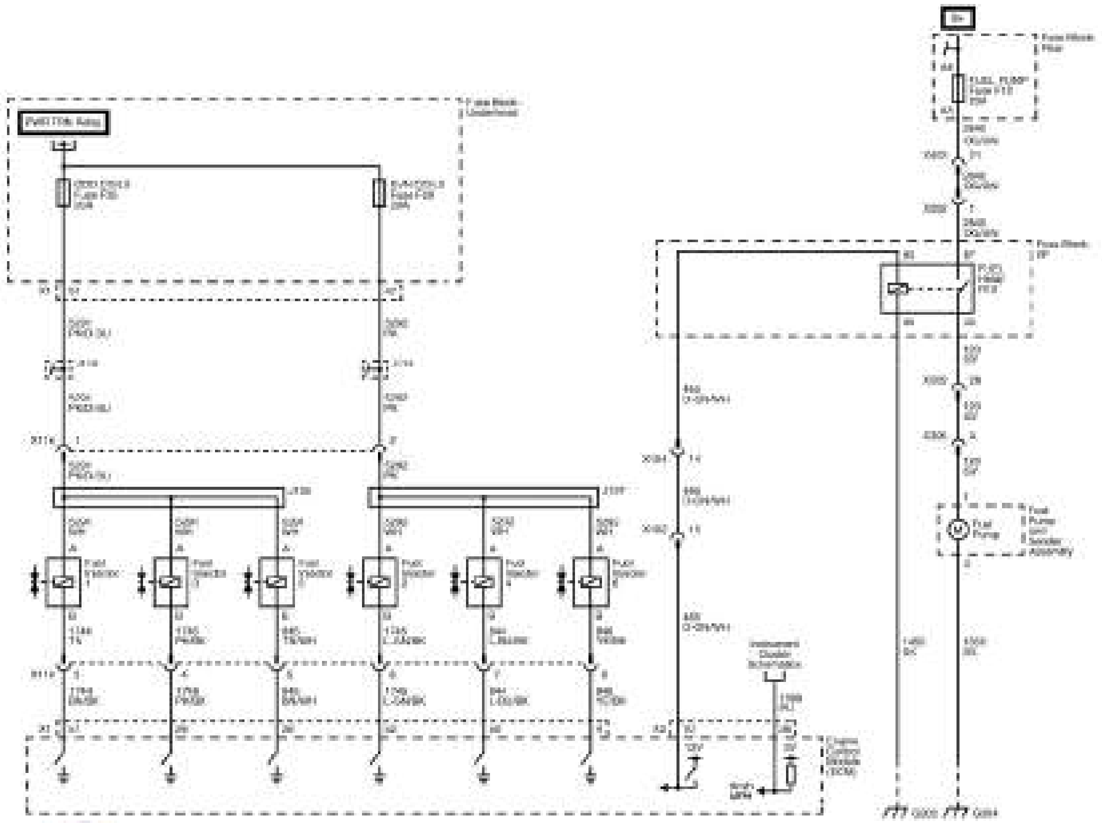
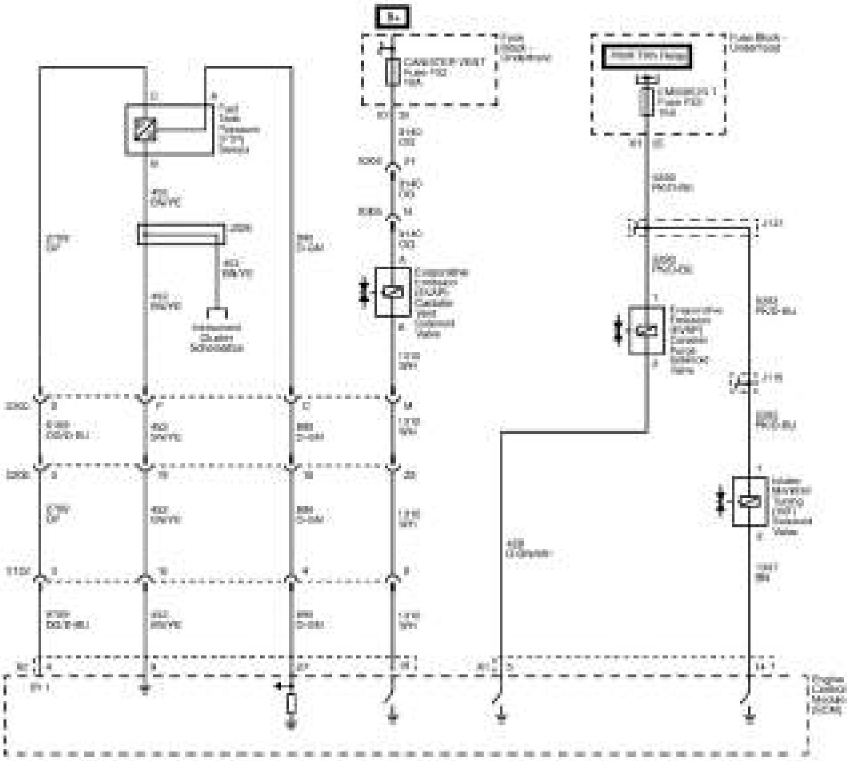
Ignition Controls - Sensors 2 of 2



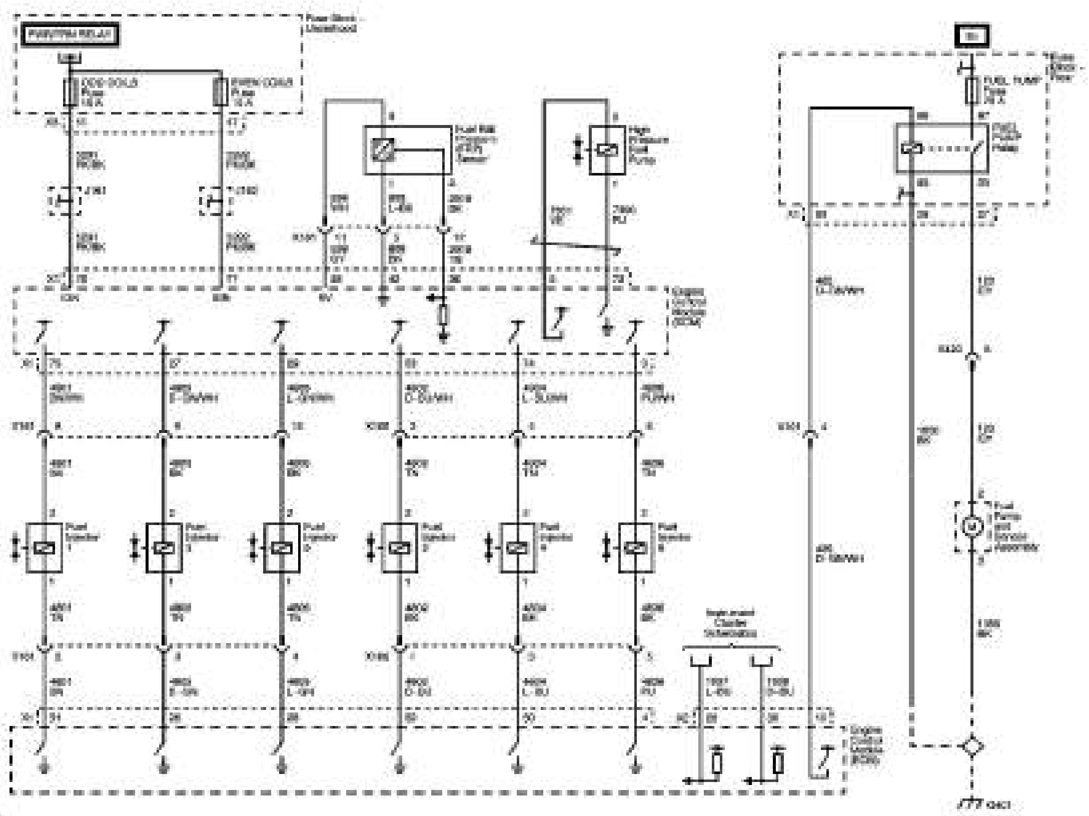
Fuel Controls - Fuel Pump and Injector Controls


B+
Fuse Block - Underhood
FUEL PUMP
Fuse Block - IP
Fuel Injector 1
Fuel Pump
Fuel Pump and Sender Assembly
Instrument Cluster Schematics
12V
5V
Engine Control Module (ECM)

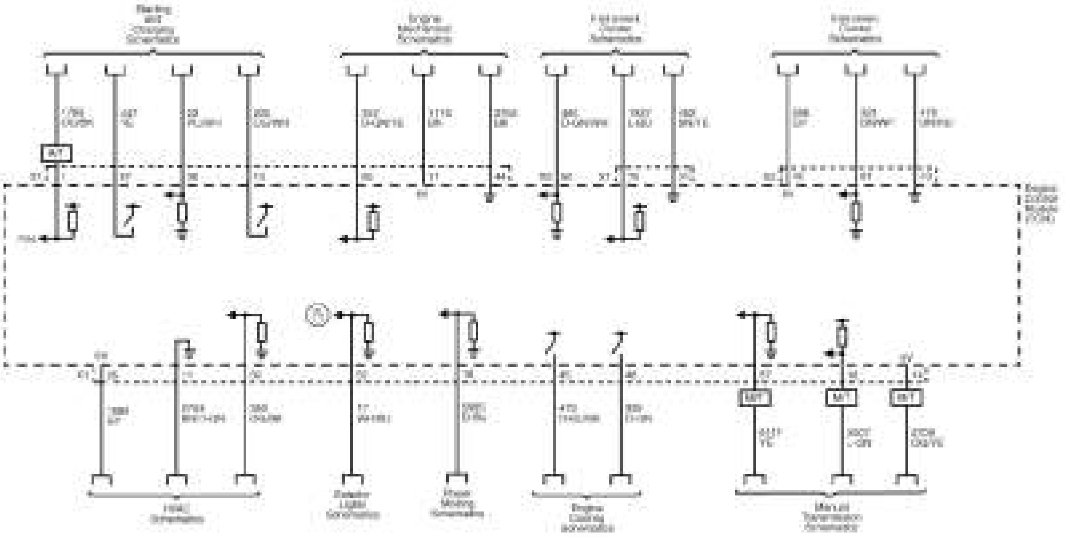
Fuel Controls - EVAP Controls


B+
Fuse Block - Underhood
Fuel Tank Pressure (FTP) Sensor
Instrument Cluster Schematics
Evaporative Emission (EVAP) Canister Vent Solenoid Valve
Evaporative Emission (EVAP) Canister Purge Solenoid Valve
Intake Manifold Tuning (IMT) Solenoid Valve
Engine Control Module (ECM)

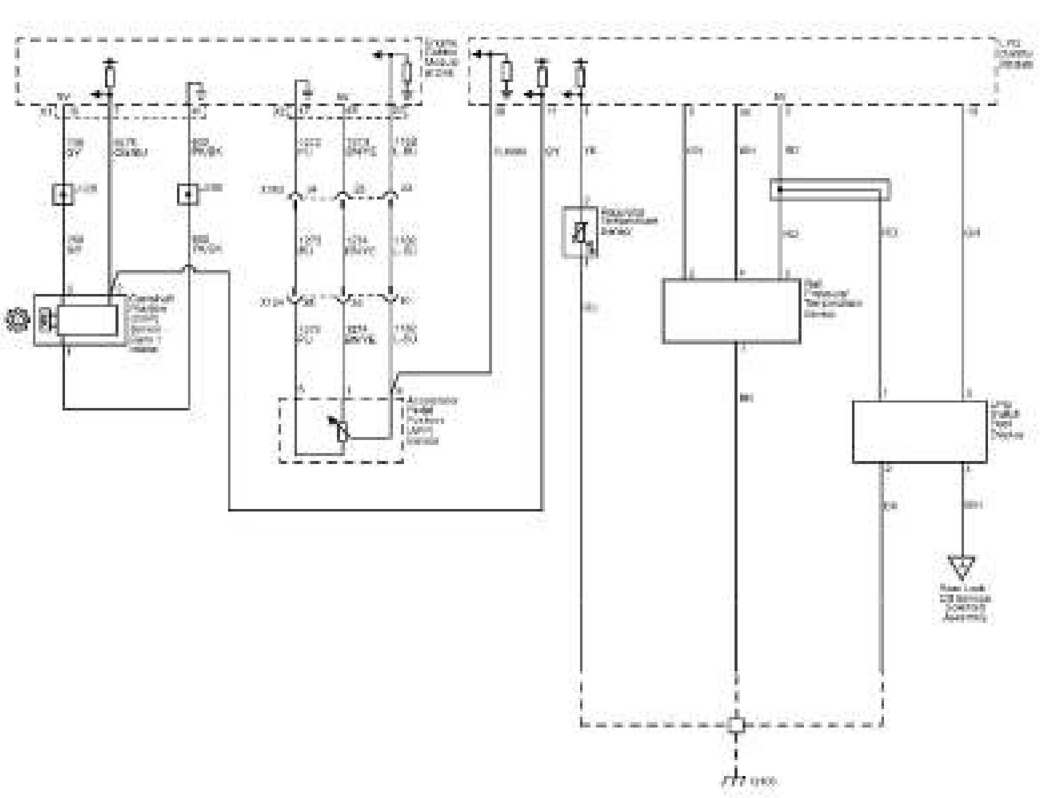
Fuel Controls - Fuel Injectors, Pressure and Fuel Pump Controls - LLT


Fuse Block - Underhood
Fuel Rail Pressure (FRP) Sensor
High Pressure Fuel Pump
Engine Control Module (ECM)
Fuel Injector
Fuel Pump Relay
Fuel Pump and Sender Assembly
Instrument Cluster Schematics

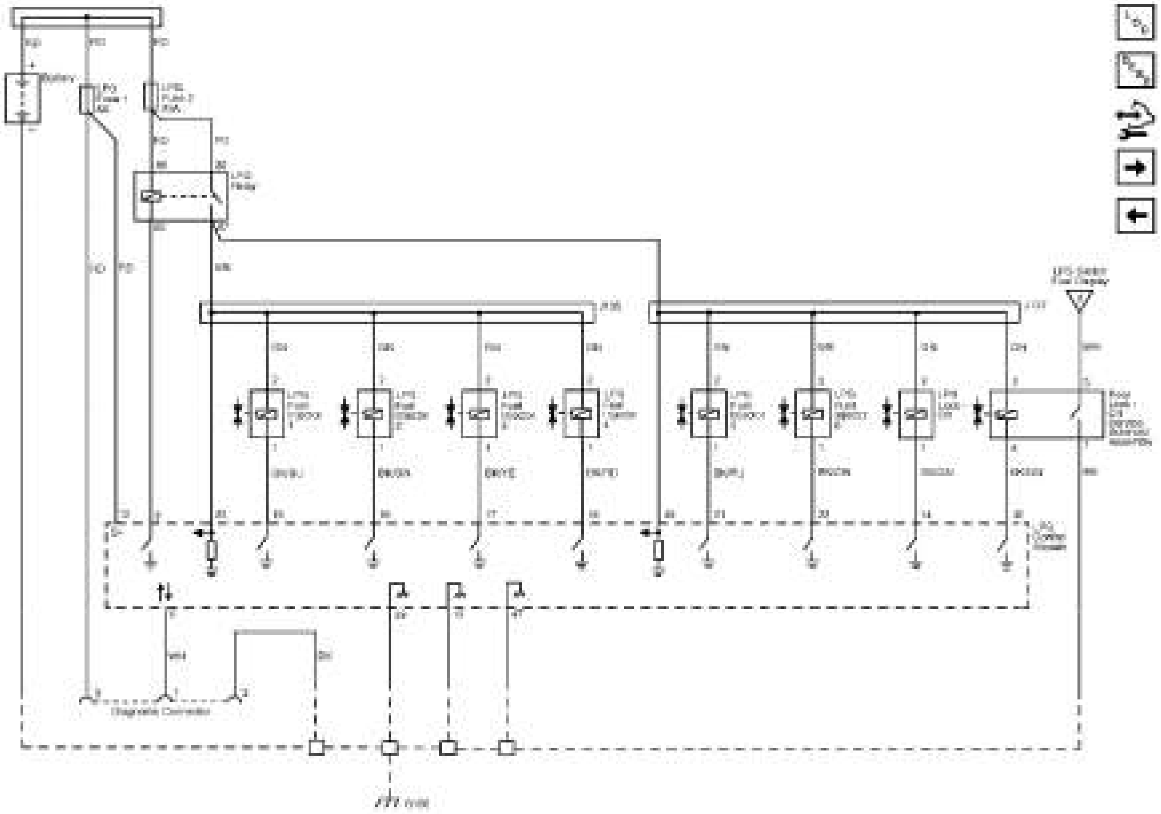
Controlled / Monitored Subsystem References


Starting and Charging Schematics
Engine Mechanical Schematics
Engine Control Module (ECM)
M/T
HVAC Schematics
Exterior Lights Schematics
Power Moding Schematics
Engine Cooling Schematics
Manual Transmission Schematics

Fuel Controls - Fuel Pump and Injector Controls

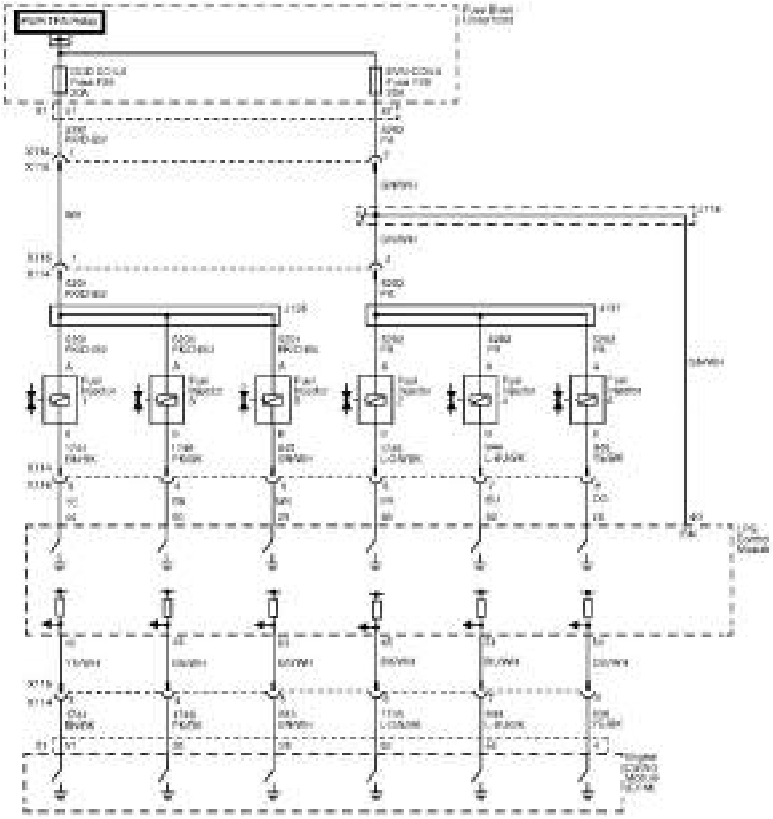

5V
X1
X2
Accelerator Pedal Position (APP) Sensor
G103

Fuel Controls - Fuel Pump and Injector Controls



2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Schematic and Routing Diagrams | **Document ID: 2196115**

Fuel Controls - Fuel Pump and Injector Controls



Diagnostic Starting Point - Engine Controls (Petrol)

Begin the system diagnosis with Diagnostic System Check - Vehicle. The Diagnostic System Check - Vehicle will provide the following information:

- The identification of the Control Modules which command the system.
- The ability of the Control Modules to communicate through the serial data circuit.
- The identification of any stored DTCs and the codes status.

The use of the Diagnostic System Check - Vehicle will identify the correct procedure for diagnosing the system and where the procedure is located.

DTC P0008 or P0009

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0008: Engine Position System Performance Bank 1

DTC P0009: Engine Position System Performance Bank 2

Circuit/System Description

The engine control module (ECM) tests for a misalignment between both camshafts on one bank of the engine and the crankshaft. The misalignment would be at an idler sprocket for either bank or at the crankshaft. Once the ECM learns the position of both camshafts on one bank of the engine, the ECM compares the learned values to a reference value. The ECM will set a DTC if both learned values for one bank of the engine are exceeding a calibrated threshold in the same direction.

Conditions for Running the DTC

- DTCs P0010, P0011, P0013, P0014, P0020, P0021, P0023, P0024, P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, P0393, P2088, P2089, P2090, P2091, P2092, P2093, P2094 and P2095 are not set.
- The engine is operating.
- The ECM has learned the camshaft positions.
- DTC P0008 and P0009 runs continuously once the above conditions are met.

Conditions for Setting the DTC

The ECM detects that both camshafts on either bank of the engine are mis-aligned with the crankshaft for greater than 4 seconds.

Action Taken When the DTC Sets

DTC P0008 and P0009 are type B DTCs.

Conditions for Clearing the DTC

DTC P0008 and P0009 are type B DTCs.

Diagnostic Aids

- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed secondary timing chain can cause this DTC to set.
- A single failed camshaft actuator or actuator solenoid will not cause this DTC to set. This diagnostic algorithm is designed to detect an alignment condition between a primary intermediate sprocket and the secondary timing chain or the alignment between a primary intermediate sprocket and the crankshaft. Either condition would cause the camshaft timing for both cams on one bank to be off an equal number of degrees.
- The presence of DTCs P0008 and P0009 along with P0016, P0017, P0018 and P0019 indicates a possible condition with the primary timing chain and the alignment between both intermediate sprockets and the crankshaft or the crankshaft reluctor wheel has moved and is no longer referenced to top dead centre (TDC).
- Observing the desired and actual camshaft angle parameters with a scan tool before a DTC sets, may help to isolate whether a condition is specific to one camshaft, one bank or caused by a condition with the primary crankshaft timing.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Clear the DTCs with a scan tool.
2. Allow the engine to reach the normal operating temperature.
3. Idle the engine for 10 minutes or until a DTC sets. Observe the DTC information with a scan tool, DTCs P0008 and P0009 should not set.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Inspect the timing chains and tensioners for excessive wear or misalignment.
   If you find a condition with the timing chains or tensioners, repair as necessary.
2. Inspect the crankshaft reluctor wheel for being mis-positioned on the crankshaft.
   If you find a condition with the crankshaft, repair as necessary.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Setting Camshaft Timing

- Camshaft Timing Drive Chain Alignment Diagram
- Camshaft Timing Drive Components Cleaning and Inspection
- Crankshaft and Bearing Cleaning and Inspection

Document ID: 1994297

Dieseling, Run-On (Petrol)

Checks	Action
DEFINITION: The engine continues to run when the ignition is turned OFF, but usually runs very roughly.	
Preliminary Checks	Refer to Important Preliminary Checks in Symptoms - Engine Controls .
Fuel System Checks	• Test for correct EVAP Purge system operation. • Test the fuel injectors for leakage. • Inspect for correct throttle blade adjustment, if applicable. • Perform the fuel system diagnostic procedure. Refer to Fuel System Diagnosis .
Additional Checks	If the engine continues to run smoothly when the ignition is turned OFF inspect for the following: • Correct ignition switch adjustment • A short to voltage in the LPG ECM ignition feed circuit.

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Document ID: 1985719

DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0010: Intake Camshaft Position Control Solenoid Circuit Malfunction Bank 1

DTC P0013: Exhaust Camshaft Position Control Solenoid Circuit Malfunction Bank 1

DTC P0020: Intake Camshaft Position Control Solenoid Circuit Malfunction Bank 2

DTC P0023: Exhaust Camshaft Position Control Solenoid Circuit Malfunction Bank 2

DTC P2088: Intake Camshaft Position Control Solenoid Circuit Low Voltage Bank 1

DTC P2089: Intake Camshaft Position Control Solenoid Circuit High Voltage Bank 1

DTC P2090: Exhaust Camshaft Position Control Solenoid Circuit Low Voltage Bank 1

DTC P2091: Exhaust Camshaft Position Control Solenoid Circuit High Voltage Bank 1

DTC P2092: Intake Camshaft Position Control Solenoid Circuit Low Voltage Bank 2

DTC P2093: Intake Camshaft Position Control Solenoid Circuit High Voltage Bank 2

DTC P2094: Exhaust Camshaft Position Control Solenoid Circuit Low Voltage Bank 2

DTC P2095: Exhaust Camshaft Position Control Solenoid Circuit High Voltage Bank 2

Circuit / System Description

The camshaft position (CMP) actuator system enables the engine control module (ECM) to change the timing of the camshafts while the engine is operating. The CMP actuator solenoid signal from the ECM is pulse width modulated (PWM). The ECM controls the CMP actuator solenoid duty cycle by controlling the amount of solenoid ON time. The CMP actuator solenoid controls the advance or the retard of each camshaft. The CMP actuator solenoid controls the oil flow that applies the pressure to advance or retard the camshafts.

Ignition voltage is supplied directly to the CMP actuator solenoid. The ECM controls the solenoid by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the DTC

- The engine speed is greater than 80 RPM.
- The ignition voltage is between 10-18 volts.
- The ECM has commanded the CMP actuator solenoid ON and OFF at least once during the ignition cycle.
- DTCs P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094 and P2095 run continuously once the above conditions are met for greater than 1 second.

Conditions for Setting the DTC

P0010, P0013, P0020, P0023

The ECM detects an open in the CMP actuator solenoid circuits for greater than 4 seconds, when the solenoid is commanded OFF.

P2088, P2090, P2092, P2094

The ECM detects a short to ground in the CMP actuator solenoid circuits for greater than 4 seconds, when the solenoid is commanded OFF.

P2089, P2091, P2093, P2095

The ECM detects a short to voltage in the CMP actuator solenoid circuits for greater than 4 seconds, when the solenoid is commanded ON.

Action Taken When the DTC Sets

DTCs P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094 and P2095 are type B DTCs.

Conditions for Clearing the DTC

DTCs P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094 and P2095 are type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. With the engine at normal operating temperature, raise the engine speed to 2,000 RPM for 10 seconds. DTCs P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094 or P2095 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate camshaft position (CMP) actuator solenoid.
2. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 1 and ground.

   If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition circuit and replace as necessary.
3. Connect a DMM, set on the diode setting, between the control circuit terminal 2 and ground. The voltage should be greater than 2.0 V.

   If the DMM displays OL, test the control circuit for a short to voltage or an open/high resistance. If the circuit/connections test normal, replace the ECM.

   If less than the specified value, test the control circuit for a short to ground. If the circuit tests normal, replace the ECM.
4. Command the CMP actuator solenoid ON and OFF with a scan tool. The DMM should transition from greater than 2 V when commanded OFF to less than 1 V when commanded ON.

   If the circuit voltage does not correspond to the specified values, replace the ECM.
5. If all circuits/connections test normal, test or replace the CMP actuator solenoid.

Component Testing

1. Ignition OFF, disconnect the harness connector at the appropriate camshaft position (CMP) actuator solenoid.
2. Test for 7-12 Ω between the control terminal 2 and the ignition terminal 1 of the camshaft position (CMP) actuator solenoid.

   If not within the specified range, replace the CMP actuator solenoid.

3. Test for infinite resistance between each terminal and the CMP actuator solenoid housing.
   If not the specified value, replace the CMP actuator solenoid valve.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake .
- Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust .
- Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake .
- Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust .
- Engine Control Module Replacement for engine control module replacement, setup, and programming

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Document ID: 1985722

DTC P0011, P0014, P0021, or P0024

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0011: Intake Camshaft Position Range/Performance Bank 1

DTC P0014: Exhaust Camshaft Position Range/Performance Bank 1

DTC P0021: Intake Camshaft Position Range/Performance Bank 2

DTC P0024: Exhaust Camshaft Position Range/Performance Bank 2

Circuit/System Description

The camshaft position (CMP) actuator system enables the engine control module (ECM) to change the timing of the camshafts while the engine is operating. The CMP actuator solenoid signal from the ECM is pulse width modulated (PWM). The ECM controls the CMP actuator solenoid duty cycle by controlling the amount of solenoid ON time. The CMP actuator solenoid controls the advance or the retard of each camshaft. The CMP actuator solenoid controls the oil flow that applies the pressure to advance or retard the camshafts.

Conditions for Running the DTC

- Before the ECM can report DTC P0011, P0014, P0021, or P0024 failed DTCs P0010, P0013, P0020, P0023, P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, P0393, P2088, P2089, P2090, P2091, P2092, P2093, P2094 and P2095 must run and pass.
- DTCs P0016, P0017, P0018, P0019, P0335, P0336 and P0338 are not set.
- The engine speed is greater than 500 RPM.
- The engine must accelerate such that the CMP actuator system is commanded from the park position to the phased position. This is considered a cam control cycle. There must be a total of 4-10 cam control cycles for at least 2.5 seconds each in the phased position.
- The engine is operating for approximately 1.8 seconds.
- DTCs P0011, P0014, P0021 and P0024 run continuously once the above conditions are met for greater than 1 second.

Conditions for Setting the DTC

- The ECM detects the difference between the desired camshaft position and the actual camshaft position angle is greater than 5 degrees.

OR

- The ECM detects the difference between the actual camshaft angle and the locked position angle is greater than 1 degree.
- The condition exists for greater than 4 seconds.

Action Taken When the DTC Sets

DTCs P0011, P0014, P0021 and P0024 are type B DTCs.

Conditions for Clearing the DTC

DTCs P0011, P0014, P0021 and P0024 are type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 35616-200 Test Lamp Kit

Diagnostic Aids

- The engine oil condition has a major impact on the camshaft actuator system.
- A low oil level condition may set this DTC. The engine may require an oil change. You may also monitor the Engine Oil Life parameter with a scan tool.
- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed camshaft, camshaft actuator, or timing chain can cause this DTC to set.

Circuit / System Verification

Note: The engine oil level and the oil pressure are critical to the correct operation of the camshaft position (CMP) actuator system. Verify that the engine has the correct oil level and the correct oil pressure before continuing with this diagnostic.

1. Ignition ON, observe the scan tool DTC information. Verify that none of the following DTCs are set. DTC P0016, P0017, P0018, P0019, P0335, P0336, P0338, P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, P0393, P0521, P0522, P0523, P0638, P2100, P2101, P2102, P2103, or P2119.

   If any of the DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.
2. Engine idling, command the suspected camshaft actuator from 0 degrees to 40 degrees and back to zero while observing the appropriate scan tool CMP Angle Variance parameters. The CMP Angle Variance should be less than 2 degrees in each of the commanded states.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate camshaft position (CMP) actuator solenoid.
2. Ignition ON, load test for B+ between the ignition circuit terminal 1 and ground.

   If less than the specified range, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition circuit and replace as necessary.

   Note: Use the *j 35616-200* Test Lamp Kit for this test. If the *j 35616-200* Test Lamp Kit is not available, use a test lamp that measures greater than 20 Ω.
3. Connect a test lamp between the control circuit terminal 2 and B+.

   Note: The voltage must be measured at the control side of the circuit.
4. Command the appropriate CMP actuator solenoid ON with a scan tool. Load test for less than 1 V between the control circuit terminal 2 and ground.

   If greater than the specified range, test the control circuit for an open/high resistance. If the circuit/connections test normal, replace the ECM.
5. Remove the CMP actuator solenoid. Inspect the CMP actuator solenoid and mounting area for the following conditions:
   - For a torn, restricted, mis-positioned, or missing screens at the CMP actuator solenoid

- For engine oil leaks between the oil sealing lands of the CMP actuator solenoid--Inspect the lands of the CMP actuator solenoid for nicks.
- For oil seepage at the CMP actuator solenoid connector

  If a condition is found, replace CMP actuator solenoid.

6. Ignition OFF, swap the suspected CMP actuator solenoid with a CMP actuator solenoid that is operating correctly.
7. Engine idling. Command the suspected camshaft actuator from 0 degrees to 40 degrees and back to zero while observing the appropriate scan tool CMP Angle Variance parameters. The CMP Angle Variance should be less than 2 degrees in each of the commanded states.

   If the CMP Angle Variance is greater than 2 degrees, replace the mechanical camshaft position (CMP) actuator.
8. If all circuits/connections test normal, test or replace the CMP actuator solenoid.

Component Testing

1. Ignition OFF, disconnect the harness connector at the appropriate camshaft position (CMP) actuator solenoid.
2. Test for 7-12 Ω between the control terminal 2 and the ignition terminal 1 of the camshaft position (CMP) actuator solenoid.

   If not within the specified range, replace the CMP actuator solenoid.
3. Test for infinite resistance between each terminal and the CMP actuator solenoid housing.

   If not the specified value, replace the CMP actuator solenoid valve.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake
- Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust
- Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake
- Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust
- Camshaft Position Actuator Replacement - Bank 1 (Right Side) Intake
- Camshaft Position Actuator Replacement - Bank 1 (Right Side) Exhaust
- Camshaft Position Actuator Replacement - Bank 2 (Left Side) Intake
- Camshaft Position Actuator Replacement - Bank 2 (Left Side) Exhaust
- Engine Control Module Replacement for engine control module replacement, setup, and programming

DTC P0016, P0017, P0018, or P0019

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0016: Crankshaft/Intake Camshaft Position not Plausible Bank 1

DTC P0017: Crankshaft/Exhaust Camshaft Position not Plausible Bank 1

DTC P0018: Crankshaft/Intake Camshaft Position not Plausible Bank 2

DTC P0019: Crankshaft/Exhaust Camshaft Position not Plausible Bank 2

Circuit/System Description

The camshaft position (CMP) actuator system enables the engine control module (ECM) to change the timing of the camshafts while the engine is operating. The CMP actuator solenoid signal from the ECM is pulse width modulated (PWM). The ECM controls the CMP actuator solenoid duty cycle by controlling the amount of solenoid ON time. The CMP actuator solenoid controls the advance or the retard of each camshaft. The CMP actuator solenoid controls the oil flow that applies the pressure to advance or retard the camshafts.

Ignition voltage is supplied directly to the CMP actuator solenoid. The ECM controls the solenoid by grounding the control circuit with a solid state device called a driver. The ECM compares the camshaft position or the camshaft angle to the position of the crankshaft.

Conditions for Running the DTC

- Before the ECM can report DTC P0016, P0017, P0018, or P0019 failed, DTCs P0010, P0011, P0013, P0014, P0020, P0021, P0023, P0024, P0335, P0336, P0338, P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, P0393, P2088, P2089, P2090, P2091, P2092, P2093, P2094 and P2095 must run and pass.
- The engine is operating for greater than 5 seconds.
- The engine coolant temperature is between 0-95°C (32-203°F).
- The calculated engine oil temperature is less than 120°C (248°F).
- DTC P0016, P0017, P0018 and P0019 run continuously once the above conditions are met for approximately 10 minutes.

Conditions for Setting the DTC

- The ECM detects one of the following conditions:
  - The ECM detects a deviation in the relationship between a camshaft and the crankshaft.
  - A camshaft is greater than 10 degrees advanced in relationship to the crankshaft.
  - A camshaft is greater than 10 degrees retarded in relationship to the crankshaft.
- The ECM detects the difference between an actual intake camshaft angle and the locked position angle is greater than 15 degrees.
- The ECM detects the difference between an actual exhaust camshaft angle and the locked position angle is greater than 21 degrees.
- The condition exists for greater than 4 seconds or a cumulative of 30 seconds.

Action Taken When the DTC Sets

DTCs P0016, P0017, P0018 and P0019 are type B DTCs.

Conditions for Clearing the DTC

DTCs P0016, P0017, P0018 and P0019 are type B DTCs.

Diagnostic Aids

- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed camshaft, camshaft actuator, camshaft sensor, crankshaft sensor or timing chain can cause this DTC to set.
- An actuator that is in the full advance or retard position can cause this DTC to set.
- The presence of DTCs P0008 and P0009 along with P0016, P0017, P0018 and P0019 indicates a possible condition with the primary timing chain and the alignment between both intermediate sprockets and the crankshaft. Or the crankshaft reluctor wheel has moved and is no longer referenced to top dead centre (TDC).
- Observing the desired and actual camshaft angle parameters with a scan tool before a DTC sets, may help to isolate whether a condition is specific to one camshaft, one bank or caused by a condition with the primary crankshaft timing.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Testing

1. Ignition ON, observe the DTC information with a scan tool. Verify that none of the following DTCs are set. DTC P0010, P0013, P0020, P0023, P0335, P0336, P0338, P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, P0393, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095.

   If any of the DTCs listed are set refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.
2. Idle the engine at normal operating temperature for 10 minutes. DTCs P0016, P0017, P0018, or P0019 should not set.

   If a DTC sets, inspect for the following:
   - The correct installation of the camshaft sensors
   - The correct installation of the crankshaft sensor
   - A timing chain tensioner condition
   - An incorrectly installed timing chain
   - Excessive play in the timing chain
   - A timing chain that jumped teeth
   - A crankshaft reluctor wheel that has moved in relationship to top dead center (TDC) on the crankshaft
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Camshaft Timing Drive Chain Alignment Diagram
- Camshaft Timing Drive Components Cleaning and Inspection
- Crankshaft and Bearing Cleaning and Inspection

DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, or P0058

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0030: O2 Sensor Heater Circuit Malfunction (Bank 1 Sensor 1)

DTC P0031: O2 Sensor Heater Circuit Low Voltage (Bank 1 Sensor 1)

DTC P0032: O2 Sensor Heater Circuit High Voltage (Bank 1 Sensor 1)

DTC P0036: O2 Sensor Heater Circuit Malfunction (Bank 1 Sensor 2)

DTC P0037: O2 Sensor Heater Circuit Low Voltage (Bank 1 Sensor 2)

DTC P0038: O2 Sensor Heater Circuit High Voltage (Bank 1 Sensor 2)

DTC P0050: O2 Sensor Heater Circuit Malfunction (Bank 2 Sensor 1)

DTC P0051: O2 Sensor Heater Circuit Low Voltage (Bank 2 Sensor 1)

DTC P0052: O2 Sensor Heater Circuit High Voltage (Bank 2 Sensor 1)

DTC P0056: O2 Sensor Heater Circuit Malfunction (Bank 2 Sensor 2)

DTC P0057: O2 Sensor Heater Circuit Low Voltage (Bank 2 Sensor 2)

DTC P0058: O2 Sensor Heater Circuit High Voltage (Bank 2 Sensor 2)

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0030, P0036, P0050, P0056	P0030, P0036, P0050, P0056	--	P0135, P0141, P0155, P0161
HO2S Heater Control Sensor 1 Bank 1 or 2	P0031, P0051	P0030, P0050	P0032, P0052	P0135, P0141, P0155, P0161
HO2S Heater Control Sensor 2 Bank 1 or 2	P0037, P0057	P0036, P0056	P0038, P0058	P0135, P0141, P0155, P0161

Circuit Description

The heated oxygen sensor (HO2S) heater reduces the time required for the oxygen sensor to reach operating temperature and maintains the operating temperature during extended idle periods. When the ignition is turned to the Run position, ignition voltage is supplied directly to the sensor heater. The engine control module (ECM) controls the heater operation by first modulating the control circuit to ground when the sensors are cold. This prevents the possibility of thermal shock to the sensor from condensation build-up on the sensor, by controlling the sensors rate of heating. After a predetermined amount of time the ECM commands the heaters ON continuously. Once the sensor reaches operating temperature the ECM may modulate the heater control circuit to ground, to maintain a desired temperature.

The ECM controls the heater by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to voltage. The ECM can determine if the control circuit is open, shorted to ground or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the DTC

P0030, P0031, P0032, P0050, P0051, P0052

- The ignition voltage is between 10-18 volts.
- The engine speed is greater than 80 RPM.
- The HO2S heater is commanded ON and OFF at least once during the ignition cycle.
- The DTCs run continuously once the above conditions are met for 1 second.

P0036, P0037, P0038, P0056, P0057, P0058

- The ignition voltage is between 10-18 volts.
- The engine speed is greater than 80 RPM.
- The HO2S heater is commanded ON and OFF at least once during the ignition cycle.
- The secondary HO2S is at operating temperature.
- The DTCs run continuously once the above conditions are met for 1 second.

Conditions for Setting the DTC

P0030, P0036, P0050, P0056

The ECM detects an open circuit in the heater circuits of the HO2S when the heater is commanded OFF. The condition exists for greater than 4 seconds or a cumulative of 30 seconds.

P0031, P0037, P0051, P0057

The ECM detects a ground in the heater circuits of the HO2S when the heater is commanded OFF. The condition exists for greater than 4 seconds or a cumulative of 30 seconds.

P0032, P0038, P0052, P0058

The ECM detects a short to voltage in the heater circuits of the HO2S when the heater is commanded ON. The condition exists for greater than 4 seconds or a cumulative of 30 seconds.

Action Taken When the DTC Sets

DTCs P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057 and P0058 are type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057 and P0058 are type B DTCs.

Diagnostic Aids

- If the condition is intermittent, move the related harnesses and connectors with the engine operating, while monitoring the circuit status for the component with a scan tool. If the circuit status parameter changes from OK or Indeterminate to Fault there is a condition with the circuit or a connection.
- An open fuse in the HO2S heater circuit may be caused by the heater element in one of the sensors. The condition may not be present until the sensor operates for a period of time. If no fault is present in the heater circuit, monitor the amperage of each heater using the DMM to determine if one of the heater elements is the cause of the open fuse. Inspect the sensor pigtail or the harness for contacting the exhaust system.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine idling at operating temperature for at least 30 seconds. Observe the DTC information, DTCs P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057 and P0058 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate heated oxygen sensor (HO2S).
2. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 1 and ground.

   Note: The ignition circuit supplies voltage to other components. Make sure you test all circuits for a short to ground or test all components for being shorted that share the ignition circuit.

   If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition circuit and replace as necessary.
3. Connect a test lamp between the heater control circuit terminal 2 and B+. The test lamp should not illuminate.

   If the test lamp is always ON, test the control circuit for a short to ground. If the circuit/connections test normal, replace the ECM.

   Note: The control circuit for the HO2S heater is pulled-up to voltage within the ECM, 2.0-3.0 V on the control circuit is normal.
4. Idle the engine, and verify the test lamp illuminates or flashes.

   If the test lamp is always OFF, test the control circuit terminal 2 for an open/high resistance. If the circuit/connections test normal, replace the ECM.
5. Ignition ON, test for 2.0-3.0 V between the control circuit terminal 2 and ground.

   If not within the specified range, test the control circuit for a short to voltage. If the circuit/connections test normal, replace the ECM.
6. If all circuits/connections test normal, test or replace the HO2S sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the heated oxygen sensor (HO2S) sensor.
2. Test for 5-25 Ω between the control terminal 2 and the ignition terminal 1 of the heated oxygen sensor (HO2S) sensor.

   If not within the specified range, replace the HO2S sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 1
- Heated Oxygen Sensor Replacement - Bank 1 Sensor 2
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 1
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 2
- Engine Control Module Replacement for engine control module replacement, setup, and programming

DTC P0040 or P0041

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0040: O2 Sensor Signals not Plausible (Bank 1 Sensor 1 & Bank 2 Sensor 1)

DTC P0041: O2 Sensor Signals not Plausible (Bank 1 Sensor 2 & Bank 2 Sensor 2)

Circuit Description

The heated oxygen sensor (HO2S) heater reduces the time required for the oxygen sensor to reach operating temperature and maintains the operating temperature during extended idle periods. When the ignition is turned to the ON position, ignition voltage is supplied directly to the sensor heater. The engine control module (ECM) controls the heater operation by first modulating the control circuit to ground when the sensors are cold. This prevents the possibility of thermal shock to the sensor from condensation build-up on the sensor, by controlling the sensors rate of heating. After a predetermined amount of time the ECM commands the heaters ON continuously. Once the sensor reaches operating temperature the ECM may modulate the heater control circuit to ground, to maintain a desired temperature.

The ECM controls the heater by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to voltage. The ECM can determine if the control circuit is open, shorted to ground or shorted to a voltage by monitoring the feedback voltage.

An HO2S Signal Swapped DTC set if the ECM detects the HO2S signal voltages are heading in the opposite direction of the commanded state.

Conditions for Running the DTC

P0040 or P0041

- The ignition voltage is between 10-18 volts.
- The engine speed is greater than 80 RPM.
- The HO2S heater is commanded ON and OFF at least once during the ignition cycle.
- The DTCs run continuously once the above conditions are met for 1 second.

Conditions for Setting the DTC

P0040 or P0041

An HO2S Signal Swapped DTC set if the ECM detects the HO2S signal voltages are heading in the opposite direction of the commanded state.

Action Taken When the DTC Sets

DTCs P0040 and P0041 are type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0040 and P0041 are type B DTCs.

Diagnostic Aids

- If the condition is intermittent, move the related harnesses and connectors with the engine operating, while monitoring the circuit status for the component with a scan tool. If the circuit status parameter changes from OK or Indeterminate to Fault there is a condition with the circuit or a connection.
- An open fuse in the HO2S heater circuit may be caused by the heater element in one of the sensors. The condition may not be present until the sensor operates for a period of time. If no fault is present in the heater circuit, monitor the amperage of each heater using the DMM to determine if one of the heater elements is the cause of the open fuse. Inspect the sensor pigtail or the harness for contacting the exhaust system.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine idling at operating temperature for at least 30 seconds. Increase the engine speed to 2000 RPM. Observe the DTC information with a scan. DTCs P0040 or P0041 should not set.

   If a DTC sets, inspect the appropriate HO2S harnesses for being connected to the correct sensor.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 .
- Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 .
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 .
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 .
- Engine Control Module Replacement for engine control module replacement, setup, and programming

DTC P0053 or P0059

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P0053: O2 Sensor Heater Resistance Range/Performance (Bank 1 Sensor 1)

DTC P0059: O2 Sensor Heater Resistance Range/Performance (Bank 2 Sensor 1)

Circuit/System Description

Heated oxygen sensors (HO2S) are used for fuel control and post catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content in the exhaust stream. The HO2S must reach operating temperature to provide an accurate voltage signal. A heating element inside the HO2S minimizes the time required for the sensor to reach operating temperature. Voltage is provided to the heater by an ignition voltage circuit through a fuse. With the engine running a ground is provided to the heater by the HO2S heater low control circuit, through a low side driver within the engine control module (ECM). The ECM commands the heater ON or OFF to maintain a specific HO2S operating temperature range.

The ECM determines the temperature by measuring the current flow through the heater and calculating the resistance. Based on the resistance the ECM can predict the sensor temperature. The sensors use pulse width modulation (PWM) to control the heater operation. The ECM calculates the heater resistance on a cold start. This diagnostic will only run once per ignition cycle. If the ECM detects that the heater calculated resistance is not within the expected range these DTC will be set.

Conditions for Running the DTC

- DTCs P0112, P0113, P0117, P0118 are not set.
- The engine is running.
- The ignition is OFF for greater than 10 hours.
- The Engine Coolant Temperature (ECT) Sensor parameter is between -30°C and +45°C (-22°F and +113°F) at engine start-up.
- The ECT Sensor parameter minus the Intake Air Temperature (IAT) Sensor parameter is less than 8°C (14°F) at engine start-up.
- DTCs P0053 and P0059 run once per drive cycle when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the affected HO2S heater low control circuit is not within a specified range at engine start-up.

Action Taken when the DTC Sets

DTCs P0053 and P0059 are type A DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0053 and P0059 are type A DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

- With the engine running at operating temperature, observe the HO2S Heater parameter with a scan tool and manipulate the related wiring and connectors.

  If manipulation does affect the parameter then repair the harness or connector.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate HO2S.
2. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal a known ground.

If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse is open, replace the HO2S.

3. Ignition OFF, verify that the test lamp is OFF between the heater low control circuit terminal of the appropriate HO2S and B+.

   If the test lamp illuminates, test the low control circuit for a short to ground.
4. Connect a test lamp between the heater low control circuit terminal of the appropriate HO2S and the B+ circuit terminal.
5. With the engine running, the test lamp should be ON steady or flashing.

   If the test lamp is not ON steady or flashing, test the low control circuit for a short to voltage and for open/high resistance. If the circuit tests normal, replace the ECM.
6. If all circuits test normal, replace the appropriate HO2S.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 .
- Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 .
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 .
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 .
- Engine Control Module Replacement for engine control module replacement, setup, and programming

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DTC P0100, P0102, or P0103

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P0100: Mass Air Flow Sensor Circuit Malfunction

DTC P0102: Mass Air Flow Sensor Voltage Low

DTC P0103: Mass Air Flow Sensor Voltage High

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition Voltage	P0100	P0100	P0100	--	P0101
MAF Sensor Signal	P0100	P0102	P0100	P0102	P0101
Low Reference	--	P0102	P0100	--	P0101

Circuit/System Description

The mass air flow (MAF) sensor is located in the air intake duct. The MAF sensor is an airflow meter that measures the amount of air that enters the engine. The MAF sensor uses a hot film that is cooled by air flowing past the sensing film as air enters the engine. The amount of cooling is proportional to the amount of the air flow. As the air flow increases greater current is required in order to maintain the hot film at a constant temperature. The engine control module (ECM) uses the MAF sensor in order to provide the correct fuel delivery for all operating conditions.

Conditions for Running the DTC

- The engine is operating.
- The ignition voltage is greater than 10 volts.
- DTC P0100, P0102 and P0103 run continuously once the above conditions are met for 6 seconds.

Conditions for Setting the DTC

P0100

- The ECM detects that the MAF sensor signal is 0.0 Hz.
- The condition exists for 4 seconds or for a cumulative of 30 seconds.

P0102

- The ECM detects that the MAF sensor signal is less than 1135 Hz.
- The condition exists for 4 seconds or for a cumulative of 30 seconds.

P0103

- The ECM detects that the MAF sensor signal is greater than 15,152 Hz.
- The condition exists for 4 seconds or for a cumulative of 30 seconds.

Action Taken When the DTC Sets

DTCs P0100, P0102 and P0103 are type B DTCs.

Conditions for Clearing the DTC

DTCs P0100, P0102 and P0103 are type B DTCs.

Diagnostic Aids

- Inspect the harness of the MAF sensor to verify that it is not routed too close to the following components:
  - The secondary ignition wires or coils
  - Any solenoids
  - Any relays
  - Any motors
- Inspect for any of the following conditions.
  - A dirty or deteriorating air filter element
  - Water intrusion in the induction system
  - Vacuum leaks
  - Brake booster leaks
  - Faulty crank case ventilation system
  - Restricted or collapsed air duct.
  - An engine mechanical condition
- Inspect for any contamination, water intrusion, or debris on the sensing elements of the MAF sensor. If debris is present, clean the sensor. If the sensor cannot be cleaned, replace the sensor.
- A high resistance may cause a driveability concern before this DTC sets.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Air Intake System Description

Electrical Information Reference

- Circuit Testing
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- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 38522 Variable Signal Generator

Circuit/System Verification

1. Engine idling for 1 minute, observe the DTC information with a scan tool. DTCs P0100, P0102 and P0103 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the MAF sensor.
2. Ignition OFF, test for less than 5 Ω between the ground circuit terminal C and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.

   Caution: Do NOT use the low reference circuit in the component harness connector for this test. Damage to the control module may occur due to excessive current draw.

3. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal B and

ground.

If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition circuit and replace as necessary.

4. Test for 4.8-5.2 V between the signal circuit terminal A and the ground circuit terminal C.

   If less than the specified range, test the signal circuit for an open/high resistance or a short to ground. If the circuit/connections test normal, replace the ECM.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit/connections test normal, replace the ECM.
5. Ignition OFF, connect the red lead of the *J 38522* Variable Signal Generator to the signal circuit terminal A at the MAF sensor harness connector. Connect the battery voltage supply to B+, and ground the black lead.
6. Set the *J 38522* Variable Signal Generator Signal switch to 5 V, the Frequency switch to 5 K, and the Duty Cycle switch to Normal.
7. Ignition ON, observe the scan tool MAF Sensor frequency parameter. The parameter should be between 4,950-5,025 Hz.

   If the parameter is not within the specified range, replace the ECM.
8. If all circuits/connections test normal, replace the MAF sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Mass Airflow Sensor with Intake Air Temperature Sensor Replacement
- Engine Control Module Replacement for engine control module replacement, setup, and programming

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DTC P0101

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P0101: Mass Air Flow Sensor Circuit Range/Performance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition 1 Voltage	P0100	P0100	P0100	--	P0101
MAF Sensor Signal	P0100	P0102	P0100	P0102	P0101
Low Reference	--	P0102	P0100	--	P0101

Circuit/System Description

The mass air flow (MAF) sensor is located in the air intake duct. The MAF sensor is an airflow meter that measures the amount of air that enters the engine. The MAF sensor uses a hot film that is cooled by air flowing past the sensing film as air enters the engine. The amount of cooling is proportional to the amount of the air flow. As the air flow increases greater current is required in order to maintain the hot film at a constant temperature. The engine control module (ECM) uses the MAF sensor in order to provide the correct fuel delivery for all operating conditions.

Conditions for Running the DTC

- Before the ECM can report DTC P0101 failed, DTCs P0100, P0102, P0103, P0121, P0122, P0123, P0221, P0222, P0223, P0335, P0336 and P0338 must run and pass.
- DTC P2176 is not set.
- The engine speed is greater than 320 RPM.
- The MAF sensor signal is greater than 11 grams per second.
- The ignition voltage is greater than 10.5 volts.
- The ECM detects greater than 150 revolutions of the crankshaft.
- DTC P0101 runs continuously once the above conditions are met for greater than 2 seconds.

Conditions for Setting the DTC

- The ECM detects that the MAF sensor signal is greater or less than the calculated air flow based on engine load and engine speed.

  OR
- The ECM detects that the MAF sensor signal is greater or less than the calculated air flow, and the ECM detects a significant error in the long term fuel trim at cruising speed.

Action Taken When the DTC Sets

DTC P0101 is a type B DTC.

Conditions for Clearing the DTC

DTC P0101 is a type B DTC.

Diagnostic Aids

- Inspect the harness of the MAF sensor to verify that it is not routed too close to the following components:
  - The secondary ignition wires or coils
  - Any solenoids
  - Any relays
  - Any motors
- Inspect for any contamination, water intrusion, or debris on the sensing elements of the MAF sensor. If debris is present, clean the sensor. If the sensor cannot be cleaned, replace the sensor.
- A high resistance may cause a driveability concern before this DTC sets.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Air Intake System Description

Electrical Information Reference

- Circuit Testing

- Connector Repairs
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- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 38522 Variable Signal Generator

Circuit / System Verification

1. Engine idling for 1 minute, observe the DTC information with a scan tool. DTC P0101 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

1. Inspect for the following conditions:
   - An engine vacuum leak
   - An air leak in the intake air duct between the mass air flow (MAF) sensor and the throttle body
   - A plugged or collapsed intake air duct
   - Objects that block the MAF sensor air inlet
   - An air filter element that is restricted
   - The hydro-carbon absorber, if equipped, in the air cleaner assembly for ruptures or deterioration.
   - A restricted throttle plate or for carbon build-up around the throttle plate
   - An unseated engine oil dip stick
   - A loose or missing engine oil fill cap
   - An over filled crankcase
   - An engine mechanical condition

   If you find any of the above conditions, repair as necessary.
2. Ignition OFF, disconnect the harness connector at the MAF sensor.
3. Ignition OFF, test for less than 5 Ω between the ground circuit terminal C and the battery ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.

   Notice: Do NOT use the low reference circuit in the component harness connector for this test. Damage to the control module may occur due to excessive current draw.

4. Ignition ON, load test the ignition circuit for B+ between terminal B and ground.
   If less than the specified value, test the ignition circuit for an open/high resistance.
5. Test for 4.8-5.2 V between the signal circuit terminal A and the ground circuit terminal C .
   If less than the specified range, test the signal circuit for an open/high resistance or a short to ground. If the circuit/connections test normal, replace the ECM.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit/connections test normal, replace the ECM.
6. Ignition OFF, connect the red lead of the *J 38522* Variable Signal Generator to the signal circuit terminal A at the MAF/IAT sensor harness connector. Connect the battery voltage supply to B+, and ground the black lead.
7. Set the *J 38522* Variable Signal Generator Signal switch to 5 V, the Frequency switch to 5K, and the Duty Cycle switch to Normal.
8. Ignition ON, observe the scan tool MAF Sensor frequency parameter. The parameter should be between 4,950-5,025 Hz.
   If the parameter is not within the specified range, replace the ECM.
9. If all circuits/connections test normal, replace the MAF sensor.

Repair Instructions

Perform the Diagnostic Repair Verification .

- Mass Airflow Sensor with Intake Air Temperature Sensor Replacement
- Engine Control Module Replacement for engine control module replacement, setup, and programming

DTC P0111-P0113

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0111: Intake Air Temperature Sensor Circuit Range/Performance

DTC P0112: Intake Air Temperature Sensor Circuit Low Voltage

DTC P0113: Intake Air Temperature Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
IAT Sensor Signal	P0112	P0111, P0113	P0113*	P0111
Low Reference	--	P0111, P0113	P0113*	P0111
* Internal ECM or sensor damage may occur if the circuit is shorted to B+				

Typical Scan Tool Data

IAT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop. *Parameter Normal Range:* -39° to +140°C (-38° to +284°F) Varies with ambient temperature.			
IAT Sensor Signal	141°C (286°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	--	-40°C (-40°F)	-40°C (-40°F)*
* Internal ECM or sensor damage may occur if the circuit is shorted to B+			

Circuit Description

The intake air temperature (IAT) sensor is an integral part of the mass air flow (MAF) sensor. The IAT sensor is a variable resistor that measures the temperature of the intake air. The engine control module (ECM) supplies 5 volts to the IAT signal circuit and supplies a ground to the low reference circuit.

The following table illustrates the difference between temperature, resistance, and voltage:

IAT	IAT Resistance	IAT Signal Voltage
Cold	High	High
Warm	Low	Low

Conditions for Running the DTC

P0111 Idle Test

- Before the ECM can report DTC P0111 failed, DTC P0101 must run and pass.
- DTCs P0112, P0113, P0116, P0117, P0118, P0119, P0125, and P0128 are not set.
- The engine coolant temperature (ECT) at engine start is less than 65°C (149°F).
- The ECT is greater than 75°C (167°F).
- The vehicle speed is less than 10 km/h (6.3 mph).
- DTC P0111 runs continuously once the above conditions are met for greater than 2 seconds.

P0111 Cruise Test

- Before the ECM can report DTC P0111 failed, DTC P0101 must run and pass.
- DTCs P0112, P0113, P0116, P0117, P0118, P0119, P0125 and P0128 are not set.
- The ECT at engine start is less than 65°C (149°F)
- The vehicle speed is greater than 60 km/h (37.4 mph).
- The MAF is between 11-42 g/s.
- Decel fuel cut-off (DFCO) is not active.
- DTC P0111 runs continuously once the above conditions are met for greater than 2 seconds.

P0112 and P0113

- The engine run time is greater than 3 minutes.
- The engine is idling for greater than 10 seconds.
- The DTCs runs continuously once the above conditions are met.

Conditions for Setting the DTC

P0111

The ECM detects that the IAT increased less than 4°C (7°F) during the idle test. The condition exists for a total of 16 seconds or 4 events of greater than 4 seconds each. Or the ECM detects that the IAT decreased less than 4°C (7°F) during the cruise test. The condition exists for a total of 28 seconds or 7 events of greater than 4 seconds each.

P0112

The ECM detects that the intake air temperature is greater than 132°C (270°F) for greater than 4 seconds or a cumulative of 30 seconds.

P0113

The ECM detects that the intake air temperature is less than -42°C (-43°F) and remains steady within 3°C (5°F) during a cumulative air flow of greater than 999 grams. The scan tool is limited to -40°C (-40°F), so the diagnostic procedure uses -39°C (-38°F) to determine if there is an IAT condition. The condition exists for greater than 4 seconds or a cumulative of 30 seconds.

Action Taken When the DTC Sets

DTCs P0111, P0112 and P0113 are type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0111, P0112 and P0113 are type B DTCs.

Diagnostic Aids

- If the vehicle has sat overnight, the IAT sensor and the ECT sensor values should display within 3°C (5°F).
- High resistance on either the IAT sensor signal circuit or the IAT sensor low reference circuit may set a DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine idling, DTC P0111, P0112 or P0113 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Observe the scan tool Intake Air Temperature (IAT) sensor parameter, while moving the MAF/IAT sensor connector and the engine control module (ECM) connector. The IAT sensor parameter should not fluctuate while moving the related harnesses and connectors.

   If the IAT parameter fluctuates greater than 3°C (5°F) while moving the related harnesses and connectors, repair the condition as necessary.
2. Ignition OFF, disconnect the harness connector at the MAF/IAT sensor.
3. Ignition OFF, remove the fuse that supplies B+ to circuit terminal 56 X2 of the ECM.

   Caution: Do NOT use a test lamp to test the continuity of the circuit. Damage to the control module may occur due to excessive current draw.

4. Test for less than 5 Ω between the low reference circuit terminal E and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance, or for a short to voltage. If the circuit/connections test normal, replace the ECM.
5. Install the fuse that supplies B+ to circuit terminal 56 X2 of the ECM.
6. Ignition ON, verify that the scan tool IAT sensor parameter is at -40°C (-40°F).

   If warmer than the specified value, test the signal circuit terminal D for a short to ground. If the circuit/connections test normal, replace the ECM.

   Note: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the sensor may be damaged.

7. Ignition ON, install a 3 A fused jumper wire between the signal circuit terminal D and ground circuit terminal C. Verify the IAT sensor parameter is greater than 134°C (274°F).

   If less than the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit/connections test normal, replace the ECM.
8. If all circuits/connections test normal, test or replace the MAF/IAT sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector of the MAF/IAT sensor.

   Note: A thermometer can be used to test the sensor off the vehicle.

2. Test the IAT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the Temperature Versus Resistance - Intake Air Temperature Sensor and verify that the resistance is within 5 percent of the specification.

   If the Resistance vs Temperature is not within 5 percent, replace the MAF/IAT sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Mass Airflow Sensor with Intake Air Temperature Sensor Replacement
- Engine Control Module Replacement for engine control module replacement, setup, and programming

DTC P0116

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0116: Engine Coolant Temperature Sensor Circuit Range/Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117	P0118, P0119	P0118, P0119*	P0116*
Low Reference	--	P0118, P0119	P0118, P0119*	P0116*
* Internal ECM or ECT sensor damage may occur if the circuit is shorted to B+				

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop. *Parameter Normal Range:* -39 to +142°C (-38 to +288°F) Varies with coolant temperature.			
ECT Sensor Signal	143°C (289°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	--	-40°C (-40°F)	-40°C (-40°F)*
* Internal ECM or ECT sensor damage may occur if the circuit is shorted to B+			

Circuit Description

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the ECT signal circuit and supplies a ground to the low reference circuit. The ECM monitors the mutual performance of the ECT and the intake air temperature (IAT) signals. The ECM monitors the warm up and cool down behavior of the sensors, after a vehicle has been driven at operating temperature and then is shut down . If the ECM detects that the ECT is not with in a predetermined range of IAT after a long soak (over night) or the ECT and IAT are not within a range of each other as compared to a previous cold start, this DTC sets.

The following table illustrates the difference between temperature, resistance and voltage:

ECT	ECT Resistance	ECT Signal Voltage
Cold	High	High
Warm	Low	Low

Conditions for Running the DTC

Condition 1

- Before the ECM can report DTC P0116 failed, DTC P0101 must run and pass.
- DTC P0112, P0113, P0117, P0118, P0119, or P2610 is not set.
- The engine run time of the previous ignition cycle was greater than 10 minutes.
- The calculated engine cool down of the previous test was greater than 50°C (120°F).
- The ignition was OFF for greater than 330 minutes after the previous engine shut down.
- The accumulated air mass of the previous ignition cycle was greater than 6,000 grams.
- The DTC runs once an ignition cycle when the above conditions are met for greater than 35 seconds.

Condition 2

- Before the ECM can report DTC P0116 failed, DTC P0101 must run and pass.
- DTCs P0112, P0113, P0117, P0118, and P0119 are not set.
- The ECT at the previous engine shut down is greater than 82°C (180°F).
- The block heater is not detected.
- The ignition was OFF for greater than 330 minutes after the previous engine shut down.
- DTC runs once an ignition cycle when the above conditions are met.

Conditions for Setting the DTC

- The ECM determines the difference between the ECT and IAT at ignition ON is not within 14°C (25°F) of the difference recorded during a previous ignition cycle, when the enable conditions were met.

  OR
- The ECM determines the IAT at ignition ON is within a calibrated range of the ECT and IAT recorded during a previous ignition cycle, but the ECT is not within 14°C (25°F) of the calibrated range.

Action Taken When the DTC Sets

DTC P0116 is a type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0116 is a type B DTC.

Diagnostic Aids

- Test the ECT and the IAT sensor at various temperature levels in order to evaluate the possibility of a skewed sensor. A skewed sensor can result in a DTC or a driveability condition. Refer to Temperature Versus Resistance - Engine Coolant Temperature Sensor and Temperature Versus Resistance - Intake Air Temperature Sensor .
- If the vehicle has sat overnight, the IAT sensor and the ECT sensor values should display within 3°C (5°F).
- After starting a cold engine, the ECT sensor temperature should rise steadily, then stabilize after the thermostat opens.
- High resistance in the circuits of either the ECT or IAT sensor may set a DTC.
- A short to ground or voltage through a conductive material or fluid may set this DTC. Inspect the ECT sensor for evidence of coolant leaking into the connector body.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine idling for 1 minute, observe the DTC information with a scan tool. DTC P0117, P0118, or P0119 should not set.

   If a DTC sets, refer to Diagnostic Trouble Code (DTC) List - Vehicle
2. Ignition OFF, inspect the cooling system surge tank for the proper coolant level. Refer to Cooling System Leak Testing and Cooling System Draining and Filling .

Inspect the engine coolant level. Verify that the cooling system is operating correctly.

If you suspect a condition with engine cooling system, refer to Symptoms - Engine Cooling

3. Inspect the thermostatically-controlled coolant heater, if equipped , for damage or modifications. Test for proper operation of the Coolant Heater. Refer to Coolant Heater Inoperative .
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the ECT sensor.
2. Ignition OFF, remove the fuse that supplies B+ to circuit terminal 56 X2 of the ECM.

Note: The control module or the sensor may be damaged if the circuit is shorted to battery positive voltage.

3. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance, or for a short to voltage. If the circuit tests normal, replace the ECM.
4. Install the fuse that supplies B+ to circuit terminal 56 X2 of the ECM.
5. Ignition ON, verify that the scan tool ECT sensor parameter is at -40°C (-40°F).

   If warmer than the specified value, test the signal circuit terminal 1 for a short to ground. If the circuit tests normal, replace the ECM.

Note: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the sensor may be damaged.

6. Ignition ON, install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2. Verify the ECT sensor parameter is greater than 142°C (288°F).

   If less than the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
7. If all circuits test normal, test or replace the ECT sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the engine coolant temperature (ECT) sensor.

Note: A thermometer can be used to test the sensor off the vehicle.

2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the Temperature Versus Resistance - Engine Coolant Temperature Sensor table and verify that the resistance is within 5 percent of the specification.

   If not within the specified range, replace the ECT sensor.

Repair Instructions

Perform the Diagnostic Repair Verification .

- Engine Coolant Temperature Sensor Replacement
- Engine Control Module Replacement for engine control module replacement, setup, and programming

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DTC P0117 or P0118

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0117: Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage

DTC P0118: Engine Coolant Temperature (ECT) Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117	P0118, P0119	P0118, P0119*	P0116
Low Reference	--	P0118, P0119	P0118, P0119*	P0116
* Sensor or ECM damage may occur if the circuit is shorted to B+				

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop. *Parameter Normal Range:* -39 to 142°C (-38 to 288°F) Varies with coolant temperature.			
ECT Sensor Signal	143°C (289°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	--	-40°C (-40°F)	-40°C (-40°F)*
* Internal ECM or ECT sensor damage may occur if the circuit is shorted to B+			

Circuit/System Description

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the ECT sensor signal circuit and supplies a ground for the low reference circuit.

The following table illustrates the difference between temperature, resistance, and voltage:

ECT	ECT Resistance	ECT Signal Voltage
Cold	High	High
Warm	Low	Low

Conditions for Running the DTC

P0117

- The start up intake air temperature (IAT) is greater than 72°C (161°F).
- The engine run time is greater than 59 seconds.
- The DTC runs continuously once the above conditions are met.

P0118

- The engine run time is greater than 10 seconds.
- The ignition is ON and the IAT parameter is warmer than 0°C (32°F).
- The DTC runs continuously when one of the above conditions is met.

Conditions for Setting the DTC

P0117

The ECM detects that the ECT is greater than 140°C (284°F) for greater than 1 second or a cumulative of 10 seconds.

P0118

The ECM detects that the ECT is less than -39°C (-38°F) for greater than 1 seconds or a cumulative of 10 seconds.

Action Taken When the DTC Sets

DTCs P0117 and P0118 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0117 and P0118 are Type B DTCs.

Diagnostic Aids

- Test the ECT sensor at various temperature levels in order to evaluate the possibility of a skewed sensor. A skewed sensor can result in a DTC or a driveability condition. Refer to Temperature Versus Resistance - Engine Coolant Temperature Sensor .
- If the vehicle has sat overnight, the IAT sensor and the ECT sensor values should display within 3°C (5°F).
- After starting a cold engine, the ECT sensor temperature should rise steadily, then stabilize

after the thermostat opens.

- High resistance in the circuits of either the ECT or IAT sensor could set a DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Ignition ON, observe the ECT Sensor parameter. The reading should be between -37 to +139°C (-35 to +282°F).
2. Engine idling for 1 minute. Observe the DTC information with a scan tool. DTCs P0117 and P0118 should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

1. Ignition OFF, disconnect the harness connector at the ECT sensor.
2. Ignition OFF, remove the fuse that supplies B+ to circuit terminal 56 X2 of the ECM.

Caution: Do NOT use a test lamp to test the continuity of the circuit. Damage to the control module may occur due to excessive current draw.

Note: The control module or the sensor may be damaged if the circuit is shorted to battery positive voltage.

3. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.
   If greater than the specified range, test the low reference circuit for an open/high resistance, or for a short to voltage. If the circuit tests normal, replace the ECM.
4. Install the fuse that supplies B+ to circuit terminal 56 X2 of the ECM.
5. Ignition ON, verify that the scan tool ECT sensor parameter is at -40°C (-40°F).
   If warmer than the specified value, test the signal circuit terminal 1 for a short to ground. If the circuit tests normal, replace the ECM.

   Note: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the sensor may be damaged.

6. Ignition ON, install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2. Verify the ECT sensor parameter is greater than 142°C (288°F).
   If colder than the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
7. If all circuits test normal, test or replace the ECT sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the engine coolant temperature (ECT) sensor.

   Note: A thermometer can be used to test the sensor off the vehicle.

2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the Temperature Versus Resistance - Engine Coolant Temperature Sensor table and verify that the resistance is within 5 percent of the specification.
   If not within the specified range, replace the ECT sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Engine Coolant Temperature Sensor Replacement
- Control Module References for ECM replacement, setup, and programming

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DTC P0119

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0119: Engine Coolant Temperature Sensor Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117	P0116, P0118, P0119	P0118*, P0119*	P0116*
Low Reference	--	P0116, P0118, P0119	P0118*, P0119*	P0116*
* Internal ECM or sensor damage may occur if the circuit is shorted to B+				

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop *Parameter Normal Range:* -39 to +142°C (-38 to +288°F) Varies with coolant temperature.			
ECT Sensor Signal	143°C (289°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	--	-40°C (-40°F)	-40°C (-40°F)*
* Internal ECM or ECT sensor damage may occur if the circuit is shorted to B+			

Circuit Description

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the ECT signal circuit and supplies a ground to the low reference circuit. The ECM monitors the performance of the ECT sensor. If the ECM detects incorrect or rapid fluctuations in the ECT signal, this DTC sets.

The following table illustrates the difference between temperature, resistance and voltage:

ECT	ECT Resistance	ECT Signal Voltage
Cold	High	High
Warm	Low	Low

Conditions for Running the DTC

- DTC P0117, P0118, or P0128 are not set.
- The ignition is ON or the engine is operating.
- DTC P0119 runs continuously once the above conditions are met.

Conditions for Setting the DTC

- The ECM detects that the ECT changed greater than an expected value during a calibrated amount of time.
- The condition exists for greater than 5 minutes.

Action Taken When the DTC Sets

DTC P0119 is a type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0119 is a type B DTC.

Diagnostic Aids

- Test the ECT sensor at various temperature levels in order to evaluate the possibility of a skewed sensor. A skewed sensor can result in a DTC or a driveability condition. Refer to Temperature Versus Resistance - Engine Coolant Temperature Sensor .
- If the vehicle has sat overnight, the IAT sensor and the ECT sensor values should display within 3°C (5°F).
- After starting a cold engine, the ECT sensor temperature should rise steadily, then stabilize after the thermostat opens.
- High resistance on either the ECT sensor signal circuit or the ECT sensor low reference circuit may set a DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Observe the ECT sensor parameter with a scan tool while moving the ECT sensor connector and the ECM connector. The ECT sensor parameter should not fluctuate while moving the related harnesses and connectors.

   Repair the suspected harness or connection if the ECT parameter fluctuates greater than 3°C (5°F) while moving the related harnesses and connectors.
2. Inspect the engine coolant level. Verify that the cooling system is operating correctly.

   If you suspect a condition with engine cooling system, refer to Symptoms - Engine Cooling .
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the ECT sensor.
2. Ignition OFF, remove the fuse that supplies B+ to circuit terminal 56 X2 of the ECM.

   Caution: Do NOT use a test lamp to test the continuity of the circuit. Damage to the control module may occur due to excessive current draw.

   Note: The control module or the sensor may be damaged if the circuit is shorted to battery positive voltage.

3. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance, or for a short to voltage. If the circuit tests normal, replace the ECM.
4. Install the fuse that supplies B+ to circuit terminal 56 X2 of the ECM.
5. Ignition ON, verify that the scan tool ECT sensor parameter is at -40°C (-40°F).

   If greater than the specified value, test the signal circuit terminal 1 for a short to ground. If the circuit tests normal, replace the ECM.

   Note: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the sensor may be damaged.

6. Ignition ON, install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2. Verify the ECT sensor parameter is greater than 142°C (288°F).
   If less than the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
7. If all circuits test normal, test or replace the ECT sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the engine coolant temperature (ECT) sensor.

   Note: A thermometer can be used to test the sensor off the vehicle.

2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the Temperature Versus Resistance - Engine Coolant Temperature Sensor table and verify that the resistance is within 5 percent of the specification.
   If not within the specified range, replace the ECT sensor.

Repair Instructions

Perform the Diagnostic Repair Verification .

- Engine Coolant Temperature Sensor Replacement
- Engine Control Module Replacement for engine control module replacement, setup, and programming

DTC P0121, P0122, P0123, P0221, P0222, or P0223

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0121: Throttle Position (TP) Sensor 1 Circuit Range/Performance

DTC P0122: Throttle Position (TP) Sensor 1 Circuit Low Voltage

DTC P0123: Throttle Position (TP) Sensor 1 Circuit High Voltage

DTC P0221: Throttle Position (TP) Sensor 2 Circuit Range/Performance

DTC P0222: Throttle Position (TP) Sensor 2 Circuit Low Voltage

DTC P0223: Throttle Position (TP) Sensor 2 Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference	P0122, P0222, P0698	P0121, P0122, P0221, P0222, P0697, P2119, P2101	P0123, P0223, P0699, P2101, P2119	P0121, P0221, P0697, P0698, P0699
TP Sensor Signal 1	P0122	P0121, P0122, P2101, P2119	P0123	P0121, P0221, P2119
TP Sensor Signal 2	P0222	P0221, P0223	P0223, P0638, P2128, P2138	P0221
Low Reference	--	P0121, P0123, P0221, P0223, P2119, P2100	P0123, P0223*	P0121, P0221
* Internal ECM or TP sensor damage may occur if the circuit is shorted to B+				

Typical Scan Tool Data

TP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating in closed loop *Parameter Normal Range:* TP Position Sensor 5%/4.2 V			

5-Volt Reference	124%/0.0 V	7%/0.0 V	113%/TP 1 4.98, TP 2, 4.50 V
TP Sensor Signal 1	4%/0.00 V	7%/0.00 V	7%/0.00 V
TP Sensor Signal 2	4%/0.00 V	4%/4.98 V	27%/4.98 V
Low Reference	--	0%/4.98 V	--

Circuit/System Description

The throttle body assembly contains 2 throttle position (TP) sensors. The TP sensors are mounted to the throttle body assembly and are not serviceable. The TP sensors provide a signal voltage that changes relative to throttle blade angle. The engine control module (ECM) supplies the TP sensors with a common 5-volt reference circuit , a common low reference circuit, and two independent signal circuits. The TP sensors have opposite functionality . TP sensor 1 signal voltage decreases from greater than 4 volts at idle to less than 1 volt at wide open throttle (WOT). TP sensor 2 signal voltage increases from less than 1 volt at idle to greater than 4 volts at WOT.

Conditions for Running the DTC

P0121

- The ignition voltage is greater than 7 volts.
- The TP sensor 1 voltage is between 0.18-4.6 volts.
- DTC P0121 runs continuously once the above conditions are met.

P0122, P0123, P0222, and P0223

- The ignition is ON, with the engine OFF, or the engine is operating.
- The ignition voltage is greater than 7 volts.
- DTC P0122 runs continuously once the above conditions are met.

P0221

- The ignition voltage is greater than 7 volts.
- The TP sensor 2 voltage is between 0.16-4.9 volts.
- DTC P0221 runs continuously once the above conditions are met.

Conditions for Setting the DTC

P0121

The TP sensor 1 disagrees greater than 9 percent from TP sensor 2, or TP sensor 1 disagrees greater than 9 percent from the predicted value for greater than 1 second or a cumulative of 10 seconds.

P0122

The ECM detects the TP sensor 1 signal voltage is less than 0.18 volt for greater than 1 second or a cumulative of 10 seconds.

P0123

The ECM detects the TP sensor 1 signal voltage is greater than 4.6 volts for greater than 1 second or a cumulative of 10 seconds.

P0221

The TP sensor 2 disagrees greater than 9 percent from TP sensor 1, or TP sensor 2 disagrees greater than 9 percent from the predicted value for greater than 1 second or a cumulative of 10 seconds.

P0222

The ECM detects the TP sensor 2 signal voltage is less than 0.16 volt for greater than 1 second or a cumulative of 10 seconds.

P0223

The ECM detects the TP sensor 2 signal voltage is greater than 4.9 volts for greater than 1 second or a cumulative of 10 seconds.

Action Taken When the DTC Sets

- DTCs P0121, P0122, P0123, P0221, P0222 and P0223 are type B DTCs.
- The ECM commands the TAC system to operate in the Reduced Engine Power mode.
- Under certain conditions the ECM commands the engine OFF.

Conditions for Clearing the MIL/DTC

DTCs P0121, P0122, P0123, P0221, P0222 and P0223 are type B DTCs.

Diagnostic Aids

If there is a condition with the TP sensors the ECM defaults to reduced power mode for the entire ignition cycle, even if the condition is corrected.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, verify that DTC P0697, P0698, or P0699 is not set.

   If a DTC is set, refer to DTC P0641-P0643, P0651-P0653, or P0697-P0699 .
2. Clear the DTC Info with a scan tool.
3. Start the engine, observe the scan tool TP Sensor 1 and 2 voltage parameters. TP sensor 1 should be between 0.17-4.6 V and TP sensor 2 should be between 0.15-4.8 V.
4. Observe the scan tool TP sensor 1 and 2 parameters while performing the tests listed below. The TP sensor 1 and 2 parameter should display Agree.
   - Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release pedal. Repeat the procedure several times.
   - Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat the procedure several times.
5. Observe the DTC Information with a scan tool. DTCs P0121, P0122, P0123, P0221, P0222, and P0223 should not set.
6. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at throttle body.
2. Ignition OFF, remove the fuse that supplies B+ to terminal 56 X2 of the ECM.

   Note: The control module or the sensor may be damaged if the circuit is shorted to battery positive voltage.
3. Test for less than 5 Ω between the low reference circuit terminal C and ground.

   If greater than the specified range, test the low reference circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
4. Install fuse that supplies B+ to terminal 56 X2 of the ECM.

5. Ignition ON, test for 4.8-5.2 V between the 5-volt reference circuit terminal E and ground.

   If less than the specified range, test the circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

   If greater than the specified range, test the circuit for a short to voltage. If the circuit tests normal, replace the ECM.
6. Ignition ON, verify that the scan tool TP sensor 1 voltage parameter is less than 0.3 V.

   If greater than the specified value, test the signal circuit terminal D for a short to voltage. If the circuit tests normal, replace the ECM.
7. Connect a 3 A fused jumper wire between the 5-volt reference circuit terminal E and the TP sensor 1 signal circuit terminal D. Verify the scan tool TP sensor 1 voltage parameter is greater than 4.89 V.

   If less than the specified value, test the signal circuit for an open/high resistance or for a short to ground. If the circuit tests normal, replace the ECM.
8. Verify the scan tool TP sensor 2 voltage parameter is greater than 4.97 V.

   If less than the specified value, test the signal circuit terminal F for a short to ground. If the circuit tests normal, replace the ECM.

   Note: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage.

9. Connect a 3 A fused jumper wire between the TP sensor 2 signal circuit terminal F and the low reference circuit terminal C. Verify the scan tool TP sensor 2 voltage parameter is less than 0.10 V.

   If greater than the specified value, test the signal circuit for an open/high resistance or for a short to voltage. If the circuit tests normal, replace the ECM.
10. If all circuits test normal, replace the throttle body assembly.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Throttle Body Assembly Replacement
- Control Module References for ECM replacement, setup, and programming

DTC P0128

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0128: Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature

Circuit Description

The engine control module (ECM) monitors the temperature of the engine coolant for engine control and as an enabling criteria for some diagnostics. The amount of air flow into an engine is proportional to the amount of heat an engine generates. The ECM monitors the amount of air flow into the engine to calculate engine coolant temperature (ECT). The ECM uses the calculated temperature to determine if the engine has warmed up to the closed loop temperature or to the thermostat regulating temperature. If the coolant temperature does not increase normally or does not reach the closed loop temperature, diagnostics that use the ECT as enabling criteria, may not run when expected.

Conditions for Running the DTC

- Before the ECM can report DTC P0128 failed, DTC P0117 must run and pass.
- DTCs P0100, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117, P0118, P0119, or P0700 is not set.
- The calculated ambient air temperature is warmer than -39°C (-38°F) and colder than 100°C (212°F).
- The vehicle speed is greater than 5 km/h (8 mph).
- The engine speed is greater than 760 RPM.
- The ECT is colder than 70°C (158°F) at start up.
- The air flow coming into the engine has accumulated to greater than 1,000 grams.
- DTC P0128 runs continuously once the above conditions have been met for approximately 15 minutes.

OR

- DTCs P0100, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117, P0118, P0119, or P0700 is not set.
- The engine speed is greater than 25 RPM.
- The block heater is not detected.
- DTC P0128 runs continuously once the above conditions have been met for approximately 8 minutes.

Conditions for Setting the DTC

- The ECM detects that the actual engine coolant temperature is 11°C (20°F) colder than the calculated thermostat regulating temperature of 89°C (192°F), for greater than 4 seconds or for a cumulative of 30 seconds.

  OR
- The ECM detects that the actual engine coolant temperature is 10°C (18°F) colder than the calculated ECT for greater than 1 second or for a cumulative time of 10 seconds.

Action Taken When the DTC Sets

DTC P0128 is a Type B DTCs.

Conditions for Clearing the MIL/DTC

DTC P0128 is a Type B DTCs.

Diagnostic Aids

An engine that soaks for about 8 hours will help diagnosis the condition. After the cold soak, operate the vehicle at highway speeds for 20 minutes while monitoring the scan tool Calculated ECT - Thermostat parameter. If there is a condition, the calculated temperature will be 10°C (18°F) warmer than the actual engine coolant temperature.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Verify that the engine coolant level is correct.

   If the engine coolant is not at the correct level, refer to Loss of Coolant .
2. Verify that the engine coolant temperature is at the normal operating temperature.

   If the engine coolant temperature is colder than the normal operating temperature, refer to Thermostat Diagnosis .
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

1. Ignition OFF, disconnect the harness connector at the ECT sensor.
2. Ignition OFF, remove the fuse that supplies B+ to circuit terminal 56 X2 of the ECM.

   Caution: Do NOT use a test lamp to test the continuity of the circuit. Damage to the control module may occur due to excessive current draw.

   Note: The control module or the sensor may be damaged if the circuit is shorted to battery positive voltage.

3. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.

   If greater than specified value, test the circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
4. Install the fuse that supplies B+ to circuit terminal 56 X2 of the ECM.
5. Ignition ON, observe the scan tool the ECT sensor parameter. Verify that the ECT sensor parameter is at -40°C (-40°F).

   If warmer than the specified value, test the signal circuit for a short to ground. If the circuit/connections test normal, replace the ECM.

   Note: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the ECT sensor may be damaged.

6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2. Verify the scan tool ECT sensor parameter is warmer than 142°C (288°F).

   If colder than the specified value, test the signal circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the ECM.
7. If all circuits test normal, test or replace the ECT sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the ECT sensor.

   Note: A thermometer can be used to the used to test the sensor off the vehicle.

2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the Temperature Versus Resistance - Engine Coolant Temperature Sensor table and verify that the resistance is within 5 percent of the

specification.

If the resistance vs. temperature is not within specified value, replace the ECT sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Engine Coolant Temperature Sensor Replacement
- Control Module References for engine control module replacement, setup, and programming

DTC P0130 or P0150

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P0130: O2 Sensor Circuit Malfunction (Bank 1 Sensor 1)

DTC P0150: O2 Sensor Circuit Malfunction (Bank 2 Sensor 1)

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Bank 1 Sensor 1 Signal	P0131	P0130, P0134	P0132	P0130, P0133
HO2S Bank 1 Sensor 2 Signal	P0137	P0140	P0138	P0139
HO2S Bank 2 Sensor 1 Signal	P0151	P0150, P0154	P0152	P0150, P0153
HO2S Bank 2 Sensor 2 Signal	P0157	P0160	P0158	P0159
Low Reference	--	P0130, P0150	P0134, P0140, P0154, P0160	--

Typical Scan Tool Data

HO2S 1 or 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop *Parameter Normal Range:* Fluctuates above and below 350-500 mV			
Sensor Signal	0-60 mV	400-415 mV	5000 mV
Low Reference	--	400-415 mV	5000 mV

Circuit Description

The engine control module (ECM) supplies a voltage near 450 mV between the heated oxygen sensor (HO2S) signal circuit and the low reference circuit. The HO2S varies the voltage over a range from about 1,000 mV when the exhaust is rich, down through about 10 mV when the exhaust is lean. The ECM monitors and stores the HO2S voltage information. The ECM evaluates the HO2S voltage samples in order to determine the amount of time that the HO2S voltage was out of range. Or, to detect if the HO2S signal voltage switches at the same rate at which the ECM is commanding the heater ON and OFF.

Conditions for Running the DTC

Condition 1 and 2

- DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 is not set.
- The engine is operating.
- The ignition voltage is greater than 10 volts.
- The HO2S 1 heater duty cycle is greater than 70 percent for greater than 8 seconds.
- The DTCs run continuously once the conditions above exist for greater than 20 seconds.

Condition 3

- Before the ECM can report that DTC P0130 or P0150 failed, DTCs P0030, P0031, P0032, P0050, P0051, P0052, P0133, P0135, P0153, and P0155 must run and pass.
- DTC P0030, P0031, P0032, P0050, P0051, P0052, P0133, P0135, P0153, P0155, P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 is not set.
- The engine is operating.
- The ignition voltage is greater than 10 volts.
- The air flow into the engine has exceeded 10 grams.
- The calculated exhaust gas temperature is greater than 600°C (1,112°F).
- The HO2S 1 heater duty cycle is less than 70 percent.
- The HO2S 2 is operating in closed loop.
- The DTCs run continuously once the conditions above exist for greater than 60 seconds.

Conditions for Setting the DTCs

Condition 1

The ECM detects that the HO2S 1 signal voltage increases greater than 2 volts in 4 out of 6 HO2S heater switch OFF samples.

Condition 2

The HO2S 1 voltage is between 600-1,150 mV and the corresponding HO2S 2 voltage is less than 100 mV for greater than 1 second.

Condition 3

The HO2S 1 voltage is between 60-400 mV and the corresponding HO2S 2 voltage is less than

500 mV for greater than 1 second.

Action Taken when the DTCs Set

DTCs P0130 and P0150 are type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0130 and P0150 are type B DTCs.

Diagnostic Aids

- The HO2S 1 voltage should be between 350-550 mV with the ignition ON. If the voltage is greater than the specified value, there is a condition with the HO2S 1 circuits. If the voltage does not change after disconnecting the HO2S, the condition is between the sensor and the ECM. If the voltage is between 350-550 mV after disconnecting the sensor, the condition is with the HO2S 1.
- Inspect the HO2S 1 harness connector for water intrusion. Moisture in a connector may cause voltage to bleed to other circuits within the connector.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the appropriate scan tool HO2S 1 voltage parameter. The HO2S 1

voltage parameter should be less than 1,025 mV.

2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate HO2S 1.
2. Ignition ON, verify that the scan tool HO2S 1 parameter is between 350-500 mV.
   If greater than the specified range, test the signal circuit of the HO2S 1 for a short to the heater circuit. If the circuit/connections test normal, replace the ECM.
3. If all circuits/connections test normal, replace the appropriate HO2S 1.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 1
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 1
- Engine Control Module Replacement for engine control module replacement, setup, and programming

2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Diagnostic Information and Procedures | **Document ID: 2054966**

DTC P0130 or P0150 (with LLT)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0130: HO2S Signal Circuit Shorted to Heater Circuit Bank 1 Sensor 1

DTC P0150: HO2S Signal Circuit Shorted to Heater Circuit Bank 2 Sensor 1

Circuit Description

The engine control module (ECM) supplies a voltage near 450 mV between the heated oxygen sensor (HO2S) signal circuit and the low reference circuit. The HO2S varies the voltage over a range from about 1,000 mV when the exhaust is rich, down through about 10 mV when the exhaust is lean. The ECM monitors and stores the HO2S voltage information. The ECM evaluates the HO2S voltage samples in order to determine the amount of time that the HO2S voltage was out of range. Or, to detect if the HO2S signal voltage switches at the same rate at which the ECM is commanding the heater ON and OFF.

Conditions for Running the DTC

Condition 1 and 2

- Before the ECM can report that DTC P0130 or P0150 failed, DTCs P0030, P0031, P0032, P0050, P0051, P0052, P0133, P0135, P0153, and P0155 must run and pass.
- DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P2146, P2149, P2152, P2155, P216A, or P216D is not set.
- The engine is greater than 240 RPM.
- The ignition voltage is greater than 10 volts.
- The HO2S 1 heater duty cycle is greater than 90 percent for greater than 5 seconds.
- The DTCs run continuously once the conditions above exist for greater than 60 seconds.

Condition 3

- Before the ECM can report that DTC P0130 or P0150 failed, DTCs P0030, P0031, P0032, P0050, P0051, P0052, P0133, P0135, P0153, and P0155 must run and pass.
- The engine is operating.
- The ignition voltage is greater than 10 volts.

- The air flow into the engine has exceeded 10 grams.
- The HO2S 1 heater duty cycle is greater than 70 percent or, the calculated exhaust gas temperature is warmer than 600°C (1,112°F).
- Closed loop fuel control is enabled.
- The evaporative emissions system (EVAP) is not performing an intrusive test.
- The DTCs run continuously once the conditions above exist for greater than 30 seconds.

Conditions for Setting the DTC

Condition 1

The ECM detects that the HO2S 1 signal voltage increases to greater than 2 volts within 4 ms of 4 out of 6 HO2S heater switch OFF samples.

Condition 2

The HO2S 1 voltage is between 520-1,150 mV and the corresponding HO2S 2 voltage is less than 100 mV.

Condition 3

The HO2S 1 voltage is between 60-400 mV and the corresponding HO2S 2 voltage is less than 500 mV.

Action Taken when the DTC Sets

DTCs P0130 and P0150 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0130 and P0150 are Type B DTCs.

Diagnostic Aids

- The HO2S 1 voltage should be between 350-550 mV with the ignition ON. If the voltage is greater than the specified value, there is a condition with the HO2S 1 circuits. If the voltage does not change after disconnecting the HO2S, the condition is between the sensor and the ECM. If the voltage is between 350-550 mV after disconnecting the sensor, the condition is with the HO2S 1.
- Inspect the HO2S 1 harness connector for water intrusion. Moisture in a connector may cause voltage to bleed to other circuits within the connector.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the appropriate scan tool HO2S 1 voltage parameter. The HO2S 1 voltage parameter should be less than 1,025 mV.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate HO2S 1.
2. Ignition ON, verify that the scan tool HO2S 1 voltage parameter is between 350-500 mV.

   If greater than the specified range, test the signal circuit terminal B of the HO2S for a short to the heater circuit terminal E. If the circuit/connections test normal, replace the ECM.
3. If all circuits/connections test normal, replace the appropriate HO2S.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 1
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 1
- Control Module References for engine control module replacement, setup, and programming

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Document ID: 1985738

DTC P0131 or P0151

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P0131: O2 Sensor Circuit Low Voltage (Bank 1 Sensor 1)

DTC P0151: O2 Sensor Circuit Low Voltage (Bank 2 Sensor 1)

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Bank 1 Sensor 1 Signal	P0131	P0134, P0135	P0132	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Signal	P0137	P0140	P0138	P0140
HO2S Bank 2 Sensor 1 Signal	P0151	P0154, P0155	P0152	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Signal	P0157	P0160	P0158	P0160 --
Low Reference	--	P0134, P0135, P0154, P0155	--	--

Typical Scan Tool Data

HO2S 1 or 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop *Parameter Normal Range:* Fluctuates above and below 350-500 mV			
Sensor Signal	0-60 mV	445-450 mV	1275 mV
Low Reference	--	445-480 mV	1275 mV

Circuit Description

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust

stream. When the engine is started the engine control module (ECM) operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air/fuel ratio. The ECM supplies the HO2S with a reference or bias voltage of about 450 mV. While the engine runs the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. This voltage will fluctuate above and below the bias voltage. Once sufficient HO2S voltage fluctuation is observed by the ECM, Closed Loop is entered. The ECM uses the HO2S voltage to determine the air/fuel ratio. An HO2S voltage that increases above bias voltage toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases below bias voltage toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the ECM to calculate the air/fuel ratio sooner.

Conditions for Running the DTC

Condition 1

- DTC P0201, P0202, P0203, P0204, P0205, P0206 P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 is not set.
- The ignition voltage is greater than 11 volts.
- The engine is operating.
- The air flow into the engine is greater than 10 grams.
- The HO2S 1 heater duty cycle is greater than 70 percent for greater than 8 seconds.
- DTC P0131 and P0151 run continuously once the conditions above exist for greater than 30 seconds.

Condition 2

- DTC P0116, P0117, P0118, P0119, P0201, P0202, P0203, P0204, P0205, P0206 P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 is not set.
- The ignition voltage is greater than 11 volts.
- The engine is operating for greater than 1 second.
- The engine coolant temperature (ECT) during the previous ignition cycle was greater than 60°C (140°F).
- The ECT at startup is less than 40°C (104°F).
- The HO2S 1 heater duty cycle is greater than 70 percent for greater than 8 seconds.
- DTC P0131 and P0151 run continuously once the conditions above exist.

Conditions for Setting the DTCs

Condition 1

The ECM detects that the HO2S 1 signal voltage is less than 60 mV while the corresponding HO2S 2 voltage is greater than 500 mV.

Condition 2

The ECM detects that the HO2S 1 signal voltage is less than 60 mV after a cold start with the engine coolant temperature (ECT) less than 40°C (104°F).

Action Taken when the DTC Sets

DTCs P0131 and P0151 are type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0131 and P0151 are type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine idling, observe the appropriate HO2S 1 voltage parameter. The voltage should fluctuate above and below the range of 350-550 mV.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate HO2S sensor.
2. Ignition ON, verify that the HO2S voltage parameter is between 350-500 mV.

If less than the specified range, test the signal circuit for a short to ground. If the circuit/connections test normal, replace the ECM.

If greater than the specified range, test the signal circuit for a short to voltage. If the circuit/connections test normal, replace the ECM.

3. Connect a 3 A fused jumper wire between the signal circuit terminal 4 and ground. Verify the scan tool HO2S voltage parameter is less than 60 mV.

   If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit/connections test normal, replace the ECM.

4. Connect a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 3. Verify the scan tool HO2S voltage parameter is less than 60 mV.

   If greater than the specified range, test the low reference circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the ECM.

5. Verify that the following conditions do not exist:
   - The HO2S is loose
   - Lean fuel injectors--Refer to Fuel Injector Balance Test with Special Tool or Fuel Injector Balance Test with Tech 2
   - Low fuel system pressure--Refer to Fuel System Diagnosis .
   - Exhaust leaks near the HO2S.
   - Engine vacuum leaks.

   If you find any of the above conditions, repair as necessary.

6. If all circuits/connections test normal, replace the HO2S sensor.

Repair Instructions

Perform the Diagnostic Repair Verification .

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 1
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 1
- Engine Control Module Replacement for engine control module replacement, setup, and programming

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DTC P0131 or P0151 (with LLT)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0131: HO2S Circuit Low Voltage Bank 1 Sensor 1

DTC P0151: HO2S Circuit Low Voltage Bank 2 Sensor 1

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Bank 1 Sensor 1 Signal	P0131	P0134, P0135	P0132	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Signal	P0137	P0140	P0138	P0140
HO2S Bank 2 Sensor 1 Signal	P0151	P0154, P0155	P0152	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Signal	P0157	P0160	P0158	P0160
Low Reference	--	P0134, P0135, P0154, P0155	--	--

Typical Scan Tool Data

HO2S 1 or 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop *Parameter Normal Range:* Fluctuates above and below 350-500 mV			
Sensor Signal	0-60 mV	445-450 mV	1275 mV
Low Reference	--	445-480 mV	1275 mV

Circuit Description

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring

the HO2S signal voltage while calculating the air-to-fuel ratio. The control module supplies the HO2S with a reference, or bias voltage of about 450 mV. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. This voltage will fluctuate above and below the bias voltage. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases above bias voltage toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases below bias voltage toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

Conditions for Running the DTC

Condition 1

- DTC P0201, P0202, P0203, P0204, P0205, P0206 P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P2146, P2149, P2152, P2155, P216A, or P216D is not set.
- The ignition voltage is greater than 10 volts.
- The engine speed is greater than 240 RPM.
- The air flow into the engine is greater than 220 grams.
- The HO2S 1 heater duty cycle is greater than 90 percent for greater than 5 seconds.
- The evaporative emissions system (EVAP) is not performing an intrusive test.
- The ECM is not commanding the air/fuel mixture lean.
- DTC P0131 and P0151 run continuously once the conditions above exist for greater than 5 seconds.

Condition 2

- DTC P0116, P0117, P0118, P0119, P0201, P0202, P0203, P0204, P0205, P0206 P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P2146, P2149, P2152, P2155, P216A, or P216D is not set.
- The ignition voltage is greater than 10 volts.
- The engine speed is greater than 240 RPM.
- The conditions for a cold start are present.
- The HO2S 1 heater duty cycle is greater than 90 percent.
- DTC P0131 and P0151 run continuously once the conditions above exist for greater than 5 seconds.

Conditions for Setting the DTC

Condition 1

The ECM detects that an HO2S 1 signal voltage is less than 60 mV while the corresponding HO2S 2 voltage is greater than 500 mV.

Condition 2

The ECM detects that an HO2S 1 signal voltage is less than 60 mV after a cold start.

Action Taken when the DTC Sets

DTCs P0131 and P0151 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0131 and P0151 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine idling, observe the appropriate scan tool HO2S 1 voltage parameter. The voltage should fluctuate above and below the range of 350-550 mV.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate HO2S 1.

2. Ignition ON, verify that the scan tool HO2S 1 voltage parameter is between 350-500 mV.

   If less than the specified range, test the signal circuit terminal B for a short to ground. If the circuit/connections test normal, replace the ECM.

   If greater than the specified range, test the signal circuit terminal B for a short to voltage. If the circuit/connections test normal, replace the ECM.
3. Install a 3 A fused jumper wire between the signal circuit terminal B and ground. Verify the HO2S voltage parameter is less than 60 mV.

   If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit/connections test normal, replace the ECM.
4. Connect a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the HO2S voltage parameter is less than 60 mV.

   If greater than the specified range, test the low reference circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the ECM.
5. Verify that the following conditions do not exist:
   - Lean condition.
   - Low fuel system pressure--Refer to Fuel System Diagnosis.
   - Fuel that is contaminated--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
   - Exhaust leaks near the HO2S.
   - Engine vacuum leaks.

     If you find any of the above conditions, repair as necessary.
6. If all circuits/connections test normal, replace the appropriate HO2S 1.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 1
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 1
- Control Module References for engine control module replacement, setup, and programming

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Diagnostic Information and Procedures |
Document ID: 1985740

DTC P0132 or P0152

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P0132: O2 Sensor Circuit High Voltage (Bank 1 Sensor 1)

DTC P0152: O2 Sensor Circuit High Voltage (Bank 2 Sensor 1)

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Bank 1 Sensor 1 Signal	P0131	P0134, P0135	P0132	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Signal	P0137	P0140	P0138	P0140
HO2S Bank 2 Sensor 1 Signal	P0151	P0154, P0155	P0152	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Signal	P0157	P0160	P0158	P0160 --
Low Reference	--	P0134, P0135, P0154, P0155	--	--

Typical Scan Tool Data

HO2S 1 or 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop *Parameter Normal Range:* Fluctuates above and below 350-500 mV			
Sensor Signal	0-60 mV	445-450 mV	1275 mV
Low Reference	--	445-480 mV	1275 mV

Circuit Description

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust

stream. When the engine is started the engine control module (ECM) operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air/fuel ratio. The ECM supplies the HO2S with a reference or bias voltage of about 450 mV. While the engine runs the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. This voltage will fluctuate above and below the bias voltage. Once sufficient HO2S voltage fluctuation is observed by the ECM, Closed Loop is entered. The ECM uses the HO2S voltage to determine the air/fuel ratio. An HO2S voltage that increases above bias voltage toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases below bias voltage toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air/fuel ratio sooner.

Conditions for Running the DTCs

P0132 or P0152

- The ignition voltage is between 10-16 volts.
- The engine is operating.

Conditions for Setting the DTCs

P0132 or P0152

The ECM detects that the H02S voltage is high.

Action Taken when the DTC Sets

DTCs P0132 and P0152 are type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0132 and P0152 are type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs

- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine idling, observe the appropriate HO2S voltage parameter. The voltage should fluctuate above and below the range of 350-550 mV.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate HO2S sensor.
2. Ignition ON, verify that the HO2S voltage parameter is between 350-500 mV.

   If less than the specified range, test the signal circuit terminal 4 for a short to ground. If the circuit/connections test normal, replace the ECM.

   If greater than the specified range, test the signal circuit terminal 4 for a short to voltage. If the circuit/connections test normal, replace the ECM.
3. Connect a 3 A fused jumper wire between the signal circuit terminal 4 and ground. Verify the scan tool HO2S voltage parameter is less than 60 mV.

   If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit/connections test normal, replace the ECM.
4. Connect a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 3. Verify the scan tool HO2S voltage parameter is less than 60 mV.

   If greater than the specified range, test the low reference circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the ECM.
5. Verify that the following conditions do not exist:
   - Leaking fuel injectors--Refer to Fuel Injector Balance Test with Special Tool or Fuel Injector Balance Test with Tech 2
   - High fuel system pressure--Refer to Fuel System Diagnosis
   - Fuel that is contaminated--Refer to Alcohol/Contaminants-in-Fuel Diagnosis
   - Restricted exhaust

     If you find any of the above conditions, repair as necessary.
6. If all circuits/connections test normal, replace the HO2S sensor.

Repair Instructions

Perform the Diagnostic Repair Verification .

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 1
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 1
- Engine Control Module Replacement for engine control module replacement, setup, and programming

DTC P0132 or P0152 (with LLT)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0132: HO2S Circuit High Voltage Bank 1 Sensor 1

DTC P0152: HO2S Circuit High Voltage Bank 2 Sensor 1

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Bank 1 Sensor 1 Signal	P0131	P0134, P0135	P0132	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Signal	P0137	P0140	P0138	P0140
HO2S Bank 2 Sensor 1 Signal	P0151	P0154, P0155	P0152	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Signal	P0157	P0160	P0158	P0160
Low Reference	--	P0134, P0135, P0154, P0155	--	--

Typical Scan Tool Data

HO2S 1 or 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop *Parameter Normal Range:* Fluctuates above and below 350-500 mV			
Sensor Signal	0-60 mV	445-450 mV	1275 mV
Low Reference	--	445-480 mV	1275 mV

Circuit Description

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring

the HO2S signal voltage while calculating the air-to-fuel ratio. The control module supplies the HO2S with a reference, or bias voltage of about 450 mV. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. This voltage will fluctuate above and below the bias voltage. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases above bias voltage toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases below bias voltage toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

Conditions for Running the DTC

- DTC P0201, P0202, P0203, P0204, P0205, P0206 P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P2146, P2149, P2152, P2155, P216A, or P216D is not set.
- The ignition voltage is greater than 10 volts.
- The engine speed is greater than 240 RPM.
- The HO2S 1 heater duty cycle is greater than 90 percent for greater than 5 seconds.
- The ECM is not commanding the air/fuel mixture rich.
- DTC P0132 and P0152 run continuously once the conditions above exist for greater than 5 seconds.

Conditions for Setting the DTC

The ECM detects that an HO2S 1 signal voltage is greater than 1,150 mV.

Action Taken when the DTC Sets

DTCs P0132 and P0152 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0132 and P0152 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine idling, observe the appropriate scan tool HO2S 1 voltage parameter. The voltage should fluctuate above and below the range of 350-550 mV.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate HO2S.
2. Ignition ON, verify that the scan tool HO2S voltage parameter is between 350-500 mV.

   If less than the specified range, test the signal circuit terminal B for a short to ground. If the circuit/connections test normal, replace the ECM.

   If greater than the specified range, test the signal circuit terminal B for a short to voltage. If the circuit/connections test normal, replace the ECM.
3. Install a 3 A fused jumper wire between the signal circuit terminal B and ground. Verify the scan tool HO2S voltage parameter is less than 60 mV.

   If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit/connections test normal, replace the ECM.
4. Connect a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the scan tool HO2S voltage parameter is less than 60 mV.

   If greater than the specified range, test the low reference circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the ECM.
5. Verify that the following conditions do not exist:
   - Leaking fuel injectors.
   - High fuel system pressure--Refer to Fuel System Diagnosis.
   - Fuel that is contaminated--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
   - Restricted exhaust.

   If you find any of the above conditions, repair as necessary.
6. If all circuits/connections test normal, replace the appropriate HO2S.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 1
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 1
- Control Module References for engine control module replacement, setup, and programming

DTC P0133 or P0153 (with LLT)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0133: HO2S Slow Response Bank 1 Sensor 1

DTC P0153: HO2S Slow Response Bank 2 Sensor 1

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Bank 1 Sensor 1 Signal	P0131	P0134, P0135	P0132	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Signal	P0137	P0140	P0138	P0140
HO2S Bank 2 Sensor 1 Signal	P0151	P0154, P0155	P0152	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Signal	P0157	P0160	P0158	P0160
Low Reference	--	P0134, P0135, P0154, P0155	--	--

Circuit Description

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. The control module supplies the HO2S with a reference, or bias voltage of about 450 mV. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. This voltage will fluctuate above and below the bias voltage. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases above bias voltage toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases below bias voltage toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

Conditions for Running the DTCs

- Before the ECM can report that DTC P0133 or P0153 failed, DTCs P0030, P0031, P0032, P0050, P0051, P0052, P0135, and P0155 must run and pass.
- DTC P0036, P0037, P0038, P0057, P0058, P0130, P0137, P0138, P0140, P0141, P0150, P0157, P0158, P0160, P0161, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0442, P0443, P0455, P0458, P0459, P2096, P2097, P2098, P2099, P2177, P2178, P2179, P2088, P2089, P2090, P2232, P2235, P2270, P2271, P2272, or P2273 is not set.
- The engine speed is 1,200-2,520 RPM.
- The closed loop fuel control is enabled.
- The engine load is 13-55 percent.
- The exhaust gas temperature is warmer than 350°C (662°F).
- The evaporative purge (EVAP) solenoid is commanded OFF, or is ON for greater than 10 seconds.
- DTC P0133 and P0153 run continuously once the conditions above exist.

Conditions for Setting the DTCs

The ECM determines that the length of time for a primary HO2S to switch from lean to rich and back to lean, which is called a switching cycle, has exceeded a predetermined threshold. The condition exists for 2.5 cycles out of a 20 cycle test sample.

Action Taken when the DTCs Set

DTCs P0133 and P0153 are Type B DTCs.

Conditions for Clearing the MIL/DTCs

DTCs P0133 and P0153 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Ignition ON, observe the scan tool DTC information. Verify no other DTC is not set.
   If any other DTC is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. Engine idling, observe the appropriate scan tool HO2S voltage parameter. The voltage should fluctuate above and below the range of 350-550 mV.
3. Observe the DTC information with a scan tool. DTCs P0133 and P0153 should not set.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

1. Verify that none of the following conditions exist:
   - Lean or rich condition.
   - Water intrusion in the HO2S harness connector
   - HO2S wiring harness damage
   - Incorrect RTV sealant
   - Low or high fuel system pressure--Refer to Fuel System Diagnosis.
   - Fuel that is contaminated--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
   - Fuel saturation of the evaporative emission (EVAP) canister
   - Exhaust leaks near the HO2S
   - Engine vacuum leaks
   - Engine oil consumption
   - Engine coolant consumption

   If you find any of the above conditions, repair as necessary.
2. If all conditions test normal, replace the appropriate HO2S.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 1
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 1
- Control Module References for engine control module replacement, setup, and programming

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DTC P0133 or P0153

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P0133: O2 Sensor Circuit Slow Response (Bank 1 Sensor 1)

DTC P0153: O2 Sensor Circuit Slow Response (Bank 2 Sensor 1)

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Bank 1 Sensor 1 Signal	P0131	P0134, P0135	P0132	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Signal	P0137	P0140	P0138	P0140
HO2S Bank 2 Sensor 1 Signal	P0151	P0154, P0155	P0152	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Signal	P0157	P0160	P0158	P0160 --
Low Reference	--	P0134, P0135, P0154, P0155	--	--

Circuit Description

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started the engine control module (ECM) operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air/fuel ratio. The ECM supplies the HO2S with a reference or bias voltage of about 450 mV. While the engine runs the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. This voltage will fluctuate above and below the bias voltage. Once sufficient HO2S voltage fluctuation is observed by the ECM, Closed Loop is entered. The ECM uses the HO2S voltage to determine the air/fuel ratio. An HO2S voltage that increases above bias voltage toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases below bias voltage toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the ECM to calculate the air/fuel ratio sooner.

Conditions for Running the DTCs

- Before the ECM can report that DTC P0133 or P0153 failed, DTCs P0030, P0031, P0032, P0050, P0051, P0052, P0135, and P0155 must run and pass.
- DTC P0036, P0037, P0038, P0057, P0058, P0130, P0137, P0138, P0140, P0141, P0150, P0157, P0158, P0160, P0161, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0442, P0443, P0455, P0458, P0459, P2096, P2097, P2098, P2099, P2177, P2178, P2179, P2088, P2089, P2090, P2232, P2235, P2270, P2271, P2272, or P2273 is not set.
- The engine speed is 1,240-2,400 RPM.
- The closed loop fuel control is enabled.
- The engine load is 18-50 percent.
- The exhaust gas temperature is warmer than 350°C (662°F).
- The evaporative purge (EVAP) solenoid is commanded OFF, or is ON for greater than 10 seconds.
- The ignition voltage is between 10-16 volts.
- The engine is operating.

Conditions for Setting the DTCs

The ECM determines that the length of time for a HO2S 1 to switch from lean to rich and back to lean, which is called a switching cycle, has exceeded a predetermined threshold. The condition exists for 12 cycles out of a 20 cycle test sample.

Action Taken when the DTCs Set

DTCs P0133 or P0153 are type B DTCs.

Conditions for Clearing the MIL/DTCs

DTCs P0133 or P0153 are type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections

- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Verify that no other DTCs are not set.

   If any other DTCs are set, refer to Powertrain Diagnostic Trouble Code (DTC) Type Definitions .
2. Engine idling, observe the HO2S voltage parameter. The voltage should fluctuate above and below the range of 350-550 mV.
3. Operate the vehicle within the conditions for running the DTC. DTC P0133 or P0153 should not set.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

1. Verify that none of the following conditions exist:
   - Lean or rich fuel injectors - Refer to Fuel Injector Balance Test with Special Tool or Fuel Injector Balance Test with Tech 2 .
   - Water intrusion in the HO2S harness connector.
   - HO2S wiring harness damage.
   - Incorrect RTV sealant.
   - Low or high fuel system pressure - Refer to Fuel System Diagnosis .
   - Fuel that is contaminated--Refer to Alcohol/Contaminants-in-Fuel Diagnosis .
   - Fuel saturation of the evaporative emission (EVAP) canister.
   - Exhaust leaks near the HO2S.
   - Engine vacuum leaks.
   - Engine oil consumption.
   - Engine coolant consumption.

   If you find any of the above conditions, repair as necessary.
2. If all conditions test normal, replace the appropriate HO2S.

Repair Instructions

Perform the Diagnostic Repair Verification .

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 1

- Heated Oxygen Sensor Replacement - Bank 2 Sensor 1
- Engine Control Module Replacement for engine control module replacement, setup, and programming

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DTC P0134 or P0154 (with LLT)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0134: HO2S Circuit Insufficient Activity Bank 1 Sensor 1

DTC P0154: HO2S Circuit Insufficient Activity Bank 2 Sensor 1

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Bank 1 Sensor 1 Signal	P0131	P0134, P0135	P0132	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Signal	P0137	P0140	P0138	P0140
HO2S Bank 2 Sensor 1 Signal	P0151	P0154, P0155	P0152	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Signal	P0157	P0160	P0158	P0160
Low Reference	--	P0134, P0135, P0154, P0155	--	--

Typical Scan Tool Data

Bank 1 or 2 HO2S 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop *Parameter Normal Range:* Fluctuates above and below 350-500 mV			
Sensor Signal	0-60 mV	445-450 mV	1275 mV
Low Reference	--	445-480 mV	1275 mV

Circuit Description

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring

the HO2S signal voltage while calculating the air-to-fuel ratio. The control module supplies the HO2S with a reference, or bias voltage of about 450 mV. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. This voltage will fluctuate above and below the bias voltage. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases above bias voltage toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases below bias voltage toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

Conditions for Running the DTCs

Condition 1

- DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P2146, P2149, P2152, P2155, P216A, or P216D is not set.
- The ignition voltage is greater than 10 volts.
- The engine speed is greater than 240 RPM.
- The HO2S 1 heater duty cycle is greater than 90 percent for more than 5 seconds.
- DTCs P0134 and P0154 run continuously once the conditions above exist for greater than 10 seconds.

Condition 2

- DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P2146, P2149, P2152, P2155, P216A, or P216D is not set.
- The ignition voltage is greater than 10 volts.
- The engine speed is greater than 240 RPM.
- The HO2S 1 is warmed up for greater than 30 seconds.
- The HO2S 1 heater duty cycle is greater than 68 percent.
- DTCs P0134 and P0154 run continuously once the conditions above exist.

Condition 3

- DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P2146, P2149, P2152, P2155, P216A, or P216D is not set.
- The ignition voltage is greater than 10 volts.
- The engine speed is greater than 240 RPM.
- The HO2S 1 is warmed up for greater than 30 seconds.
- The calculated exhaust temperature is warmer than 600°C (1,112°F).
- DTCs P0134 and P0154 run continuously once the conditions above exist.

Conditions for Setting the DTCs

Condition 1

The HO2S 1 signal voltage is between 400-520 mV, or 400-550 mV when the calculated exhaust temperature is warmer than 800°C (1,472°F).

Condition 2

The calculated internal resistance of the HO2S 1 is greater than 40,000 ohms when the calculated exhaust temperature is warmer than 600°C (1,112°F).

Condition 3

A corresponding HO2S 1 and HO2S 2 are greater than 200 mV during a decel fuel cut-off greater 3 seconds.

Action Taken when the DTC Sets

DTCs P0134 and P0154 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0134 and P0154 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine idling, observe the appropriate scan tool HO2S voltage parameter. The voltage should fluctuate above and below the range of 350-550 mV.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate HO2S.
2. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal C and ground.

   If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition circuit and replace as necessary.
3. Ignition OFF, connect a test lamp between the heater control circuit terminal D and B+.
4. Idle the engine, and verify the test lamp illuminates or flashes.

   If the test lamp is always OFF, test the control circuit for an open/high resistance. If the circuit/connections test normal, replace the ECM.
5. Ignition ON, verify that the appropriate scan tool HO2S voltage parameter is between 350-500 mV.

   If less than the specified range, test the signal circuit terminal B for a short to ground. If the circuit/connections test normal, replace the ECM.

   If greater than the specified range, test the signal circuit terminal B for a short to voltage. If the circuit/connections test normal, replace the ECM.
6. Connect a 3 A fused jumper wire between the signal circuit terminal B and ground. Verify the scan tool HO2S voltage parameter is less than 60 mV.

   If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit/connections test normal, replace the ECM.
7. Connect a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the scan tool HO2S voltage parameter is less than 60 mV.

   If greater than the specified range, test the low reference circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the ECM.
8. Verify that none of the following conditions exist:
   - The HO2S is loose
   - Lean or rich condition.
   - Water intrusion in the HO2S harness connector
   - Low or high fuel system pressure--Refer to Fuel System Diagnosis.
   - Fuel that is contaminated--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
   - Fuel saturation of the evaporative emission (EVAP) canister
   - Exhaust leaks near the HO2S
   - Engine vacuum leaks

   If you find any of the above conditions, repair as necessary.
9. If all circuits/connections test normal, replace the appropriate HO2S.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 1
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 1
- Control Module References for engine control module replacement, setup, and programming

DTC P0134 or P0154

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0134: HO2S Circuit Insufficient Activity Bank 1 Sensor 1

DTC P0154: HO2S Circuit Insufficient Activity Bank 2 Sensor 1

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Bank 1 Sensor 1 Signal	P0131	P0134, P0135	P0132	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Signal	P0137	P0140	P0138	P0140
HO2S Bank 2 Sensor 1 Signal	P0151	P0154, P0155	P0152	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Signal	P0157	P0160	P0158	P0160
Low Reference	--	P0134, P0135, P0154, P0155	--	--

Typical Scan Tool Data

Bank 1 or 2 HO2S 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop *Parameter Normal Range:* Fluctuates above and below 350-500 mV			
Sensor Signal	0-60 mV	445-450 mV	1275 mV
Low Reference	--	445-480 mV	1275 mV

Circuit Description

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust

stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. The control module supplies the HO2S with a reference, or bias voltage of about 450 mV. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. This voltage will fluctuate above and below the bias voltage. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases above bias voltage toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases below bias voltage toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

Conditions for Running the DTCs

- DTC P0131, P0151, P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 is not set.
- The engine speed is greater than 240 RPM.
- The ignition voltage is greater than 10 volts.
- The HO2S 1 heater duty cycle is greater than 90 percent for greater than 5 seconds.

  OR
- The HO2S 1 heater duty cycle is greater than 68 percent and the calculated exhaust temperature is greater than 600°C (1112°F) for greater than 30 seconds.
- DTCs P0134 and P0154 run continuously once the conditions above exist for greater than 5 seconds.

Conditions for Setting the DTCs

- An HO2S 1 signal voltage is between 400-520 mV, or 400-550 mV when the calculated exhaust temperature is greater than 800°C (1,472°F)
- The calculated internal resistance of a HO2S 1 is greater than 40,000 Ω when the calculated exhaust temperature is greater than 600°C (1112°F).
- A corresponding HO2S 1 and HO2S 2 are greater than 200 mV during a decel fuel cut-off greater than 3 seconds.
- DTC P0134 or P0154 set if any of the conditions above exist.

Action Taken when the DTC Sets

DTCs P0134 and P0154 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0134 and P0154 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine idling, observe the appropriate scan tool HO2S voltage parameter. The voltage should fluctuate above and below the range of 350-550 mV.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate HO2S.
2. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 1 and ground.

   If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition circuit and replace as necessary.
3. Ignition OFF, connect a test lamp between the heater control circuit terminal 2 and B+.
4. Idle the engine, and verify the test lamp illuminates or flashes.

   If the test lamp is always OFF, test the control circuit terminal 2 for an open/high resistance. If the circuit/connections test normal, replace the ECM.
5. Ignition ON, verify that the appropriate scan tool HO2S voltage parameter is between 350-500 mV.

   If less than the specified range, test the signal circuit terminal 4 for a short to ground. If the circuit/connections test normal, replace the ECM.

   If greater than the specified range, test the signal circuit terminal 4 for a short to voltage. If the circuit/connections test normal, replace the ECM.
6. Connect a 3 A fused jumper wire between the signal circuit terminal 4 and ground. Verify the scan tool HO2S voltage parameter is less than 60 mV.

If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit/connections test normal, replace the ECM.

7. Connect a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 3. Verify the scan tool HO2S voltage parameter is less than 60 mV.

   If greater than the specified range, test the low reference circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the ECM.

8. Verify that none of the following conditions exist:
   - The HO2S is loose
   - Lean or rich fuel injectors--Refer to Fuel Injector Solenoid Coil Test .
   - Water intrusion in the HO2S harness connector
   - Low or high fuel system pressure--Refer to Fuel System Diagnosis .
   - Fuel that is contaminated--Refer to Alcohol/Contaminants-in-Fuel Diagnosis .
   - Fuel saturation of the evaporative emission (EVAP) canister
   - Exhaust leaks near the HO2S
   - Engine vacuum leaks

   If you find any of the above conditions, repair as necessary.

9. If all circuits/connections test normal, replace the appropriate HO2S.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 1
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 1
- Control Module References for engine control module replacement, setup, and programming

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DTC P0135, P0141, P0155, or P0161

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P0135: O2 Sensor Heater Circuit Range/Performance (Bank 1 Sensor 1)

DTC P0141: O2 Sensor Heater Circuit Range/Performance (Bank 1 Sensor 2)

DTC P0155: O2 Sensor Heater Circuit Range/Performance (Bank 2 Sensor 1)

DTC P0161: O2 Sensor Heater Circuit Range/Performance (Bank 2 Sensor 2)

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage Supply - HO2S Bank 1 and 2 Sensor 1	P0030, P0031, P0050, P0051	P0135, P0141	--	--
Ignition Voltage Supply - HO2S Bank 1 and 2 Sensor 2	P0036, P0037, P0056, P0057	P0135	--	--
HO2S Bank 1 Sensor 1 Heater Control	P0031	P0030, P0134	P0032	P0135
HO2S Bank 1 Sensor 2 Heater Control	P0037	P0036, P0140	P0038	P0141
HO2S Bank 2 Sensor 1 Heater Control	P0051	P0050, P0154	P0052	P0155
HO2S Bank 2 Sensor 2 Heater Control	P0057	P0056, P0160	P0058	P0161

Circuit Description

The heated oxygen sensor (HO2S) heater reduces the time required for the oxygen sensor to reach operating temperature and maintains the operating temperature during extended idle periods. When the ignition is turned to the ON position, ignition voltage is supplied directly to the sensor heater. The engine control module (ECM) controls the heater operation by first modulating the control circuit to ground when the sensors are cold. This prevents the possibility of thermal shock to the sensor from condensation build-up on the sensor by controlling the sensor's rate of heating.

After a predetermined amount of time the ECM commands the heaters ON continuously. Once the sensor reaches operating temperature the ECM may modulate the heater control circuit to ground to maintain a desired temperature.

Conditions for Running the DTCs

P0135 or P0155

- Before the ECM can report DTC P0135 or P0155 failed, P0030, P0031, P0032, P0050, P0051, and P0052 must run and pass.
- DTC P0130, P0131, P0132, P0134, P0150, P0151, P0152, or P0154 is not set.
- The engine is operating.
- The ignition voltage is 10-18 volts.
- The intake air temperature (IAT) is greater than -30°C (-22°F).
- After the previous ignition cycle the engine OFF time was greater than 2 minutes.
- The calculated exhaust temperature is less than 524°C (975°F).
- The engine is not in decel fuel cut-off (DFCO).
- The HO2S 1 is at operating temperature for greater than 10 seconds.
- The internal HO2S 1 resistance is less than 10,000 Ω.
- The DTCs run continuously once the above conditions are met for approximately 100 seconds.

P0141 or P0161

- Before the ECM can report DTC P0141 or P0161 failed, DTCs P0030, P0031, P0032, P0050, P0051, and P0052 must run and pass.
- DTCs P0130, P0131, P0132, P0134, P0150, P0151, P0152, or P0154 are not set.
- The engine is operating.
- The ignition voltage is 10-18 volts.
- The intake air temperature (IAT) is greater than -30°C (-22°F).
- After the previous ignition cycle the engine OFF time was greater than 0 seconds.
- The calculated exhaust temperature is 360-500°C (680-932°F).
- The engine is not in decel fuel cut-off (DFCO).
- The internal HO2S 2 resistance is less than 10,000 Ω.
- The HO2S 2 heater is enabled for greater than 120 seconds.
- The DTCs run continuously once the above conditions are met for approximately 100 seconds.

Conditions for Setting the DTCs

The ECM detects that the internal resistance of an HO2S 1 or HO2S 2 heater is not within the expected range.

Action Taken When the DTC Sets

DTCs P0135, P0141, P0155 and P0161 are type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0135, P0141, P0155 and P0161 are type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Note: It may take up to 8 minutes for the DTC to set.

1. With the engine at normal operating temperature, operate the engine above 1,200 RPM for 2 minutes and then allow the engine to idle. DTCs P0135, P0141, P0155 or P0161 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate HO2S.
2. Ignition ON, test for B+ on the HO2S ignition circuit terminal 1 of the HO2S harness connector.

   If less than the specified value, repair the ignition voltage circuit of the HO2S heater for a short to ground or an open/high resistance.

3. Ignition OFF, connect a test lamp between the heater control circuit terminal 2 and B+.

   If test lamp illuminates, test the heater control circuit for a short to ground. If the circuit/connections test normal, replace the ECM.
4. Idle the engine, and verify the test lamp illuminates or flashes.

   If the test lamp is always OFF, test the control circuit terminal 2 for an open/high resistance. If the circuit/connections test normal, replace the ECM.

   Note: The control circuit for the HO2S heater is pulled-up to voltage within the ECM, 2.0-3.0 V on the control circuit is normal.

5. Ignition ON, test for 2.0-3.0 V between the control circuit terminal 2 and ground.

   If not within the specified range, test the control circuit for a short to voltage. If the circuit/connections test normal, replace the ECM.
6. If all circuits/connections test normal, test or replace the HO2S.

Component Testing

1. Ignition OFF, disconnect the harness connector at the heated oxygen sensor (HO2S) sensor.
2. Test for 5-25 Ω between the control terminal 2 and the ignition terminal 1 of the heated oxygen sensor (HO2S) sensor.

   If not within the specified range, replace the HO2S sensor.

Repair Instructions

Perform the Diagnostic Repair Verification .

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 1
- Heated Oxygen Sensor Replacement - Bank 1 Sensor 2
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 1
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 2
- Engine Control Module Replacement for engine control module replacement, setup, and programming

DTC P0137, P0138, P0140, P0157, P0158, or P0160 (with LLT)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0137: HO2S Circuit Low Voltage Bank 1 Sensor 2

DTC P0138: HO2S Circuit High Voltage Bank 1 Sensor 2

DTC P0140: HO2S Circuit Insufficient Activity Bank 1 Sensor 2

DTC P0157: HO2S Circuit Low Voltage Bank 2 Sensor 2

DTC P0158: HO2S Circuit High Voltage Bank 2 Sensor 2

DTC P0160: HO2S Circuit Insufficient Activity Bank 2 Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Bank 1 Sensor 1 Signal	P0131	P0134, P0135	P0132	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Signal	P0137	P0140, P013A	P0138	P0140, P013A, P013E
HO2S Bank 2 Sensor 1 Signal	P0151	P0154, P0155	P0152	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Signal	P0157	P0160, P013C	P0158	P0160, P013C, P014A
Low Reference	--	P0134, P0135, P0154, P0155	--	--

Typical Scan Tool Data

Bank 1 or 2 HO2S 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop. *Parameter Normal Range:* Fluctuates above and below 350-500 mV.			

Sensor Signal	0-60 mV	400-455 mV	1275 mV
Low Reference	--	400-455 mV	1275 mV

Circuit Description

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. The control module supplies the HO2S with a reference, or bias voltage of about 450 mV. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. This voltage will fluctuate above and below the bias voltage. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases above bias voltage toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases below bias voltage toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

Conditions for Running the DTCs

P0137 and P0157

- DTC P0036, P0037, P0038, P0056, P0057, P0058, P0116, P0117, P0118, P0119, or P0128 is not set.
- The engine speed is greater than 240 RPM.
- The ignition voltage is greater than 10 volts.
- The engine coolant temperature is colder than 40°C (104°F) at start-up and the engine coolant temperature was warmer than 60°C (140°F) when the ignition was turned OFF last ignition cycle.
- The calculated exhaust temperature at the HO2S 2 is warmer than 700°C (1,292°F) and the HO2S 2 is warmed up for greater than 90 seconds.
- The calculated exhaust temperature is colder than 800°C (1472°F) 5 seconds after engine start.
- DTCs P0137 and P0157 run continuously once the above conditions are met.

P0138, P0140, P0158, and P0160

- The engine speed is greater than 240 RPM.
- The ignition voltage is greater than 10 volts.
- The HO2S 2 heater duty cycle is stable and the HO2S 2 is warmed up for greater than 90 seconds.
- The calculated exhaust temperature is colder than 800°C (1472°F).
- DTCs P0138 and P0158 run continuously once the above conditions are met for greater than 5 seconds.

- DTCs P0140 and P0160 run continuously once the above conditions are met for greater than 60 seconds.

Conditions for Setting the DTC

P0137 or P0157

The ECM detects that a secondary HO2S signal voltage is less than 60 mV for greater than 1 seconds of for a cumulative of 10 seconds.

P0138 or P0158

The ECM detects that the HO2S signal voltage is greater than 1,150 mV for greater than 1 seconds or for a cumulative of 10 seconds.

P0140 or P0160

- The ECM detects that the HO2S 2 signal voltage is between 401-519 mV.
- The ECM detects that the measured internal resistance of the HO2S 2 is greater than 40,000 ohms, when the calculated exhaust temperature is warmer than 500°C (932°F).
- Either condition exists for greater than 1 second or for a cumulative of 10 seconds.

Action Taken when the DTC Sets

DTCs P0137, P0138, P0140, P0157, P0158, and P0160 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0137, P0138, P0140, P0157, P0158, and P0160 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Engine idling, observe the appropriate scan tool HO2S 2 voltage parameter. The reading should fluctuate above and below the range of 401-519 mV.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate HO2S.
2. Ignition ON, verify that the scan tool HO2S 2 voltage parameter is between 400-520 mV.

   If less than the specified range, test the signal circuit terminal B for a short to ground. If the circuit/connections test normal, replace the ECM.

   If greater than the specified range, test the signal circuit terminal B for a short to voltage. If the circuit/connections test normal, replace the ECM.
3. Connect a 3 A fused jumper wire between the signal circuit terminal B and ground. Verify the scan tool HO2S voltage parameter is less than 60 mV.

   If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit/connections test normal, replace the ECM.
4. Connect a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the scan tool HO2S voltage parameter is less than 60 mV.

   If greater than the specified range, test the low reference circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the ECM.
5. Verify that the following conditions do not exist:
   - Lean, rich, or leaking fuel injectors.
   - A fuel pressure that is too low or too high--Refer to Fuel System Diagnosis.
   - Fuel that is contaminated--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
   - Evidence of water intrusion into the electrical connector of the HO2S
   - The HO2S is loose
   - Exhaust leaks near the HO2S
   - Engine vacuum leaks

   If you find any of the above conditions, repair as necessary.
6. If all circuits/connections test normal, replace the appropriate HO2S sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 1
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 2
- Control Module References for engine control module replacement, setup, and programming

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Diagnostic Information and Procedures |
Document ID: 1985756

DTC P0137, P0138, P0140, P0157, P0158, or P0160

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0137: O2 Sensor Circuit Low Voltage (Bank 1 Sensor 2)

DTC P0138: O2 Sensor Circuit High Voltage (Bank 1 Sensor 2)

DTC P0140: O2 Sensor Circuit No Activity Detected (Bank 1 Sensor 2)

DTC P0157: O2 Sensor Circuit Low Voltage (Bank 2 Sensor 2)

DTC P0158: O2 Sensor Circuit High Voltage (Bank 2 Sensor 2)

DTC P0160: O2 Sensor Circuit No Activity Detected (Bank 2 Sensor 2)

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Bank 1 Sensor 1 Signal	P0131	P0134, P0135	P0132	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Signal	P0137	P0140, P013A	P0138	P0140, P013A, P013E
HO2S Bank 2 Sensor 1 Signal	P0151	P0154, P0155	P0152	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Signal	P0157	P0160, P013C	P0158	P0160, P013C, P014A
Low Reference	--	P0134, P0135, P0154, P0155	--	--

Typical Scan Tool Data

Bank 1 or 2 HO2S 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop *Parameter Normal Range:* Fluctuates above and below 350-500 mV			

Sensor Signal	0-60 mV	445-450 mV	1275 mV
Low Reference	--	445-480 mV	1275 mV

Circuit Description

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started the engine control module (ECM) operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air/fuel ratio. The ECM supplies the HO2S with a reference or bias voltage of about 450 mV. While the engine runs the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. This voltage will fluctuate above and below the bias voltage. Once sufficient HO2S voltage fluctuation is observed by the ECM, Closed Loop is entered. The ECM uses the HO2S voltage to determine the air/fuel ratio. An HO2S voltage that increases above bias voltage toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases below bias voltage toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the ECM to calculate the air/fuel ratio sooner.

Conditions for Running the DTCs

P0137 or P0157

- DTC P0117, P0118, or P0128 is not set.
- The HO2S 2 is at operating temperature for greater than 90 seconds.
- The engine is operating for greater than 5 seconds.
- The ignition voltage is greater than 10 volts.
- The engine coolant temperature is less than 40°C (104°F) at start-up and the engine coolant temperature was greater than 60°C (140°F) when the ignition was turned OFF last ignition cycle.
- The DTCs run continuously once the above conditions are met.

P0138, P0140, P0158, and P0160

- The HO2S 2 is at operating temperature for greater than 30 seconds.
- The engine is operating for greater than 1 second.
- The ignition voltage is greater than 10 volts.
- DTCs P0138 and P0158 runs continuously once the above conditions are met for greater than 5 seconds.
- DTCs P0140 and P0160 runs continuously once the above conditions are met for greater than 60 seconds.

Conditions for Setting the DTCs

P0137 or P0157

The ECM detects that a secondary HO2S signal voltage is less than 60 mV for greater than 1 seconds of for a cumulative of 10 seconds.

P0138 or P0158

The ECM detects that the HO2S signal voltage is greater than 1,150 mV for greater than 1 seconds or for a cumulative of 10 seconds.

P0140 or P0160

- The ECM detects that the HO2S 2 signal voltage is between 401-519 mV, when the calculated exhaust temperature is less than 800°C (1,472°F).
- The ECM detects that the HO2S 2 signal voltage is between 401-548 mV, when the calculated exhaust temperature is greater than 800°C (1,472°F).
- The ECM detects that the measured internal resistance of the HO2S is greater than 40,000 Ω, when the calculated exhaust temperature is greater than 450°C (802°F).
- The ECM detects any one of the above conditions for greater than 1 second or for a cumulative of 10 seconds.

Action Taken when the DTC Sets

DTCs P0137, P0138, P0140, P0157, P0158 and P0160 are type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0137, P0138, P0140, P0157, P0158 and P0160 are type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine idling, observe the appropriate scan tool HO2S 2 voltage parameter. The reading should fluctuate above and below the range of 350-550 mV.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate HO2S 2.
2. Ignition ON, verify that the scan tool HO2S 2 voltage parameter is between 350-500 mV.

   If less than the specified range, test the signal circuit terminal 4 for a short to ground. If the circuit/connections test normal, replace theECM.

   If greater than the specified range, test the signal circuit terminal 4 for a short to voltage. If the circuit/connections test normal, replace the ECM.
3. Connect a 3 A fused jumper wire between the signal circuit terminal 4 and ground. Verify the scan tool HO2S voltage parameter is less than 60 mV.

   If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit/connections test normal, replace the ECM.
4. Connect a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 3. Verify the scan tool HO2S 2 voltage parameter is less than 60 mV.

   If greater than the specified range, test the low reference circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the ECM.
5. Verify that the following conditions do not exist:
   - Lean, rich, or leaking fuel injectors--Refer to Fuel Injector Solenoid Coil Test.
   - A fuel pressure that is too low or too high--Refer to Fuel System Diagnosis.
   - Fuel that is contaminated--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
   - Evidence of water intrusion into the electrical connector of the HO2S
   - The HO2S is loose
   - Exhaust leaks near the HO2S
   - Engine vacuum leaks

   If you find any of the above conditions, repair as necessary.
6. If all circuits/connections test normal, replace the appropriate HO2S 2 sensor.

Repair Instructions

Perform the Diagnostic Repair Verification.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 2
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 2
- Engine Control Module Replacement for engine control module replacement, setup, and programming

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DTC P013A, P013C, P013E, or P014A

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P013A: HO2S Slow Response Rich to Lean Bank 1 Sensor 2

DTC P013C: HO2S Slow Response Rich to Lean Bank 2 Sensor 2

DTC P013E: HO2S Delayed Response Rich to Lean Bank 1 Sensor 2

DTC P014A: HO2S Delayed Response Rich to Lean Bank 2 Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Bank 1 Sensor 1 Signal	P0131	P0134, P0135	P0132	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Signal	P0137	P0140, P013A	P0138	P0140, P013A, P013E
HO2S Bank 2 Sensor 1 Signal	P0151	P0154, P0155	P0152	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Signal	P0157	P0160, P013C	P0158	P0160, P013C, P014A
Low Reference	--	P0134, P0135, P0154, P0155	--	--

Circuit Description

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. The control module supplies the HO2S with a reference, or bias voltage of about 450 mV. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. This voltage will fluctuate above and below the bias voltage. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases above bias voltage toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases below bias voltage toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

Conditions for Running the DTCs

- Before the ECM can reports that DTC P013A, P013C, P013E, or P014A failed, DTCs P0030, P0031, P0032, P0050, P0051, P0052, P0135, and P0155 must run and pass.
- DTC P0036, P0037, P0038, P0057, P0058, P0137, P0138, P0140, P0141, P0157, P0158, P0160, P0161, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0442, P0443, P0455, P0458, P0459, P2096, P2097, P2098, P2099, P2177, P2178, P2179, P2088, P2089, P2090, P2232, P2235, P2270, P2271, P2272, or P2273 is not set.
- The HO2S 2 signal voltage is greater than 590 mV at the beginning of decel fuel cut-off.
- The ignition voltage is greater than 10 volts.
- The internal controller HO2S 2 resistance is less than 500 Ω.
- The HO2S 1 and 2 are in closed loop.
- The calculated exhaust temperature for HO2S 2 is greater than 450°C (842°F).
- The HO2S 1 signal voltage is less than 141 mV
- The DTCs run continuously once the conditions above exist.

Conditions for Setting the DTCs

P013A or P013C

The ECM determines that the response time for the HO2S 2 to switch from greater than 400 mV to less than 200 mV is greater than 1 second. The condition exists for greater than 4 seconds or for a cumulative time of 30 seconds.

P013E or P014A

- The ECM determines the time for the HO2S 2 to transition from greater than 140 mV to less than 140 mV during decel fuel cut-off is greater than 4 seconds. The condition exists for greater than 4 seconds or for a cumulative time of 30 seconds.

  OR
- The ECM determines that the airflow into the engine exceeds 15 grams before the HO2S 2 voltage drops below 140 mV during decel fuel cut-off. The condition exists for greater than 4 seconds or for a cumulative time of 30 seconds.

Action Taken when the DTCs Set

DTCs P013A, P013C, P013E, and P014A are Type B DTCs.

Conditions for Clearing the MIL/DTCs

DTCs P013A, P013C, P013E, and P014A are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Verify that other DTCs are not set.

   If any other DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. Engine idling, observe the appropriate scan tool HO2S voltage parameter. The voltage should fluctuate above and below the range of 350-550 mV.
3. Observe the DTC information with a scan tool. DTC P013A, P013C, P013E, and P014A should not set.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate HO2S.
2. Ignition ON, verify that the scan tool HO2S voltage parameter is between 350-500 mV.

   If less than the specified range, test the signal circuit terminal 4 for a short to ground. If the circuit/connections test normal, replace the ECM.

   If greater than the specified range, test the signal circuit terminal 4 for a short to voltage. If the circuit/connections test normal, replace the ECM.
3. Connect a 3 A fused jumper wire between the signal circuit terminal 4 and ground. Verify the scan tool HO2S voltage parameter is less than 60 mV.

   If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit/connections test normal, replace the ECM.

4. Connect a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 3. Verify the scan tool HO2S voltage parameter is less than 60 mV.

   If greater than the specified range, test the low reference circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the ECM.

5. Verify that none of the following conditions exist:
   - Lean or rich fuel injectors--Refer to Fuel Injector Solenoid Coil Test
   - Water intrusion in the HO2S harness connector
   - HO2S wiring harness damage
   - Incorrect RTV sealant
   - Low or high fuel system pressure--Refer to Fuel System Diagnosis
   - Fuel that is contaminated--Refer to Alcohol/Contaminants-in-Fuel Diagnosis
   - Fuel saturation of the evaporative emission (EVAP) canister
   - Exhaust leaks near the HO2S
   - Engine vacuum leaks
   - Engine oil consumption
   - Engine coolant consumption

     If you find any of the above conditions, repair as necessary.

6. If all conditions test normal, replace the appropriate HO2S.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 2
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 2
- Control Module References for engine control module replacement, setup, and programming

DTC P013A, P013C, P013E, or P014A (with LLT)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P013A: HO2S Slow Response Rich to Lean Bank 1 Sensor 2

DTC P013C: HO2S Slow Response Rich to Lean Bank 2 Sensor 2

DTC P013E: HO2S Delayed Response Rich to Lean Bank 1 Sensor 2

DTC P014A: HO2S Delayed Response Rich to Lean Bank 2 Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Bank 1 Sensor 1 Signal	P0131	P0134, P0135	P0132	P0133, P2096, P2097
HO2S Bank 1 Sensor 2 Signal	P0137	P0140, P013A	P0138	P0140, P013A, P013E
HO2S Bank 2 Sensor 1 Signal	P0151	P0154, P0155	P0152	P0153, P2098, P2099
HO2S Bank 2 Sensor 2 Signal	P0157	P0160, P013C	P0158	P0160, P013C, P014A
Low Reference	--	P0134, P0135, P0154, P0155	--	--

Circuit Description

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. The control module supplies the HO2S with a reference, or bias voltage of about 450 mV. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. This voltage will fluctuate above and below the bias voltage. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases above bias voltage toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases below bias voltage toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

Conditions for Running the DTCs

- Before the ECM can reports that DTC P013A, P013C, P013E, or P014A failed, DTCs P0030, P0031, P0032, P0050, P0051, P0052, P0135, and P0155 must run and pass.
- DTC P0036, P0037, P0038, P056, P0057, P0058, P0137, P0138, P0140, P0141, P0157, P0158, P0160, P0161, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0442, P0443, P0455, P0458, P0459, P2096, P2097, P2098, P2099, P2177, P2178, P2179, P2088, P2089, P2090, P2232, P2235, P2270, P2271, P2272, or P2273 is not set.
- The ignition voltage is greater than 10 volts.
- The HO2S 1 and 2 are in closed loop.
- The HO2S 2 resistance is less than 900 ohms.
- The HO2S 2 has switched from lean to rich during the ignition cycle.
- The calculated exhaust gas mass flow rate is greater than 2.22 g/s.
- The calculated exhaust gas temperature for HO2S 2 is warmer than 450°C (842°F).
- The HO2S 1 signal voltage is less than 141 mV
- The HO2S 2 signal voltage is greater than 590 mV at the beginning of decel fuel cut-off - DTC P013E and P014A only.
- The DTCs run continuously once the conditions above exist for greater than 4 seconds.

Conditions for Setting the DTCs

P013A or P013C

The ECM determines that the response time for the HO2S 2 to switch from greater than 400 mV to less than 200 mV is greater than 800 mS. The condition exists for greater than 4 seconds or for a cumulative time of 30 seconds.

P013E or P014A

- The ECM determines the time for the HO2S 2 to transition from greater than 590 mV to less than 140 mV, during decel fuel cut-off is greater than 4 seconds. The condition exists for greater than 4 seconds or for a cumulative time of 30 seconds.

  OR
- The ECM determines that the air flow into the engine exceeded 15 grams before the HO2S 2 transitions to less than 140 mV, during decel fuel cut-off. The condition exists for greater than 4 seconds or for a cumulative time of 30 seconds.

Action Taken when the DTCs Set

DTCs P013A, P013C, P013E, and P014A are Type B DTCs.

Conditions for Clearing the MIL/DTCs

DTCs P013A, P013C, P013E, and P014A are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool DTC information. Verify no other DTC is set.

   If any other DTC is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. Engine idling, observe the appropriate scan tool HO2S voltage parameter. The voltage should fluctuate above and below the range of 401-519 mV.
3. Observe the DTC information with a scan tool. DTC P013A, P013C, P013E, and P014A should not set.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate HO2S.
2. Ignition ON, verify that the scan tool HO2S voltage parameter is between 400-520 mV.

   If less than the specified range, test the signal circuit terminal B for a short to ground. If the circuit/connections test normal, replace the ECM.

   If greater than the specified range, test the signal circuit terminal B for a short to voltage. If the circuit/connections test normal, replace the ECM.
3. Connect a 3 A fused jumper wire between the signal circuit terminal B and ground. Verify the scan tool HO2S voltage parameter is less than 60 mV.

If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit/connections test normal, replace the ECM.

4. Connect a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the scan tool HO2S voltage parameter is less than 60 mV.

   If greater than the specified range, test the low reference circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the ECM.
5. Verify that none of the following conditions exist:
   - Lean or rich condition.
   - Water intrusion in the HO2S harness connector
   - HO2S wiring harness damage
   - Incorrect RTV sealant
   - Low or high fuel system pressure--Refer to Fuel System Diagnosis.
   - Fuel that is contaminated--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
   - Fuel saturation of the evaporative emission (EVAP) canister
   - Exhaust leaks near the HO2S
   - Engine vacuum leaks
   - Engine oil consumption
   - Engine coolant consumption

   If you find any of the above conditions, repair as necessary.
6. If all conditions test normal, replace the appropriate HO2S.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 2
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 2
- Control Module References for engine control module replacement, setup, and programming

DTC P0196, P0197, or P0198

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P0196: Engine Oil Temperature Sensor Range/Performance

DTC P0197: Engine Oil Temperature Voltage Low

DTC P0198: Engine Oil Temperature Voltage High

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
EOT Sensor Signal	P0198	P0196, P0197	P0197	P0197	P0196
EOT Low Reference	--	P0196, P0197	P0197	--	P0196

Circuit/System Description

The Engine Oil Temperature (EOT) Sensor is a variable resistor that measures the temperature of the engine oil. The engine control module (ECM) supplies a 5 voltage to the EOT signal circuit and supplies a ground for the reference circuit.

Conditions for Running the DTC

P0196

- The engine speed is greater than 25 RPM.
- The engine oil temperature EOT is between -35 to +170°C (-31 to +338°F).
- The DTC runs continuously when the above enable conditions are met for greater than 10 seconds.

P0197 and P0198

- The ignition is ON, or the engine is operating.

- The DTCs runs continuously when the above enable condition is met for greater than 2 seconds.

Conditions for Setting the DTC

P0196

The ECM detects the actual EOT is 40°C (104°F) colder than the calculated EOT of the controller, for greater than 4 seconds or a cumulative time of 30 seconds.

P0197

The ECM detects the EOT is colder than -35°C (-31°F) for greater than 4 seconds or a cumulative time of 30 seconds.

P0198

The ECM detects the EOT is warmer than 170°C (331°F) for greater than 4 seconds or a cumulative time of 30 seconds.

Action Taken when the DTC Sets

DTCs P0196, P0197 and P0198 are type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0196, P0197 and P0198 are type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine operating, observe DTC information with a scan tool. DTCs P0196, P0197, or P0198 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the EOT sensor.
2. Ignition OFF, remove the fuse that supplies B+ to circuit terminal 56 X2 of the ECM.
3. Test for less than 5 Ω between the low reference circuit terminal C and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
4. Install the fuse that supplies B+ to circuit terminal 56 X2 of the ECM.
5. Ignition ON, verify the scan tool Engine Oil temperature Sensor parameter is colder than -35° C (-31°F).

   If greater than the specified range, test the signal circuit terminal B for a short to ground. If the circuit tests normal, replace the ECM.

   Note: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the sensor may be damaged.
6. Connect a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal C. Verify the scan tool EOT Sensor parameter is warmer than 171°C (340°F).

   If less than the specified range, test the signal circuit for a short to voltage or an open/high resistance, if the circuit tests normal, replace the ECM.
7. If all circuits test normal, replace the EOT/oil level sensor assembly.

Repair Instructions

Always perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Engine Control Module Replacement for ECM replacement, setup, and programming

DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0201: Injector 1 Control Circuit Malfunction

DTC P0202: Injector 2 Control Circuit Malfunction

DTC P0203: Injector 3 Control Circuit Malfunction

DTC P0204: Injector 4 Control Circuit Malfunction

DTC P0205: Injector 5 Control Circuit Malfunction

DTC P0206: Injector 6 Control Circuit Malfunction

DTC P0261: Injector 1 Control Circuit Low Voltage

DTC P0262: Injector 1 Control Circuit High Voltage

DTC P0264: Injector 2 Control Circuit Low Voltage

DTC P0265: Injector 2 Control Circuit High Voltage

DTC P0267: Injector 3 Control Circuit Low Voltage

DTC P0268: Injector 3 Control Circuit High Voltage

DTC P0270: Injector 4 Control Circuit Low Voltage

DTC P0271: Injector 4 Control Circuit High Voltage

DTC P0273: Injector 5 Control Circuit Low Voltage

DTC P0274: Injector 5 Control Circuit High Voltage

DTC P0276: Injector 6 Control Circuit Low Voltage

DTC P0277: Injector 6 Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition 1 Voltage	P0201, P0202, P0203, P0204, P0205, P0206	P0201, P0202, P0203, P0204, P0205, P0206	--	--
Injector 1 Control Circuit	P0261	P0201	P0262	--
Injector 2 Control Circuit	P0264	P0204	P0265	--
Injector 3 Control Circuit	P0267	P0203	P0268	--
Injector 4 Control Circuit	P0270	P0204	P0271	--
Injector 5 Control Circuit	P0273	P0205	P0274	--
Injector 6 Control Circuit	P0276	P0206	P0277	--

Circuit/System Description

The engine control module (ECM) enables the appropriate fuel injector on the intake stroke for each cylinder. Ignition voltage is supplied directly to the fuel injectors. The ECM controls each fuel injector by grounding the control circuit with a solid state device called a driver. The ECM monitors the status of each driver. Each driver has a feedback voltage circuit which the ECM monitors. The injector control circuits are pulled-up to voltage within the ECM . The ECM can determine if a control circuit is open, shorted to ground or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the DTC

- The engine speed is greater than 80 RPM.
- The ignition voltage is between 10-18 volts.
- The fuel injector has been commanded ON and OFF at least once.
- The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

DTC P0201, P0202, P0203, P0204, P0205 or P0206

The ECM detects the injector control circuit is open for greater than 4 seconds or for a cumulative of 50 seconds.

DTC P0261, P0264, P0267, P0270, P0273 or P0276

The ECM detects the injector control circuit is shorted to ground for greater than 4 seconds or for a cumulative of 50 seconds.

DTC P0262, P0265, P0268, P0271, P0274 or P0277

The ECM detects the injector control circuit is shorted to voltage for greater than 4 seconds or for a cumulative of 50 seconds.

Action Taken When the DTC Sets

DTCs P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276 and P0277 are type B DTCs.

Conditions for Clearing the DTC

DTCs P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276 and P0277 are type B DTCs.

Diagnostic Aids

- Performing the fuel injector coil test may help isolate an intermittent condition. Refer to Fuel Injector Solenoid Coil Test .
- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the circuit status for the component with a scan tool. The circuit status parameter changes from OK or Not Run to Fault if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Observe the scan tool Misfire Current Counters. The Misfire Current Counters should not increment.
2. Engine operating, observe the scan tool DTC information. DTCs P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, and P0277 should not set.
3. Operate the vehicle within the conditions for running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that are captured in the Freeze Frame/Failure Records Data List.

Circuit / System Testing

1. Ignition OFF, disconnect the fuel injector multi-way harness connector.

   Note: Testing for steps 2 through 4 is performed on the ECM side of the multi-way harness connector.

2. Ignition ON, probe both ignition circuits terminal 1/2 to ground with a test lamp. The test lamp should illuminate at each ignition circuit.

   If the test lamp does not illuminate, test the ignition circuits for a short to ground, or an open/high resistance. If the circuits test normal and the ignition circuit fuse is open, test or replace the fuel injector.

3. Test for 2.6-4.6 V between the appropriate fuel injector control circuit listed below and ground.
   - Injector 1 terminal 3
   - Injector 2 terminal 6
   - Injector 3 terminal 4
   - Injector 4 terminal 7
   - Injector 5 terminal 5
   - Injector 6 terminal 8

   If less than the specified range, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

   If greater than the specified range, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.

4. Probe the appropriate fuel injector control circuit listed below with a test lamp connected to B+. Engine cranking, verify the test lamp flashes.
   - Injector 1 terminal 3
   - Injector 2 terminal 6
   - Injector 3 terminal 4
   - Injector 4 terminal 7
   - Injector 5 terminal 5
   - Injector 6 terminal 8

   If the test lamp remains OFF, test the control circuit for a high resistance. If the circuit/connections test normal, replace the ECM.

   Note: Testing for steps 5 and 6 is performed on the fuel injector side of the multi-way harness connector. It may be necessary to remove the intake manifold to isolate the condition.

5. Ignition OFF, measure the resistance between the ignition voltage circuit terminal listed below and ground. The DMM should display O.L.
   - Injector 1 terminal 3
   - Injector 2 terminal 6
   - Injector 3 terminal 4
   - Injector 4 terminal 7
   - Injector 5 terminal 5
   - Injector 6 terminal 8

   If not the specified value, repair the ignition voltage, or control circuit, for a short to ground. If the circuits/connections test normal, test or replace the appropriate fuel injector.
6. Test for 12-16 Ω between the appropriate ignition voltage circuit terminal 1 or 2 and each fuel injector control circuit listed below.
   - Injector 1 terminal 3
   - Injector 2 terminal 6
   - Injector 3 terminal 4
   - Injector 4 terminal 7
   - Injector 5 terminal 5
   - Injector 6 terminal 8

   If less than the specified range, test for a short between the control circuit and the ignition voltage circuit. If the circuits/connections test normal, test or replace the appropriate fuel injector.

   If greater than the specified range, test the ignition voltage, and fuel injector control circuit, for an open/high resistance. If the circuits/connections test normal, test or replace the appropriate fuel injector.

Repair Instructions

Perform the Diagnostic Repair Verification .

- Fuel Injector and Fuel Rail Replacement
- Engine Control Module Replacement for engine control module replacement, setup, and programming

DTC P0219

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0219: Engine Over speed Condition

Circuit/System Description

This DTC is used to indicate that the engine speed exceeded the fuel cutoff limit in gear. This DTC may set if the transmission is placed in a low gear while driving down a steep grade or traveling at a high speed.

Conditions for Running the DTC

- The DTC is valid for manual transmissions only.
- The engine is running.
- Ignition voltage is between 10-18 volts.

Conditions for Setting the DTC

The ECM detects the engine speed is greater than 7,200 RPM for greater than 1 second.

Action Taken When the DTC Sets

DTC P0219 is a type A DTC.

Conditions for Clearing the DTC

DTC P0219 is a type A DTC.

Diagnostic Aids

An over speed condition can only exist when a low gear on a manual transmission is selected and the vehicle is travelling at high road speed. This DTC cannot be set by free revving the engine.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Note: This DTC is used for information only. This DTC does NOT indicate there is a condition with the crank sensor or the engine control module (ECM).

DTC P0219 is an informational DTC.

Repair Instructions

Perform the Diagnostic Repair Verification

DTC P0300-P0306 (with LLT)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0300: Engine Misfire Detected

DTC P0301: Cylinder 1 Misfire Detected

DTC P0302: Cylinder 2 Misfire Detected

DTC P0303: Cylinder 3 Misfire Detected

DTC P0304: Cylinder 4 Misfire Detected

DTC P0305: Cylinder 5 Misfire Detected

DTC P0306: Cylinder 6 Misfire Detected

Circuit/System Description

The engine control module (ECM) uses information from the crankshaft position (CKP) sensor and the camshaft position (CMP) sensors in order to determine when an engine misfire is occurring. By monitoring variations in the crankshaft rotation speed for each cylinder, the ECM is able to detect individual misfire events. A misfire rate that is high enough can cause 3-way catalytic converter damage. The malfunction indicator lamp (MIL) will flash ON and OFF when the conditions for catalytic converter damage are present. DTCs P0301 through P0306 correspond to cylinders 1 through 6. If the ECM is able to determine that a specific cylinder is misfiring, the DTC for that cylinder will set, and the corresponding fuel injector is disabled. The ECM will re-enable the fuel injector after 4 crankshaft revolutions when the misfire is not current. The ECM will re-enable the fuel injector after 8 crankshaft revolutions when the misfire is not current, if the vehicle is equipped with a manual transmission.

Conditions for Running the DTC

- DTC P0121, P0122, P0123, P0221, P0222, P0223, P0335, P0336, or P0338 is not set.
- The engine speed is between 420-7,000 RPM and steady.
- The evaporative emissions (EVAP) leak detection is not active.
- The delivered torque signal is greater than 5 percent at idle.
- The delivered torque signal is between 6-29 percent with the transmission in drive.
- The intake air temperature (IAT) is greater than -30°C (-22°F).

- The A/C compressor clutch is not changing states.
- The ECM is not receiving a rough road signal.
- The fuel level is greater than 11 percent.

  OR
- The fuel level is less than 11 percent and the MIL is illuminated for a misfire DTC, or a fuel level sensor DTC is set.
- The ECM is not in fuel cut-off or decel fuel cut-off mode.
- The throttle angle is steady.
- DTCs P0300 through P0306 run continuously when the above conditions exist for at least 1,000 engine revolutions, 200 revolutions after the first occurrence.

Conditions for Setting the DTC

P0300

The ECM detects a crankshaft rotation speed variation indicating a misfire rate sufficient to cause emissions levels to exceed a predetermined value.

P0301, P0302, P0303, P0304, P0305, P0306

The ECM detects a crankshaft rotation speed variation indicating a single cylinder misfire rate sufficient to cause emissions levels to exceed mandated standards.

Action Taken When the DTC Sets

- DTCs P0300, P0301, P0302, P0303, P0304, P0305, and P0306 are Type A (MIL flashing) or Type B1 DTCs.
- The ECM disables the fuel injector of the misfiring cylinder when a catalyst damaging misfire is present.

Conditions for Clearing the DTC

DTCs P0300, P0301, P0302, P0303, P0304, P0305, and P0306 are Type A (MIL flashing) or Type B1 DTCs.

Diagnostic Aids

- A misfire DTC could be caused by an excessive vibration from sources other than the engine. Inspect for the following possible sources:
  - A tire or wheel that is out of round or out of balance
  - Variable thickness brake rotors
  - An unbalanced drive shaft
  - Certain rough road conditions
  - Transmission operation
  - A damaged accessory drive component or belt

- High resistance in the circuits of the injectors could set a misfire DTC without setting an injector DTC. Test the injector circuits of the affected cylinder(s) for a high resistance if you suspect a condition.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 26792 HEI Spark Tester

Circuit/System Verification

1. Engine idling at the normal operating temperature.

   If there is an abnormal engine noise, refer to Symptoms - Engine Mechanical.
2. Verify that DTC P000A, P000B, P000C, P000D, P0011, P0014, P0021, P0024, P0087, P0088, P0089, P0201-P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P029D, P02A1, P02A5, P02A9, P02AD, P02B1, P0335, P0336, P0338, P0351-P0356, P2088, P2090, P2092, P2094, P2146, P2149, P2152, P2155, P216A, P216D, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 is not set.

   If a DTC is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
3. Observe the scan tool Misfire Current Cyl. 1-6 parameters. The Misfire Current Counters should not be incrementing.
4. Observe the scan tool Circuit Test Status parameters for the various components. Verify the Circuit Test Status parameters for the components that may cause a misfire display OK or Not Run.

5. Engine idling, perform the cylinder power balance test with a scan tool to isolate the misfiring cylinder. The engine speed should change when each injector is disabled.
6. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Verify that the following conditions do not exist:
   - Vacuum hose splits, kinks, and incorrect connections
   - Engine vacuum leaks
   - Crankcase ventilation system for vacuum leaks
   - Fuel pressure that is too low or too high--Refer to Fuel System Diagnosis.
   - Contaminated Fuel--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
   - Exhaust system restrictions

   If you find any of the above conditions, repair as necessary.
2. Ignition OFF, remove the ignition coil of the misfiring cylinder, but leave the electrical connector connected.
3. Inspect the ignition coil boot for the following conditions:
   - Holes
   - Tears
   - Carbon tracking
   - Oil contamination
   - water intrusion

   If you find any of the above conditions, repair as necessary.
4. Remove the fuel pump fuse from the fuse block.
5. Install the J 26792 to the boot of the appropriate ignition coil and ground.

   Note: An erratic or weak spark is considered a no spark condition.

6. Attempt to start the engine and observe the J 26792 . The spark tester should spark.

   If there is no spark, refer to Electronic Ignition (EI) System Diagnosis for diagnosis of the ignition coil.
7. Ignition OFF, remove the spark plug from the misfiring cylinder. Verify that the spark plug does not exhibit the following conditions:
   - Gas, coolant, or oil fouled--Refer to Spark Plug Inspection.
   - Cracked, worn, incorrectly gapped--Refer to Ignition System Specifications.

   If there is a condition with the spark plug, replace the spark plug.
8. Exchange the suspected spark plug with another cylinder that is operating correctly.
9. Engine idling, observe the scan tool Misfire Current Counter parameters. The misfire should not follow the spark plug exchange.

   If the misfire follows the spark plug, replace the spark plug.
10. If all conditions test normal, test or inspect for the following:
    - A lean or rich fuel injector.
    - An engine mechanical condition--Refer to Symptoms - Engine Mechanical.

Repair Instructions

- Spark Plug Replacement
- Ignition Coil Replacement - Bank 1
- Ignition Coil Replacement - Bank 2

Repair Verification

1. If the customer concern was a flashing malfunction indicator lamp (MIL), refer to DTC P0420 or P0430.
2. Clear the DTCs with a scan tool.
3. Turn OFF the ignition for 30 seconds.
4. Start the engine.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   If the DTC fails this ignition, a misfire still exists.

DTC P0300-P0306

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0300: Engine Misfire Detected

DTC P0301: Cylinder 1 Misfire Detected

DTC P0302: Cylinder 2 Misfire Detected

DTC P0303: Cylinder 3 Misfire Detected

DTC P0304: Cylinder 4 Misfire Detected

DTC P0305: Cylinder 5 Misfire Detected

DTC P0306: Cylinder 6 Misfire Detected

Circuit/System Description

The engine control module (ECM) uses information from the crankshaft position (CKP) sensor and the camshaft position (CMP) sensors in order to determine when an engine misfire is occurring. By monitoring variations in the crankshaft rotation speed for each cylinder the ECM is able to detect individual misfire events. A misfire rate that is high enough can cause 3-way catalytic converter damage. The malfunction indicator lamp (MIL) will flash ON and OFF when the conditions for catalytic converter damage are present. DTCs P0301 through P0306 correspond to cylinders 1 through 6. If the ECM is able to determine that a specific cylinder is misfiring the DTC for that cylinder will set.

Conditions for Running the DTC

- DTC P0121, P0122, P0123, P0221, P0222, P0223, P0335, P0336, or P0338 is not set.
- The engine speed is between 420-7,000 RPM and steady.
- The delivered torque signal is greater than 5.5 percent at idle.
- The delivered torque signal is between 6-29 percent with the transmission in drive.
- The intake air temperature (IAT) is greater than -30°C (-22°F).
- The A/C compressor clutch is not changing states.
- The clutch pedal position sensor is not changing states.
- The ECM is not in fuel cut-off or decel fuel cut-off mode.

- The torque management is not active.
- The antilock brake system/traction control system (ABS/TCS) is not active.
- The ECM is not receiving a rough road signal.
- The fuel level is greater than 11 percent.
- The throttle angle is steady.
- DTCs P0300 through P0306 run continuously when the above conditions exist for at least 1,000 engine revolutions.

Conditions for Setting the DTC

DTC P0300

The ECM detects a crankshaft rotation speed variation indicating a misfire rate sufficient to cause emissions levels to exceed a predetermined value for greater than 4 seconds.

DTC P0301, P0302, P0303, P0304, P0305 or P0306

The ECM detects a crankshaft rotation speed variation indicating a single cylinder misfire rate sufficient to cause emissions levels to exceed mandated standards.

Action Taken When the DTC Sets

DTCs P0300, P0301, P0302, P0303, P0304, P0305, and P0306 are Type A (MIL flashing) or Type B1 DTCs.

Conditions for Clearing the DTC

DTCs P0300, P0301, P0302, P0303, P0304, P0305, and P0306 are Type A (MIL flashing) or Type B1 DTCs.

Diagnostic Aids

- A misfire DTC could be caused by an excessive vibration from sources other than the engine. Inspect for the following possible sources:
  - A tire or wheel that is out of round or out of balance
  - Variable thickness brake rotors
  - An unbalanced drive shaft
  - Certain rough road conditions
  - Transmission operation
  - A damaged accessory drive component or belt
- High resistance in the circuits of the injectors could set a misfire DTC without setting an injector DTC. Test the injector circuits of the affected cylinder(s) for a high resistance if you suspect a condition.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 26792 HEI Spark Tester

Circuit / System Verification

1. Engine idling at the normal operating temperature. There should be no abnormal engine noise.

   If there is an abnormal engine noise, refer to Symptoms - Engine Mechanical .
2. Verify that DTC P0011, P0014, P0021, P0024, P0201-P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0335, P0336, P0338, P0351-P0356, P2088, P2090, P2092, P2094, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 is not set.

   If a DTC is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle .
3. Observe the scan tool Misfire Current Cyl. 1-6 parameters. The Misfire Current Counters should not increment.
4. Engine idling, perform the cylinder power balance test with a scan tool to isolate the misfiring cylinder. The engine speed should change when each injector is disabled.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

1. Verify that the following conditions do not exist:
   - Vacuum hose splits, kinks, and incorrect connections

- Engine vacuum leaks
- Crankcase ventilation system for vacuum leaks
- Fuel pressure that is too low or too high--Refer to Fuel System Diagnosis .
- Contaminated Fuel--Refer to Alcohol/Contaminants-in-Fuel Diagnosis .
- Exhaust system restrictions

  If you find any of the above conditions, repair as necessary.

2. Ignition OFF, remove the appropriate ignition coil of the misfiring cylinder, but leave the electrical connector connected.
3. Inspect the ignition coil boot for the following conditions:
   - Holes
   - Tears
   - Carbon tracking
   - Oil contamination
   - Water intrusion

   If you find any of the above conditions, repair as necessary.
4. Remove the fuel pump fuse from the fuse block.
5. Install the *J 26792* HEI Spark Tester to the boot of the appropriate ignition coil and ground.

   Note: An erratic or weak spark is considered a no spark condition.

6. Attempt to start the engine and observe the *J 26792* HEI Spark Tester . The spark tester should spark.

   If there is no spark, refer to Electronic Ignition (EI) System Diagnosis for diagnosis of the ignition coil.
7. Ignition OFF, remove the spark plug from the misfiring cylinder. Verify that the spark plug does not exhibit the following conditions:
   - Gas, coolant, or oil fouled--Refer to Spark Plug Inspection .
   - Cracked, worn, incorrectly gapped--Refer to Ignition System Specifications .

   If there is a condition with the spark plug, replace the spark plug.
8. Exchange the suspected spark plug with another cylinder that is operating correctly.
9. Engine idling, observe the scan tool Misfire Current Counter parameters. The misfire should not follow the spark plug exchange.

   If the misfire follows the spark plug, replace the spark plug.
10. If all conditions test normal, test or inspect for the following:
    - A lean or rich fuel injector--Refer to Fuel Injector Solenoid Coil Test .
    - An engine mechanical condition--Refer to Symptoms - Engine Mechanical

Repair Instructions

Spark Plug Replacement

Repair Verification

1. If the customer concern was a flashing malfunction indicator lamp (MIL), refer to DTC P0420 or P0430 .
2. Clear the DTCs with a scan tool.
3. Turn OFF the ignition for 30 seconds.

4. Start the engine.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   If the DTC fails this ignition, a misfire still exists.

DTC P0324

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0324: Knock Sensor (KS) Module Performance

Circuit / System Description

The knock sensor (KS) is a piezoelectric device that produces an AC voltage of different amplitude and frequency depending on the level of engine mechanical vibration. The KS system monitors the knock sensor in order to determine if detonation or spark knock is present. If the KS system determines that excessive knock is present, the engine control module (ECM) retards the spark timing based on the signal from the KS system. The KS produces an AC signal when specific frequencies are detected. The ECM then retards the timing until knock is controlled.

The ECM tests the functionality of the internal knock sensor signal evaluation circuitry. The KS circuitry within the ECM is responsible for receiving, amplifying, filtering, and evaluating the AC voltage and frequency from the knock sensors. The ECM performs two tests that determine if the internal circuitry within the ECM is functioning correctly.

Test One

The ECM internally turns OFF the knock sensor signal circuits. The ECM then applies different test signals to the internal KS circuitry to verify that each test signal output response is within range. If the ECM detects that any of the test signals are not within range, this DTC sets.

Test Two

The ECM internally turns OFF the knock sensor signal circuits. The ECM then tests for any output response when no test signals are applied. If the ECM detects an output response, this DTC sets.

Test Three

The ECM internally turns OFF the knock sensor signal circuits. The ECM generates an internal test pulse and monitors the return signal. If the return test pulse is less than a calibrated threshold, this DTC sets.

Conditions for Running the DTC

- The ECM is controlling spark.

- The engine coolant temperature is greater than 60°C (140°F).
- DTC P0324 runs continuously once the above conditions are met.

Conditions for Setting the DTC

- The ECM detects an incorrect response to the self tests performed on the internal KS circuitry.
- The condition exists for greater than 1 seconds or for a cumulative of 10 seconds.

Action Taken When the DTC Sets

DTCs P0324 is a Type B DTC.

Conditions for Clearing the DTC

DTCs P0324 is a Type B DTC.

Reference Information

Description and Operation

Knock Sensor (KS) System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Note: If you can hear an engine knock, repair the engine mechanical condition before proceeding with this diagnostic.

1. Ignition ON, observe the DTC information with a scan tool. DTC P0335, P0336, or P0338 should not be set.

   If DTC P0335, P0336, or P0338 is set, refer to DTC P0335, P0336, or P0338 for further diagnosis.
2. Clear the DTCs with a scan tool.
3. Turn OFF the ignition for 30 seconds.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data. Observe the DTC information with a scan tool.
   DTC P0324 should not set.

   If DTC P0324 failed this ignition, replace the ECM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for engine control module replacement, setup, and programming

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Diagnostic Information and Procedures |
Document ID: 2101581

DTC P0326, P0327, P0328, P0331, P0332, or P0333

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0326: Knock Sensor (KS) System Performance Bank 1

DTC P0327: Knock Sensor (KS) Circuit Low Voltage Bank 1

DTC P0328: Knock Sensor (KS) Circuit High Voltage Bank 1

DTC P0331: Knock Sensor (KS) System Performance Bank 2

DTC P0332: Knock Sensor (KS) Circuit Low Voltage Bank 2

DTC P0333: Knock Sensor (KS) Circuit High Voltage Bank 2

Circuit / System Description

The knock sensor (KS) is a piezoelectric device that produces an AC voltage of different amplitude and frequency depending on the level of engine mechanical vibration. The KS system monitors the knock sensor in order to determine if detonation or spark knock is present. If the KS system determines that excessive knock is present, the engine control module (ECM) retards the spark timing based on the signal from the KS system. The KS produces an AC signal when specific frequencies are detected. The ECM then retards the timing until knock is controlled.

In order to differentiate between normal engine noise and spark knock, the ECM samples the KS signal. The ECM samples the KS signal for a certain length of time under different engine speeds and loads during non-cylinder knock events. This sampling is used to determine a range of acceptable normal engine noise.

Conditions for Running the DTC

P0326, P0327, and P0328

- Before the ECM can report DTC P0326 or P0331 failed, DTCs P0324, P0335, P0336, and P0338 must run and pass.
- DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393 is not set.
- The engine coolant temperature (ECT) sensor is greater than 60°C (140°F).
- The engine speed is greater than 2,200 RPM.

- The increase in engine speed is less than a range of 500-2,300 RPM per second.
- The increase in engine load is less than a range of 50-100 kPa per second.
- DTCs P0326 and P0331 run continuously once the above conditions are met for approximately 20 seconds.

P0331, P0332, and P0333

- Before the ECM can report DTC P0327, P0328, P0332, or P0333 failed, DTCs P0324, P0335, P0336, and P0338 must run and pass.
- DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393 is not set.
- The engine coolant temperature (ECT) sensor is greater than 60°C (140°F).
- The increase in engine speed is less than a range of 500-2,300 RPM per second.
- The increase in engine load is less than a range of 50-100 kPa per second.
- DTCs P0327, P0328, P0332, and P0332 run continuously once the above conditions are met for approximately 20 seconds.

Conditions for Setting the DTC

P0326 and P0331

The ECM detects a KS signal voltage that is not in the range of a predetermined engine noise level in 25 of 250 test samples. The condition exists for greater than 1 seconds or for a cumulative of 10 seconds.

P0327 or P0332

The ECM detects a KS signal voltage that is less than the predetermined minimum engine noise level for greater than 1 second or for a cumulative of 10 seconds.

P0328 or P0333

The ECM detects the KS signal voltage is greater than predetermined maximum engine noise level for greater than 1 second or for a cumulative of 10 seconds.

Action Taken When the DTC Sets

DTCs P0326, P0327, P0328, P0331, P0332, and P0333 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0326, P0327, P0328, P0331, P0332, and P0333 are Type B DTCs.

Diagnostic Aids

- Inspect the KS for physical damage. A KS that is dropped or damaged may cause a DTC to set.

- Inspect the KS for proper installation. A KS that is loose or over torqued may cause a DTC to set. The KS should be free of thread sealant. The KS mounting surface should be free of burrs, casting flash, and foreign material.
- The KS must be clear of hoses, brackets, and engine electrical wiring.
- The normal voltage on the KS signal and low reference circuits is 2.43 volts when the KS is disconnected.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Knock Sensor (KS) System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine at operating temperature, all accessories OFF. Engine speed greater than 2,000 RPM, observe the appropriate scan tool KS signal voltage parameter. The voltage should be greater than 4 volts.
2. Engine idling, move the related harnesses and connectors for the KS circuits while observing the scan tool KS signal voltage parameters. The voltage should remain steady with no abrupt changes.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate KS.

   Note: If the voltage is not within the specified range on either circuit, test for a wire to wire short, short to ground or voltage between the KS circuits.

2. Ignition ON, test for 2-3 V between the signal circuit terminal 1 and ground.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuits/connections test normal, replace the ECM.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuits/connections test normal, replace the ECM.
3. Test for 2-3 V between the low reference circuit terminal 2 and ground.

   If less than the specified range, test the low reference circuit for a short to ground or an open/high resistance. If the circuits/connections test normal, replace the ECM.

   If greater than the specified range, test the low reference circuit for a short to voltage. If the circuits/connections test normal, replace the ECM.
4. If all circuits/connections test normal, test or replace the KS sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Knock Sensor Replacement - Bank 1
- Knock Sensor Replacement - Bank 2
- Control Module References for engine control module replacement, setup, and programming

DTC P0335, P0336, or P0338

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0335: Crankshaft Position Sensor Circuit Malfunction

DTC P0336: Crankshaft Position Sensor Signal Range/Performance

DTC P0338: Crankshaft Position (CKP) Sensor Circuit High Duty Cycle

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
CKP Sensor Signal	P0335	P0335	P0335	P0336
Low Reference	--	P0335	P0335, P0338	P0336
Shielded Ground	--	--	--	P0336

Circuit/System Description

The crankshaft position (CKP) sensor is located on the rear of bank 1 of the engine block. The CKP sensor produces an AC voltage of different amplitude and frequency depending on the velocity of the crankshaft. The CKP sensor works in conjunction with a 58X reluctor wheel that is attached to the crankshaft. Each tooth on the reluctor wheel are spaced 6 degrees apart with one span having a 12 degree space. The engine control module (ECM) uses the 12 degree space to determine top dead center (TDC) for cylinders 1 and 4. The ECM determines when cylinder 1 is on the compression stroke by monitoring the CKP sensor and the camshaft position (CMP) sensors. The ECM can synchronize the ignition timing, fuel injector timing and spark knock control based on the CKP sensor and the CMP sensor inputs. If the ECM loses the reference position to TDC, or the CKP signal is lost or erratic, one of these DTCs sets.

Conditions for Running the DTC

- The engine is cranking or operating
- The ECM has detected greater than 12 camshaft revolutions
- The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P0335

- The ECM does not detect a signal from the CKP sensor. The condition exists for greater than 1 second or for a cumulative time of 10 seconds.

  OR
- The ECM detects a CKP signal without a reference pulse for greater than 3 revolutions.

P0336

- The ECM re-syncs the engine position greater than 6 times during an ignition cycle.

  OR
- The ECM detects 28 or more interruptions in the engine speed signal during an ignition cycle.

P0338

The ECM detects a difference of greater than 8 teeth between reference gap position pulses.

Action Taken When the DTC Sets

DTCs P0335, P0336, P0337 and P0338 are type A DTCs.

Conditions for Clearing the DTC

DTCs P0335, P0336, P0337 and P0338 are type A DTCs.

Diagnostic Aids

The following conditions may also set the DTCs:

- Physical damage to the CKP sensor or the reluctor wheel.
- Incorrect play or looseness of the CKP sensor or the reluctor wheel.
- Incorrect installation of the CKP sensor or the reluctor wheel.
- Foreign material passing between the CKP sensor and the reluctor wheel.
- Incorrect air gap between the CKP sensor and the reluctor wheel.
- The ECM uses the camshaft position sensors to determine engine speed and position when there is a CKP sensor condition.
- The engine will operate with a CKP sensor condition only if the ECM has stored the learned reference position of the camshafts in memory. With a crankshaft position sensor condition the engine will go into a limp home mode after a hard restart. The ECM then calculates engine speed from one of the camshaft position sensors. During a limp home mode the following additional DTCs may set and should be ignored:
  - DTC P0324 Knock Sensor (KS) Module Performance.
  - DTC P1011 Intake Camshaft Position Actuator Park Position Bank 1.
- An intermittent condition in the camshaft position (CMP) sensor circuits can cause a CKP DTC

to set. Inspect the CMP sensor, harness connections, and related wiring, if you suspect this condition.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, Using a scan tool clear all DTCs. Attempt to start the engine, observe the DTC information, DTC P0335, P0336 and P0338 should not set.
2. Move related harnesses/connectors of the CKP sensor and verify the engine does not stumble, stall or change engine speed.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, remove the fuse that supplies B+ to circuit terminal 56 X2 of the ECM.
2. Disconnect the harness connector at the CKP sensor.

Notice: Do NOT use a test lamp to test the continuity of the circuit. Damage to the control module may occur due to excessive current draw.

Note: The ECM or the sensor may be damaged if the circuit is shorted to B+ voltage.

3. Test for less than 5 Ω between the low reference circuit terminal 1 and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the ECM.
4. Install the fuse that supplies B+ to circuit terminal 56 X2 of the ECM.
5. Ignition ON, measure for 4.8-5.2 V between the 5 volt reference circuit terminal 3 of the CKP sensor and ground.

   If less than the specified range, test the 5 volt reference circuit for a short to ground or an open/high resistance. If the circuits/connections test normal, replace the ECM.

   If greater than the specified range, test the 5 volt reference circuit for a short to voltage. If the circuits/connections test normal, replace the ECM.
6. Measure for 4.8-5.2 V between the signal circuit of the CKP sensor terminal 2 and ground with a DMM.

   If greater than the specified range, test for a short to voltage in the signal circuit of the CKP sensor. If circuit/connections test normal, replace the ECM.

   If less than the specified range, test for a short to ground or an open/high resistance in the signal circuit of the CKP sensor. If circuit/connections test normal, replace the ECM.
7. If all circuits/connections test normal, replace the CKP sensor.

Repair Instructions

Perform the Diagnostic Repair Verification .

- Crankshaft Position Sensor Replacement
- Engine Control Module Replacement for engine control module replacement, setup and programming.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Diagnostic Information and Procedures |
Document ID: 1992846

DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0341: Intake Camshaft Position Sensor Range/Performance Bank 1

DTC P0342: Intake Camshaft Position Sensor Low Voltage Bank 1

DTC P0343: Intake Camshaft Position Sensor High Voltage Bank 1

DTC P0346: Intake Camshaft Position Sensor Range/Performance Bank 2

DTC P0347: Intake Camshaft Position Sensor Low Voltage Bank 2

DTC P0348: Intake Camshaft Position Sensor High Voltage Bank 2

DTC P0366: Exhaust Camshaft Position Sensor Range/Performance Bank 1

DTC P0367: Exhaust Camshaft Position Sensor Low Voltage Bank 1

DTC P0368: Exhaust Camshaft Position Sensor High Voltage Bank 1

DTC P0391: Exhaust Camshaft Position Sensor Range/Performance Bank 2

DTC P0392: Exhaust Camshaft Position Sensor Low Voltage Bank 2

DTC P0393: Exhaust Camshaft Position Sensor High Voltage Bank 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
CMP Sensor 5-Volt Reference	P0343, P0348, P0368, P0393, P0652, P2122, P2138	P0343, P0348, P0368, P0393, P0651	P0653, P2123, P2138	P0341, P0346, P0366, P0391, P0651, P0652, P0653, P2138
CMP Sensor Signal Intake Bank 1	P0342	P0343	P0343	P0341

CMP Sensor Signal Intake Bank 2	P0347	P0348	P0348	P0346
CMP Sensor Signal Exhaust Bank 1	P0367	P0368	P0368	P0366
CMP Sensor Signal Exhaust Bank 2	P0392	P0393	P0393	P0391
Low Reference	--	P0343, P0348, P0368, P0393	--	P0341, P0346, P0366, P0391

Circuit/System Description

Each camshaft is equipped with a camshaft position (CMP) sensor that the engine control module (ECM) monitors. The CMP sensor is a hall effect switch that works in conjunction with a 4X reluctor wheel. The reluctor wheels are mounted to the camshaft position actuators that are mounted to the end of the camshafts. The ECM uses the CMP sensor signals in order to determine the position of the camshafts. The ECM supplies 5 volts to the CMP sensors on the 5-volt reference circuits and supplies a ground on the low reference circuits. The CMP sensors provide a signal to the ECM on the signal circuits. If the ECM detects extra or missing CMP sensor signal transitions or a signal voltage that is greater or less than the predetermined range within a certain number of crankshaft revolutions, one of these DTCs sets.

Conditions for Running the DTC

- The engine is operating for greater than 1 second.
- The DTCs run continuously once the above condition is met.

Conditions for Setting the DTC

P0341, P0346, P0366, P0391

- The ECM detects a signal from the CMP sensor, but the number of pulses are less than or greater than what is expected for one crankshaft revolution.

  OR
- The CMP sensor does NOT correlate to the crankshaft position.
- Either condition must exist for greater than 1 second, or cumulative of 10 seconds.

P0342, P0347, P0367, P0392

The CMP sensor signal voltage is always low and the ECM detects no pulses from the CMP sensor for greater than 1 second, or cumulative of 10 seconds.

P0343, P0348, P0368, P0393

The CMP sensor signal voltage is always high and the ECM detects no pulses from the CMP sensor for greater than 1 second or cumulative of 10 seconds.

Action Taken When the DTC Sets

DTCs P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392 and P0393 are type B DTCs.

Conditions for Clearing the DTC

DTCs P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392 and P0393 are type B DTCs.

Diagnostic Aids

The following conditions can also set the DTC:

- Physical damage to the CMP sensor or the reluctor wheel.
- Incorrect play or looseness of the CMP sensor or the reluctor wheel.
- Incorrect installation of the CMP sensor or the reluctor wheel.
- Foreign material passing between the CMP sensor and the reluctor wheel.
- Incorrect air gap between the CMP sensor and the reluctor wheel.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the DTC information with a scan tool. DTC P0651, P0652 or P0653 should not be set.

   If a DTC is set, refer to DTC P0641-P0643, P0651-P0653, or P0697-P0699 .
2. Engine idling, observe the DTC information with a scan tool. DTC P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, or P0393 should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, remove the fuse that supplies B+ to terminal 56 X2 of the ECM.
2. Disconnect the harness connector at the appropriate camshaft position (CMP) sensor.

   Note: The control module or the sensor may be damaged if the circuit is shorted to B+ voltage.
3. Test for less than 5 Ω between the low reference circuit terminal 1 and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the ECM.
4. Install the fuse that supplies B+ to terminal 56 X2 of the ECM.
5. Ignition ON, test for greater than 4.8 V between the 5-volt reference circuit terminal 3 and ground.

   If less than the specified value, test the 5-volt reference circuit for an open/high resistance. If the circuits/connections test normal, replace the ECM.
6. Test for 4.8-5.2 V between the signal circuit terminal 2 and ground.

   If the voltage is greater than specified range, test for a short to voltage in the signal circuit. If circuit/connections test normal, replace the ECM.

   If the voltage is less than the specified range, test for a short to ground or an open/high resistance in the signal circuit. If circuit/connections test normal, replace the ECM.
7. If all circuits/connections test normal, replace the camshaft position (CMP) sensor.

Repair Instructions

Perform the Diagnostic Repair Verification .

- Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust
- Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake
- Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust
- Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake
- Engine Control Module Replacement for engine control module replacement, setup, and programming

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DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0351: Ignition Coil 1 Control Circuit

DTC P0352: Ignition Coil 2 Control Circuit

DTC P0353: Ignition Coil 3 Control Circuit

DTC P0354: Ignition Coil 4 Control Circuit

DTC P0355: Ignition Coil 5 Control Circuit

DTC P0356: Ignition Coil 6 Control Circuit

DTC P2300: Ignition Coil 1 Control Circuit Low Voltage

DTC P2301: Ignition Coil 1 Control Circuit High Voltage

DTC P2303: Ignition Coil 2 Control Circuit Low Voltage

DTC P2304: Ignition Coil 2 Control Circuit High Voltage

DTC P2306: Ignition Coil 3 Control Circuit Low Voltage

DTC P2307: Ignition Coil 3 Control Circuit High Voltage

DTC P2309: Ignition Coil 4 Control Circuit Low Voltage

DTC P2310: Ignition Coil 4 Control Circuit High Voltage

DTC P2312: Ignition Coil 5 Control Circuit Low Voltage

DTC P2313: Ignition Coil 5 Control Circuit High Voltage

DTC P2315: Ignition Coil 6 Control Circuit Low Voltage

DTC P2316: Ignition Coil 6 Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage - Bank 1	P0300-P0306, P2300, P2306, P2312	P0300-P0306, P0351, P0353, P0355	--	P0300, P0301, P0303, P0305
Ignition Voltage - Bank 2	P0300-P0306, P2303, P2309, P2315	P0300-P0306, P0352, P0354, P0356	--	P0300, P0302, P0304, P0306
Ignition Coil 1 Control Circuit	P2300	P0301, P0351	P2301	P0300, P0301
Ignition Coil 2 Control Circuit	P2303	P0302, P0352	P2304	P0300, P0302
Ignition Coil 3 Control Circuit	P2306	P0303, P0353	P2307	P0300, P0303
Ignition Coil 4 Control Circuit	P2309	P0304, P0354	P2310	P0300, P0304
Ignition Coil 5 Control Circuit	P2312	P0305, P0355	P2313	P0300, P0305
Ignition Coil 6 Control Circuit	P2315	P0306, P0356	P2316	P0300, P0306

Circuit/System Description

The ignition system on this engine uses individual ignition coils and ignition control (IC) circuits for each cylinder. Ignition voltage is supplied to each bank of ignition coils. The engine control module (ECM) controls the ignition system operation. The ECM controls each coil using the IC circuits. The ECM commands the IC circuit low when a spark event is requested.

The sequencing and timing are ECM controlled.

Conditions for Running the DTC

- The engine is operating.
- The ignition voltage is between 10-18 volts.
- The engine speed is between 400-5,000 RPM.
- The DTCs run continuously once per crankshaft revolution after the above conditions are met for 20 crankshaft revolutions.

Conditions for Setting the DTC

P0351-P0356

The ECM detects the ignition control circuit is open for greater than 4 seconds or a cumulative of 30 seconds.

P2300, P2303, P2306, P2309, P2312, or P2315

The ECM detects the ignition control circuit is shorted to ground for greater than 4 seconds or a cumulative of 30 seconds.

P2301, P2304, P2307, P2310, P2313, or P2316

The ECM detects the ignition control circuit is shorted to voltage for greater than 4 seconds or a cumulative of 30 seconds.

Action Taken When the DTC Sets

DTCs P0351, P0352, P0353, P0354, P0355, P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, and P2316 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0351, P0352, P0353, P0354, P0355, P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, and P2316 are Type B DTCs.

Diagnostic Aids

- Inspect the ignition coils for aftermarket devices. An aftermarket device connected to the ignition coil circuits, may cause this DTC to set.
- If the condition is intermittent, moving the related harnesses and connectors, with the engine operating, while monitoring the appropriate scan tool Misfire Current Cylinder parameter may help to isolate the condition.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Electronic Ignition (EI) System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Operate the engine for 30 seconds. Observe the DTC information with a scan tool. DTC P0351, P0352, P0353, P0354, P0355, P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate ignition coil.
2. Ignition ON, verify that a test lamp illuminates between ignition voltage circuit terminal listed below and ground.
   - Terminal D for LY7
   - Terminal 2 for LLT

   If the test lamp does not illuminate, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition voltage circuit and replace as necessary.
3. Crank or start the engine. Test for 200-400 mV between the IC circuit terminal listed below and ground.
   - Terminal C for LY7
   - Terminal 1 for LLT

   If less than the specified range, test the IC circuit for a short to ground or an open/high resistance. If the circuit/connection tests normal, replace the ECM.

   If greater than the specified range, test the IC circuit for a short to voltage. If the circuit/connection tests normal, replace the ECM.
4. Connect a test lamp between the each of the ground circuits terminal listed below, and B+. The test lamp should illuminate on each circuit.
   - Terminal A for LY7
   - Terminal 3 for LLT
   - Terminal 4 for LLT

   If the test lamp does not illuminate, test the circuit for an open/high resistance.

   Note: This step only applies to the LY7 engine.
5. Ignition OFF, test for less than 5 Ω between the low reference circuit terminal B and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
6. If all circuits/connections test normal, replace the ignition coil.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Ignition Coil Replacement - Bank 1
- Ignition Coil Replacement - Bank 2
- Control Module References for engine control module replacement, setup, and programming

DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 (with LLT)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0351: Ignition Coil 1 Control Circuit

DTC P0352: Ignition Coil 2 Control Circuit

DTC P0353: Ignition Coil 3 Control Circuit

DTC P0354: Ignition Coil 4 Control Circuit

DTC P0355: Ignition Coil 5 Control Circuit

DTC P0356: Ignition Coil 6 Control Circuit

DTC P2300: Ignition Coil 1 Control Circuit Low Voltage

DTC P2301: Ignition Coil 1 Control Circuit High Voltage

DTC P2303: Ignition Coil 2 Control Circuit Low Voltage

DTC P2304: Ignition Coil 2 Control Circuit High Voltage

DTC P2306: Ignition Coil 3 Control Circuit Low Voltage

DTC P2307: Ignition Coil 3 Control Circuit High Voltage

DTC P2309: Ignition Coil 4 Control Circuit Low Voltage

DTC P2310: Ignition Coil 4 Control Circuit High Voltage

DTC P2312: Ignition Coil 5 Control Circuit Low Voltage

DTC P2313: Ignition Coil 5 Control Circuit High Voltage

DTC P2315: Ignition Coil 6 Control Circuit Low Voltage

DTC P2316: Ignition Coil 6 Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage - Bank 1	P0300-P0306, P2300, P2306, P2312	P0300-P0306, P0351, P0353, P0355	--	P0300, P0301, P0303, P0305
Ignition Voltage - Bank 2	P0300-P0306, P2303, P2309, P2315	P0300-P0306, P0352, P0354, P0356	--	P0300, P0302, P0304, P0306
Ignition Coil 1 Control Circuit	P2300	P0301, P0351	P2301	P0300, P0301
Ignition Coil 2 Control Circuit	P2303	P0302, P0352	P2304	P0300, P0302
Ignition Coil 3 Control Circuit	P2306	P0303, P0353	P2307	P0300, P0303
Ignition Coil 4 Control Circuit	P2309	P0304, P0354	P2310	P0300, P0304
Ignition Coil 5 Control Circuit	P2312	P0305, P0355	P2313	P0300, P0305
Ignition Coil 6 Control Circuit	P2315	P0306, P0356	P2316	P0300, P0306

Circuit/System Description

The ignition system on this engine uses individual ignition coils and ignition control (IC) circuits for each cylinder. Ignition voltage is supplied to each bank of ignition coils. The engine control module (ECM) controls the ignition system operation. The ECM controls each coil using the IC circuits. The ECM commands the IC circuit low when a spark event is requested.

The sequencing and timing are ECM controlled.

Conditions for Running the DTC

- The engine is operating.
- The ignition voltage is between 10-18 volts.
- The engine speed is less than 6,000 RPM.
- The DTCs run continuously once per crankshaft revolution after the above conditions are met.

Conditions for Setting the DTC

P0351-P0356

The ECM detects the ignition control circuit is open for greater than 4 seconds or a cumulative of 30 seconds.

P2300, P2303, P2306, P2309, P2312, or P2315

The ECM detects the ignition control circuit is shorted to ground for greater than 4 seconds or a cumulative of 30 seconds.

P2301, P2304, P2307, P2310, P2313, or P2316

The ECM detects the ignition control circuit is shorted to voltage for greater than 4 seconds or a cumulative of 30 seconds.

Action Taken When the DTC Sets

DTCs P0351, P0352, P0353, P0354, P0355, P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, and P2316 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0351, P0352, P0353, P0354, P0355, P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, and P2316 are Type B DTCs.

Diagnostic Aids

- Inspect the ignition coils for aftermarket devices. An aftermarket device connected to the ignition coil circuits, may cause this DTC to set.
- If the condition is intermittent, moving the related harnesses and connectors, with the engine operating, while monitoring the appropriate scan tool Misfire Current Cylinder or IC Circuit Test Status parameter may help to isolate the condition.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Electronic Ignition (EI) System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Engine idling, observe the DTC information with a scan tool. DTC P0351, P0352, P0353, P0354, P0355, P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 should not set.
2. Observe the appropriate scan tool Misfire Current Cylinder parameter. Verify the parameter does not increment.
3. Observe the appropriate scan tool IC Circuit Test Status parameters. Verify the parameters display OK or Not Run.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate ignition coil.

   Note: The ignition circuit supplies voltage to other components. Make sure you test all circuits for a short to ground or test all components for being shorted that share the ignition circuit.

2. Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal 2 and ground.

   If the test lamp does not illuminate, test the circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition voltage circuit and replace as necessary.
3. Crank or start the engine. Test for 200-400 mV between the appropriate IC circuit terminal 1 and ground.

   If less than the specified range, test the circuit for a short to ground or an open/high resistance. If the circuit/connection tests normal, replace the ECM.

   If greater than the specified range, test the circuit for a short to voltage. If the circuit/connection tests normal, replace the ECM.
4. Connect a test lamp between the each of the ground circuits terminal 3, and terminal 4, and B+. The test lamp should illuminate on each circuit.

   If the test lamp does not illuminate, test the suspected circuit for an open/high resistance.
5. If all circuits/connections test normal, replace the ignition coil.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Ignition Coil Replacement - Bank 1
- Ignition Coil Replacement - Bank 2
- Control Module References for engine control module replacement, setup, and programming

DTC P0420 or P0430

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P0420: Catalyst System Low Efficiency Bank 1

DTC P0430: Catalyst System Low Efficiency Bank 2

Circuit/System Description

In order to maintain a reasonably low emission level of hydrocarbons (HC), carbon monoxide (CO) and oxides of nitrogen (NOx) a 3-way catalytic converter (TWC) is used. The catalyst within the converter promotes a chemical reaction that oxidizes the HC and CO present in the exhaust gas. This reaction converts the gases into harmless water vapor and carbon dioxide. The catalyst also reduces the NOx , converting the NOx into nitrogen. The engine control module (ECM) monitors this process using the post catalyst heated oxygen sensor (HO2S) signal. The post-catalyst HO2S located in the exhaust stream after the TWC, produces an output signal that indicates the oxygen storage capacity of the catalyst. The oxygen storage capacity (OSC) determines the ability of the catalyst to convert the exhaust emissions effectively. If the catalyst is functioning correctly the post-catalyst HO2S signal will be far less active than the signal produced by the pre-catalyst HO2S.

To determine OSC, the ECM commands a rich air/fuel mixture until all oxygen is removed from the catalyst. The ECM then commands a lean air/fuel mixture and monitors the rear heated oxygen sensors to calculate the oxygen storage capacity. The catalyst is operated in this mode until one of the following conditions occur:

- The oxygen stored in the catalyst exceeds a calibrated threshold, which is determined from the rear HO2S signal.
- The rear HO2S indicates the catalyst to be completely saturated with oxygen, which is determined from the rear HO2S signal.

Conditions for Running the DTC

- Before the ECM can report DTC P0420 or P0430 failed, DTCs P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0053, P0056, P0057, P0058, P0059, P0101, P0102, P0103, P0121, P0122, P0123, P0130, P0131, P0132, P0133, P0135, P0137, P0138, P0140, P0141, P0150, P0151, P0152, P0153, P0155, P0157, P0158, P0160, P0161, P0221, P0222, P0223, P0335, P0336, P0338, P167A, P167B, P2096, P2097, P2098, P2099, P2195, P2196, P2197, P2198, P2232, P2235, P2237, P2240, P2243, P2247, P2251, P2254, P2270, P2271, P2272, P2273, P2297, P2298, P2626 and P2629 must run and pass.

- DTCs P0010, P0011, P0013, P0014, P0020, P0021, P0023, P0024, P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0053, P0056, P0057, P0058, P0059, P0101, P0102, P0103, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0125, P0130, P0131, P0132, P0133, P0135, P0137, P0138, P0140, P0141, P0150, P0151, P0152, P0153, P0155, P0157, P0158, P0160, P0161, P0221, P0222, P0223, P0300, P0301-P0306, P0443, P0458, P0459, P0496, P167A, P167B, P2088, P2089, P2090, P2091, P2092, P2093, P2094, P2095, P2096, P2097, P2098, P2099, P2100, P2101, P2107, P2119, P2122, P2123, P2127, P2128, P2138, P2176, P2177, P2178, P2179, P2180, P2187, P2188, P2189, P2190, P2195, P2196, P2197, P2198, P2232, P2235, P2237, P2240, P2243, P2247, P2251, P2254, P2270, P2271, P2272, P2273, P2297, P2298, P2626 and P2629 are not set
- The air flow into the engine is between 3-28 g/s and is steady within 2 percent.
- The calculated TWC temperature is between 550-900°C (1,022-1,652°F) and steady.
- The engine speed is 1,160-2,440 RPM.
- The engine load is 13-55 percent.
- The calculated TWC temperature does not change greater than 8°C (14°F) in 1 second.
- The engine is operating in Closed Loop.
- The HO2S 2 is at operating temperature for greater than a range of 140-210 seconds.
- The engine intake air temperature (IAT) is greater than -30°C (-22°F).
- The above conditions exist for approximately 17 minutes.
- DTCs P0420 and P0430 run once a drive cycle. The ECM will attempt to run this diagnostic up to 4 times a drive cycle.

Conditions for Setting the DTC

The ECM determines that the efficiency of the catalyst has degraded below a calibrated threshold for greater than 5 seconds.

Action Taken When the DTC Sets

DTCs P0420 and P0430 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0420 and P0430 are Type A DTCs.

Diagnostic Aids

Inspect for the following conditions which may cause a catalytic converter to degrade:

- An engine misfire.
- High engine oil or high coolant consumption.
- Retarded spark timing.
- A weak or poor spark.
- A lean fuel mixture.
- A rich fuel mixture.
- A damaged oxygen sensor or wiring harness.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Testing

1. Observe the DTC information with a scan tool. Verify there are no HO2S, fuel system, or misfire DTCs set.

   If there are any HO2S, fuel system, or misfire DTCs set, diagnosis the applicable DTC before proceeding with this diagnostic procedure. Refer to Diagnostic Trouble Code (DTC) List - Vehicle .
2. Inspect and verify the following:
   - The catalytic converter is an original part
   - The HO2S 2 is secure and the wiring is not damaged, or contacting the exhaust
   - The exhaust system for leaks, damage, or missing hardware

     If a condition is found, repair as necessary.

   Note: Before replacing the catalytic converter, correct any conditions that may have damaged the converter.
3. If a condition is not located, replace the catalytic converter.

Repair Instructions

Perform the Diagnostic Repair Verification .

- Catalytic Converter Replacement - Left Side
- Catalytic Converter Replacement - Right Side

DTC P0443, P0458, or P0459

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P0443: Evaporative Emission Control System Purge Solenoid Circuit Malfunction

DTC P0458: Evaporative Emission Control System Purge Solenoid Circuit Low Voltage

DTC P0459: Evaporative Emission Control System Purge Solenoid Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0458	P0443	--	--
EVAP Canister Purge Valve Control Circuit	P0458	P0443	P0459	--

Circuit/System Description

The evaporative emission (EVAP) canister purge valve is used to purge fuel vapor from the EVAP canister to the intake manifold. The EVAP canister purge valve is pulse width modulated (PWM). Ignition voltage is supplied directly to the EVAP canister purge valve. The engine control module (ECM) controls the solenoid by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground or shorted to a voltage by monitoring the feedback voltage. If the ECM detects the control circuit voltage is within a predetermined range when the circuit is commanded OFF, this DTC sets.

Conditions for Running the DTC

- The ignition is ON or the engine is operating.
- The engine speed is greater than 80 RPM.
- The ignition voltage is between 10-18 volts.
- The ECM has commanded the EVAP canister purge valve ON and OFF at least once during the ignition cycle.
- The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P0443

The ECM detects the EVAP canister purge solenoid control circuit is open. The condition exists for 4 seconds or a cumulative of 30 seconds.

P0458

The ECM detects the EVAP canister purge solenoid control circuit is shorted to ground. The condition exists for 4 seconds or a cumulative of 30 seconds.

P0459

The ECM detects the EVAP canister purge solenoid control circuit is shorted to voltage. The condition exists for 4 seconds or a cumulative of 30 seconds.

Action Taken When the DTC Sets

DTC P0443, P0458 and P0459 are type B DTCs.

Conditions for Clearing the DTC

DTC P0443, P0458 and P0459 are type B DTCs.

Diagnostic Aids

If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the circuit status for the component with a scan tool. The circuit status parameter changes from OK or Indeterminate to Fault if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

- Circuit Testing

- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, command the EVAP purge solenoid to 50 percent with a scan tool. You should hear an audible click.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the evaporative emission (EVAP) canister purge solenoid valve.
2. Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal 2 and ground.

   If the test lamp does not illuminate, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition voltage circuit fuse is open, test all components connected to the ignition voltage circuit and replace as necessary.
3. Connect a test lamp between the control circuit terminal 1 and the ignition voltage circuit terminal 2.

   Note: The control circuit for the EVAP purge solenoid is pulled-up to voltage within the ECM, 2.6-4.6 V on the control circuit is normal.

4. Command the EVAP purge solenoid to 50 percent and then to 0 percent with a scan tool. The test lamp should illuminate or flash and then go OFF.

   If the test lamp is always ON, test the control circuit terminal 1 for a short to ground. If the circuit tests normal, replace the ECM.

   If the test lamp is always OFF, test the control circuit terminal 1 for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
5. Test for 2.6-4.6 V between the control circuit terminal 1 and ground.

   If the voltage is not within the specified range, replace the ECM.
6. If all circuits test normal, test or replace the EVAP purge solenoid.

Component Testing

1. Ignition OFF, disconnect the harness connector at the EVAP purge solenoid.
2. Test for 15-20 Ω between the control terminal 1 and the ignition terminal 2 of the EVAP

purge solenoid.

If not within the specified range, replace the EVAP purge solenoid.

3. Test for infinite resistance between each terminal and the EVAP purge solenoid housing.

   If not the specified value, replace the EVAP purge solenoid.

Repair Instructions

Perform the Diagnostic Repair Verification .

- Evaporative Emission Canister Purge Solenoid Valve Replacement
- Engine Control Module Replacement for engine control module replacement, setup, and programming

DTC P0506, P0507, or P050A

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0506: Idle Speed Low

DTC P0507: Idle Speed High

DTC P050A: Cold Start Idle Air Control (IAC) System Performance

Circuit/System Description

The throttle actuator control (TAC) motor is a DC motor that is part of the throttle body assembly. The TAC motor drives the throttle valve. The engine control module (ECM) controls the TAC motor based on throttle position sensor input. The idle speed is controlled by the ECM based on various inputs. The ECM commands the TAC motor to open or close the throttle valve in order to maintain the desired idle speed. If the ECM detects the actual idle speed and the desired idle speed are not within a predetermined amount, this DTC sets.

Conditions for Running the DTC

P0506 and P0507

- DTC P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0221, P0222, P0223, P0442, P0443, P0446, P0455, P0458, P0459, P0496, P0497, or P0700 is not set.
- The intake air temperature (IAT) is greater than -11°C (+13°F).
- The engine coolant temperature (ECT) is greater than -11°C (+13°F).
- The vehicle speed is 0 km/h (0 mph).
- The engine is idling.
- The engine is operating for greater than 4 seconds.
- The evaporative emission (EVAP) system intrusive test is not active.
- A vehicle speed was detected prior to the diagnostic running.
- The DTCs run continuously once the above conditions are met for greater than 10 seconds.

P050A

- DTC P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0221, P0222, P0223, P0442, P0443, P0446, P0455, P0458, P0459, or P0700 is not set.
- The vehicle speed is 0 km/h (0 mph).
- The engine is idling.
- The ECT is less than 65°C (149°F) at cold start.
- The cold start idle speed control is enabled.
- The ECT is less than 60°C (140°F) for the duration of the test.
- DTC P050A runs once an ignition cycle when the conditions above have been met for 7 seconds.

Conditions for Setting the DTC

P0506

The actual engine speed is less than the desired idle speed by at least 100 RPM for greater than 4 seconds or for a cumulative of 30 seconds.

P0507

The actual engine speed is greater than the desired idle speed by at least 200 RPM for greater than 4 seconds or for a cumulative of 30 seconds.

P050A

- The actual engine speed is less than the desired idle speed by at least 100 RPM for greater than 4 seconds or a cumulative of 30 seconds, during a cold start.

  OR
- The actual engine speed is less than the desired idle speed by at least 200 RPM for greater than 4 seconds or a cumulative of 30 seconds, during a cold start.

Action Taken When the DTC Sets

DTCs P0506, P0507, and P050A are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0506, P0507, and P050A are Type B DTCs.

Diagnostic Aids

Inspect for a condition in which the throttle valve may have been held open. For example, ice may have formed in the throttle bore.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Observe the DTC information with a scan tool.

   If there are any throttle actuator control (TAC), throttle position (TP) sensor, accelerator pedal position (APP) sensor, or fuel rail pressure (FRP) regulator DTCs set, refer to Diagnostic Trouble Code (DTC) List - Vehicle .
2. Operate the engine within the conditions for running the DTCs for 1 minute. DTC P0506, P0507, or P050A should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Engine operating, command the engine speed up to 1,400 RPM, down to 600 RPM, up to 1,400 RPM, and then exit using the scan tool. The engine speed should steadily increase and decrease as commanded.

If the idle does not increase or decrease steadily, verify that one of the following conditions is not present:

- Vacuum leaks
- The throttle valve for the correct operation--A throttle valve that does not close correctly sets this DTC.
- Restricted air intake system
- The throttle body for damage and/or tampering
- Incorrect or malfunctioning PCV system
- Excess deposits in the throttle body

- A parasitic load on the engine--For example, a transmission condition, a belt driven accessory condition

  Repair the condition as necessary.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

DTC P0601-P0604, P0606, P0607, P062B, P0167D, P2107, or P2610 (ECM DTC)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0601: Control Module Read Only Memory (ROM)

DTC P0602: Control Module Not Programmed

DTC P0603: Control Module Long Term Memory Reset

DTC P0604: Control Module Random Access Memory (RAM)

DTC P0606: Control Module Internal Performance

DTC P062B: Control Module Fuel Injector Control Performance

DTC P167D: Control Module Ignition Coil Internal Circuit

DTC P2107: Throttle Actuator Control (TAC) Module Internal Circuit

DTC P2610: Control Module Ignition Off Timer Performance

Circuit / System Description

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM). This diagnostic also addresses if the ECM is not programmed.

Conditions for Running the DTC

P0601

- The checksum calculation at power down in the last drive cycle was completely finished.
- DTC P0601 runs once an ignition cycle when the condition is met for 30 seconds at ignition OFF.

P0602

The ignition is ON, with the engine OFF. DTC P0602 runs continuously when the ignition is ON for greater than 1 second.

P0603

- The ignition is ON.
- The power down calculation in the last drive cycle was completely finished.
- DTC P0603 runs continuously once the conditions above have been met for greater than 5 seconds.

P0604

The read/write test at power down in the last drive cycle completely finished. DTC P0604 runs once an ignition cycle when the condition is met for 5 seconds at ignition OFF.

P0606

The power down calculation in the last drive cycle was completely finished. DTC P0606 runs continuously with ignition ON or engine operating for greater than 5 seconds.

P062B

- The engine is operating.
- The ignition voltage is between 8-18 volts.
- The engine speed is greater than 80 RPM.
- DTC P062B runs continuously once the conditions above are met.

P167D

- The engine is operating.
- The engine speed is less than 6,000 RPM.
- The ignition voltage is between 10-18 volts.
- DTC P167D runs continuously once the conditions above are met.

P2107

- The vehicle speed is 0 km/h (0 mph).
- The engine speed is less than 40 RPM.
- The accelerator pedal position (APP) is less than 15 percent.
- The ECM is performing the closed throttle test with the ignition ON and the engine OFF.
- DTC P2107 runs once the above conditions are met during the throttle actuator control system initialization.

P2610

- The engine speed is greater than 240 RPM.
- DTC P2610 runs continuously once the engine is operating and the real time clock is active.

Conditions for Setting the DTC

P0601

The ECM detects a read only memory (ROM) checksum error at ECM power up. The error is detected 5 times, then a 5 second delay for MIL ON after the fifth detection.

P0602

The ECM detects that programming is incomplete. The condition exists, then a 5 second delay for MIL ON.

P0603

The ECM detects a reset error of the internal software that operates the throttle actuator control (TAC) system, during the shut down path test. The condition exists, then a 5 second delay for MIL ON.

P0604

The ECM detects random access memory (RAM) errors. The condition exists, then a 5 second delay for MIL ON.

P0606

The ECM detects an internal error of monitoring software for the throttle actuated control (TAC) system. The condition exists, then a 5 second delay for MIL ON.

P062B

The ECM detects a condition with the integrated circuits of the fuel injector driver module for greater than 4 seconds, or a cumulative of 30 seconds.

P167D

The ECM detects a condition with the integrated circuits of the ignition coil driver module for greater than 4 seconds, or a cumulative of 30 seconds.

P2107

The ECM detects the internal TP sensor 1 amplification output does not correlate with the TP sensor 1 signal voltage for more than 4 seconds.

P2610

The ECM detects the engine off timer signal is missing or not valid for greater than 1 second, or a cumulative of 10 seconds.

Action Taken When the DTC Sets

- DTCs P0601, P0602, P0603, P0604, and P0606 are Type A DTCs.
- DTC P167D, and P2610 are Type B DTCs.

Conditions for Clearing the DTC

- DTCs P0601, P0602, P0603, P0604, and P0606 are Type A DTCs.
- DTC P167D, and P2610 are Type B DTCs.

Reference Information

Description and Operation

Engine Control Module Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit / System Verification

1. Ignition ON, observe the DTC information with a scan tool. DTC P0602 or P0606 should not set.

   If DTC P0602 failed this ignition, program the ECM. If the DTC resets, replace the ECM.

   If DTC P0606 failed this ignition, clear the DTCs with a scan tool and verify the DTC does not reset. If DTC resets, replace the ECM.
2. Observe the DTC information with a scan tool. DTC P0601, P0603, P0604, P062B, P167D, P2107, or P2610 should not set.

   If a DTC failed this ignition, replace the ECM.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for engine control module replacement, setup, and programming

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DTC P0627, P0628, or P0629

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0627: Fuel Pump Relay Control Circuit

DTC P0628: Fuel Pump Relay Control Circuit Low Voltage

DTC P0629: Fuel Pump Relay Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Battery Voltage - Relay Switch	1	2	--	--
Fuel Pump Supply Voltage	1	2	3	--
Fuel Pump Relay Control	P0628	P0627	P0629	--
Fuel Pump Ground	--	P0627	--	--
1. The fuel pump fuse opens and the engine cranks but does not run. 2. The engine cranks but does not run. 3. The fuel pump operates continuously and the battery will discharge.				

Circuit/System Description

The engine control module (ECM) provides ignition voltage to the coil side of the fuel pump relay whenever the engine is cranking or running. The ECM enables the fuel pump relay as long as the engine is cranking or running and ignition system reference pulses are received. If no ignition system reference pulses are received the ECM turns OFF the fuel pump. The fuel pump relay control circuit is equipped with a feedback circuit that is pulled up to voltage within the ECM. The ECM can determine if the control circuit is open, shorted to ground or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the DTC

- The engine speed is greater than 80 RPM.

- The ignition voltage is greater than 10-18 volts.
- The ECM has commanded the fuel pump relay ON and OFF at least once during the ignition cycle.
- The above conditions are met for greater than 1 second.
- The DTCs runs continuously once the above conditions are met.

Conditions for Setting the DTC

DTC P0627

The ECM detects the voltage on the fuel pump relay control circuit is within a predetermined range when the control circuit is commanded OFF. The condition exists for a cumulative of 50 seconds.

DTC P0628

The ECM detects the fuel pump relay control circuit voltage is less than 2.21 volts when the control circuit is commanded OFF. The condition exists for a cumulative of 50 seconds.

DTC P0629

The ECM detects the fuel pump relay control circuit voltage is greater than 2.74 volts when the control circuit is commanded ON. The condition exists for a cumulative of 50 seconds.

Action Taken When the DTC Sets

DTCs P0627, P0628 and P0629 are type B DTCs.

Conditions for Clearing the DTC

DTCs P0627, P0628 and P0629 are type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Ignition ON, command the Fuel Pump Relay ON and OFF with a scan tool. You should hear an audible click.
2. Operate the vehicle within the conditions for running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that are captured in the Freeze Frame/Failure Records Data List.

Circuit / System Testing

1. Ignition OFF, disconnect the fuel pump relay.
2. Test for less than 5 Ω between the ground circuit terminal 85 and ground.

   If greater than the specified range, repair the ground circuit for an open/high resistance.
3. Connect a test lamp between the control circuit terminal 86 and ground.
4. Ignition ON, command the fuel pump ON and OFF with a scan tool. The test lamp should turn ON and OFF as commanded.

   If the test lamp remains OFF all the time, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

   If the test lamp remains ON all the time, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
5. Test for 2-3 volts on the control circuit of the fuel pump relay.

   If the voltage is not within the specified range, replace the ECM.
6. If all circuits/connections test normal, test or replace the fuel pump relay.

Component Testing

1. Measure for 70-110 Ω between terminals 85 and 86 of the fuel pump relay.

   If the resistance is not within the specified range, replace the fuel pump relay.
2. Measure for infinite resistance between the following terminals of the fuel pump relay:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If continuity is detected, replace the fuel pump relay.
3. Connect a 15 A fused jumper wire from B+ to relay terminal 86. Connect a jumper wire from ground to relay terminal 85. Test for less than 2 Ω between terminal 30 and 87 of the relay.

   If greater than the specified range, replace the fuel pump relay.

Repair Instructions

Perform the Diagnostic Repair Verification .

- Relay Replacement
- Engine Control Module Replacement for engine control module replacement, setup, and programming

DTC P0638, P2100, P2101, or P2119

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P0638: Commanded versus Actual Throttle Position Correlation

DTC P2100: Throttle Control Motor Malfunction

DTC P2101: Throttle Control Position Range/Performance

DTC P2119: Closed Throttle Position Range/Performance

Circuit/System Description

The engine control module (ECM) controls the throttle valve by applying a varying voltage to the control circuits of the throttle actuator control (TAC) motor. The ECM monitors the duty cycle that is required to actuate the throttle valve. The ECM monitors the throttle position (TP) sensors 1 and 2 to determine the actual throttle valve position.

Conditions for Running the DTCs

P0638 and P2101

- The ignition is ON or the engine is operating.
- The ignition 1 voltage is greater than 7 volts.
- DTCs P0638 and P2101 run continuously once the above conditions are met for greater than 5 second.

P2100

- Before the ECM can report DTC P2100 failed, DTC P2101 must run and pass.
- The ignition is ON or the engine is operating.
- DTC P2100 runs continuously once the above conditions are met.

P2119

- DTC P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0700, P2122, P2123, P2127, P2128, or P2138 is not set.

- The ignition is ON.
- The vehicle speed is 0 km/h (0 mph).
- The engine speed is less than 40 RPM.
- The engine coolant temperature (ECT) is between 5-100°C (41-212°F).
- The intake air temperature (IAT) is 5-143°C (41-290°F).
- The ignition voltage is greater than 10 volts.
- The accelerator pedal position (APP) is less than 15 percent.
- DTC P2119 runs once per ignition cycle when the above conditions are met for less than 1 second.

Conditions for Setting the DTC

DTC P0638

- The ECM detects that the commanded duty cycle for the range test high is greater than 80 percent.

  OR
- The ECM detects that the commanded duty cycle for the range test low is greater than 80 percent.
- Either condition exists for greater than 1 second, or a cumulative of 10 seconds.

DTC P2100

- The ECM detects the output circuit for the TAC motor is open, shorted to ground, or shorted to a voltage.
- The condition exists fro greater than 1 second, or a cumulative of 10 seconds.

DTC P2101

- The ECM detects a 4-50 percent difference between the commanded and the actual throttle plate position, dependant upon the rate of commanded throttle movement.
- The condition exists fro greater than 1 second, or a cumulative of 10 seconds.

DTC P2119

- The ECM determines that the throttle valve did not return to the rest position within 1 second.
- The condition exists for greater than 1 second, or a cumulative of 10 seconds.

Action Taken When the DTC Sets

DTCs P0638, P2100, P2101 and P2119 are type A DTCs.

Conditions for Clearing the DTC

DTCs P0638, P2100, P2101 and P2119 are type A DTCs.

Diagnostic Aids

Inspect for a condition in which the throttle valve may have been held open. For example, dirt may have formed in the throttle bore causing the throttle valve not to close.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 34730-405 Injector Test Lamp

Circuit/System Verification

1. Ignition ON, observe the DTC information with a scan tool. Verify DTC P0121, P0122, P0123, P0221, P0222, or P0223 is not set.
   If a DTC is set, refer to DTC P0121, P0122, P0123, P0221, P0222, or P0223 for further diagnosis.
2. Observe the scan tool TP sensor voltage parameters. Verify that TP sensor 1 voltage is between 3.24-3.54 V, and TP sensor 2 voltage is between 1.36-1.86 V.
   If either TP sensor voltage is not within the specified range, refer to DTC P0121, P0122, P0123, P0221, P0222, or P0223 for further diagnosis.
3. Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release the pedal. Repeat the procedure several times. DTCs P0638, P2100,

P2101, or P2119 should not set.

If DTC P0121, P0122, P0123, P0221, P0222, or P0223 set while performing this procedure, refer to DTC P0121, P0122, P0123, P0221, P0222, or P0223 for further diagnosis.

4. Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat the procedure several times. DTC P0638, P2100, P2101, or P2119 should not set.

   If a DTC P0121, P0122, P0123, P0221, P0222, or P0223 set while performing this procedure, refer to DTC P0121, P0122, P0123, P0221, P0222, or P0223 for further diagnosis.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Inspect the throttle body for the following conditions:
   - A throttle blade that is not in the rest position.
   - A throttle valve that is binding open or closed.
   - A throttle valve that opens or closes without spring pressure.

   If a condition is found, replace the throttle body.

Note: Disconnecting the throttle body harness connector causes additional DTCs to set.

2. Ignition OFF, disconnect the harness connector of the throttle body.
3. Ignition ON, test for 4.0-4.2 V between the TAC motor control 1 circuit terminal B and ground.

   If voltage is less than the specified range, test the motor control 1 circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

   If voltage is greater than the specified range, test each of the motor control circuits for a short to voltage. If the circuits tests normal, replace the ECM.
4. Connect a test lamp between the TAC motor control 2 circuit terminal A and B+. The test lamp should NOT illuminate.

   If the test lamp illuminates, test the control circuit for a short to ground. If the circuit tests normal, replace the ECM.
5. Test for greater than 3.5 V between TAC motor control 1 circuit terminal B and TAC motor control 2 circuit terminal A.

   If the voltage is less than the specified value, test the motor control 2 circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
6. Ignition OFF, connect the *J 34730-405* Injector Test Lamp between the TAC motor control 1 circuit terminal B and TAC motor control 2 circuit terminal A of the throttle body harness connector. Observe the injector test lamp while turning the ignition ON for 5 seconds and then OFF. Verify the injector test lamp illuminates brightly and then turns OFF.

   If the injector test lamp does not illuminate, replace the ECM.
7. If all circuits test normal, replace the throttle body.

Repair Instructions

Perform the Diagnostic Repair Verification .

- Throttle Body Assembly Replacement
- Engine Control Module Replacement for engine control module replacement, setup, and programming

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Diagnostic Information and Procedures |
Document ID: 2101874

DTC P0641-P0643, P0651-P0653, or P0697-P0699 (ECM DTC)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0641: 5-Volt Reference 1 Circuit

DTC P0642: 5-Volt Reference 1 Circuit Low Voltage

DTC P0643: 5-Volt Reference 1 Circuit High Voltage

DTC P0651: 5-Volt Reference 2 Circuit

DTC P0652: 5-Volt Reference 2 Circuit Low Voltage

DTC P0653: 5-Volt Reference 2 Circuit High Voltage

DTC P0697: 5-Volt Reference 3 Circuit

DTC P0698: 5-Volt Reference 3 Circuit Low Voltage

DTC P0699: 5-Volt Reference 3 Circuit High Voltage

Circuit / System Description

The engine control module (ECM) has 3 5-volt reference circuits. The ECM provides the 5-volt reference to various sensors. Each reference circuit provides a 5-volt reference for greater than one sensor. An open, short to ground, or short voltage on one of the 5-volt reference circuits can affect all the components connected to that 5-volt reference circuit. The ECM monitors the voltage on the 5-volt reference circuits.

Conditions for Running the DTC

- The ignition is ON for greater than 2 seconds.
- DTCs P0641, P0642, P0643, P0651, P0652, P0653, P0697, P0698, and P0699 run continuously when the above condition is met.

Conditions for Setting the DTC

The 5-volt reference circuit voltage is above or below a predetermined threshold. The condition exists, then a 5 second delay for MIL ON.

Action Taken When the DTC Sets

DTCs P0641, P0642, P0643, P0651, P0652, P0653, P0697, P0698, and P0699 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0641, P0642, P0643, P0651, P0652, P0653, P0697, P0698, and P0699 are Type A DTCs.

Diagnostic Aids

- The 5-volt reference 1 circuit provides 5 volts to the following sensors:
  - Fuel tank pressure (FTP) sensor terminal C, if equipped
  - Engine oil pressure (EOP) sensor terminal B
- The 5-volt reference 2 circuit provides 5 volts to the following sensors:
  - All four camshaft position (CMP) sensors terminal 3
  - Accelerator pedal position (APP) sensor 1
- The 5-volt reference 3 circuit provides 5 volts to the following sensors:
  - Throttle position (TP) sensor 1 and 2 terminal E
  - Crankshaft position (CKP) sensor terminal 3
  - Accelerator pedal position (APP) sensor 2 terminal 1
  - A/C pressure sensor terminal 1
- If the condition is intermittent, move the related harnesses and connectors with the engine operating. Monitor the scan tool 5-volt Reference Circuit Test Status parameters for the affected components. The circuit test status parameter will change from OK or Not Run to Fault if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the DTC information with a scan tool. DTC P0641, P0642, P0643, P0651, P0652, P0653, P0697, P0698, or P0699 should not set.
2. Observe the appropriate scan tool 5-volt Reference Circuit Test Status parameter. The parameter should display OK or Not Run.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Note: Additional DTCs will set when disconnecting the components.

1. Ignition OFF, disconnect the harness connector of all appropriate sensors for the applicable DTC. Refer to Diagnostic Aids.
2. Ignition ON, test for 4.6-5.2 V between one of the affected 5-volt reference circuits and ground.

   If the voltage is less than the specified range, test for a short to ground or for an open between the ECM and the circuit splice. If the circuit test normal, replace the ECM.

   If the voltage is greater than the specified range, test for a short to voltage on the 5-volt reference circuit. If the circuit test normal, replace the ECM.

Note: A short to voltage on the signal circuit of certain components may cause this DTC to set.

3. Connect each component associated with the affected 5-volt reference circuit one at a time while monitoring the appropriate scan tool 5-Volt Reference Circuit Status parameter. The parameter should continue to display OK.

   If the parameter displays Fault when a component is connected, test the signal circuit of that component for a short to voltage. If the circuit tests normal, replace the component.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Engine Oil Pressure Sensor and/or Switch Replacement
- Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake
- Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust
- Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake
- Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust

- Accelerator Pedal Position Sensor Replacement
- Throttle Body Assembly Replacement
- Crankshaft Position Sensor Replacement
- Air Conditioning (A/C) Refrigerant Pressure Sensor Replacement
- Control Module References for ECM replacement, setup, and programming

DTC P0650 (with LLT)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0650: Malfunction Indicator Lamp (MIL) Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
MIL Voltage Supply	P0650	P0650	--	--
MIL Control	P0650*	P0650	P0650	--
* The MIL remains ON				

Circuit/System Description

The malfunction indicator lamp (MIL) is located on the instrument panel cluster (IPC). The MIL informs the driver that an emission system fault has occurred and that the engine control system requires service. The engine control module (ECM) monitors the MIL control circuit for conditions that are incorrect for the commanded state of the MIL. For example, a failure condition exists if the ECM detects low voltage when the MIL is commanded OFF, or high voltage when the MIL is commanded ON.

Conditions for Running the DTC

- The engine speed is greater than 80 RPM.
- The ignition voltage is between 10-18 volts.
- The ECM has commanded the MIL ON and OFF at least once during the ignition cycle.
- DTC P0650 runs continuously once the above conditions are met.

Conditions for Setting the DTC

The ECM detects an open, a short to ground, or a short to voltage on the circuit that controls the MIL.

Action Taken When the DTC Sets

DTC P0650 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0650 is a Type B DTC.

Diagnostic Aids

If the condition is intermittent, move the related harnesses and connectors with the engine operating. Monitor the scan tool Circuit Test Status parameters for the component. The Circuit Test Status parameter will change from OK or Not Run to Fault if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool MIL Circuit Test Status parameters. Each of the MIL circuit test status parameters should display OK or Not Run.
2. Ignition ON, command the MIL ON and OFF with a scan tool. The MIL should turn ON and OFF as commanded.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

1. If any other IPC indicators or gages are inoperative, refer to Instrument Cluster Gages Inoperative.
2. Ignition OFF, disconnect the ECM harness connectors. Ignition ON, the MIL should not illuminate.

   If the MIL is illuminated, test the MIL control circuit terminal 21-X2 for a short to ground. If the circuit tests normal, replace the IPC.
3. Ignition ON, connect a 3 A fused jumper wire between the MIL control circuit terminal 21-X2 and ground. The MIL should illuminate.

   If the MIL does not illuminate, test the MIL control circuit for a short to voltage, or an open/high resistance. If the circuit test normal, replace the IPC/bulb.
4. If all circuits/connections test normal, replace the ECM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Instrument Cluster Replacement
- Control Module References for engine control module replacement, setup, and programming

DTC P0650

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0650: Malfunction Indicator (MI) Circuit Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
MIL Voltage Supply	P0650	P0650	--	--
MIL Control	P0650*	P0650	P0650	--
* The MIL remains ON				

Circuit/System Description

The malfunction indicator lamp (MIL) is located on the instrument panel cluster (IPC). The MIL informs the driver that an emission system fault has occurred and that the engine control system requires service. The engine control module (ECM) monitors the MIL control circuit for conditions that are incorrect for the commanded state of the MIL. For example a failure condition exists if the ECM detects low voltage when the MIL is commanded OFF or high voltage when the MIL is commanded ON.

Conditions for Running the DTC

- The engine speed is greater than 80 RPM.
- The ignition 1 voltage is between 10-18 volts.
- The ECM has commanded the MIL ON and OFF at least once during the ignition cycle.
- DTC P0650 runs continuously once the above conditions are met.

Conditions for Setting the DTC

- The ECM detects an open/high resistance or a short to ground/voltage on the circuit that controls the MIL.
- The condition exists for at least 4 seconds.

Action Taken When the DTC Sets

DTC P0650 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0650 is a Type B DTC.

Diagnostic Aids

If the condition is intermittent, move the related harnesses and connectors with the engine operating. Monitor the scan tool Circuit Test Status parameters for the component. The Circuit Test Status parameter will change from OK or Not Run to Fault if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, command the MIL ON and OFF with a scan tool. The MIL should turn ON and OFF as commanded.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

1. If any other IPC indicators or gauges are inoperative, refer to Instrument Cluster Gages Inoperative.
2. Ignition OFF, disconnect the ECM harness connectors. Ignition ON, the MIL should not illuminate.

   If the MIL is illuminated, test the MIL control circuit for a short to ground. If the circuit tests normal, replace the IPC.
3. Ignition ON, connect a 3 A fused jumper wire between the MIL control circuit terminal 12 X2 and ground. The MIL should illuminate.

   If the MIL does not illuminate, test the MIL control circuit for a short to voltage, or an open/high resistance. If the circuit test normal, replace the IPC.
4. If all circuits/connections test normal, replace the ECM.

Repair Instructions

Perform the Diagnostic Repair Verification.

- Instrument Cluster Replacement
- Engine Control Module Replacement.

DTC P0660, P0661, or P0662

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0660: Intake Manifold Tuning (IMT) Valve Solenoid Control Circuit

DTC P0661: Intake Manifold Tuning (IMT) Solenoid Control Circuit Low Voltage

DTC P0662: Intake Manifold Tuning (IMT) Solenoid Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0661*	P0660	--	--
IMT Control Circuit	P0661	P0660	P0662	--
*Opens the fuse that supplies voltage to the IMT solenoid.				

Circuit/System Description

An intake manifold tuning (IMT) valve is used to change the intake manifold plenum configuration. When the IMT valve is open, the intake manifold is configured to one large plenum. When the IMT valve is closed, the intake manifold is configured to two smaller plenums. The IMT valve improves engine performance at low and high engine speeds.

Ignition voltage is supplied directly to the IMT solenoid. The engine control module (ECM) controls the solenoid by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the DTC

- The engine is operating.
- The IMT solenoid has been commanded ON and OFF at least once during the ignition cycle.
- The DTCs run continuously once the above condition is met.

Conditions for Setting the DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 4 seconds, or a cumulative of 30 seconds.

Action Taken When the DTC Sets

DTCs P0660, P0661, and P0662 are Type C DTCs.

Conditions for Clearing the DTC

DTCs P0660, P0661, and P0662 are Type C DTCs.

Diagnostic Aids

If the condition is intermittent, move the related harnesses and connectors with the engine operating. Monitor the scan tool Circuit Test Status parameters for the component. The Circuit Test Status parameter will change from OK or Not Run to Fault if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Air Intake System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On, command the IMT solenoid ON and OFF with a scan tool. You should hear and feel an audible click.
2. Observe the scan tool Circuit Test Status parameter for the IMT. The parameter should display OK or Not Run.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the IMT solenoid.
2. Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal 1 and ground.

   If the test lamp does not illuminate, test the circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition circuit and replace as necessary.
3. Ignition OFF, connect a test lamp between the control circuit terminal 2 and the ignition voltage circuit terminal 1.

   Note: The control circuit for the IMT solenoid is pulled-up to voltage within the ECM, 2.0-3.0 V on the control circuit is normal.
4. Ignition ON, command the IMT solenoid ON and OFF with a scan tool. The test lamp should turn ON and OFF.

   If the test lamp remains ON all the time, test for a short to ground on the control circuit. If circuit/connections test normal, replace the ECM.

   If the test lamp remains OFF all the time, test for a short to voltage or an open/high resistance on the control circuit. If circuit/connections test normal, replace the ECM.
5. Test for 2.0-3.0 V between the control circuit terminal 2 and ground.

   If the voltage is not within the specified range, replace the ECM.
6. If all circuits/connections test normal, replace the IMT solenoid.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Intake Manifold Runner Control Solenoid Replacement
- Control Module References for engine control module replacement, setup, and programming

DTC P0685, P0686, P0687, P0689, or P0690

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0685: Engine Control Ignition Relay Circuit Malfunction

DTC P0686: Engine Control Ignition Relay Circuit Low Voltage

DTC P0687: Engine Control Ignition Relay Circuit High Voltage

DTC P0689: Engine Control Ignition Relay Feedback Circuit Low Voltage

DTC P0690: Engine Control Ignition Relay Feedback Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
B+ Supply Voltage - Coil	P0685	P0685	P0685	--	--
B+ Supply Voltage - Switch	--	P0689	P0689	P0690	--
Relay Control Circuit	P0686	P0685	P0685	P0687	P0685
Ignition 1 Voltage Circuit	--	P0689	P0689	P0690	--

Circuit/System Description

The engine controls (EC) ignition relay or main relay is a normally open relay. The relay switch is held in the open position by spring tension. Battery positive voltage is supplied directly to the relay coil and the switch contact at all times. The engine control module (ECM) supplies voltage to the relay coil control circuit via an internal integrated circuit called an output driver. When the ECM commands the powertrain relay ON, ignition voltage is supplied to several fuses in the underhood fuse block.

The fuse that provides power to terminal 3, 5, or 6 of ECM connector X2 feeds the internal ECM circuits associated with the throttle actuator control (TAC) operation.

Conditions for Running the DTC

DTC P0685, P0686, and P0687

- The battery voltage is between 10-18 volts.
- The engine speed is greater than 80 RPM.
- The powertrain relay has been commanded ON and OFF.
- The DTCs run continuously once the above condition is met.

DTC P0689 and P0690

- The battery voltage is between 10-18 volts.
- The ignition is ON.
- The DTCs runs continuously once the above condition is met.

Conditions for Setting the DTC

P0685, P0686, and P0687

The commanded state of the driver and the actual state of the control circuit do not match for greater than 4 seconds or for a cumulative of 30 seconds.

P0689 and P0690

The ECM detects that powertrain relay feedback voltage is less than 6 volts for greater than 1 second, when the powertrain relay is commanded ON or OFF. The condition exists for 4 seconds, or for a cumulative of 30 seconds.

Action Taken When the DTC Sets

DTCs P0685, P0686, P0687, P0689, and P0690 are Type C DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0685, P0686, P0687, P0689, and P0690 are Type C DTCs.

Diagnostic Aids

- This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to Battery Inspection/Test.
- An open in the relay control circuit will cause no communication with the ECM when the ignition switch is cycled OFF and then ON after the initial failure. The malfunction indicator lamp (MIL) will flash rapidly and other relays can be heard turning on and off with the ignition ON.
- When disconnecting electrical connectors or removing fuses and relays from a fuse block, always inspect the component electrical terminals for corrosion and the mating electrical terminals for tightness.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Air Intake System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, you should be able to communicate with the ECM using a scan tool.
2. Ignition ON, view the DTC information with a scan tool. DTC P0685, P0686, P0687, P0689, or P0690 should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the powertrain relay.

   Note: The test lamp is used to load the circuit and may not illuminate.

2. Connect a test lamp between the B+ supply circuit to the coil side of the powertrain relay and the negative terminal of the battery.
3. Ignition ON, test for less than 0.1 V between the B+ voltage circuit of the powertrain relay and the positive battery terminal.

   If greater than the specified value, repair the B+ voltage circuit to the coil side of the powertrain relay for a short to ground or an open/high resistance.

Note: The test lamp is used to load the circuit and may not illuminate.

4. Connect a test lamp between the B+ voltage supply circuit to the switch side of the powertrain relay and the negative terminal of the battery.
5. Ignition ON, test for less than 0.1 V between the B+ voltage circuit of the powertrain relay and the positive battery terminal.

   If greater than the specified value, repair the B+ voltage circuit to the switch side of the powertrain relay for a short to ground or an open/high resistance.
6. Ignition OFF, connect a test lamp between the control circuit of the powertrain relay and the B+ voltage supply circuit to the coil side of the powertrain relay.
7. Ignition ON. the test lamp should turn ON when the ignition switch is cycled ON and OFF when the ignition switch is cycled OFF.

   If the test lamp remains ON all the time, test for a short to ground on the control circuit. If the circuit/connections test normal, replace the ECM.

   If the test lamp remains OFF all the time, test for a short to voltage or an open/high resistance on the control circuit. If circuit/connections test normal, replace the ECM.
8. Connect a 15 A fused jumper wire between the B+ supply voltage circuit and the ignition voltage circuit of the powertrain relay.
9. Attempt to start the engine. The engine should start.

   If the engine does not start, test the ignition voltage circuit between the powertrain relay and the ECM for a short to ground or for an open/high resistance. If the circuit/connections test normal, replace the ECM.
10. If all circuits/connections test normal, test or replace the powertrain relay.

Component Testing

1. Measure for 200-250 Ω of resistance between terminals 85 and 86 of the main relay.

   If the resistance is not within the specified range, replace the main relay.
2. Measure for infinite resistance between the following terminals of the main relay:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If continuity is detected, replace the main relay.
3. Connect a 20 A fused wire from the positive terminal of the battery to relay terminal 85. Connect a jumper wire from the negative terminal of the battery to relay terminal 86. Measure for less than 2 Ω between terminals 30 and 87 of the relay.

   If the resistance measures greater than 2 Ω, replace the main relay.

Repair Instructions

Perform the Diagnostic Repair Verification.

- Relay Replacement.
- Engine Control Module Replacement for engine control module replacement, setup, and programming

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DTC P0700

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0700: Transmission Control Module (TCM) Requested MIL Illumination

Circuit/System Description

This diagnostic trouble code (DTC) indicates that an emission related transmission DTC set in the transmission control module (TCM). The engine control module (ECM) receives the TCM information over the serial data circuit. The ECM turns ON the malfunction indicator lamp (MIL) when the TCM sends a message over the serial data circuit requesting MIL illumination. The DTC information for the ECM will only display DTC P0700, but the freeze frame/failure records data will display the transmission DTC that set.

Conditions for Running the DTC

- The ignition is ON or the engine is operating.
- DTC P0700 runs continuously.

Conditions for Setting the DTC

The ECM receives a serial data message from the TCM, in order to illuminate the MIL. The condition exists, then a 5 second delay for MIL ON.

Action Taken When the DTC Sets

DTC P0700 is a type A DTC.

Conditions for Clearing the DTC

DTC P0700 is a type A DTC.

Circuit/System Verification

Note: Correct any Engine Controls DTCs before diagnosing TCM DTCs.

1. DTC P0700 is an informational DTC. If there are no Engine Controls DTCs, refer to

Powertrain Diagnostic Trouble Code (DTC) Type Definitions for diagnosis of TCM DTCs.

2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

DTC P0704

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0704: Clutch Switch Circuit

Circuit/System Description

The engine control module (ECM) supplies a 5 volts to the Clutch Switch Circuit. This circuit ensures the engine can only be started when the clutch pedal is fully depressed. When the pedal is full depressed the circuit is earthed through the switch circuit.

Conditions for Running the DTC

- The engine is running.
- The system voltage is between 9-18 volts.

Conditions for Setting the DTC

The ECM detects that 15 gear changes have been performed with less than 3 clutch pedal switch inputs.

Action Taken when the DTC Sets

DTC P0704 is a type C DTC.

Conditions for Clearing the MIL/DTC

DTC P0704 is a type C DTC.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, While observing the scan tool depress and release the clutch pedal, the scan tool display display should toggle between Inactive to Active when the pedal is depressed.

Circuit/System Testing

1. Ignition OFF, disconnect the Clutch pedal switch at the switch.
2. Ignition ON, verify that a test lamp illuminate between the signal terminal and a known ground.

   If the test lamp does not illuminates, test the signal circuit for a short to ground or an open/high resistance. If circuit tests normal replace the ECM.
3. Connect a 10A fusible link wire between the signal circuit and the earth terminal at the wiring harness connection.

   observe the scan tool active should be displayed.

   If the display still reads inactive, test the earth circuit for a short to ground or an open/high resistance.
4. If all circuits test normal replace the clutch switch.

Repair Instructions

Replace the clutch switch refer to Clutch Pedal Position Switch Replacement

Perform the Diagnostic Repair Verification.

Repair Verification

Ignition ON, While observing the scan tool depress and release the clutch pedal, the scan tool display display should toggle between Inactive to Active when the pedal is depressed.

DTC P1011-P1014

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P1011: Intake Camshaft Actuator Park Position Bank 1

DTC P1012: Exhaust Camshaft Actuator Park Position Bank 1

DTC P1013: Intake Camshaft Actuator Park Position Bank 2

DTC P1014: Exhaust Camshaft Actuator Park Position Bank 2

Circuit / System Description

The camshaft position (CMP) actuator system enables the engine control module (ECM) to change the camshaft timing of all 4 camshafts while the engine is operating. The CMP actuator assembly varies the camshaft position in response to directional changes in oil pressure. The CMP actuator solenoid controls the oil pressure that is applied to advance or retard a camshaft.

The CMP actuator assemblies have an outer housing that is driven by the engine timing chain. Inside the CMP assembly is a wheel with fixed vanes that is attached to the camshafts. The CMP actuator assemblies are also equipped with a locking pin. The locking pin prevents movement between the outer housing and the wheel vane assembly on engine start-ups. The CMP actuator is locked until sufficient oil pressure is available to control the CMP actuator. The locking pin is released by oil pressure before any movement in the CMP actuator assembly takes place.

Conditions for Running the DTC

- DTCs P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094 and P2095 are not set.
- The engine is operating for greater than 1 second.
- The ECM completed the CMP actuator solenoid output driver test.
- The engine speed is greater than 560 RPM.
- DTCs P1011, P1012, P1013 and P1014 only run on an engine start-up.

Conditions for Setting the DTC

- The ECM detects that the average of the actual camshaft angle measurements is greater than 10 degrees of the parked position angle on an engine start-up.

- The condition exists for greater than 4 seconds, or a cumulative of 50 seconds.

Action Taken When the DTC Sets

DTCs P1011, P1012, P1013 and P1014 are type C DTCs.

Conditions for Clearing the DTC

DTCs P1011, P1012, P1013 and P1014 are type C DTCs.

Diagnostic Aids

- Inform the customer that the following actions may cause DTCs P1011, P1012, P1013, or P1014 to set:
  - Turning the engine OFF while the accelerator pedal is pressed
  - Turning the engine OFF while driving
  - Pressing the accelerator pedal to start the engine
- If the customers concern is that the engine is stalling, refer to Symptoms - Engine Controls for further diagnosis.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Air Intake System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, clear the DTC information with a scan tool.

   Note: The engine oil level and the oil pressure are critical to the correct operation of the camshaft position (CMP) actuator system. Verify that the engine has the correct oil level and the correct oil pressure before continuing with this diagnostic. Refer to Fluid and Lubricant Recommendations and Oil Pressure Diagnosis and Testing.

2. Start the engine. Verify there is no abnormal engine noise during start up. Observe the DTC information with a scan tool. DTC P1011, P1012, P1013, or P1014 should not set.

   If there is an abnormal engine noise, or a DTC set, replace the appropriate CMP actuator.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Repair Instructions

Perform the Diagnostic Repair Verification.

- Camshaft Position Actuator Replacement - Bank 1 (Right Side) Intake
- Camshaft Position Actuator Replacement - Bank 1 (Right Side) Exhaust
- Camshaft Position Actuator Replacement - Bank 2 (Left Side) Intake
- Camshaft Position Actuator Replacement - Bank 2 (Left Side) Exhaust

DTC P1380

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P1380: Misfire Detected - Rough Road Data Not Available

Circuit/System Description

Correct engine misfire detection is dependent on whether or not the vehicle is experiencing a rough road condition. A rough road condition causes unexpected crankshaft fluctuations. In order to detect a rough road condition, the electronic brake control module (EBCM) communicates a wheel speed signal over the serial data circuit to the engine control module (ECM). The wheel speed sensor information allows the ECM to distinguish if the crankshaft speed variations are caused by a rough road condition or are caused by a true misfire.

Conditions for Running the DTC

- The engine is operating.
- DTC P1380 runs continuously once the above conditions are met for greater than 5 seconds.

Conditions for Setting the DTC

- The ECM detects an engine misfire while the rough road signal is unavailable.
- The condition exists for greater than 4 seconds or a cumulative of 30 seconds.

Action Taken When the DTC Sets

DTC P1380 is a Type C DTCs.

Conditions for Clearing the DTC

DTC P1380 is a Type C DTCs.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Start and idle the engine, observe the DTC information with a scan tool. DTC P1380 should not set.

   Note: If any UXXXX DTCs are set, diagnose those first.

   If DTC P1380 failed this ignition, refer to Symptoms - Antilock Brake System.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

DTC P1551

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P1551: Throttle Control Lower Position not Reached during Learning Mode

Circuit/System Description

The engine control module (ECM) controls the throttle valve by applying a varying voltage to the control circuits of the throttle actuator control (TAC) motor. The ECM monitors the duty cycle that is required to actuate the throttle valve. The ECM monitors the throttle position (TP) sensors 1 and 2 to determine the actual throttle valve position.

Conditions for Running the DTC

- The vehicle speed is 0 km/h (0 mph).
- The engine speed is less than 40 RPM.
- The engine coolant temperature (ECT) is between 5-100°C (41-212°F).
- The intake air temperature (IAT) is between 5-143°C (41-290°F).
- The ignition voltage is greater than 8 volts.
- The accelerator pedal position (APP) is less than 15 percent.
- DTC P1551 runs when the conditions above have been met for greater than 4 seconds.

Conditions for Setting the DTC

- The ECM detects the TP sensor angle is less than 11 percent or greater than 39 percent when the throttle actuator control motor is deactivated.
- The condition exists for greater than 1 second or for a cumulative of 10 seconds.

Action Taken When the DTC Sets

DTC P1551 is a type A DTC.

Conditions for Clearing the DTC

DTC P1551 is a type A DTC.

Diagnostic Aids

- The scan tool has the ability to operate the throttle actuator control system using Special Functions. This function operates the throttle through the entire range in order to determine if the throttle body and system operate correctly.
- Inspect for a condition in which the throttle valve may have been held open.
- Inspect for conditions in which ice may have formed in the throttle bore.
- The throttle valve is spring loaded to a slightly open position. This is referred to as the rest position. The throttle valve should not be completely closed, nor should it be open any greater than predetermined amount. The throttle valve should move open and to the closed position without binding under the normal spring pressure. The throttle should NOT be free to move open or closed WITHOUT spring pressure.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the DTC information with a scan tool. Verify that DTCs P0121, P0122, P0123, P0221, P0222, P0223, P2100, P2101 or P2119 are not set.

   If a DTC is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.

2. Start the engine. Observe the DTC information with a scan tool for 30 seconds. DTC P1551 should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Ignition OFF, disconnect the air intake duct at the throttle body and inspect for the following:

- Throttle valve that is NOT in the rest position.
- Throttle valve that is binding open or closed.
- Throttle valve that is free to move open or closed WITHOUT spring pressure.

If a condition is found, replace the throttle body assembly.

Repair Instructions

Perform the Diagnostic Repair Verification.

Throttle Body Assembly Replacement.

DTC P2072

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P2072: Throttle Actuator Control System - Ice Blockage

Circuit/System Description

The engine control module (ECM) controls the throttle valve by applying a varying voltage to the control circuits of the throttle actuator control (TAC) motor. The ECM monitors the duty cycle that is required to actuate the throttle valve. The ECM monitors the throttle position (TP) sensors 1 and 2 to determine the actual throttle valve position. The ECM performs diagnostics that monitor the voltage levels of both APP sensors, both TP sensors, and the throttle actuator control motor circuit. It also monitors the spring return rate of both return springs that are housed internal to the throttle body assembly. These diagnostics are performed at different times based on whether the engine is running, not running, or whether the ECM is currently in a throttle body relearn procedure. Every ignition cycle the ECM performs a quick throttle return spring test to make sure the throttle plate can return to the 7 percent rest position from the 0 percent position. This is to make sure that the throttle plate can be brought to the rest position in case of an actuator motor circuit failure

Conditions for Running the DTC

- The ignition is ON.
- The speed is less than 40 km/h (25 mph).
- The air intake temperature is greater than 40°C (104°F).

Conditions for Setting the DTC

The actual engine speed is greater than the desired engine speed by at least 200 rpm for longer than 10 seconds or the ECM detects 3 fuel cut off's due to engine over speed while the engine is idling

Action Taken When the DTC Sets

DTC P2072 is a type A DTC.

Conditions for Clearing the DTC

DTC P2072 is a type A DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Start the engine, rapidly move the accelerator pedal from the rest position, to wide open throttle position then back to the rest position. Repeat the procedure a four times. DTC P2072 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Disconnect the harness connector of the ECM. Ignition ON, load test for battery voltage on the ignition circuits at the ECM.

   If less than B+, repair the ignition circuit for an open/high resistance.
2. If all circuits/connections test OK, replace the ECM.

Repair Instructions

Perform the Diagnostic Repair Verification.

Engine Control Module Replacement for engine control module replacement, setup, and programming

DTC P2096 or P2098 (with LLT)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P2096: Post Catalyst Fuel Trim System Low Limit Bank 1

DTC P2098: Post Catalyst Fuel Trim System Low Limit Bank 2

Circuit Description

Fuel trim bias is used to keep the post catalyst air/fuel ratio within a predetermined range. This allows optimal catalyst efficiency under light load conditions at a steady cruise. The engine control module (ECM) constantly monitors how lean or rich the fuel trim bias is commanded, to determine if the fuel trim bias is greater than a calibrated amount.

Conditions for Running the DTC

- Before the ECM can report DTC P2096 or P2098 failed, DTCs P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0056, P0057, P0058, P013A, P013C, P013E, P0130, P0131, P0132, P0133, P0135, P0137, P0138, P014A, P0140, P0141, P0150, P0151, P0152, P0153, P0155, P0157, P0158, P0160, P0161, P2232, P2235, P2270, P2271, P2272, and P2273 must run and pass.
- DTC P0100, P0101, P0102, P0103, P0420, P0430, P0442, P0443, P0455, P0458, P0459, P2177, P2178, P2179, P2180, P2187, P2188, P2189 or P2190 is not set.
- The engine speed is 1,280-3,480 RPM.
- The engine load is 17-65 percent and steady.
- The closed loop fuel control is active for greater than 1 second.
- The calculated exhaust gas temperature is greater than 250°C (482°F).
- DTCs P2096 and P2098 run continuously when the conditions above have been met for greater than 130 seconds.

Conditions for Setting the DTC

The lean correction limit for a condition causing a rich air/fuel ratio has been exceeded for greater than 4 seconds or for a cumulative of 30 seconds.

Action Taken when the DTC Sets

DTCs P2096 and P2098 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2096 and P2098 are Type B DTCs.

Diagnostic Aids

An HO2S will not cause this DTC to set without the occurrence of circuit related HO2S DTCs. Do not replace an HO2S to address this DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool DTC information. Verify there is no other HO2S or fuel trim DTC set.

   If any other HO2S or fuel trim DTC is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. Verify that none of the following conditions exist:
   - Rich fuel injectors--Refer to Fuel Injector Solenoid Coil Test.
   - High fuel system pressure--Refer to Fuel System Diagnosis.
   - Fuel that is contaminated--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
   - Fuel saturation of the evaporative emissions (EVAP) canister
   - Stuck open or leaking EVAP purge valve
   - Restricted exhaust

- Incorrect PCV system operation

  If you find any of the above conditions, repair as necessary.

Warning: Refer to Road Test Warning in the Preface section.

Note: A road load condition is necessary to obtain closed loop.

3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

DTC P2096 or P2098

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P2096: Post Catalyst O2 Sensor Fuel Trim Below Lower Limit Bank 1

DTC P2098: Post Catalyst O2 Sensor Fuel Trim Below Lower Limit Bank 2

Circuit Description

Fuel trim bias is used by the ECM to keep the post catalyst HO2S voltage within a range of 580-665 mV. This allows optimal catalyst efficiency under light load conditions, such as at idle or a steady cruise. The ECM constantly monitors how lean or rich the fuel trim bias is commanded, to determine if the fuel trim bias is greater than a calibrated amount.

Conditions for Running the DTC

- Before the ECM can report DTC P2096, DTCs P0030, P0031, P0032, P0130, P0131, P0132, P0133, P0135, P0137, P0138, P0140, P0141, P2232, P2235, P2270, P2271, P2272, and P2273 must run and pass.
- DTC P0100, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0420,P0443, P0458, or P0459 is not set.
- The engine speed is 1,080-3,480 RPM.
- The engine load is 17-20 percent and steady.
- The closed loop fuel control is active for greater than 1 seconds.
- The front and rear HO2S are in Closed Loop.
- The calculated exhaust gas temperature is greater than 250°C (482°F).
- DTCs P2096 run continuously when the conditions above have been met for greater than 200 seconds.

Conditions for Setting the DTC

The lean correction limit for a condition causing a rich air/fuel mixture has been exceeded for a predetermined amount of time. The condition exists for greater than 4 seconds or for a cumulative of 30 seconds.

Action Taken when the DTC Sets

DTCs P2096 and P2098 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2096 and P2098 areType B DTCs.

Diagnostic Aids

A failed HO2S will not cause this DTC to set without the occurrence of circuit related HO2S DTCs. Do not replace an HO2S to address this DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool DTC information. Verify there is no other HO2S or fuel trim DTC set.

   If any other HO2S or fuel trim DTC is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. Verify that none of the following conditions exist:
   - Rich fuel injectors--Refer to Fuel Injector Solenoid Coil Test.
   - High fuel system pressure--Refer to Fuel System Diagnosis.
   - Fuel that is contaminated--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
   - Fuel saturation of the evaporative emissions (EVAP) canister

- Stuck open or leaking EVAP purge valve
- Restricted exhaust
- Incorrect PCV system operation

  If you find any of the above conditions, repair as necessary.

Note: The rear heated oxygen sensor (HO2S) must be in closed loop for this diagnostic to run. A road load condition is necessary to obtain closed loop.

3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Repair Instructions

Perform the Diagnostic Repair Verification.

DTC P2097 or P2099 (with LLT)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P2097: Post Catalyst Fuel Trim System High Limit Bank 1

DTC P2099: Post Catalyst Fuel Trim System High Limit Bank 2

Circuit Description

Fuel trim bias is used to keep the post catalyst air/fuel ratio within a predetermined range. This allows optimal catalyst efficiency under light load conditions at a steady cruise. The engine control module (ECM) constantly monitors how lean or rich the fuel trim bias is commanded, to determine if the fuel trim bias is greater than a calibrated amount.

Conditions for Running the DTC

- Before the ECM can report DTC P2097 or P2099 failed, DTCs P0030, P0031, P0032, P0050, P0051, P0052, P0130, P0131, P0132, P0133, P0135, P0137, P0138, P013A, P013C, P013E, P014A, P0140, P0141, P0150, P0151, P0152, P0153, P0155, P0157, P0158, P0160, P0161, P2232, P2235, P2270, P2271, P2272, and P2273 must run and pass.
- DTC P0100, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0420, P0430, P0442, P0443, P0455, P0458, or P0459 is not set.
- The engine speed is 1,280-3,480 RPM.
- The engine load is 17-65 percent and steady.
- The closed loop fuel control is active for greater than 1 second.
- The calculated exhaust gas temperature is greater than 250°C (482°F).
- DTCs P2097 and P2099 run continuously when the conditions above have been met for greater than 130 seconds.

Conditions for Setting the DTC

The rich correction limit for a condition causing a lean air/fuel ratio has been exceeded for greater than 4 seconds or for a cumulative of 30 seconds.

Action Taken when the DTC Sets

DTCs P2097 and P2099 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2097 and P2099 are Type B DTCs.

Diagnostic Aids

- An HO2S will not cause this DTC to set without the occurrence of circuit related HO2S DTCs. Do not replace an HO2S to address this DTC.
- An exhaust system leak that may not be audible can set this DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool DTC information. Verify there is no other HO2S or fuel trim DTC set.

   If any other HO2S or fuel trim DTC is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. Verify that none of the following conditions exist:
   - Exhaust system leaks--Refer to Exhaust Leakage
   - Engine vacuum leaks
   - Low fuel system pressure--Refer to Fuel System Diagnosis.
   - Fuel that is contaminated--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.

- Lean fuel injectors--Refer to Fuel Injector Solenoid Coil Test.

  If you find any of the above conditions, repair as necessary.

Warning: Refer to Road Test Warning in the Preface section.

Note: A road load condition is necessary to obtain closed loop.

3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

DTC P2097 or P2099

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P2097: Post Catalyst O2 Sensor Fuel Trim Above Upper Limit Bank 1

DTC P2099: Post Catalyst O2 Sensor Fuel Trim Above Upper Limit Bank 2

Circuit Description

Fuel trim bias is used by the ECM to keep the post catalyst HO2S voltage within a range of 580-665 mV. This allows optimal catalyst efficiency under light load conditions, such as at idle or a steady cruise. The ECM constantly monitors how lean or rich the fuel trim bias is commanded, to determine if the fuel trim bias is greater than a calibrated amount.

Conditions for Running the DTC

- Before the ECM can report DTC P2097 failed, DTCs P0030, P0031, P0032,P0130, P0131, P0132, P0133, P0135, P0137, P0138, P2232, P2235, P2270, P2271, P2272, and P2273 must run and pass.
- DTC P0100, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0420, P0443, P0458, or P0459 is not set.
- The engine speed is 1,080-3,480 RPM.
- The engine load is 17-20 percent and steady.
- The closed loop fuel control is active for greater than 1 seconds.
- The front and rear HO2S are in Closed Loop.
- The calculated exhaust gas temperature is greater than 250°C (482°F).
- DTCs P2097 and P2099 run continuously when the conditions above have been met for greater than 200 seconds.

Conditions for Setting the DTC

The rich correction limit for a condition causing a lean air/fuel mixture has been exceeded for a predetermined amount of time. The condition exists for greater than 4 seconds or for a cumulative of 30 seconds.

Action Taken when the DTC Sets

DTC P2097 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P2097 is a Type B DTC.

Diagnostic Aids

- A failed HO2S will not cause this DTC to set without the occurrence of circuit related HO2S DTCs. Do not replace an HO2S to address this DTC.
- An exhaust system leak that may not be audible can set this DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool DTC information. Verify there is no other HO2S or fuel trim DTC set.

   If any other HO2S or fuel trim DTC is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. Verify that none of the following conditions exist:
   - Exhaust leaks near the HO2S Exhaust Leakage
   - Engine vacuum leaks
   - Low fuel system pressure--Refer to Fuel System Diagnosis.

- Fuel that is contaminated--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
- Lean fuel injectors--Refer to Fuel Injector Solenoid Coil Test.

  If you find any of the above conditions, repair as necessary.

Note: The rear heated oxygen sensor (HO2S) must be in closed loop for this diagnostic to run. A road load condition is necessary to obtain closed loop.

3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Repair Instructions

Perform the Diagnostic Repair Verification.

DTC P2105

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P2105: Throttle Control Forced Engine Shutdown

Circuit/System Description

The engine control module (ECM) controls the throttle valve by applying a varying voltage to the control circuits of the throttle actuator control (TAC) motor. The ECM monitors the duty cycle that is required to actuate the throttle valve. The ECM monitors the throttle position (TP) sensors 1 and 2 to determine the actual throttle valve position.

Conditions for Running the DTC

- The ECM power down process in the last drive cycle was completely finished.
- DTC P2105 runs continuously once the above condition is met.

Conditions for Setting the DTC

- The ECM detects an incorrect voltage level at the ignition voltage supply circuits.

  OR
- The ECM detects an internal communication error.
- Either condition exists for greater than 1 second, or an a cumulative of 10 seconds.

Action Taken When the DTC Sets

DTC P2105 is a Type A DTC.

Conditions for Clearing the DTC

DTC P2105 is a Type A DTC.

Diagnostic Aids

- If DTC P2105 sets, the engine will stall and not restart until the ignition is cycled OFF and then ON.

- Additional DTCs set when P2105 sets.
- The ignition key will not be able to be removed from the ignition switch until another ignition cycle occurs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Start the engine. Rapidly move the accelerator pedal from the rest position, to wide open throttle position, back to the rest position. Repeat the procedure a few times. DTC P2105 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, remove the fuse that supplies voltage to terminal 5 X2 of the ECM. Verify the fuse is OK.

   Note: This DTC will only set if the fuse is open and the circuits are not grounded. The ignition voltage circuits must be tested thoroughly for an intermittent short to ground.

  If the fuse is open, test the ignition voltage circuit between the open fuse and the ECM for an intermittent short to ground.

2. Install the fuse.
3. Disconnect the harness connector of the ECM.
4. Ignition ON, load test for B+ on the ignition circuit terminal 5 X2 at the ECM.

   If less than B+, repair the ignition circuit for an open/high resistance.

5. If all circuits/connections test OK, replace the ECM.

Repair Instructions

Perform the Diagnostic Repair Verification.

Engine Control Module Replacement for engine control module replacement, setup, and programming

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Diagnostic Information and Procedures |
Document ID: 1986437

DTC P2122, P2123, P2127, P2128, or P2138

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P2122: Accelerator Pedal Position Sensor 1 Voltage Low

DTC P2123: Accelerator Pedal Position Sensor 1 Voltage High

DTC P2127: Accelerator Pedal Position Sensor 2 Voltage Low

DTC P2128: Accelerator Pedal Position Sensor 2 Voltage High

DTC P2138: Accelerator Pedal Position Sensor 1-2 Correlation

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Accelerator Pedal Position (APP) Sensor 1 5-Volt Reference Circuit	P0343, P0348, P0368, P0393, P0652, P2122	P2122, P2138	P0651, P2122	P0653, P2138, P2123	P0651, P0652, P0653, P2138
Accelerator Pedal Position (APP) Sensor 2 5-Volt Reference Circuit	P0122, P0222, P0335, P0642, P0698, P0700	P2127, P2138	P0697, P2127	P0123, P0221, P0699, P2138, P2128, P0700	P0697, P0698, P0699, P2138
Accelerator Pedal Position (APP) Sensor 1 Signal	P2122	P2138	P2122	P2123	P2138
Accelerator Pedal Position (APP) Sensor 2 Signal	P2127	P2138	P2127	P2128	P2138
Accelerator Pedal Position (APP) Sensor 1 Low Reference	--	P2123, P2138	P2123	--	P2138
Accelerator Pedal Position (APP) Sensor 2 Low Reference	--	P2127, P2138	P2128	--	P2138

Typical Scan Tool Data

APP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating at idle. *Parameter Normal Range:* APP Sensor 1 0%/1 Volts *Parameter Normal Range:* APP Sensor 2 0%/0.5 Volts			
5-Volt Reference	0%/0.00 Volts	0%/0.00 Volts	0%/4.98 Volts
APP Sensor 1 Signal	0%/0.00 Volts	0%/0.00 Volts	0%/4.98 Volts
APP Sensor 2 Signal	0%/0.00 Volts	0%/0.00 Volts	0%/4.98 Volts
APP Sensor 1 Low Reference	--	0%/4.98 Volts	--
APP Sensor 2 Low Reference	--	0%/4.98 Volts	--

Circuit/System Description

The accelerator pedal assembly contains two accelerator pedal position (APP) sensors. The APP sensors are mounted in the pedal assembly and are not serviceable. The APP sensors provide a signal voltage that changes relative to the position of the accelerator pedal. The engine control module (ECM) supplies a separate 5-volt reference and low reference circuit for each of the APP sensors.

The APP sensor 1 signal voltage increases as the pedal is depressed, from approximately 1.0 volt at rest to approximately 4 volts when fully depressed. The APP sensor 2 signal voltage increases as the pedal is depressed, from approximately 0.5 volt at rest to approximately 2 volts with the accelerator pedal fully depressed.

Conditions for Running the DTCs

- The ignition is ON or the engine is operating.
- The ignition voltage is greater than 7 volts.
- The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P2122

The APP sensor 1 voltage is less than 0.74 volts for greater than 1 second, or a cumulative of 10 seconds.

P2123

The APP sensor 1 voltage is greater than 4.82 volts for greater than 1 second, or a cumulative of 10 seconds.

P2127

The APP sensor 2 voltage is less than 0.63 volts for greater than 1 second, or a cumulative of 10 seconds.

P2128

The APP sensor 2 voltage is greater than 4.82 volts for greater than 1 second, or a cumulative of 10 seconds.

P2138

- The ECM detects that the voltage difference between APP sensor 1 and the calculated idle range is greater than 0.25 volts, with a released pedal.
- The ECM detects that the voltage difference between APP sensor 2 and the calculated idle range is greater than 0.31 volts, with a released pedal.
- The ECM detects that the voltage difference between APP sensor 1 and 2 is greater than 0.31 volts with a partially pressed pedal.
- The ECM detects that the voltage difference between APP sensor 1 and 2 is greater than 1.70 volts with a fully pressed pedal.
- The ECM detects that the voltage difference between APP sensor 1 and 2 is greater than 0.04 volts when AAP sensor 1 is greater than 1.17 volts.
- Any of the above conditions exist for greater than 1 second, or a cumulative of 10 seconds.

Action Taken When the DTC Sets

DTCs P2122, P2123, P2127, P2128, and P2138 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P2122, P2123, P2127, P2128, and P2138 are Type A DTCs.

Diagnostic Aids

Test the current output of the 5-volt reference circuits if you suspect high resistance in the circuit. The current output should be greater than 80 mA for APP 1 and greater than 50 mA for APP 2.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the DTC information with a scan tool. DTC P0651, P0652, P0653, P0697, P0698, or P0699 should not be set.

   If a DTC is set, refer to DTC P0641-P0643, P0651-P0653, or P0697-P0699.
2. Observe the scan tool APP Sensor voltage parameters. Verify both of the APP sensor voltages are between 0.4-4.5 V.
3. Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release pedal. Repeat the procedure several times. DTCs P2122, P2123, P2127, P2128, or P2138 should not set.
4. Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat the procedure several times. DTCs P2122, P2123, P2127, P2128, or P2138 should not set.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, remove the fuse that supplies B+ to terminal 56 X2 of the ECM.
2. Disconnect the harness connector at the accelerator pedal assembly.
3. Test for less than 5 Ω between the appropriate low reference circuit listed below and ground.
   - APP sensor 1 terminal 4
   - APP sensor 2 terminal 5

   If greater than the specified range, test the low reference circuit for a short to voltage, or an open/high resistance. If the circuit/connections test normal, replace the ECM.
4. Install the fuse that supplies B+ to terminal 56 X2 of the ECM.

   Note: The 5-volt reference circuit voltage can be within the specified range with a high resistance in the circuit. If this condition is suspected, refer to Diagnostic Aids.
5. Ignition ON, test for 4.8-5.2 V between the appropriate 5-volt reference circuit listed below and ground.
   - APP sensor 1 terminal 2

- APP sensor 2 terminal 1

  If less than the specified range, test the 5-volt reference circuit for a short to ground or open/high resistance. If the circuit/connections test normal, replace the ECM.

  If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit/connections test normal, replace the ECM.

6. Observe the scan tool APP sensor 1 voltage parameter. Verify the voltage is less than 0.3 V.

   If greater than the specified range, test the signal circuit terminal 3 for a short to voltage. If the circuit/connections test normal, replace the ECM.

7. Observe the scan tool APP sensor 2 voltage parameter. Verify the voltage is less than 0.3 V.

   If greater than the specified range, test the signal circuit terminal 6 for a short to voltage. If the circuit/connections test normal, replace the ECM.

8. Connect a 3 A fused jumper wire between the APP sensor 1 signal circuit terminal 3 and the 5-volt reference circuit terminal 2. Verify the APP sensor 1 voltage parameter is greater than 4.8 V.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit/connections test normal, replace the ECM.

9. Connect a 3 A fused jumper wire between the APP sensor 2 signal circuit terminal 6 and the 5-volt reference circuit terminal 1. Verify the APP sensor 2 voltage parameter is greater than 4.8 V.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit/connections test normal, replace the ECM.

10. If all circuits/connections test normal, test or replace the accelerator pedal assembly.

Component Testing

1. Connect a 3 A fused jumper wire between the 5-volt reference terminal of the applicable APP sensor terminal 2 or 1 and 5 V. Install a jumper wire between the applicable low reference terminal 4 or 5 and ground.
2. Sweep the sensor through the entire range while monitoring the voltage between the appropriate signal circuit terminal 3 or 6 and the low reference terminal 4 or 5 with a DMM. The voltage for APP 1 should vary between approximately 0.90-4.35 V without any spikes or dropouts. The voltage for APP 2 should vary between approximately 0.40-2.20 V without any spikes or dropouts.

   If the voltage is not within the specified range or is erratic on either APP sensor, replace the accelerator pedal assembly.

Repair Instructions

Perform the Diagnostic Repair Verification.

- Accelerator Pedal Position Sensor Replacement
- Engine Control Module Replacement for engine control module replacement, setup, and programming

DTC P2176

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P2176: Throttle Control Lower Position not Learned

Circuit/System Description

The engine control module (ECM) controls the throttle valve by applying a varying voltage to the throttle actuator control (TAC) motor. The ECM monitors the actual throttle valve position using throttle position (TP) sensor 1 and 2.

Conditions for Running the DTC

- The engine speed is less than 40 RPM.
- The vehicle speed is 0 km/h (0 mph).
- The engine coolant temperature (ECT) is between 5-101°C (41-214°F).
- The intake air temperature (IAT) is between 5-144°C (41-291°F).
- The accelerator pedal position (APP) sensor angle is less than 15 percent.
- The ignition voltage is greater than 10 volts.
- DTC P2176 runs once per igniiton cycle, when the ignition is ON and the above conditions are met for greater than 1 second.

Conditions for Setting the DTC

- The ECM detects that the TP sensor 1 voltage is not between 4.12-4.55 V after the throttle learn procedure, with the throttle at rest.
- The ECM detects that the TP sensor 2 voltage is not between 0.34-0.99 V after the throttle learn procedure, with the throttle at rest.
- The minimum throttle position is not learned after an ECM replacement.
- Either condition exists fro greater than 1 second, or a cumulative 10 seconds.

Action Taken When the DTC Sets

DTC P2176 is a Type A DTC.

Conditions for Clearing the DTC

DTC P2176 is a Type A DTC.

Circuit/System Verification

1. Ignition ON, rapidly depress the accelerator pedal from the rest position to the wide open position (WOT) and release the pedal. Repeat the procedure several times. Observe the DTC information with a scan tool. Verify that DTCs P0121, P0122, P0123, P0221, P0222, P0223, P0638, or P2101 do not set.

   If a DTC is set, refer to DTC P0121, P0122, P0123, P0221, P0222, or P0223 or DTC P0638, P2100, P2101, or P2119.
2. DTC P2176 is an informational DTC. Perform the idle learn procedure, refer to Idle Learn.

   If DTC P2176 resets after performing the idle learn procedure, replace the throttle body.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Repair Instructions

Perform the Diagnostic Repair Verification.

Throttle Body Assembly Replacement

DTC P2177, P2179, P2187, or P2189

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P2177: Fuel Trim Lean during Cruising/Acceleration Bank 1.

DTC P2179: Fuel Trim Lean during Cruising/Acceleration Bank 2.

DTC P2187 : Fuel Trim Lean during Idling/Deceleration Bank 1.

DTC P2189: Fuel Trim Lean during Idling/ Deceleration Bank 2.

Circuit Description

The engine control module (ECM) controls the air/fuel metering system in order to provide the best possible combination of driveability, fuel economy, and emission control. Fuel delivery is controlled differently during Open and Closed Loop. During Open Loop, the ECM determines fuel delivery based on sensor signals without heated oxygen sensor (HO2S) input. During Closed Loop, the HO2S inputs are added and used by the ECM to calculate short and long term fuel delivery adjustments. If the HO2S indicate a lean condition, fuel trim values will be above 0 percent. If the HO2S indicate a rich condition, fuel trim values will be below 0 percent. Short term fuel trim values change rapidly in response to the HO2S signals. Long term fuel trim makes coarse adjustments in order to maintain an air/fuel ratio of 14.7:1.

Conditions for Running the DTC

P2177 or P2179

- Before the ECM can report DTC P2177 or P2179, failed, DTCs P0008, P0009, P0010, P0011, P0013, P0014, P0016, P0017, P0018, P0019, P0020, P0021, P0023, P0024, P0101, P0121, P0122, P0123, P0133, P0153, P0201, P0202, P0203, P0204, P0205, P0206, P0221, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0335, P0336, P0338, P0443, P0458, P0459, P0461, P0462, P0463, P2068 P2088, P2089, P2090, P2091, P2092, P2093, P2094, and P2095 must run and pass.
- The engine speed is between 1,200-3,400 RPM.
- The mass air flow (MAF) is between 7-83 grams/second.
- The throttle angle is less than 100 percent.
- The engine load is between 17-55 percent.

- The fuel system is in closed loop.
- The engine is not in decel fuel cut-off (DEFCO).
- The long term fuel trim is active.
- The engine coolant temperature (ECT) is greater than 60°C (140°F).
- The intake air temperature (IAT) is less than 61°C (142°F).
- The evaporative emission (EVAP) canister purge solenoid valve is not enabled.
- The fuel level is greater than 12 percent.
- The amount of air flow into the engine is greater than 7,000 grams.
- DTC P2177 and P2179 run continuously once the above conditions are met for at least 300 seconds.

P2187 or P2189

- Before the ECM can report DTC P2187 or P2189, failed, DTCs P0008, P0009, P0010, P0011, P0013, P0014, P0016, P0017, P0018, P0019, P0020, P0021, P0023, P0024, P0101, P0121, P0122, P0123, P0133, P0153, P0201, P0202, P0203, P0204, P0205, P0206, P0221, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0335, P0336, P0338, P0443, P0458, P0459, P0461, P0462, P0463, P2068 P2088, P2089, P2090, P2091, P2092, P2093, P2094, and P2095 must run and pass.
- The engine speed is between 480-1,001 RPM.
- The engine load is between 7-32 percent.
- The MAF is between 1-8 grams per second.
- The fuel system is in closed loop.
- The engine is not in decel fuel cut-off (DEFCO).
- The long term fuel trim is active.
- The engine coolant temperature (ECT) is greater than 60°C (140°F).
- The intake air temperature (IAT) is less than 61°C (142°F).
- The evaporative emission (EVAP) canister purge solenoid valve is not enabled.
- The fuel level is greater than 12 percent.
- The amount of air flow into the engine is greater than 7,000 grams.
- DTC P2187 and P2189 run continuously once the above conditions are met.

Conditions for Setting the DTC

P2177 or P2179

The Total Fuel Trim Avg. is greater than 23 percent for 4 seconds or for a cumulative of 30 seconds.

P2187 or P2189

The Total Fuel Trim Avg. is greater than 40 percent, or the LT FT Idle/Decel is greater than 6 percent. Either condition exists for 4 seconds or for a cumulative of 30 seconds.

Action Taken When the DTC Sets

DTCs P2177, P2179, P2187 and P2189 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2177, P2179, P2187 and P2189 are Type B DTCs.

Diagnostic Aids

- Observing the LT FT Bn 1 and Bn 2 parameters, while driving the vehicle can determine whether the lean condition is effecting only one bank , or is common to both banks of the engine.
- A fuel system delivery condition causes this DTC to set. Thoroughly inspect all items that cause a lean condition. Refer to.
- Any un-metered air into the engine causes this DTC to set. Thoroughly inspect all areas of the engine for vacuum leaks.
- A MAF sensor condition can cause this DTC without setting a MAF DTC. If there is a MAF sensor condition, the MAF sensor parameters will appear to be within range.
- Inspect the air filter for being the correct one for this application. Make sure that the engine oil fill cap is in place and that it is tight. Verify that the engine oil dip stick is fully seated.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

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- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Observe the DTC information with a scan tool. DTC P2177, P2179, P2187, or P2189 should not be set.

   If there are other DTCs set besides DTC P2177, P2179, P2187 or P2189, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. Ignition ON, observe the barometric pressure (BARO) sensor pressure parameter and compare the reading on the scan tool to the barometric pressure table. Refer to Altitude Versus Barometric Pressure.

   If the BARO sensor pressure is not within the range specified for your altitude, refer to DTC P2227, P2228, or P2229.
3. Engine at normal operating temperature, observe the Total Fuel Trim Avg. parameter with a scan tool. The Total Fuel Trim Avg. should be between -22 to +23 percent.

   If not within the specified range, verify none of the following conditions exist:

   - A mass air flow (MAF) sensor signal that is skewed--If the Short Term FT parameters for both banks changes greater than 20 percent when the MAF sensor is disconnected, refer to DTC P0101.
   - The air intake system after the MAF sensor for vacuum leaks
   - Fuel contamination--Refer to Alcohol/Contaminants-in-Fuel Diagnosis and Fuel System Cleaning.
   - Splits, kinks, or improper connections at the vacuum hoses--Refer to Emission Hose Routing Diagram.
   - The fuel system is operating lean. Refer to Fuel System Diagnosis.
   - Vacuum leaks at the intake manifold or throttle body
   - Leaking crankcase ventilation system
   - The engine control module grounds for being clean, tight, and in the correct locations
   - A high engine oil level condition--A high engine oil level causes oil residue to form on the mass air flow (MAF) sensor, causing a lean indication. The MAF sensor does not need to be replaced.
   - Vacuum leaks that only affect one bank of the engine--For example, the intake manifold, the injector O-rings.
   - Lean injectors--Refer to Fuel Injector Solenoid Coil Test.
   - Missing, restricted, or leaking exhaust components--Refer to Symptoms - Engine Exhaust.
   - The heated oxygen sensor (HO2S) is installed securely and the electrical connector is not contacting the exhaust system.
   - An engine mechanical condition--Refer to Symptoms - Engine Mechanical.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Repair Instructions

Always perform the Diagnostic Repair Verification after completing the diagnostic procedure.

DTC P2178, P2180, P2188, or P2190

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P2178 : Fuel Trim Rich during Cruising/Acceleration (Bank 1)

DTC P2180 : Fuel Trim Rich during Cruising/Acceleration (Bank 2)

DTC P2188 : Fuel Trim Rich during Idling/Deceleration (Bank 1)

DTC P2190 : Fuel Trim Rich during Idling/Deceleration (Bank 2)

Circuit Description

The engine control module (ECM) controls the air/fuel metering system in order to provide the best possible combination of driveability, fuel economy, and emission control. Fuel delivery is controlled differently during Open and Closed Loop. During Open Loop, the ECM determines fuel delivery based on sensor signals without heated oxygen sensor (HO2S) input. During Closed Loop, the HO2S inputs are added and used by the ECM to calculate short and long term fuel trim fuel delivery adjustments. If the HO2S indicate a lean condition, fuel trim values will be above 0 percent. If the O2S indicate a rich condition, fuel trim values will be below 0 percent. Short term fuel trim values change rapidly in response to the HO2S signals. Long term fuel trim makes coarse adjustments in order to maintain an air/fuel ratio of 14.7:1.

Conditions for Running the DTC

P2178

- Before the ECM can report DTC P2178 failed, DTCs P0008, P0009, P0010, P0011, P0013, P0014, P0016, P0017, P0018, P0019, P0020, P0021, P0023, P0024, P0101, P0121, P0122, P0123, P0133, P0201, P0202, P0203, P0204, P0205, P0206, P0221, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0335, P0336, P0338, P0443, P0458, P0459, P0461, P0462, P0463, P2068 P2088, P2089, P2090, P2091, P2092, P2093, P2094, and P2095 must run and pass.
- The engine speed is between 1,200-3,400 RPM.
- The mass air flow (MAF) is between 7-83 grams/second.
- The throttle angle is less than 100 percent.
- The engine load is between 17-55 percent.
- The fuel system is in closed loop.

- The engine is not in decel fuel cut-off (DEFCO).
- The long term fuel trim is active.
- The engine coolant temperature (ECT) is greater than 60°C (140°F).
- The intake air temperature (IAT) is less than 61°C (142°F).
- The evaporative emission (EVAP) canister purge solenoid valve is not enabled.
- The fuel level is greater than 12 percent.
- The amount of air flow into the engine is greater than 7,000 grams.
- DTC P2178 run continuously once the above conditions are met for at least 300 seconds.

P2188

- Before the ECM can report DTC P2188 failed, DTCs P0008, P0009, P0010, P0011, P0013, P0014, P0016, P0017, P0018, P0019, P0020, P0021, P0023, P0024, P0101, P0121, P0122, P0123, P0133, P0201, P0202, P0203, P0204, P0205, P0206, P0221, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0335, P0336, P0338, P0443, P0458, P0459, P0461, P0462, P0463, P2068 P2088, P2089, P2090, P2091, P2092, P2093, P2094, and P2095 must run and pass.
- The engine speed is between 480-1,001 RPM.
- The engine load is between 7-32 percent.
- The MAF is between 1-8 grams per second.
- The fuel system is in closed loop.
- The engine is not in decel fuel cut-off (DEFCO).
- The long term fuel trim is active.
- The engine coolant temperature (ECT) is greater than 60°C (140°F).
- The intake air temperature (IAT) is less than 61°C (142°F).
- The evaporative emission (EVAP) canister purge solenoid valve is not enabled.
- The fuel level is greater than 12 percent.
- The amount of air flow into the engine is greater than 7,000 grams.
- DTC P2188 run continuously once the above conditions are met.

Conditions for Setting the DTC

P2178

The Total Fuel Trim Avg. is less than -22 percent. The condition exists for 4 seconds or for a cumulative of 30 seconds.

P2188

The Total Fuel Trim Avg. is less than -40 percent. The LT FT Idle/Decel is less than -6 percent. The condition exists for 4 seconds or for a cumulative of 30 seconds.

Action Taken When the DTC Sets

DTCs P2178 and P2188 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2178 and P2188 are Type B DTCs.

Diagnostic Aids

- A fuel system delivery condition causes this DTC to set. Thoroughly inspect all items that cause a rich condition. Refer to.
- Review the Freeze Frame/Failure Records with a scan tool.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Observe the DTC information with a scan tool. DTC P2178, P2180, P2188, or P2190 should not be set.

   If there are other DTCs set besides DTC P2178, P2180, P2188, or P2190, refer to Diagnostic Trouble Code (DTC) List - Vehicle to diagnosis the applicable DTC.
2. Ignition ON, observe the barometric pressure (BARO) sensor pressure parameter and compare the reading on the scan tool to the barometric pressure table. Refer to Altitude Versus Barometric Pressure.

   If the BARO sensor pressure is not within the range specified for your altitude, refer to DTC P2227, P2228, or P2229.
3. Engine at normal operating temperature, observe the Total Fuel Trim Avg. parameter with a scan tool. The Total Fuel Trim Avg. should be between -22 to +23 percent.

If not within the specified range, inspect for the following conditions:

- A mass air flow (MAF) sensor signal that is skewed. If the Short Term FT parameters for both banks changes greater than 20 percent when the MAF sensor is disconnected, refer to DTC P0101.
- A collapsed air intake duct
- A restricted air filter element--Refer to Air Cleaner Element Replacement.
- The MAF sensor for foreign objects.
- Excessive fuel in the crankcase--Change the oil as necessary.
- Fuel contamination--Refer to Alcohol/Contaminants-in-Fuel Diagnosis and. Fuel System Cleaning.
- The engine control module grounds for being clean, tight, and in the correct locations
- Rich injectors--Refer to Fuel Injector Solenoid Coil Test.
- Restricted exhaust system--Refer to Symptoms - Engine Exhaust.
- An engine mechanical condition--Refer to Symptoms - Engine Mechanical.

4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

DTC P2227, P2228, or P2229

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P2227: Barometric Pressure Sensor Range/Performance

DTC P2228: Barometric Pressure Sensor Voltage Low

DTC P2229: Barometric Pressure Sensor Voltage High

Circuit/System Description

The barometric pressure (BARO) sensor responds to changes in altitude and atmospheric conditions. This gives the engine control module (ECM) an indication of barometric pressure. The ECM uses this information to calculate fuel delivery. The BARO sensor has a 5-volt reference circuit, a low reference circuit and a signal circuit. The ECM supplies 5 volts to the BARO sensor on a 5-volt reference circuit, and provides a ground on a low reference circuit. The BARO sensor provides a voltage signal to the ECM on a signal circuit relative to the atmospheric pressure changes. The ECM monitors the BARO sensor signal for a voltage outside of the normal range.

Conditions for Running the DTC

P2227

- Before the ECM can report DTC P2227 failed, DTCs P0100, P0101, P0102, P0103, P0121, P0122, P0123, P0221, P0222, P0223, P2228, and P2229 must run and pass.
- The engine is operating for greater than 20 seconds.
- The mass air flow is greater than 11 g/s.
- The difference between the calculated manifold absolute pressure (MAP) and BARO pressure is less than 1.0 kPa for greater than 3 seconds.
- The evaporative emission (EVAP) leak test is not enabled.
- DTC P2227 runs continuously once the above conditions are met for 2 seconds.

P2228 or P2229

- The engine is operating.
- The DTCs run continuously once the above conditions are met for 2 seconds.

Conditions for Setting the DTC

P2227

- The ECM detects that the BARO pressure is less than 50 kPa or greater than 115 kPa.
- The ECM detects that the BARO pressure changed greater than 5 kPa within 20 seconds.
- The ECM detects that the BARO pressure changed greater than 30 kPa since the last ignition cycle.
- Any of the condition above exist for 4 seconds or for a cumulative of 50 seconds.

P2228

The ECM detects that the BARO sensor voltage is less than 0.20 volt for 4 seconds or for a cumulative of 30 seconds.

P2229

The ECM detects that the BARO sensor voltage is greater than 4.8 volts for 4 seconds or for a cumulative of 30 seconds.

Action Taken When the DTC Sets

DTCs P2227, P2228, and P2229 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2227, P2228, and P2229 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Start the engine, observe the DTC information with a scan tool. DTCs P2227, P2228 or P2229 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

1. Inspect the atmospheric vent on the ECM case for one of the following conditions:
   - Moisture in the vent inlet.
   - Debris in the vent inlet.

   If a condition exists, attempt to clean or dry the atmospheric inlet.
2. Start the engine, observe the DTC information with a scan tool. DTCs P2227, P2228 or P2229 should not set.

   If DTC P2227, P2228 or P2229 sets, replace the ECM.

Repair Instructions

Perform the Diagnostic Repair Verification.

Engine Control Module Replacement for engine control module replacement, setup, and programming.

DTC P2232 or P2235

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P2232: HO2S Signal Circuit Shorted to Heater Circuit Bank 1 Sensor 2

DTC P2235: HO2S Signal Circuit Shorted to Heater Circuit Bank 2 Sensor 2

Circuit Description

The engine control module (ECM) supplies a voltage near 450 mV between the heated oxygen sensor (HO2S) signal circuit and the low reference circuit. The HO2S varies the voltage over a range from about 1,000 mV when the exhaust is rich, down through about 10 mV when the exhaust is lean. The ECM monitors and stores the HO2S voltage information. The ECM evaluates the HO2S voltage samples in order to determine the amount of time that the HO2S voltage was out of range. Or, to detect if the HO2S signal voltage switches at the same rate at which the ECM is commanding the heater ON and OFF.

Conditions for Running the DTC

- The engine is operating.
- The ignition voltage is greater than 10 volts.
- The calculated exhaust gas temperature is less than 800°C (1,472°F).
- The HO2S heater control is enabled for greater than 90 seconds.
- DTC P2232 and P2235 run continuously once the conditions above exist for greater than 10 seconds.

Conditions for Setting the DTC

- The ECM detects that the HO2S signal voltage increases greater than 2 volts within 0.04 second, in 4 out of 6 HO2S heater switch OFF samples.
- The condition exists for greater than 1 seconds, or for a cumulative time of 10 seconds.

Action Taken when the DTC Sets

DTCs P2232 and P2235 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2232 and P2235 are Type B DTCs.

Diagnostic Aids

- The HO2S voltage should be between 350-550 mV with the ignition ON. If the voltage is greater than the specified value, there is a condition with the HO2S circuits. If the voltage does not change after disconnecting the HO2S, the condition is between the sensor and the ECM. If the voltage is between 350-550 mV after disconnecting the sensor, the condition is with the HO2S.
- Inspect the HO2S harness connector for water intrusion. Moisture in a connector may cause voltage to bleed to other circuits within the connector.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the appropriate HO2S voltage parameter. The HO2S voltage parameter should be less than 1,050 mV.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate HO2S.
2. Ignition ON, verify that the HO2S parameter is between 350-500 mV.

   If greater than 500 mV, test the signal circuit of the HO2S sensor for a short to the heater circuit. If the circuit/connections test normal, replace the ECM.
3. If all circuits/connections test normal, replace the applicable HO2S.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 2
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 2
- Control Module References for engine control module replacement, setup, and programming

DTC P2270 or P2272

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P2270: O2 Sensor Lean/Rich Switch Signal Malfunction (Bank 1 Sensor 2)

DTC P2272: O2 Sensor Lean/Rich Switch Signal Malfunction (Bank 2 Sensor 2)

Circuit Description

The engine control module (ECM) supplies a voltage near 450 mV between the heated oxygen sensor (HO2S) high signal circuit and the low reference circuit. The HO2S varies the voltage over a range from about 1,000 mV when the exhaust is rich, down through about 10 mV when the exhaust is lean. The ECM monitors and stores the HO2S voltage information. The ECM evaluates the HO2S voltage samples in order to determine the amount of time that the HO2S voltage was out of range. The ECM compares the stored HO2S voltage samples taken within each sample period and determines if the majority of the samples are out of the operating range. The ECM test for the following conditions:

- The ECM monitors the HO2S voltage to determine if the signal voltage goes above a predetermined threshold within a certain amount of time. If the ECM determines that the signal voltage remains below a threshold, the ECM will command the fuel system rich to determine if the HO2S signal voltage can be forced above the threshold within a certain amount of time.
- The ECM monitors the HO2S voltage during power enrichment to ensure that the signal voltage goes above a predetermined threshold during power enrichment.

Conditions for Running the DTC

- Before the ECM can report DTC P2270 or P2272 failed, DTCs P0036, P0037, P0038, P0137, P0138, P0140, P0141, P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, P0393, P0443, P0458, and P0459 must run and pass.
- DTC P0461, P0462, P0463, P2066, P2067, or P2068 is not set.
- The engine is operating.
- The ignition voltage is greater than 10 volts.
- The rear HO2S are at operating temperature for greater than 10 seconds.
- The long term fuel control is enabled.
- The mass air flow (MAF) sensor is greater than 10 g/s.

DTC P2270 or P2272 (w/LLT)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P2270: HO2S Signal Stuck Lean Bank 1 Sensor 2

DTC P2272: HO2S Signal Stuck Lean Bank 2 Sensor 2

Circuit Description

The engine control module (ECM) supplies a voltage near 450 mV between the heated oxygen sensor (HO2S) high signal circuit and the low reference circuit. The HO2S varies the voltage over a range from about 1,000 mV when the exhaust is rich, down through about 10 mV when the exhaust is lean. The ECM monitors and stores the HO2S voltage information. The ECM evaluates the HO2S voltage samples in order to determine the amount of time that the HO2S voltage was out of range. The ECM compares the stored HO2S voltage samples taken within each sample period and determines if the majority of the samples are out of the operating range. The ECM test for the following conditions:

- The ECM monitors the HO2S voltage to determine if the signal voltage goes above a predetermined threshold within a certain amount of time. If the ECM determines that the signal voltage remains below a threshold, the ECM will command the fuel system rich to determine if the HO2S signal voltage can be forced above the threshold within a certain amount of time.
- The ECM monitors the HO2S voltage during power enrichment to ensure that the signal voltage goes above a predetermined threshold during power enrichment.

Conditions for Running the DTC

- Before the ECM can report DTC P2270 or P2272 failed, DTCs P0036, P0037, P0038, P0056, P0057, P0058, P013A, P013C, P013E, P0137, P0138, P014A, P0140, P0141, P0157, P0158, P0160, P0161, P0443, P0458, P0459, P2096, P2098, P2177, P2179, P2187, and P2189 must run and pass.
- DTC P0461, P0462, P0463, P2066, P2067, or P2068 is not set.
- The engine speed is greater than 240 RPM.
- The ignition voltage is greater than 10 volts.
- The HO2S 2 is at operating temperature for greater than 10 seconds.
- The long term fuel control is enabled.
- The mass air flow (MAF) signal is greater than 10 g/s.

- The MAF signal is between 6-33 g/s for greater than 3 seconds during the intrusive test.
- DTCs P2270 and P2272 run continuously when the above conditions are met for approximately 10 minutes, or 20 minutes if the fuel level is less than 12 percent.

Conditions for Setting the DTC

The ECM detects that the HO2S 2 voltage is less than 629 mV for greater than 100 seconds, then an intrusive test is performed. The ECM will enrich the fuel mixture 2 percent per second and then wait for 10 seconds at 20 percent. If the ECM detects that the HO2S 2 voltage is still less than 629 mV during the intrusive test, for greater than 4 second or for a cumulative of 30 seconds the DTC sets.

Action Taken when the DTC Sets

DTCs P2270 and P2272 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2270 and P2272 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the DTC information with a scan tool. Verify that DTC P0137, P0138,

P0140, P0157, P0158, or P0160 is not set.

If any of the listed DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.

2. Operate the engine above 1,200 RPM for 30 seconds, observe the HO2S voltage parameter. The reading should fluctuate above and below the range of 401-519 mV.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Engine operating, move the related HO2S harnesses for the appropriate HO2S 2 between the HO2S harness connector and the engine control module (ECM) while monitoring the appropriate scan tool HO2S voltage parameter. Verify that the HO2S parameter does not change abruptly while moving the related harnesses.

   If the HO2S parameter does change abruptly while moving the related harnesses repair the circuit as necessary.
2. Ignition OFF, disconnect the harness connector at the appropriate HO2S 2.
3. Ignition ON, verify that the scan tool HO2S 2 parameter is between 401-519 mV.

   If less than the specified range, test the signal circuit terminal B for a short to ground. If the circuit/connections test normal, replace the ECM.
4. Verify that none of the following conditions exist:
   - The vacuum hoses for splits, kinks, and proper connection
   - The air intake system after the mass air flow (MAF) sensor for vacuum leaks
   - Exhaust system leaks
   - Lean fuel injectors--Refer to Fuel Injector Solenoid Coil Test.
   - Water intrusion in the HO2S harness connector
   - Low fuel system pressure--Refer to Fuel System Diagnosis.
   - Fuel that is contaminated--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
   - Contaminated HO2S - Silicon
   - An engine mechanical condition--Refer to Symptoms - Engine Mechanical.

     If you find any of the above conditions, repair as necessary.
5. If all circuits/connections test normal, replace the appropriate HO2S.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 2
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 2
- Control Module References for engine control module replacement, setup, and programming

DTC P2270 or P2272

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P2270: O2 Sensor Lean/Rich Switch Signal Malfunction (Bank 1 Sensor 2)

DTC P2272: O2 Sensor Lean/Rich Switch Signal Malfunction (Bank 2 Sensor 2)

Circuit Description

The engine control module (ECM) supplies a voltage near 450 mV between the heated oxygen sensor (HO2S) high signal circuit and the low reference circuit. The HO2S varies the voltage over a range from about 1,000 mV when the exhaust is rich, down through about 10 mV when the exhaust is lean. The ECM monitors and stores the HO2S voltage information. The ECM evaluates the HO2S voltage samples in order to determine the amount of time that the HO2S voltage was out of range. The ECM compares the stored HO2S voltage samples taken within each sample period and determines if the majority of the samples are out of the operating range. The ECM test for the following conditions:

- The ECM monitors the HO2S voltage to determine if the signal voltage goes above a predetermined threshold within a certain amount of time. If the ECM determines that the signal voltage remains below a threshold, the ECM will command the fuel system rich to determine if the HO2S signal voltage can be forced above the threshold within a certain amount of time.
- The ECM monitors the HO2S voltage during power enrichment to ensure that the signal voltage goes above a predetermined threshold during power enrichment.

Conditions for Running the DTC

- Before the ECM can report DTC P2270 or P2272 failed, DTCs P0036, P0037, P0038, P0137, P0138, P0140, P0141, P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, P0393, P0443, P0458, and P0459 must run and pass.
- DTC P0461, P0462, P0463, P2066, P2067, or P2068 is not set.
- The engine is operating.
- The ignition voltage is greater than 10 volts.
- The rear HO2S are at operating temperature for greater than 10 seconds.
- The long term fuel control is enabled.
- The mass air flow (MAF) sensor is greater than 10 g/s.

- The MAF sensor is between 6-33 g/s for greater than 3 seconds during the intrusive test.
- DTC P2270 and P2272 runs continuously once the above conditions are met for approximately 10 minutes when the fuel level is greater than 12 percent.
- DTC P2270 and P2272 runs continuously once the above conditions are met for approximately 20 minutes when the fuel level is less 12 percent.

Conditions for Setting the DTC

The ECM detects that the rear HO2S voltage is less than 650 mV for greater than 100 seconds, then an intrusive test is performed. The ECM will enrich the fuel mixture up to 30 percent and then wait for 10 seconds at 30 percent. The ECM detects that the HO2S voltage is less than 650 mV during the intrusive test for greater than 4 seconds or for a cumulative of 30 seconds, the DTC sets.

Action Taken when the DTC Sets

DTC P2270 and P2272 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTC P2270 and P2272 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Ignition ON, observe the DTC information with a scan tool. Verify that DTC P0137, P0138, or P0140 is not set.

   If any of the listed DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. Operate the engine above 1,200 RPM for 30 seconds, observe the HO2S voltage parameter. The reading should fluctuate above and below the range of 350-550 mV.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

1. Engine operating, move the related HO2S harnesses for the appropriate rear sensor between the HO2S harness connector and the ECM, while monitoring the appropriate HO2S voltage parameter. Verify that the HO2S parameter does not change abruptly while moving the related harnesses.

   If the HO2S parameter does change abruptly while moving the related harnesses repair the circuit as necessary.
2. Ignition OFF, disconnect the harness connector of the appropriate HO2S.
3. Ignition ON, verify that the HO2S parameter is between 350-500 mV.

   If less than the specified range, test the signal circuit terminal 4 for a short to ground. If the circuit/connections test normal, replace the ECM.
4. Verify that none of the following conditions exist:
   - Lean fuel injectors - Refer to Fuel Injector Solenoid Coil Test.
   - Water intrusion in the HO2S harness connector.
   - Low fuel system pressure - Refer to Fuel System Diagnosis.
   - The vacuum hoses for splits, kinks and proper connection.
   - The air intake system after the mass air flow (MAF) sensor for vacuum leaks.
   - Exhaust system leaks.
   - Contaminated HO2S - Silicon.
   - An engine mechanical condition. Refer to Symptoms - Engine Mechanical.

     If you find any of the above conditions, repair as necessary.
5. If all circuits/connections test normal, replace the applicable HO2S.

Repair Instructions

Perform the Diagnostic Repair Verification.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 2
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 2
- Engine Control Module Replacement for engine control module replacement, setup, and programming.

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DTC P2271 or P2273 (w/LLT)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P2271: HO2S Signal Stuck Rich Bank 1 Sensor 2

DTC P2273: HO2S Signal Stuck Rich Bank 2 Sensor 2

Circuit Description

The engine control module (ECM) supplies a voltage near 450 mV between the heated oxygen sensor (HO2S) high signal circuit and the low reference circuit. The HO2S varies the voltage over a range from about 1,000 mV when the exhaust is rich, down through about 10 mV when the exhaust is lean. The ECM monitors and stores the HO2S voltage information. The ECM evaluates the HO2S voltage samples in order to determine the amount of time that the HO2S voltage was out of range. The ECM compares the stored HO2S voltage samples taken within each sample period and determines if the majority of the samples are out of the operating range. The ECM test for the following conditions:

- The ECM monitors the HO2S voltage to determine if the signal voltage goes below a predetermined threshold within a certain amount of time. If the ECM determines that the signal voltage remains above the threshold, the ECM will command the fuel system lean to determine if the HO2S signal voltage can be forced below the threshold within a certain amount of time.
- The ECM monitors the HO2S voltage during fuel cut-off to determine if the signal voltage is greater than a predetermined threshold.

Conditions for Running the DTC

- Before the ECM can report DTC P2270 or P2272 failed, DTCs P0036, P0037, P0038, P0056, P0057, P0058, P013A, P013C, P013E, P0137, P0138, P014A, P0140, P0141, P0157, P0158, P0160, P0161, P0443, P0458, P0459, P2097, P2099, P2178, P2180, P2188, and P2190 must run and pass.
- DTC P0461, P0462, P0463, P2066, P2067, or P2068 is not set.
- The engine speed is greater than 240 RPM.
- The ignition voltage is greater than 10 volts.
- The HO2S 2 is at operating temperature for greater than 10 seconds.
- The long term fuel control is enabled.
- The mass air flow (MAF) signal is greater than 10 g/s.

- The MAF signal is between 6-33 g/s for greater than 3 seconds during the intrusive test.
- DTC P2271 and P2273 runs continuously once the conditions above are met for approximately 10 minutes, or 20 minutes if the fuel level is less than 12 percent.

Conditions for Setting the DTC

The ECM detects that the HO2S 2 voltage is greater than 629 mV for greater than 100 seconds, then an intrusive test is performed. The ECM will lean the fuel mixture -2 percent per second and then wait for 10 seconds at -15 percent. If the ECM detects that the HO2S voltage is still greater than 629 mV, for 4 seconds or for a cumulative of 30 seconds the DTC sets.

Action Taken when the DTC Sets

DTCs P2271 and P2273 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2271 and P2273 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the DTC information with a scan tool. Verify that DTC P0137, P0138, P0140, P0157, P0158, or P0160 is not set.

If any of the listed DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.

2. Operate the engine above 1,200 RPM for 30 seconds, observe the HO2S voltage parameter. The reading should fluctuate above and below the range of 401-519 mV.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Engine operating, move the related HO2S 2 harnesses for the appropriate sensor between the HO2S 2 harness connector and the ECM while monitoring the appropriate scan tool HO2S voltage parameter. Verify that the HO2S parameter does not change abruptly while moving the related harnesses.

   If the HO2S parameter does change abruptly while moving the related harnesses repair the circuit as necessary.
2. Ignition OFF, disconnect the harness connector at the appropriate HO2S.
3. Ignition ON, verify the scan tool HO2S 2 parameter is between 400-520 mV.

   If greater than the specified range, test the signal circuit terminal B for a short to voltage. If the circuit/connections test normal, replace the ECM.
4. Verify that none of the following conditions exist:
   - Rich fuel injectors--Refer to Fuel Injector Solenoid Coil Test.
   - Water intrusion in the HO2S harness connector
   - High fuel system pressure--Refer to Fuel System Diagnosis.
   - Fuel that is contaminated--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
   - A collapsed air intake duct
   - A restricted air filter element
   - Exhaust system restrictions
   - Excessive fuel in the crankcase
   - An engine mechanical condition--Refer to Symptoms - Engine Mechanical.

   If you find any of the above conditions, repair as necessary.
5. If all circuits/connections test normal, replace the appropriate HO2S.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 2
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 2
- Control Module References for engine control module replacement, setup, and programming

DTC P2271 or P2273

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P2271: O2 Sensor Rich/Lean Switch Signal Malfunction (Bank 1 Sensor 2)

DTC P2273: O2 Sensor Rich/Lean Switch Signal Malfunction (Bank 2 Sensor 2)

Circuit Description

The engine control module (ECM) supplies a voltage near 450 mV between the heated oxygen sensor (HO2S) high signal circuit and the low reference circuit. The HO2S varies the voltage over a range from about 1,000 mV when the exhaust is rich, down through about 10 mV when the exhaust is lean. The ECM monitors and stores the HO2S voltage information. The ECM evaluates the HO2S voltage samples in order to determine the amount of time that the HO2S voltage was out of range. The ECM compares the stored HO2S voltage samples taken within each sample period and determines if the majority of the samples are out of the operating range. The ECM test for the following conditions:

- The ECM monitors the HO2S voltage to determine if the signal voltage goes below a predetermined threshold within a certain amount of time. If the ECM determines that the signal voltage remains above the threshold, the ECM will command the fuel system lean to determine if the HO2S signal voltage can be forced below the threshold within a certain amount of time.
- The ECM monitors the HO2S voltage during fuel cut-off to determine if the signal voltage is greater than a predetermined threshold.

Conditions for Running the DTC

- Before the ECM can report DTC P2270 or P2273 failed, DTCs P0036, P0037, P0038, P0137, P0138, P0140, P0141, P0341, P0342, P0343, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, P0393, P0443, P0458, and P0459 must run and pass.
- DTC P0461, P0462, P0463, P2066, P2067, or P2068 is not set.
- The engine is operating.
- The ignition voltage is greater than 10 volts.
- The rear HO2S are at operating temperature for greater than 10 seconds.
- The fuel injectors are enabled.
- The long term fuel control is enabled.

- The mass air flow (MAF) sensor is greater than 10 g/s.
- The MAF sensor is between 6-33 g/s for greater than 3 seconds during the intrusive test.
- The accumulated air flow into the engine is greater than 15 grams during the fuel cut-off event.
- DTCs P2270 and P2273 run continuously once the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the rear HO2S voltage is greater than 650 mV for greater than 100 seconds, then an intrusive test is performed. The ECM will lean the fuel mixture up to -7 percent and then wait for 10 seconds at -7 percent. If the ECM detects that the HO2S voltage is still greater than 650 mV, the ECM then tests the HO2S at the next decel fuel cut-off. If the ECM detects the HO2S voltage is greater than 200 mV after 4 seconds or for a cumulative of 30 seconds in decel fuel cut-off, the DTC sets.

Action Taken when the DTC Sets

DTCs P2270 and P2273 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2270 and P2273 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Ignition ON, observe the DTC information with a scan tool. Verify that DTC P0137, P0138, or P0140 is not set.

   If any of the listed DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. Operate the engine above 1,200 RPM for 30 seconds, observe the HO2S 2 voltage parameter. The reading should fluctuate above and below the range of 350-550 mV.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

1. Engine operating, move the related HO2S harnesses for the appropriate rear sensor between the HO2S harness connector and the ECM while monitoring the appropriate HO2S voltage parameter. Verify that the HO2S parameter does not change abruptly while moving the related harnesses.

   If the HO2S parameter does change abruptly while moving the related harnesses repair the circuit as necessary.
2. Ignition OFF, disconnect the harness connector of the appropriate HO2S.
3. Ignition ON, verify that the HO2S parameter is between 350-500 mV.

   If greater than 500 mV, test the signal circuit terminal 4 for a short to voltage. If the circuit/connections test normal, replace the ECM.
4. Verify that none of the following conditions exist:
   - Rich fuel injectors - Refer to Fuel Injector Solenoid Coil Test.
   - Water intrusion in the HO2S harness connector.
   - High fuel system pressure--Refer to Fuel System Diagnosis.
   - Fuel that is contaminated--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
   - A collapsed air intake duct.
   - A restricted air filter element.
   - Exhaust system restrictions.
   - Fuel in the crankcase.
   - An engine mechanical condition. Refer to Symptoms - Engine Mechanical.

     If you find any of the above conditions, repair as necessary.
5. If all circuits/connections test normal, replace the appropriate HO2S.

Repair Instructions

Perform the Diagnostic Repair Verification.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 2
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 2
- Engine Control Module Replacement for engine control module replacement, setup, and programming.

DTC P2544

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P2544: Transmission Torque Request Circuit

Circuit / System Description

To improve shift feel, the transmission control module (TCM) may request that the engine control module (ECM) reduce engine torque during shift events. When such a request is received, the ECM responds by retarding the ignition timing and notifying the TCM that the request has succeeded. If the ECM is unable to comply with the request, the ECM sends the TCM a message that the request has failed.

Conditions for Running the DTC

- The ignition is ON for greater than 3 seconds.
- The ignition voltage is 10-18 volts.
- The serial data circuit initialized.
- The DTCs run continuously once the above condition is met.

Conditions for Setting the DTC

The ECM detects an invalid signal from the TCM for greater than 4 seconds.

Action Taken When the DTC Sets

DTC P2544 is a Type C DTC.

Conditions for Clearing the DTC

DTC P2544 is a Type C DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Observe the Freeze Frame/Failure Records with a scan tool.
2. Clear the DTCs with a scan tool.
3. Ignition OFF for 30 seconds.
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records.
   If DTC P2544 failed this ignition, replace the TCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for TCM replacement, setup, and programming.

DTC P2636

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P2636: Fuel Transfer Pump Flow Insufficient

Circuit Description

The fuel tank on this vehicle is equipped with 2 fuel level sensors, one for each reservoir of the fuel tank. Fuel is transferred from the left side of the fuel tank to the right side of the fuel tank in order to ensure all of the usable fuel volume is available. The fuel pump supplies a small amount of pressurized fuel to the siphon jet pump through the fuel feed pipe. The pressurized fuel creates a venturi action inside the siphon jet pump. The venturi action causes the fuel to be drawn out of the left side of the fuel tank. Fuel is then transferred from the left side of fuel tank to the right side of fuel tank through the internal fuel transfer tube. This diagnostic tests for too large of a difference in fuel level between the left and right side of the fuel tank. The DTC sets if the control module determines that the right side fuel level is less than a predetermined amount of the left side fuel level.

The following table illustrates the difference between temperature, resistance and voltage:

Fuel Level-Right or Left Sensor	Fuel Level Sensor Resistance	Fuel Level Sensor Voltage
Empty	Low	Low
Full	High	High

Conditions for Running the DTC

- Before the engine control module (ECM) can report DTC P2636 failed, DTCs P0462, P0463, P2067, and P2068 must run and pass.
- The engine is operating.
- DTC P2636 runs continuously once the above conditions exist for greater than 4 minutes.

Conditions for Setting the DTC

- The ECM detects that the right side fuel level is less than 11 percent and the left side fuel level is greater than 23 percent.
- The above condition is present for greater than 4 seconds or for a cumulative of 30 seconds.

Action Taken When the DTC Sets

DTC P2636 is a Type C DTC.

Conditions for Clearing the MIL/DTC

DTC P2636 is a Type C DTC.

Diagnostic Aids

Depending on the current fuel level, it may be difficult to locate a malfunctioning fuel level sensor. The condition may only occur when the fuel level is full or near empty. The fuel level sensor unit may need to be removed for further diagnosis. A fuel level sensor that has an intermittent condition causes this DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine idling for 5 minutes, observe the DTC information with a scan tool. DTC P2636 should not set.

2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector of the left side fuel level sensor.
2. Ignition ON, verify the scan tool Fuel Level Sensor-Left Tank voltage parameter is at 5.0 V.

   If less than the specified range, test the signal circuit for a short to ground. If the circuit tests normal, replace the ECM.
3. Install a 3 A fused jumper wire between the signal circuit terminal A and ground. Verify the scan tool Fuel Level Sensor-Left Tank voltage parameter is at 0.0 V.

   If greater than the specified value, test the signal circuit for a high resistance. If the circuit tests normal, replace the ECM.
4. Install a 3 A fused jumper wire between the signal circuit terminal A and the low reference circuit terminal D. Verify the scan tool Fuel Level Sensor-Left Tank voltage parameter is at 0.0 V.

   If greater than the specified value, test the low reference circuit for a high resistance. If the circuit tests normal, replace the ECM.
5. Remove the fuel tank.
6. Remove the fuel tank primary and secondary modules and inspect for the following conditions:
   - A clogged secondary fuel strainer and pick up
   - A clogged or restricted siphon jet pump
   - Broken, clogged or restricted flex tubes, primary fuel tank module
   - Broken, clogged, disconnected, or restricted fuel transfer tube inside tank

   If you find any of the above conditions, repair as necessary.
7. If all circuits/connections test normal, test or replace the left/secondary fuel level sensor.

Component Testing

1. Ignition OFF, remove the left fuel level sender from the fuel tank.
2. Connect a DMM between terminal A and terminal D.
3. Verify the secondary fuel level sender resistance remains within 40-250 Ω and changes smoothly while moving the float arm from stop to stop.

   If the resistance is outside the specified range or changes erratically while moving the float arm from stop to stop, replace the fuel level sender.

Repair Instructions

Perform the Diagnostic Repair Verification.

- Fuel Tank Draining
- Fuel Tank Replacement
- Primary Fuel Tank Module Replacement
- Secondary Fuel Tank Module Replacement
- Fuel System Cleaning
- Control Module References for engine control module replacement, setup, and programming

Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Description

Water contamination in the fuel system may cause driveability conditions such as hesitation, stalling, no start, or misfires in one or more cylinders. Water may collect near a single fuel injector at the lowest point in the fuel injection system, and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust or deterioration.

Ethanol concentrations of greater than 10 percent can cause driveability conditions and fuel system deterioration. Fuel with greater than 10 percent ethanol could result in driveability conditions such as hesitation, lack of power, stalling , or no start. Excessive concentrations of ethanol used in vehicles not designed for it may cause fuel system corrosion, deterioration of rubber components, and fuel filter restriction.

Test Procedure

1. Test the fuel composition using J 44175 Fuel Composition Tester and J44175-3 Instruction Manual.
2. If water appears in the fuel sample clean the fuel system, refer to Fuel System Cleaning.
3. Subtract 50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample. Refer to the examples in the Fuel Composition Test Examples table.
4. If the fuel sample contains greater than 15 percent ethanol, add fresh, regular gasoline to the vehicle's fuel tank.
5. Test the fuel composition.
6. If testing shows the ethanol percentage is still greater than 15 percent, replace the fuel in the vehicle. Refer to Fuel Tank Draining.

Fuel Composition Test Examples

--	Frequency (Hz)	Subtract 50	Ethanol Percent
Example A	50 Hz	-50	0
Example B	65 Hz	-50	15
Example C	129 Hz	-50	79

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Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Description

Water contamination in the fuel system may cause driveability conditions such as hesitation, stalling, no start, or misfires in one or more cylinders. Water may collect near a single fuel injector at the lowest point in the fuel rail, and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust, or deterioration.

Alcohol concentrations greater than 10 percent in the fuel can be detrimental to fuel system components. Alcohol contamination may cause fuel system corrosion, deterioration of rubber components, and subsequent fuel filter restriction. Fuel contaminated with alcohol may cause driveability conditions such as hesitation, lack of power, stalling, or no start. Some types of alcohol are more detrimental to fuel system components than others.

Alcohol in Fuel Testing Procedure

The fuel sample should be drawn from the bottom of the tank so that any water present in the tank will be detected. The sample should be bright and clear. If alcohol contamination is suspected then use the following procedure to test the fuel quality.

1. Using a 100 ml (3.38 oz) specified cylinder with 1 ml (0.34 oz) graduation marks, fill the cylinder with fuel to the 90 ml (3.04 oz) mark.
2. Add 10 ml (0.34 oz) of water in order to bring the total fluid volume to 100 ml (3.38 oz) and install a stopper.
3. Shake the cylinder vigorously for 10-15 seconds.
4. Carefully loosen the stopper in order to release the pressure.
5. Re-install the stopper and shake the cylinder vigorously again for 10-15 seconds.
6. Put the cylinder on a level surface for approximately 5 minutes in order to allow adequate liquid separation.

If alcohol is present in the fuel, the volume of the lower layer, that now contains both alcohol and water, will be greater than 10 ml (0.37 oz). For example, if the volume of the lower layer is increased to 15 ml (0.51 oz), this indicates at least 5 percent alcohol in the fuel. The actual amount of alcohol may be somewhat more because this procedure does not extract all of the alcohol from the fuel.

Particulate Contaminants in Fuel Testing Procedure

The fuel sample should be drawn from the bottom of the tank so that any contaminants present in the tank will be detected. The sample should be bright and clear. If the sample appears cloudy or contaminated with water as indicated by a water layer at the bottom of the sample, use the following procedure to diagnose the fuel.

1. Using an approved fuel container, draw approximately 0.5 liter (0.53 qt) of fuel.
2. Place the cylinder on a level surface for approximately 5 minutes in order to allow settling of the particulate contamination.

Particulate contamination will show up in various shapes and colors. Sand will typically be identified by a white or light brown crystals. Rubber will appear as black and irregular particles. If particles are found, clean the entire fuel system thoroughly. Refer to Fuel System Cleaning.

Document ID: 1994298

Backfire (Petrol)

Checks	Action
DEFINITION: The fuel ignites in the intake manifold, or in the exhaust system, making a loud popping noise.	
Preliminary Checks	Refer to Important Preliminary Checks in Symptoms - Engine Controls .
Ignition System Checks	• Remove and inspect the spark plugs for the following conditions: - Wet plugs - Cracks - Wear - Incorrect gap - Burned electrodes - Heavy deposits • Test for correct ignition system operation. • Test for crossfire between spark plugs. Test for spark plug wire failure.
Engine Mechanical Checks	• Inspect the engine for the following: - Intake manifold leaks - Incorrect valve timing - Correct engine cylinder compression - Sticking or leaking intake or exhaust valves - Exhaust system leakage • Inspect the intake and exhaust system for casting flash.
Fuel System Checks	Perform fuel system diagnosis. Refer to Fuel System Diagnosis .
Additional Checks	• Review service bulletins for LPG ECM PCM programming updates. • Verify that the correct LPG software and calibration has been programmed into the LPG ECM. • Test for correct operation of the AFO Enable circuit.

Cuts Out, Misses (Petrol)

Checks	Action
DEFINITION: A surging or jerking that follows engine speed, usually more pronounced as the engine load increases.	
Preliminary Checks	Refer to Important Preliminary Checks in Symptoms - Engine Controls .
Fuel System Checks	• Test for correct fuel system pressures. Refer to Fuel System Diagnosis . • Inspect for correct operation of the LPG fuel injectors. Refer to: Fuel Injector Balance Test with Special Tool • Test the lock-off valves / circuits for correct operation.
Ignition System Checks	• Inspect for fouled spark plugs. If fouled spark plugs are indicated the reason for the fouling must be found and corrected. • Test for faulty spark plug wires. • Test for an open ignition system ground.
Engine Mechanical Checks	Test for correct engine operation by checking for the following: • Correct engine compression • Correct engine valve timing • Worn or incorrect camshafts • Casting flash in the intake or exhaust manifold passages

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Electronic Ignition (EI) System Diagnosis

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit/System Description

Ignition 1 voltage is supplied to the ignition coils. The engine Control Module (ECM) provides a ground for the ignition coil (IC) control circuits. When the ECM removes the ground path of the ignition primary coil, the magnetic field produced by the coil collapses. The collapsing magnetic field produces a voltage in the secondary coil which ignites the spark plugs. The sequencing and timing are controlled by the ECM.

Diagnostic Aids

- The ignition coils for each bank are fused separately. If a fuse opens or the ignition 1 voltage circuit opens between the fuse and the splice, all the ignition coils for one bank of the engine would be inoperative. If the ground circuit opens at the engine block, the ignition coils would be inoperative for one bank of the engine
- Inspect the ignition coils for aftermarket devices. An aftermarket device connected to the ignition coil circuits, may cause a condition with the ignition coils.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Special Tools

- J 26792 Spark Tester
- J 43244 Relay Puller Pliers

Circuit / System Testing

> **Note:** Do not perform this diagnostic procedure if you were not sent here from a misfire DTC or the Engine Cranks but Does Not Run diagnostic.

1. Ignition OFF, disconnect the harness connector of the ignition coil.
2. Ignition ON, load test for battery voltage between the ignition voltage circuit terminal 2 and ground.

   If less than B+, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition voltage circuit and replace as necessary.
3. Crank or start the engine. Test for 200-400 mV between the appropriate IC circuit terminal 1 and ground.

   If less than the specified value, test the IC circuit for a short to ground or an open/high resistance. If the circuit/connection tests normal, replace the ECM.

   If greater than the specified value, test the IC circuit for a short to voltage. If the circuit/connection tests normal, replace the ECM.
4. Connect a test lamp between the each of the ground circuits terminal 3, and terminal 4, and B+. The test lamp should illuminate on each circuit.

   If the test lamp does not illuminate, test the suspected circuit for an open/high resistance.
5. If all circuits/connections test normal, replace the ignition coil.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Ignition Coil Replacement - Bank 1
- Ignition Coil Replacement - Bank 2

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Electronic Ignition (EI) System Diagnosis (with LLT)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit/System Description

The ignition system on this engine uses individual ignition coils and ignition control (IC) circuits for each cylinder. Ignition voltage is supplied to each bank of ignition coils. The engine control module (ECM) controls the ignition system operation. The ECM controls each coil using the IC circuits. The ECM commands the IC circuit low when a spark event is requested. The sequencing and timing are controlled by the ECM.

Diagnostic Aids

- The ignition coils for each bank are fused separately. If a fuse opens or the ignition voltage circuit opens between the fuse and the splice, all the ignition coils for one bank of the engine would be inoperative. If the ground circuit opens at the engine block, the ignition coils would be inoperative for one bank of the engine.
- Inspect the ignition coils for aftermarket devices. An aftermarket device connected to the ignition coil circuits, may cause a condition with the ignition coils.

Reference Information

Schematic Reference

Engine Controls Schematics

Description and Operation

Electronic Ignition (EI) System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

> **Note:** Do not perform this diagnostic procedure if you were not sent here from a misfire DTC or the Engine Cranks but Does Not Run diagnostic.

1. Ignition OFF, disconnect the harness connector of the ignition coil.
2. Ignition ON, load test for battery voltage between the ignition 1 voltage circuit of the ignition coil and ground.

   If less than B+, repair the ignition 1 voltage circuit of the ignition coil for a short to ground or an open/high resistance.
3. Ignition OFF, test for less than 5 Ω of resistance between the ground circuit of the ignition coil and the negative terminal of the battery.

   If greater than 5 Ω, repair the ground circuit of the ignition coil for an open/high resistance.
4. If all circuits/connections test normal, replace the ignition coil.

Repair Instructions

Perform the Diagnostic Repair Verification.

- Ignition Coil Replacement - Bank 1
- Ignition Coil Replacement - Bank 2

Engine Cranks But Does Not Run

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit/System Description

This Engine Cranks but Does Not Run diagnostic is an organized approach to identify a condition which causes the engine to crank but not start. This diagnostic directs the technician to the appropriate system diagnosis.

Diagnostic Aids

Inspect for any of the following conditions:

- The engine Control Module (ECM) uses the camshaft position (CMP) sensors to determine engine speed and position when there is a crankshaft position (CKP) sensor condition
- The engine will operate with a CKP sensor condition only if the ECM has stored the learned reference position of the camshafts in memory. With a CKP sensor condition in the signal circuit, the engine will go into a limp home mode after a hard restart. The ECM then calculates engine speed from one of the CMP sensors. During a limp home mode, the following additional DTCs may set and should be ignored:
  - DTC P0324 Knock Sensor (KS) Module Performance
  - DTC P1011 Intake Camshaft Position Actuator Park Position Bank 1
- Insufficient fuel can cause a no start condition. Thoroughly inspect the fuel delivery system for sufficient fuel volume to the fuel injectors. Inspect the fuel supply components for partial blockage or restrictions.
- Fuel injectors with partially blocked and restricted nozzles, or a malfunctioning solenoid, can cause a no start condition. Refer to Fuel Injector Solenoid Coil Test.
- There may be fuel spray at the fuel injectors and the indicated fuel pressure may be correct, yet there may not be enough fuel to start the engine. If the fuel injectors and the injector circuit are OK, and fuel spray is detected, the fuel injector ON time may be inadequate. If the engine Control Module (ECM) receives incorrect inputs from the various information sensors, the fuel delivered by the fuel injectors may be inadequate to start the engine. Check all the engine data parameters with a scan tool and compare the values indicated with the expected values or the values from a known good vehicle
- Check the crankshaft position (CKP) sensor engine reference signal with a scan tool. Observe the Engine Speed parameter while cranking the engine. The scan tool should indicate a steady 200-300 RPM while cranking. If erratic values, such as sudden spikes in the engine speed are displayed, the engine reference signal is not stable enough for the engine to start and run properly
- Inspect the engine for good secure electrical grounds

- If the engine almost starts and then stalls, check for an open in the ground circuits of the CKP sensor and the camshaft position (CMP) sensor
- Water or foreign material in the fuel can cause a no start or engine will not stay running condition. During freezing weather water can freeze inside the fuel system. The engine may start after 30 minutes in a heated repair shop. The malfunction may not recur until parked overnight in freezing temperatures. Extreme weather conditions can cause contaminated fuel to prevent the vehicle from starting
- A vehicle that starts and runs after being brought to the repair shop for a no start condition, may have an ignition system that is susceptible to moisture. Spray water on the ignition system components and the wiring in order to check for an engine starting or will not stay running concern.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools Required

- *AU-338* Fuel Pressure Gage
- *AU-465* Fuel Gauge Adapter Hose
- *J 26792* Spark Tester

Circuit/System Verification

Note: This diagnostic assumes the following:

- The battery is completely charged. Refer to Battery Inspection/Test

- The engine cranking speed is acceptable. Refer to Engine Cranks Slowly
- There is adequate fuel in the fuel tank.

1. Attempt to start the engine. Observe the DTC information with a scan tool. Verify that DTCs P0116, P0118, P0119, P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0335, P0336, P0338, P0351-P0356, P0602 ,P0603-P0606, P0627, P0628, P0629, P1629, P1631, P1632, P167D, P2105, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316 do not set.

   If any of the listed DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.
2. Ignition ON, observe the Theft Deterrent parameter with a scan tool. The parameter should display Disabled.

   If Enabled is displayed, refer to Theft Deterrent Control Module Programming and Setup.
3. Test the ignition system for spark. Refer to Electronic Ignition (EI) System Diagnosis.
4. Ignition ON, command the fuel pump ON with a scan tool. You should hear the fuel pump turn ON.

   If the fuel pump does not turn ON, refer to Fuel System Diagnosis.
5. Ignition OFF, install the *AU-338* Fuel Pressure Gage and the *AU-465* Fuel Gauge Adapter Hose . Refer to Fuel Pressure Gage Installation and Removal.

   Note:
   - The fuel pump may need to be commanded ON a few times, in order to obtain the highest possible fuel pressure
   - Do NOT start the engine for this test.
6. Ignition ON, command the fuel pump ON with a scan tool. The fuel pressure should be between 380-410 kPa (55-60 psi).

   If the fuel pressure is not within range, refer to Fuel System Diagnosis.
7. Verify that the following conditions do not exist:
   - Disconnect the MAF sensor. The engine Control Module (ECM) will ignore the MAF sensor and default to the calculated air flow.

     If disconnecting the MAF sensor corrects the condition and the connections are OK, replace the MAF sensor. Refer to Mass Airflow Sensor with Intake Air Temperature Sensor Replacement
   - Collapsed air intake duct to the throttle body
   - Restricted air filter element
   - Spark plugs for being gas or coolant fouled--Refer to Spark Plug Inspection
   - A skewed engine coolant temperature (ECT) sensor--Refer to Temperature Versus Resistance - Engine Coolant Temperature Sensor
   - Exhaust system restricted--Refer to Restricted Exhaust
   - Engine mechanical condition, for example, worn timing chain and gears, low compression--Refer to Symptoms - Engine Mechanical.

     If you find any of the above conditions, repair as necessary.

Repair Instructions

Perform the Diagnostic Repair Verification.

Fuel Injector Balance Test with Special Tool

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Diagnostic Fault Information

Fuel Injector Balance Test Example

Cylinder	1	2	3	4	5	6
First Reading	360 kPa (52 psi)	360 kPa (52 psi)	360 kPa (52 psi)	360 kPa (52 psi)	360 kPa (52 psi)	360 kPa (52 psi)
Second Reading	195 kPa (28 psi)	138 kPa (20 psi)	195 kPa (28 psi)	195 kPa (28 psi)	235 kPa (34 psi)	195 kPa (28 psi)
Amount Of Drop	166 kPa (24 psi)	222 kPa (32 psi)	166 kPa (24 psi)	166 kPa (24 psi)	125 kPa (18 psi)	166 kPa (24 psi)
Average Range: 156-176 kPa (22.5-25.5 psi)	Injector OK	Fuel Injector - Too Much Pressure Drop	Injector OK	Injector OK	Faulty Injector - Too Little Pressure Drop	Injector OK

Circuit/System Description

The scan tool is first used to energize the fuel pump relay. The fuel injector tester is then used to pulse each injector for a precise amount of time, allowing a measured amount of fuel into the manifold. This causes a drop in system fuel pressure that can be recorded and used to compare each injector.

Diagnostic Aids

- Monitoring the misfire current counters, or misfire graph, may help to isolate the fuel injector that is causing the condition
- Operating the vehicle over a wide temperature range may help isolate the fuel injector that is causing the condition
- Perform the fuel injector balance test within the conditions of the customers concern. A fuel injector condition may only be apparent at a certain temperature, or under certain conditions.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools Required

- 7371 Fuel Line Disconnect Tool
- 7370 Fuel Line Disconnect Tool
- AU-338 Fuel Pressure gauge.
- AU-465 Fuel Gauge Adaptor Hose.

Component Testing

Fuel Injector Balance Test with Special Tool

1. Ignition ON, with a scan tool verify that the engine coolant temperature (ECT) is less than 94°C (201°F).

   If the ECT is greater than 94°C (201°F) allow the engine to cool before proceeding.
2. Ignition OFF, install the fuel pressure gauge. Refer to Fuel Pressure Gage Installation and Removal.
3. Ignition ON, verify the fuel pressure is within 380-410 kPa (55-60 psi).

   If the fuel pressure is not within the specified range refer to Fuel System Diagnosis.
4. Monitor the fuel pressure gage for 1 minute. Verify that the fuel pressure does not drop more than 34 kPa (5 psi).

   If the fuel pressure decreases more than 34 kPa (5 psi) refer to Fuel System Diagnosis.

   Notice: Do Not repeat any portion of this test before running the engine in order to prevent the engine from flooding.

5. Connect a commercially available fuel injector tester to a fuel injector with the amperage supply selector switch on the fuel injector tester to the Balance Test 0.5-2.5 amp position.

6. Command the fuel pump relay ON with a scan tool and record the fuel pressure indicated by the fuel pressure gauge after the fuel pressure stabilizes. This is the first pressure reading.

   Note:

   - Repeat this step for each fuel injector in order to obtain a pressure drop value for each fuel injector
   - The fuel pressure may rise after the fuel injector stops pulsing. Record the fuel pressure value immediately after the fuel injector stops pulsing. DO NOT record the higher fuel pressure value.

7. Energize the fuel injector by depressing the Push to Start Test button on the fuel injector tester. Record the fuel pressure indicated by the fuel pressure gauge after the fuel injector has stopped pulsing. This is the second pressure reading.
8. Add all of the individual pressure drop values in order to calculate the total pressure drop. Divide the total pressure drop by the number of fuel injectors in order to calculate the average pressure drop. The difference between any individual pressure drop and the average pressure drop should not be more than 20 kPa (3 psi).

   If the difference between any individual pressure drop and the average pressure drop is more than 20 kPa (3 psi), replace the fuel injector.

Repair Instructions

Perform the Diagnostic Repair Verification.

Fuel Injector and Fuel Rail Replacement.

Fuel Injector Balance Test with Tech 2

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Diagnostic Fault Information

Fuel Injector Balance Test Example

Cylinder	1	2	3	4	5	6
First Reading	360 kPa (52 psi)	360 kPa (52 psi)	360 kPa (52 psi)	360 kPa (52 psi)	360 kPa (52 psi)	360 kPa (52 psi)
Second Reading	195 kPa (28 psi)	138 kPa (20 psi)	195 kPa (28 psi)	195 kPa (28 psi)	235 kPa (34 psi)	195 kPa (28 psi)
Amount Of Drop	166 kPa (24 psi)	222 kPa (32 psi)	166 kPa (24 psi)	166 kPa (24 psi)	125 kPa (18 psi)	166 kPa (24 psi)
Average Range: 156-176 kPa (22.5-25.5 psi)	Injector OK	Fuel Injector - Too Much Pressure Drop	Injector OK	Injector OK	Faulty Injector - Too Little Pressure Drop	Injector OK

Circuit/System Description

The scan tool first energizes the fuel pump and then the injectors for a precise amount of time allowing a measured amount of fuel into the manifold. This causes a drop in system fuel pressure that can be recorded and used to compare each injector.

Diagnostic Aids

- Monitoring the misfire current counters, or misfire graph, may help to isolate the fuel injector that is causing the condition
- Operating the vehicle over a wide temperature range may help isolate the fuel injector that is causing the condition
- Perform the fuel injector balance test within the conditions of the customers concern. A fuel injector condition may only be apparent at a certain temperature, or under certain conditions.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools Required

- 7371 Fuel Line Quick Connect Separator
- 7370 Fuel Line Quick Connect Separator.
- AU-338 Fuel Pressure Gauge.
- AU-465 Fuel Gauge Adaptor Hose.

Component Testing

Fuel Injector Balance Test with Special Tool

1. Ignition ON, with a scan tool verify that the engine coolant temperature (ECT) is less than 94°C (201°F).

   If the ECT is greater than 94°C (201°F) allow the engine to cool before proceeding.
2. Ignition OFF, install the fuel pressure gauge. Refer to Fuel Pressure Gage Installation and Removal.
3. Ignition ON, verify the fuel pressure is within 380-410 kPa (55-60 psi).

   If the fuel pressure is not within the specified range refer to Fuel System Diagnosis.
4. Monitor the fuel pressure gauge for 1 minute. Verify that the fuel pressure does not drop more than 34 kPa (5 psi).

   If the fuel pressure decreases more than 34 kPa (5 psi) refer to Fuel System Diagnosis.

   Notice: Do Not repeat any portion of this test before running the engine in order to prevent the engine from flooding.
5. With a scan tool, select the Fuel Injector Balance Test function, within the Special Functions menu. Select a fuel injector to be tested and press Enter in order to prime the fuel system. Record the fuel pressure indicated by the fuel pressure gauge after the fuel pressure stabilizes. This is the 1st pressure reading.

Note:

- Repeat this step for each fuel injector in order to obtain a pressure drop value for each fuel injector
- The fuel pressure may rise after the fuel injector stops pulsing. Record the fuel pressure value immediately after the fuel injector stops pulsing. DO NOT record the higher fuel pressure value.

6. Energize the fuel injector by depressing the Pulse Injector button on the scan tool. This will energize the fuel injector and decrease the fuel pressure. Record the fuel pressure indicated by the fuel pressure gauge after the fuel injector has stopped pulsing. This is the 2nd pressure reading.
7. Press Enter to return to the Select Injector screen.
8. Add all of the individual pressure drop values in order to calculate the total pressure drop. Divide the total pressure drop by the number of fuel injectors in order to calculate the average pressure drop. The difference between any individual pressure drop and the average pressure drop should not be more than 20 kPa (3 psi).

   If the difference between any individual pressure drop and the average pressure drop is more than 20 kPa (3 psi), replace the fuel injector.

Repair Instructions

Perform the Diagnostic Repair Verification.

Fuel Injector and Fuel Rail Replacement

Fuel Injector Solenoid Coil Test

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit/System Description

The engine control module (ECM) enables the appropriate fuel injector pulse for each cylinder. The ignition voltage is supplied directly to the fuel injectors. The ECM controls each fuel injector by grounding the control circuit via a solid state device called a driver. A fuel injector coil winding resistance that is too high or too low will affect the engine driveability. A fuel injector control circuit DTC may not set but a misfire may be apparent. The fuel injector coil windings are affected by temperature. The resistance of the fuel injector coil windings will increase as the temperature of the fuel injector increases.

Diagnostic Aids

- Monitoring the misfire current counters, or misfire graph, may help to isolate the fuel injector that is causing the condition
- Operating the vehicle over a wide temperature range may help isolate the fuel injector that is causing the condition
- Perform the fuel injector coil test within the conditions of the customers concern. A fuel injector condition may only be apparent at a certain temperature or under certain conditions.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

- The DMM and test leads must be calibrated to 0 Ω in order to prevent mis-diagnosis.

1. Engine coolant between 10-32°C (50-90°F).
2. Test for 1.30-1.73 Ω between the terminals of the fuel injector. The resistance of each fuel injector should be 1.30-1.73 Ω.

   If not within the specified range, replace the fuel injector.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Fuel Injector Replacement

Fuel Injector Solenoid Coil Test (with LLT)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit/System Description

The engine control module (ECM) enables the appropriate fuel injector pulse for each cylinder. The ECM supplies a high voltage control circuit and a low control circuit to each of the fuel injectors. The control module controls each fuel injector control circuit via a solid state device called a driver. A fuel injector coil winding resistance that is too high or too low will affect the engine driveability. The fuel injector coil windings are affected by temperature. The resistance of the fuel injector coil windings will increase as the temperature of the fuel injector increases.

Diagnostic Aids

- Monitoring the misfire current counters, or misfire graph, may help to isolate the fuel injector that is causing the condition.
- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the circuit status for the component with a scan tool. The circuit status parameter changes from OK or Indeterminate to Fault if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Schematics

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Component Testing

Note:

- The engine coolant must be within the specified range or mis-diagnosis will occur.
- The resistance test must be performed at the fuel injector or mis-diagnosis will occur.

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Component Testing

Verify the resistance of each fuel injector with one of the following methods:

- If the engine coolant temperature (ECT) sensor is between 10-32°C (50-90°F), the resistance of each fuel injector should be 11-14 Ω.

  If the resistance of any fuel injector is not 11-14 Ω, replace the fuel injector
- If the ECT sensor is not between 10-32°C (50-90°F), measure and record the resistance of each fuel injector with a DMM. Subtract the lowest resistance value from the highest resistance value. The difference between the lowest value and the highest value should be equal to or less than 3 Ω

  If the difference is equal to or less than 3 Ω, refer to Fuel Injector Balance Test with Special Tool or Fuel Injector Balance Test with Tech 2

  If the difference is more than 3 Ω, add all of the fuel injector resistance values to obtain a total resistance value. Divide the total resistance value by the number of fuel injectors to obtain an average resistance value. Subtract the lowest, and the highest, individual fuel injector resistance values from the average resistance value. Replace the fuel injector that displays the greatest resistance difference above or below the average.

Repair Instructions

Perform the Diagnostic Repair Verification.

Fuel Injector and Fuel Rail Replacement.

Fuel Pump Electrical Circuit Diagnosis

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit/System Description

The engine Control Module (ECM) provides a ground to the coil side of the fuel pump relay. When the ignition switch is first turned ON, the ECM turns ON the fuel pump relay, which applies power to the fuel pump. The ECM enables the fuel pump relay as long as the engine is cranking or running, and crankshaft reference pulses are received. If no crankshaft reference pulses are received, the ECM turns OFF the fuel pump relay after about 3 seconds.

Diagnostic Aids

The following conditions may cause the fuel pump fuse to open:

- The fuse is faulty
- There is an intermittent short to ground in the supply voltage circuit of the fuel pump
- The fuel pump has an intermittent internal condition.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

> **Note:** Fuel pump DTCs may set when using the Fuel Pump output control.

1. Ignition ON, command the fuel pump relay ON with a scan tool. You should hear the fuel pump operate for 3-5 seconds and then turn OFF.
2. If the vehicle passes the Circuit/System Verification Test, then operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that are captured in the Freeze Frame/Failure Records Data List.

Circuit/System Testing

1. Ignition OFF, the fuel pump should not be operating.

   If the fuel pump operates continuously, test for a short to voltage in supply voltage circuit of the fuel pump. If the circuit/connections test normal, replace the fuel pump relay.
2. Test the fuel pump fuse. The fuse should not be open.

   If the fuel pump fuse is open, test for a short to ground in the supply voltage circuit of the fuel pump. If the circuit/connections test normal, replace the fuel pump.
3. Ignition OFF, remove the fuel pump relay from the electrical centre.
4. Ignition ON, test for battery voltage between the B+ voltage circuit of the fuel pump relay and known ground.

   If less than B+, repair the B+ voltage circuit of the fuel pump relay for an open/high resistance.
5. Connect a 15 A fused jumper wire between the B+ circuit of the fuel pump relay and the supply voltage circuit of the fuel pump. The fuel pump should operate.

   If the fuel pump does not operate, test for the following conditions:
   - An open/high resistance in the supply voltage circuit of the fuel pump
   - An open/high resistance in the ground circuit of the fuel pump

   If the above circuit/connections test normal, replace the fuel pump.
6. If all circuit/connections test normal, test or replace the fuel pump relay.

Component Testing

1. Measure for 135-185 Ω between terminals 85 and 86 of the fuel pump relay.

   If the resistance is not within the specified range, replace the fuel pump relay.
2. Measure for infinite resistance between the following terminals of the fuel pump relay:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If continuity is detected, replace the fuel pump relay.
3. Connect a 15 A fused jumper wire from the positive terminal of the battery to relay terminal

85. Connect a jumper wire from the negative terminal of the battery to relay terminal 86. Measure for less than 2 Ω between terminals 30 and 87 of the relay.

If the resistance measures more than 2 Ω, replace the fuel pump relay.

Repair Instructions

Perform the Diagnostic Repair Verification.

- Primary Fuel Tank Module Replacement
- Relay Replacement.

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Document ID: 1992892

Fuel System Diagnosis

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit/System Description

The engine control module (ECM) enables the fuel pump relay when the ignition switch is turned ON. The ECM will disable the fuel pump relay within 3 seconds unless the ECM detects ignition reference pulses. The ECM continues to enable the fuel pump relay as long as ignition reference pulses are detected. The engine control module (ECM) disables the fuel pump relay within 3 seconds if ignition reference pulses cease to be detected and the ignition remains ON.

The fuel system is a returnless on-demand design. The fuel pressure regulator is a part of the primary fuel tank module, eliminating the need for a return pipe from the engine. A returnless fuel system reduces the internal temperature of the fuel tank by not returning hot fuel from the engine to the fuel tank. Reducing the internal temperature of the fuel tank results in lower evaporative emissions.

An electric turbine style fuel pump attaches to the primary fuel tank module inside the fuel tank. The fuel pump supplies high pressure fuel through the fuel filter, past the fuel pressure regulator, and through the fuel feed line to the fuel injection system. The fuel pressure regulator has a T-joint that diverts the needed fuel to the fuel rail with the unused fuel dropping back into the reservoir of the primary fuel tank module. The primary fuel tank module contains a reverse flow check valve. The check valve and the fuel pressure regulator maintain fuel pressure in the fuel feed line and the fuel rail in order to prevent long cranking times.

The primary fuel tank module also contains a primary jet pump and a secondary jet pump. Fuel pump flow loss, caused by vapour expulsion in the pump inlet chamber, is diverted to the primary jet pump and the secondary jet pump through a restrictive orifice located on the pump cover. The primary jet pump fills the reservoir of the primary fuel tank module. The secondary jet pump creates a venturi action which causes the fuel to be drawn from the secondary side of the fuel tank, through the fuel transfer pipe, to the primary side of the fuel tank.

Diagnostic Aids

- A vehicle that runs out of fuel above empty may indicate a condition with the siphon jet pump, or transfer lines between the fuel tanks. Inspect for blockage, foreign objects or restrictions in all related hardware
- A vehicle that runs out of fuel above empty may be caused by an inaccurate fuel level sender. Inspect the float arm for binding, or obstructions.

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References.

Special Tools Required

Commercially available Fuel Pressure gauge.

Circuit/System Verification

Note:

- Inspect the fuel system for damage or external leaks before proceeding
- Verify that adequate fuel is in the fuel tank before proceeding
- The fuel pump relay may need to be commanded ON a few times in order to obtain the highest possible fuel pressure
- DO NOT start the engine.

1. Ignition ON, command the fuel pump relay ON with a scan tool. You should hear the fuel pump turn ON and OFF for 3-5 seconds.

   If the fuel pump does not operate, refer to Fuel Pump Electrical Circuit Diagnosis.
2. Ignition OFF, all accessories OFF, install the fuel pressure gauge. Refer to Fuel Pressure Gage Installation and Removal.
3. Ignition ON, command the fuel pump relay ON with a scan tool. Verify the fuel pressure is between 380-410 kPa (55-60 psi) and remains steady for 5 minutes.
4. Operate the vehicle within the conditions of the customers concern while monitoring fuel related parameters with a scan tool.

   If the scan tool parameters do not indicate a lean condition, refer to Symptoms - Engine Controls.

Circuit/System Testing

1. Ignition ON, command the fuel pump relay ON with a scan tool and observe the fuel pressure while the fuel pump is operating. Verify the fuel pressure is between 380-410 kPa (55-60 psi).

   If the fuel pressure is more than the specified range, replace the fuel pump.

   If the fuel pressure is less than the specified range, remove the fuel tank and test/inspect for the following:

   - Restricted fuel feed line
   - Restricted or plugged fuel filter
   - Restricted or plugged strainer
   - Stuck or binding fuel level float
   - Restricted siphon jet pump

- Restricted transfer lines between fuel tanks
- Faulty fuel pressure regulator
- Poor connections at the harness connectors and ground circuits of the fuel pump

If you find a condition, repair as necessary

If all components test normal, replace the fuel pump.

Note: The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant.

2. Verify that the fuel pressure does not decrease more than 34 kPa (5 psi) in 1 minute.

   If the fuel pressure decreases more than the specified value, perform the following procedure:

   2.1. Ignition OFF, relieve the fuel pressure. Refer to Fuel Pressure Relief

   2.2. Install the *J 37287* Fuel Line Shut-Off Adapters between the fuel feed pipe and the fuel rail.

   2.3. Open the valve on the *J 37287* Fuel Line Shut-Off Adapters .

   2.4. Bleed the air from the fuel pressure gage.

   2.5. Close the valve on the *J 37287* Fuel Line Shut-Off Adapters .

   2.6. Verify that the fuel pressure does not decrease more than 34 kPa (5 psi) in 1 minute.

   If the fuel pressure remains constant, replace the fuel pump.

   If the fuel pressure drops, locate and replace the leaking fuel injector.
3. Relieve the fuel pressure to 69 kPa (10 psi). Verify that the fuel pressure does not decrease more than 14 kPa (2 psi) in 5 minutes.

   If the fuel pressure decreases more than the specified value, replace the fuel pump.
4. Remove the *J 37287* Fuel Line Shut-Off Adapters and the *AU-338* Fuel Pressure Gage . Refer to Fuel Pressure Gage Installation and Removal.
5. Operate the vehicle within the conditions of the customer concern while monitoring fuel related parameters with a scan tool.

   If the scan tool parameters indicate a lean condition, test/inspect for the following:

   - Restricted fuel feed line
   - Restricted fuel filter
   - Restricted siphon jet pump
   - Restricted transfer lines between fuel tanks
   - Faulty fuel pressure regulator
   - Poor connections at the harness connectors and ground circuits of the fuel pump

   If all components test normal and the scan tool parameters indicate a lean condition, replace the fuel pump.

Repair Instructions

Perform the Diagnostic Repair Verification.

- Primary Fuel Tank Module Replacement
- Fuel Injector and Fuel Rail Replacement

Fuel Tank Leak Test

Caution: Place a dry chemical (Class B) fire extinguisher nearby before performing any on-vehicle service procedures. Failure to follow these precautions may result in personal injury.

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit / System Description

The fuel tank leak test is used to locate any fuel or fuel vapour escaping the fuel tank area. Fuel vapours escaping above the fuel level will be detected when the evaporative emission (EVAP) leak diagnostic test is completed.

Diagnostic Aids

- Operate the vehicle under the condition of the customer concern. Under high temperature conditions fuel vapours may increase to the point of EVAP canister vapour saturation. Fuel vapours would then be released into the atmosphere. Once the engine is running and the EVAP purge is enabled, all fuel vapour release would be removed.
- Movement of the EVAP pipes or the fuel pipes may help find an intermittent condition.
- If the fuel level is low, a liquid fuel leak may not be evident.

Circuit / System Verification

1. Verify that the fuel tank and the fuel pipes are not damage or leaking.
   If you located a condition, repair as necessary before continuing with diagnostic procedure.
2. Ignition ON, command the fuel pump relay ON with a scan tool. Verify that the fuel pipes are not leaking.
   If you located a condition, repair as necessary before continuing with diagnostic procedure.

   Note: Refer to the J 41413-200 Evaporative Emissions System Tester (EEST) operation manual for detailed instructions.

3. Ignition OFF, install commercially available smoke machine.
4. Command the EVAP vent solenoid closed with a scan tool.
5. Follow manufactures instructions , connect the smoke machine.
   If a leak is located, repair as necessary.

   Note: It may be necessary to partially lower the fuel tank.

6. Using the commercially available smoke machine introduce smoke into the EVAP system. Verify that there are no vapour leaks in any of the following locations:
    - The fuel tank, the fill limiter vent valve, the pressure relief valve, and the grade vent valves
    - The fuel sender housing, the fuel sender seal, the fuel pipe, and the EVAP pipes
    - The fuel tank pressure (FTP) sensor seal
    - The fuel fill pipe and hose.

    If a leak is observed, repair as necessary.

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Hard Start (Petrol)

Checks	Action
DEFINITION: The engine cranks OK, but does not start for a long time. The engine does eventually run, or may start but immediately dies.	
Preliminary Checks	• Refer to Important Preliminary Checks in Symptoms - Engine Controls). • Make sure the vehicle operator is using the correct starting procedure.
Fuel System Checks	• Test for correct fuel relay operation. • Test for correct fuel system pressures. Refer to Fuel System Diagnosis.
Sensor Checks	• Test the ECT sensor for correct operation by performing the following: 1. Allow the engine temperature to reach ambient air temperature by leaving the engine OFF for several hours - overnight for most accurate results. 2. Turn the ignition ON while leaving the engine OFF. 3. Using a scan tool compare the ECT and IAT sensors displayed temperature. The sensors should be within 3°C (5°F) of each other. 4. Replace the ECT sensor or repair the ECT sensor circuit if the ECT is not near the expected value. • Test the TP sensor for correct operation. With the throttle blade fully at rest the monitored TP sensor voltage on a scan tool should be LESS than 0.85 volts. If the TP sensor is not near the expected voltage check for the following conditions: - A faulty TP sensor - A faulty TP sensor circuit - A sticking throttle shaft or linkage/cable assembly • Test for correct operation of the crankshaft position (CKP) sensor. • Test for correct operation of the MAP sensor - if equipped.

Hesitation, Sag, Stumble (Petrol)

Checks	Action
DEFINITION: The vehicle has a momentary lack of response when depressing the accelerator pedal. The condition can occur at any vehicle speed. The condition is usually most severe when attempting to make the vehicle move, as from a stop sign. An extremely severe condition may cause the engine to stall.	
Preliminary Checks	Refer to Important Preliminary Checks in Symptoms - Engine Controls .
Fuel System Checks	• Test for correct fuel system pressures. Refer to Fuel System Diagnosis . Inspect for low pressure during moderate or full throttle acceleration. If the fuel pressure drops below specification, there is possibly a low or regulator fault or a fuel system restriction. • Test for correct EVAP purge system operation.
Sensor Checks	• Test for correct TP sensor operation. A TP sensor that does not respond quickly and accurately to throttle plate movement may cause this symptom. • Test for correct MAP sensor operation. A MAP sensor that does not respond quickly and accurately to manifold pressure changes may cause this symptom.
Ignition System Checks	• Inspect for fouled spark plugs. If fouled spark plugs are indicated the reason for the fouling must be found and corrected. • Test for faulty spark plug wires. • Test for an open ignition system ground.
Additional Checks	• Review service bulletins for module programming updates. • Inspect for manifold or air induction system leaks. • Test for correct generator operation.

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Intake Manifold Tuning Valve Diagnosis

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit / System Description

An intake manifold tuning (IMT) valve is used to change the intake manifold plenum configuration. When the IMT valve is open, the intake manifold is configured to one large plenum. When the IMT valve is closed, the intake manifold is configured to 2 smaller plenums. The IMT valve improves engine performance at low and high engine speeds.

Ignition voltage is supplied directly to the IMT solenoid. The engine control module (ECM) controls the solenoid by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Diagnostic Aids

- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool circuit status parameters for the component. The circuit status parameters change from OK or Not Run to Fault if there is a condition with the circuit or a connection.
- Inspect the IMT solenoid valve for witness marks that indicate that the valve was hitting the intake manifold. This condition may be temperature related.

Circuit / System Verification

Ignition ON, observe the DTC information with a scan tool. Verify that DTCs P0660, P0661, or P0662 are not set.

If any of the DTCs listed are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.

Circuit / System Testing

1. Ignition OFF, remove the intake manifold tuning (IMT) valve from the intake manifold, with the electrical connector connected.
2. Ignition ON, command the IMT solenoid ON and OFF with a scan tool. Verify that the IMT solenoid operates in both directions.

   If the IMT solenoid does not operate in both directions, replace the IMT solenoid.

3. Inspect the inside of the intake manifold for the following conditions:
    - Carbon build-up that limits the movement of the IMT valve
    - Casting flash that limits the movement of the IMT valve
    - Foreign material that limits the movement of the IMT valve

    If a condition is found, repair as necessary.
4. Clean or replace the upper intake manifold.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Intake Manifold Runner Control Solenoid Replacement
- Upper Intake Manifold Replacement

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Lack of Power, Sluggishness, or Sponginess (Petrol)

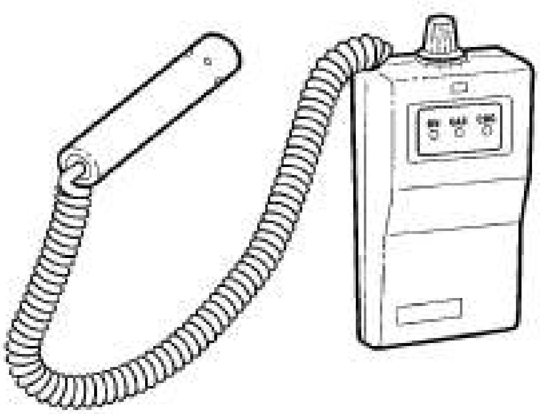
Checks	Action
DEFINITION: The engine delivers less than expected power. There is little or no increase in speed when partially applying the accelerator pedal.	
Preliminary Checks	• Refer to Important Preliminary Checks in Symptoms - Engine Controls . **Important::** Do not compare the power output of the vehicle while operating on LPG to a vehicle operating on petrol. Both fuels have different drive feel characteristics. • Verify the customers concern by comparing the power output of a similarly equipped known good vehicle to the suspect vehicle. • Inspect the air filter for correct type and for dirt or restriction. • Test the transmission for correct shift pattern and downshift operation. • Inspect the LPG ECM for the correct LPG calibration. Program the LPG ECM if necessary.
Fuel System Checks	• Test for correct fuel system pressures. Refer to Fuel System Diagnosis . • Inspect the lock-off filter and LPG fuel filter for restriction. Refer to Fuel Filter Replacement .
Ignition System Checks	**Important::** A higher secondary ignition voltage is required to operate the vehicle on LPG than on petrol. • Test for correct secondary ignition system voltage output using only the combustible gas detector Spark Tester. **Important::** More timing advance is required to operate the vehicle on LPG than on petrol. • Test for correct operation of the Knock Sensor system.
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Restrictions can include the following: • A failed catalytic converter • Damaged or collapsed pipes • An internally failed muffler - may show signs of heat distress
Engine Mechanical	Test for correct engine operation by checking for the following:

Checks	• Correct engine compression • Correct engine valve timing • Worn or incorrect camshafts
Additional Checks	• Test for correct A/C operation. A/C that is on all the time may cause this symptom. • Test for correct transmission torque converter clutch (TCC) operation, if equipped. • Test for correct generator operation. • Inspect for correct operation of the accelerator pedal. A stretched accelerator cable may cause this symptom.

Liquefied Petroleum Gas Leak Testing

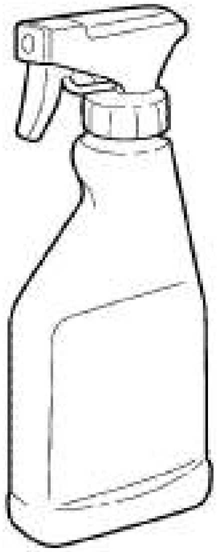
Important: The following leak test is to be performed on the LPG system high-pressure components and is to be performed at each normal maintenance schedule.

Important: The LPG leak test is to be performed in the open air in a well ventilated area, away from any ignition source and prior to bringing the vehicle into the workshop.



Important: LPG is heavier than air so test thoroughly below all components and fittings.

1. If a combustible gas detector is to be used for leak testing of the LPG system, the combustible gas detector should be capable of detecting 25 parts per million (PPM) of LPG in air.
2. It is important to follow the manufacturer's instructions in regard to adjustment and setting the instrument prior to conducting the test.
3. If a leak is present, a detector will signal its existence but not its size, and will indicate its general location, but may not be able to locate it exactly. A proving or follow up check with foam is often desirable.



Important: LPG is heavier than air so test thoroughly below all components and fittings.

4. If foam is to be used, the foaming agent should be a propriety leak test solution, formulated specifically for the purpose, such as Gameco Leak Check.
5. The leak test is performed by directing a spray of solution at each of the possible leak points in the high-pressure side of the system.
6. A leak is indicated by the presence of gas bubbles (foaming) in the solution at the leak source.

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Poor Fuel Economy (Petrol)

Checks	Action
DEFINITION: Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, the current fuel economy is noticeably lower than the vehicle's previous fuel economy, as shown by an actual road test.	
Preliminary Checks	• Refer to Important Preliminary Checks in Symptoms - Engine Controls . • Inspect the air filter for correct type and for dirt or restriction. • Inspect the vacuum hoses for leaks, restrictions and correct connections as shown on the vehicle emission control information (VECI) label. • Review the vehicle operators driving habits for the following items: - The A/C compressor clutch being engaged all the time - Excessive idling or stop and go driving - Correct tyre inflation - Excessively heavy loads being carried - Too much acceleration, too often Advise vehicle operator to fill the fuel tank and recheck fuel economy.
Fuel System Checks	• Test the fuel pressure. Refer to Fuel System Diagnosis • Inspect for fuel system leakage.
Sensor Checks	Test the engine coolant temperature (ECT) sensor for correct operation by performing the following: 1. Allow the engine temperature to reach ambient air temperature by leaving the engine OFF for several hours, overnight for most accurate results. 2. Turn the ignition ON while leaving the engine OFF. 3. Using a scan tool compare the ECT and intake air temperature (IAT) sensors displayed temperature. The sensors should be within 3°C (5°F) of each other. 4. Replace the ECT sensor or repair the ECT sensor circuit if the ECT is not near the expected value.
Ignition System Checks	• Remove and inspect the spark plugs for the following conditions: - Wet plugs - Cracks - Wear - Incorrect gap - Burned electrodes

	- Heavy deposits • Test for an open ignition control (IC) circuit. • Inspect the spark plug wires for the following: - Cracking - Hardness - Correct connections and routing **Important::** More timing advance is required to operate the vehicle on LPG than on petrol. • Test for correct operation of the Knock Sensor system.

Poor Fuel Fill Quality (Petrol)

Checks	Action
DEFINITION: Fuel filling time, as measured against previous filling time, is noticeably longer than expected.	
Fuel System Checks	Inspect for the following conditions: • A contaminated or clogged fill valve filter. A service interval is not specified for the fill valve filter. Its condition depends on fuel quality. Use of LPG with excessive amounts of contaminants will increase the frequency of service. Service if necessary. • A fill line union check valve that is restricted or incorrectly installed. The check valve flow direction arrow should point towards the fuel tank.

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Rough, Unstable, or Incorrect Idle and Stalling (Petrol)

Checks	Action
DEFINITION: The engine runs unevenly at idle. If severe enough, the engine or vehicle may shake. The engine idle speed may vary in RPM. Either condition may be severe enough to stall the engine.	
Preliminary Checks	Refer to Important Preliminary Checks in Symptoms - Engine Controls .
Sensor Checks	• Test for correct operation and performance of the oxygen sensor. Inspect the oxygen sensor for silicon contamination. Caused by fuel or the use of incorrect engine sealants, the oxygen sensor will have a white, powdery coating. The sensor will output a high, but false signal voltage. This false rich condition may cause the LPG ECM to reduce the amount of fuel to the engine. • Test the ECT sensor for correct operation by performing the following: 1. Allow the engine temperature to reach ambient air temperature by leaving the engine OFF for several hours - overnight for most accurate results. 2. Turn the ignition ON while leaving the engine OFF. 3. Using a scan tool compare the ECT and IAT sensors displayed temperature. The sensors should be within 3°C (5°F) of each other. 4. Replace the ECT sensor or repair the ECT sensor circuit if the ECT is not near the expected value. • Test for correct MAP sensor operation. A MAP sensor that does not respond quickly and accurately to manifold pressure changes may cause this symptom.
Fuel System Checks	• Determine if the condition is rich or lean by performing the following: - Operate the vehicle under the conditions of the concern. - Monitor the oxygen sensor output. • Test for leaking fuel injectors. • Inspect for correct operation of the LPG fuel injectors. Refer to: Fuel Injector Balance Test with Special Tool • Test for correct EVAP Purge system operation. • Test for correct alternative fuel system pressures. Refer to Fuel System Diagnosis .
Additional Checks	• Inspect for manifold or air induction system leaks. • Test the PCV system for correct operation and valve type. • Test for correct engine cylinder compression.

Surges/Chuggles (Petrol)

Checks	Action
DEFINITION: The engine has a power variation under a steady throttle or cruise. The vehicle feels as if speeds up and slows down with no movement of the accelerator pedal.	
Preliminary Checks	• Refer to Important Preliminary Checks in Symptoms - Engine Controls . • Ensure the vehicle operator understands the transmissions torque converter clutch (TCC) operation, if equipped. • Ensure the vehicle operator understands the A/C compressor clutch operation, if equipped.
Sensor Checks	• Test for correct operation of the vehicle speed sensor (VSS). • Test for correct operation and performance of the oxygen sensor.
Fuel System Checks	• Inspect for a lean or rich engine condition. Using a scan tool observe the oxygen sensor output while operating the vehicle under the symptom condition. • Test for correct fuel system pressures. Refer to Fuel System Diagnosis . • Inspect for correct operation of the LPG fuel injectors. Refer to: Fuel Injector Balance Test with Special Tool • Make sure that the manual shut-off valve is fully open. • Inspect for restricted LPG lock-offs or filter. Refer to and Fuel Filter Replacement .

Symptoms - Engine Controls

Symptoms Description

Driveability symptoms do not set DTCs. The driveability symptoms are defined below. Certain conditions can cause multiple symptoms. These conditions are listed together. Additional conditions that may only cause certain symptoms are listed separately. Perform the Symptoms Testing before using the Additional Symptoms Tests.

Symptoms Definition

Backfire: Fuel ignites in the intake manifold or in the exhaust system making a loud popping noise.

Cuts Out, Misses: A steady pulsation or jerking that follows engine speed which is usually more pronounced as the engine load increases. This condition is not normally felt above 1500 RPM or 48 km/h (30 mph). The exhaust has a steady spitting sound at idle or at low speed.

Detonation/Spark Knock: A mild to large ping which usually occurs worse while under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

Dieseling, Run-On: Fuel ignites in the intake manifold or in the exhaust system making a loud popping noise.

Hard Start: Engine cranks OK but does not start for a long time. The vehicle does eventually run or may start but immediately stalls.

Hesitation, Sag or Stumble: Momentary lack of response as the accelerator is pushed down. This condition can occur at any vehicle speed. This condition is usually more pronounced when first trying to make the vehicle move from a stationary position. This condition may cause the engine to stall under some conditions.

Lack of Power, Sluggishness or Sponginess: The engine delivers less than expected power. Little or no increase in speed when the accelerator pedal is pushed down part way.

Poor Fuel Economy: Fuel economy as measured by an actual road test is noticeably lower than expected. Also, the fuel economy is noticeably lower than it was on this vehicle at one time. As previously shown by an actual road test.

Poor Fuel Fill Quality: Difficulty when refuelling the vehicle.

Rough, Unstable, Incorrect Idle and Stalling: The engine runs unevenly at idle. The engine or the vehicle may shake. Engine idle may vary in speed. Either condition may cause the engine to stall.

Surges/Chuggles: Engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the accelerator pedal position.

Symptoms Verification

Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure. Verify that all of the following conditions are true:

- The engine Control Module (ECM) and the malfunction indicator lamp (MIL) are operating correctly
- There are no DTCs stored
- The scan tool data is within the normal operating range
- Bulletins are not available for the current symptom
- The ECM grounds are clean, tight and in the correct locations
- The vehicle tyres are correctly inflated and meet original equipment specifications
- The air filter element is not restricted.

Symptoms Testing

1. Test for the following conditions:
    - The fuel system for the following:
        - Correct fuel pressure. Refer to Fuel System Diagnosis
        - Fuel injectors that are leaking or incorrect operation. Refer to Fuel Injector Balance Test with Special Tool or Fuel Injector Balance Test with Tech 2.
    - The ignition system for the following:
        - Spark plugs for incorrect heat range or an abnormal condition. Refer to Spark Plug Inspection.
        - For diagnosis of coolant or oil fouled spark plugs. Refer to Loss of Coolant or Oil Consumption Diagnosis.
        - Wet down the secondary ignition system with water from a spray bottle. Wetting down the secondary ignition system may help locate damaged or deteriorated components. Look/listen for arcing or misfiring as the water is applied.
        - Weak spark using a commercially available Spark Tester. Refer to Electronic Ignition (EI) System Diagnosis.
    - The operation of the transmission torque converter clutch (TCC) The scan tool should indicate an engine speed drop when the TCC is commanded ON
    - The A/C changing state
    - Items that can cause an engine to run lean or rich. Refer to DTC P2178, P2180, P2188, or P2190
    - The crankshaft position (CKP) sensor for the correct resistance-The CKP sensor resistance may be out of range after a hot soak. The resistance should be between 700-1200 Ω
    - The engine for the following mechanical failures. Refer to Symptoms - Engine Mechanical.
        - Oil in the combustion chamber or leaking valve seals.
        - Incorrect cylinder compression.
        - Sticking or leaking valves.
        - Worn camshaft lobes.
        - Incorrect valve timing.
        - Broken valve springs.
        - Carbon buildup in the combustion chambers-Clean the chambers with top engine cleaner. Follow the instructions on the can.

    - Incorrect engine parts.
- Emission/Vacuum hoses for splits or kinks. Verify that the routing and connections are as shown on the Vehicle Emission Control Information label
- Knock sensor (KS) system for incorrect spark retard activity. Refer to Knock Sensor (KS) System Description.
- The exhaust system components for the following:
    - Physical damage or possible internal failure.
    - The three-way catalytic converters for a restriction
    - For more information, refer to Symptoms - Engine Exhaust.
- Electromagnetic interference (EMI) on the reference circuit can cause a misfire condition. You can usually detect EMI with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter with little change in actual engine speed indicates that EMI is present. Inspect the high voltage components near the ignition control circuit if a condition exists.
- Inspect the positive crankcase ventilation (PCV) system and all connections for leaks or restrictions.
- Evaporative emission (EVAP) canister purge solenoid that is stuck open.
- The engine cooling system for the following conditions:
    - The thermostat is the correct heat range-Refer to Thermostat Diagnosis.
    - Proper engine coolant level-Refer to Cooling System Draining and Filling.

2. If the above conditions do not address the symptom, refer to the additional symptoms tests.

Additional Symptoms Tests

Detonation/Spark Knock: Test the engine for an overheating condition. Refer to Engine Overheating.

Poor Fuel Economy: Inspect for foreign material accumulation in the throttle bore and for carbon deposits on the throttle plate and shaft. Also inspect for throttle body tampering.

Rough, Unstable or Incorrect Idle and Stalling: Inspect the engine mounts. Refer to Engine Mount Inspection

Surges/Chuggles: Test the heated oxygen sensors (HO2S). The HO2S should respond quickly to a change in throttle position. If the HO2S do not respond to different throttle positions inspect for contamination from fuel, silicon or the incorrect use of RTV sealant. The sensors may have a white powdery coating and result in a high but false signal voltage which gives a rich exhaust indication. The ECM reduces the amount of fuel delivered to the engine causing a driveability condition.

Hard Start

- Test the engine coolant temperature (ECT) sensor. Compare the ECT sensor value to the intake air temperature (IAT) sensor value on a cold engine. The ECT and IAT sensor values should be within ± 3°C (5°F). If the ECT sensor is out of range with the IAT sensor test the resistance of the ECT sensor. Refer to Temperature Versus Resistance - Engine Coolant Temperature Sensor for resistance specifications. Replace the ECT sensor if the resistance is not within specification. Refer to Engine Coolant Temperature Sensor Replacement in Engine Controls - 3.6L. If the sensor is within the specification, test the ECT circuits for a short to ground open/high resistance.

- Test the fuel pump relay operation. The fuel pump should turn ON for 2 seconds when the ignition is turned ON. Refer to Fuel Pump Electrical Circuit Diagnosis.

Hesitation, Sag, Stumble

- Test the fuel pressure. Refer to Fuel System Diagnosis.
- Test the generator. Refer to Symptoms - Engine Electrical. Repair the charging system if the generator output voltage is less than 9 V or more than 16 V.

Poor Fuel Economy

- Heavy loads being carried or towed
- Acceleration rate too much or too often
- Inspect for foreign material accumulation in the throttle bore, for carbon deposits on the throttle plate and shaft. Also inspect for throttle body tampering.

Poor Fuel Fill Quality

Test for the following conditions that is applicable to the current symptom.

Difficult to Fill

- Restricted vent lines
- The evaporative emission (EVAP) vent valve is stuck closed
- High fuel temperature
- A condition with the internal components of the fuel tank assembly

  For more information, refer to:
- Fuel Hose/Pipes Routing Diagram.
- Evaporative Emissions Hose Routing Diagram.
- Fuel System Description.
- Evaporative Emission Control System Description.

Fuel Odour

- Saturated EVAP canister. Refer to Evaporative Emission Control System Description
- A condition with the internal components of the fuel tank assembly. Refer to Fuel System Description.

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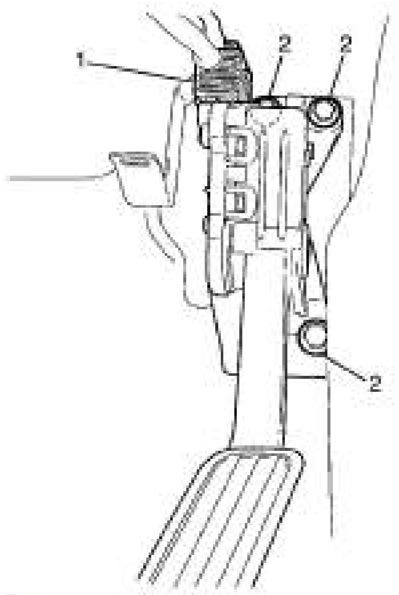
Accelerator Pedal Position Sensor Replacement

Removal Procedure

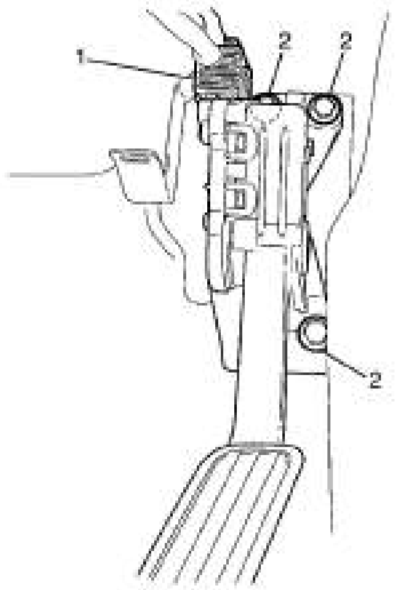
1. Remove the closeout/insulator panel from under the dashboard on the drivers side. Refer to Instrument Panel Insulator Panel Replacement - Left Side.

   Notice: Handle the electronic throttle control components carefully. Use cleanliness in order to prevent damage. Do not drop the electronic throttle control components. Do not roughly handle the electronic throttle control components. Do not immerse the electronic throttle control components in cleaning solvents of any type.



2. Disconnect the accelerator pedal position (APP) sensor electrical connector (1) from the accelerator pedal module.
3. Remove the APP sensor mounting screws (2).
4. Remove the APP sensor from the vehicle.

Installation Procedure



1. If previously removed, install the APP sensor bracket to the front of dash.

   Notice: Refer to Fastener Notice in the Preface section.

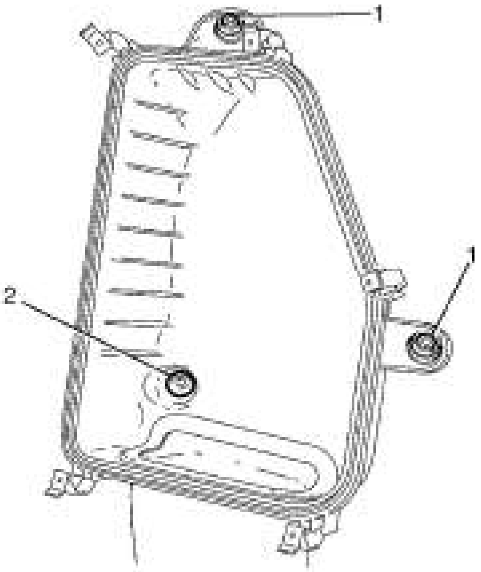
2. Install the APP sensor.

   Tighten
   Tighten the APP sensor bracket screws (2) to 9 N·m (80 lb in).

3. Connect the APP sensor electrical connector (1).
4. Operate the accelerator pedal and observe the APP angles using a scan tool. The accelerator pedal should operate freely, without binding between closed throttle and wide open throttle.
5. Install the closeout/insulator panel. Refer to Instrument Panel Insulator Panel Replacement - Left Side.

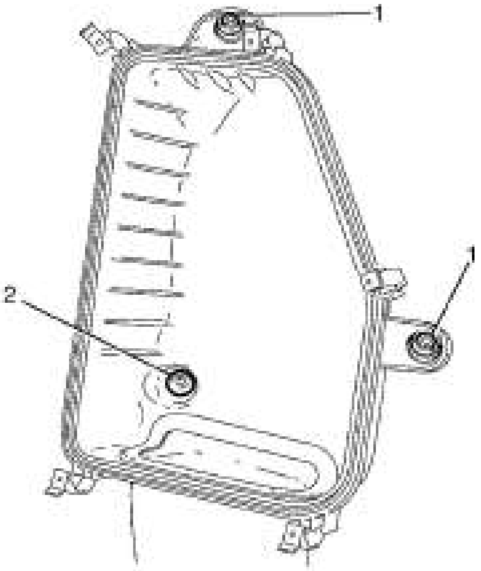
Air Cleaner Assembly Replacement

Removal Procedure



1. Remove the air cleaner intake duct. Refer to Air Cleaner Inlet Duct Replacement .
2. Remove air cleaner element refer to Air Cleaner Element Replacement
3. Remove the air cleaner to chassis retaining bolts (1).
4. Remove the air cleaner assembly from the vehicle.

Installation Procedure



1. Install the air cleaner to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the air cleaner to chassis retaining bolts (1).

   Tighten
   Tighten the air cleaner to chassis bolts to 9 N·m (78 lb in).

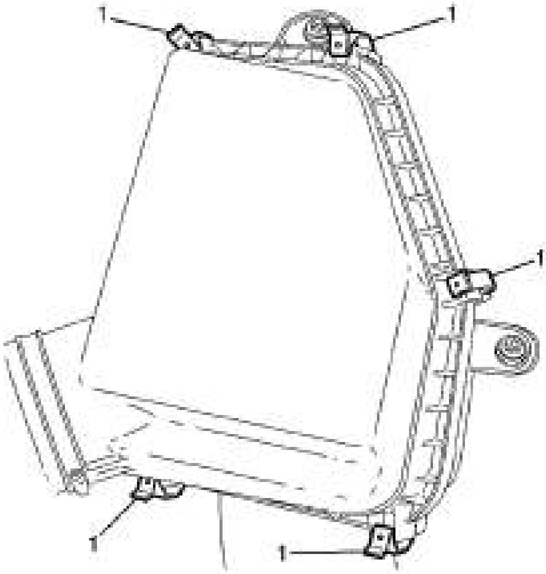
3. Install the air cleaner element Refer to Air Cleaner Element Replacement
4. Install the air cleaner intake duct. Refer to Air Cleaner Inlet Duct Replacement .

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | Document ID: 1993407

Air Cleaner Element Replacement

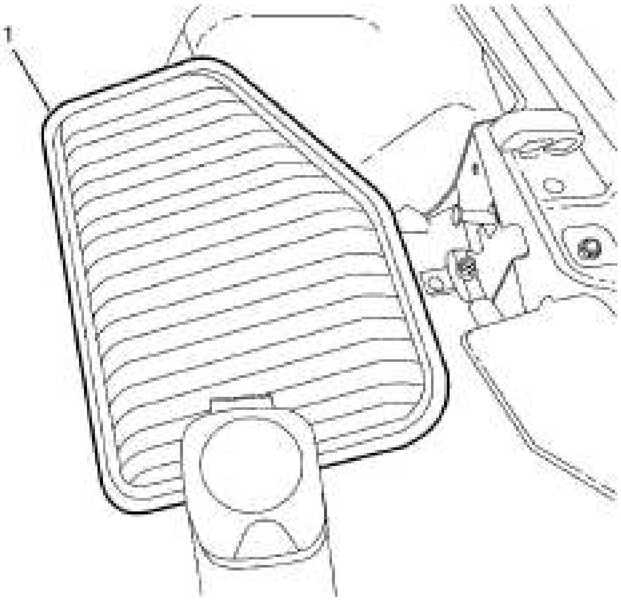
Removal Procedure

1. Remove the air cleaner intake duct. Refer to Air Cleaner Inlet Duct Replacement.

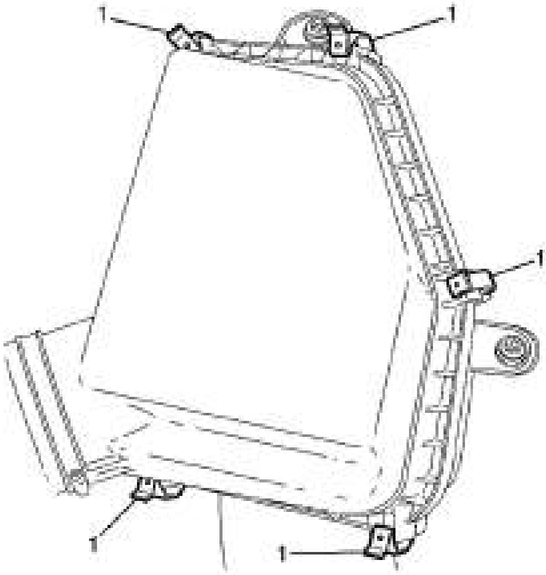


2. Release the air cleaner cover retaining clips (1) and remove the air cleaner element from the air filter assembly.

Installation Procedure



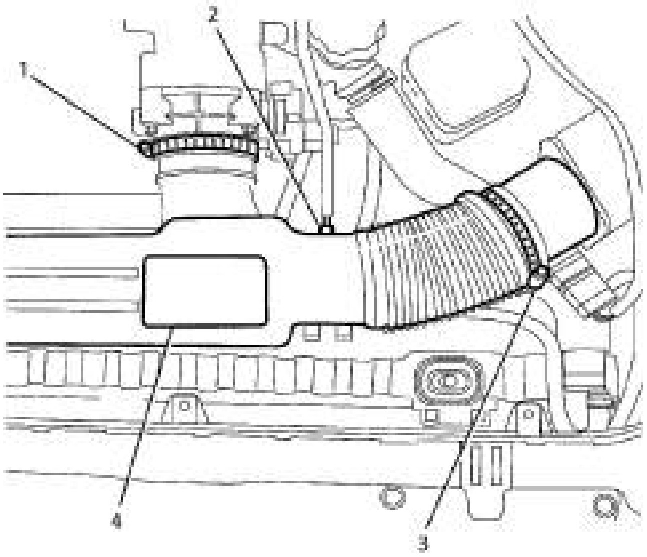
1. Install the air cleaner element (1) to the air cleaner assembly.



2. Install the air cleaner cover retaining clips (1) .
3. Install the air cleaner intake duct. Refer to Air Cleaner Inlet Duct Replacement.

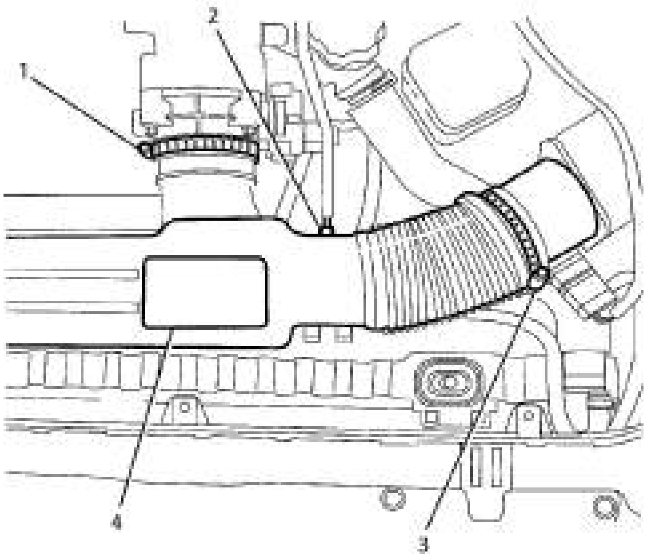
Air Cleaner Inlet Duct Replacement

Removal Procedure



1. Remove the positive crankcase ventilation (PCV) hose (2) from the air cleaner duct resonator (4).
2. Remove the air cleaner duct to throttle body retaining clamp (1).
3. Remove the air cleaner duct to air cleaner assembly clamp (3)
4. Remove the air cleaner duct (4).

Installation Procedure



1. Install the air cleaner intake duct (4) to the engine.

   Notice: Refer to Fastener Notice in the Preface section.

2. Tighten the air cleaner duct clamps.
3. Install the air cleaner duct to throttle body retaining clamp (1).

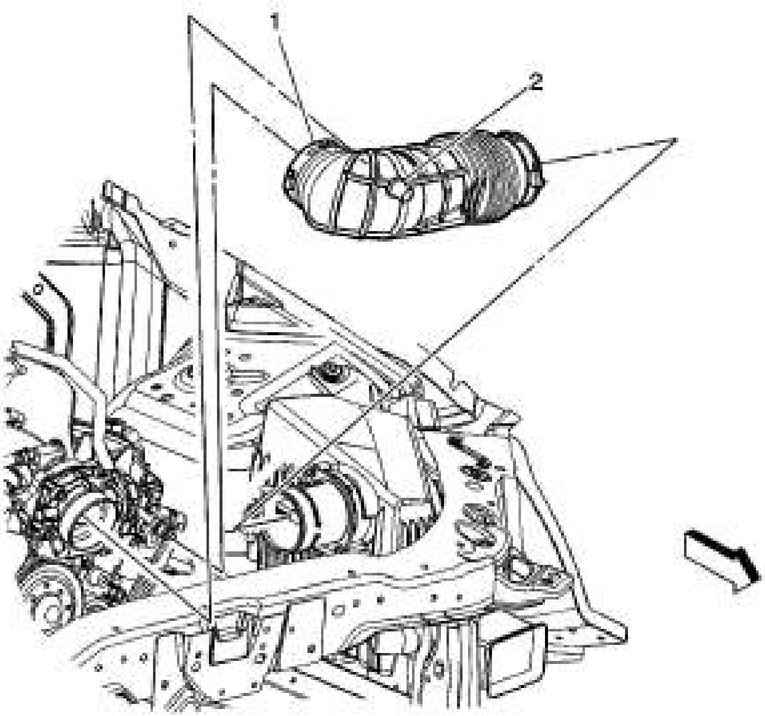
   Tighten
   Tighten the air cleaner duct clamps to 4 N·m (35 lb in).

4. Install the air cleaner duct to air cleaner assembly clamp (3)

   Tighten
   Tighten the air cleaner duct clamps to 4 N·m (35 lb in).

5. Install the PCV hose (2) to the intake duct resonator.

Air Cleaner Outlet Duct Replacement (LLT)



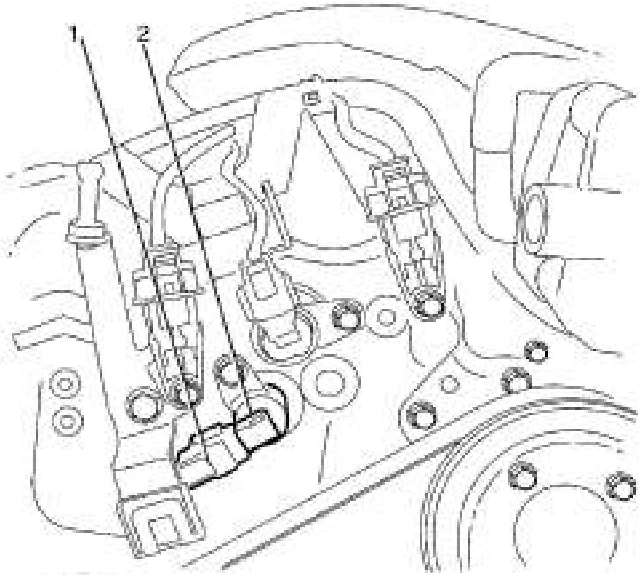
Callout	Component Name
Preliminary Procedure Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement.	
1	Clamp (Qty: 2) **Caution:** Refer to Fastener Caution in the Preface section. **Tighten** 4 N·m (35 lb in)
2	Air Cleaner Duct **Procedure** Align the air cleaner duct with the PCV vent tube during installation.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | Document ID: 1976183

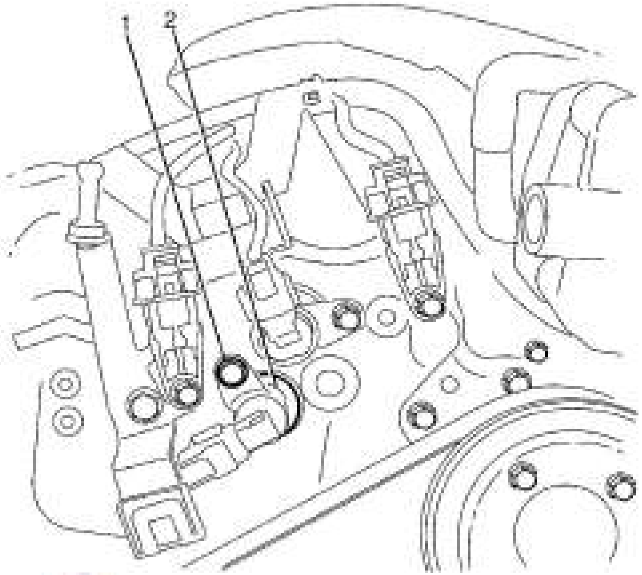
Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust

Removal Procedure

1. Turn the ignition OFF.



2. Remove the camshaft position (CMP) actuator valve electrical connector (1) from the CMP (2).

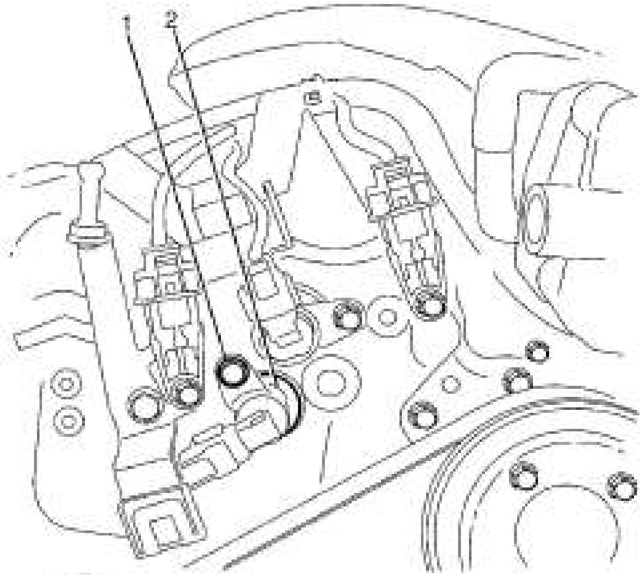


3. Remove the CMP actuator solenoid valve to engine front cover retaining bolt (1).

4. Remove the CMP actuator valve (2).
5. Inspect the CMP actuator valve seal and replace as necessary.

Installation Procedure

1. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.

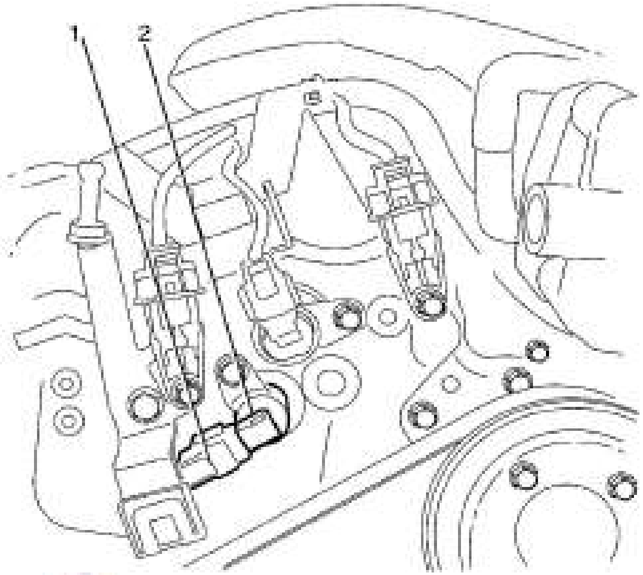


2. Install the CMP actuator valve (2) to the engine front cover.

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the CMP actuator solenoid valve to engine front cover retaining bolt (1).

   Tighten
   Tighten the bolt to 10 N·m (89 lb in).



4. Install the CMP valve electrical connector (1) to the CMP actuator valve.

Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake

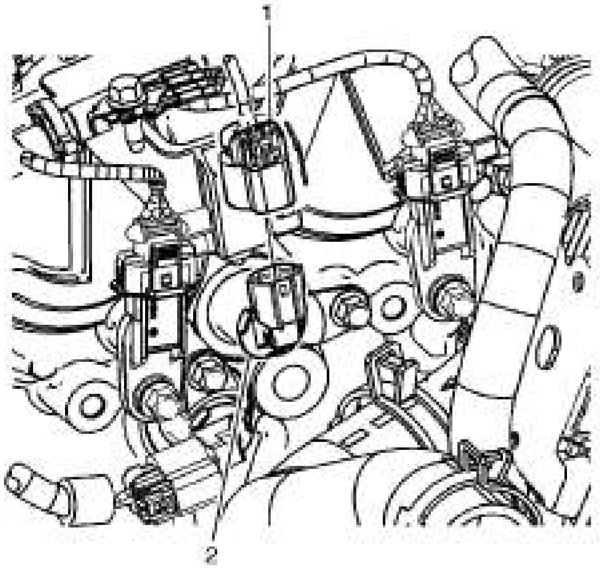
Removal Procedure

1. Turn the ignition OFF.

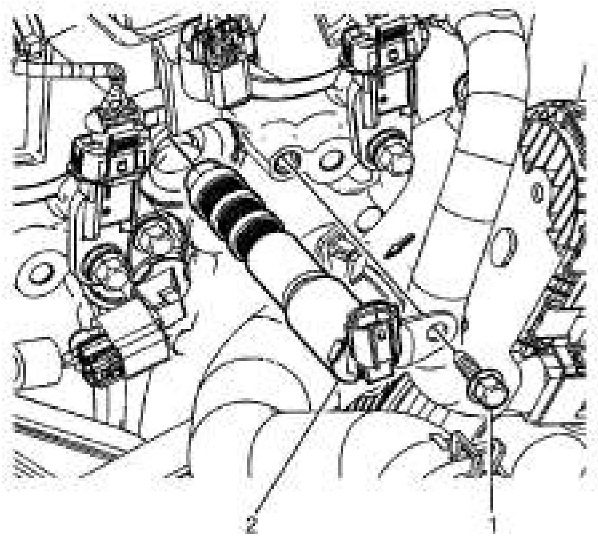
   Important: Do not remove the engine Control Module (ECM) from the ECM bracket .

   Do not remove the ECM redundant ground wire from the ECM.

2. Remove the remote earth post bracket to engine front cover retaining bolts.



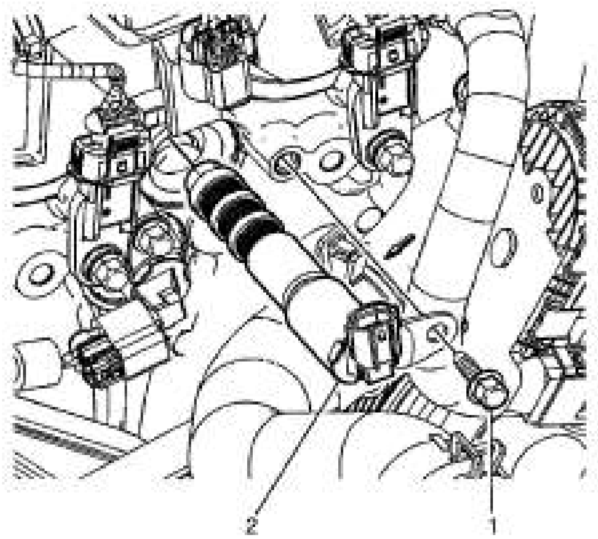
3. Remove the camshaft position (CMP) actuator valve electrical connector (1) from the CMP sensor (2).



4. Remove the CMP actuator solenoid valve to engine front cover retaining bolt (1).
5. Remove the CMP actuator valve (2) from the engine front cover.
6. Inspect the CMP actuator valve seal and replace as necessary.

Installation Procedure

1. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.

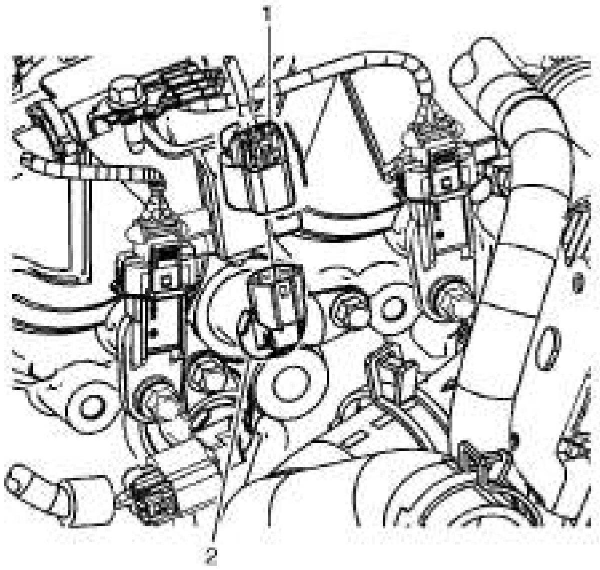


2. Install the CMP actuator valve (2) to the engine front cover.

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the CMP actuator solenoid valve to engine front cover retaining bolt (1).

Tighten
Tighten the bolt to 10 N·m (89 lb in).



4. Install the CMP actuator valve electrical connector (1) to the CMP sensor (2).
5. Install the remote earth post bracket to engine front cover retaining bolts.

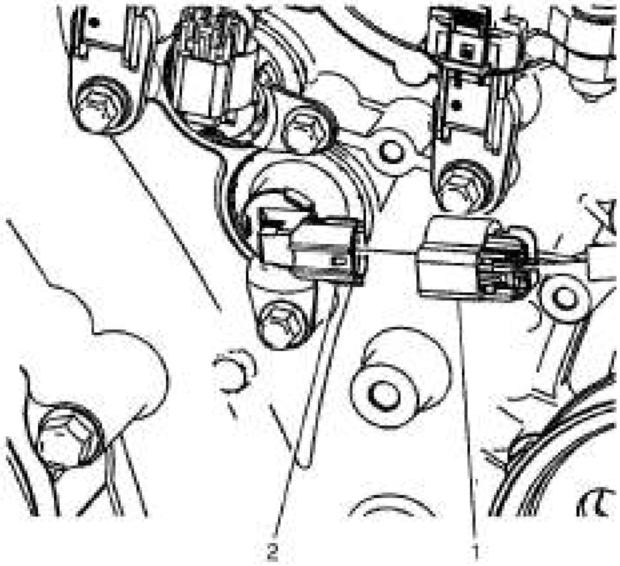
Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust

Removal Procedure

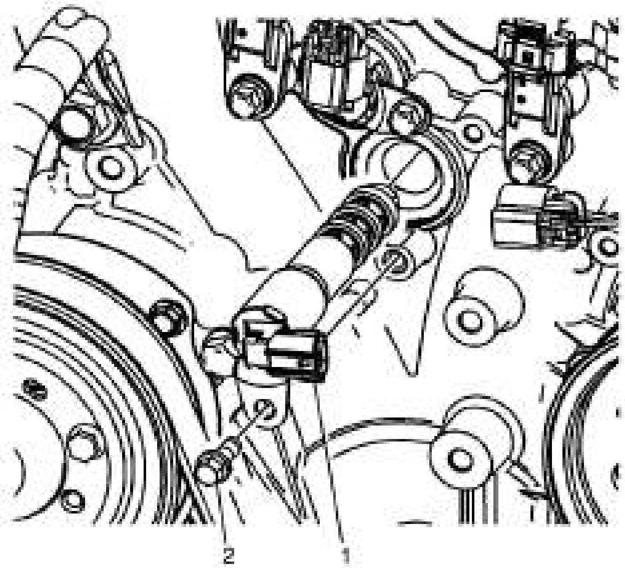
1. Turn the ignition OFF.

   Important: Do not disconnect the power steering fluid lines/hoses from the reservoir.

2. Remove the power steering fluid reservoir bolts and reposition the power steering fluid reservoir in order to provide access. Refer to Power Steering Fluid Reservoir Replacement .



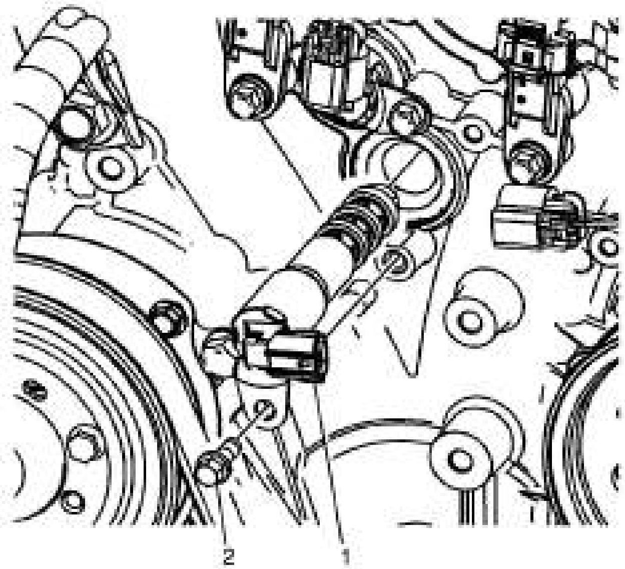
3. Remove the camshaft position (CMP) actuator valve electrical connector (1) from the CMP actuator valve (2).



4. Remove the CMP actuator solenoid valve to engine front cover retaining bolt (1).
5. Remove the CMP actuator valve (2) from the engine front cover.
6. Inspect the CMP actuator valve seal for damage and replace as necessary.

Installation Procedure

1. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.



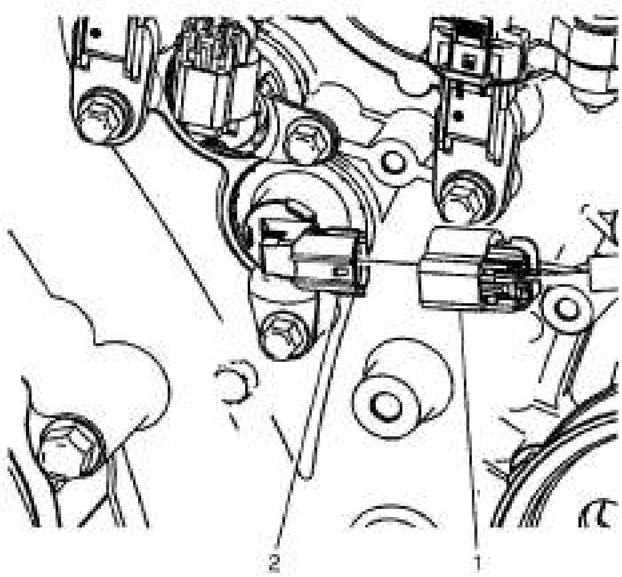
2. Install the CMP actuator valve (2) to the engine front cover.

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the CMP actuator solenoid valve to engine front cover retaining bolt (1).

Tighten

Tighten the bolt to 10 N·m (89 lb in).



4. Install the CMP actuator valve electrical connector (1) to the CMP actuator valve (2).
5. Install the power steering fluid reservoir. Refer to Power Steering Fluid Reservoir Replacement .

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | **Document ID: 1976184**

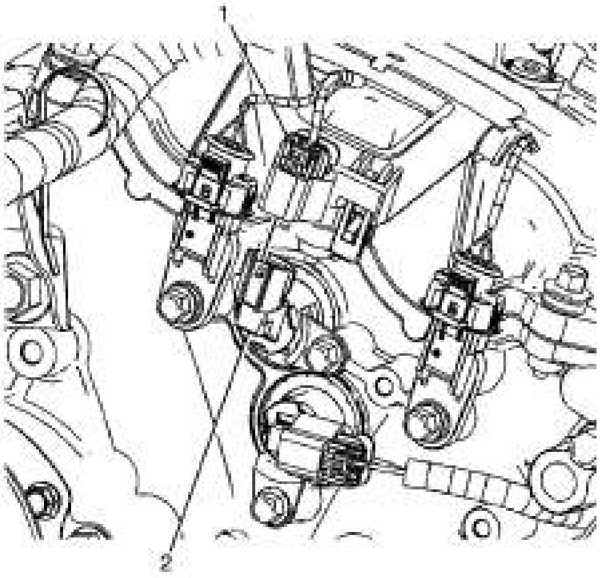
Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake

Removal Procedure

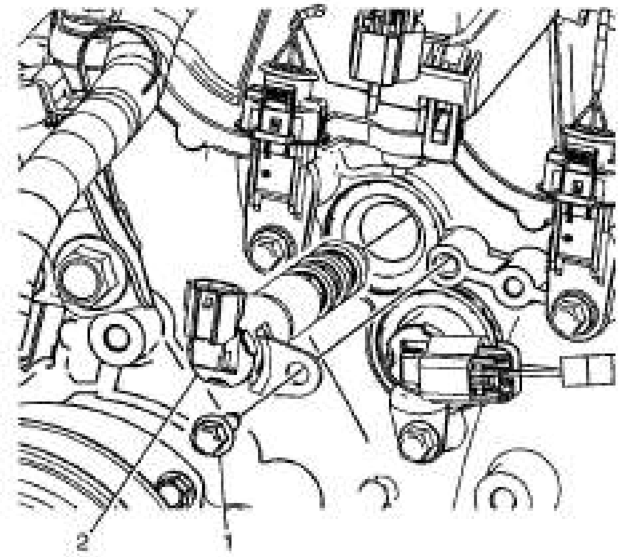
1. Turn the ignition OFF.

   Important: Do not disconnect the power steering fluid lines/hoses from the reservoir.

2. Remove the power steering fluid reservoir bolts and reposition the power steering fluid reservoir in order to provide access. Refer to Power Steering Fluid Reservoir Replacement .



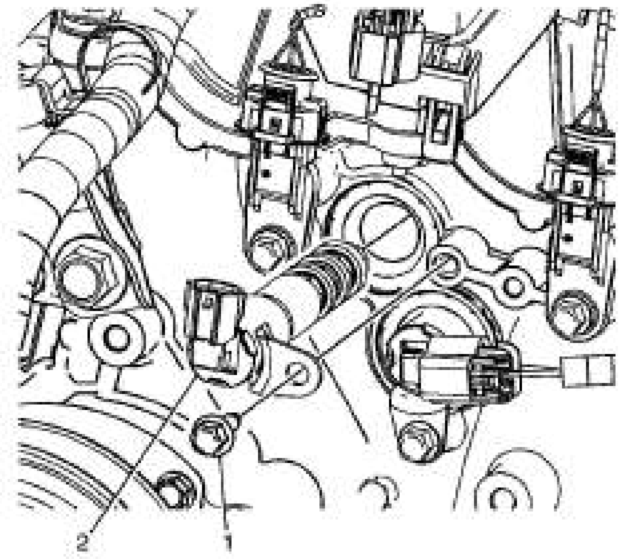
3. Remove the camshaft position (CMP) actuator valve electrical connector (1) from the CMP actuator (2).



4. Remove the CMP actuator solenoid valve to engine front cover retaining bolt (1).
5. Remove the CMP actuator valve (2) from the engine front cover.
6. Inspect the CMP actuator valve seal for damage and replace as necessary.

Installation Procedure

1. Inspect the CMP actuator valve seal for damage. Replace the seal if necessary.

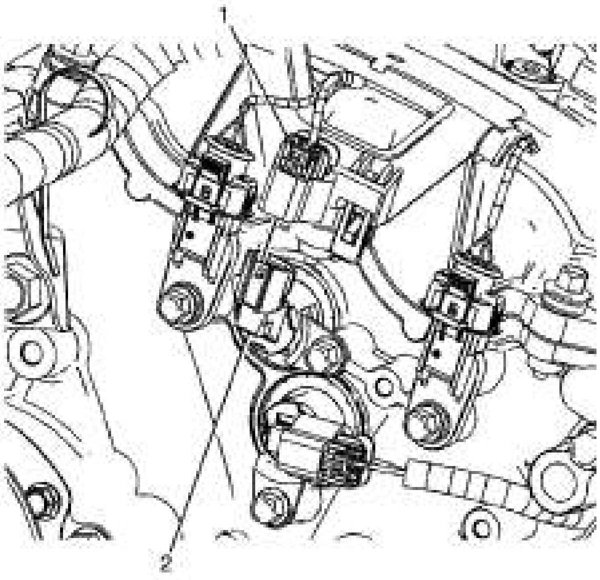


2. Install the CMP actuator valve (2) to the engine front cover.

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the CMP actuator solenoid valve to engine front cover retaining bolt (1).

Tighten
Tighten the bolt to 10 N·m (89 lb in).



4. Install the CMP actuator valve electrical connector (1) to the CMP actuator valve (2).
5. Install the power steering fluid reservoir. Refer to Power Steering Fluid Reservoir Replacement .

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | **Document ID: 1993390**

Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust

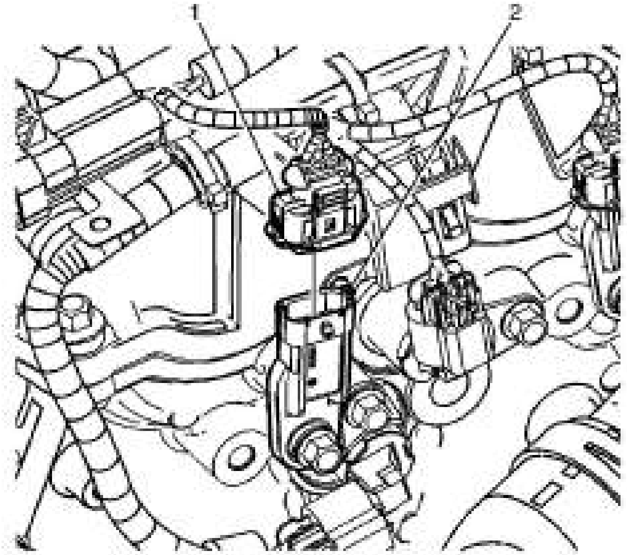
Removal Procedure

1. Turn the ignition OFF.

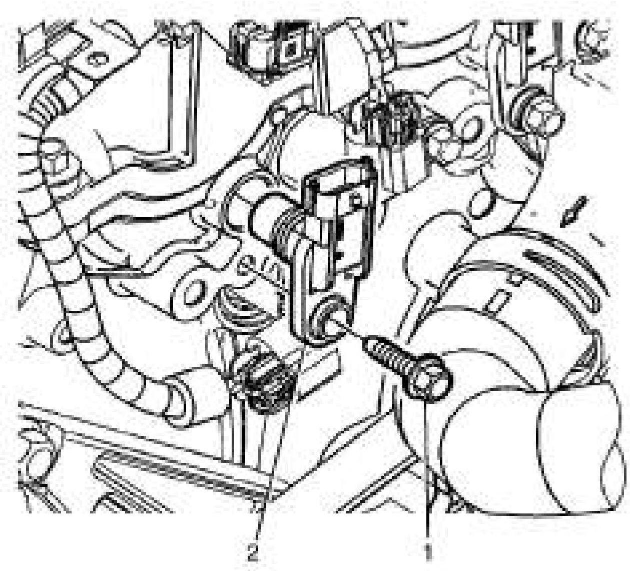
   Important: Do not remove the engine Control Module (ECM) from the ECM bracket.

   Do not remove the ECM redundant ground wire from the ECM.

2. Remove the remote earth post bracket to engine front cover retaining bolts and reposition the remote earth post bracket in order to provide access.

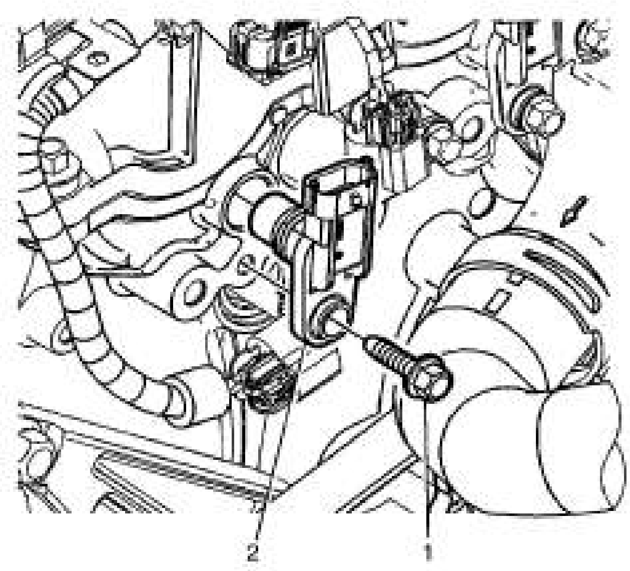


3. Remove the camshaft position (CMP) sensor electrical connector (1) from the CMP sensor (2).



4. Remove the the CMP sensor to engine front cover retaining bolt (1).
5. Remove the CMP sensor (2) from the engine front cover.

Installation Procedure

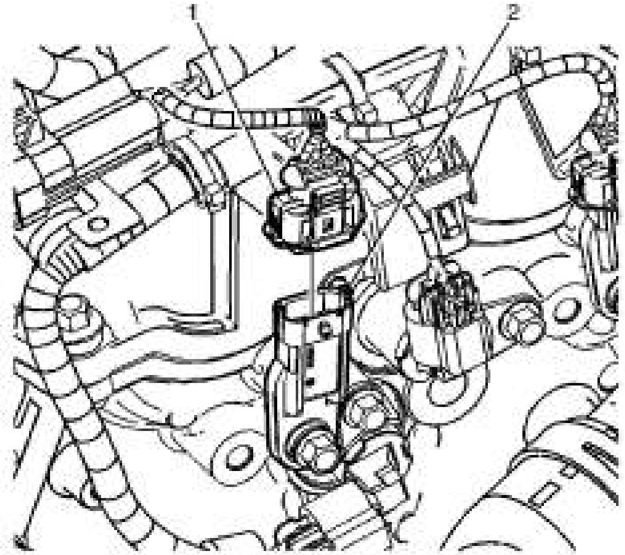


1. Install the CMP sensor (2) to the engine front cover.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the CMP sensor to engine front cover retaining bolt (1).

Tighten
Tighten the bolt (1) to 10 N·m (89 lb in).



3. Install the CMP sensor electrical connector (1) to the CMP sensor (2) .
4. Install the remote earth post bracket to engine front cover retaining bolts.

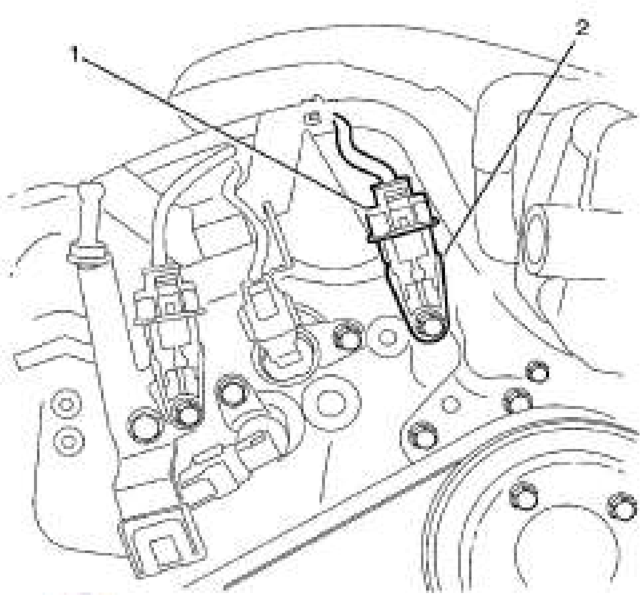
Tighten
Tighten the remote earth post bracket bolts to 10 N·m (89 lb in).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | **Document ID: 1976178**

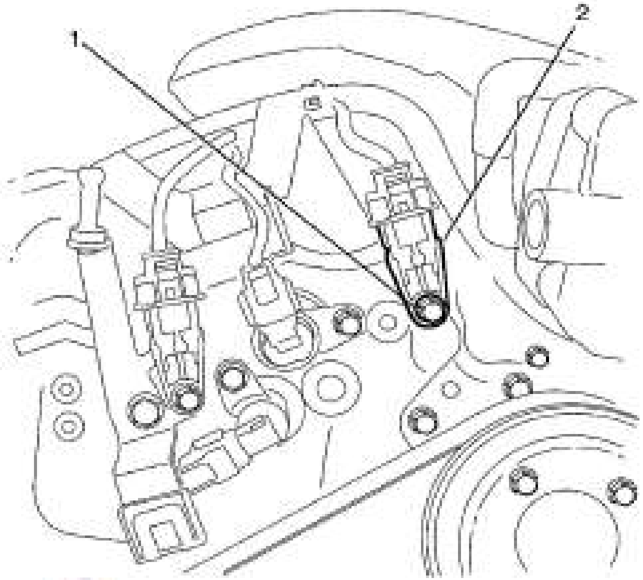
Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake

Removal Procedure

1. Turn the ignition OFF.



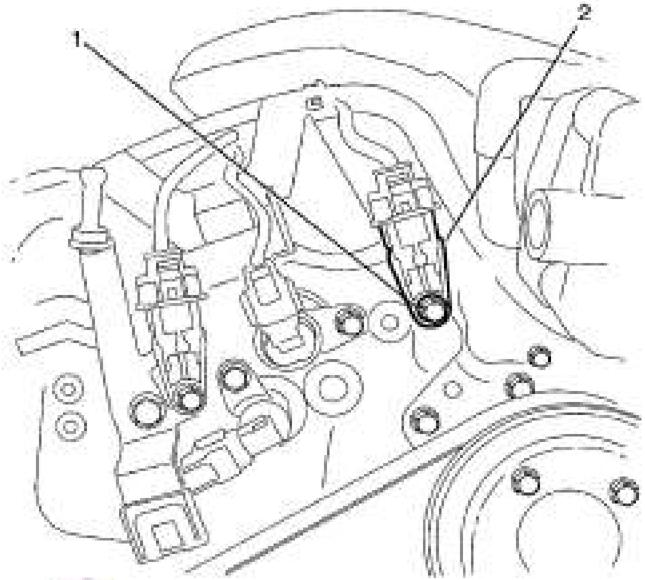
2. Remove the camshaft position (CMP) sensor electrical connector (1) from the CMP sensor (2).



3. Remove the the CMP sensor to engine front cover retaining bolt (1).

4. Remove the CMP sensor from the engine front cover (2).

Installation Procedure

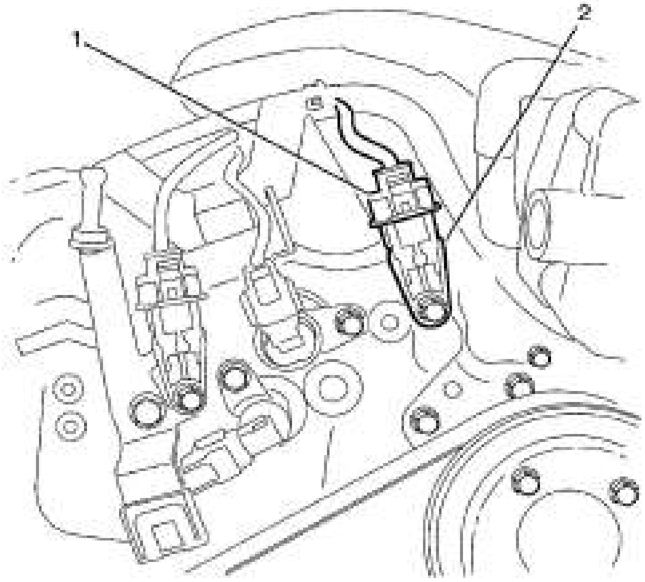


1. Install the CMP sensor (2) to the engine front cover.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the CMP sensor to engine front cover retaining bolt (1).

   Tighten
   Tighten the bolt to 10 N·m (89 lb in).



3. Install the CMP sensor electrical connector (1) to the CMP sensor.

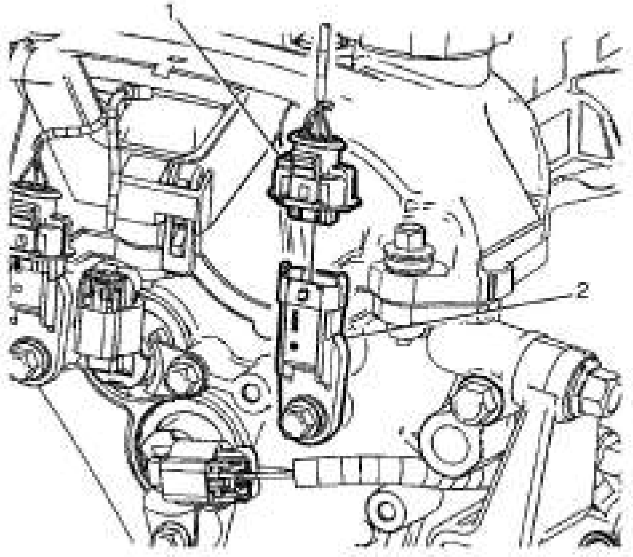
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | Document ID: 1993389

Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust

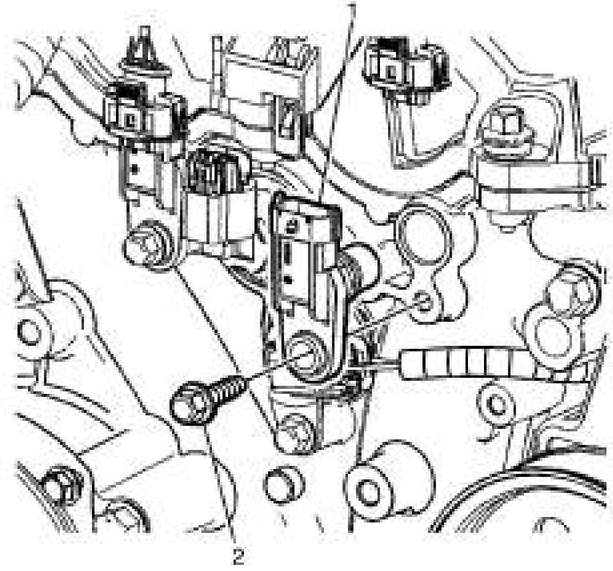
Removal Procedure

Important: Do not disconnect the power steering fluid lines/hoses from the reservoir.

1. Remove the power steering fluid reservoir bolts and reposition the power steering fluid reservoir in order to provide access. Refer to Power Steering Fluid Reservoir Replacement .

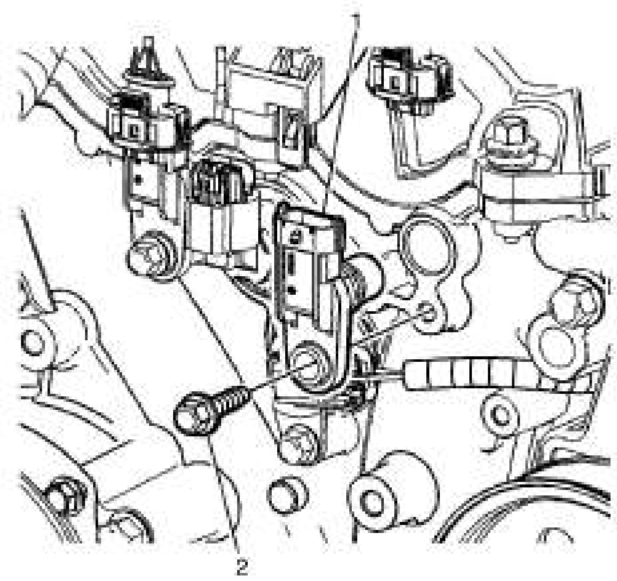


2. Remove the camshaft position (CMP) sensor electrical connector (1) from the CMP sensor (2).



3. Remove the CMP sensor to engine front cover retaining bolt (1).
4. Remove the CMP sensor (2) from the engine front cover.

Installation Procedure

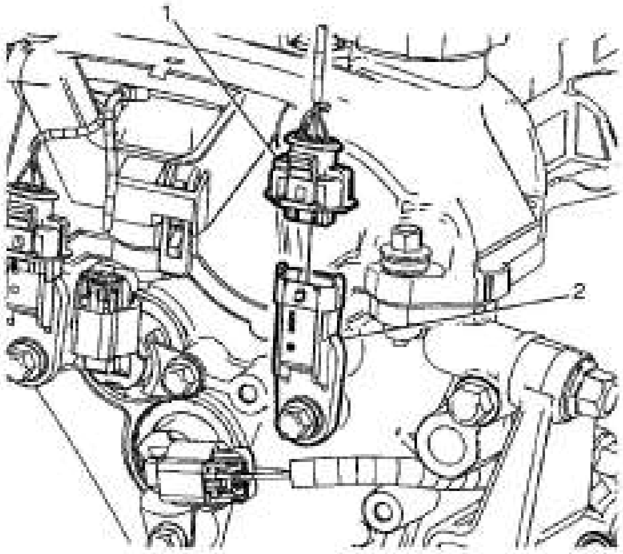


1. Install the CMP sensor to the engine front cover.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the CMP sensor to engine front cover retaining bolt (1).

   Tighten
   Tighten the bolt to 10 N·m (89 lb in).



3. Install the CMP sensor electrical connector (1) to the CMP sensor (2).
4. Install the power steering fluid reservoir. Refer to Power Steering Fluid Reservoir Replacement .

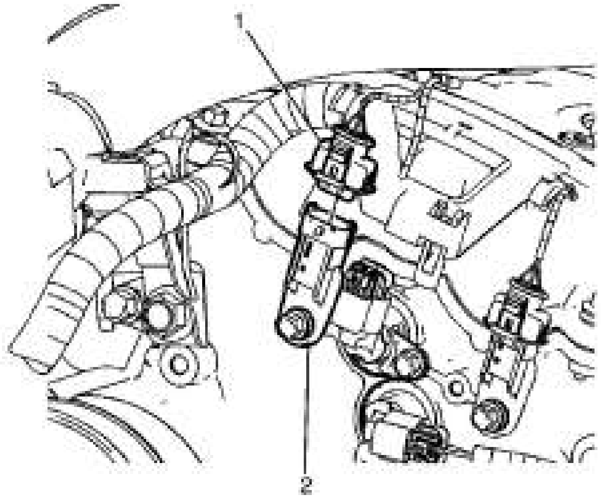
Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake

Removal Procedure

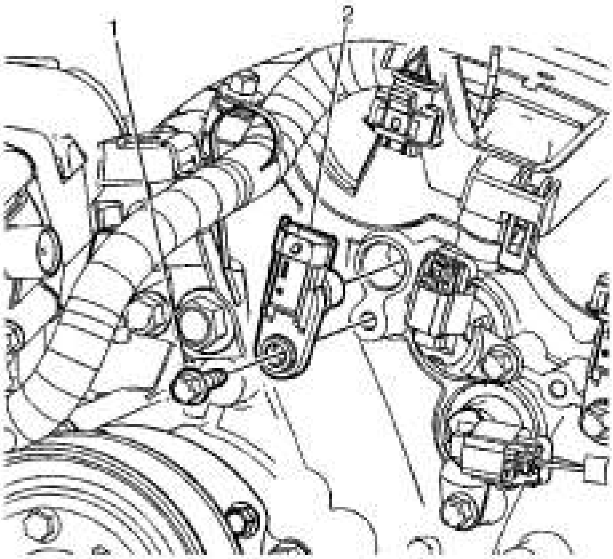
1. Turn the ignition OFF.

   Important: Do not disconnect the power steering fluid lines/hoses from the reservoir.

2. Remove the power steering fluid reservoir bolts and reposition the power steering fluid reservoir in order to provide access. Refer to Power Steering Fluid Reservoir Replacement .

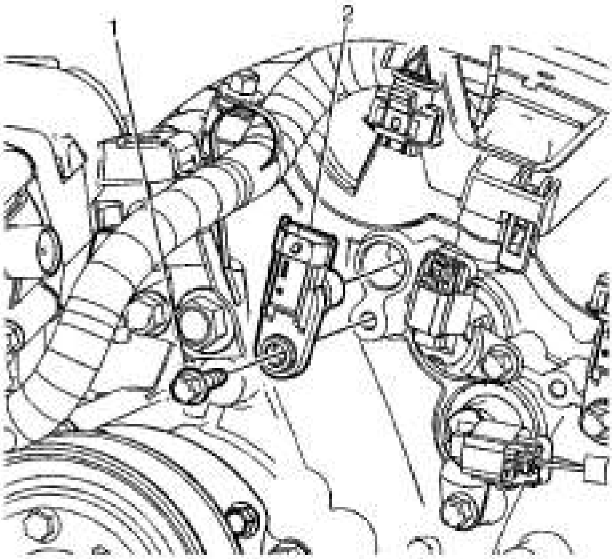


3. Remove the camshaft position (CMP) sensor electrical connector (1) from the CMP sensor (2).



4. Remove the the CMP sensor to engine front cover retaining bolt (1).
5. Remove the CMP sensor (2) from the engine front cover.

Installation Procedure

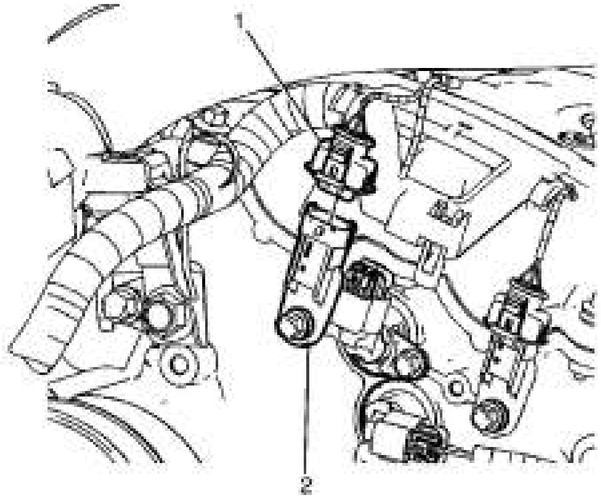


1. Install the CMP sensor (2) to the engine front cover.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the CMP sensor to engine front cover retaining bolt (1).

Tighten
Tighten the bolt to 10 N·m (89 lb in).



3. Install the CMP sensor electrical connector (1) to the CMP sensor (2).
4. Install the power steering fluid reservoir. Refer to Power Steering Fluid Reservoir Replacement .

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | **Document ID: 1993406**

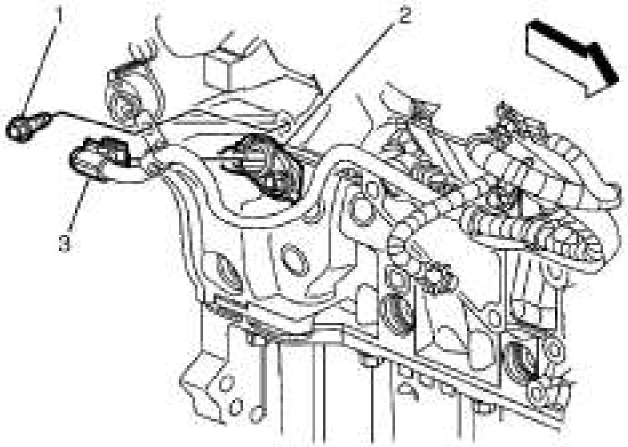
Crankshaft Position Sensor Replacement

Removal Procedure

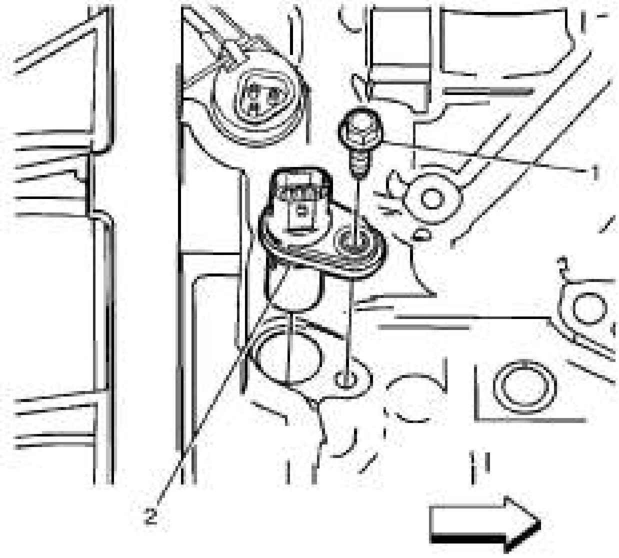
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Turn the ignition OFF.
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

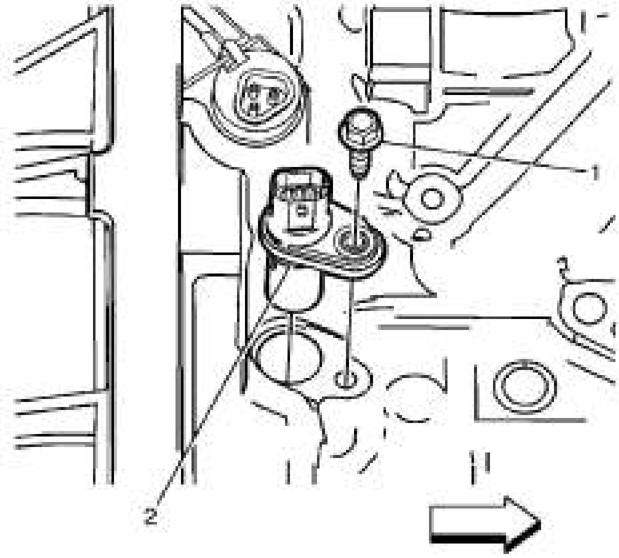


3. Reposition the wiring harness heat shield to obtain access.
4. Disconnect the crankshaft position (CKP) harness connector (3) from the CKP.



5. Remove the CKP to engine block retaining bolt (1) from the CKP sensor (2).
6. Remove the CKP sensor (2) from the engine block.

Installation Procedure

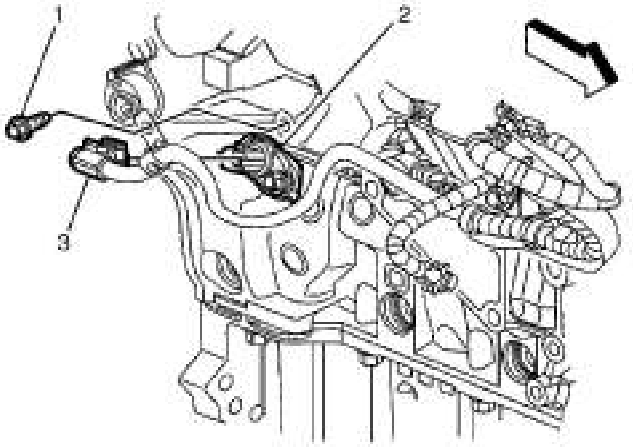


1. Install the CKP sensor (2) to the engine block.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the CKP sensor to engine block retaining bolt (1).

   Tighten
   Tighten the crankshaft position sensor bolt to 10 N·m (89 lb in).



3. Connect the CKP electrical connector (3) to the CKP sensor.
4. Lower the vehicle.

Engine Control Module Replacement (RHD)

Pre-Removal Procedure

If the engine control module (ECM) is replaced, the following procedures must be performed:

> **Important:** When replacing the ECM, the ECM must be reset prior to removal. Failure to perform this procedure will result in the inability to:
> - Test the ECM for warranty purposes.
> - Install the ECM into other vehicles.

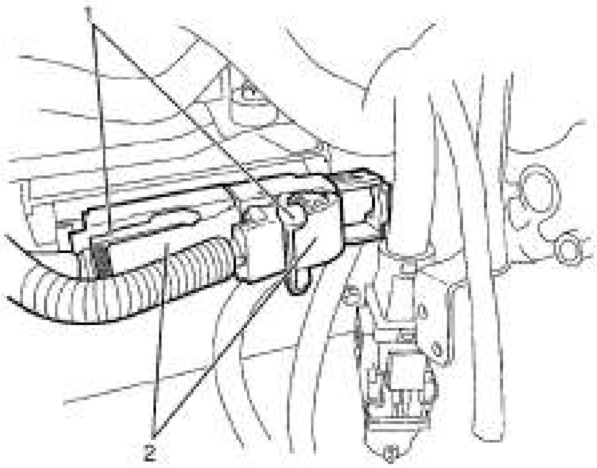
1. ECM reset procedure.
2. ECM reprogramming - Refer to Service Programming System (SPS) Notice .
3. Theft Deterrent programming - Refer to Theft Deterrent Control Module Programming and Setup .

Removal Procedure

> **Caution:** Refer to Safety Glasses Caution in the Preface section.

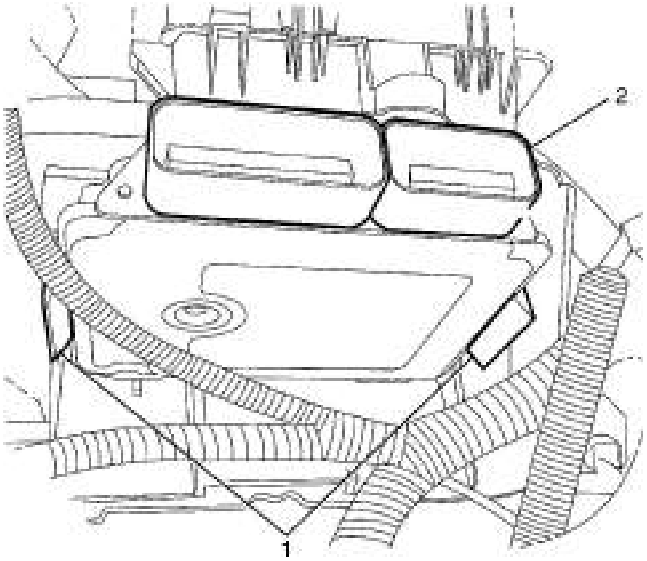
> **Notice:** Always turn the ignition off when installing or removing the ECM connectors in order to prevent damage to the components.

1. Turn the ignition OFF.
2. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement .



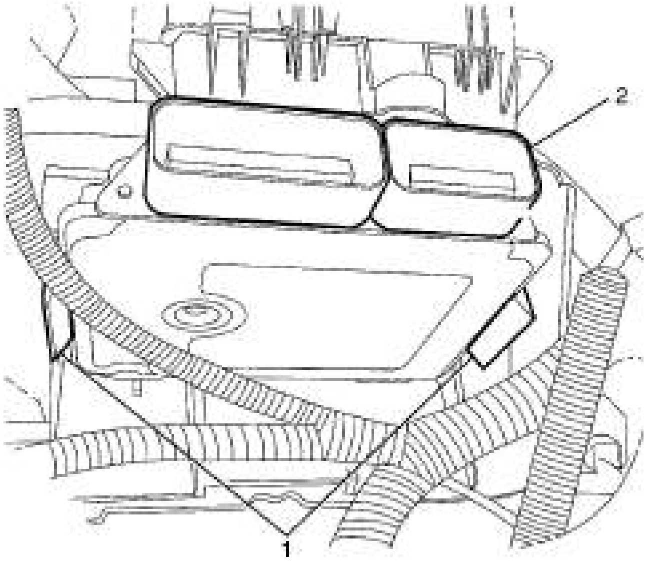
Important: Disconnect the rear electrical connector from the ECM first.

4. Unlock the ECM electrical connector lock levers (1) and disconnect the ECM electrical connectors (2).

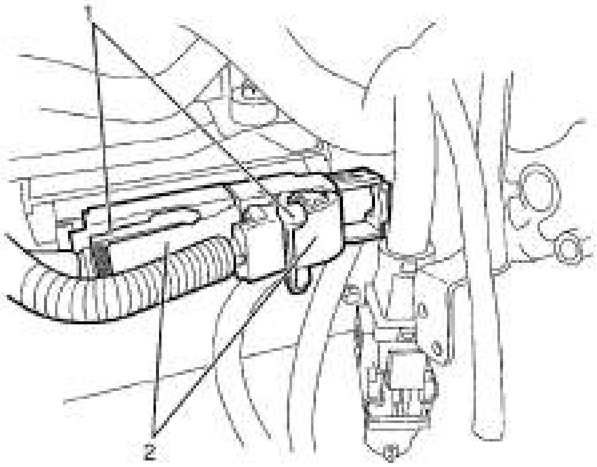


5. Remove the ECM (2) from the ECM housing by pushing both ECM retaining clips (1) outwards.

Installation Procedure



1. Install the ECM (2) to the ECM housing, make sure the ECM retaining clips (1) are located correctly.



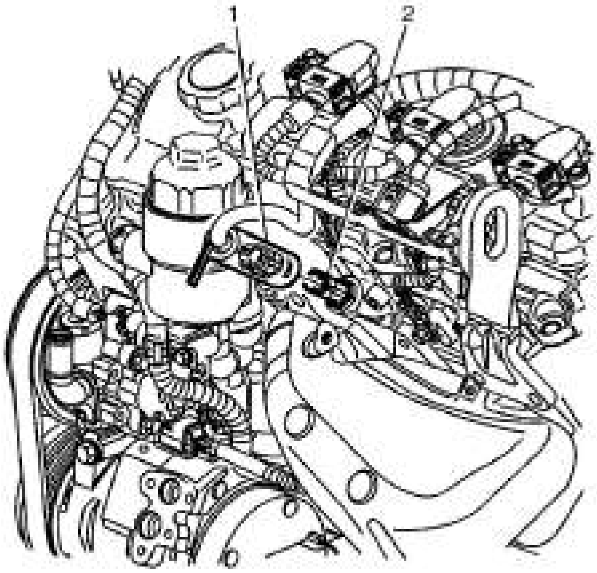
2. Connect the ECM electrical connectors (2) and lock the connector lock levers (1) into place.
3. Connect the battery negative cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
4. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement .
5. Program the ECM. Refer to Engine Control Module Programming and Setup .
6. If you encounter an ECM programming error, with a display message of "Starting Disabled, Remove Key" on the driver information centre, with a diagnostic test code (DTC) of P1631, perform the "10-Minute Relearn Procedure" found in Programming Theft Deterrent Control Module Programming and Setup. Refer to Theft Deterrent Control Module Programming and Setup .
7. Turn OFF the ignition for at least 5 seconds after the programming event is complete.
8. Perform the idle learn procedure. Refer to Idle Learn .
9. Use the scan tool to clear all DTCs.

Engine Coolant Temperature Sensor Replacement

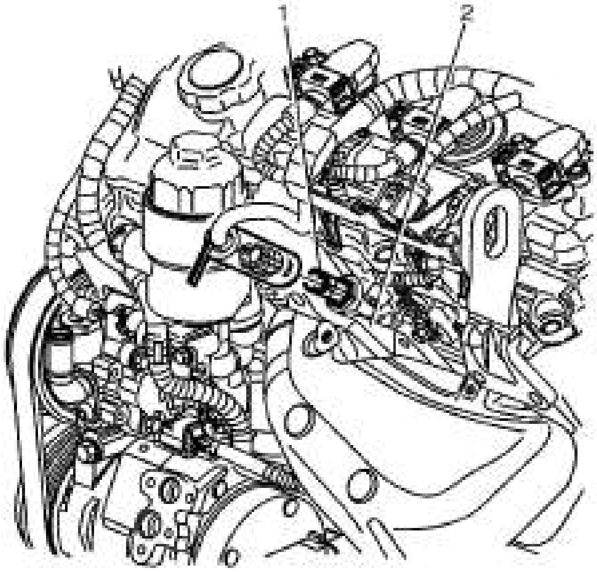
Removal Procedure

Caution: Allow sufficient time for the engine to cool before removing the ECT sensor. A hot engine may cause an excessive coolant loss or a personal injury.

1. Turn the ignition OFF.



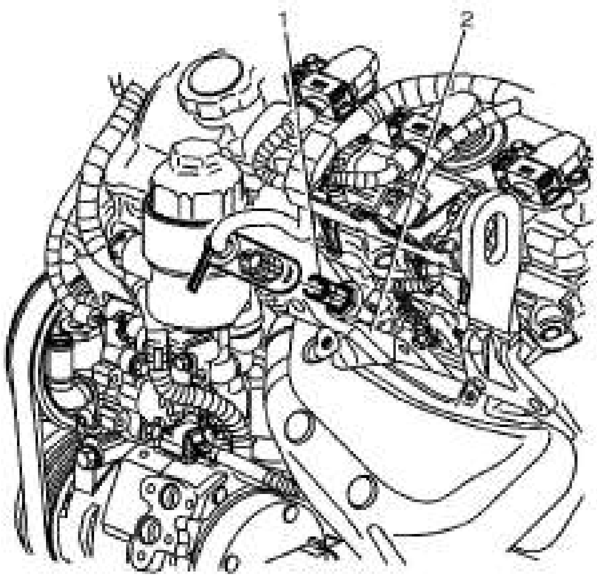
2. Remove the engine coolant temperature sensor harness connector (1) from the coolant temperature sensor (2).



3. Remove the engine coolant temperature sensor (1) from the engine (2).

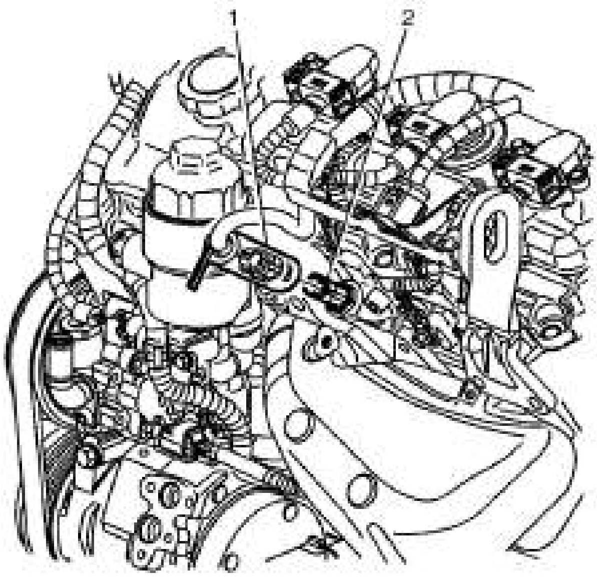
Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



1. Install the coolant temperature sensor (1) to the engine.

Tighten
Tighten the coolant temperature sensor to 22 N·m (16 lb ft).



2. Install the coolant temperature sensor electrical connector (1) to the coolant temperature sensor.
3. Inspect and fill the cooling system as necessary. Refer to Cooling System Draining and Filling.

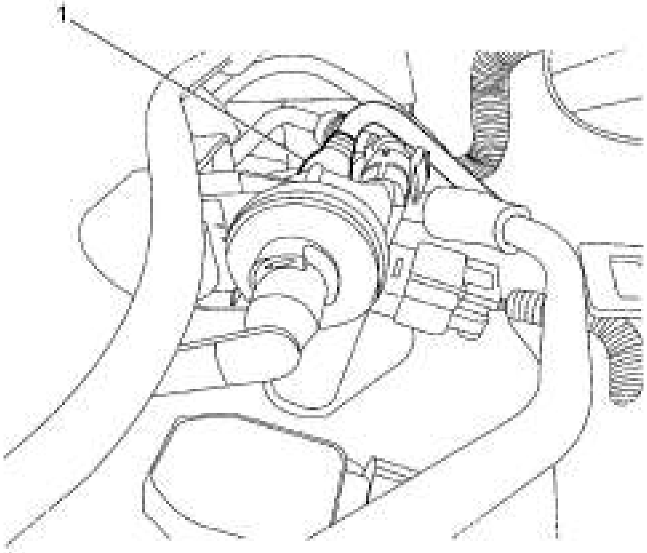
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | **Document ID: 1997201**

Evaporative Emission Canister Purge Solenoid Valve Replacement

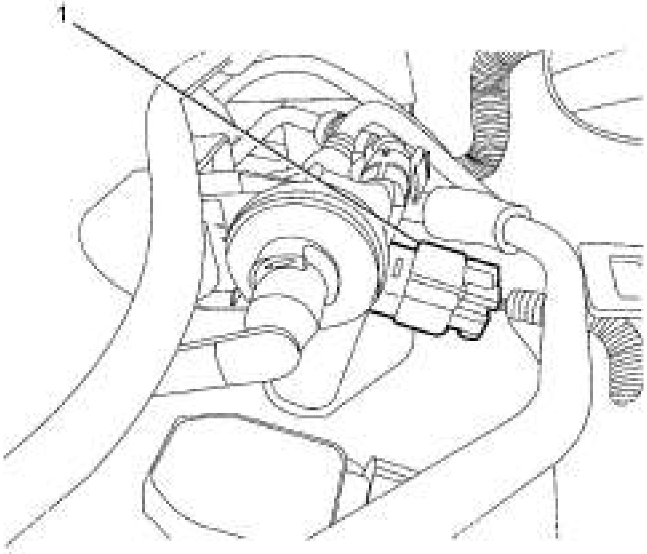
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

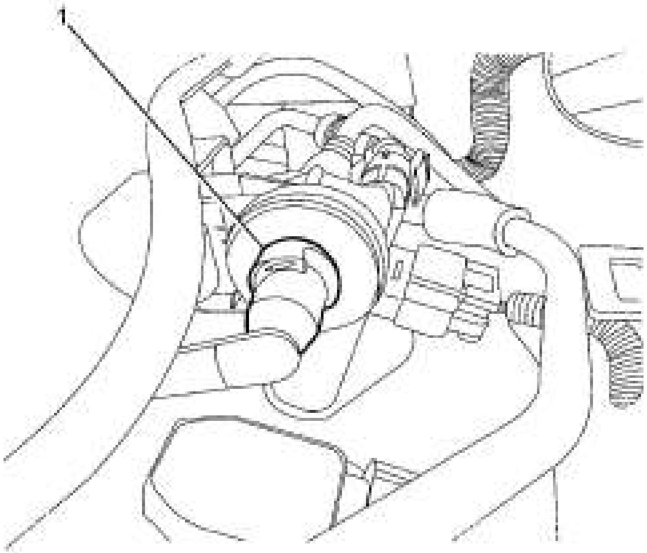
1. Turn the ignition OFF.



2. Disconnect the purge line (1) from the purge valve solenoid.

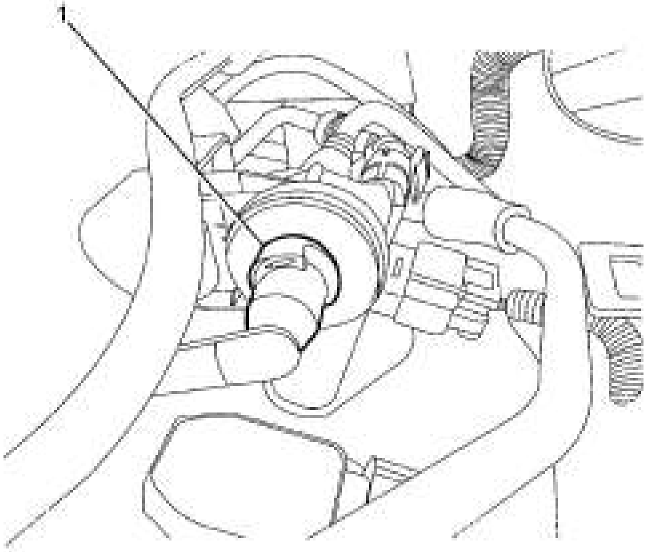


3. Disconnect the purge valve solenoid electrical connector (1).

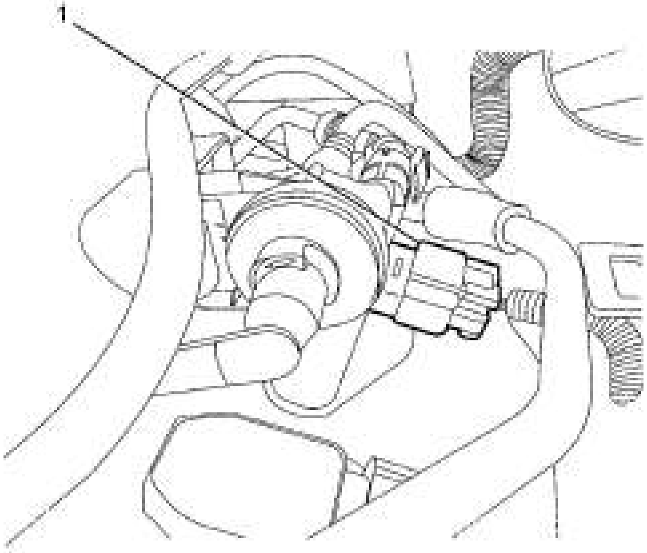


4. Disconnect the purge line (1) from the manifold side of the purge valve solenoid.
5. Remove the purge valve solenoid.

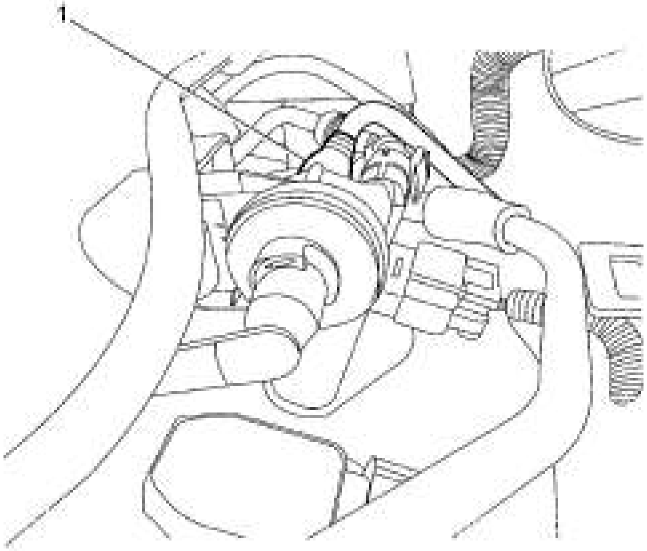
Installation Procedure



1. Install the purge valve solenoid.
2. Connect the purge line (1) from the manifold side of the purge valve solenoid.



3. Connect the purge valve solenoid electrical connector.



4. Connect the purge line (1) to the purge valve solenoid.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | **Document ID: 1976141**

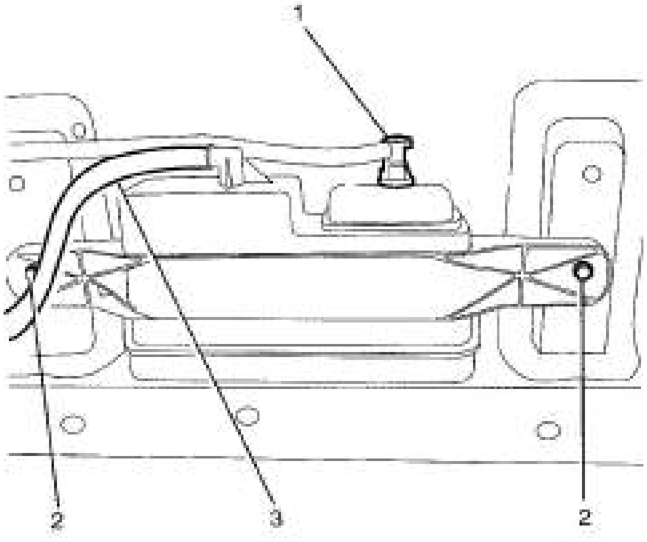
Evaporative Emission Canister Replacement

Removal Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

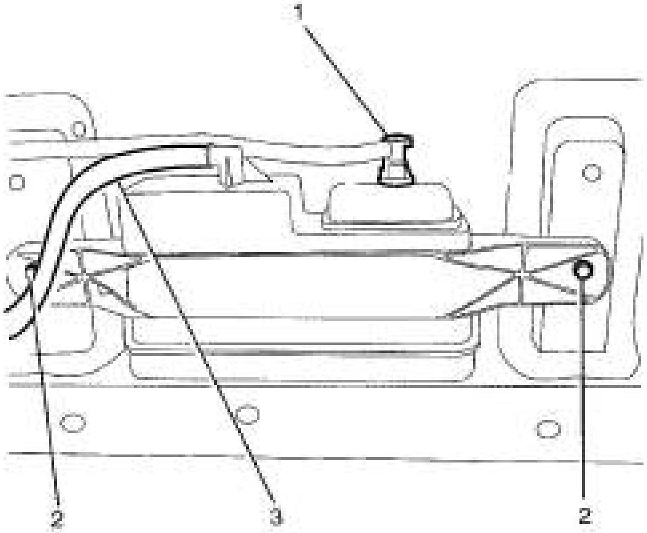
1. Remove the rear frame. Refer to Rear Frame Replacement.



2. Disconnect the evaporative emission (EVAP) hoses (1&3) from the EVAP canister.
3. Remove the purge canister to chassis retaining bolts (2).

Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



1. Install the purge canister to chassis retaining bolts (2).

   Tighten
   Tighten the EVAP canister retaining nuts to 6 N·m (53 lb in).

2. Connect the evaporative emission (EVAP) hoses (1&3) from the EVAP canister.
3. Install the rear frame. Refer to Rear Frame Replacement.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | **Document ID: 1976193**

Evaporative Emission Hoses/Pipes Replacement - Chassis/Canister

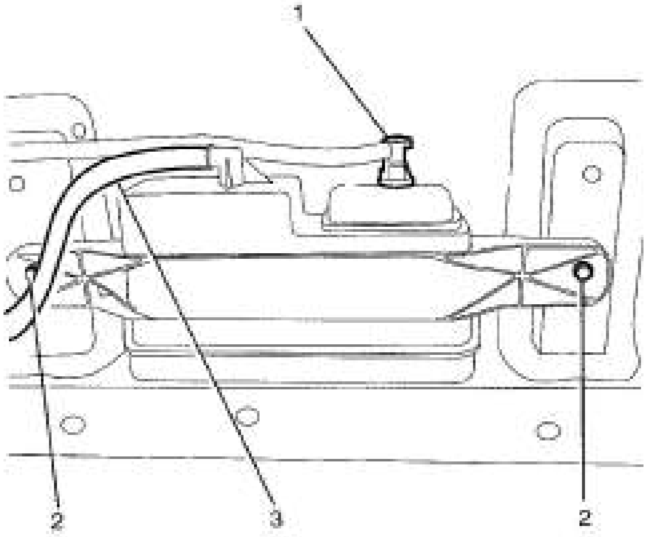
Removal Procedure

- Do not attempt to repair sections of nylon pipes. Replace damaged nylon pipes.
- Replace the vapour hoses/pipes with original equipment or parts that meet original specifications.

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the rear frame. Refer to Rear Frame Replacement .
3. Remove the fuel tank. Refer to Fuel Tank Replacement .



4. Disconnect the canister purge pipe (1) from the canister.
5. Remove the canister vent pipe (3) from the canister by twisting and pulling it away from the canister.
6. Remove the canister to under body retaining bolts (2).
7. Remove the evaporative emission canister from the vehicle.
8. Remove the EVAP hose from the fuel tank.

Installation Procedure

2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | **Document ID: 2132043**

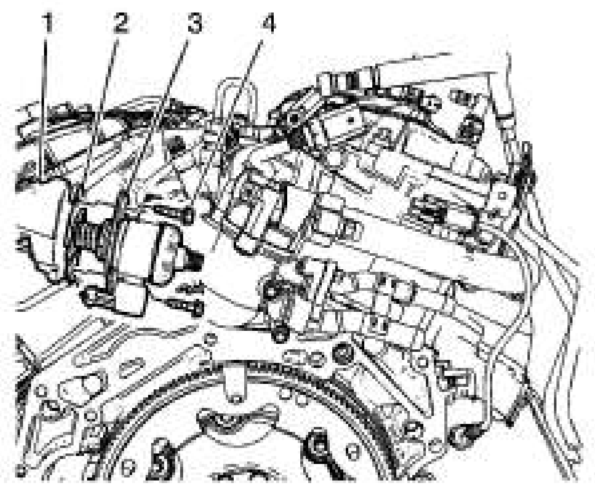
Fuel Pump Replacement (LLT)

Special Tools

EN-48896 HP Fuel Pump Installation Alignment Gage

Removal Procedure

1. Relieve the low and high side fuel system pressure. Refer to Fuel Pressure Relief.
2. Remove the cross vehicle brace. Refer to Cross Vehicle Brace Replacement.
3. Remove the high pressure fuel pump shield. Refer to Fuel Pipe Shield Replacement.
4. Remove the intake manifold. Refer to Intake Manifold Replacement.
5. Remove the wiper module. Refer to Windshield Wiper Motor Replacement.

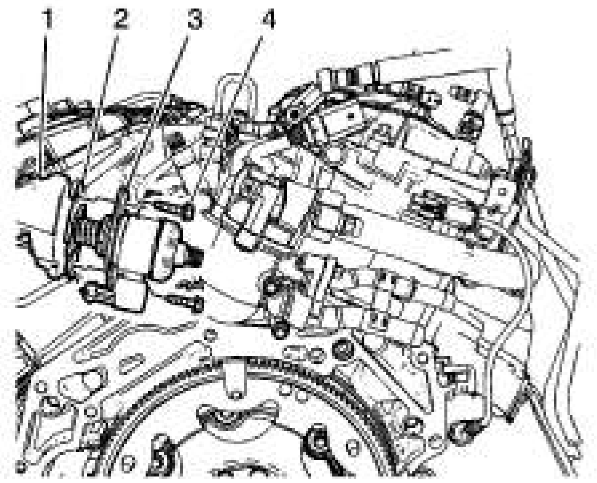


6. Disconnect the engine wiring harness electrical connector from the high pressure fuel pump.
7. Remove the radiator surge tank outlet pipe. Refer to Radiator Surge Tank Outlet Hose/Pipe Replacement
8. Remove the low pressure feed pipe. Refer to Fuel Feed Pipe Replacement.
9. Remove the high pressure pipe. Refer to Fuel Feed Intermediate Pipe Replacement. Discard this pipe.
10. Remove and discard the high pressure fuel pump bolts (4).
11. Remove the high pressure fuel pump (3).
12. Remove and discard the high pressure fuel pump gasket (2).
13. Remove and discard the high pressure fuel pump O-ring.
14. Remove the high pressure fuel pump roller lifter.

Installation Procedure

Note: The camshaft must be in the base circle position before the high pressure fuel pump is installed.

1. Use the EN-48896 to ensure that the camshaft lobe is in the base circle position. At base circle the tool will be flush with the head.
2. Lubricate the high pressure fuel pump cylinder head bore and roller lifter with camshaft prelube GM P/N 12345501 (Canadian P/N 992704) or equivalent.
3. Install high pressure fuel pump roller lifter.
4. Install a NEW high pressure fuel pump O-ring.



Note: The high pressure fuel pump gasket has a retaining feature to hold the pump retaining bolts in place.

5. Position the NEW high pressure fuel pump gasket (2) and bolts (4) to the fuel pump.
6. Install the high pressure fuel pump (3) to the cylinder head (1). Force will be required while hand tightening the bolts.

Caution: Refer to Fastener Caution in the Preface section.

7. Tighten the high pressure fuel pump retaining bolts to **15 N·m (11 lb ft)**.
8. Ensure the high pressure fuel pump and fuel rail fittings are clean prior to assembly.
9. Install a NEW high pressure fuel pipe. Refer to Fuel Feed Intermediate Pipe Replacement.
10. Install the fuel feed pipe to the high pressure fuel pump. Refer to Fuel Feed Pipe Replacement.
11. Connect the high pressure fuel pump wiring harness.
12. Install the radiator surge tank outlet pipe. Refer to Radiator Surge Tank Outlet Hose/Pipe Replacement.
13. Install the fuel tank cap.

Note: If a fuel leak accrues at the fuel rail, the fuel rail will need to be replaced.

14. Inspect for leaks using the following procedure:
    - 14.1. Turn ON the ignition, with the engine OFF for 2 seconds.
    - 14.2. Turn OFF the ignition, for 10 seconds.
    - 14.3. Turn ON the ignition, with the engine OFF.

    4. Inspect for fuel leaks.

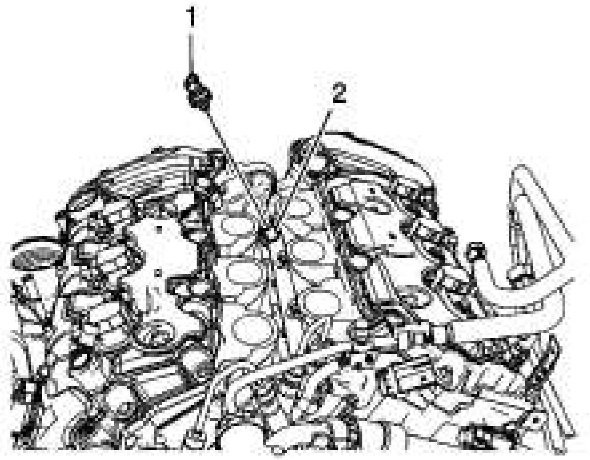
15. Install the pressure relief cap to the fuel feed pipe.
16. Install the wiper module. Refer to Windshield Wiper Motor Replacement.
17. Install the intake manifold. Refer to Intake Manifold Replacement.
18. Install the high pressure fuel pump shield. Refer to Fuel Pipe Shield Replacement.
19. Install the cross vehicle brace. Refer to Cross Vehicle Brace Replacement.

2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | **Document ID: 2131941**

Fuel Pressure Sensor Replacement (LLT)

Removal Procedure

1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief.
2. Remove the cross vehicle brace. Refer to Cross Vehicle Brace Replacement.
3. Remove the intake manifold. Refer to Intake Manifold Replacement
4. Remove the foam insulator from the fuel rails.



Note: Applying force to the plastic housing of the sensor will destroy the sensor. To tighten or loosen, only apply force to the attached hexagon.

5. Using a 27 mm socket, remove the fuel pressure sensor (1) from the fuel injection fuel rail (2). Discard the fuel pressure sensor.
6. Allow any fuel to drain from the fuel rail and pressure sensor location.
7. Dry the sealing cone in the fuel rail and the area around the sensor joint with a lint free cloth.
8. Inspect the sealing cone in the fuel rail. The surface should be free of fuel, debris, and burrs.

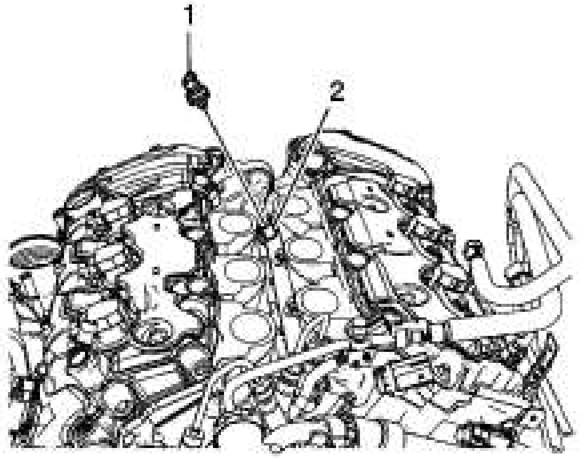
Installation Procedure

Note: Applying force to the plastic housing of the sensor will destroy the sensor. To tighten or loosen, only apply force to the attached hexagon.

Note: Ensure that the fuel rail threads have been cleaned of any excess fuel, or the NEW fuel injection fuel rail fuel pressure sensor will NOT seal properly.

1. Lubricate the threads and the sealing cone in the fuel rail with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.
2. Lubricate the threads and sealing cone on the NEW fuel injection fuel rail fuel pressure sensor

with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.



3. Install the NEW fuel pressure sensor (1) to the fuel injection fuel rail (2) hand tight.
4. Remove the NEW fuel injection fuel rail fuel pressure sensor, re-lubricate following steps 1 and 2 above.

Caution: Refer to Fastener Caution in the Preface section.

5. Install the NEW fuel pressure sensor (1) to the fuel injection fuel rail (2) and tighten to **33 N·m (25 lb ft)**.
6. Install the foam insulator from the fuel rails.
7. Install the intake manifold. Refer to Intake Manifold Replacement

Note: If a fuel leak accrues at the fuel rail, the fuel rail will need to be replaced.

8. Inspect for fuel leaks using the following procedure:
   - 8.1. Turn ON the ignition, with the engine OFF for 2 seconds.
   - 8.2. Turn OFF the ignition, for 10 seconds.
   - 8.3. Turn ON the ignition, with the engine OFF.
   - 8.4. Inspect for fuel leaks.
9. Install the cross vehicle brace. Refer to Cross Vehicle Brace Replacement.

Fuel Pressure Relief (With High Pressure Pump - LLT)

Warning: Fuel that flows out at high pressure can cause serious injury to the skin and eyes. ALWAYS depressurize the fuel system before removing components that are under high fuel pressure.

> **Note:** If a scan tool is not available, WAIT at LEAST 2 hours after the engine has been run, before removing the high pressure fuel line.

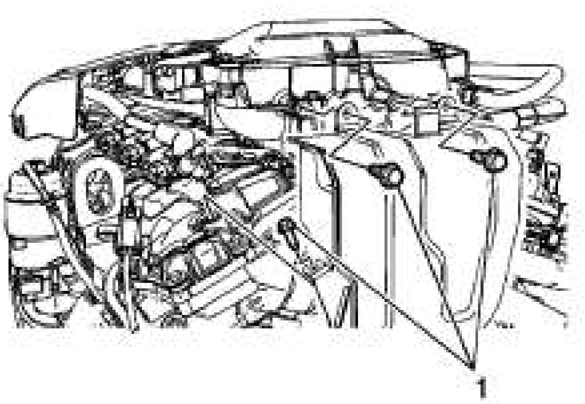
1. Install a scan tool to the vehicle and command the fuel pump relay OFF, allowing the low pressure fuel pump to shut off.
2. Start the vehicle and allow the engine to idle until the engine stops. The engine will stop in approximately 20-30 seconds.
3. Turn the ignition OFF.
4. Using the scan tool, verify that there is little to no fuel pressure, if there still is fuel pressure repeat step 2.

2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | **Document ID: 2132038**

Fuel Pipe Shield Replacement (LLT)

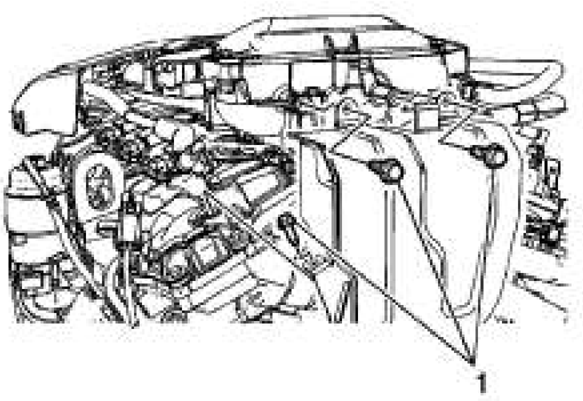
Removal Procedure

1. Remove the cross vehicle brace. Refer to Cross Vehicle Brace Replacement.
2. Remove the fuel injection sight shield. Refer to Fuel Injector Sight Shield Replacement
3. Remove the intake manifold insulator.
4. Remove the wiper transmission. Refer to Windshield Wiper Transmission Replacement.



5. Remove the fuel pipe shield to intake manifold bolts (1).
6. Remove the fuel pipe shield to cylinder bolt (1).
7. Carefully remove the fuel pipe shield from the vehicle. Take care not to damage the insulation behind the shield.

Installation Procedure



1. Position the fuel pipe shield behind the high pressure fuel pump. Take care not to damage the insulation behind the shield.
2. Install the fuel pipe shield to cylinder bolt (1). Hand tighten at this time.

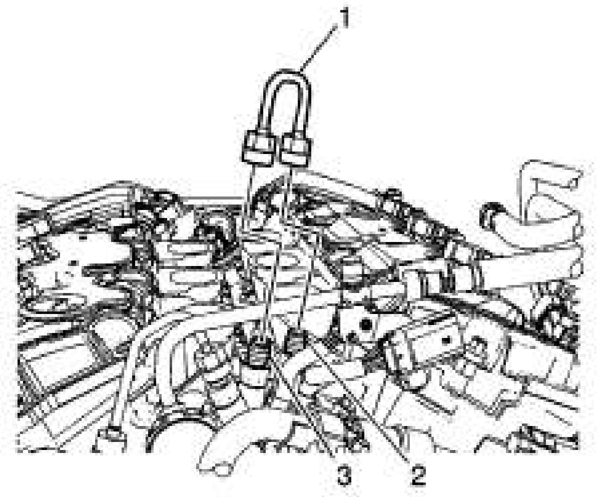
   Caution: Refer to Fastener Caution in the Preface section.

3. Install the fuel pipe shield to intake manifold bolts (1).
   - 3.1. Tighten the fuel pipe shield to manifold bolts to **23 N·m (17 lb ft)**.
   - 3.2. Tighten the fuel pipe shield to head bolt to **10 N·m (89 lb in)**.
4. Instal the wiper transmission. Refer to Windshield Wiper Transmission Replacement.
5. Install the fuel injection sight shield. Refer to Fuel Injector Sight Shield Replacement
6. Install the cross vehicle brace. Refer to Cross Vehicle Brace Replacement.

Fuel Injection Fuel Rail Crossover Tube Replacement (LLT)

Removal Procedure

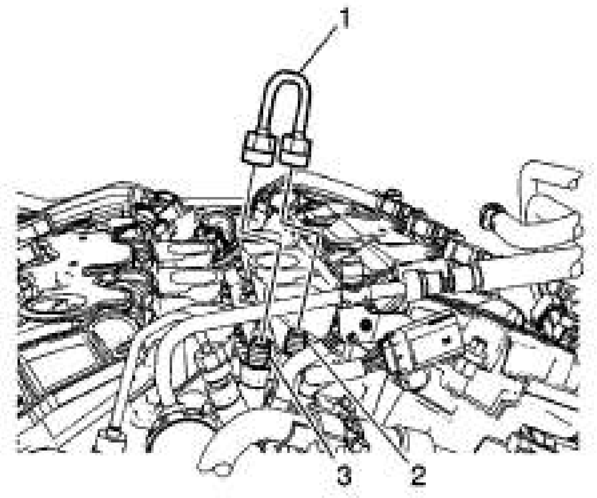
1. Remove the fuel injection sight shield. Refer to Fuel Injector Sight Shield Replacement.
2. Remove the high pressure pump shield. Refer to Fuel Pipe Shield Replacement.
3. Relieve the fuel system pressure. Refer to Fuel Pressure Relief.
4. Remove the intake manifold. Refer to Intake Manifold Replacement.



5. Loosen the fuel rail crossover pipe (1) fitting to the right fuel rail (2).
6. Loosen the fuel rail crossover pipe (1) fitting to the right fuel rail (3).
7. Remove the fuel rail crossover pipe (1) from the vehicle. Discard the pipe.

Installation Procedure

1. Ensure that the fuel rail crossover pipe, right fuel rails fittings and left fuel rail fittings are clean and dry prior to assembly.
2. Lubricate the pipes with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.



3. Position the fuel rail crossover pipe (1) to the right fuel rails fitting (2) and left fuel rail fitting (3).

Caution: Refer to Fastener Caution in the Preface section.

4. Tighten the fuel rail crossover pipe fittings.
   4.1. Tighten the fittings first pass to **16 N·m (12 lb ft)**.
   4.2. Tighten the fittings final pass to **32 N·m (24 lb ft)**.

Note: If a fuel leak accrues at the right fuel rail fitting (2) or left fuel rail fitting (3), that component will need to be replaced.

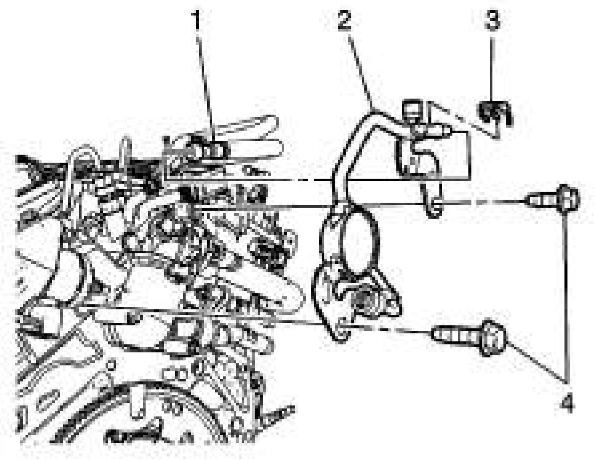
5. Inspect for leaks using the following procedure:
   5.1. Turn ON the ignition, with the engine OFF for 2 seconds.
   5.2. Turn OFF the ignition, for 10 seconds.
   5.3. Turn ON the ignition, with the engine OFF.
   5.4. Inspect for fuel leaks.
6. Install the low side fuel pressure service port cap.
7. Install the fuel tank cap.
8. Install the intake manifold. Refer to Intake Manifold Replacement.
9. Install the high pressure pump shield. Refer to Fuel Pipe Shield Replacement.
10. Install the fuel injection sight shield. Refer to Fuel Injector Sight Shield Replacement.

2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | **Document ID: 2131942**

Fuel Feed Pipe Replacement (LLT)

Removal Procedure

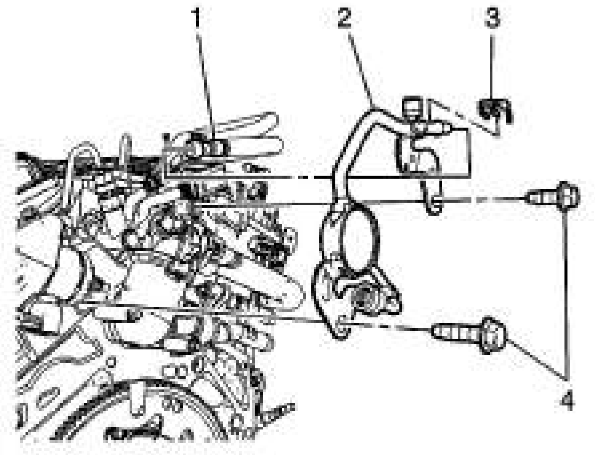
1. Remove the fuel injection sight shield. Refer to Fuel Injector Sight Shield Replacement.
2. Remove the high pressure pump shield. Refer to Fuel Pipe Shield Replacement.
3. Relieve the low side fuel system pressure. Refer to Fuel Pressure Relief.
4. Remove the radiator surge tank outlet pipe. Refer to Radiator Surge Tank Outlet Hose/Pipe Replacement.



5. Disconnect the fuel feed line quick connect fitting from the fuel feed pipe (2). Refer to Metal Collar Quick Connect Fitting Service.
6. Loosen the fuel feed pipe fitting to the high pressure fuel pump.
7. Remove the fuel feed pipe bolts (4) from the cylinder heads.
8. Remove the fuel feed pipe from the engine and high pressure fuel pump.

Installation Procedure

1. Ensure that the fuel feed pipe and fuel pump fittings are clean and dry prior to assembly.
2. Lubricate the pipes with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.



3. Position the fuel feed pipe (2) to the cylinder head and high pressure fuel pump.
4. Install the fuel feed pipe fitting to the high pressure fuel pump hand tight.

Caution: Refer to Fastener Caution in the Preface section.

5. Install the fuel feed pipe bolts (4).
   - Tighten the bolts to **50 N·m (37 lb ft)**.
   - Tighten the fitting to **28 N·m (20 lb ft)**.
6. Connect the fuel feed line quick connect fitting to the fuel feed pipe (2). Refer to Fuel Pipe Shield Replacement.

Note: If a fuel leak accrues at the high pressure fuel pump, the pump will need to be replaced.

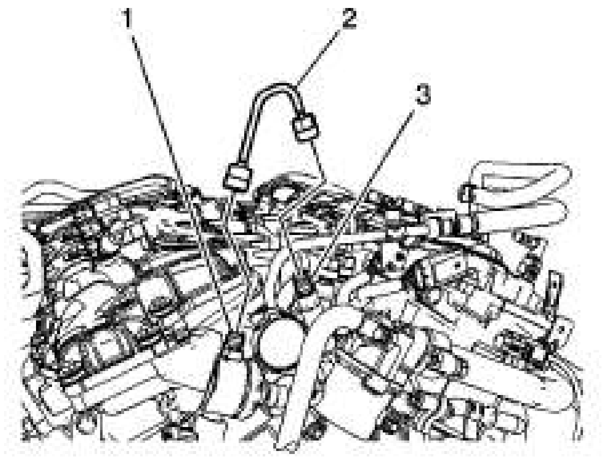
7. Inspect for leaks using the following procedure:
   7.1. Turn ON the ignition, with the engine OFF for 2 seconds.
   7.2. Turn OFF the ignition, for 10 seconds.
   7.3. Turn ON the ignition, with the engine OFF.
   7.4. Inspect for fuel leaks.
8. Install the low side fuel pressure service port cap.
9. Install the fuel tank cap.
10. Install the radiator surge tank outlet pipe. Refer to Radiator Surge Tank Outlet Hose/Pipe Replacement.
11. Install the high pressure pump shield. Refer to Fuel Pipe Shield Replacement.
12. Install the fuel injection sight shield. Refer to Fuel Injector Sight Shield Replacement.

2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | **Document ID: 2132029**

Fuel Feed Intermediate Pipe Replacement (LLT)

Removal Procedure

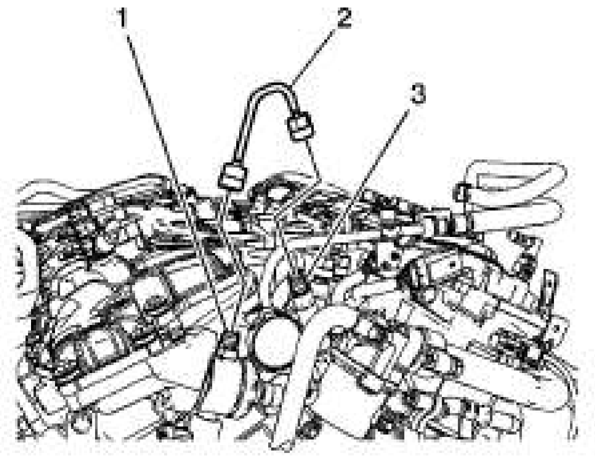
1. Remove the fuel injection sight shield. Refer to Fuel Injector Sight Shield Replacement.
2. Remove the high pressure pump shield. Refer to Fuel Pipe Shield Replacement.
3. Relieve fuel system pressure. Refer to Fuel Pressure Relief.



4. Remove the foam insulator from the pipes.
5. Loosen the high pressure pipe fitting to the high pressure fuel pump (1).
6. Loosen the high pressure pipe fitting to the left fuel rail (3).
7. Remove the high pressure fuel pipe (2) from the vehicle. Discard the pipe.

Installation Procedure

1. Ensure that the high pressure fuel pipe, fuel rail fitting and fuel pump fitting are clean and dry prior to assembly.
2. Lubricate the pipes with silicon free engine oil GM P/N 12345610 (Canadian P/N 993193) or equivalent.



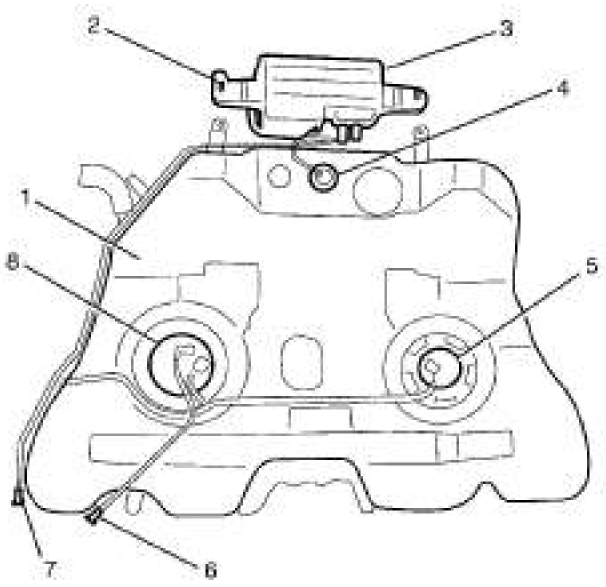
3. Position the high pressure fuel pipe (2) to the high pressure fuel pump fitting (1) and left fuel rail (3). hand tighten the fitting.

   Caution: Refer to Fastener Caution in the Preface section.

4. Tighten the high pressure fuel pipe fitting.
   1. Tighten the fitting a first pass to **16 N·m (12 lb ft)**.
   2. Tighten the fitting a final pass to **32 N·m (24 lb ft)**.

   Note: If a fuel leak accrues at the high pressure fuel pump or the fuel rail, that component will need to be replaced.

5. Inspect for leaks using the following procedure:
   1. Turn ON the ignition, with the engine OFF for 2 seconds.
   2. Turn OFF the ignition, for 10 seconds.
   3. Turn ON the ignition, with the engine OFF.
   4. Inspect for fuel leaks.
6. Install the low side fuel pressure service port cap.
7. Install the fuel tank cap.
8. Install the high pressure pump shield. Refer to Fuel Pipe Shield Replacement.
9. Install the fuel injection sight shield. Refer to Fuel Injector Sight Shield Replacement.



1. Position the EVAP hose to the fuel tank.
2. Install the chassis to canister EVAP hose to the following:
   - The body retainer (1)
   - The 3 retaining features (2) on the fuel tank
   - The retainer clip (3)
3. Install the fuel tank. Refer to Fuel Tank Replacement .
4. Install the rear frame. Refer to Rear Frame Replacement .
5. Lower the vehicle.

Filler Tube Replacement

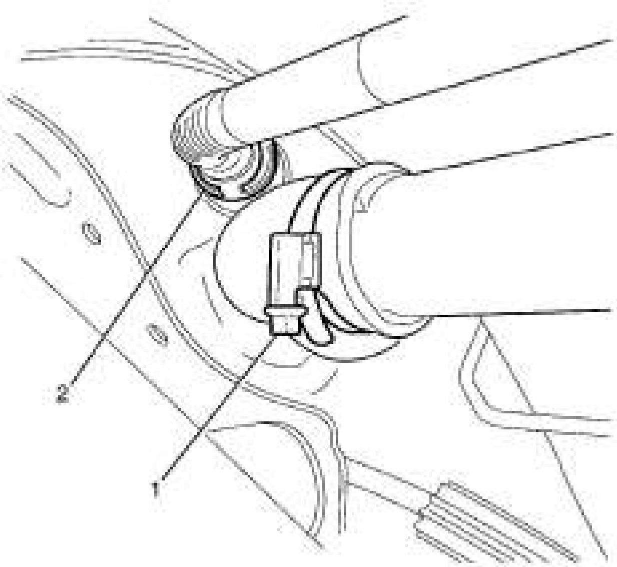
Removal Procedure

1. Remove the fuel filler cap.

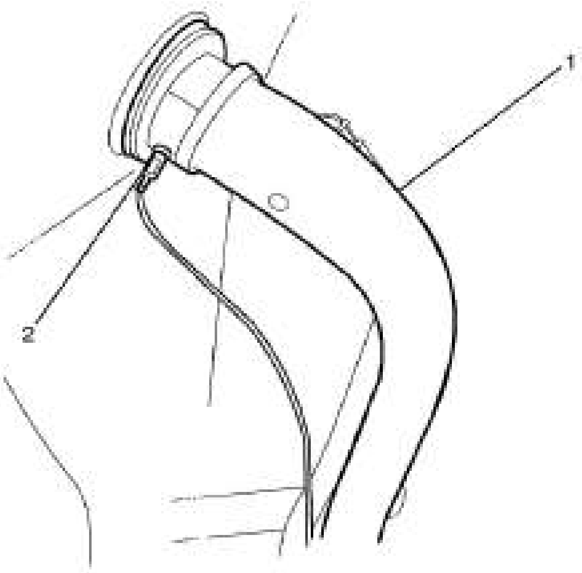
   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

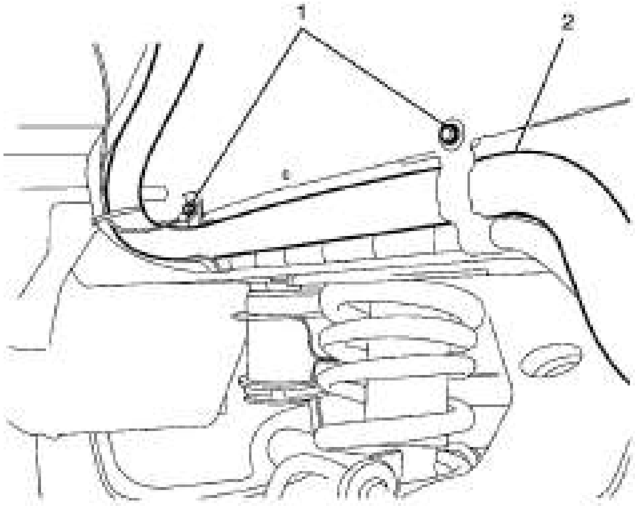
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
3. Drain the fuel tank below the level of the fuel filler hose. Refer to Fuel Tank Draining .



4. Remove the right rear wheel. Refer to Tire and Wheel Removal and Installation .
5. Remove the Wheelhouse Liner Replacement - Rear. Refer to Rear Wheelhouse Panel Liner Replacement .
6. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement .
7. Disconnect the filler tube from the fuel tank (1).
8. Disconnect the evaporative emission (EVAP) line (2), by squeezing both sides of the line and pulling it toward the rear of the vehicle.



9. Remove rubber seal surround from the filler tube .
10. Remove the earth lead (2) from the filler tube (1).

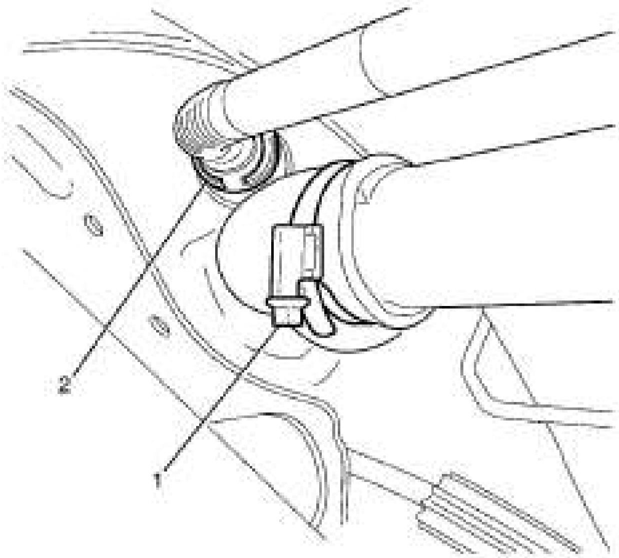


11. Remove the filer tube to chassis retaining bolts (1 from filler tube (2).
12. Remove the fuel filler tube from the vehicle (2).

Installation Procedure

1. Position the fuel filler tube to the vehicle.

Notice: Refer to Component Fastener Tightening Notice in the Preface section.

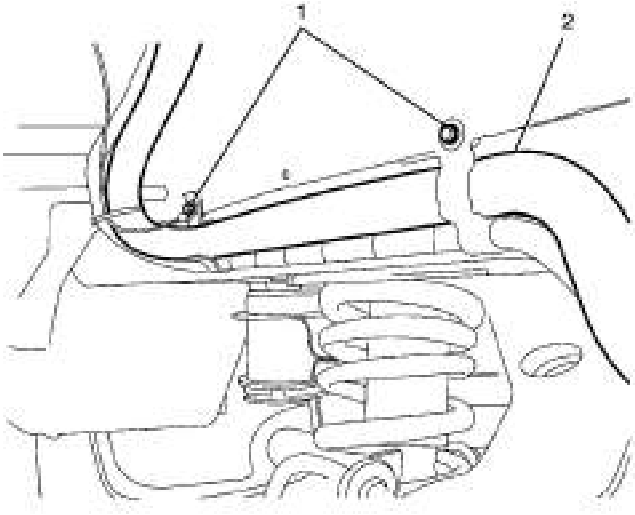


2. Connect the filler hose (1) to the fuel tank.

   Tighten
   Tighten the fuel filler tube hose clamp (3) to 3.5 N·m (31 lb in).

3. Install the evaporative emission (EVAP) line (2), listen for an audible click to confirm fitting.

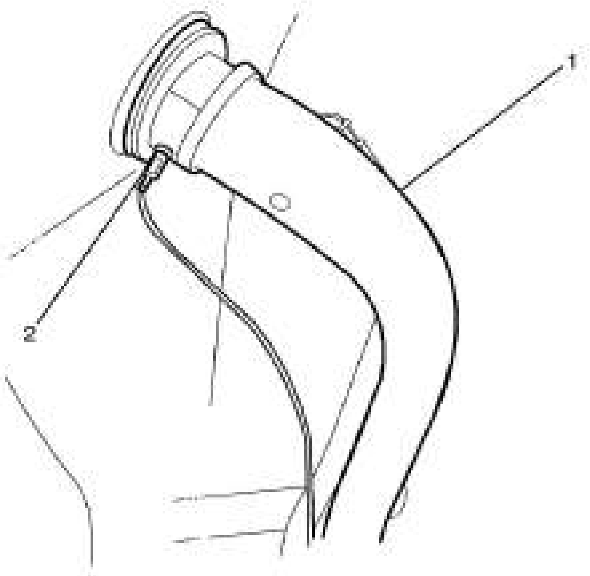
   Notice: Refer to Fastener Notice in the Preface section.



4. Install the fuel filler tube to chassis retaining bolts.

   Tighten

Tighten the bolts to 9 N·m (80 lb in).



5. Install rubber seal surround to the filler tube (1).
6. Install the earth lead to the filler tube (2).
7. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement .
8. Install the Wheelhouse Liner Replacement - Rear. Refer to Rear Wheelhouse Panel Liner Replacement .
9. Lower the vehicle.
10. Add fuel to the fuel tank.
11. Inspect for fuel leaks.
12. Install the fuel filler cap.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | **Document ID: 2038741**

Fuel Filter Replacement (Petrol)

Removal Procedure - Up to xx/xx

The fuel filter is an integral part of the fuel pump assembly and must be replaced as an assembly. For replacement refer to Primary Fuel Tank Module Replacement.

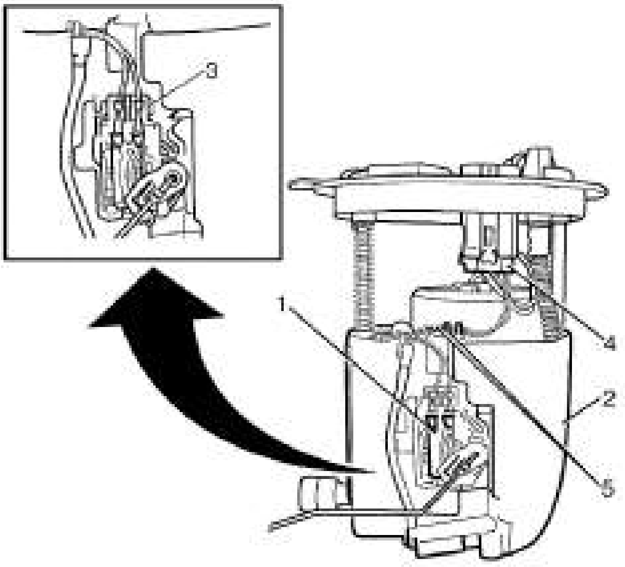
Removal Procedure - From xx/xx

Caution: Refer to Gasoline/Gasoline Vapors Caution in the Preface section.

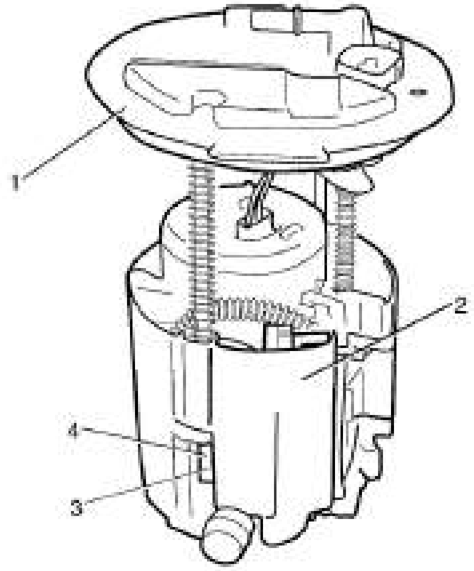
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

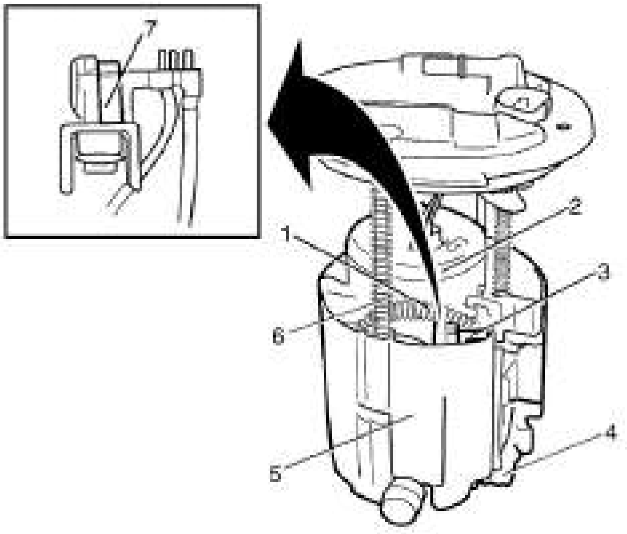
1. Remove the fuel tank. Refer to Fuel Tank Replacement.
2. Remove the primary fuel tank module assembly from the fuel tank. Refer to Primary Fuel Tank Module Replacement.



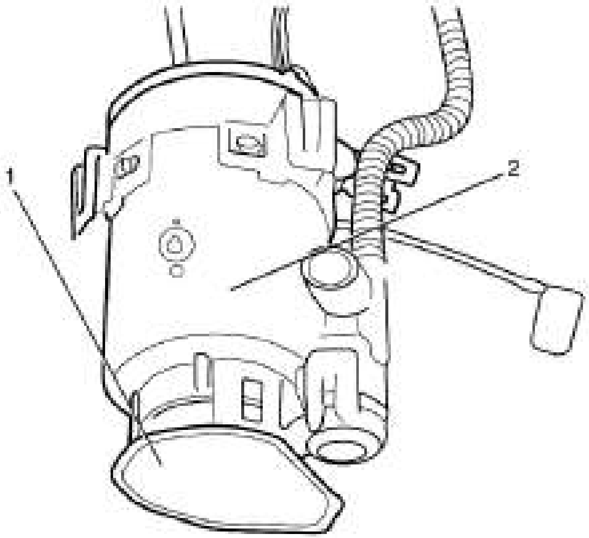
3. Disconnect the fuel level sensor connector (4) and unclip the wiring from the harness securing clips (5).
4. Unlock the locking clip (3) and gently push the fuel level sensor upwards.
5. Remove the fuel level sensor (1) from the lower half of the primary fuel tank module assembly (2).



6. Press down on the primary fuel tank module assembly upper half and remove the circlip (3) from the shaft (4).
7. Separate the upper halve (1) and lower halve (2) of the primary fuel tank module assembly.

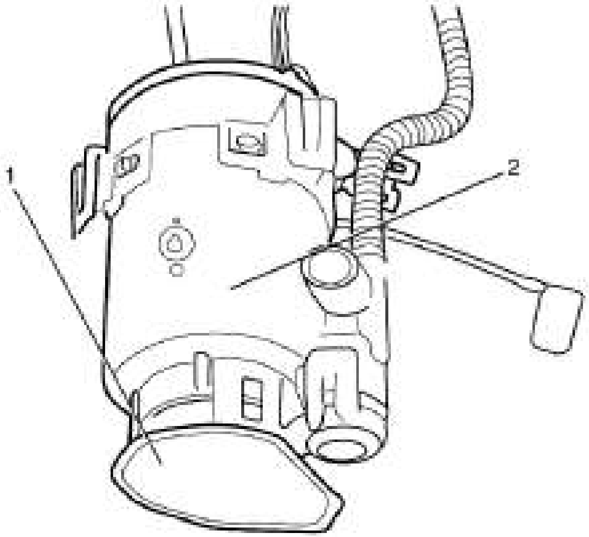


8. Remove the spring (6) from the primary fuel tank module assembly (5).
9. Unclip the piping (4) with a suitable tool.
10. Unclip the connector (7) with a suitable tool.
11. Make a note of the routing of the pipes (1) and (3).
12. Carefully remove the fuel pump housing (2) from the primary fuel tank module assembly (5).

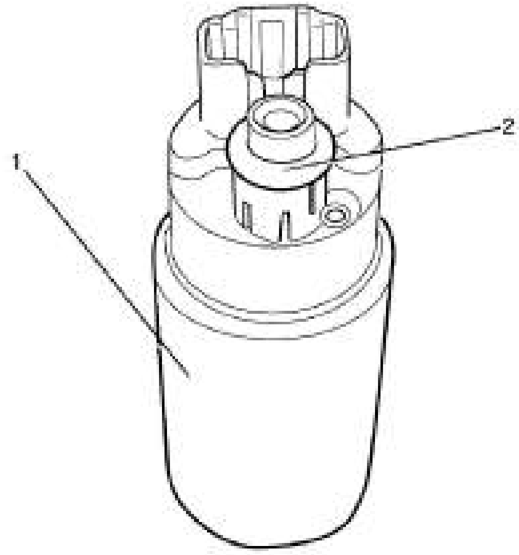


13. Carefully pry the fuel filter (2) from the fuel pump housing (3).

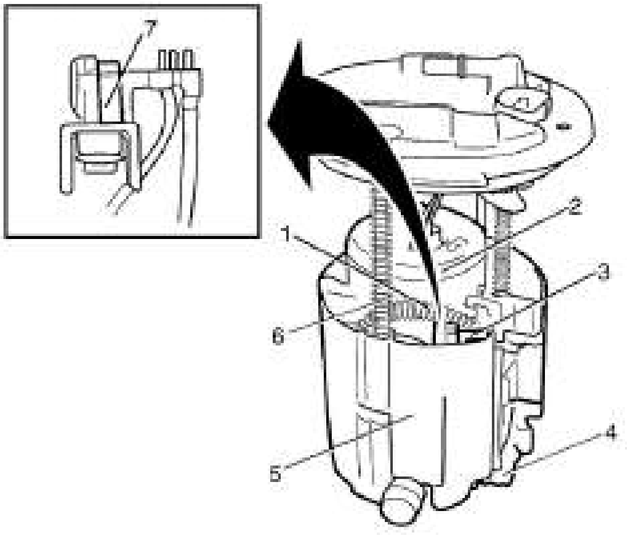
Installation Procedure - From xx/xx



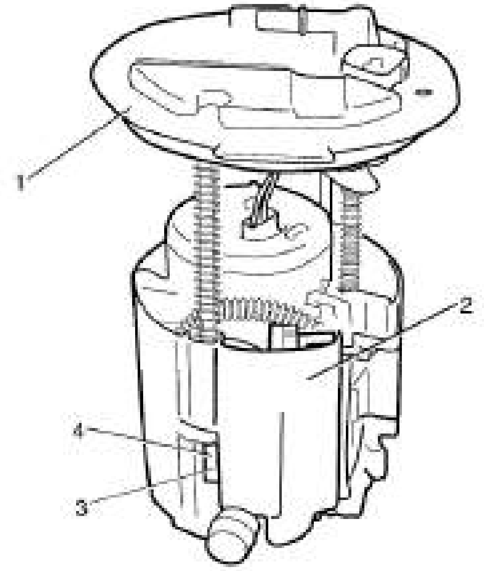
1. Locate and attach the fuel filter (1) to the fuel pump housing (3).



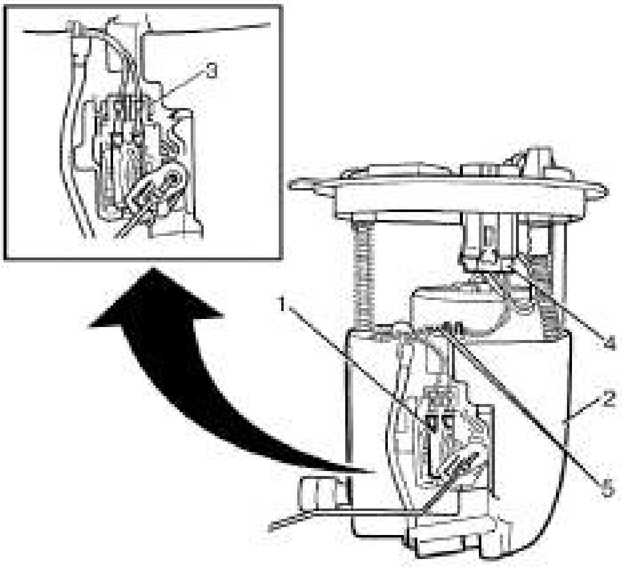
2. Fit a NEW O-ring seal (1) to the fuel outlet (2) and lubricate the NEW O-ring seal with an approved lubricant.



3. Route pipes (1) and (3) as noted earlier.
4. Press down on connector and listen for an audible click to confirm fitment.
5. Locate and install the fuel pump housing (2) into the primary fuel tank module assembly (5).
6. Locate and install the piping (4) to the primary fuel tank module assembly (5). Listen for audible click to confirm fitment.
7. Install the spring (6) to the fuel tank module assembly (5).



8. Assemble the primary fuel tank module assembly (1) and (2).
9. Press down on the primary fuel tank module assembly and install the circlip (3) to the shaft (4).



10. Locate and install the fuel tank level sensor (1) to the primary fuel tank module assembly (2). Make sure that the locking clip (3) engages.
11. Connect the fuel level sensor connector (4) and route the wiring through the harness securing clips (5).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | Document ID: 1976138

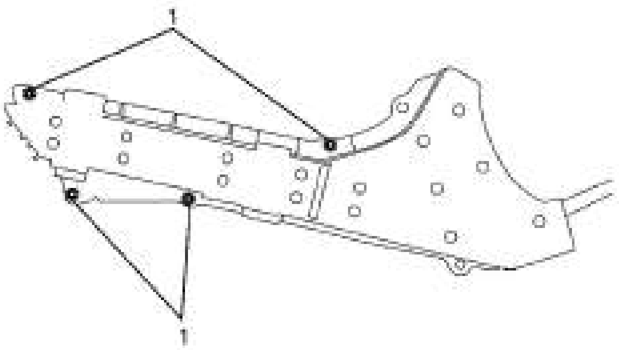
Fuel Hose/Pipes Replacement - Chassis

Removal Procedure

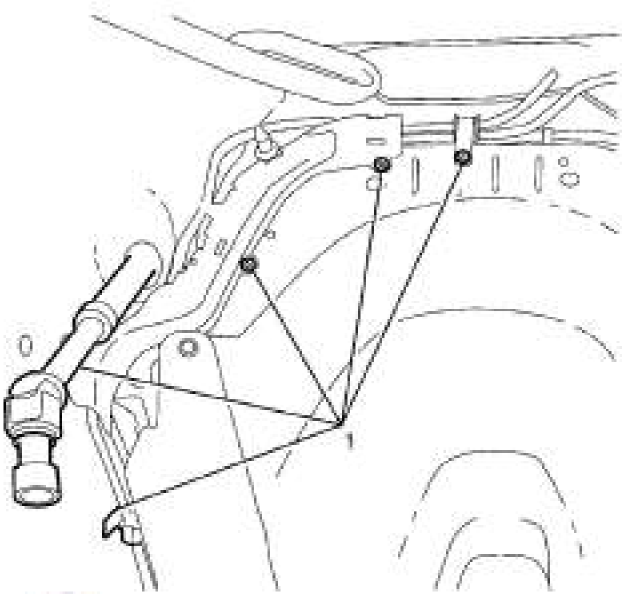
Caution: Refer to Gasoline/Gasoline Vapors Caution in the Preface section.

Important: The fuel system hose/pipes are serviceable individually or as a complete fuel/brake bundle assembly, the following procedure is servicing the fuel hose/pipes individually.

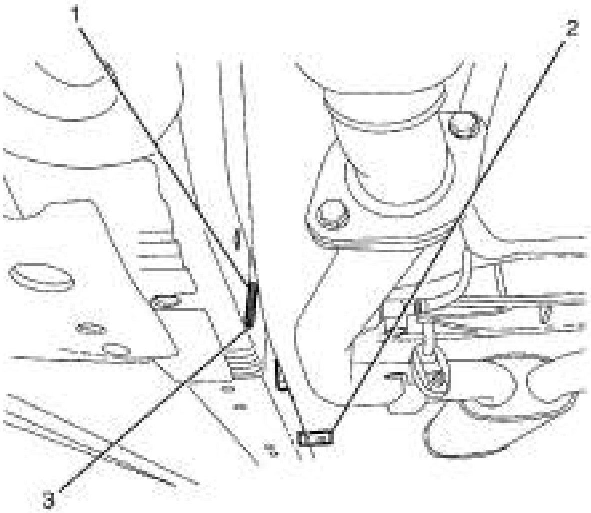
1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
2. Before you service any fuel system connection, relieve the fuel system pressure. Refer to the Fuel Pressure Relief .
3. Remove the exhaust and exhaust heat shields. Refer to Exhaust System Replacement
4. Remove the engine. Refer to Engine Replacement
5. Disconnect the fuel and EVAP lines at the fuel tank. Refer to Fuel Tank Replacement
6. Disconnect the fuel and evaporative emission (EVAP) lines at the engine compartment.



7. Remove the retaining bolts (1) and the retaining nuts (1) securing the rear stone guard.



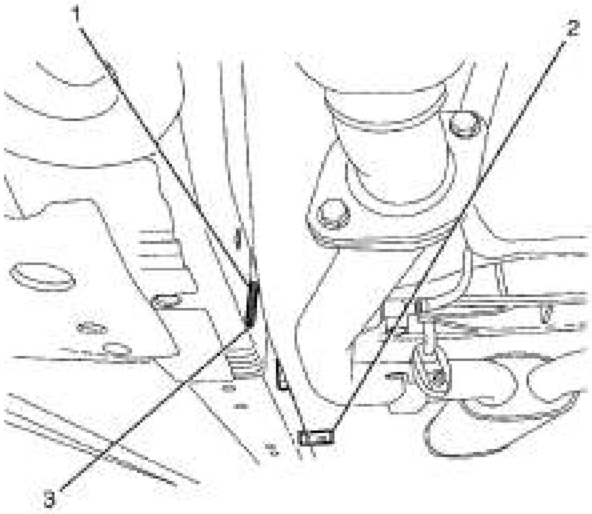
8. Remove all the fuel line bracket pop rivets securing the fuel and EVAP pipes to the vehicle body.



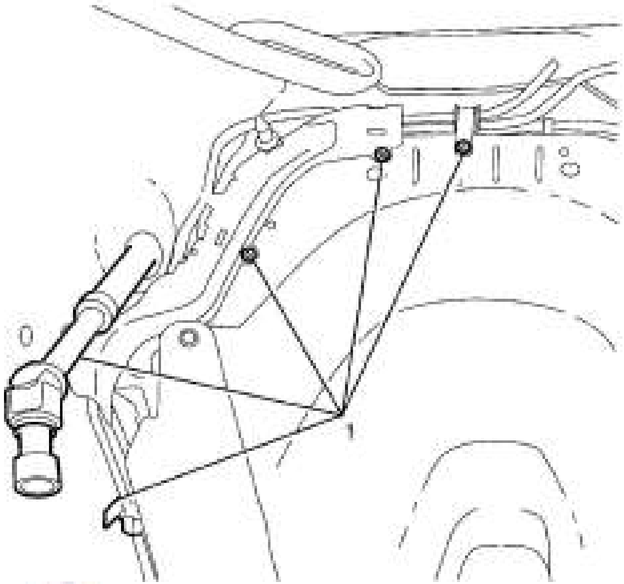
9. Remove all the fuel line bracket pop rivets securing the fuel and EVAP pipes to the body tunnel.
10. Remove the fuel and EVAP lines from the vehicle.

Installation Procedure

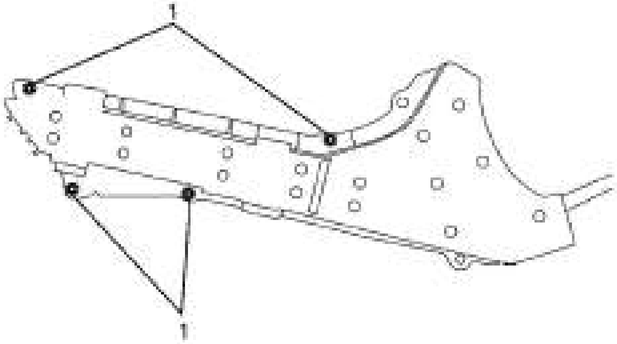
1. Install the fuel and EVAP lines to the vehicle.



2. Install all the fuel line bracket pop rivets securing the fuel and EVAP pipes to the body tunnel.



3. Install all the fuel line bracket pop rivets securing the fuel and EVAP pipes to the vehicle body.



4. Install the retaining bolts (1) and the retaining nuts (1) securing the rear stone guard.
5. Connect the fuel and evaporative emission (EVAP) lines at the engine compartment.
6. Connect the fuel and EVAP lines at the fuel tank. Refer to Fuel Tank Replacement .
7. Install the engine. Refer to Engine Replacement .
8. Install the exhaust and exhaust heat shields. Refer to Exhaust System Replacement .
9. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .

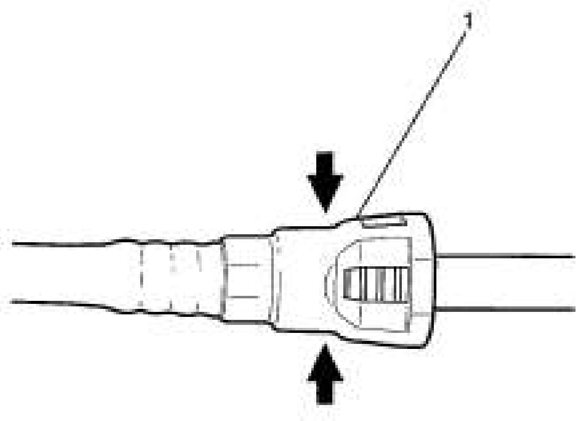
Fuel Injector and Fuel Rail Replacement

Removal Procedure

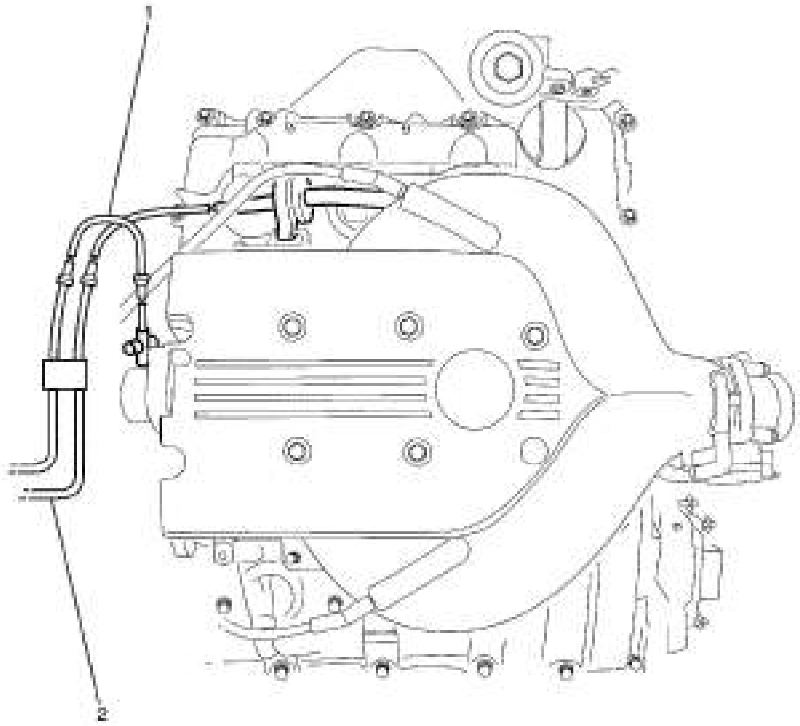
Caution: Refer to Gasoline/Gasoline Vapors Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief.
2. Remove the upper intake manifold with the lower intake manifold. Refer to Upper Intake Manifold Replacement



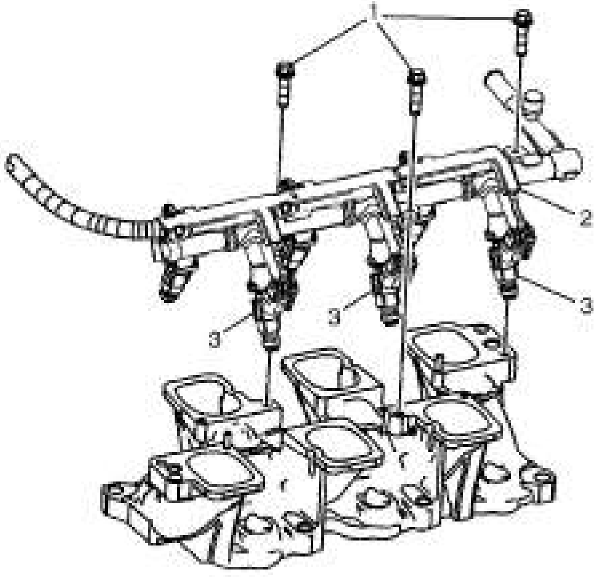
3. Remove the fuel pipe retaining clip (1).



4. Disconnect the fuel feed line pipe (2) from the fuel injector rail. Refer to Metal Collar Quick Connect Fitting Service.

   Caution: Refer to Safety Glasses and Compressed Air Caution in the Preface section.

5. Use compressed air in order to remove debris from the area where the fuel injectors enter the intake manifold.

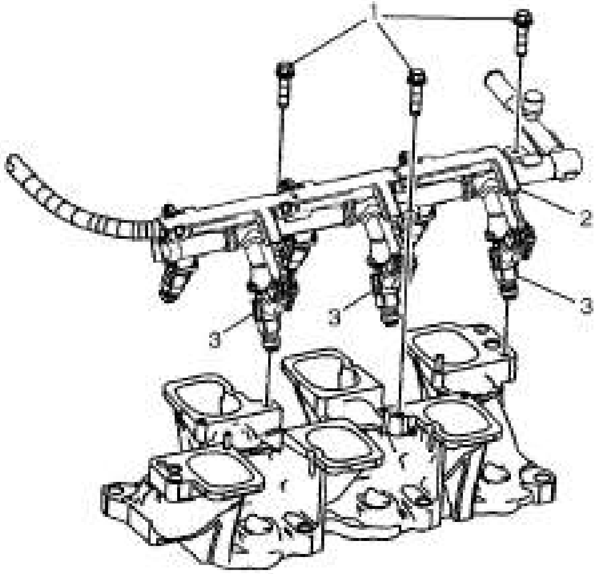


6. Remove the fuel rail to lower inlet manifold retaining bolts (1).

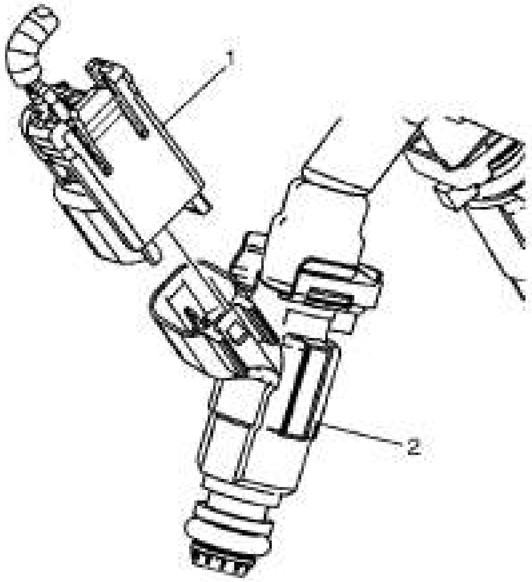
Notice:

- Remove the fuel rail assembly carefully in order to prevent damage to the injector electrical connector terminals and the injector spray tips. Support the fuel rail after the fuel rail is removed in order to avoid damaging the fuel rail components.
- Cap the fittings and plug the holes when servicing the fuel system in order to prevent dirt and other contaminants from entering open pipes and passages.

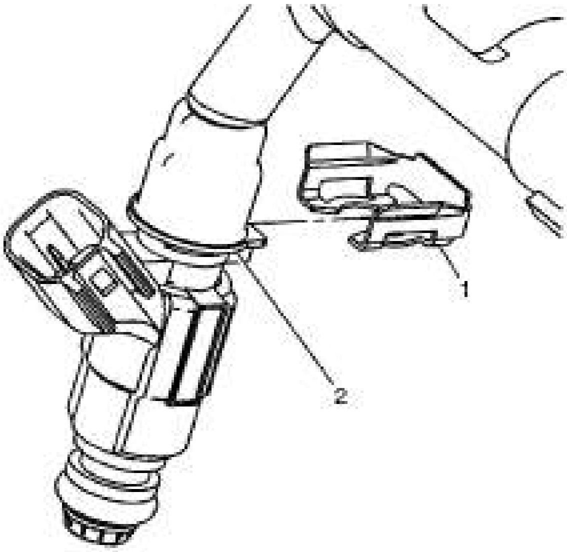
7. Remove the fuel rail (2) and the fuel injectors (3) from the manifold.



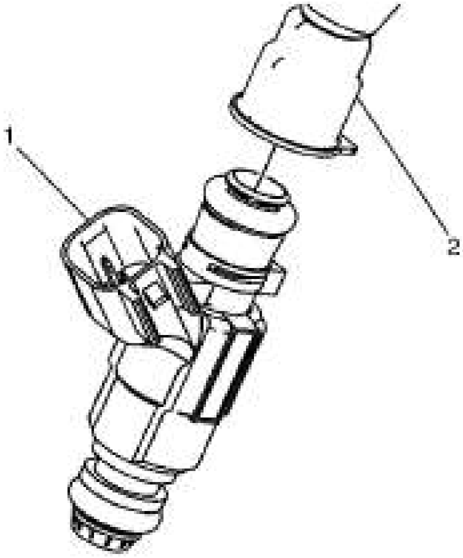
8. Disengage the fuel injector electrical connector lock (1).



9. Disconnect the fuel injector electrical connector (1) from the fuel injector (2).



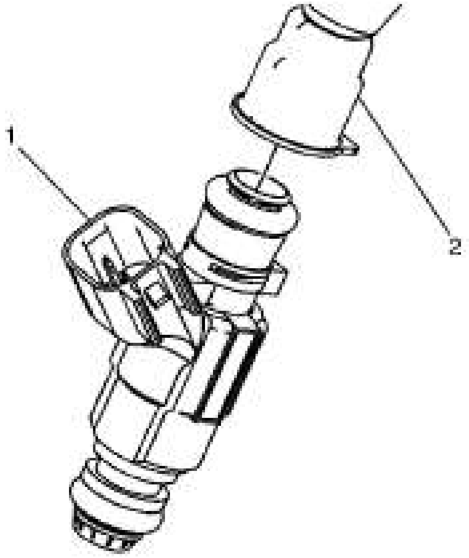
10. Remove the fuel injector retainer clip (1) from the fuel rail (2).



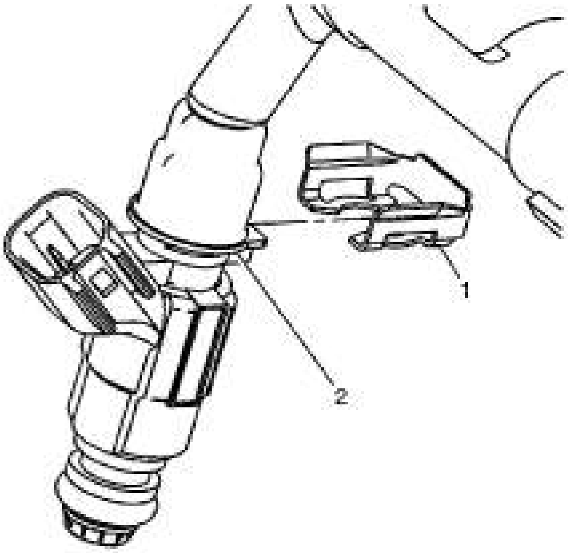
11. Remove the fuel injector (1) from the fuel rail (2).
12. Remove and discard the fuel injector seals.

Installation Procedure

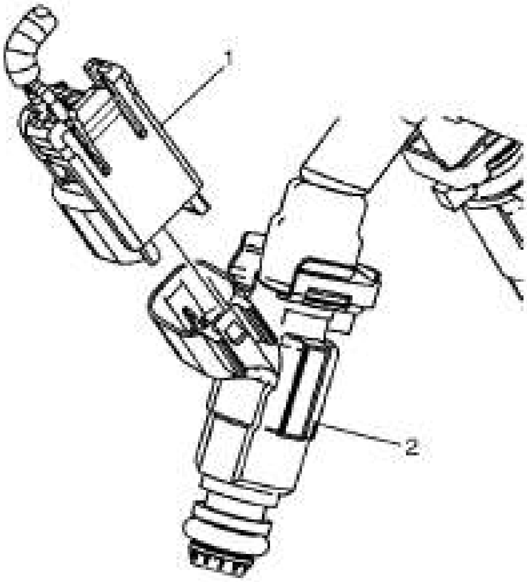
1. Install NEW fuel injector seals.



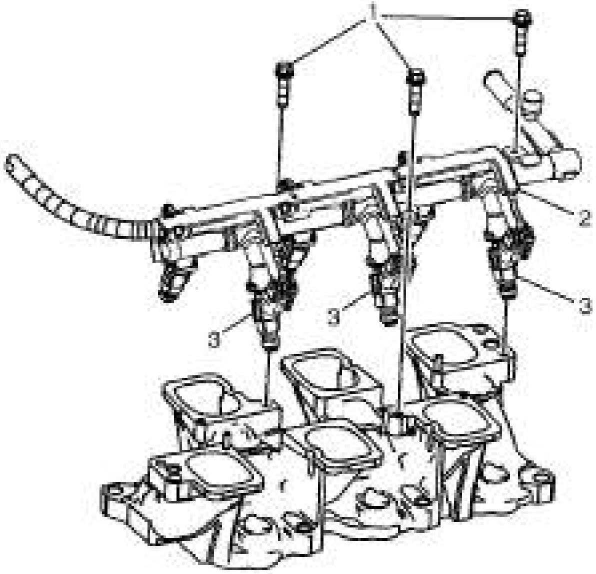
2. Install the fuel injector (1) to the fuel rail (2).



3. Install the fuel injector retainer clip (1) to the fuel rail (2).



4. Install the fuel injector electrical connector (1) to the fuel injector (2).
5. Engage the fuel injector electrical connector lock.

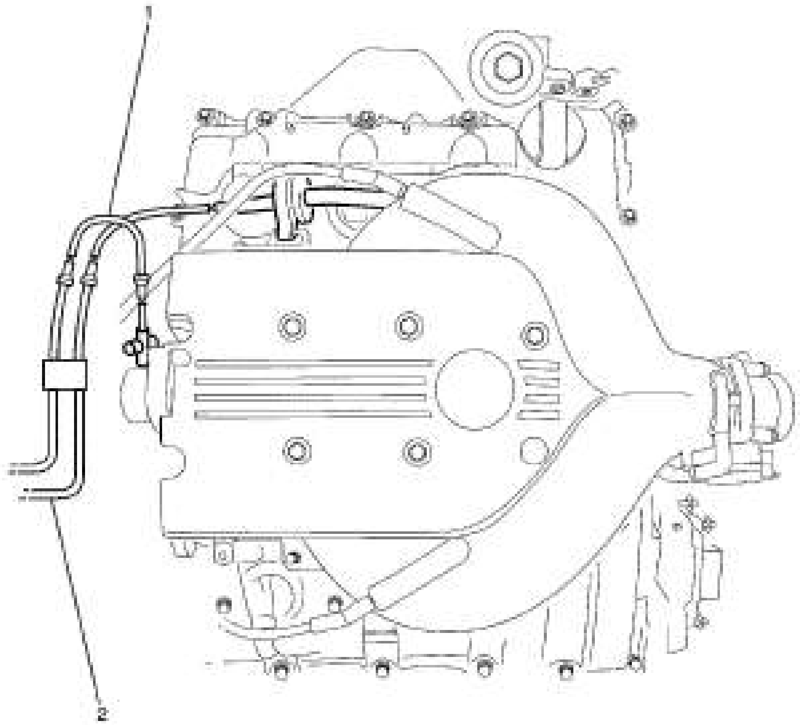


6. Install the fuel rail (2) with the fuel injectors (1) to the lower manifold.

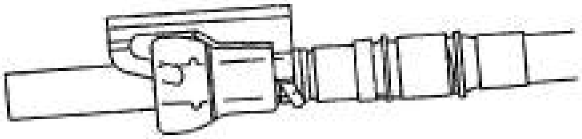
   Notice: Refer to Fastener Notice in the Preface section.

7. Install the fuel rail to lower manifold retaining bolts (1).

   Tighten
   Tighten the fuel rail bolts to 10 N·m (89 lb in).



8. Connect the fuel feed line (1) to the fuel rail. Refer to Metal Collar Quick Connect Fitting Service.



9. Install the fuel pipe retaining clip.
10. Install the upper intake manifold. Refer to Upper Intake Manifold Replacement

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | Document ID: 2006682

Fuel Injector Replacement (LPG)

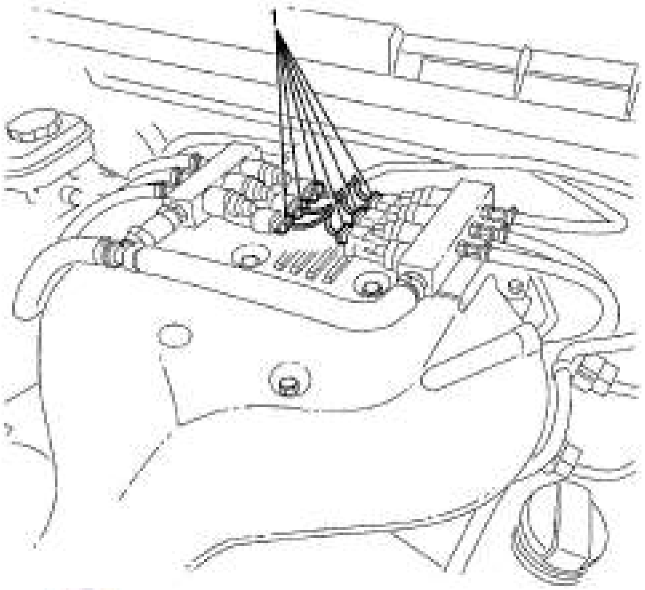
Removal Procedure

Caution: Refer to General Repair Instructions in the Preface section.

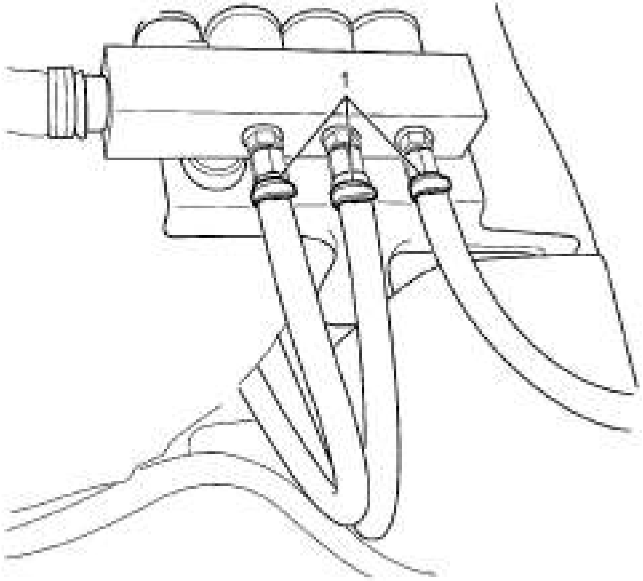
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Fuel Pressure Relief in the Preface section.

1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief.



2. Disconnect the LPG injector electrical connectors (1).

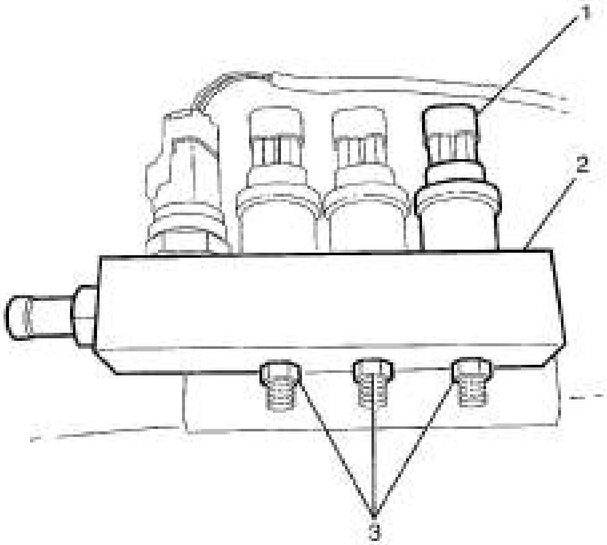


Important: The hose clamps (1) require special pliers to remove and fit.

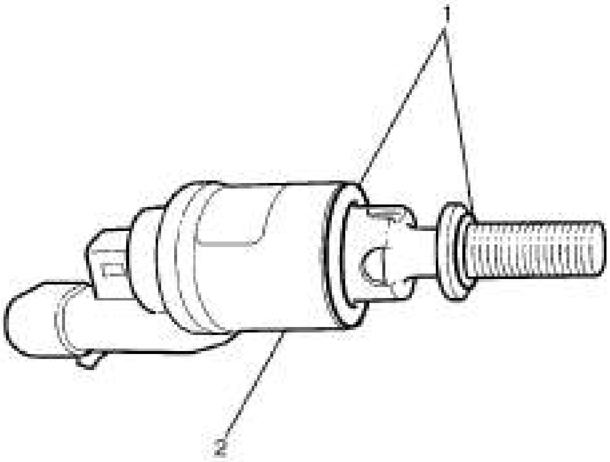
3. Remove the hose clamps (1) from the LPG injector hoses.

   Discard the clamps

4. Disconnect the LPG injector hoses from the fuel rail.



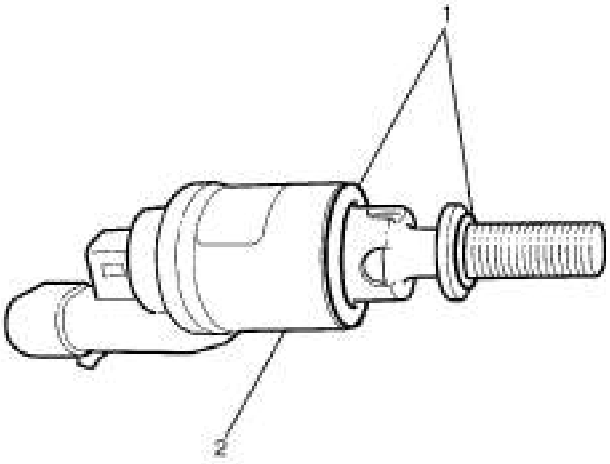
5. Remove the LPG injector to fuel rail retaining nuts (3).
6. Remove the LPG injectors (1) from the fuel rail (2).



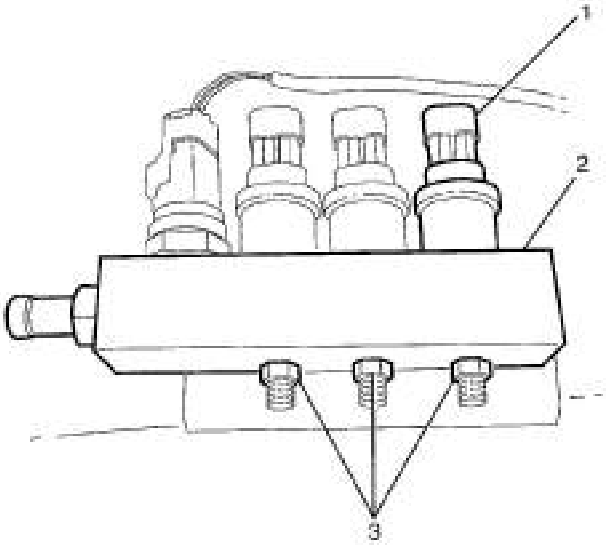
7. Remove the O-rings (1) from the LPG injector (2).

   Discard the O-rings.

Installation Procedure



1. Install the NEW O-rings (1) to the NEW LPG injector (2).

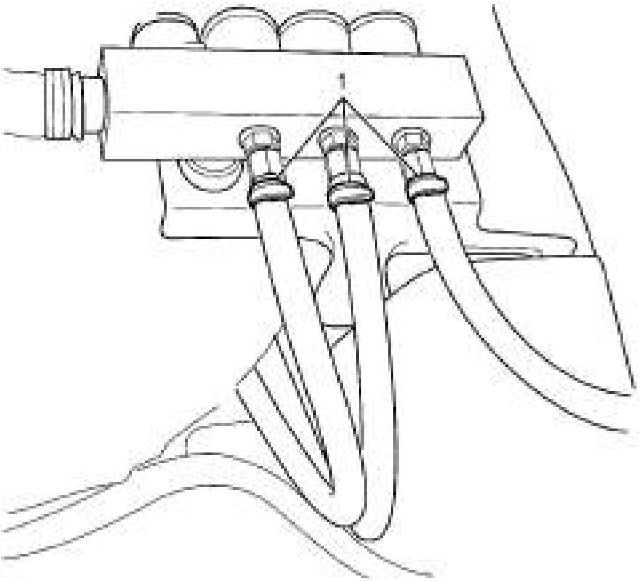


2. Position the NEW LPG injector (1) to the fuel rail (2).

   Notice: Refer to Fastener Notice in the Preface section.

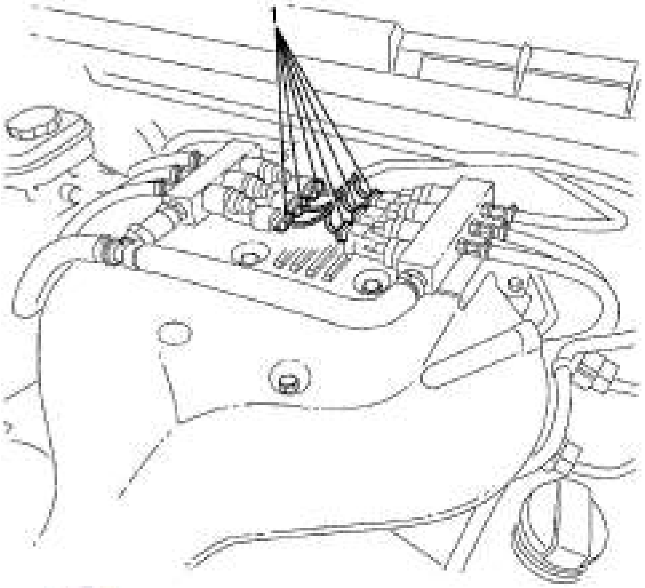
3. Install the NEW LPG injector to fuel rail retaining nuts (3).

   Tighten
   Tighten the nuts to 5 N·m (44 lb in).



Important: The hose clamps (1) require special pliers to remove and fit.

4. Secure the NEW LPG injector hose clamps (1).



5. Install the LPG injector electrical connectors (1).
6. Start the vehicle and inspect for LPG fuel leaks at the serviced fitting's using the combustible gas detector or an equivalent liquid leak detector.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | **Document ID: 2053073**

Fuel Level Sensor Replacement

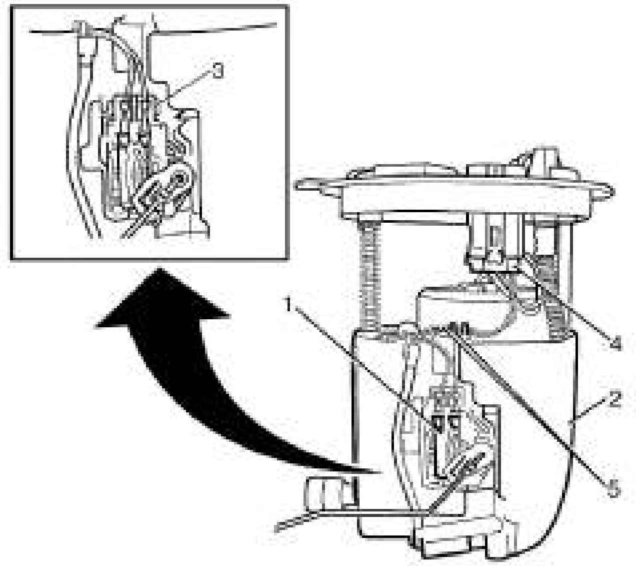
Removal Procedure

Caution: Refer to Gasoline/Gasoline Vapors Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

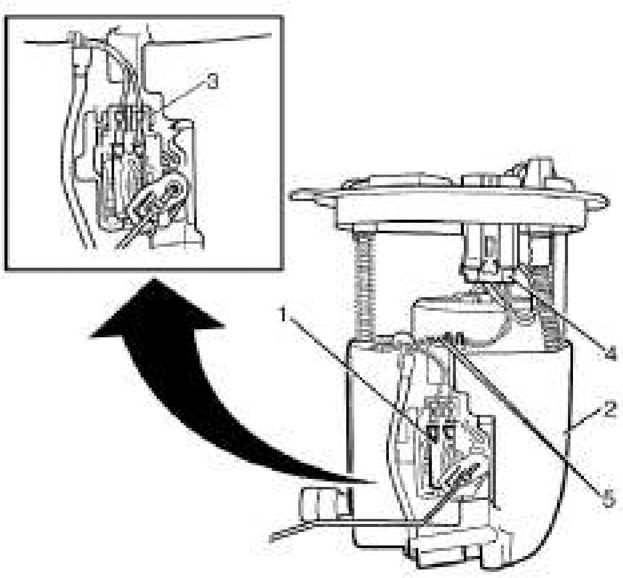
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Remove the fuel tank. Refer to Fuel Tank Replacement .
2. Remove the primary fuel tank module assembly from the fuel tank. Refer to Primary Fuel Tank Module Replacement .



3. Disconnect the fuel level sensor connector (4) and unclip the wiring from the harness securing clips (5).
4. Remove the fuel level sensor from the primary fuel tank module assembly.
5. Unlock the locking clip (3) and gently push the fuel level sensor upwards.
6. Remove the fuel level sensor from the primary fuel tank module assembly.

Installation Procedure



1. Locate and install the fuel tank level sensor (1) to the primary fuel tank module assembly (2). Make sure that the locking clip (3) engages.
2. Connect the fuel level sensor connector (4) and route the wiring through the harness securing clips (5).
3. Install the fuel level sensor to the primary fuel tank module assembly.
4. Install the primary fuel tank module assembly to the fuel tank. Refer to Primary Fuel Tank Module Replacement .
5. Install the fuel tank. Refer to Fuel Tank Replacement .

Fuel Pressure Gage Installation and Removal

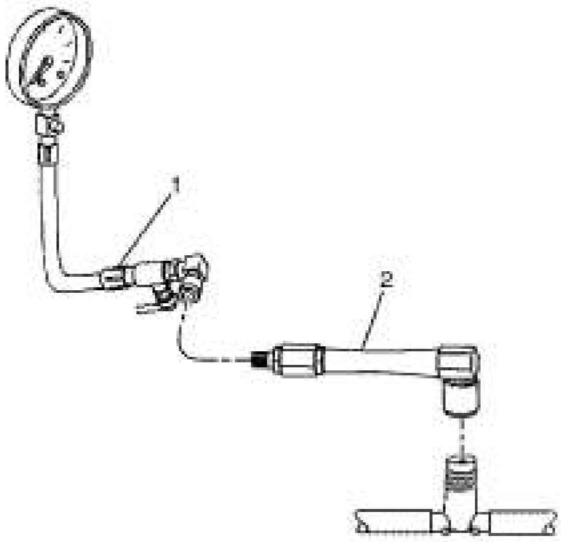
Tools Required

AU-338 Fuel Pressure Gauge

AU-465 Fuel Pressure Gauge Hose Adapter

Removal Procedure

1. Turn OFF the ignition.
2. Command the fuel pump OFF with the scan tool.
3. Open the bleed valve on the fuel pressure gauge in order to bleed the remaining fuel from the fuel pressure gauge.
4. Remove the bleed hose from the fuel pressure gauge.



5. Disconnect the AU-338 (2) fuel pressure gauge from the AU-465 (1). Wrap a shop towel around the fitting while connecting the gauge in order to avoid spillage.
6. Disconnect the AU-465 (1) fuel pressure test hose adapter to the fuel pressure connection. Wrap a shop towel around the fitting while connecting the AU-465 (1) in order to avoid spillage.
7. Install the fuel pressure service connection dust cap to the fuel rail.
8. Install the engine covers. Refer to Engine Cover Replacement .

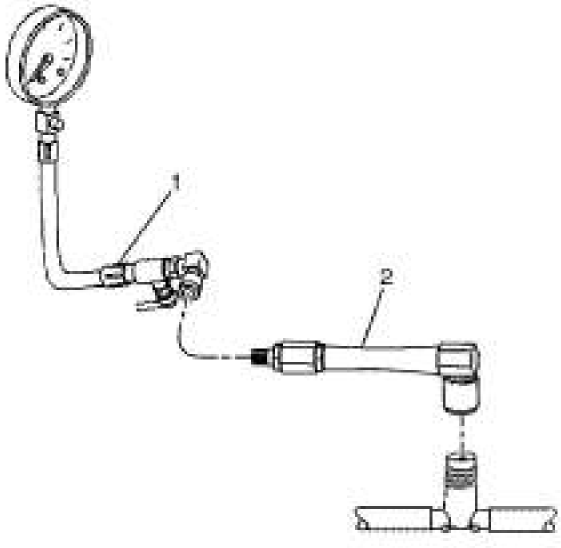
Installation Procedure

Caution: Refer to Gasoline/Gasoline Vapors Caution in the Preface section.

Notice: Clean all of the following areas before performing any disconnections in order to avoid possible contamination in the system:

- The fuel pipe connections
- The hose connections
- The areas surrounding the connections

1. Remove the engine covers. Refer to Engine Cover Replacement .



2. Remove the fuel pressure service connection dust cap from the fuel rail.
3. Connect the AU-465 (1) fuel pressure test hose adapter to the fuel pressure connection. Wrap a shop towel around the fitting while connecting the AU-465 (1) in order to avoid spillage.
4. Connect the AU-338 (2) fuel pressure gauge to the AU-465 (1). Wrap a shop towel around the fitting while connecting the gauge in order to avoid spillage.
5. Turn ON the ignition.

Caution: Do not drain the fuel into an open container. Never store the fuel in an open container due to the possibility of a fire or an explosion.

6. Place the bleed hose of the fuel pressure gauge into a suitable container.
7. Open the bleed valve on the fuel pressure gauge in order to bleed the air from the fuel pressure gauge.
8. Command the fuel pump ON with a scan tool.
9. Close the bleed valve on the fuel pressure gauge.
10. Inspect for fuel leaks.

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Fuel Pressure Relief (Petrol)

Tools Required

- J 34730-1A Fuel Pressure Gauge
- AU-453 Fuel Pressure Test Hose Adapter

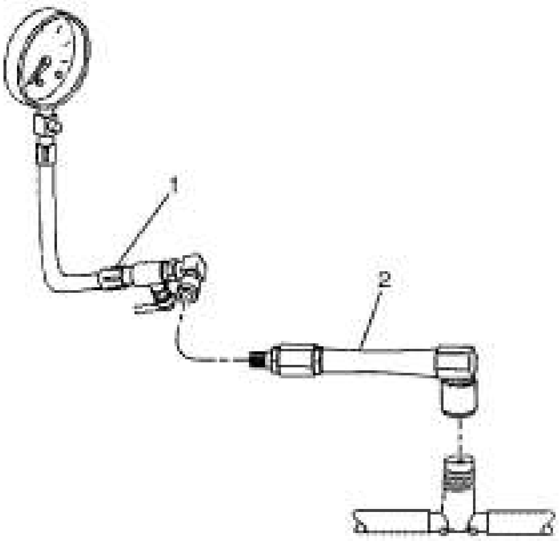
Caution: Gasoline or gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.

Caution: Relieve the fuel system pressure before servicing fuel system components in order to reduce the risk of fire and personal injury.

After relieving the system pressure, a small amount of fuel may be released when servicing the fuel lines or connections. In order to reduce the chance of personal injury, cover the regulator and the fuel line fittings with a shop towel before disconnecting. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Turn the ignition OFF.
2. Disconnect the negative battery cable in order to avoid possible fuel discharge if an accidental attempt is made to start the engine. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove the fuel injector sight shield.



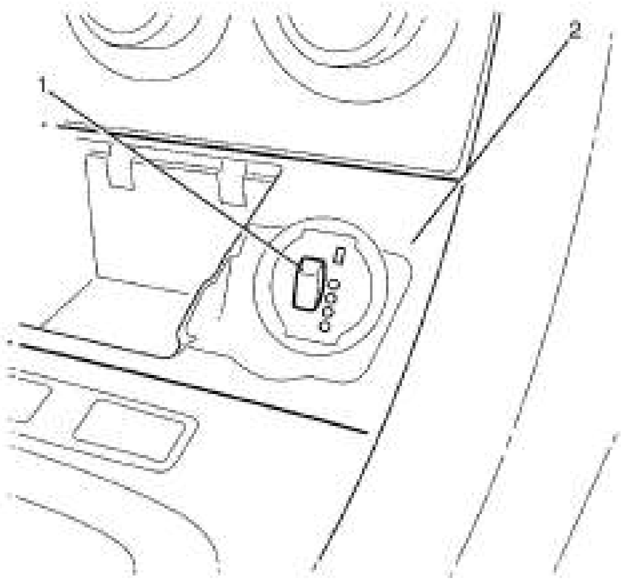
4. Connect the AU-453 (1) fuel pressure test hose adapter to the fuel pressure connection. Wrap a shop towel around the fitting while connecting the AU-453 (1) in order to avoid spillage.
5. Connect the J 34730-1A (2) fuel pressure gauge to the AU-453 (1). Wrap a shop towel

around the fitting while connecting the gauge in order to avoid spillage.

6. Install the bleed hose into an approved container.
7. Open the valve in order to bleed the system pressure. Fuel connections are now safe for servicing.
8. Drain any fuel remaining in the gauge into an approved container.
9. Install the fuel injector sight shield.
10. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .

Fuel Selector Switch Replacement

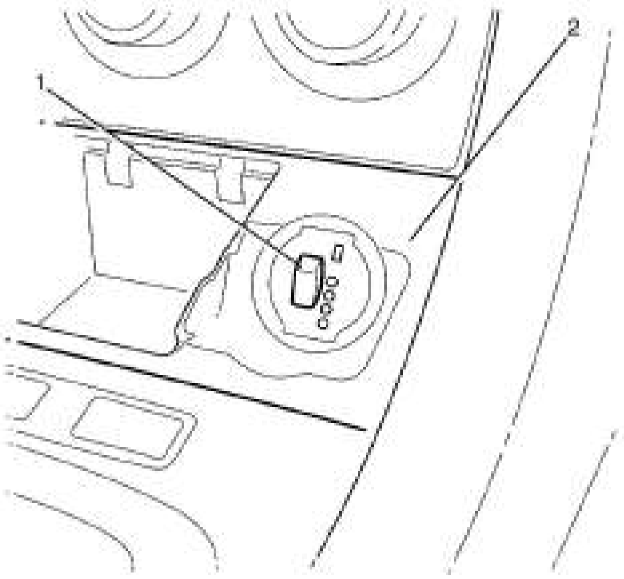
Removal Procedure



1. Remove the LPG switch/gauge (1) assembly from the panel (2).
2. Disconnect the LPG switch/gauge assembly electrical connector.
3. Remove the LPG switch/gauge (1) assembly from the vehicle.

Installation Procedure

1. Position the LPG switch/gauge assembly to the panel.
2. Connect the LPG switch/gauge assembly electrical connector.



3. Install the LPG switch/gauge assembly (1) to panel (2).

Fuel System Cleaning

Caution: Refer to Gasoline/Gasoline Vapors Caution in the Preface section.

Important: The following procedure covers the disassembly and the inspection of the complete fuel supply system. If the fuel system is contaminated, the fuel system can be cleaned. You can usually determine the extent of the fuel system contamination during the disassembly.

1. Inspect the fuel system for contamination of the fuel lines if the lines are contaminated.
2. Remove the fuel module assemblies. Refer to Primary Fuel Tank Module Replacement and Secondary Fuel Tank Module Replacement .
3. Locate the tank in a suitable work area away from any heat, any flame, or any other source of ignition.
4. Perform the following procedures:
   - Inspect the fuel sender strainer. Replace the primary fuel tank module if the strainer is contaminated.
   - Inspect the secondary fuel tank module for debris. Clean the secondary fuel tank module if debris is found.

   Caution: Wear safety glasses when using compressed air, as flying dirt particles may cause eye injury.

   - Use compressed air in order to apply air pressure to the transfer tube.

Important: When flushing the fuel tank, handle the fuel and water mixture as a hazardous material. Handle the fuel and water in accordance with all applicable local, state, and federal laws and regulations.

5. Flush the fuel tank with running hot water for at least five minutes. Pour the water out of the fuel sender assembly opening. Rock the tank in order to make sure that the removal of the water from the tank is complete.
6. Refer to Metal Collar Quick Connect Fitting Service to disconnect the following quick connect fittings from the fuel rail:

   The feed hose/pipe

7. Use compressed air in order to apply air pressure to the fuel lines in the opposite direction from the normal fuel flow.
8. Remove the fuel injectors and fuel rail. Refer to Fuel Injector and Fuel Rail Replacement .
9. Clean and inspect the fuel injectors and fuel rail.

Installation Procedure

1. Assemble the fuel system as follows:

   Install the fuel injectors and fuel rail. Refer to Fuel Injector and Fuel Rail Replacement .

2. Install the fuel module assemblies. Refer to Primary Fuel Tank Module Replacement and

Secondary Fuel Tank Module Replacement .

3. Refer to Metal Collar Quick Connect Fitting Service to connect the following quick connect fittings to the fuel rail:

   The feed hose/pipe

Fuel Tank Draining

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Gasoline/Gasoline Vapors Caution in the Preface section.

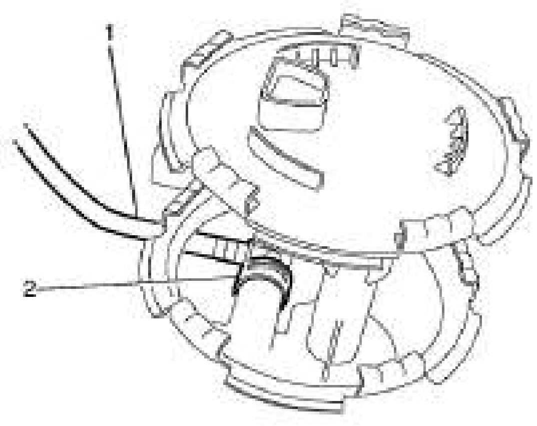
Caution: Never drain or store fuel in an open container. Always use an approved fuel storage container in order to reduce the chance of fire or explosion.

Caution: Place a dry chemical (Class B) fire extinguisher nearby before performing any on-vehicle service procedures. Failure to follow these precautions may result in personal injury.

1. Remove the fuel filler cap.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



3. Disconnect the fuel feed line (1) from the fuel feed pipe (2). Refer to Plastic Collar Quick Connect Fitting Service .

   Important: Up to 26 Litres (7 gallons) of residual fuel may remain in the secondary side of the fuel tank.

4. Connect a commercially available fuel pump to the fuel feed line (1).
5. Operate the commercially available fuel pump and drain the fuel into an approved fuel container.
6. Disconnect the commercially available fuel pump from the fuel feed line (1).
7. If the tank is not being removed, connect the fuel feed line (1) to the fuel feed pipe (2). Refer to Plastic Collar Quick Connect Fitting Service .

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | **Document ID: 1996241**

Fuel Tank Replacement (LWB SWB)

Removal Procedure

Tools Required

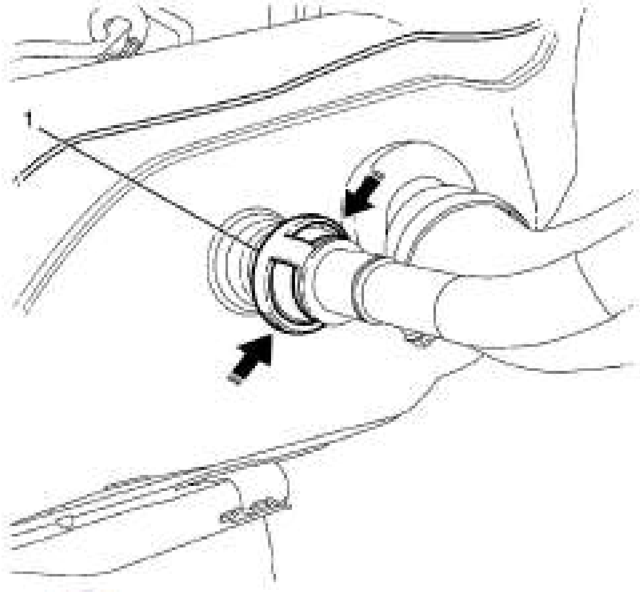
EN-48536 Frame Support Tool (Engine Lower 65 mm Kit)

Caution: Refer to Gasoline/Gasoline Vapors Caution in the Preface section.

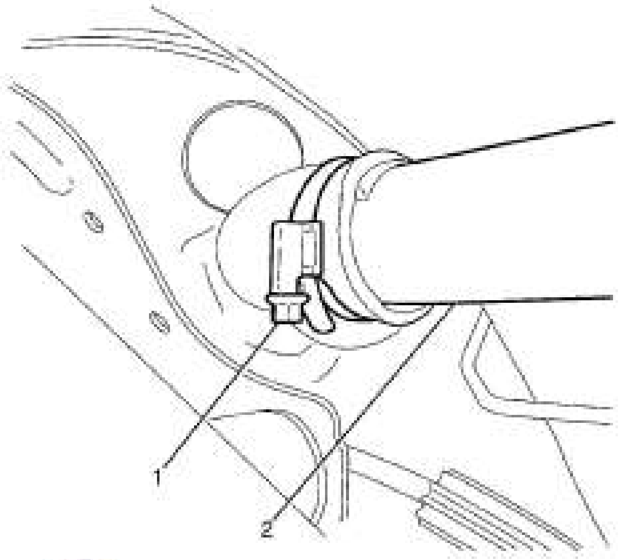
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

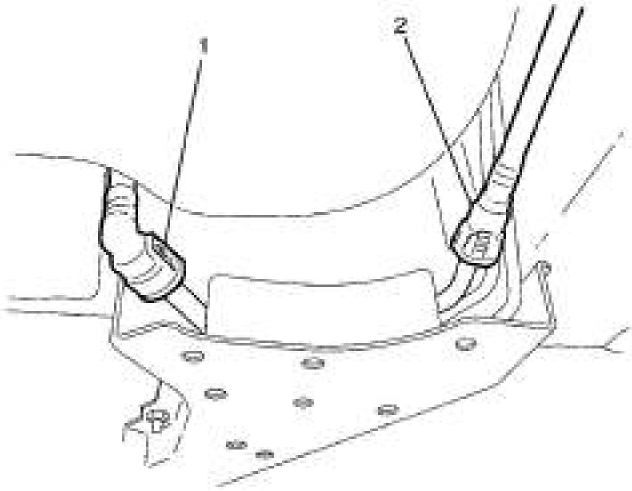
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Drain the fuel tank. Refer to Fuel Tank Draining .
3. Relieve the fuel system pressure. Refer to Fuel Pressure Relief .
4. Remove the exhaust system. Refer to Exhaust System Replacement .
5. Remove the propeller shaft. Refer to Propeller Shaft Replacement .
6. Remove the right rear wheel. Refer to Tire and Wheel Removal and Installation .



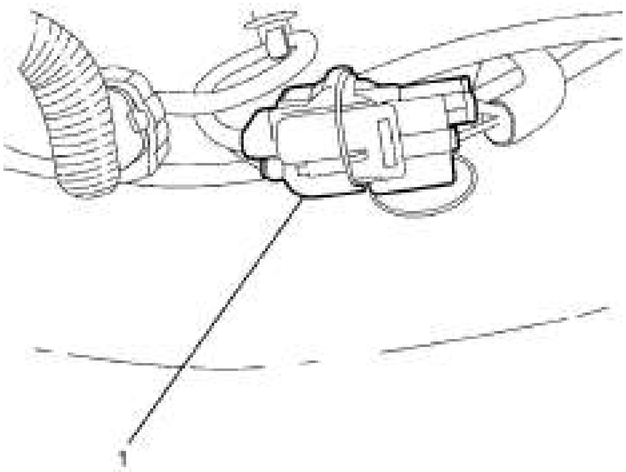
7. Disconnect the evaporative emission (EVAP) line (1), by squeezing both sides of the line (as indicated in the illustration) and pulling it toward the rear of the vehicle.



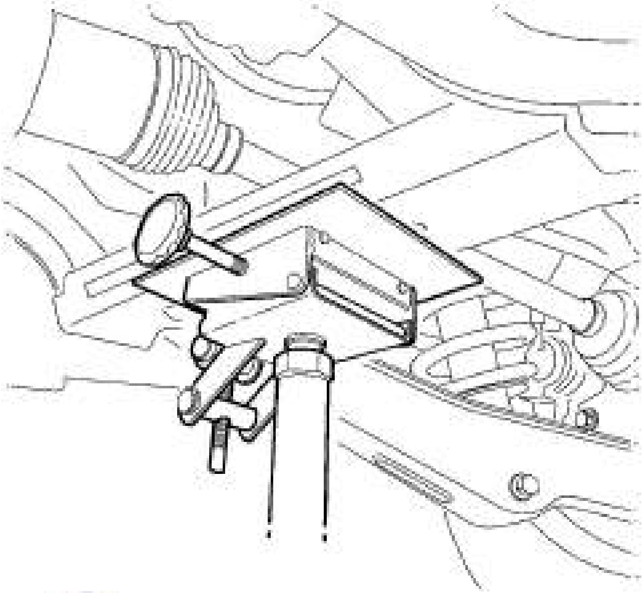
8. Release the worm drive hose clamp (1) and remove the filler tube (2).



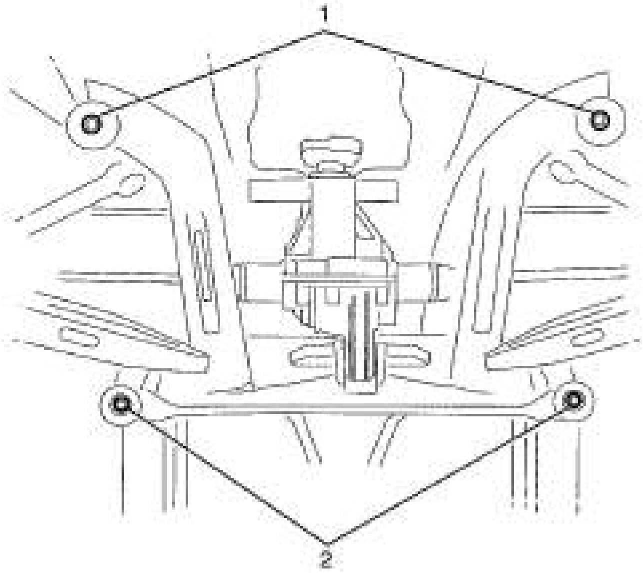
9. Disconnect the fuel feed line (1) and evaporative emission (EVAP) line (2). Refer to Plastic Collar Quick Connect Fitting Service .



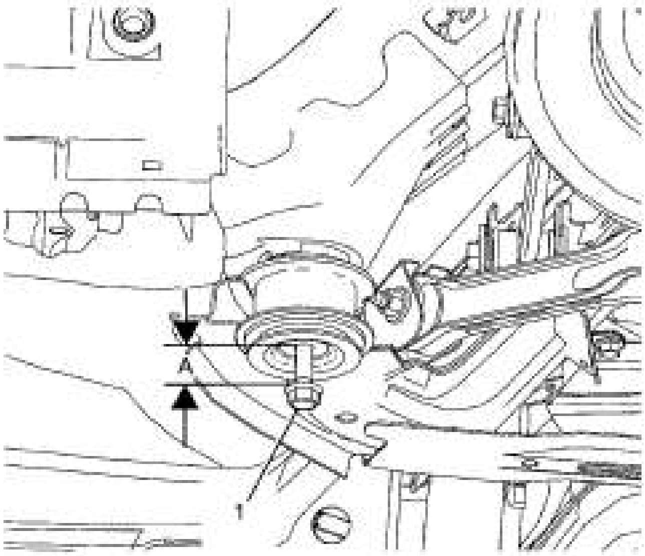
10. Disconnect the fuel tank electrical connector (1).



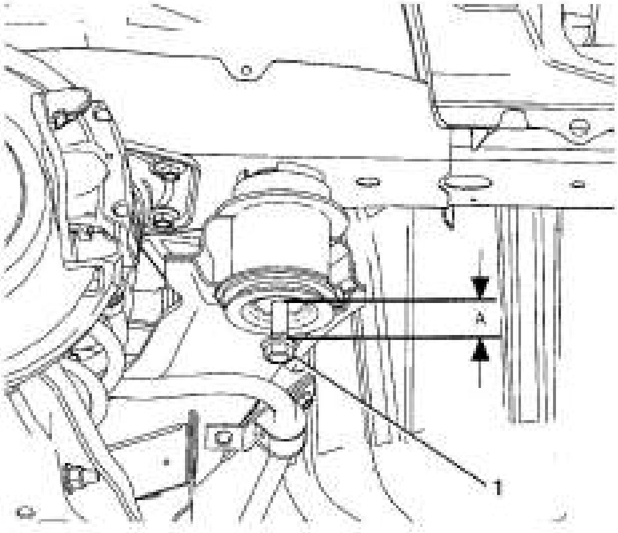
11. Support the rear frame assembly using a suitable tool.



12. Remove the rear frame to chassis retaining bolts (1) and (2) and discard.

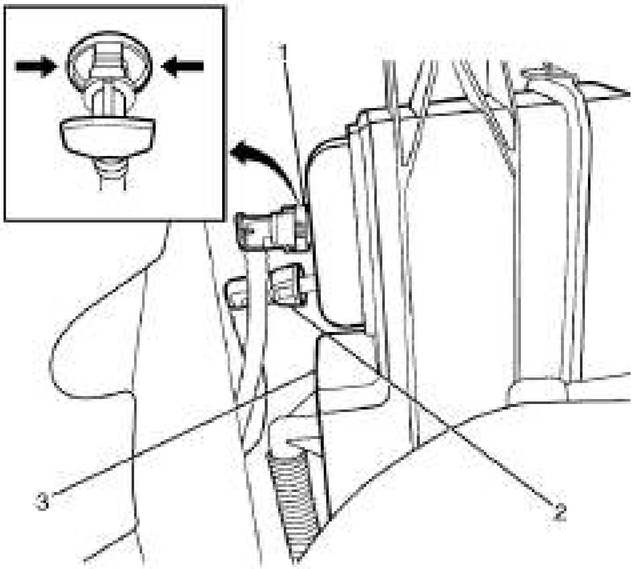


13. Support the rear frame using the bolt (1) from the EN-48536 special tool kit . Repeat for the opposite side.



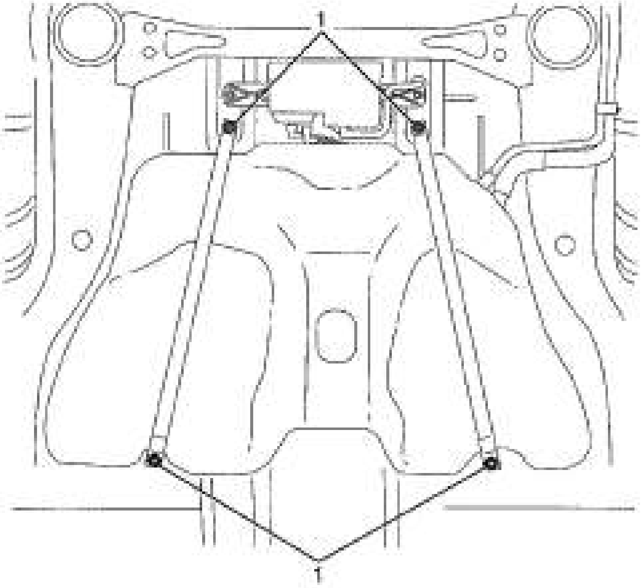
Important: When lowering the rear frame use care not to over extend the rear brake hoses.

14. Support the rear frame using the bolt (1) from the EN-48536 special tool kit . Repeat for the opposite side.
15. Lower the rear frame approximately 50 millimetre's (2 in) (A) at the rear mounting surface between the rear frame and the chassis.
16. This will allow clearance to access the fuel tank strap bolts.
17. Remove the fuel tank heat shield. Refer to Fuel Tank Heat Shield Replacement .
18. Disconnect the park brake rear cables from the park brake front cable equalizer bracket assembly. Refer to Parking Brake Front Cable Replacement .



19. Disconnect the evapouritive emission line (2) from the evapourative emission canister (3).

Refer to Plastic Collar Quick Connect Fitting Service .



20. Remove the fuel tank strap to chassis retaining bolts (1).
21. Position the fuel tank straps away from the fuel tank.
22. Carefully bend the fuel tank straps enough to allow the fuel tank to be removed.

Important: Make sure the following are free from the surrounding components while lowering the fuel tank:

- The fuel tank wiring harness.
- The fuel hoses at the chassis pipes.

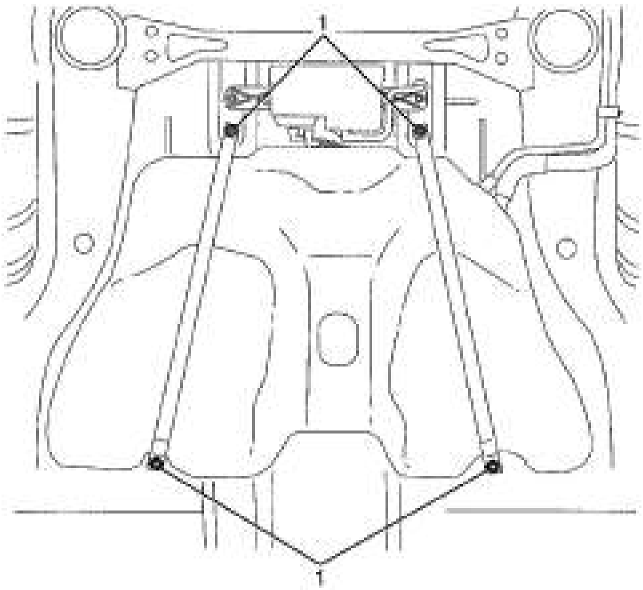
23. With the aid of an assistant, carefully lower the fuel tank from the vehicle.
24. Remove the following components if replacing just the fuel tank.
    - The primary fuel tank module - Refer to Primary Fuel Tank Module Replacement .
    - The secondary fuel tank module - Refer to Secondary Fuel Tank Module Replacement .

Installation Procedure

1. Install the following components if fuel tank replacement was necessary.
    - The primary fuel tank module--Refer to Primary Fuel Tank Module Replacement .
    - The secondary fuel tank module--Refer to Secondary Fuel Tank Module Replacement .

Important: Make sure the following are properly routed while raising the fuel tank:

- The fuel tank wiring harness.
- The fuel hoses at the chassis pipes.



2. With the aid of an assistant, carefully raise the fuel tank to the vehicle.

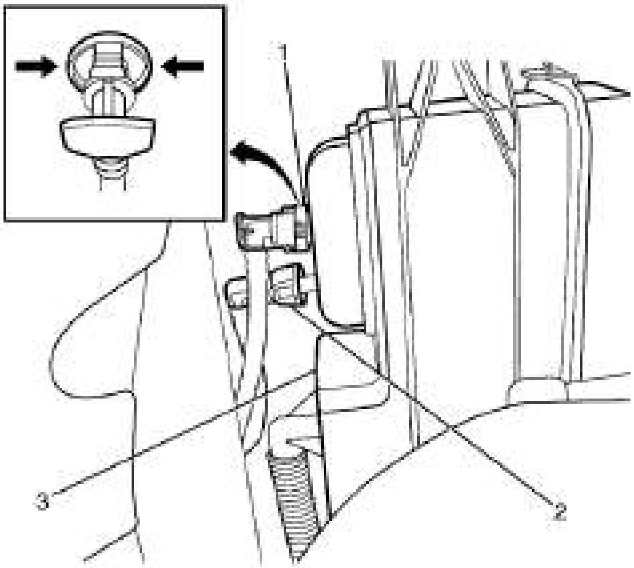
   Important: Make sure the fuel tank straps are not pressed into the fuel tank.

3. Carefully install the fuel tank straps back to their original form.
4. Position the fuel tank straps around the rear frame and upward into position, aligning the holes in the straps with the threaded holes in the chassis.

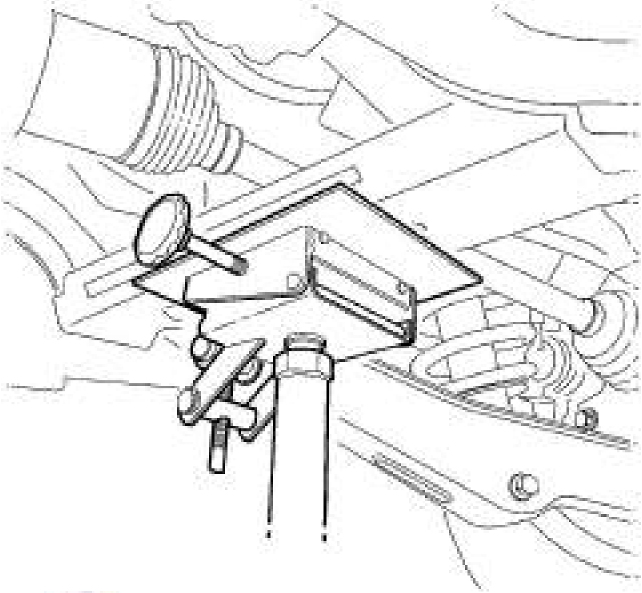
   Notice: Refer to Fastener Notice in the Preface section.

5. Install the fuel tank strap bolts.

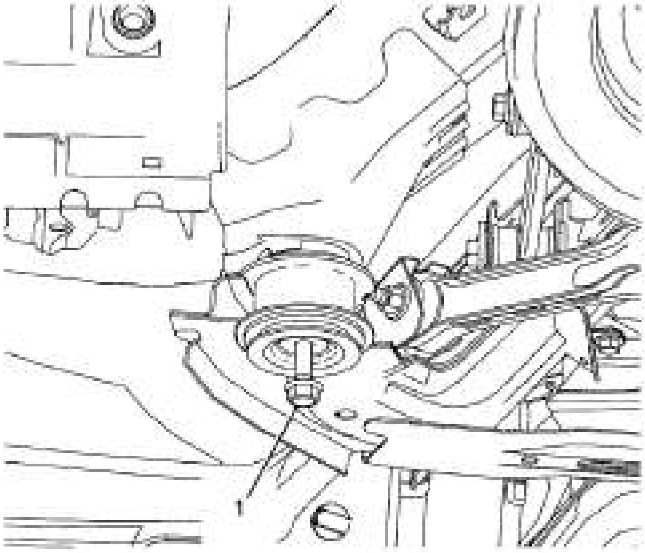
   Tighten
   Tighten the fuel tank strap bolts to 20 N·m (15 lb ft).



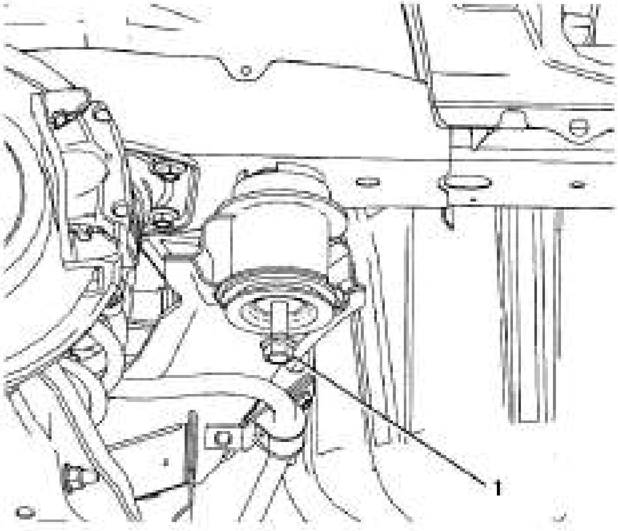
6. Connect the evapourative emission line (2) to the evapourative emission canister (3). Refer to Plastic Collar Quick Connect Fitting Service .



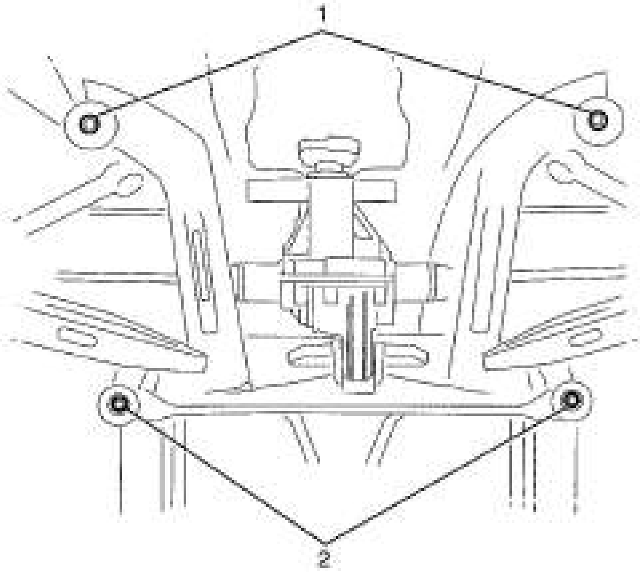
7. Raise the rear frame assembly using suitable tool.



8. Remove the special tool EN-48536 bolt (1) from the rear frame. Repeat for the opposite side.



9. Remove the special tool EN-48536 bolt (1) from the rear frame. Repeat for the opposite side.
10. Using a suitable tool clean the threaded holes in the rear chassis.



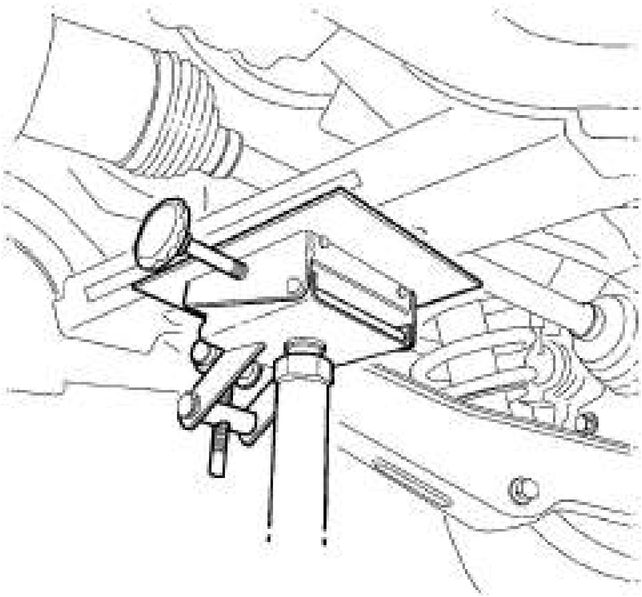
Important: Rear frame retaining bolts must not to be fully tightened at this stage.

11. Install the NEW rear frame to chassis retaining bolts (2).

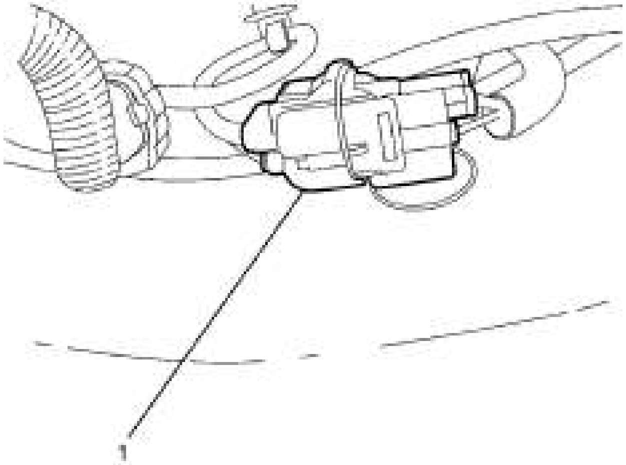
    Do not fully tighten at this stage.

12. After retaining bolts (1 and 2) are installed tighten to.

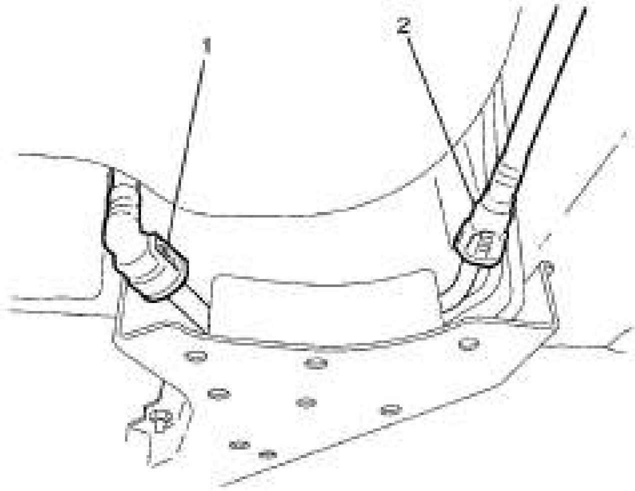
    Tighten
    - First Pass: Tighten the bolts to 65 N·m (48 lb ft)
    - Final Pass: Tighten the bolts a further 125 degrees.



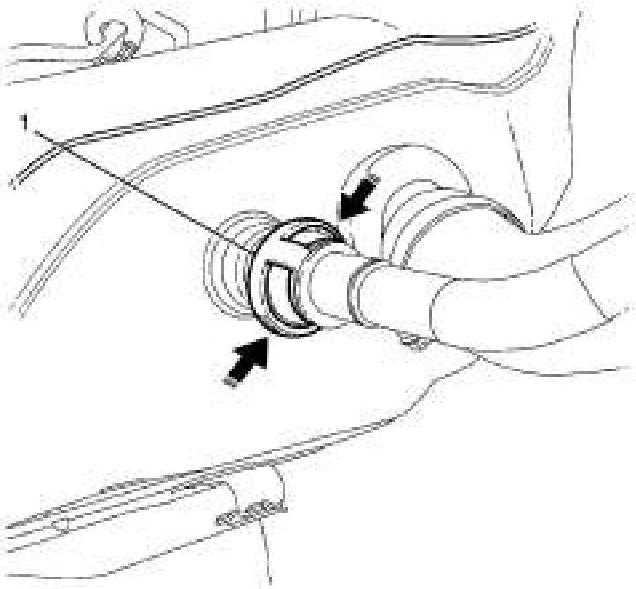
13. Remove the support tool.



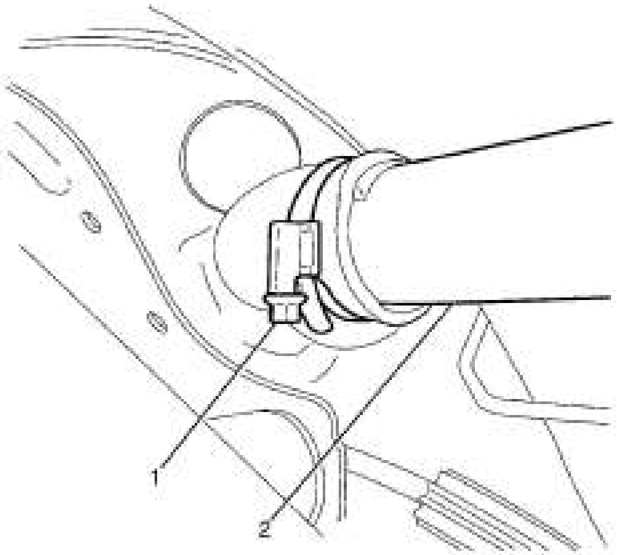
14. Connect the fuel tank electrical connector (1).



15. Refer to Plastic Collar Quick Connect Fitting Service , in order to connect the following to the chassis bundle:
    - The fuel feed line
    - The fuel EVAP hose



16. Install the evaporative emission (EVAP) line (1), listen for an audible click to confirm fitting.



17. Connect the filler hose (2) to the fuel tank.

    Tighten
    Tighten the fuel filler tube hose clamp (1) to 4 N·m (35 lb in).

18. Connect the park brake rear cables to the park brake front cable equalizer bracket assembly. Refer to Parking Brake Front Cable Replacement .
19. Install the propeller shaft. Refer to Propeller Shaft Replacement .
20. Install the exhaust system. Refer to Exhaust System Replacement .
21. Install the right rear wheel. Refer to Tire and Wheel Removal and Installation .
22. Refill the fuel tank.
23. Inspect for fuel leaks.

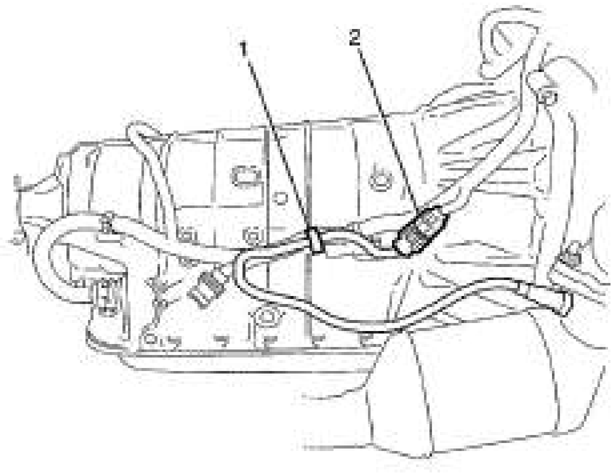
Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 (NT3)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

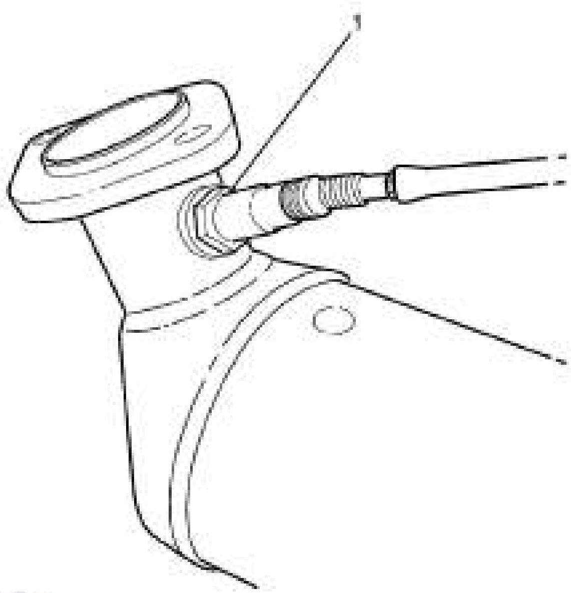
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Ignition OFF.



2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Disconnect the heated oxygen sensor (HO2S) from the electrical connector retaining clip (1).
4. Disconnect the heated oxygen sensor (HO2S) electrical connector (2) from the harness connector on the transmission case.
5. Remove the catalytic converter. refer to Catalytic Converter Replacement - Right Side.

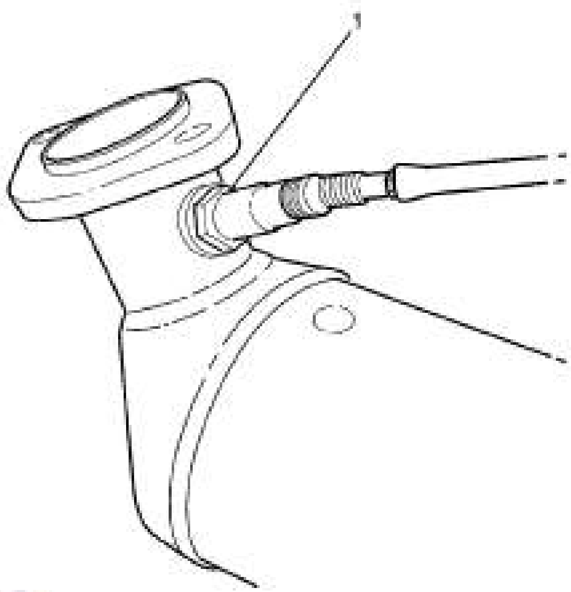
Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.



6. Remove the HO2S (1) from the catalytic converter.

Installation Procedure

Notice: Refer to Component Fastener Tightening Notice in the Preface section.

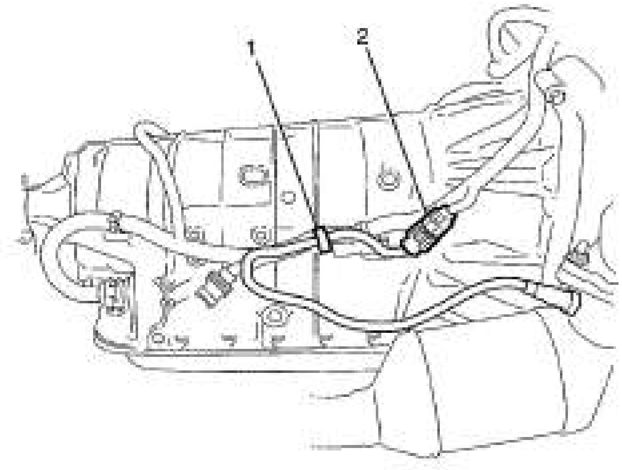


Important: New oxygen sensors should have a special anti-seize compound already applied to the sensor threads. If you are installing the original sensor, apply an approved anti-seize compound to the sensor threads.

1. Install the HO2S to the catalytic converter.

   Tighten
   Tighten the HO2S to 40 N·m (30 lb ft).

2. Install the catalytic converter to the vehicle. Refer to Catalytic Converter Replacement - Right Side.



3. Connect the heated oxygen sensor (HO2S) electrical connector (2) to the harness connector on the transmission case.
4. Connect the heated oxygen sensor (HO2S) to the electrical connector retaining clip (1).
5. Lower the vehicle.

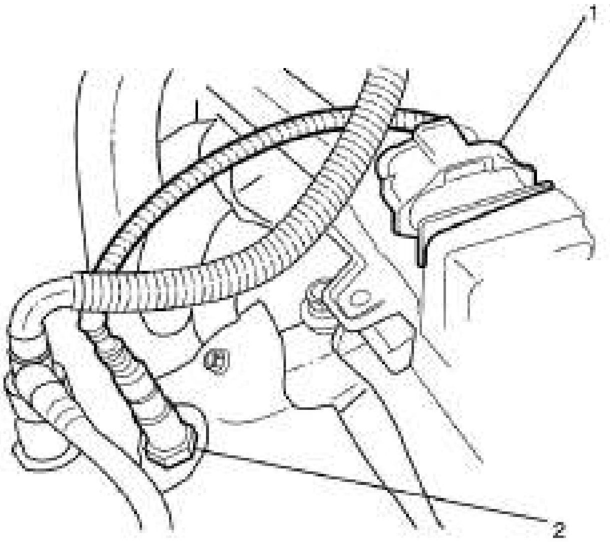
Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 (NT4)

Removal Procedure

1. Ignition OFF.

   Caution: Refer to Battery Disconnect Warning in the Preface section.

2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove the engine cover. Refer to Engine Cover Replacement .



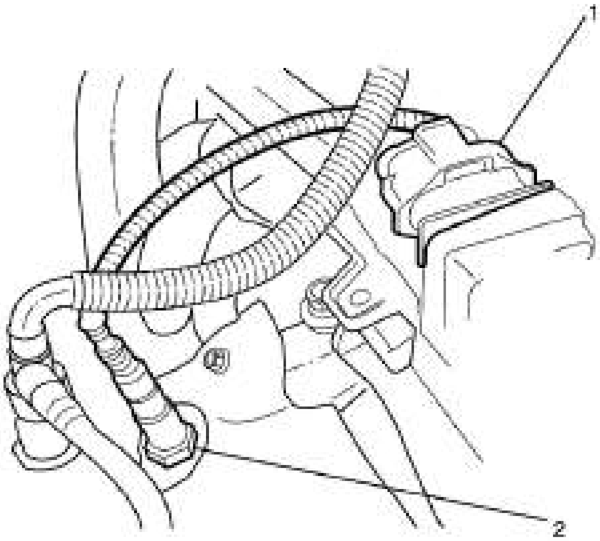
4. Disconnect the heated oxygen sensor (HO2S) electrical connector (1).

   Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.

5. Remove the HO2S (2) from the exhaust manifold.

Installation Procedure

Notice: Refer to Component Fastener Tightening Notice in the Preface section.



Important: New oxygen sensors should have a special anti-seize compound already applied to the sensor threads. If you are installing the original sensor, apply an approved anti-seize compound to the sensor threads.

1. Install the HO2S (2) into the exhaust manifold.

   Tighten
   Tighten the HO2S to 40 N·m (30 lb ft).

2. Connect the HO2S electrical connector (1).
3. Install the engine cover. Refer to Engine Cover Replacement.
4. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .

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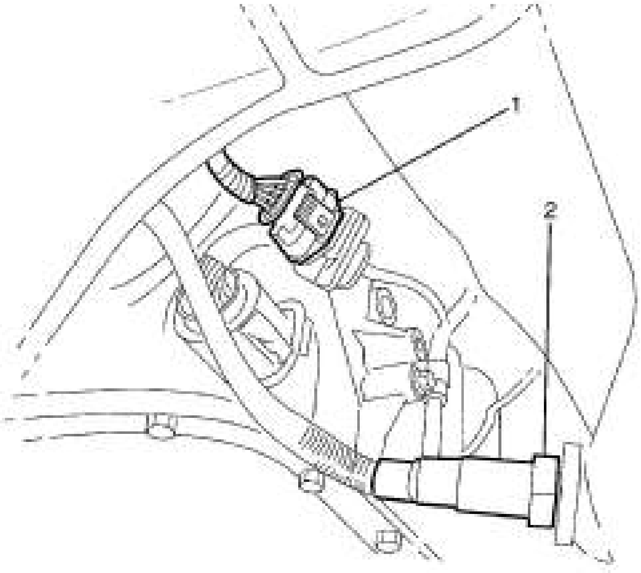
Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 (NT3)

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

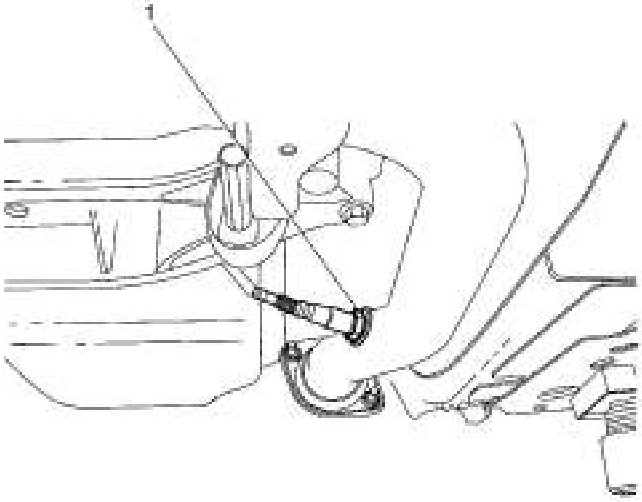
Removal Procedure

1. Turn the ignition OFF.
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



3. Disconnect the heated oxygen sensor (HO2S) electrical connector (1) from the harness connector.

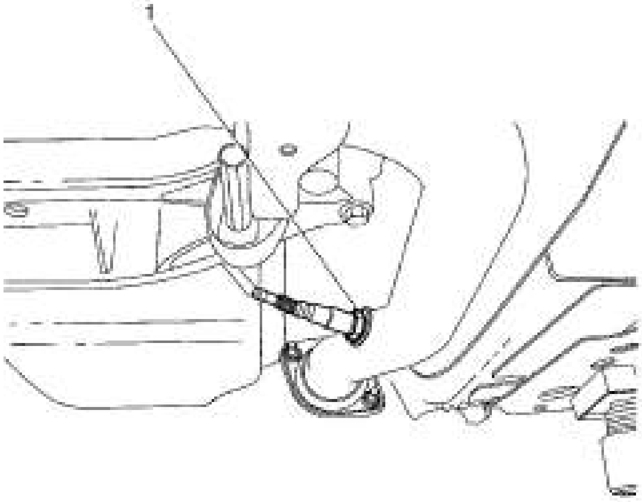
   Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.



4. Remove the HO2S (1) from the exhaust pipe.

Installation Procedure

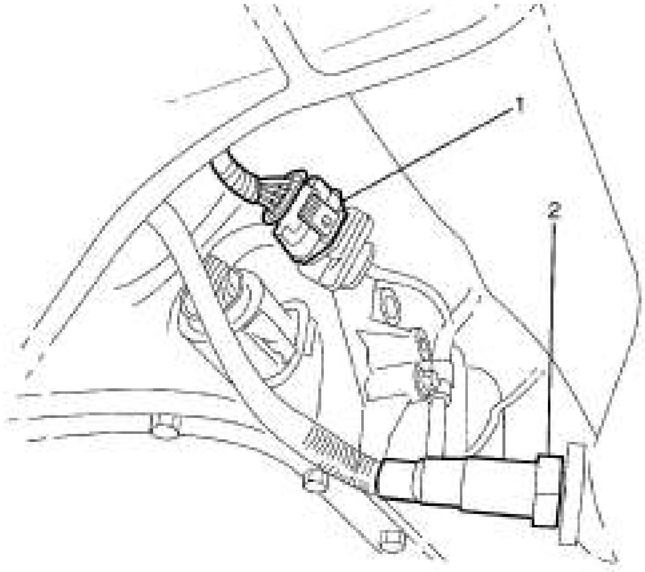
Notice: Refer to Component Fastener Tightening Notice in the Preface section.



Important: New oxygen sensors should have a special anti-seize compound already applied to the sensor threads. If you are installing the original sensor, apply an approved anti-seize to the sensor threads.

1. Install the HO2S (1) to the exhaust pipe.

   Tighten
   Tighten the HO2S to 40 N·m (30 lb ft).



2. Connect the HO2S electrical connector (1) to the harness connector.
3. Lower the vehicle.

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Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 (NT4)

Removal Procedure

1. Ignition OFF.

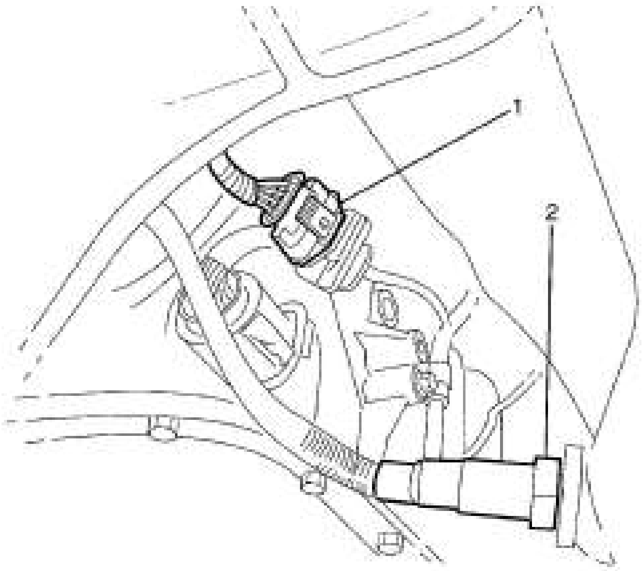
   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



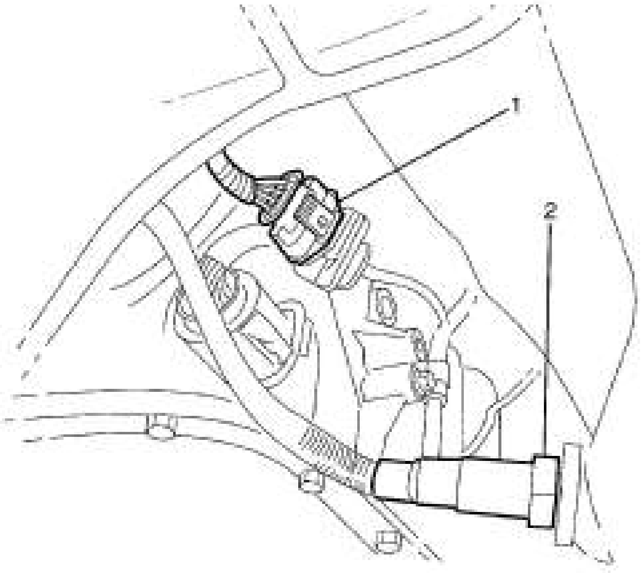
4. Disconnect the heated oxygen sensor (HO2S) electrical connector (1) from the harness connector.

   Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.

5. Remove the HO2S (2) from the exhaust pipe.

Installation Procedure

Notice: Refer to Component Fastener Tightening Notice in the Preface section.



Important: New oxygen sensors should have a special anti-seize compound already applied to the sensor threads. If you are installing the original sensor, apply an approved anti-seize compound to the sensor threads.

1. Install the HO2S (2) into the exhaust pipe.

   Tighten
   Tighten the HO2S to 40 N·m (30 lb ft).

2. Connect the HO2S electrical connector (1) to the harness connector.
3. Lower the vehicle.
4. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

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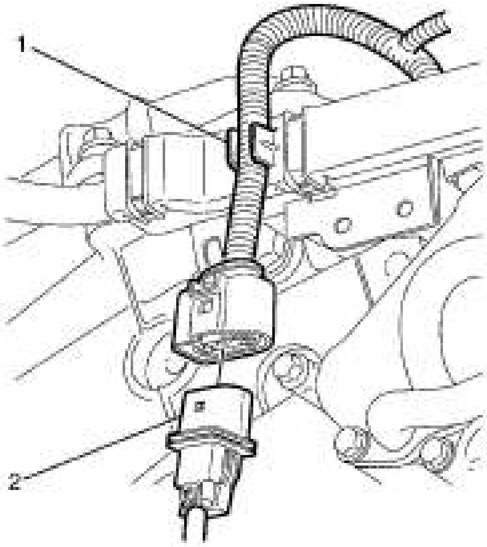
Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 (NT3)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

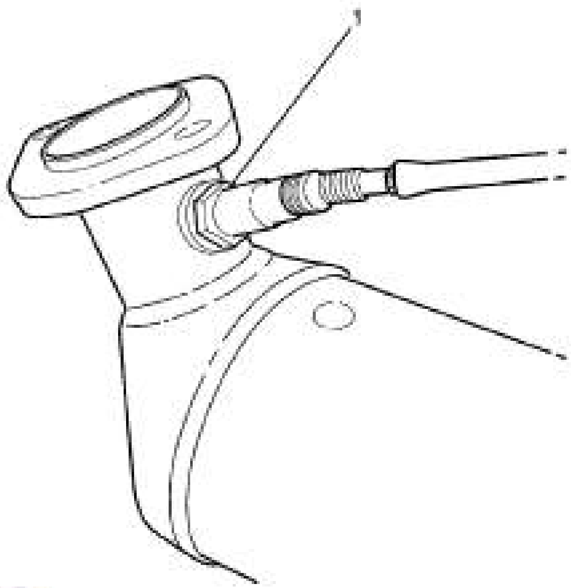
1. Ignition Off.



2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Remove the HO2S electrical connector from the wiring harness bracket (1).

Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.

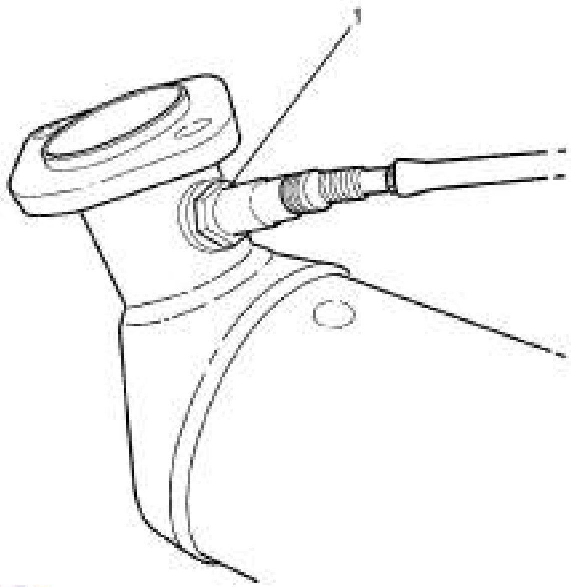
4. Disconnect the heated oxygen sensor (HO2S) electrical connector (2).



5. Remove the HO2S (1) from the catalytic converter.

Installation Procedure

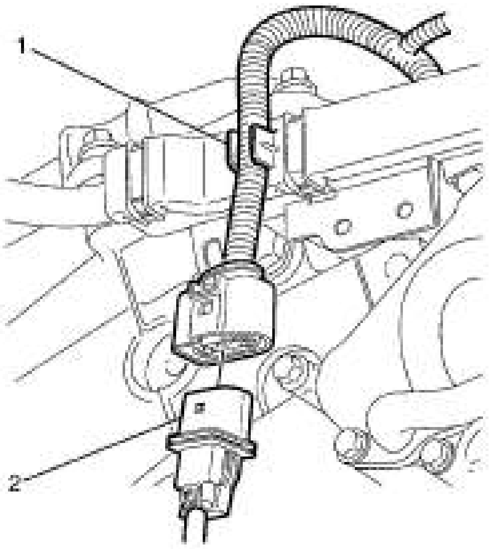
Notice: Refer to Component Fastener Tightening Notice in the Preface section.



Important: New oxygen sensors should have a special anti-seize compound already applied to the sensor threads. If you are installing the original sensor, apply an approved compound to the sensor threads.

1. Install the HO2S (1) to the catalytic converter.

   Tighten
   Tighten the HO2S to 40 N·m (30 lb ft).



2. Connect the HO2S electrical connector (2) to the harness connector.
3. Install the HO2S electrical connector to the wiring harness bracket (1).
4. Lower the vehicle.

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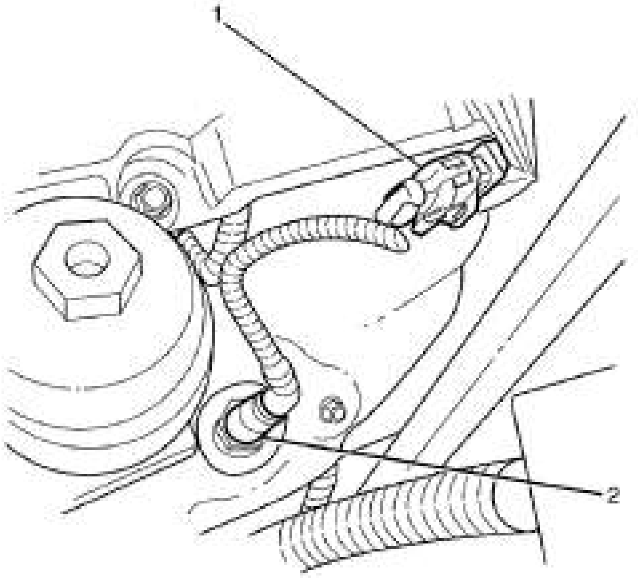
Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 (NT4)

Removal Procedure

1. Ignition OFF.

   Caution: Refer to Battery Disconnect Warning in the Preface section.

2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove the engine cover. Refer to Engine Cover Replacement.



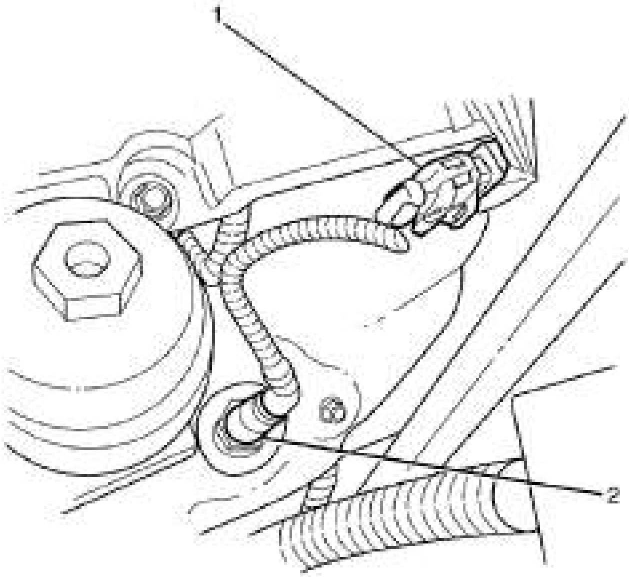
4. Disconnect the heated oxygen sensor (HO2S) electrical connector (1).

   Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.

5. Remove the HO2S (2) from the exhaust manifold.

Installation Procedure

Notice: Refer to Component Fastener Tightening Notice in the Preface section.



Important: New oxygen sensors should have a special anti-seize compound already applied to the sensor threads. If you are installing the original sensor, apply an approved anti-seize compound to the sensor threads.

1. Install the HO2S (2) into the exhaust manifold.

   Tighten
   Tighten the HO2S to 40 N·m (30 lb ft).

2. Connect the HO2S electrical connector (1).
3. Install the engine cover. Refer to Engine Cover Replacement.
4. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .

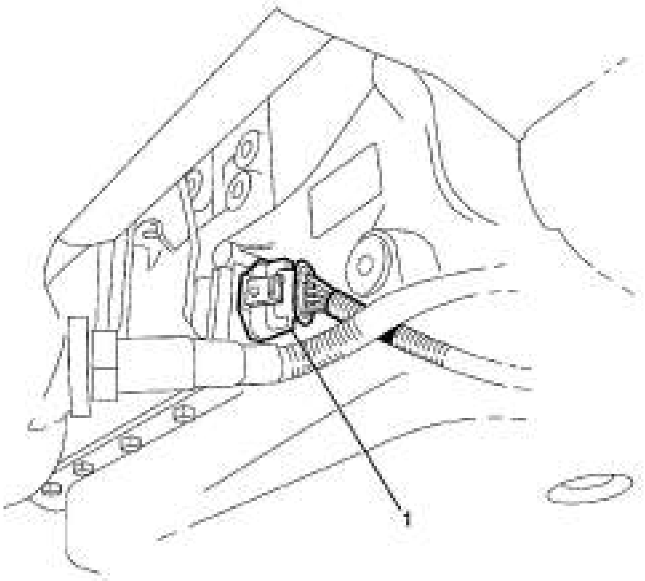
Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 (NT3)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

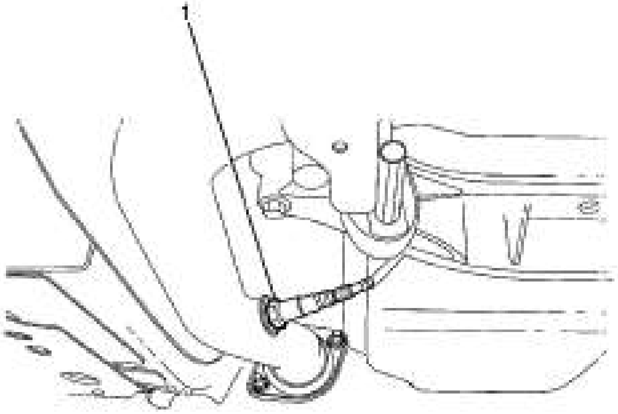
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Ignition Off.
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



3. Disconnect the heated oxygen sensor (HO2S) electrical connector (1) from the wiring harness.
4. Remove the HO2S wiring harness from the transmission case.

Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.

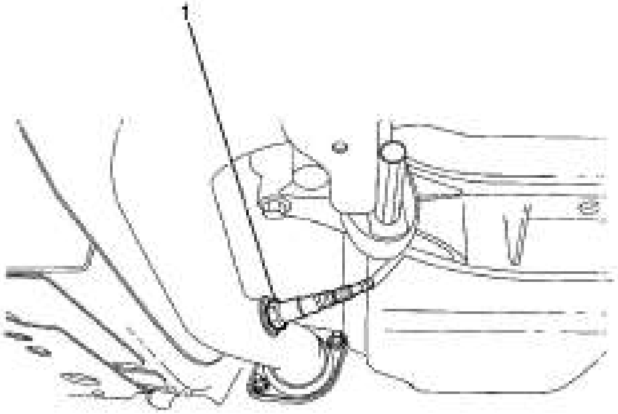


Important: Removal of the oxygen sensor is easier when the engine temperature is above 48°C (120°F).

5. Remove the HO2S (1) from the exhaust pipe.

Installation Procedure

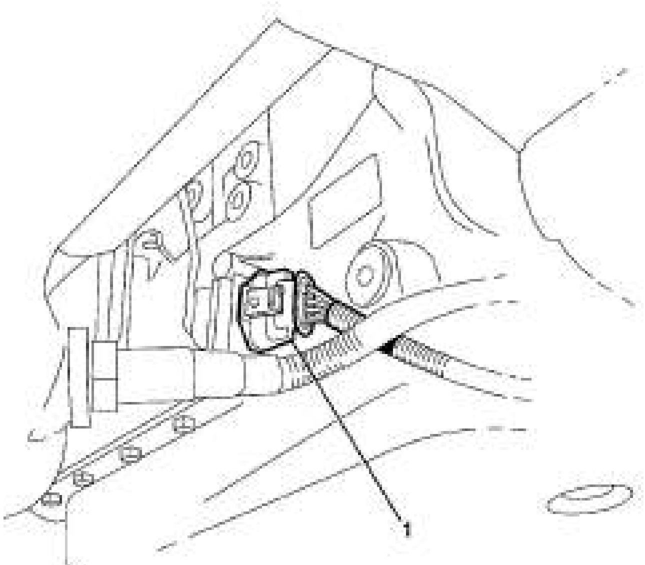
Notice: Refer to Component Fastener Tightening Notice in the Preface section.



Important: New oxygen sensors should have a special anti-seize compound already applied to the sensor threads. If you are installing the original sensor, apply an approved anti-seize compound to the sensor threads.

1. Install the HO2S.

   Tighten
   Tighten the HO2S to 40 N·m (30 lb ft).



2. Connect the HO2S electrical connector (1) to the harness connector.
3. Install the HO2S wiring harness to the transmission case.
4. Lower the vehicle.

Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 (NT4)

Removal Procedure

1. Ignition OFF.

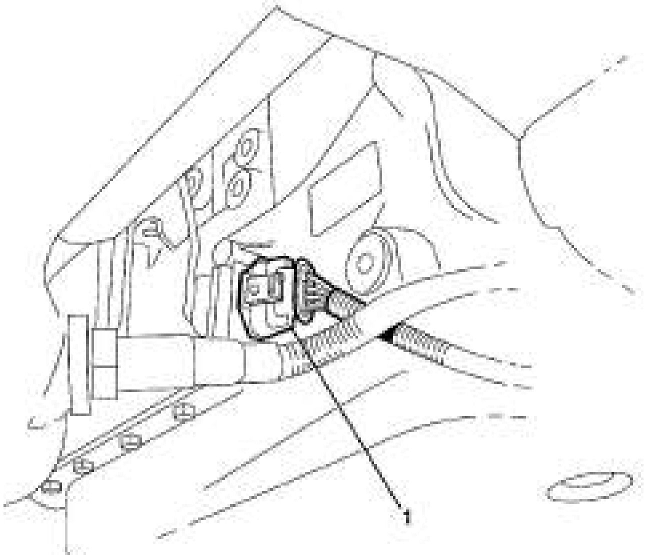
   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

   Caution: Refer to Safety Glasses Caution in the Preface section.

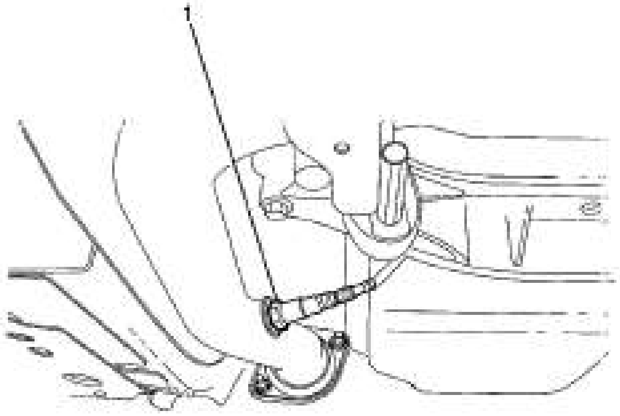
   Caution: Refer to Vehicle Lifting Caution in the Preface section.

3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



4. Disconnect the heated oxygen sensor (HO2S) electrical connector (1) from the wiring harness.
5. Detach the HO2S wiring harness from the transmission case.

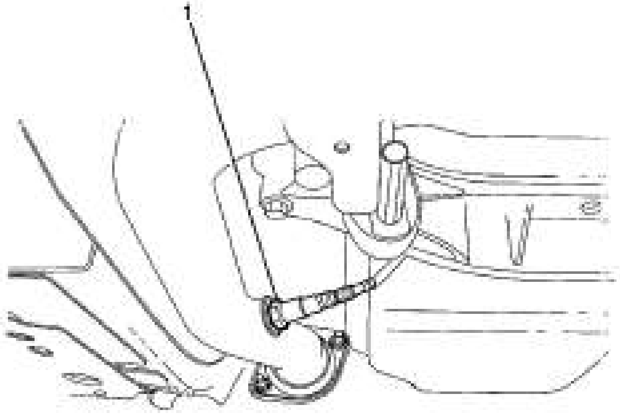
   Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.



6. Remove the HO2S (1) from the exhaust pipe.

Installation Procedure

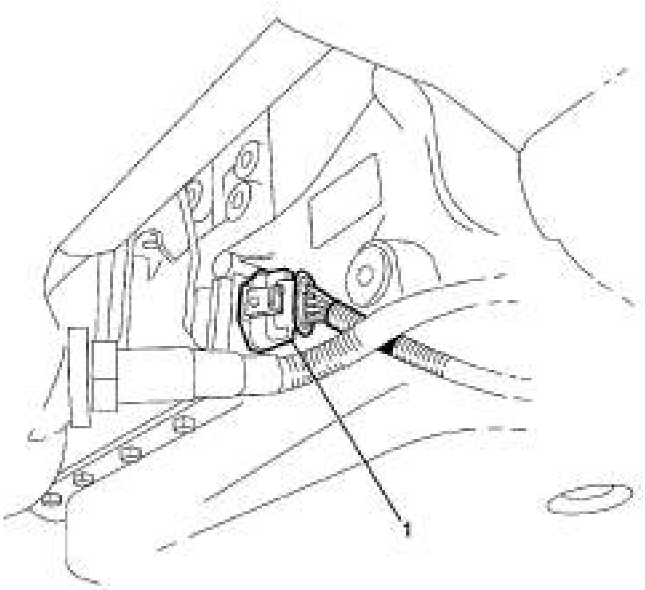
Notice: Refer to Component Fastener Tightening Notice in the Preface section.



Important: New oxygen sensors should have a special anti-seize compound already applied to the sensor threads. If you are installing the original sensor, apply an approved anti-seize compound to the sensor threads.

1. Install the HO2S (1) into the exhaust pipe.

   Tighten
   Tighten the HO2S to 40 N·m (30 lb ft).



2. Connect the HO2S electrical connector (1) to the harness connector.
3. Attach the HO2S wiring harness to the transmission case.
4. Lower the vehicle.
5. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

Idle Learn

Description

The engine Control Module (ECM) learns the idle position of the throttle body to enable the correct idle operation. Any time the ECM or the throttle body is replaced, the ECM must learn the idle position. The engine idle may be unstable or DTC's may set if the idle position is not learned.

Conditions for Running the Idle Learn Procedure

- DTCs P0121, P0122, P0123, P0221, P0222, P0223, P0638, P2100, P2101, P2105, P2107, and P2119 are not set.
- The engine speed is less than 40 RPM.
- The vehicle speed is 0 km/h (0 mph).
- The accelerator pedal position is less than 14.9 percent.
- The ignition 1 voltage is more than 10 volts.
- The engine coolant temperature is between 5-85°C (41-185°F).
- The intake air temperature is between 5-60°C (41-140°F).

Idle Learn Procedure

1. Turn OFF the ignition for 30 seconds.
2. Turn ON the ignition, with the engine OFF for 60 seconds.
3. Make sure the above conditions are met before proceeding with this procedure.
4. Do not perform this procedure if a throttle position (TP) sensor or other throttle actuator control (TAC) system DTCs are set other than P2176. The ECM will not perform the idle learn procedure with these DTC's set.
5. Turn OFF the ignition.
6. Turn ON the ignition, with the engine OFF.
7. Clear the DTCs with a scan tool.

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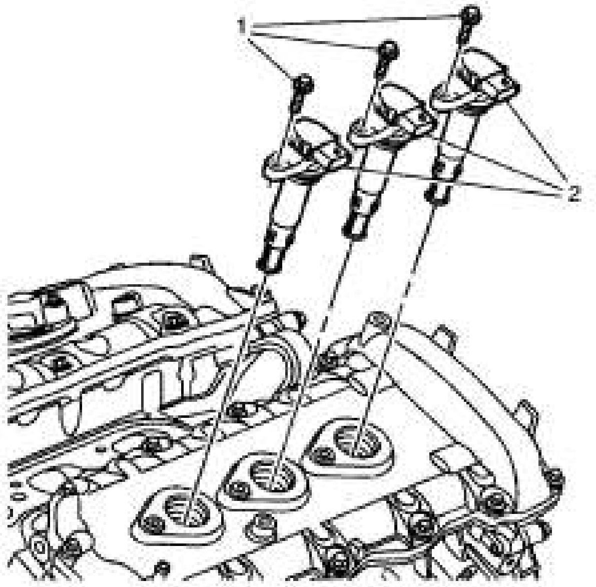
Ignition Coil Replacement - Bank 1

Removal Procedure

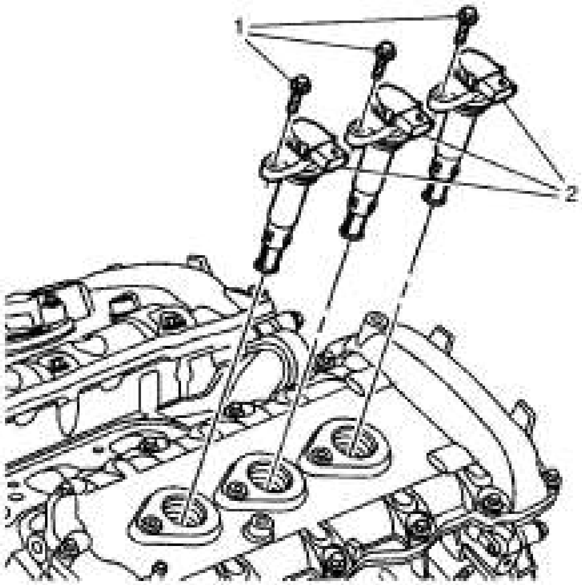
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Turn the ignition OFF.
2. Remove the engine cover. Refer to Engine Cover Replacement.
3. Remove the upper intake manifold Refer to Upper Intake Manifold Replacement



4. Remove the ignition coil harness connector from the ignition coil.
5. Remove the ignition coil to camshaft cover retaining bolts (1).
6. Remove the ignition coils (2) from the vehicle.

Installation Procedure



1. Install the ignition coil (2) to the engine.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the ignition coil to camshaft cover retaining bolts (1).

   Tighten
   Tighten the ignition coil bolt(s) to 10 N·m (89 lb in).

3. Install the ignition coil harness connector to the ignition coil.
4. Install the upper intake manifold Refer to Upper Intake Manifold Replacement
5. Install the engine cover. Refer to Engine Cover Replacement.

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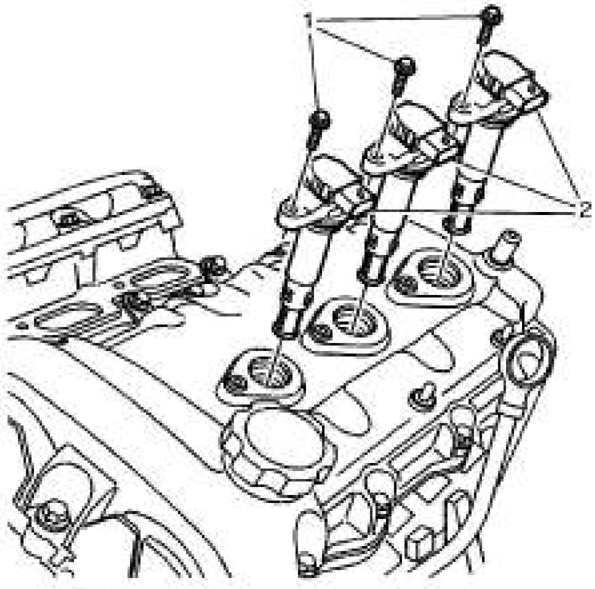
Ignition Coil Replacement - Bank 2

Removal Procedure

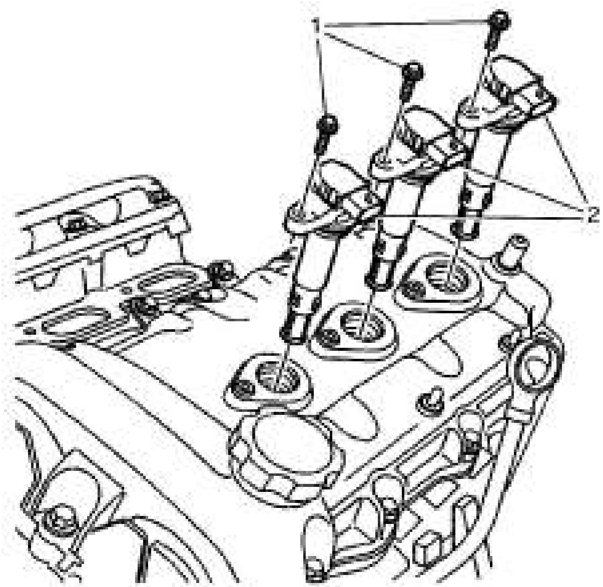
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Turn the ignition OFF.
2. Remove the engine cover. Refer to Engine Cover Replacement.
3. Remove the upper intake manifold Refer to Upper Intake Manifold Replacement.



4. Remove the ignition coil harness connector from the ignition coil.
5. Remove the ignition coil to camshaft cover retaining bolts (1).
6. Remove the ignition coil from the vehicle (2).

Installation Procedure



1. Install the ignition coils (2) to the engine.

   Notice: Refer to Fastener Notice in the Preface section.

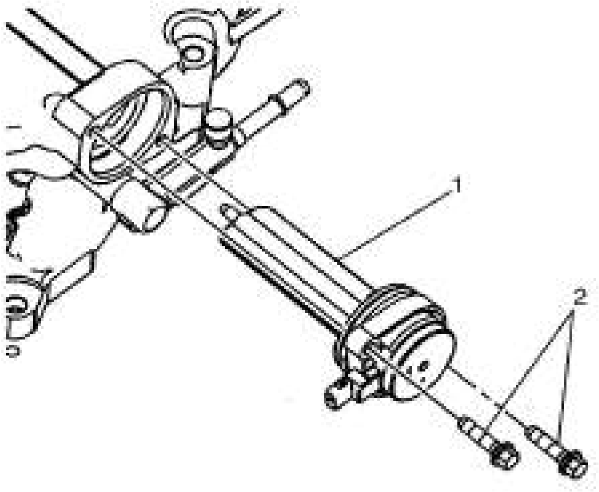
2. Install the ignition coil to camshaft cover retaining bolts (1).

   Tighten
   Tighten the ignition coil bolt(s) to 10 N·m (89 lb in).

3. Install the ignition coil harness connector to the ignition coil.
4. Install the upper intake manifold Refer to Upper Intake Manifold Replacement
5. Install the engine cover. Refer to Engine Cover Replacement.

Intake Manifold Runner Control Solenoid Replacement

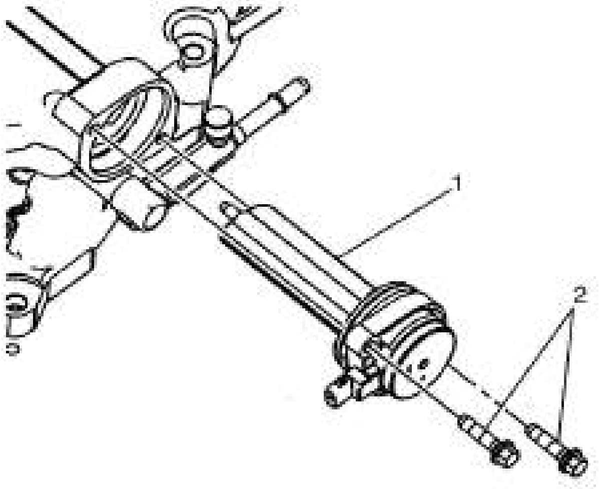
Removal Procedure



Important: DO NOT separate the upper intake manifold from the lower intake manifold.

1. Remove the upper intake manifold with the lower intake manifold. Refer to Lower Intake Manifold Replacement.
2. Remove the intake manifold runner control solenoid to intake manifold retaining bolts (2) from the intake manifold runner control solenoid (1).
3. Remove the intake manifold runner control solenoid (1) from the manifold.

Installation Procedure



1. Install the intake manifold runner control solenoid (1) to the manifold.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the intake manifold runner control solenoid to manifold retaining bolts (2) to intake manifold runner control solenoid.

   Tighten
   Tighten the intake manifold runner control solenoid bolts (2) to 10 N·m (89 lb in).

3. Install the upper intake manifold. Refer to Lower Intake Manifold Replacement.

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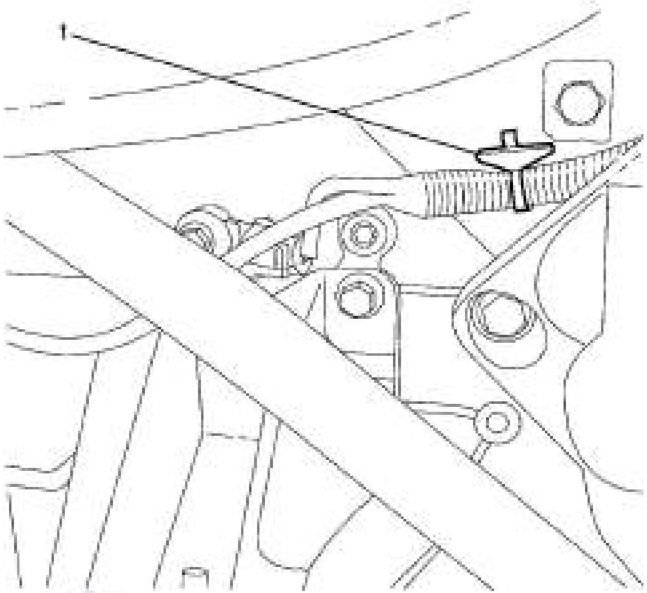
Knock Sensor Replacement - Bank 1

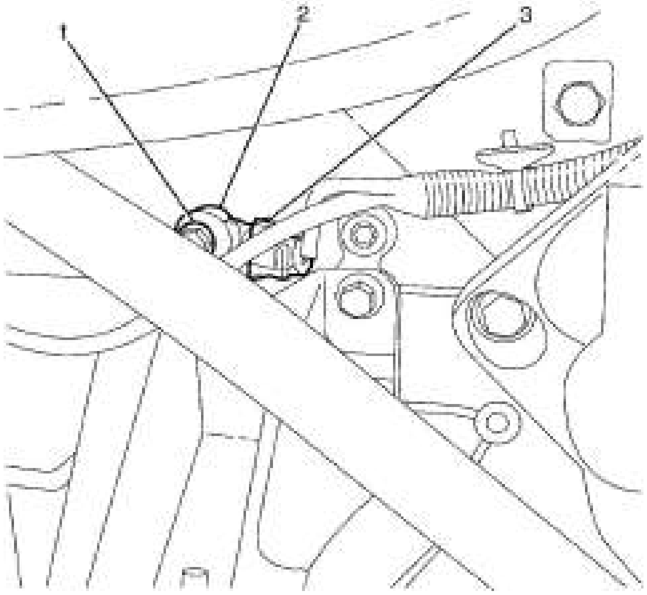
Removal Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.



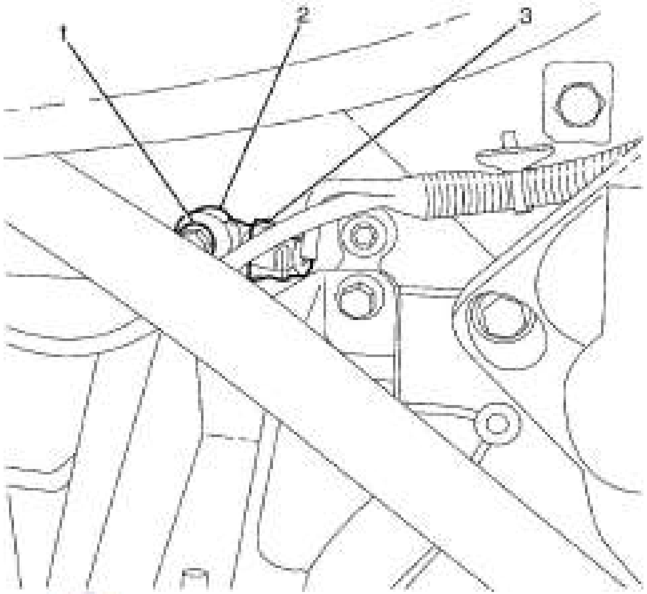
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Disconnect the wiring harness retaining clip (1).



3. Remove the knock sensor (KS) electrical (1) connector from the KS (2)
4. Remove the KS (3) to engine block retaining bolt (2).

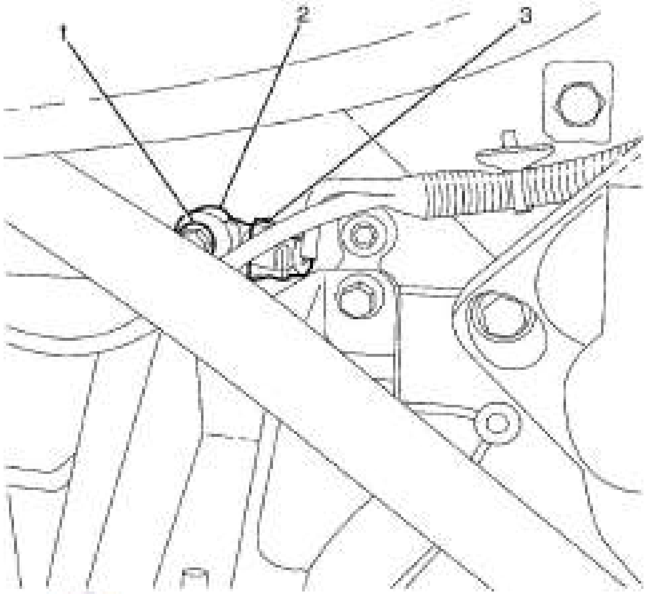
Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



1. Install the KS (3) to engine block retaining bolt (2).

   Tighten
   Tighten the KS bolt to 23 N·m (17 lb ft).

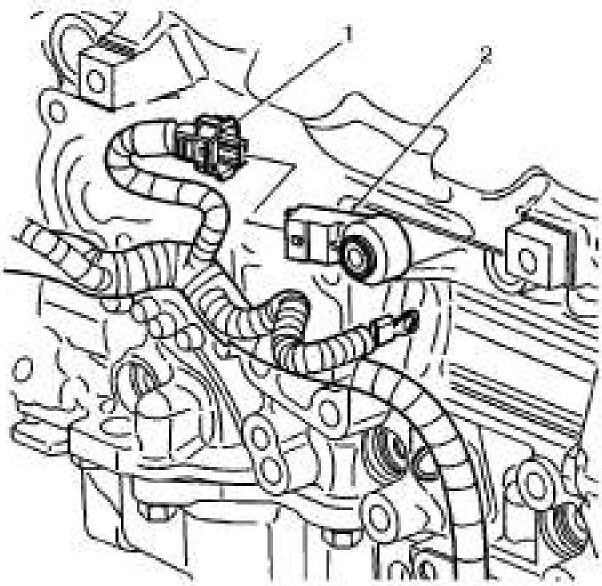


2. Install the knock sensor (KS) electrical (1) connector to the KS (2)
3. Lower the vehicle.

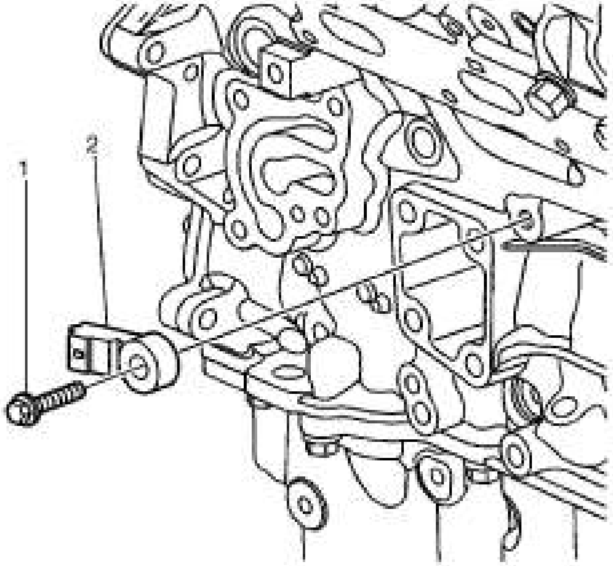
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | **Document ID: 1976152**

Knock Sensor Replacement - Bank 2

Removal Procedure

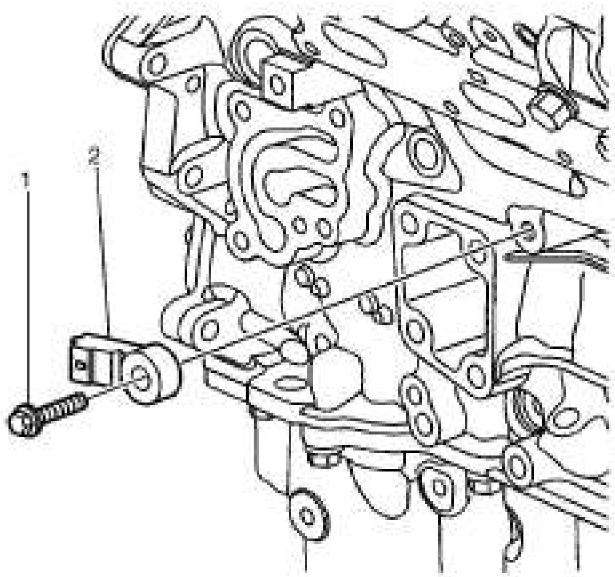


1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the knock sensor (KS) electrical connector (1) from the KS (2).



3. Remove the KS to engine block retaining bolt (1) from the KS sensor.
4. Remove the KS (2) from the engine.

Installation Procedure

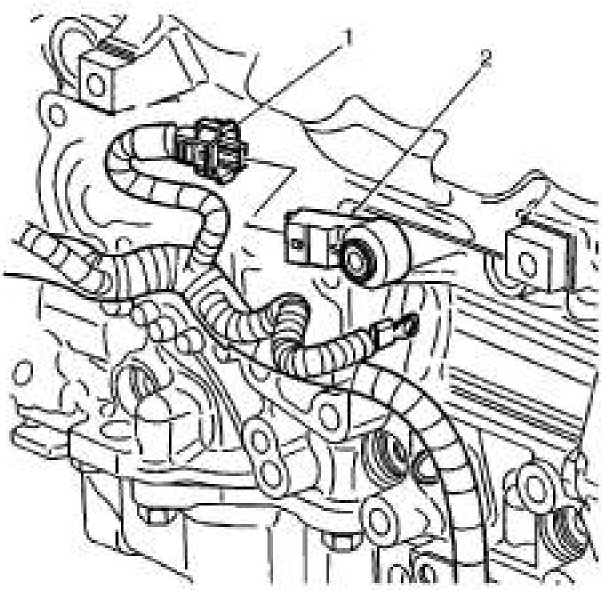


1. Install the KS (2) to the engine.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the KS to engine block retaining bolt (1).

   Tighten
   Tighten the KS bolt (1)to 23 N·m (17 lb ft).



3. Install the KS electrical connector (1) to the K sensor (2).
4. Lower the vehicle.

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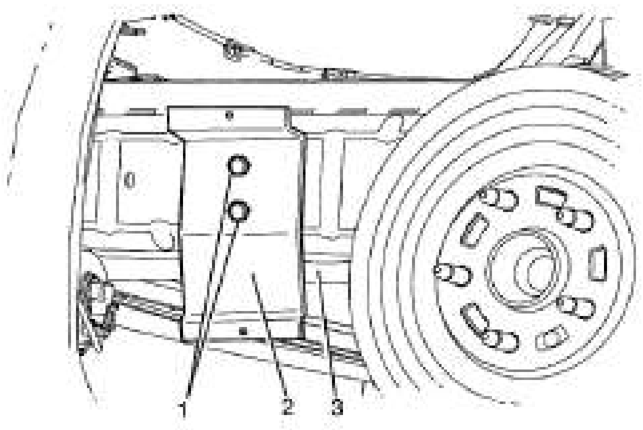
Liquefied Petroleum Gas Control Module Bracket Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

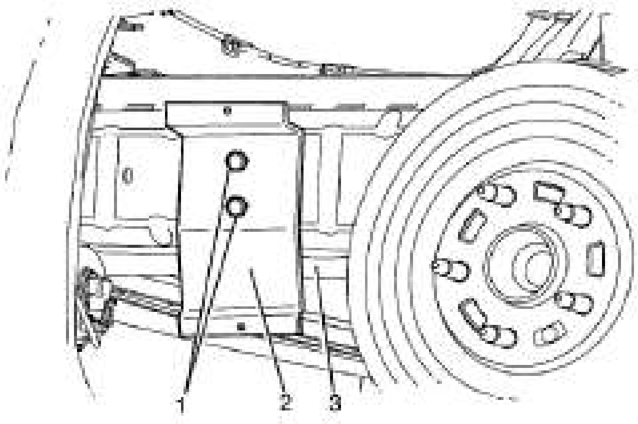
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the left front wheel. Refer to Tire and Wheel Removal and Installation.
3. Remove the left front wheel house liner. Refer to Front Wheelhouse Liner Replacement.
4. Remove the LPG control module. Refer to Liquefied Petroleum Gas Control Module Replacement.



Important: Use a suitable tool to drill out the rivets.

5. Remove the LPG control module bracket to body retaining rivets (1).
6. Remove the LPG control module bracket (2) from the vehicle (3).

Installation Procedure



1. Position the LPG control module bracket (2) to the vehicle (3).
2. Install the LPG control module bracket to body retaining rivets (1).
3. Install the LPG control module. Refer to Liquefied Petroleum Gas Control Module Replacement.
4. Install the left front wheel house liner. Refer to Front Wheelhouse Liner Replacement.
5. Install the left front wheel. Refer to Tire and Wheel Removal and Installation.

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Liquefied Petroleum Gas Control Module Replacement

Removal Procedure

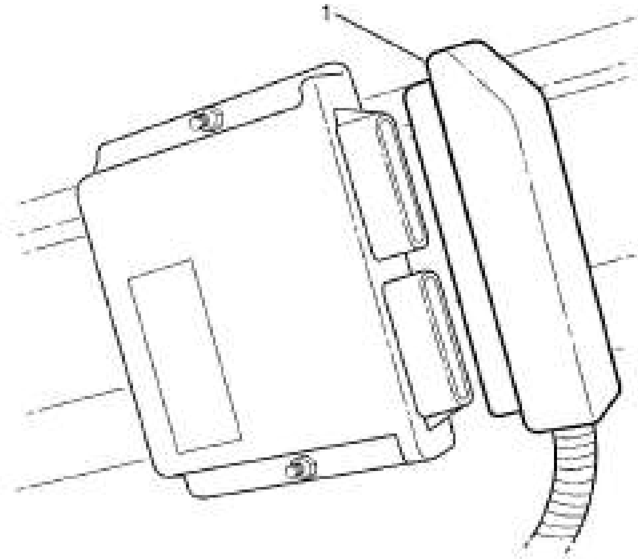
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Battery Disconnect Caution in the Preface section.

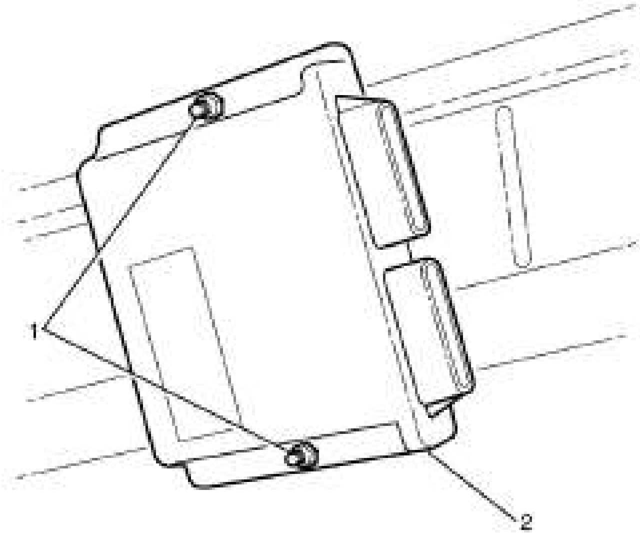
1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Remove the left front wheel. Refer to Tire and Wheel Removal and Installation.
4. Remove the left front wheel house liner. Refer to Front Wheelhouse Liner Replacement.

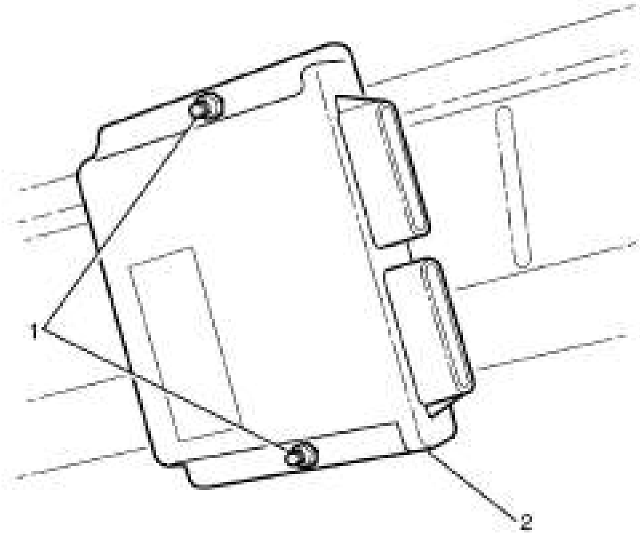


5. Disconnect the LPG control module electrical connector (1).



6. Remove the LPG control module to LPG control module bracket retaining nuts (1).
7. Remove the LPG control module (2) from the vehicle.

Installation Procedure

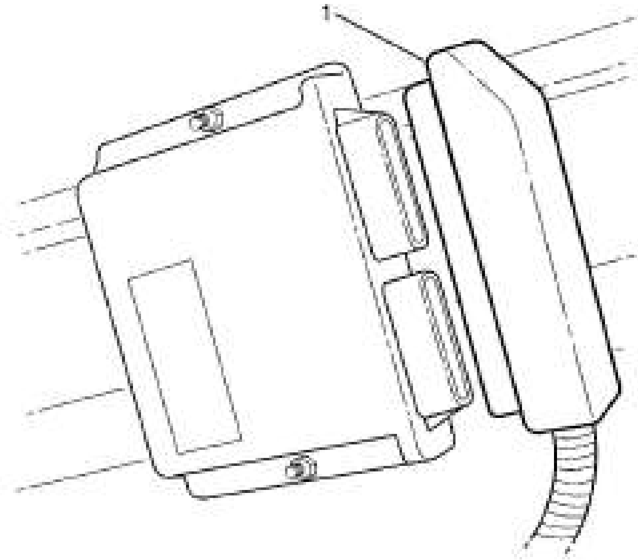


1. Position the LPG control module (2) to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the LPG control module to LPG control module bracket retaining nuts (1).

Tighten
Tighten the nuts to 5 N·m (44 lb in).



3. Connect the LPG control module electrical connector (1).
4. Install the left front wheel house liner. Refer to Front Wheelhouse Liner Replacement.
5. Install the left front wheel. Refer to Tire and Wheel Removal and Installation.
6. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | **Document ID: 2006647**

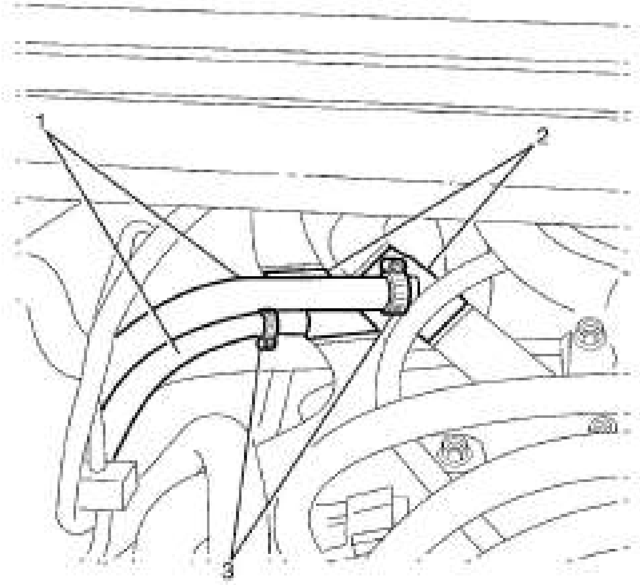
Liquefied Petroleum Gas Tank Filler Hose Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Radiator Cap Removal Caution in the Preface section.

1. Remove the radiator cap.

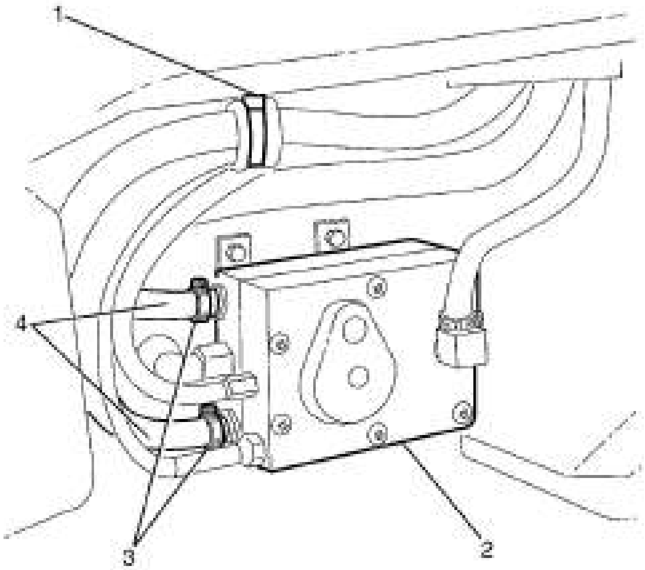


Important: Place a suitable container underneath the vehicle to collect draining coolant.

2. Release the LPG coolant hose clamps (3).
3. Disconnect the LPG coolant hoses (1) from the 'T' fittings (2).

Caution: Refer to Vehicle Lifting Caution in the Preface section.

4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
5. Remove the right front wheel. Refer to Tire and Wheel Removal and Installation.
6. Remove the right front wheel house liner. Refer to Front Wheelhouse Liner Replacement.

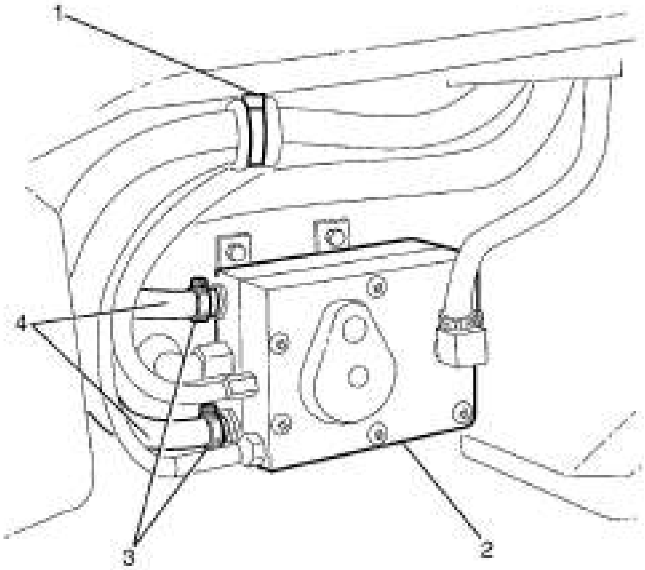


7. Remove the LPG coolant hose to body retaining clip (1).
8. Release the LPG coolant hose clamps (3) at the LPG convertor (2).

Important: Take care as coolant will leak when the LPG coolant hoses (4) are removed.

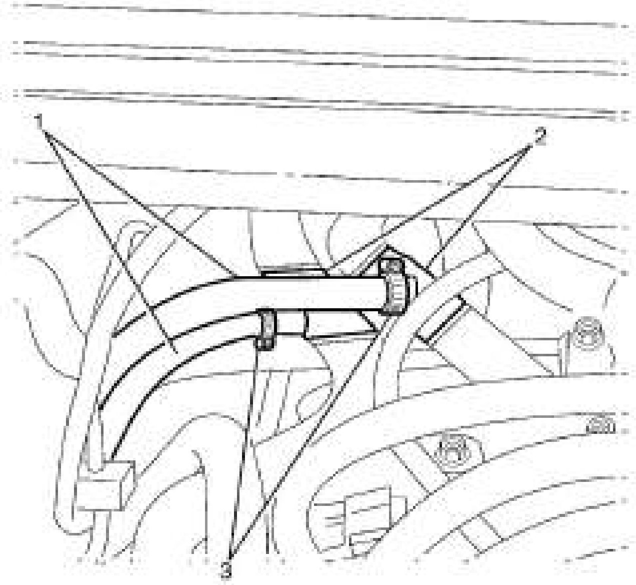
9. Disconnect the LPG coolant hoses (4) from the LPG convertor (2).
10. Remove the LPG coolant hoses (4) from the vehicle.

Installation Procedure



1. Position the LPG coolant hoses (4) to the vehicle.
2. Fit LPG coolant hose clamps (3) to the LPG coolant hoses (4).

3. Connect the LPG coolant hoses (4) to the LPG convertor (2).
4. Secure the LPG coolant hose clamps (3).
5. Secure the LPG coolant hose to body retaining clip (1).



6. Connect the LPG coolant hoses (1) to the LPG coolant hose (2) 'T' fittings.
7. Secure the LPG coolant hose clamps (3) ensuring that the clamp fastens the hose to the 'T' fittings (2).
8. Fill the cooling system. Refer to Cooling System Draining and Filling.
9. Install the radiator cap.
10. Inspect the cooling system for leaks.
11. Install the right front wheel house liner. Refer to Front Wheelhouse Liner Replacement.
12. Install the right front wheel. Refer to Tire and Wheel Removal and Installation.

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Liquefied Petroleum Gas Tank Filler Valve Receptacle Replacement

Removal Procedure

Caution: Refer to General Repair Instructions in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Fuel Pressure Relief in the Preface section.

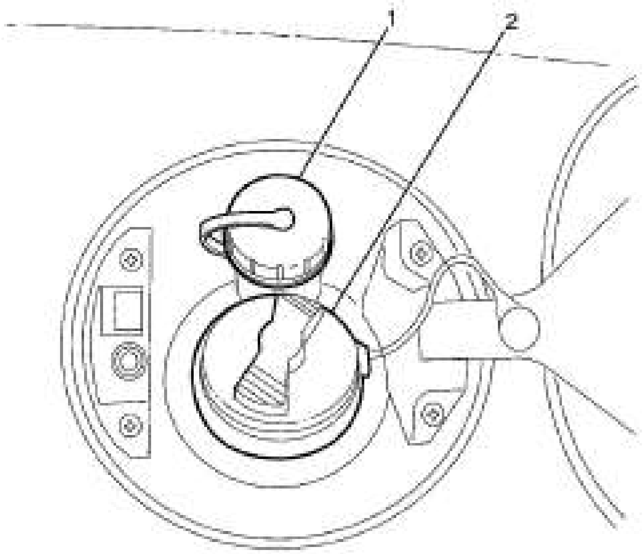
1. Park the vehicle in a well ventilated area, away from any ignition source.

Caution: Refer to Battery Disconnect Caution in the Preface section.

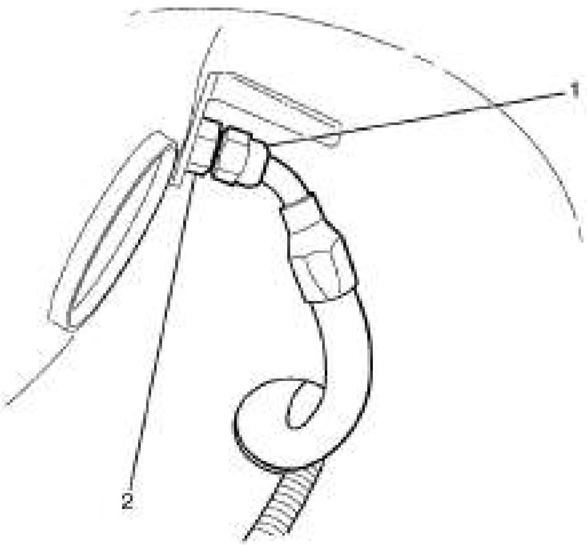
2. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
4. Remove the right rear wheel. Refer to Tire and Wheel Removal and Installation.
5. Remove the right rear wheel house liner. Refer to Rear Wheelhouse Panel Liner Replacement.



6. Remove the petrol fill tube (2) to allow access to the LPG fill valve (1) retaining nut. Refer to Filler Tube Replacement.



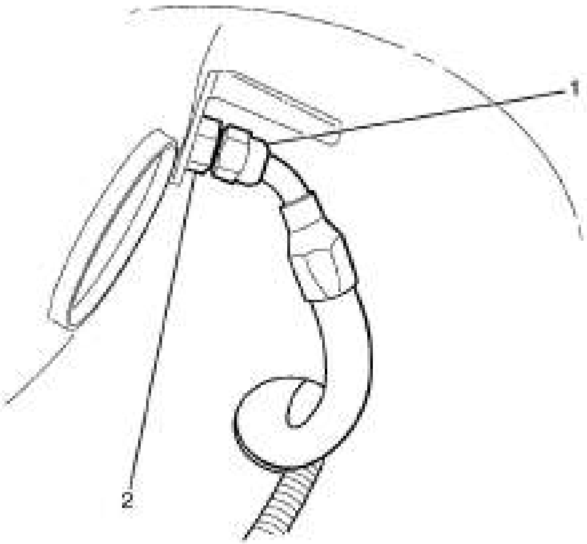
Important: Hold the LPG fill valve at (2) when detaching the fitting (1).

7. Remove the LPG fill line fitting (1) from LPG fill valve (2).
8. Remove the LPG fill valve to body retaining nut (2).
9. Remove the LPG fill valve from the vehicle.

Installation Procedure

1. Position the LPG fill valve to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.

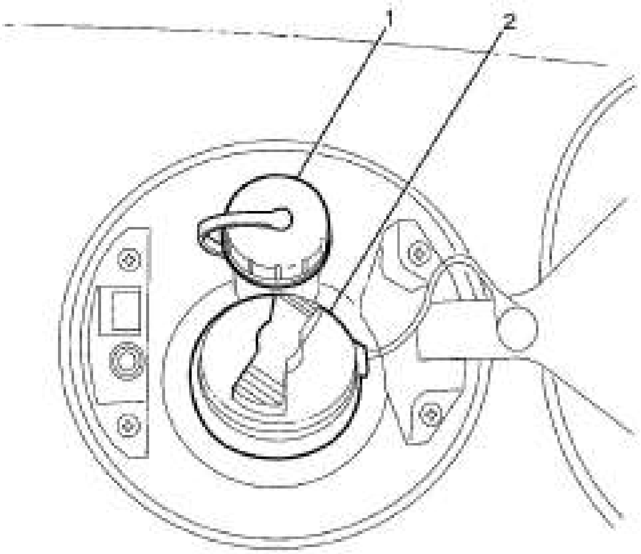


2. Install the LPG fill valve to body retaining nut (2).

   Tighten
   Tighten the nut to 18 N·m (13 lb ft).

3. Install the fitting (1) to the LPG fill valve (2).

   Tighten
   Tighten the fitting to 18 N·m (13 lb ft).



4. Install the petrol fill tube (2). Refer to Filler Tube Replacement.

   Important: Make sure that both of the filler caps can be removed.

5. Check clearance between the LPG fill valve (1) and the petrol filler tube (2).
6. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
7. Install a small amount of LPG to pressurise the fill line and inspect for LPG fuel leaks at the serviced fitting's and fill valve using the combustible gas detector or an equivalent liquid leak detector.
8. Install the right rear wheel house liner. Refer to Rear Wheelhouse Panel Liner Replacement.
9. Install the right rear wheel. Refer to Tire and Wheel Removal and Installation.

Liquefied Petroleum Gas Tank Unloading

Caution: Refer to General Repair Instructions in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Fuel Pressure Relief in the Preface section.

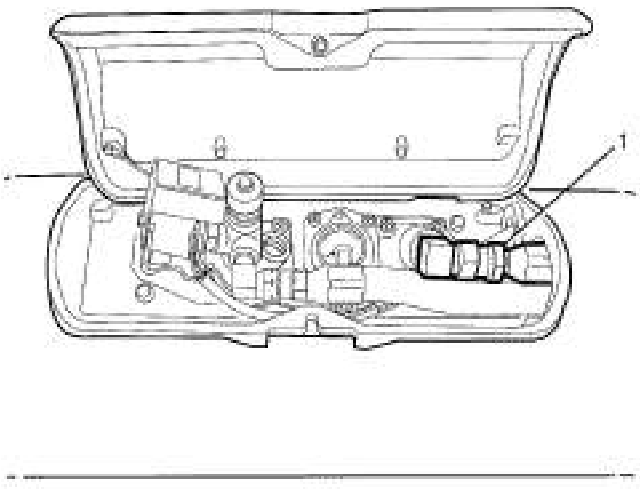
1. Park the vehicle in a well ventilated area, away from any ignition source.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

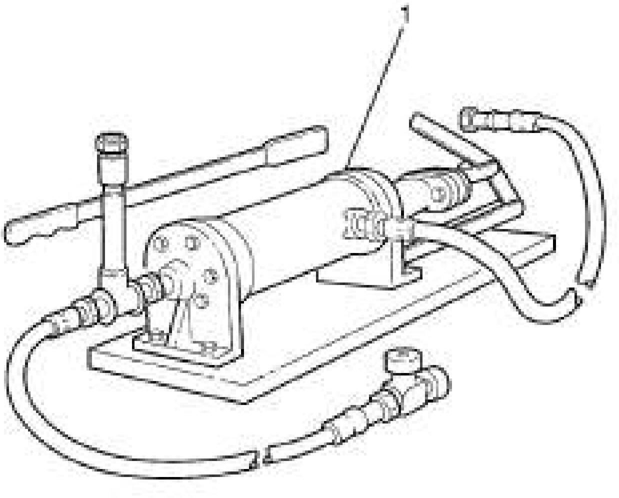
   Caution: Refer to Vehicle Lifting Caution in the Preface section.

3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



Important: Support the LPG tank fitting when removing the fill line fitting (1).

4. Disconnect the fill line fitting (1) from the LPG tank.



5. Connect an Apollo LPG pump (1) or equivalent to the manual service valve assembly connection.
6. Open the manual service valve and pump-out the LPG tank, following the instructions provided by the LPG pump manufacturer.
7. Pump-out the LPG tank until completely empty.
8. When the LPG tank is completely empty, close the manual service and disconnect the pump.

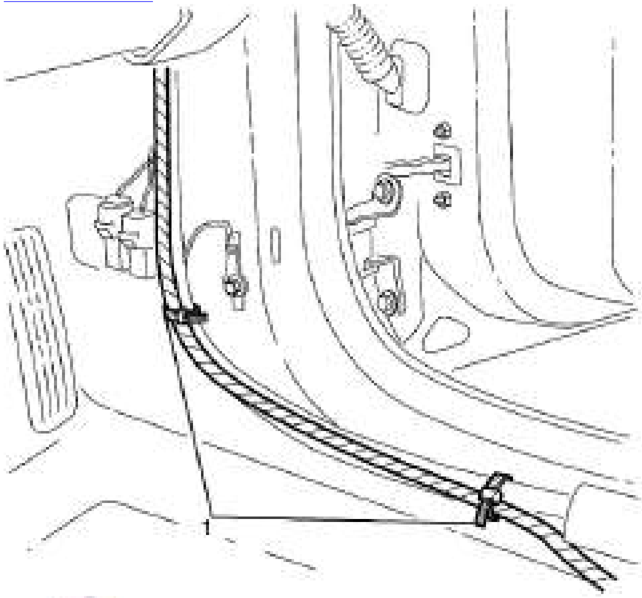
Liquefied Petroleum Gas Wiring Harness Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

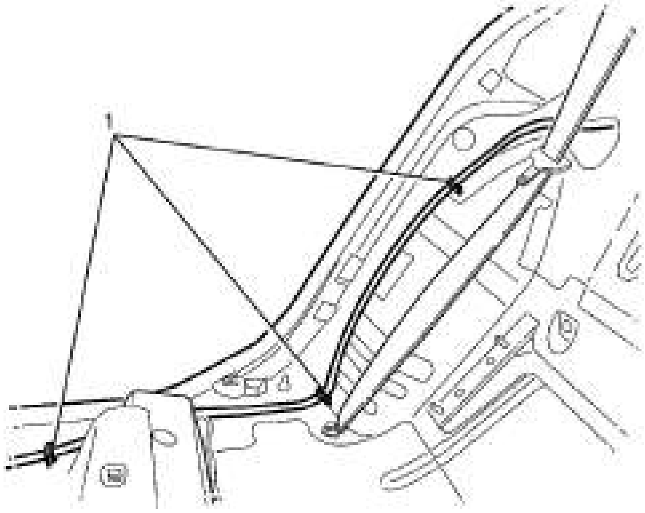
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.



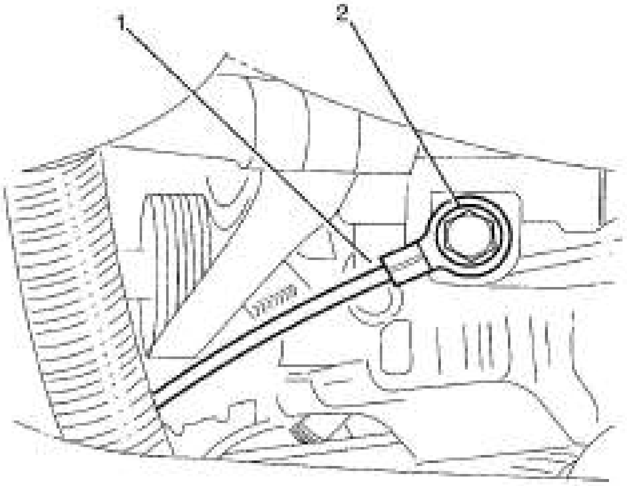
Important: The LPG wiring harness is retained with cable ties.

2. Remove the LPG wiring harness retainers (1) from inside the vehicle.

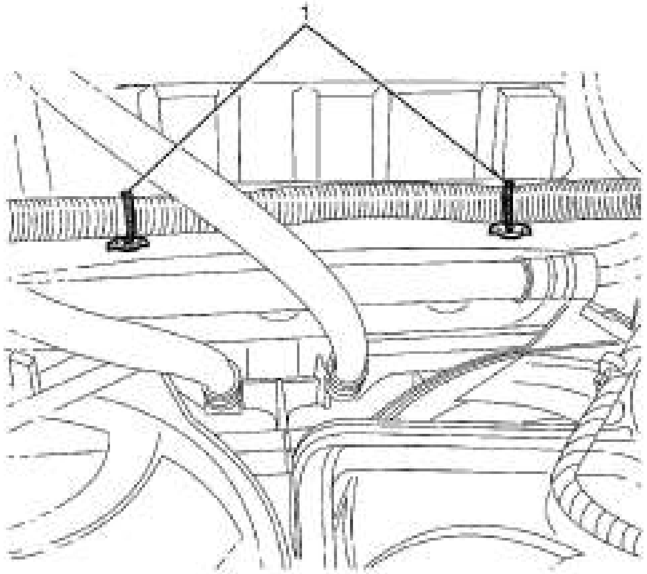


Important: The LPG wiring harness is retained with cable ties.

3. Remove the LPG wiring harness retainers (1) from inside the vehicle.

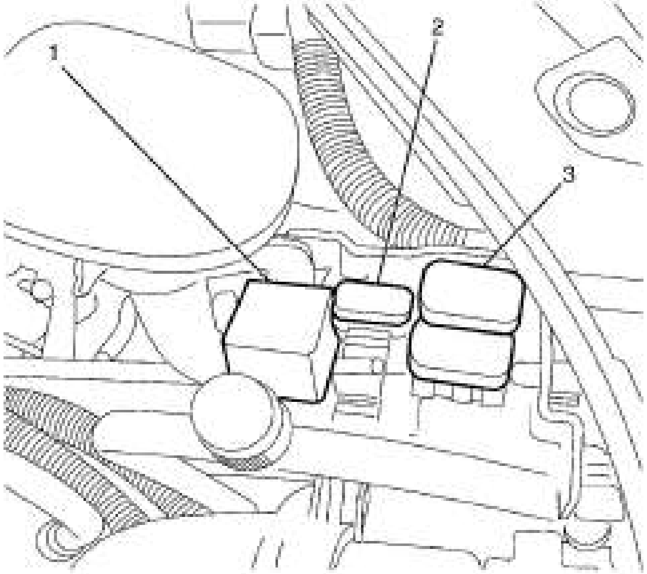


4. Remove the LPG wiring harness earth cable (1) from the lower bolt (2) of the air conditioning compressor.

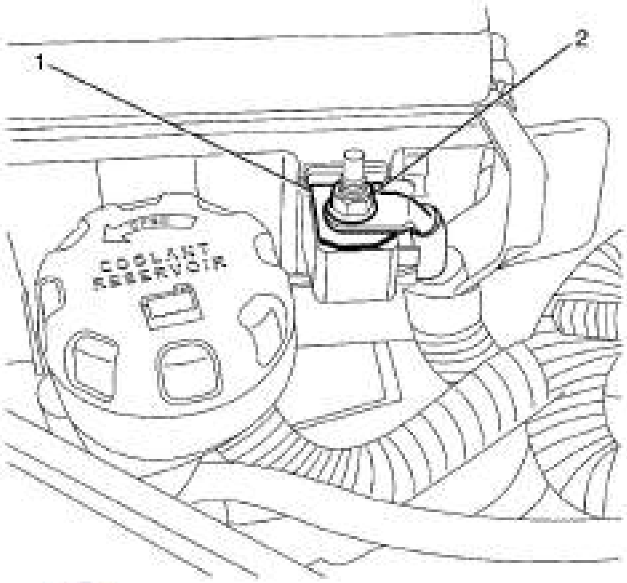


Important: The retaining connectors are located near the bottom of the radiator.

5. Remove the LPG wiring harness retaining connectors (1) from inside the engine bay.



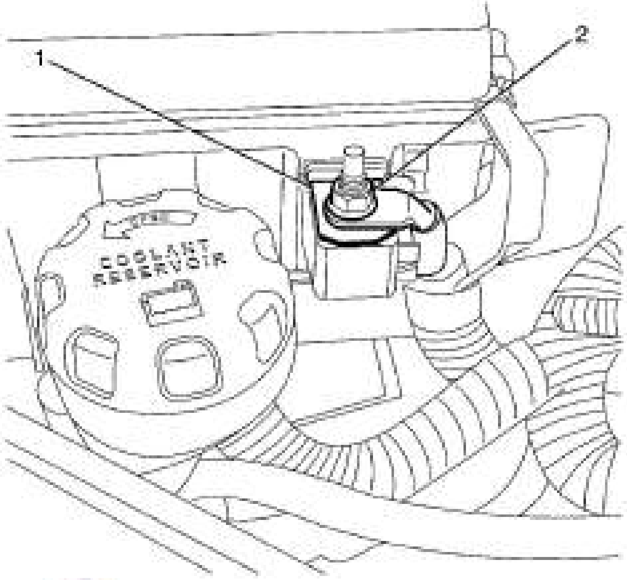
6. Remove the LPG fuses (3), relay (1) and diagnostic connector (2).



7. Remove the LPG wiring harness power cable (1) retaining nut (2).
8. Remove the wiring harness from the vehicle.

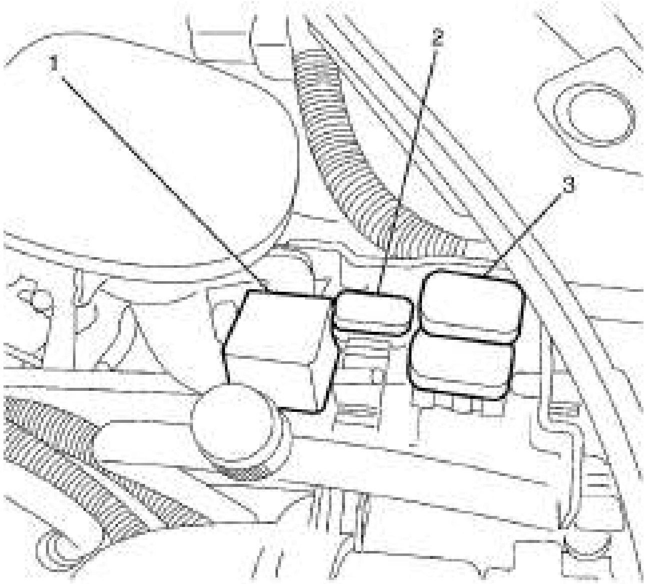
Installation Procedure

1. Position the LPG wiring harness in the vehicle.



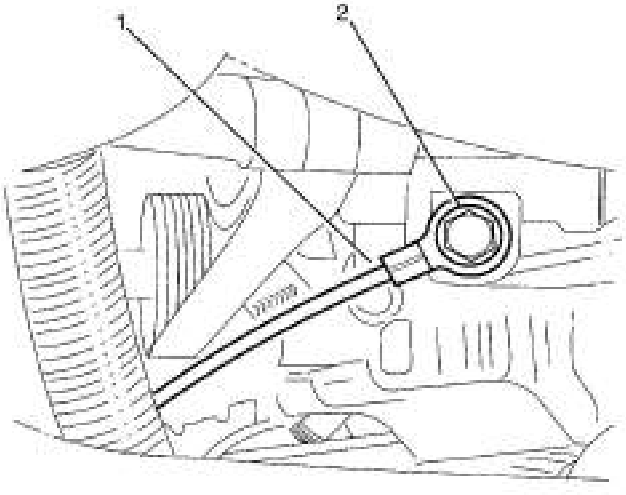
2. Install the LPG wiring harness power cable (1) to the power source.
3. Install the LPG wiring harness power cable (1) retaining nut (2).

   Tighten
   Tighten the nut to xx N·m (xx lb ft).



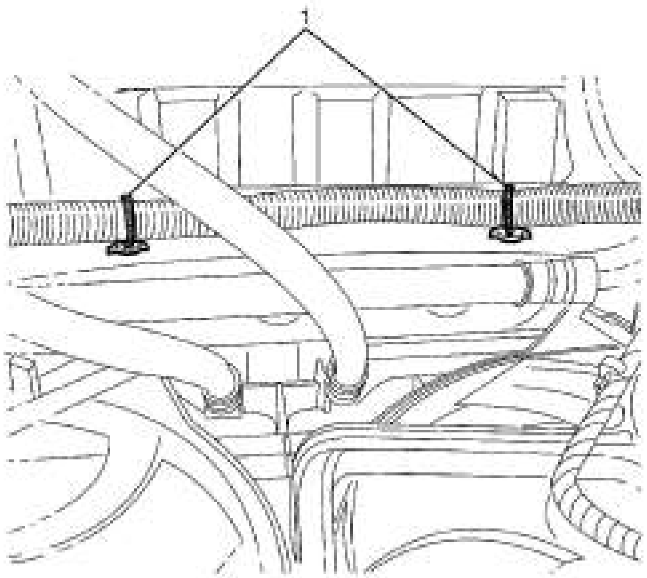
4. Install the LPG fuses (3), relay (1) and diagnostic connector (2).

   Notice: Refer to Fastener Notice in the Preface section.

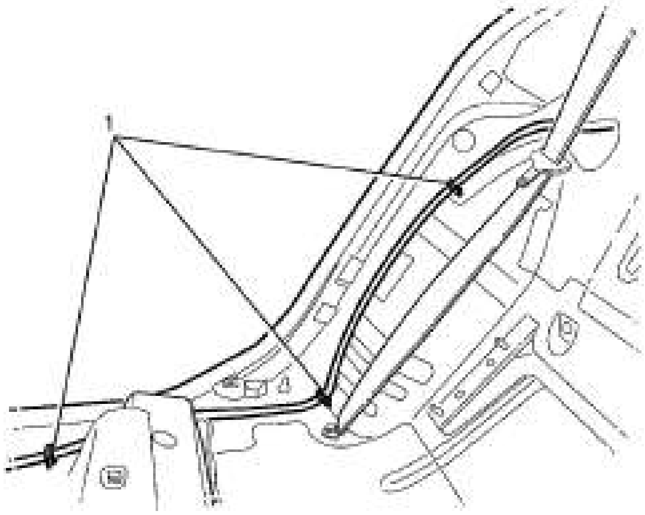


5. Install the LPG wiring harness earth cable (1) to the lower bolt (2) on the air conditioning compressor.

   Tighten
   Tighten the nuts to 22 N·m (16 lb ft).

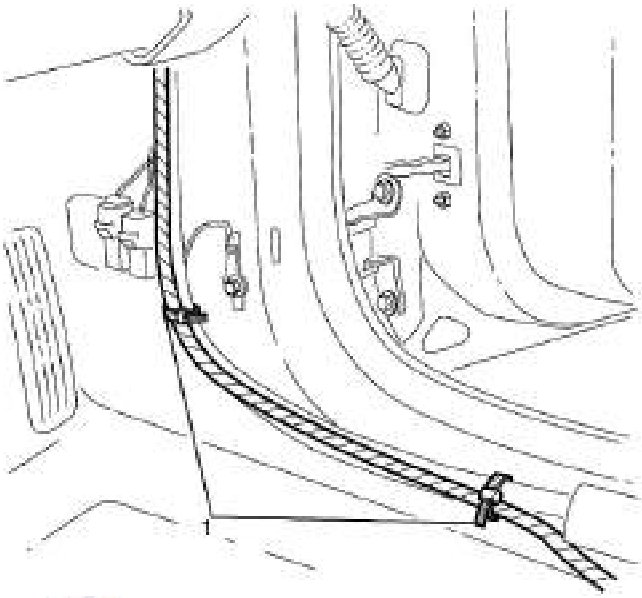


6. Install the LPG wiring harness electrical retaining connectors (1) to the inside of the engine bay.



Important: Cable tie the LPG wiring harness to the vehicle wiring harness.

7. Install the LPG wiring harness retainers (1) to the inside of the vehicle.



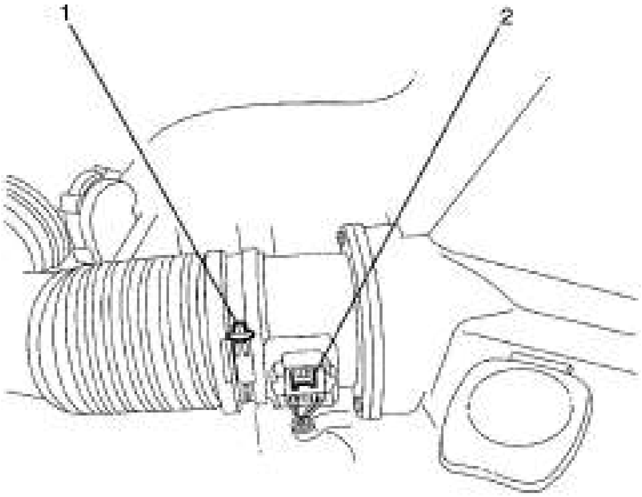
Important: Cable tie the LPG wiring harness to the vehicle wiring harness.

8. Install the LPG wiring harness retainers (1, 2) to inside the vehicle.
9. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

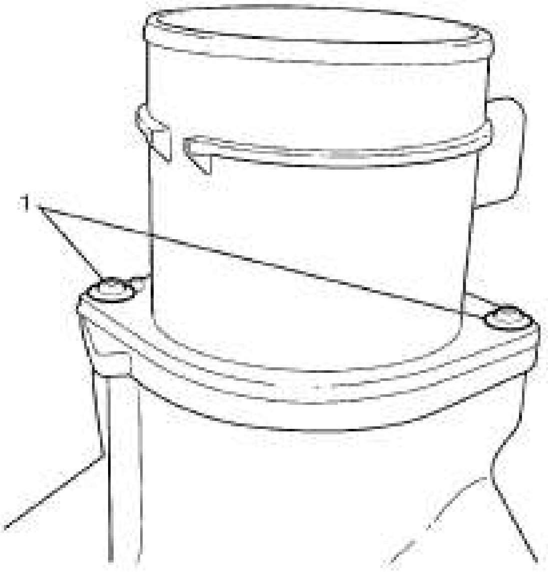
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | Document ID: 1976225

Mass Airflow Sensor with Intake Air Temperature Sensor Replacement

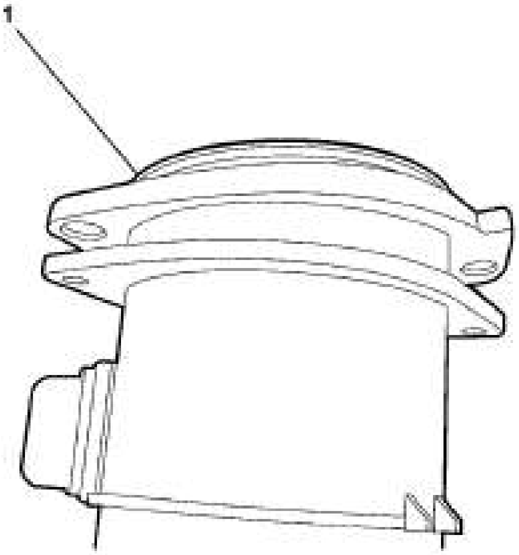
Removal Procedure



1. Ignition OFF.
2. Remove the air cleaner intake duct. Refer to Air Cleaner Inlet Duct Replacement.
3. Remove the mass air flow (MAF) harness connector (2) from the MAF sensor.
4. Remove the MAF sensor air box retaining clamps (1) .

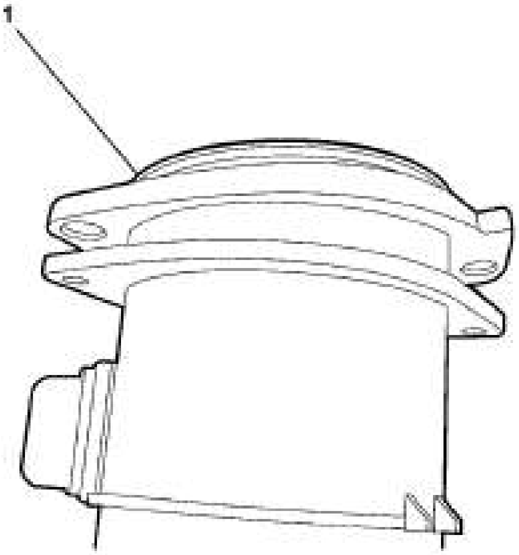


5. Remove the MAF sensor to air box retaining screws (1).



6. Remove the MAF sensor seal and discard the seal.

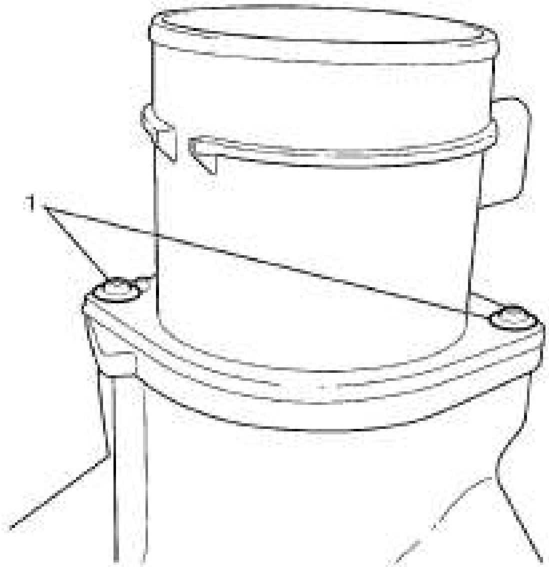
Installation Procedure



Important: Make note of the MAF sensor orientation when fitting to the air induction tube ensuring, arrow pointing toward the engine.

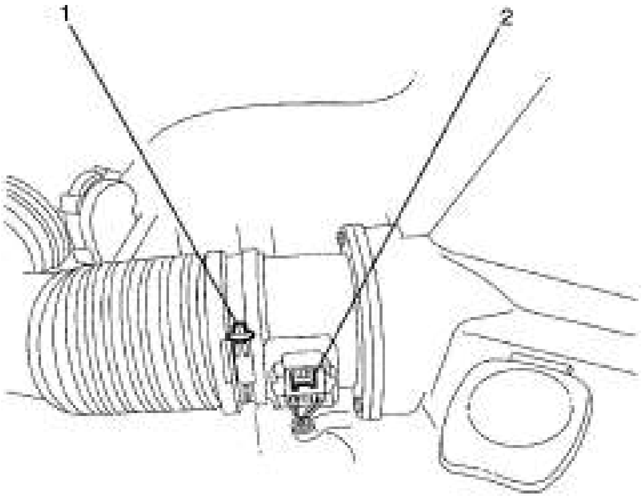
1. Install the new MAF sensor seal (1) locating the seal in the location holes and the MAF sensor.

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the MAF sensor to air box retaining screws (1).

   Tighten
   Tighten the MAF sensor screws to 4 N·m (35 lb in).



3. Install the air cleaner intake duct. Refer to Air Cleaner Inlet Duct Replacement.

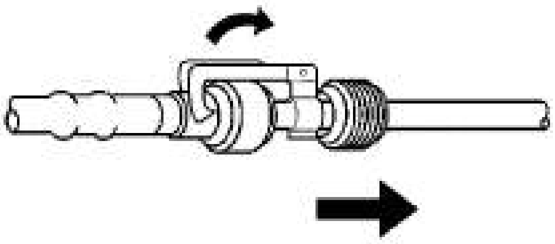
4. Install the mass air flow (MAF) harness connector (2).
5. Install the MAF sensor clamps (1) to the MAF sensor.

Metal Collar Quick Connect Fitting Service

Tools Required

- 7370 Fuel Line Quick Connect Separator
- 7371 Fuel Line Quick Connect Separator
- J 37088-A Fuel Line Quick Connect Separator

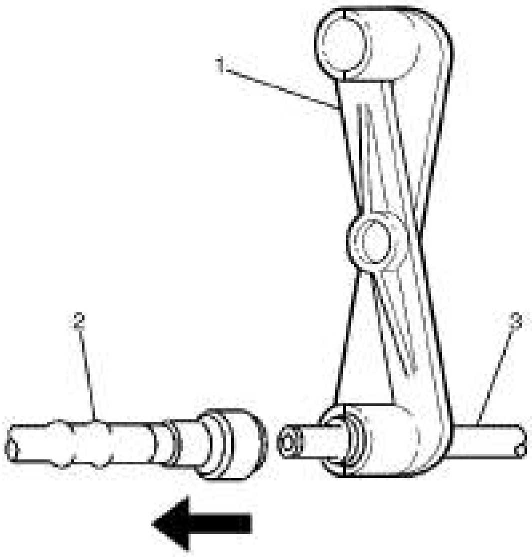
Removal Procedure



1. Before you service any fuel system connection, relieve the fuel system pressure Refer to the Fuel Pressure Relief .
2. Slide the dust cover from the quick-connect fitting if fitted.
3. Disconnect the fuel hose clip verifier from the quick connect fitting.

Caution: Wear safety glasses when using compressed air, as flying dirt particles may cause eye injury.

4. Use compressed air in order to blow any dirt from the fitting.

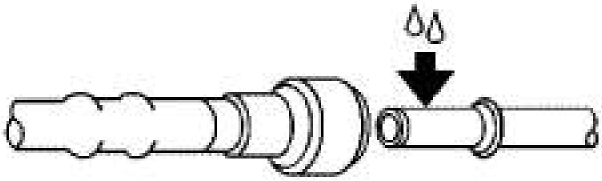


5. Choose the correct tool (1) for the size of the fitting from J 37088-A , 7370 or 7371 . Insert the selected tool into the male connector (3), then push inward in order to release the locking tabs.
6. Pull the female connector (2) away from the male connector.
7. Remove the J 37088-A , 7370 or 7371 from the male connector.

Notice: If necessary, remove rust or burrs from the fuel pipes with an emery cloth. Use a radial motion with the fuel pipe end in order to prevent damage to the O-ring sealing surface. Use a clean shop towel in order to wipe off the male tube ends. Inspect all the connections for dirt and burrs. Clean or replace the components and assemblies as required.

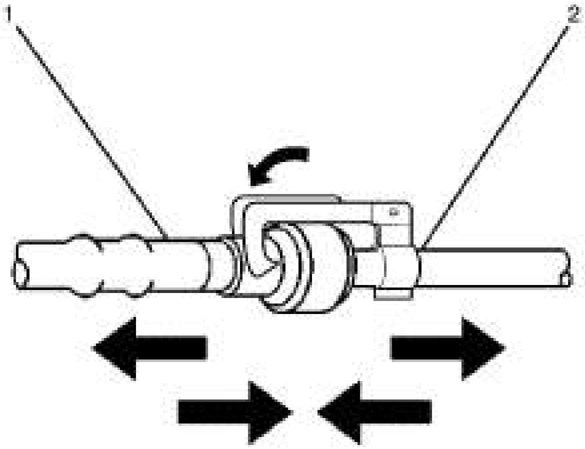
8. Using a clean shop towel, wipe off the male pipe end.
9. Inspect both ends of the fitting for dirt and for burrs. Clean or replace the components as required.

Installation Procedure

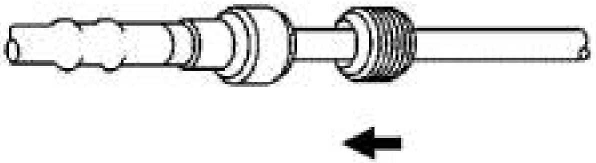


Caution: Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings in order to reduce the risk of fire and personal injury. This will ensure proper reconnection and prevent a possible fuel leak. During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.

1. Apply a few drops of clean engine oil to the male pipe end.
2. Push both sides of the fitting together in order to cause the retaining tabs to snap into place.



3. Pull and push repeatedly on both sides (1 and 2) of the fitting to make sure the connection is secure.
4. Connect the fuel hose clip verifier from the quick connect fitting.



5. Reposition the dust cover over the quick-connect fitting if fitted.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions | **Document ID: 2038741**

Fuel Filter Replacement (Petrol)

Removal Procedure - Up to xx/xx

The fuel filter is an integral part of the fuel pump assembly and must be replaced as an assembly. For replacement refer to Primary Fuel Tank Module Replacement.

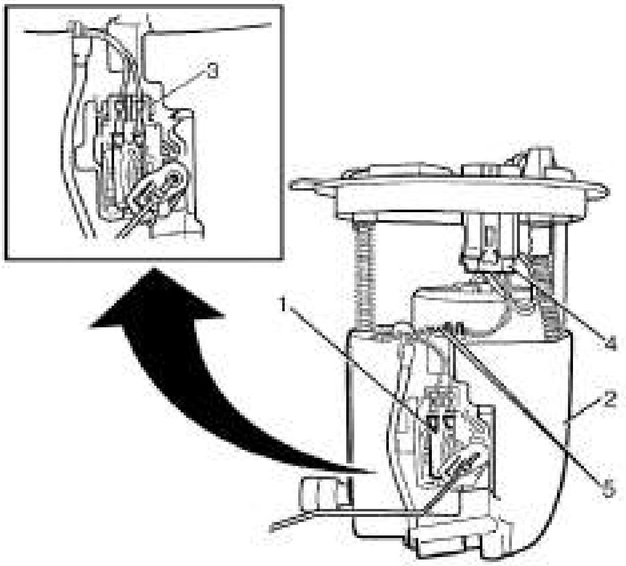
Removal Procedure - From xx/xx

Caution: Refer to Gasoline/Gasoline Vapors Caution in the Preface section.

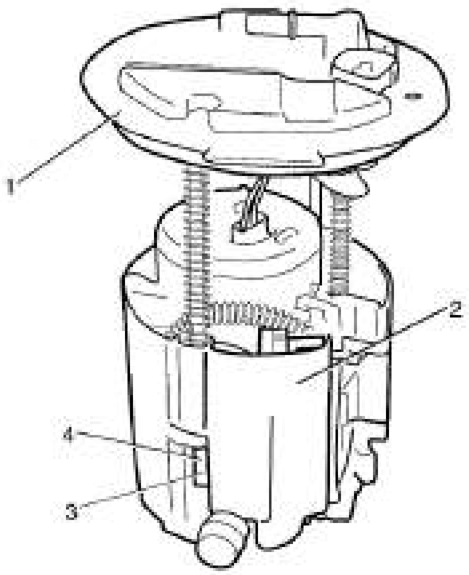
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

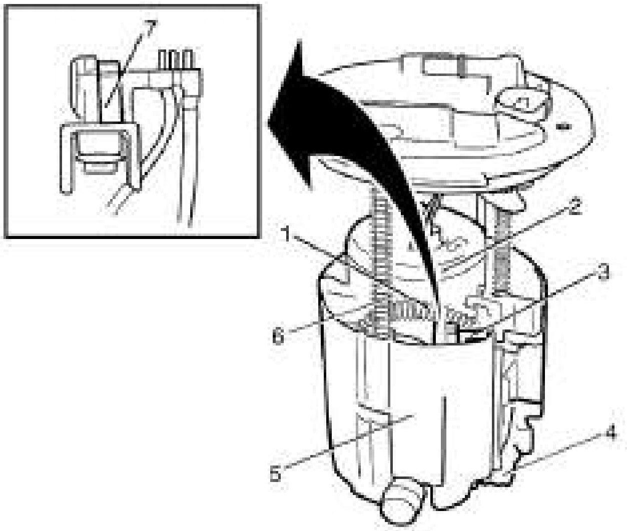
1. Remove the fuel tank. Refer to Fuel Tank Replacement.
2. Remove the primary fuel tank module assembly from the fuel tank. Refer to Primary Fuel Tank Module Replacement.



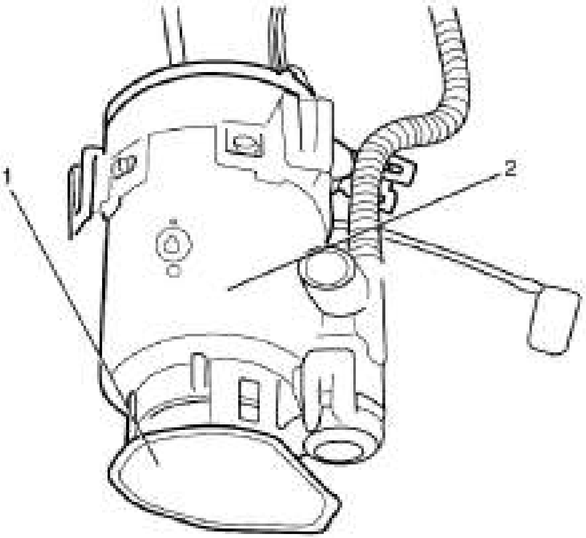
3. Disconnect the fuel level sensor connector (4) and unclip the wiring from the harness securing clips (5).
4. Unlock the locking clip (3) and gently push the fuel level sensor upwards.
5. Remove the fuel level sensor (1) from the lower half of the primary fuel tank module assembly (2).



6. Press down on the primary fuel tank module assembly upper half and remove the circlip (3) from the shaft (4).
7. Separate the upper halve (1) and lower halve (2) of the primary fuel tank module assembly.

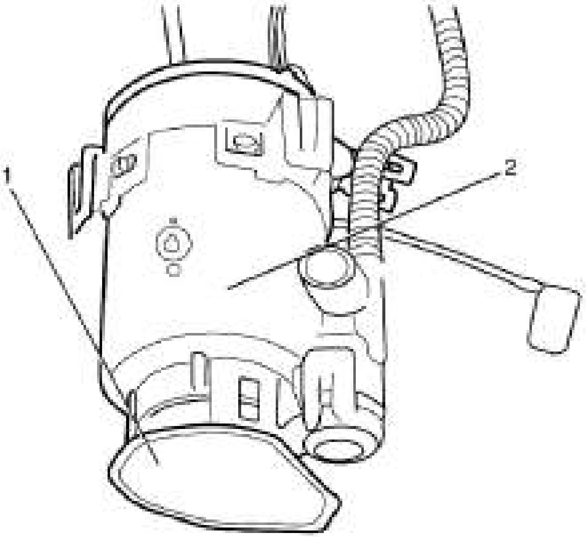


8. Remove the spring (6) from the primary fuel tank module assembly (5).
9. Unclip the piping (4) with a suitable tool.
10. Unclip the connector (7) with a suitable tool.
11. Make a note of the routing of the pipes (1) and (3).
12. Carefully remove the fuel pump housing (2) from the primary fuel tank module assembly (5).

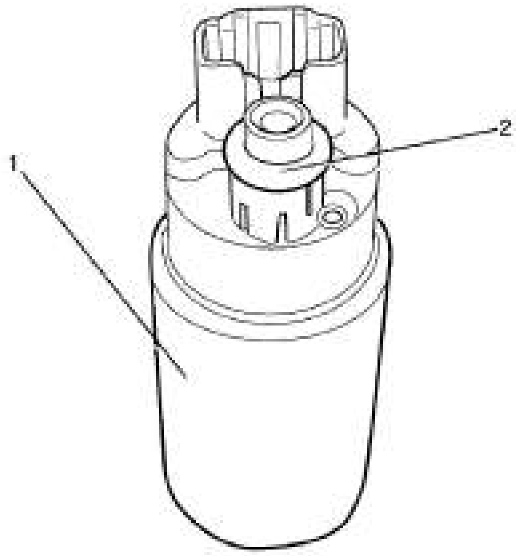


13. Carefully pry the fuel filter (2) from the fuel pump housing (3).

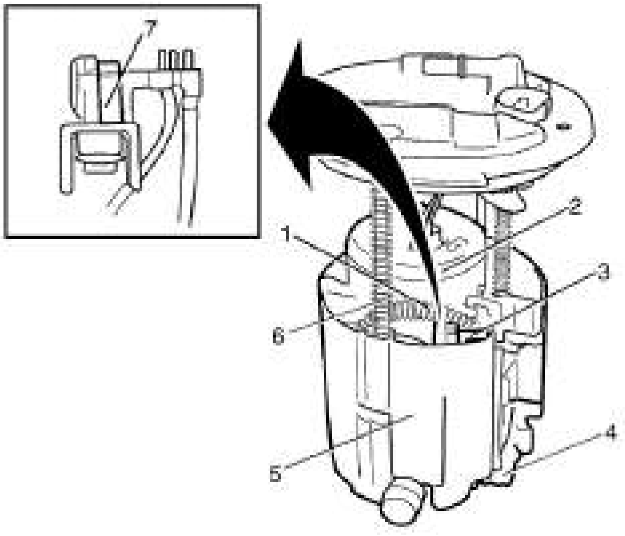
Installation Procedure - From xx/xx



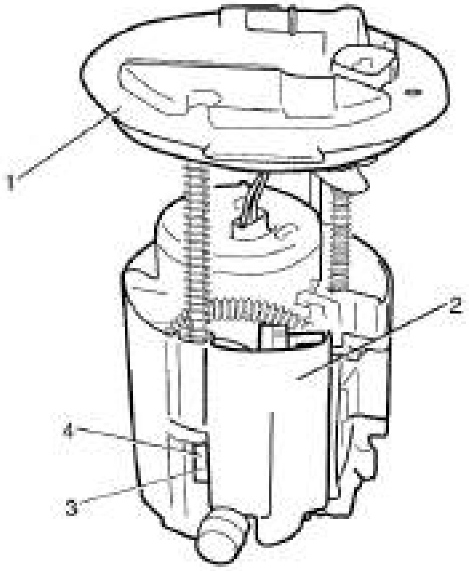
1. Locate and attach the fuel filter (1) to the fuel pump housing (3).



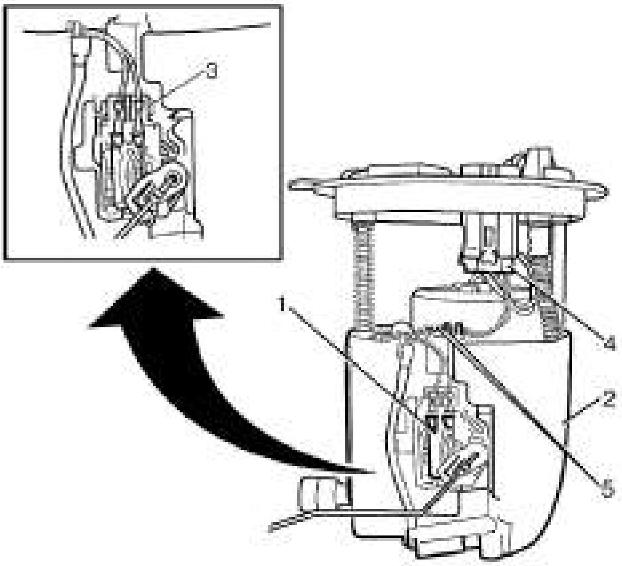
2. Fit a NEW O-ring seal (1) to the fuel outlet (2) and lubricate the NEW O-ring seal with an approved lubricant.



3. Route pipes (1) and (3) as noted earlier.
4. Press down on connector and listen for an audible click to confirm fitment.
5. Locate and install the fuel pump housing (2) into the primary fuel tank module assembly (5).
6. Locate and install the piping (4) to the primary fuel tank module assembly (5). Listen for audible click to confirm fitment.
7. Install the spring (6) to the fuel tank module assembly (5).



8. Assemble the primary fuel tank module assembly (1) and (2).
9. Press down on the primary fuel tank module assembly and install the circlip (3) to the shaft (4).



10. Locate and install the fuel tank level sensor (1) to the primary fuel tank module assembly (2). Make sure that the locking clip (3) engages.
11. Connect the fuel level sensor connector (4) and route the wiring through the harness securing clips (5).

Primary Fuel Level Sensor Replacement

The fuel level sensor is an integral part of the fuel pump assembly and must be replaced as an assembly. For replacement refer to Primary Fuel Tank Module Replacement.

Primary Fuel Tank Module Replacement

Tools Required

J 45747 Fuel Tank Sender Wrench.

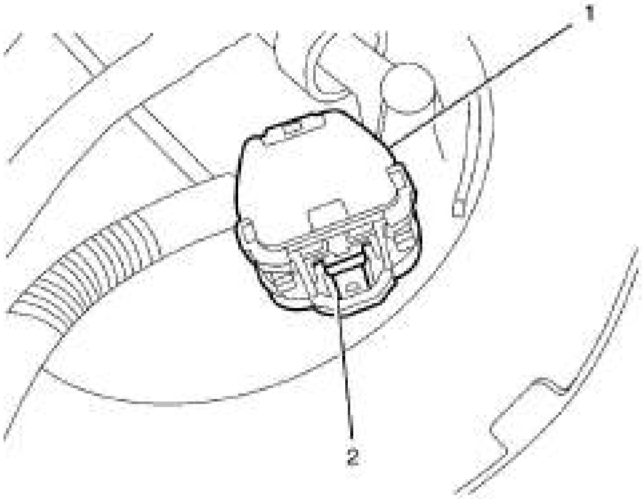
Removal Procedure

Caution: Refer to Gasoline/Gasoline Vapors Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

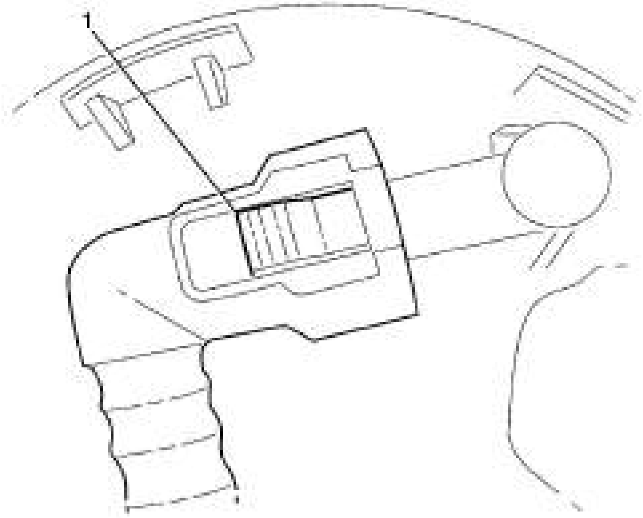
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Remove the fuel tank. Refer to Fuel Tank Replacement .

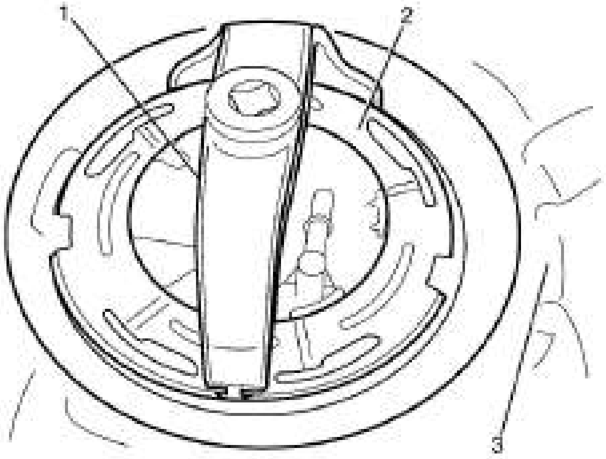


Important: Press release tab (2) on the electrical connector to release.

2. Disconnect the electrical connector (1) from the primary fuel tank module.



3. Remove the fuel supply tube . Refer to Plastic Collar Quick Connect Fitting Service .

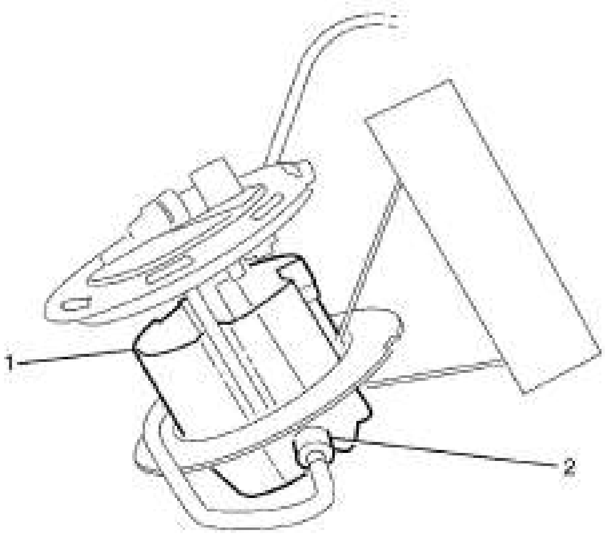


Important: Do not allow the tool to come in contact with the fuel pipes while unlocking the cam lock ring.

4. Rotate the cam lock ring (1) counter-clockwise using the J 45747 .

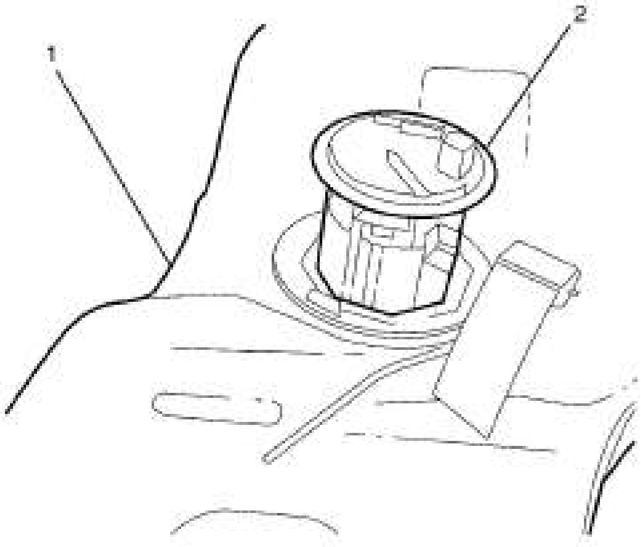
Important: The cam lock ring (1) is a single use part and therefore must be discarded after removal.

5. Remove the cam lock ring (1) from the fuel tank.

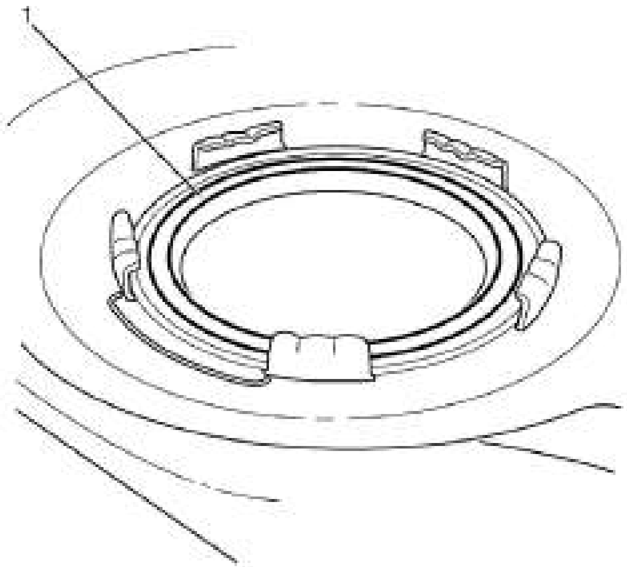


Important: The primary fuel tank module (1) is vertical in the installed position, but pivots for removal.

6. Carefully lift the primary fuel tank module (1) from the fuel tank only enough to access the transfer tube (2).
7. Disconnect the fuel transfer tube from the module assembly (2).



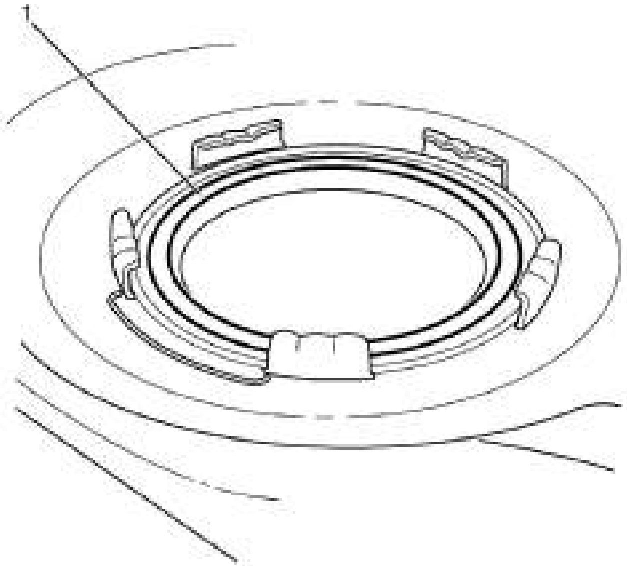
8. Remove the primary fuel tank module (1) from the fuel tank (2).



9. Remove the primary fuel tank module seal (1) from the primary fuel tank module.

   Discard the primary fuel tank module seal.

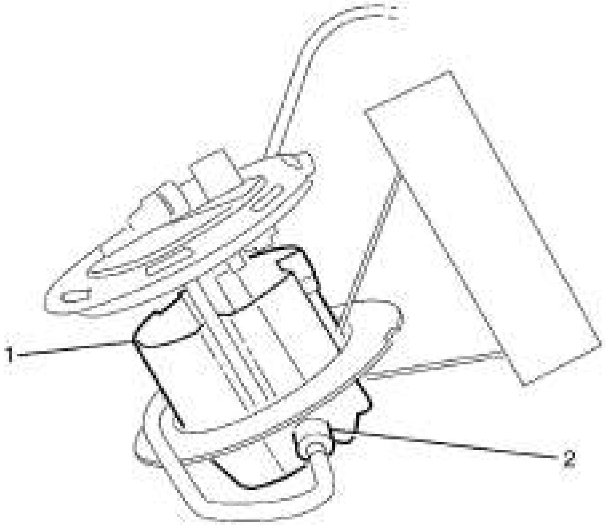
Installation Procedure



Important: Make sure the seal bead is facing the fuel tank.

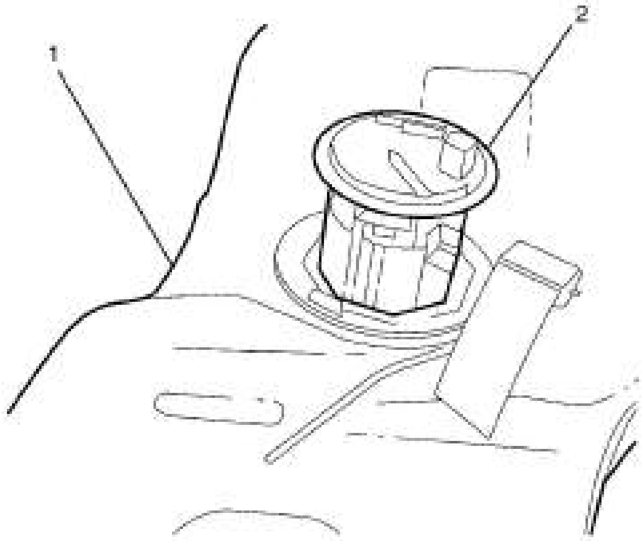
Important: Lubricate the seal before installation with an approved lubricant.

1. Place a NEW primary fuel tank module seal (1) over the primary fuel tank module (2).

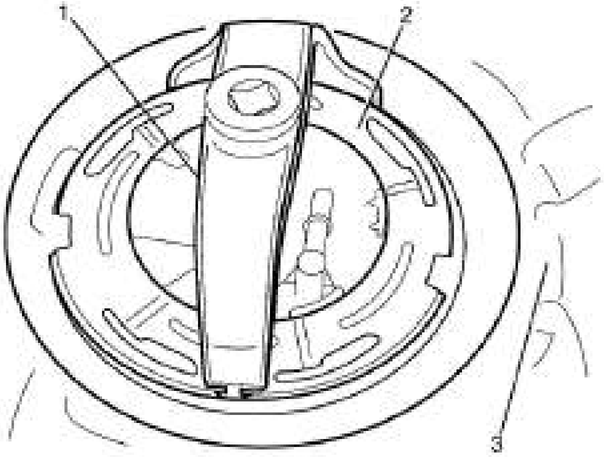


Important: The primary fuel tank module (1) is vertical in the installed position, but pivots for installation/removal.

2. Carefully install the primary fuel tank module (1) to the fuel tank only enough to access the transfer tube (2).
3. Connect the fuel transfer tube to the primary fuel tank module assembly (2).



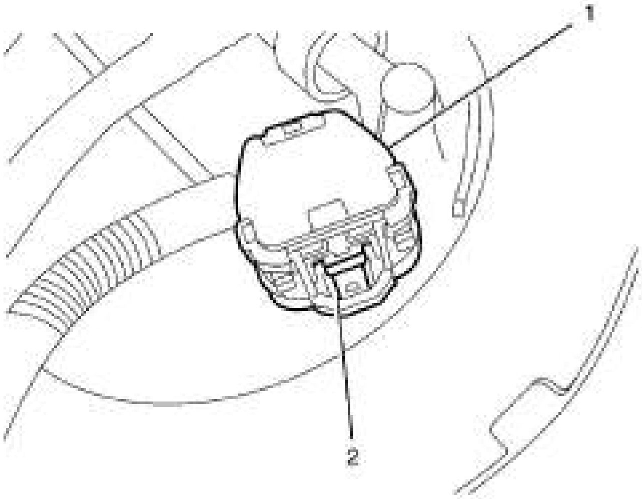
4. Install the primary fuel tank module (1) to the fuel tank (2).



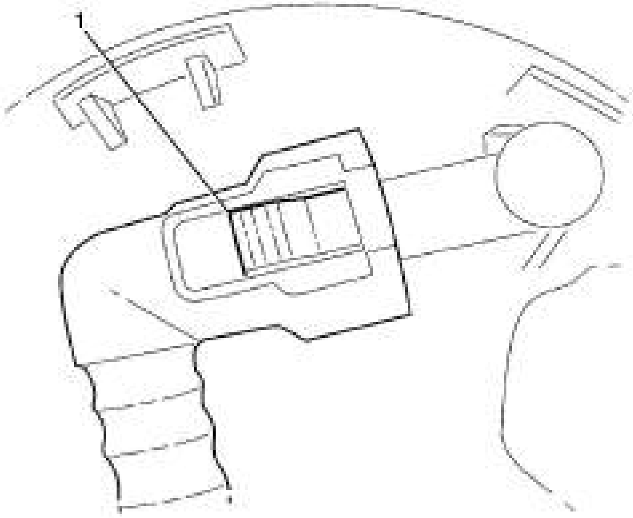
5. Install a NEW cam lock ring (1) to the fuel tank.

   Important: Do not allow the tool to come in contact with the fuel pipes while locking the cam lock ring.

6. Rotate the cam lock ring (1) clockwise using the J 45747 until fully seated.



7. Connect the electrical connector (1) to the primary fuel tank module.



8. Install the fuel supply tube to the fuel tank module. Refer to Plastic Collar Quick Connect Fitting Service .
9. Install the fuel tank. Refer to Fuel Tank Replacement .

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Secondary Fuel Tank Module Replacement

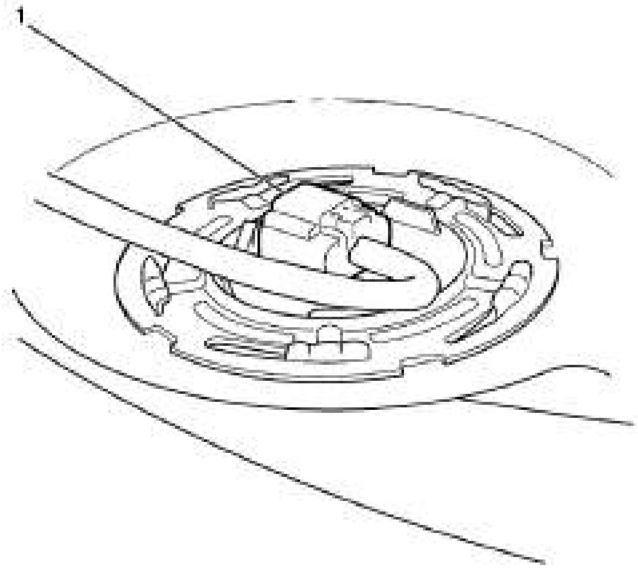
Tools Required

CH-48482 Fuel Tank Sender Wrench

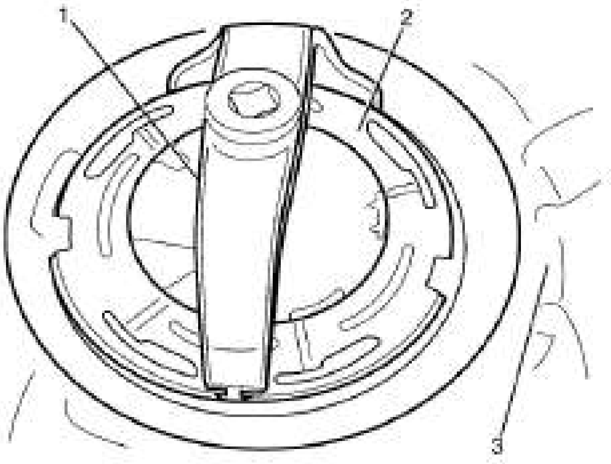
Removal Procedure

Caution: Refer to Gasoline/Gasoline Vapors Caution in the Preface section.

1. Remove the fuel tank. Refer to Fuel Tank Replacement.



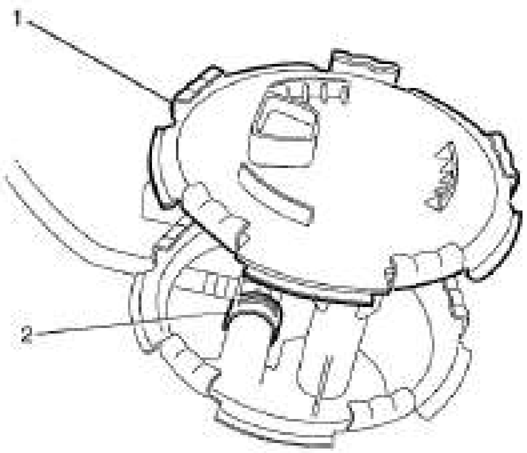
2. Disconnect the secondary fuel tank module electrical connector (1).



3. Rotate the cam lock ring (2) counter-clockwise using the CH-48482 (1).

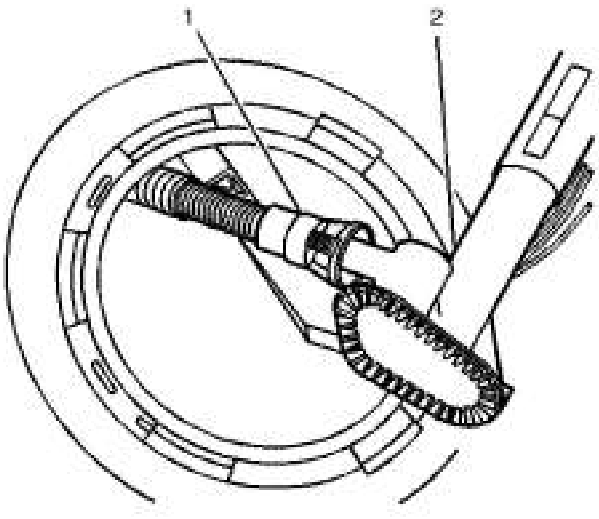
   Important: The cam lock ring (1) is a single use part and therefore must be discarded after removal.

4. Remove the cam lock ring (2) from the fuel tank.

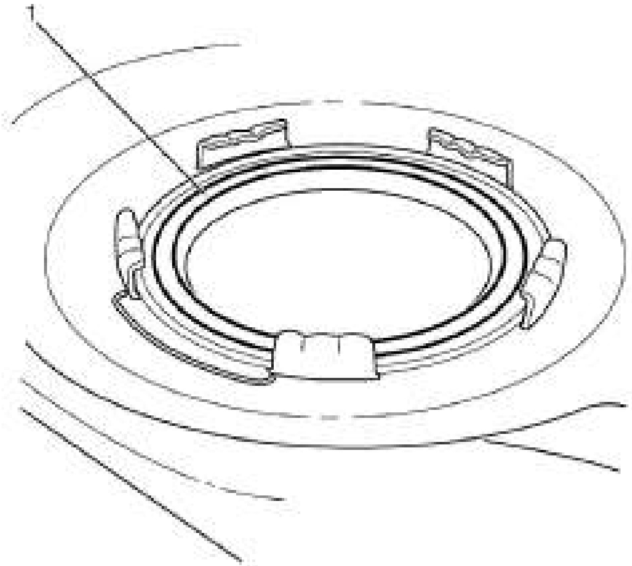


Important: The secondary fuel tank module (1) is vertical in the installed position, but pivots for removal.

5. Carefully lift the secondary fuel tank module (1) from the fuel tank only enough to access the transfer tube (2).



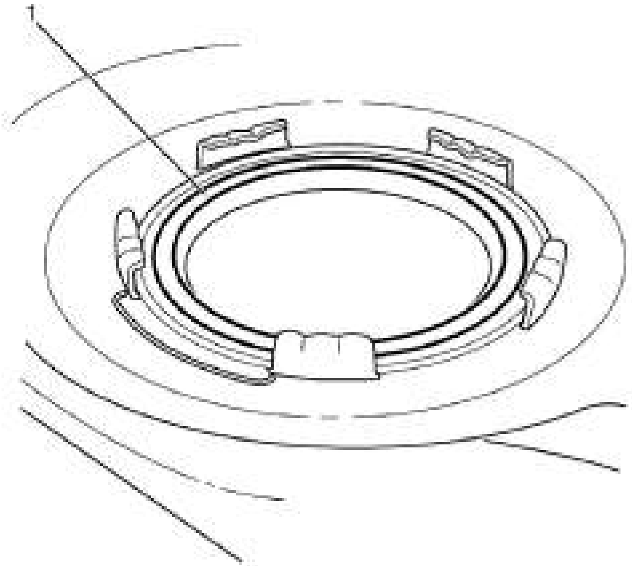
6. Remove the fuel supply tube (1). Refer to Plastic Collar Quick Connect Fitting Service.
7. Remove the secondary fuel tank module (2) from the fuel tank.



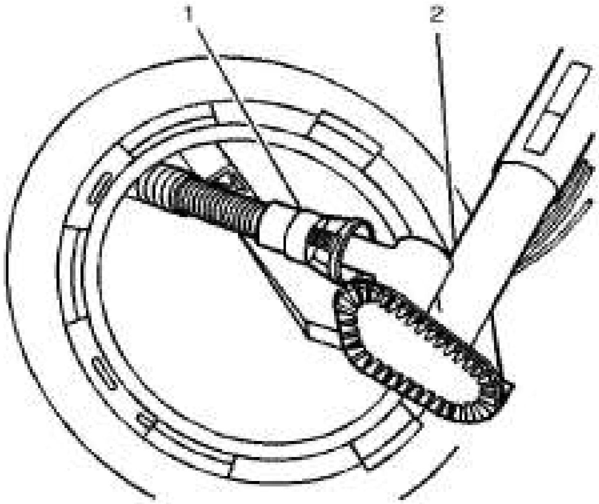
8. Remove the secondary fuel tank module seal (1) from the fuel tank.

   Do not reuse the seal.

Installation Procedure



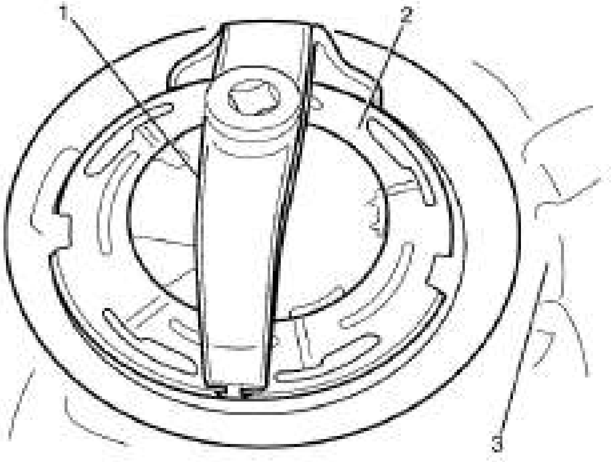
1. Place the new secondary fuel tank module seal (1) in the locating groove on the fuel tank.



2. Complete the following in order to connect the transfer tube (1) to the secondary fuel tank module (2).
   - 2.1. Grasp the transfer tube (1) from inside the fuel tank.
   - 2.2. Position the module (2) near the module opening.
   - 2.3. Connect the transfer tube (1) to the module (2).

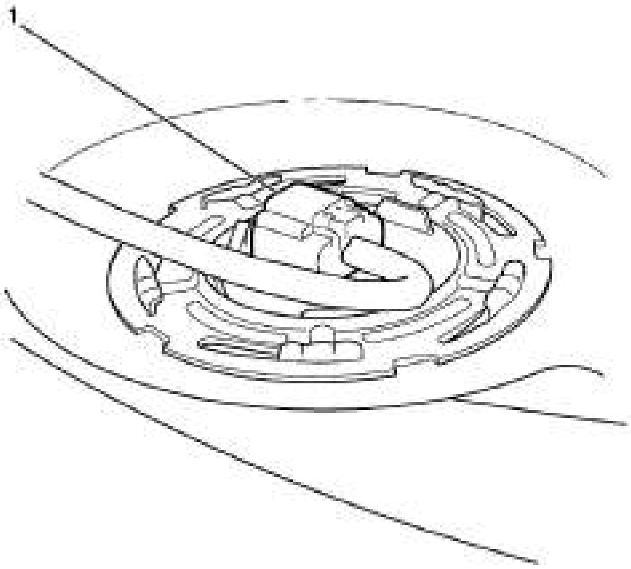
Important: Make sure the fuel level float is free from binding while inserting the module (2).

3. Carefully insert the secondary fuel tank module (2) into the fuel tank.
4. Press the secondary fuel tank module (2) downward, aligning the module to the encapsulated ring.



5. Install a NEW cam lock ring (2) to the fuel tank (3).

6. Rotate the cam lock ring (2) clockwise using the CH-48482 (1) until fully seated.



7. Connect the secondary fuel tank module electrical connector (1).
8. Install the fuel tank. Refer to Fuel Tank Replacement.

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Spark Plug Inspection

Spark Plug Operation

1. Worn or dirty spark plugs may operate well at idle speeds, but frequently fail at higher load. Bad spark plugs are often responsible for the following conditions:
    - Power loss
    - Poor fuel economy
    - Loss of speed
    - Hard starting
    - Poor engine performance
    - Oil getting past worn piston rings
    - Breaking in a new or recently overhauled engine.
2. Misfiring is a general term that applies to a poor running engine. With misfiring, the ignition spark is not igniting the air/fuel mixture at the proper time. While other possible causes must be investigated, the spark plugs should be inspected first. Spark voltage should not reach ground before jumping across the gap at the tip of the spark plug. This leaves the air/fuel mixture unburned, causing misfiring. Pre-ignition misfiring occurs when the spark plug tip overheats, igniting the mixture before the spark jumps.
3. Carbon fouling of the spark plug is indicated by dry carbon deposits on the portion of the spark plug inside of the cylinder. Excess idling and driving at slower speeds under light engine loads can keep the spark plug temperatures so low that these deposits are not burned off. Rich fuels or poor ignition system output may also cause carbon fouling.
4. Normal spark plug operation results in brown to grayish tan deposits on the area of the spark plug that enters the cylinder. A small amount of reddish brown, yellow, and white powdery residue may also be present on the insulator tip around the centre electrode. These deposits are normal combustion by-products of fuels and lubricating oils which contain additives.
5. Deposit fouling of the spark plug occurs when the normal reddish brown, yellow, or white deposits of combustion by-products become sufficient enough to cause misfiring. In some cases, these deposits melt and form a shiny glaze on the insulator around the centre electrode. If the fouling is found only in one or two of the cylinders, valve stem clearances or the intake valve seals may be allowing excess lubricating oil to enter the cylinder, particularly if the deposits are heavier on the intake valve side of the spark plug.
6. Excess gap means that the air space between the centre and side electrodes at the bottom of the spark plug is too wide for consistent firing. This may be due to incorrect gap adjustment or to excess wear of the electrodes during use. A gap that is too small may cause idling instability. Excess gap wear might indicate vehicle operation at continual high speeds or with high engine loads. This causes the spark plugs to run too hot. Lean fuel mixtures may also cause the wear.
7. incorrect torque or seating can cause a spark plug to run hot, eventually leading to excess gap wear. In extreme cases, an over-tightened or under-tightened spark plug can cause exhaust blow-by. The cylinder head seats must make good contact for sufficient heat transfer and spark plug cooling. Dirty or damaged threads in the head or on the spark plug can keep the spark plug from seating even though the proper torque is applied. Once the spark plugs are properly seated, tighten the spark plugs properly.
8. Cracked or broken insulators and insulator tips may be the result of incorrect installation or heat shock. Heat shock is a rapid increase in the insulator tip temperature which causes the insulator material to crack. The upper insulators can be broken when a poorly-fitting tool is used during servicing, or when the spark plug is hit from the outside. Cracks in the upper insulator may be inside the shell or invisible. The breakage may result in oil or water

penetration causing failure. Heat shock breakage in the lower insulator tip generally occurs during extreme engine operating conditions such as higher RPM or heavy loading. Over advanced timing or low grade fuels may also cause heat shock breakage. Always replace spark plugs with broken or cracked insulators.

9. Damage during gaping can occur when the tool is pushed against the centre electrode or the surrounding insulator, causing the insulator to crack. When gaping a spark plug, bend only the outside electrode. Keep tools free of any other parts.
10. Spark plugs with less than the recommended amount of service can sometimes be cleaned and re-gaped, then returned to service. If there is any doubt about the serviceability of a spark plug, replace the spark plug.

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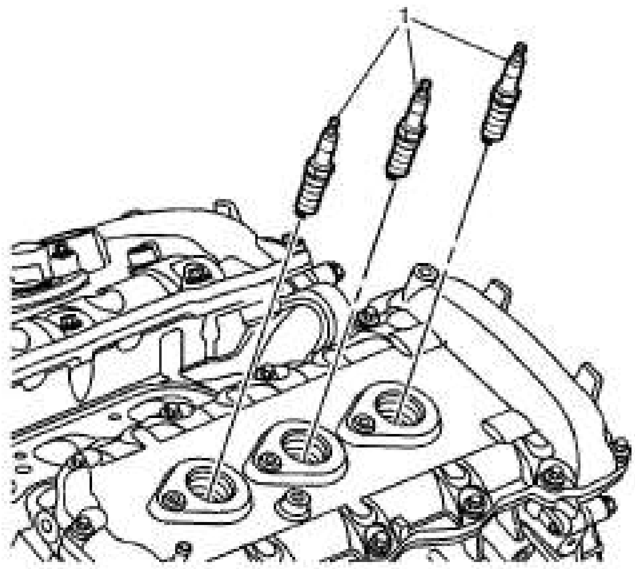
Spark Plug Replacement

Removal Procedure



1. Turn the ignition OFF.
2. Remove the ignition coil. Refer to Ignition Coil Replacement - Bank 1 and/or Ignition Coil Replacement - Bank 2.

   Caution: Refer to Safety Glasses and Compressed Air Caution in the Preface section.

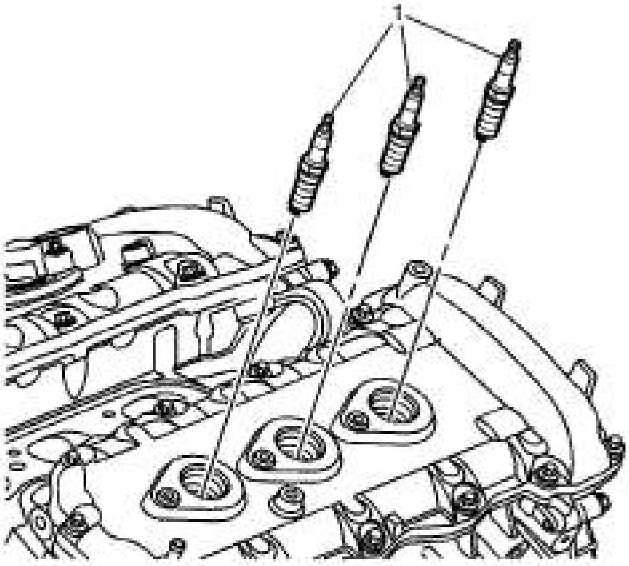
   Notice: Clean the spark plug recess area before removing the spark plug. Failure to do so could result in engine damage because of dirt or foreign material entering the cylinder head, or by the contamination of the cylinder head threads. The contaminated threads may prevent the proper seating of the new plug. Use a thread chaser to clean the threads of any contamination.

3. Use compressed air in order to remove debris from the spark plug cavity.

   Notice: Allow the engine to cool before removing the spark plugs. Attempting to remove the spark plugs from a hot engine may cause the plug threads to seize, causing damage to cylinder head threads.

4. Remove the spark plugs (1) from the cylinder head.

Installation Procedure



Notice: Use only the spark plugs specified for use in the vehicle. Do not install spark plugs that are either hotter or colder than those specified for the vehicle. Installing spark plugs of another type can severely damage the engine.

Notice: Check the gap of all new and reconditioned spark plugs before installation. The pre-set gaps may have changed during handling. Use a round feeler gage to ensure an accurate check. Installing the spark plugs with the wrong gap can cause poor engine performance and may even damage the engine.

1. Make sure that the spark plug gap is equivalent to the spark plug gap specification. Refer to Ignition System Specifications.

   Notice: Be sure that the spark plug threads smoothly into the cylinder head and the spark plug is fully seated. Use a thread chaser, if necessary, to clean threads in the cylinder head. Cross-threading or failing to fully seat the spark plug can cause overheating of the plug, exhaust blow-by, or thread damage.

2. Install the spark plug.

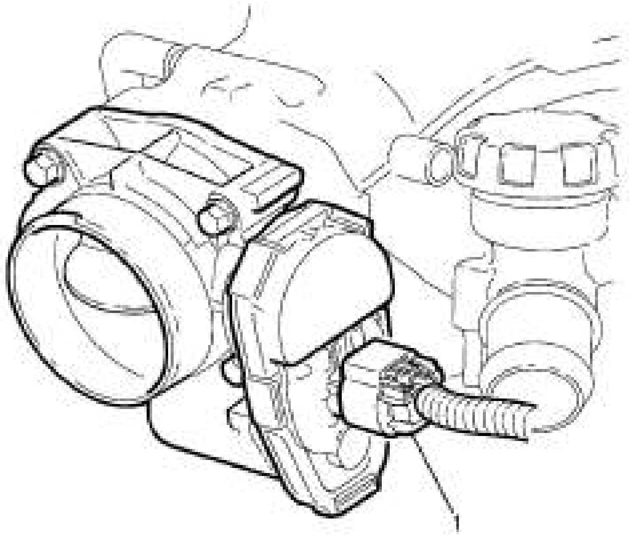
   Tighten
   Tighten the spark plug to 20 N·m (15 lb ft).

3. Install the ignition coil. Refer to Ignition Coil Replacement - Bank 1 and/or Ignition Coil Replacement - Bank 2

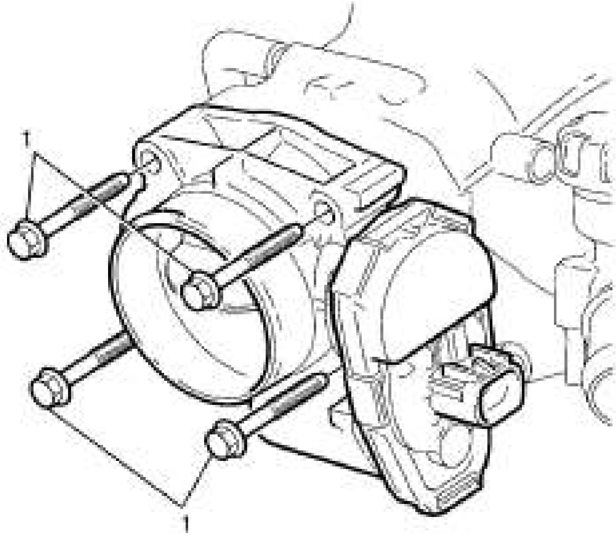
Throttle Body Assembly Replacement

Removal Procedure

1. Turn the ignition OFF.
2. Remove the air cleaner intake duct. Refer to Air Cleaner Inlet Duct Replacement.



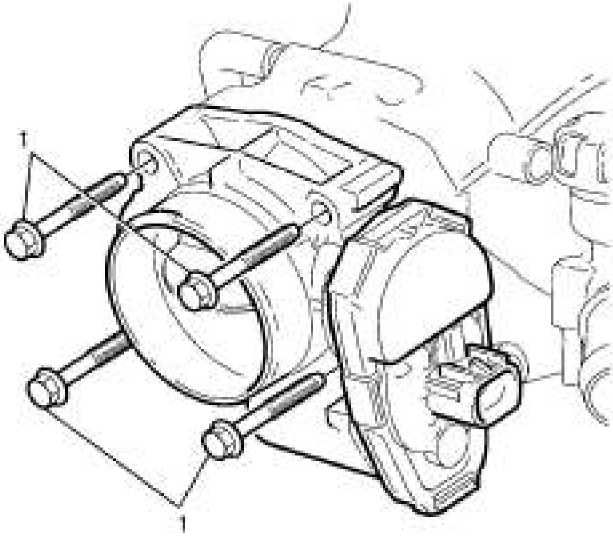
3. Remove the throttle body electrical connector (1) from the throttle body.



4. Remove the the throttle body bolts to upper intake manifold retaining bolts (1)
5. Remove the throttle body and gasket from the vehicle.

Installation Procedure

1. Carefully clean the throttle body mounting surfaces of any gasket and/or sealing material.

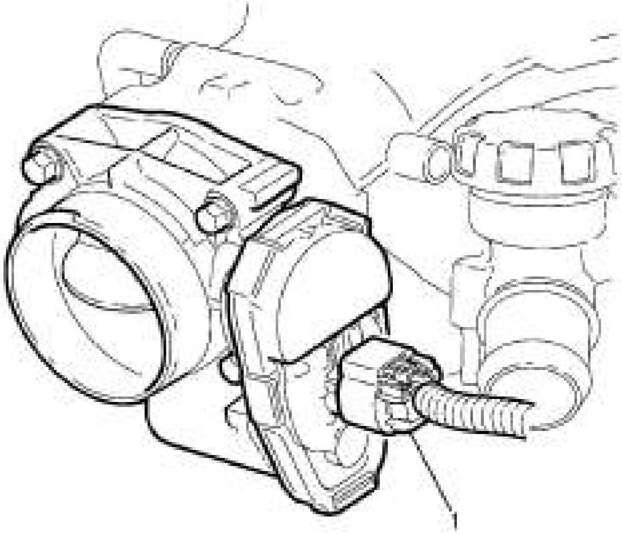


2. Install the throttle body and NEW gasket to the vehicle

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the throttle body bolts to upper intake manifold retaining bolts (1).

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).



4. Install the throttle body electrical connector (1) to the throttle body.
5. Install the air cleaner intake duct. Refer to Air Cleaner Inlet Duct Replacement.
6. Perform the idle learn procedure. Refer to Idle Learn
7. Use the scan tool to clear all DTCs.

Throttle Body Inspection and Cleaning

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.
2. Fully open the throttle valve in order to Inspect the throttle body bore and the throttle valve plate for any deposits.

   Notice: Do not subject a throttle body assembly which contains the following components to an immersion cleaner or a strong solvent:

   - Throttle position (TP) sensor
   - Idle air control (IAC) valve
   - Sealed throttle shaft bearings

   The cleaners will damage the electric components or sensors.

   The cleaners will damage some of these components that contain seals or O-rings.

   Solvents can wash away or break down the grease used on non-serviceable throttle shaft bearings.

   Never use a wire brush or scraper to clean the throttle body. A wire brush or sharp tools may damage the throttle body components.

   Do not use a cleaner that contains methyl ethyl ketone. This extremely strong solvent may damage components and is not necessary for this type of cleaning.

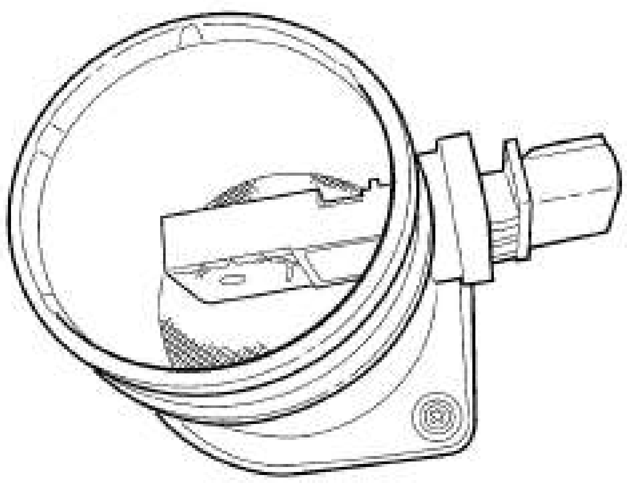
3. Use a clean shop towel and an approved Top Engine Cleaner. Clean the throttle body bore and the throttle valve plate.

   If necessary, use a parts cleaning brush in order to remove heavy deposits.

4. Install the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.

Air Intake System Description

Mass Air Flow Sensor



The MAF sensor measures the amount of air coming into the engine. This direct airflow measurement is more accurate than the calculated airflow information obtained from the other sensor inputs. The MAF sensor also houses an integrated intake air temperature (IAT) sensor. The MAF sensor uses the following circuits:

- An ignition 1 voltage circuit
- A 5-volt reference circuit
- A low reference circuit
- A signal circuit
- IAT signal circuit

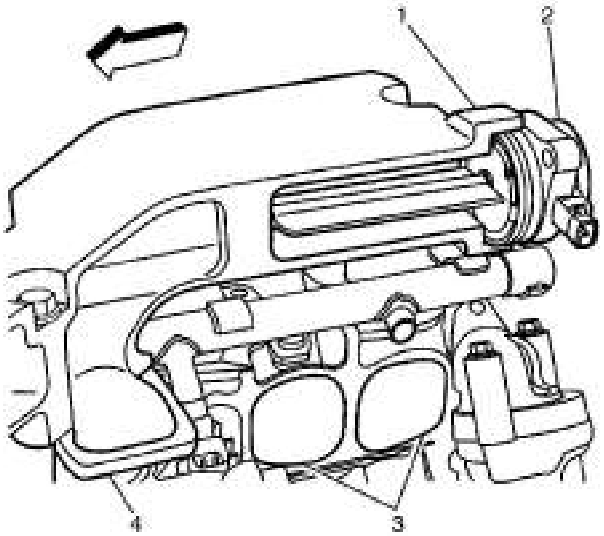
The MAF sensor that is used on this vehicle measures the air flow rate. The MAF output voltage is a function of the power required to keep the air flow sensing elements at a fixed temperature above the ambient temperature. The air flowing through the sensor cools the sensing elements. The amount of cooling is proportional to the amount of air flow. As the air flow increases, more current is needed in order to maintain the hot film at a constant temperature. The MAF sensor converts the changes in the current draw to a voltage signal that the ECM monitors. The ECM calculates the air flow based on this signal.

The ECM monitors the MAF sensor signal voltage and can determine if the sensor signal voltage is too low or too high. The ECM can also detect airflow that is inappropriate for a given operating condition based on the signal voltage.

The scan tool displays the MAF value and displays the value in grams per second (g/s). Values should change rather quickly on acceleration, but should remain fairly stable at any given engine speed. If the ECM detects a condition with the MAF sensor circuits, the following DTCs set:

- P0101 Mass Air Flow (MAF) Sensor Performance
- P0102 Mass Air Flow (MAF) Sensor Circuit Low Voltage
- P0103 Mass Air Flow (MAF) Sensor Circuit High Voltage

Intake Manifold Runner Control (IMRC) Solenoid



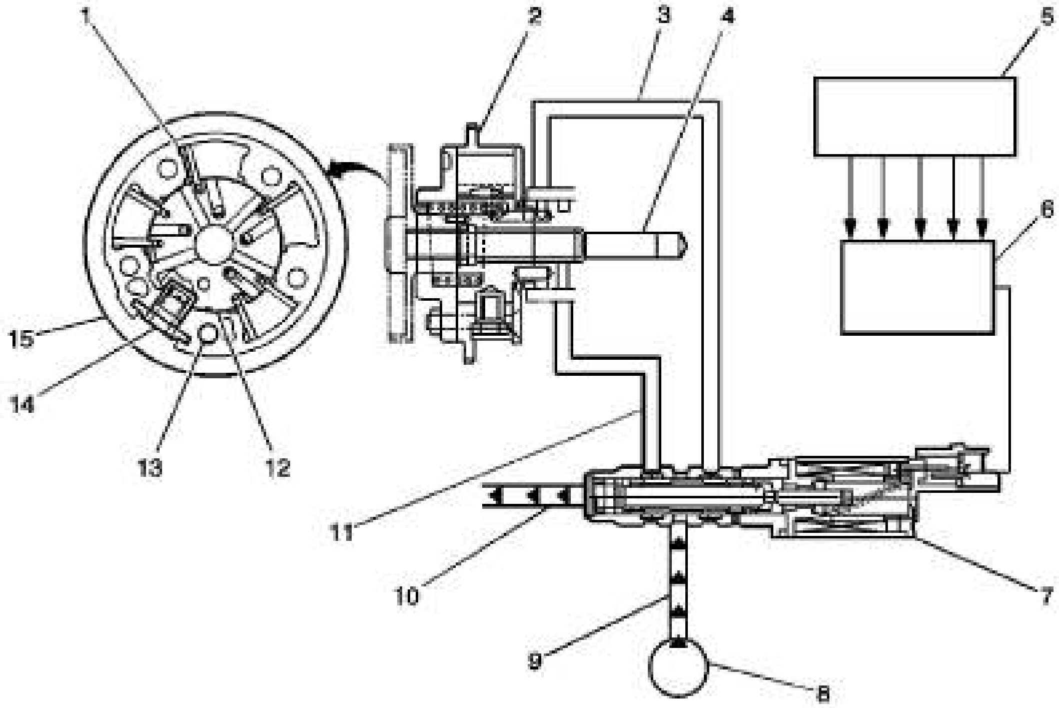
The characteristic torque curve of a normally aspirated engine depends mainly on how the engines average pressure changes over the engine speed band. The average pressure is proportional to the volume of the air mass present in the cylinder when the inlet valve is closed. The design of the inlet system determines how large an air mass can be drawn into a cylinder at a given engine speed.

An intake manifold runner control (IMRC) valve (2) is used to change the intake manifold runner configuration. When the IMRC valve is open, the intake manifold is configured to one large plenum (4). When the IMRC valve is closed, the intake manifold is configured to two smaller plenums (3). The two intake manifold runner sizes result in different torque curves which improves performance at low and high engine speeds. The IMRC valve is located in the intake manifold (1). The IMRC valve solenoid is supplied with ignition 1 voltage and is controlled by the engine Control Module (ECM).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Description and Operation | Document ID: 1992794

Camshaft Actuator System Description

Camshaft Actuator System Overview



(1) Camshaft Actuator Vane
(2) Timing Chain Sprocket
(3) Engine Oil Pressure-For retarding the camshaft
(4) Camshaft
(5) Input Signals from Engine Sensors
(6) Engine Control Module (ECM)
(7) Camshaft Actuator Solenoid
(8) Engine Oil Pump
(9) Engine Oil Pressure Supply
(10) Engine Oil Drain
(11) Engine Oil Pressure-For advancing the camshaft
(12) Camshaft Actuator Rotor
(13) Camshaft Position Sensor Reluctor
(14) Camshaft Actuator Lock Pin
(15) Camshaft Actuator Housing

The camshaft actuator system enables the engine Control Module (ECM) to change camshaft timing of all 4 camshafts while the engine is operating. The CMP actuator assembly (15) varies the camshaft position in response to directional changes in oil pressure. The CMP actuator solenoid valve controls the oil pressure that is applied to advance or retard a camshaft. Modifying camshaft timing under changing engine demand provides better balance between the following performance concerns:

- Engine power output
- Fuel economy
- Lower tail pipe emissions

The CMP actuator solenoid valve (7) is controlled by the ECM. The crankshaft position (CKP) sensor and the CMP sensors are used to monitor changes in camshaft positions. The ECM uses the following information in order to calculate the desired camshaft positions:

- The engine coolant temperature (ECT) sensor
- The calculated engine oil temperature (EOT)
- The mass air flow (MAF) sensor
- The throttle position (TP) sensor
- The vehicle speed sensor (VSS)
- The volumetric efficiency

Operation

The CMP actuator assembly has an outer housing that is driven by an engine timing chain. Inside the assembly is a rotor with fixed vanes that is attached to the camshaft. Oil pressure that is applied to the fixed vanes will rotate a specific camshaft in relationship to the crankshaft. The movement of the intake camshafts will advance the intake valve timing up to a maximum of 50 crankshaft degrees. The movement of the exhaust camshafts will retard the exhaust valve timing up to a maximum of 50 crankshaft degrees. When oil pressure is applied to the return side of the vanes, the camshafts will return to 0 crankshaft degrees, or top dead center (TDC). The CMP actuator solenoid valve directs the oil flow that controls the camshaft movement. The ECM commands the CMP solenoid to move the solenoid plunger and spool valve until oil flows from the advance passage (11). Oil flowing thru the CMP actuator assembly from the CMP solenoid advance passage applies pressure to the advance side of the vanes in the CMP actuator assembly. When the camshaft position is retarded, the CMP actuator solenoid valve directs oil to flow into the CMP actuator assembly from the retard passage (3). The ECM can also command the CMP actuator solenoid valve to stop oil flow from both passages in order to hold the current camshaft position.

The ECM operates the CMP actuator solenoid valve by pulse width modulation (PWM) of the solenoid coil. The higher the PWM duty cycle, the larger the change in camshaft timing. The CMP actuator assembly also contains a lock pin (14) that prevents movement between the outer housing and the rotor vane assembly. The lock pin is released by oil pressure before any movement in the CMP actuator assembly takes place. The ECM is continuously comparing CMP sensor inputs with CKP sensor input in order to monitor camshaft position and detect any system malfunctions. If a condition exists in either the intake or exhaust camshaft actuator system, the opposite bank, intake or exhaust, camshaft actuator will default to 0 crankshaft degrees.

CMP Actuator System Operation

Driving Condition	Change in Camshaft Position	Objective	Result

Idle	No Change	Minimize Valve Overlap	Stabilize Idle Speed
Light Engine Load	Retard Valve Timing	Decrease Valve Overlap	Stable Engine Output
Medium Engine Load	Advance Valve Timing	Increase Valve Overlap	Better Fuel Economy with Lower Emissions
Low to Medium RPM with Heavy Load	Advance Valve Timing	Advance Intake Valve Closing	Improve Low to Mid-range Torque
High RPM with Heavy Load	Retard Valve Timing	Retard Intake Valve Closing	Improve Engine Output

Electronic Ignition (EI) System Description

The electronic ignition (EI) system produces and controls a high-energy secondary spark. This spark is used to ignite the compressed air/fuel mixture at precisely the correct time. This provides optimal performance, fuel economy, and control of exhaust emissions. This ignition system uses an individual coil for each cylinder. The ignition coils are mounted in the center of each camshaft cover with short integrated boots connecting the coils to the spark plugs. The driver modules within each ignition coil are commanded ON/OFF by the engine Control Module (ECM). The ECM primarily uses engine speed, the MAF sensor signal, and position information from the crankshaft position (CKP) and the camshaft position (CMP) sensors. This controls the sequence, dwell, and timing of the spark. The EI system consists of the following components:

Crankshaft Position (CKP) Sensor

The crankshaft position (CKP) sensor works in conjunction with a 58 tooth reluctor wheel on the crankshaft. The engine Control Module (ECM) monitors the voltage between the CKP sensor signal circuits. As each reluctor wheel tooth rotates past the sensor, the sensor creates an analog signal. This analog signal is processed by the ECM. The reluctor wheel teeth are 6 degrees apart. Having only 58 teeth leaves a 12 degree span that is uncut. This creates a signature pattern that enables the ECM to determine the CKP. The ECM can determine which pair of cylinders is approaching top dead center based on the CKP signal alone. The camshaft position (CMP) sensor signals are used in order to determine which of these 2 cylinders is on a firing stroke, and which is on the exhaust stroke. The ECM uses this to properly synchronize the ignition system, the fuel injectors, and the knock control. This sensor is also used in order to detect misfire.

Camshaft Position (CMP) Sensor

This engine uses 4 camshaft position (CMP) sensors, one for each camshaft. The CMP sensor signals are a digital ON/OFF pulse, output 4 times per revolution of the camshaft. The CMP sensor does not directly affect the operation of the ignition system. The CMP sensor information is used by the engine Control Module (ECM) to determine the position of the 4 camshafts relative to the crankshaft position. By monitoring the CMP and crankshaft position (CKP) signals the ECM can accurately time the operation of the fuel injectors. The ECM supplies the CMP sensor with a 5-volt reference circuit and a low reference circuit. The CMP sensor signals are an input to the ECM. These signals are also used to detect camshaft alignment with the crankshaft.

Ignition Coils

Each ignition coil contains a solid state driver module as its primary element. The engine Control Module (ECM) signals the coil driver to initiate a firing event by applying ignition control (IC) circuit voltage for the appropriate time, or dwell. When the voltage is removed the coil fires the spark plug. The ignition coils use the following circuits:

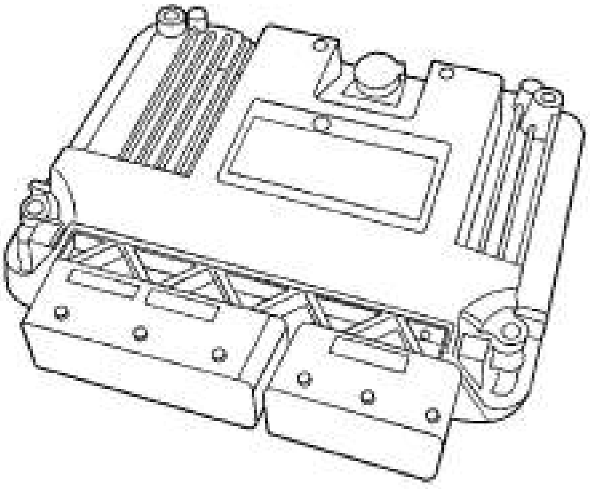
- An ignition 1 voltage supply circuit
- An IC circuit
- Two ground circuits

Engine Control Module (ECM)

The engine Control Module (ECM) controls all ignition system functions, and constantly corrects the spark timing. The ECM monitors information from various sensor inputs that include the following components:

- The throttle position (TP) sensor
- The engine coolant temperature (ECT) sensor
- The mass air flow (MAF) sensor
- The intake air temperature (IAT) sensor
- The vehicle speed sensor (VSS)
- The transmission gear position or range information sensors
- The engine knock sensors (KS)
- Ambient pressure sensor (BARO)

Engine Control Module Description



The engine Control Module (ECM) interacts with many more emission related components and systems, and monitors emission related components and systems for deterioration. OBD II diagnostics monitor the system performance and a diagnostic trouble code (DTC) sets if the system performance degrades.

The malfunction indicator lamp (MIL) operation and the DTC storage are dictated by the DTC type. A DTC is ranked as a Type A or Type B if the DTC is emissions related. Type C is a non-emissions related DTC.

The ECM is in the engine compartment. The ECM is the control centre of the engine controls system. The ECM controls the following components:

- The fuel injection system
- The ignition system
- The emission control systems
- The on-board diagnostics
- The A/C and fan systems
- The throttle actuation control (TAC) system

The ECM constantly monitors the information from various sensors and other inputs, and controls the systems that affect the vehicle performance and the emissions. The ECM also performs diagnostic tests on various parts of the system. The ECM can recognize operational errors and alert the driver via the MIL. When the ECM detects a malfunction, the ECM stores a DTC. The condition area is identified by the particular DTC that is set. This aids the technician in making repairs.

ECM Function

The ECM can supply 5 volts or 12 volts to the various sensors or switches. This is done through pull-up resistors to the regulated power supplies within the ECM. In some cases, even an ordinary shop voltmeter will not give an accurate reading because the resistance is too low. Therefore, a DMM with at least 10 megaohms input impedance is required in order to make sure accurate voltage readings.

The ECM controls the output circuits by controlling the ground or the power feed circuit through the transistors or a device called an output driver module.

EPROM

The electronically erasable programmable read only memory (EPROM) is a permanent memory that is physically part of the ECM. The EPROM contains program and calibration information that the ECM needs in order to control the powertrain operation.

Special equipment, as well as the correct program and calibration for the vehicle, are required in order to reprogram the ECM.

Theft Deterrent System Frequency Code Programming

This vehicle is equipped with a theft deterrent system which interfaces with the ECM. If the ECM is replaced, program the new ECM with the frequency code of the theft deterrent module that is currently on the vehicle. The vehicle will not start until this procedure is completed.

KS Module

The ECM employs an internal integrated circuit to continuously monitor the knock control evaluation circuit. The knock sensor (KS) module contains the circuitry that allows the ECM to utilize the knock sensor (KS) signals and diagnose the KS sensors and circuitry. If the ECM detects a fault in the ability of the KS module to sample these signals, a DTC sets.

Data Link Connector (DLC)

The data link connector (DLC) is a 16-pin connector that provides the technician a means of accessing serial data for aid in the diagnosis. This connector allows the technician to use a scan tool in order to monitor the various serial data parameters, and display the DTC information. The DLC is located inside of the drivers compartment, underneath the dash.

Malfunction Indicator Lamp (MIL)

The malfunction indicator lamp (MIL) is inside of the instrument panel cluster (IPC). The MIL is controlled by the ECM and illuminates when the ECM detects a condition that affects the vehicle emissions.

ECM Service Precautions

The ECM, by design, can withstand the normal current draws that are associated with the vehicle operations. However, care must be used in order to avoid overloading any of these circuits. When testing for opens or shorts, do not ground or apply voltage to any of the ECM circuits unless the diagnostic procedure instructs you to do so. These circuits should only be tested with a DMM.

Emissions Diagnosis For State I/M Programs

This OBD II equipped vehicle is designed to diagnose any conditions that may lead to incorrect levels of the following emissions:

- Hydrocarbons (HC)
- Carbon monoxide (CO)
- Oxides of nitrogen (NOx)
- Evaporative emission (EVAP) system losses

Should this vehicles on-board diagnostic system (ECM) detect a condition that may result in incorrect emissions, the ECM turns ON the MIL and stores a DTC that is associated with the condition.

Aftermarket (Add-On) Electrical And Vacuum Equipment

Notice: Do not attach add-on vacuum operated equipment to this vehicle. The use of add-on vacuum equipment may result in damage to vehicle components or systems.

Notice: Connect any add-on electrically operated equipment to the vehicle's electrical system at the battery (power and ground) in order to prevent damage to the vehicle.

Aftermarket, add-on, electrical and vacuum equipment is defined as any equipment installed on a vehicle after leaving the factory that connects to the vehicles electrical or vacuum systems. No allowances have been made in the vehicle design for this type of equipment.

Add-on electrical equipment, even when installed to these strict guidelines, may still cause the power-train system to malfunction. This may also include equipment not connected to the vehicle electrical system, such as portable telephones and radios. Therefore, the first step in diagnosing any power-train condition is to make sure all of the after-market electrical equipment is removed or disconnected from the vehicle. After this is done, if the problem still exists, the problem may be diagnosed in the normal manner.

Electrostatic Discharge (ESD) Damage

Important: In order to prevent possible electrostatic discharge damage to the ECM, DO NOT touch the connector pins on the ECM.

The electronic components that are used in the control systems are often designed to carry very low voltage. The electronic components are susceptible to damage caused by electrostatic discharge. Less than 100 volts of static electricity can cause damage to some electronic components. By comparison, it takes as much as 4,000 volts for a person to even feel the zap of a static discharge.

There are several ways for a person to become statically charged. The most common methods of charging are by friction and by induction. An example of charging by friction is a person sliding across a car seat.

Charging by induction occurs when a person with well insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off leaving the person highly charged with the opposite polarity. Static charges can cause damage, therefore, it is important to use care when handling and testing electronic components.

Emissions Control Information Label

The underhood Vehicle Emissions Control Information Label contains important emission specifications and setting procedures. This identifies the year, the manufacturing division of the engine, the displacement of the engine in Litres, the class of the vehicle, and type of fuel metering system. There is also an illustrated emission components and vacuum hose schematic.

This label is located in the engine compartment.

Underhood Inspection

Important: This inspection is very important and must be done carefully and thoroughly.

Perform a careful underhood inspection when performing any diagnostic procedure or diagnosing the cause of an emission test failure. This can often lead to repairing a condition without further steps. Use the following guidelines when performing an inspection:

- Inspect all of the vacuum hoses for correct routing, pinches, cuts, or disconnects.
- Inspect any hoses that are difficult to see.
- Inspect all of the wires in the engine compartment for the following conditions:
  - Burned or chafed spots
  - Pinched wires
  - Contact with sharp edges
  - Contact with hot exhaust manifolds

Basic Knowledge Required

Notice: Lack of basic knowledge of this powertrain when performing diagnostic procedures could result in incorrect diagnostic performance or damage to powertrain components. Do not attempt to diagnose a powertrain problem without this basic knowledge.

A basic understanding of hand tools is necessary in order to effectively use this section of the Service Manual.

You must be familiar with some of the basics of engine operation and electrical diagnosis in order to use this section of the service manual.

- Basic electrical circuits--You should have an understanding of basic electricity and know the meaning of voltage (volts), current (amps), and resistance (ohms). You should understand what happens in a circuit with an open or a shorted wire, and you should be able to identify a shorted or open circuit by using a DMM. You should be able to read and understand a wiring diagram.
- Use of digital multimeter, You should be familiar with the DMM, particularly the essential tool . You should be able to use the meter in order to measure the voltage (volts), the resistance (ohms), the current (amps), intermittent (min/max), and frequency (Hertz).

- Use of circuit testing tools--You should not use a test lamp to diagnose the engine controls system unless you are specifically instructed to do so. You should know how to the use jumper wires in order to test the components and allow the DMM readings without damaging the terminals. You should know how to use the J 35616 connector test adapter kit and use the kit whenever the diagnostic procedures call for front probing any connector.

Evaporative Emission Control System Description

EVAP System Operation

The evaporative emission (EVAP) control system limits fuel vapors from escaping into the atmosphere. Fuel tank vapors are allowed to move from the fuel tank, due to pressure in the tank, through the vapor pipe, into the EVAP canister. Carbon in the canister absorbs and stores the fuel vapors. Excess pressure is vented through the vent line and EVAP vent valve to atmosphere. The EVAP canister stores the fuel vapors until the engine is able to use them. At an appropriate time, the control module will command the EVAP purge valve ON, open, allowing engine vacuum to be applied to the EVAP canister. With the EVAP vent valve OFF, open, fresh air will be drawn through the valve and vent line to the EVAP canister. Fresh air is drawn through the canister, pulling fuel vapors from the carbon. The air/fuel vapor mixture continues through the EVAP purge pipe and EVAP purge valve into the intake manifold to be consumed during normal combustion. The Control Module uses several tests to determine if the EVAP system is leaking.

Canister Vent Restriction Test

If the EVAP vent system is restricted, fuel vapors will not be properly purged from the EVAP canister. The Control Module tests this by commanding the EVAP purge valve ON, open; and commanding the EVAP vent valve OFF, open; and monitoring the FTP sensor for an increase in vacuum. If vacuum increases more than a calibrated value, DTC P0446 sets.

Purge Solenoid Leak Test

If the evaporative emission (EVAP) purge solenoid does not seal properly, fuel vapours may enter the engine at an undesired time, causing driveability concerns. The control module tests for this by commanding the EVAP purge solenoid OFF, closed; sealing the system, and monitoring the ECM for an increase in vacuum. If the control module detects that EVAP system vacuum increases above a calibrated value, DTC P0496 will set.

Check Gas Cap Message - If Equipped

The control module sends a serial data message to the driver information center (DIC) illuminating the Check Gas Cap message when a malfunction in the evaporative emission (EVAP) system and a large leak test fails.

EVAP System Components

The EVAP system consists of the following components:

EVAP Canister

The canister is filled with carbon pellets used to absorb and store fuel vapors. Fuel vapor is stored in the canister until the Control Module determines that the vapor can be consumed in the normal combustion process.

EVAP Purge Solenoid

The EVAP purge valve controls the flow of vapors from the EVAP system to the intake manifold. This normally closed valve is pulse width modulated (PWM) by the Control Module to precisely control the flow of fuel vapor to the engine. The valve will also be opened during some portions of the EVAP testing, allowing engine vacuum to enter the EVAP system.

Fuel System Description

System Overview

The fuel tank stores the fuel supply. An electric fuel pump, located in the fuel tank with the fuel sender assembly that pumps the fuel to the fuel rail assembly. The pump provides the fuel at a pressure greater than is needed by the injectors. The fuel pressure regulator, part of the fuel sender assembly, keeps the fuel available to the injectors at a regulated pressure. The fuel system is returnless.

Fuel Tank

The fuel storage tank is made of high density polyethylene. The fuel storage tank is held in place by 2 metal straps that are attached to the under body of the vehicle. The tank shape includes a sump in order to maintain a constant supply of fuel around the fuel pump strainer during low fuel conditions or during aggressive manoeuvres.

The fuel tank also contains a fuel vapor vent valve with a roll-over protection. The vent valve also features a 2-phase vent calibration which increases the fuel vapor flow to the canister when the operating temperatures increase the tank pressure beyond an established threshold.

On-Board ReFuelling Vapor Recovery (ORVR) System

The on-board refuelling vapour recovery (ORVR) system is an on-board vehicle system to recover fuel vapors during the vehicle reFuelling operation. The flow of liquid fuel down to the fuel tank filler neck provides a liquid seal. The purpose of ORVR is to prevent refuelling vapour from exiting the fuel tank filler neck. The ORVR components are listed below, with a brief description of their operation:

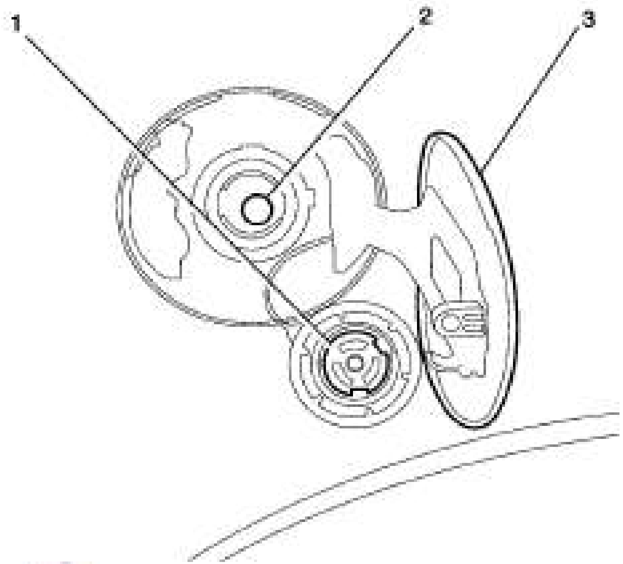
- The fuel tank--The fuel tank contains the modular fuel sender, the fuel limiter vent valve (FLVV), and 1 rollover valve.
- The fuel filler pipe--The fuel filler pipe carries fuel from the fuel nozzle to the fuel tank.
- The evaporative emission (EVAP) canister--The EVAP canister receives refuelling vapour from the fuel system, stores the vapour, and releases the vapour to the engine upon demand.
- The vapour lines--The vapor lines transport fuel viper from the tank assembly to the EVAP canister and engine.
- The check valve--The check valve limits fuel spit-back from the fuel tank during the refuelling operation by allowing fuel flow only into the fuel tank. The check valve is located at the bottom of the fuel filler pipe.
- The modular fuel sender assembly--The modular fuel sender assembly pumps fuel to the engine from the fuel tank.
- The fuel tank pressure (FTP) sensor is located on top of the fuel tank vapour dome.
- The FLVV--The FLVV acts as a shut-off valve. The FLVV is located in the fuel tank. This valve has the following functions:
  - Controlling the fuel tank fill level by closing the primary vent from the fuel tank
  - Preventing fuel from exiting the fuel tank via the vapour line to the canister

  - Providing fuel spillage protection in the event of a vehicle roll-over by closing the vapour path from the tank to the engine
- The pressure vacuum relief valve--The pressure vacuum relief valve provides venting of fuel tank pressure and vacuum. The valve is located in the fuel fill cap.
- The vapour re-circulation line--The vapour re-circulation line is used to transport vapour from the fuel tank to the top of the fill pipe during refuelling to reduce vapour loading to the enhanced EVAP canister.

Fuel Tank Filler Pipe

In order to prevent refuelling with leaded fuel, the fuel filler pipe has a built-in restrictor and a deflector. The opening in the restrictor will accept only the smaller unleaded gasoline fuel nozzle which must be fully inserted in order to bypass the deflector. The tank is vented during filling by an internal vent tube inside of the filler pipe.

Fuel Filler Cap



(1) Fuel Tank Filler Cap

(2) Fuel Tank Filler Pipe

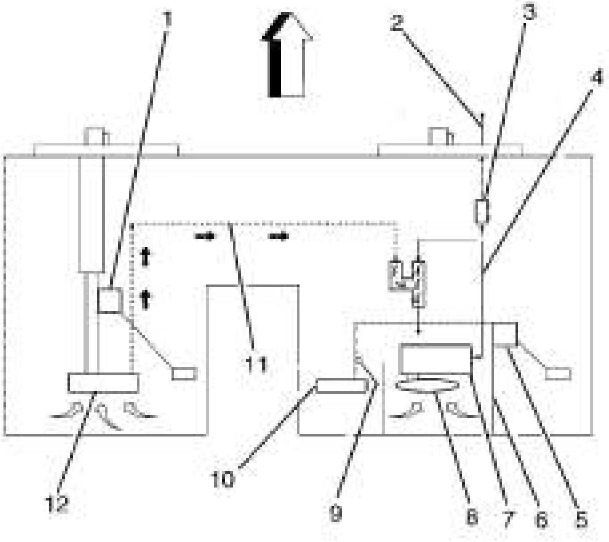
(3) Fuel Filler Door

Notice: If a fuel tank filler cap requires replacement, use only a fuel tank filler cap with the same features. Failure to use the correct fuel tank filler cap can result in a serious malfunction of the fuel and EVAP system.

The fuel tank filler pipe is equipped with a turn to vent screw on the type cap which incorporates a ratchet action in order to prevent over-tightening.

The turn to vent feature allows the fuel tank pressure relief prior to removal. Instructions for proper use are imprinted on the cap cover. A vacuum safety relief valve is incorporated into this cap.

Modular Fuel Sender



(1) Secondary Fuel Level Sensor - Left
(2) fuel feed line to Engine
(3) 2-Way Check Valve - Fuel Supply
(4) Siphon Jet Pump
(5) Primary Fuel Level Sensor - Right
(6) Fuel Reservoir/Bucket
(7) Fuel Pump
(8) Fuel Strainer/Pick up
(9) Return Fuel Check Valve for Reservoir
(10) Return Fuel Jet Pump
(11) Fuel Transfer Line
(12) Fuel Strainer/Pickup

The modular fuel sender assembly mounts to the threaded opening of the plastic fuel tank with a seal and a retainer ring. The reservoir, containing the exterior inlet strainer, the electric fuel pump and the pump strainer, maintains contact with the tank bottom. This design provides:

- Optimum fuel level in the integral fuel reservoir during all fuel tank levels and during driving conditions
- An accurate tank fuel level measuring accuracy
- An proper coarse straining and added pump inlet filtering
- More extensive internal fuel pump isolation for noiseless operation

The modular fuel sender assembly maintains an optimum fuel level in the reservoir (bucket). The fuel entering the reservoir is drawn in by the following components:

- The first stage of the fuel pump through the external strainer
  and/or
- The secondary umbrella valve
  or
- The return fuel line, whenever the level of fuel is below the top of the reservoir

Fuel Pump

The electric fuel pump is a turbine pump which is located inside of the modular fuel sender. The electric fuel pump operation is controlled by the engine control module (ECM) through the fuel pump relay.

Fuel Pressure Regulator Assembly

The fuel pressure regulator is a diaphragm-operated relief valve located in the modular fuel pump and sender assembly. Its principal function is to maintain a controlled pressure at the injectors at all times by regulating fuel flow into the fuel feed line. With the ignition ON and the engine OFF, system fuel pressure at the pressure test connection should be 380-440 kPa (55-64 psi).

Fuel Sender Strainers

The strainers act as a coarse filter to perform the following functions:

- Filter contaminants
- Separate water from fuel
- Provide a wicking action that helps draw fuel into the fuel pump

Fuel stoppage at the strainer indicates that the fuel tank contains an abnormal amount of sediment or water. Therefore, the fuel tank will need to be removed and cleaned, and the filter strainer should be replaced.

Fuel Filter Assembly

The fuel filter assembly is contained within the modular fuel pump and sender assembly reservoir and forms the containment housing for the fuel pump. The filter comprises a paper element which traps particles in the fuel that may damage the fuel injection system. The fuel filter is made to withstand maximum fuel system pressure, changes in temperature and exposure to fuel additives.

Fuel Level Sender Assemblies

The fuel level sender assembly comprises of two fuel level float and wire arm assemblies, a ceramic variable resistor card assembly , and a detachable nylon wiper. The ceramic resistor card is attached to a plastic card holder which attaches to the reservoir. A metal contact fork with brushes is connected to the detachable nylon wiper. This assembly provides a variable circuit resistance to the engine control module (ECM) depending on wiper contact position. Two circuit wires run from the resistor card and extend up to connect with the modular fuel pump to cover assembly wiring connector on the underside of the modular fuel pump and sender assembly cover. The ECM averages out any slosh variation in the fuel tank and sends this signal to the fuel level indicator on the instrument panel fuel gauge.

Quick-Connect Fittings

Quick-connect fittings provide a simplified means of installing and connecting fuel system components. The fittings consist of a unique female connector and a compatible male pipe end. "O" rings, located inside the female connector, provide the fuel seal. Integral locking tabs or fingers hold the fittings together.

Fuel Pipe O-Rings

"O" rings seal the threaded connections in the fuel system. The fuel system "O" ring seals are made of a special material. The fuel pipe "O" rings are not a serviceable item.

EVAP Pipes and Hoses

The evaporative emission (EVAP) tubes extend from the fuel tank module and the EVAP canister vent to the EVAP canister. These tubes are located on the top rear of the fuel tank. The EVAP purge tube/pipe extends from the EVAP canister on top of the fuel tank to the EVAP purge solenoid in the engine compartment. The chassis EVAP purge pipe is constructed of steel.

Fuel Rail

The fuel rail consists of 3 parts:

- The pipe that carries fuel to each injector
- The fuel pressure test port
- Six individual fuel injectors

The fuel rail is mounted on the intake manifold and distributes the fuel to each cylinder through the individual injectors.

Fuel Injectors

The fuel injector is a solenoid device that is controlled by the ECM. When the ECM energizes the injector coil, a normally closed ball valve opens, allowing the fuel to flow past a director plate to the injector outlet. The director plate has holes that control the fuel flow, generating a dual conical spray pattern of finely atomized fuel at the injector outlet. The fuel from the outlet is directed at both of the intake valves, causing the fuel to become further vaporized before entering the combustion chamber.

The fuel injectors will cause various driveability conditions if the following conditions occur:

- If the injectors will not open
- If the injectors are stuck open
- If the injectors are leaking
- If the injectors have a low coil resistance

Fuel Pump Electrical Circuit

When the ignition switch is in the ON position, before engaging the starter, the engine control module (ECM) energizes the fuel pump relay for two seconds, causing the fuel pump to pressurize the fuel system. If the ECM does not receive ignition reference pulses with the engine cranking or running within two seconds, the ECM shuts OFF the fuel pump relay, causing the fuel pump to stop.

Engine Fuelling

The engine is fuelled by six individual injectors, one for each cylinder, that are controlled by the ECM. The ECM controls each injector by energizing the injector coil for a brief period once every other engine revolution. The length of this brief period, or pulse, is carefully calculated by the ECM to deliver the correct amount of fuel for proper driveability and emissions control. The period of time when the injector is energized is called the pulse width and is measured in milliseconds, thousandths of a second.

While the engine is running, the ECM is constantly monitoring the inputs and recalculating the appropriate pulse width for each injector. The pulse width calculation is based on the injector flow rate, mass of fuel the energized injector will pass per unit of time, the desired air/fuel ratio, and actual air mass in each cylinder and is adjusted for battery voltage, short term, and long term fuel trim. The calculated pulse is timed to occur as each cylinders intake valves are closing to attain largest duration and most vaporization.

Fuelling during a crank is slightly different than fuelling during an engine run. As the engine begins to turn, a prime pulse may be injected to speed starting. As soon as the ECM can determine where in the firing order the engine is, the ECM begins pulsing the injectors. The pulse width during the crank is based on the coolant temperature and the engine load.

The Fuelling system has several automatic adjustments in order to compensate for the differences in the fuel system hardware, the driving conditions, the fuel used, and the vehicle aging. The basis for the fuel control is the pulse width calculation that is described above. Included in this calculation are an adjustment for the battery voltage, the short term fuel trim, and the long term fuel trim. The battery voltage adjustment is necessary since the changes in the voltage across the injector affect the injector flow rate. The short term and the long term fuel trims are fine and gross adjustments to the pulse width that are designed in order to maximize the driveability and emissions control. These fuel trims are based on the feedback from the oxygen sensors in the exhaust stream and are only used when the fuel control system is in a Closed Loop operation.

Under certain conditions, the Fuelling system will turn OFF the injectors for a period of time. This is referred to as fuel shut-off. Fuel shut-off is used in order to improve traction, save fuel, improve emissions, and protect the vehicle under certain extreme or abusive conditions.

In case of a major internal failure, the ECM may be able to use a back-up fuel strategy for limp in mode that will run the engine until service can be performed.

Sequential Fuel Injection (SFI)

The ECM controls the fuel injectors based on information that the ECM receives from several information sensors. Each injector is fired individually in the engine firing order, which is called sequential fuel injection. This allows precise fuel metering to each cylinder and improves the driveability under all of the driving conditions.

The ECM has several operating modes for fuel control, depending on the information that has been received from the sensors.

Starting Mode

With the ignition ON, before engaging the starter, the engine control module (ECM) energizes the fuel pump relay for two seconds allowing the fuel pump to build up pressure. The ECM first checks speed density, then switches to the mass air flow (MAF) sensor. The ECM also uses the engine coolant temperature (ECT), throttle position (TP), and manifold absolute pressure (MAP) sensors to determine the proper air/fuel ratio for starting. The ECM controls the amount of fuel delivered in the starting mode by changing the pulse width of the injectors. This is done by pulsing the injectors for very short times.

Clear Flood Mode

If the engine is flooded with fuel during starting and will not start, the Clear Flood Mode can be manually selected. To select Clear Flood Mode, push the accelerator to wide open throttle (WOT). With this signal, the ECM will completely turn OFF the injectors and will maintain this stage as long as the ECM indicates a WOT condition with engine speed below 1,000 RPM.

Run Mode

The Run Mode has 2 conditions: Open Loop operation and Closed Loop operation. When the engine is first started and the engine speed is above 480 RPM, the system goes into Open Loop operation. In Open Loop operation, the ECM ignores the signals from the oxygen sensors and calculates the required injector pulse width based primarily on inputs from the MAF, IAT and ECT sensors.

In Closed Loop, the ECM adjusts the calculated injector pulse width for each bank of injectors based on the signals from each oxygen sensor.

Acceleration Mode

The ECM monitors the changes in the TP and the MAF sensor signals in order to determine when the vehicle is being accelerated. The ECM will then increase the injector pulse width in order to provide more fuel for enhanced performance.

Deceleration Mode

The ECM monitors changes in TP and MAF sensor signals to determine when the vehicle is being decelerated. The ECM will then decrease injector pulse width or even shut OFF injectors for short periods to reduce exhaust emissions, and for better (engine braking) deceleration.

Battery Voltage Correction Mode

The ECM can compensate in order to maintain acceptable vehicle driveability when the ECM sees a low battery voltage condition. The ECM compensates by performing the following functions:

- Increasing the injector pulse width in order to maintain the proper amount of fuel being delivered
- Increasing the idle speed to increase the generator output

Fuel Cutoff Mode

The engine control module (ECM) cuts OFF fuel from the fuel injectors when the following conditions are met in order to protect the powertrain from damage and improve driveability:

- The ignition is OFF. This prevents engine run-on.
- The ignition is ON, but there is no ignition reference signal. This prevents flooding or backfiring.
- The engine speed is too high, above the red line.
- The vehicle speed is too high, above rated tire speed.
- During an extended, high speed, closed throttle coast down, this reduces emissions and increases engine braking.
- During extended deceleration, in order to prevent damage to the catalytic converters.
- The torque management enabled--Transmission shifts or abusive maneuvers.
- The traction control enabled--In conjunction with the front brakes applying

Fuel Trim

The engine control module (ECM) controls the air/fuel metering system in order to provide the best possible combination of driveability, fuel economy and emission control. The ECM monitors the heated oxygen sensor (HO2S) signal voltage while in Closed Loop and regulates the fuel delivery by adjusting the pulse width of the fuel injectors based on this signal. The ideal fuel trim values are around 0 percent for both short term and long term fuel trim. A positive fuel trim value indicates the ECM is adding fuel in order to compensate for a lean condition by increasing the pulse width. A negative fuel trim value indicates that the ECM is reducing the amount of fuel in order to compensate for a rich condition by decreasing the pulse width. A change made to the fuel delivery changes the short term and long term fuel trim values. The short term fuel trim values change rapidly in response to the HO2S signal voltage. These changes fine tune the engine fuelling. The long term fuel trim makes coarse adjustments to the fuelling in order to re-centre and restore control to short term fuel trim. A scan tool can be used to monitor the short term and long term fuel trim values. The long term fuel trim diagnostic is based on an average of several of the long term speed load learn cells. The ECM selects the cells based on the engine speed and engine load. If the ECM detects an lean or rich condition, the ECM will set a fuel trim DTC.

Fuel System Description (With LLT)

Fuel System Overview

The fuel tank stores the fuel supply. The fuel pump module, located in the fuel tank, supplies fuel through the fuel feed pipe to the high pressure fuel pump. The high pressure fuel pump supplies fuel to a variable-pressure fuel rail. Fuel enters the combustion chamber through precision multi-hole fuel injectors. The high pressure fuel pump, fuel rail pressure, fuel injection timing, and injection duration are controlled by the engine control module (ECM).

Fuel Tank

The fuel storage tank is made of high density polyethylene. The fuel storage tank is held in place by 2 metal straps that are attached to the under body of the vehicle. The tank shape includes a sump in order to maintain a constant supply of fuel around the fuel pump strainer during low fuel conditions or during aggressive maneuvers.

The fuel tank also contains a fuel vapor vent valve with a roll-over protection. The vent valve also features a 2-phase vent calibration which increases the fuel vapor flow to the canister when the operating temperatures increase the tank pressure beyond an established threshold.

On-Board Refueling Vapor Recovery (ORVR) System

The on-board refueling vapor recovery (ORVR) system is an on-board vehicle system to recover fuel vapors during the vehicle refueling operation. The flow of liquid fuel down to the fuel tank filler neck provides a liquid seal. The purpose of ORVR is to prevent refueling vapor from exiting the fuel tank filler neck. The ORVR components are listed below, with a brief description of their operation:

- The fuel tank--The fuel tank contains the modular fuel sender, the fuel limiter vent valve (FLVV), and 1 rollover valve.
- The fuel filler pipe--The fuel filler pipe carries fuel from the fuel nozzle to the fuel tank.
- The evaporative emission (EVAP) canister--The EVAP canister receives refueling vapor from the fuel system, stores the vapor, and releases the vapor to the engine upon demand.
- The vapor lines--The vapor lines transport fuel vapor from the tank assembly to the EVAP canister and engine.
- The check valve--The check valve limits fuel spit-back from the fuel tank during the refueling operation by allowing fuel flow only into the fuel tank. The check valve is located at the bottom of the fuel filler pipe.
- The modular fuel sender assembly--The modular fuel sender assembly pumps fuel to the engine from the fuel tank.
- The fuel tank pressure (FTP) sensor is located on top of the fuel tank vapor dome.
- The FLVV--The FLVV acts as a shut-off valve. The FLVV is located in the fuel tank. This valve has the following functions:
  - Controlling the fuel tank fill level by closing the primary vent from the fuel tank
  - Preventing fuel from exiting the fuel tank via the vapor line to the canister
  - Providing fuel spillage protection in the event of a vehicle rollover by closing the vapor path

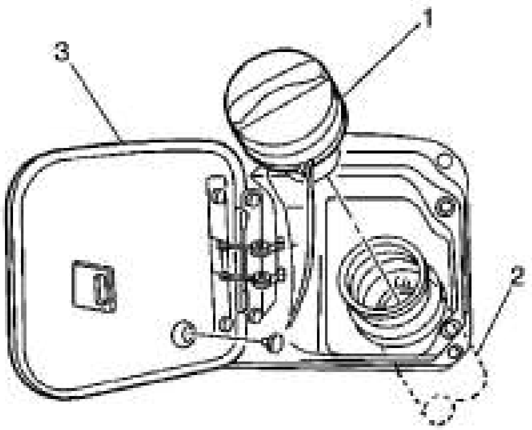
from the tank to the engine

- The pressure vacuum relief valve--The pressure vacuum relief valve provides venting of excessive fuel tank pressure and vacuum. The valve is located in the fuel fill cap.
- The vapor recirculation line--The vapor recirculation line is used to transport vapor from the fuel tank to the top of the fill pipe during refueling to reduce vapor loading to the enhanced EVAP canister.

Fuel Tank Filler Pipe

In order to prevent refueling with leaded fuel, the fuel filler pipe has a built-in restrictor and a deflector. The opening in the restrictor will accept only the smaller unleaded gasoline fuel nozzle which must be fully inserted in order to bypass the deflector. The tank is vented during filling by an internal vent tube inside of the filler pipe.

Fuel Filler Cap



(1) Fuel Tank Filler Cap
(2) Fuel Tank Filler Pipe
(3) Fuel Filler Door

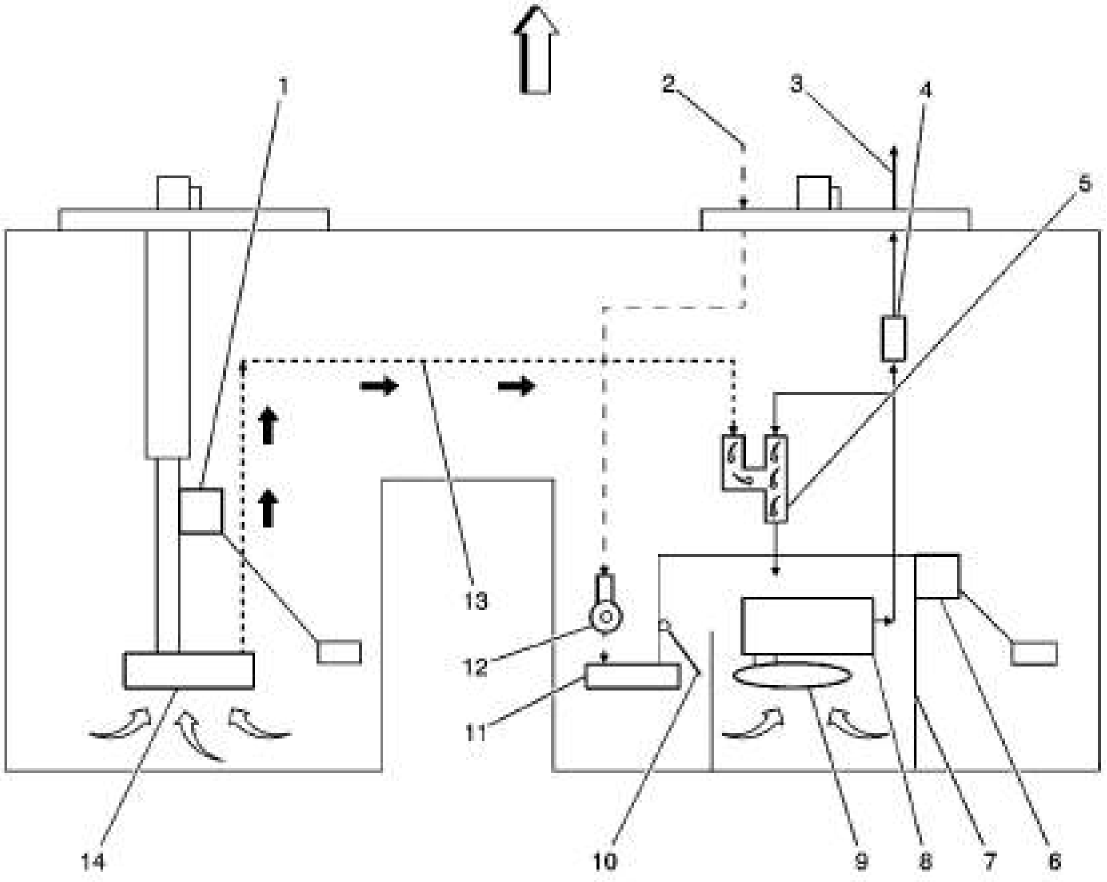
Caution: Use a fuel tank filler pipe cap with the same features as the original when a replacement is necessary. Failure to use the correct fuel tank filler pipe cap can result in a serious malfunction of the fuel system.

The fuel tank filler pipe is equipped with a turn to vent screw on the type cap which incorporates a ratchet action in order to prevent over-tightening.

The turn to vent feature allows the fuel tank pressure relief prior to removal. Instructions for proper use are imprinted on the cap cover. A vacuum safety relief valve is incorporated into this cap.

Modular Fuel Sender

Fuel System Diagram



(1) Secondary Fuel Level Sensor - Left
(2) Fuel Return Pipe from Engine
(3) Fuel Feed Pipe to Engine
(4) 2-Way Check Valve - Fuel Supply
(5) Siphon Jet Pump
(6) Primary Fuel Level Sensor - Right
(7) Fuel Reservoir/Bucket
(8) Fuel Pump
(9) Fuel Strainer/Pick up
(10) Return Fuel Check Valve for Reservoir
(11) Return Fuel Jet Pump
(12) Fuel Pressure Regulator

(13) Fuel Transfer Line
(14) Fuel Strainer/Pickup

The modular fuel sender assembly mounts to the threaded opening of the plastic fuel tank with a seal and a retainer ring. The reservoir, containing the exterior inlet strainer, the electric fuel pump and the pump strainer, maintains contact with the tank bottom. This design provides:

- Optimum fuel level in the integral fuel reservoir during all fuel tank levels and during driving conditions
- An improved tank fuel level measuring accuracy
- An improved coarse straining and added pump inlet filtering
- More extensive internal fuel pump isolation for noiseless operation

The modular fuel sender assembly maintains an optimum fuel level in the reservoir (bucket). The fuel entering the reservoir is drawn in by the following components:

- The first stage of the fuel pump through the external strainer

  and/or
- The secondary umbrella valve

  or
- The return fuel line, whenever the level of fuel is below the top of the reservoir

Fuel Pump

The electric fuel pump is a turbine pump which is located inside of the modular fuel sender. The electric fuel pump operation is controlled by the engine control module (ECM) through the fuel pump relay.

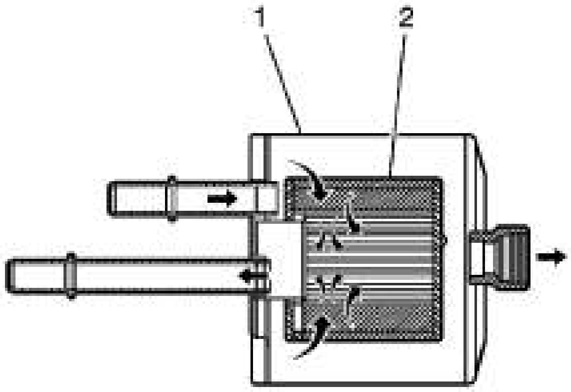
Fuel Sender Strainers

The strainers act as a coarse filter to perform the following functions:

- Filter contaminants
- Separate water from fuel
- Provide a wicking action that helps draw fuel into the fuel pump

Fuel stoppage at the strainer indicates that the fuel tank contains an abnormal amount of sediment or water. Therefore, the fuel tank will need to be removed and cleaned, and the filter strainer should be replaced.

In-Line Fuel Filter

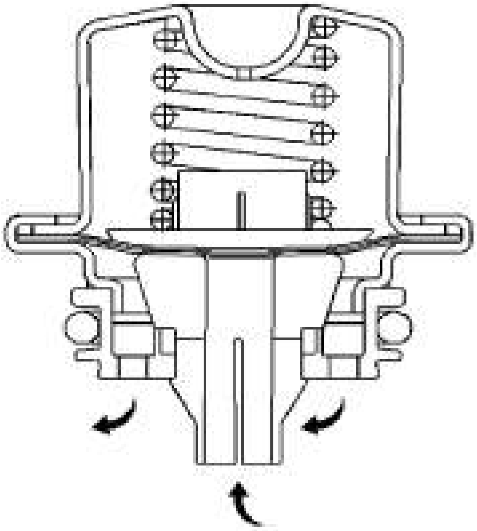


The fuel filter is located on the fuel feed pipe, between the fuel pump and the fuel rail. The electric fuel pump supplies fuel through the in-line fuel filter to the fuel injection system. The fuel pressure regulator keeps the fuel available to the fuel injectors at a regulated pressure. Unused fuel is returned from the fuel filter to the fuel tank by a separate fuel return pipe. The paper filter element (2) traps particles in the fuel that may damage the fuel injection system. The filter housing (1) is made to withstand maximum fuel system pressure, exposure to fuel additives, and changes in temperature. There is no service interval for fuel filter replacement. Replace a restricted fuel filter.

EVAP Lines and Hoses

The EVAP line extends from the fuel tank vent valve to the EVAP canister and into the engine compartment. The EVAP line is made of nylon and connects to the EVAP canister with a quick connect fitting.

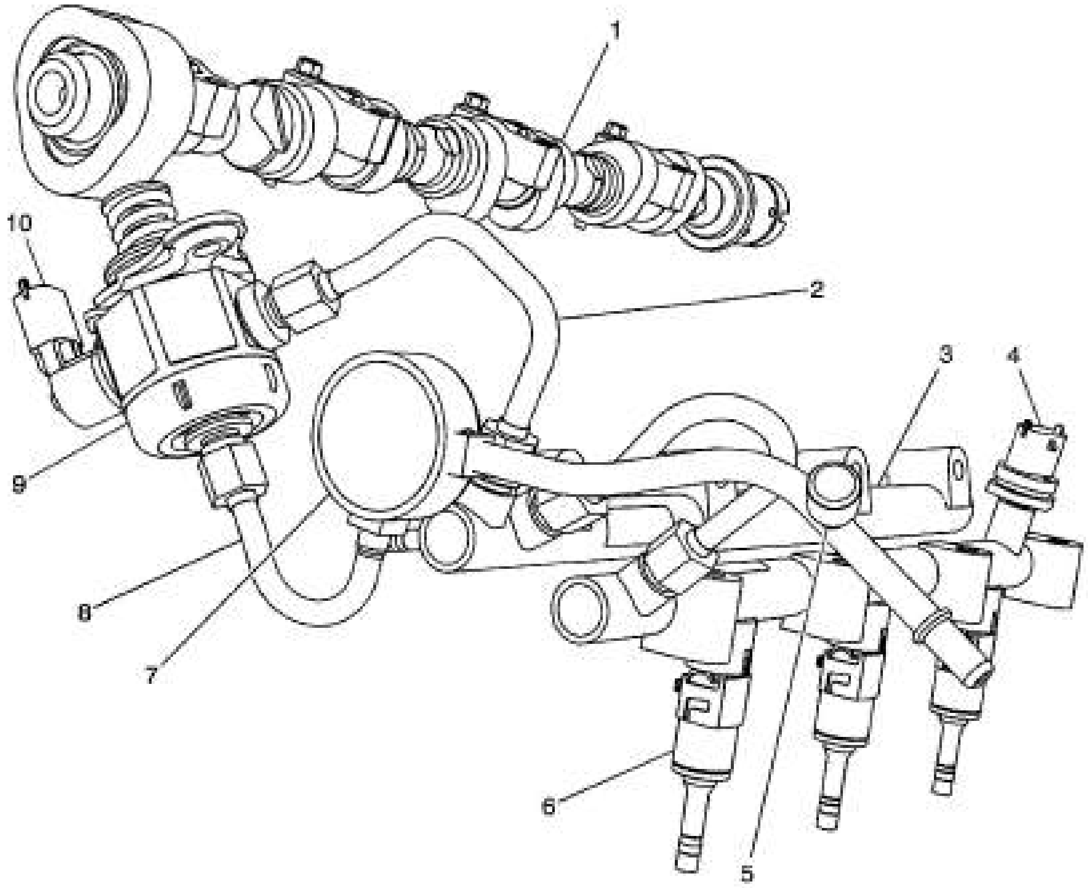
Fuel Pressure Regulator



The fuel pressure regulator attaches to the fuel return pipe on the fuel sender assembly. The fuel pressure regulator is a diaphragm-operated relief valve. A software bias compensates the injector on-time because the fuel pressure regulator is not referenced to manifold vacuum. The injector pulse width varies with the signal from the mass air flow (MAF)/intake air temperature (IAT) sensor.

With the engine running at idle, the system fuel pressure at the pressure test connection should be between 380-410 kPa (55-60 psi). With the system pressurized and the pump OFF the pressure should stabilize and hold. If the pressure regulator supplies a fuel pressure which is too low or too high, a driveability condition will result.

High Pressure Fuel Pump



The high pressure fuel pump (9) is a mechanical one cylinder design driven by an eccentric on the exhaust camshaft (1) of bank 2. High pressure fuel is regulated by the fuel rail pressure (FRP) regulator, which is a part of the high pressure fuel pump. The FRP regulator is a magnetic actuator which controls the inlet valve of the high pressure pump. The ECM provides battery voltage on the actuator high circuit and ground on the actuator low reference circuit. Both circuits are controlled by the ECM. When the ECM deactivates the FRP regulator, both circuits are disabled and the inlet valve is held open with spring pressure. When the ECM activates the FRP regualtor, the low circuit driver connects the low reference circuit to ground and the high circuit driver pulse-width modulates (PWM) the high circuit. The ECM uses the camshaft and crankshaft position sensor inputs to synchronize the FRP regulator with the position of the eccentric on the camshaft. The ECM regulates fuel pressure by adjusting the portion of each pump stroke that provides fuel to the rail. The high pressure fuel pump also contains an integrated pressure relief valve.

Fuel Rail Assembly

The fuel rail assembly (3) attaches to each cylinder head. The fuel rail distributes high pressure fuel to the fuel injectors. The fuel rail assembly consists of the following components:

- Six fuel injectors

- A fuel rail pressure (FRP) sensor

Fuel Injectors

The fuel injection system is a high pressure, direct injection, returnless on-demand design. The fuel injectors (6) are mounted in the cylinder head beneath the intake ports and spray fuel directly into the combustion chamber. Direct injection requires high fuel pressure due to the fuel injector's location in the combustion chamber. Fuel pressure must be higher than compression pressure requiring a high pressure fuel pump. The fuel injectors also require more electrical power due to the high fuel pressure. The ECM supplies a separate high voltage supply circuit and a driver circuit for each fuel injector.

The fuel injector assembly is an inside opening electrical magnetic injector. The injector has six precision machined holes that generate a cone shaped oval spray pattern. The fuel injector has a slim extended tip in order to allow a sufficient cooling jacket in the cylinder head.

The fuel injectors will cause various driveability conditions if the following conditions occur:

- If the injectors will not open
- If the injectors are stuck open
- If the injectors are leaking
- If the injectors have a low coil resistance

Fuel Rail Fuel Pressure Sensor

The fuel rail pressure sensor (4) detects fuel pressure within the fuel rail. The engine control module (ECM) provides a 5 volt reference voltage on the 5 volt reference circuit and ground on the low reference circuit. The ECM receives a varying signal voltage on the signal circuit. The ECM monitors the voltage on the FRP sensor circuits. When the fuel pressure is high, the signal voltage is high. When the fuel pressure is low, the signal voltage is low.

Fuel Pump Relay

The fuel pump relay allows the ECM to energize the fuel pump. The ECM supplies B+ to the fuel pump relay which enables the fuel pump whenever the crankshaft position (CKP) sensor pulses are detected.

Engine Fueling

The engine is fueled by six individual injectors, one for each cylinder, that are controlled by the ECM. The ECM controls each injector by energizing the injector coil for a brief period once every other engine revolution. The length of this brief period, or pulse, is carefully calculated by the ECM to deliver the correct amount of fuel for proper driveability and emissions control. The period of time when the injector is energized is called the pulse width and is measured in milliseconds, thousandths of a second.

While the engine is running, the ECM is constantly monitoring the inputs and recalculating the appropriate pulse width for each injector. The pulse width calculation is based on the injector flow rate, mass of fuel the energized injector will pass per unit of time, the desired air/fuel ratio, and actual air mass in each cylinder and is adjusted for battery voltage, short term, and long term fuel trim. The calculated pulse is timed to occur as each cylinders intake valves are closing to attain largest duration and most vaporization.

Fueling during a crank is slightly different than fueling during an engine run. As the engine begins to turn, a prime pulse may be injected to speed starting. As soon as the ECM can determine where in the firing order the engine is, the ECM begins pulsing the injectors. The pulse width during the crank is based on the coolant temperature and the engine load.

The fueling system has several automatic adjustments in order to compensate for the differences in the fuel system hardware, the driving conditions, the fuel used, and the engine aging. The basis for the fuel control is the pulse width calculation that is described above. Included in this calculation are an adjustment for the battery voltage, the short term fuel trim, and the long term fuel trim. The battery voltage adjustment is necessary since the changes in the voltage across the injector affect the injector flow rate. The short term and the long term fuel trims are fine and coarse adjustments to the pulse width that are designed in order to maximize the driveability and emissions control. These fuel trims are based on the feedback from the oxygen sensors in the exhaust stream and are only used when the fuel control system is in a Closed Loop operation.

Under certain conditions, the fueling system will turn OFF the injectors for a period of time. This is referred to as fuel shut-off. Fuel shut-off is used in order to improve traction, save fuel, improve emissions, and protect the vehicle under certain extreme or abusive conditions.

In case of a major internal problem, the ECM may be able to use a back-up fuel strategy for limp in mode that will run the engine until service can be performed.

Sequential Fuel Injection (SFI)

The ECM controls the fuel injectors based on information that the ECM receives from several information sensors. Each injector is fired individually in the engine firing order, which is called sequential fuel injection. This allows precise fuel metering to each cylinder and improves the driveability under all of the driving conditions.

The ECM has several operating modes for fuel control, depending on the information that has been received from the sensors.

Starting Mode

When the ECM detects reference pulses from the CKP sensor, the ECM will enable the fuel pump. The fuel pump runs and builds up pressure in the fuel system. The ECM then monitors the MAF, IAT, engine coolant temperature (ECT), and the throttle position (TP) sensor signal in order to determine the required injector pulse width for starting.

Clear Flood Mode

If the engine is flooded with fuel during starting and will not start, the Clear Flood Mode can be manually selected. To select Clear Flood Mode, push the accelerator to wide open throttle (WOT). With this signal, the ECM will completely turn OFF the injectors and will maintain this stage as long as the ECM indicates a WOT condition with engine speed below 1,000 RPM.

Run Mode

The Run Mode has 2 conditions: Open Loop operation and Closed Loop operation. When the engine is first started and the engine speed is above 480 RPM, the system goes into Open Loop operation. In Open Loop operation, the ECM ignores the signals from the oxygen sensors and calculates the required injector pulse width based primarily on inputs from the MAF, IAT and ECT sensors.

In Closed Loop, the ECM adjusts the calculated injector pulse width for each bank of injectors based on the signals from each oxygen sensor.

Acceleration Mode

The ECM monitors the changes in the TP and the MAF sensor signals in order to determine when the vehicle is being accelerated. The ECM will then increase the injector pulse width in order to provide more fuel for improved performance.

Deceleration Mode

The ECM monitors changes in TP and MAF sensor signals to determine when the vehicle is being decelerated. The ECM will then decrease injector pulse width or even shut OFF injectors for short periods to reduce exhaust emissions, and for better (engine braking) deceleration.

Battery Voltage Correction Mode

The ECM can compensate in order to maintain acceptable vehicle driveability when the ECM sees a low battery voltage condition. The ECM compensates by performing the following functions:

- Increasing the injector pulse width in order to maintain the proper amount of fuel being delivered
- Increasing the idle speed to increase the generator output

Fuel Shut-Off Mode

The ECM has the ability to completely turn OFF all of the injectors or selectively turn OFF some of the injectors when certain conditions are met. These fuel shut-off modes allow the ECM to protect the engine from damage and also to improve the vehicles driveability.

The ECM will disable all of the six injectors under the following conditions:

- Ignition OFF--Prevents engine run-on
- Ignition ON but no CKP signal--Prevents flooding or backfiring
- A high engine speed--Above the red line
- A high vehicle speed--Above the rated tire speed
- Closed throttle cast down--Reduces the emissions and increases engine braking.

The ECM will selectively disable the injectors under the following conditions:

- The torque management enabled--Transmission shifts or abusive maneuvers.
- The traction control enabled--In conjunction with the front brakes applying

Knock Sensor (KS) System Description

The knock sensor (KS) system detects engine knocking or pinging. The ECM will retard the spark timing based on the signals from the KS system. The KS produce an AC voltage that is sent to the engine Control Module (ECM). The amount of the AC voltage produced is proportional to the amount of knock.

The ECM monitors the voltage of the sensors after each cylinder has fired.

If knock occurs in any of the cylinders, the ignition will be retarded for that particular cylinder. If the knocking then stops, the ignition will be restored to what it was before in steps.

Should knocking continue in the same cylinder in spite of the ignition being retarded, the ECM will retard the ignition an additional steps, and so on, up to a maximum of 12 degrees of retard. The ignition will also be retarded at high ambient temperatures in order to counteract knocking tendencies provoked by high intake air temperatures.

Should either bank 1 or bank 2 sensor fail to work, or should an internal circuit failure occur, the ignition timing will then use a default strategy. The default strategy will retard the ignition the maximum allowed amount to protect the engine from possible damage.

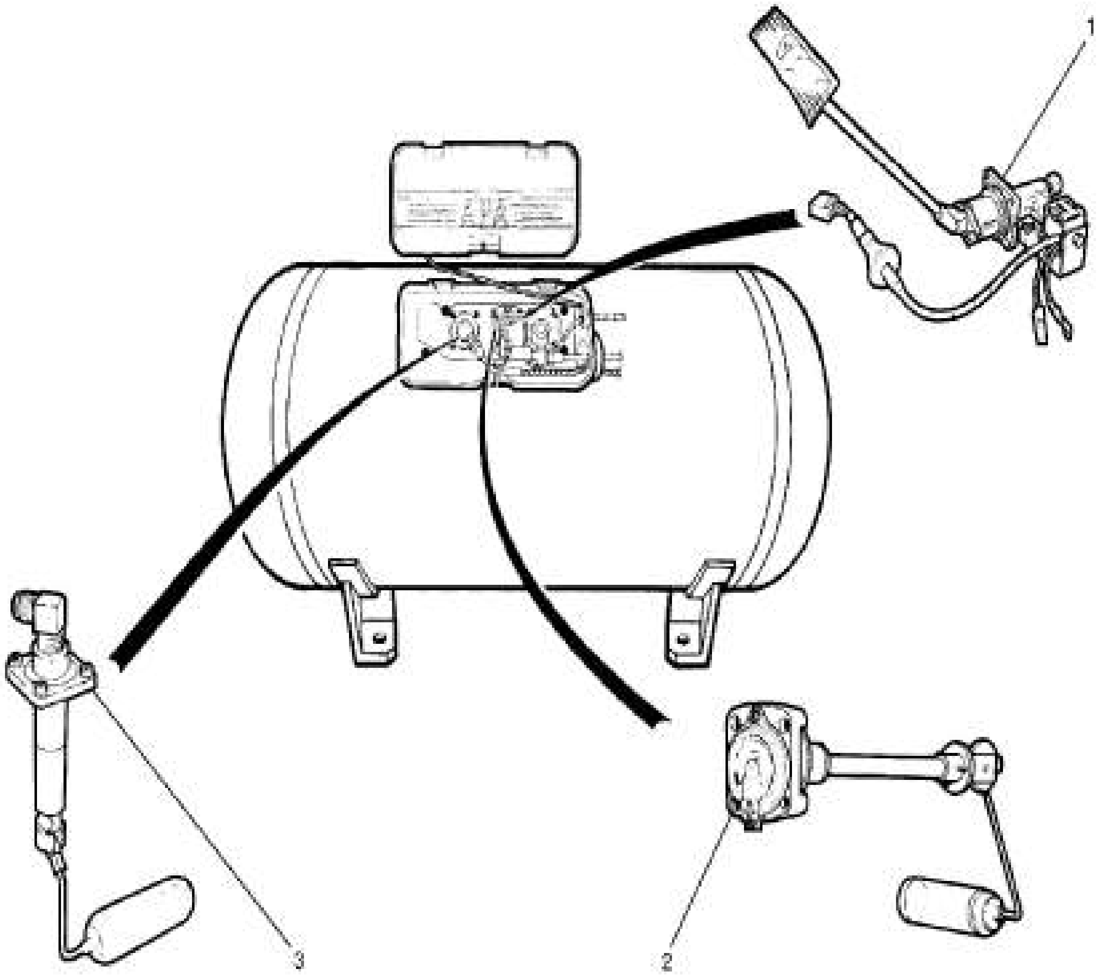
Liquefied Petroleum Gas System Description and Operation

The LPG system works with the petrol system to make a dual fuel vehicle. The LPG system comprises of an LPG tank located in the boot, an LPG filler located in the petrol filler compartment, two LPG lock-off's one is located on the LPG tank and the other underneath the driver, an LPG convertor located behind the left front wheelhouse liner, an LPG control module located behind the right front wheelhouse liner, six LPG injectors located on top of the engine, an LPG switch/gauge located in the floor console in the cigarette lighter compartment, LPG diagnostic connector and fuses located on the left of the radiator.

The fuel selector switch has two positions and a fuel indicator lamp, which changes colour to indicate which fuel mode the vehicle is currently on. Red indicates petrol, amber indicates currently transferring to selected fuel and green is LPG operation. When LPG is selected the engine will start and run on petrol until the required conditions are reached, at which time the system will automatically transfer to LPG operation. When operating on LPG, during certain higher RPM and load conditions, the system will electronically switch to petrol.

LPG Tank

LPG Tank Components



(1) Rear Lock-Off/Service Solenoid Valve Assembly and Excess Flow Valve
(2) Tank Fuel Gauge Assembly
(3) Automatic Fill Limiter (AFL)

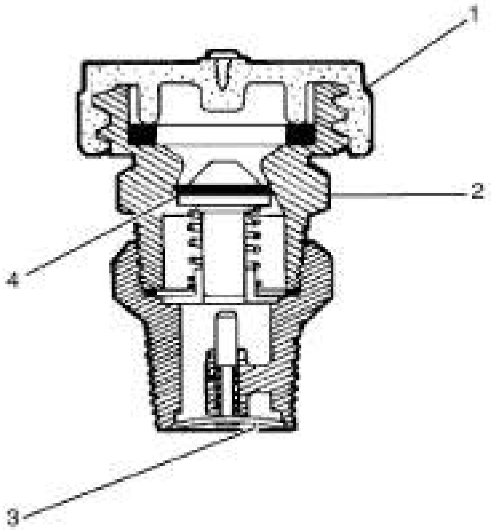
The LPG Tank is made of carbon steel and is manufactured to stringent safety standards. LPG must be stored at approximately 750 kPa at 20°C to remain a liquid. The vapour pressure inside the LPG tank will vary with ambient temperature - as the ambient temperature rises, so does the vapour pressure. The LPG tank is heat treated during manufacture and MUST NOT be heated or welded in any way.

The LPG tank is fitted in the rear compartment, under the rear parcel shelf. The LPG tank incorporates a gas-tight compartment (valve box) which is vented to atmosphere via a vent hose and contains the following components:

- Pressure relief valve.
- Rear lock-off/service solenoid valve assembly and excess flow valve.
- Tank fuel gauge assembly, and Automatic fill limiter (AFL).

These components are either attached into or onto the LPG tank. As the LPG tank is located in the luggage compartment, if any of these components were to leak, or there was an excess pressure discharge, the LPG would be vented to atmosphere via the vent hose and will not vent into the vehicle.

Filler Valve



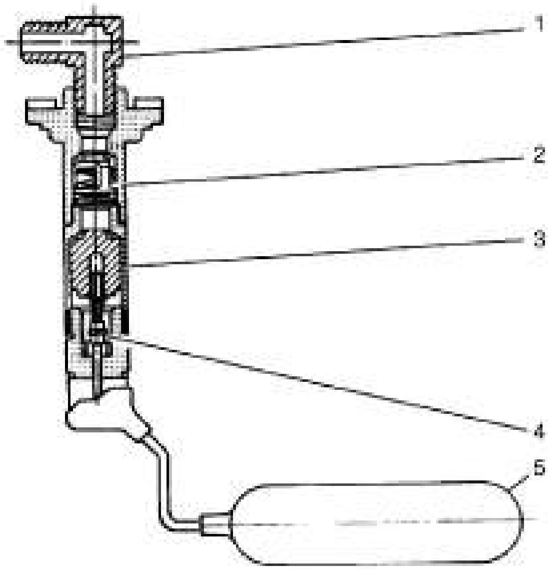
The filler valve is located in the fuel filler pocket, adjacent to the petrol filler.

The valve incorporates two spring-loaded non-return valves (3 & 4) and a sealed cap (1) fitted to the filling connection (2).

The connection is designed to shear off in the event of the vehicle being driven away with the filler hose inadvertently attached. In this situation, the lower valve remains intact, avoiding the LPG discharging.

The filler valve is connected to the LPG tank AFL inlet elbow by a filler line, which is routed through the LPG tank vent hose.

Automatic Fill Limiter



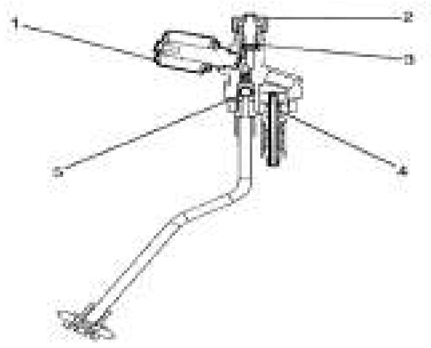
The Automatic Fill Limiter (AFL) is fitted into the LPG tank. The inlet elbow (1) connects the to the LPG filler line.

When the tank is being filled with liquid LPG, the AFL float (5) rises with the liquid within the LPG tank. The float arm is connected to an actuator (4) that operates a shut-off piston (3). When the level reaches approximately 80% full, the piston (3) is in the closed position, effectively shutting off the flow of LPG into the tank.

The remaining 20% of the tank volume is necessary vapour space to allow for the expansion of the liquid that occurs as the temperature of the liquid increases.

The AFL is also fitted with a non-return valve (2) to prevent the gas escaping.

Rear Lock-Off / Service Solenoid Valve Assembly



The rear lock-off/service solenoid valve assembly is fitted to the LPG tank and is four valves in one, it contains the following valves:

- Manual shut off valve.
- Electrically operated solenoid valve.
- Excess flow valve.
- Pressure relief valve.

Manual Shut-Off Valve

The manual shut off valve (3) allows the supply of LPG to be manually shut off for servicing, a leak in the system develops or in the event of a vehicle accident by turning the knob (2).

Solenoid Valve

The solenoid valve (1) is an electrically operated valve, which allows the flow of LPG from the tank into the service line. The solenoid valve is energised for three seconds when the ignition key is first turned on, or constantly while the engine is being cranked or is running.

The solenoid valve (1) will shut off the LPG flow when the ignition is switched off and/or the engine stops running.

Excess Flow Valve

The excess flow valve (4) will close automatically if the flow of liquid LPG is excessive, shutting off the supply of liquid LPG. The valve will automatically reopen when the excess flow condition has ceased.

The excess flow valve is designed to shut off if the flow exceeds a specified amount, as would occur if the service line was severed or opened.

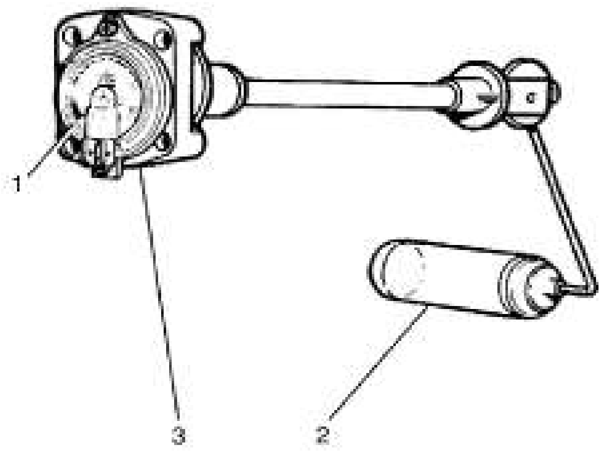
Pressure Relief Valve

If pressure within the LPG tank exceeds approximately 2,550 kPa, the valve (4) opens, overcoming spring tension. The excess pressure will then be vented into the valve box through the orifice (5) and then to atmosphere via the vent hose.

The valve will continue to vent the LPG tank until the pressure drops below 2,550 kPa and the spring closes the valve.

During normal operating conditions the pressure relief valve should not operate.

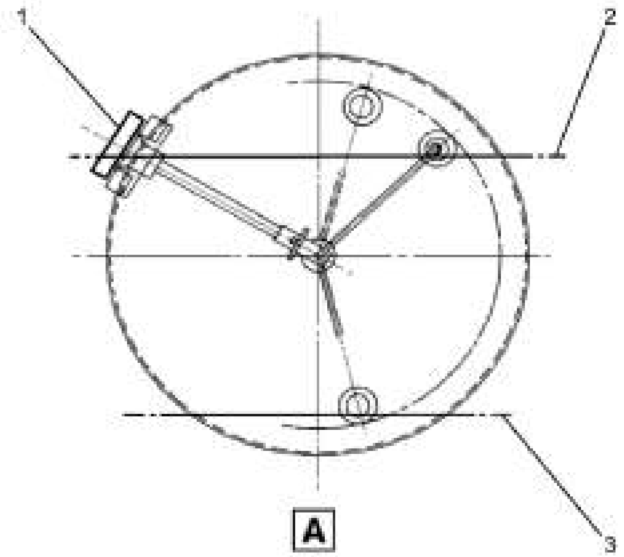
LPG Tank Fuel Gauge Assembly



The tank fuel gauge assembly (1, typical) has a float (2) similar to a petrol gauge sender unit, and a fuel contents gauge (3).

As the liquid level in the LPG tank rises, so too does the float. The float is connected to a magnet within the assembly. Any change in the position of the liquid level is transmitted to the fuel contents gauge via the float and magnet.

The magnetic field produced by the magnet causes the fuel contents gauge mounted on the exterior of the tank to move in relation to the magnet's position.

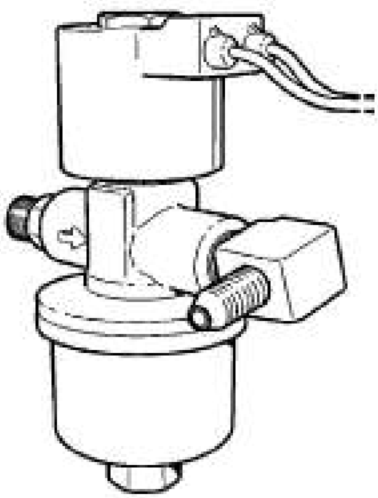


The fuel contents gauge (1) will show full when the liquid level in the tank is at 80% (2). It will show empty when the tank contents falls to approximately 8.5 litres (3).

The fuel gauge sender unit within the fuel contents gauge, incorporates a variable resistor that will vary its resistance from approximately 0 ohms when the tank is empty to approximately 90 ohms when the tank is full.

This change in resistance is used by the LPG control module to determine how many of the fuel level LED's will be activated in the fuel selector switch and fuel level control indicators. When the vehicle is switched to petrol operation, the contents of the petrol tank will be displayed on the instrument cluster.

LPG Front Lock-Off



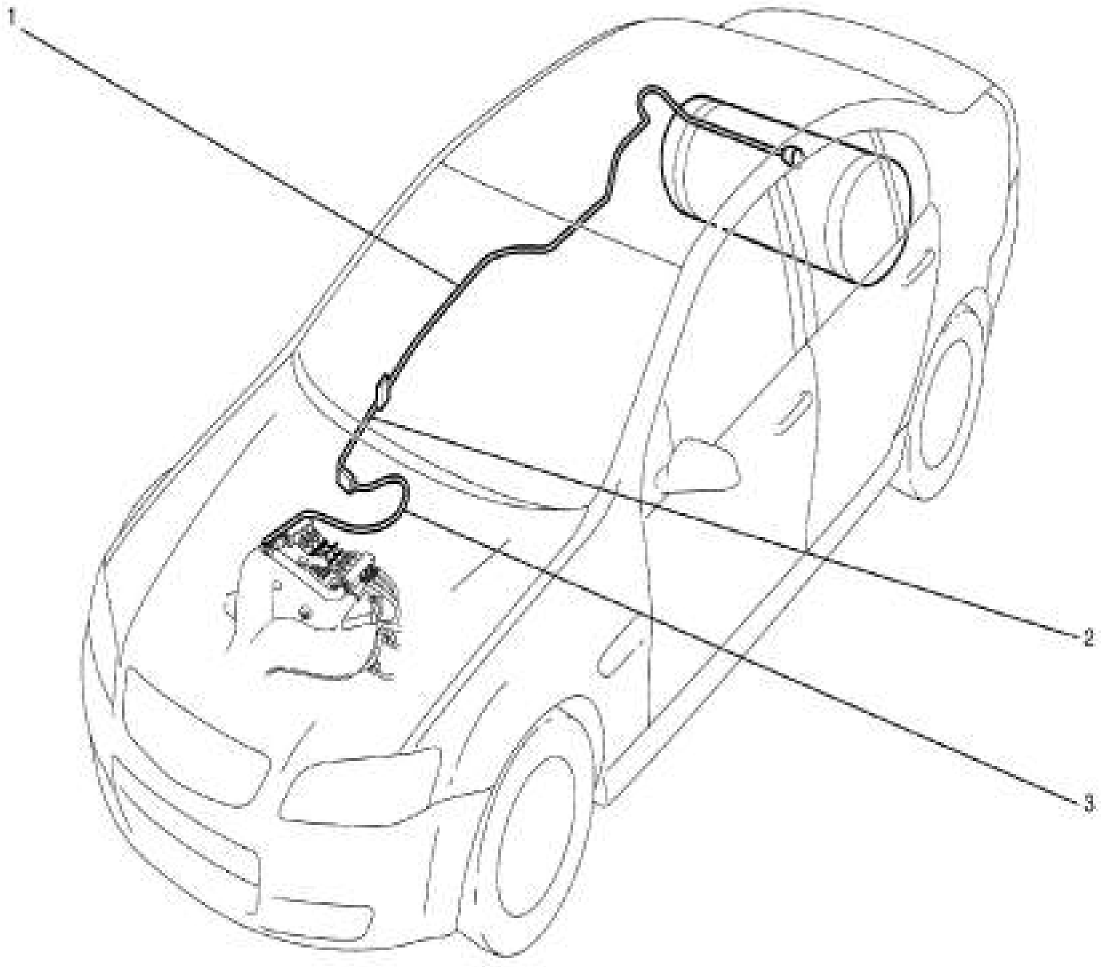
The LPG front lock-off is an electrically operated solenoid valve, which allows or prevents the flow of liquid LPG to the reducer when energised or de-energised by the LPG control module.

The LPG lock-off is energised for three seconds when the ignition is turned on, or constantly while the engine is being cranked or is running.

A filter is incorporated into the design, that is to be serviced every 120,000 km.

When the engine stops running, or the ignition is turned off, the LPG control module de-energises the LPG front lock-off and the supply of LPG is shut off.

Service Line



(1) Rear Service Line

(2) Intermediate Service Line

(3) Front Service Line

The service line carries the liquid LPG from the manual service valve at the LPG storage tank to the LPG lock-off. The service line consists of three major components: the front (3), intermediate (2) and rear (1) service line.

Reducer

Construction

The reducer (also known as a converter) functions are to:

- Control the flow of liquid LPG into the reducer.
- Provide a heat sink to allow vaporisation of the LPG and to prevent icing because of the temperature drop with the volume increase.
- Regulate the output pressure to suit engine requirements.

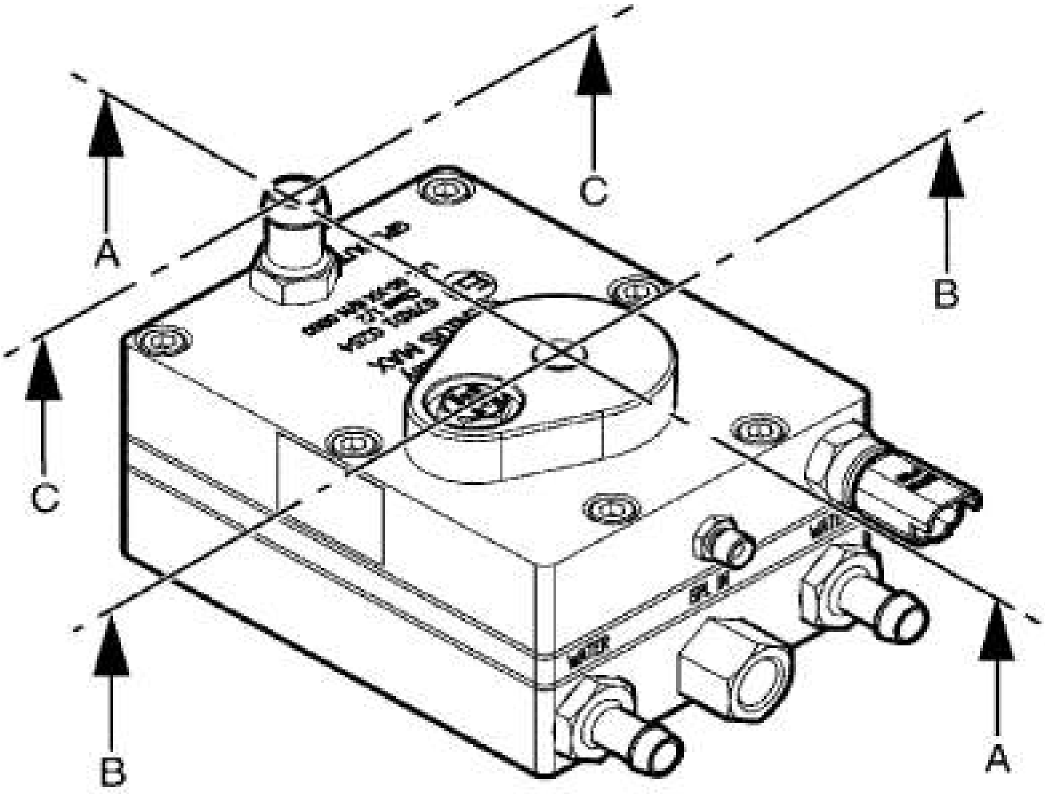


Figure 8A2 -0 21 shows the three sectioned views that follow

Referring to sectioned view "A-A", the Reducer comprises the lower (18) and upper (4) bodies, with an intermediate plate (11), separated by two gaskets (19) and (21).

The upper body (4), contains the pressure regulator spring (1) contained between the upper (2) and lower (6) caps, the upper one of which is adjustable via an externally adjustable screw (3). The diaphragm, located between the upper body and intermediate plate is supported by a small plate (10) and the lower spring cap (6). The upper end of the control shaft (16) is connected to the diaphragm, the two small support plates and Bauer spring (7) by a self-locking nut (5).

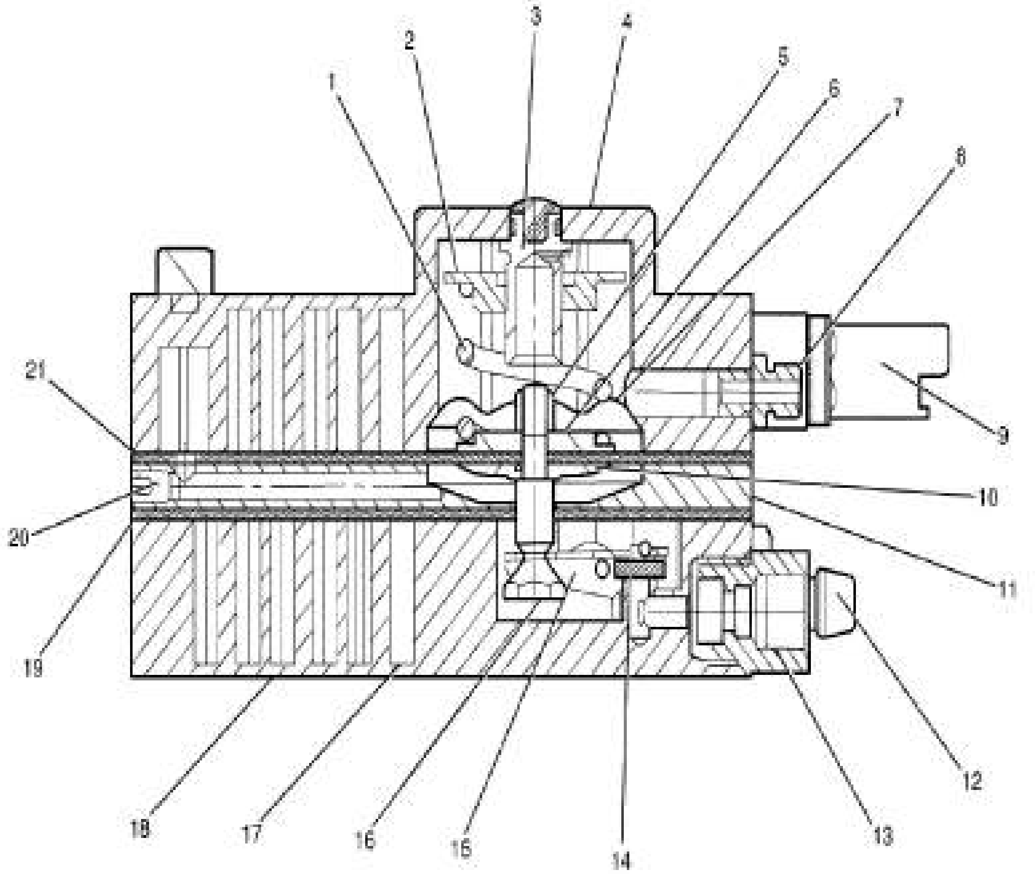
Also installed into the upper plate is a fitting (8) for the fitment of a small tube, sensing the engine intake manifold vacuum (or absolute pressure). Also included in the upper plate is a regulating pressure valve (refer to Figure 8A2 - 23 for detail of this valve).

The lower plate contains the primary valve (14) and priming valve pivoting arm (15), connected to the lower end of the control shaft (16). A fitting (13) for the high pressure liquid LPG is provided and the two fittings (12) for the engine coolant (only one is shown in this sectioned view.

Both plates are provided with channels (17) to allow engine coolant to flow around the assembly, with the heat being transferred to the very cold vapour, raising its temperature (and pressure). The Intermediate plate plugged drain (20) in the intermediate plate (11) allows movement of the LPG vapour from the lower (18) to the upper (4) plates.

To summarise, the flow of liquid LPG into the reducer is regulated by the priming valve (14) that is controlled by the vertical movement of the control shaft (16) acting on the priming valve pivot arm (15). The control shaft (16) is connected at the upper end, to the diaphragm separating the upper body (4) and the intermediate plate (11).

Reducer (Section A - A)



(1) Pressure Regulation Spring
(2) Upper Spring Cap
(3) Spring Tension Adjusting Screw
(4) Upper Body
(5) Control Shaft Nut
(6) Lower Spring Cap

(7) Bauer Spring
(8) Intake Manifold Pressure Fitting
(9) Temperature Sensor
(10) Lower Diaphragm Support Plate
(11) Intermediate Plate
(12) Engine Coolant Fitting (2 of)
(13) LPG Liquid Input Fitting
(14) Primary Valve
(15) Primary Valve Pivot Arm
(16) Control Shaft
(17) Coolant Channel
(18) Lower Body
(19) Gasket
(20) Intermediate Plate Plugged Drain
(21) Gasket
(22) LPG Vapour Output Fitting

Operation

The conversion of the high pressure liquid LPG coming from the front LPG lock-off to a low pressure, very cold vapour is controlled by the primary valve (14). In turn, the opening of the primary valve is controlled by the vertical movement of the control shaft (16) acting on the primary valve pivot arm (15), that pivots about the pin, anchored to the lower body (18).

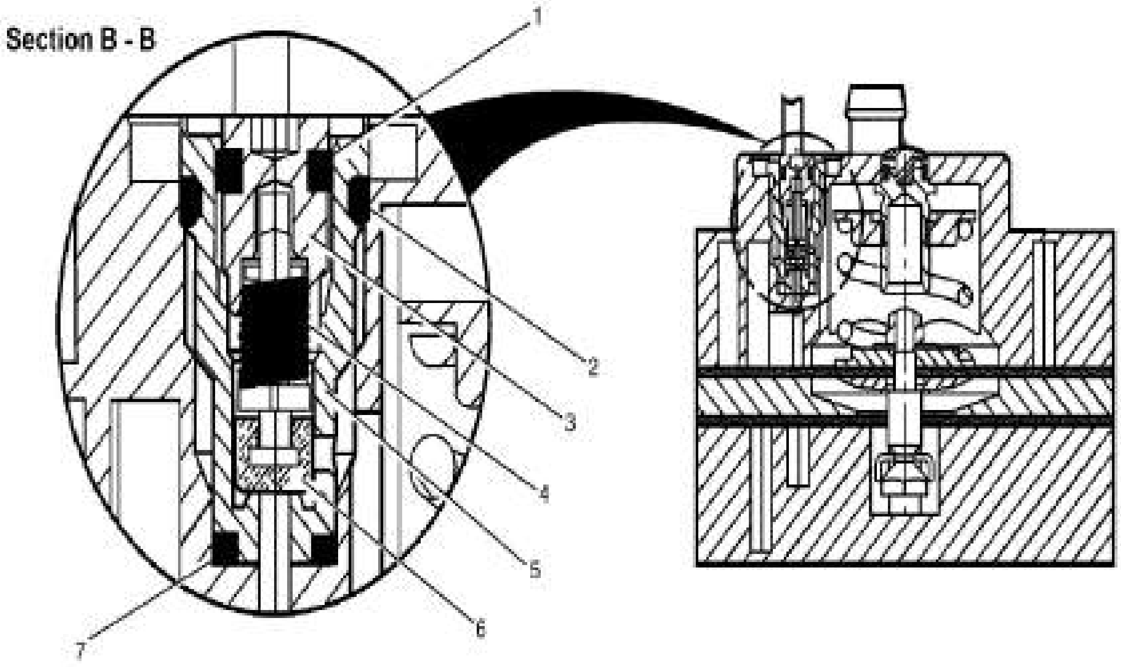
In the process of rapidly reducing the pressure from approximately 1,260 kPa in the tank to atmospheric (101.3 kPa), the liquid LPG changes state to become a vapour and this causes a rapid reduction in temperature. To compensate for this and to assist in vaporisation, engine coolant circulates through the heat exchanger channels (17) in the upper and lower bodies. The reducer seals off LPG flow when the engine is stopped.

The pressure regulating spring (1), acting on the upper side of the diaphragm (6), pushes the diaphragm down. This opens the primary valve (14), allowing LPG to enter the reducer and then to flow through the heat exchanger (17) where the LPG changes state from a liquid to a vapour.

When the engine is cranked or running, a vacuum is created in the engine intake manifold that is transmitted to one end of the reducer by tubing screwed onto the fitting (8). This tube is connected to a ‘T’ piece in the vacuum line and also connected to the P1 MAP sensor. The effect of this vacuum is to work against the regulating spring force, together with the pressure of the LPG acting on the underneath side of the primary diaphragm. This combined action achieves a balance on each side of the diaphragm.

LPG released from the reducer flows through to the vapour filter, before being delivered to each LPG injector manifold by tubing.

Pressure Limit Valve (Section B - B)



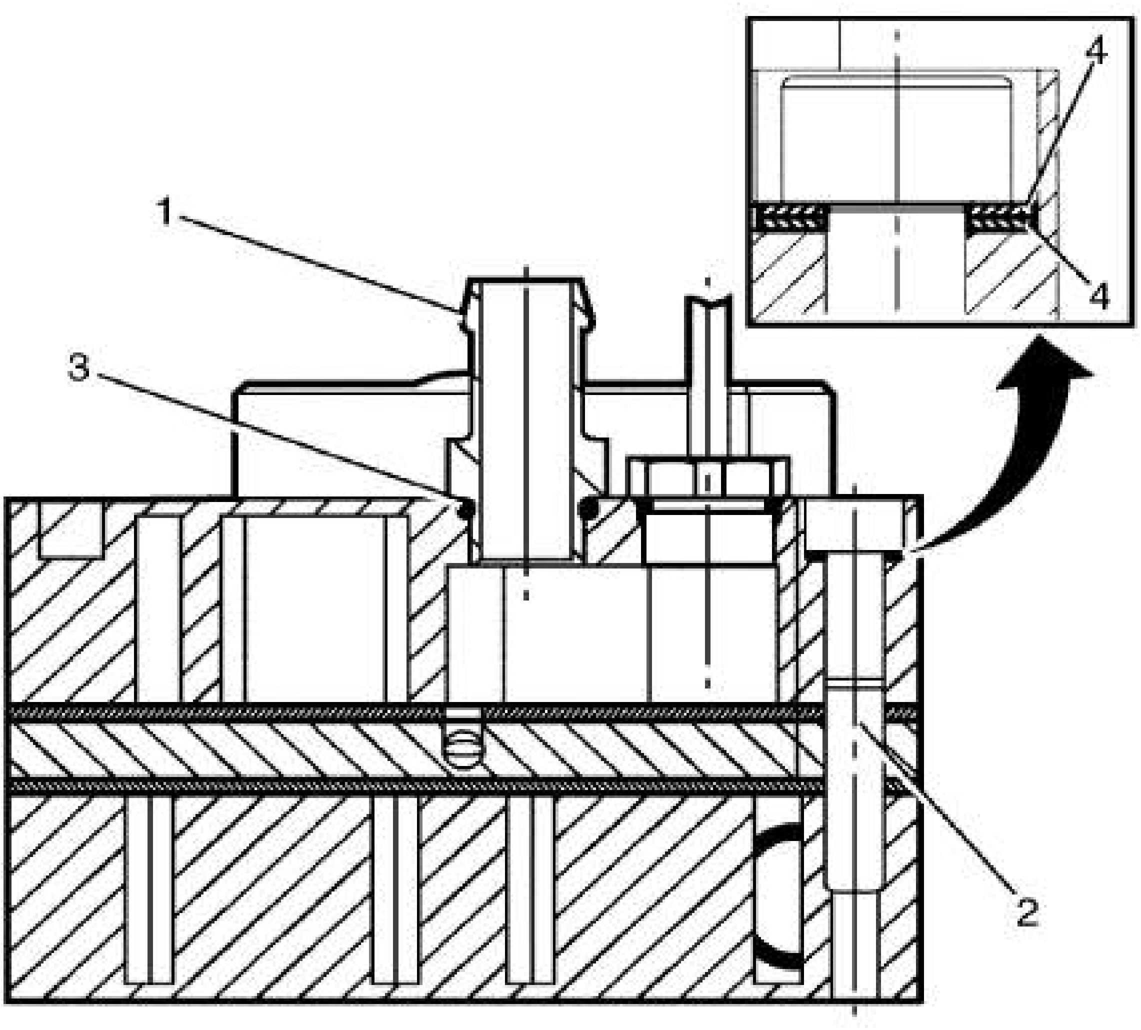
The pressure limiting device consists of the body (5) that is screwed into the reducer upper plate and sealed by O-rings (1 and 2). The adjustment screw (3) that preloads the spring (4) and the piston (6), also sealed by an O-ring (1). At the end of the piston is a seal (7) that seals the sensed LPG pressure.

Should the LPG vapour pressure rise beyond the pre-set value, the piston seal (6) will be lifted off its seat by the LPG pressure, allowing excess vapour to be vented internally into the output stage of the reducer. In this way, no LPG resulting from this pressure control, is released into the atmosphere.

Important: Under no circumstances is the spring force of the pressure limit valve to be tampered with or altered.

Fitment of this valve is purely as a precaution as it is very rarely required to operate. Should it be activated however, it would only be for a very short time and no LPG vapour enters the engine compartment.

Temperature Sensor (Section C -- C)

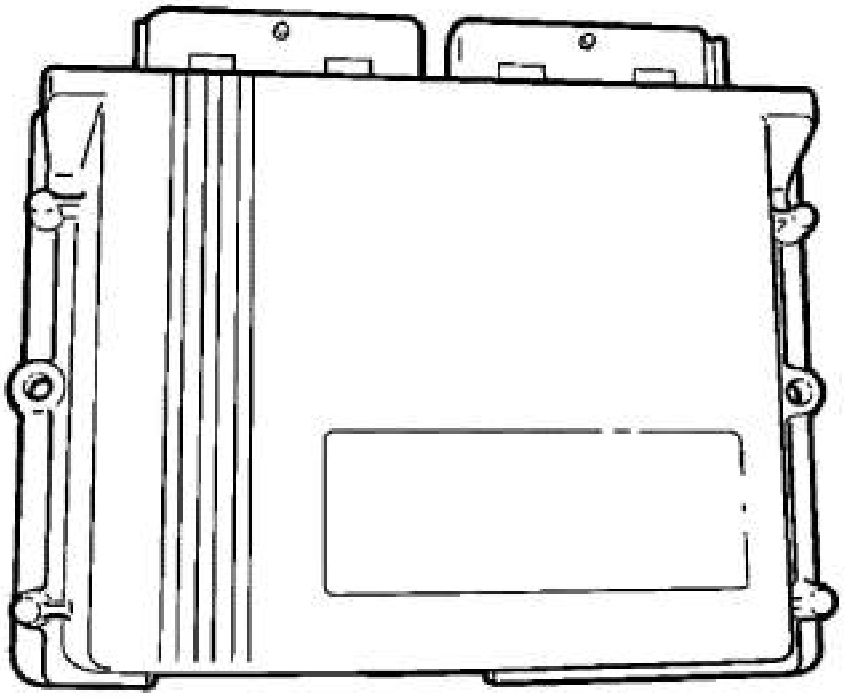


Section C - C shows the location of the NTC resistance, temperature sensor (5) that is located in the outlet stage of the reducer. Until the exiting LPG vapour reaches a prescribed temperature, the LPG ECU will keep the engine running on petrol, regardless of the fuel switch position.

In this way, running on LPG is not possible until the engine coolant reaches a pre-determined temperature.

The outlet fitting (1) and the temperature sensor (5) are sealed by O-rings (3 and 6). The bolts (2) clamping the reducer upper and lower bodies together are sealed by O-Rings (4) under each of the bolt heads.

LPG Control Module



The LPG Electronic Control Unit (ECU), controls the two operating modes: Petrol or LPG.

Petrol Mode

When operating in petrol mode, the LPG ECU signals the smart unit at the LPG tank to stop LPG flow. At the same time, the front LPG Lock-Off solenoid is also de-energised, further preventing LPG flow to the reducer. As the emulator signal is not used in this situation, the vehicle then operates on petrol with full engine management control from the engine ECU. The engine then operates in the same way that a single fuelled petrol engine would do. In this mode, the instrument cluster fuel gauge will show the amount of petrol in the petrol fuel tank.

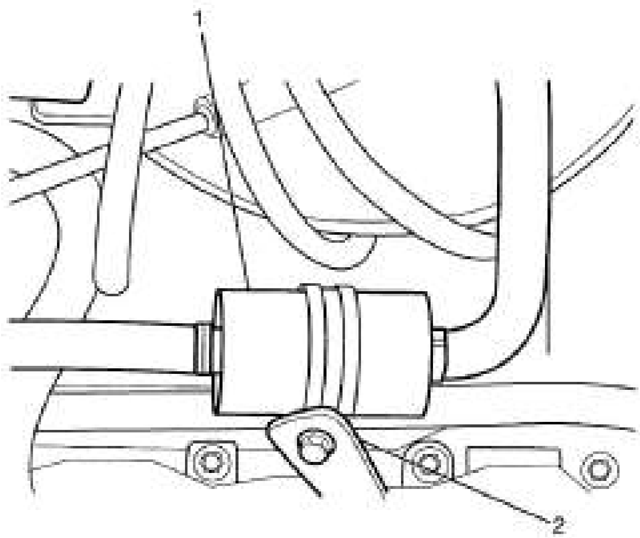
LPG Mode

When operating in the LPG mode, the ECU energises the Smart Unit and the Front Lock-Off solenoid, allowing LPG to flow to the ‘Genius Max’ reducer. The engine switch-over to LPG however, will not occur until engine temperature is high enough to provide adequate vaporisation of the LPG

Once the temperature is up to the pre-determined level, the LPG ECU will activate the emulators and the engine ECM will then control the pulse width of the LPG injectors.

When operating in LPG mode under conditions of prolonged high speed / high load operation, a small amount of petrol is injected into the engine to cool the valves and catalytic reducer.

Vapour Filters

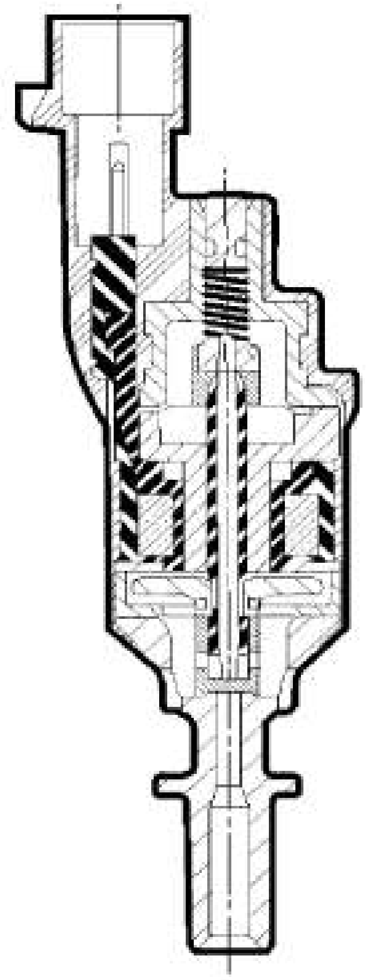


The vapour filter (2) is mounted to a bracket (4) and secured to the mounting bracket by a nut and washer.

Exiting LPG vapour from the reducer passes through the vapour filter and vapour lines (1 & 3) and then to each of the LPG injector manifolds.

Servicing of the vapour filter is by replacement, every 15,000 km.

LPG Fuel Injectors



The BRC LPG injectors are referred to as a ‘bottom feed’ type because the injector is fully immersed in the gas manifold.

When the injector solenoid is energised, the internal valve is lifted from its seat against an internal spring force, by an electro-magnet. This action allows gas to be injected into the engine intake manifold, via a hose.

At the base of the internal valve is a rubber seal, to ensure reliable sealing.

The injector voltage supply is referred to as ‘peak and hold’. This means that battery voltage is applied to the electromagnet to effect a rapid opening and then varied to maintain the valve in an open position.

The injector open time is controlled by the engine ECM as previously described.

The injector coil resistance is 1.8Ω @ 20° C.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Description and Operation | **Document ID: 1974752**

Throttle Actuator Control (TAC) System Description

- The throttle actuator control (TAC) system is used to improve emissions, fuel economy, and driveability. The TAC system removes the mechanical link between the accelerator pedal and the throttle plate. The TAC system removes the need for a cruise Control Module and idle air control motor. The following is a list of TAC system components:
- The accelerator pedal assembly includes the following components:
  - The accelerator pedal
  - The accelerator pedal position (APP) sensor 1
  - The APP sensor 2
- The throttle body assembly includes the following components:
  - The throttle position (TP) sensor 1
  - The TP sensor 2
  - The throttle actuator motor
  - The throttle plate
- The engine Control Module (ECM)

1. The ECM monitors the driver demand for acceleration with 2 APP sensors. The APP sensor 1 signal voltage range is from about 0.98-4.16 volts as the accelerator pedal is moved from the rest pedal position to the full pedal travel position. The APP sensor 2 range is from about 0.49-2.08 volts as the accelerator pedal is moved from the rest pedal position to the full pedal travel position. The ECM processes this information along with other sensor inputs to command the throttle plate to a certain position.
2. The throttle plate is controlled with a direct current motor called a throttle actuator control motor. The ECM can move this motor in the forward or reverse direction by controlling battery voltage and/or ground to 2 internal drivers. The throttle plate is held at a 7 percent rest position using a constant force return spring. This spring holds the throttle plate to the rest position when there is no current flowing to the actuator motor.
3. The ECM monitors the throttle plate angle with 2 TP sensors. The TP sensor 1 signal voltage range is from about 4.86-0.86 volts as the throttle plate is moved from 0 percent to wide open throttle (WOT). The TP sensor 2 voltage range is from about 0.82-4.14 volts as the throttle plate is moved from 0 percent to WOT.
4. The ECM performs diagnostics that monitor the voltage levels of both APP sensors, both TP sensors, and the throttle actuator control motor circuit. It also monitors the spring return rate of both return springs that are housed internal to the throttle body assembly. These diagnostics are performed at different times based on whether the engine is running, not running, or whether the ECM is currently in a throttle body relearn procedure.
5. Every ignition cycle, the ECM performs a quick throttle return spring test to make sure the throttle plate can return to the 7 percent rest position from the 0 percent position. This is to assure that the throttle plate can be brought to the rest position in case of an actuator motor circuit failure. Observe, under cold conditions, the ECM commands the throttle plate to 7 percent with the ignition ON and the engine OFF to release any ice that may have formed on the throttle plate.

Throttle Body Relearn Procedure

The engine Control Module (ECM) stores values that include the lowest possible throttle position (TP) sensor positions-0 percent, the rest positions-7 percent, and the return rate of both springs.

These values will only be erased or overwritten if the ECM is reprogrammed or if a throttle body relearn procedure is performed. Observe, if the battery is disconnected, the ECM will immediately perform a throttle body relearn procedure when the ignition is turned ON.

A throttle body relearn procedure is performed any time the ignition is turned ON, with the engine OFF for longer than 29 seconds when the following conditions have been met:

- The engine speed is less than 40 RPM.
- The vehicle speed is 0 km/h (0 mph).
- The engine coolant temperature (ECT) is between 5-85°C (41-185°F).
- The intake air temperature (IAT) is between than 5-60°C (41-140°F).
- The accelerator pedal position (APP) sensor angle is less than 14.9 percent.
- The ignition 1 voltage is more than 10 volts.

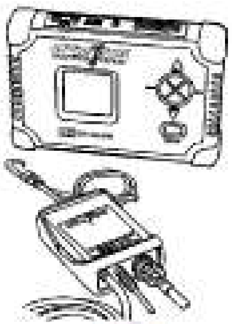
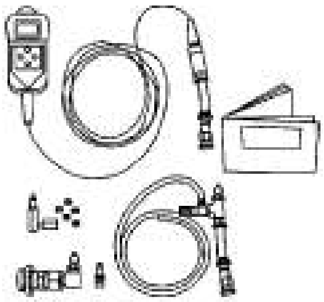
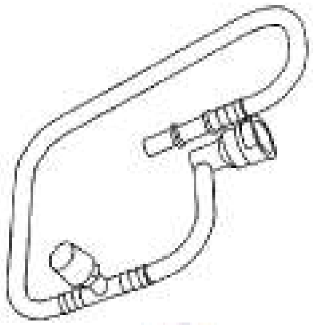
After 29 seconds, the ECM commands the throttle plate from the rest position to full closed, then to around 10 percent open. This procedure takes about 6-8 seconds. If any faults occur in the throttle actuator control (TAC) system, a DTC sets. At the start of this procedure, the scan tool TAC Learn Counter parameter should display 0, then count up to 11 after the procedure is completed. If the counter did not start at 0, or if the counter did not end at 11, a fault has occurred and a DTC should set.

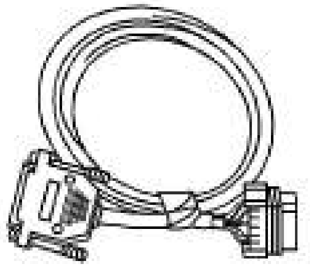
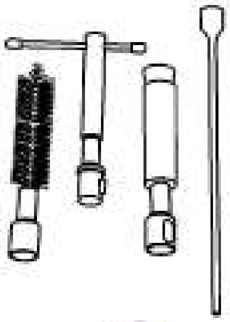
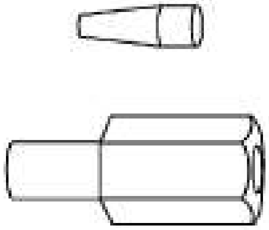
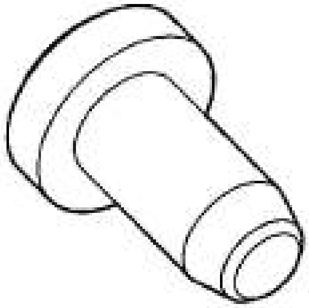
TAC System Default Actions/Reduce Power Modes

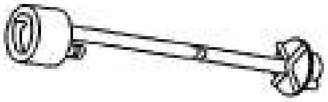
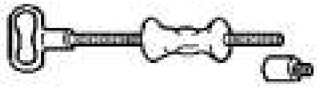
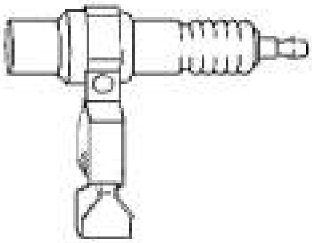
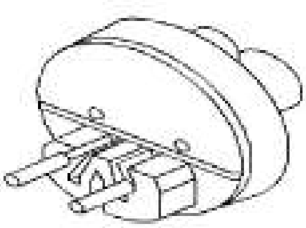
1. There are 2 reduce power modes that the engine Control Module (ECM) can default to if an error is detected in the throttle actuator control (TAC) system. If an accelerator pedal position (APP) sensor 1 or APP sensor 2 circuit fault, throttle position (TP) sensor 2 circuit fault, or if a TP sensor 1 circuit fault is detected with some APP angle, the ECM goes into one of the 2 reduce power modes. In this mode, the engine torque is limited so that the vehicle cannot reach speeds of more than 100 km/h (60 mph). The ECM remains in this reduce power mode during the entire ignition cycle even if the fault is corrected.
2. If there is a condition with the throttle actuator control circuits, throttle actuator command vs actual position fault, return spring check fault, or a TP sensor 1 circuit fault, the ECM goes into the other reduce engine power mode. In this mode, the engine speed is limited to 2,500 RPM and the 3-6 fuel injectors are randomly turned OFF. At this time the Reduced Power indicator is commanded ON. The ECM remains in the reduce power mode during the entire ignition cycle even if the fault is corrected. Observe, if a TP sensor 1 or throttle actuator control circuit fault is present at the time the vehicle is at idle, with no accelerator pedal angle, the engine may stall.

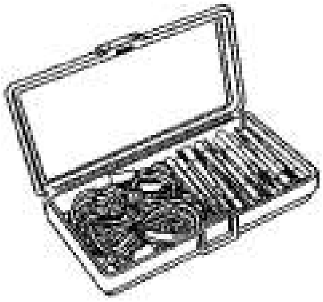
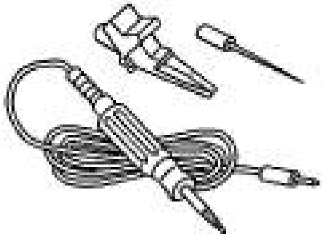
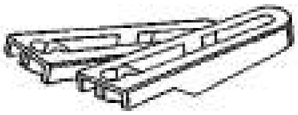
2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L | Special Tools and Equipment | **Document ID: 2126280**

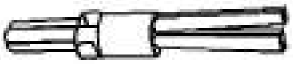
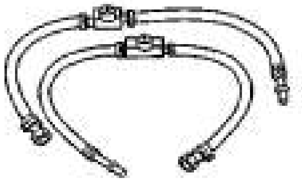
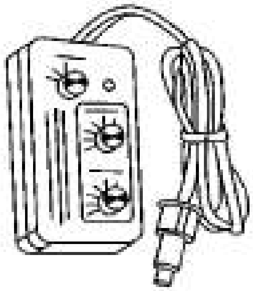
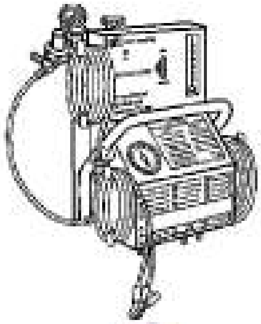
Special Tools

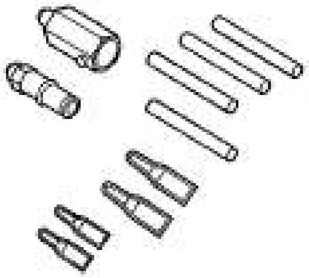
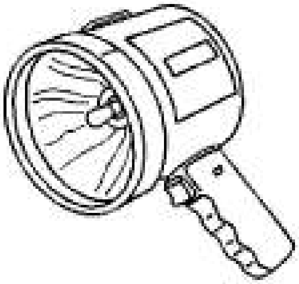
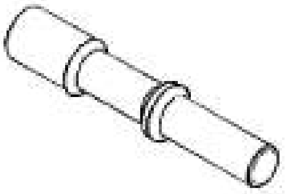
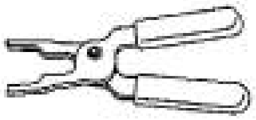
Illustration	Tool Number/Description
	CH 47976 Active Fuel Injector Tester
	CH 48027 Digital Pressure Gage
	CH 48096 EVAP Service Access Port Tool
	EL 39021-460

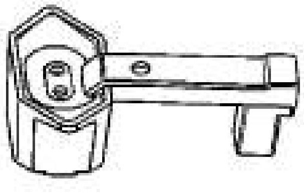
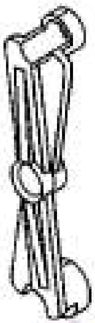
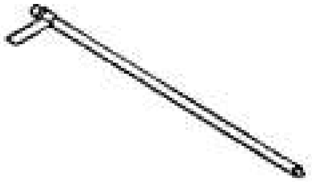
	Fuel Injector Test Adapter
	EN 47909 Injector Bore and Sleeve Cleaning Kit
	EN 48266 Injector Seal Installer/Sizer
	EN 48896 HP Fuel Pump Installation Alignment Gage

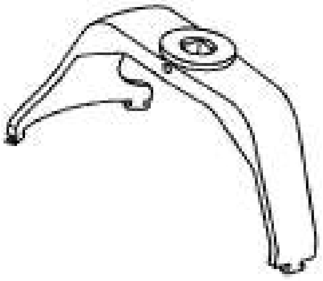
	GE 41415-50 Fuel Tank Cap Adapter
	J 2619-01 Slide Hammer
	J 26792 HEI Spark Tester
	J 34730-405 Injector Test Lamp

	J 35616-A/B-8637 Connector Test Adapter Kit
	J 35616-200 Test Light - Probe Kit
	J 37088-A Fuel Line Disconnect Tool Set
	J 37281-A Injector Remover

	
	J 37287 Fuel Line Shut-Off Adapters
	J 38522 Variable Signal Generator
	J 41413-200 Evaporative Emission System Tester (EEST)

	J 41413-300 EVAP Cap and Plug Kit
	J 41413-SPT High Intensity White Light
	J 42960-02 Fuel Flapper Door Holder
	J 43244 Relay Puller Pliers

	J 44175 Fuel Composition Tester
	J 44581 Fuel Line Disconnect Tool
	J 45004 Fuel Tank Drain Hose
	J 45722 Fuel Sender Lock Ring Wrench

Temperature Versus Resistance

°C	°F	OHMS
Temperature vs Resistance Values (Approximate)		
150	302	47
140	284	60
130	266	77
120	248	100
110	230	132
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

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Altitude Versus Barometric Pressure

Altitude Measured in Meters (m)	Altitude Measured in Feet (ft)	Barometric Pressure Measured in Kilopascals (kPa)
Determine your altitude by contacting a local weather station or by using another reference source.		
4 267	14,000	56-64
3 962	13,000	58-66
3 658	12,000	61-69
3 353	11,000	64-72
3 048	10,000	66-74
2 743	9,000	69-77
2 438	8,000	71-79
2 134	7,000	74-82
1 829	6,000	77-85
1 524	5,000	80-88
1 219	4,000	83-91
914	3,000	87-95
610	2,000	90-98
305	1,000	94-102
0	0 Sea Level	96-104
-305	-1,000	101-105

Ignition System Specifications

Application	Specification	
	Metric	English
Firing Order	1-8-7-2-6-5-4-3	
Spark Plug Wire Resistance	188-312 ohms	
Spark Plug Torque	15 N·m	11 lb ft
Spark Plug Gap	1.02 mm	0.040 in
Spark Plug Type	Platinum	

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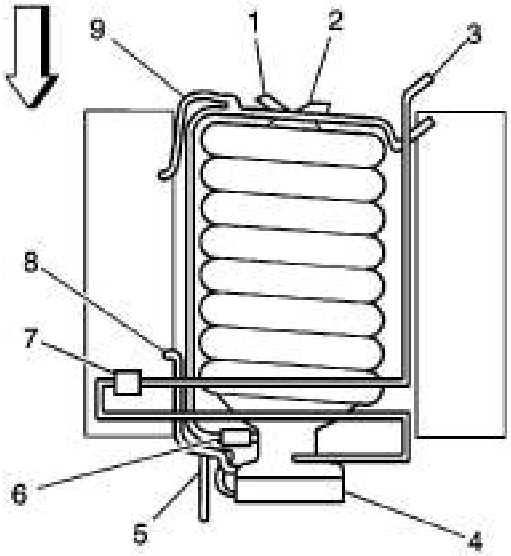
Fastener Tightening Specifications

Application	Specifications	
	Metric	English
Accelerator Pedal Position (APP) Sensor Assembly Retaining Bolts	20 N·m	15 lb ft
Air Cleaner Lower Housing Retaining Bolts	10 N·m	89 lb in
Camshaft Position (CMP) Sensor Retaining Bolt	25 N·m	18 lb ft
Crankshaft Position (CKP) Sensor Retaining Bolt	25 N·m	18 lb ft
Engine Coolant Temperature (ECT) Sensor	20 N·m	15 lb ft
Evaporative Emissions (EVAP) Canister Retaining Bolts	6 N·m	53 lb in
Fuel Filler Hose Clamps	4 N·m	35 lb in
Fuel Pipe Stone Guard Retaining Nuts	5 N·m	44 lb in
Fuel Rail Retaining Bolts	10 N·m	89 lb in
Fuel Tank Strap Upper Retaining Bolts	20 N·m	15 lb ft
Heated Oxygen Sensor (HO2S)	41 N·m	30 lb ft
Ignition Coil to Ignition Plate Assembly Retaining Bolts	12 N·m	106 lb in
Knock Sensor (KS) Retaining Bolt	20 N·m	15 lb ft
Spark Plug New Cylinder Head	20 N·m	15 lb ft
Spark Plug Old Cylinder Head	15 N·m	11 lb ft
Throttle Body Retaining Bolts	12 N·m	106 lb in
Fuel Rail Ground Strap To Intake Manifold Retaining Bolts	10 N·m	89 lb in
Air Cleaner Intake Duct to Throttle Body Retaining Clamp	4 N·m	35 lb in
Ignition Coil To Rocker Cover Retaining Blots	12 N·m	106 lb in
Fuel Filler Pipe to Chassis Retaining Bolts	9 N·m	80 lb in
Rear Subframe to Chassis Retaining Bolts		
First Pass:	65 N·m	48 lb ft
Final Pass:	125 Degrees	
Intake Air Temperature/Mass Air Flow (AT/ MAF) to Air Intake Duct Retaining Clamp	2 N·m	18 lb in
Intake Air Temperature/Mass Air Flow (AT/ MAF) to Upper Air Cleaner Body Retaining Clamp	2 N·m	18 lb in

Document ID: 1727995

Emission Hose Routing Diagram



(1) Not Used
(2) To Power Brake Vacuum Assist
(3) To EVAP Canister
(4) Throttle Body
(5) Engine Coolant Hoses
(6) Positive Crankcase Ventilation (PCV) Valve
(7) EVAP Canister Purge Solenoid Valve
(8) Crankcase Ventilation Hose
(9) Crankcase Ventilation Hose

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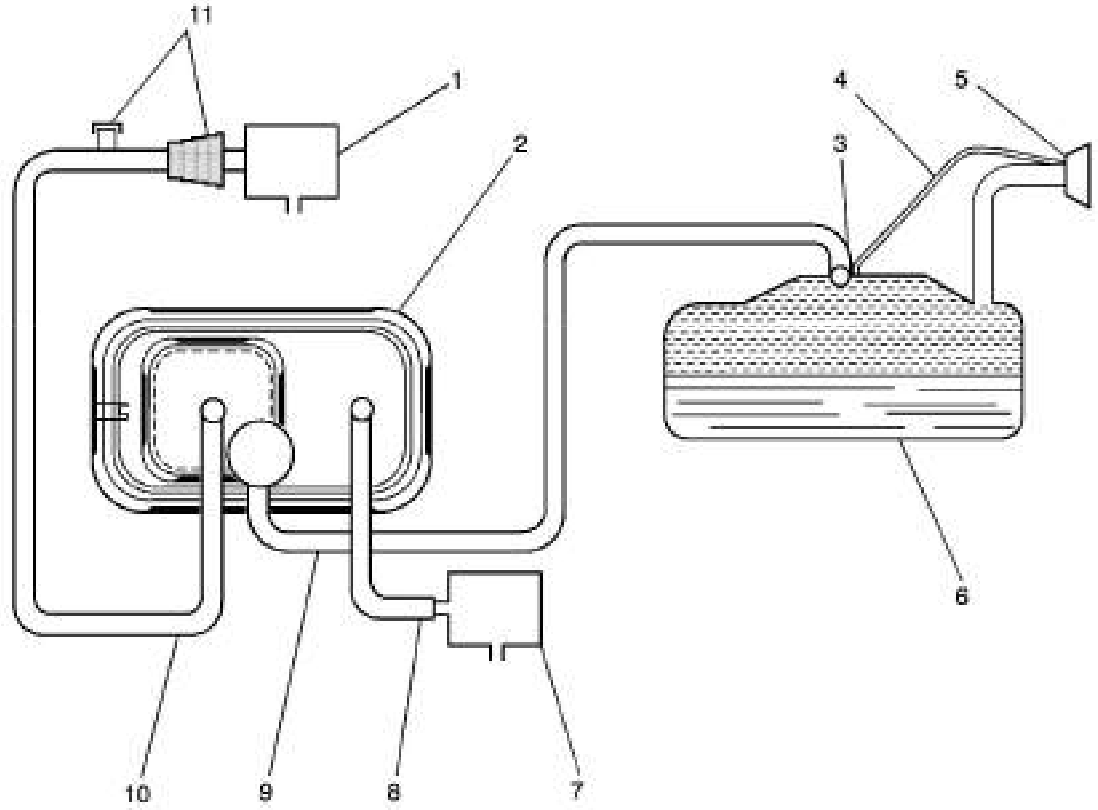
Document ID: 1720335

Evaporative Emissions Hose Routing Diagram



(1) EVAP Canister Purge Solenoid Valve
(2) EVAP Canister
(3) Fluid Level Vent Valve
(4) Vapor Recirculation tube
(5) Fuel Fill Neck and Fill Cap
(6) Fuel Tank
(7) EVAP Canister Vent Valve
(8) Vent Hose/Pipe
(9) EVAP Vapor tube
(10) EVAP Purge tube
(11) EVAP Service Port or Service Access Connector

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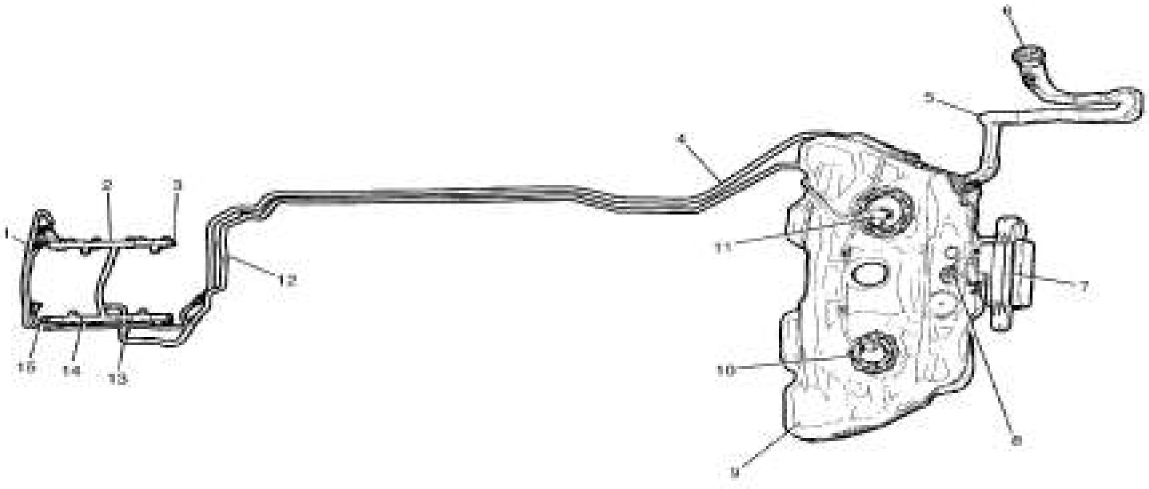
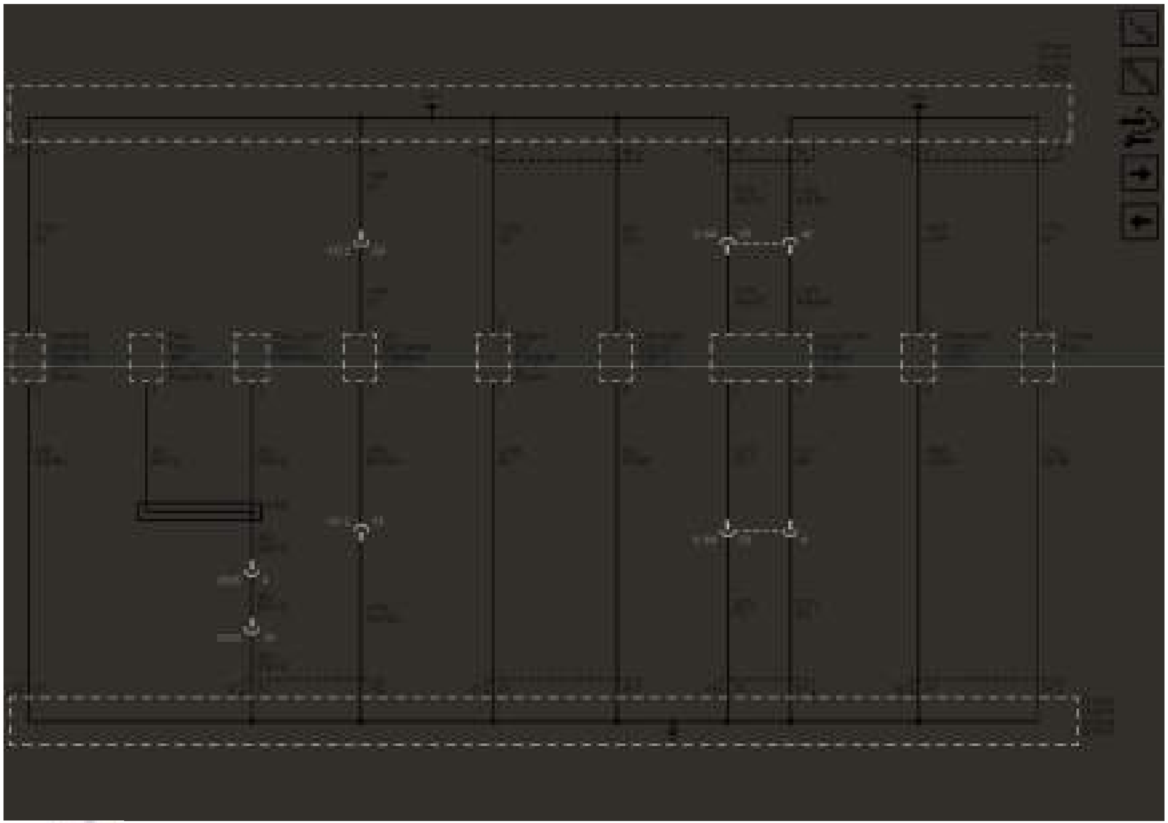
Document ID: 1997616

Fuel Hose / Pipes Routing Diagram

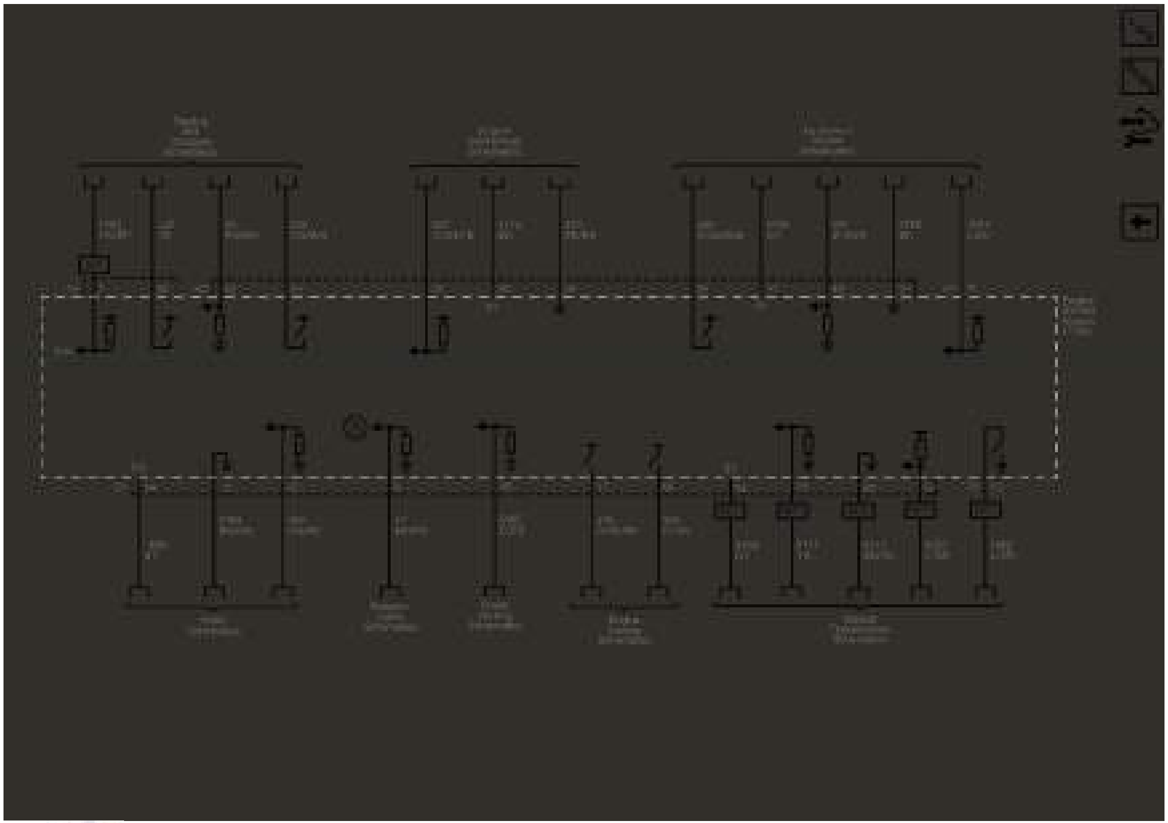


(1) EVAP Service Port
(2) Fuel Rail Bank 1
(3) Fuel Injector
(4) Vapour Purge Pipe to Purge Solenoid
(5) Fuel Fill Pipe
(6) Fuel Fill Cap
(7) EVAP Canister
(8) Fuel Tank to EVAP Canister Vapour Vent Hose
(9) Fuel TankQuick Connect Fitting
(10) Secondary Sender Assembly
(11) Modular Fuel Pump and Primary Sender Assembly
(12) Feed Line to Fuel Rail
(13) Quick Connect Fitting
(14) Fuel Rail Bank 2
(15) Fuel Pressure Schrader Valve

5 Volt Reference and Low Reference



Controlled / Monitored Subsystem References



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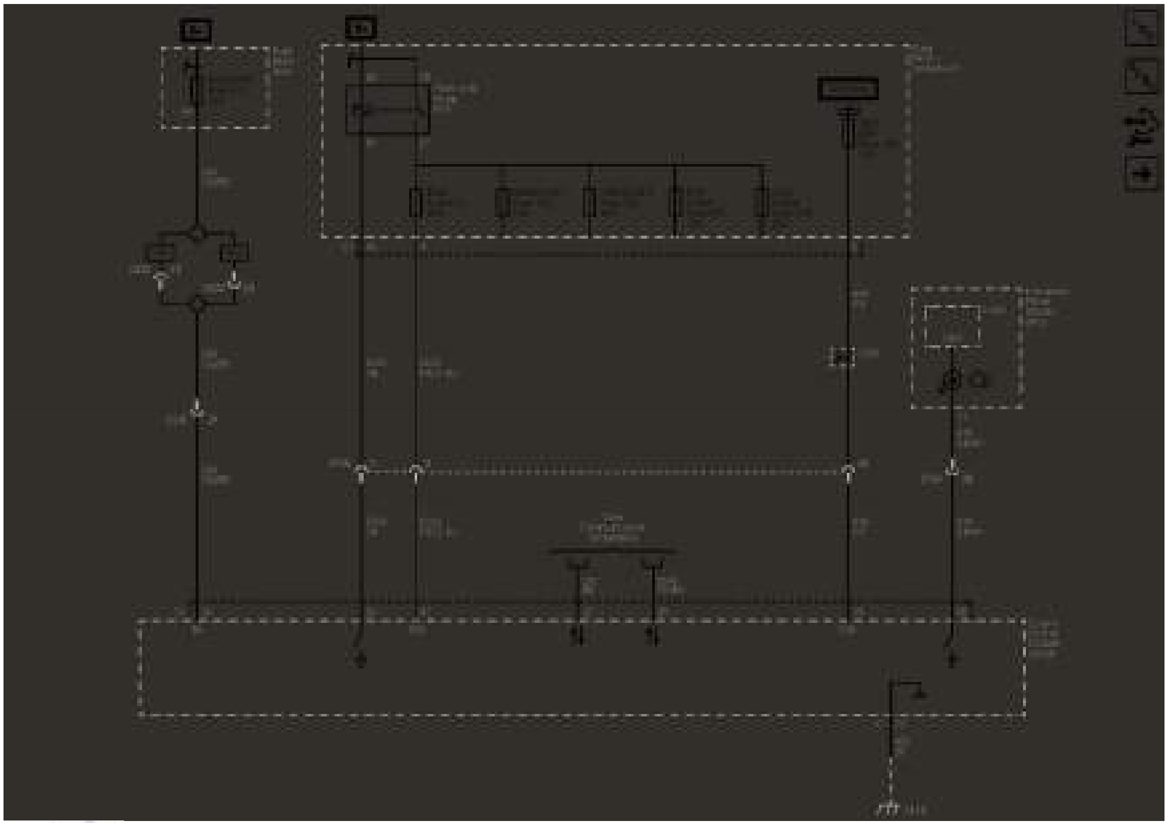
Document ID: 2021937

ECM Power, Ground and Serial Data



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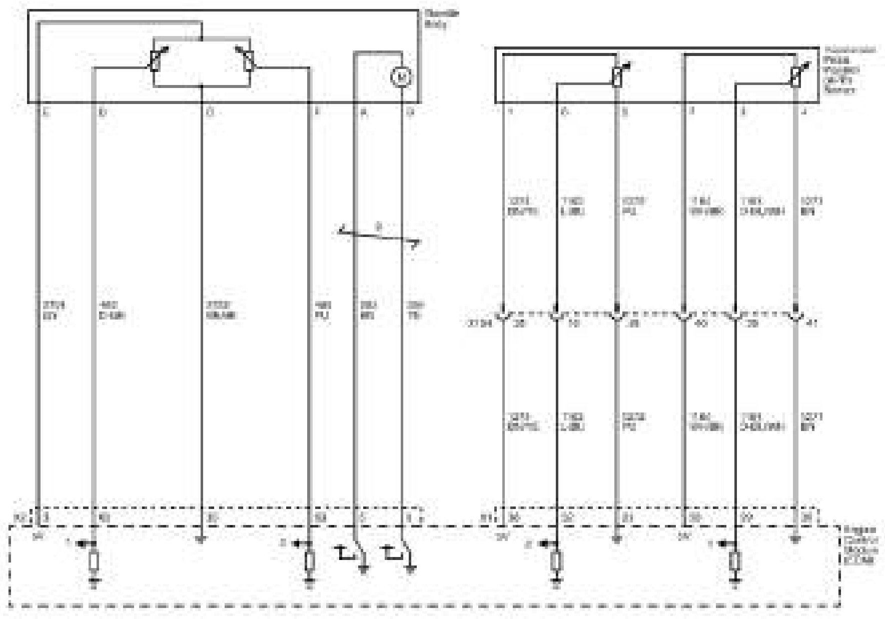
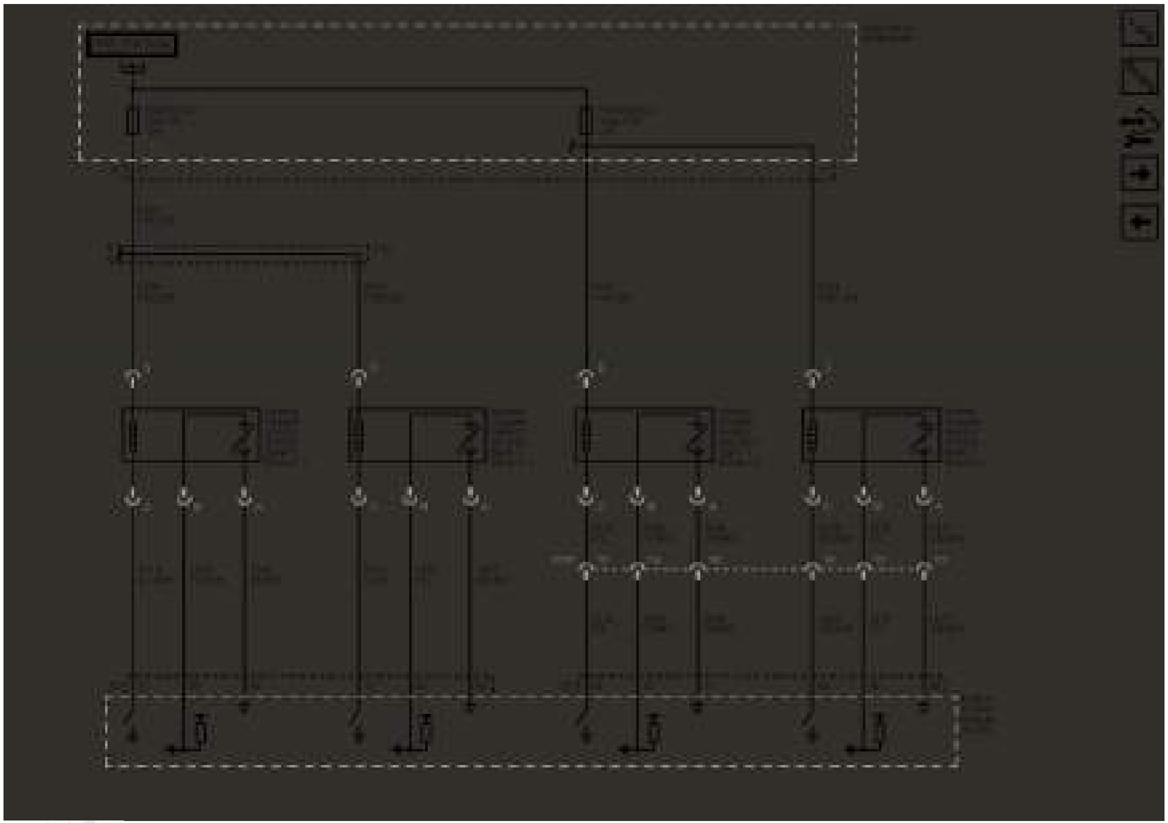
Document ID: 2146254

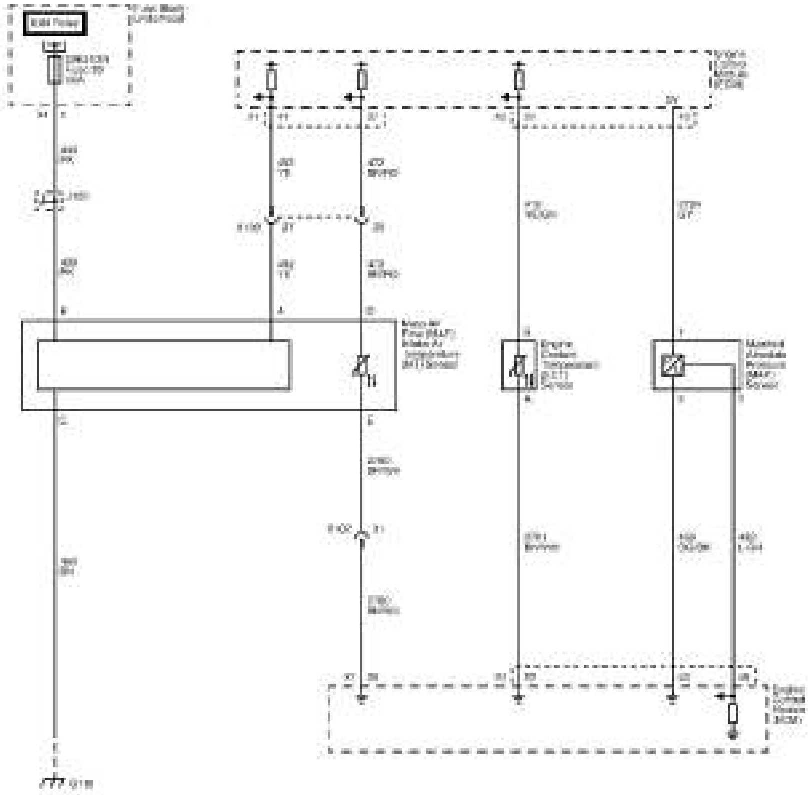
Engine Data Sensors - Electronic Throttle Controls



Engine Data Sensors - HO2S



Engine Data Sensors - Pressure and Temperature


Engine Control Module (ECM)
Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor
Engine Coolant Temperature (ECT) Sensor
Manifold Absolute Pressure (MAP) Sensor
Engine Control Module (ECM)

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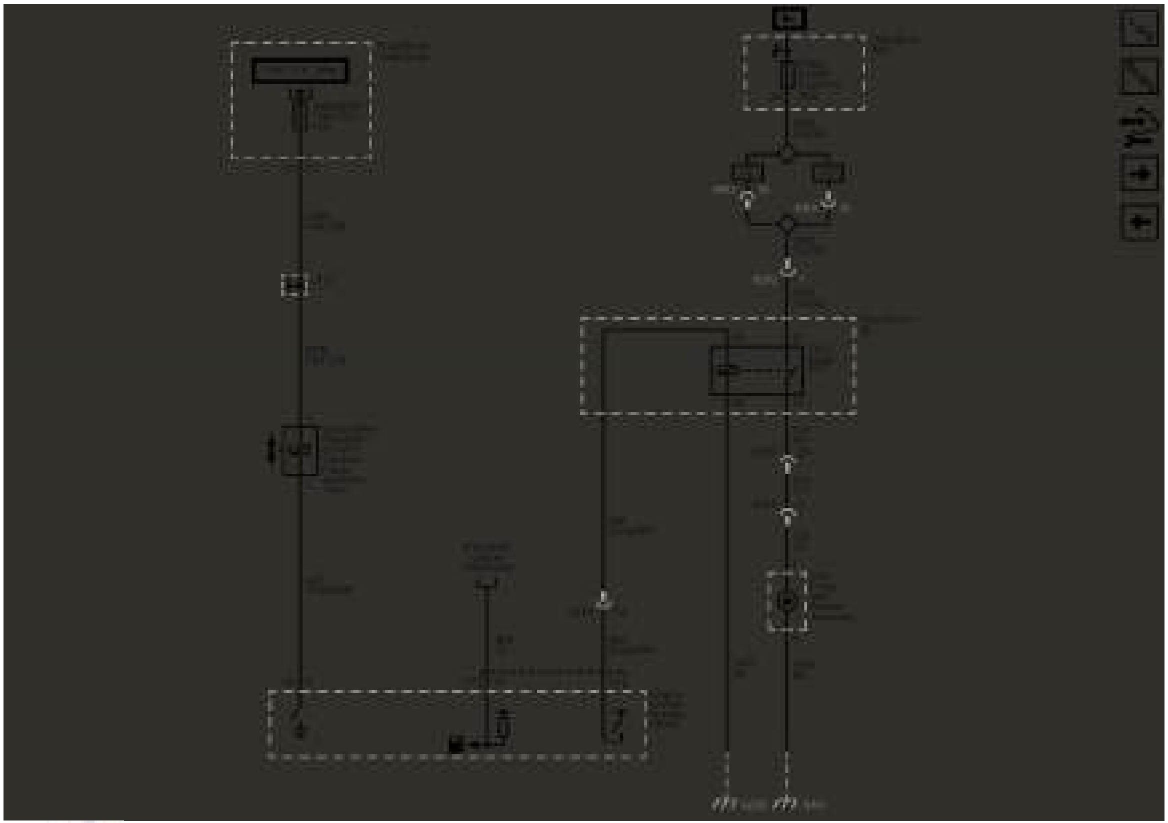
Fuel Controls - EVAP and Fuel Pump Controls



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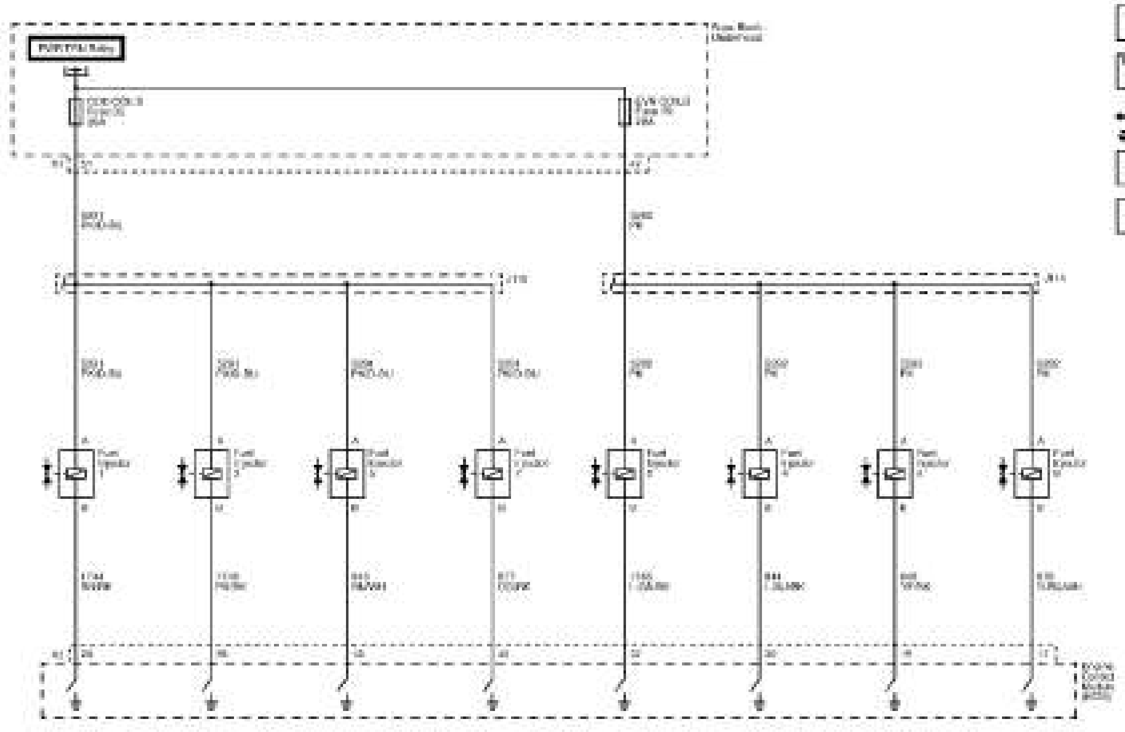
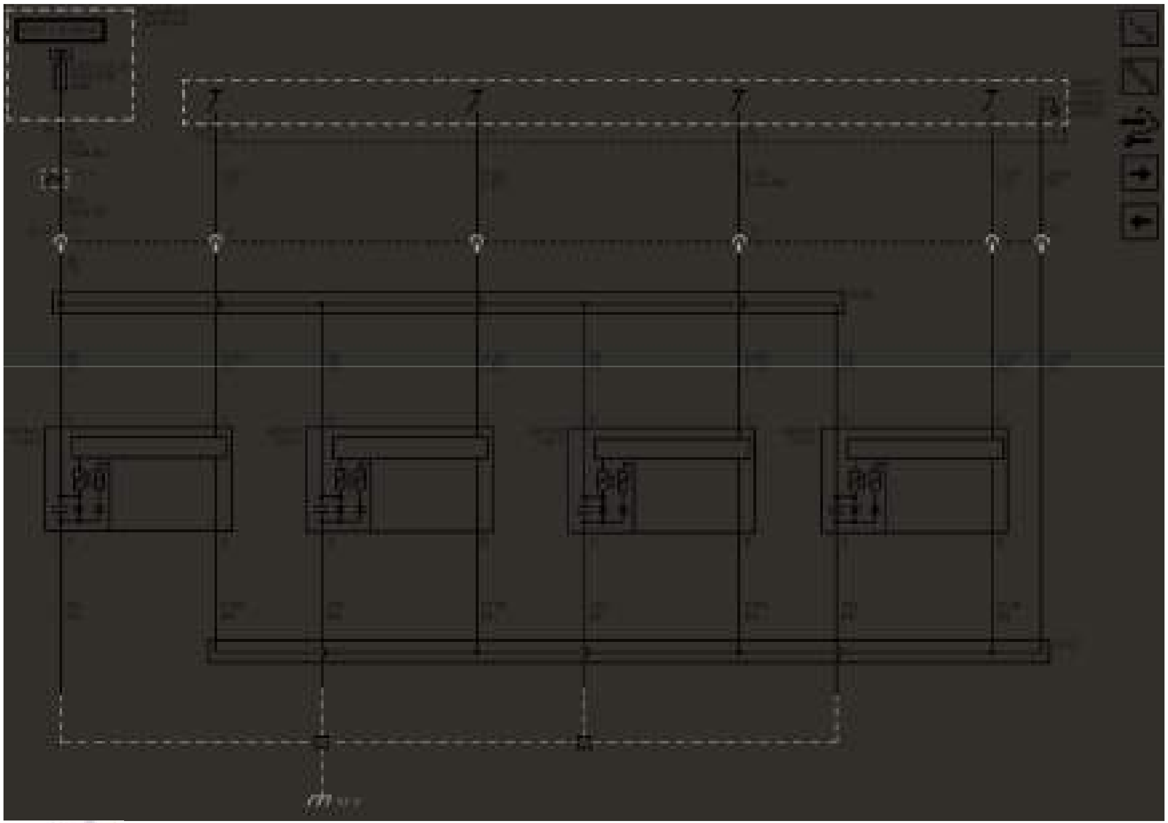
Document ID: 2146259

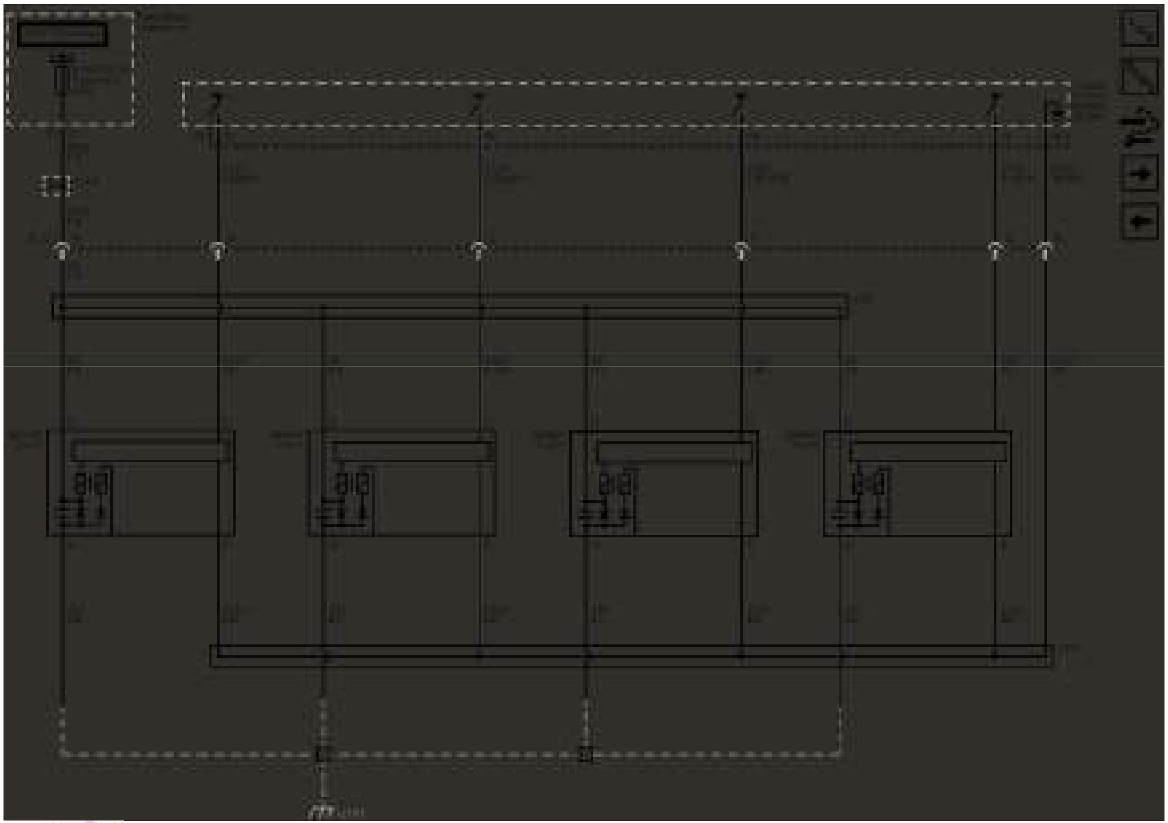
Fuel Controls - Fuel Injectors



Ignition Controls - Ignition System Coils 1, 3, 5, and 7



Ignition Controls - Ignition System Coils 2, 4, 6, and 8



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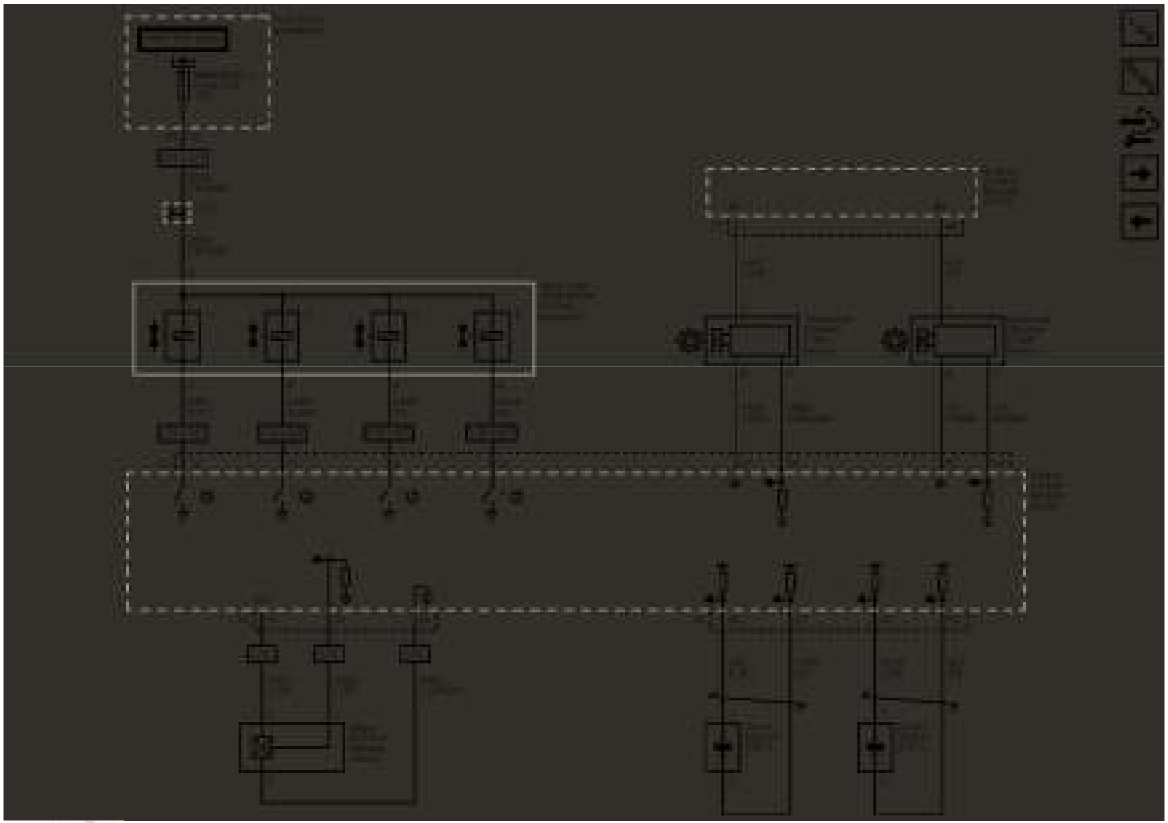
Document ID: 2146258

Ignition Controls - Sensors and Active Fuel Management



Diagnostic Starting Point - Engine Controls

Begin the system diagnosis with Diagnostic System Check - Vehicle. The Diagnostic System Check - Vehicle will provide the following information:

- The identification of the control modules which command the system
- The ability of the control modules to communicate through the serial data circuit
- The identification of any stored diagnostic trouble codes (DTCs) and the codes' statuses

The use of the Diagnostic System Check - Vehicle will identify the correct procedure for diagnosing the system and where the procedure is located.

Scan Tool Data List

The Engine Scan Tool Data List contains all engine related parameters that are available on the scan tool. The list is arranged in alphabetical order. A parameter may appear in any one of the data lists and in some cases may appear more than once or in more than one data list in order to group certain related parameters together.

Use the Engine Scan Tool Data List only after the following conditions are determined:

- The Diagnostic System Check - Vehicle is completed.
- There are no diagnostic trouble codes (DTCs).
- The on-board diagnostics are functioning correctly.

Scan tool values from an engine that is operating correctly may be used for comparison with the engine you are diagnosing. The Engine Scan Tool Data List represents the values that would be seen on a normal operating engine.

Important: Do not use a scan tool that displays faulty data. The scan tool concern should be reported to the manufacturer. Use of a faulty scan tool may result in mis-diagnosis and unnecessary parts replacement.

Only the parameters listed below are referenced in this service information for use in diagnosis. If all values are within the typical range described below, refer to Symptoms - Engine Controls.

Scan Tool Parameter	Data List	Parameter Range/Units	Typical Data Values
Engine Idling/Radiator Hose Hot/Park or Neutral/Closed Loop/Accessories Off			
5V Reference Voltage Circuit 1		Valid Invalid	This parameter displays the voltage sensed on the 5-volt reference 1 circuit at the control module.
5V Reference Voltage Circuit 2		Valid Invalid	This parameter displays the voltage sensed on the 5-volt reference 2 circuit at the control module.
A/C Cutoff Mode (Air Conditioning)		Inactive Pressure Max. Acceleration Active	
A/C Disengagement 1st History		Present Not Present	
A/C Disengagement 1st History		Present Not Present	
A/C Disengagement 2nd History		Present Not Present	

A/C Disengagement 3rd History		Present Not Present	The parameter displays the last 8 air conditioning (A/C) compressor disengages in order from 1 to 8 with 8 being the most recent. There are about 8 possible causes for the A/C compressor to disengage.
A/C Disengagement 4th History		Present Not Present	
A/C Disengagement 5th History		Present Not Present	
A/C Disengagement 6th History		Present Not Present	
A/C Disengagement 7th History		Present Not Present	
A/C Disengagement 8th History		Present Not Present	
A/C Pressure Sensor	--	0 - 3,450 kPa	This parameter displays the pressure from the A/C high side pressure sensor signal circuit to the control module.
A/C Pressure Sensor	--	0 - 5 Volts	The scan tool displays 0-5 Volts. The scan tool displays approximately ?? Volts when the ignition is ON.
Accelerator Pedal Position Sensor 1-2 Correlation	--	Okay	This parameter displays Disagree if the control module detects the signal voltage from APP sensor 1 is not in correct relationship to APP sensor 2. The scan tool displays Agree under the normal operating conditions.
	--	Not Okay	
A/C Request (Air Conditioning)		Not Present	This parameter displays the state of the air conditioning (A/C) request input to the control module from the heating, ventilation, and air conditioning (HVAC) controls. The scan tool will display Not Present indicates the control module is not receiving a request from the HVAC system to ground the A/C clutch relay control circuit.
Actual Torque	--	0 - 100 %	This parameter displays the engine load in percent based on inputs to the control module from various engine sensors. The scan tool will display a low percentage when the engine is at idle with little or no load. The scan tool will display a high percentage when the engine is running at a high RPM under a heavy load
			This parameter displays the commanded state of the generator

Alternator F Terminal	0 - 100 %		by the control module. A High value indicates a high charging command, and a low value indicates a low charging command.
Alternator L Terminal Circuit	--	On/Off	This parameter displays if the control module is allowing the generator to operate. The scan tool displays ON if the generator is allowed to operate. The scan tool displays OFF if the control module is disabling the generator.
Alternator L Terminal Duty Cycle	--		
Amibent Temperature	--	° C	This parameter displays the ambient, outside, air temperature as calculated by the control module.
APP Sensor (Acceleration)	--	0 - 100 %	This parameter displays the position of the Accelerator Pedal as calculated by the Accelerator Pedal Position Sensor.
APP Sensor 1 (Accelerator Pedal Position)	--	%	This parameter displays the voltage signal sent to the control module from accelerator pedal position (APP) sensor 1 of the APP sensor assembly. APP sensor 1 is a range of values indicating a low voltage when the accelerator pedal is not pressed to a high voltage when the accelerator pedal is fully pressed.
APP Sensor 1 (Accelerator Pedal Position)	--	Volts	The scan tool displays 0-?? Volts. The scan tool displays approximately ?? Volts when the ignition is ON.
APP Sensor 1 (Accelerator Pedal Position)	--	%	This parameter displays the angle of the accelerator pedal position (APP) sensor 1 as calculated by the control module using the signal from the APP sensor 1. APP sensor 1 is a range of values indicating a low percentage when the accelerator pedal is not pressed to a high percentage when the accelerator pedal is fully pressed.
APP Sensor 2 (Accelerator Pedal Position)	--	Volts	The scan tool displays 0-?? Volts. The scan tool displays approximately ?? Volts when the ignition is ON.
APP Sensor 2			This parameter displays the angle of the accelerator pedal position (APP) sensor 1 as calculated by the control module using the signal from the APP sensor 1. APP sensor 1 is a

(Accelerator Pedal Position)	--	%	range of values indicating a low percentage when the accelerator pedal is not pressed to a high percentage when the accelerator pedal is fully pressed.
Auto Learn Counter		Counts	
Auto Learn Timer		h:m:s	
B1 Average Injection Time (Bank 1)		ms	
B1 Catalyst Temperature	--	° C	This parameter displays the B1 catalytic converter temperature as calculated by the control module.
B1 LTFT Cruise/Acceleration (Bank 1 Long Term Fuel Trim)		%	The scan tool displays in %. This parameter is the long term fuel trim for this bank as calculated by the control module. The scan tool will display of more than 0 percent indicating that time is being added to the injector pulse width, increasing the amount of fuel to this bank of the engine. The scan tool will display a value of less than 0 indicating time is being subtracted from the injector pulse width, reducing the amount fuel to this bank of the engine. A value of 0 percent indicates no compensation is required to operate the engine at the desired air/fuel ratio.
B1S1 O2 Sensor (Bank 1 Sensor 1)	--	mV	This parameter displays the voltage from the signal produced by the heated oxygen sensor used to monitor fuel trim for cylinder bank 1. The scan tool will display a low voltage reading when that cylinder bank is running lean. The scan tool will display a high voltage reading when that cylinder bank is running rich.
B1S1 O2 Sensor Heater (Bank 1 Sensor 1)	--	On/Off	This parameter displays the commanded state of the bank 1 sensor 1 heater by the control module. The scan tool will display ON when the heater is commanded ON. The scan tool will display OFF when the heater is commanded OFF.
B1S1 O2 Sensor Heater Circuit Status (Bank 1 Sensor 1)	--	Passed_Failed_Incomplete	This parameter displays the commanded state of the bank 1 sensor 1 heater by the control module. The scan tool will display ON when the heater is commanded ON. The scan tool will display OFF

			when the heater is commanded OFF.
B1S2 O2 Sensor (Bank 1 Sensor 2)		mV	This parameter displays the voltage from the signal produced by the heated oxygen sensor used to monitor catalyst efficiency for cylinder bank 1. The scan tool will display a low voltage reading when that cylinder bank is running lean. The scan tool will display a high voltage reading when that cylinder bank is running rich.
B1S2 O2 Sensor Heater (Bank 1 Sensor 2)		On/Off	This parameter displays the commanded state of the bank 1 sensor 2 heater by the control module. The scan tool will display a higher value as the heater command is increased, and a lower value if the heater is not commanded ON.
B1S2 O2 Sensor Heater Circuit Status (Bank 1 Sensor 2)		Passed_Failed_Incomplete	This parameter displays the commanded state of the bank 1 sensor 2 heater by the control module. The scan tool will display ON when the heater is commanded ON. The scan tool will display OFF when the heater is commanded OFF.
B2 Average Injection Time (Bank 2)		ms	
B2 Catalyst Temperature (Bank 2)	--	° CA	This parameter displays the B1 catalytic converter temperature as calculated by the control module.
B2 LTFT Cruise/Acceleration (Bank 2 Long Term Fuel Trim)	--	0 - 100 %	The scan tool displays in %. This parameter is the long term fuel trim for this bank as calculated by the control module. The scan tool will display of more than 0 percent indicating that time is being added to the injector pulse width, increasing the amount of fuel to this bank of the engine. The scan tool will display a value of less than 0 indicating time is being subtracted from the injector pulse width, reducing the amount fuel to this bank of the engine. A value of 0 percent indicates no compensation is required to operate the engine at the desired air/fuel ratio.
B2 Short Term Fuel Trim (Bank 2)	--	0 - 100 %	
			This parameter displays the voltage from the signal produced by the heated oxygen sensor used to

B2S1 O2 Sensor (Bank 2 Sensor 1)	--	mV	monitor fuel trim for cylinder bank 2. The scan tool will display a low voltage reading when that cylinder bank is running lean. The scan tool will display a high voltage reading when that cylinder bank is running rich.
B2S1 O2 Sensor Heater (Bank 2 Sensor 1)	--	On/Off	This parameter displays the commanded state of the bank 2 sensor 1 heater by the control module. The scan tool will display a higher value as the heater command is increased, and a lower value if the heater is not commanded ON.
B2S1 O2 Sensor Heater Circuit Status (Bank 2 Sensor 1)	--	Passed_Failed_Incomplete	This parameter displays the commanded state of the bank 2 sensor 1 heater by the control module. The scan tool will display ON when the heater is commanded ON. The scan tool will display OFF when the heater is commanded OFF.
B2S2 O2 Sensor (Bank 2 Sensor 2)		mV	This parameter displays the voltage from the signal produced by the heated oxygen sensor used to catalyst efficiency for cylinder bank 2. The scan tool will display a low voltage reading when that cylinder bank is running lean. The scan tool will display a high voltage reading when that cylinder bank is running rich.
B2S2 O2 Sensor Heater (Bank 2 Sensor 2)		On/Off	his parameter displays the commanded state of the bank 2 sensor 2 heater by the control module. The scan tool will display a higher value as the heater command is increased, and a lower value if the heater is not commanded ON.
B2S2 O2 Sensor Heater (Bank 2 Sensor 2)		mA	
B2S2 O2 Sensor Heater Circuit Status (Bank 2 Sensor 2)		Passed_Failed_Incomplete	This parameter displays the commanded state of the bank 2 sensor 2 heater by the control module. The scan tool will display ON when the heater is commanded ON. The scan tool will display OFF when the heater is commanded OFF.
			This parameter displays the barometric pressure as calculated by the control module using the signal from the manifold absolute pressure (MAP) sensor measured when the

Barometer Pressure	--	kPa	ignition is turned on with the engine not running. The control module will update the barometric pressure during wide-open throttle (WOT) conditions. The scan tool will display a low value when the barometric pressure is low, and a high value when the barometric pressure is high.
Brake Lamp Switch	--	Active/Inactive	This parameter displays the state of the brake pedal as determined by the control module based on an input from the stop lamp pedal switch. This switch turns on the stop lamps when the brake pedal is depressed. The scan tool will display Active when the brake pedal is depressed.
Calculated Air Flow	--	g/s	
Calculated APP Sensor 1 (Accelerator Pedal Position)	--	0 - 100 %	This parameter displays the angle of the throttle position (TP) sensor 1 in percent. This information is calculated by the control module using the signal from the throttle position sensor 1. The scan tool will display a low percentage when the throttle plates are closed. The scan tool will display a high percentage when the throttle plates are fully open.
Calculated APP Sensor 2 (Accelerator Pedal Position)	--	0 - 100 %	This parameter displays the angle of the throttle position (TP) sensor 2 in percent. This information is calculated by the control module using the signal from the throttle position sensor 2. The scan tool will display a low percentage when the throttle plates are closed. The scan tool will display a high percentage when the throttle plates are fully open.
Calculated Pedal Position	--	0 - 100 %	This parameter displays the angle of the accelerator pedal as calculated by the control module using the signals from the accelerator pedal position sensors. The APP indicated angle is a range of values indicating a low percentage when the accelerator pedal is not pressed to a high percentage when the accelerator pedal is fully pressed.
			This parameter displays the angle of the throttle position (TP) sensor in

Calculated Throttle Position	--	0 - 100 %	percent. This information is calculated by the control module using the signal from the throttle position sensor. The scan tool will display a low percentage when the throttle plates are closed. The scan tool will display a high percentage when the throttle plates are fully open.
Camshaft Active Counter	--	Counts	This parameter displays an incrementing counter when the control module receives a signal form the camshaft position (CMP) sensor.
Camshaft Sensor Engine Speed	--	RPM	This parameter displays the speed of the engine as calculated by the signal from the camshaft position (CMP) sensor.
Catalyst Protection Mode	--	No_Yes	This parameter displays if the control module is commanding catalytic converter protection.
CC Disengagement 1st History	--	On/Off	The parameter displays the last 8 cruise control disengages in order from 1 to 8, with 8 being the most recent. There are about 33 possible causes for the cruise control to disengage.
CC Disengagement 2nd History	--	On/Off	
CC Disengagement 3rd History	--	On/Off	
CC Disengagement 4th History	--	On/Off	
CC Disengagement 5th History	--	On/Off	
CC Disengagement 6th History	--	On/Off	
CC Disengagement 7th History	--	On/Off	
CC Disengagement 8th History	--	On/Off	
Clutch Pedal Start Switch	--	Inactive_Active	This parameter displays the state of the clutch pedal as determined by the control module from the clutch start switch.
Clutch Pedal Switch	--	Inactive_Active	This parameter displays the current state of the clutch pedal as determined by the control module.
			This parameter indicates whether the engine meets the conditions for a cold start-up during the present ignition cycle. The scan tool displays Yes when the conditions for a cold start-up are met during this ignition

Cold Start Up	--	Yes/No	cycle. The scan tool displays No when the conditions for a cold start-up are not met during the present ignition cycle. Conditions for a cold start-up require the coolant temperature and the intake air temperature to be below a predetermined temperature and within a certain range of each other. These conditions must occur after the engine was warmed up to a specific temperature during the previous ignition cycle.
Commanded Air/Fuel Equivalence Ratio	--	0.0:1	This parameter displays the ratio of air to fuel as calculated by the control module based on various sensor inputs. The scan tool will display a lower air fuel ratio when a richer air to fuel mixture is commanded. The scan tool will display a higher air fuel ratio when a leaner air to fuel mixture is commanded. In closed loop operation the air fuel ratio should normally be around 14.2-14.7 to 1.
Commanded B1S1 O2 Sensor Heater (Bank 1 Sensor 1)	--	0 - 100 %	This parameter displays the commanded state of the bank 1 sensor 1 heater by the control module. The scan tool will display a higher value as the heater command is increased, and a lower value if the heater is not commanded ON.
Commanded B1S2 O2 Sensor Heater (Bank 1 Sensor 2)	--	0 - 100 %	This parameter displays the commanded state of the bank 1 sensor 2 heater by the control module. The scan tool will display a higher value as the heater command is increased, and a lower value if the heater is not commanded ON.
Commanded B2S1 O2 Sensor Heater (Bank 2 Sensor 1)	--	0 - 100 %	This parameter displays the commanded state of the bank 2 sensor 1 heater by the control module. The scan tool will display a higher value as the heater command is increased, and a lower value if the heater is not commanded ON.
Commanded B2S2 O2 Sensor Heater (Bank 2 Sensor 2)	--	0 - 100 %	This parameter displays the commanded state of the bank 2 sensor 2 heater by the control module. The scan tool will display a higher value as the heater command is increased, and a lower value if the heater is not commanded ON.

Coolant Temperature	--	Degrees	This parameter displays the temperature of the engine coolant based on a voltage input from the engine coolant temperature (ECT) sensor to the control module. The scan tool will display a low value when the coolant temperature is low, and a high value when the coolant temperature is high.
Crank Request	--	Active/Inactive	This parameter displays whether the ignition switch has been cycled to the crank position requesting the control module to activate the starter relay.
Crankshaft Active Count	--	Counts	This parameter displays an incrementing counter when the control module receives a signal from the crankshaft position (CKP) sensor.
Crankshaft Resynchronise	--	Counts	This parameter displays the number of times the control module re-syncs with the crankshaft position (CKP) sensor.
Crankshaft Speed	--	RPM	This parameter displays the engine speed as calculated by the control module using the signal form the crankshaft position (CKP) sensor.
Cruise Control	--	On/Off	This parameter displays the status of the cruise control system as determined by the control module. The scan tool will display On when the cruise control system is in control of vehicle speed. The scan tool will display Off when the cruise control system is not operating.
Cruise Control Active	--	Yes/No	This parameter displays the status of the cruise control system as determined by the control module. The scan tool will display Yes when the cruise control system is in control of vehicle speed. The scan tool will display No when the cruise control system is not operating.
Cruise Control Cancel	--	Active/Inactive	This parameter displays the status of the Cruise Control Cancel.
Cruise Resume/Acceleration Switch	--	Active/Inactive	This parameter displays the status of the Cruise Resume/Acceleration switch.
Cruise Set / Decel Switch	--	Active/Inactive	This parameter displays the status of the Cruise Set/Deceleration switch.

Cycles of Misfire	--	Counts	This parameter displays the number of cylinder firing events that were recorded as misfires as determined by the control module.
Cylinder 1 Ignition Circuit Status	--		This parameter displays the state of the fuel injector control circuit. The parameter displays Fault if the fuel injector control circuit is open, shorted to ground, or shorted to voltage. This parameter displays indeterminate until the control circuit has been commanded ON.
Cylinder 1 Injector Circuit Status	--	Passed_Failed_Incomplete	This parameter displays the status of the output driver for the injector control circuit. The scan tool will display OK, Incomplete, Short B+, Short Gnd/Open. The scan tool will display OK if the circuit is operating correctly. The scan tool will display a fault if there is an open, short to ground, or a short to voltage on the circuit.
Cylinder 1 Knock Detected	--	Yes/No	This parameter displays the knock retard as commanded by the control module for cylinders 1-6. Each cylinder is controlled individually based on both knock sensor signal inputs.
Cylinder 2 Ignition Circuit Status	--		This parameter displays the state of the fuel injector control circuit. The parameter displays Fault if the fuel injector control circuit is open, shorted to ground, or shorted to voltage. This parameter displays indeterminate until the control circuit has been commanded ON.
Cylinder 2 Injector Circuit Status	--	Passed_Failed_Incomplete	This parameter displays the status of the output driver for the injector control circuit. The scan tool will display OK, Incomplete, Short B+, Short Gnd/Open. The scan tool will display OK if the circuit is operating correctly. The scan tool will display a fault if there is an open, short to ground, or a short to voltage on the circuit.
Cylinder 2 Knock Detected	--	Yes/No	This parameter displays the knock retard as commanded by the control module for cylinders 1-6. Each cylinder is controlled individually based on both knock sensor signal inputs.
			This parameter displays the state of

Cylinder 3 Ignition Circuit Status	--		the fuel injector control circuit. The parameter displays Fault if the fuel injector control circuit is open, shorted to ground, or shorted to voltage. This parameter displays indeterminate until the control circuit has been commanded ON.
Cylinder 3 Injector Circuit Status	--	Passed_Failed_Incomplete	This parameter displays the status of the output driver for the injector control circuit. The scan tool will display OK, Incomplete, Short B+, Short Gnd/Open. The scan tool will display OK if the circuit is operating correctly. The scan tool will display a fault if there is an open, short to ground, or a short to voltage on the circuit.
Cylinder 3 Knock Detected	--	Yes/No	This parameter displays the knock retard as commanded by the control module for cylinders 1-6. Each cylinder is controlled individually based on both knock sensor signal inputs.
Cylinder 4 Ignition Circuit Status	--		This parameter displays the state of the fuel injector control circuit. The parameter displays Fault if the fuel injector control circuit is open, shorted to ground, or shorted to voltage. This parameter displays indeterminate until the control circuit has been commanded ON.
Cylinder 4 Injector Circuit Status	--	Passed_Failed_Incomplete	This parameter displays the status of the output driver for the injector control circuit. The scan tool will display OK, Incomplete, Short B+, Short Gnd/Open. The scan tool will display OK if the circuit is operating correctly. The scan tool will display a fault if there is an open, short to ground, or a short to voltage on the circuit.
Cylinder 4 Knock Detected	--	Yes/No	This parameter displays the knock retard as commanded by the control module for cylinders 1-6. Each cylinder is controlled individually based on both knock sensor signal inputs.
Cylinder 5 Ignition Circuit Status	--		This parameter displays the state of the fuel injector control circuit. The parameter displays Fault if the fuel injector control circuit is open, shorted to ground, or shorted to voltage. This parameter displays

			indeterminate until the control circuit has been commanded ON.
Cylinder 5 Injector Circuit Status	--	Passed_Failed_Incomplete	This parameter displays the status of the output driver for the injector control circuit. The scan tool will display OK, Incomplete, Short B+, Short Gnd/Open. The scan tool will display OK if the circuit is operating correctly. The scan tool will display a fault if there is an open, short to ground, or a short to voltage on the circuit.
Cylinder 5 Knock Detected	--	Yes/No	This parameter displays the knock retard as commanded by the control module for cylinders 1-6. Each cylinder is controlled individually based on both knock sensor signal inputs.
Cylinder 6 Ignition Circuit Status	--		This parameter displays the state of the fuel injector control circuit. The parameter displays Fault if the fuel injector control circuit is open, shorted to ground, or shorted to voltage. This parameter displays indeterminate until the control circuit has been commanded ON.
Cylinder 6 Injector Circuit Status	--	Passed_Failed_Incomplete	This parameter displays the status of the output driver for the injector control circuit. The scan tool will display OK, Incomplete, Short B+, Short Gnd/Open. The scan tool will display OK if the circuit is operating correctly. The scan tool will display a fault if there is an open, short to ground, or a short to voltage on the circuit.
Cylinder 6 Knock Detected	--	Yes/No	This parameter displays the knock retard as commanded by the control module for cylinders 1-6. Each cylinder is controlled individually based on both knock sensor signal inputs.
Cylinder 7 Ignition Circuit Status	--		This parameter displays the state of the fuel injector control circuit. The parameter displays Fault if the fuel injector control circuit is open, shorted to ground, or shorted to voltage. This parameter displays indeterminate until the control circuit has been commanded ON.
			This parameter displays the status of the output driver for the injector control circuit. The scan tool will

Cylinder 7 Injector Circuit Status	--	Passed_Failed_Incomplete	display OK, Incomplete, Short B+, Short Gnd/Open. The scan tool will display OK if the circuit is operating correctly. The scan tool will display a fault if there is an open, short to ground, or a short to voltage on the circuit.
Cylinder 7 Knock Detected	--	Yes/No	This parameter displays the knock retard as commanded by the control module for cylinders 1-6. Each cylinder is controlled individually based on both knock sensor signal inputs.
Cylinder 8 Injector Circuit Status	--		This parameter displays the state of the fuel injector control circuit. The parameter displays Fault if the fuel injector control circuit is open, shorted to ground, or shorted to voltage. This parameter displays indeterminate until the control circuit has been commanded ON.
Cylinder 8 Injector Circuit Status	--	Passed_Failed_Incomplete	This parameter displays the status of the output driver for the injector control circuit. The scan tool will display OK, Incomplete, Short B+, Short Gnd/Open. The scan tool will display OK if the circuit is operating correctly. The scan tool will display a fault if there is an open, short to ground, or a short to voltage on the circuit.
Cylinder 8 Knock Detected	--	Yes/No	This parameter displays the knock retard as commanded by the control module for cylinders 1-6. Each cylinder is controlled individually based on both knock sensor signal inputs.
Dec. Fuel Cutoff (Deceleration)	--	Active/Inactive	This parameter displays the status of the operating mode of the control module used to turn off the fuel injectors and the evaporative emission (EVAP) canister purge valve during certain deceleration conditions.
Desired Engine Idle Speed	--	RPM	This parameter displays the desired engine idle speed as commanded by the control module.
Desired Throttle Position	--	0 - 100 %	This parameter displays the angle of the throttle position (TP) in percent. This information is calculated by the control module using the signals from the throttle position sensors. The scan tool will display a low

			percentage when the throttle plates are closed. The scan tool will display a high percentage when the throttle plates are fully open.
Distance Since DTC Cleared	--	Km	This parameter displays the distance accumulated since an emission diagnostic trouble code was cleared. The scan tool will display increasing distance as the vehicle is driven.
ECM Immobilised	--	No_Yes	The scan tool displays Yes or No. The scan tool displays Yes if the body control module (BCM) and the control module lose communications with each other after the BCM sends the correct password. The scan tool displays No if the BCM is communicating the correct password to the ECM.
Engine Control Ignition Relay	--	On/Off	This parameter displays the state of the control circuit control module power relay as commanded by the control module. The scan tool displays ON with the engine running.
Engine Control Ignition Relay Circuit Status	--	Passed_Failed_Incomplete	This parameter displays the status of the output driver for the EC Ignition Relay control circuit. The scan tool will display OK, Incomplete, Short B+, Short Gnd/Open. The scan tool will display OK if the circuit is operating correctly. The scan tool will display a fault if there is an open, short to ground, or a short to voltage on the circuit.
Engine Control Ignition Relay Feedback	--	V	This parameter displays the voltage available at the EC ignition relay pin of the control module.
Engine Load	--	%	This parameter displays the calculated engine load in percent based on inputs to the control module from various engine sensors.
Engine Oil Life Remaining	--	0 - 100 %	This parameter displays the percent of engine oil life remaining. The controller calculates the engine oil life by monitoring engine load, coolant temperature, and engine speed.
Engine Oil Pressure	--	kPa	This parameter displays the engine oil pressure.
Engine Oil Pressure			The scan tool displays 0-?? Volts. The scan tool displays

Sensor	--	Volts	approximately ?? Volts when the ignition is ON.
Engine Oil Temperature	--	Degree	This parameter displays the temperature of the engine oil.
Engine Run Time	--	hh:mm:ss	This parameter displays the time elapsed since the engine was started. The scan tool will display the time in hours, minutes and seconds. The engine run time will reset to zero as soon as the engine stops running.
Engine Speed	--	RPM	This parameter displays the speed of the crankshaft as calculated by the control module based on inputs from the Crankshaft Position (CKP) Sensor. The scan tool will display the engine speed in revolutions per minute (RPM).
Engine Speed Circuit Status	--	Passed_Failed_Incomplete	This parameter displays the status of the engine speed circuit. The scan tool will display OK, Incomplete, Short B+, Short Gnd/Open. The scan tool will display OK/Incomplete if the circuit is operating correctly.
EVAP Purge Solenoid (Evaporative Emission)	--	%	This parameter displays the on-time or duty cycle of the EVAP canister purge solenoid commanded by the control module. Zero percent indicates no purge. One hundred percent indicates full purge.
EVAP Purge Solenoid Valve Circuit Status (Evaporative Emission)	--	Passed_Failed_Incomplete	This parameter displays the status of the output driver for the evaporative emission purge solenoid control circuit. The scan tool will display OK, Incomplete, Short B+, Short Gnd/Open. The scan tool will display OK/Incomplete if the circuit is operating correctly. The scan tool will display a fault if there is an open, short to ground, or a short to voltage on the circuit.
Fan Relay 1	--	On/Off	This parameter displays the state of the fan relay control circuit. The parameter displays Fault if the fan relay control circuit is open, shorted to ground, or shorted to voltage. The parameter displays Indeterminate until the circuit has been commanded ON.
			This parameter displays the state of the fan relay control circuit. The parameter displays Fault if the fan

Fan Relay 1 Circuit Status	--	Passed_Failed_Incomplete	relay control circuit is open, shorted to ground, or shorted to voltage. The parameter displays Indeterminate until the circuit has been commanded ON.
Fan Relay 2 and 3	--	On/Off	This parameter displays the control module commanded state of the fan relay control circuit.
Fan Relay 2 and 3 Circuit Status	--	Passed_Failed_Incomplete	This parameter displays the state of the fan relay control circuit. The parameter displays Fault if the fan relay control circuit is open, shorted to ground, or shorted to voltage. The parameter displays Indeterminate until the relay control circuit has been commanded ON.
Fuel Level	--	0 - 100 %	This parameter displays the amount of fuel remaining in tall of the fuel tanks of the vehicle as a percentage. The control module calculates this level using the signals from the sensors used to monitor the fuel level in the fuel tanks. The scan tool will display a low reading when the total fuel level in the vehicle is low or near empty. The scan tool will display a high reading when the fuel level in the tank is high or near full.
Fuel Level Sensor 1 (Right)	--	Volts	The scan tool displays 0-?? Volts. The scan tool displays approximately ?? Volts when the ignition is ON.
Fuel Level Sensor 2 (left)	--	Volts	The scan tool displays 0-?? Volts. The scan tool displays approximately ?? Volts when the ignition is ON.
Fuel Pump Relay	--	On/Off	This parameter displays the commanded state of the fuel pump relay control circuit. The fuel pump relay should be ON when the scan tool indicates the fuel pump relay command is ON. The fuel pump relay should be OFF when the scan tool indicates the fuel pump relay command is OFF.
Fuel System Status	--	Closed Loop_Open Loop	The scan tool displays Open Loop or Closed Loop. The scan tool displays Closed Loop if the control module is controlling the fuel delivery according to the heated oxygen sensor (HO2S) voltages. The scan tool displays open loop if the control module is not adjusting for HO2S

			inputs. In open loop the control module bases fuel deliver on throttle position, engine coolant temperature, and mass airflow sensor inputs.
Fuel Pump Relay Circuit Status	--	Passed_Failed_Incomplete	This parameter displays the state of the fuel pump relay control circuit. The parameter displays Fault if the fuel pump relay control circuit is open, shorted to ground, or shorted to voltage. The parameter displays Indeterminate until the circuit has been commanded ON.
Fuel Trim Cell	--	Index	This parameter displays the fuel trim cell as calculated by the control module based on many sensor inputs. The fuel trim cell indicates which cell is currently active.
Fuel Trim Learn	--	Enable/Disable	The scan tool displays Enabled or Disabled. When conditions are appropriate for enabling long term fuel trim corrections, the scan tool displays Enabled. If the scan tool displays Disabled, then long term fuel trim will not respond to changes in short term fuel trim.
Hot Open Loop	--	Inactive_Active	This parameter indicates the status of the fuel delivery system. The scan tool will display Active if the fuel system is running in Open Loop due to a temperature concern. The scan tool will display Inactive if the fuel system is operating normally.
Ignition Accessory Signal	--	On/Off	This parameter displays the state of the ignition input to the control module from the ignition switch. The scan tool will display ON when the ignition switch is in the ignition accessory position. The scan tool will display OFF when the ignition switch is in any other position.
Ignition Voltage	--	Volts	The scan tool displays 0-?? Volts. The scan tool displays approximately ?? Volts when the ignition is ON.
Injector 1 Disabled Due	--	Yes/No	
Injector 2 Disabled Due	--	Yes/No	
Injector 3 Disabled Due	--	Yes/No	

Injector 4 Disabled Due	--	Yes/No	
Injector 5 Disabled Due	--	Yes/No	
Injector 6 Disabled Due	--	Yes/No	
Injector 7 Disabled Due	--	Yes/No	
Injector 8 Disabled Due	--	Yes/No	
Intake Air Temp	--	Degrees	This parameter displays the temperature of the intake air calculated by the control module based on the input from the intake air temperature (IAT). The scan tool will display a low value for a low intake air temperature, and a high value for a high intake air temperature.
Knock Retard	--	Degrees	The scan tool displays in °. This parameter indicates the amount of timing retard commanded by the control module. The scan tool will display a lower value if no knock is detected, and a higher value as more knock is detected and the control module retards the ignition timing.
MAF Performance Test (Mass Air Flow)	--	Okay_Fail	
Malfunction Indicator (MI)	--	On_Off	This parameter displays the commanded state of the malfunction indicator lamp (MIL) control circuit. The malfunction indicator lamp should be on when the scan tool indicates the MIL Command is On. The malfunction indicator lamp should be off when the scan tool indicates the MIL Command is Off. The control module will command the MIL On when the ignition is ON with the engine OFF in order to perform a bulb check.
Malfunction Indicator (MI) Circuit Status	--	Passed_Failed_Incomplete	This parameter displays the status of the output driver for the malfunction indicator lamp control circuit. The scan tool will display Passed, Failed or Incomplete. The scan tool will display Pass/Fail if the circuit is operating correctly. The scan tool will display Incomplete if there is an open, short to ground, or

			a short to voltage on the circuit.
Manifold Absolute Pressure	--	kPa	The scan tool displays kPa. This parameter displays the pressure inside of the intake manifold as calculated by the control module based on the input from the MAP sensor. The scan tool will display a high value at cruising speed or wide open throttle (WOT). The scan tool will display a low value at idle speed.
Mass Air Flow Sensor	--	Hz	The scan tool displays in Hz. This parameter indicates the frequency signal sent from the MAF sensor to the control module. the scan tool will display a high value indicates a higher engine speed. The scan tool will display a low value at idle.
MI Requested by DTC (Malfunction Indicator)	--	No_Yes	This parameter indicates the reason the control module illuminated the MIL. The scan tool will display YES when the MIL is requested as a result of an A or B type DTC. The scan tool will display NO if the MIL is illuminated for another reason, such as transmission DTCs.
Misfire Current Cylinder 1	--	(#)	The scan tool will display in counts. This parameter indicates the number of cylinder firing events detected as possible misfires on each cylinder during the last 200 crankshaft revolutions as calculated by the control module. The scan tool will display a low number for a low number of cylinder misfire events. The scan tool will display a high number for a high number of cylinder misfire events.
Misfire Current Cylinder 2	--	(#)	
Misfire Current Cylinder 3	--	(#)	
Misfire Current Cylinder 4	--	(#)	
Misfire Current Cylinder 5	--	(#)	
Misfire Current Cylinder 6	--	(#)	
Misfire Current Cylinder 7	--	(#)	
Misfire Current Cylinder 8	--	(#)	
Misfire History Cylinder 1	--	(#)	The scan tool displays in counts. This parameter displays the total level of cylinder misfires that have been calculated for each cylinder by
Misfire History Cylinder 2	--	(#)	
Misfire History Cylinder 3	--	(#)	
Misfire History Cylinder 4	--	(#)	

Misfire History Cylinder 5	--	(#)	the control module. This parameter will not update or show activity until a misfire DTC has become active. The misfire history counters will update every 200 cylinder firing events.
Misfire History Cylinder 6	--	(#)	
Misfire History Cylinder 7	--	(#)	
Misfire History Cylinder 8	--	(#)	
Number of Warm-ups Since DTC Cleared	--	Counts	This parameter indicates the number of warm-up cycles that have occurred Since DTCs were cleared. The scan tool will display a higher counts as more warm-up cycles have occurred since the DTCs were cleared
Oil Change Symbol	--	On_Off	
Oil Level	--	Normal_Low	This parameter displays the state of the engine oil level switch as determined by the control module. The scan tool will display Normal or Low. OK indicates that the engine oil level is not too low for safe operation of the engine. Low indicates the engine oil level is abnormally low and has closed the engine oil level switch.
Oil Temperature Sensor	--	°C	This parameter displays the engine oil pressure.
Power Enrichment	--	Active/Inactive	Scan tool displays ACTIVE or INACTIVE. ACTIVE displayed indicates that the control module has detected conditions appropriate to operate in Power Enrichment mode. The control module commands Power Enrichment mode when a large increase in throttle position and load is detected. While in Power Enrichment, the control module will increase the amount of fuel delivered by entering Open Loop and increasing the injector pulse width.
Powertrain Immobiliser Status	--		
Reduced Engine Power	--	Active/Inactive	The scan tool displays Active or Inactive. The scan tool displays Active when the control module receives a signal from the throttle actuator control (TAC) module that a TAC system fault is occurring. The scan tool displays inactive when the

			engine is operating normally.
Requested Torque	--	0 - 100 %	This parameter indicates the percentage of available torque requested from the engine to the transmission as calculated by the control module. The scan tool will display a higher value for higher torque, and a lower value for lower torque.
Security Code Accepted	--	Yes_No	
Security Code Lockout	--	Active_Inactive	
Security Code Programmed	--	Yes_No	
Spark Advance	--	Degrees CA	This parameter displays the amount of spark advance the control module is commanding on the ignition control circuits. The control module determines the desired advance.
Start-Up ECT	--	°C	This parameter indicates the engine coolant temperature at start-up, as calculated by the control module based on the input from the engine coolant temperature sensor. The scan tool will display a higher value at higher engine start-up temperatures, and a lower value at lower start-up temperatures.
Start-Up IAT	--	°C	Indicates the intake air temperature (IAT) at the time that the vehicle was started. Used to determine if the last start-up was a cold start. The scan tool range is -39 to +140° C (-38 to +284°F). This parameter indicates the ambient air temperature at start-up.
Starter Relay	--	On/Off	This parameter displays the control modules commanded state of the starter motor relay control circuit.
Starter Relay Circuit Status	--	Incomplete_Pass_Fail	This parameter displays the status of the output driver for the starter relay control circuit. The scan tool will display OK, Incomplete, Short B+, Short Gnd/Open. The scan tool will display OK/Incomplete if the circuit is operating correctly. The scan tool will display a fault if there is an open, short to ground, or a short to voltage on the circuit.
			This parameter indicates the status

TAC Forced Engine Shutdown (Throttle Actuator Control)	--	No_Yes	of TAC control by the control module. The scan tool will display YES if the engine has been shut down due to a throttle control fault. The scan tool will display NO if the engine has not been shut down by a throttle control fault.
TAC Motor (Throttle Actuator Control)	--	Enabled_Disabled	This parameter indicates the status of the TAC motor driver. The scan tool will display Enabled if TAC motor operation is allowed. The scan tool will display disabled if the TAC motor is disabled.
TAC Motor Command (Throttle Actuator Control)	--	%	This parameter indicates the required duty cycle to maintain a desired throttle position. The scan tool will display a higher value if more effort is required to move the throttle to the desired position, such as physical resistance. The scan tool will display a lower value if less effort is required to move the throttle to the desired position.
Torque Management Spark Retard	--	°CA	his parameter indicates how much the ignition spark timing is being retarded to control torque by the control module. The scan tool will display a higher value under extreme torque control conditions such as spinning wheels. The scan tool will display a lower value under low torque control conditions such as light driving.
Total Knock Retard		Degrees CA	This parameter indicates how much ignition spark timing is being retarded due to all control systems monitored by the control module. The scan tool will display a high value during extreme conditions such as high temperatures and antilock braking. The scan tool will display a lower value during lighter driving conditions.
Total Misfire		(#)	The scan tool range is 0-255 counts. This parameter indicates the total level of misfire that has been detected on each cylinder. The misfire history counters will not update or show any activity until a misfire or DTC P0300 has become active. The misfire history counter will update every 200 cylinder firing events.

TP Sensor 1 (Throttle Position)	0 - 100 %	This parameter displays the angle of the throttle position (TP) sensor 1 in percent. This information is calculated by the control module using the signal from the throttle position sensor 1. The scan tool will display a low percentage when the throttle plates are closed. The scan tool will display a high percentage when the throttle plates are fully open.
TP Sensor 1 (Throttle Position)	Volts	The scan tool displays 0-?? Volts. The scan tool displays approximately ?? Volts when the ignition is ON.
TTP Sensor 1- 2 Correlation (Throttle Position)	Okay_Not Okay	This parameter displays the results of a control module test that compares signals from the throttle position (TP) sensors 1 and 2 . The scan tool will display Agree when the signal from TP sensor 1 corresponds with the signal from TP sensor 2. The scan tool will display Disagree when the signal from TP sensor 1 conflicts with the signal from TP sensor 2.
TP Sensor 1 Learned Lower Position (Throttle Position)	V	This parameter displays the learned minimum value of TP sensor 1 as recorded by the control module during the last learn procedure.
TP Sensor 2 (Throttle Position)	%	This parameter displays the angle of the throttle position (TP) sensor 2 in percent. This information is calculated by the control module using the signal from the throttle position sensor 2. The scan tool will display a low percentage when the throttle plates are closed. The scan tool will display a high percentage when the throttle plates are fully open.
TP Sensor 2 (Throttle Position)	Volts	The scan tool displays 0-?? Volts. The scan tool displays approximately ?? Volts when the ignition is ON.
TP Sensor 2 Learned Lower Position (Throttle Position)	Volts	The scan tool displays 0-?? Volts. The scan tool displays approximately ?? Volts when the ignition is ON.
		This parameter indicates the current state of the gear select switch on the transmission/transaxle as calculated by the control module

Transmission Gear	P-N_In Gear	based on the TR switch. The scan tool status will switch from High to Low as different combinations are met. On the scan tool in Park, the PRNDL would read P and A will be Low, and B and C will be High.
Transmission Oil Temperature	°C	
Vehicle Speed	Km/h	This parameter indicates the vehicle speed calculated by the control module based on an input from the vehicle speed sensor (VSS). the scan tool will display a high value at higher vehicle speeds, and a low value at lower vehicle speeds.
Vehicle Speed Circuit Status		This parameter displays the status of the Vehicle Speed Circuit. The scan tool will display OK, Incomplete, Short B+, Short Gnd/Open. The scan tool will display OK/Incomplete if the circuit is operating correctly.
Warm-ups without Emission Related DTC's	(w/o unit)	Faults: The scan tool displays in counts. This parameter counts the number of warm-up cycles without an emission fault present. The parameter increments until a fault occurs. If a fault occurs, the counter reverts to 0 until the fault is corrected. Clearing information with a scan tool or a loss of power to the ECM also resets the counter to 0.
Warm-ups without Non-Emission Related DTC'S	(w/o unit)	The scan tool displays in counts. This parameter counts the number of warm-up cycles without a non-emission fault present. The parameter increments until a fault occurs. If a fault occurs, the counter reverts to 0 until the fault is corrected. Clearing information with a scan tool or a loss of power to the ECM also resets the counter to 0.
Wide Open Throttle	No_Yes	This parameter indicates the throttle status commanded by the control module. The scan tool will display YES is the vehicle throttle is commanded to wide open. The scan tool will display NO if the vehicle throttle is commanded to an amount less than 100 percent.

DTC C1209, C1223, C1227, or C1234

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC C1209: Left Rear Wheel Speed Sensor Circuit High

DTC C1223: Left Rear Wheel Speed Sensor Circuit

DTC C1227: Left Rear Wheel Speed Sensor Circuit Range/Performance

DTC C1234: Left Rear Wheel Speed Sensor Circuit Low

Circuit/System Description

The wheel speed sensor receives a 12-volt power supply voltage from the electronic brake control module (EBCM) and provides an output signal to the EBCM. As the wheel spins, the wheel speed sensor sends the EBCM a DC square wave signal. The EBCM uses the frequency of the square wave signal to calculate the wheel speed. If the EBCM identifies an error, it sets a code and communicates via GMLAN to the engine control module (ECM).

Conditions for Running the DTC

Ignition voltage is between 9 and 16 volts.

Conditions for Setting the DTC

- The engine must be ON.
- The vehicle speed is greater than 16 km/h (10 mph).

Action Taken when the DTC Sets

DTCs C1209, C1223, C1227 and C1234 are type C DTCs.

Conditions for Clearing the MIL/DTC

DTCs C1209, C1223, C1227 and C1234 are type C DTCs.

Reference Information

Schematic Reference

- Engine Controls Schematics .
- Antilock Brake System Schematics .

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing .
- Testing for Intermittent Conditions and Poor Connections .
- Wiring Repairs .

Scan Tool Reference

Control Module References

Circuit/System Verification

The ECM sets DTCs C1209, C1223, C1227 and C1234 in conjunction with the EBCM, any EBCM wheel speed sensor DTCs should be diagnosed ahead of performing the test below.

Circuit/System Testing

1. Verify that no other DTCs are set.
   If any other DTCs are set, refer to Diagnostic Trouble Code (DTC) Type Definitions .
2. Ignition ON, using a scan tool view the current DTC's.
   If any of the following DTCs C1209, C1223, C1227 or C1234, are set to current replace ECM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Engine Control Module Replacement for engine control module replacement, setup and programming.

DTC C1210, C1224, C1228, or C1235

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC C1210: Right Rear Wheel Speed Sensor Circuit High

DTC C1224: Right Rear Wheel Speed Sensor Circuit

DTC C1228: Right Rear Wheel Speed Sensor Circuit Range/Performance

DTC C1235: Right Rear Wheel Speed Sensor Circuit Low

Circuit/System Description

The wheel speed sensor receives a 12-volt power supply voltage from the electronic brake control module (EBCM) and provides an output signal to the EBCM. As the wheel spins, the wheel speed sensor sends the EBCM a DC square wave signal. The EBCM uses the frequency of the square wave signal to calculate the wheel speed. If the EBCM identifies an error, it sets a code and communicates via GMLAN to the engine control module (ECM).

Conditions for Running the DTC

Ignition voltage is between 9 and 16 volts.

Conditions for Setting the DTC

- The engine must be ON.
- The vehicle speed is greater than 16 km/h (10 mph).

Action Taken when the DTC Sets

DTCs C1210, C1224, C1228 and C1235 are type C DTCs.

Conditions for Clearing the MIL/DTC

DTCs C1210, C1224, C1228 and C1235 are type C DTCs.

Reference Information

Schematic Reference

- Engine Controls Schematics.
- Antilock Brake System Schematics.

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing.
- Testing for Intermittent Conditions and Poor Connections.
- Wiring Repairs.

Scan Tool Reference

Control Module References

Circuit/System Verification

The ECM sets DTCs C1210, C1224, C1228 and C1235 in conjunction with the EBCM, any EBCM wheel speed sensor DTC should be diagnosed ahead of performing the test below.

Circuit/System Testing

1. Verify that no other DTCs are set.
   If any other DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. Ignition ON, using a scan tool view the current DTC's.
   If any of the following DTCs C1210, C1224, C1228 or C1235, are set to current replace ECM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Engine Control Module Replacement for engine control module replacement, setup and programming.

DTC P0016

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0016: Crankshaft Position (CKP) Camshaft Position (CMP) Correlation

Circuit / System Description

The engine control module (ECM) uses the crankshaft position (CKP) sensor and the camshaft position (CMP) sensor pulses to monitor the correlation between the crankshaft and the camshaft position. The crankshaft reluctor wheel consists of a 60-tooth pattern with 2 teeth missing for the reference gap. Each tooth is evenly spaced 6 degrees apart, except for the reference gap. The camshaft reluctor wheel has 4 teeth, 2 narrow, and 2 wide. The 4 trailing edges of each tooth are evenly spaced at 90 degrees apart around the circumference of the camshaft sprocket. With the engine running, and the CMP actuator in the parked position, the ECM expects the camshaft signal pulses to occur 36 crankshaft degrees before top dead center (BTDC) for cylinder number 1, and every 90 degrees thereafter.

Conditions for Running the DTC

- DTC P0335, P0336, P0340, P0341, P0641, or P0651 is not set.
- The engine is running.
- The engine speed is less than 2,000 RPM.
- DTC P0016 runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the CMP sensor pulses occur more than 11 crank degrees before, or 11 crank degrees after, nominal position for 24 out of 30 engine cycles.

Action Taken When the DTC Sets

DTC P0016 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0016 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Electronic Ignition (EI) System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Start the engine.
2. Allow the engine to reach normal operating temperature.
3. Allow the engine to idle.
4. Observe the DTC information with a scan tool.

   If the scan tool indicates P0016 has failed this ignition cycle, continue with the Circuit/System Testing.
5. If the vehicle passes the Circuit/System Verification Test, then operate the vehicle within the Conditions For Running the DTC. You may also operate the vehicle within the conditions that are captured in the Freeze Frame/Failure Records Data List.

Circuit/System Testing

Important: You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Inspect the engine front cover area, or review the service history of the vehicle for any recent repairs involving the timing chain, timing chain tensioner, camshaft, crankshaft, camshaft actuator, or sprockets.

If recent repairs were made, refer to Camshaft Timing Chain and Sprocket Replacement , and inspect the timing chain, timing chain tensioner, and both sprockets for proper timing alignment or indexing.

2. Remove the engine front cover, refer to Engine Front Cover Replacement and inspect the timing chain, timing chain tensioner, and sprockets for wear or damage. Refer to Camshaft Timing Chain and Sprocket Cleaning and Inspection.

   If any components are worn or damage, replace as necessary.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Camshaft Timing Chain and Sprocket Replacement

DTC P0030, P0036, P0053, P0054, P0135, or P0141

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0030: HO2S Heater Control Circuit Bank 1 Sensor 1

DTC P0036: HO2S Heater Control Circuit Bank 1 Sensor 2

DTC P0053: HO2S Heater Resistance Circuit Bank 1 Sensor 1

DTC P0054: HO2S Heater Resistance Circuit Bank 1 Sensor 2

DTC P0135: HO2S Heater Performance Bank 1 Sensor 1

DTC P0141: HO2S Heater Performance Bank 1 Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S Heater Voltage Supply	Opens fuse	P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, P0161	P0030, P0036, P0050, P0056, P0135, P0141, P0155, P0161	--	P0135, P0141, P0155, P0161
HO2S Heater Low Control	P0030, P0036	P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, P0161	P0030, P0036, P0050, P0056, P0135, P0141, P0155, P0161	P0030, P0036, P0050, P0056, P0135, P0141, P0155, P0161	P0135, P0141, P0155, P0161

Typical Scan Tool Data

HO2S Sensor 1 Voltage

Circuit	Short to Ground	Open	Short to Voltage

Parameter Normal Range: 200-800 mV			
HO2S Heater Low Control	0 A	0 A	0 A
HO2S Heater Voltage Supply	0 A	0 A	1-2 A

Circuit/System Description

Heated oxygen sensors (HO2S) are used for fuel control and post catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content in the exhaust stream. The HO2S must reach operating temperature to provide an accurate voltage signal. A heating element inside the HO2S minimizes the time required for the sensors to reach operating temperature. Voltage is provided to the heater by an ignition voltage circuit through a fuse. With the engine running, ground is provided to the heater by the HO2S heater low control circuit through a low side driver within the engine control module (ECM). The ECM uses pulse width modulation (PWM) to control the HO2S heater operation to maintain a specific HO2S operating temperature range.

Conditions for Running the DTC

P0030 or P0036

- The Ignition 1 Signal parameter is between 11-18 volts.
- The engine speed is more than 400 RPM.
- DTC P0030 or P0036 runs continuously when the above conditions are met for 1 second.

P0053 or P0054

- DTCs P0112, P0113, P0117, P0118 are not set.
- The engine is started.
- The ignition voltage is less than 18 volts.
- The ignition is OFF for more than 10 hours.
- The Engine Coolant Temperature (ECT) Sensor parameter is between -30 to +45°C (-22 to +113°F) at engine start-up.
- The Engine Coolant Temperature (ECT) Sensor parameter minus the Intake Air Temperature (IAT) Sensor parameter is less than 8°C (14°F) at engine start-up.
- DTC P0053 or P0054 run once per drive cycle when the above conditions are met.

P0135

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0125, P0128, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The ECT Sensor parameter is more than 50°C (122°F).
- The Ignition 1 Signal parameter is between 10-18 volts.
- The MAF Sensor parameter is between 3-40 g/s.
- The Engine Run Time parameter is more than 300 seconds.

- The Engine Speed parameter is between 500-3,000 RPM.
- DTC P0135 runs the heater current test once per drive cycle when the above conditions are met for 120 seconds.

P0141

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0125, P0128, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The ECT Sensor parameter is more than 50°C (122°F).
- The Ignition 1 Signal parameter is between 10-18 volts.
- The MAF Sensor parameter is between 3-40 g/s.
- The Engine Run Time parameter is more than 300 seconds.
- The Engine Speed parameter is between 500-3,000 RPM.
- DTC P0141 runs the heater current test twice per drive cycle when the above conditions are met for 120 seconds.

Conditions for Setting the DTC

P0030 or P0036

- The ECM detects that the affected HO2S heater low control circuit is not within a specified range.
- DTCs P0030 or P0036 set within 3 seconds when the above condition is met.

P0053

- The ECM detects that the affected HO2S heater low control circuit is not within a specified resistance range at engine start-up.
- DTCs P0053 sets within 1 second when the above condition is met.

P0054

- The ECM detects that the affected HO2S heater low control circuit is not within a specified resistance range at engine start-up.
- DTC P0054 sets within 1 second when the above condition is met.

P0135

- The ECM detects that the HO2S 1 heater current parameter is more than 3.125 amps or less than 0.25 amp.
- DTC P0135 sets within 120 seconds during the heater current test when the above condition is met.

P0141

- The ECM detects that the HO2S 2 heater current parameter is more than 2.875 amps or less than 0.25 amp.
- DTC P0141 sets within 120 seconds during the heater current test when the above condition is met.

Action Taken When the DTC Sets

DTCs P0030, P0036, P0053, P0054, P0135, and P0141 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0030, P0036, P0053, P0054, P0135, and P0141 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Heated Oxygen Sensor Wiring Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Allow the engine to reach operating temperature. With the engine running, observe the HO2S Heater parameter with a scan tool. The value should vary from below 2A to above 1A.
2. With the engine running at operating temperature, observe the HO2S Heater parameter with a scan tool and manipulate the related wiring and connectors.

   If manipulation does affect the parameter then repair the harness or connector.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not

reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Important: You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Ignition OFF, disconnect the harness connector at the appropriate HO2S.
2. Ignition ON, verify that a test lamp illuminates between the appropriate HO2S heater voltage supply circuit terminal D and ground.

   If the test lamp does not illuminate, test the HO2S heater voltage supply circuit for a short to ground or an open/high resistance. If the circuit tests normal and the HO2S heater voltage supply circuit fuse is open, test all components connected to the fuse and replace as necessary.
3. Ignition ON, verify that a test lamp does not illuminate between the appropriate HO2S heater voltage supply circuit terminal D and the appropriate HO2S heater low control circuit terminal listed below:
   - B1S1 terminal C
   - B1S2 terminal C

   If the lamp illuminates, test the HO2S heater low control circuit for a short to ground. If the circuit tests normal, replace the ECM.
4. Engine running, leave the test lamp connected from the previous step. The lamp should flash or be ON steady.

   If the test lamp is not ON steady or flashing, test the HO2S heater low control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.

   Important:
   - The output driver should detect a short to voltage and turn OFF. If a resistance fault is present the driver will remain ON and the scan tool will display more than 0.0 amp. Less than 10 ohms may set a DTC.
   - Performing this test may set additional DTCs.

5. Ignition OFF, install a 30A fused jumper wire between the appropriate HO2S heater voltage supply circuit terminal D and the appropriate HO2S heater low control circuit terminal listed below:
   - B1S1 terminal C
   - B1S2 terminal C
6. Engine running, verify the appropriate scan tool HO2S Heater parameter is less than 0.1 amp.

   If more than the specified range, test the HO2S heater voltage supply and HO2S heater low control circuits for more than 1 ohm. If the circuits test normal, replace the ECM.
7. If the ECM and all circuits test normal, replace the appropriate HO2S.

Repair Instructions

Notice: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution in the Preface section.

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 1
- Heated Oxygen Sensor Replacement - Bank 1 Sensor 2
- Control Module References for ECM replacement, setup, and programming

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Document ID: 2152471

DTC P0050, P0056, P0059, P0060, P0155, or P0161

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0050: HO2S Heater Control Bank 2 Sensor 1

DTC P0056: HO2S Heater Control Bank 2 Sensor 2

DTC P0059: HO2S Heater Resistance Bank 2 Sensor 1

DTC P0060: HO2S Heater Resistance Bank 2 Sensor 2

DTC P0155: HO2S Heater Performance Bank 2 Sensor 1

DTC P0161: HO2S Heater Performance Bank 2 Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S Heater Voltage Supply	Opens fuse	P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, P0161	P0030, P0036, P0050, P0056, P0135, P0141, P0155, P0161	--	P0135, P0141, P0155, P0161
HO2S Heater Low Control	P0030, P0036	P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, P0161	P0030, P0036, P0050, P0056, P0135, P0141, P0155, P0161	P0030, P0036, P0050, P0056, P0135, P0141, P0155, P0161	P0135, P0141, P0155, P0161

Typical Scan Tool Data

HO2S Heater

Circuit	Short to Ground	Open	Short to Voltage

Parameter Normal Range: 200-800 mV			
HO2S Heater Low Control	0 A	0 A	0 A
HO2S Heater Voltage Supply	0 A	0 A	1-2 A

Circuit/System Description

Heated oxygen sensors (HO2S) are used for fuel control and post catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content in the exhaust stream. The HO2S must reach operating temperature to provide an accurate voltage signal. A heating element inside the HO2S minimizes the time required for the sensors to reach operating temperature. Voltage is provided to the heater by an ignition voltage circuit through a fuse. With the engine running, ground is provided to the heater by the HO2S heater low control circuit through a low side driver within the engine control module (ECM). The ECM uses pulse width modulation (PWM) to control the HO2S heater operation to maintain a specific HO2S operating temperature range.

Conditions for Running the DTC

P0050 or P0056

- The ignition 1 signal parameter is between 11-18 volts.
- The engine speed is more than 400 RPM.
- DTCs 0050 or P0056 run once per drive cycle when the above conditions are met.

P0059 or P0060

- DTCs P0112, P0113, P0117, P0118 are not set.
- The engine is started.
- The ignition voltage is less than 18 volts.
- The ignition is OFF form more than 10 hours.
- The Engine Coolant Temperature (ECT) Sensor parameter is between -30 and +45°C (-22 and +113°F) at engine start-up.
- The Engine Coolant Temperature (ECT) Sensor parameter minus the Intake Air Temperature (IAT) Sensor parameter is less than 8°C (14°F) at engine start-up.
- DTCs P0059 or P0060 run once per drive cycle when the above conditions are met.

P0155

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0125, P0128, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The ECT Sensor parameter is more than 50°C (122°F).
- The Ignition 1 Signal parameter is between 10-18 volts.
- The MAF Sensor parameter is between 3-40 g/s.
- The Engine Run Time parameter is more than 300 seconds.

- The Engine Speed parameter is between 500-3,000 RPM.
- DTC P0155 runs the heater current test once per drive cycle when the above conditions are met for 120 seconds.

P0161

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0125, P0128, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The ECT Sensor parameter is more than 50°C (122°F).
- The Ignition 1 Signal parameter is between 10-18 volts.
- The MAF Sensor parameter is between 3-40 g/s.
- The Engine Run Time parameter is more than 300 seconds.
- The Engine Speed parameter is between 500-3,000 RPM.
- DTC P0161 runs the heater current test twice per drive cycle when the above conditions are met for 120 seconds.

Conditions for Setting the DTC

P0050 or P0056

- The ECM detects that the affected HO2S heater low control circuit is not within a specified range at engine start-up.
- DTCs P0050, and P0056 set within 1 second when the above condition is met.

P0059

- The ECM detects that the affected HO2S heater low control circuit is not within a specified resistance range at engine start-up.
- DTCs P0059 sets within 1 second when the above condition is met.

P0060

- The ECM detects that the affected HO2S heater low control circuit is not within a specified resistance range at engine start-up.
- DTCs P0060 sets within 1 second when the above condition is met.

P0155

- The ECM detects that the HO2S 1 heater current parameter is more than 3.125 amps or less than 0.25 amp.
- DTC P0155 sets within 120 seconds during the heater current test when the above condition is met.

P0161

- The ECM detects that the HO2S 2 heater current parameter is more than 2.875 amps or less than 0.25 amp.
- DTC P0161 sets within 120 seconds during the heater current test when the above condition is met.

Action Taken When the DTC Sets

DTCs P0050, P0056, P0059, P0060, P0155, and P0161 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0050, P0056, P0059, P0060, P0155, and P0161 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Heated Oxygen Sensor Wiring Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Allow the engine to reach operating temperature. With the engine running, observe the HO2S Heater parameter with a scan tool. The value should vary from below 2A to above 1A.
2. With the engine running at operating temperature, observe the HO2S Heater parameter with a scan tool and manipulate the related wiring and connectors.

   If manipulation does affect the parameter then repair the harness or connector.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not

reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Important: You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Ignition OFF, disconnect the harness connector at the appropriate HO2S.
2. Ignition ON, verify that a test lamp illuminates between the appropriate HO2S heater voltage supply circuit terminal D and ground.

   If the test lamp does not illuminate, test the HO2S heater voltage supply circuit for a short to ground or an open/high resistance. If the circuit tests normal and the HO2S heater voltage supply circuit fuse is open, test all components connected to the fuse and replace as necessary.
3. Ignition ON, verify that a test lamp does not illuminate between the appropriate HO2S heater voltage supply control circuit terminal D and the appropriate HO2S heater low control circuit terminal listed below:
   - B2S1 terminal C
   - B2S2 terminal C

   If the lamp illuminates, test the HO2S heater low control circuit for a short to ground. If the circuit tests normal, replace the ECM.
4. Engine running, leave the test lamp connected from the previous step. The lamp should flash or be ON steady.

   If the test lamp is not ON steady or flashing, test the HO2S heater low control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.

   Important:
   - The output driver should detect a short to voltage and turn OFF. If a resistance fault is present the driver will remain ON and the scan tool will display more than 0.0 amp. Less than 10 ohms may set a DTC.
   - Performing this test may set additional DTCs.
5. Ignition OFF, install a 30A fused jumper wire between the appropriate HO2S heater voltage supply circuit terminal D and the appropriate HO2S heater low control circuit terminal listed below:
   - B2S1 terminal C
   - B2S2 terminal C
6. Engine running, verify the appropriate scan tool HO2S Heater parameter is less than 0.1 amp.

   If more than the specified range, test the HO2S heater voltage supply and HO2S heater low control circuits for more than 1 ohm. If the circuits test normal, replace the ECM.
7. If the ECM and all circuits test normal, replace the appropriate HO2S.

Repair Instructions

Notice: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution in the Preface section.

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 2 Sensor 1
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 2
- Control Module References for ECM replacement, setup, and programming

DTC P0068 or P0121

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0068: Throttle Body Airflow Performance

DTC P0121: Throttle Position (TP) Sensor 1 Performance

Circuit / System Description

The engine control module (ECM) uses the following information to calculate an expected airflow rate:

- The throttle position (TP)
- The barometric pressure (BARO)
- The manifold absolute pressure (MAP)
- The intake air temperature (IAT)
- The engine RPM

Conditions for Running the DTC

P0068

- DTCs P0641, P0651, P1516, P2101, P2119, P2176 are not set.
- The engine is running.
- DTC P0068 run continuously when the above conditions are met.

P0121

- DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0128, P0315, P0335, P0336 are not set.
- The engine speed is more than 450 RPM.
- The IAT Sensor parameter is between -7 to +125°C (+19 to +257°F).
- The ECT Sensor parameter is between 70-125°C (158-257°F).
- DTC P0121 run continuously when the above conditions are met.

Conditions for Setting the DTC

P0068

The ECM detects that the throttle position and the indicated engine load do not correspond with the expected load and throttle position for less than 1 second.

P0121

The predicted air flow and the predicted MAP combined are outside a calibrated range for more than 3 seconds.

Action Taken When the DTC Sets

P0068

- DTC P0068 is a Type A DTC.
- The control module commands the throttle actuator control (TAC) system to operate in the Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions the control module commands the engine OFF.

P0121

DTC P0121 is a Type B DTC.

Conditions for Clearing the MIL/DTC

- DTC P0068 is a Type A DTC.
- DTC P0121 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections

- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Testing

1. Inspect for the following conditions:
    - Vacuum hoses for splits, kinks, and proper connections as shown on Vehicle Emission Control Information label
    - Inspect thoroughly for any type of leak or restriction
    - Air leaks at throttle body mounting area and intake manifold sealing surfaces
    - Throttle body for dirt, debris, and coking--Refer to Throttle Body Cleaning.
2. Allow the engine to reach operating temperature. Observe the MAP Sensor Voltage parameter with a scan tool. Voltage should be more than 0.8 volt and less than 4 volts.

    If more than 4 volts or less than 0.8 volt, refer to DTC P0106.
3. Idle the engine. Observe the MAP Sensor kPa parameter with a scan tool. Increase the engine speed slowly and then back to idle. The MAP sensor kPa should change smoothly and gradually as engine speed is increased and returned to idle.

    If the MAP sensor kPa does not change, refer to DTC P0106.
4. Take a snapshot of the engine data list while performing the actions listed below. The mass air flow (MAF) sensor g/s should change smoothly and gradually as the engine speed is increased and is returned to idle.
    - Idle the engine.
    - Increase the engine speed slowly to 3,000 RPM, then back to idle.
    - Exit from the snapshot and review the data.
    - Observe the Mass Air Flow (MAF) Sensor parameter frame by frame with a scan tool. The MAF sensor g/s should change smoothly and gradually as the engine speed is increased and is returned to idle.

        If the MAF sensor g/s does not change smoothly and gradually as the engine speed is increased and is returned to idle, refer to DTC P0101 or P1101.
5. Inspect the throttle body for the following conditions:
    - Loose or damaged throttle blade
    - Broken throttle shaft
    - Any throttle body damage

    If any of these conditions exist, replace the throttle body assembly.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Throttle Body Assembly Replacement

- Control Module References for ECM replacement, setup, and programming

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DTC P0101 or P1101

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0101 : Mass Air Flow (MAF) Sensor Performance

DTC P1101: Intake Air Flow System Performance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition 1 Voltage	P0102	P0101	P0102	--	P0101, P0103
MAF Sensor Signal	P0102	P0102	P0102	P0102	P0101, P0103, P1101
Ground	--	P0102	P0102	--	P0102

Typical Scan Tool Data

MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions *Parameter Normal Range:* 1,700-9,500 Hz			
Ignition 1 Voltage	0 Hz	0 Hz	--
MAF Sensor Signal	0 Hz	0 Hz	0 Hz
Ground	--	0 Hz	--

Circuit Description

The intake flow rationality diagnostic provides the within-range rationality check for the mass air flow (MAF), manifold absolute pressure (MAP), and the throttle position (TP) sensors. This is an explicit model-based diagnostic containing 4 separate models for the intake system.

- The throttle model describes the flow through the throttle body and is used to estimate the MAF through the throttle body as a function of barometric pressure (BARO), TP, intake air temperature (IAT), and estimated MAP. The information from this model is displayed on the scan tool as the MAF Performance Test parameter.

- The first intake manifold model describes the intake manifold and is used to estimate MAP as a function of the MAF into the manifold from the throttle body and the MAF out of the manifold caused by engine pumping. The flow into the manifold from the throttle uses the MAF estimate calculated from the above throttle model. The information from this model is displayed on the scan tool as the MAP Performance Test 1 parameter.
- The second intake manifold model is identical to the first intake manifold model except that the MAF sensor measurement is used instead of the throttle model estimate for the throttle air input. The information from this model is displayed on the scan tool as the MAP Performance Test 2 parameter.
- The fourth model is created from the combination and additional calculations of the throttle model and the first intake manifold model. The information from this model is displayed on the scan tool as the TP Performance Test parameter.

The estimates of MAF and MAP obtained from this system of models and calculations are then compared to the actual measured values from the MAF, MAP, and the TP sensors and to each other to determine the appropriate DTC to fail. The following table illustrates the possible failure combinations and the resulting DTC or DTCs.

Scan Tool Diagnostic Test Results

MAF Performance Test	MAP Performance Test 1	MAP Performance Test 2	TP Performance Test	DTCs Passed	DTCs Failed
--	--	OK	OK	P0101, P0106, P0121, P1101	None
OK	OK	Fault	OK	P0101, P0106, P0121, P1101	None
Fault	OK	Fault	OK	P0106, P0121, P1101	P0101
OK	Fault	Fault	OK	P0101, P0121, P1101	P0106
Fault	Fault	Fault	OK	P0121, P1101	P0101, P0106
--	--	OK	Fault	P0101, P0106, P1101	P0121
OK	OK	Fault	Fault	P0101, P0106, P0121, P1101	None
Fault	OK	Fault	Fault	P0101, P0106, P0121	P1101

--	Fault	Fault	Fault	P0101, P0106, P0121	P1101

Conditions for Running the DTCs

- DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0128, P0335, P0336 are not set.
- The engine speed is between 450-8,000 RPM.
- The IAT Sensor parameter is between -7 to +125°C (+19 to +257°F).
- The ECT Sensor parameter is between 70-125°C (158-257°F).
- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTC

The engine control module (ECM) detects that the actual measured airflow from the MAF, MAP, and TP sensors is not within range of the calculated airflow that is derived from the system of models for more than 0.5 second.

Action Taken When the DTC Sets

DTCs P0101 and P1101 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0101 and P1101 are Type B DTCs.

Diagnostic Aids

- A steady or intermittent high resistance of 15 ohms or greater on the ignition 1 voltage circuit will cause the MAF sensor signal to be increased by as much as 60 g/s. To pinpoint this condition perform a voltage drop test on the circuit.
- Depending on the current ambient temperature, and the vehicle operating conditions, a MAF sensor signal circuit that is shorted to the IAT signal circuit will increase or decrease the MAF sensor signal that is interpreted by the ECM. Additionally it may cause a rapid fluctuation in the IAT Sensor parameter.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Special Tools

J 38522 Variable Speed Generator

Circuit/System Verification

1. Verify that DTC P0641 or P0651 is not set.

   If any of the DTCs are set, refer to DTC P0641 or P0651.
2. Verify that restrictions do not exist in the exhaust system. Refer to Restricted Exhaust.
3. Engine running at idle, observe the scan tool MAF Sensor parameter. The reading should be between 1,700-3,200 Hz depending on the ECT.
4. A wide open throttle (WOT) acceleration from a stop should cause the MAF Sensor parameter on the scan tool to increase rapidly. This increase should be from 4-8 g/s at idle to greater than 150 g/s at the time of the 1-2 shift.
5. Use the scan tool and compare the MAF Sensor parameter to a known good vehicle under various operating conditions.
6. Verify the proper operation of the MAP sensor. A skewed MAP sensor will cause the barometric pressure (BARO) value to be inaccurate. Refer to DTC P0106.
7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Verify the integrity of the entire air induction system by inspecting for the following conditions:
   - Any damaged components
   - Loose or improper installation
   - An air flow restriction
   - Any vacuum leak
   - Water intrusion
   - In cold climates, inspect for any snow or ice buildup
   - The MAF sensor element for contamination
2. Ignition OFF, disconnect the harness connector at the MAF/IAT sensor.
3. Ignition OFF and scan tool disconnected for 90 seconds, test for less than 5 ohms between the ground circuit terminal C and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal B and

ground.

If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance.

5. Ignition ON, test for 4.8-5.2 volts between the signal circuit terminal A and ground.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
6. Ignition OFF, connect the red lead of the J 38522 to the signal circuit terminal A at the MAF/IAT sensor harness connector. Connect the battery voltage supply to B+. Connect the black lead to ground.
7. Set the J 38522 Signal switch to 5 volts, the Frequency switch to 5K, and the Duty Cycle switch to Normal.
8. Engine idling, observe the scan tool MAF Sensor parameter. The scan tool MAF Sensor parameter should be between 4,950-5,025 Hz.

   If the MAF Sensor parameter is not within the specified range, replace the ECM.
9. If the circuits test normal, test or replace the MAF sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Mass Airflow Sensor/Intake Air Temperature Sensor Replacement
- Control Module References for ECM replacement, setup, and programming

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DTC P0102 or P0103

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0102: Mass Air Flow (MAF) Sensor Circuit Low Frequency

DTC P0103: Mass Air Flow (MAF) Sensor Circuit High Frequency

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition 1 Voltage	P0102	P0101, P0102	P0102	--	P0101, P0103
MAF Sensor Signal	P0102	P0102	P0102	P0102	P0101, P0103, P1101
Ground	--	P0102	P0102	--	P0102

Typical Scan Tool Data

MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage
Ignition 1 Voltage	0 Hz	0 Hz	--
MAF Sensor Signal	0 Hz	0 Hz	0 Hz
Ground	--	0 Hz	--

Circuit/System Description

The mass air flow (MAF) sensor is integrated with the intake air temperature (IAT) sensor. The MAF sensor is an air flow meter that measures the amount of air entering the engine. The engine control module (ECM) uses the MAF sensor signal to provide the correct fuel delivery for all engine speeds and loads. A small quantity of air entering the engine indicates a deceleration or idle condition. A large quantity of air entering the engine indicates an acceleration or high load condition. The MAF/IAT sensor has the following circuits:

- An ignition 1 voltage circuit
- A ground circuit

- A MAF sensor signal circuit
- An IAT sensor signal circuit
- A low reference circuit

The ECM applies 5 volts to the MAF sensor on the MAF sensor signal circuit. The sensor uses the voltage to produce a frequency based on the inlet air flow through the sensor bore. The frequency varies within a range of near 1,700 Hertz at idle to near 9,500 Hertz at maximum engine load.

Conditions for Running the DTC

- The engine is running for more than one second.
- The ignition 1 signal is more than 8 volts.
- The above conditions are met for more than one second.
- These DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P0102

The ECM detects that the MAF Sensor parameter is less than 1,500 Hz for greater than 5 seconds.

P0103

The ECM detects that the MAF Sensor parameter is more than 14,500 Hz for greater than 5 seconds.

Action Taken When the DTC Sets

DTCs P0102 and P0103 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0102 and P0103 are Type B DTCs.

Diagnostic Aids

- Verify the integrity of the air induction system by inspecting for the following conditions:
  - A restricted or collapsed air intake duct
  - A misaligned air intake duct
  - A dirty or deteriorating air filter element
  - Any objects blocking the air inlet screen of the MAF/IAT sensor
  - Any water intrusion in the induction system
  - Any contamination or debris on the sensing elements of the MAF sensor
  - Damaged components
  - Loose or improper installation

  - Any air flow restriction
  - Any vacuum leak
- A wide open throttle (WOT) acceleration from a stop should cause the MAF sensor parameter on the scan tool to increase rapidly. This increase should be from 3-8 g/s at idle to 100 g/s or more at the time of the 1-2 shift.
- Verify that any electrical aftermarket devices are properly connected and grounded. Refer to Checking Aftermarket Accessories.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 38522 Variable Signal Generator

Circuit/System Verification

- Engine running, observe the scan tool MAF Sensor parameter. The reading should be between 1,700-3,800 Hz, depending on the engine coolant temperature (ECT).
- A wide open throttle (WOT) acceleration from a stop should cause the MAF sensor parameter on the scan tool to increase rapidly. This increase should be from 3-8 g/s at idle to greater than 180 g/s at the time of the 1-2 shift.
- Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Important: All electrical components and accessories must be turned OFF and allowed to power down.

1. Ignition OFF, disconnect the MAF/IAT harness connector at the MAF/IAT sensor.
2. Ignition OFF and scan tool disconnected for 90 seconds, test for less than 5 ohms between the ground circuit terminal C and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal B and ground.

   If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance.
4. Ignition ON, test for 4.8-5.2 volts between the signal circuit terminal A and ground.

   If less than the specified range, test the signal circuit terminal A for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
5. Ignition OFF, connect the red lead of the J 38522 to the signal circuit terminal A at the MAF/IAT sensor harness connector. Connect the battery voltage supply to B+. Connect the black lead to ground.
6. Set the J 38522 signal to 5 volts, the Frequency to 5K, and the Duty Cycle to Normal.
7. Engine idling, observe the scan tool MAF Sensor parameter. The scan tool MAF Sensor parameter should be between 4,950-5,025 Hz.

   If the MAF Sensor parameter is not within the specified range, replace the ECM.
8. If all other circuits test normal, replace the MAF sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Mass Airflow Sensor/Intake Air Temperature Sensor Replacement
- Control Module References for ECM replacement, setup, and programming

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DTC P0106

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0106: Manifold Absolute Pressure (MAP) Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5-Volt Reference	P0107, P0452, P0522, P0532, P0641	P0106, P0107	P0107	P0106, P0108, P0453, P0533, P0641	P0106, P0107
MAP Sensor Signal	P0107	P0106, P0107	P0107	P0106, P0108	P0106, P0107, P1101
Low Reference	--	P0106, P0108	P0106, P0108	--	P0106, P0108

Typical Scan Tool Data

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running, transmission in Park or Neutral *Parameter Normal Range:* 20-48 kPa (Varies with altitude)			
5-Volt Reference	10 kPa	10 kPa	104 kPa
MAP Sensor Signal	10 kPa	10 kPa	104 kPa
Low Reference	--	80-103 kPa	--

Circuit Description

The intake flow rationality diagnostic provides the within-range rationality check for the mass air flow (MAF), manifold absolute pressure (MAP), and the throttle position (TP) sensors. This is an explicit model-based diagnostic containing 4 separate models for the intake system.

- The throttle model describes the flow through the throttle body and is used to estimate the MAF through the throttle body as a function of barometric pressure (BARO), TP, intake air temperature (IAT), and estimated MAP. The information from this model is displayed on the scan tool as the MAF Performance Test parameter.

- The first intake manifold model describes the intake manifold and is used to estimate MAP as a function of the MAF into the manifold from the throttle body and the MAF out of the manifold caused by engine pumping. The flow into the manifold from the throttle uses the MAF estimate calculated from the above throttle model. The information from this model is displayed on the scan tool as the MAP Performance Test 1 parameter.
- The second intake manifold model is identical to the first intake manifold model except that the MAF sensor measurement is used instead of the throttle model estimate for the throttle air input. The information from this model is displayed on the scan tool as the MAP Performance Test 2 parameter.
- The fourth model is created from the combination and additional calculations of the throttle model and the first intake manifold model. The information from this model is displayed on the scan tool as the TP Performance Test parameter.

The estimates of MAF and MAP obtained from this system of models and calculations are then compared to the actual measured values from the MAF, MAP, and the TP sensors and to each other to determine the appropriate DTC to fail. The following table illustrates the possible failure combinations and the resulting DTC or DTCs.

Scan Tool Diagnostic Test Results

MAF Performance Test	MAP Performance Test 1	MAP Performance Test 2	TP Performance Test	DTCs Passed	DTCs Failed
--	--	OK	OK	P0101, P0106, P0121, P1101	None
OK	OK	Fault	OK	P0101, P0106, P0121, P1101	None
Fault	OK	Fault	OK	P0106, P0121, P1101	P0101
OK	Fault	Fault	OK	P0101, P0121, P1101	P0106
Fault	Fault	Fault	OK	P0121, P1101	P0101, P0106
--	--	OK	Fault	P0101, P0106, P1101	P0121
OK	OK	Fault	Fault	P0101, P0106, P0121, P1101	None
Fault	OK	Fault	Fault	P0101, P0106, P0121	P1101

--	Fault	Fault	Fault	P0101, P0106, P0121	P1101

Conditions for Running the DTC

- DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0128, P0335, P0336 are not set.
- The engine is running.
- The IAT Sensor parameter is between -7 and +125°C (+19 and 257°F).
- The ECT Sensor parameter is between 70-125°C (158-257°F).
- This DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The engine control module (ECM) detects that the MAP sensor pressure is not within range of the calculated pressure that is derived from the system of models for more than 0.5 second.

Action Taken When the DTC Sets

DTC P0106 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0106 is a Type B DTC.

Diagnostic Aids

Important: Verify that the engine is in good mechanical condition before continuing with this diagnostic.

- A skewed or stuck engine coolant temperature (ECT) or IAT sensor will cause the calculated models to be inaccurate and may cause this DTC to run when it should not. Refer to Temperature Versus Resistance.
- The BARO that is used by the ECM to calculate the air flow models is initially based on the MAP sensor at ignition ON. When the engine is running, the ECM will continually update the BARO value near wide open throttle using the MAP sensor and a calculation. A skewed MAP sensor will cause the BARO value to be inaccurate. Use the scan tool and compare the BARO parameter at ignition ON to the Altitude vs. Barometric Pressure Table. Refer to Altitude Versus Barometric Pressure.
- A skewed MAP sensor will also cause the first and second intake manifold models to disagree with the actual MAP sensor measurements. Use the scan tool and compare the MAP Sensor parameter to a known good vehicle, under various operating conditions.
- Inspect for the following conditions:
    - Incorrect CAM timing--Refer to Camshaft Timing Chain and Sprocket Replacement for the correct timing.
    - Worn piston rings--Refer to Engine Compression Test.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. If DTC P0641 or P0651 are set, refer to DTC P0641 or P0651.
2. Verify that restrictions do not exist in the exhaust system. Refer to Restricted Exhaust.
3. Verify that the engine is in good mechanical condition. Refer to Symptoms - Engine Mechanical for the 4.8L, 5.3L, 6.0L and 6.2L engine.
4. Ignition OFF for 90 seconds, determine the current vehicle testing altitude. Ignition ON, observe the scan tool BARO Sensor parameter. Compare the parameter to the Altitude Versus Barometric Pressure table. The BARO sensor pressure parameter should be within the specified range indicated in the table.
5. A skewed MAP sensor will also cause the first and second intake manifold models to disagree with the actual MAP sensor measurements. Use the scan tool and compare the MAP Sensor parameter to a known good vehicle under various operating conditions. The readings should be within 3 kPa of the known good vehicle.
6. Ignition ON, observe the scan tool MAP sensor parameter. Start the engine. The MAP Sensor parameter should change.

   If the vehicle passes the Circuit System Verification Test, operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that are captured in the Freeze Frame/Failure Records list.

Circuit/System Testing

Important: All electrical components and accessories must be turned OFF and allowed to power down.

1. Verify the integrity of the air induction system by inspecting for the following conditions:
   - Any damaged components
   - Loose or improper installation
   - Improperly routed vacuum hoses
   - Any vacuum leak
   - Any type of restriction
   - MAP sensor seal that is missing or damaged
2. Verify that restrictions do not exist in the MAP sensor vacuum source.
3. Ignition OFF, disconnect the harness connector at the MAP sensor.
4. Ignition OFF for 90 seconds, test for less than 5 ohms between the low reference circuit terminal 2 and ground.

   If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
5. Ignition ON, test for 4.8-5.2 volts between the 5-volt reference circuit terminal 1 and ground.

   If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

   If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
6. Verify the scan tool MAP Sensor parameter is less than 12 kPa.

   If greater than the specified range, test the signal circuit terminal 3 for a short to voltage. If the circuit tests normal, replace the ECM.
7. Install a 3A fused jumper wire between the signal circuit terminal 3 and the 5-volt reference circuit terminal 1. Verify the scan tool MAP Sensor parameter is greater than 103 kPa.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
8. If all circuits test normal, test or replace the MAP sensor.

Component Testing

Important: You must perform the Circuit/System Testing in order to verify the integrity of the MAP sensor circuits before proceeding with the Component Testing.

Skewed Sensor Test

1. Using the following steps and referencing the table below will determine if the MAP sensor is skewed.
2. Ignition ON, engine OFF, observe the MAP sensor scan tool parameter.
3. Use the observed MAP Sensor Scan Tool parameter that is closest to a value that is indicated in the first column.
4. Using the MityVac to apply 5 in Hg of vacuum to the MAP sensor, the parameter in the first column should decrease by 17 kPa. The acceptable range is indicated in the second column.
5. Using the MityVac to apply 10 in Hg of vacuum to the MAP sensor, the parameter in the first column should decrease by 34 kPa. The acceptable range is indicated in the third column.

Ignition ON, Engine OFF, MAP Sensor Parameter	MAP Sensor Parameter With 5 Inches of Vacuum Applied	MAP Sensor Parameter With 10 Inches of Vacuum Applied
100 kPa	79-87 kPa	62-70 kPa
95 kPa	74-82 kPa	57-65 kPa

90 kPa	69-77 kPa	52-60 kPa
80 kPa	59-67 kPa	42-50 kPa
70 kPa	49-57 kPa	32-40 kPa
60 kPa	39-47 kPa	22-30 kPa

Erratic Signal Test

1. Ignition OFF, remove the MAP sensor.
2. Install a 3A fused jumper wire between the 5-volt reference circuit terminal 1 and the corresponding terminal of the MAP sensor.
3. Install a jumper wire between the low reference terminal 2 of the MAP sensor and ground.
4. Install a jumper wire at terminal B of the MAP sensor.
5. Connect a DMM between the jumper wire from the terminal 3 of the MAP sensor and ground.
6. Ignition ON, with the MityVac, slowly apply vacuum to the sensor while observing the voltage on the DMM. The voltage should vary between 4.9-0.2 volts without any spikes or dropouts.

   If the voltage is erratic, replace the MAP sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Manifold Absolute Pressure Sensor Replacement
- Control Module References for ECM replacement, setup, and programming

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DTC P0107 or P0108

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0107: Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage

DTC P0108: Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5-Volt Reference	P0107, P0452, P0522, P0532, P0641	P0106, P0107	P0107	P0106, P0108, P0453, P0522, P0533, P0641	P0106, P0107
MAP Sensor Signal	P0107	P0106, P0107	P0107	P0108	P0106, P0107, P1101
Low Reference	--	P0106, P0108	P0106, P0108	--	P0106, P0108

Typical Scan Tool Data

MAP Sensor

Circuit	Normal Range	Short to Ground	Open	Short to Voltage
5-Volt Reference	--	10 kPa	10 kPa	104 kPa
MAP Sensor Signal	12-103 kPa	10 kPa	10 kPa	104 kPa
Low Reference	--	--	80-103 kPa	--

Circuit Description

The manifold absolute pressure (MAP) sensor measures the pressure inside the intake manifold. Pressure in the intake manifold is affected by engine speed, throttle opening, air temperature, and barometric pressure (BARO). A diaphragm within the MAP sensor is displaced by the pressure changes that occur from the varying load and operating conditions of the engine. The sensor translates this action into electrical resistance. The MAP sensor wiring includes 3 circuits. The engine control module (ECM) supplies a regulated 5 volts to the sensor on a 5-volt reference circuit. The ECM supplies a ground on a low reference circuit. The MAP sensor provides a signal voltage to the ECM, relative to the pressure changes, on the MAP sensor signal circuit. The ECM converts the signal voltage input to a pressure value.

Under normal operation the highest pressure that can exist in the intake manifold is equal to BARO. This occurs when the vehicle is operated at wide-open throttle (WOT) or when the ignition is ON while the engine is OFF. Under these conditions, the ECM uses the MAP sensor to determine the current BARO. The lowest manifold pressures occur when the vehicle is idling or decelerating. MAP can range from 10 kPa, when pressures are low, to as much as 104 kPa when pressures are high, depending on the BARO. The ECM monitors the MAP sensor signal for pressure outside of the normal range.

Conditions for Running the DTC

P0107

- DTCs P0641, P0651, P1516, P2101, P2125, P2135, P2138, P2176 are not set.
- The engine speed is greater than 400 RPM.
- The throttle angle is greater than 0 percent when the engine speed is less than 800 RPM.

  OR
- The throttle angle is greater than 13 percent when the engine speed is greater than 800 RPM.
- This DTC runs continuously when the above conditions are met.

P0108

- DTCs P0101, P0102, P0103, P0120, P0122, P0123, P0220, P0222, P0223, P1516, P2101, P2125, P2135, P2138, P2176 are not set.
- The engine has been running for a period of time that is determined by the start-up engine coolant temperature (ECT). The time ranges from 8 seconds at less than -30°C (-22°F) to 3 seconds at greater than 30°C (86°F).
- The throttle angle is less than 1 percent when the engine speed is less than 1,200 RPM.

  OR
- The throttle angle is less than 20 percent when the engine speed is greater than 1,200 RPM.
- This DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0107

The ECM detects that the MAP sensor voltage is less than 0.2 volt for more than 5 seconds.

P0108

The ECM detects that the MAP sensor voltage is more than 4.5 volts for greater than 5 seconds.

Action Taken When the DTC Sets

DTCs P0107 and P0108 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0107 and P0108 are Type B DTCs.

Diagnostic Aids

Verify the integrity of the MAP sensor system by inspecting for the following conditions:

- Intake manifold vacuum leaks
- Any damage to the MAP sensor housing
- Any damage to the MAP sensor seal
- A loose or improperly installed MAP sensor
- A restriction in the vacuum source of the MAP sensor

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

- Use the scan tool and compare the MAP Sensor parameter to a known good vehicle, under various operating conditions.
- Use the scan tool and compare the MAP Sensor parameter at ignition ON, with the engine OFF, to the Altitude vs Barometric Pressure table. Refer to Altitude Versus Barometric Pressure.

Circuit/System Testing

Important: All electrical components and accessories must be turned OFF and allowed to power down.

1. Ignition OFF, disconnect the harness connector at the MAP sensor.
2. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal 2 and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8-5.2 volts between the 5-volt reference circuit terminal 1 and ground.

   If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

   If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Verify the scan tool MAP Sensor parameter is less than 12 kPa.

   If greater than the specified range, test the signal circuit terminal 3 for a short to voltage. If the circuit tests normal, replace the ECM.
5. Install a 3A fused jumper wire between the signal circuit terminal 3 and the 5-volt reference circuit terminal 1. Verify the scan tool MAP Sensor parameter is greater than 103 kPa.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
6. If all circuits test normal, test or replace the MAP sensor.

Component Testing

Important: You must perform the Circuit/System Testing in order to verify the integrity of the MAP sensor circuits before proceeding with the Component Testing.

1. Turn ON the ignition, with the engine OFF, and remove the MAP sensor.
2. Install a 3A fused jumper wire between the 5-volt reference circuit terminal 1 and the corresponding terminal of the MAP sensor.
3. Install a jumper wire between the low reference circuit terminal 2 of the MAP sensor and ground.
4. Install a jumper wire at the MAP sensor signal circuit terminal 3.
5. Connect a DMM between the jumper wire from the MAP sensor signal circuit and ground.
6. Install the MityVac to the MAP sensor vacuum port. Slowly apply vacuum to the sensor while observing the voltage on the DMM. The voltage should vary between 0-5.2 volts without any spikes or dropouts.

   If the voltage is not within the specified range or is erratic, replace the MAP sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Manifold Absolute Pressure Sensor Replacement
- Control Module References for ECM replacement, setup, and programming

DTC P0112 or P0113

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0112: Intake Air Temperature (IAT) Sensor Circuit Low Voltage

DTC P0113: Intake Air Temperature (IAT) Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
IAT Sensor Signal	P0112	P0113	P0113	P0113	--
Low Reference	--	P0113	P0113	P0113	--

Typical Scan Tool Data

IAT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running *Parameter Normal Range:* Varies with ambient temperature			
IAT Sensor Signal	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	--	-40°C (-40°F)	-40°C (-40°F)

Circuit/System Description

The intake air temperature (IAT) sensor is a variable resistor. The IAT sensor has a signal circuit and a low reference circuit. The IAT sensor measures the temperature of the air entering the engine. The engine control module (ECM) supplies 5 volts to the IAT signal circuit, and a ground for the IAT low reference circuit.

Conditions for Running the DTC

P0112

- DTCs P0116, P0117, P0118, P0128, P0502, P0503 are not set.
- The engine is running for greater than 10 seconds.
- The engine coolant temperature (ECT) is less than 150°C (302°F).
- This DTC runs continuously when the above conditions are met.

P0113

- DTCs P0101, P0102, P0103, P0116, P0117, P0118, P0128, P0502, P0503 are not set.
- The engine is running for greater than 10 seconds.
- The ECT is more than -40°C (-40°F).
- The MAF Sensor parameter is greater than 511 g/s.
- This DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0112

The ECM detects that the IAT sensor parameter is warmer than 150°C (302°F) for greater than 6.3 seconds.

P0113

The ECM detects that the IAT sensor parameter is colder than -60°C (-76°F) for greater than 6.3 seconds.

Action Taken When the DTC Sets

DTCs P0112 and P0113 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0112 and P0113 are Type B DTCs.

Diagnostic Aids

- With the ignition ON, the engine OFF, if the engine is cold, a properly functioning IAT sensor will gradually increase the scan tool IAT Sensor parameter. This is due to the heat that is generated by the mass air flow (MAF) sensor heating elements.
- Depending on the ambient temperature, an IAT sensor signal circuit or low reference circuit that is shorted to the MAF sensor signal circuit can cause a DTC P0113 to set. This condition causes a rapid fluctuation in the IAT Sensor parameter.
- An IAT sensor signal circuit that is shorted to the MAF sensor ignition circuit can cause a DTC P0113 to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, observe the scan tool IAT Sensor parameter. The reading should be between -38 to +149°C (-38 to +300°F) depending on the current ambient temperature and the vehicle operating conditions.
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the IAT sensor.
2. Ignition OFF for 90 seconds, test for less than 5 ohms between the low reference circuit terminal E and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, verify the scan tool IAT parameter is colder than -39°C (-38°F).

   If greater than the specified range, test the signal circuit terminal D for a short to ground. If the circuit tests normal, replace the ECM.
4. Install a 3A fused jumper wire between the signal circuit terminal D and ground. Verify the scan tool IAT parameter is greater than 149°C (300°F).

   If less than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, test or replace the IAT sensor.

Component Testing

Measure and record the resistance of the IAT sensor at various ambient temperatures, and then compare those measurements to the Temperature vs Resistance table. Refer to Temperature Versus Resistance.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Mass Airflow Sensor/Intake Air Temperature Sensor Replacement
- Control Module References for ECM replacement, programming, and setup

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DTC P0116

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0116: Engine Coolant Temperature (ECT) Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117	P0118	P0118	P0118	P0116, P0128
Low Reference	--	P0118	P0118	P0118	P0128

Typical Scan Tool Data

ECT Sensor Temperature

Circuit	Normal Range	Short to Ground	Open	Short to Voltage
ECT Sensor Signal	-39 to +120°C (-38 to +248°F)	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	--	--	-40°C (-40°F)	-40°C (-40°F)

Circuit/System Description

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the ECT sensor signal circuit, and supplies a ground to the low reference circuit. The ECM uses this high side coolant rationality diagnostic to determine if the input from the ECT sensor is skewed warmer than normal. The internal clock of the ECM will record the amount of time the ignition is OFF. If the calibrated ignition OFF timer is met at start-up, the ECM will compare the temperature difference between the ECT and the intake air temperature (IAT), to determine if the temperatures are within an acceptable operating range of each other.

Conditions for Running the DTC

- DTCs P0112, P0113, P0117, P0118, P0502, P0503, P0601, P0603, P062F, P2610 are not set.
- The vehicle has had a minimum ignition OFF time of 10 hours.
- The ignition is ON.
- The start-up IAT is more than -7°C (+19°F).
- The Fuel Level Sensor parameter is more than 5 percent.
- This DTC runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

- The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 30°C (54°F) more than the IAT sensor.

  OR
- The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 10°C (18°F) more than the IAT sensor, and the time spent cranking the engine is more than 10 seconds, when the fuel level is more than 5 percent.

  OR
- With the power-up IAT more than -7°C (+19°F), the ECM detects a temperature difference at power-up that indicates that the ECT sensor is 20°C (36°F) more than the IAT sensor. Then the vehicle must be driven for more than 6 minutes and 40 seconds at more than 40 km/h (25 mph). If the IAT sensor then decreases more than 4°C (7°F), an engine block heater was detected and the test is aborted. If the IAT sensor does not decrease, an engine block heater was not detected and DTC P0116 will set.

Action Taken When the DTC Sets

DTC P0116 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0116 is a Type B DTC.

Diagnostic Aids

- The use of non-thermostatically controlled aftermarket block heater will cause this DTC to set.
- Inspect the ECT sensor terminals for corrosion and for engine coolant leaking through the sensor. Engine coolant that is leaking through the sensor will create a high resistance short to ground. This condition results in less voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a warmer ECT.
- An IAT sensor that is skewed colder at various ambient temperatures due to greater resistance than is normal will increase the range between these two sensors. Measure and record the resistance of the IAT sensor at various ambient temperatures, then compare those measurements to the Temperature vs Resistance table. Refer to Temperature Versus Resistance.
- A slight to moderate resistance in the IAT sensor signal circuit or low reference circuit will increase the range between these two sensors. This condition results in a greater voltage on the IAT sensor signal circuit, which is interpreted by the ECM as a colder IAT.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition OFF, inspect the cooling system surge tank for the proper coolant level. Refer to Cooling System Leak Testing and Cooling System Draining and Filling.
2. Inspect the thermostatically-controlled coolant heater, if equipped, for damage or modifications. Test for proper operation of the coolant heater. Refer to Coolant Heater Inoperative.
3. Ignition OFF for 8 hours or greater.
4. Ignition ON, observe the scan tool IAT and ECT sensor parameters. The ECT, IAT, and ambient temperature should be within 6°C (11°F) of each other.
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the ECT sensor.
2. Ignition OFF for 90 seconds, test for less than 5 ohms between the low reference circuit terminal A and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, verify the scan tool ECT parameter is colder than -39°C (-38°F).

   If greater than the specified range, test the signal circuit terminal B for a short to ground. If the circuit tests normal, replace the ECM.
4. Install a 3A fused jumper wire between the signal circuit terminal B and the low reference

circuit terminal A. Verify the scan tool ECT parameter is greater than 149°C (300°F).

   If less than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.

5. If all circuits test normal, test or replace the ECT sensor.
6. Inspect for the proper operation of the OEM block heater cord by verifying that the thermostat has turned OFF the heater at temperatures warmer than -10° (+14°F).

Component Testing

Measure and record the resistance of the ECT sensor at various ambient temperatures, then compare those measurements to the Temperature vs Resistance table. Refer to Temperature Versus Resistance.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Engine Coolant Temperature Sensor Replacement
- Control Module References for ECM replacement, setup, and programming

DTC P0117 or P0118

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0117: Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage

DTC P0118: Engine Coolant Temperature (ECT) Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117	P0118	P0118	P0118*	P0116, P0125, P0128
Low Reference	--	P0118	P0118	P0118*	P0125, P0128
*ECM or sensor damage may occur if the circuit is shorted to B+					

Typical Scan Tool Data

ECT Sensor Temperature

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop *Parameter Normal Range:* Varies with coolant temperature			
ECT Sensor Signal	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	--	-40°C (-40°F)	-40°C (-40°F)

Circuit/System Description

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the ECT signal circuit and supplies a ground to the low reference circuit.

Conditions for Running the DTC

P0117

- The engine is running for more than 10 seconds.
  OR
- The ignition is ON when the intake air temperature (IAT) is less than 50°C (122°F).
- This DTC runs continuously when the above conditions are met.

P0118

- The engine is running for more than 10 seconds.
  OR
- The ignition is ON when the IAT is more than 0°C (32°F).
- This DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0117

The ECM detects that the ECT is more than 150°C (302°F) for more than 5 seconds.

P0118

The ECM detects that the ECT is less than -60°C (-76°F) for more than 5 seconds.

Action Taken When the DTC Sets

DTCs P0117 and P0118 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0117 and P0118 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

> **Warning:** Under pressure, the temperature of the solution in the radiator can be considerably higher, without boiling. Removing the radiator cap while the engine is hot (pressure is high), will cause the solution to boil instantaneously, with explosive force. The solution will spew out over the engine, fenders, and the person removing the cap. Serious bodily injury may result. Flammable antifreeze, such as alcohol, is not recommended for use at any time. Flammable antifreeze could cause a serious fire.

1. Turn OFF the ignition.
2. Inspect the cooling system surge tank for the proper engine coolant level. Refer to Cooling System Leak Testing and Cooling System Draining and Filling.
3. Turn ON the ignition, with the engine OFF.
4. Use the scan tool to verify the proper operation of the engine cooling system fans.
5. Turn OFF the ignition.
6. Verify the proper heat range, and the operation of the thermostat. Refer to Thermostat Diagnosis.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the ECT sensor.
2. Ignition OFF for 90 seconds, test for less than 5 ohms between the low reference circuit terminal A and ground.
   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, verify the scan tool ECT parameter is colder than -39°C (-38°F).
   If greater than the specified range, test the signal circuit terminal B for a short to ground. If the circuit tests normal, replace the ECM.
4. Install a 3A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the scan tool ECT parameter is greater than 149°C (300°F).
   If less than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, test or replace the ECT sensor.

Component Testing

Measure and record the resistance of the ECT sensor at various ambient temperatures, then compare those measurements to the Temperature vs Resistance table. Refer to Temperature Versus Resistance.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Engine Coolant Temperature Sensor Replacement
- Control Module References for ECM replacement, setup, and programming

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DTC P0120, P0122, P0123, P0220, P0222, P0223, or P2135

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0120: Throttle Position (TP) Sensor 1 Circuit

DTC P0122: Throttle Position (TP) Sensor 1 Circuit Low Voltage

DTC P0123: Throttle Position (TP) Sensor 1 Circuit High Voltage

DTC P0220: Throttle Position (TP) Sensor 2 Circuit

DTC P0222: Throttle Position (TP) Sensor 2 Circuit Low Voltage

DTC P0223: Throttle Position (TP) Sensor 2 Circuit High Voltage

DTC P2135: Throttle Position (TP) Sensor 1-2 Correlation

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
TP Sensor 1 Signal	P0122	P2135	P0122	P0123	P0068, P0121
TP Sensor 1 5-Volt Reference	P0122	P2135	P0122	P0123	--
TP Sensor 1 Low Reference	--	P2135	P0123	--	--
TP Sensor 2 Signal	P0222	P2135	P0223	P0223	P0068, P0121
TP Sensor 2 5-Volt Reference	P0222	P2135	P0222	P0223	--
TP Sensor 2 Low Reference	--	P2135	P0223	--	--

Typical Scan Tool Data

TP Sensor 1

Circuit	Short to Ground	Open	Short to Voltage

Normal Range: 4.75-0.35 V			
TP Sensor 1 Signal	0 V	0 V	5 V
TP Sensor 1 5-Volt Reference	0 V	0 V	5 V
TP Sensor 1 Low Reference	--	5 V	--

TP Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 0.35-4.65 V			
TP Sensor 2 Signal	0 V	5 V	5 V
TP Sensor 2 5-Volt Reference	0 V	0 V	5 V
TP Sensor 2 Low Reference	--	5 V	--

Circuit/System Description

The throttle actuator control (TAC) system uses two throttle position (TP) sensors to monitor the throttle position. The TP sensors 1 and 2 are located within the throttle body assembly. Each sensor has the following circuits:

- A 5-volt reference circuit
- A low reference circuit
- A signal circuit

Two processors are also used to monitor the TAC system data. Both processors are located within the engine control module (ECM). Each signal circuit provides both processors with a signal voltage proportional to throttle plate movement. Both processors monitor each other's data to verify that the indicated TP calculation is correct.

Conditions for Running the DTC

P0120, P0122, P0123, P0220, P0222, and P0223

- DTC P0601, P0602, P0603, P0604, P0606, P0607, P0641, P0651 are not set.
- The system voltage is more than 5.23 volts.
- The ignition is in the Unlock/Accessory or Run position.
- DTC P0120, P0122, P0123, P0220, P0222, P0223 run continuously when the above conditions are met.

P2135

- The system voltage is more than 5.23 volts.
- The ignition is in the Unlock/Accessory or Run position.
- DTC P0120, P0220, P0641, P0651 are not set.
- DTC P2135 runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0120

TP sensor 1 voltage is less than 0.325 volt or more than 4.75 volts for more than 1 second.

P0122

The ECM detects that the TP sensor 1 voltage is less than 0.325 volt for more than 1 second.

P0123

The ECM detects that the TP sensor 1 voltage is more than 4.75 volts for more than 1 second.

P0220

The TP sensor 2 voltage is less than 0.25 volt or more than 4.59 volts for more than 1 second.

P0222

The ECM detects that the TP sensor 2 voltage is less than 0.25 volt for more than 1 second.

P0223

The ECM detects that the TP sensor 2 voltage is more than 4.59 volts for more than 1 second.

P2135

The difference between the TP sensor 1 and TP sensor 2 exceeds a predetermined value for more than 2 seconds.

Action Taken When the DTC Sets

- DTC P0120, P0122, P0123, P0220, P0222, P0223, and P2135 are Type A DTCs.
- The control module commands the TAC system to operate in the Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions the control module commands the engine OFF.

Conditions for Clearing the MIL/DTC

DTCs P0120, P0122, P0123, P0220, P0222, P0223, and P2135 are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Description and Operation

Throttle Actuator Control (TAC) System Description

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool TP sensor 1 voltage parameter. The reading should be between 4.75-0.33 volts and change with accelerator pedal input.
2. Ignition ON, observe the scan tool TP sensor 2 voltage parameter. The reading should be between 0.25-4.59 volts and change with accelerator pedal input.
3. Ignition ON, observe the scan tool TP sensor 1 and 2 parameter. The scan tool should indicate agree.
4. Clear the DTCs with the scan tool. Operate the vehicle within the Conditions for Running the DTC, or within the conditions that you observed from the Freeze Frame/Failure Records.
5. Verify that DTC P0120 or P0220 are not the only throttle position DTCs set.

   If DTC P0120 or P0220 are the only DTCs set, replace the control module.
6. Verify that DTCs P0641 or P0651 are not set.

   If DTC P0641 or P0651 is set, refer to DTC P0641 or P0651.
7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the throttle body. Allow up to 2 minutes for the ECM to completely power down.
2. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal C and ground.

   If greater than 5 ohms, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8-5.2 volts between 5-volt reference circuit terminal E and ground.

If less than 4.8 volts, test 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

If greater than 5.2 volts, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.

4. Verify the scan tool TP sensor 1 voltage is less than 0.1 volt.

   If greater than 0.1 volt, test the signal circuit terminal D for a short to voltage. If the circuit tests normal, replace the ECM.
5. Verify the scan tool TP sensor 2 voltage is greater than 4.8 volts.

   If less than 4.8 volts, test the signal circuit terminal F for a short to ground. If the circuit tests normal, replace the ECM.
6. Install a 3A fused jumper wire between the signal circuit terminal D and the 5-volt reference circuit terminal E of the TP sensor 1. Verify the TP sensor 1 voltage is greater than 4.8 volts.

   If less than 4.8 volts, test the TP sensor 1 signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
7. Install a test lamp between the signal circuit terminal F of the TP sensor 2 and ground. The test lamp should not illuminate.

   If the test lamp illuminates, test the TP sensor 2 signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
8. Install a 3A fused jumper wire between the signal circuit terminal F and the low reference circuit terminal C of the TP sensor 2. Verify that the TP sensor 2 voltage is less than 0.1 volt.

   If greater than 1.0 volt, test the TP sensor 2 signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
9. Ignition OFF, disconnect the harness connector at the ECM.
10. Test for less than 5 ohms on all TP sensor circuits between the following terminals:
    - ECM X2 signal circuit terminal 65 to TP terminal D
    - ECM X2 signal circuit terminal 63 to TP terminal F
    - ECM X2 5-volt reference circuit terminal 3 to terminal E

    If greater than 5 ohms, repair the affected circuit for open/high resistance.
11. Test for infinite resistance between TP sensor 1 signal circuit terminal D and TP sensor signal circuit terminal F.

    If less than infinite resistance, repair the short between TP sensor 1 signal circuit and TP sensor 2 signal circuit.
12. If all circuits test normal, replace the throttle body.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Throttle Body Assembly Replacement
- Control Module References for ECM replacement, setup, and programming

DTC P0128

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0128: Engine Coolant Temperature Below Thermostat Regulating Temperature

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117	P0118	P0118	P0118	P0116, P0128
Low Reference	--	P0118	P0118	P0118	P0128

Typical Scan Tool Data

ECT Sensor Temperature

Circuit	Normal Range	Short to Ground	Open	Short to Voltage
ECT Sensor Signal	-39 to +120°C (-38 to +248°F)	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	--	--	-40°C (-40°F)	-40°C (-40°F)

Circuit/System Description

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the ECT signal circuit and supplies a ground to the low reference circuit.

The purpose of both of these rationality diagnostics are to use the ECT sensor to determine if the engine coolant will heat up at the correct rate and also meet the calibrated target temperatures under various operating conditions.

The ECM uses the start-up ECT and the start-up intake air temperature (IAT) to begin the diagnostic calculation. The air flow into the engine is accumulated and vehicle speed, distance and engine run time are also factored to determine if the ECT does increase normally, and reach the calibrated target temperatures.

Conditions for Running the DTC

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0171, P0172, P0174, P0175, P0502, P0503 are not set.
- The start-up IAT is more than -7°C (+19°F).
- The start-up ECT is less than 70°C (158°F), when the IAT is above 10°C (50°F).
- The start-up ECT is less than 50°C (122°F), when the IAT is below 10°C (50°F).
- The engine run time is between 90 seconds and 22 minutes.
- The vehicle has traveled more than 2.4 kilometers (1.5 miles) at more than 8 km/h (5 mph).
- The accumulated airflow is between 20-75 g/s, with the minimum average airflow more than 10 g/s.
- The fuel ethanol percentage is less than 85 percent.
- This DTC runs once per ignition cycle within the enabling conditions.

Conditions for Setting the DTC

The ECM detects that the minimum ECT of 75°C (167°F) has not been met, when the IAT is more than 10°C (50°F).

OR

The ECM detects that the minimum ECT of 55°C (131°F) has not been met, when the IAT is less than 10°C (50°F).

Action Taken when the DTC Sets

DTC P0128 is Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0128 is Type B DTC.

Diagnostic Aids

- DTC P0128 occurring with insufficient vehicle interior heating is an indication of improper thermostat operation.
- Inspect the ECT sensor terminals and the ECT harness connector for corrosion. This condition results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.
- This diagnostic runs in a specific range. Measure and record the resistance of the ECT sensor at various ambient temperatures between -7 to +80°C (+19 to +176°F), then compare those measurements to the Temperature Versus Resistance.
- A slight to moderate resistance in the ECT sensor signal circuit or low reference circuit will affect this diagnostic. This condition results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition OFF, inspect the cooling system surge tank for proper coolant level. Refer to Cooling System Leak Testing and Cooling System Draining and Filling.
2. Ignition OFF for 8 hours or greater.
3. Ignition ON, observe the scan tool IAT Sensor and ECT Sensor parameters. The ECT, IAT, and ambient temperatures should be within 6°C (11°F) of each other.
4. Use the scan tool to verify the proper operation of the engine cooling system fans.

   Note: A critical analysis of the operation of the thermostat is necessary, to properly diagnose these DTCs.

5. Verify the proper heat range, and the operation of the thermostat. Refer to Thermostat Diagnosis.
6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the ECT sensor.
2. Ignition OFF for 90 seconds, test for less than 5 ohms between the low reference circuit terminal A and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, verify the scan tool ECT Sensor parameter is less than -39°C (-38°F).

   If warmer than the specified range, test the signal circuit terminal B for a short to ground. If the circuit tests normal, replace the ECM.
4. Install a 3A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the scan tool ECT Sensor parameter is greater than 149°C (300°F).

   If colder than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, test or replace the ECT sensor.

Component Testing

Measure and record the resistance of the ECT sensor at different ambient temperatures, and then compare those measurements to the Temperature Versus Resistance Table. Refer to Temperature Versus Resistance.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Engine Coolant Temperature Sensor Replacement
- Engine Coolant Thermostat Replacement
- Engine Control Module Replacement for ECM replacement, setup and programming.

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DTC P0131, P0132, P0137, or P0138

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0131: HO2S Circuit Low Voltage Bank 1 Sensor 1

DTC P0132: HO2S Circuit High Voltage Bank 1 Sensor 1

DTC P0137: HO2S Circuit Low Voltage Bank 1 Sensor 2

DTC P0138: HO2S Circuit High Voltage Bank 1 Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0132, P0137, P0140, P0151, P0152, P0157, P0158, P1133	P0131, P0132, P0133, P0134, P0137, P0140, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P0131, P0132, P0133, P0134, P0137, P0140, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160, P1133, P1153	P0133, P0134, P0140, P0153, P0154, P0160, P1133, P1153
HO2S Low Signal	--	P0131, P0132, P0133, P0134, P0138, P0140, P0151, P0152, P0153, P0154, P0158, P0160, P1133, P1153	P0131, P0132, P0133, P0134, P0138, P0140, P0151, P0152, P0153, P0154, P0158, P0160, P1133, P1153	P0134, P0138, P0140, P0154, P0158, P0160, P1133, P1153	--

Typical Scan Tool Data

HO2S Sensor 1 Voltage

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200-800 mV			
HO2S High Signal	0 mV	Approximately 470 mV	Approximately 1,100 mV

HO2S Low Signal	455 mV	Approximately 450 mV	Approximately 445 mV

Circuit / System Description

Heated oxygen sensors (HO2S) are used for fuel control and post catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content in the exhaust stream. The HO2S must reach operating temperature to provide an accurate voltage signal. Heating elements inside the HO2S minimize the time required for the sensors to reach operating temperature. The engine control module (ECM) supplies the HO2S with a reference, or bias, voltage of about 450 mV. When the engine is first started, the ECM operates in Open Loop, ignoring the HO2S voltage signal. Once the HO2S reaches operating temperature and Closed Loop is achieved, the HO2S generates a voltage within a range of 0-1,000 mV that fluctuates above and below bias voltage. High HO2S voltage indicates a rich exhaust stream. Low HO2S voltage indicates a lean exhaust stream.

Conditions for Running the DTC

P0131

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The Loop Status parameter is Closed.
- The Ignition 1 Signal parameter is between 10-18 volts.
- The Fuel Level Sensor parameter is more than 10 percent.
- The Throttle Position (TP) Indicated Angle parameter is between 3-70 percent.
- DTC P0131 runs continuously when the above conditions are met for 2 seconds.

P0132

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The Loop Status parameter is Closed.
- The Ignition 1 Signal parameter is between 10-18 volts.
- The Fuel Level Sensor parameter is more than 10 percent.
- The Throttle Position (TP) Sensor parameter is between 0-70 percent.
- DTC P0132 runs continuously when the above conditions are met for 2 seconds.

P0137

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.

- The Loop Status parameter is Closed.
- The Ignition 1 Signal parameter is between 10-18 volts.
- The Fuel Level Sensor parameter is more than 10 percent.
- The TP Sensor parameter is between 3-70 percent.
- DTC P0137 runs the lean test continuously when the above conditions are met for 2 seconds.

P0138

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The Loop Status parameter is Closed.
- The Ignition 1 Signal parameter is between 10-18 volts.
- The Fuel Level Sensor parameter is more than 10 percent.
- The TP Sensor parameter is between 3-70 percent.
- DTC P0138 runs the rich test continuously when the above conditions are met for 2 seconds.

Conditions for Setting the DTC

P0131

- The ECM detects that the HO2S 1 Voltage parameter is less than 50 mV.
- DTC P0131 sets within 100 seconds during the lean test when the above condition is met.

P0132

- The ECM detects that the HO2S 1 parameter is more than 1,050 mV.
- DTC P0132 sets within 15 seconds during the rich test when the above condition is met.

P0137

- The ECM detects that the HO2S 1 voltage parameter is less than 50 mV.
- DTC P0137 sets within 100 seconds during the lean test when the above condition is met.

P0138

- The ECM detects that the HO2S 1 voltage parameter is more than 1,050 mV.
- DTC P0138 sets within 100 seconds during the rich test when the above condition is met.

Action Taken When the DTC Sets

DTCs P0131, P0132, P0137, and P0138 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0131, P0132, P0137, and P0138 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Heated Oxygen Sensor Wiring Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. If any HO2S heater DTCs are set, perform those diagnostics first.
2. Allow the engine to reach operating temperature.
3. Engine running, observe the affected HO2S parameter with a scan tool.
    - The pre-catalyst oxygen sensors value should vary from below 200 mV to above 800 mV and respond to fueling changes.
    - The post-catalyst oxygen sensors value should change more than 200 mV when the throttle is quickly cycled 3 times from closed to wide open and back to closed after running the engine at 1,500 RPM for 30 seconds.
4. The affected HO2S may be damaged due to contamination. Prior to replacing the affected HO2S, inspect for the following sources of contamination:

    Notice: Refer to Silicon Contamination of Heated Oxygen Sensors Caution in the Preface section.

    - A silicon contaminated HO2S
    - Fuel contamination--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.

- Engine oil consumption--Refer to Oil Consumption Diagnosis.
- Engine coolant consumption--Refer to Loss of Coolant.

5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Important: All modules must be powered down or misdiagnosis may result.

1. Ignition OFF, disconnect the scan tool and wait 60 seconds to ensure all modules are powered down.
2. Ignition OFF, disconnect the harness connector at the appropriate HO2S.
3. Ignition OFF, measure for less than 5 ohms between the appropriate HO2S low signal circuit terminal A and ground.

   If more than the specified range, test the appropriate HO2S low signal circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
4. Ignition ON, verify the appropriate scan tool HO2S parameter is approximately 450 mV.

   If more than the specified value, test the appropriate HO2S high signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.

   If less than the specified value, test the appropriate HO2S high signal circuit for a short to ground. If the circuit tests normal, replace the ECM.
5. Ignition ON, install a 3A fused jumper wire at the HO2S high signal circuit terminal B. Toggle the jumper wire between the HO2S low signal circuit terminal A and battery voltage. Verify the appropriate scan tool HO2S parameter toggles between 0 mV and approximately 1,000 mV.

   If the appropriate scan tool HO2S parameter does not toggle correctly, test the HO2S high signal circuit for an open/high resistance. If the circuits test normal, replace the ECM.
6. If all circuits test normal, replace the appropriate HO2S.

Repair Instructions

Notice: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution in the Preface section.

Important: For DTC P0131 and P0132, in order to ensure that the performance of the catalyst has not been affected by the fault that set this DTC, operate the vehicle within the conditions for running and setting DTC P0420 and verify that P0420 runs and passes. Refer to DTC P0420 or P0430.

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 1
- Heated Oxygen Sensor Replacement - Bank 1 Sensor 2
- Control Module References for ECM replacement, setup, and programming

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DTC P0133, P0134, P0140, P1133, P2270, or P2271

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0133: HO2S Slow Response Bank 1 Sensor 1

DTC P0134: HO2S Circuit Insufficient Activity Bank 1 Sensor 1

DTC P0140: HO2S Circuit Insufficient Activity Bank 1 Sensor 2

DTC P1133: HO2S Insufficient Switching Bank 1 Sensor 1

DTC P2270: HO2S Signal Stuck Lean Bank 1 Sensor 2

DTC P2271: HO2S Signal Stuck Rich Bank 1 Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0132, P0137, P0140, P0151, P0152, P0157, P0158, P1133	P0131, P0132, P0133, P0134, P0137, P0140, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P0131, P0132, P0133, P0134, P0137, P0140, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160, P1133, P1153	P0133, P0134, P0140, P0153, P0154, P0160, P1133, P1153, P2270, P2271
HO2S Low Signal	--	P0131, P0132, P0133, P0134, P0138, P0140, P0151, P0152, P0153, P0154, P0158, P0160, P1133	P0131, P0132, P0133, P0134, P0138, P0140, P0151, P0152, P0153, P0154, P0158, P0160, P1133, P1153	P0134, P0138, P0140, P0154, P0158, P0160, P1133, P1153	--

Typical Scan Tool Data

HO2S Sensor 1 Voltage

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200-800 mV			
HO2S High Signal	0 mV	Approximately 470 mV	Approximately 1,100 mV
HO2S Low Signal	455 mV	Approximately 450 mV	Approximately 445 mV

Circuit / System Description

Heated oxygen sensors (HO2S) are used for fuel control and post catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content in the exhaust stream. The HO2S must reach operating temperature to provide an accurate voltage signal. Heating elements inside the HO2S minimize the time required for the sensors to reach operating temperature. The engine control module (ECM) supplies the HO2S with a reference, or bias, voltage of about 450 mV. When the engine is first started, the ECM operates in Open Loop, ignoring the HO2S voltage signal. Once the HO2S reaches operating temperature and Closed Loop is achieved, the HO2S generates a voltage within a range of 0-1,000 mV that fluctuates above and below bias voltage. High HO2S voltage indicates a rich exhaust stream. Low HO2S voltage indicates a lean exhaust stream.

Conditions for Running the DTC

P0133

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The Engine Coolant Temperature (ECT) Sensor parameter is more than 60°C (140°F).
- The Intake Air Temperature (IAT) Sensor parameter is more than -40°C (-40°F)
- The Ignition 1 Signal parameter is between 10-18 volts.
- The Fuel Level Sensor parameter is more than 10 percent.
- The Engine Run Time parameter is more than 160 seconds.
- The Engine Speed parameter is between 1,200-3,000 RPM.
- The Barometric (BARO) Pressure parameter is more than 70 kPa.
- The Mass Airflow (MAF) Sensor parameter is between 20-55 g/s.
- The Loop Status parameter is Closed.
- The Throttle Position (TP) Indicated Angle parameter is more than 5 percent.
- DTC P0133 runs once per drive cycle when the above conditions are met for 1 second.

P0134

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The Ignition 1 Signal parameter is between 10-18 volts.
- The engine run time is more than 300 seconds.

- DTC P0134 runs continuously when the above conditions are met.

P0140

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The Ignition 1 Signal parameter is between 10-18 volts.
- The Engine Run Time parameter is more than 300 seconds.
- The Loop Status parameter is closed.
- DTC P0140 runs once per drive cycle when the above conditions are met.

P1133

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The ECT Sensor parameter is more than 60°C (140°F).
- The Engine Speed parameter is between 1,200-3,000 RPM.
- The Ignition 1 Signal parameter is between 10-18 volts.
- The Engine Run Time parameter is more than 160 seconds.
- The Loop Status parameter is Closed.
- The TP Indicated Angle parameter is more than 5 percent.
- The Fuel Level Sensor parameter is more than 10 percent.
- The BARO Pressure parameter is more than 70 kPa.
- The MAF Sensor parameter is between 20-55 g/s.
- DTC P1133 runs once per drive cycle when the above conditions are met for 1 second.

P2270

- DTCs P0036, P0037, P0038, P0137, P0138, P0140, P0141, P0443, P0458, P0459, P2232 are not set.
- The Ignition 1 Signal parameter is between 10-18 volts.
- The Engine Speed parameter is between 500-5,000 RPM.
- The MAF Sensor parameter is between 3-50 g/s.
- The Vehicle Speed parameter is between 24-132 km/h (15-82 mph).
- The Fuel Level Sensor parameter is more than 10 percent.
- The Loop Status parameter is closed.
- DTC P2270 runs once per drive cycle when the above conditions are met.

P2271

- DTCs P0036, P0037, P0038, P0137, P0138, P0140, P0141, P0443, P0458, P0459, P2232 are not set.
- The Ignition 1 Signal parameter is between 10-18 volts.
- The Engine Speed parameter is between 500-5,000 RPM.
- The MAF Sensor parameter is between 3-50 g/s.
- The Vehicle Speed parameter is between 24-132 km/h (15-82 mph).
- The Fuel Level Sensor parameter is more than 10 percent.
- The Loop Status parameter is closed.
- DTC P2271 runs once per drive cycle when the above conditions are met for 1 second.

Conditions for Setting the DTC

P0133

- The ECM detects that the HO2S 1 rich-to-lean or lean-to-rich average response time is more than a calibrated value.
- DTC P0133 sets within 100 seconds when the above condition is met.

P0134

- The ECM detects that the HO2S 1 parameter is between 350-550 mV for 100 seconds.
- The Throttle Position (TP) Indicated Angle parameter changes more than 5 percent, 1 time.
- DTC P0134 sets within 100 seconds when the above conditions are met.

P0140

- The ECM detects that the HO2S 1 parameter is between 410-490 mV.
- The TP Indicated Angle parameter changes more than 5 percent 6 times.
- DTC P0140 sets within 100 seconds when the above conditions are met.

P1133

- The ECM detects that the HO2S 1 rich-to-lean counts, or the lean-to-rich counts are less than a calibrated value.
- DTC P1133 sets within 100 seconds when the above condition is met.

P2270

- The ECM detects that the HO2S 2 voltage oscillations are slower than a calibrated value.
- DTC P2270 sets within 4 seconds when the above condition is met continuously, or within 50 seconds when the above condition is met cumulatively.

P2271

- The ECM detects that the HO2S 2 voltage oscillations are faster than a calibrated value.
- DTC P2271 sets within 4 seconds when the above condition is met continuously, or within 50 seconds when the above condition is met cumulatively.

Action Taken When the DTC Sets

DTCs P0133, P0134, P0140, P1133, P2270, and P2271 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0133, P0134, P0140, P1133, P2270, and P2271 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Heated Oxygen Sensor Wiring Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. If any HO2S heater DTCs are set, perform those diagnostics first.
2. Allow the engine to reach operating temperature.
3. Engine running, observe the affected HO2S parameter with a scan tool.
    - The pre-catalyst oxygen sensors value should vary from below 200 mV to above 800 mV and respond to fueling changes.
    - The post-catalyst oxygen sensors value should change more than 200 mV when the throttle is quickly cycled 3 times from closed to wide open and back to closed after

running the engine at 1,500 RPM for 30 seconds.

4. The affected HO2S may be damaged due to contamination. Prior to replacing the affected HO2S, inspect for the following sources of contamination:

   Notice: Refer to Silicon Contamination of Heated Oxygen Sensors Caution in the Preface section.

   - A silicon contaminated HO2S
   - Fuel contamination--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
   - Engine oil consumption--Refer to Oil Consumption Diagnosis.
   - Engine coolant consumption--Refer to Loss of Coolant.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Important: All modules must be powered down or misdiagnosis may result.

1. Ignition OFF, disconnect the scan tool and wait 60 seconds to ensure all modules are powered down.
2. Ignition OFF, disconnect the harness connector at the appropriate HO2S.
3. Ignition OFF, measure for less than 5 ohms between the appropriate HO2S low signal circuit terminal A and ground.

   If more than the specified range, test the appropriate HO2S low signal circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
4. Ignition ON, verify the appropriate scan tool HO2S parameter is approximately 450 mV.

   If more than the specified value, test the appropriate HO2S high signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.

   If less than the specified value, test the appropriate HO2S high signal circuit for a short to ground. If the circuit tests normal, replace the ECM.
5. Ignition ON, install a 3A fused jumper wire at the HO2S high signal circuit terminal B. Toggle the jumper wire between the HO2S low signal circuit terminal A and battery voltage. Verify the appropriate scan tool HO2S parameter toggles between 0 mV and approximately 1,000 mV.

   If the appropriate scan tool HO2S parameter does not toggle correctly, test the HO2S high signal circuit for an open/high resistance. If the circuits test normal, replace the ECM.
6. If all circuits test normal, replace the appropriate HO2S.

Repair Instructions

Notice: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution in the Preface section.

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 1
- Heated Oxygen Sensor Replacement - Bank 1 Sensor 2
- Control Module References for ECM replacement, setup, and programming

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DTC P0151, P0152, P0157, or P0158

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0151: HO2S Circuit Low Voltage Bank 2 Sensor 1

DTC P0152: HO2S Circuit High Voltage Bank 2 Sensor 1

DTC P0157: HO2S Circuit Low Voltage Bank 2 Sensor 2

DTC P0158: HO2S Circuit High Voltage Bank 2 Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0132, P0137, P0140, P0151, P0152, P0157, P0158, P1133	P0131, P0132, P0133, P0134, P0137, P0140, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P0131, P0132, P0133, P0134, P0137, P0140, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160, P1133, P1153	P0133, P0134, P0140, P0153, P0154, P0160, P1133, P1153
HO2S Low Signal	--	P0131, P0132, P0133, P0134, P0138, P0140, P0151, P0152, P0153, P0154, P0158, P0160, P1133, P1153	P0131, P0132, P0133, P0134, P0138, P0140, P0151, P0152, P0153, P0154, P0158, P0160, P1133, P1153	P0134, P0138, P0140, P0154, P0158, P0160, P1133, P1153	--

Typical Scan Tool Data

HO2S Sensor 1 Voltage

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200-800 mV			
HO2S High Signal	0 mV	Approximately 470 mV	Approximately 1,100 mV

HO2S Low Signal	455 mV	Approximately 450 mV	Approximately 445 mV

Circuit / System Description

Heated oxygen sensors (HO2S) are used for fuel control and post catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content in the exhaust stream. The HO2S must reach operating temperature to provide an accurate voltage signal. Heating elements inside the HO2S minimize the time required for the sensors to reach operating temperature. The engine control module (ECM) supplies the HO2S with a reference, or bias, voltage of about 450 mV. When the engine is first started, the ECM operates in Open Loop, ignoring the HO2S voltage signal. Once the HO2S reaches operating temperature and Closed Loop is achieved, the HO2S generates a voltage within a range of 0-1,000 mV that fluctuates above and below bias voltage. High HO2S voltage indicates a rich exhaust stream. Low HO2S voltage indicates a lean exhaust stream.

Conditions for Running the DTC

P0151

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The Loop Status parameter is Closed.
- The Ignition 1 Signal parameter is between 10-18 volts.
- The Fuel Level Sensor parameter is more than 10 percent.
- The Throttle Position (TP) Indicated Angle parameter is between 3-70 percent.
- DTC P0151 runs continuously when the above conditions are met for 2 seconds.

P0152

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The Loop Status parameter is Closed.
- The Ignition 1 Signal parameter is between 10-18 volts.
- The Fuel Level Sensor parameter is more than 10 percent.
- The Throttle Position (TP) Sensor parameter is between 0-70 percent.
- DTC P0152 runs continuously when the above conditions are met for 2 seconds.

P0157

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.

- The Loop Status parameter is Closed.
- The Ignition 1 Signal parameter is between 10-18 volts.
- The Fuel Level Sensor parameter is more than 10 percent.
- The TP Sensor parameter is between 3-70 percent.
- DTC P0157 runs the lean test continuously when the above conditions are met for 2 seconds.

P0158

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The Loop Status parameter is Closed.
- The Ignition 1 Signal parameter is between 10-18 volts.
- The Fuel Level Sensor parameter is more than 10 percent.
- The TP Sensor parameter is between 3-70 percent.
- DTC P0158 runs the rich test continuously when the above conditions are met for 2 seconds.

Conditions for Setting the DTC

P0151

- The ECM detects that the HO2S 1 Voltage parameter is less than 50 mV.
- DTC P0151 sets within 100 seconds during the lean test when the above condition is met.

P0152

- The ECM detects that the HO2S 1 parameter is more than 1,050 mV.
- DTC P0152 sets within 15 seconds during the rich test when the above condition is met.

P0157

- The ECM detects that the HO2S 1 voltage parameter is less than 50 mV.
- DTC P0157 sets within 100 seconds during the lean test when the above condition is met.

P0158

- The ECM detects that the HO2S 1 voltage parameter is more than 1,050 mV.
- DTC P0158 sets within 100 seconds during the rich test when the above condition is met.

Action Taken When the DTC Sets

DTCs P0151, P0153, P0157, P0158 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0151, P0153, P0157, P0158 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Heated Oxygen Sensor Wiring Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. If any HO2S heater DTCs are set, perform those diagnostics first.
2. Allow the engine to reach operating temperature.
3. Engine running, observe the affected HO2S parameter with a scan tool.
   - The pre-catalyst oxygen sensors value should vary from below 200 mV to above 800 mV and respond to fueling changes.
   - The post-catalyst oxygen sensors value should change more than 200 mV when the throttle is quickly cycled 3 times from closed to wide open and back to closed after running the engine at 1,500 RPM for 30 seconds.
4. The affected HO2S may be damaged due to contamination. Prior to replacing the affected HO2S, inspect for the following sources of contamination:

   Notice: Refer to Silicon Contamination of Heated Oxygen Sensors Caution in the Preface section.

   - A silicon contaminated HO2S
   - Fuel contamination--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.

- Engine oil consumption--Refer to Oil Consumption Diagnosis.
- Engine coolant consumption--Refer to Loss of Coolant.

5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Important: All modules must be powered down or misdiagnosis may result.

1. Ignition OFF, disconnect the scan tool and wait 60 seconds to ensure all modules are powered down.
2. Ignition OFF, disconnect the harness connector at the appropriate HO2S.
3. Ignition OFF, measure for less than 5 ohms between the appropriate HO2S low signal circuit terminal A and ground.

   If more than the specified range, test the appropriate HO2S low signal circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
4. Ignition ON, verify the appropriate scan tool HO2S parameter is approximately 450 mV.

   If more than the specified value, test the appropriate HO2S high signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.

   If less than the specified value, test the appropriate HO2S high signal circuit for a short to ground. If the circuit tests normal, replace the ECM.
5. Ignition ON, install a 3A fused jumper wire at the HO2S high signal circuit terminal B. Toggle the jumper wire between the HO2S low signal circuit terminal A and battery voltage. Verify the appropriate scan tool HO2S parameter toggles between 0 mV and approximately 1,000 mV.

   If the appropriate scan tool HO2S parameter does not toggle correctly, test the HO2S high signal circuit for an open/high resistance. If the circuits test normal, replace the ECM.
6. If all circuits test normal, replace the appropriate HO2S.

Repair Instructions

Notice: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution in the Preface section.

Important: For DTC P0151 and P0152, in order to ensure that the performance of the catalyst has not been affected by the fault that set this DTC, operate the vehicle within the conditions for running and setting DTC P0420 and verify that P0420 runs and passes. Refer to DTC P0420 or P0430.

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 2 Sensor 1
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 2
- Control Module References for replacement, setup, and programming

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Document ID: 2152477

DTC P0153, P0154, P0160, P1153, P2272, or P2273

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0153: HO2S Slow Response Bank 2 Sensor 1

DTC P0154: HO2S Circuit Insufficient Activity Bank 2 Sensor 1

DTC P0160: HO2S Circuit Insufficient Activity Bank 2 Sensor 2

DTC P1153: HO2S Insufficient Switching Bank 2 Sensor 1

DTC P2272: HO2S Signal Stuck Lean Bank 2 Sensor 2

DTC P2273: HO2S Signal Stuck Rich Bank 2 Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0132, P0137, P0140, P0151, P0152, P0157, P0158, P1133	P0131, P0132, P0133, P0134, P0137, P0140, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P0131, P0132, P0133, P0134, P0137, P0140, P0151, P0152, P0153, P0154, P0157, P0160, P1133, P1153	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160, P1133, P1153	P0133, P0134, P0140, P0153, P0154, P0160, P1133, P1153, P2272, P2273
HO2S Low Signal	--	P0131, P0132, P0133, P0134, P0138, P0140, P0151, P0152, P0153, P0154, P0158, P0160, P1133	P0131, P0132, P0133, P0134, P0138, P0140, P0151, P0152, P0153, P0154, P0158, P0160, P1133, P1153	P0134, P0138, P0140, P0154, P0158, P0160, P1133, P1153	--

Typical Scan Tool Data

HO2S Sensor 1 Voltage

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200-800 mV			
HO2S High Signal	0 mV	Approximately 470 mV	Approximately 1,100 mV
HO2S Low Signal	455 mV	Approximately 450 mV	Approximately 445 mV

Circuit/System Description

Heated oxygen sensors (HO2S) are used for fuel control and post catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content in the exhaust stream. The HO2S must reach operating temperature to provide an accurate voltage signal. Heating elements inside the HO2S minimize the time required for the sensors to reach operating temperature. The engine control module (ECM) supplies the HO2S with a reference, or bias, voltage of about 450 mV. When the engine is first started, the ECM operates in Open Loop, ignoring the HO2S voltage signal. Once the HO2S reaches operating temperature and Closed Loop is achieved, the HO2S generates a voltage within a range of 0-1,000 mV that fluctuates above and below bias voltage. High HO2S voltage indicates a rich exhaust stream. Low HO2S voltage indicates a lean exhaust stream.

Conditions for Running the DTC

P0153

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The Engine Coolant Temperature (ECT) Sensor parameter is more than 60°C (140°F).
- The Intake Air Temperature (IAT) Sensor parameter is more than -40°C (-40°F).
- The Ignition 1 Signal parameter is between 10-18 volts.
- The Fuel Level Sensor parameter is more than 10 percent.
- The Engine Run Time parameter is more than 160 seconds.
- The Engine Speed parameter is between 1,200-3,000 RPM.
- The Barometric (BARO) Pressure parameter is more than 70 kPa.
- The Mass Airflow (MAF) Sensor parameter is between 20-55 g/s.
- The Loop Status parameter is Closed.
- The Throttle Position (TP) Indicated Angle parameter is more than 5 percent.
- DTC P0153 runs once per drive cycle when the above conditions are met for 1 second.

P0154

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The Ignition 1 Signal parameter is between 10-18 volts.
- The engine run time is more than 300 seconds.

- DTC P0154 runs continuously when the above conditions are met.

P0160

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The Ignition 1 Signal parameter is between 10-18 volts.
- The Engine Run Time parameter is more than 300 seconds.
- The Loop Status parameter is closed.
- DTC P0160 runs once per drive cycle when the above conditions are met.

P1153

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The ECT Sensor parameter is more than 60°C (140°F).
- The IAT Sensor parameter is more than -40°C (-40°F).
- The Engine Speed parameter is between 1,200-3,000 RPM.
- The Ignition 1 Signal parameter is between 10-18 volts.
- The Engine Run Time parameter is more than 160 seconds.
- The Loop Status parameter is Closed.
- The TP Indicated Angle parameter is more than 5 percent.
- The Fuel Level Sensor parameter is more than 10 percent.
- The BARO Pressure parameter is more than 70 kPa.
- The MAF Sensor parameter is between 20-55 g/s.
- DTC P1153 runs once per drive cycle when the above conditions are met for 1 second.

P2272

- DTCs P0036, P0037, P0038, P0137, P0138, P0140, P0141, P0443, P0458, P0459, P2232 are not set.
- The Ignition 1 Signal parameter is between 10-18 volts.
- The Engine Speed parameter is between 500-5,000 RPM.
- The MAF Sensor parameter is between 3-50 g/s.
- The Vehicle Speed parameter is between 24-132 km/h (15-82 mph).
- The Fuel Level Sensor parameter is more than 10 percent.
- The Loop Status parameter is closed.
- DTC P2272 runs once per drive cycle when the above conditions are met.

P2273

- DTCs P0036, P0037, P0038, P0137, P0138, P0140, P0141, P0443, P0458, P0459, P2232 are not set.
- The Ignition 1 Signal parameter is between 10-18 volts.
- The Engine Speed parameter is between 500-5,000 RPM.
- The MAF Sensor parameter is between 3-50 g/s.
- The Vehicle Speed parameter is between 24-132 km/h (15-82 mph).
- The Fuel Level Sensor parameter is more than 10 percent.
- The Loop Status parameter is closed.
- DTC P2273 runs once per drive cycle when the above conditions are met for 1 second.

Conditions for Setting the DTC

P0153

- The ECM detects that the HO2S 1 rich-to-lean or lean-to-rich average response time is more than a calibrated value.
- DTC P0133 sets within 100 seconds when the above condition is met.

P0154

- The ECM detects that the HO2S 1 parameter is between 350-550 mV for 100 seconds.
- The Throttle Position (TP) Indicated Angle parameter changes more than 5 percent, 1 time.
- DTC P0154 sets within 100 seconds when the above conditions are met.

P0160

- The ECM detects that the HO2S 1 parameter is between 410-490 mV.
- The TP Indicated Angle parameter changes more than 5 percent 1 time.
- DTC P0160 sets within 100 seconds when the above conditions are met.

P1153

- The ECM detects that the HO2S 1 rich-to-lean counts, or the lean-to-rich counts are less than a calibrated value.
- DTC P1153 sets within 100 seconds when the above condition is met.

P2272

- The ECM detects that the affected HO2S is below 730 mV.
- DTC P2272 sets within 1 second when the above condition is met.

P2273

- The ECM detects that the affected HO2S is above 225 mV.

- DTC P2273 sets within 1 second when the above condition is met.

Action Taken When the DTC Sets

DTCs P0153, P0154, P0160, P1153, P2272, and P2273 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0153, P0154, P0160, P1153, P2272, and P2273 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Heated Oxygen Sensor Wiring Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. If any HO2S heater DTCs are set, perform those diagnostics first.
2. Allow the engine to reach operating temperature.
3. Engine running, observe the affected HO2S parameter with a scan tool.
   - The pre-catalyst oxygen sensors value should vary from below 200 mV to above 800 mV and respond to fueling changes.
   - The post-catalyst oxygen sensors value should change more than 200 mV when the throttle is quickly cycled 3 times from closed to wide open and back to closed after running the engine at 1,500 RPM for 30 seconds.
4. The affected HO2S may be damaged due to contamination. Prior to replacing the affected

HO2S, inspect for the following sources of contamination:

Notice: Refer to Silicon Contamination of Heated Oxygen Sensors Caution in the Preface section.

- A silicon contaminated HO2S
- Fuel contamination--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
- Engine oil consumption--Refer to Oil Consumption Diagnosis.
- Engine coolant consumption--Refer to Loss of Coolant.

5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Important: All modules must be powered down or misdiagnosis may result.

1. Ignition OFF, disconnect the scan tool and wait 60 seconds to ensure all modules are powered down.
2. Ignition OFF, disconnect the harness connector at the appropriate HO2S.
3. Ignition OFF, measure for less than 5 ohms between the appropriate HO2S low signal circuit terminal A and ground.

   If more than the specified range, test the appropriate HO2S low signal circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
4. Ignition ON, verify the appropriate scan tool HO2S parameter is approximately 450 mV.

   If more than the specified value, test the appropriate HO2S high signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.

   If less than the specified value, test the appropriate HO2S high signal circuit for a short to ground. If the circuit tests normal, replace the ECM.
5. Ignition ON, install a 3A fused jumper wire at the HO2S high signal circuit terminal B. Toggle the jumper wire between the HO2S low signal circuit terminal A and battery voltage. Verify the appropriate scan tool HO2S parameter toggles between 0 mV and approximately 1,000 mV.

   If the appropriate scan tool HO2S parameter does not toggle correctly, test the HO2S high signal circuit for an open/high resistance. If the circuits test normal, replace the ECM.
6. If all circuits test normal, replace the appropriate HO2S.

Repair Instructions

Notice: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution in the Preface section.

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 2 Sensor 1
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 2
- Control Module References for ECM replacement, setup, and programming

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Document ID: 2076050

DTC P0171, P0172, P0174, or P0175

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0171: Fuel Trim System Lean Bank 1

DTC P0172: Fuel Trim System Rich Bank 1

DTC P0174: Fuel Trim System Lean Bank 2

DTC P0175: Fuel Trim System Rich Bank 2

Circuit/System Description

The engine control module (ECM) controls the air/fuel metering system in order to provide the best possible combination of driveability, fuel economy, and emission control. Fuel delivery is controlled differently during Open Loop and Closed Loop (CL). During Open Loop, the ECM determines fuel delivery based on sensor signals without heated oxygen sensor (HO2S) input. During CL, the ECM adds HO2S inputs and level of purge to calculate the short and long term fuel trim (FT) adjustments. If the HO2S indicates a lean condition, the fuel trim values will be above 0 percent. If the HO2S indicates a rich condition, the FT values will be below 0 percent. The short term FT values change rapidly in response to the HO2S voltage signals. The long term FT makes coarse adjustments in order to maintain an optimum air/fuel ratio. A block of cells contain information arranged in combinations of engine RPM and engine load for a full range of vehicle operating conditions. The long term FT diagnostic is based on an average of cells currently being used. The ECM selects the cells based on the engine speed and load. The FT diagnostic will conduct a test to determine if a rich failure actually exists or if excessive vapor from the evaporative emission (EVAP) canister is causing a rich condition.

If the ECM detects an excessively lean condition, DTC P0171 or P0174 sets. If the ECM detects an excessively rich condition, DTC P0172 or P0175 sets.

Conditions for Running the DTC

- DTCs P0030, P0036, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0117, P0118, P0120, P0121, P0128, P0130, P0131, P0132, P0133, P0134, P0135, P0136, P0137, P0138, P0140, P0141, P0201-P0208, P0220, P0300, P0301-P0304, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P1106, P1107, P1114, P1115, P1133, P1516, P2101, P2119, P2120, P2125, P2135, P2138, P2176 are not set.
- The engine is in Closed Loop status.
- The engine coolant temperature (ECT) is between -40 and +150°C (-40 and +302°F).

- The intake air temperature (IAT) is between -20 and +150°C (-4 and +302°F).
- The manifold absolute pressure (MAP) is between 10-255 kPa (1.45-37 psi).
- The vehicle speed is less than 134 km/h (83 mph).
- The engine speed is between 375-7,000 RPM.
- The mass air flow (MAF) is between 1-510 g/s.
- The barometric pressure (BARO) is more than 70 kPa (10.2 psi).
- The fuel level is more than 10 percent.
- This diagnostic runs continuously when the above conditions have been met.

Conditions for Setting the DTC

- The average long term FT weighted average value is more or less than a calibrated value.
- The above condition is present for approximately 3 minutes after the Conditions for Running the DTC have been met.

Action Taken When the DTC Sets

The ECM records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the ECM stores this information in the Failure Records. If the diagnostic reports a failure on the second ignition cycle the ECM records the operating conditions at the time of the failure. The ECM writes the operating conditions to the Freeze Frame and updates the Failure Records. The ECM illuminates the malfunction indicator lamp (MIL) when one of the following occur:

- The ECM detects the same fuel trim failure during 2 consecutive trips.
- The ECM detects any fuel trim failure during any subsequent trip if the conditions at the time of failure meet the following criteria:
  - The engine load is within 20 percent of the previous test that failed.
  - The engine speed is within 375 RPM of the previous test that failed.
  - The engine coolant temperature is in the same range of the previous test that failed.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the malfunction indicator lamp (MIL) at the beginning of the fourth ignition cycle, after 3 ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC and related Freeze Frame data clears after 40 warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Reference Information

Electrical Information Reference

- Circuit Testing

- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

- Disregard any transmission symptoms, antilock brake system (ABS) indicators, and traction control system (TCS) indicators until any fuel trim faults are repaired. A fuel trim fault may cause default actions such as harsh shifts and illumination of the ABS/TCS indicators.
- E85 compatible engine only--Over estimation of the ethanol content will result in a rich shift of fuel trim values, and under-estimation will result in a lean shift of fuel trim values. A fuel trim DTC may set if the learned alcohol content, Fuel Alcohol Content parameter on the scan tool, is different than the measured alcohol content in the vehicle such that fuel trim values exceed failure threshold values.
- Verify that other DTCs are not set.

  If any DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
- Allow the engine to reach operating temperature. With the engine running, observe the HO2S parameter with a scan tool. The HO2S value should vary from approximately 40 mV to approximately 900 mV, and respond to fueling changes.

  If the value does not vary from approximately 40 mV to approximately 900 mV, refer to DTC P0131, P0132, P0137, or P0138 , DTC P0133, P0134, P0140, P1133, P2270, or P2271 , DTC P0153, P0154, P0160, P1153, P2272, or P2273 , or DTC P0153, P0154, P0160, P1153, P2272, or P2273.

Important: EVAP purge enablement may cause the FT to be momentarily outside the normal range.

- The normal Short Term FT parameter should be between +10 percent and -10 percent, with near 0 percent the optimum, with the engine running at operating temperature.
- The Long Term FT parameter should be between +10 percent and -10 percent, with near 0 percent the optimum, with the engine running at operating temperature.
- Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

P0171 or P0174

Allow the engine to reach operating temperature. With the engine running, observe the affected Long Term FT parameter with a scan tool. The reading should be between 0-19 percent.

If not within the specified range, inspect for the following:

- With the ignition ON and the engine OFF, observe the manifold absolute pressure (MAP) sensor parameter. The MAP sensor pressure should be within the range specified for your altitude. Refer to Altitude Versus Barometric Pressure.

  Refer to DTC P0106 if the MAP sensor does not indicate the correct barometric pressure.
- With the engine idling, observe the mass air flow (MAF) sensor parameter. The MAF sensor parameter should be within 2-6 g/s at idle.

  Refer to DTC P0101 or P1101 or DTC P0102 or P0103 if the MAF sensor parameter is not within 2-6 g/s at idle.
- Vacuum hoses for splits, kinks, and improper connections
- Insufficient fuel in the tank
- Low fuel pressure--Refer to Fuel System Diagnosis.
- Fuel contamination--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
- Malfunctioning fuel injectors--Refer to Fuel Injector Diagnosis.
- Missing, loose, or leaking exhaust components from the HO2S forward--Refer to Symptoms - Engine Exhaust.
- Vacuum leaks at the intake manifold, the throttle body, and the injector O-rings
- The air induction system and the air intake ducts for leaks or for a missing air filter element
- A cracked EVAP canister
- Evaporative pipes obstructed or leaking--Refer to Fuel Hose/Pipes Routing Diagram.
- The crankcase ventilation system for leaks
- The HO2S for improper installation and for electrical wires or connectors that may have contacted the exhaust system
- The HO2S signal circuit open, shorted to ground, or shorted to the low reference circuit
- Malfunctioning engine components--Refer to Symptoms - Engine Mechanical.

P0172 or P0175

Allow the engine to reach operating temperature. With the engine running, observe the affected Long Term FT parameter with a scan tool. The reading should be between -19 and 0 percent.

If not within the specified range, inspect for the following:

- With the engine idling and the transmission in the Park or Neutral position, observe the manifold absolute pressure (MAP) sensor parameter. The MAP sensor parameter should be between 19-42 kPa.

  Refer to DTC P0106 if the MAP sensor parameter is not between 19-42 kPa.
- With the engine idling, observe the mass air flow (MAF) sensor parameter. The MAF sensor parameter should be within 2-6 g/s at idle.

  Refer to DTC P0101 or P1101 or DTC P0102 or P0103 if the MAF sensor parameter is not within 2-6 g/s at idle.
- Vacuum hoses for splits, kinks, and improper connections
- The air intake duct for being collapsed or restricted
- The air filter for being dirty or restricted
- Objects blocking the throttle body
- Excessive fuel in the crankcase due to leaking fuel injectors

- The evaporative emissions control system for improper operation--Refer to Fuel Hose/Pipes Routing Diagram.
- Excessive fuel pressure--Refer to Fuel System Diagnosis.
- Malfunctioning fuel injectors--Refer to Fuel Injector Diagnosis.
- Fuel contamination--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
- The HO2S for improper installation and for electrical wires or connectors that may have contacted the exhaust system
- The HO2S signal circuit shorted to voltage

Repair Instructions

- Air Cleaner Assembly Replacement
- Air Cleaner Element Replacement
- Evaporative Emission Canister Replacement
- Evaporative Emission Canister Purge Solenoid Valve Replacement
- Evaporative Emission Canister Vent Solenoid Valve Replacement
- Evaporative Emission Hoses/Pipes Replacement - Engine
- Fuel Hose/Pipes Replacement - Chassis
- Fuel Injector Replacement
- Fuel System Cleaning
- Fuel Tank Draining
- Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 and Heated Oxygen Sensor Replacement - Bank 2 Sensor 1
- Manifold Absolute Pressure Sensor Replacement
- Mass Airflow Sensor/Intake Air Temperature Sensor Replacement
- Throttle Body Assembly Replacement

Repair Verification

Important:

- After repairs, use the scan tool Fuel Trim Reset function in order to reset the Long Term Fuel Trim.
- To verify the performance of the catalytic converter has not been affected by the condition that set this DTC, perform the Repair Verification for DTC P0420 or P0430. Refer to DTC P0420 or P0430.

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming, or setup procedures that are required when a component or module is removed or replaced.
3. Turn ON the ignition, with the engine OFF.

   Important: DO NOT clear codes with the engine running. The codes may reset in the same ignition cycle.

4. Clear the DTCs.
5. Turn OFF the ignition for 60 seconds.

6. Start the engine.
7. Duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not reset. If the DTC resets, or another DTC is present, refer to the Diagnostic Trouble Code (DTC) List - Vehicle and perform the appropriate diagnostic procedure.

DTC P0196, P0197, or P0198

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P0196: Engine Oil Temperature Sensor Circuit Range/Performance

DTC P0197: Engine Oil Temperature Sensor Circuit Low Input

DTC P0198: Engine Oil Temperature Sensor Circuit High Input

Circuit / System Description

The engine oil temperature (EOT) sensor is a variable resistor that measures the temperature of the engine oil. The engine control module (ECM) supplies a 5 voltage to the EOT signal circuit and supplies a ground for the reference circuit.

Conditions for Running the DTC

P0112, P0196 or P0198

- The engine has been running for more than 10 seconds.
- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTC

P0196

The ECM detects that the engine EOT sensor is not within 100°C of predetermined values.

P0197

The ECM detects that the EOT sensor is less than -35°C of longer than 3 seconds.

P0198

The ECM detects that the EOT sensor is greater than 170°C for longer than 3 seconds.

Action Taken when the DTC Sets

DTCs P0196, P0197 and P0198 are type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0196, P0197 and P0198 are type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Verification

Inspect condition of oil system. Refer to Oil Pressure Diagnosis and Testing.

Circuit/System Testing

P0196, P0197 or P0198

1. Ignition ON, engine OFF.
2. Disconnect the EOT sensor.
3. Measure for proper voltage range of 4.9-5.2 Volts.

   If the voltage is less than 4.9 volts, test the EOT sensor circuit for a short to ground or an open/high resistance.

   If the voltage is greater than 5.2 volts, test the EOT circuit for a short to voltage.

   If the EOT circuit tests normal and the voltage is not within the proper range then replace the ECM.
4. Connect a 3 amp fusiable link between the signal circuit of the EOT and the low reference circuit.

   Observe the sensor parameters while connecting and disconnecting the link between the EOT sensor signal and the low reference circuit.

   the EOT should switch between the upper and lower limits.

if the EOT signal does not switch between the upper and lower limits then replace the ECM..

if the EOT signal does switch between the upper and lower limits then replace the EOT.

Component Testing

Measure and record the resistance of the EOT sensor at various temperatures and then compare those measurements to the Temperature Versus Resistance Table. Refer to Temperature Versus Resistance - Engine Coolant Temperature Sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for ECM replacement, setup and programming

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DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0201: Injector 1 Control Circuit

DTC P0202: Injector 2 Control Circuit

DTC P0203: Injector 3 Control Circuit

DTC P0204: Injector 4 Control Circuit

DTC P0205: Injector 5 Control Circuit

DTC P0206: Injector 6 Control Circuit

DTC P0207: Injector 7 Control Circuit

DTC P0208: Injector 8 Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition 1 Voltage - INJ Fuse A	P0201, P0203, P0205, P0207, P0300	P0201, P0203, P0205, P0207, P0300	--	--
Ignition 1 Voltage - INJ Fuse B	P0202, P0204, P0206, P0208, P0300	P0202, P0204, P0206, P0208, P0300	--	--
Fuel Injector 1 Control	P0201	P0201	P0201	--
Fuel Injector 2 Control	P0202	P0202	P0202	--
Fuel Injector 3 Control	P0203	P0203	P0203	--
Fuel Injector 4 Control	P0204	P0204	P0204	--

Fuel Injector 5 Control	P0205	P0205	P0205	--
Fuel Injector 6 Control	P0206	P0206	P0206	--
Fuel Injector 7 Control	P0207	P0207	P0207	--
Fuel Injector 8 Control	P0208	P0208	P0208	--

Circuit/System Description

The control module enables the appropriate fuel injector pulse for each cylinder. Ignition voltage is supplied to the fuel injectors. The control module controls each fuel injector by grounding the control circuit via a solid state device called a driver. The control module monitors the status of each driver. If the control module detects an incorrect voltage for the commanded state of the driver, a fuel injector control circuit DTC sets.

Conditions for Running the DTC

- The engine is running.
- The ignition voltage is more than 11 volts.
- DTC P0201-P0208 runs continuously when the above conditions are met.

Conditions for Setting the DTC

- The control module detects an incorrect voltage on the fuel injector control circuit.
- The above condition is met for 1 second.

Action Taken When the DTC Sets

DTCs P0201, P0202, P0203, P0204, P0205, P0206, P0207, and P0208 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0201, P0202, P0203, P0204, P0205, P0206, P0207, and P0208 are Type B DTCs.

Diagnostic Aids

Performing the Fuel Injector Diagnosis may help isolate an intermittent condition. Refer to Fuel Injector Diagnosis.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 34730-405 Injector Test Lamp

Circuit/System Testing

1. Ignition OFF, disconnect the affected fuel injector harness connector at the fuel injector.
2. Ignition ON, verify that a test lamp illuminates between the ignition 1 voltage circuit terminal A and ground.

   If the test lamp does not illuminate, test the ignition 1 voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition 1 voltage circuit fuse is open, test or replace the fuel injector.
3. Connect the J 34730-405 between the control circuit terminal B and the ignition 1 voltage circuit terminal A.
4. Command the fuel injector ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the engine control module (ECM).

   If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, test or replace the fuel injector.

Component Testing

Important: The engine coolant temperature (ECT) sensor must be between 10-32°C (50-90°F) for an accurate measurement.

Measure for 11-14 ohms of resistance between the terminals of the fuel injector.

If the resistance is not within the specified range, replace the fuel injector.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Fuel Injector Replacement
- Control Module References for ECM replacement, setup, and programming

DTC P0230

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0230: Fuel Pump Relay Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Battery Voltage - Relay Switch Side	[1]	[2]	--	--
Fuel Pump Supply Voltage	[1]	[2]	[3]	--
Fuel Pump Relay Control	P0230	P0230	P0230	--
Fuel Pump Relay Ground	--	P0230	--	--
Fuel Pump Ground	--	[2]	--	--

[1] Open fuel pump fuse, cranks no start

[2] Cranks no start

[3] Fuel pump operates continuously, then discharged battery

Circuit/System Description

The control module enables the fuel pump relay when the ignition switch is turned ON. The control module will disable the fuel pump relay within 2 seconds unless the control module detects ignition reference pulses. The control module continues to enable the fuel pump relay as long as ignition reference pulses are detected. The control module disables the fuel pump relay within 2 seconds if ignition reference pulses cease to be detected and the ignition remains ON.

The control module monitors the voltage on the fuel pump relay control circuit. If the control module detects an incorrect voltage on the fuel pump relay control circuit, a fuel pump relay control DTC sets.

Conditions for Running the DTC

- The ignition voltage is between 11-18 volts.
- DTC P0230 runs continuously when the above conditions are met.

Conditions for Setting the DTC

- The control module detects that the commanded state of the driver and the actual state of the control circuit do not match.
- The above condition is met for a minimum of 2.5 seconds.

Action Taken When the DTC Sets

DTC P0230 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0230 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 43244 Relay Puller Pliers

Circuit / System Verification

Important: An open or a short to voltage in the control circuit will cause both the Ckt. Open Test Status and the Ckt. Short Volts Test Status parameters to display Fault.

- Ignition ON, command the fuel pump relay ON and OFF with a scan tool while observing the following control circuit status parameters:
  - Fuel Pump Relay Ckt. Short Gnd Test Status
  - Fuel Pump Relay Ckt. Open Test Status
  - Fuel Pump Relay Ckt. Short Volts Test Status
- Each parameter should toggle between OK and Not Run or Not Run and OK.

Circuit / System Testing

1. Ignition OFF, disconnect the fuel pump relay.
2. Ignition ON, verify that a test lamp illuminates between the ground circuit terminal and B+.

   If the test lamp does not illuminate, test the ground circuit for a short to voltage or an open/high resistance.
3. Verify that a test lamp does not illuminate between the ground circuit terminal and the control circuit terminal.

   If the test lamp illuminates, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Remove the test lamp.
5. Command the fuel pump relay ON with a scan tool. Verify the scan tool fuel pump relay Ckt. Short Grnd Test Status parameter is OK.

   If not the specified value, test the fuel pump relay control circuit for a short to ground. If the circuit tests normal, replace the ECM.
6. Install a 3A fused jumper wire between the fuel pump relay control circuit terminal and the ground circuit terminal. Command the fuel pump ON with a scan tool. Verify the scan tool fuel pump relay Ckt. Short Grnd Test Status parameter is Fault.

   If not the specified value, test the fuel pump relay control circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
7. If all circuits test normal, test or replace the fuel pump relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Relay Replacement
- Control Module References for ECM replacement, setup, and programming

DTC P0300-P0308

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0300: Engine Misfire Detected

DTC P0301: Cylinder 1 Misfire Detected

DTC P0302: Cylinder 2 Misfire Detected

DTC P0303: Cylinder 3 Misfire Detected

DTC P0304: Cylinder 4 Misfire Detected

DTC P0305: Cylinder 5 Misfire Detected

DTC P0306: Cylinder 6 Misfire Detected

DTC P0307: Cylinder 7 Misfire Detected

DTC P0308: Cylinder 8 Misfire Detected

Circuit/System Description

The engine control module (ECM) uses information from the crankshaft position (CKP) sensor in order to determine when an engine misfire is occurring, and uses information from the camshaft position (CMP) sensor in order to determine which cylinder is misfiring. By monitoring variations in the crankshaft rotation speed for each cylinder, the ECM is able to detect individual misfire events. If the ECM detects a misfire rate sufficient to cause emission levels to exceed mandated standards, DTC P0300 sets. Under certain driving conditions, a misfire rate can be high enough to cause the catalytic converter to overheat, possibly damaging the converter. The malfunction indicator lamp (MIL) will flash ON and OFF when catalytic converter overheating conditions are present and DTC P0300 is set. DTCs P0301-P0308 corresponds to cylinders 1-8. If the ECM is able to determine that a specific cylinder is misfiring, the DTC for that cylinder will also set.

Conditions for Running the DTC

- DTC P0010, P0011, P0101, P0102, P0103, P0106, P0108, P0116, P0117, P0118, P0128, P0220, P0335, P0336, P0502, P1258, P3401, P3425, P3441, and P3449 are not set.
- The engine speed is between 650-6,200 RPM.
- The ignition voltage is between 11-18 volts.

- The engine coolant temperature (ECT) is between -7 and +130°C (+19 and +266°F).
- The fuel level is more than 10 percent.
- The antilock brake system (ABS) and the traction control system (TCS) are not active.
- The power management is not active.
- The transmission is not changing gears.
- The ECM is not in fuel shut-off, or decel fuel cut-off mode.
- Excessive drive wheel slip is not detected.
- The power take-off is disabled.
- The cylinder deactivation is not in progress.
- A manual transmission with a throttle position less than 95 percent.
- DTCs P0300-P0308 run continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM is detecting a crankshaft rotation speed variation indicating a misfire sufficient to cause emission levels to exceed mandated standards.

Action Taken When the DTC Sets

- DTCs P0300-P0308 are Type B DTCs.
- When the MIL is flashing the fuel injector may be disabled for the misfiring cylinder to protect the catalytic converter.
- Depending on the conditions that set the DTC, the engine may go into Open Loop.

Conditions for Clearing the MIL/DTC

- DTCs P0300-P0308 are Type B DTCs.
- The DTC must run and pass under the same operating conditions that were present when the DTC failed.

Diagnostic Aids

- Ensure that each fuel injector is connected to the proper fuel injector harness connector.
- A misfire may only occur when the engine is operating under a load or when the engine is cold.
- A high resistance condition on any ignition control (IC) circuit can cause an engine misfire P0300-P0308 DTC to set without setting an IC circuit P0351-P0358 DTC.
- This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to Battery Inspection/Test.
- A misfire DTC could be caused by an excessive vibration from sources other than the engine. Inspect the following for possible sources of vibration:
  - A tire or wheel that is out of round or balance
  - Variable thickness brake rotors
  - An unbalanced drive shaft

- Certain rough road conditions
- A damaged accessory drive component or belt
- A damaged reluctor wheel
- The Crankshaft Position System Variation Learn procedure may need to be performed.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 26792 HEI Spark Tester

Circuit / System Verification

1. Verify that no other DTCs are set.
   If a DTC is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. Engine idling, verify there is no abnormal engine noise.
   If there is an abnormal engine noise, refer to Symptoms - Engine Mechanical.
3. Observe the Misfire Current Counters with a scan tool. The Misfire Current Counters should not be incrementing. A random misfire, across one or more cylinders that are not steadily incrementing may be normal for this engine.
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

Important: You must perform the Circuit/System Verification first.

1. Verify that the following conditions do not exist:
   - The fuel injector wire harness electrical connectors are connected to the wrong fuel injectors. Refer to Engine Controls Schematics.
   - Engine vacuum leaks
   - Fuel pressure that is too low or too high--Refer to Fuel System Diagnosis.
   - Contaminated fuel--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
   - Restricted exhaust system--Refer to Restricted Exhaust.
   - The cylinder deactivation system, for misfire on either cylinders 1, 4, 6, or 7--Refer to Cylinder Deactivation (Active Fuel Management) System Diagnosis.
2. Measure the resistance of the spark plug wire, and verify the condition of the spark plug wire. Refer to Ignition System Specifications and Spark Plug Wire Inspection.

   If the resistance value is not within the specified range, or does not pass the inspection, replace the spark plug wire.
3. Reinstall the spark plug wire to the ignition module/coil assembly.
4. Install the J 26792 to the spark plug wire boot.

   Important: An erratic or weak spark is considered a no spark condition.

5. Attempt to start the engine and observe the J 26792 . The spark plug tester should spark.

   If there is no spark, refer to Electronic Ignition (EI) System Diagnosis.
6. Ignition OFF, remove the spark plug from the misfiring cylinder. Verify that the following conditions do not exist with the spark plug:
   - Gas, coolant, or oil fouled
   - Cracked, worn, or incorrectly gapped--Refer to Spark Plug Inspection.

     If there is a condition with the spark plug, replace the spark plug.
7. Exchange the suspected spark plug with another cylinder that is operating correctly.
8. Operate the engine under the conditions in which the misfire occurred, this may include putting the engine under a load or allowing the engine to return to a cold condition. Observe the Misfire Current Counters with a scan tool. The misfire should not follow the spark plug exchange.

   If the misfire follows with the spark plug, replace the spark plug.
9. If all conditions test normal, test or inspect for the following:
   - A lean or rich fuel injector--Refer to Fuel Injector Diagnosis.
   - An engine mechanical condition--Refer to Symptoms - Engine Mechanical.

Repair Instructions

- Spark Plug Replacement
- Ignition Coil Replacement
- Engine Control Module Replacement
- Engine Control Module Programming and Setup

Repair Verification

If the customer concern was a flashing MIL, perform the following procedure:

1. Install any components that have been removed or replaced during diagnosis.
2. Perform any adjustments, programming or setup procedures that are required when a component is removed or replaced.
3. Clear the DTCs.
4. Turn OFF the ignition for 60 seconds.
5. If the repair was related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not reset. If the DTC resets or another DTC is present, refer to the Diagnostic Trouble Code (DTC) List - Vehicle and perform the appropriate diagnostic procedure.
6. To verify that the performance of the catalytic converter has not been affected by the condition that set this DTC, perform the Repair Verification for DTCs P0420 and P0430. Refer to DTC P0420 or P0430.

DTC P0315

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0315: Crankshaft Position (CKP) System Variation Not Learned

Circuit/System Description

The crankshaft position (CKP) system variation learn feature is used to calculate reference period errors caused by slight build tolerance variations in the CKP sensor, crankshaft, and CKP sensor position. The calculated error allows the engine control module (ECM) to accurately compensate for reference period variations. This enhances the ability of the ECM to detect misfire events over a wide range of engine speeds and load conditions. The ECM stores the Crankshaft Position System Variation values after a learn procedure has been performed. If the actual crankshaft position variation is not stored within the CKP compensating value look up table, then DTC P0300 may set. If the CKP system variation values are not stored in the ECM memory, or a proper ECM power down does not occur after completing the CKP Learn Procedure, then DTC P0315 sets.

Conditions for Running the DTC

The diagnostic runs continuously.

Conditions for Setting the DTC

The ECM detects that the CKP system variation values are not stored in memory.

Action Taken When the DTC Sets

DTC P0315 is a Type A code.

Conditions for Clearing the MIL/DTC

DTC P0315 is a Type A code.

Diagnostic Aids

This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to Battery Inspection/Test.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

Important: The CKP System Variation Learn Procedure may have to be repeated up to 5 times before the procedure is learned.

1. Perform the CKP System Variation Learn Procedure. Refer to Crankshaft Position System Variation Learn.
2. If the CKP System Variation Learn Procedure cannot be performed successfully, inspect for the following conditions:
   - Any worn crankshaft main bearings
   - A damaged or misaligned reluctor wheel
   - Excessive crankshaft runout
   - A damaged crankshaft--Refer to Crankshaft and Bearing Cleaning and Inspection.
   - Interference in the signal circuit of the CKP sensor
   - The ignition switch is left in the ON position, until the battery is discharged
   - An ECM power disconnect, with the ignition ON, that may have erased the CKP system variation values and set DTC P0315
   - Any debris between the CKP sensor and the reluctor wheel

   If the ECM is still unable to complete the learn procedure, replace the ECM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Engine Control Module Programming and Setup
- Engine Control Module Replacement

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DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0324: Knock Sensor (KS) Module Performance

DTC P0325: Knock Sensor (KS) Circuit Bank 1

DTC P0326: Knock Sensor (KS) Performance

DTC P0327: Knock Sensor (KS) Circuit Low Voltage Bank 1

DTC P0328: Knock Sensor (KS) Circuit High Voltage Bank 1

DTC P0330: Knock Sensor (KS) Circuit Bank 2

DTC P0332: Knock Sensor (KS) Circuit Low Voltage Bank 2

DTC P0333: Knock Sensor (KS) Circuit High Voltage Bank 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Knock Sensor Signal	P0327, P0328, P0332, P0333	P0325, P0330	P0327, P0332	P0326

Circuit/System Description

The knock sensor (KS) system enables the engine control module (ECM) to control the ignition timing for the best possible performance while protecting the engine from potentially damaging levels of detonation. The ECM monitors 2 separate KS, one on each side of the engine block. Each KS produces an AC voltage that varies, depending on the vibration levels detected during engine operation. The ECM receives the KS signal through 2 isolated signal circuits for each KS. The ECM adjusts the spark timing based on the amplitude and frequency of each KS signal. The ECM learns a minimum noise levels for each sensor at idle speed and uses calibrated noise level value for the rest of the RPM range. The ECM should monitor a normal KS signal within the noise channel.

Conditions for Running the DTC

P0324

This DTC runs continuously when the engine speed is greater than or equal to 1,500 RPM and the engine load is greater than a calibrated amount.

P0326

This DTC runs continuously when:

- The engine speed is greater than or equal to 500 RPM.
- The MAP is greater than 55 kPa.
- DTCs P0120, P0121, P0122, or P0123 are not set.

P0325, P0327, P0328, P0330, P0332, and P0333

The DTCs run continuously when:

- The engine coolant temperature (ECT) is greater than -40°C (-40°F).
- The engine run time is greater than 1 second.
- PTO is not active.

Conditions for Setting the DTC

P0324

The ECM has detected an internal circuitry fault.

P0325 and P0330

The KS signal circuits are open or shorted together for 5 seconds.

P0326

- The KS signal indicates an engine knock is present.
- The ECM has commanded the spark retard to a value, which is more than the calibrated value, for a specific engine load and speed.
- The above conditions exist for more than 5 seconds.

P0327, P0328, P0332, and P0333

The KS signal circuits are shorted to voltage or ground.

Action Taken When the DTC Sets

- DTCs P0324, P0325, P0326, P0327, P0328, P0330, P0332, and P0333 are Type B codes.
- The ignition timing is retarded to reduce the potential of engine damaging spark knock.

Conditions for Clearing the DTC

DTCs P0324, P0325, P0326, P0327, P0328, P0330, P0332, and P0333 are Type B codes.

Diagnostic Aids

- Inspect the KS for physical damage. A KS that is dropped or damaged may cause a DTC to set.
- Inspect the KS for proper installation. A KS that is loose or over-torqued may cause a DTC to set.
- The KS mounting surface should be free of burs, casting flash, and foreign material.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Electronic Ignition (EI) System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 35616 GM Approved Terminal Test Kit

Circuit/System Testing

P0324

Important: If DTC P0325, P0326, P0327, P0328, P0330, P0332, or P0333 are also set, diagnose those DTCs first.

DTC P0324 indicates an internal control module circuitry failure. Replace the ECM.

P0325, P0327, P0328, P0330, P0332, P0333

1. Ignition ON, engine OFF.
2. Disconnect the appropriate KS harness connector.
3. Measure for 2-3 volts between each of the following circuits and ground on the ECM side of the harness connector:
   - The KS signal circuit, terminal A
   - The KS signal circuit, terminal B

     If less than the specified range, test the circuits for a short to ground or an open/high resistance. If the circuits test normal, replace the ECM.

     If greater than the specified range, test the circuits for a short to voltage. If the circuits test normal, replace the ECM.
4. If all circuits test normal, replace the KS.

P0326

Important: If DTC P0325, P0327, P0328, P0330, P0333, P0335, or P0336 are also set, diagnose those DTCs first.

- Inspect for a loose or broken engine mount, engine mounted accessory, or accessory mounting bracket.
- Inspect for excessive engine mechanical noise. Refer to Symptoms - Engine Mechanical.

Component Testing

1. Connect a DMM to both KS signal circuits, terminals A and B, at the KS.
2. Set the DMM to the 400 mV AC hertz scale and wait for the DMM display to stabilize at 0 Hz.

   Important: DO NOT tap on plastic engine components.

3. Tap on the engine block with a non-metallic object near the KS while observing the signal indicated on the DMM.
4. The DMM should display a fluctuating frequency while tapping on the engine block.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Engine Control Module Programming and Setup
- Engine Control Module Replacement
- Knock Sensor Replacement

DTC P0335

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0335: Crankshaft Position (CKP) Sensor Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference Circuit	P0651	P0335	P0651, P2135	--
CKP Sensor Signal Circuit	P0335	P0335	P0335	P0336
Low Reference Circuit	--	P0335	P0335	--

Circuit/System Description

The crankshaft position (CKP) sensor circuits consist of an engine control module (ECM) supplied 5-volt reference circuit, low reference circuit and an output signal circuit. The CKP sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes between the peaks and valleys of a 58-tooth reluctor wheel on the crankshaft. Each tooth on the reluctor wheel is spaced at 60-tooth spacing, with 2 missing teeth for the reference gap. The CKP sensor produces an ON/OFF DC voltage of varying frequency, with 58 output pulses per crankshaft revolution. The frequency of the CKP sensor output depends on the velocity of the crankshaft. The CKP sensor sends a digital signal, which represents an image of the crankshaft reluctor wheel, to the ECM as each tooth on the wheel rotates past the CKP sensor. The ECM uses each CKP signal pulse to determine crankshaft speed and decodes the crankshaft reluctor wheel reference gap to identify crankshaft position. This information is then used to sequence the ignition timing and fuel injection events for the engine. The ECM also uses CKP sensor output information to determine the crankshaft relative position to the camshaft, to detect cylinder misfire, and to control the CMP actuator if equipped.

Conditions for Running the DTC

- DTC P0340, P0341, P0641, or P0651 is not set.
- The engine is cranking or running.

- DTC P0335 runs continuously when the above conditions are met.

Conditions for Setting the DTC

Note: The ECM detects engine movement by sensing the airflow through the MAF sensor, when airflow is greater than 3 grams per second, or by sensing camshaft position (CMP) sensor pulses.

- The ECM detects that the starter is commanded on and the engine has been cranking for more than 4 seconds without a CKP sensor pulse.
- The ECM detects that the engine is running, but has not received a CKP sensor pulse for 2 of 10 engine cycles.

Action Taken When the DTC Sets

- DTC P0335 is a Type A DTC.
- The CMP actuator if equipped is commanded to the parked position.
- The ignition system defaults to a limp home mode. The CMP sensor is used to determine engine position.

Conditions for Clearing the DTC

DTC P0335 is a Type A DTC.

Diagnostic Aids

- With this DTC set, the engine may crank for an extended period of time during start-up.
- This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to Battery Inspection/Test.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Electronic Ignition (EI) System Description

Electrical Information Reference

- Circuit Testing

- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 35616-A/BT-8637 Connector Test Adapter Kit

Circuit/System Verification

1. Ignition OFF, inspect the engine wiring harness carrying the CKP sensor circuits for the following conditions:
   - Close routing of aftermarket electrical equipment.
   - Close to solenoids, motors, and relays.

     If any of these are determined to be a possible source of electrical interference, correct any wire harness routing or component placement conditions.
2. Start the engine. Using the live plot function on the scan tool, select the CMP sensor parameter. Change the minimum spec to 400, and the maximum spec to 4,000 RPM. Select the CKP sensor parameter. Change the minimum spec to 600, and the maximum spec to 3,300 RPM.
3. Observe the scan tool.
4. Quickly accelerate and release the accelerator pedal several times. Do not accelerate past 3,200 RPM. The graphed lines on the live plot display should track together across the screen.
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Note: You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Ignition OFF, disconnect the harness connector at the crankshaft position (CKP) sensor.
2. Test for less than 1 ohm between the CKP low reference circuit, terminal B, and ground.

   If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8-5.2 volts between the CKP 5-volt reference circuit, terminal C and ground.

   If less than the specified range, test the 5-volt reference circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the ECM.

   If greater than the specified range, test the 5-volt reference circuit for a short to voltage.

If the circuit tests normal, replace the ECM.

4. Ignition ON, test for 4.8-5.2 volts between the CKP signal circuit terminal A and ground.

   If less than the specified range, test the signal circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the ECM.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
5. Ignition OFF, connect a fused jumper wire to the CKP signal circuit terminal A.
6. Ignition ON, momentarily touch the other end of the fused jumper wire to the battery negative post. The CKP Active counter, should increment.

   If the CKP Active counter increments, test or replace the CKP sensor.

   If the CKP Active counter does not increment, replace the ECM.

Component Testing

Note: You must perform the Circuit/System Testing before proceeding with Component Testing.

1. Inspect the CKP sensor for correct installation. Remove the CKP sensor from the engine and inspect the sensor O-ring for damage.

   If the sensor is loose, incorrectly installed, or damaged, replace the CKP sensor.
2. Connect the CKP sensor harness connector to the CKP sensor.
3. Ignition ON, engine OFF. Observe the CKP Active counter parameter on the scan tool.
4. Pass a flat steel object across the tip of the sensor repeatedly. The CKP Active counter parameter should increment with each pass of the steel object.

   If the parameter does not increment, replace the CKP sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Crankshaft Position Sensor Replacement
- Engine Control Module Programming and Setup
- Engine Control Module Replacement

DTC P0336

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0336: Crankshaft Position (CKP) Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference Circuit	P0651	P0335	P0651, P2135	--
CKP Sensor Signal Circuit	P0335	P0335	P0335	P0336
Low Reference Circuit	--	P0335	P0335	--

Circuit/System Description

The crankshaft position (CKP) sensor circuits consist of an engine control module (ECM) supplied 5-volt reference circuit, low reference circuit and an output signal circuit. The CKP sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes between the peaks and valleys of a 58-tooth reluctor wheel on the crankshaft. Each tooth on the reluctor wheel is spaced at 60-tooth spacing, with 2 missing teeth for the reference gap. The CKP sensor produces an ON/OFF DC voltage of varying frequency, with 58 output pulses per crankshaft revolution. The frequency of the CKP sensor output depends on the velocity of the crankshaft. The CKP sensor sends a digital signal, which represents an image of the crankshaft reluctor wheel, to the ECM as each tooth on the wheel rotates past the CKP sensor. The ECM uses each CKP signal pulse to determine crankshaft speed and decodes the crankshaft reluctor wheel reference gap to identify crankshaft position. This information is then used to sequence the ignition timing and fuel injection events for the engine. The ECM also uses CKP sensor output information to determine the crankshaft relative position to the camshaft, to detect cylinder misfire, and to control the CMP actuator if equipped.

Conditions for Running the DTC

- DTC P0340, P0341, P0641, or P0651 is not set.
- The engine is cranking or running.

- DTC P0336 runs continuously when the above conditions are met.

Conditions for Setting the DTC

Note: The ECM detects engine movement by sensing the airflow through the MAF sensor, when airflow is greater than 3 grams per second, or by sensing camshaft position (CMP) sensor pulses.

- The ECM detects that the engine is running, but receives less than 53 or more than 63 CKP sensor pulses, during each engine revolution, for 8 of 10 engine revolutions.
- The ECM detects that the engine is running, but more than 25 crankshaft resyncs have occurred within 20 seconds.
- The ECM detects that the engine has been running, but the crankshaft does not sync for 0.4 second.

Action Taken When the DTC Sets

- DTC P0336 is a Type A DTC.
- The CMP actuator if equipped is commanded to the parked position.
- The ignition system defaults to a limp home mode. The CMP sensor is used to determine engine position.

Conditions for Clearing the DTC

DTC P0336 is a Type A DTC.

Diagnostic Aids

- With this DTC set, the engine may crank for an extended period of time during start-up.
- This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to Battery Inspection/Test.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Electronic Ignition (EI) System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 35616-A/BT-8637 Connector Test Adapter Kit

Circuit/System Verification

1. Ignition OFF, inspect the engine wiring harness carrying the CKP sensor circuits for the following conditions:
    - Close routing of aftermarket electrical equipment.
    - Close to solenoids, motors, and relays.

      If any of these are determined to be a possible source of electrical interference, correct any wire harness routing or component placement conditions.
2. Start the engine. Using the live plot function on the scan tool, select the CMP sensor parameter. Change the minimum spec to 400, and the maximum spec to 4,000 RPM. Select the CKP sensor parameter. Change the minimum spec to 600, and the maximum spec to 3,300 RPM.
3. Observe the scan tool.
4. Quickly accelerate and release the accelerator pedal several times. Do not accelerate past 3,200 RPM. The graphed lines on the live plot display should track together across the screen.
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Note: You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Ignition OFF, inspect the CKP sensor for looseness and correct installation.

   If the CKP sensor is loose, inspect the sensor and the O-ring for damage, replace as necessary.
2. Inspect the engine for the following conditions:
    - Engine oil for debris and contamination
    - Crankshaft reluctor wheel for damage
    - The timing chain, tensioner, and sprockets for wear or damage

If debris is found in the engine oil, inspect the internal engine components to determine the cause. Repair or replace any worn or damaged components.

Component Testing

Note: You must perform the Circuit/System Testing before proceeding with Component Testing.

1. Inspect the CKP sensor for correct installation. Remove the CKP sensor from the engine and inspect the sensor O-ring for damage.

   If the sensor is loose, incorrectly installed, or damaged, replace the CKP sensor.
2. Connect the CKP sensor harness connector to the CKP sensor.
3. Ignition ON, engine OFF. Observe the CKP Active counter parameter on the scan tool.
4. Pass a flat steel object across the tip of the sensor repeatedly. The CKP Active counter parameter should increment with each pass of the steel object.

   If the parameter does not increment, replace the CKP sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Crankshaft Position Sensor Replacement
- Engine Control Module Programming and Setup
- Engine Control Module Replacement

DTC P0340

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0340: Camshaft Position (CMP) Sensor Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference Circuit	P0107, P0452, P0522, P0532, P0641	P0340	P0641	--
CMP Sensor Signal Circuit	P0340	P0340	P0340	P0341
Low Reference Circuit	--	P0340	P0340	--

Circuit/System Description

The 4X camshaft position (CMP) sensor circuits consist of an engine control module (ECM) supplied 5-volt reference circuit, low reference circuit, and an output signal circuit. The CMP sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes between the peaks and valleys of a 4-tooth reluctor wheel attached to the camshaft. As each reluctor wheel tooth rotates past the CMP sensor, the resulting change in the magnetic field is used by the sensor electronics to produce a digital output pulse. The sensor returns a digital ON/OFF DC voltage pulse of varying frequency, with 2 narrow, and 2 wide output pulses per camshaft revolution that represent an image of the camshaft reluctor wheel. The frequency of the CMP sensor output depends on the velocity of the camshaft. The ECM decodes the narrow and wide tooth pattern to identify camshaft position. This information is then used to sequence the ignition timing and fuel injection events for the engine. The ECM also uses CMP sensor output information to determine the camshaft relative position to the crankshaft, to control the CMP actuator if equipped, and for limp-home operation.

Conditions for Running the DTC

- DTC P0335, P0336, P0641, or P0651 is not set.
- The engine is cranking or running.
- DTC P0340 runs continuously when the above conditions are met.

Conditions for Setting the DTC

Important: The ECM detects engine movement by sensing the airflow through the MAF sensor, when airflow is greater than 3 grams per second, or by sensing crankshaft position (CKP) sensor pulses.

- The ECM detects that the starter is commanded on and the engine has been cranking for more than 4 seconds without a CMP sensor pulse.
- The ECM detects that the engine has started, but did not receive a CMP sensor pulse during the first engine revolution.
- The ECM detects that the engine is running, but does not receive a CMP sensor pulse for 800 of 1000 engine cycles.

Action Taken When the DTC Sets

- DTC P0340 is a Type B DTC.
- The CMP actuator if equipped is commanded to the parked position.
- The ignition system defaults to a failed CMP sensor limp home mode.

Conditions for Clearing the DTC

DTC P0340 is a Type B DTC.

Diagnostic Aids

- With a DTC set, the engine may crank for an extended period of time during start-up.
- This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to Battery Inspection/Test.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Electronic Ignition (EI) System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs

- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 35616-A/BT-8637 Connector Test Adapter Kit

Circuit/System Verification

1. Ignition OFF, inspect the engine wiring harness carrying the CMP sensor circuits for the following conditions:
   - Close routing of aftermarket electrical equipment.
   - Close to solenoids, motors, and relays.

   If any of these are determined to be a possible source of electrical interference, correct any wire harness routing or component placement conditions.
2. Start the engine. Using the live plot function on the scan tool, select the CMP sensor parameter. Change the minimum spec to 400, and the maximum spec to 4,000 RPM. Select the CKP sensor parameter. Change the minimum spec to 600, and the maximum spec to 3,300 RPM.
3. Observe the scan tool.
4. Quickly accelerate and release the accelerator pedal several times. Do not accelerate past 3,200 RPM. The graphed lines on the live plot display should track together across the screen.
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the camshaft position (CMP) sensor.
2. Test for less than 1 ohm on the CMP low reference circuit, terminal B, and ground.

   If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8-5.2 volts between the CMP 5-volt reference circuit terminal A and ground.

   If less than the specified range, test the 5-volt reference circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the ECM.

   If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Ignition ON, test for 4.8-5.2 volts between the CMP signal circuit terminal C and ground.

   If less than the specified range, test the signal circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the ECM.

If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.

5. Ignition OFF, connect a fused jumper wire to the CMP signal circuit terminal C.
6. Ignition ON, momentarily touch the other the other end of the fused jumper wire to the battery negative post. The scan tool should show the CMP Active counter incrementing.

   If the CMP Active counter increments, test or replace the CMP sensor.

   If the CMP Active counter does not increment, replace the ECM.

Component Testing

Important: You must perform the Circuit/System Testing before proceeding with Component Testing.

1. Inspect the CMP sensor for correct installation. Remove the CMP sensor from the engine and inspect the sensor O-ring for damage.

   If the sensor is loose, incorrectly installed, or damaged, replace the CMP sensor.
2. Connect the CMP sensor harness connector to the CMP sensor.
3. Ignition ON, engine OFF. Observe the CMP Active counter parameter on the scan tool.
4. Pass a flat steel object across the tip of the sensor repeatedly. The CMP Active counter parameter should increment with each pass of the steel object.

   If the parameter does not increment, replace the CMP sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Camshaft Position Sensor Replacement
- Engine Control Module Programming and Setup
- Engine Control Module Replacement

DTC P0341

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0341: Camshaft Position (CMP) Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference Circuit	P0107, P0452, P0522, P0532, P0641	P0340	P0641	--
CMP Sensor Signal Circuit	P0340	P0340	P0340	P0341
Low Reference Circuit	--	P0340	P0340	--

Circuit/System Description

The 4X camshaft position (CMP) sensor circuits consist of an engine control module (ECM) supplied 5-volt reference circuit, low reference circuit, and an output signal circuit. The CMP sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes between the peaks and valleys of a 4-tooth reluctor wheel attached to the camshaft. As each reluctor wheel tooth rotates past the CMP sensor, the resulting change in the magnetic field is used by the sensor electronics to produce a digital output pulse. The sensor returns a digital ON/OFF DC voltage pulse of varying frequency, with two narrow, and two wide output pulses per camshaft revolution that represent an image of the camshaft reluctor wheel. The frequency of the CMP sensor output depends on the velocity of the camshaft. The ECM decodes the narrow and wide tooth pattern to identify camshaft position. This information is then used to sequence the ignition timing and fuel injection events for the engine. The ECM also uses CMP sensor output information to determine the camshaft relative position to the crankshaft, to control the CMP actuator if equipped, and for limp-home operation.

Conditions for Running the DTC

- DTC P0335, P0336, P0641, or P0651 is not set.
- The engine is cranking or running.
- DTC P0341 runs continuously when the above conditions are met.

Conditions for Setting the DTC

Important: The ECM detects engine movement by sensing the airflow through the MAF sensor, when airflow is greater than 3 grams per second, or by sensing crankshaft position (CKP) sensor pulses.

- The ECM detects that the engine was started, but has received less than 2 or more than 8 CMP sensor pulses during the first engine resolution.
- The ECM detects that the engine has started and is running, but receives less than 398 or more than 402 CMP pulses per 100 engine cycles in 800 of 1000 engine cycles.

Action Taken When the DTC Sets

- DTC P0341 is a Type B DTC.
- The CMP actuator if equipped is commanded to the parked position.
- The ignition system defaults to a failed CMP sensor limp home mode.

Conditions for Clearing the DTC

DTC P0341 is a Type B DTC.

Diagnostic Aids

- With this DTC set, the engine may crank for an extended period of time during start-up.
- This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to Battery Inspection/Test.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Electronic Ignition (EI) System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections

- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 35616-A/BT-8637 Connector Test Adapter Kit

Circuit/System Verification

1. Ignition OFF, inspect the engine wiring harness carrying the CMP sensor circuits for the following conditions:
   - Close routing of aftermarket electrical equipment
   - Close to solenoids, motors, and relays.

   If any of these are determined to be a possible source of electrical interference, correct any wire harness routing or component placement conditions.
2. Start the engine. Using the live plot function on the scan tool, select the CMP sensor parameter. Change the minimum spec to 400, and the maximum spec to 4,000 RPM. Select the CKP sensor parameter. Change the minimum spec to 600, and the maximum spec to 3,300 RPM.
3. Observe the scan tool.
4. Quickly accelerate and release the accelerator pedal several times. Do not accelerate past 3,200 RPM. The graphed lines on the live plot display should track together across the screen.
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, inspect the CMP sensor for looseness and correct installation.

   If the CMP sensor is loose, inspect the sensor and the O-ring for damage, and replace as necessary.
2. Inspect the engine for the following conditions:
   - Engine oil for debris
   - Camshaft reluctor wheel for damage
   - The timing chain, timing chain tensioner, and sprockets for wear or damage

   If debris is found in the engine oil, inspect the internal engine components to determine the cause. Repair or replace any worn or damaged components.

Component Testing

Important: You must perform the Circuit/System Testing before proceeding with Component Testing.

1. Inspect the CMP sensor for correct installation. Remove the CMP sensor from the engine and inspect the sensor O-ring for damage.

   If the sensor is loose, incorrectly installed, or damaged, replace the CMP sensor.
2. Connect the CMP sensor harness connector to the CMP sensor.
3. Ignition ON, engine OFF, observe the CMP Active Counter parameter on the scan tool.
4. Pass a flat steel object across the tip of the sensor repeatedly. The CMP Active Counter parameter should increment with each pass of the steel object.

   If the parameter does not increment, replace the CMP sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Camshaft Position Sensor Replacement
- Engine Control Module Programming and Setup
- Engine Control Module Replacement

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DTC P0351-P0358

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0351: Ignition Coil 1 Control Circuit

DTC P0352: Ignition Coil 2 Control Circuit

DTC P0353: Ignition Coil 3 Control Circuit

DTC P0354: Ignition Coil 4 Control Circuit

DTC P0355: Ignition Coil 5 Control Circuit

DTC P0356: Ignition Coil 6 Control Circuit

DTC P0357: Ignition Coil 7 Control Circuit

DTC P0358: Ignition Coil 8 Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Coil 1 Control Circuit	P0300, P0351	P0300, P0351	P0300, P0351	--
Ignition Coil 2 Control Circuit	P0300, P0352	P0300, P0352	P0300, P0352	--
Ignition Coil 3 Control Circuit	P0300, P0353	P0300, P0353	P0300, P0353	--
Ignition Coil 4 Control Circuit	P0300, P0354	P0300, P0354	P0300, P0354	--
Ignition Coil 5 Control Circuit	P0300, P0355	P0300, P0355	P0300, P0355	--
Ignition Coil 6 Control Circuit	P0300, P0356	P0300, P0356	P0300, P0356	--
Ignition Coil 7 Control Circuit	P0300, P0357	P0300, P0357	P0300, P0357	--
Ignition Coil 8	P0300, P0358	P0300, P0358	P0300, P0358	--

Control Circuit				

Circuit/System Description

The ignition system on this engine uses an individual coil/module for each cylinder. The engine control module (ECM) controls the spark event for each cylinder through the eight individual ignition control (IC) circuits. When the ECM commands the IC circuit ON, electrical current will flow through the primary winding of the ignition coil, creating a magnetic field. When a spark event is requested, the ECM will command the IC circuit OFF, interrupting current flow through the primary winding. The magnetic field created by the primary winding will collapse across the secondary coil windings, producing a high voltage across the spark plug electrodes. The ECM uses information from the crankshaft position (CKP) sensor, and the camshaft position (CMP) sensor for sequencing and timing of the spark events. Each ignition coil/module assembly has the following circuits:

- Ignition voltage
- Ground
- Ignition control (IC)
- Low reference

If the ECM detects that the IC circuit has an incorrect voltage level, DTC P0351-P0358 will set.

Conditions for Running the DTC

- The ignition is ON.
- DTC P0351-P0358 runs continuously when the above condition is met.

Conditions for Setting the DTC

The ECM detects one of the following failures on the IC circuit:

- An open
- A short to ground
- A short to voltage

Action Taken When the DTC Sets

DTCs P0351-P0358 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0351-P0358 are Type B DTCs.

Diagnostic Aids

- This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to Battery Inspection/Test.

- A high resistance condition on any IC circuit can cause an engine misfire without setting DTC P0351-P0358.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Electronic Ignition (EI) System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. With the engine running, monitor the following ignition control (IC) circuit status parameters with a scan tool:
   - Cylinder 1-8 IC Ckt. Short Gnd Test Status
   - Cylinder 1-8 IC Ckt. Open Test Status
   - Cylinder 1-8 IC Ckt. Short to Volts Test Status

     Each parameter should display OK.
2. With the engine running, observe the Misfire Current counters with a scan tool.

   The counters should not be incrementing.
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. With the engine running, monitor the Cylinder 1-8 IC Circuit Status parameters with a scan tool.

   If a short to GND or Open status test displays FAULT, test for an open/high resistance or short to ground on the affected IC circuit terminal C.

If a short to volts status test displays FAULT, test for a short to voltage on the affected IC circuit terminal C.

Important: A high resistance on any IC circuit can cause a misfire condition before DTCs P0351-P0358 set.

2. Exchange the affected ignition coil/module with the ignition coil/module of a cylinder that is not affected.
3. Start and run the engine. With a scan tool, monitor the IC circuit parameters and the Misfire Current counters.

   If the circuit status fault identified or the misfire transfers with the ignition coil/module, replace the ignition coil/module assembly.

   If the circuit status fault identified or the misfire does not transfer with the ignition coil/module, replace the ECM.

Repair Instructions

- Ignition Coil Replacement
- Engine Control Module Replacement
- Engine Control Module Programming and Setup

Repair Verification

Important: An IC circuit fault condition will result in an engine misfire, and under certain driving conditions could possibly overheat the 3-way catalytic converter.

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming, or setup procedures that are required when a component or module is removed or replaced.
3. Start and run the engine. With a scan tool, monitor the IC circuit status parameters. All IC circuit status parameters should display OK.

   If another DTC is present, refer to Diagnostic Trouble Code (DTC) List - Vehicle and perform the appropriate diagnostic.
4. To verify that the performance of the catalytic converter has not been affected by the condition that set this DTC, perform the Repair Verification for DTC P0420 or P0430. Refer to DTC P0420 or P0430.

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DTC P0420 or P0430

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0420: Catalyst System Low Efficiency Bank 1

DTC P0430: Catalyst System Low Efficiency Bank 2

Circuit / System Description

Important: A new converter with less than 100 miles on it may set DTC P0420 or P0430 due to out-gassing of the internal matting. Operating the vehicle at highway speeds for approximately 1 hour may correct the condition.

A 3-way catalytic converter (TWC) controls emissions by converting hydrocarbons (HC) and carbon monoxide (CO) into carbon dioxide (CO2), and oxides of nitrogen (NOx) into nitrogen. The TWC also stores oxygen. When the listed idle conditions follow the listed driving conditions the Catalyst System Efficiency test will run. The engine control module (ECM) monitors this oxygen storage capacity by comparing the pre and post-catalyst oxygen sensor signals while adding and subtracting fuel during specific idle conditions. The ECM compares the pre and post-catalyst oxygen sensor signals to determine if the oxygen storage capacity of the catalyst is degraded.

Conditions for Running the DTC

1. Driving Conditions
    - DTCs P0030, P0031, P0036, P0037, P0038, P0068, P0106, P0107, P0108, P0112, P0113, P0117, P0118, P0120, P0121, P0122, P0123, P0125, P0128, P0130, P0131, P0132, P0133, P0134, P0135, P0136, P0137, P0138, P0140, P0141, P0171, P0172, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0300, P0315, P0326, P0327, P0336, P0340, P0341, P0442, P0446, P0452, P0453, P0455, P0496, P0500 (manual transmission only), P0502, P0506, P0507, P0601, P0602, P0606, P0641, P0722, P0723, P1133, P1134, P1516, P1621, P2135, P2138, P2176 are not set.
    - The engine has been running for more than 2 minutes.
    - The vehicle has been driven at more than 1,000 RPM for more than 10 seconds.
    - The vehicle is in Closed Loop.
    - The vehicle has Fuel Trim Learn enabled.
    - The Engine Coolant Temperature (ECT) parameter is between 45-128°C (113-262°F).
    - The Barometric Pressure (BARO) parameter is more than 70 kPa.
    - The Catalytic Converter Calculated Temperature parameter is greater than or equal to

375°C (707°F).
    - The Intake Air Temperature (IAT) parameter is between -20 and +85°C (-4 and +185°F).
    - The battery voltage is more than 11 volts.
2. Idle Conditions
    - The vehicle speed is less than 3.2 km/h (2 mph).
    - For automatic transmissions, the transmission is in Reverse, Drive, or Low.
    - The Throttle Position (TP) parameter is 2 percent or less.
    - The short term fuel trim (FT) is between -10 and +10 percent.
    - This diagnostic attempts one test during each valid idle period when the above conditions have been met. This diagnostic attempts up to 6 tests during each drive cycle.

Conditions for Setting the DTC

- The ECM has determined the catalyst efficiency has degraded below a calibrated threshold.
- This diagnostic may conclude in one test attempt. However, this diagnostic may require as many as 18 test attempts, which would require at least 3 drive cycles. Each test attempt may conclude within approximately 1 minute.

Action Taken When the DTC Sets

DTCs P0420 and P0430 are Type A DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0420 and P0430 are Type A DTCs.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Electrical Information Reference

Diagnostic Trouble Code (DTC) List - Vehicle

Circuit/System Verification

Notice: Refer to Three-Way Catalytic Converter Damage Caution in the Preface section.

Notice: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution in the Preface section.

Important: A new converter with less than 100 miles on it may set DTC P0420 or P0430 due to out-gassing of the internal matting. Operating the vehicle at highway speeds for approximately 1 hour may correct the condition.

1. If any other DTCs are set perform those diagnostics first.

2. Inspect for the following conditions, which may cause a catalytic converter to degrade:
   - An engine misfire
   - High engine oil or high coolant consumption
   - Retarded spark timing
   - A weak or poor spark
   - A lean fuel mixture
   - A rich fuel mixture
   - A damaged oxygen sensor or wiring harness
   - The catalyst test may abort if the vehicle falls outside the conditions for running the DTC.
   - A catalyst may be temporarily degraded if a fuel with high sulfur content has been used. Drive the vehicle at highway speeds for 10 minutes and retest the converter.
3. Operate the vehicle within the Conditions for Running the DTC.

   If the DTC fails this key cycle, continue with this procedure.
4. Inspect the catalytic converter for the following conditions:
   - Dents
   - A severe discoloration caused by excessive temperatures
   - Road damage
   - An internal rattle caused by damaged catalyst substrate
   - Restrictions

   If a condition is found, replace the catalytic converter.
5. Inspect the exhaust system for the following conditions:
   - Leaks
   - Physical damage
   - Loose or missing hardware
   - Properly torqued HO2S
   - Restrictions

   If a condition is found, repair the exhaust system.
6. Inspect the post catalyst HO2S for the following conditions:
   - A grounded wiring harness
   - Damage

   If a condition is found, replace the post catalyst HO2S.

   If no physical condition is detected, replace the catalytic converter.

Repair Instructions

Important: A new converter with less than 100 miles on it may set DTC P0420 or P0430 due to out-gassing of the internal matting. Operating the vehicle at highway speeds for approximately 1 hour may correct the condition.

- Exhaust Manifold Replacement - Left Side
- Exhaust Manifold Replacement - Right Side
- Heated Oxygen Sensor Replacement - Bank 1 Sensor 2
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 2

- Exhaust Leakage
- Restricted Exhaust

Repair Verification

1. Clear the DTCs.
2. Allow the engine coolant temperature to reach 70°C (156°F).
   - Place the gear selector in Park, Neutral for manual.
   - Set the parking brake.
3. Press and hold the service brake.
4. Run the engine for 6 minutes at 2500 RPM.
5. Allow engine speed to return to idle speed, then place gear selector into Drive, or apply clutch pedal for manual.
6. After 2 minutes verify that DTC P0420 or P0430 have passed or failed this ignition cycle.

   If not passed or failed this ignition cycle, the test aborted resulting in an inconclusive test result. The above test may need to be repeated up to 5 more times during this drive cycle. The first test should be run after the initial warm up period of 6 minutes. Between subsequent tests maintain 2,500 RPM for 2 minutes.
7. If 6 tests have been attempted and the DTC has not run or passed during this key cycle, turn the key to OFF for 30 seconds, then run the procedure a second time.
8. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

DTC P0443

DTC Descriptor

DTC P0443: Evaporative Emission Control System Purge Control Valve Circuit Malfunction

Diagnostic Fault Information

Important: Always perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.

Circuit	Short to Ground	High Resistance	Open	Short to Voltage
Ignition 1 Voltage - Purge Supply	P0443	P0443	P0443	--
EVAP Purge Solenoid Control	P0443	P0443	P0443	P0443

Circuit/System Description

An ignition voltage is supplied directly to the evaporative emission (EVAP) canister purge solenoid valve. The EVAP canister purge solenoid valve is pulse width modulated (PWM). The scan tool displays the amount of ON time as a percentage. The control module monitors the status of the driver. The engine control module (ECM) controls the EVAP canister purge solenoid valve ON time by grounding the control circuit via an internal switch called a driver. If the ECM detects an incorrect voltage for the commanded state of the driver this DTC sets.

Conditions for Running the DTC

- Ignition ON.
- The system voltage is between 9-18 volts.
- DTC P0443 runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for a minimum of 6 seconds.

Action Taken when the DTC Sets

DTC P0443 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0443 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Troubleshooting with a Test Lamp
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Verification

Ignition ON , engine OFF, you should hear a clicking sound when the EVAP canister purge solenoid valve is commanded to 50 percent with a scan tool. The clicking sound should stop when the EVAP canister purge solenoid valve is commanded to 0 percent. The rate at which the valve cycles should increase when the command state is increased and decrease when the command state is decreased.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the EVAP canister purge solenoid valve.
2. Ignition ON, verify that a test lamp illuminates between the voltage supply circuit terminal A and ground.

   If the test lamp does not illuminate, test the voltage supply circuit for a short to ground or an open/high resistance. If the circuit tests normal and the voltage supply circuit fuse is open, test or replace the EVAP canister purge solenoid.
3. Connect a test lamp between the voltage supply circuit terminal A and the control circuit terminal B.
4. Command the EVAP canister purge solenoid valve to 50 percent with a scan tool. The test lamp should respond to the command.

   If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the ECM.

   If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, replace the canister purge solenoid valve.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Evaporative Emission Canister Purge Solenoid Valve Replacement
- Control Module References

DTC P0506 or P0507

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provide an overview of each diagnostic category.

DTC Descriptors

DTC P0506: Idle Speed Low

DTC P0507: Idle Speed High

Circuit/System Description

The throttle actuator control (TAC) motor is controlled by the engine control module (ECM). The DC motor located in the throttle body drives the throttle blade. In order to decrease idle speed, along with spark and fuel delivery changes the ECM commands the throttle closed reducing air flow into the engine and the idle speed decreases. In order to increase idle speed, the ECM commands the throttle plate open allowing more air to pass the throttle plate.

Conditions for Running the DTC

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0117, P0118, P0120, P0122, P0123, P0171, P0172, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0221, P0222, P0223, P0230, P0300, P0336, P0442, P0446, P0449, P0452, P0453, P0455, P0462, P0463, P0496, P1516, P2101, P2135, P2176 are not set.
- The engine is operating for at least 60 seconds.
- The engine is idling for greater than 10 seconds.
- The engine coolant temperature (ECT) is more than -60°C (-140°F).
- The intake air temperature (IAT) is more than -20°C (-4°F).
- The barometric pressure (BARO) is more than 70 kPa.
- The system voltage is between 9-18 volts.
- The vehicle speed is less than 1.6 km/h (1 mph).
- DTC P0506 and P0507 run continuously when the above conditions are met.

Conditions for Setting the DTC

P0506

The actual idle speed is approximately 100 RPM lower than the desired idle speed.

P0507

The actual idle speed is approximately 200 RPM greater than the desired idle speed.

Action Taken When the DTC Sets

DTCs P0506 and P0507 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0506 and P0507 are Type B DTCs.

Diagnostic Aids

- A stalling condition can cause DTC P0506 to set.
- An intermittent vehicle speed sensor (VSS) signal can cause DTC P0507 to set.
- An intermittent clutch pedal position sensor signal, if equipped, can cause DTC P0506 to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Important: The engine must first be running for greater than 60 seconds, then idle at a steady state for an additional 10 seconds before comparing the actual and desired engine idle speed parameters.

1. Use a scan tool to compare the desired engine idle speed to the actual engine idle speed.
   Actual engine idle speed should be no greater than 100 RPM below desired.
   Actual engine idle speed should be no greater than 200 RPM above desired.
2. If any other DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Inspect for any condition that can reduce idle speed by increasing engine load.
   - Incorrect torque converter clutch (TCC) operation
   - Accessories that require additional torque to operate
   - Excessive deposits in the throttle body
   - Restricted exhaust
   - Mechanical conditions that limit engine speed
   - Repair any conditions, if necessary.
2. Inspect for the following conditions:
   - Vacuum leaks
   - A faulty positive crankcase ventilation (PCV) valve

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provide an overview of each diagnostic category.

DTC Descriptors

DTC P0601: Control Module Read Only Memory (ROM)

DTC P0602: Control Module Not Programmed

DTC P0603: Control Module Long Term Memory Reset

DTC P0604: Control Module Random Access Memory (RAM)

DTC P0606: Control Module Internal Performance

DTC P0607: Control Module Performance

DTC P060D: Control Module Accelerator Pedal Position (APP) System Performance

DTC P062F: Control Module Long Term Memory Performance

DTC P2610: Control Module Ignition Off Timer Performance

Description

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM) and the throttle actuator control (TAC) system. This diagnostic also addresses if the ECM is not programmed.

The ECM monitors its ability to read and write to the memory. It also monitors a timing function. The ECM and the TAC processors are used to monitor the TAC system data. Both processors monitor the other processors data to verify that the indicated APP calculation is correct. The ECM performs an intrusive test in order to confirm that the APP signals are not shorted together. The ECM accomplishes this by pulling the APP sensor 2 low momentarily and looking for sensor 1 to also be pulled low.

Conditions for Running the DTC

P0601

- The ignition switch is in Run or Crank.
- DTC P0601 runs continuously when the above condition is met.

P0602

- The ignition switch is in Run or Crank.
- DTC P0602 runs once per ignition cycle.

P0603

- The ignition switch is in Run or Crank.
- DTC P0603 runs once per ignition cycle.

P0604

- The ignition switch is in Run or Crank.
- DTC P0604 runs continuously when the above condition is met.

P0606

- The ignition switch is in the Unlock/Accessory, Run, or Crank positions.
- The system voltage is more than 5.23 volts.
- DTC P0606 runs continuously when the above conditions are met.

P0607

- The ignition switch is in Unlock, Accessory, Run or Crank.
- The system voltage is more than 5.23 volts.
- DTCs P0601, P0602, P0603, P0604, P0606, P062F, P0641, P0651, P2610 are not set
- DTC P0607 runs continuously when the above conditions are met.

P060D

- DTC P0606 is not set.
- The ignition switch is in the Unlock, Accessory, Run, or Crank position.
- The system voltage is more than 5.23 volts.
- DTC P060D runs continuously when the above conditions are met.

P062F

- The ignition is ON.
- DTC P062F runs once per ignition cycle.

P2610

- The ECM is powered down.
- The intake air temperature is between -40 to +125°C (-40 to +257°F).
- DTC P2610 runs once per ignition cycle.

Conditions for Setting the DTC

The ECM detects an internal failure or incomplete programming for more than 10 seconds.

Actions Taken When the DTC Sets

- DTCs P0601, P0602, P0603, P0604, P0606, P060D, and P062F are Type A DTCs.
- DTC P0607 is a Type C DTC.
- DTC P2610 is a Type B DTC.

Conditions for Clearing the MIL/DTC

- DTCs P0601, P0602, P0603, P0604, P0606, P060D, and P062F are Type A DTCs.
- DTC P0607 is a Type C DTC.
- DTC P2610 is a Type B DTC.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Testing

1. Observe the DTCs with the scan tool.

   If DTC P0602 is set, attempt to program the ECM before replacing the ECM. Refer to Service Programming System (SPS).

   If DTC P0602 resets, replace the ECM.

   Important: An intermittent or momentary, less than 1 second, loss of system voltage during throttle tip-in may set DTC P060D.

2. Test the voltage and ground inputs to the ECM for the following:
   - A short
   - An open
   - High resistance

   If all circuits test normal, replace the ECM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for ECM replacement, programming and setup

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L | Diagnostic Information and Procedures |
Document ID: 2045428

DTC P0641 or P0651

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P0641: 5V Reference Circuit 1 Malfunction

DTC P0651: 5V Reference Circuit 2 Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Accelerator Pedal Position (APP) Sensor 1 5-Volt Reference 2 Circuit	P0651	P2122	P0651	--
Accelerator Pedal Position (APP) Sensor 2 5-Volt Reference 1 Circuit	P0641	P2127	P0641	--
Air Conditioning (A/C) Refrigerant Pressure Sensor 5-Volt Reference 1 Circuit	P0641	P0532	P0641	--
Camshaft Position (CMP) Sensor 5-Volt Reference 1 Circuit	P0641	P0340	P0641	--
Engine Oil Pressure (EOP) Sensor 5-Volt Reference 1 Circuit	P0641	P0522	P0641	--
Fuel Tank Pressure (FTP) Sensor 5-Volt Reference 1 Circuit	P0641	P0452	P0641	--
Manifold Absolute Pressure (MAP) Sensor 5-Volt Reference 1 Circuit	P0641	P0107	P0641	--
The Crankshaft Position (CKP) Sensor 5-Volt Reference 2 Circuit	P0651	P0335	P0651	--
Throttle Position (TP) Sensor 1 and 2 5-Volt Reference 2 Circuit	P0651	P0122, P0222	P0651	--

Circuit/System Description

The engine control module (ECM) has 2 internal 5-volt reference buses called 5 volt reference 1 and 5 volt reference 2. Each reference bus provides 5 volt reference circuits for more than one sensor. Therefore a fault condition on one 5 volt reference circuit will affect the other 5 volt reference circuits connected to that reference bus. The ECM monitors the voltage on the 5 volt reference buses.

The 5 volt reference 1 bus provides 5 volts to the following sensors:

- The manifold absolute pressure (MAP) sensor.
- The fuel tank pressure (FTP) sensor
- The air conditioning (A/C) refrigerant pressure sensor.
- The accelerator pedal position (APP) sensor 2.
- The engine oil pressure (EOP) sensor.
- The camshaft position (CMP) sensor.

The 5 volt reference 2 bus provides 5 volts to the following sensors:

- The APP sensor 1.
- The throttle position (TP) sensor 1 and 2.
- The crankshaft position (CKP) sensor.

Conditions for Running the DTC

- DTCs P0601, P0602, P0603, P0604, P0605, P0606, P0607, P060D, P062F and P2610 are not set.
- The ignition is in Unlock, Accessory, Run, or Crank.
- The ignition voltage is more than 5.23 volts.
- DTCs P0641 and P0651 run continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects a voltage out of tolerance condition on the 5-volt reference 1 or 2 bus for more than 0.5 second.

Action Taken when the DTC Sets

DTCs P0641 and P0651 are Type A DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0641 and P0651 are Type A DTCs.

Diagnostic Aids

- The 5-volt reference 1 bus provides 5 volts to the following sensors:
  - The manifold absolute pressure (MAP) sensor
  - The fuel tank pressure (FTP) sensor

  - The accelerator pedal position (APP) sensor 2
  - The air injector reaction (AIR) pressure sensor, if equipped
  - The engine oil pressure (EOP) switch
  - The air conditioning (A/C) refrigerant pressure sensor
  - The camshaft position (CMP) sensor
- The 5-volt reference 2 bus provides 5 volts to the following sensors:
  - The APP sensor 1
  - The throttle position (TP) sensor 1 and 2
  - The crankshaft position (CKP) sensor
- It may be possible to locate the fault by disconnecting one component at a time from the affected 5-volt reference circuit while viewing the 5-Volt Reference circuit status parameter on the scan tool. The scan tool parameter will change from Fault to OK when the source of the fault is disconnected. If all 5-volt reference components have been disconnected and a fault is still indicated, the fault may exist in the wiring harness.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Observe the scan tool 5-volt reference 1 circuit status and the 5-volt reference 2 circuit status parameters. Verify the parameters display OK.
2. Ignition ON, observe the DTC information with a scan tool. DTC P0641 and P0651 should not set on this ignition cycle.
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Important: A short to voltage on the signal circuit of certain components may cause this DTC to set.

1. Ignition ON, disconnect the harness connector of all appropriate sensors for the applicable DTC. Refer to Diagnostic Aids for the appropriate sensors.
2. Ignition ON, measure for 4.8-5.2 volts between one of the 5-volt reference circuits and ground.

   If less than the specified range, test for a short to ground on all 5-volt reference circuits. If all circuits test normal, replace the ECM.

   If greater than the specified range, test for a short to voltage on all the 5-volt reference circuits. If all circuits test normal, replace the ECM.
3. Connect each component associated with the 5-volt reference circuit, one at a time, while monitoring the voltage. Verify the voltage remains between 4.8-5.2 volts.

   If not within the specified range when a component is connected, test the signal circuit for a short to voltage. If the circuit tests normal, replace the appropriate component.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Accelerator Pedal Position Sensor Replacement
- Air Conditioning (A/C) Refrigerant Pressure Sensor Replacement
- Camshaft Position Sensor Replacement
- Crankshaft Position Sensor Replacement
- Engine Oil Pressure Sensor and/or Switch Replacement
- Fuel Tank Pressure Sensor Replacement
- Manifold Absolute Pressure Sensor Replacement
- Throttle Body Assembly Replacement
- Control Module References for ECM replacement, setup, and programming

DTC P0650

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0650: Malfunction Indicator (MI) Circuit Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open	Short to Voltage	Signal Performance
MIL Voltage Supply	P0650	P0650	--	--
MIL Control	P0650/MIL ON	P0650	P0650	--

Circuit/System Description

The malfunction indicator lamp (MIL) is located on the instrument panel cluster (IPC).

The MIL informs the driver that an emission system fault has occurred and that the engine control system requires service. The engine control module (ECM) monitors the MIL control circuit for conditions that are incorrect for the commanded states of the MIL.

Conditions for Running the DTC

- The ignition is in the Run or Crank position.
- The ignition voltage is between 9-18 volts.
- DTC P0650 runs continuously when the ignition is ON.

Conditions for Setting the DTC

The ECM detects that the commanded state of the MIL driver and the actual state of the control circuit do not match for more than 5 seconds.

Action Taken when the DTC Sets

DTC P0650 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0650 is a Type B DTC.

Reference Information

Schematic Reference

- Instrument Cluster Schematics.
- Engine Controls Schematics.

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Connector Repairs
- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit / System Verification

Using a scan tool, command the MIL light On and OFF.

Circuit / System Testing

1. Ignition OFF.
2. Disconnect the MIL light harness connector at the ECM.
3. Ignition ON, engine OFF. Connect a 3A fusible link wire between the MIL light control circuit on the wiring harness connector at the ECM and a known ground.

    If MIL light illuminates, replace the ECM.

    If MIL does not illuminate, inspect the MIL light control circuit for an open/high resistance or a short to ground.
4. If all circuits test normal, replace the IPC.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Instrument Cluster Replacement.
- Control Module References for ECM replacement, setup and programming

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L | Diagnostic Information and Procedures |
Document ID: 2125603

DTC P0685, P0689, or P0690

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0685: Engine Controls Ignition Relay Control Circuit

DTC P0689: Engine Controls Relay Feedback Circuit Low Voltage

DTC P0690: Engine Controls Relay Feedback Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil B+	P0685	P0685	--	--
Relay Switch B+	P0689	P0689	--	--
Relay Coil Control	P0685	P0685	P0685	--
Relay Ignition Output Ignition 1 Voltage	P0689	P0689	P0690	--

Typical Scan Tool Data

EC Ignition Relay

Display Parameters	Normal Range	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Ignition ON, engine OFF, powertrain relay commanded ON.				
EC Ignition Powertrain Relay Circuit Status	OK/Incomplete	Short to GRD/Open	Short to GRD/Open	Short to B+
EC Ignition Powertrain Relay Command	ON	ON	ON	ON
EC Ignition Powertrain Relay Feedback Signal	12-12.9 V	0.0 V	0.0 V	12-12.9 V

Circuit/System Description

The powertrain relay is a normally open relay. The relay armature is held in the open position by spring tension. Battery positive voltage is supplied directly to the relay coil and the armature contact at all times. The engine control module (ECM) supplies the ground path to the relay coil control circuit via an internal integrated circuit called an output driver module (ODM). The ODM output control is configured to operate as a low side driver for the powertrain relay. The ODM for the powertrain relay also incorporates a fault detection circuit, which is continuously monitored by the ECM. When the ECM commands the powertrain relay ON, ignition 1 voltage is supplied to the ECM, and to several additional circuits.

Conditions for Running the DTC

P0685

- The ignition is ON.
- The battery voltage is between 9-16 volts.

P0689

- The ignition is ON.
- The powertrain relay is commanded ON.
- DTC P0685 is not set.

P0690

- This DTC will run with the ignition ON or OFF.
- This DTC will run when the powertrain relay is commanded ON or OFF.
- DTC P0685 is not set.

Conditions for Setting the DTC

P0685

- The commanded state of the ODM and the actual state of the control circuit do not match.
- The condition is present for more than 5 seconds.

P0689

- The ECM detects less than 5 volts on the ignition 1 voltage circuit to the ECM.
- The condition is present for more than 5 seconds.

P0690

- The ECM detects more than 16 volts on the ignition 1 voltage circuit to the ECM when the relay is commanded ON.
- The ECM detects more than 2 volts on the ignition 1 voltage circuit to the ECM when the relay is commanded OFF.
- The condition is present for more than 2 seconds.

Action Taken When the DTC Sets

DTCs P0685, P0689, and P0690 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0685, P0689, and P0690 are Type B DTCs.

Diagnostic Aids

This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to Battery Inspection/Test.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- J 35616 GM-Approved Terminal Test Kit
- J 43244 Relay Puller Pliers

Circuit/System Verification

1. Engine running, command the powertrain relay ON and OFF, with a scan tool, while observing the following powertrain relay coil control circuit status parameters.

- Powertrain relay coil control Ckt. Short Gnd Test Status
- Powertrain relay coil control Ckt. Open Test Status
- Powertrain relay coil control Ckt. Short Volts Test Status
- Each parameter should toggle between OK and Not Run or Not Run and OK

2. Ignition ON, engine OFF, with a test lamp, probe both test points of all the fuses that are powered by the powertrain relay. The test lamp should illuminate ON for at least one test point of each fuse.
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Important: You must perform the Circuit/System Verification first.

1. Ignition OFF, disconnect the powertrain relay.
2. Ignition ON, verify that a test lamp illuminates between the powertrain relay coil B+ terminal 85 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the battery positive cable to the underhood fuse block.
3. Ignition OFF, verify that a test lamp does not illuminate between the powertrain relay coil B+ terminal 85 circuit and the control circuit terminal 86.

   If the test lamp illuminates, test the control circuit for a short to ground. If the circuit tests normal, replace the ECM.
4. Remove the test lamp.
5. Command the powertrain relay ON, with a scan tool. Verify with a scan tool that the powertrain relay Ckt. Short Volts Test Status parameter is OK.

   If not the specified value, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
6. Test the coil side of the powertrain relay terminal 85 and 86 for 200-240 ohms.

   If not within the specified value, replace the relay.
7. Ignition OFF, disconnect the ECM X1 connector.
8. Test the powertrain relay control circuit X1-59 for an open/high resistance.

   If the circuit tests normal, replace the ECM.
9. Verify that a test lamp does not illuminate between the relay ignition 1 terminal 30 voltage circuit and ground.

   If the test lamp illuminates, test the relay ignition 1 voltage circuit terminal 87 for a short to voltage. If the circuit tests normal, replace the ECM.
10. Verify that a test lamp illuminates between the relay switch B+ terminal 87 and ground.

    If the test lamp does not illuminate, test the relay switch B+ terminal 87 circuit for a short to ground, or an open/high resistance. If the circuits test normal, and the fuse for the ignition 1 voltage circuit is open, test the ignition 1 voltage circuit to the ECM for a short to ground. If the circuit tests normal, replace the ECM.
11. Connect a 20 A fused jumper wire between the relay switch B+ terminal 87 and the relay ignition 1 voltage circuit terminal 30.
12. Ignition ON, engine OFF, monitor the EC Ignition Relay Feedback parameter with a scan tool. The parameter should display B+.

    If the parameter does not display B+, test the ignition 1 voltage circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
13. If all circuits test normal, replace the relay.

Repair Instructions

- Engine Control Module Programming and Setup
- Engine Control Module Replacement
- Relay Replacement

Repair Verification

1. Install any components that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming, or setup procedures that are required when a component or module is removed or replaced.
3. Clear the DTCs.
4. Turn OFF the ignition for 60 seconds.
5. Ignition ON, command the powertrain relay ON and OFF with a scan tool, while observing the powertrain relay circuit status parameters, The circuit status parameters should change from OK to Not Run or Not Run to OK.

   If another DTC is present, refer to Diagnostic Trouble Code (DTC) List - Vehicle and perform the appropriate diagnostic procedure.

DTC P0700

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0700: Transmission Control Module (TCM) Requested MIL Illumination

Circuit/System Description

The transmission control module (TCM) uses the (GMLAN) to signal the engine control module (ECM) that the TCM is requesting malfunction indicator lamp (MIL) illumination. This happens when the TCM has determined that a failure affecting emissions has occurred in transmission control system. When the ECM receives the a message from the TCM, DTC P0700 will set.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The TCM is requesting MIL illumination.

Action Taken When the DTC Sets

DTC P0700 is a Type A DTC.

Conditions for Clearing the MIL/DTC

DTC P0700 is a Type A DTC.

Diagnostic Aids

DTC P0700 can not be cleared from the ECM until the related TCM codes have been cleared.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Diagnostic Trouble Code (DTC) List - Vehicle to correct any transmission DTCs

DTC P1174 or P1175

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P1174: Fuel Trim Cylinder Balance Bank 1

DTC P1175: Fuel Trim Cylinder Balance Bank 2

Circuit/System Description

The Fuel Trim Cylinder Balance diagnostic detects a rich or lean cylinder to cylinder air/fuel ratio imbalance in each bank. The diagnostic monitors the pre-catalyst heated oxygen sensor (HO2S) signal's frequency and amplitude characteristics by calculating an accumulated voltage over a predetermined sample period. An imbalance is indicated when multiple samples of the accumulated voltage are consistently higher than the desired value.

Conditions for Running the DTC

- DTCs P0030, P0036, P0050, P0053, P0059, P0101, P0102, P0103, P0106, P0107, P0108, P0117, P0118, P0128, P0131, P0132, P0133, P0134, P0135, P0151, P0152, P0153, P0154, P0155, P0201-P0206, P0300, P0301-P0306, P0411, P0412, P0418, P0442, P0443, P0446, P0449, P0452, P0453, P0454, P0455, P0496, P1133, P1153, P1516, P2101, P2119, P2120, P2125, P2135, P2138, P2176, P2431, P2432, P2433, P2440, P2A00, P2A03 are not set.
- The device control is not active.
- The intrusive diagnostics are not active.
- The engine overspeed protection is not active.
- The power take-off (PTO) is not active.
- The traction control is not active.
- The fuel control is in air-fuel Closed Loop.
- The system voltage is more than 10 volts, or less than 18 volts.
- The engine run time is greater than 100 seconds.
- The engine coolant temperature (ECT) is greater than -20°C (-4°F).
- The engine speed is greater than 425 RPM, but less than 6,000 RPM.
- The mass air flow is greater than 25 g/s, but less than 510 g/s.

Conditions for Setting the DTC

Multiple samples of the pre-catalyst HO2S accumulated voltage are consistently greater than the desired value.

Action Taken When the DTC Sets

DTCs P1174 and P1175 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P1174 and P1175 are Type B DTCs.

Diagnostic Aids

- The fuel trim cylinder balance diagnostic is very sensitive to heated oxygen sensor (HO2S) design. A non-OE sensor or an incorrect part number may set a false DTC.
- Monitoring the misfire current counters, or misfire graph, may help to isolate the cylinder that is causing the condition.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Troubleshooting with a Test Lamp
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Read and record the Freeze Frame/Failure Records data taking note of the speed and load at which the DTC set.
2. Diagnose any other DTCs that are set. Refer to Diagnostic Trouble Code (DTC) List - Vehicle.

3. With the engine idling and the transmission in the Park or Neutral position, observe the manifold absolute pressure (MAP) sensor parameter. The MAP sensor parameter should be between 19-42 kPa.

   If the MAP sensor parameter is not between 19-42 kPa, refer to DTC P0106 or DTC P0107 or P0108.
4. Inspect the air induction system for modified, damaged, leaking, or restricted components.
5. Inspect the crankcase ventilation system for improper operation.
6. Inspect the vacuum hoses for splits, kinks, and improper connections.
7. Inspect for vacuum leaks at the intake manifold, the throttle body, and the injector O-rings.
8. Test for a restricted, damaged, leaking, or modified exhaust system from the catalytic converter forward. Refer to Symptoms - Engine Exhaust.
9. Test the fuel injectors for improper operation. Refer to Fuel Injector Diagnosis.
10. Test for fuel contamination. Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
11. Test for excessive fuel in the crankcase due to leaking injectors.
12. Test the ignition system for improper operation. Refer to Electronic Ignition (EI) System Diagnosis.
13. Test the engine for any mechanical conditions such as sticking valves, lifters, etc., which could alter the flow into the combustion chamber. Refer to Symptoms - Engine Mechanical.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure. Verify the repair under the same speed and load as noted in the Freeze Frame/Failure Records data recorded during testing.

DTC P1380 or P1381

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provide an overview of each diagnostic category.

DTC Descriptors

DTC P1380: Misfire Detected - Rough Road Data Not Available

DTC P1381: Misfire Detected - No Communication with Brake Control Module

System Description

The engine control module (ECM) detects engine misfire by detecting variations in crankshaft deceleration between firing strokes. For accurate detection of engine misfire, the ECM must distinguish between crankshaft deceleration caused by actual misfire and deceleration caused by rough road conditions. The antilock brake system (ABS) can detect if the vehicle is on a rough road based on wheel acceleration/deceleration data supplied by the wheel speed sensors. If the ABS detects rough road above predetermined threshold, this information is sent to the ECM. The ECM uses the rough road information when calculating engine misfire. If the ABS is malfunctioning and cannot detect rough roads, the misfire diagnostic will continue to run; however, if an engine misfire DTC sets, this DTC also sets indicating that rough road data was not available, or there was no communication with the brake control module during the misfire calculation due to an ABS malfunction.

Conditions for Running the DTC

- The vehicle speed is greater than 8 km/h (5 mph).
- The engine speed is less than 7,000 RPM.
- The engine load is less than 60 percent.
- Engine misfire is detected and DTC P0300 sets with the MIL illuminated.
- DTCs P1380 and P1381 run continuously when the above conditions are met.

Conditions for Setting the DTC

P1380

- The ABS controller sends a message to the ECM indicating that a failure has occurred in the ABS module.
- Engine misfire is detected and DTC P0300 set.

P1381

- An ABS malfunction exists for more than 10 seconds, preventing the ECM from receiving rough road detection data.
- Engine misfire is detected and DTC P0300 set.

Action Taken When the DTC Sets

DTCs P1380 and P1381 are Type C DTCs.

Conditions for Clearing the DTC

DTCs P1380 and P1381 are Type C DTCs.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

Monitor the ABS DTCs on the scan tool.

> If any ABS DTCs are set, diagnose those first. Refer to Diagnostic Trouble Code (DTC) List - Vehicle
>
> If there are no ABS DTCs set, refer to the following:

Symptoms - Antilock Brake System

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L | Diagnostic Information and Procedures |
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DTC P1400

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provide an overview of each diagnostic category.

DTC Descriptor

DTC P1400: Cold Start Emission Reduction Control System

Circuit/System Description

The catalytic converter must be warmed to efficiently reduce the emissions. The cold start strategy is to reduce the amount of time it takes to warm the catalytic converter. During a cold start, the engine idle speed is elevated and spark timing is retarded to allow the catalyst to warm quickly. This diagnostic monitors the following to build an exhaust energy model:

- Engine speed
- Spark advance
- Throttle position
- Engine airflow
- Engine coolant temperature
- Engine runtime
- Park/neutral position
- Vehicle speed

The actual model is then compared to the expected exhaust energy model.

Conditions for Running the DTC

- The engine is running, and a cold start has been detected.
- Vehicle speed is less than 2 km/h (1 mph).
- The engine is at idle with no input from the accelerator pedal.
- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0220, P0222, P0223, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0335, P0336, P0351, P0352, P0353, P0501, P0502, P0506, P0507, P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, P0641, P0651, P1101, P1516, P1682, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, P2176, P2610 are not set.

This DTC runs for 15 seconds within the first 2 minutes of start-up. This diagnostic runs once per trip when a cold start has been determined.

Conditions for Setting the DTC

The actual exhaust energy model does not match the expected exhaust energy model.

Action Taken When the DTC Sets

DTC P1400 is a Type A DTC.

Conditions for Clearing the MIL/DTC

DTC P1400 is a Type A DTC.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Description and Operation

Engine Control Module Description

Diagnostic Aids

Any loading of the engine that lowers engine RPM, such as with partial application of the clutch, A/C cycling etc., during the first 120 seconds of engine runtime may set this DTC.

Circuit/System Verification

1. Allow the engine to cool.
2. Start and idle the engine for at least 2 minutes.
3. DTC P1400 should run and pass.

Circuit/System Testing

- Inspect the air intake system for the following:
  - Damage, restriction, or modification
  - Dirty or deteriorating air filter element
  - Crankcase ventilation system for correct operation--Refer to Crankcase Ventilation System Inspection/Diagnosis .
  - Water intrusion

  - Vacuum leak and other un-metered air downstream of the mass air flow (MAF) sensor
  - Intake manifold leak
- Inspect the exhaust system for the following:
  - Water intrusion
  - Exhaust leak
  - Damaged, restricted, modified or enhanced exhaust system--Refer to Symptoms - Engine Exhaust .
- Inspect the engine mechanical for items that could alter the air flow into the combustion chamber. Refer to Symptoms - Engine Mechanical .

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

DTC P1516, P2101, P2119, or P2176

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P1516: Throttle Actuator Control (TAC) Module Throttle Actuator Position Performance

DTC P2101: Throttle Actuator Position Performance

DTC P2119: Throttle Closed Position Performance

DTC P2176: Minimum Throttle Position Not Learned

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Motor Control 1	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176
Motor Control 2	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176

Circuit/System Description

The engine control module (ECM) is the control center for the throttle actuator control (TAC) system. The ECM determines the drivers intent and then calculates the appropriate throttle response. The ECM achieves throttle positioning by providing a pulse width modulated voltage to the TAC motor. The TAC system uses the following circuits:

- Motor control 1
- Motor control 2

Two processors are also used to monitor the TAC system data. Both processors are located within the ECM. Both processors monitor each other's data to verify that the indicated throttle position is correct.

Conditions for Running the DTC

P1516 and P2101

- The ignition is ON.
- The ignition voltage is more than 8 volts.
- The system is not in the Battery Save mode.
- The engine is running.
- DTC P0068 is not set.
- DTCs P1516 and P2101 run continuously when the above conditions are met.

P2119

- The ignition is ON.
- The vehicle speed is 0 km/h (0 mph).
- The ignition 1 voltage is more than 10 volts.
- DTC P2119 runs once per ignition cycle when the above conditions are met for more than 1 second.

P2176

- The ignition is ON.
- DTCs P0120, P0122, P0123, P0220, P0222, P0223 are not set.
- DTC P2176 runs once per key cycle.

Conditions for Setting the DTC

P1516

The indicated throttle position does not match the predicted throttle position for more than 0.5 second.

P2101

The indicated throttle position does not match the predicted throttle position for more than 0.3 second.

P2119

The ECM determines that the throttle valve did not return to the rest position within 720 milliseconds.

P2176

The difference between the predicted and the actual throttle position is more than a calibrated amount for more than 1.5 seconds.

Action Taken When the DTC Sets

P1516, P2101, and P2176

- DTCs P1516, P2101, and P2176 are Type A DTCs.
- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.
- The control module commands the TAC system to operate in the Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions, the control module commands the engine OFF.

P2119

- DTC P2119 is a Type C DTC.
- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The MIL will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- The driver information center, if equipped, may display a message.

Conditions for Clearing the MIL/DTC

- DTCs P1516, P2101, and P2176 are Type A DTCs.
- DTC P2119 is a Type C DTC.
- The control module turns OFF the MIL after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs

- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, engine OFF, use a scan tool to observe the throttle position (TP) sensor 1 indicated position. Throttle position should increase as pedal is applied, and decrease as pedal is released. When no accelerator pedal activity is detected, the throttle position will return to the spring loaded default position.

   Important: A low voltage condition may set this DTC.

2. Review the Freeze Frame/Failure Records and ensure sufficient ignition voltage was present when the DTC was set.
   If voltage was low, verify with the owner that the battery was not discharged. If the battery has not been discharged, refer to Power Mode Mismatch.
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Caution: Turn OFF the ignition before inserting fingers into the throttle bore. Unexpected movement of the throttle blade could cause personal injury.

1. Inspect the throttle body for the following conditions:
   - A throttle blade that is NOT in the rest position
   - A throttle blade that is binding open or closed
   - A throttle blade that is free to move open or closed WITHOUT spring pressure

   If a condition is found, replace the throttle body assembly.

   Important: Disconnecting the throttle body harness connector causes additional DTCs to set.

2. Ignition OFF, disconnect the harness connector at the throttle body.
3. Ignition ON, verify that a test lamp does not illuminate between motor control 1 circuit terminal B and ground.
   If test lamp illuminates, test the motor control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Ignition ON, verify that a test lamp does not illuminate between motor control 2 circuit terminal A and ground.
   If the test lamp illuminates, test the motor control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
5. Ignition ON, verify that a test lamp does not illuminate between motor control 1 circuit terminal B and B+.
   If the test lamp illuminates, test the motor control circuit for a short to ground. If the

circuit tests normal, replace the ECM.

6. Ignition ON, verify that a test lamp does not illuminate between motor control 2 circuit terminal A and B+.

   If the test lamp illuminates, test the motor control circuit for a short to ground. If the circuit tests normal, replace the ECM.

7. Ignition OFF, allow sufficient time for the ECM to completely power down. Connect a DMM between the motor control 1 circuit terminal B and ground.

   Important: When measuring peak voltage, ensure that the DMM is on the proper voltage scale and that the response time is set to 1 ms.

8. Measure for B+ on the motor control 1 circuit terminal B as the ignition is turned ON.

   If the peak voltage is not within 1 volt of B+, test the circuit for an open/high resistance. If the circuit tests normal, replace the ECM.

9. Ignition OFF, allow sufficient time for the ECM to completely power down.
10. Measure for B+ on the motor control 2 circuit terminal A as the ignition is turned ON.

    If the peak voltage is not within 1 volt of B+, test the circuit for an open/high resistance. If the circuit tests normal, replace the ECM.

11. If all circuits test normal, replace the throttle body.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Throttle Body Assembly Replacement
- Control Module References for ECM replacement, setup, and programming

DTC P1682

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P1682: Ignition 1 Switch Circuit 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition 1 Voltage, Powertrain Relay	P0689	P0689, P1682	P0690	--
Ignition 1 Voltage, Run/Crank Relay	--	P1682	--	--

Typical Scan Tool Data

Ignition Scan Tool Data

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, engine OFF, and run/crank and powertrain relay are commanded ON			
Ignition 1 Voltage, Run/Crank	0 Volts	0 Volts	12 Volts
EC Ignition (Powertrain) Relay Feedback Signal	0 Volts	0 Volts	12 Volts

Circuit/System Description

There are 2 ignition 1 voltage circuits supplied to the engine control module (ECM). The first ignition circuit is provided by the powertrain relay, through a fuse. This ignition 1 voltage circuit supplies power to all the internal ECM circuits associated with the throttle actuator control (TAC) operation. The second ignition 1 voltage circuit is supplied by the run/crank relay through a fuse, and is used to power the remaining internal ECM circuits. If the ECM detects a voltage difference between the 2 ignition 1 voltage circuits, DTC P1682 will set.

Conditions for Running the DTC

- The ignition is ON.

- System voltage is more than 7 volts.
- The powertrain relay is commanded ON.
- DTC P1682 runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the voltage level difference is greater than 3 volts between the 2 ignition 1 voltage circuits for less than 1 second.

Action Taken When the DTC Sets

DTC P1682 is a Type A DTC.

Conditions for Clearing the DTC

DTC P1682 is a Type A DTC.

Diagnostic Aids

This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to Battery Inspection/Test.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 35616 Connector Test Adapter Kit

Circuit/System Verification

Important: On the scan tool, the powertrain relay is referred to as the EC ignition relay.

1. If DTCs P0685, P0689, or P0690 are set, diagnose those DTCs first.
2. Ignition ON, engine OFF, observe both the Ignition 1 Voltage signal and the EC Ignition Relay Feedback signal parameters on the scan tool. Both parameter values should display no more than 3 volts difference between the 2 parameters.
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Important: You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Ignition OFF, disconnect the powertrain relay.
2. Ignition ON, verify that a test lamp does not illuminate between the powertrain relay controlled output circuit terminal and ground.

   If the test lamp illuminates, test the powertrain relay controlled output circuit for a short to voltage.
3. Ignition OFF, verify that a test lamp illuminates between the powertrain relay coil voltage supply circuit terminal and ground.

   If the test lamp does not illuminate, test the powertrain relay coil voltage supply circuit for a short to ground or an open/high resistance.
4. Verify that a test lamp illuminates between the powertrain relay switch voltage supply circuit terminal and ground.

   If the test lamp does not illuminate, test the powertrain relay switch voltage supply circuit for an open/high resistance.
5. Disconnect the ECM.
6. Ignition ON, verify that a test lamp illuminates between ECM connector terminal X1-19 and ground.

   If the test lamp does not illuminate, test the ignition 1 relay controlled output circuit for a short to ground or open/high resistance.

   If the circuit tests normal and its fuse is open, replace the ECM.
7. Ignition OFF, connect the harness connector at the ECM.
8. Ignition ON, connect a jumper wire between the powertrain relay voltage supply circuit terminal and the powertrain relay controlled output circuit terminal. Verify the EC Ignition Relay Feedback parameter indicates battery positive voltage.

   If not the specified value, test the powertrain relay controlled output circuit for a short to ground or an open/high resistance. If the circuit tests normal and its fuse is open, replace the ECM.
9. If all circuits test normal, replace the powertrain relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Relay Replacement
- Engine Control Module Replacement
- Engine Control Module Programming and Setup

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DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provide an overview of each diagnostic category.

DTC Descriptors

DTC P2120: Accelerator Pedal Position (APP) Sensor 1 Circuit

DTC P2122: Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage

DTC P2123: Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage

DTC P2125: Accelerator Pedal Position (APP) Sensor 2 Circuit

DTC P2127: Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage

DTC P2128: Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage

DTC P2138: Accelerator Pedal Position (APP) Sensor 1-2 Correlation

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
APP Sensor 1 Signal	P2122	P2138	P2122	P2123	--
APP Sensor 1 5-Volt Reference	P2122	P2138	P2122	P2123	--
APP Sensor 1 Low Reference	--	P2138	P2123	--	--
APP Sensor 2 Signal	P2127	P2138	P2127	P2128	--
APP Sensor 2 5-Volt Reference	P2127	P2138	P2127	P2128	--
APP Sensor 2 Low Reference	--	P2138	P2128	--	--

Typical Scan Tool Data

APP Sensor 1 and 2

	Normal	Short to	Open or High	Short to

Circuit	Range	Ground	Resistance	Voltage
APP Sensor 1 Signal	0.33-4.75 V	0 V	0 V	5 V
APP Sensor 1 5-Volt Reference	0.33-4.75 V	0 V	0 V	5 V
APP Sensor 1 Low Reference	0.33-4.75 V	--	4.96 V	--
APP Sensor 2 Signal	0.33-2.50 V	0 V	0 V	5 V
APP Sensor 2 5-Volt Reference	0.33-2.50 V	0 V	0 V	5 V
APP Sensor 2 low Reference	0.33-2.50 V	--	4.92 V	--

Circuit/System Description

The throttle actuator control (TAC) system uses two accelerator pedal position (APP) sensors to monitor the accelerator pedal position. The APP sensors 1 and 2 are located within the pedal assembly. Each sensor has the following circuits:

- A 5-volt reference circuit
- A low reference circuit
- A signal circuit

Two processors are also used to monitor the TAC system data. Both processors are located within the engine control module (ECM). Each signal circuit provides both processors with a signal voltage proportional to pedal movement. Both processors monitor each other's data to verify that the indicated APP calculation is correct.

Conditions for Running the DTC

P2120, P2122, P2123, P2125, P2127, P2128

- The system voltage is more than 5.23 volts.
- The ignition is in the Unlock/Accessory or Run position.
- DTC P0641 and P0651 are not set.
- DTC P2120, P2122, P2123, P2125, P2127, P2128 run continuously when the above conditions are met.

P2138

- The system voltage is more than 5.23 volts.
- The ignition is in the Unlock/Accessory or Run position.
- DTC P0641, P0651, P2120, P2125 are not set.
- DTC P2138 runs continuously when the above conditions are met.

Conditions for Setting the DTC

P2120

The APP sensor 1 voltage is less than 0.325 volt, or more than 4.75 volts for more than 0.4 second.

P2122

The ECM detects that the APP sensor 1 voltage is less than 0.325 volt for more than 0.4 second.

P2123

The ECM detects that the APP sensor 1 voltage is more than 4.75 volts for more than 0.4 second.

P2125

The APP sensor 2 voltage is less than 0.325 volt, or more than 4.75 volts for more than 0.4 second.

P2127

The ECM detects that the APP sensor 2 voltage is less than 0.325 volt for more than 0.4 second.

P2128

The ECM detects that the APP sensor 2 voltage is more than 4.75 volts for more than 0.4 second.

P2138

The voltage difference between APP sensor 1 and APP sensor 2 exceeds a predetermined value for more than 2 seconds.

Action Taken When the DTC Sets

- DTCs P2120, P2122, P2123, P2125, P2127, P2128, and P2138 are Type A DTCs.
- The control module commands the TAC system to operate in the Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions the control module commands the engine OFF.

Conditions for Clearing the MIL/DTC

DTCs P2120, P2122, P2123, P2125, P2127, P2128, and P2138 are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool APP sensor 1 voltage parameter. The reading should be between 0.32-4.75 volts, and change with accelerator pedal input.
2. Ignition ON, observe the scan tool APP sensor 2 voltage parameter. The reading should be between 0.32-4.75 volts, and change with accelerator pedal input.
3. Ignition ON, observe the scan tool APP sensor 1 and 2 parameter. The scan tool should indicate agree.
4. Clear the DTCs with the scan tool. Operate the vehicle within the Conditions for Running the DTC, or within the conditions that you observed from the Freeze Frame/Failure Records.

   If DTC P2120 or P2125 are the only DTCs set, replace the control module.

   If DTC P0641 or P0651 are set, refer to DTC P0641 or P0651.
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the accelerator pedal. Allow sufficient time for the ECM to power down.
2. Test for less than 5 ohms between each low reference circuit terminals 4 and 5 and ground.

   If greater than 5 ohms, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8-5.2 volts between each 5-volt reference circuit terminals 2 and 1 and ground.

   If less than 4.8 volts, test the affected 5-volt reference circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the ECM.

   If greater than 5.2 volts, test the affected 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Ignition ON, verify the scan tool APP sensor 1 and 2 voltages are less than 0.1 volt.

   If greater than 0.1 volt, test the APP sensor 1 and 2 signal circuits terminals 3 and 6 for a short to voltage. If the circuit tests normal, replace the ECM.

5. Install a 3A fused jumper wire between the signal circuit terminal 3 and the 5-volt reference circuit terminal 2 of the APP sensor 1. Verify the scan tool parameter AP sensor 1 voltage is greater than 4.8 volts.

   If less than 4.8 volts, test the APP sensor 1 signal circuit for an open, or short to ground. If the circuit tests normal, replace the ECM.

6. Install a 3A fused jumper wire between the signal circuit terminal 6 and the 5-volt reference circuit terminal 1 of the APP sensor 2. Verify that the scan tool parameter APP sensor 2 voltage is greater than 4.8 volts.

   If less than 4.8 volts, test the APP sensor 2 signal circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the ECM.

7. Ignition OFF, disconnect the harness connector at the ECM.
8. Test for less than 5 ohms of resistance on all APP sensor circuits between the following terminals:
   - ECM X1 signal circuit terminal 29 to APP terminal 3
   - ECM X1 signal circuit terminal 32 to APP terminal 6
   - ECM X1 5-volt reference circuit terminal 36 to terminal 1
   - ECM X1 5-volt reference circuit terminal 56 to terminal 2

   If greater than 5 ohms, repair the affected circuit.

9. Test for infinite resistance between APP sensor 1 signal circuit terminal 3 and APP sensor 2 signal circuit terminal 6.

   If less than infinite resistance, repair the short between APP sensor 1 signal circuit and APP sensor 2 signal circuits.

   If all circuits test normal, replace the accelerator pedal.

Component Test

Important: Perform the Circuit/System Testing before proceeding with the Component Test.

Dynamic Test

1. Install a 3A fused jumper wire between the 5-volt reference terminal of the applicable APP sensor and 5 volts. Install a jumper wire between the low reference terminal and a ground.
2. Sweep the sensor through the entire range while monitoring the voltage between the signal terminal and the low reference terminal with a DMM. The voltage should vary between 0.30-4.98 volts without any spikes or dropouts.

   If the voltage is not within the specified range or is erratic, replace the accelerator pedal assembly.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Accelerator Pedal Position Sensor Replacement
- Control Module References for ECM replacement, setup, and programming

DTC P250A

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P250A: Engine Oil Level Sensor Circuit

Circuit/System Description

The engine oil level (EOP) sensor changes voltage based on the engine oil pressure. The EOP sensor is a 3-wire sensor comprising of the signal circuit, the low reference circuit and the 5 volt reference circuit. The engine control module (ECM) supplies 5 volts to the EOP sensor via the 5 volt reference circuit and provides ground via the EOP low reference circuit. The ECM monitors the signal circuit of the EOP sensor to determine the engine oil pressure sensor voltage is within the normal operating range of approximately 1-4 volts. When the engine oil pressure is high, the EOP sensor voltage is high and the ECM senses a high signal voltage. When the engine oil pressure is low, the EOP sensor voltage is low and the ECM senses a low signal voltage. The ECM sends the EOP information to the instrument panel cluster (IPC) via GMLAN serial data message.

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

- The ECM detects that the EOP sensor signal circuit is greater than 4.4 volts.
- The above condition is present for greater than 10 seconds.

Action Taken when the DTC Sets

DTC P250A is a type C store Only DTC.

Conditions for Clearing the MIL/DTC

DTC P250A is a type C store Only DTC.

Reference Information

Schematic Reference

- Instrument Cluster Schematics
- Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the engine oil pressure (EOP) sensor.
2. Ignition OFF, test for less than 1 ohm of resistance between the low reference circuit and a known ground.

   If greater than 1 ohm, test the low reference circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8-5.2 volts between the 5 volt reference circuit and a known ground.

   If less than 4.8 volts, test the 5 volt reference circuit for a short to ground or an open/high resistance. If the circuit test normal, replace the ECM.

   If greater than 5.2 volts, test the 5 volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Connect an approved test lamp between the 5-volt reference circuit and the signal circuit at the wiring harness connector.

   If the test lamp does not illuminate test the signal circuit for a open/high resistance. If the circuit tests normal replace the ECM.
5. If all circuits test normal, test or replace the EOP sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Engine Oil Pressure Sensor and/or Switch Replacement.
- Engine Control Module Replacement for engine control module replacement, setup and programming.

DTC P2544

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provide an overview of each diagnostic category.

DTC Descriptor

DTC P2544: Transmission Torque Request Circuit

Circuit / System Description

To improve shift feel, the transmission control module (TCM) may request that the engine control module (ECM) reduce engine torque during shift events. When such a request is received, the ECM responds by retarding the base ignition timing and notifying the TCM that the request has succeeded. If the ECM is unable to comply with the request, the ECM sends the TCM a message that the request has failed.

The torque reduction request is sent to the ECM through a communication network called the controller area network (CAN). Two circuits are used to communicate CAN data between the ECM and TCM. A fault in the CAN will not cause DTC P2544 to set by itself. If a CAN fault occurs, other DTCs will set before DTC P2544.

When the TCM receives a torque reduction failure message from the ECM, then DTC P2544 will set. DTC P2544 is a type B DTC.

Conditions for Running the DTC

- The engine run time is greater than 5 seconds.
- No other CAN errors are present.

Conditions for Setting the DTC

The ECM notifies the TCM that a torque reduction request has failed for 2 seconds.

Action Taken When the DTC Sets

- DTC P2544 is a Type B DTC.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.

- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P2544 in TCM history.

Conditions for Clearing the DTC

- DTC P2544 is a Type B DTC.
- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to Battery Inspection/Test

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Testing

Observe the DTCs in the scan tool

If DTC P0604 is set, replace the ECM.

If DTC P0604 is not set, replace the TCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for ECM or TCM replacement, programming, and setup.

DTC P3400

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P3400: Cylinder Deactivation System Performance

Circuit / System Description

The Cylinder Deactivation System Performance diagnostic is a test of the internal mechanical condition of the engine, during operation in V4 mode. The engine control module (ECM) determines the internal mechanical condition of the engine through the actual measured values of the mass airflow (MAF) sensor, the intake manifold absolute pressure (MAP) sensor, and the throttle position (TP) sensor. The actual measured values of the 3 sensors are then compared to the calculated values for V4 mode, stored in the ECM. If the measured values are incorrect for V4 mode, the ECM will set DTC P3400, and will return to V8 mode operation.

Conditions for Running the DTC

- DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0119, P0335, and P0336 are not set.
- The engine speed is between 450-6,400 RPM.
- The IAT Sensor parameter is between -7 and +125°C (+19 and +257°F).
- The ECT Sensor parameter is between 70- 125°C (158-257°F).
- Time in V8 mode is more than 2 seconds.
- Time in V4 mode is more than 2 seconds.
- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTC

- The ECM detects that the actual measured values from the MAF sensor, MAP sensor, and TP sensor, is not within the range of the calculated values for V4 mode.
- The above condition is met for more than 100 milliseconds.

Action Taken When the DTC Sets

- DTC P3400 is a Type B DTC.

- The engine will return to V8 mode.

Conditions for Clearing the DTC

DTC P3400 is a Type B DTC.

Diagnostic Aids

- This DTC will not set during engine idling conditions. The vehicle will need to be driven for the DTC to set.
- This test procedure requires that the vehicle battery has passed a load test and its completely charged. Refer to Battery Inspection/Test.
- The valve lifter oil manifold (VLOM) solenoids are assigned to the following engine cylinders:
  - Solenoid #1--Cylinder #1
  - Solenoid #2--Cylinder #4
  - Solenoid #3--Cylinder #6
  - Solenoid #4--Cylinder #7

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cylinder Deactivation (Active Fuel Management) System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Start and idle the engine.
2. Allow the engine to reach normal engine operating temperature. The engine should idle smoothly, without any misfires. If the engine misfires, refer to DTC P0300-P0308.
3. Monitor the cylinder deactivation system data parameters with a scan tool.
4. Road test the vehicle under light throttle and load conditions that will allow the engine to command V4 mode. If all enabling conditions are met for cylinder deactivation, and if no internal engine hydraulic/mechanical fault conditions are present, the ECM will continue with V4 mode operation.
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Electrical System Testing

1. If DTCs P3401, P3425, P3441, or P3449 are set, refer to DTC P3401, P3425, P3441, or P3449.
2. Ignition ON, the engine OFF, command each VLOM solenoid ON and OFF using the scan tool output control function. While standing next to the engine compartment, you should be able to hear the solenoid energize and de-energize with each scan tool output control command.

   If you cannot hear each solenoids energize and de-energize, then refer to Cylinder Deactivation (Active Fuel Management) System Diagnosis.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

DTC P3401, P3425, P3441, or P3449

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P3401: Cylinder 1 Deactivation Solenoid Control Circuit

DTC P3425: Cylinder 4 Deactivation Solenoid Control Circuit

DTC P3441: Cylinder 6 Deactivation Solenoid Control Circuit

DTC P3449: Cylinder 7 Deactivation Solenoid Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition 1 Voltage Circuit to Deactivation Solenoids	P3401, P3425, P3441, P3449	P3401, P3425, P3441, P3449	P3401, P3425, P3441, P3449	--
Deactivation Solenoid Control Circuits	P3401, P3425, P3441, P3449	P3401, P3425, P3441, P3449	P3401, P3425, P3441, P3449	--

Typical Scan Tool Data

Cylinder Deactivation System Command

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Vehicle traveling at 40 mph, under a light load and steady throttle input *Parameter Normal Range:* V4 mode			
Cylinder Deactivation System Command	V8 mode	V8 mode	--

Cylinder 1, 4, 6, 7 Deactivation Solenoid Command

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Vehicle traveling at 40 mph, under a light load and steady throttle input			

Parameter Normal Range: ON			
Cylinder 1, 4, 6, 7 Deactivation Solenoid Command	OFF	OFF	--

Cylinder Deactivation Performance

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Vehicle traveling at 40 mph, under a light load and steady throttle input *Parameter Normal Range:* OK			
Cylinder Deactivation Performance	Fault	Fault	--

Circuit/System Description

Each of the 4 valve lifter oil manifold (VLOM) solenoid windings, are connected in parallel to a fused ignition circuit, supplied by the powertrain relay, in the underhood fuse block. The control circuit for each solenoid is connected to an individual low side driver, internal to the engine control module (ECM). Each low side driver has its own fault detection circuit, which monitors the solenoid control circuit for an incorrect voltage level. If an incorrect voltage level, such as an open/high resistance, or short to ground is detected, the low side driver will turn OFF, and the fault detection circuit will communicate the condition to the central processor internal to the ECM. These DTCs will set when the ECM detects an incorrect voltage level on the ignition circuit, the solenoids, or a solenoid control circuit, after the ignition switch is turned ON. If a VLOM solenoid control circuit DTC is set, the ECM will command V8 mode, turn ON the malfunction indicator light (MIL), and turn OFF the fuel injector for that cylinder, resulting in an engine misfire.

Conditions for Running the DTC

- The engine speed is greater than 400 RPM.
- The ignition voltage is between 9-18 volts.
- DTC P3401, P3425, P3441, and P3449 runs continuously when the above conditions are met.

Conditions for Setting the DTC

- The ECM detects that the commanded state of the low side driver and the actual voltage level of the control circuit do not match.
- The condition is present for 20 out of 25 sample counts.

Action Taken When the DTC Sets

- DTC P3401, P3425, P3441, and P3449 are Type B DTCs.
- The engine will return to V8 mode.
- The fuel injector will turn OFF for the cylinder that has a cylinder deactivation DTC set, resulting in an engine misfire.

Conditions for Clearing the DTC

DTC P3401, P3425, P3441, and P3449 are Type B DTCs.

Diagnostic Aids

The VLOM solenoids are assigned to the following engine cylinders:

- Solenoid #1 = Cylinder #1
- Solenoid #2 = Cylinder #4
- Solenoid #3 = Cylinder #6
- Solenoid #4 = Cylinder #7

Important: This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to Battery Inspection/Test.

1. Remove and inspect the fuse for the valve lifter oil manifold assembly.
   If the fuse is open, then a short to ground condition exists in the circuit.
2. Ignition ON, engine OFF, measure and record the ignition voltage at the fuse for the valve lifter oil manifold (VOLM) assembly.
3. Connect a DMM in series with a 15A fused jumper wire and a non-fused jumper wire across the exposed fuse terminals in the underhood fuse block.
4. Select the 10A range and zero out the DMM display.
5. Command each VLOM solenoid ON with a scan tool.
6. Record the amperage reading display on the DMM for each solenoid.
   If zero current is detected, then an open circuit condition exists in the circuit.
7. Calculate the resistance for each solenoid circuit. The total resistance for each solenoid circuit should be within 11-22 ohms.
   If the total circuit resistance exceeds 22 ohms, an open/high resistance condition exists in the circuit.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cylinder Deactivation (Active Fuel Management) System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections

- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EN-46999 Displacement On Demand Tester

Circuit/System Verification

1. Engine running, command the affected cylinder deactivation solenoid ON and OFF, with a scan tool, while observing the following cylinder deactivation control circuit status parameters.
   - Cylinder 1, 4, 6, or 7 solenoid control Ckt. Short Gnd Test Status
   - Cylinder 1, 4, 6, or 7 solenoid control Ckt. Open Test Status
   - Cylinder 1, 4, 6, or 7 solenoid control Ckt. Short Volts Test Status
   - Each parameter should toggle between OK and Not Run or Not Run and OK
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Important: You must perform the Circuit/System Verification first.

1. Disconnect the valve lifter oil manifold (VOLM) harness connector.
2. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal E and ground.

   If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test or replace the VLOM assembly.
3. Verify that a test lamp does not illuminate between the ignition circuit terminal E and the affected control circuit terminal.

   If the test lamp illuminates, test the control circuit for a short to ground. If the circuit tests normal, replace the ECM.
4. Remove the test lamp.
5. Command the affected cylinder deactivation solenoid ON with a scan tool. Verify with a scan tool that the affected cylinder deactivation solenoid Ckt. Short Volts Test Status parameter is OK.

   If not the specified value, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
6. Install a 3A fused jumper wire between the affected control circuit terminal and the ignition circuit terminal E. Command the affected cylinder deactivation solenoid ON with a scan tool. Verify with a scan tool that the affected cylinder deactivation solenoid Ckt. Short Volts Test Status parameter is displaying Fault.

If not the specified value, test the control circuit for an open/high resistance. If the circuit tests normal, replace the ECM.

7. If all the circuits test normal, test or replace the VOLM assembly.

Component Testing

Important: Perform the Circuit/System Testing first.

Static Test

1. Ignition OFF, disconnect the VLOM harness connector at the VLOM assembly.
2. Connect the cable that is labeled resistance from the displacement on demand (DoD) tester to the VLOM connector.
3. Connect the power leads from the DoD tester to B+ and ground. Test for 11-18 ohms on each VLOM solenoid.

   If the resistance is not within the specified range for each solenoid, replace the VLOM assembly.
4. Test for infinite resistance between each VLOM circuit terminal and the VLOM housing.

   If less than infinite resistance, replace the VLOM assembly.

Dynamic Test

1. Ignition OFF, disconnect the VLOM harness connector at the VLOM assembly.
2. Connect the cable that is labeled power from the displacement on demand DoD tester to the VLOM connector.
3. Connect the power leads from the DoD tester to B+ and ground.
4. Command each VLOM solenoid ON and OFF using the DoD tester. You should be able to hear each solenoid turn ON and OFF.

   If the function does not perform as specified, replace the VLOM assembly.

Repair Instructions

- Engine Control Module Programming and Setup
- Engine Control Module Replacement

Repair Verification

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming, or setup procedures that are required when a component or module is removed or replaced.
3. Clear the DTCs.
4. Turn OFF the ignition for 60 seconds.
5. Engine running, command each cylinder deactivation solenoid ON and OFF with a scan tool, while observing the cylinder deactivation circuit status parameters. The circuit status parameters should change from OK to NOT Run or Not Run to OK.

   If another DTC is present, refer to Diagnostic Trouble Code (DTC) List - Vehicle and perform the appropriate diagnostic procedure.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L | Schematic and Routing Diagrams |

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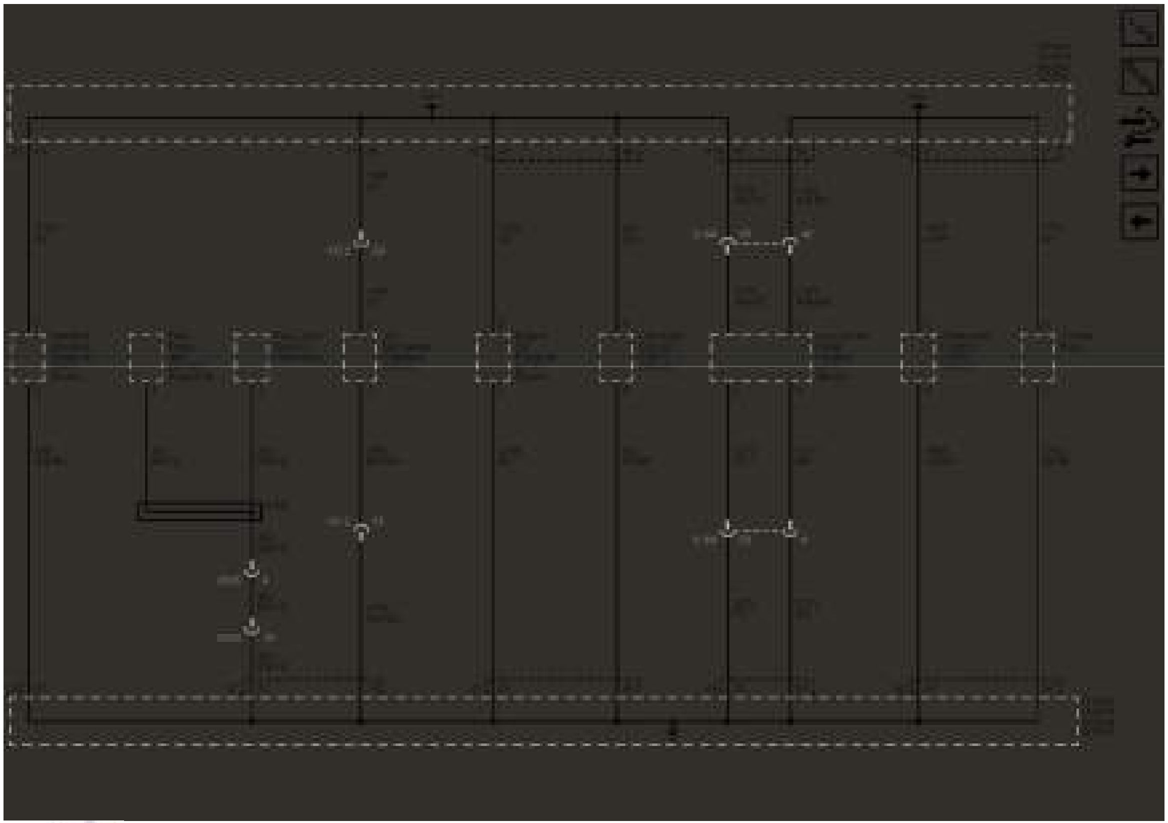
5 Volt Reference and Low Reference



Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)

Description

Water contamination in the fuel system may cause driveability conditions such as hesitation, stalling, no start, or misfires in one or more cylinders. Water may collect near a single fuel injector at the lowest point in the fuel injection system, and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust or deterioration.

Ethanol concentrations of greater than 10 percent can cause driveability conditions and fuel system deterioration. Fuel with more than 10 percent ethanol could result in driveability conditions such as hesitation, lack of power, stalling , or no start. Excessive concentrations of ethanol used in vehicles not designed for it may cause fuel system corrosion, deterioration of rubber components, and fuel filter restriction.

Test Procedure

1. Test the fuel composition using J 44175 Fuel Composition Tester and J44175-3 Instruction Manual.
2. Subtract 50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample. Refer to the examples in the Fuel Composition Test Examples table.
3. If the fuel sample contains more than 15 percent ethanol, add fresh, regular gasoline to the vehicle's fuel tank.
4. Test the fuel composition.
5. If testing shows the ethanol percentage is still more than 15 percent, replace the fuel in the vehicle.

Fuel Composition Test Examples

--	Frequency (Hz)	Subtract 50	Ethanol Percent
Example A	50 Hz	-50	0
Example B	65 Hz	-50	15
Example C	129 Hz	-50	79

Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool)

Description

Water contamination in the fuel system may cause driveability conditions such as hesitation, stalling, no start, or misfires in one or more cylinders. Water may collect near a single fuel injector at the lowest point in the fuel injection system, and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust, or deterioration.

Alcohol concentrations of 10 percent or greater in fuel can be detrimental to fuel system components. Alcohol contamination may cause fuel system corrosion, deterioration of rubber components, and subsequent fuel filter restriction. Some types of alcohol are more detrimental to fuel system components than others. Ethanol is commonly used in gasoline, but in concentrations of no more than 10 percent. Some fuels, such as E85, contain a very high percentage of ethanol. Fuel with more than 10 percent ethanol may cause driveability conditions such as hesitation, lack of power, stalling, or no start.

Alcohol in Fuel Testing Procedure

The fuel sample should be drawn from the bottom of the tank so that any water present in the tank will be detected. The sample should be bright and clear. If alcohol contamination is suspected then use the following procedure to test the fuel quality.

1. Using a 100 ml (3.4 oz) specified cylinder with 1 ml (0.03 oz) graduation marks, fill the cylinder with fuel to the 90 ml (3.04 oz) mark.
2. Add 10 ml (0.34 oz) of water in order to bring the total fluid volume to 100 ml (3.4 oz) and install a stopper.
3. Shake the cylinder vigorously for 10-15 seconds.
4. Carefully loosen the stopper in order to release the pressure.
5. Re-install the stopper and shake the cylinder vigorously again for 10-15 seconds.
6. Put the cylinder on a level surface for approximately 5 minutes in order to allow adequate liquid separation.

If alcohol is present in the fuel, the volume of the lower layer, which would now contain both alcohol and water, will be more than 10 ml (0.34 oz). For example, if the volume of the lower layer is increased to 15 ml (0.51 oz), this indicates at least 5 percent alcohol in the fuel. The actual amount of alcohol may be somewhat more because this procedure does not extract all of the alcohol from the fuel.

Particulate Contaminants in Fuel Testing Procedure

The fuel sample should be drawn from the bottom of the tank so that any water present in the tank will be detected. The sample should be bright and clear. If the sample appears cloudy, or contaminated with water, as indicated by a water layer at the bottom of the sample, use the following procedure to diagnose the fuel.

1. Using an approved fuel container, draw approximately 0.5 liter (0.13 gal) of fuel.

2. Place the cylinder on a level surface for approximately 5 minutes in order to allow settling of the particulate contamination.

Particulate contamination will show up in various shapes and colors. Sand will typically be identified by a white or light brown crystals. Rubber will appear as black and irregular particles. If particles are found clean the entire fuel system thoroughly.

Electronic Ignition (EI) System Diagnosis

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit/System Description

This ignition system uses individual ignition module/coil assemblies for each cylinder. The engine control module (ECM) controls the spark events by transmitting the timing pulses on the ignition control (IC) circuits to the individual ignition module/coil assemblies in firing order sequence. Each ignition module/coil has the following circuits:

- Ignition voltage
- Ground
- Ignition Control (IC)
- Low reference

Diagnostic Aids

- Depending on location in the spliced ignition voltage circuit, a slight resistance can cause a misfire or a crank/no start condition. A voltage drop test on the circuit will pinpoint this condition.
- A slight to moderate resistance on any IC circuit can cause a misfire before DTC P0351-P0358 sets.
- Extended engine cranking time may foul the spark plugs with excessive fuel.
- When disconnecting electrical connectors or removing fuses and relays from a fuse block, always inspect both mating electrical terminals for corrosion and terminal tightness.
- Use the J 35616 for any test that requires probing the underhood fuse block terminals, component wire harness terminals, or the ECM wire harness terminals.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- J 26792 Spark Plug Tester
- J 35616-A/BT-8637 Connector Test Adapter Kit

Circuit/System Verification

1. Verify that the engine is in good mechanical condition before continuing with this diagnostic.
2. Verify the following conditions:
    - The ignition coils/modules are correctly wired and connected
    - The proper firing order
    - The proper spark plug type
    - The proper spark plug gap and torque
    - The proper ohm values for the spark plug wires
    - Refer to Ignition System Specifications and Spark Plug Inspection.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the affected ignition coil/modules.
2. Ignition OFF for 90 seconds, test for less than 5 ohms between the ground circuit terminal A and ground.

    If greater than the specified range, test the ground circuit for an open/high resistance.
3. Test for less than 5 ohms between the low reference circuit terminal B and ground.

    If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.

    Important: If the ignition fuse is open, it will be necessary to test the spliced ignition circuits and the components for a short to ground.

4. Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal D and ground.

    If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance.
5. Exchange the affected ignition coil/module with the ignition coil/module of a good cylinder.
6. Start the engine and observe the scan tool Misfire Current Cylinder parameters.

    If the misfire transfers with the suspect ignition coil/module, replace as needed.

7. If the circuits test normal, test or replace the spark plugs.

Component Testing

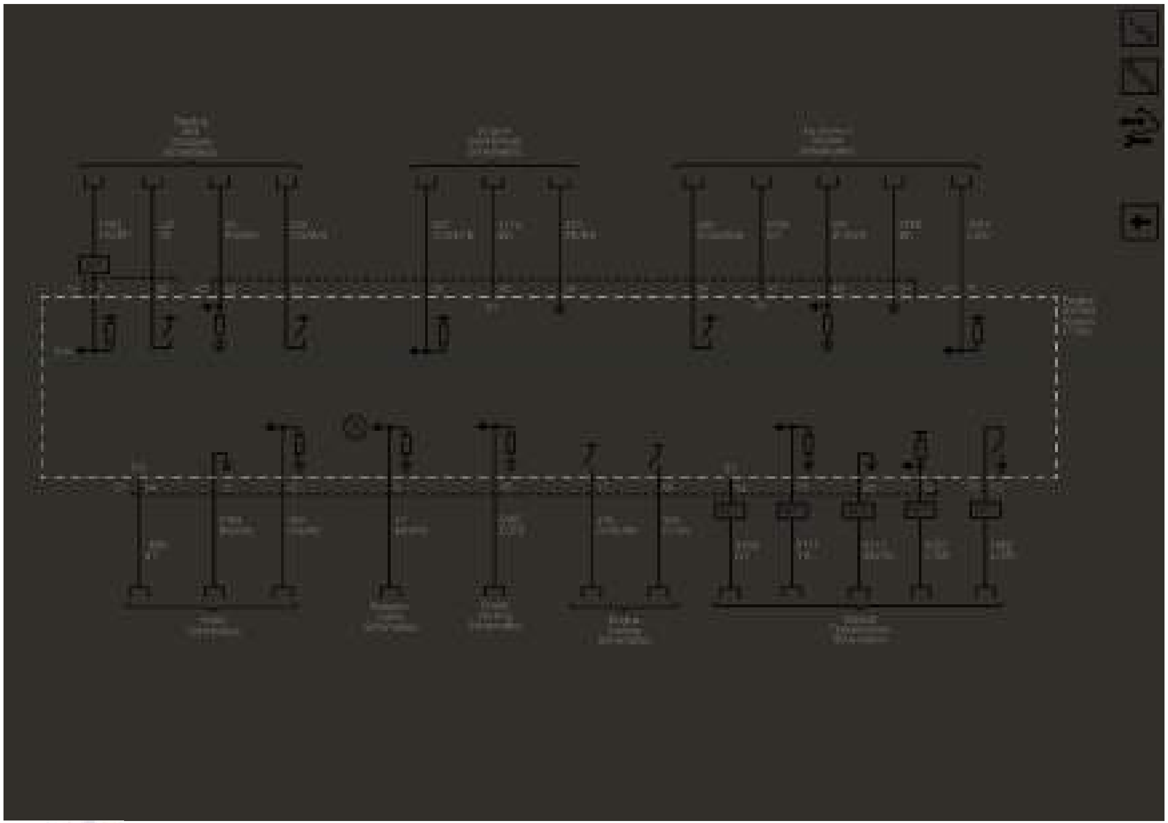
Use the J 26792 to verify the output of each ignition module/coil.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Engine Control Module Programming and Setup
- Engine Control Module Replacement
- Ignition Coil Replacement
- Spark Plug Replacement

Controlled / Monitored Subsystem References



Cylinder Deactivation (Active Fuel Management) System Diagnosis (L98, LS2, LS3)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit Description

To provide maximum fuel economy under light load driving conditions, the engine control module (ECM) will command the valve lifter oil manifold (VLOM) solenoids ON, to deactivate engine cylinders 1 and 7 on the left bank, and cylinders 4 and 6 on the right bank. The VLOM consists of 4 electrically operated normally closed solenoids, which directs pressurized engine oil to 8 deactivating valve lifters. All 4 VLOM solenoids are connected in parallel to a fused ignition circuit supplied by the powertrain relay. The control circuit for each solenoid is connected to an individual low side driver internal to the ECM. When enabling conditions for V4 mode are met, the ECM will command each low side driver to turn ON, in engine firing order sequence.

Diagnostic Aids

The VLOM solenoids are assigned to the following engine cylinders:

- Solenoid #1--Cylinder #1
- Solenoid #2--Cylinder #4
- Solenoid #3--Cylinder #6
- Solenoid #4--Cylinder #7

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cylinder Deactivation (Active Fuel Management) System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. If any DTCs are set, then repair those DTC first. Refer to Diagnostic System Check - Vehicle.
2. Start and idle the engine.
3. Allow the engine to reach normal engine operating temperature. The engine should idle smoothly without any misfires. If the engine misfires, refer to DTC P0300-P0308.
4. Monitor the cylinder deactivation system data parameters with a scan tool.
5. Road test the vehicle under light throttle and load conditions that will allow the ECM to command V4 mode. If all enabling conditions are met for cylinder deactivation, and if no internal engine hydraulic/mechanical fault conditions are present, the ECM will continue operation in V4 mode.

   If the vehicle passes the Circuit/System Verification test, then review the active fuel management driving information in the Features and Controls section of the owners manual with the vehicle operator, or instruct the vehicle operator in the proper driving techniques to obtain V4 mode.

   If the vehicle does not pass the Circuit/System Verification test, then review the cylinder deactivation inhibit reasons listed on the scan tool.

Circuit/System Testing

Electrical System Testing

Ignition ON and the engine OFF, command each VLOM solenoid ON and OFF using the scan tool. Standing next to the engine compartment, you should be able to hear the solenoid energize and de-energize with each command.

If you cannot hear each solenoid energize and de-energize, then refer to DTC P3401, P3425, P3441, or P3449.

Mechanical System Testing

1. Connect a vacuum gage to the EVAP vacuum tube fitting on the electronic throttle body. DO NOT use a compound pressure and vacuum gage. The vacuum gage on a hand held vacuum pump will work fine for this test.
2. Start the engine. Allow the engine to reach normal operation temperature.
3. With a scan tool, command each VLOM solenoid ON, one at a time. Each time a solenoid is command ON, you should observe a fluctuating drop of intake manifold vacuum, and a misfire on the cylinder that was deactivated.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Engine Cranks But Does Not Run

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit/System Description

This Engine Cranks but Does Not Run diagnostic is an organized approach to identify a condition which causes the engine to crank but does not continue to run. This diagnostic directs the service technician to the appropriate system diagnosis. This diagnostic assumes the vehicle system voltage levels are adequate for starter motor operation. Refer to Battery Inspection/Test and Engine Cranks Slowly. The fuel level supply must be adequate, and the fuel quality must be able to sustain the combustion process.

Diagnostic Aids

- When disconnecting electrical connectors or removing fuses and relays from a fuse block, always inspect both mating electrical terminals for corrosion and terminal tightness.
- Use the J 35616 Connector Test Adapter Kit for any test that requires probing the underhood fuse block terminals, component wire harness terminals, or the ECM wire harness terminals.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- J 34730-1A Fuel Pressure Gage
- J 35616-A/BT-8637 Connector Test Adapter Kit
- J 43244 Relay Puller Pliers

Circuit / System Verification

Attempt to start the engine. The engine should start and run.

If the vehicle passes the Circuit/System Verification test, refer to Testing for Intermittent Conditions and Poor Connections.

Circuit / System Testing

1. Crank the engine for up to 30 seconds.
2. Observe the vehicle DTC information with a scan tool.
   If any of the following DTCs are set, diagnose these DTCs first: DTC P0117, P0118, P0122, P0123, P0201-P0208, P0222, P0223, P0335, P0336, P0351-P0358, P0562, P0563, P0601-P0604, P0606, P0607, P062F, P0633, P0685, P0690, P1631, P1682, or P2610. Refer to Diagnostic Trouble Code (DTC) List - Vehicle.
3. With the ignition ON and the engine OFF, test the fuses that are supplied ignition 1 voltage by the powertrain relay. The test lamp should illuminate ON for each test point of the fuses.
   If the test lamp does not illuminate ON for at least one test point of each fuse, refer to DTC P0685, P0689, or P0690.
4. Crank the engine for 15 seconds. Observe the engine speed parameter with a scan tool.
   If engine RPM is not indicated, refer to DTC P0335.
5. Install a spark plug tester onto one ignition module/coil assembly on each bank of the engine.
6. Observe both spark plug testers.

   Note: An erratic or weak spark is considered a no spark condition.

7. Crank the engine for 15 seconds. The ignition coil secondary voltage should be observed across the gap of both spark plug testers.
   If the ignition coil secondary voltage is not observed, is inconsistent, or weak on either spark plug tester, refer to Electronic Ignition (EI) System Diagnosis.
8. With the ignition ON and the engine OFF, command the fuel pump ON and OFF with the scan tool. The fuel pump should energize when commanded ON, and de-energize when commanded OFF.
   If the fuel pump does not turn ON and OFF, refer to Fuel System Diagnosis.
9. Turn OFF the ignition.
10. Install the J 34730-1A Fuel Pressure Gage. With the ignition ON and the engine OFF, command the fuel pump ON several times with the scan tool. Refer to Fuel System Diagnosis for the fuel pressure specification.
11. Inspect for the following conditions:

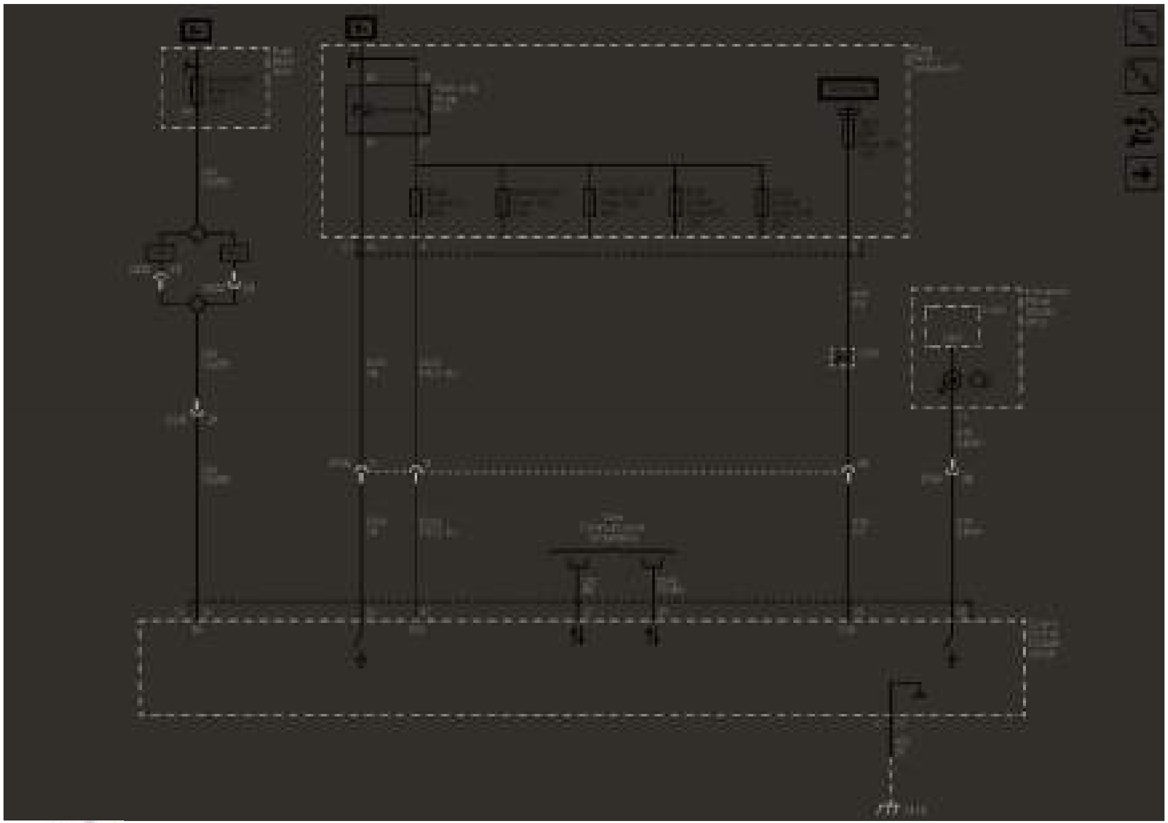
- Compare the actual engine coolant temperature to the ECT parameter.
- Filter and air intake system for restrictions and obstructions
- Test the fuel for contamination--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
- Inspect the spark plugs--Refer to Spark Plug Inspection.
- Test the exhaust system for restrictions--Refer to Restricted Exhaust.
- Engine mechanical conditions, such as worn timing chain, sprocket gears, low compression, etc.--Refer to Symptoms - Engine Mechanical.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Document ID: 2021937

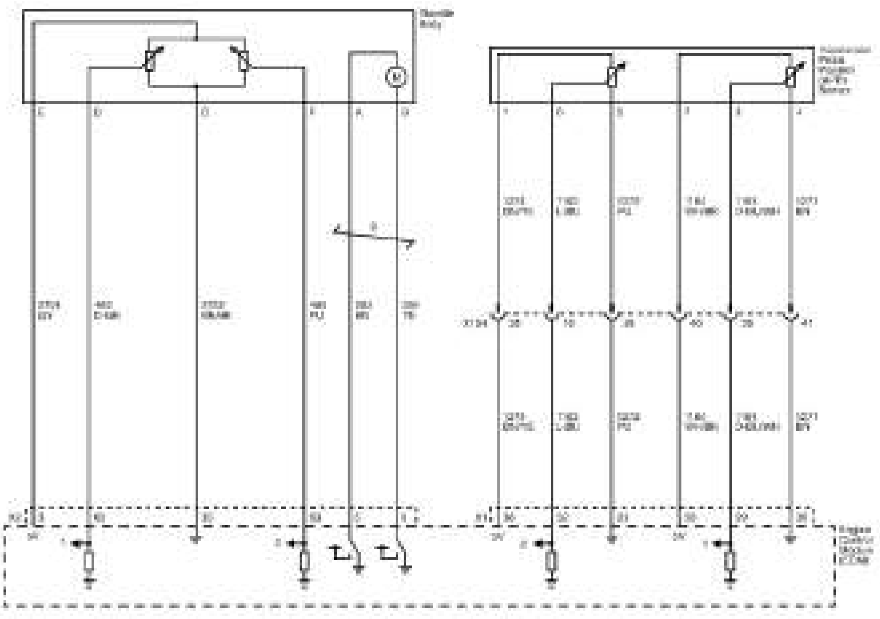
ECM Power, Ground and Serial Data



2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L | Schematic and Routing Diagrams |

Document ID: 2146254

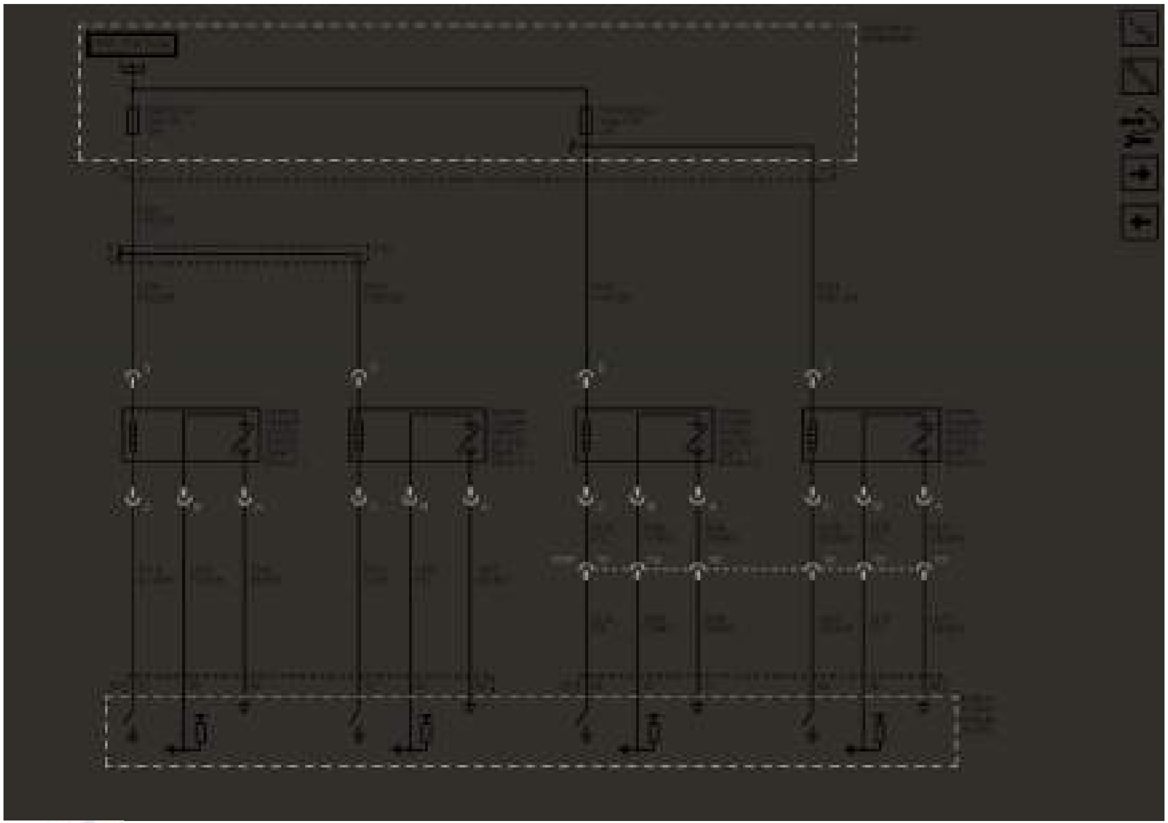
Engine Data Sensors - Electronic Throttle Controls


Throttle Body
M
X194
5V
5V
5V
Engine Control Module (ECM)

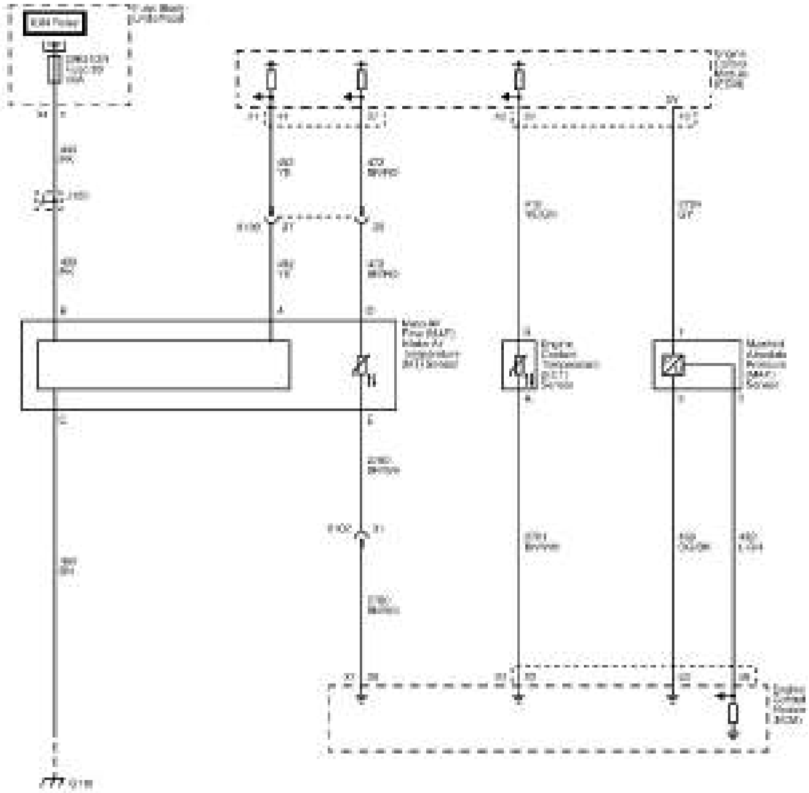
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L | Schematic and Routing Diagrams |

Document ID: 2146255

Engine Data Sensors - HO2S



Engine Data Sensors - Pressure and Temperature


Engine Coolant Temperature (ECT) Sensor
Manifold Absolute Pressure (MAP) Sensor
Engine Control Module (ECM)

Evaporative Emission System Diagnosis

Operating Instructions for the Evaporative Emission System Tester (EEST)

Vehicle Setup

Important: A large difference between the vehicle temperature and shop temperature will seriously affect the accuracy of the tests. Always allow enough time, at least 15 minutes, for the vehicle temperature to adjust to the shop temperature. Refer to Temperature Variation Instructions for more information about vehicle versus shop temperatures.

1. Engine OFF, open the hood. Position a large fan to blow air under the vehicle onto the fuel tank area.
2. Connect the red battery clip from the tester to the positive battery terminal.

Important: The vehicle battery must be fully charged for optimum tester performance.

3. Connect the black battery clip from the tester to chassis ground.

Flowmeter Test - Leak Detection

1. Open the Nitrogen tank valve and turn the NITROGEN/SMOKE valve on the front control panel to NITROGEN.
2. Connect the hose to the correct test orifice on the bottom front of the tester. For orifice size, refer to the GM Service manual for the vehicle being tested. The vehicle specific information can be found in service procedures for DTCs that relate to evaporative emission (EVAP) system leaks.
3. Press and release the remote switch to activate the tester.
4. Position the sliding red flag on the flowmeter to align with the floating indicator. When the red flag is set, press and release the remote switch to deactivate the tester.
5. Remove the hose from the test orifice and install the hose onto the vehicle. For proper connection location, and the special tool numbers for any adapters that may be required, refer to the service manual for the vehicle being tested. The vehicle specific information can be found in service procedures for DTCs that relate to EVAP system leaks.
6. Seal the EVAP system per instructions in the service manual. Most systems can be sealed using a scan tool output control for the EVAP canister vent solenoid valve. Other systems require that the system be plugged. Refer to the service manual for vehicle being tested for specific instructions.

Important:

- Larger volume fuel tanks, and/or those with lower fuel levels, may require several minutes to fill with nitrogen.
- Static buildup may cause the float indicator to stick. It may be necessary to tap on the flowmeter to free up the float.

7. Press and release the remote switch to activate the nitrogen flow and fill the system.
8. Compare the stable floating indicator position to the red flag.

- ABOVE the red flag, the result is UNACCEPTABLE, FAIL--Go to Smoke Procedure
- BELOW the red flag, the result is ACCEPTABLE, PASS--Test complete

9. Press and release the remote switch to deactivate the tester.

Smoke Procedure - Locate the Leak

Important: It is not recommended to use the tester in an outside repair bay area because wind and sunlight may affect temperature and your ability to see the smoke.

1. Turn OFF any fans that may cause air movement around or near the vehicle.

Important: Completely unwind the nitrogen/smoke hose from the bracket to optimize the tester's performance.

2. Connect the nitrogen/smoke hose to the vehicle as directed in the service manual. Some vehicles require that the nitrogen/smoke hose be connected at the front of the EVAP system at the EVAP service port. An adapter may be necessary. Other vehicles require the connection be made at the rear of the system using an adapter at the fuel fill cap. Consult the service manual for vehicle specific instructions regarding connection location and adapters.
3. Open the nitrogen tank valve and turn the NITROGEN/SMOKE valve on the control panel to SMOKE.

Important: The remote switch operates in a push ON, push OFF fashion.

4. Press and release the remote switch to activate the tester and inject smoke into the EVAP system.
5. Verify smoke has filled the EVAP system by opening the system opposite the end where smoke is injected. When injecting smoke at the service port, remove the fuel fill cap, or temporarily leave the EVAP canister vent valve open, until smoke is observed. Then close the system and continue testing. If using a special tool fuel fill cap adapter at the filler neck, use the J 41413-VLV EVAP Service Port Vent Fitting tool at the service port until smoke is observed, then remove the J 41413-VLV tool and continue with the test.

Important: Inject smoke in less than 2-minute cycles for optimum tester performance.

6. Press and release the remote switch to deactivate the tester.

Important: For optimum visual smoke performance, deactivate the smoke flow and allow the system pressure to drop. Allowing the smoke to exit small holes at a low flow rate greatly enhances visibility.

7. Introduce smoke into the system for an additional 60 seconds. Continue introducing smoke at 15-second intervals, as necessary.
8. Using the a high-intensity white light , inspect the entire EVAP system path, and look for the source of the leak indicated by the exiting smoke. Introduce smoke at 15-second intervals, as needed, until leak source is identified.

Temperature Variation Instructions

The Concern

Ideal circumstances for conducting the EVAP Flowmeter Test require equal temperatures between the nitrogen gas and the vehicle EVAP system. Significant differences in temperature between them can result in a flow or pressure change during testing, causing misleading results. Typically, the Evaporative Emissions System Tester is stored indoors, approximately 21°C (70°F). Vehicles brought in for diagnosis may have an EVAP system at significantly different temperatures -40 to +43°C (-40 to +110°F).

For Example

Important: With no temperature difference between the nitrogen gas and EVAP system, the resulting vehicle EVAP system pressure will remain stable at 13 inches H2O once pressurized, providing no leaks are present.

When the EVAP Flowmeter Tests are performed with significant differences in temperature between the nitrogen gas and the vehicle EVAP system, the following results can occur:

- An increase in flow during the flowmeter test can be caused by a vehicle’s warm EVAP system cooling down.
- A decrease in flow during the flowmeter test can be caused by a vehicle’s cool EVAP system warming up.

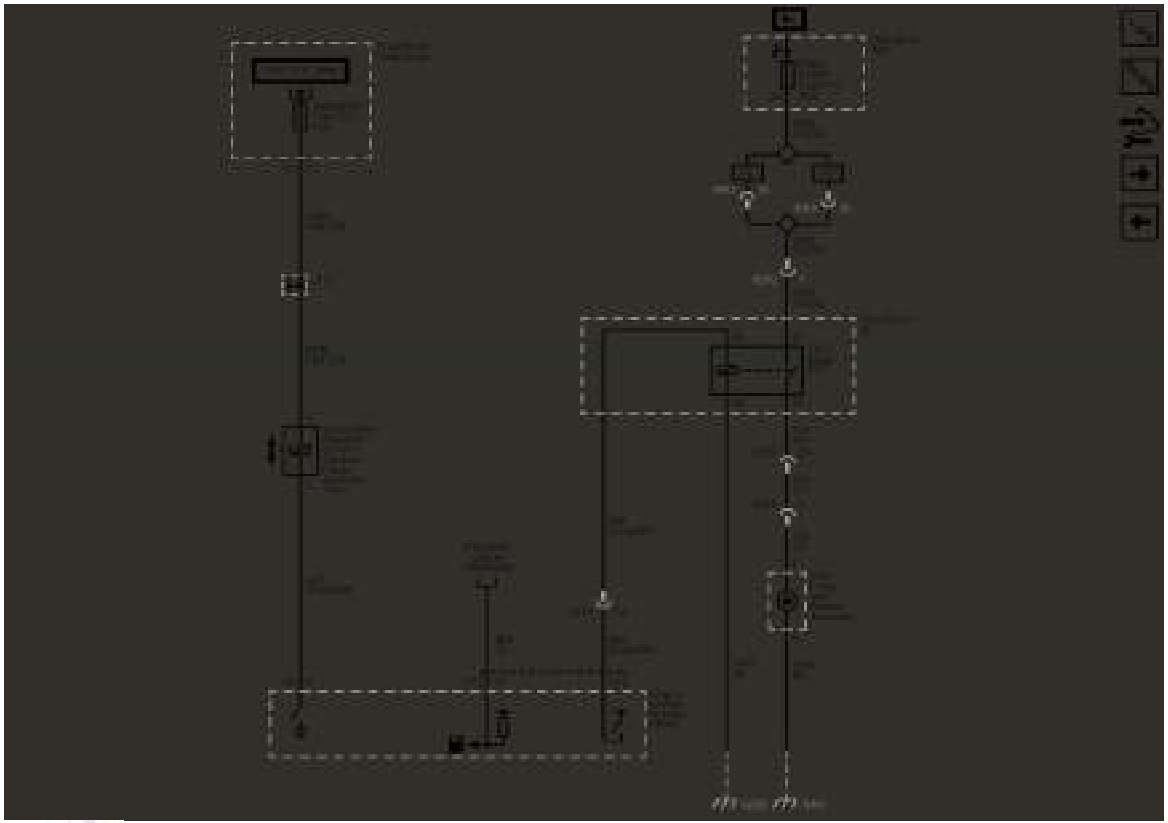
The Solution

When working on a vehicle with significant temperature differences between the vehicle EVAP system and the nitrogen gas, allow the vehicle EVAP system temperature to stabilize as close as possible to the temperature of the nitrogen gas before conducting the Flowmeter Test.

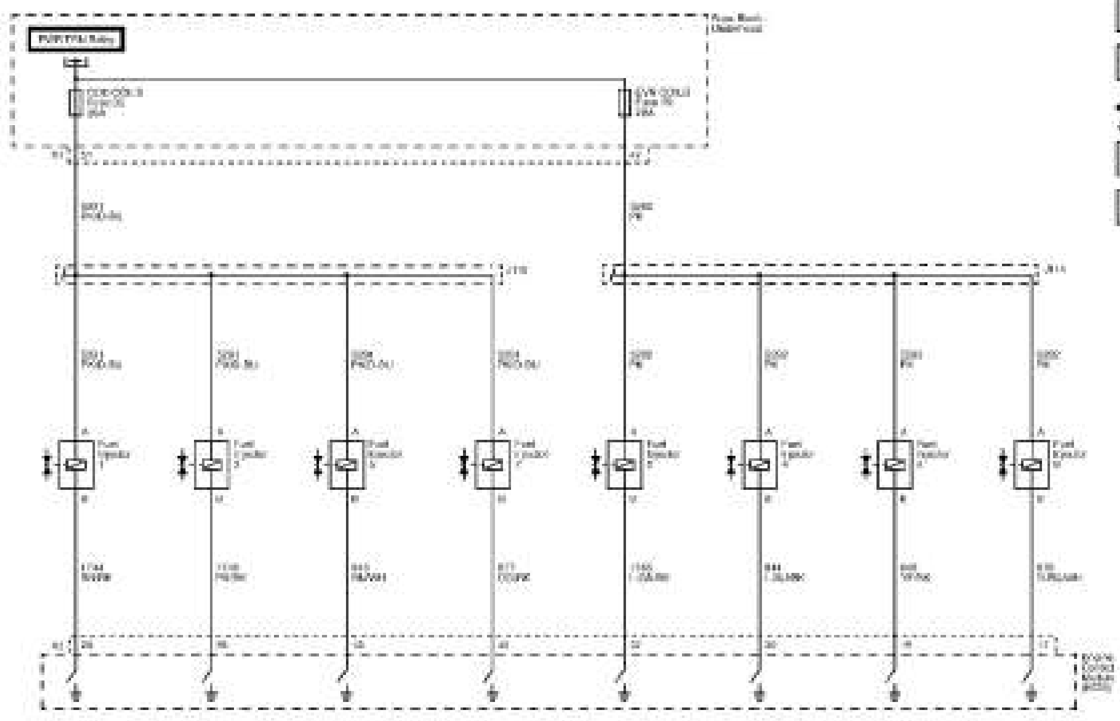
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L | Schematic and Routing Diagrams |

Document ID: 2146260

Fuel Controls - EVAP and Fuel Pump Controls



Fuel Controls - Fuel Injectors


Fuse Block - Underhood
Fuel Injector 1
Fuel Injector 3
Fuel Injector 5
Fuel Injector 7
Fuel Injector 2
Fuel Injector 4
Fuel Injector 6
Fuel Injector 8
Engine Control Module (ECM)

Fuel Injector Diagnosis (W/J39021 or W/Tech 2)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provide an overview of each diagnostic category.

Circuit/System Description

The control module enables the appropriate fuel injector pulse for each cylinder. The ignition voltage is supplied directly to the fuel injectors. The control module controls each fuel injector by grounding the control circuit via a solid state device called a driver. A fuel injector coil winding resistance that is too high or too low will affect the engine driveability. A fuel injector control circuit DTC may not set, but a misfire may be apparent. The fuel injector coil windings are affected by temperature. The resistance of the fuel injector coil windings will increase as the temperature of the fuel injector increases.

When performing the fuel injector balance test, the scan tool is first used to energize the fuel pump relay. The fuel injector tester or the scan tool is then used to pulse each injector for a precise amount of time, allowing a measured amount of the fuel to be injected. This causes a drop in the system fuel pressure that can be recorded and used to compare each injector.

Diagnostic Aids

- Monitoring the misfire current counters, or misfire graph, may help to isolate the fuel injector that is causing the condition.
- Operating the vehicle over a wide temperature range may help isolate the fuel injector that is causing the condition.
- Perform the fuel injector coil test within the conditions of the customer's concern. A fuel injector condition may only be apparent at a certain temperature, or under certain conditions.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- CH-48027 Digital Pressure Gage
- J 39021 Fuel Injector Coil and Balance Tester
- J 44602 Injector Test Adapter

Component Testing

Fuel Injector Coil Test

Verify the resistance of each fuel injector with one of the following methods:

- If the engine coolant temperature (ECT) sensor is between 10-32°C (50-90°F), the resistance of each fuel injector should be 11-14 ohms.

  If the injectors measure OK, perform the Fuel Injector Balance Test - Fuel Pressure Test.

  If not within the specified range, replace the fuel injector.
- If the ECT sensor is not between 10-32°C (50-90°F), measure and record the resistance of each fuel injector with a DMM. Subtract the lowest resistance value from the highest resistance value. The difference between the lowest value and the highest value should be equal to or less than 3 ohms.

  If the difference is equal to or less than 3 ohms, refer to Fuel Injector Balance Test - Fuel Pressure Test for further diagnosis of the fuel injectors.

  If the difference is more than 3 ohms, add all of the fuel injector resistance values to obtain a total resistance value. Divide the total resistance value by the number of fuel injectors to obtain an average resistance value. Subtract the lowest individual fuel injector resistance value from the average resistance value. Compute the difference between the highest individual fuel injector resistance value and the average resistance value. Replace the fuel injector that displays the greatest difference above or below the average.

Important:

- DO NOT perform this test if the engine coolant temperature (ECT) is above 94°C (201°F). Irregular fuel pressure readings may result due to hot soak fuel boiling.
- Verify that adequate fuel is in the fuel tank before proceeding with this diagnostic.
- Before proceeding with this test review the User Manual CH 48027-5 for Safety Information

and Instructions.

Fuel Injector Balance Test-Fuel Pressure Test

1. Install a CH-48027 . Refer to Fuel Pressure Gage Installation and Removal.
2. Turn ON the ignition, with the engine OFF.

   Important:
   - The fuel pump relay may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.
   - DO NOT start the engine.

3. Command the fuel pump relay ON with a scan tool.
4. Observe the fuel pressure gage with the fuel pump commanded ON. The fuel pressure should be 345-414 kPa (50-60 psi).

   If the fuel pressure is not 345-414 kPa (50-60 psi), refer to Fuel System Diagnosis.
5. Monitor the CH-48027 for one minute. The fuel pressure should not decrease more than 34 kPa (5 psi).

   If the fuel pressure decreases more than 34 kPa (5 psi), refer to Fuel System Diagnosis.
6. Perform the Fuel Injector Balance Test with Special Tool or the Fuel Injector Balance Test with Tech 2.

Fuel Injector Balance Test with Special Tool

1. Set the amperage supply selector switch on the fuel injector tester to the Balance Test 0.5-2.5 amp position.
2. Connect the J 39021 to a fuel injector with a J 44602 .
3. Command the fuel pump relay ON and then OFF three times with a scan tool. On the last command, as the fuel pressure begins to slowly degrade and stabilize, select a fuel pressure within 34 kPa (5 psi) of the maximum pump pressure. Record this fuel pressure. This is the starting pressure at which you will pulse each injector.
4. Command the fuel pump relay ON one more time and energize the fuel injector by depressing the Push to Start Test button on the J 39021 at the previously selected pressure.
5. After the injector stops pulsing, select Min from the Display Mode and record the Min pressure.

   Important: New test results will not be recorded if the Min/Max results are not cleared after each injector is tested.

6. Clear the Min/Max results.
7. Select Normal from the Display Mode.
8. Repeat steps 2 and 4 through 7 for each fuel injector.
9. Perform the Pressure Drop Calculation.

Fuel Injector Balance Test with Tech 2

1. Command the fuel pump relay ON and then OFF three times with a scan tool. On the last command, as the fuel pressure begins to slowly degrade and stabilize, select a fuel pressure within 34 kPa (5 psi) of the maximum pump pressure. Record this fuel pressure. This is the starting pressure at which you will pulse each injector.
2. With a scan tool, select the Fuel Injector Balance Test function within the Special Functions menu.

3. Select an injector to be tested.
4. Press Enter to prime the fuel system.
5. Energize the fuel injector by depressing the Pulse Injector button on the scan tool at the previously selected pressure.
6. After the injector stops pulsing, select Min from the Display Mode on the CH-48027 and record the Min pressure.

   Important: New test results will not be recorded if the Min/Max results are not cleared after each injector is tested.

7. Clear the Min/Max results on the CH-48027 .
8. Select Normal from the Display Mode on the CH-48027 .
9. Press Enter on the scan tool to bring you back to the Select Injector screen.
10. Repeat steps 3 through 9 for each fuel injector.
11. Perform the Pressure Drop Calculation.

Pressure Drop Calculation

1. Subtract the minimum pressure from the starting pressure for one fuel injector. The result is the pressure drop value.
2. Obtain a pressure drop value for each fuel injector.
3. Add all of the individual pressure drop values except for the injector suspected of being faulty. This is the total pressure drop.
4. Divide the total pressure drop by the number of fuel injectors that were added together. This is the average pressure drop. The difference between any individual pressure drop and the average pressure drop should not be more than 20 kPa (3 psi).
   - If the difference between any individual pressure drop and the average pressure drop is more than 20 kPa (3 psi), replace the fuel injector, E-85 only. All other engine, refer to Fuel Injector Cleaning.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Fuel Injector Replacement

Fuel Injector Diagnosis (W/CH47976)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provide an overview of each diagnostic category.

Circuit/System Description

The control module enables the appropriate fuel injector pulse for each cylinder. The ignition voltage is supplied directly to the fuel injectors. The control module controls each fuel injector by grounding the control circuit via a solid state device called a driver. A fuel injector coil winding resistance that is too high or too low will affect the engine driveability. A fuel injector control circuit DTC may not set, but a misfire may be apparent. The fuel injector coil windings are affected by temperature. The resistance of the fuel injector coil windings will increase as the temperature of the fuel injector increases.

The CH-47976 , is used to test the fuel pump, fuel system leak down, and the fuel injectors. Following the User Guide, CH 47976-11, and the on screen prompts or selections, will indicate the steps required to perform each of the available tests. The tester will perform all of the tests automatically and display results of the test. The results can also be down loaded for storage and printing.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Special Tools

CH-47976 Active Fuel Injector Tester

Component Testing

Fuel Injector Coil Test

Verify the resistance of each fuel injector with one of the following methods:

- If the engine coolant temperature (ECT) sensor is between 10-32°C (50-90°F), the resistance of each fuel injector should be 11-14 ohms.

  If the injectors measure OK, perform the Active Fuel Injector Tester (AFIT) Test Procedure.

  If not within the specified range, replace the fuel injector.
- If the ECT sensor is not between 10-32°C (50-90°F), measure and record the resistance of each fuel injector with a DMM. Subtract the lowest resistance value from the highest resistance value. The difference between the lowest value and the highest value should be equal to or less than 3 ohms.

  If the difference is equal to or less than 3 ohms, refer to AFIT Test Procedure.

  If the difference is more than 3 ohms, add all of the fuel injector resistance values to obtain a total resistance value. Divide the total resistance value by the number of fuel injectors to obtain an average resistance value. Subtract the lowest individual fuel injector resistance value from the average resistance value. Compute the difference between the highest individual fuel injector resistance value and the average resistance value. Replace the fuel injector that displays the greatest difference above or below the average.

Important:

- DO NOT perform this test if the engine coolant temperature (ECT) is above 94°C (201°F). Irregular fuel pressure readings may result due to hot soak fuel boiling.
- Verify that adequate fuel is in the fuel tank before proceeding with this diagnostic.

AFIT Test Procedure

1. Turn OFF all accessories.
2. Turn OFF the ignition.
3. Install the AFIT. Refer to the AFIT User Guide.
4. Turn ON the AFIT and select the vehicle.
5. Turn ON the ignition and perform the Injector Test.

   If the AFIT aborts testing due to fuel pressure or fuel leak down, refer to Fuel System Diagnosis.
6. View the test results.

   If any injector exceeds the recommended tolerance, replace the injector(s), E-85 only. All other engine, refer to Fuel Injector Cleaning.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Fuel Injector Replacement

Document ID: 1992892

Fuel System Diagnosis

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit/System Description

The engine control module (ECM) enables the fuel pump relay when the ignition switch is turned ON. The ECM will disable the fuel pump relay within 3 seconds unless the ECM detects ignition reference pulses. The ECM continues to enable the fuel pump relay as long as ignition reference pulses are detected. The engine control module (ECM) disables the fuel pump relay within 3 seconds if ignition reference pulses cease to be detected and the ignition remains ON.

The fuel system is a returnless on-demand design. The fuel pressure regulator is a part of the primary fuel tank module, eliminating the need for a return pipe from the engine. A returnless fuel system reduces the internal temperature of the fuel tank by not returning hot fuel from the engine to the fuel tank. Reducing the internal temperature of the fuel tank results in lower evaporative emissions.

An electric turbine style fuel pump attaches to the primary fuel tank module inside the fuel tank. The fuel pump supplies high pressure fuel through the fuel filter, past the fuel pressure regulator, and through the fuel feed line to the fuel injection system. The fuel pressure regulator has a T-joint that diverts the needed fuel to the fuel rail with the unused fuel dropping back into the reservoir of the primary fuel tank module. The primary fuel tank module contains a reverse flow check valve. The check valve and the fuel pressure regulator maintain fuel pressure in the fuel feed line and the fuel rail in order to prevent long cranking times.

The primary fuel tank module also contains a primary jet pump and a secondary jet pump. Fuel pump flow loss, caused by vapour expulsion in the pump inlet chamber, is diverted to the primary jet pump and the secondary jet pump through a restrictive orifice located on the pump cover. The primary jet pump fills the reservoir of the primary fuel tank module. The secondary jet pump creates a venturi action which causes the fuel to be drawn from the secondary side of the fuel tank, through the fuel transfer pipe, to the primary side of the fuel tank.

Diagnostic Aids

- A vehicle that runs out of fuel above empty may indicate a condition with the siphon jet pump, or transfer lines between the fuel tanks. Inspect for blockage, foreign objects or restrictions in all related hardware
- A vehicle that runs out of fuel above empty may be caused by an inaccurate fuel level sender. Inspect the float arm for binding, or obstructions.

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References.

Special Tools Required

Commercially available Fuel Pressure gauge.

Circuit / System Verification

Note:

- Inspect the fuel system for damage or external leaks before proceeding
- Verify that adequate fuel is in the fuel tank before proceeding
- The fuel pump relay may need to be commanded ON a few times in order to obtain the highest possible fuel pressure
- DO NOT start the engine.

1. Ignition ON, command the fuel pump relay ON with a scan tool. You should hear the fuel pump turn ON and OFF for 3-5 seconds.

   If the fuel pump does not operate, refer to Fuel Pump Electrical Circuit Diagnosis.
2. Ignition OFF, all accessories OFF, install the fuel pressure gauge. Refer to Fuel Pressure Gage Installation and Removal.
3. Ignition ON, command the fuel pump relay ON with a scan tool. Verify the fuel pressure is between 380-410 kPa (55-60 psi) and remains steady for 5 minutes.
4. Operate the vehicle within the conditions of the customers concern while monitoring fuel related parameters with a scan tool.

   If the scan tool parameters do not indicate a lean condition, refer to Symptoms - Engine Controls.

Circuit / System Testing

1. Ignition ON, command the fuel pump relay ON with a scan tool and observe the fuel pressure while the fuel pump is operating. Verify the fuel pressure is between 380-410 kPa (55-60 psi).

   If the fuel pressure is more than the specified range, replace the fuel pump.

   If the fuel pressure is less than the specified range, remove the fuel tank and test/inspect for the following:

   - Restricted fuel feed line
   - Restricted or plugged fuel filter
   - Restricted or plugged strainer
   - Stuck or binding fuel level float
   - Restricted siphon jet pump

- Restricted transfer lines between fuel tanks
- Faulty fuel pressure regulator
- Poor connections at the harness connectors and ground circuits of the fuel pump

If you find a condition, repair as necessary

If all components test normal, replace the fuel pump.

Note: The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant.

2. Verify that the fuel pressure does not decrease more than 34 kPa (5 psi) in 1 minute.

   If the fuel pressure decreases more than the specified value, perform the following procedure:

   2.1. Ignition OFF, relieve the fuel pressure. Refer to Fuel Pressure Relief

   2.2. Install the *J 37287* Fuel Line Shut-Off Adapters between the fuel feed pipe and the fuel rail.

   2.3. Open the valve on the *J 37287* Fuel Line Shut-Off Adapters .

   2.4. Bleed the air from the fuel pressure gage.

   2.5. Close the valve on the *J 37287* Fuel Line Shut-Off Adapters .

   2.6. Verify that the fuel pressure does not decrease more than 34 kPa (5 psi) in 1 minute.

   If the fuel pressure remains constant, replace the fuel pump.

   If the fuel pressure drops, locate and replace the leaking fuel injector.
3. Relieve the fuel pressure to 69 kPa (10 psi). Verify that the fuel pressure does not decrease more than 14 kPa (2 psi) in 5 minutes.

   If the fuel pressure decreases more than the specified value, replace the fuel pump.
4. Remove the *J 37287* Fuel Line Shut-Off Adapters and the *AU-338* Fuel Pressure Gage . Refer to Fuel Pressure Gage Installation and Removal.
5. Operate the vehicle within the conditions of the customer concern while monitoring fuel related parameters with a scan tool.

   If the scan tool parameters indicate a lean condition, test/inspect for the following:

   - Restricted fuel feed line
   - Restricted fuel filter
   - Restricted siphon jet pump
   - Restricted transfer lines between fuel tanks
   - Faulty fuel pressure regulator
   - Poor connections at the harness connectors and ground circuits of the fuel pump

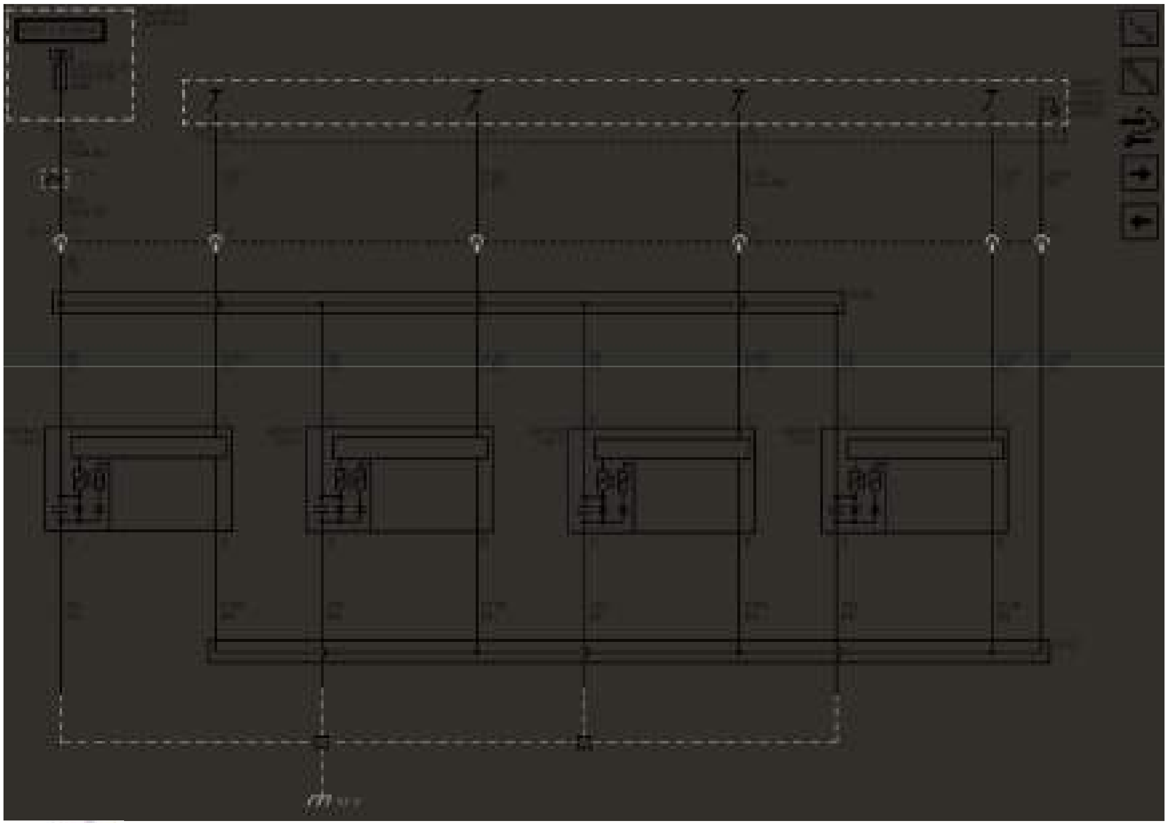
   If all components test normal and the scan tool parameters indicate a lean condition, replace the fuel pump.

Repair Instructions

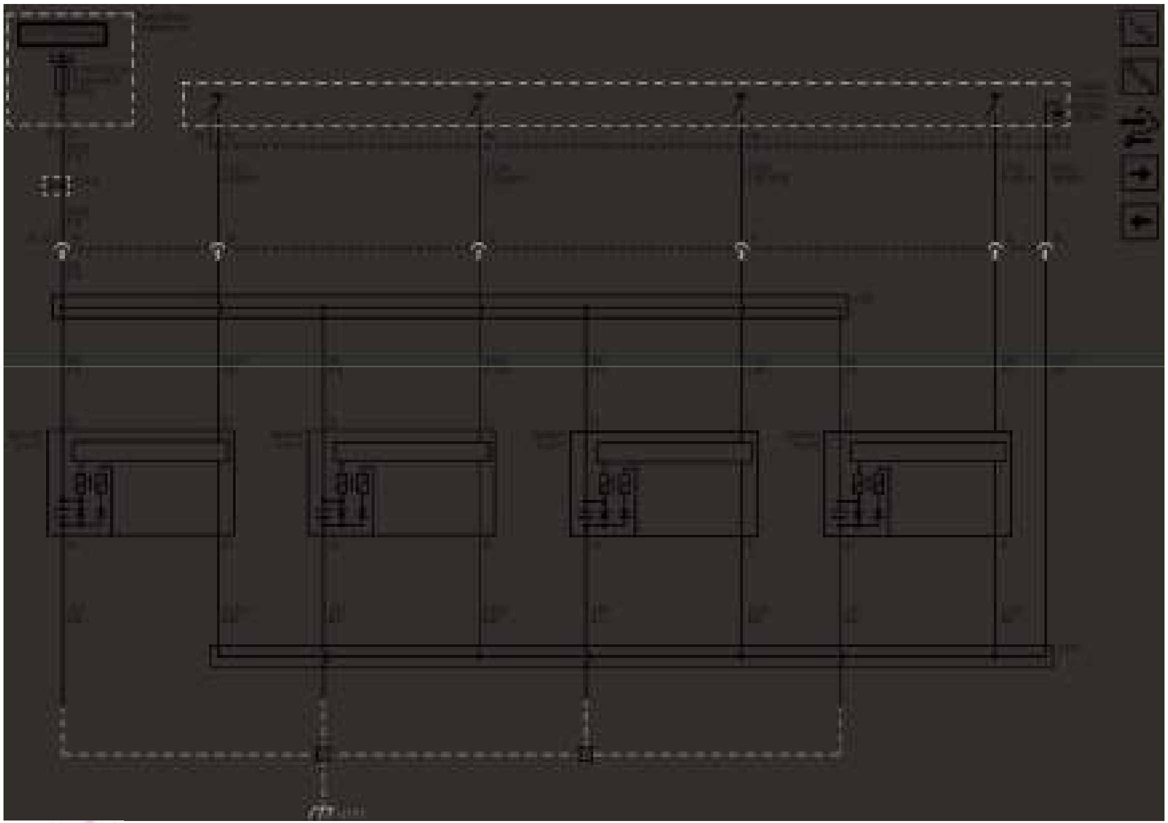
Perform the Diagnostic Repair Verification.

- Primary Fuel Tank Module Replacement
- Fuel Injector and Fuel Rail Replacement

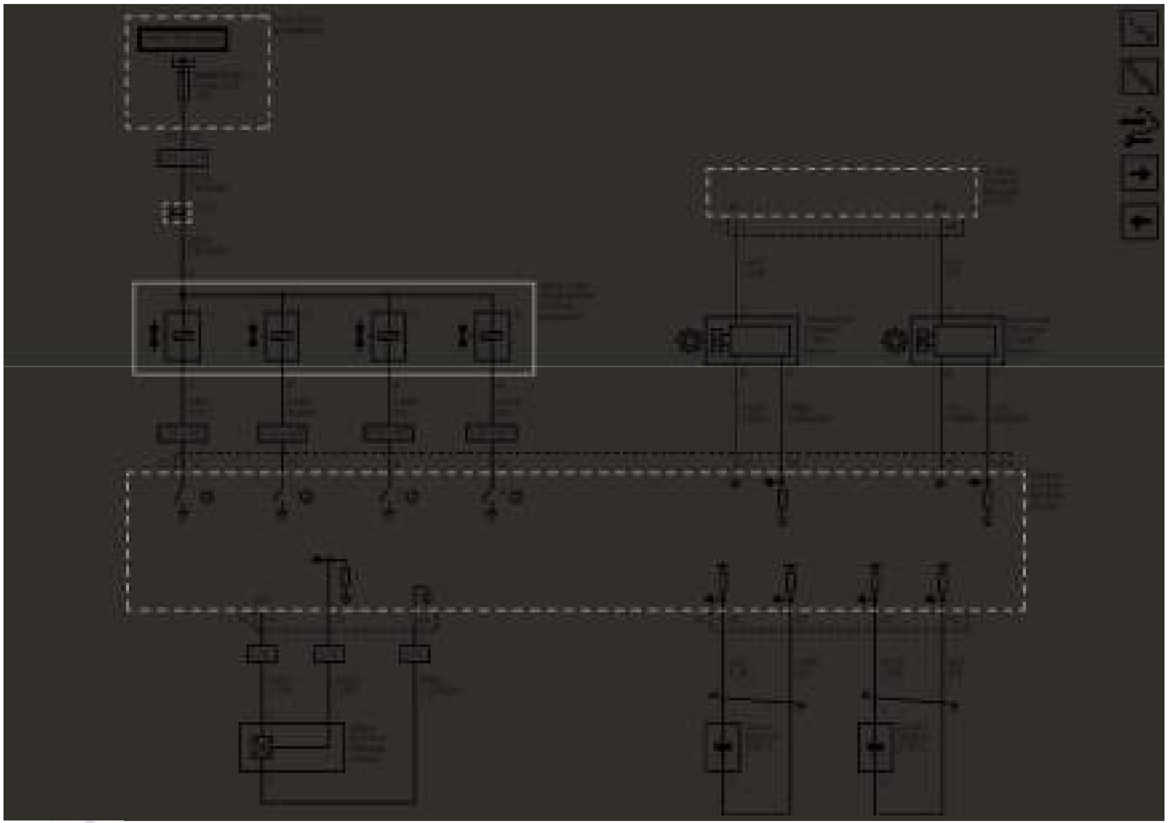
Ignition Controls - Ignition System Coils 1, 3, 5, and 7



Ignition Controls - Ignition System Coils 2, 4, 6, and 8



Ignition Controls - Sensors and Active Fuel Management



Inspection / Maintenance (I / M) Complete System Set Procedure

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Description

The purpose of the Inspection/Maintenance (I/M) Complete System Set Procedure is to satisfy the enable criteria necessary to execute all of the I/M readiness diagnostics and complete the drive cycles for those particular diagnostics. When all I/M monitored diagnostic tests are completed, the I/M System Status indicators are set to YES. Perform the I/M Complete System Set Procedure if any I/M System Status indicators are set to NO.

I / M Data List

To determine if the I/M readiness diagnostic tests can be run this ignition cycle, use a scan tool to observe the I/M monitor enabled parameters in the I/M Data List.

Conditions for Meeting a Cold Start

- The ignition voltage between 11-18 volts.
- The barometric pressure (BARO) is more than 75 kPa.
- The start-up engine coolant temperature (ECT) is between 4-30°C (39-86°F).
- The start-up intake air temperature (IAT) is between 4-30°C (39-86°F).
- The difference between the IAT and the ECT is less than or equal to 6°C (10.8°F).
- The ambient air temperature is between 4-30°C (39-86°F).
- The fuel level is between 15-85 percent.

Circuit / System Verification

Review the I/M Status indicators with a scan tool. All I/M System Status indicators should report YES.

Inspection / Maintenance (I / M) System Set Procedure

> **Important:** Whenever the ignition is turned ON, ignition positive voltage is supplied to the heated oxygen sensor (HO2S) heaters. After verifying the enable criteria, turn OFF the ignition for approximately 5 minutes to allow the sensors to cool before continuing with the test. Once the engine is started, do NOT turn the engine OFF for the remaining portion of the set procedure.

1. Ensure that the vehicle meets the conditions for a cold start listed above.
2. The evaporative emission (EVAP) I/M System Status indicator should display YES.

   If the EVAP I/M System Status indicator displays NO, perform the EVAP Service Bay Test, if applicable. If the EVAP Service Bay Test is NOT available, it may take up to 6 drive cycles, with up to 17 hours between drive cycles, for the EVAP I/M System Status indicator to transition to YES.
3. The O2S Heater I/M System Status indicator should display YES.

   If the O2S Heater I/M System Status indicator displays NO, ensure that the ignition has been turned OFF for at least 10 hours.
4. Turn OFF all accessories; HVAC system, other electrical loads, including aftermarket/add-on equipment, etc.
5. Set the vehicle parking brake and ensure the vehicle is in Park for automatic transmission or Neutral for manual transmission.
6. Turn OFF all accessories; HVAC system, other electrical loads, including aftermarket/add-on equipment, etc.
7. Start and idle the engine for at least 2 minutes and until 65°C (149°F) is achieved.
8. Run the engine for 6.5 minutes within the following conditions:
   - MAF parameter between 4-30 g/s
   - Engine speed steady between 1,000-3,000 RPM
9. Return the engine to idle for 1 minute.
10. Apply and hold the brake pedal, and shift to Drive for automatic transmission, or apply the clutch pedal for manual transmission and operate the vehicle within the following conditions for 2 minutes:
    - Depress the accelerator pedal until throttle position (TP) sensor angle is more than 2 percent.
    - Mass air flow (MAF) signal between 15-30 g/s
    - RPM steady between 1,200-2,000 RPM

    Important: DO NOT touch the accelerator pedal during the idle period. A change in TP sensor angle or an increase in engine speed may invalidate this portion of the test.
11. Release the accelerator pedal and shift the vehicle to Park for automatic transmission, or Neutral and release the clutch pedal for manual transmission, and allow the engine to idle for 2 minutes.
12. Quickly depress the accelerator pedal until TP sensor angle is more than 8 percent and return to idle, repeat 3 times.
13. Allow engine to idle for at least 2 minutes.

    Caution: Refer to Road Test Warning in the Preface section.
14. Release the parking brake and drive vehicle at 24 km/h (15 mph) or slower for 2 minutes.
15. Continue to drive the vehicle for at least 5.5 miles between 45-112 km/h (28-70 mph) with the vehicle reaching at least 80 km/h (50 mph).
16. Release the accelerator pedal for at least 2 seconds. This will allow the vehicle to enter decel fuel cut-off.
17. Depress the accelerator pedal until the TP sensor angle is increased 3-20 percent and maintain a safe speed for 1 minute.
18. Safely stop the vehicle, with the engine in Drive for automatic transmission or in Neutral with the clutch pedal depressed and parking brake applied for manual transmission, idle for 2 minutes.
19. Shift to Park for automatic and apply the parking brake, or neutral and release clutch pedal for manual.

Important: Do NOT disturb the vehicle or turn ON the ignition until told to do so. Disturbing the vehicle may invalidate this portion of the test.

20. Turn OFF the ignition and exit the vehicle. Do NOT disturb the vehicle for 60 minutes.
21. Observe the Inspection/Maintenance (I/M) System Status with a scan tool. All of the I/M System Status indicators should display YES.

    If the EVAP I/M System Status indicator displays NO, turn OFF the ignition for 17 hours, ensure that the vehicle meets the conditions for a cold start, and repeat steps 12-18 six more times, or until the EVAP I/M System Status indicator transitions to YES. If the indicator continues to display NO, refer to the Inspection/Maintenance (I/M) System DTC Table to identify the DTCs that did not run. Follow the Conditions for Running the DTC in order to set the EVAP I/M System Status indicator

    If any of the I/M System Status indicators display NO, refer to the Inspection/Maintenance (I/M) System DTC Table for the indicator which did not display YES. The I/M System DTC Table identifies the DTCs associated with each I/M System Status Indicator. Follow the Conditions for Running the DTC in order to set the associated status indicator.

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Inspection/Maintenance (I/M) System Check

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Description

Several states require that a vehicle pass on-board diagnostic (OBD) system tests and the inspection/maintenance (I/M) emission inspection in order to renew license plates. This is accomplished by viewing the I/M System Status display on a scan tool. Using a scan tool, the technician can observe the I/M System Status in order to verify that the vehicle meets the criteria that comply with the local area requirements.

Conditions for Updating the I/M System Status

Each system monitor requires at least one, and sometimes several diagnostic tests. The result of each test is reported by a DTC. A system monitor is complete when either all of the DTCs composing the monitor have Run and Passed, or when any one of the DTCs comprising the monitor has illuminated the malfunction indicator lamp (MIL). Once the system monitor is complete, the I/M System Status display will indicate YES in the Completed column.

For example, when the HO2S Heater Status indicates YES, either all of the oxygen sensor heater tests have passed or one of the tests has illuminated the MIL. If the vehicle has 4 heated oxygen sensors, either all 4 heater circuit tests have passed or one of the heater circuit tests has illuminated the MIL. The I/M System Status will indicate NO under the Completed column when any of the required tests for that system have not run. The following is a list of conditions that would set the I/M System Status indicator to NO:

- The vehicle is new from the factory and has not yet been driven through the necessary drive conditions to complete the tests.
- The battery has been disconnected or discharged below operating voltage.
- The control module power or ground has been interrupted.
- The control module has been reprogrammed.
- The control module DTCs have been cleared.

Monitored Emission Control Systems

The OBD II System monitors all emission control systems that are on-board. The OBD II regulations require monitoring of the following:

- The air conditioning system
- The catalytic converter efficiency

- Comprehensive component monitoring--Emission related inputs and outputs
- The evaporative emission (EVAP) system
- The fuel delivery system
- Heated catalyst monitoring
- Misfire monitoring
- The oxygen sensor system (O2S or HO2S)
- The oxygen sensor heater system (HO2S heater)

For the specific DTCs required for each system, refer to Inspection/Maintenance (I/M) System DTC Table. Systems such as fuel delivery, misfire, and comprehensive components may not be listed in a system status list. These tests run continuously and do not require an I/M System Status indicator.

Circuit/System Verification

Review the I/M System Status indicators. All I/M System Status indicators should report YES.

Circuit/System Testing

> **Important:** Many DTC related repairs will instruct the technician to clear the DTC information. Clearing the DTC will reset the I/M System Status indicators to NO. Performing the I/M Complete System Set Procedure will set each of the I/M System Status indicators to YES.

1. Observe the Engine DTC information with a scan tool.

   If a DTC is set that would prevent the I/M System Status tests from completing, diagnose that DTC before continuing. Refer to Inspection/Maintenance (I/M) System DTC Table.
2. Review applicable service bulletins for software updates that would prevent the I/M System Status tests from completing.

   If a control module re-program or other repair is required, perform the Inspection/Maintenance (I/M) Complete System Set Procedure.
3. Observe the I/M System Status indicators.

   If any I/M System Status indicators report NO, perform the Inspection/Maintenance (I/M) Complete System Set Procedure.

Inspection/Maintenance (I/M) System DTC Table

System	DTCs Required to Set System Status to YES
If an I/M System Status indicator did NOT update to YES during the Inspection/Maintenance (I/M) Complete System Set Procedure , review each indicator and reference this table to determine each DTC associated with the I/M System Status Indicator. Each DTC listed below has specific conditions that must be met for the diagnostic to run. Included within the conditions are additional DTCs which, if set, may inhibit the DTCs listed below from running. Reviewing and operating the vehicle within the Conditions for Running for each DTC listed below will allow the I/M System Status Indicators to transition to YES.	
Catalyst	DTC P0420 or P0430
Oxygen Sensor	• DTC P0131, P0132, P0137, or P0138 • DTC P0133, P0134, P0140, P1133, P2270, or P2271 • DTC P0151, P0152, P0157, or P0158 • DTC P0153, P0154, P0160, P1153, P2272, or P2273
Oxygen Sensor Heater	• DTC P0030, P0036, P0053, P0054, P0135, or P0141 • DTC P0050, P0056, P0059, P0060, P0155, or P0161

Malfunction Indicator Lamp (MIL) Diagnosis

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit / System Description

Ignition voltage is supplied to the malfunction indicator lamp (MIL). The engine control module (ECM) turns the MIL ON by grounding the MIL control circuit.

Reference Information

Schematic Reference

- Instrument Cluster Schematics
- Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

Ignition ON, the MIL should turn ON and OFF when commanded with a scan tool.

Circuit / System Testing

1. Ignition OFF, disconnect the harness connector at the instrument panel cluster (IPC).
2. Ignition ON, verify that a test lamp illuminates between the ignition circuit and ground.

   If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, replace the IPC.

3. Connect a test lamp between the control circuit and the ignition circuit.
4. Command the MIL ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the ECM.

   If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.

5. If all circuits test normal, replace the IPC.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Instrument Cluster Replacement
- Control Module References for ECM replacement, setup, and programming

Poor Fuel Fill Quality

Problem	Causes
DEFINITION: Difficulty when refueling the vehicle.	
Difficult to fill	• The check valve is stuck closed. • The fill limiter vent valve is stuck closed. • The evaporative emission (EVAP) canister is restricted. • Restricted EVAP pipes. • High Reid vapor pressure. • High fuel temperature. • The fuel filler hose/pipe is pinched, kinked or blocked. • The fuel feed hose, or crossover hose, is pinched, kinked or blocked. • The ignition switch is ON.
Over fill	• The pressure relief valve in the fill limiter vent valve is stuck open. • The pressure relief valve in the fill limiter vent is valve leaking. • The fill limiter vent valve is stuck open. • The fill limiter vent valve is leaking.
Pre-mature shut-off of the fuel dispensing nozzle	• The check valve is stuck closed. • The fill limiter vent valve is stuck closed. • The EVAP canister is restricted. • Restricted EVAP pipes. • High Reid vapor pressure. • High fuel temperature. • The fuel filler hose/pipe is pinched, kinked or blocked. • The fuel feed hose, or crossover hose, is pinched, kinked or blocked. • The ignition switch is ON.
Fuel spit back	• The check valve is stuck open. • The check valve is stuck closed. • The check valve is leaking. • High Reid vapor pressure. • High fuel temperature.
Liquid fuel in the EVAP canister	

	• The fill limiter vent valve is stuck open. • The fill limiter vent valve is leaking.
Liquid fuel leak	• The pressure relief valve in the fill limiter vent valve is stuck open. • The pressure relief valve in the fill limiter vent valve is leaking. • The fuel filler hose is loose or torn. • The fuel feed hose, or crossover hose, is loose or torn. • The fill limiter vent valve is stuck open.
Fuel odor	• The pressure relief valve in the fill limiter vent valve is stuck open. • The pressure relief valve in the fill limiter vent valve is leaking. • The EVAP canister is saturated.

Powertrain Relay Diagnosis

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Typical Scan Tool Data

EC Ignition Relay

Display Parameters	Normal Range	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Ignition ON, engine OFF, powertrain relay commanded ON.				
EC Ignition Powertrain Relay Circuit Status	OK/Incomplete	Short to GRD/Open	Short to GRD/Open	Short to B+
EC Ignition Powertrain Relay Command	ON	ON	ON	ON
EC Ignition Powertrain Relay Feedback Signal	12-12.9 V	0.0 V	0.0 V	12-12.9 V

Circuit/System Description

The powertrain relay is a normally open relay. The relay armature is held in the open position by spring tension. Battery positive voltage is supplied directly to the relay coil and the armature contact at all times. The engine control module (ECM) supplies the ground path to the relay coil control circuit via an internal integrated circuit called an output driver module (ODM). The ODM output control is configured to operate as a low side driver for the powertrain relay. The ODM for the powertrain relay also incorporates a fault detection circuit, which is continuously monitored by the ECM. When the ECM commands the powertrain relay ON, ignition 1 voltage is supplied to the ECM, and to several additional circuits.

Diagnostic Aids

This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to Battery Inspection/Test.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- J 35616 GM-Approved Terminal Test Kit
- J 43244 Relay Puller Pliers

Circuit/System Verification

1. Engine running, command the powertrain relay ON and OFF, with a scan tool, while observing the following powertrain relay coil control circuit status parameters.
   - Powertrain relay coil control Ckt. Short Gnd Test Status
   - Powertrain relay coil control Ckt. Open Test Status
   - Powertrain relay coil control Ckt. Short Volts Test Status
   - Each parameter should toggle between OK and Not Run or Not Run and OK
2. Ignition ON, engine OFF, with a test lamp, probe both test points of all the fuses that are powered by the powertrain relay. The test lamp should illuminate ON for at least one test point of each fuse.
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Important: You must perform the Circuit/System Verification first.

1. Ignition OFF, disconnect the powertrain relay.
2. Ignition ON, verify that a test lamp illuminates between the powertrain relay coil B+, and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the battery positive cable to the underhood fuse block.
3. Ignition OFF, verify that a test lamp does not illuminate between the powertrain relay coil B+ circuit and the control circuit.

   If the test lamp illuminates, test the control circuit for a short to ground. If the circuit tests normal, replace the ECM.
4. Remove the test lamp.
5. Command the powertrain relay ON, with a scan tool. Verify with a scan tool that the

powertrain relay Ckt. Short Volts Test Status parameter is OK.

If not the specified value, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.

6. Test the coil side of the powertrain relay for 65-110 ohms.

   If not within the specified value, replace the relay.

7. Ignition OFF, disconnect the ECM C1 connector.
8. Test the powertrain relay control circuit for an open/high resistance.

   If the circuit tests normal, replace the ECM.

9. Verify that a test lamp does not illuminate between the relay ignition 1 voltage circuit and ground.

   If the test lamp illuminates, test the relay ignition 1 voltage circuit for a short to voltage. If the circuit tests normal, replace the ECM.

10. Verify that a test lamp illuminates between the relay switch B+ and ground.

    If the test lamp does not illuminate, test the relay switch B+ circuit for a short to ground, or an open/high resistance. If the circuits test normal, and the fuse for the ignition 1 voltage circuit is open, test the ignition 1 voltage circuit to the ECM for a short to ground. If the circuit tests normal, replace the ECM.

11. Connect a 20 A fused jumper wire between the relay switch B+ and the relay ignition 1 voltage circuit.
12. Ignition ON, engine OFF, monitor the EC Ignition Relay Feedback parameter with a scan tool. The parameter should display B+.

    If the parameter does not display B+, test the ignition 1 voltage circuit for an open/high resistance. If the circuit tests normal, replace the ECM.

13. If all circuits test normal, replace the relay.

Repair Instructions

- Engine Control Module Programming and Setup
- Engine Control Module Replacement
- Relay Replacement

Repair Verification

1. Install any components that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming, or setup procedures that are required when a component or module is removed or replaced.
3. Clear the DTCs.
4. Turn OFF the ignition for 60 seconds.
5. Ignition ON, command the powertrain relay ON and OFF with a scan tool, while observing the powertrain relay circuit status parameters, The circuit status parameters should change from OK to Not Run or Not Run to OK.

   If another DTC is present, refer to Diagnostic Trouble Code (DTC) List - Vehicle and perform the appropriate diagnostic procedure.

Service Bay Test

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Description

The purpose of the evaporative emission (EVAP) Service Bay Test is to aid in resetting the EVAP inspection/maintenance (I/M) system status. For this vehicle that is equipped with the engine off natural vacuum (EONV) diagnostic, the Service Bay Test uses the scan tool to initiate the engine control module (ECM) regular sequence of EVAP system DTC tests, but with different enable criteria. By using the Service Bay Test the I/M indicator can be set without the need for multiple cold soaks.

The scan tool displays for the Service Bay Test are based on the events that occur within the following three categories:

- The engine running portion of the tests--The vehicle must remain at rest, in Park, or in Neutral, during this portion of the test. This test inspects for large leaks, a leaking purge valve and/or vent system restrictions. The scan tool will display test progress or the reason for an abort or failure.
- Drive cycle--The scan tool will display time and distance needed to warm the fuel.
- Ignition OFF--During this portion of the test, the engine controller will remain active for up to 45 minutes when the ignition is turned OFF to allow control of the EVAP vent valve and run the EONV test. The engine controller inspects for small leaks during this period by monitoring fuel tank pressure or vacuum. If the system is sealed, there will be a pressure or vacuum change. Pressure or vacuum changes that are less than the calibrated values indicate a leak.

When the EVAP diagnostics are initiated by the Service Bay Test, the scan tool will indicate if the enable conditions listed below are not met, or will display a specific reason if the test aborts. When complete, the display will indicate that the tests passed or failed.

Conditions for Running the Test

The following conditions must be met in order to enable the Service Bay Test:

- The battery voltage is between 11-18 volts.
- The engine coolant temperature (ECT) is less than 70°C (158°F) at start-up.
- The EVAP I/M system status indicator is set to NO.
- The fuel level is 15-85 percent capacity and cannot be refueled during the tests.
- There are no DTCs displayed.
- The vehicle must be driven for the time and distance specified on the scan tool.

- The ambient air temperature is between 0-40°C (32-104°F).
- The ignition must remain OFF during the engine OFF portion of the test, and the vehicle must remain at rest.

Test Procedure

Note: If the Service Bay Test aborts or fails, a DTC will NOT be set.

1. Install a scan tool.
2. Select the Service Bay Test with the scan tool.

   Warning: Refer to Road Test Warning in the Preface section.

3. Follow the instructions on the scan tool.

   If the test aborts, correct the condition for running the test, then retest.

   If the test fails, repair the vehicle for the condition indicated by the failure message on the scan tool.
4. Verify that the EVAP I/M system status is set to YES.

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Symptoms - Engine Controls

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provide an overview of each diagnostic category.

Symptoms Description

Symptoms cover conditions that are not covered DTCs. Certain conditions can cause multiple symptoms. These conditions are listed together under Symptoms Testing. Conditions that may only cause certain symptoms are listed separately under Additional Symptoms Test. Perform the Symptoms Testing before using the Additional Symptoms Tests. Poor Fuel Fill Quality test may be performed separately from the Symptoms Testing and Additional Symptoms Tests procedures.

Symptoms Definition

Backfire: Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

Cuts Out, Misses: A steady pulsation or jerking that follows engine speed, which is usually more pronounced as the engine load increases. This condition is not normally felt above 1500 RPM or 48 km/h (30 mph). The exhaust has a steady spitting sound at idle or at low speed.

Detonation/Spark Knock: A mild to severe ping which usually occurs worse while under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

Dieseling, Run-On: The engine continues to run after the key is turned OFF, but runs very rough.

Hard Start: Engine cranks OK, but does not start for a long time. The vehicle does eventually run, or may start but immediately stalls.

Hesitation, Sag, Stumble: Momentary lack of response as the accelerator is pushed down. This condition can occur at any vehicle speed. This condition is usually more pronounced when first trying to make the vehicle move, as from a stop. This condition may cause the engine to stall in severe conditions.

Lack of Power, Sluggishness, or Sponginess: The engine delivers less than expected power. Little or no increase in speed when the accelerator pedal is pushed down part way.

Poor Fuel Economy: Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, the fuel economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.

Poor Fuel Fill Quality: Difficulty when refueling the vehicle.

Rough, Unstable, or Incorrect Idle and Stalling: The engine runs unevenly at idle. If severe, the engine or the vehicle may shake. Engine idle may vary in speed. Either condition may be severe enough to stall the engine.

Surges/Chuggles: Engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the accelerator pedal position.

Symptoms Verification

Before using the Symptom tables, perform the following inspections:

- Ensure that the engine control module (ECM) and malfunction indicator lamp (MIL) are operating correctly.
- Ensure that there are no DTCs that are stored.
- Ensure that the scan tool data is within a normal operating range.
- Verify the customer concern.
- Perform the Visual/Physical Inspection in this section. The visual/physical inspection is extremely important, and can lead to correcting a condition without additional testing. It may also help reveal the cause of an intermittent condition.

Identifying Intermittent Conditions

Many intermittent conditions occur with harness or connector movement due to engine torque, rough pavement, vibration or physical movements of a component. Refer to the following for a list of issues that may cause an intermittent condition:

- Moisture and water intrusion in connectors, terminals, and components
- Incomplete connector mating
- Poor terminal contact
- High circuit or component resistance--High resistance can include any resistance, regardless of the amount, which can interrupt the operation of the component.
- Harness that is too short or tight.
- Wire insulation that is chaffed or cut.
- High or low ambient temperature
- High or low engine coolant temperatures
- High underhood temperatures
- Heat build up in component or circuit due to circuit resistance, poor terminal contact, or high electrical load
- High or low system voltage
- High vehicle load conditions
- Rough road surfaces
- Electro-magnetic interference (EMI)/circuit interference from relays, solenoids or other electrical surge
- Incorrect installation of aftermarket, add on accessories

Visual/Physical Check

- Ensure that the control module grounds are clean, tight, and correctly located. Refer to

Wiring Repairs.

- Ensure that the vacuum hoses are not split, kinked, and properly connected, as shown on the Vehicle Emission Control Information label.
- Ensure that the air filter is clean and free from restrictions.
- Ensure that there is no water intrusion in connectors terminals and components.
- Inspect the air intake ducts for the following conditions:
  - Collapsed
  - Damaged areas
  - Looseness
  - Incorrect installation
  - Leaking
- Inspect for air leaks at the throttle body mounting area, the mass air flow (MAF) sensor and intake manifold sealing surfaces.
- Inspect the wiring harness for the following conditions:
  - Poor connections
  - Pinches
  - Cuts
- Inspect for loose, damaged, unseated, or missing sensors/components.
- Inspect the terminals for corrosion and correct contact.

Symptoms Testing

Backfire, Cuts Out / Misses, Detonation / Spark Knock, Dieseling / Run-On, Hard Start, Hesitation / Sag / Stumble, Lack of Power / Sluggishness / Sponginess, Poor Fuel Economy, Rough, Unstable, or Incorrect Idle and Stalling, or Surges / Chuggles

1. Test for the following conditions:
   - The fuel system for the following:
     - Each fuel injector is connected to the proper fuel injector harness connector.
     - Correct fuel pressure--Refer to Fuel System Diagnosis
     - Fuel injectors that are leaking or improper operation--Refer to Fuel Injector Diagnosis.
     - Contaminated or a poor fuel quality condition--Refer to Alcohol/Contaminants-in-Fuel Diagnosis.
   - The ignition system for the following:
     - Spark plugs for incorrect heat range or an abnormal condition--Refer to Spark Plug Inspection.
     - For diagnosis of coolant or oil fouled spark plugs, refer to Loss of Coolant or Symptoms - Engine Mechanical.
     - Wet down the secondary ignition system with water from a spray bottle. Wetting down the secondary ignition system may help locate damaged or deteriorated components. Look/listen for arcing or misfiring as the water is applied.
     - Weak spark using the J 26792 Spark Tester--Refer to Electronic Ignition (EI) System Diagnosis.

- The operation of the transmission torque converter clutch (TCC)--The scan tool should indicate an engine speed drop when the TCC is commanded ON.
- The operation of the A/C compressor
- Items that can cause an engine to run rich or lean.
- Inspect the heated oxygen sensors (HO2S). The HO2S should respond quickly to different throttle positions.

Notice: Refer to Heated Oxygen and Oxygen Sensor Caution in the Preface section.

- Water intrusion in the HO2S connector
- The cylinder deactivation system. Refer to Cylinder Deactivation (Active Fuel Management) System Diagnosis.

Important: The embossed arrows on the MAF sensor indicate the direction of the intake air flow. The arrows must point toward the engine.

- Inspect the MAF sensor installation. A MAF sensor that is incorrectly installed may cause a hard start. Install the MAF in the proper direction. Refer to Mass Airflow Sensor/Intake Air Temperature Sensor Replacement.
- Inspect the MAF sensor connections.
- Engine oil contaminated by fuel
- The engine for the following mechanical failures--Refer to Symptoms - Engine Mechanical :
  - Excessive oil in the combustion chamber or leaking valve seals
  - Incorrect cylinder compression
  - Sticking or leaking valves
  - Worn camshaft lobes
  - Incorrect valve timing
  - Worn rocker arms
  - Broken valve springs
  - Excessive carbon buildup in the combustion chambers--Clean the chambers with top engine cleaner. Follow the instructions on the can.
  - Incorrect engine parts
- Vacuum hoses for splits or kinks--Verify that the routing and connections are as shown on the Vehicle Emission Control Information label.
- Knock sensor (KS) system for excessive spark retard activity--Refer to DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333.
- The exhaust system components for the following:
  - Physical damage or possible internal failure
  - The three-way catalytic converters for a restriction
  - For more information, refer to Symptoms - Engine Exhaust.
- Electromagnetic interference (EMI) on the reference circuit can cause a misfire condition. You can usually detect EMI with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter with little change in actual engine speed indicates that EMI is present. Inspect the high voltage components near the ignition

control circuit if a condition exists.

- The crankcase ventilation valve for proper operation--Refer to Crankcase Ventilation System Inspection/Diagnosis.
- Evaporative emission (EVAP) canister purge solenoid that is stuck open
- The engine cooling system for the following conditions:
  - The thermostat is the correct heat range. Refer to Thermostat Diagnosis.
  - Proper engine coolant level--Refer to Cooling System Draining and Filling.

2. If the above conditions do not address the symptom, refer to the additional symptoms tests.

Additional Symptoms Tests

Detonation/Spark Knock: Test the engine for an overheating condition. Refer to Symptoms - Engine Cooling.

Poor Fuel Economy: Inspect for foreign material accumulation in the throttle bore, and for carbon deposits on the throttle plate and shaft. Also inspect for throttle body tampering.

Rough, Unstable, or Incorrect Idle and Stalling: Inspect the engine mounts.

Surges/Chuggles: Test the heated oxygen sensors (HO2S). The HO2S should respond quickly to a change in throttle position. If the HO2S do not respond to different throttle positions, inspect for contamination from fuel, silicon, or the incorrect use of RTV sealant. The sensors may have a white powdery coating and result in a high, but false, signal voltage, which gives a rich exhaust indication. The ECM reduces the amount of fuel delivered to the engine, causing a driveability condition.

Hard Start

- Test the engine coolant temperature (ECT) sensor. Compare the ECT sensor value to the intake air temperature (IAT) sensor value on a cold engine. The ECT and IAT sensor values should be within ± 3°C (5°F). If the ECT sensor is out of range with the IAT sensor, test the resistance of the ECT sensor. Refer to Temperature Versus Resistance for resistance specifications. Replace the ECT sensor if the resistance is not within specification. Refer to Engine Coolant Temperature Sensor Replacement. If the sensor is within the specification, test the ECT circuits for a high resistance.
- Test the idle air control (IAC) system.
- Test the fuel pump relay operation. The fuel pump should turn ON for 2 seconds when the ignition is turned ON. Refer to Fuel System Diagnosis.

Hesitation, Sag, Stumble

- Test the manifold absolute pressure (MAP) sensor. Refer to DTC P0106.
- Test the generator. Refer to Symptoms - Engine Electrical. Repair the charging system if the generator output voltage is less than 9 volts or more than 16 volts.

Poor Fuel Economy

- Heavy loads being carried or towed.
- Acceleration rate too much or too often.

- Inspect for foreign material accumulation in the throttle bore, and for carbon deposits on the throttle plate and shaft. Also inspect for throttle body tampering.

Poor Fuel Fill Quality

Test for the following conditions that is applicable to the current symptom.

Difficult to Fill

- Restricted vent lines
- The evaporative emission (EVAP) vent valve is stuck closed
- High fuel temperature
- A condition with the internal components of the fuel tank assembly.

  For more information, refer to:
- Evaporative Emissions Hose Routing Diagram
- Fuel System Description
- Evaporative Emission Control System Description

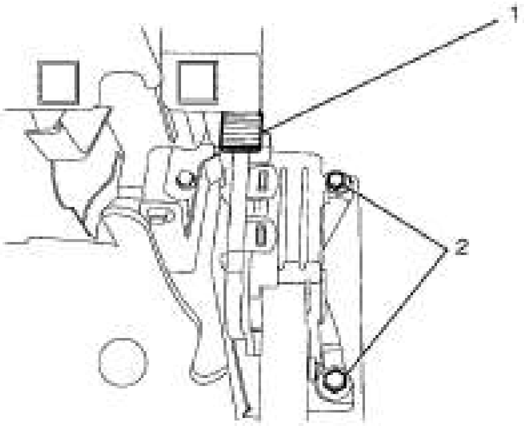
Fuel Odor

- Saturated EVAP canister--Refer to Evaporative Emission Control System Description.
- A condition with the internal components of the fuel tank assembly--Refer to Fuel System Description.

Accelerator Pedal Position Sensor Replacement

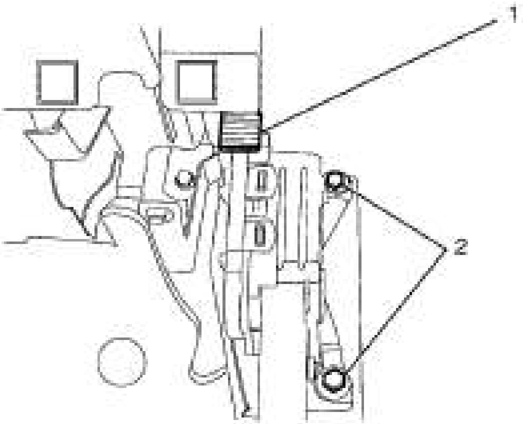
Removal Procedure

Notice: Handle the electronic throttle control components carefully. Use cleanliness in order to prevent damage. Do not drop the electronic throttle control components. Do not roughly handle the electronic throttle control components. Do not immerse the electronic throttle control components in cleaning solvents of any type.



1. Remove the left instrument panel (I/P) on the lower closeout insulator panel. Refer to Knee Bolster Replacement.
2. Disconnect the electrical connector (1) to the accelerator pedal sensor module.
3. Remove the accelerator pedal to steering column support bracket retaining bolts (2).
4. Remove the accelerator pedal.

Installation Procedure



1. Install the accelerator pedal to the steering column support bracket.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the accelerator pedal to steering column support bracket retaining bolts (2).

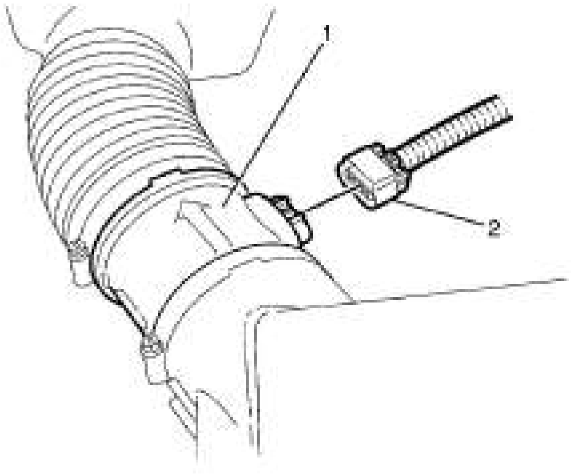
   Tighten
   Tighten the accelerator pedal mounting bolts to 20 N·m (15 lb ft).

3. Connect the accelerator pedal sensor module electrical connector (1).
4. Inspect for correct carpet fit under the accelerator pedal.
5. If re-programming is required. Refer to Control Module References.
6. Install the left I/P on the lower closeout insulator panel. Refer to Knee Bolster Replacement.

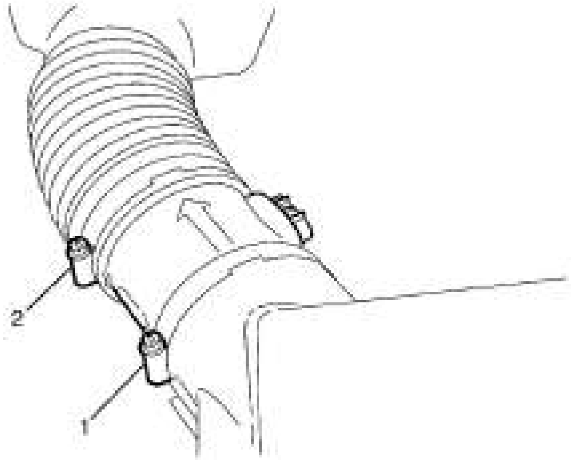
Air Cleaner Assembly Replacement

Removal Procedure

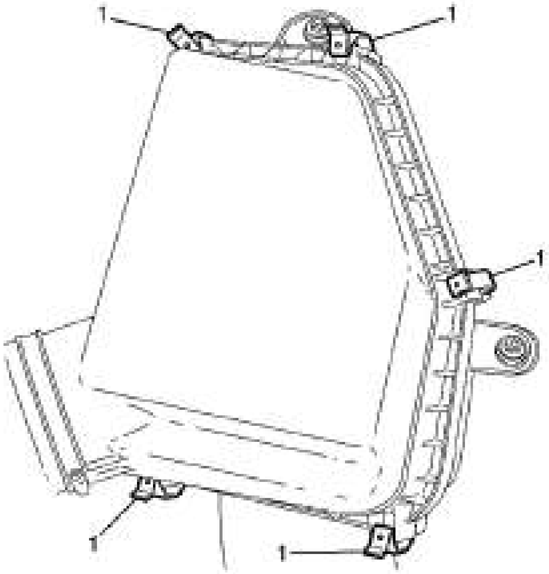
1. Remove the engine cover. Refer to Engine Cover Replacement .



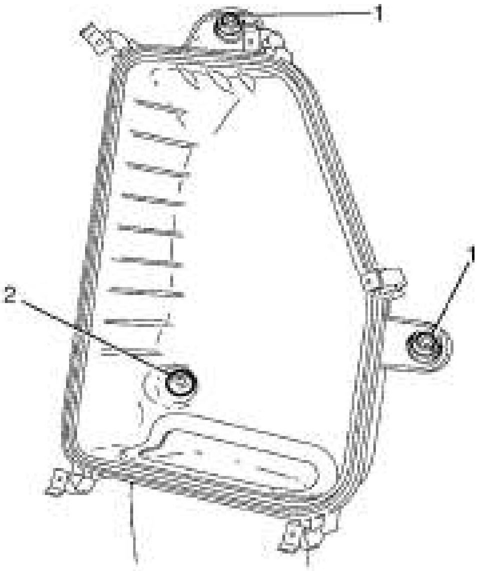
2. Disconnect the wiring harness connector (2) to the intake air temperature (IAT)/mass air flow (MAF) sensor (1).



3. Loosen the IAT/MAF to upper air cleaner body retaining clamp (1).
4. Loosen the IAT/MAF to air intake duct retaining clamp (2).

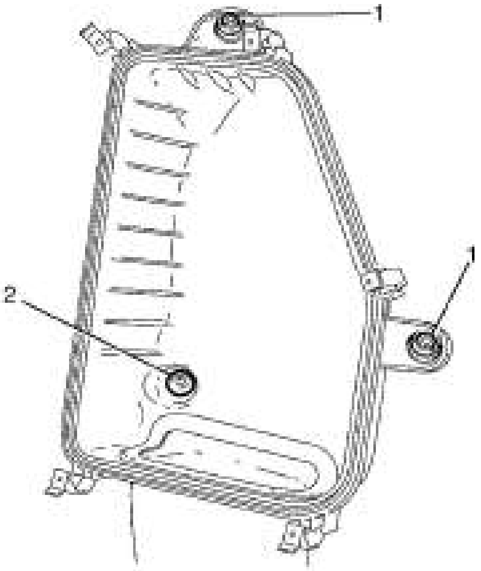


5. Remove five retaining clips (1) securing the upper air cleaner body.
6. Remove upper air cleaner body and air cleaner filter assembly.
7. Remove the air cleaner element. Refer to Air Cleaner Element Replacement .



8. Remove the lower air cleaner body to front inner wheelhouse retaining nuts (1).
9. Disengage the lower air cleaner body to front inner wheelhouse retainer (2).
10. Remove the lower air cleaner body from the vehicle.

Installation Procedure



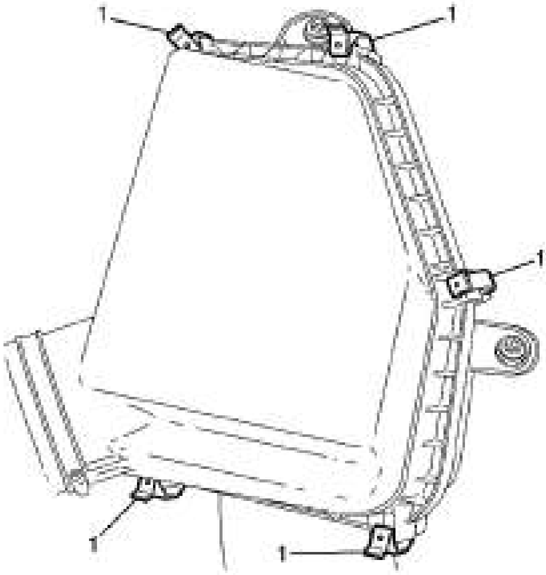
1. Install the lower air cleaner body to the front inner wheelhouse
2. Engage the lower air cleaner body to the front inner wheelhouse retainer (2).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the lower air cleaner body to front inner wheelhouse retaining nuts (1).

   Tighten
   Tighten the nuts to 10 N·m (89 lb in).

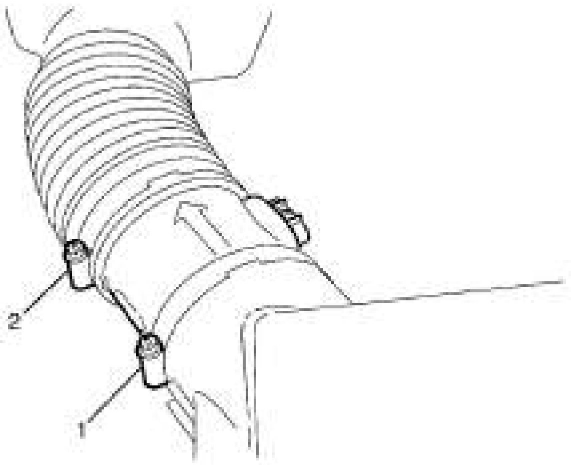
4. Install the air cleaner element to the lower air cleaner body. Refer to Air Cleaner Element Replacement .



5. Assemble the air cleaner element into the upper air cleaner body and place the upper body

onto the lower air cleaner body.

6. Install the five retaining clips (1) securing the upper air cleaner body to the lower air cleaner body.

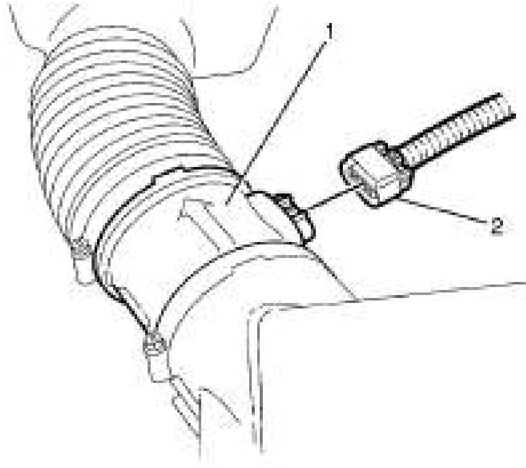


7. Install the IAT/ MAF sensor to the upper air cleaner body.
8. Install the IAT/MAF sensor to the air intake duct.
9. Tighten the IAT/MAF sensor to upper air cleaner body retaining clamp (1).

   Tighten
   Tighten the clamp to 2 N·m (18 lb in).

10. Tighten the IAT/MAF sensor to air intake duct retaining clamp (2).

    Tighten
    Tighten the clamp to 2 N·m (18 lb in).



11. Connect wiring harness connector (2) to the IAT/ MAF sensor (1).
12. Install the engine cover. Refer to Engine Cover Replacement .

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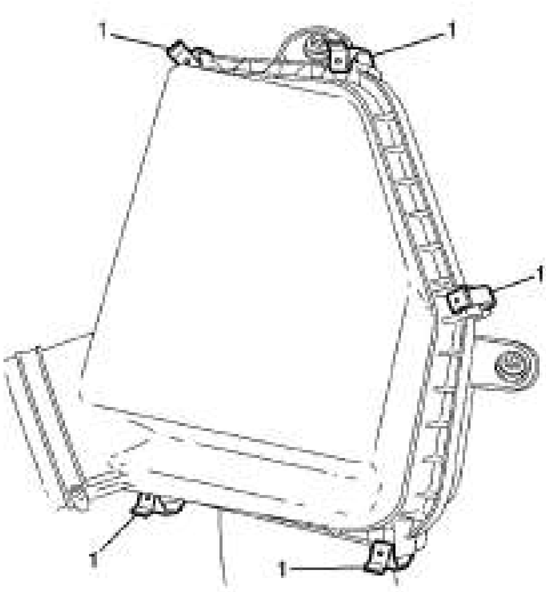
Air Cleaner Element Replacement

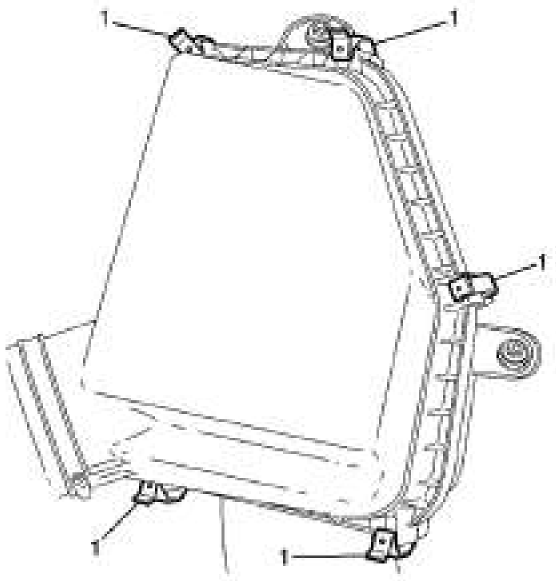
Removal Procedure



1. Remove five retaining clips (1) securing the upper air cleaner body.
2. Remove upper air cleaner body and air cleaner filter assembly.
3. Remove the air cleaner element from the air cleaner assembly.

   Discard the air cleaner element.

Installation Procedure



1. Install a NEW air cleaner element to the lower air cleaner body.
2. Reassemble the air cleaner element into the upper air cleaner body and place the upper air cleaner body onto the lower air cleaner body.
3. Reinstall the five retaining clips (1) securing the upper air cleaner body to the lower air cleaner body.

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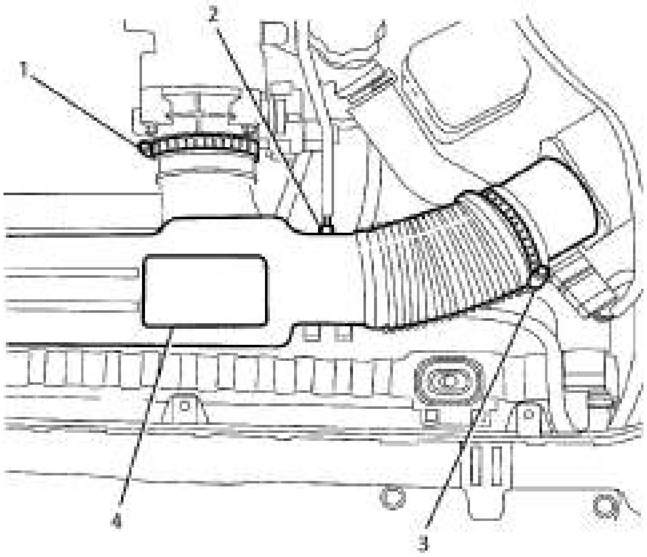
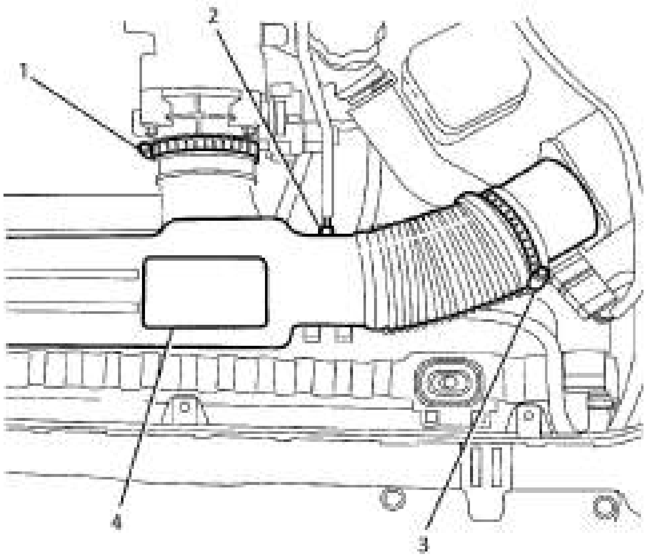
Air Cleaner Inlet Duct Replacement

Removal Procedure



1. Remove the positive crankcase ventilation (PCV) hose (2) from the air cleaner duct resonator (4).
2. Remove the air cleaner duct to throttle body retaining clamp (1).
3. Remove the air cleaner duct to intake air temperature (IAT)/mass air flow (MAF) sensor retaining clamp (3)
4. Remove the air cleaner duct (4).

Installation Procedure



1. Install the air cleaner intake duct (4) to the engine.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the air cleaner duct to throttle body retaining clamp (1).

   Tighten
   Tighten the clamp to 4 N·m (35 lb in).

3. Install the air cleaner duct to IAT/MAF retaining clamp (3)

   Tighten
   Tighten the clamp to 4 N·m (35 lb in).

4. Install the PCV hose (2) to the intake duct resonator.

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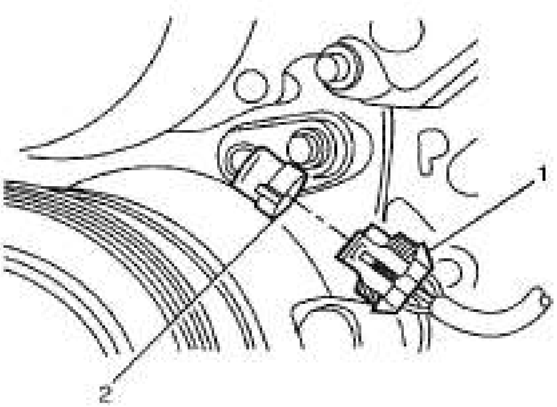
Camshaft Position Sensor Replacement

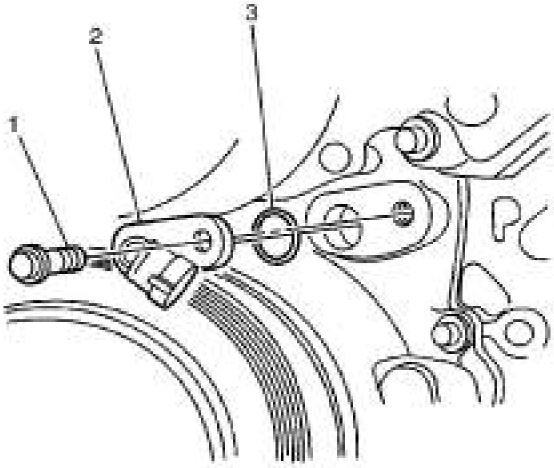
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
2. Remove the engine cover. Refer to Engine Cover Replacement .



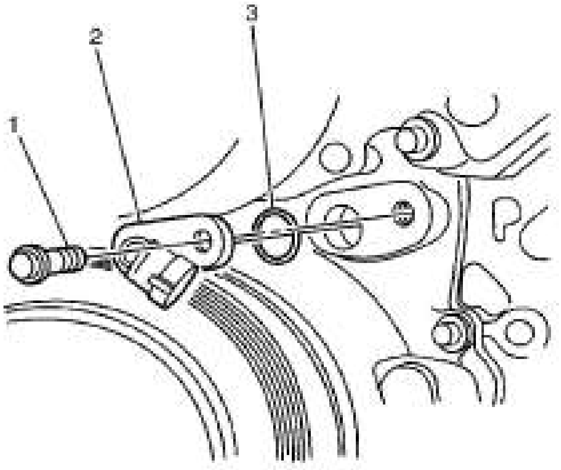
3. Disconnect the camshaft position (CMP) sensor electrical connector (1).



4. Remove the CMP sensor to engine front cover retaining bolt (1).
5. Remove the CMP sensor (2) from the engine front cover.
6. Remove the CMP sensor O-ring (3) from the CMP sensor and discard.

   Discard the O-ring.

Installation Procedure



Important: Install a NEW "O" ring to the camshaft sensor

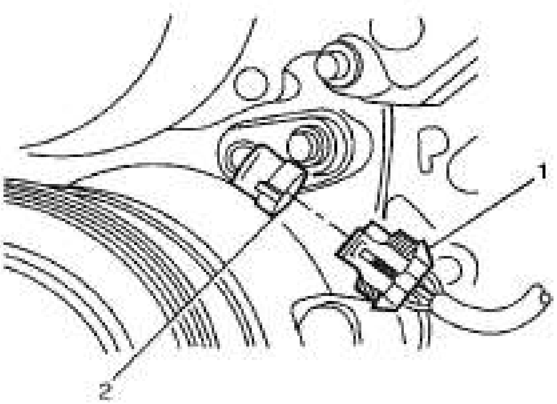
Important: Before installing the camshaft sensor, apply a small amount of clean motor oil to the O-ring (3).

1. Install a NEW O-ring (3) to the CMP sensor.
2. Install the CMP sensor (2) to the engine front cover.

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the CMP sensor to engine front cover retaining bolt (1).

   Tighten
   Tighten the bolt 25 N·m (18 lb ft).



4. Connect the CMP sensor electrical connector (1) to wiring harness.
5. Install the engine cover. Refer to Engine Cover Replacement .
6. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
7. If re-programming is required. Refer to Control Module References .

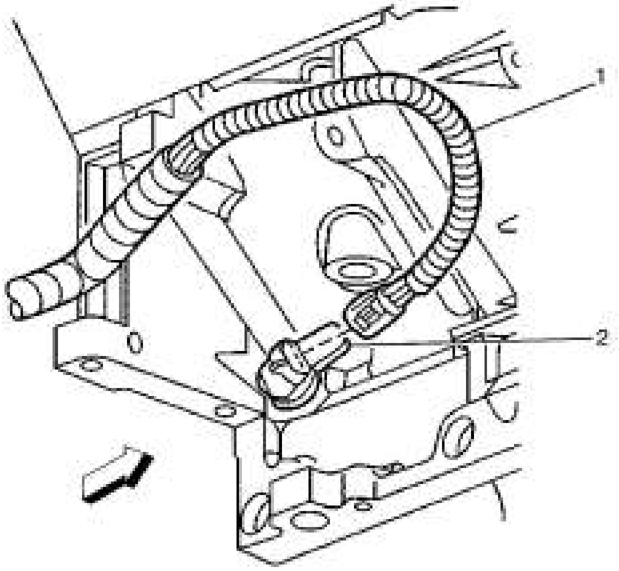
Crankshaft Position Sensor Replacement

Removal Procedure

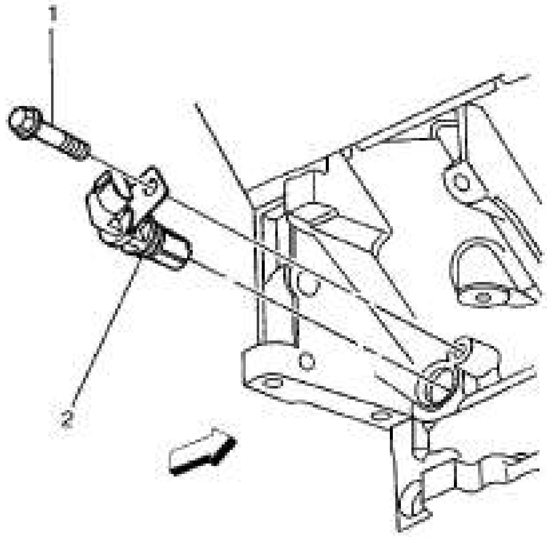
Caution: Refer to Protective Goggles and Glove Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
3. Remove the starter. Refer to Starter Motor Replacement .

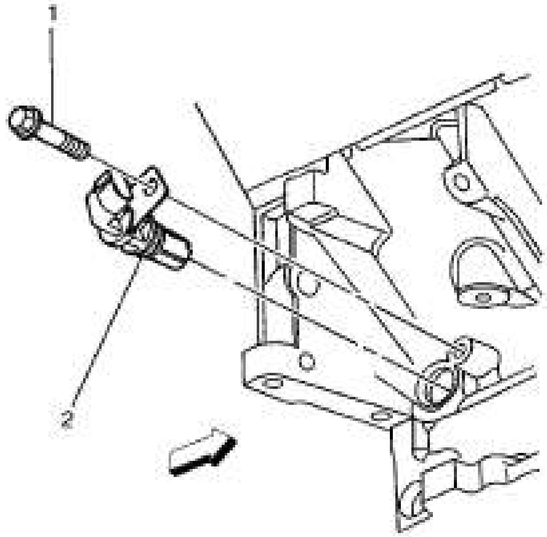


4. Disconnect the crankshaft position (CKP) sensor electrical connector (2) from the wiring harness (1).



5. Remove the CKP sensor to engine block retaining bolt (1).
6. Remove the CKP sensor (2) from the engine block.

Installation Procedure

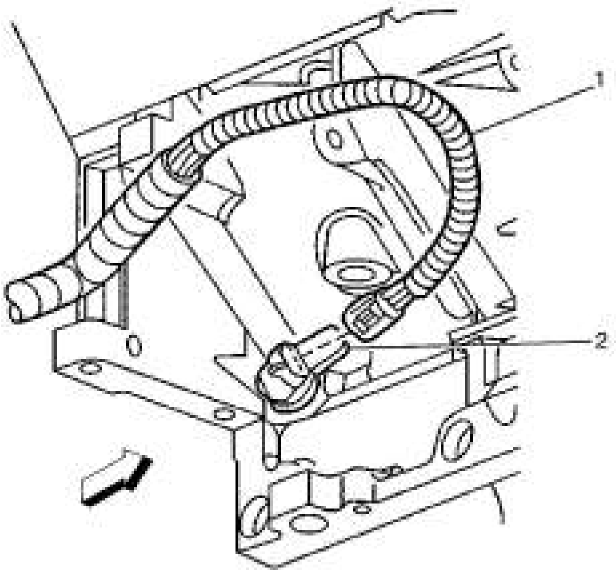


1. Install the CKP sensor (2) to the engine block.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the CKP sensor to engine block retaining bolt (1).

Tighten
Tighten the bolt to 25 N·m (18 lb ft).



3. Connect the CKP sensor electrical connector (2) to the wiring harness (1).
4. Install the starter. Refer to Starter Motor Replacement .
5. Lower the vehicle.
6. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
7. If re-programming is required. Refer to Control Module References .

Crankshaft Position System Variation Learn

1. Install a scan tool.
2. Monitor the engine control module (ECM) for DTCs with a scan tool. If other DTCs are set, except DTC P0315, refer to Diagnostic Trouble Code (DTC) List - Vehicle for the applicable DTC that set.
3. Select the crankshaft position (CKP) variation learn procedure with a scan tool.
4. The scan tool instructs you to perform the following:
   - 4.1. Accelerate to wide open throttle (WOT).
   - 4.2. Release throttle when fuel cut-off occurs.
   - 4.3. Observe fuel cut-off for applicable engine.
   - 4.4. Engine should not accelerate beyond calibrated RPM value.
   - 4.5. Release throttle immediately if value is exceeded.
   - 4.6. Block drive wheels.
   - 4.7. Set parking brake.
   - 4.8. DO NOT apply brake pedal.
   - 4.9. Cycle ignition from OFF to ON.
   - 4.10. Apply and hold brake pedal.
   - 4.11. Start and idle engine.
   - 4.12. Turn A/C OFF.
   - 4.13. Vehicle must remain in Park or Neutral.
   - 4.14. The scan tool monitors certain component signals to determine if all the conditions are met to continue with the procedure. The scan tool only displays the condition that inhibits the procedure. The scan tool monitors the following components:
     - CKP sensors activity--If there is a CKP sensor condition, refer to the applicable DTC that set.
     - Camshaft position (CMP) sensor activity--If there is a CMP sensor condition, refer to the applicable DTC that set.
     - Engine coolant temperature (ECT)--If the ECT is not warm enough, idle the engine until the engine coolant temperature reaches the correct temperature.
5. Enable the CKP System Variation Learn Procedure with a scan tool.

   Important: While the learn procedure is in progress, release the throttle immediately when the engine starts to decelerate. The engine control is returned to the operator and the engine responds to throttle position after the learn procedure is complete.

6. Accelerate to WOT.
7. Release when the fuel cut-off occurs.
8. Test in progress.
9. The scan tool displays Learn Status: Learned this ignition. If the scan tool indicates that DTC P0315 ran and passed, the CKP Variation Learn Procedure is complete. If the scan tool indicates DTC P0315 failed or did not run, refer to DTC P0315. If any other DTCs set, refer to Diagnostic Trouble Code (DTC) List - Vehicle for the applicable DTC that set.
10. Turn OFF the ignition for 30 seconds after the learn procedure is completed successfully.
11. The CKP Variation Learn Procedure is also required when the following service procedures have been performed, regardless of whether DTC P0315 is set:

- A CKP sensor replacement
- An engine replacement
- A ECM replacement
- A harmonic balancer replacement
- A crankshaft replacement
- Any engine repairs which disturb the CKP sensor relationship

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Engine Control Module Replacement

Engine control module (ECM) service should normally consist of either ECM replacement or electrically erasable programmable read only memory (EEPROM) programming. If the diagnostic procedures require ECM replacement, inspect the ECM first to see if the correct part is being used.

Important: In order to prevent internal ECM damage, the ignition must be OFF when you disconnect or reconnect the power to the ECM. For example, disconnect the power when you work with the following components:

- A battery cable
- The ECM pigtail
- The ECM fuse
- Jumper cables

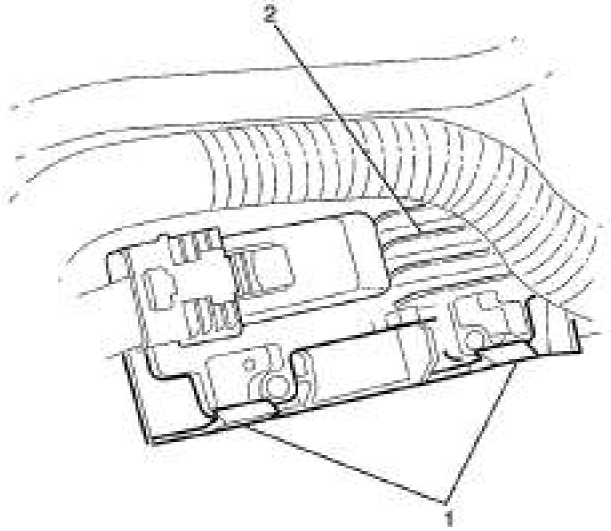
Important: When you diagnose or replace the ECM, remove any debris from the ECM connector surfaces before servicing the ECM module connector gaskets. Make sure that the gaskets are installed correctly. The gaskets prevent contamination intrusion into the ECM.

Important:: The replacement ECM MUST be programmed.

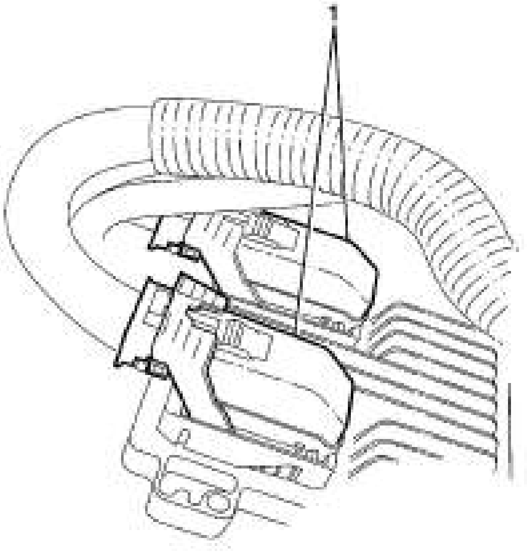
Removal Procedure

Important: It is necessary to record the remaining engine oil life. If the replacement module is not programmed with the remaining engine oil life, the engine oil life will default to 100%. If the replacement module is not programmed with the remaining engine oil life, the engine oil will need to be changed at 5000 km (3,000 mi) from the last engine oil change.

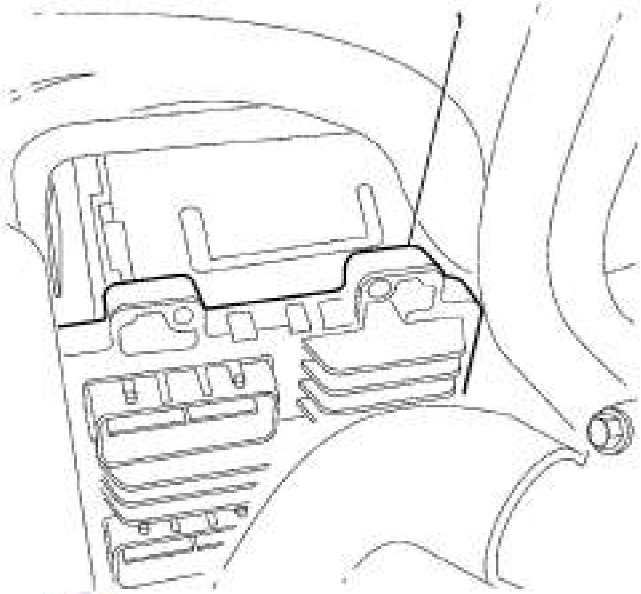
1. Using a scan tool, retrieve the percentage of remaining engine oil. Record the remaining engine oil life.
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .



3. Release the ECM retaining clips (1) and detach the ECM (2).



4. Move the connector lock levers to the unlock position and disconnect the ECM electrical connectors (1).

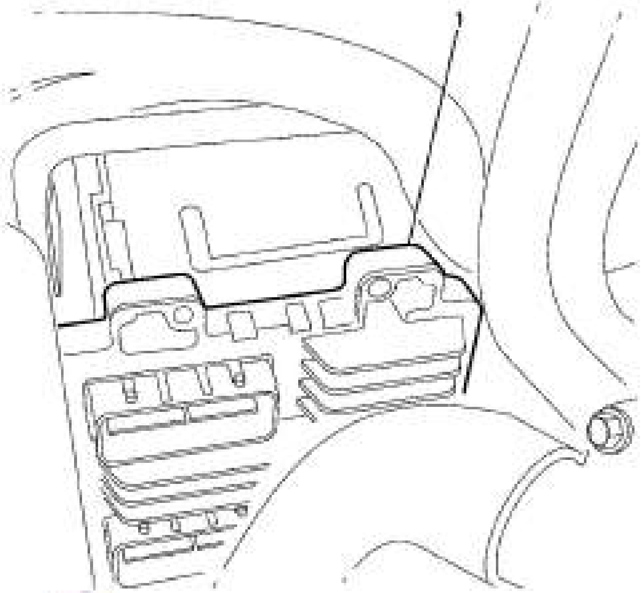


5. Remove the ECM from the vehicle.

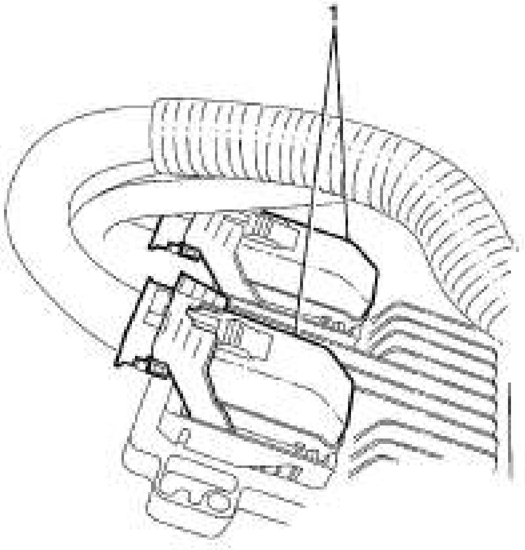
Installation Procedure

Notice: Do not touch the connector pins or soldered components on the circuit board in order to prevent possible electrostatic discharge (ESD) damage to the PCM.

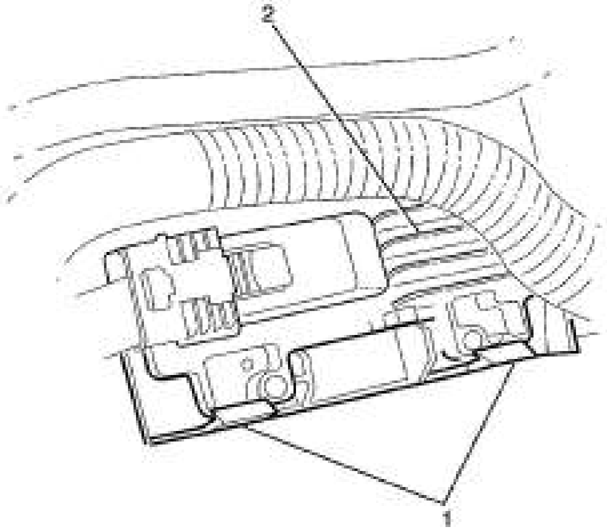
Notice: In order to prevent internal damage to the PCM, the ignition must be OFF when disconnecting or reconnecting the PCM connector.



1. Install the ECM to the vehicle.



2. Connect the ECM electrical connectors (1).



3. Engage the ECM retaining clips (1) to secure the ECM (2).
4. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
5. If a new ECM is being installed, program the ECM. Refer to Service Programming System (SPS) .

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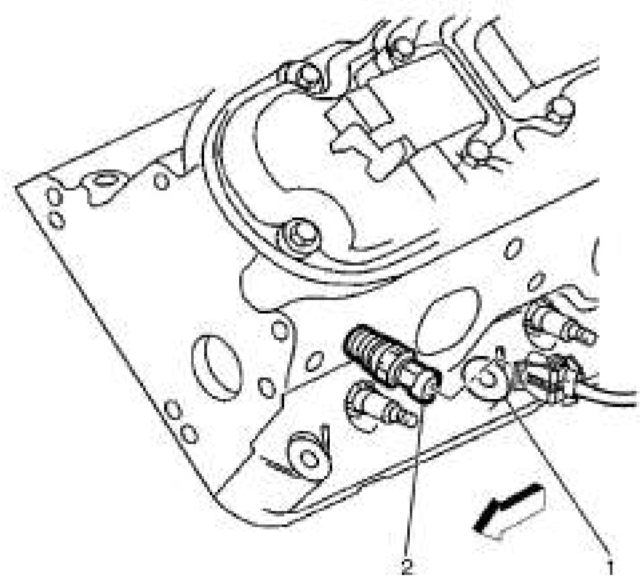
Engine Coolant Temperature Sensor Replacement

Removal Procedure

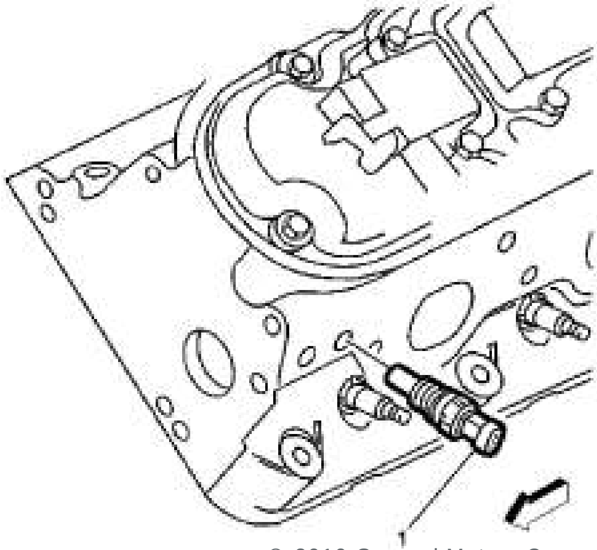
1. Turn OFF the ignition.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

2. Raise the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Drain the engine coolant below the level of the engine coolant temperature (ECT) sensor. Refer to Cooling System Draining and Filling.
4. Lower the vehicle.



5. Disconnect the ETC wiring harness connector (1) from the ECT sensor.



Notice: Use care when handling the coolant sensor. Damage to the coolant sensor will affect the operation of the fuel control system.

6. Remove the ECT sensor (2) from the cylinder head.

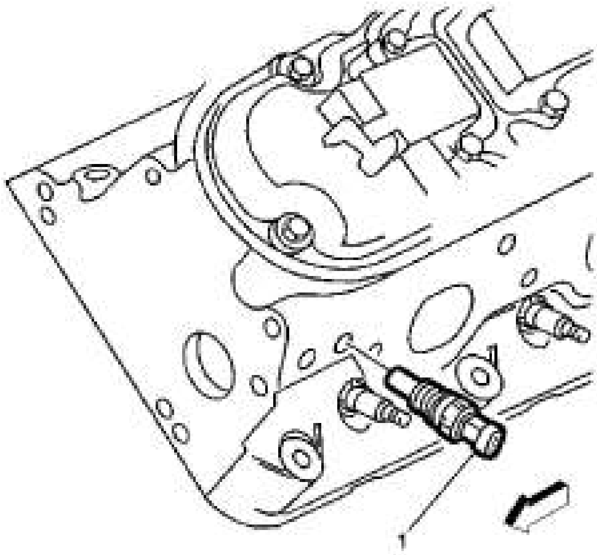
Installation Procedure

Notice: Replacement components must be the correct part number for the application. Components requiring the use of the thread locking compound, lubricants, corrosion inhibitors, or sealants are identified in the service procedure. Some replacement components may come with these coatings already applied. Do not use these coatings on components unless specified. These coatings can affect the final torque, which may affect the operation of the component. Use the correct torque specification when installing components in order to avoid damage.

Notice: Use care when handling the coolant sensor. Damage to the coolant sensor will affect the operation of the fuel control system.

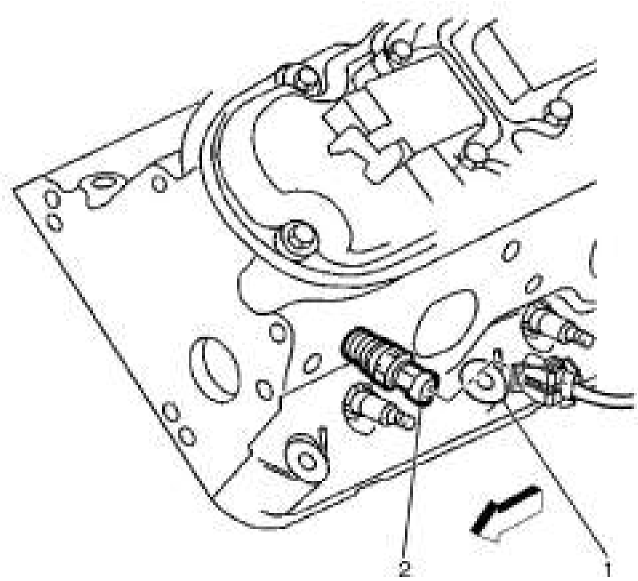
1. Coat the ECT sensor threads with sealer or the equivalent.

Notice: Refer to Fastener Notice in the Preface section.



2. Install the ECT sensor (2) to the cylinder head.

Tighten
Tighten the ECT sensor to 20 N·m (15 lb ft).

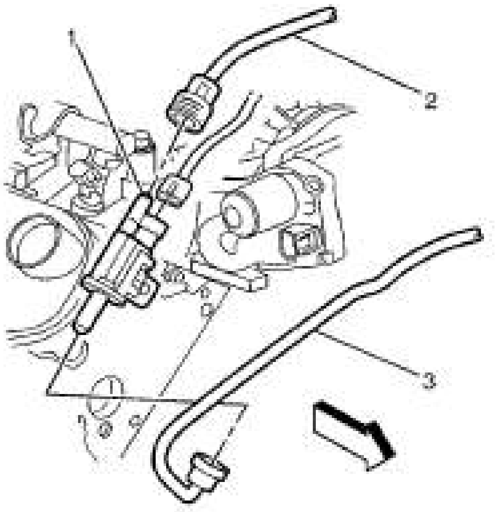


3. Connect the ETC wiring harness connector (1) ECT sensor.
4. Refill the engine coolant. Refer to Cooling System Draining and Filling.

Evaporative Emission Canister Purge Solenoid Valve Replacement

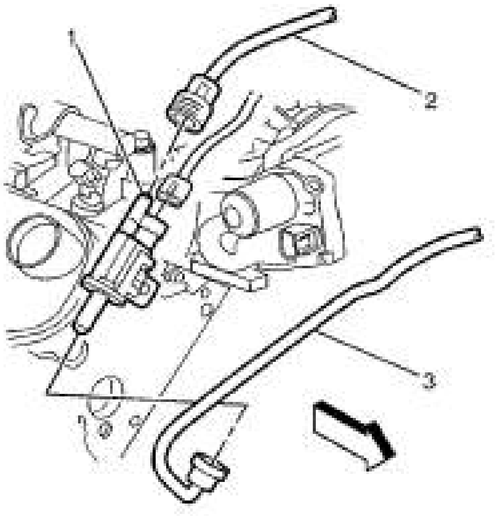
Removal Procedure

1. Relieve the fuel system pressure. Refer to the Fuel Pressure Relief .



2. Disconnect the EVAP engine pipe (2) to EVAP chassis tube. Refer to Plastic Collar Quick Connect Fitting Service .
3. Disconnect the EVAP engine tube (3) to throttle body. Refer to Plastic Collar Quick Connect Fitting Service .
4. Disconnect the wiring connector from the EVAP purge solenoid.
5. Remove the EVAP purge solenoid (1) from the vehicle.

Installation Procedure



1. Install the EVAP purge solenoid (1) to the vehicle.
2. Connect the wiring connector to the EVAP purge solenoid.
3. Connect the EVAP engine tube (3) to throttle body. Refer to Plastic Collar Quick Connect Fitting Service .
4. Connect the EVAP engine pipe (2) to EVAP chassis tube. Refer to Plastic Collar Quick Connect Fitting Service .

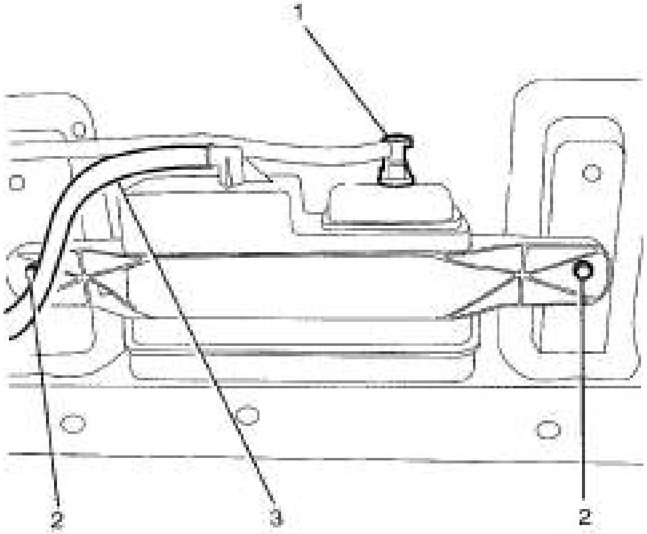
Evaporative Emission Canister Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

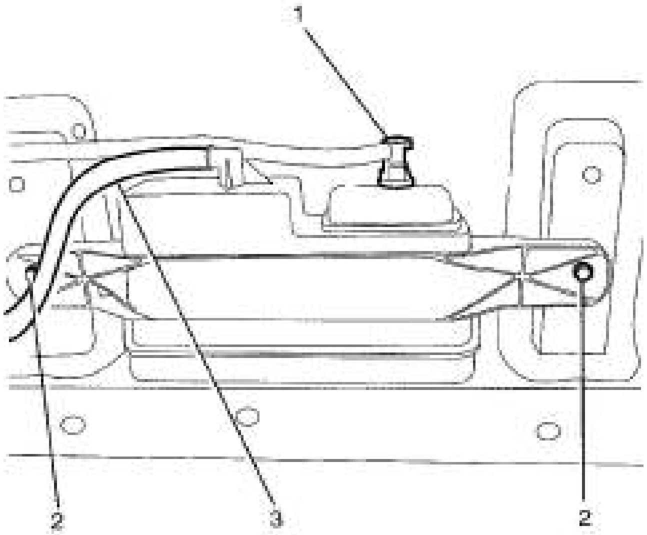
1. Raise the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear frame. Refer to Rear Frame Replacement.



3. Disconnect the canister purge tube (1) from the canister.
4. Remove the canister vent tube (3) from the canister by twisting and pulling it away from the canister.
5. Remove the canister to under body retaining bolts (2).
6. Remove the evaporative emission canister from the vehicle.

Installation Procedure

1. Install the evaporative emission canister to the vehicle.



2. Install the evaporative emission canister retaining bolts (2), hand tighten only.

   Notice: Refer to Fastener Notice in the Preface section.

3. Tighten the evaporative emission canister to vehicle retaining bolts.

   Tighten
   Tighten the bolts to 6 N·m (53 lb in).

4. Install the canister vent pipe (3) to the canister vent port.
5. Align the canister purge pipe quick connector (1) with the canister purge pipe port and push the connector firmly onto the port.
6. Install the rear frame. Refer to Rear Frame Replacement.
7. Lower the vehicle.

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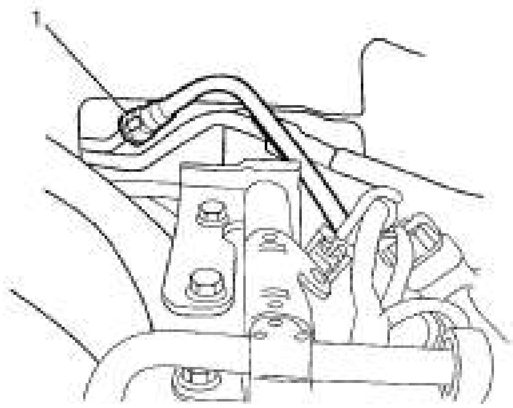
Evaporative Emission Hoses/Pipes Replacement - Engine

Removal Procedure

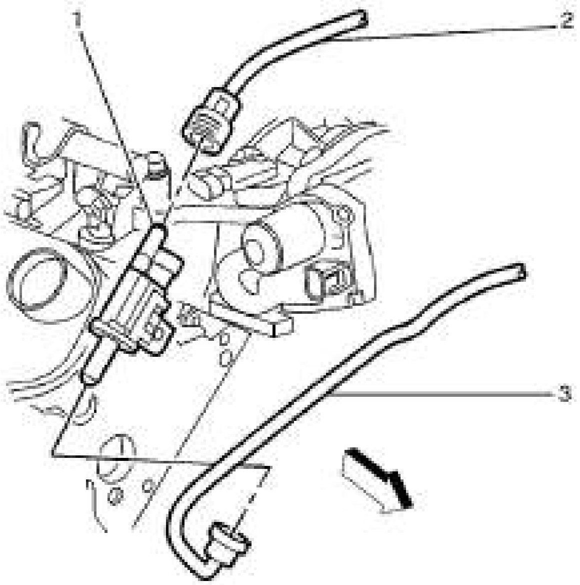
Notice: Clean all of the following areas before performing any disconnections in order to avoid possible contamination in the system:

- The fuel pipe connections
- The hose connections
- The areas surrounding the connections

1. Loosen the fuel filler cap to relieve any vapour pressure.
2. Disconnect the negative battery cable.
3. Remove the engine cover. Refer to Engine Cover Replacement .

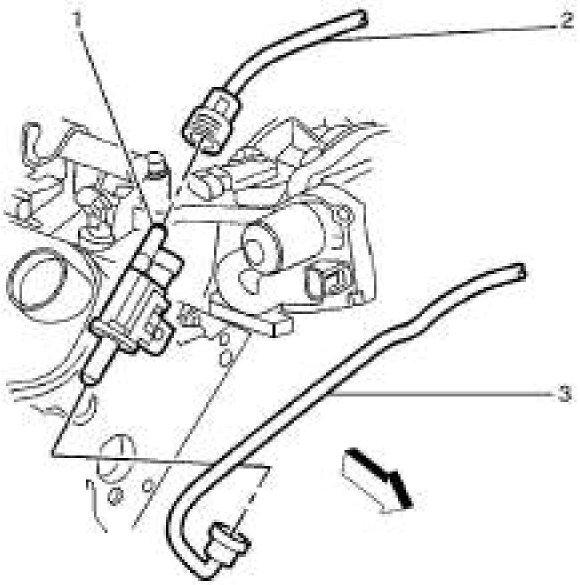


4. Disconnect the EVAP engine tube (1) from the evaporative emission chassis pipe. Refer to Plastic Collar Quick Connect Fitting Service.

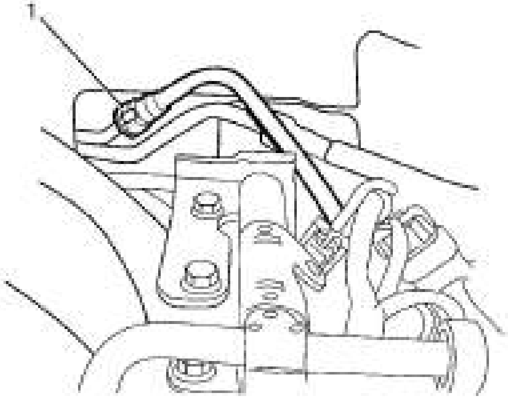


5. Disconnect the EVAP engine tube (2) from the EVAP valve solenoid. Refer to Plastic Collar Quick Connect Fitting Service.
6. Remove the EVAP engine tube (2) from the engine compartment.

Installation Procedure



1. Install the EVAP engine tube (2) to the EVAP valve solenoid. Refer to Plastic Collar Quick Connect Fitting Service.



2. Connect the EVAP engine tube (1) to the EVAP chassis pipe. Refer to Plastic Collar Quick Connect Fitting Service.
3. Install the oil filler cap.
4. Connect the negative battery cable.
5. Install the engine cover. Refer to Engine Cover Replacement .

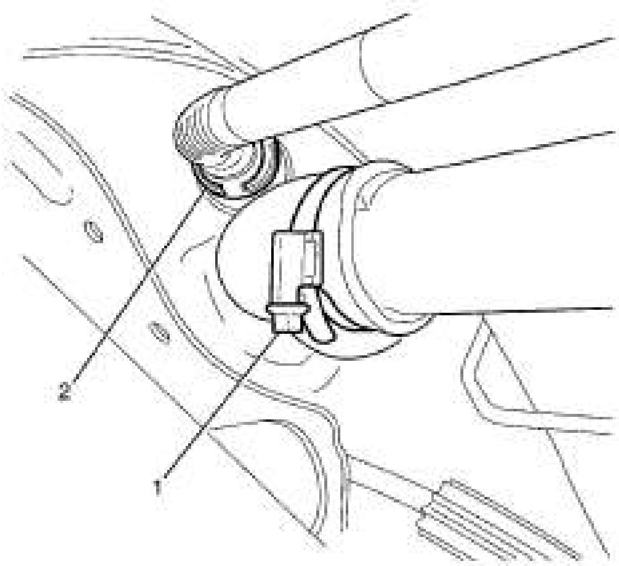
Filler Tube Replacement

Removal Procedure

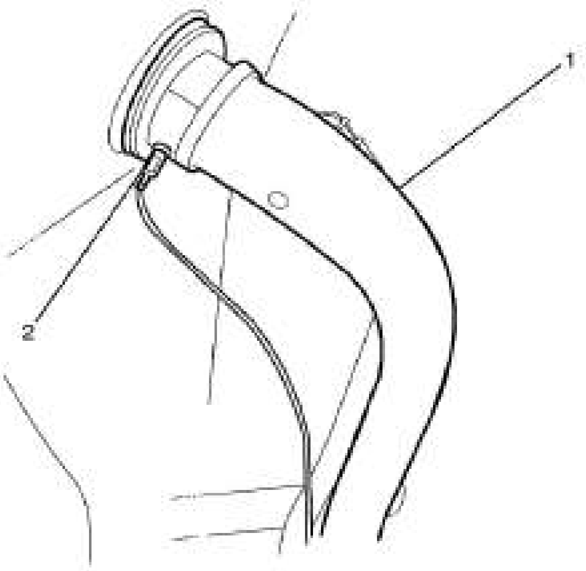
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

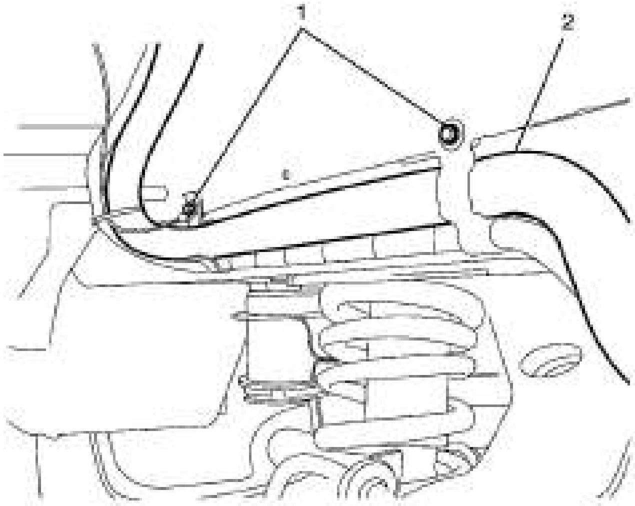
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the fuel filler cap.
3. Drain the fuel tank below the level of the fuel filler hose. Refer to Fuel Tank Draining .
4. Remove the right rear wheel. Refer to Tire and Wheel Removal and Installation .
5. Remove the rear bumper fascia. Refer to Rear Bumper Fascia Replacement .
6. Remove the rear wheelhouse liner. Refer to Rear Wheelhouse Panel Liner Replacement .



7. Loosen the fuel filler tube to fuel tank neck retaining clamp (1).
8. Remove the fuel filler tube to fuel tank neck.
9. Disconnect the fuel filler vent tube (2) from the fuel tank. Refer to Plastic Collar Quick Connect Fitting Service .



10. Remove the fuel filler tube to upper fuel filler neck rubber seal surround.
11. Remove the earth lead connector (2) to upper fuel filler neck.

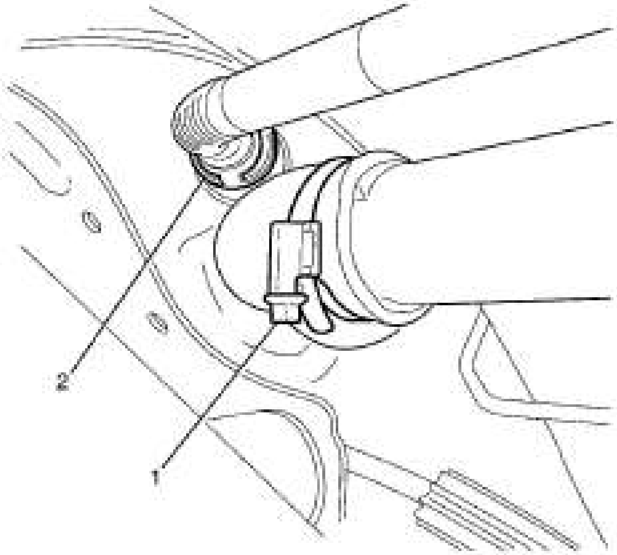


12. Remove the fuel filler tube to chassis retaining bolts (1).
13. Remove the fuel filler tube from the vehicle (2).

Installation Procedure

1. Install the fuel filler tube to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.

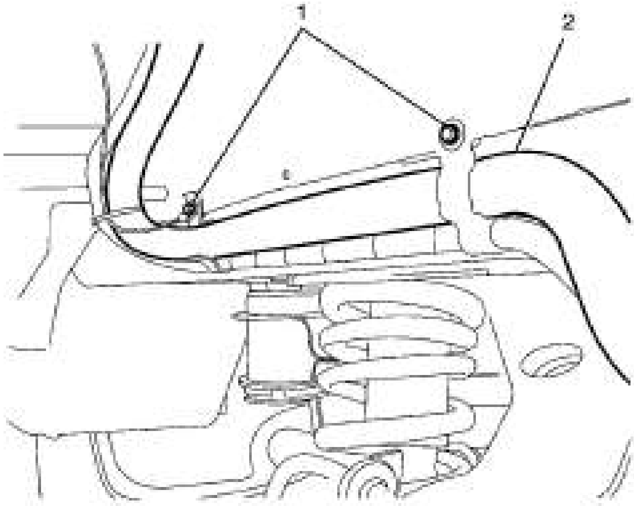


2. Install the fuel filler tube to fuel tank neck retaining clamp (1).

   Tighten
   Tighten the clamp to 3.5 N·m (31 lb in).

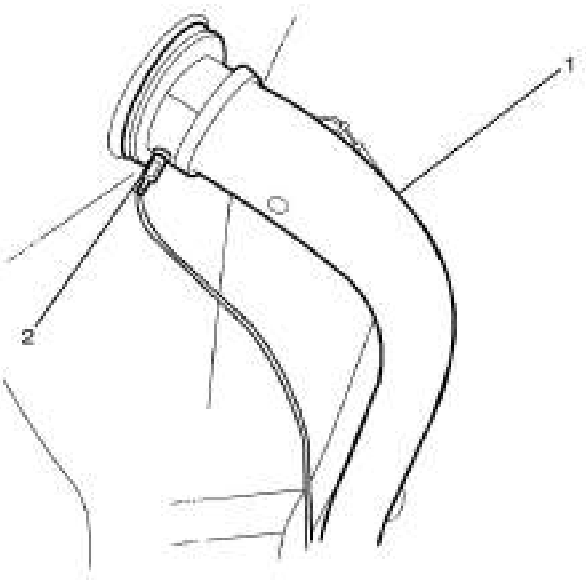
3. Connect the fuel filler vent tube (2) to the fuel tank. Refer to Plastic Collar Quick Connect Fitting Service .

   Notice: Refer to Fastener Notice in the Preface section.



4. Install the fuel filler tube to chassis retaining bolts (1).

Tighten
Tighten the bolts to 9 N·m (80 lb in).



5. Install the fuel filler tube to upper fuel filler neck rubber seal surround.
6. Install the earth lead connector (2) to upper filler neck.
7. Install the rear wheelhouse liner. Refer to Rear Wheelhouse Panel Liner Replacement .
8. Install the rear bumper fascia. Refer to Rear Bumper Fascia Replacement .
9. Install the right rear wheel. Refer to Tire and Wheel Removal and Installation .
10. Add fuel to the fuel tank.
11. Inspect for fuel leaks.
12. Install the fuel filler cap.

Fuel Filter Replacement

The fuel filter is an integral part of the fuel pump assembly and must be replaced as an assembly. For replacement refer to Primary Fuel Tank Module Replacement .

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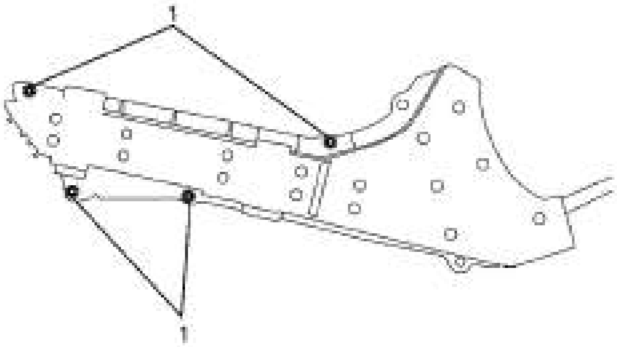
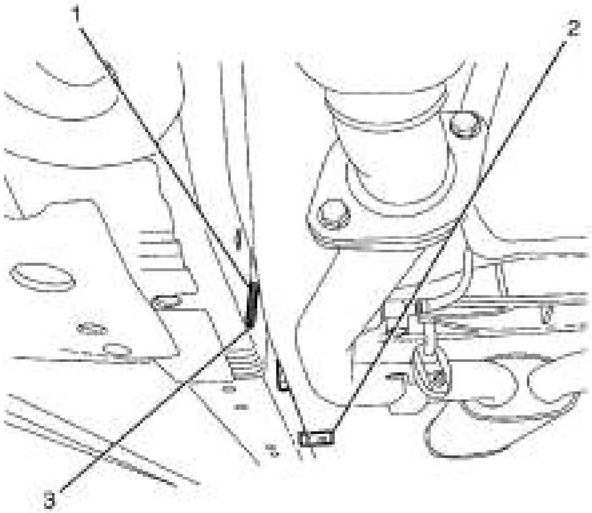
Fuel Hose/Pipes Replacement - Chassis

Removal Procedure

1. Before you service any fuel system connection, relieve the fuel system pressure. Refer to the Metal Collar Quick Connect Fitting Service.
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Disconnect the fuel and evaporative emission (EVAP) lines at the engine compartment. Refer to Fuel Hose/Pipes Replacement - Engine Compartment.
4. Remove the engine. Refer to Engine Replacement.
5. Disconnect the fuel and EVAP lines at the fuel tank. Refer to Fuel Tank Replacement.



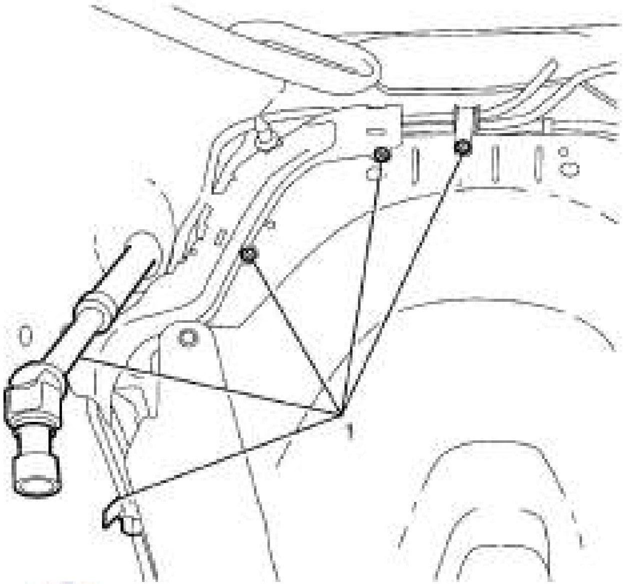
6. Remove the stone guard to under body retaining nuts (1).



7. Remove the fuel line bracket to under body pop rivet retainer (1) and discard.

   Discard the pop rivet.

8. Remove the fuel line insulators (2 and 3) from the chassis fuel lines.



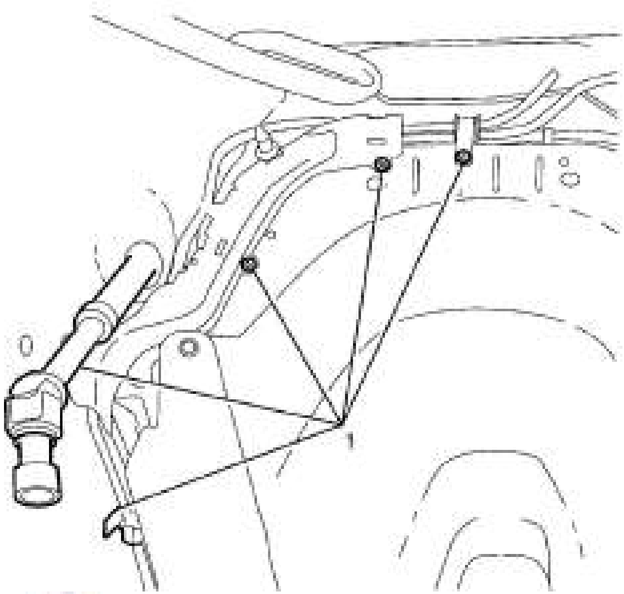
9. Remove the fuel line brackets to engine bay pop rivet retainers (1) and discard.

   Discard the pop rivet.

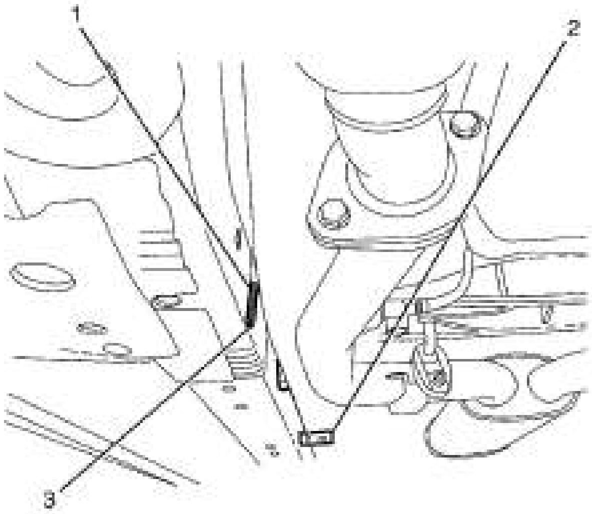
10. Remove the fuel line insulators from the engine bay fuel lines.
11. Remove the fuel and EVAP lines from the vehicle.

Installation Procedure

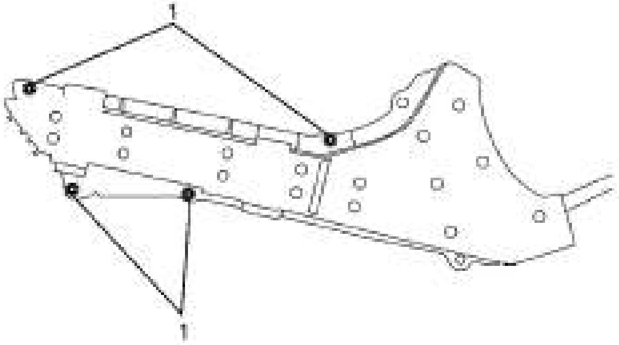
1. Install the fuel and EVAP lines to the vehicle.
2. Install the fuel line insulators to the engine bay fuel lines.



3. Install the fuel line brackets to the engine bay.
4. Install the NEW fuel line brackets to engine bay pop rivet retainers (1).



5. Install the fuel line insulators (2 and 3) to the chassis fuel lines.
6. Install the NEW fuel line retaining bracket to under body pop rivet retainer (1).



7. Install the fuel line stone guard to under body retaining nuts (1).

   Tighten
   Tighten the bolts to 5 N·m (44 lb in).

8. Install the fuel and EVAP lines at the fuel tank. Refer to Fuel Hose/Pipes Replacement - Engine Compartment.
9. Install the engine. Refer to Engine Replacement.
10. Install the fuel and EVAP lines at the engine compartment. Refer to Fuel Tank Replacement.
11. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
12. If re-programming is required. Refer to Control Module References.
    12.1. Turn ON the ignition for 2 seconds.
    12.2. Turn OFF the ignition for 2 seconds.
    12.3. Turn ON the ignition.
    12.4. Inspect for fuel leaks.

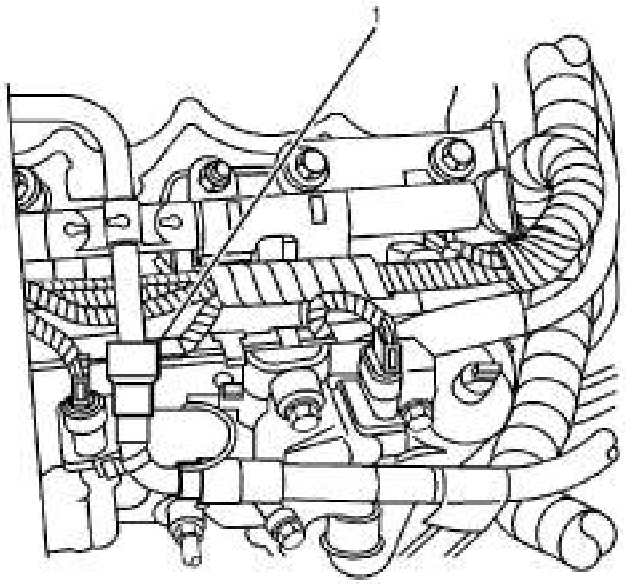
Fuel Hose / Pipes Replacement - Engine Compartment

Removal Procedure

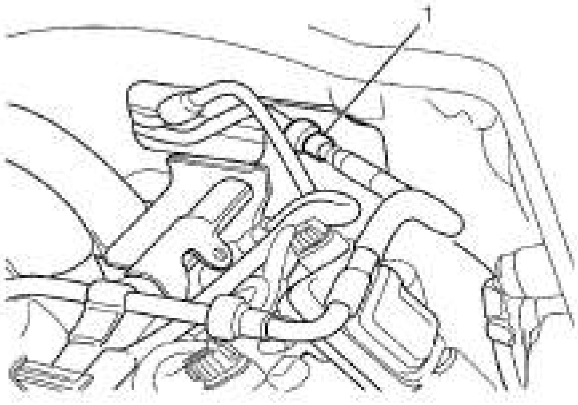
Notice: Clean all of the following areas before performing any disconnections in order to avoid possible contamination in the system:

- The fuel pipe connections
- The hose connections
- The areas surrounding the connections

1. Remove the engine cover. Refer to Engine Cover Replacement .
2. Relieve the fuel system pressure. Refer to Fuel Pressure Relief.
3. Loosen the fuel filler cap to relieve any vapour pressure.
4. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.

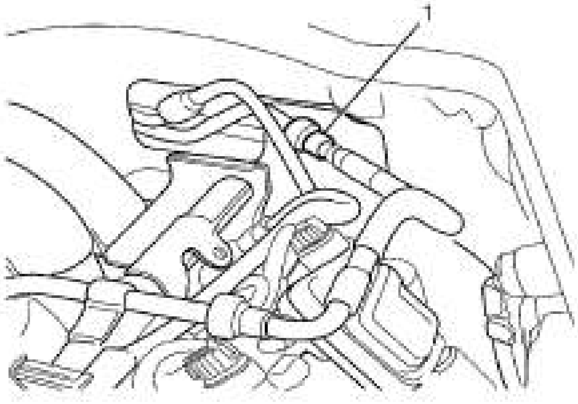


5. Disconnect the engine compartment fuel feed pipe (1) at the fuel rail. Refer to Metal Collar Quick Connect Fitting Service.

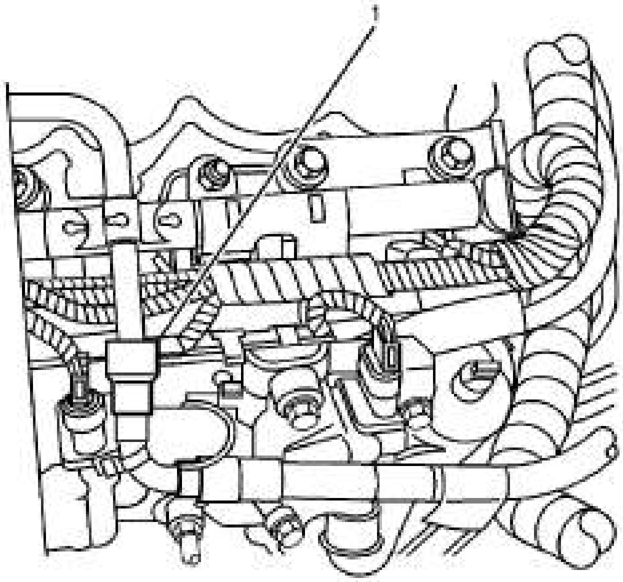


6. Disconnect the fuel feed pipe (1) from the fuel feed line. Refer to Metal Collar Quick Connect Fitting Service.
7. Cap the fuel pipe to prevent possible fuel system contamination.

Installation Procedure



1. Connect the fuel feed pipe (1) from the fuel feed line. Refer to Metal Collar Quick Connect Fitting Service.



2. Install the engine compartment fuel feed pipe (1) at the fuel rail. Refer to Metal Collar Quick Connect Fitting Service.
3. Install the fuel filler cap.
4. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
    - 4.1. Turn ON the ignition for 2 seconds.
    - 4.2. Turn OFF the ignition for 2 seconds.
    - 4.3. Turn ON the ignition.
    - 4.4. Inspect for fuel leaks.
5. Install the engine cover. Refer to Engine Cover Replacement .

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Fuel Injection Fuel Rail Assembly Replacement

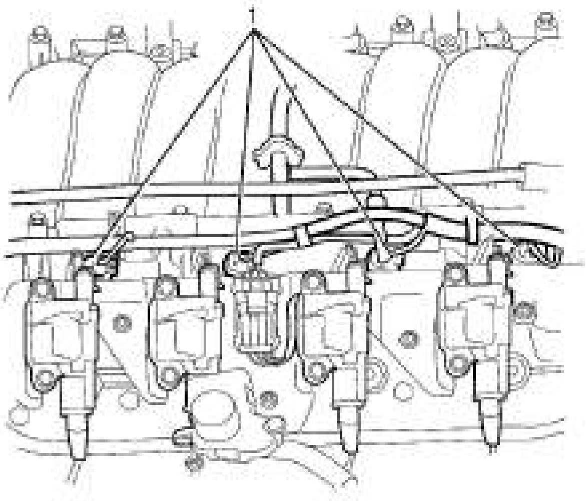
Removal Procedure

1. Relieve the fuel system pressure. Refer to the Fuel Pressure Relief .
2. Before removal, clean the fuel rail assembly with a spray type engine cleaner, if necessary. Follow the package instructions. Do not soak fuel rails in liquid cleaning solvent.

Notice:

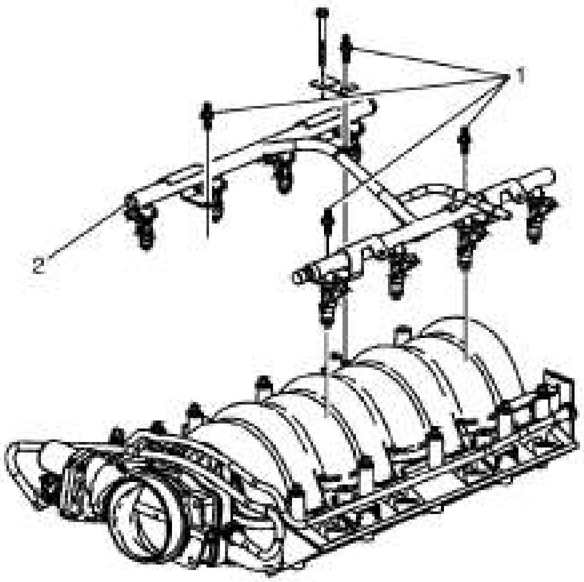
- Remove the fuel rail assembly carefully in order to prevent damage to the injector electrical connector terminals and the injector spray tips. Support the fuel rail after the fuel rail is removed in order to avoid damaging the fuel rail components.
- Cap the fittings and plug the holes when servicing the fuel system in order to prevent dirt and other contaminants from entering open pipes and passages.

3. Disconnect the fuel feed hose from the fuel rail. Refer to Metal Collar Quick Connect Fitting Service .

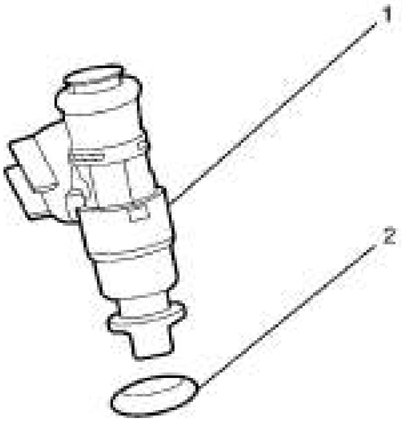


Important: Identify the connectors to their corresponding injectors to make sure correct sequential injector firing order after reassembly.

4. Disconnect the injector electrical connectors (2) to the injectors.



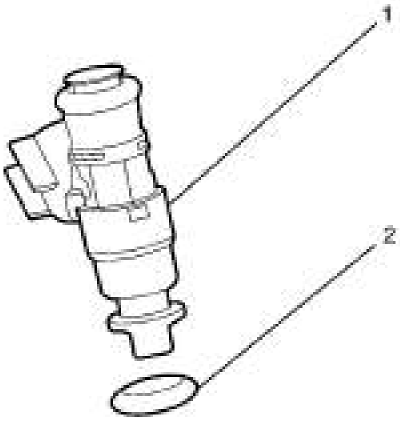
5. Disconnect the electrical harness from the fuel rail brackets.
6. Remove the fuel rail ground strap to intake manifold retaining bolt (1).
7. Remove the fuel rail to intake manifold retaining bolts (2).
8. Lift evenly on both sides of the fuel rail , and remove the fuel rail assembly.



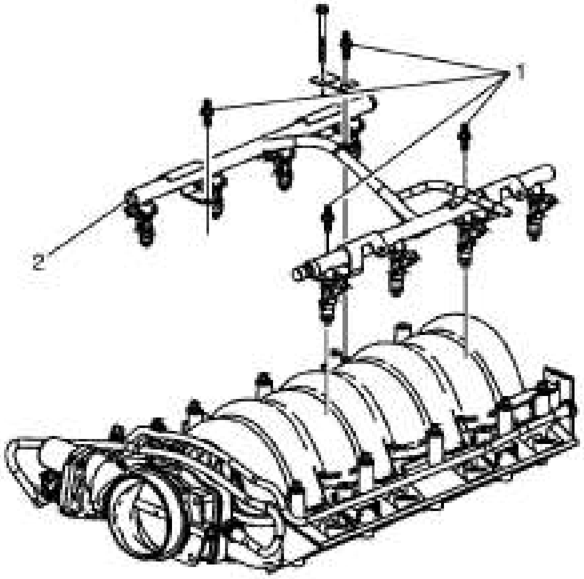
9. Remove the injector lower O-ring seal (2) from the spray tip end of each injector and discard.

   Discard the O-ring seals.

Installation Procedure



1. Lubricate the NEW lower injector O-ring seals (2) with clean engine oil.
2. Install the new O-ring seals (2) on the spray tip end of each injector.



3. Install the fuel rail assembly to the intake manifold.
4. Apply a 0.5 mm (0.020 in) band of approved threadlock to the threads of the fuel rail retaining bolts.

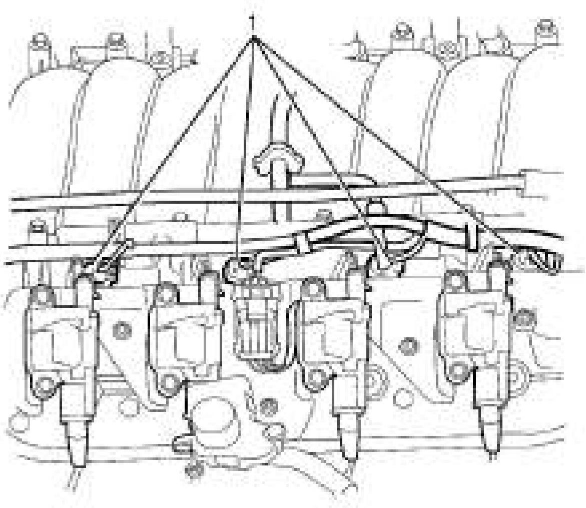
   Notice: Refer to Fastener Notice in the Preface section.

5. Install the fuel rail to intake manifold retaining bolts (2).

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).

6. Install the fuel rail ground strap to intake manifold retaining bolts (1).

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).



7. Connect the injector electrical connectors (1) to the injectors.
   - Install each connector on the proper injector in order to make sure correct sequential injector firing order.
   - Rotate the injectors as required in order to avoid stretching the wire harness.
8. Connect the electrical harness to the fuel rail brackets.
9. Connect the fuel feed hose to the fuel rail fuel pipe. Refer to Metal Collar Quick Connect Fitting Service .
10. Connect the negative battery cable.
11. Inspect for leaks.
    11.1. Turn ON the ignition for 2 seconds.
    11.2. Turn OFF the ignition for 10 seconds.
    11.3. Turn ON the ignition.
    11.4. Inspect for fuel leaks.

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Fuel Injector Cleaning

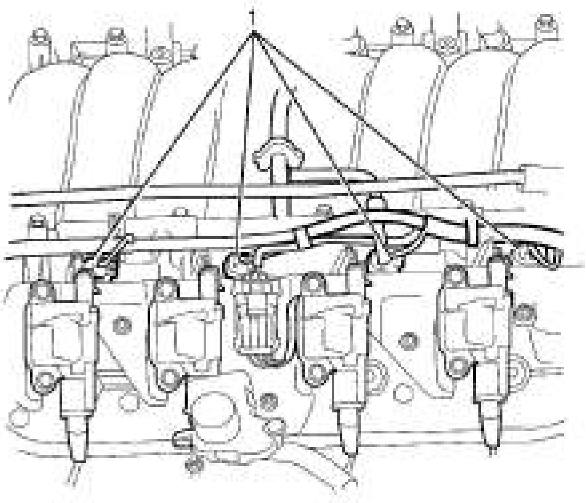
Removal Procedure

1. Relieve the fuel system pressure. Refer to the Fuel Pressure Relief .
2. Before removal, clean the fuel rail assembly with a spray type engine cleaner, if necessary. Follow the package instructions. Do not soak fuel rails in liquid cleaning solvent.

Notice:

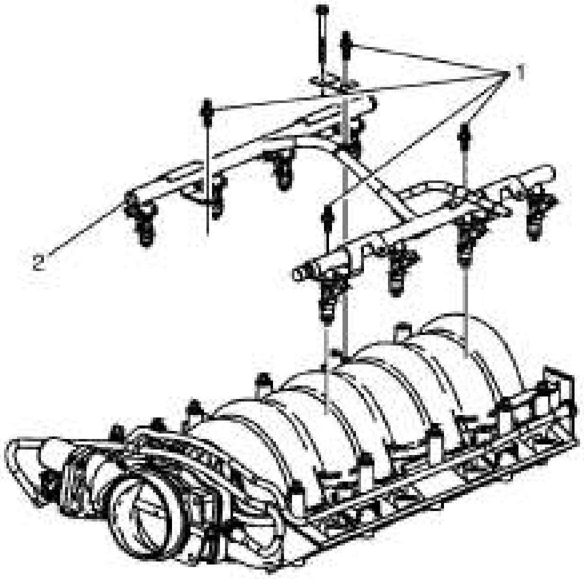
- Remove the fuel rail assembly carefully in order to prevent damage to the injector electrical connector terminals and the injector spray tips. Support the fuel rail after the fuel rail is removed in order to avoid damaging the fuel rail components.
- Cap the fittings and plug the holes when servicing the fuel system in order to prevent dirt and other contaminants from entering open pipes and passages.

3. Disconnect the fuel feed hose from the fuel rail. Refer to Metal Collar Quick Connect Fitting Service .

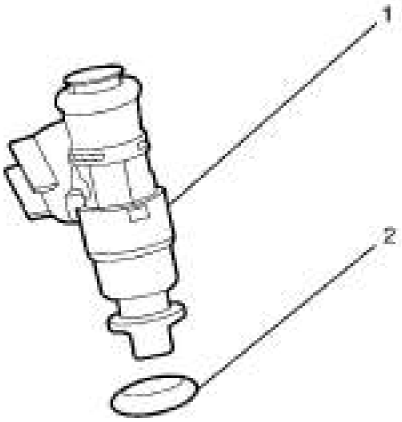


Important: Identify the connectors to their corresponding injectors to make sure correct sequential injector firing order after reassembly.

4. Disconnect the injector electrical connectors (2) to the injectors.



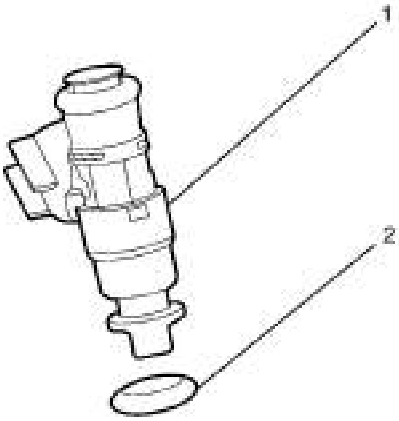
5. Disconnect the electrical harness from the fuel rail brackets.
6. Remove the fuel rail ground strap to intake manifold retaining bolt (1).
7. Remove the fuel rail to intake manifold retaining bolts (2).
8. Lift evenly on both sides of the fuel rail , and remove the fuel rail assembly.



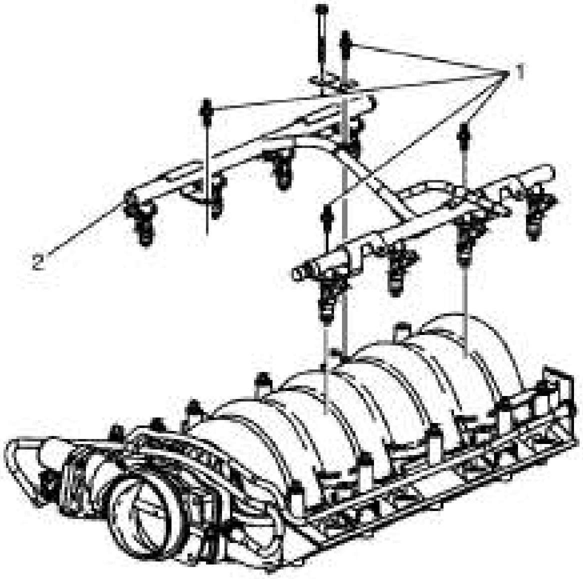
9. Remove the injector lower O-ring seal (2) from the spray tip end of each injector and discard.

   Discard the O-ring seals.

Installation Procedure



1. Lubricate the NEW lower injector O-ring seals (2) with clean engine oil.
2. Install the new O-ring seals (2) on the spray tip end of each injector.



3. Install the fuel rail assembly to the intake manifold.
4. Apply a 0.5 mm (0.020 in) band of approved threadlock to the threads of the fuel rail retaining bolts.

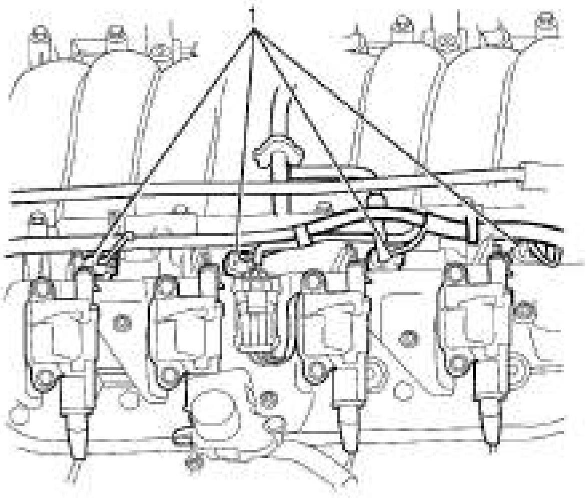
   Notice: Refer to Fastener Notice in the Preface section.

5. Install the fuel rail to intake manifold retaining bolts (2).

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).

6. Install the fuel rail ground strap to intake manifold retaining bolts (1).

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).



7. Connect the injector electrical connectors (1) to the injectors.
   - Install each connector on the proper injector in order to make sure correct sequential injector firing order.
   - Rotate the injectors as required in order to avoid stretching the wire harness.
8. Connect the electrical harness to the fuel rail brackets.
9. Connect the fuel feed hose to the fuel rail fuel pipe. Refer to Metal Collar Quick Connect Fitting Service .
10. Connect the negative battery cable.
11. Inspect for leaks.
    - 11.1. Turn ON the ignition for 2 seconds.
    - 11.2. Turn OFF the ignition for 10 seconds.
    - 11.3. Turn ON the ignition.
    - 11.4. Inspect for fuel leaks.

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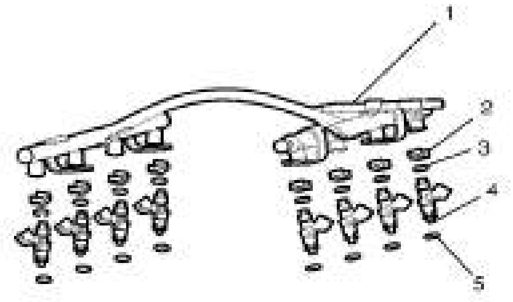
Fuel Injector Replacement

Removal Procedure

1. Remove the fuel rail assembly. Refer to Fuel Injection Fuel Rail Assembly Replacement.



2. Remove the fuel injector to fuel rail assembly retaining clips (2).

   Notice: Use care in removing the fuel injectors in order to prevent damage to the fuel injector electrical connector pins or the fuel injector nozzles. Do not immerse the fuel injector in any type of cleaner. The fuel injector is an electrical component and may be damaged by this cleaning method.

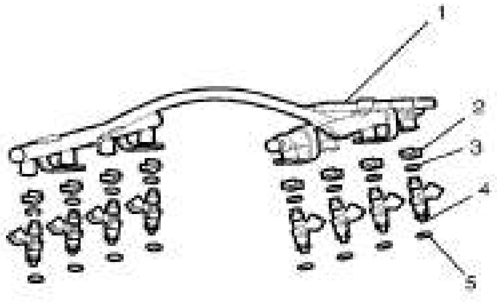
3. Remove the fuel injector (4) from the fuel rail (1).
4. Remove the injector lower O-ring seal (5) from the spray tip end of each injector and discard.

   Discard the O-ring seals.

5. Remove the injector upper O-ring seal (3) from the fuel rail end of each injector and discard.

   Discard the O-ring seals.

Installation Procedure



1. Apply a small amount of clean motor oil to the O-rings (3) and (5), before installing the new fuel injector.
2. Install the NEW injector upper O-ring seals (3) to the injectors.
3. Install the NEW injector lower O-ring seals (5) to the injectors.
4. Install the fuel injector (4) in the fuel rail (1).
5. Install the retaining clips for the fuel injector (3).
6. Install the fuel rail assembly. Refer to Fuel Injection Fuel Rail Assembly Replacement.
    - 6.1. Turn the ignition switch ON for 2 seconds.
    - 6.2. Turn the ignition switch OFF for 10 seconds.
    - 6.3. Turn the ignition switch ON.
    - 6.4. Inspect for fuel leaks.

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Fuel Level Sensor Replacement

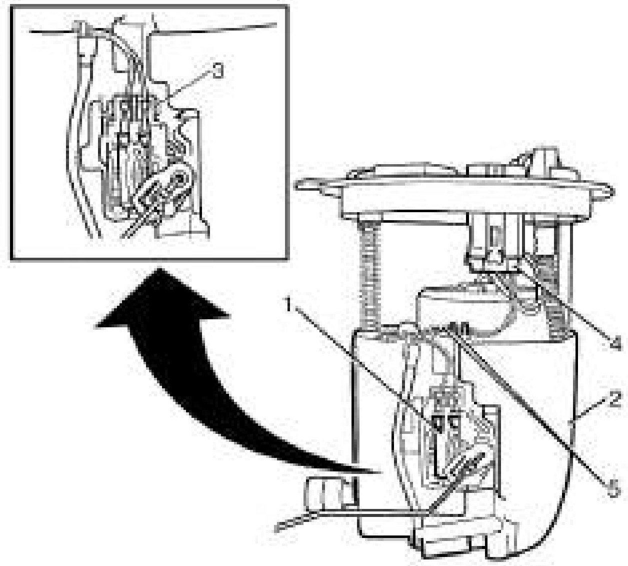
Removal Procedure

Caution: Refer to Gasoline/Gasoline Vapors Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

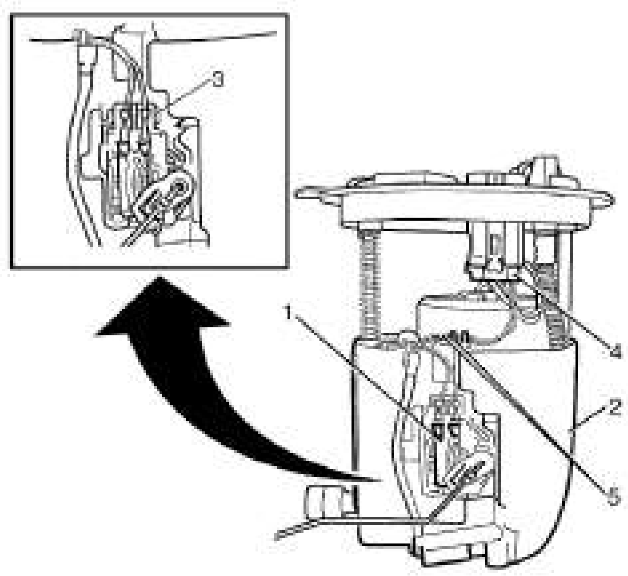
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Remove the fuel tank. Refer to Fuel Tank Replacement .
2. Remove the primary fuel tank module assembly from the fuel tank. Refer to Primary Fuel Tank Module Replacement .



3. Disconnect the fuel level sensor connector (4) and unclip the wiring from the harness securing clips (5).
4. Remove the fuel level sensor from the primary fuel tank module assembly.
5. Unlock the locking clip (3) and gently push the fuel level sensor upwards.
6. Remove the fuel level sensor from the primary fuel tank module assembly.

Installation Procedure



1. Locate and install the fuel tank level sensor (1) to the primary fuel tank module assembly (2). Make sure that the locking clip (3) engages.
2. Connect the fuel level sensor connector (4) and route the wiring through the harness securing clips (5).
3. Install the fuel level sensor to the primary fuel tank module assembly.
4. Install the primary fuel tank module assembly to the fuel tank. Refer to Primary Fuel Tank Module Replacement .
5. Install the fuel tank. Refer to Fuel Tank Replacement .

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Fuel Pressure Gage Installation and Removal

Tools Required

- DW100-010
- AU-453

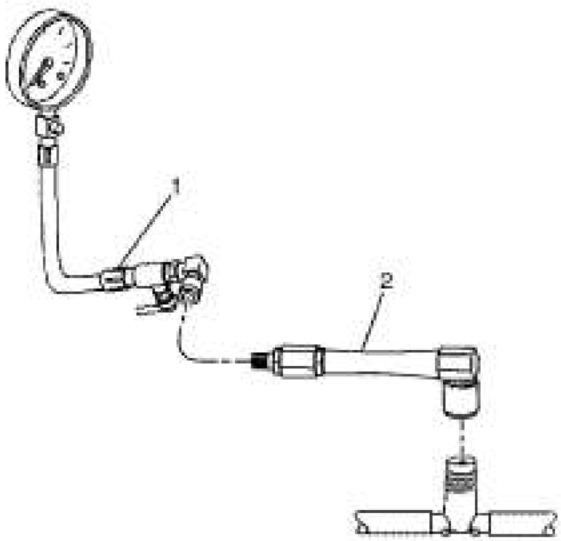
Installation Procedure

Caution: Refer to Gasoline/Gasoline Vapors Caution in the Preface section.

> **Caution:** Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gage. Place the towel in an approved container when the connection of the fuel pressure gage is complete.

> **Notice:** Clean all of the following areas before performing any disconnections in order to avoid possible contamination in the system:
> - The fuel pipe connections
> - The hose connections
> - The areas surrounding the connections

1. Remove the engine covers. Refer to Engine Cover Replacement .



2. Remove the fuel pressure service connection dust cap from the fuel rail.
3. Connect the AU-453 (1) fuel pressure test hose adapter to the fuel pressure connection. Wrap a shop towel around the fitting while connecting the AU-453 (1) in order to avoid spillage.
4. Connect the DW100-010 (2) fuel pressure gauge to the AU-453 (1). Wrap a shop towel

around the fitting while connecting the gauge in order to avoid spillage.

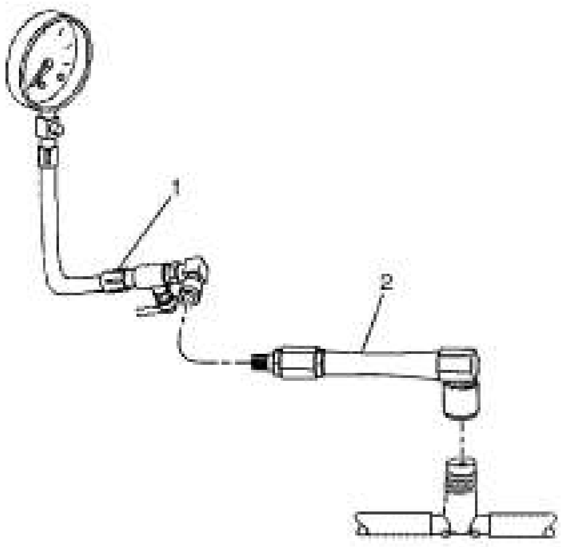
5. Turn ON the ignition.

Caution: Do not drain the fuel into an open container. Never store the fuel in an open container due to the possibility of a fire or an explosion.

6. Place the bleed hose of the fuel pressure gauge into a suitable container.
7. Open the bleed valve on the fuel pressure gauge in order to bleed the air from the fuel pressure gauge.
8. Command the fuel pump ON with a scan tool.
9. Close the bleed valve on the fuel pressure gauge.
10. Inspect for fuel leaks.

Removal Procedure

1. Turn OFF the ignition.
2. Command the fuel pump OFF with the scan tool.
3. Open the bleed valve on the fuel pressure gauge in order to bleed the remaining fuel from the fuel pressure gauge.
4. Remove the bleed hose from the fuel pressure gauge.



5. Disconnect the DW100-010 (2) fuel pressure gauge from the AU-453 (1). Wrap a shop towel around the fitting while connecting the gauge in order to avoid spillage.
6. Disconnect the AU-453 (1) fuel pressure test hose adapter to the fuel pressure connection. Wrap a shop towel around the fitting while connecting the AU-453 (1) in order to avoid spillage.
7. Install the fuel pressure service connection dust cap to the fuel rail.
8. Install the engine covers. Refer to Engine Cover Replacement .

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Fuel Pressure Relief

Tools Required

- J 29658-D Fuel Pressure Gauge
- AU-453 Fuel Pressure Test Hose Adapter

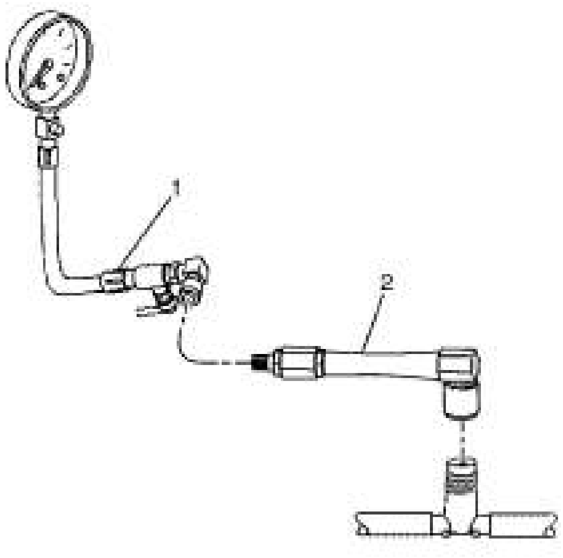
Caution: Gasoline or gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.

Caution: Relieve the fuel system pressure before servicing fuel system components in order to reduce the risk of fire and personal injury.

After relieving the system pressure, a small amount of fuel may be released when servicing the fuel lines or connections. In order to reduce the chance of personal injury, cover the regulator and the fuel line fittings with a shop towel before disconnecting. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Turn the ignition OFF.
2. Disconnect the negative battery cable in order to avoid possible fuel discharge if an accidental attempt is made to start the engine. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove the fuel injector sight shield.



4. Connect the EN-47620 (1) fuel pressure test hose adapter to the fuel pressure connection. Wrap a shop towel around the fitting while connecting the J 29658-D (1) in order to avoid spillage.
5. Connect the J 29658-D (2) fuel pressure gauge to the EN-47620 (1). Wrap a shop towel

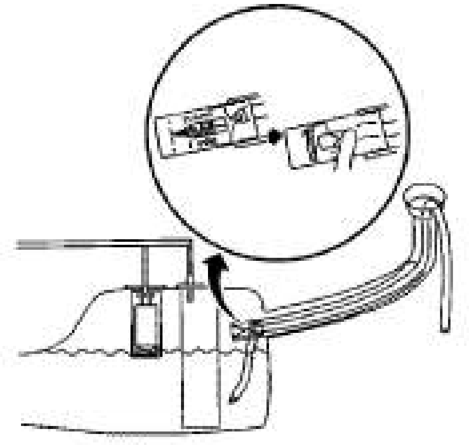
around the fitting while connecting the gauge in order to avoid spillage.

6. Install the bleed hose into an approved container.
7. Open the valve in order to bleed the system pressure. Fuel connections are now safe for servicing.
8. Drain any fuel remaining in the gauge into an approved container.
9. Install the fuel injector sight shield.
10. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .

Fuel Tank Draining

Tools Required

- J 45004 Fuel Tank Drain Hose
- J 42960-2 Fuel Flapper Door Holder



Caution: Never drain or store fuel in an open container. Always use an approved fuel storage container in order to reduce the chance of fire or explosion.

Notice: Do not run the fuel pump unless the fuel pump is submerged in fuel in order to prevent damage to the fuel pump.

1. Remove the fuel filler cap.
2. Install the J 42960-2 into the fuel fill pipe in order to hold the door open.
3. Insert the J 45004 into the fuel tank until the hose reaches the bottom of the fuel tank.
4. Use an air operated pump device in order to drain as much fuel through the fuel fill pipe as possible.

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Fuel Tank Replacement

Special Tools

- EN-46843
- 7370
- 7371
- EN-48536

Removal Procedure

1. Ignition OFF.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

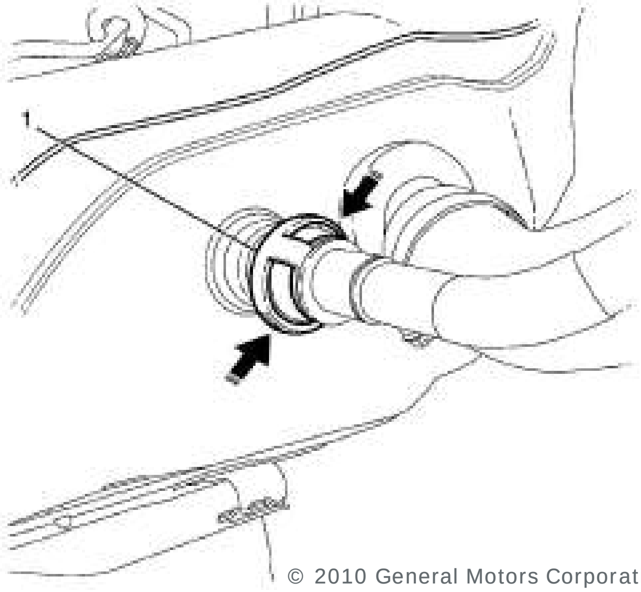
   Caution: Refer to Gasoline/Gasoline Vapors Caution in the Preface section.

3. Drain the fuel tank into a suitable container. Refer to Fuel Tank Draining.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

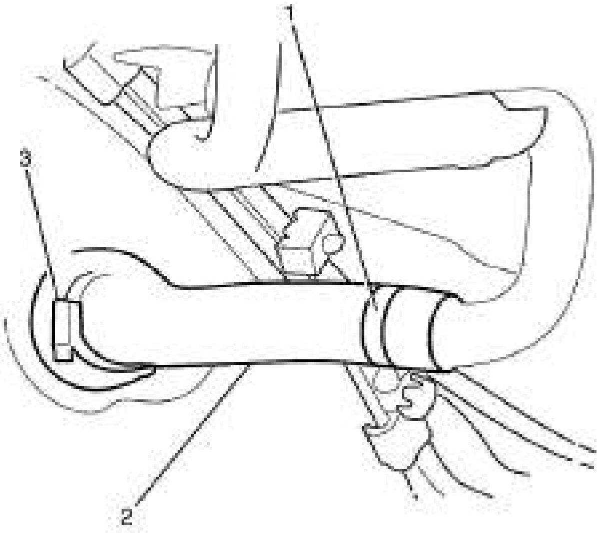
   Caution: Refer to Safety Glasses Caution in the Preface section.

4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
5. Remove the right rear wheel. Refer to Tire and Wheel Removal and Installation.
6. Remove the exhaust system for access. Refer to Exhaust System Replacement.
7. Remove the propeller shaft. Refer to Propeller Shaft Replacement.
8. Remove the park brake cables. Refer to Parking Brake Rear Cable Replacement.

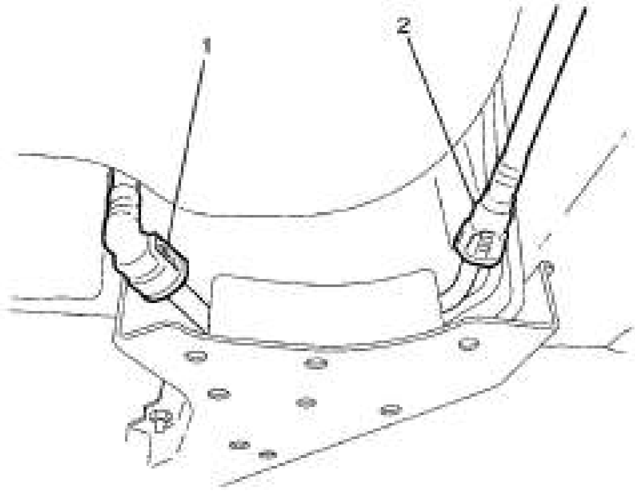


Important: Squeezes the collar of the EVAP canister hose connector (1) to release the connector.

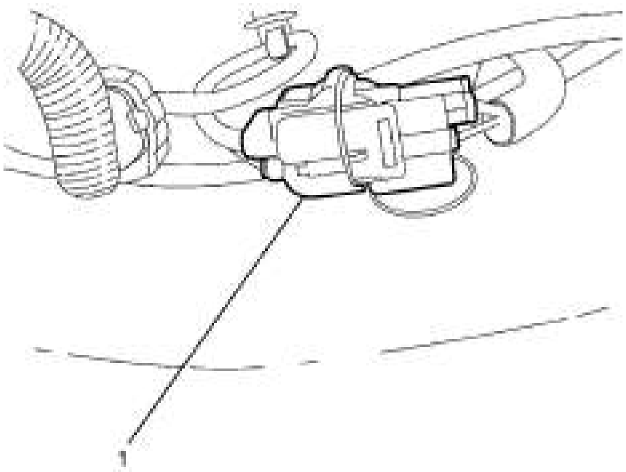
9. Disconnect the filler vent tube connector (1) from the fuel tank assembly.



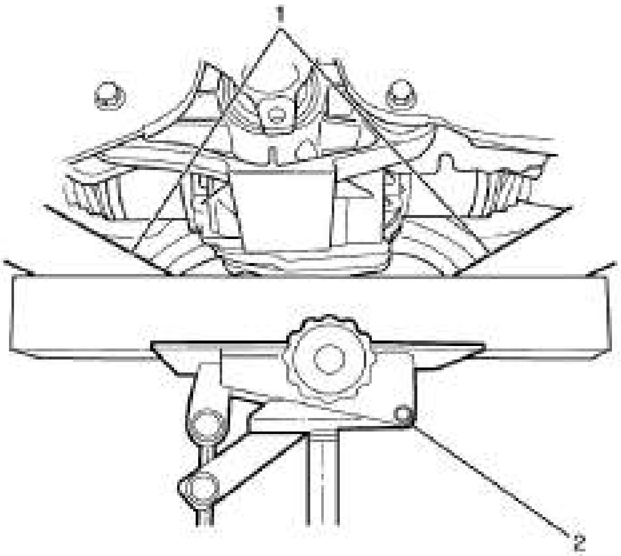
10. Remove the retaining hose clamp (1) from the fuel filler hose (2).
11. Remove the retaining hose clamp (3) from the fuel filler hose (2).
12. Remove the fuel filler hose (2) from the vehicle.



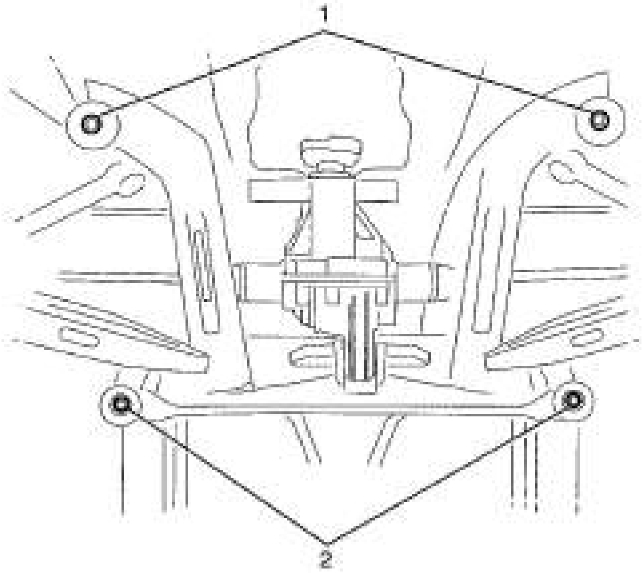
13. Disconnect the fuel feed line connector (1) using 7371 .
14. Disconnect the EVAP line (2). Refer to Plastic Collar Quick Connect Fitting Service.



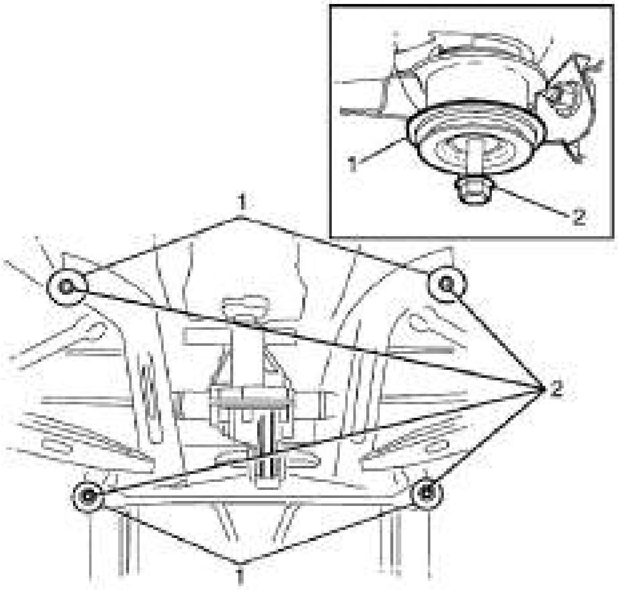
15. Disconnect the fuel tank electrical connector (1) from the chassis electrical harness.



16. Support the rear frame assembly (1) using a suitable tool (2).



17. Remove the rear frame to chassis retaining bolts (1) and discard.
18. Remove the rear frame to chassis retaining bolts (2) and discard.

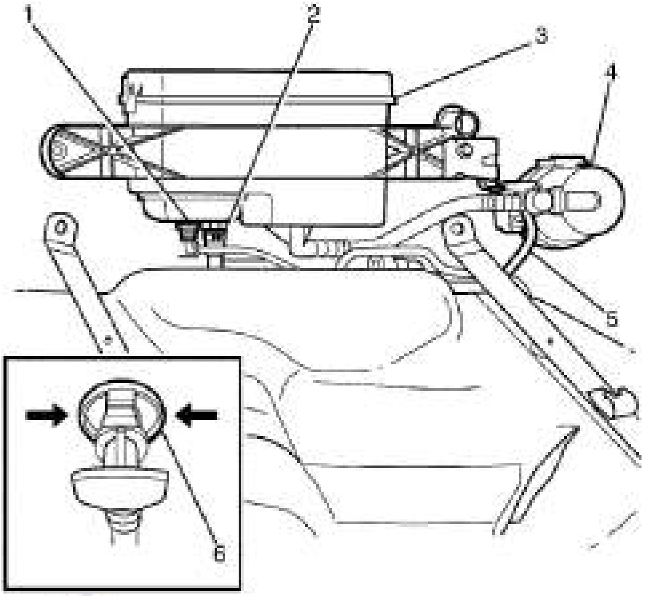


Important: Make sure that the bolts (2) extends 50mm (2 in) from the rear frame.

19. Install the bolts (2) of EN-48536 to the rear frame mounts (1).

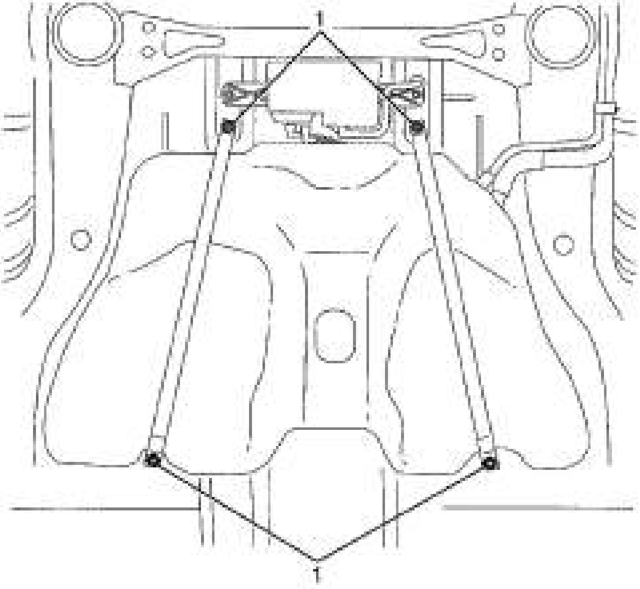
Important: When lowering the rear frame do not to damage the rear brake hoses.

20. Lower the rear frame onto the bolts (2) of EN-48536 .



Important: Squeezes the collar (6) of the EVAP canister hose connector to release the connector (1).

21. Detach the EVAP canister hose connector (1) from the EVAP canister (3).
22. Detach the EVAP canister hose connector (2) from the EVAP canister (3). Refer to Plastic Collar Quick Connect Fitting Service.
23. Disconnect the electrical connector (5) from the EVAP canister vent solenoid (4).



Important: Take care not to damage the following components when lowering the fuel tank assembly.

- The fuel tank assembly wiring harness.

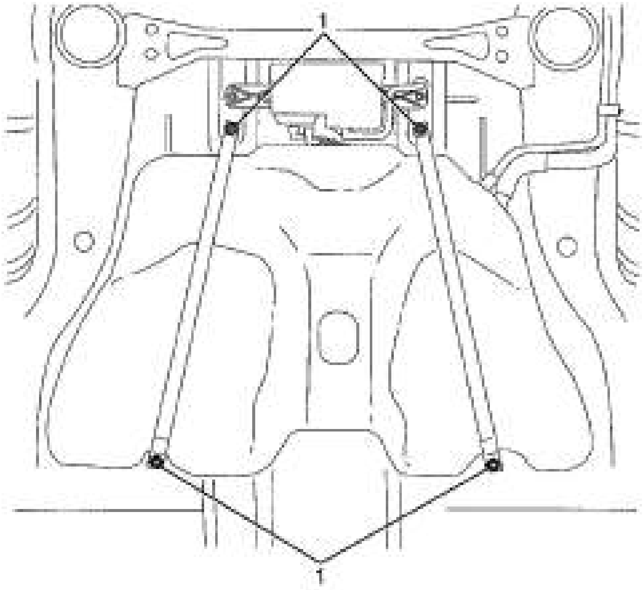
- The fuel feed pipe.
- The EVAP pipes.

Important: Support the fuel tank assembly with a suitable tool before removing the fuel tank assembly straps to chassis retaining bolts (1)

24. Remove the fuel tank strap to chassis retaining bolts (1).
25. With the aid of an assistant, carefully manoeuvre the fuel tank assembly from the vehicle.
26. Remove the following components if replacing the fuel tank:
    - The primary fuel tank module--Refer to Primary Fuel Tank Module Replacement.
    - The secondary fuel tank module--Refer to Secondary Fuel Tank Module Replacement.
    - The fuel tank pressure sensor. Refer to Fuel Tank Pressure Sensor Replacement.
    - The fuel tank assembly electrical harness.
    - The fuel tank EVAP pipes.

Installation Procedure

1. If the fuel tank was replaced, install the following components:
    - The primary fuel tank module--Refer to Primary Fuel Tank Module Replacement.
    - The secondary fuel tank module--Refer to Secondary Fuel Tank Module Replacement.
    - The fuel tank pressure sensor. Refer to Fuel Tank Pressure Sensor Replacement.
    - The fuel tank assembly electrical harness.
    - The fuel tank EVAP pipes.



Important: Take care not to damage the following components when installing the fuel tank assembly to the vehicle:

- The fuel tank assembly wiring harness.

- The fuel feed pipe.
- The EVAP pipes.

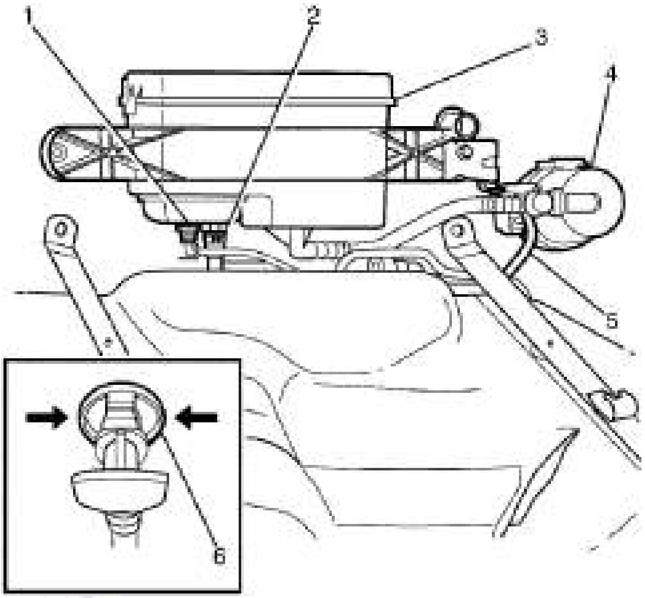
Important: Support the fuel tank assembly with a suitable tool while installing the fuel tank assembly straps to chassis retaining bolts (1).

2. With the aid of an assistant, carefully manoeuvre and install the fuel tank assembly to the vehicle.

Notice: Refer to Fastener Notice in the Preface section.

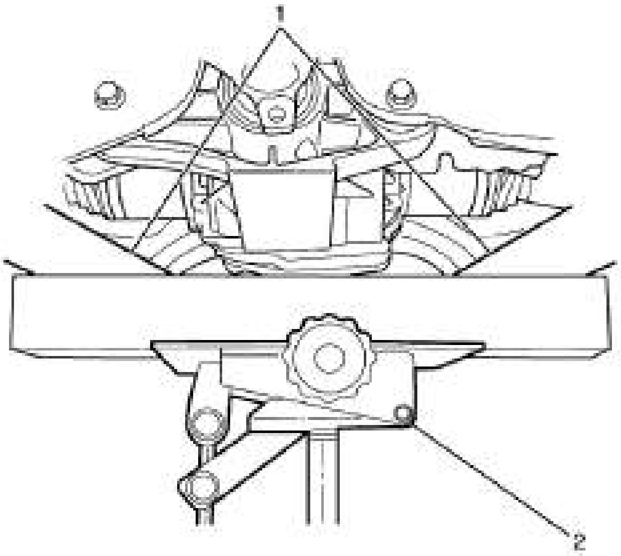
3. Install the fuel tank assembly strap to chassis retaining bolts (1).

Tighten
Tighten the fuel tank strap bolts to 20 N·m (15 lb ft)

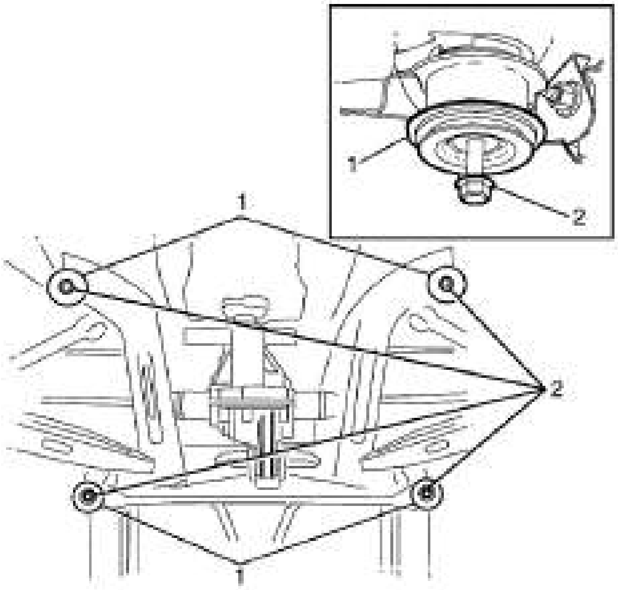


Important: Listen for an audible click to confirm correct installation.

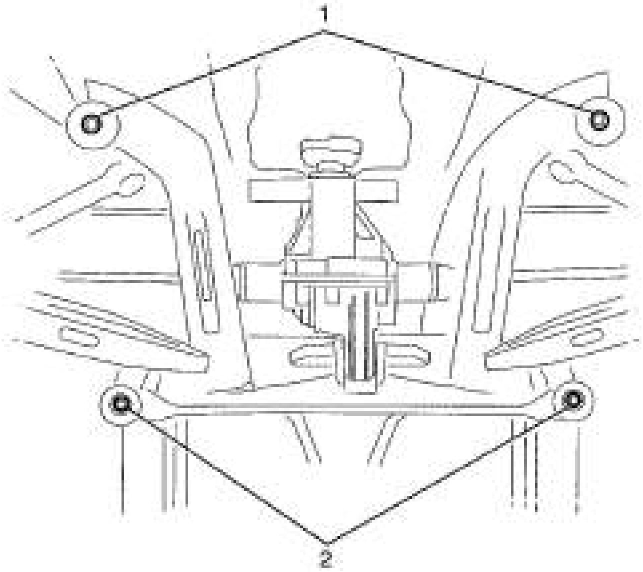
4. Attach the EVAP canister hose connector (1) to the EVAP canister (3).
5. Attach the EVAP canister hose connector (2) to the EVAP canister (3). Refer to Plastic Collar Quick Connect Fitting Service.
6. Connect the electrical connector (5) to the EVAP canister vent solenoid (4).



7. Raise and support the rear frame assembly (1) into its position using a suitable tool (2).



8. Remove the bolts (2) of EN-48536 from the rear frame mounts (1).



Important: Using a suitable tool clean the threaded holes of the rear frame to chassis retaining bolts.

9. Install the NEW rear frame to chassis retaining bolts (2).

   Do not fully tighten at this stage.

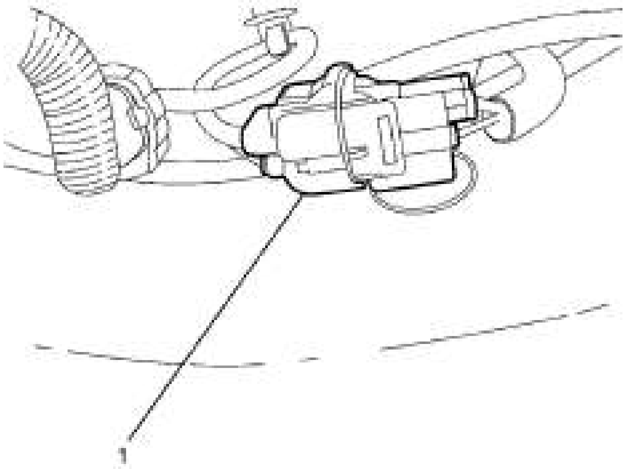
10. Install the NEW rear frame to chassis retaining bolts (1).

    Do not fully tighten at this stage.

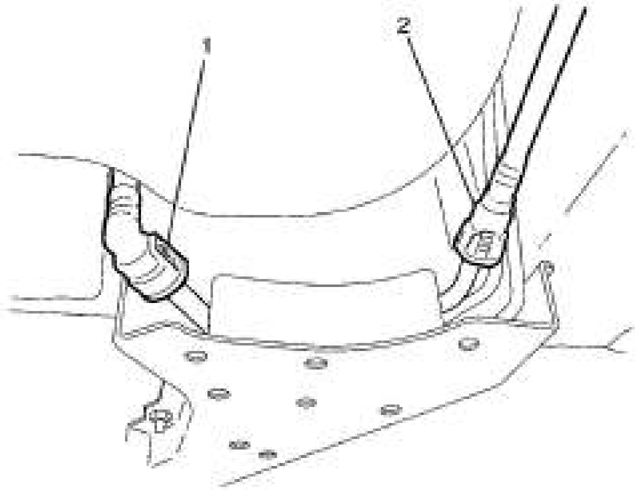
11. Tighten the NEW rear frame to chassis retaining bolts (1) and (2) to:

    First Pass
    Tighten the bolts to 65 N·m (48 lb ft)

    Final Pass
    Tighten the bolts a further 125 degrees.

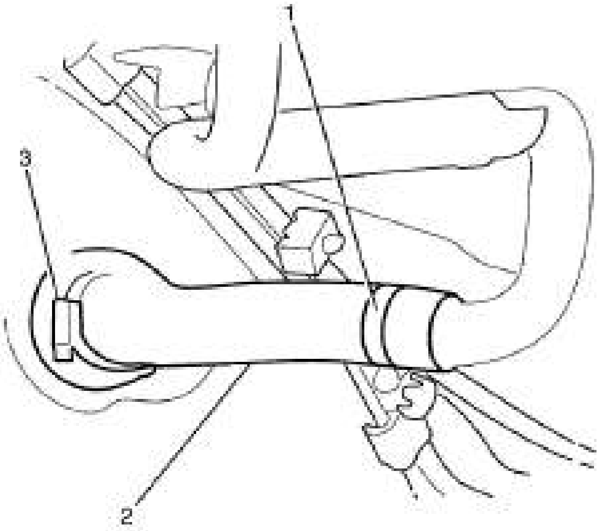


12. Connect the fuel tank assembly electrical connector (1) to the chassis electrical harness.



Important: Listen for an audible click to confirm correct installation.

13. Connect the EVAP line (2) to the EVAP chassis pipe. Refer to Plastic Collar Quick Connect Fitting Service.
14. Connect the fuel feed line (1) to the chassis fuel feed pipe.

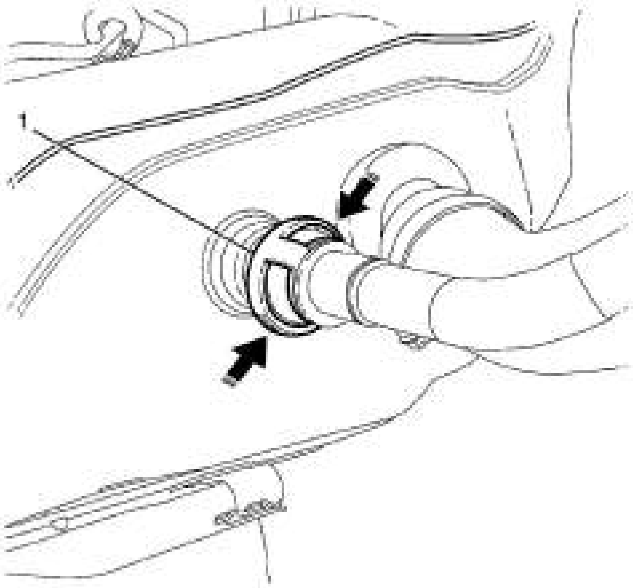


15. Install the fuel filler hose (2) to the vehicle.
16. Install the retaining hose clamp (1) to the fuel filler hose (2).

    Tighten
    Tighten the fuel filler hose to 4 N·m (35 lb in).

17. Install the retaining hose clamp (3) to the fuel filler hose (2).

    Tighten
    Tighten the fuel filler hose to 4 N·m (35 lb in).



Important: Listen for an audible click to confirm correct installation.

18. Connect the filler vent tube connector (1) to the fuel tank assembly.
19. Install the park brake cables. Refer to Parking Brake Rear Cable Replacement.
20. Install the propeller shaft. Refer to Propeller Shaft Replacement.
21. Install the exhaust system. Refer to Exhaust System Replacement.
22. Install the right rear wheel. Refer to Tire and Wheel Removal and Installation.
23. Lower the vehicle to the ground.
24. Fill the fuel tank with the drained fuel.
25. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
26. Inspect for fuel leaks using the following procedure:
    - Turn ON the ignition, with the engine OFF for 2 seconds.
    - Turn OFF the ignition, for 10 seconds.
    - Turn ON the ignition, with the engine OFF.
    - Inspect for leaks.

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Heated Oxygen Sensor Replacement - Bank 1 Sensor 1

Important: Allow the exhaust system to cool to an ambient temperature before removal of the oxygen sensor. Failure to adhere may result in personal injury.

When removing the catalytic converters (1), it is necessary to disconnect the wiring harness connectors from the pre-catalytic oxygen sensor.

Service Precautions

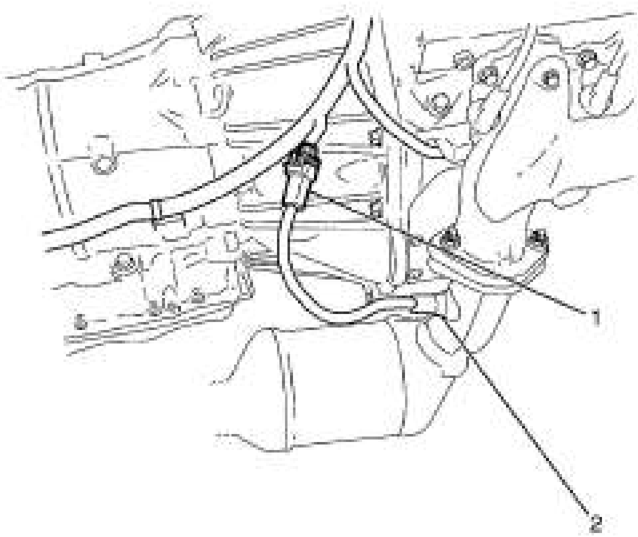
- Keep the oxygen sensor free of contaminates. Do not use any solvents to clean the sensor.
- Do not attempt to repair any part of the sensor including the wiring and connector. Replace the sensor if any damage is evident.
- When the exhaust system is cold the oxygen sensor may be difficult to remove. Excessive force may damage the threads in the exhaust assembly.
- If reusing the old oxygen sensor apply an anti-seize compound to the thread. New oxygen sensors come with the compound already applied.

Removal Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

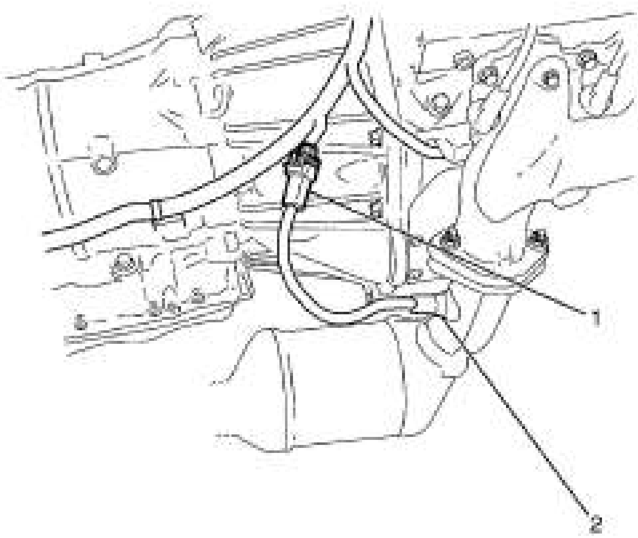


3. Disconnect the wiring harness connector (1) to the oxygen sensor wiring harness.
4. Remove the right catalytic converter from the vehicle. Refer to Catalytic Converter

Replacement - Right Side .

5. Loosen and remove the oxygen sensor (2). Take care not to damage the oxygen sensor.

Installation Procedure



Important: If using the old oxygen sensor (2) coat the threads with an anti-seize compound.

1. Install the oxygen sensor (2) to the right catalytic converter.

   Tighten
   Tighten the oxygen sensor to 40 N·m (30 lb ft).

2. Install the right catalytic converter to the vehicle. Refer to Catalytic Converter Replacement - Right Side .
3. Connect the wiring harness connector (1) to the oxygen sensor harness.
4. Lower the vehicle.
5. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
6. If re-programming is required. Refer to Control Module References .
7. Check for codes using a suitable scanner,

Heated Oxygen Sensor Replacement - Bank 1 Sensor 2

When removing the front exhaust pipes, it is necessary to disconnect the wiring harness connectors from the post-catalytic oxygen sensors.

Service Precautions

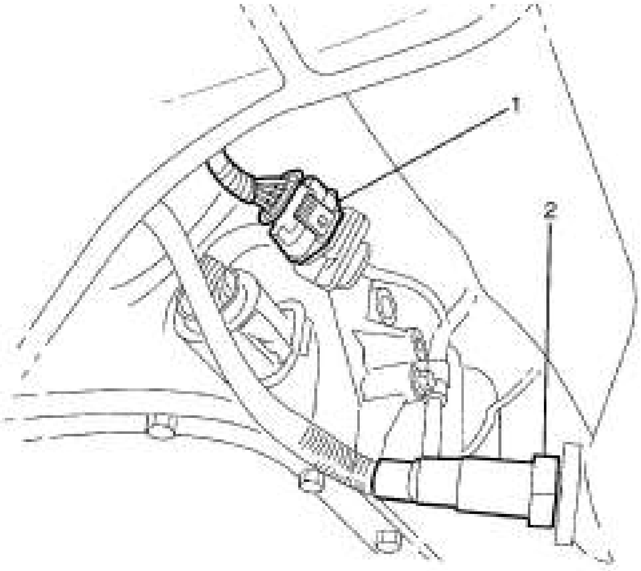
- Keep the oxygen sensor free of contaminates. Do not use any solvents to clean the sensor.
- Do not attempt to repair any part of the sensor including the wiring and connector. Replace the sensor if any damage is evident.
- When the exhaust system is cold the oxygen sensor may be difficult to remove. Excessive force may damage the threads in the exhaust assembly.
- If reusing the old oxygen sensor apply an anti-seize compound to the thread. New oxygen sensors come with the compound already applied.

Removal Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

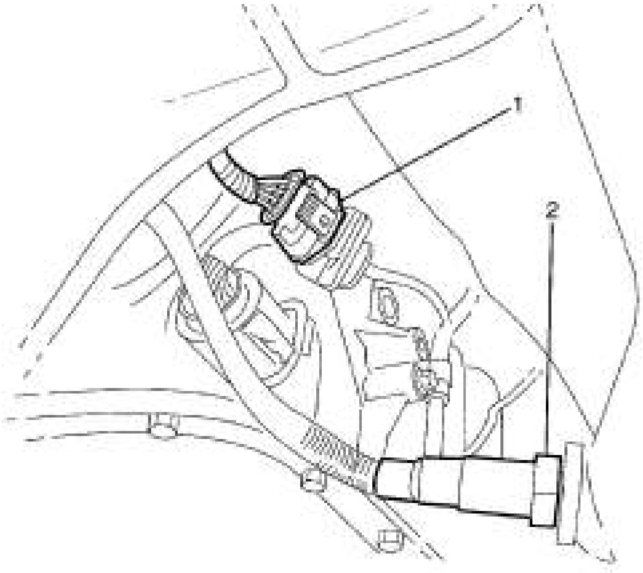
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



3. Disconnect the wiring harness connector (1) for the oxygen sensor wiring harness.
4. Loosen and remove the oxygen sensor (2) to catalytic converter. Take care not to damage the oxygen sensor.

Installation Procedure



Important: If using the old oxygen sensor (2) coat the threads with an anti-seize compound.

1. Install the oxygen sensor (2) to the right catalytic converter.

   Tighten
   Tighten the oxygen sensor to 40 N·m (30 lb ft).

2. Connect the wiring harness connector (1) to the oxygen sensor wiring harness.
3. Lower the vehicle.
4. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
5. If re-programming is required. Refer to Control Module References .
6. Check for codes using a suitable scanner.

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Heated Oxygen Sensor Replacement - Bank 2 Sensor 1

When removing the catalytic converters (1), it is necessary to disconnect the wiring harness connectors from the pre-catalytic oxygen sensor.

Service Precautions

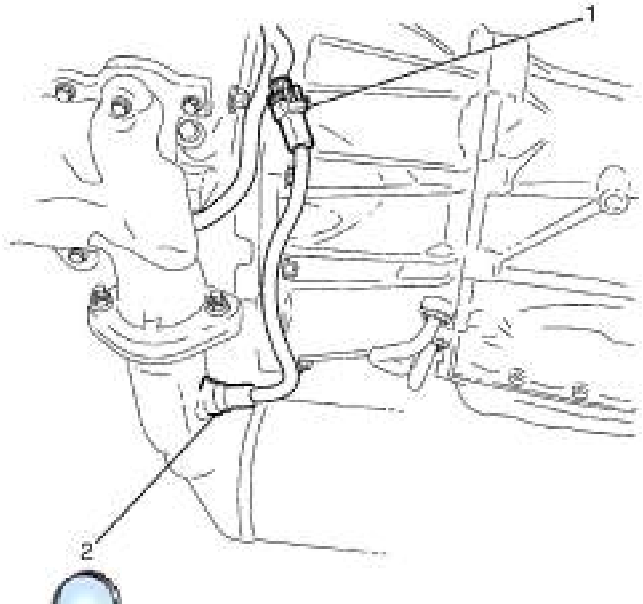
- Keep the oxygen sensor free of contaminates. Do not use any solvents to clean the sensor.
- Do not attempt to repair any part of the sensor including the wiring and connector. Replace the sensor if any damage is evident.
- When the exhaust system is cold the oxygen sensor may be difficult to remove. Excessive force may damage the threads in the exhaust assembly.
- If reusing the old oxygen sensor apply an anti-seize compound to the thread. New oxygen sensors come with the compound already applied.

Removal Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

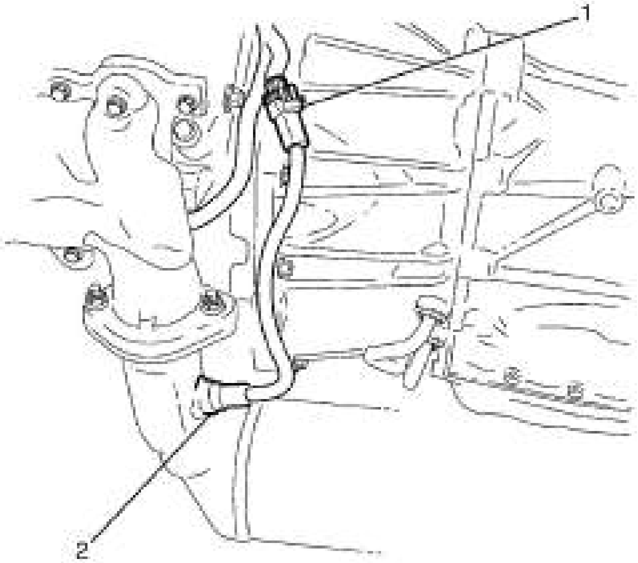
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



3. Disconnect the wiring harness connector (1) to the oxygen sensor wiring harness.
4. Remove the left catalytic converter from the vehicle. Refer to Catalytic Converter Replacement - Left Side .
5. Loosen and remove the oxygen sensor (2). Take care not to damage the oxygen sensor.

Installation Procedure

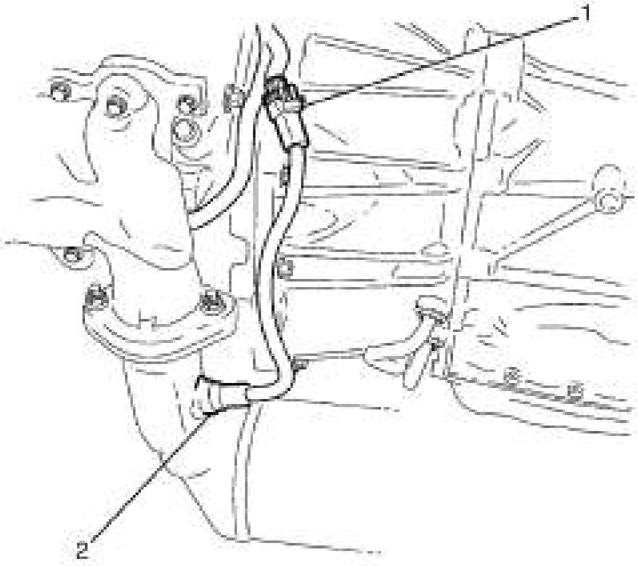


Important: If using the old oxygen sensor (2) coat the threads with an anti-seize compound.

1. Install the oxygen sensor (2) to the left catalytic converter.

   Tighten
   Tighten the oxygen sensor to 40 N·m (30 lb ft).

2. Install the left catalytic converter to the vehicle. Refer to Catalytic Converter Replacement - Left Side .



3. Connect the wiring harness connector (1) to oxygen sensor wiring harness.
4. Lower the vehicle.
5. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
6. If re-programming is required. Refer to Control Module References .
7. Check for codes using a suitable scanner,

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Heated Oxygen Sensor Replacement - Bank 2 Sensor 2

When removing the front exhaust pipes, it is necessary to disconnect the wiring harness connectors from the post-catalytic oxygen sensors.

Service Precautions

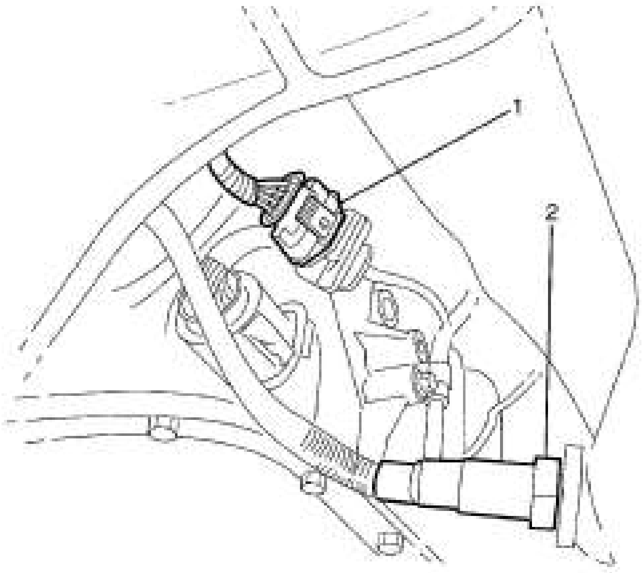
- Keep the oxygen sensor free of contaminates. Do not use any solvents to clean the sensor.
- Do not attempt to repair any part of the sensor including the wiring and connector. Replace the sensor if any damage is evident.
- When the exhaust system is cold the oxygen sensor may be difficult to remove. Excessive force may damage the threads in the exhaust assembly.
- If reusing the old oxygen sensor apply an anti-seize compound to the thread. New oxygen sensors come with the compound already applied.

Removal Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

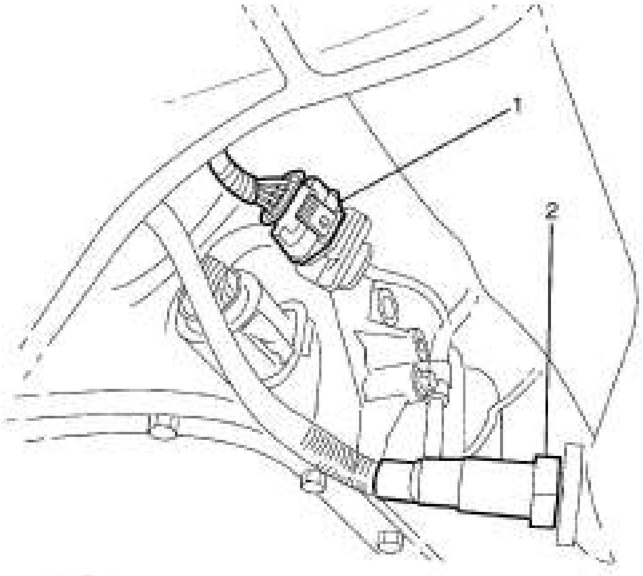
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



3. Disconnect the wiring harness connector (1) to the oxygen sensor wiring harness.
4. Loosen and remove the oxygen sensor (2). Take care not to damage the oxygen sensor.

Installation Procedure

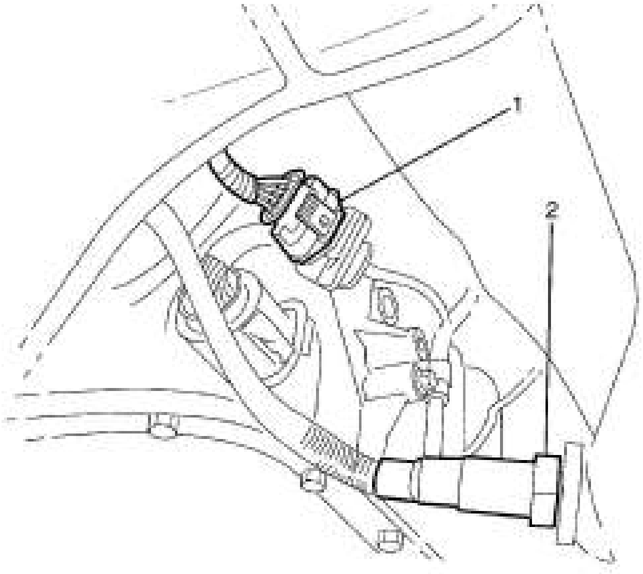


Important: If using the old oxygen sensor (2) coat the threads with an anti-seize compound.

1. Install the oxygen sensor (2) to the right catalytic converter.

   Tighten
   Tighten the oxygen sensor to 40 N·m (30 lb ft).

2. Tighten the oxygen sensor. Refer to Fastener Tightening Specifications .



3. Connect the wiring harness connector (1) to the oxygen sensor wiring harness.
4. Lower the vehicle.

5. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
6. If re-programming is required. Refer to Control Module References .
7. Check for codes using a suitable scanner.

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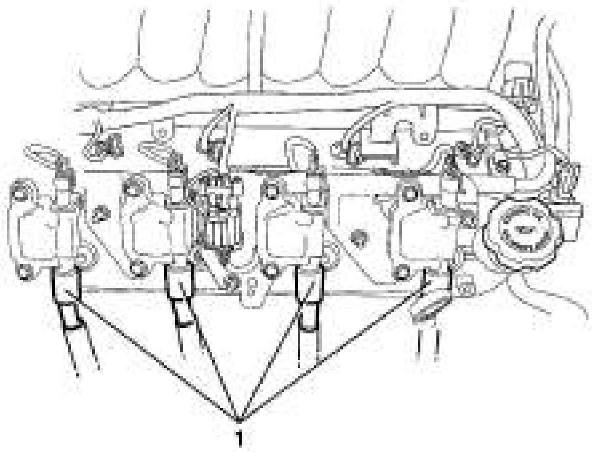
Ignition Coil Replacement

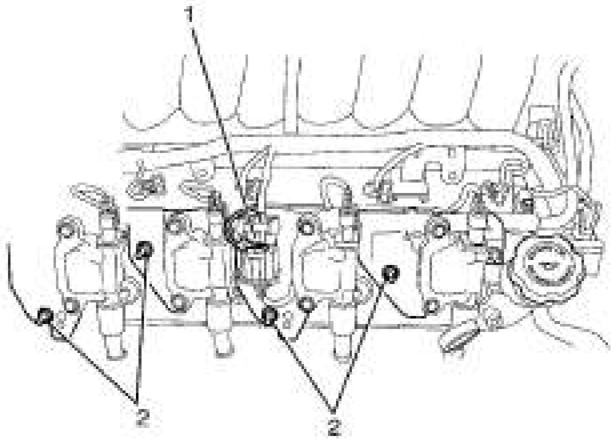
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

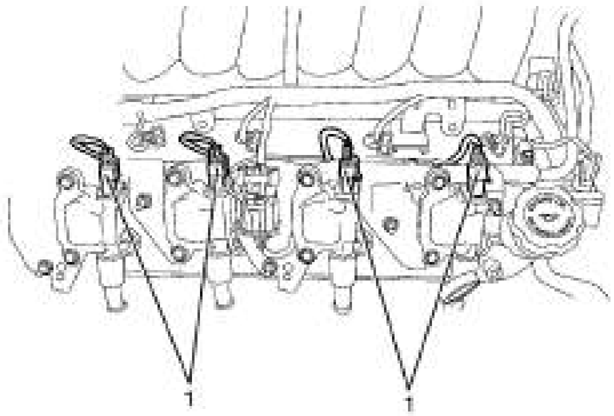
1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
2. Remove the engine cover. Refer to Engine Cover Replacement .



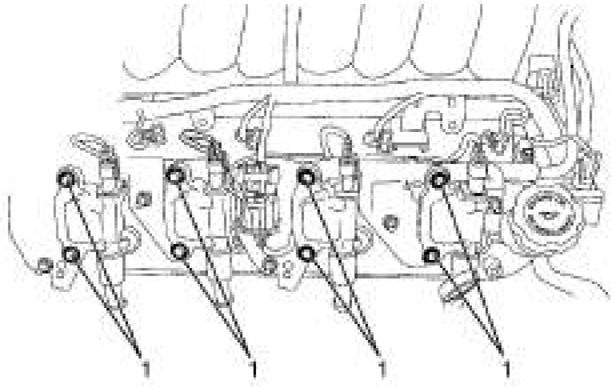
3. Disconnect the spark plug wires (1) from the ignition coils.



4. Disconnect the main ignition coil harness connector (1) from the ignition coil assembly.
5. Remove the ignition coil assembly to rocker cover retaining bolts (2).

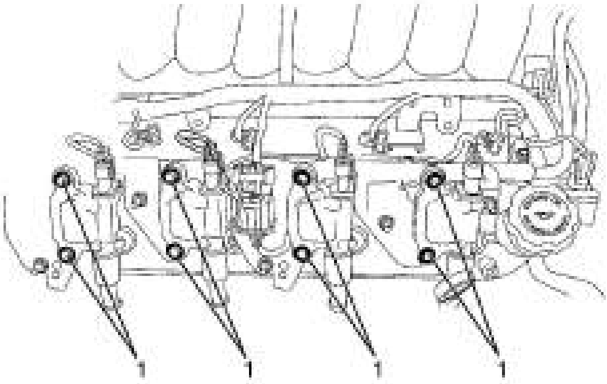


6. Remove the ignition coil assembly from the engine
7. Disconnect the ignition coil to ignition coil wiring harness connectors (1)



8. Remove the ignition coil to ignition coil assembly retaining bolts (1)
9. Remove the ignition coils from the ignition coil assembly.

Installation Procedure

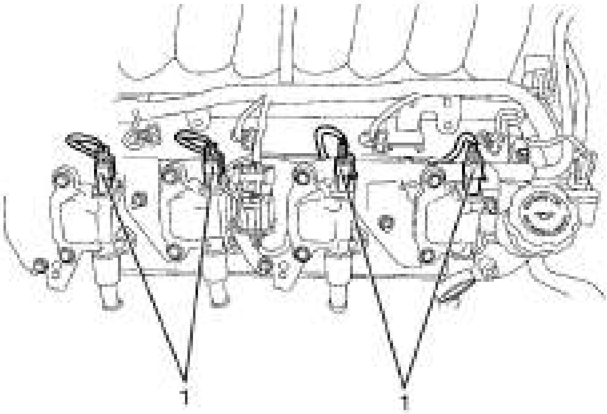


1. Install the ignition coil assembly.

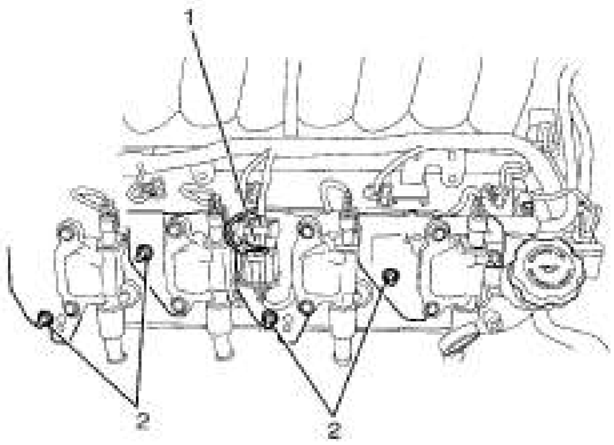
   Notice: Refer to Fastener Notice in the Preface section.

2. Install the ignition coil to ignition coil assembly retaining bolts (1).

   Tighten
   Tighten the bolts to 12 N·m (106 lb in).



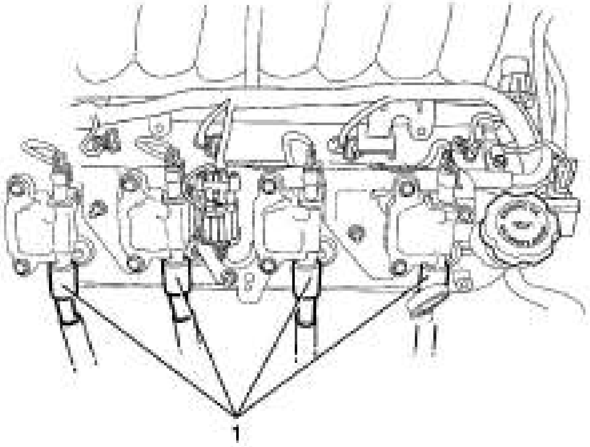
3. Connect the ignition coil to ignition coil wiring harness connectors (1).
4. Install the ignition coil assembly to the engine.



5. Install the ignition coil assembly to rocker cover retaining bolts (2)

   Tighten
   Tighten the bolts to 12 N·m (106 lb in).

6. Connect the main ignition coil harness connector (1) to the ignition coil assembly.



7. Connect the spark plug wires (1) to the ignition coils.
8. Install the engine cover. Refer to Engine Cover Replacement .
9. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .

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Knock Sensor Replacement

Removal Procedure

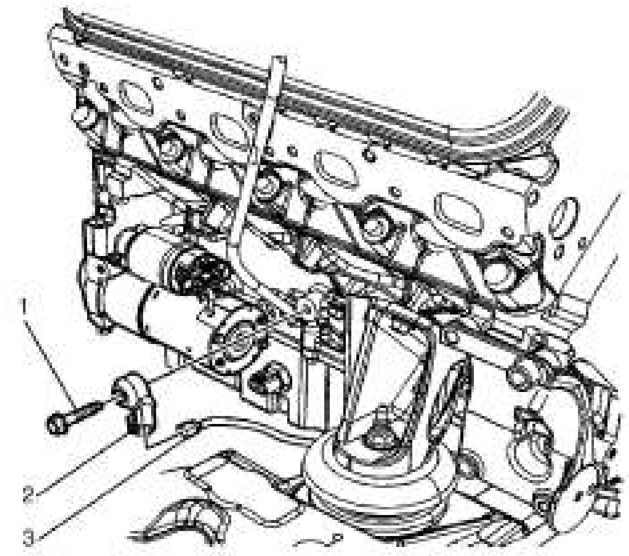
Right Bank

Caution: Refer to Protective Goggles and Glove Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

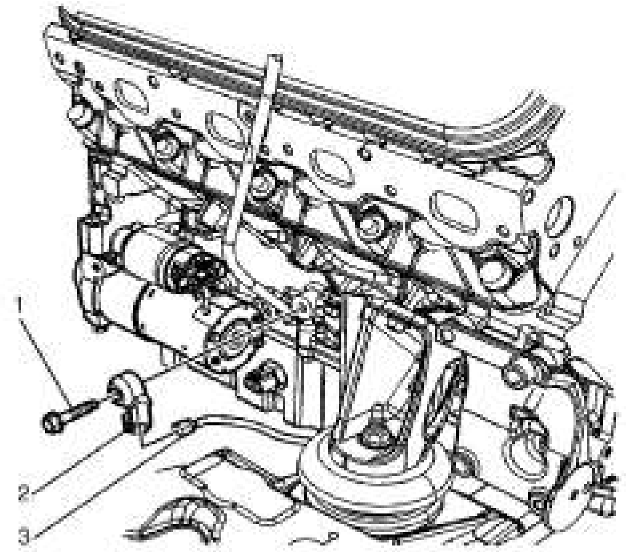
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Remove the starter motor. Refer to Starter Motor Replacement.



4. Disconnect the engine wiring harness (3) from the knock sensor (2).
5. Remove the knock sensor to engine block retaining bolt (1).
6. Remove the knock sensor (2) from the engine block.

Installation Procedure



1. Connect the engine wiring harness (3) to the knock sensor (2).
2. Position the knock sensor (2) on the engine block.

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the knock sensor to engine block retaining bolt (1).

   Tighten
   Tighten the bolt to 20 N·m (15 lb ft).

4. Install the starter motor. Refer to Starter Motor Replacement.
5. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.

Removal Procedure

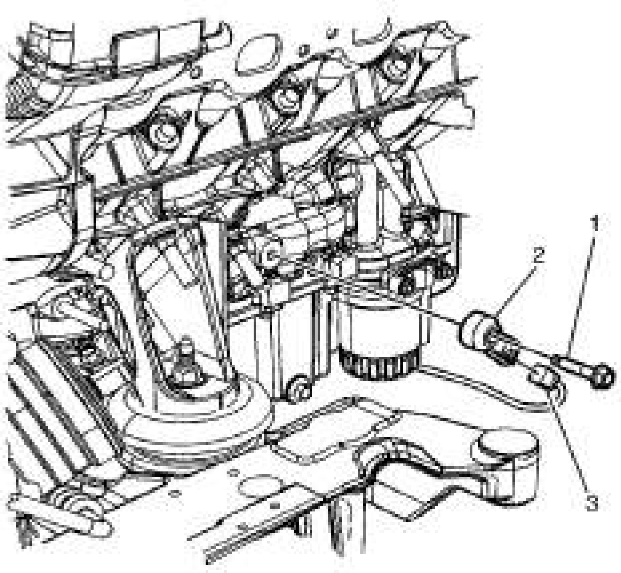
Left Bank

Caution: Refer to Protective Goggles and Glove Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

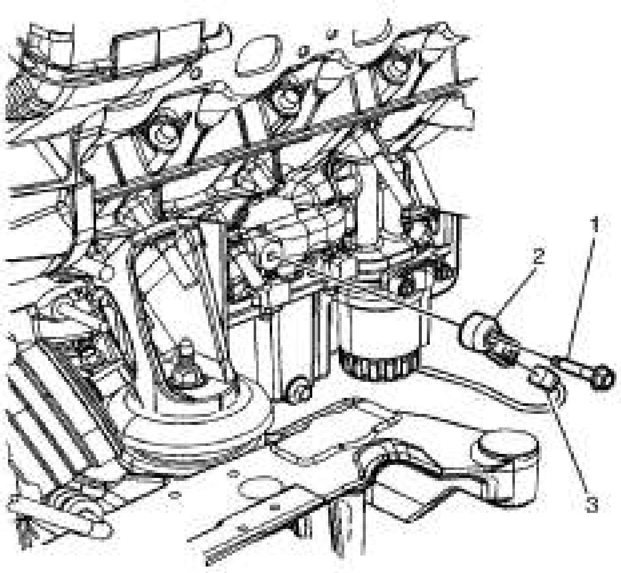
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



3. Disconnect the engine wiring harness (3) from the knock sensor (2).
4. Remove the knock sensor to engine block retaining bolt (1).
5. Remove the knock sensor (2) from the engine block.

Installation Procedure



1. Connect the engine wiring harness (3) to the knock sensor (2).
2. Position the knock sensor (2) on the engine block.

Notice: Refer to Fastener Notice in the Preface section.

3. Install the knock sensor to engine block retaining bolt (1).

Tighten
Tighten the bolt to 20 N·m (15 lb ft).

4. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.

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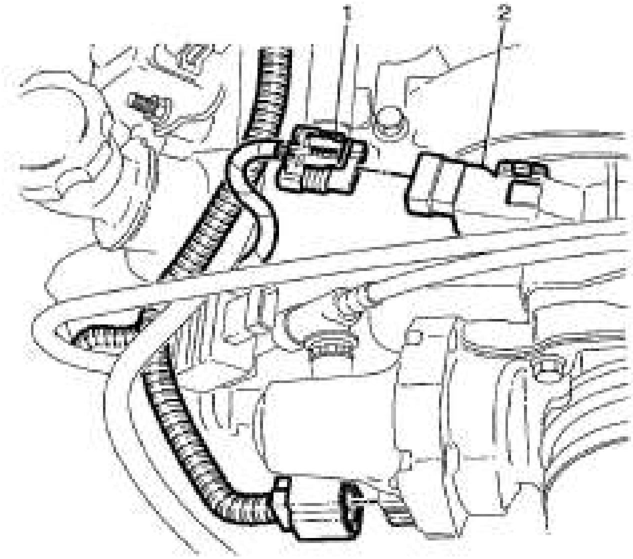
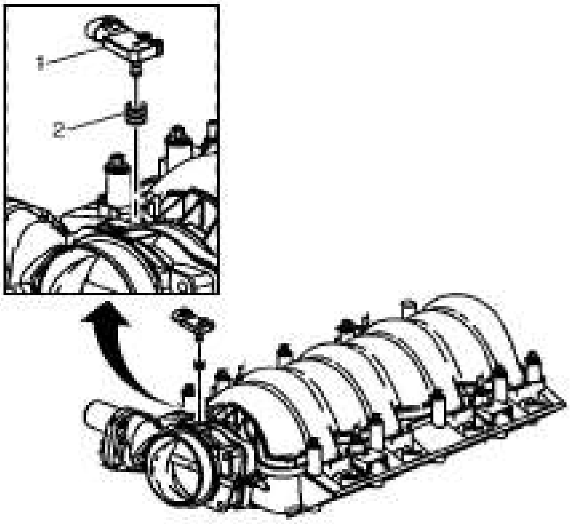
Manifold Absolute Pressure Sensor Replacement

Removal Procedure

1. Remove the oil filler cap.
2. Remove the engine cover. Refer to Engine Cover Replacement.

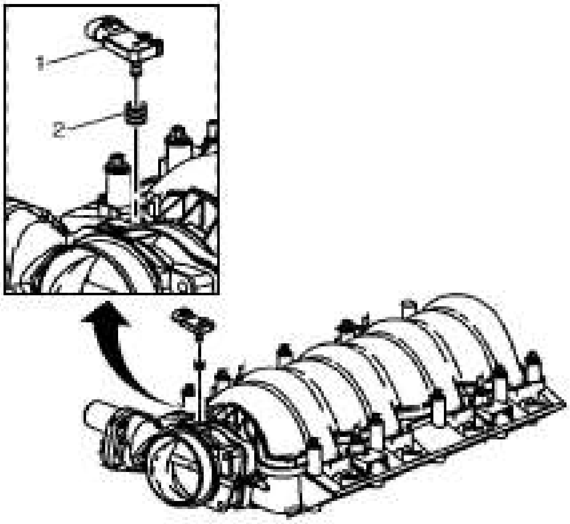


3. Disconnect the manifold absolute pressure (MAP) sensor wiring harness connector (1).
4. Disengage the MAP sensor (2) to MAP sensor retaining clip.

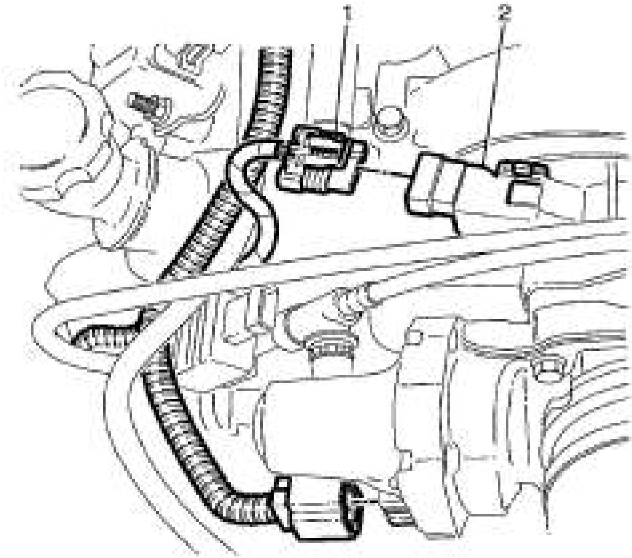


5. Remove the MAP sensor (1) from the intake manifold.
6. Check the MAP sensor seal (2) for deterioration, replace if necessary.

Installation Procedure



1. Install the MAP sensor (1) to the intake manifold.



2. Make sure that the MAP sensor (2) is engaged into the MAP sensor retaining clip.
3. Connect the MAP sensor wiring harness connector (1) to the MAP sensor.
4. If re-programming is required. Refer to Control Module References .
5. Install the engine cover. Refer to Engine Cover Replacement .
6. Install the oil filler cap.

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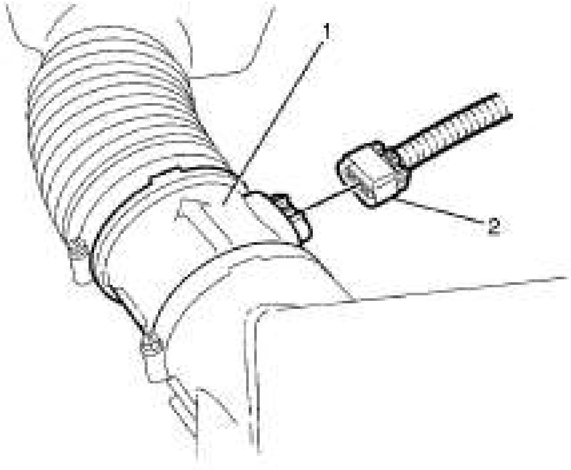
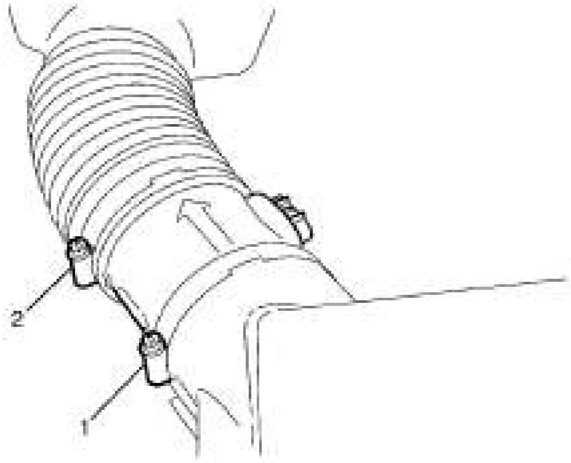
Mass Airflow Sensor with Intake Air Temperature Sensor Replacement

Removal Procedure

1. Remove the radiator and air baffle. Refer to Radiator Air Upper Baffle and Deflector Replacement .

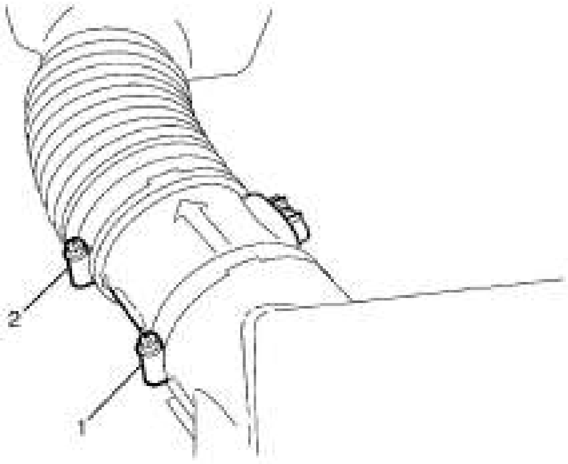


2. Disconnect the mass air flow (MAF)/air intake temperature (IAT) wiring harness connector (2) to mass air flow (MAF)/air intake temperature (IAT) sensor (1).



3. Loosen the air intake duct to MAF/IAT sensor retaining clamp (2).
4. Loosen the upper air cleaner body to MAF/IAT sensor retaining clamp (1).
5. Remove the air intake duct from the mass air flow MAF/IAT sensor.
6. Remove the MAF/IAT sensor (3) from the upper air cleaner body.

Installation Procedure



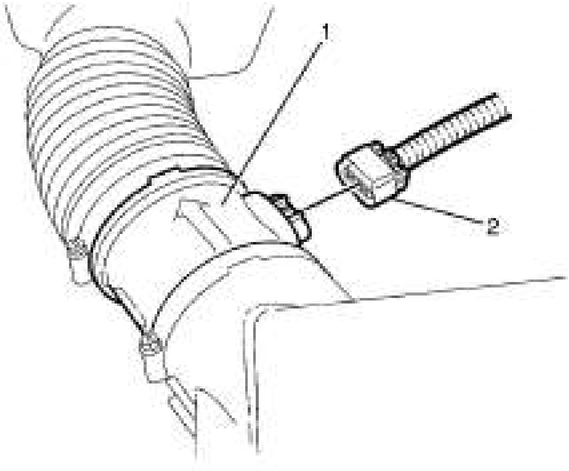
Important: Make sure that the arrow on the MAF/IAT sensor is pointing to the front, radiator, indicate the proper air flow direction. The arrow must point toward the engine.

1. Install the MAF/IAT sensor to the upper air cleaner body.
2. Install the air intake duct to the MAF/IAT sensor.
3. Position the retaining clamps (1 and 2) to the MAF/IAT sensor.

Notice: Refer to Fastener Notice in the Preface section.

4. Tighten the MAF/IAT retaining clamps (1 and 2).

Tighten
Tighten the clamps to 4 N·m (35 lb in).



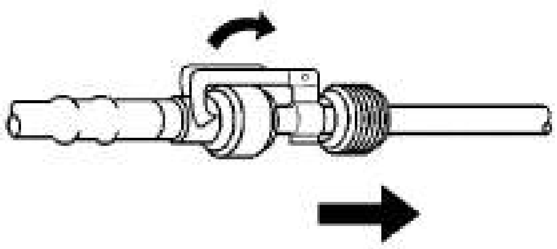
5. Connect the MAF/IAT wiring harness connector (2) to the MAF/IAT sensor.
6. If re-programming is required. Refer to Control Module References .
7. Install the radiator and air baffle. Refer to Radiator Air Upper Baffle and Deflector Replacement .

Metal Collar Quick Connect Fitting Service

Tools Required

- 7370 Fuel Line Quick Connect Separator
- 7371 Fuel Line Quick Connect Separator
- J 37088-A Fuel Line Quick Connect Separator

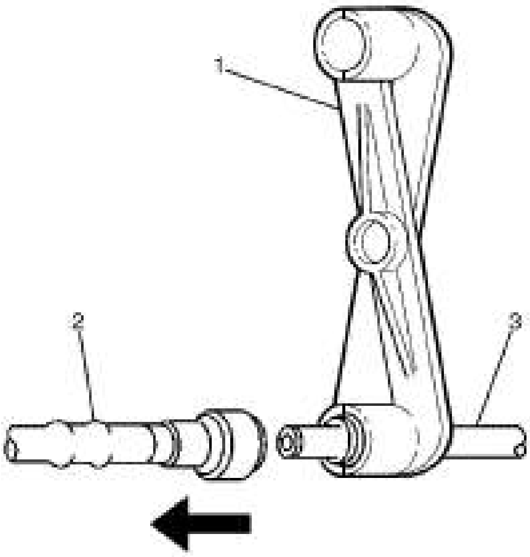
Removal Procedure



1. Before you service any fuel system connection, relieve the fuel system pressure Refer to the Fuel Pressure Relief.
2. Slide the dust cover from the quick-connect fitting if fitted.
3. Disconnect the fuel hose clip verifier from the quick connect fitting.

Caution: Wear safety glasses when using compressed air, as flying dirt particles may cause eye injury.

4. Use compressed air in order to blow any dirt from the fitting.

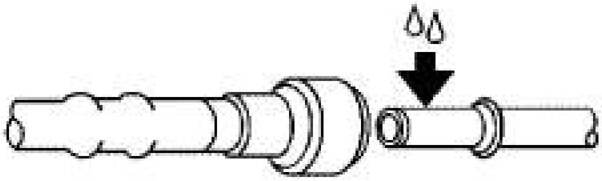


5. Choose the correct tool (1) for the size of the fitting from J 37088-A , 7370 or 7371 . Insert the selected tool into the male connector (3), then push inward in order to release the locking tabs.
6. Pull the female connector (2) away from the male connector.
7. Remove the J 37088-A Fuel Line Quick Connect Separator, 7370 or 7371 from the male connector.

Notice: If necessary, remove rust or burrs from the fuel pipes with an emery cloth. Use a radial motion with the fuel pipe end in order to prevent damage to the O-ring sealing surface. Use a clean shop towel in order to wipe off the male tube ends. Inspect all the connections for dirt and burrs. Clean or replace the components and assemblies as required.

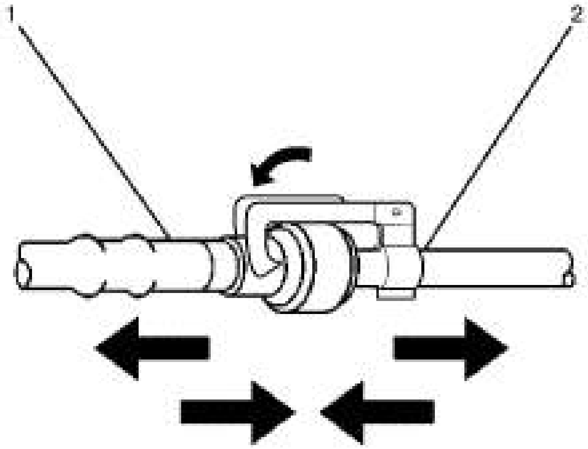
8. Using a clean shop towel, wipe off the male pipe end.
9. Inspect both ends of the fitting for dirt and for burrs. Clean or replace the components as required.

Installation Procedure

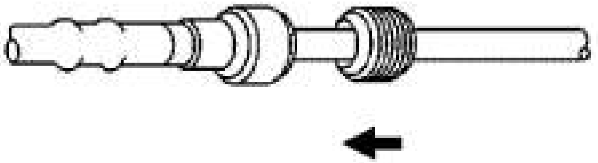


Caution: Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings in order to reduce the risk of fire and personal injury. This will ensure proper reconnection and prevent a possible fuel leak. During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.

1. Apply a few drops of clean engine oil to the male pipe end.
2. Push both sides of the fitting together in order to cause the retaining tabs to snap into place.



3. Pull and push repeatedly on both sides (1 and 2) of the fitting to make sure the connection is secure.
4. Connect the fuel hose clip verifier from the quick connect fitting.



5. Reposition the dust cover over the quick-connect fitting if fitted.

Plastic Collar Quick Connect Fitting Service

Tools Required

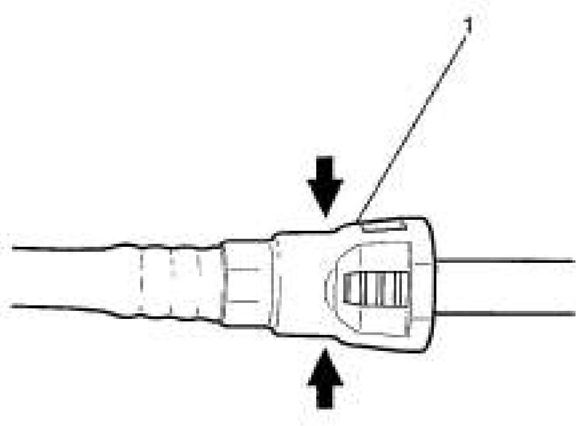
AU-533

Removal Procedure

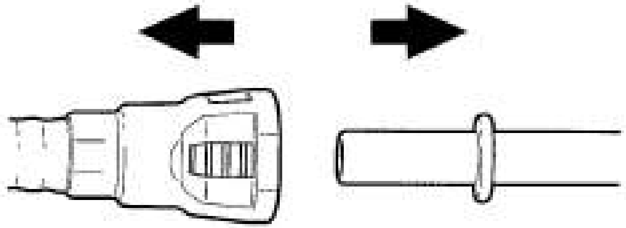
Caution: Refer to Gasoline/Gasoline Vapors Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief .
2. Blow dirt out of the fitting using compressed air.



3. Install the quick connect tool over the quick connect fitting (1).



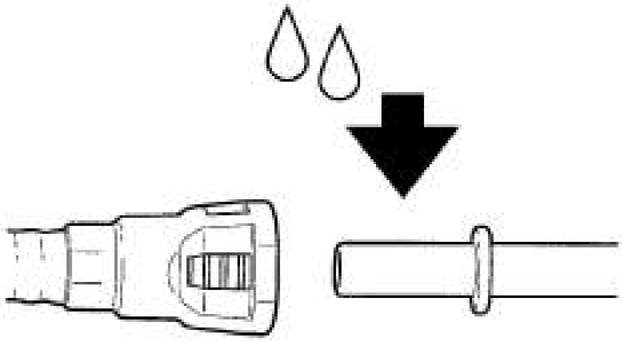
4. Pull the connection apart.
5. Using a clean shop towel, wipe off the male pipe end
6. Inspect both ends of the fitting for dirt and burrs.
7. Clean or replace the components as required.

Installation Procedure

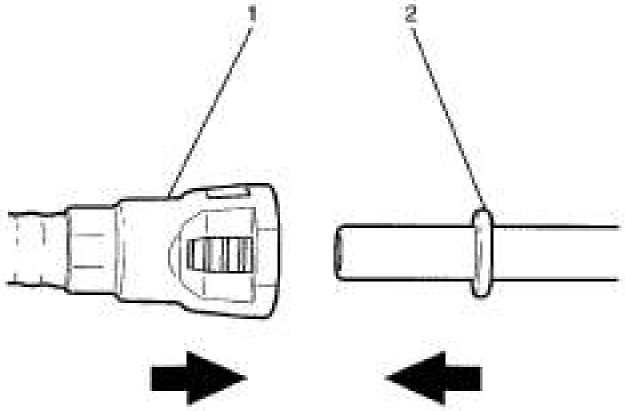
Caution: In order to reduce the risk of fire and personal injury, before connecting fuel pipe fittings, always apply a few drops of clean engine oil to the male pipe ends.

This will ensure proper reconnection and prevent a possible fuel leak.

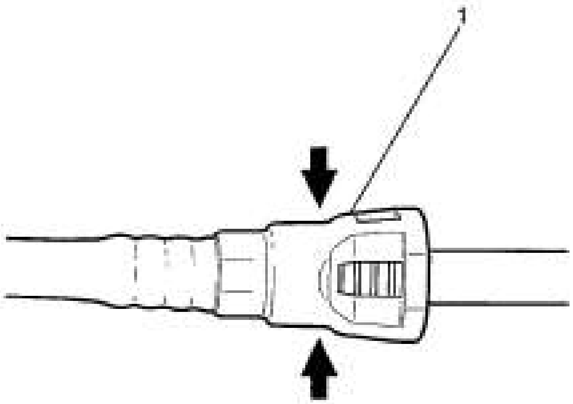
During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.



1. Apply a few drops of clean engine oil to the male pipe end.



2. Push both sides (1 & 2) of the quick-connect fitting together to cause the retaining tabs/fingers to snap into place.



3. Pull on both sides of the quick-connect fitting (1) to make sure the connection is secure.
4. Inspect for leaks using the following procedure:
    - 4.1. Turn the ignition ON, with the engine OFF for 2 seconds.
    - 4.2. Turn the ignition OFF, for 10 seconds.
    - 4.3. Turn the ignition ON, with the engine OFF for 2 seconds.
    - 4.4. Turn the ignition OFF.
    - 4.5. Inspect for leaks.

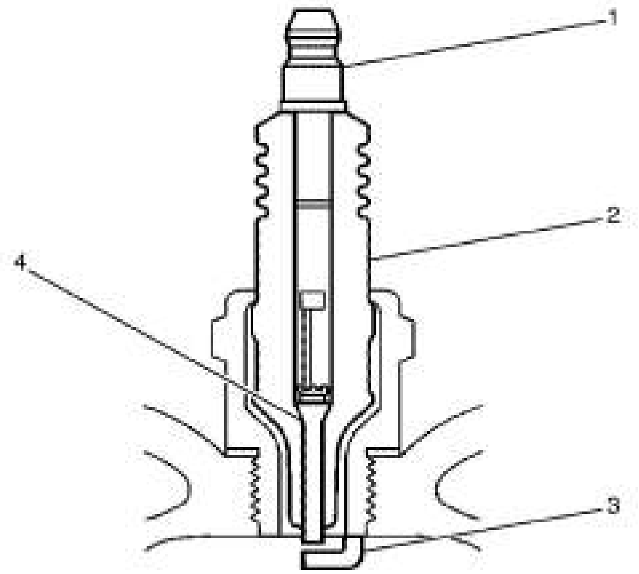
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L | Repair Instructions | **Document ID: 2037121**

Spark Plug Inspection

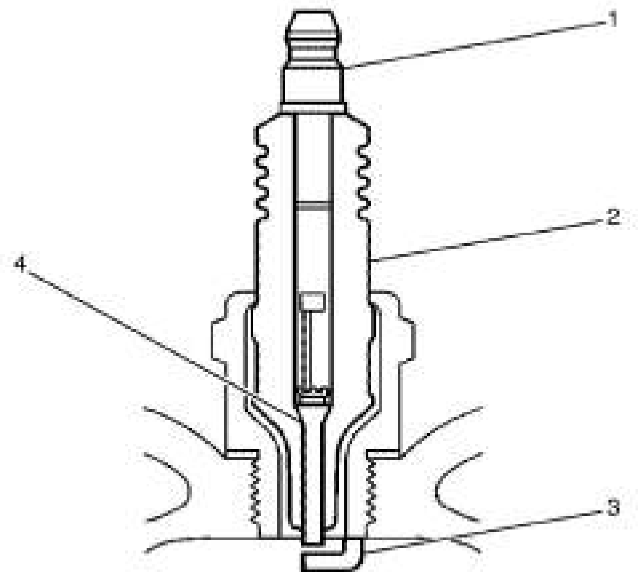
Spark Plug Usage

- Make sure that the correct spark plug is installed. An incorrect spark plug causes poor driveability conditions. Refer to Ignition System Specifications .
- Make sure that the spark plug has the correct heat range. An incorrect heat range causes the following conditions:
  - Spark plug fouling due to a colder plug
  - A pre-ignition condition, causing spark plug and/or engine damage due to a hotter plug

Spark Plug Inspection

- 

  - Inspect the terminal post (1) for damage.
  - Inspect for a bent or broken terminal post (1).
  - Test for a loose terminal post (1) by twisting and pulling the post. The terminal post (1) should NOT move.
-



- Inspect the insulator (2) for flashover or for carbon tracking soot. This condition is caused by the electrical charge travelling across the insulator (2) between the terminal post (1) and ground. Inspect for the following conditions:
  - Inspect the spark plug boot for damage.
  - Inspect the spark plug recess area of the cylinder head for moisture from such as oil, coolant, or from water. A saturated spark plug boot causes arcing to ground.

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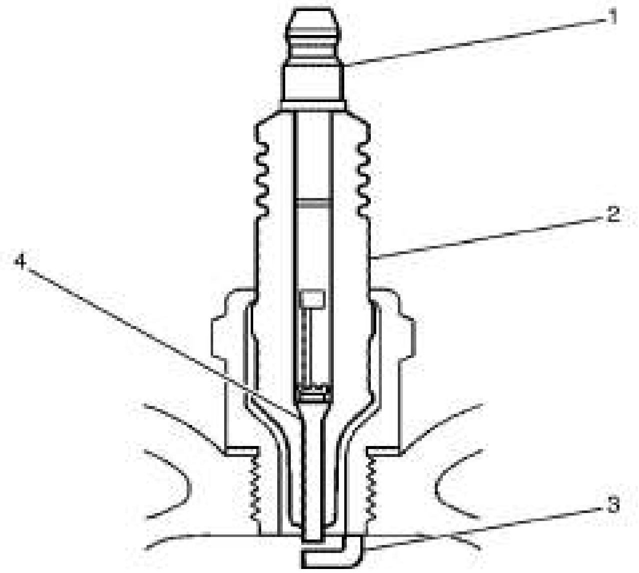
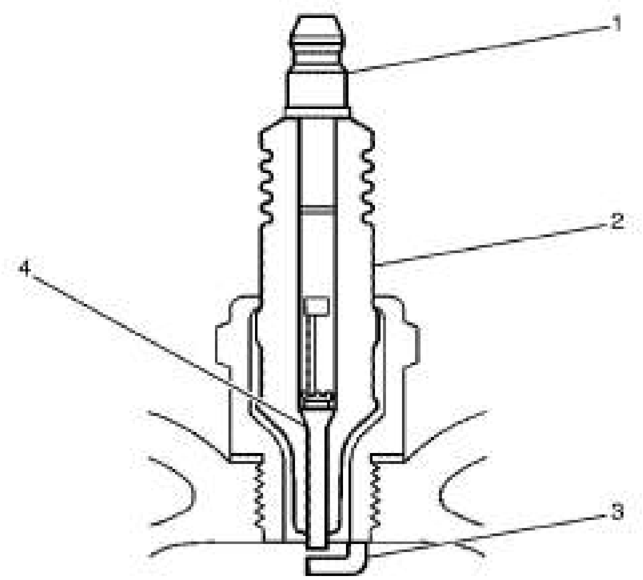


- Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of through the electrodes (3, 4).

•



- l Inspect for evidence of incorrect arcing.
- Measure the gap between the centre electrode (4) and the side electrode (3) terminals. Refer to Ignition System Specifications.
- Inspect for the correct spark plug torque. Refer to Ignition System Specifications . Insufficient torque can prevent correct spark plug operation. An over-torqued spark plug causes the insulator (2) to crack.
- Inspect for signs of tracking that occurred near the insulator tip instead of at the centre electrode (4).
- Inspect for a side electrode (3) that is broken or worn.
- Inspect for a broken, worn, or loose centre electrode (4) by shaking the spark plug.
- A rattling sound indicates internal damage.
- A loose centre electrode (4) reduces the spark intensity.
- Inspect for bridged electrodes (3 and 4). Deposits on the electrodes reduce or eliminate the gap.
- Inspect for worn or missing platinum pads on the electrodes (3 and 4), if equipped.
- Inspect for excessive fouling.
- l Inspect the spark plug recess area of the cylinder head for debris. Dirty or damaged threads can cause the spark plug not to seat correctly during installation.

Spark Plug Visual Inspection

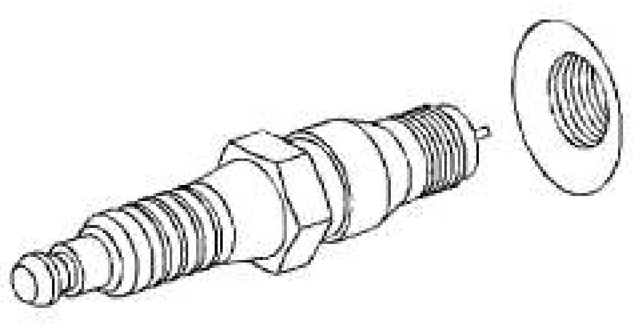
- l Normal operation. Brown to grayish-tan spark plugs, with small amounts of white powdery deposits are normal combustion by-products from fuels with additives.
- l Carbon-fouled plugs. Dry, fluffy black carbon or soot caused by the following conditions:
- Rich fuel mixtures
- Leaking fuel injectors
- Excessive fuel pressure

- Restricted air filter element
- Incorrect combustion
- Reduced ignition system voltage output
  - Weak coils
  - Worn ignition wires
  - Incorrect spark plug gap
- Excessive idling or slow speeds during light loads can keep the spark plug temperatures so low that the normal combustion deposits may not burn off.
- Deposit fouling. Oil, coolant, or additives that include substances such as silicone, evidenced by a very white coating, reduces the spark intensity. Most powdery deposits will not affect spark intensity unless they form into a glazing over the electrode.

Spark Plug Replacement

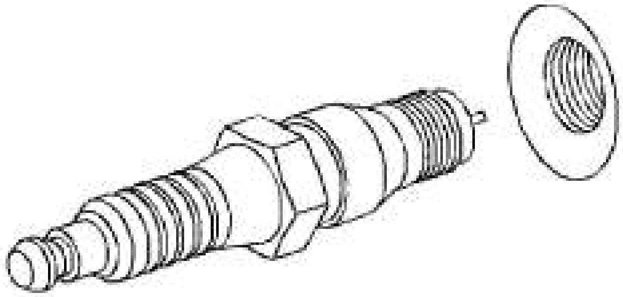
Removal Procedure

1. Remove the engine cover. Refer to Engine Cover Replacement .
2. Remove the spark plug wires. Refer to Spark Plug Wire Replacement .



3. Loosen each spark plug 1 or 2 turns.
4. Use a brush, or use compressed air in order to remove any dirt from the spark plugs.
5. Remove the spark plugs one at a time and place each plug in a tray marked with the corresponding cylinder numbers.

Installation Procedure



1. Inspect each spark plug gap. Adjust each plug as needed.

   Specification
   Spark plug gap: 1.524 mm (0.060 in).

   Notice: Refer to Fastener Notice in the Preface section.

2. Hand start the spark plugs in the corresponding cylinders.
3. Tighten the spark plugs.

   Tighten
   - Tighten the engine spark plug on a NEW cylinder head to 20 N·m (15 lb ft).
   - Tighten the engine spark plug on subsequent installations to 15 N·m (11 lb ft).
4. Install the spark plug wires. Refer to Spark Plug Wire Replacement .
5. Install the engine cover. Refer to Engine Cover Replacement .

Spark Plug Wire Inspection

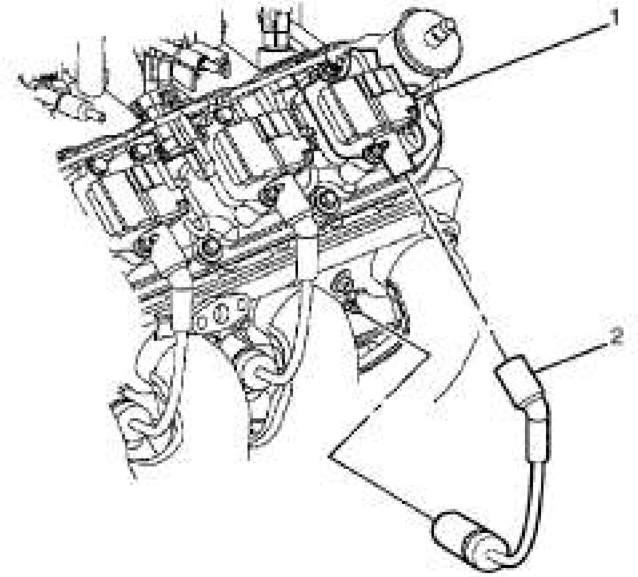
Important: Spark plug wire integrity is vital for proper engine operation. A thorough inspection will be necessary to accurately identify conditions that may affect engine operation. Inspect for the following conditions:

1. Correct routing of the spark plug wires. Incorrect routing may cause cross-firing.
2. Inspect for any signs of cracks or splits in the wires.
3. Inspect each boot for the following conditions:
    - Tearing
    - Piercing
    - Arcing
    - Carbon tracking
    - Corroded terminals
4. If corrosion, carbon tracking or arcing are indicated on a spark plug wire boot or on a terminal, replace the wire and the component connected to the wire.

Spark Plug Wire Replacement

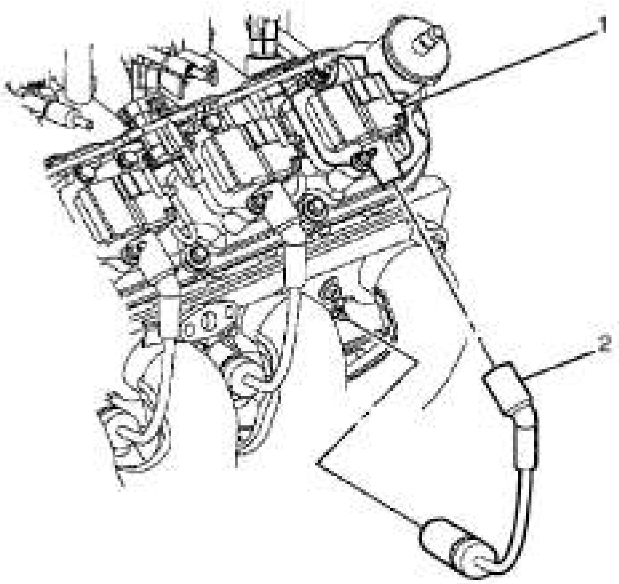
Removal Procedure

1. Remove the engine cover. Refer to Engine Cover Replacement .



2. Disconnect the spark plug wire (2) to the spark plug.
   - Twist each spark plug boot 1/2 turn.
   - Pull only on the boot in order to remove the wire from each spark plug.
3. Disconnect the spark plug wire from the ignition coil (1).
   - Twist each spark plug boot 1/2 turn.
   - Pull only on the boot in order to remove the wire from the ignition coil.

Installation Procedure



1. Install the spark plug wire to the ignition coil (1).
2. Install the spark plug wire (2) to the spark plug.
3. Inspect the spark plug wire for proper installation:
   - Push sideways on each spark plug boot in order to inspect the seating.
   - Reinstall any loose spark plug boot.
4. Install the engine cover. Refer to Engine Cover Replacement .

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L | Repair Instructions | **Document ID: 2038138**

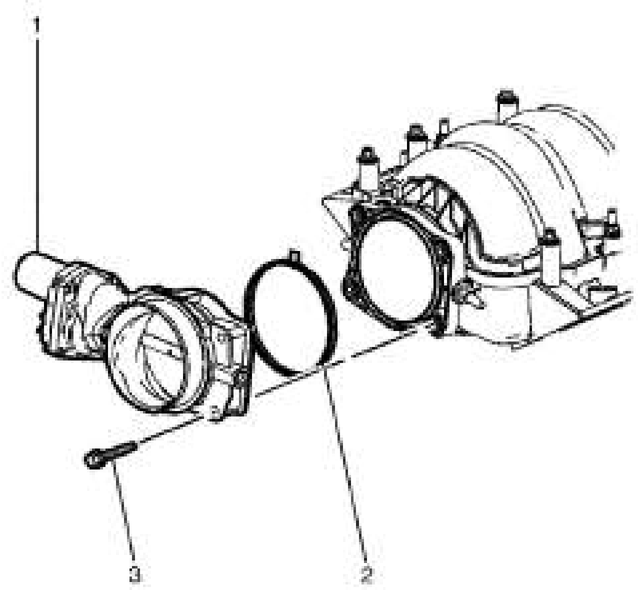
Throttle Body Assembly Replacement

Removal Procedure

1. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.

Notice: Do not insert any tools into the throttle body bore in order to avoid damage to the throttle valve plate.

Notice: Handle the electronic throttle control components carefully. Use cleanliness in order to prevent damage. Do not drop the electronic throttle control components. Do not roughly handle the electronic throttle control components. Do not immerse the electronic throttle control components in cleaning solvents of any type.



Important: The intake manifold, throttle body, fuel injection rail, and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.

2. Remove the electrical wire harness connector from the throttle body.
3. Remove the throttle body to intake manifold retaining bolts (3).
4. Remove the throttle body (1).

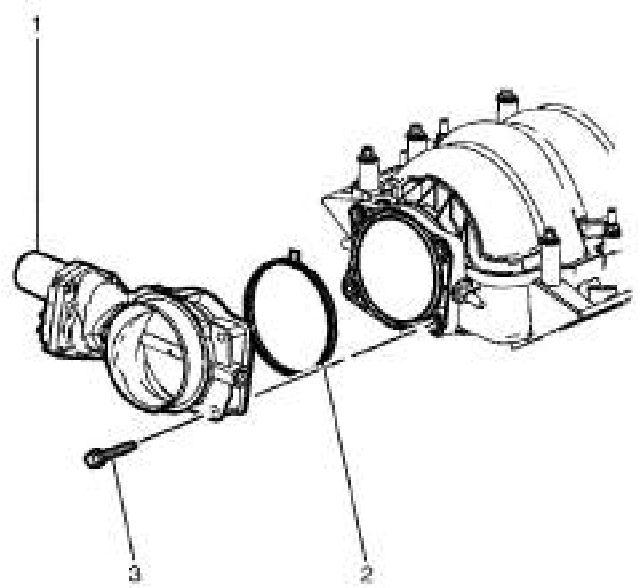
Important: The throttle body gasket is a single use part. The gasket must be discarded after removal.

5. Remove the throttle body to intake manifold gasket (2), and discard.

Discard the throttle body gasket.

6. Clean the throttle body and intake manifold mating surfaces.

Installation Procedure



Important: DO NOT use the throttle body gasket again. Install a NEW gasket during assembly.

1. Install a new throttle body to intake manifold gasket (2). Align the locating tab of the gasket with the notch in the manifold.
2. Install the throttle body (1) to the intake manifold.

Notice: Refer to Fastener Notice in the Preface section.

3. Install the throttle body to intake manifold retaining bolts (3).

Tighten
Tighten the bolts to 12 N·m (106 lb in).

4. Install the electrical wire harness connector from the throttle body.
5. Install the air intake duct to the throttle body. Refer to Air Cleaner Inlet Duct Replacement.
6. If re-programming is required. Refer to Control Module References.

Throttle Body Cleaning

Important: Over extended time and mileage, deposits may accumulate on the back of the throttle valve plate. Occasionally the deposit may accumulate to a point where perceived pedal effort is affected. This procedure should not be performed on vehicles with low mileage, under 80 450 kilometers (50,000 miles).

1. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.

   Notice: Do not insert any tools into the throttle body bore in order to avoid damage to the throttle valve plate.

2. Inspect the throttle body bore and inspect the throttle valve plate for deposits. The throttle valve must be opened in order to inspect all surfaces.

   Notice: Do not use any solvent that contains Methyl Ethyl Ketone (MEK). This solvent may damage fuel system components.

3. Clean the throttle body bore and the throttle valve plate using a clean shop towel with an approved Top Engine Cleaner.
4. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.

Throttle Learn

Description

The engine control module (ECM) learns the airflow through the throttle body to ensure the correct idle. The learned airflow values are stored within the ECM. These values are learned to adjust for production variation and will continuously learn during the life of the vehicle to compensate for reduced airflow due to coking. Anytime the throttle body airflow rate changes, for example due to cleaning or replacing, the values must be relearned.

A vehicle that had a heavily coked throttle body that has been cleaned or replaced may take several drive cycles to learn out the coking. To accelerate the process, the scan tool has the ability to reset all learned values back to zero. A new ECM will also have values set to zero.

The idle may be unstable or a DTC may set if the learned values do not match the actual airflow.

Conditions for Running the Throttle Learn Procedure

With Scan Tool - Reset Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0220, P0222, P0223, P0300, P0351, P0352, P0353, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, or P2176 are not set.
- Ignition ON, engine OFF.
- The vehicle speed sensor (VSS) is 0 km/h (0 mph).

Without Scan Tool - Learn Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0220, P0222, P0223, P0300, P0351, P0352, P0353, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, or P2176 are not set.
- The engine speed is between 450-4,000 RPM.
- The manifold absolute pressure (MAP) is greater than 5 kPa.
- The mass air flow (MAF) is greater than 2 g/s.
- The ignition 1 voltage is greater than 10 volts.

Throttle Learn

With Scan Tool - Reset Procedure

1. Ignition ON, engine OFF, with a scan tool, perform the Idle Learn Reset in Module Setup.
2. Start the engine, monitor the TB Idle Airflow Compensation parameter. The TB Idle Airflow

Compensation value should equal 0 percent and the engine should be idling at a normal idle speed.

3. Clear the DTCs and return to the diagnostic that referred you here.

Without Scan Tool - Learn Procedure

Important: Do NOT perform this procedure if DTCs are set. Refer to Diagnostic Trouble Code (DTC) List - Vehicle.

1. Start and idle the engine in PARK for 3 minutes.
2. With a scan tool, monitor desired and actual RPM.
3. The ECM will start to learn the new idle cells and Desired RPM should start to decrease.
4. Ignition OFF for 60 seconds.
5. Start and idle the engine in PARK for 3 minutes.
6. After the 3 minute run time the engine should be idling normal.

   Important: During the drive cycle the check engine light may come on with idle speed DTCs. If idle speed codes are set, clear codes so the ECM can continue to learn.

   If the engine idle speed has not been learned the vehicle will need to be driven at speeds above 70 km/h (44 mph) with several decelerations and extended idles.

7. After the drive cycle, the engine should be idling normally.

   If the engine idle speed has not been learned, turn OFF the ignition for 60 seconds and repeat step 6.

8. Once the engine speed has returned to normal, clear DTCs and return to the diagnostic that referred you here.

Cylinder Deactivation (Active Fuel Management) System Description

To provide maximum fuel economy under light load driving conditions, the engine control module (ECM) will command the cylinder deactivation system ON to deactivate engine cylinders 1 and 7 on the left bank, and cylinders 4 and 6 on the right bank, switching to a V4 mode. The engine will operate on 8 cylinders, or V8 mode, during engine starting, engine idling, and medium to heavy throttle applications.

When commanded ON, the ECM will determine what cylinder is firing, and begin deactivation on the next closest deactivated cylinder in firing order sequence. The Gen IV engine has a firing order of 1-8-7-2-6-5-4-3. If cylinder number 1 is on its combustion event when cylinder deactivation is commanded ON, the next cylinder in the firing order sequence that can be deactivated is cylinder number 7. If cylinder number 5 is on its combustion event when cylinder deactivation is commanded ON, then the next cylinder in the firing order sequence that can be deactivated is cylinder number 4.

Cylinder deactivation is accomplished by not allowing the intake and exhaust valves to open on the selected cylinders by using special valve lifters. The deactivation lifters contain spring loaded locking pins that connect the internal pin housing of the lifter to the outer housing. The pin housing contains the lifter plunger and pushrod seat which interfaces with the pushrod. The outer housing contacts the camshaft lobe through a roller. During V8 mode, the locking pins are pushed outward by spring force, locking the pin housing and outer housing together causing the lifter to function as a normal lifter. When V4 mode is commanded ON, the locking pins are pushed inward with engine oil pressure directed from the valve lifter oil manifold (VLOM) assembly solenoids. When the lifter pin housing is unlocked from the outer housing, the internal pin housing will remain stationary, while the outer housing will move with the profile of the camshaft lobe, which results in the valve remaining closed. One VLOM solenoid controls both the intake and exhaust valves for each deactivating cylinder. There are 2 distinct oil passages going to each cylinder deactivation lifter bore, one for the hydraulic lash-adjusting feature of the lifter, and one for controlling the locking pins used for cylinder deactivation.

Although both intake and exhaust valve lifters are controlled by the same solenoid in the VLOM, the intake and exhaust valves do not become deactivated at the same time. Cylinder deactivation is timed so that the cylinder is on an intake event. During an intake event, the intake cam lobe is pushing the valve lifter upwards to open the intake valve against the force of the valve spring. The force exerted by the valve spring is acting on the side of the lifter locking pins, preventing them from moving until the intake valve has closed. When the intake valve lifter reaches the base circle of the camshaft lobe, the valve spring force is reduced, allowing the locking pins to move, deactivating the intake valve. However, when cylinder deactivation is commanded ON, the exhaust valve for the deactivated cylinder is in the closed position, allowing the locking pins on the valve lifter to move immediately, and deactivate the exhaust valve.

By deactivating the exhaust valve first, this allows the capture of a burnt air/fuel charge or exhaust gas charge in the combustion chamber. The capture of exhaust gases in the combustion chamber will contribute to a reduction in oil consumption, noise and vibration levels, and exhaust emissions when operating in V4 mode. During the transition from V8 to V4 mode, the fuel injectors will be turned OFF on the deactivated cylinders. The ignition system secondary voltage or spark is still present across the spark plug electrodes on the deactivated cylinders. If all enabling conditions are met and maintained for cylinder deactivation operation, the ECM calibrations will limit cylinder deactivation to a cycle time of 10 minutes in V4 mode, and then return to V8 mode for 1 minute.

Switching between V8 and V4 mode is accomplished in less than 250 milliseconds, making the transitions seamless and transparent to the vehicle operator. The 250 milliseconds includes the time for the ECM to sequence the transitions, the response time for the VLOM solenoids to energize, and the time for the valve lifters to deactivate, all within 2 revolutions of the engine crankshaft.

The cylinder deactivation system consists of the following components:

- The VLOM assembly
- Eight special valve lifters, 2 per deactivating cylinder
- The engine oil pressure regulator valve for cylinder deactivation operation
- Gen IV cylinder deactivation engine block
- The ECM

Valve Lifter Oil Manifold (VLOM) Assembly

The cylinder deactivation system uses an electro-hydraulic actuator device called the valve lifter oil manifold (VLOM) assembly. The VLOM is bolted to the top of the engine valley, below the intake manifold assembly. The VLOM consists of 4 electrically operated Normally Closed Solenoids. Each solenoid controls the application of engine oil pressure to the intake and exhaust valve lifters on the cylinders selected to deactivate. Engine oil pressure is routed to the VLOM assembly from a passage on the rear of the cylinder block.

All 4 VLOM solenoids are connected in parallel to a fused ignition 1 voltage circuit, supplied by the powertrain relay. The ground or control circuit for each solenoid is connected to the engine control module (ECM).

When all enabling conditions are met for cylinder deactivation, the ECM will ground each solenoid control circuit in firing order sequence, allowing current to flow through the solenoid windings. With the coil windings energized, the solenoid valve opens, redirecting engine oil pressure through the VLOM into 8 separate vertical passages in the engine lifter valley. The 8 vertical passages, 2 per cylinder, are connected to the valve lifter bores of the cylinders to be deactivated. When vehicle-operating conditions require a return to V8 mode, the ECM will turn OFF the control circuit for the solenoids, allowing the solenoid valves to close. With the solenoid valves closed, engine oil pressure in the control ports is exhausted through the body of the solenoids into the engine block lifter valley. The housing of the VLOM incorporates several bleeds in the oil passages to purge any air trapped in the VLOM or engine block.

To control any contamination to the hydraulic circuits, a small replaceable oil screen is located in the VLOM oil inlet passage, below the oil pressure sensor. The oil pressure sensor is a 3-wire sensor which provides oil pressure information to the ECM.

During service, use extreme care in keeping the VLOM assembly free of any contamination or foreign material.

Engine Control Module (ECM)

The engine control module (ECM) is responsible for the management and control of all engine functions. Each ECM comes equipped with a specific set of software/calibrations designed for that engine and vehicle application. The ECM will determine engine operating parameters, based upon information from a network of switches, sensors, modules and communication with other controllers located throughout vehicle. Internal to the ECM is an integrated circuit device called a low-side driver. The low-side driver is designed to operate internally, like an electronic switch. An individual low-side driver controls each valve lifter oil manifold (VLOM) solenoid. When enabling conditions for V4 mode are met, the ECM will command the low-side driver to ground each VLOM solenoid control circuit, in firing order sequence. Internal to the low-side driver is a fault detection circuit, which monitors the solenoid control circuit for an incorrect voltage level. If an incorrect voltage level, such as an open, high resistance, or short to ground, is detected, the low-side driver, along with the fault detection circuit, will communicate the condition to the central processor in the ECM. The ECM will then command a return to V8 mode, set a corresponding DTC, and illuminate the malfunction indicator lamp (MIL) on the instrument panel.

Cylinder Deactivation Inhibit Reasons

Listed below are the powertrain conditions that will inhibit V4 mode, while operating under light load driving conditions:

- Engine manifold vacuum low
- Brake booster vacuum pressure low
- Accelerator pedal position rate of increase too high, electronic throttle control
- Accelerator pedal position too high, electronic throttle control
- Ignition voltage out of range
- Engine oil pressure out of range
- Engine oil temperature out of range
- Engine RPM out of range
- Transmission gear incorrect
- Transmission range incorrect
- Transmission gear shift in progress
- All cylinders activated via scan tool output control
- Minimum time in V8 mode not met
- Maximum V4 mode time exceeded
- Engine oil aeration present
- Decel fuel cutoff active
- Fuel shut-off timer active
- Minimum heater temp low, HVAC system
- Reduced engine power active, electronic throttle control
- Brake torque management active
- Axle torque limiting active
- Engine metal over temperature protection active
- Catalytic converter over temperature protection active
- Piston protection active, knock detected
- Hot coolant mode active
- Engine over speed protection active
- Fault Active or Fault Pending--cylinder deactivation is disabled for the following faults:
    - Brake Booster Vacuum Sensor

- Manifold Absolute Pressure Sensor
- Engine Oil Pressure Sensor
- Engine Coolant Temperature Sensor
- Vehicle Speed Sensor
- Crankshaft Position Sensor
- Engine Misfire Detected
- Cylinder Deactivation Solenoid Driver Circuit

The scan tool output control is used to deactivate half of the engine cylinders, V4 mode, by commanding all of the solenoids ON, or deactivate one cylinder switching to a V7 mode, by commanding ON one solenoid. Listed below are the powertrain conditions that will inhibit V4 mode, or V7 mode, with the engine running, while using the scan tool output control function:

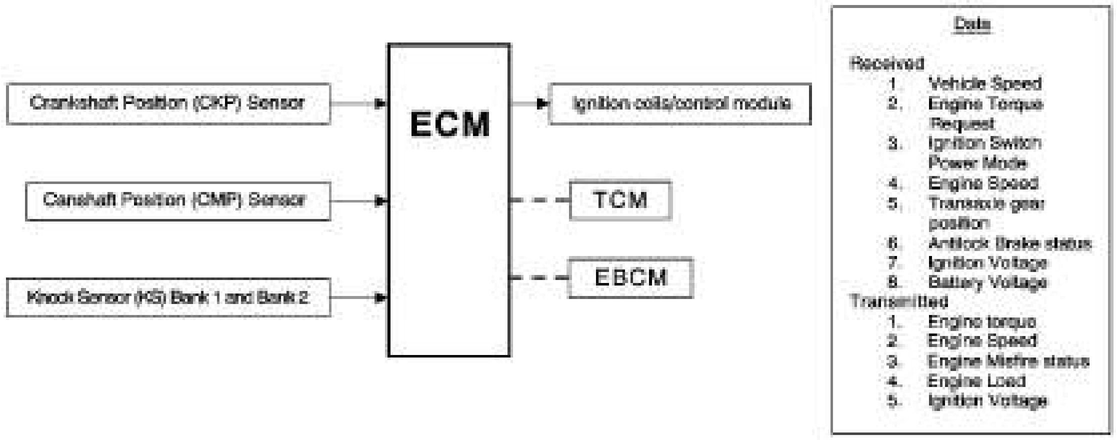
- Engine speed out of range
- Manifold absolute pressure (MAP) sensor fault
- Accelerator pedal position too high, electronic throttle control
- Piston protection active, knock detected
- Engine oil temperature out of range
- Engine oil pressure out of range
- Engine oil aeration present
- Engine metal over temperature protection active
- Accelerator pedal position rate of increase too high, electronic throttle control
- Cylinder deactivation solenoid driver circuit fault
- Engine coolant temperature sensor fault
- Catalytic converter over temperature protection active
- Brake booster vacuum pressure low
- Brake Booster Vacuum Pressure Sensor Fault
- Axle torque limiting active
- Brake torque management active
- Vehicle speed sensor fault
- Engine coolant temperature too high
- Engine not running
- Vehicle speed not zero
- Engine coolant temperature low
- Reduced Engine Power Active, electronic throttle control
- Transmission gear incorrect
- Transmission range incorrect
- Ignition voltage out of range
- Maximum V4 mode time exceeded

Listed below are the powertrain conditions that will inhibit a cylinder deactivation solenoid from being energized, with the ignition ON and the engine OFF, while using the scan tool output control function:

- Engine speed not zero
- Vehicle speed not zero
- Transmission not in park or neutral
- Ignition voltage out of range

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L | Description and Operation | **Document ID: 1958455**

Electronic Ignition (EI) System Description


Crankshaft Position (CKP) Sensor
Camshaft Position (CMP) Sensor
Knock Sensor (KS) Bank 1 and Bank 2
ECM
Ignition coils/control module
TCM
EBCM
Data
Received
1. Vehicle Speed
2. Engine Torque Request
3. Ignition Switch Power Mode
4. Engine Speed
5. Transaxle gear position
6. Antilock Brake status
7. Ignition Voltage
8. Battery Voltage
Transmitted
1. Engine torque
2. Engine Speed
3. Engine Misfire status
4. Engine Load
5. Ignition Voltage

Electronic Ignition (EI) System Operation

The electronic ignition (EI) system produces and controls the high energy secondary spark. This spark ignites the compressed air/fuel mixture at precisely the correct time, providing optimal performance, fuel economy, and control of exhaust emissions. The engine control module (ECM) primarily collects information from the crankshaft position (CKP) and camshaft position (CMP) sensors to control the sequence, dwell, and timing of the spark.

Crankshaft Position (CKP) Sensor

The crankshaft position (CKP) sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes of the teeth and slots of the reluctor wheel on the crankshaft. The reluctor wheel is spaced at 60-tooth spacing, with 2 missing teeth for the reference gap. The reference gap is used to identify the crankshaft position at each start-up. The CKP sensor produces an ON/OFF DC voltage of varying frequency, with 58 output pulses per crankshaft revolution. The CKP sensor sends a digital signal to the ECM as each tooth on the reluctor wheel rotates past the CKP sensor. The ECM uses each CKP signal pulse to determine crankshaft speed position. This information is then used to determine the optimum ignition and injection points of the engine. The ECM also uses CKP sensor output information to determine the camshaft relative position to the crankshaft, to control camshaft phasing, and to detect cylinder misfire.

Camshaft Position (CMP) Sensor

The sensor detects magnetic flux changes between the four narrow and wide tooth slots on the reluctor wheel. The CMP sensor provides a digital ON/OFF DC voltage of varying frequency per each camshaft revolution. The ECM will recognize the narrow and wide tooth patterns to identify camshaft position, or which cylinder is in compression and which is in exhaust. The information is then used to determine the correct time and sequence for fuel injection and ignition spark events.

Knock Sensor (KS)

The knock sensor (KS) system enables the control module to control the ignition timing for the best possible performance while protecting the engine from potentially damaging levels of detonation, also known as spark knock. The KS system uses one or 2 flat response 2-wire sensors. The sensor uses piezo-electric crystal technology that produces an AC voltage signal of varying amplitude and frequency based on the engine vibration or noise level. The amplitude and frequency are dependant upon the level of knock that the KS detects. The control module receives the KS signal through the signal circuit. The KS ground is supplied by the control module through the low reference circuit.

The control module learns a minimum noise level, or background noise, at idle from the KS and uses calibrated values for the rest of the RPM range. The control module uses the minimum noise level to calculate a noise channel. A normal KS signal will ride within the noise channel. As engine speed and load change, the noise channel upper and lower parameters will change to accommodate the normal KS signal, keeping the signal within the channel. In order to determine which cylinders are knocking, the control module only uses KS signal information when each cylinder is near top dead center (TDC) of the firing stroke. If knock is present, the signal will range outside of the noise channel.

If the control module has determined that knock is present, it will retard the ignition timing to attempt to eliminate the knock. The control module will always try to work back to a zero compensation level, or no spark retard. An abnormal KS signal will stay outside of the noise channel or will not be present. KS diagnostics are calibrated to detect faults with the KS circuitry inside the control module, the KS wiring, or the KS voltage output. Some diagnostics are also calibrated to detect constant noise from an outside influence such as a loose/damaged component or excessive engine mechanical noise.

Ignition Coils

Each ignition coil has an ignition 1 voltage feed and a ground circuit. The engine control module (ECM) supplies a low reference and an ignition control (IC) circuit. Each ignition coil contains a solid state driver module. The ECM will command the IC circuit ON, which allows the current to flow through the primary coil windings. When the ECM commands the IC circuit OFF, this will interrupt current flow through the primary coil windings. The magnetic field created by the primary coil windings will collapse across the secondary coil windings, which induces a high voltage across the spark plug electrodes.

Engine Misfire Detection

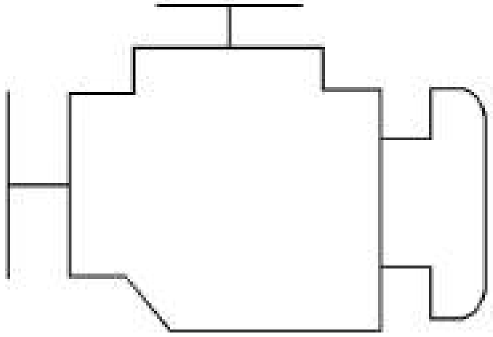
The CKP sensor is used to determine when an engine misfire is occurring. The CMP sensor is used to determine which cylinder is misfiring. By monitoring variations in the crankshaft rotation speed for each cylinder, the ECM is able to detect individual misfire events. For accurate detection of engine misfire, the ECM must distinguish between crankshaft deceleration caused by actual misfire and deceleration caused by rough road conditions. The antilock brake system (ABS) can detect if the vehicle is on a rough road based on wheel acceleration/deceleration data supplied by the wheel speed sensors. If the ABS detects rough road above a predetermined threshold, this information is sent to the ECM. The ECM uses the rough road information when calculating engine misfire. Under certain driving conditions, a misfire rate can be high enough to cause the 3-way catalytic converter (TWC) to overheat damaging the converter. The malfunction indicator lamp (MIL) will flash ON and OFF when converter overheating, damaging conditions are present.

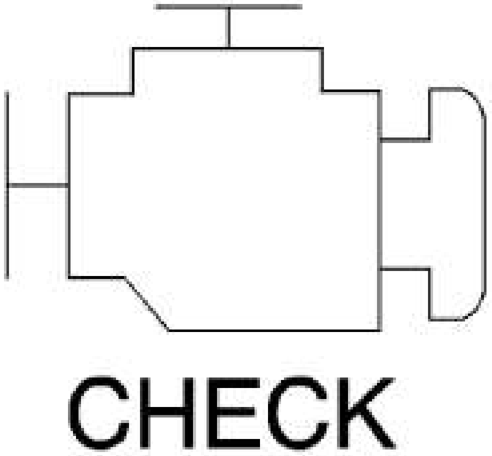
Engine Control Module Description

The powertrain has electronic controls to reduce exhaust emissions while maintaining excellent driveability and fuel economy. The engine control module (ECM) is the control center of this system. The ECM monitors numerous engine and vehicle functions. The ECM constantly monitors the information from various sensors and other inputs, and controls the systems that affect vehicle performance and emissions. The ECM also performs the diagnostic tests on various parts of the system. The ECM can recognize operational problems and alert the driver via the malfunction indicator lamp (MIL). When the ECM detects a malfunction, the ECM stores a diagnostic trouble code (DTC). The problem area is identified by the particular DTC that is set. The control module supplies a buffered voltage to various sensors and switches. Review the components and wiring diagrams in order to determine which systems are controlled by the ECM.

Malfunction Indicator Lamp (MIL) Operation

The malfunction indicator lamp (MIL) is located in the instrument panel cluster. The MIL will display as either SERVICE ENGINE SOON or one of the following symbols when commanded ON:





The MIL indicates that an emissions related fault has occurred and vehicle service is required.

The following is a list of the modes of operation for the MIL:

- The MIL illuminates when the ignition is turned ON, with the engine OFF. This is a bulb test to ensure the MIL is able to illuminate.
- The MIL turns OFF after the engine is started if a diagnostic fault is not present.
- The MIL remains illuminated after the engine is started if the control module detects a fault. A diagnostic trouble code (DTC) is stored any time the control module illuminates the MIL due to an emissions related fault. The MIL turns OFF after three consecutive ignition cycles in which a Test Passed has been reported for the diagnostic test that originally caused the MIL to illuminate.
- The MIL flashes if the control module detects a misfire condition which could damage the catalytic converter.
- When the MIL is illuminated and the engine stalls, the MIL will remain illuminated as long as the ignition is ON.
- When the MIL is not illuminated and the engine stalls, the MIL will not illuminate until the ignition is cycled OFF and then ON.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L | Description and Operation | **Document ID: 1236733**

Evaporative Emission Control System Description

EVAP System Operation

The evaporative emission (EVAP) control system limits fuel vapors from escaping into the atmosphere. Fuel tank vapors are allowed to move from the fuel tank, due to pressure in the tank, through the vapor pipe, into the EVAP canister. Carbon in the canister absorbs and stores the fuel vapors. Excess pressure is vented through the vent line and EVAP vent solenoid valve to the atmosphere. The EVAP canister stores the fuel vapors until the engine is able to use them. At an appropriate time, the control module will command the EVAP purge solenoid valve ON, allowing engine vacuum to be applied to the EVAP canister. With the EVAP vent solenoid valve OFF, fresh air is drawn through the vent solenoid valve and the vent line to the EVAP canister. Fresh air is drawn through the canister, pulling fuel vapors from the carbon. The air/fuel vapor mixture continues through the EVAP purge pipe and EVAP purge solenoid valve into the intake manifold to be consumed during normal combustion. The control module uses several tests to determine if the EVAP system is leaking.

Large Leak Test

This tests for large leaks and restrictions to the purge path in the evaporative emission (EVAP) system. When the enabling criteria has been met, the control module commands the EVAP vent solenoid valve ON and the EVAP purge solenoid valve ON, allowing vacuum into the EVAP system. The control module monitors the fuel tank pressure (FTP) sensor voltage to verify that the system is able to reach a predetermined level of vacuum within a set amount of time.

Small Leak Test

The engine off natural vacuum (EONV) diagnostic is the small-leak detection diagnostic for the evaporative emission (EVAP) system. While previous leak detection methods were performed with the engine running, the EONV diagnostic monitors the EVAP system pressure or vacuum with the ignition OFF. Because of this, it may be normal for the control module to remain active for up to 40 minutes after the ignition is turned OFF. This is important to remember when performing a parasitic draw test on vehicles equipped with EONV.

The EONV utilizes the temperature changes in the fuel tank immediately following a drive cycle to use the naturally occurring vacuum or pressure in the fuel tank. When the vehicle is driven, the temperature rises in the tank. After the vehicle is parked, the temperature in the tank continues to rise for a period of time, then starts to drop. The EONV diagnostic relies on this temperature change and the corresponding pressure change in a sealed system, to determine if an EVAP system leak is present.

The EONV diagnostic is designed to detect leaks as small as 0.51 mm (0.020 in). The diagnostic can determine if a small leak is present based on vacuum or pressure readings in the EVAP system. When the system is sealed, a finite amount of pressure or vacuum will be observed. When a 0.51 mm (0.020 in) leak is present, often little or no pressure or vacuum is observed. If the test reports a failing value, DTC P0442 will set.

Canister Vent Restriction Test

If the evaporative emission (EVAP) vent system is restricted, fuel vapors will not be properly purged from the EVAP canister. The control module tests this by commanding the EVAP purge solenoid valve ON, commanding the EVAP vent solenoid valve OFF, and monitoring the fuel tank pressure (FTP) sensor for an increase in vacuum. If the vacuum increases more than a calibrated value, DTC P0446 will set.

Purge Solenoid Valve Leak Test

If the evaporative emission (EVAP) purge solenoid valve does not seal properly fuel vapors could enter the engine at an undesired time, causing driveability concerns. The control module tests for this by commanding the EVAP purge solenoid valve OFF and the vent solenoid valve ON, sealing the system, and monitors the fuel tank pressure (FTP) for an increase in vacuum. If the control module detects that the EVAP system vacuum increases above a calibrated value, DTC P0496 will set.

Check Gas Cap Message

The control module sends a class 2 message to the driver information center (DIC) illuminating the Check Gas Cap message when a malfunction in the evaporative emission (EVAP) system and a large leak test fails.

EVAP System Components

The evaporative emission (EVAP) system consists of the following components:

EVAP Canister

The canister is filled with carbon pellets used to absorb and store fuel vapors. Fuel vapor is stored in the canister until the control module determines that the vapor can be consumed in the normal combustion process.

EVAP Purge Solenoid Valve

The EVAP purge solenoid valve controls the flow of vapors from the EVAP system to the intake manifold. The purge solenoid valve opens when commanded ON by the control module. This normally closed valve is pulse width modulated (PWM) by the control module to precisely control the flow of fuel vapor to the engine. The valve will also be opened during some portions of the EVAP testing, allowing engine vacuum to enter the EVAP system.

EVAP Vent Solenoid Valve

The EVAP vent solenoid valve controls fresh airflow into the EVAP canister. The valve is normally open. The control module commands the valve ON, closing the valve during some EVAP tests, allowing the system to be tested for leaks.

Fuel Tank Pressure Sensor

The fuel tank pressure (FTP) sensor measures the difference between the pressure or vacuum in the fuel tank and outside air pressure. The control module provides a 5-volt reference and a ground to the FTP sensor. The FTP sensor provides a signal voltage back to the control module that can vary between 0.1-4.9 volts. A high FTP sensor voltage indicates a low fuel tank pressure or vacuum. A low FTP sensor voltage indicates a high fuel tank pressure.

Fuel System Description

System Overview

The fuel tank stores the fuel supply. An electric fuel pump, located in the fuel tank with the fuel sender assembly that pumps the fuel to the fuel rail assembly. The pump provides the fuel at a pressure greater than is needed by the injectors. The fuel pressure regulator, part of the fuel sender assembly, keeps the fuel available to the injectors at a regulated pressure. The fuel system is returnless.

Fuel Tank

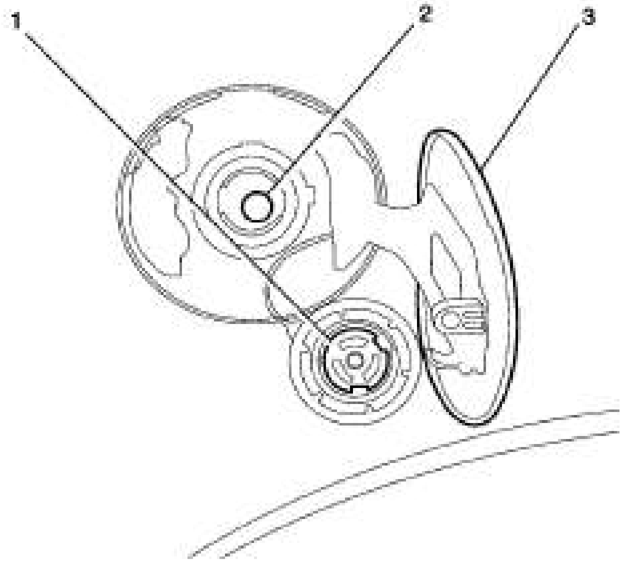
The fuel storage tank is made of high density polyethylene. The fuel storage tank is held in place by 2 metal straps that are attached to the under body of the vehicle. The tank shape includes a sump in order to maintain a constant supply of fuel around the fuel pump strainer during low fuel conditions or during aggressive manoeuvres.

The fuel tank also contains a fuel vapor vent valve with a roll-over protection. The vent valve also features a 2-phase vent calibration which increases the fuel vapor flow to the canister when the operating temperatures increase the tank pressure beyond an established threshold.

Fuel Tank Filler Pipe

In order to prevent refuelling with leaded fuel, the fuel filler pipe has a built-in restrictor and a deflector. The opening in the restrictor will accept only the smaller unleaded gasoline fuel nozzle which must be fully inserted in order to bypass the deflector. The tank is vented during filling by an internal vent tube inside of the filler pipe.

Fuel Filler Cap

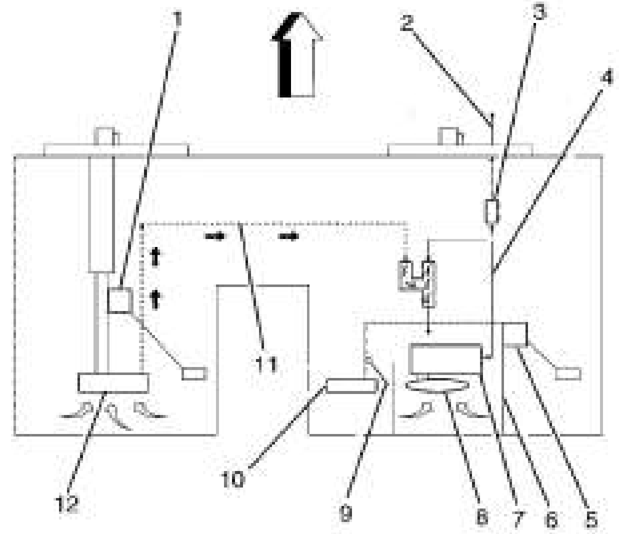


(1) Fuel Tank Filler Cap
(2) Fuel Tank Filler Pipe
(3) Fuel Filler Door

Notice: If a fuel tank filler cap requires replacement, use only a fuel tank filler cap with the same features. Failure to use the correct fuel tank filler cap can result in a serious malfunction of the fuel and EVAP system.

The fuel filler cap (1) is a screw-on type, with an integrated tightening torque limiting mechanism. When installing the cap, tighten it until a ratcheting (clicking) sound is heard, indicating the cap is properly tightened. The fuel tank filler cap is tethered to the fuel filler pocket. The fuel tank filler cap requires a quarter of a turn in order to be removed.

Modular Fuel Sender



(1) Secondary Fuel Level Sensor - Left
(2) Fuel feed line to Engine
(3) 2-Way Check Valve - Fuel Supply
(4) Siphon Jet Pump
(5) Primary Fuel Level Sensor - Right
(6) Fuel Reservoir/Bucket
(7) Fuel Pump
(8) Fuel Strainer/Pick up
(9) Return Fuel Check Valve for Reservoir
(10) Return Fuel Jet Pump
(11) Fuel Transfer Line

(12) Fuel Strainer/Pickup

The modular fuel sender assembly mounts to the threaded opening of the plastic fuel tank with a seal and a retainer ring. The reservoir, containing the exterior inlet strainer, the electric fuel pump and the pump strainer, maintains contact with the tank bottom. This design provides:

- Optimum fuel level in the integral fuel reservoir during all fuel tank levels and during driving conditions
- An improved tank fuel level measuring accuracy
- An improved coarse straining and added pump inlet filtering
- More extensive internal fuel pump isolation for noiseless operation

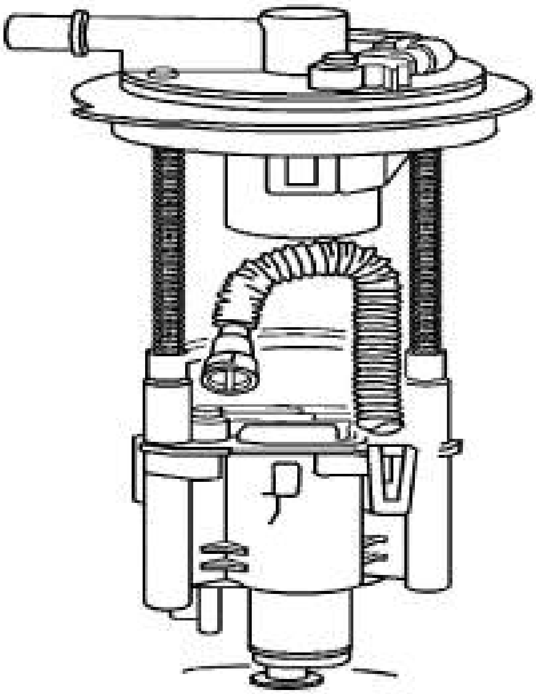
The modular fuel sender assembly maintains an optimum fuel level in the reservoir (bucket). The fuel entering the reservoir is drawn in by the following components:

- The first stage of the fuel pump through the external strainer

  and/or
- The secondary umbrella valve

  or
- The return fuel line, whenever the level of fuel is below the top of the reservoir

Fuel Pump



The fuel pump is incorporated into the design of the modular fuel sender assembly inside the fuel tank and is an electric, high pressure, single turbine design. The fuel pump provides fuel to the fuel rail assembly at a specified flow and pressure. The fuel pump delivers a constant flow of fuel to the engine, even during low fuel conditions or aggressive vehicle manoeuvres. The engine control module (ECM) controls the electric fuel pump operation through the fuel pump relay.

Fuel Pressure Regulator Assembly

The fuel pressure regulator is a diaphragm-operated relief valve located in the modular fuel pump and sender assembly. Its principal function is to maintain a controlled pressure at the injectors at all times by regulating fuel flow into the fuel feed line. With the ignition ON and the engine OFF, system fuel pressure at the pressure test connection should be 380-440 kPa (55-64 psi).

Fuel Pump Strainer

The fuel strainer connects onto the fuel pump inlet port on the end cap of the fuel pump assembly and consists of a finely woven plastic filter. A metal compression ring is fitted around the plastic strainer to fuel pump feed port and the complete fuel strainer assembly is fastened to the fuel pump end cap with a metal speed clip fastener. The strainers function is to filter fuel contaminants from within the fuel reservoir and also act to wick the fuel. The fuel strainer is serviced as part of the complete fuel pump and strainer assembly. Fuel stoppage at the strainer indicates an abnormal amount of sediment in the fuel tank which should be removed before reinstallation of the fuel tank into the vehicle.

Fuel Filter Assembly

The fuel filter assembly is contained within the modular fuel pump and sender assembly reservoir and forms the containment housing for the fuel pump. The filter comprises a paper element which traps particles in the fuel that may damage the fuel injection system. The fuel filter is made to withstand maximum fuel system pressure, changes in temperature and exposure to fuel additives.

Fuel Level Sender Assemblies

The fuel level sender assembly comprises of two fuel level float and wire arm assemblies, a ceramic variable resistor card assembly , and a detachable nylon wiper. The ceramic resistor card is attached to a plastic card holder which attaches to the reservoir. A metal contact fork with brushes is connected to the detachable nylon wiper. This assembly provides a variable circuit resistance to the engine control module (ECM) depending on wiper contact position. Two circuit wires run from the resistor card and extend up to connect with the modular fuel pump to cover assembly wiring connector on the underside of the modular fuel pump and sender assembly cover. The ECM averages out any slosh variation in the fuel tank and sends this signal to the fuel level indicator on the instrument panel fuel gauge.

Nylon Fuel Pipes

Caution: In order to reduce the risk of fire and personal injury observe the following items:

- Replace all nylon fuel pipes that are nicked, scratched or damaged during installation, do not attempt to repair the sections of the nylon fuel pipes
- Do not hammer directly on the fuel harness body clips when installing new fuel pipes. Damage to the nylon pipes may result in a fuel leak.
- Always cover nylon vapor pipes with a wet towel before using a torch near them. Also, never

expose the vehicle to temperatures higher than 115°C (239°F) for more than one hour, or more than 90°C (194°F) for any extended period.

- Apply a few drops of clean engine oil to the male pipe ends before connecting fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. (During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.)

Important: The fuel pipe "O" rings are not a serviceable item

Nylon fuel pipes are designed to perform the same job as the steel or flexible fuel pipes or hoses. Nylon pipes are constructed to withstand maximum fuel system pressure, exposure to fuel additives, and changes in temperature. There are three sizes of nylon pipes used: 3/8 in ID for the fuel feed, 5/16 in ID for the evaporative emission tube, and 1/2 in ID for the vent. Heat-resistant rubber hose and/or corrugated plastic conduit protect the sections of the pipes that are exposed to chafing, to high temperature or to vibration.

Nylon fuel pipes are somewhat flexible and can be formed around gradual turns under the vehicle. However, if nylon fuel pipes are forced into sharp bends, the pipes will kink and restrict the fuel flow. Once exposed to fuel, nylon pipes may become stiffer and are more likely to kink if the pipes are bent too far. Take special care when working on a vehicle with nylon fuel pipes.

Quick-Connect Fittings

Quick-connect fittings provide a simplified means of installing and connecting fuel system components. The fittings consist of a unique female connector and a compatible male pipe end. "O" rings, located inside the female connector, provide the fuel seal. Integral locking tabs or fingers hold the fittings together.

Fuel Pipe O-Rings

"O" rings seal the threaded connections in the fuel system. The fuel system "O" ring seals are made of a special material. The fuel pipe "O" rings are not a serviceable item.

EVAP Pipes and Hoses

The evaporative emission (EVAP) tubes extend from the fuel tank module and the EVAP canister vent to the EVAP canister. These tubes are located on the top rear of the fuel tank. The EVAP purge tube/pipe extends from the EVAP canister on top of the fuel tank to the EVAP purge solenoid in the engine compartment. The chassis EVAP purge pipe is constructed of steel.

On-Board Refueling Vapor Recovery System (ORVR)

The on-board refuelling vapour recovery system (ORVR) is an on-board vehicle system that is designed to recover the fuel vapours during the vehicle refuelling operation. The flow of liquid fuel down the fuel filler pipe provides a liquid seal, which prevents the vapour from leaving the fuel filler pipe. An evaporative emission (EVAP) pipe transports the fuel vapour to the EVAP canister for use by the engine. Listed below are the ORVR system components with a brief description of their operation:

- The EVAP canister. The EVAP canister receives refuelling vapour from the fuel system, stores the vapour and releases the vapour to the engine upon demand.

- The EVAP pipes. The EVAP pipes transport the fuel vapour from the fuel tank to the EVAP canister.
- The fuel filler pipe. The fuel filler pipe carries the fuel from the fuel nozzle to the fuel tank.
- The check valve. The check valve limits fuel spit back from the fuel tank during the refuelling operation by allowing the fuel flow only into the fuel tank. This check valve is located at the bottom of the fuel filler pipe.
- The modular fuel sender assembly. The assembly pumps the fuel to the engine from the fuel tank.
- The fill limiter vent valve (FLVV). This valve acts as a shut-off valve. The FLVV is located at the top of the fuel sender assembly. This valve is not serviced separately. The FLVV has the following functions:
  - The FLW controls the fuel tank fill level by closing the primary vent from the fuel tank.
  - The FLW prevents the fuel from exiting the fuel tank via the EVAP pipe to the canister.
  - The FLW provides fuel-spillage protection in the event of a vehicle roll over by closing the vapour path from the tank to the EVAP canister.

Modes of Operation

The engine control module (ECM) looks at voltages from several sensors to determine how much fuel to give the engine. The fuel is delivered under one of several conditions called modes. The ECM controls all modes.

Starting Mode

With the ignition ON, before engaging the starter, the engine control module (ECM) energizes the fuel pump relay for two seconds allowing the fuel pump to build up pressure. The ECM first checks speed density, then switches to the mass air flow (MAF) sensor. The ECM also uses the engine coolant temperature (ECT), throttle position (TP), and manifold absolute pressure (MAP) sensors to determine the proper air/fuel ratio for starting. The ECM controls the amount of fuel delivered in the starting mode by changing the pulse width of the injectors. This is done by pulsing the injectors for very short times.

Clear Flood Mode

If the engine is flooded with fuel during starting and will not start, the Clear Flood Mode can be manually selected. To select Clear Flood Mode, push the accelerator to wide open throttle (WOT). With this signal, the ECM will completely turn OFF the injectors and will maintain this stage as long as the ECM indicates a WOT condition with engine speed below 1,000 RPM.

Run Mode

The Run Mode has 2 conditions: Open Loop operation and Closed Loop operation. When the engine is first started and the engine speed is above 480 RPM, the system goes into Open Loop operation. In Open Loop operation, the ECM ignores the signals from the oxygen sensors and calculates the required injector pulse width based primarily on inputs from the MAF, IAT and ECT sensors.

In Closed Loop, the ECM adjusts the calculated injector pulse width for each bank of injectors based on the signals from each oxygen sensor.

Acceleration Mode

The ECM monitors the changes in the TP and the MAF sensor signals in order to determine when the vehicle is being accelerated. The ECM will then increase the injector pulse width in order to provide more fuel for improved performance.

Deceleration Mode

The ECM monitors changes in TP and MAF sensor signals to determine when the vehicle is being decelerated. The ECM will then decrease injector pulse width or even shut OFF injectors for short periods to reduce exhaust emissions, and for better (engine braking) deceleration.

Battery Voltage Correction Mode

The ECM can compensate in order to maintain acceptable vehicle driveability when the ECM sees a low battery voltage condition. The ECM compensates by performing the following functions:

- Increasing the injector pulse width in order to maintain the proper amount of fuel being delivered
- Increasing the idle speed to increase the generator output

Fuel Cutoff Mode

The engine control module (ECM) cuts OFF fuel from the fuel injectors when the following conditions are met in order to protect the powertrain from damage and improve driveability:

- The ignition is OFF. This prevents engine run-on.
- The ignition is ON, but there is no ignition reference signal. This prevents flooding or backfiring.
- The engine speed is too high, above the red line.
- The vehicle speed is too high, above rated tire speed.
- During an extended, high speed, closed throttle coast down, this reduces emissions and increases engine braking.
- During extended deceleration, in order to prevent damage to the catalytic converters.
- The torque management enabled--Transmission shifts or abusive maneuvers.
- The traction control enabled--In conjunction with the front brakes applying

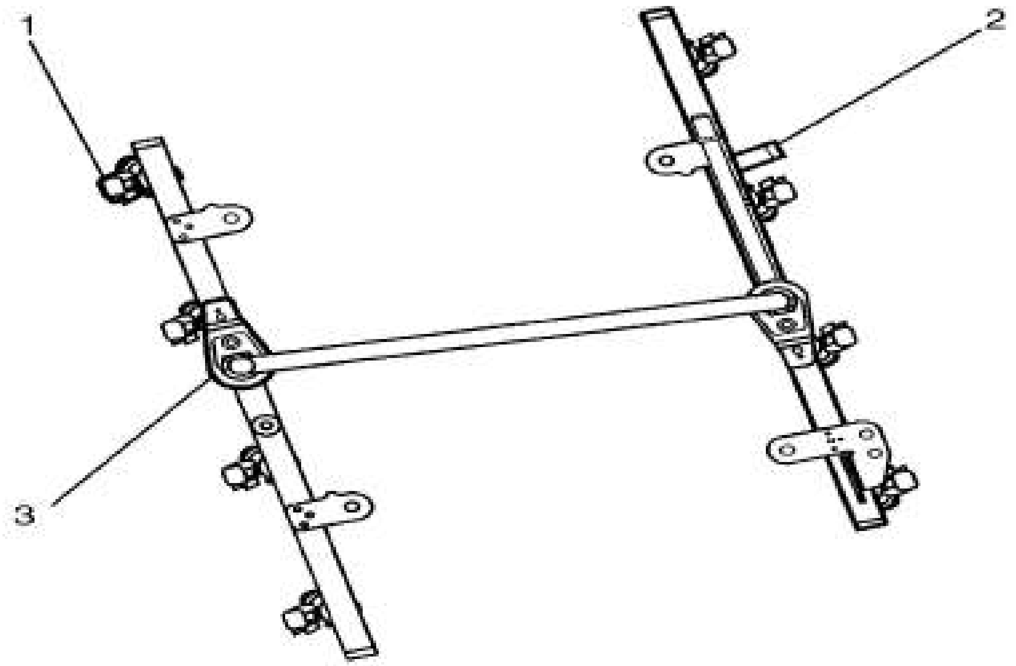
Fuel Trim

The engine control module (ECM) controls the air/fuel metering system in order to provide the best possible combination of driveability, fuel economy and emission control. The ECM monitors the heated oxygen sensor (HO2S) signal voltage while in Closed Loop and regulates the fuel delivery by adjusting the pulse width of the fuel injectors based on this signal. The ideal fuel trim values are around 0 percent for both short term and long term fuel trim. A positive fuel trim value indicates the ECM is adding fuel in order to compensate for a lean condition by increasing the pulse width. A negative fuel trim value indicates that the ECM is reducing the amount of fuel in order to compensate for a rich condition by decreasing the pulse width. A change made to the fuel delivery changes the short term and long term fuel trim values. The short term fuel trim values change rapidly in response to the HO2S signal voltage. These changes fine tune the engine fuelling. The long term fuel trim makes coarse adjustments to the fuelling in order to re-centre and restore control to short term fuel trim. A scan tool can be used to monitor the short term and long term fuel trim values. The long term fuel trim diagnostic is based on an average of several of the long term speed load learn cells. The ECM selects the cells based on the engine speed and engine load. If the ECM detects an excessive lean or rich condition, the ECM will set a fuel trim DTC.

Fuel Pump Electrical Circuit

When the ignition switch is in the ON position, before engaging the starter, the engine control module (ECM) energizes the fuel pump relay for two seconds, causing the fuel pump to pressurize the fuel system. If the ECM does not receive ignition reference pulses with the engine cranking or running within two seconds, the ECM shuts OFF the fuel pump relay, causing the fuel pump to stop.

Fuel Rail Assembly



The fuel rail assembly attaches to the engine intake manifold. The fuel rail assembly performs the following functions:

- Positions the injectors (3) in the intake manifold
- Distributes fuel evenly to the injectors through the fuel rail (2)
- Fuel Rail Feed Pipe (1)

Fuel Injectors

The top-feed fuel injector assembly is a solenoid-operated device, controlled by the engine control module (ECM), that meters pressurized fuel to a single engine cylinder. The ECM energizes the injector solenoid, which opens a ball valve, allowing the fuel to flow past the ball valve, and through a recessed flow director plate. The director plate has multiple machined holes that control the fuel flow, generating a conical spray pattern of finely atomized fuel at the injector tip. Fuel is directed at the intake valve, causing the fuel to become further atomized and vaporized before entering the combustion chamber. An injector that is stuck partly open can cause a loss of pressure after the engine shutdown. Consequently, long cranking times would be noticed on some engines.

Engine Fueling

The engine is fueled by eight individual injectors, one for each cylinder, that are controlled by the ECM. The ECM controls each injector by energizing the injector coil for a brief period once every other engine revolution. The length of this brief period, or pulse, is carefully calculated by the ECM to deliver the correct amount of fuel for proper driveability and emissions control. The period of time when the injector is energized is called the pulse width and is measured in milliseconds, thousandths of a second.

While the engine is running, the ECM is constantly monitoring the inputs and recalculating the appropriate pulse width for each injector. The pulse width calculation is based on the injector flow rate, mass of fuel the energized injector will pass per unit of time, the desired air/fuel ratio, and actual air mass in each cylinder and is adjusted for battery voltage, short term, and long term fuel trim. The calculated pulse is timed to occur as each cylinders intake valves are closing to attain largest duration and most vaporization.

Fueling during a crank is slightly different than fueling during an engine run. As the engine begins to turn, a prime pulse may be injected to speed starting. As soon as the ECM can determine where in the firing order the engine is, the ECM begins pulsing the injectors. The pulse width during the crank is based on the coolant temperature and the engine load.

The fueling system has several automatic adjustments in order to compensate for the differences in the fuel system hardware, the driving conditions, the fuel used, and the vehicle aging. The basis for the fuel control is the pulse width calculation that is described above. Included in this calculation are an adjustment for the battery voltage, the short term fuel trim, and the long term fuel trim. The battery voltage adjustment is necessary since the changes in the voltage across the injector affect the injector flow rate. The short term and the long term fuel trims are fine and gross adjustments to the pulse width that are designed in order to maximize the driveability and emissions control. These fuel trims are based on the feedback from the oxygen sensors in the exhaust stream and are only used when the fuel control system is in a Closed Loop operation.

Under certain conditions, the fueling system will turn OFF the injectors for a period of time. This is referred to as fuel shut-off. Fuel shut-off is used in order to improve traction, save fuel, improve emissions, and protect the vehicle under certain extreme or abusive conditions.

In case of a major internal problem, the ECM may be able to use a back-up fuel strategy for limp in mode that will run the engine until service can be performed.

Sequential Fuel Injection (SFI)

The ECM controls the fuel injectors based on information that the ECM receives from several information sensors. Each injector is fired individually in the engine firing order, which is called sequential fuel injection. This allows precise fuel metering to each cylinder and improves the driveability under all of the driving conditions.

The ECM has several operating modes for fuel control, depending on the information that has been received from the sensors.

Throttle Actuator Control (TAC) System Description

Purpose

The throttle actuator control (TAC) system delivers improved throttle response and greater reliability and eliminates the need for mechanical cable. The TAC system performs the following functions:

- Accelerator pedal position sensing
- Throttle positioning to meet driver and engine demands
- Throttle position sensing
- Internal diagnostics
- Cruise control functions
- Manage TAC electrical power consumption

The TAC system includes the following components:

- The accelerator pedal position (APP) sensors
- The throttle body assembly
- The engine control module (ECM)

Accelerator Pedal Position (APP) Sensor

The accelerator pedal contains two individual accelerator pedal position (APP) sensors within the assembly. The APP sensors one and two are potentiometer type sensors each with three circuits:

- A 5-volt reference circuit
- A low reference circuit
- A signal circuit

The APP sensors are used to determine the pedal angle. The engine control module (ECM) provides each APP sensor a 5-volt reference circuit and a low reference circuit. The APP sensors provide the ECM with signal voltage proportional to the pedal movement. The APP sensor 1 signal voltage at rest position is less than 1 volt and increases as the pedal is actuated. The APP sensor 2 signal voltage at rest position above 4 volts and decreases as the pedal is actuated.

Throttle Body Assembly

The throttle assembly contains the following components:

- The throttle blade
- The throttle actuator motor
- The throttle position (TP) sensor one and two

The throttle body functions similar to a conventional throttle body with the following exceptions:

- An electric motor opens and closes the throttle valve.
- The throttle blade is spring loaded in both directions and the default position is slightly open.
- There are two individual TP sensors within the throttle body assembly.

The TP sensors are used to determine the throttle plate angle. The TP sensors provide the engine control module (ECM) with a signal voltage proportional to throttle plate movement. The TP signal voltage for both 1 and 2 at closed throttle is below 1 volt and increases as the throttle plate is opened.

Throttle Body Relearn Procedure

The engine Control Module (ECM) stores values that include the lowest possible throttle position (TP) sensor positions-0 percent, the rest positions-7 percent, and the return rate of both springs. These values will only be erased or overwritten if the ECM is reprogrammed or if a throttle body relearn procedure is performed. Observe, if the battery is disconnected, the ECM will immediately perform a throttle body relearn procedure when the ignition is turned ON.

A throttle body relearn procedure is performed any time the ignition is turned ON, with the engine OFF for longer than 29 seconds when the following conditions have been met:

- The engine speed is less than 40 RPM.
- The vehicle speed is 0 km/h (0 mph).
- The engine coolant temperature (ECT) is between 5-85°C (41-185°F).
- The intake air temperature (IAT) is between than 5-60°C (41-140°F).
- The accelerator pedal position (APP) sensor angle is less than 14.9 percent.
- The ignition 1 voltage is more than 10 volts.

After 29 seconds, the ECM commands the throttle plate from the rest position to full closed, then to around 10 percent open. This procedure takes about 6-8 seconds. If any faults occur in the throttle actuator control (TAC) system, a DTC sets. At the start of this procedure, the scan tool TAC Learn Counter parameter should display 0, then count up to 11 after the procedure is completed. If the counter did not start at 0, or if the counter did not end at 11, a fault has occurred and a DTC should set.

Engine Control Module

The engine control module (ECM) is the control centre for the throttle actuator control (TAC) system. The ECM determines the drivers intent and then calculates the appropriate throttle response. The ECM achieves throttle positioning by providing a pulse width modulated voltage to the TAC motor.

Modes of Operation

Normal Mode

During the operation of the throttle actuator control (TAC) system, several modes or functions are considered normal. The following modes may be entered during normal operation:

- Minimum pedal value. At first start-up, the engine control module (ECM) updates the learned minimum pedal value.
- Minimum throttle position (TP) values. At first start-up, the ECM updates the learned minimum TP value. In order to learn the minimum TP value, the throttle blade is moved to the closed position.
- Ice break mode. If the throttle is not able to reach a predetermined minimum throttle position, the ice break mode is entered. During the ice break mode, the ECM commands the maximum pulse width several times to the throttle actuator motor in the closing direction.
- Battery saver mode. After a predetermined time without engine RPM, the ECM commands the battery saver mode. During the battery saver mode, the TAC module removes the voltage from the motor control circuits, which removes the current draw used to maintain the idle position and allows the throttle to return to the spring loaded default position.

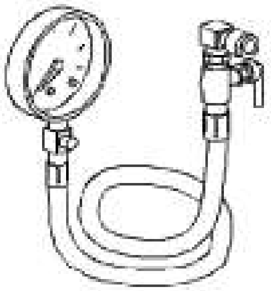
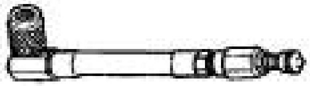
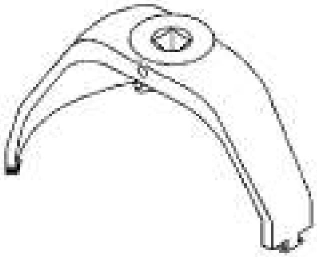
Reduced Engine Power Mode

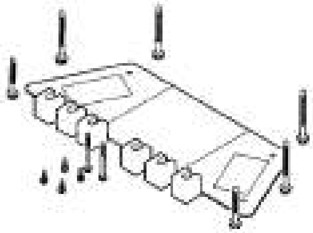
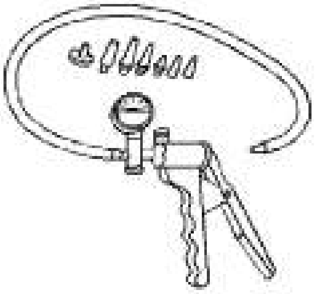
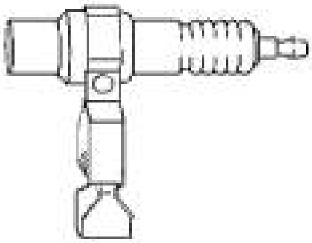
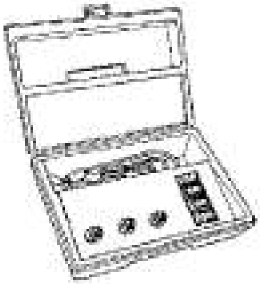
When the ECM detects a condition with the TAC system, the ECM may enter a reduced engine power mode. Reduced engine power may cause one or more of the following conditions:

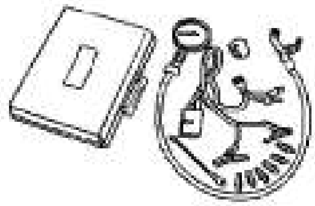
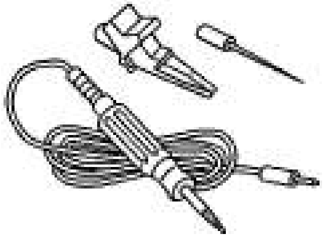
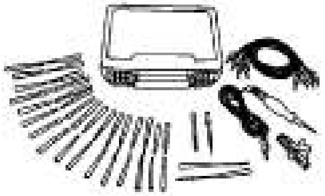
- Acceleration limiting. The ECM will continue to use the accelerator pedal for throttle control, however, the vehicle acceleration is limited.
- Limited throttle mode. The ECM will continue to use the accelerator pedal for throttle control, however, the maximum throttle opening is limited.
- Throttle default mode. The ECM will turn OFF the throttle actuator motor and the throttle will return to the spring loaded default position.
- Forced idle mode. The ECM will perform the following actions:
  - Limit engine speed to idle by positioning the throttle position, or by controlling the fuel and spark if the throttle is turned OFF.
  - Ignore the accelerator pedal input.
- Engine shutdown mode. The ECM will disable fuel and de-energize the throttle actuator.

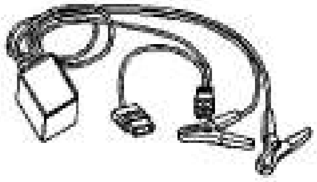
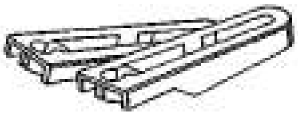
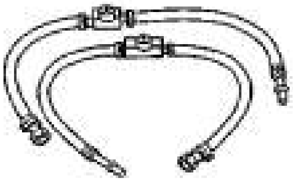
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Controls and Fuel - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L | Special Tools and Equipment | **Document ID: 2007983**

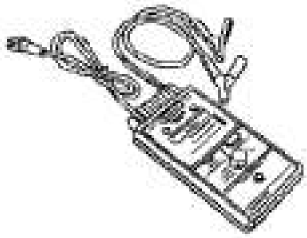
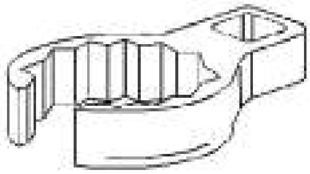
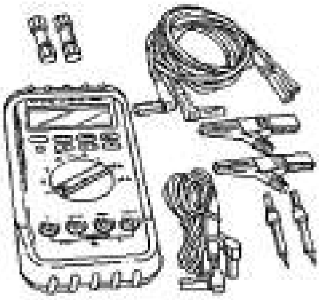
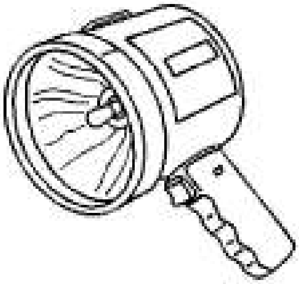
Special Tools

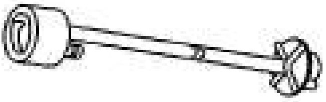
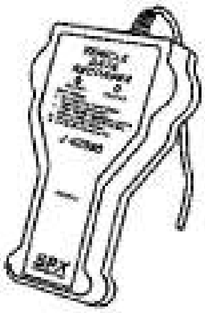
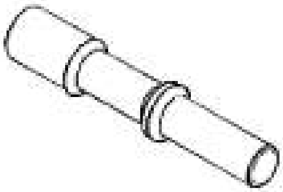
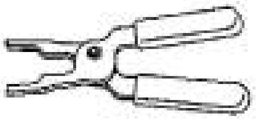
Illustration	Tool Number/Description
	AU338 Fuel Pressure gauge
	AU453 Fuel Pressure Test Hose Adapter
	CH-48482 Fuel Sender Lock Ring Wrench
	EN-48536

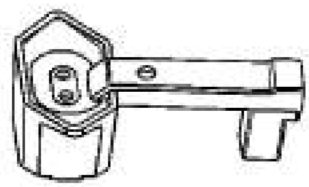
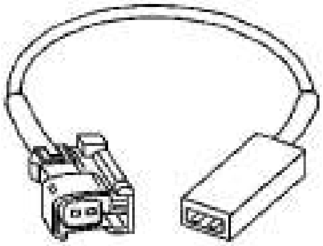
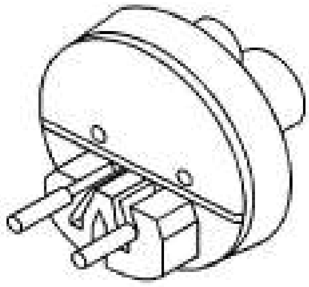
	Frame Support Tool (Engine Lower 65mm Kit)
	J 23738-A Vacuum Pump
	J 26792 Spark Tester
	J 33431-B Signal Generator and Instrument Panel Tester

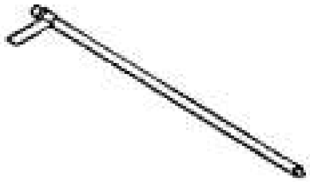
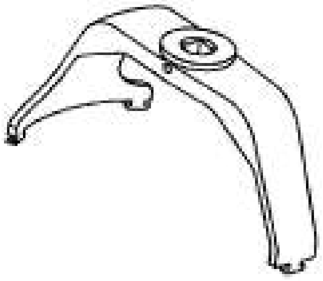
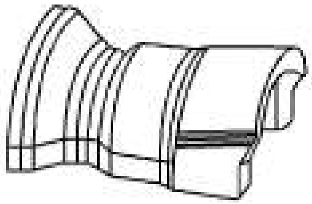
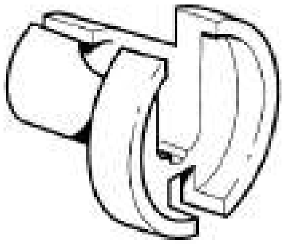
	J 34730-E Fuel Pressure gauge Kit
	J 35616-200 Test Lamp Kit
	J 35616-A Connector Test Adapter Kit
	J 35689-A Metri-Pack Terminal Kit

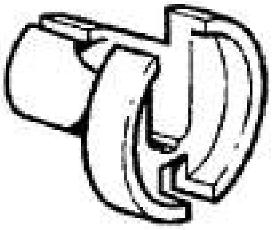
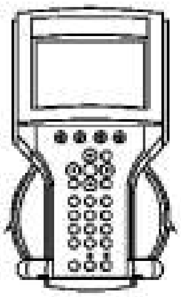
	J 37027-1A IAC Motor Driver
	J 37088-A Fuel Line Quick Connect Separator
	J 37287 Inlet and Return Fuel Line Shut-off Adapters
	J 39021 Fuel Injector Coil/Balance Tester

	
	J 39194-B Oxygen Sensor Wrench
	J 39200 Digital Multimeter
	J 41413-SPT High Intensity White Light

	GE 41415-50 Fuel Tank Cap Adapter
	J 42598 Vehicle Data Recorder
	J 42960-2 Fuel Flapper Door Holder
	J 43244 Relay Puller Pliers

	J 44175 Fuel Composition Tester
	J 44602 Fuel Injector Test Adapter
	J 44603 Fuel Injector Test Lamp
	J 45004-1 Fuel Tank Drain Hose

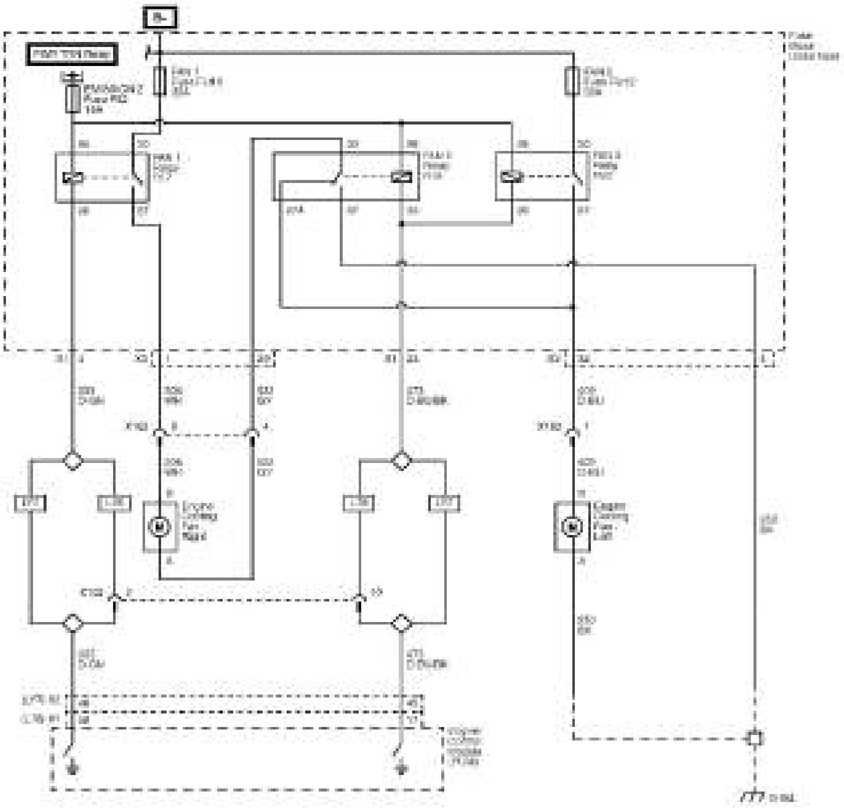
	
	J 45722 Fuel Tank Lock Ring Remover
	CH 46843 Quick Connect Fitting Release Tool
	7370 Fuel Line Quick Connect Separator

	7371 Fuel Line Quick Connect Separator
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Condenser to Radiator Retaining Bolt	11 N·m	97 lb in
Coolant Air Bleed Hose Retaining Clamp	4 N·m	35 lb in
Coolant Air Bleed Pipe Retaining Bolts	12 N·m	106 lb in
Coolant Inlet Pipe to Alternator Bracket Retaining Nut - 3.6L	25 N·m	18 lb ft
Coolant Recovery Reservoir Retaining Nuts	17 N·m	13 lb ft
Cooling Fan Blade Retaining Nut	6 N·m	53 lb in
Cooling Fan Motor to Fan Shroud Bolt	10 N·m	89 lb in
Coolant Inlet Pipe Retaining Bolt	35 N·m	26 lb ft
Heater Pipe Assembly to Thermostat Housing Retaining Bolts - 3.6L	10 N·m	89 lb in
Radiator Cap	5 N·m	44 lb in
Radiator Drain Plug	2 N·m	18 lb in
Thermostat Housing Retaining Bolts - 6.0L	14 N·m	124 lb in
Thermostat Housing to Cylinder Block Retaining Bolts - 3.6L	10 N·m	89 lb in
• Water Pump to Engine Front Cover Retaining Bolts - 3.6	10 N·m	89 lb in
• Water Pump Pulley to Water Pump Retaining Bolts - 3.6	10 N·m	89 lb in
Water Pump Retaining Bolts - 6.0L	25 N·m	18 lb ft
• First Pass	15 N·m	11 lb ft
• Final Pass	25 N·m	18 lb ft

Engine Cooling Schematics


B+
Engine Cooling Fan Right
Engine Cooling Fan - Left

Diagnostic Starting Point - Engine Cooling

Begin the system diagnosis with the Diagnostic System Check - Vehicle. The Diagnostic System Check will provide the following information:

- The identification of the control module(s) which command the system.
- The ability of the control module(s) to communicate through the serial data circuit.
- The identification of any stored diagnostic trouble codes (DTCs) and their status.

The use of the Diagnostic System Check will identify the correct procedure for diagnosing the system and where the procedure is located.

DTC P0480 or P0481

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0480: Cooling Fan 1 Control Circuit Malfunction

DTC P0481: Cooling Fan 2 Control Circuit Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Low Speed Cooling Fan Relay Control Circuit	P0480	P0480	P0480
Low Speed Cooling Fan Relay Coil Voltage Supply Circuit	P0480	P0480	P0480
High Speed Cooling Fan Relay Control Circuit	P0481	P0481	P0481
High Speed Cooling Fan Relay Coil Voltage Supply Circuit	P0481	P0481	P0481

Circuit/System Description

The engine control module (ECM) grounds the cooling fan relay control circuits through an internal solid state device called a driver. The primary function of the driver is to supply the ground for the component being controlled. Each driver has a fault line that is monitored by the ECM. When the ECM is commanding a component ON the voltage potential of the control circuit should be low, near 0 volts. When the ECM is commanding the control circuit to a component OFF the voltage potential of the circuit should be high near battery voltage. If the ECM detects that the actual state of the control circuit does not match the expected state, a DTC will set.

Conditions for Running the DTC

- The ignition is ON.
- The system voltage is between 9-18 volts.

Conditions for Setting the DTC

- An imcorrect voltage level has been detected on the cooling fan relay control circuit.
- The condition must be present for a minimum of 30 seconds.

Action Taken when the DTC Sets

DTCs P0480 and P0481 are type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0480 and P0481 are type B DTCs.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Verification

Ignition ON, command each relay ON and OFF with a scan tool. Feel or listen to verify that each relay turns ON and OFF with each command.

Circuit/System Testing

1. Ignition OFF, disconnect the fan relay.
2. Ignition ON, verify that a test lamp does not illuminate between the earth terminal and a known ground.

   If the test lamp illuminates, test the control circuit for a short to voltage.
3. Ignition ON, Connect a test lamp between the control circuit terminal and a known ground.

   Command the relay ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

If the test lamp is always ON, test the relay control circuit for a short to voltage. If the circuit tests normal replace the ECM.

If the test lamp is always OFF, test the relay control circuit for a short to ground or an open/high resistance. If the circuit tests normal replace the ECM.

4. Connect a test lamp between the Battery + terminal and a known ground.

   If the test lamp does not illuminates, test the Battery + for a short to ground or an open/high resistance.

5. Connect a 30-A fusible link wire between the battery positive post and the fan voltage supply circuit terminal and verify fan activation.

   If the fan does not activate, test the fan voltage supply circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the fan.

6. If all circuits test normal replace the affected relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Repair Verification

Ignition ON, command the relay ON and OFF with a scan tool. Feel or listen to verify that the relay turns ON and OFF with each command.

DTC P0480, P0481, P0691, P0692, P0693, or P0694 (V6)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0480: Cooling Fan Relay 1 Control Circuit

DTC P0481: Cooling Fan Relay 2 Control Circuit

DTC P0691: Cooling Fan Relay 1 Control Circuit Low Voltage

DTC P0692: Cooling Fan Relay 1 Control Circuit High Voltage

DTC P0693: Cooling Fan Relay 2 Control Circuit Low Voltage

DTC P0694: Cooling Fan Relay 2 Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition Circuit	P0691, P0693	P0480, P0481	--	--
Relay Switch Ignition Circuit	*	*	--	--
Fan 1 Relay Control Circuit	P0691	P0480	P0692	--
Fan 2 Relay and Fan 3 Relay Control Circuit	P0693	P0481	P0694	--
Relay Controlled Output Circuit	*	*	**	--
*Fans inoperative without a DTC. **Fans always ON without a DTC.				

Circuit/System Description

The engine control module (ECM) commands the fans ON in either high speed or low speed, depending on cooling requirements. In low speed, both fans are turned ON at a reduced speed. High speed has both fans turned ON at full speed.

In low speed operation, the ECM applies ground to the coil side of the low speed fan 1 relay. This energizes the coil and applies voltage directly to the right cooling fan through the switch side of the relay. The right fan is connected in series to the left cooling fan through the de-energized fan 2 relay. The series circuit operates both fans at low speed.

In high speed operation, the ECM applies a ground to the coil side of the fan 1 relay, the fan 2 relay, and the high speed fan 3 relay. When energized, the fan 3 relay applies voltage directly to the left cooling fan through the switch side of the relay. Simultaneously, the fan 1 relay and the fan 2 relay provide ignition voltage and a direct path to ground for the left cooling fan. With both fans connected in a parallel circuit, each fan receives full voltage and operates at high speed.

Conditions for Running the DTC

- The ignition voltage is between 8-18 volts.
- The engine speed is more than 40 RPM.
- The ECM driver transitions from ON to OFF or from OFF to ON.

Conditions for Setting the DTC

P0480

The ECM detects an open on the low speed cooling fan 1 relay control circuit for more than 1 second.

P0481

The ECM detects an open circuit on the high speed cooling fan 2 relay control circuit for more than 1 second.

P0691

The ECM detects a short to ground on the low speed cooling fan 1 relay control circuit for more than 1 second.

P0692

The ECM detects a short to voltage on the low speed cooling fan 1 relay control circuit for more than 1 second.

P0693

The ECM detects a short to ground on the high speed cooling fan 2 relay control circuit for more than 1 second.

P0694

The ECM detects a short to voltage on the high speed cooling fan 2 relay control circuit for more than 1 second.

Action Taken When the DTC Sets

DTCs P0480, P0481, P0691, P0692, P0693, and P0694 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0480, P0481, P0691, P0692, P0693, and P0694 are Type B DTCs.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cooling System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, command the appropriate fan relay ON and OFF with a scan tool. Listen or feel the relay click.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect all three cooling fan relays.

Note: The following test must be performed on all three fan relay circuits.

2. Ignition ON, verify that a test lamp illuminates between ground and the relay coil ignition circuit terminal listed below:
   - Fan 1 and Fan 3 relays terminal 85
   - Fan 2 relay terminal 86

   If the test lamp does not illuminate, test the relay coil ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the relay coil ignition circuit fuse is open, test all components connected to the ignition circuit and replace as necessary.

Note: The following test must be performed on all three fan relay circuits.

3. Test for 2.6-4.6 volts between ground and the relay coil control circuit terminal listed below:
   - Fan 1 and Fan 3 relays terminal 86
   - Fan 2 relay terminal 85

   If less than the specified range, test the relay coil control circuit for an open/high resistance or for a short to ground. If the circuit tests normal, replace the ECM.

   If greater than the specified range, test the relay coil control circuit for a short to voltage. If the circuit tests normal, replace the ECM.

Note: The following test must be performed on all three fan relay circuits.

4. Connect a test lamp between the relay coil control circuit and the relay coil ignition circuit, terminals 85 and 86.
5. Command the fan relay ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always OFF, replace the ECM.
6. If all the circuits test normal, test or replace the appropriate relay.

Component Testing

1. Ignition OFF, disconnect the cooling fan relay.
2. Test for 70-110 ohms between terminals 85 and 86.

   If the resistance is not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

     If not the specified range, replace the relay.

Note: This test only applies to 5 terminal relays.

4. Test for less than 2 ohms between terminals 30 and 87A.

   If greater than the specified range, replace the relay.
5. Install a 20A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and

87.

If greater than the specified range, replace the relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Relay Replacement
- Control Module References for ECM replacement, setup, and programming

DTC P1258

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of the diagnostic category.

DTC Descriptor

DTC P1258: Engine Coolant Overtemperature - Protection Mode Active

Circuit/System Description

The engine control module (ECM) uses the engine coolant temperature (ECT) sensor to monitor the engine for an over-termperature condition. This condition occurs when the coolant temperature is above a calibrated value for a calibrated length of time. The ECM will disable half of the cylinders by turning OFF the fuel injectors. By disabling half of cylinders, the ECM is able to reduce the temperature of the coolant.

Conditions for Running the DTC

- The engine is running for greater than 30 seconds.
- DTC P0116, P0117, P0118, or P0128 are not set.

Conditions for Setting the DTC

- The ECM detects that the engine coolant temperature is greater than 136°C (277°F) for more than 1 second or a cumulative time of 10 seconds - V6 applications.
- The ECM detects that the engine coolant temperature is greater than 131°C (267.8°F) for more than 7 seconds - V8 applications.

Action Taken When the DTC Sets

- DTC P1258 is a Type A DTC.
- The engine will operate in the Overheated Engine Protection Operating Mode.
- The instrument panel (IP) will illuminate the coolant indicator lamp and the driver information center (DIC), if equipped, may display a message.

Conditions for Clearing the DTC

DTC P1258 is a Type A DTC.

Reference Information

Description and Operation

Cooling System Description and Operation

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

Note: If DTCs P0480, P0481, P0691, P0692, P0693, or P0694 are set, diagnose those DTCs first.

1. Observe the engine coolant level. The engine coolant level should be within operating range. Refer to Capacities - Approximate Fluid, and Engine Coolant in the Owner's Manual.
2. Ensure that the vehicle has the correct engine coolant, with correct concentration, and is not old, contaminated, or contains additives. Refer to Recommended Fluids and Lubricants in the Owner's Manual.
3. Inspect the cooling system for the following:
    - Cooling system leaks
    - Kinked or pinched hoses, especially at the radiator
    - Loose, missing, or damaged radiator air seals or deflectors
    - The radiator and A/C condenser for any air flow obstructions or bent fins--Refer to Symptoms - Engine Cooling.

    Note: A small delay occurs before the ECM changes the cooling fan speed.

4. Command the cooling fans in both low and high speed.

    If the cooling fans do not operate in both speeds, refer to Cooling Fan Inoperative.
5. Test the thermostat for the correct operation. Refer to Thermostat Diagnosis.
6. Test the engine cooling system for overheating. Refer to Engine Overheating.
7. Inspect the water pump and coolant flow for correct operation. Refer to Water Pump Replacement.
8. Inspect the engine for worn/leaking/cracked cylinder heads and engine block. Refer to Coolant in Combustion Chamber and Coolant in Engine Oil.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Cooling Fan Always On

Step	Action	Yes	No
Schematic Reference: Engine Cooling Schematics . *Connector End View Reference:* Component Connector End Views . DEFINITION: One or both engine cooling fan motors run continuously in high or low speed.			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go To Diagnostic System Check - Vehicle
2	Ignition ON, engine OFF. Are both cooling fans operating at low speed?	Go to Step 4	Go to Step 3
3	Is the left cooling fan operating at high speed?	Go to Step 5	Go to Testing for Intermittent Conditions and Poor Connections in Wiring Systems.
4	Remove the low speed fan relay. Did the fans turn OFF?	Go to Step 6	Repair the cooling fan motor supply voltage circuit of the right cooling fan for a short to voltage. Refer to Wiring Repairs .
5	Remove the high speed fan relay. Did the left cooling fan turn OFF?	Go to Step 7	Repair the cooling fan motor supply voltage circuit of the left cooling fan for a short to voltage. Refer to Wiring Repairs .
6	Inspect for poor connections at the low speed fan relay. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	System OK	Replace the low speed fan relay.
7	Inspect for poor connections at the high speed fan relay. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	System OK	Replace the high speed fan relay.

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Engine Fails To Reach Normal Operating Temperature

Step	Action	Yes	No
1	1. Ensure that the cooling system is full. 2. Allow the engine to cool. 3. Start the engine. 4. Turn the air conditioning system off. 5. Inspect the engine cooling fan(s). Is the electric cooling fan on?	Go to Step 2	Go to Step 3
2	1. Diagnose and repair the cooling fan system. Refer to Cooling Fan Always On. 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to Step 3	System OK
3	Install the Scan Tool to the DLC. Compare the Scan Tool coolant temperature reading to the I/P cluster coolant temperature. Is the I/P cluster coolant temperature close to the reading on the Scan Tool?	Go to Step 5	Go to Step 4
4	1. Diagnose and repair the coolant temperature gauge system. 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to Step 5	System OK
5	Inspect the thermostat for correct operation. Refer to Thermostat Diagnosis. Is the thermostat operating correctly?	System OK	Go to Step 6
6	1. Replace the thermostat. Refer to Engine Coolant Thermostat Replacement. 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to Step 1	System OK

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Cooling Fan Inoperative

Step	Action	Yes	No
Schematic Reference: Engine Cooling Schematics . *Connector End View Reference:* Component Connector End Views DEFINITION: One or both cooling fan motors are inoperative in either high, low, or both speeds.			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to Diagnostic System Check - Vehicle .
2	1. Install the can tool. 2. Ignition ON, engine OFF. 3. With a scan tool, command the fans low speed ON and OFF. Do the low speed engine cooling fans turn ON and OFF with each command?	Go to Step 3	Go to Step 4
3	**Important:** A 3-second delay occurs before the engine control module (ECM) changes the cooling fan speed. With a scan tool, command the fans high speed ON and OFF. Do the high speed engine cooling fans turn ON and OFF with each command?	Go to Testing for Intermittent Conditions and Poor Connections .	Go to Step 6
4	**Important:** Do NOT remove the jumper wire that you will be connecting until your testing is completed. If the low speed fan fuse opens when you connect the fused jumper wire, repair the cooling fan motor supply voltage circuit of the right cooling fan motor for a short to ground. 1. Disconnect the low speed fan relay. 2. Connect a jumper wire between the battery positive voltage circuit and the cooling fan motor supply voltage circuit of the low speed fan relay. Do both cooling fans operate in low speed?	Go to Step 14	Go to Step 5
	1. Disconnect the fan relay. 2. With a test lamp connected to a good		

5	ground, probe the cooling fan low reference circuit at the low speed fan relay. Does the test lamp illuminate?	Go to Step 9	Go to Step 8
6	Does the right cooling fan operate at high speed?	Go to Step 15	Go to Step 7
7	Inspect the ground circuit of the Low Speed fan relay for an open or high resistance. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	System OK	Go to Step 15
8	1. Install the Low Speed fan relay. 2. Disconnect the right cooling fan electrical connector. 3. With a test lamp connected to a good ground, probe the cooling fan motor supply voltage circuit at the right cooling fan motor connector. Does the test lamp illuminate?	Go to Step 12	Go to Step 13
9	1. Install the low speed fan relay. 2. Disconnect the left cooling fan motor connector. 3. With a test lamp connected to a good ground, probe the cooling fan motor supply voltage circuit at the left cooling fan connector. Does the test lamp illuminate?	Go to Step 11	Go to Step 10
10	Inspect the cooling fan motor supply voltage circuit for an open or high resistance. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	System OK	Go to Step 15
11	Inspect the ground circuit of the left cooling fan for an open or high resistance. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	System OK	Go to Step 17
12	Inspect the cooling fan low reference circuit for an open or high resistance. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	System OK	Go to Step 16
13	Inspect the cooling fan motor supply voltage circuit of the right cooling fan for an open or high resistance. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	System OK	Inspect the battery positive voltage circuit for an open or high resistance. Refer to Wiring Repairs .

14	Inspect for poor connections at the low speed fan relay. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	System OK	Replace the low speed fan relay.
15	Inspect for poor connections at the high speed fan relay. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs .	System OK	Replace the high speed fan relay.
16	Inspect for poor connections at the harness connector of the right cooling fan. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	System OK	Replace the right cooling fan. Refer to Cooling Fan and Shroud Replacement .
17	Inspect for poor connections at the harness connector of the left cooling fan. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	System OK	Replace the left cooling fan. Refer to Cooling Fan and Shroud Replacement .

Cooling System Leak Testing

Tools Required

- KM-6327 Pressure Tester Adapter (previously released for Vectra)
- KM-471 Pressure Tester Adapter (previously released for Vectra)
- J 24460-01 Cooling System and Cap Pressure Tester

Caution: Under pressure, the temperature of the solution in the radiator can be considerably higher, without boiling. Removing the radiator cap while the engine is hot (pressure is high), will cause the solution to boil instantaneously, with explosive force. The solution will spew out over the engine, fenders, and the person removing the cap. Serious bodily injury may result. Flammable antifreeze, such as alcohol, is not recommended for use at any time. Flammable antifreeze could cause a serious fire.

Caution: In order to help avoid being burned, do not remove the radiator cap while the engine and the radiator are hot. Scalding fluid and steam can be blown out under pressure if the cap is removed too soon.

Remove the coolant pressure cap.

Test the operation of the coolant pressure cap. Refer to Pressure Cap Testing .

Ensure that the coolant level is correct.

> **Notice:** Refer to General Repair Instructions in the Preface section.

1. Install the coolant filler neck adapter (2) to commercially available cooling system pressure tester (1).
2. Install the assembly to the engine coolant filler neck.
3. Using compressed air, blow dry any spilled coolant around coolant filler neck.

> **Caution:** Refer to General Repair Instructions in the Preface section.

4. Using the cooling system pressure tester pump, pressurise the cooling system to 150 kPa (22 psi) absolute maximum and check for leaks at the following points:
   - All hose and hose connections.
   - Overflow hose connection at coolant outlet housing connection.
   - Radiator seams and core.
   - Corroded or damaged engine core plugs.
   - Water pump and gasket.
   - Thermostat housing and inlet pipe connection.
   - Radiator drain cock.
   - Vehicle heating system (e.g. heater core and water valve).
   - Check engine oil dipstick for evidence of engine oil contamination with the coolant.
5. Repair any leaks as required.

Notice: Refer to General Repair Instructions in the Preface section.

6. If pressure will not hold, there is a leak in the cooling system. Repair as necessary.

Black Light and Dye Leak Diagnosis Method

Caution: Refer to Cooling System Draining and Filling in the Preface section.

Caution: Under pressure, the temperature of the solution in the radiator can be considerably higher, without boiling. Removing the radiator cap while the engine is hot (pressure is high), will cause the solution to boil instantaneously, with explosive force. The solution will spew out over the engine, fenders, and the person removing the cap. Serious bodily injury may result. Flammable antifreeze, such as alcohol, is not recommended for use at any time. Flammable antifreeze could cause a serious fire.

Caution: In order to help avoid being burned, do not remove the radiator cap while the engine and the radiator are hot. Scalding fluid and steam can be blown out under pressure if the cap is removed too soon.

1. Remove the pressure cap.
2. Pour a specified amount of dye into the cooling system.
3. Road test the vehicle under normal operating conditions.
4. Direct the black light towards the suspect area. Any fluid leak will appear as a bright coloured path leading to the source.
5. Repair the fluid leak and carry out a second road test to ensure the leak has been rectified.
6. Refer to the manufacture's direction when preforming this method.

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Pressure Cap Testing

Tools Required

- J 24460-01 EN-48501 Pressure Cap Adapter
- J 24460-01 J-48501 Radiator Cap Pressure Adapter
- J 24460-01 J-24460-01 Cooling System and Cap Pressure Tester

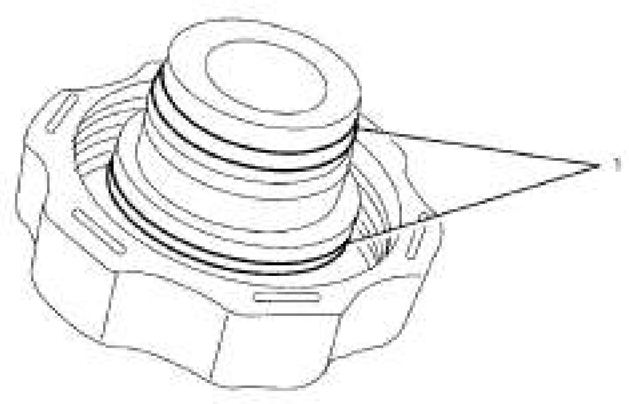
Caution: Under pressure, the temperature of the solution in the radiator can be considerably higher, without boiling. Removing the radiator cap while the engine is hot (pressure is high), will cause the solution to boil instantaneously, with explosive force. The solution will spew out over the engine, fenders, and the person removing the cap. Serious bodily injury may result. Flammable antifreeze, such as alcohol, is not recommended for use at any time. Flammable antifreeze could cause a serious fire.

Caution: In order to help avoid being burned, do not remove the radiator cap while the engine and the radiator are hot. Scalding fluid and steam can be blown out under pressure if the cap is removed too soon.

Caution: Refer to Radiator Cap Removal Caution in the Preface section.

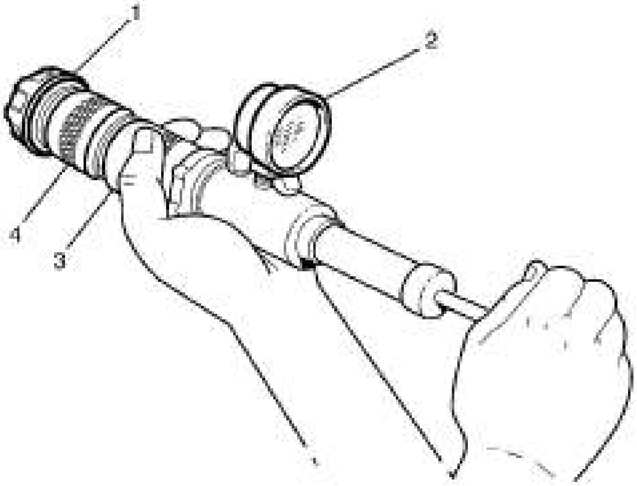
Caution: Refer to Safety Glasses Caution in the Preface section.

Ensure engine is below 50 C before removing the coolant pressure cap.



Caution: Refer to General Repair Instructions in the Preface section.

Inspect and clean the sealing O-rings (1) with a wet cloth.

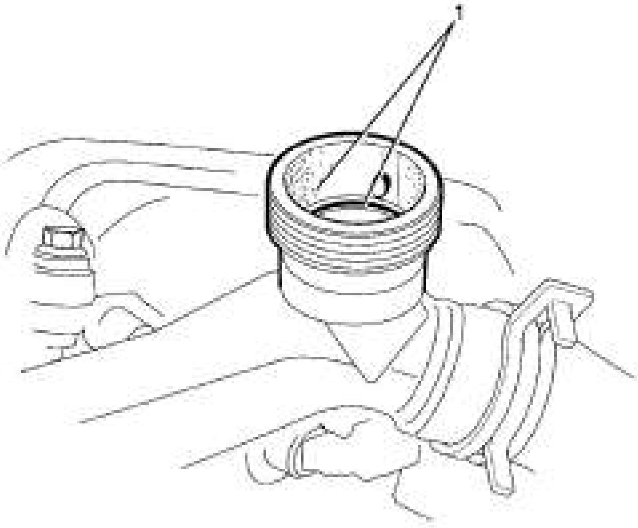


1. Attach the coolant filler cap (1) to a commercially available cooling system pressure tester (2), using the pressure cap adapter (4) and the pressure tester adapter (3).

   Notice: Refer to General Repair Instructions in the Preface section.

2. Slowly pressurise cap to 120 - 150 kPa (17 - 22 psi).

   Notice: Refer to General Repair Instructions in the Preface section.



3. Prior to installing the coolant pressure cap ensure that the coolant filler neck cap seating surface (1) is clean and free from obstruction.

   Notice: Refer to Fastener Notice in the Preface section.

4. Install the coolant pressure cap.

   Tighten
   Tighten the cap to 3.0 Nm (27 lb in).

Symptoms - Engine Cooling

Engine Control Module (ECM) Scan Tool Output Controls

Scan Tool Output Control	Additional Menu Selection(s)	Description
Fan Relay 1	Fan Relays	The scan tool displays a Commanded State of OFF or ON. This allows you to communicate with the ECM and activate or deactivate the cooling fan 1 relay, manually turning the low speed fans ON and OFF.
Fan Relays 2 and 3	Fan Relays	The scan tool displays a Commanded State of OFF or ON. This allows you to communicate with the ECM to activate or deactivate the cooling fan 2 relay and the cooling fan 3 relay. This turns the high speed fans ON and OFF.
Fan Relays 1, 2 and 3	Fan Relays	The scan tool displays a commanded state of OFF or ON. This allows you to communicate with the ECM to activate or deactivate the cooling fan 1 relay, manually turning the low speed fans ON. After a 3 second delay the ECM will activate the cooling fan 2 relay and the cooling fan 3 relay. This turns the high speed fans ON and OFF.

Thermostat Diagnosis

Tools Required

J 24731 Tempil stick

The coolant thermostat can be tested using a temperature (tempil) stick. The temperature stick is a pencil-like device which has a wax material containing certain chemicals that melt at a given temperature. Temperature sticks can be used to determine a thermostat's operating range by rubbing 87°C (188°F) and 97°C (206°F) sticks on the outlet coolant hose.

1. Use a tempilstick in order to find the opening and the closing temperatures of the thermostat.

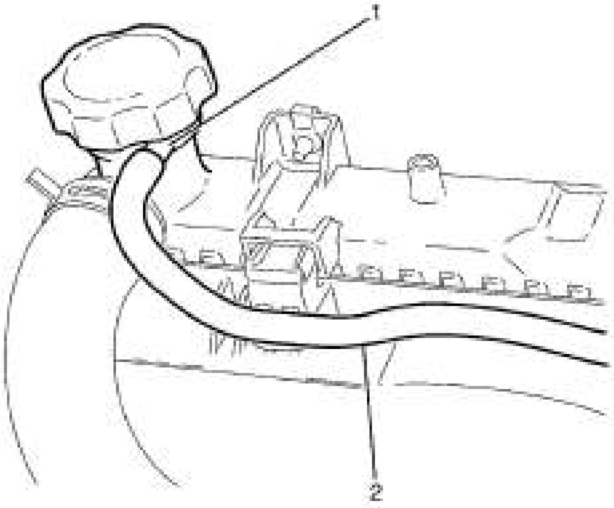
   J 24731 tempilstick melts at 87°C (188°F). The thermostat should begin to open at 82°C (181°F).

2. Replace the thermostat if it does not operate correctly between this temperature range.

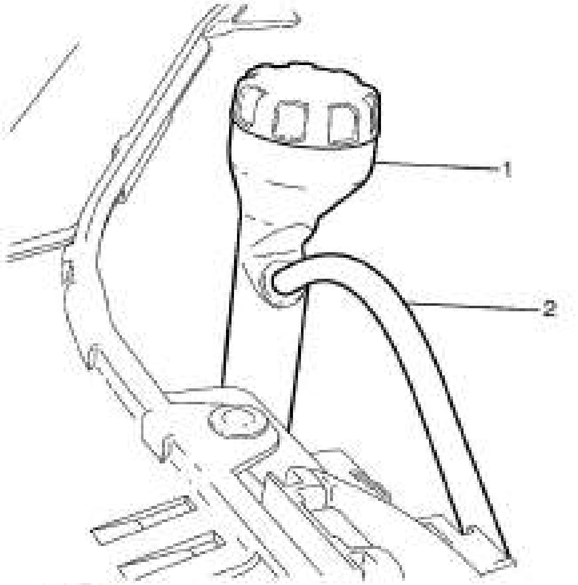
Coolant Recovery Reservoir Pipe Replacement (3.6L Engine)

Removal Procedure

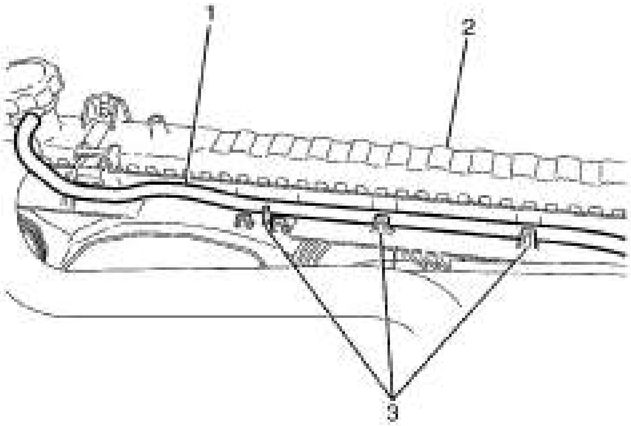
1. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement in Body Front End.



2. Detach the coolant recovery hose (2) from the radiator outlet pipe (1).

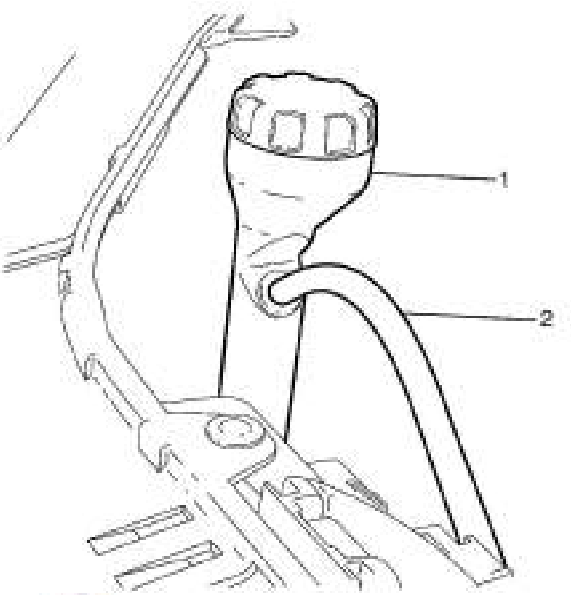


3. Remove the coolant recovery hose (2) from the coolant recovery reservoir filler neck (1).

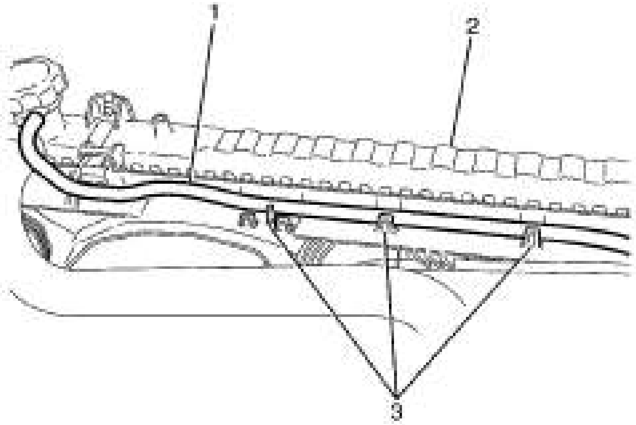


4. Detach and remove the coolant recovery reservoir hose (1) from the coolant recovery reservoir retaining locks (3) located on the radiator (2).

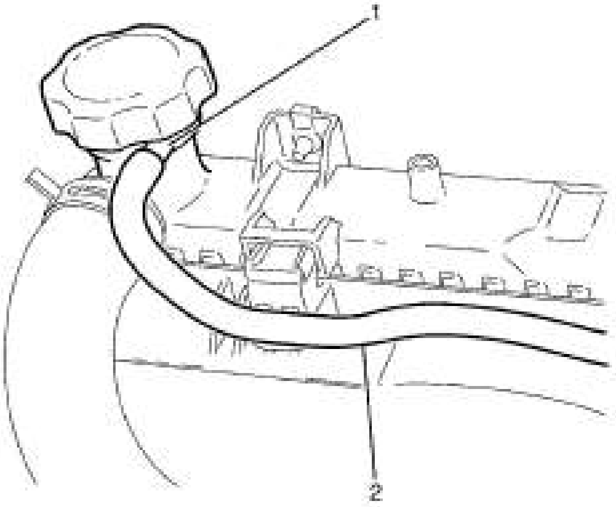
Installation Procedure



1. Install the coolant recovery reservoir hose (2) into the coolant recovery reservoir filler neck (1).



2. Attach the coolant recovery reservoir hose (1) into the coolant recovery reservoir retaining locks (3) located on the radiator (2).



3. Attach the coolant recovery reservoir hose (2) to the radiator outlet pipe (1).
4. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement in Body Front End.
5. Check the coolant level. Refer to Cooling System Draining and Filling.

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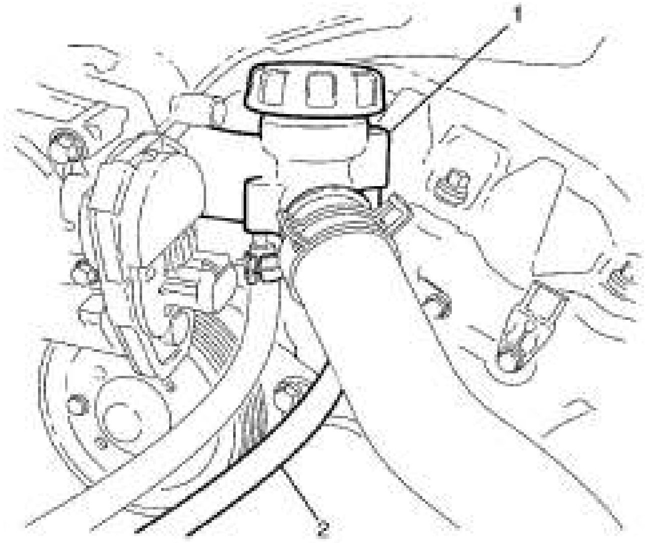
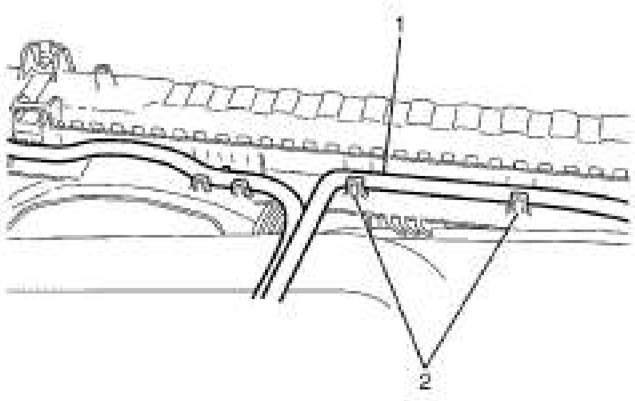
Coolant Recovery Reservoir Pipe Replacement (6.0L Engine)

Removal Procedure

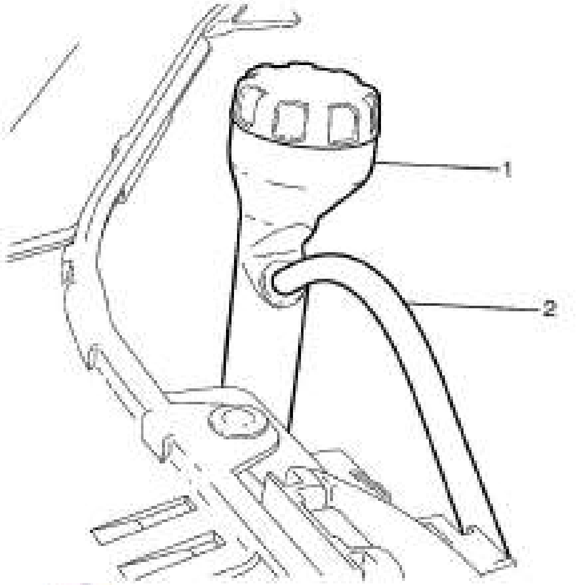
1. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement in Body Front End.
2. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.



3. Detach the coolant recovery hose from the outlet housing (1).

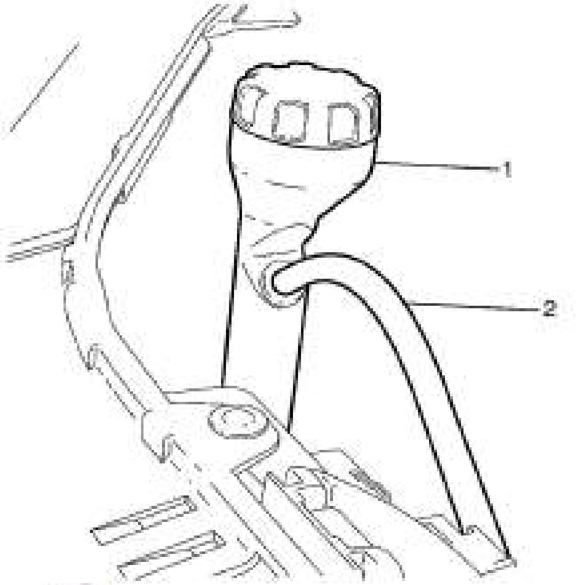


4. Detach the coolant recovery reservoir hose (1) from the radiator retaining clips (2).

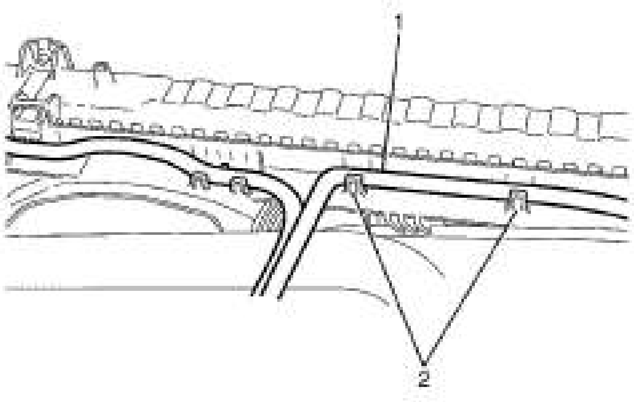


5. Detach and remove the coolant recovery hose (2) from the coolant recovery reservoir filler neck (1).

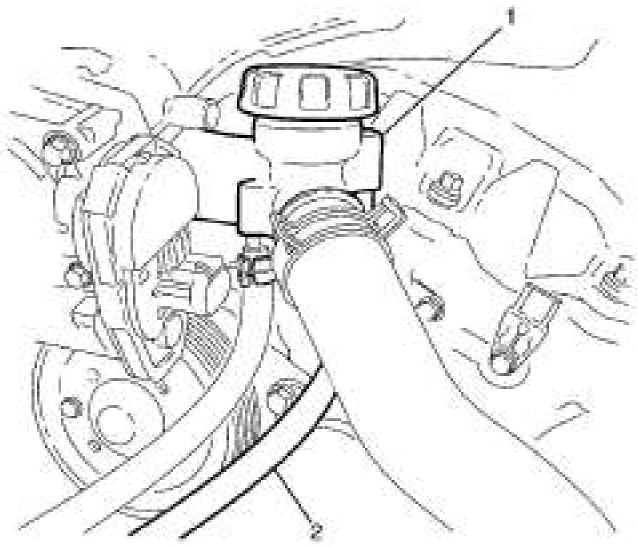
Installation Procedure



1. Attach the coolant recovery hose (2) to the coolant recovery reservoir filler neck (1).



2. Attach the coolant recovery reservoir hose (1) into the radiator (2) retaining clips (3).



3. Attach the coolant recovery hose (2) to the outlet housing (1).
4. Inspect the coolant level and "top up" if necessary.
5. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.
6. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement in Body Front End.

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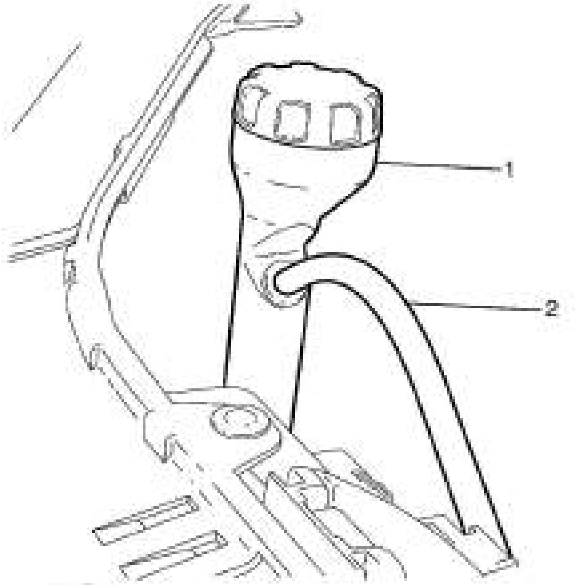
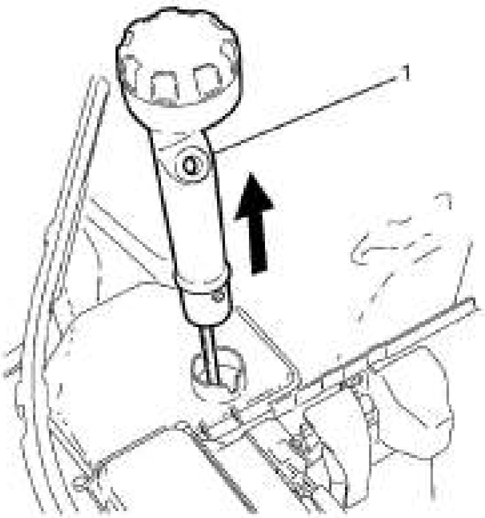
Coolant Recovery Reservoir Replacement

Removal Procedure

1. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement in Body Front End.



2. Disconnect the coolant recovery hose (2) from the coolant recovery reservoir filler neck (1).

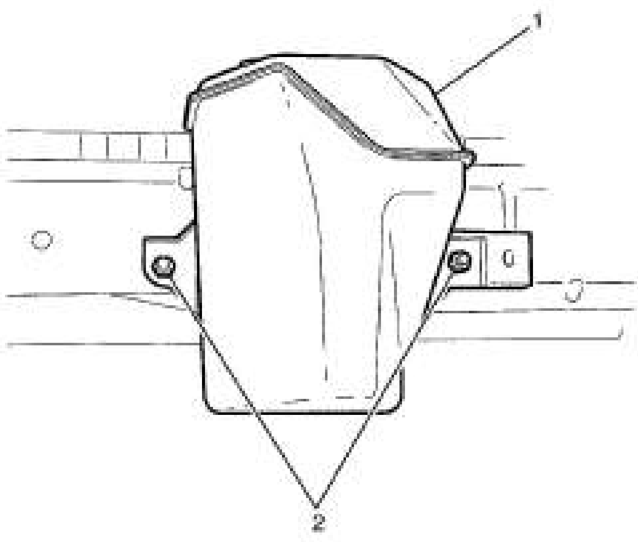


3. Remove the coolant recovery reservoir filler neck (1).

Caution: Refer to Safety Glasses Caution in the Preface section.

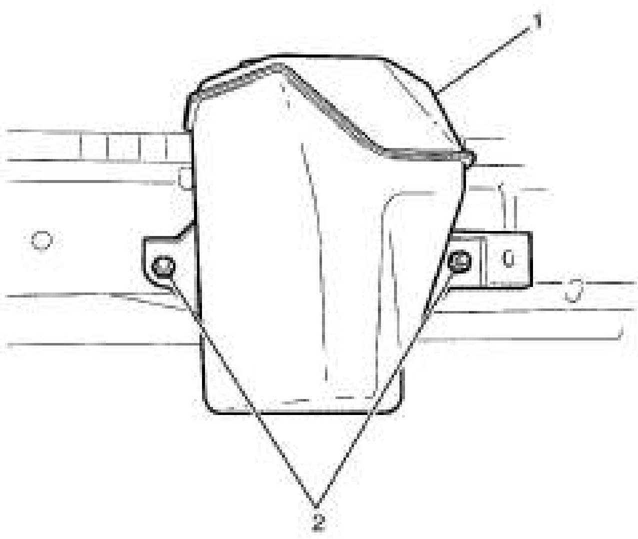
Caution: Refer to Vehicle Lifting Caution in the Preface section.

4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
5. Remove the right hand front wheel. Refer to Tire and Wheel Removal and Installation.
6. Remove the wheel house liner. Refer to Front Wheelhouse Liner Replacement.
7. Remove the air deflector. Refer to Front Air Deflector Replacement.



8. Remove the coolant recovery reservoir retaining nuts (2).
9. Remove the coolant recovery reservoir (1).

Installation Procedure



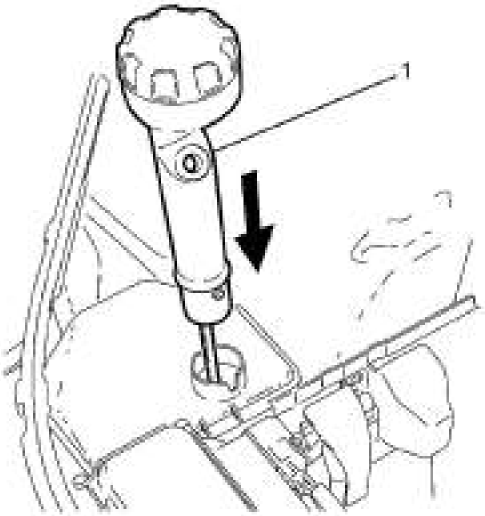
1. Install the coolant recovery reservoir (1).

Notice: Refer to Fastener Notice in the Preface section.

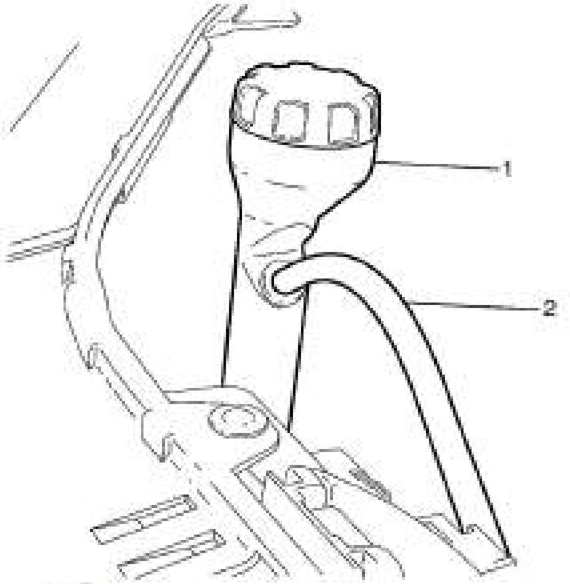
2. Install the coolant recovery retaining nuts (2).

Tighten
Tighten the nuts to 17 N·m (13 lb ft).

3. Install the air deflector. Refer to Front Air Deflector Replacement.
4. Install the wheel house liner. Refer to Front Wheelhouse Liner Replacement.
5. Install the right hand front wheel. Refer to Tire and Wheel Removal and Installation.
6. Lower the vehicle.



7. Install the coolant recovery reservoir filler neck (1).



8. Connect the coolant recovery reservoir hose (2) to the coolant recovery reservoir filler neck

(1)

9. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement in Body Front End.
10. Fill the coolant reservoir to the fill level. Refer to Cooling System Draining and Filling.
11. Inspect cooling system for leaks.

Coolant System Flushing

Radiator Flush

1. Drain the cooling system. Refer to Cooling System Draining and Filling .

   Caution: Refer to Safety Glasses Caution in the Preface section.

2. Remove the lower radiator outlet hose at the coolant inlet pipe connection.
3. Remove the upper radiator inlet hose at the coolant outlet housing connection.

   Notice: Refer to General Repair Instructions in the Preface section.

4. Attach a lead away hose to the open end of the upper radiator hose.
5. Attach a suitable piece of hose or adaptor between the flushing gun and the open end of the lower radiator hose.
6. Connect and operate the flushing equipment as recommended by the manufacturer.

   Caution: Refer to General Repair Instructions in the Preface section.

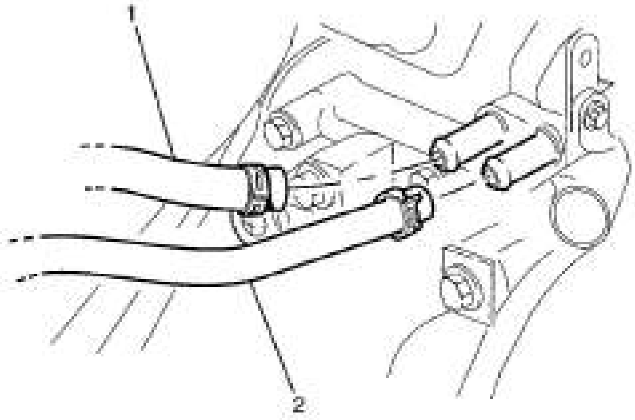
7. Continue flushing until water from the lead away hose runs clean and clear.
8. Install all disconnected hoses, ensuring that they are correctly position and securely clamped.
9. Fill the cooling system. Refer to Cooling System Draining and Filling .
10. Pressure test the cooling system. Refer to Cooling System Leak Testing .

Heater Hoses and Core

Important: Do not use a chemical flush.

Store used coolant in the correct manner, such as in a used engine coolant holding tank. Do not pour used coolant down a drain. Ethylene glycol antifreeze is a very toxic chemical. Do not dispose of coolant into the sewer system or ground water. This is illegal and ecologically unsound.

1. Drain the cooling system. Refer to Cooling System Draining and Filling .

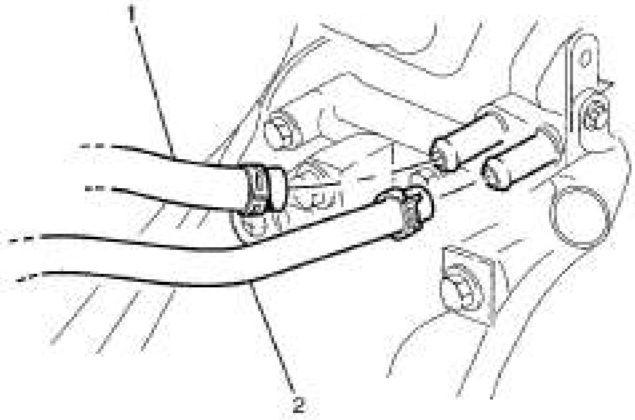


Important: Make a note of how the inlet and outlet hoses were removed for correct installation.

2. Remove both heater hoses (1) and (2) from their connections at the water pump.
3. Direct the hose (1) that was connected to the water pump's rear-most connection into a suitable container.

Caution: Refer to General Repair Instructions in the Preface section.

4. Attach the hose (2) from the front connection to the flushing gun.
5. Connect and operate the flushing gun.



6. Install the heater hoses (1) and (2), ensuring they are installed in the correct positions.

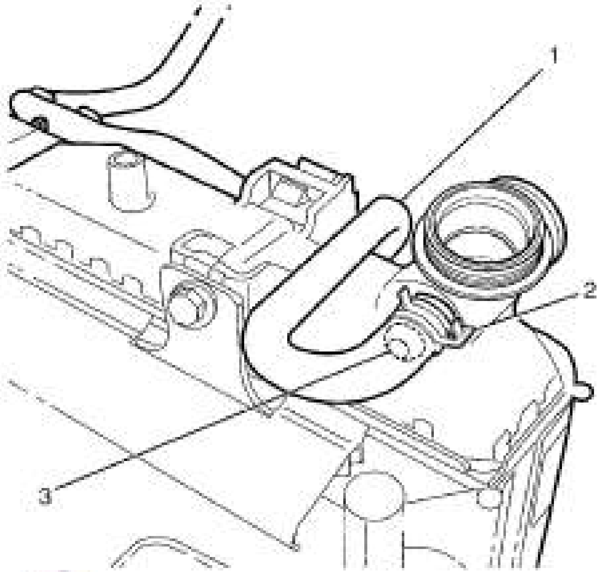
7. Fill the cooling system. Refer to Cooling System Draining and Filling .
8. Pressure test the cooling system. Refer to Cooling System Leak Testing .

Engine

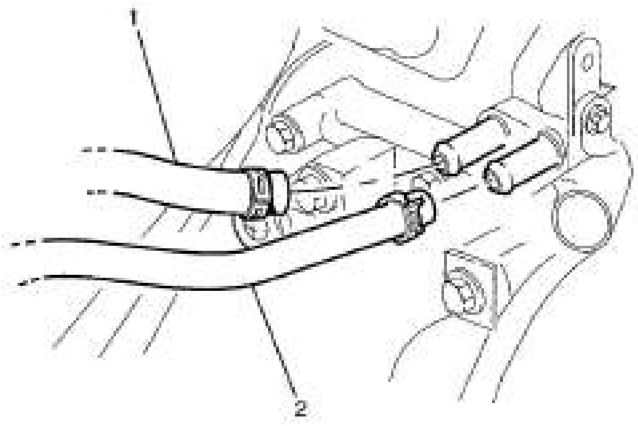
Important: Do not use a chemical flush.

Store used coolant in the correct manner, such as in a used engine coolant holding tank. Do not pour used coolant down a drain. Ethylene glycol antifreeze is a very toxic chemical. Do not dispose of coolant into the sewer system or ground water. This is illegal and ecologically unsound.

1. Drain the cooling system. Refer to Cooling System Draining and Filling .
2. Detach the inlet hose. Refer to Radiator Inlet Hose Replacement .
3. Detach the outlet hose. Refer to Radiator Outlet Hose Replacement .
4. Remove the thermostat housing. Refer to Engine Coolant Thermostat Housing Replacement .
5. Remove the thermostat. Refer to Engine Coolant Thermostat Replacement .
6. Install the thermostat housing. Refer to Engine Coolant Thermostat Housing Replacement .

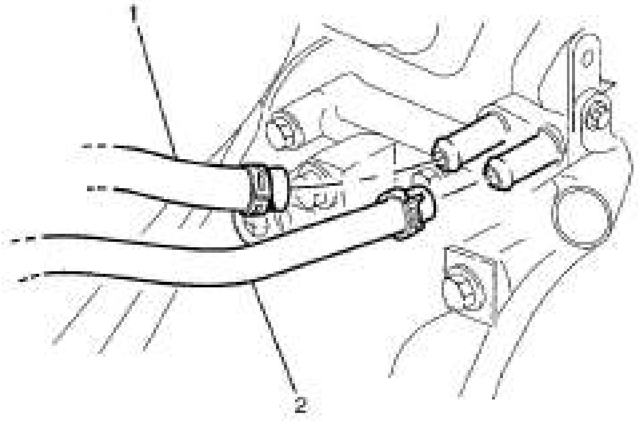


7. Remove the engine coolant air bleed hose (1) by releasing retaining hose clamp (2) and remove it from the radiator spigot (3) and temporarily plug the end of the hose.



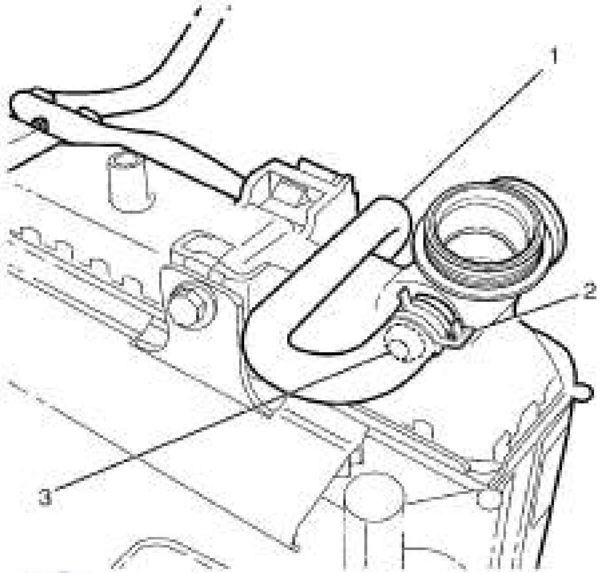
Important: Make a note of how the inlet and outlet hoses were removed for correct installation.

8. Remove the heater hoses (1) and (2) from their connections at the water pump. Seal the pump connections by looping the water pump heater inlet connection tothe outlet connection using a suitable piece of hose and two retaining clamps.
9. Install a lead-away hose to the thermostat housing and a length of suitable hose between the water pump outlet fitting and the flushing gun.
10. Connect and operate the flushing gun.
11. Unplug the air bleed hose and continue flushing until the water runs clear.



12. Install the heater hoses (1) and (2), ensuring they are installed in the correct positions.
13. Install the thermostat. Refer to Engine Coolant Thermostat Replacement .

14. Install the thermostat housing. Refer to Engine Coolant Thermostat Housing Replacement .



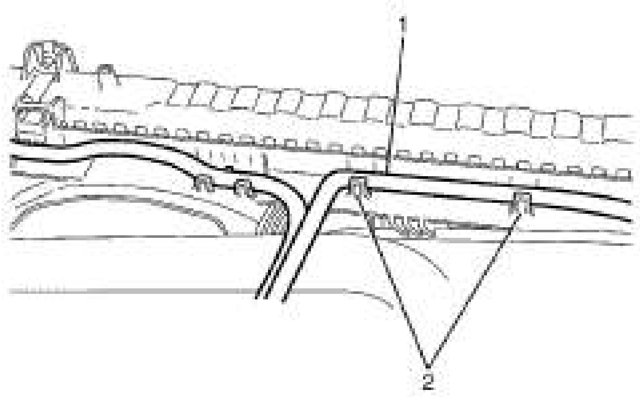
15. Attach the coolant air bleed hose (1) to the radiator spigot (3).
16. Secure the coolant air bleed hose (1) with the retaining hose clamp (2)
17. Attach the outlet hose. Refer to Radiator Outlet Hose Replacement .
18. Attach the inlet hose. Refer to Radiator Inlet Hose Replacement .
19. Fill the cooling system. Refer to Cooling System Draining and Filling .
20. Pressure test the cooling system. Refer to Cooling System Leak Testing .

Cooling Fan and Shroud Replacement

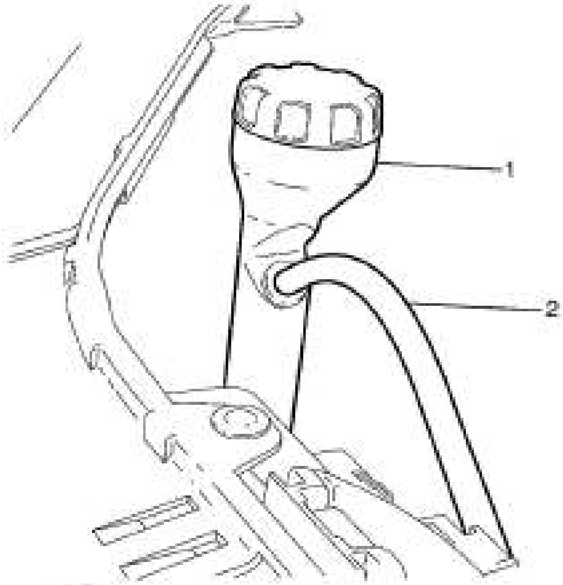
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

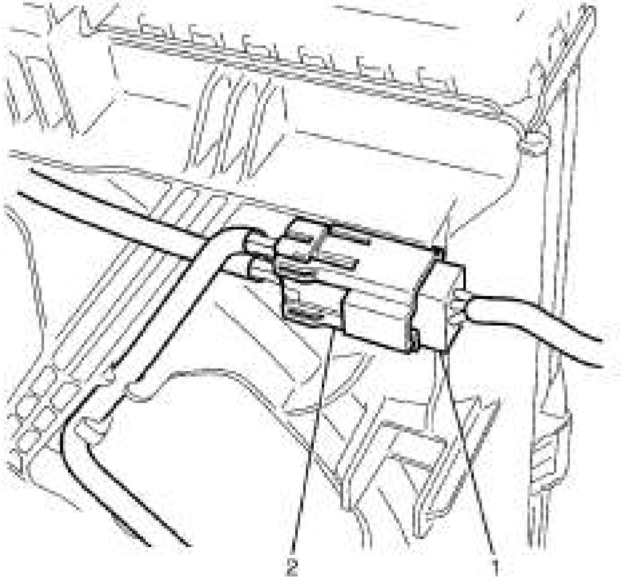
1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection
2. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement .
3. Remove the Mass Air Flow sensor. Refer to Mass Airflow Sensor/Intake Air Temperature Sensor Replacement for 3.6L engine, or Mass Airflow Sensor/Intake Air Temperature Sensor Replacement for 6.0L engine.
4. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement for 3.6L engine, or Air Cleaner Inlet Duct Replacement for 6.0L engine.
5. Remove the radiator inlet hose. Refer to Radiator Inlet Hose Replacement .



6. Detach and remove the coolant recovery hose (1) from the coolant recovery hose retaining locks (2).



7. Detach the coolant recovery reservoir hose (2) from the coolant recovery reservoir (1).

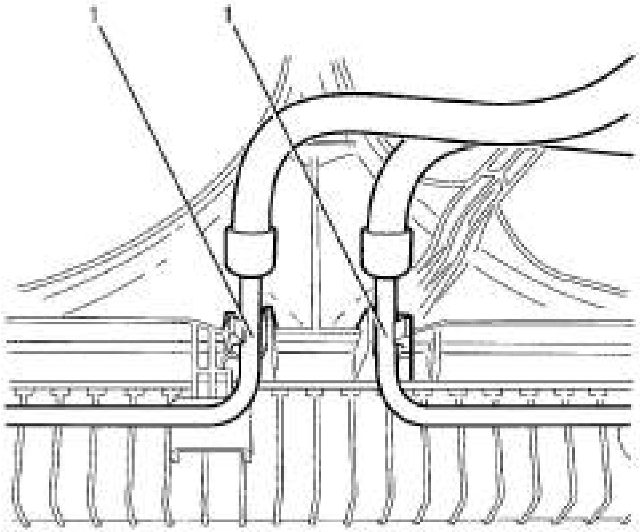


8. Detach the cooling fan motor electrical connector (2), from the main wiring harness (1).

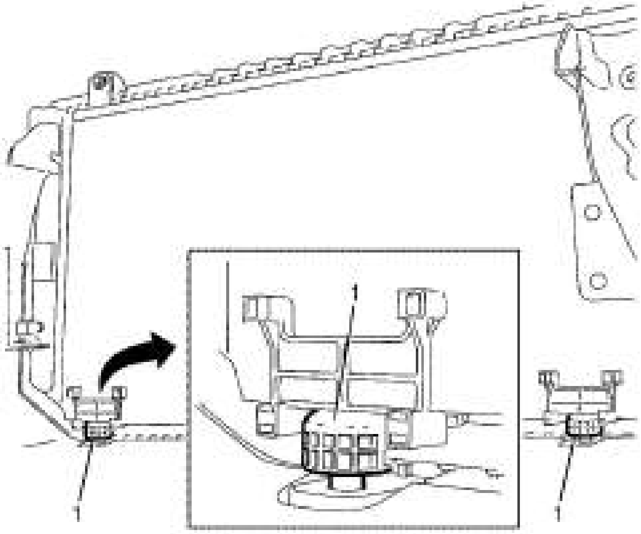
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

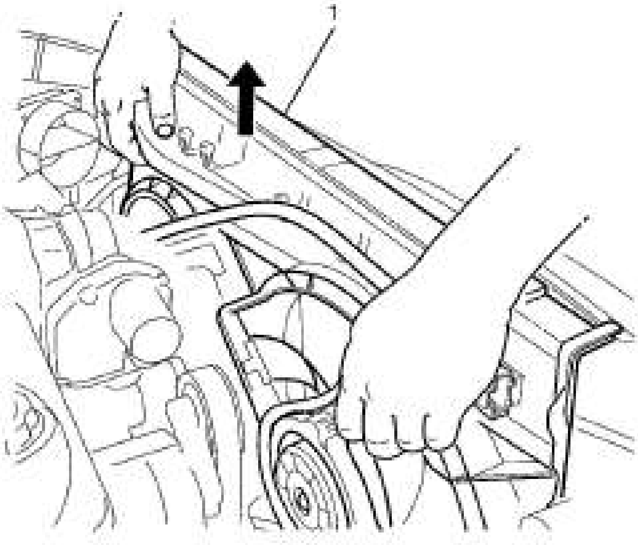
9. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



10. Detach the transmission cooling hoses (1) from the fan shroud.
11. Lower the vehicle.



12. Remove the fan shroud (3) by pressing down on retaining lugs (1) to release it from the radiator assembly (2).

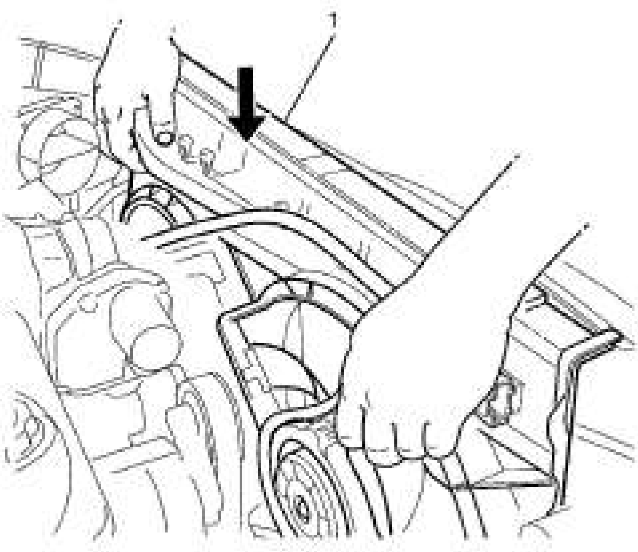


Important: When removing or installing the fan assembly always hold it by the fan motor mounting struts.

Important: Do not grasp the assembly by the fan rings as this may cause vibrations when the fans are in motion.

13. While holding the fan motor mounting struts remove the cooling fan and shroud assembly (1).

Installation Procedure

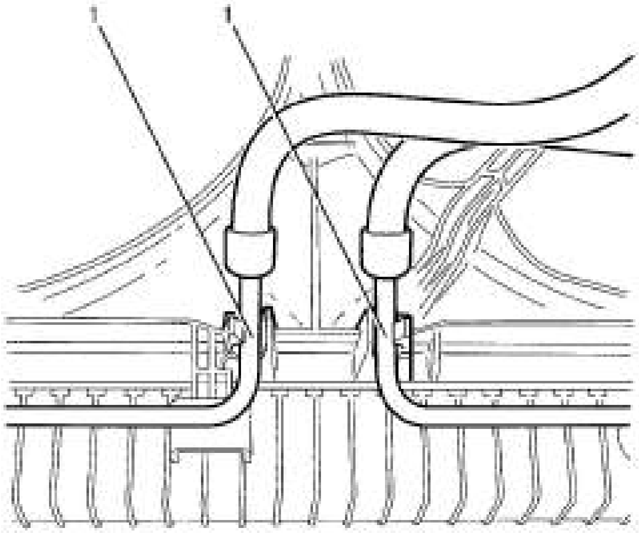


1. Install the cooling fan and shroud assembly (1).
2. Install the cooling fan and shroud assembly (1) onto the radiator (2) by pushing assembly forward until tabs lock into radiator retaining lugs. Listen for an audible click to confirm fitting.

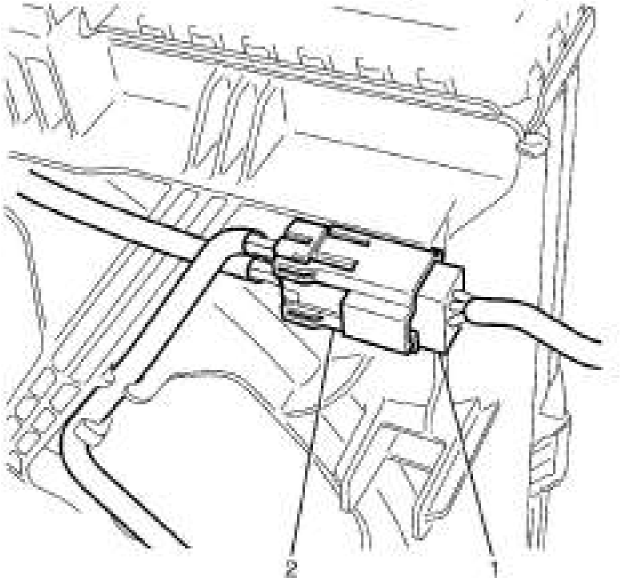
   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

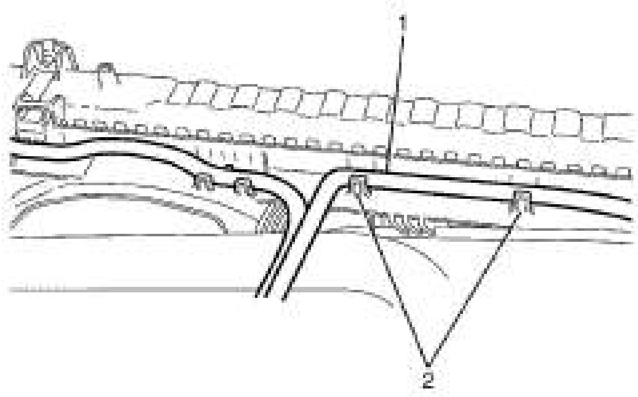
3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



4. Install the transmission cooling hoses (1) onto the fan assembly.



5. Attach the cooling fan electrical connector (2) to the main wiring harness (1).



6. Attach the coolant recovery hose (1) into the coolant recovery hose retaining locks (2).
7. Install the radiator inlet hose. Refer to Radiator Inlet Hose Replacement .
8. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacementfor 3.6L engine, or Air Cleaner Inlet Duct Replacement for 6.0L engine.
9. Install the Mass Air Flow sensor. Refer to Mass Airflow Sensor/Intake Air Temperature Sensor Replacement for 3.6L engine, or Mass Airflow Sensor/Intake Air Temperature Sensor Replacement for 6.0L engine.
10. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement .
11. Connect the battery ground lead to the vehicle. Refer to Battery Negative Cable Disconnection and Connection .
12. Start and run engine until the cooling fans are activated.

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Cooling System Draining and Filling

Draining Procedure (3.6L Engine)

Caution: Refer to Battery Disconnect Caution in the Preface section.

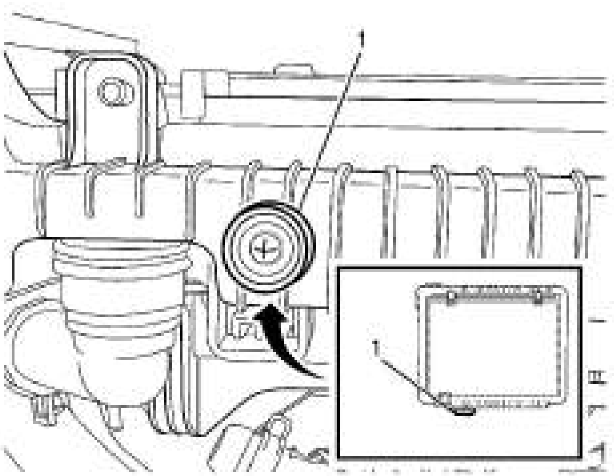
Caution: Refer to Radiator Cap Removal Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
2. Ensure engine is below 50 C before removing the Coolant pressure cap.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

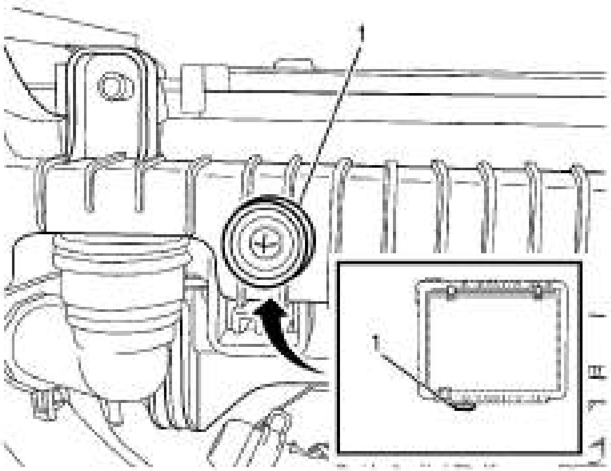


4. Place a drain pan under the drain cock (1).

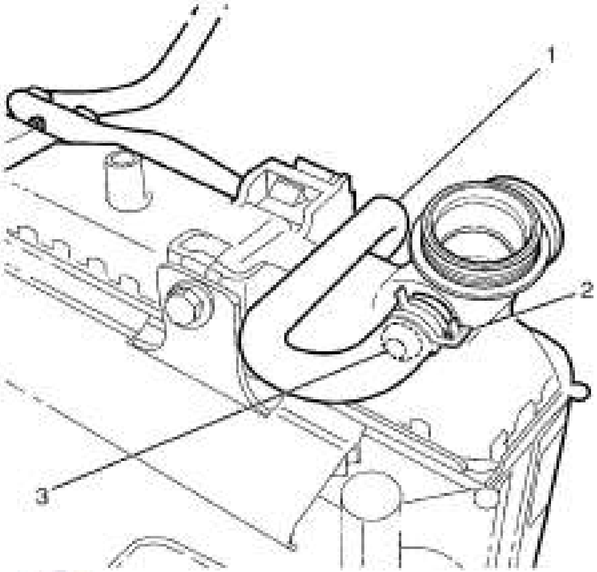
Important: If drain cock is not being replaced do not remove it from the radiator.

5. Loosen the drain cock until coolant flows out of the radiator.
6. Inspect the engine coolant for the following conditions:
   - Discolored appearance -- follow the flush procedure. Refer to Coolant System Flushing .
   - Normal in appearance -- follow the filling procedure. Refer to Cooling System Draining and Filling .

Filling Procedure



1. Tighten the drain cock (1).
2. Lower the vehicle.
3. With the engine off, remove the coolant filler cap.

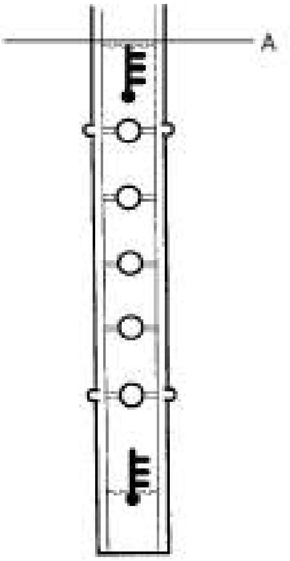


4. Remove the engine coolant air bleed hose (1) by releasing retaining hose clamp (2) and remove it from the radiator spigot (3).

   Notice: Refer to General Repair Instructions in the Preface section.

5. Slowly fill the cooling system with a mixture of 50/50 dex cool and water until coolant flows out of air bleed hose spigot. Refit air bleed hose.
6. Continue to fill the system until full. Wait several seconds and "top up" if levels drops.
7. Start engine.

8. With engine idling top up coolant until full, wait for several seconds and "top up" if level drops.
9. Stop engine, wait several seconds and "top up" if level drops.
10. When full, fit coolant filler cap and switch off engine.



11. Check coolant in coolant recovery reservoir. Adjust coolant in the reservoir to the top of the graphic mark (A) on the dipstick.

Draining Procedure (6.0L Engine)

Caution: Refer to Battery Disconnect Caution in the Preface section.

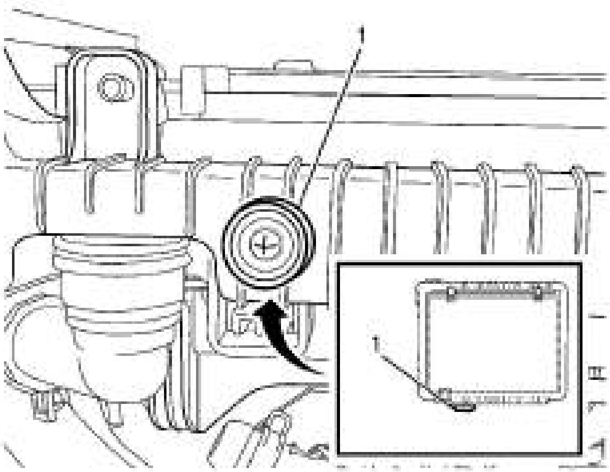
Caution: Refer to Radiator Cap Removal Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
2. Ensure engine is below 50 C before removing the Coolant pressure cap.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

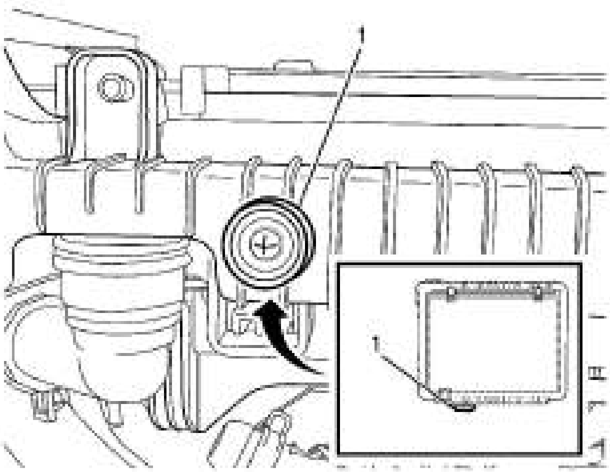


4. Place a drain pan under the drain cock (1).

   Important: If drain cock is not being replaced do not remove it from the radiator.

5. Loosen the drain cock until coolant flows out of the radiator.
6. Inspect the engine coolant for the following conditions:
   - Discolored appearance -- follow the flush procedure. Refer to Coolant System Flushing .
   - Normal in appearance -- follow the filling procedure. Refer to Cooling System Draining and Filling .

Filling Procedure



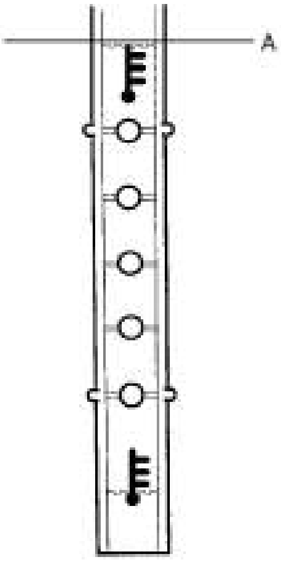
1. Tighten the drain cock (1).
2. Lower the vehicle.
3. With the engine off, remove the coolant filler cap.

Notice: Refer to General Repair Instructions in the Preface section.

4. Slowly fill the cooling system with a mixture of 50/50 Dex Cool and water until full, wait several seconds and "top up" if level drops.

Notice: Refer to General Repair Instructions in the Preface section.

5. Start engine.
6. With engine idling top up coolant until full, wait for several seconds and "top up" if level drops.
7. When full, fit coolant filler cap and switch off engine.



8. Check coolant level in coolant recovery reservoir. Adjust coolant level in the reservoir to the top of graphic mark (A) on the dipstick.

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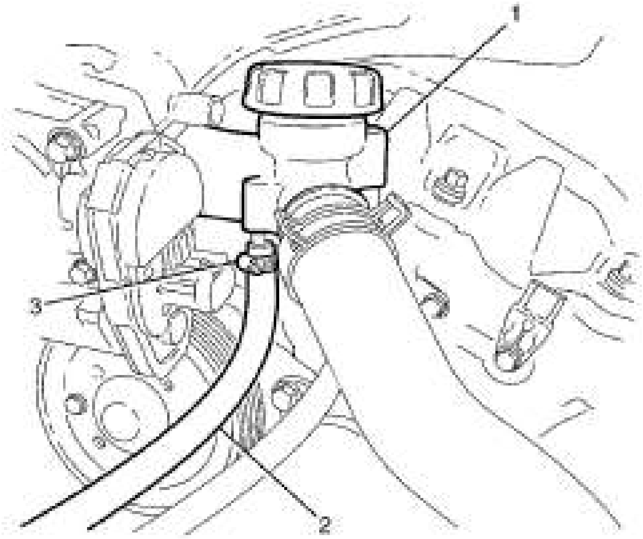
Engine Coolant Air Bleed Hose Replacement (3.6L)

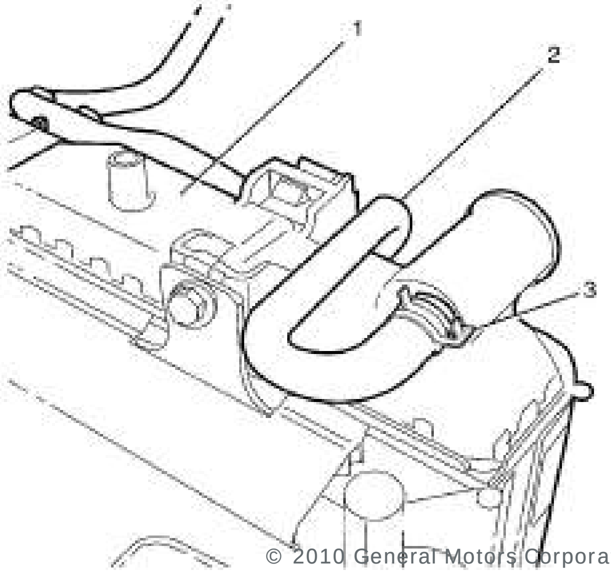
Removal Procedure

1. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement in Body Front End.
2. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.

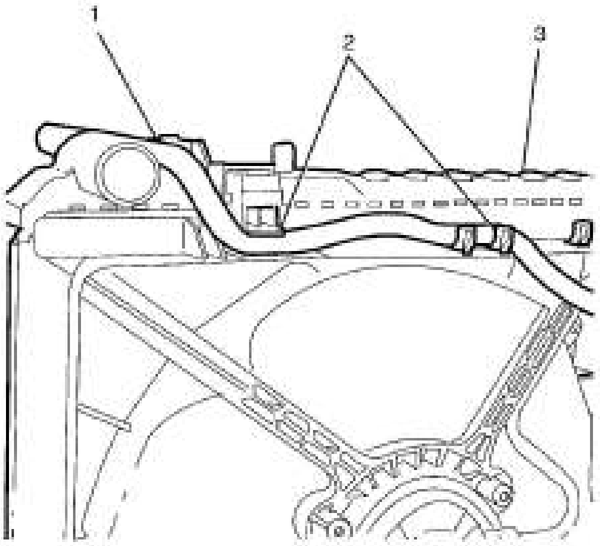
Caution: Refer to Safety Glasses Caution in the Preface section.



3. Release the hose clamp (3) and remove the coolant air bleed hose (2) from the outlet housing (1).

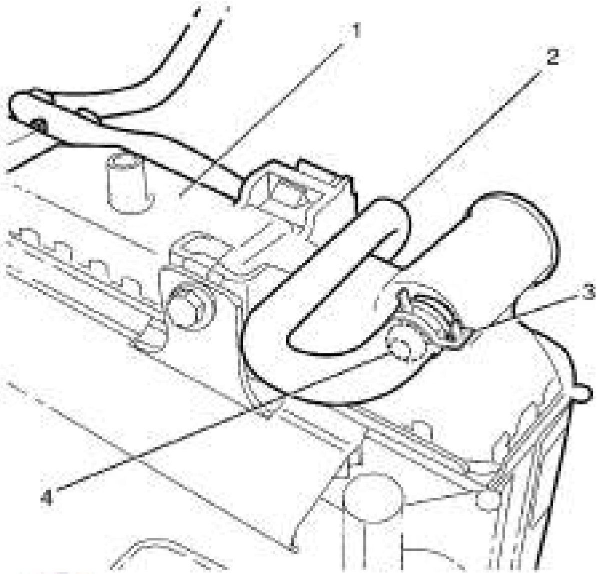


4. Release the hose clamp (3) and remove the coolant air bleed hose (2) from the radiator (1).

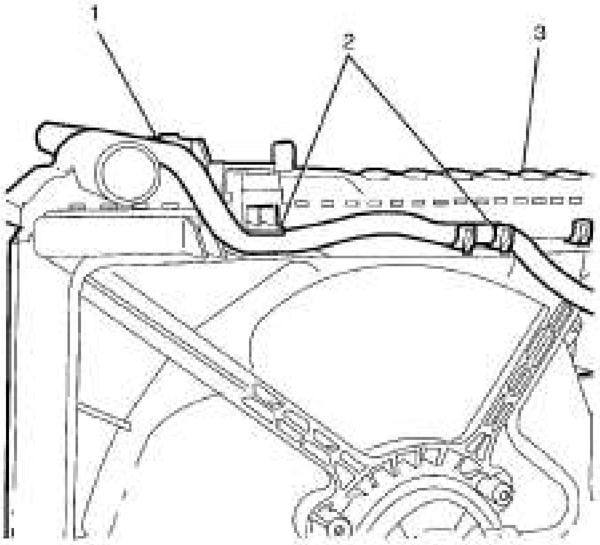


5. Detach and remove the coolant air bleed hose (1) from coolant air bleed hose retaining clips (2) located on the radiator (3).

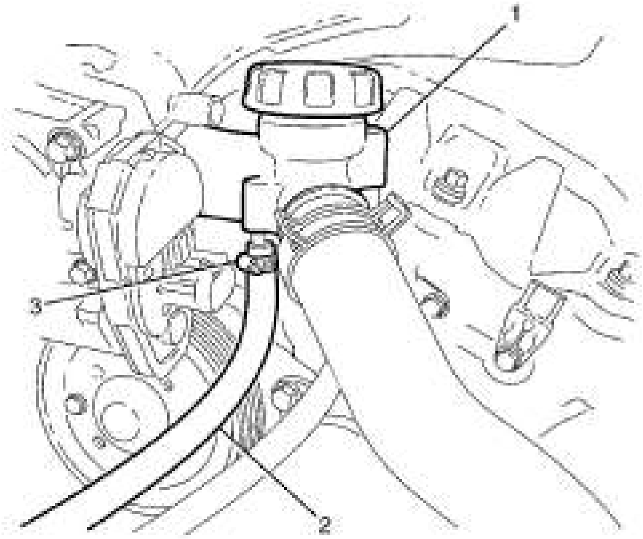
Installation Procedure



1. Install the air bleed hose (2) onto the radiator (1) spigot (4) and secure with the coolant air bleed hose clamp (3).



2. Attach the coolant air bleed hose (1) into the retaining clips (2) located on the radiator (3).



3. Install the coolant air bleed hose (2) onto the outlet housing (1) and secure with hose clamp (3).
4. Install the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.
5. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.
6. Check the coolant level. Refer to Cooling System Draining and Filling.

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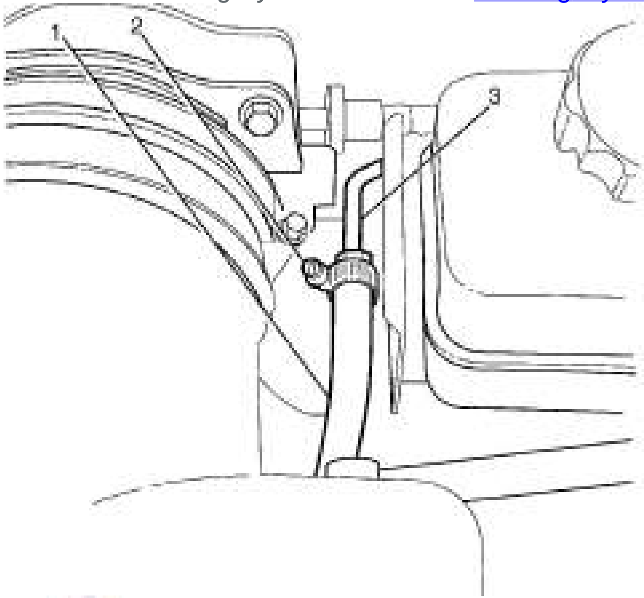
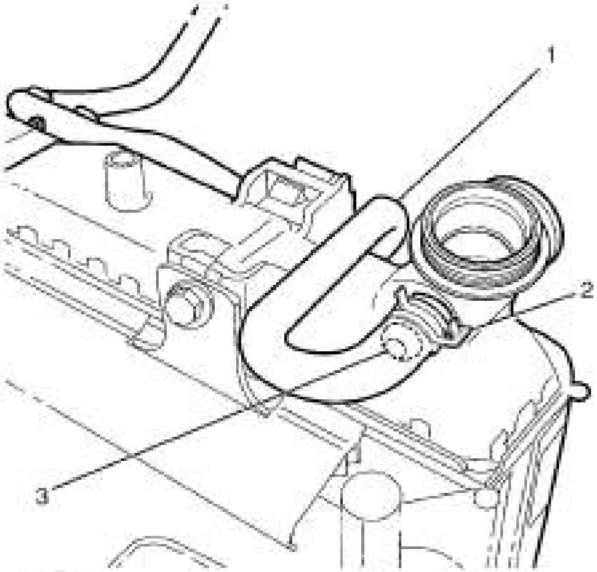
Engine Coolant Air Bleed Hose Replacement (6.0L)

Removal Procedure

1. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement in Body Front End.
2. Drain the cooling system. Refer to Cooling System Draining and Filling.



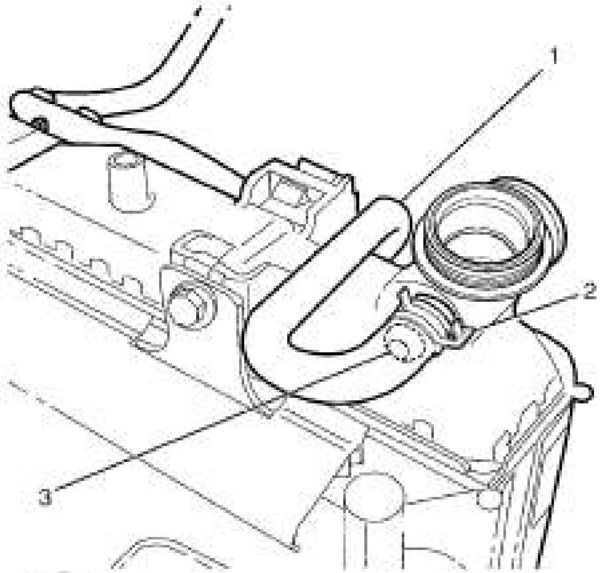
3. Release the coolant air bleed hose retaining clamp (2) and remove the coolant air bleed hose (1) from the coolant air bleed pipe (3).



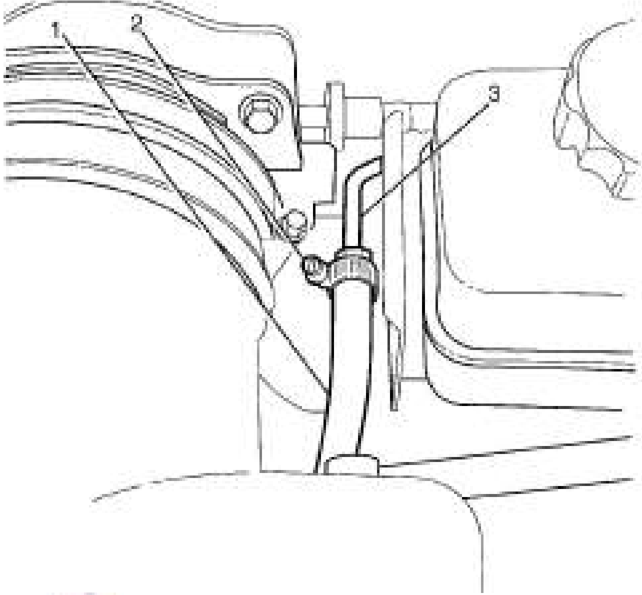
4. Release the retaining hose clamp (2) on the coolant air bleed hose (1) and remove it from

the radiator spigot (3).

Installation Procedure



1. Attach the coolant air bleed hose (1) to the radiator spigot (3)
2. Secure the coolant air bleed hose (1) with the retaining hose clamp (2)

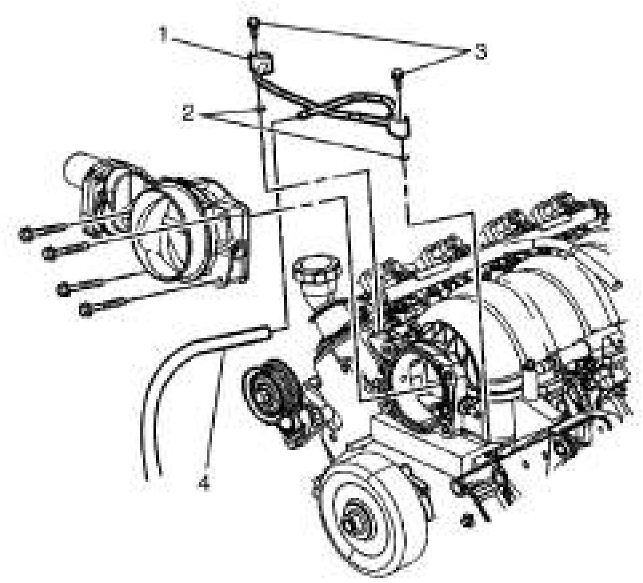


3. Attach and secure coolant air bleed hose (1) to the coolant air bleed pipe (3) and secure with the retaining hose clamp (2).
4. Fill the cooling system. Refer to Cooling System Draining and Filling.
5. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement in Body Front End.

Engine Coolant Air Bleed Pipe Replacement

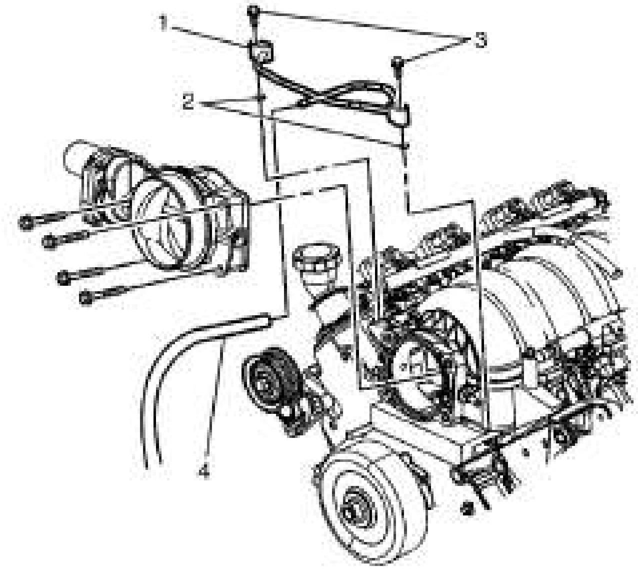
Removal Procedure

Important: Removal of the intake manifold is NOT required to service the coolant air bleed pipe, but is required to service the coolant air bleed pipe covers and/or gaskets.



1. Drain a gallon of coolant. Refer to Cooling System Draining and Filling.
2. Remove the throttle air body assembly. Refer to Throttle Body Assembly Replacement.
3. Remove the coolant air bleed hose (4).
4. Remove the coolant air bleed pipe mounting bolts (3).
5. Remove the coolant air bleed pipe (1) and O-rings (2).

Installation Procedure



1. Position the coolant air bleed pipe (1) and O-rings (2) on the cylinder heads.
2. Install the mounting bolts (3) for the coolant air bleed pipe (1).

   Tighten
   Tighten the bolts to 12 N·m (106 lb in).

3. Install the coolant air bleed hose (4).
4. Install the throttle air body assembly. Refer to Throttle Body Assembly Replacement.
5. Fill the cooling system. Refer to Cooling System Draining and Filling.

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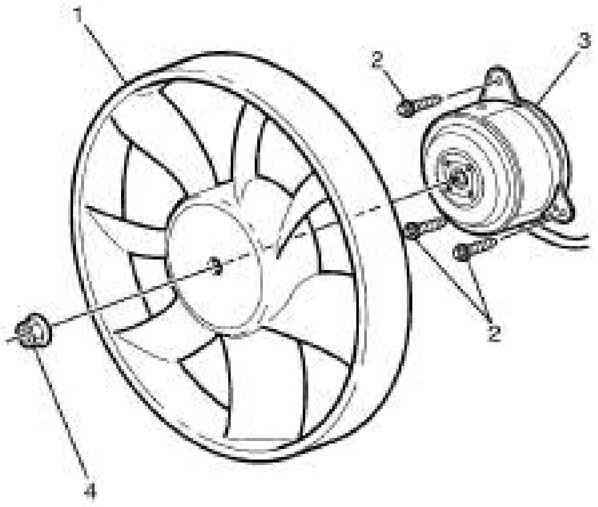
Engine Coolant Fan Motor Replacement

Removal Procedure

1. Remove the cooling fan and shroud assembly. Refer to Cooling Fan and Shroud Replacement.

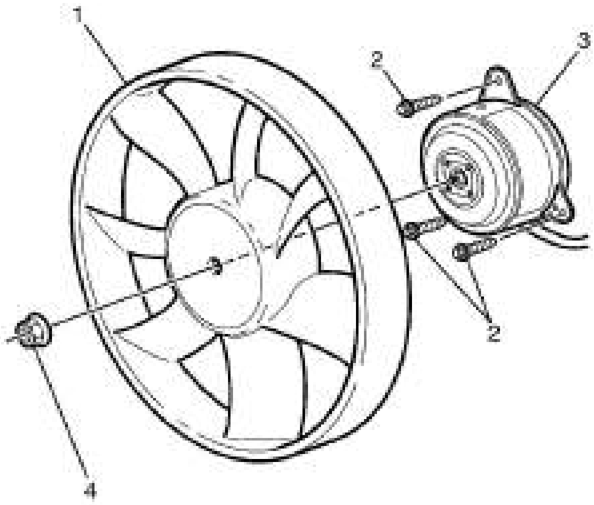


2. Disconnect electrical harness connector from motor.

Important: Armature shaft is left hand thread.

3. Remove the cooling fan motor (3) to fan retaining nut (4).
4. Separate fan blade (1) from the fan motor (3).
5. Remove the cooling fan motor to fan shroud retaining bolts (2).
6. Remove the cooling fan motor from shroud.

Installation Procedure



1. Install the cooling fan motor (3) to shroud.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install cooling fan motor to shroud retaining bolts (2).

   Tighten
   Tighten the bolts (2) to 10 N·m (89 lb in).

   Important: When replacing the fan and fan motor, ensure the fan to fan motor retaining nut is replaced.

3. Install the fan (1) to the cooling fan motor (3).
4. Install the fan (1) to the fan motor (2) retaining nut (4).

   Notice: Refer to Fastener Notice in the Preface section.

   Tighten
   Tighten the nut (3) to 6 N·m (53 lb in).

5. Install the cooling fan and shroud assembly. Refer to Cooling Fan and Shroud Replacement.
6. Start and run engine until the cooling fans are activated.

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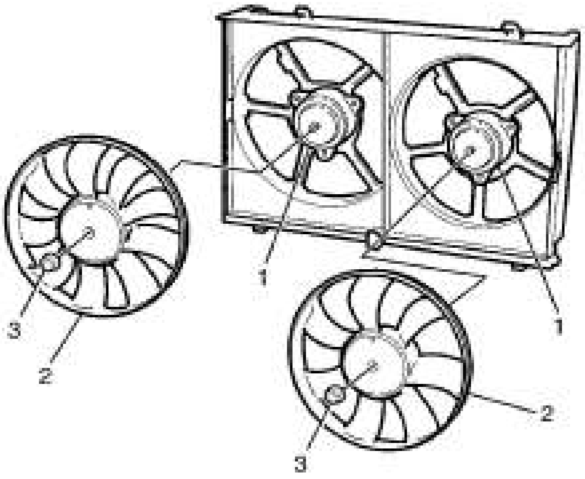
Engine Coolant Fan Replacement

Removal Procedure

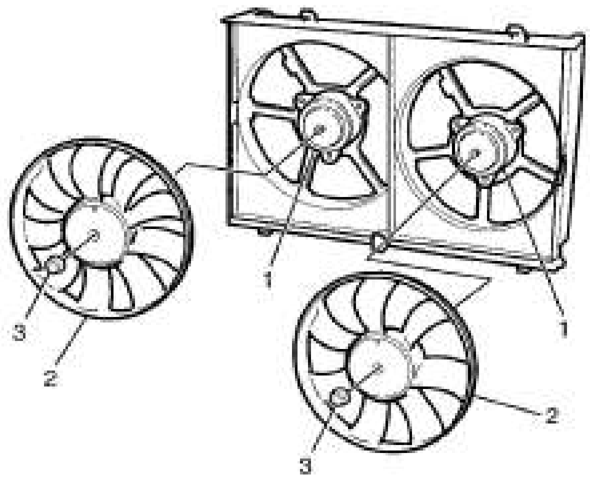
1. Remove the cooling fan and shroud assembly. Refer to Cooling Fan and Shroud Replacement.



Important: Armature shaft and nut is left hand thread.

2. Remove the cooling fans (2) retaining nuts (3).
3. Remove the cooling fans (2) from the cooling fan motor (1).

Installation Procedure



Important: When installing the cooling fans, ensure they are install as per removal.

1. Install the cooling fans (2) to the cooling fan motor (1).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the cooling fan (2) to fan motor retaining nut (3).

   Tighten
   Tighten the nut to 6.0 N·m (53 lb in).

3. Install the cooling fan and shroud assembly. Refer to Cooling Fan and Shroud Replacement.
4. Start and run engine until cooling fans are activated.

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Engine Coolant Inlet Pipe Replacement

Removal Procedure

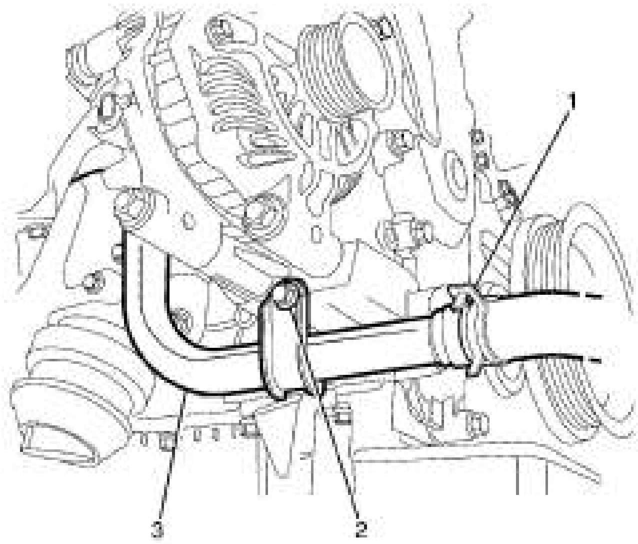
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.

Caution: Refer to Radiator Cap Removal Caution in the Preface section.

2. Ensure engine is below 50 C before removing the coolant pressure cap.
3. Remove the engine cover. Refer to Engine Cover Replacement in Engine Mechanical - 3.6L
4. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.
5. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.
6. Drain the cooling system. Refer to Cooling System Draining and Filling.
7. Remove the right side catalytic converter. Refer to Catalytic Converter Replacement - Right Side.

Caution: Refer to Safety Glasses Caution in the Preface section.

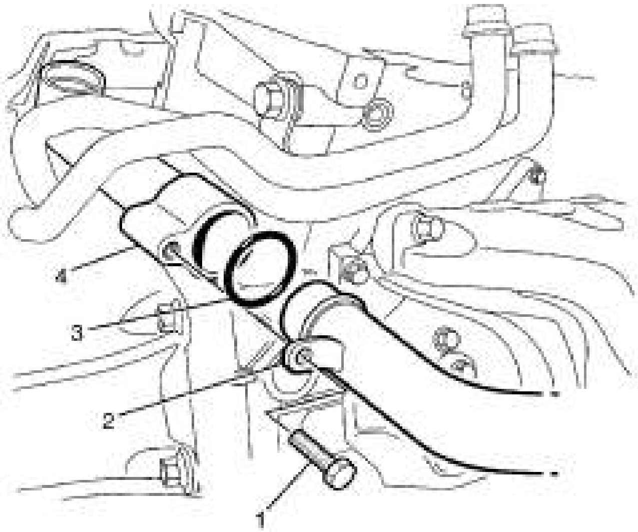


8. Detach the lower radiator hose by removing the retaining hose clamp (1) and removing it from the coolant inlet pipe (3).

Caution: Refer to Vehicle Lifting Caution in the Preface section.

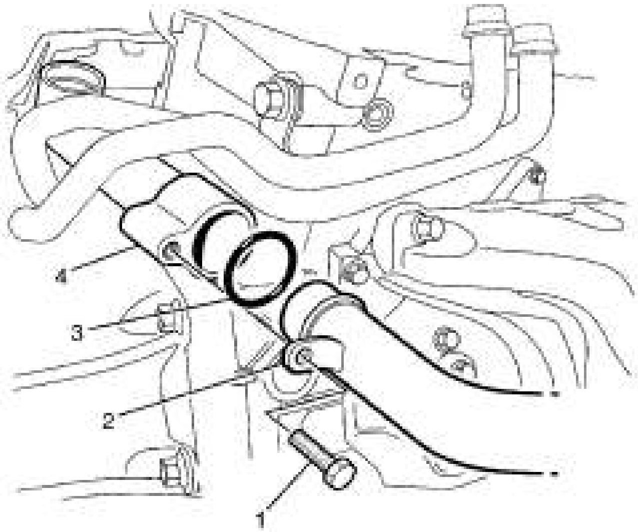
9. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
10. Remove the air deflector. Refer to Front Air Deflector Replacement.

11. Remove the coolant inlet pipe to alternator bracket retaining (2).
12. Lower vehicle



13. Remove the retaining bolt (1) which secures the inlet pipe (2) to the thermostat housing (4).
14. Manoeuvre the coolant inlet pipe towards the front of the engine and remove it from below, between the cross member and radiator.
15. Remove the coolant inlet pipe O-ring (3).

Installation Procedure



Important: Always renew the coolant inlet O-ring (3).

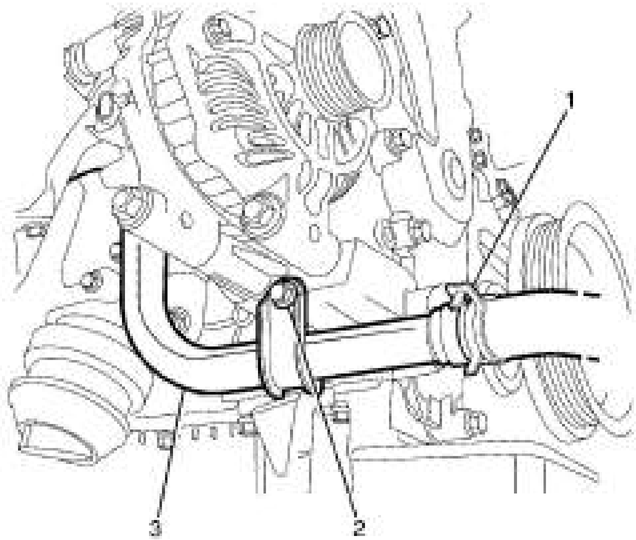
1. Ensure all mating surfaces are thoroughly cleaned, using only a fine abrasive material.
2. Install the coolant inlet pipe (2) at the thermostat end (4).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the coolant inlet pipe retaining bolt (1).

   Tighten
   Tighten the bolt to 35 N·m (26 lb ft).

4. Raise and support the front of the vehicle. Refer to Lifting and Jacking the Vehicle.



5. Install the coolant inlet pipe to alternator bracket retaining nut (2).

   Tighten
   Tighten the nut to 25 N·m (18 lb ft).

   Caution: Refer to Installing Hoses without Twists or Bends Notice in the Preface section.

6. Attach the inlet hose to the inlet pipe (3) and secure with retaining hose clamp (1)
7. Install the air deflector. Refer to Front Air Deflector Replacement.
8. Lower the vehicle.
9. Install the right side catalytic converter. Refer to Catalytic Converter Replacement - Right Side.
10. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.
11. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.
12. Install the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.
13. Fill the cooling system. Refer to Cooling System Draining and Filling.
14. Inspect cooling system for coolant leaks.

Engine Coolant Thermostat Housing Replacement (3.6L Engine LWB)

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the engine cover. Refer to Engine Cover Replacement in Engine Mechanical - 3.6L.
3. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.
4. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement in Body Front End.
5. Remove the catalytic converter assembly from the vehicle. Refer to Catalytic Converter Replacement - Right Side.
6. Lower the transmission by 65mm. Refer to Transmission Replacement.

Important: Store used coolant in the correct manner, such as in a used engine coolant holding tank. Do not pour used coolant down a drain. Ethylene glycol antifreeze is a very toxic chemical. Do not dispose of coolant into the sewer system or ground water. This is illegal and ecologically unsound.

7. Drain the cooling system. Refer to Cooling System Draining and Filling.

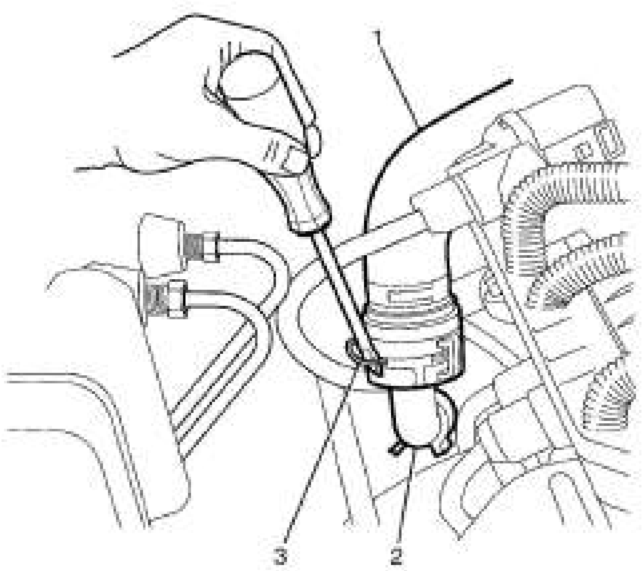
Important: Do NOT separate the upper and lower intake manifolds.

8. Remove the intake manifolds. Refer to Upper Intake Manifold Replacement and Refer to Lower Intake Manifold Replacement.

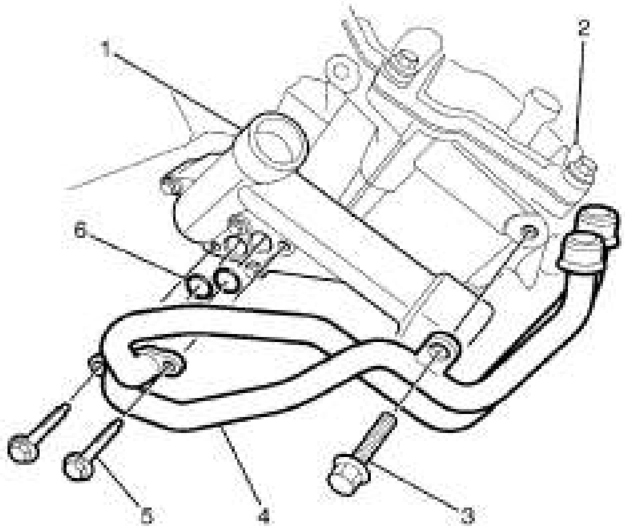
Important: Assure material used to cover intake ports is lint free to prevent any foreign matter entering the ports.

9. Cover the exposed intake ports.
10. Remove the coolant inlet pipe. Refer to Engine Coolant Inlet Pipe Replacement in Engine Cooling.

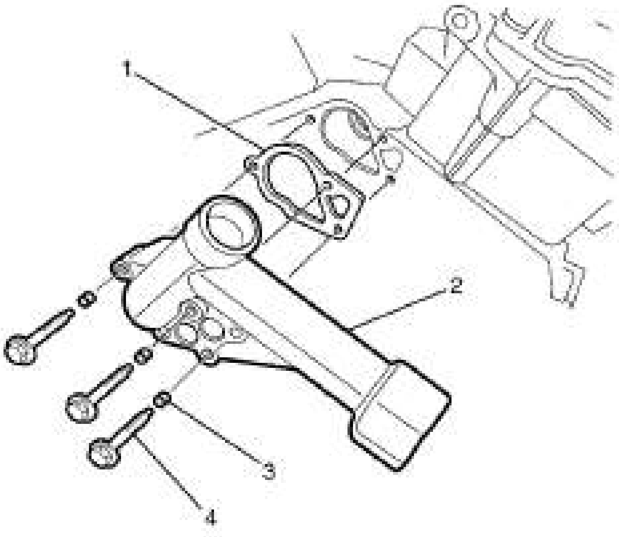
Caution: Refer to Safety Glasses Caution in the Preface section.



11. Detach the heater hose (1) quick connect fitting by releasing the retaining clip (3) with a suitable screwdriver, from the heater pipe (2).
12. Disconnect the heater hoses (1) from the heater pipes (1).
13. Disconnect the engine harness to obtain easier access to the heater hose flange and thermostat housing bolts. Refer to Ignition Coil Replacement - Bank 1 and Ignition Coil Replacement - Bank 2.



14. Remove the bolt (3) which secures the heater hose assembly (4) to the right hand cylinder head (2).
15. Remove the heater hose assembly to thermostat housing (1) retaining bolts (5).
16. Remove the heater hose assembly and discard the O-ring seals (6).



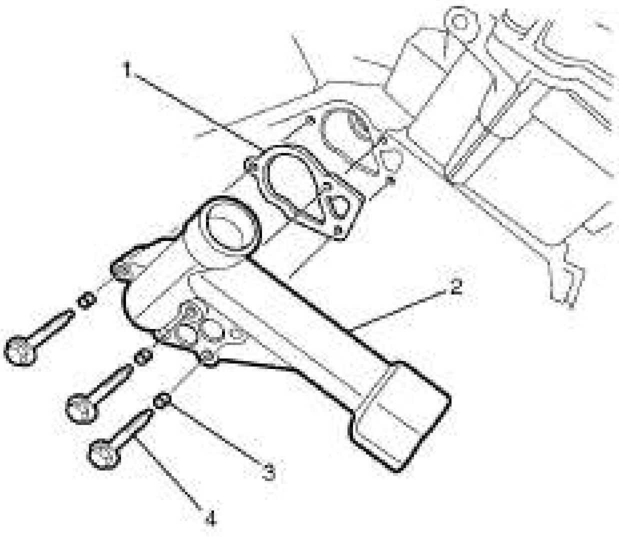
Important: The thermostat housing has one longer bolt which is located in the upper left of the housing.

Important: When replacing the thermostat housing always renew the block gasket (1).

17. Remove the thermostat housing retaining bolts (4) rubber grommets (3) then remove the thermostat housing (2).

Installation Procedure

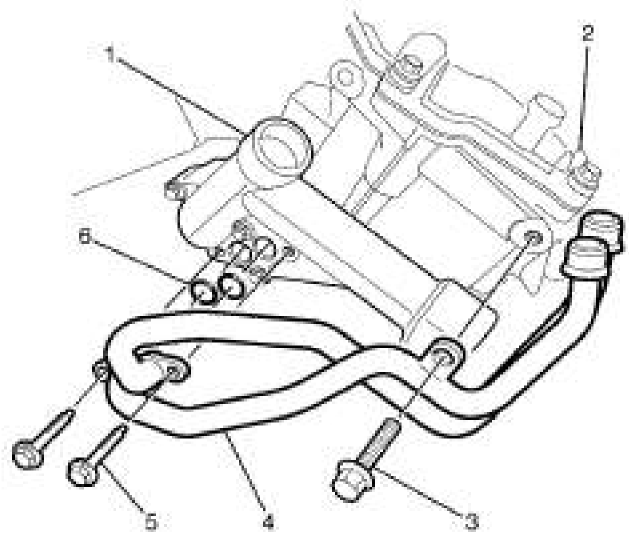
Notice: Refer to Fastener Notice in the Preface section.



1. Install the thermostat housing retaining bolts (4) ensuring a new block gasket (1) and rubber grommets (3) has been fitted.

   Tighten
   Tighten the bolts (4) to 10 N·m (89 lb in).

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the heater pipe assembly (4) to thermostat housing (1) retaining bolts ensuring new O-ring seals (6) have been fitted.

   Tighten
   Tighten the bolts (5) to 10 N·m (89 lb in).

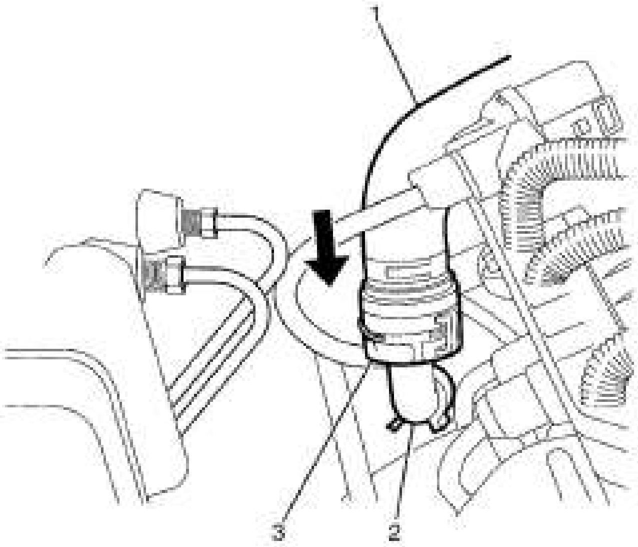
3. Install the heater pipe assembly (4) to cylinder head (2) retaining bolt (3).

   Tighten
   Tighten the bolts to 35 N·m (26 lb ft).

4. Install the engine harness. Refer to Ignition Coil Replacement - Bank 1 and Ignition Coil Replacement - Bank 2.

   Caution: Refer to Installing Hoses without Twists or Bends Notice in the Preface section.

   Caution: Refer to Safety Glasses Caution in the Preface section.



5. Attach the heater hose (1) quick connect fitting (3) by pushing the hose onto the heater pipe (2) listen for a audible click to confirm fitting.
6. Install the coolant inlet pipe. Refer to Engine Coolant Inlet Pipe Replacement in Engine Cooling.

Important: Do NOT separate the upper and lower intake manifolds.

7. Install the intake manifolds. Refer to Upper Intake Manifold Replacement and Refer to Lower Intake Manifold Replacement.
8. Install the air deflector. Refer to Front Air Deflector Replacement.
9. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.
10. Install the engine cover. Refer to Engine Cover Replacement in Engine Mechanical - 3.6L.
11. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement in Body Front End.
12. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.
13. Fill the cooling system. Refer to Cooling System Draining and Filling.
14. Inspect cooling system for leaks.

Engine Coolant Thermostat Housing Replacement (3.6L Engine SWB)

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the engine cover. Refer to Engine Cover Replacement.
3. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.
4. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.
5. Remove the catalytic converter assembly from the vehicle. Refer to Catalytic Converter Replacement - Right Side.
6. Lower the transmission by 65mm. Refer to Transmission Replacement.

Important: Store used coolant in the correct manner, such as in a used engine coolant holding tank. Do not pour used coolant down a drain. Ethylene glycol antifreeze is a very toxic chemical. Do not dispose of coolant into the sewer system or ground water. This is illegal and ecologically unsound.

7. Drain the cooling system. Refer to Cooling System Draining and Filling.

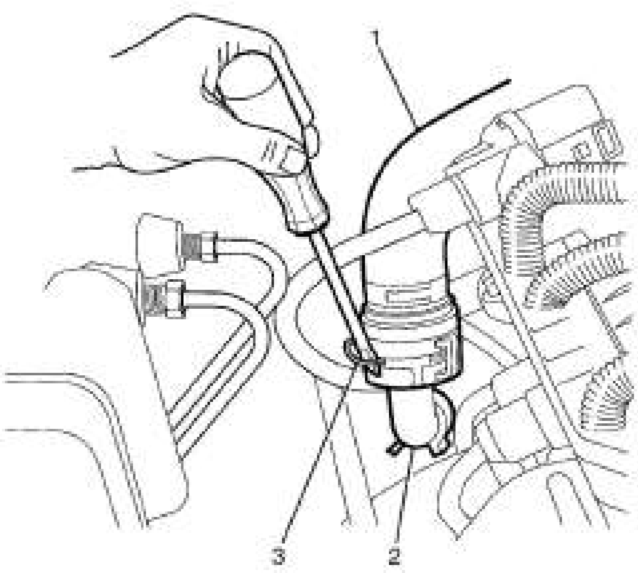
Important: Do NOT separate the upper and lower intake manifolds.

8. Remove the intake manifolds. Refer to Lower Intake Manifold Replacement.

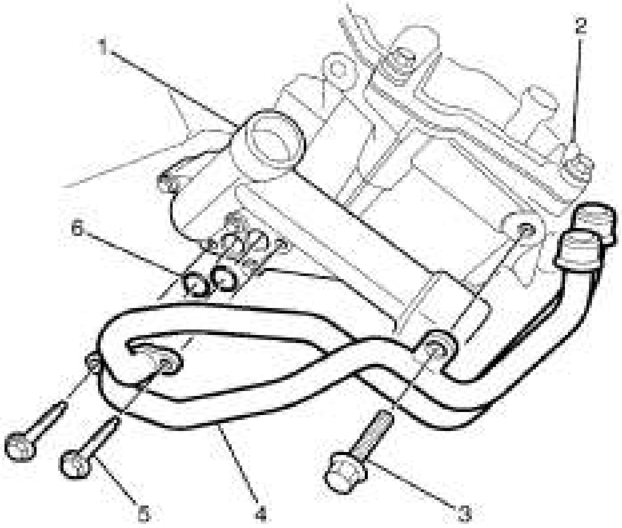
Important: Assure material used to cover intake ports is lint free to prevent any foreign matter entering the ports.

9. Cover the exposed intake ports.
10. Remove the coolant inlet pipe. Refer to Engine Coolant Inlet Pipe Replacement.

Caution: Refer to Safety Glasses Caution in the Preface section.

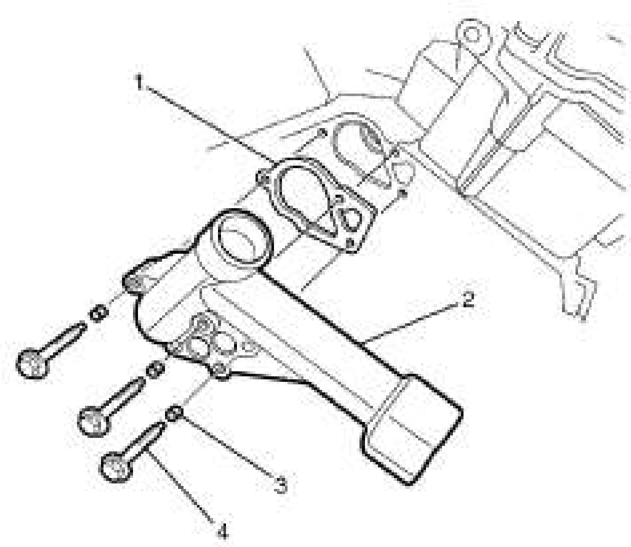


11. Detach the heater hose (1) quick connect fitting by releasing the retaining clip (3) with a suitable screwdriver, from the heater pipe (2).
12. Disconnect the heater hoses (1) from the heater pipes (2).
13. Disconnect the engine harness to obtain easier access to the heater hose flange and thermostat housing bolts. Refer to Ignition Coil Replacement - Bank 1 and Ignition Coil Replacement - Bank 2.



14. Remove the heater hose assembly to right hand cylinder head retaining bolt (3).
15. Remove the heater hose assembly to thermostat housing retaining bolts (5).
16. Remove the heater hose assembly (4) from the thermostat housing (1) and cylinder head (2).
17. Remove the O-ring seals (6)

    Discard the O-ring seals



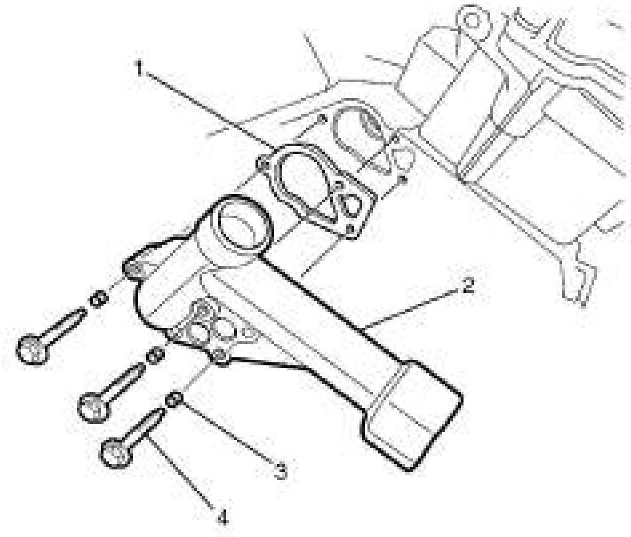
Important: The thermostat housing has one longer bolt which is located in the upper left of the housing.

Important: When replacing the thermostat housing always renew the block gasket (1).

18. Remove the thermostat housing retaining bolts (4) rubber grommets (3) then remove the thermostat housing (2).

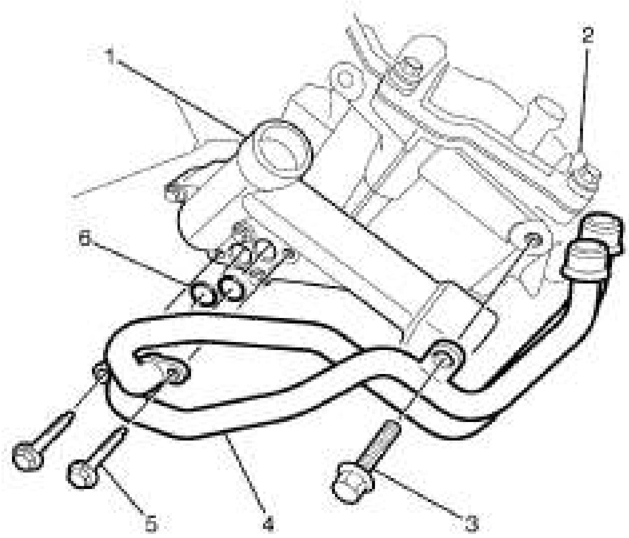
Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



1. Install the thermostat housing retaining bolts (4) ensuring a new block gasket (1) and rubber grommets (3) has been fitted.

   Tighten
   Tighten the bolts (4) to 10 N·m (89 lb in).



2. Install the NEW O-ring seals (6) to the thermostat housing (1).
3. Install the heater pipe assembly (4) to the thermostat housing (1) and cylinder head (2).

   Notice: Refer to Fastener Notice in the Preface section.

4. Install the heater hose assembly to thermostat housing retaining bolts (5).

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).

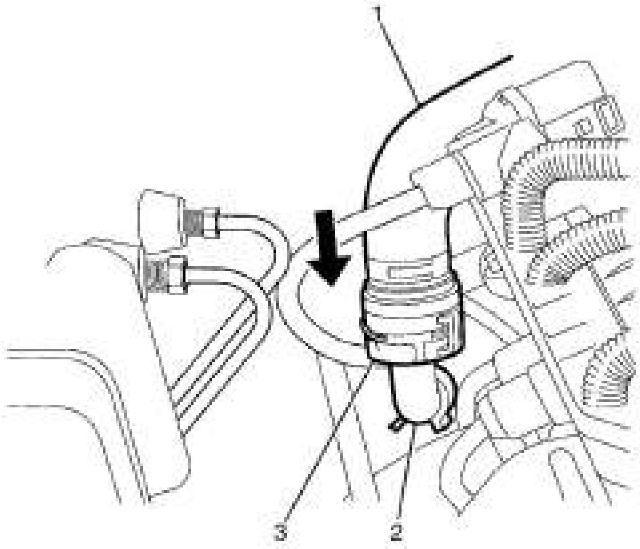
5. Install the heater hose assembly to right hand cylinder head retaining bolt (3)

   Tighten
   Tighten the bolt to 35 N·m (26 lb ft).

6. Install the engine harness. Refer to Ignition Coil Replacement - Bank 1 and Ignition Coil Replacement - Bank 2.

   Caution: Refer to Installing Hoses without Twists or Bends Notice in the Preface section.

   Caution: Refer to Safety Glasses Caution in the Preface section.



7. Attach the heater hose (1) quick connect fitting (3) by pushing the hose onto the heater pipe (2) listen for a audible click to confirm fitting.
8. Install the coolant inlet pipe. Refer to Engine Coolant Inlet Pipe Replacement.

Important: Do NOT separate the upper and lower intake manifolds.

9. Install the intake manifolds. Refer to Upper Intake Manifold Replacement and Refer to Lower Intake Manifold Replacement.
10. Install the air deflector. Refer to Front Air Deflector Replacement.
11. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.
12. Install the engine cover. Refer to Engine Cover Replacement.
13. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.
14. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.
15. Fill the cooling system. Refer to Cooling System Draining and Filling.
16. Inspect cooling system for leaks.

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Engine Coolant Thermostat Housing Replacement (6.0L Engine)

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.

Caution: Refer to Radiator Cap Removal Caution in the Preface section.

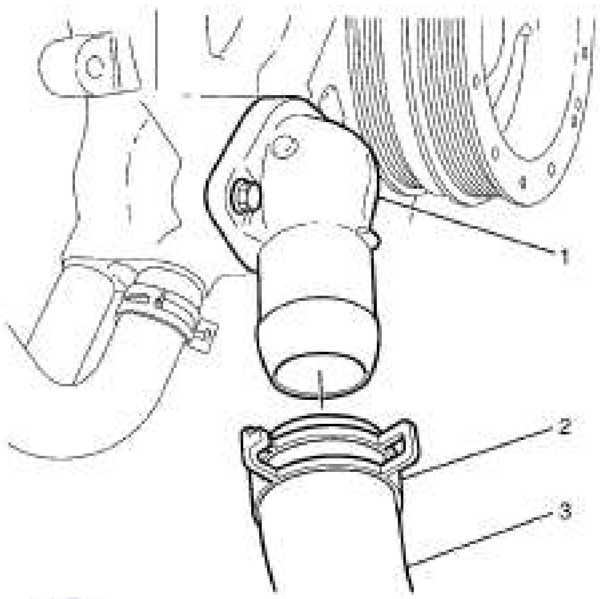
2. Ensure engine is below 50 C before removing the coolant pressure cap.
3. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement
4. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

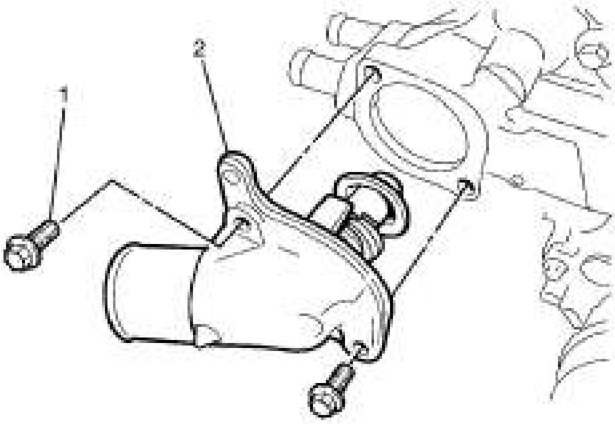
5. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
6. Drain the coolant into a suitable container. Refer to Cooling System Draining and Filling.
7. Lower the vehicle.

Caution: Refer to Safety Glasses Caution in the Preface section.



8. Release the retaining hose clamp (2) and detach the hose (3) from the thermostat housing

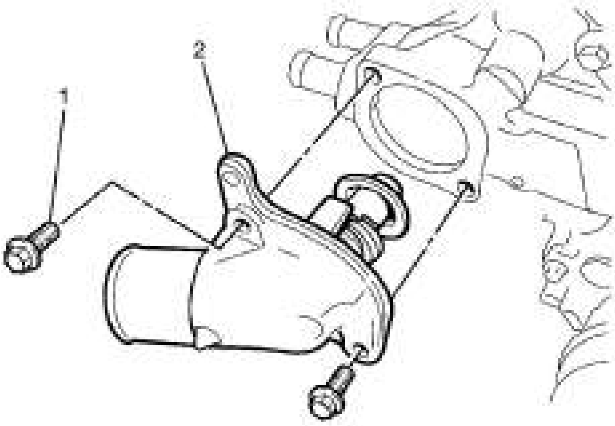
end (1).



9. Remove the thermostat housing (2) to water pump retaining bolts (1), and remove thermostat housing.
10. If the housing is to be replaced, discard the O-ring.

Installation Procedure

1. Install thermostat. Refer to Engine Coolant Thermostat Replacement.
2. Ensure all mating surfaces are thoroughly cleaned, using only a fine abrasive material.



Important: Ensure a new O-ring seal is used.

3. Install the thermostat housing (2).

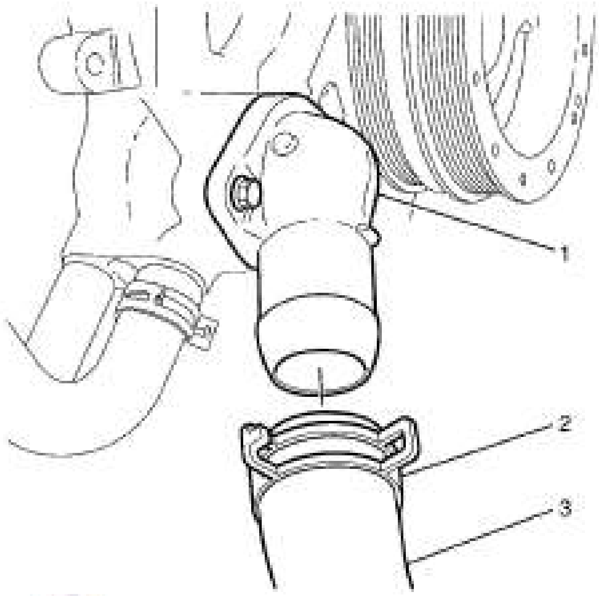
4. Install the thermostat housing to water Pump retaining bolts (1).

   Notice: Refer to Fastener Notice in the Preface section.

   Tighten
   Tighten the bolts (1) to 14 N·m (124 lb in).

   Caution: Refer to Installing Hoses without Twists or Bends Notice in the Preface section.

   Caution: Refer to Safety Glasses Caution in the Preface section.



5. Install the hose (3) to the thermostat housing (1), by opening the retaining hose clamp (2) and securing it over the hose.
6. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement
7. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacement
8. Fill the cooling system. Refer to Cooling System Draining and Filling.
9. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.
10. Inspect cooling system for leaks.
11. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.

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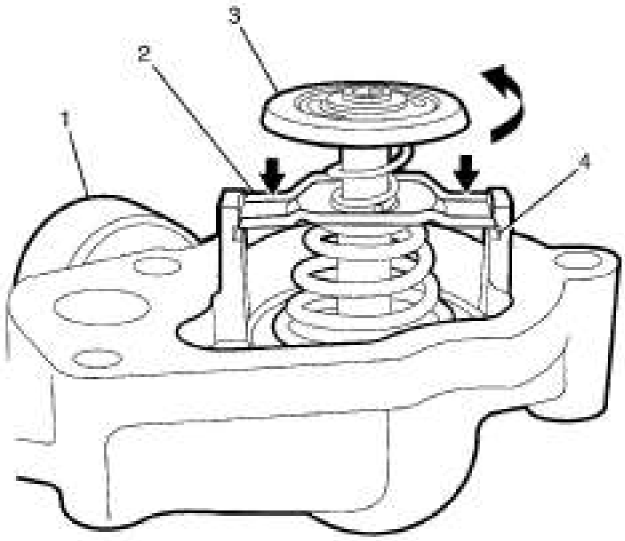
Engine Coolant Thermostat Replacement (3.6L Engine)

Removal Procedure

1. Remove the thermostat housing. Refer to Engine Coolant Thermostat Housing Replacement .



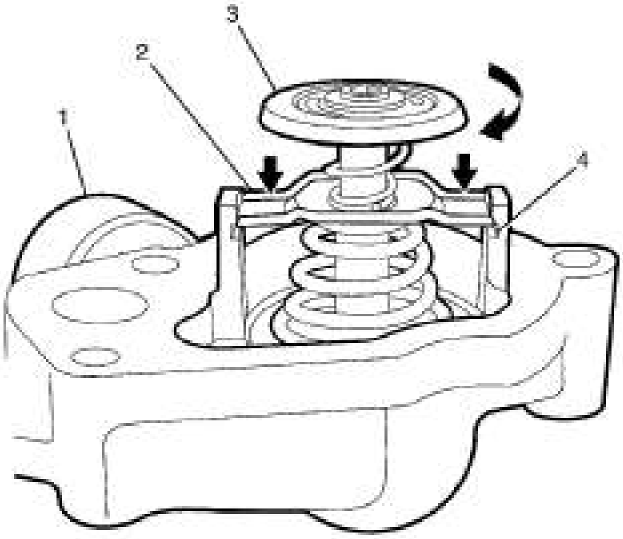
2. Place thermostat housing in a soft jaw vice.

   Caution: Refer to Safety Glasses Caution in the Preface section.

3. While depressing the thermostat (3) rotate the retaining bar (2) anti-clockwise in the housing (1) until it clears the retaining lugs (4).
4. Carefully release the thermostat spring force.
5. Remove the thermostat from it's housing.

Installation Procedure

1. Ensure that the thermostat housing in clean and free of damage.



2. While pressing the thermostat (3) rotate the retaining bar (2) clockwise in the housing (1) until it locks into the retaining lugs (4).
3. Install the thermostat housing. Refer to Engine Coolant Thermostat Housing Replacement .

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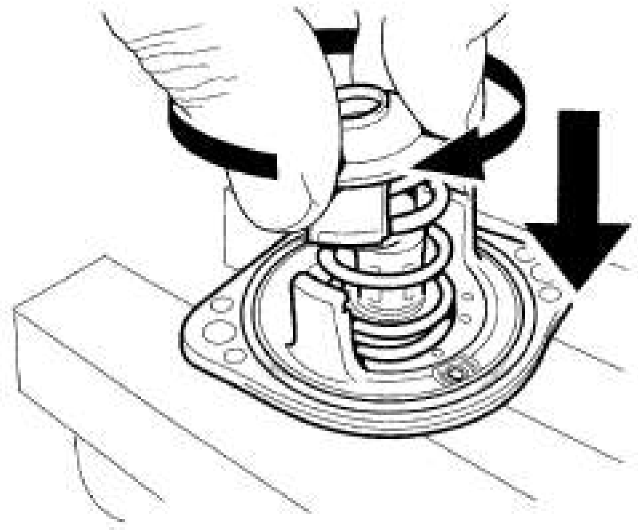
Engine Coolant Thermostat Replacement (6.0L Engine)

Removal Procedure

Notice: Refer to General Repair Instructions in the Preface section.

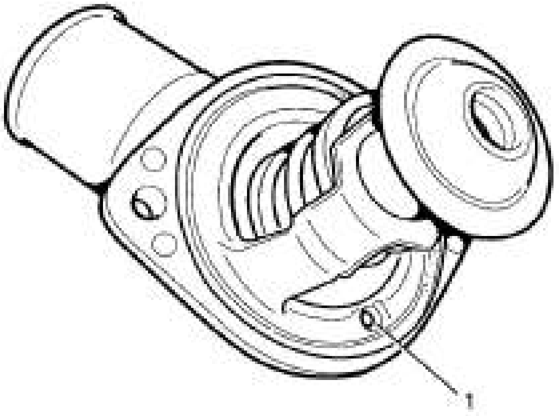
1. Remove the thermostat housing. Refer to Engine Coolant Thermostat Housing Replacement.
2. Place thermostat housing in a soft jaw vice.

   Caution: Refer to Safety Glasses Caution in the Preface section.

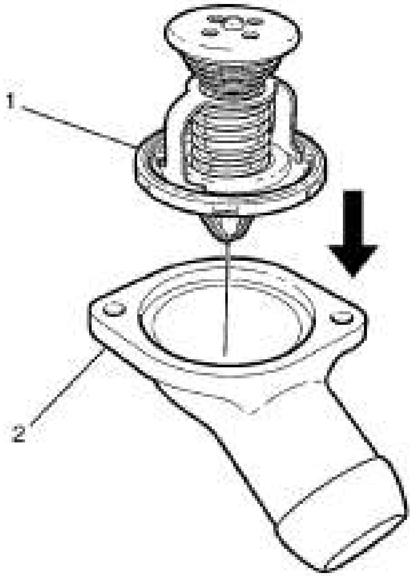


3. Press and rotate the springs of the thermostat to release it from the thermostat housing.
4. Remove the thermostat from the thermostat housing.

Installation Procedure



1. Assure that the air bleed ball (1) is not jammed by slightly shaking the assembly.



2. Place the thermostat (1) assembly into the thermostat housing (2).
3. Install the thermostat, by rotating and locking it into the thermostat housing.

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Radiator Air Lower Baffle and Deflector Replacement (LWB SWB)

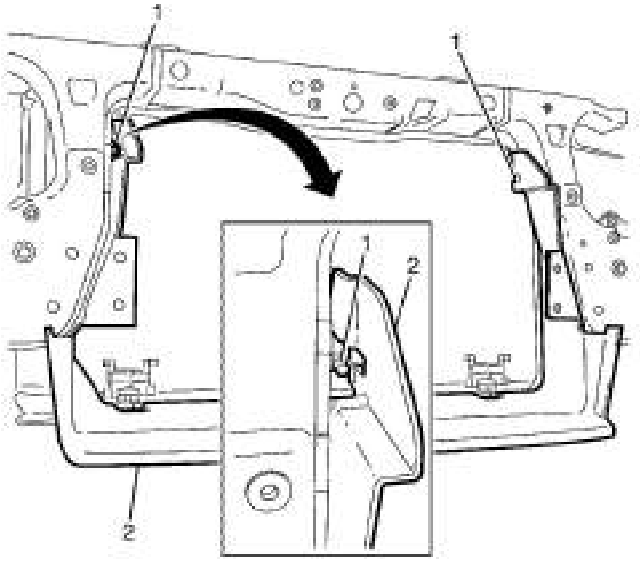
Removal procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the air deflector. Refer to Front Air Deflector Replacement.
3. Remove the front fascia. Refer to Front Bumper Fascia Replacement.
4. Remove the front impact bar. Refer to Front Bumper Impact Bar Replacement.
5. Lower the vehicle.
6. Detach the ambient sensor. Refer to Ambient Air Temperature Sensor Replacement.
7. Remove the washer solvent container. Refer to Windshield Washer Solvent Container Replacement.
8. Detach the wiring loom from the duct.

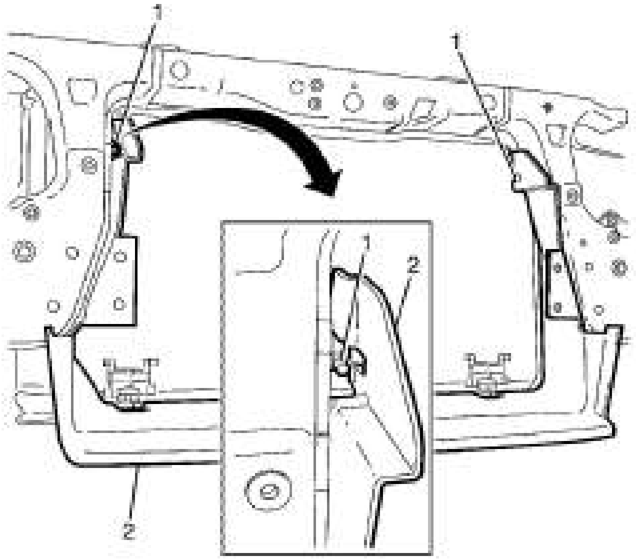
Caution: Refer to Safety Glasses Caution in the Preface section.



9. Remove the retaining pins (1) on either side of the air baffle (2).
10. Remove air baffle out of locating lugs and remove from front of vehicle.

Installation Procedure

1. Install the air baffle into the locating lugs.



2. Install the air baffle retaining pins (1) located at either side of the baffle (2).
3. Attach the wiring loom to the duct.
4. Attach the ambient sensor. Refer to Ambient Air Temperature Sensor Replacement.
5. Install the washer solvent container. Refer to Windshield Washer Solvent Container Replacement.

   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

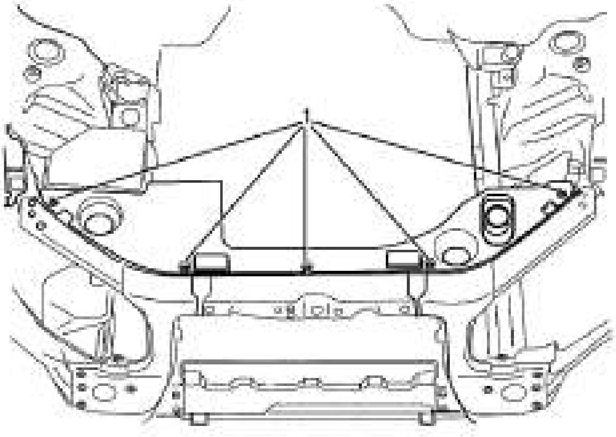
6. Raise and support vehicle. Refer to Lifting and Jacking the Vehicle.
7. Install the front impact bar. Refer to Front Bumper Impact Bar Replacement.
8. Install the front fascia. Refer to Front Bumper Fascia Replacement.
9. Instal the air deflector. Refer to Front Air Deflector Replacement.
10. Lower vehicle.
11. Inspect vehicle for correct alignment of body panels. Refer to Dimensions - Body.

Radiator Air Upper Baffle and Deflector Replacement

Removal Procedure - Up to 05 Feb 2007

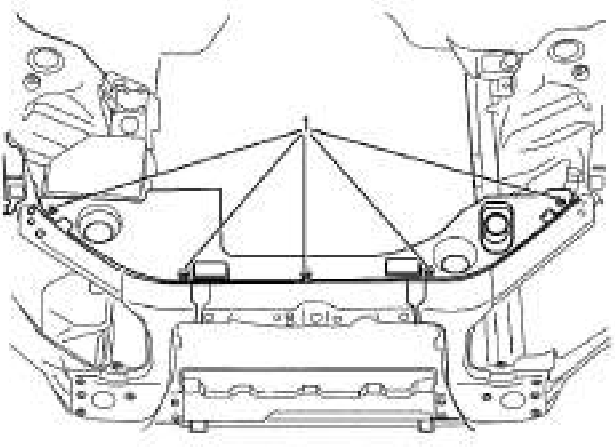
> **Important:** When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Install a suitable hood brace to the vehicle.



2. Remove the radiator air baffle and deflector to front end module retaining scrivets (1).
3. Remove the radiator air baffle and deflector from the front end module.

Installation Procedure - Up to 05 Feb 2007



1. Install the radiator air baffle and deflector to the front end module.
2. Install the radiator air baffle and deflector to front end module retaining scrivets (1).
3. Remove the suitable hood brace from the vehicle.

Radiator Cleaning

- **Caution:** NEVER spray water on a hot heat exchanger. The resulting steam could cause personal injury.

  Notice: The heat exchanger fins are necessary for good heat transfer. Do not brush the fins. This may cause damage to the fins, reducing heat transfer.

  Important: Remove bugs, leaves, dirt and other debris by blowing compressed air through the engine side of the radiator.

  - Some conditions may require the use of warm water and a mild detergent.
- Clean the A/C condenser fins.
- Clean between the A/C condenser and radiator.
- Clean the radiator cooling fins.
- Straighten any damaged cooling fins.

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Radiator Drain Cock Replacement

Replacement Procedure

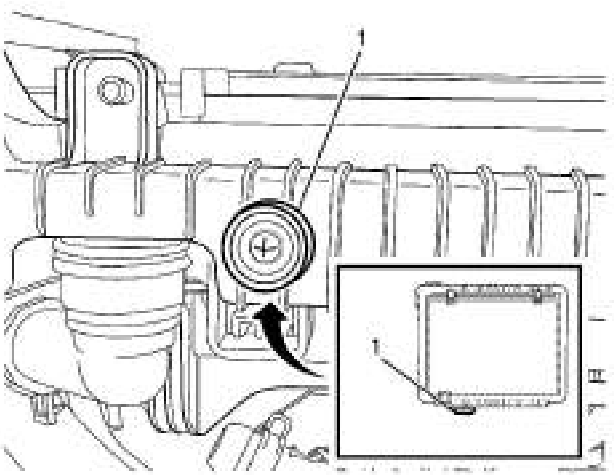
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Radiator Cap Removal Caution in the Preface section.

1. Remove the filler cap.

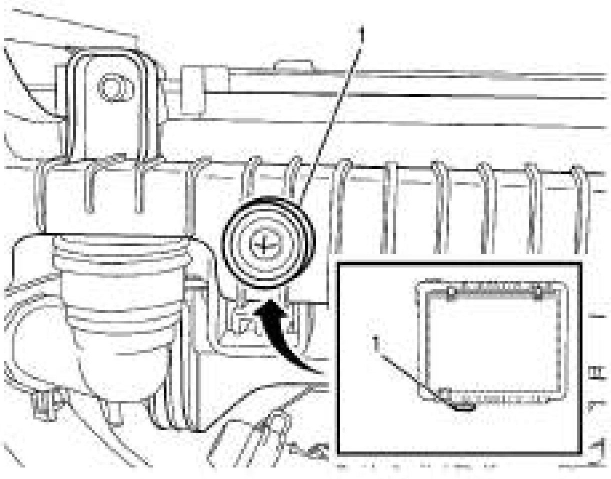
   Caution: Refer to Vehicle Lifting Caution in the Preface section.

2. Raise and support the front of the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Drain the cooling system. Refer to Cooling System Draining and Filling.



4. Remove the drain cock (1).

Installation Procedure



1. Install the drain cock plug (1) ensuring a new O-ring is used.

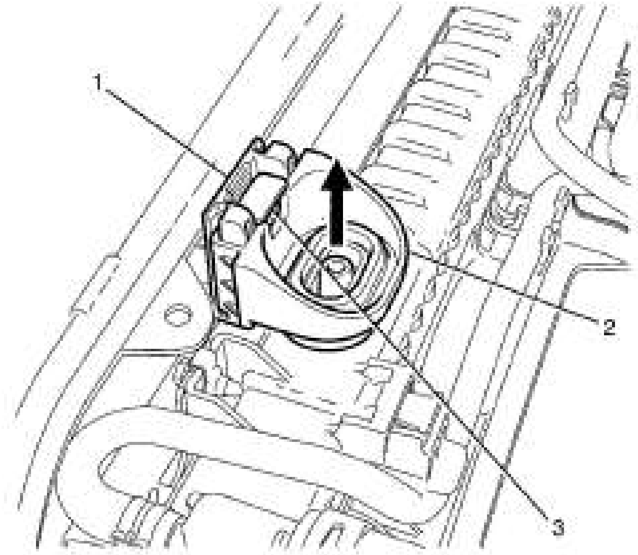
   Tighten
   Tighten the drain cock plug (1) to 2 N·m (18 lb in).

2. Lower the vehicle.
3. Fill the cooling system. Refer to Cooling System Draining and Filling.
4. Inspect the cooling system for leaks.

Radiator Hose Quick Connect Fitting

Removal Procedure

1. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement in Body Front End.
2. Drain the cooling system. Refer to Cooling System Draining and Filling.
3. Detach the radiator outlet hose. Refer to Radiator Outlet Hose Replacement.

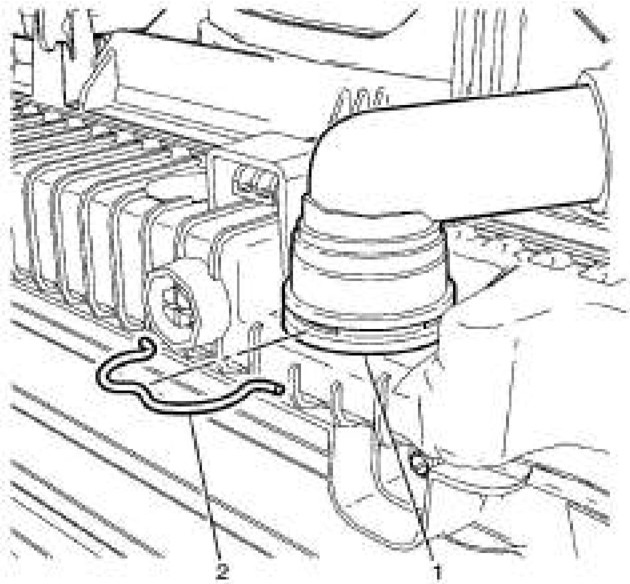


4. Remove the radiator support brackets (2) from top of radiator by rasing the securing lock (3) 10mm and then sliding the bracket off the radiator slide pin (1). Carry out same procedure for other bracket.
5. Raise and support the radiator assembly out of the rubber grommets located in the cross member.

Caution: Refer to Safety Glasses Caution in the Preface section.

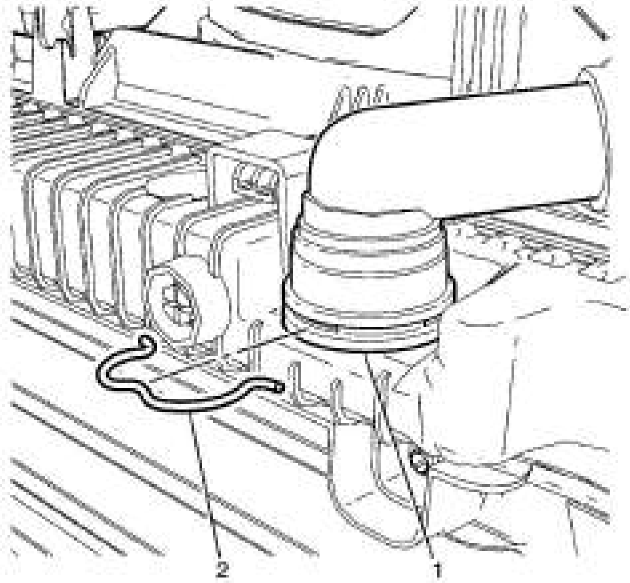
Caution: Refer to Vehicle Lifting Caution in the Preface section.

6. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
7. Remove the air deflector. Refer to Front Air Deflector Replacement.



8. Remove the retaining clip (2) from the outlet hose quick connect fitting (1).
9. Remove the outlet hose quick connect fitting (1) from the radiator assembly.

Installation Procedure



1. Install the outlet hose quick connect fitting retaining clip (2) to the quick connect fitting (1).
2. Install the outlet hose quick connect fitting (1) to the radiator spigot.
3. Install the outlet hose quick connect fitting retaining clip (2) slightly pull on the quick connect fitting to confirm fitting.
4. Install the air deflector. Refer to Front Air Deflector Replacement.
5. Lower the vehicle.
6. Attach the radiator outlet hose. Refer to Radiator Outlet Hose Replacement.

7. Fill the cooling system. Refer to Cooling System Draining and Filling.
8. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement in Body Front End.

Radiator Inlet Hose Replacement (3.6L Engine)

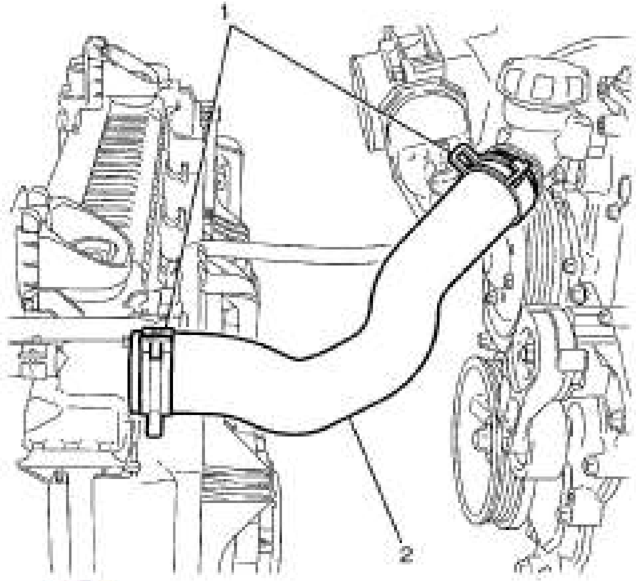
Removal Procedure

1. Drain the cooling system. Refer to Cooling System Draining and Filling.
2. Remove the engine cover. Refer to Engine Cover Replacement in Engine Mechanical - 3.6L
3. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement in Body Front End.
4. Remove the mass air flow sensor. Refer to Mass Airflow Sensor with Intake Air Temperature Sensor Replacement.
5. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Radiator Cap Removal Caution in the Preface section.

6. Ensure engine is below 50 C before removing the coolant pressure cap.



7. Remove the retaining hose clamps (1) back on the inlet hose (2) at both ends.

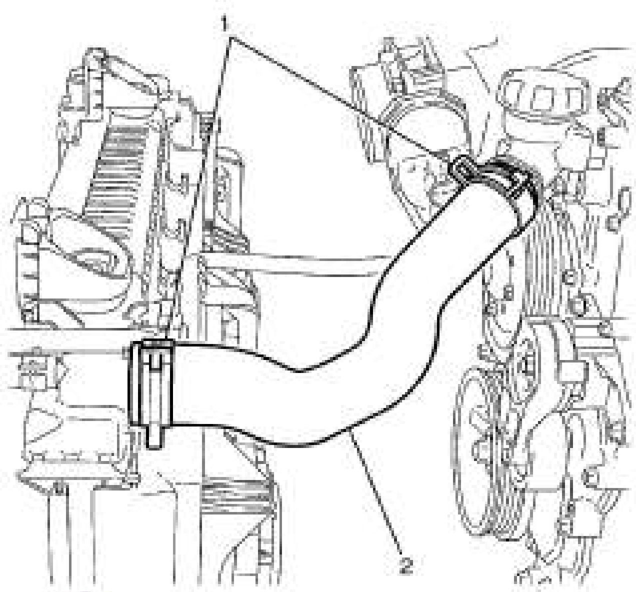
Important: If inlet hose (2) is not being replaced leave retaining clamp's (1) attached to hose.

8. Remove the inlet hose (2) at both ends.

Installation Procedure

Caution: Refer to Installing Hoses without Twists or Bends Notice in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.



1. Install the inlet hose (2).
2. Secure the inlet hose (2) at both ends, by opening the retaining hose clamps (1) and sliding them over the hose (2).
3. Install the mass air flow meter. Refer to Mass Airflow Sensor with Intake Air Temperature Sensor Replacement.
4. Install the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.
5. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement in Body Front End.
6. Install the engine cover. Refer to Engine Cover Replacement in Engine Mechanical - 3.6L.
7. Fill the cooling system. Refer to Cooling System Draining and Filling.
8. Inspect cooling system for leaks.

Radiator Inlet Hose Replacement (6.0L Engine)

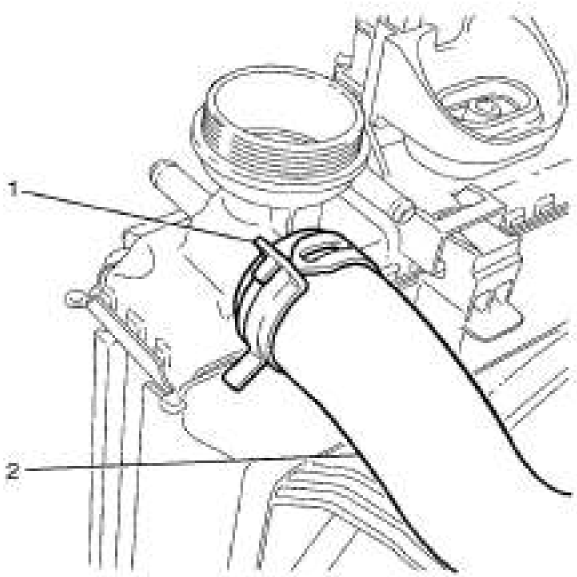
Removal Procedure

1. Drain the cooling system. Refer to Cooling System Draining and Filling .
2. Remove the engine cover. Refer to Engine Cover Replacement .
3. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement .
4. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement .
5. Remove the mass air flow meter. Refer to Mass Airflow Sensor/Intake Air Temperature Sensor Replacement .

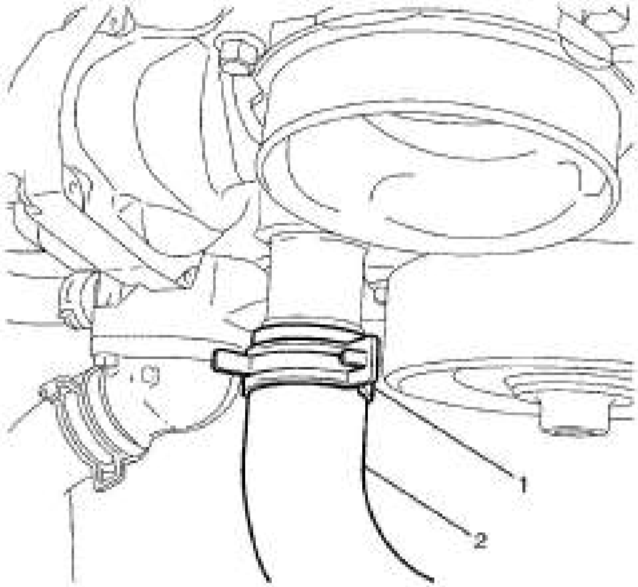
Caution: Refer to Radiator Cap Removal Caution in the Preface section.

6. Ensure engine is below 50 C before removing the coolant pressure cap.

Caution: Refer to Safety Glasses Caution in the Preface section.



7. Release the retaining hose clamp (1) and disconnect the radiator inlet hose (2) from the radiator.



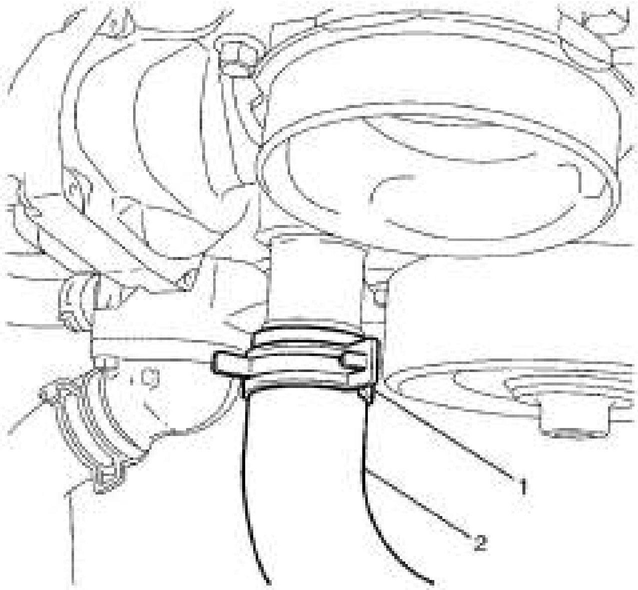
8. Release the retaining hose clamp (1) and disconnect the radiator inlet hose (2) from the water pump.

   Important: If the inlet hose (2) is not being replaced leave retaining clamp (1) attached to the inlet hose.

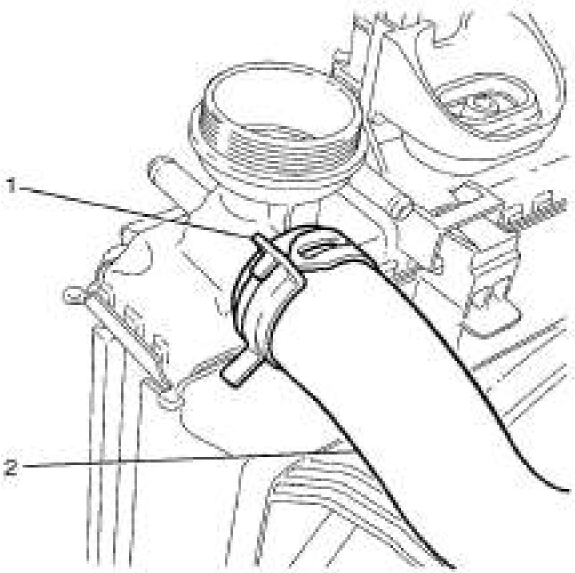
9. Remove the inlet hose (2) from both ends.

Installation Procedure

Caution: Refer to Installing Hoses without Twists or Bends Notice in the Preface section.



1. Install the inlet hose (2).
2. Secure the inlet hose (2) at the water pump end, by opening the retaining hose clamp (1) and securing it over the outlet hose (2).



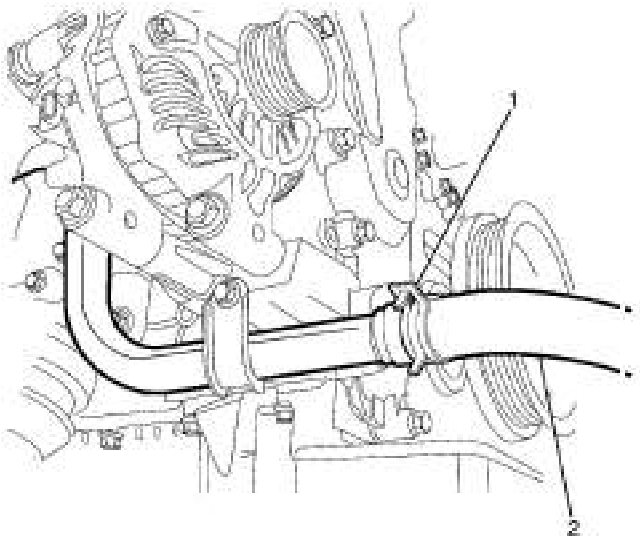
3. Secure the hose (2) at the radiator end by opening the retaining hose clamp (1) and retaining it over the hose (2).
4. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement .
5. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacement .
6. Install the mass air flow sensor. Refer to Mass Airflow Sensor/Intake Air Temperature Sensor Replacement .
7. Install the engine cover. Refer to Engine Cover Replacement .
8. Fill the cooling system. Refer to Cooling System Draining and Filling .
9. Inspect cooling system for leaks.

Radiator Outlet Hose Replacement (3.6L Engine)

Removal Procedure

1. Drain the cooling system. Refer to Cooling System Draining and Filling .

   Caution: Refer to Safety Glasses Caution in the Preface section.

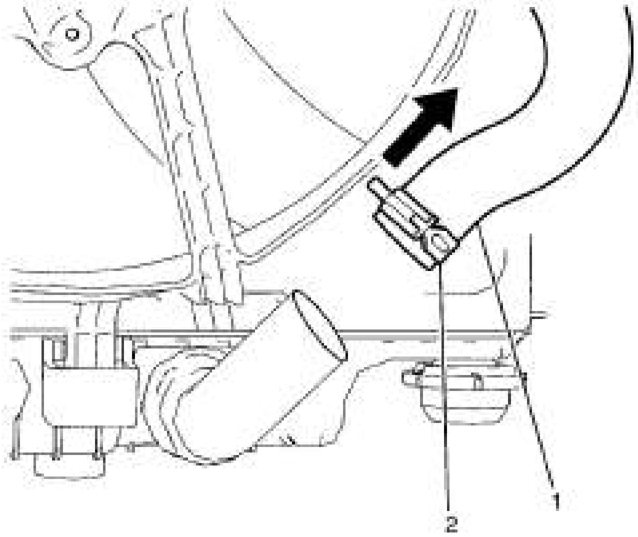


Important: If outlet hose (1) is not being replaced leave retaining clamp (2) attached to outlet hose.

2. Release the retaining hose clamp (1) and remove the outlet hose (2).

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
4. Remove the air deflector. Refer to Front Air Deflector Replacement .



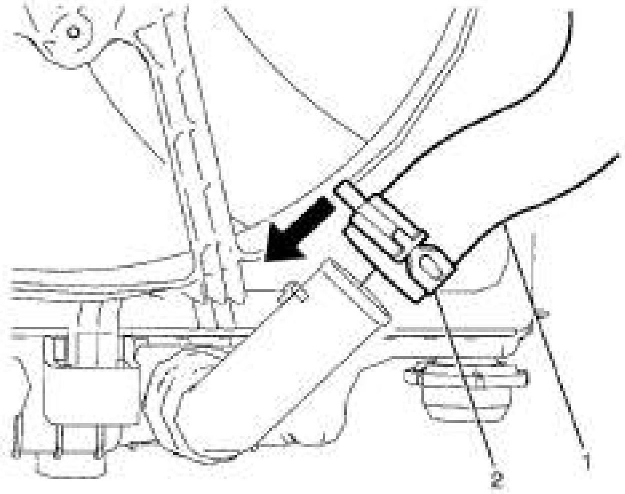
Important: If outlet hose (1) is not being replaced leave retaining clamp (2) attached to hose.

Important: Access to the outlet hose is restricted, removal of the cooling fan's will aid access. Refer to Cooling Fan and Shroud Replacement .

5. Remove the outlet hose (1) by releasing the retaining hose clamp (2)

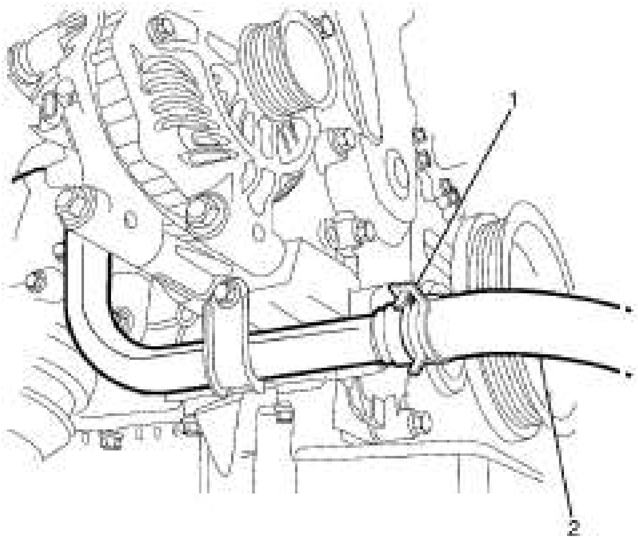
Installation Procedure

Caution: Refer to Installing Hoses without Twists or Bends Notice in the Preface section.



1. Install the outlet hose (1) and secure it with the retaining hose clamp (2).
2. Install the air deflector. Refer to Front Air Deflector Replacement .
3. Lower the vehicle.

Caution: Refer to Safety Glasses Caution in the Preface section.



4. Secure the outlet hose (2) by opening the retaining hose clamp (1) and sliding it over the hose (2).
5. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement .
6. Fill the cooling system. Refer to Cooling System Draining and Filling .
7. Inspect cooling system for leaks.

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Radiator Outlet Hose Replacement (6.0L Engine)

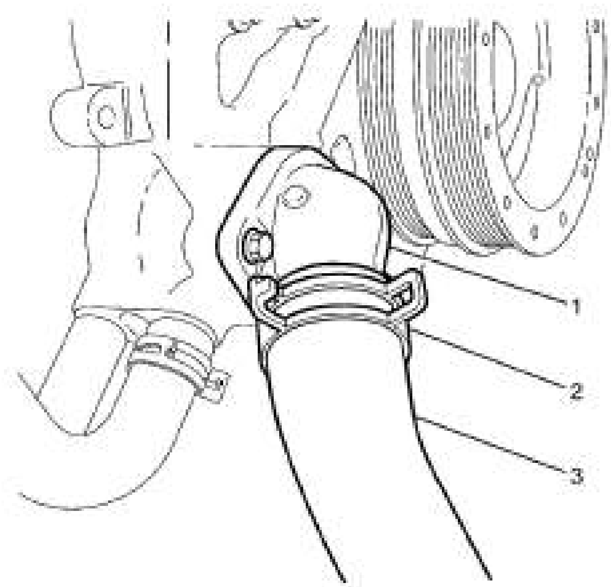
Removal Procedure

1. Drain the cooling system. Refer to Cooling System Draining and Filling.
2. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.
3. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.

Caution: Refer to Radiator Cap Removal Caution in the Preface section.

4. Ensure engine is below 50 C before removing the radiator cap.

Caution: Refer to Safety Glasses Caution in the Preface section.

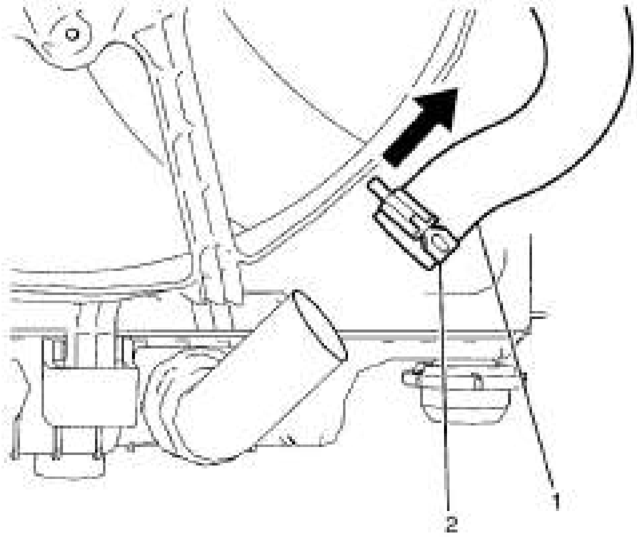


Important: If outlet hose (3) is not being replaced leave retaining clamp (2) attached to hose.

5. Release the outlet hose retaining hose clamp (2).
6. Detach the outlet hose (3) from the thermostat housing (1).

Caution: Refer to Vehicle Lifting Caution in the Preface section.

7. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
8. Remove the air deflector. Refer to Front Air Deflector Replacement.



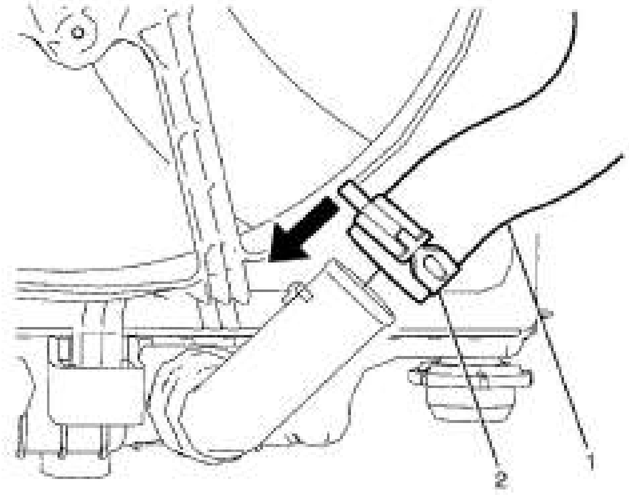
Important: If outlet hose (1) is not being replaced leave retaining clamp (2) attached to hose.

Important: Access to the outlet hose is restricted, removal of the cooling fan's will aid with access. Refer to Cooling Fan and Shroud Replacement.

9. Remove the outlet hose (1) by releasing the retaining hose clamp (2).
10. Remove the outlet hose (1).

Installation Procedure

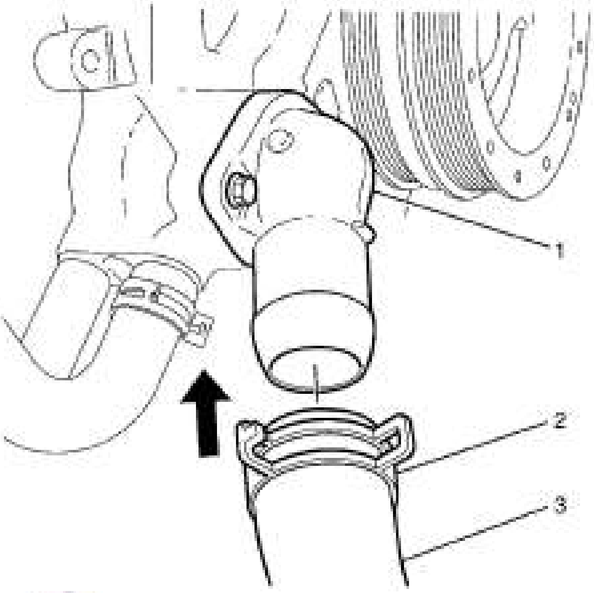
Caution: Refer to Installing Hoses without Twists or Bends Notice in the Preface section.



1. Install the bottom end of the outlet hose (1).

   Notice: Refer to General Repair Instructions in the Preface section.

2. Secure the hose by sliding the retaining hose clamp (2) over it.
3. Install the air deflector. Refer to Front Air Deflector Replacement.
4. Lower the vehicle.



5. Install the top end of the outlet hose (3), onto the thermostat housing (1).
6. Secure the outlet hose by sliding the retaining hose clamp (2) over it.
7. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.
8. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.
9. Fill the cooling system. Refer to Cooling System Draining and Filling.
10. Inspect cooling system for leaks.

Radiator Replacement

Tools Required

AU-525 Quick Connect Release Tool

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .

Caution: Refer to Radiator Cap Removal Caution in the Preface section.

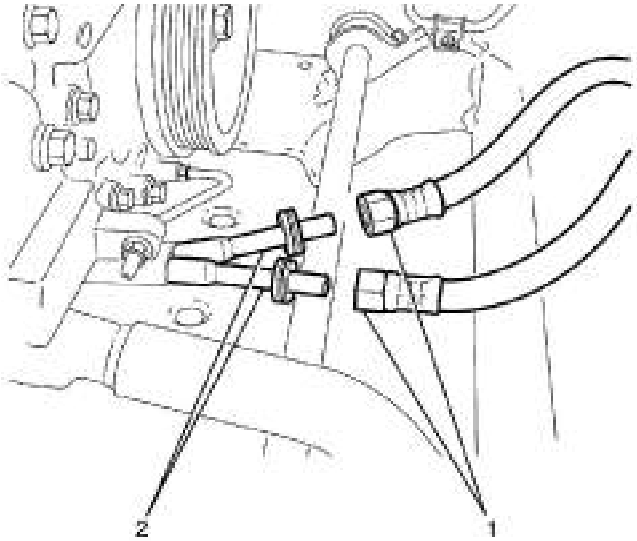
2. Ensure engine is below 50 C before removing the coolant pressure cap.
3. Drain the cooling system. Refer to Cooling System Draining and Filling .
4. Remove the engine cover. Refer to Engine Cover Replacement for 3.6L engine or Engine Cover Replacement for 6.0L engine.
5. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement .
6. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement for 3.6L engine or Air Cleaner Inlet Duct Replacement for 6.0L engine.
7. Remove the mass air flow meter. Refer to Mass Airflow Sensor/Intake Air Temperature Sensor Replacementfor 3.6L engine or Mass Airflow Sensor/Intake Air Temperature Sensor Replacement for 6.0L engine.
8. Detach the radiator inlet hose. Refer to Radiator Inlet Hose Replacement.

Caution: Refer to Safety Glasses Caution in the Preface section.

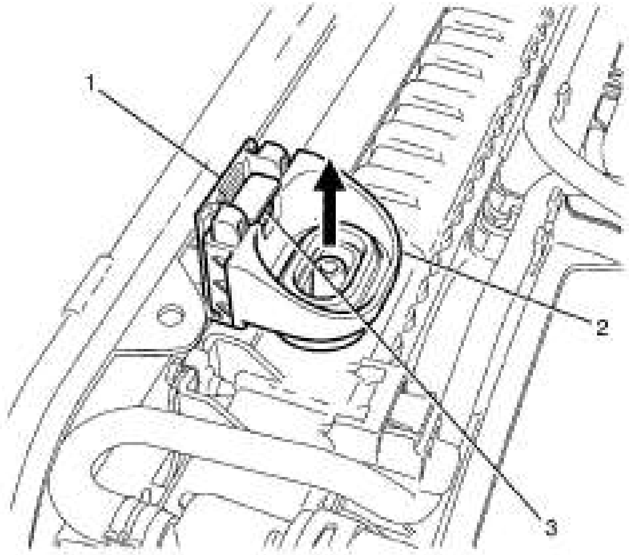
Caution: Refer to Vehicle Lifting Caution in the Preface section.

9. Raise and support vehicle. Refer to Lifting and Jacking the Vehicle .
10. Remove the air deflector. Refer to Front Air Deflector Replacement .
11. Detach the radiator outlet hose. Refer to Radiator Outlet Hose Replacement.
12. Lower the vehicle.
13. Detach the coolant recovery reservoir hose. Refer to Coolant Recovery Reservoir Replacement .
14. Remove the coolant air bleed hose. Refer to Engine Coolant Air Bleed Hose Replacement .
15. Place a suitable container beneath the radiator and engine.

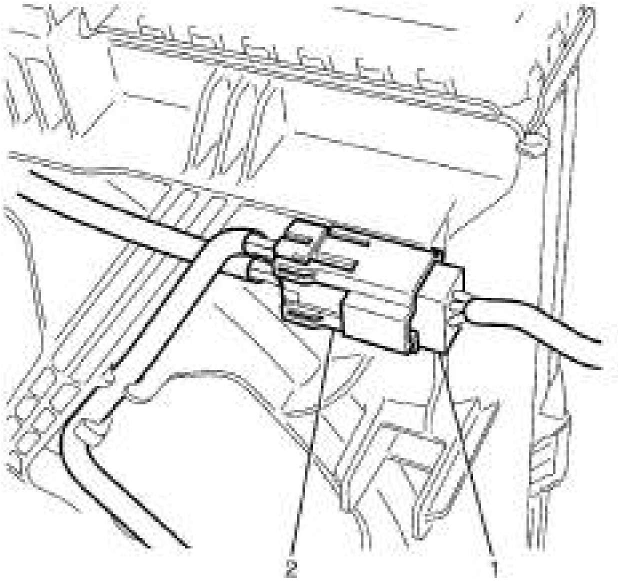
Caution: Refer to General Repair Instructions in the Preface section.



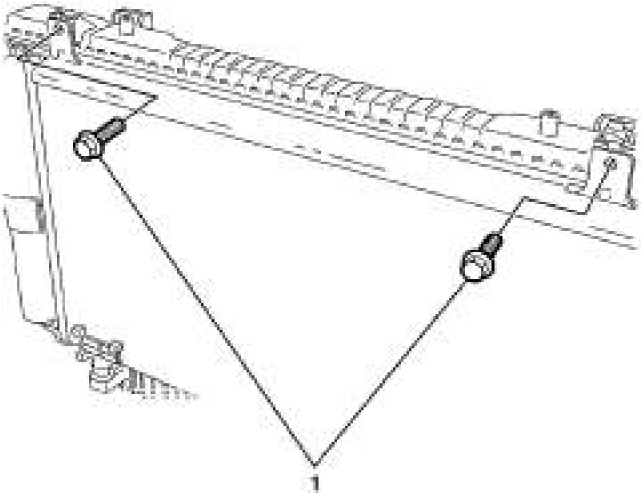
16. Disconnect the transmission cooler line (2) from the flexible hose (1) using the AU-525 .
    - Detach plastic cover from hose fitting and slide along pipe
    - Open the AU-525 then close and clip around the hose to be disconnected.
    - While holding the flexible hose (1) push the hose inwards with one hand, then pull back to separate from the steel hose piping (2).
    - Repeat procedure for the second fitting.



17. Remove the radiator support brackets (2) from top of radiator by rasing the securing lock (3) 10mm and then sliding the bracket off the radiator slide pin (1). Carry out same procedure for other bracket.

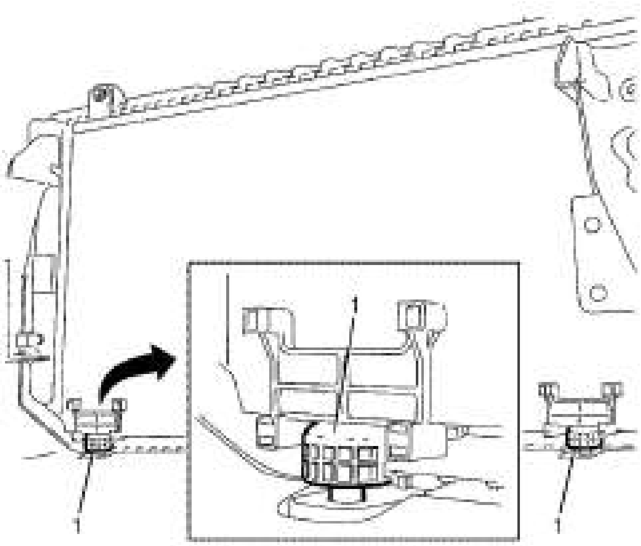


18. Disconnect the cooling fans electrical connector (2) from the main wiring loom connector (1).

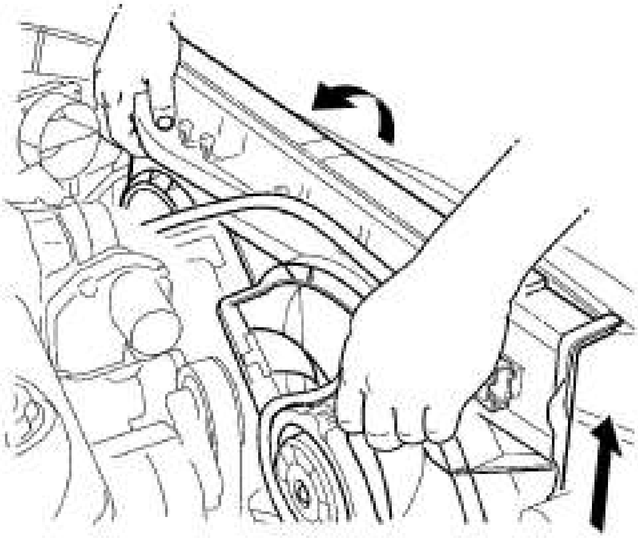


19. Remove the two radiator and condenser retaining bolts (1).

Notice: Refer to General Repair Instructions in the Preface section.

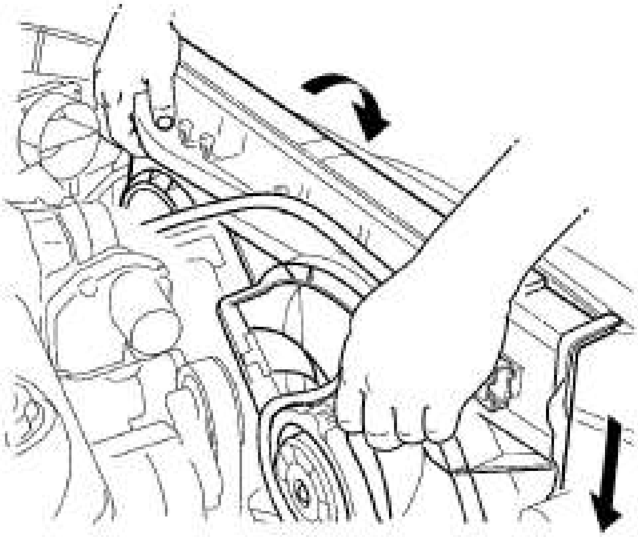


20. Detach the condenser by lifting it out of the retaining brackets located on the radiator assembly.

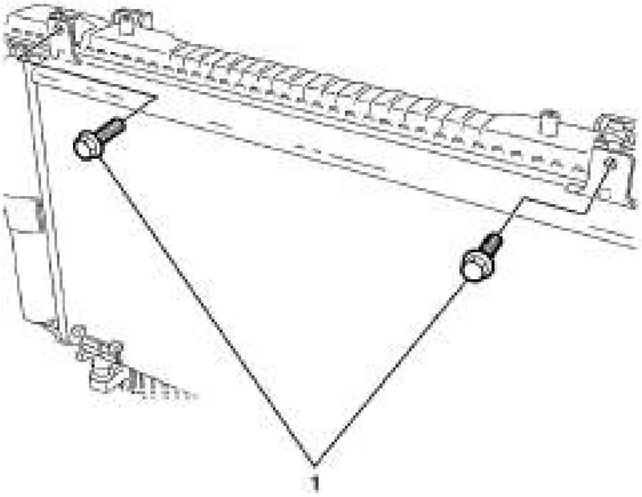


21. Remove the radiator and fan assembly, by tilting it forward and lifting it out of the rubber grommets located in the cross member.

Installation Procedure



1. Install the radiator into the rubber retaining grommets located in the cross member.

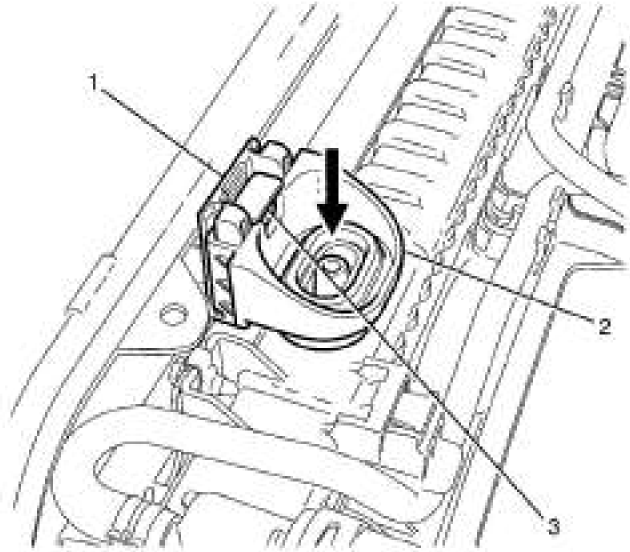


2. Install the condenser into the radiator

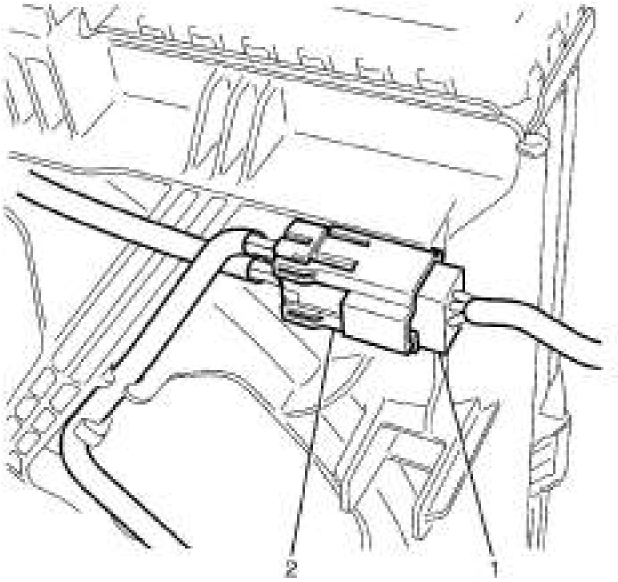
   Notice: Refer to Fastener Notice in the Preface section.

3. Install the two radiator and condenser retaining bolts (1).

   Tighten
   Tighten the radiator and condenser bolts to 11 N·m (97 lb in).

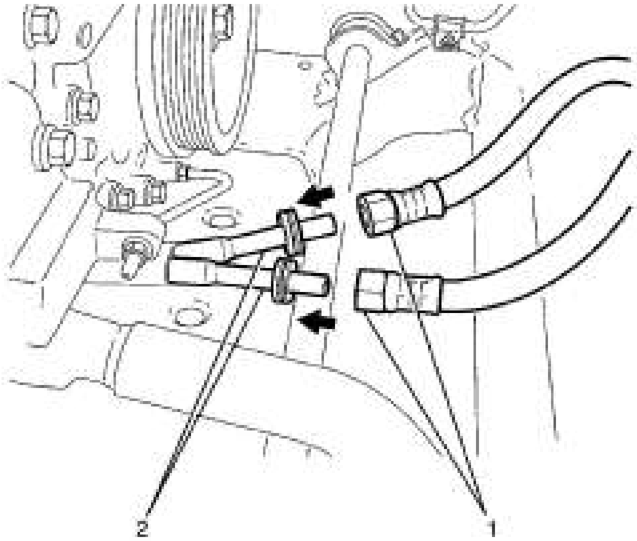


4. Install the radiator retaining brackets (2), onto the radiator slide pin (1).
5. Secure the retaining brackets by pushing the securing lock (3) downwards until lock reaches bottom of radiator bracket.



6. Connect the cooling fans electrical connector (2) to the main wiring loom connector (1)

Caution: Refer to General Repair Instructions in the Preface section.



7. Connect the flexible hoses (1) to the transmission cooler lines (2), listen for an audible click to confirm fitting.
8. Push plastic cover forward along pipe and clip onto hose fitting.

   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

9. Raise and support vehicle. Refer to Lifting and Jacking the Vehicle .
10. Install the outlet hose to the radiator. Refer to Radiator Outlet Hose Replacement .
11. Lower vehicle.
12. Install the coolant air bleed hose. Refer to Engine Coolant Air Bleed Hose Replacement .
13. Install the coolant recovery reservoir hose. Refer to Coolant Recovery Reservoir Replacement .
14. Install the inlet hose. Refer to Radiator Inlet Hose Replacement .
15. Install the air deflector. Refer to Front Air Deflector Replacement .
16. Install the mass air flow meter. Refer to Mass Airflow Sensor/Intake Air Temperature Sensor Replacement for 3.6L engine or Mass Airflow Sensor/Intake Air Temperature Sensor Replacement for 6.0L engine.
17. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacement for 3.6L engine or Air Cleaner Inlet Duct Replacement for 6.0L engine.
18. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement .
19. Install the engine cover. Refer to Engine Cover Replacement for 3.6L engine or Engine Cover Replacement for 6.0L engine.
20. Install the battery ground lead to the vehicle. Refer to Battery Negative Cable Disconnection and Connection .
21. Fill the cooling system. Refer to Cooling System Draining and Filling .
22. Inspect cooling system for leaks.

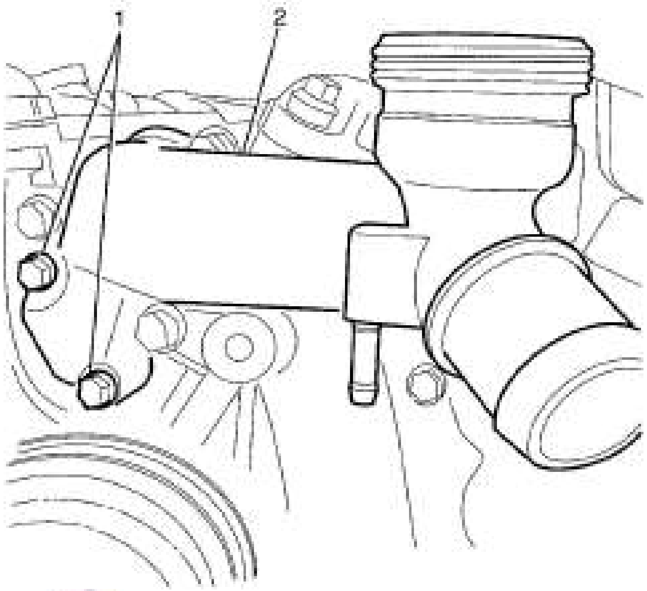
Water Outlet Replacement

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

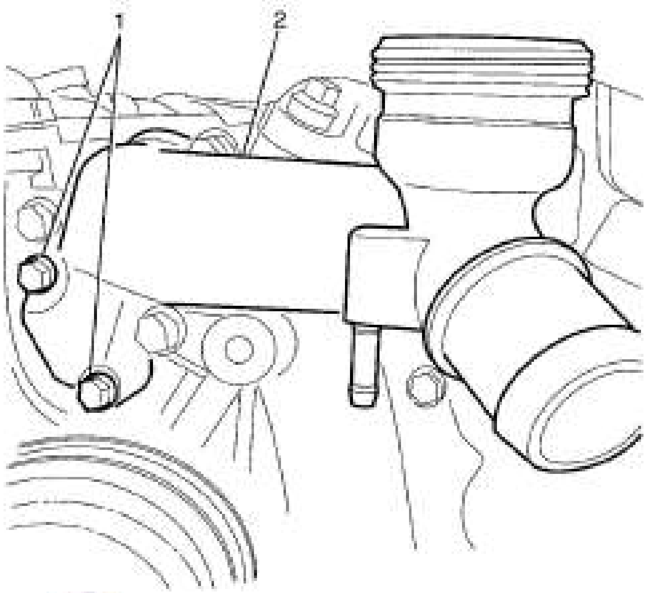
1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
2. Drain the cooling system. Refer to Cooling System Draining and Filling .
3. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement .
4. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement .
5. Remove the intake manifold. Refer to Intake Manifold Removal .
6. Detach the radiator inlet hose. Refer to Radiator Inlet Hose Replacement .
7. Detach the coolant recovery reservoir hose. Refer to Coolant Recovery Reservoir Replacement .
8. Detach the coolant air bleed hose. Refer to Engine Coolant Air Bleed Hose Replacement .

Notice: Refer to General Repair Instructions in the Preface section.



9. Remove the water outlet housing (2) to intake manifold retaining bolts (1).
10. Remove the water outlet housing.
11. Discard the rubber O-ring and seal.

Installation Procedure



Important: Ensure a new rubber O-ring and seal is used when installing the water outlet housing.

1. Install the water outlet housing (2) to the intake manifold.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the water outlet housing (2) to intake manifold retaining bolts (1).

   Tighten
   Tighten the bolts to xx N·m (xx lb in).

3. Attach the coolant air bleed hose. Refer to Engine Coolant Air Bleed Hose Replacement .
4. Attach the coolant recovery reservoir hose. Refer to Coolant Recovery Reservoir Replacement .
5. Attach the radiator inlet hose. Refer to Radiator Inlet Hose Replacement .
6. Install the intake manifold. Refer to Intake Manifold Removal .
7. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacement .
8. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement .
9. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
10. Fill the cooling system. Refer to Cooling System Draining and Filling .
11. Inspect cooling system for leaks.

Water Pump Replacement (3.6L Engine)

Removal Procedure

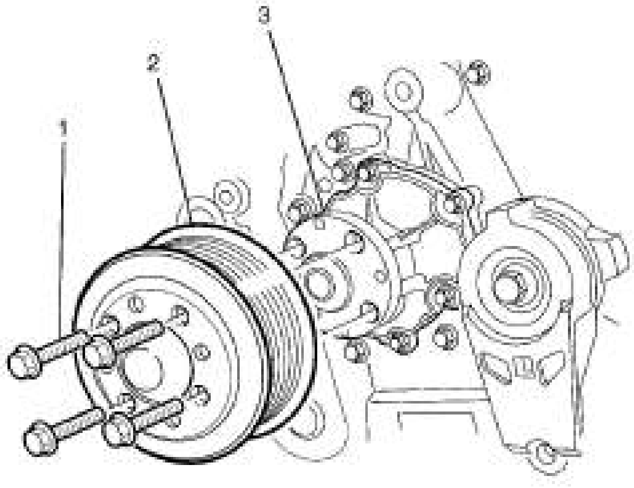
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Drain the cooling system. Refer to Cooling System Draining and Filling.
3. Remove the engine cover. Refer to Engine Cover Replacement in Engine Mechanical - 3.6L.
4. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.
5. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement in Body Front End.
6. Remove the engine drive belt. Refer to Drive Belt Replacement.

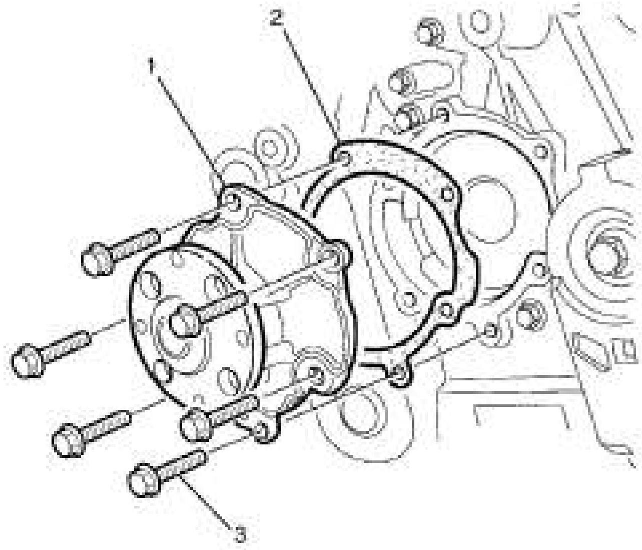
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Radiator Cap Removal Caution in the Preface section.

7. Ensure engine is below 50 C before removing the coolant pressure cap.



8. Remove the water pump pulley to water pump retaining bolts (1).
9. Remove the water pump pulley (2) from the water pump (3).



Important: Use a soft hammer to separate the water pump from the engine cover.

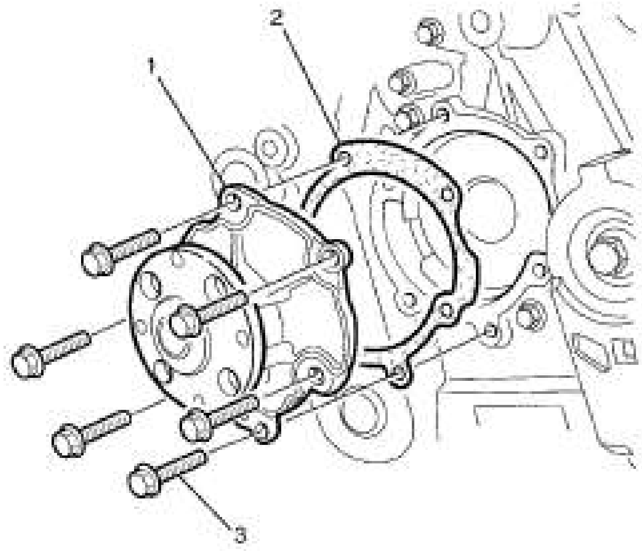
10. Remove the water pump to engine front cover retaining bolts (3).
11. Remove the water pump (1).
12. Remove the water pump gasket (2).

    Discard the gasket.

Installation Procedure

Important: Make sure all mating surfaces are clean and free of grease.

1. Using a water sealant install the water pump and gasket to front engine cover.
2. Make sure all retaining bolts are clean and free of debris.

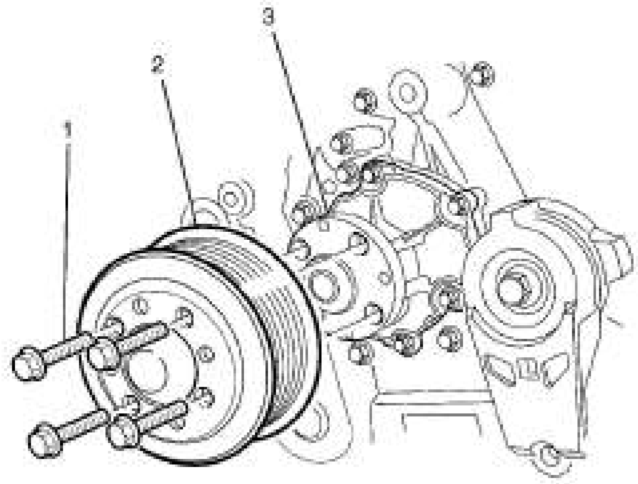


3. Install the water pump (1) and NEW gasket (2).

Notice: Refer to Fastener Notice in the Preface section.

4. Install the water pump to engine front cover retaining bolts (3).

Tighten
Tighten the bolts to 10 N·m (89 lb in).



5. Install the water pump pulley (2) to the water pump (3)
6. Install the water pump pulley to water pump retaining bolts (1).

Tighten
Tighten the bolts to 10 N·m (89 lb in).

7. Install the drive belt. Refer to Drive Belt Replacement.
8. Install the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.
9. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement in Body Front End.
10. Install the engine cover. Refer to Engine Cover Replacement in Engine Mechanical - 3.6L.
11. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.
12. Fill cooling system. Refer to Cooling System Draining and Filling.
13. Start engine and check for leaks.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Cooling | Repair Instructions | **Document ID: 2042176**

Water Pump Replacement (6.0L Engine)

Removal Procedure

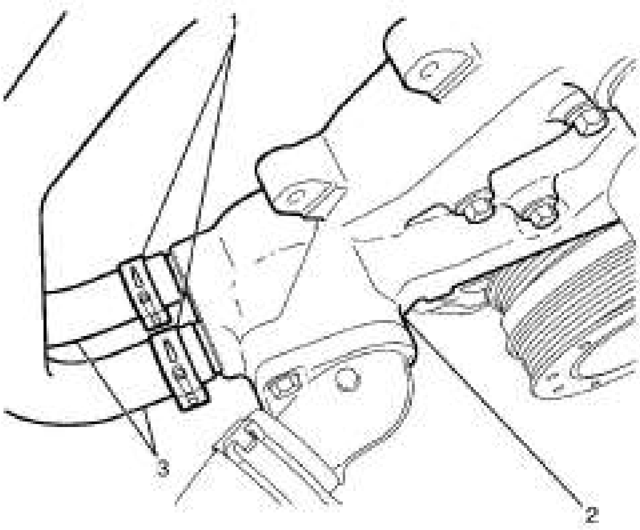
Caution: Refer to Battery Disconnect Caution in the Preface section.

Important: The water pump is not a serviceable item and should be replaced as an assembly.

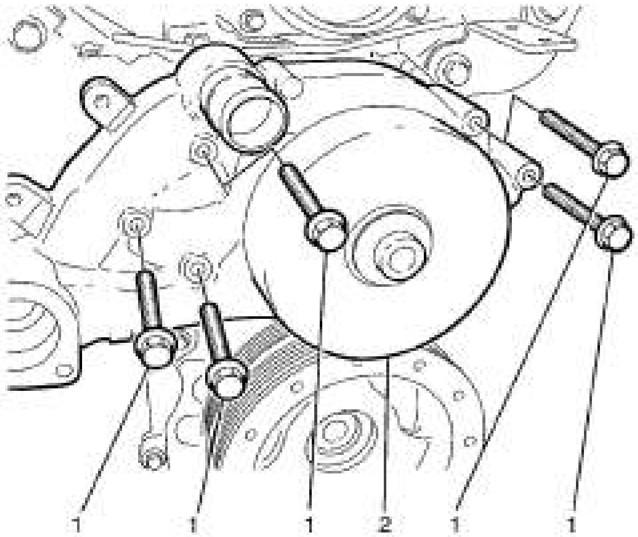
1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Drain the cooling system. Refer to Cooling System Draining and Filling.
3. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement .
4. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement .
5. Remove the engine drive belt. Refer to Drive Belt Replacement - Accessory.

Caution: Refer to Radiator Cap Removal Caution in the Preface section.

6. Remove the coolant pressure cap.
7. Detach the inlet hose. Refer to Radiator Inlet Hose Replacement.
8. Detach the outlet hose. Refer to Radiator Outlet Hose Replacement.



9. Detach the heater hoses (1) from the water pump (2).
10. Remove drive belt tensioner. Refer to Drive Belt Tensioner Replacement - Accessory.

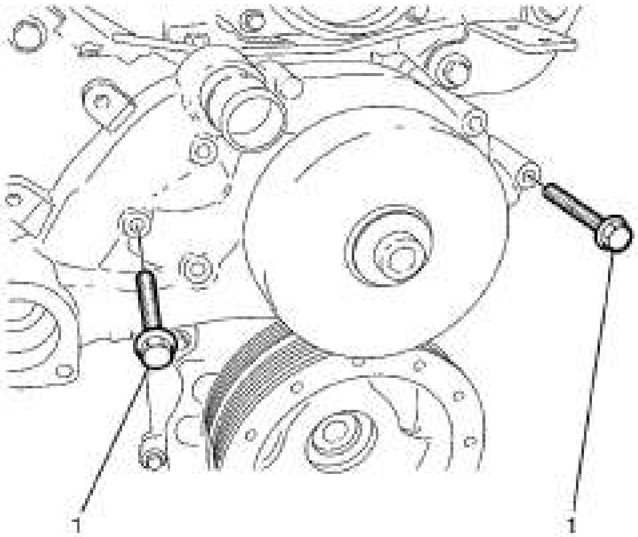


11. Remove the water pump (2) retaining bolts (1).

    Notice: Refer to General Repair Instructions in the Preface section.

12. Remove the water pump.

Installation Procedure



Important: Ensure all mating surfaces are clean and free of grease.

1. Insert two retaining bolts (1) at each end of the pump, place the new gasket of the bolts and use this as a guide to install the pump.

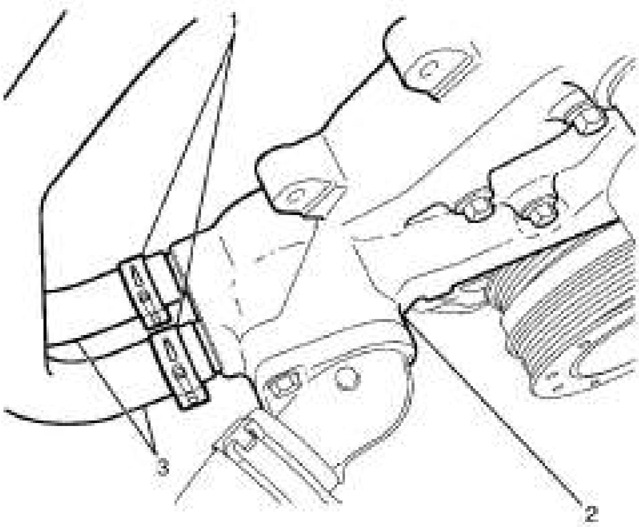
   Notice: Refer to Fastener Notice in the Preface section.

2. Install and tighten the remaining bolts.

   Tighten
   Tighten the bolts at first pass to 15 N·m (11 lb ft).

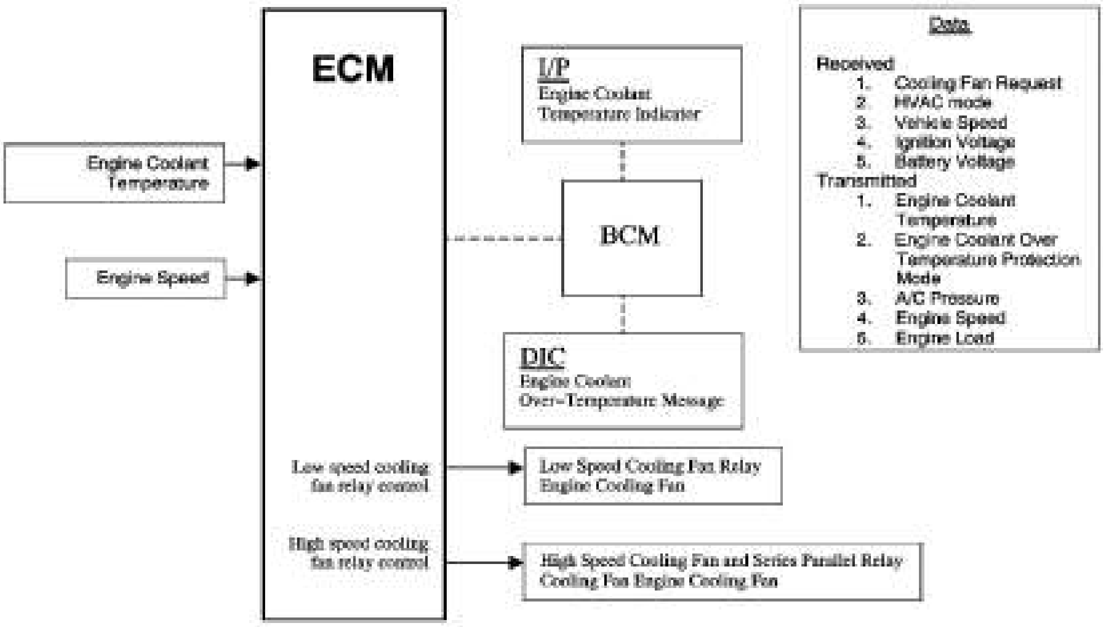
   Tighten the bolts at final pass to 25 N·m (18 lb ft).

3. Install drive belt tensioner. Refer to Drive Belt Tensioner Replacement - Accessory.
4. Install the outlet hose to the water pump. Refer to Radiator Outlet Hose Replacement.
5. Install the inlet hose to the water pump. Refer to Radiator Inlet Hose Replacement.



6. Install the heater hoses (1) to the water pump (2).
7. Install the engine drive belt. Refer to Drive Belt Replacement - Accessory.
8. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.
9. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.
10. Install the ground battery lead to the vehicle. Refer to Battery Negative Cable Disconnection and Connection.
11. Fill the cooling system. Refer to Cooling System Draining and Filling.
12. Inspect cooling system for leaks.
13. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.

Cooling Fan Description and Operation


ECM
Engine Coolant Temperature
Engine Speed
I/P
Engine Coolant Temperature Indicator
BCM
DIC
Engine Coolant Over-Temperature Message
Low speed cooling fan relay control
High speed cooling fan relay control
Low Speed Cooling Fan Relay Engine Cooling Fan
High Speed Cooling Fan and Series Parallel Relay Cooling Fan Engine Cooling Fan
Data
Received
1. Cooling Fan Request
2. HVAC mode
3. Vehicle Speed
4. Ignition Voltage
5. Battery Voltage
Transmitted
1. Engine Coolant Temperature
2. Engine Coolant Over Temperature Protection Mode
3. A/C Pressure
4. Engine Speed
5. Engine Load

The engine cooling fan system consists of 2 electrical cooling fans and 3 fan relays. The relays are arranged in a series parallel (S/P) configuration that allows the engine control module (ECM) to operate both fans together at low or high speeds, depending on cooling requirements. The cooling fans and fan relays receive battery positive voltage from the underhood fuse block. The ground path is provided at G104.

During low speed operation, the ECM supplies the ground path for the low speed fan 1 relay through the fan 1 relay or low speed control circuit. This energizes the low speed fan relay coil, closes the relay contacts, and supplies battery positive voltage from the FAN 1 fuse through the cooling fan motor supply voltage circuit to the right cooling fan. The ground path for the right cooling fan is through the cooling fan 2 relay and the left cooling fan. The result is a series circuit with both fans running at low speed.

During high speed operation the ECM supplies the ground path for the fan 1 relay through the fan 1 relay low speed control circuit. The ECM supplies a ground path for the high speed fan 3 relay and the fan 2 relay through the fan 2 relay or high speed control circuit. This energizes the fan 2 relay coil, closes the relay contacts, and provides a ground path for the right cooling fan. At the same time, the fan 3 relay coil is energized closing the relay contacts, and provides battery positive voltage from the FAN 2 fuse on the cooling fan motor supply voltage circuit, to the left cooling fan. During high speed fan operation, both engine cooling fans have their own ground path. The result is a parallel circuit with both fans running at high speed.

Cooling System Description and Operation

Cooling System

The cooling system's function is to maintain an efficient engine operating temperature during all engine speeds and operating conditions. The cooling system is designed to remove approximately one-third of the heat produced by the burning of the air-fuel mixture. When the engine is cold, the system cools slowly or not at all. This allows the engine to warm quickly.

Cooling Cycle

Coolant is drawn from the radiator outlet and into the water pump inlet by the water pump.

Coolant is also pumped through the water pump outlet and into the engine block. In the engine block, the coolant circulates through the water jackets surrounding the cylinders where it absorbs heat.

The coolant is then forced through the cylinder head gasket openings and into the cylinder heads. In the cylinder heads, the coolant flows through the water jackets surrounding the combustion chambers and valve seats, where it absorbs additional heat.

Operation of the cooling system requires correct functioning of all cooling system components. The cooling system consists of the following components:

Coolant

The engine coolant is a solution made up of a 50-50 mixture of DEX-COOL and clean drinkable water. The coolant solution carries excess heat away from the engine to the radiator, where the heat is dissipated to the atmosphere.

Radiator

The radiator is a heat exchanger. It consists of a core and 2 tanks. The aluminium core is a downflow tube and fin design. This is a series of tubes that extend vertically down from the inlet tank to the outlet tank. Fins are placed around the outside of the tubes to increase heat transfer from the coolant to the atmosphere. The inlet and outlet tanks are moulded with a high temperature, nylon reinforced plastic. A high temperature rubber gasket seals the tank flange edge. The tanks are clamped to the core with clinch tabs. The tabs are part of the aluminium header at each end of the core.

The radiator removes heat from the coolant passing through it. The fins on the core absorb heat from the coolant passing through the tubes. As air passes between the fins, it absorbs heat and cools the coolant.

During vehicle use, the coolant heats and expands. The coolant that is displaced by this expansion flows into the coolant recovery. As the coolant circulates, air is allowed to exit. This is an advantage to the cooling system. Coolant without bubbles absorbs heat much better than coolant with bubbles.

Screw On Pressure Cap

The pressure cap is a cap that seals and pressurizes the cooling system. It contains a blow off or pressure valve and a vacuum or atmospheric valve. The pressure valve is held against its seat by a spring of predetermined strength, which protects the radiator by relieving pressure if it exceeds 15 psi.

The pressure cap allows pressure in the cooling system to build up. As the pressure builds, the boiling point of the coolant goes up as well. Therefore, the coolant can be safely run at a temperature much higher than the boiling point of the coolant at atmospheric pressure. The hotter the coolant is, the faster the heat moves from the radiator to the cooler, passing air. The pressure in the cooling system can get too high. However, when the pressure exceeds the strength of the spring, it raises the pressure valve so that the excess pressure can escape. As the engine cools down, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum causes the vacuum valve to open, allowing coolant from the recovery bottle to be sucked back into the cooling system. This equalizes the pressure in the cooling system with atmospheric pressure, preventing the radiator from collapsing.

Coolant Recovery System

The coolant recovery system consists of a plastic coolant recovery reservoir and overflow hose. The recovery reservoir provides an air space in the cooling system that allows the coolant to expand and contract. The coolant recovery system provides a coolant fill point and a central air bleed location. It is partially filled with coolant and is connected to the radiator fill neck with the overflow tube. Coolant can flow back and forth between the radiator and the reservoir.

In effect, a cooling system with a coolant recovery reservoir is a closed system. When the pressure in the cooling system gets too high, it will open the pressure valve in the pressure cap. This allows the coolant, which has expanded due to being heated, to flow through the overflow hose and into the recovery reservoir. As the engine cools down, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum opens the vacuum valve in the pressure cap, allowing some of the coolant in the reservoir to be siphoned back into the radiator. Under normal operating conditions, no coolant is lost. Although the coolant level in the recovery reservoir goes up and down, the radiator and cooling system are kept full.

During vehicle use, the coolant heats and expands. The increased coolant volume flows into the recovery reservoir. As the coolant circulates, any air that is present in the cooling system will accumulate at the pressure cap as this is the highest point. When the pressure cap releases it is the air which is expelled first. When the systems goes into vacuum it will suck coolant back in.

Water Pump

The water pump is a centrifugal vane impeller type pump. The pump consists of a housing with coolant inlet and outlet passages and an impeller. The impeller is a flat plate mounted on the pump shaft with a series of flat or curved blades or vanes. When the impeller rotates, the coolant between the vanes is thrown outward by centrifugal force. The impeller shaft is supported by one or more sealed bearings. These sealed bearings never need to be lubricated. With a sealed bearing, grease cannot leak out, and dirt and water cannot get in.

The purpose of the water pump is to circulate coolant throughout the cooling system. The water pump is driven by the crankshaft via the drive belt.

Thermostat

The thermostat is a coolant flow control component. It's purpose is to regulate the operating temperature of the engine. It utilizes a temperature sensitive wax-pellet element. The element connects to a valve through a piston. When the element is heated, it expands and exerts pressure against a rubber diaphragm. This pressure forces the valve to open. As the element is cooled, it contracts. This contraction allows a spring to push the valve closed.

When the coolant temperature is below 86°C (186°F) for V8 and 82°C (180°F) for V6 the thermostat valve remains closed. This prevents circulation of the coolant to the radiator and allows the engine to warm up quickly. After the coolant temperature reaches 86°C (186°F) or 82°C (180°F) the thermostat valve will begin to open. The coolant is then allowed to circulate through the radiator where the engine heat is dissipated to the atmosphere. The thermostat also provides a restriction in the cooling system, even after it has opened. This restriction creates a pressure difference which prevents cavitation at the water pump and forces coolant to circulate through the engine block.

Transmission Oil Cooler

The transmission oil cooler is a heat exchanger. It is located inside the bottom of the radiator. The transmission fluid temperature is regulated by the temperature of the engine coolant that surrounds the oil cooler as the transmission fluid passes down through the cooler.

The transmission oil pump pumps the fluid through the transmission oil cooler feed line to the oil cooler. The fluid enters the oil cooler on the RHS, and then flows left through the cooler while the engine coolant absorbs heat from the fluid. The fluid is then pumped through the transmission oil cooler return line to the transmission.

Cooling Fan Operation

The cooling fans operate in two stages for V8 and three stages for V6; in both low and high stages both fans run. In stage 1 (low) the two fan motors are connected in series so both fans run at low speed. In stage 2 (high) each fan motor is connected to battery voltage so both fans run at high speed, (cooling fan operation is controlled by the engine control module (ECM) based on inputs from the following: V6 has a mid speed stage which has one fan at high speed and the other fan is off).

- The A/C request signal
- The A/C refrigerant pressure sensor
- The engine coolant temperature (ECT) sensor

Low Speed - Both Fans Operate at Low Speed

When the conditions for low speed operation are met the ECM provides a ground to the coil of engine cooling fan relay 1, causing it to operate (turn ON). The fan current path is then from the battery via the left radiator fan fuse, through the left fan motor, cooling fan relay 2, the right fan motor and cooling fan relay 1 to ground.

The conditions for low speed operation are:

- There is an A/C request and:
- A/C refrigerant pressure is greater than 1517 kPa (220 psi).
- ECT is greater than 109°C (228°F) for V6 or 104°C (219°F) V8.

- ECT is greater than 121°C (250°F) for V6 or 113°C (235°F) for V8 when the engine is switched off (in this case stage 1 will operate for approximately four minutes - this is referred to as low fan run-on).

Low speed operation will cease when:

- There is no A/C request and the ECT is less than 105°C (221°F) for V6 or 100°C (212°F) for V8.
- There is an A/C request and the A/C pressure is less than 1000 kPa (145 psi) and the ECT is less than 105°C (220°F) for V6 or 100°C (212°F) for V8.

Mid Speed - Left Fan Operates at High Speed (V6 Only)

When the conditions for mid speed operation are met the left fan gets battery voltage and operates at high speed. The right fan does not operate.

The conditions for Mid Speed operation are:

- The A/C has been requested and the A/C pressuer is greater than 1700 kPa (247psi).
- The ECT is greater than 112°C (234°F) for V6 .

  Mid speed operation will cease and revert to low speed operation when:
- ECT is less than 108°C (226°F) and there is no A/C request.
- There is an A/C request and the A/C pressure is less than 1200 kPa (174psi) and the ect is less than 108°C (226°F).

High Speed - Both Fans Operate at High Speed

When the conditions for high speed operation are met the ECM provides - in addition to that already provided for the coil of engine cooling fan relay 1 - a ground to the coils of engine cooling fan relays 2 and 3, causing them to operate (turn ON). For the left fan, the current path is then from the battery via the left radiator fan fuse, through the left fan motor and engine cooling fan relay 2 to ground. For the right fan, the current path is from the battery via the right radiator fan fuse, through engine cooling fan relay 3, through the right fan motor and engine cooling fan relay 1 to ground. The conditions for high speed operation are:

- The A/C has been requested and the A/C refrigerant pressure is greater than 2000 kPa (290 psi).
- The ECT is greater than 117.5°C (243°F) for V6 or 109°C (228°F) for V8.
- An ECT sensor fault is detected and a DTC is set.
- There is a body control module (BCM) message response fault, which will cause a powertrain interface module (PIM) DTC to set.

If low speed operation is off when the conditions for high speed operation are met, high speed operation will be initiated five seconds after initiation of low speed operation.

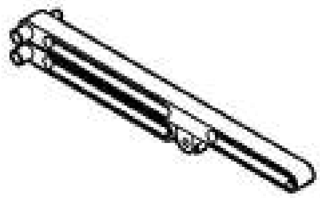
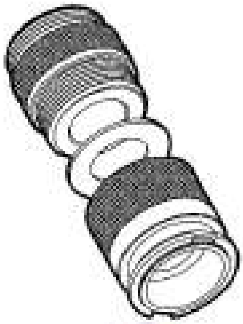
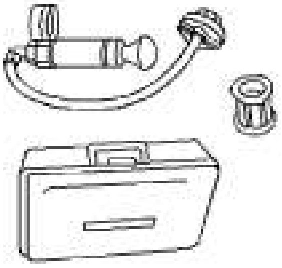
High speed operation will cease and revert to low or medium speed operation when:

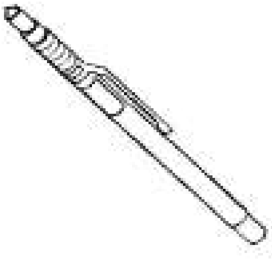
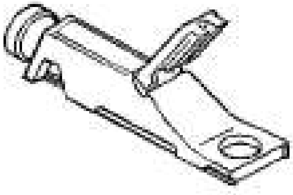
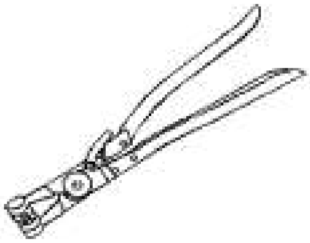
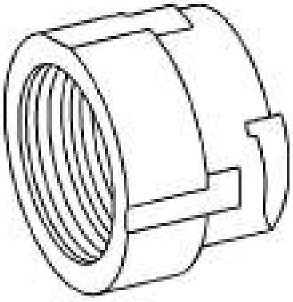
- The ECT is less than 112°C (235°F) for V6 or 103°C (217°F) for V8 and there is no A/C request.

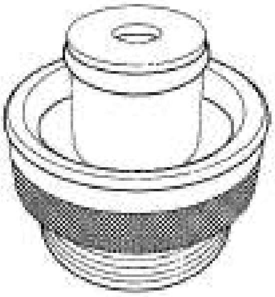
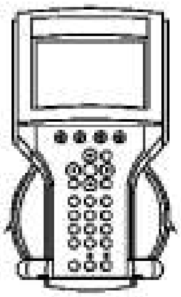
- There is an A/C request and the A/C refrigerant pressure is less than 1400 kPa (203 psi) and ect is less than 112°C (235°F) for V6 or 103°C (217°F) for V8.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Cooling | Special Tools and Equipment | **Document ID: 1989412**

Special Tools

Illustration	Tool Number / Description
	EN 46104 Water Pump Pulley Holding Tool
	EN 48501 Radiator cap pressure adapter
	J 24460-01 Cooling System Pressure Tester
	J 24731

	Tempilstick 206
	J 26568 Coolant and Battery Fluid Tester
	J 38185 Hose Clamp Pliers
	KM 471 Cooling system test adaptor

	KM 6327 Cooling system test adaptor
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Alternator Bracket to Block Retaining Bolts (alternator Support)	XX N·m	XX lb in
Alternator Bracket to Block Retaining Bolt (Main)	23 N·m	17 lb ft
Alternator Output Battery Terminal Nut (LY7)	13 N·m	115 lb in
Alternator Output Battery Terminal Nut (V8)	10 N·m	89 lb in
Alternator to Alternator Bracket Retaining Nuts	XX N·m	XX lb in
Alternator to Alternator Bracket Retaining Studs	XX N·m	XX lb in
Alternator to Block Retaining Bolt (Front)	50 N·m	37 lb ft
Alternator to Block Retaining Bolt (Side)	50 N·m	37 lb ft
Battery Cable to Battery Clamp Retaining Nut	17 N·m	13 lb ft
Battery Cable to Battery Terminal Retaining Nut	17 N·m	13 lb ft
Battery Negative Cable to Battery	6 N·m	53 lb in
Battery Negative Cable to Chassis Retaining Bolt	15 N·m	11 lb ft
Battery Negative Cable to Engine Block Retaining Bolt	25 N·m	18 lb ft
Battery Negative Cable to Engine Block Stud (LY7)	25 N·m	18 lb ft
Battery Isolator Retaining Bolts	11 N·m	97 lb in
Battery Positive Cable to Alternator Battery Output Terminal Retaining Bolt	4 N·m	35 lb in
Battery Positive Cable to Battery	6 N·m	53 lb in
Battery Positive Cable to Battery Remote Positive Post Retaining Bolt	XX N·m	XX lb in
Battery Positive Cable to Starter Motor Terminal Retaining Nut	13 N·m	115 lb in
Battery Positive Cable to Starter Terminal Retaining Nut (LY7, L98)	13 N·m	115 lb in
Battery Positive Cable to UBC Retaining Nut	15 N·m	11 lb ft
Battery Retainer Bolt	18 N·m	13 lb ft
Battery Retainer Plate to Battery Retainer Strap Retaining Nut	18 N·m	13 lb ft
Battery Retainer Strap Nuts to Battery Retainer Strap (Sportwagon)	6 N·m	53 lb in
Battery Tray to Chassis Retaining Bolt	6 N·m	53 lb in
Battery Tray to Chassis Retaining Bolts (Sportwagon)	25 N·m	18 lb ft
Coolant Inlet Pipe to Alternator Mounting Bracket Retaining Nut	22 N·m	16 lb ft
Front Battery Positive Cable to Alternator Retaining Nut (Sportwagon)	13 N·m	115 lb in
Front Battery Positive Cable to UBEC Plate Retaining Nut (Sportwagon)	10 N·m	89 lb in
Ground Strap to Chassis Retaining Bolt	XX N·m	XX lb in
Ground Strap to Cylinder Head Bolt (L98)	25 N·m	18 lb ft
Power Steering Pump to Power Steering Pump Bracket Retaining Bolts	XX N·m	XX lb in
Primary and Secondary Battery Isolator Retaining Nuts	XX N·m	XX lb in
Remote Battery Positive Post to Battery Positive Cable Retaining Bolt (Sportwagon)	15 N·m	11 lb ft

Starter Battery Positive Cable to Starter Motor Retaining Nut (Sportwagon)	20 N·m	15 lb ft
Starter Motor Bolt (L98)	30 N·m	22 lb ft
Starter Motor Bolt (LY7)	50 N·m	37 lb ft
Starter Motor Heatsheild to Starter Motor Retaining Bolts (Sportwagon)	5 N·m	44 lb in
Starter Motor Soleniod Cable to Starter Motor Retaining Bolts V6	20 N·m	14 lb ft
Starter Motor Soleniod Cable to Starter Motor Retaining Bolts V8	10 N·m	89 lb in
Starter Motor to Bell Housing Retaining Bolts - 6.0L	XX N·m	XX lb in
Starter Motor to Cylinder Block Retaining Bolts - 3.6L	58 N·m	42 lb ft
Starter Solenoid B+ Terminal Nut (L98, LY7)	4 N·m	35 lb in

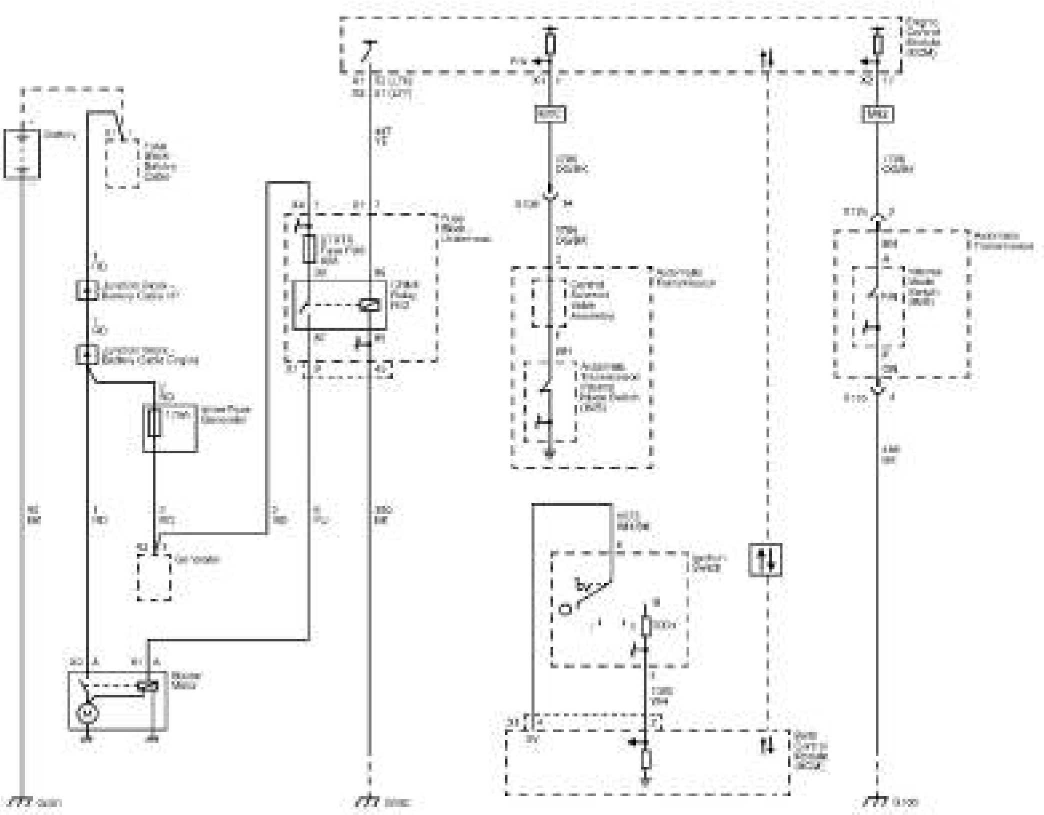
Battery Usage

Application	Specification
Cold Cranking Amperage (CCA)	640 A
Amp Hours	63 A/H
Reserve Capacity	110 Minutes
Replacement Model Number	101-6YR

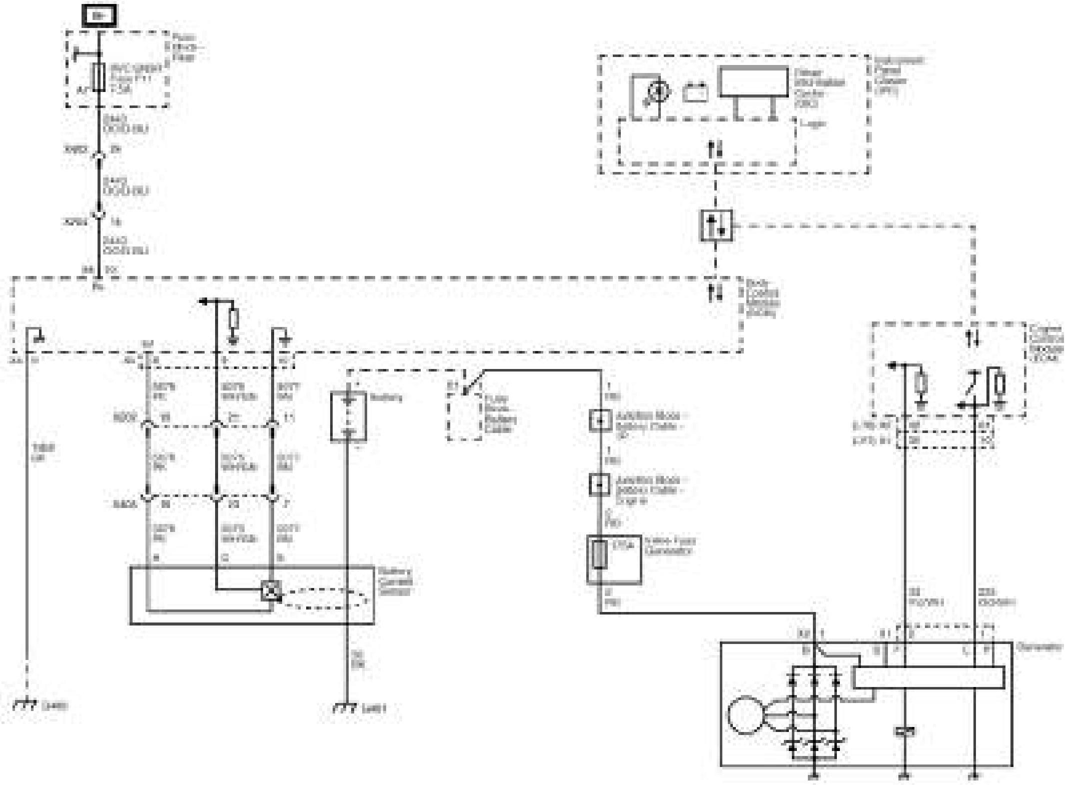
Generator Usage

Application	Specification
Alternator Model	SC2
Rated Output	155 Amps
Load Test Output	108 Amps

Starting


Battery
Fuse Block Underhood
Engine Control Module (ECM)
Automatic Transmission
Generator

Charging



Diagnostic Starting Point - Engine Electrical

Begin the system diagnosis with the Diagnostic System Check - Vehicle in Vehicle DTC Information. The Diagnostic System Check will provide the following information:

- The identification of the control modules which command the system
- The ability of the control modules to communicate through the serial data circuit
- The identification of any stored diagnostic trouble codes (DTCs) and their status.

The use of the Diagnostic System Check will identify the correct procedure for diagnosing the system and where the procedure is located.

DTC B1516 (Current)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC B1516 08: Battery Current Sensor Signal Invalid

DTC B1516 66: Battery Current Sensor Wrong Mounting Position

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference	B1516 08	B1516 08	--	--
Signal	B1516 08	B1516 08	B1516 08	B1516 08, B1516 66
Low Reference	--	B1516 08	--	--

Circuit/System Description

The battery current sensor is a 3-wire hall effect current sensor. The battery current sensor monitors the battery current. It directly inputs to the body control module (BCM). It creates a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes.

Conditions for Running the DTC

- The ignition is ON.
- The engine is running.

Conditions for Setting the DTC

B1516 08

The battery current signal is less than 4 percent or greater than 96 percent duty cycle for 2 minutes.

B1516 66

The battery current polarity is positive for 2 minutes.

Action Taken When the DTC Sets

The regulated voltage control (RVC) is disabled.

Conditions for Clearing the DTC

The DTC passes when the battery current returns to the normal range for 15 seconds.

Diagnostic Aids

DTC B1516 08 could be set by overcharging with a battery charger or jump starting.

Reference Information

Schematic Reference

- Starting and Charging Schematics
- Body Control System Schematics

Connector End View Reference

Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

for scan tool information

Circuit / System Testing

B1516 08

1. Ignition OFF, disconnect the harness connector at the battery current sensor.
2. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 Ω between the low reference circuit terminal B and ground.
   - If greater than specified range , test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the BCM.

3. Ignition ON, test for 4.8-5.2 V between the 5-volt reference circuit terminal A and ground.

   If less than the specified range , test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests, normal replace the BCM.

   If greater than the specified range , test the 5-volt reference circuit for a short to voltage. If the circuit tests, normal replace the BCM.
4. Ignition ON, test for 4.8-5.2 V between the signal circuit terminal C and ground.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, replace the battery current sensor.

B1516 66

1. Verify that the battery current sensor is installed securely around the negative battery cable, with the tape tab pointing away from the negative terminal on the battery.

   If the battery current sensor is not installed correctly, remove and reinstall the sensor properly.
2. Replace the battery current sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Battery Negative Cable Replacement for battery current sensor replacement.
- Control Module References for BCM replacement, setup, and programming

DTC B1516 (Update)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC B1516 08: Battery Current Sensor Performance Signal Invalid

DTC B1516 66: Battery Current Sensor Performance Wrong Mounting Position

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference	B1516 08	B1516 08	--	--
Signal	B1516 08	B1516 08	B1516 08	B1516 08, B1516 66
Low Reference	--	B1516 08	--	--

Typical Scan Tool Data

Battery Current - BCM

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, engine OFF. Headlamps, HVAC, and all accessories Off. *Parameter Normal Range:* -3 amps to -25 amps			
5-Volt Reference	-59.9 amps	-59.9 amps	-6.2 amps
Signal	-59.9 amps	59.9 amps	59.9 amps
Low Reference	--	59.9 amps	--

Circuit/System Description

The battery current sensor is a 3-wire hall effect current sensor. The body control module (BCM) supplies a 5 volt reference voltage and a ground circuit to the battery current sensor. The battery current sensor measures the amount of current flowing to or from the battery and supplies a pulse width modulation (PWM) signal to the BCM. The BCM monitors the battery current signal and sets DTC B1516 08 if the signal is outside the normal range of 4-96 percent duty cycle. The BCM also monitors the current polarity, and sets DTC B1516 66 if reverse polarity is detected.

Conditions for Running the DTC

B1516 08

- The BCM is awake.
- The engine is running.

B1516 66

- The BCM is awake.
- The engine is OFF.

Conditions for Setting the DTC

B1516 08

The BCM detects the battery current sensor signal is less than 4 percent or greater than 96 percent duty cycle for 2 minutes.

B1516 66

The BCM detects the battery current sensor polarity is positive for 2 minutes.

Action Taken When the DTC Sets

- The regulated voltage control (RVC) is disabled.
- The "SERVICE VEHICLE SOON" warning message will be displayed on the driver information centre.

Conditions for Clearing the DTC

The DTC will clear when the battery current sensor signal returns to the normal for greater than 15 seconds.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, headlamps, HVAC and all accessories OFF, observe the scan tool BCM Battery Current parameter. The reading should be between -3 amps and -25 amps. Whilst observing the scan tool turn the headlamps and accessories ON and OFF, the scan tool parameter should change when headlamps and accessories are operated.

Circuit/System Testing

B1516 08

1. Ignition OFF, disconnect the harness connector at the battery current sensor.
2. Ignition OFF for 90 seconds, test for less than 5 ohms between the low reference circuit terminal B and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance.
3. Ignition ON, test for 4.8-5.2 volts between the 5-volt reference circuit terminal A and ground.

   If less than the specified range , test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, then replace the BCM.

   If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, then replace the BCM.
4. Ignition ON, test for 4.8-5.2 volts between the signal circuit terminal C and ground.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, replace the battery current sensor.

B1516 66

1. Verify that the battery current sensor is installed securely around the positive battery cable, with the tape tab pointing toward the positive terminal on the battery.

   If the battery current sensor is not installed correctly, remove and reinstall the sensor properly.
2. If the battery current sensor is installed correctly, replace the battery current sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Battery Current Sensor
- Control Module References for BCM replacement, setup, and programming.

DTC B1517

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC B1517 03: Battery Voltage Below Threshold

DTC B1517 07: Battery Voltage Above Threshold

DTC B1517 5A: Battery Voltage Plausibility Failure

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	B1517 03, B1517 5A	B1517 03, B1517 5A	--	--
B+ High resolution	B1517 03, B1517 5A	B1517 03, B1517 5A	--	--
Ground	--	B1517 03, B1517 5A	--	--

Circuit/System Description

The body control module (BCM) has designated circuits for monitoring vehicle system voltage. The BCM monitors the system voltage to ensure that the voltage stays within the proper range. Damage to components, and incorrect data may occur when the system voltage is out of range. The BCM monitors the system voltage over an extended length of time. If the BCM detects the system voltage is outside an expected range for the calibrated length of time.

Conditions for Running the DTC

- The BCM has power and ground.
- The ignition is not in the START position.

Conditions for Setting the DTC

B1517 03

- The battery voltage is less than 11 V.

- The engine speed is greater than 1,100 RPM.
- The above conditions are met for 15 seconds.

B1517 07

- The battery voltage is greater than 16 V.
- The engine speed is greater than 1,100 RPM.
- The above conditions are met for 15 seconds.

B1517 5A

The battery voltage differs by 2 V on the BCM battery sense circuits for 10 seconds.

Action Taken When the DTC Sets

- The instrument panel cluster (IPC) illuminates the charge indicator.
- The driver information center (DIC) displays the SERVICE BATTERY CHARGING SYSTEM warning message.

Conditions for Clearing the DTC

- The DTC will clear current status when fault is no longer present.
- The history DTC will clear after 50 consecutive ignition cycles have occurred without a malfunction.

Diagnostic Aids

- A high or low voltage DTC set in multiple modules indicates a concern in the charging system. Refer to.
- This DTC may be set by overcharging with a battery charger, or jump by starting.
- Inspect the ground connection G409 and ensure that it is clean and tight.

Reference Information

Schematic Reference

- Starting and Charging Schematics
- Body Control System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, accessories OFF, measure and record the voltage at the battery voltage at the battery terminals. The voltage should be between 12.6 and 15.0 V

   If not within the specified range, refer to Charging System Test
2. Observe the scan tool BCM Battery Voltage parameter. The reading should be between 12.6 and 15.0 V

Circuit/System Testing

1. Ignition OFF, disconnect the harness connectors at the BCM.
2. Ignition OFF, test for less than 3 Ω between the ground circuit terminal 9 X4 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition On, verify that a test lamp illuminates between the B+ circuit and terminal 10X4 and ground.

   If the test lamp does not illuminate, test the B+ circuits for a short to ground or an open/high resistance.
4. If all circuits test normal, replace the BCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for BCM replacement, setup, and programming

DTC B1527

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B1527: High Parasitic Load Detected

Circuit/System Description

The body control module (BCM) monitors the state of charge (SOC) of the electrical system. If the BCM senses that the SOC at ignition On is 30 percent lower than what it was when the engine was running.

Conditions for Running the DTC

The ignition must be in Accessory or Run mode for this code to set.

Conditions for Setting the DTC

The SOC at ignition On is 30 percent lower than when the engine was running and battery drain is more than 2 amps.

Action Taken When the DTC Sets

There is no battery telltale illuminated or DIC message displayed.

Conditions for Clearing the DTC

- The DTC will clear if the fault does not return after 50 consecutive ignition cycles.
- The DTC will clear when run SOC is greater than or equal to 80 percent.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, compare the scan tool Prev. State of Charge and Start Up State of Charge parameters. The scan tool readings should not differ by greater than 30 percent.

> If the scan tool readings differ by greater than 30 percent, refer to Battery Electrical Drain/Parasitic Load Test

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

DTC C0899

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC C0899: Device Voltage Low

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	C0899	C0899	--	--
Ground	--	C0899	--	--

Circuit/System Description

The electronic brake control module (EBCM) monitors the ignition voltage level available for system operation. A low voltage condition prevents the system from operating properly.

Conditions for Running the DTC

ignition is ON.

Conditions for Setting the DTC

This DTC will set if the B+ voltage to EBCM is less than 9 V for 100 msec.

Action Taken When the DTC Sets

- The traction control system (TCS) and vehicle stability enhancement system (VSES) are disabled for the duration of the ignition cycle.
- The multi function display (MFD) displays the ABS Fault message.
- The brake warning indicator illuminates.
- The driver information center (DIC) displays the STABILITY CONTROL ASSISTANCE/STABILITY CONTROL OFF MESSAGE.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The EBCM automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Diagnostic Aids

- A low voltage DTC in multiple modules indicates a concern in the charging system
- Inspect the ground connection G102 to ensure that it is clean and tight.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

ABS Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information.

Circuit / System Verification

1. Engine running measure and record the voltage at the battery terminals. Verify that the battery voltage is 12.6-15.5 V.

   If not within the specified range, refer to Charging System Test

2. Observe the scan tool EBCM Battery Voltage Signal parameter. The reading should be between 12.6 and 15.5 V.

Circuit / System Testing

1. Ignition OFF, disconnect the harness connector at the EBCM.
2. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 Ω between the ground circuit terminals listed below and ground:

- Terminal 1
- Terminal 4

  If greater than the specified range, test the ground circuit for an open/high resistance.

3. Verify that a test lamp illuminates between the B+ circuit terminals listed below and ground:
   - Terminal 2
   - Terminal 3

   If the test lamp does not illuminate, test the B+ circuits for a short to ground or an open/high resistance.
4. If all circuits test normal, replace the EBCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for EBCM replacement, setup and programming

DTC C0900

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC C0900 00: Device Voltage High

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	C0899 00	C0899 00	--	--
Ground	--	C0899 00	--	--

Circuit/System Description

The EBCM monitors the ignition voltage. If the voltage level is too high, damage may result in the system. When a high voltage condition is detected the EBCM turns OFF the system relay which removes battery voltage from the solenoid valves and pump motor.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The system voltage is greater than 16 V for 100 msec.

Action Taken When the DTC Sets

- Traction Control System (TCS) and Vehicle Stability Enhancement System (VSES) disabled for the duration of the ignition cycle.
- ABS disabled if ignition voltage exceeds 19.5 V.
- The TCS indicator turns ON.
- The Antilock Brake System (ABS) indicator turns ON if voltage exceeds 19.5 V.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The EBCM automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Diagnostic Aids

- A high voltage value in multiple modules indicates a concern in the charging system.
- DTC C0900 could be set by overcharging with a battery charger or jump starting.
- Inspect the ground connection G102 to ensure that it is clean and tight.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

ABS Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information.

Circuit / System Verification

1. Engine running measure and record the voltage at the battery terminals. Verify that the battery voltage is 12.6-15.5 V

   If not within the specified range, refer to Charging System Test
2. Engine running, observe the scan tool EBCM Battery Voltage Signal parameter. The reading should be between 12.6 and 15.5 V

   If not within the specified range, replace the EBCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for EBCM replacement, setup and programming.

DTC P0560

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0560: System Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
IGN I	P0560	P0560	--	--
Ground	--	P0560	--	--

Circuit/System Description

The engine control module (ECM) monitors the system voltage to ensure that the voltage stays within the proper range. Damage to components and incorrect data may occur when the voltage is out of range.

Conditions for Running the DTC

- The vehicle speed is below 40 km/h (25 mph).
- The system voltage is below 11 V or above 16 V.
- Engine speed is above 1,500 RPM.

Conditions for Setting the DTC

The ECM detects a system voltage out of range for 2 seconds.

Action Taken When the DTC Sets

DTC P0560 is a C type DTC.

Conditions for Clearing the DTC

DTC P0560 is a C type DTC.

Diagnostic Aids

- A high or low voltage DTC set in multiple modules indicates a concern in the charging system.
- A possible cause of this DTC could be overcharging with a battery charger or jump starting.
- A high or low voltage value in multiple modules indicates a concern in the charging system.
- Inspect the ECM ground connection, to verify that it is clean tight.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Engine running, accessories OFF, measure and record the battery voltage at the battery terminals. The voltage should be between 12.6 and 15.0 V
   If not within the specified range, refer to Charging System Test
2. Observe the scan tool ECM Ignition 1 Signal parameter. The reading should be between 12.6 and 15.0 V

Circuit / System Testing

1. Ignition OFF, disconnect the harness connectors at the ECM.
2. Ignition OFF, and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 Ω between the ground circuit terminals listed below and ground.
   - Terminal 1 X2
   - Terminal 2 X2
   - Terminal 4 X2

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition On, verify that a test lamp illuminates between the IGN/B+ circuit terminals listed below and ground:
   - Terminal 3 X2
   - Terminal 5 X2
   - Terminal 6 X2
   - Terminal 54 X2
   - Terminal 56 X2

   If the test lamp does not illuminate , test the IGN/B+ circuit for a short to ground or an open/high resistance.
4. If all circuits test normal, replace the ECM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for ECM replacement, setup, and programming

DTC P0562 (ECM)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0562: System Voltage Low

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
IGN I	P0562	P0562	--	--
Ground	--	P0562	--	--

Circuit/System Description

The engine control module (ECM) monitors the system voltage to ensure that the voltage stays within the proper range. Damage to components, and incorrect data may occur when the voltage is out of range.

Conditions for Running the DTC

- The vehicle speed is above 8 km/h (5 mph).
- The system voltage is between 9.5-18 V.

Conditions for Setting the DTC

The ECM detects a system voltage below 10 V for 5 seconds.

Action Taken When the DTC Sets

DTC P0562 is a C type DTC.

Conditions for Clearing the DTC

DTC P0562 is a C type DTC.

Diagnostic Aids

- A low voltage DTC set in multiple modules indicates a concern in the charging system.
- A low voltage value in multiple modules indicates a concern in the charging system.
- Inspect the ECM ground connection, to verify that it is clean tight.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, accessories OFF, measure and record the battery voltage at the battery terminals. The voltage should be between 12.6 and 15.0 V

   If not within the specified range, refer to Charging System Test.
2. Observe the scan tool ECM Ignition 1 Signal parameter. The reading should be between 12.6 and 15.0 V

Circuit/System Testing

1. Ignition OFF, disconnect the harness connectors at the ECM.
2. Ignition OFF, and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 Ω between the ground circuit terminals listed below and ground.
   - Terminal 1 X2

- Terminal 2 X2
- Terminal 4 X2

If greater than the specified range, test the ground circuit for an open/high resistance.

3. Ignition On, verify that a test lamp illuminates between the IGN/B+ circuit terminals listed below and ground:
    - Terminal 3 X2
    - Terminal 5 X2
    - Terminal 6 X2
    - Terminal 54 X2
    - Terminal 56 X2

    If the test lamp does not illuminate , test the IGN/B+ circuit for a short to ground or an open/high resistance.
4. If all circuits test normal, replace the ECM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for ECM replacement, setup, and programming

DTC P0563 (ECM)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0563: System Voltage High Input

Circuit/System Description

The engine control module (ECM) monitors the system voltage to ensure that the voltage stays within the proper range. Damage to components and incorrect data may occur when the voltage is out of range.

Conditions for Running the DTC

- The vehicle speed is above 8 km/h (5 mph).
- The system voltage is between 9.5-18 V.

Conditions for Setting the DTC

The ECM detects a system voltage above 16 V.

Action Taken when the DTC Sets

DTC P0563 is a type C Store Only DTC.

Conditions for Clearing the MIL/DTC

DTC P0563 is a type C Store Only DTC.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs
- Charging System Test

Scan Tool Reference

Control Module References

Diagnostic Aids

A possible cause of this DTC may be overcharging with a battery charger or jump starting.

Circuit/System Verification

Ignition ON, engine OFF, observe the Ignition voltage signal parameter in the ECM data list. The Ignition voltage signal parameter should read less than 16 V.

Circuit/System Testing

1. Measure the battery voltage and compare it with the Ignition circuit signal parameter in the ECM data list. Verify that battery and Ignition voltage signal readings do not differ more than 1 V.
   If greater than 1 V test the ignition circuit of the ECM for short to voltage or an open/high resistance, if the circuit tests normal replace the ECM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

DTC P0615

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0615: Starter Relay Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0615	P0615	P0615	--
Ground	--	P0615	--	--

Circuit/System Description

When the ignition switch is placed in the START position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the START position. The BCM then sends a message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the clutch pedal is depressed or the transmission is in Park/Neutral. If it is, the ECM then supplies 12 V to the control circuit of the STRTR relay. When this occurs, battery voltage is supplied through the switch of the STRTR relay to the starter solenoid.

Conditions for Running the DTC

- The Ignition is in the START position.
- The system voltage is between 9.5-18 V.

Conditions for Setting the DTC

The ECM detects improper voltage on the control circuit of the STRTR relay.

Action Taken When the DTC Sets

DTC P0615 is a C type DTC.

Conditions for Clearing the DTC

DTC P0615 is a C type DTC.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, theft deterrent or automatic transmission DTCs are set that would cause the ECM not to enable engine starting.

Circuit/System Testing

1. Ignition OFF, disconnect the STRTR relay.
2. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 Ω between the relay ground circuit terminal 85 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition OFF, connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85.
4. With the transmission range selector in park or neutral, cycle the ignition between the OFF and CRANK position. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for short to voltage. If the circuit tests normal, replace the ECM.

   If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

5. If all circuits tests normal, replace the STRTR relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Relay Replacement
- Control Module References for ECM replacement, setup, and programming

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DTC P0621

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0621: Generator L-Terminal Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	P0622	P0622	--	--
Generator Turn ON Signal	P0621	P0621	P0621	--
Generator Field Duty Cycle Signal	P0622	P0622	P0622	P0622

Circuit/System Description

The engine control module (ECM) uses the generator turn ON signal circuit to control the load of the generator on the engine. A high side driver in the ECM applies a voltage to the voltage regulator. This signals the voltage regulator to turn the field circuit ON and OFF. The ECM monitors the state of the generator turn ON signal circuit. The ECM should detect low voltage on generator turn on signal circuit when the ignition is ON and the engine is OFF, or when the charging system malfunctions. With the engine running, the ECM should detect high voltage on the generator turn on signal circuit. The ECM performs the Ignition ON and RUN tests to determine the status of the generator turn on signal circuit.

Conditions for Running the DTC

- No generator, crankshaft position (CKP) sensors, or camshaft position (CMP) sensor DTCs are set.
- The ignition ON, engine OFF for ignition on test.
- The engine is running for the run test.

Conditions for Setting the DTC

- During the ignition on test, the ECM detects high voltage on the generator turn on signal circuit for 5 seconds.

- During the run test, the ECM detects low voltage on the generator turn on signal circuit for 15 seconds.

Action Taken When the DTC Sets

DTC P0621 is a C type DTC.

Conditions for Clearing the DTC

DTC P0621 is a C type DTC.

Reference Information

Schematic Reference

- Starting and Charging Schematics
- Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Testing

1. Ignition OFF, disconnect the X1 harness connector at the generator.
2. Ignition ON, test for less than 1 V between the signal circuit terminal 1 and ground.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.

3. Engine running, test for greater than 3.5 V between the signal circuit terminal 1 and ground.
   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
4. If the circuit tests normal, replace the generator.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Generator Replacement
- Control Module References for ECM replacement, setup, and programming

DTC P0622

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0622: Generator F-Terminal Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	P0622	P0622	--	--
Turn ON Signal	P0621	P0621	P0621	--
Field Duty Cycle Signal	P0622	P0622	P0622	P0622

Circuit/System Description

The engine control module (ECM) uses the generator field duty cycle signal circuit, or F-terminal circuit, to monitor the duty cycle of the generator. The generator field duty cycle signal circuit connects to high side of the field windings in the generator. A pulse width modulated (PWM) high side driver in the voltage regulator turns the field windings ON and OFF. The ECM uses the PWM signal input to determine the generator load on the engine. This allows the ECM to adjust the idle speed to compensate for high electrical loads. The ECM monitors the status of the generator field duty cycle signal circuit. When the ignition is ON and the engine is OFF, the ECM should detect a duty cycle near 0 percent. When the engine is running, the duty cycle should be between 5-99 percent.

Conditions for Running the DTC

- No generator, crankshaft position (CKP) sensor, or camshaft (CMP) sensor DTCs are set.
- Ignition ON engine OFF, for the Ignition ON test.
- Engine running, engine speed less than 3,000 RPM for the RUN test.

Conditions for Setting the DTC

- DTC P0621 is not set.
- Ignition ON engine OFF, the ECM detects a PWM signal that is greater than 65 percent for 5 seconds.

- Engine running, the ECM detects a PWM signal that is less than 5 percent for 15 seconds.

Action Taken When the DTC Sets

DTC P0622 is a C type DTC.

Conditions for Clearing the DTC

DTC P0622 is a C type DTC.

Reference Information

Schematic Reference

- Starting and Charging Schematics
- Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Engine running, observe the scan tool GEN-F Terminal Signal parameter. The GEN-F Terminal Signal parameter should display between 5-95 percent.

Circuit/System Testing

1. Verify that a test lamp illuminates between the B+ circuit terminal 1 X2 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
2. Ignition OFF, disconnect the X1 harness connector at the generator.
3. Ignition ON, verify the scan tool ECM GEN-F Terminal Signal parameter displays less than 5 percent.

   If greater than the specified range, test the signal circuit terminal 2 for a short to voltage. If the circuit tests normal, replace the ECM.
4. Install a 3A fused jumper wire between B+ and the signal circuit.
5. Verify the scan tool ECM GEN-F Terminal Signal parameter displays greater than 95 percent.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
6. If all circuits test normal replace the generator.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Generator Replacement
- Control Module References for ECM replacement, setup, and programming

DTC P0625 or P0626

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0625: Generator F Terminal Low Voltage

DTC P0626: Generator F Terminal High Voltage

Circuit/System Description

The engine control module (ECM) uses the alternator field duty cycle signal circuit to monitor the duty cycle of the alternator. The alternator field duty cycle signal circuit connects to high side of the field windings in the alternator. A pulse width modulated (PWM) high side driver in the voltage regulator turns the field windings ON and OFF. The ECM uses the PWM signal input to determine the alternator load on the engine. This allows the ECM to adjust the idle speed to compensate for high electrical loads. The ECM monitors the status of the alternator field duty cycle signal circuit. When the key is in the RUN position and the engine is OFF, the ECM should detect a duty cycle near 0 percent. When the engine is running, the duty cycle should be between 5-95 percent.

Conditions for Running the DTC

- The vehicle speed is above 8 km/h (5 mph).
- The system voltage is between 9.5-18 volts.

Conditions for Setting the DTC

With the engine running, the ECM detects a PWM signal less than 5 percent for at least 15 seconds.

Action Taken when the DTC Sets

DTC's P0625 and P0626 are type C Store Only DTCs

Conditions for Clearing the MIL/DTC

DTC's P0625 and P0626 are type C Store Only DTCs

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Verification

With the scan tool installed, ignition ON and the engine running, observe the alternator-F Terminal Signal parameter in the ECM data list. The alternator-F Terminal Signal parameter should read between 5 and 95 percent.

Circuit/System Testing

1. Ignition OFF, disconnect the alternator harness connector.
2. With the ignition ON, engine OFF, connect a test lamp to battery positive voltage and repeatedly probe the alternator field duty cycle circuit, harness side while monitoring the alternator-F Terminal Signal Parameter in the ECM data list, it should change from 0 percent to above 95 percent.

   If the alternator-F Terminal Signal parameter was not affected by the test lamp, test the alternator-F Terminal Signal circuit for a short to ground or an open/high resistance. If circuit tests normal replace the ECM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References

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DTC P1668, P2500, or P2501

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P1668 : Generator L-Terminal Control Circuit

DTC P2500 : Generator L-Terminal Circuit Low Voltage

DTC P2501 : Generator L-Terminal Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Alternator L-Terminal Circuit	P2500	P1668	P2501	P1668

Circuit/System Description

The engine control module (ECM) uses the alternator turn ON signal circuit to control the load of the alternator on the engine. A high side driver in the ECM applies a voltage to the voltage regulator. This signals the voltage regulator to turn the field circuit ON and OFF. The ECM monitors the state of the alternator turn ON signal circuit. The ECM should detect low voltage on alternator turn on signal circuit when the ignition is ON and the engine is OFF or when the charging system malfunctions. With the engine running, the ECM should detect high voltage on the alternator turn on signal circuit. The ECM performs key ON and RUN tests to determine the status of the alternator turn on signal circuit.

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

With the engine running, the ECM detects low/high compared to a predetermined voltage on the alternator turn on signal circuit for at least 15 seconds.

Action Taken when the DTC Sets

DTCs P1668, P2500 or P2501 are type C store only DTCs.

Conditions for Clearing the MIL/DTC

DTCs P1668, P2500 or P2501 are type C store only DTCs.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Testing

1. With ignition ON and the engine OFF, disconnect the alternator harness at the alternator and measure the voltage of the alternator turn on signal circuit should read near 0 volts.

   If greater than 0 volts test the alternator turn on signal circuit for a short to voltage. If circuit test normal replace the ECM.
2. With ignition ON and the engine running, the voltage of the alternator turn on signal circuit should read over 3.5 volts.

   If no voltage is measured, test the alternator turn on signal circuit for a short to ground an open/high resistance If circuit tests normal replace the ECM.
3. If all circuits test normal Refer to Charging System Test .

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Electrical | Diagnostic Information and Procedures | **Document ID: 2194761**

Battery Charging

Special Tools

J 42000 Battery Tester

- For best results, use an automatic taper-rate battery charger with a voltage capability of 16 volts.
- The charging area should be well ventilated.
- Do not charge a battery that appears to be frozen. Allow the battery to warm to room temperature and test it using the J 42000 before charging.

Battery State of Charge

Note: Using voltage to determine the batteries state of charge (SOC) is only accurate after the battery has been at rest for 24 hours. This is enough time for the acid in each cell to equalize. If the battery has been charged or discharged in the past 24 hours, the battery SOC will only be an estimate.

The maintenance-free batteries SOC is estimated by reading the voltage of the battery across the battery terminals. Because the voltage is affected by current flow into or out of the battery, the engine must be stopped and all electrical loads turned OFF, including parasitic loads, when checking the voltage. The voltage can also be affected if the battery has just been charged or discharged, so it is important to consider what has happened to the battery in the time just before testing. Use the following procedure to determine the batteries SOC:

1. Be sure all electrical loads are turned OFF.
2. Determine whether the battery has been used in a vehicle or charged within the past 12 hours.
   - If the answer is no, the terminal voltage will be stabilized and no action is necessary before reading the voltage. Skip to step 3.
   - If the answer is yes, terminal voltage will not be stabilized and you should wait 12 hours since the last time the battery was used.
3. Estimate the battery temperature by determining the average temperature to which the battery has been exposed for the past 12 hours.

   Note: The table is accurate to 10 percent only after the battery has been at rest for 12 hours.

4. Measure the battery voltage at the battery terminals. Refer to the following table to determine the SOC according to the estimated battery temperature:

Battery Voltage	% Charge at 0°C (32°F)	% Charge at 25°C (75°F)
12.75 V	100%	100%
12.7 V	100%	90%
12.6 V	90%	75%
12.45 V	75%	65%

12.2 V	65%	45%
12.0 V	40%	20%

Use the SOC information as follows:

- A battery with a SOC that is below 65 percent must always be recharged before returning it to service or continuing storage.
- A battery with a SOC that is 65 percent or greater is generally considered to be charged enough in order to be returned to normal service or in order to continue storage. However, if the battery is being used in slow traffic or with short drive times, or if the temperature is very hot or very cold, the battery should be fully charged, to at least 90 percent, before returning it to service or continuing storage.

Charging Time Required

The time required to charge a battery will vary depending upon the following factors:

- The battery charger capacity--The higher the charger amperage, the less time it will take to charge the battery.
- The SOC of the battery--A completely discharged battery requires more than twice as much charging time as a half charged battery. In a discharged battery with a voltage below 11 volts, the battery has a very high internal resistance and may only accept a very low current at first. Later, as the charging current causes the acid content to increase in the electrolyte, the charging current will increase. Extremely discharged batteries may not activate the reversed voltage protection in some chargers. Refer to the manufacturer's instructions for operating this circuitry.
- The temperature of the battery--The colder the battery is, the more time it takes to recharge the battery. The charging current accepted by a cold battery is very low at first. As the battery warms, the charging current will increase.

Charging Procedure

Caution: Turn OFF the ignition when connecting or disconnecting the battery cables, the battery charger or the jumper cables. Failure to do so may damage the ECM/PCM or other electronic components.

Caution: Refer to Fastener Caution in the Preface section.

When charging side-terminal batteries with the battery cables connected, connect the charger to the positive cable bolt and to a ground located away from the battery. When charging side-terminal batteries with the battery cables disconnected, install the battery side terminal adapters and connect the charger to the adapters.

Tighten
Tighten the battery side terminal adapters to 15 N·m (11 lb ft).

Use the following procedure to charge the battery:

1. Turn OFF the charger.
2. Ensure that all of the battery terminal connections are clean and tight.

3. Connect the charger positive lead to the battery positive terminal on the battery or the remote jumper stud underhood.

   Caution: Do not connect the negative charger lead to the housings of other vehicle electrical accessories or equipment. The action of the battery charger may damage such equipment.

4. Connect the negative charger lead to a solid engine ground or to a ground stud in the engine compartment that is connected directly to the battery negative terminal, but away from the battery. If the negative battery cable is disconnected and a terminal adapter is being used, connect directly to the adapter.
5. Turn ON the charger and set to the highest setting for normal charging.
6. Inspect the battery every half hour after starting the battery charger.
   - Charge the battery until the taper-rate charger indicates that the battery is fully charged.
   - Estimate the battery temperature by feeling the side of the battery. If it feels hot to the touch or its temperature is over 45°C (125°F), discontinue charging and allow the battery to cool before resuming charging.
7. After charging, test the battery. Refer to Battery Inspection/Test.

Battery Common Causes of Malfunction

A battery is not designed to last forever. With proper care, however, the battery will provide years of good service. If the battery tests good but still fails to perform well, the following are some of the more common causes:

- A vehicle accessory was left on overnight.
- The driving speeds have been slow with frequent stops, stop-and-go driving, with many electrical accessories in use, particularly air conditioning, headlights, wipers, heated rear window, cellular telephone, etc.
- The electrical load has exceeded the generator output, particularly with the addition of aftermarket equipment.
- Existing conditions in the charging system, including the following possibilities:
  - A slipping belt
  - A bad generator
- The battery has not been properly maintained, including a loose battery hold down or missing battery insulator if used.
- There are mechanical conditions in the electrical system, such as a short or a pinched wire, attributing to power failure. Refer to General Electrical Diagnosis.

Electrolyte Freezing

The freezing point of electrolyte depends on its specific gravity. A fully charged battery will not freeze until the ambient temperature gets below -54°C (-65°F). However, a battery with a low state of charge may freeze at temperatures as high as -7°C (20°F). Since freezing may ruin a battery, the battery should be protected against freezing by keeping it properly charged above 80 percent state of charge, the freezing point of the battery will be somewhere below -32°C (-25°F).

Battery Protection During Vehicle Storage

Certain devices on the vehicle maintain a small continuous current drain, parasitic load, on the battery. A battery that is not used for an extended period of time will discharge. Eventually permanent damage will result. Discharged batteries will also freeze in cold weather. Refer to Battery Inspection/Test.

In order to maintain the battery state of charge while storing the vehicle for more than 30 days:

Warning: Refer to Battery Disconnect Warning in the Preface section.

Disconnect the battery ground cable to protect the battery from discharge by parasitic current drains.

When the battery cannot be disconnected:

1. Maintain a high state of charge.
2. Establish a regular schedule for recharging the battery every 20-45 days.

A battery that has remained in a discharged state for a long period of time is difficult to recharge or may be permanently damaged.

Battery Electrical Drain / Parasitic Load Test

Special Tools

J 38758 Parasitic Draw Test Switch

Diagnostic Aids

- Be sure to rule out any possible obvious influences, such as customer error or aftermarket equipment.
- Customer driving habits, such as regular short trips. This does not allow enough time to properly charge the battery. Refer to Battery Description and Operation.
- Verify that the battery and charging system are in proper working order. Refer to Battery Charging and Charging System Test.
- A battery discharging for no apparent reason while the vehicle is parked can be caused by an intermittent draw, such as a module waking up, or a continuous draw, such as a dome light or stuck relay.
- Some systems and modules such as OnStar®, and regulated voltage control (RVC), if equipped, are designed to wake-up, perform a task, and go back asleep at regular intervals. Refer to Body Control System Description and Operation for the system or modules description and operation.
- Remote keyless entry (RKE) will wake up due to an outside input. Refer to Keyless Entry System Description and Operation for the system description and operation.

Note: The battery specification listed below is a generic specification. Refer to Battery Usage when testing the battery.

- The battery run down time will vary depending on cold cranking amperage (CCA) and reserve capacity (RC). If the CCA and RC are higher, then the battery run down time would be longer. If the CCA and RC are lower, then the battery run down time would be shorter. The graph below indicates roughly how many days a 690 CCA battery with at 110 min. RC (60.5 AH) starting at 80 percent state of charge will last with a constant current draw until it reaches 50 percent state of charge. Differences in battery rating and temperature will affect the results.

Current Drain	Days
25 mA	30.5
50 mA	16.5
75 mA	11
100 mA	8.25
250 mA	3.3
500 mA	1.65
750 mA	1
1 A	0.8
2 A	0.4

Load Test

Warning: Refer to Battery Disconnect Warning in the Preface section.

Caution: Do not turn the parasitic draw test switch to the OFF position with the engine running. Damage will occur to the vehicle's electrical system.

Caution: The test switch must be in the ON position when removing the fuses in order to maintain continuity in the electrical system. This avoids damaging the digital multimeter due to accidental overloading, such as a door being opened to change a fuse.

Note: The test switch on the J 38758 is marked ON and OFF. When the test switch is in the ON position, the circuit is closed and electrical current will pass through the switch. When the test switch is in the OFF position, the circuit is open and electrical current will not pass through the switch.

1. Disconnect the battery negative cable from the battery negative terminal. Refer to Battery Negative Cable Disconnection and Connection.
2. Install the male end of the J 38758 to the battery ground terminal.
3. Turn the J 38758 test switch to the OFF position.
4. Install the battery negative cable to the female end of the J 38758 .
5. Turn the J 38758 test switch to the ON position.
6. Road test the vehicle and activate ALL of the accessories, including the radio and air conditioning. This may take up to 30 minutes.
7. Park the vehicle. Turn the ignition switch to the OFF position and remove the ignition switch key.
8. Connect a 10 A fused jumper wire to the test switch tool terminals.
9. Turn the J 38758 test switch to the OFF position. The current now flows through the jumper wire.
10. Wait 1 minute. If the fuse blows, install an inductive ammeter to locate the current draw.
11. Turn the test switch to ON and then remove the fused jumper wire.
12. Set a digital multimeter to the 10 A scale.
13. Connect the digital multimeter to the test switch tool terminals.
14. Turn the J 38758 test switch to the OFF position. The current flows now through the digital multimeter.
15. Wait 1 minute. Check and record the current reading.
    - 15.1. When there is a current reading of 2 A or less, turn the J 38758 test switch to the ON position. The electrical current will now pass through the switch.
    - 15.2. Then switch the digital multimeter down to the 2 A scale for a more accurate reading when the J 38758 test switch is turned OFF.
16. Turn the J 38758 test switch to the OFF position. Wait up to 45 minutes for most vehicles.
17. Check and record the current reading.
18. Note the battery reserve capacity, amp hour rating. Refer to Battery Usage.
    - 18.1. Divide the reserve capacity by 4, amp hour rating by 2.4.
    - 18.2. Compare this to the multimeter milliampere reading taken in the previous step. The parasitic current drain should not exceed this number. Example: If a battery has a reserve capacity of 100 minutes, (60 A/H) the current drain should not exceed 25 mA.
19. If excessive current drain is not found at this time and there are no other apparent causes, complete the following:
    - 19.1. Using the MIN/MAX function of the digital multimeter, monitor the parasitic drain overnight or during the day. This will determine if something has been activated during that time frame.

Caution: The test switch must be in the ON position when removing the fuses in order to maintain continuity in the electrical system. This avoids damaging the digital multimeter due to accidental overloading, such as a door being opened to change a fuse.

Note: Removing fuses, relays, and connectors to determine the failure area may wake up modules. You must wait for these modules to go to sleep or use the sleep function on the scan tool.

19.2. When the vehicle has an unacceptable amount of parasitic current drain, remove each fuse one at a time until the current drain falls to an acceptable level. This will indicate which circuit is causing the drain. Refer to Power Distribution Schematics to diagnose exactly which part of the suspect circuit is causing the parasitic drain. In some cases a non-fused circuit or component, such as a relay, is the cause of excessive parasitic current drain.

19.3. Repeat the parasitic current drain test procedure after any repair has been completed to make sure that the parasitic current drain is at an acceptable level.

19.4. When the cause of the excessive current drain has been located and repaired, remove the J 38758 .

20. Connect the battery negative cable to the battery negative terminal.

Battery Inspection/Test

Special Tools

J 42000 Battery Tester

Diagnostic Aids

Warning: Refer to Battery Disconnect Warning in the Preface section.

Note:

- The battery test using the J 42000 Battery Tester requires correct connections to the battery terminals. A failure to obtain the correct connections during the test may result in a failed test on a good battery.
- Use the Out of Vehicle test for each battery when testing a vehicle with dual batteries.

Follow these instructions in order to avoid an incorrect diagnosis because of connections:

- If testing the vehicle with the battery cables still connected, wiggle the J 42000 clips on the terminal bolt. This may cut through any coating or through any oxidation that may be present on the bolt.

  Even new bolts contain a protective coating that may insulate or cause a resistance in the test circuit.
- If correct connections to the battery terminal bolts in the vehicle are in doubt, perform the following steps:
  1. Disconnect the negative battery cable.
  2. Disconnect the positive battery cable.
  3. Install the test adapters on the terminals.
  4. Follow the instructions for testing a removed battery.
- If the tester displays a REPLACE BATTERY or BAD CELL-REPLACE result for a battery tested in the vehicle with the battery cables connected, perform the following steps:
  1. Disconnect the negative battery cable.
  2. Disconnect the positive battery cable.
  3. Install the tester adapters.

     Note: Always write the test code displayed by the tester on the repair order for any warranty purposes. The number is a unique code that describes the test data for a particular battery at a particular time. The test code may occasionally repeat when you retest the same battery. More often, each test will result in a different code. Use the test code from the second, or Out of Vehicle test.
  4. Follow the instructions for testing a removed battery.
  5. Replace the battery only if the second test shows a REPLACE BATTERY or BAD CELL-REPLACE result.

Use the test code from the second test for any warranty purposes.

- Use the correct terminal adapters.

  Do not use any common bolts or a combination of bolts, of nuts, and of washers as adapters when testing the battery.

  Use the test adapters that are provided with the J 42000 or GM P/N 12303040 terminal adapters. If the adapters that are provided with the J 42000 require replacement, use GM P/N 12303040. Any other adapter may not contact the correct areas of the battery terminal, causing a resistance that may result in an invalid battery test result.

Circuit / System Testing

Warning: Unless directed otherwise, the ignition and start switch must be in the OFF or LOCK position, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.

1. Inspect the battery for a cracked, broken, or damaged case, which may be indicated by battery acid leakage.

   If there is any apparent damage, replace the battery.
2. Verify the cold cranking amperage (CCA), and reserve capacity (RC) and/or amp hour (AH) rating of the battery to the original battery or original equipment (OE) specification. Refer to Battery Usage.

   If the battery does not meet or exceed specifications, replace the battery.
3. Verify that the battery cables are clean and tight. The battery terminal bolts should be torqued as specified in Fastener Tightening Specifications.

   If the battery cable(s) need to be cleaned, clean as required and tighten as specified.

   If the battery cable(s) are damaged, replace then tighten as specified.
4. Install the J 42000 and follow directions supplied by the tester.

   If the tester calls for charging the battery, refer to Battery Charging.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Battery Positive Cable Replacement
- Battery Negative Cable Replacement
- Battery Replacement

Charge Indicator Always On

Electrical Information Reference

- Diagnostic System Check - Vehicle .
- Circuit Testing .
- Testing for Intermittent Conditions and Poor Connections .
- Wiring Repairs .
- Battery Inspection/Test .
- Battery Electrical Drain/Parasitic Load Test .
- Battery Common Causes of Malfunction .
- Charging System Test .

The driver information center (DIC) may display a "Charging System Failure" message. This message being displayed is the result of a message being sent by the engine control module (ECM), instrument panel module (IPM), dash integration module (DIM) or the instrument panel cluster (IPC) to the DIC. Each module has a different criteria for requesting the message to be displayed.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Turn off all accessories.
2. With a scan tool, observe the Battery Voltage parameter in the IPM or DIM data list, ECM data list and the IPC) data list.
3. The voltage should be between 11.9 volts and 15.9 volts. If not within this range carry out charging system test.
4. The voltage should be within 1 volt of each other. If not within 1 volt carry out circuit testing.
5. If no fault in circuit replace the affected module.

Repair Instructions

Engine Control Module Replacement .

Charge Indicator Inoperative

Electrical Information Reference

- Diagnostic System Check - Vehicle.
- Circuit Testing.
- Testing for Intermittent Conditions and Poor Connections.

The alternator warning indicator is only illuminated for 6 seconds after the ignition is switched to the ON position with the engine OFF.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Carry out the Diagnostic System Check.
2. Ignition on alternator warning light should illuminate for 6 second.

   If the alternator warning does not illuminate, connect the scan tool and command the alternator warning light ON.

   If the light does not illuminate replace instrument panel cluster.

Repair Instructions

Instrument Cluster Replacement.

Charging System Test

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Reference Information

Description and Operation

Charging System Description and Operation

Electrical Information Reference

Testing for Intermittent Conditions and Poor Connections

Circuit/System Verification

Engine ON, observe the charge indicator on the instrument panel cluster (IPC) or message in the driver information center (DIC). The charge indicator on the IPC should be turned OFF and the DIC should not display charging system message.

If the charge indicator is not on the IPC and a charging system message is not displayed on the DIC, refer to Testing for Intermittent Conditions and Poor Connections.

If the charge indicator is on the IPC or a charging system message is displayed on the DIC, refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition ON, verify that no generator or battery current sensor DTCs are set that would cause a charging system concern.
   If DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. Ignition OFF, measure the voltage across the battery terminals. The voltage should read 12.0 V or greater at room temperature.
   If not within specified value, refer to Battery Inspection/Test.
3. Connect a carbon pile tester to the battery.
4. Start the engine and increase the engine speed to 2,500 RPM. Observe the voltage reading on the tester. The voltage should read between 12.6-15.0 V.
   If not within specified range, replace the generator.
5. Adjust the carbon pile tester to the specified load test output value, refer to Generator Usage.
   If not within specified value, replace the generator.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Generator Replacement

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Electrical | Diagnostic Information and Procedures | **Document ID: 2194772**

Engine Cranks Slowly

Inspect the following items:

- Battery--Perform the Battery Inspection/Test. Refer to Battery Inspection/Test.
- Wiring--Inspect the wiring for damage. Inspect all connections to the starter motor, the solenoid, the battery, and all ground connections. Refer to:
  - Circuit Testing
  - Wiring Repairs
  - Testing for Intermittent Conditions and Poor Connections
  - Connector Repairs
- Engine--Verify that the engine is not seized.

If the battery, the wiring, and the engine are functioning properly, and the engine continues to crank slowly, replace the starter motor. Refer to Starter Replacement.

Generator Noise Diagnosis

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Aids

Noise from a generator may be due to electrical or mechanical noise. Electrical noise or magnetic whine usually varies with the electrical load placed on the generator and is a normal operating characteristic of all generators. When diagnosing a noisy generator, it is important to remember that loose or misaligned components around the generator may transmit the noise into the passenger compartment and that replacing the generator may not solve the problem.

Circuit/System Testing

1. Start the engine, verify the noise can be heard. Compare the concern to a similar vehicle.
2. Inspect the generator, generator mounting, wiring harness, heater hoses, A/C lines or other accessory equipment that may be misrouted or be the cause of noise being transmitted into the passenger compartment.
3. Ignition OFF, remove the engine drive belt. Verify the generator, idler pulley and tensioner pulley spin freely.

   If any of the pulleys do not spin freely, replace the affected component.
4. Loosen all generator mounting bolts and ensure the generator is properly aligned. Tighten mounting bolts to specification, refer to Generator Replacement.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Drive Belt Replacement for the 3.6L engine.
- Drive Belt Tensioner Replacement for the 3.6L engine.
- Drive Belt Idler Pulley Replacement for the 3.6L engine.
- Drive Belt Replacement - Accessory for the 6.0L and 6.2L.
- Drive Belt Tensioner Replacement - Accessory for the for the 6.0L and 6.2L.
- Drive Belt Tensioner Replacement - Air Conditioning for the 6.0L and 6.2L.
- Generator Removal

Starter Noise Diagnosis

Circuit / System Testing

1. Remove the flywheel inspection cover.
2. Inspect the flywheel for the following:
   - Loose flywheel bolts
   - Chipped gear teeth
   - Missing gear teeth
   - Bent flywheel

   If not within specifications, secure the flywheel bolts or replace the flywheel.

   If all inspections were within specification, replace the starter motor.

Repair Instructions

- Fastener Tightening Specifications for the 3.6L engine
- Fastener Tightening Specifications for the 6.0L and 6.2L engine
- Engine Flywheel Removal for the 3.6L engine
- Engine Flywheel Replacement for the 6.0L and 6.2L engine
- Starter Motor Replacement

Starter Solenoid Clicks, Engine Does Not Crank

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Verify that battery is sufficiently charged and that the battery cables are clean and tight.

   If battery not sufficiently charged, refer to Battery Charging.

   If battery cables are not within specified torque , refer to Fastener Tightening Specifications.
2. Place the ignition switch to the start position. The starter solenoid should click.

   If starter solenoid does not click. refer to Starter Solenoid Does Not Click
3. Remove the drive belts Refer to Drive Belt Replacement for the 3.6L engine or Drive Belt Replacement - Accessory for the 6.0L engine.
4. Place the ignition switch to the START position.

If the engine cranks, inspect the engine and belt drive system for mechanical binding, seized engine, or seized generator, etc.

If the engine does not crank, refer to Engine Will Not Crank - Crankshaft Will Not Rotate for the 3.6L engine or Engine Will Not Crank - Crankshaft Will Not Rotate for the 6.0L engine.

5. Test for less than 0.5 volts between the positive battery cable and terminal A X1 at the solenoid as the ignition switch is placed to the START position.

   If greater than the specified value, replace the positive battery cable.

6. Test for less than 0.5 volts between the negative battery cable and the starter motor case as the ignition switch is placed to the START position.

   If greater than the specified value, replace the negative battery cable.

7. If all circuits test normal, replace the starter motor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Battery Positive Cable Replacement
- Battery Negative Cable Replacement
- Starter Replacement

Starter Solenoid Does Not Click

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ terminal 30	1	1	--	--
ECM Park/ Neutral Signal	2	1	--	--
Coil Control terminal 86	--	1	3	--
Control Output terminal 87	1	1	3	--
Coil Ground terminal 85	--	1	--	--
1. No crank 2. Cranks in any gear 3. Cranks all the time				

Circuit/System Description

When the ignition switch is placed in the START position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the START position. The BCM then sends a message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the transmission is in Park or Neutral. If it is, the ECM then supplies 12 V to the control circuit of the starter relay. When this occurs, battery voltage is supplied through the switch of the starter relay to the starter solenoid.

Reference Information

Schematic Reference

- Starting and Charging Schematics
- Automatic Transmission Controls Schematics for the (5L40-E / 5L50-E) transmission
- Automatic Transmission Controls Schematics for the (6L50-E / 6L80-E / 6L90-E) transmission

Connector End View Reference

Component Connector End Views

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, verify that no starter relay, clutch pedal, theft deterrent, or automatic transmission DTCs are set that would cause the ECM to disable engine starting.

   If DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. Ignition ON, observe the scan tool BCM Current Power Mode parameter. Place ignition switch in the crank position, the parameter should display Crank Request.

   If not the specified value, refer to Power Mode Mismatch.
3. Transmission range selector in park , verify the scan tool ECM PNP Switch and TCM IMS parameters display Park/Neutral.

   If the TCM IMS parameter does not indicate Park/Neutral. Refer to Transmission Internal Mode Switch Logic for the 5L40-E / 5L50-E transmission or Transmission Internal Mode Switch Logic for the 6L50-E / 6L80-E / 6L90-E transmission.

   If the ECM Park/Neutral parameter does not indicate Park/Neutral. Refer to ECM Park Switch Circuit Malfunction.
4. Transmission range selector in park or neutral, attempt to start the vehicle. The starter relay should click and the engine should begin cranking.

   If the starter relay does not click or the engine does not crank, refer to Starter Relay Circuit Malfunction.

Circuit/System Testing

ECM Park Switch Circuit Malfunction (5L40-E / 5L50-E)

1. Ignition OFF, disconnect the harness connector at the AT Inline 20-Way at the transmission.
2. Ignition ON, install a 3A fused jumper wire between the signal circuit terminal 2 and ground. Verify the scan tool ECM PNP switch parameter displays Park/Neutral.

   If not the specified value, test the signal circuit for an open/high resistance. If the circuit tests normal, replace the ECM.

3. If all circuits test normal, test or replace the internal mode switch (IMS).

ECM Park Switch Circuit Malfunction (6L50-E / 6L80-E / 6L90-E)

1. Ignition OFF, disconnect the harness connector at the AT Inline 16-Way at the transmission.
2. Ignition ON, test for B+ between terminal 3 and ground. (note this circuit will not light a test lamp)

   If not the specified value, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
3. If all circuits test normal, test or replace the internal mode switch (IMS).

Starter Relay Circuit Malfunction

1. Ignition OFF, disconnect the starter relay.
2. Ignition OFF, test for less than 5 Ω between the relay ground circuit terminal 85 and ground.

   If greater than the specified range , test the ground circuit for an open/high resistance.
3. Ignition ON, verify a test lamp illuminates between the relay switch B+ circuit terminal 30 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
4. Ensure the parking brake is applied and the transmission is in PARK. Momentarily install a 40A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87. The starter solenoid should engage and the engine should begin cranking.

   If the solenoid does not engage, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the starter motor.
5. Connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85.
6. With the transmission range selector in park or neutral, cycle the ignition between the OFF and CRANK position. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.

   If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
7. If all circuits test normal, test or replace the starter relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the starter relay.
2. Test for 60-250 Ω between terminals 85 and 86.

   If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If not the specified value, replace the relay.

4. Install a 20 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 Ω between terminals 30 and 87.
    If greater than specified range, replace the relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Relay Replacement
- Starter Replacement
- Control Module References for ECM replacement, setup and programming

Symptoms - Engine Electrical

Important: The following steps must be completed before using the symptom tables.

- Perform Control Module References before using the Symptom Tables in order to verify that all of the following are true:
  - There are no DTCs set.
  - The control modules can communicate via the serial data link.
- Review the system descriptions and operations in order to familiarize yourself with the system functions. Refer to one of the following system operations:
  - Battery Description and Operation
  - Charging System Description and Operation
  - Electrical Power Management Description and Operation
  - Starting System Description and Operation

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the starting and charging systems. Refer to Checking Aftermarket Accessories.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Battery Inspection/Test
- Battery Electrical Drain/Parasitic Load Test
- Battery Common Causes of Malfunction
- Charging System Test
- Generator Noise Diagnosis
- Starter Solenoid Does Not Click
- Starter Solenoid Clicks, Engine Does Not Crank
- Engine Cranks Slowly
- Starter Noise Diagnosis

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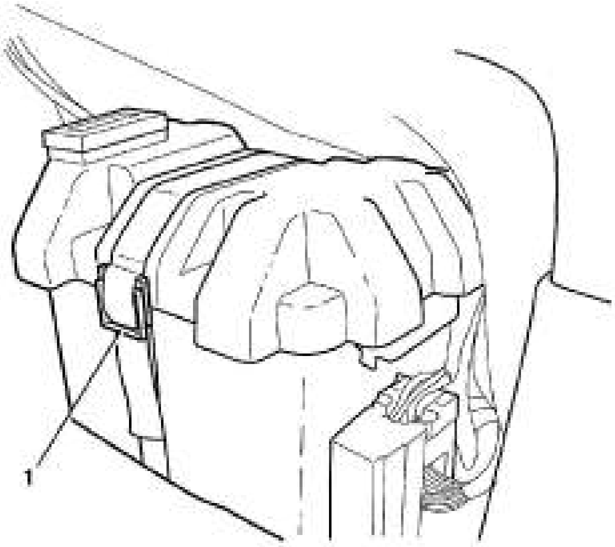
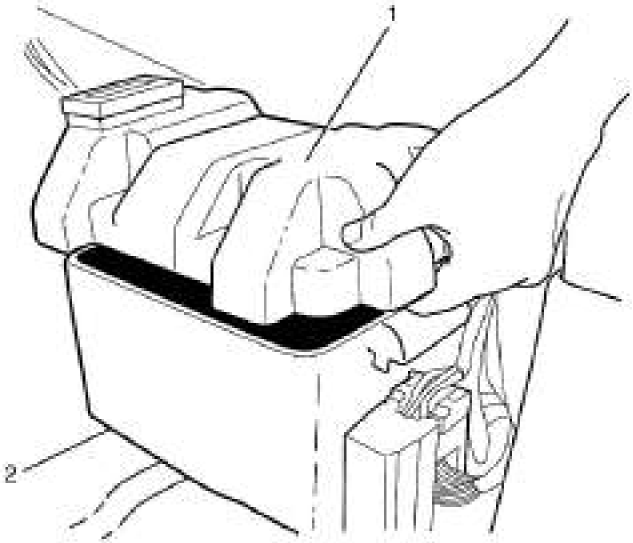
Auxiliary Battery Replacement

Removal Procedure

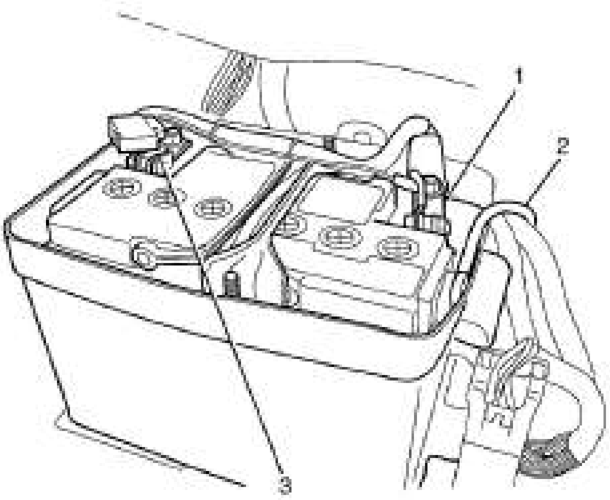


Important: The auxiliary battery is located in the luggage compartment in the RHS rear quarter panel cavity.

1. Loosen and detach the auxiliary battery top cover retaining strap (1).



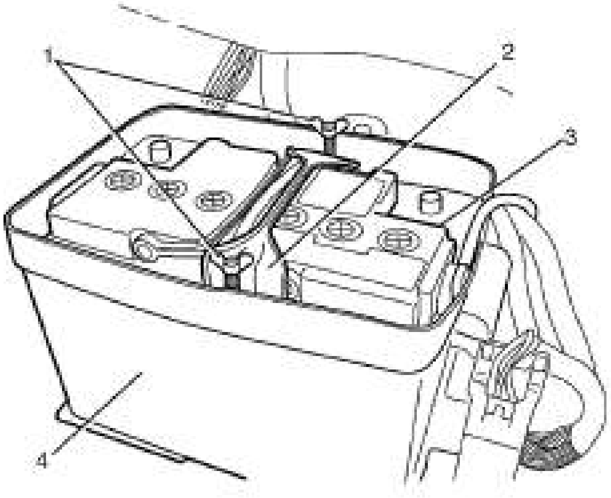
2. Remove the auxiliary battery top cover (1) from the auxiliary battery box (2).



3. Remove the auxiliary battery vent tube (2).
4. Disconnect the battery positive cable (3).

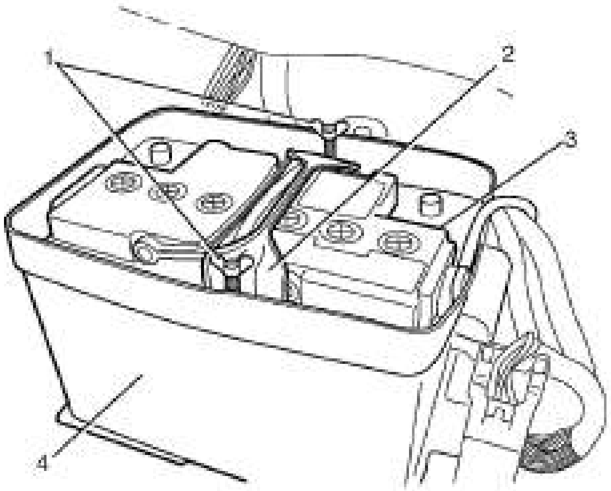
Caution: Refer to Battery Disconnect Caution in the Preface section.

5. Disconnect the auxiliary battery negative cable (1). Refer to Battery Negative Cable Disconnection and Connectionl.



6. Remove the auxiliary battery retaining wing nuts (1) and remove the battery retainer (2).
7. Remove the auxiliary battery (3) out of the auxiliary battery box (4).

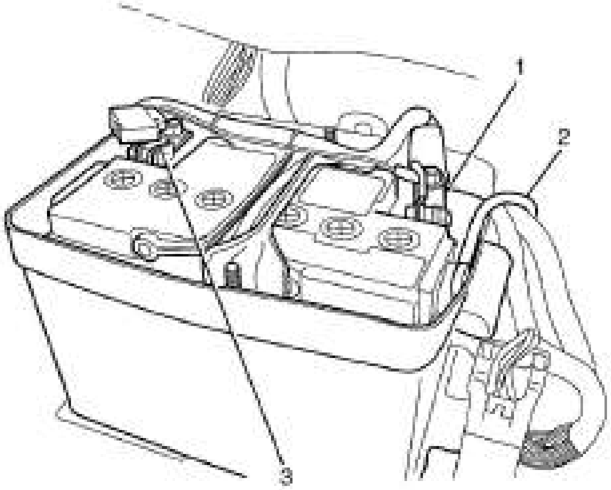
Installation Procedure



1. Install the auxiliary battery (3) into the battery box (4).
2. Install the auxiliary battery retaining bracket (2).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the auxiliary bracket retaining wing nuts (1).

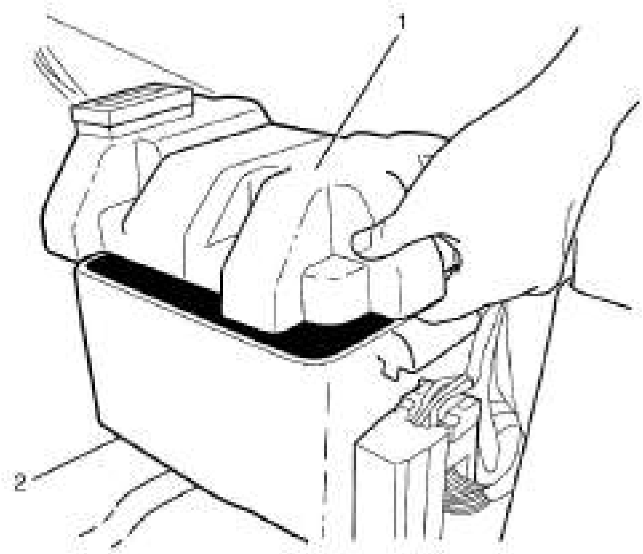


4. Connect the battery positive cable (3).

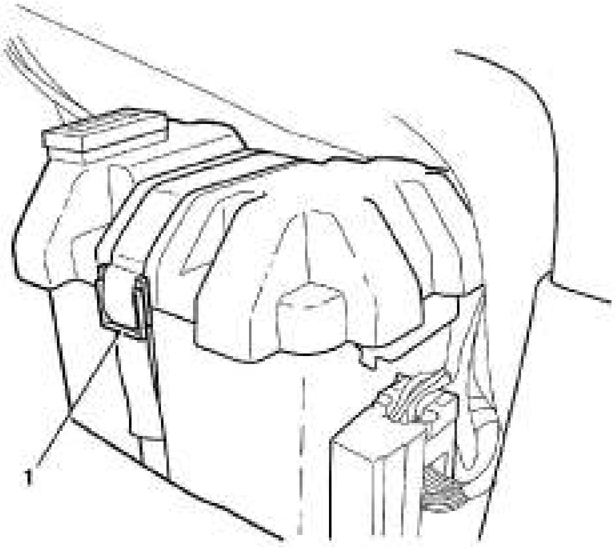
   Tighten
   Tighten the nut to 17 N·m (13 lb ft).

5. Install the auxiliary battery vent tube (2).

6. Connect the auxiliary negative battery cable (1). Refer to Battery Negative Cable Disconnection and Connection.



7. Install the auxiliary battery top cover (1) to the auxiliary battery box (2).



8. Attach and tighten the auxiliary battery top cover retaining strap (1).
9. Test the vehicles electrical components for correct operation.

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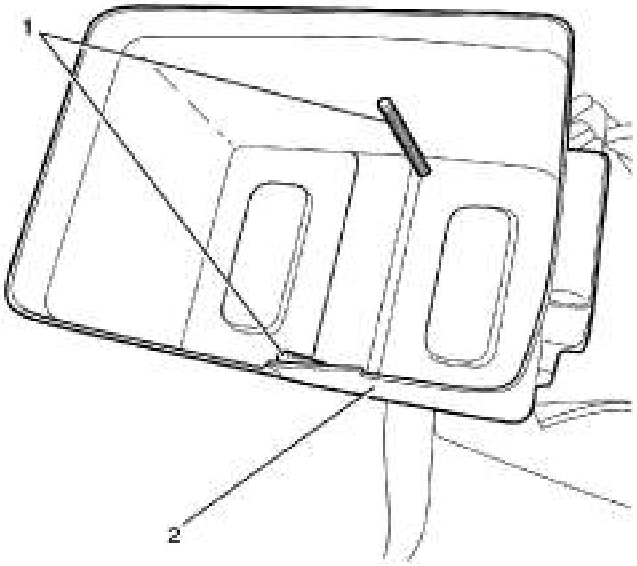
Auxiliary Battery Tray Replacement

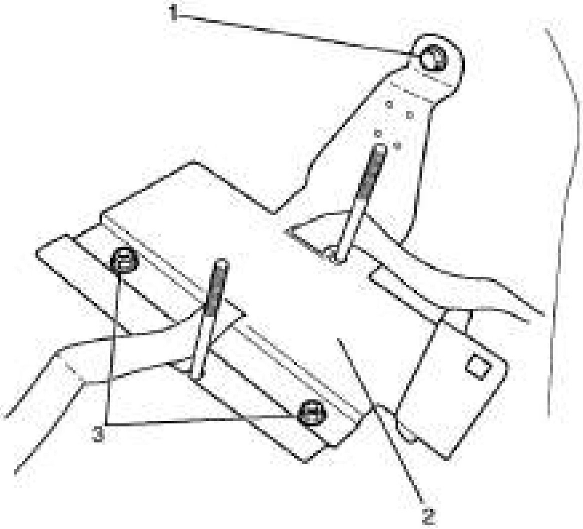
Removal Procedure

1. Remove the auxiliary battery. Refer to Auxiliary Battery Replacement.



Important: Lift the auxiliary battery box (2) upward and over the battery bracket retaining posts (1).

2. Remove the auxiliary battery box (2).

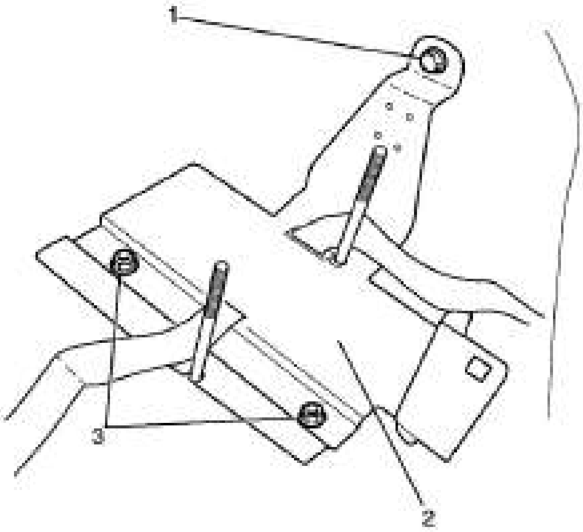


Important: The auxiliary battery tray is retained with micro-encapsulated nuts.

Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

3. Remove the auxiliary battery tray assembly retaining bolt (1).
4. Remove the auxiliary battery tray assembly retaining nut and bolts (3).
5. Remove the auxiliary battery tray assembly (2) from the vehicle.

Installation Procedure



1. Install the battery tray assembly (2) to the vehicle.

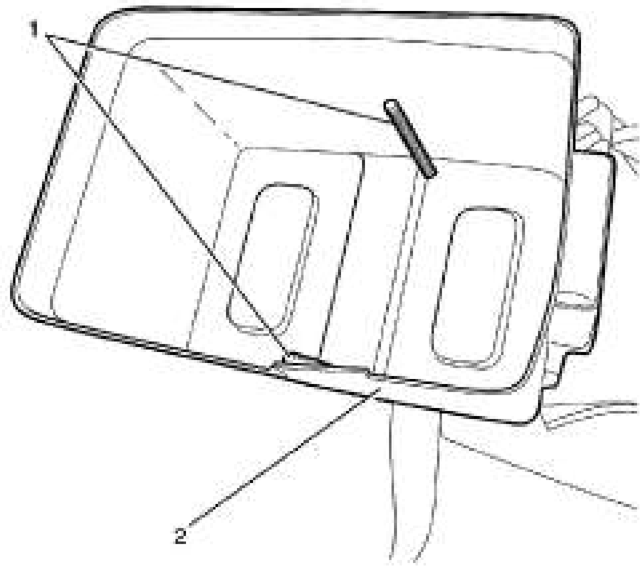
   Notice: Refer to Fastener Notice in the Preface section.

2. Install the auxiliary battery tray assembly (2) retaining bolt (1).

   Tighten
   Tighten the bolt to 9 N·m (80 lb in).

3. Install the auxiliary battery tray assembly retaining nut and bolts (3).

   Tighten
   Tighten the nut and bolts to 9 N·m (80 lb in).



Important: Make sure the battery bracket retaining post's (1) are correctly secure under the battery tray assembly.

4. Install the auxiliary battery box (2).
5. Install the auxiliary battery. Refer to Auxiliary Battery Replacement.

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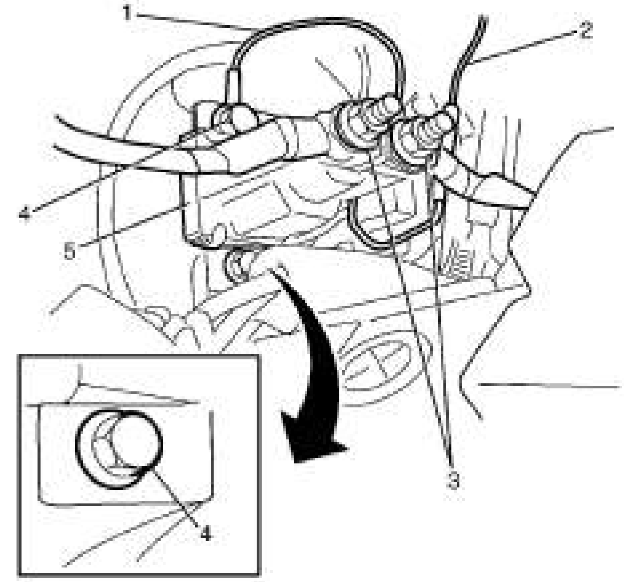
Battery Isolator Replacement

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery negative cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.



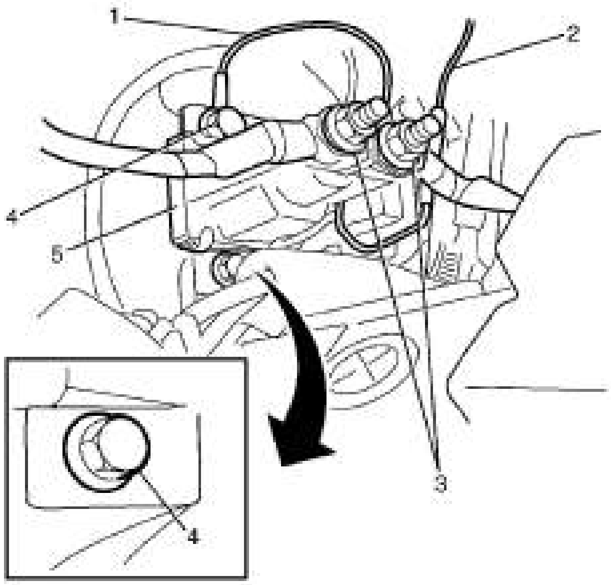
Important: The battery isolator (5) is located in the luggage compartment in the LHS rear quarter panel.

2. Remove the primary and secondary battery cable retaining nuts (3).
3. Disconnect the primary and secondary battery cables from the battery isolator (5).
4. Disconnect the battery isolator (5) input connector (2).

Important: The battery isolator negative cable (1) is secure with the battery isolator retaining bolts, make sure the ground cable is removed when removing the retaining bolts (7).

5. Remove the battery isolator retaining bolts (4).
6. Remove the battery isolator (5).

Installation Procedure



1. Install the battery isolator (5).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the battery isolator retaining bolts (4).

   Tighten
   Tighten the bolts to 11 N·m (97 lb in).

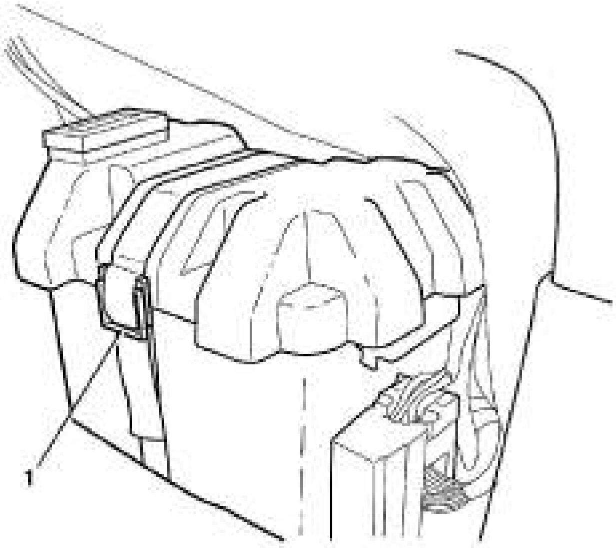
3. Connect the battery isolator input connector (2).
4. Connect the primary and secondary battery cables to the battery isolator (5).
5. Install the primary and secondary battery isolator retaining nuts (3).

   Tighten
   Tighten the nuts to xx N·m (xx lb in).

6. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.

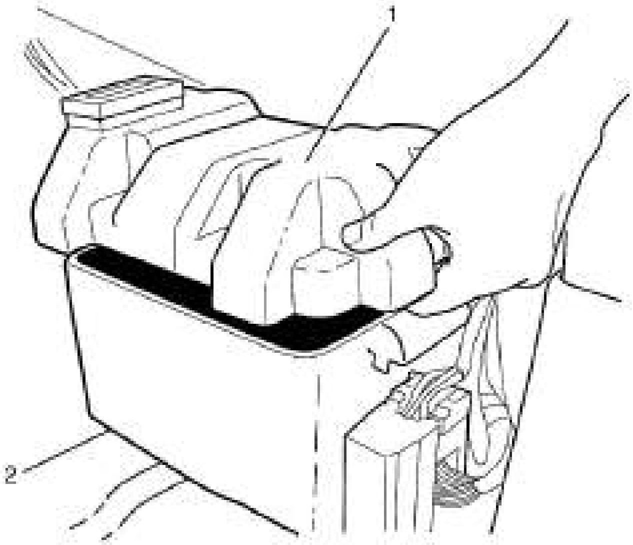
Battery Negative Cable Disconnection and Connection (Auxiliary)

Removal Procedure



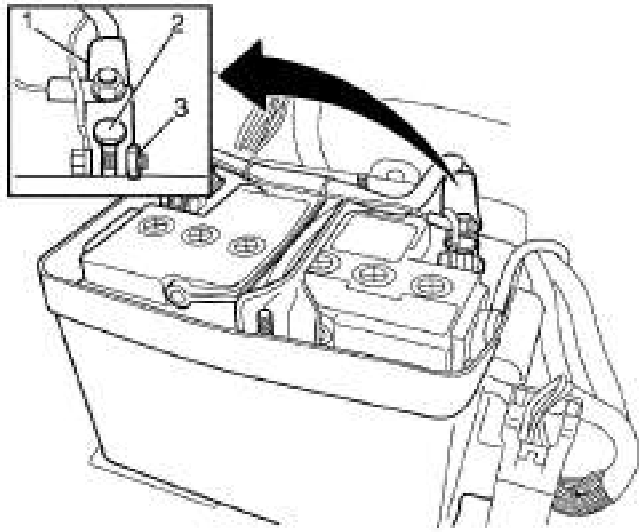
Important: The auxiliary battery is located in the luggage compartment in the RHS rear quarter panel cavity.

1. Loosen and detach the auxiliary battery top cover retaining strap (1).



2. Remove the auxiliary battery top cover (1) from the auxiliary battery box (2).

   Caution: Refer to Battery Disconnect Caution in the Preface section.

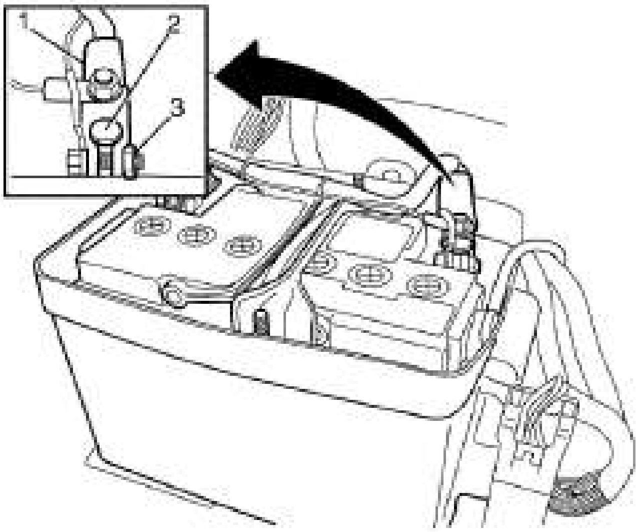


3. Remove the battery negative cable to battery terminal retaining nut (3).

   Important: Clean any existing corrosion from the battery negative terminal (2) and the battery negative cable (1).

4. Remove the battery negative cable (1) from the battery negative terminal (2).

Installation Procedure

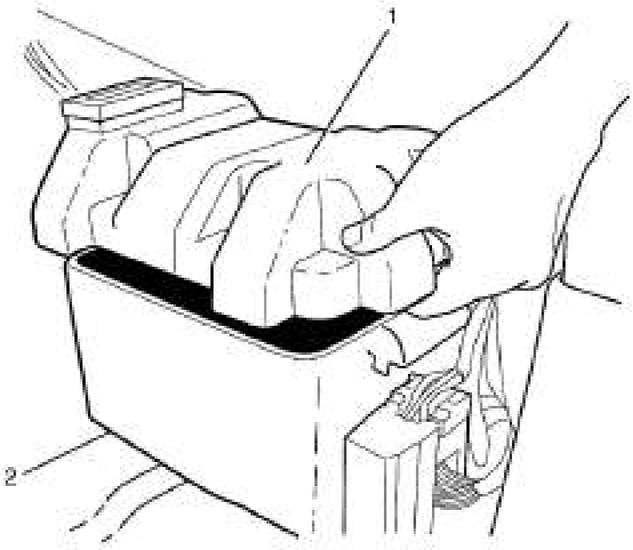


1. Install the battery negative cable (1) to the battery negative terminal (2).

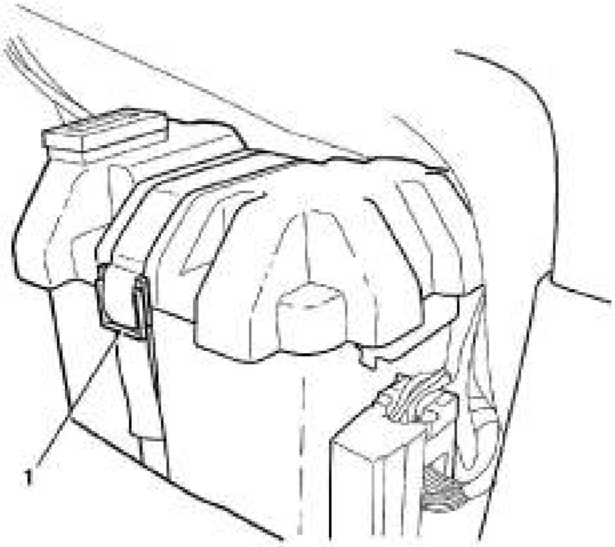
   Notice: Refer to Fastener Notice in the Preface section.

2. Install the battery negative cable to battery negative terminal retaining nut (3).

   Tighten
   Tighten the nut to 17 N·m (13 lb ft).



3. Install the auxiliary battery top cover (1) to the auxiliary battery box (2).

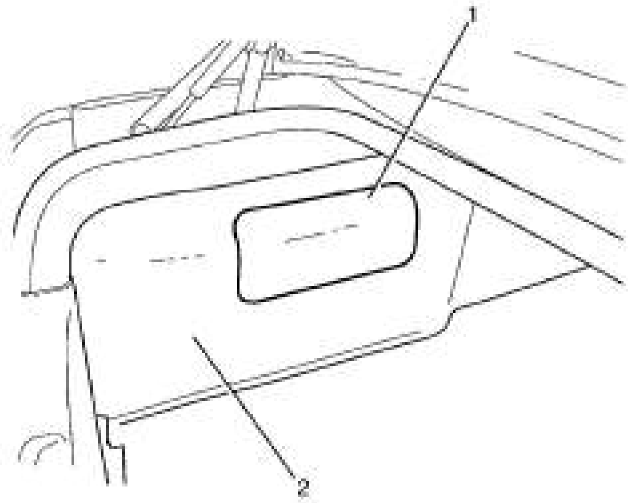


4. Attach and tighten the auxiliary battery top cover retaining strap (1).
5. Test the vehicles electrical components for correct operation.

Battery Negative Cable Disconnection and Connection (Except Auxiliary)

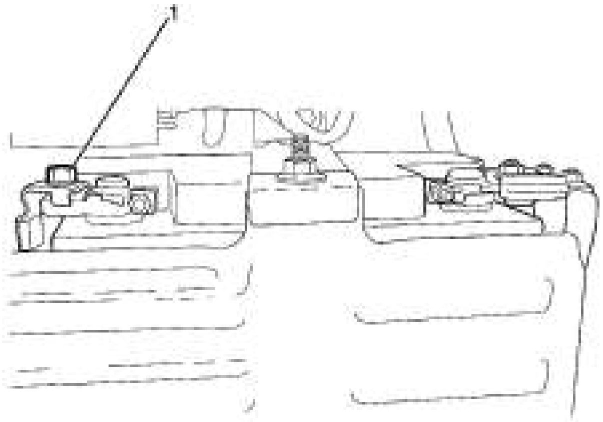
Disconnection Procedure

1. Open the rear compartment lid.



2. Remove the left-hand cargo area carpet side access panel (1) from the left-hand cargo area carpet side (2).

Caution: Refer to Battery Disconnect Caution in the Preface section.

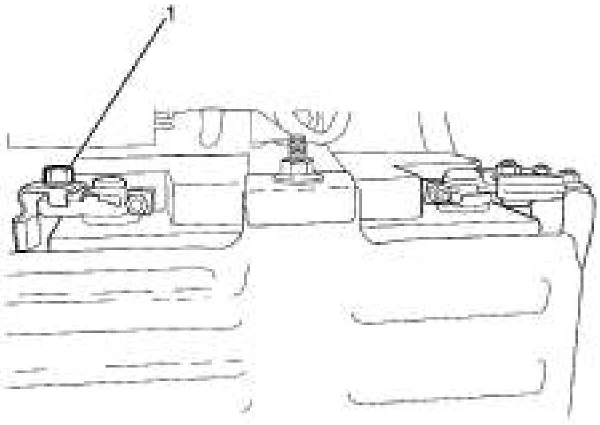


Important: Clean any existing corrosion from the battery terminal and the battery negative cable end.

3. Remove the battery negative cable to battery terminal retaining nut (1).

Connect Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.



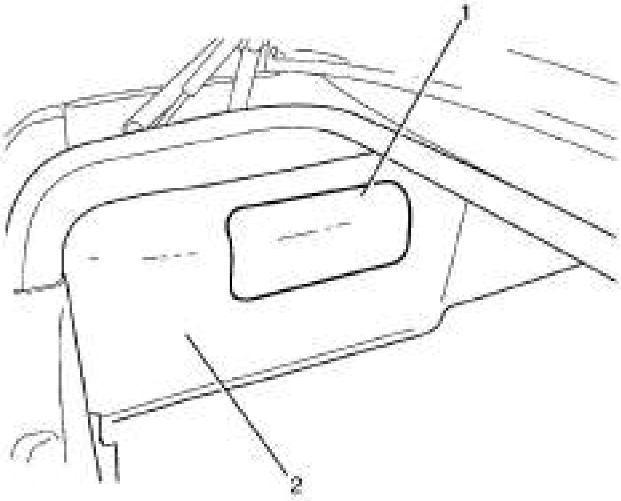
Important: Clean any existing corrosion from the battery terminal and the battery negative cable end.

1. Connect the battery negative cable to the battery.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the battery negative cable to battery terminal retaining nut (1), Tighten the battery negative cable nut.

   Tighten
   Tighten the nut to 17 N·m (13 lb ft).



3. Install the left-hand cargo area carpet side access panel (1) in the left-hand cargo area carpet side (2).
4. Close the rear compartment lid.

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Battery Positive Cable Replacement (Sedan)

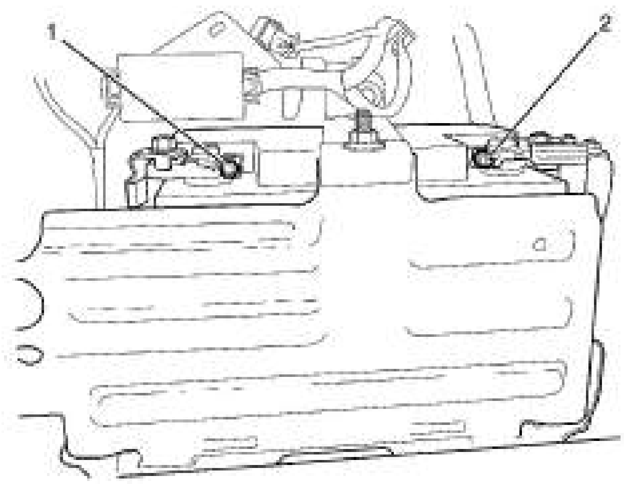
Removal Procedure - Rear

Important:

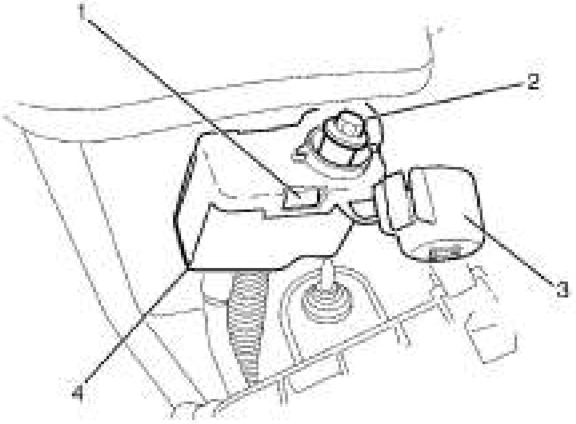
- Always use replacement cables that are of the same type, diameter and length of the cables that you are replacing.
- Always route the replacement cable the same as the original cable.

1. Remove the front seat. Refer to Front Seat Replacement - Bucket.
2. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement.
3. Remove the rear seat back. Refer to Rear Seat Back Replacement.
4. Remove the left front floor panel carpet. Refer to Front Floor Panel Carpet Replacement.
5. Remove the rear quarter trim panel. Refer to Quarter Lower Rear Trim Panel Replacement.
6. Remove the cargo area centre carpet. Refer to Rear Compartment Floor Panel Carpet Replacement
7. Remove the left-hand cargo area carpet side. Refer to Rear Compartment Side Trim Panel Replacement

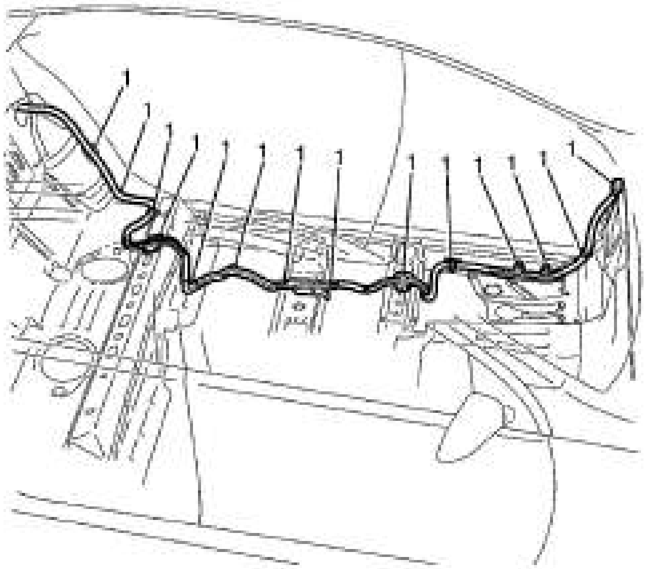
Caution: Refer to Battery Disconnect Caution in the Preface section.



8. Disconnect the battery negative cable (1). Refer to Battery Negative Cable Disconnection and Connection.
9. Disconnect the battery positive cable (2) from the battery.

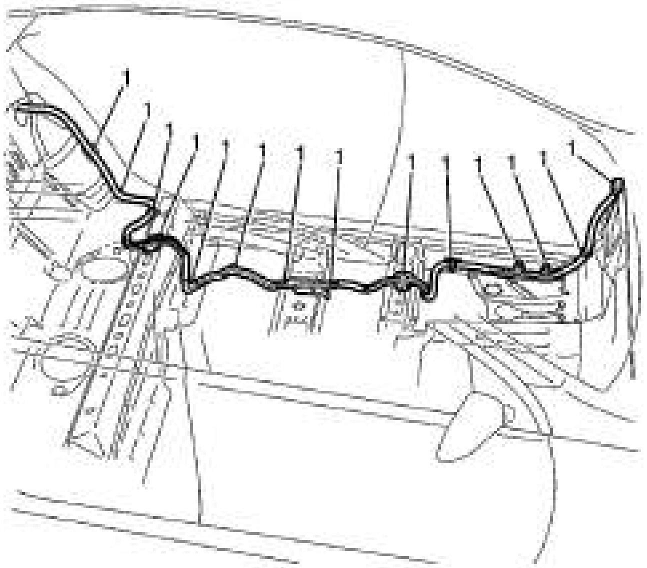


10. Detach the battery post cover (3)..
11. Press the retaining clip (1) to remove battery post protective cover (4).
12. Remove the battery post retaining bolt (2).



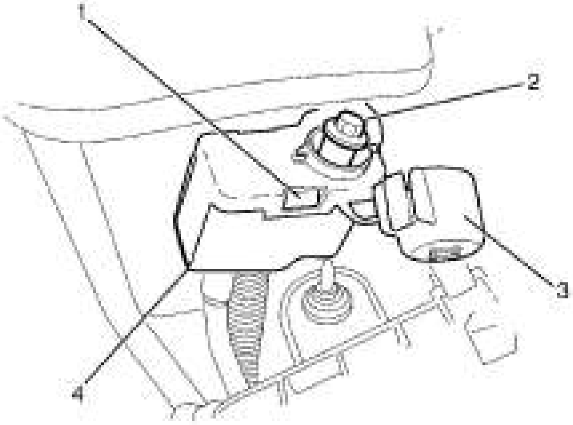
13. Remove the battery positive cable to chassis retaining clips (1).
14. Remove the battery positive cable from the vehicle.

Installation Procedure - Rear



1. Install the battery positive cable to the vehicle.
2. Install the battery positive cable to chassis retaining clips (1).

   Notice: Refer to Fastener Notice in the Preface section.

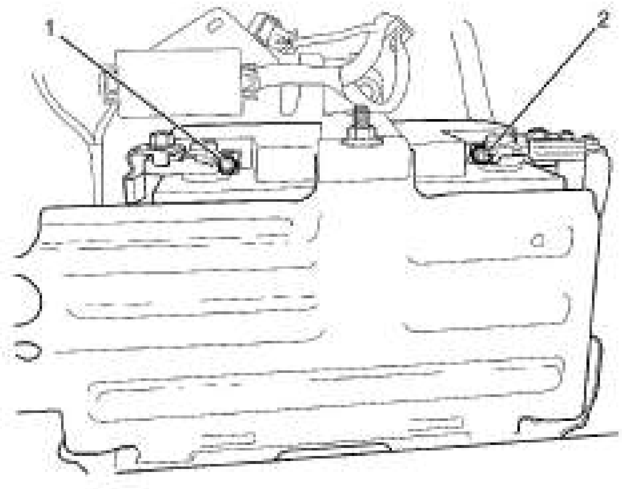


3. Install the battery post retaining bolt (2)

   Tighten
   Tighten the post retaining bolt to 15 N·m (11 lb ft).

4. Install the battery post protective cover (4).
5. Attach the battery post cover (3).

Caution: Refer to Battery Disconnect Caution in the Preface section.

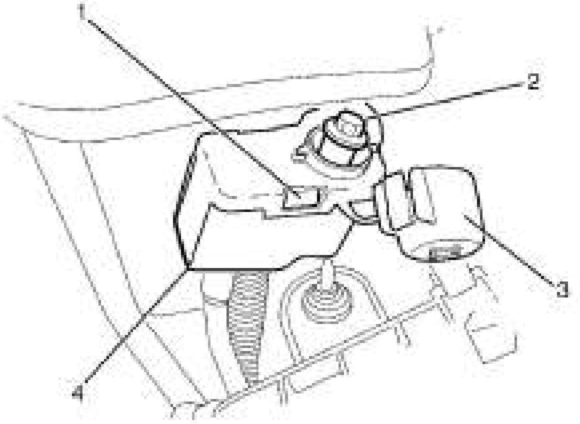


6. Connect the battery positive cable (2) to the battery.
7. Connect the battery negative cable (1). Refer to Battery Negative Cable Disconnection and Connection.
8. Install the rear floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement
9. Install the rear quarter trim panel. Refer to Quarter Lower Rear Trim Panel Replacement.
10. Install the left front floor panel carpet. Refer to Front Floor Panel Carpet Replacement.
11. Install the rear seat back. Refer to Rear Seat Back Replacement.
12. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.
13. Install the front seat. Refer to Front Seat Replacement - Bucket.
14. Install the left-hand cargo area carpet side. Refer to Rear Compartment Side Trim Panel Replacement
15. Install the cargo area centre carpet. Refer to Rear Compartment Floor Panel Carpet Replacement
16. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

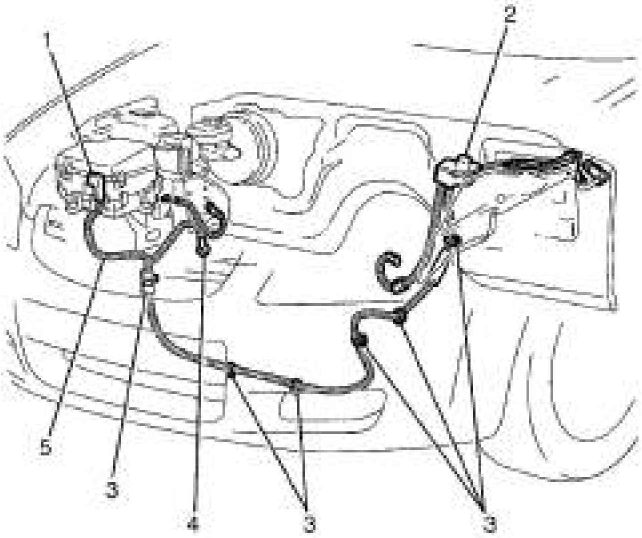
Removal Procedure - Front (3.6L Engines)

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the front air deflector. Refer to Front Air Deflector Replacement.

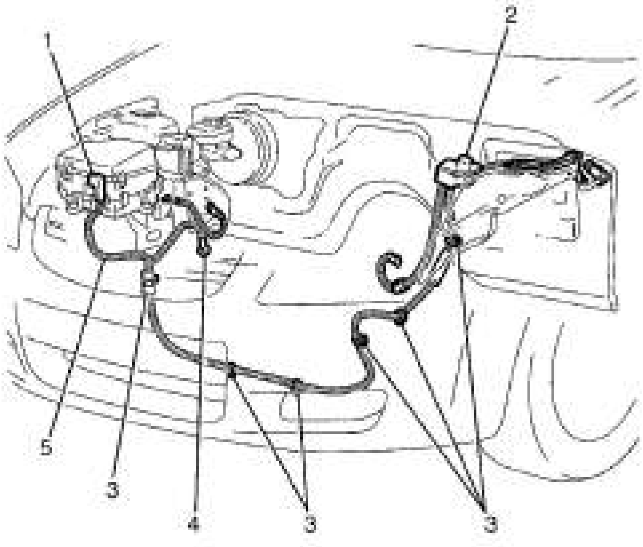


3. Detach the battery post cover (3).
4. Press the retaining clip (1) to remove battery post protective cover (4).
5. Remove the battery post retaining bolt (2).



6. Remove the front battery positive cable from battery post (2).
7. Remove the front battery positive cable to underhood body electrical centre retaining bolt (1).
8. Remove the front battery positive cable to alternator retaining nut (4).
9. Remove the front battery positive cable to chassis retaining clips (3).
10. Remove the front battery positive cable (5) from the engine compartment.

Installation Procedure - Front (3.6L Engines)



1. Install the front battery positive cable (5) to the engine compartment.
2. Install the front battery positive cable to chassis retaining clips (3).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the front battery positive cable to battery post (2).

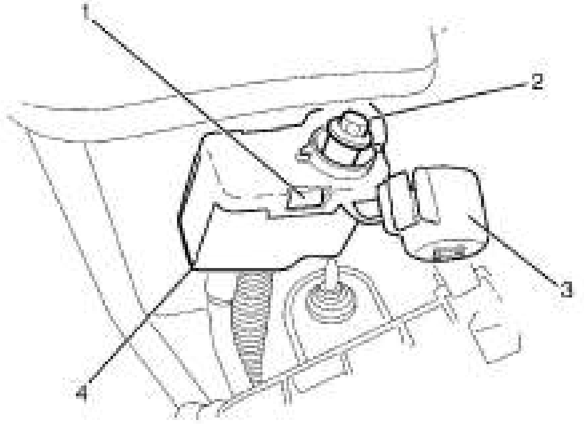
   Tighten
   Tighten the post retaining bolt to 15 N·m (11 lb ft).

4. Install the battery positive cable to underhood body electrical centre retaining nut (1).

   Tighten
   Tighten the retaining nut to 10 N·m(89 lb in).

5. Install the battery positive cable to alternator battery output terminal, install the retaining nut (4).

   Tighten
   Tighten the retaining nut to 13 N·m (115 lb in).

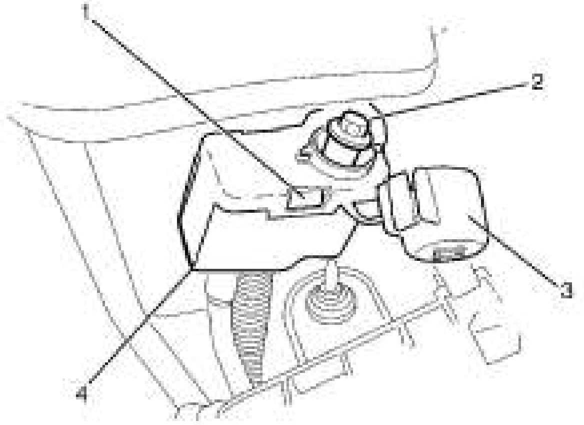


6. Install the battery post protective cover (4).
7. Attach the battery post cover (3).
8. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
9. Install the front air deflector. Refer to Front Air Deflector Replacement.

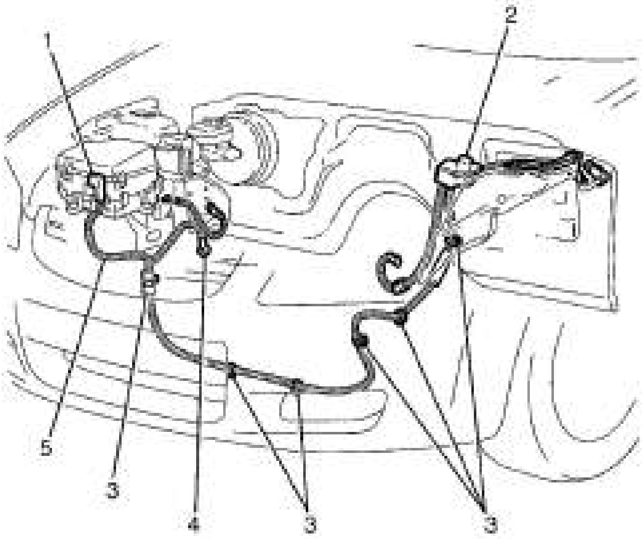
Removal Procedure - Front (6.0L Engines)

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the front air deflector. Refer to Front Air Deflector Replacement.

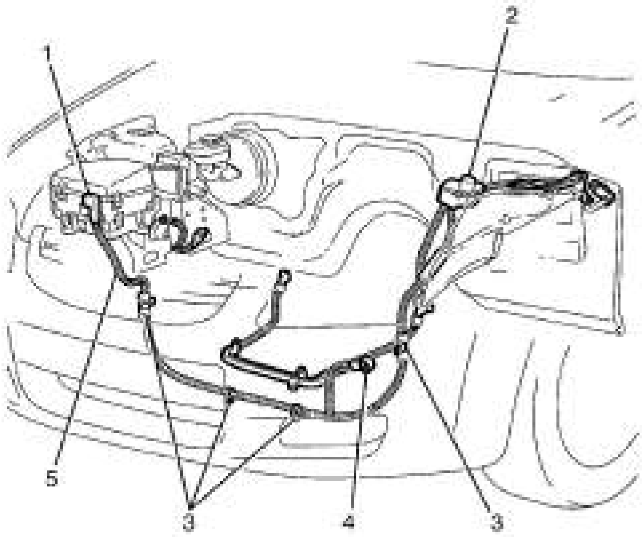


3. Detach the battery post cover (3).
4. Press the retaining clip (1) to remove battery post protective cover (4).
5. Remove the battery post retaining bolt (2).



6. Remove the front battery positive cable from battery post (2).
7. Remove the front battery positive cable to underhood body electrical centre retaining bolt (1).
8. Remove the front battery positive cable to alternator retaining nut (4).
9. Remove the front battery positive cable to chassis retaining clips (3).
10. Remove the front battery positive cable (5) from the engine compartment.

Installation Procedure - Front 6.0L Engines)



1. Install the front battery positive cable (5) to the engine compartment.
2. Install the front battery positive cable to chassis retaining clips (3).

Notice: Refer to Fastener Notice in the Preface section.

3. Install the front battery positive cable to battery post (2).

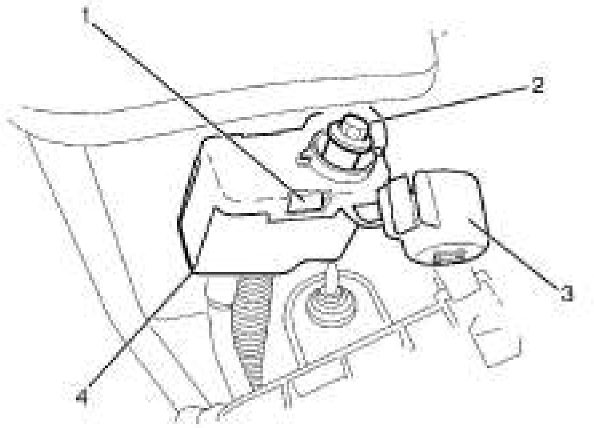
Tighten
Tighten the post retaining bolt to 15 N·m (11 lb ft).

4. Install the battery positive cable to underhood body electrical centre retaining nut (1).

Tighten
Tighten the retaining nut to 10 N·m(89 lb in).

5. Install the battery positive cable to alternator retaining nut (4).

Tighten
Tighten the retaining nut to 13 N·m (115 lb in).



6. Install the battery post protective cover (4).
7. Attach the battery post cover (3).
8. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
9. Install the front air deflector. Refer to Front Air Deflector Replacement.

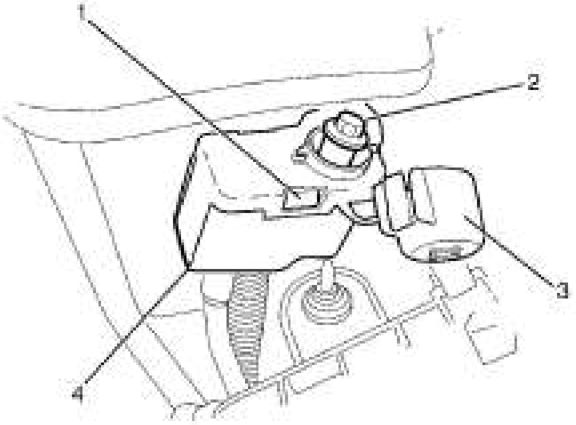
Removal Procedure - Starter (3.6L Engines)

Caution: Refer to Battery Disconnect Caution in the Preface section.

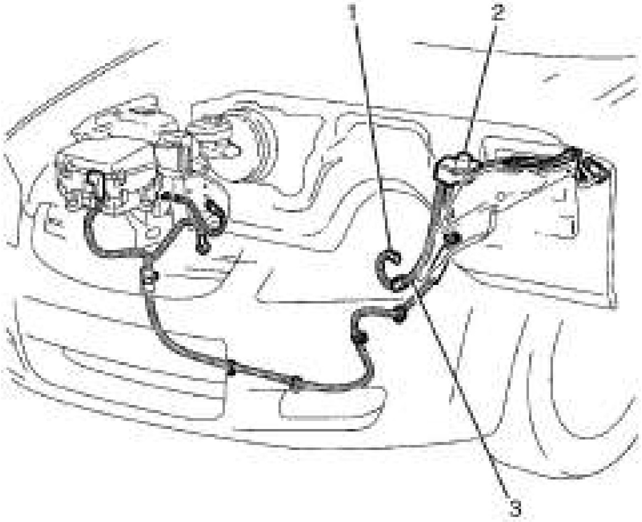
1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and

Connection.

2. Remove the front air deflector. Refer to Front Air Deflector Replacement.

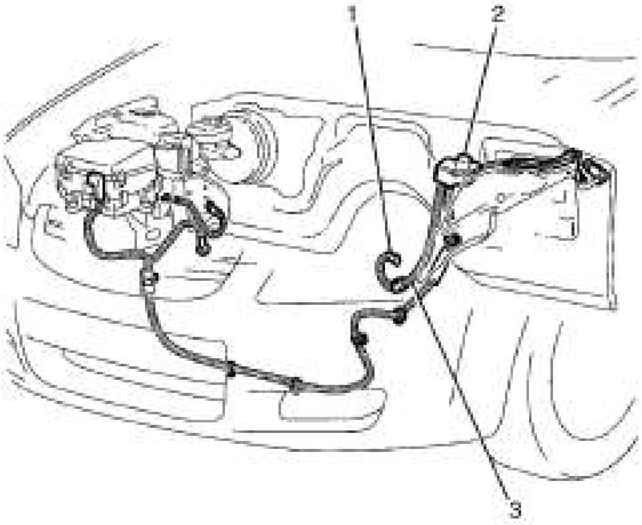


3. Detach the battery post cover (3).
4. Press the retaining clip (1) to remove battery post protective cover (4).
5. Remove the battery post retaining bolt (2).



6. Remove the starter battery positive cable from battery post (2).
7. Remove the starter battery positive cable (3) to starter motor retaining bolt (1).
8. Remove the front battery positive cable to chassis retaining clips.
9. Remove the starter battery positive cable (3) from the engine compartment.

Installation Procedure - Starter (3.6L Engines)



1. Install the starter battery positive cable (3) to the engine compartment.

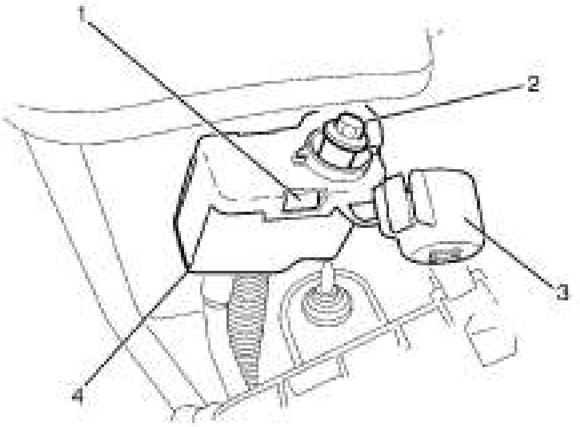
   Notice: Refer to Fastener Notice in the Preface section.

2. Install the starter battery positive cable to battery post (2).

   Tighten
   Tighten the post retaining bolt to 15 N·m (11 lb ft).

3. Install the starter battery positive cable to starter motor and install the retaining nut (1).

   Tighten
   Tighten the retaining nut to 20 N·m (14 lb ft).

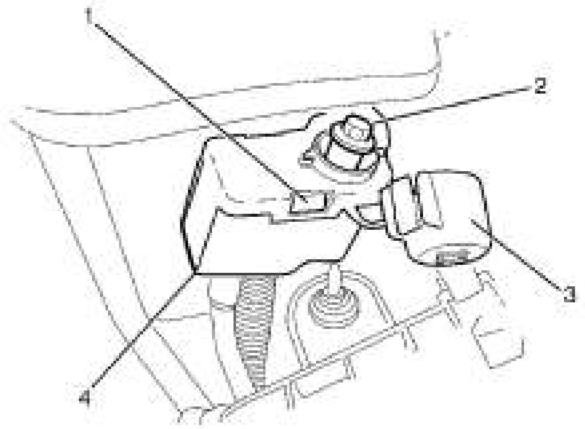


4. Install the battery post protective cover (4).
5. Attach the battery post cover (3).

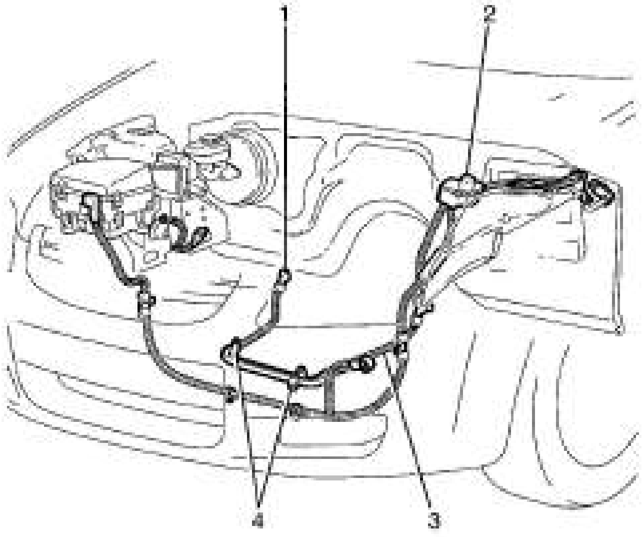
Removal Procedure - Starter (6.0L Engines)

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the front air deflector. Refer to Front Air Deflector Replacement.

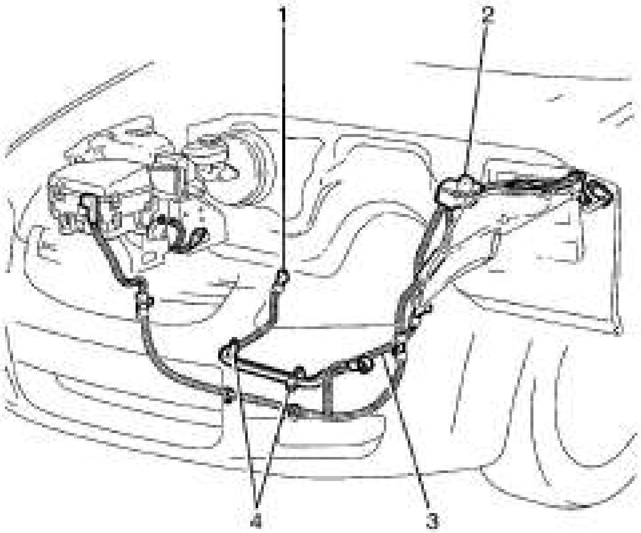


3. Detach the battery post cover (3).
4. Press the retaining clip (1) to remove battery post protective cover (4).
5. Remove the battery post retaining bolt (2).



6. Remove the starter battery positive cable from the battery post (2).
7. Remove the starter battery positive cable (3) to starter motor retaining bolt (1).
8. Remove the starter battery positive cable to chassis retaining clips (4).
9. Remove the starter battery positive cable (3) from the engine compartment.

Installation Procedure - Starter (6.0L Engines)



1. Install the starter battery positive cable (3) to the engine compartment.
2. Install the starter battery positive cable to chassis retaining clips (4).

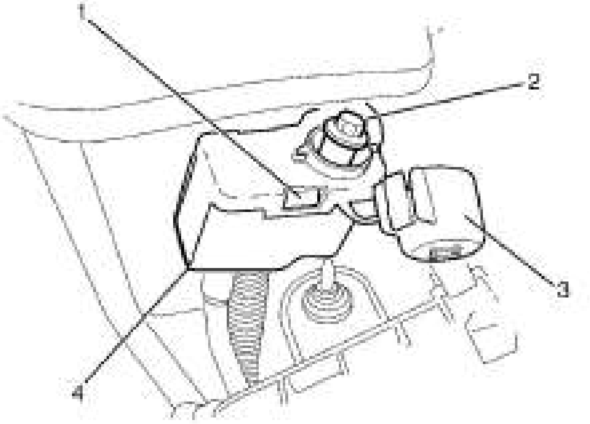
   Notice: Refer to Fastener Notice in the Preface section.

3. Install the starter battery positive cable to battery post (2).

   Tighten
   Tighten the post retaining bolt to 15 N·m (11 lb ft).

4. Install the starter battery positive cable to starter motor and install retaining nut (1).

   Tighten
   Tighten the retaining nut to 20 N·m (14 lb ft).



5. Install the battery post protective cover (4).
6. Attach the battery post cover (3).
7. Install the front air deflector. Refer to Front Air Deflector Replacement.
8. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Electrical | Repair Instructions | **Document ID: 2079432**

Battery Positive Cable Replacement (Sportwagon)

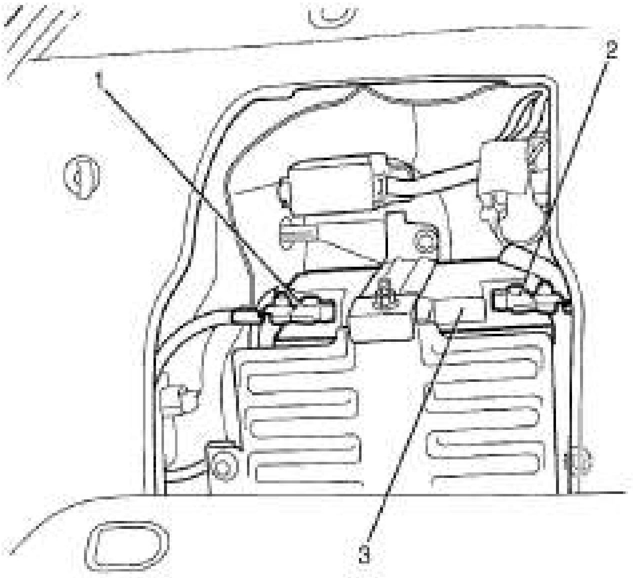
Removal Procedure - Rear

Important:

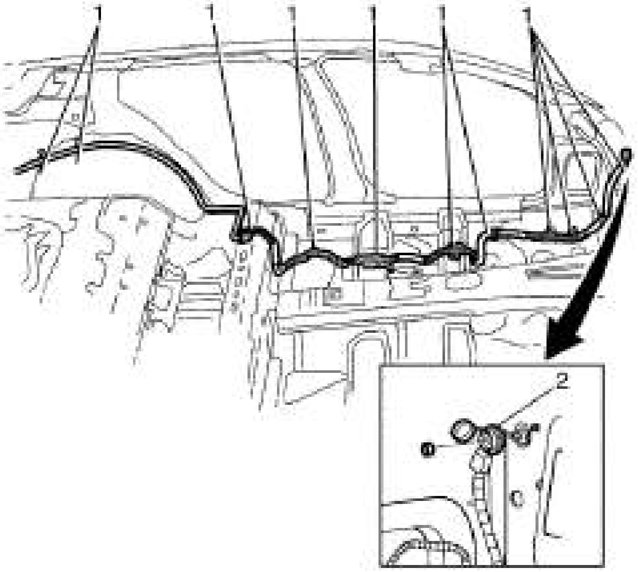
- Always use replacement cables that are of the same type, diameter and length of the cables that you are replacing.
- Always route the replacement cable the same as the original cable.

1. Remove the front seat. Refer to Front Seat Replacement - Bucket.
2. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement.
3. Remove the rear seat back. Refer to Rear Seat Back Replacement.
4. Remove the left front floor panel carpet. Refer to Front Floor Panel Carpet Replacement.
5. Remove the body lock pillar lower trim panel. Refer to Body Lock Pillar Lower Trim Panel Replacement.
6. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
7. Remove the luggage shade. Refer to Luggage Shade Replacement.
8. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
9. Remove the rear compartment side trim panel access hole cover. Refer to Rear Compartment Side Trim Panel Access Hole Cover Replacement.
10. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
11. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
12. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.

Caution: Refer to Battery Disconnect Caution in the Preface section.

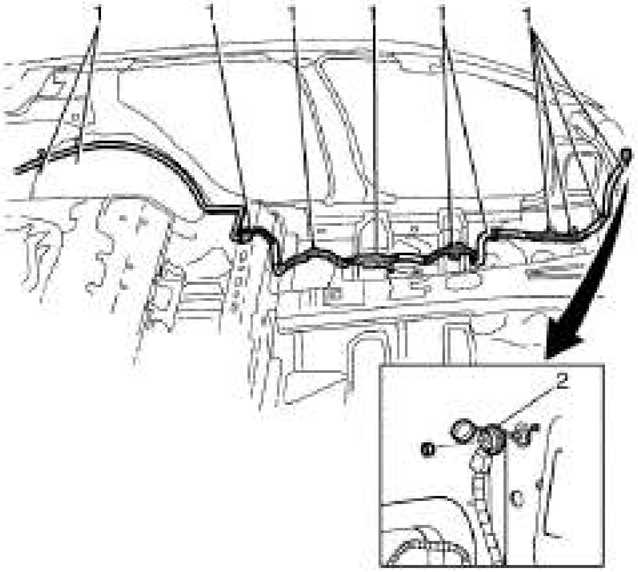


13. Disconnect the battery negative cable (1) from the battery (3). Refer to Battery Negative Cable Disconnection and Connection.
14. Disconnect the battery positive cable (2) from the battery (3).

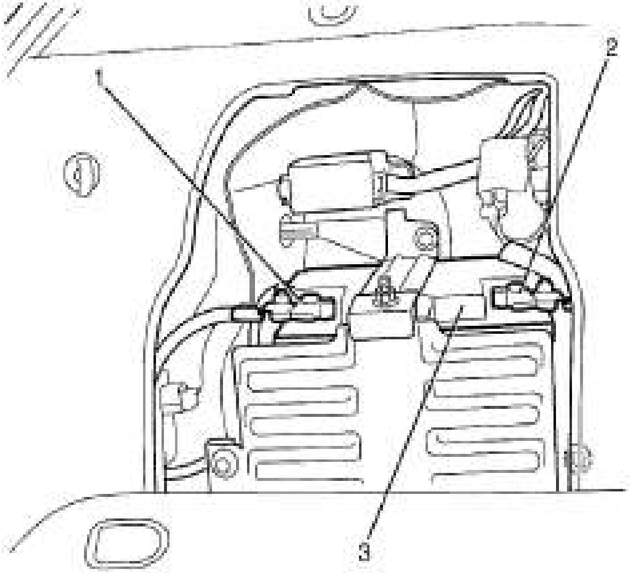


15. Detach the positive cable from the firewall.
16. Remove the battery positive cable to chassis retaining clips (1).
17. Remove the battery positive cable to firewall retaining stud (2).
18. Remove the battery positive cable from the vehicle.

Installation Procedure - Rear



1. Install the battery positive cable to the vehicle.
2. Install the battery positive cable to firewall retaining stud (2).
3. Install the battery positive cable to chassis retaining clips (1).
4. Install the battery positive cable to the firewall.



5. Connect the battery positive cable (2) to the battery (3).

   Tighten
   Tighten the nut to 6 N·m (53 lb in).

6. Connect the battery negative cable (1) to the battery (3). Refer to Battery Negative Cable Disconnection and Connection.

   Tighten
   Tighten the nut to 6 N·m (53 lb in).

7. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
8. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
9. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
10. Install the rear compartment side trim panel access hole cover. Refer to Rear Compartment Side Trim Panel Access Hole Cover Replacement.
11. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
12. Install the luggage shade. Refer to Luggage Shade Replacement.
13. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
14. Install the body lock pillar lower trim panel. Refer to Body Lock Pillar Lower Trim Panel Replacement.
15. Install the left front floor panel carpet. Refer to Front Floor Panel Carpet Replacement.
16. Install the rear seat back. Refer to Rear Seat Back Replacement.
17. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.

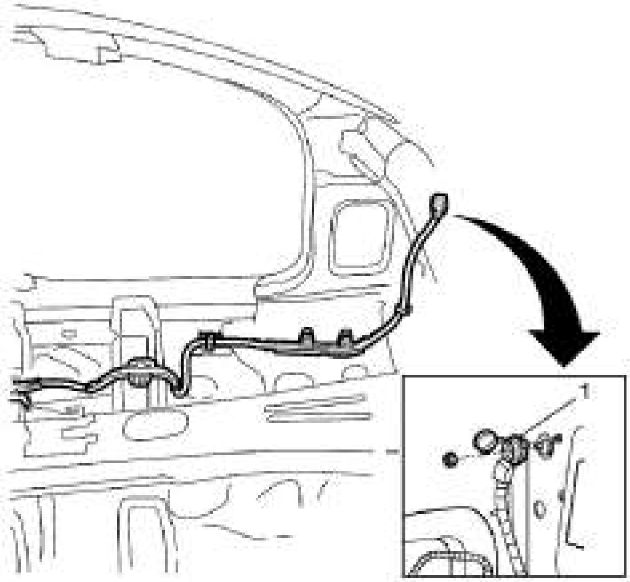
18. Install the front seat. Refer to Front Seat Replacement - Bucket.

Removal Procedure - Intermediate

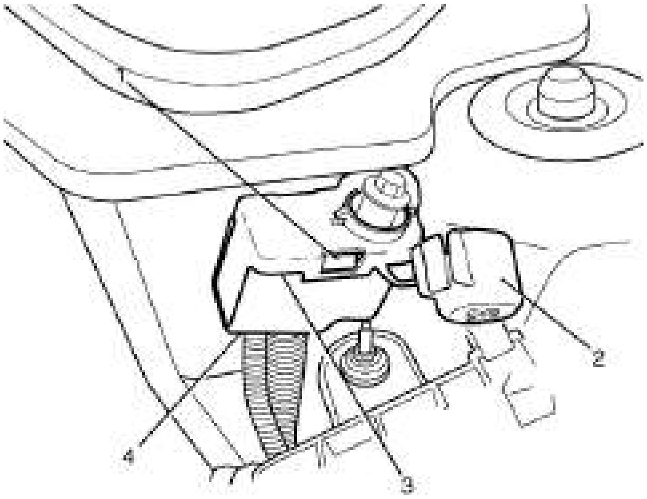
Important:

- Always use replacement cables that are of the same type, diameter and length of the cables that you are replacing.
- Always route the replacement cable the same as the original cable.

1. Remove the instrument panel insulator panel. Refer to Instrument Panel Insulator Panel Replacement - Left Side.
2. Remove the instrument panel outer trim cover. Refer to Instrument Panel Outer Trim Cover Replacement.
3. Remove the instrument panel compartment. Refer to Instrument Panel Compartment Replacement.



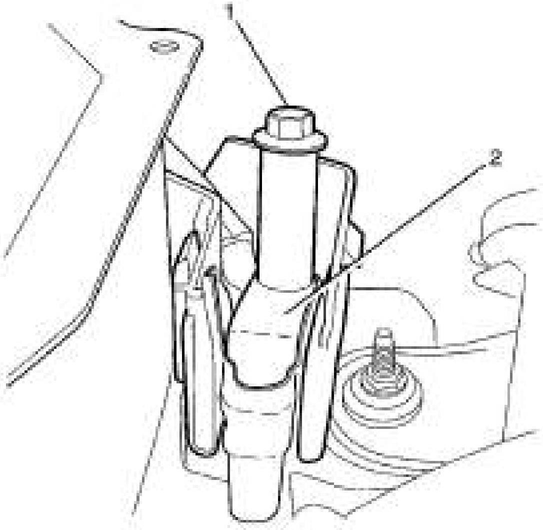
4. Remove the battery positive cable to firewall retaining stud (1).
5. Remove the windshield wiper arm. Refer to Windshield Wiper Arm Replacement.
6. Remove the hood rear seal. Refer to Hood Rear Seal Replacement.
7. Remove the air inlet grille. Refer to Air Inlet Grille Panel Replacement.



8. Detach the remote battery positive post cover (2) from the remote battery positive cable upper protective cover (3).

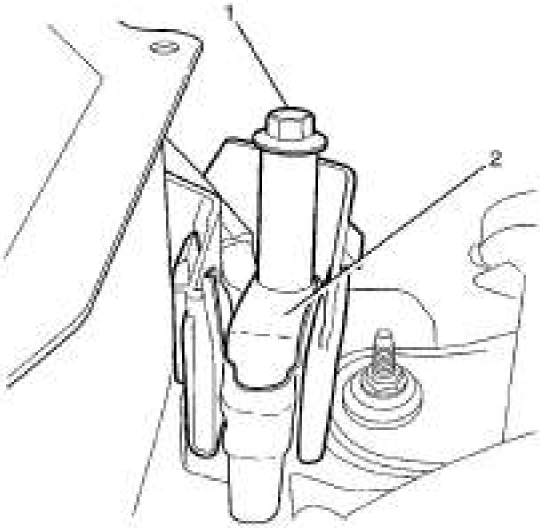
   Important: Remove the remote battery positive cable upper protective cover (3) by pressing the retaining clips (1) and lifting the remote battery positive cable upper protective cover (3) upwards.

9. Remove the remote battery positive cable upper protective cover (3) from the remote battery positive cable lower protective cover (4).



10. Remove the remote battery positive post to battery positive cable retaining bolt (1).
11. Remove the battery positive cable (2).

Installation Procedure - Intermediate

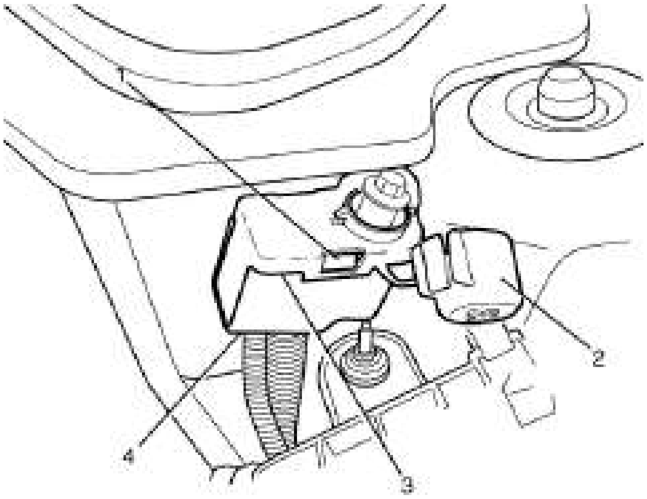


1. Install the battery positive cable (2) to the remote battery post.

   Notice: Refer to Fastener Notice in the Preface section.

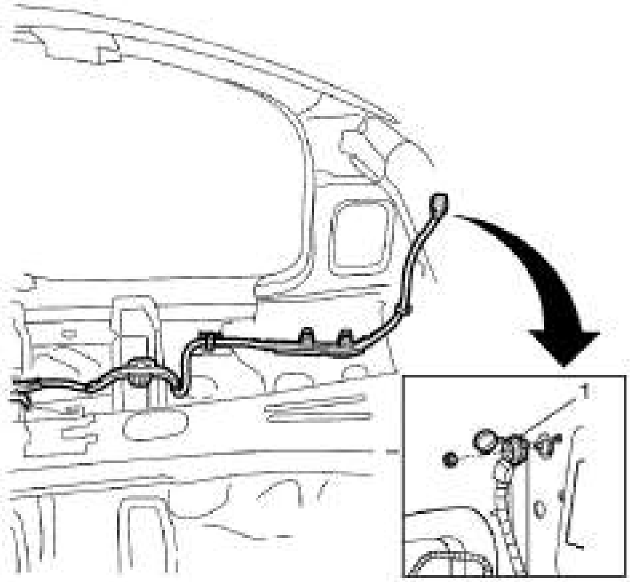
2. Install the remote battery positive post to battery positive cable retaining bolt (1).

   Tighten
   Tighten the bolt to 15 N·m (11 lb ft).



Important: Listen for an audible click from the retaining clip (1) to confirm correct fitting of the remote battery positive cable upper protective cover (3) to the remote battery positive cable lower protective cover (4).

3. Install the remote battery positive cable upper protective cover (3) to the remote battery positive cable lower protective cover (4).
4. Attach the battery post cover (2) to the remote battery positive cable upper protective cover (3).
5. Install the air inlet grille. Refer to Air Inlet Grille Panel Replacement.
6. Install the hood rear seal. Refer to Hood Rear Seal Replacement.
7. Install the windshield wiper arm. Refer to Windshield Wiper Arm Replacement.

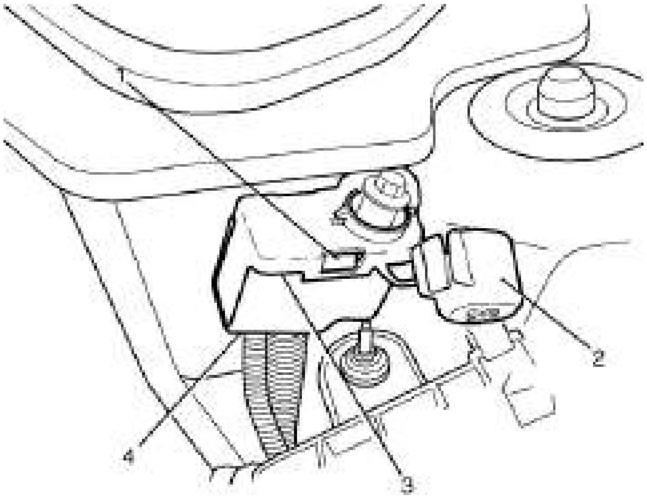


8. Install the battery positive cable to firewall retaining stud (1).
9. Install the instrument panel compartment. Refer to Instrument Panel Compartment Replacement.
10. Install the instrument panel outer trim cover. Refer to Instrument Panel Outer Trim Cover Replacement.
11. Install the instrument panel insulator panel. Refer to Instrument Panel Insulator Panel Replacement - Left Side.

Removal Procedure - Front (3.6L Engine)

Caution: Refer to Battery Disconnect Caution in the Preface section.

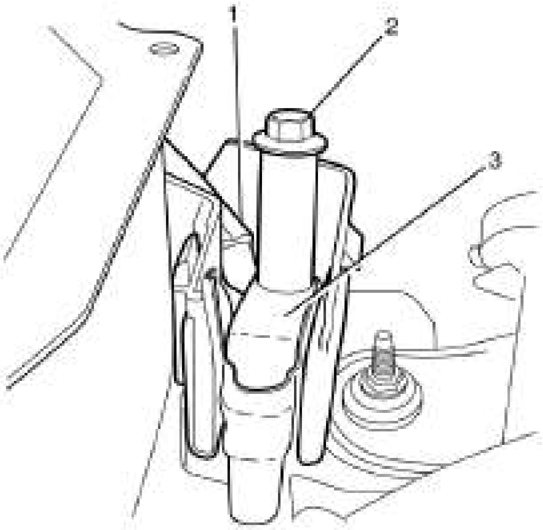
1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the front air deflector. Refer to Front Air Deflector Replacement.



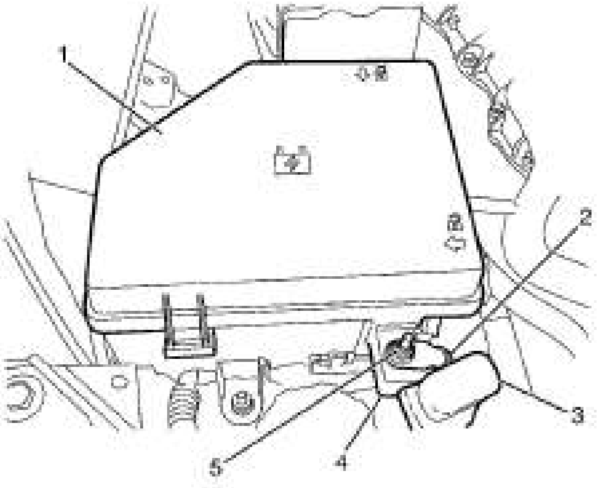
3. Detach the remote battery positive post cover (2) from the remote battery positive cable upper protective cover (3).

   Important: Remove the remote battery positive cable upper protective cover (3) by pressing the retaining clip (1) and lifting the remote battery positive cable upper protective cover (3) upwards.

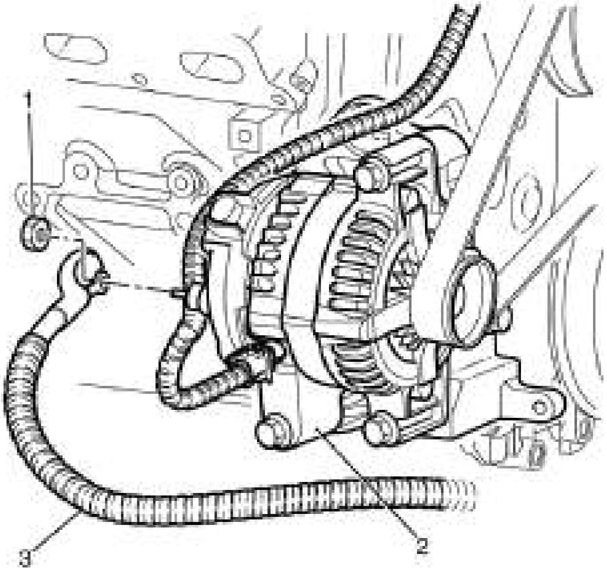
4. Remove the remote battery positive cable upper protective cover (3) from the remote battery positive cable lower protective cover (4).



5. Remove the remote battery positive post to battery positive cable retaining bolt (2).
6. Disconnect the front battery positive cable (3) from the battery post.
7. Disconnect the rear battery positive cable (1) from the battery post.

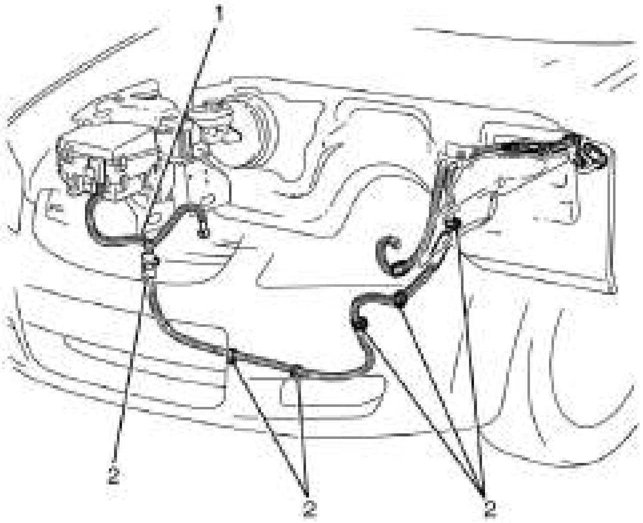


8. Remove the underhood body electrical centre (UBEC) cover (1).
9. Remove the front battery positive cable protective cover (3).
10. Remove the front battery positive cable to UBEC plate retaining nut (5).
11. Disconnect the front battery positive cable (2) from the UBEC plate (4).



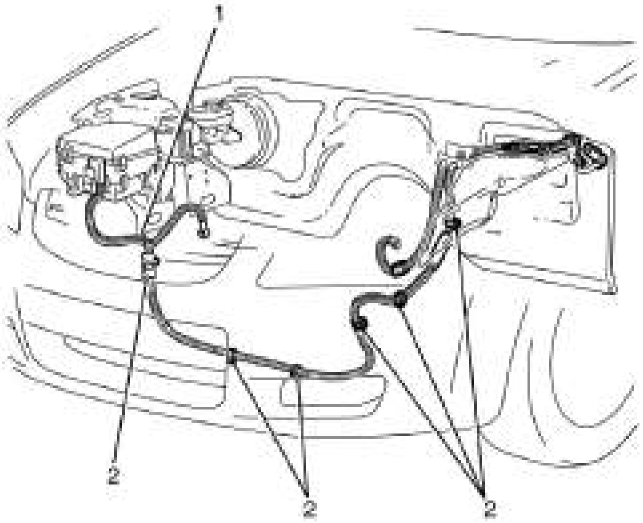
Important: Reposition the protective boot on the front battery positive cable (3) to gain access to the front battery positive cable to alternator retaining nut (1).

12. Remove the front battery positive cable to alternator retaining nut (1).
13. Disconnect the front battery positive cable (3) from the alternator (2).

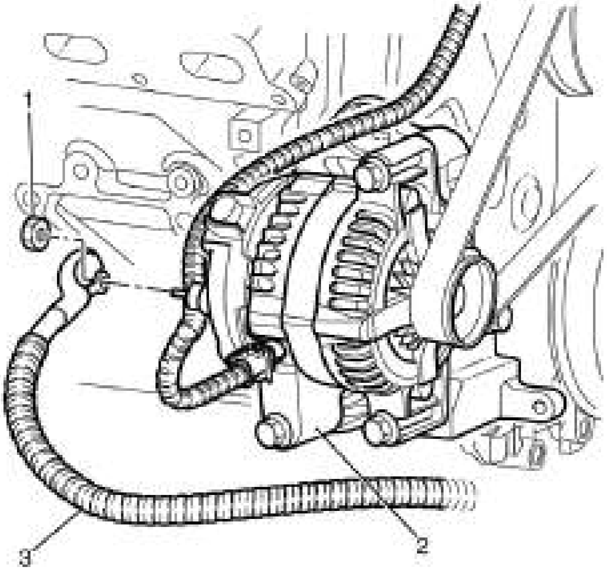


14. Remove the front battery positive cable to chassis retaining clips (2).
15. Remove the front battery positive cable (1) from the engine compartment.

Installation Procedure - Front (3.6L Engine)



1. Install the front battery positive cable (1) to the engine compartment.
2. Install the front battery positive cable to chassis retaining clips (2).

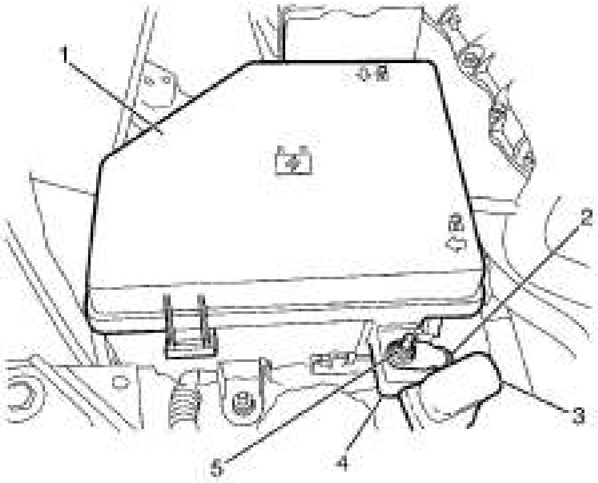


3. Connect the front battery positive cable (2) to the alternator (3).

   Notice: Refer to Fastener Notice in the Preface section.

4. Install the front battery positive cable to alternator retaining nut (1).

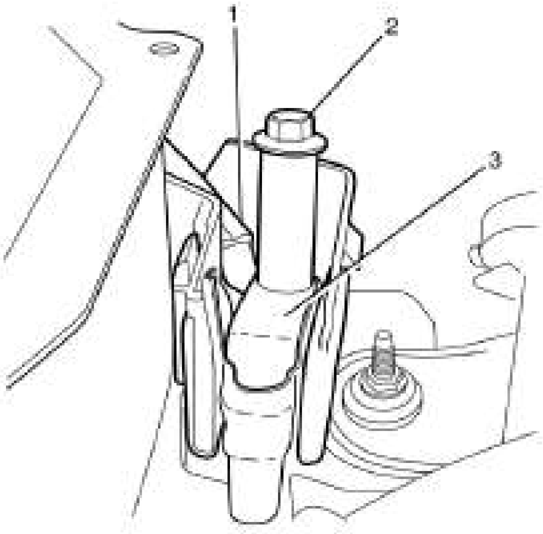
   Tighten
   Tighten the nut to 13 N·m (115 lb in).



5. Connect the front battery positive cable (2) to the UBEC plate (4).
6. Install the front battery positive cable to the UBEC plate retaining nut (5).

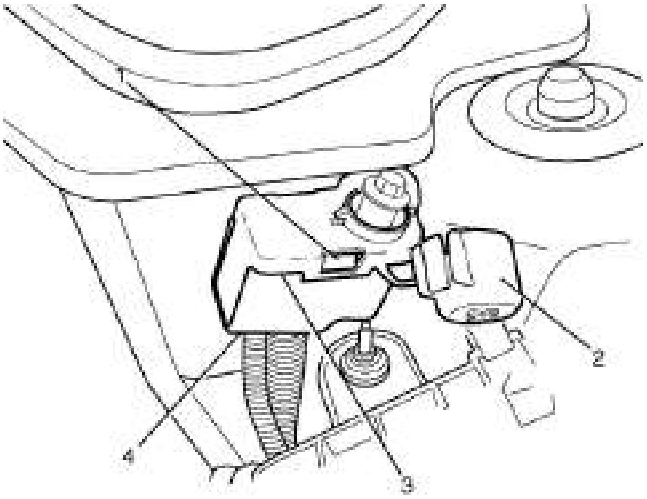
Tighten
Tighten the nut to 10 N·m (89 lb in).

7. Install the front battery positive cable protective cover (3) to the positive cable.
8. Install the UBEC cover (1).



9. Connect the rear battery positive cable (1) to the battery post.
10. Connect the front battery positive cable (3) to the battery post.
11. Install the remote battery positive post to the battery positive cable retaining bolt (2).

Tighten
Tighten the bolt to 15 N·m (13 lb ft).



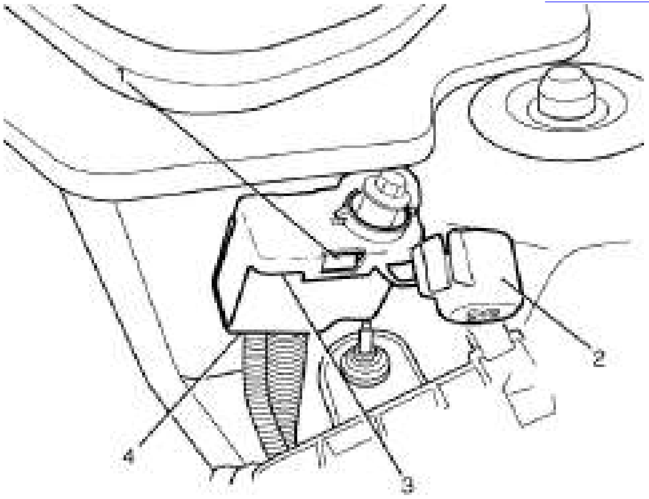
Important: Listen for an audible click from the retaining clip (1) to confirm correct fitting of the remote battery positive cable upper protective cover (3) to the remote battery positive cable lower protective cover (4).

12. Install the remote battery positive cable upper protective cover (3) to the remote battery positive cable lower protective cover (4).
13. Attach the remote battery positive post cover (2) to the remote battery positive cable upper protective cover (3).
14. Install the front air deflector. Refer to Front Air Deflector Replacement.
15. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

Removal Procedure - Front (6.0L Engine)

Caution: Refer to Battery Disconnect Caution in the Preface section.

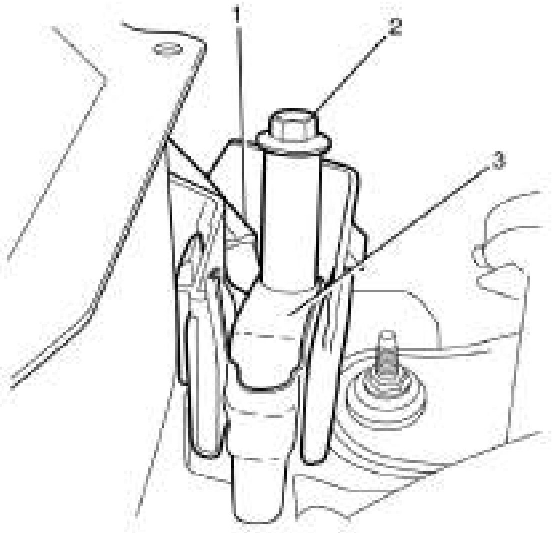
1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the front air deflector. Refer to Front Air Deflector Replacement.



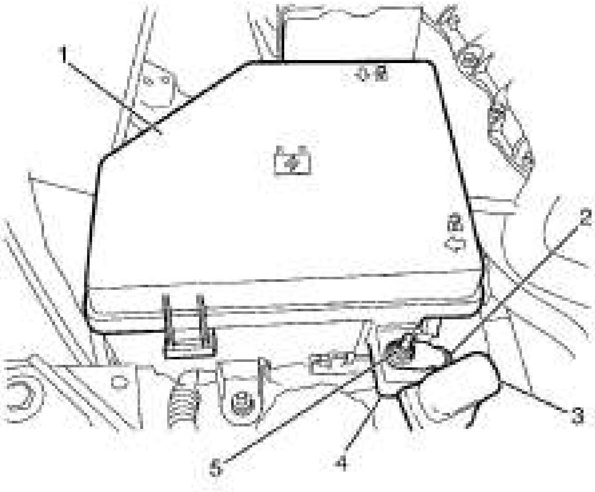
3. Detach the remote battery positive post cover (2) from the remote battery positive cable upper protective cover (3).

Important: Remove the remote battery positive cable upper protective cover (3) by pressing the retaining clip (1) and lifting the remote battery positive cable upper protective cover (3) upwards.

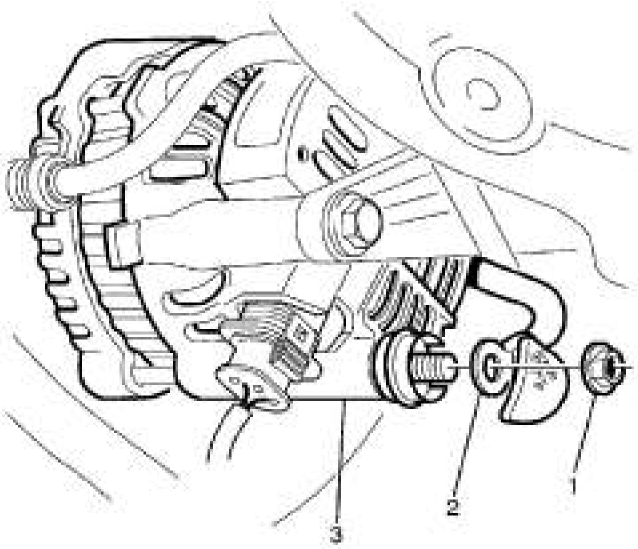
4. Remove the remote battery positive cable upper protective cover (3) from the remote battery positive cable lower protective cover (4).



5. Remove the remote battery positive post to battery positive cable retaining bolt (2).
6. Disconnect the front battery positive cable (3) from the remote battery positive post.
7. Disconnect the rear battery positive cable (1) from the remote battery positive post.

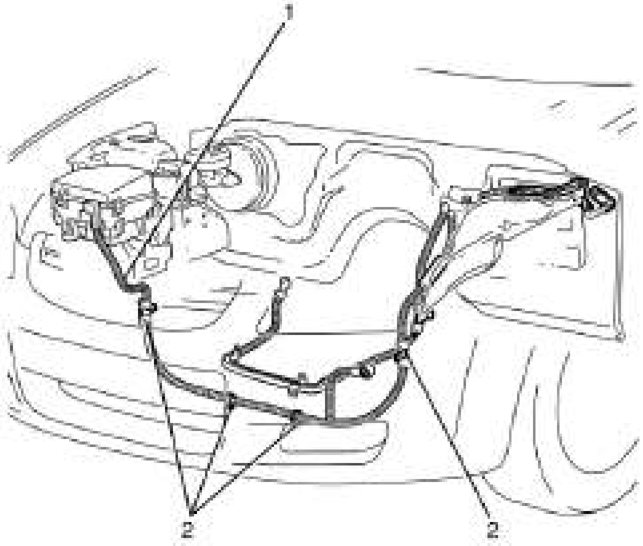


8. Remove the underhood body electrical centre (UBEC) cover (1).
9. Remove the front battery positive cable protective cover (3).
10. Remove the front battery positive cable to UBEC plate retaining bolt (5).
11. Disconnect the front battery positive cable (2) from the UBEC plate (4).



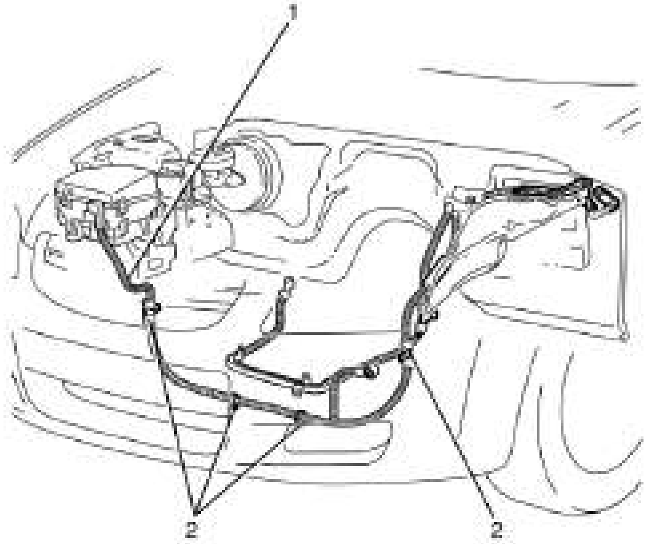
Important: Reposition the protective boot on the front battery positive cable (2) to gain access to the front battery positive cable to alternator retaining nut (1).

12. Remove the front battery positive cable to alternator retaining nut (1).
13. Remove the front battery positive cable (2) from the alternator (3).

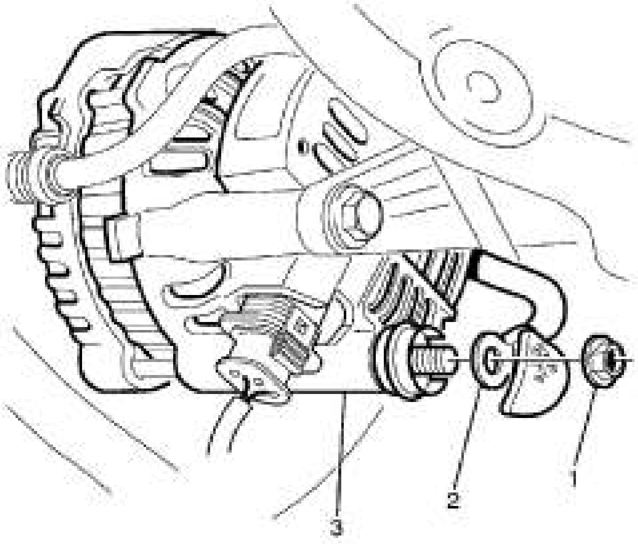


14. Remove the front battery positive cable to chassis retaining clips (2).
15. Remove the front battery positive cable (1) from the engine compartment.

Installation Procedure - Front (6.0L Engine)



1. Install the front battery positive cable (1) to the engine compartment.
2. Install the front battery positive cable to chassis retaining clips (2).

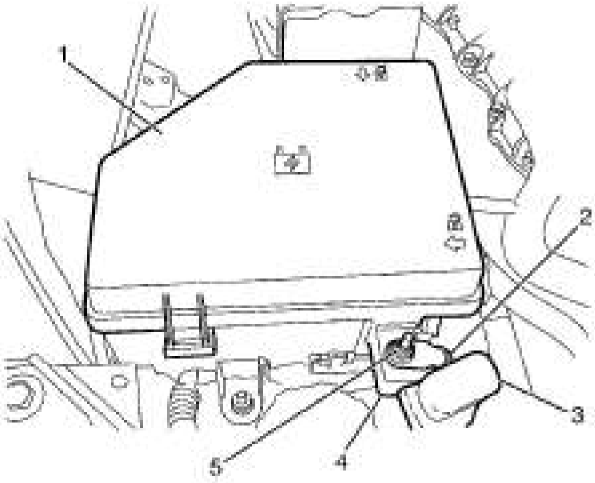


3. Connect the front battery positive cable (2) to the alternator (3).

   Notice: Refer to Fastener Notice in the Preface section.

4. Install the front battery positive cable to alternator retaining nut (1).

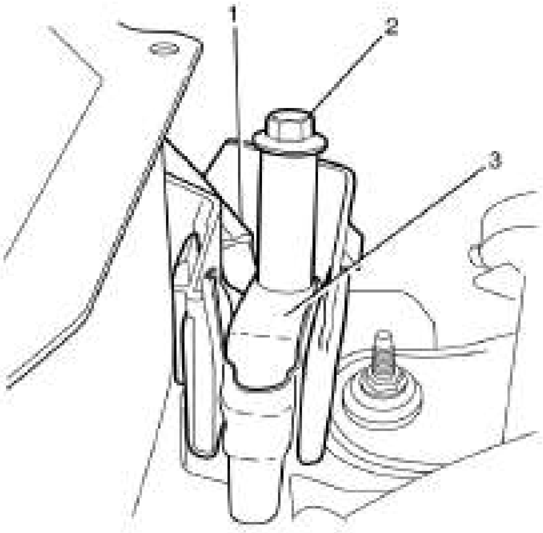
   Tighten
   Tighten the nut to 13 N·m (115 lb in).



5. Connect the front battery positive cable (2) to the UBEC plate (4).
6. Install the front battery positive cable to UBEC plate retaining bolt (5).

Tighten
Tighten the bolt to 10 N·m (89 lb in).

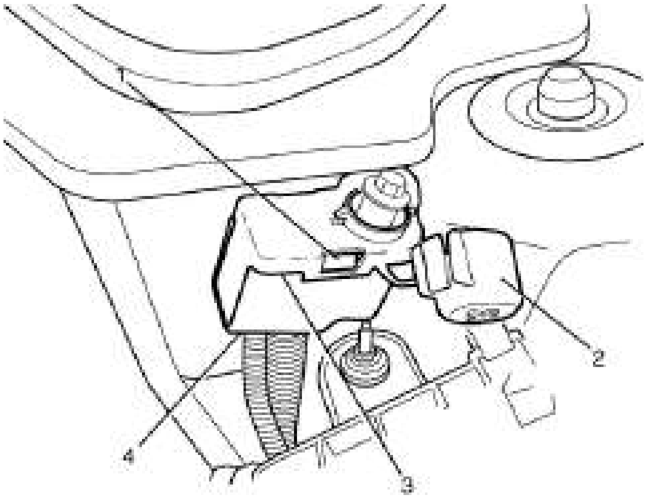
7. Install the front battery positive cable protective cover (3) to the positive cable.
8. Install the UBEC cover (1).



9. Connect the rear battery positive cable (1) to the remote battery positive post.
10. Connect the front battery positive cable (3) to the remote battery positive post.
11. Install the remote battery positive post to battery positive cable retaining bolt (2).

Tighten

Tighten the bolt to 15 N·m (11 lb ft).



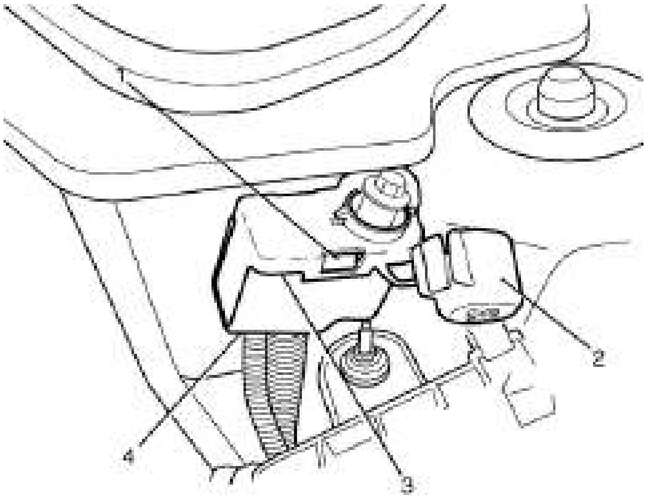
Important: Listen for an audible click from the retaining clip (1) to confirm correct fitting of the remote battery positive cable upper protective cover (3) to the remote battery positive cable lower protective cover (4).

12. Install the remote battery positive cable upper protective cover (3) to the remote battery positive cable lower protective cover (4).
13. Attach the remote battery positive post cover (2) to the remote battery positive cable upper protective cover (3).
14. Install the front air deflector. Refer to Front Air Deflector Replacement.
15. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

Removal Procedure - Starter (3.6L Engine)

Caution: Refer to Battery Disconnect Caution in the Preface section.

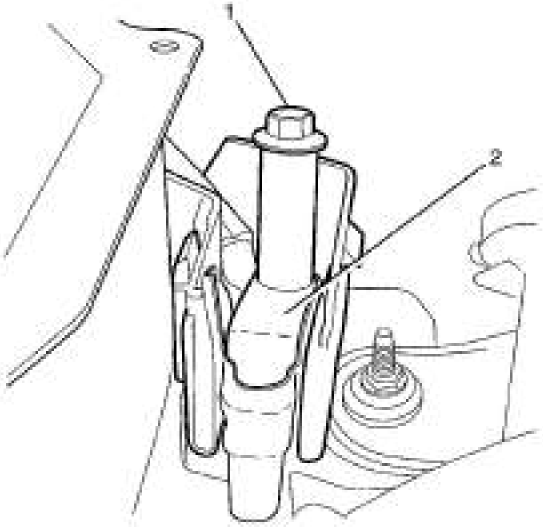
1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the front air deflector. Refer to Front Air Deflector Replacement.



3. Detach the remote battery positive post cover (2) from the remote battery positive cable upper protective cover (3).

   Important: Remove the remote battery positive cable upper protective cover (3) by pressing the retaining clip (1) and lifting the remote battery positive cable upper protective cover (3) upwards.

4. Remove the remote battery positive cable upper protective cover (3) from the remote battery positive cable lower protective cover (4).

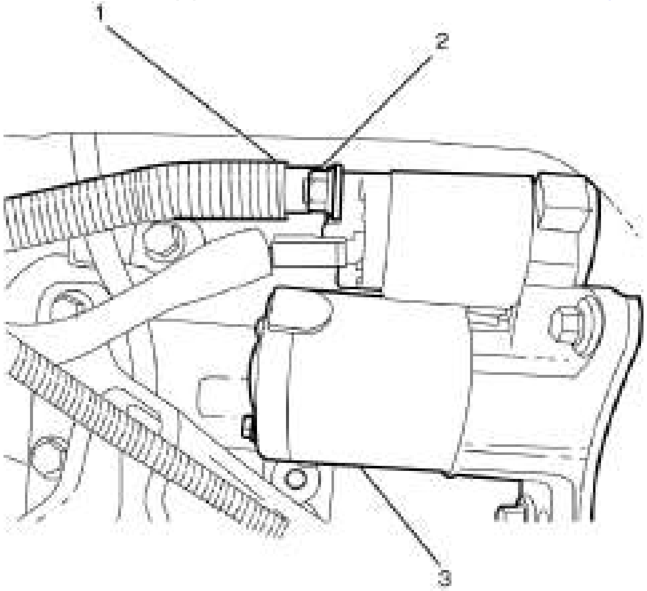


5. Remove the remote positive battery post to battery positive cable retaining bolt (1).
6. Disconnect the starter battery positive cable (2) from the remote positive battery post.

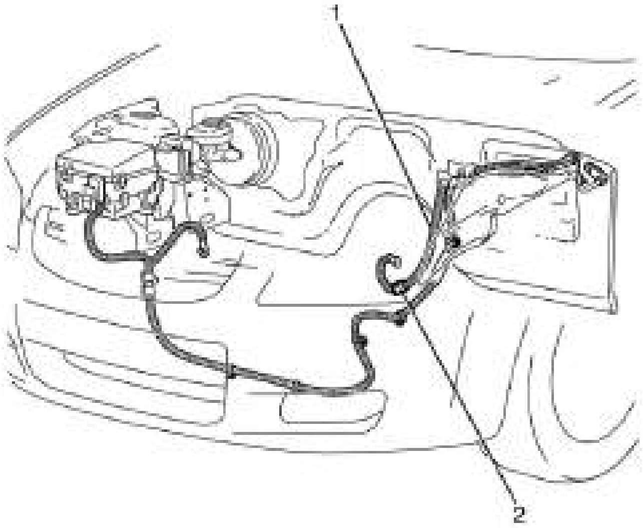
   Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

7. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

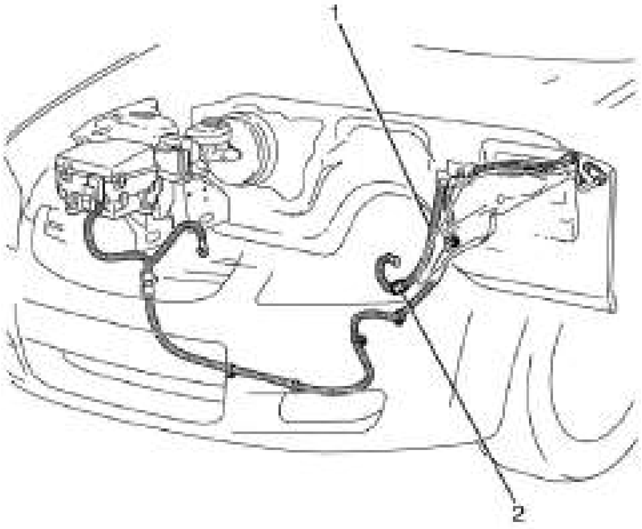


8. Remove the starter battery positive cable to starter motor retaining nut (2).
9. Disconnect the starter battery positive cable (1) from the starter motor (3).
10. Lower the vehicle.

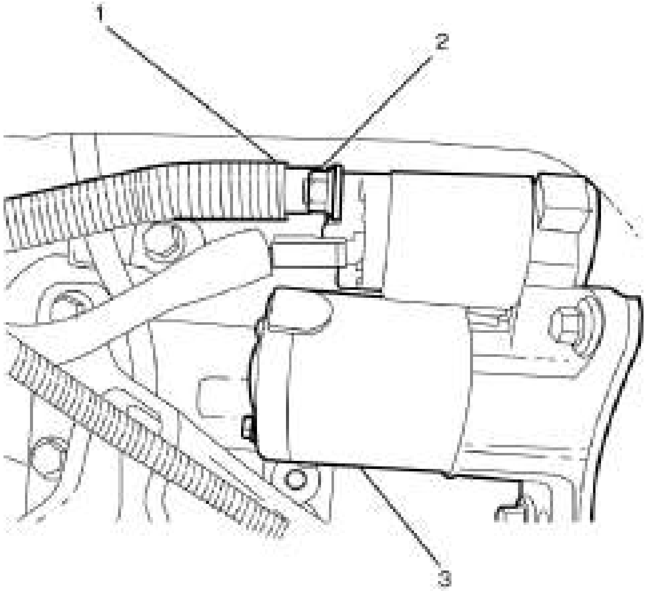


11. Detach the starter battery positive cable (1) from the starter battery positive cable retaining clip (2).
12. Remove the starter battery positive cable (1) from the engine compartment.

Installation Procedure - Starter (3.6L Engine)



1. Install the starter battery positive cable (1) to the engine compartment.
2. Attach the starter battery positive cable (1) to the starter battery positive cable retaining clip (2).
3. Raise the vehicle.



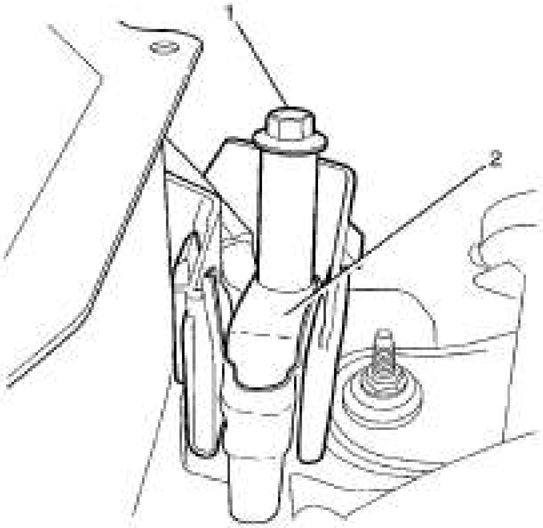
4. Connect the starter battery positive cable (1) to the starter motor (3).

   Notice: Refer to Fastener Notice in the Preface section.

5. Install the starter battery positive cable to starter motor retaining nut (2).

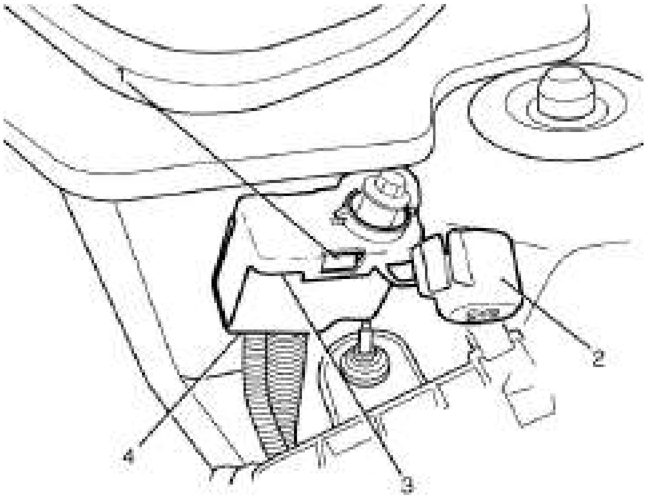
   Tighten
   Tighten the nut to 11 N·m (97 lb in).

6. Lower the vehicle.



7. Connect the starter battery positive cable (2) to the remote battery positive post.
8. Install the remote battery positive post to battery positive cable retaining bolt (1).

   Tighten
   Tighten the bolt to 15 N·m (11 lb ft).



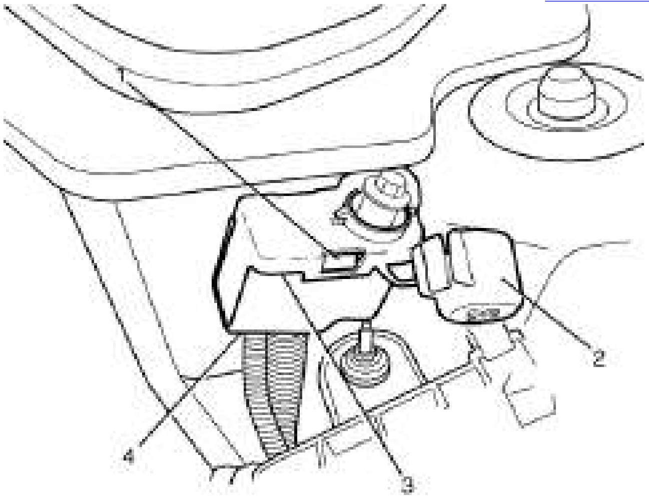
Important: Listen for an audible click from the retaining clip (1) to confirm correct fitting of the remote battery positive cable upper protective cover (3) to the remote battery positive cable lower protective cover (4).

9. Install the remote battery positive cable upper protective cover (3) to the remote battery positive cable lower protective cover (4).
10. Attach the remote battery positive post cover (2) to the remote battery positive cable upper protective cover (3).
11. Install the front air deflector. Refer to Front Air Deflector Replacement.
12. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

Removal Procedure - Starter (6.0L Engine)

Caution: Refer to Battery Disconnect Caution in the Preface section.

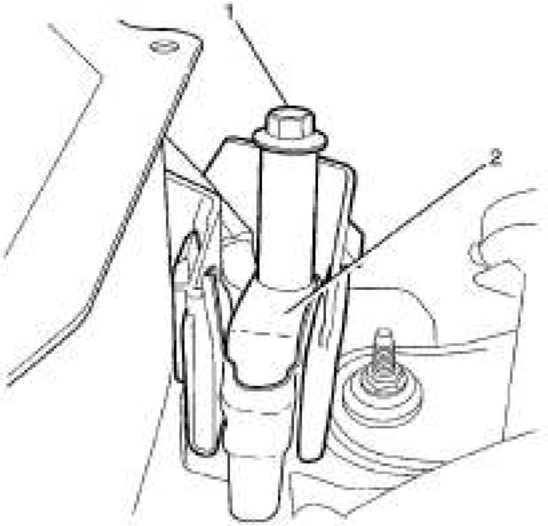
1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the front air deflector. Refer to Front Air Deflector Replacement.



3. Detach the remote battery positive post cover (2) from the remote battery positive cable upper protective cover (3).

Important: Remove the remote battery positive cable upper protective cover (3) by pressing the retaining clip (1) and lifting the remote battery positive cable upper protective cover (3) upwards.

4. Remove the remote battery positive cable upper protective cover (3) from the remote battery positive cable lower protective cover (4).

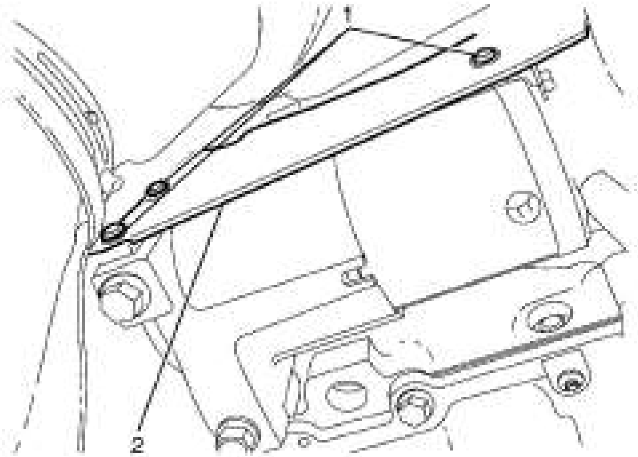


5. Remove the remote battery positive post to battery positive cable retaining bolt (1).
6. Disconnect the starter battery positive cable (2) to the remote battery positive post.

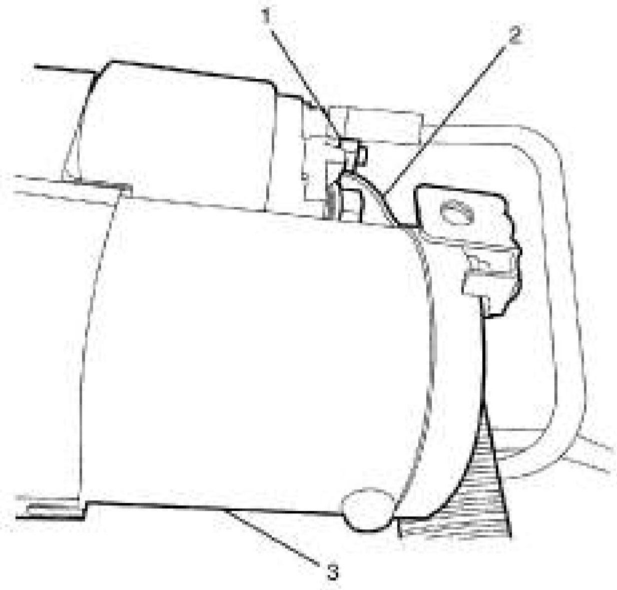
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

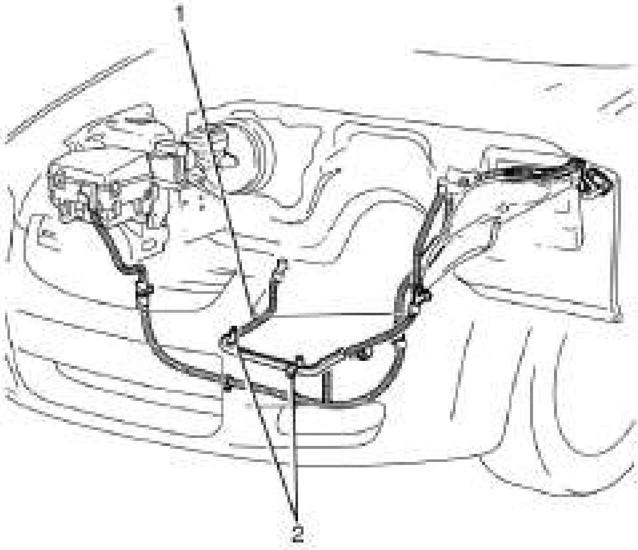
7. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
8. Remove the right catalytic converter. Refer to Catalytic Converter Replacement - Right Side.



9. Remove the starter motor heat shield to starter motor retaining bolts (1).
10. Remove the starter motor heat shield (2) from the starter motor.

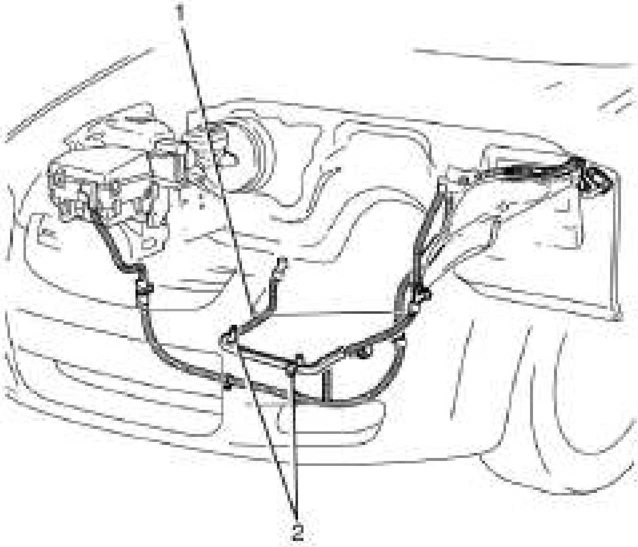


11. Remove the starter battery positive cable to starter motor retaining nut (1).
12. Disconnect the starter battery positive cable (2) from the starter motor (3).
13. Lower the vehicle.

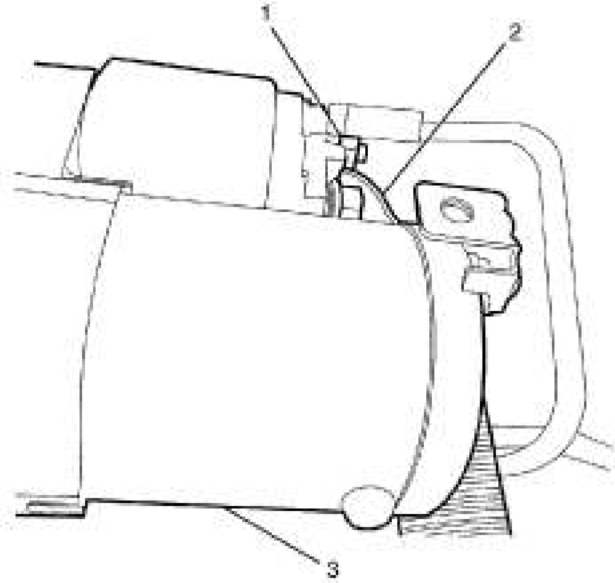


14. Detach the starter battery positive cable from the chassis retaining clips (2).
15. Remove the starter battery positive cable (1) from the engine compartment.

Installation Procedure - Starter (6.0L Engine)



1. Install the starter battery positive cable (1) to the engine compartment.
2. Attach the starter battery positive cable to the chassis retaining clips (2).
3. Raise the vehicle.

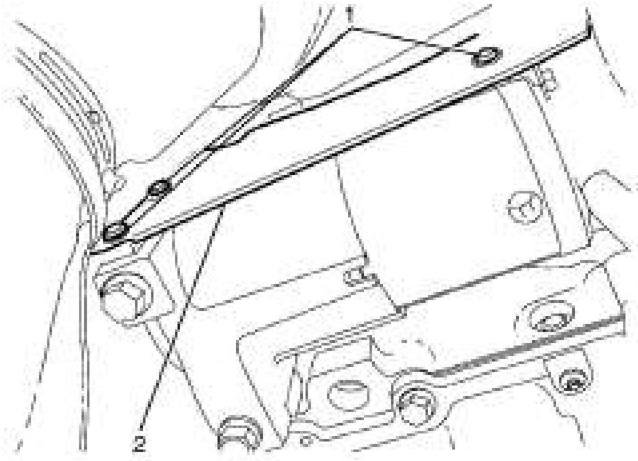


4. Connect the starter battery positive cable (2) to the starter motor (3).

   Notice: Refer to Fastener Notice in the Preface section.

5. Install the starter battery positive cable to starter motor retaining nut (1).

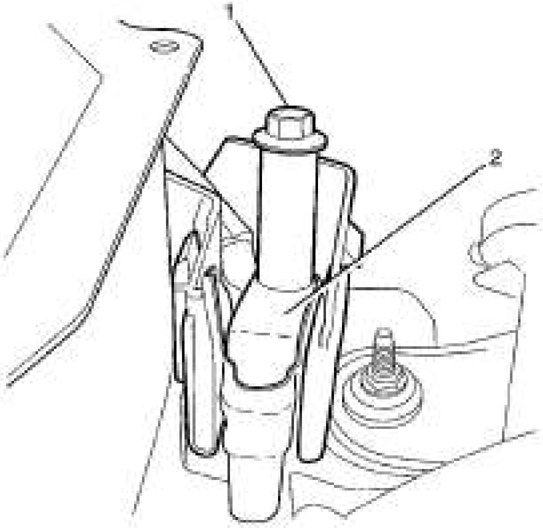
   Tighten
   Tighten the nut to 10 N·m (89 lb in).



6. Install the starter motor heat shield to the starter motor (2).
7. Install the starter motor heat shield to starter motor retaining bolts (1).

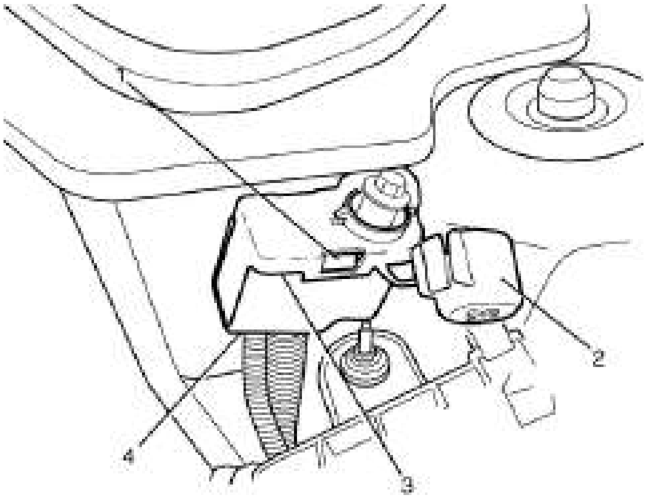
Tighten
Tighten the bolts to 5 N·m (44 lb in).

8. Install the right catalytic converter. Refer to Catalytic Converter Replacement - Right Side.
9. Lower the vehicle.



10. Connect the starter battery positive cable (2) to the remote battery positive post.
11. Install the remote battery positive post to battery positive cable retaining bolt (2).

Tighten
Tighten the bolts to 15 N·m (11 lb ft).



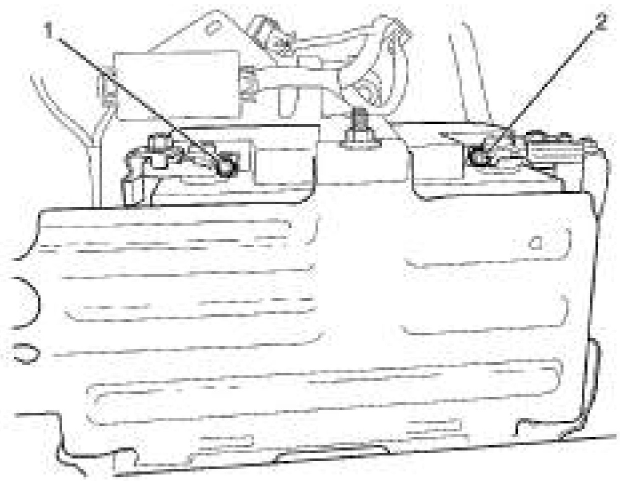
Important: Listen for an audible click from the retaining clip (1) to confirm correct fitting of the remote battery positive cable upper protective cover (3) to the remote battery positive cable lower protective cover (4).

12. Install the remote battery positive cable upper protective cover (3) to the remote battery positive cable lower protective cover (4).
13. Attach the remote battery positive post cover (2) to the remote battery positive cable upper protective cover (3).
14. Install the front air deflector. Refer to Front Air Deflector Replacement.
15. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

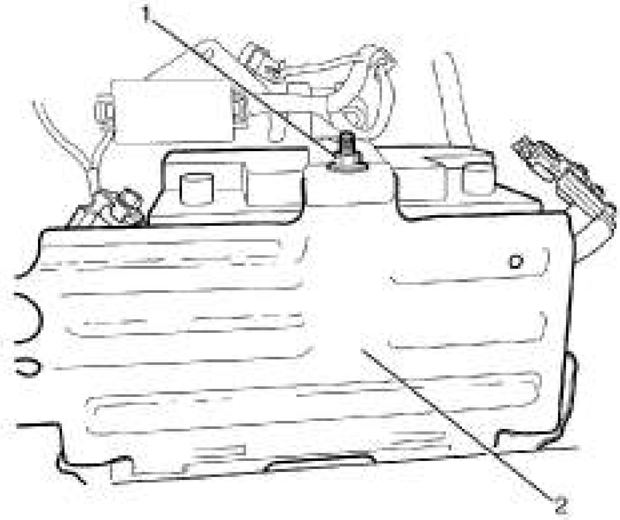
Battery Replacement (Sedan)

Removal Procedure

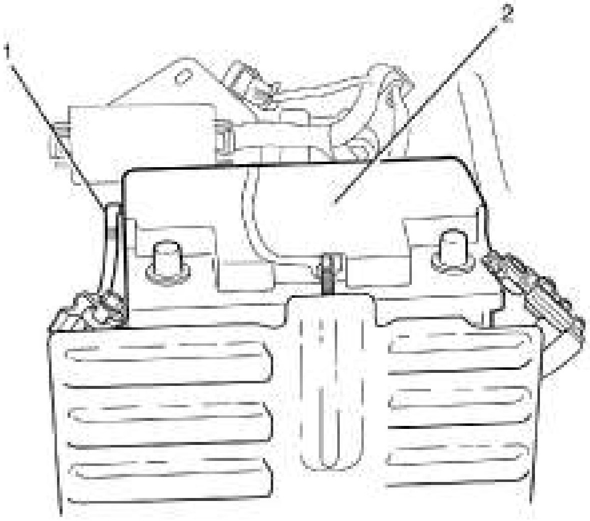
1. Remove the cargo area centre carpet. Refer to Rear Compartment Floor Panel Carpet Replacement
2. Remove the left-hand side cargo area trim. Refer to Rear Compartment Side Trim Panel Replacement



3. Disconnect the battery negative cable (1) from the battery. Refer to Battery Negative Cable Disconnection and Connection.
4. Disconnect the battery positive cable (2) from the battery.

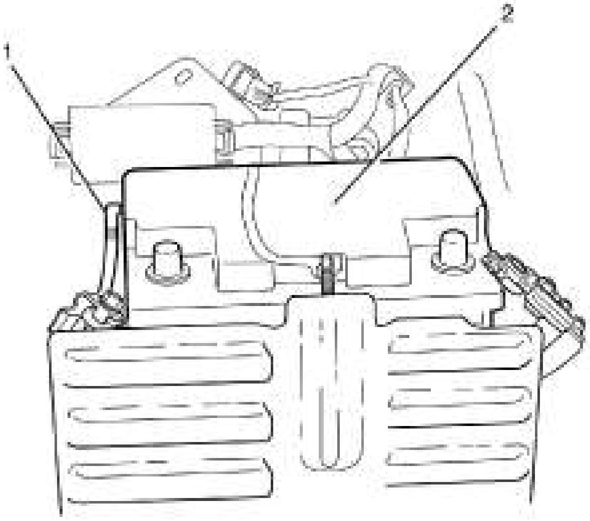


5. Remove the battery retainer strap nut (1) from the battery retainer.
6. Remove the battery retainer plate (2) from the vehicle.



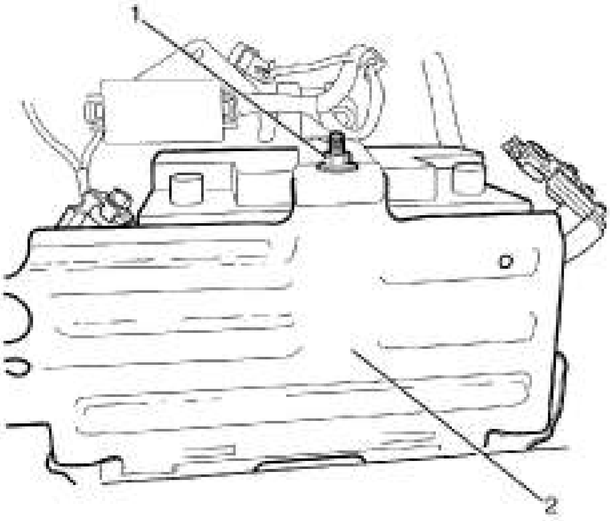
7. Detach the battery vent hose (1) from the battery (2).
8. Remove the battery (2) from the vehicle.

Installation Procedure



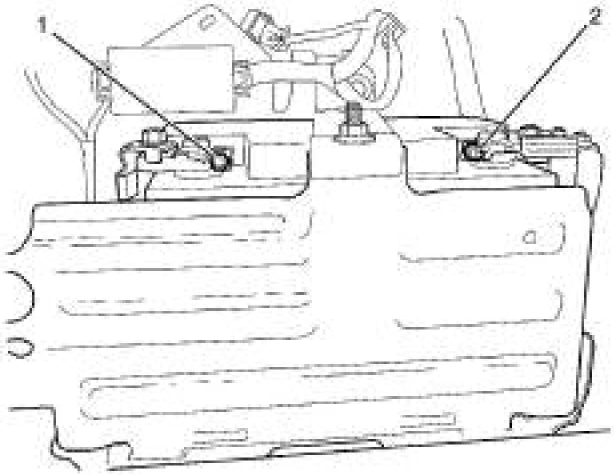
1. Install the battery (2) to the vehicle.
2. Attach the battery vent hose (1) to the battery (2).

Notice: Refer to Fastener Notice in the Preface section.



3. Install the battery retainer plate (2), locate the retainer strap to the retainer plate and install the battery retainer strap nut (1).

   Tighten
   Tighten the nut to 18 N·m (13 lb ft).



4. Connect the battery positive cable (2) to the battery.

   Tighten

Tighten the nut to 17 N·m (13 lb ft).

5. Connect the battery negative cable (1). Refer to Battery Negative Cable Disconnection and Connection.

   Tighten
   Tighten the nut to 17 N·m (13 lb ft).

6. Install the cargo area centre carpet. Refer to Rear Compartment Side Trim Panel Replacement
7. Instal the left-hand side cargo area trim. Refer to Rear Compartment Floor Panel Carpet Replacement
8. Close rear compartment lid.

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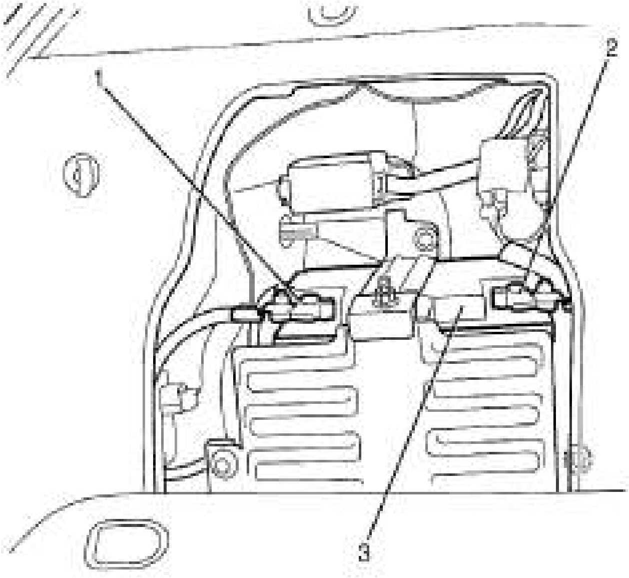
Battery Replacement (Sportwagon)

Removal Procedure

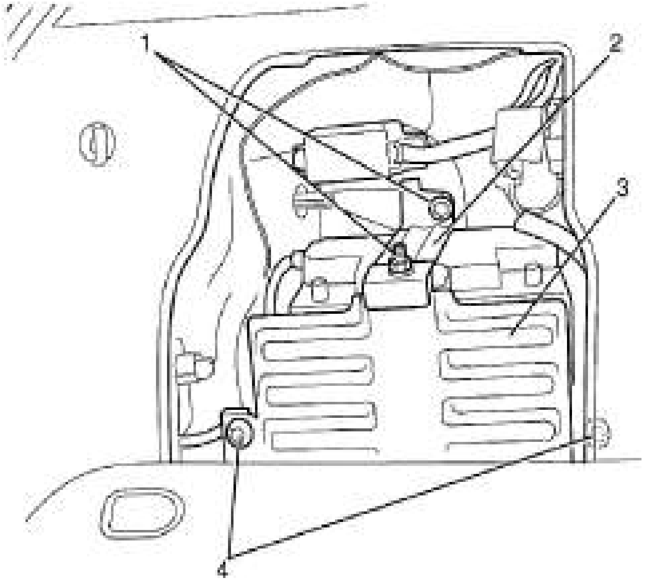
1. Open the liftgate.

   Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

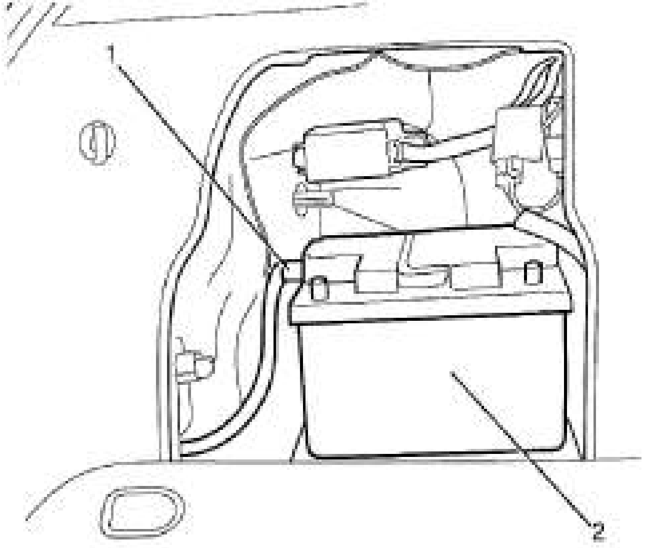
2. Install a suitable liftgate brace to the vehicle.
3. Remove the rear compartment side trim panel access hole cover. Refer to Rear Compartment Side Trim Panel Access Hole Cover Replacement.



4. Disconnect the battery negative cable (1) from the battery (3). Refer to Battery Negative Cable Disconnection and Connection.
5. Disconnect the battery positive cable (2) from the battery (3).

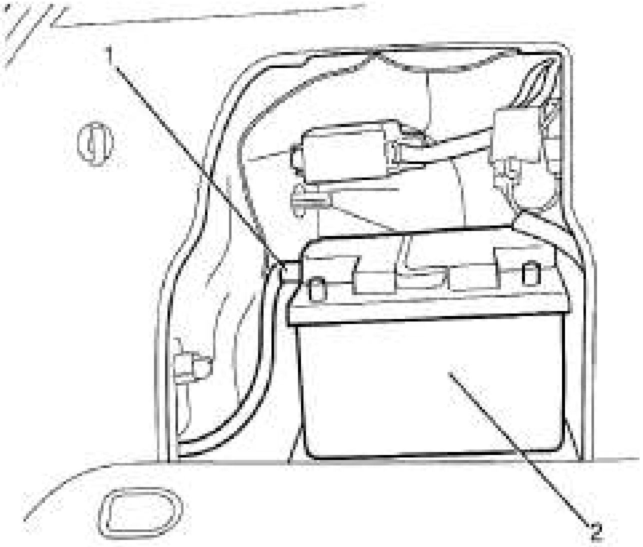


6. Remove the battery retainer strap nuts (1) from the battery retainer strap (2).
7. Remove the battery retainer strap (2).
8. Remove the battery retainer plate to battery tray retaining bolts (4).
9. Remove the battery retainer plate (3) from the vehicle.

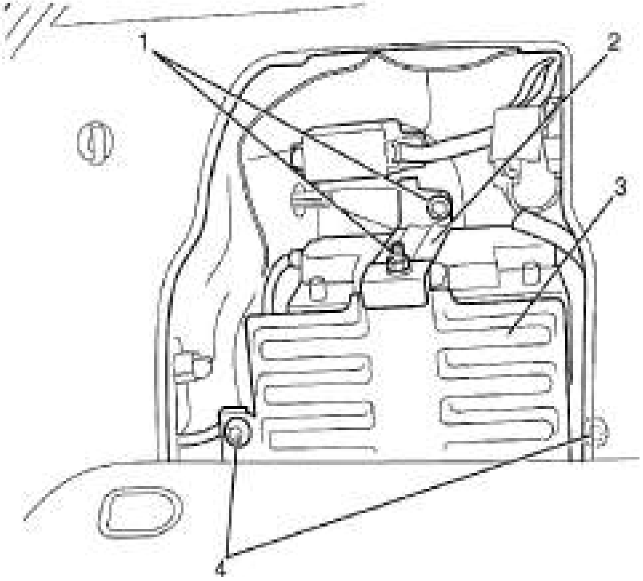


10. Pull out the battery vent hose (1) from the battery (2).
11. Remove the battery (2) from the vehicle.

Installation Procedure



1. Install the battery (2) to the vehicle.
2. Push in the battery vent hose (1) to the battery (2).



3. Install the battery retainer plate (3) to the vehicle.

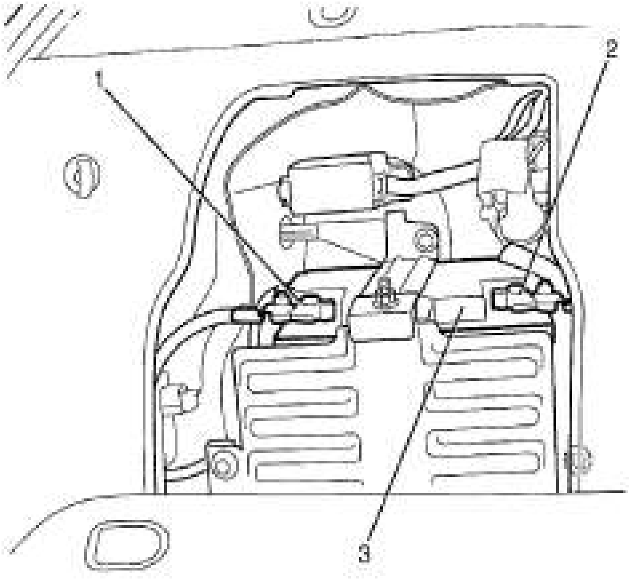
   Notice: Refer to Fastener Notice in the Preface section.

4. Install the battery retainer plate to battery tray retaining bolts (4).

   Tighten
   Tighten the bolts to 6 N·m (53 lb in).

5. Install the battery retainer strap (2).
6. Install the battery retainer strap nuts (1) to the battery retainer strap (2).

Tighten
Tighten the nuts to 6 N·m (53 lb in).



7. Connect the battery positive cable (2) to the battery (3).

   Tighten
   Tighten the nut to 5 N·m (44 lb in).

8. Connect the battery negative cable (1) to the battery (3). Refer to Battery Negative Cable Disconnection and Connection.

   Tighten
   Tighten the nut to 5 N·m (44 lb in).

9. Install the rear compartment side trim panel access hole cover. Refer to Rear Compartment Side Trim Panel Access Hole Cover Replacement.

   Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

10. Remove the suitable liftgate brace from the vehicle.
11. Close the liftgate.

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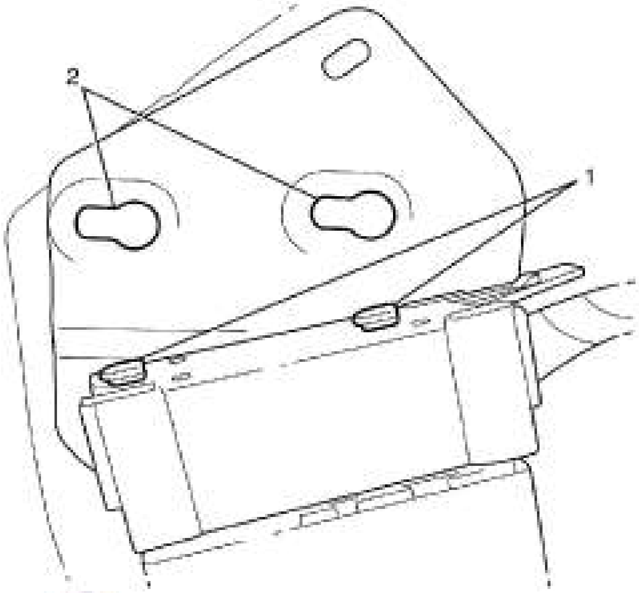
Battery Tray Replacement (Sedan)

Removal Procedure

1. Remove the cargo area centre carpet. Refer to Rear Compartment Floor Panel Carpet Replacement
2. Remove the left-hand side cargo area trim. Refer to Rear Compartment Side Trim Panel Replacement

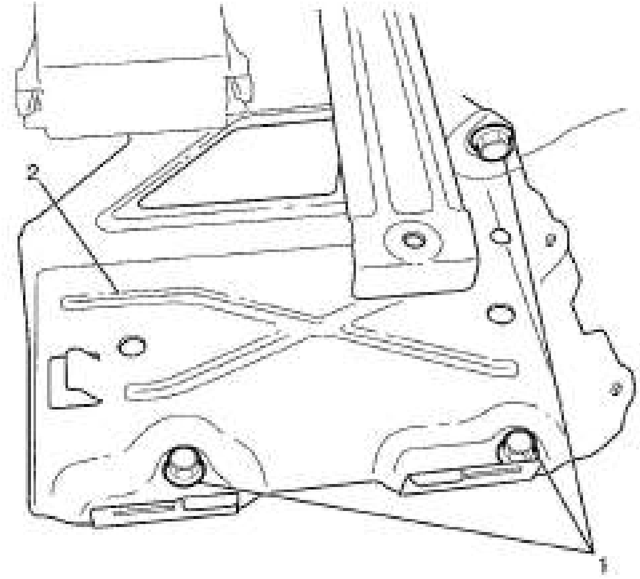
Caution: Refer to Battery Disconnect Caution in the Preface section.

3. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
4. Remove the battery refer to Battery Replacement.



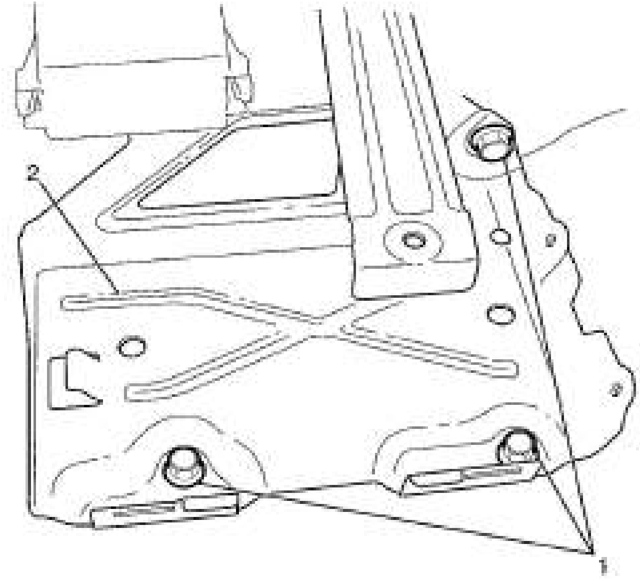
Important: To remove the fuse box, the locking tabs (1) must be released, push the fuse box towards the front of the vehicle to allow the fuse box to be released from the battery tray (2).

5. Remove the fuse box from the battery tray to allow access to the retaining bolts.



6. Remove the battery tray to chassis mounting bolts (1).
7. Remove the battery tray from the vehicle (2).

Installation Procedure

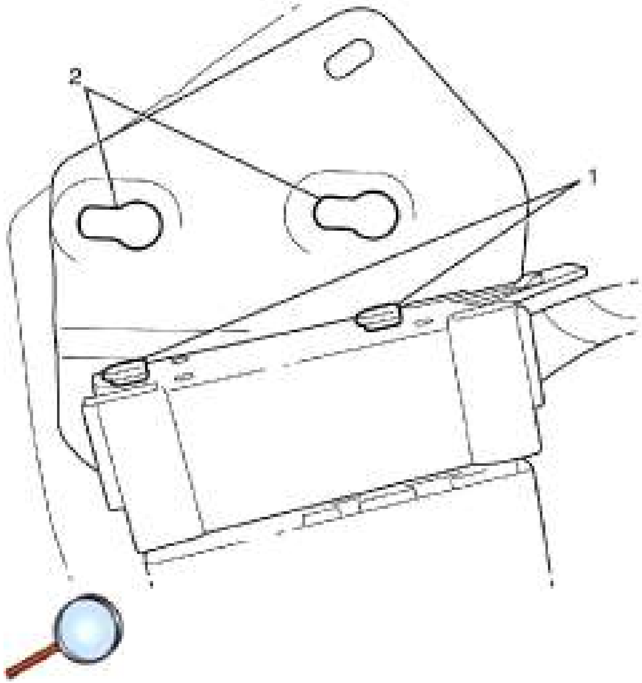


1. Fit the battery tray to the vehicle (2).

   Notice: Refer to Fastener Notice in the Preface section.

2. Fit the battery tray to chassis retaining bolts (1).

Tighten
Tighten the bolts to 25 N·m (18 lb ft).



Important: The fuse box locking tabs (1) must be located correctly into the battery tray (2), push the fuse box towards the rear of the vehicle to lock the fuse box into place.

3. Install the fuse box to the battery tray.

Caution: Refer to Battery Disconnect Caution in the Preface section.

4. Install the battery refer to Battery Replacement.
5. Install the left-hand side cargo area trim. Refer to Rear Compartment Side Trim Panel Replacement
6. Install the cargo area centre carpet.. Refer to Rear Compartment Floor Panel Carpet Replacement

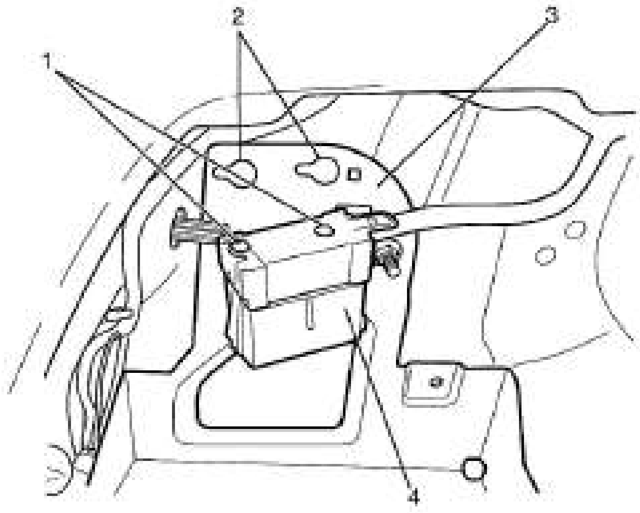
Battery Tray Replacement (Sportwagon)

Removal Procedure

1. Open the liftgate.

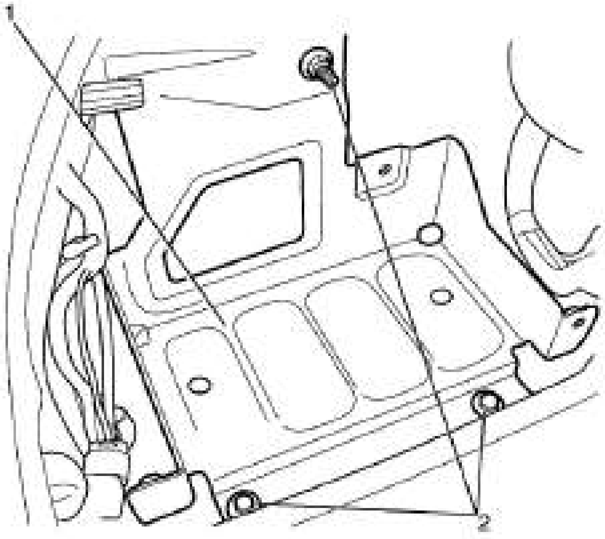
   Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

2. Install a suitable liftgate brace to the vehicle.
3. Remove the rear compartment side trim panel access hole cover. Refer to Rear Compartment Side Trim Panel Access Hole Cover Replacement.
4. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
5. Remove the battery. Refer to Battery Replacement.



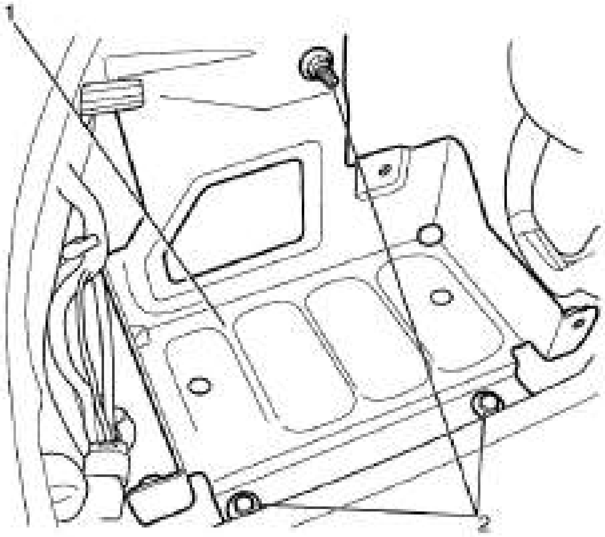
Important: To detach the fuse box, the locking tabs (1) must be released, push the fuse box (4) towards the front of the vehicle to detach from the battery tray (3).

6. Detach the fuse box (4) from the battery tray (3).



7. Remove the battery tray to chassis retaining bolts (2).
8. Remove the battery tray (1) from the vehicle.

Installation Procedure

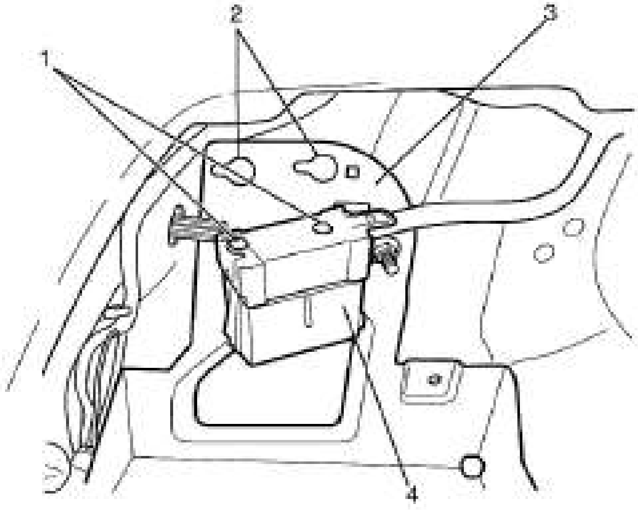


1. Install the battery tray (1) to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the battery tray to chassis retaining bolts (2).

Tighten
Tighten the nut to 25 N·m (18 lb ft).



Important: The fuse box locking tabs (1) must be located correctly into the battery tray (3), push the fuse box towards the rear of the vehicle to lock the fuse box (4) into place.

3. Attach the fuse box (4) to the battery tray (3).
4. Install the battery. Refer to Battery Replacement.
5. Install the rear compartment side trim panel access hole cover. Refer to Rear Compartment Side Trim Panel Access Hole Cover Replacement.

Important: When a suitable hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

6. Remove the suitable liftgate brace to the vehicle.
7. Close the liftgate.

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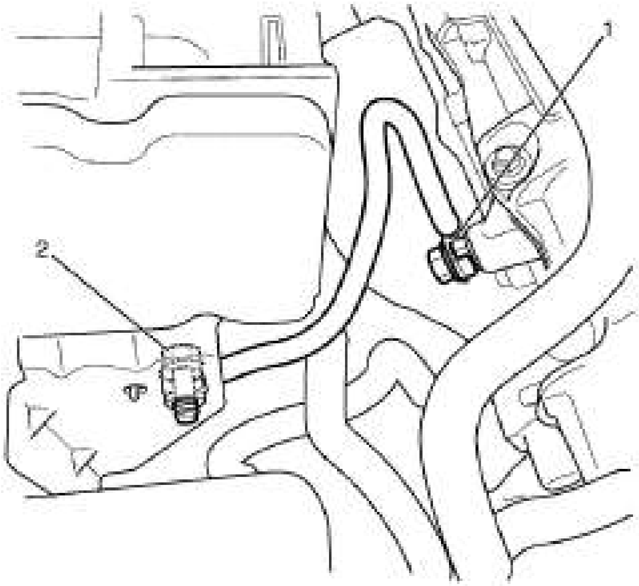
Engine Ground Strap Replacement (3.6L Engine)

Removal Procedure

1. Ignition OFF.

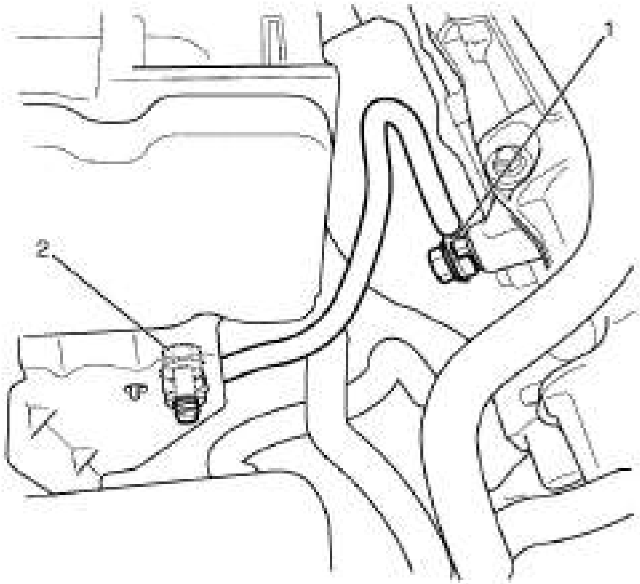
   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.



3. Remove the engine ground strap to the right side engine cylinder head retaining nut (1).
4. Remove the engine ground strap to ABS module mounting bracket retaining bolt (2).
5. Remove the engine ground strap from the vehicle.

Installation Procedure



1. Position the engine ground strap to the correct position.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the engine ground strap to ABS module mounting bracket retaining bolt (2).

   Tighten
   Tighten the bolt to 15 N·m(11 lb ft).

3. Install the engine ground strap to the right side engine cylinder head retaining nut (1).

   Tighten
   Tighten the nut to 25 N·m(18 lb ft).

   Caution: Refer to Battery Disconnect Caution in the Preface section.

4. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

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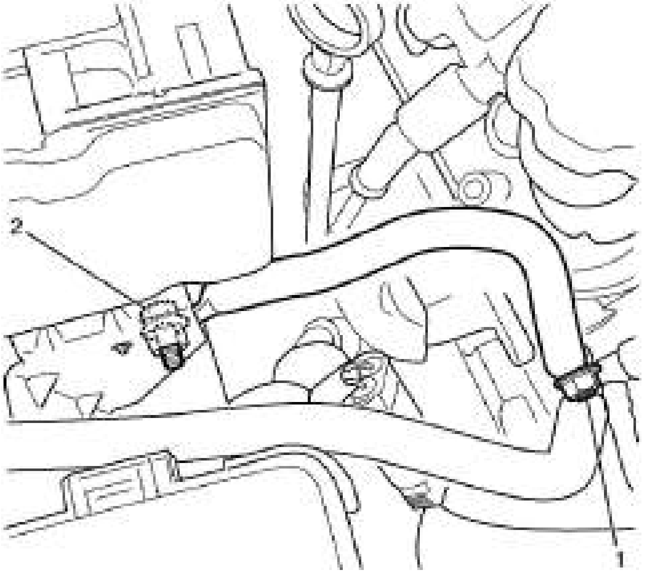
Engine Ground Strap Replacement (6.0L Engine)

Removal Procedure

1. Ignition OFF.

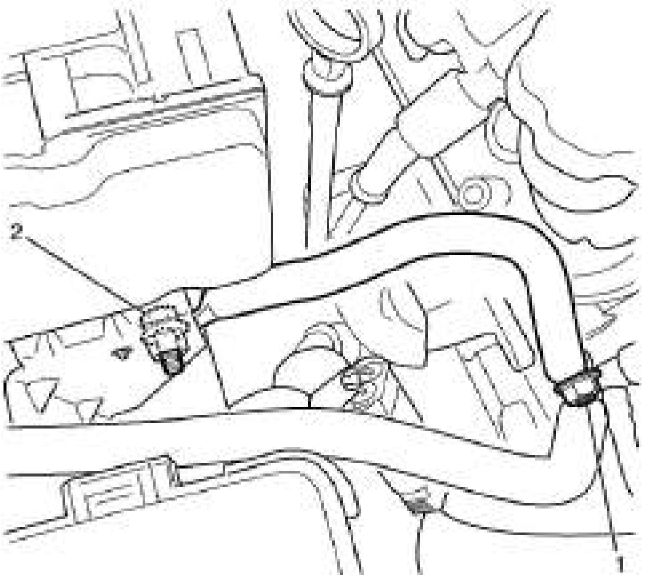
   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.



3. Remove the engine ground strap to the right side engine cylinder head retaining nut (1).
4. Remove the engine ground strap to ABS module mounting bracket retaining bolt (2).
5. Remove the engine ground strap from the vehicle.

Installation Procedure



1. Position the engine ground strap to the correct position.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the engine ground strap to ABS module mounting bracket retaining bolt (2).

   Tighten
   Tighten the bolt to 15 N·m(11 lb ft).

3. Install the engine ground strap to the right side engine cylinder head retaining nut (1).

   Tighten
   Tighten the nut to 25 N·m(18 lb ft).

   Caution: Refer to Battery Disconnect Caution in the Preface section.

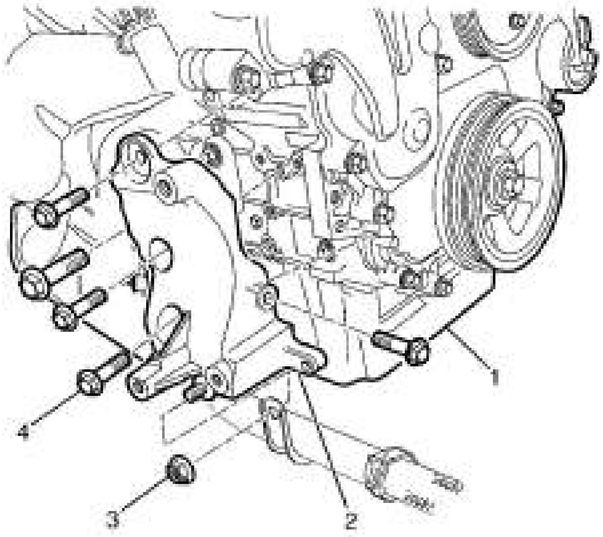
4. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Electrical | Repair Instructions | **Document ID: 1977444**

Generator Bracket Replacement (3.6L Engine)

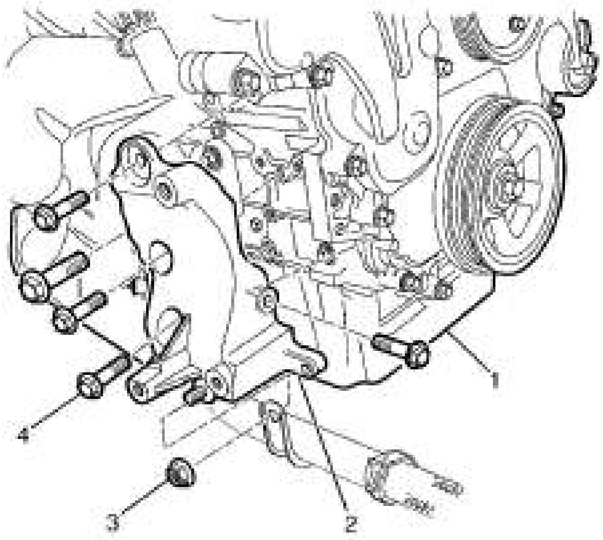
Removal Procedure

1. Remove the alternator. Refer to Generator Replacement.



2. Remove the coolant inlet pipe to alternator mounting bracket retaining nut (3).
3. Remove the alternator mounting bracket to cylinder block retaining bolts (4).
4. Remove the alternator mounting bracket (2) from the cylinder block (1).

Installation Procedure



1. Install the alternator bracket (2) to the engine block.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the alternator bracket to engine block retaining bolts.

   Tighten
   Tighten the bolts to 50 N·m (37 lb ft).

3. Install the coolant inlet pipe to alternator mounting bracket retaining nut (3).

   Tighten
   Tighten the bolts to 22 N·m (16 lb ft).

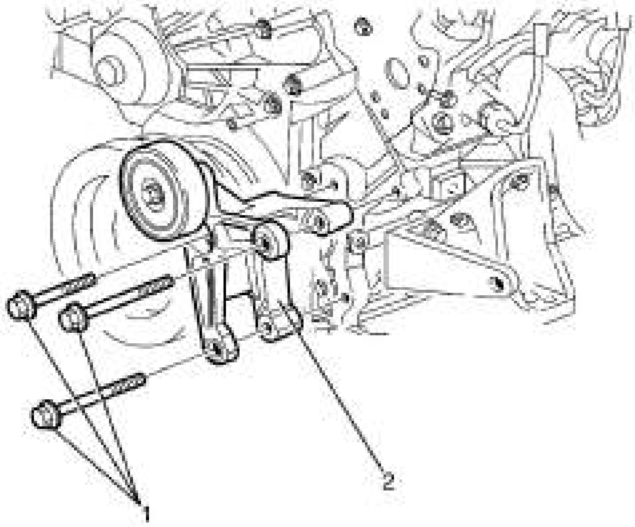
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Electrical | Repair Instructions | Document ID: 1977440

Generator Bracket Replacement (6.0L Engine)

Removal Procedure

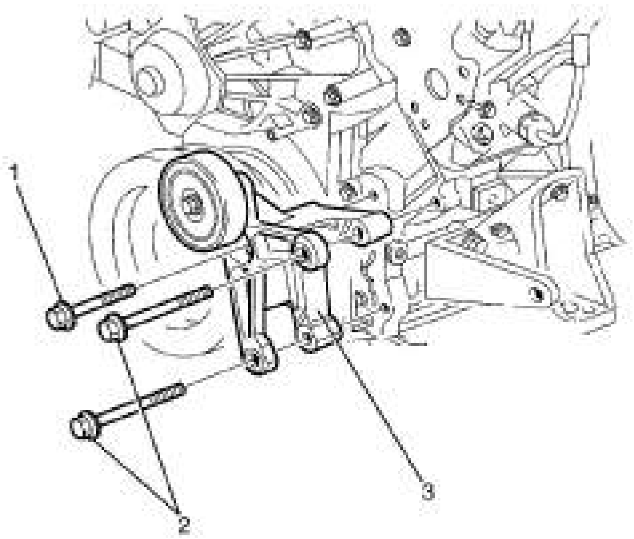
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Ignition OFF.
2. Remove the alternator. Refer to Generator Replacement .



3. Remove the alternator bracket to engine block mounting bolts (1).
4. Remove the alternator bracket (2) from the vehicle.

Installation Procedure



1. Install the alternator bracket (3) to the engine block.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the alternator bracket to engine block mounting bolts (1).

   Tighten
   Tighten the bolts in the sequence shown.

   Tighten
   Tighten the bolts 1 to 27 N·m (20 lb ft).

   Tighten
   Tighten the bolt 2 to 50 N·m (37 lb ft).

3. Install the alternator. Refer to Generator Replacement .

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Generator Replacement (3.6L Engine)

Removal Procedure

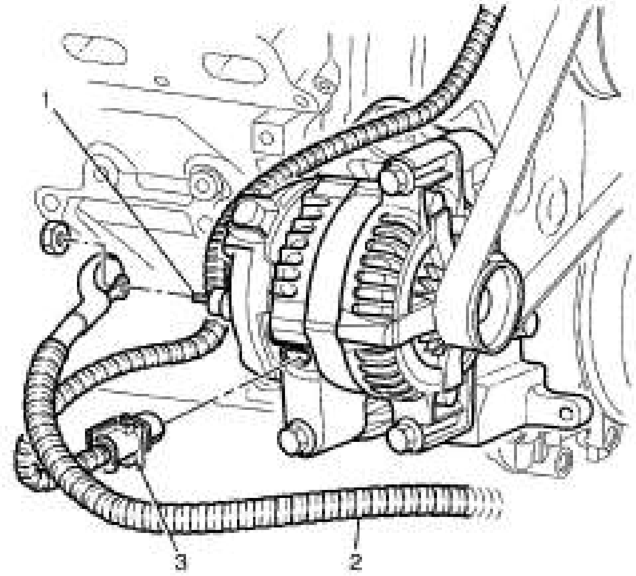
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

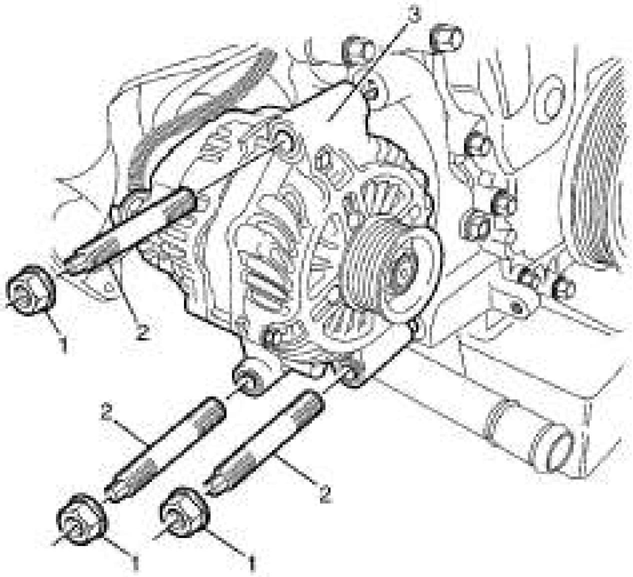
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the drive belt from the alternator. Refer to Drive Belt Replacement.

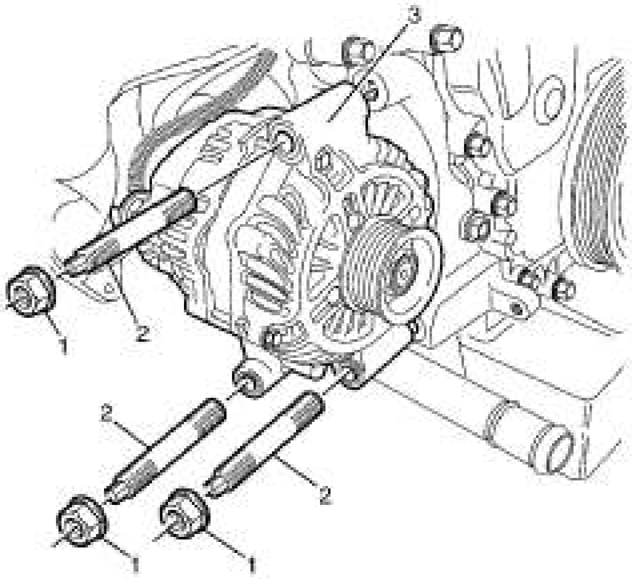


4. Disconnect the electrical connector (3) from the alternator.
5. Reposition the protective boot from the alternator output terminal for access.
6. Remove the alternator output terminal nut (1) and disconnect the battery positive lead from the alternator.



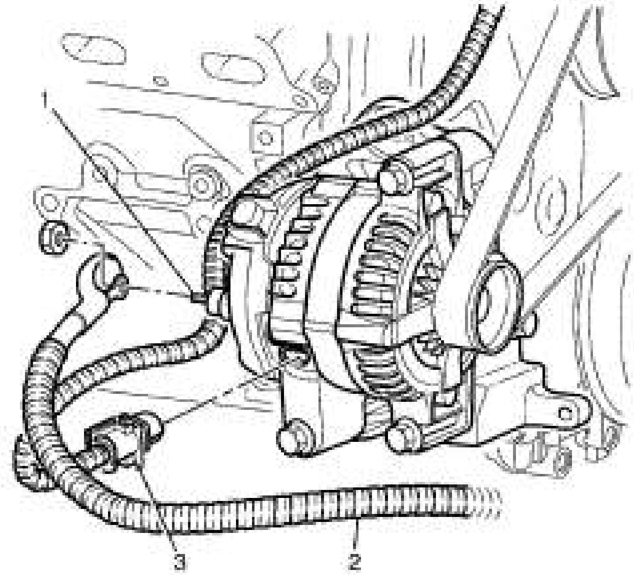
7. Remove the alternator to alternator retaining nuts (1).
8. Remove the alternator to alternator bracket retaining studs (2).
9. Remove the alternator from the vehicle (3).

Installation Procedure



1. Install the alternator (3) to the alternator mounting bracket.
2. Install the alternator to alternator bracket retaining studs (2).
3. Instal the alternator to alternator bracket retaining nuts (1).

Tighten
Tighten the nut to xx N·m (xx lb in).



4. Install the battery positive lead and the alternator terminal nut (1) to the alternator.

   Tighten
   Tighten the nut to 13 N·m (115 lb in).

5. Install the terminal boot.
6. Connect the electrical connector (3) to the alternator.
7. Lower the vehicle.
8. Install the drive belt to the alternator. Refer to Drive Belt Replacement.
9. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

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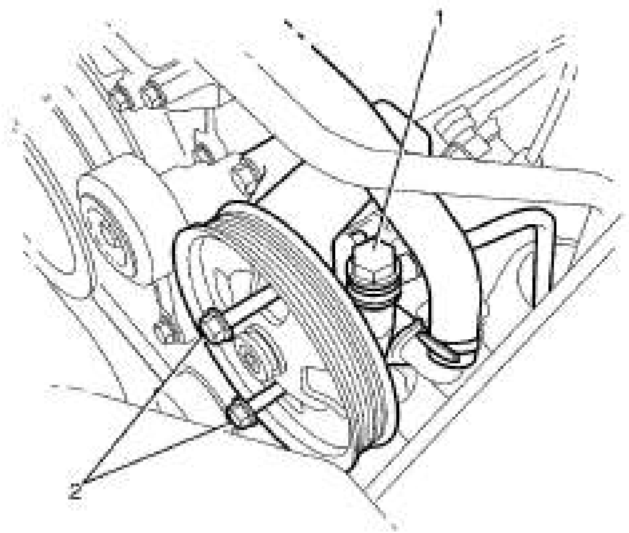
Generator Replacement (6.0L Engine)

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

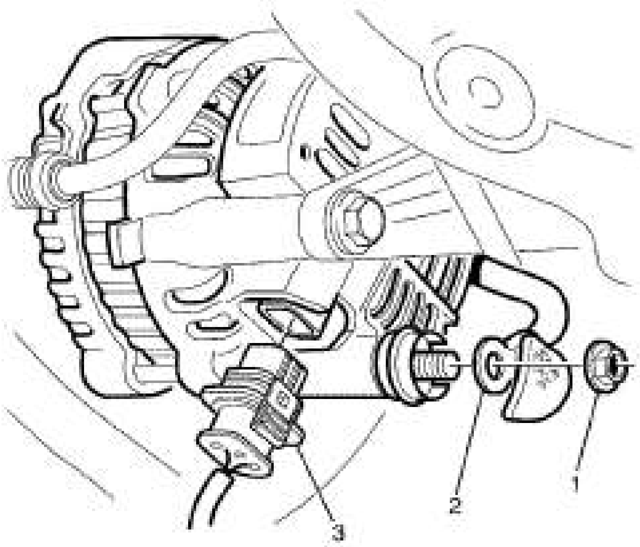
1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the engine cover. Refer to Engine Cover Replacement.
3. Remove air filter assembly. Refer to Air Cleaner Assembly Replacement.
4. Remove the induction tube from throttle body. Refer to Air Cleaner Inlet Duct Replacement.
5. Remove the mass air flow (MAF) sensor. Refer to Mass Airflow Sensor/Intake Air Temperature Sensor Replacement.
6. Remove the drive belt. Refer to Drive Belt Replacement - Accessory.



7. Remove the power steering pump to power steering hose banjo bolt (1)

Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

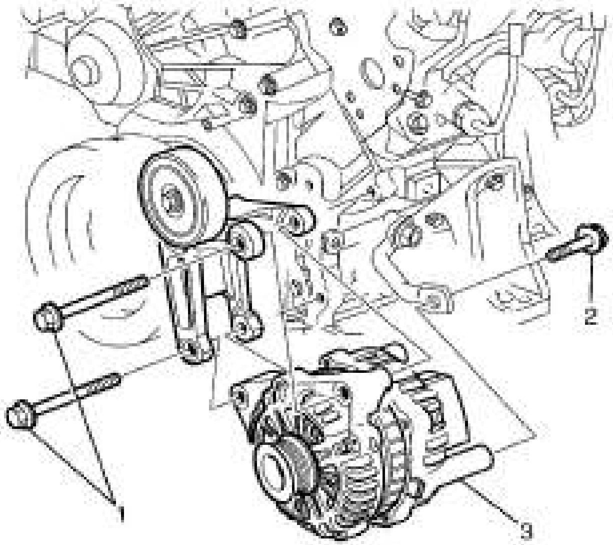
8. Remove the power steering pump to power steering pump bracket retaining bolts (2).
   - Discard the bolts.
   - Place the power steering pump to allow access to the alternator



9. Remove the alternator battery positive cable nut (1) from the alternator.
10. Remove the alternator battery positive cable (2) from the alternator stud.

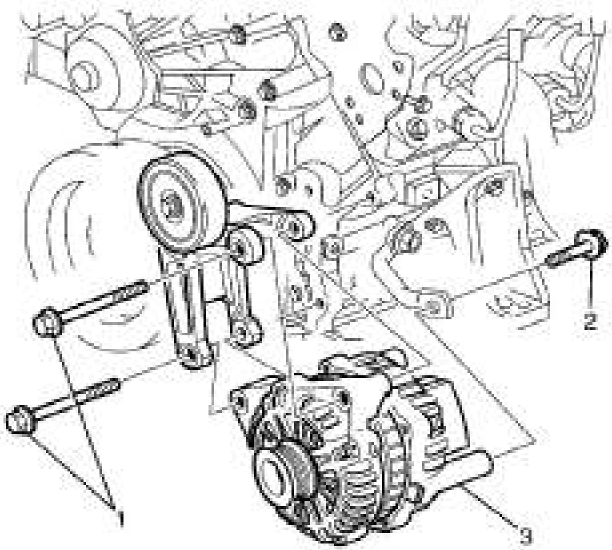
Important: Press the retainer tabs to remove electrical connector.

11. Remove the electrical connector (3) from the alternator.



12. Remove the alternator retaining bolts (1&2).
13. Remove the alternator (3) from the vehicle.

Installation Procedure

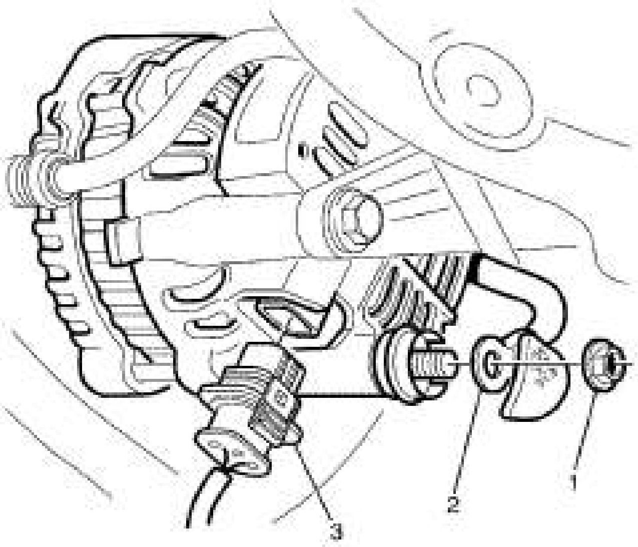


1. Install the alternator to the alternator mounting bracket.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install alternator retaining bolts (1 and 2).

   Tighten
   Tighten the bolts to 34 N·m (25 lb in).

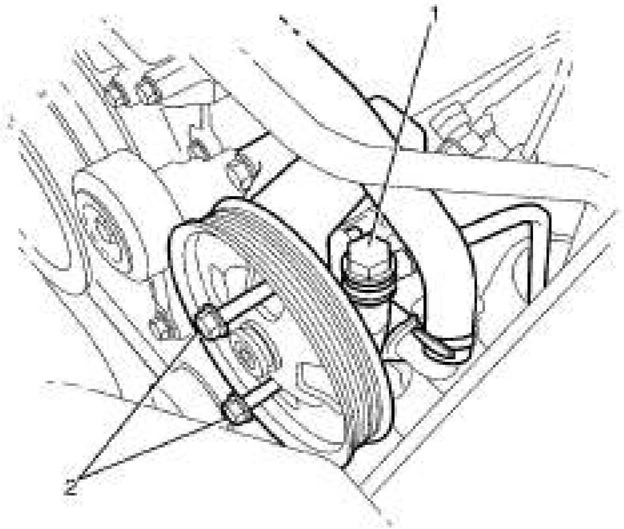


3. Install the alternator battery positive cable (2) to the alternator stud.
4. Install the alternator battery cable nut (1) to the alternator.

Tighten
Tighten the bolts to 13 N·m (115 lb in).

Important: Ensure locking tabs are located into the correct position.

5. Install the electrical connector (3).



6. Install the power steering pump to the power steering pump bracket.
7. Install the power steering pump to power steering pump bracket retaining bolts (2).

Tighten
Tighten the bolts to 30 N·m (23 lb ft).

8. Install the power steering pump to power steering hose banjo fitting bolt (1). Refer to Power Steering System Bleeding.
9. Install the drive belt. Refer to Drive Belt Replacement - Accessory.
10. Install the induction tube to the throttle body. Refer to Air Cleaner Inlet Duct Replacement.
11. Install the mass air flow (MAF) sensor. Refer to Mass Airflow Sensor/Intake Air Temperature Sensor Replacement.
12. Install the air box. Refer to Air Cleaner Assembly Replacement.
13. Install the engine dress cover. Refer to Engine Cover Replacement.
14. Reconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

Starter Replacement (3.6L Engine)

Removal Procedure

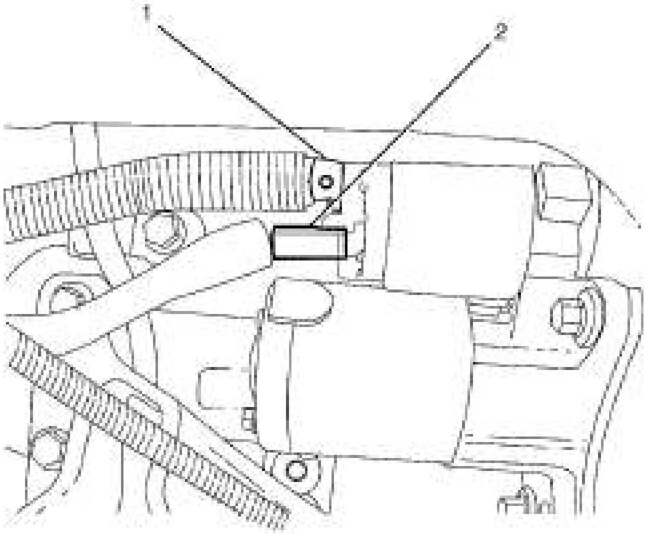
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

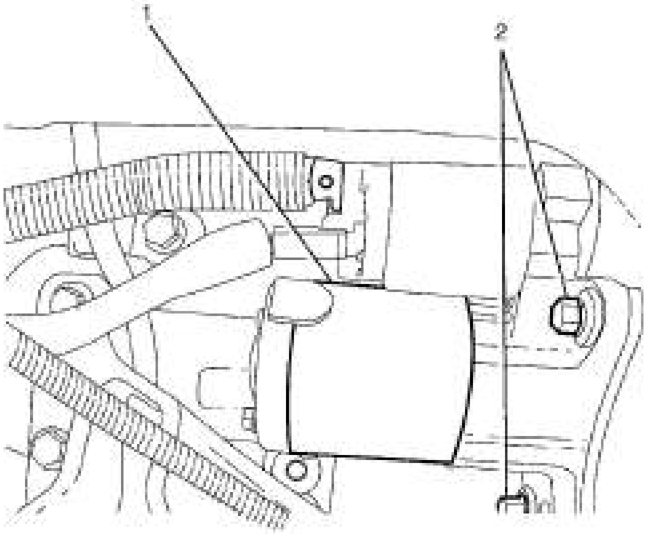
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Ignition OFF.

Caution: Refer to Battery Disconnect Caution in the Preface section.

3. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.



4. Remove the starter motor solenoid electrical connector (2) from the starter motor.
5. Remove the battery positive cable retaining nut (1) from the starter motor solenoid .



6. Remove the starter motor to bell housing retaining bolts (2).
7. Remove the starter motor (1) from the vehicle.

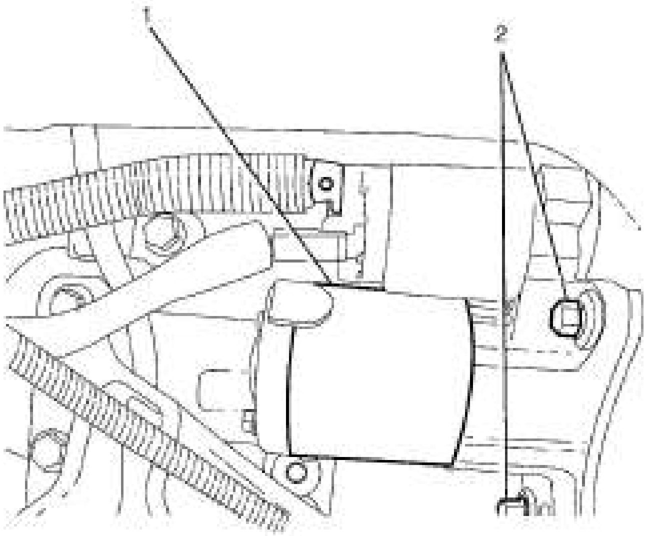
Installation Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

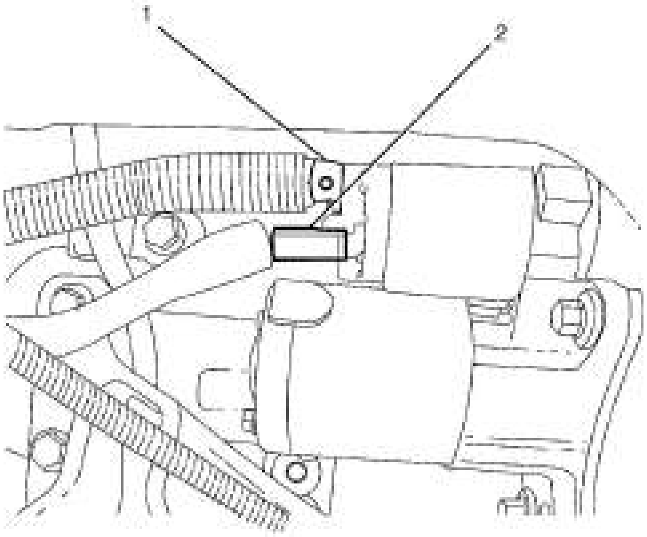
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Manoeuvre the starter motor into place, locating into the correct position on the bell housing.

Notice: Refer to Fastener Notice in the Preface section.



3. Install the starter motor to bell housing (2) retaining bolt.

   Tighten
   Tighten the bolts to 50 N·m (37 lb ft).



4. Install the battery positive cable to the battery solenoid.
5. Install the starter motor solenoid cable to the starter motor retaining nut (1).

   Tighten
   Tighten the nut to 20 N·m (14 lb ft).

6. Install the starter motor solenoid cable (1) to the starter motor.
7. Lower the vehicle from supports. Refer to Lifting and Jacking the Vehicle.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

8. Connect negative battery terminal. Refer to Battery Negative Cable Disconnection and Connection.

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Starter Replacement (6.0L Engine)

Removal Procedure

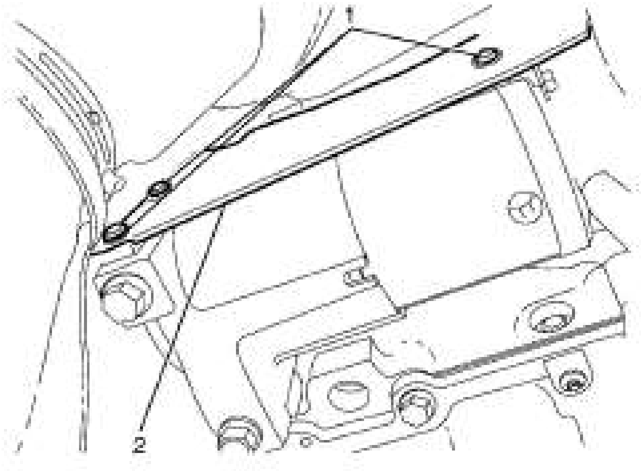
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

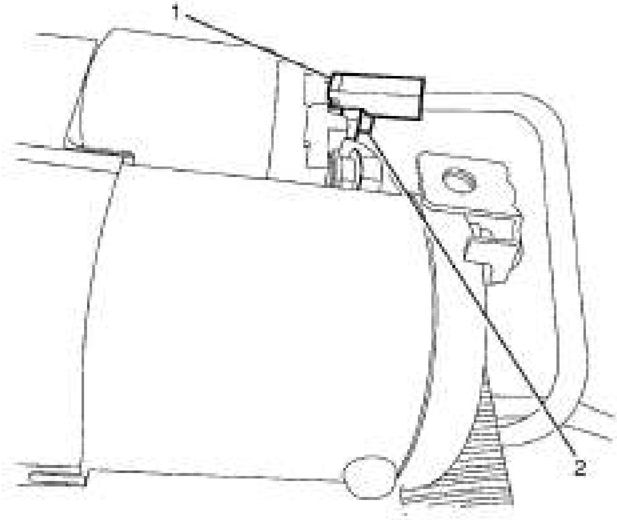
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

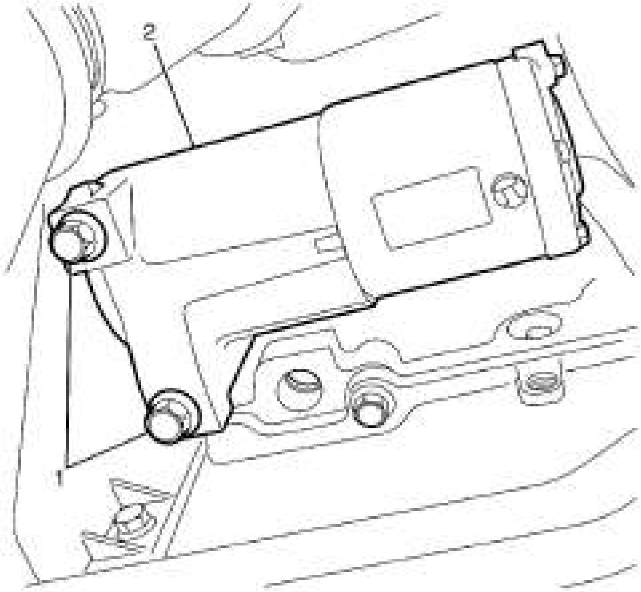
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Remove the right catalytic converter from the vehicle. Refer to Catalytic Converter Replacement - Right Side.



4. Remove the starter motor heat shield to starter motor retaining bolts (1).
5. Remove the heat shield from the vehicle (2).



6. Remove the starter motor solenoid cable (1) from the starter motor.
7. Remove battery positive cable retaining nut (2) from the starter motor solenoid.



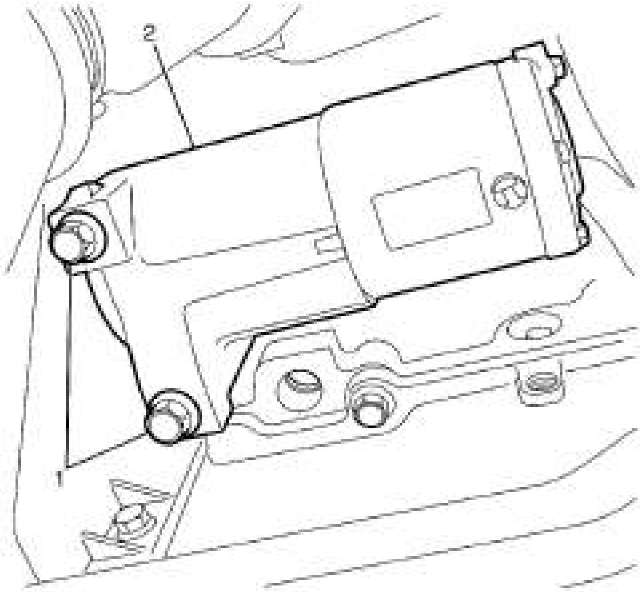
8. Remove starter motor to engine block retaining bolts (1).
9. Manoeuvre the starter motor (2) out and down between the transmission bell housing and body sub frame.

Installation Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

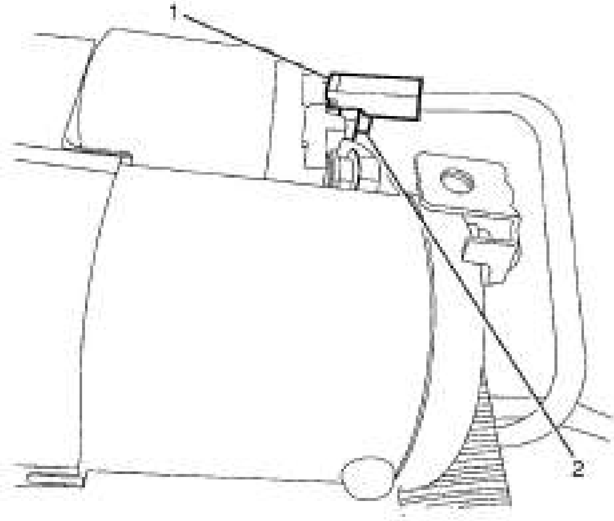


2. Manoeuvre the starter motor (2) Into position between the transmission bell housing and body sub frame.

   Notice: Refer to Fastener Notice in the Preface section.

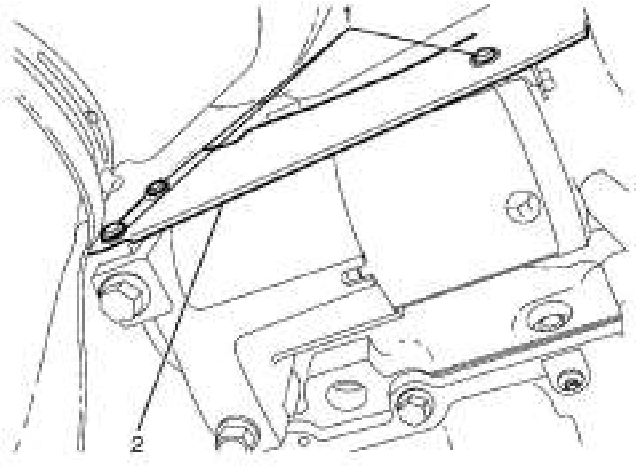
3. Install starter motor to bell housing retaining bolts (1).

   Tighten
   Tighten the bolts to xx N·m (xx lb ft).



4. Install the starter motor solenoid cable (2), to the starter motor solenoid terminal.
5. Install battery positive cable retaining nut (1) to the starter motor battery positive terminal.

Tighten
Tighten the solenoid cable nut to 10 N·m (7 lb ft).



6. Install the heat shield to the vehicle (2).
7. Install the heat shield to starter motor retaining bolts (1).

   Tighten
   Tighten the bolts to (5) N·m (44) lb in).

8. Install the right catalytic converter to the vehicle. Refer to Catalytic Converter Replacement - Right Side.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

9. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
10. Remove the safety stands.
11. Lower the vehicle to the ground.

Starter Shield Replacement

Removal Procedure

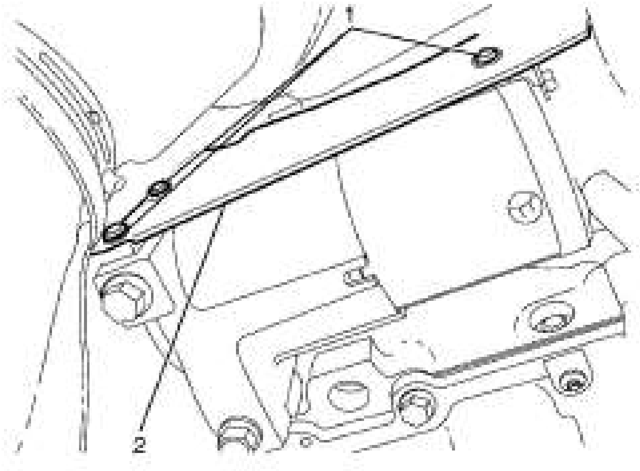
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .

Caution: Refer to Safety Glasses Caution in the Preface section.

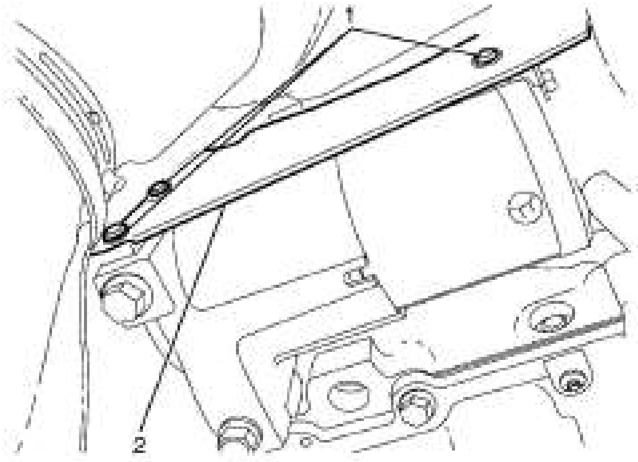
Caution: Refer to Vehicle Lifting Caution in the Preface section.

2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
3. Remove the right catalytic converter from the vehicle. Refer to Catalytic Converter Replacement - Right Side .



4. Remove the heat shield to starter motor retaining bolts (1).
5. Remove the heat shield (2) from the vehicle.

Installation Procedure



1. Install the heat shield (2) to the vehicle.
2. Install the heat shield to starter motor retaining bolts (1).

   Tighten
   Tighten the bolts to 30 N·m (22 lb ft).

3. Install the right catalytic converter to the vehicle. Refer to Catalytic Converter Replacement - Right Side .
4. Connect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .

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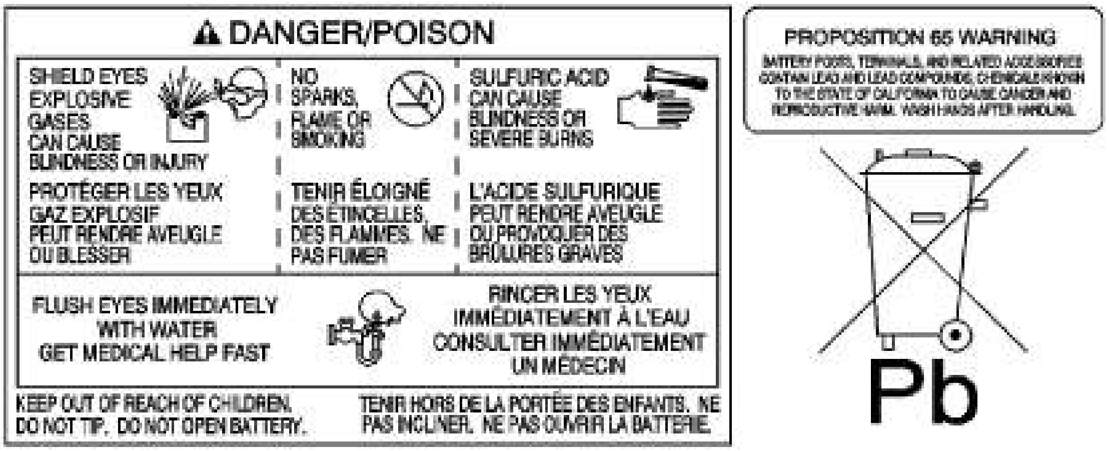
Battery Description and Operation


DANGER/POISON
SHIELD EYES EXPLOSIVE GASES CAN CAUSE BLINDNESS OR INJURY
PROTÉGER LES YEUX GAZ EXPLOSIF PEUT RENDRE AVEUGLE OU BLESSER
NO SPARKS, FLAME OR SMOKING
TENIR ÉLOIGNÉ DES ÉTINCELLES, DES FLAMMES. NE PAS FUMER
SULFURIC ACID CAN CAUSE BLINDNESS OR SEVERE BURNS
L'ACIDE SULFURIQUE PEUT RENDRE AVEUGLE OU PROVOQUER DES BRÛLURES GRAVES
FLUSH EYES IMMEDIATELY WITH WATER GET MEDICAL HELP FAST
RINCER LES YEUX IMMÉDIATEMENT À L'EAU CONSULTER IMMÉDIATEMENT UN MÉDECIN
KEEP OUT OF REACH OF CHILDREN. DO NOT TIP. DO NOT OPEN BATTERY.
TENIR HORS DE LA PORTÉE DES ENFANTS. NE PAS INCLINER. NE PAS OUVRIR LA BATTERIE.
PROPOSITION 65 WARNING
BATTERY POSTS, TERMINALS, AND RELATED ACCESSORIES CONTAIN LEAD AND LEAD COMPOUNDS, CHEMICALS KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER AND REPRODUCTIVE HARM. WASH HANDS AFTER HANDLING.
Pb

Caution: Batteries produce explosive gases. Batteries contain corrosive acid. Batteries supply levels of electrical current high enough to cause burns. Therefore, in order to reduce the risk of personal injury while working near a battery, observe the following guidelines:

- Always shield your eyes.
- Avoid leaning over the battery whenever possible.
- Do not expose the battery to open flames or sparks.
- Do not allow battery acid to contact the eyes or the skin.
  - Flush any contacted areas with water immediately and thoroughly.
  - Get medical help.

Important: Because of the materials used in the manufacture of automotive lead-acid batteries, dealers and service shops that handle them are subject to regulations issued by various state or local agencies. Other regulations may also apply in other locations. Always know and follow these regulations when handling batteries.

Batteries that are no longer wanted must be disposed of by an approved battery recycler and must never be thrown in the rubbish or sent to a land-fill.

Batteries that are not part of the vehicle itself, not the battery under the hood, must only be transported on public streets for business purposes via approved hazardous material transportation procedures.

Battery storage, charging and testing facilities in repair shops must meet various requirements for ventilation, safety equipment, material segregation, etc.

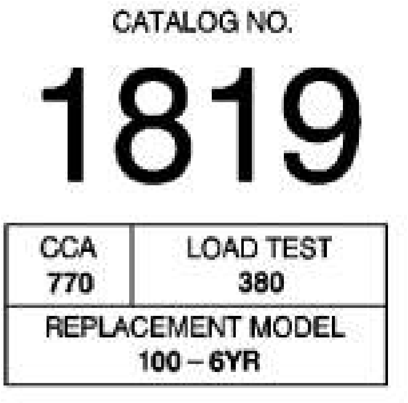
The maintenance-free battery has no vent plugs in the cover. The battery is completely sealed except for 2 small vent holes in the side. These vent holes allow the small amount of gas that is produced in the battery to escape.

The battery has 3 functions as a major source of energy:

- Engine cranking
- Voltage stabilizer
- Alternate source of energy with alternator overload

The battery specification label, example below, contains information about the following:

- The test ratings
- The original equipment catalogue number
- The recommended replacement model number


CATALOG NO.

1819

CCA	LOAD TEST
770	380

REPLACEMENT MODEL
100 – 6YR

Battery Ratings

A battery may have 3 ratings:

- Amp Hour (AH)
- Reserve Capacity (RC)
- Cold Cranking Amperage (CCA)

When a battery is replaced, use a battery with the same ratings. Refer to the battery specification label on the original battery or refer to Battery Usage .

Amp Hour (AH)

The amp hour rating of a battery is the amount of time it takes a fully charged battery, being discharged at a constant rate of 1 amperes and a constant temperature of 27°C (80°F), to reach a terminal voltage of 10.5 volts. Refer to Battery Usage for the amp hour rating of the original equipment battery.

Reserve Capacity (RC)

Reserve capacity is the amount of time in minutes it takes a fully charged battery, being discharged at a constant rate of 25 amperes and a constant temperature of 27°C (80°F), to reach a terminal voltage of 10.5 volts. Refer to Battery Usage for the reserve capacity rating of the original equipment battery.

Cold Cranking Amperage (CCA)

The cold cranking amperage is an indication of the ability of the battery to crank the engine at cold temperatures. The cold cranking amperage rating is the minimum amperage the battery must maintain for 30 seconds at -18°C (0°F) while maintaining at least 7.2 volts. Refer to Battery Usage for the cold cranking amperage rating for this vehicle.

Police Package Special Equipment Battery Options

Important: GM cannot be held responsible for any changes made to the vehicle. All electrical and body modifications must be preformed by experience and qualified technicians.

- Be sure that any modified or added wiring will not impact the function of the vehicles factory wiring system.
- See that all wiring is correctly protected by fuses, and not causing a overload to connectors and components.
- Do not route wiring in areas of the vehicle where temperatures can be high or where wiring may be cut, pinched or rubbed.
- See that all wiring is of the same or smaller gauge to that of the wire it is being attached to for correct fuse protection.
- Be sure that all holes drilled in the body are correctly sealed and corrosion protected. See that the vehicles wiring harnesses, piping, and other components have not been displaced or damaged during customer installation of equipment and wiring.
- See that the vehicles wiring harnesses, piping, and other components have not been displaced or damaged during customer installation of equipment and wiring.

Electrical Connections

Overloading the vehicles electrical system may damage the vehicles accessories. Do not overload the vehicles system by having unnecessary accessories at the same time.

Auxiliary Battery

The auxiliary battery is located in the rear compartment in the right hand side quarter panel cavity. The auxiliary battery has a secondary fuse box attached to the right hand side of the battery tray. The function of the auxiliary battery is to supply power to all of the after market components fitted to the vehicle:

- Sirens.
- Flashing lights (Front, rear and roof).

- Two way radio.
- Speed detector.

Battery Isolator

The electrical system has a battery isolator located in the rear compartment mounted on the left hand side quarter panel, the isolator should be mounted as close as possible to the Start Battery with the coil terminal facing up or horizontal. The battery isolator is designed to protect the Start Battery from excessive discharge whist allowing the auxiliary battery to supply non-essential loads. The battery isolator detects the Start Battery voltage when it drops below 12.7 Volts on a 12V system (25.4 volts on a 24V system) the solenoid will open, separating the Start Battery from the auxiliary battery. Once the engine has been started the battery isolator monitors the Start Battery and the charging system. When the charging system reaches 13.6V (27.2 Volts on a 24V system) indicating a fully charge Start Battery, the battery isolator will close the solenoid connecting the auxiliary battery to the Start Battery and the charging system.

Charging System Description and Operation

Electrical Power Management (EPM) Overview

The Electrical Power Management (EPM) system is designed to monitor and control the charging system and send diagnostic messages to alert the driver of a possible fault with the battery and/or alternator. This EPM system primarily utilizes existing on-board computer capability to maximize the effectiveness of the alternator, to manage the load, improve battery State Of Charge (SOC) and minimize the system's impact on fuel economy. The EPM system performs 3 functions:

- It monitors the battery voltage and estimates the battery condition.
- It takes corrective actions by boosting idle speeds and adjusting the regulated voltage.
- It performs diagnostics and driver notification.

The battery condition is estimated during ignition-off and during ignition-on. During ignition-off the State Of Charge (SOC) of the battery is determined by measuring the open circuit voltage. The SOC is a function of the acid concentration and the internal resistance of the battery and is estimated by reading the battery open circuit voltage when the battery has been at rest for several hours.

The SOC can be used as a diagnostic tool to tell the customer or the dealer the condition of the battery. Throughout ignition-on, the algorithm continuously estimates SOC based on adjusted net amp hours, battery capacity, initial SOC, and temperature.

While running, the battery degree of discharge is primarily determined by a battery current sensor, which is integrated to obtain net amp hours.

In addition, the EPM function is designed to perform Regulated Voltage Control (RVC) to improve battery SOC, battery life and fuel economy. This is accomplished by using knowledge of the battery SOC and temperature to set the charging voltage to an optimum battery voltage level for recharging without detriment to battery life.

The Charging System Description and Operation is divided into 3 sections. The first section describes the charging system components and their integration into the EPM. The second section describes charging system operation. The third section describes the Instrument Panel Cluster (IPC) operation of the charge indicator, Driver Information Centre (DIC) messages and voltmeter operation if equipped.

Charging System Components

Alternator

The alternator is not a serviceable component. If there is a diagnosed failure of the alternator it must be replaced as an assembly. The engine drive belt drives the alternator. When the rotor is spun it induces an alternating current (AC) into the stator windings. This AC current then passes through a series of diodes and is converted to a direct current (DC) for use by the vehicle electrical systems. This DC voltage also charges the battery when the engine is running. The alternator output is monitored and controlled by the BCM.

Body Control Module (BCM)

The Body Control Module (BCM) is a LAN device. It communicates with the engine control module (ECM) and the instrument panel cluster (IPC) for electrical power management (EPM) operation. The BCM determines the output of the alternator and sends the information to the ECM for control of the alternator field control circuit. It monitors the alternator field duty cycle signal circuit information sent from the ECM for control of the alternator. It also monitors the battery current sensor, the battery positive voltage circuit and estimated battery temperature to determine the battery state of charge (SOC).

Battery Current Sensor

The battery current sensor is a serviceable component that is located on the negative battery cable. The battery current sensor is a 3-wire Hall effect current sensor and monitors the battery current. It directly inputs to the BCM. It creates a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes.

Engine Control Module (ECM)

The ECM directly controls the alternator field control circuit input to the alternator. The ECM receives control decisions based on messages from the BCM. It monitors the alternators alternator field duty cycle signal circuit and sends the information to the BCM.

Instrument Panel Cluster (IPC)

The IPC provides a means of customer notification in case of a failure and a voltmeter if equipped. There are 2 means of notification, a charge indicator and a driver information centre (DIC) message of SERVICE BATTERY CHARGING SYSTEM.

Charging System Operation

The purpose of the charging system is to maintain the battery charge and vehicle loads. There are 6 modes of operation and they include:

- Battery Sulfation Mode
- Charge Mode
- Fuel Economy Mode
- Headlamp Mode
- Start Up Mode
- Voltage Reduction Mode

The engine control module (ECM) controls the alternator through the alternator field control circuit. It monitors the alternator performance though the alternator field duty cycle signal circuit. The ECM controls the alternator through the alternator field control circuit. The signal is a 5 volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes. The following table shows the commanded duty cycle and output voltage of the alternator:

Commanded Duty Cycle	alternator Output Voltage

10%	11 V
20%	11.56 V
30%	12.12 V
40%	12.68 V
50%	13.25 V
60%	13.81 V
70%	14.37 V
80%	14.94 V
90%	15.5 V

The alternator provides a feedback signal of the alternator voltage output through the alternator field duty cycle signal circuit to the ECM. This information is sent to the body control module (BCM). The signal is a 5-volt PWM signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-99 percent. Between 0-5 percent and 100 percent are for diagnostic purposes.

Battery Sulfation Mode

The BCM will enter this mode when the interpreted alternator output voltage is less than 13.2 volts for 45 minutes. When this condition exists the BCM will enter Charge Mode for 2-3 minutes. The BCM will then determine which mode to enter depending on voltage requirements.

Charge Mode

The BCM will enter Charge Mode when ever one of the following conditions are met.

- The wipers are ON for than 3 seconds.
- GMLAN (Climate Control Voltage Boost Mode Request) is true, as sensed by the HVAC control head. High speed cooling fan, rear defogger and HVAC high speed blower operation can cause the BCM to enter the Charge Mode.
- The estimated battery temperature is less than 0°C (32°F).
- Battery State of Charge is less than 80 percent.
- Vehicle Speed is greater than 145 kph (90 mph)
- Current Sensor Fault Exists
- System Voltage was determined to be below 12.56 volts

When any one of these conditions is met, the system will set targeted alternator output voltage to a charging voltage between 13.9-15.5 volts, depending on the battery state of charge and estimated battery temperature.

Fuel Economy Mode

The BCM will enter Fuel Economy Mode when the estimated battery temperature is at least 0°C (32°F) but less than or equal to 80°C (176°F), the calculated battery current is less than 15 amps and greater than -8 amps, and the battery state of charge (SOC) is greater than or equal to 80 percent. Its targeted alternator output voltage is the open circuit voltage of the battery and can be between 12.5-13.1 volts. The BCM will exit this mode and enter Charge Mode when any of the conditions described above are present.

Headlamp Mode

The BCM will enter Headlamp Mode when ever the headlamps are ON (high or low beams). Voltage will be regulated between 13.9-14.5 volts

Start Up Mode

When the engine is started the BCM sets a targeted alternator output voltage of 14.5 volts for 30 seconds.

Voltage Reduction Mode

The BCM will enter voltage reduction mode when the calculated ambient air temperature is above 0°C (32°F). The calculated battery current is less than 1 amp and greater than -7 amps, and the alternator field duty cycle is less than 99 percent. Its targeted alternator output voltage is 12.9 volts. The BCM will exit this mode once the criteria are met for Charge Mode.

Instrument Panel Cluster (IPC) Operation

Charge Indicator Operation

The instrument panel cluster (IPC) illuminates the charge indicator and displays a warning message in the driver information centre (DIC) when the one or more of the following occurs:

- The engine control module (ECM) detects that the alternator output is less than 11 volts or greater than 16 volts. The IPC receives a GMLAN message from the ECM requesting illumination.
- The IPC determines that the system voltage is less than 11 volts or greater than 16 volts for more than 30 seconds. The IPC receives a GMLAN message from the body control module (BCM) indicating there is a system voltage range concern.
- The IPC performs the displays test at the start of each ignition cycle. The indicator illuminates for approximately 3 seconds.
- The ignition is ON, with the engine OFF.

Battery Voltage

The IPC displays the system voltage as received from the BCM over the GMLAN serial data circuit. If there is no communication with the BCM then the display will read all dashes until communication is restored.

SERVICE BATTERY CHARGING SYSTEM

The BCM and the ECM will send a GMLAN message to the DIC for the SERVICE BATTERY CHARGING SYSTEM message to be displayed. It is commanded ON when a charging system DTC is a current DTC. The message is turned OFF when the conditions for clearing the DTC have been met.

Starting System Description and Operation

The starter motor is a non-repairable unit. the starter motor has pole pieces that are arranged around the armature. Both solenoid windings are energized. The pull-in winding circuit is completed to the ground through the starter motor. The windings work together magnetically to pull and hold in the plunger. The plunger moves the shift lever. This action causes the starter drive assembly to rotate on the armature shaft spline as it engages with the flywheel ring gear/flex plate on the engine. Moving at the same time, the plunger also closes the solenoid switch contacts in the starter solenoid. Full battery voltage is applied directly to the starter motor and it cranks the engine.

As soon as the solenoid switch contacts close, current stops flowing thorough the pull-in winding because battery voltage is applied to both ends of the windings. The hold-in winding remains energized. Its magnetic field is strong enough to hold the plunger, shift lever, starter drive assembly, and solenoid switch contacts in place to continue cranking the engine. When the engine starts, pinion overrun protects the armature from over run until the switch is opened.

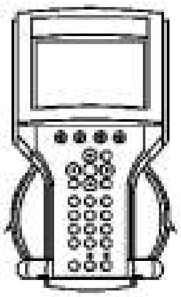
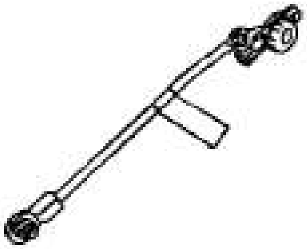
When the ignition switch is released from the START position, the START relay opens and battery voltage is removed from the starter solenoid terminal. Current flows from the motor contacts through both windings to the ground at the end of the hold-in winding. However, the direction of the current flow through the pull-in winding is now opposite the direction of the current flow when the winding was first energized.

The magnetic fields of the pull-in and hold-in windings now oppose one another. This action of the windings, along with the help of the return spring, causes the starter drive assembly to disengage and the solenoid switch contacts to open simultaneously. As soon as the contacts open, the starter circuit is turned off.

Circuit Description (Key Start)

When the ignition switch is placed in the Start position, a discrete 12 volt signal is supplied to the body control module (BCM) notifying it that the ignition is in the Start position. The BCM then sends a message to the engine control module (ECM) notifying it that CRANK has been requested. The ECM verifies that the transmission is in Park or Neutral. If it is the ECM then supplies 12 volts to the control circuit of the crank relay. When this occurs, battery positive voltage is supplied through the switch side of the crank relay to starter solenoid.

Special Tools

Illustration	Tool Number / Description
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.
	J 38758 Parasitic Draw Test Switch

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Catalytic Converter to Exhaust Manifold Retaining Nuts (3.6L Engine)	45 N·m	33 lb ft
Catalytic Converter to Exhaust Manifold Retaining Nuts (6.0L Engine)	45 N·m	33 lb ft
Centre Exhaust Heat Shield to Body Retaining Bolts	4 N·m	35 lb in
Centre Insulator Hanger Bracket to Differential Retaining Bolt	45 N·m	33 lb ft
Exhaust Manifold Heat Shield to Exhaust Manifold Retaining Bolts (3.6L Engine)	10 N·m	89 lb in
Exhaust Manifold Heat Shield to Exhaust Manifold Retaining Bolts (6.0L Engine)	10 N·m	89 lb in
Exhaust Manifold to Cylinder Head Retaining Bolts (3.6L Engine)	20 N·m	15 lb ft
Exhaust Manifold to Cylinder Head Retaining Bolts (6.0L Engine)	20 N·m	15 lb ft
Exhaust Muffler Heat Shield to Body Retaining Bolts	4 N·m	35 lb in
Front Exhaust Foil Heat Shield to Body Retaining Bolt	4 N·m	35 lb in
Fuel Tank Heat Shield to Fuel Tank Retaining Nuts	4 N·m	35 lb in
Intermediate Exhaust Assembly to Catalytic Converter Retaining Nuts	40 N·m	30 lb ft
Rear Insulator Hanger Bracket to Body Retaining Bolts	26 N·m	19 lb ft
Rear Muffler to Intermediate Exhaust Assembly Retaining Nuts	45 N·m	33 lb ft

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Diagnostic Starting Point - Engine Exhaust

Begin the system diagnosis by reviewing the exhaust system description and operation. Reviewing the information will help you determine the correct symptom diagnostic procedure when a malfunction exists. It will also help you determine if the condition described by the customer is normal operation. To identify the correct procedure for diagnosing the system, refer to Symptoms - Engine Exhaust.

Symptoms - Engine Exhaust

- Review the exhaust system description and operation in order to familiarise yourself with the system functions. Refer to Exhaust System Description.
- All diagnostics on a vehicle should follow a logical process. Strategy based diagnostics is a uniform approach for repairing all systems. The diagnostic flow is the place to start when repairs are necessary and may always be used in order to resolve a system problem. For a detailed explanation, refer to Strategy Based Diagnosis.

Visual / Physical Inspection

- Inspect for aftermarket or non-OEM devices. These could affect the operation and performance of the exhaust system.
- Verify the exact operating conditions under which the concern exists. Note factors such as engine RPM, engine temperature, engine load, and frequency of concern.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause any symptom.

Intermittent

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating as designed.

Symptom List

For the following symptoms, refer to Restricted Exhaust

- Loss of Power
- Poor fuel economy
- Poor acceleration

For the following symptoms, refer to Exhaust Leakage.

- Exhaust hissing
- Exhaust popping

For the following symptoms, refer to Exhaust Noise.

- Exhaust rattle
- Loud exhaust
- Exhaust buzz, groan or hum

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Restricted Exhaust

Tools Required

J 35314-A Exhaust Back Pressure Gauge

Diagnostic Aids

Caution: Refer to Hot Exhaust System Caution in the Preface section.

For dual exhaust systems a quick check of exhaust flow will help determine which side of the exhaust system is restricted. The side that has less exhaust flow is the side that will be suspect, and diagnosis should begin there.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. The exhaust system has very low back pressure under normal conditions. If the exhaust system is restricted, a significant increase in the exhaust pressure is noticed on the J 35314-A .

   Removing the heated oxygen sensor may set a DTC. When finishing this diagnostic table all codes must be cleared.

4. This step will isolate the catalytic converter from the remainder of the exhaust system.

7. Confirming that the condition has been fixed is essential. If the symptom still exists and the vehicle has a dual exhaust system, proceed to Step 2 and repeat diagnostic procedure on the opposite exhaust pipe.

Step	Action	Value(s)	Yes	No
1	Did you verify the customers complaint?	--	Go to Step 2	--
2	Did you review the exhaust symptoms diagnostic information and perform the necessary inspections?	--	Go to Step 3	Go to Symptoms - Engine Exhaust.
	1. Remove the pre-catalytic converter heated oxygen sensor (HO2S) that is in front of and closest to the catalytic converter. Refer to the appropriate procedure. • Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 or Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 for 3.6L engine. • Heated Oxygen Sensor Replacement -			

3	• Bank 1 Sensor 1 or Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 for 6.0L engine. 2. Install the J 35314-A in place of the pre-catalytic converter heated oxygen sensor (HO2S). 3. Start the engine. 4. Increase and monitor the engine speed at 2,500 RPM. 5. Observe the exhaust system back pressure reading on the gauge. Does the reading exceed the specified value?	9 kPa (1.25 psi)	Go to Step 4	Go to Step 7
4	1. Turn the engine off and place the ignition in the OFF position. 2. Remove the J 35314-A . 3. Re-install the pre-catalytic converter heated oxygen sensor (HO2S). Refer to the appropriate procedure. • Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 or Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 for 3.6L engine. • Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 or Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 for 6.0L engine. 4. Remove the post-catalytic converter heated oxygen sensor (HO2S). Refer to the appropriate procedure. • Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 or Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 for 3.6L engine. • Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 or Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 for 6.0L engine. 5. Install the J 35314-A in place of the pre-catalytic converter heated oxygen sensor (HO2S). 6. Start the engine. 7. Increase and monitor the engine speed at 2,500 RPM. 8. Observe the exhaust system back pressure reading on the gauge. Does the reading exceed the specified value?	9 kPa (1.25 psi)	Go to Step 5	Go to Step 6
	Inspect the exhaust system for the following conditions: • Damage in the exhaust pipe			

5	• Debris in the exhaust pipe • Muffler or resonator internal failure • Two-layer exhaust pipe separation Did you find and correct the condition?	--	Go to Step 7	--
6	Replace the catalytic converter. Refer to Catalytic Converter Replacement - Left Side, Catalytic Converter Replacement - Right Side. Did you find and correct the condition?	--	Go to Step 7	--
7	1. Remove the J 35314-A . 2. Re-install the applicable heated oxygen sensor (HO2S). Refer to the appropriate procedure. • Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 or Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 for 3.6L engine. • Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 or Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 for 6.0L engine. 3. If re-programming is required. Refer to Control Module References. 4. Clear any codes. 5. Road test the vehicle in order to verify the repair. Did you correct the condition?	--	System OK	Go to Step 2

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Exhaust Leakage

Problem	Action
Caution: Refer to Hot Exhaust System Caution in the Preface section. DEFINITION: An exhaust leak may show stains at the area of the leak. The leak may be felt by holding a hand close to the suspected areas or using a smoke pencil. The leak may make a popping or hissing noise. Refer to Symptoms - Engine Exhaust, prior to beginning this table.	
Misaligned or incorrectly installed exhaust system components	• Align and tighten the exhaust system components to the required specifications. Refer to Fastener Tightening Specifications. • Make sure the exhaust hangers are in the proper locations and not loose. Refer to Exhaust System Insulator, Hanger, Bracket Replacement or Exhaust Hanger Mounting Bracket Replacement.
Exhaust leaks at the following connections: • Exhaust manifold to pipe • Flanges	Tighten the affected components to the required specifications. Refer to Fastener Tightening Specifications.
Seals or gaskets leaking • Exhaust manifold to cylinder head • Exhaust pipes to exhaust manifold • Catalytic converter connection	Replace the leaking seal or gasket. Refer to the affected components repair procedure for service.
Irregularities at the mating surfaces on the flange connections	Repair as required or replace the affected component. Refer to the affected components repair procedure for service.
Exhaust manifold cracked or broken	Replace the exhaust manifold. Refer to Exhaust Manifold Replacement - Left Side, Exhaust Manifold Replacement - Right Side, Exhaust Manifold Replacement - Left Side or Exhaust Manifold Replacement - Right Side.
Exhaust system component connection welds leaking	Replace the leaking component. Refer to the affected component's procedure for service.
Muffler or resonator, if equipped, damaged or leaking at the seams	Replace the affected muffler. Refer to Exhaust Muffler Replacement - Left Side or Exhaust Muffler Replacement - Right Side.

Exhaust Noise

Condition	Action
Caution: Refer to Hot Exhaust System Caution in the Preface section. DEFINITION: An audible or physical noise due to a faulty component or damaged components causing a loose or misaligned exhaust system resulting in a rattle or vibration noise, i.e. buzz, groan, hum. Refer to Symptoms - Engine Exhaust , prior to beginning this table.	
Popping or hissing noise	Exhaust leak. Refer to Exhaust Leakage .
Loud exhaust	1. Compare to a known good vehicle. 2. Inspect for a damaged or failed muffler. 3. Replace the faulty muffler. Refer to Exhaust Muffler Replacement - Left Side or Exhaust Muffler Replacement - Right Side
External rattle or vibration noise	1. Inspect for a bent or loose hanger, loose heat shield, or loose clamp. 2. Inspect for an exhaust pipe causing interference. 3. Repair or replace the affected component. Refer to the affected component's service procedure.
Internal rattle	1. Test the components by tapping with a rubber mallet to confirm a rattle. 2. Replace the faulty catalytic converter, or muffler. Refer to one of the following procedures: • Catalytic Converter Replacement - Left Side . • Catalytic Converter Replacement - Right Side . • Exhaust Muffler Replacement - Left Side . • Exhaust Muffler Replacement - Right Side .

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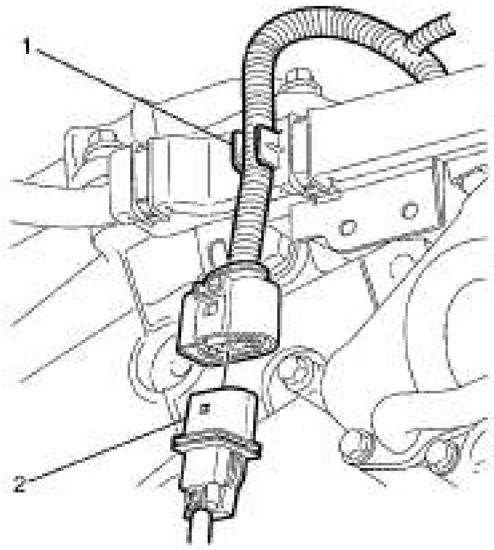
Catalytic Converter Replacement - Left Side (3.6L Engine)

Removal Procedure

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
2. Remove the engine dress cover. Refer to Engine Cover Replacement .

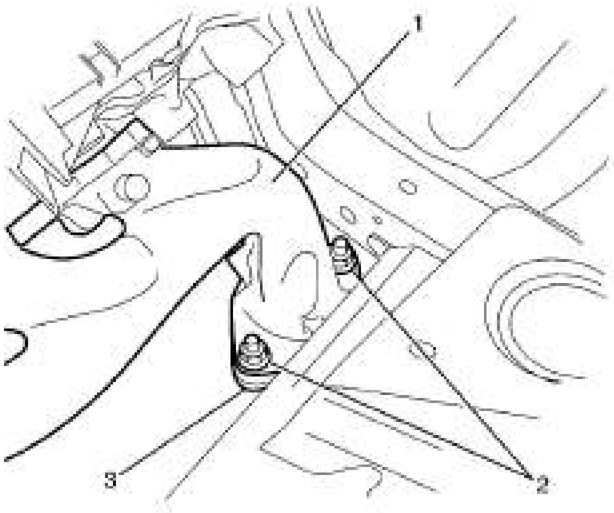
Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.



3. Remove the left pre-catalytic converter heated oxygen sensor (HO2S) wiring loom from the engine wiring loom retaining clip (1).
4. Disconnect the left pre-catalytic converter heated oxygen sensor (HO2S) wiring connector (2) from the main wiring harness.

Caution: Refer to Exhaust Service Caution in the Preface section.

Caution: Refer to Protective Goggles and Glove Caution in the Preface section.



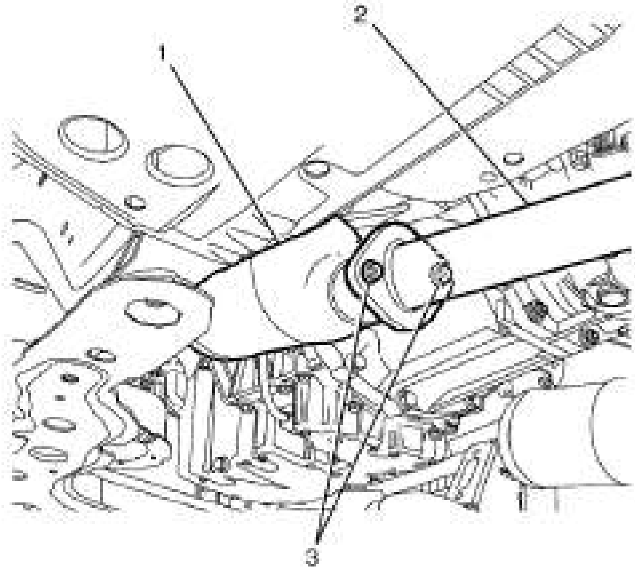
Important: The left catalytic converter to exhaust manifold retaining nuts (2) are single use parts. They must be discarded after removal.

5. Remove the left catalytic converter to exhaust manifold retaining nuts (2).

   Discard the nuts.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

6. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
7. Pull down and back on the left catalytic converter (3) to disconnect from the exhaust manifold (1).

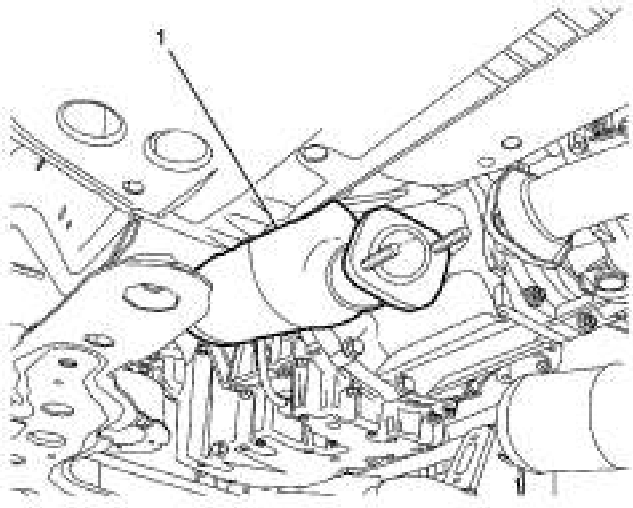


Important: The intermediate exhaust assembly to left catalytic converter retaining nuts (3) are single use parts. They must be discarded after removal.

8. Remove the intermediate exhaust assembly to left catalytic converter retaining nuts (3).

   Discard the nuts.

9. Disconnect the intermediate exhaust assembly (2) from the left catalytic converter (1).

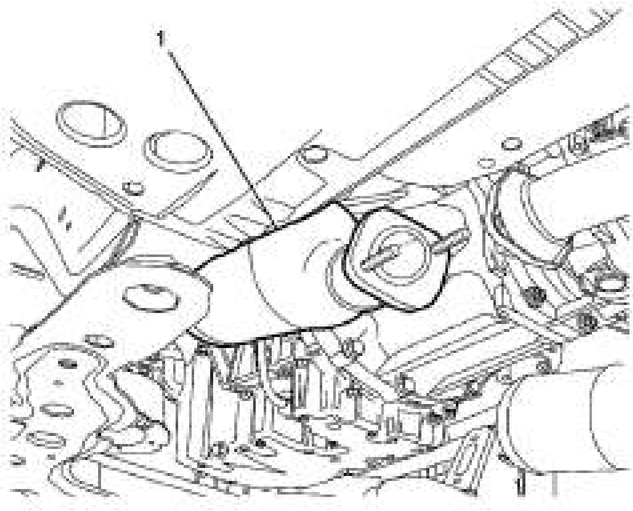


10. Remove the left catalytic converter (1) from the vehicle.
11. Remove the left pre-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 .

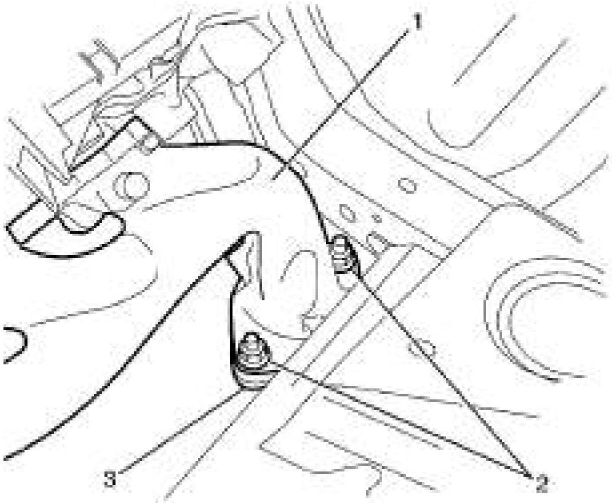
Installation Procedure

Notice: Refer to Exhaust Service Caution in the Preface section.

1. Install the left pre-catalytic converter HO2S to the left catalytic converter. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 .



2. Install the left catalytic converter (1) to the vehicle.



Important: Make sure that a NEW sealing ring is fitted prior to installation. Failure to comply may cause the exhaust system to perform poorly.

3. Lift the left catalytic converter (3) up and forward to connect to the exhaust manifold (1).
4. Lower the vehicle.

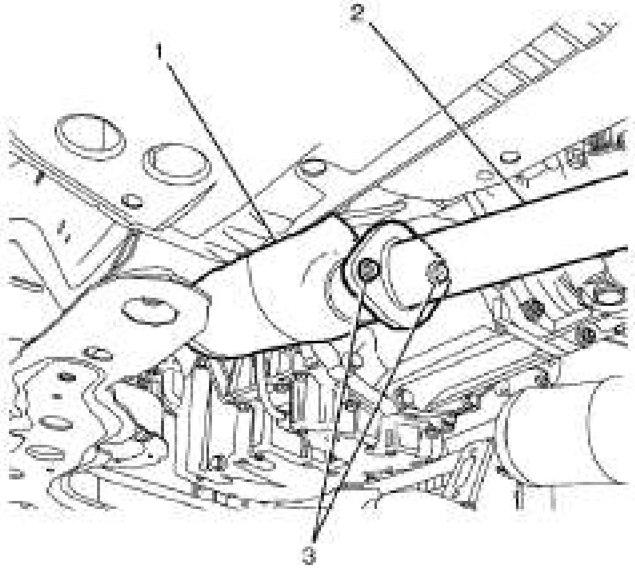
Important: Do not fully tighten the left catalytic converter to exhaust manifold retaining nuts (2) at this stage.

5. Install the left catalytic converter to exhaust manifold retaining nuts (2).

Do not fully tighten at this stage.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

6. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



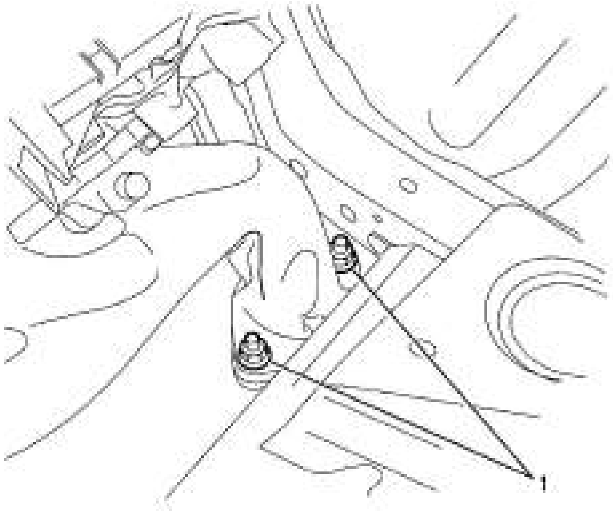
7. Align the intermediate exhaust assembly (2) to the left catalytic converter (1).

Notice: Refer to Fastener Notice in the Preface section.

8. Tighten the intermediate exhaust assembly to left catalytic converter retaining nuts (3).

Tighten
Tighten the nuts to 40 N·m (30 lb ft).

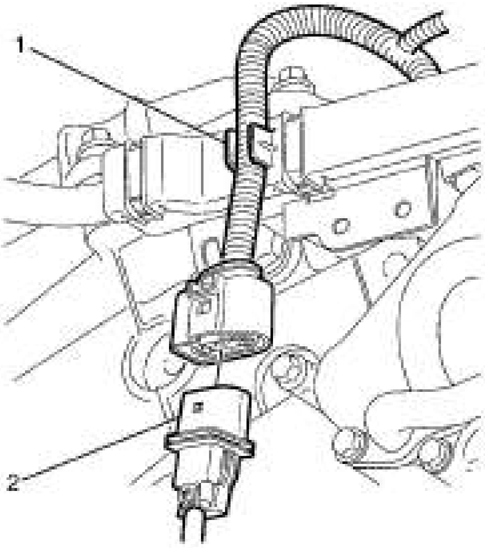
9. Lower the vehicle.



10. Tighten the left catalytic converter to exhaust manifold retaining nuts (1).

    Tighten
    Tighten the nuts to 45 N·m (33 lb ft).

11. Make sure that the exhaust system is clear of all other components and chassis. If the exhaust system is not clear of all the other components loosen all retaining nuts and re-align. Refer to Exhaust System Alignment .
12. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



13. Connect the left pre-catalytic converter heated oxygen sensor (HO2S) wiring connector (2) to the main wiring harness.
14. Install the left pre-catalytic converter heated oxygen sensor (HO2S) wiring loom to the engine wiring loom retaining clip (1).
15. Lower the vehicle.
16. Install the engine dress cover. Refer to Engine Cover Replacement .
17. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
18. If re-programming is required. Refer to Control Module References .
19. Perform diagnostic system check using diagnostic scan tool, clear all relative DTCs and inspect the system for correct operation.

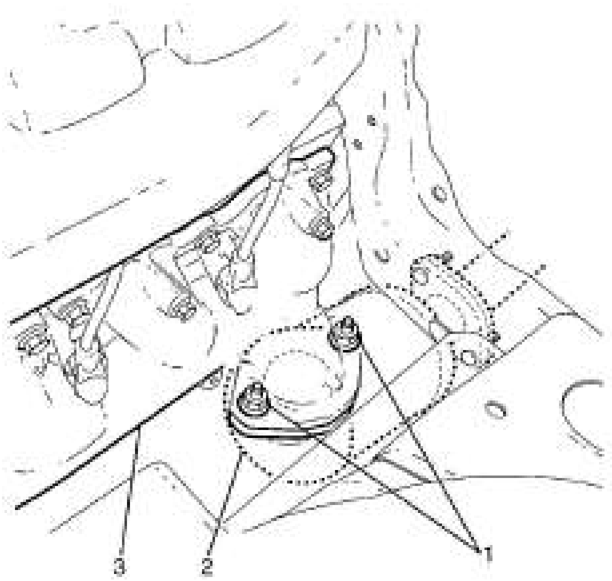
Catalytic Converter Replacement - Left Side (6.0L Engine)

Removal Procedure

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .

   Caution: Refer to Exhaust Service Caution in the Preface section.

   Caution: Refer to Protective Goggles and Glove Caution in the Preface section.



Important: The left catalytic converter to exhaust manifold retaining nuts (1) are single use parts. They must be discarded after removal.

2. Remove the left catalytic converter to exhaust manifold retaining nuts (1).

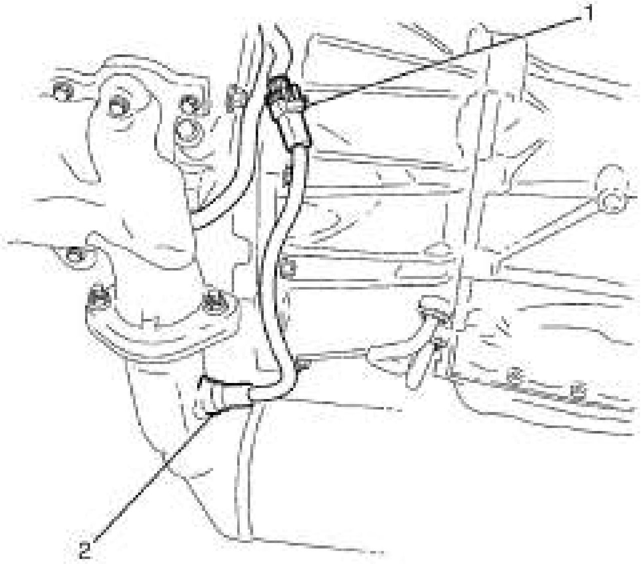
   Discard the nuts.

3. Disconnect the left catalytic converter (2) from the exhaust manifold (3).

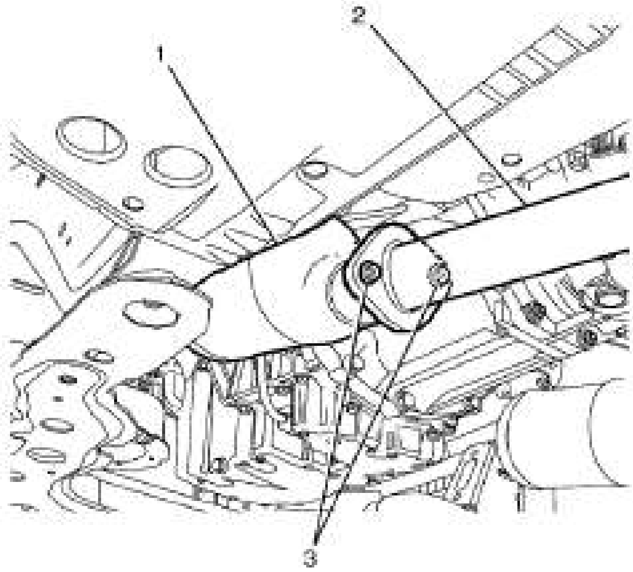
   Caution: Refer to Vehicle Lifting Caution in the Preface section.

4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

   Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.



5. Disconnect the left pre-catalytic converter heated oxygen sensor (HO2S) electrical connector (1).

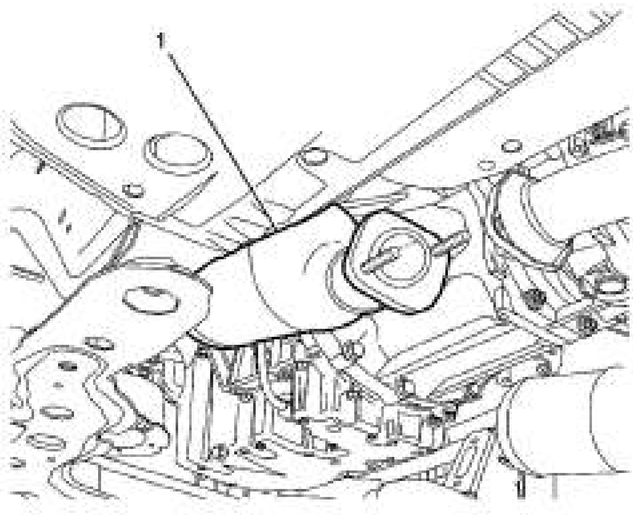


Important: The intermediate exhaust assembly to left catalytic converter retaining nuts (3) are single use parts. They must be discarded after removal.

6. Remove the intermediate exhaust assembly to left catalytic converter retaining nuts (3).

   Discard the nuts.

7. Disconnect the intermediate exhaust assembly (2) from the left catalytic converter (1).

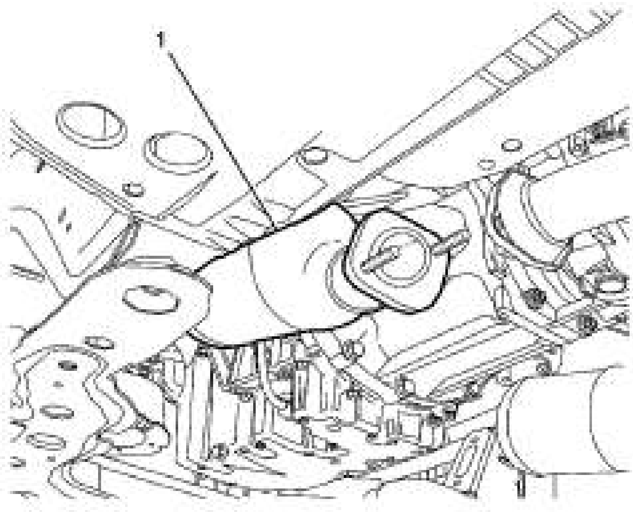


8. Remove the left catalytic converter (1) from the vehicle.
9. Remove the left pre-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 1.

Installation Procedure

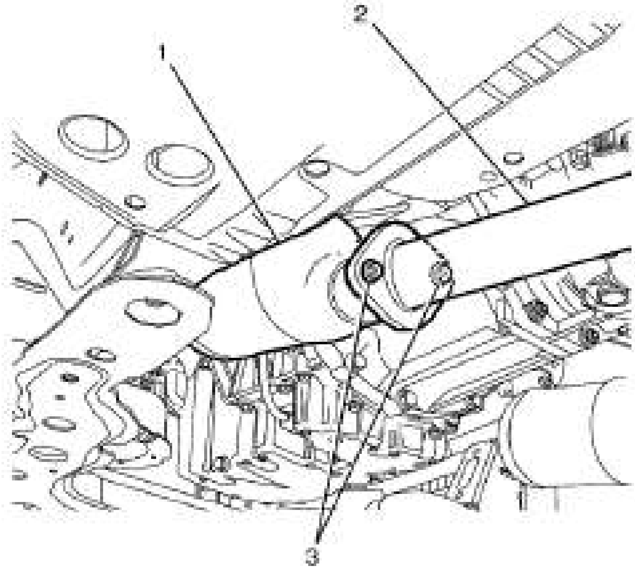
1. Install the left pre-catalytic converter HO2S to the left catalytic converter. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 1.

   Caution: Refer to Exhaust Service Caution in the Preface section.

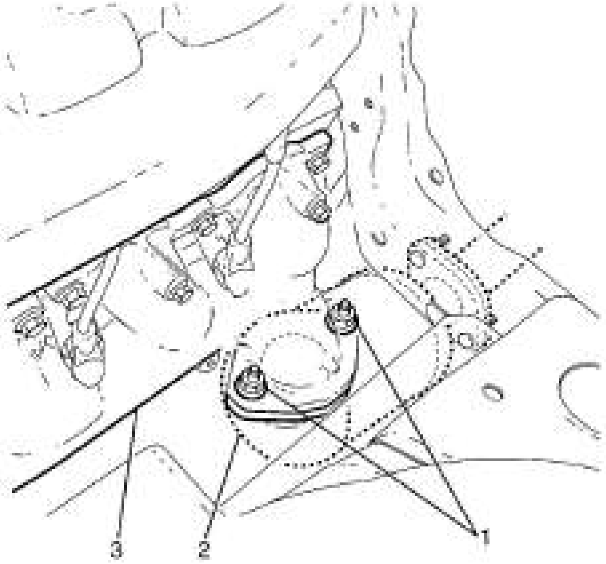


Important: Make sure that a new sealing ring is fitted prior to installation. Failure to comply may cause the exhaust system to perform poorly.

2. Install the left catalytic converter (1) to the vehicle.



3. Align the intermediate exhaust assembly (2) to the left catalytic converter (1) by pushing back and down on the intermediate exhaust assembly (2).



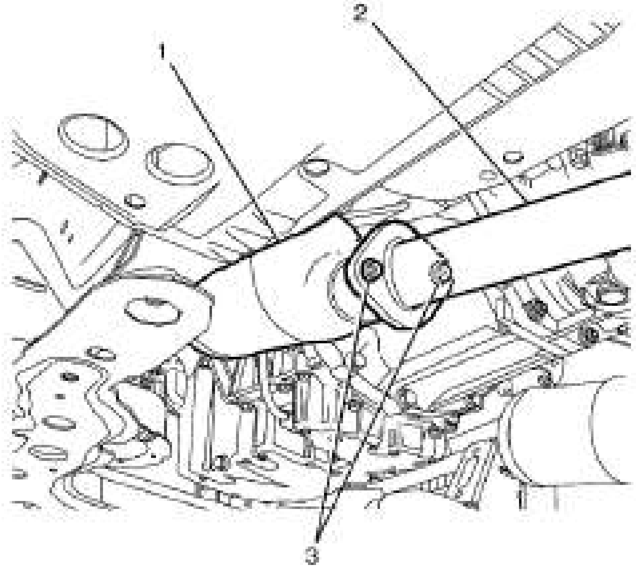
4. Push up and forward on the left catalytic converter (2) to connect to the exhaust manifold (3).
5. Lower the vehicle.
6. Install the left catalytic converter to exhaust manifold retaining nuts (1).
7. Tighten the left catalytic converter to exhaust manifold retaining nuts (1).

Tighten

Tighten the nuts to 45 N·m (33 lb ft).

Caution: Refer to Vehicle Lifting Caution in the Preface section.

8. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

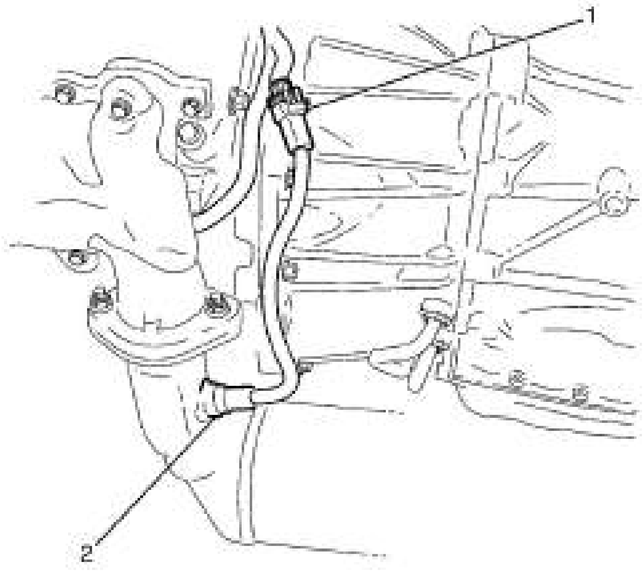


9. Install the intermediate exhaust assembly to left catalytic converter retaining nuts (3).

Notice: Refer to Fastener Notice in the Preface section.

10. Tighten the intermediate exhaust assembly to left catalytic converter retaining nuts (3).

Tighten
Tighten the nuts to 40 N·m (30 lb ft).



11. Connect the left pre-catalytic converter HO2S electrical connector (1).
12. Make sure that the exhaust system is clear of all other components and chassis. If the exhaust system is not clear of all the other components loosen all retaining nuts and re-align. Refer to Exhaust System Alignment .
13. Lower the vehicle to the ground.
14. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
15. If re-programming is required. Refer to Control Module References .
16. Perform diagnostic system check using diagnostic scan tool, clear all relative DTCs and inspect the system for correct operation.

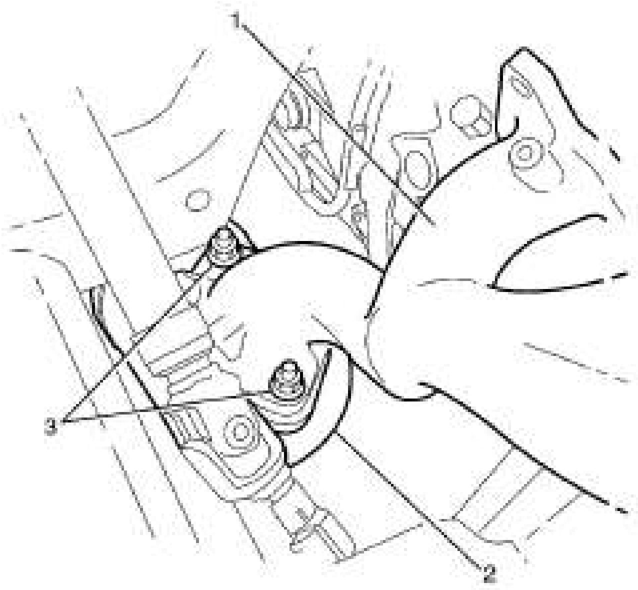
Catalytic Converter Replacement - Right Side (3.6L Engine)

Removal Procedure

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
2. Remove the engine dress cover. Refer to Engine Cover Replacement .

Caution: Refer to Exhaust Service Caution in the Preface section.

Caution: Refer to Protective Goggles and Glove Caution in the Preface section.



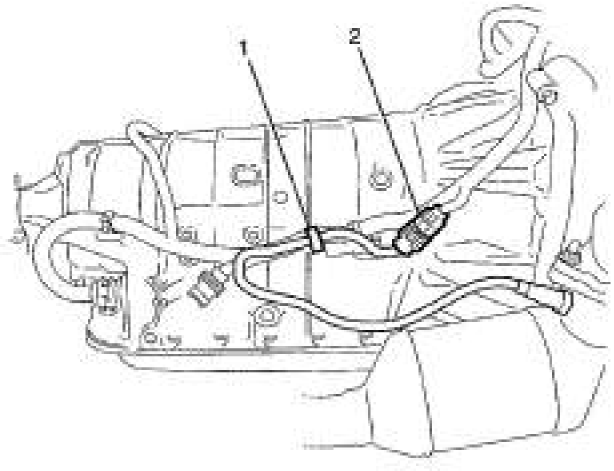
Important: The right catalytic converter to exhaust manifold retaining nuts (3) are single use parts. They must be discarded after removal.

3. Remove the right catalytic converter to exhaust manifold retaining nuts (3).

Discard the nuts.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

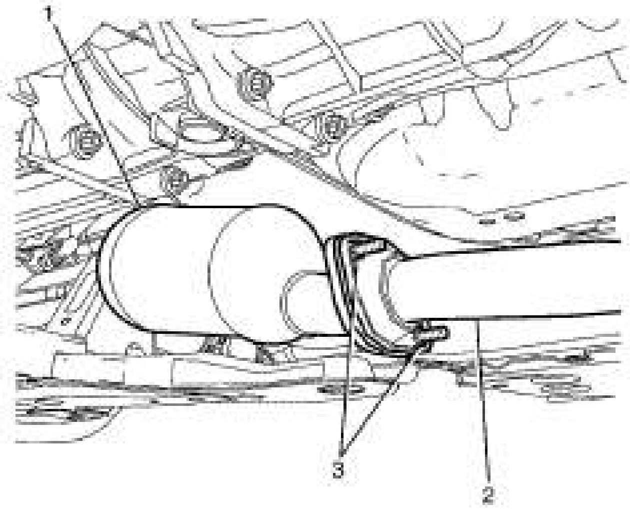
4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



5. Remove the right pre-catalytic converter heated oxygen sensor (HO2S) wiring loom from the transmission wiring loom retraining clip (1).

   Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.

6. Disconnect the right pre-catalytic converter heated oxygen sensor (HO2S) electrical connector (2).



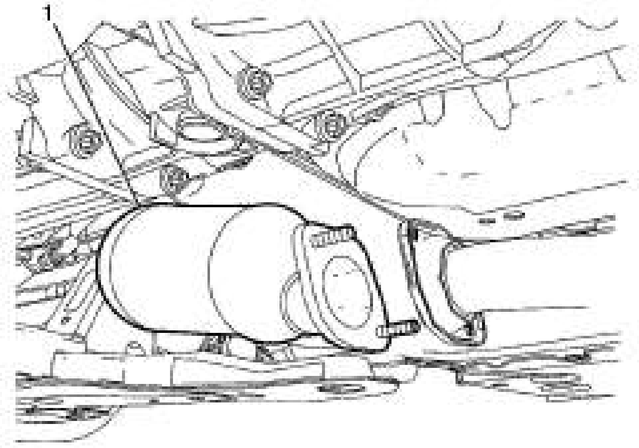
7. Pull down and back on the right catalytic converter (1) to disconnect from the exhaust manifold.

   Important: The intermediate exhaust assembly to right catalytic converter retaining nuts (3) are single use parts. They must be discarded after removal.

8. Remove the intermediate exhaust assembly to right catalytic converter retaining nuts (3).

   Discard the nuts.

9. Disconnect the intermediate exhaust assembly (2) from the right catalytic converter (1).

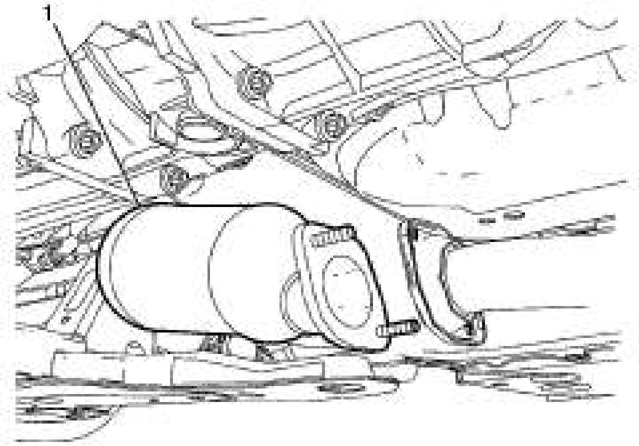


10. Remove the right catalytic converter (1) from the vehicle.
11. Remove the right pre-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 .

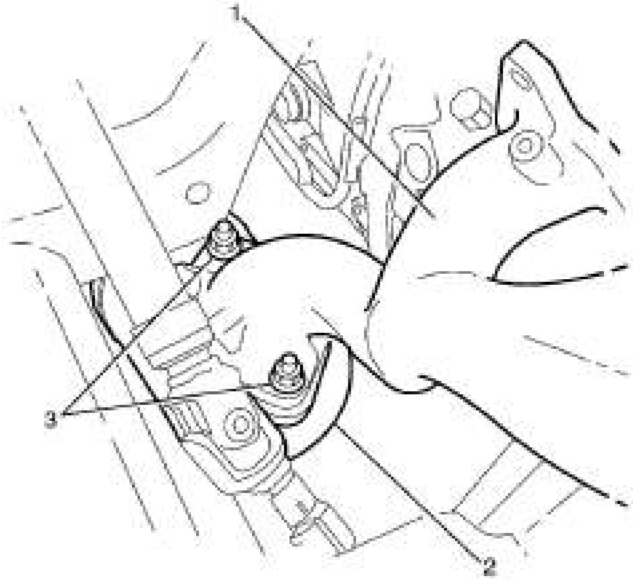
Installation Procedure

Caution: Refer to Exhaust Service Caution in the Preface section.

1. Install the right pre-catalytic converter HO2S to the right catalytic converter. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 .



2. Install the right catalytic converter (1) to the vehicle.



Important: Make sure that a NEW sealing ring is fitted prior to installation. Failure to comply may cause the exhaust system to perform poorly.

3. Lift the right catalytic converter (2) up and forward to connect to the exhaust manifold (1).
4. Lower the vehicle.

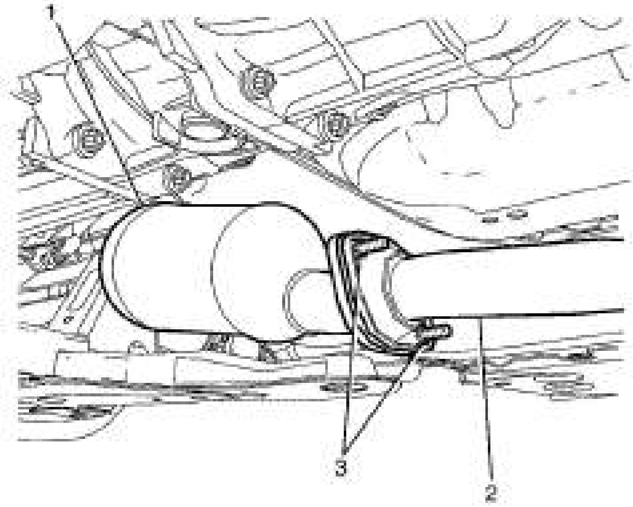
Important: Do not fully tighten the right catalytic converter to exhaust manifold retaining nuts (3) at this stage.

5. Install the right catalytic converter to exhaust manifold retaining nuts (3).

Do not fully tighten at this stage.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

6. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

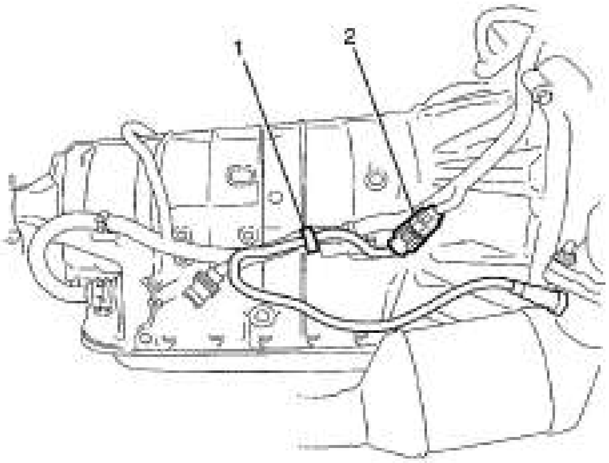


7. Align the intermediate exhaust assembly (2) to the right catalytic converter (1).

   Notice: Refer to Fastener Notice in the Preface section.

8. Tighten the intermediate exhaust assembly to left catalytic converter retaining nuts (3).

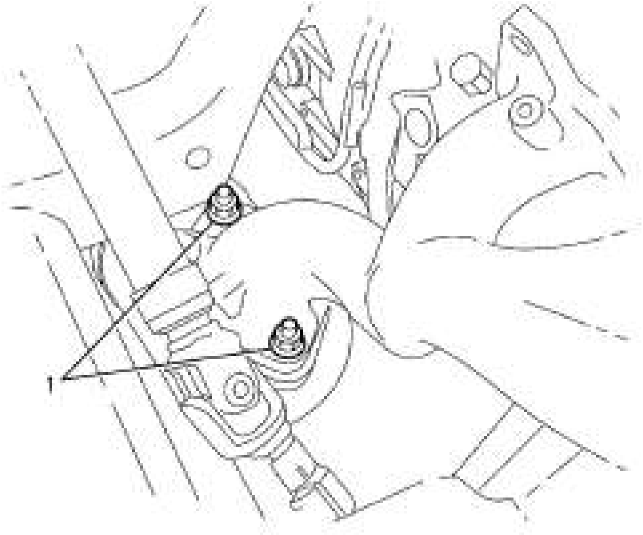
   Tighten
   Tighten the nuts to 40 N·m (30 lb ft).



9. Connect the left pre-catalytic converter heated oxygen sensor (HO2S) wiring connector (2) to the main wiring harness.
10. Install the left pre-catalytic converter heated oxygen sensor (HO2S) wiring loom from the

engine wiring loom retaining clip (1).

11. Lower the vehicle.



12. Tighten the right catalytic converter to exhaust manifold retaining nuts (2).

    Tighten
    Tighten the nuts to 45 N·m (33 lb ft).

13. Make sure that the exhaust system is clear of all other components and chassis. If the exhaust system is not clear of all the other components loosen all retaining nuts and re-align. Refer to Exhaust System Alignment .
14. Install the engine dress cover. Refer to Engine Cover Replacement .
15. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
16. If re-programming is required. Refer to Control Module References .
17. Perform diagnostic system check using diagnostic scan tool, clear all relative DTCs and inspect the system for correct operation.

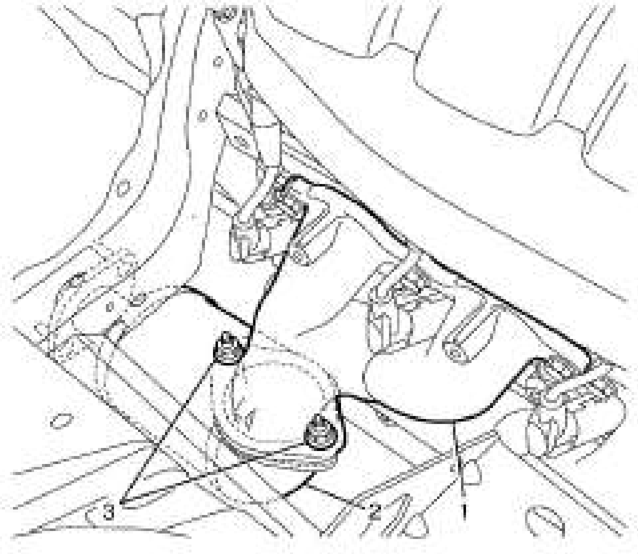
Catalytic Converter Replacement - Right Side (6.0L Engine)

Removal Procedure

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .

   Caution: Refer to Exhaust Service Caution in the Preface section.

   Caution: Refer to Protective Goggles and Glove Caution in the Preface section.



Important: The right catalytic converter to exhaust manifold retaining (3) are single use parts. They must be discarded after removal.

2. Remove the right catalytic converter to exhaust manifold retaining nuts (3).

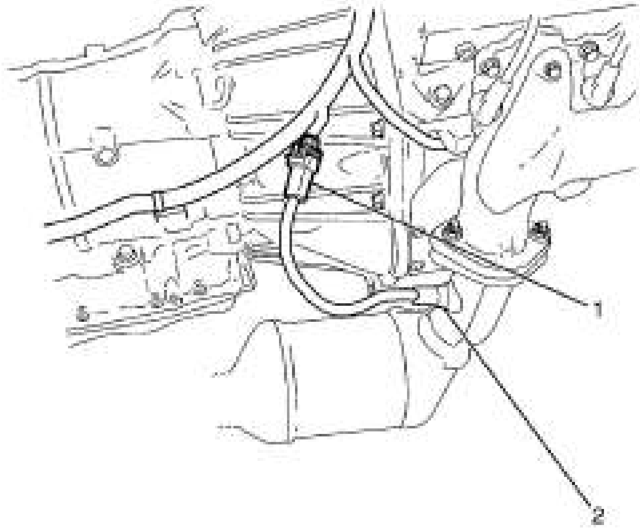
   Discard the nuts.

3. Disconnect the right catalytic converter (2) from the exhaust manifold (1).

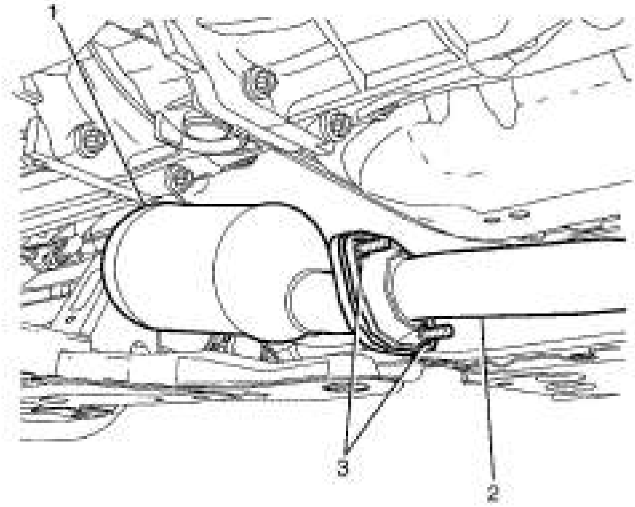
   Caution: Refer to Vehicle Lifting Caution in the Preface section.

4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

   Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.



5. Disconnect the right pre-catalytic converter heated oxygen sensor (HO2S) electrical connector (1).

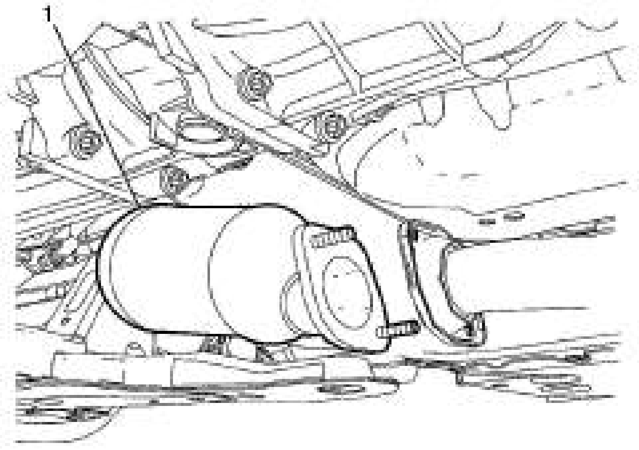


Important: The intermediate exhaust assembly to right catalytic converter retaining nuts (3) are single use parts. They must be discarded after removal.

6. Remove the intermediate exhaust assembly to right catalytic converter retaining nuts (3).

   Discard the nuts.

7. Disconnect the intermediate exhaust assembly (2) from the right catalytic converter (1).

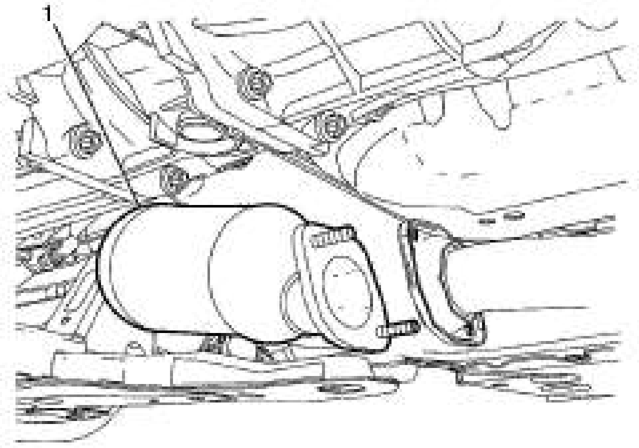


8. Remove the right catalytic converter (1) from the vehicle.
9. Remove the right pre-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 1.

Installation Procedure

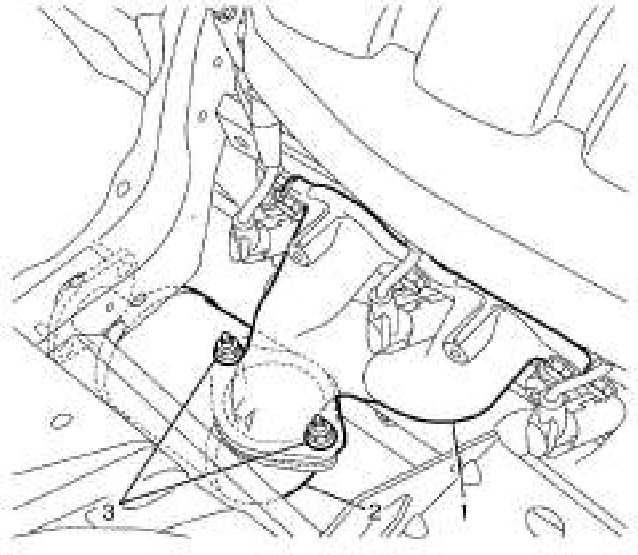
Caution: Refer to Exhaust Service Caution in the Preface section.

1. Install the right pre-catalytic converter heated oxygen sensor (HO2S) to the right catalytic converter. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 1.



Important: Make sure that a new sealing ring if fitted prior to installation. Failure to comply may cause the exhaust system to perform poorly.

2. Install the right catalytic converter (1) to the vehicle.



3. Push up and forward on the right catalytic converter (2) to connect the exhaust manifold (1).
4. Lower the vehicle.

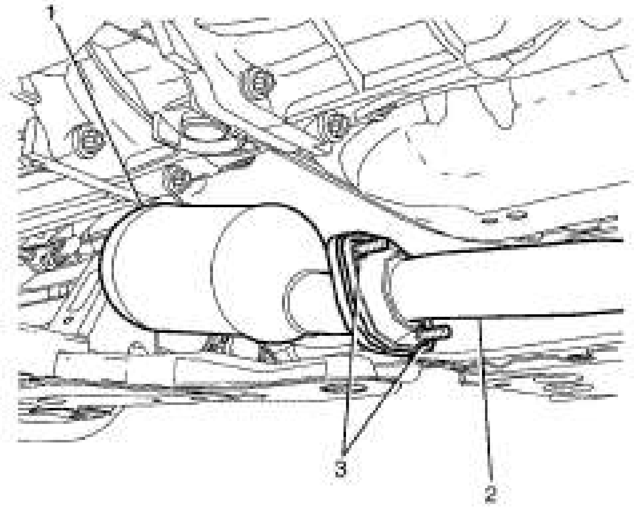
Important: Do not fully tighten the right catalytic converter to exhaust manifold retaining nuts (3) at this stage.

5. Install the right catalytic converter to exhaust manifold retaining nuts (3).

Do not fully tighten at this stage.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

6. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

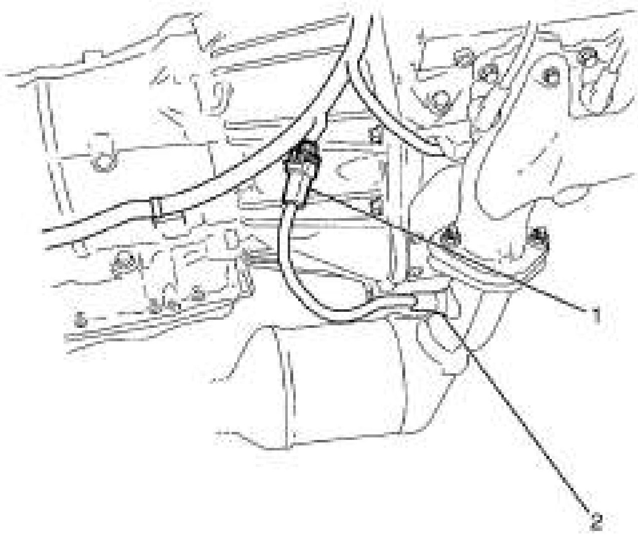


7. Align the intermediate exhaust assembly (2) to the right catalytic converter (1).

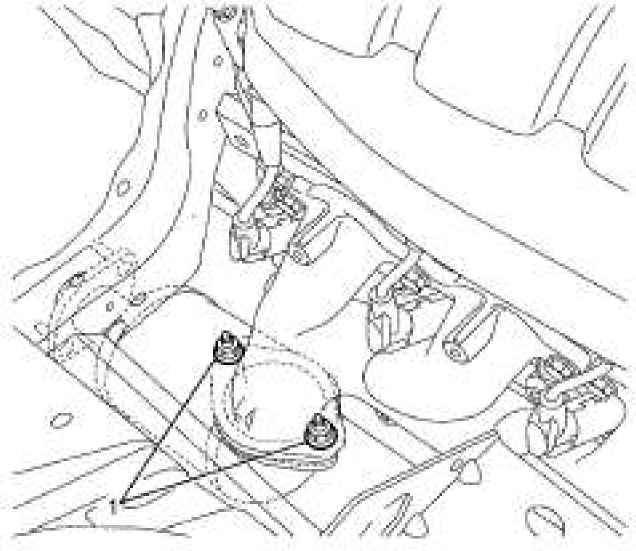
Notice: Refer to Fastener Notice in the Preface section.

8. Tighten the intermediate exhaust assembly to right catalytic converter retaining nuts (3).

Tighten
Tighten the nuts to 40 N·m (30 lb ft).



9. Connect the right pre-catalytic converter HO2S electrical connector (1).
10. Lower the vehicle.



11. Tighten the right catalytic converter to exhaust manifold retaining nuts (1).

    Tighten
    Tighten the nuts to 45 N·m (33 lb ft).

12. Make sure the exhaust system is clear of all other components and chassis. If the exhaust system is not clear of all the other components loosen all retaining nuts and re-align. Refer to Exhaust System Alignment .
13. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
14. If re-programming is required. Refer to Control Module References .
15. Perform diagnostic system check using diagnostic scan tool, clear all relative DTCs and inspect system for correct operation.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Exhaust | Repair Instructions | **Document ID: 2035206**

Exhaust Crossover Pipe Replacement

Removal Procedure

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .

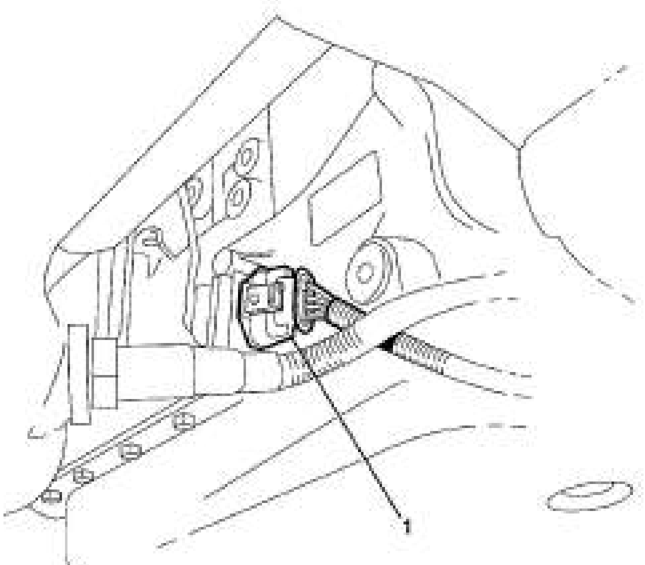
   Caution: Refer to Exhaust Service Caution in the Preface section.

   Caution: Refer to Protective Goggles and Glove Caution in the Preface section.

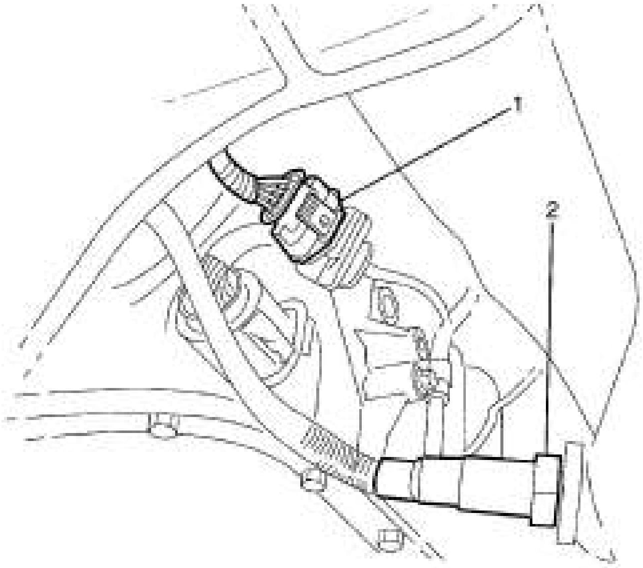
   Caution: Refer to Vehicle Lifting Caution in the Preface section.

2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
3. Support the exhaust system using a suitable jack.
4. Remove the rear exhaust muffler assemblies. Refer to Exhaust Muffler Replacement - Left Side and Exhaust Muffler Replacement - Right Side .

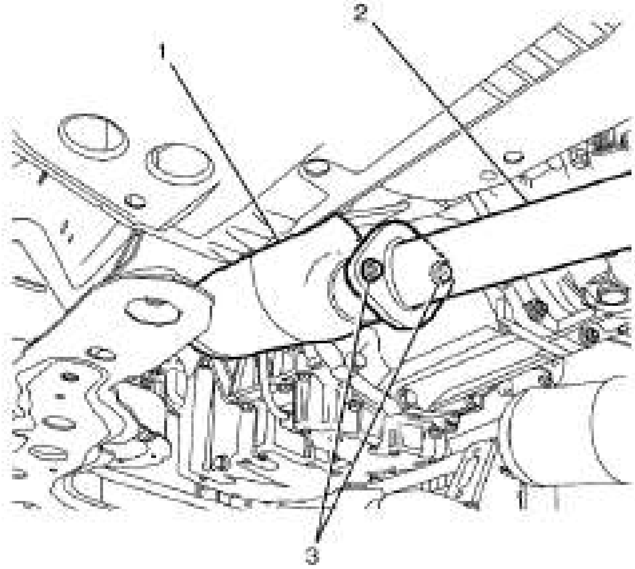
   Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.



5. Disconnect the left post-catalytic converter heated oxygen sensor (HO2S) electrical connector (1).



6. Disconnect the right post-catalytic converter HO2S electrical connector (1).

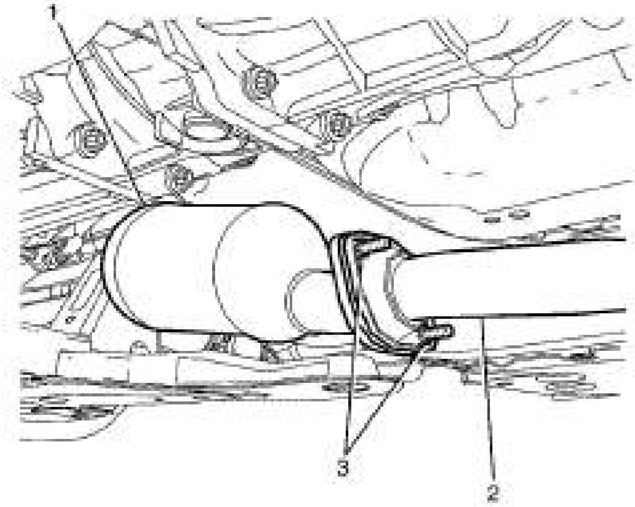


Important: The intermediate exhaust assembly to left catalytic converter retaining nuts (3) are single use parts. They must be discarded after removal.

7. Remove the intermediate exhaust assembly to left catalytic converter retaining nuts (3).

   Discard the nuts.

8. Disconnect the intermediate exhaust assembly (2) from the left catalytic converter (1).

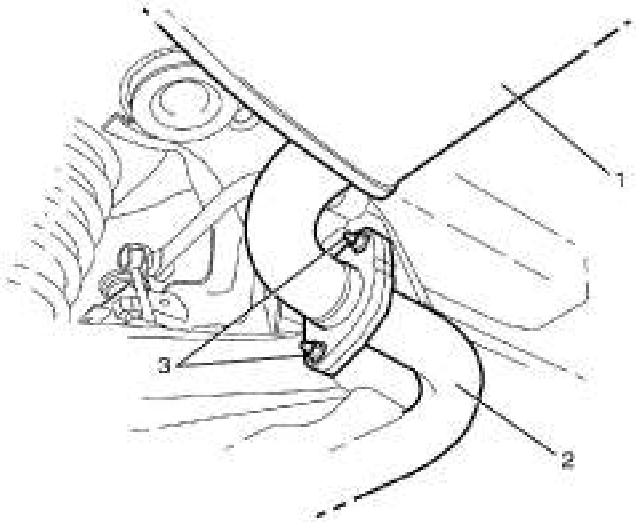


Important: The intermediate exhaust assembly to right catalytic converter retaining nuts (3) are single use parts. They must be discarded after removal.

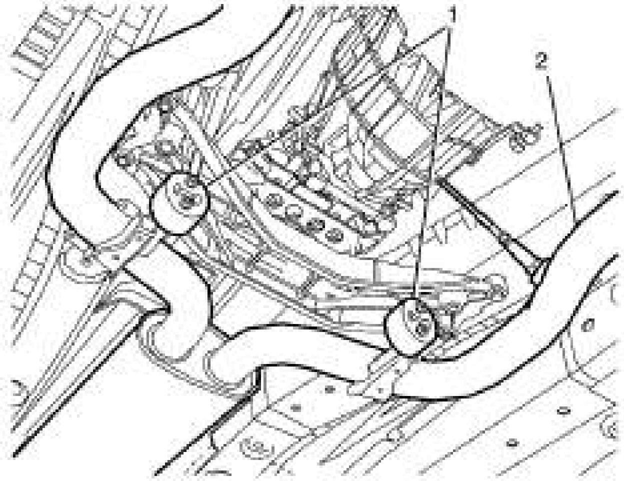
9. Remove the intermediate exhaust assembly to right catalytic converter retaining nuts (3).

   Discard the nuts.

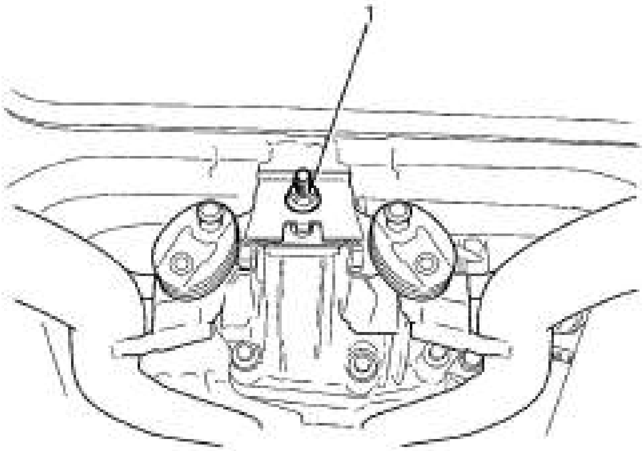
10. Disconnect the intermediate exhaust assembly (2) from the right catalytic converter (1).



11. Remove the intermediate exhaust assembly to rear muffler retaining bolts (3).



12. Detach the intermediate exhaust assembly (2) by removing the front insulator hangers (1) if fitted.



13. Detach the intermediate exhaust assembly (2) by removing the centre insulator hanger bracket to differential retaining bolt (1).
14. Carefully lower the intermediate exhaust assembly from the vehicle.
15. Remove the left post-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 for 3.6L engine or Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 for 6.0L engine.
16. Remove the right post-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 for 3.6L engine or Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 for 6.0L engine.

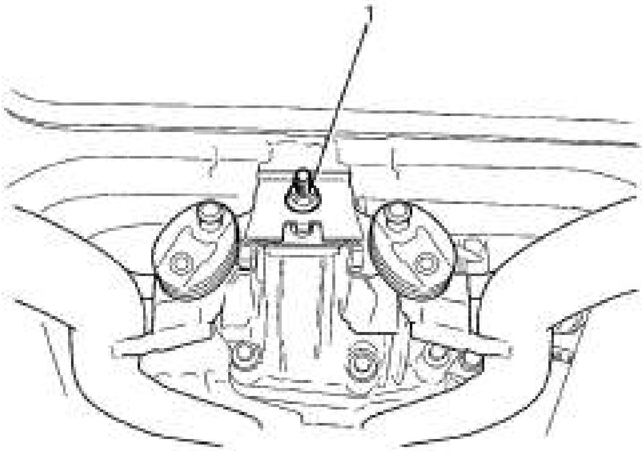
Installation Procedure

1. Clean all threads and flange faces of the intermediate exhaust system.
2. Always check the condition of the catalytic converter to intermediate pipe flange gaskets and replace as necessary.
3. Install the left post-catalytic converter HO2S to the intermediate exhaust system. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 for 3.6L engine or Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 for 6.0L engine.
4. Install the right post-catalytic converter HO2S to the intermediate exhaust system. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 for 3.6L engine or Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 for 6.0L engine.

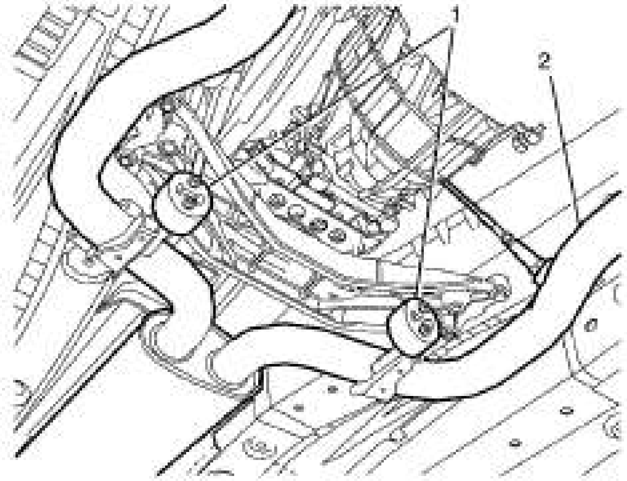
Notice: Refer to Exhaust System Inspection Notice in the Preface section.

Notice: Refer to Exhaust Service Caution in the Preface section.

5. Position the intermediate exhaust assembly to the vehicle using a suitable jack.

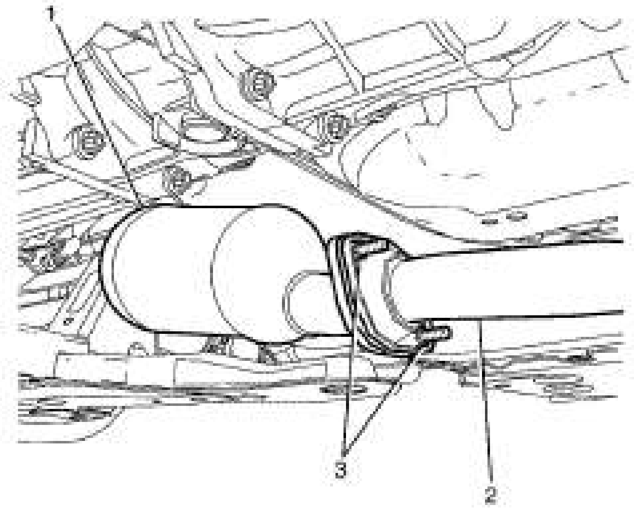


6. Attach the intermediate exhaust assembly (2) by installing the centre insulator hanger bracket to differential retaining bolt (1).



7. Attach the intermediate exhaust assembly (2) by installing the front insulator hangers (1) if fitted.
8. Tighten the intermediate exhaust assembly to rear muffler retaining bolts.

   Tighten
   Tighten the bolts to 45 N·m (33 lb ft).

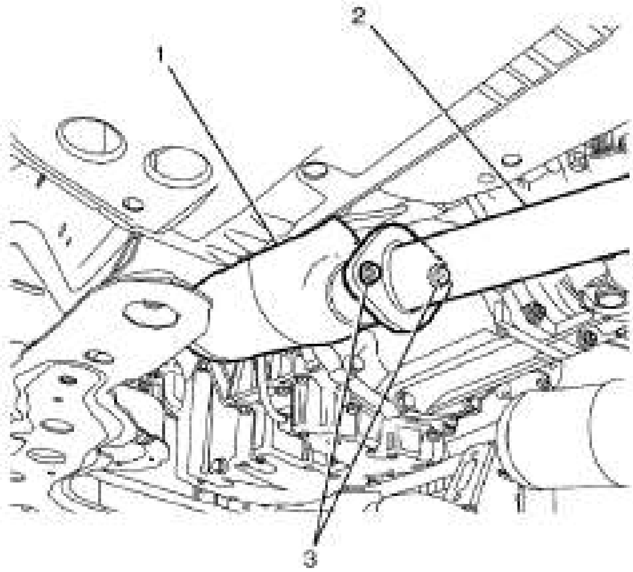


9. Align the intermediate exhaust assembly (2) to the right catalytic converter (1).

   Notice: Refer to Fastener Notice in the Preface section.

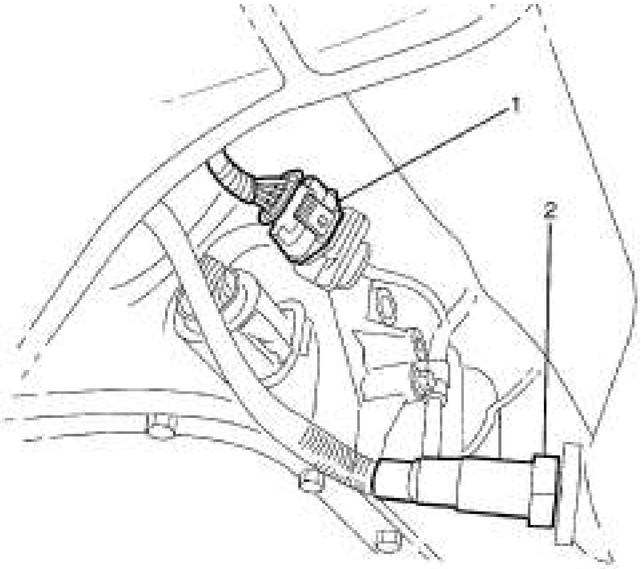
10. Tighten the intermediate exhaust assembly to right catalytic converter retaining nuts (3).

Tighten
Tighten the nuts to 40 N·m (30 lb ft).

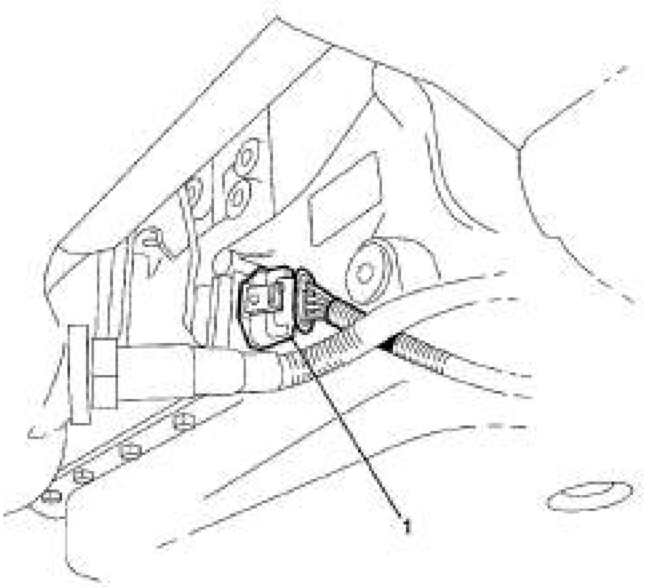


11. Align the intermediate exhaust assembly (2) to the left catalytic converter (1).
12. Tighten the intermediate exhaust assembly to left catalytic converter retaining nuts (3).

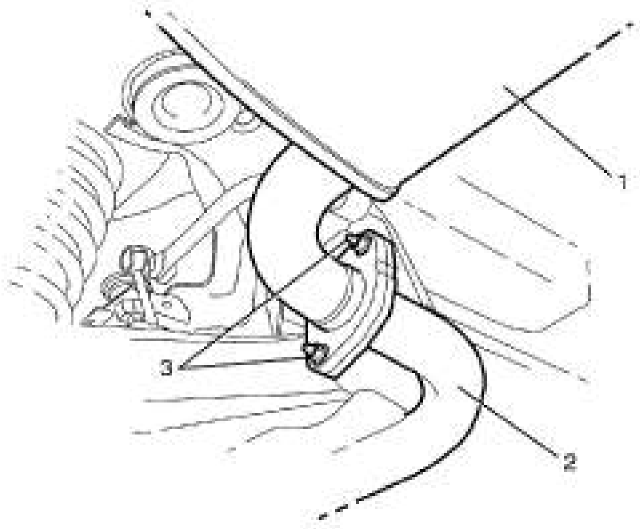
Tighten
Tighten the nuts to 40 N·m (30 lb ft).



13. Connect the right post-catalytic converter HO2S electrical connector (1).



14. Connect the left post-catalytic converter HO2S electrical connector (1).



15. Connect the left rear muffler (1) to the intermediate exhaust assembly (2).

    Notice: Refer to Fastener Notice in the Preface section.

16. Install the left rear muffler to intermediate exhaust assembly retaining bolts (3).

    Tighten
    Tighten the bolts to 45 N·m (33 lb ft).

17. Make sure that the exhaust system is clear of all other components and chassis. If the exhaust system is not clear of all the other components loosen all retaining nuts and re-align. Refer to Exhaust System Alignment .

18. Lower the vehicle to the ground.
19. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
20. If re-programming is required. Refer to Control Module References .
21. Perform diagnostic system check using diagnostic scan tool, clear all relative DTCs and inspect the system for correct operation.

Exhaust Front Heat Shield Replacement

Removal Procedure

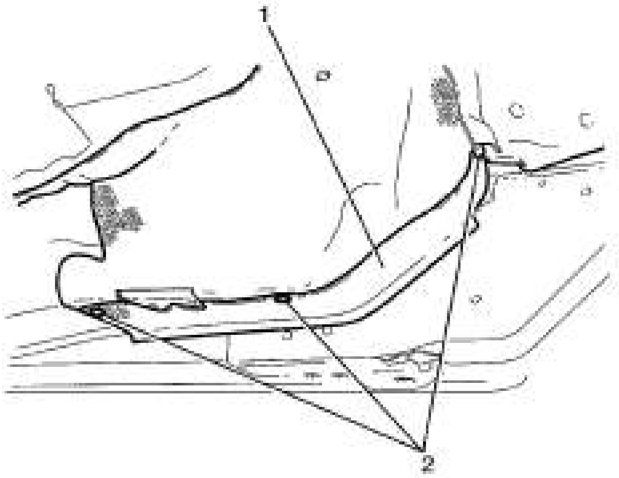
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

   Caution: Refer to Exhaust Service Caution in the Preface section.

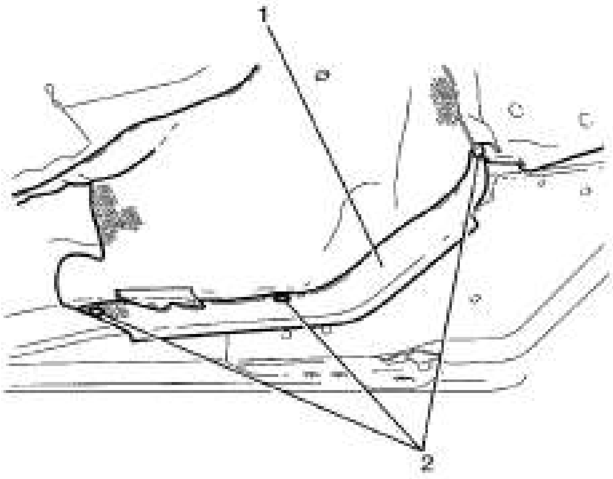
2. Remove the catalytic converter. Refer to Catalytic Converter Replacement - Left Side, Catalytic Converter Replacement - Right Side.



3. Remove the front exhaust foil heat shield to body retaining bolts (2).
4. Remove the front exhaust foil heat shield (1).

Installation Procedure

1. Install the front exhaust foil heat shield (1).



Notice: Refer to Fastener Notice in the Preface section.

2. Install the front exhaust foil heat shield to body retaining bolts (2).

   Tighten
   Tighten the bolts to 4 N·m (35 lb in).

3. Install the catalytic converter. Refer to Catalytic Converter Replacement - Left Side, Catalytic Converter Replacement - Right Side.
4. Lower the vehicle to the ground.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Exhaust | Repair Instructions | **Document ID: 1977420**

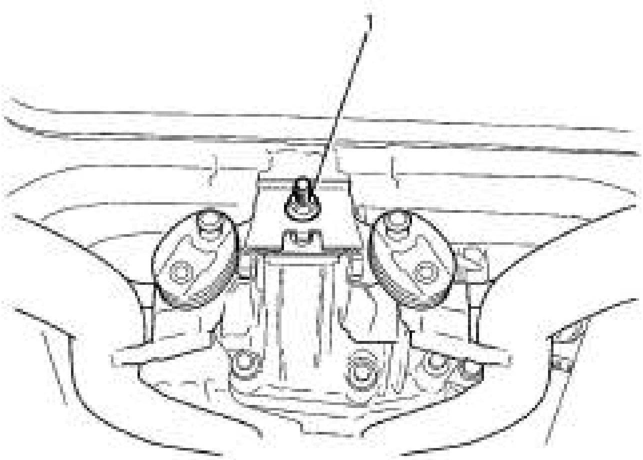
Exhaust Hanger Mounting Bracket Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

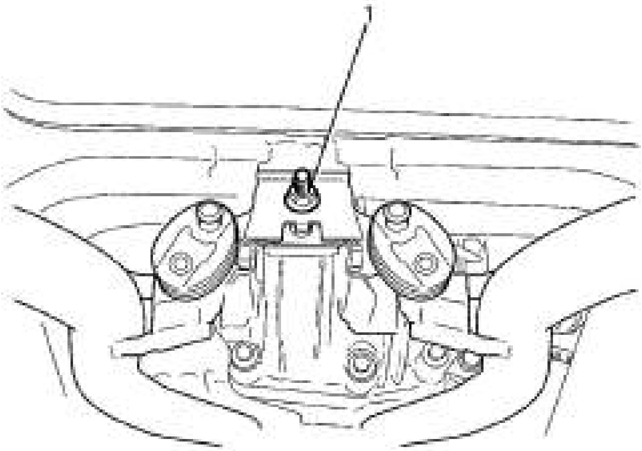
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



2. Detach the intermediate exhaust assembly (2) by removing the centre insulator hanger bracket to differential retaining bolt (1).
3. Remove the intermediate exhaust assembly to centre insulator hanger bracket insulators.

Installation Procedure



1. Install the intermediate exhaust assembly (2) by removing the centre insulator hanger bracket to differential retaining bolt (1).

   Tighten
   Tighten the nuts to 45 N·m (33 lb ft).

2. Install the intermediate exhaust assembly to centre insulator hanger bracket insulators.
3. Lower the vehicle.

Exhaust Heat Shield Replacement - Center

Removal Procedure

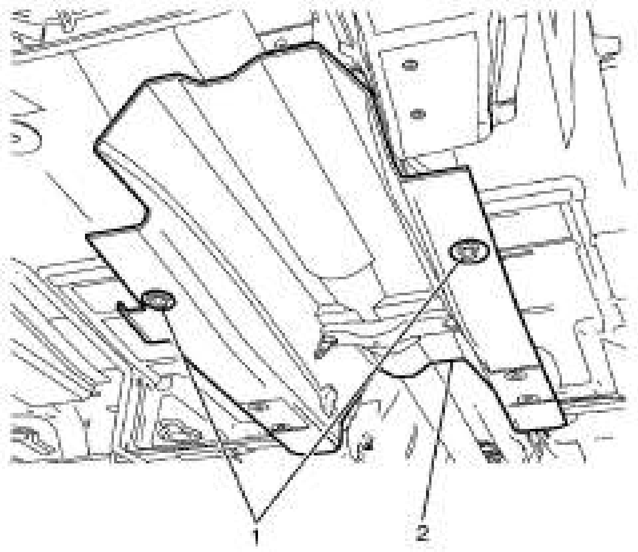
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

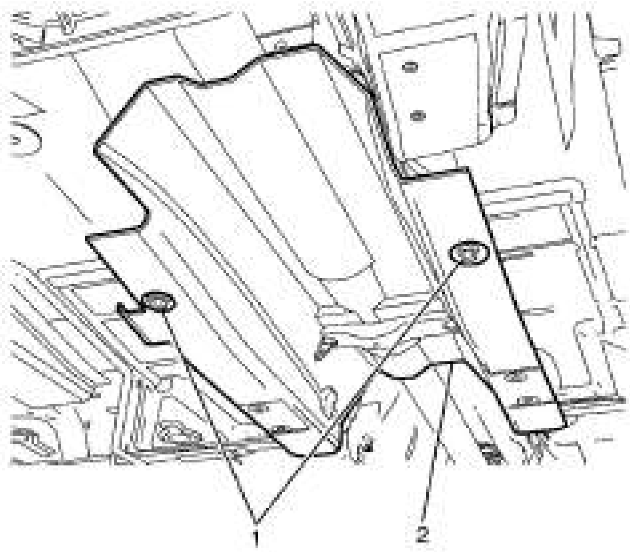
Caution: Refer to Exhaust Service Caution in the Preface section.

2. Remove the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement.



3. Remove the centre exhaust heat shield to body retaining bolts (1).
4. Remove the centre exhaust heat shield (2).

Installation Procedure



1. Position the centre exhaust heat shield (2) to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the centre exhaust heat shield to body retaining bolts (1).

   Tighten
   Tighten the bolts to 4 N·m (35 lb in).

3. Install the intermediate exhaust assembly. Refer to Exhaust Crossover Pipe Replacement.
4. Lower the vehicle to the ground.

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Exhaust Manifold Heat Shield Replacement - Left Side (NT4)

Removal Procedure

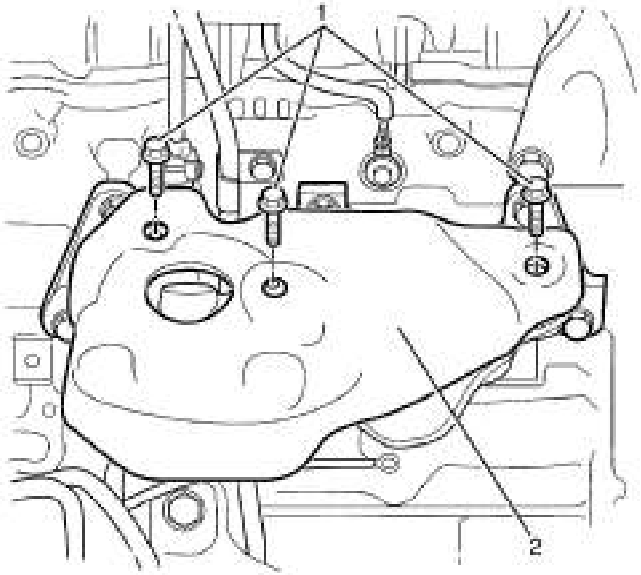
Caution: Refer to Exhaust Service Caution in the Preface section.

Caution: Refer to Protective Goggles and Glove Caution in the Preface section.

1. Ignition OFF.

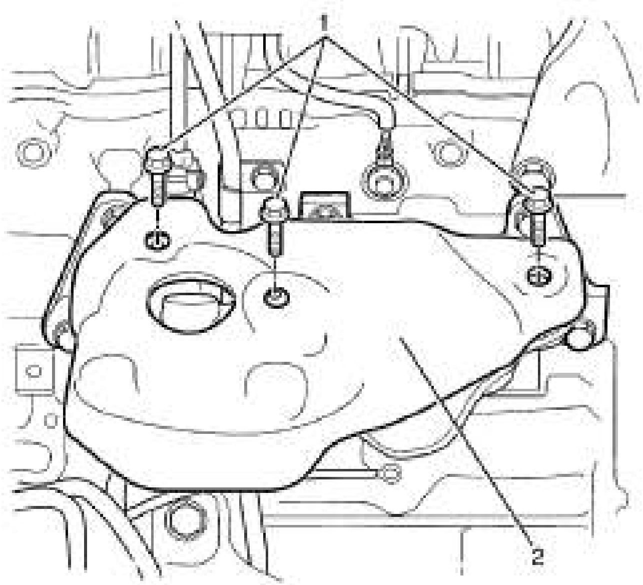
   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the engine cover. Refer to Engine Cover Replacement.
4. Remove the left pre-catalytic convertor heated oxygen sensor (HO2S). Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 1.



5. Remove the exhaust manifold heat shield to exhaust manifold retaining bolts (1).
6. Remove the exhaust manifold heat shield (2).

Installation Procedure



1. Install the exhaust manifold heat shield (2).

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the exhaust manifold heat shield to exhaust manifold retaining bolts (1).

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).

3. Install the left pre-catylitic convertor HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 1.
4. Install the engine cover. Refer to Engine Cover Replacement.
5. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

Exhaust Manifold Heat Shield Replacement - Right Side (NT4)

Removal Procedure

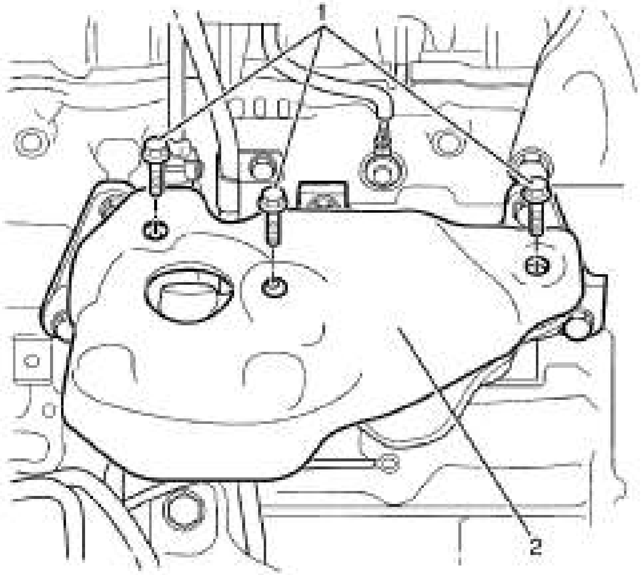
Caution: Refer to Exhaust Service Caution in the Preface section.

Caution: Refer to Protective Goggles and Glove Caution in the Preface section.

1. Ignition OFF.

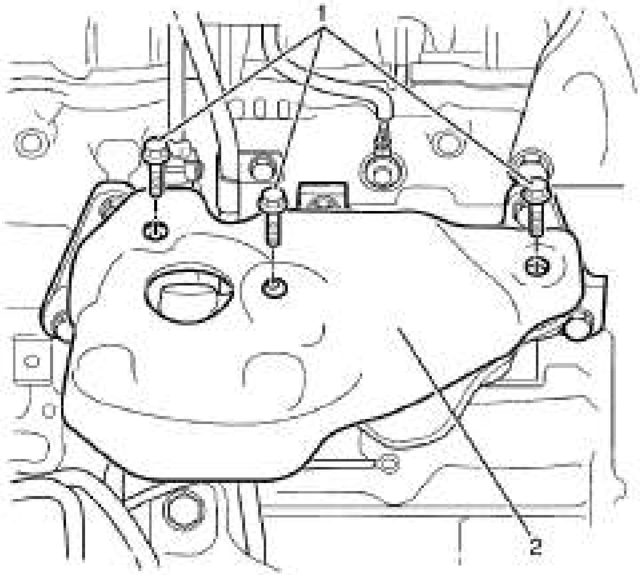
Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the engine cover. Refer to Engine Cover Replacement.
4. Remove the right pre-catalytic convertor heated oxygen sensor (HO2S). Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 1.



5. Remove the exhaust manifold heat shield to exhaust manifold retaining bolts (1).
6. Remove the exhaust manifold heat shield (2).

Installation Procedure



1. Install the exhaust manifold heat shield (2).

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the exhaust manifold heat shield to exhaust manifold retaining bolts (1).

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).

3. Install the right pre-catalytic convertor HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 1.
4. Install the engine cover. Refer to Engine Cover Replacement.
5. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

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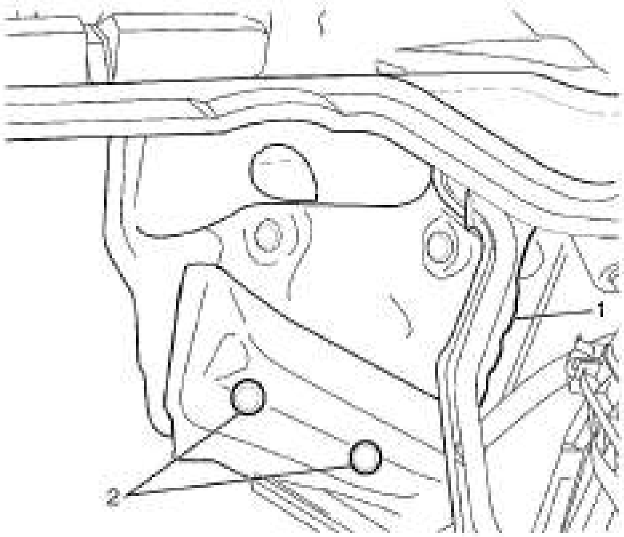
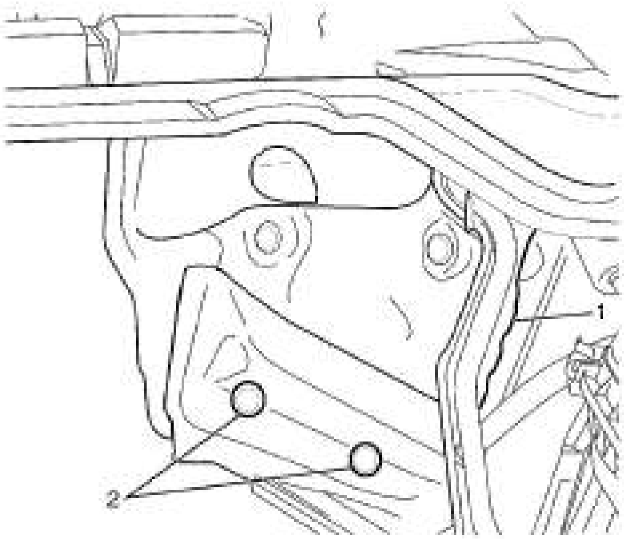
Exhaust Manifold Heat Shield Replacement

Removal Procedure



1. Remove the exhaust manifold heat shield to air box retaining clips (2).
2. Remove the exhaust manifold heat shield (1) from the vehicle.

Installation Procedure



1. Install the exhaust manifold heat shield to the vehicle (1)
2. Install the exhaust manifold heat shield to air box retaining clips (2)

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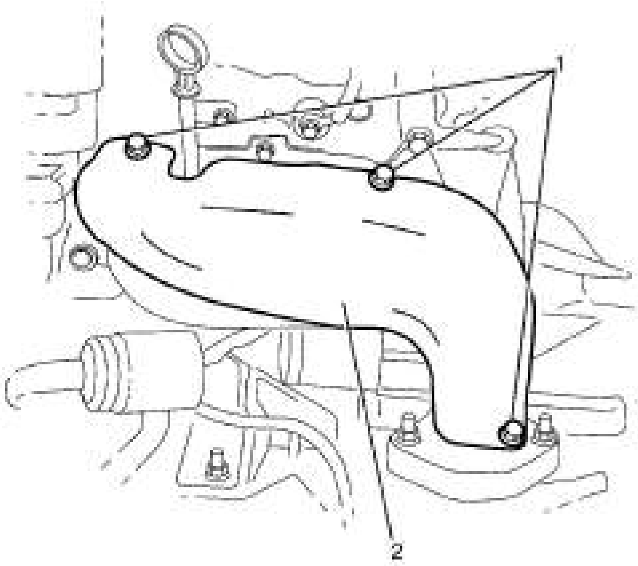
Exhaust Manifold Replacement - Left Side (3.6L Engine NT3)

Removal Procedure

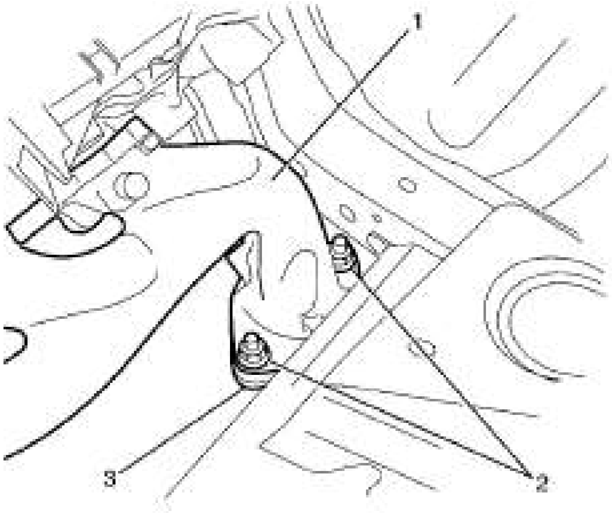
1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the engine dress cover. Refer to Engine Cover Replacement.

   Caution: Refer to Exhaust Service Caution in the Preface section.

   Caution: Refer to Protective Goggles and Glove Caution in the Preface section.



3. Remove the exhaust manifold heat shield to exhaust manifold retaining bolts (1).
4. Remove the exhaust manifold heat shield (2).
5. Remove the oil level indicator tube. Refer to Oil Level Indicator and Tube Removal.



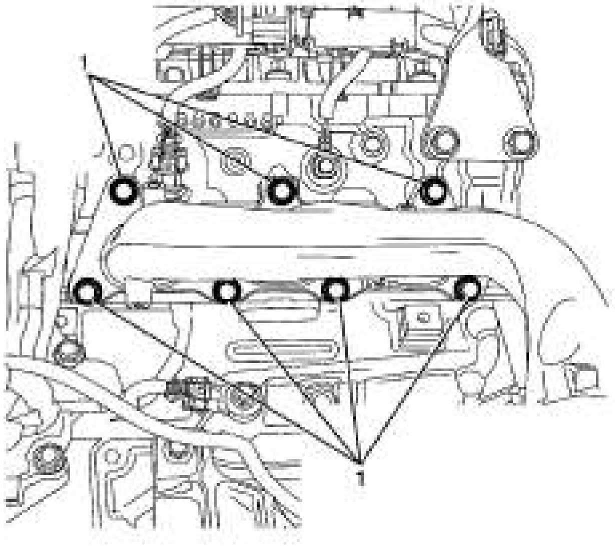
Important: The left catalytic converter to exhaust manifold retaining nuts (2) are single use parts. They must be discarded after removal.

6. Remove the left catalytic converter to exhaust manifold retaining nuts (2).

   Discard the nuts.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

7. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
8. Remove the left catalytic converter. Refer to Catalytic Converter Replacement - Left Side.
9. Remove the starter motor. Refer to Starter Replacement.
10. Lower the vehicle.



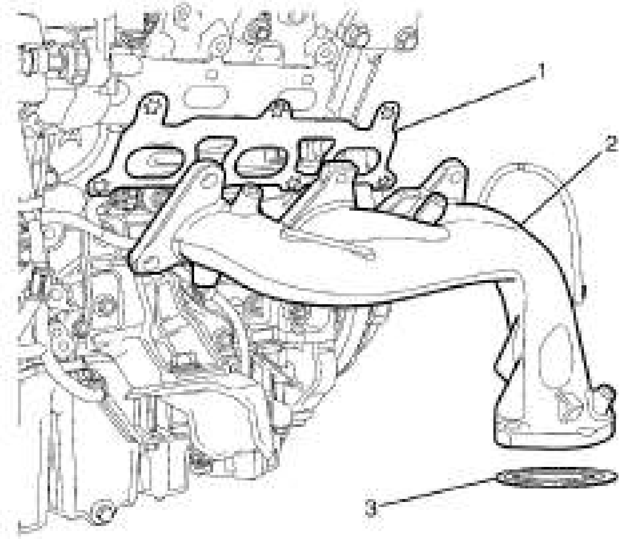
11. Loosen the exhaust manifold to cylinder head retaining bolts (1) working from the outside to the centre.

    Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

12. Remove the exhaust manifold to cylinder head retaining bolts (1).

    Discard the bolts.

13. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



Important: Make sure that the surrounding wiring harness and electrical connectors are not damaged when removing the exhaust manifold (2).

Important: The exhaust manifold gasket (1) and sealing ring (3) are single use parts. They must be discarded after removal.

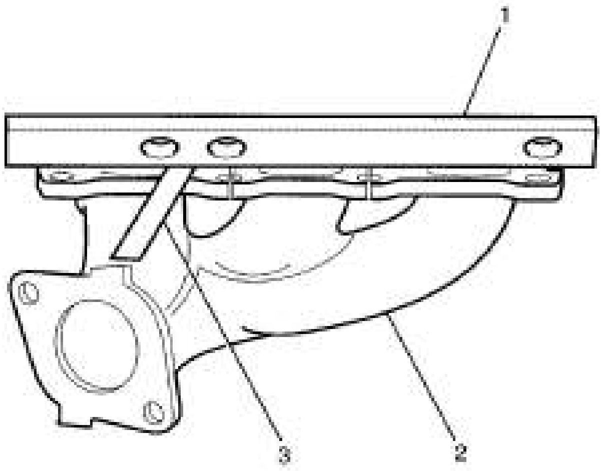
14. Remove the exhaust manifold (2).

    Discard the exhaust manifold gasket (1) and sealing ring (3).

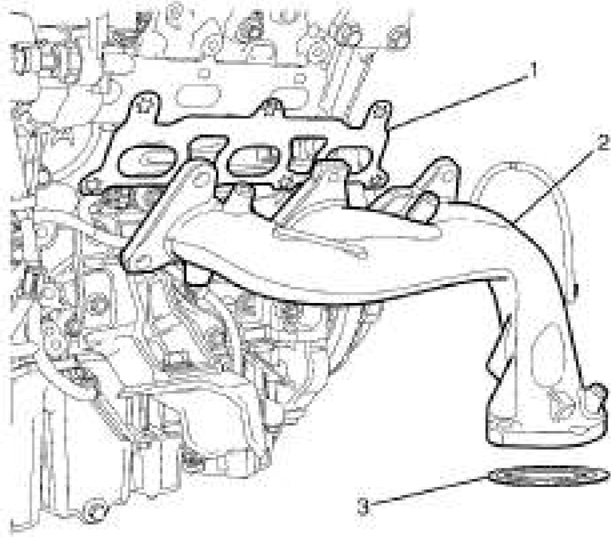
Installation Procedure

Notice: Refer to Exhaust Service Caution in the Preface section.

1. Before installation inspect for the following:
    - Damage to the gasket sealing surfaces.
    - Distortion of exhaust manifold mating surface.
    - Damage to the exhaust mounting holes.



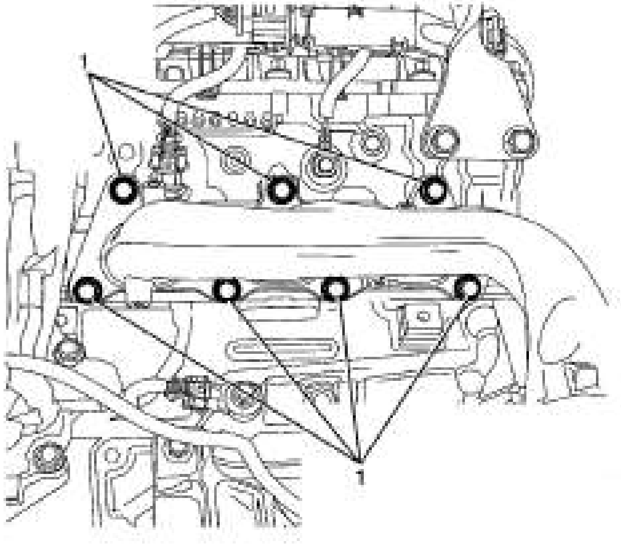
2. Check for distortion on the mating surface of the exhaust manifold (2) by using a straight edge (1) and a feeler gauge (3).
3. Clean the exhaust manifold and catalytic converter flange mating surfaces.



4. Install a NEW exhaust manifold gasket (1) and NEW sealing ring (3) to the exhaust manifold (2).

   Notice: Refer to Exhaust System Inspection Notice in the Preface section.

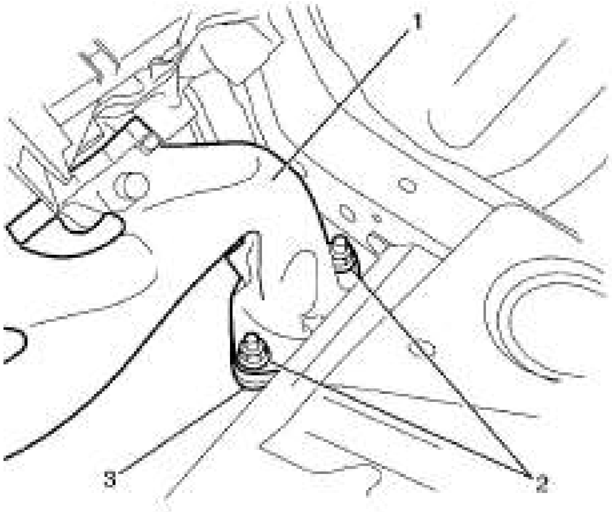
5. Install the exhaust manifold assembly to the engine.
6. Lower the vehicle.



Important: Do not fully tighten the exhaust manifold to cylinder head retaining bolts (1) at this stage.

7. Install the NEW exhaust manifold to cylinder head retaining bolts (1).

   Do not fully tighten at this stage.



Important: Make sure the sealing ring is seated correctly.

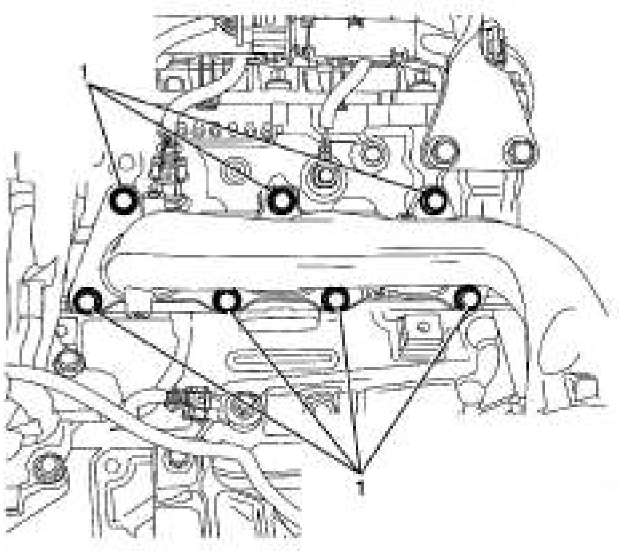
8. Install the left catalytic converter. Refer to Catalytic Converter Replacement - Left Side.

9. Install the starter motor. Refer to Starter Replacement.

   Notice: Refer to Fastener Notice in the Preface section.

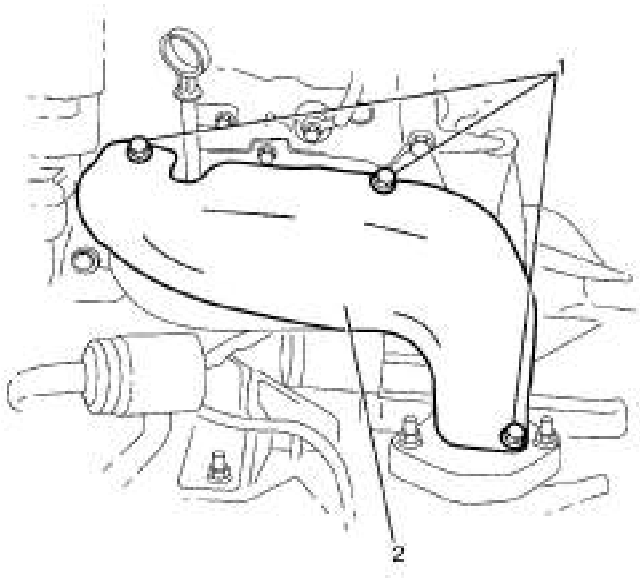
10. Install the NEW left catalytic converter to exhaust manifold retaining nuts (2).

    Tighten
    Tighten the nuts to 45 N·m (33 lb ft).



11. Tighten the exhaust manifold to cylinder head retaining bolts (1) working from the centre to the outside.

    Tighten
    Tighten the bolts to 20 N·m (15 lb ft).



12. Install the exhaust manifold heat shield (2).
13. Install the exhaust manifold heat shield to exhaust manifold retaining bolts (1).

    Tighten
    Tighten the bolts to 10 N·m (89 lb in).

14. Install the engine dress cover. Refer to Engine Cover Replacement.
15. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.

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Exhaust Manifold Replacement - Left Side (3.6L Engine NT4)

Removal Procedure

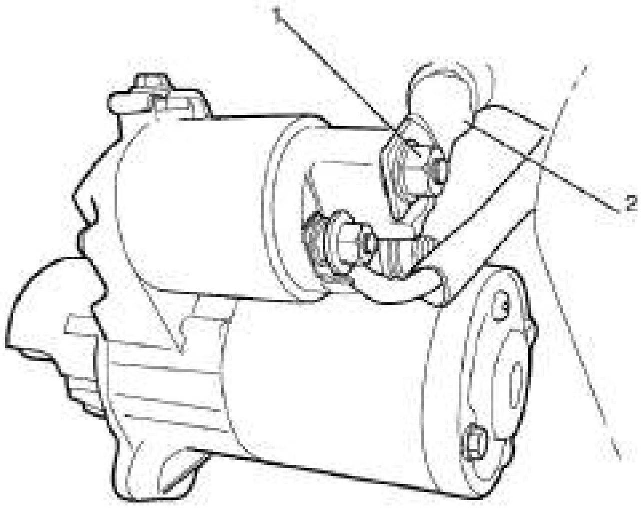
Caution: Refer to Exhaust Service Caution in the Preface section.

Caution: Refer to Protective Goggles and Glove Caution in the Preface section.

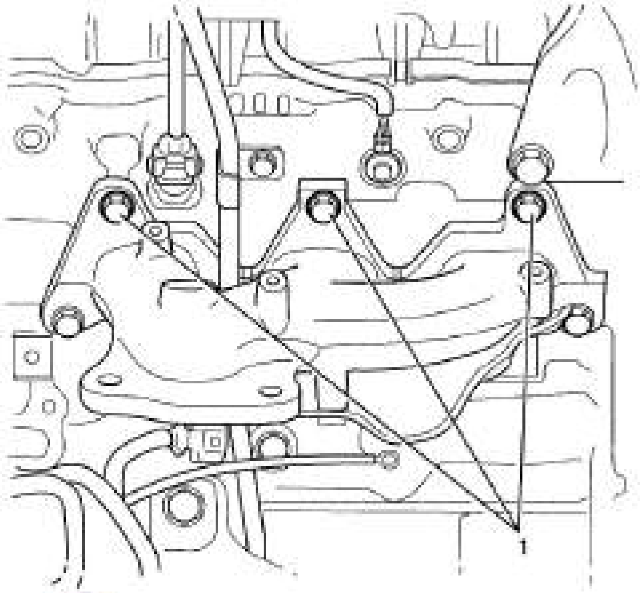
1. Ignition OFF.

Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove the engine cover. Refer to Engine Cover Replacement.
4. Remove the left pre-catalytic convertor heated oxygen sensor (HO2S). Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 1.
5. Remove the exhaust manifold heat shield. Refer to Exhaust Manifold Heat Shield Replacement - Left Side .
6. Remove the oil level indicator tube. Refer to Oil Level Indicator and Tube Removal .
7. Remove the left catalytic converter. Refer to Catalytic Converter Replacement - Left Side .



8. Remove the battery positive cable retaining nut (1) from the starter motor solenoid.
9. Remove the battery positive cable (2) from the starter motor.



Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

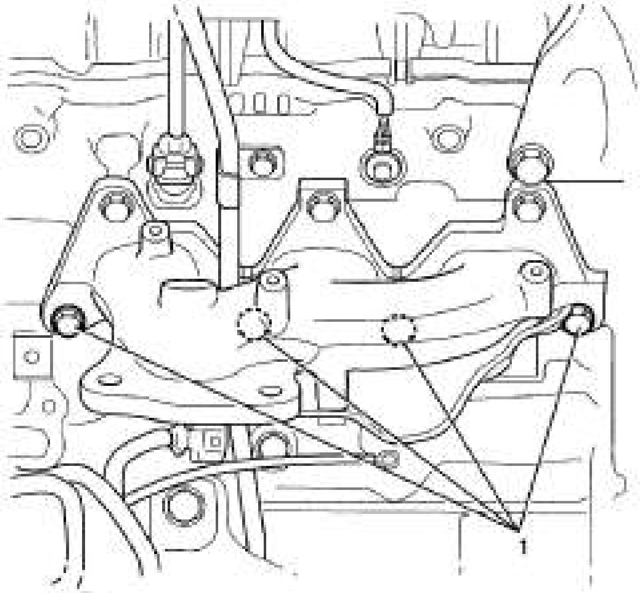
10. Remove the exhaust manifold to cylinder head retaining bolts (1).

    Discard the bolts.

    Caution: Refer to Safety Glasses Caution in the Preface section.

    Caution: Refer to Vehicle Lifting Caution in the Preface section.

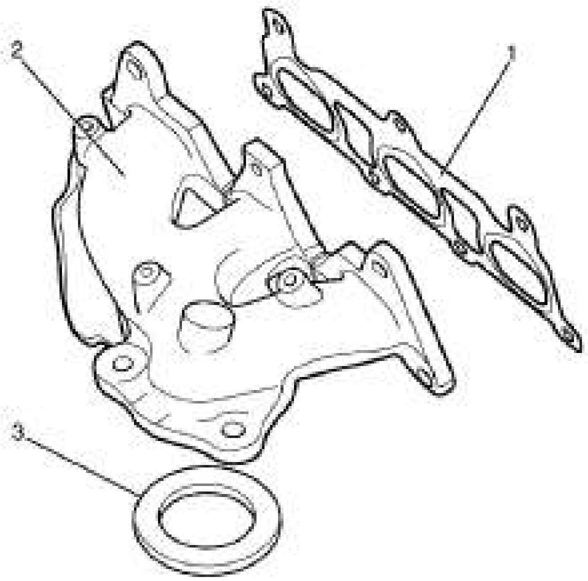
11. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

12. Remove the exhaust manifold to cylinder head retaining bolts (1).

    Discard the bolts.



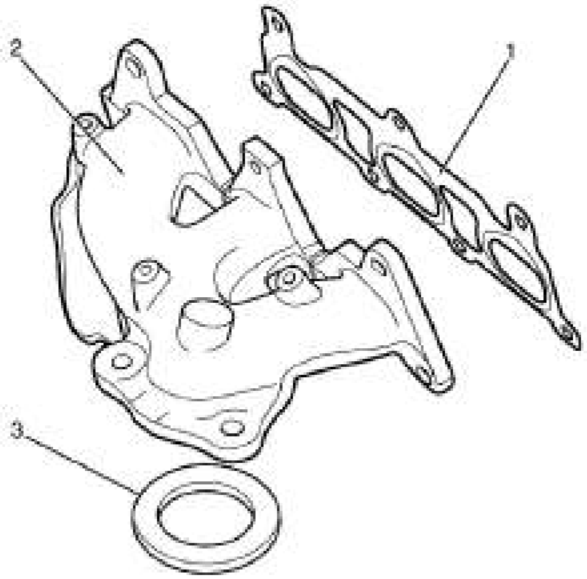
Important: Make sure that the surrounding wiring harness and electrical connectors are not damaged when removing the exhaust manifold (2).

Important: The exhaust manifold gasket (1) and sealing ring (3) are single use parts. They must be discarded after removal.

13. Remove the exhaust manifold (2) from the engine assembly.
14. Separate the exhaust manifold (2) from the exhaust manifold gasket (1) and sealing ring (3).
15. Discard the exhaust manifold gasket (1) and sealing ring (3).

Installation Procedure

1. Inspect the exhaust manifold before installation. Refer to Exhaust Manifold Cleaning and Inspection - Left Side.



Important: Make sure the sealing ring is seated correctly.

2. Install a NEW exhaust manifold gasket (1) and NEW sealing ring (3) to the exhaust manifold (2).

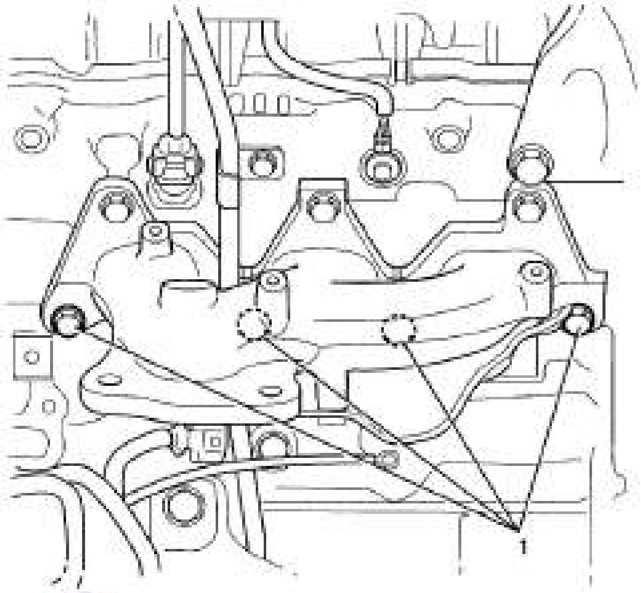
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

Important: A suitable support must be used to support the exhaust manifold while the vehicle is being lowered.

4. Install the exhaust manifold assembly (2) to the engine.



Important: Do not fully tighten the exhaust manifold to cylinder head retaining bolts (1) at this stage.

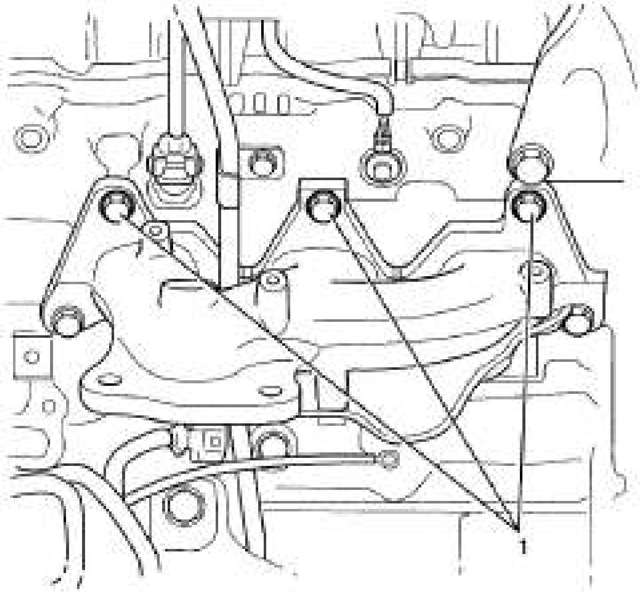
5. Install NEW exhaust manifold to cylinder head retaining bolts (1).

Caution: Refer to Fastener Caution in the Preface section.

6. Tighten the exhaust manifold to cylinder head retaining bolts (1) working from the centre to the outside.

Tighten
Tighten the bolts to 20 N·m (15 lb ft).

7. Lower the vehicle.



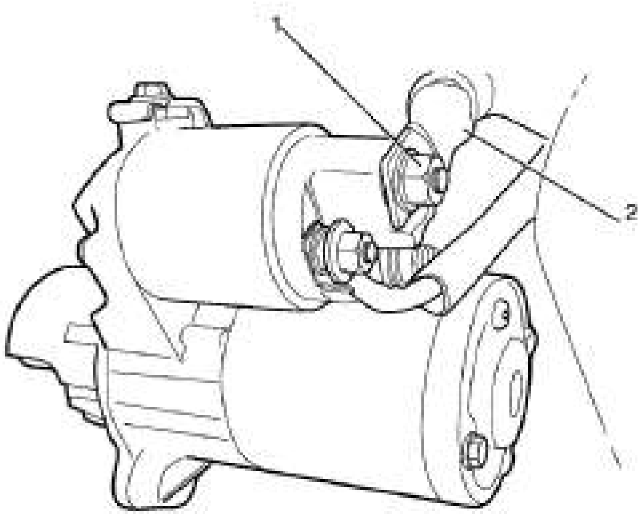
Important: Do not fully tighten the exhaust manifold to cylinder head retaining bolts (1) at this stage.

8. Install NEW exhaust manifold to cylinder head retaining bolts (1).

Caution: Refer to Fastener Caution in the Preface section.

9. Tighten the exhaust manifold to cylinder head retaining bolts (1) working from the centre to the outside.

Tighten
Tighten the bolts to 20 N·m (15 lb ft).



10. Install the battery positive cable (2) to the starter motor.
11. Install the battery positive cable retaining nut (1) to the starter motor solenoid.

Tighten
Tighten the nut to 10 N·m (89 lb in).

12. Install the left catalytic converter. Refer to Catalytic Converter Replacement - Left Side .
13. Install the exhaust manifold heat shield. Refer to Exhaust Manifold Heat Shield Replacement - Left Side .
14. Install the left pre-catalytic convertor HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 .
15. Install the engine cover. Refer to Engine Cover Replacement.
16. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection .

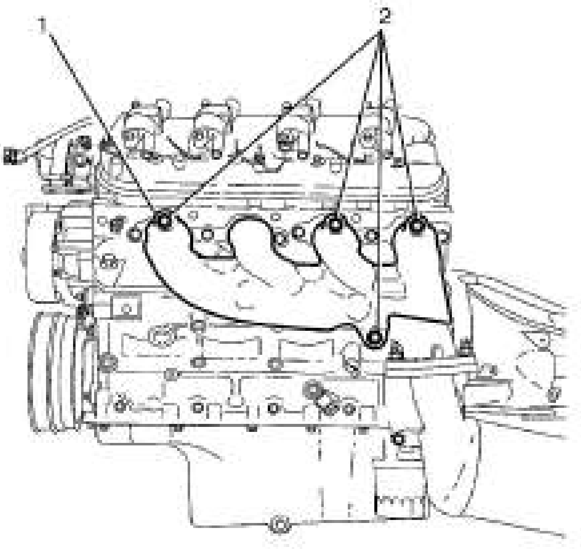
Exhaust Manifold Replacement - Left Side (6.0L Engine LWB SWB)

Removal Procedure

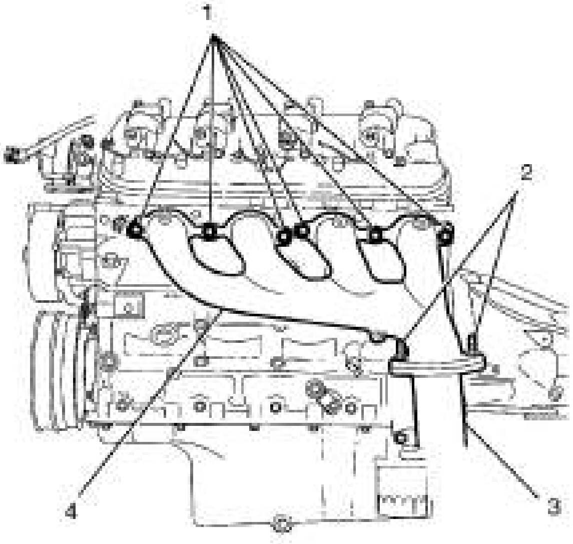
1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the engine dress cover. Refer to Engine Cover Replacement.
3. Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement.
4. Remove the left side spark plug leads. Refer to Spark Plug Wire Replacement.
5. Remove the left side spark plugs from the cylinder head. Refer to Spark Plug Replacement.

Caution: Refer to Exhaust Service Caution in the Preface section.

Caution: Refer to Protective Goggles and Glove Caution in the Preface section.



6. Remove the exhaust manifold heat shield to exhaust manifold retaining bolts (2).
7. Remove the exhaust manifold heat shield (1).
8. Remove the engine coolant temperature sensor. Refer to Engine Coolant Temperature Sensor Replacement.



Important: The left catalytic converter to exhaust manifold retaining nuts (2) are single use parts. They must be discarded after removal.

9. Remove the left catalytic converter to exhaust manifold retaining nuts (2).

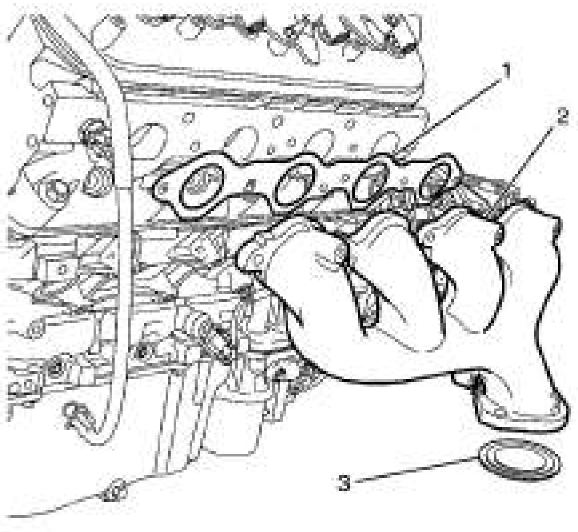
   Discard the nuts.

10. Disconnect the left catalytic converter (3) from the exhaust manifold (4).
11. Loosen the exhaust manifold to cylinder head retaining bolts (1) working from the outside to the centre.

    Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

12. Remove the exhaust manifold to cylinder head retaining bolts (1).

    Discard the bolts.



Important: Make sure that the surrounding wiring harness and electrical connectors are not damaged when removing the exhaust manifold (2).

Important: The exhaust manifold gasket (1) and sealing ring (3) are single use parts. They must be discarded after removal.

13. Remove the exhaust manifold (2).

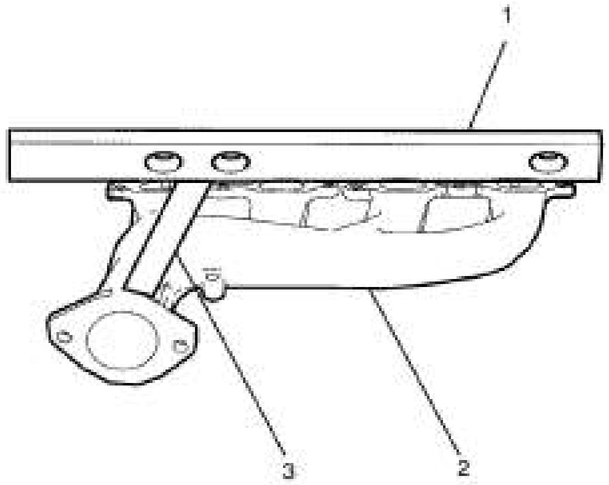
    Discard the exhaust manifold gasket (1) and sealing ring (3).

Installation Procedure

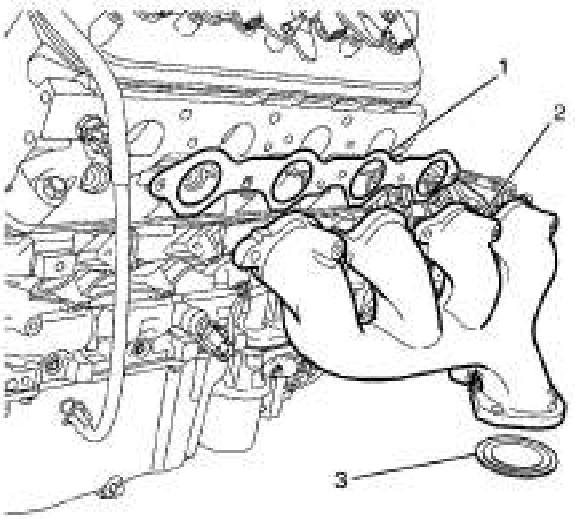
Inspect

Notice: Refer to Exhaust Service Caution in the Preface section.

1. Before installation inspect for the following:
    - Damage to the gasket sealing surfaces.
    - Distortion of exhaust manifold mating surface.
    - Damage to the exhaust mounting holes.



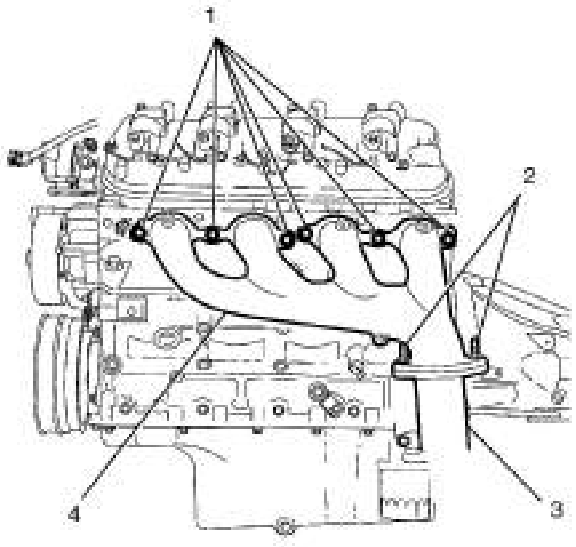
2. Check for distortion on the mating surface of the exhaust manifold (3) by using a straight edge (1) and a feeler gauge (2).
3. Clean the exhaust manifold and catalytic converter flange mating surfaces.



4. Install a NEW exhaust manifold gasket (1) and NEW sealing ring (3) to the exhaust manifold (2).

   Notice: Refer to Exhaust System Inspection Notice in the Preface section.

5. Install the exhaust manifold assembly to the engine.



Important: Do not fully tighten the exhaust manifold to cylinder head retaining bolts (1) at this stage.

6. Install the NEW exhaust manifold to cylinder head retaining bolts (1).

   Do not fully tighten at this stage.

   Important: Make sure the sealing ring is seated correctly.

7. Lift the left catalytic converter (3) up and forward to connect to the exhaust manifold (4).
8. Clean the threads of the exhaust manifold to catalytic converter retaining studs with a suitable cleaning solvent.

   Notice: Refer to Fastener Notice in the Preface section.

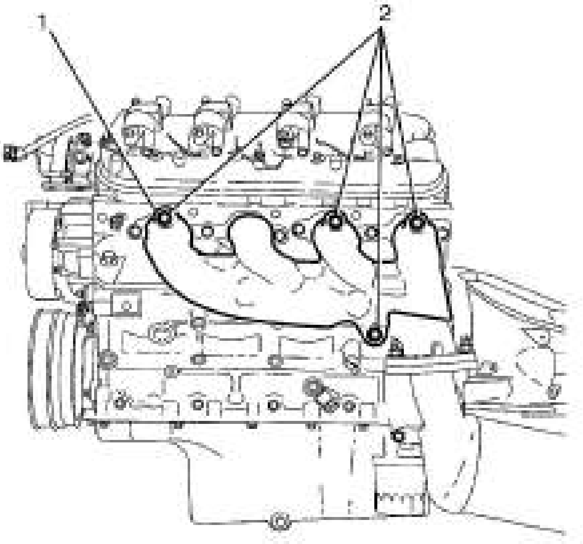
9. Install the NEW left catalytic converter to exhaust manifold retaining nuts (2).

   Tighten
   Tighten the nuts to 45 N·m (33 lb ft).

10. Tighten the exhaust manifold to cylinder head retaining bolts (1) working from the centre to the outside.

    Tighten
    Tighten the bolts to 20 N·m (15 lb ft).

11. Install the engine coolant temperature sensor. Refer to Engine Coolant Temperature Sensor Replacement .



12. Install the exhaust manifold heat shield (1).
13. Install the exhaust manifold heat shield to exhaust manifold retaining bolts (2).

    Tighten
    Tighten the bolts to 10 N·m (89 lb in).

14. Install the left side spark plugs to the cylinder head. Refer to Spark Plug Replacement.
15. Install the left side spark plug leads. Refer to Spark Plug Wire Replacement.
16. Install the air intake duct. Refer to Air Cleaner Assembly Replacement.
17. Install the engine dress cover. Refer to Engine Cover Replacement.
18. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.

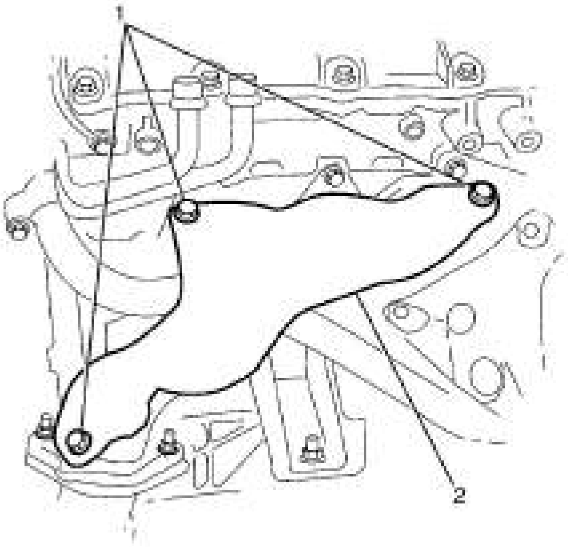
Exhaust Manifold Replacement - Right Side (3.6L Engine NT3)

Removal Procedure

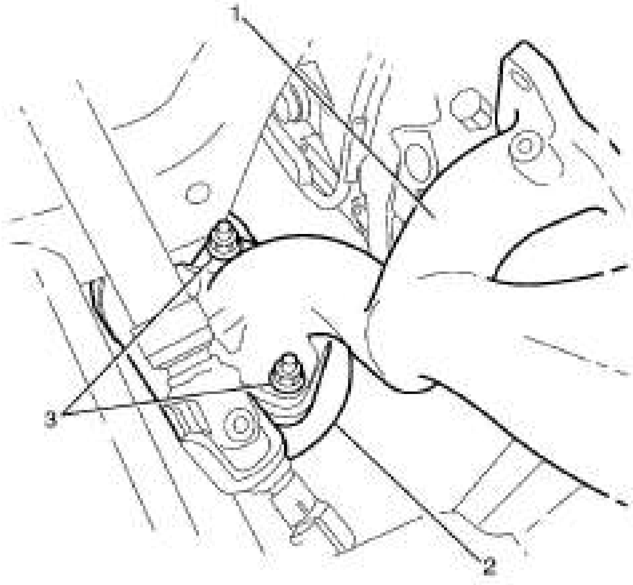
1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the engine dress cover. Refer to Engine Cover Replacement.

Caution: Refer to Exhaust Service Caution in the Preface section.

Caution: Refer to Protective Goggles and Glove Caution in the Preface section.



3. Remove the exhaust manifold heat shield to exhaust manifold retaining bolts (1).
4. Remove the exhaust manifold heat shield (2).

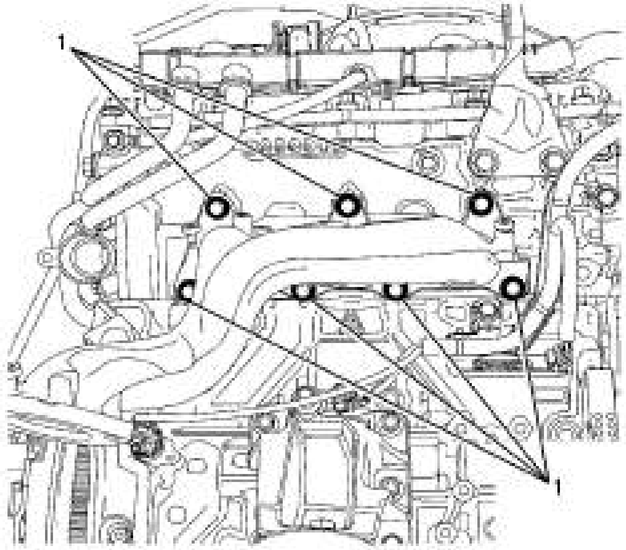


Important: The right catalytic converter to exhaust manifold retaining nuts (3) are single use parts. They must be discarded after removal.

5. Remove the right catalytic converter to exhaust manifold retaining nuts (3).

   Discard the nuts.

6. Remove the right catalytic converter. Refer to Catalytic Converter Replacement - Right Side.
7. Lower the vehicle.

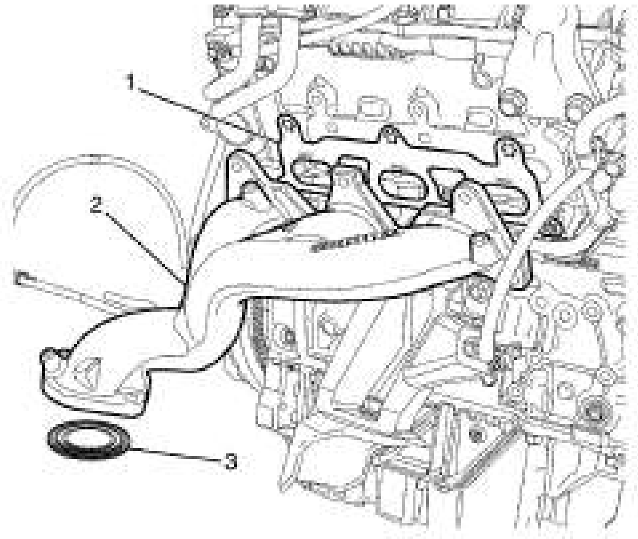


8. Loosen the exhaust manifold to cylinder head retaining bolts (1) working from the outside to the centre.

Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

9. Remove the exhaust manifold to cylinder head retaining bolts (1).

   Discard the bolts.



Important: Make sure that the surrounding wiring harness and electrical connectors are not damaged when removing the exhaust manifold (2).

Important: The exhaust manifold gasket (1) and sealing ring (3) are single use parts. They must be discarded after removal.

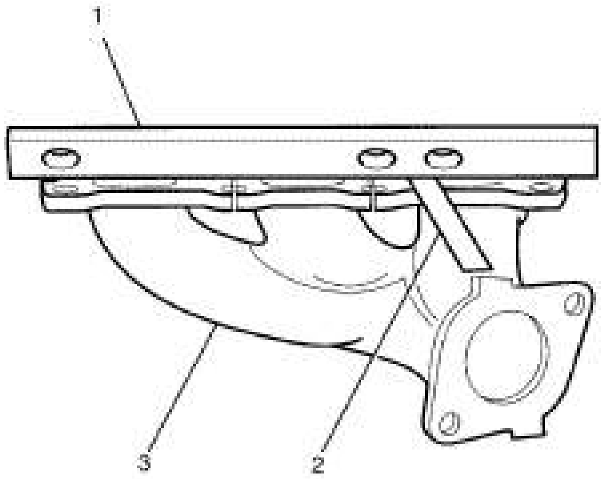
10. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
11. Remove the exhaust manifold (2).

    Discard the exhaust manifold gasket (1) and sealing ring (3).

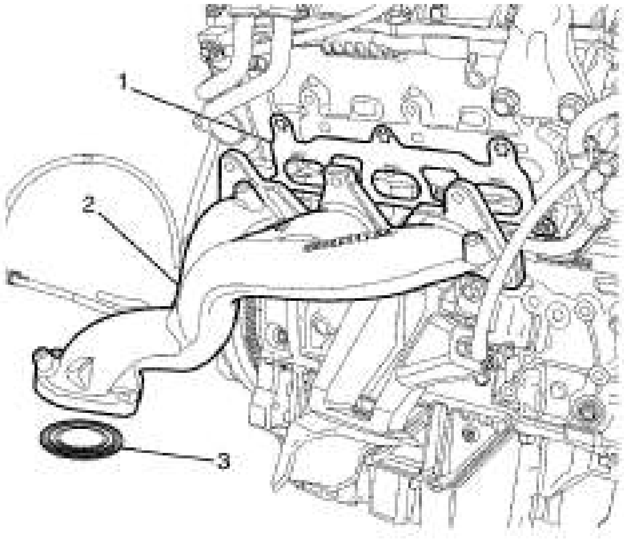
Installation Procedure

Notice: Refer to Exhaust Service Caution in the Preface section.

1. Before installation inspect for the following:
   - Damage to the gasket sealing surfaces.
   - Distortion of exhaust manifold mating surface.
   - Damage to the exhaust mounting holes.



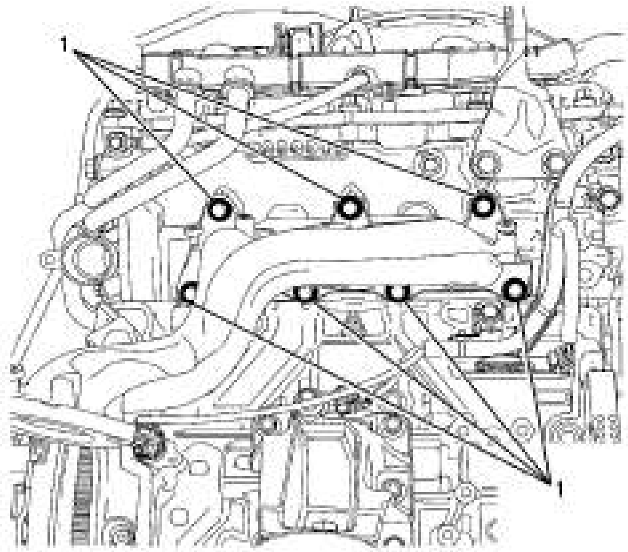
2. Check for distortion on the mating surface of the exhaust manifold (3) by using a straight edge (1) and a feeler gauge (2).
3. Clean the exhaust manifold and catalytic converter flange mating surfaces.



4. Install a NEW exhaust manifold gasket (1) and NEW sealing ring (3) to the exhaust manifold (2).

   Notice: Refer to Exhaust System Inspection Notice in the Preface section.

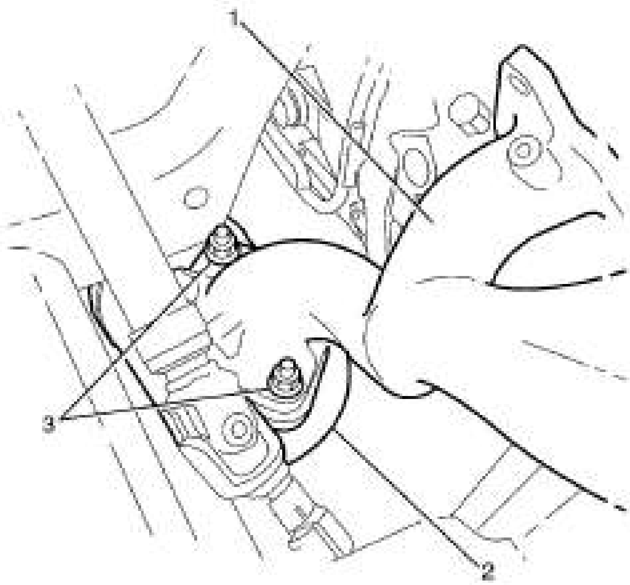
5. Install the exhaust manifold assembly to the engine.



Important: Do not fully tighten the exhaust manifold to cylinder head retaining bolts (1) at this stage.

6. Install the NEW exhaust manifold to cylinder head retaining bolts (1).

   Do not fully tighten at this stage.



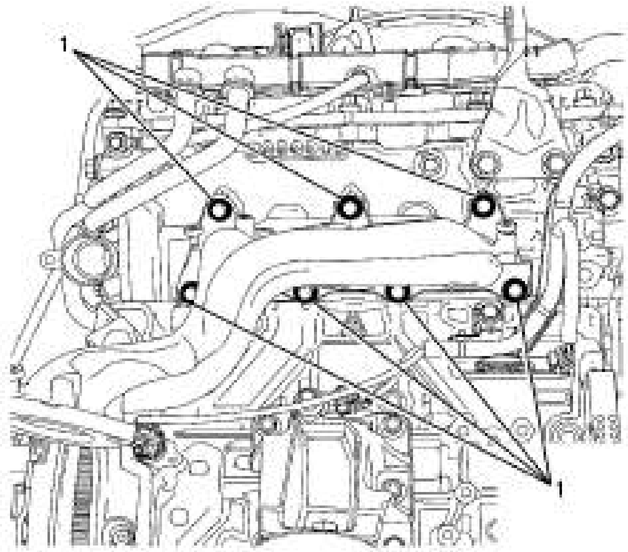
Important: Make sure the sealing ring is seated correctly.

7. Install the right catalytic converter. Refer to Catalytic Converter Replacement - Right Side.

Notice: Refer to Fastener Notice in the Preface section.

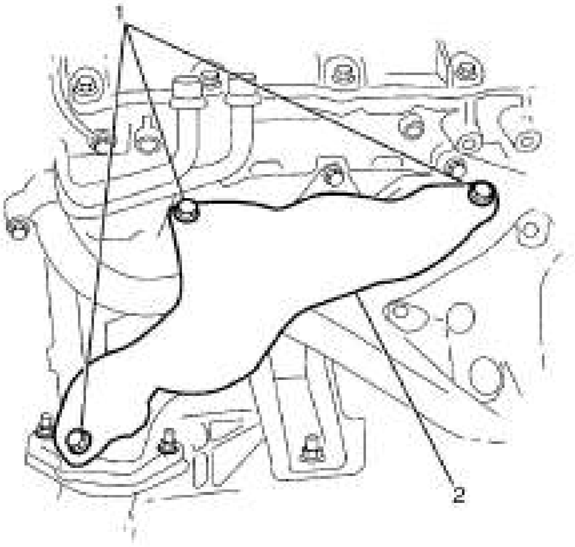
8. Install the NEW right catalytic converter to exhaust manifold retaining nuts (3).

Tighten
Tighten the nuts to 45 N·m (33 lb ft).



9. Tighten the exhaust manifold to cylinder head retaining bolts (1) working from the centre to the outside.

Tighten
Tighten the bolts to 20 N·m (15 lb ft).



10. Install the exhaust manifold heat shield (2).
11. Install the exhaust manifold heat shield to exhaust manifold retaining bolts (1).

    Tighten
    Tighten the bolts to 10 N·m (89 lb in).

12. Install the engine dress cover. Refer to Engine Cover Replacement.
13. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.

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Exhaust Manifold Replacement - Right Side (3.6L Engine NT4)

Removal Procedure

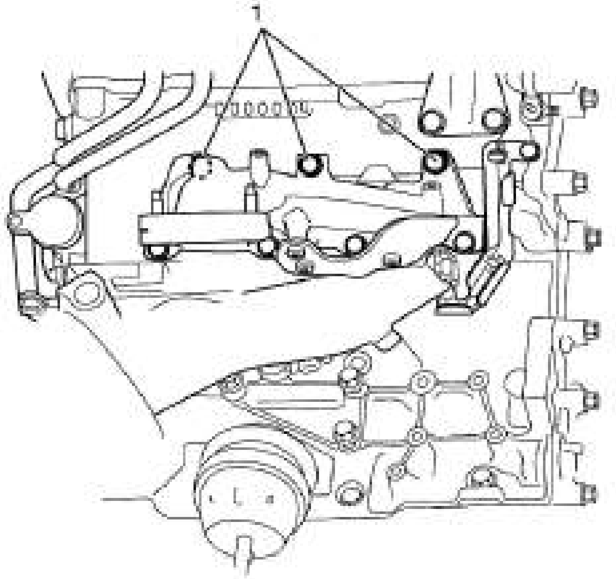
Caution: Refer to Exhaust Service Caution in the Preface section.

Caution: Refer to Protective Goggles and Glove Caution in the Preface section.

1. Ignition OFF.

Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove the engine cover. Refer to Engine Cover Replacement.
4. Remove the right pre-catalytic convertor heated oxygen sensor (HO2S). Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 1.
5. Remove the exhaust manifold heat shield. Refer to Exhaust Manifold Heat Shield Replacement - Right Side .
6. Remove the right catalytic converter. Refer to Catalytic Converter Replacement - Right Side .



Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

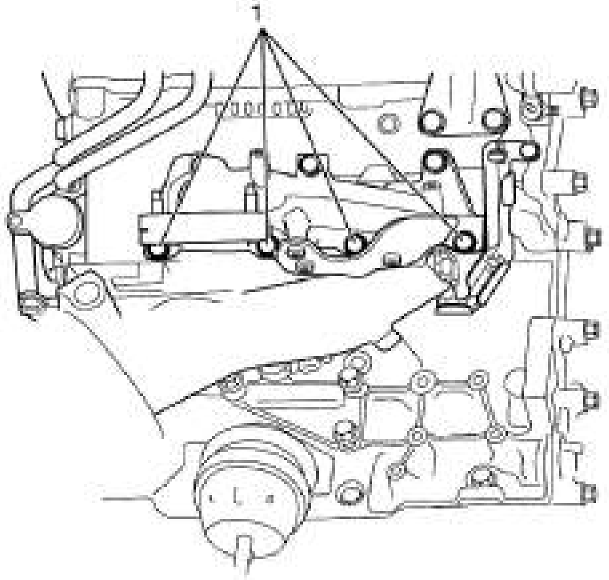
7. Remove the exhaust manifold to cylinder head retaining bolts (1).

Discard the bolts.

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

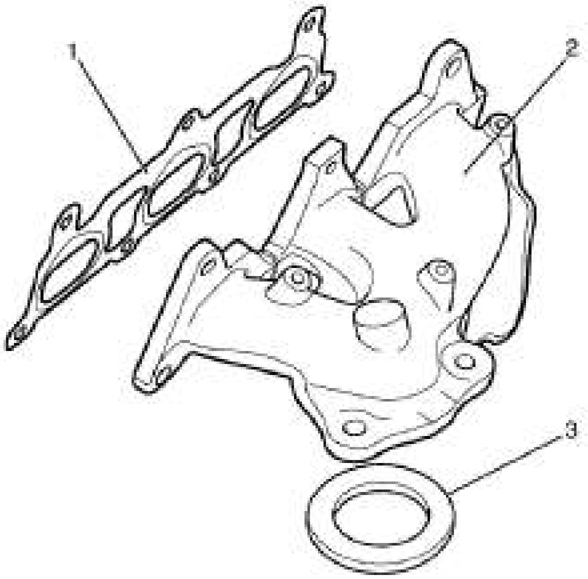
8. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

9. Remove the exhaust manifold to cylinder head retaining bolts (1).

   Discard the bolts.



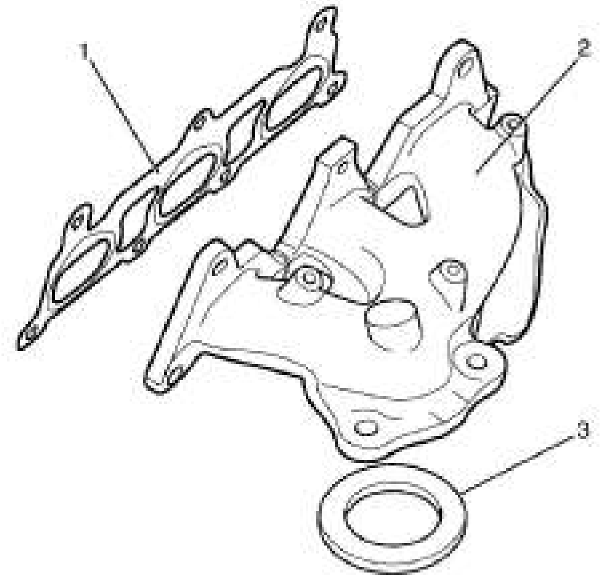
Important: Make sure that the surrounding wiring harness and electrical connectors are not damaged when removing the exhaust manifold (2).

Important: The exhaust manifold gasket (1) and sealing ring (3) are single use parts. They must be discarded after removal.

10. Remove the exhaust manifold (2) from the engine assembly.
11. Separate the exhaust manifold (2) from the exhaust manifold gasket (1) and sealing ring (3).
12. Discard the exhaust manifold gasket (1) and sealing ring (3).

Installation Procedure

1. Inspect the exhaust manifold before installation. Refer to Exhaust Manifold Cleaning and Inspection - Right Side.



2. Install a NEW exhaust manifold gasket (1) and NEW sealing ring (3) to the exhaust manifold (2).

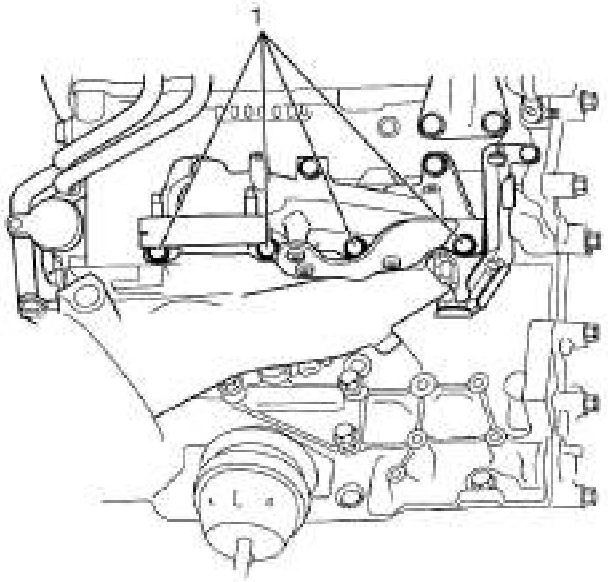
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

Important: A suitable support must be used to support the exhaust manifold while the vehicle is being lowered.

4. Install the exhaust manifold assembly (2) to the engine.



Important: Do not fully tighten the exhaust manifold to cylinder head retaining bolts (1) at this stage.

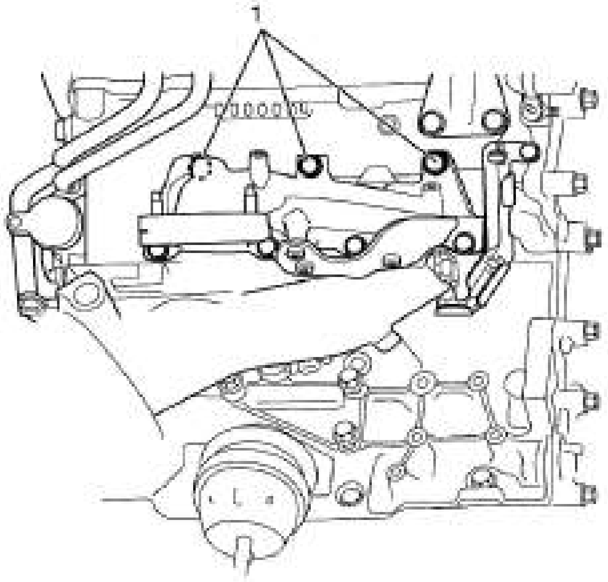
5. Install NEW exhaust manifold to cylinder head retaining bolts (1).

Caution: Refer to Fastener Caution in the Preface section.

6. Tighten the exhaust manifold to cylinder head retaining bolts (1) working from the centre to the outside.

Tighten
Tighten the bolts to 20 N·m (15 lb ft).

7. Lower the vehicle.



Important: Do not fully tighten the exhaust manifold to cylinder head retaining bolts (1) at this stage.

8. Install NEW exhaust manifold to cylinder head retaining bolts (1).

   Caution: Refer to Fastener Caution in the Preface section.

9. Tighten the exhaust manifold to cylinder head retaining bolts (1) working from the centre to the outside.

   Tighten
   Tighten the bolts to 20 N·m (15 lb ft).

10. Install the right catalytic converter. Refer to Catalytic Converter Replacement - Right Side .
11. Install the exhaust manifold heat shield. Refer to Exhaust Manifold Heat Shield Replacement - Right Side .
12. Install the right pre-catalytic convertor HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 .
13. Install the engine cover. Refer to Engine Cover Replacement.
14. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection .

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Exhaust Manifold Replacement - Right Side (6.0L Engine)

Removal Procedure

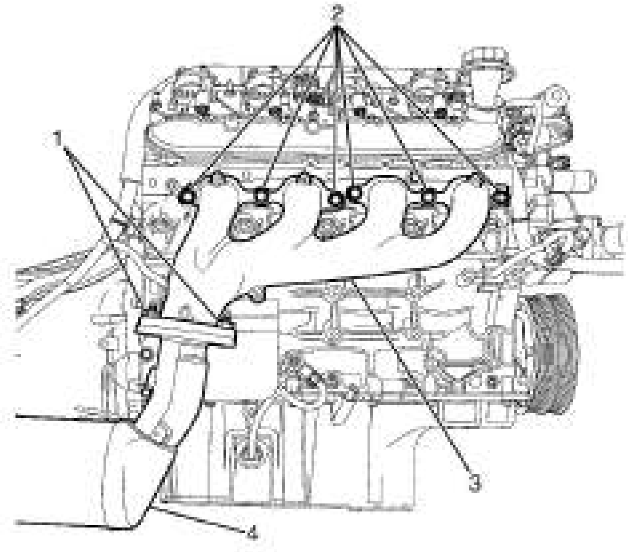
Warning: Refer to Exhaust Service Warning in the Preface section.

Warning: Refer to Protective Goggles and Glove Warning in the Preface section.

1. Ignition OFF.

Warning: Refer to Battery Disconnect Warning in the Preface section.

2. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the engine cover. Refer to Engine Cover Replacement.
4. Remove the oil level indicator tube. Refer to Oil Level Indicator Tube Replacement.
5. Remove the right side spark plug leads. Refer to Spark Plug Wire Replacement.
6. Remove the right side spark plugs from the cylinder head. Refer to Spark Plug Replacement.
7. Remove the right side exhaust manifold heat shield. Refer to Exhaust Manifold Heat Shield Replacement - Right Side.



Note: The right catalytic converter to exhaust manifold retaining nuts (1) are single use parts. They must be discarded after removal.

8. Remove the right catalytic converter to exhaust manifold retaining nuts (1).

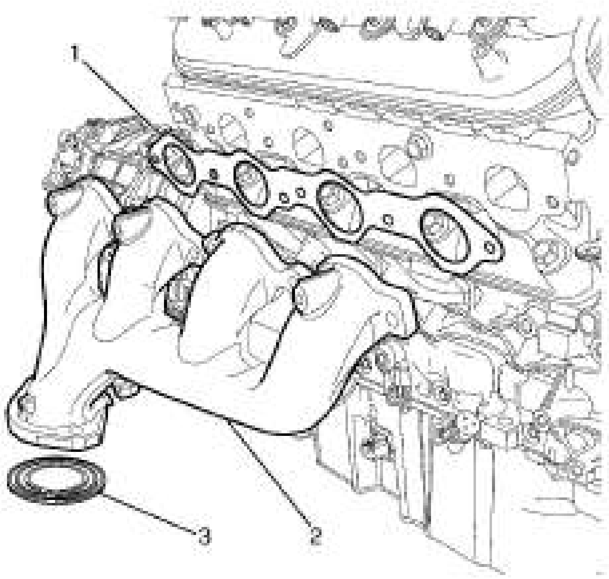
Discard the nuts.

9. Disconnect the right catalytic converter (4) from the exhaust manifold (3).
10. Loosen the exhaust manifold to cylinder head retaining bolts (2) working from the outside to the centre.

    Note: Bolts with micro-encapsulated thread sealant must be discarded after removal.

11. Remove the exhaust manifold to cylinder head retaining bolts (2).

    Discard the bolts.



Note: Make sure that the surrounding wiring harness and electrical connectors are not damaged when removing the exhaust manifold (2).

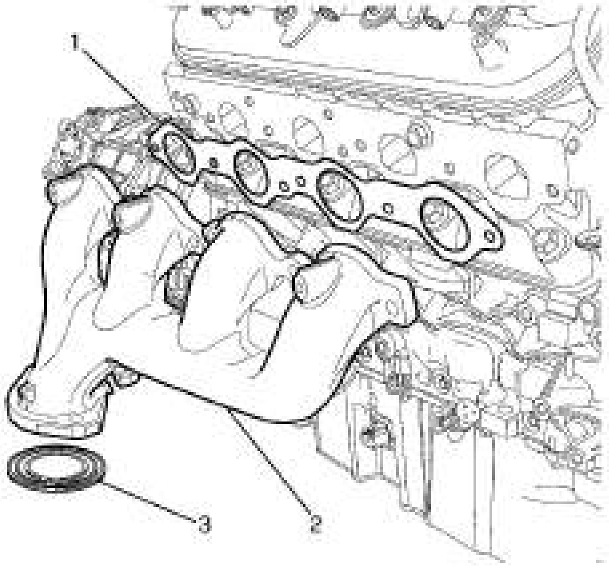
Note: The exhaust manifold gasket (1) and sealing ring (3) are single use parts. They must be discarded after removal.

12. Remove the exhaust manifold (2).

    Discard the exhaust manifold gasket (1) and sealing ring (3).

Installation Procedure

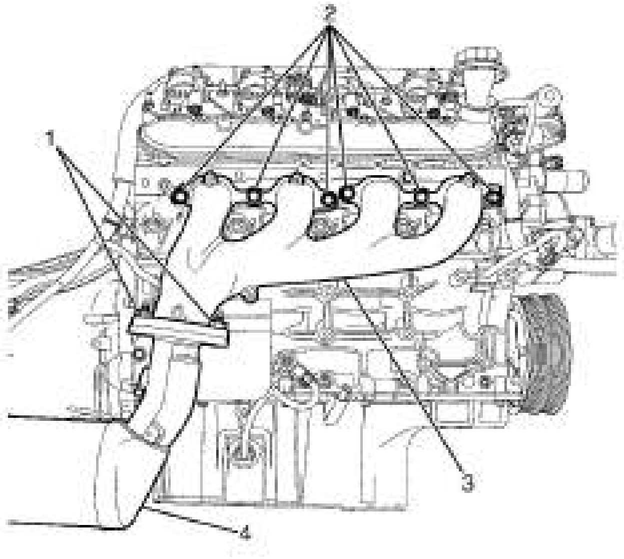
1. Clean and inspect the exhaust manifold. Refer to Exhaust Manifold Cleaning and Inspection.



2. Install NEW exhaust manifold gasket (1) and NEW sealing ring (3) to the exhaust manifold (2).

Caution: Refer to Exhaust System Inspection Caution in the Preface section.

3. Install the exhaust manifold assembly to engine.



4. Install the NEW exhaust manifold to cylinder head retaining bolts (1).
5. Tighten the exhaust manifold to cylinder head retaining bolts (2) working from the centre to the outside to **20 N·m (15 lb ft)**.

Note: Make sure the sealing ring is seated correctly.

6. Lift the right catalytic converter (4) up and forward to connect to the exhaust manifold (3).

7. Clean the threads of the exhaust manifold to catalytic converter retaining studs with a suitable cleaning solvent.

   Caution: Refer to Fastener Caution in the Preface section.

8. Install the NEW right catalytic converter to exhaust manifold retaining nuts (1) and tighten to **45 N·m (33 lb ft)**
9. Install the right side exhaust manifold heat shield. Refer to Exhaust Manifold Heat Shield Replacement - Right Side.
10. Install the right side spark plugs to the cylinder head. Refer to Spark Plug Replacement.
11. Install the right side spark plug leads. Refer to Spark Plug Wire Inspection.
12. Install the oil level indicator tube. Refer to Oil Level Indicator Tube Replacement.
13. Install the engine cover. Refer to Engine Cover Replacement.
14. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

Exhaust Muffler Heat Shield Replacement - Left Side

Removal Procedure

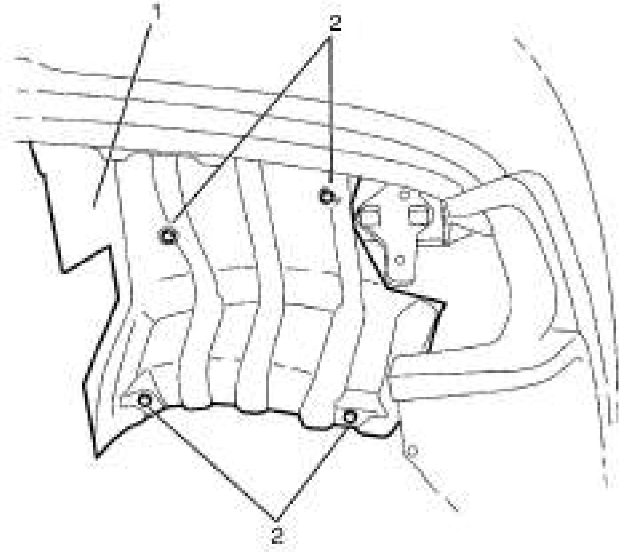
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

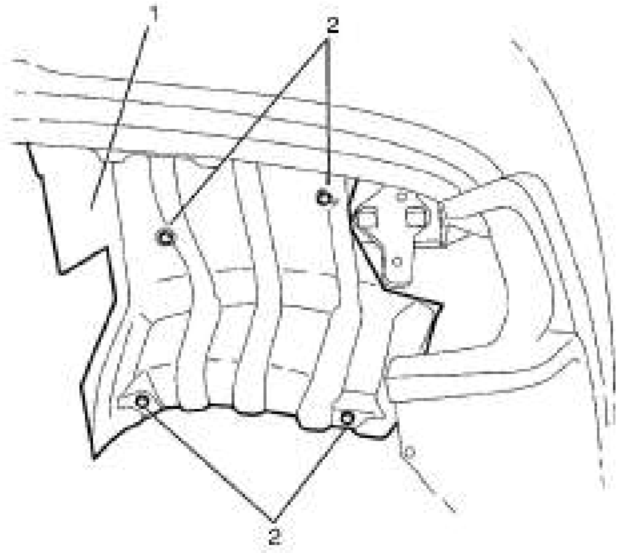
Caution: Refer to Exhaust Service Caution in the Preface section.

2. Remove the left rear muffler assembly. Refer to Exhaust Muffler Replacement - Left Side.



3. Remove the left exhaust muffler heat shield to body retaining bolts (2).
4. Remove the left exhaust muffler heat shield (1).

Installation Procedure



1. Position the left exhaust muffler heat shield (1) to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the left exhaust muffler heat shield to body retaining bolts (2).

   Tighten
   Tighten the bolts to 4 N·m (35 lb in).

3. Install the left rear muffler assembly. Refer to Exhaust Muffler Replacement - Left Side.
4. Lower the vehicle to the ground.

Exhaust Muffler Heat Shield Replacement - Right Side

Removal Procedure

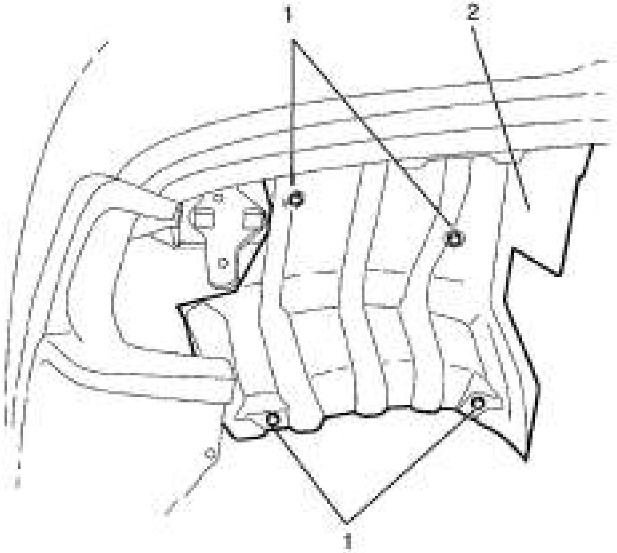
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

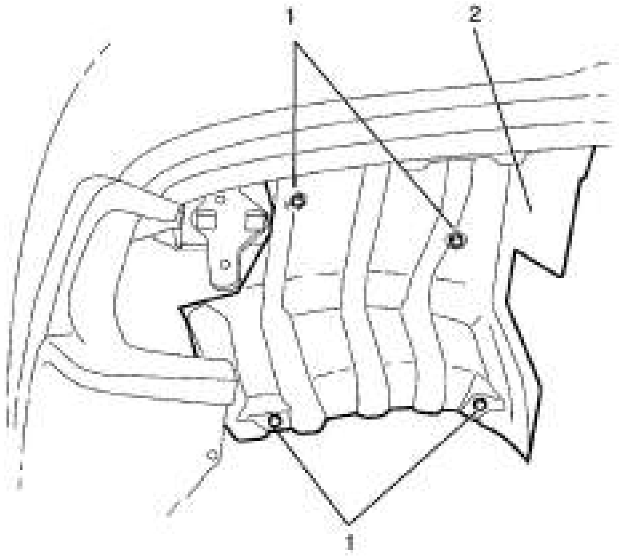
Caution: Refer to Exhaust Service Caution in the Preface section.

2. Remove the right rear muffler assembly. Refer to Exhaust Muffler Replacement - Right Side.



3. Remove the right exhaust muffler heat shield to body retaining bolts (1).
4. Remove the right exhaust muffler heat shield (2).

Installation Procedure



1. Position the right exhaust muffler heat shield (2) to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the right exhaust muffler heat shield to body retaining bolts (1).

   Tighten
   Tighten the bolts to 4 N·m (35 lb in).

3. Install the right rear muffler assembly. Refer to Exhaust Muffler Replacement - Right Side.
4. Lower the vehicle to the ground.

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Exhaust Muffler Replacement - Left Side

Removal Procedure

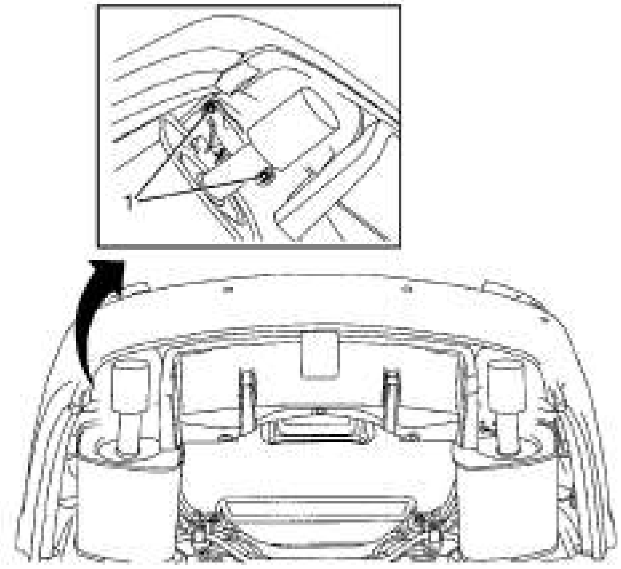
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

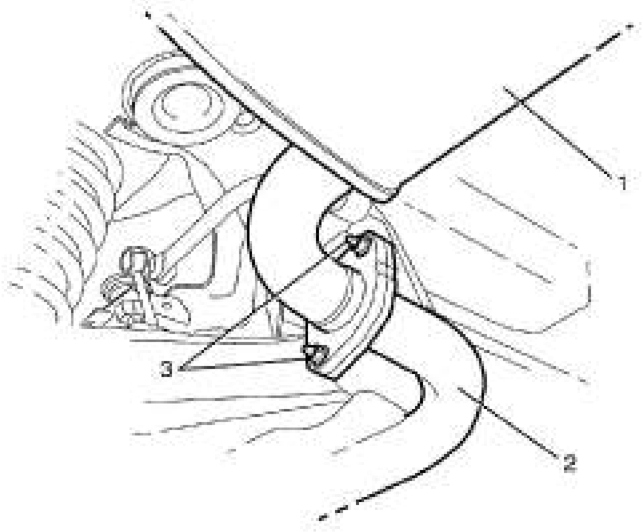
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

Caution: Refer to Exhaust Service Caution in the Preface section.

2. Support the exhaust system using a suitable jack.

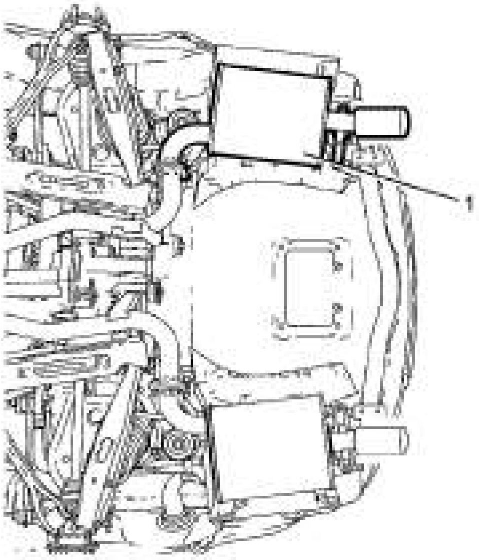


3. Remove the rear insulator hanger to body retaining bolts (1).



Important: The left rear muffler to intermediate exhaust assembly retaining nuts (3) are single use parts. They must be discarded after removal.

4. Remove the left rear muffler to intermediate exhaust assembly retaining bolts (3).
5. Disconnect the left rear muffler (1) from the intermediate exhaust assembly (2).

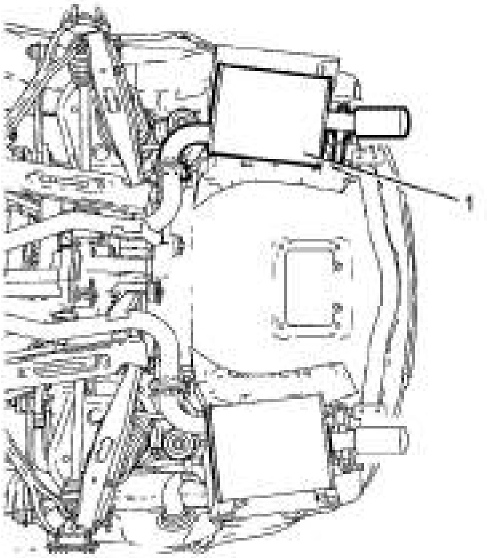


6. Remove the left rear muffler (1) from the vehicle.

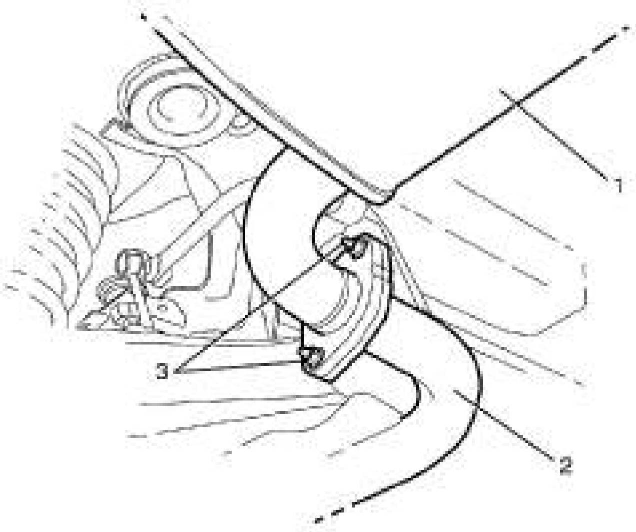
Installation Procedure

Important: The originally equipped exhaust extension pipe can be cut and reused when replacing a rear muffler. Only reuse if the extension pipe is in an acceptable condition.

1. Clean the threads of the rear exhaust assembly with a suitable cleaning solvent.



2. Install the left rear muffler (1) to the vehicle.

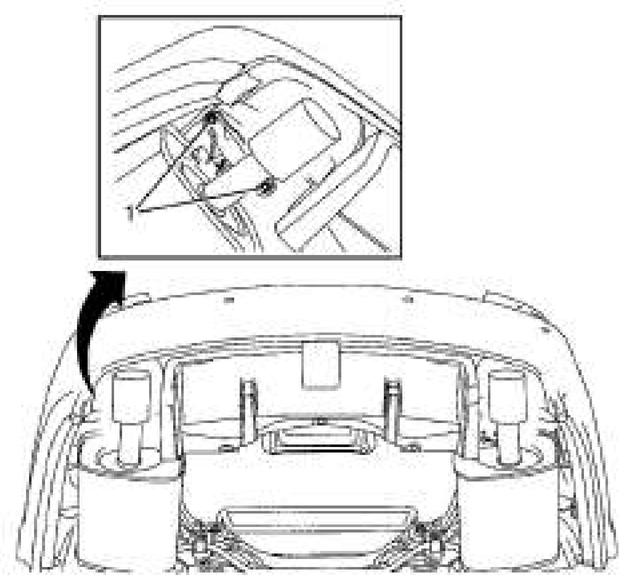


3. Connect the left rear muffler (1) to the intermediate exhaust assembly (2).

   Notice: Refer to Fastener Notice in the Preface section.

4. Install the left rear muffler to intermediate exhaust assembly retaining bolts (3).

   Tighten
   Tighten the bolts to 45 N·m (33 lb ft).



5. Install the rear insulator hanger to body retaining bolts (1).

   Tighten
   Tighten the bolts to 26 N·m (19 lb ft).

6. Make sure that the exhaust system is clear of all other components and chassis. If the exhaust system is not clear of all the other components loosen all retaining nuts and re-align. Refer to Exhaust System Alignment .
7. Lower the vehicle to the ground.

Exhaust Muffler Replacement - Right Side

Removal Procedure

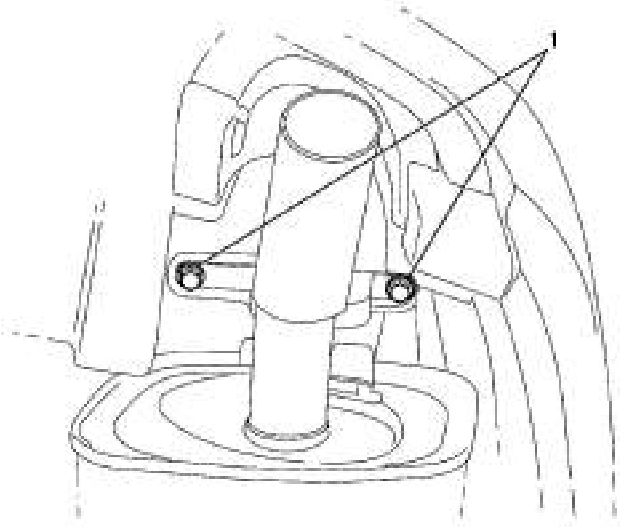
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

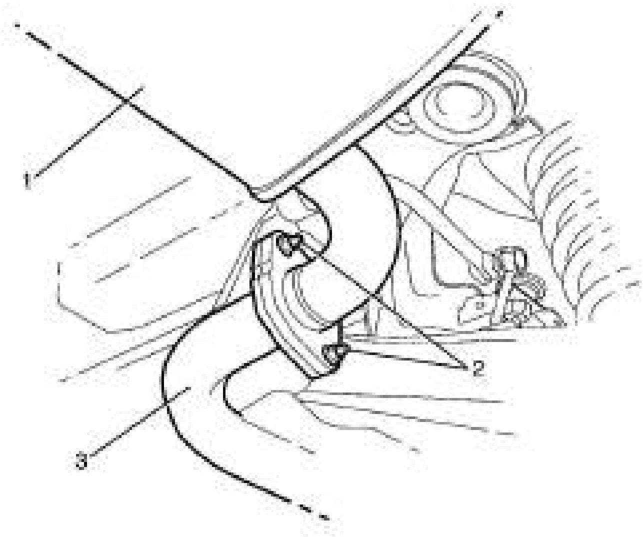
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

Caution: Refer to Exhaust Service Caution in the Preface section.

2. Support the exhaust system using a suitable jack.

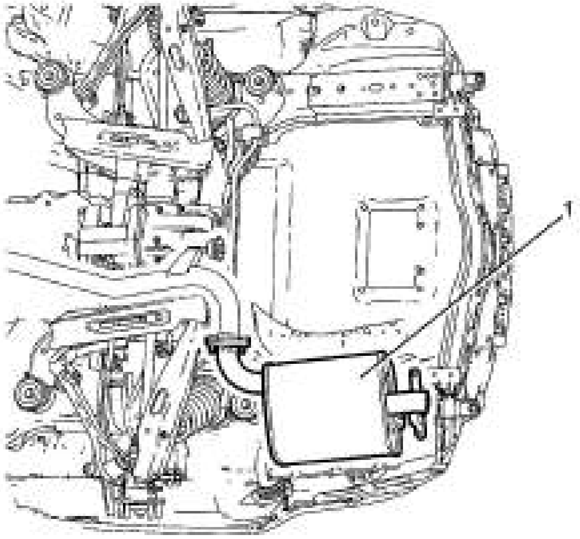


3. Remove the rear insulator hanger to body retaining bolts (1).



Important: The right rear muffler to intermediate exhaust assembly retaining nuts (2) are single use parts. They must be discarded after removal.

4. Remove the right rear muffler to intermediate exhaust assembly retaining bolts (2).
5. Disconnect the right rear muffler (1) from the intermediate exhaust assembly (3).

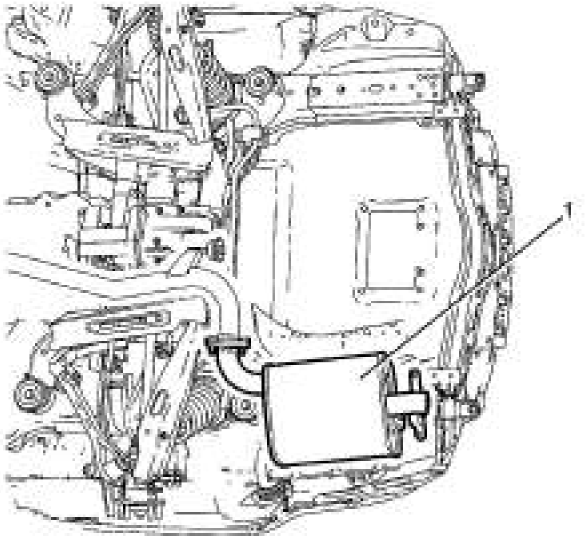


6. Remove the right rear muffler (1) from the vehicle.

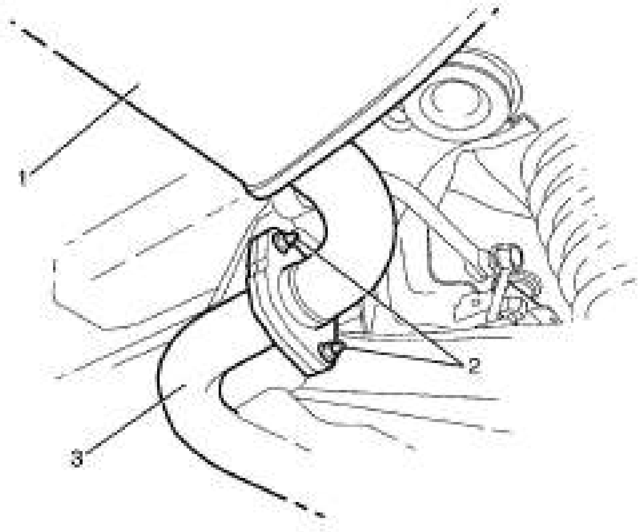
Installation Procedure

Important: The originally equipped exhaust extension pipe can be cut and reused when replacing a rear muffler. Only reuse if the extension pipe is in an acceptable condition.

1. Clean the threads of the rear exhaust assembly with a suitable cleaning solvent.



2. Install the right rear muffler (1) to the vehicle.

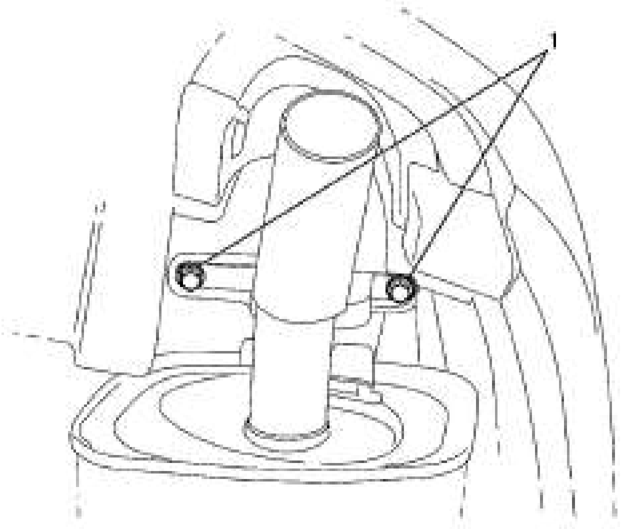


3. Align the right rear muffler (1) to the intermediate exhaust assembly (3).

   Notice: Refer to Fastener Notice in the Preface section.

4. Install the right rear muffler to intermediate exhaust assembly retaining bolts (2).

   Tighten
   Tighten the bolts to 45 N·m (33 lb ft).



5. Install the rear insulator hanger to body retaining bolts (1).

   Tighten
   Tighten the bolts to 26 N·m (19 lb ft).

6. Make sure that the exhaust system is clear of all other components and chassis. If the exhaust system is not clear of all the other components loosen all retaining nuts and re-align. Refer to Exhaust System Alignment .
7. Lower the vehicle.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Exhaust | Repair Instructions | **Document ID: 1996249**

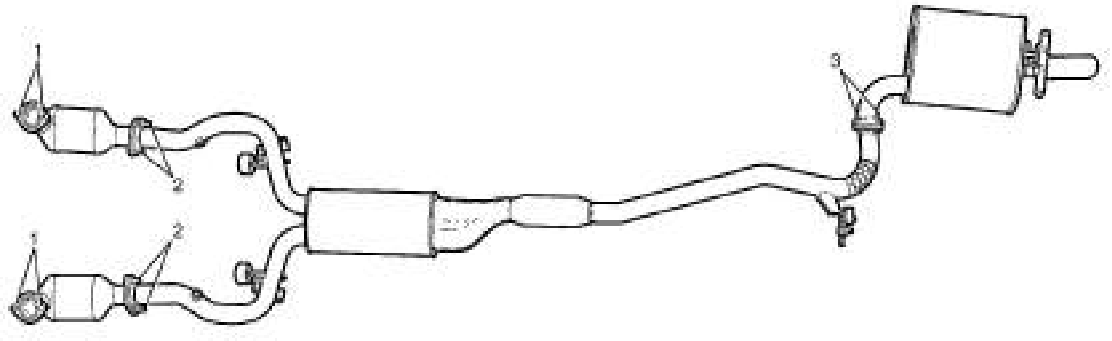
Exhaust System Alignment (LEO and LW2 Engines)

Notice: Refer to Exhaust System Inspection Notice in the Preface section.

Caution: Refer to Exhaust Service Caution in the Preface section.

Important: This procedure is only to be performed if the exhaust is incorrectly aligned or is not clear of all other components or chassis.

Important: Make sure all exhaust retaining nuts and bolts are loose before conducting this procedure.



1. Initially tighten catalytic converter to exhaust manifold retaining nuts (1).

   Tighten
   Tighten the nuts to 20 N·m (15 lb ft).

2. Tighten catalytic converter to exhaust manifold retaining nuts (1).

   Tighten
   Tighten the nuts to 45 N·m (33 lb ft).

3. Tighten exhaust crossover pipe to catalytic converter retaining nuts (2).

   Tighten
   Tighten the nuts to 40 N·m (30 lb ft).

4. Tighten muffler to exhaust crossover pipe retaining bolts (3).

   Tighten
   Tighten the nuts to 45 N·m (33 lb ft).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Exhaust | Repair Instructions | Document ID: 1996248

Exhaust System Alignment (LY7 and L98 Engines)

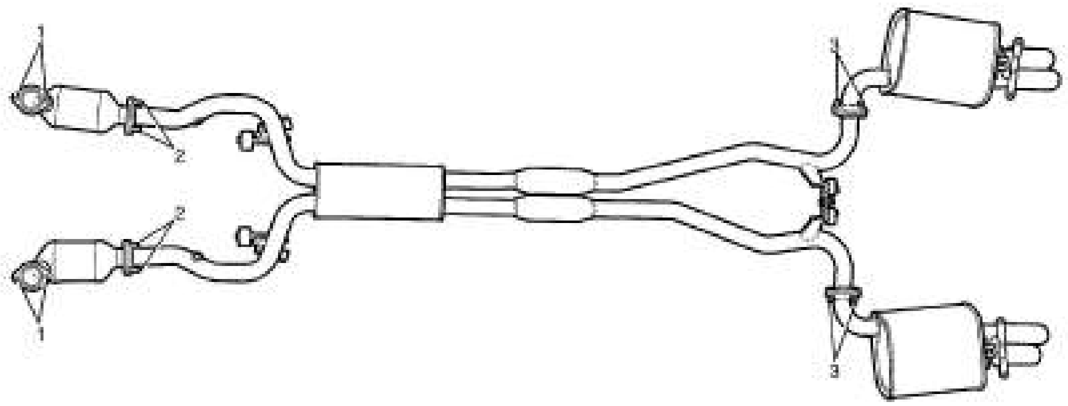
Notice: Refer to Exhaust System Inspection Notice in the Preface section.

Notice: Refer to Exhaust Service Caution in the Preface section.

Important: This procedure is only to be performed if the exhaust is incorrectly aligned or is not clear of all other components or chassis.

Important: Make sure all exhaust retaining nuts and bolts are loose before conducting this procedure.

Important: The L98 exhaust is pictured but flange bolts are in the same location on LY7.



1. Initially tighten catalytic converter to exhaust manifold retaining nuts (1).

   Tighten
   Tighten the nuts to 20 N·m (15 lb ft).

2. Tighten catalytic converter to exhaust manifold retaining nuts (1).

   Tighten
   Tighten the nuts to 45 N·m (33 lb ft).

3. Tighten exhaust crossover pipe to catalytic converter retaining nuts (2).

   Tighten
   Tighten the nuts to 40 N·m (30 lb ft).

4. Tighten muffler to exhaust crossover pipe retaining bolts (3).

   Tighten

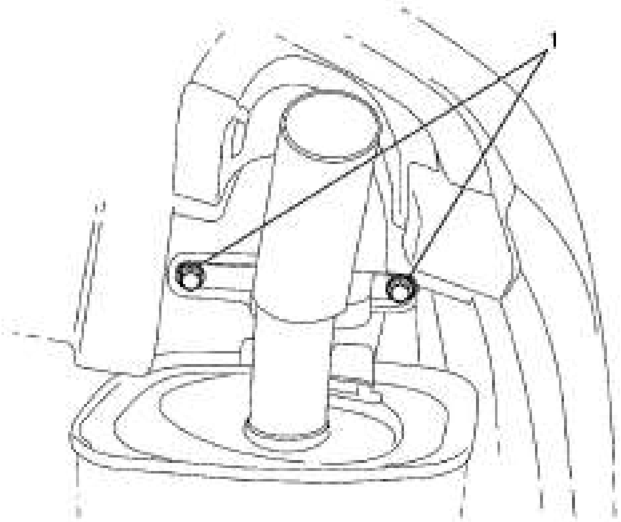
Tighten the nuts to 45 N·m (33 lb ft).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Exhaust | Repair Instructions | **Document ID: 1977422**

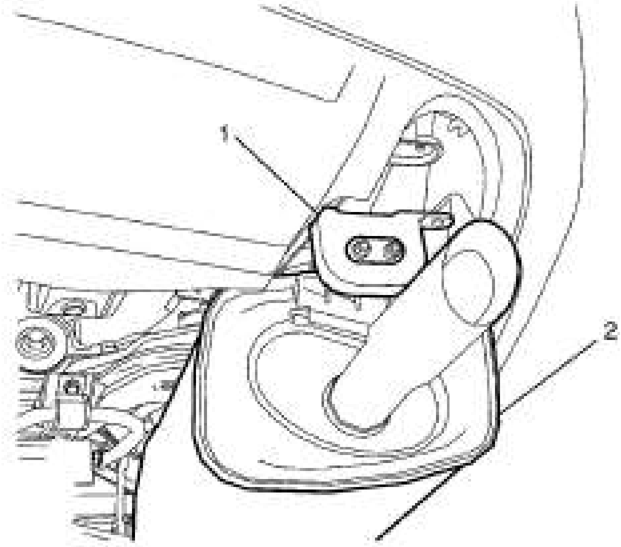
Exhaust System Insulator, Hanger, Bracket Replacement

Removal Procedure

Caution: Refer to Exhaust Service Caution in the Preface section.

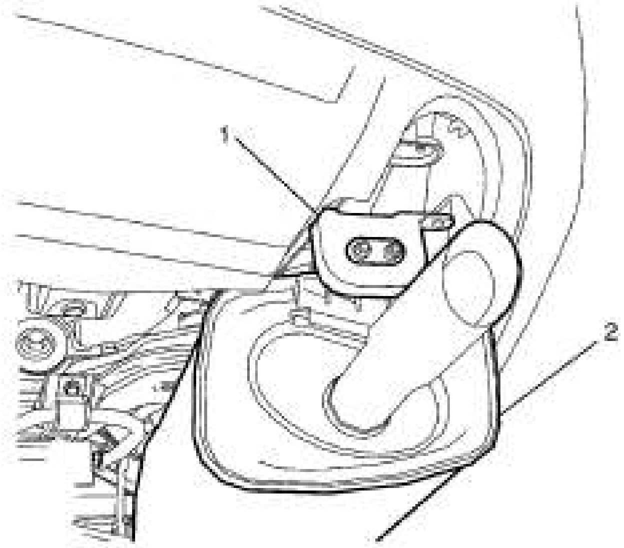


1. Remove the rear Insulator hanger to body retaining bolts (1).

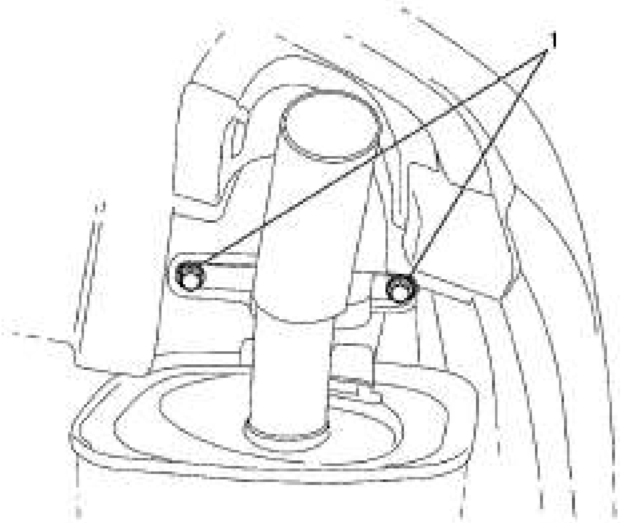


2. Remove the rear insulator hanger (1) from the rear muffler (2).

Installation Procedure



1. Install the rear insulator hanger (1) to the rear muffler (2).



2. Install the rear insulator hanger to body retaining bolts (1).

Tighten
Tighten the bolts to 26 N·m (19 lb ft).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Exhaust | Repair Instructions | **Document ID: 2077308**

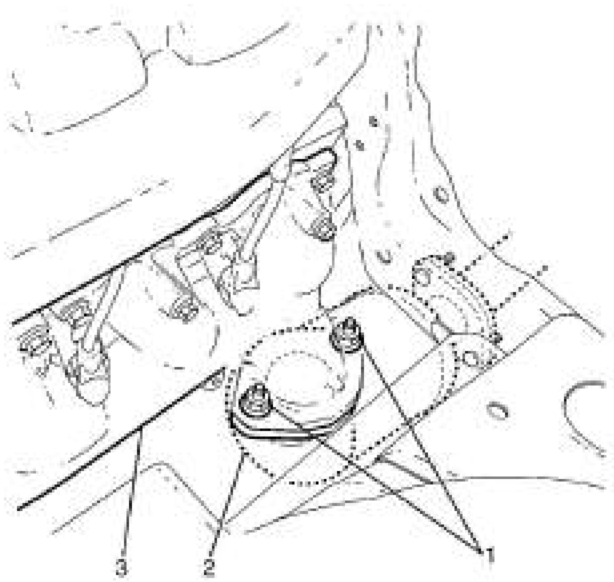
Exhaust System Replacement (L98)

Removal Procedure - Up to 31 May 2007

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.

   Caution: Refer to Exhaust Service Caution in the Preface section.

   Caution: Refer to Protective Goggles and Glove Caution in the Preface section.

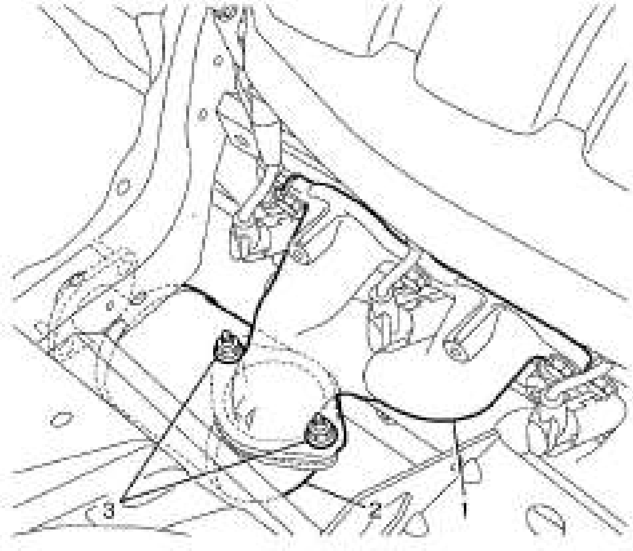


Important: The left catalytic converter to exhaust manifold retaining nuts (1) are single use parts. They must be discarded after removal.

2. Remove the left catalytic converter to exhaust manifold retaining nuts (1).

   Discard the nuts.

3. Disconnect the left catalytic converter (2) from the exhaust manifold (3).



Important: The right catalytic converter to exhaust manifold retaining nuts (3) are single use parts. They must be discarded after removal.

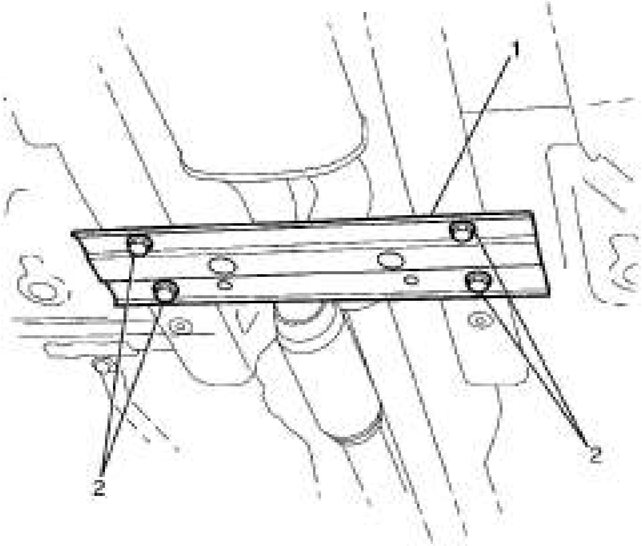
4. Remove the right catalytic converter to exhaust manifold retaining nuts (3).

   Discard the nuts.

5. Disconnect the right catalytic converter (2) from the exhaust manifold (1).

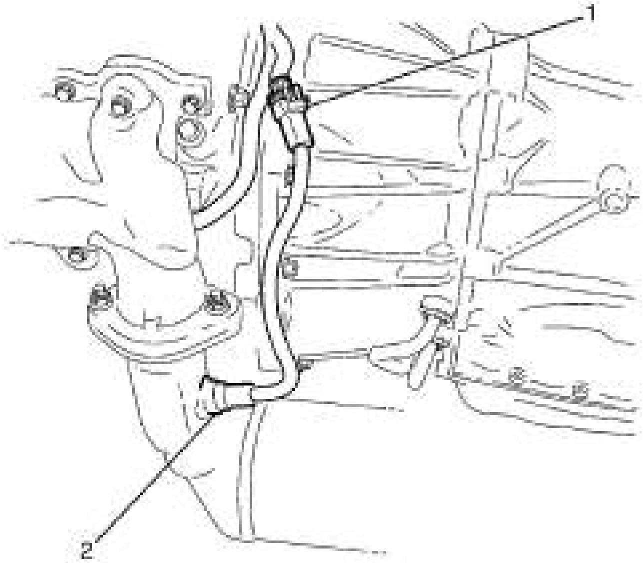
   Caution: Refer to Vehicle Lifting Caution in the Preface section.

6. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

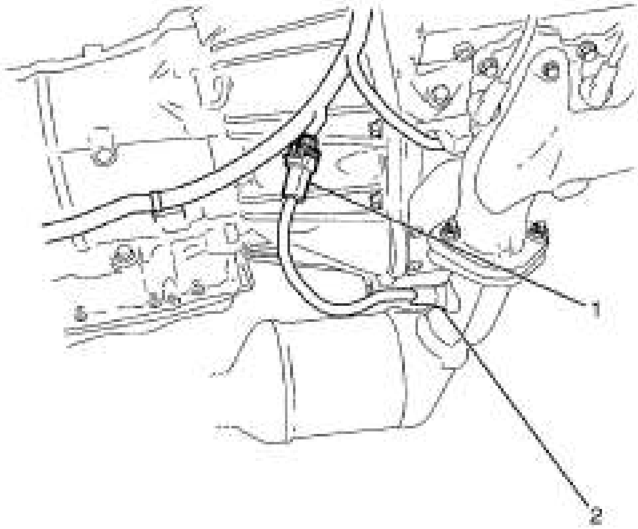


7. Remove the transmission tunnel cross-brace to body retaining bolts (2).
8. Remove the transmission tunnel cross-brace (1).
9. Support the exhaust system using a suitable jack.

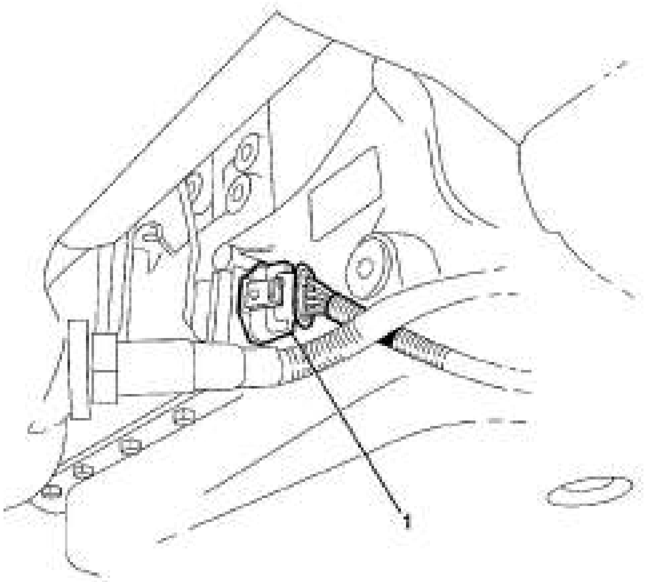
Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.



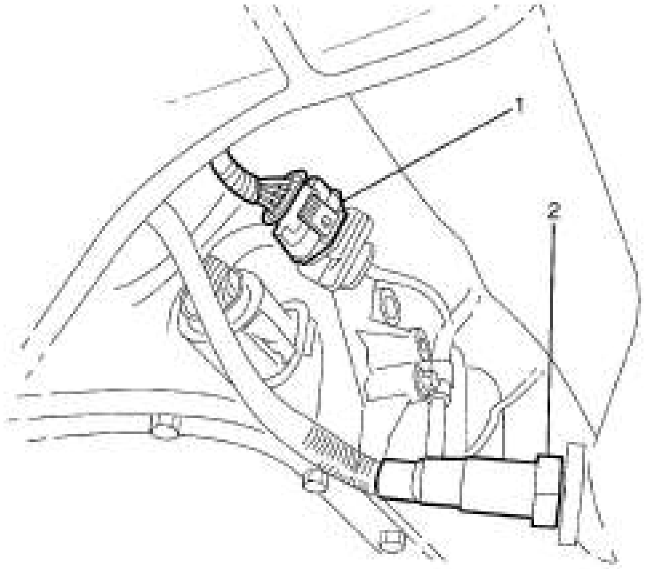
10. Disconnect the left pre-catalytic converter HO2S electrical connector (1).



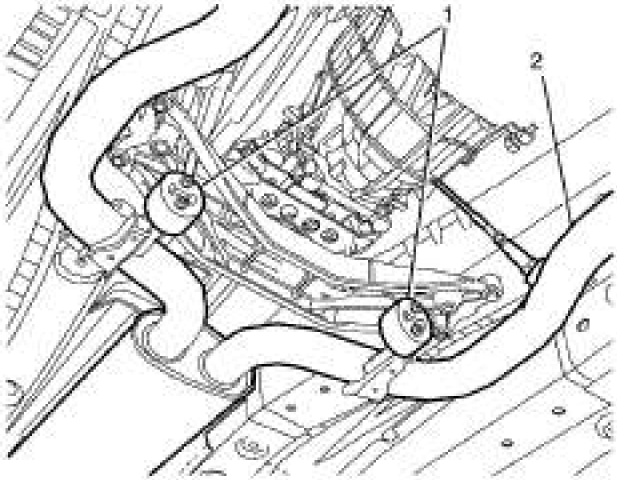
11. Disconnect the right pre-catalytic converter HO2S electrical connector (2).



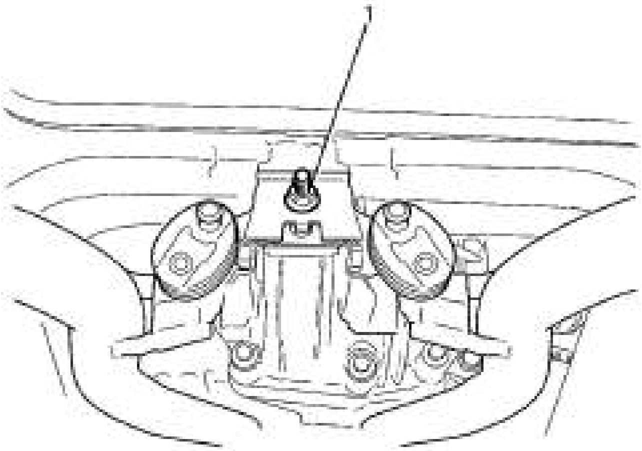
12. Disconnect the left post-catalytic converter HO2S electrical connector (1).



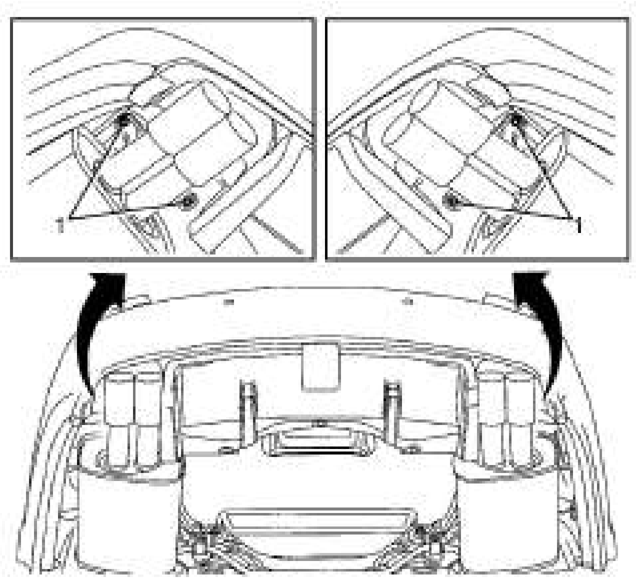
13. Disconnect the right post-catalytic converter HO2S electrical connector (1).



14. Detach the exhaust system (2) by removing the front insulator hangers (1).



15. Detach the exhaust system (2) by removing the centre insulator hanger bracket to differential retaining bolt (1).



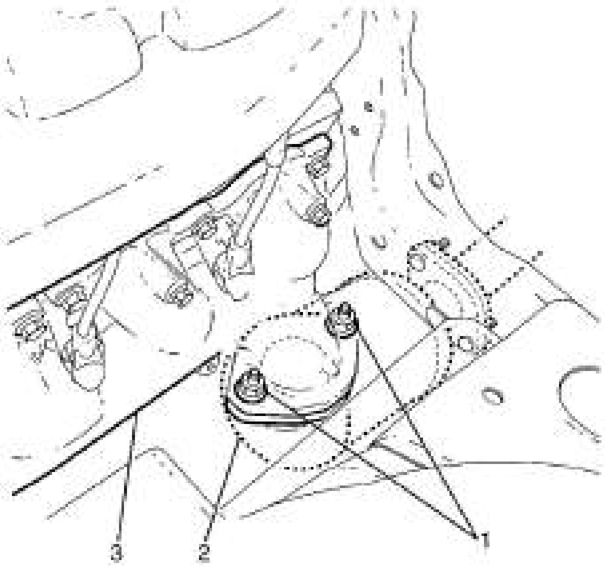
16. Remove the rear insulator hanger to body retaining bolts (1).
17. With the aid of an assistant or using a suitable jack; carefully lower the exhaust system from the vehicle.
18. Carefully lower the exhaust system from the vehicle.
19. Remove the left pre-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 1.
20. Remove the left post-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 2.
21. Remove the right pre-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 1.
22. Remove the right post-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 2.

Installation Procedure - Up to 31 May 2007

1. Install the left pre-catalytic converter HO2S to the left catalytic converter. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 1.
2. Install the left post-catalytic converter HO2S to the intermediate exhaust assembly. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 2.
3. Install the right pre-catalytic converter HO2S to the right catalytic converter. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 1.
4. Install the right post-catalytic converter HO2S to the intermediate exhaust assembly. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 2.

   Notice: Refer to Exhaust Service Caution in the Preface section.

5. With the aid of an assistant or using a suitable jack; carefully raise the exhaust system to the vehicle.



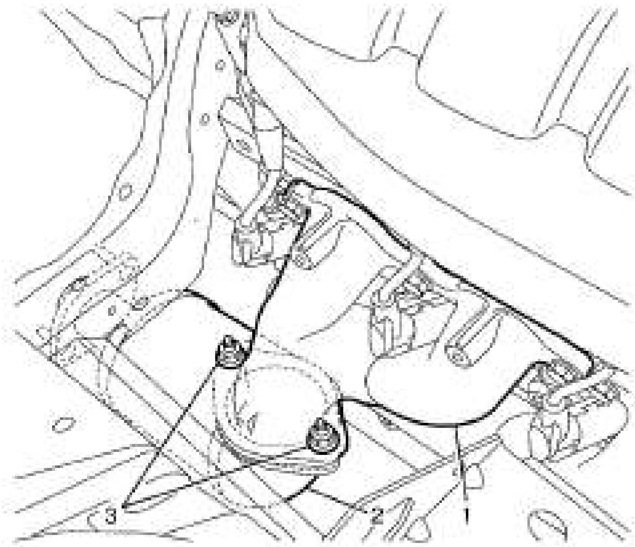
Important: Make sure that a NEW sealing ring is fitted prior to installation. Failure to comply may cause the exhaust system to perform poorly.

6. Push up and forward on the left catalytic converter (2) to connect to the exhaust manifold (3).

   Important: Do not fully tighten the left catalytic converter to exhaust manifold retaining nuts (1) at this stage.

7. Install the NEW left catalytic converter to exhaust manifold retaining nuts (2).

   Do not fully tighten at this stage.

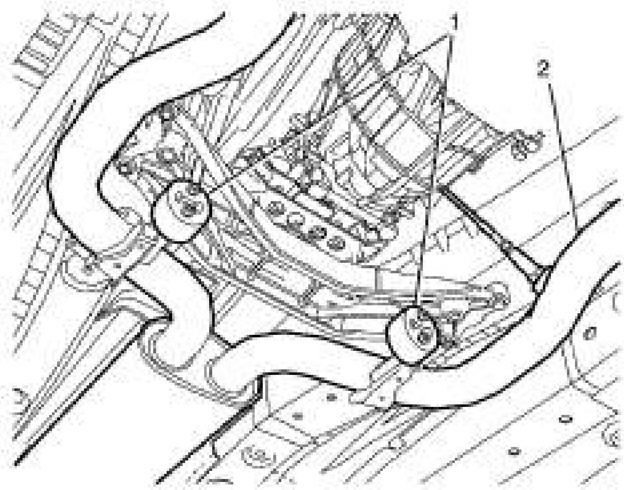


8. Push up and forward on the right catalytic converter (2) to connect to the exhaust manifold (1).

   Important: Do not fully tighten the right catalytic converter to exhaust manifold retaining nuts (3) at this stage.

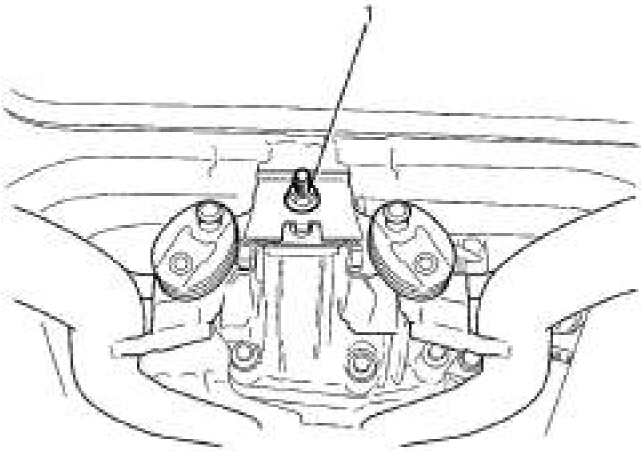
9. Install the NEW right catalytic converter to exhaust manifold retaining nuts (3).

   Do not fully tighten at this stage.



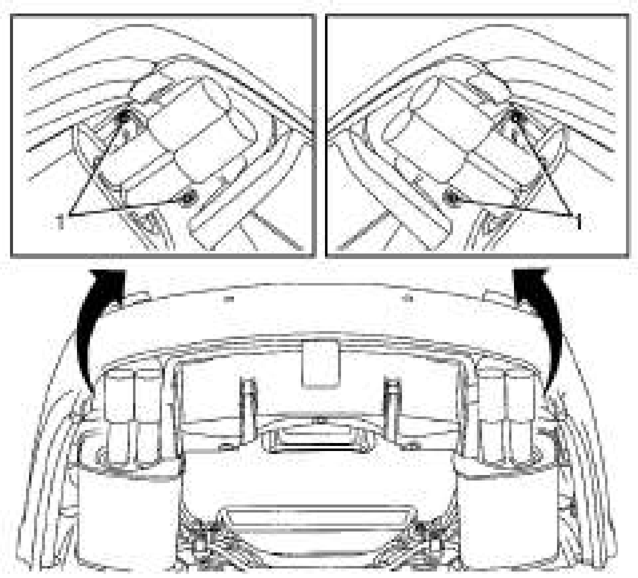
10. Attach the exhaust system (2) by installing the front insulator hangers (1).

    Notice: Refer to Fastener Notice in the Preface section.



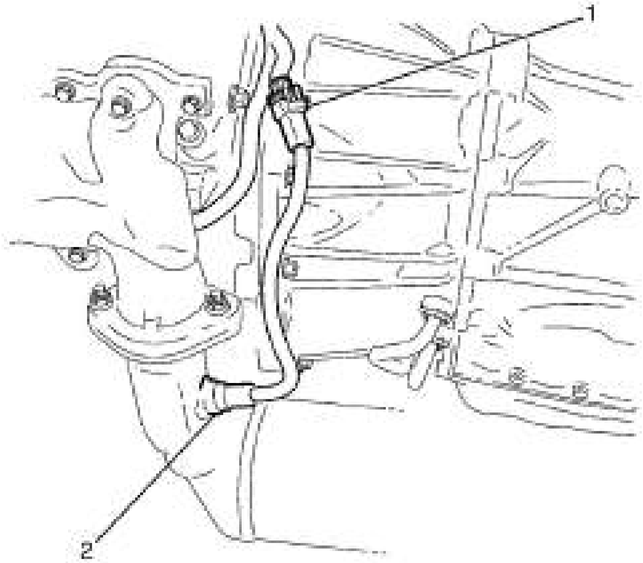
11. Attach the exhaust system (2) by installing the centre insulator hanger bracket to differential retaining bolt (1).

    Tighten
    Tighten the nuts to 45 N·m (33 lb ft).

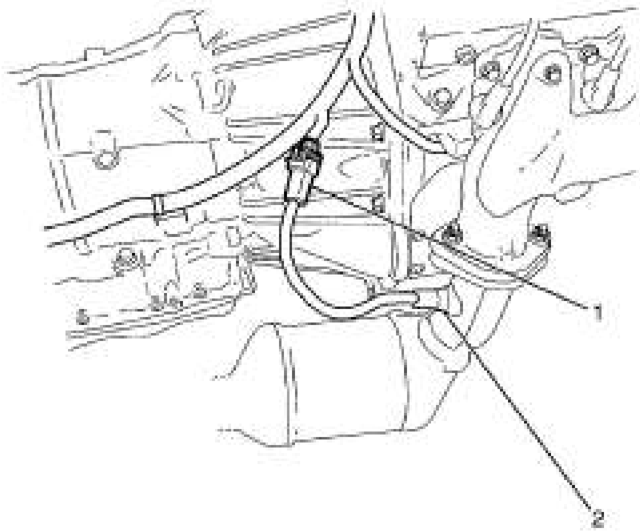


12. Install the rear insulator hanger to body retaining bolts (1).

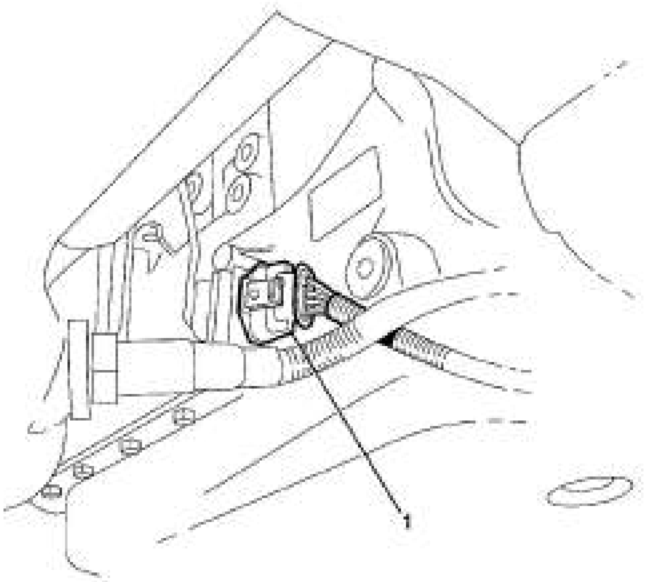
    Tighten
    Tighten the bolts to 26 N·m (19 lb ft).



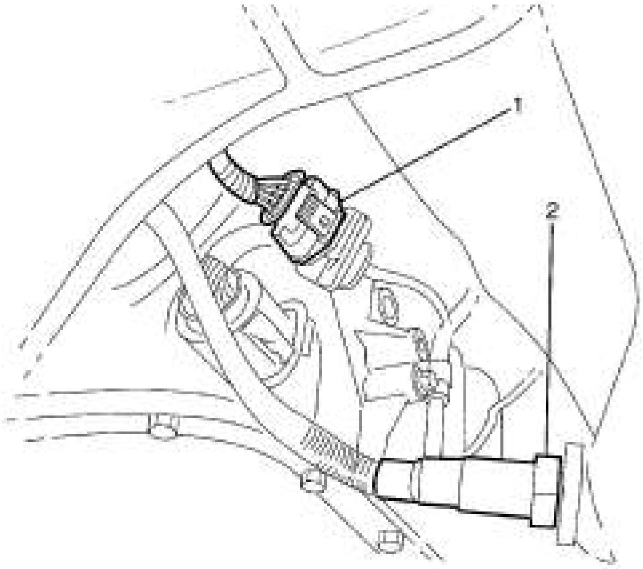
13. Connect the left pre-catalytic converter HO2S electrical connector (1).



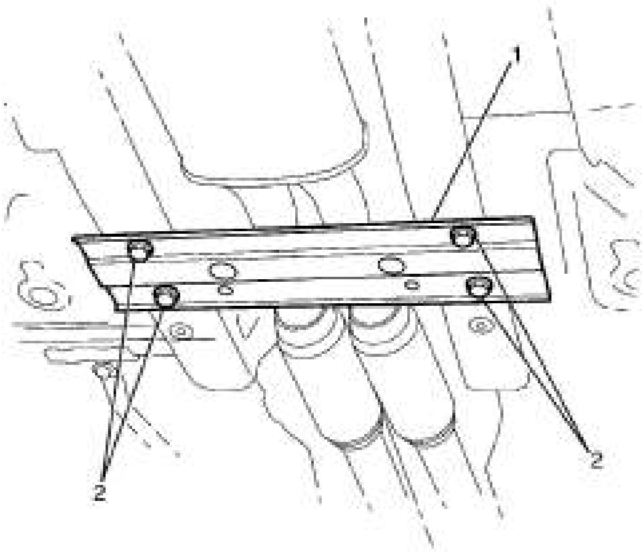
14. Connect the right pre-catalytic converter HO2S electrical connector (2).



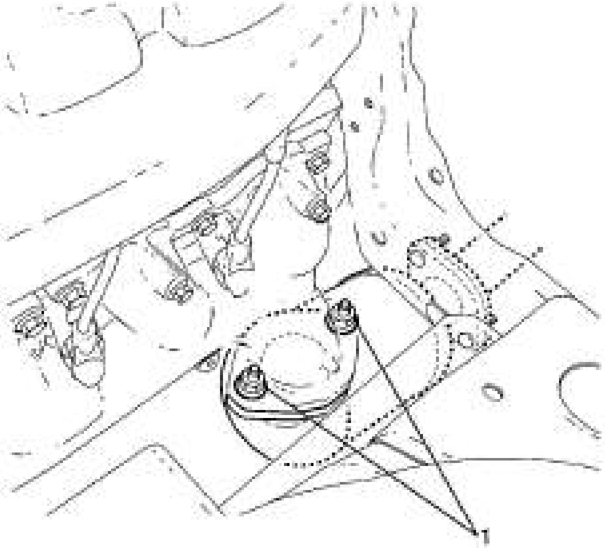
15. Connect the left post-catalytic converter HO2S electrical connector (1).



16. Connect the right post-catalytic converter HO2S electrical connector (1).

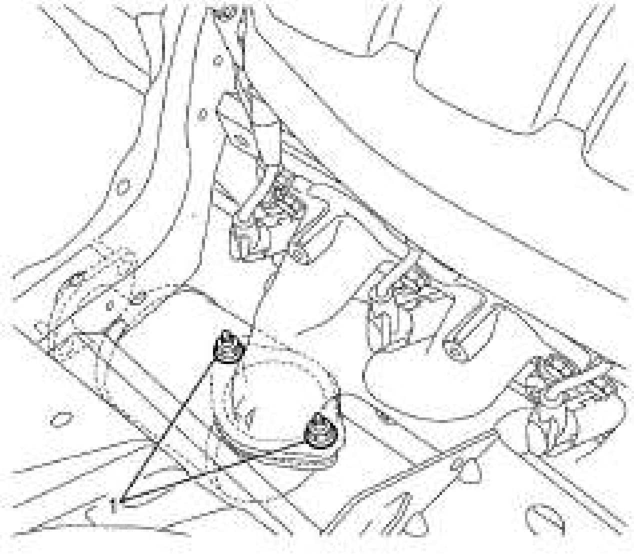


17. Install the transmission tunnel cross-brace (1).
18. Install the transmission tunnel cross-brace to body retaining bolts (2).
19. Remove the jack supporting the exhaust system.
20. Lower vehicle.



21. Tighten the left catalytic converter to exhaust manifold retaining nuts (1).

    Tighten
    Tighten the nuts to 45 N·m (33 lb ft).



22. Tighten the right catalytic converter to exhaust manifold retaining nuts (1).

    Tighten
    Tighten the nuts to 45 N·m (33 lb ft).

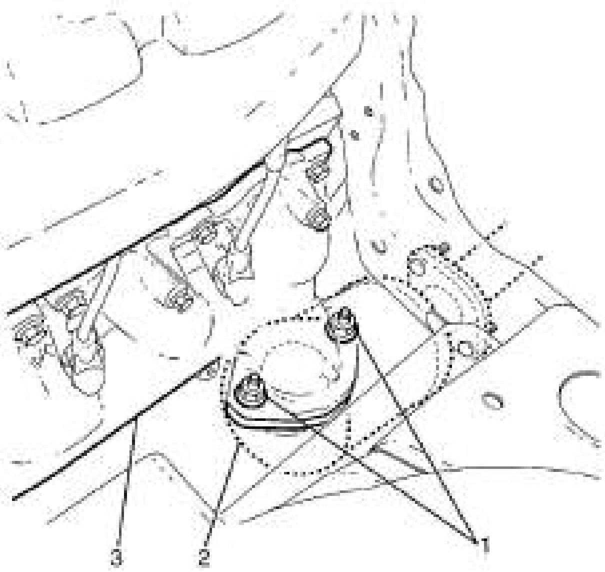
23. Make sure that the exhaust system is clear of all other components and chassis. If the exhaust system is not clear of all the other components loosen all retaining nuts and re-align. Refer to Exhaust System Alignment.
24. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.
25. If re-programming is required. Refer to Control Module References.
26. Perform diagnostic system check using diagnostic scan tool, clear all relative DTCs and inspect the system for correct operation.

Removal Procedure - From 31 May 2007

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.

   Caution: Refer to Exhaust Service Caution in the Preface section.

   Caution: Refer to Protective Goggles and Glove Caution in the Preface section.

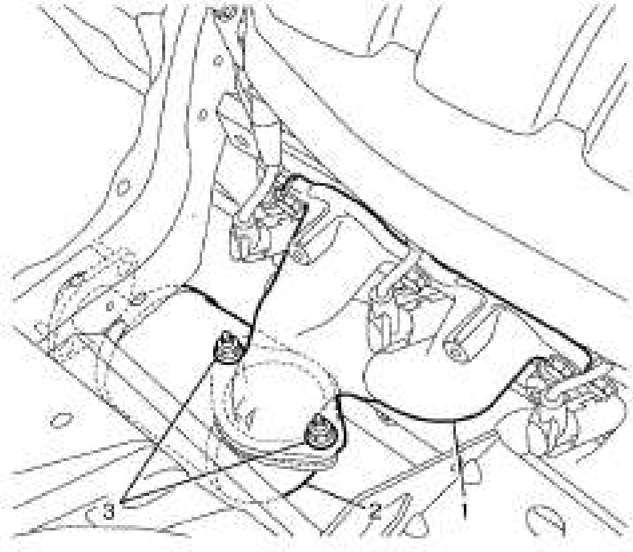


Important: The left catalytic converter to exhaust manifold retaining nuts (1) are single use parts. They must be discarded after removal.

2. Remove the left catalytic converter to exhaust manifold retaining nuts (1).

   Discard the nuts.

3. Disconnect the left catalytic converter (2) from the exhaust manifold (3).



Important: The right catalytic converter to exhaust manifold retaining nuts (3) are single use parts. They must be discarded after removal.

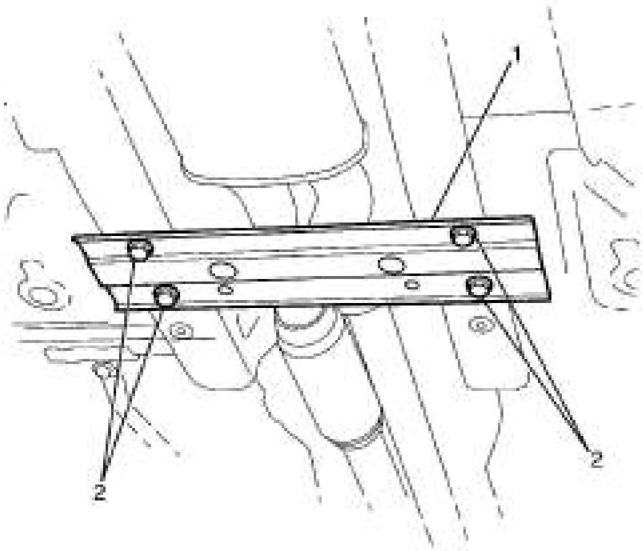
4. Remove the right catalytic converter to exhaust manifold retaining nuts (3).

   Discard the nuts.

5. Disconnect the right catalytic converter (2) from the exhaust manifold (1).

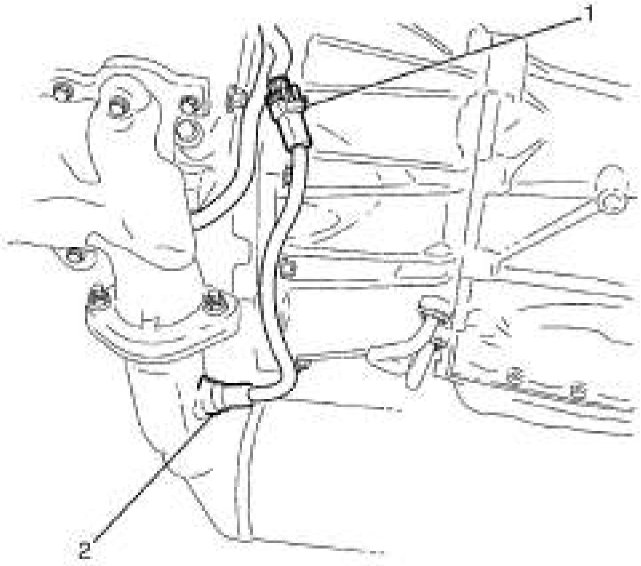
   Caution: Refer to Vehicle Lifting Caution in the Preface section.

6. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

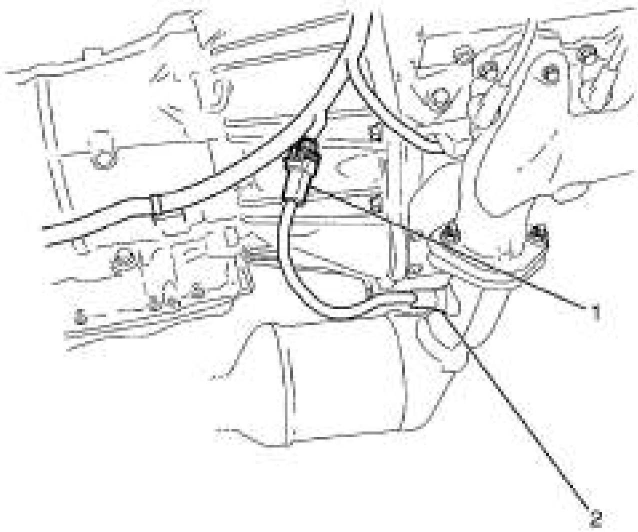


7. Remove the transmission tunnel cross-brace to body retaining bolts (2).
8. Remove the transmission tunnel cross-brace (1).
9. Support the exhaust system using a suitable jack.

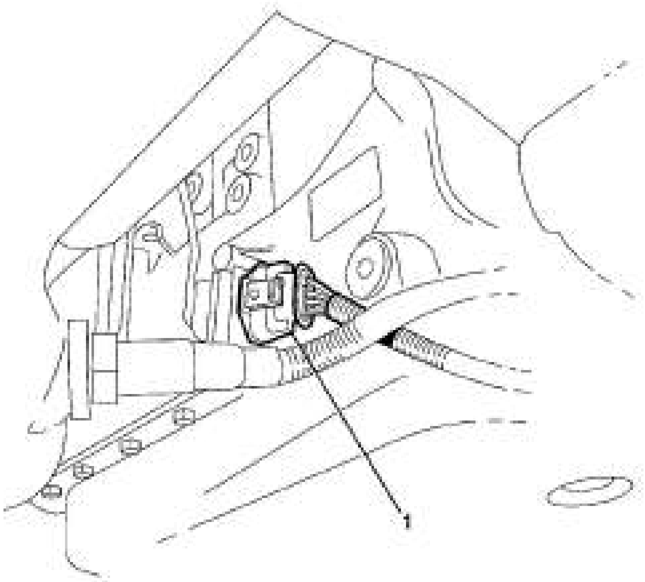
   Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.



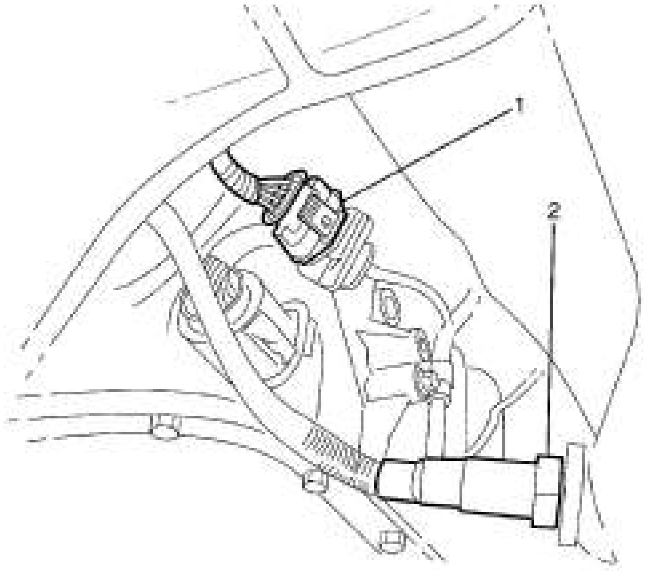
10. Disconnect the left pre-catalytic converter HO2S electrical connector (1).



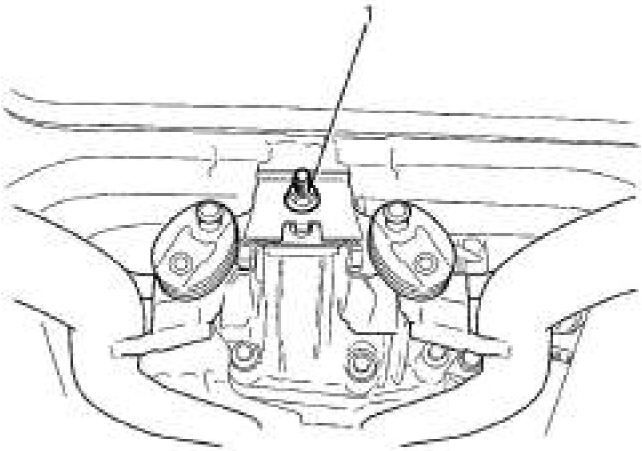
11. Disconnect the right pre-catalytic converter HO2S electrical connector (2).



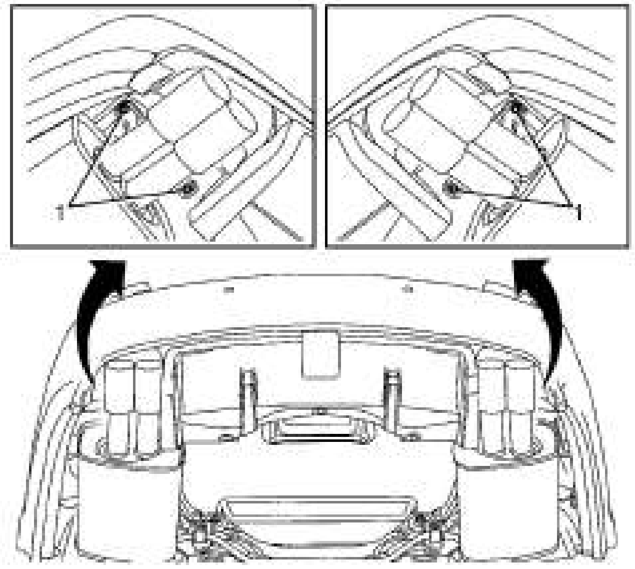
12. Disconnect the left post-catalytic converter HO2S electrical connector (1).



13. Disconnect the right post-catalytic converter HO2S electrical connector (1).



14. Detach the exhaust system (2) by removing the centre insulator hanger bracket to differential retaining bolt (1).



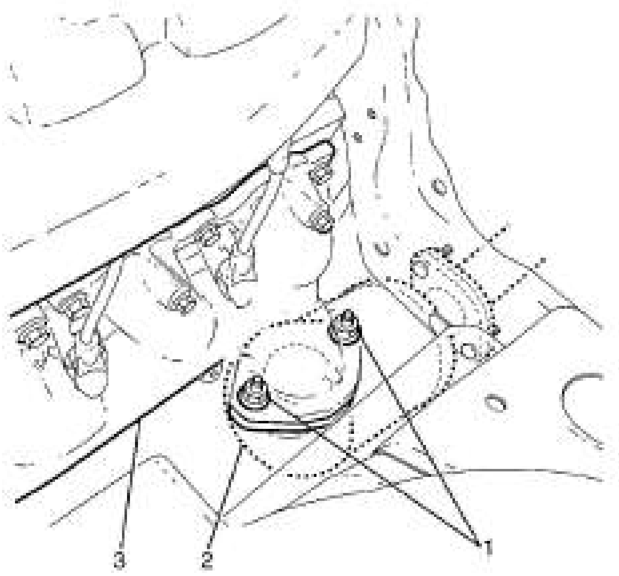
15. Remove the rear insulator hanger to body retaining bolts (1).
16. With the aid of an assistant or using a suitable jack; carefully lower the exhaust system from the vehicle.
17. Carefully lower the exhaust system from the vehicle.
18. Remove the left pre-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 1.
19. Remove the left post-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 2.
20. Remove the right pre-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 1.
21. Remove the right post-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 2.

Installation Procedure - From 31 May 2007

1. Install the left pre-catalytic converter HO2S to the left catalytic converter. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 1.
2. Install the left post-catalytic converter HO2S to the intermediate exhaust assembly. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 2.
3. Install the right pre-catalytic converter HO2S to the right catalytic converter. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 1.
4. Install the right post-catalytic converter HO2S to the intermediate exhaust assembly. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 2.

Notice: Refer to Exhaust Service Caution in the Preface section.

5. With the aid of an assistant or using a suitable jack; carefully raise the exhaust system to the vehicle.



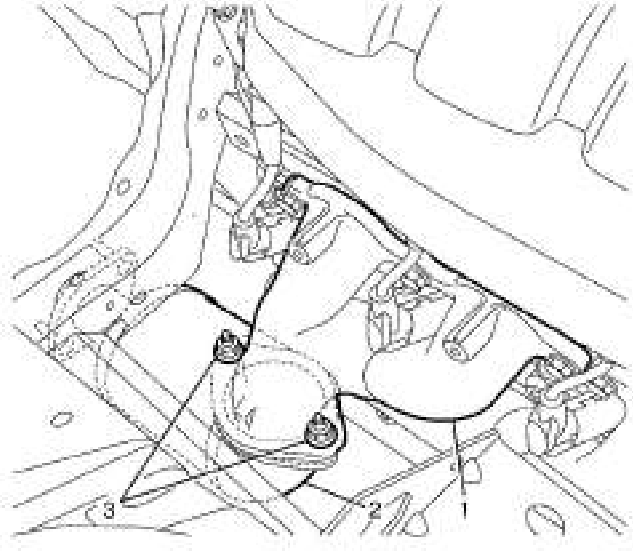
Important: Make sure that a NEW sealing ring is fitted prior to installation. Failure to comply may cause the exhaust system to perform poorly.

6. Push up and forward on the left catalytic converter (2) to connect to the exhaust manifold (3).

Important: Do not fully tighten the left catalytic converter to exhaust manifold retaining nuts (1) at this stage.

7. Install the NEW left catalytic converter to exhaust manifold retaining nuts (2).

Do not fully tighten at this stage.



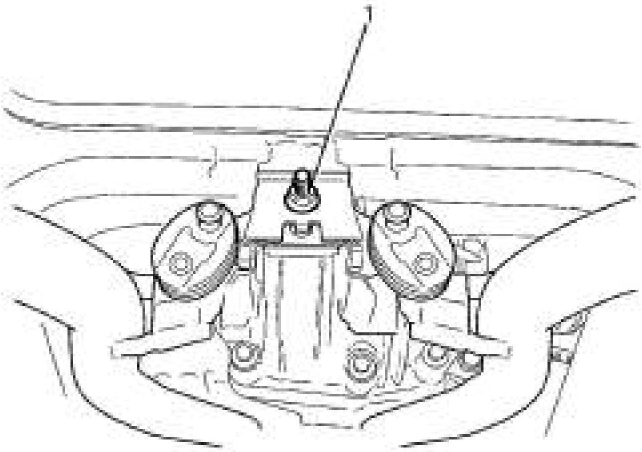
8. Push up and forward on the right catalytic converter (2) to connect to the exhaust manifold (1).

   Important: Do not fully tighten the right catalytic converter to exhaust manifold retaining nuts (3) at this stage.

9. Install the NEW right catalytic converter to exhaust manifold retaining nuts (3).

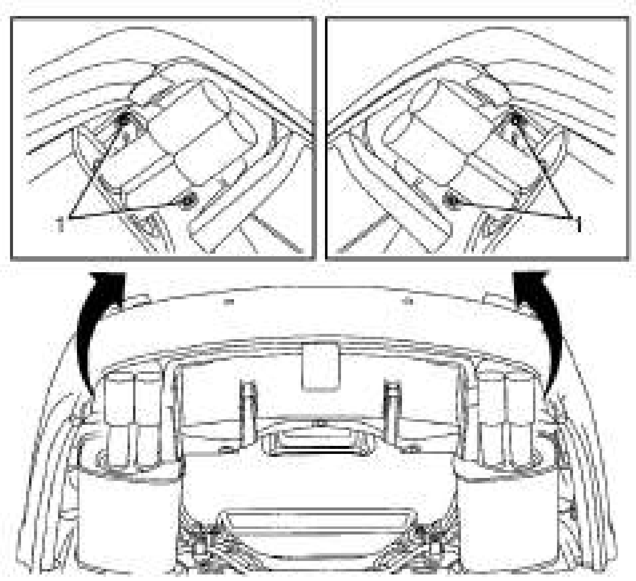
   Do not fully tighten at this stage.

   Notice: Refer to Fastener Notice in the Preface section.



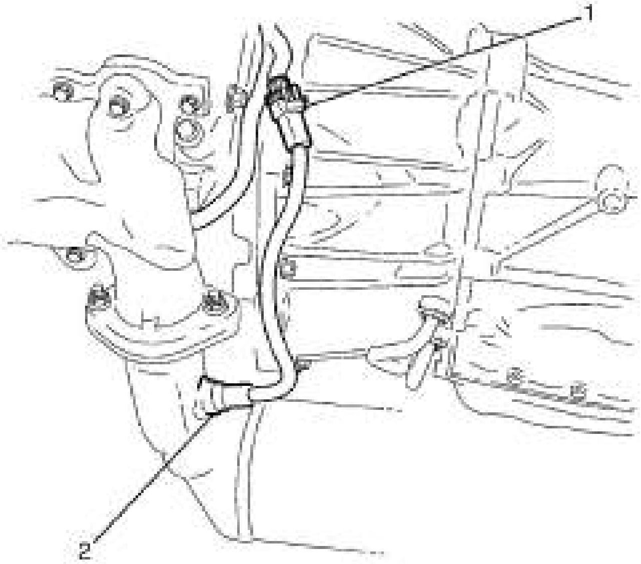
10. Attach the exhaust system (2) by installing the centre insulator hanger bracket to differential retaining bolt (1).

    Tighten
    Tighten the nuts to 45 N·m (33 lb ft).

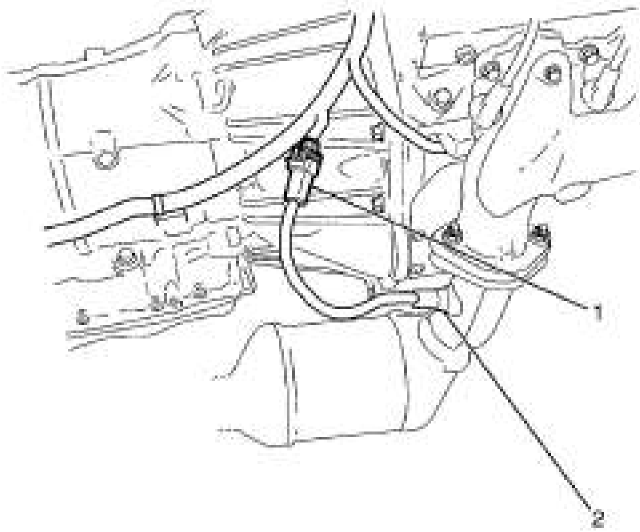


11. Install the rear insulator hanger to body retaining bolts (1).

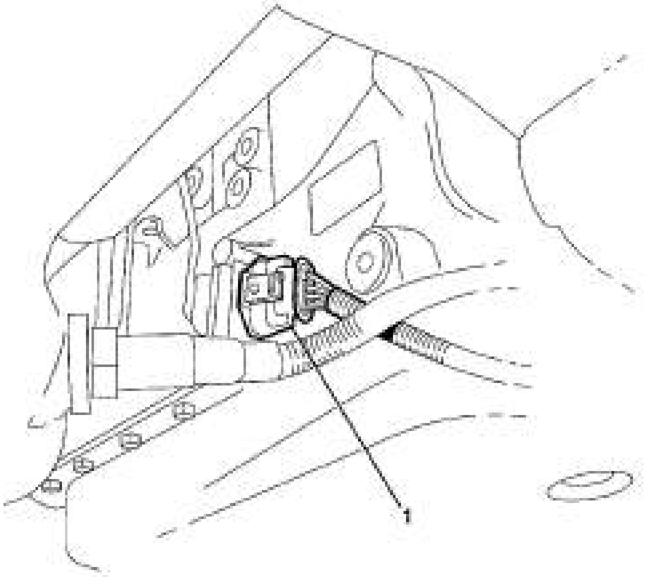
    Tighten
    Tighten the bolts to 26 N·m (19 lb ft).



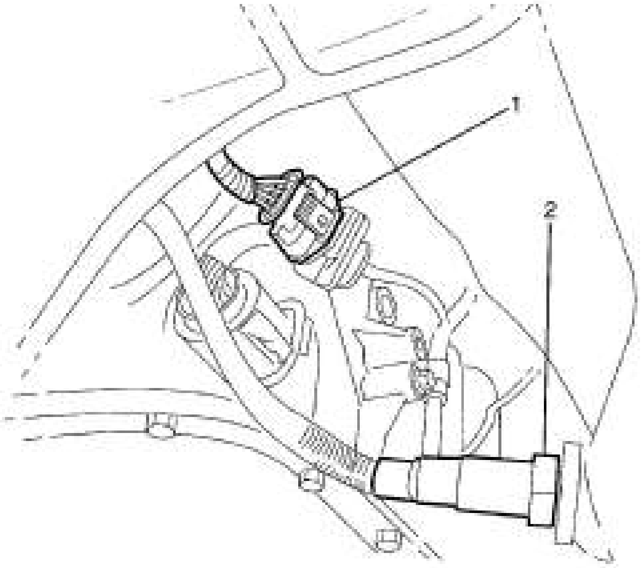
12. Connect the left pre-catalytic converter HO2S electrical connector (1).



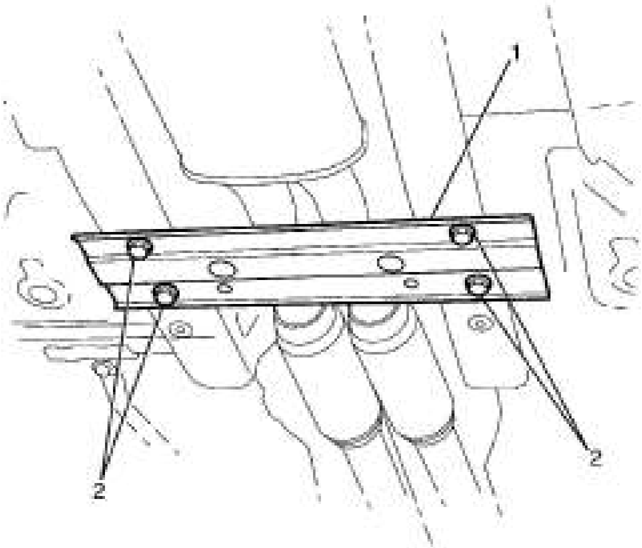
13. Connect the right pre-catalytic converter HO2S electrical connector (2).



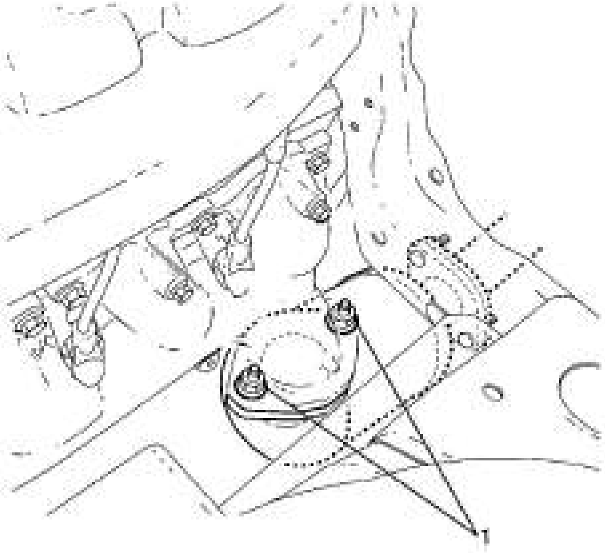
14. Connect the left post-catalytic converter HO2S electrical connector (1).



15. Connect the right post-catalytic converter HO2S electrical connector (1).

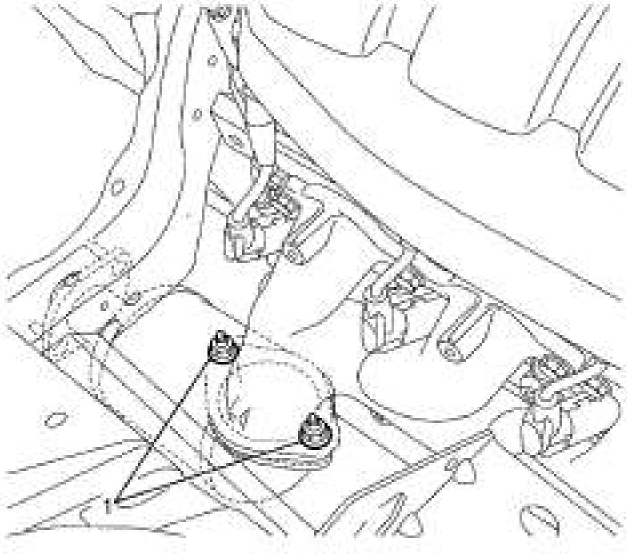


16. Install the transmission tunnel cross-brace (1).
17. Install the transmission tunnel cross-brace to body retaining bolts (2).
18. Remove the jack supporting the exhaust system.
19. Lower vehicle.



20. Tighten the left catalytic converter to exhaust manifold retaining nuts (1).

    Tighten
    Tighten the nuts to 45 N·m (33 lb ft).



21. Tighten the right catalytic converter to exhaust manifold retaining nuts (1).

    Tighten
    Tighten the nuts to 45 N·m (33 lb ft).

22. Make sure that the exhaust system is clear of all other components and chassis. If the exhaust system is not clear of all the other components loosen all retaining nuts and re-align.

Refer to Exhaust System Alignment.

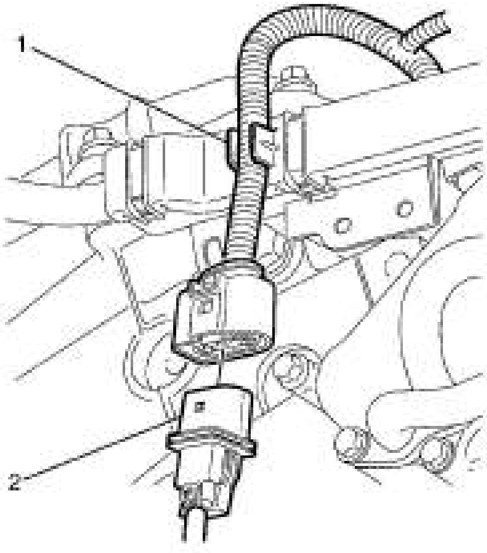
23. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.
24. If re-programming is required. Refer to Control Module References.
25. Perform diagnostic system check using diagnostic scan tool, clear all relative DTCs and inspect the system for correct operation.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Exhaust | Repair Instructions | Document ID: 2077346

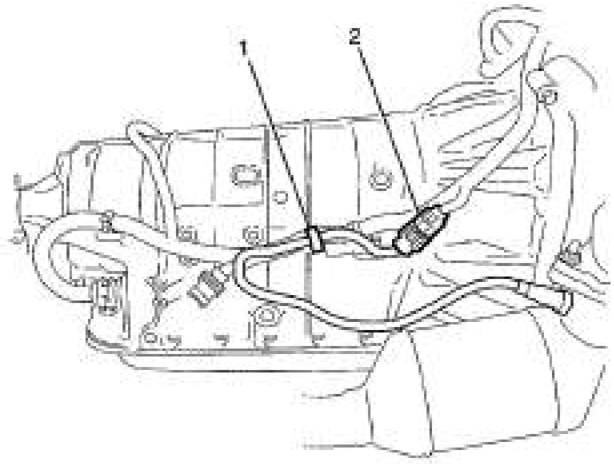
Exhaust System Replacement (LEO and LW2)

Removal Procedure - Up to 31 May 2007

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the engine dress cover. Refer to Engine Cover Replacement .
3. Remove the sound shield to bulk head retainers.



4. Remove the left pre-catalytic converter heated oxygen sensor (HO2S) wiring loom from the engine wiring loom retaining clip (1).
5. Disconnect the left pre-catalytic converter heated oxygen sensor (HO2S) wiring connector (2) from the main wiring harness.
6. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



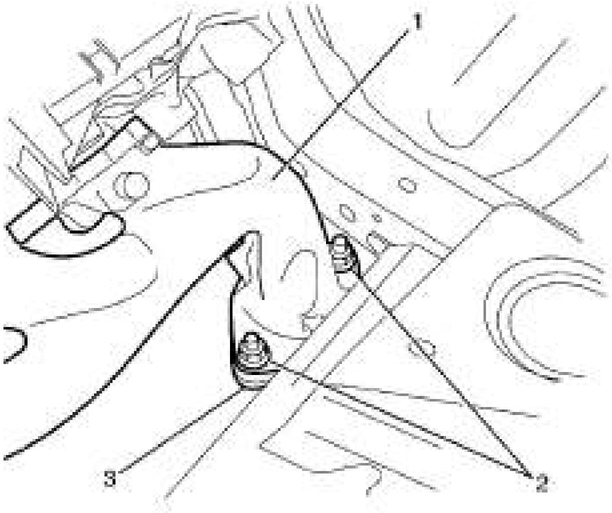
7. Remove the right pre-catalytic converter heated oxygen sensor (HO2S) wiring loom from the transmission wiring loom retraining clip (1).

   Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.

8. Disconnect the right pre-catalytic converter heated oxygen sensor (HO2S) electrical connector (2).

   Caution: Refer to Exhaust Service Caution in the Preface section.

   Caution: Refer to Protective Goggles and Glove Caution in the Preface section.

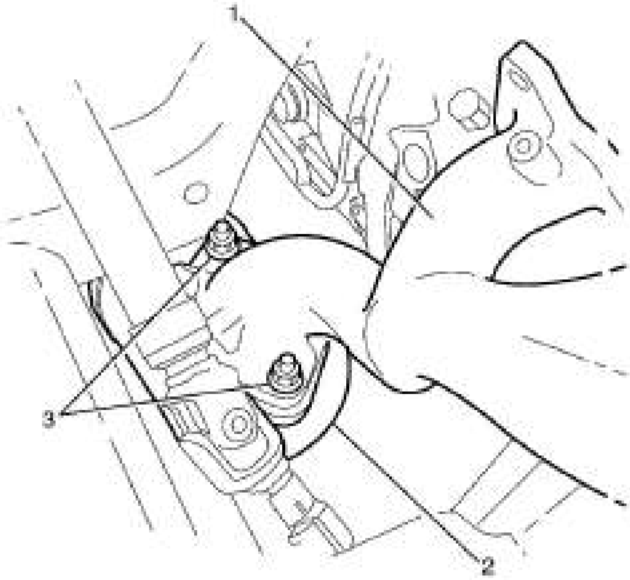


Important: The left catalytic converter to exhaust manifold retaining nuts (2) are single use parts. They must be discarded after removal.

9. Remove the left catalytic converter to exhaust manifold retaining nuts (2).

   Discard the nuts.

10. Pull down and back on the left catalytic converter (3) to disconnect from the left exhaust manifold (1).



Important: The right catalytic converter to exhaust manifold retaining nuts (3) are single use parts. They must be discarded after removal.

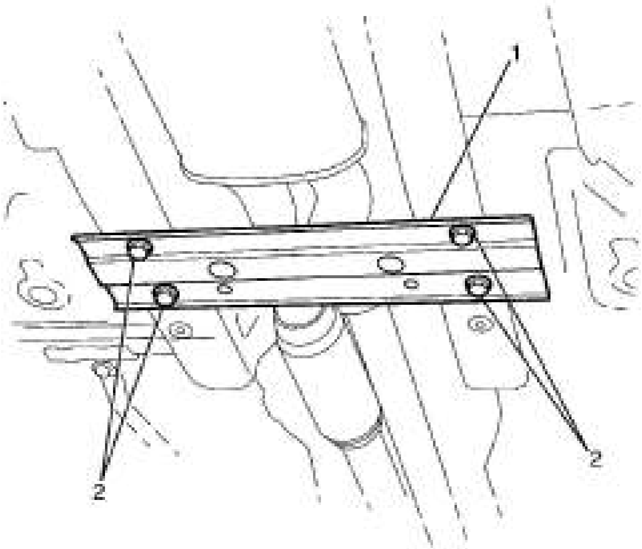
11. Remove the right catalytic converter to exhaust manifold retaining nuts (3).

    Discard the nuts.

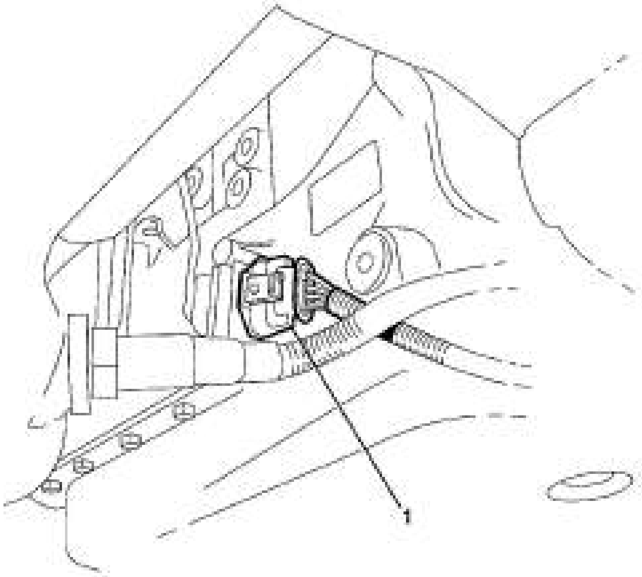
12. Pull down and back on the right catalytic converter (2) to disconnect from the right exhaust manifold (1).

    Caution: Refer to Vehicle Lifting Caution in the Preface section.

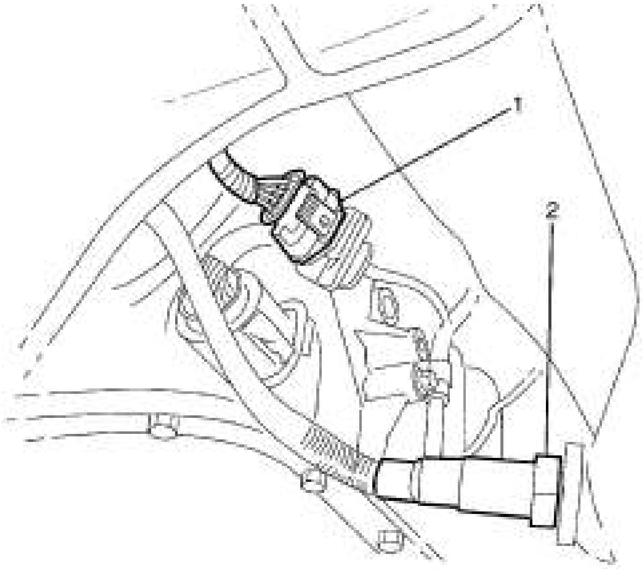
13. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



14. Remove the transmission tunnel cross-brace to body retaining bolts (2).
15. Remove the transmission tunnel cross-brace (1).



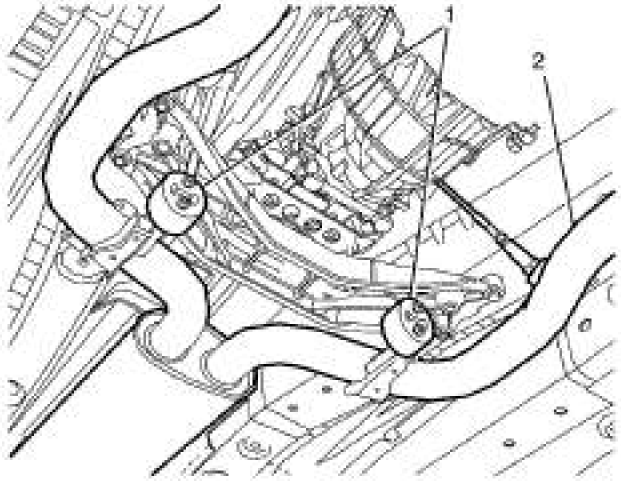
16. Disconnect the left post-catalytic converter HO2S electrical connector (1).



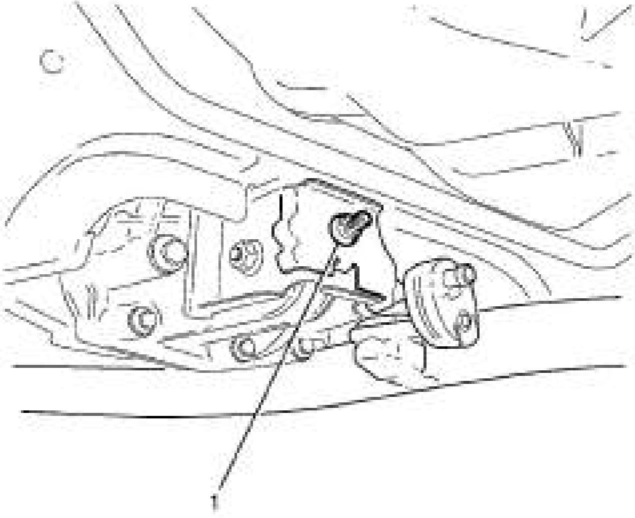
17. Disconnect the right post-catalytic converter HO2S electrical connector (1).

Notice: Refer to Exhaust System Inspection Notice in the Preface section.

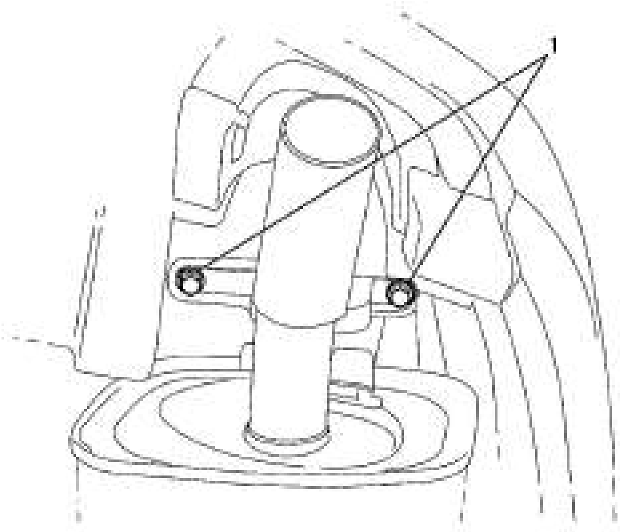
18. Support the exhaust system using a suitable jack.



19. Detach the exhaust system (2) by removing the front insulator hangers (1) if fitted.



20. Detach the exhaust system (2) by removing the centre insulator hanger bracket to differential retaining bolt (1).



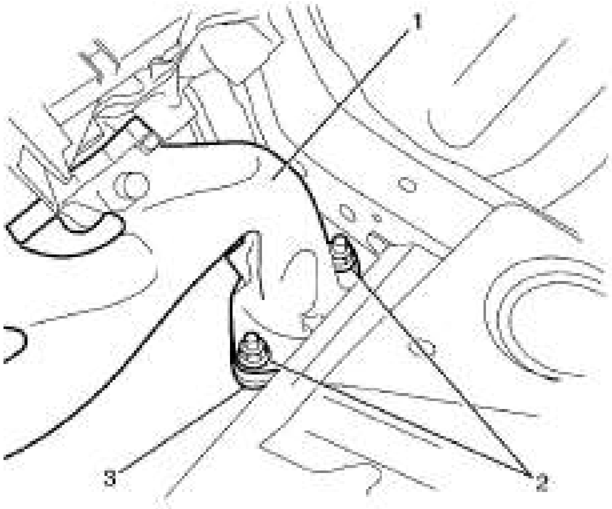
21. Remove the rear insulator hanger to body retaining bolts (1).
22. With the aid of an assistant or using a suitable jack; carefully lower the exhaust system from the vehicle.
23. Remove the left pre-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 .
24. Remove the left post-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 .
25. Remove the right pre-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 .
26. Remove the right post-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 .

Installation Procedure - Up to 31 May 2007

1. Install the left pre-catalytic converter HO2S to the left catalytic converter. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 1.
2. Install the left post-catalytic converter HO2S to the intermediate exhaust assembly. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 2.
3. Install the right pre-catalytic converter HO2S to the right catalytic converter. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 1.
4. Install the right post-catalytic converter HO2S to the intermediate exhaust assembly. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 2.

   Notice: Refer to Exhaust Service Caution in the Preface section.

5. With the aid of an assistant or using a suitable jack; carefully raise the exhaust system to the vehicle.



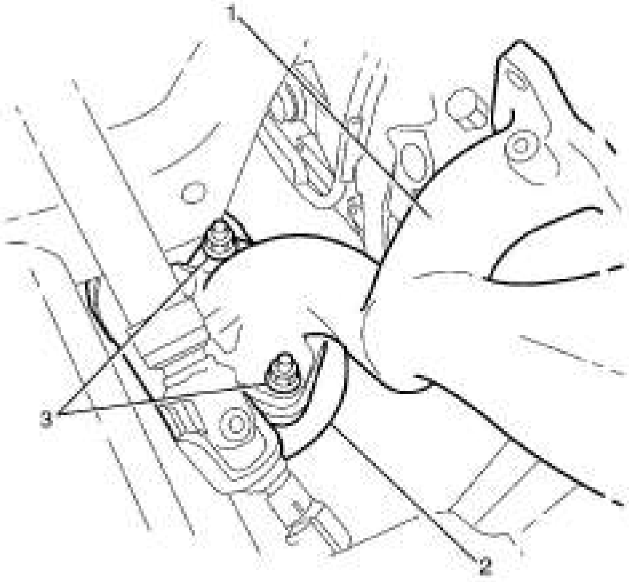
Important: Make sure that a NEW sealing ring is fitted prior to installation. Failure to comply may cause the exhaust system to perform poorly.

6. Push up and forward on the left catalytic converter (3) to connect to the left exhaust manifold (1).

Important: Do not fully tighten the left catalytic converter to left exhaust manifold retaining nuts (2) at this stage.

7. Install the NEW left catalytic converter to left exhaust manifold retaining nuts (2).

Do not fully tighten at this stage.

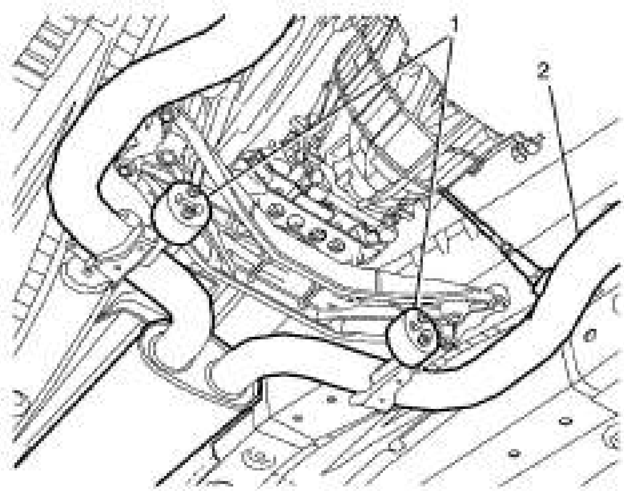


8. Push up and forward on the right catalytic converter (3) to connect to the right exhaust manifold (1).

   Important: Do not fully tighten the right catalytic converter to right exhaust manifold retaining nuts (2) at this stage.

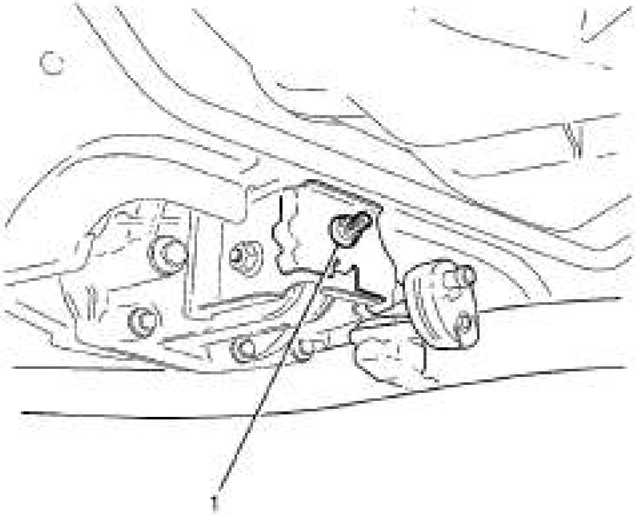
9. Install the NEW right catalytic converter to right exhaust manifold retaining nuts (2).

   Do not fully tighten at this stage.



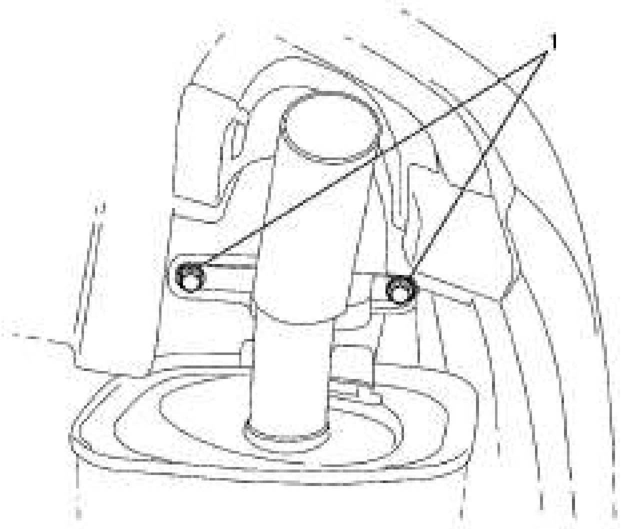
10. Attach the exhaust system (2) by installing the front insulator hangers (1) if fitted.

    Notice: Refer to Fastener Notice in the Preface section.



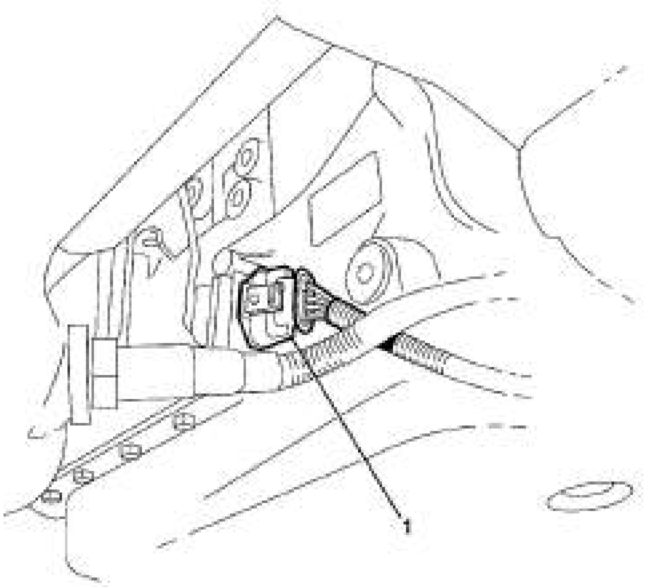
11. Attach the exhaust system (2) by installing the centre insulator hanger bracket to differential retaining bolt (1).

    Tighten
    Tighten the bolt to 45 N·m (33 lb ft).

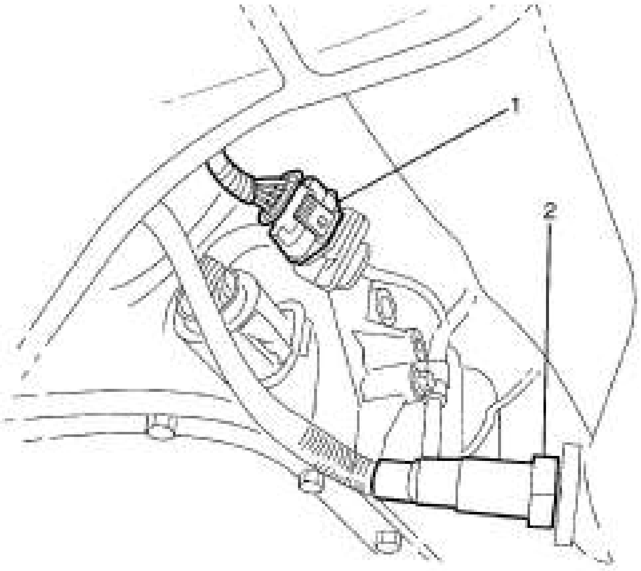


12. Install the rear insulator hanger to body retaining bolts (1).

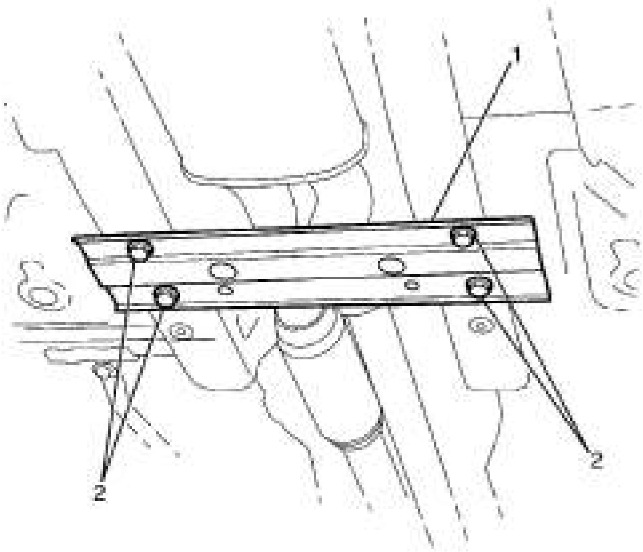
    Tighten
    Tighten the bolts to 26 N·m (19 lb ft).



13. Connect the left post-catalytic converter HO2S electrical connector (1).



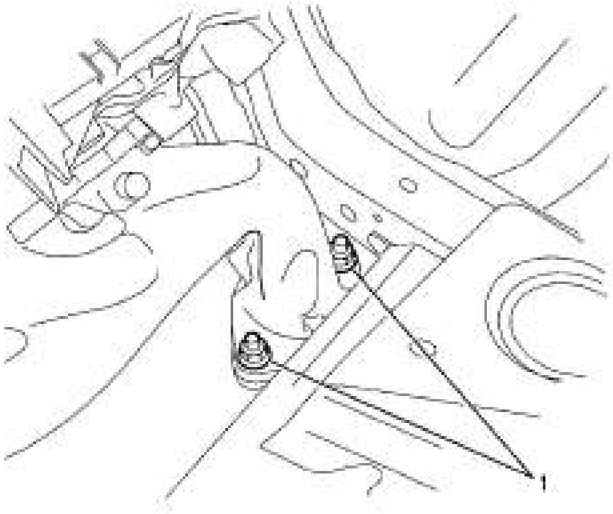
14. Connect the right post-catalytic converter HO2S electrical connector (1).



15. Install the transmission tunnel cross-brace (1).
16. Install the transmission tunnel cross-brace to body retaining bolts (2).

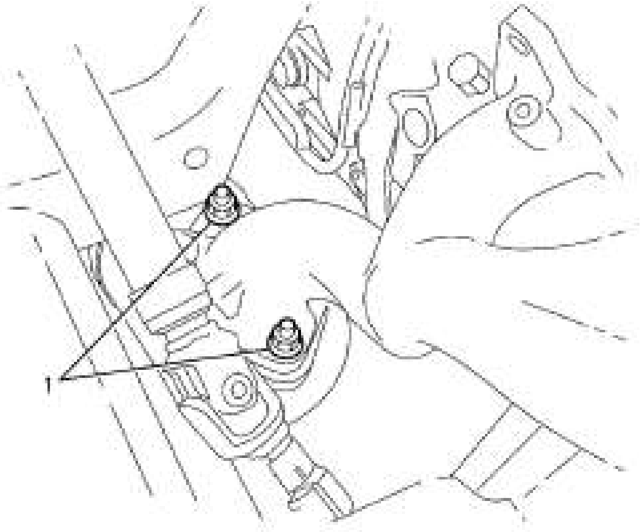
    Tighten
    Tighten the nuts to xx N·m (xx lb ft).

17. Remove the jack supporting the exhaust system.
18. Lower vehicle.



19. Tighten the left catalytic converter to left exhaust manifold retaining nuts (1).

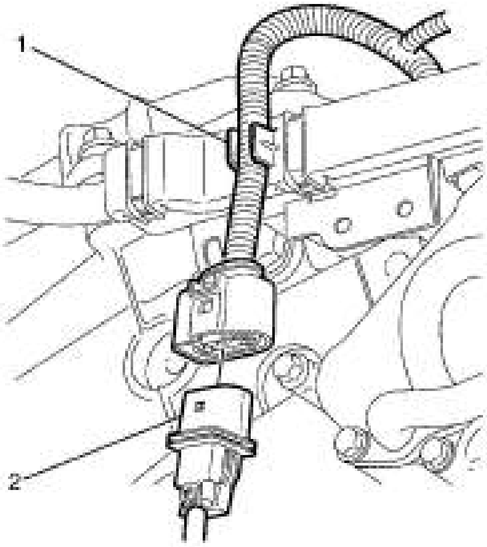
    Tighten
    Tighten the nuts to 45 N·m (33 lb ft).



20. Tighten the right catalytic converter to right exhaust manifold retaining nuts (1).

    Tighten
    Tighten the nuts to 45 N·m (33 lb ft).

21. Make sure that the exhaust system is clear of all other components and chassis. If the exhaust system is not clear of all the other components loosen all retaining nuts and re-align. Refer to Exhaust System Alignment .
22. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

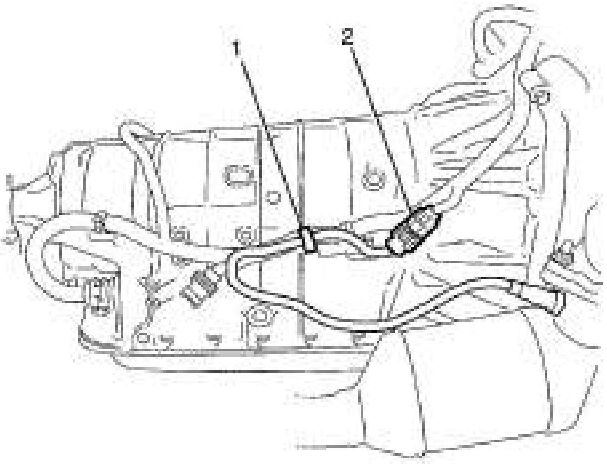


23. Connect the left pre-catalytic converter heated oxygen sensor (HO2S) wiring connector (2) to the main wiring harness.
24. Install the left pre-catalytic converter heated oxygen sensor (HO2S) wiring loom to the

engine wiring loom retaining clip (1).

25. Lower the vehicle.

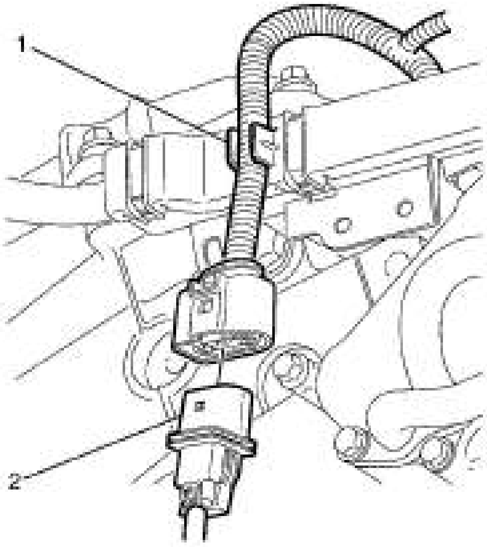
Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.



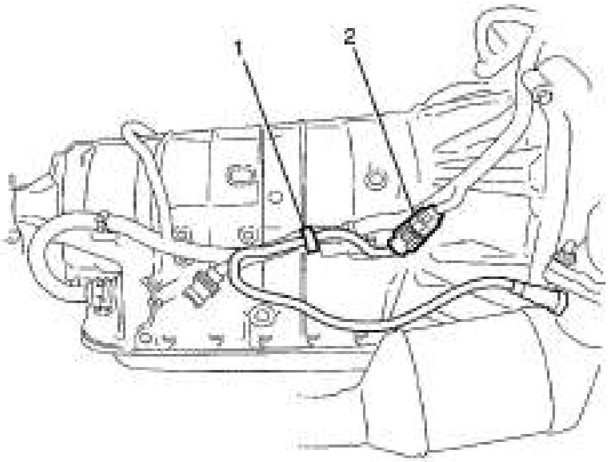
26. Connect the right pre-catalytic converter heated oxygen sensor (HO2S) electrical connector (2).
27. Install the right pre-catalytic converter heated oxygen sensor (HO2S) wiring loom from the transmission wiring loom retraining clip (1).
28. Install the engine dress cover. Refer to Engine Cover Replacement .
29. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.
30. If re-programming is required. Refer to Control Module References .
31. Perform diagnostic system check using diagnostic scan tool, clear all relative DTCs and inspect the system for correct operation.

Removal Procedure - From 31 May 2007

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the engine dress cover. Refer to Engine Cover Replacement .
3. Remove the sound shield to bulk head retainers.



4. Remove the left pre-catalytic converter heated oxygen sensor (HO2S) wiring loom from the engine wiring loom retaining clip (1).
5. Disconnect the left pre-catalytic converter heated oxygen sensor (HO2S) wiring connector (2) from the main wiring harness.
6. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



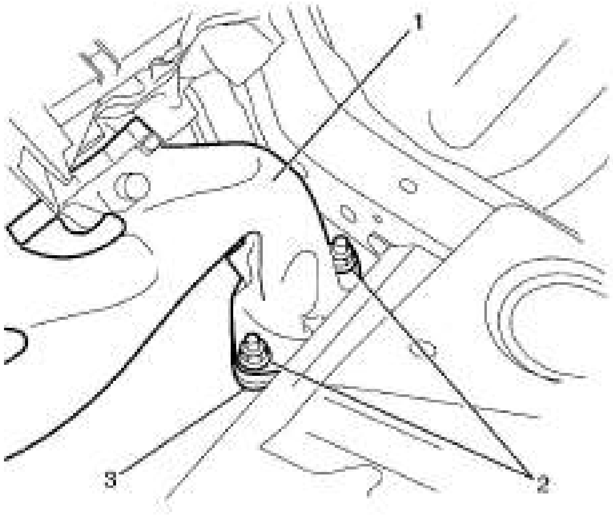
7. Remove the right pre-catalytic converter heated oxygen sensor (HO2S) wiring loom from the transmission wiring loom retraining clip (1).

   Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.

8. Disconnect the right pre-catalytic converter heated oxygen sensor (HO2S) electrical connector (2).

Caution: Refer to Exhaust Service Caution in the Preface section.

Caution: Refer to Protective Goggles and Glove Caution in the Preface section.

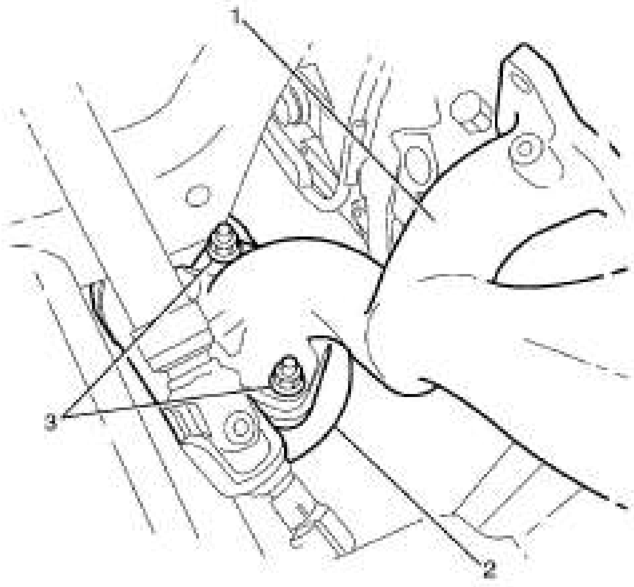


Important: The left catalytic converter to exhaust manifold retaining nuts (2) are single use parts. They must be discarded after removal.

9. Remove the left catalytic converter to exhaust manifold retaining nuts (2).

   Discard the nuts.

10. Pull down and back on the left catalytic converter (3) to disconnect from the left exhaust manifold (1).



Important: The right catalytic converter to exhaust manifold retaining nuts (3) are single use parts. They must be discarded after removal.

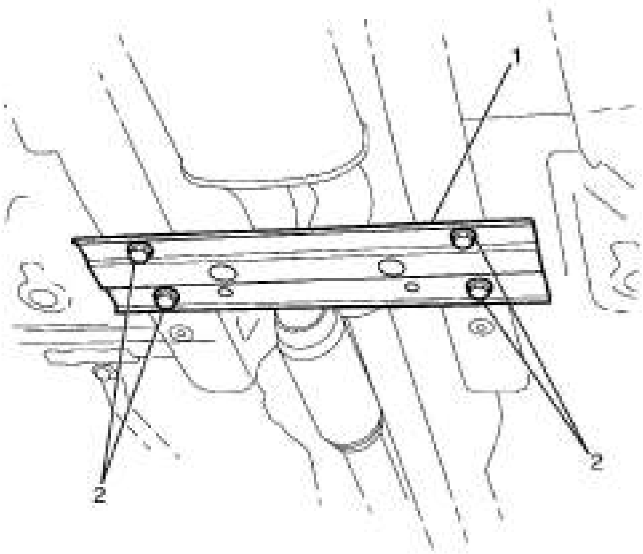
11. Remove the right catalytic converter to exhaust manifold retaining nuts (3).

    Discard the nuts.

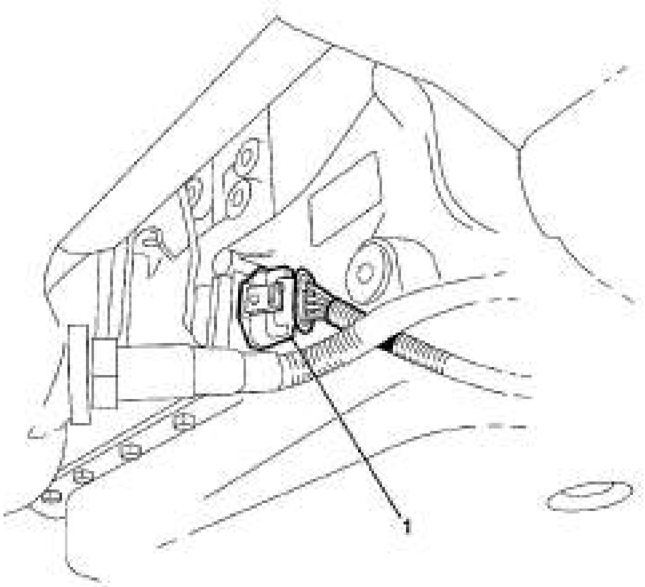
12. Pull down and back on the right catalytic converter (2) to disconnect from the right exhaust manifold (1).

    Caution: Refer to Vehicle Lifting Caution in the Preface section.

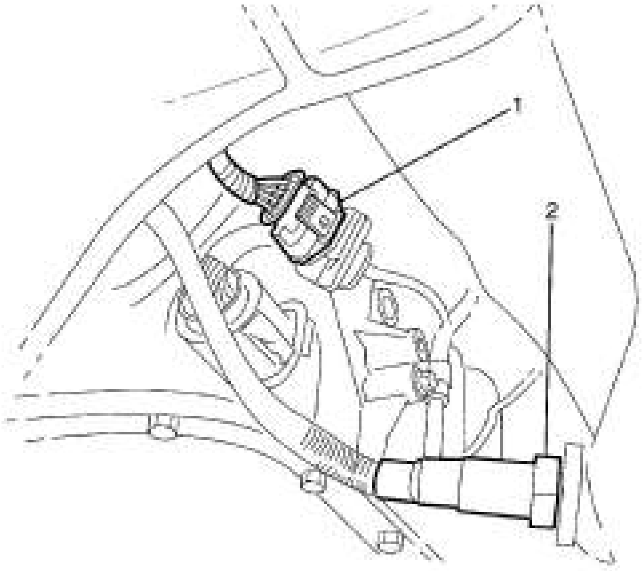
13. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



14. Remove the transmission tunnel cross-brace to body retaining bolts (2).
15. Remove the transmission tunnel cross-brace (1).



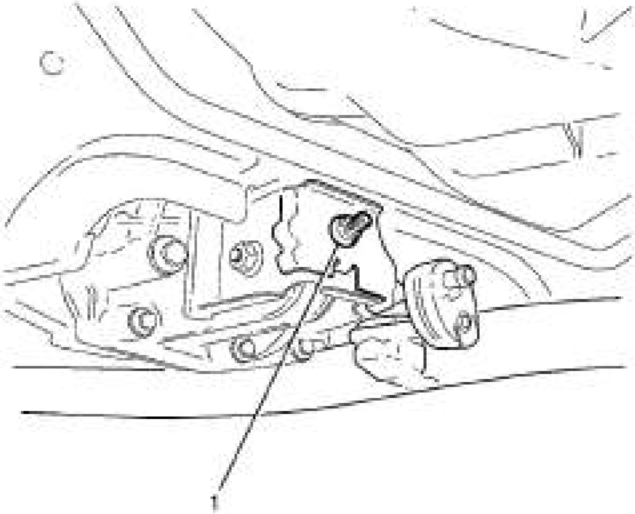
16. Disconnect the left post-catalytic converter HO2S electrical connector (1).



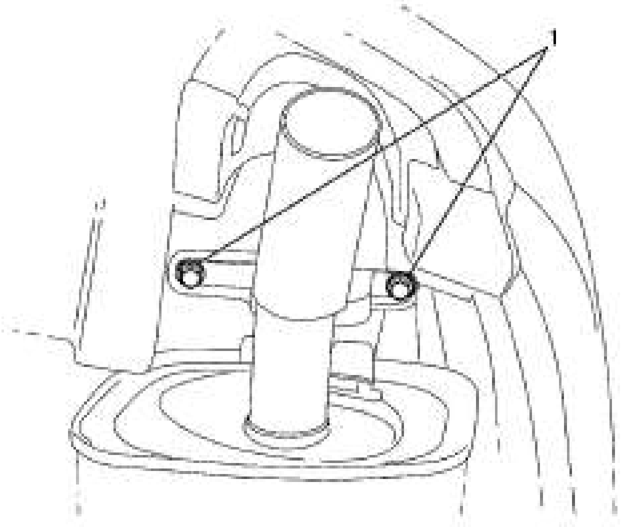
17. Disconnect the right post-catalytic converter HO2S electrical connector (1).

    Notice: Refer to Exhaust System Inspection Notice in the Preface section.

18. Support the exhaust system using a suitable jack.



19. Detach the exhaust system (2) by removing the centre insulator hanger bracket to differential retaining bolt (1).



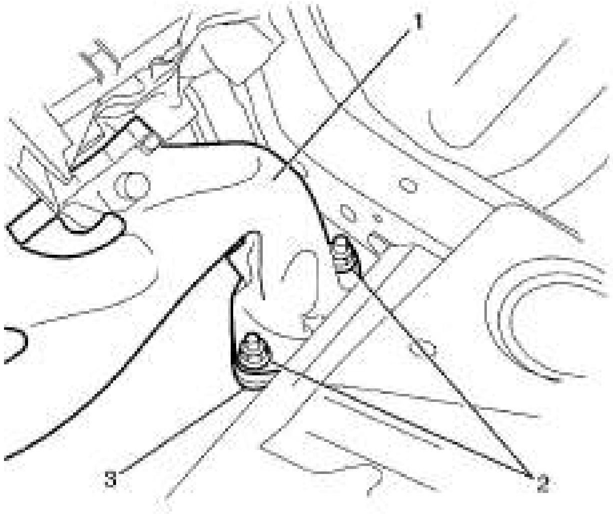
20. Remove the rear insulator hanger to body retaining bolts (1).
21. With the aid of an assistant or using a suitable jack; carefully lower the exhaust system from the vehicle.
22. Remove the left pre-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 .
23. Remove the left post-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 .
24. Remove the right pre-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 .
25. Remove the right post-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 .

Installation Procedure - From 31 May 2007

1. Install the left pre-catalytic converter HO2S to the left catalytic converter. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 1.
2. Install the left post-catalytic converter HO2S to the intermediate exhaust assembly. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 2.
3. Install the right pre-catalytic converter HO2S to the right catalytic converter. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 1.
4. Install the right post-catalytic converter HO2S to the intermediate exhaust assembly. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 2.

   Notice: Refer to Exhaust Service Caution in the Preface section.

5. With the aid of an assistant or using a suitable jack; carefully raise the exhaust system to the vehicle.



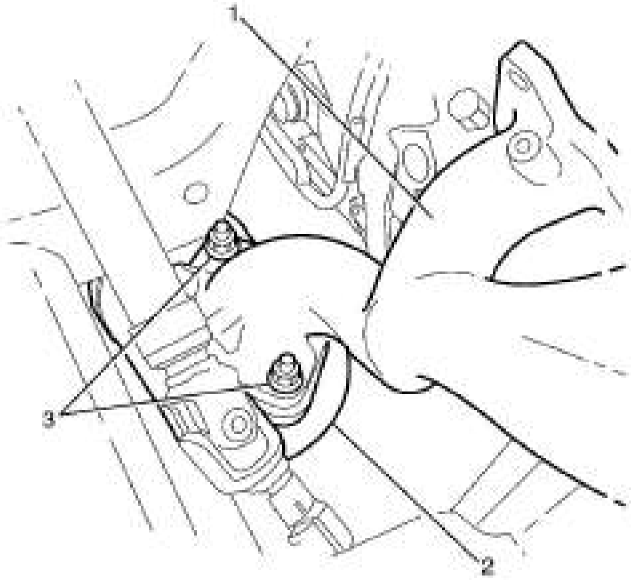
   Important: Make sure that a NEW sealing ring is fitted prior to installation. Failure to comply may cause the exhaust system to perform poorly.

6. Push up and forward on the left catalytic converter (3) to connect to the left exhaust manifold (1).

   Important: Do not fully tighten the left catalytic converter to left exhaust manifold retaining nuts (2) at this stage.

7. Install the NEW left catalytic converter to left exhaust manifold retaining nuts (2).

   Do not fully tighten at this stage.



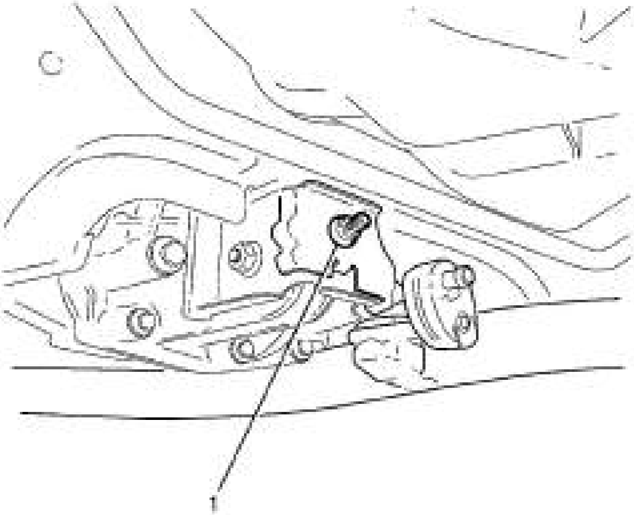
8. Push up and forward on the right catalytic converter (3) to connect to the right exhaust manifold (1).

   Important: Do not fully tighten the right catalytic converter to right exhaust manifold retaining nuts (2) at this stage.

9. Install the NEW right catalytic converter to right exhaust manifold retaining nuts (2).

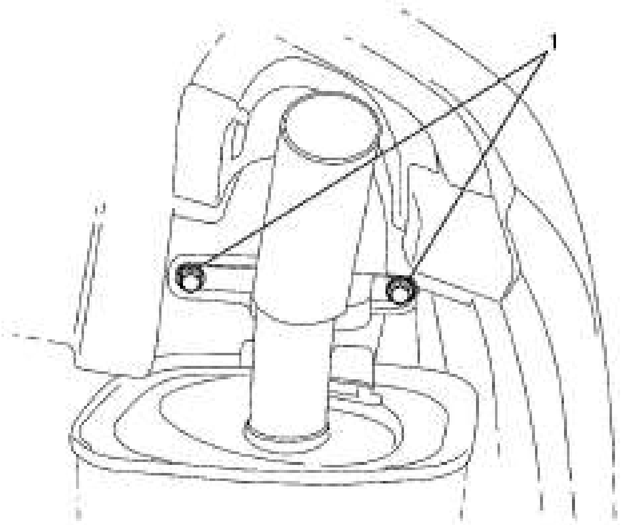
   Do not fully tighten at this stage.

   Notice: Refer to Fastener Notice in the Preface section.



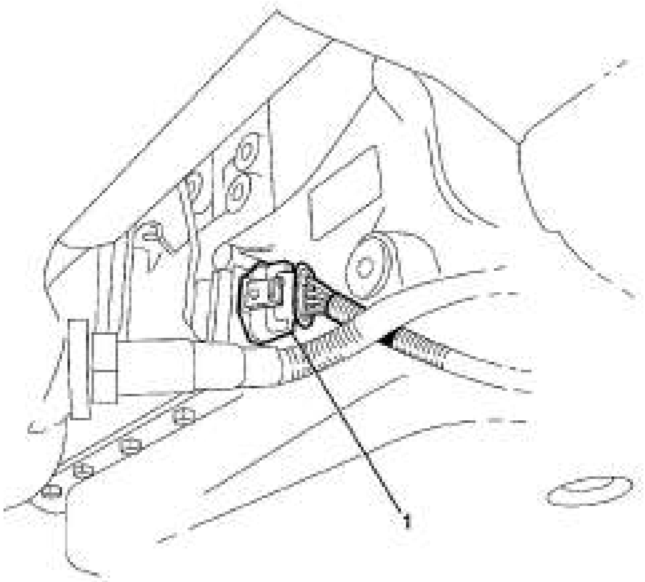
10. Attach the exhaust system (2) by installing the centre insulator hanger bracket to differential retaining bolt (1).

    Tighten
    Tighten the bolt to 45 N·m (33 lb ft).

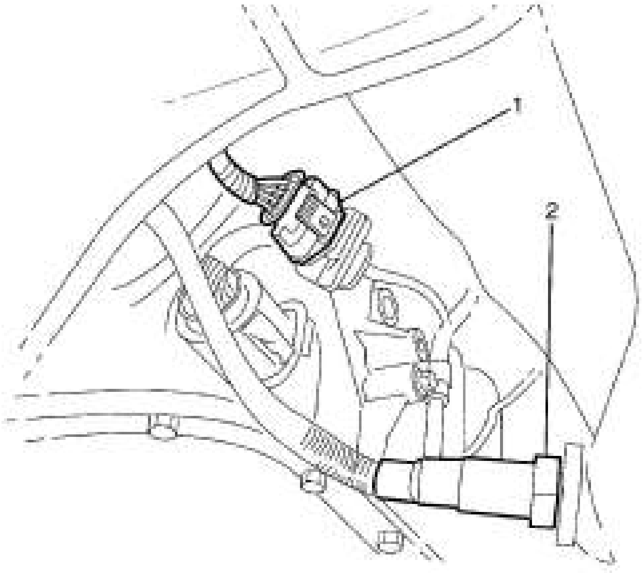


11. Install the rear insulator hanger to body retaining bolts (1).

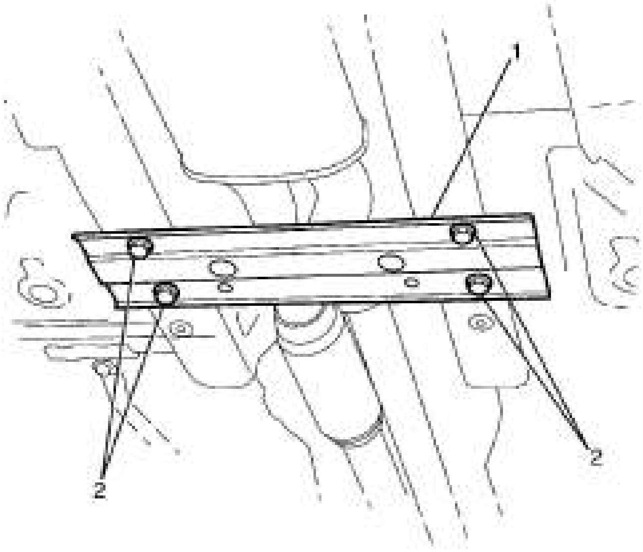
    Tighten
    Tighten the bolts to 26 N·m (19 lb ft).



12. Connect the left post-catalytic converter HO2S electrical connector (1).



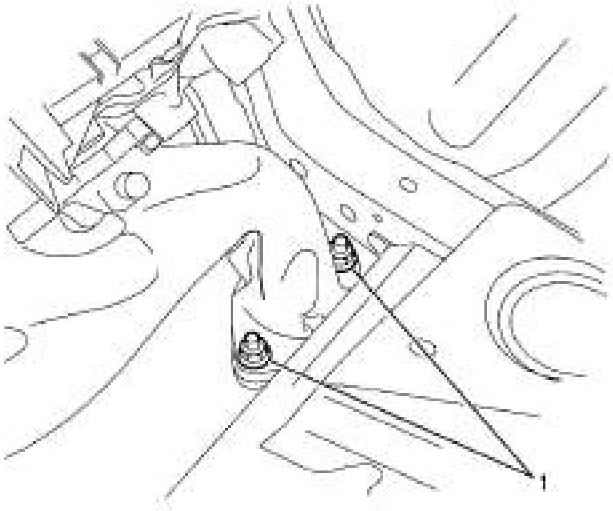
13. Connect the right post-catalytic converter HO2S electrical connector (1).



14. Install the transmission tunnel cross-brace (1).
15. Install the transmission tunnel cross-brace to body retaining bolts (2).

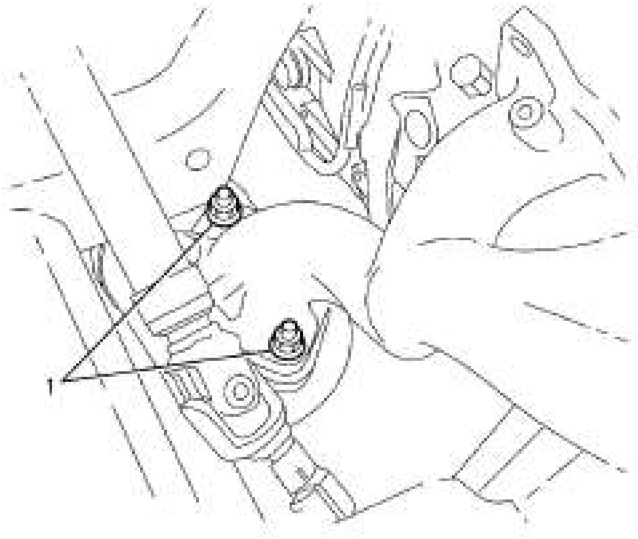
    Tighten
    Tighten the nuts to xx N·m (xx lb ft).

16. Remove the jack supporting the exhaust system.
17. Lower vehicle.



18. Tighten the left catalytic converter to left exhaust manifold retaining nuts (1).

    Tighten
    Tighten the nuts to 45 N·m (33 lb ft).



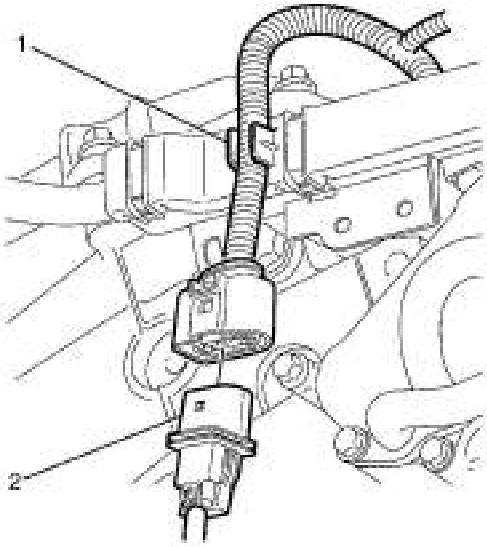
19. Tighten the right catalytic converter to right exhaust manifold retaining nuts (1).

    Tighten
    Tighten the nuts to 45 N·m (33 lb ft).

20. Make sure that the exhaust system is clear of all other components and chassis. If the exhaust system is not clear of all the other components loosen all retaining nuts and re-align.

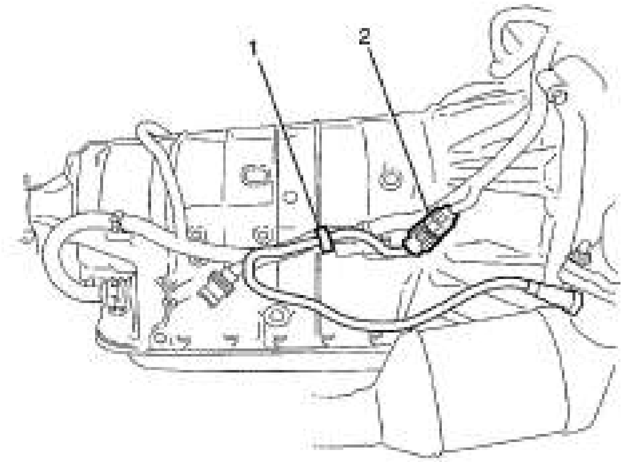
Refer to Exhaust System Alignment .

21. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



22. Connect the left pre-catalytic converter heated oxygen sensor (HO2S) wiring connector (2) to the main wiring harness.
23. Install the left pre-catalytic converter heated oxygen sensor (HO2S) wiring loom to the engine wiring loom retaining clip (1).
24. Lower the vehicle.

Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.



25. Connect the right pre-catalytic converter heated oxygen sensor (HO2S) electrical connector (2).

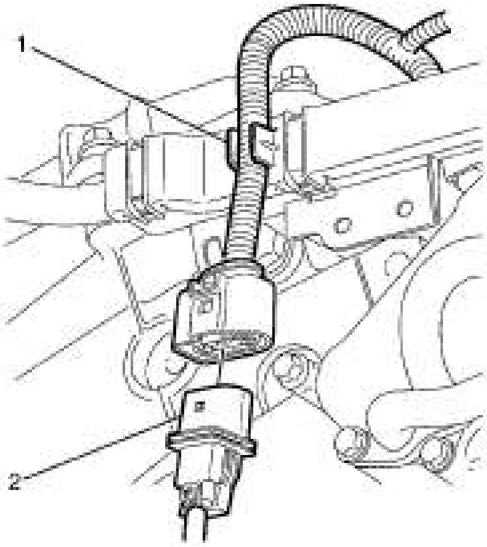
26. Install the right pre-catalytic converter heated oxygen sensor (HO2S) wiring loom from the transmission wiring loom retraining clip (1).
27. Install the engine dress cover. Refer to Engine Cover Replacement .
28. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.
29. If re-programming is required. Refer to Control Module References .
30. Perform diagnostic system check using diagnostic scan tool, clear all relative DTCs and inspect the system for correct operation.

Exhaust System Replacement (LY7)

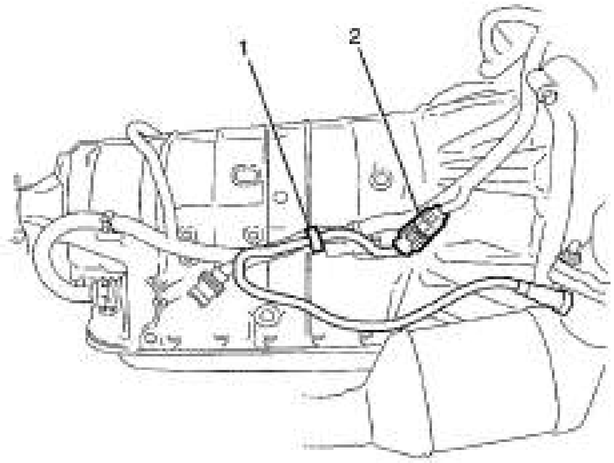
Removal Procedure - Up to 31 May 2007

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
2. Remove the engine dress cover. Refer to Engine Cover Replacement .

Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.



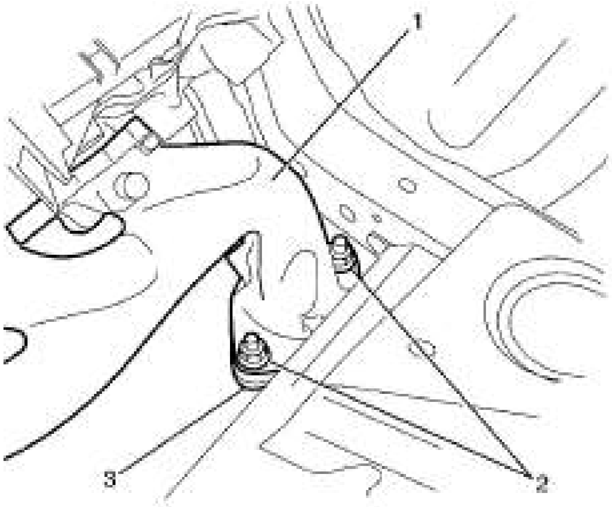
3. Disconnect the left pre-catalytic converter heated oxygen sensor (HO2S) electrical connector (2).



4. Disconnect the right pre-catalytic converter HO2S electrical connector (1).

 Caution: Refer to Exhaust Service Caution in the Preface section.

 Caution: Refer to Protective Goggles and Glove Caution in the Preface section.

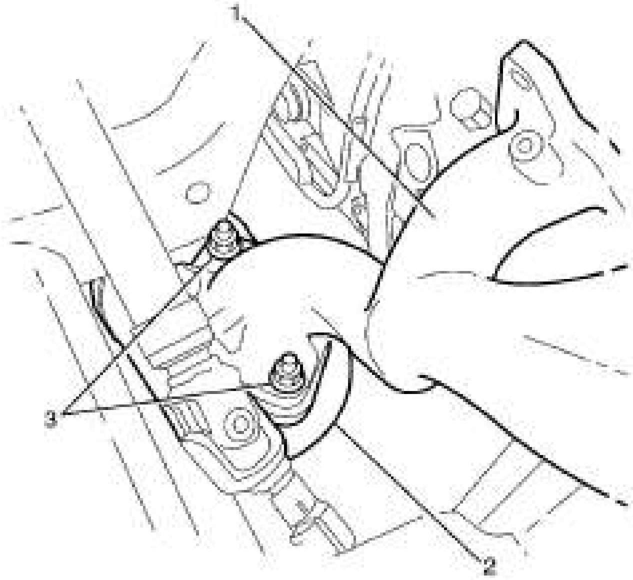


Important: The left catalytic converter to exhaust manifold retaining nuts (2) are single use parts. They must be discarded after removal.

5. Remove the left catalytic converter to exhaust manifold retaining nuts (2).

Discard the nuts.

6. Pull down and back on the left catalytic converter (3) to disconnect from the left exhaust manifold (1).



Important: The right catalytic converter to exhaust manifold retaining nuts (3) are single use parts. They must be discarded after removal.

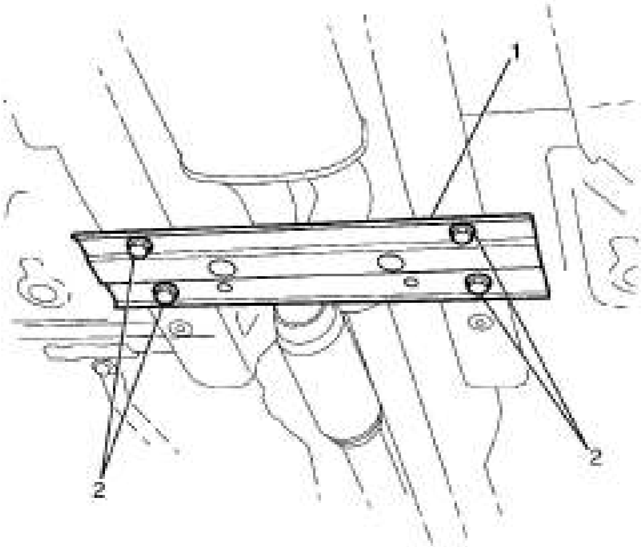
7. Remove the right catalytic converter to exhaust manifold retaining nuts (3).

   Discard the nuts.

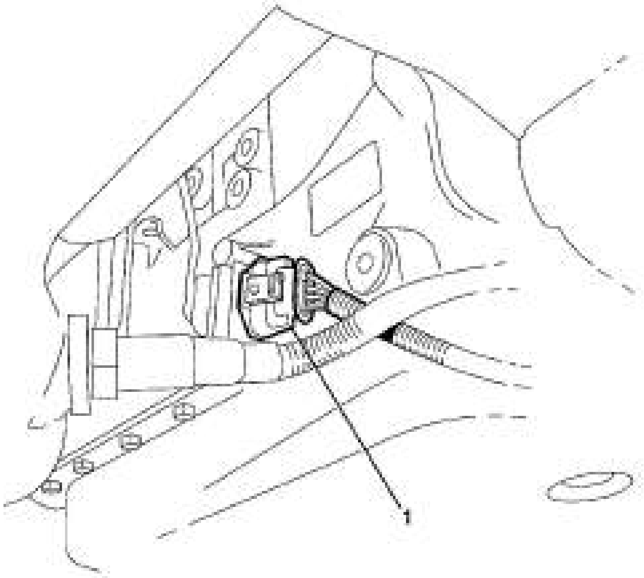
8. Pull down and back on the right catalytic converter (2) to disconnect from the right exhaust manifold (1).

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

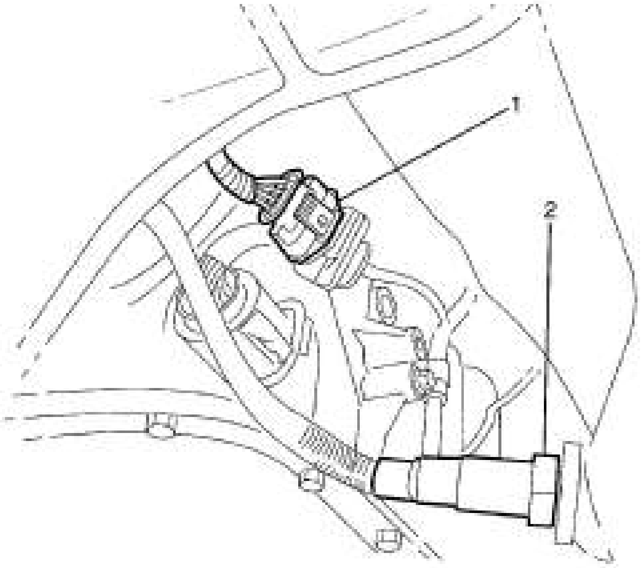
9. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



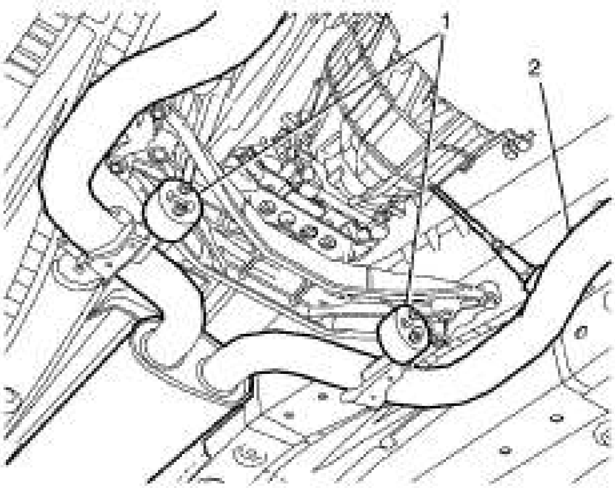
10. Remove the transmission tunnel cross-brace to body retaining bolts (2).
11. Remove the transmission tunnel cross-brace (1).



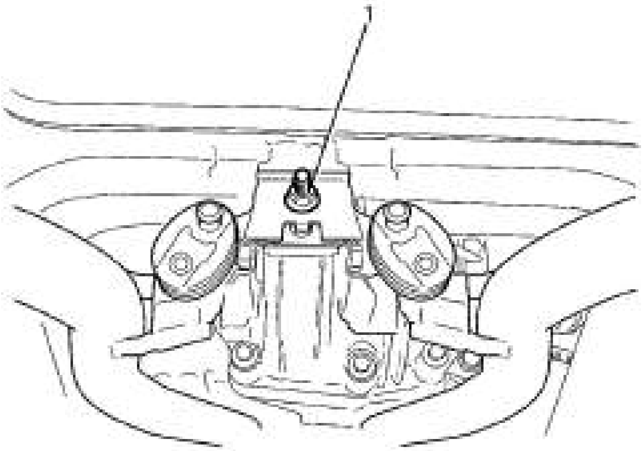
12. Disconnect the left post-catalytic converter HO2S electrical connector (1).



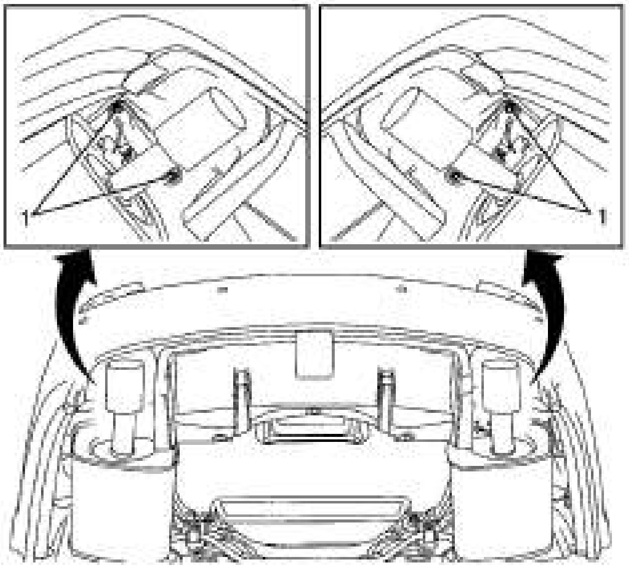
13. Disconnect the right post-catalytic converter HO2S electrical connector (1).
14. Support the exhaust system using a suitable jack.



15. Detach the exhaust system (2) by removing the front insulator hangers (1) if fitted.



16. Detach the exhaust system (2) by removing the centre insulator hanger bracket to differential retaining bolt (1).



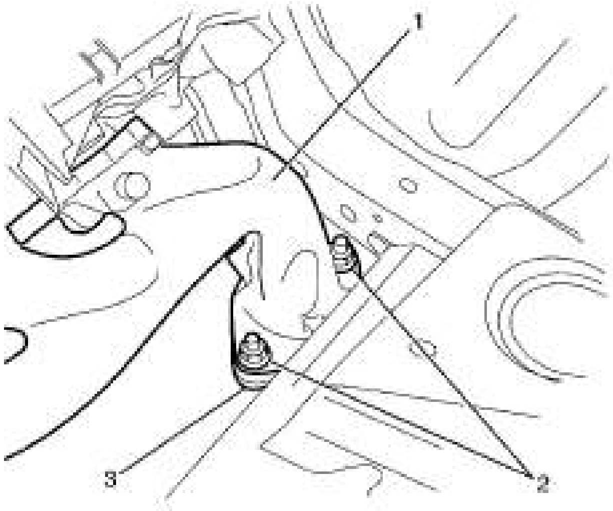
17. Remove the rear insulator hanger to body retaining bolts (1).
18. With the aid of an assistant or using a suitable jack; carefully lower the exhaust system from the vehicle.
19. Remove the left pre-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 .
20. Remove the left post-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 .
21. Remove the right pre-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 .
22. Remove the right post-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 .

Installation Procedure - Up to 31 May 2007

1. Install the left pre-catalytic converter HO2S to the left catalytic converter. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 .
2. Install the left post-catalytic converter HO2S to the intermediate exhaust assembly. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 .
3. Install the right pre-catalytic converter HO2S to the right catalytic converter. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 .
4. Install the right post-catalytic converter HO2S to the intermediate exhaust assembly. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 .

   Notice: Refer to Exhaust Service Caution in the Preface section.

5. With the aid of an assistant or using a suitable jack; carefully raise the exhaust system to the vehicle.



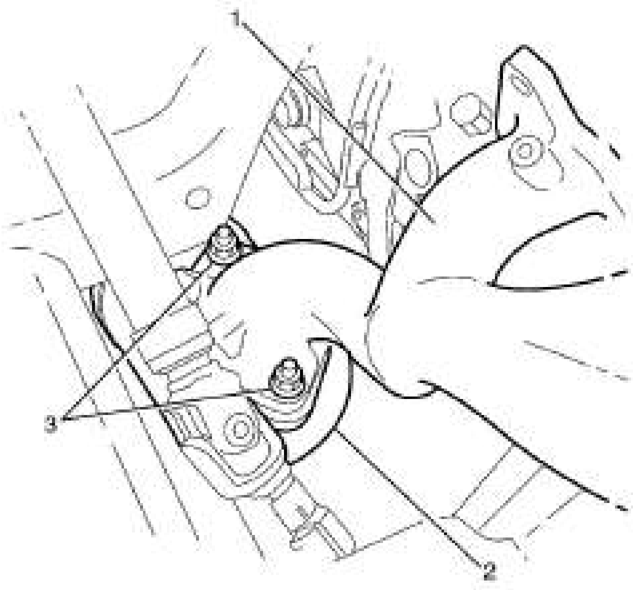
Important: Make sure that a NEW sealing ring is fitted prior to installation. Failure to comply may cause the exhaust system to perform poorly.

6. Push up and forward on the left catalytic converter (3) to connect to the left exhaust manifold (1).

   Important: Do not fully tighten the left catalytic converter to left exhaust manifold retaining nuts (2) at this stage.

7. Install the NEW left catalytic converter to left exhaust manifold retaining nuts (2).

   Do not fully tighten at this stage.

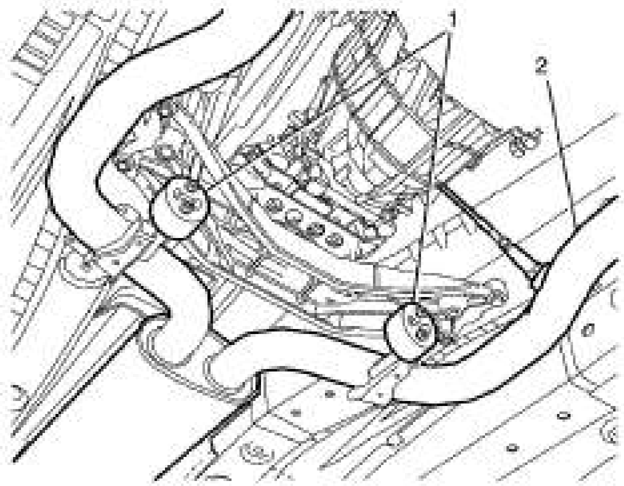


8. Push up and forward on the right catalytic converter (2) to connect to the right exhaust manifold (1).

   Important: Do not fully tighten the right catalytic converter to right exhaust manifold retaining nuts (3) at this stage.

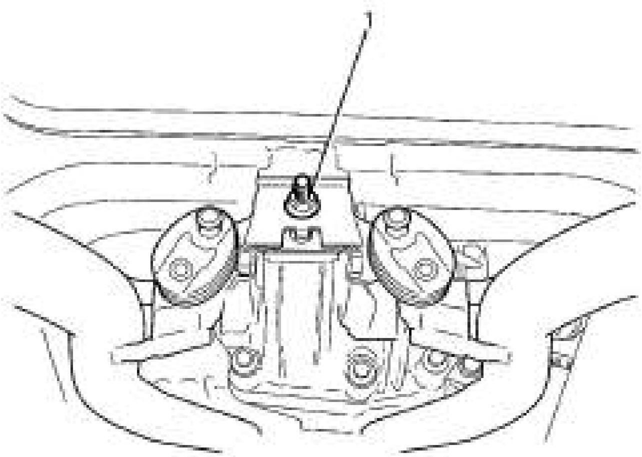
9. Install the NEW right catalytic converter to right exhaust manifold retaining nuts (3).

   Do not fully tighten at this stage.



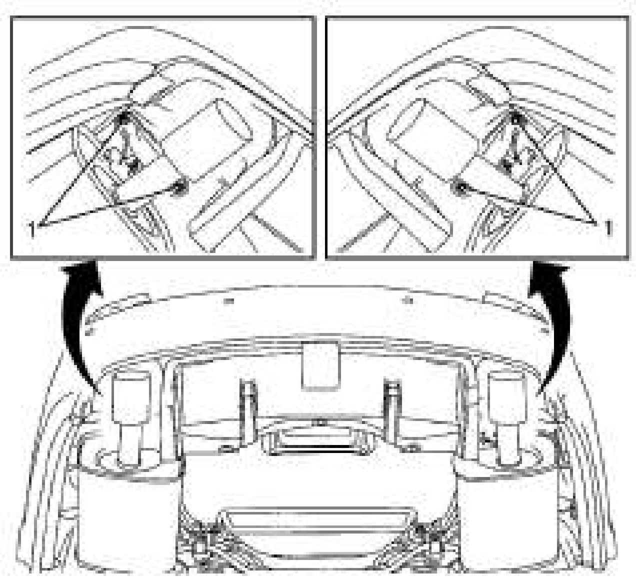
10. Attach the exhaust system (2) by installing the front insulator hangers (1) if fitted.

Notice: Refer to Fastener Notice in the Preface section.



11. Attach the exhaust system (2) by installing the centre insulator hanger bracket to differential retaining bolt (1).

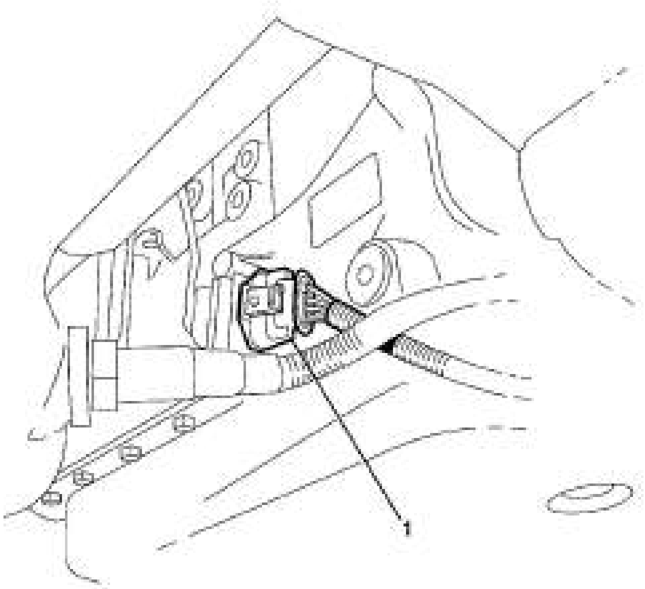
Tighten
Tighten the bolt to 45 N·m (33 lb ft).



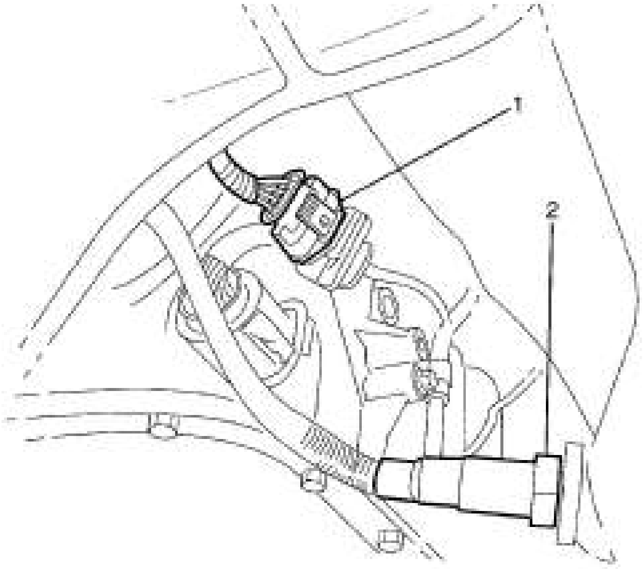
12. Install the rear insulator hanger to body retaining bolts (1).

Tighten

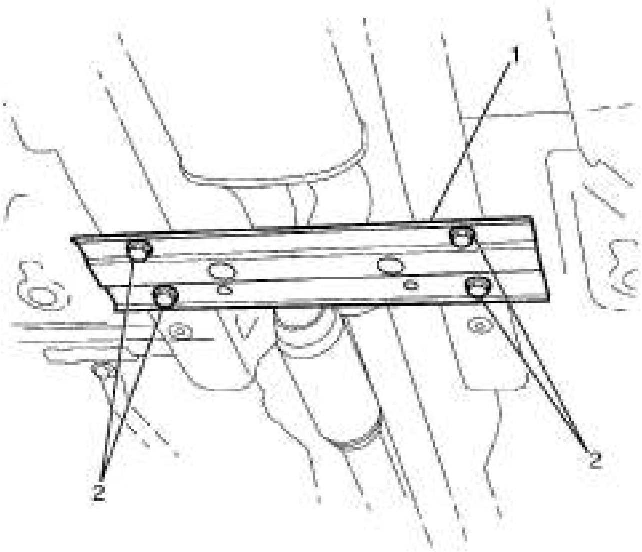
Tighten the bolts to 26 N·m (19 lb ft).



13. Connect the left post-catalytic converter HO2S electrical connector (1).



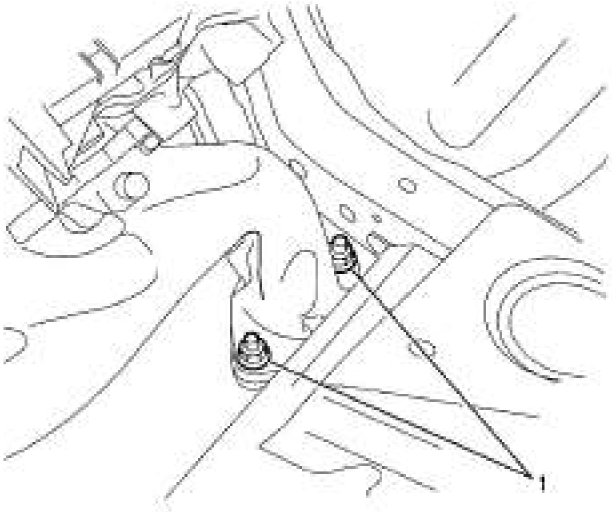
14. Connect the right post-catalytic converter HO2S electrical connector (1).



15. Install the transmission tunnel cross-brace (1).
16. Install the transmission tunnel cross-brace to body retaining bolts (2).

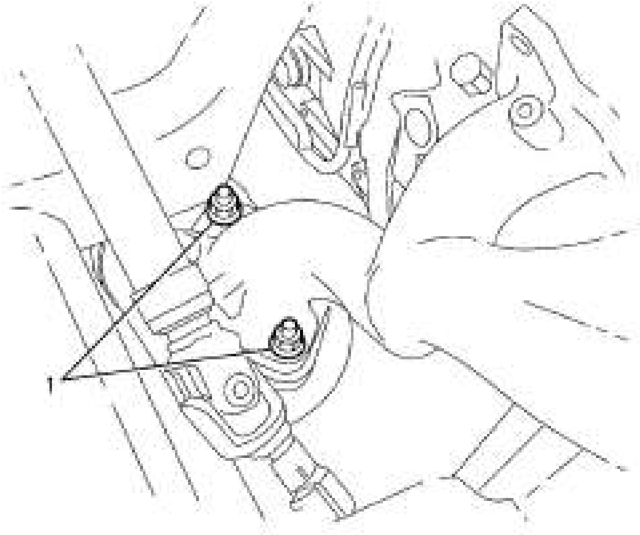
Tighten
Tighten the nuts to xx N·m (xx lb ft).

17. Remove the jack supporting the exhaust system.
18. Lower vehicle.



19. Tighten the left catalytic converter to left exhaust manifold retaining nuts (1).

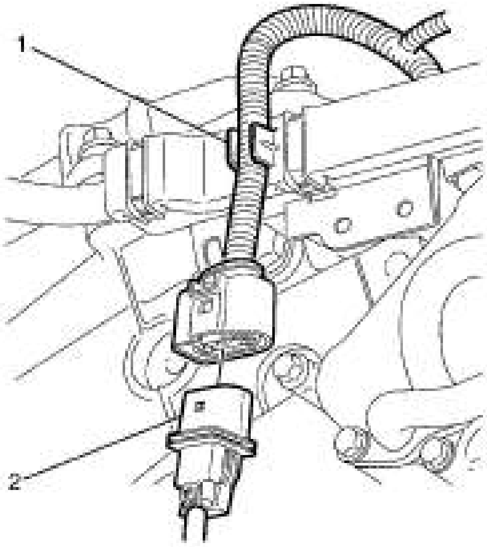
Tighten
Tighten the nuts to 45 N·m (33 lb ft).



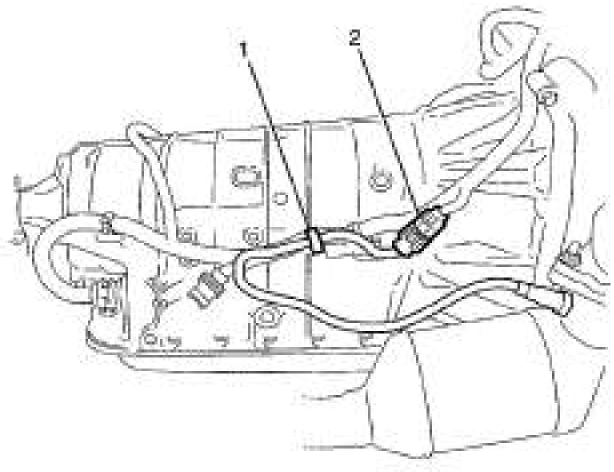
20. Tighten the right catalytic converter to right exhaust manifold retaining nuts (1).

    Tighten
    Tighten the nuts to 45 N·m (33 lb ft).

21. Make sure that the exhaust system is clear of all other components and chassis. If the exhaust system is not clear of all the other components loosen all retaining nuts and re-align. Refer to Exhaust System Alignment .



22. Connect the left pre-catalytic converter HO2S electrical connector (2).

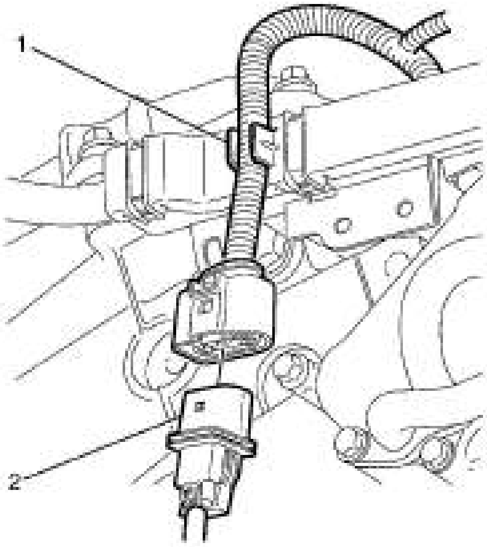


23. Connect the right pre-catalytic converter HO2S electrical connector (2).
24. Install the engine dress cover. Refer to Engine Cover Replacement in Engine Mechanical - 3.6L.
25. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
26. If re-programming is required. Refer to Control Module References .
27. Perform diagnostic system check using diagnostic scan tool, clear all relative DTCs and inspect the system for correct operation.

Removal Procedure - From 31 May 2007

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
2. Remove the engine dress cover. Refer to Engine Cover Replacement .

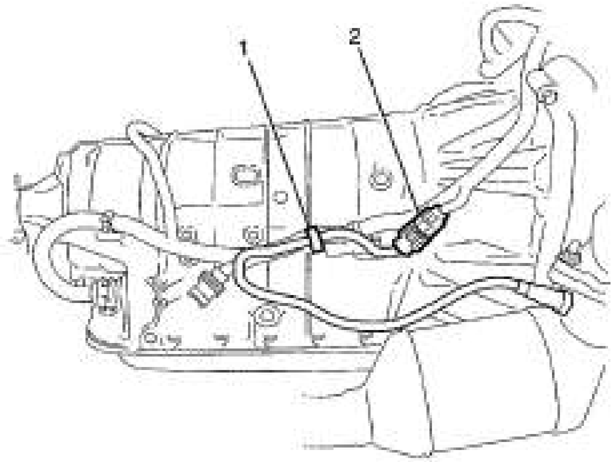
Notice: Refer to Heated Oxygen and Oxygen Sensor Notice in the Preface section.



3. Disconnect the left pre-catalytic converter heated oxygen sensor (HO2S) electrical connector (2).

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

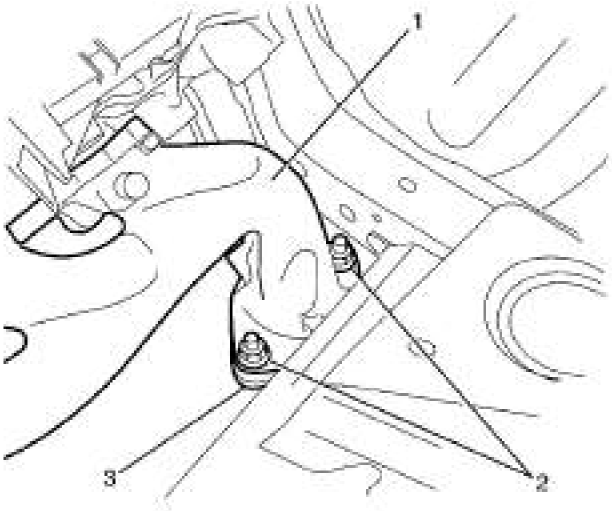
4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



5. Disconnect the right pre-catalytic converter HO2S electrical connector (1).

   Caution: Refer to Exhaust Service Caution in the Preface section.

   Caution: Refer to Protective Goggles and Glove Caution in the Preface section.

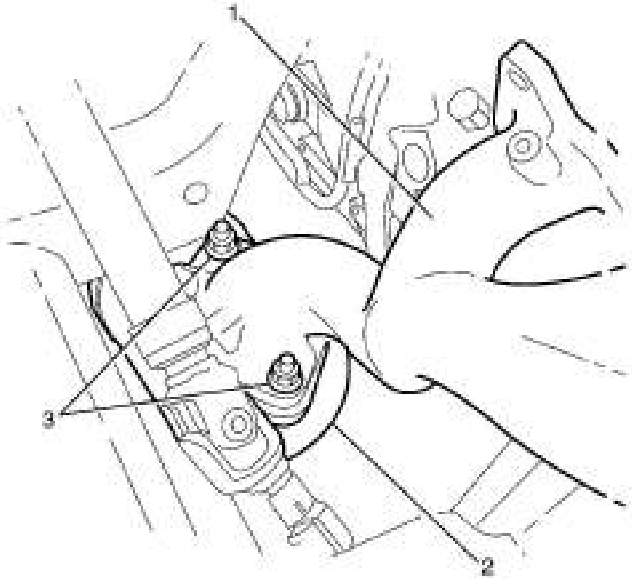


Important: The left catalytic converter to exhaust manifold retaining nuts (2) are single use parts. They must be discarded after removal.

6. Remove the left catalytic converter to exhaust manifold retaining nuts (2).

   Discard the nuts.

7. Pull down and back on the left catalytic converter (3) to disconnect from the left exhaust manifold (1).



Important: The right catalytic converter to exhaust manifold retaining nuts (3) are single use parts. They must be discarded after removal.

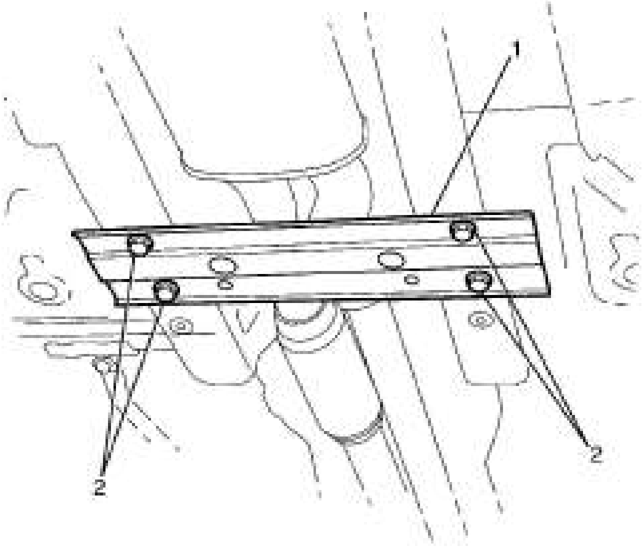
8. Remove the right catalytic converter to exhaust manifold retaining nuts (3).

   Discard the nuts.

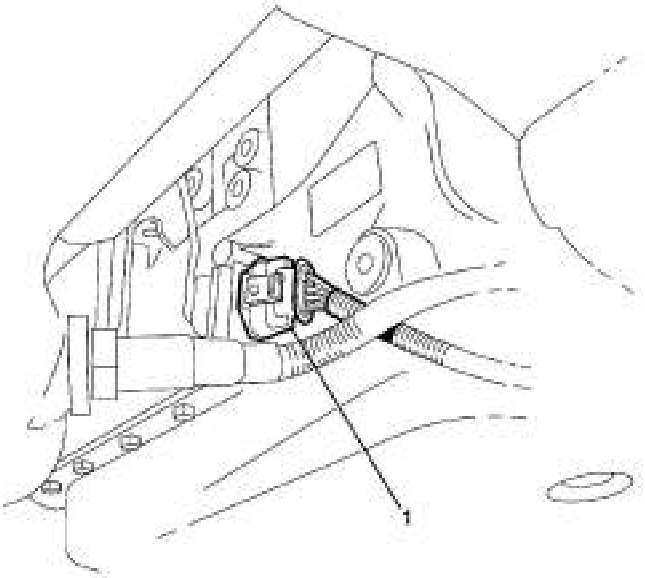
9. Pull down and back on the right catalytic converter (2) to disconnect from the right exhaust manifold (1).

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

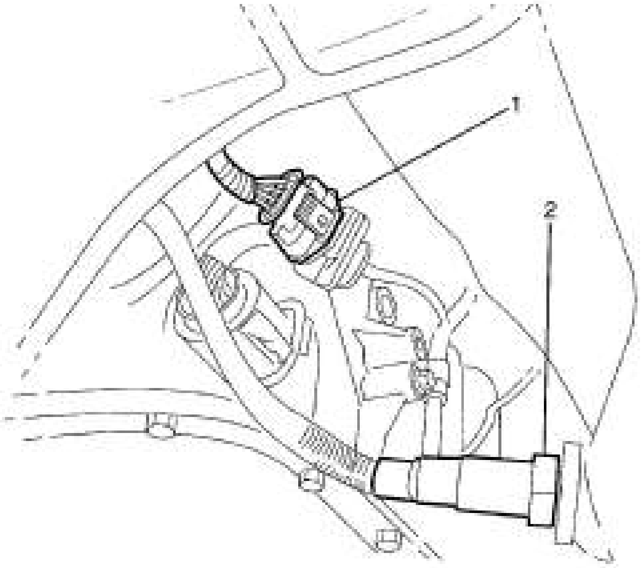
10. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



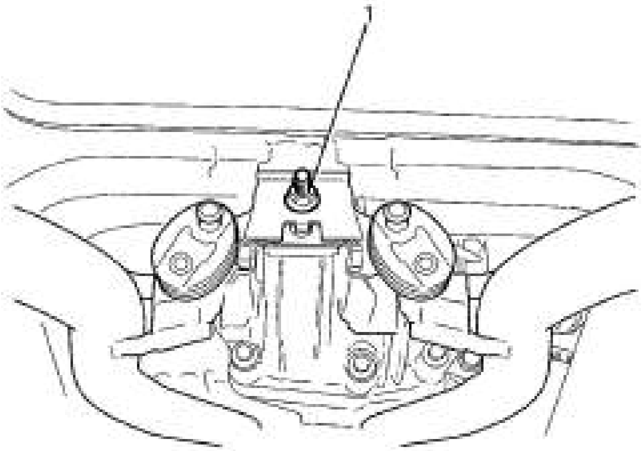
11. Remove the transmission tunnel cross-brace to body retaining bolts (2).
12. Remove the transmission tunnel cross-brace (1).



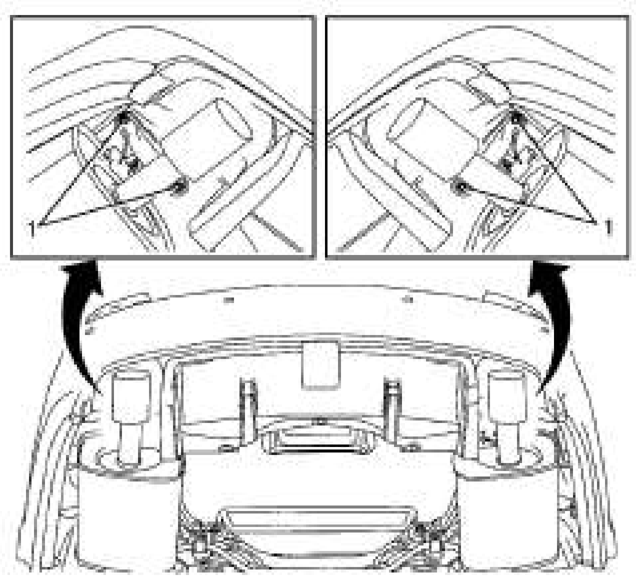
13. Disconnect the left post-catalytic converter HO2S electrical connector (1).



14. Disconnect the right post-catalytic converter HO2S electrical connector (1).
15. Support the exhaust system using a suitable jack.



16. Detach the exhaust system (2) by removing the centre insulator hanger bracket to differential retaining bolt (1).



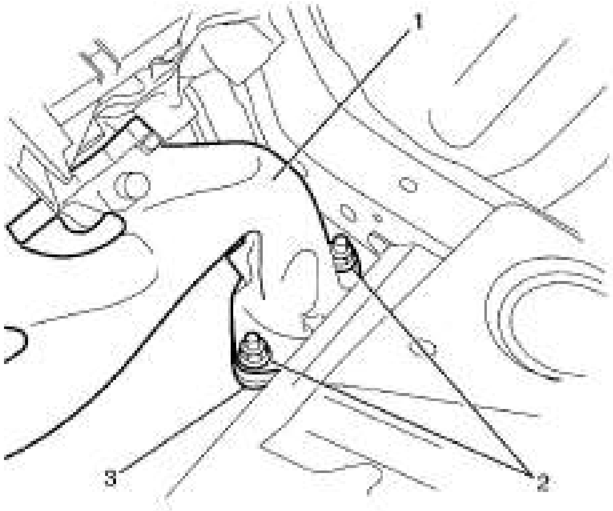
17. Remove the rear insulator hanger to body retaining bolts (1).
18. With the aid of an assistant or using a suitable jack; carefully lower the exhaust system from the vehicle.
19. Remove the left pre-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 .
20. Remove the left post-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 .
21. Remove the right pre-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 .
22. Remove the right post-catalytic converter HO2S. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 .

Installation Procedure - From 31 May 2007

1. Install the left pre-catalytic converter HO2S to the left catalytic converter. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 .
2. Install the left post-catalytic converter HO2S to the intermediate exhaust assembly. Refer to Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 .
3. Install the right pre-catalytic converter HO2S to the right catalytic converter. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 .
4. Install the right post-catalytic converter HO2S to the intermediate exhaust assembly. Refer to Heated Oxygen Sensor Replacement - Bank 2 Sensor 2 .

   Notice: Refer to Exhaust Service Caution in the Preface section.

5. With the aid of an assistant or using a suitable jack; carefully raise the exhaust system to the vehicle.



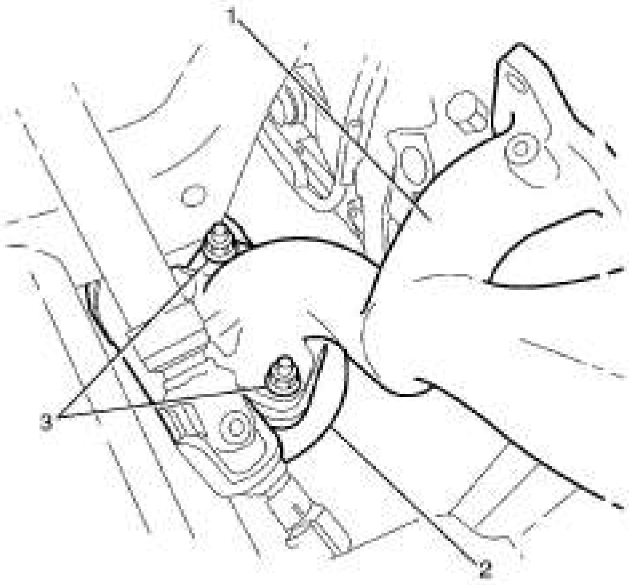
Important: Make sure that a NEW sealing ring is fitted prior to installation. Failure to comply may cause the exhaust system to perform poorly.

6. Push up and forward on the left catalytic converter (3) to connect to the left exhaust manifold (1).

   Important: Do not fully tighten the left catalytic converter to left exhaust manifold retaining nuts (2) at this stage.

7. Install the NEW left catalytic converter to left exhaust manifold retaining nuts (2).

   Do not fully tighten at this stage.



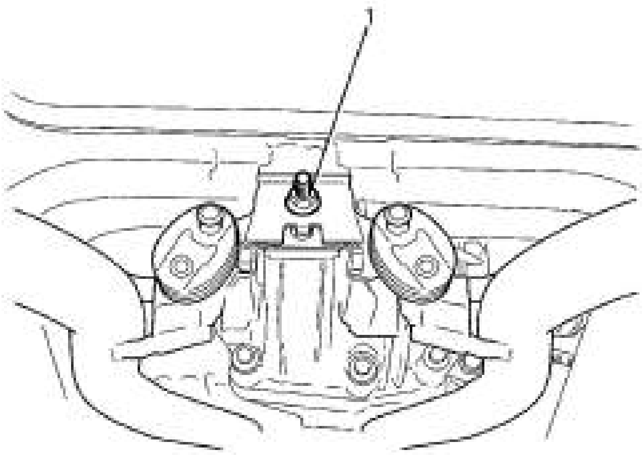
8. Push up and forward on the right catalytic converter (2) to connect to the right exhaust manifold (1).

   Important: Do not fully tighten the right catalytic converter to right exhaust manifold retaining nuts (3) at this stage.

9. Install the NEW right catalytic converter to right exhaust manifold retaining nuts (3).

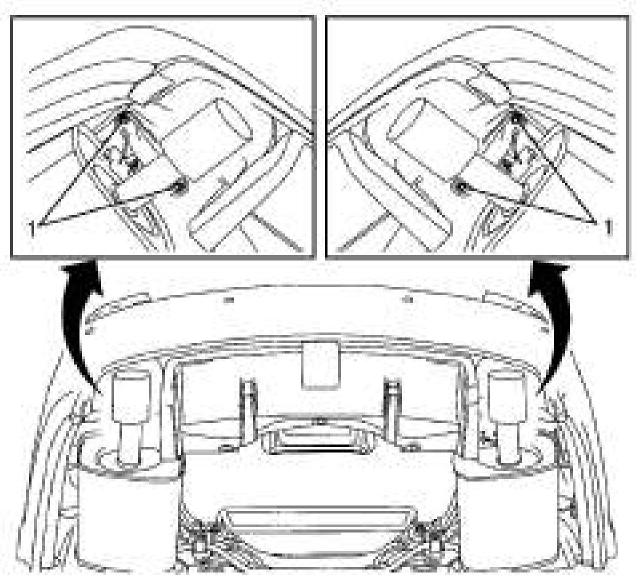
   Do not fully tighten at this stage.

   Notice: Refer to Fastener Notice in the Preface section.



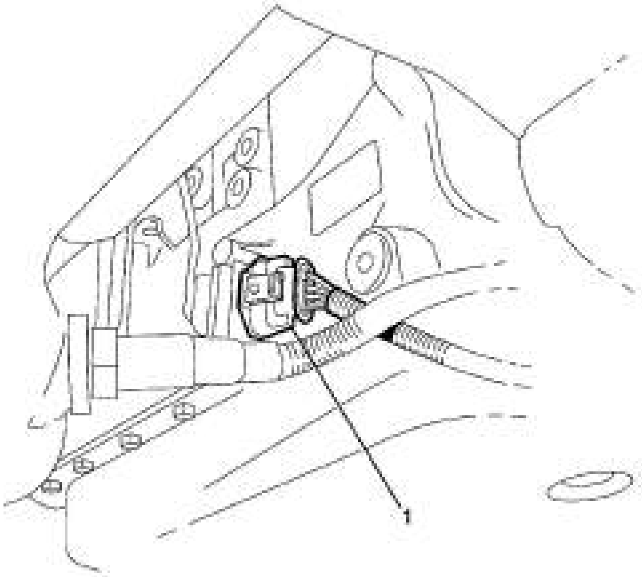
10. Attach the exhaust system (2) by installing the centre insulator hanger bracket to differential retaining bolt (1).

    Tighten
    Tighten the bolt to 45 N·m (33 lb ft).

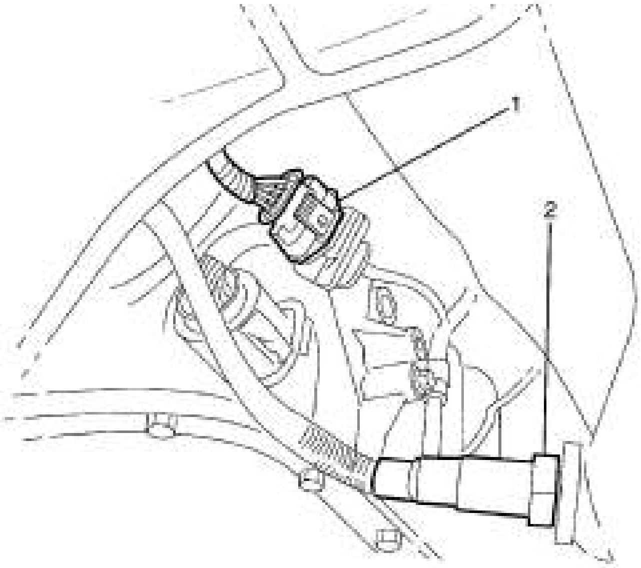


11. Install the rear insulator hanger to body retaining bolts (1).

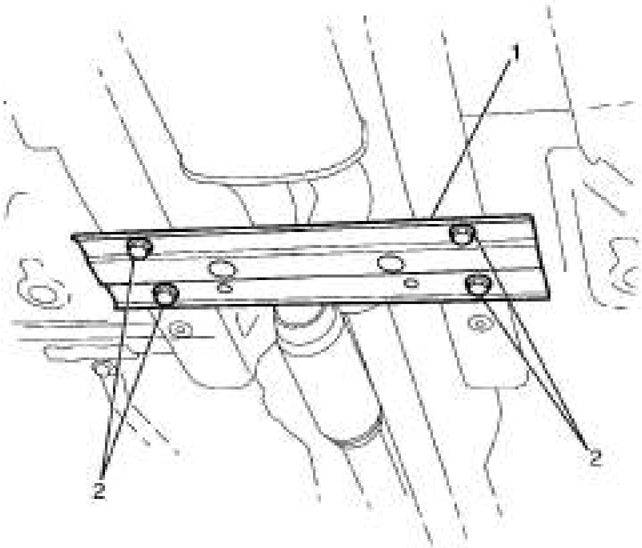
    Tighten
    Tighten the bolts to 26 N·m (19 lb ft).



12. Connect the left post-catalytic converter HO2S electrical connector (1).



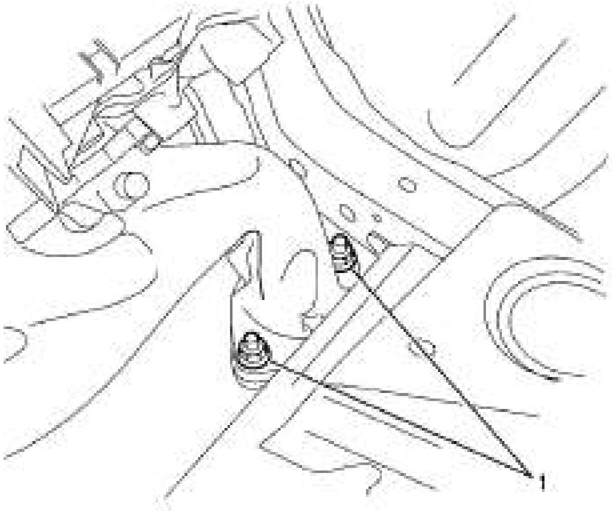
13. Connect the right post-catalytic converter HO2S electrical connector (1).



14. Install the transmission tunnel cross-brace (1).
15. Install the transmission tunnel cross-brace to body retaining bolts (2).

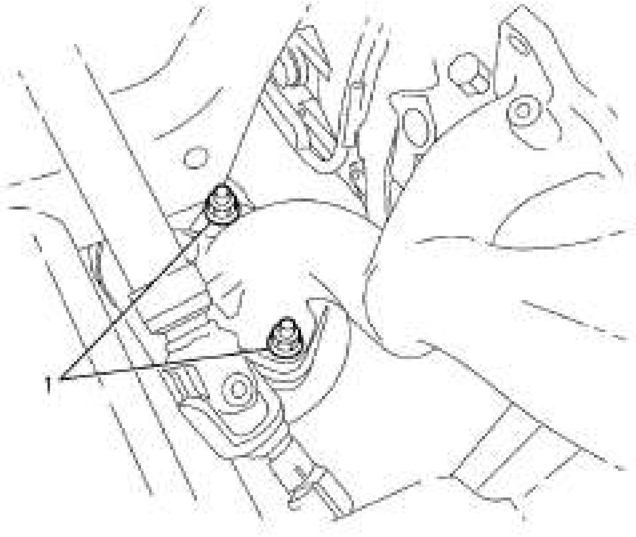
Tighten
Tighten the nuts to xx N·m (xx lb ft).

16. Remove the jack supporting the exhaust system.
17. Lower vehicle.



18. Tighten the left catalytic converter to left exhaust manifold retaining nuts (1).

    Tighten
    Tighten the nuts to 45 N·m (33 lb ft).

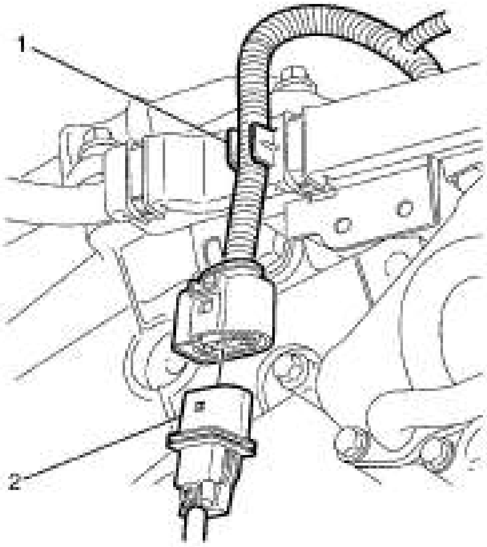


19. Tighten the right catalytic converter to right exhaust manifold retaining nuts (1).

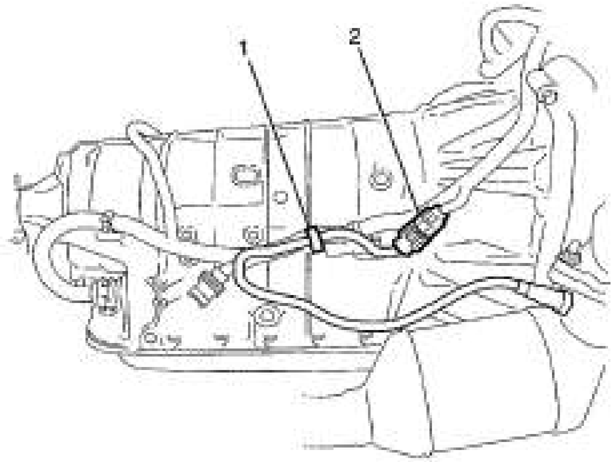
    Tighten
    Tighten the nuts to 45 N·m (33 lb ft).

20. Make sure that the exhaust system is clear of all other components and chassis. If the exhaust system is not clear of all the other components loosen all retaining nuts and re-align.

Refer to Exhaust System Alignment .



21. Connect the left pre-catalytic converter HO2S electrical connector (2).



22. Connect the right pre-catalytic converter HO2S electrical connector (2).
23. Install the engine dress cover. Refer to Engine Cover Replacement in Engine Mechanical - 3.6L.
24. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
25. If re-programming is required. Refer to Control Module References .
26. Perform diagnostic system check using diagnostic scan tool, clear all relative DTCs and inspect the system for correct operation.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Exhaust | Repair Instructions | **Document ID: 1977396**

Fuel Tank Heat Shield Replacement

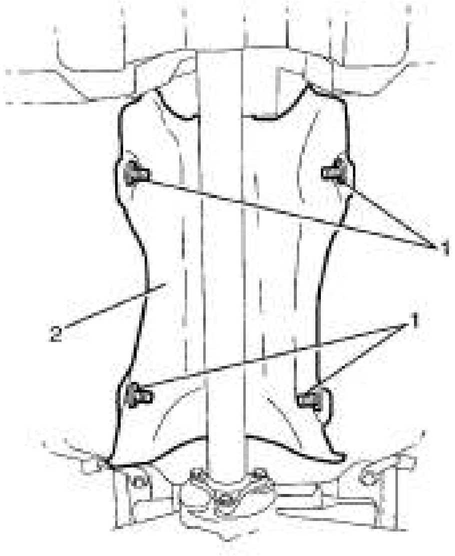
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

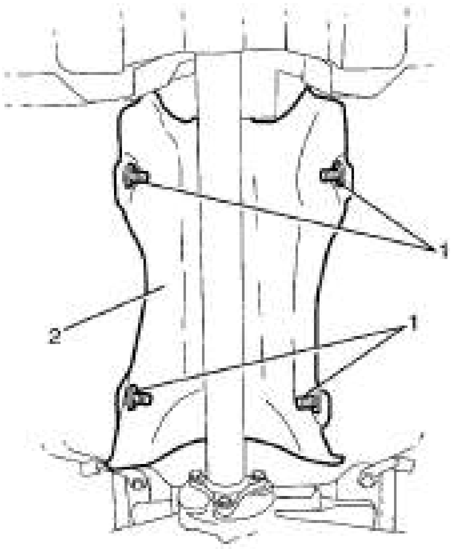
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

Caution: Refer to Exhaust Service Caution in the Preface section.



2. Remove the fuel tank heat shield to fuel tank retaining nuts (1).
3. Remove the fuel tank heat shield (2).

Installation Procedure



1. Position the fuel tank heat shield (2) to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the fuel tank heat shield to fuel tank retaining nuts (1).

   Tighten
   Tighten the nuts to 4 N·m (35 lb in).

3. Lower the vehicle to the ground.

Exhaust System Description

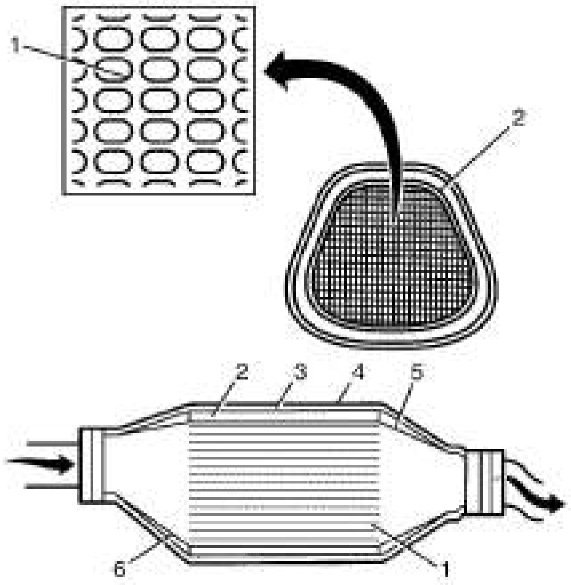
Important: Use of non-OEM parts may cause driveability concerns.

Information contained within this section describes the general exhaust system.

Through developments in various emissions reduction system, significant reductions in emissions have been achieved. The developments have been primarily concerned with refinements in engine calibration and the optimization of exhaust system catalytic converter configurations.

The catalytic converter is similar to a muffler in appearance however, within the outer stainless steel shell (4), there is a ceramic monolith (1) which is honeycombed in the direction of the exhaust, as shown. The ceramic monolith is surrounded by a mat (2), which has the primary function of holding the monolith firmly in place to prevent any contact with the inner shell (3). A mesh (5 and 6) at each end of the converter prevents exhaust gases from fouling and eroding the mat.

Surfaces of the ceramic monolith that are exposed to exhaust gases are coated with a catalytic material. This material contains rhodium and platinum, which act to facilitate the chemical reactions necessary to oxidize carbon monoxide and hydrocarbons into harmless carbon dioxide.



The catalytic converter is a substance that accelerates a chemical reaction without itself being changed. Engine exhaust gases contain carbon monoxide (CO), hydrocarbons (HC) and oxides of nitrogen (NOx). When the exhaust gases flow through the monolith, reactions with the catalytic converter occur. CO and HC are converted by oxidation with oxygen (O_2) in the exhaust gases to produce carbon dioxide (CO_2) and water vapour (H_2O). NOx is converted by reduction with CO to produce nitrogen (N_2). The catalytic converter is called a three-way type because it simultaneously converts three components of exhaust gas (CO, HC and NOx) to harmless natural gases.

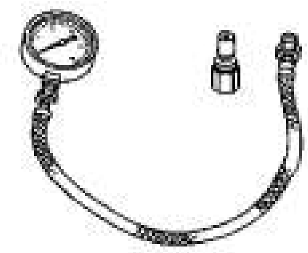
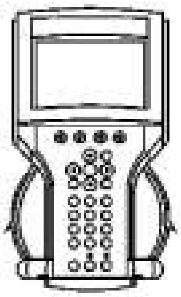
Service Notes

- Vehicles fitted with a catalytic converter should not be operated with leaded petrol. Lead will contaminate the catalytic converter.
- Do not drop the catalytic converter as it will damage the ceramic monolith.
- Do not allow water, oil or fuel to enter the converter as the ceramic monolith will be contaminated.
- Do not drive the vehicle with the engine misfiring or with any of the spark plug leads disconnected.

Important: Catalytic converter can be damaged or rendered infective, if:

- Operated outside the limits of the closed loop mixture control system.
- The engine burns excessive amount of oil.
- The exhaust temperature at the converter is too high (exceeds 840°C).

Special Tools

Illustration	Tool Number / Description
	J 35314-A Exhaust Back Pressure Gage
	70000861 Scan Tool Used for diagnosis of vehicle electrical system.

Fastener Tightening Specifications (SWBRHD)

Application	Specification	
	Metric	English
A/C		
• Compressor Retaining Bolts	22 N·m	17 lb ft
• Compressor Bracket Retaining Bolts	58 N·m	43 lb ft
• Compressor Hose Assembly to Compressor Retaining Bolt	9 N·m	80 lb in
Alternator		
• Alternator to Alternator Bracket Retaining Studs	18 N·m	13 lb ft
• Alternator to Alternator Bracket Stud Retaining Nuts	18 N·m	13 lb ft
• Alternator Bracket to Engine Block Retaining Bolts - Side-M10	58 N·m	43 lb ft
• Alternator Bracket to Engine Block Retaining Bolts - Front-M10	58 N·m	43 lb ft
• Alternator Bracket to Engine Block Retaining Bolts - Side-M8	23 N·m	17 lb ft
• Battery Cable to Alternator Retaining Nut	13 N·m	115 lb in
Camshaft Position Actuator		
• Camshaft Position Actuator to Camshaft Retaining Bolt	58 N·m	43 lb ft
• Camshaft Position Actuator Solenoid Valve to Engine Front Cover Retaining Bolt	10 N·m	89 lb in
Camshaft Bearing Cap to Cylinder Head Retaining Bolts	10 N·m	89 lb in
Camshaft Cover to Cylinder Head Retaining Bolts	10 N·m	89 lb in
Camshaft Intermediate Drive Chain Idler to Cylinder Block Retaining Bolt	58 N·m	43 lb ft
Camshaft Position Sensor to Engine Front Cover Retaining Bolt	10 N·m	89 lb in
Connecting Rod Bolt		
• First Pass	30 N·m	22 lb ft
• Second Pass - Counter Clockwise	Back Off to Zero	
• Third Pass	25 N·m	18 lb ft
• Final Pass	110 Degrees	
Coolant Inlet Pipe		
• Radiator Outlet Pipe to Alternator Mounting Bracket Retaining Nut	22 N·m	16 lb ft
Coolant Outlet Housing to Intake Manifold Retaining Bolts	10 N·m	89 lb in
Crankshaft Balancer to Crankshaft Retaining Bolt		
• First Pass	100 N·m	74 lb ft
• Final Pass	150 Degrees	
Crankshaft Bearing Cap to Cylinder Block Retaining Bolts		
Inner		

• First Pass	20 N·m	15 lb ft
• Final Pass	80 degrees	
Outer		
• First Pass	15 N·m	10 lb ft
• Final Pass	110 Degrees	
Side		
• First Pass	30 N·m	22 lb ft
• Final Pass	60 Degrees	
Crankshaft Rear Oil Seal Housing to Cylinder Block Retaining Bolts	10 N·m	89 lb in
Cylinder Head to Cylinder Block Retaining Bolts - M8		
• First Pass	15 N·m	10 lb ft
• Final Pass	60 Degrees	
Cylinder Head to Cylinder Block Retaining Bolts - M11		
• First Pass	45 N·m	33 lb ft
• Second Pass	Counter Clockwise 120 degrees	
• Third Pass	30 N·m	22 lb ft
• Final Pass	150 degrees	
Cylinder Head Coolant Threaded Plugs	45 N·m	33 lb ft
• Drive Belt Idler Pulley to Accessory Drive Mounting Bracket Retaining Bolt	58 N·m	43 lb ft
• Drive Belt Tensioner to Engine Front Cover Retaining Bolts	22 N·m	16 lb ft
Pressure Plate to Flywheel Retaining Bolts		
First Pass	15 N·m	11 lb ft
Second Pass	30 N·m	22 lb ft
Third Pass	90° Degrees	
Engine Flywheel to Crankshaft Retaining Bolts		
• First Pass	30 N·m	22 lb ft
• Final Pass	75 Degrees	
Engine Driveplate to Crankshaft Retaining Bolts		
• First Pass	30 N·m	22 lb ft
• Final Pass	45 Degrees	
Engine Front Cover to Cylinder Block Retaining Bolts		
• First Pass	20 N·m	15 lb ft
• Final Pass	60 Degrees	
Engine Cover Mounting Bracket to Cylinder Head Retaining Bolt	35 N·m	26 lb ft
Engine Mount		
• Engine Mount Bracket to Cylinder Block Retaining Bolts	50 N·m	37 lb ft
• Engine Mount to Engine Mount Bracket Retaining Nut	80 N·m	59 lb ft
• Engine Mount to Front Subframe Retaining Nuts	80 N·m	59 lb ft
Fuel Injector Harness Electrical Connector/EVAP Valve Mounting	10 N·m	89 lb in

Bracket to Intake Manifold Retaining Bolt		
Engine Wiring Harness Bracket		
• Engine Wiring Harness Bracket to Cylinder Head Rear Retaining Bolts	40 N·m	30 lb ft
• Engine Wiring Harness Bracket to Cylinder Block Retaining Bolt	10 N·m	89 lb in
• Engine Wiring Harness Bracket to Right Bank Cylinder Head Retaining Bolt	10 N·m	89 lb in
Engine Wiring Harness Ground		
• Engine Wiring Harness Ground to Left Bank Cylinder Head Retaining Bolt	10 N·m	89 lb in
• Engine Wiring Harness Ground to Right Bank Cylinder Head Front Retaining Bolt	10 N·m	89 lb in
• Engine Wiring Harness Ground to Right Bank Cylinder Head Rear Retaining Bolt	10 N·m	89 lb in
Exhaust Manifold		
• Exhaust Manifold to Cylinder Head Retaining Bolts	20 N·m	15 lb ft
• Exhaust Manifold Heat Shield to Exhaust Manifold Retaining Bolts	10 N·m	89 lb in
Fuel Injector Rail to Lower Intake Manifold Retaining Bolts	10 N·m	89 lb in
Vehicle Body Ground Cable to Cylinder Head Retaining Bolt	50 N·m	37 lb ft
Heater Pipe Assembly to Thermostat Housing Retaining Bolts	10 N·m	89 lb in
Ignition Coil to Camshaft Cover Retaining Bolts	10 N·m	89 lb in
Intake Manifold		
• Engine Cover Ball Stud	7 N·m	62 lb in
• Intake Manifold Runner Control (IMRC) Flap to Upper Intake Manifold Retaining Bolts	10 N·m	89 lb in
• Upper Intake Manifold-to-Cylinder Head Retaining Bolts - Long	23 N·m	17 lb ft
• Upper Intake Manifold-to-Cylinder Head Retaining Bolts - Short	23 N·m	17 lb ft
• Upper Intake Manifold-to-Lower Intake Manifold Retaining Bolts	23 N·m	17 lb ft
Oil Pan Drain Plug	25 N·m	18 lb ft
Oil Filter Cap	25 N·m	18 lb ft
Oil Filter Housing Adapter		
• Oil Filter Adapter to Cylinder Head Retaining Bolt - M10	65 N·m	48 lb ft
• Oil Filter Adapter to Cylinder Block Retaining Bolts - M8	23 N·m	17 lb ft
Oil Gallery Plug	31 N·m	23 lb ft
Oil Jet to Cylinder Block Retaining Bolts	10 N·m	89 lb in
Oil Level Indicator Tube Bracket to Cylinder Head Retaining Bolt	10 N·m	89 lb in
Oil Level Sensor to Oil Pan Retaining Bolt	20 N·m	15 lb ft
Oil Pan		

• Front Cover to Oil Pan Retaining Bolts	23 N·m	17 lb ft
• Oil Pan to Cylinder Block Retaining Bolts - M8	23 N·m	17 lb ft
• Oil Pan to Crankshaft Rear Oil Seal Housing Retaining Bolts - M6	10 N·m	89 lb in
• Transmission to Oil Pan Retaining Bolts	48 N·m	17 lb ft
• Oil Pan Baffle to Oil Pan Retaining Bolts	10 N·m	89 lb in
• Oil Pan Scraper to Oil Pan Retaining Bolts	10 N·m	89 lb in
Oil Pressure Sender	20 N·m	15 lb ft
Oil Pump		
• Oil Pump to Cylinder Block Retaining Bolts	23 N·m	17 lb ft
• Oil Pump Cover to Oil Pump Housing Retaining Bolts	10 N·m	89 lb in
Oil Suction Pipe to Oil Pan Retaining Bolts	10 N·m	89 lb in
Power Steering Pump		
• Power Steering Bracket to Cylinder Head Retaining Bolt	58 N·m	43 lb ft
• Power Steering Bracket to Engine Front Cover Retaining Bolt	58 N·m	43 lb ft
• Power Steering Bracket to Cylinder Block Retaining Bolt	58 N·m	43 lb ft
• Power Steering Pump to Power Steering Pump Bracket Retaining Bolts	27 N·m	22 lb ft
• Power Steering Fluid Reservoir Bracket to Engine Front Cover Retaining Bolts	9 N·m	80 lb in
Primary Camshaft Drive Chain		
• Primary Camshaft Drive Chain Lower Guide to Oil Pump Retaining Bolts	13 N·m	115 lb in
• Primary Camshaft Drive Chain Tensioner to Cylinder Block Retaining Bolts	23 N·m	17 lb ft
• Primary Camshaft Drive Chain Upper Guide to Cylinder Block Retaining Bolts	23 N·m	17 lb ft
Secondary Camshaft Drive Chain		
• Secondary Camshaft Drive Chain Guide to Cylinder Block Retaining Bolts	23 N·m	17 lb ft
• Secondary Camshaft Drive Chain Shoe to Cylinder Block Retaining Bolt	23 N·m	17 lb ft
• Secondary Camshaft Drive Chain Tensioner to Cylinder Block Retaining Bolts		
• First Pass	5 N·m	44 lb in
• Final Pass	23 N·m	17 lb ft
Spark Plugs		
Fit New Spark Plug	20 N·m	15 lb ft
Refit Existing Spark Plug	18 N·m	13 lb ft
Starter Motor		
• Starter Motor to Cylinder Block Retaining Bolts	58 N·m	42 lb ft
• Battery Positive Cable to Starter Motor Terminal Retaining Nut	13 N·m	115 lb in
Thermostat Housing to Cylinder Block Retaining Bolts	10 N·m	89 lb in

Throttle Body Bolts to Upper Intake Manifold Retaining Bolts	10 N·m	89 lb in
Transmission		
• Transmission Support to Body Retaining Bolts	58 N·m	43 lb ft
• Shift Selector Linkage Rod to Shift Selector Shaft Retaining Nut	9 N·m	84 lb in
Water Pump		
• Water Pump to Engine Front Cover Retaining Bolts	10 N·m	89 lb in
• Water Pump Pulley to Water Pump Retaining Bolts	10 N·m	89 lb in

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Specifications | **Document ID: 1990913**

Engine Mechanical Specifications

Table 1: LE0
Table 2: LY7
Table 3: LW2

LE0

Application	Specification	
	Metric	English
General		
Engine Type	V-6	
Displacement	3.6 Litres	218 cu in
RPO	LE0	
Engine Performance	180 kW 330 N·m	241 hp 243. lb ft
Bore	94 mm	3.700 in
Stroke	85.6 mm	3.370 in
Compression Ratio	10.2:1	
Cranking RPM - at 40° C (104°F)	80 RPM	
Idle Speed RPM	700	
Firing Order	1-2-3-4-5-6	
Spark Plug Gap	1.1 mm	0.0433 in
Block		
Crankshaft Main Bearing Bore Diameter	72.867-72.881 mm	2.8688-2.8693 in
Cylinder Bore Diameter	94 mm	3.700
Cylinder Bore Out-of-Round - Production Maximum	0.013 mm	0.0005 in
Camshaft		
Camshaft Bearing Inside Diameter - Front Number 1	35.000-35.020 mm	1.3779-1.3787 in
Camshaft Bearing Inside Diameter - Middle and Rear, 2-4	27.000-27.020 mm	1.0630-1.0638 in
Camshaft End Play	0.045-0.215 mm	0.0018-0.0085 in
Camshaft Journal Diameter - Front, 1	34.936-34.960 mm	1.3754-1.3764 in
Camshaft Journal Diameter - Middle and Rear, 2-4	26.936-26.960 mm	1.0605-1.0614 in
Camshaft Journal Out-of-Round	0.006 mm	0.0002 in
Camshaft Journal to Bore Clearance	0.040-0.084 mm	0.0016-0.0033 in
Camshaft Lobe Duration - Exhaust @ 0.150 mm	238 degrees	

(0.0059 in) Lift		
Camshaft Lobe Duration - Intake @ 0.150 mm (0.0059 in) Lift	226 degrees	
Camshaft Lobe Lift - Exhaust	42.456-42.756 mm	1.6715-1.6833 in
Camshaft Lobe Lift - Intake	42.385-42.685 mm	1.6687-1.6805 in
Camshaft Lobe Overlap @ 0.150 mm (0.0059 in) Lift	0 degrees	
Camshaft Runout - Front and Rear, 1 and 4	0.025 mm	0.0010 in
Camshaft Runout - Middle, 2 and 3	0.050 mm	0.0020 in
Camshaft Timing @ 0.15 mm (0.0059 in) Lift		
Valve Opens - Exhaust	-221 degrees BTDC	
Valve Opens - Intake	15 degrees ATDC	
Centerline - Exhaust	103 degrees ATDC	
Centerline - Intake	126 degrees ATDC	
Valve Closes - Exhaust	17 degrees ATDC	
Valve Closes - Intake	239 degrees ATDC	
Valve Lift - Exhaust	10.9 mm	0.429 in
Valve Lift - Intake	10.4 mm	0.409 in
Camshaft Phasing		
Intake	0- -50° Crank (advance)	
Exhaust	N/A	
Cooling System		
Thermostat Full Open Temperature	95°C	203°F
Connecting Rod		
Connecting Rod Bearing Clearance	0.010-0.070 mm	0.0004-0.0028 in
Connecting Rod Bore Diameter - Bearing End	59.620-59.636 mm	2.3472-2.3479 in
Connecting Rod Bore Diameter - Pin End	24.007-24.021 mm	0.9452-0.9457 in
Connecting Rod Length - Center to Center	150.400 mm	5.921
Connecting Rod Side Clearance	0.095-0.355 mm	0.0037-0.0140 in
Connecting Rod Width - Bearing End		
Production	21.775 mm	0.8573 in
Service	21.770-21.780 mm	0.8571-0.8575 in
Connecting Rod Width - Pin End		
Production	26.000 mm	1.0236 in
Service	25.950-26.050 mm	1.0217-1.0256 in

Crankshaft		
Connecting Rod Journal Diameter	55.992-56.008 mm	2.2044-2.2050 in
Connecting Rod Journal Out-of-Round	0.005 mm	0.0002 in
Connecting Rod Journal Taper	0.005 mm	0.0002 in
Connecting Rod Journal Width		
Production	22.000 mm	0.8661 in
Service	21.920-22.080 mm	0.8630-0.8693 in
Crankshaft End Play	0.100-0.330 mm	0.0039-0.0130 in
Crankshaft Main Bearing Clearance	0.010-0.060 mm	0.0004-0.0024 in
Crankshaft Main Journal Diameter	67.992-68.008 mm	2.676-2.677 in
Crankshaft Main Journal Out-of-Round	0.005 mm	0.0002 in
Crankshaft Main Journal Taper	0.005 mm	0.0002 in
Crankshaft Main Journal Thrust Wall		
Runout	0.000-0.040 mm	0.0000-0.0016 in
Square	0.000-0.010 mm	0.0000-0.0004 in
Crankshaft Main Journal Width, 1, 2, 4		
Production	24.000 mm	0.9449 in
Service	23.900-24.100 mm	0.9409-0.9488 in
Crankshaft Main Journal Width, 3		
Production	24.400 mm	0.9606 in
Service	24.360-24.440 mm	0.9591-0.9622 in
Crankshaft Pilot Bearing Bore Diameter	20.965-20.995 mm	0.8254-0.8266 in
Crankshaft Rear Flange Runout	0.025 mm	0.0010 in
Crankshaft Reluctor Ring Runout - Maximum	0.5 mm	0.0020 in
Crankshaft Runout	0.030 mm	0.0012 in
Crankshaft Thrust Bearing Clearance	0.076-0.305 mm	0.0030-0.0120 in
Crankshaft Thrust Surface - Height Diameter	95.000 mm	3.7401 in
Crankshaft Thrust Surface Runout	0.040 mm	0.0016 in
Cylinder Head		
Combustion Chamber Volume	54.5 cc	3.325 cu in
Valve Guide Bore - Exhaust	6.005-6.025 mm	0.2362-0.2370 in
		0.2362-

Valve Guide Bore - Intake	6.005-6.025 mm	0.2370 in
Valve Guide Installed Height	14.050-14.550 mm	0.5531-0.5728 in
Valve Lifter Bore Diameter	12.008-12.030 mm	0.4728-0.4736 in
Lubrication System		
Oil Capacity - With Oil and Oil Filter Change	6.7 Liters	5.9 Quarts
Oil Pressure - Minimum @ Idle	74 kPa	10 psi
Oil Pressure - Minimum @ 2,000 RPM	377 kPa	54 psi
Piston Cooling Jet Valve Opening Pressure	1.8-2.2 bar	26-32 psi
Oil Pump		
Gear Diameter - Outer	87.095-87.175 mm	3.4289-3.4321 in
Gear Pocket - Depth	15.565-15.600 mm	0.6128-0.6142 in
Gear Pocket - Diameter	87.275-87.325 mm	3.4360-3.4380 in
Gear Thickness - Drive/Driven	15.511-15.536 mm	0.6107-0.6117 in
Gear-to-Cover Clearance - Drive/Driven	0.030-0.085 mm	0.0012-0.0033 in
Gear-to-Housing Clearance - Drive/Driven	0.100-0.230 mm	0.0039-0.0091 in
Inner Gear Tip Clearance	0.075-0.180 mm	0.0030-0.0071 in
Crankshaft Clearance to Housing	0.040-0.130 mm	0.0016-0.0051 in
Inner Gerotor Hub Diameter	53.310-53.335 mm	2.0988-2.0998 in
Housing Hub Diameter	53.380-53.420 mm	2.1016-2.1031 in
Inner Gerotor Hub Clearance to Housing	0.045-0.110 mm	0.0018-0.0043 in
Piston Ring End Gap		
First Compression Ring	0.150-0.300 mm	0.0059-0.0118 in
Second Compression Ring	0.280-0.480 mm	0.0110-0.0189 in
Oil Control Ring	0.150-0.600 mm	0.0059-0.0236 in
Piston Ring to Groove Clearance		
First Compression Ring	0.030-0.065 mm	0.0012-0.0026 in
Second Compression Ring	0.015-0.060 mm	0.0006-0.0024 in

Oil Control Ring	0.030-0.170 mm	0.0012-0.0669 in
Piston Ring Thickness		
First Compression Ring	1.175-1.190 mm	0.0463-0.0469 in
Second Compression Ring	1.470-1.495 mm	0.0579-0.0589 in
Oil Control Ring	2.360-2.480 mm	0.0929-0.0976 in
Pistons and Pins		
Piston Diameter	93.956-93.974 mm	3.5022-3.5029 in
Piston Pin Bore Diameter	24.005-24.009 mm	0.9452-0.9454 in
Piston Ring Groove Width - First Compression Ring	1.220-1.240 mm	0.0480-0.0488 in
Piston Ring Groove Width - Second Compression Ring	1.510-1.530 mm	0.0595-0.0602 in
Piston Ring Groove Width - Oil Control Ring	2.510-2.530 mm	0.0988-0.0996 in
Piston to Bore Clearance	0.026-0.052 mm	0.0008-0.0013 in
Pin		
Piston Pin Clearance to Connecting Rod Bore	0.007-0.024 mm	0.0003-0.0010 in
Piston Pin Clearance to Piston Pin Bore	0.004-0.015 mm	0.0003-0.0006 in
Piston Pin Diameter	23.997-24.000 mm	0.9448-0.9449 in
Piston Pin Length	60.6004-61.100 mm	2.5685-2.5882 in
Valve System		
Valve Face Angle	44.25 degrees	
Valve Face Runout	0.038 mm	0.0015 in
Valve Face Width - Exhaust	2.750 mm	0.1083 in
Valve Face Width - Intake	2.180 mm	0.0858 in
Valve Head Diameter- Exhaust	30.470-30.730 mm	1.199-1.209 in
Valve Head Diameter- Inlet	36.830-37.090 mm	1.45-1.46 mm
Valve Installed Height	35.26-36.69 mm	1.3870-1.4445 in
Valve Length - Exhaust	97.11 mm	3.8232 in
Valve Length - Intake	101.23 mm	3.9854 in
Valve Seat Angle - Seating Surface	45 degrees	

Valve Seat Angle - Relief Surface	30 degrees	
Valve Seat Angle - Undercut Surface	60 degrees	
Valve Seat Runout - Maximum	0.080 mm	0.0031 in
Valve Seat Width - Exhaust Seating Surface	1.400-1.800 mm	0.0551-0.0709 in
Valve Seat Width - Intake Seating Surface	1.000-1.400 mm	0.0394-0.0551 in
Valve Stem Diameter - Exhaust	5.955-5.975 mm	0.2344-0.2352 in
Valve Stem Diameter - Intake	5.955-5.975 mm	0.2344-0.2352 in
Valve Stem-to-Guide Clearance - Exhaust	0.040-0.08 mm	0.0014-0.0030 in
Valve Stem-to-Guide Clearance - Intake	0.030-0.070 mm	0.0010-0.0026 in
Valve Lifter Diameter	11.986-12.000 mm	0.4720-0.4724 in
Valve Lifter-to-Bore Clearance	0.037-0.041 mm	0.0015-0.0016 in
Rocker Arms		
Valve Rocker Arm Ratio	1.68 to 1	
Valve Rocker Arm Roller Diameter	17.740-17.800 mm	0.6987-0.7008 in
Valve Springs		
Valve Spring Coil Thickness	3.250 x 3.900 mm	0.1280 x 0.1535 in
Valve Spring Diameter - Inside Top	12.200-12.700 mm	0.4760-0.4957 in
Valve Spring Diameter - Outside Top	18.00-18.450 mm	0.7087-0.7264 in
Valve Spring Diameter - Inside Bottom	17.950-20.500 mm	0.7067-0.8071 in
Valve Spring Diameter - Outside Bottom	26.000 mm	1.0236 in
Valve Spring Free Length	42.500-45.500 mm	1.6555-1.7657 in
Valve Spring Installed Height - Closed	35.000 mm	1.3779 in
Valve Spring Installed Height - Open	24.000 mm	0.9449 in
Valve Spring Load - Closed	247-273 N	56-61 lb
Valve Spring Load - Open	598-662 N	134-149 lb
Valve Spring Total Number of Coils	7.1	

LY7

Application	Specification	
	Metric	English
General		

Engine Type	V-6	
Displacement	3.6 Litres	218 cu in
RPO	LY7	
Engine Performance	195 kW 340 N·m	261 hp 250 lb ft
Bore	94 mm	3.700 in
Stroke	85.6 mm	3.370 in
Compression Ratio	10.2:1	
Cranking RPM - at 40° C (104°F)	80 RPM	
Idle Speed RPM	700 A/C Off - 700 A/C On	
Firing Order	1-2-3-4-5-6	
Spark Plug Gap	1.1 mm	0.0433 in
Block		
Crankshaft Main Bearing Bore Diameter	72.867-72.881 mm	2.8688-2.8693 in
Cylinder Bore Diameter	94 mm	3.700
Cylinder Bore Out-of-Round - Production Max.	0.013 mm	0.0005 in
Camshaft		
Camshaft Bearing Inside Diameter - Front Number 1	35.000-35.020 mm	1.3779-1.3787 in
Camshaft Bearing Inside Diameter - Middle and Rear Number 2-4	27.000-27.020 mm	1.0630-1.0638 in
Camshaft End Play	0.045-0.215 mm	0.0018-0.0085 in
Camshaft Journal Diameter - Front, 1	34.936-34.960 mm	1.3754-1.3764 in
Camshaft Journal Diameter - Middle and Rear, 2-4	26.936-26.960 mm	1.0605-1.0614 in
Camshaft Journal Out-of-Round	0.006 mm	0.0002 in
Camshaft Journal to Bore Clearance	0.040-0.084 mm	0.0016-0.0033 in
Camshaft Lobe Duration - Exhaust @ 0.150 mm (0.0059 in) Lift	238 degrees	
Camshaft Lobe Duration - Intake @ 0.150 mm (0.0059 in) Lift	226 degrees	
Camshaft Lobe Lift - Exhaust	42.456-42.756 mm	1.6715-1.6833 in
Camshaft Lobe Lift - Intake	42.385-42.685 mm	1.6687-1.6805 in
Camshaft Lobe Overlap @ 0.150 mm (0.0059 in) Lift	0 degrees	
Camshaft Runout - Front and Rear, 1 and 4	0.025 mm	0.0010 in
Camshaft Runout - Middle 2 and 3	0.050 mm	0.0020 in
Camshaft Timing @ 0.15 mm (0.0059 in) Lift		
Valve Opens - Exhaust	229 degrees BTDC	

Valve Opens - Intake	14 degrees ATDC	
Centerline - Exhaust	111 degrees ATDC	
Centerline - Intake	132 degrees ATDC	
Valve Closes - Exhaust	9 degrees ATDC	
Valve Closes - Intake	252 degrees ATDC	
Valve Lift - Exhaust	10.9 mm	0.429 in
Valve Lift - Intake	10.4 mm	0.409 in
Camshaft Phasing		
Intake	0- -50° Crank (advance)	
Exhaust	0- +50° Crank (retard)	
Cooling System		
Thermostat Full Open Temperature	95°C	203°F
Connecting Rod		
Connecting Rod Bearing Clearance	0.010-0.070 mm	0.0004-0.0028 in
Connecting Rod Bore Diameter - Bearing End	59.620-59.636 mm	2.3472-2.3479 in
Connecting Rod Bore Diameter - Pin End	24.007-24.021 mm	0.9452-0.9457 in
Connecting Rod Length - Center to Center	150.400 mm	5.921
Connecting Rod Side Clearance	0.095-0.355 mm	0.0037-0.0140 in
Connecting Rod Width - Bearing End		
Production	21.775 mm	0.8573 in
Service	21.770-21.780 mm	0.8571-0.8575 in
Connecting Rod Width - Pin End		
Production	26.000 mm	1.0236 in
Service	25.950-26.050 mm	1.0217-1.0256 in
Crankshaft		
Connecting Rod Journal Diameter	55.992-56.008 mm	2.2044-2.2050 in
Connecting Rod Journal Out-of-Round	0.005 mm	0.0002 in
Connecting Rod Journal Taper	0.005 mm	0.0002 in
Connecting Rod Journal Width		
Production	22.000 mm	0.8661 in
Service	21.920-22.080 mm	0.8630-0.8693 in
Crankshaft End Play	0.100-0.330 mm	0.0039-0.0130 in
Crankshaft Main Bearing Clearance	0.010-0.060 mm	0.0004-0.0024 in

Crankshaft Main Journal Diameter	67.992-68.008 mm	2.676-2.677 in
Crankshaft Main Journal Out-of-Round	0.005 mm	0.0002 in
Crankshaft Main Journal Taper	0.005 mm	0.0002 in
Crankshaft Main Journal Thrust Wall		
Runout	0.000-0.040 mm	0.0000-0.0016 in
Square	0.000-0.010 mm	0.0000-0.0004 in
Crankshaft Main Journal Width, #1, 2, 4		
Production	24.000 mm	0.9449 in
Service	23.900-24.100 mm	0.9409-0.9488 in
Crankshaft Main Journal Width, #3		
Production	24.400 mm	0.9606 in
Service	24.360-24.440 mm	0.9591-0.9622 in
Crankshaft Pilot Bearing Bore Diameter	20.965-20.995 mm	0.8254-0.8266 in
Crankshaft Rear Flange Runout	0.025 mm	0.0010 in
Crankshaft Reluctor Ring Runout - Maximum	0.5 mm	0.0020 in
Crankshaft Runout	0.030 mm	0.0012 in
Crankshaft Thrust Bearing Clearance	0.076-0.305 mm	0.0030-0.0120 in
Crankshaft Thrust Surface - Height Diameter	95.000 mm	3.7401 in
Crankshaft Thrust Surface Runout	0.040 mm	0.0016 in
Cylinder Head		
Combustion Chamber Volume	54.5 cc	3.325 cu in
Valve Guide Bore - Exhaust	6.005-6.025 mm	0.2362-0.2370 in
Valve Guide Bore - Intake	6.005-6.025 mm	0.2362-0.2370 in
Valve Guide Installed Height	14.050-14.550 mm	0.5531-0.5728 in
Valve Lifter Bore Diameter	12.008-12.030 mm	0.4728-0.4736 in
Lubrication System		
Oil Capacity - With Oil and Oil Filter Change	6.7 Liters	5.9 Quarts
Oil Pressure - Minimum @ Idle	74 kPa	10 psi
Oil Pressure - Minimum @ 2,000 RPM	377 kPa	54 psi
Piston Cooling Jet Valve Opening Pressure	1.8-2.2 bar	26-32 psi
Oil Pump		
Gear Diameter - Outer	87.095-87.175 mm	3.4289-3.4321 in

Gear Pocket - Depth	15.565-15.600 mm	0.6128-0.6142 in
Gear Pocket - Diameter	87.275-87.325 mm	3.4360-3.4380 in
Gear Thickness - Drive/Driven	15.511-15.536 mm	0.6107-0.6117 in
Gear-to-Cover Clearance - Drive/Driven	0.030-0.085 mm	0.0012-0.0033 in
Gear-to-Housing Clearance - Drive/Driven	0.100-0.230 mm	0.0039-0.0091 in
Inner Gear Tip Clearance	0.075-0.180 mm	0.0030-0.0071 in
Crankshaft Clearance to Housing	0.040-0.130 mm	0.0016-0.0051 in
Inner Gerotor Hub Diameter	53.310-53.335 mm	2.0988-2.0998 in
Housing Hub Diameter	53.380-53.420 mm	2.1016-2.1031 in
Inner Gerotor Hub Clearance to Housing	0.045-0.110 mm	0.0018-0.0043 in
Piston Ring End Gap		
First Compression Ring	0.150-0.300 mm	0.0059-0.0118 in
Second Compression Ring	0.280-0.480 mm	0.0110-0.0189 in
Oil Control Ring	0.150-0.600 mm	0.0059-0.0236 in
Piston Ring to Groove Clearance		
First Compression Ring	0.030-0.065 mm	0.0012-0.0026 in
Second Compression Ring	0.015-0.060 mm	0.0006-0.0024 in
Oil Control Ring	0.030-0.170 mm	0.0012-0.0669 in
Piston Ring Thickness		
First Compression Ring	1.175-1.190 mm	0.0463-0.0469 in
Second Compression Ring	1.470-1.495 mm	0.0579-0.0589 in
Oil Control Ring	2.360-2.480 mm	0.0929-0.0976 in
Pistons and Pins		
Piston Diameter	93.956-93.974 mm	3.5022-3.5029 in
Piston Pin Bore Diameter	24.005-24.009 mm	0.9452-0.9454 in

Piston Ring Groove Width - First Compression Ring	1.220-1.240 mm	0.0480-0.0488 in
Piston Ring Groove Width - Second Compression Ring	1.510-1.530 mm	0.0595-0.0602 in
Piston Ring Groove Width - Oil Control Ring	2.510-2.530 mm	0.0988-0.0996 in
Piston to Bore Clearance	0.026-0.052 mm	0.0008-0.0013 in
Pin		
Piston Pin Clearance to Connecting Rod Bore	0.007-0.024 mm	0.0003-0.0010 in
Piston Pin Clearance to Piston Pin Bore	0.004-0.015 mm	0.0003-0.0006 in
Piston Pin Diameter	23.997-24.000 mm	0.9448-0.9449 in
Piston Pin Length	60.6004-61.100 mm	2.5685-2.5882 in
Valve System		
Valve Face Angle	44.25 degrees	
Valve Face Runout	0.038 mm	0.0015 in
Valve Face Width - Exhaust	2.750 mm	0.1083 in
Valve Face Width - Intake	2.180 mm	0.0858 in
Valve Head Diameter- Exhaust	30.470-30.730 mm	1.199-1.209 in
Valve Head Diameter- Inlet	36.830-37.090 mm	1.45-1.46 mm
Valve Installed Height	35.26-36.69 mm	1.3870-1.4445 in
Valve Length - Exhaust	97.11 mm	3.8232 in
Valve Length - Intake	101.23 mm	3.9854 in
Valve Seat Angle - Seating Surface	45 degrees	
Valve Seat Angle - Relief Surface	30 degrees	
Valve Seat Angle - Undercut Surface	60 degrees	
Valve Seat Runout - Maximum	0.080 mm	0.0031 in
Valve Seat Width - Exhaust Seating Surface	1.400-1.800 mm	0.0551-0.0709 in
Valve Seat Width - Intake Seating Surface	1.000-1.400 mm	0.0394-0.0551 in
Valve Stem Diameter - Exhaust	5.955-5.975 mm	0.2344-0.2352 in
Valve Stem Diameter - Intake	5.955-5.975 mm	0.2344-0.2352 in
Valve Stem-to-Guide Clearance - Exhaust	0.040-0.08 mm	0.0014-0.0030 in
		0.0010-

Valve Stem-to-Guide Clearance - Intake	0.030-0.070 mm	0.0026 in
Valve Lifter Diameter	11.986-12.000 mm	0.4720-0.4724 in
Valve Lifter-to-Bore Clearance	0.037-0.041 mm	0.0015-0.0016 in
Rocker Arms		
Valve Rocker Arm Ratio	1.68 to 1	
Valve Rocker Arm Roller Diameter	17.740-17.800 mm	0.6987-0.7008 in
Valve Springs		
Valve Spring Coil Thickness	3.250 x 3.900 mm	0.1280 x 0.1535 in
Valve Spring Diameter - Inside Top	12.200-12.700 mm	0.4760-0.4957 in
Valve Spring Diameter - Outside Top	18.00-18.450 mm	0.7087-0.7264 in
Valve Spring Diameter - Inside Bottom	17.950-20.500 mm	0.7067-0.8071 in
Valve Spring Diameter - Outside Bottom	26.000 mm	1.0236 in
Valve Spring Free Length	42.500-45.500 mm	1.6555-1.7657 in
Valve Spring Installed Height - Closed	35.000 mm	1.3779 in
Valve Spring Installed Height - Open	24.000 mm	0.9449 in
Valve Spring Load - Closed	247-273 N	56-61 lb
Valve Spring Load - Open	598-662 N	134-149 lb
Valve Spring Total Number of Coils	7.1	

LW2

Application	Specification	
	Metric	**English**
General		
Engine Type	V-6	
Displacement	3.6 Litres	218 cu in
RPO	LW2	
Engine Performance	175 kW 325 N·m	235 hp 240 lb ft
Bore	94 mm	3.700 in
Stroke	85.6 mm	3.370 in
Compression Ratio	10.2:1	
Cranking RPM - at 40° C (104°F)	80 RPM	
Idle Speed RPM (AT)	600 A/C Off - 600 A/C On	
Firing Order	1-2-3-4-5-6	
Spark Plug Gap	1.1 mm	0.0433 in
Block		

• Crankshaft Main Bearing Bore Diameter	72.867-72.881 mm	2.8688-2.8693 in
• Cylinder Bore Diameter	94 mm	3.700
• Cylinder Bore Out-of-Round - Production Max.	0.013 mm	0.0005 in
Camshaft		
• Camshaft Bearing Inside Diameter - Front, 1	35.000-35.020 mm	1.3779-1.3787 in
• Camshaft Bearing Inside Diameter - Middle and Rear, 2-4	27.000-27.020 mm	1.0630-1.0638 in
• Camshaft End Play	0.045-0.215 mm	0.0018-0.0085 in
• Camshaft Journal Diameter - Front, 1	34.936-34.960 mm	1.3754-1.3764 in
• Camshaft Journal Diameter - Middle and Rear, 2-4	26.936-26.960 mm	1.0605-1.0614 in
• Camshaft Journal Out-of-Round	0.006 mm	0.0002 in
• Camshaft Journal to Bore Clearance	0.040-0.084 mm	0.0016-0.0033 in
• Camshaft Lobe Duration - Exhaust @ 0.150 mm (0.0059 in) Lift	238 degrees	
• Camshaft Lobe Duration - Intake @ 0.150 mm (0.0059 in) Lift	226 degrees	
• Camshaft Lobe Lift - Exhaust	42.456-42.756 mm	1.6715-1.6833 in
• Camshaft Lobe Lift - Intake	42.385-42.685 mm	1.6687-1.6805 in
• Camshaft Lobe Overlap @ 0.150 mm (0.0059 in) Lift	0 degrees	
• Camshaft Runout - Front and Rear, 1 and 4	0.025 mm	0.0010 in
• Camshaft Runout - Middle 2 and 3	0.050 mm	0.0020 in
• Camshaft Timing @ 0.15 mm (0.0059 in) Lift		
• Valve Opens - Exhaust	-221 degrees BTDC	
• Valve Opens - Intake	15 degrees ATDC	
• Centerline - Exhaust	103 degrees ATDC	
• Centerline - Intake	126 degrees ATDC	
• Valve Closes - Exhaust	17 degrees ATDC	
• Valve Closes - Intake	239 degrees ATDC	
• Valve Lift - Exhaust	10.9 mm	0.429 in
• Valve Lift - Intake	10.4 mm	0.409 in
Camshaft Phasing		
Intake	0- -50° Crank (advance)	
Exhaust	N/A	
Cooling System		
• Thermostat Full Open Temperature	95°C	203°F

Connecting Rod		
Connecting Rod Bearing Clearance	0.010-0.070 mm	0.0004-0.0028 in
Connecting Rod Bore Diameter - Bearing End	59.620-59.636 mm	2.3472-2.3479 in
Connecting Rod Bore Diameter - Pin End	24.007-24.021 mm	0.9452-0.9457 in
Connecting Rod Length - Center to Center	150.400 mm	5.921
Connecting Rod Side Clearance	0.095-0.355 mm	0.0037-0.0140 in
Connecting Rod Width - Bearing End		
Production	21.775 mm	0.8573 in
Service	21.770-21.780 mm	0.8571-0.8575 in
Connecting Rod Width - Pin End		
Production	26.000 mm	1.0236 in
Service	25.950-26.050 mm	1.0217-1.0256 in
Crankshaft		
Connecting Rod Journal Diameter	55.992-56.008 mm	2.2044-2.2050 in
Connecting Rod Journal Out-of-Round	0.005 mm	0.0002 in
Connecting Rod Journal Taper	0.005 mm	0.0002 in
Connecting Rod Journal Width		
Production	22.000 mm	0.8661 in
Service	21.920-22.080 mm	0.8630-0.8693 in
Crankshaft End Play	0.100-0.330 mm	0.0039-0.0130 in
Crankshaft Main Bearing Clearance	0.010-0.060 mm	0.0004-0.0024 in
Crankshaft Main Journal Diameter	67.992-68.008 mm	2.676-2.677 in
Crankshaft Main Journal Out-of-Round	0.005 mm	0.0002 in
Crankshaft Main Journal Taper	0.005 mm	0.0002 in
Crankshaft Main Journal Thrust Wall		
Runout	0.000-0.040 mm	0.0000-0.0016 in
Square	0.000-0.010 mm	0.0000-0.0004 in
Crankshaft Main Journal Width, #1, 2, 4		
Production	24.000 mm	0.9449 in
Service	23.900-24.100 mm	0.9409-0.9488 in

Crankshaft Main Journal Width, #3		
Production	24.400 mm	0.9606 in
Service	24.360-24.440 mm	0.9591-0.9622 in
Crankshaft Pilot Bearing Bore Diameter	20.965-20.995 mm	0.8254-0.8266 in
Crankshaft Rear Flange Runout	0.025 mm	0.0010 in
Crankshaft Reluctor Ring Runout - Maximum	0.5 mm	0.0020 in
Crankshaft Runout	0.030 mm	0.0012 in
Crankshaft Thrust Bearing Clearance	0.076-0.305 mm	0.0030-0.0120 in
Crankshaft Thrust Surface - Height Diameter	95.000 mm	3.7401 in
Crankshaft Thrust Surface Runout	0.040 mm	0.0016 in
Cylinder Head		
Combustion Chamber Volume	54.5 cc	3.325 cu in
Valve Guide Bore - Exhaust	6.005-6.025 mm	0.2362-0.2370 in
Valve Guide Bore - Intake	6.005-6.025 mm	0.2362-0.2370 in
Valve Guide Installed Height	14.050-14.550 mm	0.5531-0.5728 in
Valve Lifter Bore Diameter	12.008-12.030 mm	0.4728-0.4736 in
Lubrication System		
Oil Capacity - With Oil and Oil Filter Change	6.7 Liters	5.9 Quarts
Oil Pressure - Minimum @ Idle	74 kPa	10 psi
Oil Pressure - Minimum @ 2,000 RPM	377 kPa	54 psi
Piston Cooling Jet Valve Opening Pressure	1.8-2.2 bar	26-32 psi
Oil Pump		
Gear Diameter - Outer	87.095-87.175 mm	3.4289-3.4321 in
Gear Pocket - Depth	15.565-15.600 mm	0.6128-0.6142 in
Gear Pocket - Diameter	87.275-87.325 mm	3.4360-3.4380 in
Gear Thickness - Drive/Driven	15.511-15.536 mm	0.6107-0.6117 in
Gear-to-Cover Clearance - Drive/Driven	0.030-0.085 mm	0.0012-0.0033 in
Gear-to-Housing Clearance - Drive/Driven	0.100-0.230 mm	0.0039-0.0091 in
Inner Gear Tip Clearance	0.075-0.180 mm	0.0030-0.0071 in
Crankshaft Clearance to Housing	0.040-0.130 mm	0.0016-

		0.0051 in
Inner Gerotor Hub Diameter	53.310-53.335 mm	2.0988-2.0998 in
Housing Hub Diameter	53.380-53.420 mm	2.1016-2.1031 in
Inner Gerotor Hub Clearance to Housing	0.045-0.110 mm	0.0018-0.0043 in
Piston Ring End Gap		
First Compression Ring	0.150-0.300 mm	0.0059-0.0118 in
Second Compression Ring	0.280-0.480 mm	0.0110-0.0189 in
Oil Control Ring	0.150-0.600 mm	0.0059-0.0236 in
Piston Ring to Groove Clearance		
First Compression Ring	0.030-0.065 mm	0.0012-0.0026 in
Second Compression Ring	0.015-0.060 mm	0.0006-0.0024 in
Oil Control Ring	0.030-0.170 mm	0.0012-0.0669 in
Piston Ring Thickness		
First Compression Ring	1.175-1.190 mm	0.0463-0.0469 in
Second Compression Ring	1.470-1.495 mm	0.0579-0.0589 in
Oil Control Ring	2.360-2.480 mm	0.0929-0.0976 in
Pistons and Pins		
Piston Diameter	93.956-93.974 mm	3.5022-3.5029 in
Piston Pin Bore Diameter	24.005-24.009 mm	0.9452-0.9454 in
Piston Ring Groove Width - First Compression Ring	1.220-1.240 mm	0.0480-0.0488 in
Piston Ring Groove Width - Second Compression Ring	1.510-1.530 mm	0.0595-0.0602 in
Piston Ring Groove Width - Oil Control Ring	2.510-2.530 mm	0.0988-0.0996 in
Piston to Bore Clearance	0.026-0.052 mm	0.0008-0.0013 in
Pin		
Piston Pin Clearance to Connecting Rod Bore	0.007-0.024 mm	0.0003-0.0010 in
Piston Pin Clearance to Piston Pin Bore	0.004-0.015 mm	0.0003-0.0006 in

Piston Pin Diameter	23.997-24.000 mm	0.9448-0.9449 in
Piston Pin Length	60.6004-61.100 mm	2.5685-2.5882 in
Valve System		
Valve Face Angle	44.25 degrees	
Valve Face Runout	0.038 mm	0.0015 in
Valve Face Width - Exhaust	2.750 mm	0.1083 in
Valve Face Width - Intake	2.180 mm	0.0858 in
Valve Head Diameter- Exhaust	30.470-30.730 mm	1.199-1.209 in
Valve Head Diameter- Inlet	36.830-37.090 mm	1.45-1.46 mm
Valve Installed Height	35.26-36.69 mm	1.3870-1.4445 in
Valve Length - Exhaust	97.11 mm	3.8232 in
Valve Length - Intake	101.23 mm	3.9854 in
Valve Seat Angle - Seating Surface	45 degrees	
Valve Seat Angle - Relief Surface	30 degrees	
Valve Seat Angle - Undercut Surface	60 degrees	
Valve Seat Runout - Maximum	0.080 mm	0.0031 in
Valve Seat Width - Exhaust Seating Surface	1.400-1.800 mm	0.0551-0.0709 in
Valve Seat Width - Intake Seating Surface	1.000-1.400 mm	0.0394-0.0551 in
Valve Stem Diameter - Exhaust	5.955-5.975 mm	0.2344-0.2352 in
Valve Stem Diameter - Intake	5.955-5.975 mm	0.2344-0.2352 in
Valve Stem-to-Guide Clearance - Exhaust	0.040-0.08 mm	0.0014-0.0030 in
Valve Stem-to-Guide Clearance - Intake	0.030-0.070 mm	0.0010-0.0026 in
Valve Lifter Diameter	11.986-12.000 mm	0.4720-0.4724 in
Valve Lifter-to-Bore Clearance	0.037-0.041 mm	0.0015-0.0016 in
Rocker Arms		
Valve Rocker Arm Ratio	1.68 to 1	
Valve Rocker Arm Roller Diameter	17.740-17.800 mm	0.6987-0.7008 in
Valve Springs		
Valve Spring Coil Thickness	3.250 x 3.900 mm	0.1280 x 0.1535 in

• Valve Spring Diameter - Inside Top	12.200-12.700 mm	0.4760-0.4957 in
• Valve Spring Diameter - Outside Top	18.00-18.450 mm	0.7087-0.7264 in
• Valve Spring Diameter - Inside Bottom	17.950-20.500 mm	0.7067-0.8071 in
• Valve Spring Diameter - Outside Bottom	26.000 mm	1.0236 in
• Valve Spring Free Length	42.500-45.500 mm	1.6555-1.7657 in
• Valve Spring Installed Height - Closed	35.000 mm	1.3779 in
• Valve Spring Installed Height - Open	24.000 mm	0.9449 in
• Valve Spring Load - Closed	247-273 N	56-61 lb
• Valve Spring Load - Open	598-662 N	134-149 lb
• Valve Spring Total Number of Coils	7.1	

2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Specifications | **Document ID: 1998042**

Engine Mechanical Specifications (LLT)

Application	Specification	
	Metric	**English**
General		
• Engine Type	V-6	
• Displacement	3.6 Liter	217 cu in
• RPO	LLT	
• VIN	V	
• Bore	94 mm	3.7008 in
• Stroke	85.6 mm	3.37 in
• Compression Ratio	11.4:1	
• Cranking RPM - at 40° C (104°F)	80 RPM	
• Idle Speed	600 A/C Off - 700 A/C On	
• Firing Order	1-2-3-4-5-6	
• Spark Plug Gap	1.1 mm	0.0433 in
Block		
• Crankshaft Main Bearing Bore Diameter	72.867-72.881 mm	2.8688-2.8693 in
• Cylinder Bore Diameter	93.992-94.008 mm	3.7005-3.7011 in
• Cylinder Bore Out-of-Round - Production Max.	0.013 mm	0.0005 in
Camshaft		
• Camshaft Bearing Inside Diameter - Front Number 1	35.000-35.020 mm	1.3779-1.3787 in
• Camshaft Bearing Inside Diameter - Middle and Rear Number 2-4	27.000-27.020 mm	1.0630-1.0638 in
• Camshaft End Play	0.045-0.215 mm	0.0018-0.0085 in
• Camshaft Journal Diameter - Front Number 1	34.936-34.960 mm	1.3754-1.3764 in
• Camshaft Journal Diameter - Middle and Rear Number 2-4	26.936-26.960 mm	1.0605-1.0614 in
• Camshaft Journal Out-of-Round	0.006 mm	0.0002 in
• Camshaft Journal to Bore Clearance	0.040-0.084 mm	0.0016-0.0033 in
• Camshaft Lobe Duration - Exhaust @ 0.150 mm (0.0059 in) Lift	238 degrees	
• Camshaft Lobe Duration - Intake @ 0.150 mm (0.0059 in) Lift	237 degrees	
• Camshaft Lobe Lift - Exhaust	42.425-42.725 mm	1.6703-1.6821 in

Camshaft Lobe Lift - Intake	42.385-42.685 mm	1.6687-1.6805 in
Camshaft Lobe Overlap @ 0.150 mm (0.0059 in) Lift	0 degrees	
Camshaft Runout - Front and Rear Number 1 and 4	0.025 mm	0.0010 in
Camshaft Runout - Middle 2 and 3	0.050 mm	0.0020 in
Camshaft Timing @ 0.15 mm (0.0059 in) Lift		
Valve Opens - Exhaust	-229 degrees BTDC	
Valve Opens - Intake	14 degrees ATDC	
Centerline - Exhaust	111 degrees ATDC	
Centerline - Intake	132 degrees ATDC	
Valve Closes - Exhaust	9 degrees ATDC	
Valve Closes - Intake	251 degrees ATDC	
Valve Lift - Exhaust	10.8 mm	0.4252 in
Valve Lift - Intake	10.8 mm	0.4252 in
Cooling System		
Thermostat Full Open Temperature	95°C	203°F
Connecting Rod		
Connecting Rod Bearing Clearance	0.010-0.070 mm	0.0004-0.0028 in
Connecting Rod Bore Diameter - Bearing End	59.620-59.636 mm	2.3472-2.3479 in
Connecting Rod Bore Diameter - Pin End	24.007-24.021 mm	0.9452-0.9457 in
Connecting Rod Length - Center to Center	150.400 mm	5.9212 in
Connecting Rod Side Clearance	0.095-0.355 mm	0.0374-0.0140 in
Connecting Rod Width - Bearing End		
Production	21.775 mm	0.8573 in
Service	21.725-21.825 mm	0.8553-0.8593 in
Connecting Rod Width - Pin End		
Production	21.775 mm	0.8573 in
Service	21.725-21.825 mm	0.8553-0.8593 in
Crankshaft		
Connecting Rod Journal Diameter	55.992-56.008 mm	2.2044-2.2050 in
Connecting Rod Journal Out-of-Round	0.005 mm	0.0002 in
Connecting Rod Journal Taper	0.005 mm	0.0002 in
Connecting Rod Journal Width		
Production	22.000 mm	0.8661 in

Service	21.920-22.080 mm	0.8630-0.8693 in
Crankshaft End Play	0.100-0.330 mm	0.0039-0.0130 in
Crankshaft Main Bearing Clearance	0.010-0.060 mm	0.0004-0.0024 in
Crankshaft Main Journal Diameter	67.992-68.008 mm	2.6768-2.6775 in
Crankshaft Main Journal Out-of-Round	0.005 mm	0.0002 in
Crankshaft Main Journal Taper	0.005 mm	0.0002 in
Crankshaft Main Journal Thrust Wall		
Runout	0.000-0.040 mm	0.0000-0.0016 in
Square	0.000-0.010 mm	0.0000-0.0004 in
Crankshaft Main Journal Width, #2, 4		
Production	24.000 mm	0.9449 in
Service	23.900-24.100 mm	0.9409-0.9488 in
Crankshaft Main Journal Width, #3		
Production	24.400 mm	0.9606 in
Service	24.360-24.440 mm	0.9591-0.9622 in
Crankshaft Pilot Bearing Bore Diameter	20.965-20.995 mm	0.8254-0.8266 in
Crankshaft Rear Flange Runout	0.025 mm	0.0010 in
Crankshaft Reluctor Ring Runout - Maximum	1.500 mm	0.0591 in
Crankshaft Runout	0.030 mm	0.0012 in
Crankshaft Thrust Bearing Clearance	0.076-0.305 mm	0.0030-0.0120 in
Crankshaft Thrust Surface - Height Diameter	95.000 mm	3.7401 in
Crankshaft Thrust Surface Runout	0.040 mm	0.0016 in
Cylinder Head		
Combustion Chamber Volume	53.6 cc	3.271 cu in
Valve Guide Bore - Exhaust	6.000-6.020 mm	0.2362-0.2370 in
Valve Guide Bore - Intake	6.000-6.020 mm	0.2362-0.2370 in
Valve Guide Installed Height	14.050-14.550 mm	0.5531-0.5728 in
Valve Lifter Bore Diameter	12.008-12.030 mm	0.4728-0.4736 in
Lubrication System		
Oil Capacity - with Filter	5.68 Liters	6 Quarts

l Oil Capacity - without Filter	5.20 Liters	5.5 Quarts
l Oil Pressure - Minimum @ Idle	69 kPa	10 psi
l Oil Pressure - Minimum @ 2,000 RPM	138 kPa	20 psi
l Piston Cooling Jet Valve Opening Pressure	1.7-2.3 bar	25-33 psi
Oil Pump		
l Gear Diameter - Outer	87.095-87.175 mm	3.4289-3.4321 in
l Gear Pocket - Depth	15.565-15.600 mm	0.6128-0.6142 in
l Gear Pocket - Diameter	87.275-87.325 mm	3.4360-3.4380 in
l Gear Thickness - Drive/Driven	15.511-15.536 mm	0.6107-0.6117 in
l Gear-to-Cover Clearance - Drive/Driven	0.030-0.085 mm	0.0012-0.0033 in
l Gear-to-Housing Clearance - Drive/Driven	0.100-0.230 mm	0.0039-0.0091 in
l Inner Gear Tip Clearance	0.075-0.180 mm	0.0030-0.0071 in
l Crankshaft Clearance to Housing	0.040-0.130 mm	0.0016-0.0051 in
l Inner Gerotor Hub Diameter	53.310-53.335 mm	2.0988-2.0998 in
l Housing Hub Diameter	53.380-53.420 mm	2.1016-2.1031 in
l Inner Gerotor Hub Clearance to Housing	0.045-0.110 mm	0.0018-0.0043 in
Piston Rings		
l Piston Ring End Gap		
l First Compression Ring	0.150-0.300 mm	0.0059-0.0118 in
l Second Compression Ring	0.280-0.480 mm	0.0110-0.0189 in
l Oil Control Ring	0.150-0.600 mm	0.0059-0.0236 in
l Piston Ring to Groove Clearance		
l First Compression Ring	0.030-0.065 mm	0.0012-0.0026 in
l Second Compression Ring	0.015-0.060 mm	0.0006-0.0024 in
l Oil Control Ring	0.030-0.170 mm	0.0012-0.0067 in
l Piston Ring Thickness		
l First Compression Ring	1.175-1.190 mm	0.0463-0.0469 in

Second Compression Ring	1.470-1.495 mm	0.0579-0.0589 in
Oil Control Ring	2.360-2.480 mm	0.0929-0.0976 in
Pistons and Pins		
Piston		
Piston Diameter	93.956-93.974 mm	3.6990-3.6998 in
Piston Pin Bore Diameter	24.004-24.009 mm	0.9450-0.9452 in
Piston Ring Groove Width - First Compression Ring	1.220-1.240 mm	0.0480-0.0488 in
Piston Ring Groove Width - Second Compression Ring	1.510-1.530 mm	0.0595-0.0602 in
Piston Ring Groove Width - Oil Control Ring	2.510-2.530 mm	0.0988-0.0996 in
Piston to Bore Clearance	0.026-0.052 mm	0.0010-0.0021 in
Pin		
Piston Pin Clearance to Connecting Rod Bore	0.007-0.024 mm	0.0003-0.0010 in
Piston Pin Clearance to Piston Pin Bore	0.004-0.012 mm	0.0002-0.0005 in
Piston Pin Diameter	23.997-24.000 mm	0.9448-0.9449 in
Piston Pin Length	60.600-61.100 mm	2.3858-2.4055 in
Valve System		
Valves		
Valve Face Angle	44.25 degrees	
Valve Face Runout	0.038 mm	0.0015 in
Valve Face Width - Exhaust	2.750 mm	0.1083 in
Valve Face Width - Intake	2.180 mm	0.0858 in
Valve Head Diameter - Exhaust	30.470-30.730 mm	1.1996-1.2098 in
Valve Head Diameter - Intake	36.830-37.090 mm	1.4500-1.4602 in
Valve Installed Height	35.23-36.69 mm	1.3870-1.4445 in
Valve Length - Exhaust	97.110 mm	3.8232 in
Valve Length - Intake	101.230 mm	3.9854 in
Valve Seat Angle - Seating Surface	45 degrees	
Valve Seat Angle - Relief Surface	30 degrees	
Valve Seat Angle - Undercut Surface	60 degrees	

Valve Seat Roundness- Maximum	0.025 mm	0.0010 in
Valve Seat Runout - Maximum	0.080 mm	0.0032 in
Valve Seat Width - Exhaust Seating Surface	1.400-1.800 mm	0.0551-0.0709 in
Valve Seat Width - Exhaust Relief Surface	0.700-0.900 mm	0.0276-0.0354 in
Valve Seat Width - Intake Seating Surface	1.000-1.400 mm	0.0394-0.0551 in
Valve Seat Width - Intake Relief Surface	0.500-0.700 mm	0.0197-0.0276 in
Valve Stem Diameter - Exhaust	5.945-5.965 mm	0.2341-0.2348 in
Valve Stem Diameter - Intake	5.955-5.975 mm	0.2344-0.2352 in
Valve Stem-to-Guide Clearance - Exhaust	0.035-0.075 mm	0.0014-0.0030 in
Valve Stem-to-Guide Clearance - Intake	0.025-0.065 mm	0.0010-0.0026 in
Valve Lifters - Stationary Hydraulic Lifter Assembly (SHLA)		
Valve Lifter (SHLA) Diameter	12.008-12.030 mm	0.4728-0.4736 in
Valve Lifter (SHLA)-to-Bore Clearance	0.037-0.041 mm	0.0015-0.0016 in
Rocker Arms		
Valve Rocker Arm Ratio	1.68 to 1	
Valve Rocker Arm Roller Diameter	17.750-17.800 mm	0.6988-0.7008 in
Valve Springs		
Valve Spring Coil Thickness	3.250 x 3.900 mm	0.1280 x 0.1535 in
Valve Spring Diameter - Inside Top	12.090-12.590 mm	0.4760-0.4957 in
Valve Spring Diameter - Outside Top	20.140 mm	0.7929 in
Valve Spring Diameter - Inside Bottom	17.950-18.450 mm	0.7067-0.7264 in
Valve Spring Diameter - Outside Bottom	26.000 mm	1.0236 in
Valve Spring Free Length	42.050-44.850 mm	1.6555-1.7657 in
Valve Spring Installed Height - Closed	35.000 mm	1.3779 in
Valve Spring Installed Height - Open	24.000 mm	0.9449 in
Valve Spring Load - Closed	247-273 N	56-61 lb
Valve Spring Load - Open	598-662 N	134-149 lb
Valve Spring Total Number of Coils	7.1	

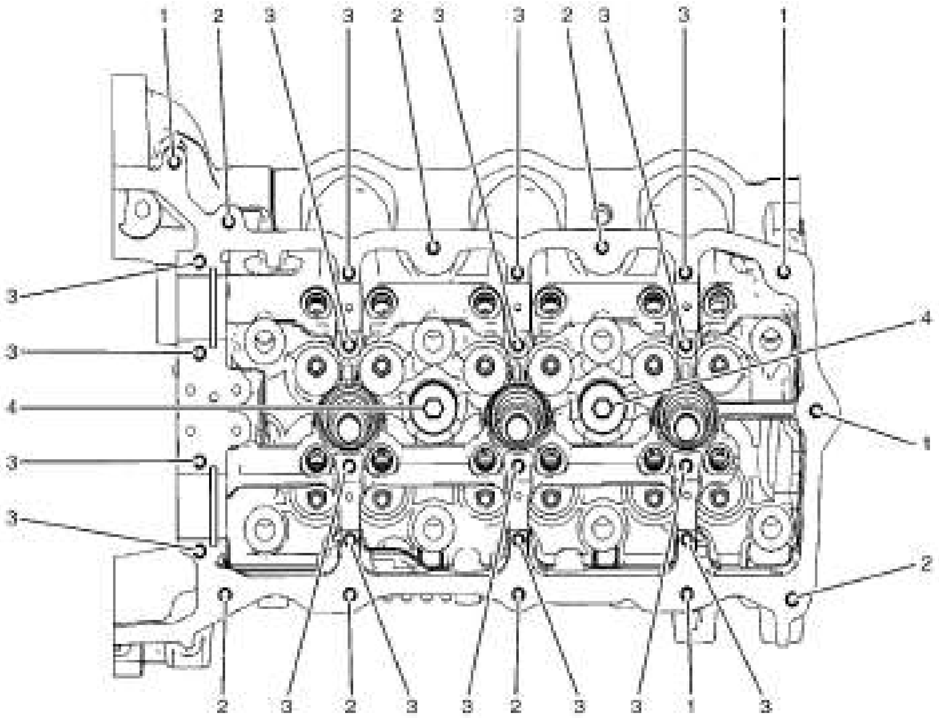
Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material
Coolant and Oil Plug Threads	LOCTITE 242 ™ or equivalent
Oil Pan, Engine Front Cover, Crankshaft Rear Oil Seal Housing, Expansion Plugs	THREEBOND TB1207D™ or equivalent

Thread Repair Specifications

Table 1: Left Cylinder Head Camshaft Cover Face
Table 2: Left Cylinder Head Front Face
Table 3: Left Cylinder Head Intake Face
Table 4: Left Cylinder Head Exhaust Face
Table 5: Left Cylinder Head Rear Face
Table 6: Right Cylinder Head Camshaft Cover Face
Table 7: Right Cylinder Head Front Face
Table 8: Right Cylinder Head Intake Face
Table 9: Right Cylinder Head Exhaust Face
Table 10: Right Cylinder Head Rear Face
Table 11: Engine Block Front
Table 12: Engine Block Left Side
Table 13: Engine Block Right Side
Table 14: Engine Block Rear
Table 15: Engine Block Bottom
Table 16: Engine Block Left Deck Face
Table 17: Engine Block Right Deck Face
Table 18: Engine Front Cover
Table 19: Upper Intake Manifold - Top
Table 20: Upper Intake Manifold - Front
Table 21: Upper Intake Manifold - Rear
Table 22: Lower Intake Manifold - Top
Table 23: Oil Pan Front
Table 24: Oil Pan Left Side
Table 25: Oil Pan Rear
Table 26: Oil Pan Bottom
Table 27: Oil Pan Top

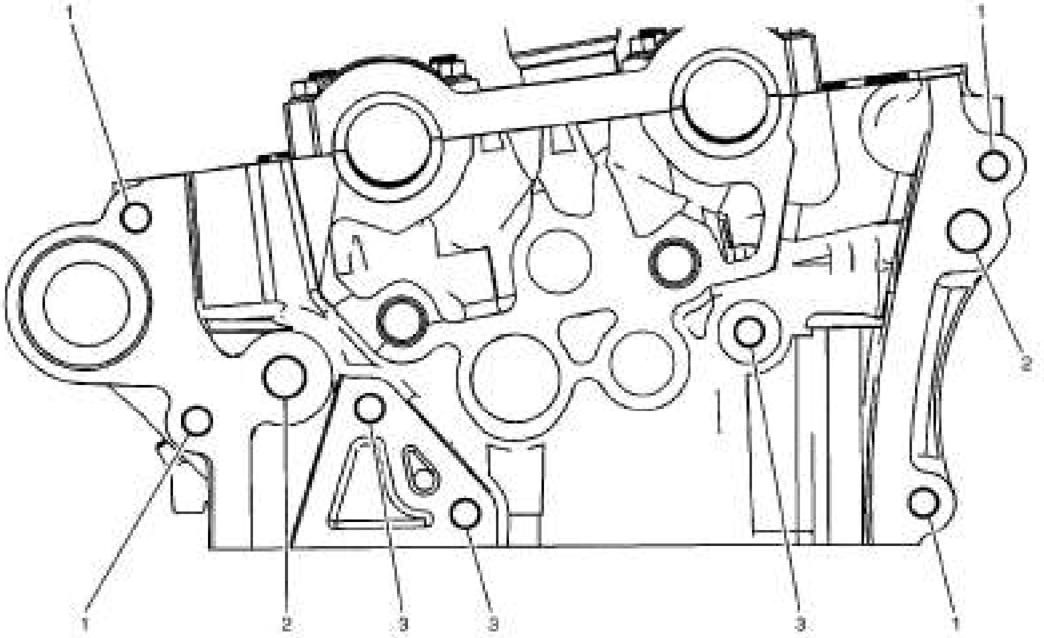
Left Cylinder Head Camshaft Cover Face



Left Cylinder Head Camshaft Cover Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.0	0.7087
2	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	
3	M6 x 1.0	701	N/A	N/A	203	204	205	28.5	1.1220	24.0	0.9449
4	M20 x 1.5	715	716	N/A	717	718	719	25.0	0.9842	17.0	0.6693

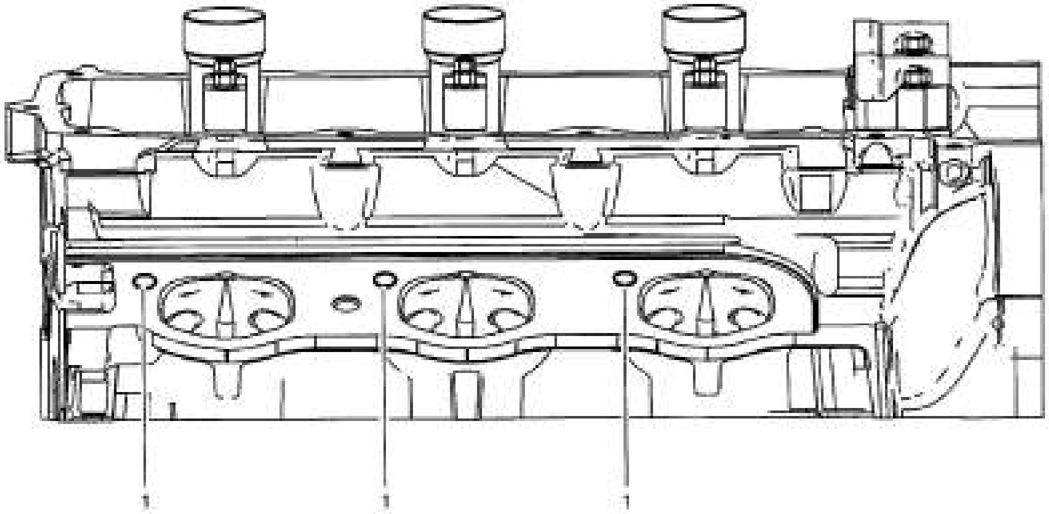
Left Cylinder Head Front Face



Left Cylinder Head Front Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	THRU		THRU	
2	M12 x 1.75	856	857	N/A	858	859	416	40.0	1.5748	32.5	1.2795
3	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.122	23	0.905

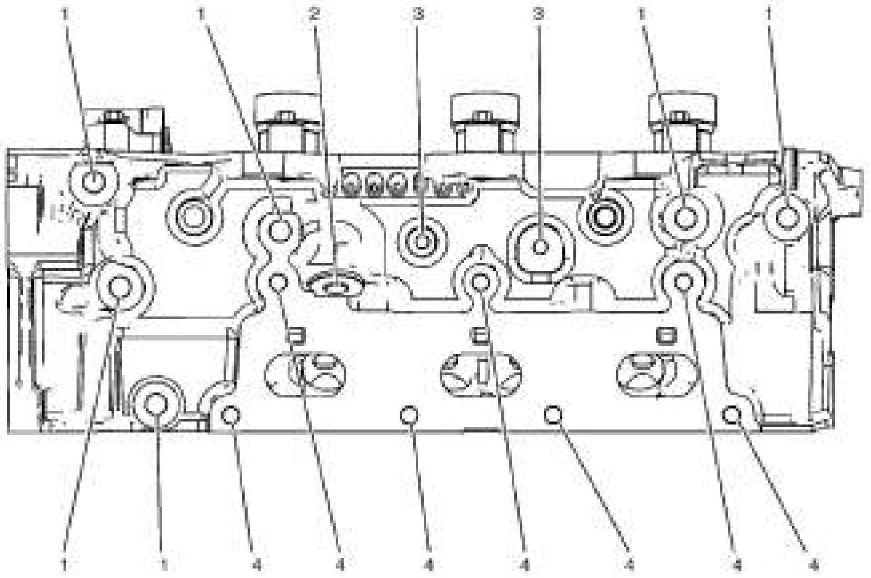
Left Cylinder Head Intake Face



Left Cylinder Head Intake Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055

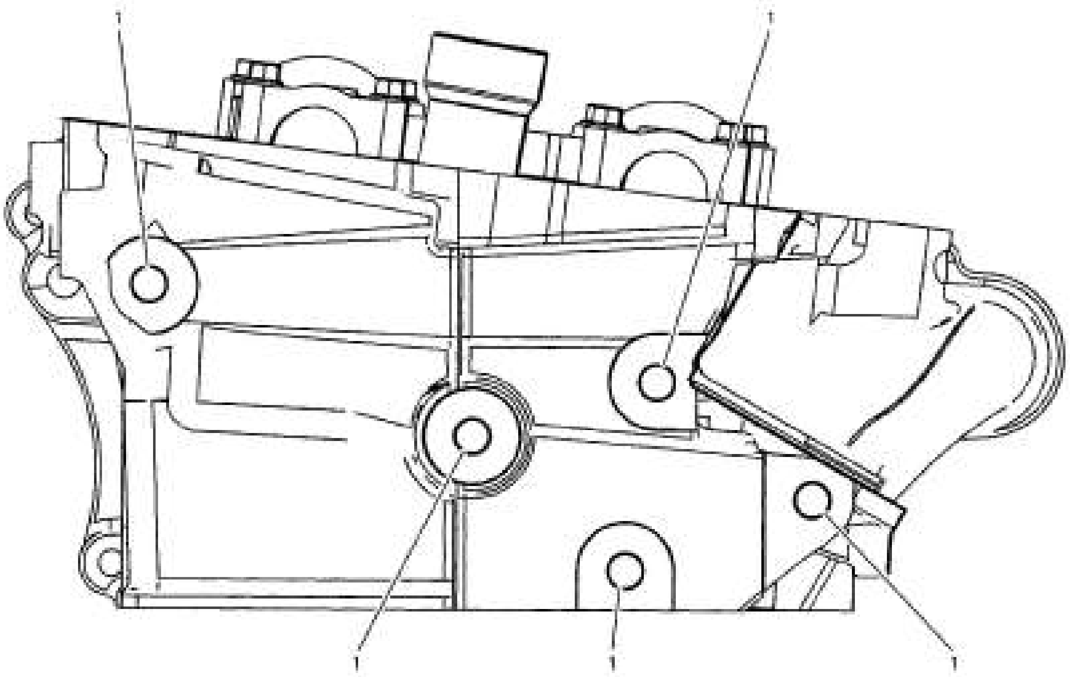
Left Cylinder Head Exhaust Face



Left Cylinder Head Exhaust Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3189	27.0	1.0630
2	M12 x 1.5	705	706	N/A	707	708	709	27.5	1.0827	13.0	0.5118
3	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.0	0.7087
4	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055

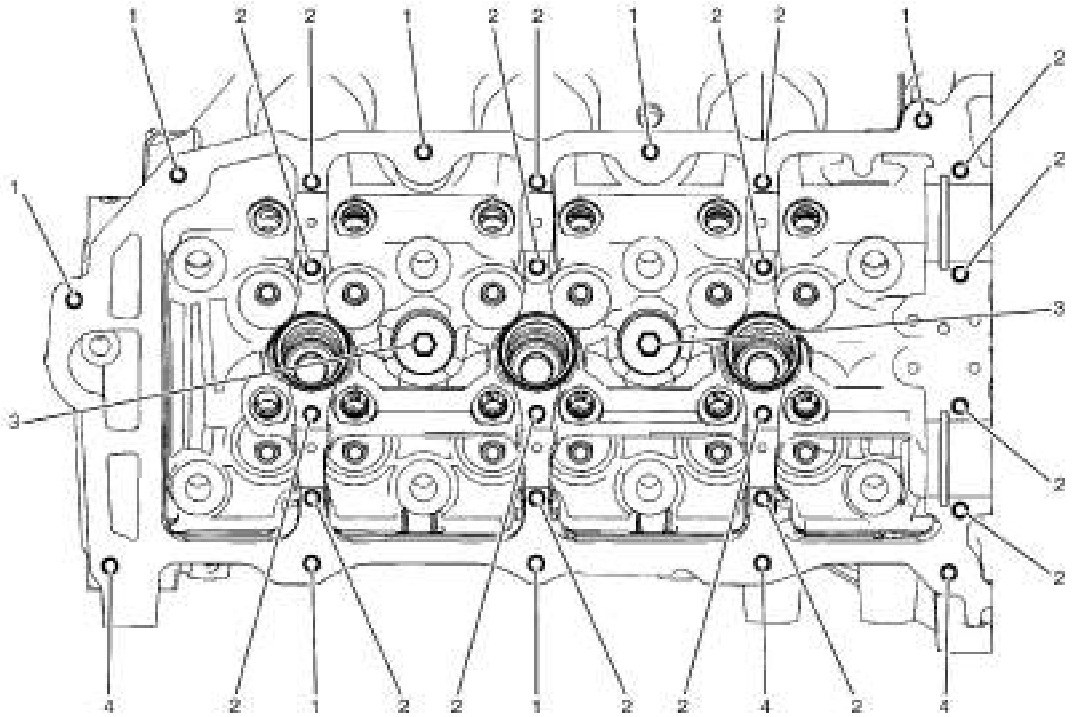
Left Cylinder Head Rear Face



Left Cylinder Head Rear Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3189	27.0	1.0630

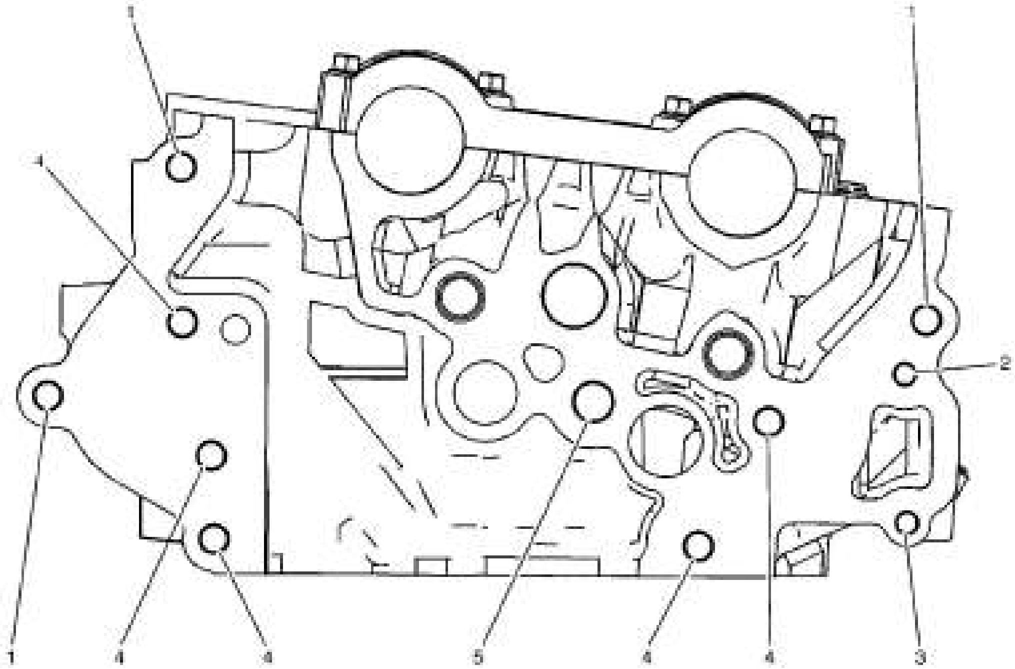
Right Cylinder Head Camshaft Cover Face



Right Cylinder Head Camshaft Cover Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	
2	M6 x 1.0	701	N/A	N/A	203	204	205	28.5	1.1220	24.0	0.9449
3	M20 x 1.5	715	716	N/A	717	718	719	25.0	0.9842	17.0	0.6693
4	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.0	0.7087

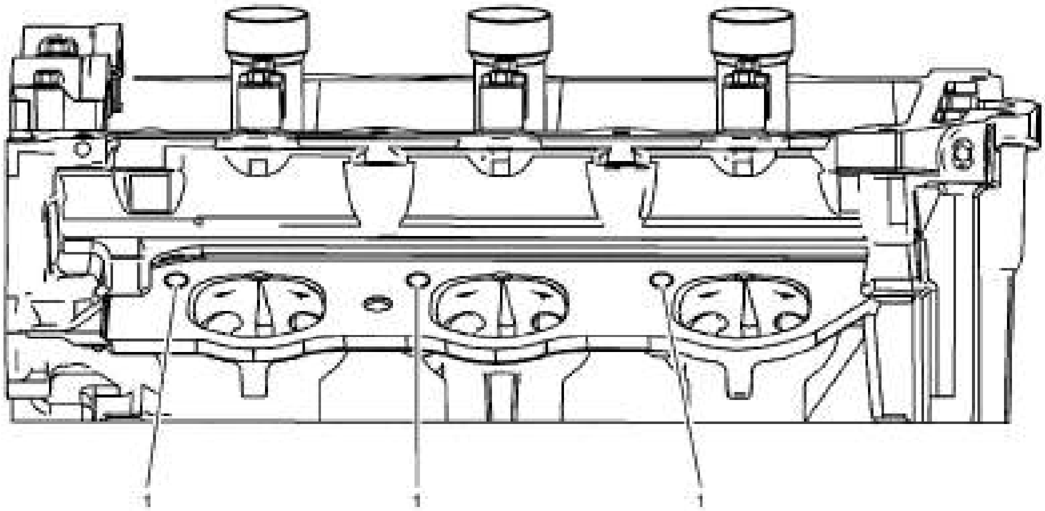
Right Cylinder Head Front Face



Right Cylinder Head Front Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	THRU		THRU	
2	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8880	18.0	0.7087
3	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	
4	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
5	M12 x 1.75	856	857	N/A	858	859	416	40.0	1.5748	32.5	1.2795

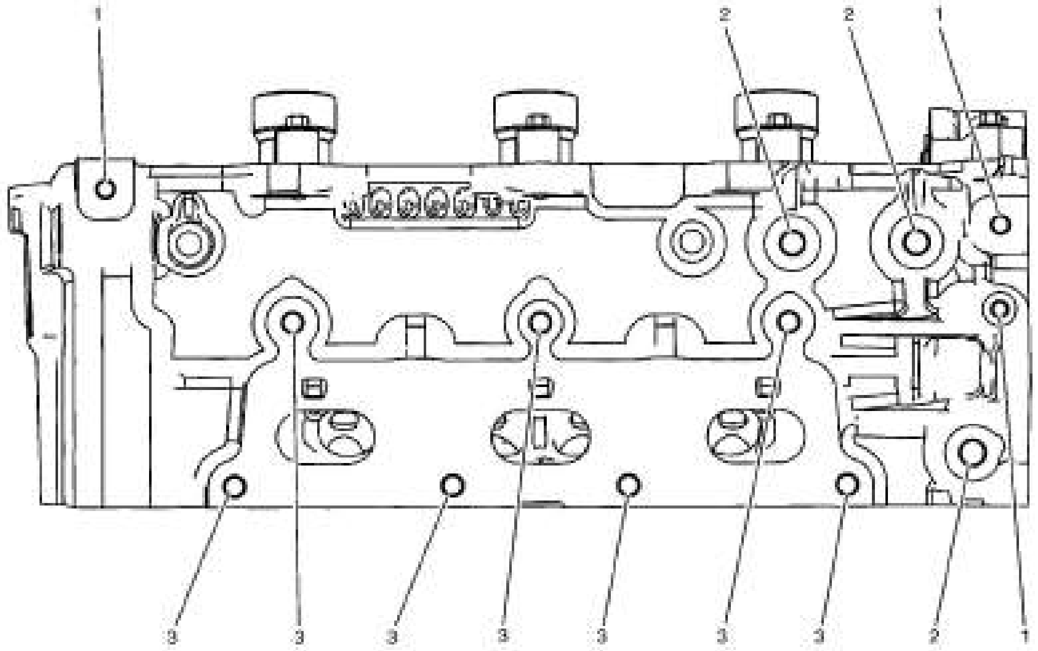
Right Cylinder Head Intake Face



Right Cylinder Head Intake Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055

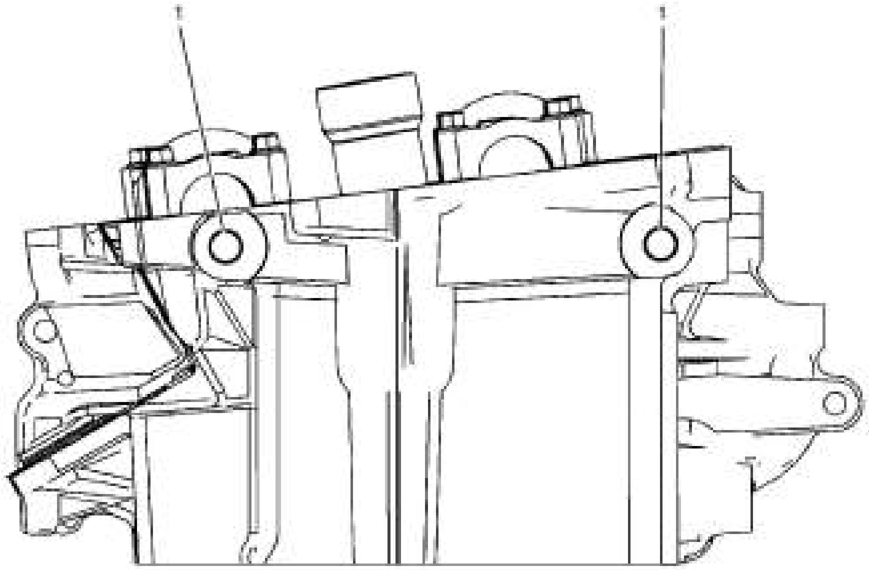
Right Cylinder Head Exhaust Face



Right Cylinder Head Exhaust Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.0	0.7087
2	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3189	27.0	1.0630
3	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055

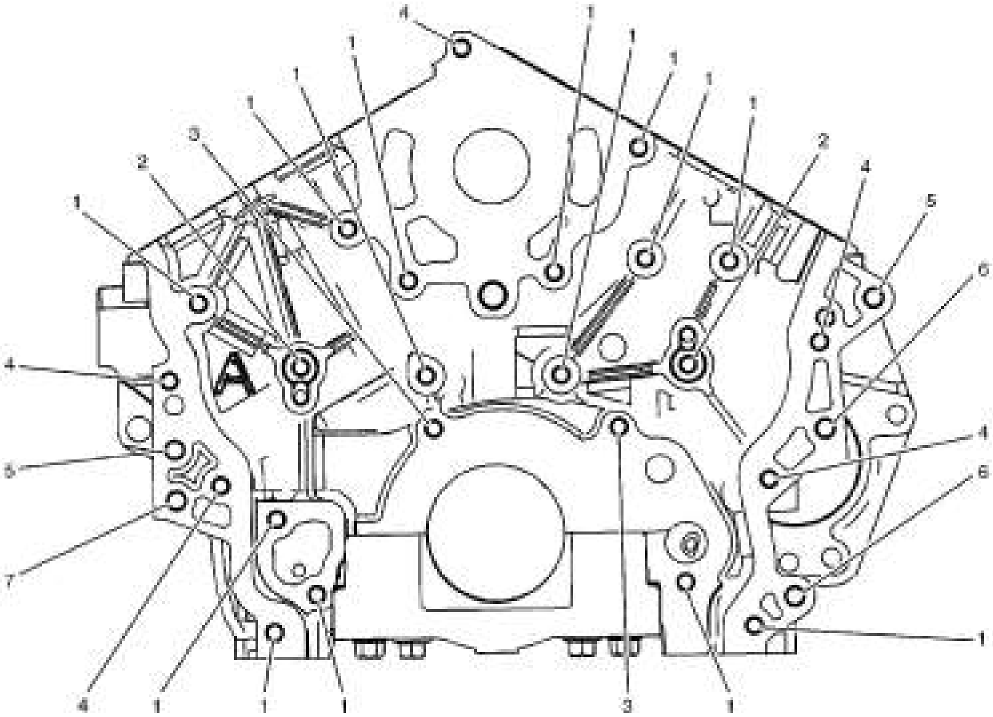
Right Cylinder Head Rear Face



Right Cylinder Head Rear Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3189	27.0	1.0630

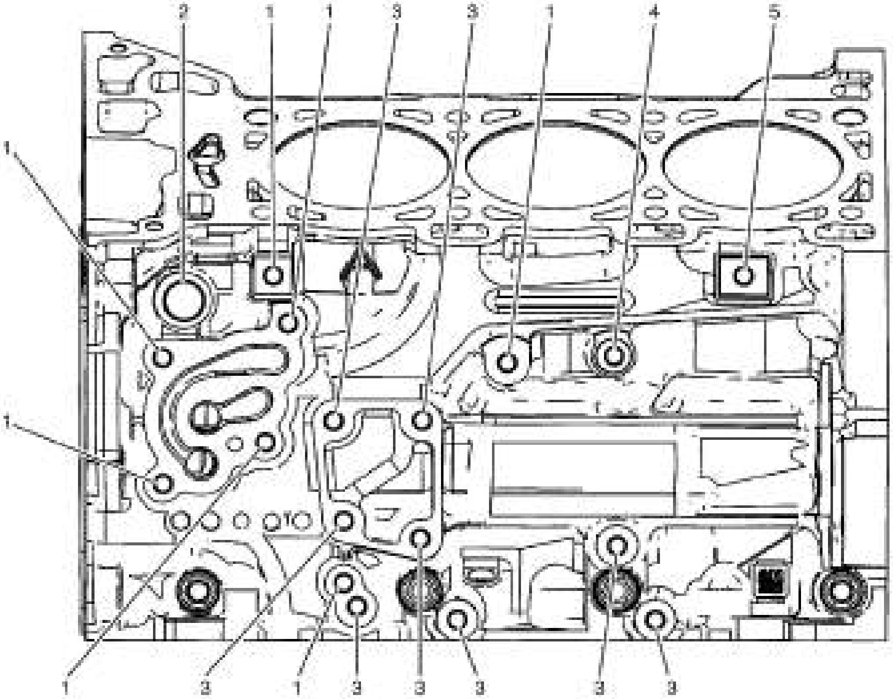
Engine Block Front



Engine Block Front

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
2	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3189	27.0	1.0630
3	M8 x 1.25	206	207	N/A	208	209	210	THRU		23.0	0.9055
4	M8 x 1.25	206	207	N/A	208	209	210	THRU		THRU	
5	M10 x 1.5	211	212	N/A	213	214	215	THRU		28.0	1.1024
6	M10 x 1.5	211	212	N/A	213	214	215	THRU		20.0	0.7874

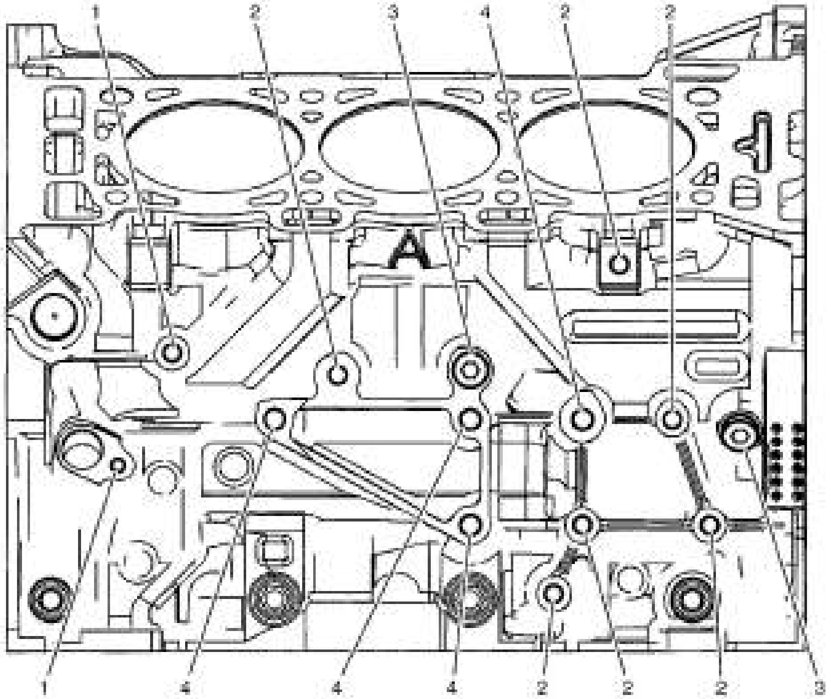
Engine Block Left Side



Engine Block Left Side

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
2	M20 x 1.5	715	716	N/A	717	718	719	30.0	1.1810	20.0	0.7874
3	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3190	27.0	1.0630
4	M14 x 1.5	409	410	N/A	411	412	735	THRU		15.0	0.5905
5	M8 x 1.25	206	207	N/A	208	209	415	16.5	0.6496	11.0	0.4331

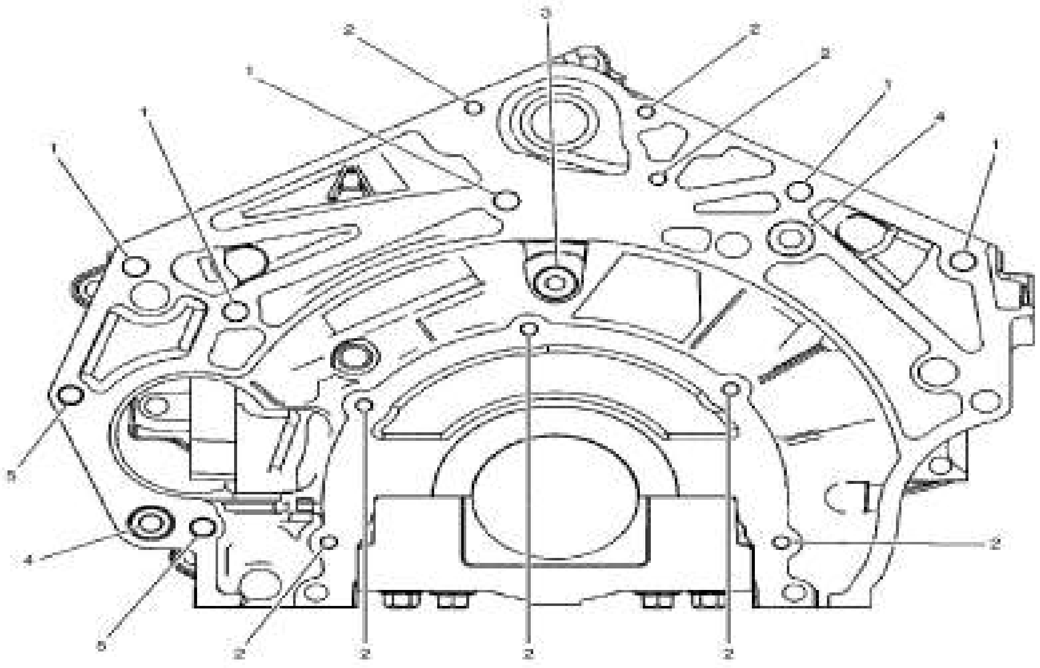
Engine Block Right Side



Engine Block Right Side

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.0	0.7087
2	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
3	M14 x 1.5	409	410	N/A	411	412	735	THRU		15.0	0.5905
4	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3190	27.0	1.0630

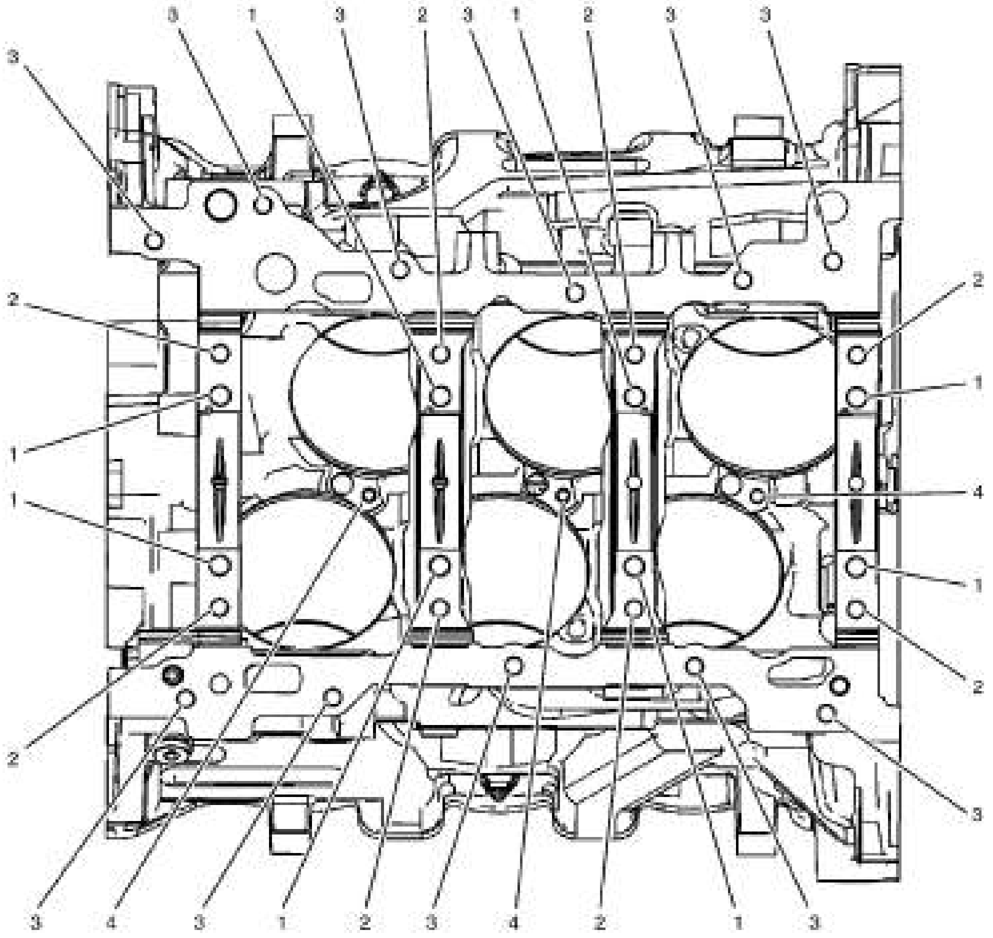
Engine Block Rear



Engine Block Rear

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	420	33.5	1.3190	27.0	1.0630
2	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.0	0.7087
3	M14 x 1.5	409	410	N/A	411	412	735	THRU		15.0	0.5905
4	M10 x 1.5	211	212	N/A	213	214	216	39.5	1.5551	33.0	1.2992
5	M10 x 1.5	211	212	N/A	213	214	420	THRU		THRU	

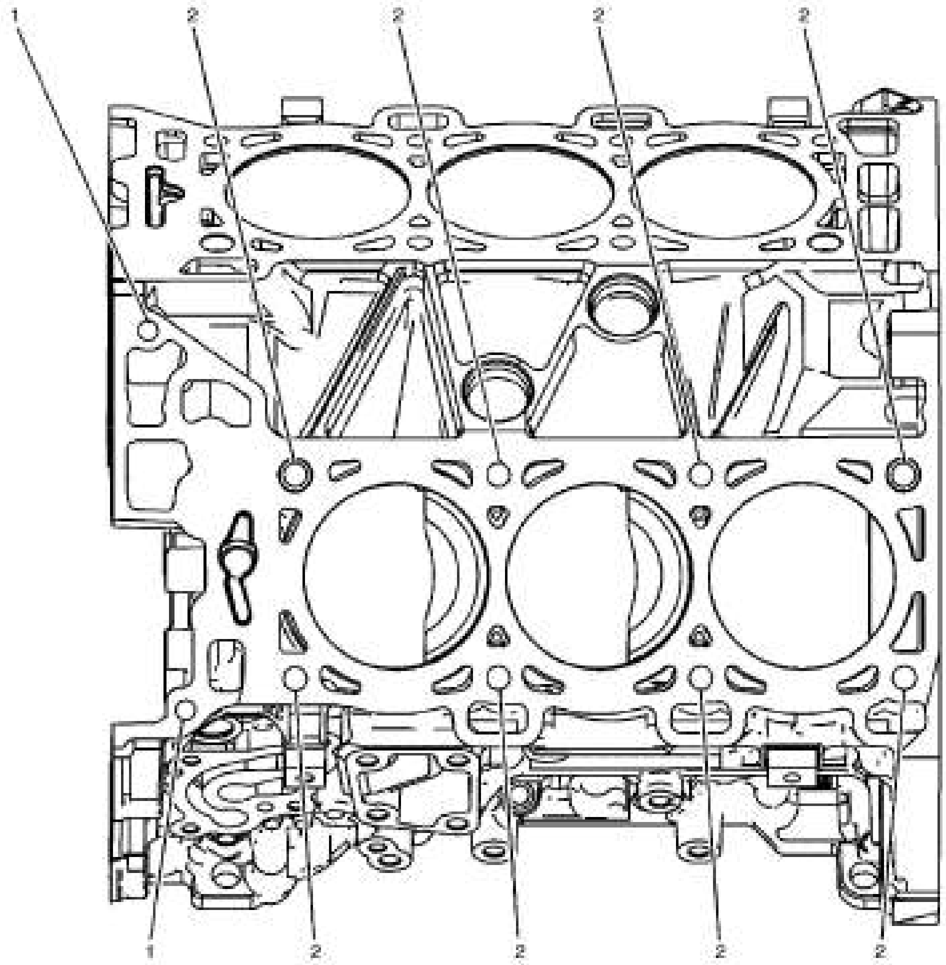
Engine Block Bottom



Engine Block Bottom

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M10 x 2.0	720	N/A	N/A	721	722	104	56.0	2.2047	49.0	1.9291
2	M8 x 1.25	702	N/A	N/A	703	704	620	46.0	1.8110	40.5	1.5945
3	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
4	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	

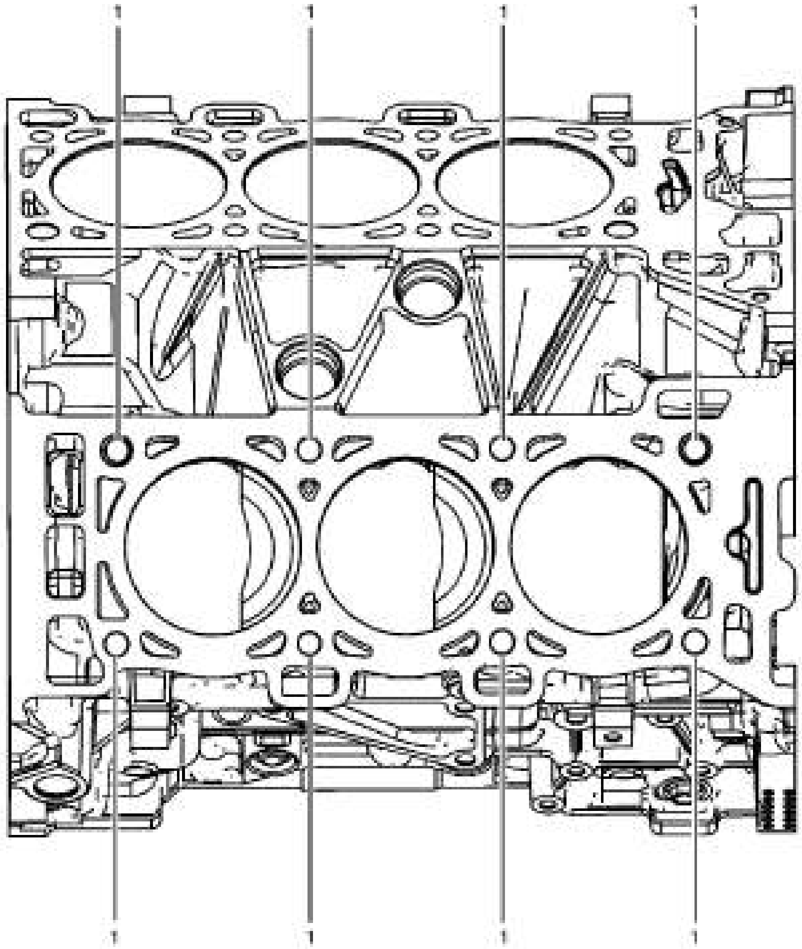
Engine Block Left Deck Face



Engine Block Left Deck Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
2	M11 x 2.0	723	N/A	N/A	724	725	108	102.5	4.0354	94.0	3.7008

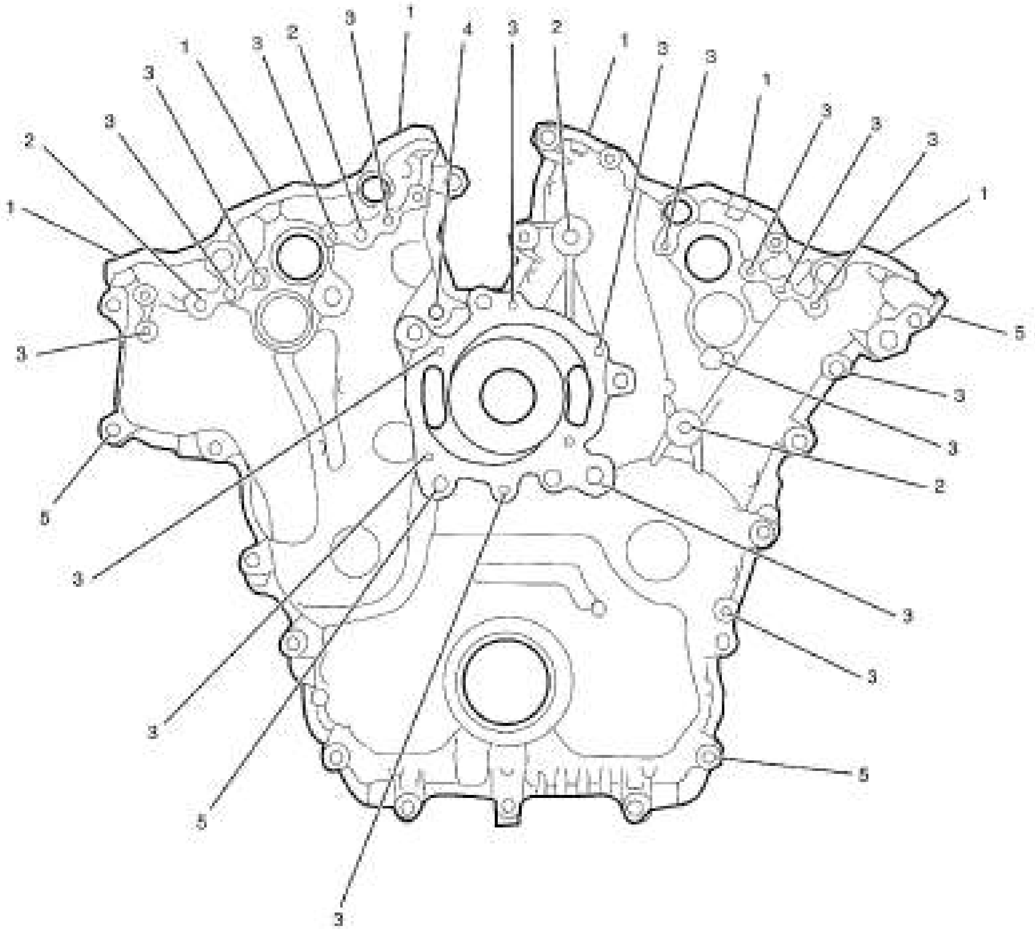
Engine Block Right Deck Face



Engine Block Right Deck Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M11 x 2.0	723	N/A	N/A	724	725	108	102.5	4.0354	94.0	3.7008

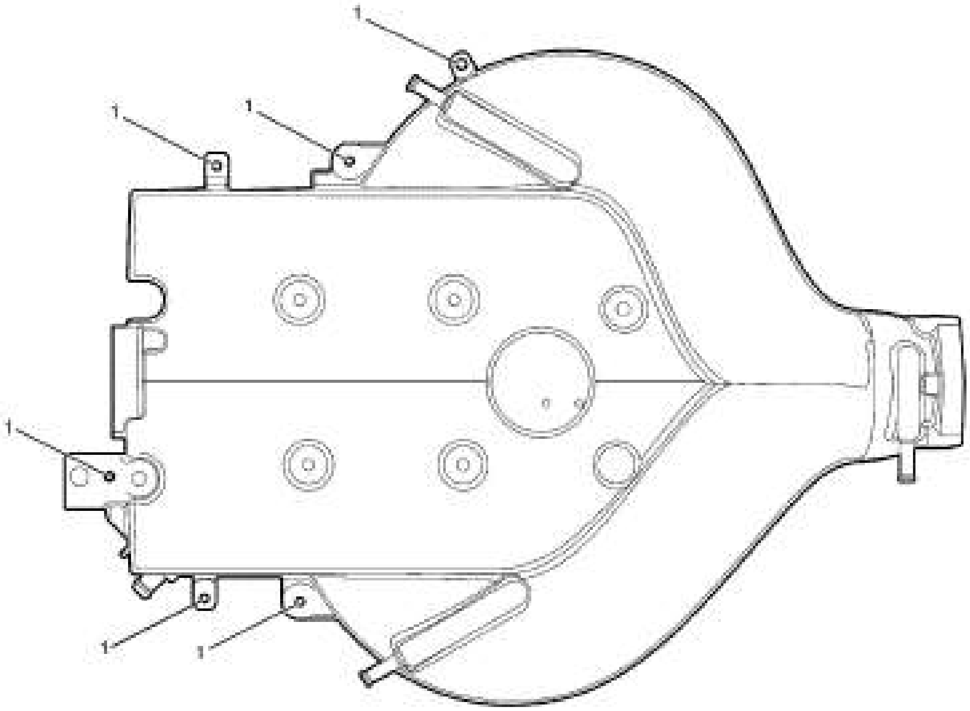
Engine Front Cover



Engine Front Cover

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	
2	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
3	M6 x 1.0	201	202	N/A	203	204	205	21.5	0.8465	18.0	0.7087
4	M10 x 1.5	211	212	N/A	213	214	215	THRU		THRU	
5	M10 x 1.5	211	212	N/A	213	214	420	32.5	1.2795	27.0	1.0630

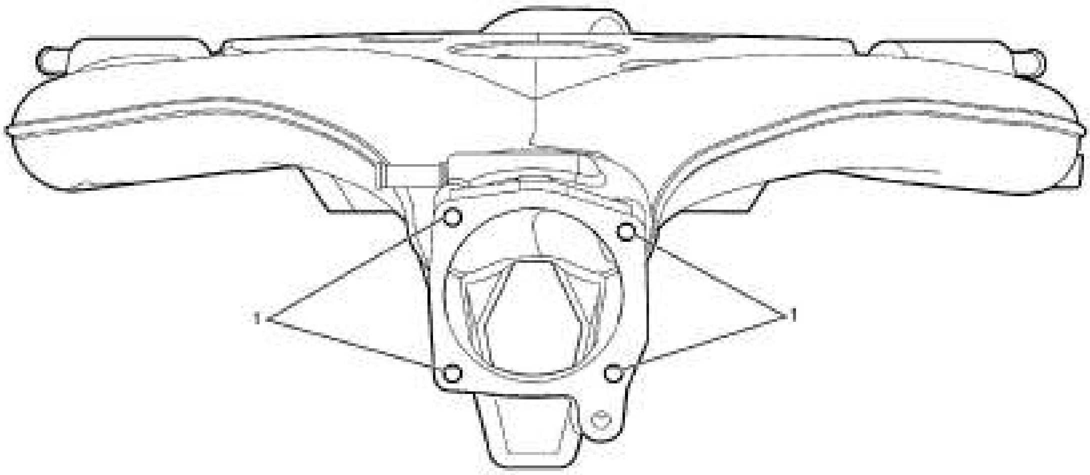
Upper Intake Manifold - Top



Upper Intake Manifold - Top

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	

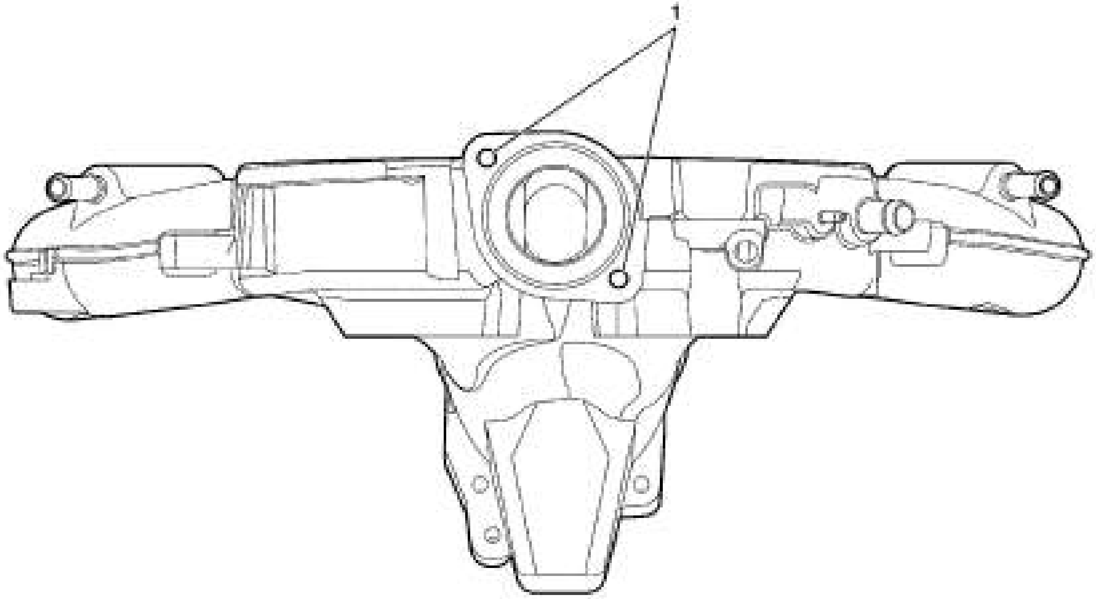
Upper Intake Manifold - Front



Upper Intake Manifold - Front

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	

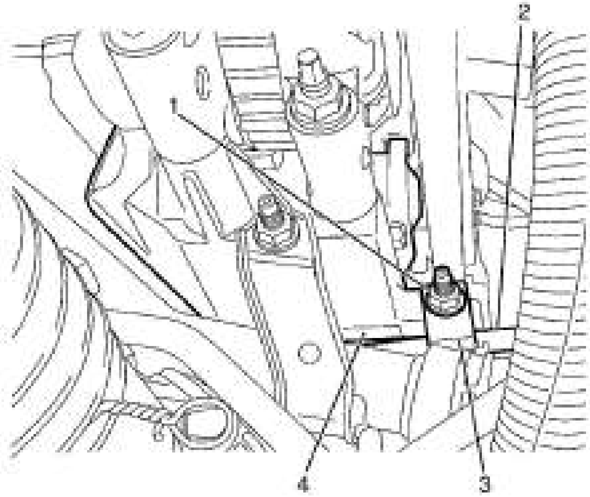
Upper Intake Manifold - Rear



Upper Intake Manifold - Rear

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	

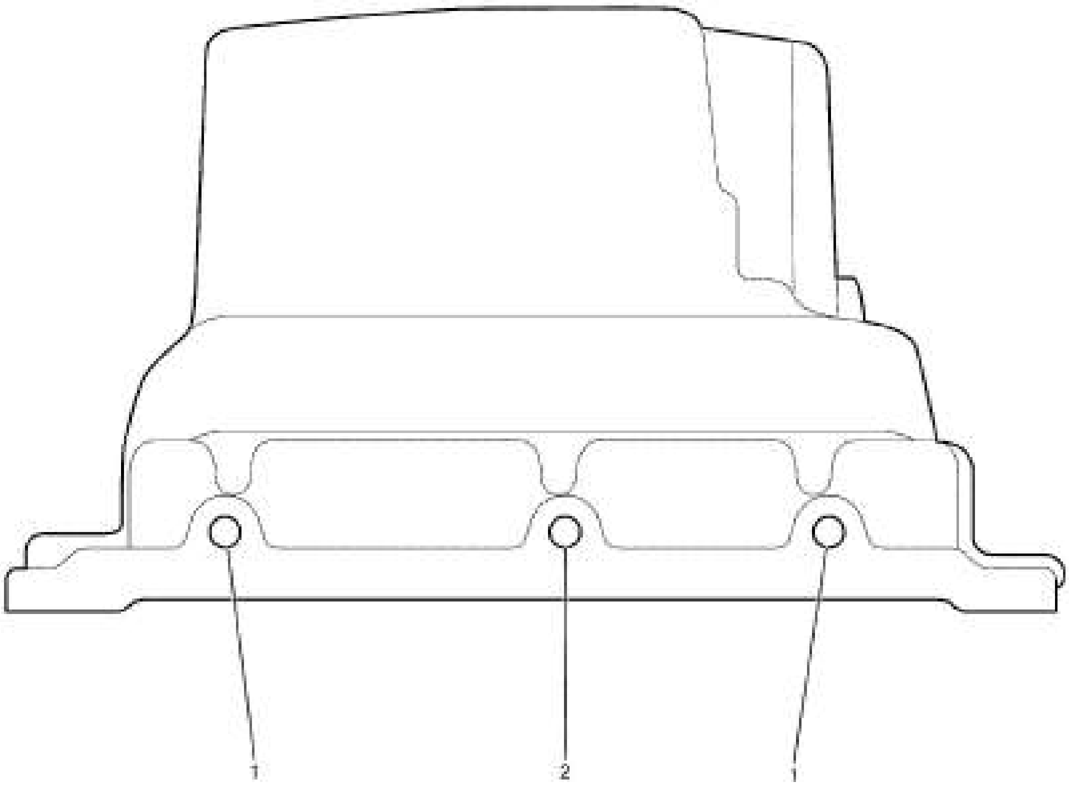
Lower Intake Manifold - Top



Lower Intake Manifold - Top

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	
2	M8 x 1.25	206	207	N/A	208	209	210	THRU		THRU	

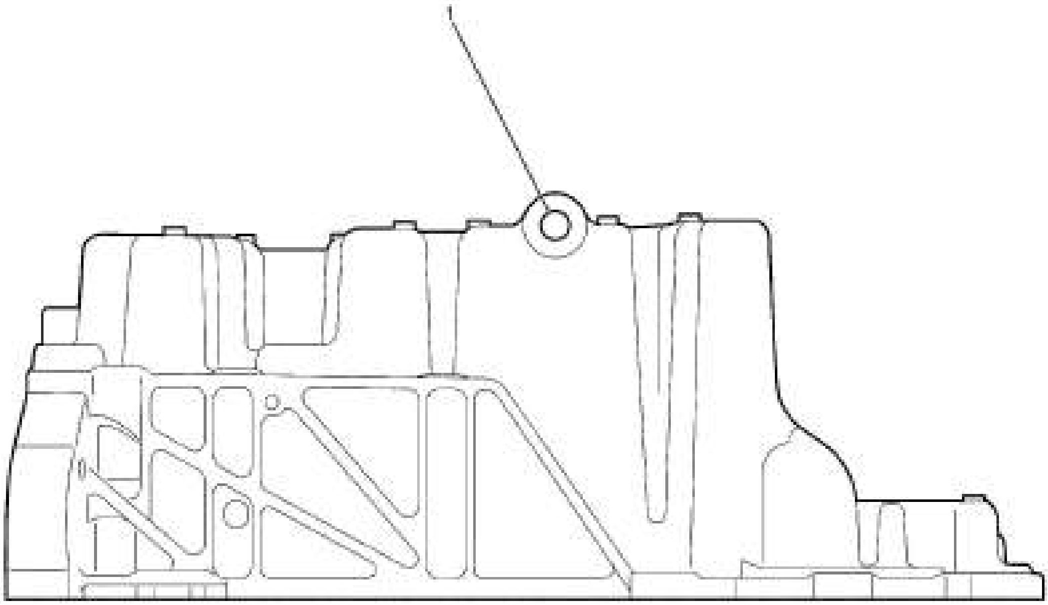
Oil Pan Front



Oil Pan Front

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
2	M8 x 1.25	610	N/A	N/A	208	209	620	37.5	1.4764	32.0	1.2598

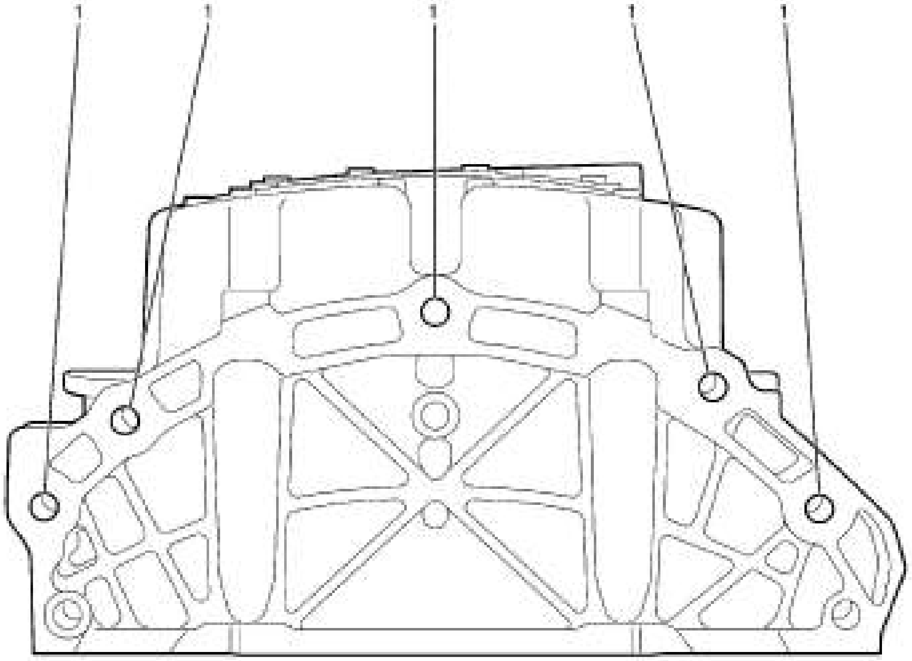
Oil Pan Left Side



Oil Pan Left Side

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M12 x 1.75	856	857	N/A	858	859	416	THRU		THRU	

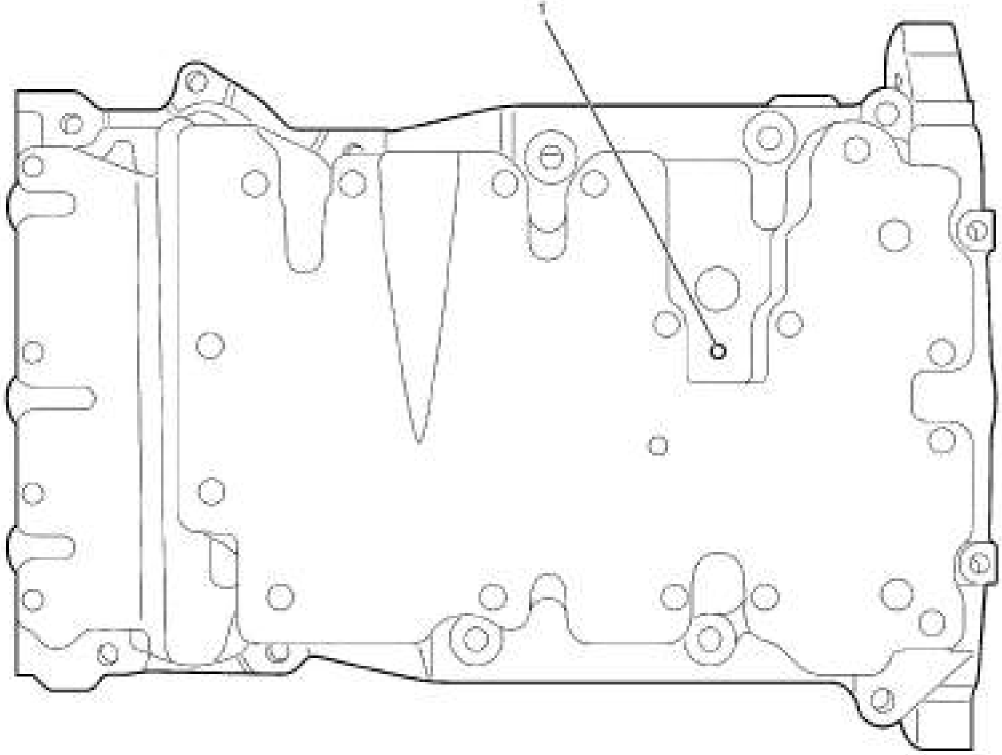
Oil Pan Rear



Oil Pan Rear

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	215	THRU		THRU	

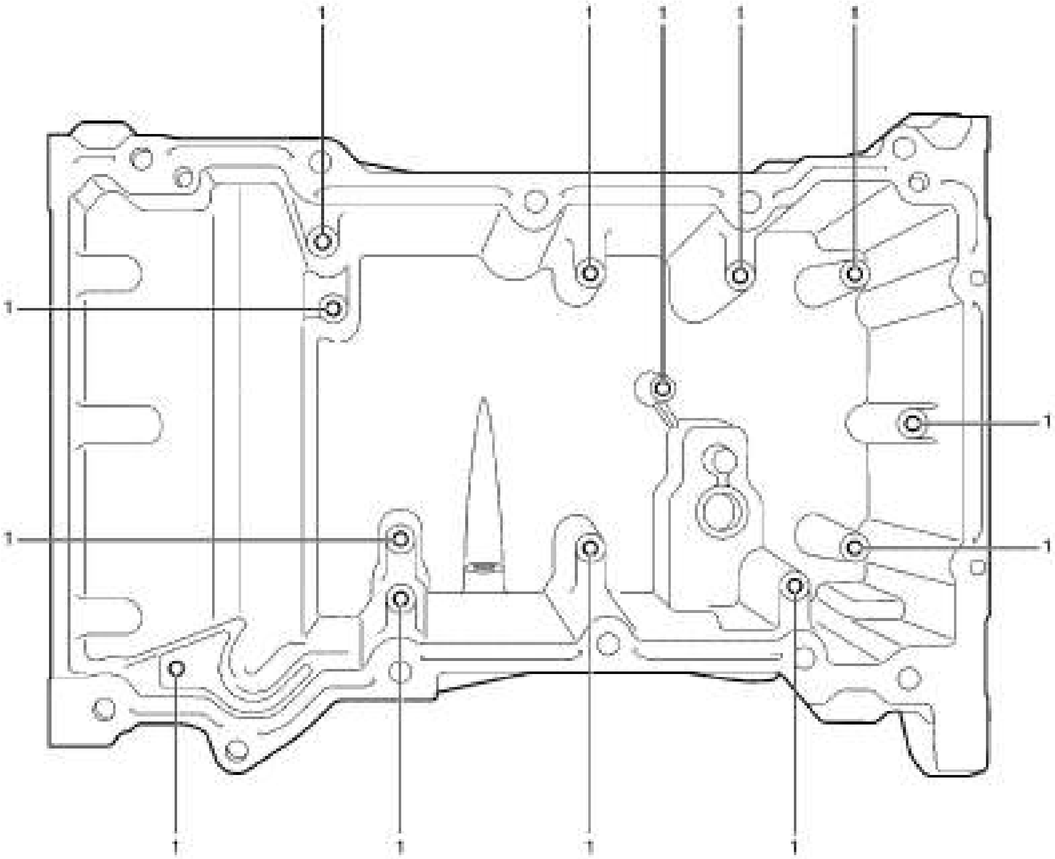
Oil Pan Bottom



Oil Pan Bottom

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	701	N/A	N/A	203	204	205	22.5	0.8858	18.0	0.7087

Oil Pan Top

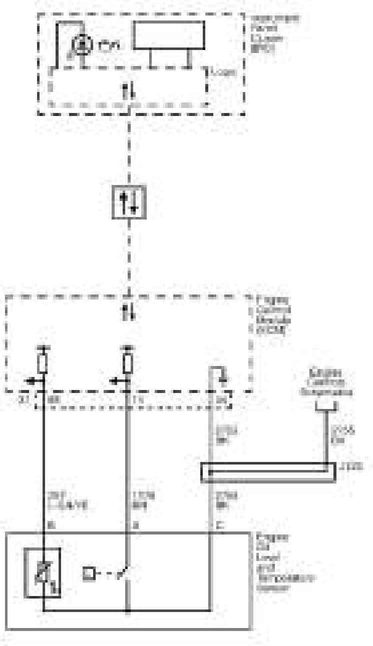


Oil Pan Top

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	701	N/A	N/A	203	204	205	28.0	1.1024	23.5	0.9252

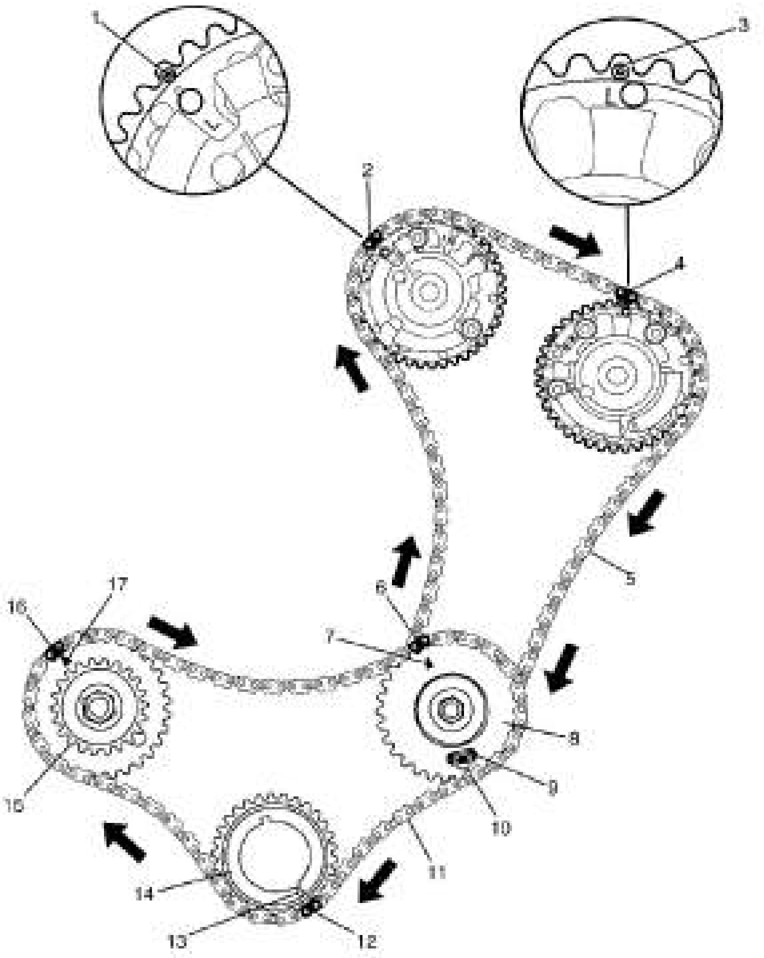
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Schematic and Routing Diagrams | **Document ID: 2154358**

Engine Mechanical Schematics


Instrument Panel Cluster (IPC)
Engine Control Module (ECM)
B
A
C
Engine Oil Level and Temperature Sensor

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Schematic and Routing Diagrams | **Document ID: 1997720**

Stage One



(1) Left Intake Camshaft Position (CMP) Actuator Timing Mark
(2) Left Intake Secondary Camshaft Timing Drive Chain Timing Link
(3) Left Exhaust Camshaft Position (CMP) Actuator Timing Mark
(4) Left Exhaust Secondary Camshaft Timing Drive Chain Timing Link
(5) Left Secondary Camshaft Timing Drive Chain
(6) Primary Camshaft Drive Chain Timing Link for the Left Primary Camshaft Intermediate Drive Chain Sprocket
(7) Left Primary Camshaft Intermediate Drive Chain Sprocket Timing Mark for the Primary Camshaft Drive Chain
(8) Left Primary Camshaft Intermediate Drive Chain Sprocket
(9) Left Secondary Camshaft Timing Drive Chain Timing Link for the Left Primary Camshaft Intermediate Drive Chain Sprocket

(10) Left Primary Camshaft Intermediate Drive Chain Sprocket Timing Window for the Left Secondary Camshaft Timing Drive Chain Timing Link

(11) Primary Camshaft Drive Chain

(12) Primary Camshaft Drive Chain Timing Link for the Crankshaft Sprocket

(13) Crankshaft Sprocket Timing Mark

(14) Crankshaft Sprocket

(15) Right Primary Camshaft Intermediate Drive Chain Sprocket

(16) Primary Camshaft Drive Chain Timing Link for the Right Primary Camshaft Intermediate Drive Chain Sprocket

(17) Right Primary Camshaft Intermediate Drive Chain Sprocket Timing Mark

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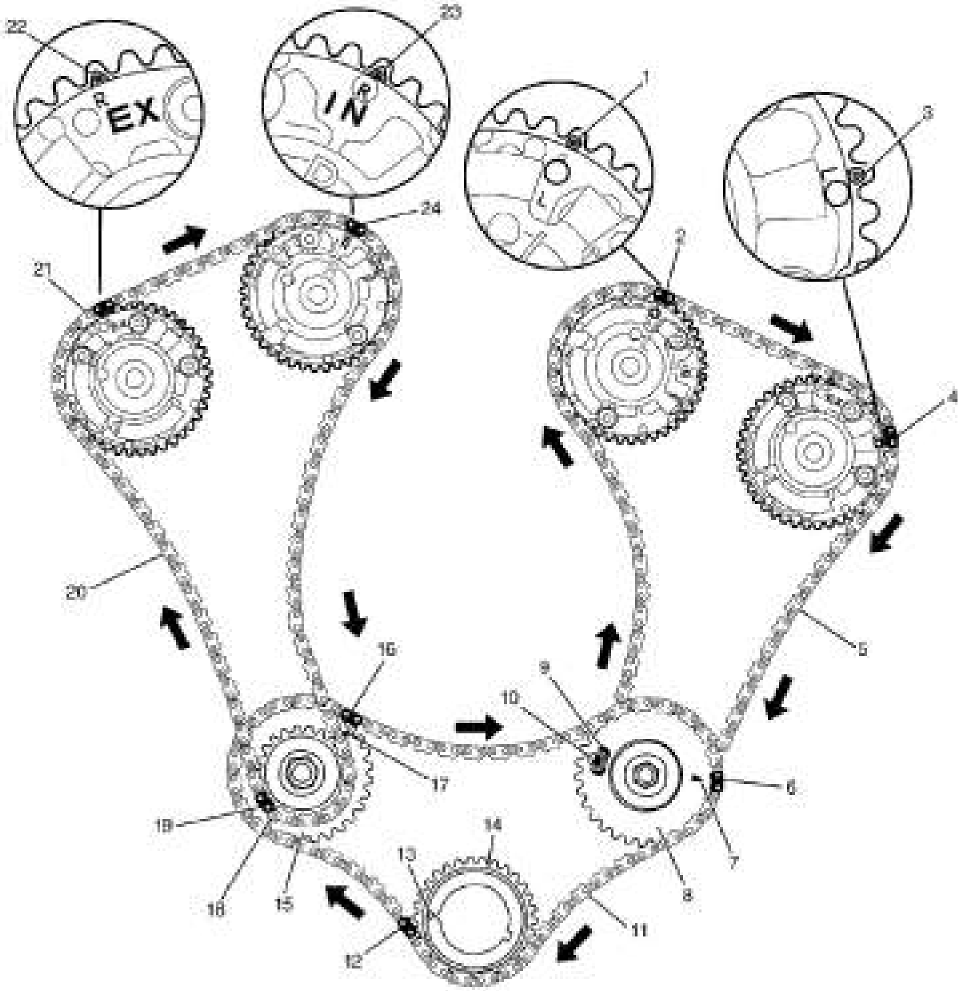
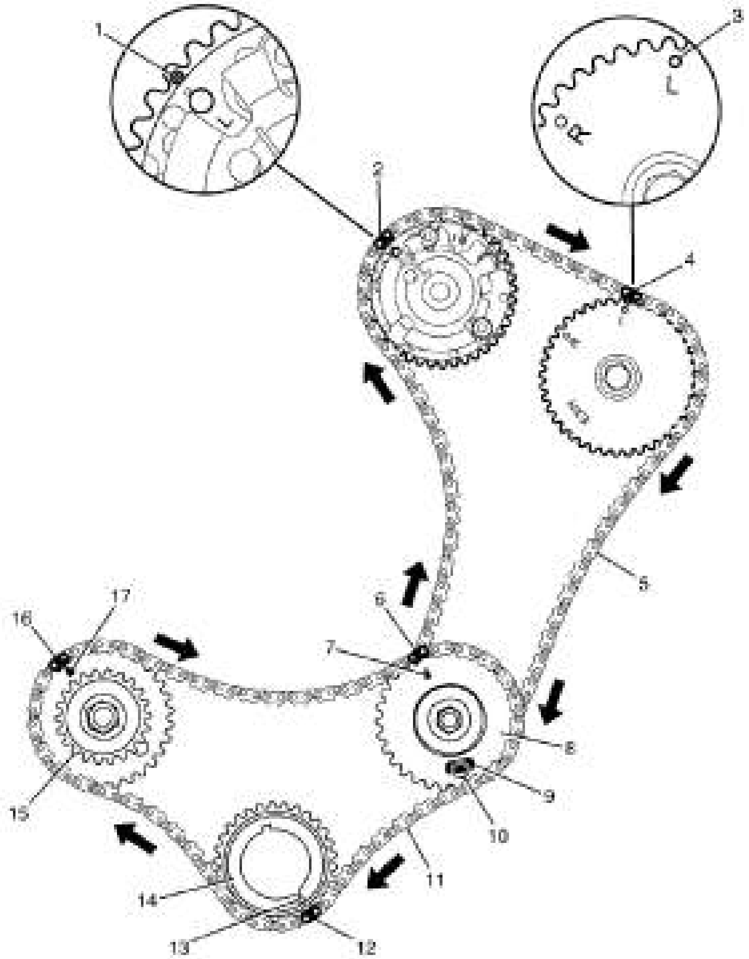
Stage Two



(1) Left Intake Camshaft Position (CMP) Actuator Timing Mark
(2) Left Intake Secondary Camshaft Timing Drive Chain Timing Link
(3) Left Exhaust Camshaft Position (CMP) Actuator Timing Mark
(4) Left Exhaust Secondary Camshaft Timing Drive Chain Timing Link
(5) Left Secondary Camshaft Timing Drive Chain
(6) Primary Camshaft Drive Chain Timing Link for the Left Primary Camshaft Intermediate Drive Chain Sprocket
(7) Left Primary Camshaft Intermediate Drive Chain Sprocket Timing Mark for the Primary Camshaft Drive Chain
(8) Left Primary Camshaft Intermediate Drive Chain Sprocket
(9) Left Secondary Camshaft Timing Drive Chain Timing Link for the Left Primary Camshaft Intermediate Drive Chain Sprocket

(10) Left Primary Camshaft Intermediate Drive Chain Sprocket Timing Window
(11) Primary Camshaft Drive Chain
(12) Primary Camshaft Drive Chain Timing Link for the Crankshaft Sprocket
(13) Crankshaft Sprocket Timing Mark
(14) Crankshaft Sprocket
(15) Right Primary Camshaft Intermediate Drive Chain Sprocket
(16) Primary Camshaft Drive Chain Timing Link for the Right Primary Camshaft Intermediate Drive Chain Sprocket
(17) Right Primary Camshaft Intermediate Drive Chain Sprocket Timing Mark for the Primary Camshaft Drive Chain
(18) Right Primary Camshaft Intermediate Drive Chain Sprocket Timing Mark/Window for the Right Secondary Camshaft Timing Drive Chain
(19) Right Secondary Camshaft Timing Drive Chain Timing Link for the Right Primary Camshaft Intermediate Drive Chain Sprocket
(20) Right Secondary Camshaft Timing Drive Chain
(21) Right Exhaust Secondary Camshaft Timing Drive Chain Timing Link
(22) Right Exhaust Camshaft Position (CMP) Actuator Timing Mark
(23) Right Intake Camshaft Position (CMP) Actuator Timing Mark
(24) Right Intake Secondary Camshaft Timing Drive Chain Timing Link

Stage One



(1) Left Intake Camshaft Position (CMP) Actuator Timing Mark

(2) Left Intake Secondary Camshaft Timing Drive Chain Timing Link

(3) Left Exhaust Camshaft Sprocket Timing Mark

(4) Left Exhaust Secondary Camshaft Timing Drive Chain Timing Link

(5) Left Secondary Camshaft Timing Drive Chain

(6) Primary Camshaft Drive Chain Timing Link for the Left Primary Camshaft Intermediate Drive Chain Sprocket

(7) Left Primary Camshaft Intermediate Drive Chain Sprocket Timing Mark for the Primary Camshaft Drive Chain

(8) Left Primary Camshaft Intermediate Drive Chain Sprocket

(9) Left Secondary Camshaft Timing Drive Chain Timing Link for the Left Primary Camshaft Intermediate Drive Chain Sprocket

(10) Left Primary Camshaft Intermediate Drive Chain Sprocket Timing Window for the Left Secondary Camshaft Timing Drive Chain Timing Link
(11) Primary Camshaft Drive Chain
(12) Primary Camshaft Drive Chain Timing Link for the Crankshaft Sprocket
(13) Crankshaft Sprocket Timing Mark
(14) Crankshaft Sprocket
(15) Right Primary Camshaft Intermediate Drive Chain Sprocket
(16) Primary Camshaft Drive Chain Timing Link for the Right Primary Camshaft Intermediate Drive Chain Sprocket
(17) Right Primary Camshaft Intermediate Drive Chain Sprocket Timing Mark

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Camshaft Timing Drive Chain Alignment Diagram

Figure 1: Camshaft Timing Drive Chain Alignment LY7 Stage One
Figure 2: Camshaft Timing Drive Chain Alignment LY7 Stage Two
Figure 3: Camshaft Timing Drive Chain Alignment diagram LE0, LW2 Stage One
Figure 4: Camshaft Timing Drive Chain Alignment Diagram LE0, LW2 Stage Two

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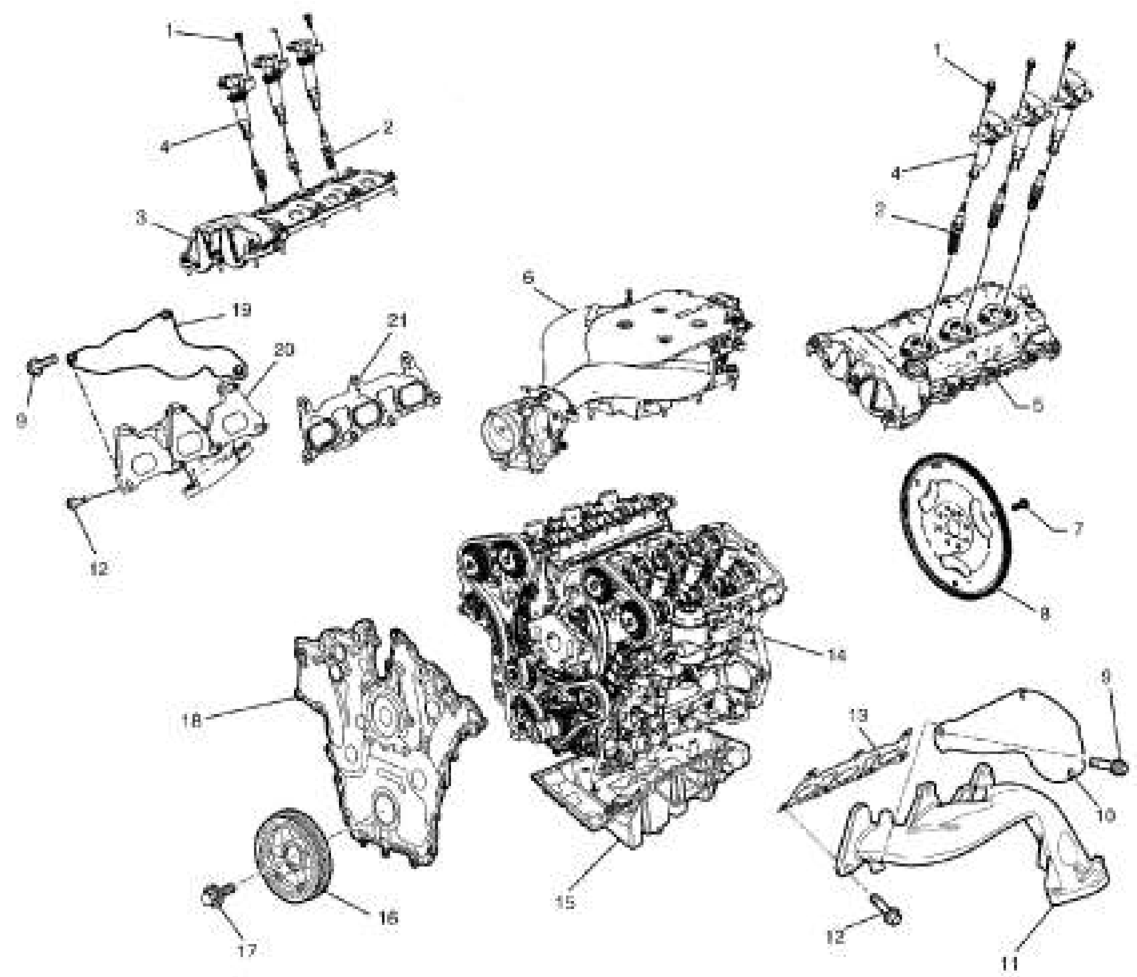
Engine Covers and Component Assemblies (1 of 2)

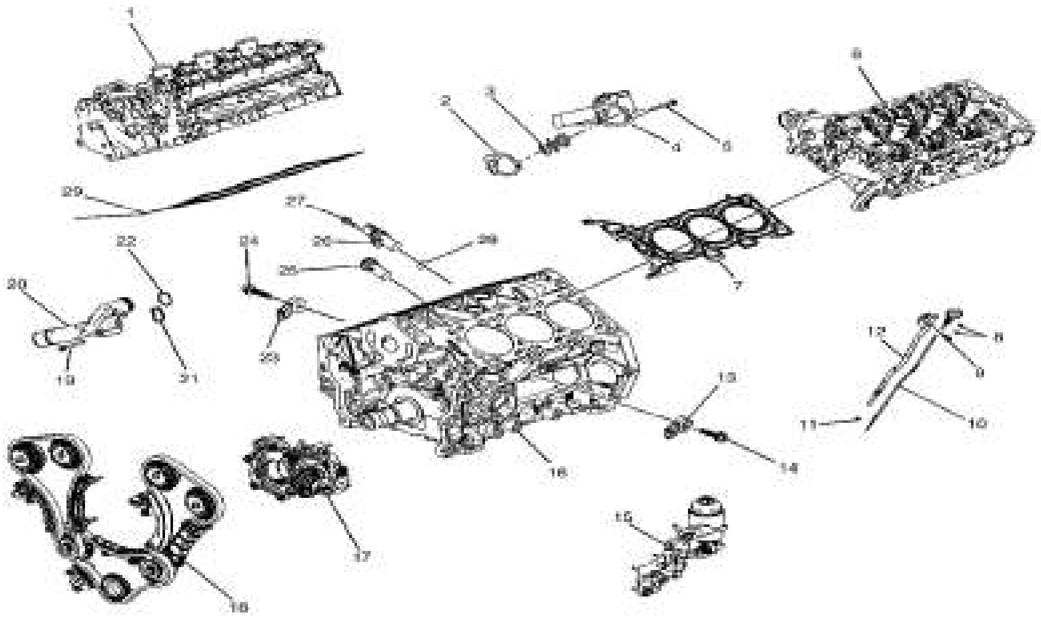


(1) Ignition Coil Assembly to Camshaft Cover Assembly Retaining Bolt
(2) Spark Plug
(3) Camshaft Cover Assembly - Right Side
(4) Ignition Coil Assembly
(5) Camshaft Cover Assembly - Left Side
(6) Intake Manifold Assembly
(7) Engine Flywheel to Crankshaft Retaining Bolt
(8) Engine Flywheel
(9) Exhaust Manifold Heat Shield to Exhaust Manifold Retaining Bolt
(10) Exhaust Manifold Heat Shield - Left Side
(11) Exhaust Manifold - Left Side

(12) Exhaust Manifold to Cylinder Head Retaining Bolt
(13) Exhaust Manifold Gasket - Left Side
(14) Engine Assembly
(15) Oil Pan Assembly
(16) Crankshaft Balancer
(17) Crankshaft Balancer to Crankshaft Retaining Bolt
(18) Engine Front Cover Assembly
(19) Exhaust Manifold Heat Shield - Right Side
(20) Exhaust Manifold - Right Side
(21) Exhaust Manifold Gasket - Right Side

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Component Locator | **Document ID: 1985182**

Engine Covers and Component Assemblies (2 of 2)

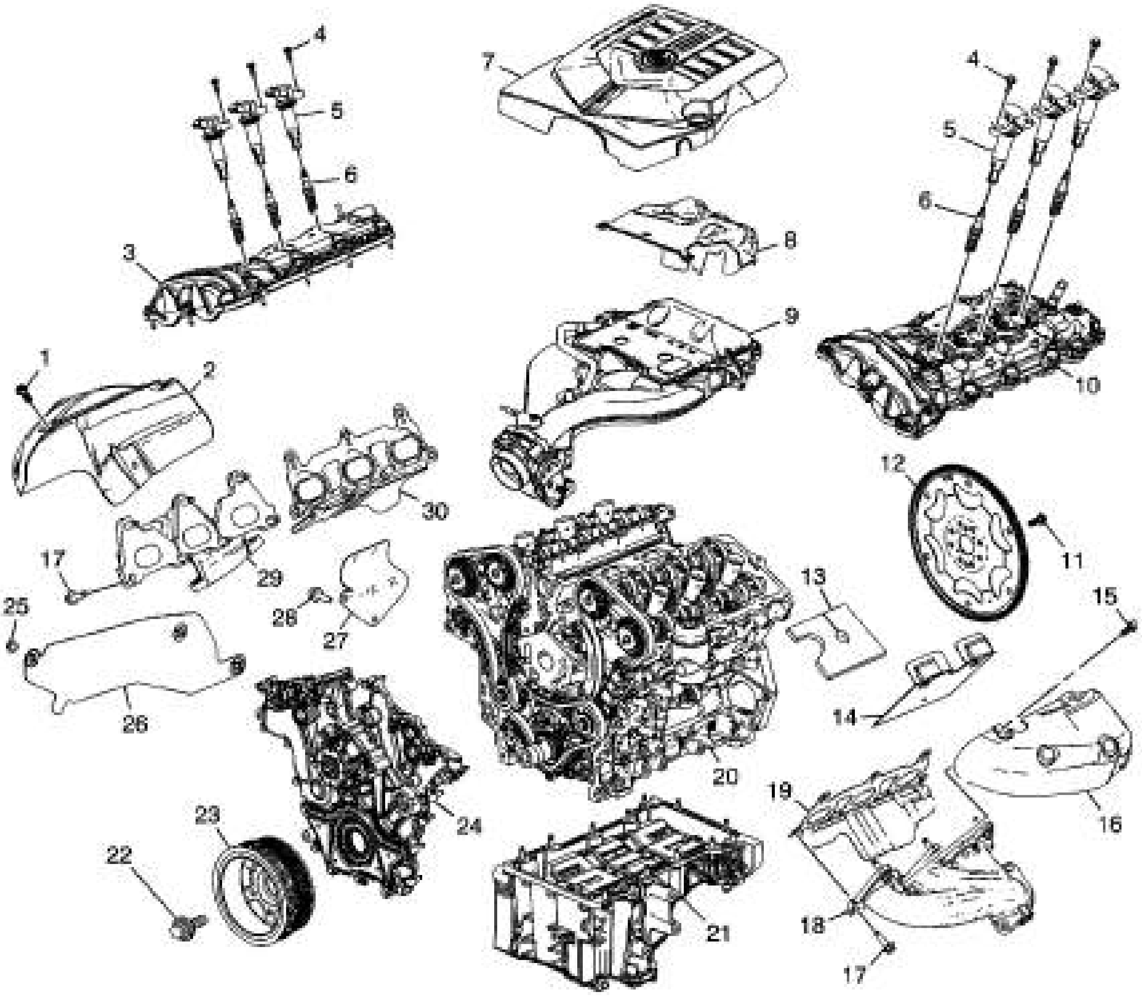


(1) Cylinder Head Assembly - Right Side
(2) Engine Cooling Thermostat Gasket
(3) Engine Cooling Thermostat
(4) Engine Cooling Thermostat Housing
(5) Engine Cooling Thermostat Housing Bolt
(6) Cylinder Head Assembly - Left Side
(7) Cylinder Head Gasket - Left Side
(8) Oil Level Indicator O-rings
(9) Oil Level Indicator Tube Bolt
(10) Oil Level Indicator
(11) Oil Level Indicator Tube O-ring
(12) Oil Level Indicator Tube
(13) Knock Sensor - Bank 1
(14) Knock Sensor to Cylinder Block Retaining Bolt - Bank 1
(15) Oil Filter Adapter Assembly
(16) Engine Short Block Assembly
(17) Oil Pump Assembly
(18) Timing Drive Assembly

(19) Water Outlet to Cylinder Block Retaining Bolt
(20) Water Outlet
(21) Water Outlet Seal
(22) Water Outlet O-ring
(23) Knock Sensor - Bank 2
(24) Knock Sensor to Cylinder Block Retaining Bolt - Bank 2
(25) Engine Coolant Heater
(26) Crankshaft Position Sensor
(27) Crankshaft Position Sensor to Cylinder Block Retaining Bolt
(28) Crankshaft Position Sensor O-ring
(29) Cylinder Head Gasket - Right Side

2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Component Locator | **Document ID: 2134395**

Engine Covers and Component Assemblies (1 of 2) (LLT)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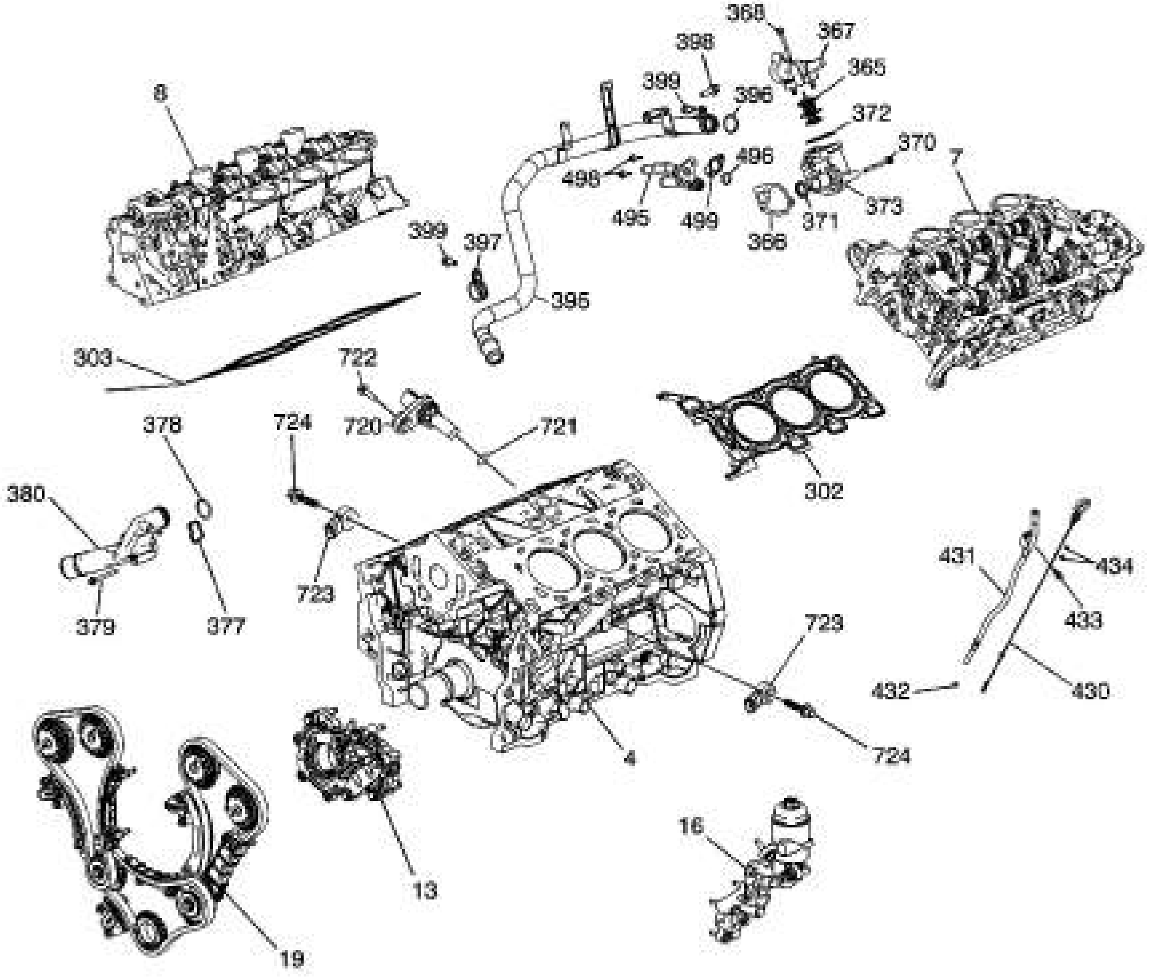
(1) Right Exhaust Manifold Heat Shield Bolt
(2) Right Exhaust Manifold Heat Shield
(3) Right Camshaft Cover Assembly
(4) Ignition Coil Bolt
(5) Ignition Coil
(6) Spark Plug
(7) Fuel Injector Sight Shield Cover
(8) Upper Intake Manifold Cover
(9) Intake Manifold Assembly
(10) Left Camshaft Cover Assembly
(11) Engine Flywheel Bolt

(12) Engine Flywheel
(13) Left Exhaust Manifold Upper Heat Shield
(14) Left Exhaust Manifold Lower Heat Shield
(15) Left Exhaust Manifold Heat Shield Bolt
(16) Left Exhaust Manifold Heat Shield
(17) Cylinder Head Exhaust Manifold Bolt
(18) Left Exhaust Manifold
(19) Left Exhaust Manifold Gasket
(20) Engine Assembly
(21) Oil Pan Assembly
(22) Crankshaft Balancer Bolt
(23) Crankshaft Balancer
(24) Engine Front Cover Assembly
(25) Right Exhaust Manifold Lower Heat Shield Retainers
(26) Right Exhaust Manifold Lower Heat Shield
(27) Exhaust Manifold Lower Heat Shield
(28) Exhaust Manifold Lower Heat Shield Bolt
(29) Right Exhaust Manifold
(30) Right Exhaust Manifold Gasket

2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Component Locator | **Document ID: 1993597**

Engine Covers and Component Assemblies (2 of 2) (LLT)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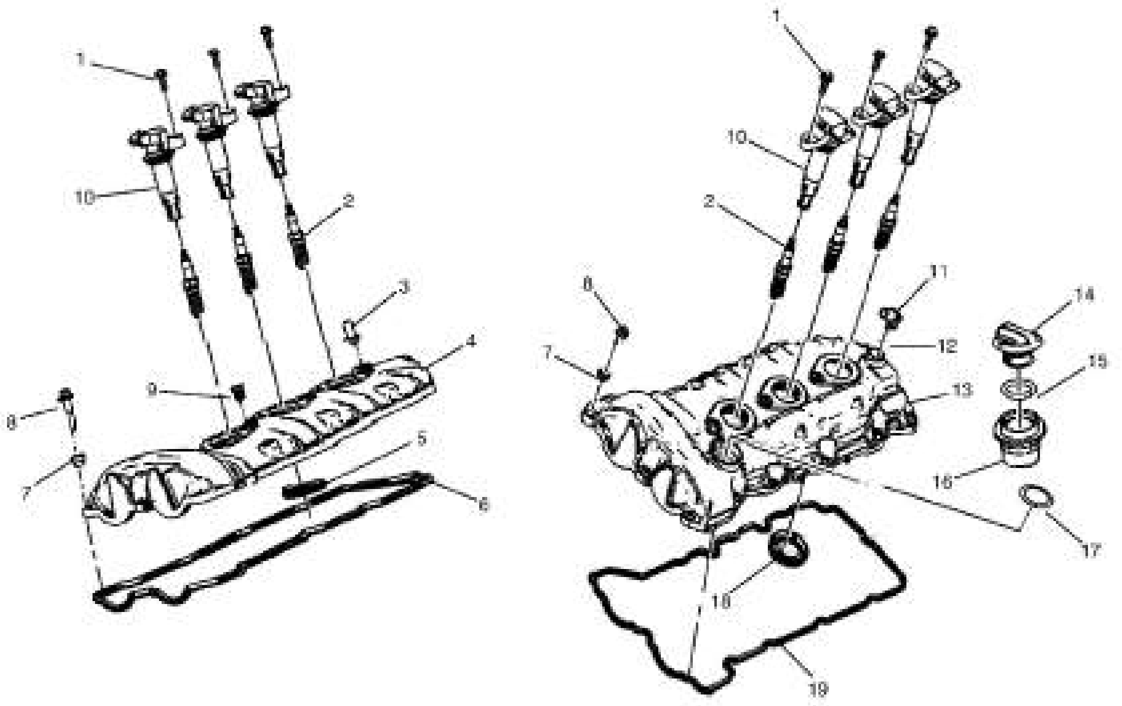
(4) Engine Short Block Assembly
(7) Left Cylinder Head Assembly
(8) Right Cylinder Head Assembly
(13) Oil Pump Assembly
(16) Oil Filter Adapter Assembly
(19) Timing Drive Assembly
(302) Left Cylinder Head Gasket
(303) Right Cylinder Head Gasket
(365) Engine Cooling Thermostat
(366) Engine Cooling Thermostat Gasket
(367) Engine Cooling Thermostat Housing

(368) Engine Cooling Thermostat Housing Bolt
(370) Engine Cooling Thermostat Lower Housing Bolt
(371) Engine Cooling Thermostat Lower Housing Seal
(372) Engine Cooling Thermostat Seal
(373) Engine Cooling Thermostat Lower Housing
(377) Water Outlet Seal
(378) Water Outlet O-ring
(379) Water Outlet Bolt
(380) Water Outlet
(395) Coolant Pipe
(396) Coolant Pipe O-ring
(397) Coolant Pipe Clamp
(398) Coolant Pipe Bracket Bolt - Large
(399) Coolant Pipe Bracket Bolt - Small
(399) Coolant Pipe Bracket Bolt - Small
(430) Oil Level Indicator
(431) Oil Level Indicator Tube
(432) Oil Level Indicator Tube O-ring
(433) Oil Level Indicator Tube Bolt
(434) Oil Level Indicator Handle O-ring
(495) Water Inlet/Outlet Pipe
(496) Water Inlet/Outlet Pipe O-ring
(498) Water Inlet/Outlet Pipe Bolts
(499) Water Inlet/Outlet Pipe Gaskets
(720) Crankshaft Position Sensor
(721) Crankshaft Position Sensor O-ring
(722) Crankshaft Position Sensor Bolt
(723) Knock Sensor
(723) Knock Sensor
(724) Knock Sensor Bolt
(724) Knock Sensor Bolt

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Component Locator | **Document ID: 1985184**

Camshaft Cover Assembly

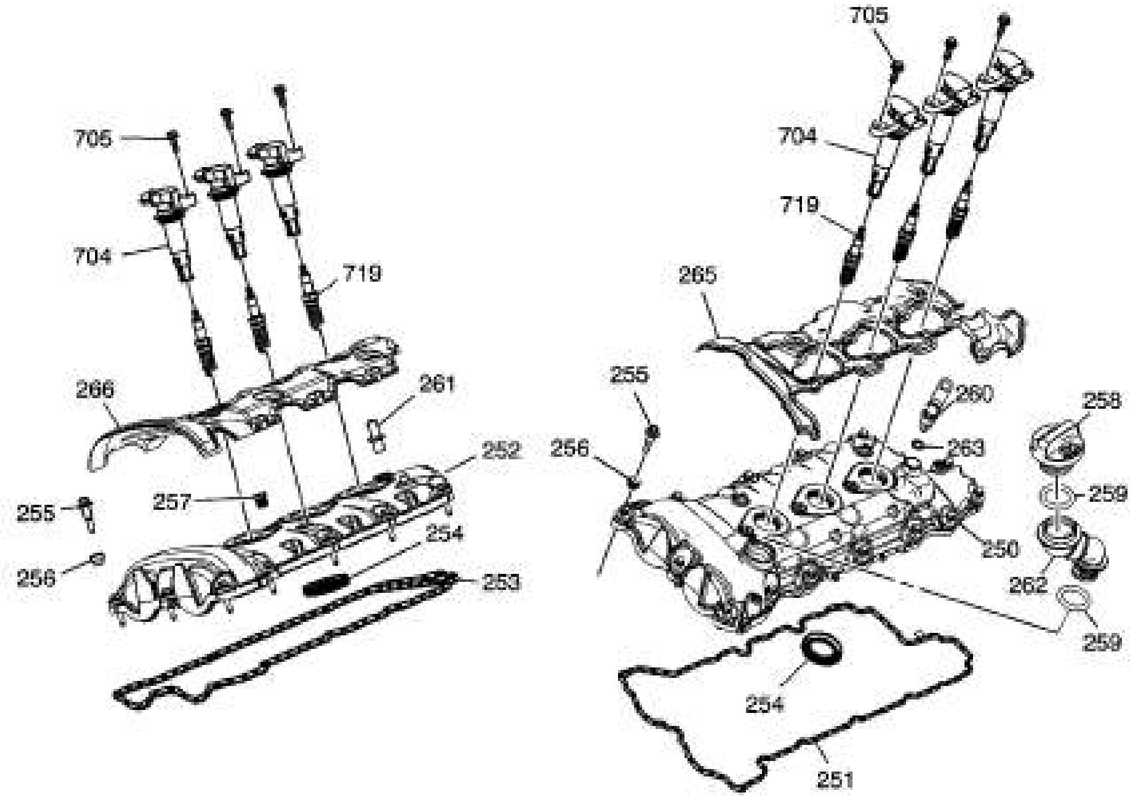


(1) Ignition Coil to Camshaft Cover Retaining Bolt
(2) Spark Plug
(3) Camshaft Cover PCV Fitting Orifice - Right Side
(4) Camshaft Cover - Right Side
(5) Camshaft Cover Spark Plug Port Seal - Right Side
(6) Camshaft Cover Gasket - Right Side
(7) Camshaft Cover Bolt Insulator
(8) Camshaft Cover Bolt
(9) Ignition Coil Bolt Thread Insert
(10) Ignition Coil
(11) Camshaft Cover PCV Fitting - Left Side

(12) Camshaft Cover PCV Fitting - Left Side
(13) Camshaft Cover - Left Side
(14) Oil Fill Cap
(15) Oil Fill O-Ring
(16) Oil Fill Tube
(17) Oil Fill O-Ring
(18) Camshaft Cover Spark Plug Port Seal - Left Side
(19) Camshaft Cover Gasket - Left Side

2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Component Locator | **Document ID: 1993598**

Camshaft Cover Assembly (LLT)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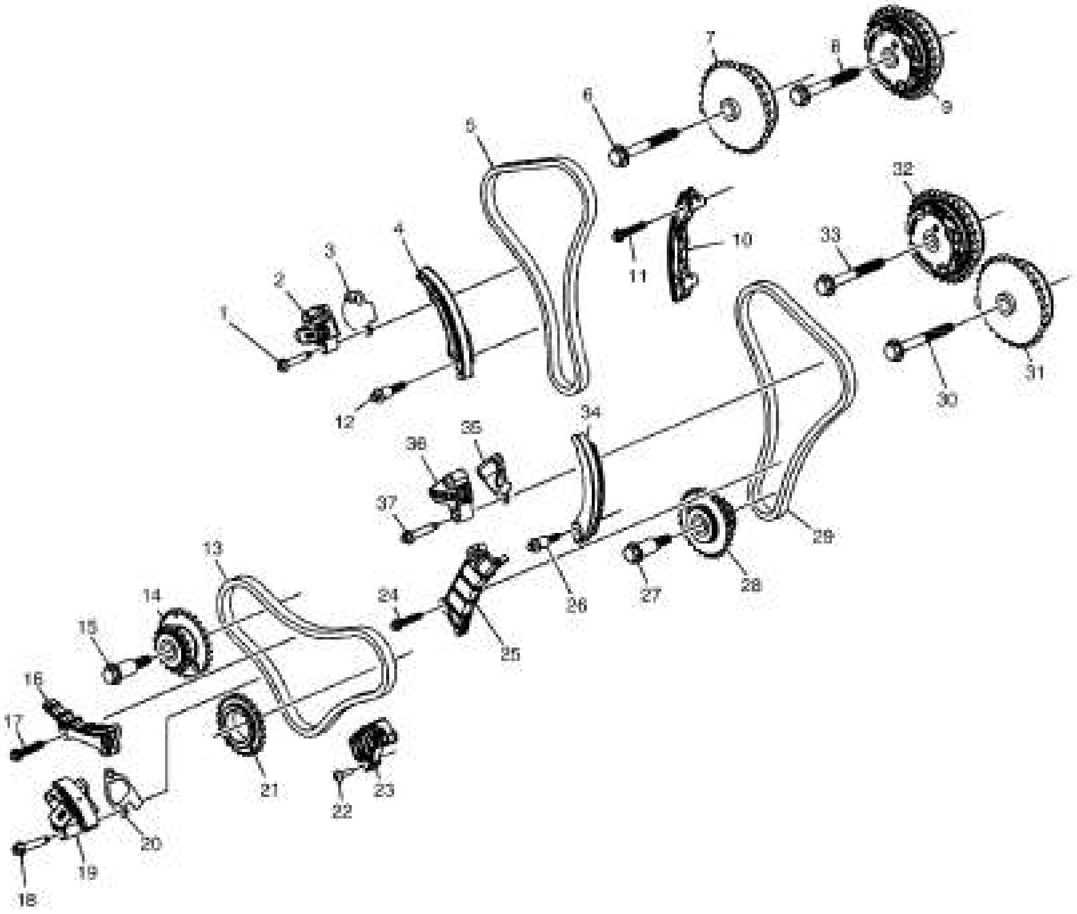
(250) Left Camshaft Cover
(251) Left Camshaft Cover Gasket
(252) Right Camshaft Cover
(253) Right Camshaft Cover Gasket
(254) Camshaft Cover Spark Plug Port Seal
(254) Camshaft Cover Spark Plug Port Seal
(255) Camshaft Cover Bolt
(255) Camshaft Cover Bolt
(256) Camshaft Cover Bolt Insulator
(256) Camshaft Cover Bolt Insulator
(257) Ignition Coil Bolt Thread Insert

(258) Oil Fill Cap
(259) Oil Fill O-ring
(259) Oil Fill O-ring
(260) Left Camshaft Cover PCV Fitting
(261) Right Camshaft Cover PCV Fitting Orifice
(262) Oil Fill Tube
(263) Left Camshaft Cover PCV Fitting O-ring
(265) Left Camshaft Housing Cover Insulator
(266) Right Camshaft Housing Cover Insulator
(704) Ignition Coil
(704) Ignition Coil
(705) Ignition Coil Bolt
(705) Ignition Coil Bolt
(719) Spark Plug
(719) Spark Plug

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Component Locator | **Document ID: 1985187**

Camshaft Timing Components (LE0 & LW2)



(1) Timing Chain Tensioner and Guide Bolt - Right Side
(2) Secondary Timing Chain Tensioner - Right Side
(3) Secondary Timing Chain Tensioner Gasket - Right Side
(4) Secondary Timing Chain Shoe - Right Side
(5) Secondary Timing Chain - Right Side
(6) Exhaust Camshaft Sprocket to Camshaft Retaining Bolt - Bank 2
(7) Exhaust Camshaft Sprocket - Bank 2
(8) Camshaft Position Actuator to Camshaft Retaining Bolt - Bank 2
(9) Intake Camshaft Position Actuator - Bank 2
(10) Secondary Timing Chain Guide Bolt - Right Side
(11) Secondary Timing Chain Guide - Right Side

(12) Secondary Timing Chain Shoe Bolt - Right Side
(13) Primary Timing Chain
(14) Camshaft Intermediate Drive Chain Idler Sprocket
(15) Camshaft Intermediate Drive Chain Idler Sprocket Bolt
(16) Primary Timing Chain Upper Guide
(17) Primary Timing Chain Guide Bolt
(18) Primary Timing Chain Tensioner Bolt
(19) Primary Timing Chain Tensioner
(20) Primary Timing Chain Tensioner Gasket
(21) Crankshaft Sprocket
(22) Primary Timing Chain Lower Guide Bolt
(23) Primary Timing Chain Lower Guide
(24) Secondary Timing Chain Guide Bolt - Left Side
(25) Secondary Timing Chain Guide - Left Side
(26) Secondary Timing Chain Shoe Bolt - Left Side
(27) Camshaft Intermediate Drive Shaft Sprocket Bolt - Left Side
(28) Camshaft Intermediate Drive Shaft Sprocket - Left Side
(29) Secondary Timing Chain - Left Side
(30) Exhaust Camshaft Sprocket to Camshaft Retaining Bolt - Bank 1
(31) Exhaust Camshaft Sprocket - Bank 1
(32) Intake Camshaft Position Actuator - Bank 1
(33) Camshaft Position Actuator to Camshaft Retaining Bolt - Bank 1
(34) Secondary Timing Chain Shoe - Left Side
(35) Secondary Timing Chain Tensioner Gasket - Left Side
(36) Secondary Timing Chain Tensioner - Left Side
(37) Timing Chain Tensioner Bolt - Left Side

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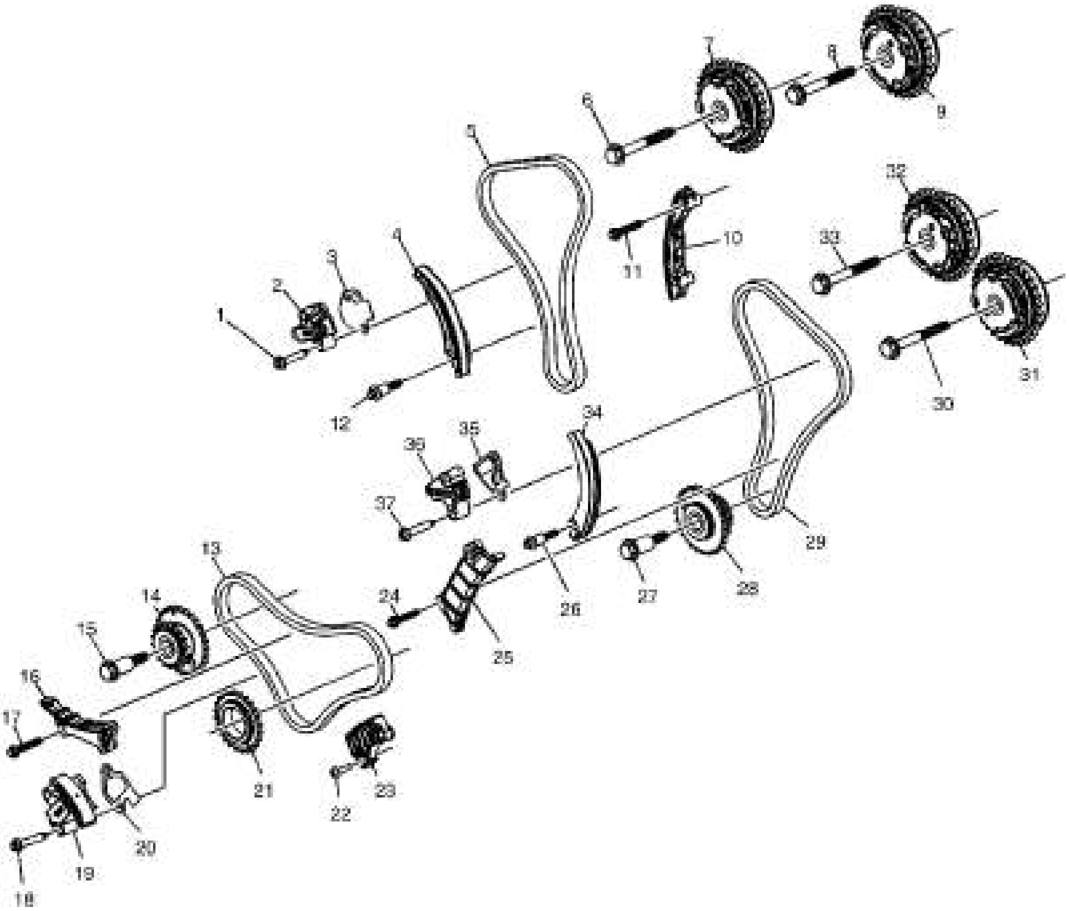
Camshaft Timing Components (LY7)

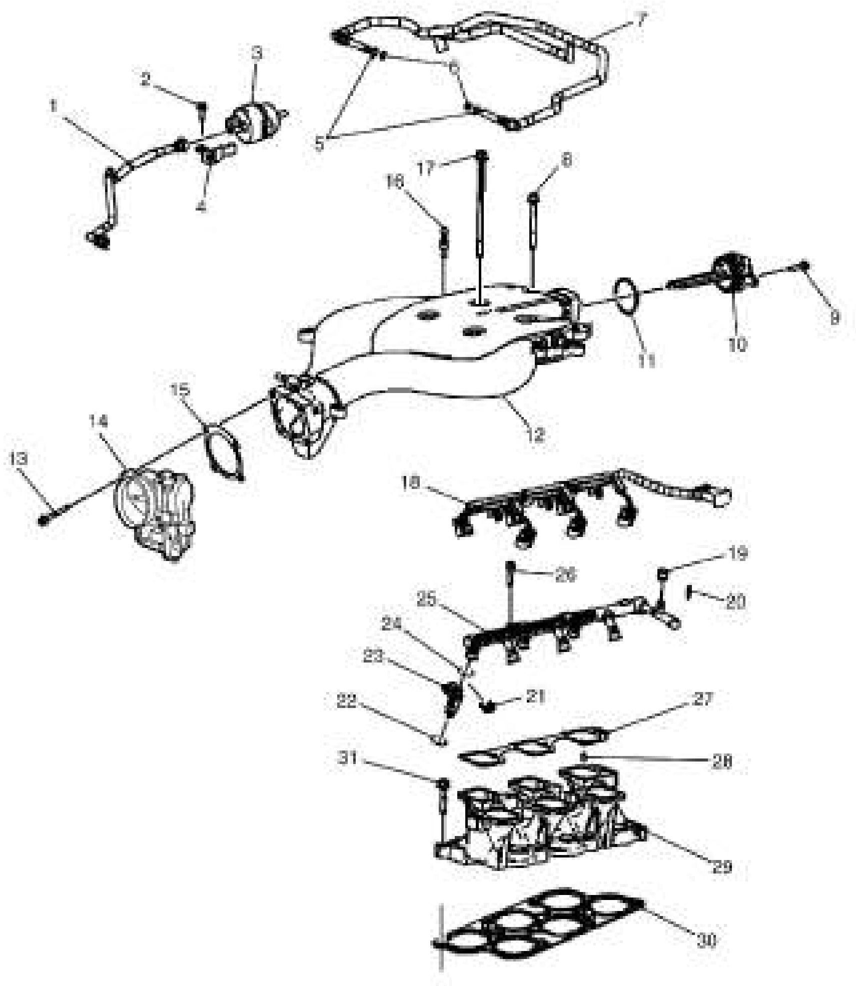


(1) Timing Chain Tensioner and Guide Bolt - Right Side
(2) Secondary Timing Chain Tensioner - Right Side
(3) Secondary Timing Chain Tensioner Gasket - Right Side
(4) Secondary Timing Chain Shoe - Right Side
(5) Secondary Timing Chain - Right Side
(6) Camshaft Position Actuator to Camshaft Retaining Bolt - Bank 2
(7) Exhaust Camshaft Position Actuator - Bank 2
(8) Camshaft Position Actuator to Camshaft Retaining Bolt - Bank 2
(9) Intake Camshaft Position Actuator - Bank 2
(10) Secondary Timing Chain Guide Bolt - Right Side
(11) Secondary Timing Chain Guide - Right Side

(12) Secondary Timing Chain Shoe Bolt - Right Side
(13) Primary Timing Chain
(14) Camshaft Intermediate Drive Chain Idler Sprocket
(15) Camshaft Intermediate Drive Chain Idler Sprocket Bolt
(16) Primary Timing Chain Upper Guide
(17) Primary Timing Chain Guide Bolt
(18) Primary Timing Chain Tensioner Bolt
(19) Primary Timing Chain Tensioner
(20) Primary Timing Chain Tensioner Gasket
(21) Crankshaft Sprocket
(22) Primary Timing Chain Lower Guide Bolt
(23) Primary Timing Chain Lower Guide
(24) Secondary Timing Chain Guide Bolt - Left Side
(25) Secondary Timing Chain Guide - Left Side
(26) Secondary Timing Chain Shoe Bolt - Left Side
(27) Camshaft Intermediate Drive Shaft Sprocket Bolt - Left Side
(28) Camshaft Intermediate Drive Shaft Sprocket - Left Side
(29) Secondary Timing Chain - Left Side
(30) Camshaft Position Actuator to Camshaft Retaining Bolt - Bank 1
(31) Exhaust Camshaft Position Actuator - Bank 1
(32) Intake Camshaft Position Actuator - Bank 1
(33) Camshaft Position Actuator to Camshaft Retaining Bolt - Bank 1
(34) Secondary Timing Chain Shoe - Left Side
(35) Secondary Timing Chain Tensioner Gasket - Left Side
(36) Secondary Timing Chain Tensioner - Left Side
(37) Timing Chain Tensioner Bolt - Left Side

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Component Locator | **Document ID: 1985189**

Intake Manifold

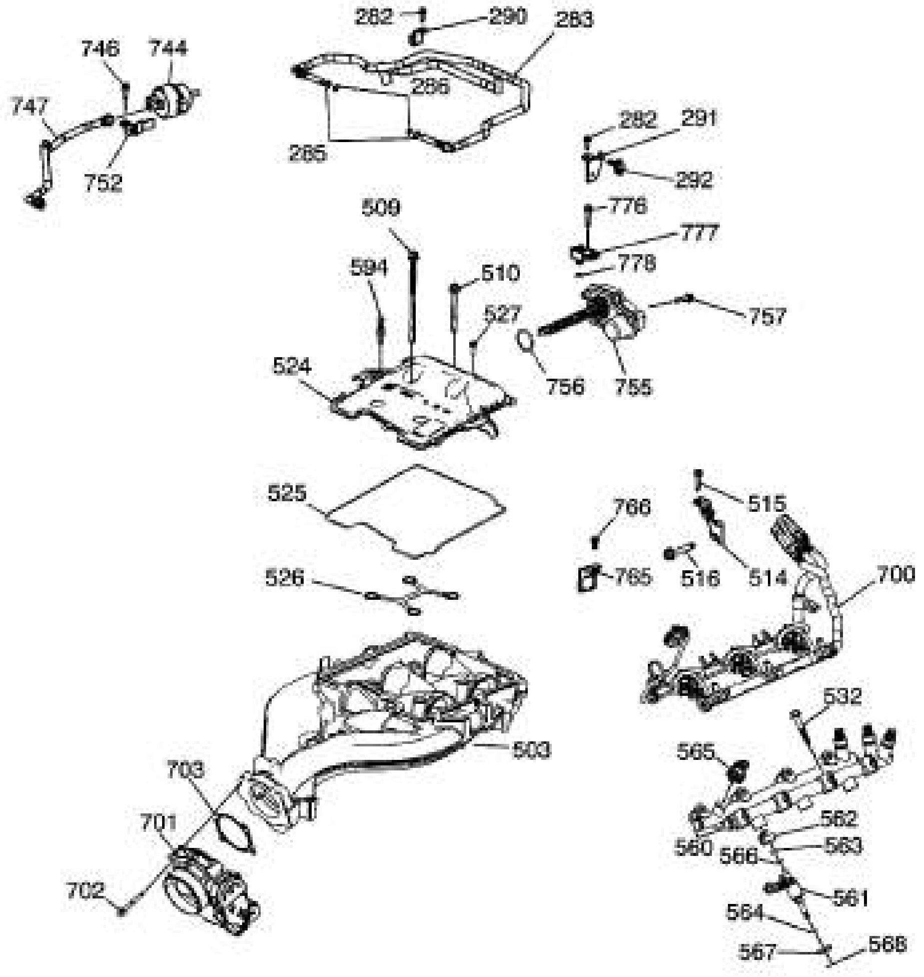


(1) Evaporative Emission (EVAP) Canister Purge Solenoid Valve Tube
(2) EVAP Canister Purge Solenoid Valve Bolt
(3) EVAP Canister Purge Solenoid Valve
(4) EVAP Canister Purge Solenoid Valve Bracket
(5) Positive Crankcase Ventilation (PCV) Hose O-Ring Outer/Larger
(6) PCV Hose O-Ring Inner/Smaller
(7) PCV Hose
(8) Upper Intake Manifold Bolt - Short
(9) Intake Manifold Runner Control Flap Retaining bolt
(10) Intake Manifold Runner Control Flap
(11) Intake Manifold Runner Control Flap O-Ring

(12) Upper Intake Manifold Assembly
(13) Throttle Body Retaining Bolt
(14) Throttle Body
(15) Throttle Body Gasket
(16) Engine Cover Ball Stud
(17) Upper Intake Manifold Bolt - Long
(18) Fuel Injector Wiring Harness
(19) Fuel Pressure Service Valve Cap
(20) Fuel Pressure Service Valve
(21) Fuel Injector Retaining Clip
(22) Fuel Injector Lower Seal
(23) Fuel Injector
(24) Fuel Injector Upper Seal
(25) Fuel Rail
(26) Fuel Rail Bolt
(27) Upper Intake Manifold Gasket
(28) Lower Intake Manifold to Upper Intake Manifold Guide Pin
(29) Lower Intake Manifold
(30) Lower Intake Manifold Gasket
(31) Lower Intake Manifold Retaining Bolt

2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Component Locator | **Document ID: 1993600**

Intake Manifold (LLT)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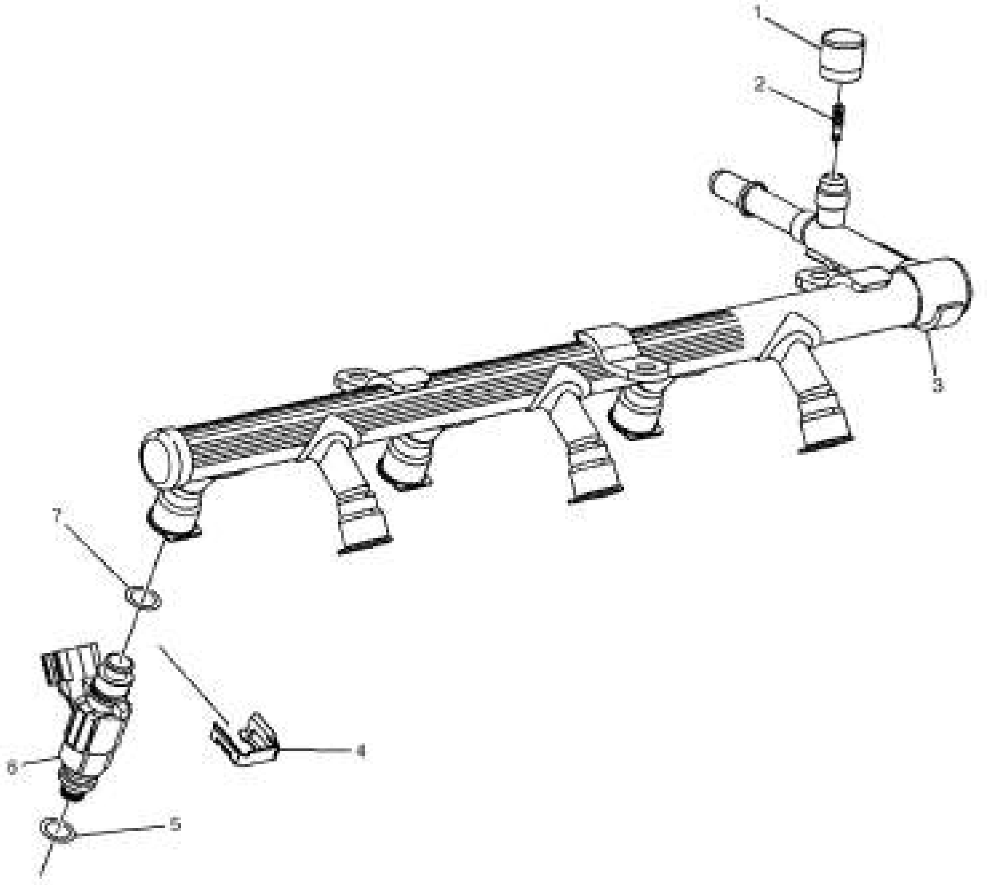
(282) PCV Hose Bolt
(282) PCV Hose Bolt
(283) Dirty PCV Hose
(285) PCV Hose O-ring Outer/Larger
(286) PCV Hose O-ring Inner/Smaller
(290) PCV Hose Right Bracket
(291) PCV Hose Left Bracket
(292) PCV Hose Clip
(503) Upper Intake Manifold
(509) Upper Intake Manifold Bolt - Long
(510) Upper Intake Manifold Bolt - Short

(514) Intake Manifold Brace
(515) Intake Manifold Brace Small Bolt
(516) Intake Manifold Brace Large Bolt
(524) Intake Manifold Cover
(525) Intake Manifold Cover Gasket
(526) Intake Manifold Cover Lower Gasket
(527) Intake Manifold Cover Bolt
(532) Fuel Rail Bolt
(560) Fuel Rail
(561) Fuel Injector
(562) Fuel Injector Retainer
(563) Fuel Injector O-ring Seal
(564) Fuel Injector Teflon Seal
(565) Fuel Pressure Sensor
(566) Fuel Injector Spacer
(567) Fuel Injector Isolator Cup
(568) Fuel Injector Isolator Cup Retaining Ring
(594) Fuel Injector Sight Shield Cover Ball Stud
(700) Fuel Injector Wiring Harness
(701) Throttle Body
(702) Throttle Body Bolt
(703) Throttle Body Gasket
(744) EVAP Purge Solenoid
(746) EVAP Purge Solenoid Bolt
(747) EVAP Purge Solenoid Tube
(752) EVAP Purge Solenoid Bracket
(755) Intake Manifold Tuning Valve
(756) Intake Manifold Tuning Valve O-ring
(757) Intake Manifold Tuning Valve Bolt
(765) Fuel Injector Wiring Harness Bracket
(766) Fuel Injector Wiring Harness Bracket Bolt
(776) BARO Sensor Bolt
(777) BARO Sensor
(778) BARO Sensor O-ring

Fuel Rail



(1) Fuel Pressure Service Valve Cap

(2) Fuel Pressure Service Valve

(3) Fuel Rail

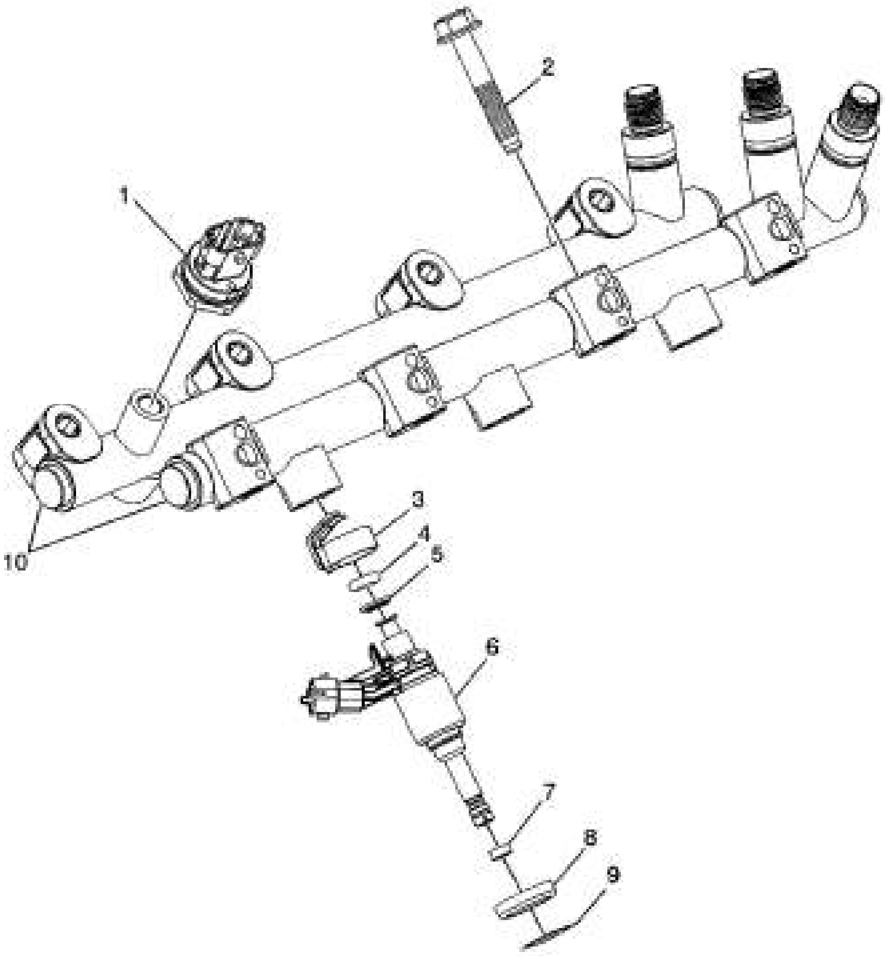
(4) Fuel Injector Retainer

(5) Fuel Injector Lower Seal

(6) Fuel Injector

(7) Fuel Injector Upper Seal

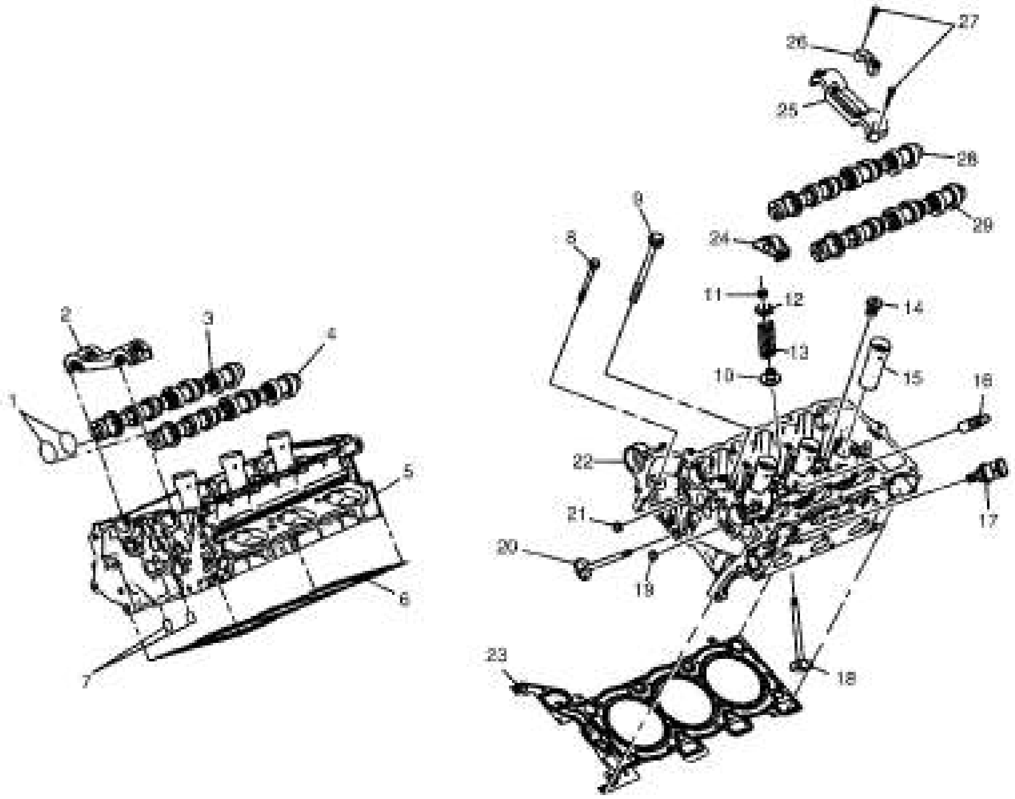
Fuel Rail (LLT)



(1) Fuel Pressure Sensor
(2) Fuel Rail Bolt
(3) Fuel Injector Retainer
(4) Fuel Injector O-ring Seal
(5) Fuel Injector Spacer
(6) Fuel Injector
(7) Fuel Injector Teflon Seal
(8) Fuel Injector Isolator Cup
(9) Fuel Injector Isolator Cup Retaining Ring
(10) Fuel Rail

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Component Locator | **Document ID: 1985191**

Cylinder Head Assemblies

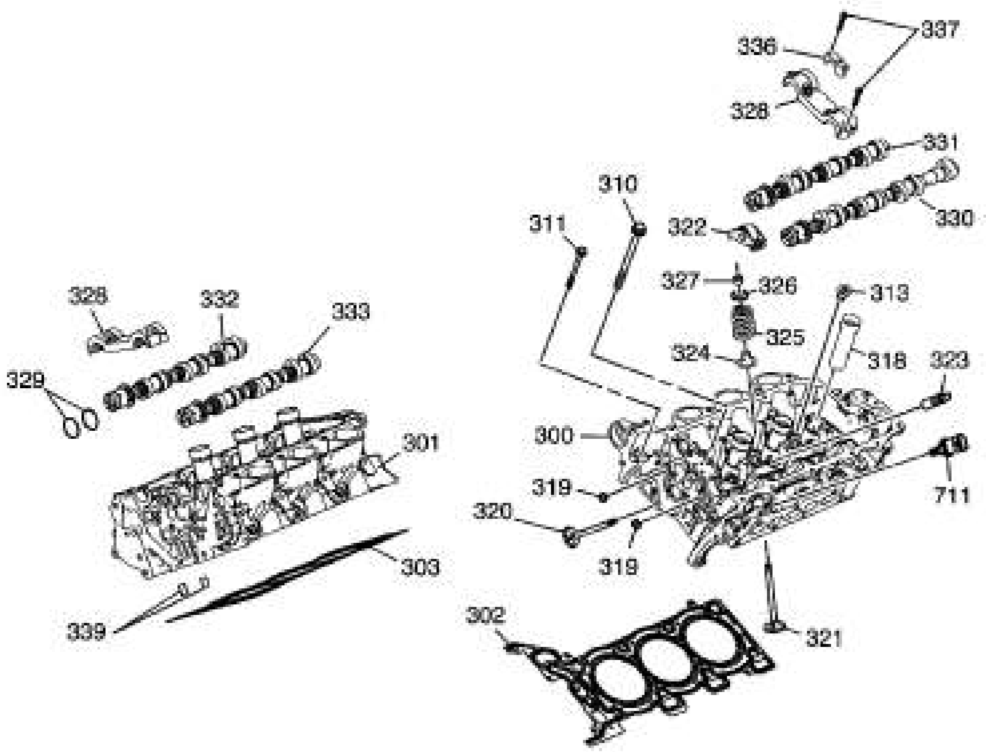


(1) Camshaft Oil Seal Ring
(2) Cylinder Head Camshaft Front Thrust Bearing Cap
(3) Exhaust Camshaft - Right Side
(4) Intake Camshaft - Right Side
(5) Cylinder Head - Right Side
(6) Cylinder Head Gasket - Right Side
(7) Cylinder Head Oil Gallery Check Valve
(8) Cylinder Head Front Bolt
(9) Cylinder Head Bolt
(10) Valve Stem Oil Seal
(11) Valve Collets

(12) Valve Spring Cap
(13) Valve Spring
(14) Cylinder Head Coolant Hole Threaded Plug
(15) Spark Plug Sleeve
(16) Hydraulic Valve Lash Adjuster Assembly
(17) Engine Coolant Temperature Sensor
(18) Exhaust Valve
(19) Cylinder Head Oil Gallery Expansion Plug - 14 mm
(20) Intake Valve
(21) Cylinder Head Oil Gallery Expansion Plug - 14 mm
(22) Cylinder Head - Left Side
(23) Cylinder Head Gasket - Left Side
(24) Valve Rocker Arm Assembly
(25) Cylinder Head Camshaft Front Thrust Bearing Cap
(26) Cylinder Head Camshaft Cap - Intermediate
(27) Cylinder Head Camshaft Cap Bolt
(28) Intake Camshaft - Left Side
(29) Exhaust Camshaft - Left Side

2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Component Locator | **Document ID: 1993604**

Cylinder Head Assemblies (LLT)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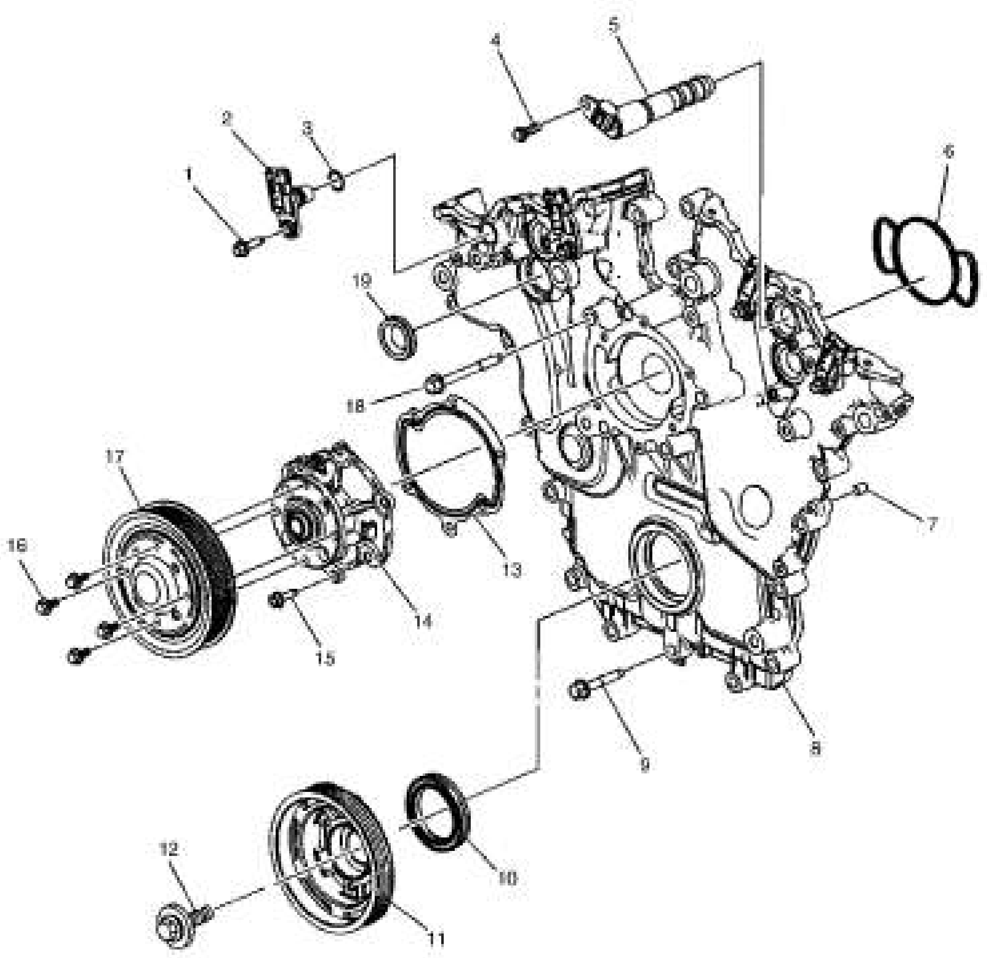
321

(300) Left Cylinder Head
(301) Right Cylinder Head
(302) Left Cylinder Head Gasket
(303) Right Cylinder Head Gasket
(310) Cylinder Head Bolt
(311) Cylinder Head Front Bolt
(313) Cylinder Head Coolant Hole Threaded Plug
(318) Spark Plug Sleeve
(319) Cylinder Head Oil Gallery Expansion Plug - 14 mm
(319) Cylinder Head Oil Gallery Expansion Plug - 14 mm
(320) Exhaust Valve
(321) Intake Valve
(322) Valve Rocker Arm Assembly
(323) Hydraulic Valve Lash Adjuster Assembly
(324) Valve Stem Oil Seal
(325) Valve Spring
(326) Valve Spring Cap
(327) Valve Stem Key

(328) Cylinder Head Camshaft Front Thrust Bearing Cap
(328) Cylinder Head Camshaft Front Thrust Bearing Cap
(329) Camshaft Oil Seal Ring
(330) Left Exhaust Camshaft
(331) Left Intake Camshaft
(332) Right Intake Camshaft
(333) Right Exhaust Camshaft
(336) Cylinder Head Camshaft Cap - Intermediate
(337) Cylinder Head Camshaft Cap Bolt
(339) Cylinder Head Oil Gallery Check Valve
(711) Engine Coolant Temperature Sensor

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Component Locator | **Document ID: 1985192**

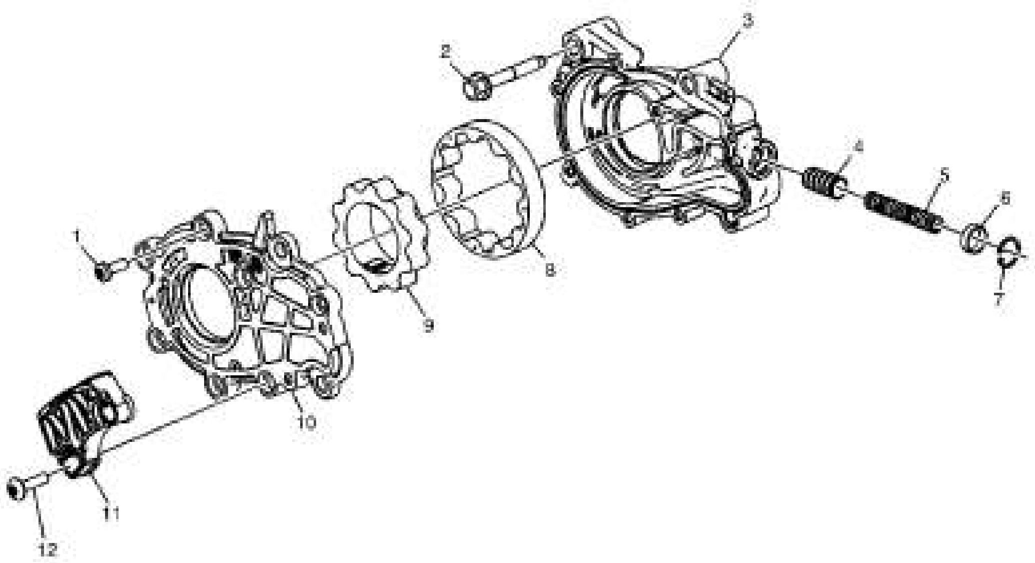
Engine Front Cover



(1) Camshaft Position Sensor Bolt
(2) Camshaft Position Sensor
(3) Camshaft Position Sensor O-Ring
(4) Camshaft Position Actuator Solenoid Valve to Engine Front Cover Retaining Bolt
(5) Camshaft Position Actuator Solenoid Valve
(6) Engine Front Cover to Cylinder Block Seal
(7) Engine Front Cover Guide Pin
(8) Engine Front Cover
(9) Engine Front Cover Retaining Bolt
(10) Crankshaft Front Oil Seal
(11) Crankshaft Balancer

(12) Crankshaft Balancer Bolt
(13) Water Pump Gasket
(14) Water Pump Assembly
(15) Water Pump Bolt
(16) Water Pump Pulley Bolt
(17) Water Pump Pulley
(18) Engine Front Cover Retaining Bolt
(19) Camshaft Position Actuator Solenoid Valve Seal

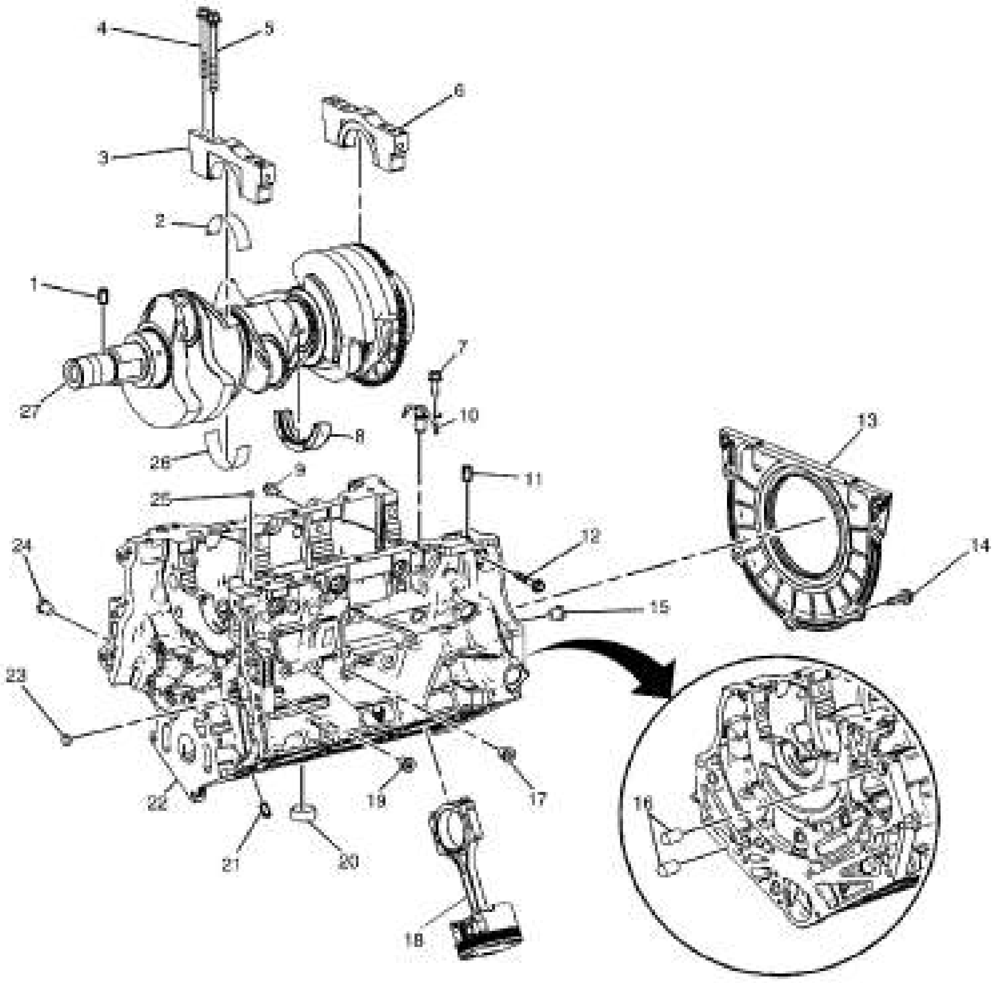
Oil Pump



(1) Oil Pump Cover Retaining Bolt
(2) Oil Pump Retaining Bolt
(3) Oil Pump Housing
(4) Oil Pressure Relief Valve
(5) Oil Pressure Relief Valve Spring
(6) Oil Pressure Relief Valve Bore Plug
(7) Oil Pressure Relief Valve Bore Plug Retainer Clip
(8) Oil Pump Driven Gear
(9) Oil Pump Drive Gear
(10) Oil Pump Cover
(11) Primary Camshaft Drive Chain Lower Guide
(12) Primary Camshaft Drive Chain Lower Guide Retaining Bolt

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Component Locator | **Document ID: 1985194**

Engine Block Assembly

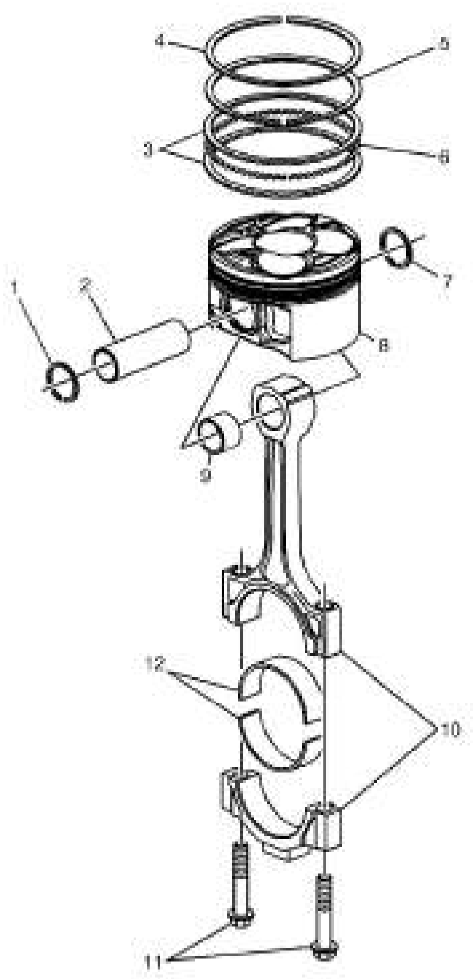


(1) Crankshaft Sprocket Pin
(2) Crankshaft Lower Bearing
(3) Crankshaft Bearing Cap
(4) Crankshaft Bearing Cap Outboard Bolt
(5) Crankshaft Bearing Cap Inboard Bolt
(6) Crankshaft Bearing Thrust Cap
(7) Oil Jet Retaining Bolt
(8) Oil Jet
(9) Crankshaft Upper Thrust Bearing #3
(10) Cylinder Block-to-Oil Pan Alignment Dowels
(11) Crankshaft Bearing Cap Side Bolt - Long

(12) Engine Block Oil Gallery Threaded Plug - 14 mm
(13) Crankshaft Rear Oil Seal Housing Assembly
(14) Crankshaft Rear Oil Seal Housing Assembly Bolt
(15) Cylinder Block-to-Transmission Alignment Dowels
(16) Engine Block Coolant Drain Threaded Plug - 14 mm
(17) Piston and Connecting Rod Assembly
(18) Engine Block Oil Gallery Threaded Plug - 14 mm
(19) Engine Block Core Coolant Expansion Plug - 34.3 mm
(20) Cylinder Head Locating Pin
(21) Engine Block
(22) Engine Block Oil Gallery Expansion Plug - 14 mm
(23) Engine Block Oil Gallery Threaded Plug - 20 mm
(24) Engine Block Oil Gallery Expansion Plug - 10 mm
(25) Crankshaft Bearing Cap Side Bolt - Short
(26) Crankshaft Upper Bearing
(27) Crankshaft

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Component Locator | Document ID: 1985196

Piston, Rings, Bearing and Connecting Rod

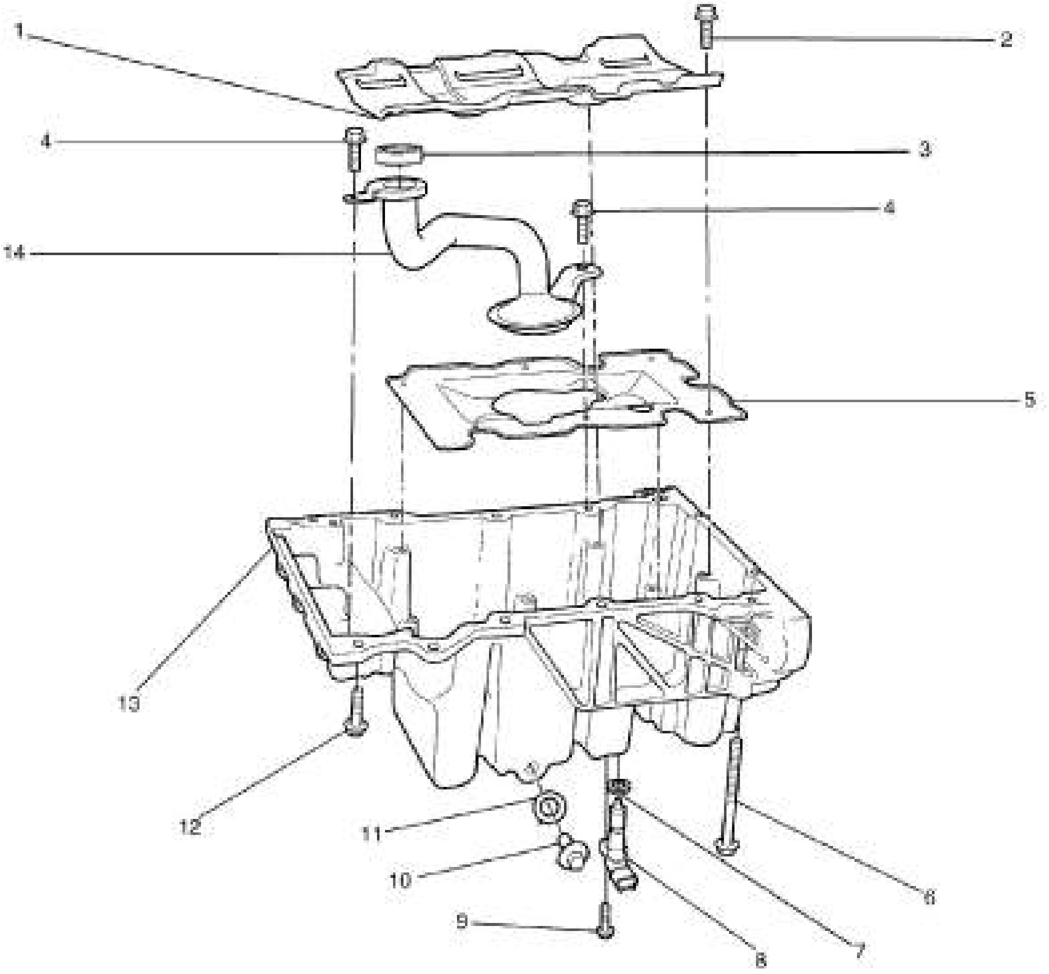


(1) Piston Pin Retainer
(2) Piston Pin
(3) Piston Oil Control Rail Ring
(4) Piston Upper Compression Ring
(5) Piston Lower Compression Ring
(6) Piston Oil Control Ring Spacer
(7) Piston Pin Retainer
(8) Piston
(9) Connecting Rod Bushing
(10) Connecting Rod
(11) Connecting Rod Bolt

(12) Connecting Rod Bearing

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Component Locator | **Document ID: 1985198**

Oil Pan Assembly

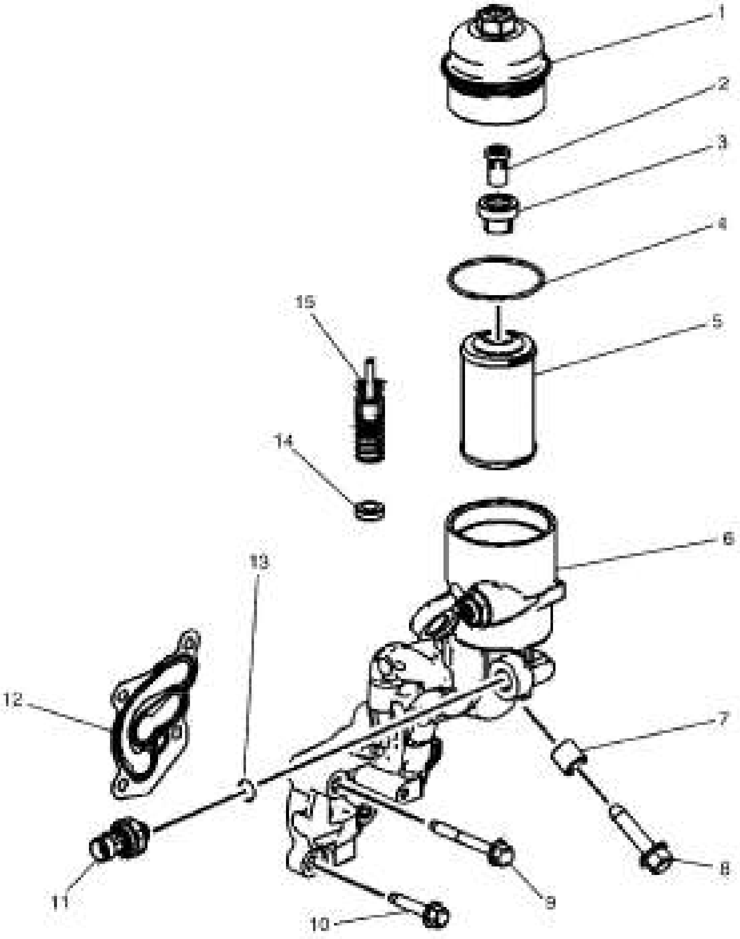


(1) Oil Pan Baffle Scraper
(2) Oil Pan Scraper to Oil Pan Retaining Bolt
(3) Oil Pump Suction Pipe Seal
(4) Oil Suction Pipe to Oil Pan Retaining Bolt
(5) Oil Pan Baffle
(6) Oil Pan Bolt - Long
(7) Engine Oil Level Sensor O-Ring
(8) Engine Oil Level Sensor
(9) Engine Oil Level Sensor Bolt
(10) Oil Pan Drain Plug
(11) Oil Pan Drain Plug O-Ring

(12) Oil Pan Bolt - Short
(13) Oil Pan
(14) Oil Pump Suction Pipe

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Component Locator | **Document ID: 1985199**

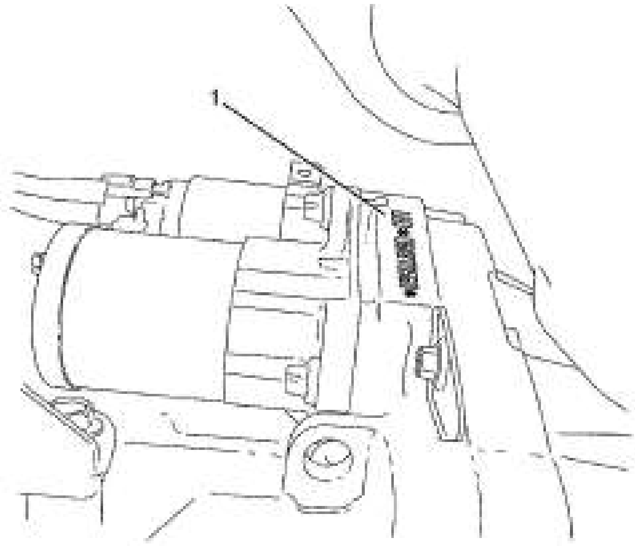
Oil Filter Adapter



(1) Oil Filter AdapterCap
(2) Oil Filter Bypass Valve
(3) Drain Valve Assembly
(4) Oil Filter Cap O-ring
(5) Oil Filter Cartridge
(6) Oil Filter Adapter
(7) Oil Filter Adapter Bolt Sleeve
(8) Oil Filter Adapter Bolt - Large
(9) Oil Filter Adapter Bolt - Long
(10) Oil Filter Adapter Bolt
(11) Engine Oil Pressure Sensor

(12) Oil Filter Adapter Gasket
(13) Engine Oil Pressure Sensor O-ring
(14) Drain Valve Assembly Seal
(15) Oil Filter Bypass Valve Body

Engine Identification



Important: The location of the Engine Serial Number has changed from the previous model. The vehicle must be raised to view the Engine Serial Number as it can only be seen from underneath the vehicle.

The Engine Serial Number is located on the left-hand side at the rear of the engine cylinder block (1) and is stamped or laser etched onto the block at the assembly plant. When reading the Engine Serial Number the following information can be obtained:

Engine Serial Number LE0*061870560* is used as an example:

- The first three digits, LE0, identify the engine model by its Regular Production Option (RPO) code as an LE0 engine.
- The next digit, *, is a number limiter and has no meaning.
- The next two digits, 06, identify the build year as 2006.
- The next three digits, 187, identify the Julian date the engine was manufactured as day 187.
- The next four digits, 0560, identify the assembly plant sequence number as 0560.
- The next digit, *, is a number limiter and has no meaning.

Base Engine Misfire with Abnormal Internal Lower Engine Noises

Cause	Correction
Abnormalities, extreme cracking, bumps or missing areas, in the accessory drive belt. Abnormalities in the accessory drive system and/or components may cause engine RPM variations, noises similar to a faulty lower engine and also lead to a misfire condition. A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to Drive Belt Replacement.
Worn, damaged, or mis-aligned accessory drive components or pulley runout above acceptable tolerances. A misfire code may be present without an actual misfire condition.	Inspect the components, repair or replace as required.
Loose or incorrectly installed engine flywheel or crankshaft balancer. A misfire code may be present without an actual misfire condition.	Repair or replace the engine flywheel and/or crankshaft balancer as required. Refer to Engine Flywheel Replacement or Crankshaft Balancer Replacement.
Worn or broken piston rings Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. Refer to Spark Plug Inspection. • Inspect the cylinders for a loss of compression. Refer to Engine Compression Test. • Perform cylinder leak down and compression testing to determine the cause. • Repair or replace as required.
Worn crankshaft thrust bearings. Severely worn thrust surfaces on the crankshaft and/or thrust bearing may permit fore and aft movement of the crankshaft and create a DTC without an actual misfire condition.	Replace the crankshaft and bearings as required.

Base Engine Misfire with Abnormal Valve Train Noise

Cause	Correction
Worn or loose Stationary Hydraulic Lash Adjusters (SHLAs), valve rocker arms. The SHLAs, valve rocker arm, roller bearing should be intact and in the correct position.	Replace the SHLAs, valve rocker arms, as required.
Sticking valves. Carbon buildup on the valve stem can cause the valve not to close correctly.	Repair or replace as required.
Worn or mis-aligned above acceptable tolerances timing chain or chains.	Replace the timing chain or chains and sprockets as required.
Worn camshaft lobes.	Replace the camshaft or camshafts and high SHLAs, valve lifters.
Sticking SHLAs, lifters.	Replace the SHLAs as required.

Base Engine Misfire with Coolant Consumption

Cause	Correction
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and cylinder block cooling system passages. Refer to Diagnostic Starting Point - Engine Cooling. Coolant consumption may or may not cause the engine to overheat.	• Inspect for spark plugs saturated by coolant. Refer to Spark Plug Inspection. • Perform a cylinder leak down test. Refer to Cylinder Leakage Test • Inspect the cylinder heads and cylinder block for damage to the coolant passages and/or a faulty head gasket. • Repair or replace as required.

Base Engine Misfire with Excessive Oil Consumption

Cause	Correction
Worn valves, valve guides and/or valve stem oil seals.	1. Inspect the spark plugs for oil deposits. Refer to Spark Plug Inspection. 2. Repair or replace as required.
Worn piston rings. Oil consumption may or may not cause the engine to misfire.	1. Inspect the spark plugs for oil deposits. Refer to Spark Plug Inspection 2. Inspect the cylinders for a loss of compression. Refer to Engine Compression Test. 3. Perform cylinder leak down and compression testing to determine the cause. 4. Repair or replace as required.

Base Engine Misfire without Internal Engine Noises

Cause	Correction
Abnormalities, extreme cracking, bumps, or missing areas, in the accessory drive belt. Abnormalities in the accessory drive system and/or components may cause engine RPM variations and lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to Drive Belt Replacement.
Worn, damaged, or mis-aligned accessory drive components or pulley runout above acceptable tolerances may lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Inspect the components: Repair or replace as required.
Loose or incorrectly installed engine flywheel or crankshaft balancer. A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required. Refer to Engine Flywheel Replacementt or Crankshaft Balancer Replacement.
Restricted exhaust system. An extreme restriction in the exhaust flow can cause significant loss of engine performance and may set a DTC. Possible causes of restrictions include collapsed or dented pipes or plugged mufflers and/or catalytic converters.	Repair or replace as required. Refer to engine exhaust for the required procedure.
Incorrectly installed or damaged vacuum hoses.	Repair or replace as required.
Incorrect sealing between the intake manifold and cylinder heads, intake manifold and throttle body and/or pressure relief valve and intake manifold.	Replace the intake manifold, plenum duct, cylinder heads, throttle body, pressure relief valve or gaskets as required.
Incorrectly installed or damaged EVAP purge solenoid and/or O-ring seal.	Repair or replace the EVAP purge solenoid as required.
Worn or loose Stationary Hydraulic Lash Adjusters (SHLAs), valve rocker arms. The stationary hydraulic lash adjusters (SHLAs), valve rocker arm, roller bearing should be intact and in the correct position	Replace the SHLAs, valve rocker arms, as required.
Sticking valves. Carbon buildup on the valve stem can cause the valve not to close correctly.	Repair or replace as required.
Timing chain or chains worn or mis-aligned above acceptable tolerances.	Replace the timing chain or chains and sprockets as required.

Worn camshaft lobes.	Replace the camshaft or camshafts and high Stationary Hydraulic Lash Adjusters (SHLAs), valve lifters.
Oil pressure above acceptable tolerances. A lubrication system with oil pressure above acceptable tolerances may lead to valve lifter pump-up above acceptable tolerances and loss of compression.	• Perform an oil pressure test. Refer to Oil Pressure Diagnosis and Testing. • Repair or replace the oil pump as required.
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and cylinder block cooling system passages. Refer to Diagnostic Starting Point - Engine Cooling. Coolant consumption may or may not cause the engine to overheat.	• Inspect for spark plugs saturated by coolant. Refer to Spark Plug Inspection. • Inspect the cylinder heads, cylinder block, and/or head gaskets. • Repair or replace as required.
Worn piston rings. Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. Refer to Spark Plug Inspection. • Inspect the cylinders for a loss of compression. Refer to Engine Compression Test. • Perform cylinder leak down and compression testing to identify the cause. • Repair or replace as required.
A damaged crankshaft reluctor wheel. A damaged crankshaft reluctor wheel can result in different symptoms depending on the severity and location of the damage. • Systems with EXTREME reluctor ring damage may exhibit periodic loss of crankshaft position, stop delivering a signal, and then re-sync the crankshaft position. • Systems with SLIGHT reluctor ring damage may exhibit no loss of crankshaft position and no misfire may occur. However, a P0300 DTC may be set.	Replace the crankshaft as required.

Coolant in Combustion Chamber

Cause	Correction
DEFINITION: White smoke and/or coolant type odor above acceptable tolerances coming from the exhaust pipe may indicate coolant in the combustion chamber. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an "overtemperature" condition which may cause engine component damage. 1. A slower than normal cranking speed may indicate coolant entering the combustion chamber. Refer to Engine Will Not Crank - Crankshaft Will Not Rotate. 2. Remove the spark plugs and inspect for spark plugs saturated by coolant or coolant in the cylinder bore. 3. Inspect by performing a cylinder leakage test. Refer to Cylinder Leakage Test. During this test, above acceptable air bubbles within the coolant may indicate a faulty gasket or damaged component. 4. Inspect by performing a cylinder compression test. Two cylinders "side-by-side" on the cylinder block, with low compression, may indicate a failed cylinder head gasket. Refer to Engine Compression Test.	
Cracked intake manifold or failed gasket.	Replace the components as required.
Faulty cylinder head gasket.	Replace the head gasket and components as required. Refer to Cylinder Head Cleaning and Inspection. Refer to Cylinder Head Replacement - Left Side or Cylinder Head Replacement - Right Side.
Warped cylinder head.	Machine the cylinder head to the correct flatness, if applicable and replace the cylinder head gasket. Refer to Cylinder Head Cleaning and Inspection.
Cracked cylinder head.	Replace the cylinder head and gasket.
Cracked cylinder liner or cylinder block.	Replace the components as required.
Cylinder head or cylinder block porosity.	Replace the components as required.

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Coolant in Engine Oil

Cause	Correction
DEFINITION: Foamy or discolored oil or an engine oil "overfill" condition may indicate coolant entering the engine crankcase. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an "overtemperature" condition which may cause engine component damage. Contaminated engine oil and oil filter should be changed. 1. Inspect the oil for above acceptable foaming or an overfill condition. Oil diluted by coolant may not correctly lubricate the crankshaft bearings and may lead to component damage. Refer to Lower Engine Noise, Regardless of Engine Speed . 2. Inspect by performing a cylinder leakage test. Refer to Cylinder Leakage Test . During this test, air bubbles within the cooling system may indicate a faulty gasket or damaged component. 3. Inspect by performing a cylinder compression test. Two cylinders "side-by-side" on the cylinder block with low compression may indicate a failed cylinder head gasket. Refer to Engine Compression Test .	
Faulty external engine oil cooler.	Replace the components as required.
Faulty cylinder head gasket.	Replace the head gasket and components as required. Refer to Cylinder Head Cleaning and Inspection . Refer to Cylinder Head Replacement - Left Side or Cylinder Head Replacement - Right Side
Warped cylinder head.	Machine the cylinder head to correct flatness, if applicable, and replace the cylinder head gasket. Refer to Cylinder Head Cleaning and Inspection .
Cracked cylinder head.	Replace the cylinder head and gasket.
Cracked cylinder liner or cylinder block.	Replace the components as required.
Cylinder head, block, or manifold porosity.	Replace the components as required.

Crankcase Ventilation System Inspection/Diagnosis

Crankcase Ventilation (CV) System Inspection

- Test for vacuum at the vacuum hose where it connects to the crankcase ventilation housing. There should be manifold vacuum present at the hose. If there is no vacuum, inspect for a plugged hose, leaking hose or a plugged vent adapter.
- Plug the end of the vacuum hose while the engine is running. Inspect the hose for any areas that collapse when the end of the hose is blocked. Replace the hose if it collapses when blocked.
- If oil has accumulated in the intake air duct, inspect for the following conditions:
  - Plugged vacuum orifice in the crankcase ventilation housing.
  - Plugged or restricted crankcase ventilation housing.
  - Crankcase pressure or blow-by above acceptable tolerances. Refer to Oil Consumption Diagnosis.
- Additional items to inspect:
  - Plugged or leaking fresh air vent hose assembly or vent adapter.
  - Plugged or restricted passages in the throttle body.
  - Missing or damaged O-ring seals on the vent adapter.
  - Inspect the cam covers, the oil pan gasket, and other sealing areas for leaks.

Results of Incorrect Operation

A plugged crankcase ventilation housing or hose may contribute to the following conditions:

- A rough idle.
- Stalling or a slow idle speed.
- Oil leaks.
- Oil accumulation in the intake air duct.
- Sludge in the engine.

A leaking housing or hose may contribute to the following conditions:

- A rough idle.
- Stalling.
- Unstable idle speed.

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Cylinder Leakage Test

Tools Required

- J 35667-A Cylinder Head Leakdown Tester
- J 39313 Spark Plug Port Adapter

Important: A leakage test may be performed in order to measure cylinder/combustion chamber leakage. High cylinder leakage may indicate one or more of the following:

- Worn or burnt valves.
- Broken valve springs.
- Stuck valve lifters.
- Incorrect valve lash.
- Damaged piston.
- Worn piston rings.
- Worn or scored cylinder bore.
- Damaged cylinder head gasket.
- Cracked or damaged cylinder head.
- Cracked or damaged cylinder block.

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the spark plugs. Refer to Spark Plug Replacement.
3. Rotate the crankshaft to place the piston in the cylinder being tested at Top Dead Center (TDC) of the compression stroke.
4. Thread the J 39313 into the spark plug hole.
5. Install the J 35667-A or equivalent.

Important: It may be necessary to hold the crankshaft balancer bolt to prevent the engine from rotating.

6. Apply air pressure to the J 35667-A J 35667-A and adjust according to the manufacturers instructions.
7. Record the cylinder leakage value. Cylinder leakage that exceeds 25 percent is considered above acceptable and may require component service. In above acceptable leakage situations, inspect for the following conditions:
   - Air leakage sounds at the throttle body or air inlet hose may indicate a worn or burnt intake valve or a broken valve spring.
   - Air leakage sounds at the exhaust extension pipe may indicate a worn or burnt exhaust valve or a broken valve spring.
   - Air leakage sounds from the crankcase, oil level indicator tube, or oil fill tube may indicate worn piston rings, a damaged piston, a worn or scored cylinder bore, a damaged cylinder block or a damaged cylinder head.
   - Air bubbles in the cooling system may indicate a damaged cylinder head or a damaged

cylinder head gasket.

8. Perform the leakage test on the remaining cylinders and record the values.

Diagnostic Starting Point - Engine Mechanical

Begin the system diagnosis by reviewing the Disassembled Views, Engine Component Description, Drive Belt System Description and Lubrication Description. Reviewing the description and operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the description and operation information will also help you determine if the condition described by the customer is normal operation. Refer to Symptoms - Engine Mechanical to identify the correct procedure for diagnosing the system and where the procedure is located.

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Drive Belt Chirping, Squeal, and Whine Diagnosis (Squeal)

Diagnostic Aids

A loose or incorrect installation of a body component, a suspension component, or other items of the vehicle may cause the squeal noise.

If the noise is intermittent, verify the accessory drive components by varying their loads making sure they are operated to their maximum capacity. An overcharged A/C system, power steering system with a pinched hose or wrong fluid, or a alternator failing are suggested items to inspect.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. The noise may not be engine related. This step is to verify that the engine is making the noise. If the engine is not making the noise DO NOT proceed further with this table.

3. The noise may be an internal engine noise. Removing the drive belt and operating the engine for a brief period will verify the squeal noise is the drive belt or an accessory drive component. When removing the drive belt the water pump will not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belt removed.

4. This test is to verify that an accessory drive component does not have a seized bearing. With the belt removed test the bearings in the accessory drive components for turning smoothly. Also test the accessory drive components with the engine operating by varying the load on the components to verify that the components operate correctly.

5. This test is to verify that the drive belt tensioner operates correctly. If the drive belt tensioner is not operating correctly, correct belt tension may not be achieved to keep the drive belt from slipping which may cause a squeal noise.

6. This test is to verify that the drive belt is not too long, which may prevent the drive belt tensioner from working correctly. Also if an incorrect length drive belt was installed, it may not be routed correctly and may be turning an accessory drive component in the wrong direction.

7. Misalignment of the pulleys may be caused from incorrect mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across 2 or 3 pulleys. If a misaligned pulley is found, refer to that accessory drive component for the correct installation procedure for that pulley.

8. This test is to verify that the pulleys are the correct diameter or width. Using a known good vehicle compare the pulley sizes.

Step	Action	Yes	No

Notice: Refer to Belt Dressing Notice in the Preface section.

DEFINITION: The following items are indications of drive belt squeal:

- A loud screeching noise that is caused by a slipping drive belt. This is unusual for a drive belt with multiple ribs.
- The noise occurs when a heavy load is applied to the drive belt, such as an air conditioning compressor engagement snapping the throttle, or slipping on a seized pulley or a faulty accessory drive component.

1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	Verify that there is a squeal noise. Does the engine make the squeal noise?	Go to Step 3	Go to Diagnostic Aids
3	**Important:** When removing the drive belt the water pump will not be operating and the engine may overheat. 1. Remove the drive belt. Refer to Drive Belt Replacement. 2. Operate the engine for no longer than 30 to 40 seconds. Does the noise still exist?	Go to Symptoms - Engine Mechanical	Go to Step 4
4	Inspect for an accessory drive component seized bearing or a faulty accessory drive component. Did you find and correct the condition?	Go to Step 9	Go to Step 5
5	Test the drive belt tensioner for correct operation. Refer to Drive Belt Tensioner Diagnosis. Did you find and correct the condition?	Go to Step 9	Go to Step 6
6	Inspect for the correct drive belt length. Refer to Drive Belt Replacement. Did you find and correct the condition?	Go to Step 9	Go to Step 7
7	Inspect for misalignment of a pulley. Did you find and correct the condition?	Go to Step 9	Go to Step 8
8	Inspect for the correct pulley size. Did you find and correct the condition?	Go to Step 9	Go to Diagnostic Aids
9	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

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Drive Belt Chirping, Squeal, and Whine Diagnosis (Whine)

Diagnostic Aids

The drive belts will not cause the whine noise.

If the whine noise is intermittent, verify the accessory drive components by varying their loads making sure they are operated to their maximum capacity. Such items, but not limited to, may be an A/C system overcharged, the power steering system restricted or the wrong fluid, or the alternator failing.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. This test is to verify that the noise is being caused by the drive belts or the accessory drive components. When removing the drive belt, the water pump will not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belts removed.
4. The inspection should include checking the drive belt tensioners and the drive belt idler pulley bearings. The drive belts may have to be installed and the accessory drive components operated separately by varying their loads. Refer to the suspected accessory drive component for the correct inspection and replacement procedure.

Step	Action	Yes	No
Notice: Refer to Belt Dressing Notice in the Preface section. DEFINITION: A high pitched continuous noise that may be caused by an accessory drive component failed bearing.			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	Verify that there is a whine noise. Does the engine make the whine noise?	Go to Step 3	Go to Diagnostic Aids
3	**Important:** When removing the drive belt the water pump will not be operating and the engine may overheat. 1. Remove the drive belt. Refer to Drive Belt Replacement. 2. Operate the engine for no longer than 30 to 40 seconds. Does the whine noise still exist?	Go to Symptoms - Engine Mechanical	Go to Step 4

4	Inspect for a failed accessory drive component bearing. Did you find and repair the condition?	Go to Step 5	Go to Diagnostic Aids
5	Operate the system in order to verify the repair. Did you correct the condition?	System OK	--

Drive Belt Excessive Wear Diagnosis

Diagnostic Aids

Wear on a drive belt above acceptable tolerances is usually caused by an incorrect installation or the wrong drive belt for the application.

Minor misalignment of the drive belt pulleys will not cause wear above acceptable tolerances, but will probably cause the drive belt to make a noise or to fall off.

Misalignment of the drive belt pulleys above acceptable tolerances will cause wear above acceptable tolerances and may also make the drive belt fall off.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. The inspection is to verify the drive belt is correctly installed on all of the drive belt pulleys. Wear on the drive belt may be caused by miss-positioning the drive belt by one groove on a pulley.

3. The installation of a drive belt that is too wide or too narrow will cause wear on the drive belt. The drive belt ribs should match all of the grooves on all of the pulleys.

4. This inspection is to verify the drive belt is not contacting any parts of the engine or body while the engine is operating. There should be sufficient clearance when the drive belt accessory drive components load varies. The drive belt should not come in contact with an engine or a body component when snapping the throttle.

Step	Action	Yes	No
Notice: Refer to Belt Dressing Notice in the Preface section. DEFINITION: Wear at the outside ribs of the drive belt due to an incorrectly installed drive belt.			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	Inspect the drive belt for the correct installation. Refer to Drive Belt Replacement. Did you find the condition?	Go to Step 5	Go to Step 3
3	Confirm the drive belt is the correct specification for the engine. Did you find the condition?	Go to Step 5	Go to Step 4
4	Inspect for the drive belt rubbing against a bracket, hose, or wiring harness.		

	Did you find and repair the condition?	Go to Step 6	Go to Diagnostic Aids
5	Replace the drive belt. Refer to Drive Belt Replacement. Did you complete the replacement?	Go to Step 6	-
6	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-

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Drive Belt Falls Off and Excessive Wear Diagnosis

Diagnostic Aids

If the drive belt repeatedly falls off the drive belt pulleys, this is because of pulley misalignment.

An extra load that is quickly applied or released by an accessory drive component may cause the drive belt to fall off the pulleys. Verify the accessory drive components operate correctly.

If the drive belt is the incorrect length, the drive belt tensioner may not keep the correct tension on the drive belt.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. This inspection is to verify the condition of the drive belt. Damage may have occurred to the drive belt when the drive belt fell off. The drive belt may have been damaged, which caused the drive belt to fall off. Inspect the belt for cuts, tears, sections of ribs missing, or damaged belt plies.
4. Misalignment of the pulleys may be caused from incorrect mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across 2 or 3 pulleys. If a misaligned pulley is found, refer to that accessory drive component for the correct installation procedure of that pulley.
5. Inspecting the pulleys for being bent should include inspecting for a dent or other damage to the pulleys that may prevent the drive belt from not seating correctly in all of the pulley grooves or on the smooth surface of a pulley when the back side of the belt is used to drive the pulley.
6. Accessory drive component brackets that are bent or cracked will let the drive belt fall off.
7. Inspecting the fasteners can address the possibility that a wrong bolt, nut, spacer, or washer was installed. Missing, loose, or wrong fasteners, may cause pulley misalignment due to the bracket moving under load. Over tightening the fasteners may cause misalignment of the accessory drive component bracket.

Step	Action	Yes	No
Notice: Refer to Belt Dressing Notice in the Preface section. DEFINITION: The drive belt falls off the pulleys or may not ride correctly on the pulleys.			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	Inspect for a damaged drive belt.	Go to	

	Did you find the condition?	Step 3	Go to Step 4
3	Install a new drive belt. Refer to Drive Belt Replacement. Does the drive belt continue to fall off?	Go to Step 4	System OK
4	Inspect for misalignment of the pulleys. Did you find and repair the condition?	Go to Step 12	Go to Step 5
5	Inspect for a bent or dented pulley. Did you find and repair the condition?	Go to Step 12	Go to Step 6
6	Inspect for a bent or cracked bracket. Did you find and repair the condition?	Go to Step 12	Go to Step 7
7	Inspect for incorrect, loose or missing fasteners. Did you find incorrect, loose or missing fasteners?	Go to Step 8	Go to Step 9
8	**Notice:** Refer to Fastener Notice in the Preface section. 1. Tighten any loose fasteners. Refer to Fastener Tightening Specifications. 2. Replace incorrect or missing fasteners. Does the drive belt continue to fall off?	Go to Step 9	System OK
9	Test the drive belt tensioner for operating correctly. Refer to Drive Belt Tensioner Diagnosis. Does the drive belt tensioner operate correctly?	Go to Step 11	Go to Step 10
10	Replace the drive belt tensioner. Refer to Drive Belt Tensioner Replacement. Does the drive belt continue to fall off?	Go to Step 11	System OK
11	Inspect for a failed drive belt idler and drive belt tensioner pulley bearings. Did you find and repair the condition?	Go to Step 12	Go to Diagnostic Aids
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 2

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Drive Belt Rumbling and Vibration Diagnosis (Rumble)

Diagnostic Aids

Vibration from the engine operating may cause a body component or another part of the vehicle to make a rumbling noise.

The drive belt may have a condition that can not be seen or felt. Sometimes replacing the drive belt may be the only repair for the symptom.

If replacing the drive belt, completing the diagnostic table, and the noise is only heard when the drive belt is installed, there might be an inoperative accessory drive component. Varying the load on the different accessory drive components may aid in identifying which component is causing the rumbling noise.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. This test is to verify that the symptom is present during diagnosing. Other vehicle components may cause a similar symptom.
3. This test is to verify the drive belt is causing the rumbling noise. A rumbling noise may be confused with an internal engine noise due to the similarity in the description. When removing the drive belt the water pump will not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belts removed.
4. Inspecting the drive belt is to ensure that it is not causing the noise. Small cracks across the ribs of the drive belt will not cause the noise. Belt separation is identified by the plies of the belt separating and may be seen at the edge of the belt or felt as a lump in the belt.
5. Small amounts of pilling is normal condition and acceptable. When the pilling is extreme the drive belt does not have a smooth surface for correct operation.

Step	Action	Yes	No
Notice: Refer to Belt Dressing Notice in the Preface section. DEFINITION: • A low pitch tapping, knocking, or thumping noise heard at or just above idle. • Heard once per revolution of the drive belt or a pulley. • Rumbling may be caused from: - Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove. - The separation of the drive belt. - A damaged drive belt.			

1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	Verify that there is a rumbling noise. Does the engine make the rumbling noise?	Go to Step 3	Go to Diagnostic Aids
3	**Important:** When removing the drive belt the water pump will not be operating and the engine may overheat. 1. Remove the drive belt. Refer to Drive Belt Replacement. 2. Operate the engine for no longer than 30 to 40 seconds. Does the rumbling noise still exist?	Go to Symptoms - Engine Mechanical	Go to Step 4
4	Inspect the drive belt for damage, separation, or sections of missing ribs. Did you find any of these conditions?	Go to Step 7	Go to Step 5
5	Inspect for extreme pilling of more than 1/3 of the drive belt pulley grooves. Did you find extreme pilling?	Go to Step 6	Go to Step 7
6	1. Clean the drive belt pulleys using a suitable wire brush. 2. Reinstall the drive belt. Refer to Drive Belt Replacement. Did you complete the repair?	Go to Step 8	-
7	Install a new drive belt. Refer to Drive Belt Replacement. Did you complete the replacement?	Go to Step 8	-
8	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Diagnostic Aids

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Drive Belt Rumbling and Vibration Diagnosis (Vibration)

Diagnostic Aids

The accessory drive components can have an affect on engine vibration. Such as, but not limited to, the A/C system over charged, the power steering system restricted or the incorrect fluid, or an extra load on the alternator. To help identify an intermittent or an incorrect condition, vary the loads on the accessory drive components.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. This test is to verify that the symptom is present during diagnosing. Other vehicle components may cause a similar symptom such as the exhaust system, or the drivetrain.
3. This test is to verify that the drive belt or accessory drive components may be causing the vibration. When removing the drive belt the water pump will not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belt removed.
4. The drive belt may cause a vibration. While the drive belt is removed, this is the best time to inspect the condition of the belt.
6. Inspecting of the fasteners can address the possibility that a wrong bolt, nut, spacer, or washer was installed.
8. Inspect the water pump shaft for being bent. Also, inspect the water pump bearings for smooth operation and play above acceptable tolerances. Compare the water pump with a known good water pump.
9. Accessory drive component brackets that are bent, cracked, or loose may put extra strain on that accessory component causing it to vibrate.

Step	Action	Yes	No
Notice: Refer to Belt Dressing Notice in the Preface section. DEFINITION: The following items are indications of drive belt vibration: • The vibration is engine-speed related. • The vibration may be sensitive to accessory load.			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical .
2	Verify that the vibration is engine related. Does the engine make the vibration?	Go to Step 3	Go to Diagnostic Aids

3	**Important:** When removing the drive belt the water pump will not be operating and the engine may overheat. 1. Remove the drive belt. Refer to Drive Belt Replacement . 2. Operate the engine for no longer than 30 to 40 seconds. Does the engine still make the vibration?	Go to Drive Belt Rumbling and Vibration Diagnosis	Go to Step 4
4	Inspect the drive belt for wear, damage, debris build-up and missing drive belt ribs. Did you find any of these conditions?	Go to Step 5	Go to Step 6
5	Install a new drive belt. Refer to Drive Belt Replacement . Did you complete the replacement?	Go to Step 10	-
6	Inspect for incorrect, loose or missing fasteners. Did you find any of these conditions?	Go to Step 7	Go to Step 8
7	**Notice:** Refer to Fastener Notice in the Preface section. 1. Tighten any loose fasteners. Refer to Fastener Tightening Specifications . 2. Replace incorrect or missing fasteners. Did you complete the repair?	Go to Step 10	-
8	Inspect for a bent water pump shaft. Refer to Water Pump Replacement . Did you find and correct the condition?	Go to Step 10	Go to Step 9
9	Inspect for bent or cracked brackets. Did you find and correct the condition?	Go to Step 10	Go to Diagnostic Aids
10	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

Drive Belt Tensioner Diagnosis

Step	Action	Yes	No
1	Remove the drive belt. Refer to Drive Belt Replacement. Inspect the drive belt tensioner pulley. Is the drive belt tensioner pulley loose or misaligned?	Go to Step 4	Go to Step 2
2	Rotate the drive belt tensioner. Does the tensioner rotate without any unusual resistance or binding?	Go to Step 3	Go to Step 4
3	1. Use a torque wrench in order to measure the torque required to move the tensioner off of the stop. 2. Use a torque wrench on a known good tensioner in order to measure the torque required to move the tensioner off of the stop. Is the first torque reading within 10% of the second torque reading?	System OK	Go to Step 4
4	Replace the drive belt tensioner. Refer to Drive Belt Tensioner Replacement. Is the repair complete?	System OK	-

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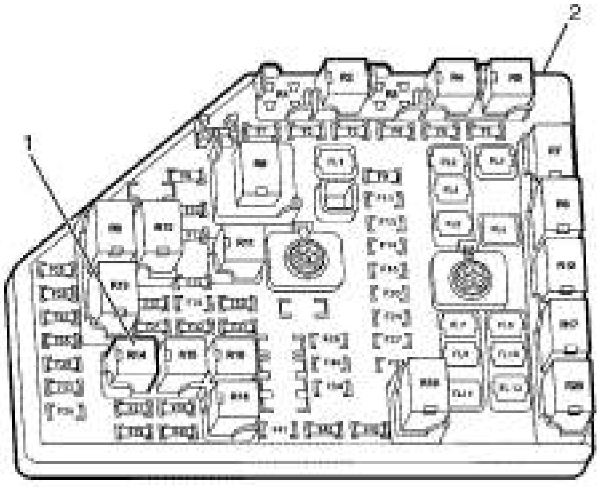
Engine Compression Test

Tools Required

J 39313 Spark Plug Port Adapter.

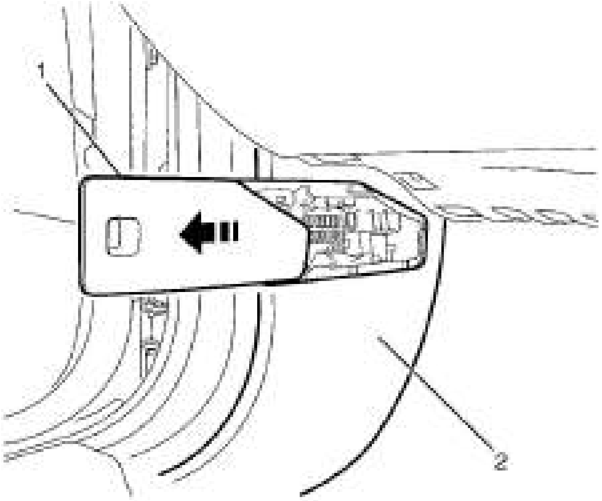
A compression pressure test of the engine cylinders determines the condition of the rings, the valves and the head gasket.

1. Run the engine until it reaches normal operating temperature. The battery must be at or near full charge.
2. Charge the battery if the battery is not fully charged.
3. Turn the engine to the OFF position.



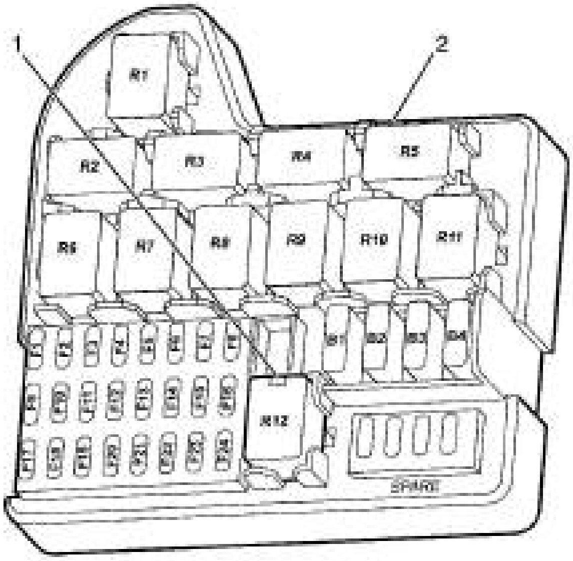
Important: Remove the ignition relay (1) from the under hood body electrical centre (2).

4. Disable the ignition system.



Important: Pull the instrument panel fuse block cover (1) rearward to disengage it from the left hand hinge pillar trim (2).

5. Remove the instrument panel fuse block cover (1).

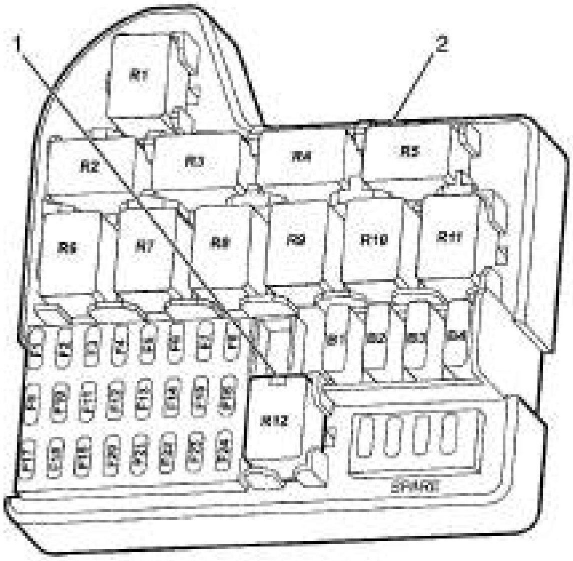


Important: Remove the fuel pump relay (1) from the instrument panel fuse block (2).

6. Disable the fuel injection system.
7. Remove the spark plugs from all cylinders. Refer to Spark Plug Replacement.
8. Measure the engine compression, using the following procedure:
    8.1. Thread the J 39313 into the spark plug hole.

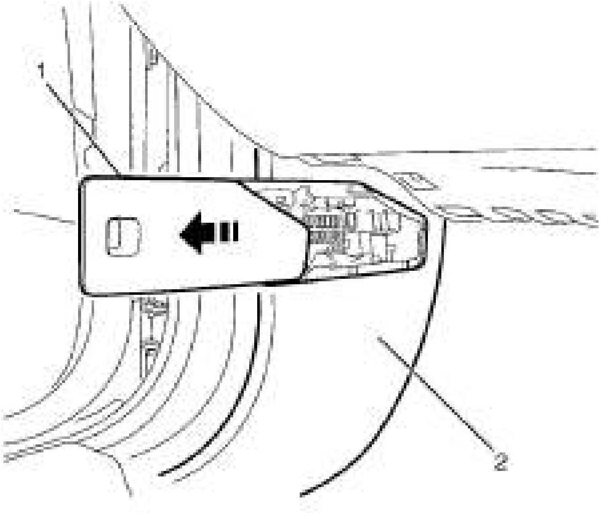
  8.2. Thread the compression gauge into the J 39313 .
  8.3. Have an assistant depress the accelerator to the wide open throttle position and crank the engine through, at least 4 compression strokes, in the testing cylinder.
  8.4. Check and record the readings on the gauge at each stroke.
  8.5. Remove the compression gauge from the J 39313 .
  8.6. Remove the J 39313 from the spark plug hole.
  8.7. Repeat the compression test for each cylinder.

9. Record the compression readings from all of the cylinders.
   - The lowest reading should not be less than 70 percent of the highest reading.
   - No cylinder reading should be less than 965 kPa (140 psi).
10. If a cylinder has low compression, inject approximately 15 ml (1 tablespoon) of engine oil into the combustion chamber through the spark plug hole. Measure the compression again and record the reading.
    - Normal -- Compression builds up quickly and evenly to the specified compression for each cylinder.
    - Piston Rings Leaking -- Compression is low on the first stroke. Compression builds up with the following strokes, but does not reach normal. Compression improves considerably when you add oil.
    - Valves Leaking -- Compression is low on the first stroke. Compression usually does not build up on the following strokes. Compression does not improve much when you add oil.
    - If 2 adjacent cylinders have lower than normal compression, and injecting oil into the cylinders does not increase the compression, the cause may be a head gasket leaking between the cylinders.



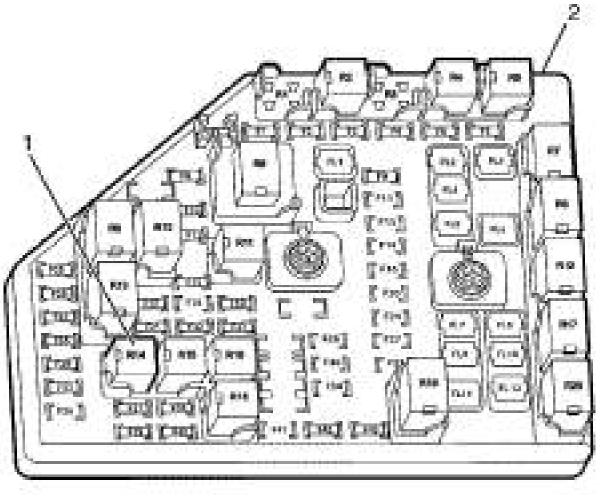
Important: Install the fuel pump fuse to the rear fuse and relay centre fuse block.

11. Enable the fuel injection system.



Important: Push the fuse block access cover (1) forward to engage it to the left hand hinge pillar trim (2).

12. Install the left hand hinge pillar trim fuse block access cover (1).



Important: Install the ignition relay (1) to the under bonnet fuse block (2).

13. Enable the ignition system.
14. Install the spark plugs to all cylinders. Refer to Spark Plug Replacement.

Engine Noise on Start-Up, but Only Lasting a Few Seconds

Cause	Correction
Incorrect oil filter.	Install the correct oil filter.
Incorrect oil viscosity.	Drain the engine oil and replace with the correct viscosity oil.
High Stationary Hydraulic Lash Adjuster (SHLA), valve lifter, leak down rate.	Replace the SHLAs, valve lifters, as required.
Worn crankshaft thrust bearing.	• Inspect the thrust bearing and crankshaft. • Repair or replace as required.
Damaged or faulty oil filter by-pass valve.	• Inspect the oil filter by-pass valve for correct operation. • Replace the oil filter as required.

Engine Noise Under Load

Cause	Correction
Low oil pressure.	1. Perform an oil pressure test. Refer to Oil Pressure Diagnosis and Testing. 2. Repair or replace as required.
Detonation or spark knock.	Verify the correct operation of the ignition controls. Refer to Electronic Ignition (EI) System Diagnosis.
Loose torque converter bolts.	1. Inspect the torque converter bolts and engine flywheel. 2. Repair as required.
Cracked engine flywheel.	1. Inspect the engine flywheel and bolts. 2. Repair as required.
Connecting rod bearing clearance above acceptable tolerances.	Inspect the following components, and repair as required: • The connecting rod bearings • The connecting rods • The crankshaft
Crankshaft bearing clearance above acceptable tolerances.	Inspect the following components, and repair as required: • The crankshaft bearings • The crankshaft journals • The cylinder block crankshaft bearing bore

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Engine Will Not Crank - Crankshaft Will Not Rotate

Cause	Correction
Seized accessory drive system component.	1. Remove the accessory drive belt or belts. 2. Rotate the crankshaft by hand at the crankshaft balancer or the engine flywheel location. 3. Repair or replace as required.
Hydraulically locked cylinder. • Coolant/antifreeze in cylinder. • Oil in cylinder. • Fuel in cylinder.	1. Remove the spark plugs and check for fluid. 2. Inspect for broken head gasket or gaskets. 3. Inspect for cracked cylinder block or cylinder head. 4. Inspect for a sticking fuel injector. 5. Repair or replace as required.
Seized automatic transmission torque converter.	1. Remove the torque converter bolts. 2. Rotate the crankshaft by hand at the crankshaft balancer or the engine flywheel location. 3. Repair or replace as required.
Material in cylinder. • Broken valve. • Piston material. • Foreign material.	1. Inspect the cylinder for damaged components and/or foreign materials. 2. Repair or replace as required.
Seized crankshaft or connecting rod bearings.	1. Inspect the crankshaft and the connecting rod bearings. 2. Repair as required.
Bent or broken connecting rod.	1. Inspect the connecting rods. 2. Repair as required.
Broken crankshaft.	1. Inspect the crankshaft. 2. Repair as required.
Seized or broken camshaft.	1. Inspect the camshaft or camshafts. 2. Inspect the cylinder head camshaft journals for damage. 3. Repair as required.
Seized or broken camshaft timing components.	1. Inspect the following sprockets: • The crankshaft sprocket. • The exhaust sprockets. • The intake sprockets. 2. Inspect the following chains: • The primary camshaft drive chain. • The secondary camshaft drive chains. 3. Inspect the following guides: • The lower primary camshaft drive chain guide. • The upper primary camshaft drive chain guides.

	4. Inspect the secondary camshaft drive chain shoe. 5. Inspect the following tensioners: • The primary camshaft drive chain tensioner. • The secondary camshaft drive chain tensioners. 6. Repair as required.
Seized or broken valve train components.	1. Inspect the Stationary Hydraulic Lash Adjusters (SHLAs), rocker arms. 2. Inspect the lifters. 3. Inspect the valves. 4. Inspect the valve springs. 5. Repair as required.

Lower Engine Noise, Regardless of Engine Speed

Cause	Correction
Low oil pressure.	1. Perform an oil pressure test. Refer to Oil Pressure Diagnosis and Testing. 2. Repair or replace damaged components as required.
• Worn accessory drive components. • Abnormalities such as extreme cracking, bumps or missing areas in the accessory drive belt and/or misalignment of system components.	1. Inspect the accessory drive system. 2. Repair or replace as required.
Loose or damaged crankshaft balancer.	1. Inspect the crankshaft balancer. 2. Repair or replace as required.
Detonation or spark knock.	Verify the correct operation of the ignition controls system. Refer to Electronic Ignition (EI) System Diagnosis.
Loose torque converter bolts.	1. Inspect the torque converter bolts and engine flywheel. 2. Repair or replace as required.
Loose or damaged engine flywheel.	Repair or replace the engine flywheel.
• Damaged oil pan, contacting the oil pump screen. • An oil pan that has been damaged may incorrectly position the oil pump screen, preventing correct oil flow to the oil pump.	1. Inspect the oil pan. 2. Inspect the oil pump screen. 3. Repair or replace as required.
Oil pump screen loose, damaged or restricted.	1. Inspect the oil pump screen. 2. Repair or replace as required.
Piston-to-cylinder bore clearance above acceptable tolerances.	1. Inspect the piston and cylinder bore. 2. Repair as required.
Piston pin-to-bore clearance above acceptable tolerances.	1. Inspect the piston, piston pin, and the connecting rod. 2. Repair or replace as required.
Connecting rod bearing clearance above acceptable tolerances.	Inspect the following components, and repair as required: • The connecting rod bearings • The connecting rods • The crankshaft • The crankshaft journals
Crankshaft bearing clearance above acceptable	Inspect the following components, and

tolerances.	repair as required: • The crankshaft bearings • The crankshaft journals
• Incorrect piston, piston pin and connecting rod installation. • Pistons must be installed with the mark or dimple on the top of the piston facing the front of the engine. Piston pins must be centered in the connecting rod pin bore.	1. Verify the pistons, piston pins and connecting rods are installed correctly. 2. Repair as required.

Oil Consumption Diagnosis

Checks	Causes
DEFINITION: Oil consumption (not due to leaks) above acceptable tolerances is the use of 1.9 L (2 qts) or more of engine oil within 3 200 km (2,000 mi). The causes of oil consumption above acceptable tolerances may include the following conditions:	
Preliminary	• External oil leaks - Refer to Oil Leak Diagnosis. • Incorrect oil level or incorrect reading of the oil level indicator. Position the vehicle on a level surface, run the engine for a few minutes, allow adequate drain down time (2-3 minutes) and check for the correct engine oil level. • Incorrect oil viscosity. Refer to the vehicle owners manual and use the recommended SAE grade and viscosity for the prevailing temperatures. • Continuous high speed driving and/or extreme usage. • Crankcase ventilation system restrictions or malfunctioning components. • Worn valve guides and/or valve stems. • Worn, missing or incorrectly installed valve stem oil seals. • Piston rings not seated correctly. Allow adequate time for the rings to seat. • Piston rings broken or worn • Piston and rings incorrectly installed or miss-fitted to the cylinder bore

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Oil Leak Diagnosis

<table>
<tr><th>Checks</th><th>Action</th></tr>
<tr><td colspan="2">Caution: It is important to correctly identify the source of an oil leak. A power steering fluid leak or spillage can travel across the valley area of the engine and run out the weep hole, which is located at the back of the block. Failure to correctly identify the source of an oil leak can lead to the incorrect or unnecessary replacement of components.

Most fluid leaks can be repaired by first visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. Once the leak is identified, determine the cause of the leak. Repair the cause of the leak as well as the leak itself.</td></tr>
<tr><td>Locating and identifying the leak</td><td>To determine if the leaking fluid is engine oil, transmission fluid, power steering fluid, brake fluid, or some other fluid, use the visual inspection method.</td></tr>
<tr><td>Visual Inspection Method</td><td>1. Bring the vehicle to normal operating temperature.
2. Park the vehicle over a clean surface.
3. Wait several minutes, then check for drips.
4. Identify the type of fluid, and the approximate location of the leak.
5. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas.
6. Check for leaks at sealing surfaces, fittings, or from cracked or damaged components.
7. If you cannot locate the leak, do the following:
7.1. Completely clean the entire engine and surrounding components.
7.2. Operate the vehicle for several kilometres at normal operation temperature and at varying speeds.
7.3. Park the vehicle over a clean surface.
7.4. Wait several minutes, then check for drips.
7.5. Identify the type of fluid, and the approximate location of the leak.
7.6. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas.
7.7. See possible causes for leaks.
8. If you still cannot locate the leak, use the powder method or the black light and dye method.</td></tr>
<tr><td>Powder Method</td><td>1. Completely clean the entire engine and surrounding components.
2. Apply an aerosol-type powder (baby powder, foot powder, etc.) to the suspected area.
3. Operate the vehicle for several miles at normal operation temperature and at varying speeds.
4. Identify the type of fluid, and the approximate location of the leak, from the discolorations in the powder surface.
5. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas.
6. See possible causes for leaks.</td></tr>
<tr><td>Black Light and</td><td>1. A dye and light kit is available for finding leaks. Use the J 28428-E</td></tr>
</table>

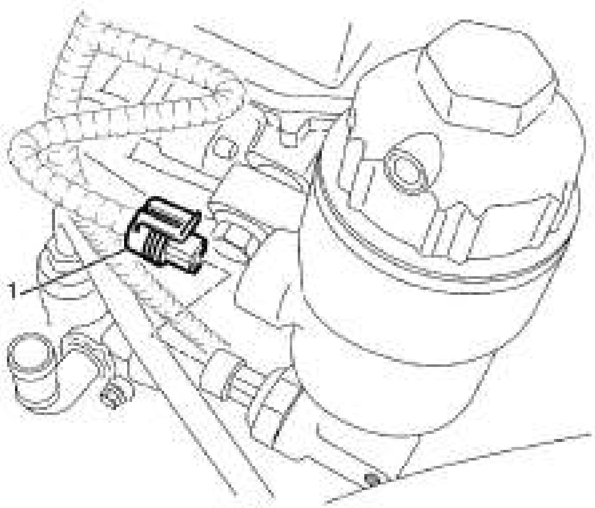
Dye Method	High-Intensity Black Light Kit or equivalent. Refer to the manufacturer's instructions when using the tool. 2. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 3. See possible causes for leaks.
Possible Causes for Leaks	Check for the following conditions: • Higher than recommended fluid levels. • Higher than recommended fluid pressures. • Plugged or malfunctioning fluid filters or pressure bypass valves. • Plugged or malfunctioning engine ventilation system. • Incorrectly tightened or damaged fasteners. • Cracked or porous components. • Incorrect sealants or gaskets where required. • Incorrect sealant or gasket installation. • Damaged or worn gaskets or seals. • Damaged or worn sealing surfaces.

Oil Pressure Diagnosis and Testing

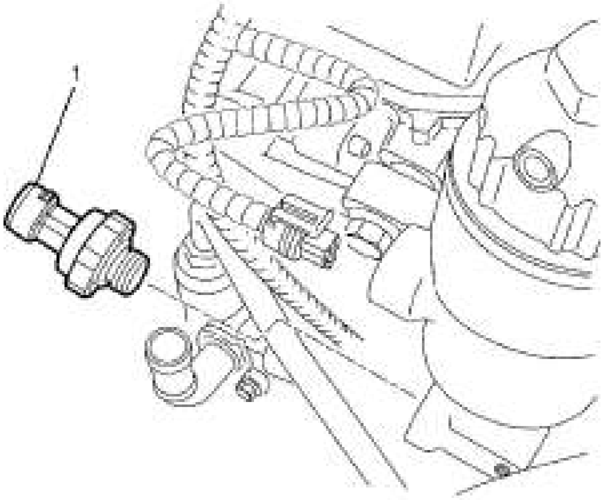
Tools Required

- J 21867 Pressure Gauge
- J-21867-6 Oil Pressure Adapter Fitting

1. Position the vehicle on a level surface, run the vehicle for a few minutes, allow adequate drain down time (2-3 minutes), and measure for a low oil level.
2. If required, add the recommended grade engine oil and fill the crankcase until the oil level measures full on the oil level indicator.
3. Run the engine briefly, 10-15 seconds, and verify low or no oil pressure on the vehicle gauge or light.
4. Listen for a noisy valve train or a knocking noise.
5. Inspect for the following:
   - Foamy oil
   - Slow idle speed
   - Plugged oil filter
   - Oil diluted by the following:
     - Water
     - Engine coolant
     - Unburned fuel mixtures
   - Malfunctioning oil filter bypass valve
   - Incorrect or faulty oil pressure gauge
   - Incorrect or faulty oil pressure gauge sensor
   - incorrect engine oil viscosity for the expected temperature



6. Disconnect the oil pressure sensor connector (1).



7. Remove the oil pressure sensor (1).
8. Install the J 21867 with the J-21867-6 to the oil filter adapter (2).
9. Measure the engine oil pressure.
10. Compare the readings to the Engine Mechanical Specifications.
11. If the engine oil pressure is below specifications, inspect the engine for one or more of the following:
    - Loose oil filter adapter bolts.
    - Missing or damaged oil filter adapter O-ring seal or seals.
    - Worn or dirty oil pump.
    - Loose oil pump-to-cylinder block bolts.
    - Loose, plugged or damaged oil pump screen.
    - Missing or damaged oil pump screen O-ring seal.
    - Damage or leak in the oil pump screen suction tube.
    - Malfunctioning oil pump pressure regulator valve.
    - Missing or incorrectly installed oil gallery plugs.
    - Loose camshaft intermediate drive shaft bolts.
    - Bearing clearance above acceptable tolerances for the following:
        - Connecting rod or rods.
        - Crankshaft.
        - Camshaft or camshafts.
        - Camshaft intermediate drive shaft sprocket.
    - Cracked, porous or restricted oil galleries.
    - Broken valve lifters.
12. Repair or replace components as necessary.

Symptoms - Engine Mechanical

Strategy Based Diagnostics

1. Perform a Diagnostic System Check - Vehicle, before using the symptom tables, if applicable.
2. Review the system operations in order to familiarise yourself with the system functions. Refer to Disassembled Views and Engine Component Description and Drive Belt System Description and Lubrication Description.

All diagnosis on a vehicle should follow a logical process. Strategy based diagnostics is a uniform approach for repairing all systems. The diagnostic flow may always be used in order to resolve a system condition. The diagnostic flow is the place to start when repairs are necessary. For a detailed explanation, refer to Strategy Based Diagnosis.

Visual / Physical Inspection

- Inspect for aftermarket devices which may affect the operation of the engine. Refer to Checking Aftermarket Accessories.
- Inspect the easily accessible or visible system components for obvious damage or conditions which may cause the symptom.
- Check for the correct oil level, correct oil viscosity, and correct filter application.
- Verify the exact operating conditions under which the concern exists. Note factors such as engine RPM, ambient temperature, engine temperature, amount of engine warm-up time, and other specifics.
- Compare the engine sounds, if applicable, to a known good engine and make sure you are not trying to correct a normal condition.

Intermittent

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating correctly.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Base Engine Misfire without Internal Engine Noises.
- Base Engine Misfire with Abnormal Internal Lower Engine Noises.
- Base Engine Misfire with Abnormal Valve Train Noise.
- Base Engine Misfire with Coolant Consumption.
- Base Engine Misfire with Excessive Oil Consumption.
- Engine Noise on Start-Up, but Only Lasting a Few Seconds.
- Upper Engine Noise, Regardless of Engine Speed.
- Lower Engine Noise, Regardless of Engine Speed.
- Engine Noise Under Load

- Engine Will Not Crank - Crankshaft Will Not Rotate.
- Engine Compression Test.
- Oil Consumption Diagnosis.
- Oil Pressure Diagnosis and Testing.
- Oil Leak Diagnosis.

Upper Engine Noise, Regardless of Engine Speed

Cause	Correction
Low oil pressure.	1. Perform an oil pressure test. Refer to Oil Pressure Diagnosis and Testing. 2. Repair or replace as required.
Loose and/or worn Stationary Hydraulic Lash Adjuster (SHLA), valve rocker arm.	1. Inspect the SHLA, valve rocker arm. 2. Repair or replace as required.
Incorrect lubrication to the SHLAs, valve rocker arms.	Inspect the following components, and repair or replace as required: • The SHLA, valve rocker arm • The high stationary SHLA, valve lifter • The oil filter • The oil pump and pump screen • The cylinder head oil galleries • The cylinder block oil galleries
Broken valve spring	Replace the valve spring.
Worn or dirty SHLAs, valve lifters	Replace the SHLAs, valve lifters.
Stretched or broken timing chain or chains and/or damaged sprocket teeth	Replace the timing chain or chains and sprockets.
Worn timing chain tensioner or tensioners	Replace the timing chain tensioner or tensioners as required.
Worn timing chain shoe or shoes	Replace the timing chain shoe or shoes as required.
Worn timing chain guide or guides	Replace the timing chain guide or guides as required.
Worn engine camshaft lobes	1. Inspect the engine camshaft lobes. 2. Replace the camshaft or camshafts and SHLAs, valve lifters, as required.
Worn valve guides or valve stems	Inspect the following components, and repair as required: • The valves • The valve guides
• Stuck valves • Carbon on the valve stem or valve seat may cause the valve to stay open	Inspect the following components, and repair as required: • The valves • The valve guides

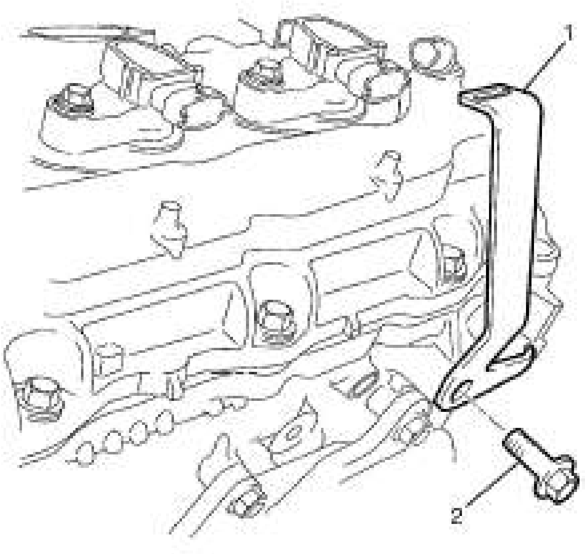
Camshaft Cover Replacement - Left Side

Tools Required

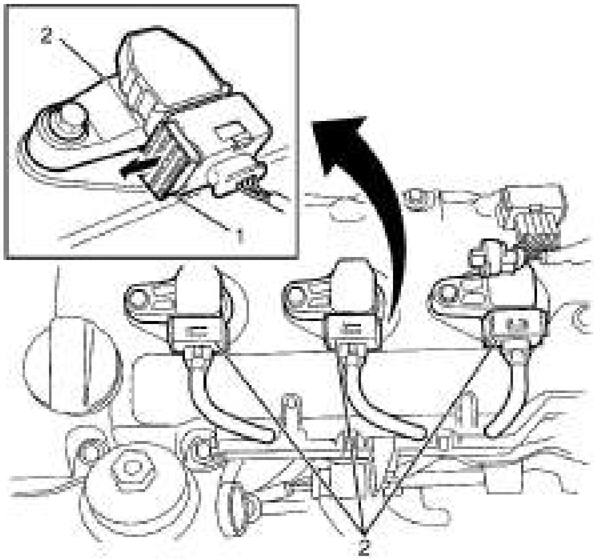
EN 46101 Spark Plug Tube Plugs

Removal Procedure

1. Remove the engine covers. Refer to Engine Cover Replacement .
2. Remove the upper intake manifold with the lower intake manifold. Refer to Lower Intake Manifold Replacement .

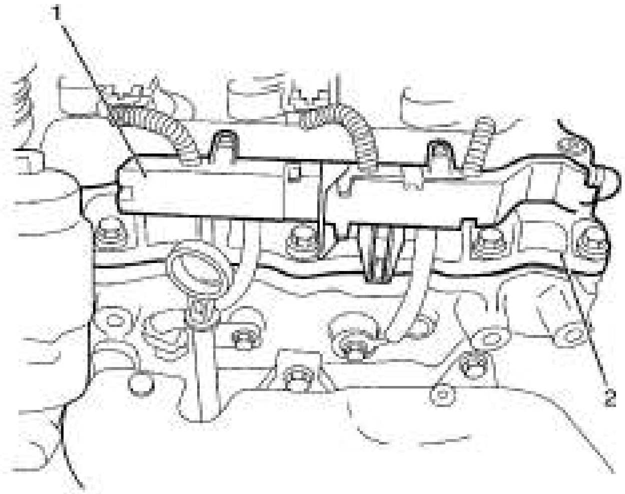


3. Remove the engine covers mounting bracket to cylinder head retaining bolt (2).
4. Remove the engine covers mounting bracket (1).



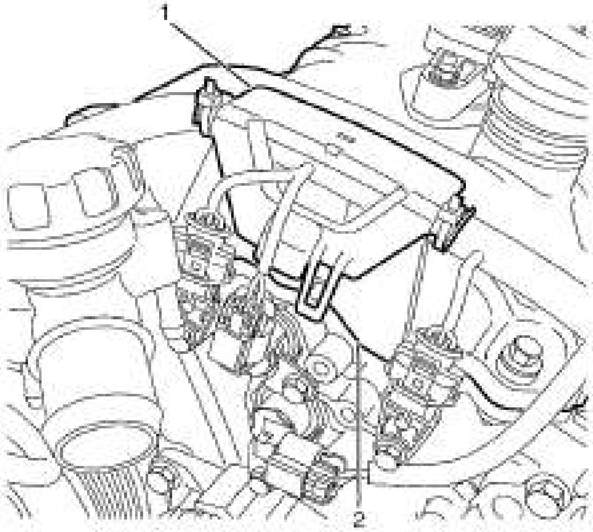
Important: Use a suitable tool to slide the connector retaining latch (1) in the direction of the arrow.

5. Disconnect the ignition coil electrical connectors (2).



Important: Use a suitable tool to detach the wiring harness (1) clips from the camshaft cover (2), then lift the wiring harness (1) upwards to detach from the camshaft cover (2).

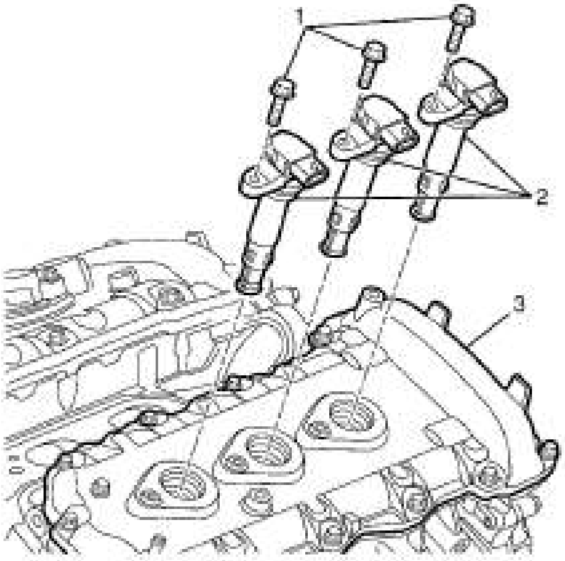
6. Remove the wiring harness (1) from the camshaft cover (2).



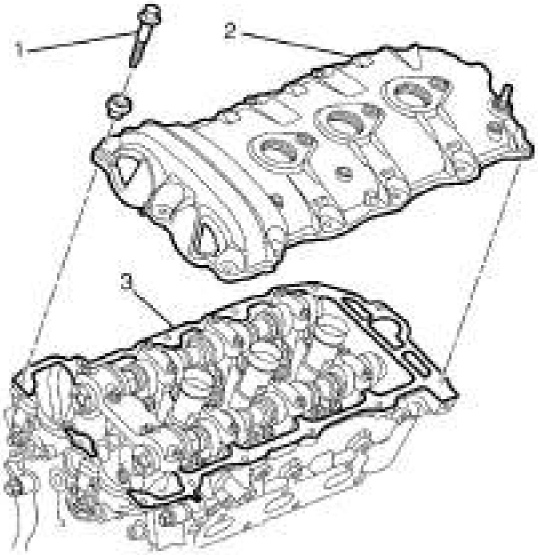
Important: It is not necessary to disconnect the engine front cover electrical connectors.

Important: Use a suitable tool to detach the wiring harness (1) clip from the camshaft cover (2), then lift the wiring harness (1) upwards to detach from the camshaft cover (2).

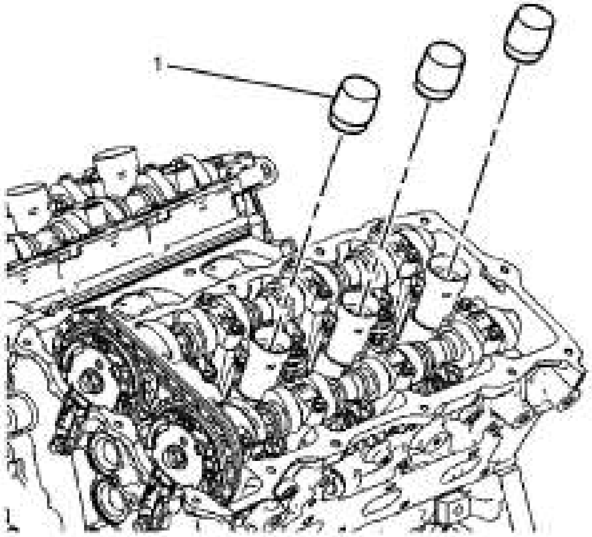
7. Remove the wiring harness (1) from the front of the camshaft cover (2).
8. Reposition and secure the wiring harness (1) away from the camshaft cover (2) in order to provide clearance for removal of the camshaft cover (2).



9. Remove the ignition coil to camshaft cover retaining bolts (1).
10. Remove the ignition coils (2) from the camshaft cover (3).



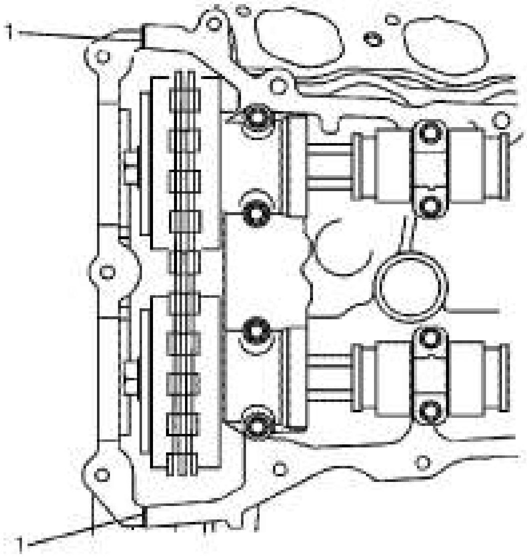
11. Remove the camshaft cover to cylinder head retaining bolts (1).
12. Remove the camshaft cover (2) from the cylinder head (3).
13. Remove and discard the camshaft cover seal and grommets.



14. Install the EN-46101 (1) to the spark plug tubes to prevent dirt and other contaminants from entering the cylinders.

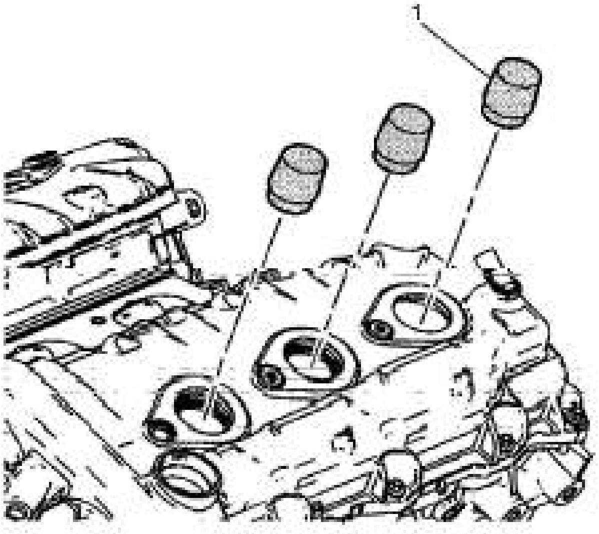
Installation Procedure

1. Install a NEW camshaft cover seal and NEW grommets.

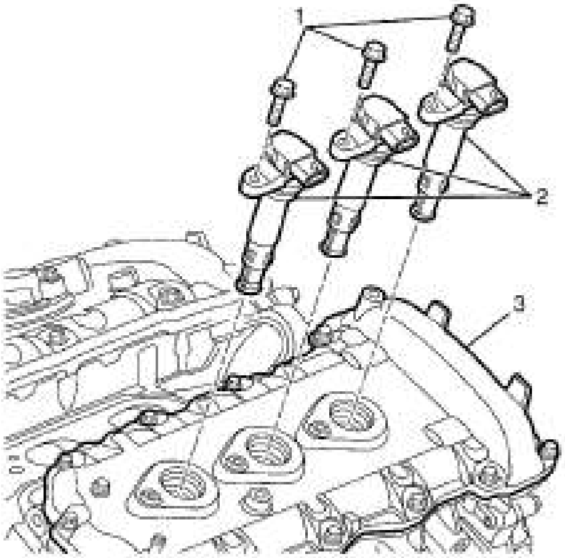


Important: Make sure the sealing surfaces of the cylinder head and camshaft cover are clean.

2. Place a 3mm bead of RTV sealant (1) on the join line between the engine front cover and the cylinder head.
3. Install the camshaft cover. Refer to Camshaft Cover Installation - Left Side .



4. Remove the EN 46101 EN 46101 (1) from the spark plug tubes of the left cylinder head.

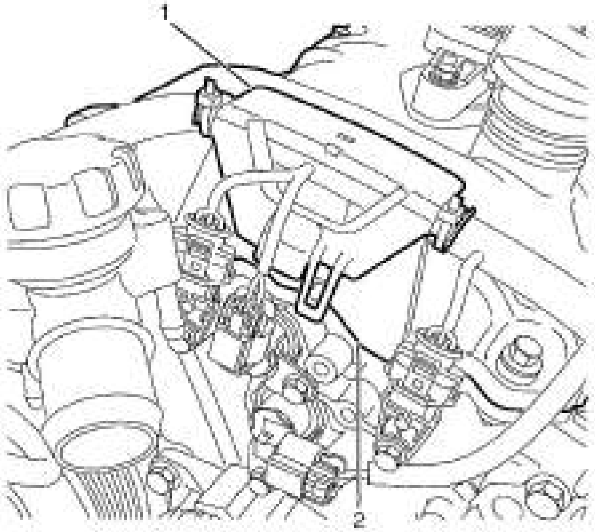


5. Install the ignition coils (2) to the camshaft cover (3).

   Notice: Refer to Fastener Notice in the Preface section.

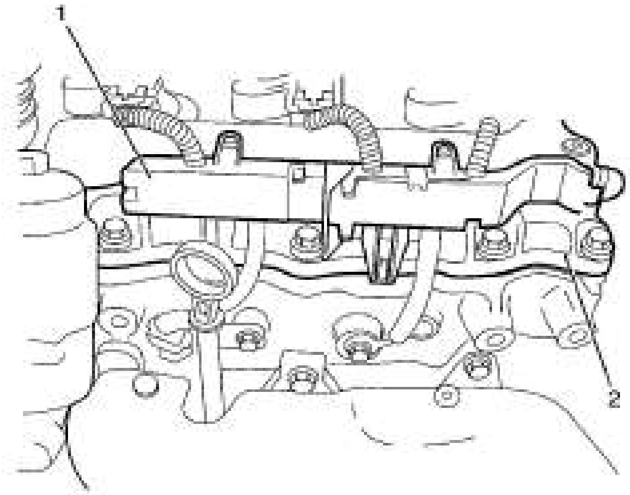
6. Install the ignition coil to camshaft cover retaining bolts (1).

   Tighten
   Tighten the bolt to 10 N·m (89 lb in).



Important: Make sure the wiring harness (1) is located on the camshaft cover (2) locating lugs and the clips are engaged.

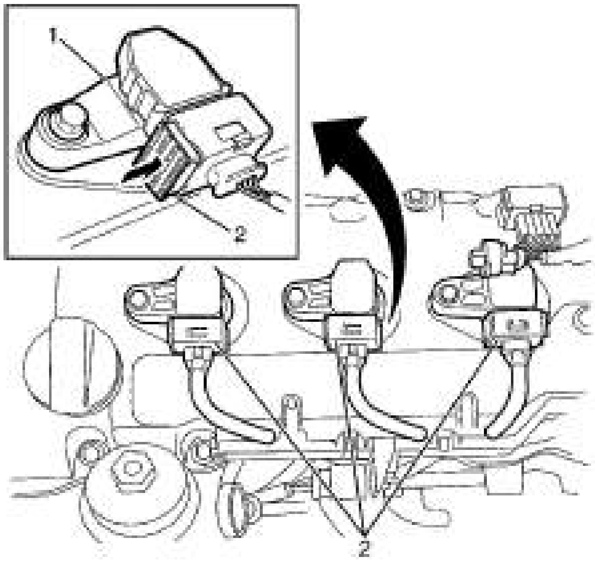
7. Install the wiring harness (1) to the front of the camshaft cover (2).



Important: Make sure the wiring harness (1) is located on the camshaft cover (2) locating lugs and the clips are engaged.

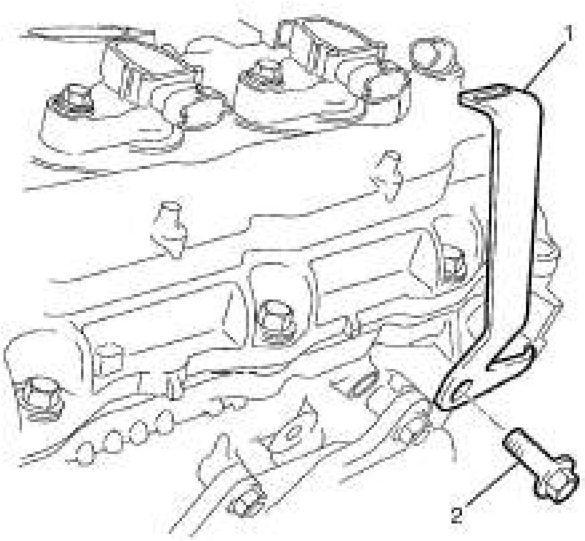
Important: Install the wiring harness from the side of the camshaft cover by sliding the conduit up and inboard.

8. Install the wiring harness (1) to the camshaft cover (2).



Important: Slide the connector retaining latch (2) in the direction of the arrow.

9. Connect the ignition coil electrical connectors (1).



10. Install the engine covers mounting bracket to cylinder head retaining bolt (1).

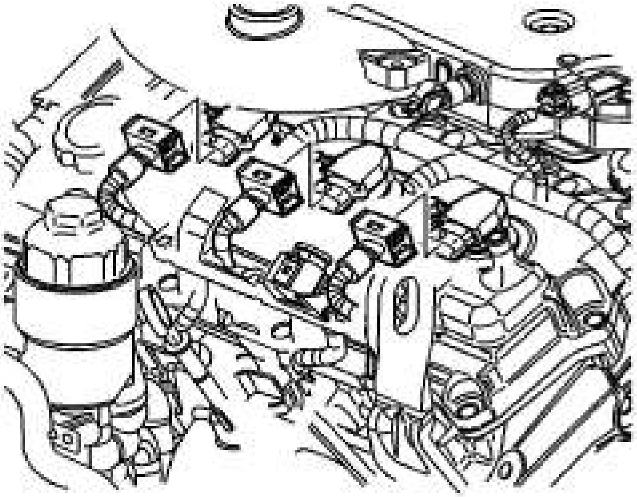
    Tighten
    Tighten the bolt to 35 N·m (26 lb ft).

11. Install the engine covers mounting bracket (2).
12. Install the upper intake manifold with the lower intake manifold. Refer to Lower Intake Manifold Replacement .
13. Install the engine covers. Refer to Engine Cover Replacement .

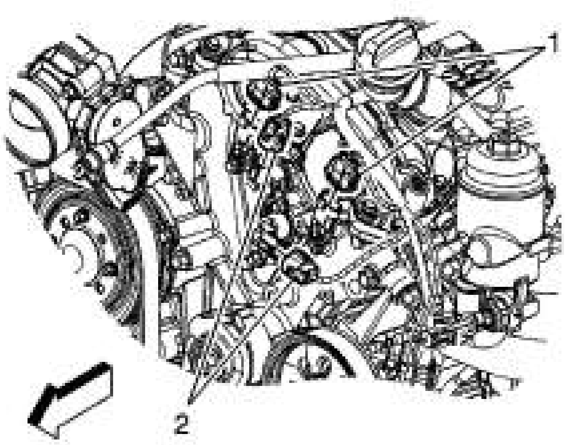
2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - On Vehicle | Document ID: 2114959

Camshaft Cover Replacement - Left Side (LLT)

Removal Procedure



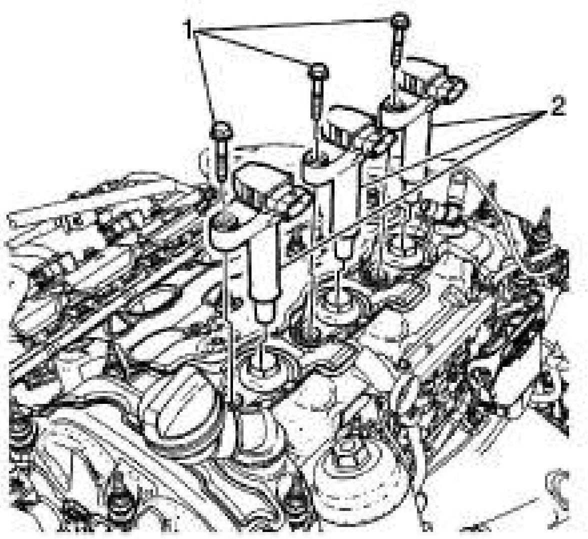
1. Remove the intake manifold. Refer to Intake Manifold Replacement.
2. Remove the fuel pipe shield. Refer to Fuel Pipe Shield Replacement.
3. Remove the crankcase ventilation pipe. Refer to Positive Crankcase Ventilation Hose/Pipe/Tube Replacement.
4. Disconnect the ignition coil electrical connectors.



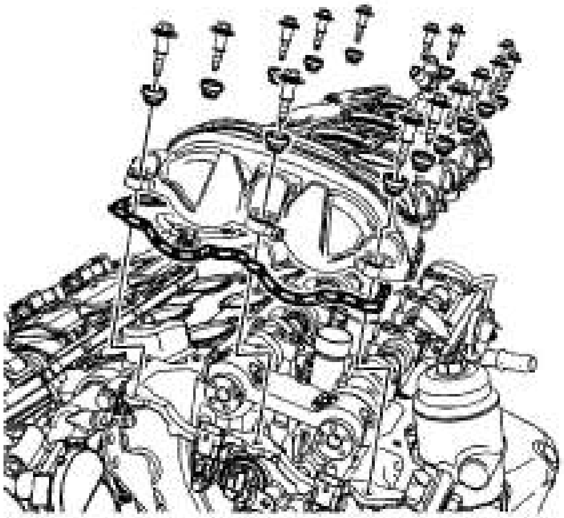
5. Remove the wiring harness from the side of the camshaft cover by sliding the conduit down and outboard.
6. Remove the wiring conduit retainers from the camshaft cover by rotating the wiring harness conduit retainers counterclockwise.

Note: It is not necessary to disconnect the engine front cover electrical connectors.

7. Disconnect the camshaft position sensors (1) and camshaft actuator valve (2) electrical connectors.
8. Reposition and secure the wiring harnesses away from the camshaft cover in order to provide clearance.

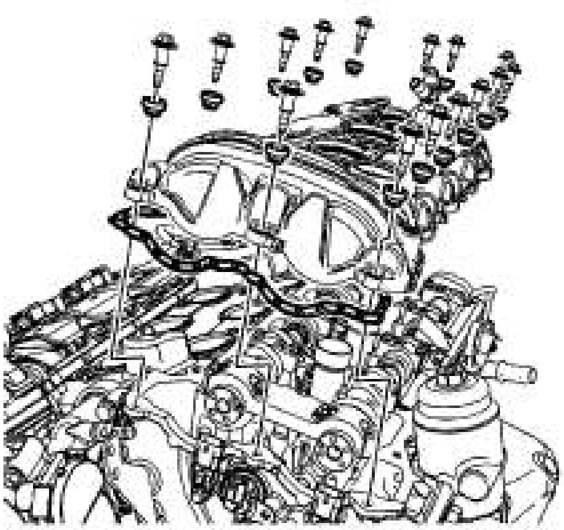


9. Remove the ignition coil bolts (1).
10. Remove the ignition coils (2).

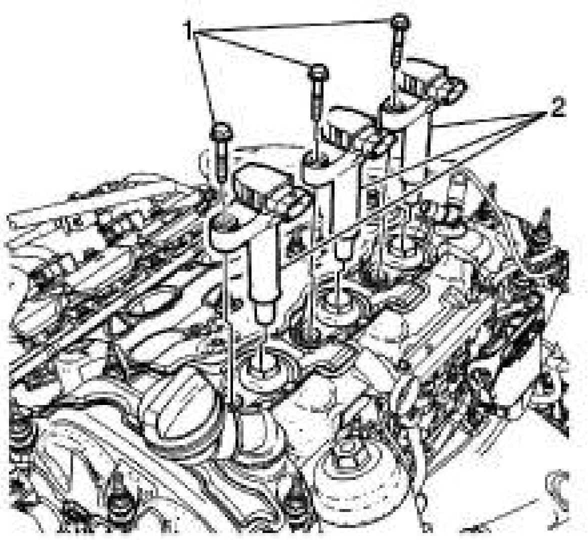


11. Remove the camshaft cover.
12. Remove and discard the camshaft cover seal (1) and grommets (2).

Installation Procedure



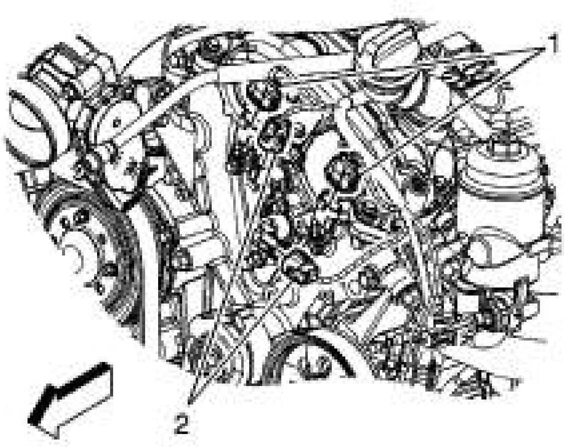
1. Install a NEW camshaft cover seal (1) and NEW grommets (2).
2. Install the camshaft cover. Refer to Camshaft Cover Installation - Left Side.



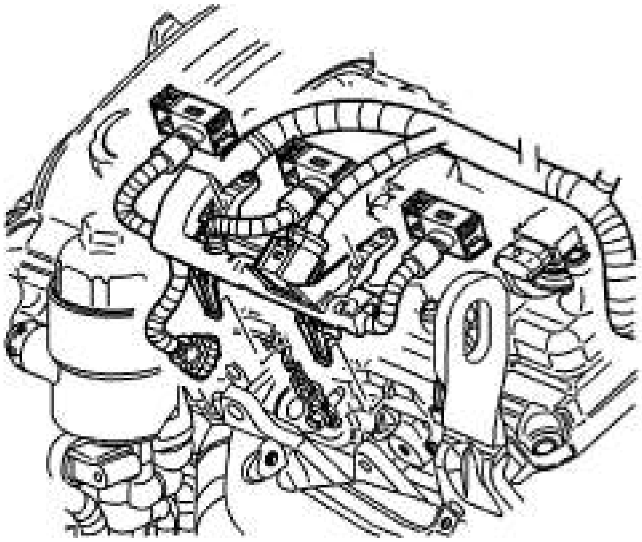
3. Install the ignition coils (2).

Caution: Refer to Fastener Caution in the Preface section.

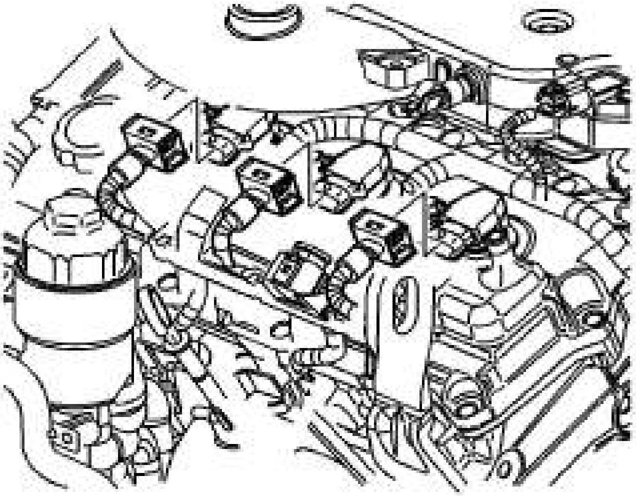
4. Install the ignition coil bolts (1) and tighten to **10 N·m (89 lb in)**.



5. Connect the camshaft actuator valves (2) and the camshaft position sensor (1) electrical connectors.
6. Install the wiring harness conduit retainers to the wiring harness conduit.



7. Install the wiring harness to the side of the camshaft cover.



8. Connect the ignition coil electrical connectors.
9. Install the crankcase ventilation pipe. Refer to Positive Crankcase Ventilation Hose/Pipe/Tube Replacement.
10. Install the fuel pipe shield. Refer to Fuel Pipe Shield Replacement.
11. Install the intake manifold. Refer to Intake Manifold Replacement.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - On Vehicle | **Document ID: 1977629**

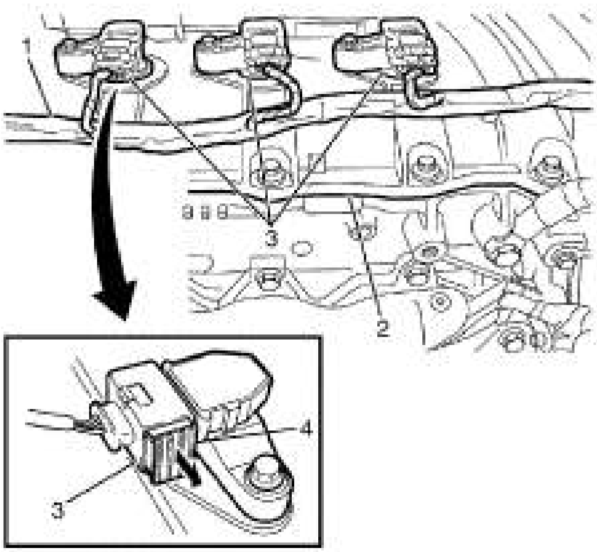
Camshaft Cover Replacement - Right Side

Tools Required

EN 46101 Spark Plug Tube Plugs

Removal Procedure

1. Remove the engine covers. Refer to Engine Cover Replacement .
2. Remove the upper intake manifold with the lower intake manifold. Refer to Lower Intake Manifold Replacement .

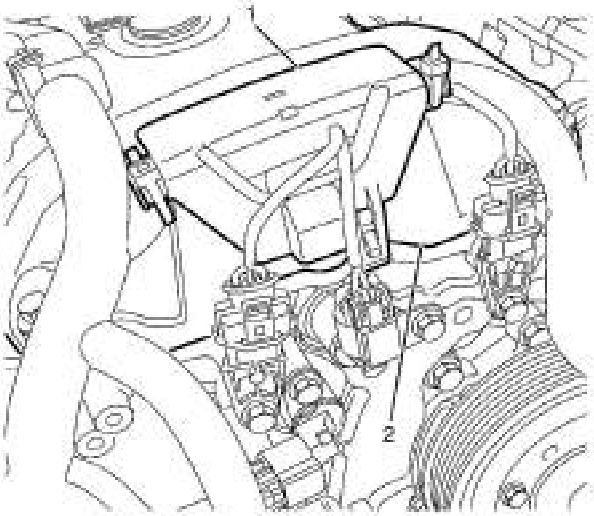


Important: Use a suitable tool to slide the connector retaining latch (4) in the direction of the arrow.

3. Disconnect the ignition coil electrical connectors (3).

Important: Use a suitable tool to detach the wiring harness (1) clips from the camshaft cover (2).

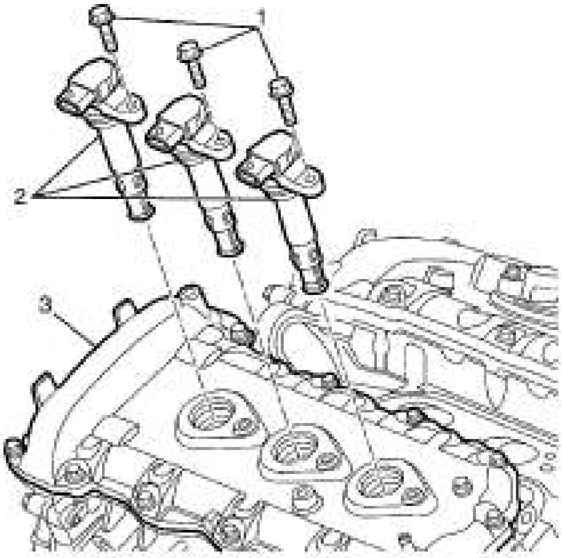
4. Remove the wiring harness (1) from the camshaft cover (2).



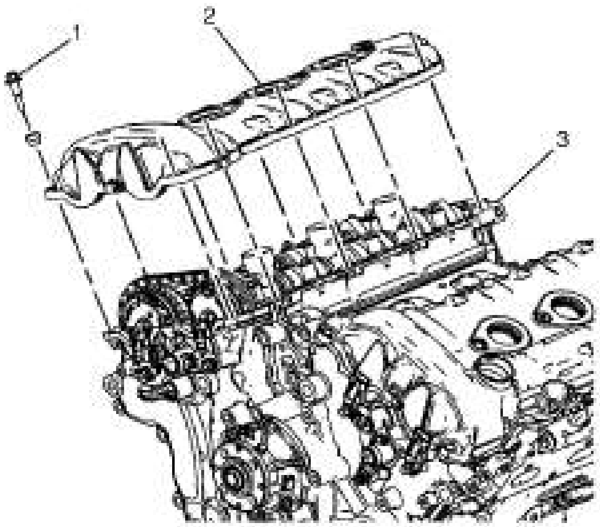
Important: It is not necessary to disconnect the engine front cover electrical connectors.

Important: Use a suitable tool to detach the wiring harness (1) clip from the camshaft cover (2), then lift the wiring harness (1) upwards to detach from the camshaft cover (2).

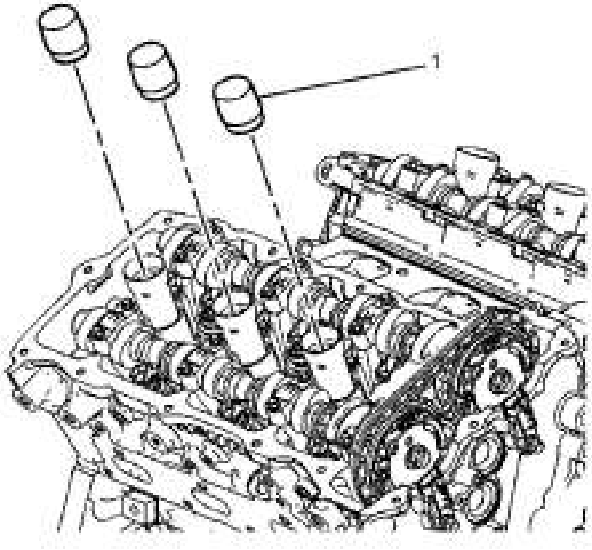
5. Remove the wiring harness (1) from the front of the camshaft cover (2).
6. Reposition and secure the wiring harness (1) away from the camshaft cover (2) in order to provide clearance for removal of the camshaft cover (2).



7. Remove the ignition coil to camshaft cover retaining bolts (1).
8. Remove the ignition coils (2) from the camshaft cover (3).

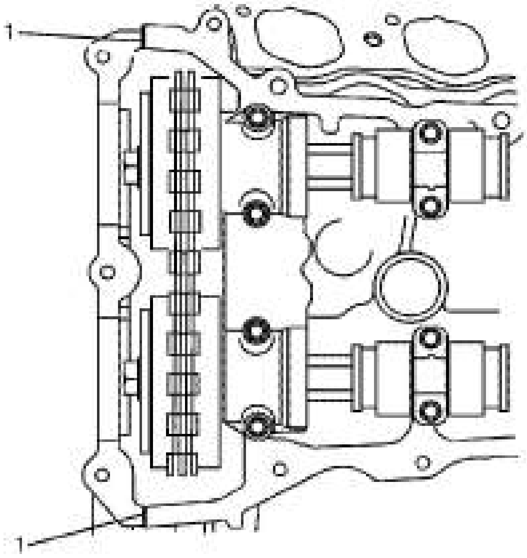


9. Remove the camshaft cover to cylinder head retaining bolts (1).
10. Remove the camshaft cover (2) from the cylinder head (3).
11. Remove and discard the camshaft cover seal and grommets.



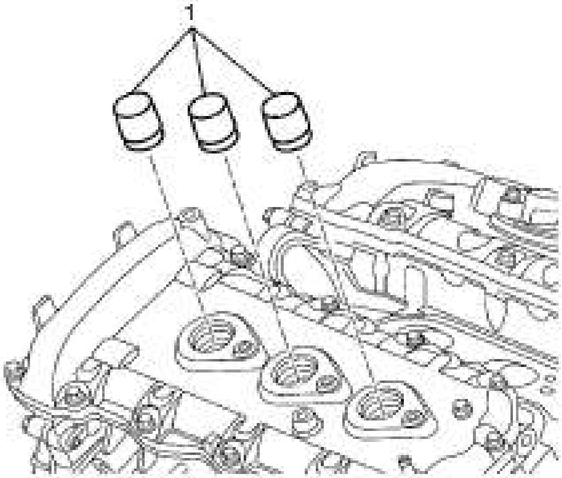
12. Install the EN-46101 (1) to the spark plug tubes to prevent dirt and other contaminants from entering the cylinders.

Installation Procedure

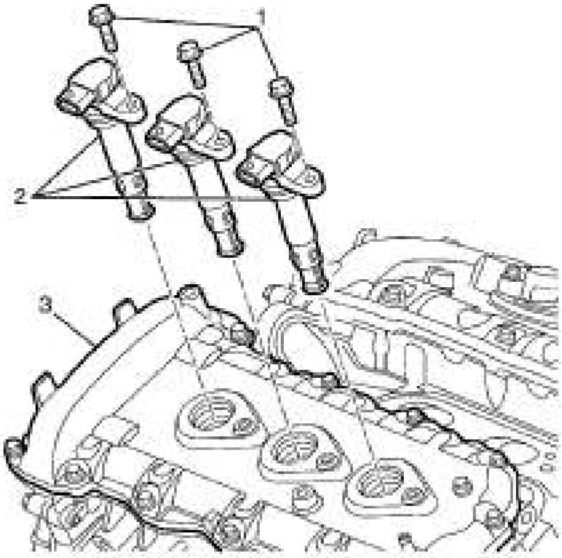


Important: Make sure the sealing surfaces of the cylinder head and camshaft cover are clean.

1. Place a 3mm bead of RTV sealant (1) on the join line between the engine front cover and the cylinder head.
2. Install a NEW camshaft cover seal and NEW grommets.
3. Install the camshaft cover. Refer to Camshaft Cover Installation - Right Side .



4. Remove the EN-46101 (1).

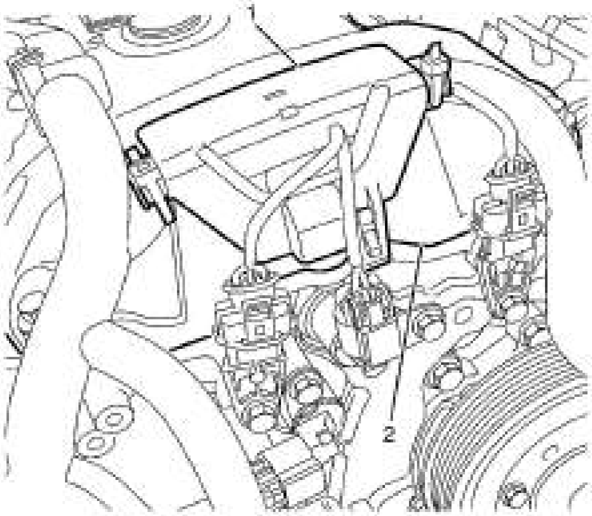


5. Install the ignition coils (2) to the camshaft cover (3).

   Notice: Refer to Fastener Notice in the Preface section.

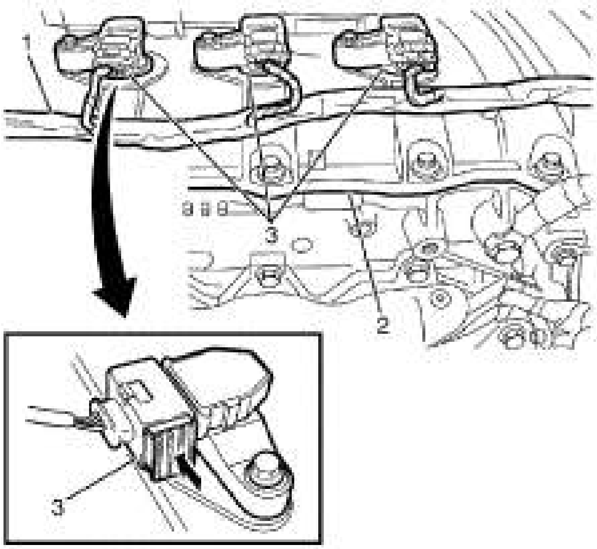
6. Install the ignition coil to camshaft cover retaining bolts (1).

   Tighten
   Tighten the bolt to 10 N·m (89 lb in).



Important: Make sure the wiring harness (1) is located on the camshaft cover (2) locating lugs and the clips are engaged.

7. Install the wiring harness (1) to the front of the camshaft cover (2).



Important: Make sure the wiring harness (1) is located on the camshaft cover (2) locating lugs and the clips are engaged.

8. Install the wiring harness (1) to the camshaft cover (2).

Important: Slide the connector retaining latch (4) in the opposite direction of the arrow.

9. Connect the ignition coil electrical connectors (1).
10. Install the upper intake manifold with the lower intake manifold. Refer to Lower Intake Manifold Replacement .
11. Install the engine covers. Refer to Engine Cover Replacement .

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - On Vehicle | Document ID: 1995135

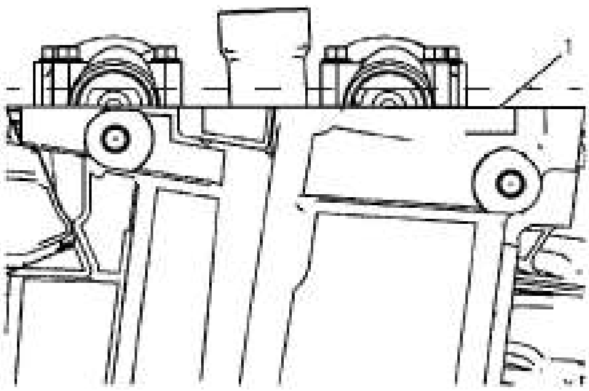
Camshaft Position Actuator Replacement - Bank 1 (Right Side) Exhaust

Tools Required

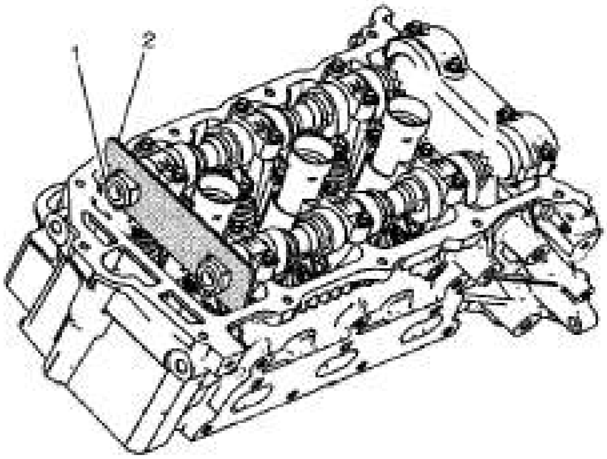
- EN 46105 Camshaft Locking Tools
- EN-48313 Timing Chain Retention Tool
- EN 46111 Crankshaft Rotation Socket

Removal Procedure

1. Remove the engine covers. Refer to Engine Cover Replacement.
2. Remove the upper intake manifold with the lower intake manifold. Refer to Lower Intake Manifold Replacement.
3. Remove the right side camshaft cover. Refer to Camshaft Cover Replacement - Right Side.
4. Remove the camshaft position sensors. Refer to Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust and Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake.
5. Remove the camshaft position (CMP) actuator solenoids. Refer to (if fitted) Camshaft Position Actuator Replacement - Bank 1 (Right Side) Exhaust and Camshaft Position Actuator Replacement - Bank 1 (Right Side) Intake.
6. Remove the crankshaft balancer. Refer to Crankshaft Balancer Removal.

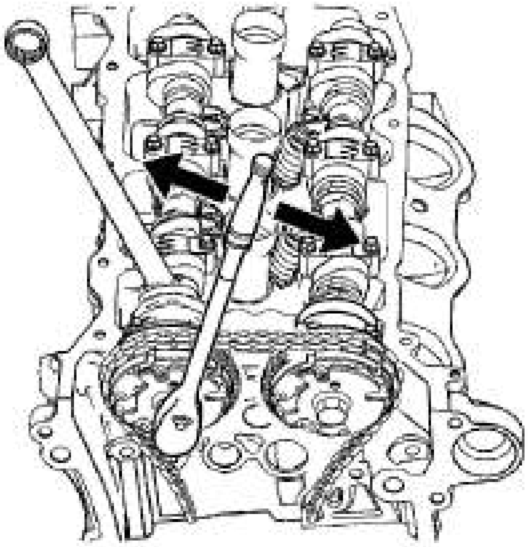


7. Rotate the crankshaft with the EN 46111 until the camshafts are in a neutral (low tension) position. The camshaft flats will be parallel with the camshaft cover rail (1).



8. Install the EN 46105 (1) onto the rear of the right side camshafts (2)

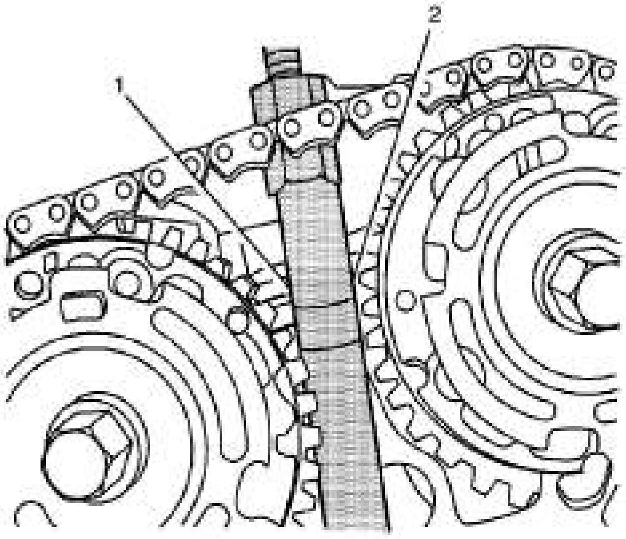
Notice: Refer to Torque Reaction Against Timing Drive Chain Notice in the Preface section.



Important:

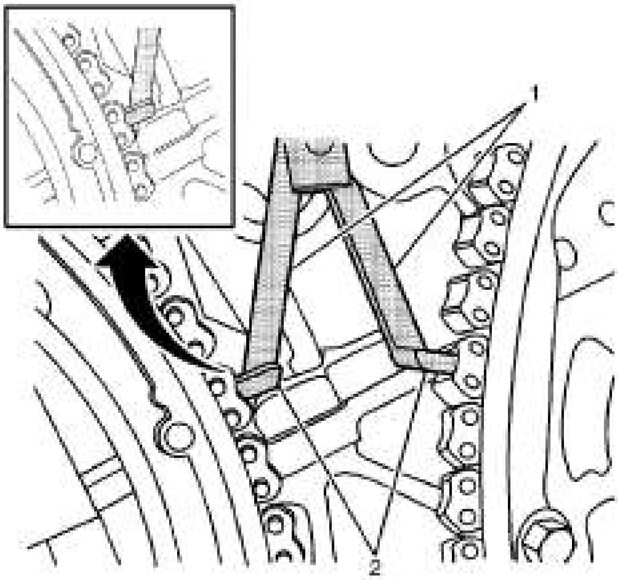
- Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.
- DO NOT remove the camshaft position actuator to camshaft retaining bolt at this time.

9. Loosen the right side exhaust camshaft position actuator to camshaft retaining bolt.



Important: The front engine cover is removed in the following graphics for illustration purposes and is not required to perform the procedure.

10. Loosen the EN-48313 so that the legs are retracted.
11. Insert the EN-48313 between the camshaft actuators, rearward of the timing chain until the top line that is scribed in the body of the tool (1) is adjacent to the top surface of the cylinder head (2). This is the approximate installed position.



12. Make sure that the feet (2) on the legs (1) of the EN-48313 are facing the front of the engine.

Important: DO NOT tighten EN-48313 at this stage.

13. Partially expand the legs (1) of the EN-48313 by turning the T-shaped handle clockwise.

    Important: Make sure that the feet (2) of the EN-48313 are correctly engaged into one of the link pockets to prevent chain slipping during tightening.

14. Continue expanding the EN-48313 until the feet (2) contact the timing chain.

    Notice: Refer to Torque Reaction Against Timing Drive Chain Notice in the Preface section.

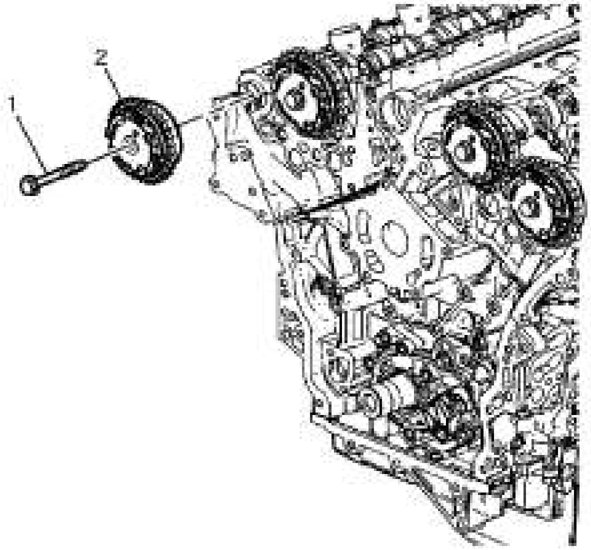
15. Hand tighten the EN-48313 .

    Important: DO NOT allow the body of the EN-48313 to rotate when tightening the T-handle.

16. Use an open-end wench on the hex cast into the body of the EN-48313 and hand tighten the T-handle.
17. Use an open-end wrench on the hex cast into the right intake and exhaust camshafts and rotate the camshafts towards each other in order create slack in the chain between the actuators.
18. The EN-48313 is now correctly installed to hold the timing chain in position.

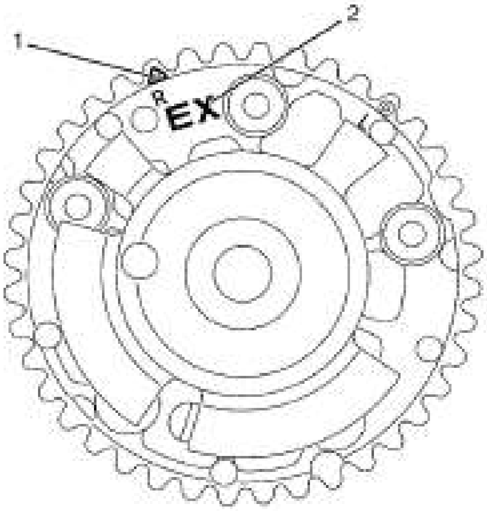
    Important: Make sure that the camshaft timing chain and the camshaft position actuators are marked for correct assembly.

19. Mark the timing chain and the camshaft position actuators.

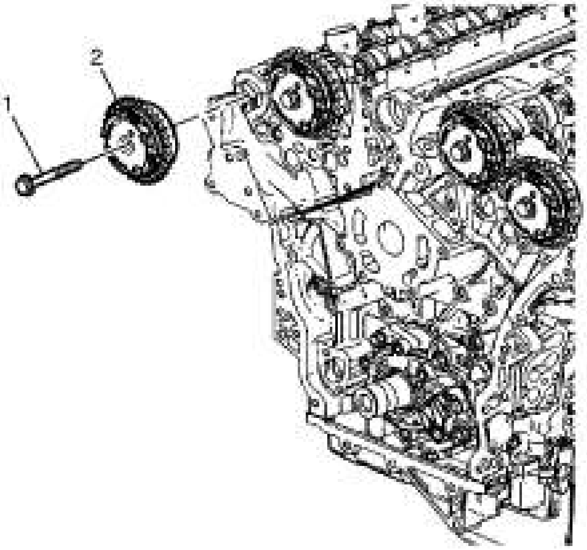


20. Remove the right side exhaust camshaft position actuator to camshaft retaining bolt (1).
21. Remove the right side exhaust camshaft position actuator (2).

Installation Procedure



1. Make sure the correct camshaft position actuator is installed. Observe the body of the camshaft position actuator for the "EX" marking (1). The marking is for an exhaust camshaft position actuator.
2. Make sure the correct timing mark is used. Observe the outer ring of the camshaft position actuator for the "R" and triangle marking (2). The marking is for alignment to the highlighted timing chain link on the right side of the engine.



3. Install the right side exhaust camshaft position actuator (2).

Important:

- Make sure that the marks on the camshaft position actuators and the timing chain are aligned.
- DO NOT tighten the right intake camshaft position actuator to camshaft retaining bolt (1) at this time.

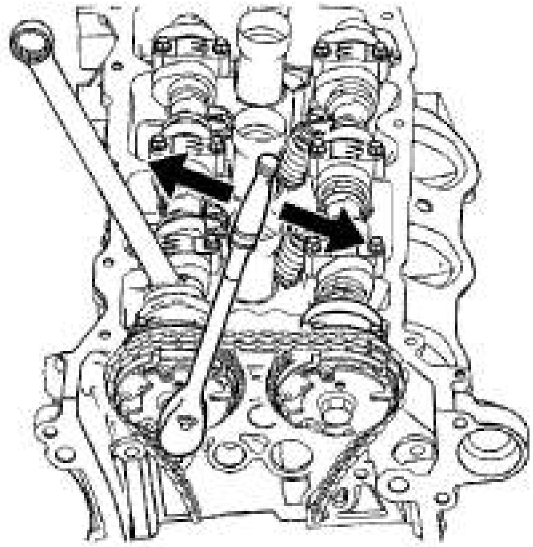
4. Install the right side camshaft position actuator to camshaft retaining bolt (1).

   DO NOT fully tighten at this stage.

5. Remove EN-48313 .

   Notice: Refer to Torque Reaction Against Timing Drive Chain Notice in the Preface section.

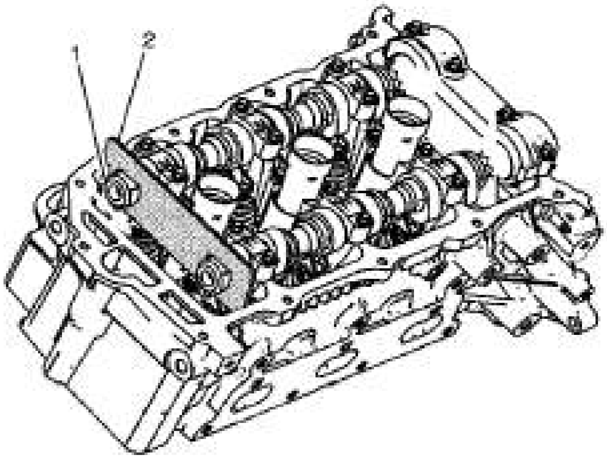
   Notice: Refer to Fastener Notice in the Preface section.



Important: Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.

6. Tighten the camshaft position actuator to camshaft retaining bolt.

   Tighten
   Tighten bolt to 58 N·m (43 lb ft).



7. Remove the EN 46105 (2) from the rear of the right side camshafts (1)
8. Install the camshaft position (CMP) actuator solenoids. Refer to (if fitted) Camshaft Position Actuator Replacement - Bank 1 (Right Side) Exhaust and Camshaft Position Actuator Replacement - Bank 1 (Right Side) Intake.
9. Install the camshaft position sensors. Refer to Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust and Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake.
10. Install the crankshaft balancer. Refer to Crankshaft Balancer Installation.
11. Install the right side camshaft cover. Refer to Camshaft Cover Replacement - Right Side.
12. Install the upper intake manifold with the lower intake manifold. Refer to Lower Intake Manifold Replacement.
13. Install the engine covers. Refer to Engine Cover Replacement.

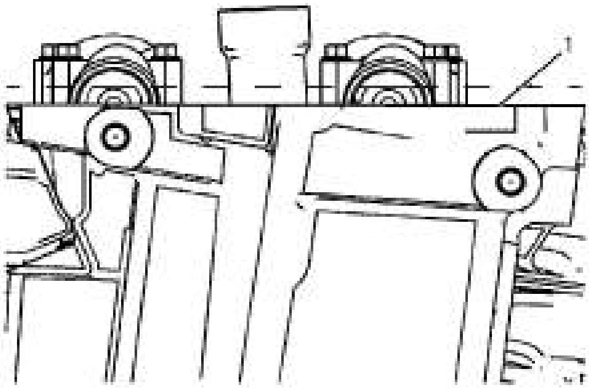
Camshaft Position Actuator Replacement - Bank 1 (Right Side) Intake

Tools Required

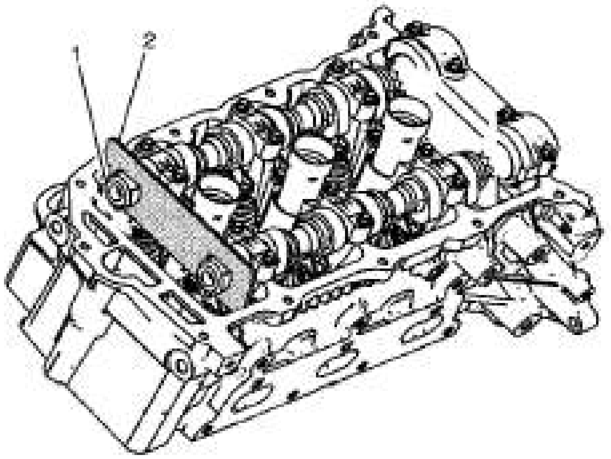
- EN 46105 Camshaft Locking Tools
- EN-48313 Timing Chain Retention Tool
- EN 46111 Crankshaft Rotation Socket

Removal Procedure

1. Remove the engine covers. Refer to Engine Cover Replacement .
2. Remove the upper intake manifold with the lower intake manifold. Refer to Lower Intake Manifold Replacement .
3. Remove the right side camshaft cover. Refer to Camshaft Cover Replacement - Right Side .
4. Remove the camshaft position sensors. Refer to Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust and Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake .
5. Remove the camshaft position (CMP) actuator solenoids. Refer to (if fitted) Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust and Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake .
6. Remove the crankshaft balancer. Refer to Crankshaft Balancer Removal .

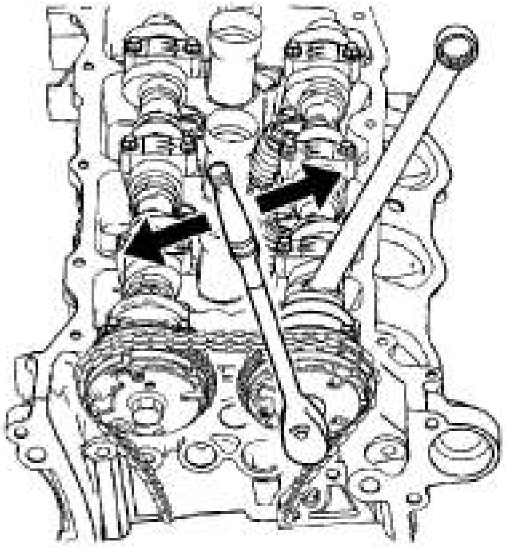


7. Rotate the crankshaft with the EN 46111 until the camshafts are in a neutral (low tension) position. The camshaft flats will be parallel with the camshaft cover rail (1).



8. Install the EN 46105 (2) onto the rear of the right side camshafts (1)

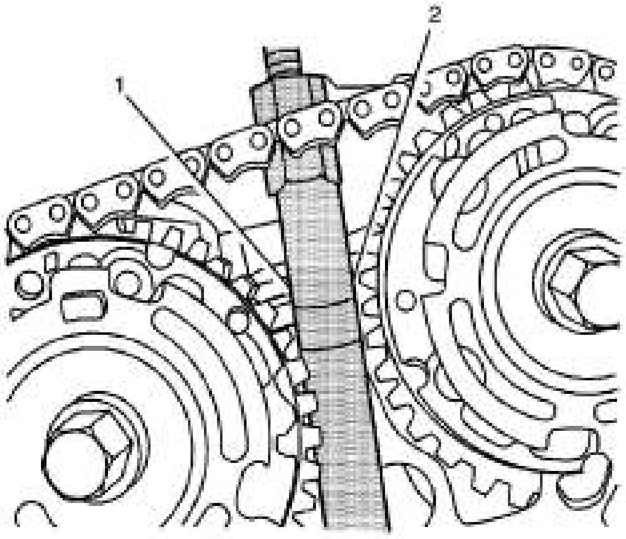
Notice: Refer to Torque Reaction Against Timing Drive Chain Notice in the Preface section.



Important:

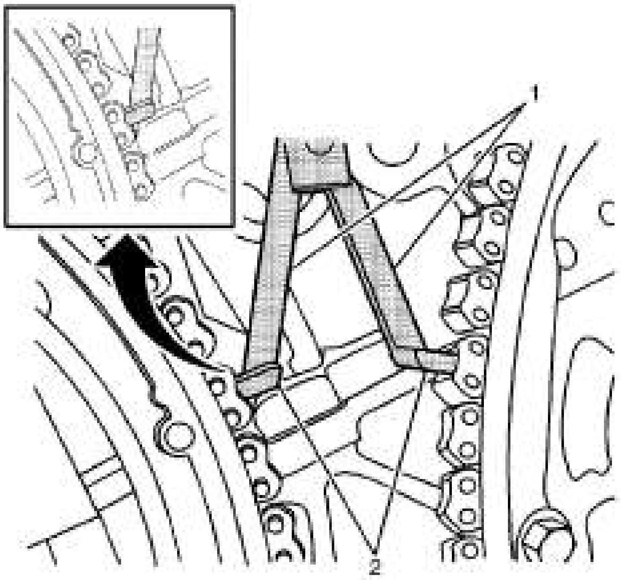
- Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.
- DO NOT remove the camshaft position actuator to camshaft retaining bolt at this time.

9. Loosen the right side intake camshaft position actuator to camshaft retaining bolt.
10. Loosen the EN-48313 so that the legs are retracted.



Important: The front engine cover is removed in the following graphics for illustration purposes and is not required to perform the procedure.

11. Insert the EN-48313 between the camshaft actuators, rearward of the timing chain until the top line that is scribed in the body of the tool (1) is adjacent to the top surface of the cylinder head (2). This is the approximate installed position.



12. Make sure that the feet (2) on the legs (1) of the EN-48313 are facing the front of the engine.

Important: DO NOT tighten EN-48313 at this stage.

13. Partially expand the legs (1) of the EN-48313 by turning the T-shaped handle clockwise.

Important: Make sure that the feet (2) of the EN-48313 is correctly engaged into one of the link pockets to prevent chain slipping during tightening.

14. Continue expanding the EN-48313 until the feet (2) contact the timing chain.

Notice: Refer to Torque Reaction Against Timing Drive Chain Notice in the Preface section.

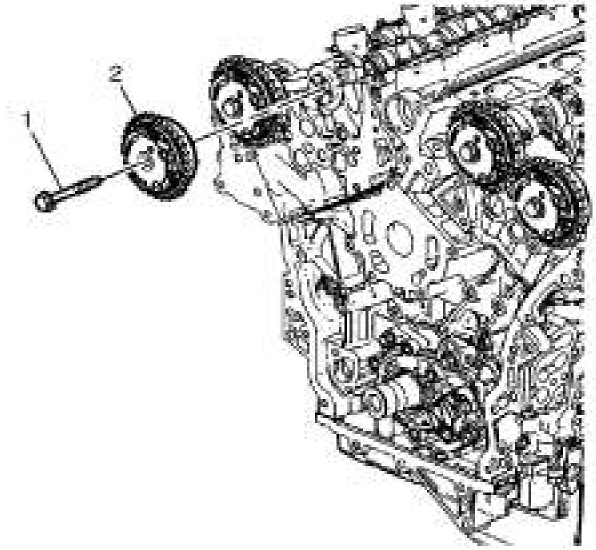
15. Hand tighten the EN-48313 .

Important: DO NOT allow the body of the tool to rotate when tightening the T-handle.

16. Use an open-end wench on the hex cast into the body of the EN-48313 and hand tighten the T-handle.
17. Use an open-end wrench on the hex cast into the right intake and exhaust camshafts and rotate the camshafts towards each other in order create slack in the chain between the actuators.
18. The EN-48313 is now correctly installed to hold the timing chain in position.

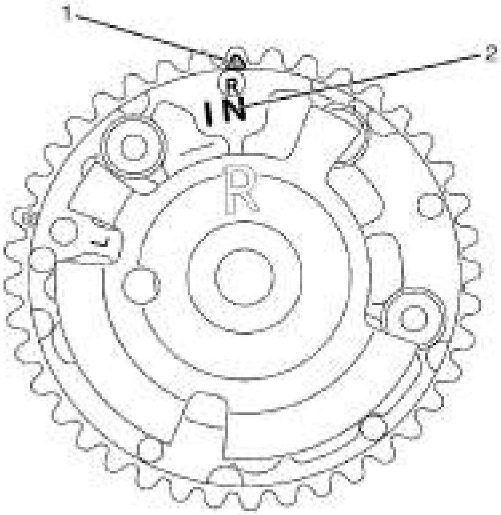
Important: Make sure that the camshaft timing chain and the camshaft position actuators are marked for correct assembly.

19. Mark the timing chain and the camshaft position actuators.

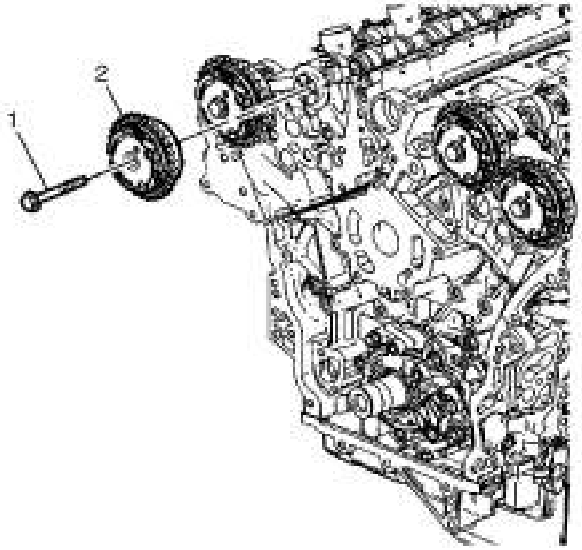


20. Remove the right side intake camshaft position actuator to camshaft retaining bolt (1).
21. Remove the right side intake camshaft position actuator (2).

Installation Procedure



1. Make sure the correct camshaft position actuator is installed. Observe the body of the camshaft position actuator for the "IN" marking (2). The marking is for an intake camshaft position actuator.
2. Make sure the correct timing mark is used. Observe the outer ring of the camshaft position actuator for the "R" and triangle marking (1). The marking is for alignment to the highlighted timing chain link on the right side of the engine.



3. Install the right side intake camshaft position actuator (2).

Important:

- Make sure that the marks on the camshaft position actuators and the timing chain are aligned.
- DO NOT tighten the right intake camshaft position actuator to camshaft retaining bolt (1) at this time.

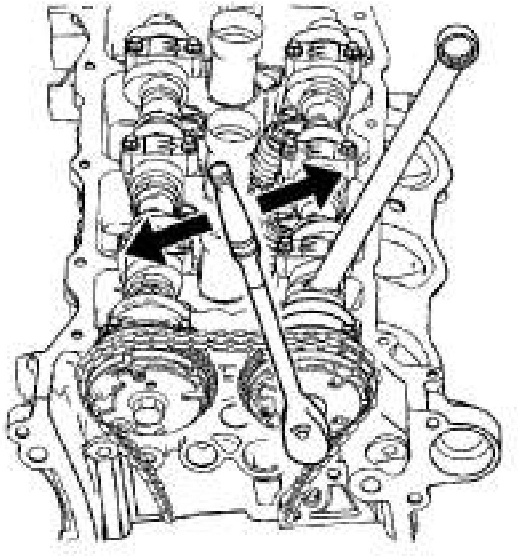
4. Install the right side intake camshaft position actuator to camshaft retaining bolt (1).

   DO NOT fully tighten at this stage.

5. Remove the EN 46108 EN 48313.

   Notice: Refer to Torque Reaction Against Timing Drive Chain Notice in the Preface section.

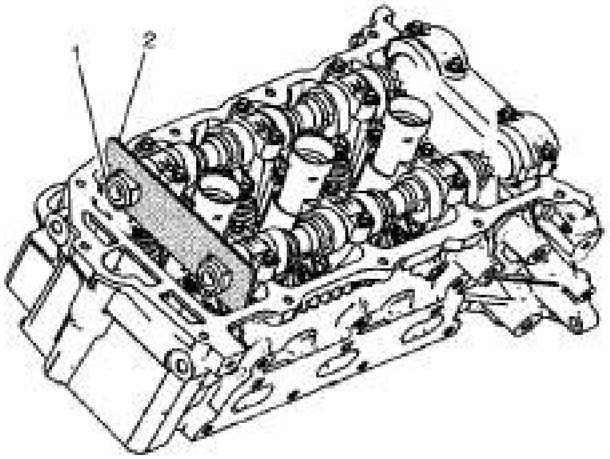
   Notice: Refer to Fastener Notice in the Preface section.



Important: Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.

6. Tighten the camshaft position actuator to camshaft retaining bolt.

   Tighten
   Tighten the bolt to 58 N·m (43 lb ft).



7. Remove the EN 46105 (2) from the rear of the right side camshafts (1)
8. Install the camshaft position (CMP) actuator solenoids. Refer to (if fitted) Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust and Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake .
9. Install the camshaft position sensors. Refer to Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust and Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake .
10. Install the crankshaft balancer. Refer to Crankshaft Balancer Installation .
11. Install the right side camshaft cover. Refer to Camshaft Cover Replacement - Right Side .
12. Install the upper intake manifold with the lower intake manifold. Refer to Lower Intake Manifold Replacement .
13. Install the engine covers. Refer to Engine Cover Replacement .

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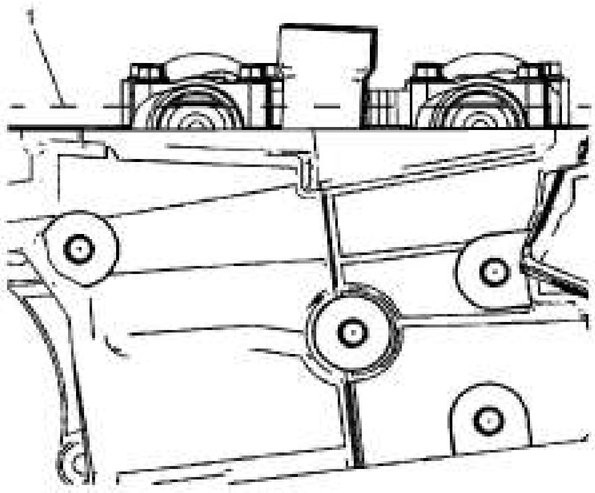
Camshaft Position Actuator Replacement - Bank 2 (Left Side) Exhaust

Tools Required

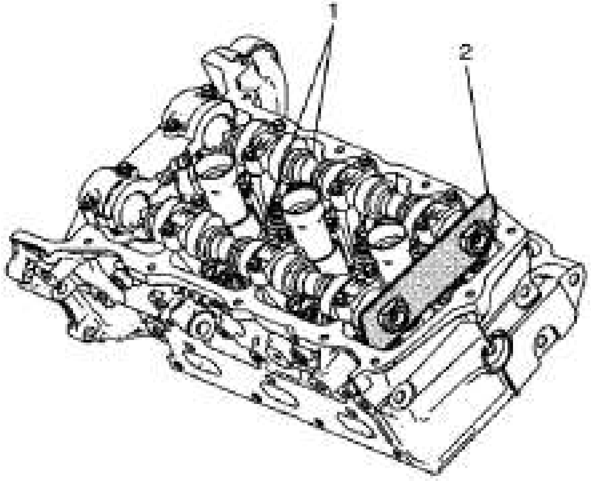
- EN 46105 Camshaft Locking Tools
- EN-48313 Timing Chain Retention Tool
- EN 46111 Crankshaft Rotation Socket

Removal Procedure

1. Remove the engine covers. Refer to Engine Cover Replacement.
2. Remove the upper intake manifold with the lower intake manifold. Refer to Lower Intake Manifold Replacement.
3. Remove the left side camshaft cover. Refer to Camshaft Cover Replacement - Left Side.
4. Remove the camshaft position sensors. Refer to (if fitted) Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust and Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake.
5. Remove the camshaft position (CMP) actuator solenoids. Refer to (if fitted) Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust and Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake.
6. Remove the crankshaft balancer. Refer to Crankshaft Balancer Removal.

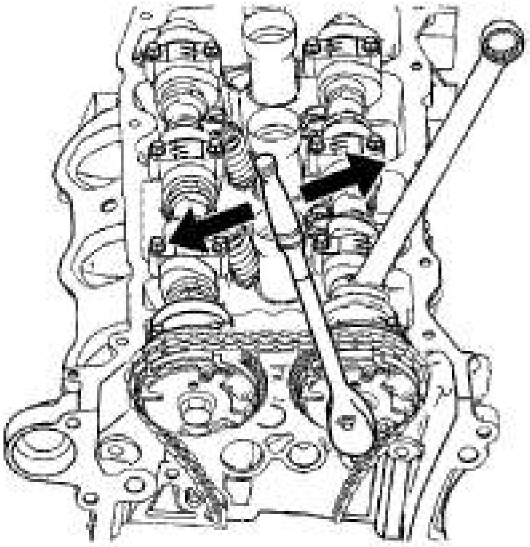


7. Rotate the crankshaft with the EN 46111 until the camshafts are in a neutral (low tension) position. The camshaft flats will be parallel with the camshaft cover rail (1).



8. Install the EN 46105 (2) onto the rear of the left side camshafts (1).

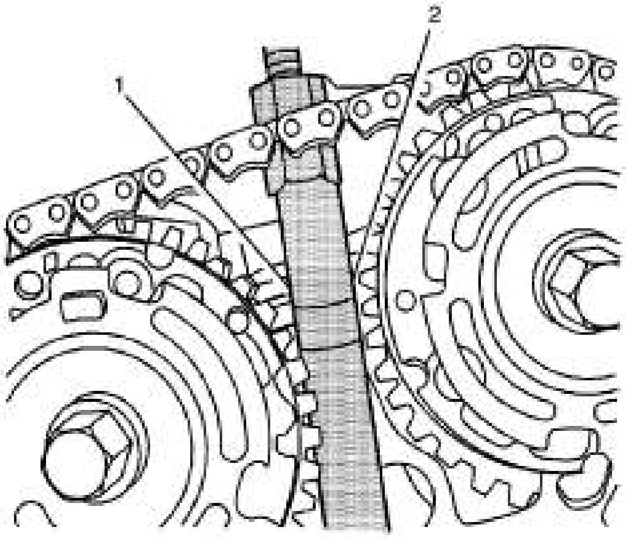
   Notice: Refer to Torque Reaction Against Timing Drive Chain Notice in the Preface section.



Important:

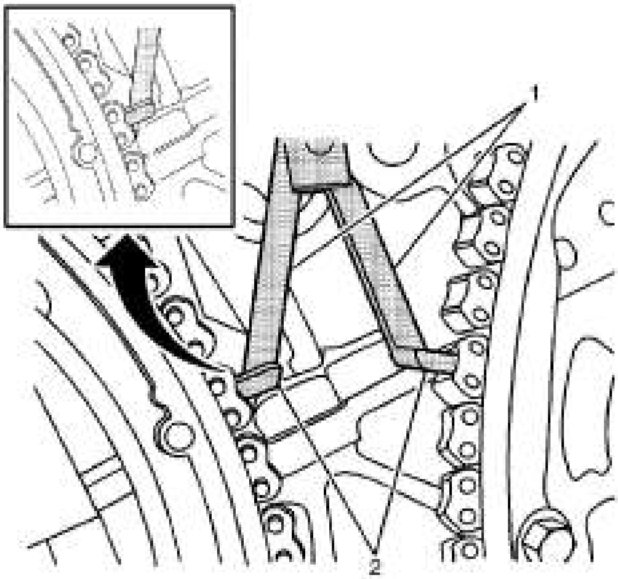
- Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.
- DO NOT remove the camshaft position actuator to camshaft retaining bolt at this time.

9. Loosen the left side exhaust camshaft position actuator to camshaft retaining bolt.
10. Loosen the EN-48313 so that the legs are retracted.



Important: The front engine cover is removed in the following graphics for illustration purposes and is not required to perform the procedure.

11. Insert the EN-48313 between the camshaft actuators, rearward of the timing chain until the top line that is scribed in the body of the tool (1) is adjacent to the top surface of the cylinder head (2). This is the approximate installed position.



12. Make sure that the feet (2) on the legs (1) of the EN-48313 are facing the front of the engine.

Important: DO NOT tighten the EN-48313 at this stage.

13. Partially expand the legs (1) of EN-48313 by turning the T-shaped handle clockwise.

Important: Make sure that the feet (2) of the EN-48313 are correctly engaged into one of the link pockets to prevent chain slipping during tightening.

14. Continue expanding the EN-48313 until the feet (2) contact the timing chain.

Notice: Refer to Torque Reaction Against Timing Drive Chain Notice in the Preface section.

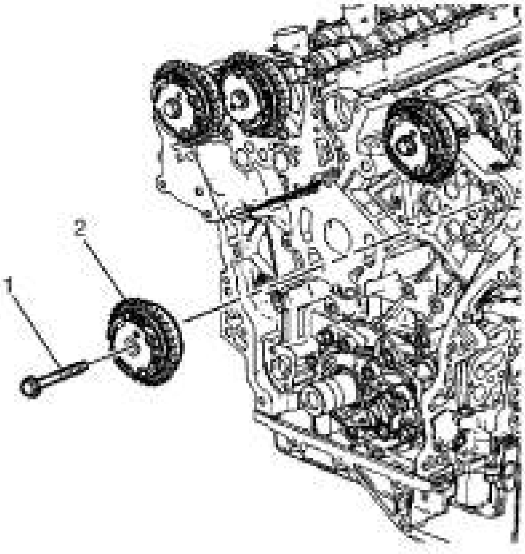
15. Hand tighten the EN-48313 .

Important: DO NOT allow the body of the EN-48313 to rotate when tightening the T-handle.

16. Use an open-end wench on the hex cast into the body of the EN-48313 and hand tighten the T-handle.
17. Use an open-end wrench on the hex cast of the left side intake and exhaust camshafts and rotate the camshafts towards each other in order create slack in the chain between the actuators.
18. The EN-48313 is now correctly installed to hold the timing chain in position.

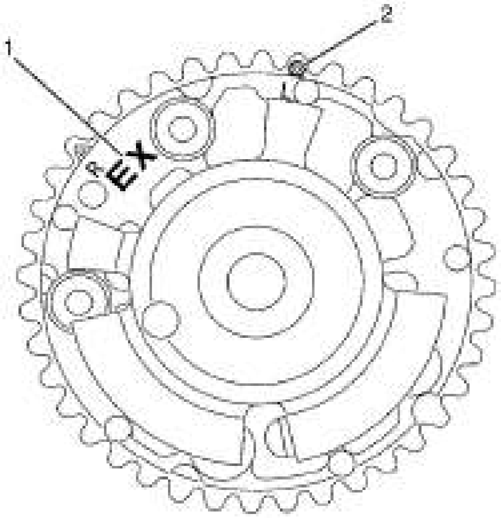
Important: Make sure that the camshaft timing chain and the camshaft position actuators are marked for correct assembly.

19. Mark the timing chain and the camshaft position actuators.

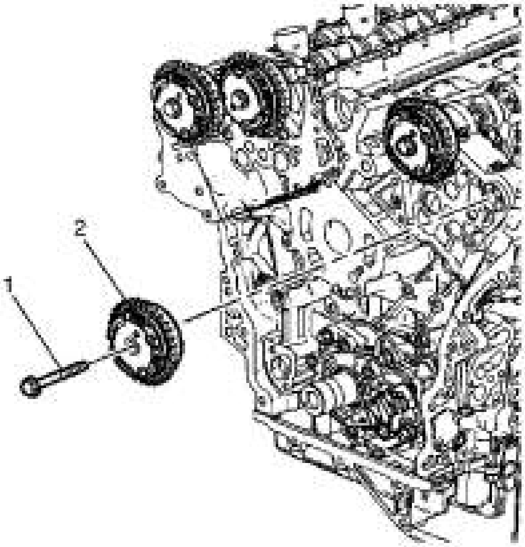


20. Remove the left side exhaust camshaft position actuator to camshaft retaining bolt (1).
21. Remove the left side exhaust camshaft position actuator (2).

Installation Procedure



1. Make sure the correct camshaft position actuator is installed. Observe the body of the camshaft position actuator for the "EX" marking (1). The marking is for an exhaust camshaft position actuator.
2. Make sure the correct timing mark is used. Observe the outer ring of the camshaft position actuator for the "L" and circle marking (2). The marking is for alignment to the highlighted timing chain link on the left side of the engine.



3. Install the left side exhaust camshaft position actuator (2).

Important:

- Make sure that the marks on the camshaft position actuators and the timing chain are aligned.
- DO NOT tighten the left side exhaust camshaft position actuator to camshaft retaining bolt (1) at this time.

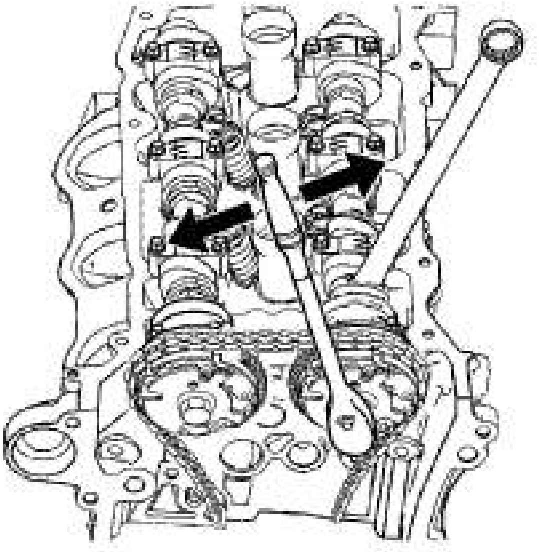
4. Install the camshaft position actuator to camshaft retaining bolt (1).

   DO NOT fully tighten at this stage.

5. Remove EN-48313 .

   Notice: Refer to Torque Reaction Against Timing Drive Chain Notice in the Preface section.

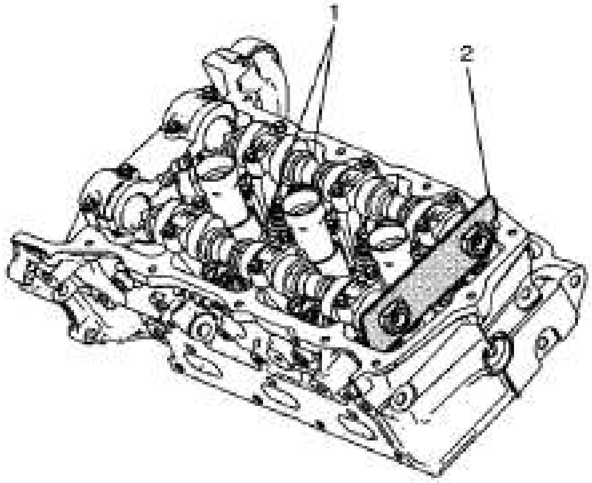
   Notice: Refer to Fastener Notice in the Preface section.



Important: Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.

6. Tighten the camshaft position actuator to camshaft retaining bolt.

   Tighten
   Tighten the bolt to 58 N·m (43 lb ft).



7. Remove the EN 46105 (2) from the rear of the left side camshafts (1).
8. Install the camshaft position (CMP) actuator solenoids. Refer to (if fitted) Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust and Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake
9. Install the camshaft position sensors. Refer to (if fitted) Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust and Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake.
10. Install the crankshaft balancer. Refer to Crankshaft Balancer Installation.
11. Install the left bank camshaft cover. Refer to Camshaft Cover Replacement - Left Side.
12. Install the upper intake manifold with the lower intake manifold. Refer to Lower Intake Manifold Replacement.
13. Install the engine covers. Refer to Engine Cover Replacement.

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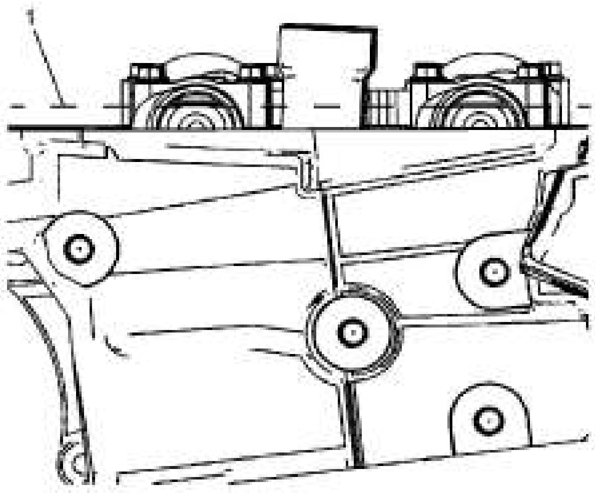
Camshaft Position Actuator Replacement - Bank 2 (Left Side) Intake

Tools Required

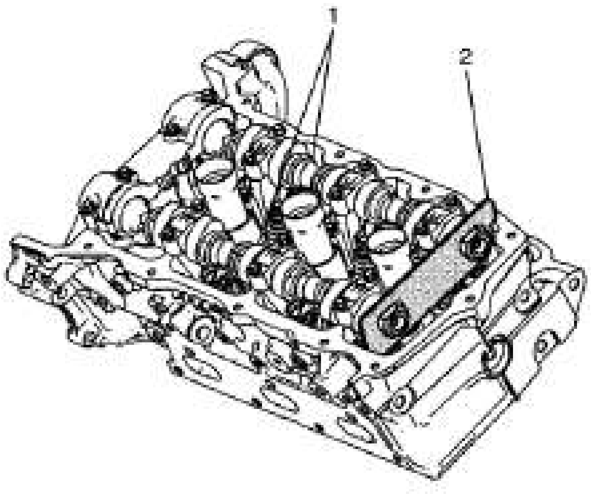
- EN 46105 Camshaft Locking Tools
- EN-48313 Timing Chain Retention Tool
- EN 46111 Crankshaft Rotation Socket

Removal Procedure

1. Remove the engine covers. Refer to Engine Cover Replacement.
2. Remove the upper intake manifold with the lower intake manifold. Refer to Lower Intake Manifold Replacement.
3. Remove the left side camshaft cover. Refer to Camshaft Cover Replacement - Left Side.
4. Remove the camshaft position sensors. Refer to (if fitted) Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust and Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake.
5. Remove the camshaft position (CMP) actuator solenoids. Refer to (if fitted) Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust and Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake.
6. Remove the crankshaft balancer. Refer to Crankshaft Balancer Removal.

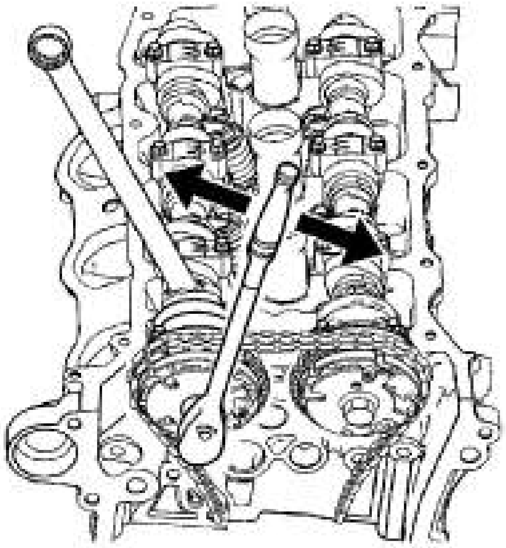


7. Rotate the crankshaft with the EN 46111 until the camshafts are in a neutral (low tension) position. The camshaft flats will be parallel with the camshaft cover rail (1).



8. Install the EN 46105 (2) onto the rear of the left side camshafts (1).

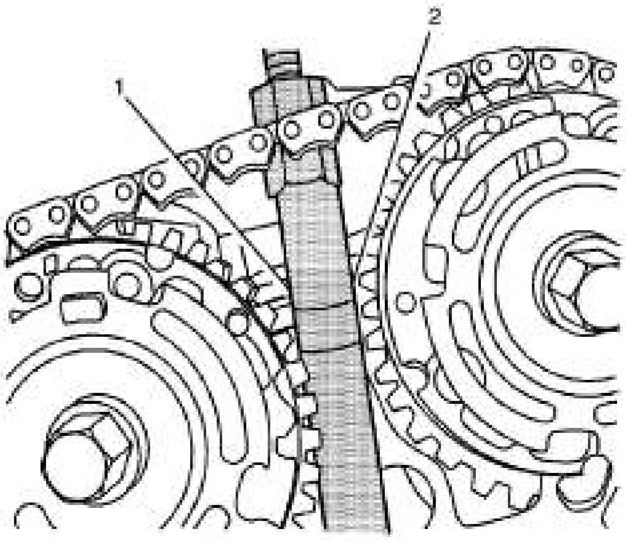
   Notice: Refer to Torque Reaction Against Timing Drive Chain Notice in the Preface section.



Important:

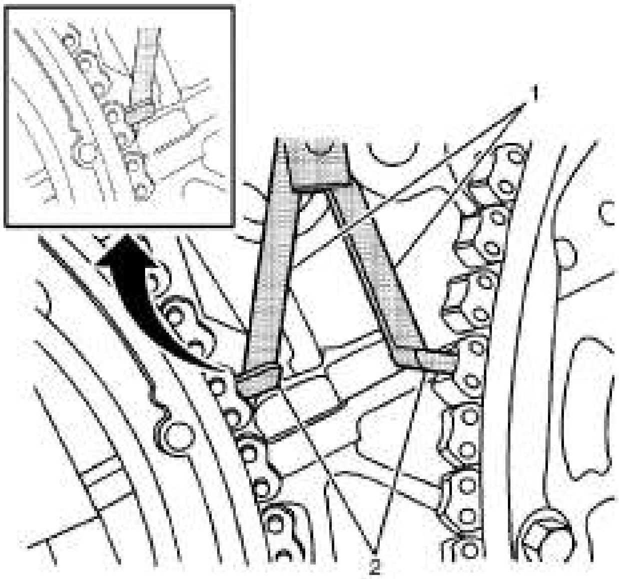
- Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.
- DO NOT remove the camshaft position actuator to camshaft retaining bolt at this time.

9. Loosen the left side intake camshaft position actuator to camshaft retaining bolt.
10. Loosen the EN-48313 so that the legs are retracted.



Important: The front engine cover is removed in the following graphics for illustration purposes and is not required to perform the procedure.

11. Insert the EN-48313 between the camshaft actuators, rearward of the timing chain until the top line that is scribed in the body of the tool (1) is adjacent to the top surface of the cylinder head (2). This is the approximate installed position.



12. Make sure that the feet (2) on the legs (1) of the EN-48313 are facing the front of the engine.

Important: DO NOT tighten EN-48313 at this stage.

13. Partially expand the legs (1) of the EN-48313 by turning the T-shaped handle clockwise.

Important: Make sure that the feet (2) of the EN-48313 are correctly engaged into one of the link pockets to prevent chain slipping during tightening.

14. Continue expanding the EN-48313 until the feet (2) contact the timing chain.

Notice: Refer to Torque Reaction Against Timing Drive Chain Notice in the Preface section.

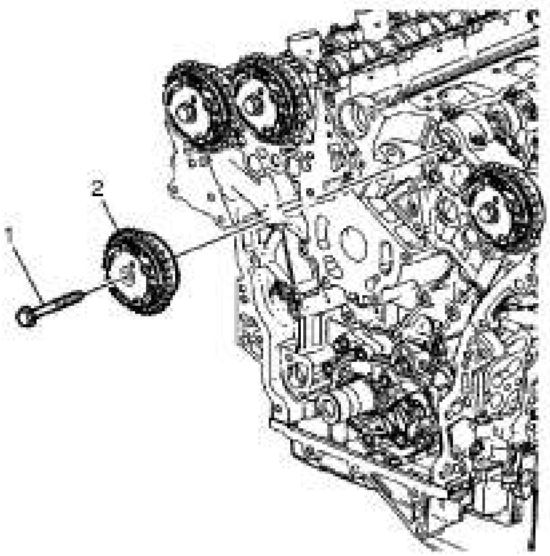
15. Hand tighten the EN-48313 .

Important: DO NOT allow the body of the EN-48313 to rotate when tightening the T-handle.

16. Use an open-end wench on the hex cast into the body of the EN-48313 and hand tighten the T-handle.
17. Use an open-end wrench on the hex cast of the left side intake and exhaust camshafts and rotate the camshafts towards each other in order create slack in the chain between the actuators.
18. The EN-48313 is now correctly installed to hold the timing chain in position.

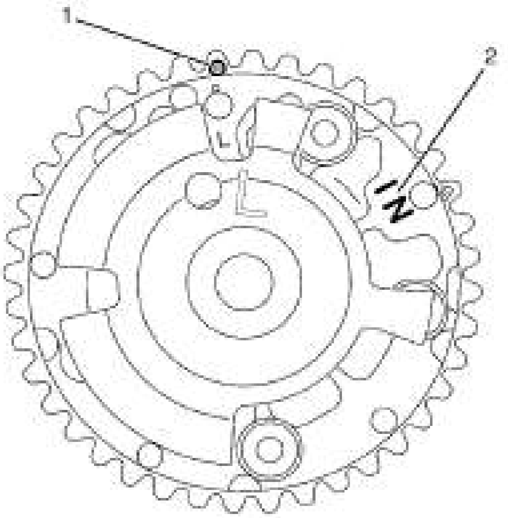
Important: Make sure that the camshaft timing chain and the camshaft position actuators are marked for correct assembly.

19. Mark the timing chain and the camshaft position actuators.

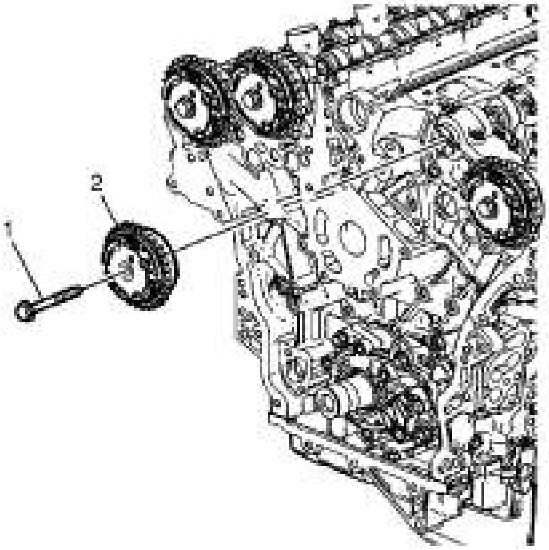


20. Remove the left side intake camshaft position actuator to camshaft retaining bolt (1).
21. Remove the left side intake camshaft position actuator (2).

Installation Procedure



1. Make sure the correct camshaft position actuator is installed. Observe the body of the camshaft position actuator for the "IN" marking (2). The marking is for an intake camshaft position actuator.
2. Make sure the correct timing mark is used. Observe the outer ring of the camshaft position actuator for the "L" and circle marking (1). The marking is for alignment to the highlighted timing chain link on the left side of the engine.



3. Install the left side intake camshaft position actuator (2).

Important:

- Make sure that the marks on the camshaft position actuators and the timing chain are aligned.
- DO NOT tighten the right intake camshaft position actuator to camshaft retaining bolt (1) at this time.

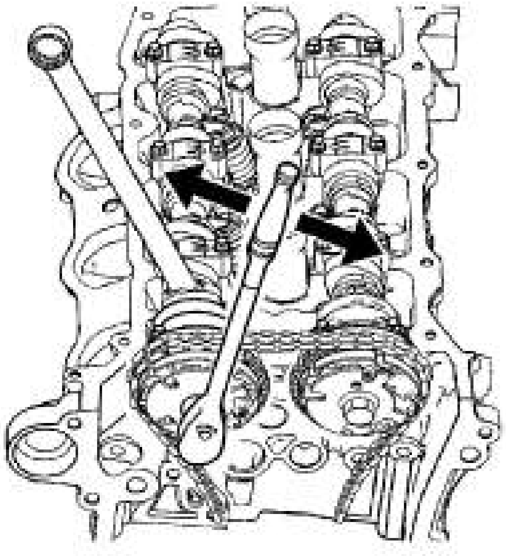
4. Install the camshaft position actuator to camshaft retaining bolt (1).

   DO NOT fully tighten at this stage.

5. Remove EN-48313 .

   Notice: Refer to Torque Reaction Against Timing Drive Chain Notice in the Preface section.

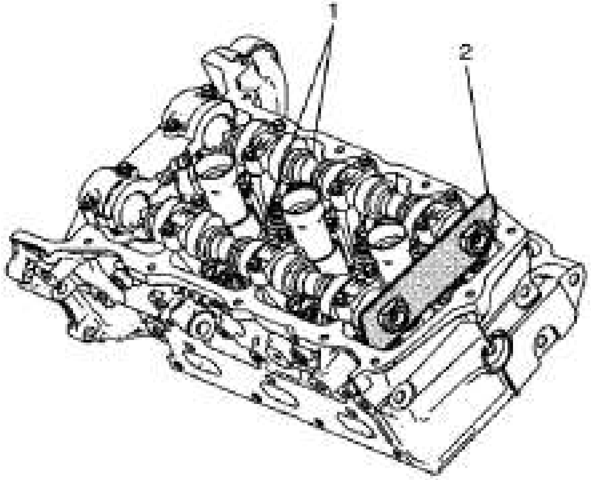
   Notice: Refer to Fastener Notice in the Preface section.



Important: Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.

6. Tighten the camshaft position actuator to camshaft retaining bolt.

   Tighten
   Tighten the bolt to 58 N·m (43 lb ft).



7. Remove the EN 46105 (2) from the rear of the left side camshafts (1)
8. Install the camshaft position (CMP) actuator solenoids. Refer to (if fitted) Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaustand Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake.
9. Install the camshaft position sensors. Refer to (if fitted) Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust and Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake.
10. Install the crankshaft balancer. Refer to Crankshaft Balancer Installation.
11. Install the left bank camshaft cover. Refer to Camshaft Cover Replacement - Left Side.
12. Install the upper intake manifold with the lower intake manifold. Refer to Lower Intake Manifold Replacement.
13. Install the engine covers. Refer to Engine Cover Replacement.

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Camshaft Replacement - Left Side

Removal Procedure

1. Remove the left side camshaft position actuators. Refer to Camshaft Position Actuator Replacement - Bank 2 (Left Side) Exhaust and Camshaft Position Actuator Replacement - Bank 2 (Left Side) Intake.
2. Remove the left side camshafts. Refer to Camshaft Removal - Left Side.

Installation Procedure

1. Install the left side camshafts. Refer to Camshaft Removal - Left Side.
2. Install the left side camshaft position actuators. Refer to Camshaft Position Actuator Replacement - Bank 2 (Left Side) Exhaust and Camshaft Position Actuator Replacement - Bank 2 (Left Side) Intake.

Camshaft Replacement - Right Side

Removal Procedure

1. Remove the right side camshaft position actuators. Refer to Camshaft Position Actuator Replacement - Bank 1 (Right Side) Exhaust and Camshaft Position Actuator Replacement - Bank 1 (Right Side) Intake.
2. Remove the right side camshafts. Refer to Camshaft Removal - Right Side.

Installation Procedure

1. Install the right side camshafts. Refer to Camshaft Installation - Right Side.
2. Install the right side camshaft position actuators. Refer to Camshaft Position Actuator Replacement - Bank 1 (Right Side) Exhaust and Camshaft Position Actuator Replacement - Bank 1 (Right Side) Intake.

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Crankshaft Balancer Replacement

Tools Required

- EN 46106 Flywheel Holding Tool.
- J 45059 Angle Meter.

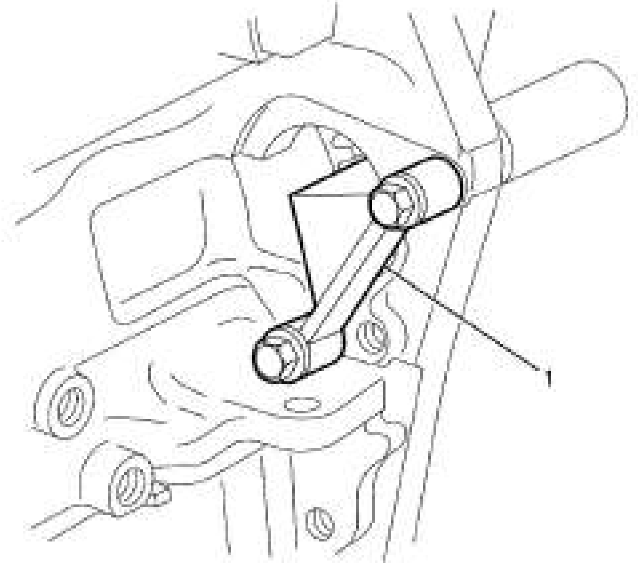
Removal Procedure

1. Remove the drive belt. Refer to Drive Belt Replacement .

   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

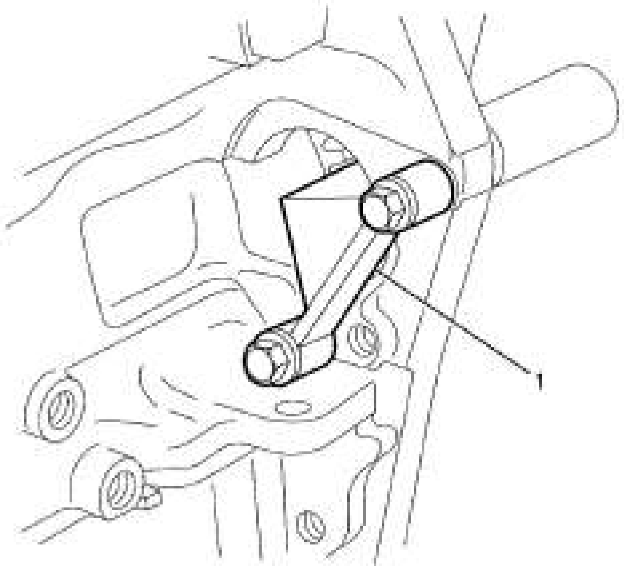
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
3. Remove the starter motor. Refer to Starter Motor Replacement .



4. Install the EN 46106 (1) through the starter mounting hole.
5. Lower the vehicle.
6. Remove the front air deflector. Refer to Front Air Deflector Replacement .
7. Remove the crankshaft balancer. Refer to Crankshaft Balancer Removal .

Installation Procedure

1. Install the crankshaft balancer. Refer to Crankshaft Balancer Installation .
2. Install the front air deflector. Refer to Front Air Deflector Replacement .
3. Raise the vehicle.



4. Remove EN 46106 (1) from the starter mounting hole.
5. Remove the starter motor. Refer to Starter Motor Replacement .
6. Install the drive belt. Refer to Drive Belt Replacement .

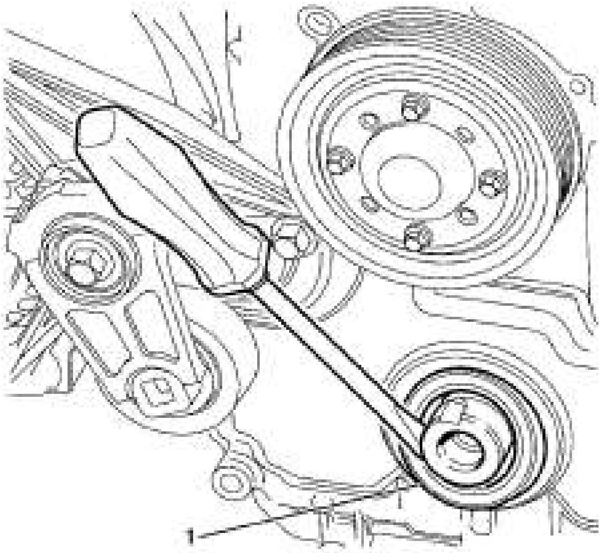
Crankshaft Front Oil Seal Replacement

Tools Required

J 29184 Oil Seal Installer

Removal Procedure

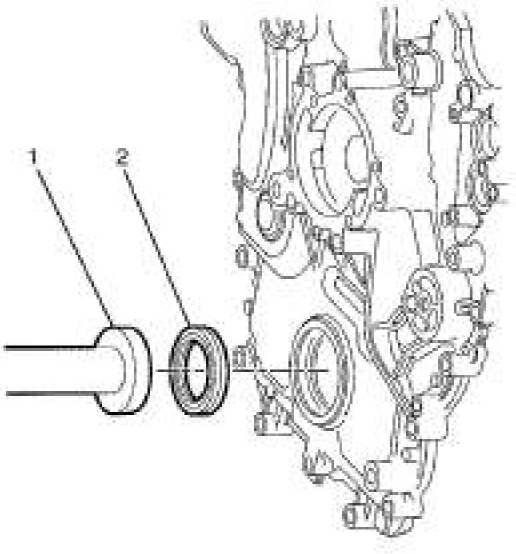
1. Remove the drive belt. Refer to Drive Belt Replacement.
2. Remove the crankshaft balancer. Refer to Crankshaft Balancer Replacement.



Important: DO NOT damage the sealing surfaces of the front cover or the crankshaft when prying the crankshaft front oil seal for removal. Damaging the sealing surface may cause leakage or require replacement of the damaged component.

3. Use a flat-bladed tool in order to remove the crankshaft oil seal (1).

Installation Procedure



Important: DO NOT lubricate the crankshaft front oil seal or the crankshaft balancer sealing surfaces.

1. Use the J 29184 (1) or equivalent to install the crankshaft front oil seal (2).
2. Install the crankshaft balancer. Refer to Crankshaft Balancer Installation.
3. Install the drive belt. Refer to Drive Belt Replacement.

Crankshaft Rear Oil Seal and Housing Replacement

Removal Procedure

1. Remove the engine flywheel. Refer to Engine Flywheel Replacement.
2. Remove the oil pan. Refer to Oil Pan Replacement.
3. Remove the crankshaft rear oil seal and housing. Refer to Crankshaft Rear Oil Seal and Housing Removal.

Installation Procedure

1. Install the crankshaft rear oil seal and housing. Refer to Crankshaft Rear Oil Seal and Housing Installation.
2. Install the oil pan. Refer to Oil Pan Replacement.
3. Install the engine flywheel. Refer to Engine Flywheel Replacement.

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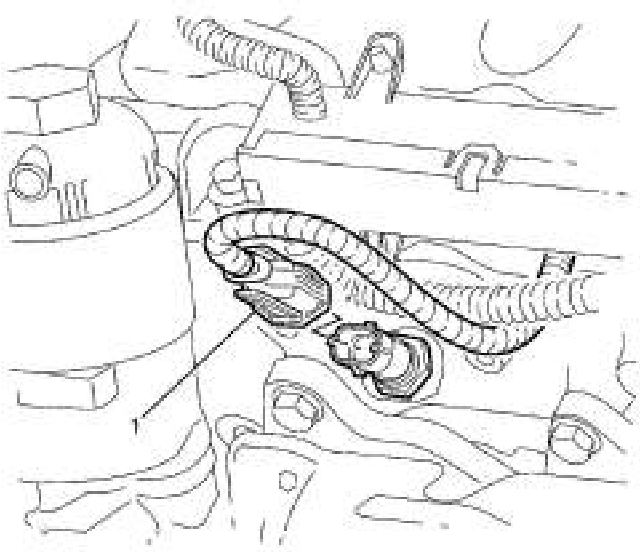
Cylinder Head Replacement - Left Side (RHD)

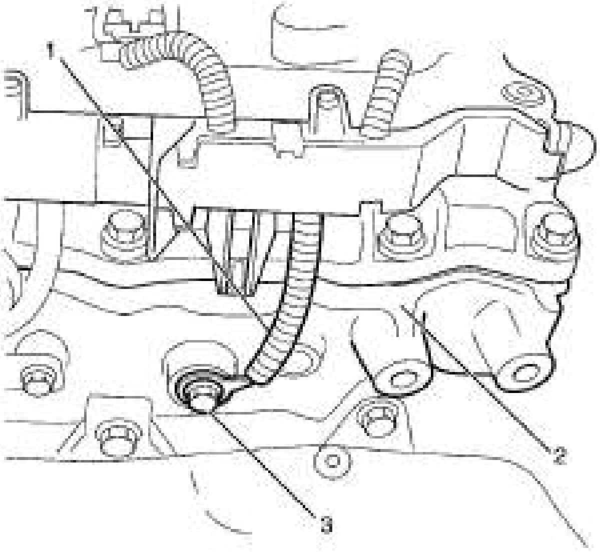
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

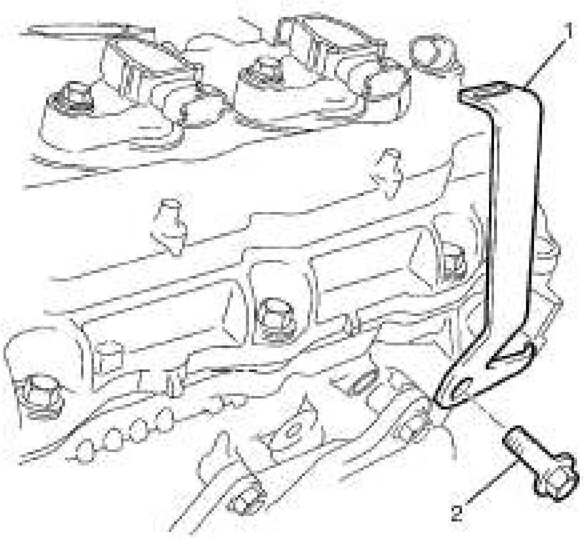
1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the air inlet grille panel. Refer to Air Inlet Grille Panel Replacement.
3. Remove the engine covers. Refer to Engine Cover Replacement.
4. Remove the left camshaft cover. Refer to Camshaft Cover Replacement - Left Side.
5. Remove the left bank secondary timing chain. Refer to Secondary Camshaft Drive Chain Replacement - Left Side.
6. Remove the oil level indicator. Refer to Oil Level Indicator and Tube Replacement.



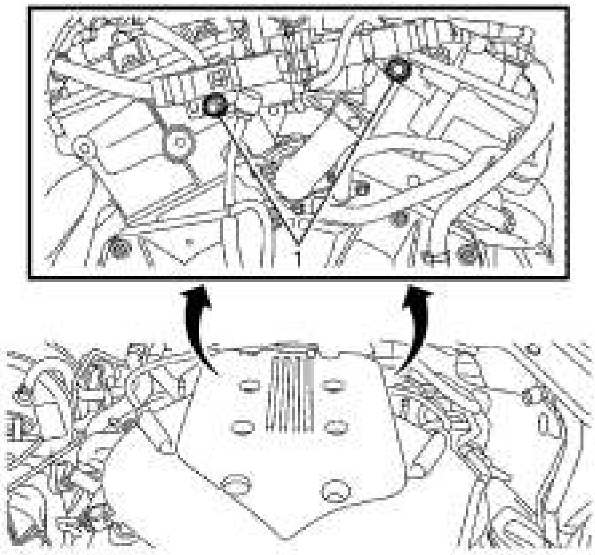
7. Disconnect the coolant temperature sensor electrical connector (1).



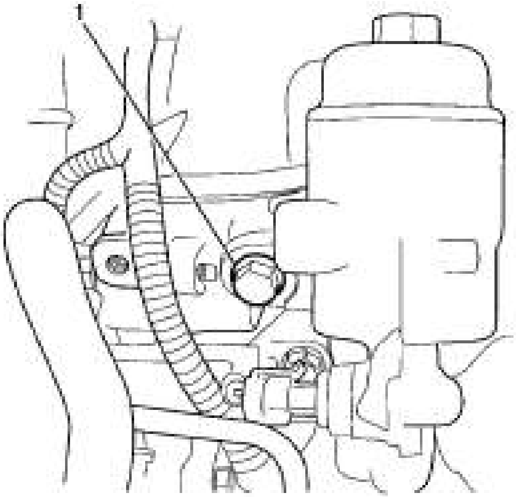
8. Remove the wiring harness ground to cylinder head retaining bolt (3).
9. Remove the wiring harness ground (1) from the cylinder head (2).
10. Remove the upper intake manifold with the lower intake manifold. Refer to Lower Intake Manifold Replacement.



11. Remove the left engine cover mounting bracket to cylinder head retaining bolt (2).
12. Remove the left engine cover mounting bracket (2) from the cylinder head.

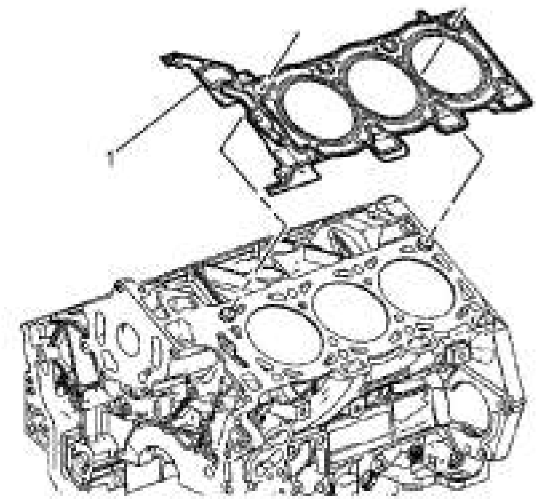


13. Remove the engine wiring harness bracket to cylinder head retaining bolts (1).
14. Remove the catalytic converter. Refer to Catalytic Converter Replacement - Left Side.



Important: DO NOT remove the oil filter adapter.

15. Remove the oil filter adapter upper bolt (1).
16. Remove the cylinder head with the exhaust manifold. Refer to Cylinder Head Removal - Left Side.



Important: Cylinder head gaskets must be discarded whenever the cylinder head has been removed from the cylinder block.

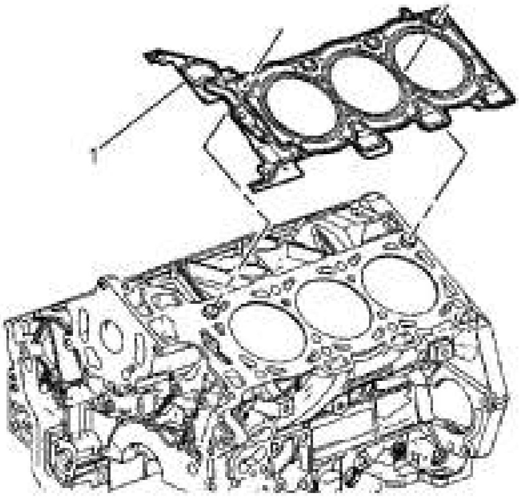
17. Remove the cylinder head gasket (1).

    Discard the gasket.

18. Clean and inspect the cylinder head and the cylinder block sealing surfaces. Refer to Cylinder Head Cleaning and Inspection and Engine Block Cleaning and Inspection.
19. If necessary, perform the following steps:
    - Remove the exhaust manifold from the cylinder head. Refer to Exhaust Manifold Removal - Left Side.
    - Disassemble the cylinder head. Refer to Cylinder Head Disassemble.

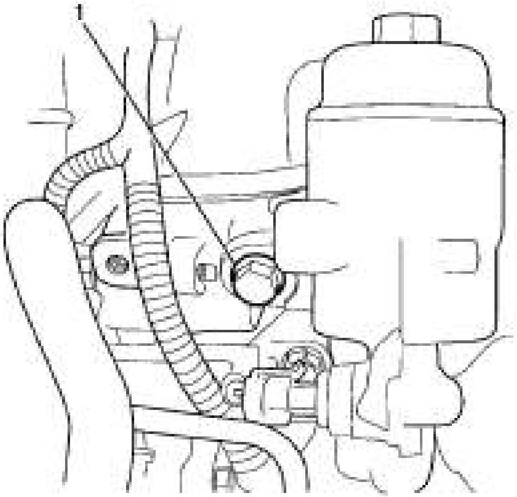
Installation Procedure

1. If necessary, perform the following steps:
    - Assemble the cylinder head. Refer to Cylinder Head Assemble.
    - Install the exhaust manifold to the cylinder head. Refer to Exhaust Manifold Installation - Left Side.



2. Install a NEW cylinder head gasket (1).
3. Install the cylinder head with the exhaust manifold to the engine. Refer to Cylinder Head Installation - Left Side.

   Notice: Refer to Fastener Notice in the Preface section.

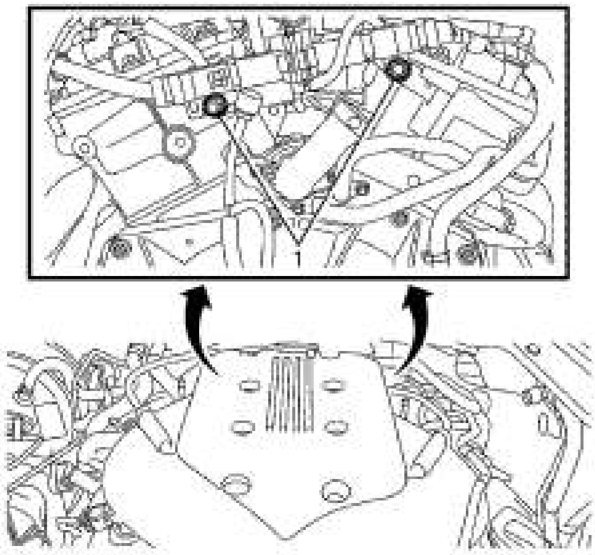


4. Install the oil filter adapter upper retaining bolt (1).

   Tighten
   Tighten the bolt to 65 N·m (48 lb in).

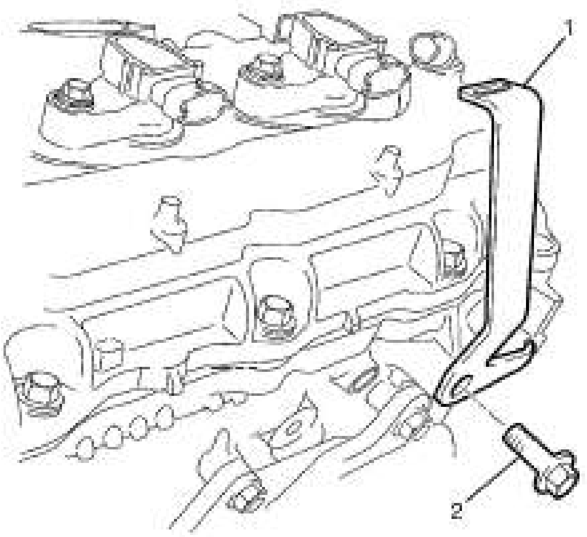
5. Install the catalytic converter to the exhaust manifold. Refer to Catalytic Converter

Replacement - Left Side.



6. Install the wiring harness bracket (2) to the rear of the cylinder head (3).
7. Install the wiring harness bracket to cylinder head retaining bolts (1).

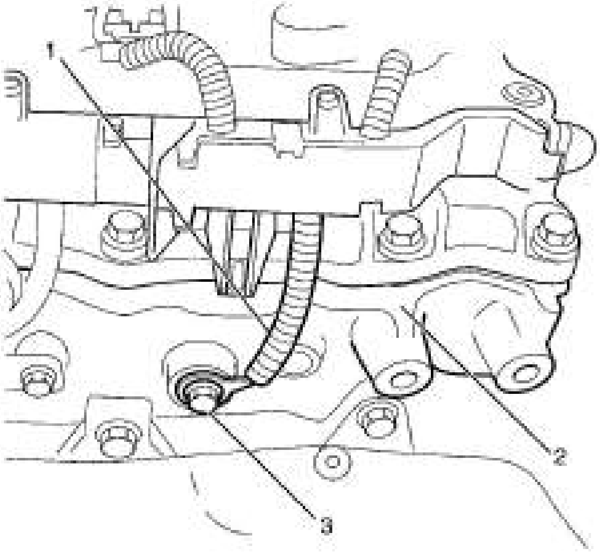
Tighten
Tighten the bolts to 10 N·m (89 lb in).



8. Install the left engine cover mounting bracket (1) to cylinder head retaining bolt (2).

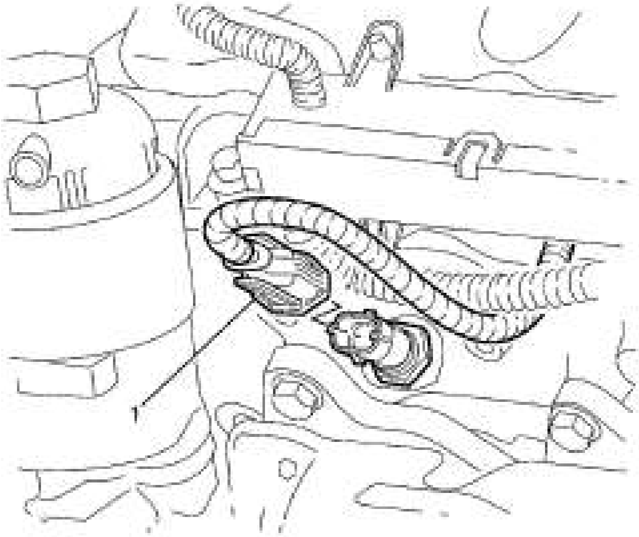
Tighten
Tighten the bolt to 35 N·m (26 lb in).

9. Install the engine covers mounting bracket to cylinder head retaining bolt (2).
10. Install the upper intake manifold with the lower intake manifold. Refer to Lower Intake Manifold Replacement.



11. Install the wiring harness ground (1) to the cylinder head (2).
12. Install the wiring harness ground to cylinder head retaining bolt (3).

Tighten
Tighten the bolt to 10 N·m (89 lb in).



13. Connect the coolant temperature sensor electrical connector (1).
14. Install the oil level indicator. Refer to Oil Level Indicator and Tube Replacement.
15. Install the left bank secondary timing chain. Refer to Secondary Camshaft Drive Chain

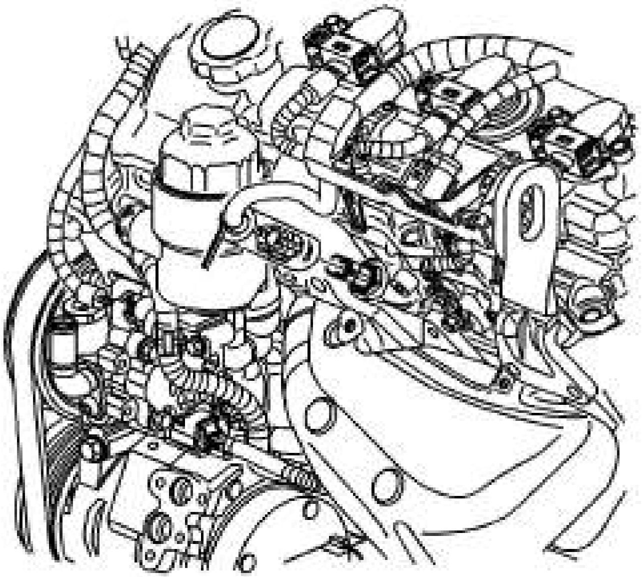
Replacement - Left Side.

16. Install the left camshaft cover. Refer to Camshaft Cover Replacement - Left Side.
17. Install the engine covers. Refer to Engine Cover Replacement.
18. Install the air inlet grille panel. Refer to Air Inlet Grille Panel Replacement.
19. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

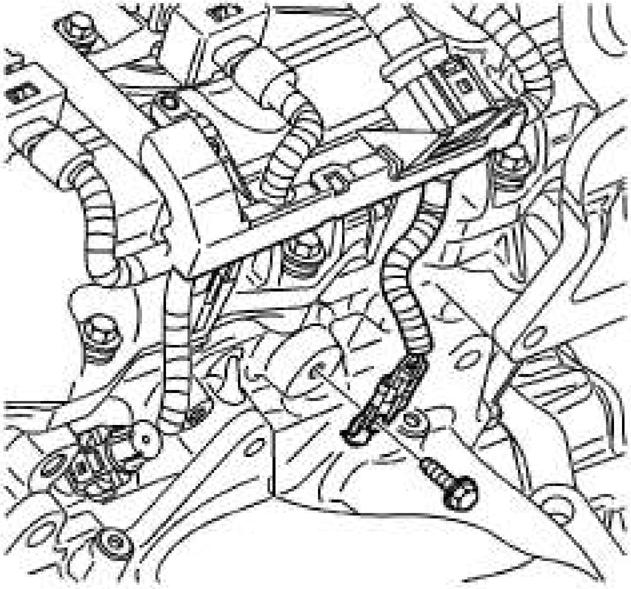
Cylinder Head Replacement - Left Side (LLT)

Removal Procedure

1. Remove the left bank secondary timing chain. Refer to Secondary Camshaft Drive Chain Replacement - Left Side.
2. Remove the oil level indicator. Refer to Oil Level Indicator and Tube Replacement.
3. Remove the fuel pump. Refer to Fuel Pump Replacement.



4. Remove the heat shield from the coolant temperature sensor and disconnect the coolant temperature sensor electrical connector.



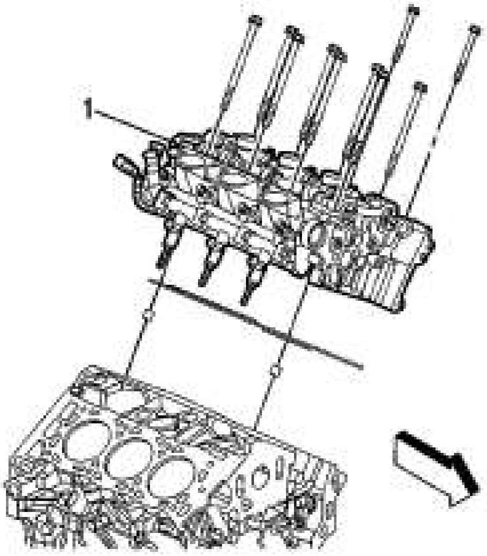
5. Remove the wiring harness ground from the cylinder head.
6. Disconnect the wiring harness electrical connector located at the side of the cylinder head.
7. Remove the wiring harness connector bracket from the side of the cylinder head.

Note: DO NOT disconnect the power steering pipes and/or hoses.

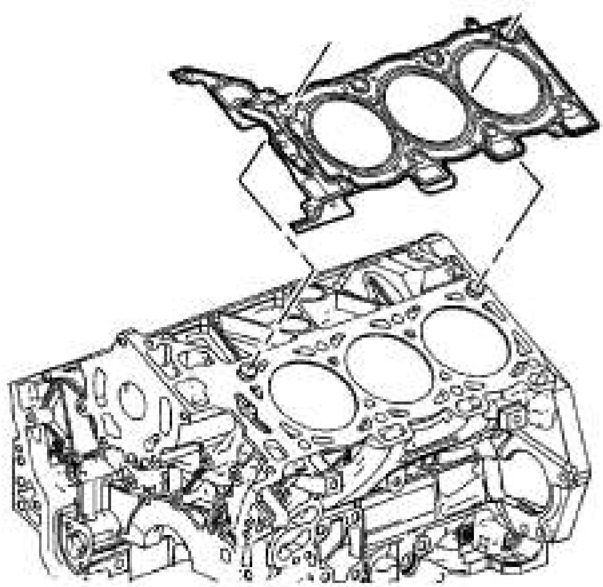
8. Remove the power steering pump bolts. Refer to Power Steering Pump Replacement.
9. Remove the surge tank hose from the bracket at the rear of the cylinder head.
10. Remove the wiring harness bracket from the rear of the cylinder head.
11. Remove the catalytic converter. Refer to Catalytic Converter Replacement - Left Side.
12. Remove the oil level indicator. Refer to Oil Level Indicator and Tube Replacement.

Note: Do not remove the oil filter adapter.

13. Remove the oil filter adapter upper bolt.



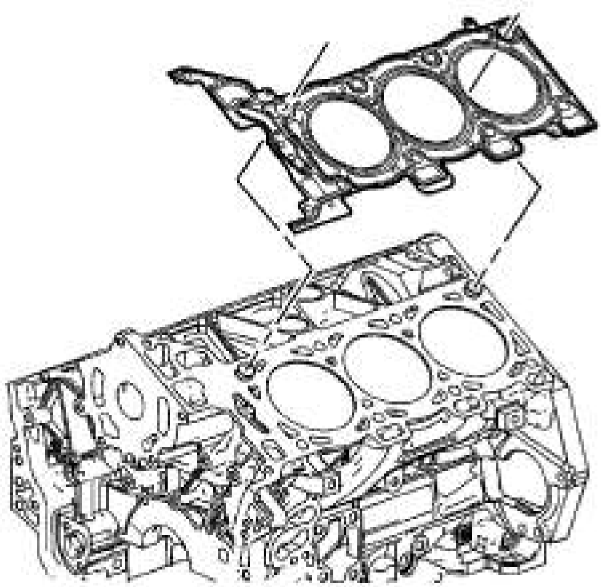
14. Remove the cylinder head (1) with the exhaust manifold. Refer to Cylinder Head Removal - Right Side.



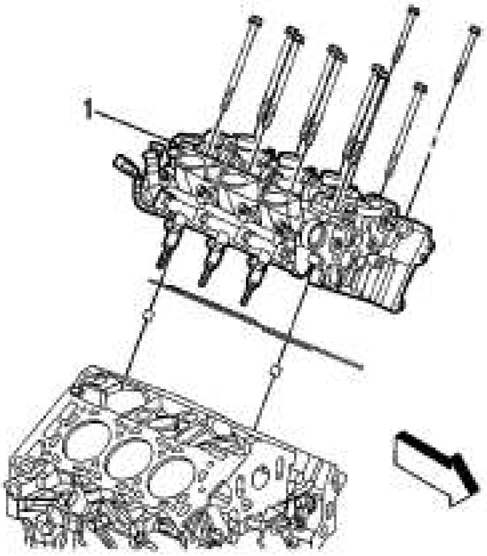
15. Remove and discard the cylinder head gasket.
16. Clean and inspect the cylinder head and the engine block sealing surfaces. Refer to Cylinder Head Cleaning and Inspection and Engine Block Cleaning and Inspection.
17. If necessary, perform the following steps:
    - 17.1. Remove the exhaust manifold from the cylinder head. Refer to Exhaust Manifold Removal - Left Side.
    - 17.2. Disassemble the cylinder head. Refer to Cylinder Head Disassemble.

Installation Procedure

1. If necessary, perform the following steps:
    - 1.1. Assemble the cylinder head. Refer to Cylinder Head Assemble.
    - 1.2. Install the exhaust manifold to the cylinder head. Refer to Exhaust Manifold Installation - Left Side.

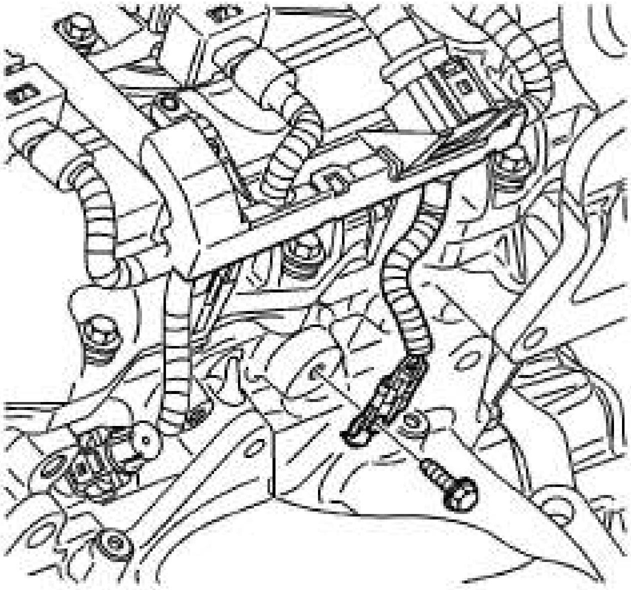


2. Install a NEW cylinder head gasket.

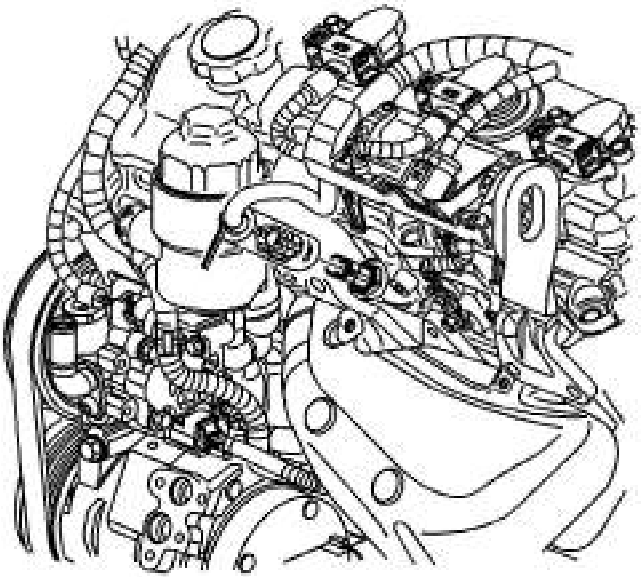


3. Carefully install the cylinder head (1) with the exhaust manifold to the engine. Refer to Cylinder Head Installation - Left Side.
4. Install the oil filter adapter upper bolt. Refer to Oil Filter Adapter Installation.
5. Install the oil level indicator. Refer to Oil Level Indicator and Tube Replacement.
6. Install the catalytic converter to the exhaust manifold. Refer to Catalytic Converter Replacement - Left Side.
7. Install the wiring harness bracket to the rear of the cylinder head.
8. Install the surge tank hose to the bracket at the rear of the cylinder head.
9. Install the power steering pump bolts. Refer to Power Steering Pump Replacement.
10. Install the wiring harness connector bracket from the side of the cylinder head.
11. Disconnect the wiring harness electrical connector located at the side of the cylinder head.

Caution: Refer to Fastener Caution in the Preface section.



12. Install the wiring harness ground to the cylinder head and tighten the bolt to **10 N·m (89 lb in)**.



13. Install the coolant temperature sensor electrical connector heat shield.
14. Install the fuel pump. Refer to Fuel Pump Replacement.
15. Install the oil level indicator. Refer to Oil Level Indicator and Tube Replacement.
16. Install the left bank secondary timing chain. Refer to Secondary Camshaft Drive Chain Replacement - Left Side.

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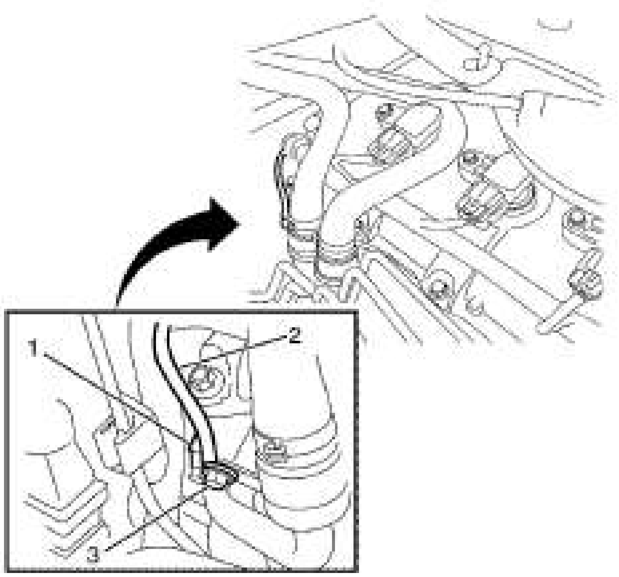
Cylinder Head Replacement - Right Side (RHD)

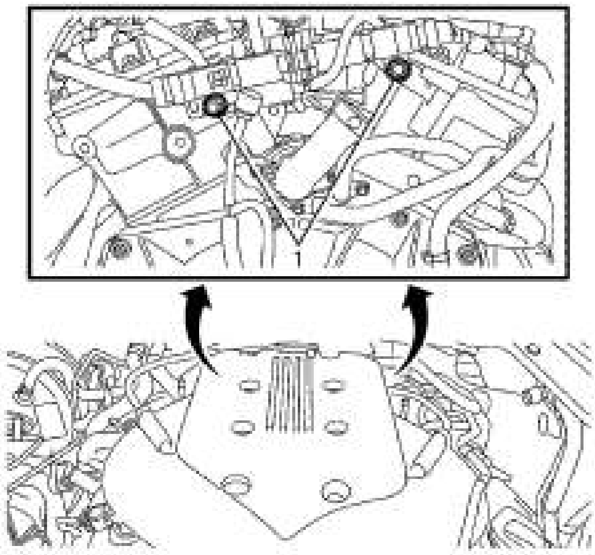
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

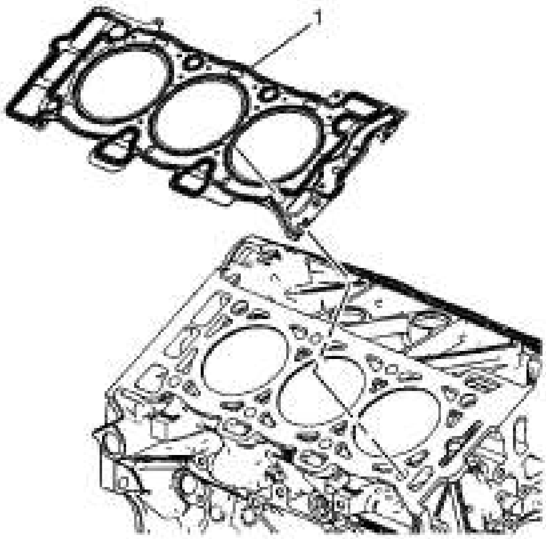
1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the air inlet grille panel. Refer to Air Inlet Grille Panel Replacement.
3. Remove the engine covers. Refer to Engine Cover Replacement.
4. Remove the right camshaft cover. Refer to Camshaft Cover Replacement - Right Side.
5. Remove the left bank secondary timing chain. Refer to Secondary Camshaft Drive Chain Replacement - Left Side.



6. Remove the wiring harness ground to cylinder head retaining bolts (1).
7. Remove the wiring harness ground (2) from the side of the cylinder head (3).
8. Remove the coolant inlet pipe. Refer to Engine Coolant Inlet Pipe Replacement.



9. Remove the engine wiring harness bracket to cylinder head retaining bolts (1).
10. Remove the catalytic converter. Refer to Catalytic Converter Replacement - Right Side.
11. Remove the cylinder head with the exhaust manifold..



Important: Cylinder head gaskets must be discarded whenever the cylinder head has been removed from the cylinder block

12. Remove and discard the cylinder head gasket (1).

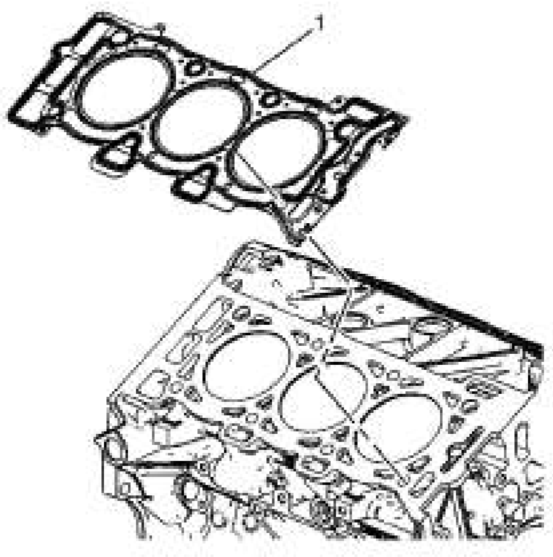
    Discard the gasket

13. Clean and inspect the cylinder head and the cylinder block sealing surfaces. Refer to Cylinder Head Cleaning and Inspectionand Engine Block Cleaning and Inspection.

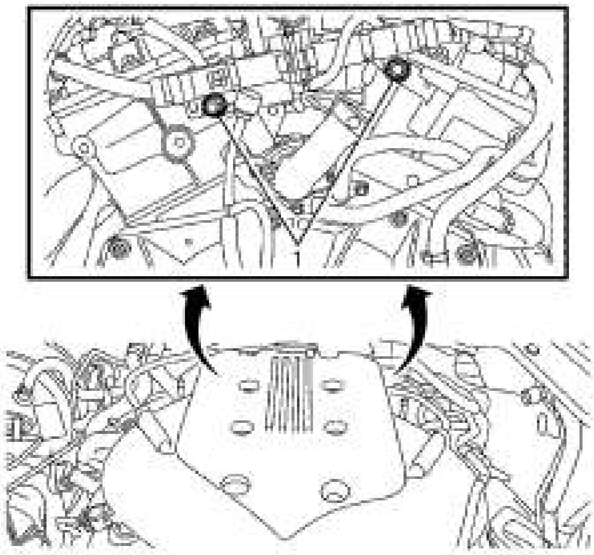
14. If necessary, perform the following steps:
    - Remove the exhaust manifold from the cylinder head. Refer to Exhaust Manifold Removal - Right Side.
    - Disassemble the cylinder head. Refer to Cylinder Head Disassemble.

Installation Procedure

1. If necessary, perform the following steps:
    - Assemble the cylinder head. Refer to Cylinder Head Assemble.
    - Install the exhaust manifold to the cylinder head. Refer to Exhaust Manifold Installation - Right Side.



2. Install a NEW cylinder head gasket (1).
3. Install the cylinder head with the exhaust manifold to the engine..
4. Install the catalytic converter to the exhaust manifold. Refer to Catalytic Converter Replacement - Right Side.

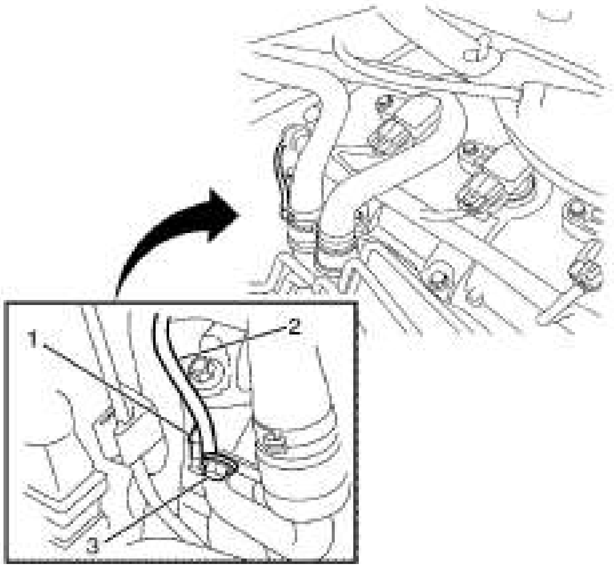


5. Install the engine wiring harness bracket to cylinder head retaining bolts (1).

   Notice: Refer to Fastener Notice in the Preface section.

6. Install the wiring harness bracket to cylinder head retaining bolts (1).

   Tighten
   Tighten the bolt to 10 N·m (89 lb in).



7. Install the wiring harness ground to the side of the cylinder head.
8. Install the wiring harness ground to right cylinder head retaining bolt (3).

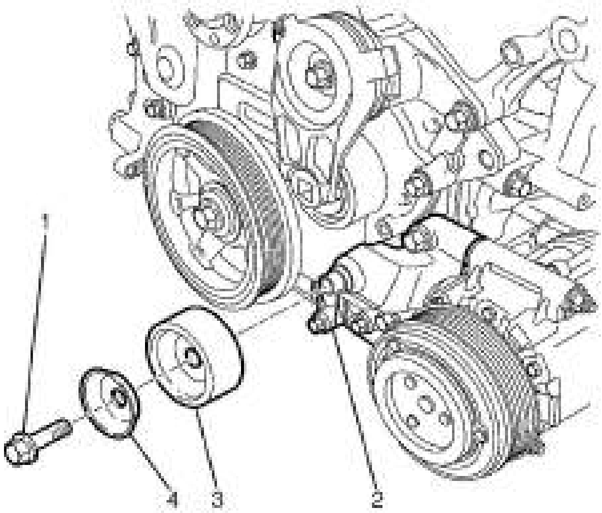
Tighten
Tighten the bolt to 10 N·m (89 lb in).

9. Install the coolant inlet pipe. Refer to Engine Coolant Inlet Pipe Replacement.
10. Install the right camshaft cover. Refer to Camshaft Cover Replacement - Right Side.
11. Install the left bank secondary timing chain. Refer to Secondary Camshaft Drive Chain Replacement - Left Side.
12. Install the engine covers. Refer to Engine Cover Replacement.
13. Install the air inlet grille panel. Refer to Air Inlet Grille Panel Replacement.
14. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

Drive Belt Idler Pulley Replacement

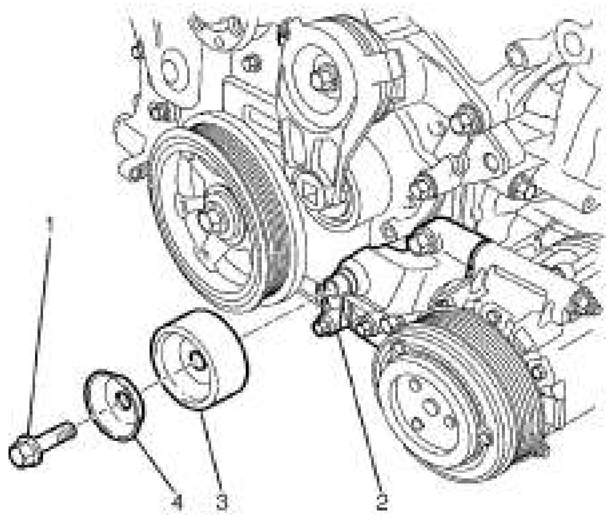
Removal Procedure

1. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.
2. Remove the drive belt. Refer to Drive Belt Replacement.



3. Remove the drive belt idler pulley to accessory drive mounting bracket retaining bolt (1).
4. Remove the dished washer (4) and drive belt idler pulley (3) from the accessory drive mounting bracket (2).

Installation Procedure



1. Install the dished washer (4) and drive belt idler pulley (3) to the accessory drive mounting bracket (2).
2. Hand tighten the drive belt idler pulley to accessory drive mounting bracket retaining bolt (1).

   Notice: Refer to Fastener Notice in the Preface section.

3. Tighten the drive belt idler pulley to accessory drive mounting bracket retaining bolt.

   Tighten
   Tighten the bolt to 58 N·m (43 lb ft).

4. Install the drive belt. Refer to Drive Belt Replacement.
5. Install the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.

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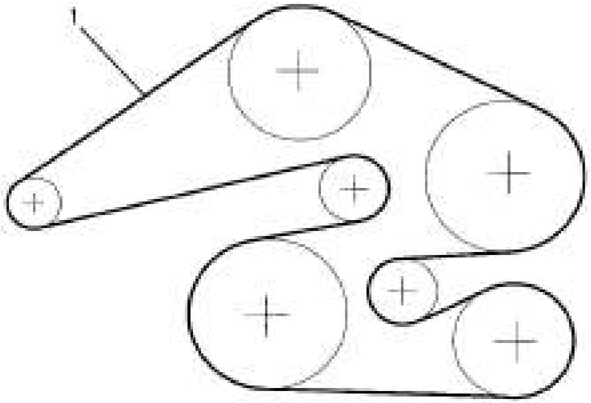
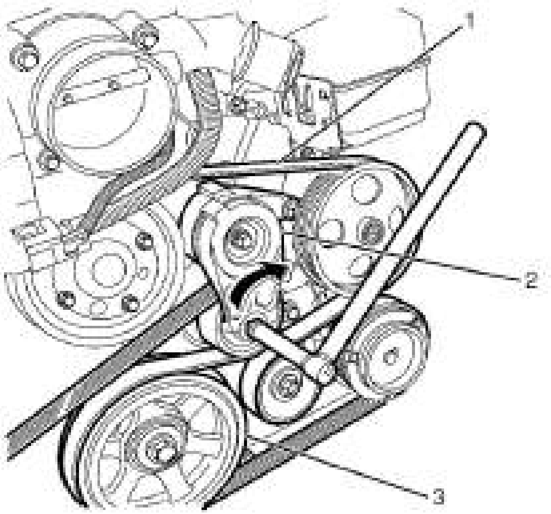
Drive Belt Replacement (With Air Conditioning)

Removal Procedure

1. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.



2. Note the routing of the drive belt (1).

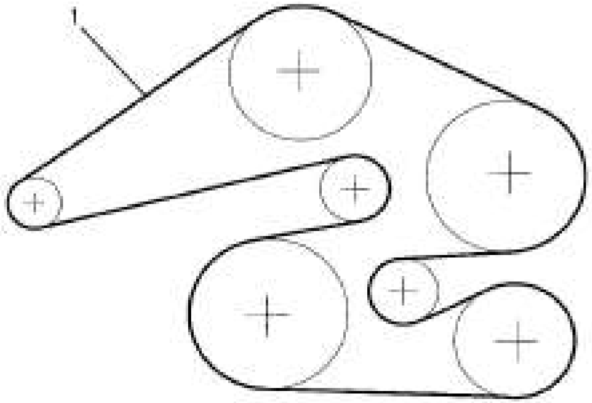


Important: Using a suitable tool rotate the drive belt tensioner (2) clockwise.

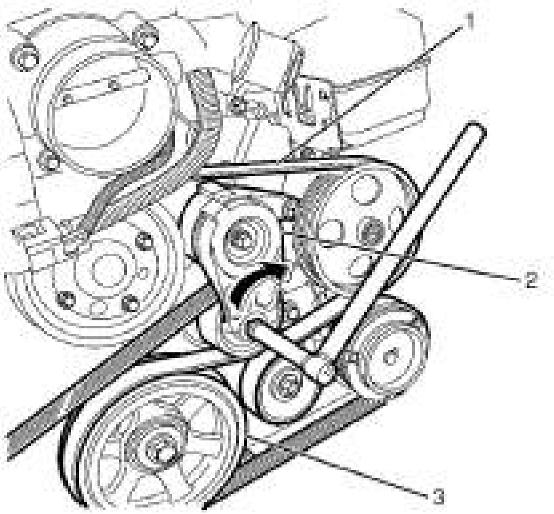
3. Rotate the drive belt tensioner (2) clockwise in order to release tension on the drive belt (1).

4. Remove the drive belt (1) from the crankshaft pulley (3).
5. Slowly release the drive belt tensioner (2).
6. Remove the drive belt (1).

Installation Procedure



1. Install and correctly route the drive belt (1) around the following:
   - Water pump pulley
   - Generator
   - Drive belt tensioner
   - Crankshaft balancer
   - Air conditioning compressor
   - Power steering pump



2. Using a suitable tool rotate the drive belt tensioner (2) clockwise.
3. Install the drive belt (1) to the crankshaft pulley (3).

   Important: Make sure the drive belt (1) is correctly aligned and seated into the grooves of the accessory drive pulleys.

4. Slowly release the drive belt tensioner (2).
5. Remove the suitable tool from the drive belt tensioner (2).
6. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.

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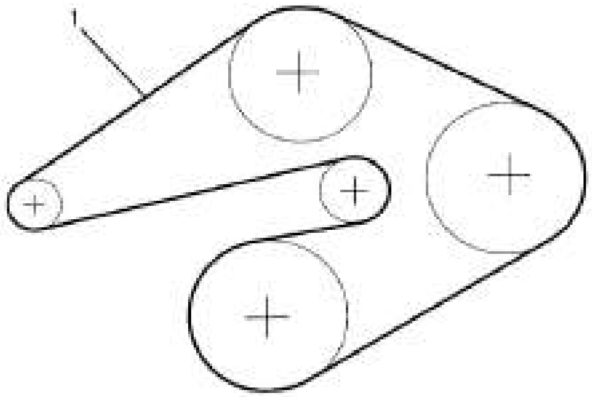
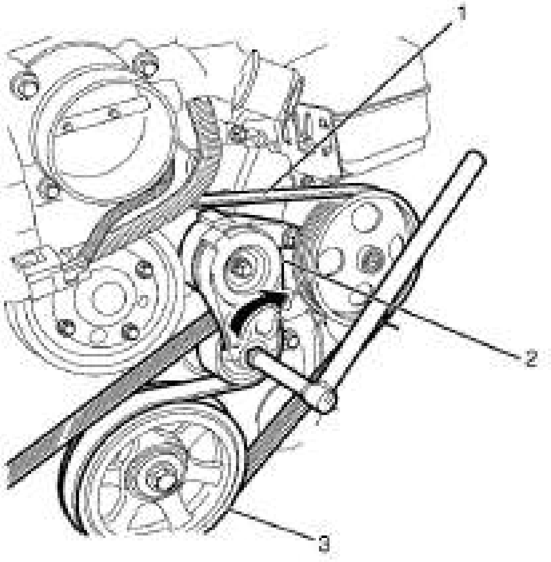
Drive Belt Replacement (Without Air Conditioning)

Removal Procedure

1. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.



2. Note the routing of the drive belt (1).

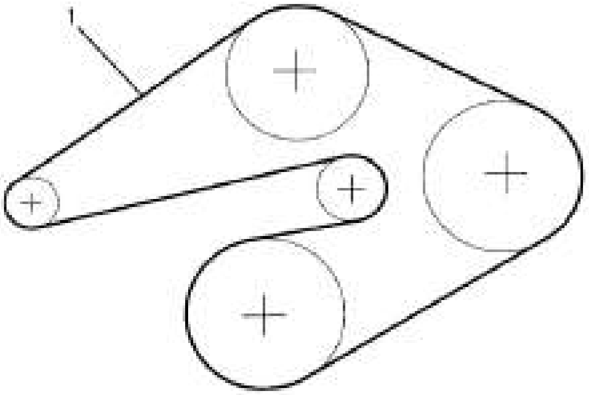


Important: Using a suitable tool rotate the drive belt tensioner (2) clockwise.

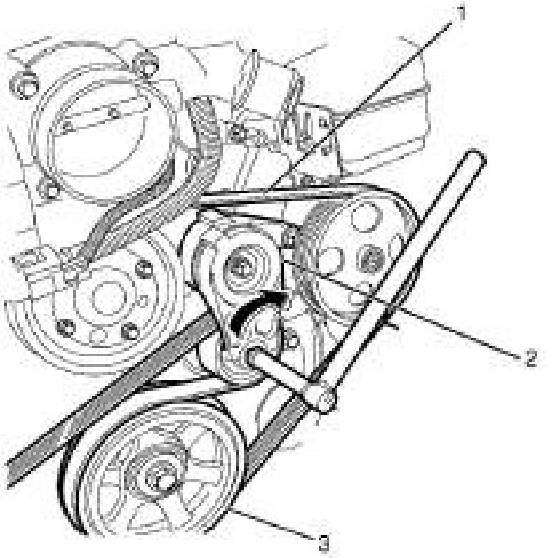
3. Rotate the drive belt tensioner (2) clockwise in order to release tension on the drive belt (1).

4. Remove the drive belt (1) from the crankshaft pulley (3).
5. Slowly release the drive belt tensioner (2).
6. Remove the drive belt (1).

Installation Procedure



1. Install and correctly route the drive belt (1) around the following:
   - Water pump pulley
   - Generator
   - Drive belt tensioner
   - Crankshaft balancer
   - Power steering pump



2. Using a suitable tool rotate the drive belt tensioner (2) clockwise.
3. Install the drive belt (1) to the crankshaft pulley (3).

   Important: Make sure the drive belt (1) is correctly aligned and seated into the grooves of the accessory drive pulleys.

4. Slowly release the drive belt tensioner (2).
5. Remove the suitable tool from the drive belt tensioner (2).
6. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.

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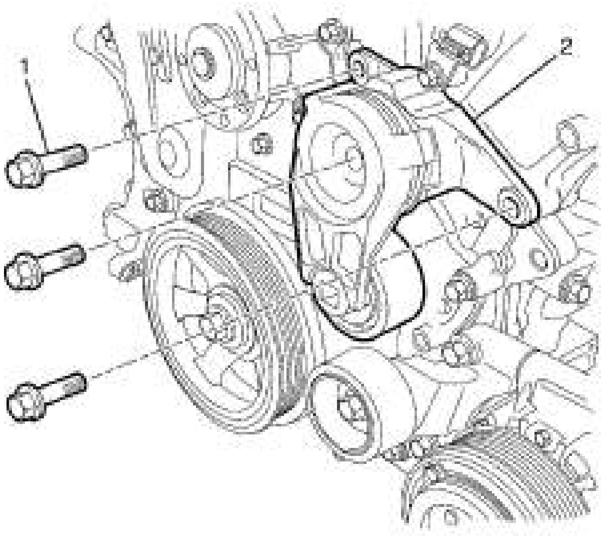
Drive Belt Tensioner Replacement (With Air Condictioning)

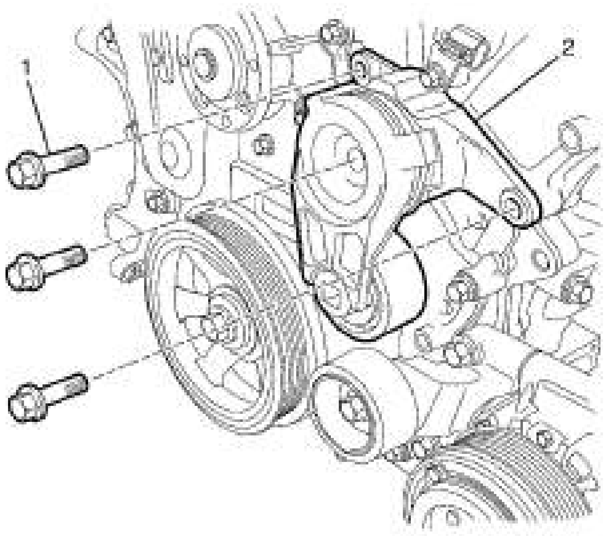
Removal Procedure

1. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.
2. Remove the drive belt. Refer to Drive Belt Replacement.



3. Remove the drive belt tensioner to engine front cover retaining bolts (1).
4. Remove the drive belt tensioner (2).

Installation Procedure



1. Install the drive belt tensioner (2) to the engine front cover.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the drive belt tensioner to engine front cover retaining bolts (1).

   Tighten
   Tighten the bolts to 22 N·m (17 lb ft).

3. Install the drive belt. Refer to Drive Belt Replacement.
4. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.

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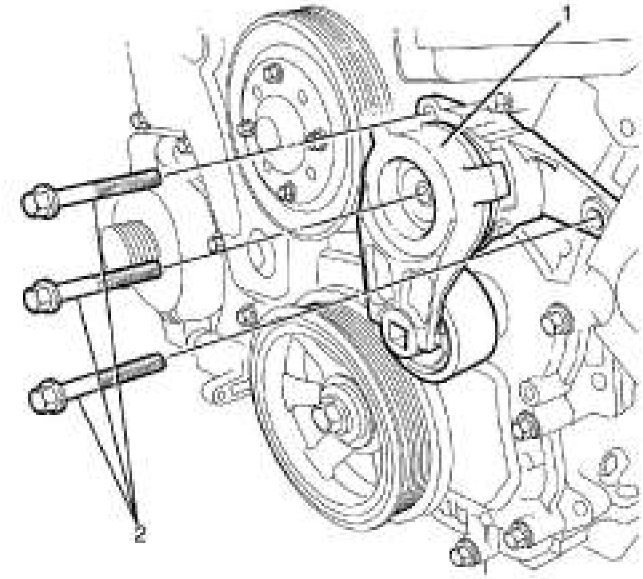
Drive Belt Tensioner Replacement (Without Air Condictioning)

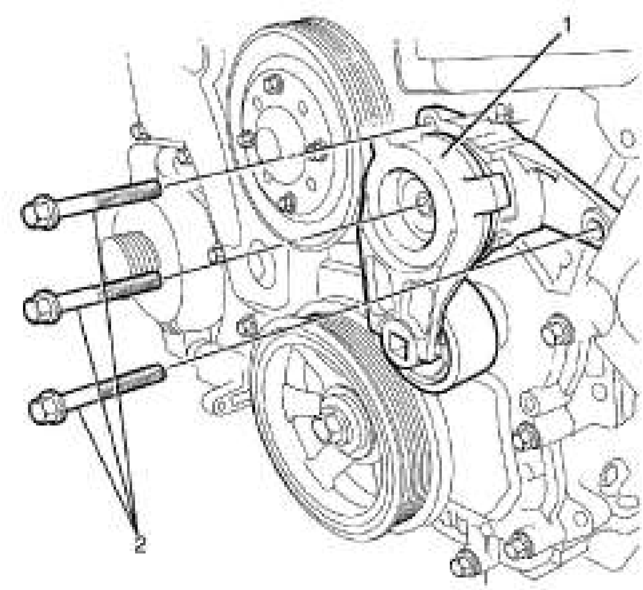
Removal Procedure

1. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.
2. Remove the drive belt. Refer to Drive Belt Replacement.



3. Remove the drive belt tensioner to engine front cover retaining bolts (2).
4. Remove the drive belt tensioner (1).

Installation Procedure



1. Install the drive belt tensioner (1) to the engine front cover.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the drive belt tensioner to engine front cover retaining bolts (2).

   Tighten
   Tighten the bolts to 22 N·m (17 lb ft).

3. Install the drive belt. Refer to Drive Belt Replacement.
4. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.

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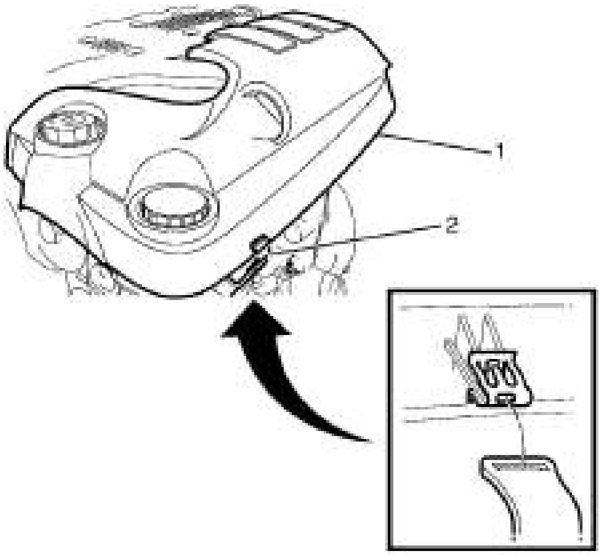
Engine Cover Replacement

Removal Procedure

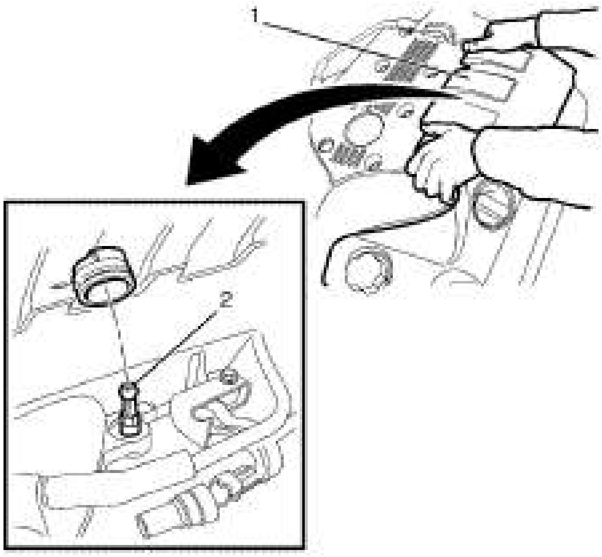
1. Remove the cross car brace, if fitted. Refer to Front End Panel Module Carrier Assembly Replacement .



Important: The right hand engine cover has only one outer retaining clip (2) at the front. The left hand engine cover has one front and one rear outer retaining clip.

Important: Grasp and pry the engine covers (1) upwards to detach the engine covers (1) from the outer retaining clips (2).

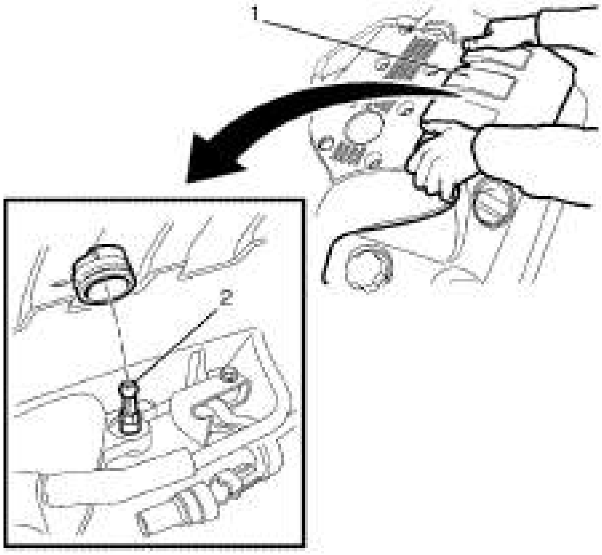
2. Detach the engine covers (1) from the outer retaining clips (2).



Important: Disengage the engine covers (1) from the ball studs (2) by pulling up firmly on the rear and front of the engine covers (1).

3. Detach the engine covers (1) from the ball studs (2).
4. Remove the engine covers (1).

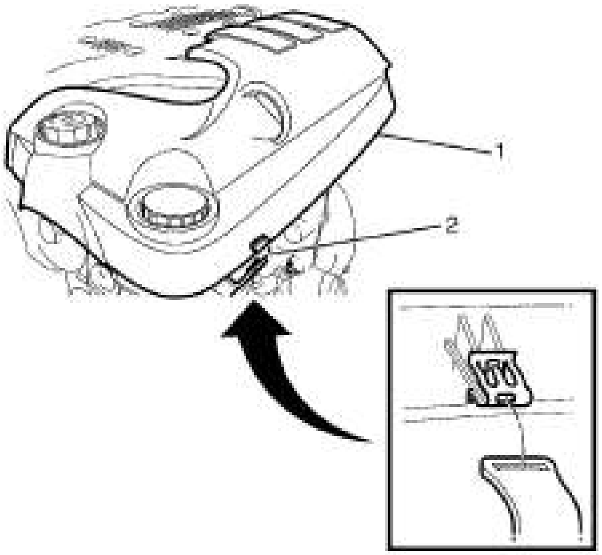
Installation Procedure



1. Position the engine covers (1) over the intake manifold so the grommets are aligned with the ball studs (2).

Important: Press the engine covers (1) down firmly near the ball studs to attach the engine covers (1) to the ball studs (2).

2. Attach the engine covers (1) to the ball studs (2).



Important: The right hand engine cover has only one outer retaining clip (2) at the front. The left hand engine cover has one front and one rear outer retaining clip.

Important: Press the engine covers (1) down firmly near the outer retaining clips to attach the engine covers (1) to the outer retaining clips (2).

3. Attach the engine covers (1) to the outer retaining clips (2).
4. Install the cross car brace, if fitted. Refer to Front End Panel Module Carrier Assembly Replacement

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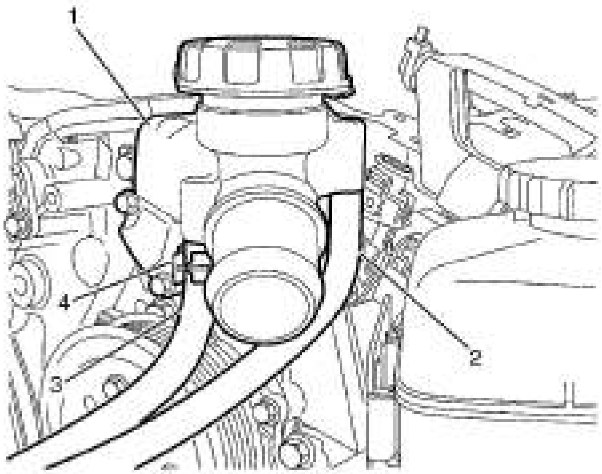
Engine Front Cover Replacement

Tools Required

EN 46109 Engine Front Cover Installation Guide Pins

Removal Procedure

1. Remove the engine covers. Refer to Engine Cover Replacement .
2. Remove the upper intake manifold with the lower intake manifold. Refer to Lower Intake Manifold Replacement .
3. Remove the camshaft covers. Refer to Camshaft Cover Replacement - Left Side and Camshaft Cover Replacement - Right Side .
4. Drain the engine coolant. Refer to Cooling System Draining and Filling .
5. Remove the radiator outlet hose. Refer to Radiator Outlet Hose Replacement .



6. Compress the coolant bleed hose retaining clamp (4) at the outlet housing (1) end and slide 50 mm (2 in) along the coolant bleed hose (3).
7. Remove the coolant bleed hose (3) from the outlet housing (1).

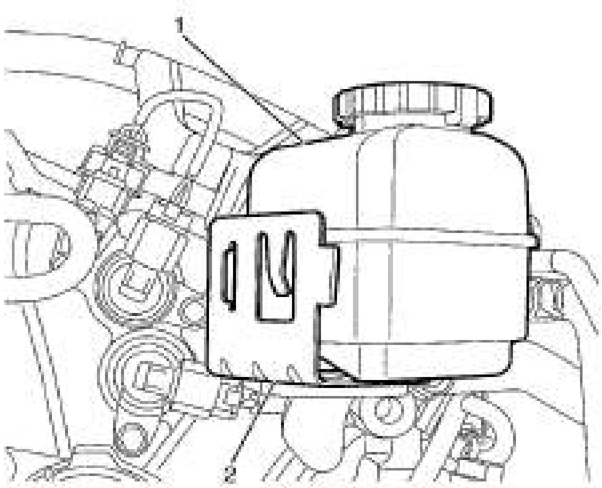
   Important: Twist and pull the coolant recovery hose (2) to remove from the outlet housing (1).

8. Disconnect the coolant recovery hose (2) from the outlet housing (1).

   Important: Plug or cap the hoses and inlets when separating the cooling system components, this prevents dirt and other contaminants from entering the cooling system.

9. Plug or cap the cooling system hoses and inlets
10. Remove the water outlet housing. Refer to Water Outlet Housing Replacement .
11. Remove the drive belt. Refer to Drive Belt Replacement .

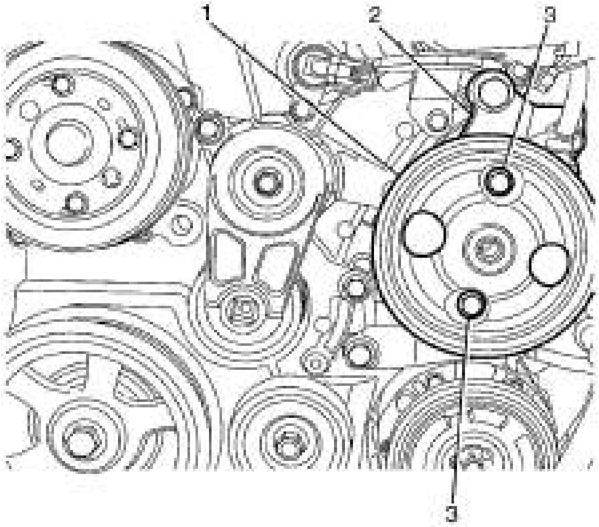
12. Remove the drive belt tensioner. Refer to Drive Belt Tensioner Replacement .
13. Remove the alternator bracket with the alternator. Refer to Generator Bracket Replacement .



Important: DO NOT disconnect the power steering pipes or drain the power steering fluid.

Important: The locking tang on the power steering reservoir bracket (2) must be released before removing the power steering reservoir (1). Release the locking tang on the power steering reservoir bracket (2) with a suitable tool.

14. Separate power steering fluid reservoir (1) from the power steering fluid reservoir bracket (2).
15. Reposition and secure the power steering fluid reservoir away from the power steering fluid reservoir (1) bracket (2).

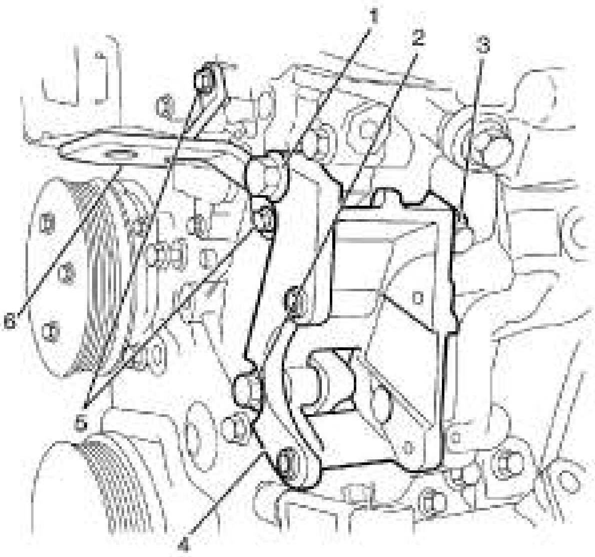


Important: DO NOT disconnect the power steering pipes/hoses.

Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

Important: Make sure all the bolt holes are thoroughly cleaned and all micro-encapsulated thread sealant is removed.

16. Remove the power steering pump to power steering bracket retaining bolts (3).
    - Discard the bolts.
    - Clean the bolt holes.
17. Remove the power steering pump (1) from the power steering bracket (2).
18. Secure and reposition the power steering pump (1) away from the power steering bracket (2).



Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

Important: Make sure all the bolt holes are thoroughly cleaned and all micro-encapsulated thread sealant is removed.

19. Remove the power steering fluid reservoir bracket to engine front cover retaining bolts (5).
    - Discard the bolts.
    - Clean the bolt holes.
20. Remove the power steering fluid reservoir bracket (6).

Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

Important: Make sure all the bolt holes are thoroughly cleaned and all micro-encapsulated thread sealant is removed.

21. Remove the power steering bracket to cylinder head retaining bolt (3).
    - Discard the bolt.
    - Clean the bolt hole.

Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

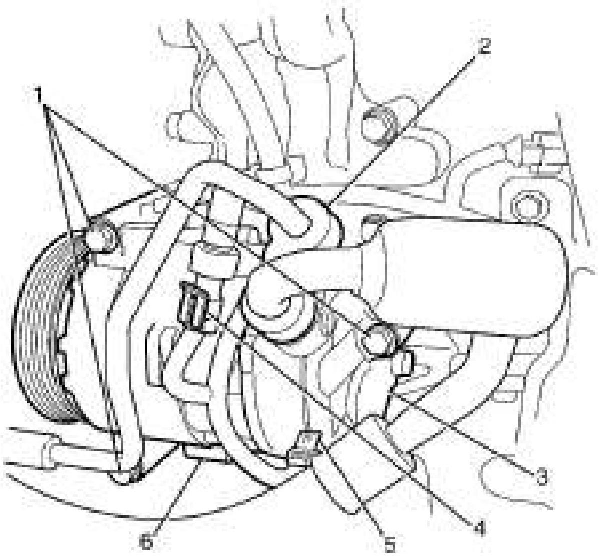
Important: Make sure all the bolt holes are thoroughly cleaned and all micro-encapsulated thread sealant is removed.

22. Remove the power steering bracket to engine front cover retaining bolt (1).
    - Discard the bolt.
    - Clean the bolt hole.

Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

Important: Make sure all the bolt holes are thoroughly cleaned and all micro-encapsulated thread sealant is removed.

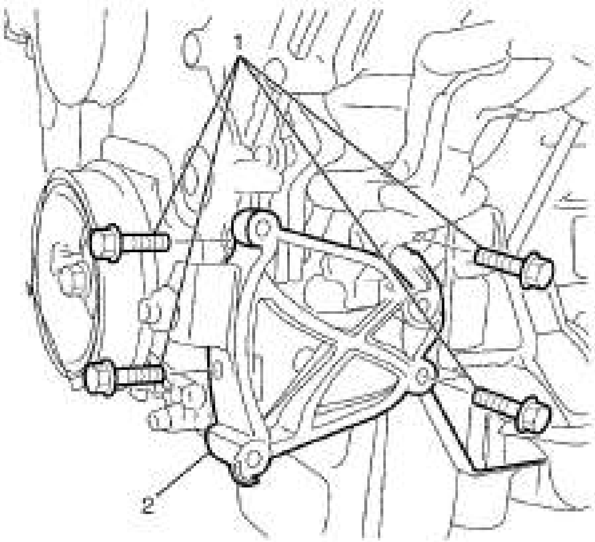
23. Remove the power steering bracket to cylinder block retaining bolt (2).
    - Discard the bolt.
    - Clean the bolt hole.
24. Remove the power steering pump bracket (4).



25. Disconnect the A/C pressure transducer electrical connector (4).
26. Disconnect the A/C compressor electrical connector (5).

Important: DO NOT disconnect the A/C pipes (2) from the A/C compressor (6).

27. Remove the A/C compressor to A/C compressor/power steering pump mounting bracket retaining bolts (1).
28. Secure and reposition the A/C compressor (6) away from the A/C compressor mounting bracket (3).



29. Remove the compressor bracket mounting bolts (1).
30. Remove the compressor bracket (2).
31. Remove the crankshaft balancer. Refer to Crankshaft Balancer Replacement .
32. Remove the camshaft position sensors. Refer to (if fitted) Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust . Refer to (if fitted) Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust and Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake . Refer to Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake .
33. Remove the camshaft position (CMP) actuator solenoids. Refer to (if fitted) Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust and Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake (if fitted) Camshaft Position Actuator Replacement - Bank 1 (Right Side) Exhaust and Camshaft Position Actuator Replacement - Bank 1 (Right Side) Intake .
34. Remove the engine front cover with the water pump. Refer to Engine Front Cover Removal .
35. Disassemble the engine front cover as necessary. Refer to Engine Front Cover Disassemble .

Important: DO NOT use sharp and/or metal gasket scrapers in order to clean the sealing surfaces.

36. Carefully clean the engine front cover sealing surfaces. Refer to Engine Front Cover Cleaning and Inspection .

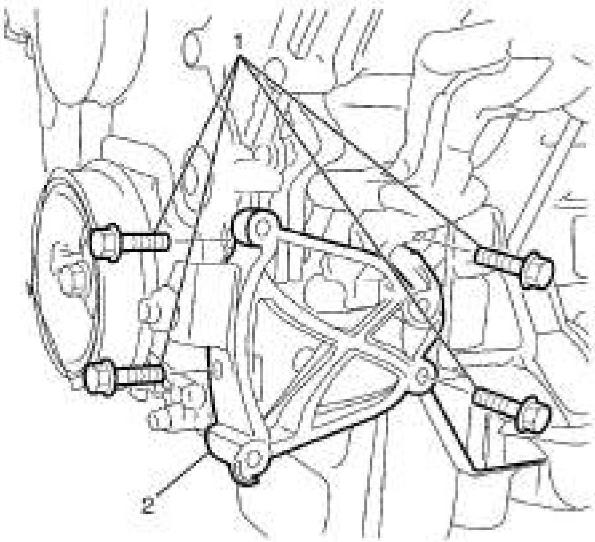
Important: Insert a piece of cardboard between the oil pan front and the oil pump in order to prevent any contaminants from falling into the oil pan.

37. Carefully clean the engine front cover sealing surfaces. Refer to Engine Front Cover Cleaning and Inspection .
38. Use compressed air in order to remove any engine coolant from the engine cooling passages and from the top of the oil pan scraper (windage tray).

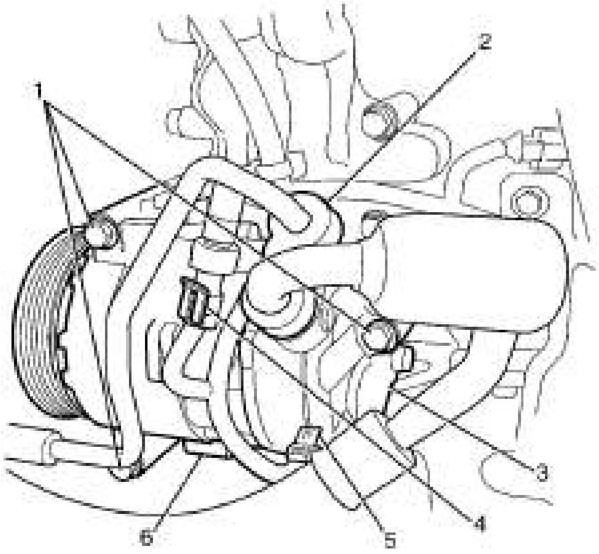
Installation Procedure

1. Assemble the engine front cover as necessary. Refer to Engine Front Cover Assemble .

2. Use the EN 46109 to install the engine front cover. Refer to Engine Front Cover Installation .
3. Install the camshaft position (CMP) actuator solenoids. Refer to (if fitted) Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust and Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake . Refer to (if fitted) Camshaft Position Actuator Replacement - Bank 1 (Right Side) Exhaust and Camshaft Position Actuator Replacement - Bank 1 (Right Side) Intake .
4. Install the camshaft position sensors. Refer to (if fitted) Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust and Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake . Refer to (if fitted) Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust and Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake .
5. Install the crankshaft balancer. Refer to Crankshaft Balancer Replacement .



6. install the compressor bracket (2).
7. Install the compressor bracket mounting bolts (1).



Important: Make sure the A/C pipes (2) are not twisted or kinked upon compressor installation.

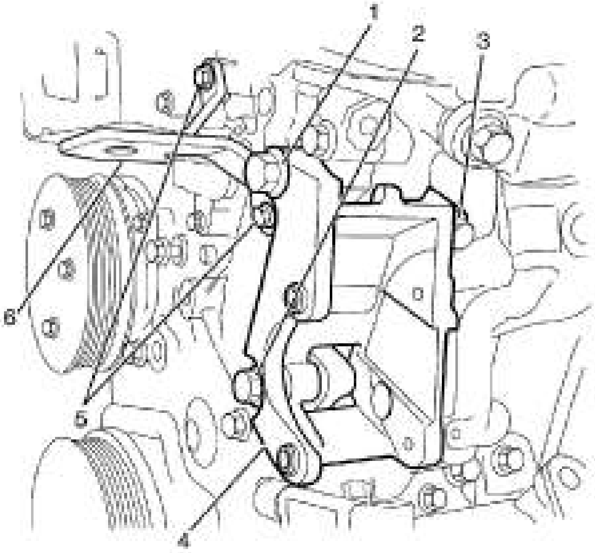
8. Install the A/C compressor (6) with the A/C pipes (2) to the A/C compressor mounting bracket (3).

Notice: Refer to Fastener Notice in the Preface section.

9. Install the compressor to compressor mounting bracket retaining bolts (1)

Tighten
Tighten the bolts to 22 N·m (16 lb ft).

10. Connect the A/C pressure transducer electrical connector (4).
11. Connect the A/C compressor electrical connector (5).



12. Install the power steering pump bracket (4).
13. Install a NEW power steering bracket to cylinder head retaining bolt (3).

Tighten
Tighten the bolt to 58 N·m (43 lb ft).

14. Install a NEW power steering bracket to engine front cover retaining bolts (1).

Tighten
Tighten the bolt to 58 N·m (43 lb ft).

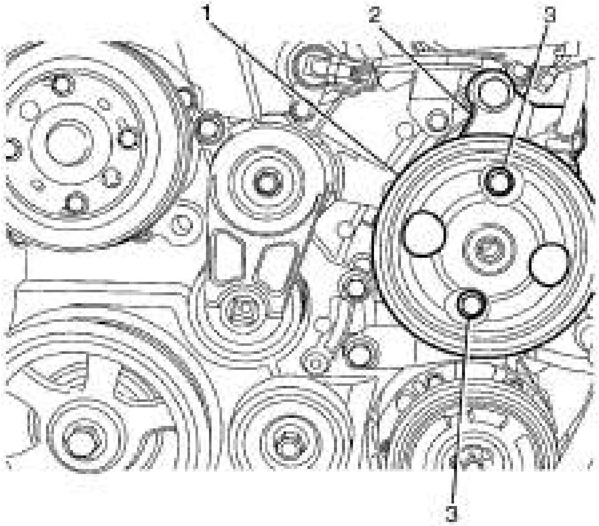
15. Install a NEW power steering bracket to cylinder block retaining bolt (2).

Tighten
Tighten the bolt to 58 N·m (43 lb ft).

16. Install the power steering fluid reservoir bracket (6).
17. Install the NEW power steering fluid reservoir bracket to engine front cover retaining

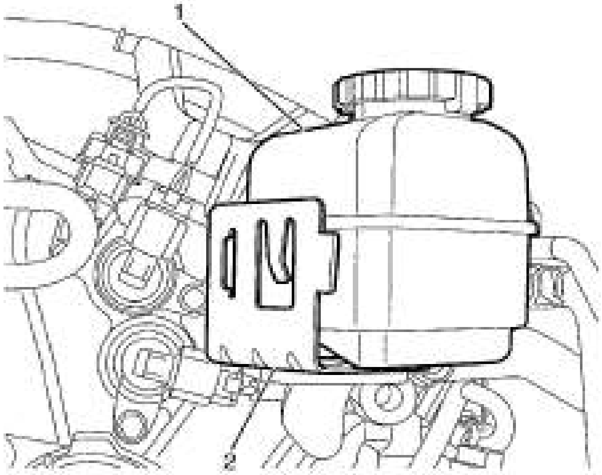
bolts (5).

Tighten
Tighten the bolts to 9 N·m (80 lb ft).



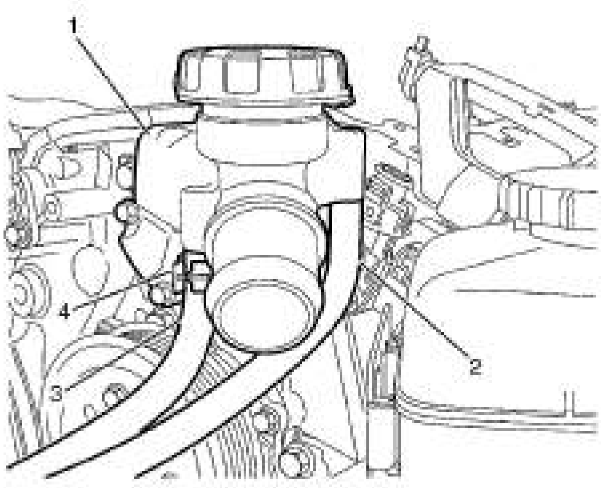
18. Install the power steering pump (2) to the power steering pump bracket (1).
19. Install the NEW power steering pump to power steering pump bracket retaining bolts (3).

Tighten
Tighten the bolts to 27 N·m (22 lb ft).



Important: Make sure the power steering reservoir (1) and the locking tang on the power steering reservoir bracket (2) are engaged to avoid an induced rattle condition.

20. Install the power steering fluid reservoir (1) to the power steering fluid reservoir bracket (2).
21. Install the alternator bracket with the alternator. Refer to Generator Bracket Replacement .
22. Install the belt tensioner. Refer to Drive Belt Tensioner Replacement .
23. Install the drive belt. Refer to Drive Belt Replacement .
24. Install the water outlet housing. Refer to Water Outlet Housing Replacement .



25. Remove the plug or cap at the cooling system hoses and inlets
26. Install the coolant bleed hose (3) to the outlet housing (1).
27. Compress the coolant bleed hose retaining clamp (4) and position back to its original location on the coolant bleed hose (3).
28. Connect the coolant recovery hose (2) from the outlet housing (1).
29. Install the radiator outlet hose. Refer to Radiator Outlet Hose Replacement .
30. Install the camshaft covers. Refer to Camshaft Cover Replacement - Left Side and Camshaft Cover Replacement - Right Side .
31. Install the upper intake manifold with the lower intake manifold. Refer to Lower Intake Manifold Replacement .
32. Install the engine covers. Refer to Engine Cover Replacement .
33. Fill the cooling system. Refer to Cooling System Draining and Filling .
34. Change the engine oil. Refer to Engine Oil and Oil Filter Replacement .

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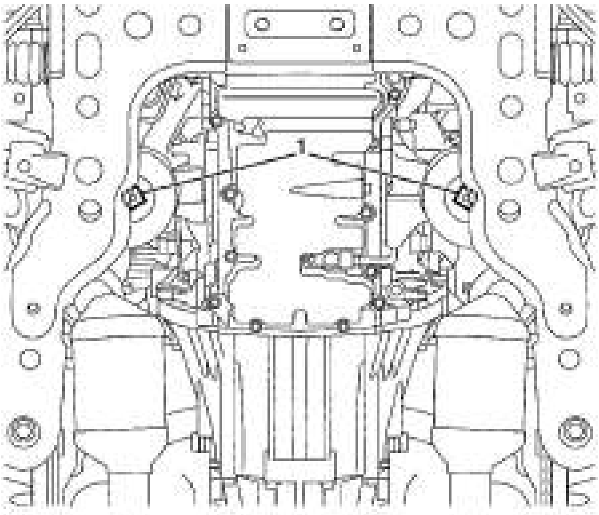
Engine Mount Bracket Replacement - Left Side

Removal Procedure

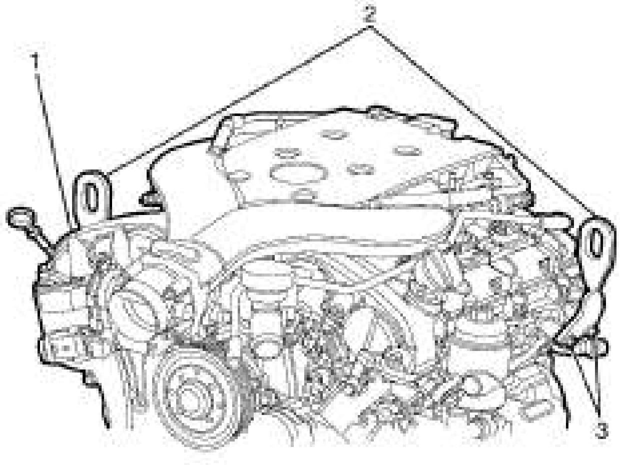
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the engine splash shield. Refer to Engine Splash Shield Replacement.



3. Remove the lower engine mount retaining nuts (1).
4. Lower the vehicle.



5. Position the EN 46114 (2) on the engine (1).

   Notice: Refer to Fastener Notice in the Preface section.

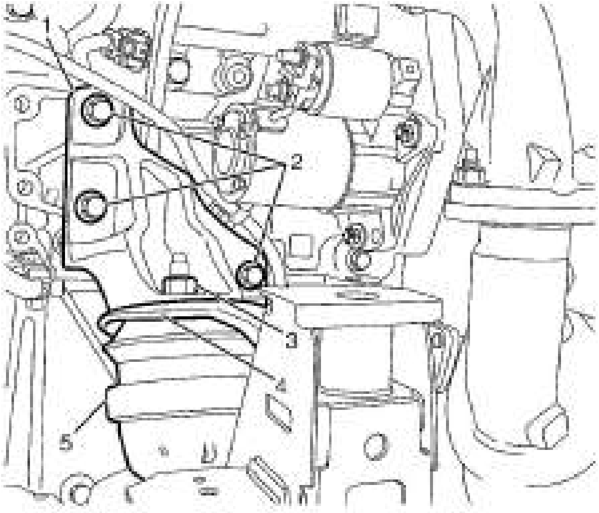
6. Install the EN 46114 to cylinder head retaining bolts (3).

   Tighten
   Tighten the bolts to 50 N·m (36 lb ft).

   Important: Use a suitable tool to raise the engine.

   Important: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

7. Raise the engine until the weight of the engine is removed from the left hand engine mount.



8. Remove the left hand engine mount to engine mount bracket retaining nut (3).

   Important: If required raise the engine further to provide adequate space.

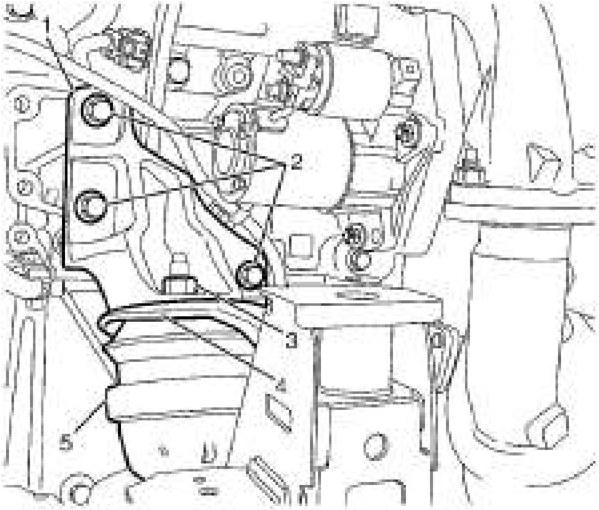
   Important: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

9. Remove the left hand engine mount (5) from the left hand engine mount bracket (1).

   Important: DO NOT distort or bend the left hand engine mount heat shield (4).

10. Remove the left hand engine mount bracket to cylinder block retaining bolts (2).
11. Remove the left hand engine mount bracket (1).

Installation Procedure



Important: DO NOT distort or bend the left hand engine mount heat shield (4).

1. Install the left hand engine mount bracket (1).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the left hand engine mount bracket to cylinder block retaining bolts (2).

   Tighten
   Tighten the bolts to 60 N·m (44 lb ft).

3. Position the left hand engine mount (5) on the left hand engine mount bracket (1).
4. Install the left hand engine mount to engine mount bracket retaining nut (3).

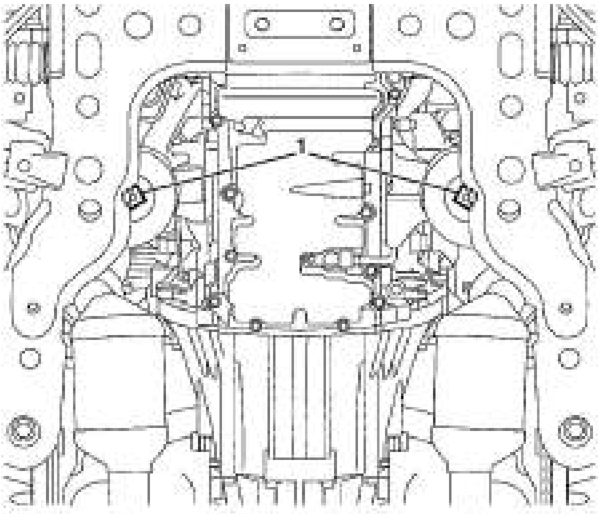
   Tighten
   Tighten the nut to 80 N·m (59 lb ft).

5. Lower the engine until the weight is resting on the left hand engine mount.

   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

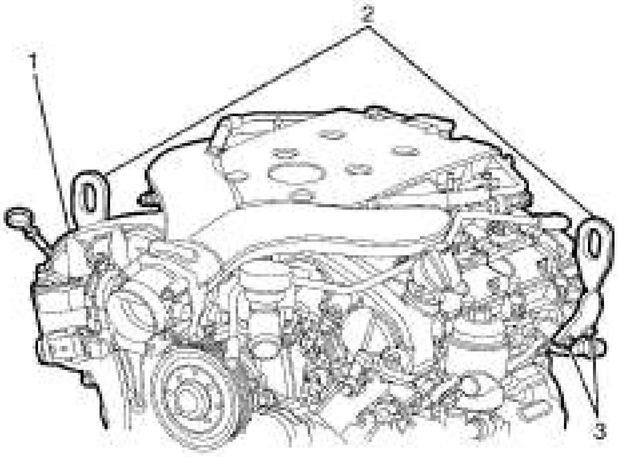
6. Raise the vehicle.



7. Install the engine mount to front subframe retaining nut (1).

   Tighten
   Tighten the nuts to 80 N·m (59 lb ft).

8. Install the engine splash shield. Refer to Engine Splash Shield Replacement.
9. Lower the vehicle to the ground.



10. Remove the EN 46114 to cylinder head retaining bolts (3).
11. Remove the EN 46114 (2) from the engine (1).

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Engine Mount Bracket Replacement - Right Side

Removal Procedure

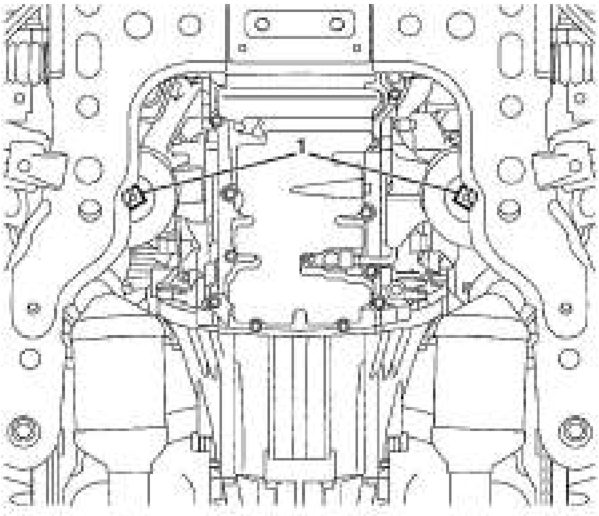
Tools Required

EN 46114 Engine Lift Brackets.

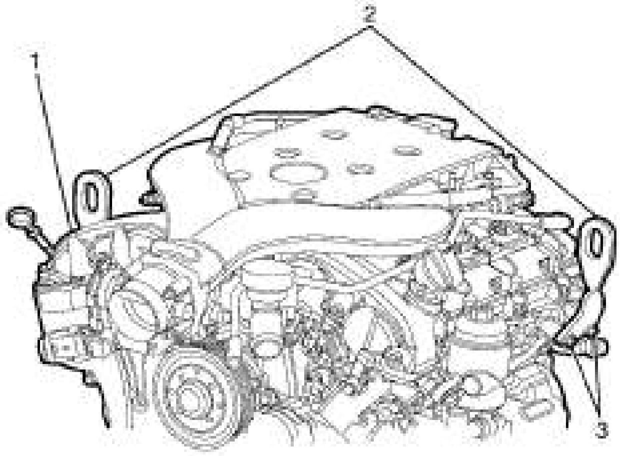
> **Caution:** Refer to Safety Glasses Caution in the Preface section.

> **Caution:** Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the engine splash shield. Refer to Engine Splash Shield Replacement .



3. Remove the lower engine mount retaining nuts (1).
4. Lower the vehicle.



5. Position the EN 46114 (2) on the engine (1).

   Notice: Refer to Fastener Notice in the Preface section.

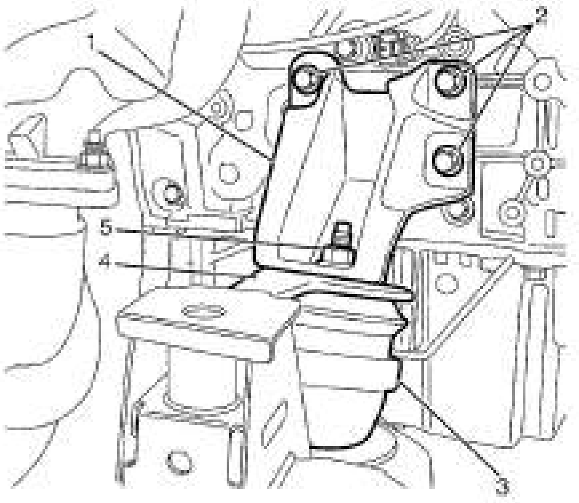
6. Install the EN 46114 to cylinder head retaining bolts (3).

   Tighten
   Tighten the bolts to 50 N·m (36 lb ft).

   Important: Use a suitable tool to raise the engine.

   Important: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

7. Raise the engine until the weight of the engine is removed from the right hand engine mount.



8. Remove the right hand engine mount to engine mount bracket retaining nut (5).

   Important: If required raise the engine further to provide adequate space.

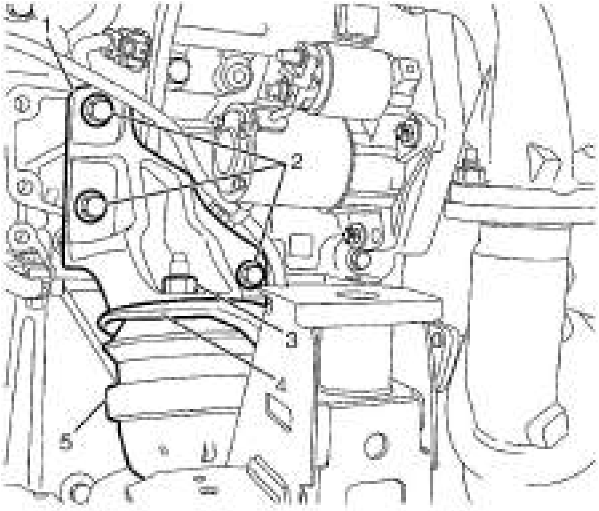
   Important: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

9. Remove the right hand engine mount (3) from the right hand engine mount bracket (1).

   Important: DO NOT distort or bend the right hand engine mount heat shield (4).

10. Remove the right hand engine mount bracket to cylinder block retaining bolts (2).
11. Remove the right hand engine mount bracket (1).

Installation Procedure



Important: DO NOT distort or bend the right hand engine mount heat shield (4).

1. Install the right hand engine mount bracket (1).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the right hand engine mount bracket to cylinder block retaining bolts (2).

   Tighten
   Tighten the bolts to 60 N·m (44 lb ft).

3. Position the right hand engine mount (3) on the right hand engine mount bracket (1).
4. Install the right hand engine mount to engine mount bracket retaining nut (5).

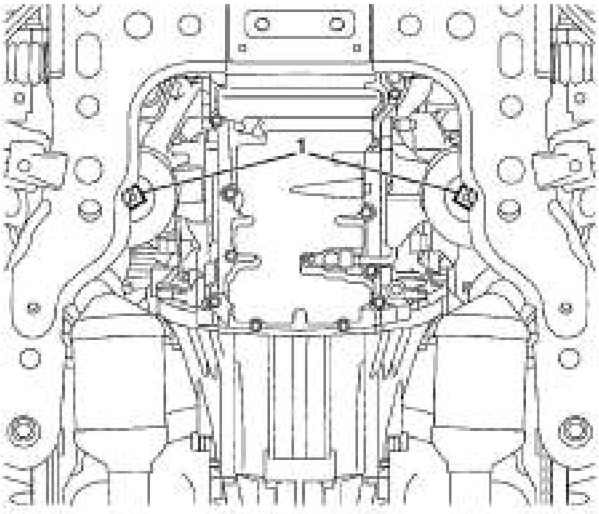
   Tighten
   Tighten the nut to 80 N·m (59 lb ft).

5. Lower the engine until the weight is resting on the right hand engine mount.

   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

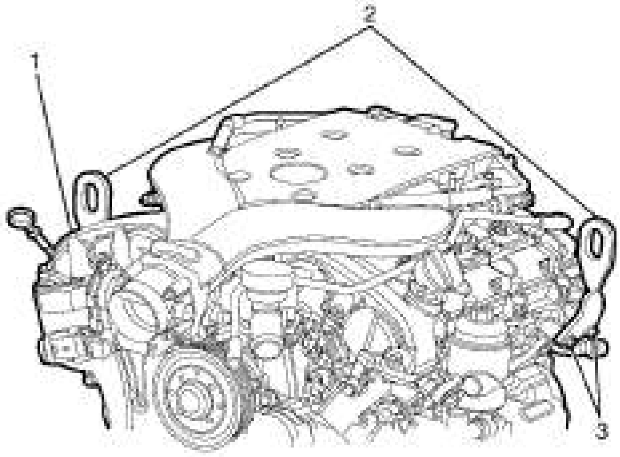
6. Raise the vehicle.



7. Install the engine mount to front subframe retaining nut (1).

   Tighten
   Tighten the nuts to 80 N·m (59 lb ft).

8. Install the engine splash shield. Refer to Engine Splash Shield Replacement .
9. Lower the vehicle to the ground.



10. Remove the EN 46114 to cylinder head retaining bolts (3).
11. Remove the EN 46114 (2) from the engine (1).

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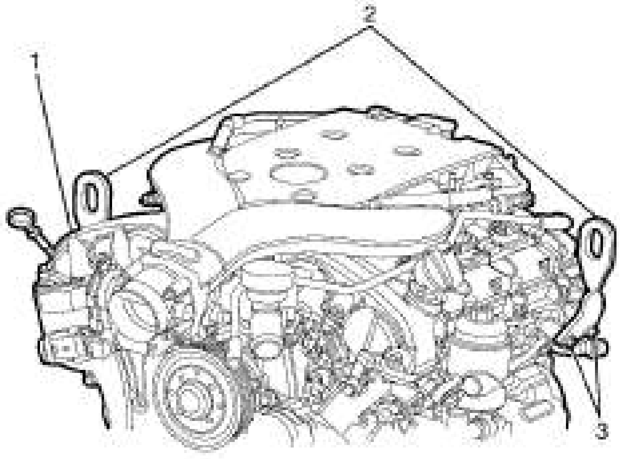
Engine Mount Inspection



1. Position the EN 46114 (2) on the engine (1).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the EN 46114 to cylinder head retaining bolts (3).

   Tighten
   Tighten the bolts to 50 N·m (36 lb ft).

   Notice: Broken or deteriorated mounts can cause misalignment and destruction of certain drive train components. When a single mount breaks, the remaining mounts are subjected to abnormally high stresses.

   Important: Raising the engine, will remove the weight from the engine mount and create a slight tension in the rubber mount.

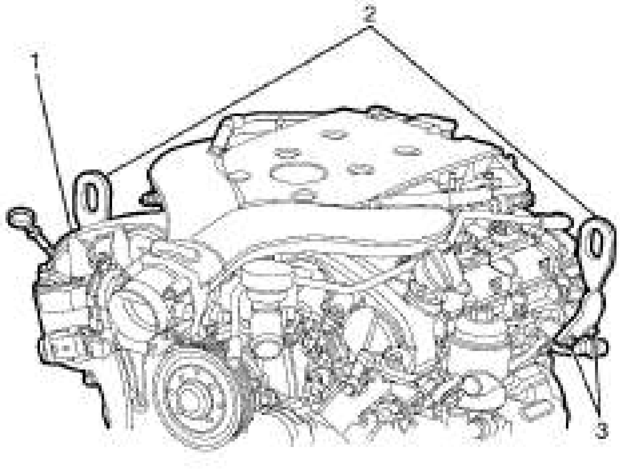
3. Use a suitable engine lifting tool to raise the engine until the weight of the engine is removed from the engine mounts.

   Important: Before replacing any engine mount due to suspected fluid loss, verify that the source of the fluid is actually the engine mount, not the engine or other accessories.

4. Observe the engine mount while raising the engine. Replace the engine mount if the mount exhibits any of the following conditions:
   - The hard rubber surface is covered with heat check cracks.
   - The rubber is separated from the metal plate of the engine mount.

- The rubber is split through the center of the engine mount.
- The GLYCOL™ fluid is leaking from the engine mount.

5. If there is movement between the metal plate of the engine mount and its attaching points, lower the engine on the engine mount. Tighten the bolts or nuts attaching the engine mount to the frame or engine mount bracket. Refer to Engine Mount Replacement - Left Side or Engine Mount Replacement - Right Side.



6. Remove the EN 46114 to cylinder head retaining bolts (3).
7. Remove the EN 46114 (2) from the engine (1).

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Engine Mount Replacement - Left Side

Removal Procedure

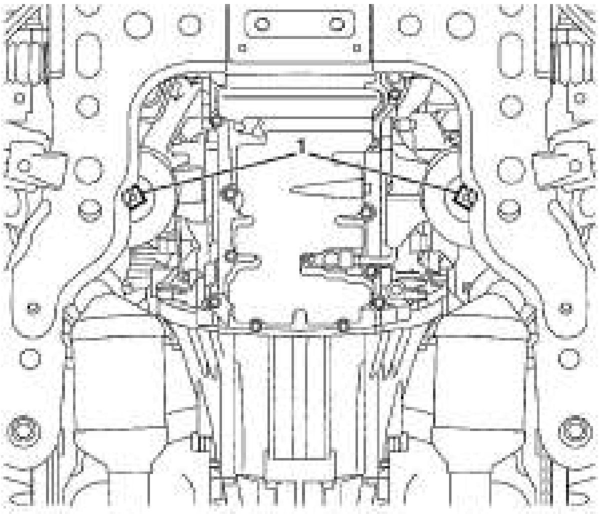
Tools Required

EN 46114 Engine Lift Brackets.

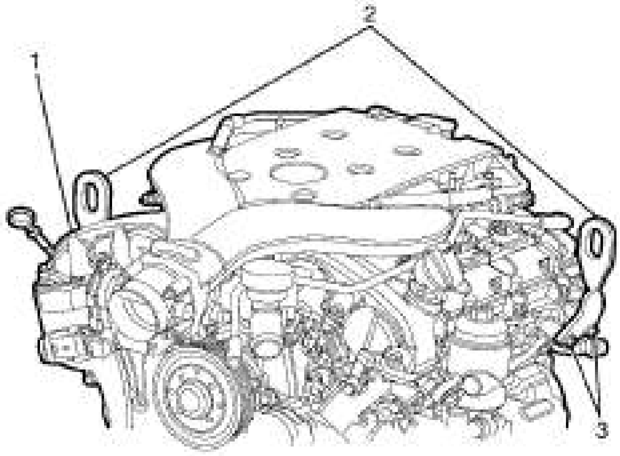
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the engine splash shield. Refer to Engine Splash Shield Replacement .



3. Remove the engine mount to front subframe retaining nuts (1).
4. Lower the vehicle.



5. Position the EN 46114 (2) on the engine (1).

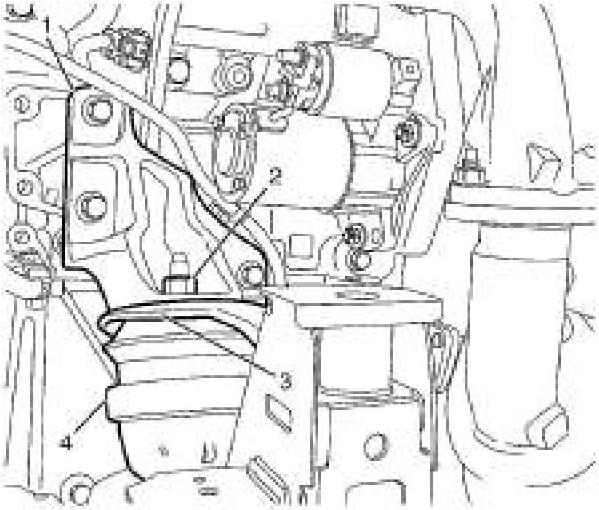
   Notice: Refer to Fastener Notice in the Preface section.

6. Install the EN 46114 to cylinder head retaining bolts (3).

   Tighten
   Tighten the bolts to 50 N·m (36 lb ft).

   Important: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

7. Use a suitable engine lifting tool to raise the engine until the weight of the engine is removed from the left hand engine mount.



8. Remove the left hand engine mount to engine mount bracket retaining nut (2).

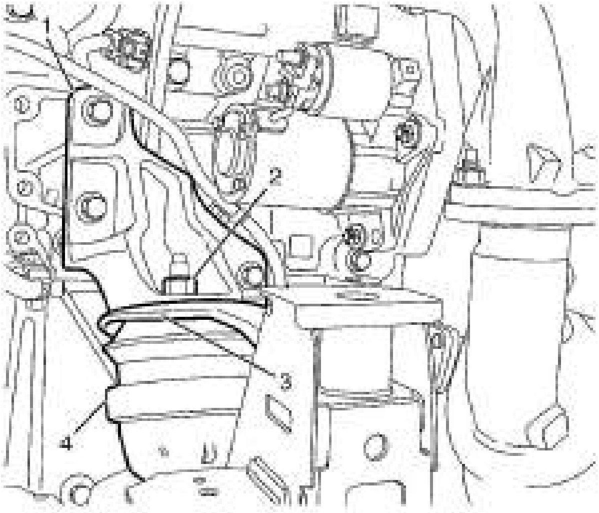
   Important: If required raise the engine further to provide adequate space.

   Important: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

   Important: DO NOT distort or bend the left hand engine mount heat shield (3).

9. Remove the left hand engine mount (4) from the left hand engine mount bracket (1).

Installation Procedure



Important: DO NOT distort or bend the left hand engine mount heat shield (3).

1. Position the left hand engine mount (4) on the left hand engine mount bracket (1).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the left hand engine mount to engine mount bracket retaining nut (2).

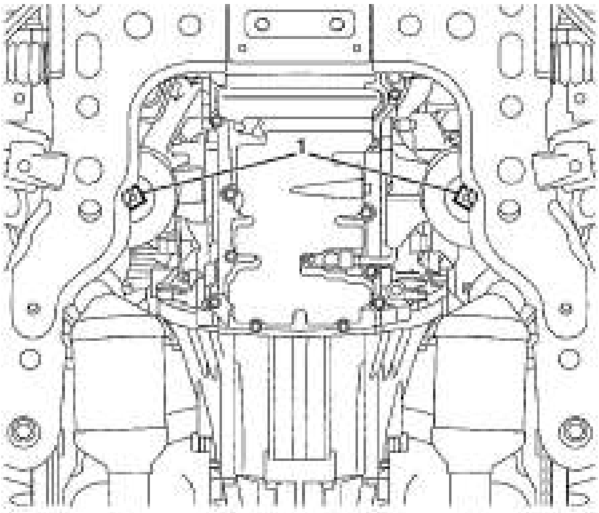
   Tighten
   Tighten the nut to 80 N·m (59 lb ft).

3. Lower the engine until the weight is resting on the left hand engine mount.

   Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

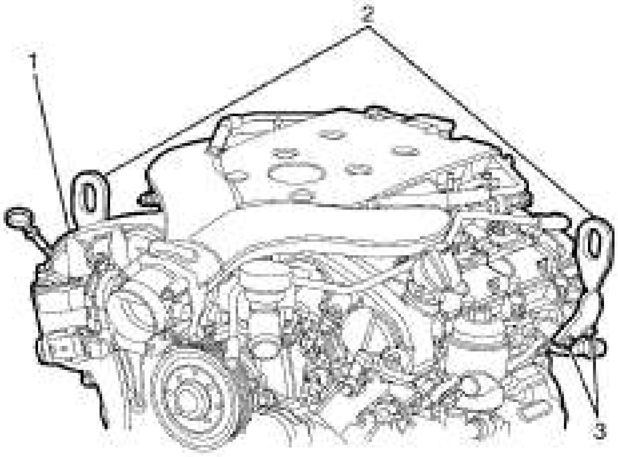
4. Raise the vehicle.



5. Install the engine mount to front subframe retaining nuts (1).

Tighten
Tighten the nuts to 80 N·m (59 lb ft).

6. Install the engine splash shield. Refer to Engine Splash Shield Replacement .
7. Lower the vehicle to the ground.



8. Remove the EN 46114 to cylinder head retaining bolts (3).
9. Remove the EN 46114 (2) from the engine (1).

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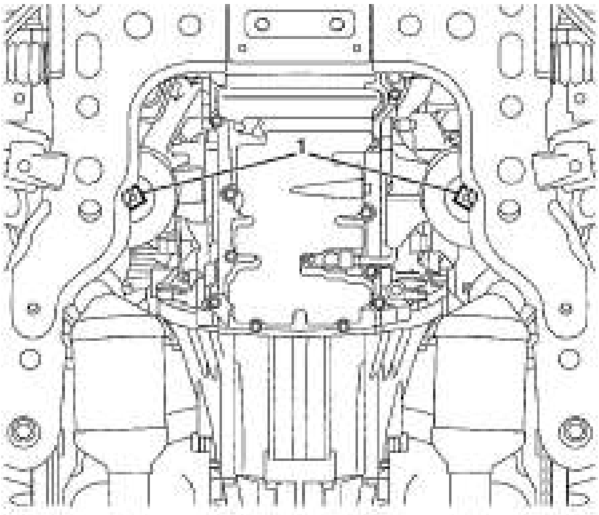
Engine Mount Replacement - Right Side

Removal Procedure

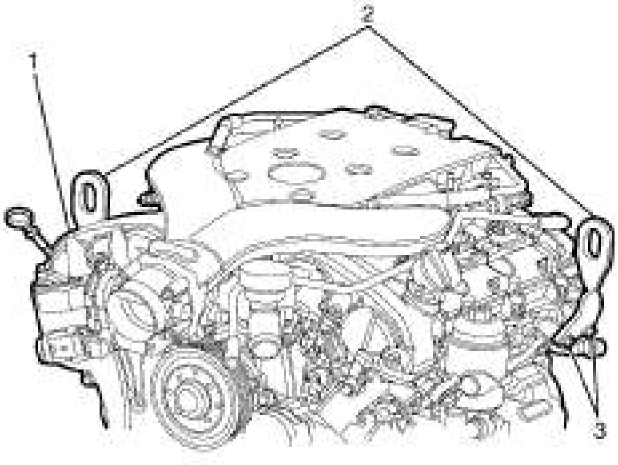
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the engine splash shield. Refer to Engine Splash Shield Replacement.



3. Remove the engine mount to front subframe retaining nuts (1).
4. Lower the vehicle.



5. Position the EN 46114 (2) on the engine (1).

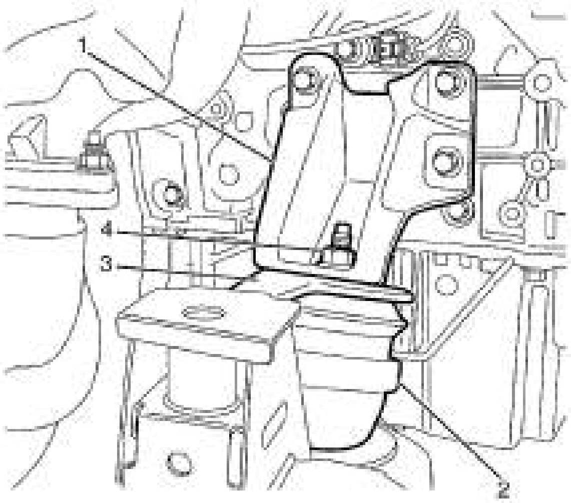
   Notice: Refer to Fastener Notice in the Preface section.

6. Install the EN 46114 to cylinder head retaining bolts (3).

   Tighten
   Tighten the bolts to 50 N·m (36 lb ft).

   Important: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

7. Use a suitable engine lifting tool to raise the engine until the weight of the engine is removed from the right hand engine mount.



8. Remove the right hand engine mount to engine mount bracket retaining nut (4).

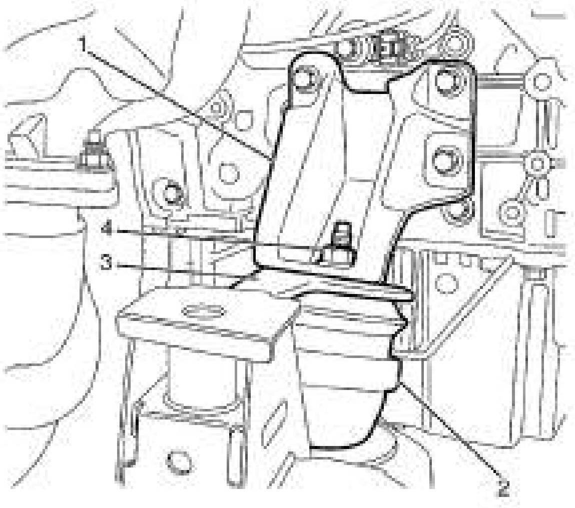
   Important: If required raise the engine further to provide adequate space.

   Important: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

   Important: DO NOT distort or bend the right hand engine mount heat shield (3).

9. Remove the right hand engine mount (2) from the right hand engine mount bracket (1).

Installation Procedure



Important: DO NOT distort or bend the right hand engine mount heat shield (3).

1. Position the right hand engine mount (2) on the right hand engine mount bracket (1).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the right hand engine mount to engine mount bracket retaining nut (4).

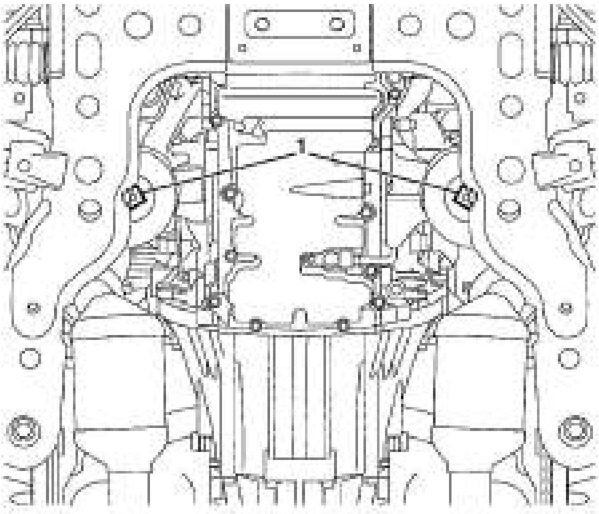
   Tighten
   Tighten the nut to 80 N·m (59 lb ft).

3. Lower the engine until the weight is resting on the right hand engine mount.

   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

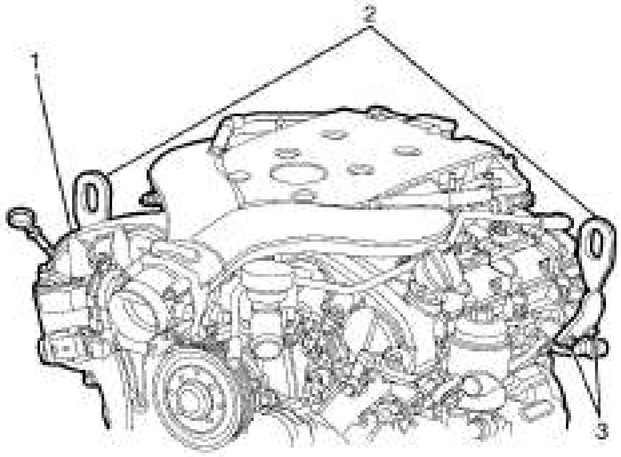
4. Raise the vehicle.



5. Install the engine mount to front subframe retaining nuts (1).

   Tighten
   Tighten the nuts to 80 N·m (59 lb ft).

6. Install the engine splash shield. Refer to Engine Splash Shield Replacement.
7. Lower the vehicle to the ground.

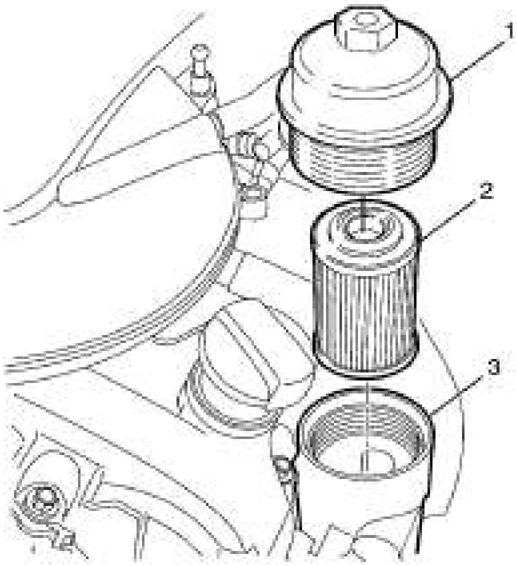


8. Remove the EN 46114 to cylinder head retaining bolts (3).
9. Remove the EN 46114 (2) from the engine (1).

Engine Oil and Oil Filter Replacement

Removal Procedure

1. Turn the ignition OFF.



Important: Use a six-point socket to remove the oil filter cap (1).

2. Remove the oil filter adapter cap (1) from the engine oil filter adapter (3).

Important: The oil filter cartridge (2) must be replaced at every service interval.

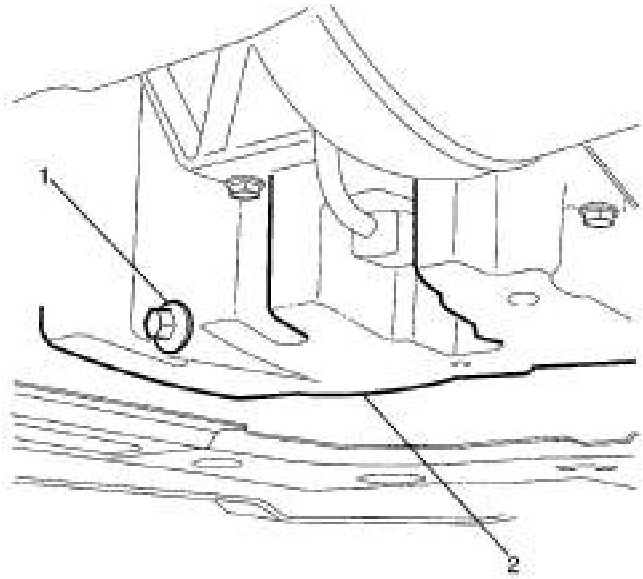
3. Remove the oil filter cartridge (2).

Discard the oil filter cartridge (2).

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

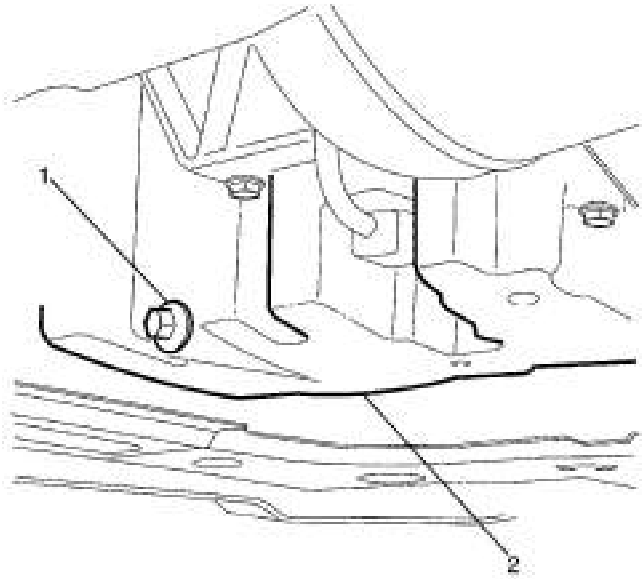
4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



5. Place a suitable container below the oil pan drain plug (1).
6. Remove the oil pan drain plug (1) from the oil pan (2).
7. Allow the oil to drain completely.

Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.

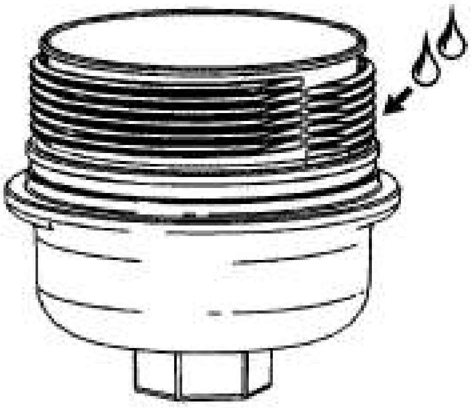


1. Install the oil pan drain plug (1) to the oil pan (2).

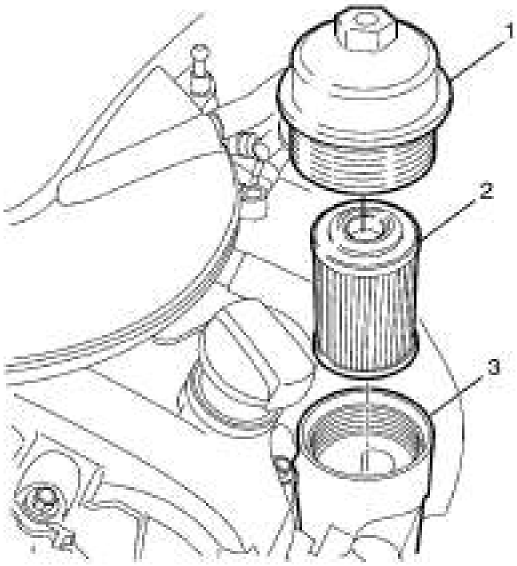
   Tighten
   Tighten the oil pan drain plug to 25 N·m (18 lb ft).

2. Lower the vehicle.

Notice: Refer to General Repair Instructions in the Preface section.



3. Lubricate the oil filter cap threads with clean engine oil.



4. Install the NEW oil filter cartridge (2).

Notice: Refer to Fastener Notice in the Preface section.

Notice: Refer to General Repair Instructions in the Preface section.

Important: Use a six-point socket to install the oil filter cap.

5. Install the oil filter cap (1) to the engine oil filter adapter (3).

   Tighten
   Tighten the oil filter cap to 25 N·m (18 lb ft).

6. Fill the engine with the appropriate oil type and quantity. Refer to Fluid and Lubricant Recommendations and Approximate Fluid Capacities .
7. Reset the service reminder display. Refer to Service Display Reminders .

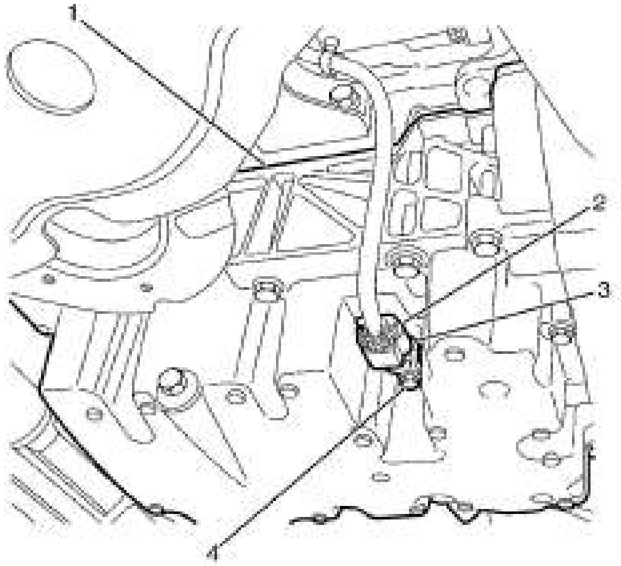
Engine Oil Level Sensor and/or Switch Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

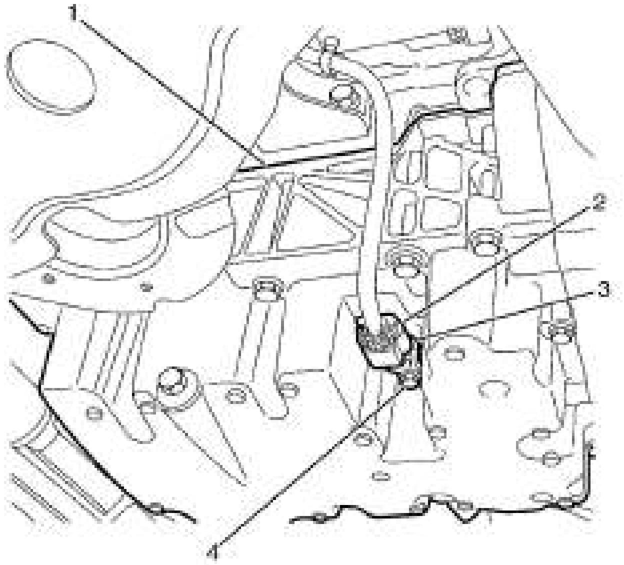
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the Engine Splash Shield. Refer to Engine Splash Shield Replacement .



3. Drain the engine oil. Refer to Engine Oil and Oil Filter Replacement .
4. Disconnect the engine oil level switch electrical connector (2).
5. Remove the engine oil level switch to oil pan retaining bolt (4).
6. Remove the engine oil level switch (3) from the oil pan (1).

Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



1. Install the engine oil level switch (2) to the oil pan (3).

   Tighten
   Tighten the engine oil level switch bolt to 20 N·m (15 lb ft).

2. Connect the engine oil level switch electrical connector (1).
3. Install the front air deflector. Refer to Front Air Deflector Replacement .
4. Lower the vehicle.
5. Fill the engine oil. Refer to Engine Oil and Oil Filter Replacement .
6. Inspect for oil leaks after engine start up.

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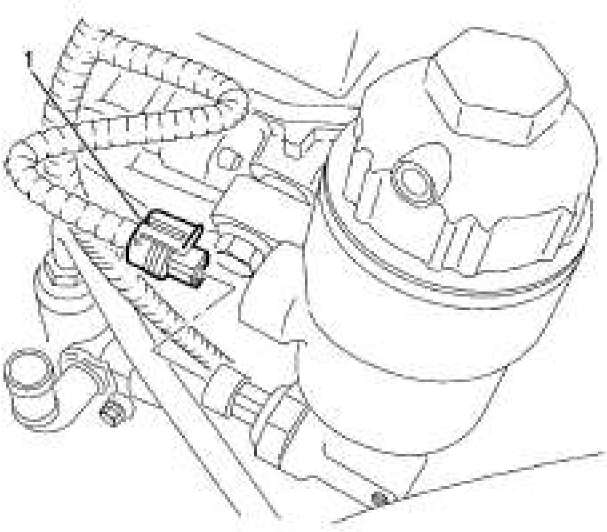
Engine Oil Pressure Sensor and/or Switch Replacement

Tools Required

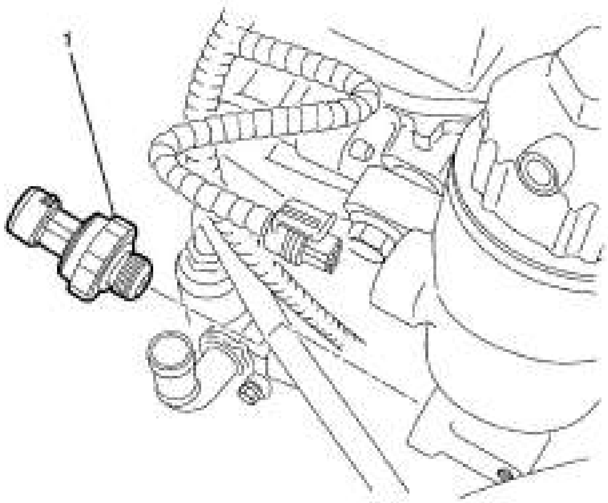
J 41712 Oil Pressure Sensor Socket

Removal Procedure

1. Turn the ignition OFF.
2. Remove the left hand engine cover. Refer to Engine Cover Replacement.



3. Disconnect the oil pressure sensor electrical connector (1).

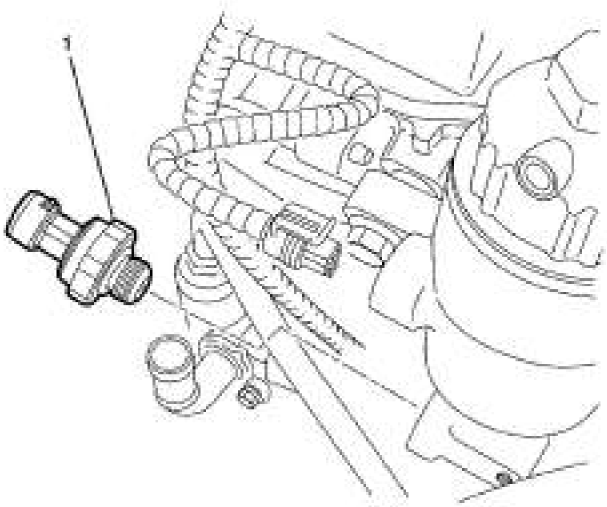


Important: A small amount of oil will drain out of the oil filter housing when the oil pressure sensor is removed. Use a shop towel to absorb the oil.

4. Use the J 41712 in order to remove the oil pressure sensor (1).

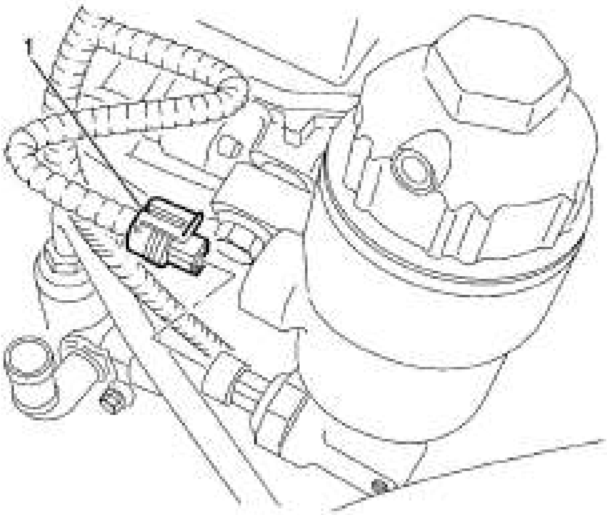
Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



1. Use the J 41712 in order to install the oil pressure sensor (1).

Tighten
Tighten the oil pressure sensor to 20 N·m (15 lb ft).



2. Connect the oil pressure sensor electrical connector (1).
3. Install the left hand engine cover. Refer to Engine Cover Replacement.

Engine Replacement (RHD)

Tools Required

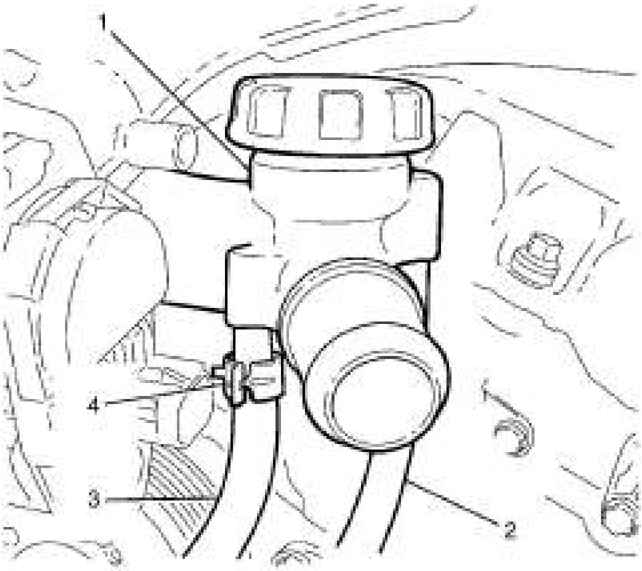
- AU-525 Quick Connect Release Tool.
- EN 46114 Engine Lift Brackets.

Important: The front wheels of the vehicle must be maintained in the straight ahead position and the steering column must be in the LOCK position before disconnecting the steering column or intermediate shaft. Failure to follow these procedures will cause incorrect alignment of some components during installation and result in damage to the SIR coil assembly.

1. Turn the ignition key to the LOCK position.

Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove the engine covers. Refer to Engine Cover Replacement .
4. Remove the radiator air intake baffle. Refer to Cooling Fan and Shroud Replacement .
5. Recover the air conditioning (A/C) refrigerant. Refer to Refrigerant Recovery and Recharging .
6. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement .
7. Depressurise the fuel system. Refer to Fuel Pressure Relief .
8. Drain the cooling system. Refer to Cooling System Draining and Filling .
9. Remove the radiator outlet hose. Refer to Radiator Outlet Hose Replacement .



10. Compress the coolant bleed hose retaining clamp (4) at the outlet housing (1) end and slide 50 mm (2 in) along the coolant bleed hose (3).
11. Remove the coolant bleed hose (3) from the outlet housing (1).

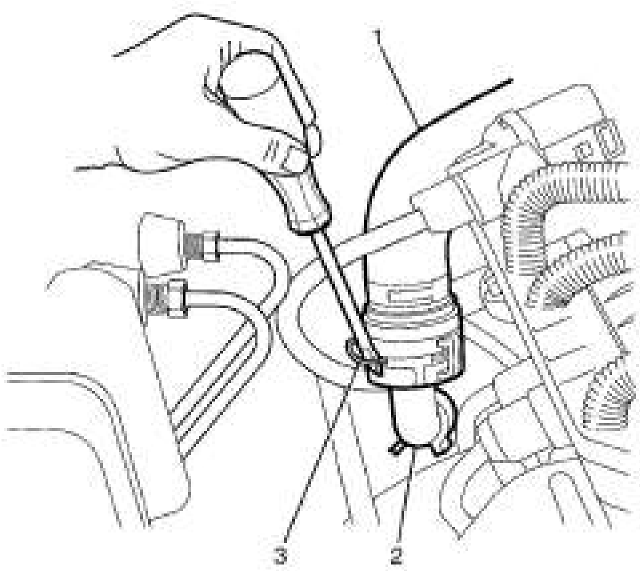
Important: Twist and pull the coolant recovery hose (2) to remove from the outlet housing (1).

12. Disconnect the coolant recovery hose (2) from the outlet housing (1).

Important: Plug or cap the hoses and inlets when separating the cooling system components, this prevents dirt and other contaminants from entering the cooling system.

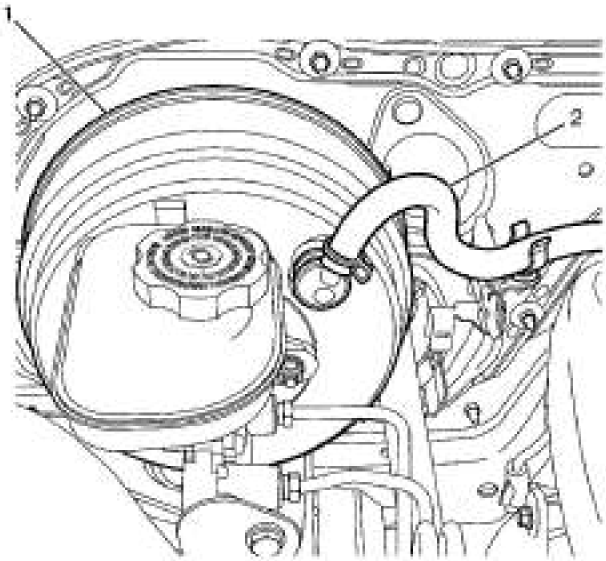
13. Plug or cap the cooling system hoses and inlets

Caution: Refer to Safety Glasses Caution in the Preface section.



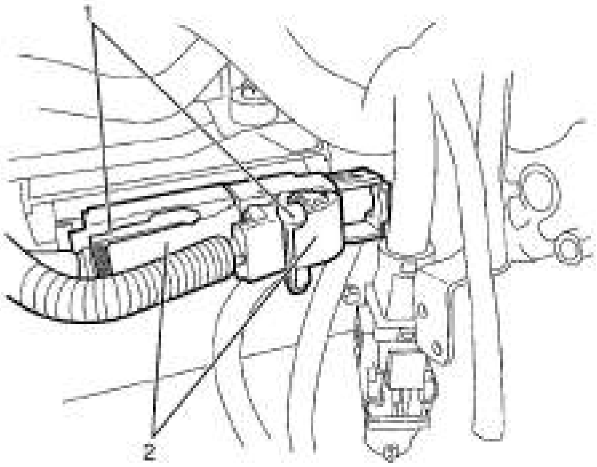
Important: The inlet and outlet heater hoses (1) are retained to the heater pipes (2) by quick connect fittings. Disconnect the heater hose (1) quick connect fittings by releasing the retaining clips (3) with a suitable screwdriver.

14. Disconnect the heater hose (1) from the heater pipes (2) in two places.

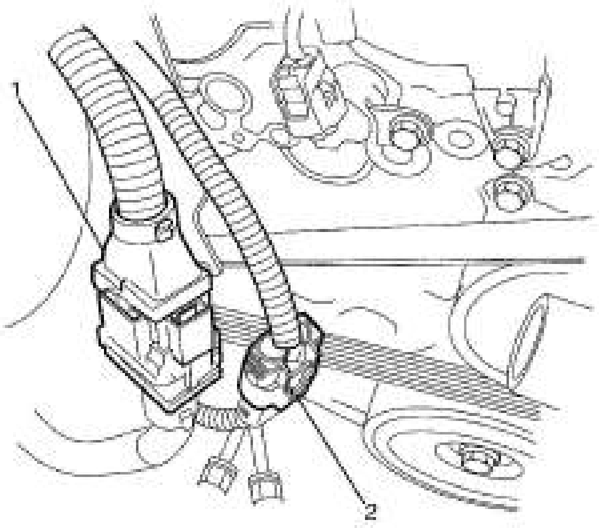


Important: With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal becomes firm, in order to deplete the vacuum brake booster power reserve.

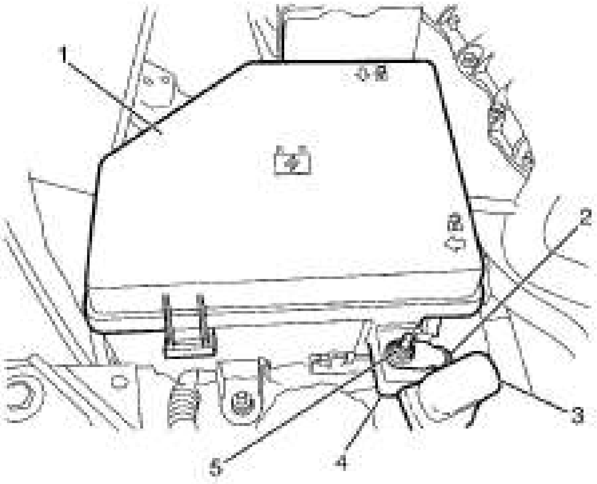
15. Deplete the vacuum brake booster power reserve.
16. Disconnect the vacuum hose and the vacuum brake booster check valve (2) from vacuum brake booster (1).



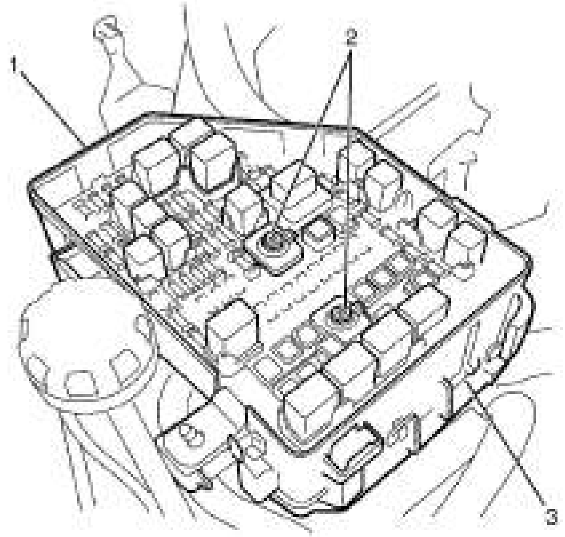
17. Rotate the engine control module (ECM) electrical connector levers (1) up to the unlocked position.
18. Disconnect ECM electrical connectors (2).



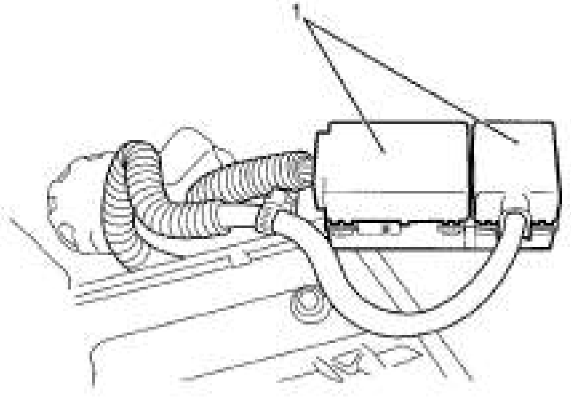
19. Disconnect the 56 pin engine wiring harness to main wiring harness electrical connector (1).
20. Disconnect the 2 pin engine wiring harness to main wiring harness electrical connector (2).



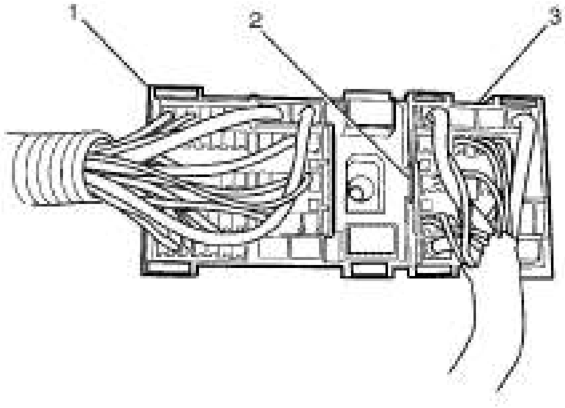
21. Remove the under hood body electrical centre (BEC) lid (1).
22. Remove the positive cable protective cover (3).
23. Remove the positive cable to under hood BEC plate retaining bolt (5).
24. Disconnect the positive cable (2) from the upper under hood BEC plate (4).



25. Remove the under hood BEC upper plate to lower plate retaining bolts (2).
26. Raise the upper under hood BEC plate (1) from the lower under hood BEC plate (3).

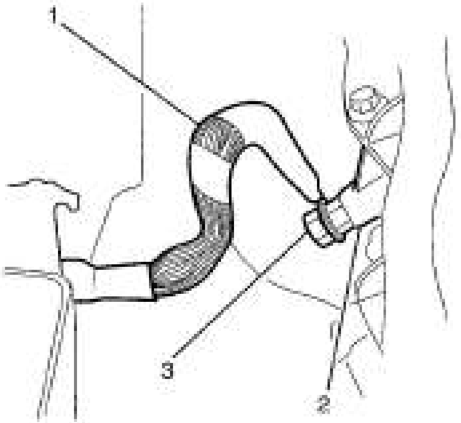


27. Detach the protector (1) from the base of the under hood BEC connector.

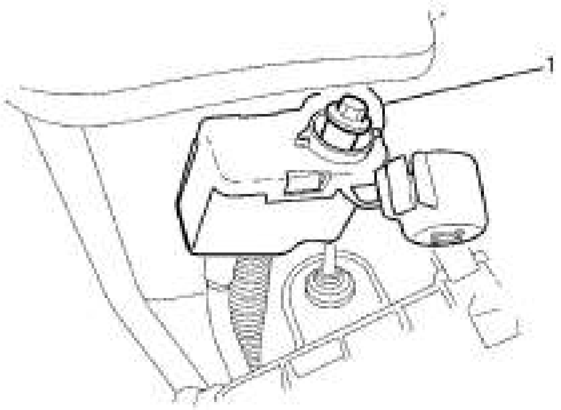


Important: Use a suitable tool to depress the connector locking tang (2), then pull the body harness connector (1) upward and the engine connector (3) downward to separate the body harness connector (1) from the engine connector (3).

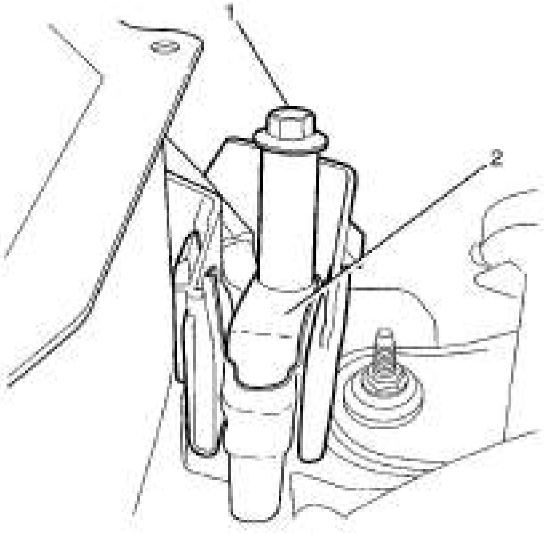
28. Separate the body harness connector (1) from the engine connector (3).
29. Reposition and secure the engine wiring harness and connector (3) on the engine.



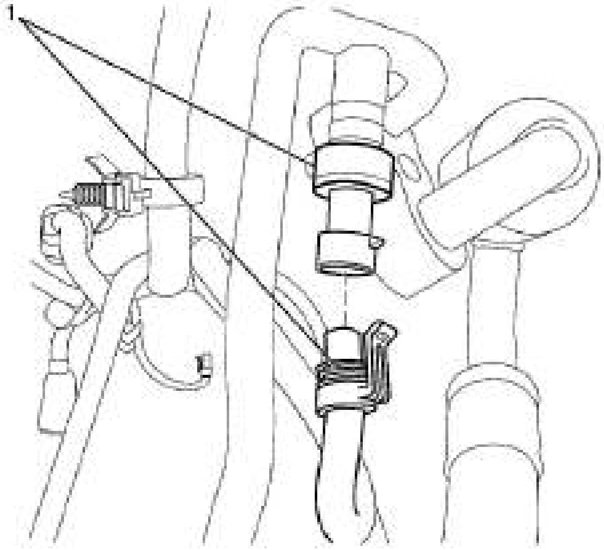
30. Remove the vehicle body ground cable to cylinder head retaining bolt (3)
31. Disconnect the vehicle body ground cable (1) from the cylinder head (2).



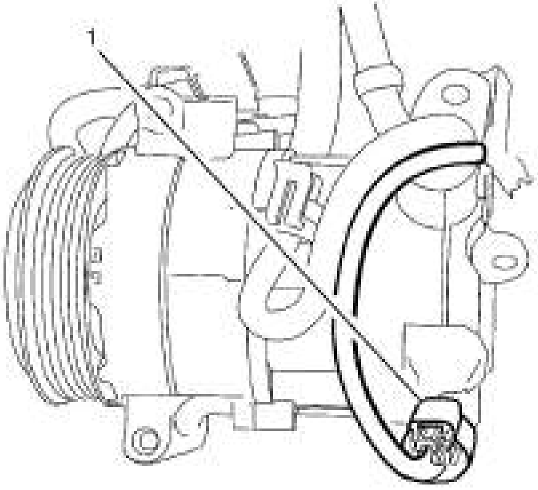
32. Remove the remote battery positive post cover (1).



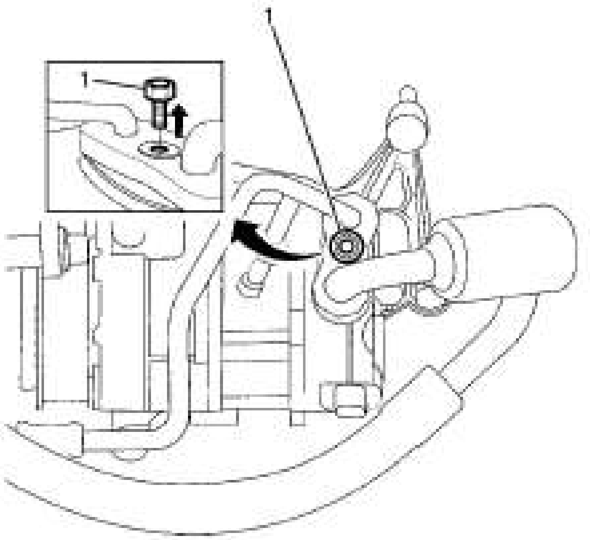
33. Remove the remote battery positive post to wiring harness retaining bolt (1).
34. Remove the wiring harness (2).



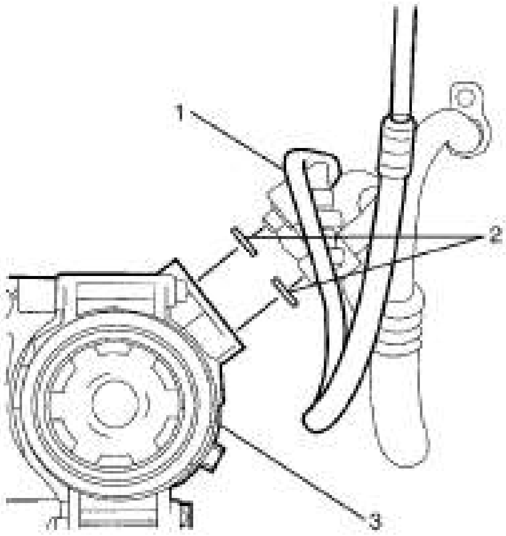
35. Disconnect the A/C pressure transducer electrical connector (1).



36. Disconnect the A/C compressor electrical connector (1).



37. Remove the suction/discharge line pad to A/C compressor retaining nut (1).



38. Disconnect the A/C suction/discharge line pad (1) from the A/C compressor (3).

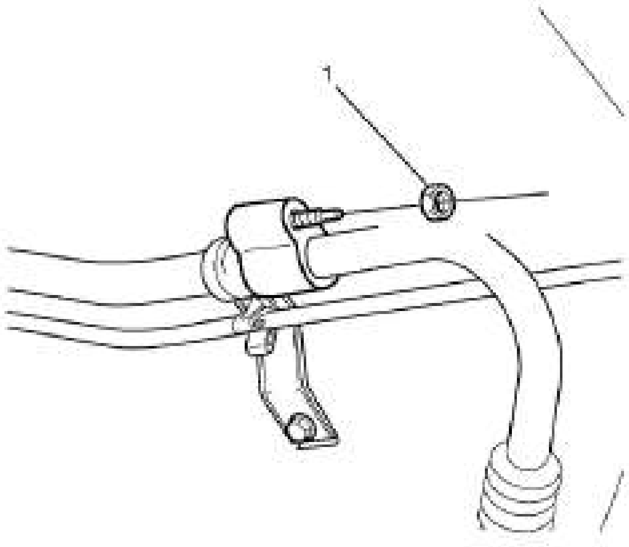
Important: Plug or cap the A/C suction/discharge pipe ends and the compressor ports immediately to prevent contamination and absorption of moisture from the atmosphere.

39. Plug or cap the A/C suction/discharge pipe (1) ends and the compressor (3) ports.

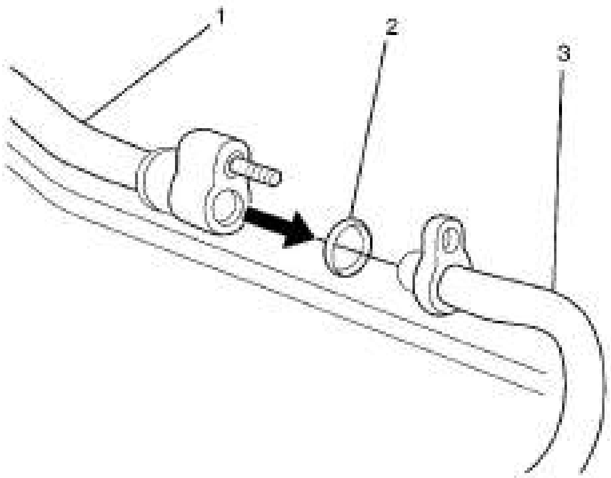
Important: The A/C sealing O-rings (2) are a single use component and will not reseal. Install NEW A/C sealing O-rings (2) whenever the A/C suction/discharge line pad (1) is removed from the A/C compressor (3).

40. Remove and discard the A/C suction/discharge pipe sealing O-rings (2).

Discard the A/C suction/discharge pipe sealing O-rings (2).



41. Remove the A/C suction pipe pad to A/C suction pipe retaining nut (1).



42. Disconnect the upper A/C suction pipe (1) from the lower A/C suction tube (3).

Important: Plug or cap the A/C suction pipe ends (1 and 3) immediately to prevent contamination and absorption of moisture from the atmosphere.

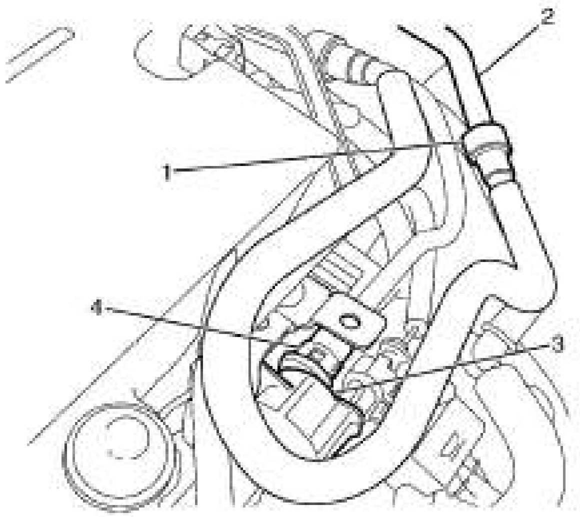
43. Plug or cap the A/C suction pipe ends.

Important: The A/C suction pipe sealing O-ring (2) is a single use component and will not reseal. Install a NEW A/C suction pipe sealing O-ring (2) whenever the upper A/C suction pipe (1) is removed from the lower A/C suction pipe (3).

44. Remove and discard the A/C suction pipe sealing O-ring (2).

    Discard the A/C suction pipe sealing O-ring (2).

45. Reposition and retain the A/C suction/discharge pipes away from the engine.



46. Disconnect the fuel feed hose (1) from the fuel feed pipe (2). Refer to Metal Collar Quick Connect Fitting Service or Plastic Collar Quick Connect Fitting Service .

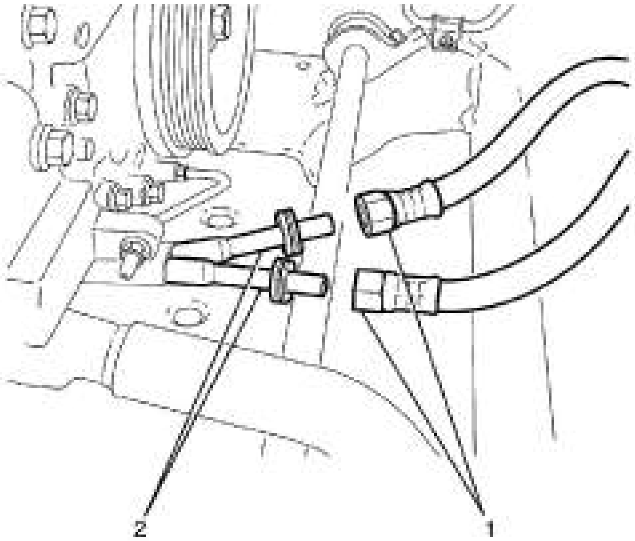
    Important: Plug or cap the fuel feed pipe (2) and fuel feed hose (1) ends to prevent fuel leaks and/or contamination.

47. Plug or cap the fuel feed pipe (2) and fuel feed hose (1) ends.
48. Disconnect the evaporative emission (EVAP) purge line (4) from the purge solenoid (3). Refer to Metal Collar Quick Connect Fitting Service or Plastic Collar Quick Connect Fitting Service .
49. Plug or cap the (EVAP) purge line (4) and the purge solenoid (3) ends.

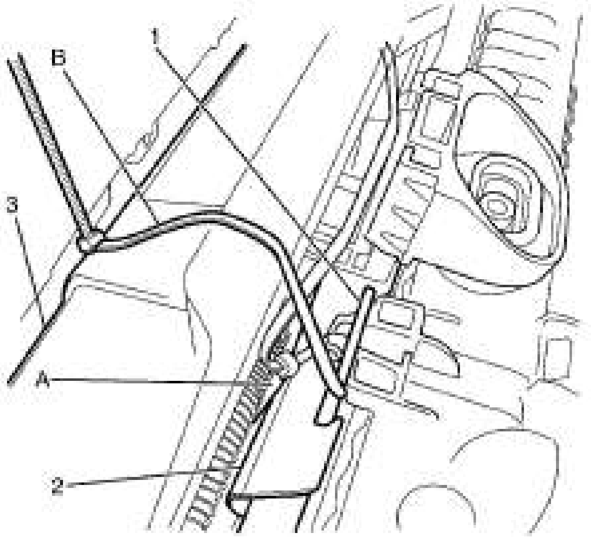
    Important: The flexible hoses are not serviced separately. Therefore if the hose's require replacement, then the hose and radiator to hose cooler hose assembly must be fitted.

    Important: When removal is complete plug hose openings with a clean lint free cloth to prevent foreign matter entry.

50. Place a suitable container beneath the radiator and engine.



51. Disconnect the transmission cooler line (2) from the flexible hose (1) at the quick connect fitting using the AU-525 .
    - Open the AU-525 then close and clip around the hose to be disconnected.
    - While holding the flexible hose (1) push the hose inwards with one hand, then pull back to separate from the steel hose piping (2).
    - Repeat for the second fitting if required.
52. Reposition and secure the flexible hoses (1) away from the engine and subframe.



Important: It is necessary to secure the radiator and condenser assembly (2) to the front end assembly (3) as the radiator and condenser assembly is supported to the subframe.

Important: Thread zip tie A around the front end assembly and zip tie B through the radiator and condenser mount (1). Insert zip tie A into the retainer of zip tie B and insert zip tie B into the retainer of zip tie A.

53. Secure radiator and condenser assembly (2) to the front end assembly (3) with large zip ties or equivalent.

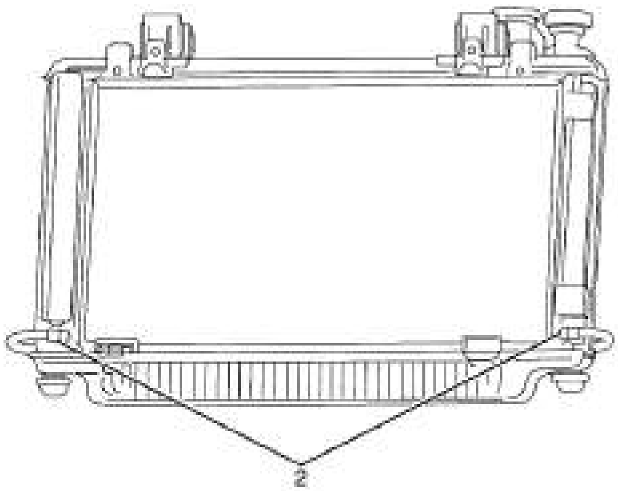
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

54. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
55. Remove the front air deflector. Refer to Front Air Deflector Replacement .
56. Remove the Engine Splash Shield. Refer to Engine Splash Shield Replacement .
57. Disconnect the radiator inlet hose. Refer to Radiator Inlet Hose Replacement .

Important: Plug or cap the hoses and inlets when separating the cooling system components, this prevents dirt and other contaminants from entering the cooling system.

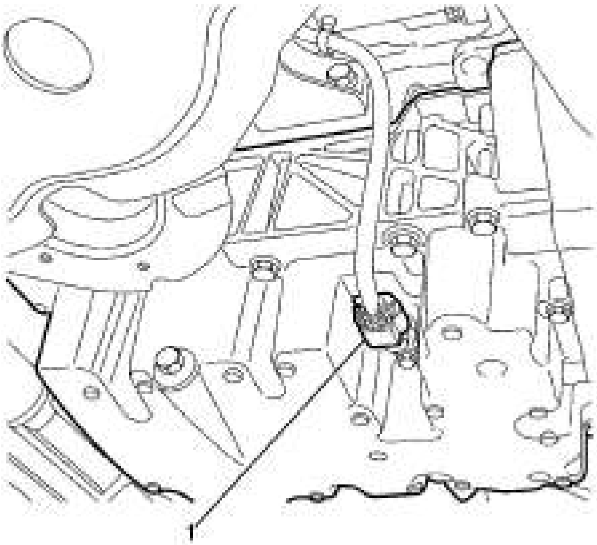
58. Plug or cap the cooling system hoses and inlets.



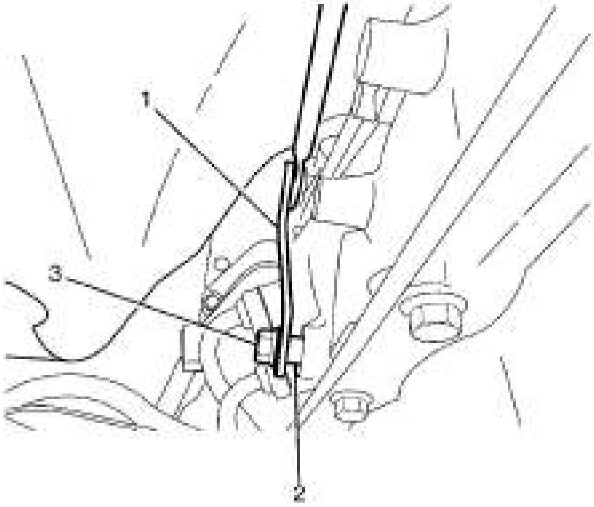
59. Disconnect the power steering cooler hoses (1).

Important: Plug or cap the power steering cooler hose (1) ends to prevent leaks and/or contamination.

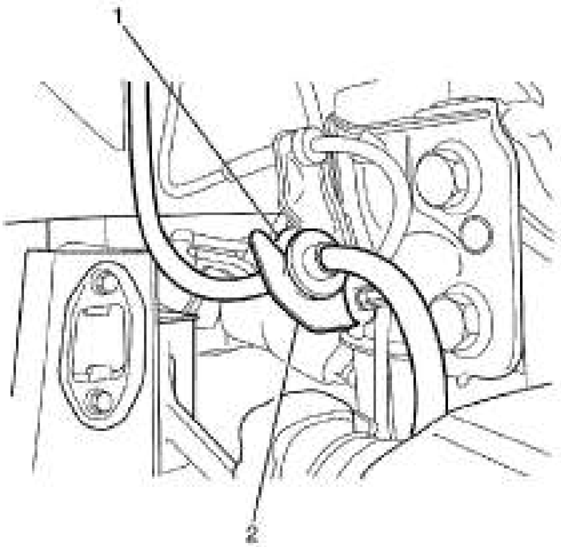
60. Plug or cap the power steering cooler hose (1) ends.



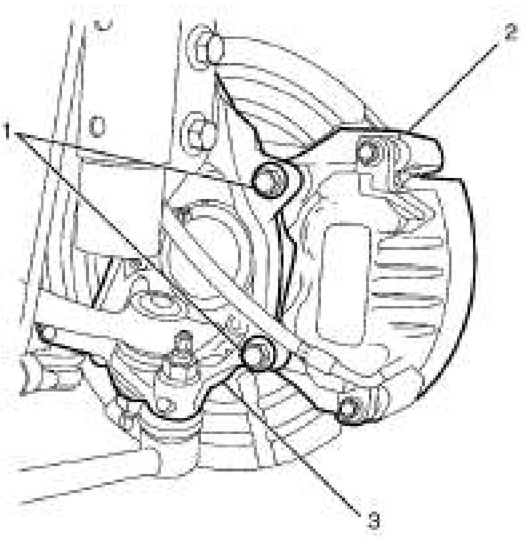
61. Disconnect the oil level/temperature sensor electrical connector (1).
62. Remove the Exhaust system. Refer to Exhaust System Replacement .
63. Remove the centre exhaust heat shield. Refer to Exhaust Heat Shield Replacement - Center .
64. Remove the propeller shaft. Refer to Propeller Shaft Replacement .



65. Remove the shift selector linkage rod to shift selector shaft retaining nut (3).
66. Remove the shift selector linkage rod (1) from the shift selector shaft (2).
67. Remove the starter motor. Refer to Starter Motor Replacement .
68. Partially lower the vehicle.
69. Remove the front wheels. Refer to Tire and Wheel Removal and Installation .



70. Detach the brake hose (1) from the strut mounted brake hose retaining bracket (2).



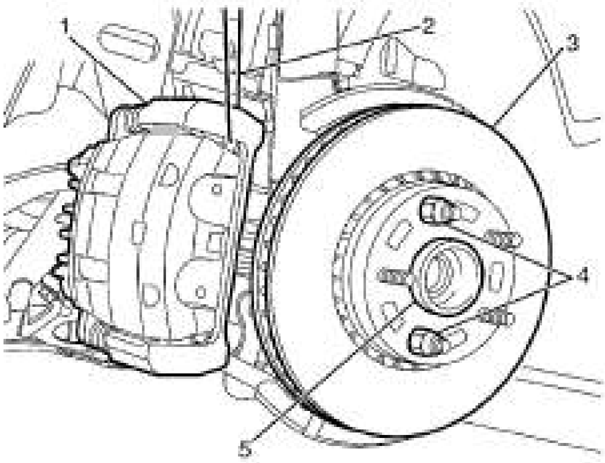
Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

Important: Make sure all the bolt holes are thoroughly cleaned and all micro-encapsulated thread sealant is removed.

71. Remove the brake caliper anchor plate to knuckle retaining bolts (1).
    - Discard the bolts.
    - Clean the bolt holes.

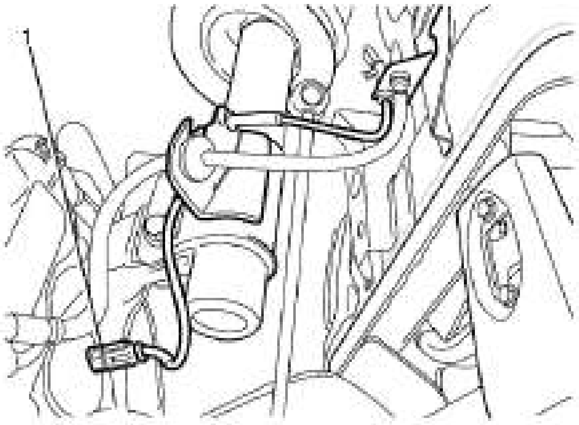
Important: DO NOT disconnect the hydraulic brake flexible hose from the brake caliper otherwise complete bleeding of the braking system will be necessary.

72. Remove the brake caliper (2) from the steering knuckle (3).

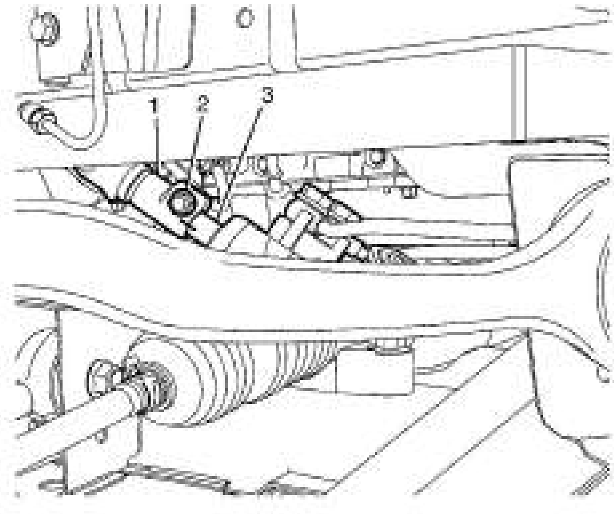


Notice: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

73. Support the brake caliper (1) with heavy mechanic's wire, or equivalent (2).
74. Install 2 wheel nuts (4) to retain the brake disc (3) to the hub (5).



75. Disconnect the wheel speed sensor jumper harness electrical connector (1) and secure away from the subframe and suspension components.



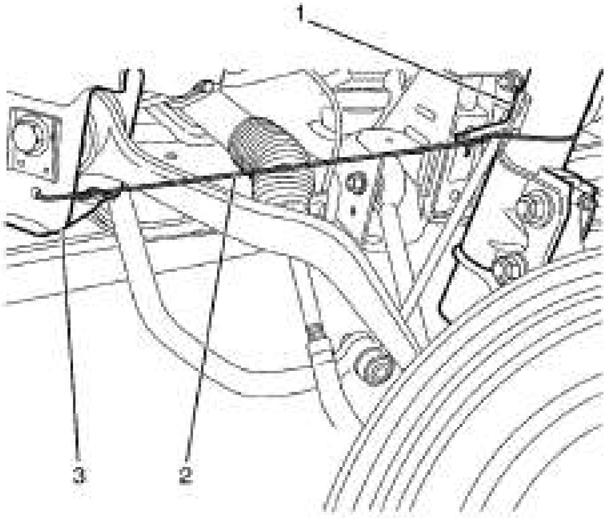
Important: Observing the orientation of the intermediate steering shaft (1) with reference to the pinion shaft (3) will minimise the potential of incorrect steering column assembly alignment.

76. Mark the intermediate steering shaft (1) in relation to the pinion shaft (3).
77. Remove the intermediate steering shaft to pinion shaft retaining bolt (2).

Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

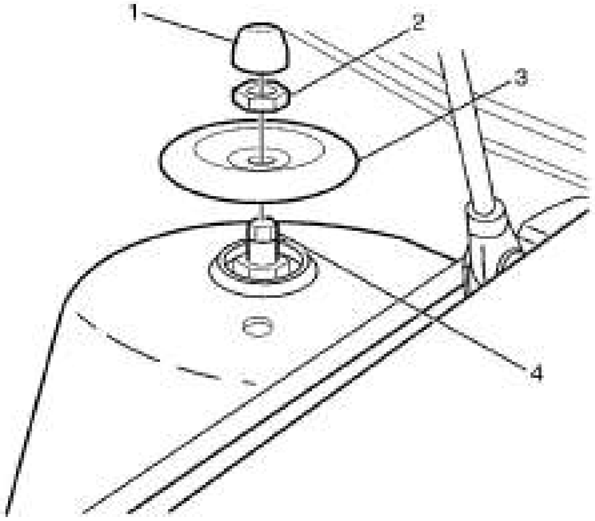
Important: Make sure the bolt hole is thoroughly cleaned and all micro-encapsulated thread sealant is removed.

78. Disconnect the intermediate shaft (2) from the pinion shaft (3).
    - Discard the bolt.
    - Clean the bolt hole.
79. Partially lower the vehicle.



Important: The strut assembly (1) must be secured to the subframe (3) to prevent damage to the front wheelhouse liner, fenders and suspension components.

80. Retain the strut assembly (1) to the subframe (3) using heavy mechanics wire or equivalent (2).



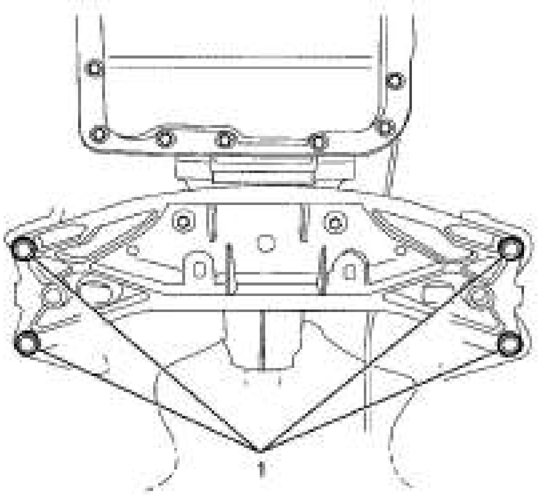
81. Remove the stud dust cover (1) from the strut assembly to body retaining nut (2).

Important: The strut assembly (4) must be supported from underneath before the strut assembly to body retaining nut (2) is removed.

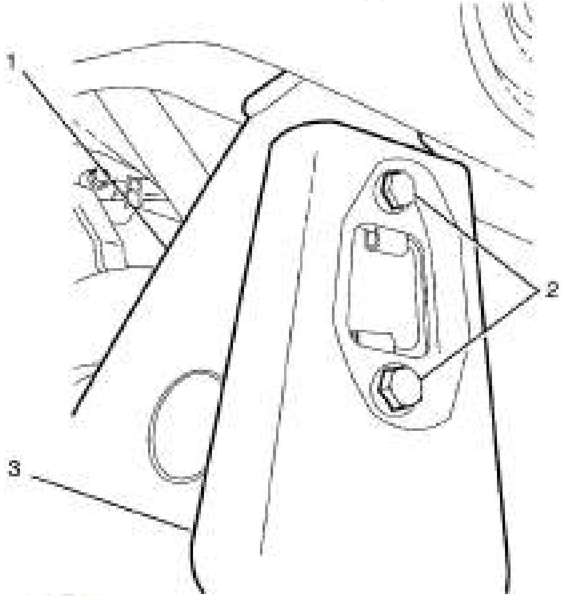
82. Remove the strut assembly to body retaining nut (2) while holding the strut piston shaft (4).

Discard the nut.

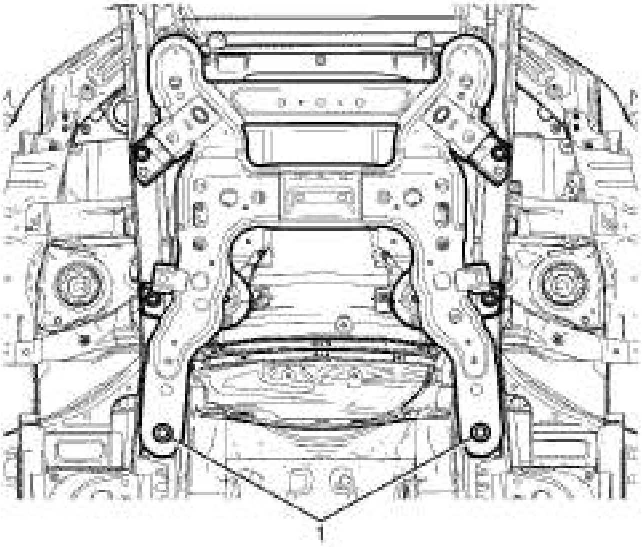
83. Remove the strut assembly to body retaining plate (3).
84. Position a suitable powertrain and/or engine lift table below the frame, engine and transmission.
85. Raise the lift table and/or lower the vehicle to support the frame, engine and transmission.



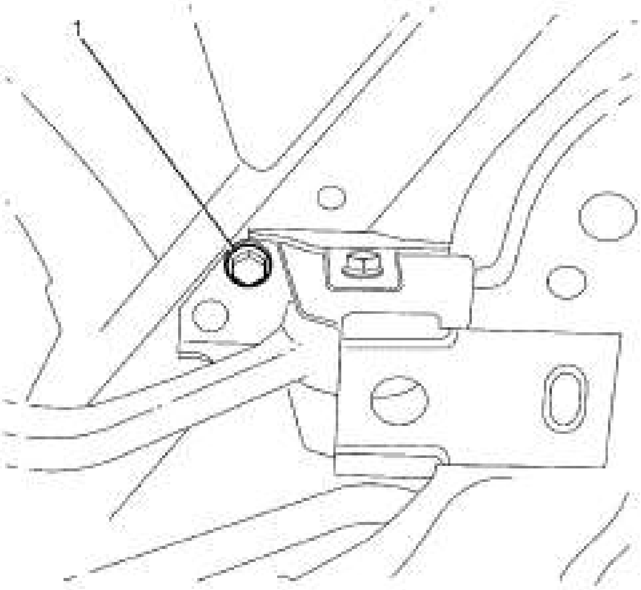
86. Remove the transmission support to body retaining bolts (1).



87. Remove the subframe reinforcement plate to subframe retaining bolts (2).
88. Remove the subframe reinforcement plate (3) from the subframe (1).

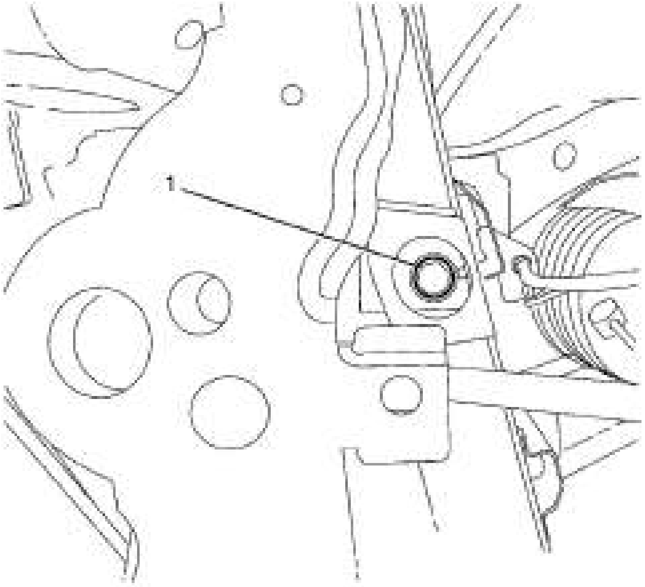


89. Remove the subframe to body rear retaining bolts (1).



Important: Only right side depicted in graphic, left side similar.

90. Remove the subframe to body front retaining bolts (1).

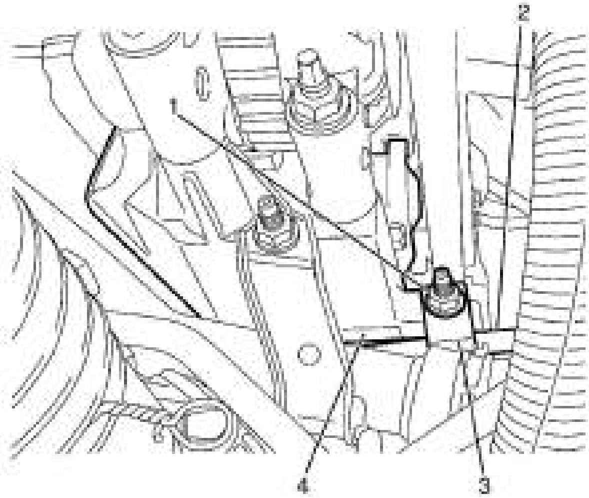


Important: Only right side depicted in graphic, left side similar.

91. Remove the subframe to body retaining bolts (1).

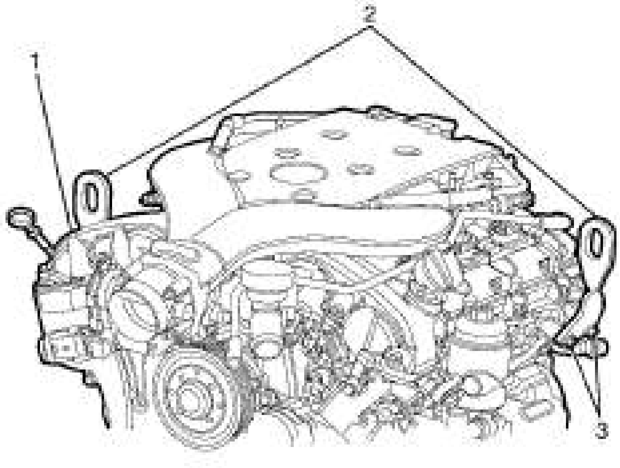
Important: Make sure that all the hoses, wires, pipes and front struts clear the vehicle during the removal process.

92. With the aid of an assistant, lower the table and/or raise the vehicle to remove the engine, transmission, front suspension and subframe assembly from the vehicle.
93. Remove the engine and transmission wiring harness and related components. Refer to Engine Wiring Harness Assembly Removal .



94. Remove the transmission cooler line clamp to alternator mounting bracket retaining nut (1).

95. Remove the transmission cooler line clamp (3) and transmission cooler lines (2) from the alternator mounting bracket (4).



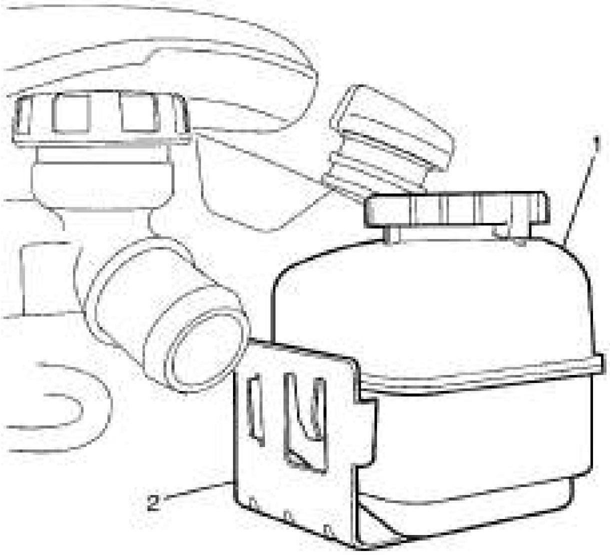
96. Position the EN 46114 (2) on the engine (1).

    Notice: Refer to Fastener Notice in the Preface section.

97. Install the EN 46114 to cylinder head retaining bolts (3).

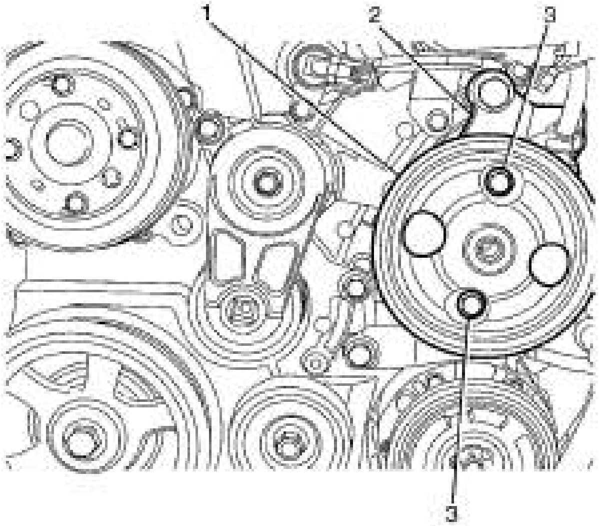
    Tighten
    Tighten the bolts to 50 N·m (36 lb ft).

98. Connect a floor crane to the engine lift brackets and raise the floor crane to partially support the engine.
99. Position a second powertrain lift table below the transmission.
100. Remove the transmission. Refer to Transmission Replacement in Automatic Transmission -- 4L60-E/4L65-E/4L70-E or Transmission Replacement in Automatic Transmission -- 5L40-E/5L50-E.
101. Remove the engine flywheel. Refer to Engine Flywheel Removal .
102. Remove the catalytic converters. Refer to Catalytic Converter Replacement - Left Side and Catalytic Converter Replacement - Right Side .
103. Remove the drive belt. Refer to Drive Belt Replacement .



Important: The locking tang on the power steering reservoir bracket (2) must be released before removing the power steering reservoir (1). Release the locking tang on the power steering reservoir bracket (2) with a suitable tool.

104. Separate power steering fluid reservoir (1) from the power steering fluid reservoir bracket (2).



Important: DO NOT disconnect the power steering pipes/hoses.

Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

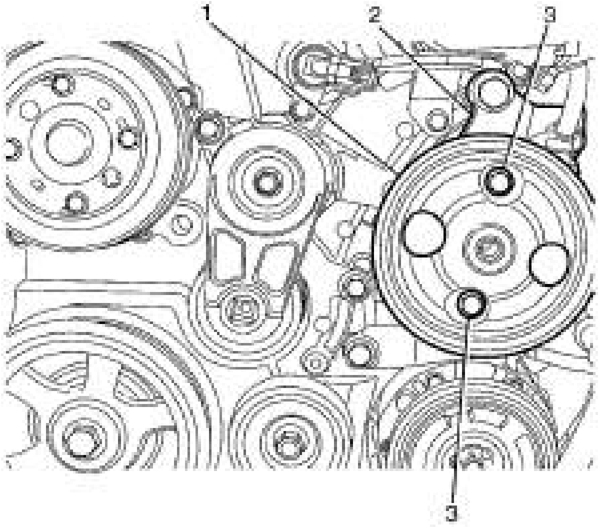
Important: Make sure all the bolt holes are thoroughly cleaned and all micro-encapsulated thread sealant is removed.

105. Remove the power steering pump to power steering pump bracket retaining bolts (3).
    - Discard the bolts.
    - Clean the bolt hole.
106. Remove the power steering pump (1) from the power steering pump bracket (2) position the power steering pump aside.
107. Remove the A/C compressor. Refer to Air Conditioning Compressor Replacement .
108. Remove the A/C compressor mounting bracket. Refer to Compressor Mounting Bracket Replacement .
109. Remove the alternator. Refer to Generator Replacement .
110. Remove the alternator bracket. Refer to Generator Bracket Replacement .
111. Attach a suitable lifting chain and hooks to the 2 EN 46114 .
112. Using a suitable lifting crane, slightly raise the engine to clear the engine mount stud.
113. Remove the engine mount brackets with the engine mounts. Refer to Engine Mount Bracket Replacement - Left Side and Engine Mount Bracket Replacement - Right Side .
114. Remove the engine from the subframe

    If required mount the engine on a suitable engine stand.

Installation Procedure

1. Use a floor crane in order to install the engine to the frame.
2. Install the engine mount brackets with the engine mounts. Refer to Engine Mount Bracket Replacement - Left Side and Engine Mount Bracket Replacement - Right Side .
3. Raise the floor crane to partially support the engine
4. Install the alternator bracket. Refer to Generator Bracket Replacement .
5. Install the alternator. Refer to Generator Replacement .
6. Install the A/C compressor mounting bracket. Refer to Compressor Mounting Bracket Replacement .
7. Install the A/C compressor. Refer to Air Conditioning Compressor Replacement .

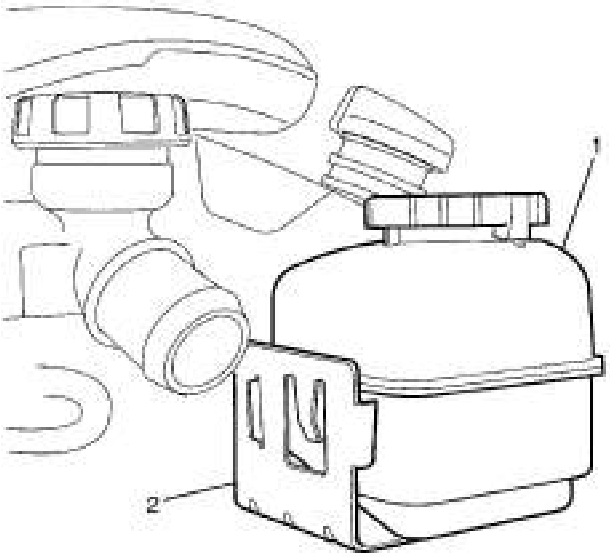


8. Install the power steering pump (1) to the power steering pump bracket (2).

Notice: Refer to Fastener Notice in the Preface section.

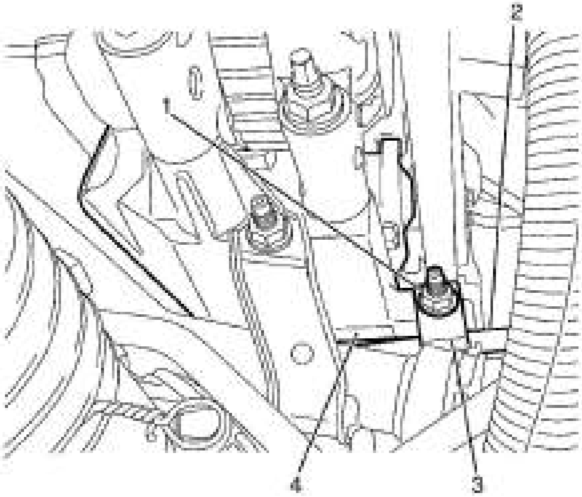
9. Install the NEW power steering pump to power steering pump bracket retaining bolts (3).

Tighten
Tighten the bolts to 27 N·m (22 lb ft).



Important: Make sure the power steering reservoir (2) and the power steering reservoir bracket locking tang (1) are engaged to avoid an induced rattle condition.

10. Install the power steering fluid reservoir to the power steering fluid reservoir bracket.
11. Install the drive belt. Refer to Drive Belt Replacement .
12. Install the catalytic converters. Refer to Catalytic Converter Replacement - Left Side and Catalytic Converter Replacement - Right Side .
13. Install the flywheel. Refer to Engine Flywheel Removal .
14. Install the transmission. Refer to Transmission Replacement in Automatic Transmission -- 4L60-E/4L65-E/4L70-E or Transmission Replacement in Automatic Transmission -- 5L40-E/5L50-E.



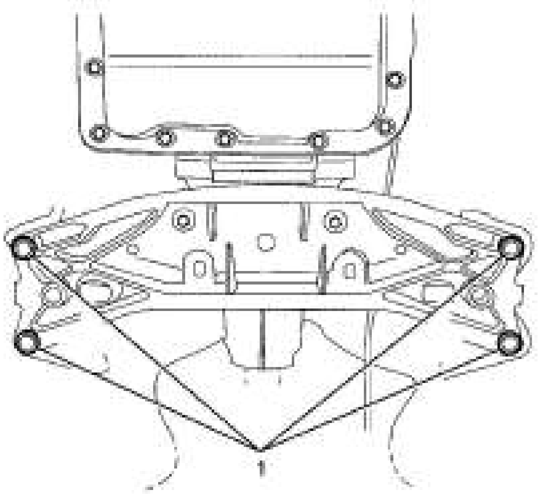
15. Install the transmission cooler line clamp (3) and transmission cooler lines (2) to the alternator mounting bracket (4).
16. Install the transmission cooler line clamp to alternator mounting bracket retaining nut (1).

    Tighten
    Tighten the nut to 22 N·m (16 lb ft).

17. Install the engine and transmission wiring harness and related components. Refer to Engine Wiring Harness Assembly Removal .

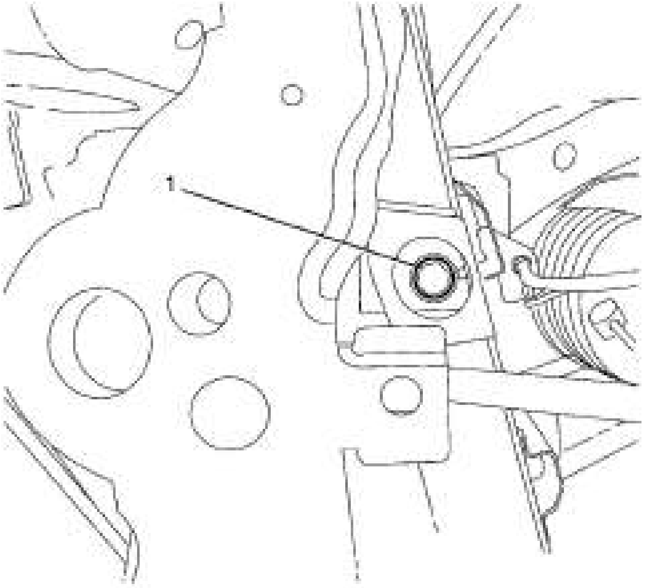
    Important: Make sure that all the hoses, wires, pipes and shock modules clear the vehicle during the installation process.

18. With the aid of an assistant, raise the table and/or lower the vehicle to install the engine, transmission, front suspension and subframe assembly to the vehicle.



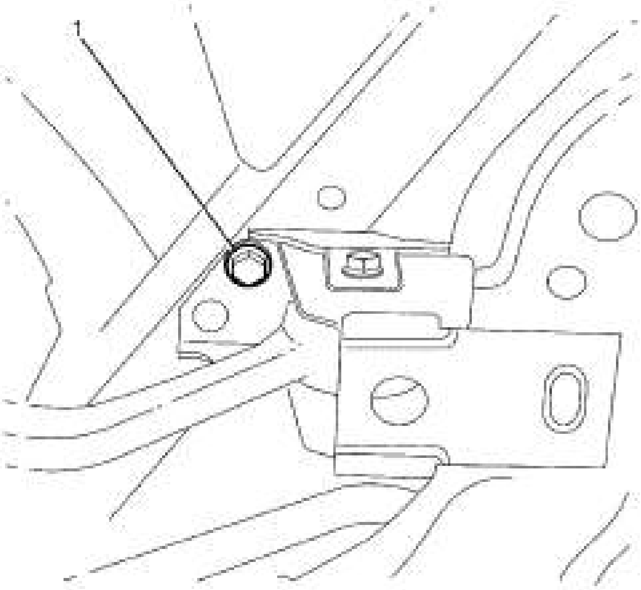
19. Install the transmission support to body retaining bolts (1).

    Tighten
    Tighten the bolts to 58 N·m (43 lb ft).



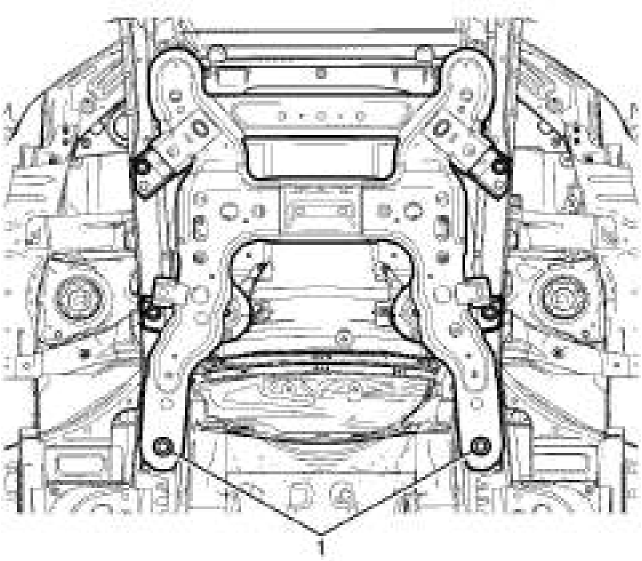
20. Install the subframe to body retaining bolts (1).

    Tighten
    Tighten the bolts to 160 N·m (118 lb ft).



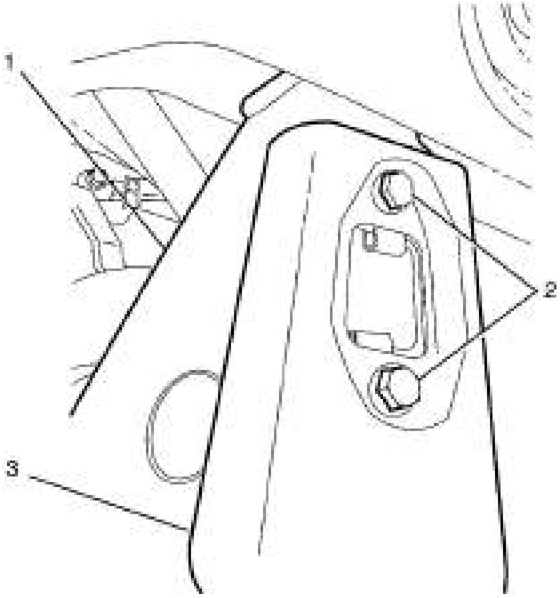
21. Install the subframe to body front retaining bolts (1).

Tighten
Tighten the bolts to 160 N·m (118 lb ft).



22. Install the subframe to body rear retaining bolts (1).

Tighten
Tighten the bolts to 240 N·m (177 lb ft).

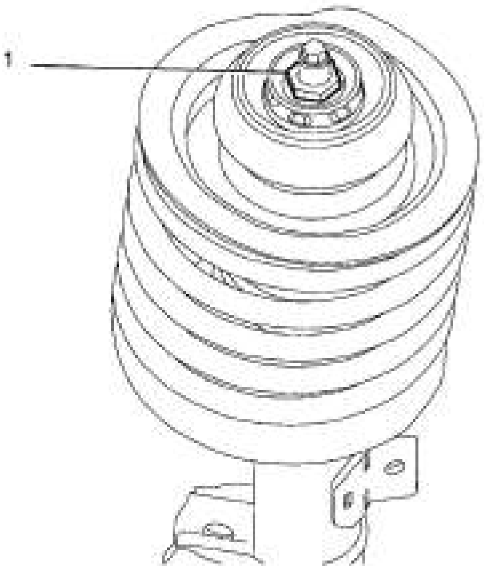


23. Install the subframe reinforcement plate (3) to the subframe (1).
24. Install the subframe reinforcement plate to subframe retaining bolts (2).

Tighten
Tighten the bolts to 17 N·m (13 lb ft).

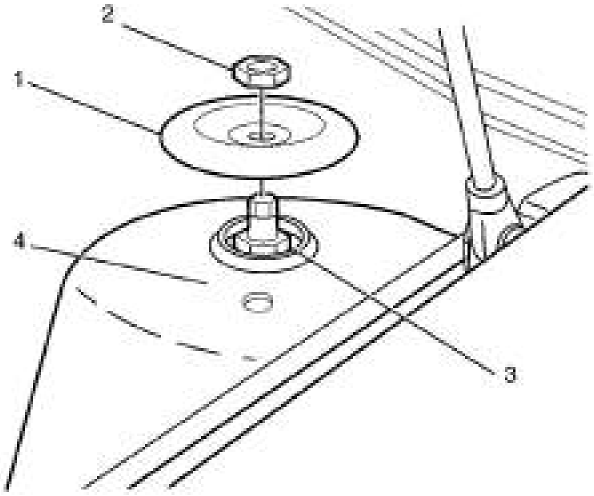
25. Lower the lift table and/or raise the vehicle to remove the support from the frame, engine and transmission.
26. Remove the powertrain and/or engine lift table from the frame, engine and transmission.
27. Partially lower the vehicle.

Notice: Refer to Fastener Notice in the Preface section.



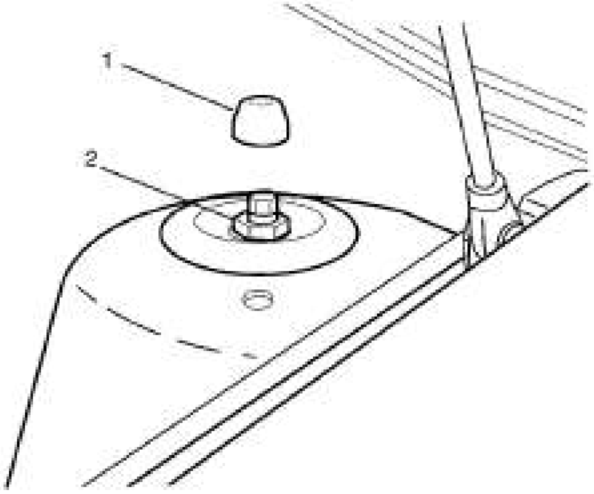
Important: The strut assembly retaining nut (1) must be checked for correct torque before installing the strut assembly into the vehicle. The strut assembly retaining nut torque must be 75 N·m (55 lb ft).

28. Check the torque of the strut assembly retaining nut (1), correct if necessary.

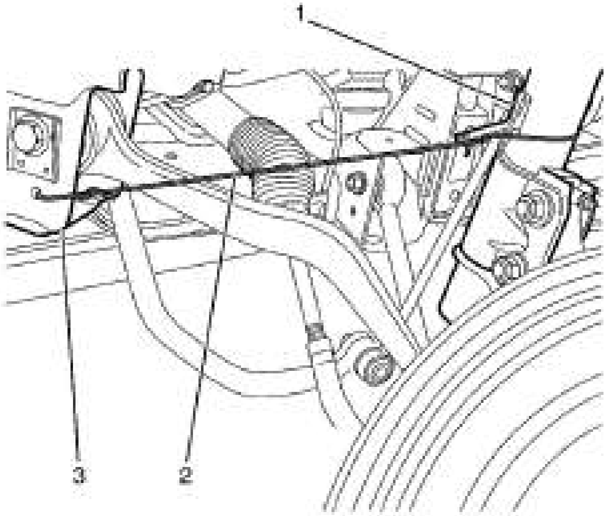


29. Install the strut assembly (3) to the vehicle (4).
30. Install strut assembly to body retaining plate (1).
31. Tighten the NEW strut assembly to body retaining nut (2).

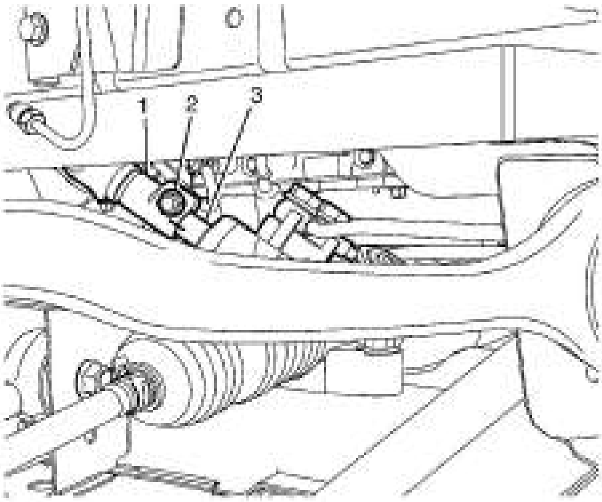
    Tighten
    Tighten the nut to 55 N·m (40 lb ft).



32. Install the dust cover (1) to the strut assembly to body retaining nut (2).
33. Partially raise the vehicle.



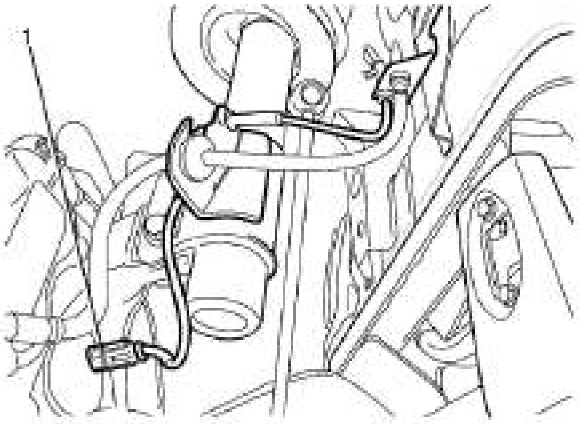
34. Remove the heavy mechanics wire or equivalent (2) retaining the strut assembly (1) to the subframe (3).



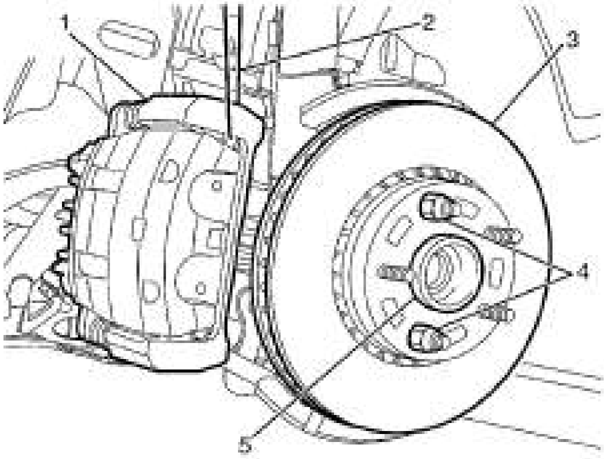
Important: The intermediate steering shaft and pinion shaft splines must be installed in the position recorded during removal and aligned with the marks previously made.

35. Connect the intermediate steering shaft (1) to the pinion shaft (3).
36. Install NEW the intermediate steering shaft to pinion shaft retaining bolt (2).

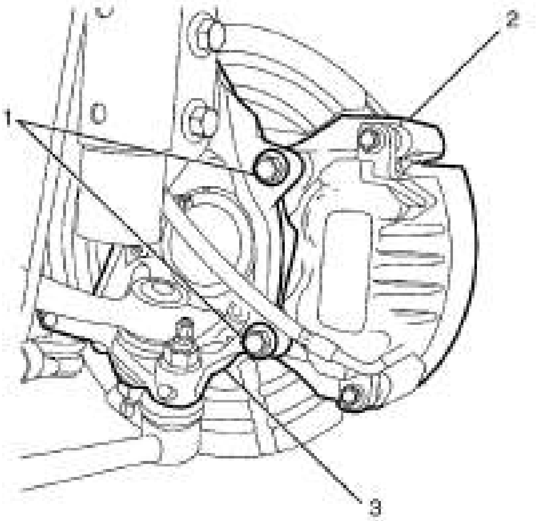
Tighten
Tighten the bolt to 25 N·m (18 lb ft).



37. Connect the wheel speed sensor jumper harness electrical connector (1).



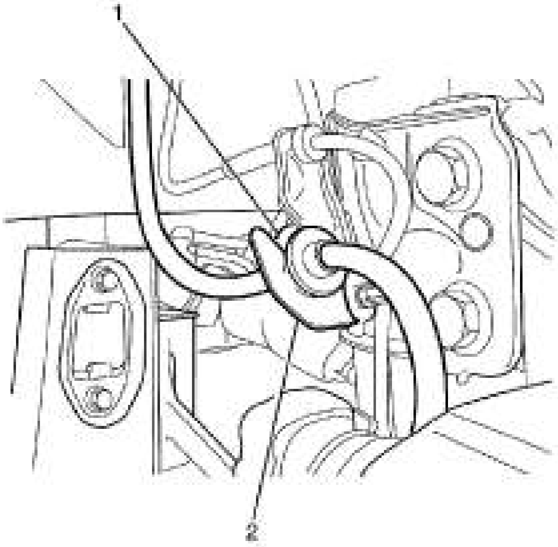
38. Remove the heavy mechanic's wire, or equivalent support (2) from the brake caliper (1).
39. Remove the wheel nuts (4) retaining the brake disc (3) to the hub (5).



Notice: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

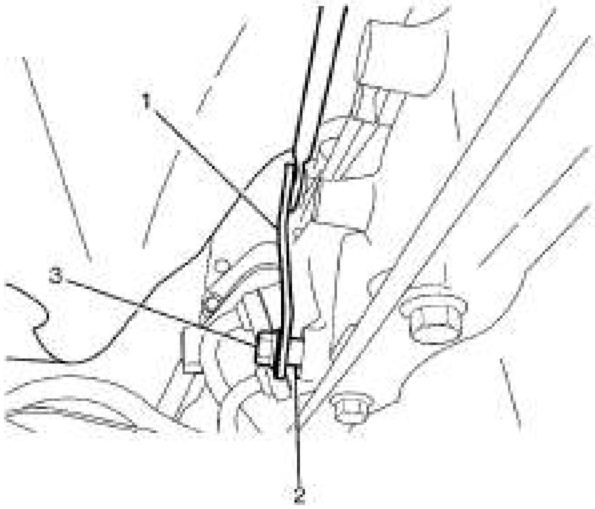
40. Install the brake caliper assembly (2) to the steering knuckle (3).
41. Install the NEW brake caliper anchor plate to knuckle retaining bolts (1).

Tighten
Tighten to 60 N·m +120° (44 lb in +120°).



Notice: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

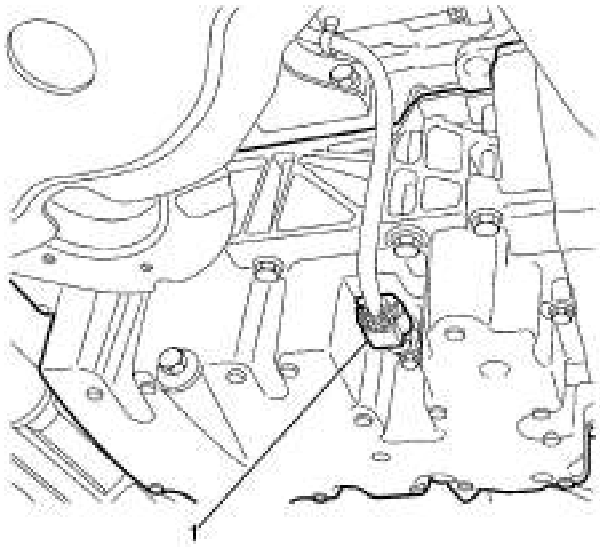
42. Attach the brake hose (1) to the strut mounted brake hose retaining bracket (2).
43. Install the front wheels. Refer to Tire and Wheel Removal and Installation .



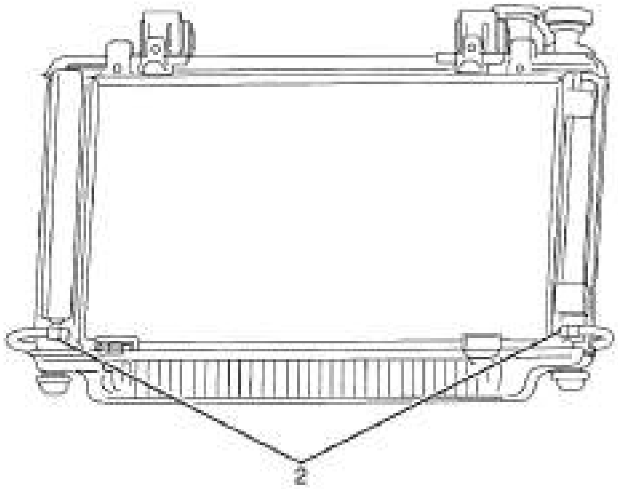
44. Install the shift selector linkage rod (1) to the shift selector shaft (2).
45. Install the shift selector linkage rod to shift selector shaft retaining nut (3).

Tighten
Tighten the nut to 9 N·m (80 lb in).

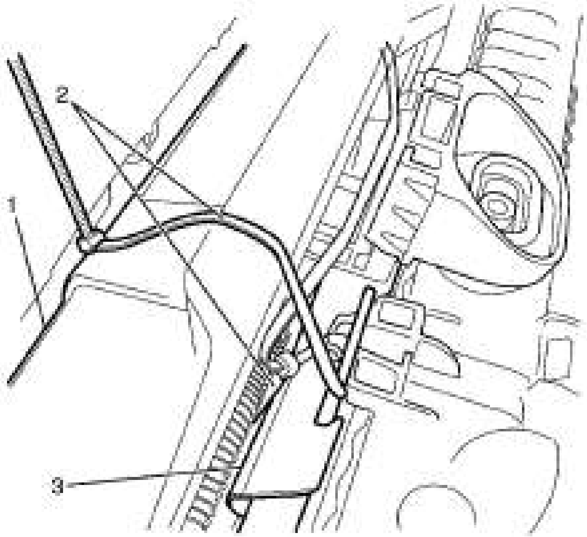
46. Install the starter motor. Refer to Starter Motor Replacement .
47. Install the propeller shaft. Refer to Propeller Shaft Replacement .
48. Install the centre exhaust heat shield. Refer to Exhaust Heat Shield Replacement - Center .
49. Install the Exhaust system. Refer to Exhaust System Replacement .



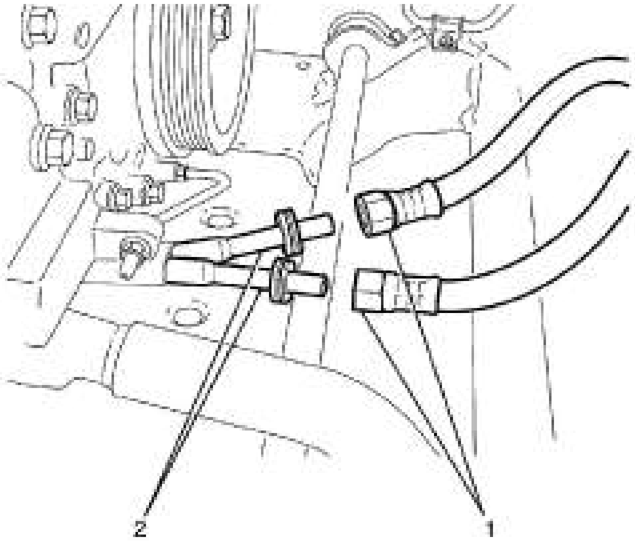
50. Connect the low oil level sensor electrical connector (1).



51. Remove the plug or cap at the power steering cooler hose (1) ends.
52. Connect the power steering cooler hoses (1).
53. Remove the plug or cap from the cooling system hoses and inlets.
54. Connect the radiator inlet hose. Refer to Radiator Inlet Hose Replacement .
55. Install the Engine Splash Shield. Refer to Engine Splash Shield Replacement .
56. Install the front air deflector. Refer to Front Air Deflector Replacement .
57. Lower the vehicle.



58. Remove the zip ties (2) or equivalent securing the radiator and condenser assembly (3) to the front end assembly (1).



Important: The AU-525 is not required for installation.

59. Remove the clean lint free cloth at the transmission cooler lines (2) and the flexible hoses (1).

Important: The flexible hoses are not serviced separately. Therefore if the hose's require replacement, then the hose and radiator to hose cooler hose assembly must be fitted.

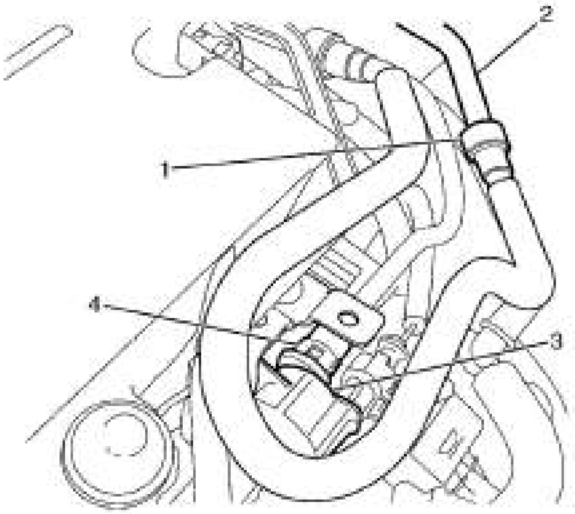
60. Align both flexible hose's with both steel cooler lines.

Important: Listen for an audible click to confirm fitting.

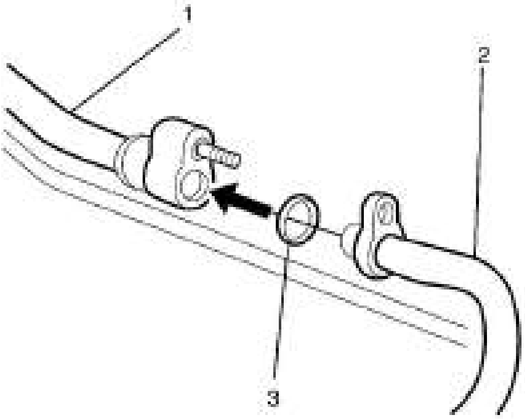
61. Hold the cooler line (2) and connect the flexible hose (1) by pushing together. Repeat procedure for other hose.

Important: When adding or changing transmission fluid use only recommended automatic transmission fluid.

62. Check and top up transmission fluid level if required.

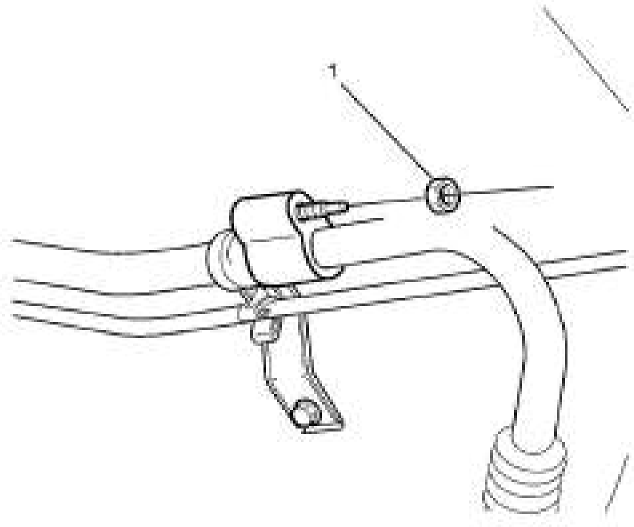


63. Remove the plug or cap at the fuel feed hose (1) and fuel feed pipe (2) ends.
64. Connect the fuel feed hose (1) to the fuel feed pipe (2). Refer to Metal Collar Quick Connect Fitting Service or Plastic Collar Quick Connect Fitting Service .
65. Remove the plug or cap at the EVAP purge line (4) and the purge solenoid (3) ends.
66. Connect the EVAP purge line (4) to the purge solenoid (3). Refer to Metal Collar Quick Connect Fitting Service or Plastic Collar Quick Connect Fitting Service .



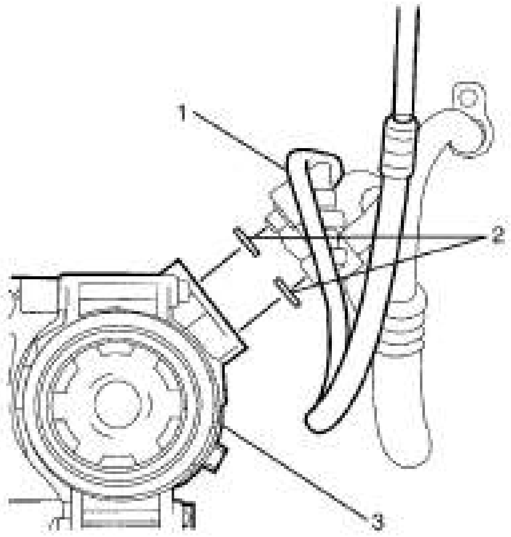
Important: DO NOT coat the new sealing washer with oil. They must be fitted dry. The use of mineral oil will render the washer useless, as the washer WILL swell causing refrigerant to leak out.

67. Install a NEW sealing washer (3) to suction pipe joint.
68. Position the upper suction pipe (1) to the lower suction pipe (2).



69. Install the A/C suction pipe pad to A/C suction pipe retaining nut (1).

Tighten
Tighten the nut to 22 N·m(16 lb ft).

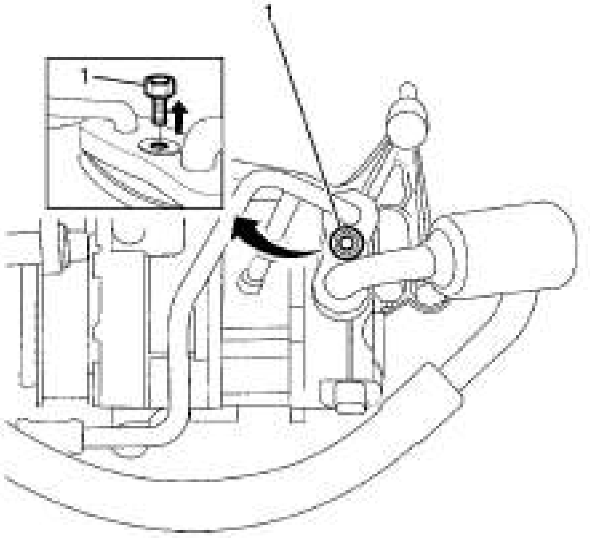


70. Remove the plug or cap at the A/C suction/discharge pipe (1) ends and the compressor (2) ports.

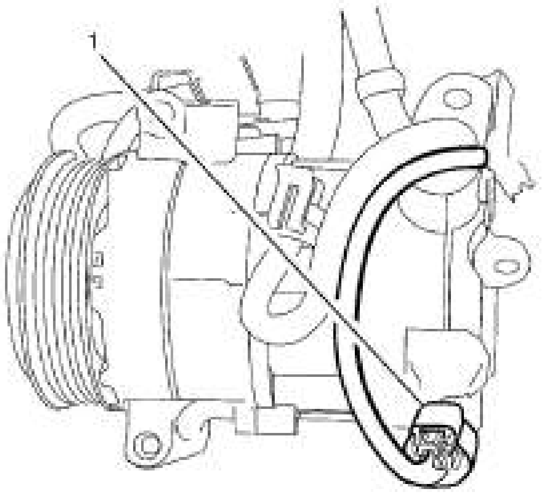
Important: The A/C sealing O-rings must be fitted dry. DO NOT lubricate the A/C sealing O-rings.

71. Fit the NEW A/C suction/discharge pipe sealing O-ring (2) to the suction pipe.

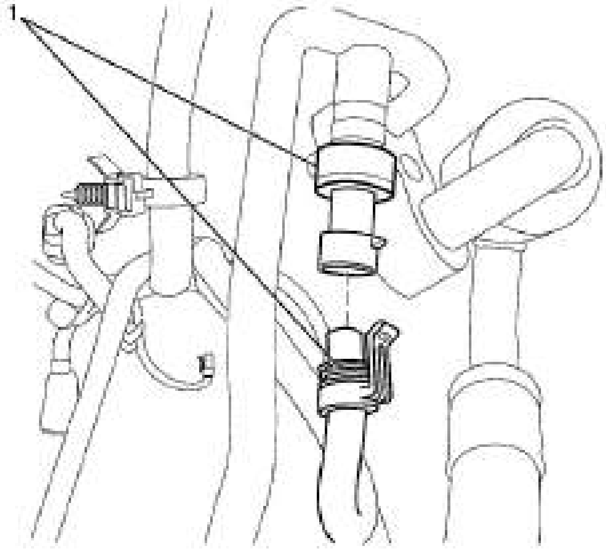
72. Connect the A/C suction/discharge line pad (1) to the A/C compressor (2).



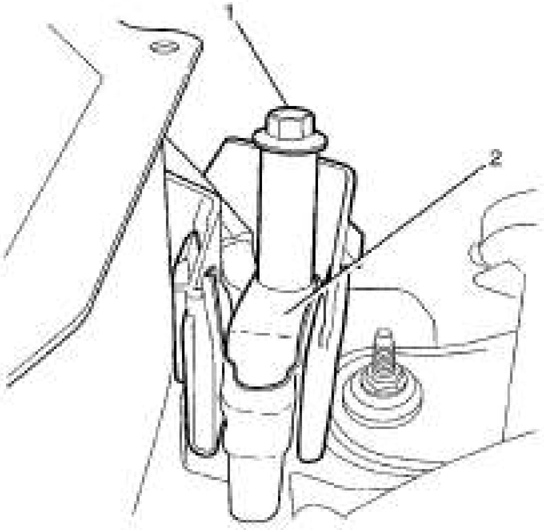
73. Install the suction/discharge line pad to A/C compressor retaining nut (1).



74. Connect the A/C compressor electrical connector (1).

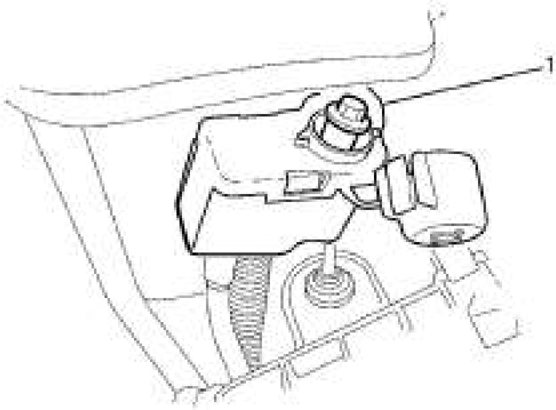


75. Connect the A/C pressure transducer electrical connector (1).



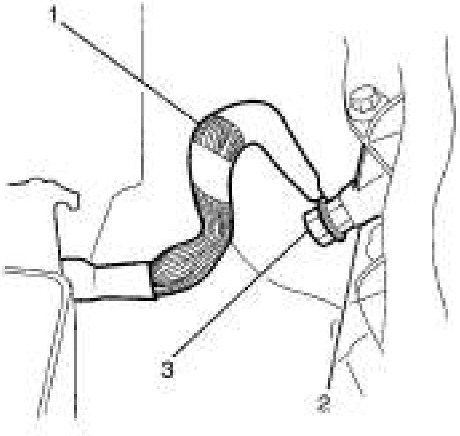
76. Install the wiring harness (2).
77. Install the remote battery positive post to wiring harness retaining bolt (1).

Tighten
Tighten the bolt to 15 N·m (11 lb ft).



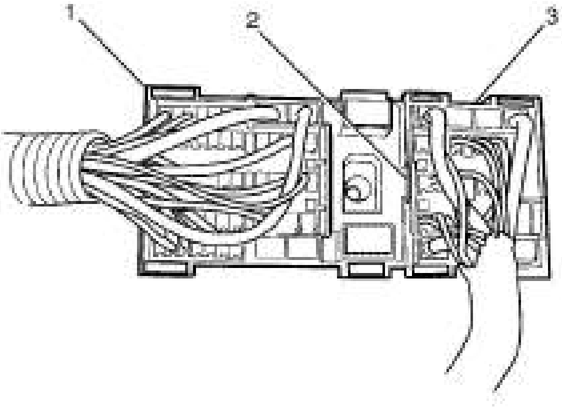
Important: Make sure the clips on the remote battery positive post cover (1) are engaged to avoid an induced rattle condition.

78. Install the remote battery positive post cover (1).



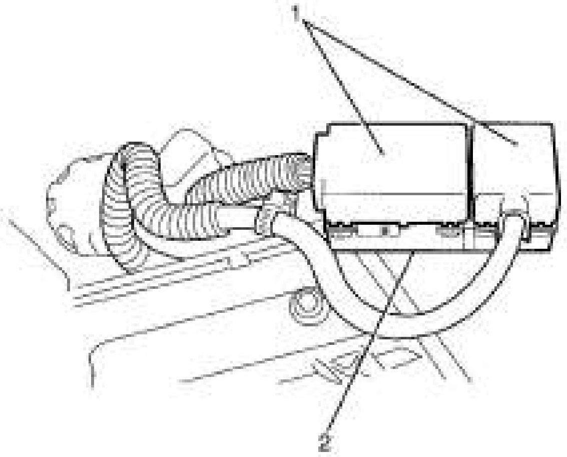
79. Connect the vehicle body ground cable (1) to the cylinder head (2).
80. Install the vehicle body ground cable to the cylinder head retaining bolt (3)

Tighten
Tighten the bolt to 10 N·m(89 lb in).

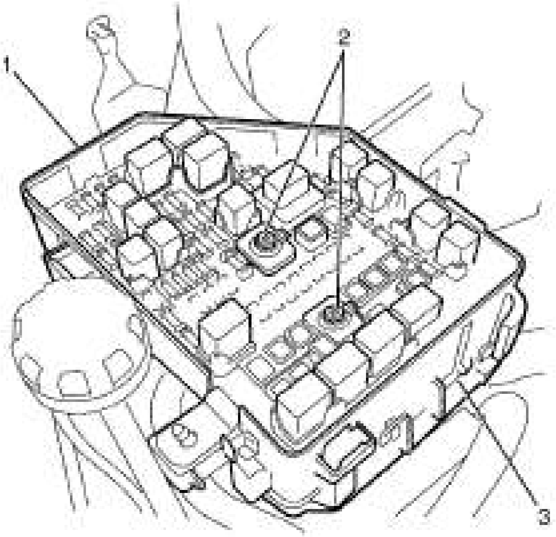


Important: Listen for a audible click from the locking tang (2) to confirm fitting.

81. Slide the engine connector (3) into the body harness connector (1) to join.



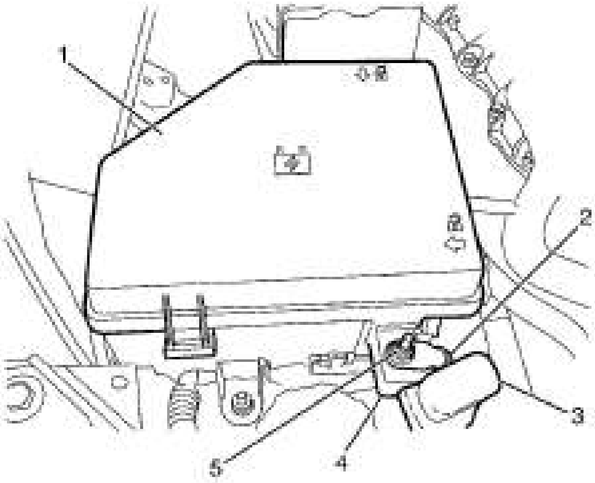
82. Attach the protector (1) to the base of the under hood BEC connector (2).



83. Install the upper under hood BEC plate (1) to the lower under hood BEC plate (3).

Important: The under hood BEC upper plate to lower plate retaining bolts (2) DO NOT have a torque specification. Listen for an audible clicking sound whilst tightening the under hood BEC upper plate to lower plate retaining bolts (2) to confirm correct fitting.

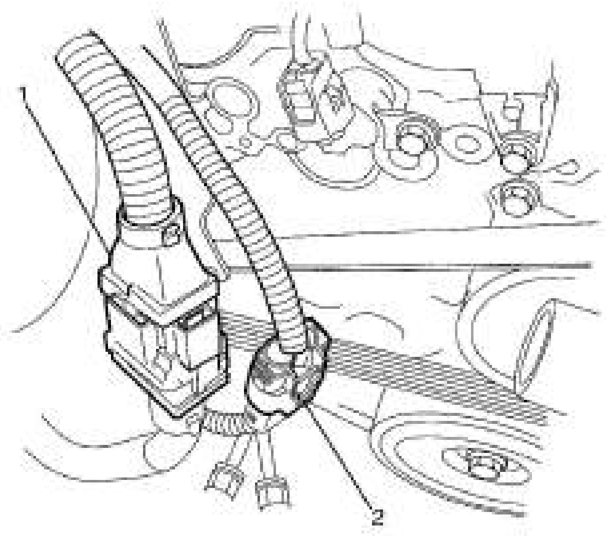
84. Install the under hood BEC upper plate to lower plate retaining bolts (2).



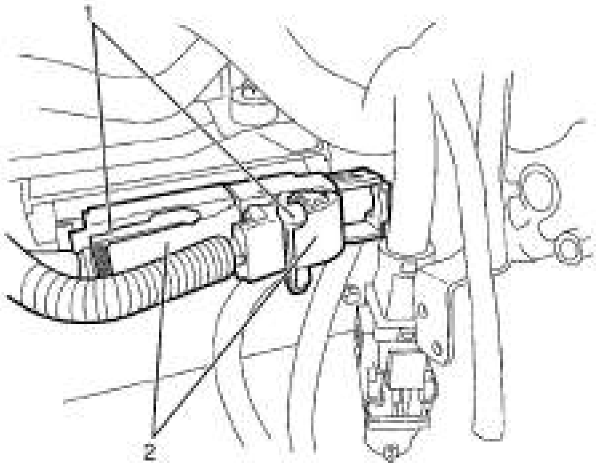
85. Connect the positive cable (2) to the upper under hood BEC plate (4).
86. Install the positive cable to under hood BEC plate retaining bolt (5).

Tighten
Tighten the bolt to 10 N·m(89 lb ft).

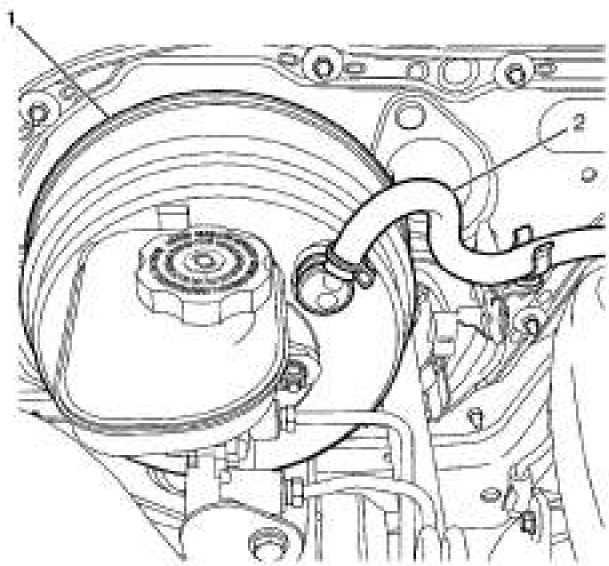
87. Install the positive cable protective cover (3).
88. Install the under hood body electrical centre (BEC) lid (1).



89. Connect the 56 pin engine wiring harness to main wiring harness electrical connector (1).
90. Connect the 2 pin engine wiring harness to main wiring harness electrical connector (2).

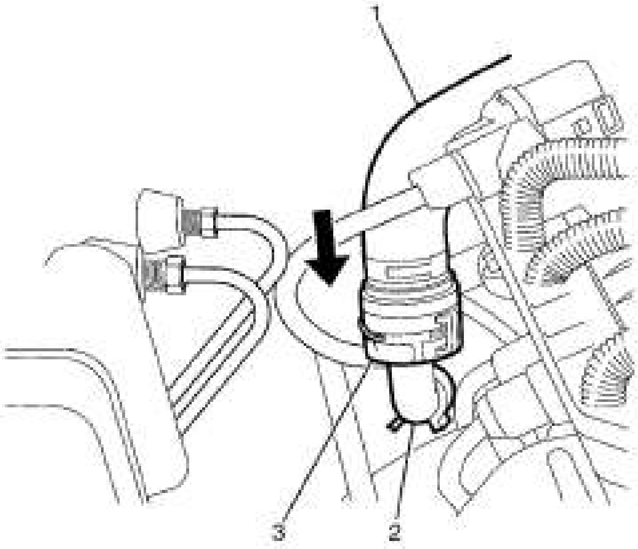


91. Connect ECM electrical connectors (2).
92. Rotate the engine control module (ECM) electrical connector levers (1) to the locked position.



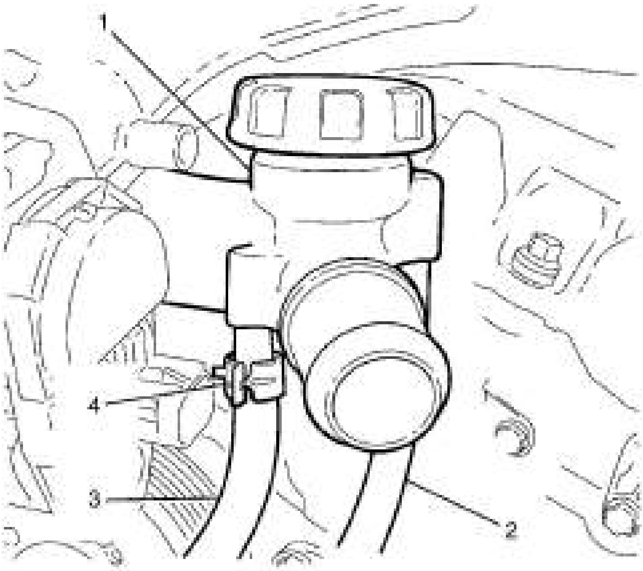
93. Connect the vacuum hose and the vacuum brake booster check valve (2) from vacuum brake booster (1).

Caution: Refer to Installing Hoses without Twists or Bends Notice in the Preface section.



Important: Listen for a audible click to confirm fitting in two places

94. Attach the heater hose (1) quick connect fitting (3) by pushing the hose onto the heater pipe (2).



95. Remove the plug or cap at the cooling system hoses and inlets
96. Install the coolant bleed hose (3) to the outlet housing (1).
97. Compress the coolant bleed hose retaining clamp (4) and position back to its original location on the coolant bleed hose (3).
98. Connect the coolant recovery hose (2) from the outlet housing (1).
99. Install the radiator outlet hose. Refer to Radiator Outlet Hose Replacement .
100. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
101. Refill the cooling system. Refer to Cooling System Draining and Filling .
102. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacement .
103. Recharge the air conditioning (A/C) system. Refer to Refrigerant Recovery and Recharging .
104. Install the radiator air intake baffle. Refer to Radiator Air Upper Baffle and Deflector Replacement .
105. Install the engine covers. Refer to Engine Cover Replacement .
106. Disable the ignition system.
107. Crank the engine several times. Listen for any unusual noises or evidence that parts are binding.
108. Enable the ignition system.
109. Start the engine and listen for unusual noises.
110. Check the vehicle oil pressure gauge and confirm that the engine has acceptable oil pressure.

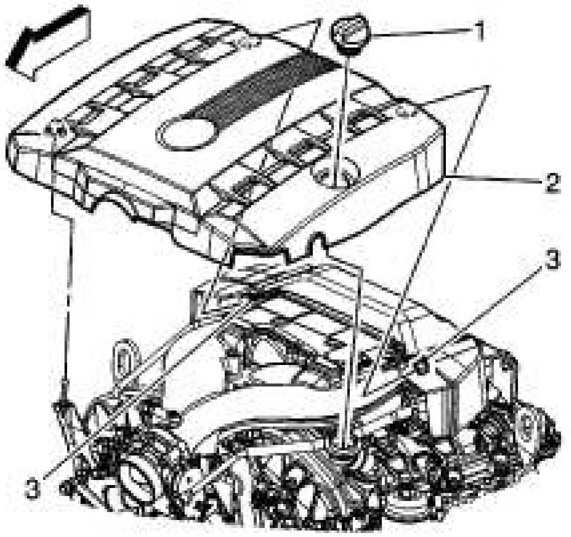
     If necessary, install an oil pressure gauge and measure the engine oil pressure.

111. Run the engine speed at about 1,000 RPM until the engine has reached normal operating temperature.
112. Listen for sticking stationary hydraulic lash adjuster, (SHLAs) (valve lifters) and other unusual noises.
113. Inspect for fuel, oil, and/or other coolant leaks while the engine is running.

2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - On Vehicle | Document ID: 1958267

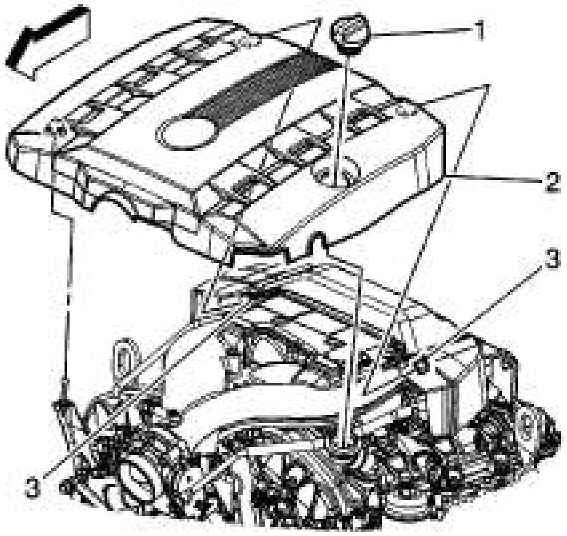
Fuel Injector Sight Shield Replacement (LLT)

Removal Procedure



1. Remove the cross car brace, if necessary. Refer to Cross Vehicle Brace Replacement .
2. Remove the oil fill cap (1).
3. Disengage the cover/shield (2) from the ball studs by pulling up firmly on the right and left front of the engine cover.
4. Pull the engine cover/sight shield forward to remove from the rear tabs (3).
5. Remove the engine cover/sight shield .
6. Remove the front compartment sight shield, if necessary. Refer to Front Compartment Sight Shields Replacement .

Installation Procedure

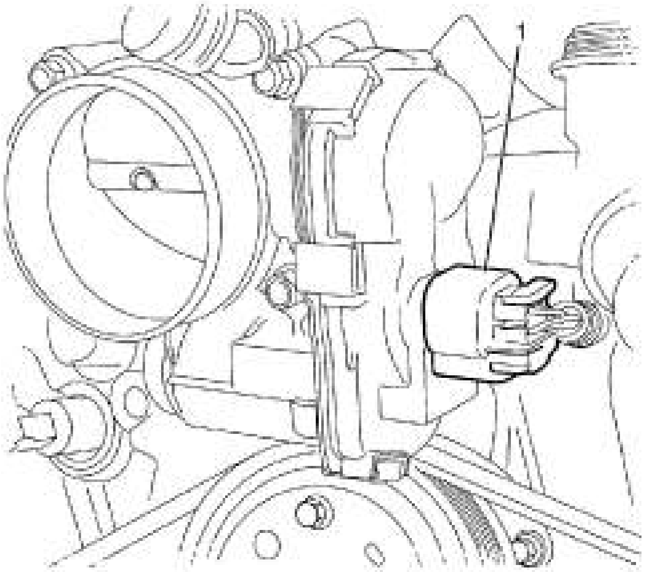


1. Install the front compartment sight shield, if necessary. Refer to Front Compartment Sight Shields Replacement .
2. Raise the front edge of the cover (2) while inserting the rear tabs (3).
3. Lower the front edge of the cover and slide cover rearward so that the rear tabs slide under the retainers.
4. Align the cover over the oil fill tube.
5. Press the cover down firmly on the ball stud at the right front corner.
6. Install the oil fill cap (1).
7. Install the cross car brace, if necessary. Refer to Cross Vehicle Brace Replacement .

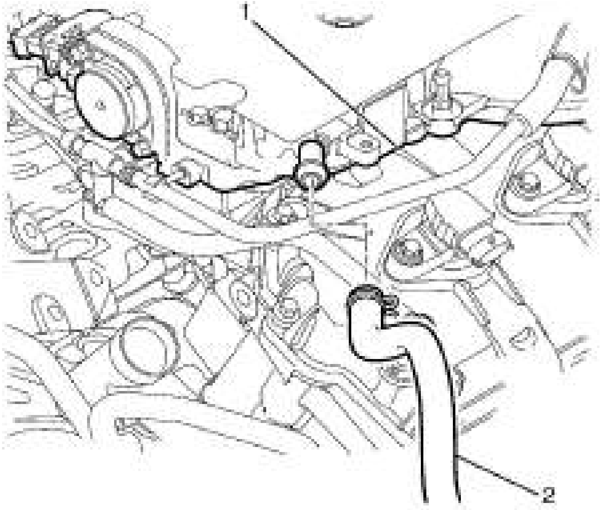
Lower Intake Manifold Replacement

Caution: Refer to Battery Disconnect Caution in the Preface section.

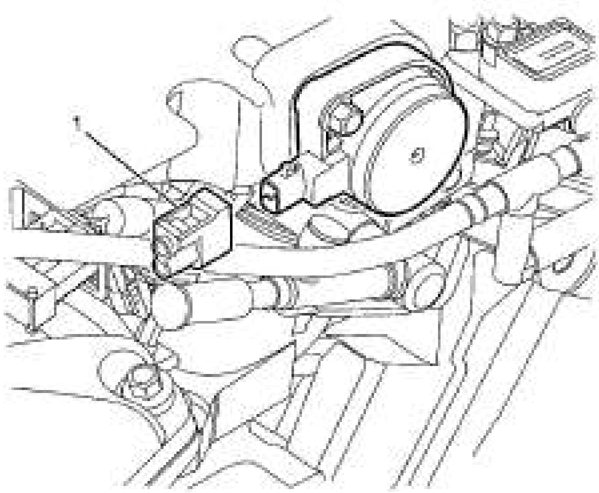
1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the engine covers. Refer to Engine Cover Replacement.
3. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.



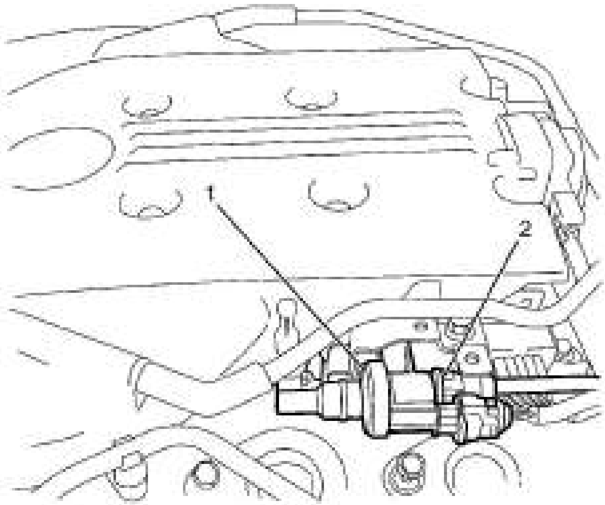
4. Disconnect the throttle body electrical connector (1).



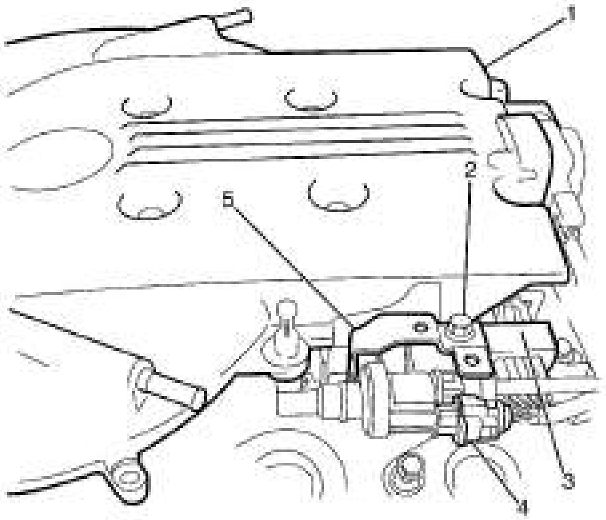
5. Disconnect the brake booster vacuum hose (2) from the intake manifold (1).



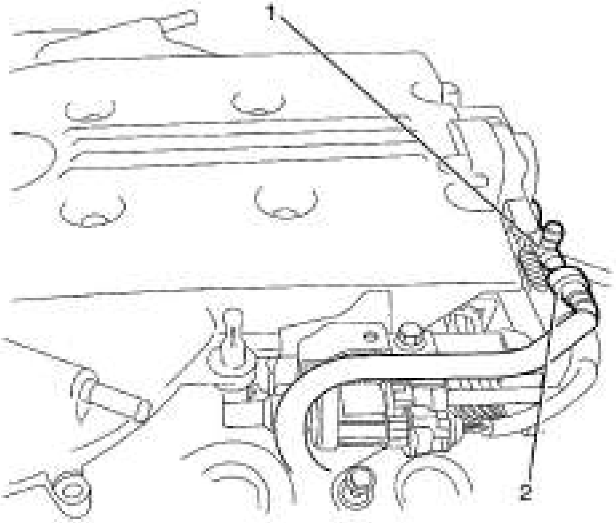
6. Disconnect the Inlet Manifold Runner Control (IMRC) solenoid connector (1).



7. Disconnect the evaporative emission (EVAP) purge line (1) from the purge solenoid (2). Refer to Metal Collar Quick Connect Fitting Service or Plastic Collar Quick Connect Fitting Service.
8. Plug or cap the (EVAP) purge line (1) and the purge solenoid (2) ends.
9. Remove the PCV tube and PCV fresh air tubes. Refer to Positive Crankcase Ventilation Hose/Pipe/Tube Replacement.



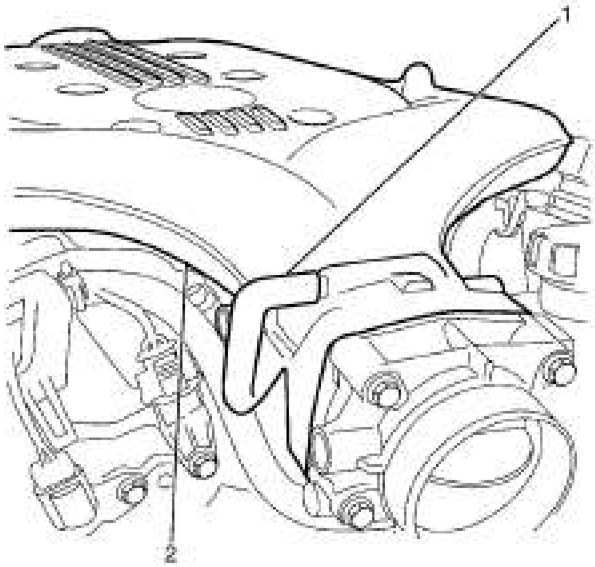
10. Disconnect the EVAP valve electrical connector (4)
11. Disconnect the fuel injector harness electrical connector (3)
12. Remove the fuel injector harness electrical connector/EVAP valve mounting bracket to intake manifold retaining bolt (2).
13. Reposition the fuel injector harness electrical connector/EVAP valve mounting bracket (5) away from the intake manifold (1).



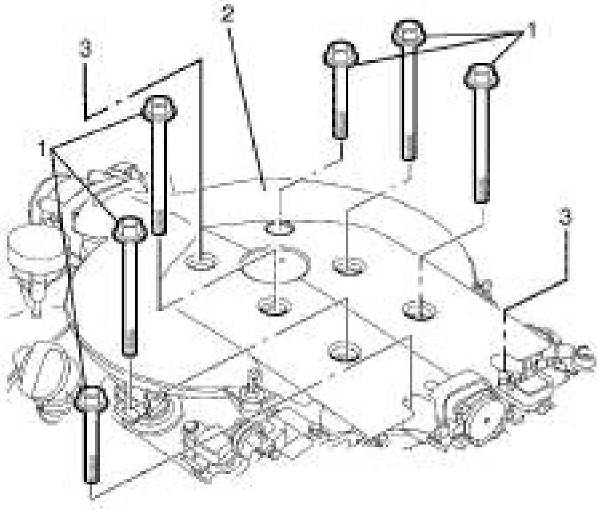
14. Disconnect the fuel feed pipe (2) from the fuel rail (1). Refer to Metal Collar Quick Connect Fitting Service or Plastic Collar Quick Connect Fitting Service.

    Important: Plug or cap the fuel feed pipe (2) and fuel rail (1) ends to prevent fuel leaks and/or contamination.

15. Plug or cap the fuel feed pipe (2) and fuel rail (1) ends.



16. Disconnect the EVAP line (1) from the intake manifold (2).



Important:

- DO NOT remove the upper intake manifold to lower intake manifold retaining bolts (3).
- DO NOT kink or damage the fuel pipe.

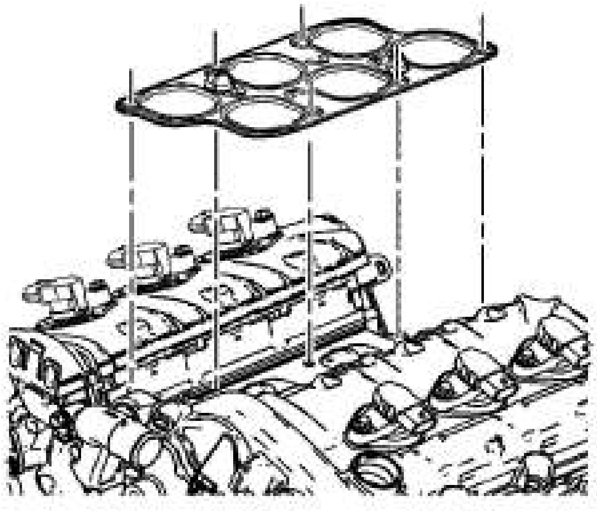
17. Remove the intake manifold to cylinder head retaining bolts (1).
18. Remove the intake manifold assembly (2).

Important: The cylinder heads and engine valley must be plugged with a clean lint free cloth to prevent foreign matter entry into the engine.

19. Plug the cylinder heads and engine valley with a clean lint free cloth.
20. Disassemble the intake manifold as to replace the lower intake manifold. Refer to Intake Manifold Disassemble.
21. Clean and inspect the intake manifold and the sealing surfaces. Refer to Intake Manifold Cleaning and Inspection.

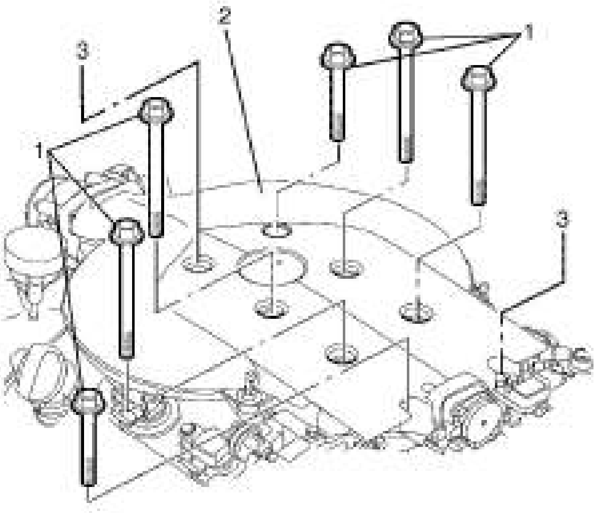
Installation Procedure

1. Assemble the intake manifold as necessary. Refer to Intake Manifold Assemble.
2. Remove the clean lint free cloth from the cylinder heads and engine valley.



Important: Inspect and replace the lower intake manifold gasket only if the gasket is worn or damaged.

3. Install the lower intake manifold gasket.



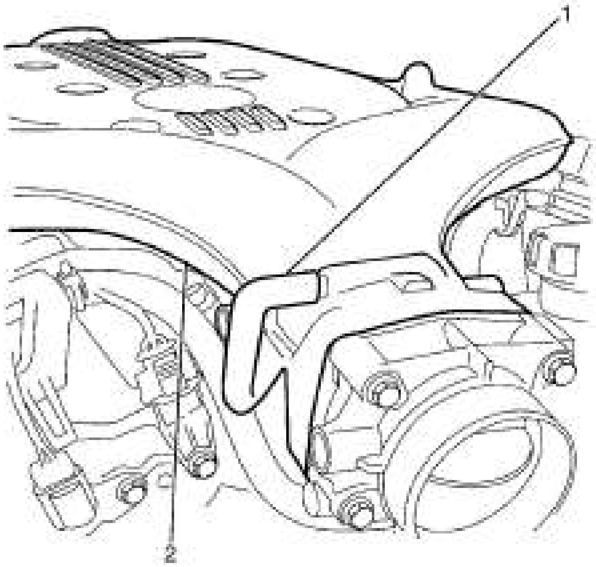
4. Install the intake manifold assembly (2).

   Notice: Refer to Fastener Notice in the Preface section.

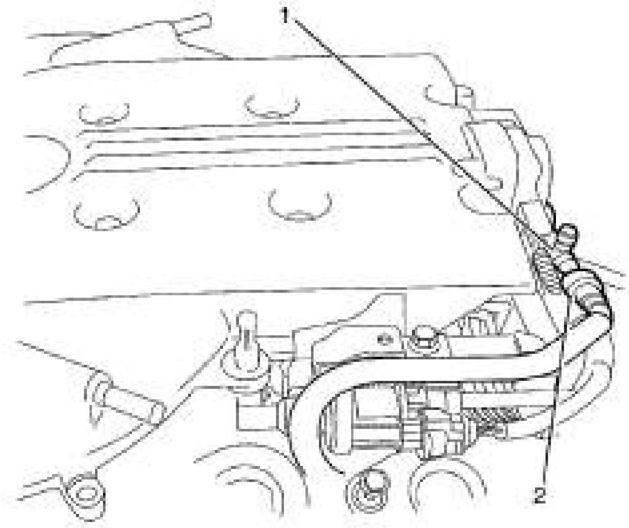
   Important: Tighten the intake manifold to cylinder head retaining bolts (1) in a circular pattern starting at the center (long bolts) and moving outward.

5. Install the intake manifold to cylinder head retaining bolts (1).

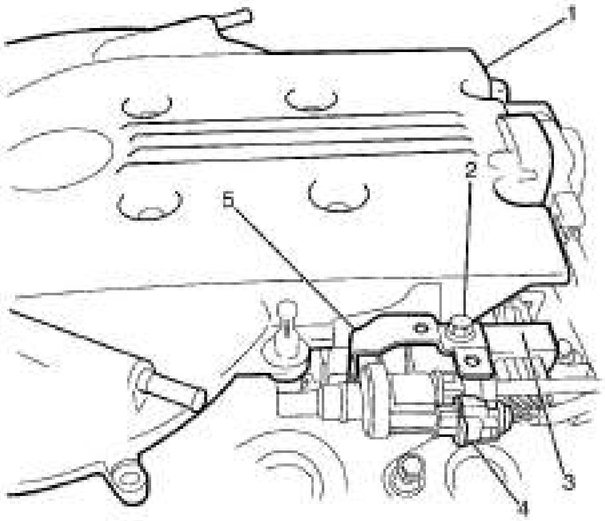
   Tighten
   Tighten the bolts to 23 N·m (17 lb ft).



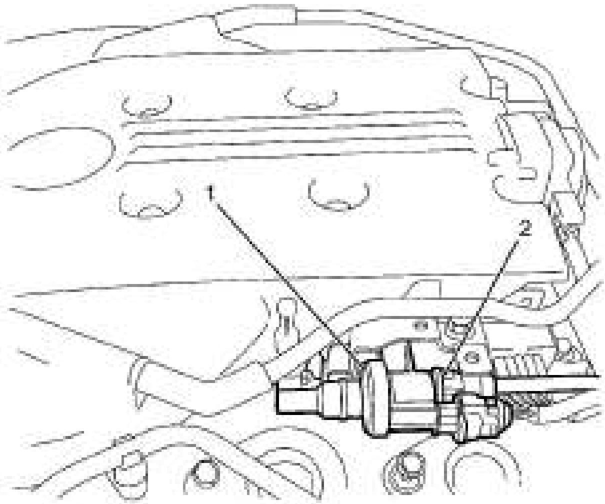
6. Connect the EVAP line (1) to the intake manifold (2).



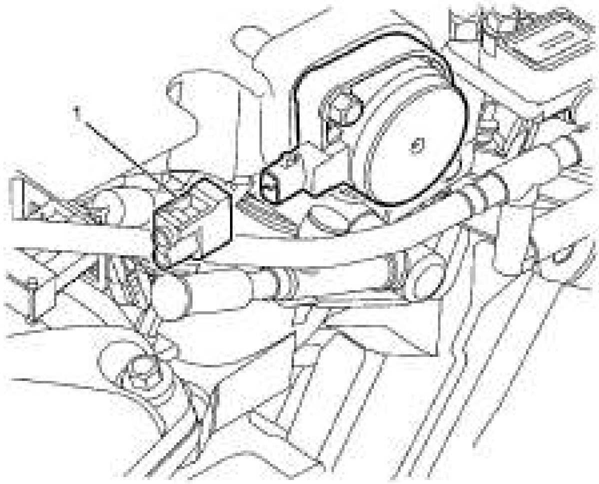
7. Remove the plug or cap at the fuel feed pipe (1) and fuel rail (2) ends
8. Connect the fuel feed pipe (1) to the fuel rail (2). Refer to Metal Collar Quick Connect Fitting Service or Plastic Collar Quick Connect Fitting Service.



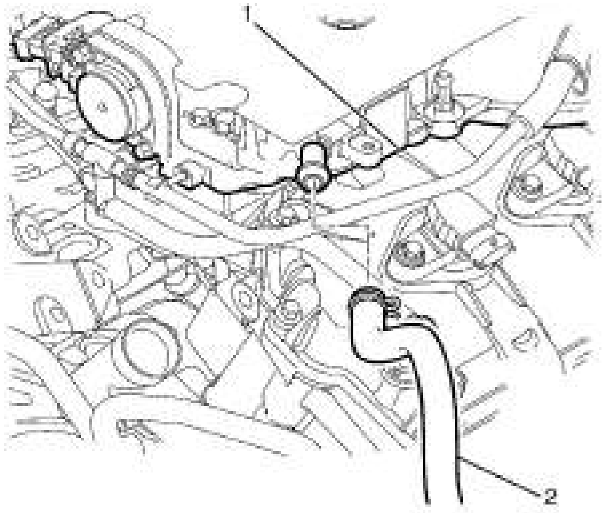
9. Install the fuel injector harness electrical connector/EVAP valve mounting bracket (5) to the intake manifold (1).
10. Install the fuel injector harness electrical connector/EVAP valve mounting bracket to intake manifold retaining bolt (2).
11. Connect the fuel injector harness electrical connector (3)
12. Connect the EVAP valve electrical connector (4)
13. Install the PCV tube and PCV fresh air tubes. Refer to Positive Crankcase Ventilation Hose/Pipe/Tube Replacement.



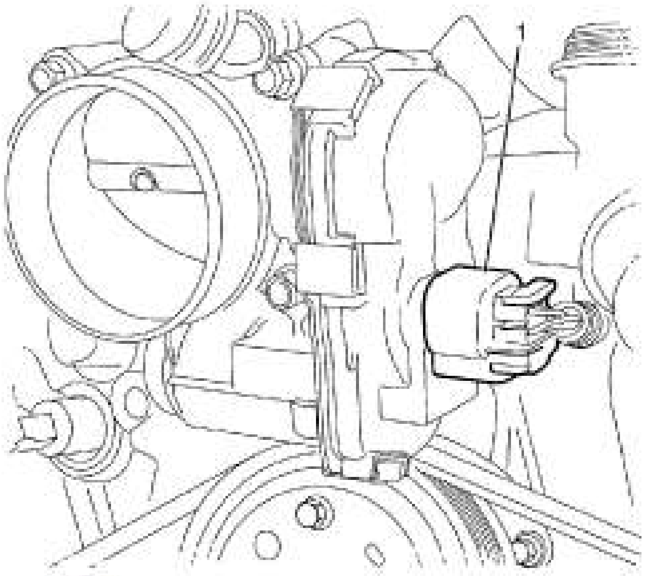
14. Remove the plug or cap from the (EVAP) purge line (2) and the purge solenoid (1) ends.
15. Connect the evaporative emission (EVAP) purge line (2) from the purge solenoid (1). Refer to Metal Collar Quick Connect Fitting Service or Plastic Collar Quick Connect Fitting Service.



16. Connect the Inlet Manifold Runner Control (IMRC) electrical connector (1).



17. Connect the brake booster vacuum hose (2) to the intake manifold (1).



18. Connect the throttle body electrical connector (1).
19. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.
20. Install the engine covers. Refer to Engine Cover Replacement.
21. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

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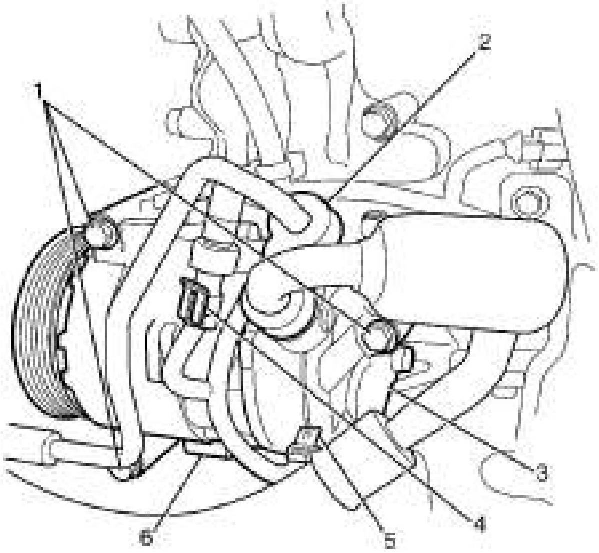
Oil Filter Adapter Replacement

Removal Procedure

1. Remove the engine covers. Refer to Engine Cover Replacement.
2. Remove the oil filter. Refer to Engine Oil and Oil Filter Replacement.
3. Remove the drive belt. Refer to Drive Belt Replacement.



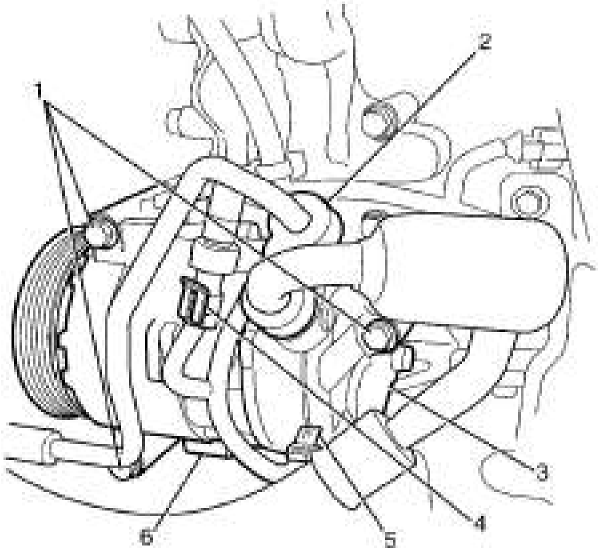
4. Disconnect the A/C pressure transducer electrical connector (4).
5. Disconnect the A/C compressor electrical connector (5).

Important: DO NOT disconnect the A/C pipes (2) from the A/C compressor (6).

6. Remove the A/C compressor to A/C compressor/power steering pump mounting bracket retaining bolts (1).
7. Secure and reposition the A/C compressor (6) away from the A/C compressor mounting bracket (3) in order to gain access to the oil filter adapter to cylinder block retaining bolts..
8. Remove the oil filter adapter. Refer to Oil Filter Adapter Removal.

Installation Procedure

1. Install the oil filter adapter. Refer to Oil Filter Adapter Installation.



Important: Make sure the A/C pipes (2) are not twisted or kinked upon compressor installation.

2. Install the A/C compressor (6) with the A/C pipes (2) to the A/C compressor mounting bracket (3).
3. Install the A/C compressor to A/C compressor mounting bracket retaining bolts (1).
4. Connect the A/C pressure transducer electrical connector (4).
5. Connect the A/C compressor electrical connector (5).
6. Install the drive belt. Refer to Drive Belt Replacement.
7. Install the oil filter. Refer to Engine Oil and Oil Filter Replacement.
8. Install the engine covers. Refer to Engine Cover Replacement.

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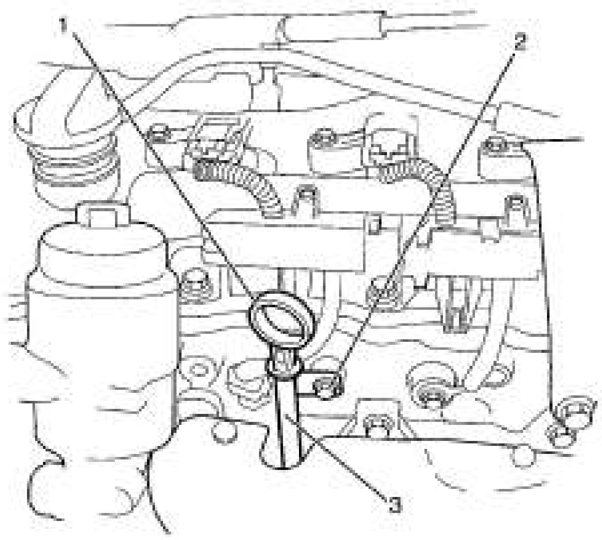
Oil Level Indicator Tube Replacement

Removal Procedure

1. Turn the ignition OFF.

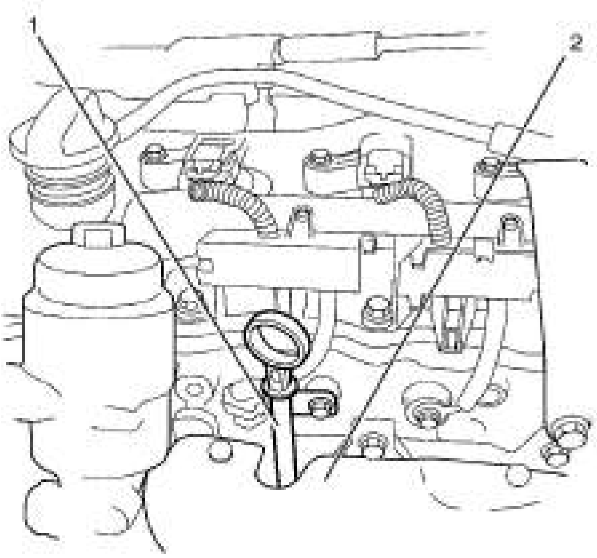


2. Remove the oil level indicator tube bracket to cylinder head retaining bolt (2).
3. Remove the oil level indicator (1) from the oil level indicator tube (3).

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
5. Remove the knock sensor. Refer to Knock Sensor Replacement - Bank 2.
6. Lower the vehicle.



7. Remove the oil level indicator tube (1) up through the exhaust manifold (2).
8. If you are replacing only the oil level indicator tube seal, remove and discard the old seal.

Installation Procedure

1. Install the oil level indicator and tube. Refer to Oil Level Indicator and Tube Installation.

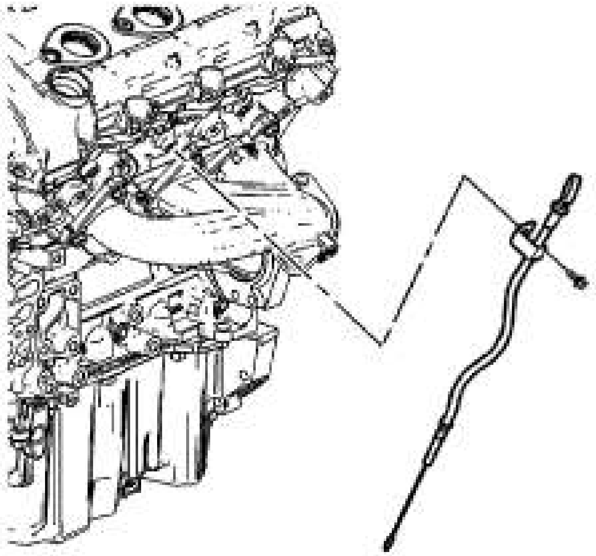
   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Install the knock sensor. Refer to Knock Sensor Replacement - Bank 2.
4. Lower the vehicle.

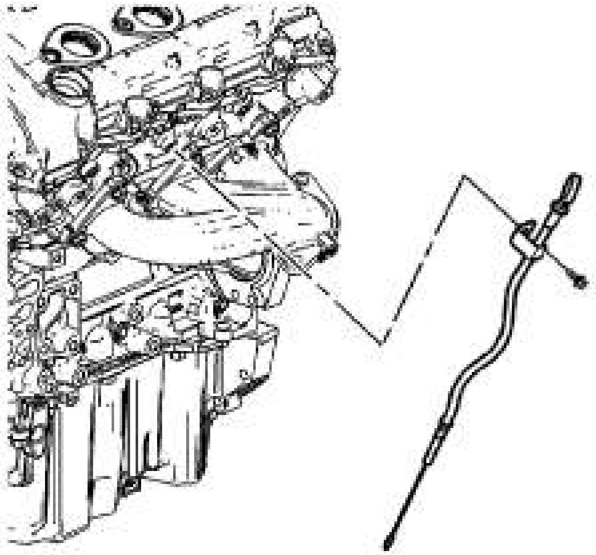
Oil Level Indicator Tube Replacement (LLT)

Removal Procedure



1. Remove the front compartment sight shield as necessary. Refer to Front Compartment Sight Shields Replacement .
2. Remove the oil level indicator from the oil level indicator tube.
3. Remove the oil level indicator tube bolt.
4. Remove the engine splash shield. Refer to Engine Splash Shield Replacement.
5. Lower the vehicle.
6. Remove the oil level indicator tube up through the exhaust manifold.
7. If you are replacing only the oil level indicator tube seal, remove and discard the old seal.

Installation Procedure



1. Install the oil level indicator and tube. Refer to Oil Level Indicator and Tube Installation.
2. Install the engine splash shield. Refer to Engine Splash Shield Replacement.
3. Lower the vehicle.
4. Install the front compartment sight shield as necessary. Refer to Front Compartment Sight Shields Replacement.

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Oil Pan Replacement (RHD)

Removal Procedure

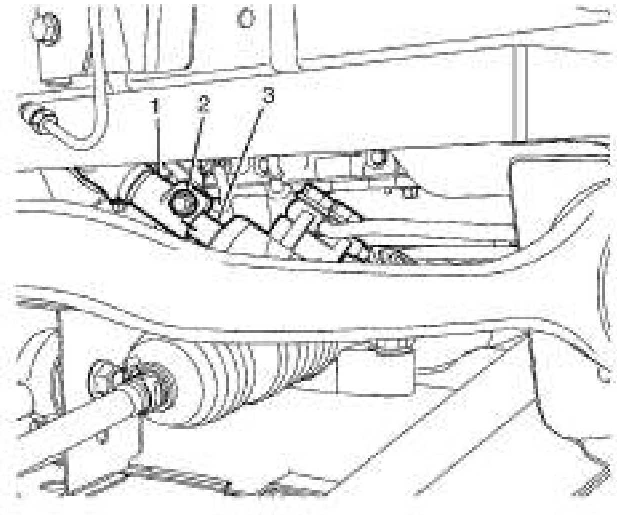
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
3. Drain the engine oil. Refer to Engine Oil and Oil Filter Replacement .
4. Remove the engine splash shield. Refer to Engine Splash Shield Replacement .
5. Remove the front air deflector. Refer to Front Air Deflector Replacement .



Important: Observing the orientation of the intermediate steering shaft (1) with reference to the pinion shaft (3) will minimise the potential of incorrect steering column assembly alignment.

Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

6. Mark the intermediate steering shaft (1) in relation to the pinion shaft (3) and discard.

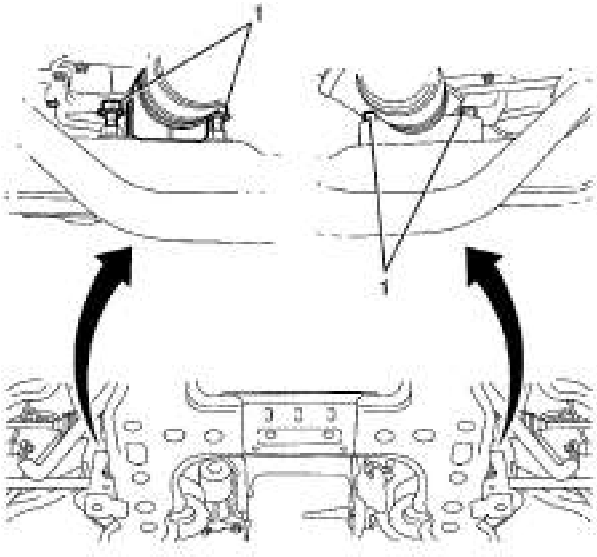
   Discard the bolt.

7. Remove the intermediate steering shaft to pinion shaft retaining bolt (2).

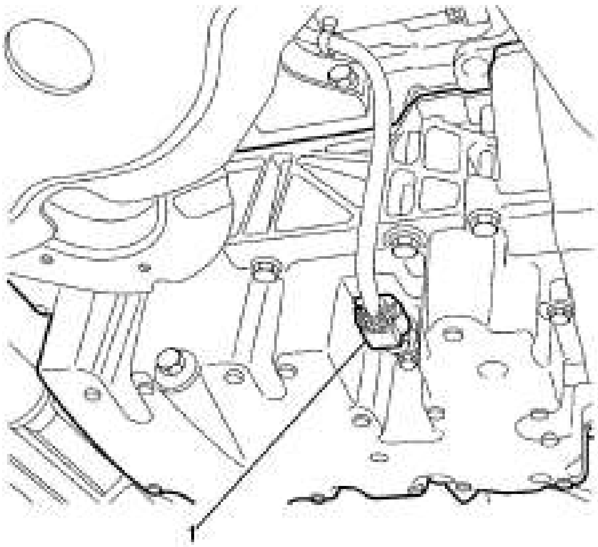
Important: Make sure the bolt hole is thoroughly cleaned and all micro-encapsulated thread sealant is removed.

8. Disconnect the intermediate shaft (2) from the pinion shaft (3).

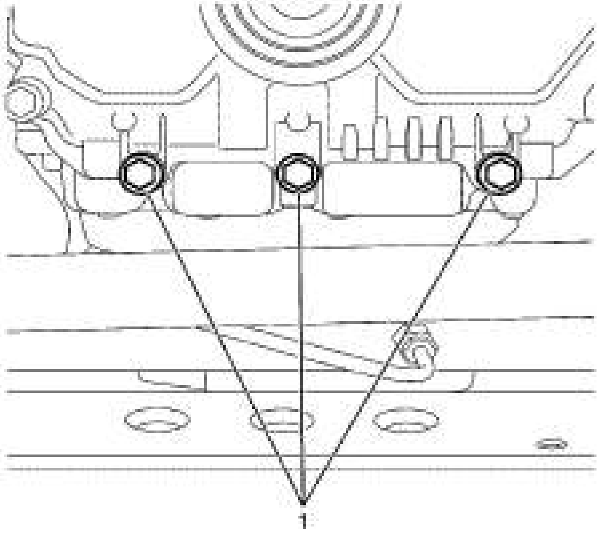
   Clean the bolt hole.



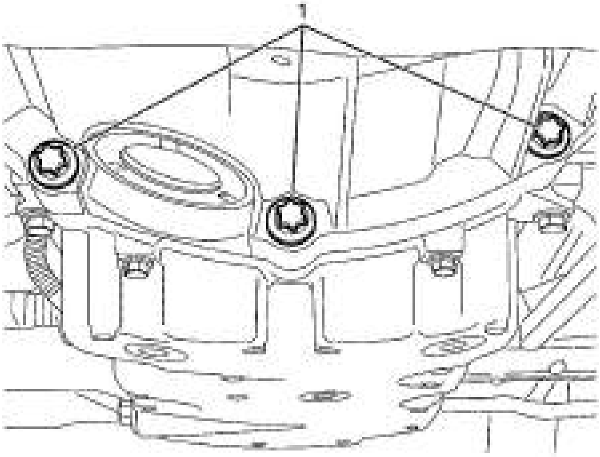
9. Remove the steering gear to subframe retaining bolts (1).
10. Slide the steering gear forward to gain full access to the sump.



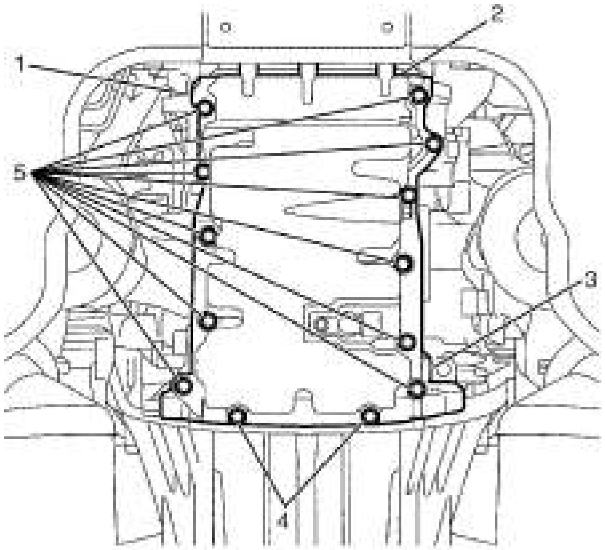
11. Disconnect the oil level/temperature sensor electrical connector (1).



12. Remove the front cover to oil pan retaining bolts (1).



13. Remove the transmission to oil pan retaining bolts (1).



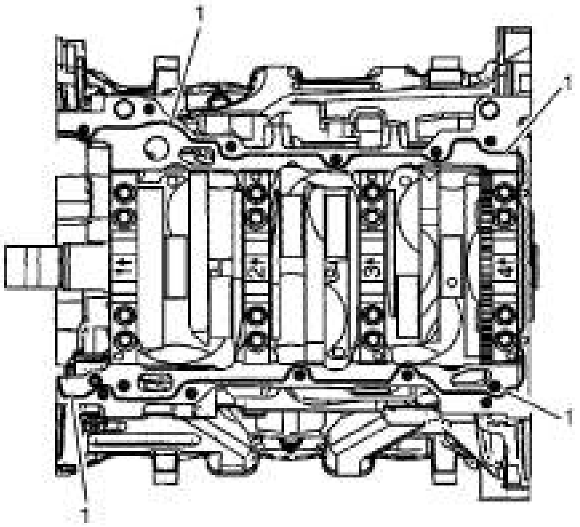
14. Remove the M6 rear oil pan to ccrankshaft rear oil seal housing retaining bolts (4).
15. Remove the M8 oil pan to cylinder block retaining bolts (5).

Important: Using the pry points (1 and 3) to shear the RTV sealant.

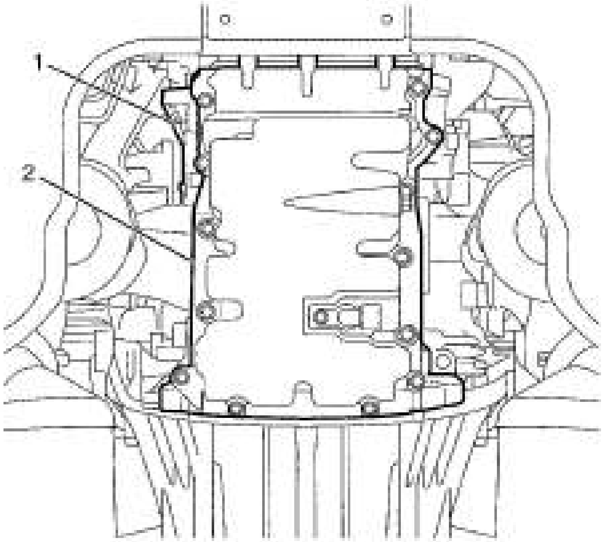
16. Remove the oil pan (2) from the cylinder block.
17. Perform the following steps as necessary.
    - Disassemble the oil pan. Refer to Oil Pan Disassemble .
    - Clean and inspect the oil pan. Refer to Oil Pan Cleaning and Inspection .

Installation Procedure

1. Assemble the oil pan as necessary. Refer to Oil Pan Assemble .

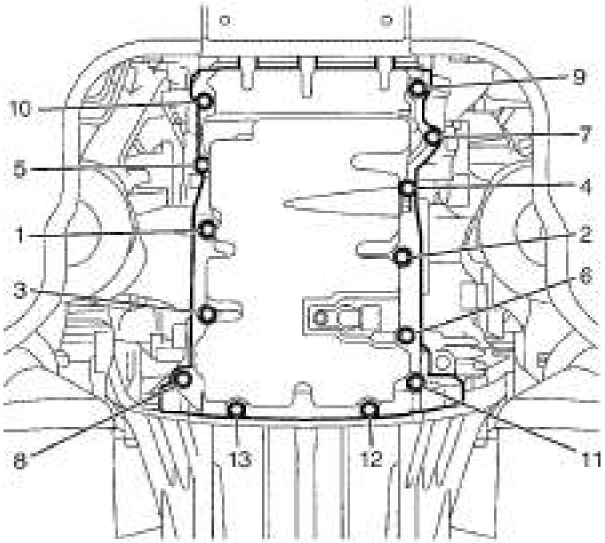


2. Place a three mm (0.118 in) bead of RTV sealant (1) on the block pan rail and the crankshaft rear oil seal housing.



3. Position the oil pan (1) onto the engine block (2).

Notice: Refer to Fastener Notice in the Preface section.

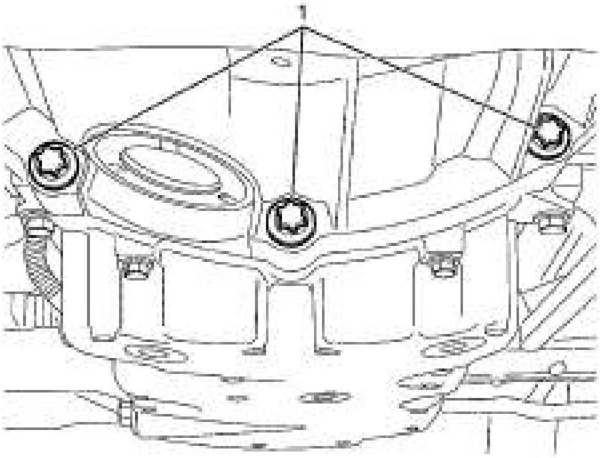


4. Install the M8 oil pan to cylinder block retaining bolts (1-11).
5. Install the M6 oil pan to crankshaft rear oil seal housing retaining bolts (12, 13).

Tighten
Tighten the M6 bolts (12, 13) to 10 N·m (89 lb in).

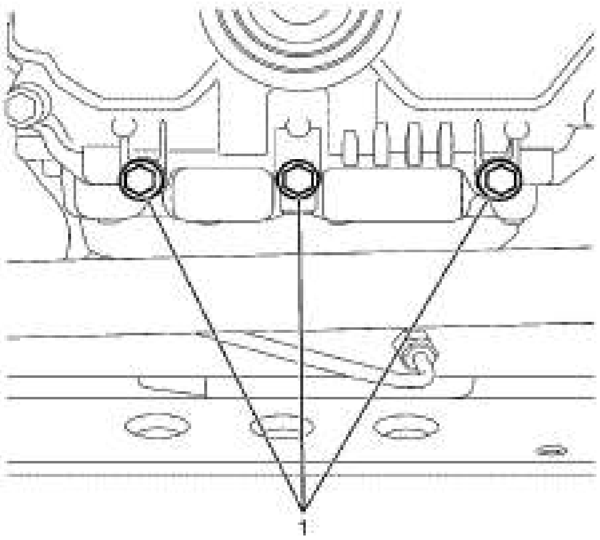
6. Tighten the M8 oil pan to cylinder block retaining bolts (1-11) and M6 oil pan to crankshaft rear oil seal housing retaining bolts (12, 13) in the sequence shown.

   Tighten
   Tighten the M8 bolts (1-11) to 23 N·m (17 lb ft).



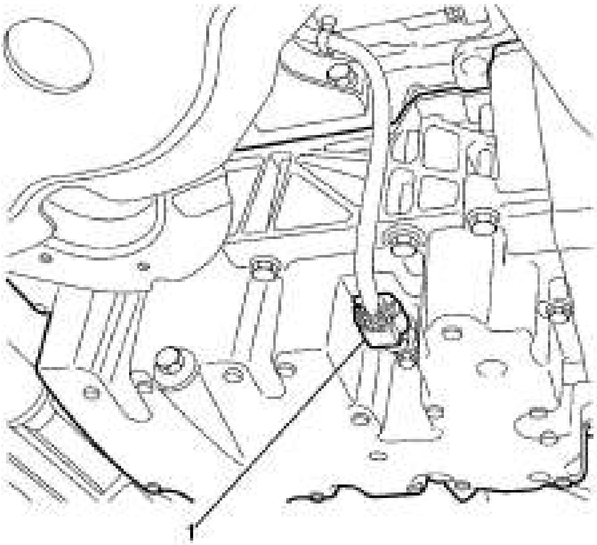
7. Install the transmission to oil pan retaining bolts (1).

   Tighten
   Tighten the bolts to 48 N·m (17 lb ft).

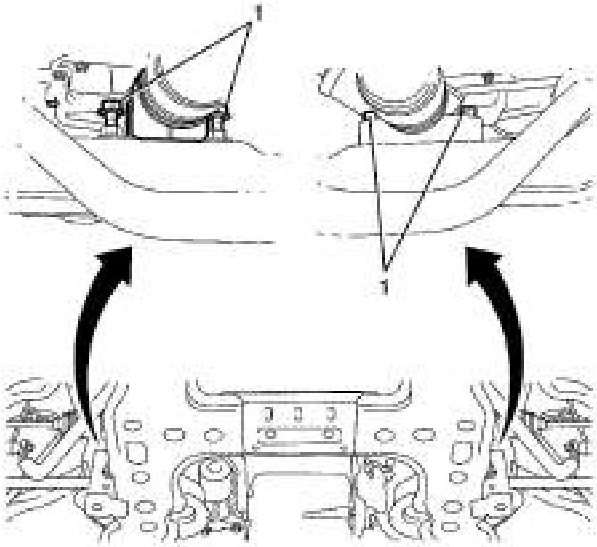


8. Install the front cover to oil pan retaining bolts (1).

   Tighten
   Tighten the bolts to 23 N·m (17 lb ft).

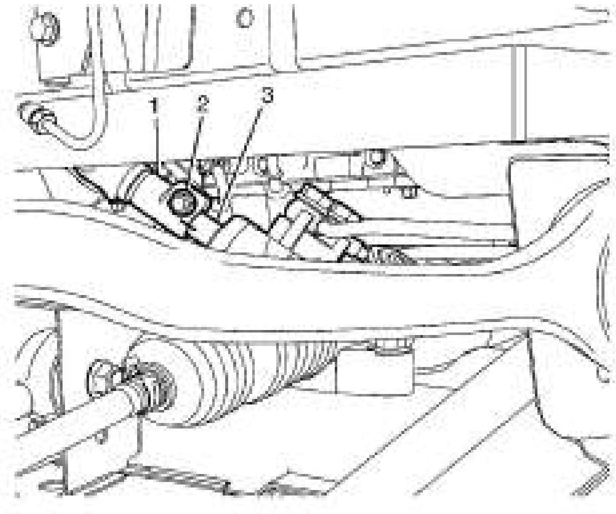


9. Connect the oil level/temperature sensor electrical connector (1) to the oil level/temperature sensor.
10. Position the steering gear in the correct location.



11. Install the steering gear to subframe retaining bolts (1).

Tighten
Tighten the Bolts to 65 N·m (48 lb ft).



Important: The intermediate steering shaft and pinion shaft splines must be installed in the position recorded during removal and aligned with the marks previously made.

12. Connect the intermediate steering shaft (1) to the pinion shaft (3).
13. Install the NEW intermediate steering shaft to pinion shaft retaining bolt (2).

    Tighten
    Tighten the bolt to 25 N·m (16 lb ft).

14. Install the engine splash shield. Refer to Engine Splash Shield Replacement .
15. Install the front air deflector. Refer to Front Air Deflector Replacement .
16. Lower the vehicle to the ground
17. Fill the engine with new engine oil. Refer to Engine Oil and Oil Filter Replacement .
18. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .

Oil Pump Replacement

Removal Procedure

1. Remove the engine covers. Refer to Engine Cover Replacement.
2. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to Spark Plug Replacement.
3. Remove the engine front cover. Refer to Engine Front Cover Replacement.

   Important: DO NOT remove the left bank idler sprocket.

4. Remove the primary timing chain. Refer to Primary Camshaft Intermediate Drive Chain Removal.
5. Remove the crankshaft sprocket. Refer to Crankshaft Sprocket Removal.
6. Remove the oil pump bolts and the oil pump. Refer to Oil Pump Removal.
7. Perform the following steps as necessary:
   - Disassemble the oil pump. Refer to Oil Pump Disassemble.
   - Clean and inspect the oil pump. Refer to Oil Pump Disassemble.

Installation Procedure

1. Assemble the oil pump as necessary. Refer to Oil Pump Assemble.
2. Install the oil pump. Refer to Oil Pump Installation.
3. Install the crankshaft sprocket. Refer to Crankshaft Sprocket Installation.
4. Install the primary timing chain. Refer to Primary Camshaft Intermediate Drive Chain Installation.
5. Install the spark plugs. Refer to Spark Plug Replacement.
6. Install the engine front cover. Refer to Engine Front Cover Replacement.
7. Install the engine covers. Refer to Engine Cover Replacement.

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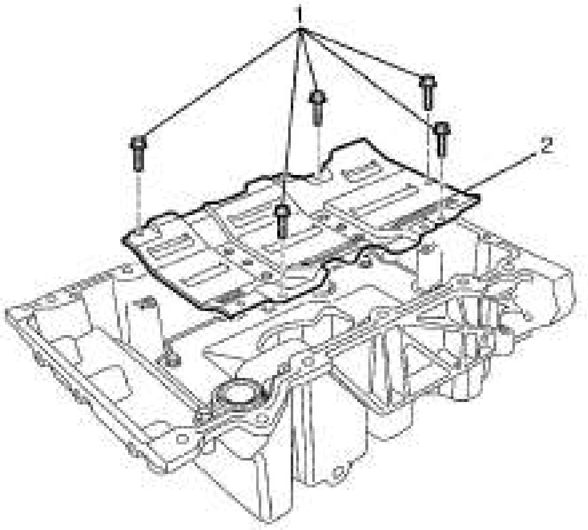
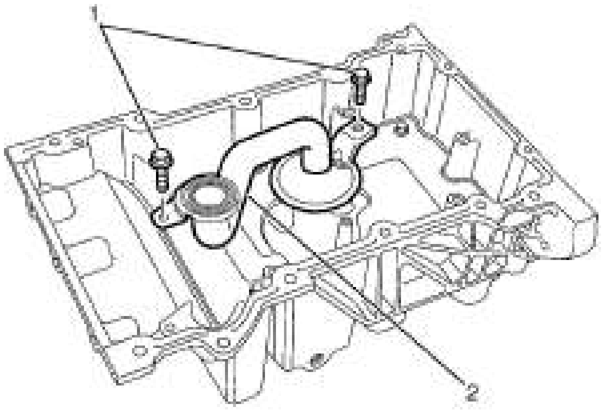
Oil Pump Suction Pipe and Screen Assembly Replacement

Removal Procedure

1. Remove the oil pan. Refer to Oil Pan Replacement.

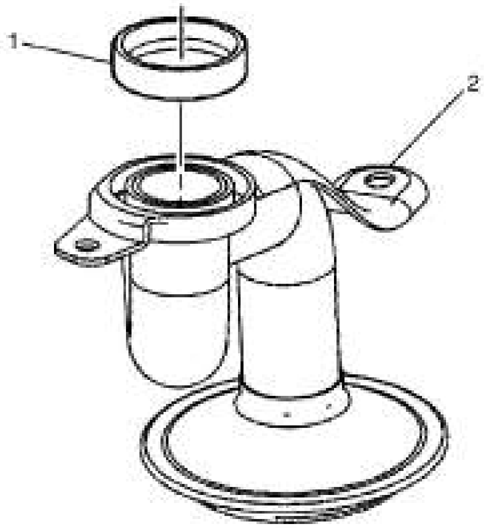


2. Remove the oil pan scraper bolts (1).
3. Remove the oil pan scraper (2).



4. Remove the oil suction pipe to oil pan retaining bolts (1).

5. Remove the oil suction pipe (2).

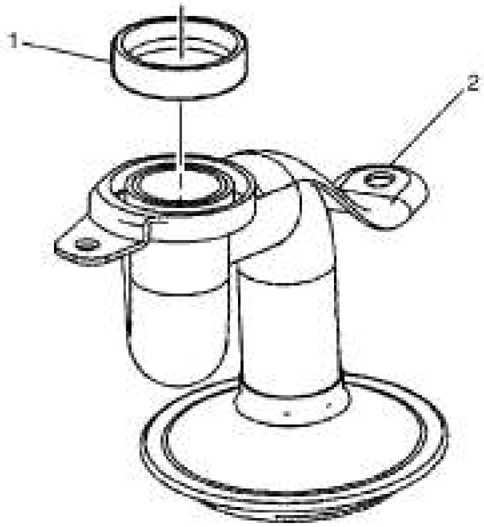


Important: The oil suction pipe seal (1) is a single use component and must be discarded whenever the oil suction pipe (2) is removed.

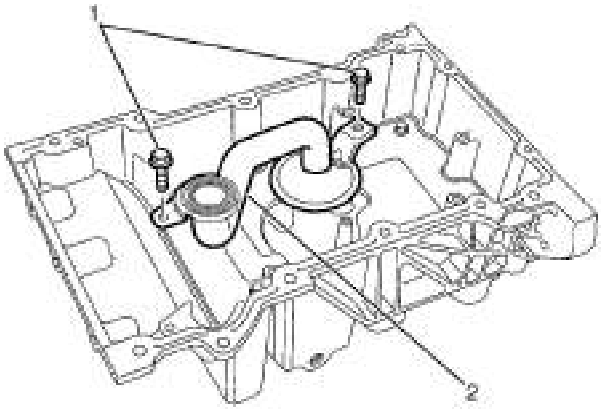
6. Remove the oil suction pipe seal (1) from the oil suction pipe (2).

   Discard the oil suction pipe seal (1).

Installation Procedure



1. Install a NEW oil suction pipe seal (1) onto the oil suction pipe (2).

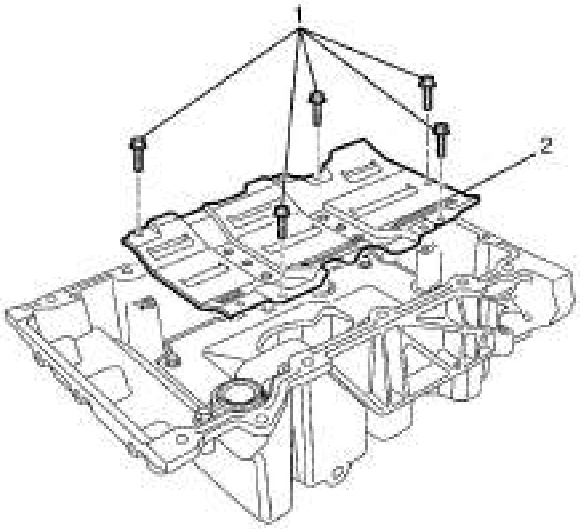


2. Install the oil suction pipe (2).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the oil suction pipe to oil pan retaining bolts (1).

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).



4. Install the oil pan scraper (2).
5. Install the oil pan scraper to oil pan retaining bolts (1).

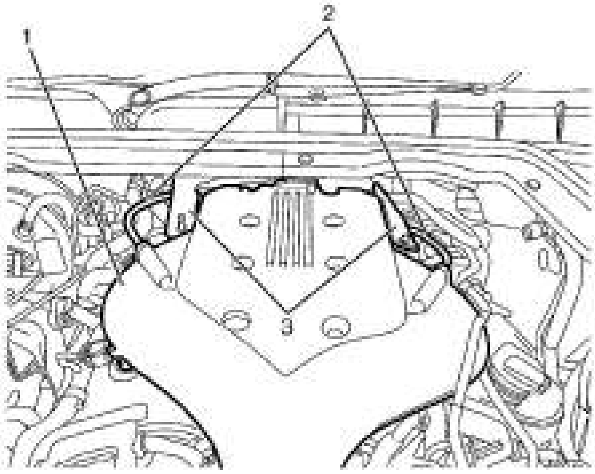
Tighten
Tighten the oil pan scraper bolts to 10 N·m (89 lb in).

6. Install the oil pan. Refer to Oil Pan Replacement.

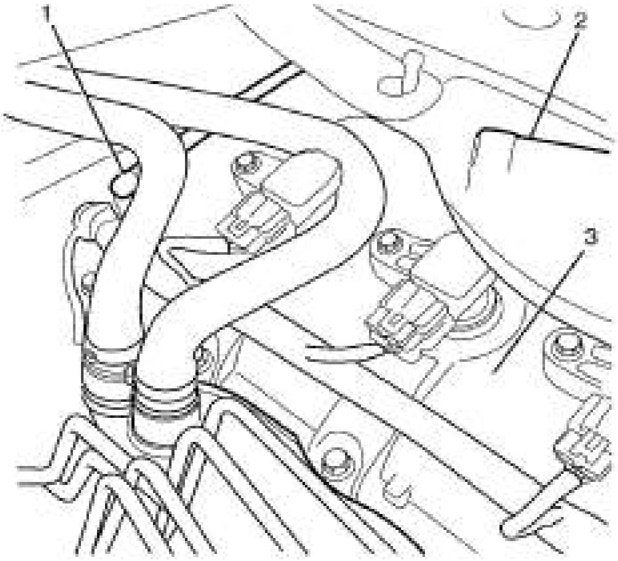
Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (RHD)

Removal Procedure

1. Remove the engine covers. Refer to Engine Cover Replacement.



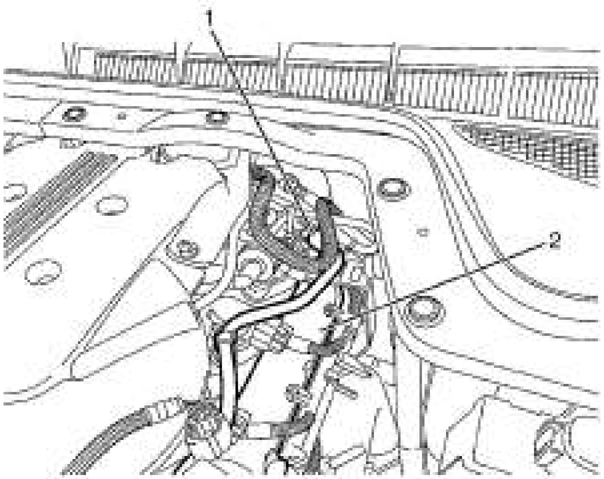
2. Detach and reposition the noise insulation panel (3) from the engine cover ball studs on the intake manifold assembly (1).
3. Disconnect the PCV tube (2) from both sides of the upper intake manifold assembly (1).



4. Disconnect the PCV tube (1) from the right camshaft cover (3).

   Important: Install a rubber cap or plug to the right hand camshaft cover (3) to prevent dust and dirt entry.

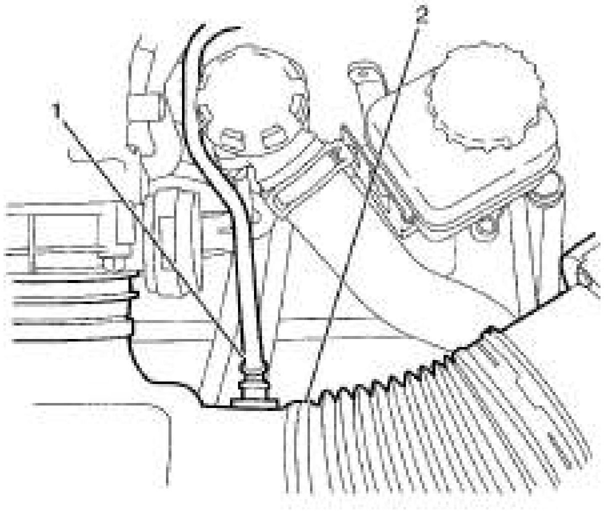
5. Plug the right hand camshaft cover (3).
6. Remove the PCV tube (1) from the intake manifold assembly (2).



7. Disconnect the PCV tube (1) from the left hand camshaft cover (2).

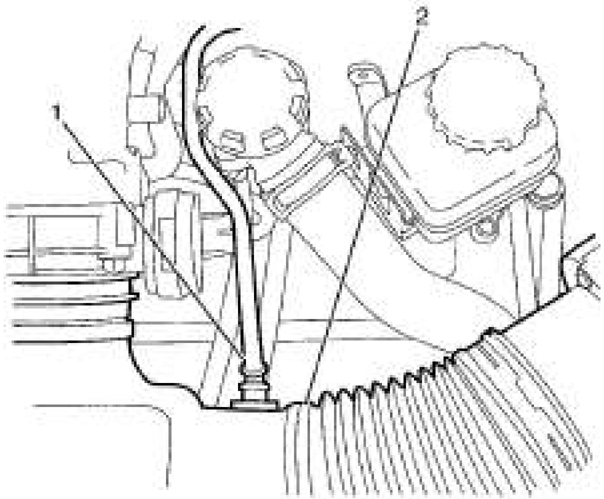
   Important: Install a rubber cap or plug to the left hand camshaft cover (2) to prevent dust and dirt entry.

8. Plug the left hand camshaft cover (2).

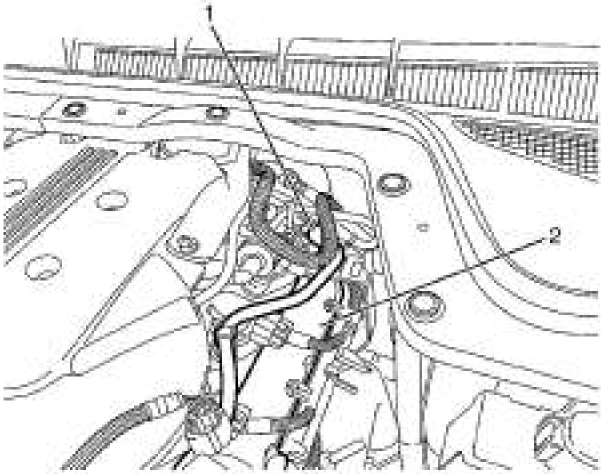


9. Disconnect the PCV tube (1) from the air intake assembly (2).

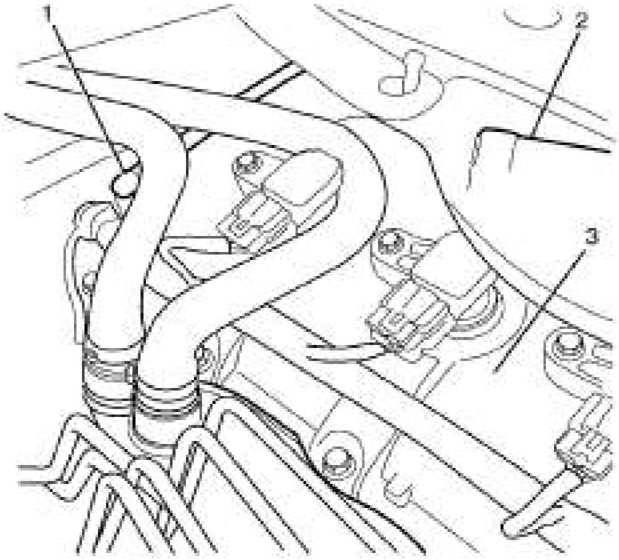
Installation Procedure



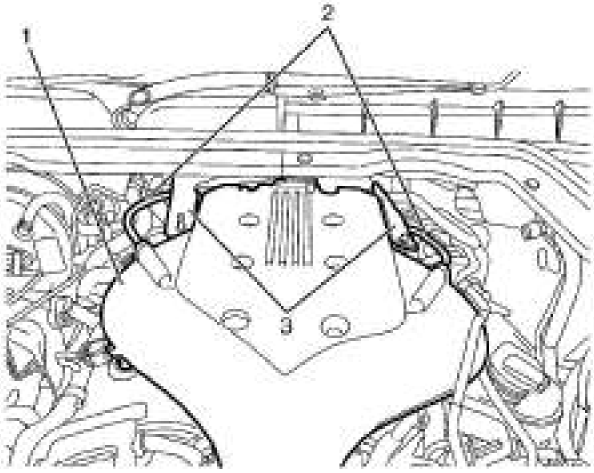
1. Connect the PCV tube (1) to the air intake assembly (2).



2. Remove the plug from the left hand camshaft cover (2).
3. Connect the PCV tube (1) to the left hand camshaft cover (2).



4. Install the PCV tube (1) to the intake manifold assembly (2).
5. Remove the plug from the right hand camshaft cover (3).
6. Connect the PCV tube (1) to the right camshaft cover (3).

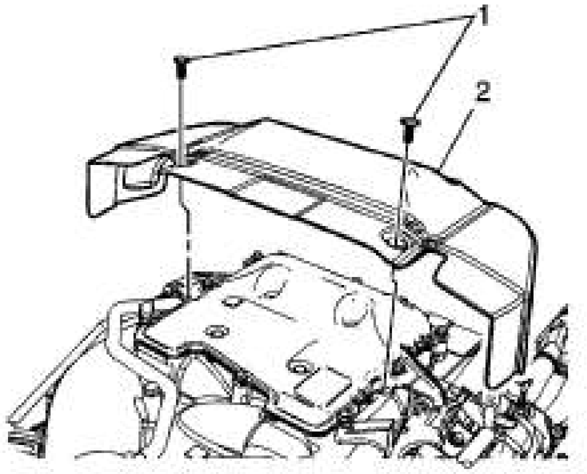


7. Connect the PCV tube (3) from both sides of the upper intake manifold assembly (2).
8. Attach the noise insulation panel (1) to the engine cover ball studs on the intake manifold assembly (2).
9. Install the engine covers. Refer to Engine Cover Replacement.

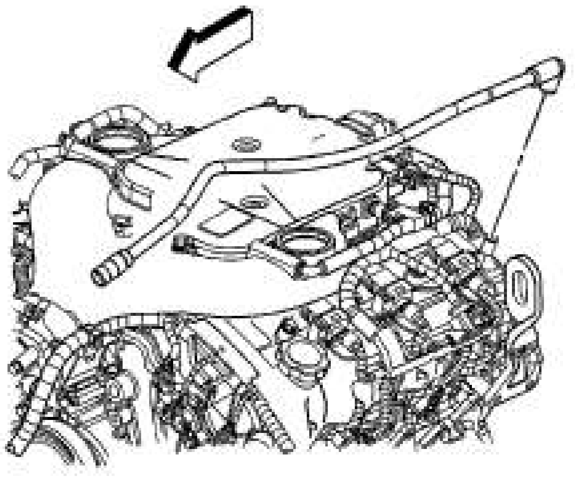
2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - On Vehicle | Document ID: 1977762

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LLT)

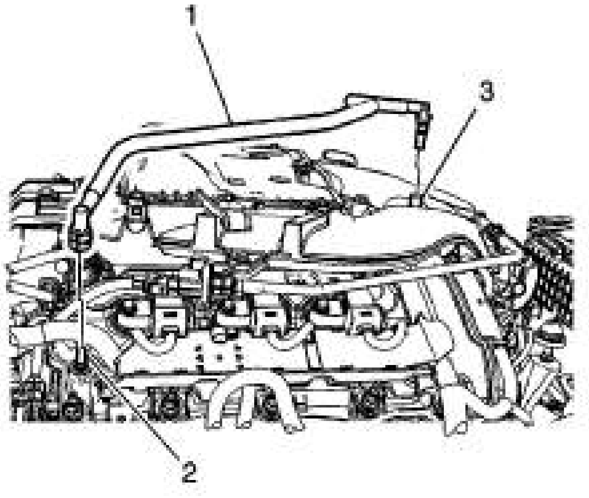
Removal Procedure



1. Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement .
2. Remove two intake manifold insulator retaining pins (1)
3. Remove the intake manifold insulator (2)

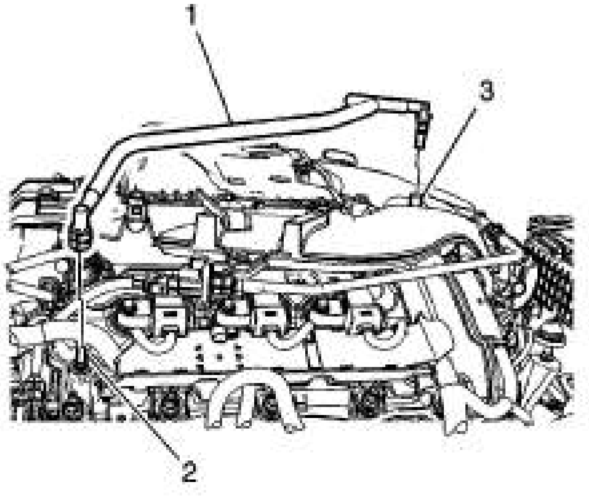


4. Remove the positive crankcase ventilation (PCV) fresh air tube from the left camshaft cover.
5. Remove the PCV fresh air tube from the air inlet.

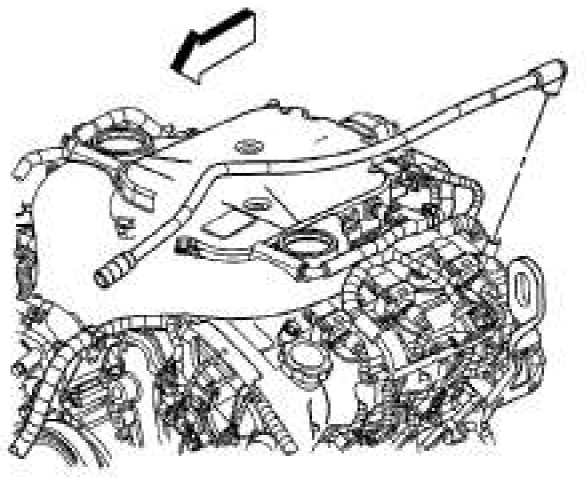


6. Remove the PCV dirty air tube (1) from the right camshaft cover (2).
7. Remove the PCV dirty air tube (1) from the intake manifold (3).

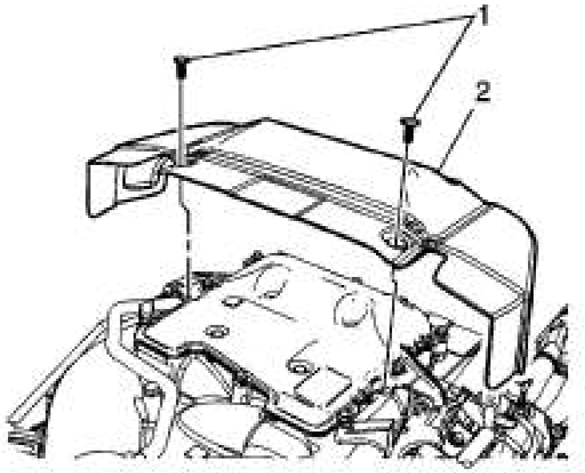
Installation Procedure



1. Install the PCV dirty air tube (1) to the intake manifold (3).
2. Install the PCV dirty air tube (1) to the right camshaft cover (2).



3. Install the PCV fresh air tube to the air inlet.
4. Install the PCV fresh air tube to the left camshaft cover.



5. Install the intake manifold insulator (2)
6. Install two intake manifold insulator retaining pins (1)
7. Install the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement .

Primary Camshaft Drive Chain Guide Replacement - Lower

The primary camshaft drive chain guide is not serviceable separately. If the guide is worn or damaged, the guide must be replaced with the oil pump.

Primary Camshaft Drive Chain Guide Replacement - Upper

Removal Procedure

1. Remove the engine covers. Refer to Engine Cover Replacement.
2. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to Spark Plug Replacement.
3. Remove the engine front cover. Refer to Engine Front Cover Replacement.
4. Remove the primary camshaft drive chain tensioner. Refer to Primary Camshaft Intermediate Drive Chain Tensioner Removal.
5. Remove the primary upper camshaft drive chain guide. Refer to Primary Timing Chain Guide Removal - Upper.

Installation Procedure

1. Install the primary upper camshaft drive chain guide. Refer to Primary Timing Chain Guide Installation - Upper.
2. Install the primary camshaft drive chain tensioner. Refer to Primary Camshaft Intermediate Drive Chain Tensioner Removal.
3. Install the spark plugs. Refer to Spark Plug Replacement.
4. Install the engine front cover. Refer to Engine Front Cover Replacement.
5. Install the engine covers. Refer to Engine Cover Replacement.

Primary Camshaft Drive Chain Tensioner Replacement

Removal Procedure

1. Remove the engine covers. Refer to Engine Cover Replacement.
2. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to Spark Plug Replacement.
3. Remove the engine front cover. Refer to Engine Front Cover Replacement.

Important: If the entire camshaft timing system is not in Stage 2, refer to Camshaft Timing Drive Chain Alignment Diagram, mark the timing chain and sprockets in order to ensure correct reassembly.

4. Remove the primary camshaft drive chain tensioner. Refer to Primary Camshaft Intermediate Drive Chain Tensioner Removal.

Installation Procedure

1. Install the primary camshaft drive chain tensioner. Refer to Primary Camshaft Intermediate Drive Chain Tensioner Removal.
2. Install the spark plugs. Refer to Spark Plug Replacement.
3. Install the engine front cover. Refer to Engine Front Cover Replacement.
4. Install the engine covers. Refer to Engine Cover Replacement.

Secondary Camshaft Drive Chain Guide Replacement - Left Side

Removal Procedure

1. Remove the engine covers. Refer to Engine Cover Replacement.
2. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to Spark Plug Replacement.
3. Remove the engine front cover. Refer to Engine Front Cover Replacement.
4. Remove the left bank secondary camshaft drive chain tensioner. Refer to Secondary Camshaft Drive Chain Tensioner Removal - Left Side.
5. Remove the left bank secondary camshaft drive chain guide. Refer to Secondary Camshaft Drive Chain Guide Removal - Left Side.

Installation Procedure

1. Install the left bank secondary camshaft drive chain guide. Refer to Secondary Camshaft Drive Chain Guide Installation - Left Side.
2. Install the left bank secondary camshaft drive chain tensioner. Refer to Secondary Camshaft Drive Chain Tensioner Installation - Left Side.
3. Install the spark plugs. Refer to Spark Plug Replacement.
4. Install the engine front cover. Refer to Engine Front Cover Replacement.
5. Install the engine covers. Refer to Engine Cover Replacement.

Secondary Camshaft Drive Chain Guide Replacement - Right Side

Removal Procedure

1. Remove the engine covers. Refer to Engine Cover Replacement.
2. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to Spark Plug Replacement.
3. Remove the engine front cover. Refer to Engine Front Cover Replacement.
4. Remove the right bank secondary camshaft drive chain tensioner. Refer to Secondary Camshaft Drive Chain Tensioner Removal - Right Side.
5. Remove the right bank secondary camshaft drive chain guide. Refer to Secondary Camshaft Drive Chain Guide Removal - Right Side.

Installation Procedure

1. Install the right bank secondary camshaft drive chain guide. Refer to Secondary Camshaft Drive Chain Guide Installation - Right Side.
2. Install the right bank secondary camshaft drive chain tensioner. Refer to Secondary Camshaft Drive Chain Tensioner Removal - Right Side.
3. Install the spark plugs. Refer to Spark Plug Replacement.
4. Install the engine front cover. Refer to Engine Front Cover Replacement.
5. Install the engine covers. Refer to Engine Cover Replacement.

Secondary Camshaft Drive Chain Replacement - Left Side

Removal Procedure

1. Remove the engine covers. Refer to Engine Cover Replacement.
2. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to Spark Plug Replacement.
3. Remove the engine front cover. Refer to Engine Front Cover Replacement.
4. Remove the right bank secondary camshaft drive chain tensioner. Refer to Secondary Camshaft Drive Chain Tensioner Removal - Right Side.
5. Remove the right bank secondary camshaft drive chain shoe. Refer to Secondary Camshaft Drive Chain Shoe Removal - Right Side.
6. Remove the right bank secondary camshaft drive chain guide. Refer to Secondary Camshaft Drive Chain Guide Removal - Right Side.
7. Remove the right bank secondary camshaft drive chain. Refer to Secondary Camshaft Drive Chain Removal - Right Side.
8. Remove the primary camshaft drive chain tensioner. Refer to Primary Camshaft Intermediate Drive Chain Tensioner Removal.
9. Remove the primary upper camshaft drive chain guide. Refer to Primary Timing Chain Guide Removal - Upper.
10. Remove the primary camshaft drive chain. Refer to Primary Camshaft Intermediate Drive Chain Removal.
11. Remove the right bank camshaft intermediate drive chain idler. Refer to Camshaft Intermediate Drive Chain Idler Removal - Right Side.
12. Remove the left bank secondary camshaft drive chain tensioner. Refer to Secondary Camshaft Drive Chain Tensioner Removal - Left Side.
13. Remove the left bank secondary camshaft drive chain shoe. Refer to Secondary Camshaft Drive Chain Shoe Removal - Left Side.
14. Remove the left bank secondary camshaft drive chain guide. Refer to Secondary Camshaft Drive Chain Guide Removal - Left Side.
15. Remove the left bank camshaft intermediate drive chain idler. Refer to Camshaft Intermediate Drive Chain Idler Removal - Left Side.
16. Remove the left bank secondary camshaft drive chain. Refer to Secondary Camshaft Drive Chain Removal - Left Side.
17. Clean and inspect all of the camshaft timing drive components. Refer to Camshaft Timing Drive Components Cleaning and Inspection.

Installation Procedure

1. Install the left bank secondary camshaft drive chain. Refer to Secondary Camshaft Drive Chain Installation - Left Side.
2. Install the left bank camshaft intermediate drive chain idler. Refer to Camshaft Intermediate Drive Chain Idler Installation - Left Side.
3. Install the left bank secondary camshaft drive chain guide. Refer to Secondary Camshaft Drive Chain Guide Installation - Left Side.
4. Install the left bank secondary camshaft drive chain shoe. Refer to Secondary Camshaft Drive Chain Shoe Installation - Left Side.
5. Install the left bank secondary camshaft drive chain tensioner. Refer to Secondary Camshaft Drive Chain Tensioner Installation - Left Side.
6. Install the right bank camshaft intermediate drive chain idler. Refer to Camshaft

Intermediate Drive Chain Idler Installation - Right Side.

7. Install the primary camshaft drive chain. Refer to Primary Camshaft Intermediate Drive Chain Installation.
8. Install the primary upper camshaft drive chain guide. Refer to Primary Timing Chain Guide Installation - Upper.
9. Install the primary camshaft drive chain tensioner. Refer to Primary Camshaft Intermediate Drive Chain Tensioner Removal.
10. Install the right bank secondary camshaft drive chain. Refer to Secondary Camshaft Drive Chain Installation - Right Side.
11. Install the right bank secondary camshaft drive chain guide. Refer to Secondary Camshaft Drive Chain Guide Installation - Right Side.
12. Install the right bank secondary camshaft drive chain shoe. Refer to Secondary Camshaft Drive Chain Shoe Installation - Right Side.
13. Install the right bank secondary camshaft drive chain tensioner. Refer to Secondary Camshaft Drive Chain Shoe Installation - Right Side.
14. Install the spark plugs. Refer to Spark Plug Replacement.
15. Install the engine front cover. Refer to Engine Front Cover Replacement.
16. Install the engine covers. Refer to Engine Cover Replacement.

Secondary Camshaft Drive Chain Replacement - Right Side

Removal Procedure

1. Remove the engine covers. Refer to Engine Cover Replacement.
2. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to Spark Plug Replacement.
3. Remove the engine front cover. Refer to Engine Front Cover Replacement.
4. Remove the right bank secondary camshaft drive chain tensioner. Refer to Secondary Camshaft Drive Chain Tensioner Removal - Right Side.
5. Remove the right bank secondary camshaft drive chain shoe. Refer to Secondary Camshaft Drive Chain Shoe Removal - Right Side.
6. Remove the right bank secondary camshaft drive chain guide. Refer to Secondary Camshaft Drive Chain Guide Removal - Right Side.
7. Remove the right bank secondary camshaft drive chain. Refer to Secondary Camshaft Drive Chain Removal - Right Side.

Installation Procedure

1. Install the right bank secondary camshaft drive chain. Refer to Secondary Camshaft Drive Chain Installation - Right Side.
2. Install the right bank secondary camshaft drive chain guide. Refer to Secondary Camshaft Drive Chain Guide Installation - Right Side.
3. Install the right bank secondary camshaft drive chain shoe. Refer to Secondary Camshaft Drive Chain Shoe Installation - Right Side.
4. Install the right bank secondary camshaft drive chain tensioner. Refer to Secondary Camshaft Drive Chain Shoe Installation - Right Side.
5. Install the spark plugs. Refer to Spark Plug Replacement.
6. Install the engine front cover. Refer to Engine Front Cover Replacement.
7. Install the engine covers. Refer to Engine Cover Replacement.

Secondary Camshaft Drive Chain Shoe Replacement - Left Side

Removal Procedure

1. Remove the engine covers. Refer to Engine Cover Replacement.
2. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to Spark Plug Replacement.
3. Remove the engine front cover. Refer to Engine Front Cover Replacement.
4. Remove the left bank secondary camshaft drive chain shoe. Refer to Secondary Camshaft Drive Chain Shoe Removal - Left Side.

Installation Procedure

1. Install the left bank secondary camshaft drive chain shoe. Refer to Secondary Camshaft Drive Chain Shoe Installation - Left Side.
2. Install the spark plugs. Refer to Spark Plug Replacement.
3. Install the engine front cover. Refer to Engine Front Cover Replacement.
4. Install the engine covers. Refer to Engine Cover Replacement.

Secondary Camshaft Drive Chain Shoe Replacement - Right Side

Removal Procedure

1. Remove the engine covers. Refer to Engine Cover Replacement.
2. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to Spark Plug Replacement.
3. Remove the engine front cover. Refer to Engine Front Cover Replacement.
4. Remove the right bank secondary camshaft drive chain tensioner. Refer to Secondary Camshaft Drive Chain Tensioner Removal - Right Side.
5. Remove the right bank secondary camshaft drive chain shoe. Refer to Secondary Camshaft Drive Chain Shoe Removal - Right Side.

Installation Procedure

1. Install the right bank secondary camshaft drive chain shoe. Refer to Secondary Camshaft Drive Chain Shoe Installation - Right Side.
2. Install the right bank secondary camshaft drive chain tensioner. Refer to Secondary Camshaft Drive Chain Tensioner Removal - Right Side.
3. Install the spark plugs. Refer to Spark Plug Replacement.
4. Install the engine front cover. Refer to Engine Front Cover Replacement.
5. Install the engine covers. Refer to Engine Cover Replacement.

Secondary Camshaft Drive Chain Tensioner Replacement - Left Side

Removal Procedure

1. Remove the engine covers. Refer to Engine Cover Replacement.
2. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to Spark Plug Replacement.
3. Remove the engine front cover. Refer to Engine Front Cover Replacement.
4. Remove the left bank secondary camshaft drive chain tensioner. Refer to Secondary Camshaft Drive Chain Tensioner Removal - Left Side.

Installation Procedure

1. Install the left bank secondary camshaft drive chain tensioner. Refer to Secondary Camshaft Drive Chain Tensioner Installation - Left Side.
2. Install the spark plugs. Refer to Spark Plug Replacement.
3. Install the engine front cover. Refer to Engine Front Cover Replacement.
4. Install the engine covers. Refer to Engine Cover Replacement.

Secondary Camshaft Drive Chain Tensioner Replacement - Right Side

Removal Procedure

1. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to Spark Plug Replacement.
2. Remove the engine front cover. Refer to Engine Front Cover Replacement.
3. Remove the right bank secondary camshaft drive chain tensioner. Refer to Secondary Camshaft Drive Chain Tensioner Removal - Right Side.

Installation Procedure

1. Install the right bank secondary camshaft drive chain tensioner. Refer to Secondary Camshaft Drive Chain Shoe Installation - Right Side.
2. Install the spark plugs. Refer to Spark Plug Replacement.
3. Install the engine front cover. Refer to Engine Front Cover Replacement.
4. Install the engine covers. Refer to Engine Cover Replacement.

Setting Camshaft Timing

Important: Setting the camshaft timing is necessary whenever the camshaft drive system has been disturbed such that the relationship between any chain and sprocket has been lost. Even when only one sprocket is involved, multiple crankshaft rotations will not produce conditions where correct timing can be confirmed.

If necessary, follow the left bank secondary camshaft drive chain replacement procedures to reset the camshaft timing. Refer to Secondary Camshaft Drive Chain Replacement - Left Side .

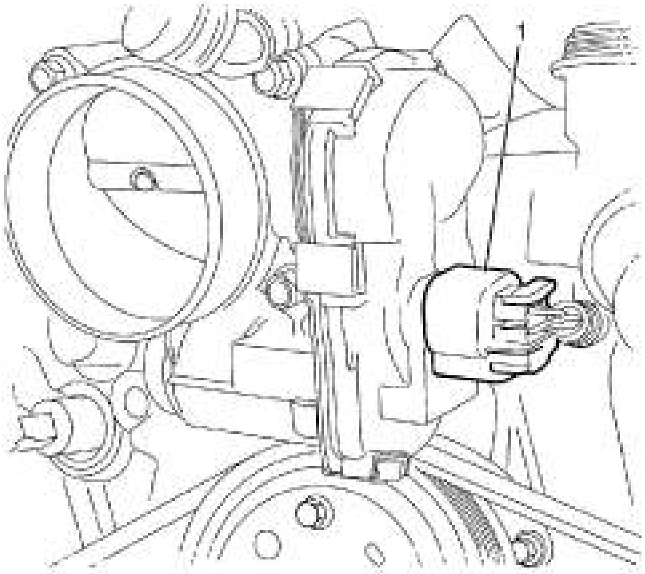
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - On Vehicle | **Document ID: 1995097**

Upper Intake Manifold Replacement

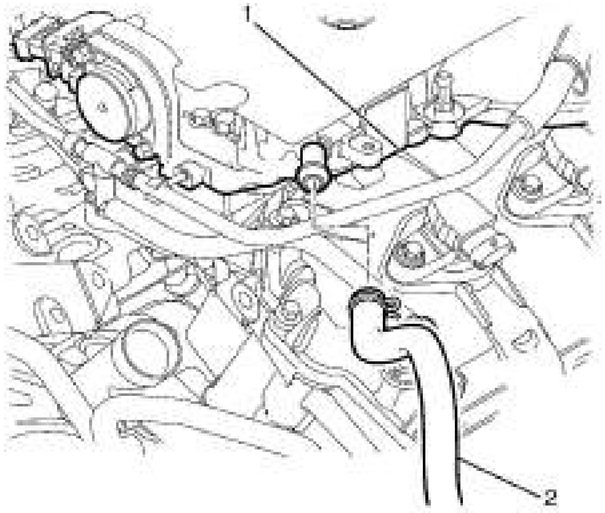
Removal Procedure

> **Caution:** Refer to Battery Disconnect Caution in the Preface section.

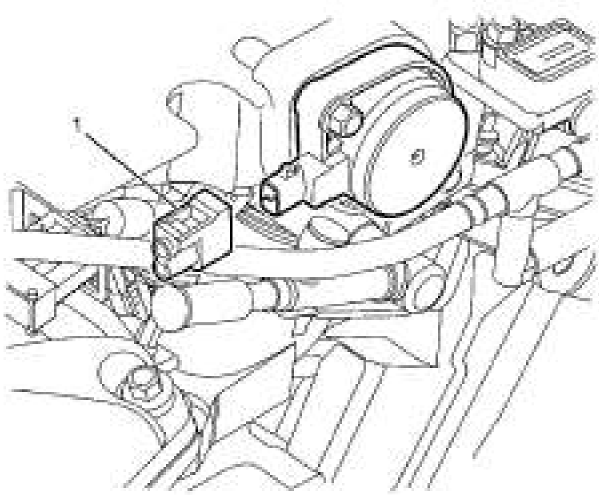
1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
2. Remove the engine covers. Refer to Engine Cover Replacement .
3. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement .



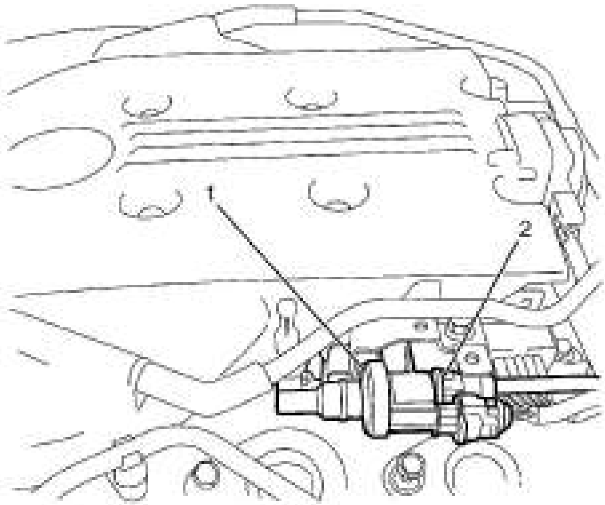
4. Disconnect the throttle body electrical connector (1).



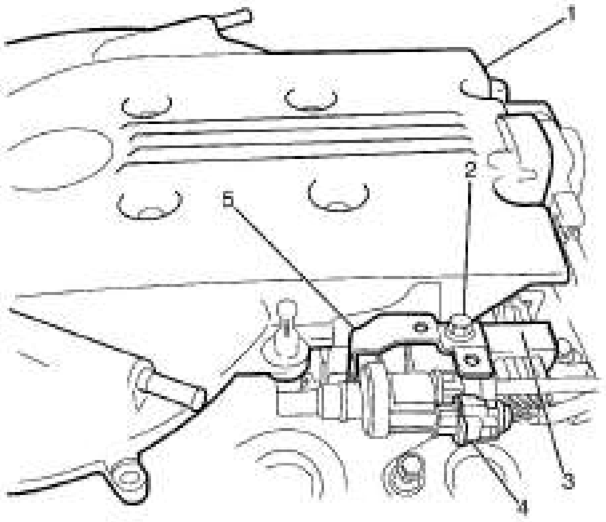
5. Disconnect the brake booster vacuum hose (2) from the intake manifold (1).



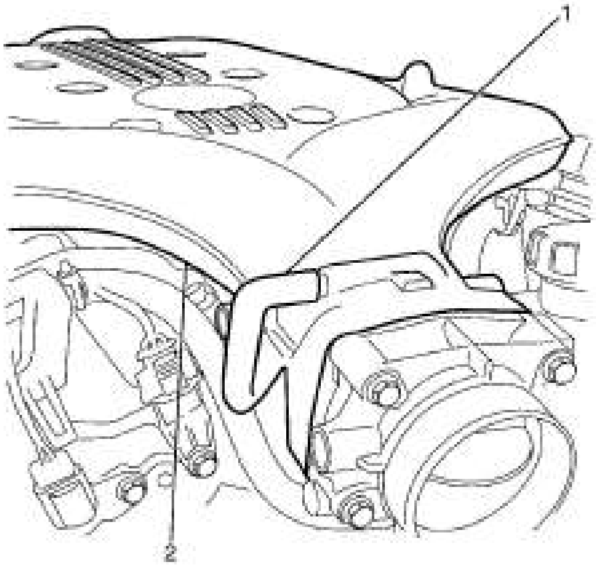
6. Disconnect the Inlet Manifold Runner Control (IMRC) electrical connector (1).



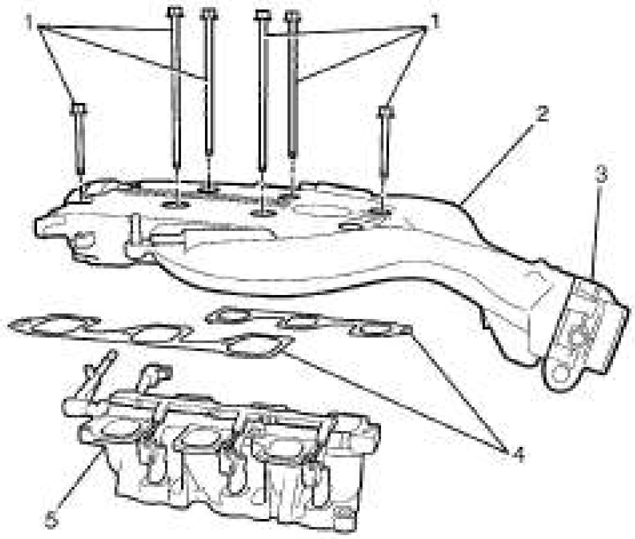
7. Disconnect the evaporative emission (EVAP) purge line (1) from the purge solenoid (2). Refer to Metal Collar Quick Connect Fitting Service or Plastic Collar Quick Connect Fitting Service .
8. Plug or cap the (EVAP) purge line (1) and the purge solenoid (2) ends.
9. Remove the PCV tube and PCV fresh air tubes. Refer to Positive Crankcase Ventilation Hose/Pipe/Tube Replacement .



10. Disconnect the EVAP valve electrical connector (4)
11. Disconnect the fuel injector harness electrical connector (3)
12. Remove the fuel injector harness electrical connector/EVAP valve mounting bracket to intake manifold retaining bolt (2).
13. Reposition the fuel injector harness electrical connector/EVAP valve mounting bracket (5) away from the intake manifold (1).



14. Disconnect the EVAP hose (1) from the intake manifold (2).



15. Remove the upper intake manifold bolts (1).
16. Remove the upper intake manifold (2) and the throttle body (3) as an assembly.

    Important: The upper intake manifold gaskets (4) must be discarded after removal.

17. Remove the upper intake manifold gaskets (4).

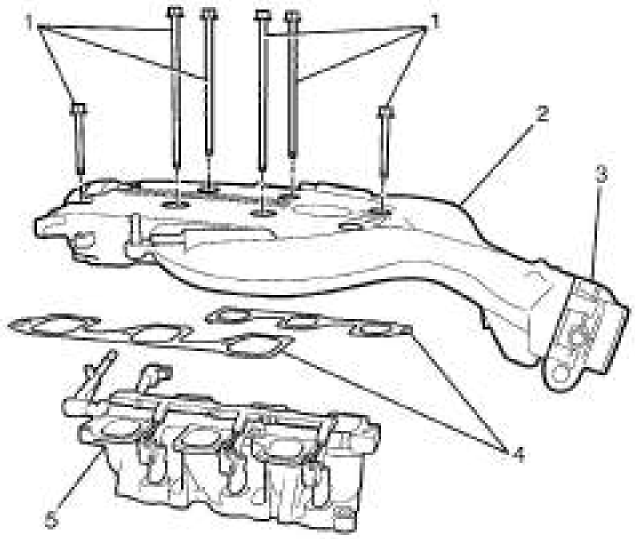
    Discard the gaskets

    Important: The lower intake manifold (5) must be plugged with a clean lint free cloth to prevent foreign matter entry into the engine.

18. Plug the lower intake manifold (5) with a clean lint free cloth.
19. If the upper intake manifold is being replaced, disassemble the intake manifold. Refer to Intake Manifold Disassemble .
20. Clean and inspect the intake manifold. Refer to Intake Manifold Cleaning and Inspection .

Installation Procedure

1. If the upper intake manifold is being replaced, assemble the intake manifold. Refer to Intake Manifold Assemble .



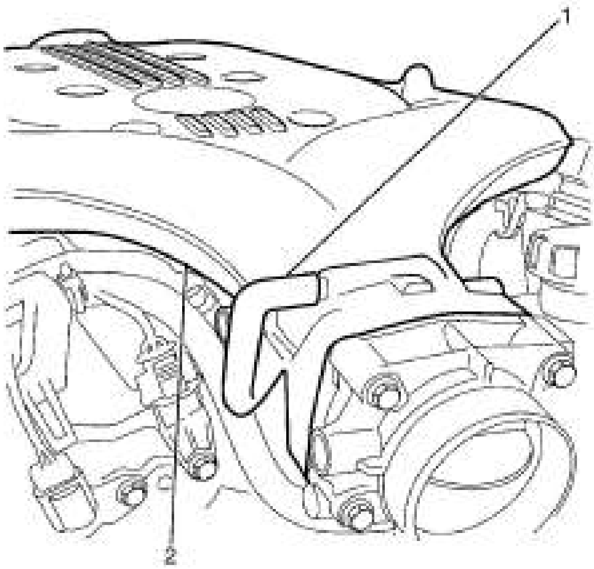
2. Remove the clean lint free cloth from the lower intake manifold (5)
3. Install NEW upper intake manifold gaskets (4).
4. Install the upper intake manifold (2) and the throttle body (3) as an assembly.

   Notice: Refer to Fastener Notice in the Preface section.

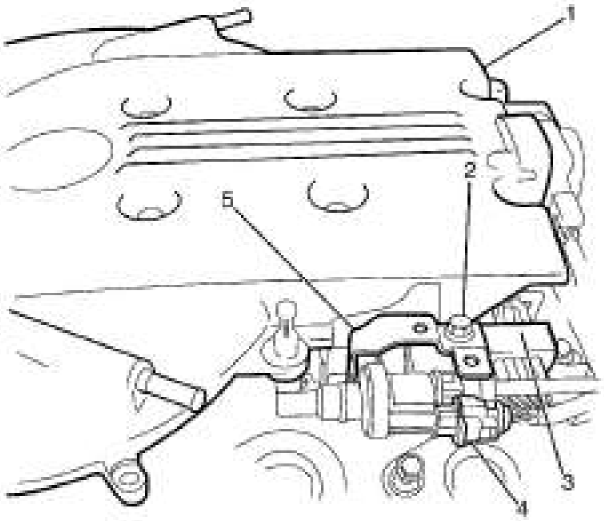
   Important: Tighten the intake manifold bolts (1) in a circular pattern starting at the center (long bolts) and moving outward.

5. Install the upper intake manifold bolts (1).

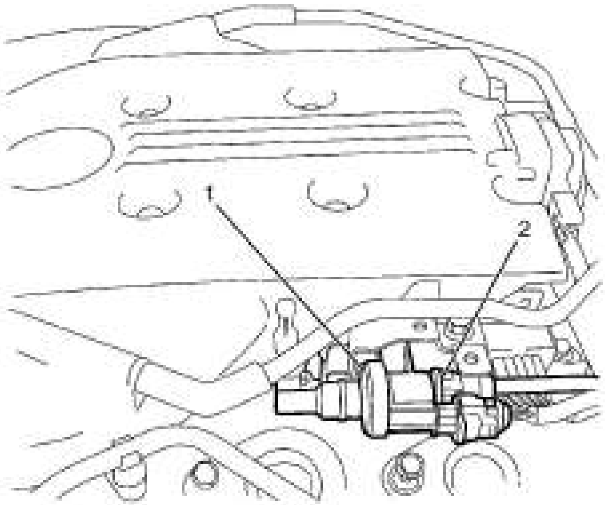
   Tighten
   Tighten the upper intake manifold bolts to 23 N·m (17 lb ft).



6. Connect the EVAP line (1) to the intake manifold (2).

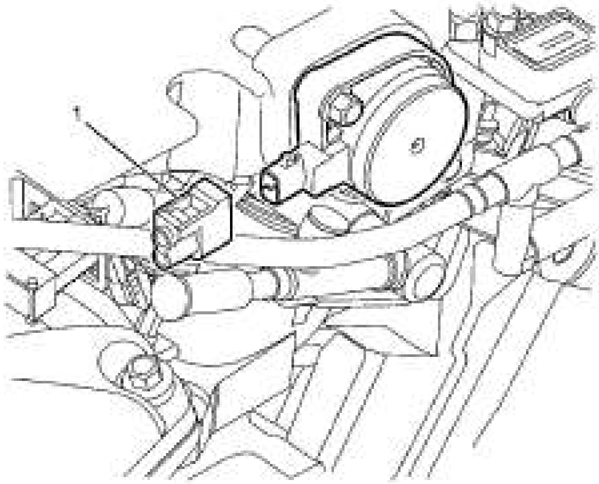


7. Install the fuel injector harness electrical connector/EVAP valve mounting bracket (5) to the intake manifold (1).
8. Install the fuel injector harness electrical connector/EVAP valve mounting bracket to intake manifold retaining bolt (2).
9. Connect the fuel injector harness electrical connector (3)
10. Connect the EVAP valve electrical connector (4)
11. Install the PCV tube and PCV fresh air tubes. Refer to Positive Crankcase Ventilation Hose/Pipe/Tube Replacement .

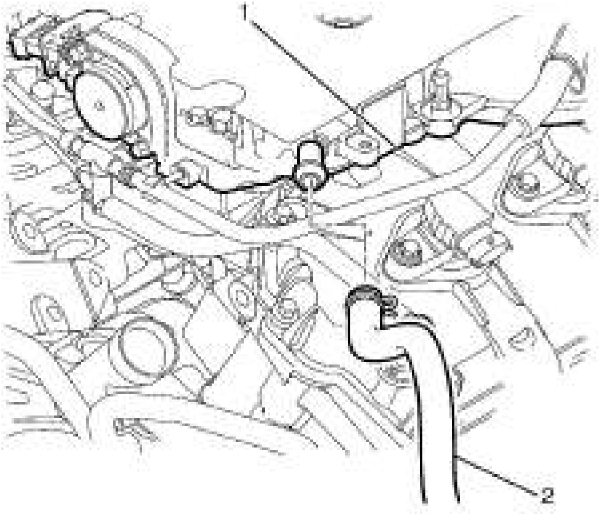


12. Remove the plug or cap from the (EVAP) purge line (1) and the purge solenoid (2) ends.
13. Connect the evaporative emission (EVAP) purge line (1) from the purge solenoid (2). Refer to

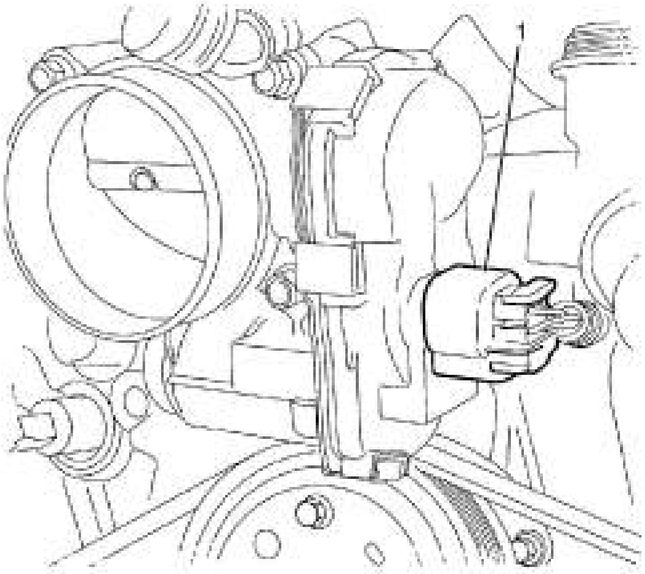
Metal Collar Quick Connect Fitting Service or Plastic Collar Quick Connect Fitting Service .



14. Connect the Inlet Manifold Runner Control (IMRC) electrical connector (1).



15. Connect the brake booster vacuum hose (2) to the intake manifold (1).



16. Connect the throttle body electrical connector (1).
17. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacement .
18. Install the engine covers. Refer to Engine Cover Replacement .
19. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .

Valve Lifter Replacement - Left Side

Removal Procedure

1. Remove the applicable camshaft(s). Camshaft Replacement - Left Side.
2. Remove the rocker arms. Refer to Valve Rocker Arm Removal - Left Side.
3. Remove the lifters. Refer to Valve Lifter Removal - Left Side.
4. Clean and inspect the camshaft(s), rocker arm(s) and lifter(s). Repair or replace as necessary. Refer to Camshaft Cleaning and Inspection and Valve Rocker Arm Cleaning and Inspection and Valve Lifters Cleaning and Inspection.

Installation Procedure

1. Install the lifters. Refer to Valve Lifter Installation - Left Side.
2. Install the rocker arms. Refer to Valve Rocker Arm Installation - Left Side.
3. Install the applicable camshaft(s). Refer to Camshaft Replacement - Left Side.

Valve Lifter Replacement - Right Side

Removal Procedure

1. Remove the applicable camshaft(s). Refer to Camshaft Replacement - Right Side.
2. Remove the rocker arms. Refer to Valve Rocker Arm Removal - Right Side.
3. Remove the lifters. Refer to Valve Lifter Removal - Right Side.
4. Clean and inspect the camshaft(s), rocker arm(s) and lifter(s). Repair or replace as necessary. Refer to Camshaft Cleaning and Inspection and Valve Rocker Arm Cleaning and Inspection and Valve Lifters Cleaning and Inspection.

Installation Procedure

1. Install the lifters. Refer to Valve Lifter Installation - Right Side.
2. Install the rocker arms. Refer to Valve Rocker Arm Installation - Right Side.
3. Install the applicable camshaft(s). Refer to Camshaft Installation - Right Side.

Valve Rocker Arm Replacement - Left Side

Removal Procedure

1. Remove the applicable camshaft(s). Refer to Camshaft Replacement - Left Side.
2. Remove the rocker arms. Refer to Valve Rocker Arm Removal - Left Side.
3. Clean and inspect the camshaft(s) and the rocker arm(s). Repair or replace as necessary. Refer to Camshaft Cleaning and Inspection and Valve Lifters Cleaning and Inspection.

Installation Procedure

1. Install the rocker arms. Refer to Valve Rocker Arm Installation - Left Side.
2. Install the applicable camshaft(s). Refer to Camshaft Replacement - Left Side.

Valve Rocker Arm Replacement - Right Side

Removal Procedure

1. Remove the applicable camshaft(s). Refer to Camshaft Replacement - Right Side.
2. Remove the rocker arms. Refer to Valve Rocker Arm Removal - Right Side.
3. Clean and inspect the camshaft(s) and the rocker arm(s). Repair or replace as necessary. Refer to Camshaft Cleaning and Inspection and Valve Lifters Cleaning and Inspection.

Installation Procedure

1. Install the rocker arms. Refer to Valve Rocker Arm Installation - Right Side.
2. Install the applicable camshaft(s). Refer to Camshaft Installation - Right Side.

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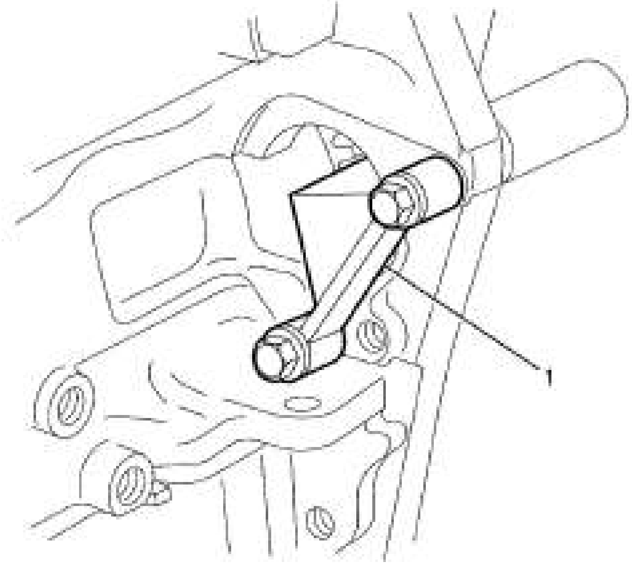
Valve Stem Oil Seal and Valve Spring Replacement - Left Side

Tools Required

- EN 46106 Flywheel Holding Tool
- EN 46110 On-Vehicle Valve Spring Compressor
- EN 46116 Valve Stem Seal Remover/Installer
- J 39313 Spark Plug Port Adapter
- EN 46117 Valve Collet Remover/Installer

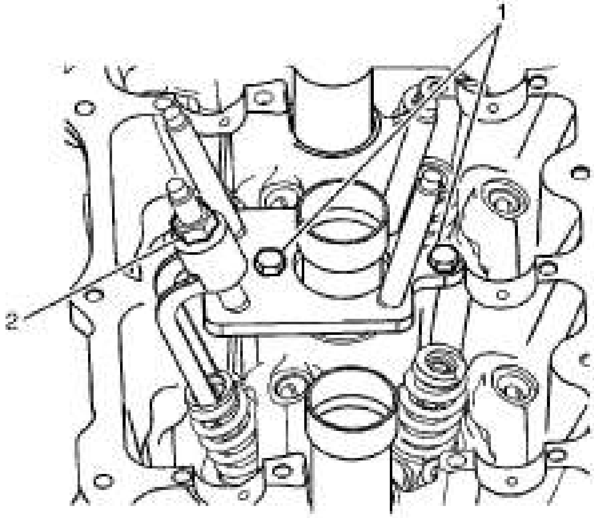
Removal Procedure

1. Remove the starter motor. Refer to Starter Motor Replacement.

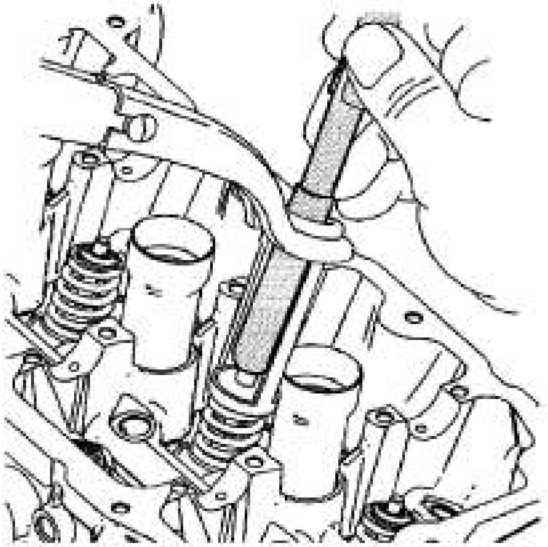


Important: If the EN 46106 (1) is not installed, the crankshaft may rotate. If the crankshaft rotates, disassembly and reassembly of the entire camshaft timing system may be required.

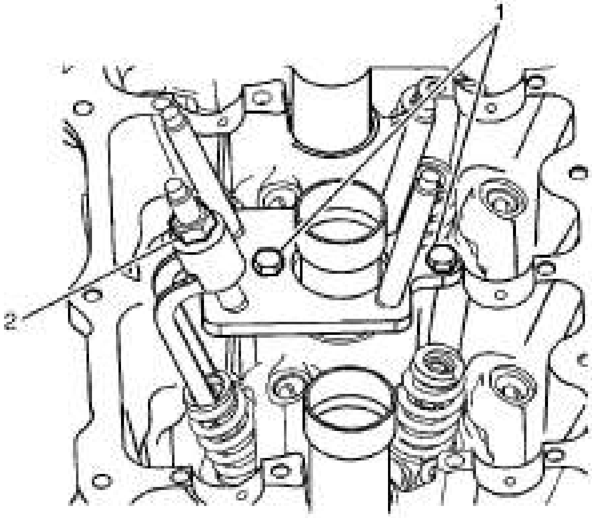
2. Install the EN 46106 (1) in order to prevent crankshaft rotation.
3. Remove the camshafts and rocker arms. Refer to Camshaft Replacement - Left Side.
4. Remove the spark plug from the applicable cylinder. Refer to Spark Plug Replacement.
5. Install the J 39313 to the applicable cylinder.
6. Connect the J 39313 to a compressed air source.
7. Install the EN 46110 above the applicable cylinder.



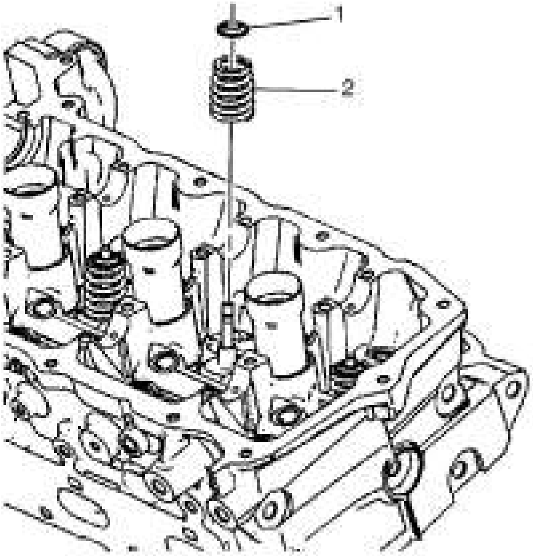
8. Install the EN 46110 to cylinder head retaining bolts (1)
9. Tighten the EN 46110 valve spring compressor nut (2).



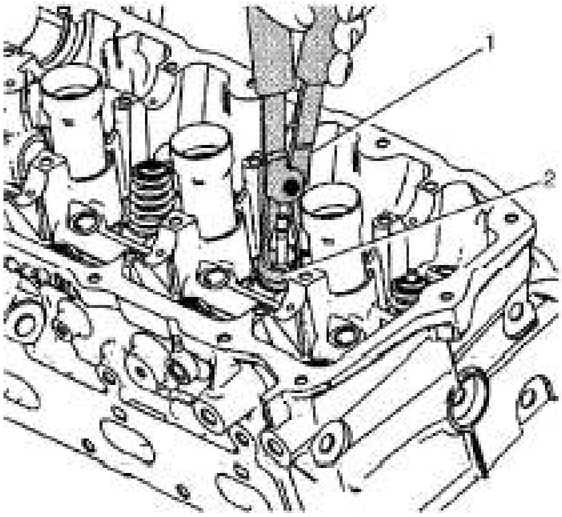
10. Remove the valve collets using the EN 46117 .



11. Loosen the EN 46110 valve spring compressor nut (2).
12. Remove the EN 46110 to cylinder head retaining bolts (1).
13. Remove the EN 46110 .



14. Remove the valve spring retainer (1).
15. Remove the valve spring (2).



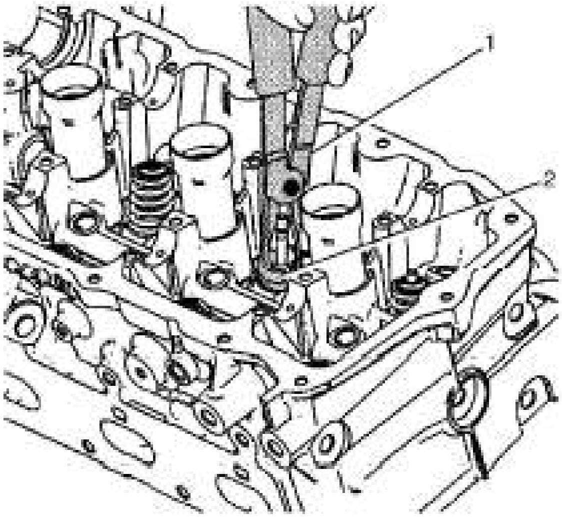
Important: NEVER reuse a valve stem oil seal.

16. Remove the valve stem oil seal (2) using the EN 46116 (1).

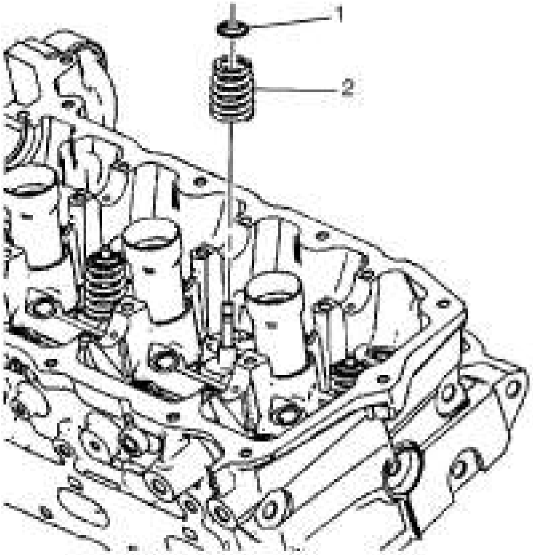
    Discard the valve stem oil seals.

17. Repeat these procedures for the remaining valves.

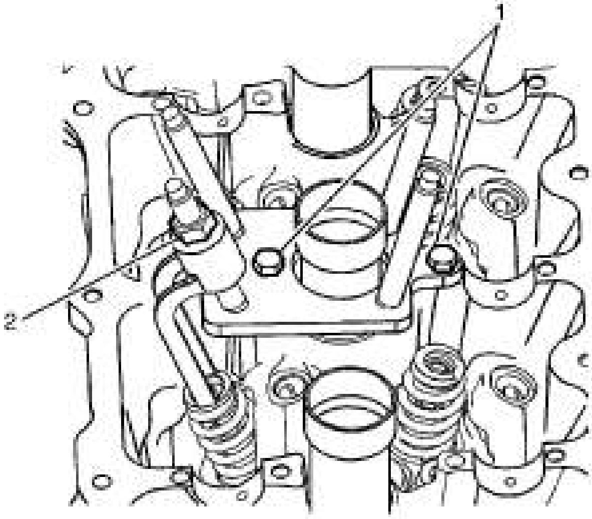
Installation Procedure



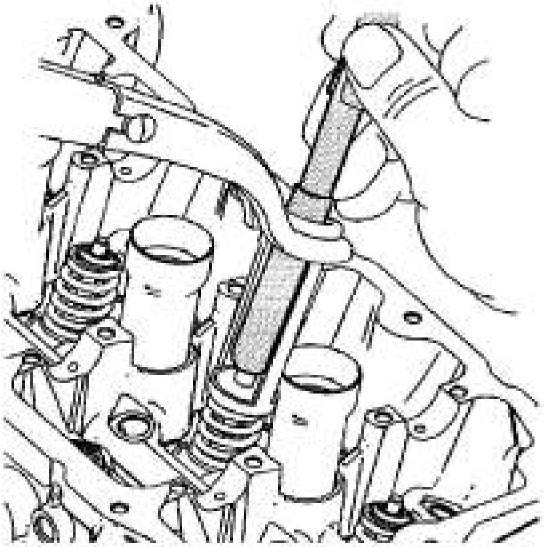
1. Use the EN 46116 (1) in order to install the NEW valve stem seal (2).



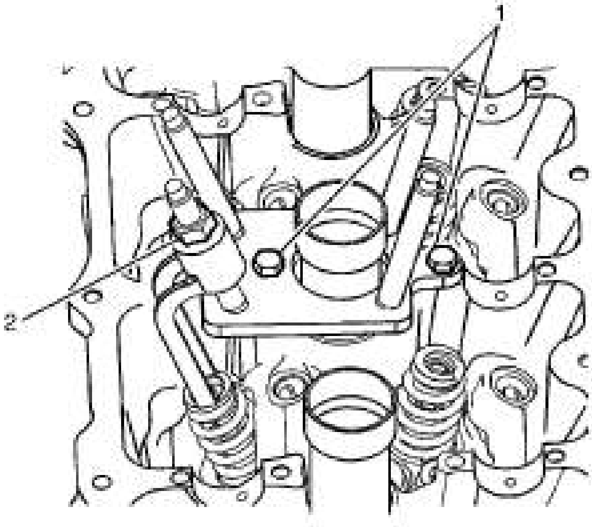
2. Install the valve spring (2).
3. Install the valve spring retainer (1).



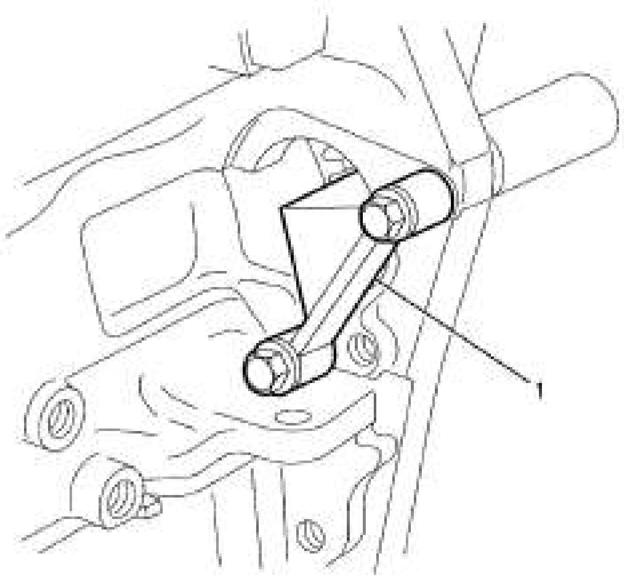
4. Install the EN 46110 above the applicable valve spring.
5. Install the EN 46110 to cylinder head retaining bolts (1)
6. Tighten the EN 46110 valve spring compressor nut (2).



7. Install the valve collets using the EN 46117 (1).



8. Loosen the EN 46110 valve spring compressor nut (2).
9. Remove the EN 46110 to cylinder head retaining bolts (1).
10. Remove the EN 46110
11. Disconnect the J 39313 from the compressed air source.
12. Remove the J 39313 .
13. Install the spark plugs. Refer to Spark Plug Replacement.
14. Install the rocker arms and camshafts. Refer to Camshaft Replacement - Left Side.



15. Remove the EN 46106 (1).
16. Install the starter motor. Refer to Starter Motor Replacement.

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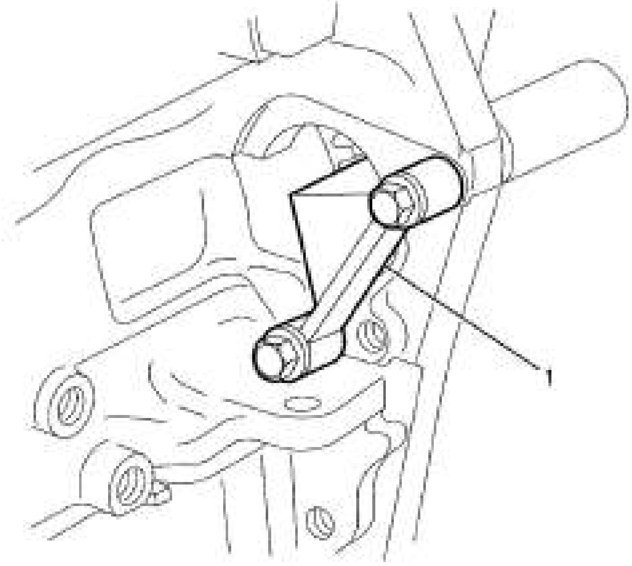
Valve Stem Oil Seal and Valve Spring Replacement - Right Side

Tools Required

- EN 46106 6 Flywheel Holding Tool
- EN 46110 On-Vehicle Valve Spring Compressor
- EN 46116 Valve Stem Seal Remover/Installer
- J 39313 Spark Plug Port Adapter
- EN 46117 Valve Collet Remover/Installer

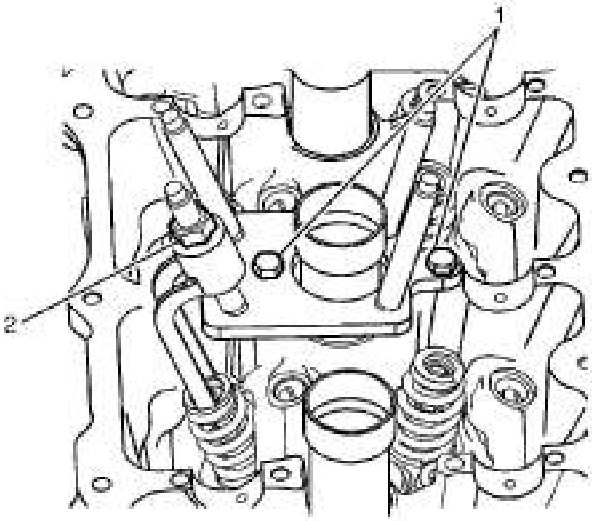
Removal Procedure

1. Remove the starter motor. Refer to Starter Motor Replacement.

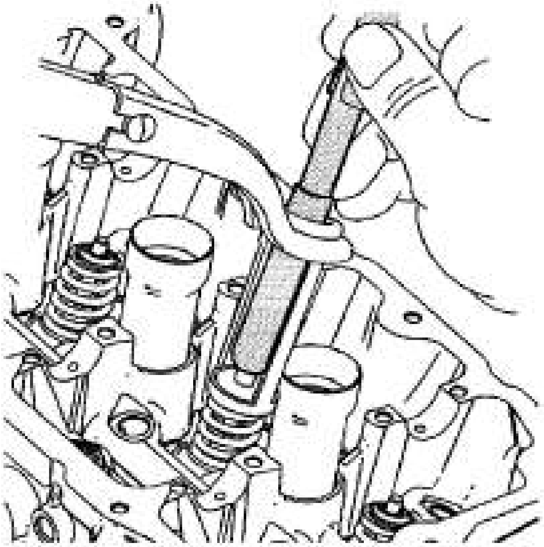


Important: If the EN 46106 is not installed, the crankshaft may rotate. If the crankshaft rotates, disassembly and reassembly of the entire camshaft timing system may be required.

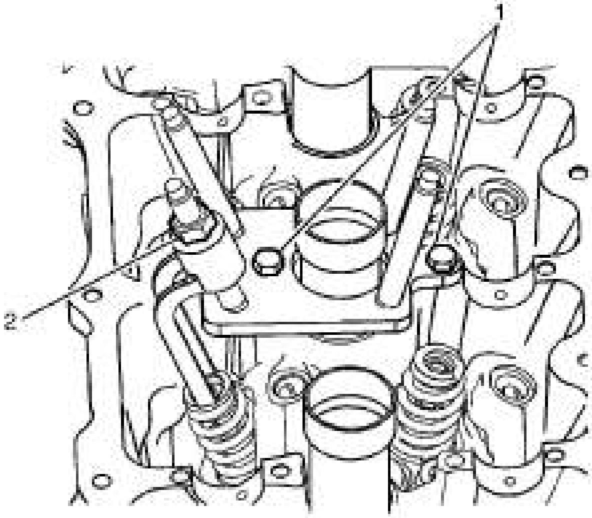
2. Install the EN 46106 (1).
3. Remove the camshafts and rocker arms. Refer to Camshaft Replacement - Left Side.
4. Remove the spark plug from the applicable cylinder. Refer to Spark Plug Replacement.
5. Install the J 39313 to the applicable cylinder.
6. Connect the J 39313 to a compressed air source.
7. Install the EN 46110 above the applicable cylinder.



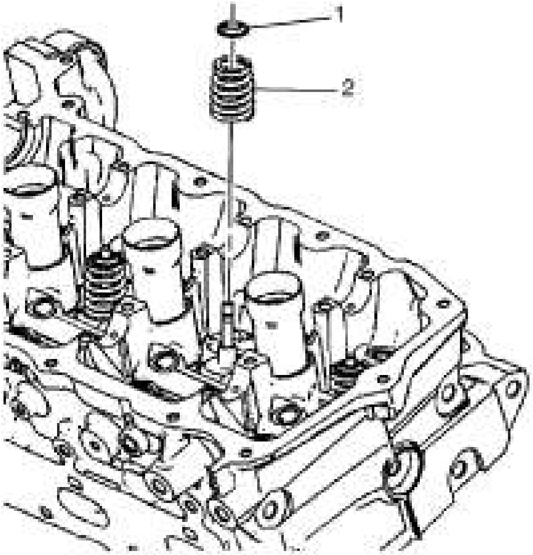
8. Install the EN 46110 to cylinder head retaining bolts (1)
9. Tighten the EN 46110 valve spring compressor nut (2).



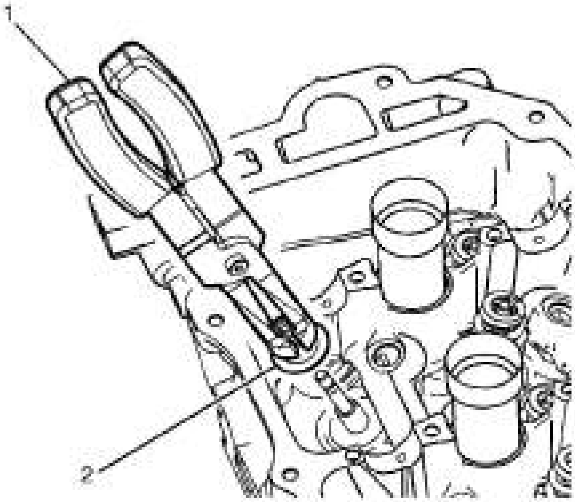
10. Remove the valve collets using the EN 46117 .



11. Loosen the EN 46110 valve spring compressor nut (2).
12. Remove the EN 46110 to cylinder head retaining bolts (1).
13. Remove the EN 46110 .

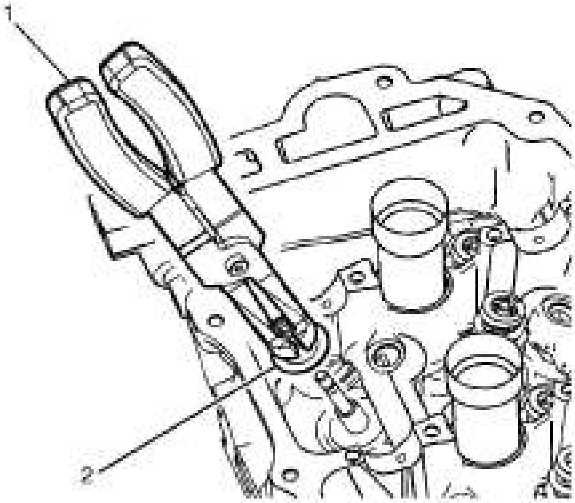


14. Remove the valve spring retainer (1).
15. Remove the valve spring (2).

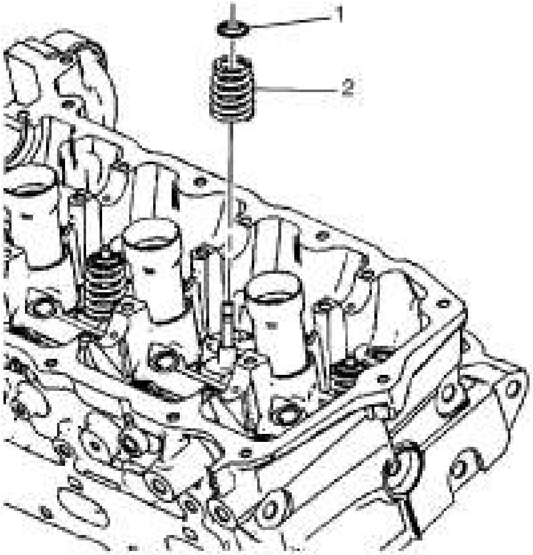


16. Use the EN 46116 (1) in order to remove the valve stem seal (2).

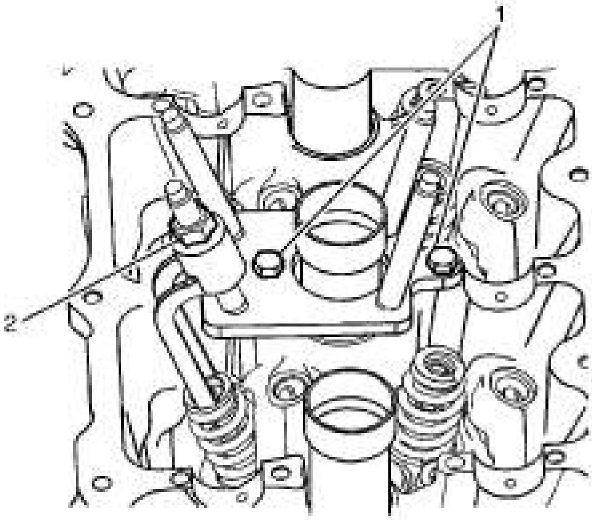
Installation Procedure



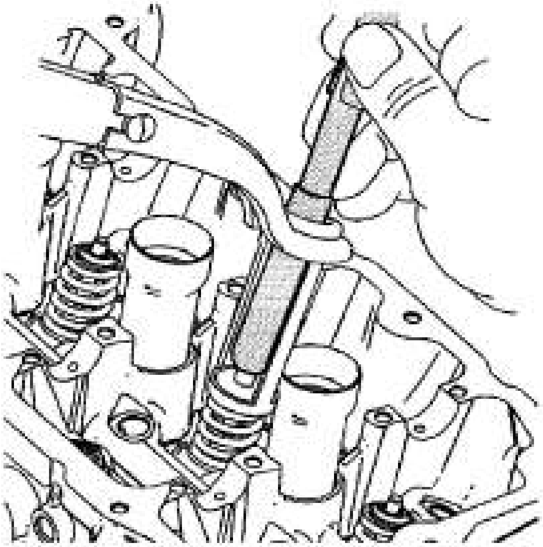
1. Use the EN 46116 (1) in order to install the valve stem seal (2).



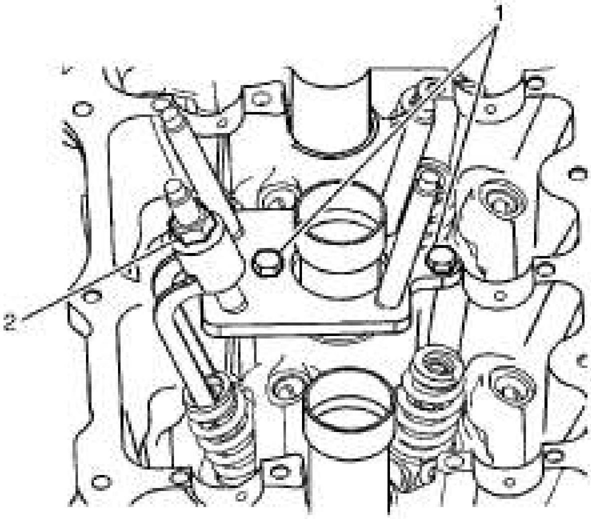
2. Install the valve spring (2).
3. Install the valve spring retainer (1).



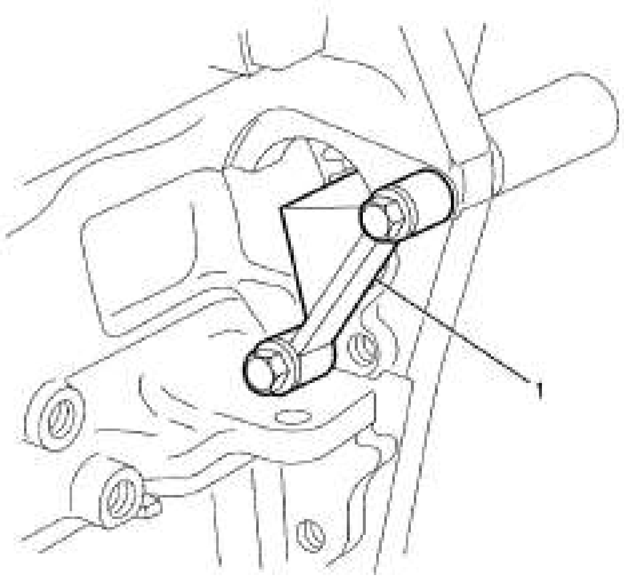
4. Install the EN 46110 above the applicable valve spring.
5. Install the EN 46110 to cylinder head retaining bolts (1)
6. Tighten the EN 46110 valve spring compressor nut (2).



7. Install the valve collets using the EN 46117 .



8. Loosen the EN 46110 valve spring compressor nut (2).
9. Remove the EN 46110 to cylinder head retaining bolts (1).
10. Remove the EN 46110 .
11. Disconnect the J 39313 from the compressed air source.
12. Remove the J 39313 .
13. Install the spark plugs. Refer to Spark Plug Replacement.
14. Install the rocker arms and camshafts. Refer to Camshaft Replacement - Left Side.



15. Remove the EN 46106 (1).
16. Install the starter motor. Refer to Starter Motor Replacement.

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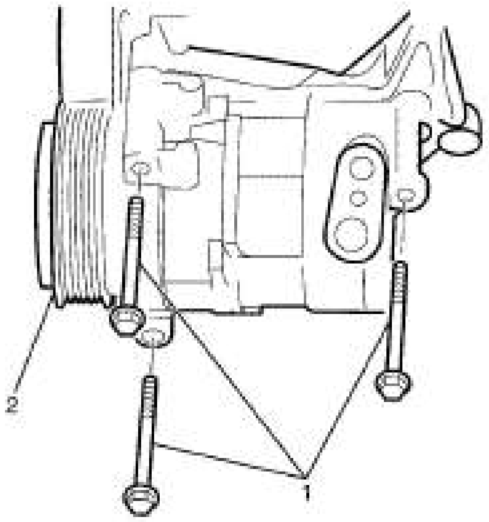
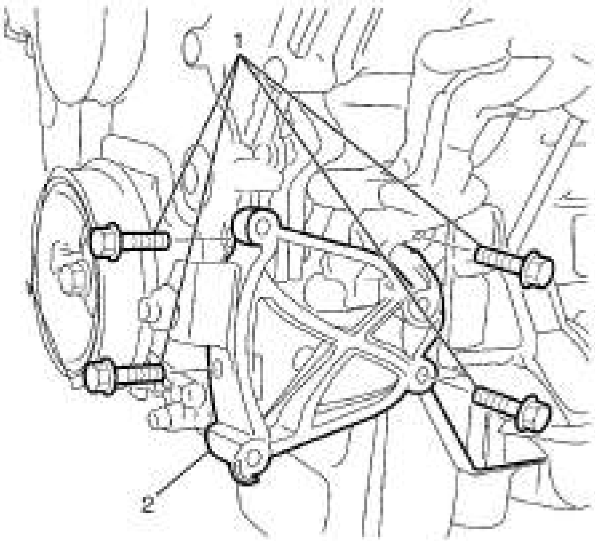
Air Conditioning (A/C) Compressor Removal



Important: The compressor must be supported before removing the compressor to compressor mounting bracket retaining bolts (1).

1. Remove the compressor to compressor mounting bracket retaining bolts (1).
2. Remove the compressor (2) by sliding forwards and upwards.

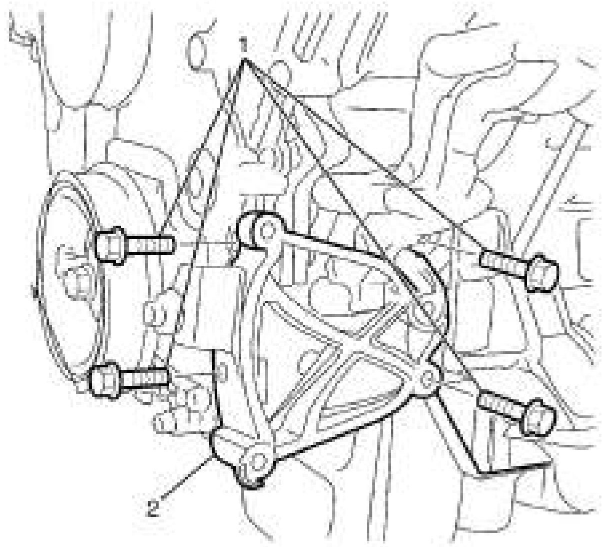


3. Remove the compressor mounting bracket to engine retaining bolts (1).

4. Remove the compressor mounting bracket (2).

Air Conditioning (A/C) Compressor Installation

Important: Follow the procedure sequence in order to prevent drive belt mis-alignment and/or possible damage/distortion to the components.



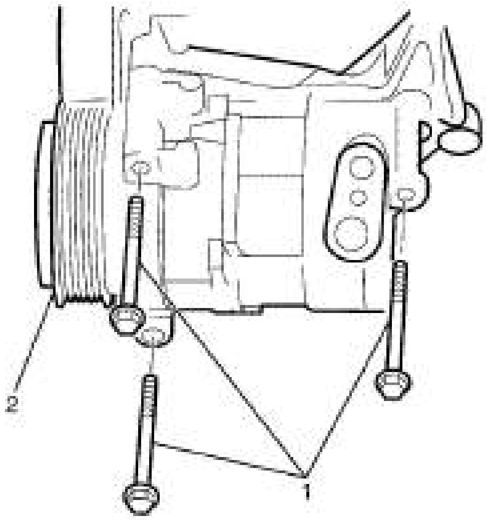
1. Install the A/C compressor bracket (2).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the A/C compressor bracket to cylinder block retaining bolts (1).

   Tighten
   Tighten the bolt to 58 N·m (42 lb ft).

3. If you are replacing the compressor, balance the compressor oil. Refer to Air Conditioning Compressor Oil Balancing.



4. Install the A/C compressor (2).
5. Install the A/C compressor to A/C compressor bracket retaining bolts (1).

   Tighten
   Tighten the nuts to 22 N·m (16 lb ft).

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Camshaft Cleaning and Inspection

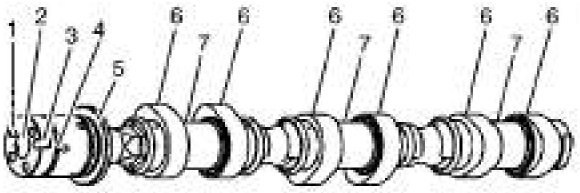
Cleaning Procedure

1. Clean the camshaft in solvent.

   Caution: Refer to Safety Glasses Caution in the Preface section.

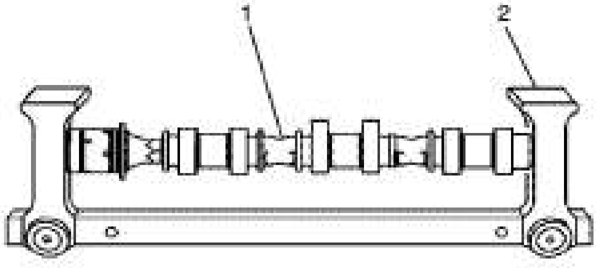
2. Dry the camshaft with compressed air.

Visual Inspection

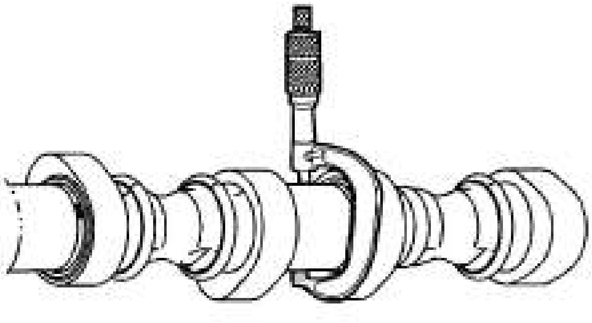


1. Inspect the camshaft oil feed holes (1) to the camshaft position actuator for dirt, debris or blockage.
2. Inspect the threaded hole (2) for damage.
3. Inspect the camshaft position actuator locating notch (3) for damage or wear.
4. Inspect the camshaft sealing grooves (4) for damage.
5. Inspect the camshaft thrust surface (5) for damage.
6. Inspect the camshaft lobes (6) and journals (7) for the following conditions:
   - Scoring or pitting above acceptable tolerances
   - Discoloration from overheating
   - Deformation from wear above acceptable tolerances, especially the camshaft lobes
7. If any of the above conditions exist on the camshaft, replace the camshaft.

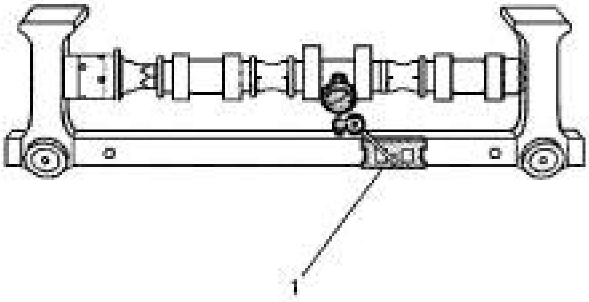
Camshaft Measurement



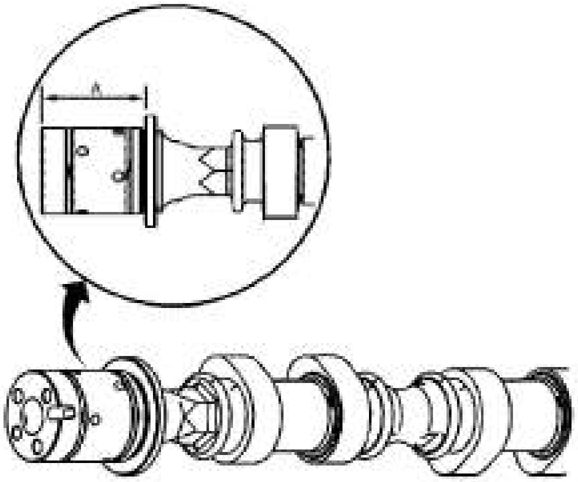
1. With the camshaft (1) in a suitable fixture (2), measure the camshaft (1) for wear.



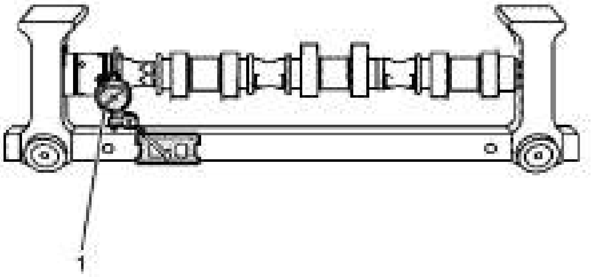
2. Measure and record the camshaft journals (2) for diameter and out-of-round using an outside micrometer (1). Refer to Engine Mechanical Specifications .
   - If the diameter is smaller than specifications, replace the camshaft.
   - If the out-of-round exceeds specifications, replace the camshaft.



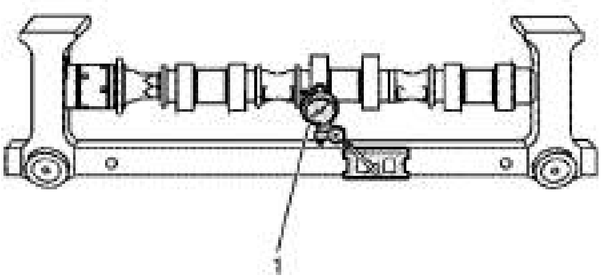
3. Measure and record the camshaft runout using a dial indicator (1). Refer to Engine Mechanical Specifications .



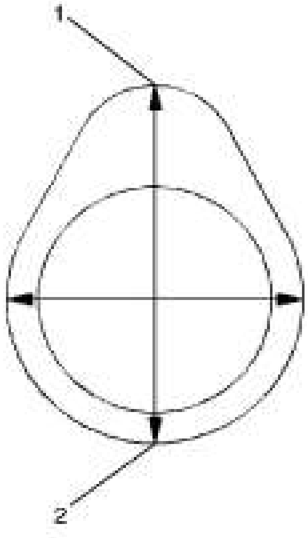
4. Measure the camshaft thrust width (A) for wear using a depth micrometer. Refer to Engine Mechanical Specifications .



5. Measure the camshaft thrust wall surface for runout using a dial indicator (1). Refer to Engine Mechanical Specifications .
6. If the camshaft is damaged or worn beyond specifications, replace the camshaft. No machining of the camshaft is allowed.



7. Measure the camshaft lobes for wear using a dial indicator (1).

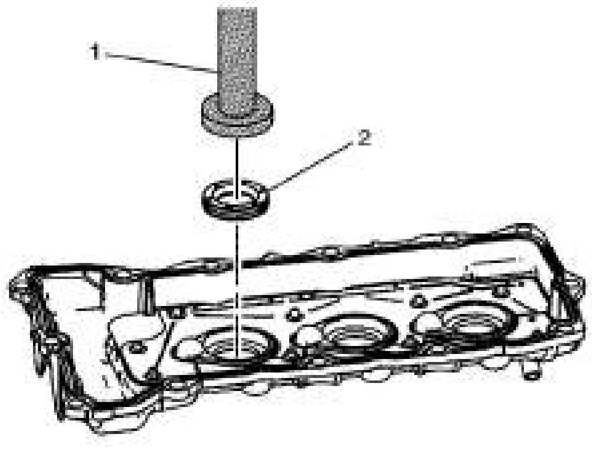


8. Place the dial indicator with the indicator tip on the base circle (2) of the camshaft lobe.
    1. Place the dial indicator at zero.
    2. Rotate the camshaft until the indicator tip is at the highest point (1) on the lobe. This reading is the lift of the camshaft lobe. Refer to Engine Mechanical Specifications .
    3. If the indicated measurement is significantly lower than these specifications, replace the camshaft or engine performance will be reduced.

Camshaft Cover Assemble

Tools Required

J 24254 Oil Seal Installer



Install the NEW ignition coil seals (2) using the J 24254 (1).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | **Document ID: 1977673**

Camshaft Cover Cleaning and Inspection

Cleaning Procedure

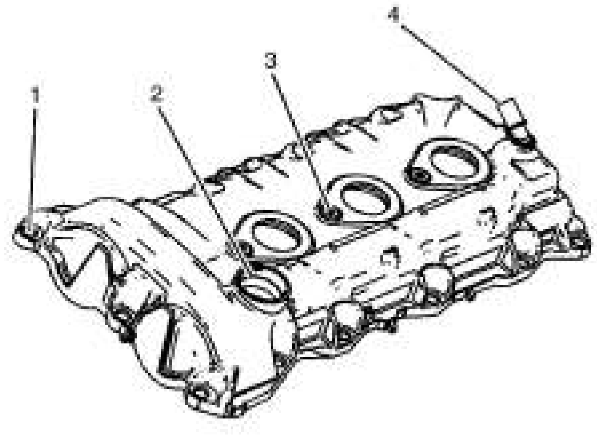
1. Clean the camshaft covers in solvent.

   Caution: Refer to Safety Glasses Caution in the Preface section.

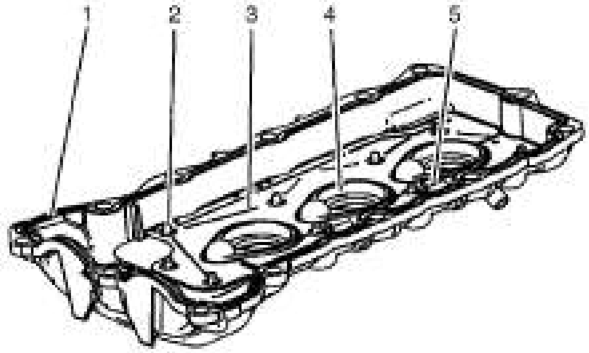
2. Dry the camshaft covers with compressed air.

Inspection Procedure

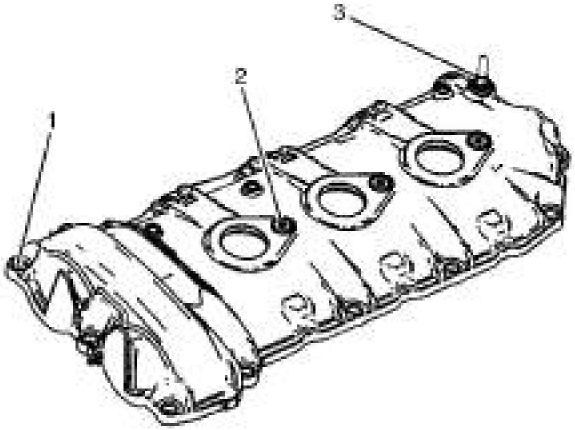
1. Inspect each camshaft cover for the dents or damage to the exterior. A dented or damaged camshaft cover may:
   - Leak engine oil.
   - Effect crankcase ventilation.
   - Interfere with the camshafts.
   - Interfere with the ignition coil sealing.
   - Allow water or condensation to enter the engine.



2. Inspect the exterior of the left camshaft cover for the following conditions:
   - Damage to the camshaft cover bolt holes (1).
   - Damage to the oil fill hole (2).
   - Damage to the mounting holes (3) for the ignition coil assembly.
   - Damage to the Positive Crankcase Ventilation (PCV) hose connector (4) -- A damaged PCV hose connector is replaceable.

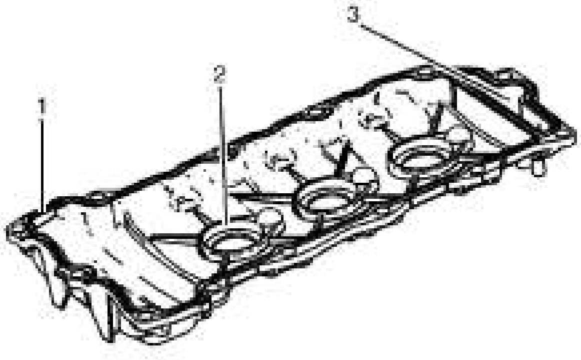


3. Inspect the interior of the left camshaft cover for the following conditions:
   - Gouges or damage to the camshaft cover sealing groove (1).
   - Damaged, loose or missing baffle fasteners (2).
   - Damaged, loose or missing baffle (3).
   - Gouges or damage to the ignition coil seal bore (4).
   - Restrictions to the ventilation system (5).



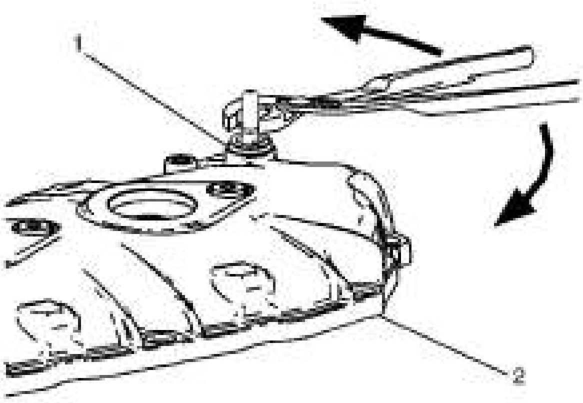
4. Inspect the exterior of the right camshaft cover for the following conditions:
   - Damage to the camshaft cover bolt holes (1).
   - Damage to the mounting holes (2) for the ignition coil assembly.
   - Damage to the PCV orifice (3) -- A damaged PCV orifice can be replaced. Refer to PCV

Orifice Replacement.



5. Inspect the interior of the right camshaft cover for the following conditions:
    - Gouges or damage to the camshaft cover sealing groove (1).
    - Gouges or damage to the ignition coil seal bore (2).
    - Restrictions to the ventilation system (3).
6. Repair or replace the camshaft cover or covers as necessary.

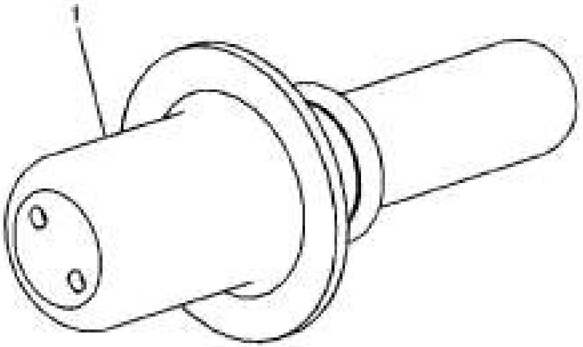
PCV Orifice Replacement



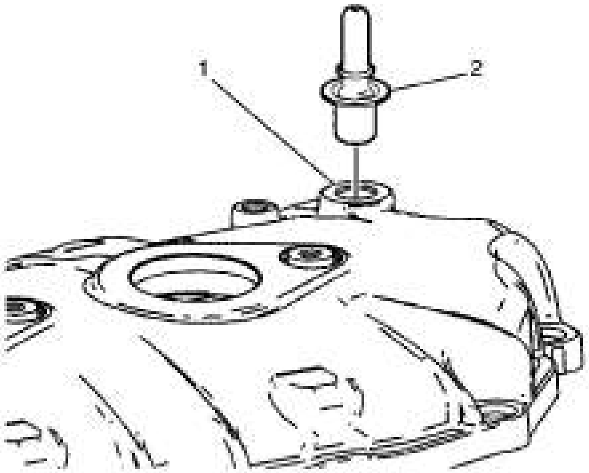
Important: If the PCV orifice is damaged or plugged and cannot be cleaned out, the PCV orifice can be replaced.

Important: Remove the PCV orifice (1) by griping the neck of the PCV orifice (1) with pliers and twisting and pulling out of the right camshaft cover (2).

1. Remove the PCV orifice (1) from the right camshaft cover (2).

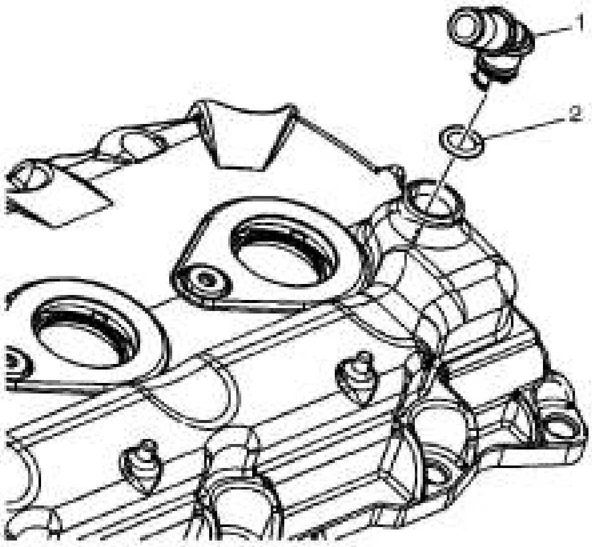


2. Apply a Holden approved sealant to the NEW PCV orifice (1).



3. Install the NEW PCV orifice (2) into the right camshaft cover (1). After insertion, twist the PCV orifice (2) in order to address any vertical leak paths in the sealant.

PCV Fitting Replacement

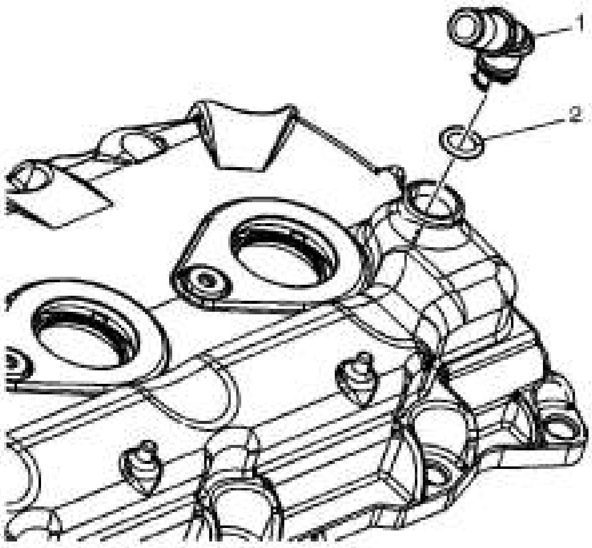


Important: If the PCV fitting (1) is damaged or plugged and cannot be cleaned out, the PCV fitting (1) can be replaced.

Important: The PCV fitting O-ring (2) is a single use component and must be discarded whenever the PCV fitting (1) is removed.

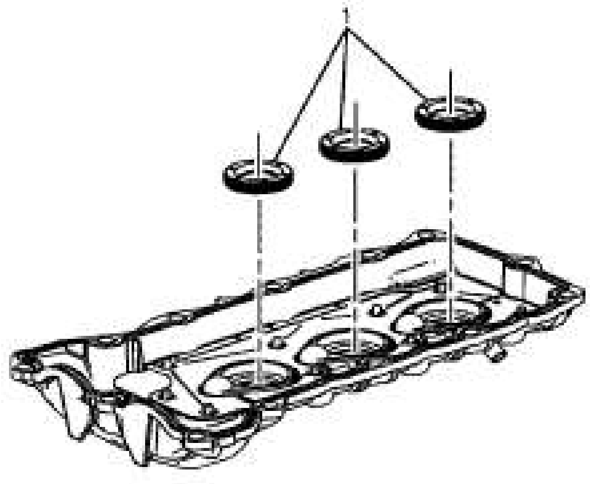
1. Remove the PCV fitting (1).

   Discard the PCV fitting O-ring (2).



2. Install the NEW PCV fitting (1) with a NEW PCV fitting O-ring (2).

Camshaft Cover Disassemble



Remove and discard the ignition coil seals (1).

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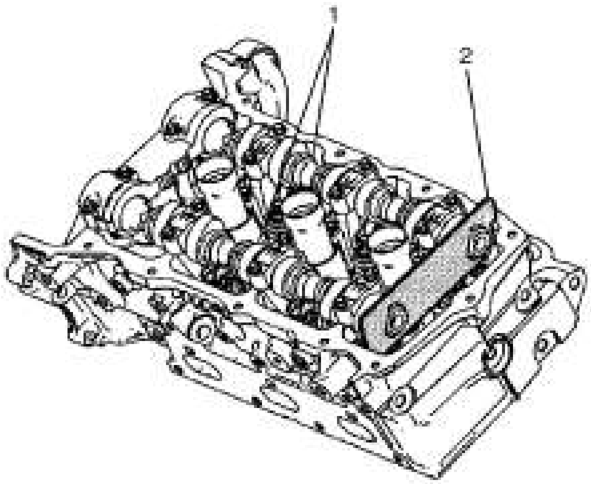
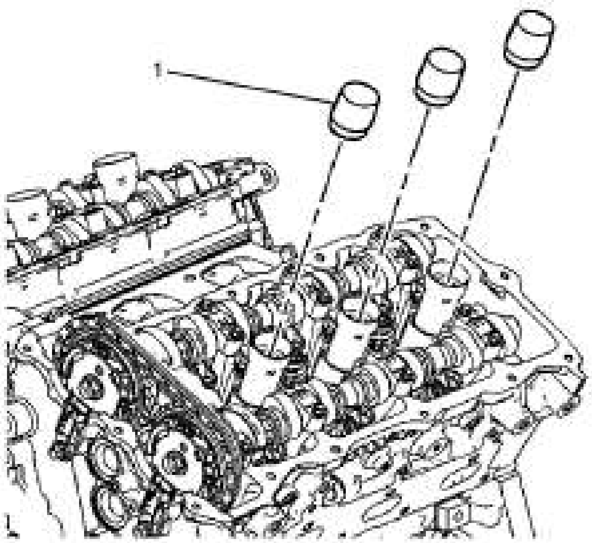
Camshaft Cover Installation - Left Side

Tools Required

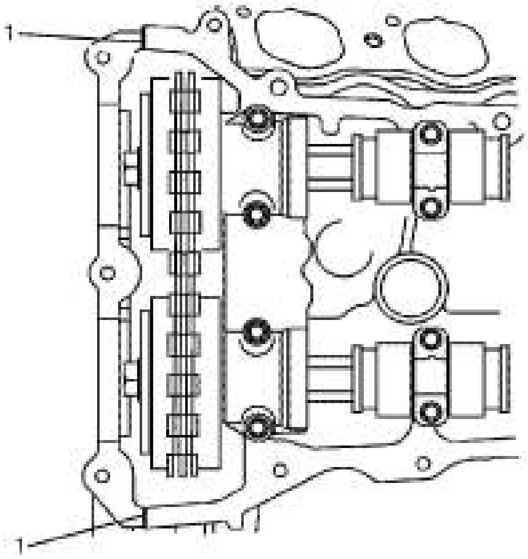
- EN 46101 Spark Plug Tube Seal Guide
- EN 46105 Camshaft Locking Tools



1. Remove the EN 46105 (2) from the rear of the left hand camshafts (1).

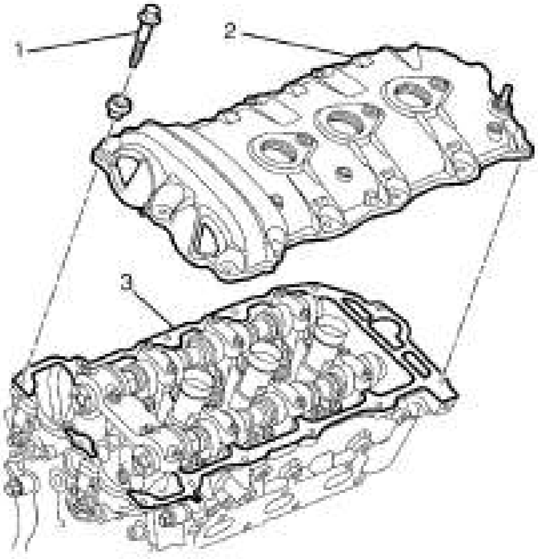


2. Install the EN 46101 (1) onto the spark plug tubes of the left cylinder head.
3. Install the camshaft cover bolt grommets prior to installing the camshaft cover bolts.
4. Wipe the camshaft cover sealing surface on the left cylinder head with a clean, lint-free cloth.



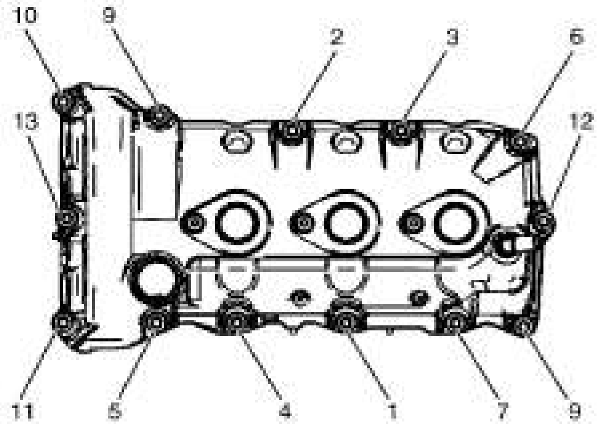
Important: Make sure the sealing surfaces of the cylinder head and camshaft cover are clean.

5. Place a 3mm bead of RTV sealant (1) on the join line between the engine front cover and the cylinder head.
6. Install a NEW camshaft cover seal and NEW grommets.



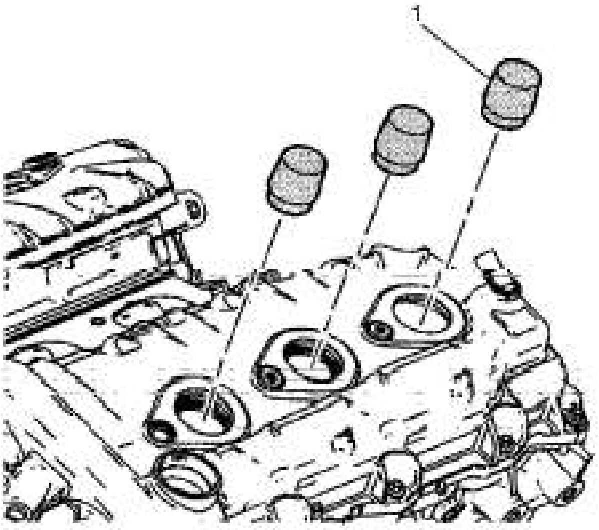
7. Install the camshaft cover (2) from the cylinder head (3).
8. Loosely install the left camshaft cover to cylinder head retaining bolts (1).

Notice: Refer to Fastener Notice in the Preface section.

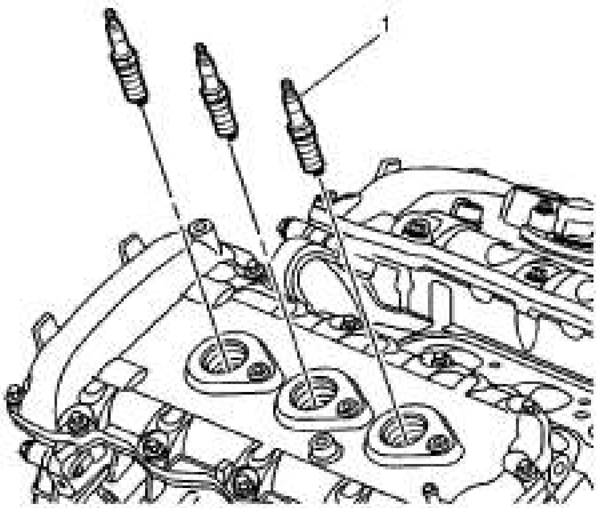


9. Tighten the left camshaft cover to cylinder head retaining bolts in the sequence shown.

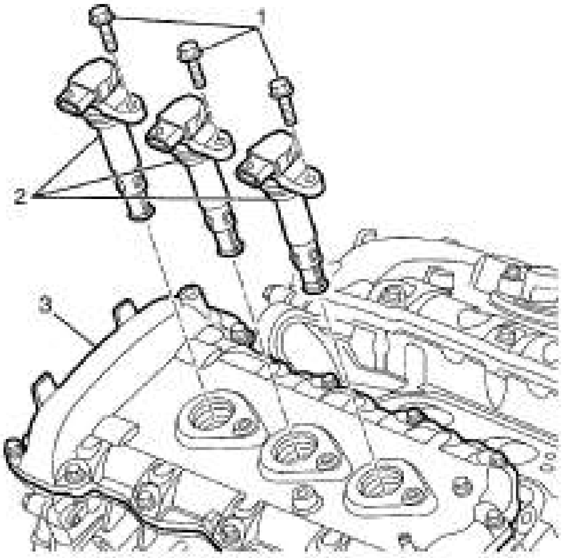
   Tighten
   Tighten the bolts in sequence to 10 N·m (89 lb in).



10. Remove the EN 46101 (1) from the spark plug tubes of the left cylinder head.



11. Install the spark plugs (1).



Important: DO NOT damage the spark plug and/or the seal in the left camshaft cover or an engine misfire condition may result.

12. Install the ignition coils (2) to the camshaft cover (3).
13. Install each ignition coil to camshaft cover retaining bolt (1).

Tighten
Tighten the bolt to 10 N·m (89 lb in).

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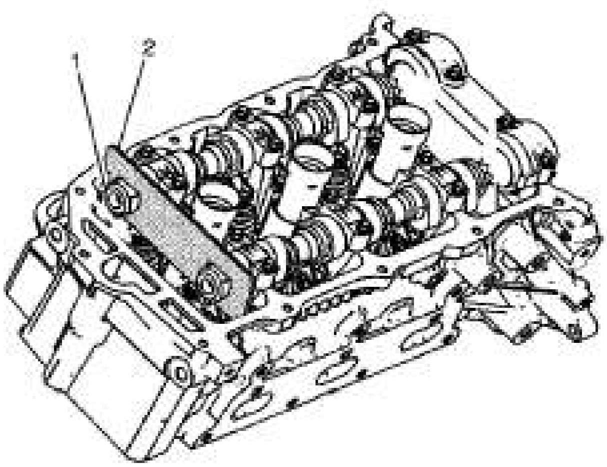
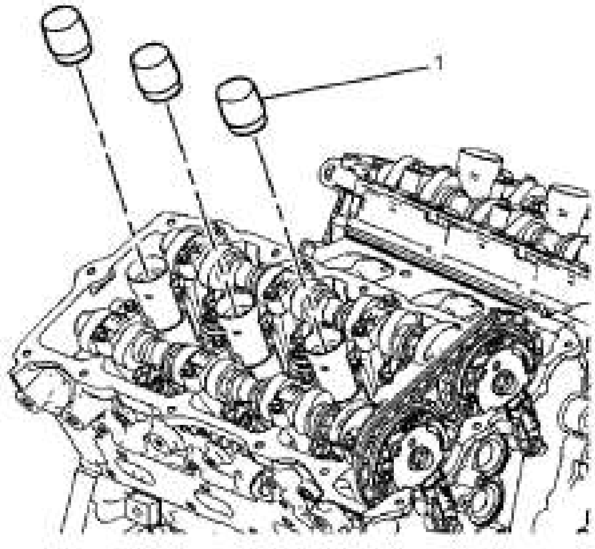
Camshaft Cover Installation - Right Side

Tools Required

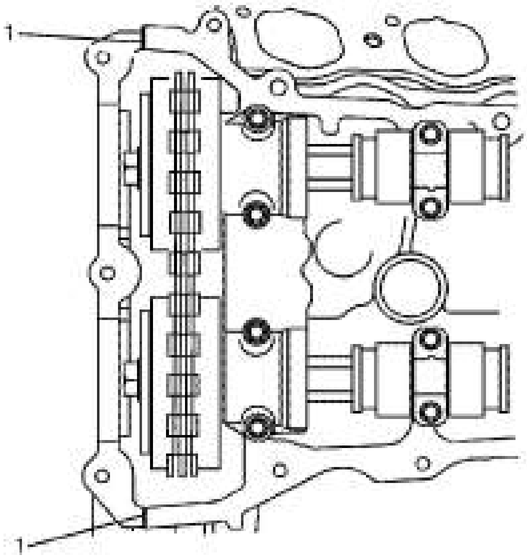
- EN 46101 Spark Plug Tube Seal Guide
- EN 46105 Camshaft Locking Tools



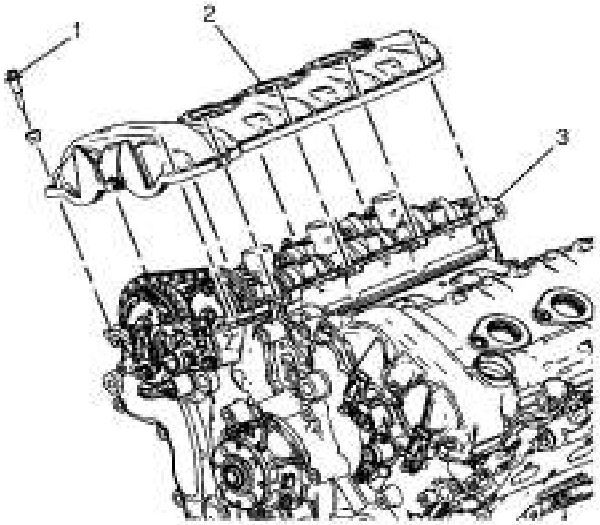
1. Remove the EN 46105 (2) from the rear of the right camshafts (1).



2. Install the EN 46101 (1) onto the spark plug tubes of the right cylinder head.
3. Install the camshaft cover bolt grommets prior to installing the camshaft cover bolts.
4. Wipe the camshaft cover sealing surface on the right cylinder head with a clean, lint-free cloth.

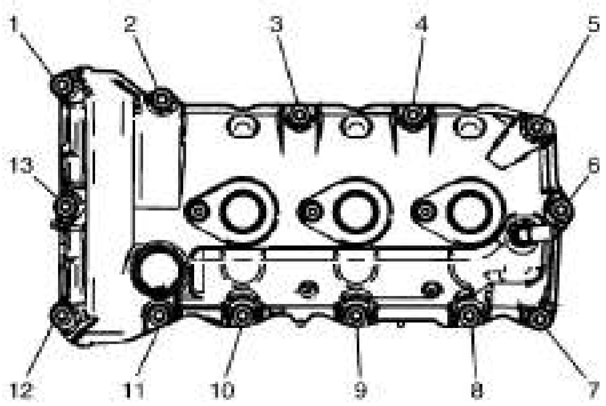


5. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant on the engine front cover split lines (1).



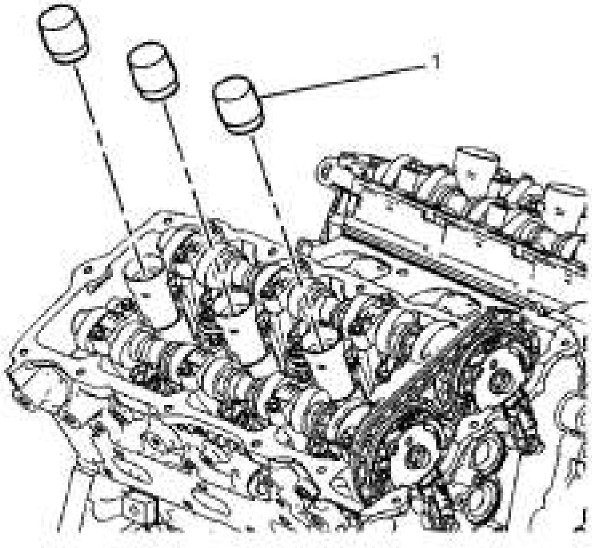
6. Place the right camshaft cover (2) into position onto the right cylinder head (3).
7. Loosely install the right camshaft cover bolts (1).

Notice: Refer to Fastener Notice in the Preface section.

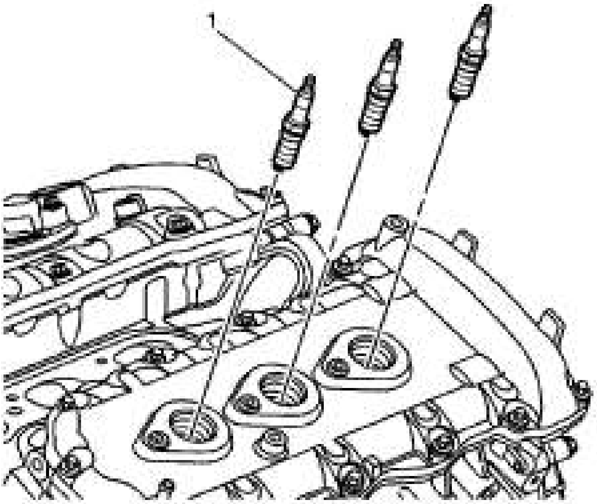


8. Tighten the left camshaft cover to cylinder head retaining bolts in the sequence shown.

   Tighten
   Tighten the bolts in sequence to 10 N·m (89 lb in).

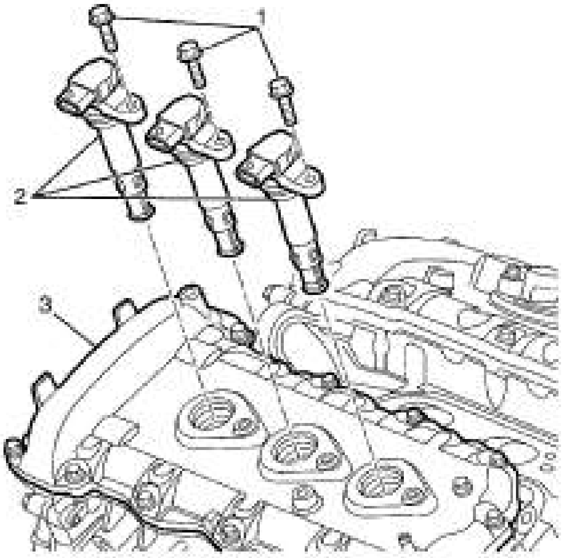


9. Remove the EN 46101 (1) from the spark plug tubes of the right cylinder head.



10. Install the NEW spark plugs (1).

    Tighten
    Tighten the spark plugs to 20 N·m (15 lb ft).



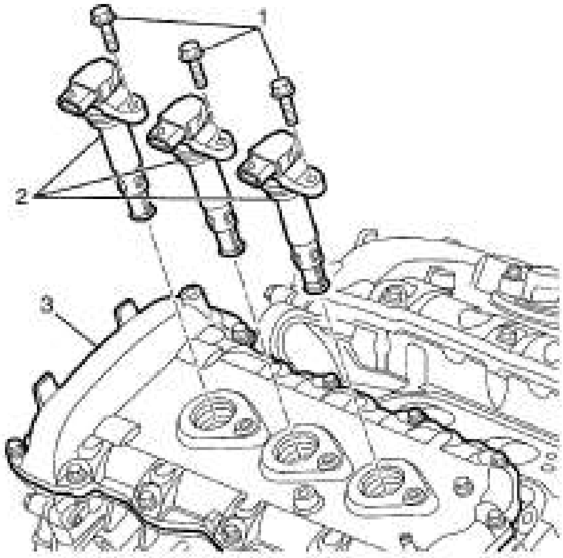
Important: DO NOT damage the spark plug and/or the seal in the left camshaft cover or an engine misfire condition may result.

11. Install the ignition coils (2).
12. Install each ignition coil to camshaft cover retaining bolt (1).

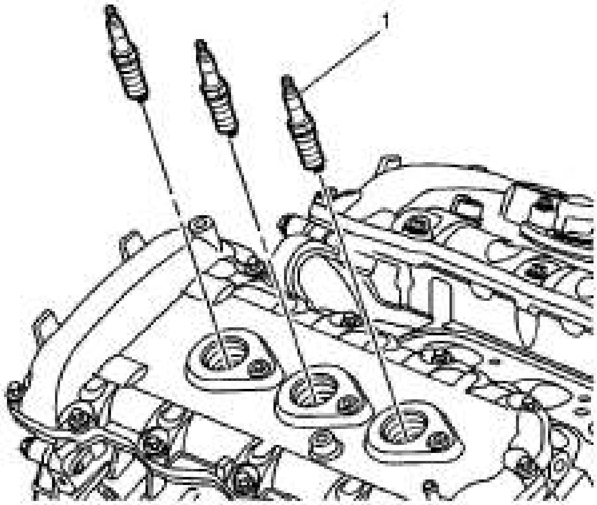
Tighten

Tighten the bolt to 10 N·m (89 lb in).

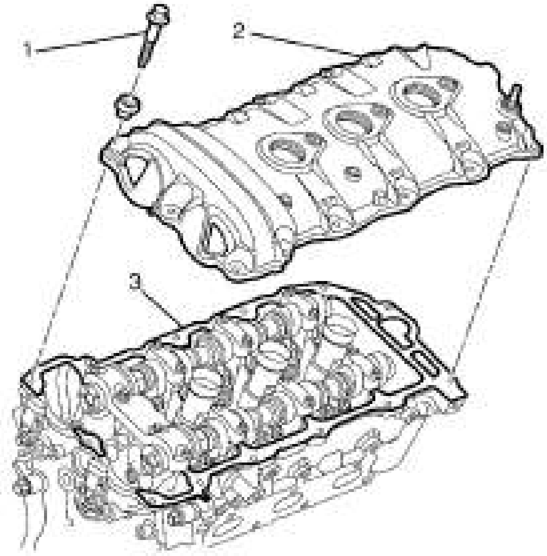
Camshaft Cover Removal - Left Side



1. Remove the ignition coil to camshaft cover retaining bolts (1).
2. Remove the ignition coils (2) from the camshaft cover (3).



3. Remove the spark plugs (1).



4. Remove the camshaft cover to cylinder head retaining bolts (1).
5. Remove the camshaft cover (2) from the cylinder head (3).

Important: The camshaft cover seal and grommets must be discarded whenever the camshaft cover has been removed from the cylinder head (2).

6. Remove the camshaft cover seal and grommets.

Discard the seal and grommets

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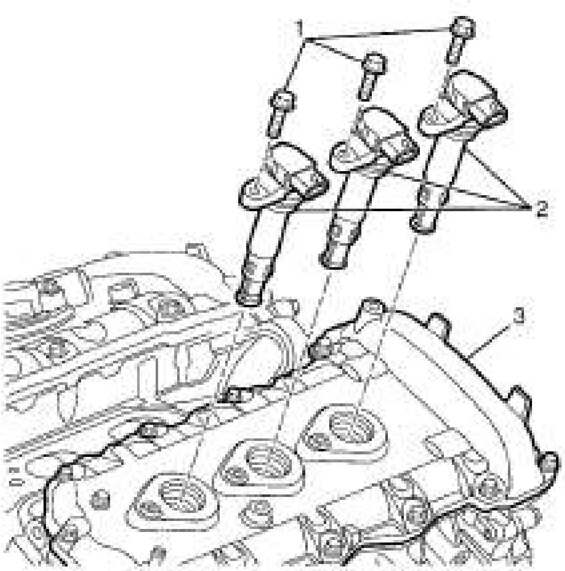
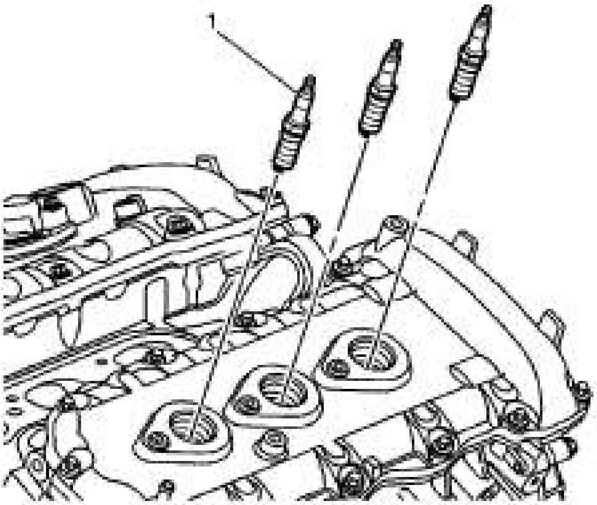
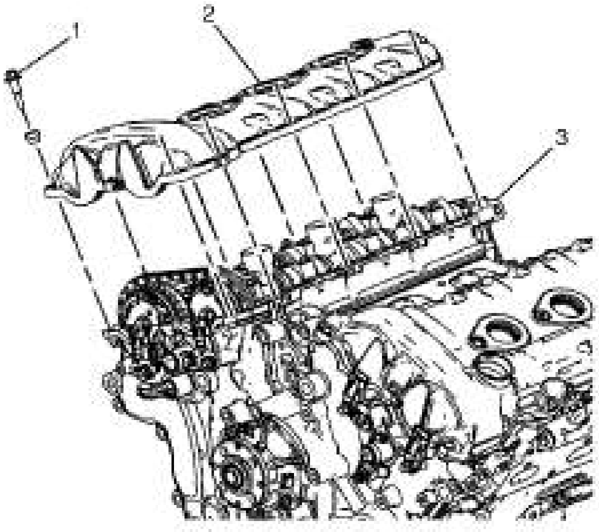
Camshaft Cover Removal - Right Side



1. Remove the ignition coil to camshaft cover retaining bolts (1).
2. Remove the ignition coils (2) from the camshaft cover (3).



3. Remove the spark plugs (1).



4. Remove the camshaft cover to cylinder head retaining bolts (1).
5. Remove the camshaft cover (2) from the cylinder head (3).

   Important: The camshaft cover seal and grommets must be discarded whenever the camshaft cover has been removed from the cylinder head (2).

6. Remove the camshaft cover seal and grommets.

   Discard the seal and grommets

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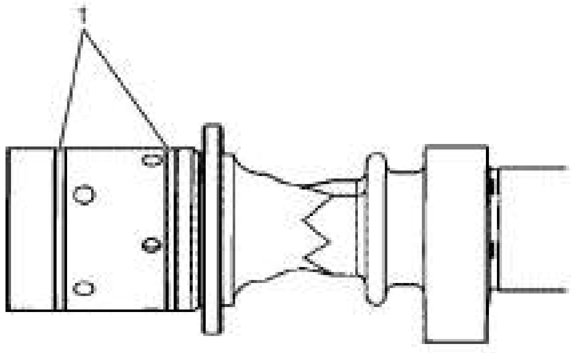
Camshaft Installation - Left Side

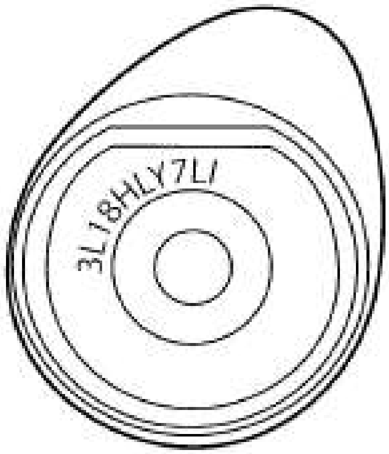
Tools Required

EN 46111 Crankshaft Rotation Socket

1. Ensure that the crankshaft is in the stage one timing drive assembly position using the EN 46111 . Refer to Camshaft Timing Drive Chain Alignment Diagram.



2. Make sure that the camshaft sealing rings (1) are in place in the camshaft grooves.



3. Select the proper camshaft for the particular installation location. ID markings are on the

rear end of each camshaft. The ID markings are defined as follows:

3.1. The first five digits refer to the date and time of production.

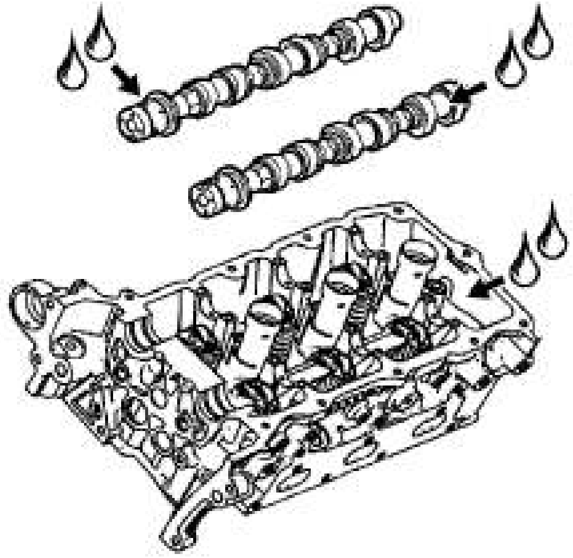
Example: 3L18H.

3.2. Digits 6-9 refer to the production code.

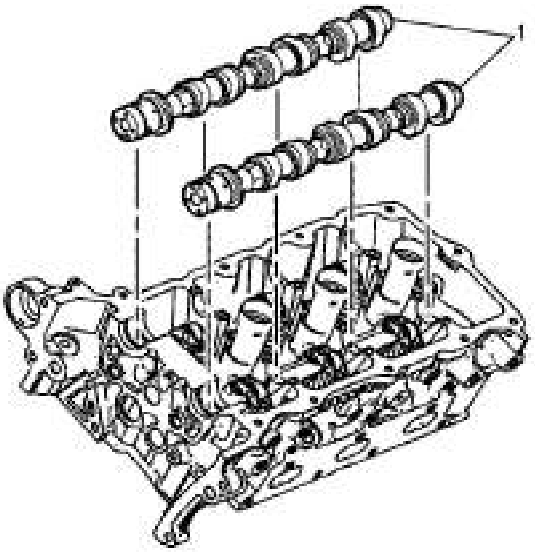
LY7 - High Feature V6

3.3. The last two digits refer to the camshaft position.

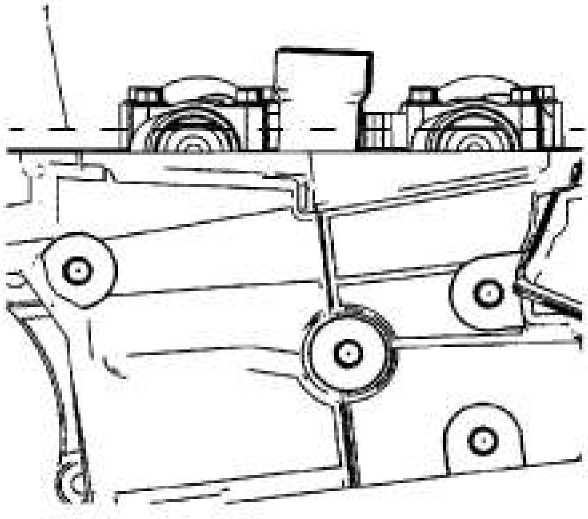
- Example:
- LI - Left Bank Intake
- LE - Left Bank Exhaust
- RI - Right Bank Intake
- RE - Right Bank Exhaust



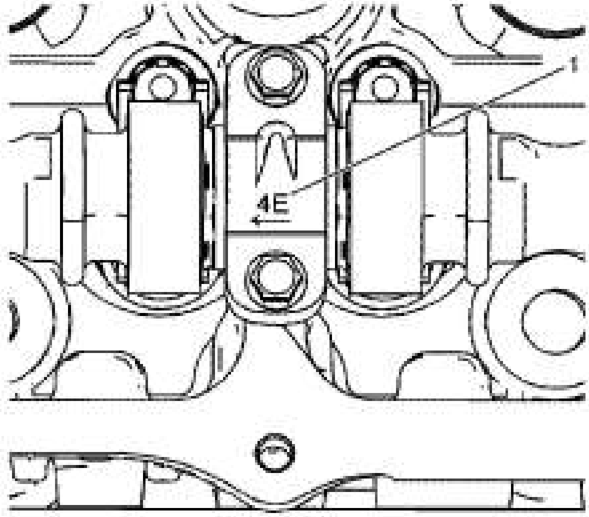
4. Apply a liberal amount of engine oil to the camshaft (1) journals and the left cylinder head (2) camshaft carriers.



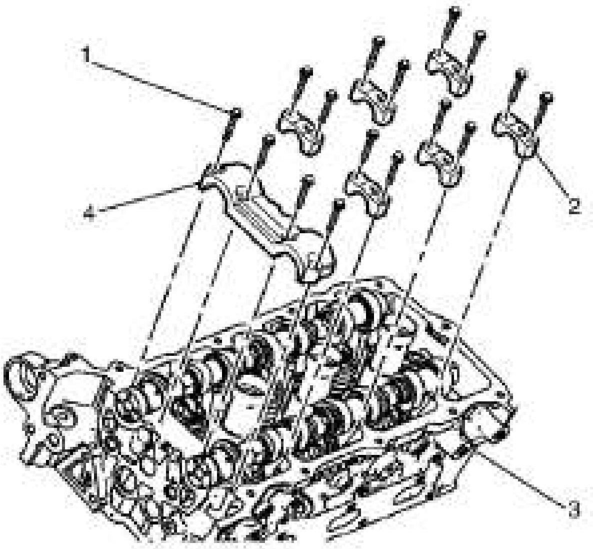
5. Place the camshafts (1) in position in the left cylinder head (2).



6. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the left cylinder head camshaft cover rail.

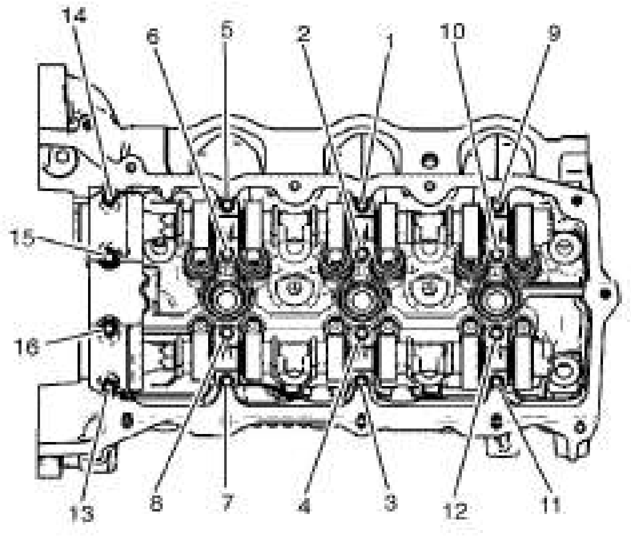


7. Observe the markings on the left cylinder head camshaft bearing caps. Each bearing cap is marked (1) in order to identify its location. The markings have the following meanings:
   - The raised feature must always be oriented toward the center of the cylinder head.
   - The I indicates the intake camshaft.
   - The E indicates the exhaust camshaft.
   - The number 1, 3, 5 indicates the cylinder position from the front of the cylinder block.
8. Apply a liberal amount of engine oil to the camshaft bearing caps.



9. Install the camshaft bearing thrust cap (4) in the first journal of the right cylinder head (3).
10. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head (3).
11. Hand start all the camshaft bearing cap to cylinder head retaining bolts (1).

Notice: Refer to Fastener Notice in the Preface section.



12. Tighten the camshaft bearing cap to cylinder head retaining bolts in the sequence shown.

    Tighten
    Tighten the bolts in sequence to 10 N·m (89 lb in).

13. Loosen the center intake camshaft bearing cap to cylinder head retaining bolts (1, 2) and the center exhaust camshaft bearing cap to cylinder head retaining bolts (3, 4).
14. Retighten the center camshaft bearing cap to cylinder head retaining bolts (1, 2, 3, 4).

    Tighten
    Retighten the bolts to 10 N·m (89 lb in).

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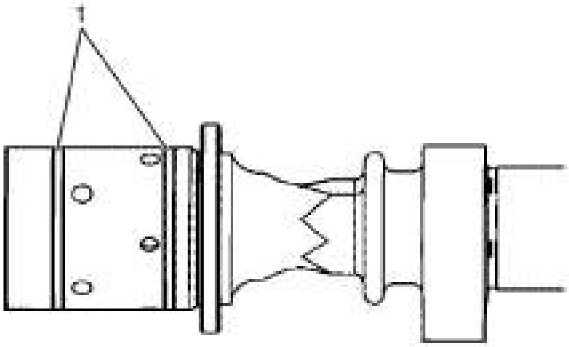
Camshaft Installation - Right Side

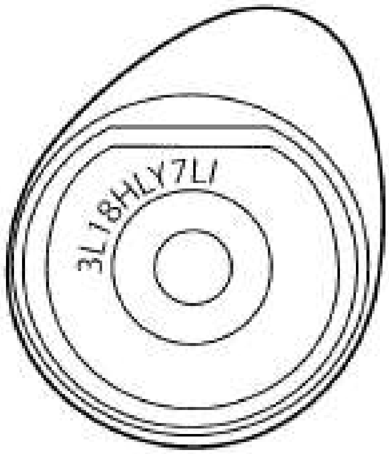
Tools Required

EN 46111 Crankshaft Rotation Socket

1. Ensure that the crankshaft is in the stage one timing drive assembly position using the EN 46111 . Refer to Camshaft Timing Drive Chain Alignment Diagram .



2. Make sure that the camshaft sealing rings (1) are in place in the camshaft grooves.



3. Select the proper camshaft for the particular installation location. ID markings are on the

rear end of each camshaft. The ID markings are defined as follows:

3.1. The first five digits refer to the date and time of production.

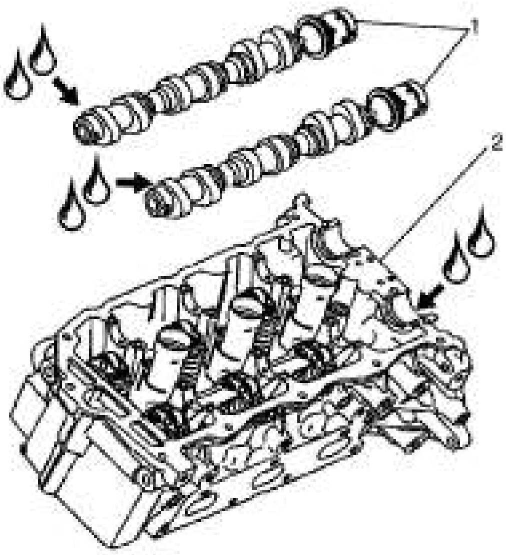
Example: 3L18H.

3.2. Digits 6-9 refer to the production code.

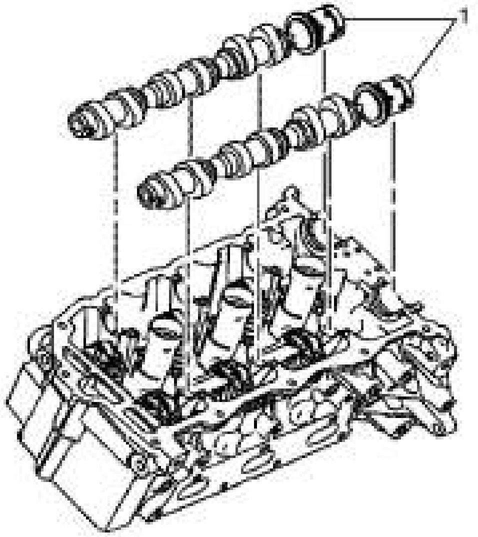
LY7 - High Feature V6

3.3. The last two digits refer to the camshaft position.

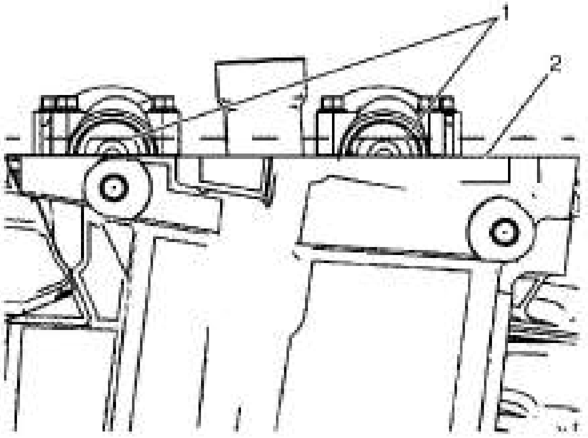
- Example:
- LI - Left Bank Intake
- LE - Left Bank Exhaust
- RI - Right Bank Intake
- RE - Right Bank Exhaust



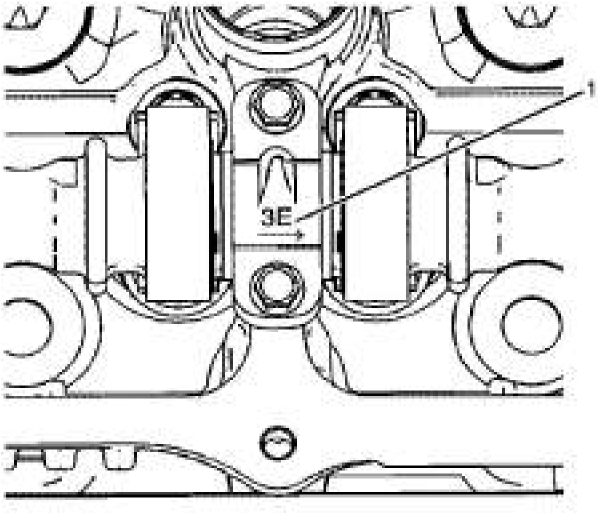
4. Apply a liberal amount of engine oil to the camshaft (1) journals and the right cylinder head (2) camshaft carriers.



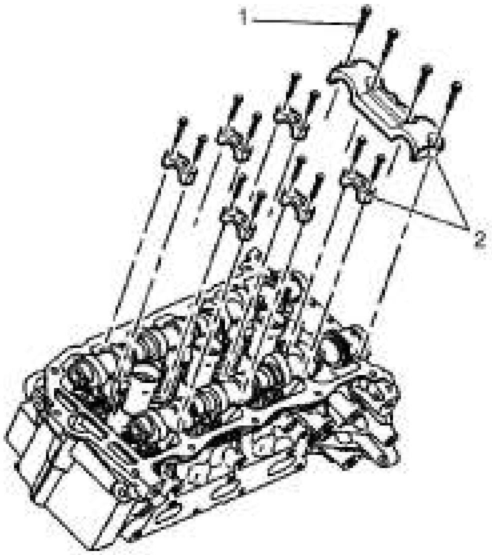
5. Place the camshafts (1) in position in the right cylinder head (2).



6. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the right cylinder head camshaft cover rail.

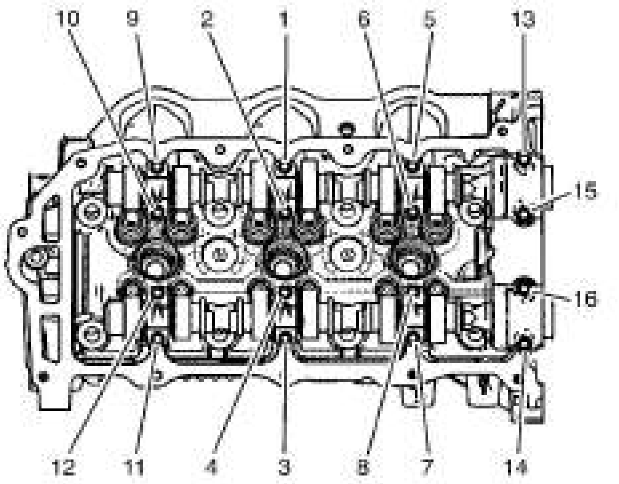


7. Observe the markings on the right cylinder head camshaft bearing caps. Each bearing cap is marked (1) in order to identify its location. The markings have the following meanings:
   - The raised feature must always be oriented toward the center of the cylinder head.
   - The I indicates the intake camshaft.
   - The E indicates the exhaust camshaft.
   - The number 1, 3, 5 indicates the cylinder position from the front of the cylinder block.
8. Apply a liberal amount of engine oil to the camshaft bearing caps.



9. Install the camshaft bearing thrust cap (2) in the first journal of the right cylinder head.
10. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
11. Hand start all the camshaft bearing cap to cylinder head retaining bolts (1).

Notice: Refer to Fastener Notice in the Preface section.



12. Tighten the camshaft bearing cap to cylinder head retaining bolts in the sequence shown.

    Tighten
    Tighten the bolts in sequence to 10 N·m (89 lb in).

13. Loosen the center intake camshaft bearing cap to cylinder head retaining bolts (1, 2) and the center exhaust camshaft bearing cap to cylinder head retaining bolts (3, 4).
14. Retighten the center camshaft bearing cap to cylinder head retaining bolts (1, 2, 3, 4).

    Tighten
    Retighten the bolts to 10 N·m (89 lb in).

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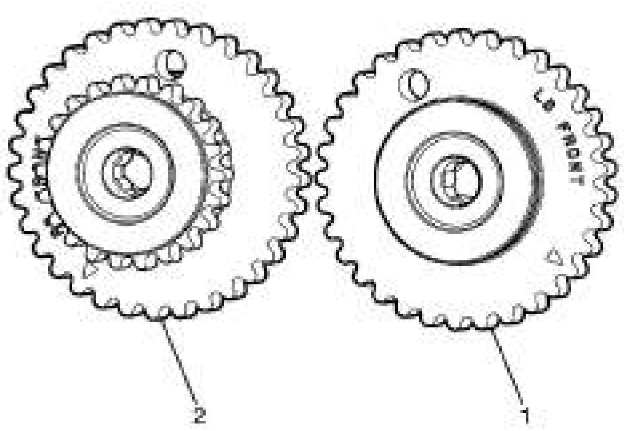
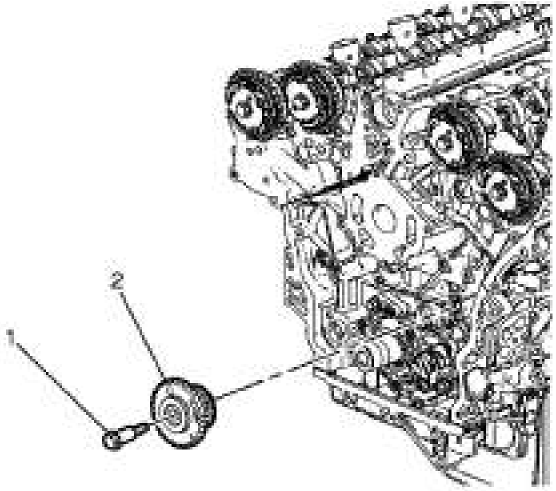
Camshaft Intermediate Drive Chain Idler Installation - Left Side



1. Make sure that the left camshaft intermediate drive chain idler (1) is being installed. The recessed hub (2) and the larger sprocket of the left camshaft intermediate drive chain idler is installed outward. The raised hub and the smaller sprocket of the left camshaft intermediate drive chain idler is installed towards the cylinder block.



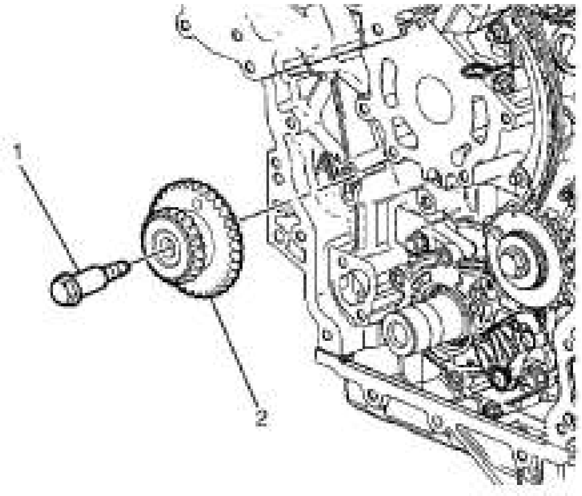
2. Install the left camshaft intermediate drive chain idler (2).

Notice: Refer to Fastener Notice in the Preface section.

3. Install the camshaft intermediate drive chain idler to cylinder block retaining bolt (1).

   Tighten
   Tighten the bolt to 58 N·m (43 lb ft).

Camshaft Intermediate Drive Chain Idler Installation - Right Side



Important: The recessed hub and the smaller sprocket of the right camshaft intermediate drive chain idler (2) is installed outward. The raised hub and the larger sprocket of the right camshaft intermediate drive chain idler (2) is installed towards the block.

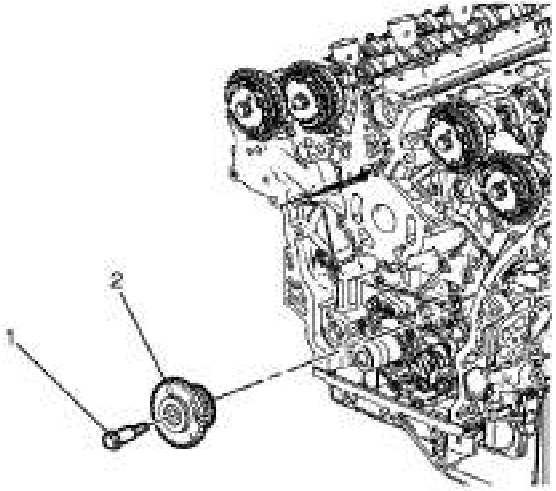
1. Install the right camshaft intermediate drive chain idler (2).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the camshaft intermediate drive chain idler bolt (1).

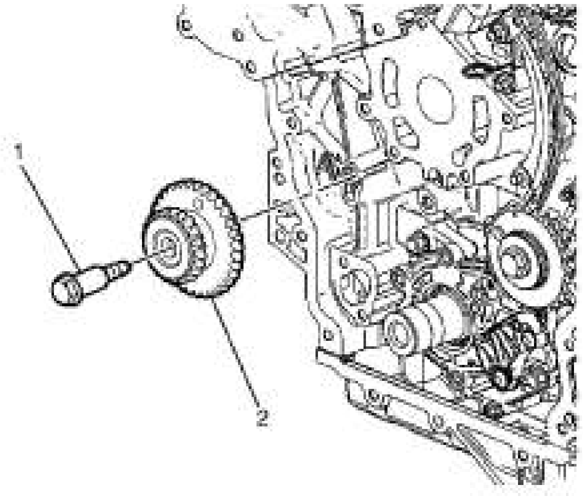
   Tighten
   Tighten the bolt to 58 N·m (43 lb ft).

Camshaft Intermediate Drive Chain Idler Removal - Left Side



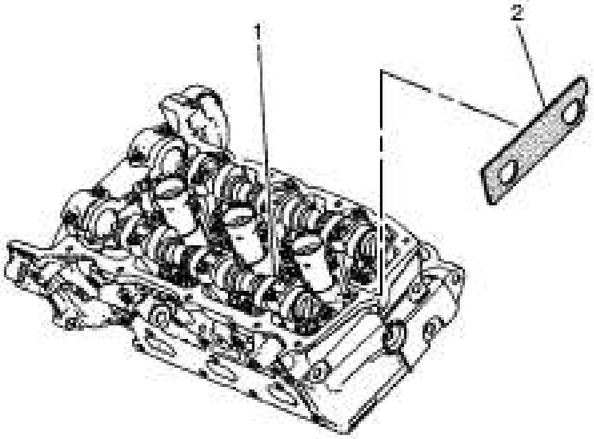
1. Remove the left camshaft intermediate drive chain idler to cylinder block retaining bolt (1).
2. Remove the left camshaft intermediate drive chain idler (2).

Camshaft Intermediate Drive Chain Idler Removal - Right Side



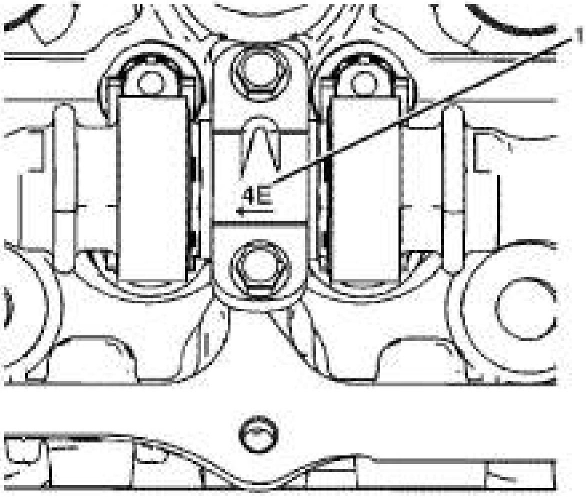
1. Remove the right camshaft intermediate drive chain idler bolt (1).
2. Remove the right camshaft intermediate drive chain idler (2).

Camshaft Removal - Left Side



Important: EN 46105 (2) was installed to the camshafts (1) as part of the left bank cylinder head camshaft position actuator removal procedure.

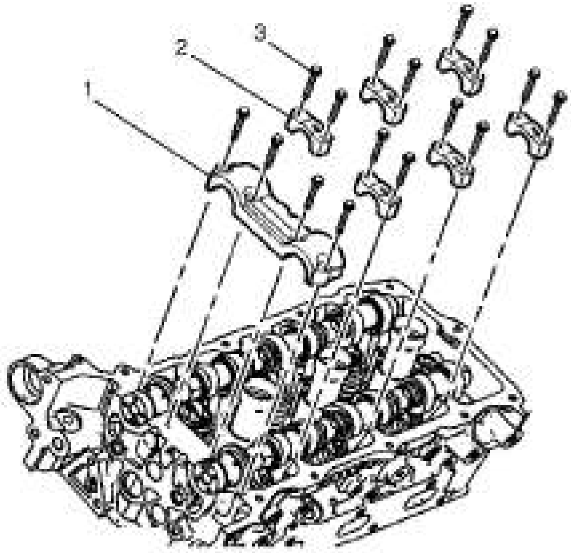
1. Remove the EN 46105 (2) from the left bank camshafts (1).
2. Position the camshaft lobes in a neutral position.



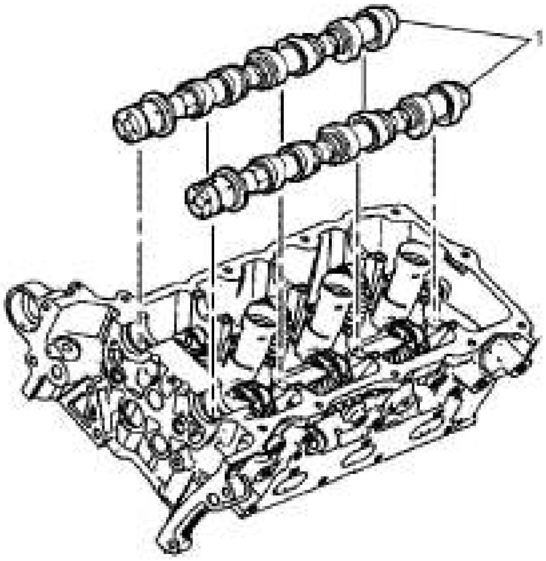
3. Observe the markings (1) on the bearing caps. Each bearing cap is marked in order to

identify its location. The markings have the following meanings:

- The raised feature must always be oriented toward the center of the cylinder head.
- The I indicates the intake camshaft.
- The E indicates the exhaust camshaft.
- The number indicates the journal position from the front of the cylinder block.



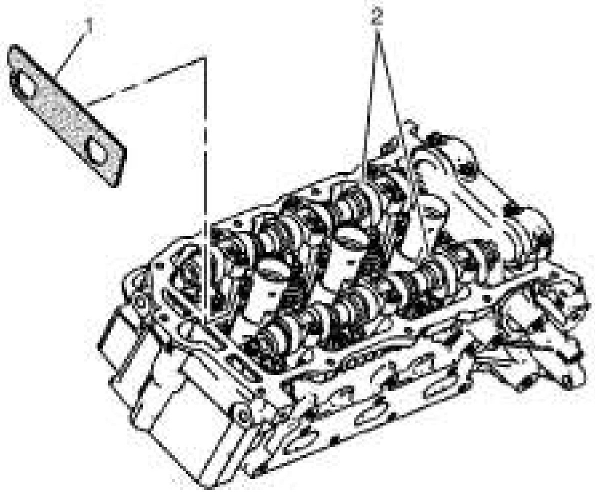
4. Remove the camshaft bearing cap to cylinder head retaining bolts (3).
5. Remove the camshaft bearing caps (1 and 2).



6. Remove the camshafts (1).

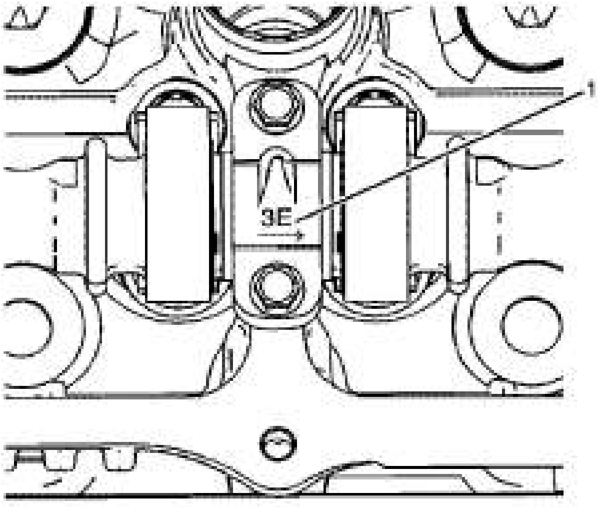
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | **Document ID: 1977598**

Camshaft Removal - Right Side



Important: EN 46105 (1) was installed to the camshafts (2) as part of the right bank cylinder head camshaft position actuator removal procedure.

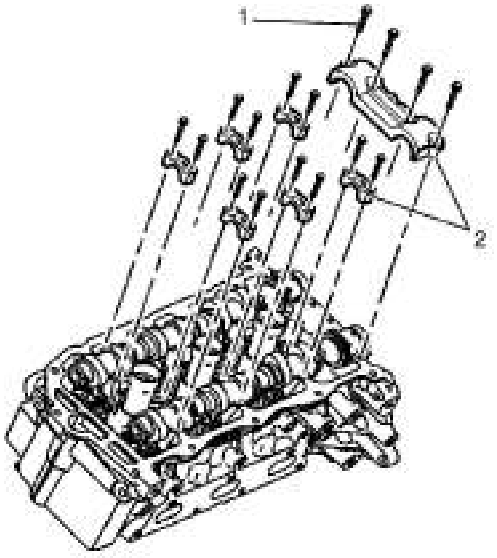
1. Remove the EN 46105 (1) from the right bank camshafts (2).
2. Position the camshaft lobes in a neutral position.



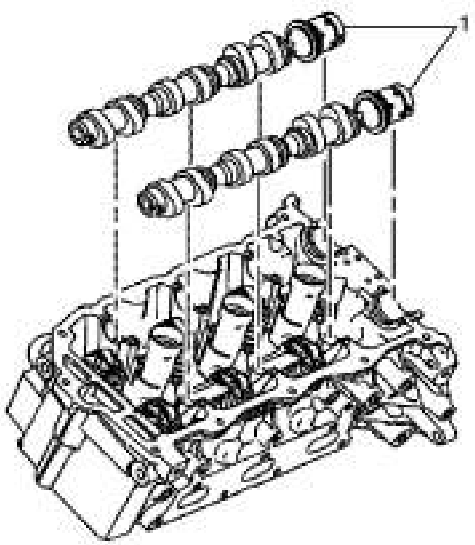
3. Observe the markings (1) on the bearing caps. Each bearing cap is marked in order to

identify its location. The markings have the following meanings:

- The raised feature must always be oriented toward the center of the cylinder head.
- The I indicates the intake camshaft.
- The E indicates the exhaust camshaft.
- The number indicates the journal position from the front of the cylinder block.



4. Remove the camshaft bearing cap to cylinder head retaining bolts (1).
5. Remove the camshaft bearing caps (2).



6. Remove the camshafts (1).

Camshaft Timing Drive Components Cleaning and Inspection

Cleaning Procedure

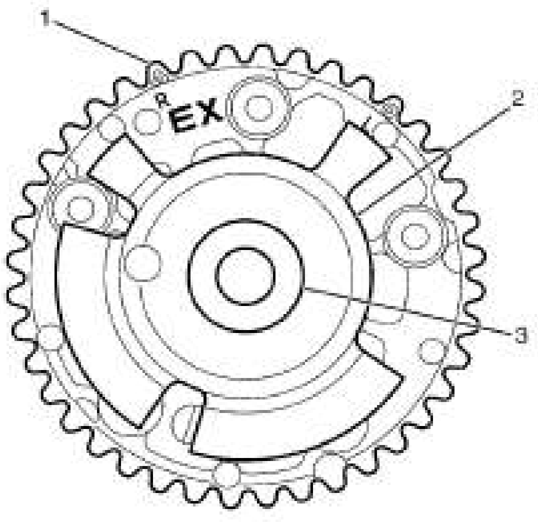
1. Clean all the following components with solvent:
   - Crankshaft sprocket.
   - Primary timing drive chain.
   - Primary timing drive chain shoe.
   - Primary timing drive chain guides.
   - Primary timing drive chain tensioner.
   - Secondary timing drive chains.
   - Secondary timing drive chain shoes.
   - Secondary timing drive chain guides.
   - Secondary timing drive chain tensioners.
   - Timing component fastening bolts.
2. Clean each camshaft position actuator's exterior with solvent.

   Caution: Refer to Safety Glasses Caution in the Preface section.

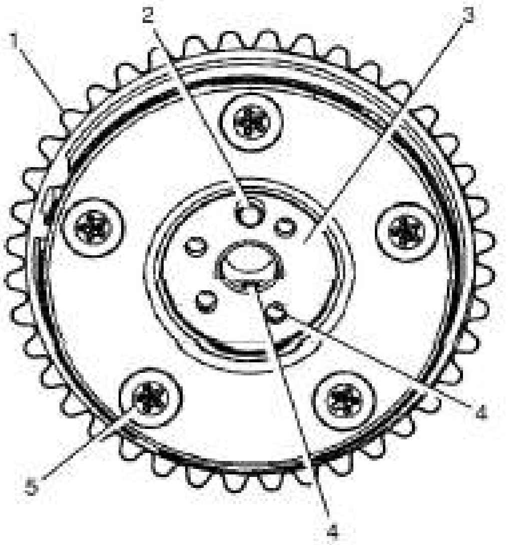
3. Dry the timing components with compressed air.

Visual Inspection

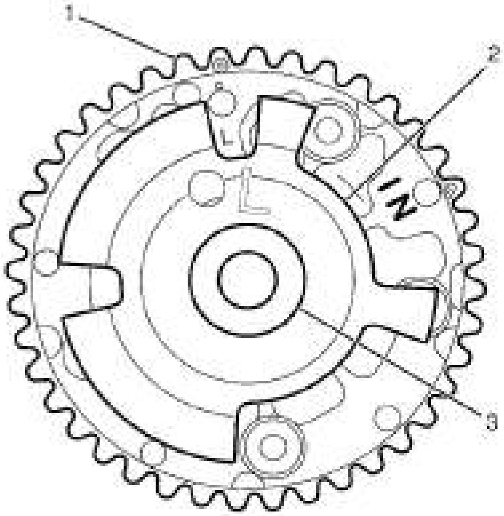
Camshaft Position Actuators (LY7 Engine)



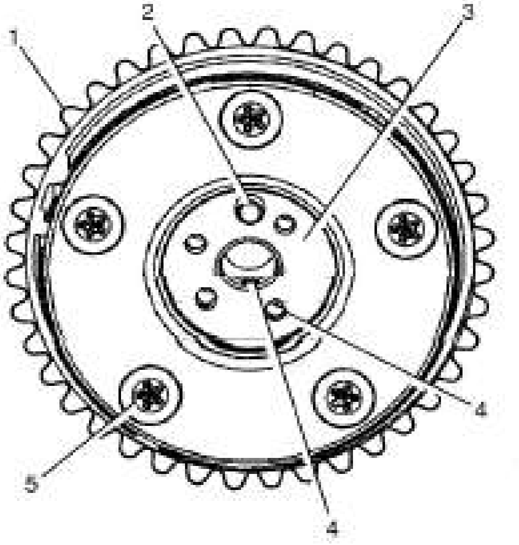
1. Inspect the front of the exhaust camshaft position actuators for the following:
    - Sprocket damage (1).
    - Reluctor/sensor wheel damage (2).
    - Camshaft position actuator to camshaft retaining bolt seating/sealing inner hub flange damage (3).



2. Inspect the back of the exhaust camshaft position actuators for the following:
    - Sprocket damage (1).
    - Camshaft locating pin damage (2).
    - Camshaft seating/sealing inner hub flange damage (3).
    - Blockage to the oil passages (4).
    - Loose or missing housing bolts (5).



3. Inspect the front of the intake camshaft position actuators for the following:
   - Sprocket damage (1).
   - Reluctor/sensor wheel damage (2).
   - Camshaft position actuator oil control valve bolt seating/sealing inner hub flange damage (3).

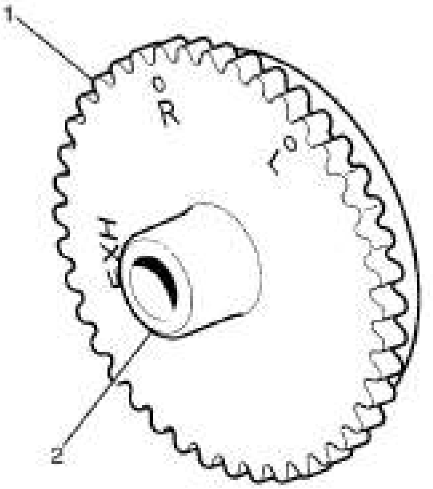


4. Inspect the back of the intake camshaft position actuators for the following:
   - Sprocket damage (1).
   - Camshaft locating pin damage (2).
   - Camshaft seating/sealing inner hub flange damage (3).
   - Blockage to the oil passages (4).

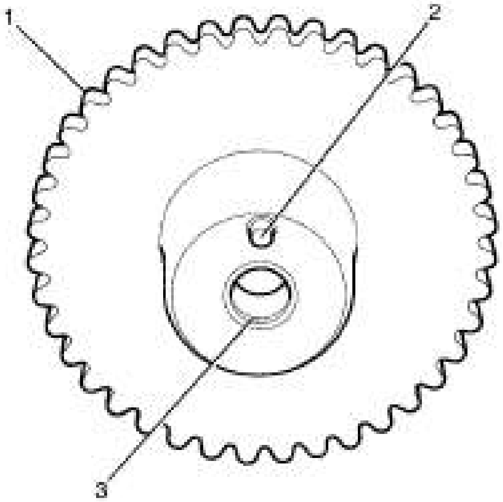
- Loose or missing housing bolts (5).

5. Replace a damaged camshaft position actuator.

Camshaft Position Actuators and Sprockets (LE0 & LW2 Engines)

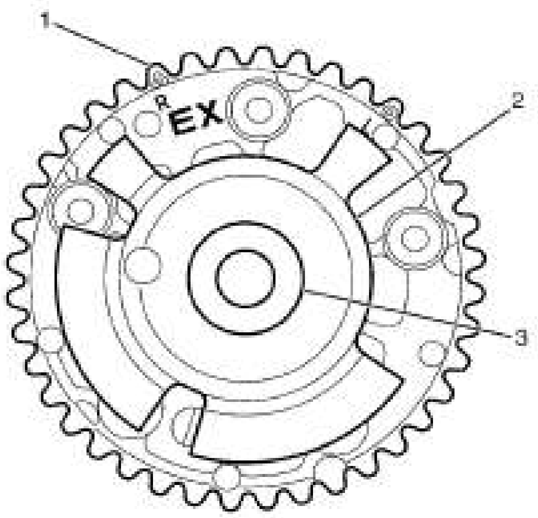


1. Inspect the front of the exhaust camshaft sprockets for the following:
   - Sprocket damage (1).
   - Exhaust camshaft sprocket bolt seating inner hub damage (2).

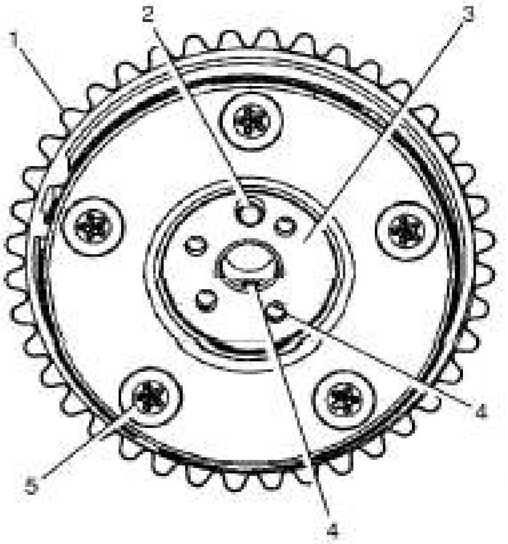


2. Inspect the back of the exhaust camshaft sprockets for the following:
   - Sprocket damage (1).

- Camshaft locating pin damage (2).
- Camshaft seating/ sealing inner hub flange damage (3).



3. Inspect the front of the intake camshaft position actuators for the following:
   - Sprocket damage (1).
   - Reluctor/sensor wheel damage (2).
   - Camshaft position actuator oil control valve bolt seating/sealing inner hub flange damage (3).

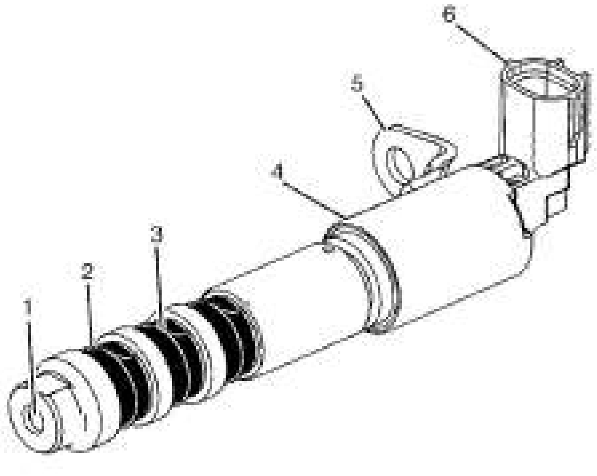


4. Inspect the back of the intake camshaft position actuators for the following:
   - Sprocket damage (1).

- Camshaft locating pin damage (2).
- Camshaft seating/sealing inner hub flange damage (3).
- Blockage to the oil passages (4).
- Loose or missing housing bolts (5).

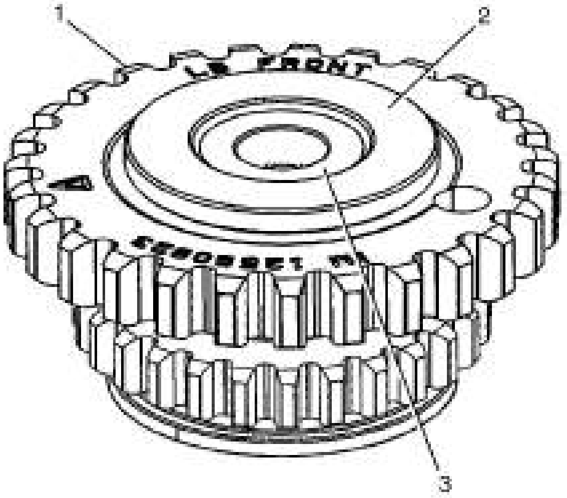
5. Replace a damaged camshaft position actuator.

Camshaft Position Actuator Solenoids

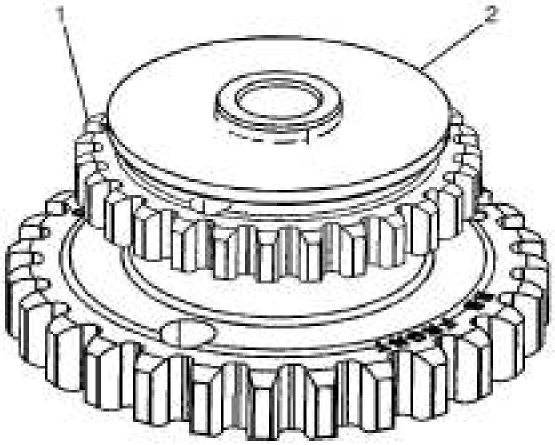


1. Inspect the camshaft position actuator solenoids for the following:
    - Blockage to the oil passage (1).
    - Missing or damaged oil screen clip (2).
    - Blockage or damage to the oil screen (3).
    - Damage to the sealing surface for the camshaft position actuator solenoid oil seal (4).
    - Damage to the bracket (5).
    - Damage to the wiring harness connection and/or terminals (6).
2. Replace a damaged camshaft position actuator solenoid.

Left Intermediate Sprocket

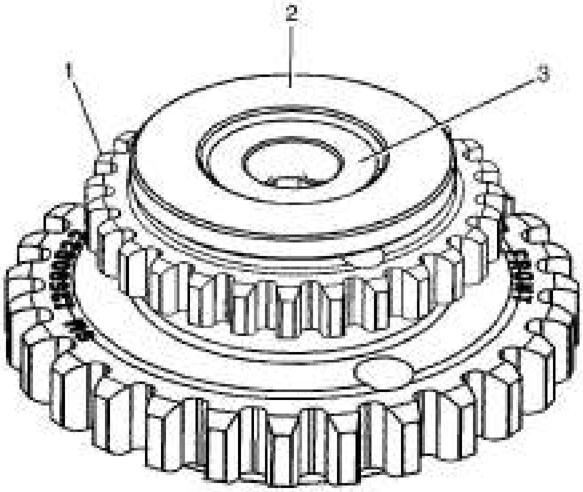


1. Inspect the front of the left intermediate sprocket for the following:
    - Damage to the primary camshaft drive chain sprocket (1).
    - Damage to the hub bearing (2) -- Ensure the hub bearing spins freely. If the hub bearing wobbles, is noisy or feels rough when rotated replace the intermediate sprocket.
    - Damage to the bolt flange seating/sealing surface (3).

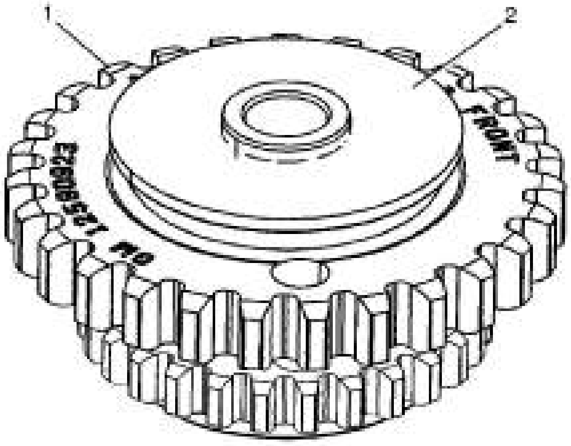


2. Inspect the back of the intermediate sprocket for the following:
    - Damage to the left secondary camshaft drive chain sprocket (1).
    - Damage to the bearing hub-to-engine block sealing surface (2).
3. Replace a damaged left intermediate sprocket.

Right Intermediate Sprocket



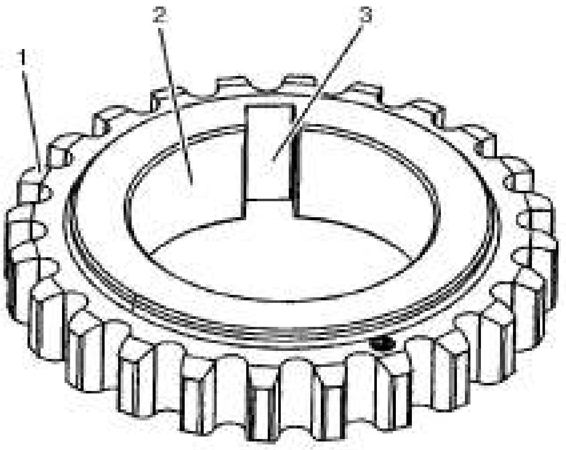
1. Inspect the front of the right intermediate sprocket for the following:
   - Damage to the right secondary camshaft drive chain sprocket (1)
   - Damage to the bearing hub bearing (2) -- Ensure the hub bearing spins freely. If the hub bearing wobbles, is noisy or feels rough when rotated replace the intermediate sprocket.
   - Damage to the bolt flange seating/sealing surface (3)



2. Inspect the back of the right intermediate sprocket for the following:
   - Damage to the primary camshaft drive chain sprocket (1)

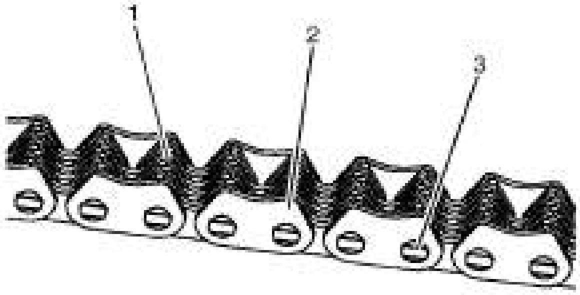
  - Damage to the bearing hub-to-engine block sealing surface (2)
3. Replace a damaged right intermediate sprocket.

Crankshaft Sprocket



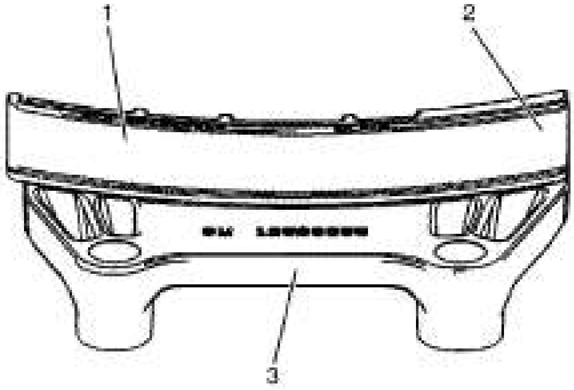
1. Inspect the crankshaft sprocket for the following:
   - Sprocket damage (1)
   - Bore damage (2)
   - Keyway damage (3)
2. Replace a damaged crankshaft sprocket.

Primary and Secondary Timing Chains



1. Inspect the primary and secondary timing chains for the following:
    - Binding or worn links (1)
    - Loose links (2)
    - Loose pins (3)
2. Replace a damaged primary timing chain.

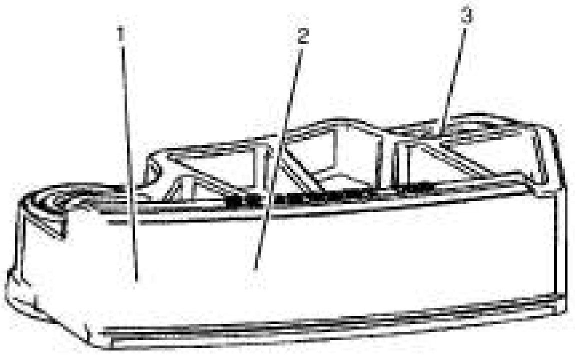
Primary Timing Chain Upper Guide



1. Inspect the primary timing chain upper guide for the following:
    - Worn guide surface (1)

  - Cracked or broken guide surface (2)
  - Cracked or damaged guide base (3)
2. Replace a damaged primary timing chain upper guide.

Primary Timing Chain Lower Guide

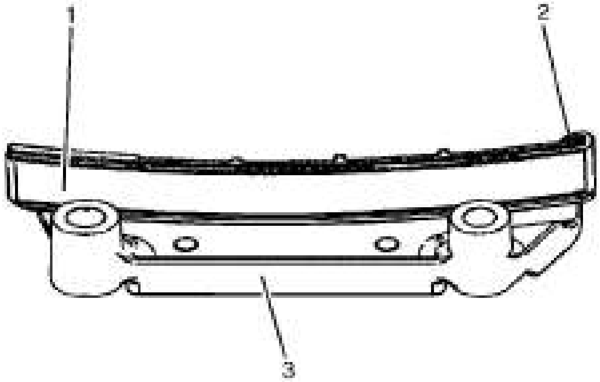


1. Inspect the primary timing chain lower guide for the following:
   - Worn guide surface (1)
   - Cracked or broken guide surface (2)
   - Cracked or damaged guide base (3)

   Important: The primary camshaft drive chain lower guide is not a serviceable component. If the primary camshaft drive chain lower guide is to be reused, the primary camshaft drive chain lower guide is not to be removed from the oil pump cover. If the primary camshaft drive chain lower guide must be replaced, the oil pump must be replaced.

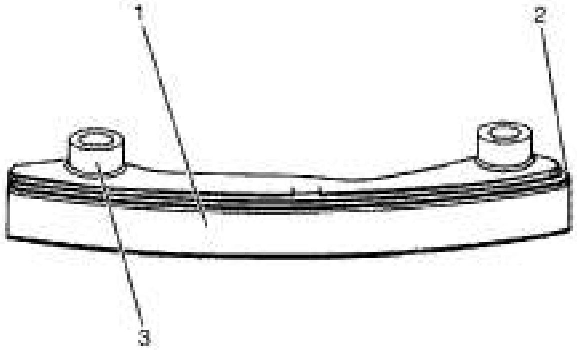
2. Replace a damaged primary timing chain lower guide by replacing the oil pump.

Left Secondary Timing Chain Guide



1. Inspect the left secondary timing chain guide for the following:
   - Worn guide surface (1)
   - Cracked or broken guide surface (2)
   - Cracked or damaged guide base (3)
2. Replace a damaged left secondary timing chain guide.

Right Secondary Timing Chain Guide

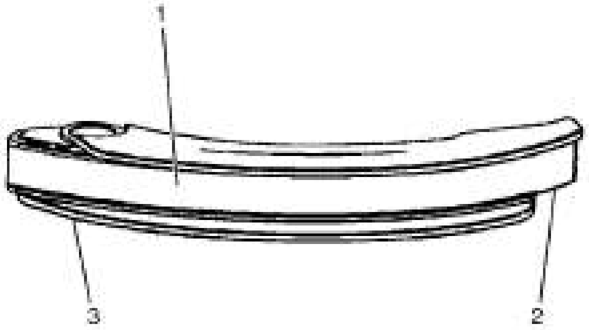


1. Inspect the right secondary timing chain guide for the following:
   - Worn guide surface (1)

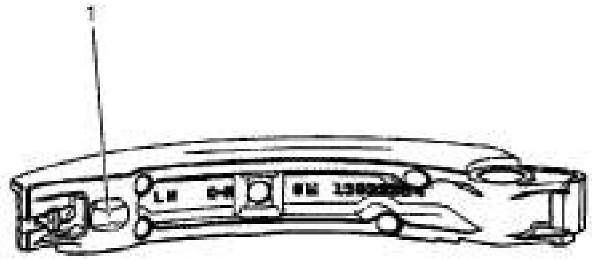
- Cracked or broken guide surface (2)
- Cracked or damaged guide base (3)

2. Replace a damaged right secondary timing chain guide.

Left Secondary Timing Chain Shoe

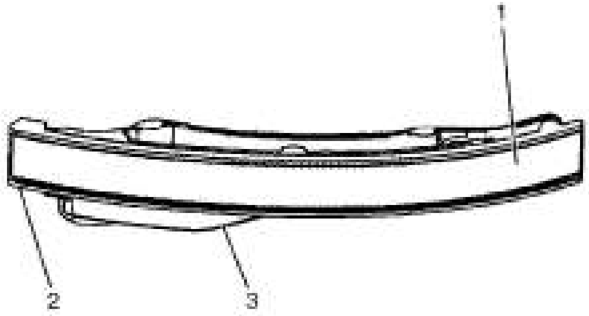


1. Inspect the front of the left secondary timing chain shoe for the following:
   - Worn shoe surface (1)
   - Cracked or broken shoe surface (2)
   - Cracked or damaged shoe (3)

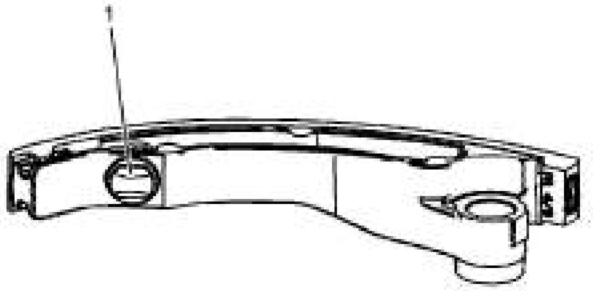


2. Inspect the back of the left secondary timing chain shoe for a damaged, worn or missing left secondary timing chain tensioner contact pad (1).
3. Replace a damaged left secondary timing chain shoe.

Right Secondary Timing Chain Shoe

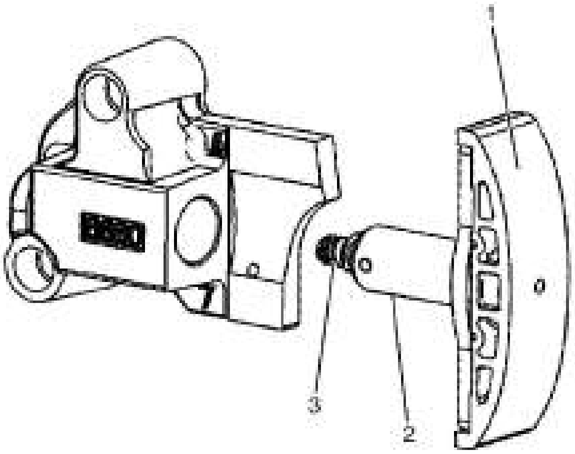


1. Inspect the front of the right secondary timing chain shoe for the following:
   - Worn shoe surface (1)
   - Cracked or broken shoe surface (2)
   - Cracked or damaged shoe (3)



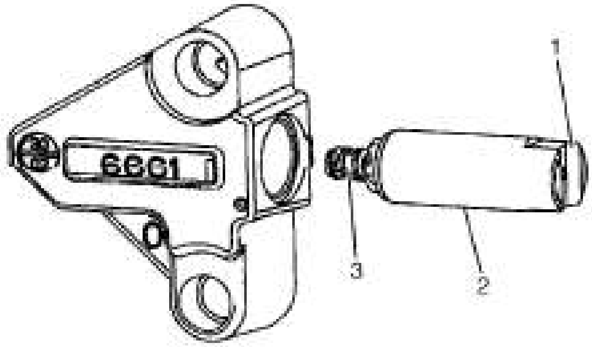
2. Inspect the back of the right secondary timing chain shoe for a damaged, worn or missing right secondary timing chain tensioner contact pad (1).
3. Replace a damaged right secondary timing chain shoe.

Primary Timing Chain Tensioner



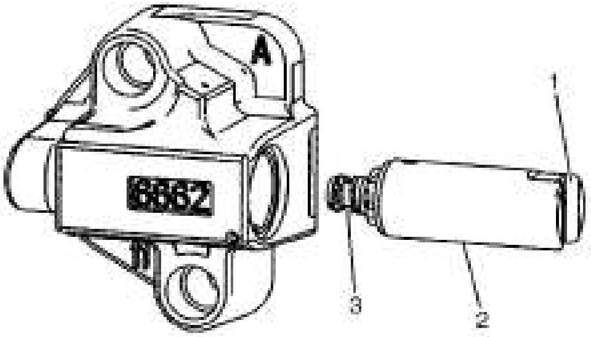
1. Inspect the primary timing chain tensioner for worn primary timing chain tensioner shoe surface (1).
2. Inspect the primary timing chain tensioner for locked or binding timing chain tensioner. Reset the plunger (3) and ensure the plunger moves freely (2) in and out of the body of the tensioner. Refer to Primary Camshaft Intermediate Drive Chain Tensioner Removal.
3. Replace a damaged primary timing chain tensioner.

Left Secondary Timing Chain Tensioner



1. Inspect the left secondary timing chain tensioner for damaged plunger-to-shoe contact surface (1).
2. Inspect the left secondary timing chain tensioner for locked or binding timing chain tensioner. Reset the plunger (3) and ensure the plunger moves freely (2) in and out of the body of the tensioner. Refer to Secondary Camshaft Drive Chain Tensioner Installation - Left Side.
3. Replace a damaged left secondary timing chain tensioner.

Right Secondary Timing Chain Tensioner



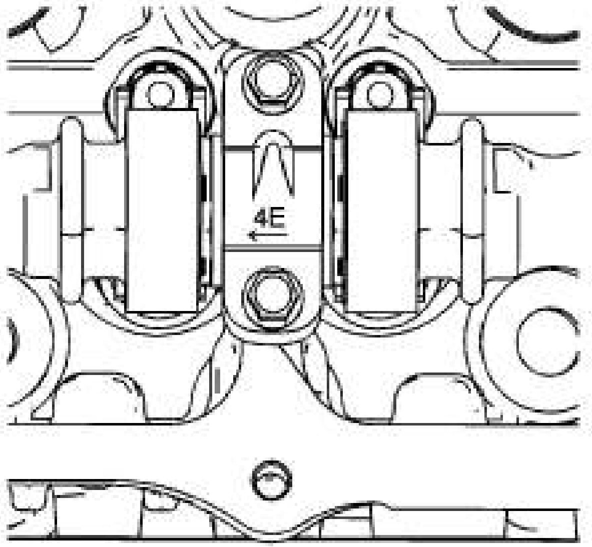
1. Inspect the right secondary timing chain tensioner for damaged plunger-to-shoe contact surface (1).
2. Inspect the right secondary timing chain tensioner for locked or binding timing chain

tensioner. Reset the plunger (3) and ensure the plunger moves freely (2) in and out of the body of the tensioner. Refer to Secondary Camshaft Drive Chain Tensioner Installation - Right Side.

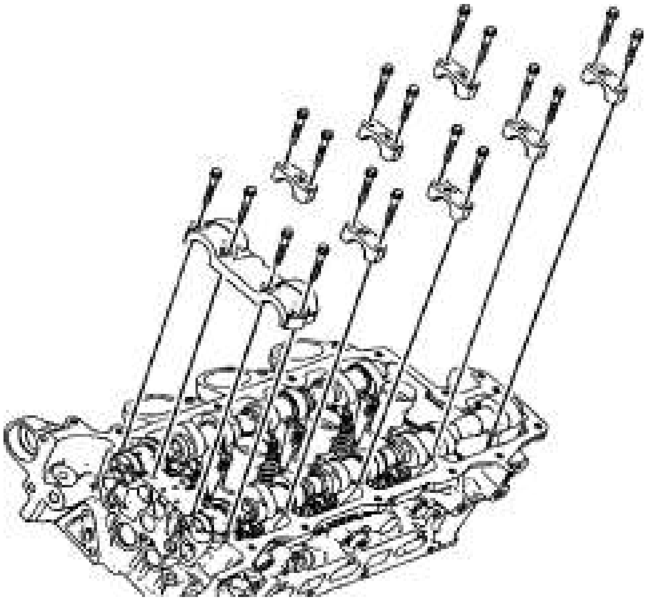
3. Replace a damaged right secondary timing chain tensioner.

2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | **Document ID: 1978377**

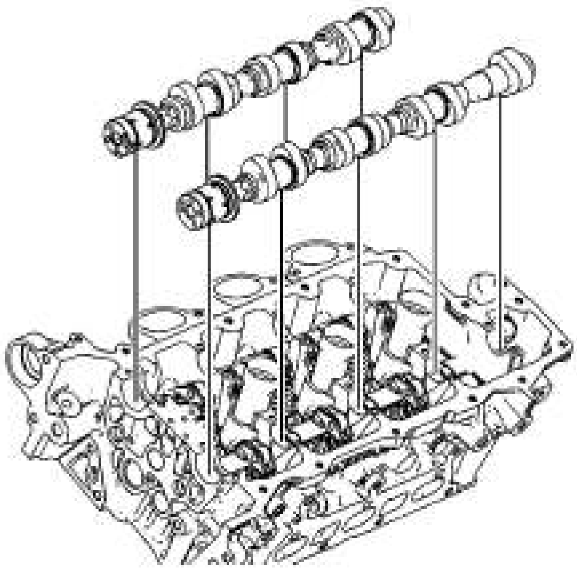
Camshaft Removal - Left Side (LLT)



1. Observe the markings on the bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
   - The raised feature must always be oriented toward the center of the cylinder head.
   - The I indicates the intake camshaft.
   - The E indicates the exhaust camshaft.
   - The number indicates the journal position from the front of the engine.



2. Remove the camshaft bearing cap bolts.
3. Remove the camshaft bearing caps.

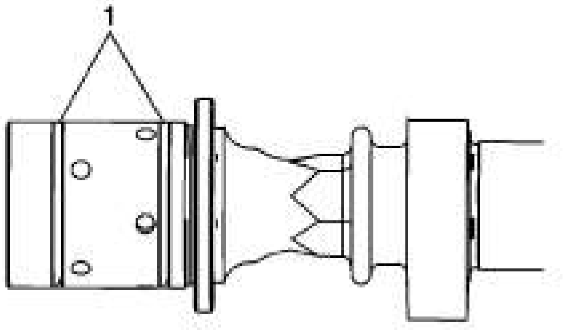


Important: Mark the camshafts upon removal to ensure installation is in the correct position.

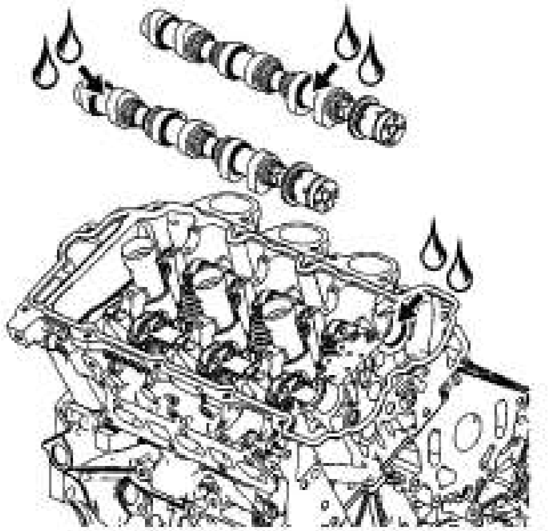
4. Remove the camshafts.
5. Replace the camshaft bearing caps and bolts.

2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | **Document ID: 2134558**

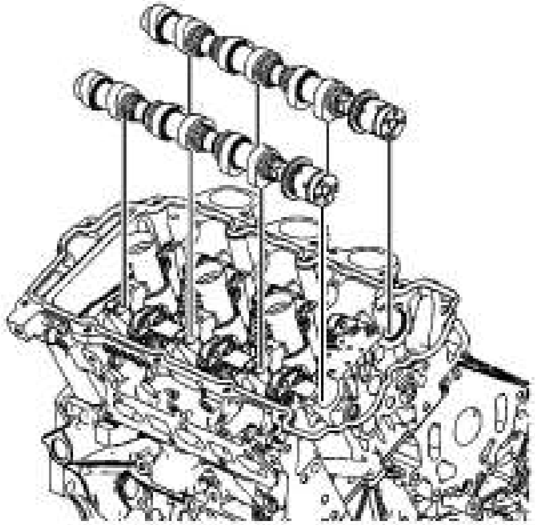
Camshaft Installation - Right Side (LLT)



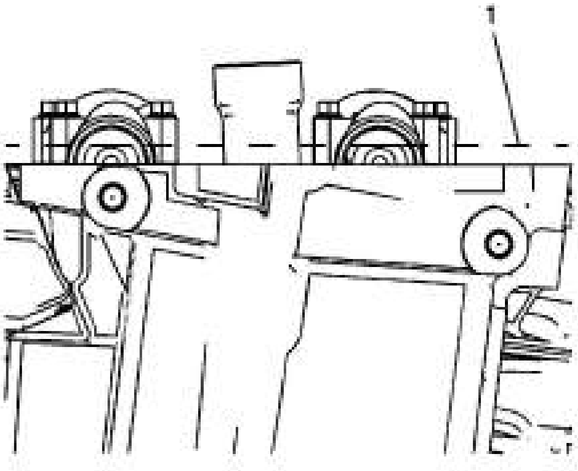
1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.



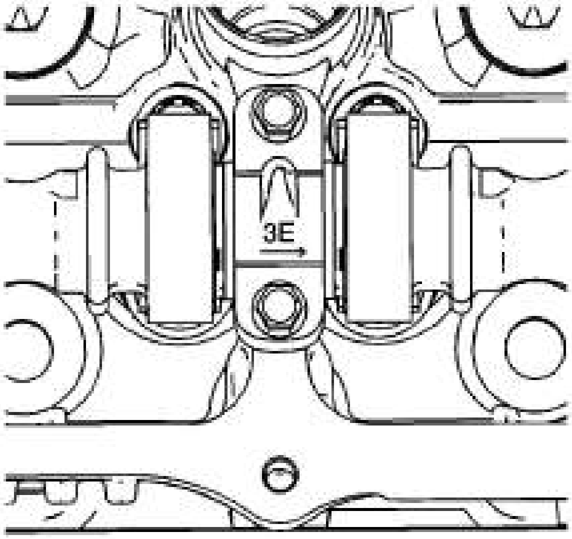
2. Apply a liberal amount of lubricant GM P/N 12345501 (Canadian P/N 992704) or equivalent to the camshaft journals and the right cylinder head camshaft carriers.



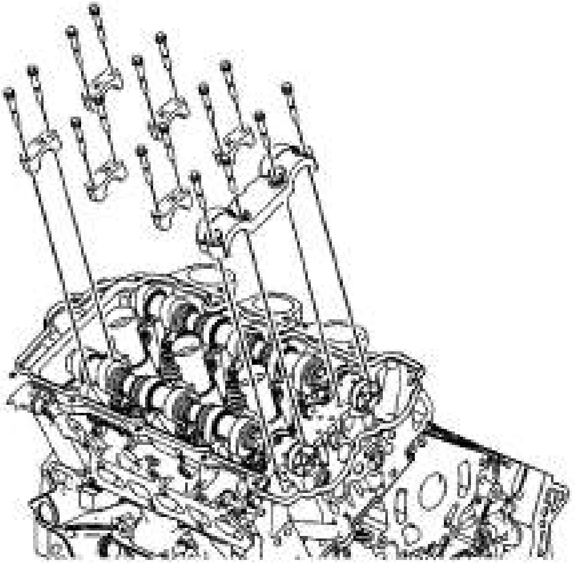
3. Place the right intake and right exhaust camshafts in position in the right cylinder head.



4. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the right cylinder head camshaft cover rail.

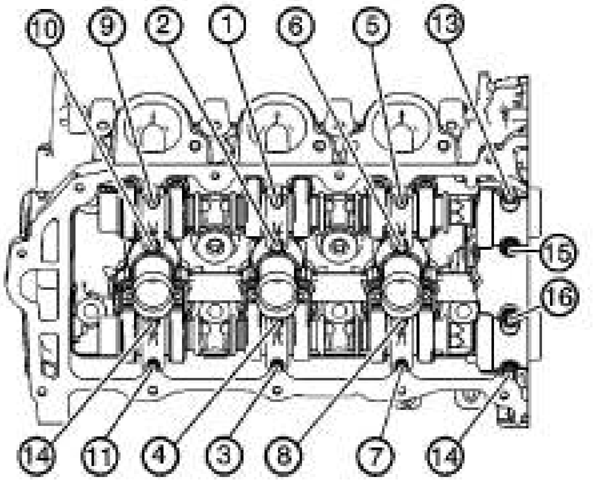


5. Observe the markings on the right cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
   - The raised feature must always be oriented toward the center of the cylinder head.
   - The I indicates the intake camshaft.
   - The E indicates the exhaust camshaft.
   - The number 1, 3, 5 indicates the cylinder position from the front of the engine.
6. Apply a liberal amount of lubricant GM P/N 12345501 (Canadian P/N 992704) or equivalent to the camshaft bearing caps.



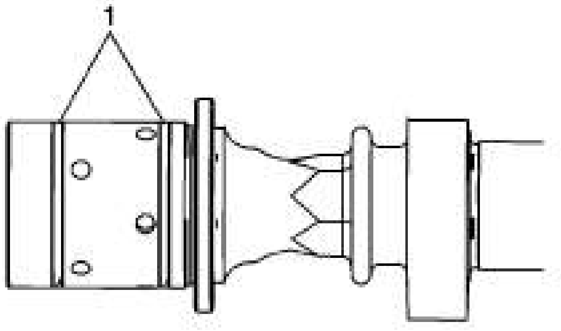
7. Install the camshaft bearing thrust caps in the first journal of the right cylinder head.
8. Install the remaining bearing caps with their orientation mark toward the center of the cylinder head.
9. Hand start all the camshaft bearing cap bolts.

Caution: Refer to Fastener Caution in the Preface section.

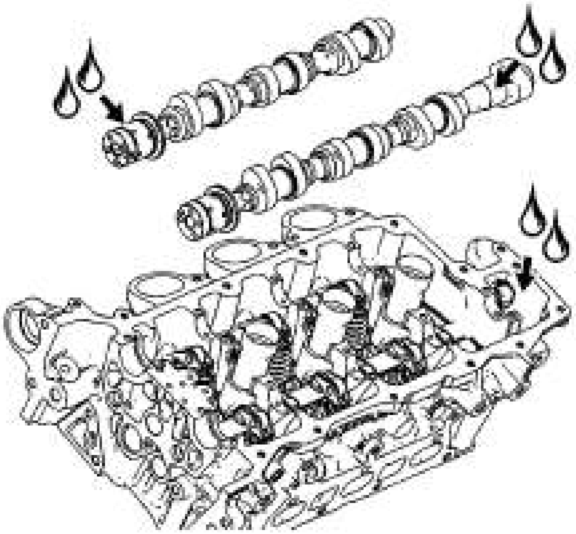


10. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to **10 N·m (89 lb in)**.
11. Loosen the center intake camshaft bearing cap bolts (1, 2) and the center exhaust camshaft bearing cap bolts (3, 4).
12. Retighten the center camshaft bearing cap bolts (1, 2, 3, 4) and retighten the camshaft bearing cap bolts to **10 N·m (89 lb in)**.

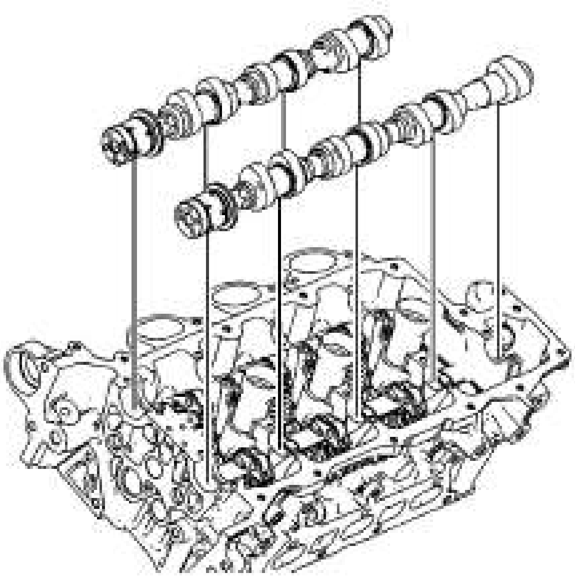
Camshaft Installation - Left Side (LLT)



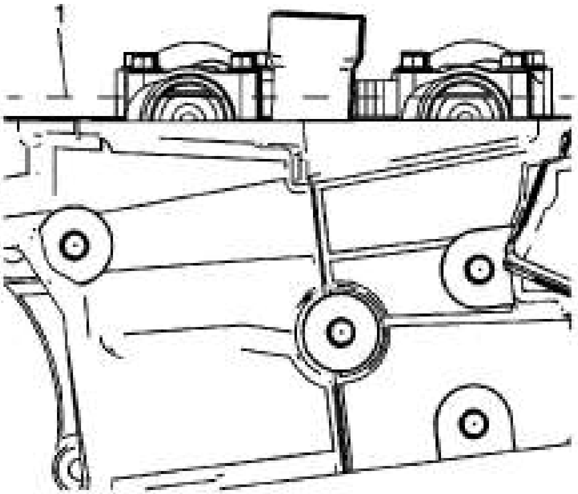
1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.



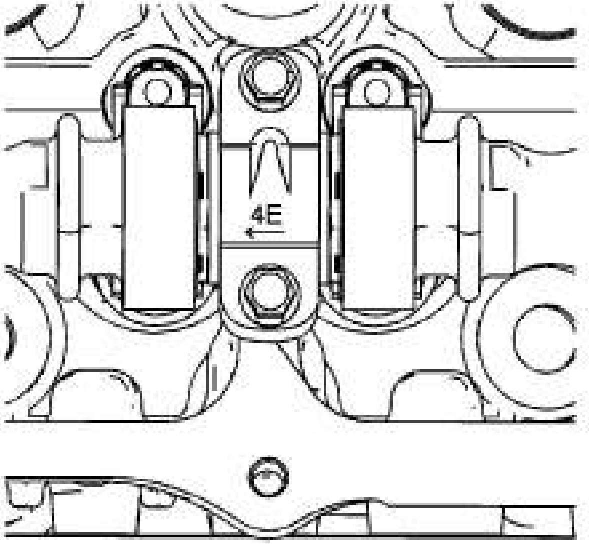
2. Apply a liberal amount of lubricant GM P/N 12345501 (Canadian P/N 992704) or equivalent to the camshaft journals and the left cylinder head camshaft carriers.



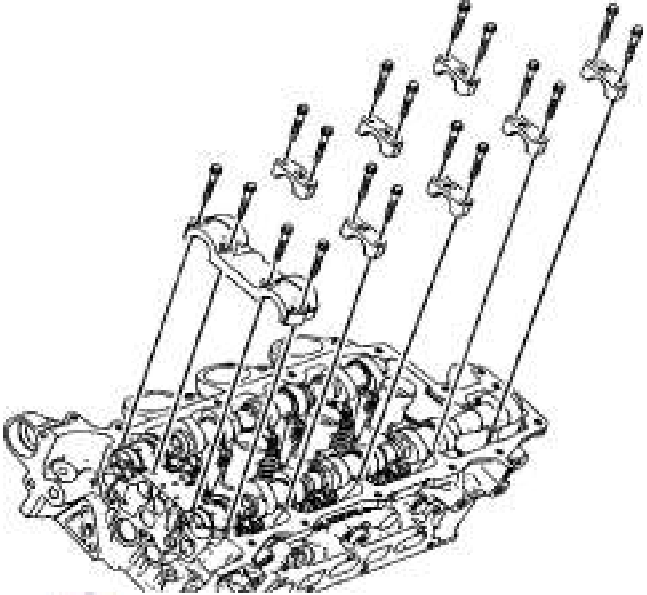
3. Place the left intake and left exhaust camshafts in position in the left cylinder head.



4. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the left cylinder head camshaft cover rail.

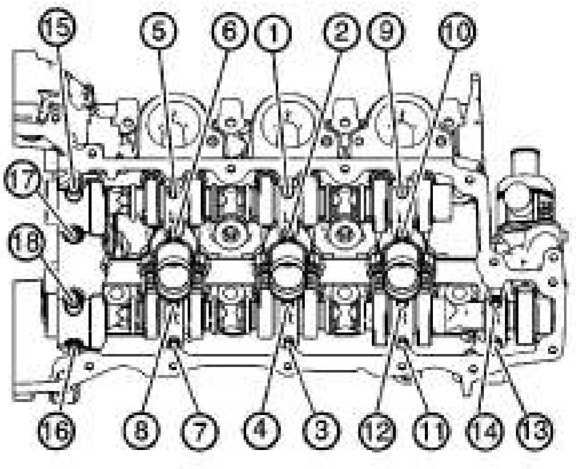


5. Observe the markings on the left cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
   - The raised feature must always be oriented toward the center of the cylinder head.
   - The I indicates the intake camshaft.
   - The E indicates the exhaust camshaft.
   - The number 2, 4, 6 indicates the cylinder position from the front of the engine.
6. Apply a liberal amount of lubricant GM P/N 12345501 (Canadian P/N 992704) or equivalent to the camshaft bearing caps.



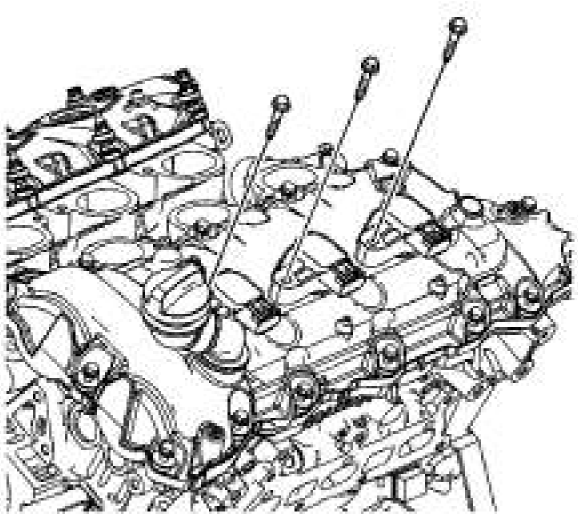
7. Install the camshaft bearing thrust cap in the first journal of the left cylinder head.
8. Install the remaining bearing caps with their orientation mark toward the center of the cylinder head.
9. Hand start all the camshaft bearing cap bolts.

Caution: Refer to Fastener Caution in the Preface section.

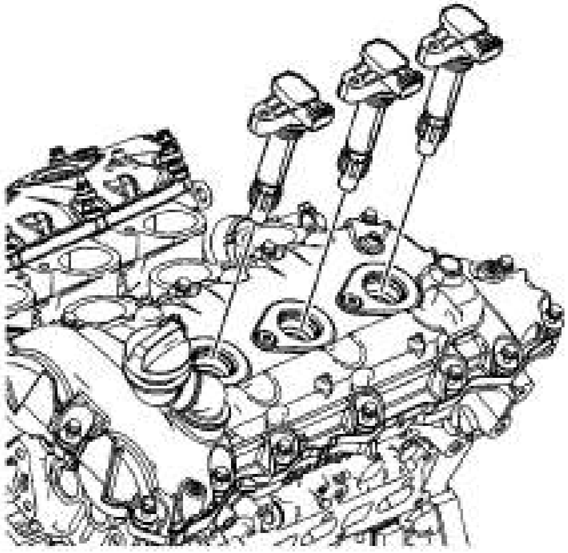


10. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to **10 N·m (89 lb in)**.
11. Loosen the center intake camshaft bearing cap bolts 1, 2 and the center exhaust camshaft bearing cap bolts 3, 4.
12. Retighten the center camshaft bearing cap bolts 1, 2, 3, 4 and retighten the camshaft bearing cap bolts to **10 N·m (89 lb in)**.

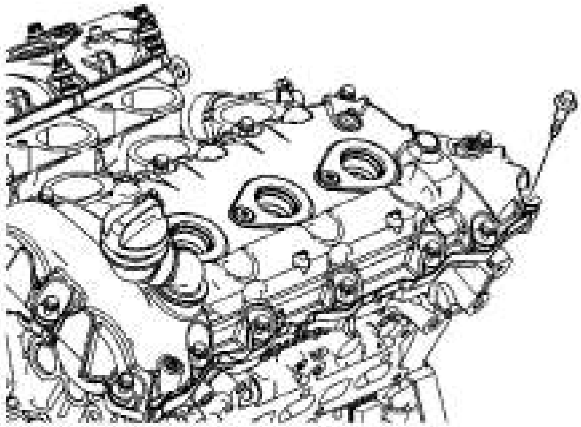
Camshaft Cover Removal - Left Side (LLT)



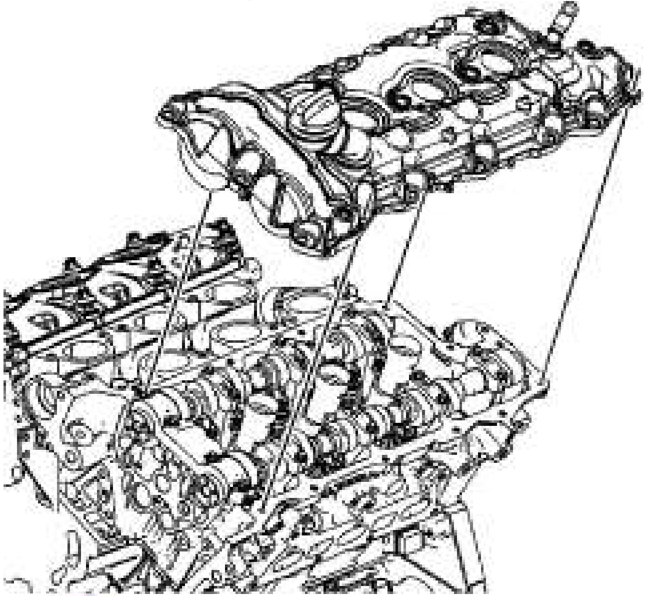
1. Remove the ignition coil bolts.



2. Remove the ignition coils.



3. Remove the left camshaft cover bolts.
4. Remove and discard the camshaft cover grommets and camshaft cover bolts if they are serviced with the grommet.



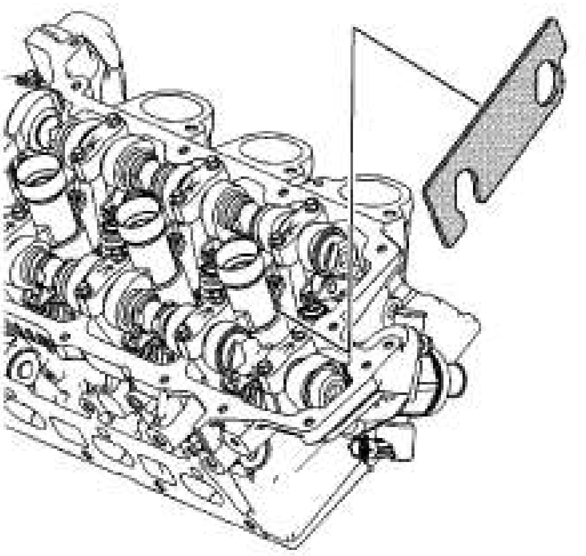
5. Remove the left camshaft cover from the left cylinder head.

Camshaft Cover Installation - Left Side (LLT)

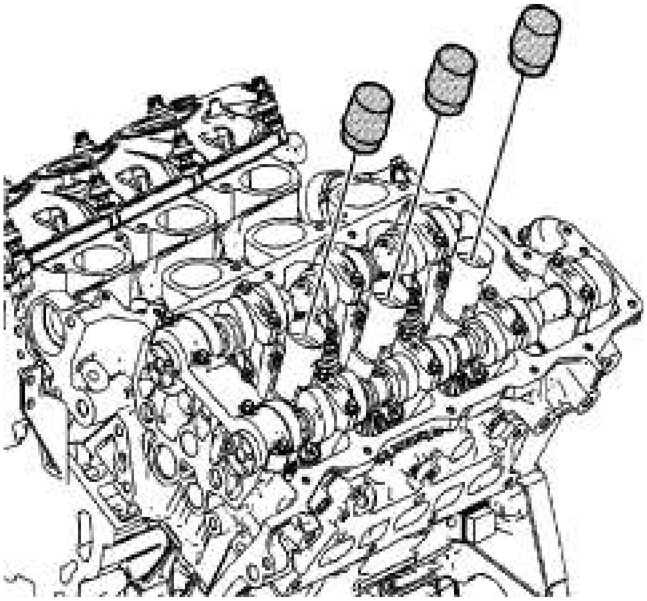
Special Tools

- *EN 46101* Spark Plug Tube Seal Guide
- *EN-48383* Camshaft Retaining Tools

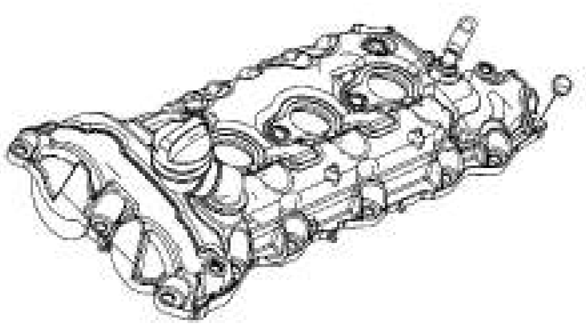
For equivalent regional tools, refer to Special Tools.



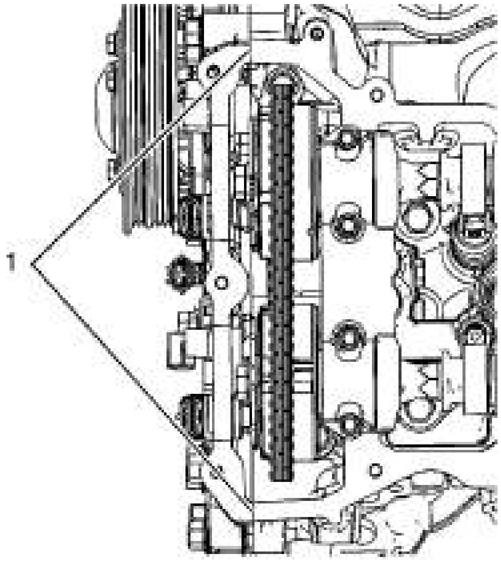
1. Remove the EN 48383-2 from the rear of the left camshafts.



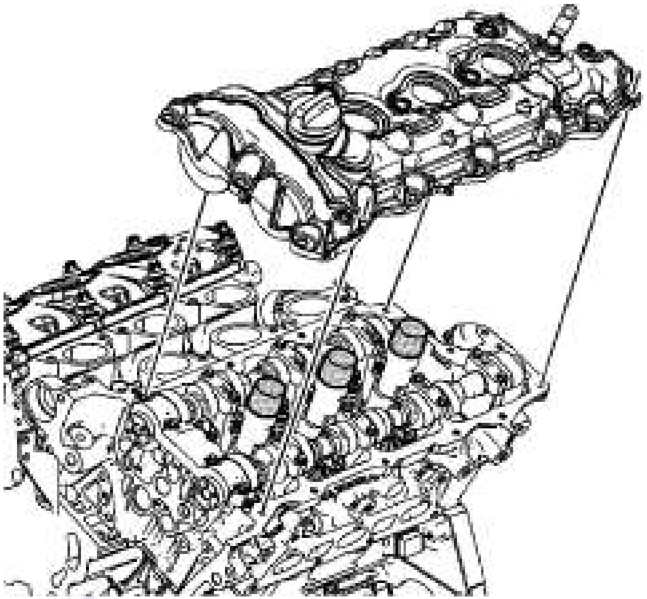
2. Install the *EN 46101* guide onto the spark plug tubes of the left cylinder head.



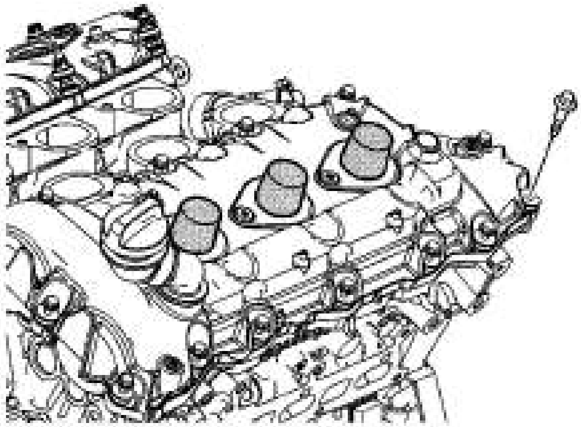
3. Install the NEW camshaft cover bolt grommets prior to installing the camshaft cover bolts.
4. Wipe the camshaft cover sealing surface on the left cylinder head with a clean, lint-free cloth.



5. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant, GM P/N 12378521 (Canadian P/N 88901148) or equivalent, on the engine front cover split lines (1).

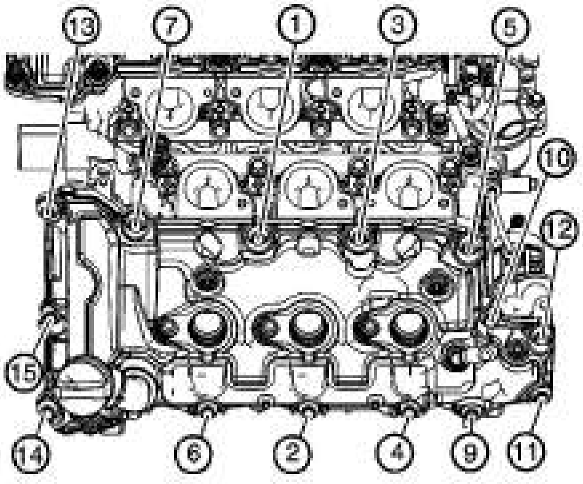


6. Place the left camshaft cover into position onto the left cylinder head.

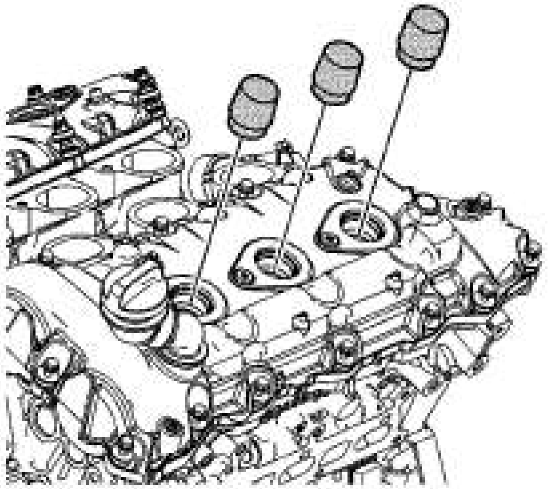


7. Loosely install the left camshaft cover bolts.

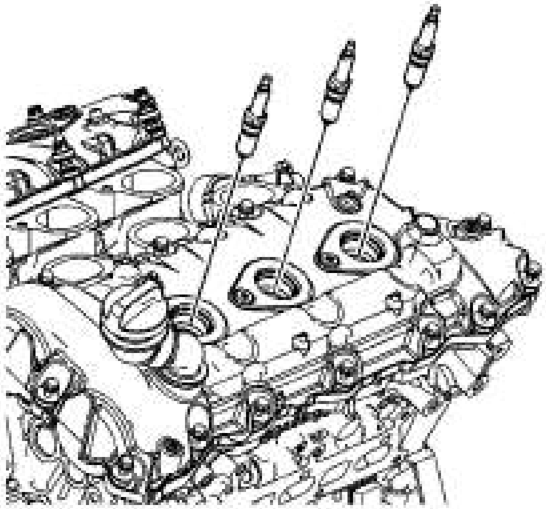
Caution: Refer to Fastener Caution in the Preface section.



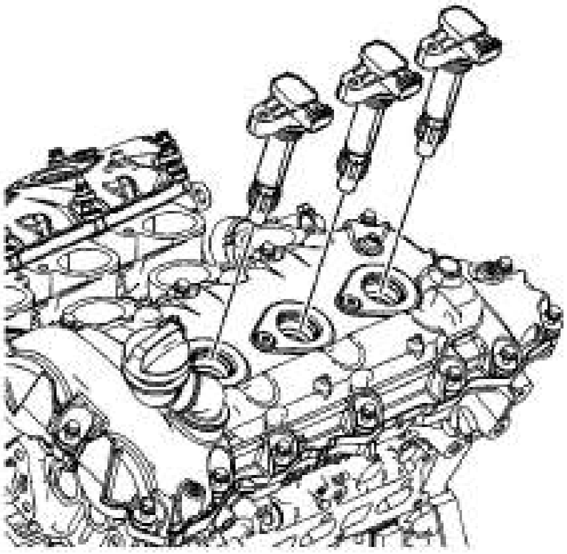
8. Tighten the left camshaft cover bolts in the sequence shown.
    8.1. Tighten the left camshaft cover bolts in the sequence to **10 N·m (89 lb in).**
    8.2. Tighten the left camshaft cover bolts a second pass in the sequence to **10 N·m (89 lb in)**.



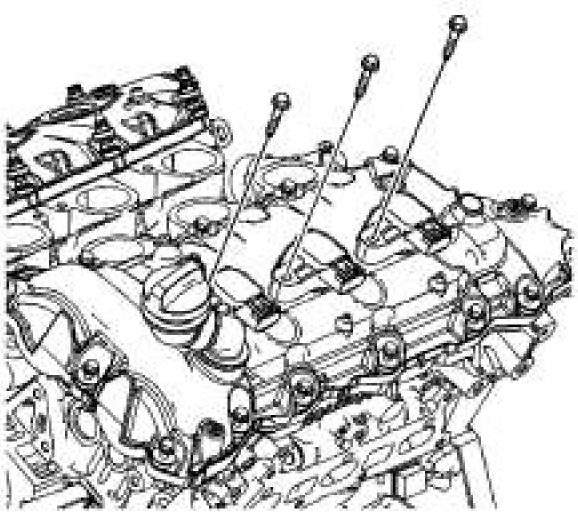
9. Remove the *EN 46101* guide from the spark plug tubes of the left cylinder head.



10. Install the NEW spark plugs into the left cylinder head and tighten to **20 N·m (15 lb ft)**..



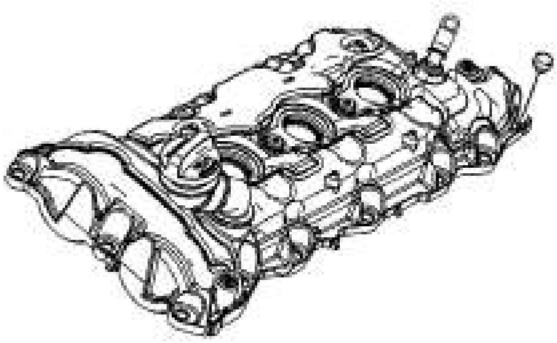
11. Install the ignition coils.



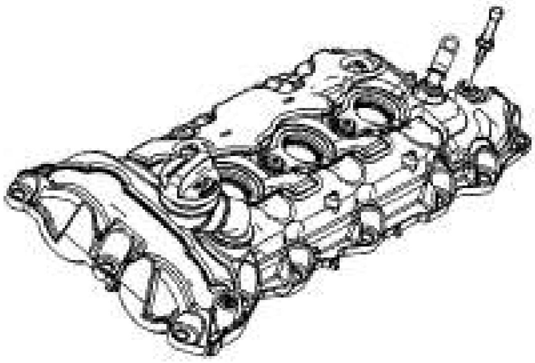
12. Install the ignition coil bolts and tighten to **10 N·m (89 lb in)**.

Camshaft Cover Disassemble (LLT)

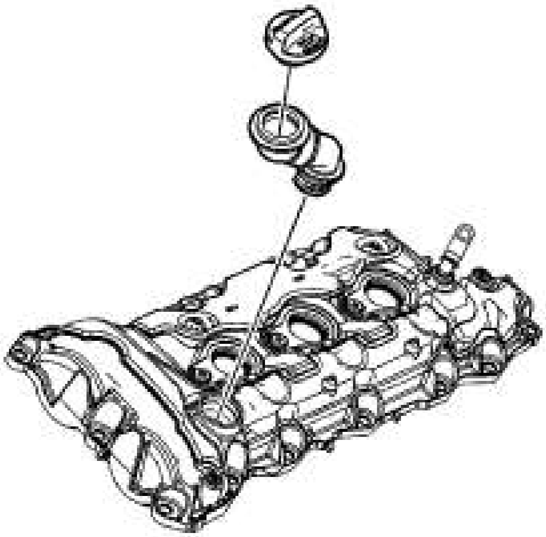
Left Camshaft Cover



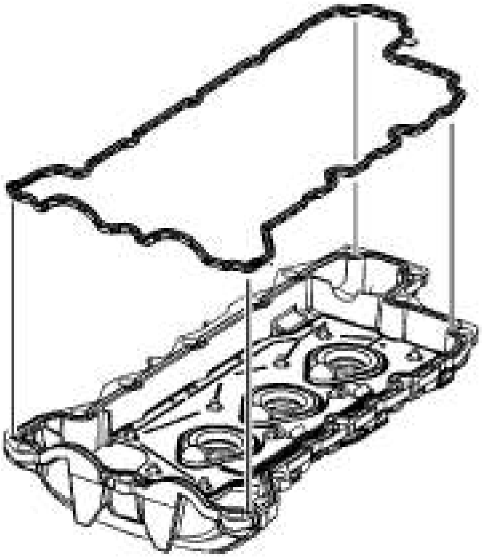
1. Remove and discard the left camshaft cover bolt grommets.



2. Remove the fuel injector sight shield ballstud.

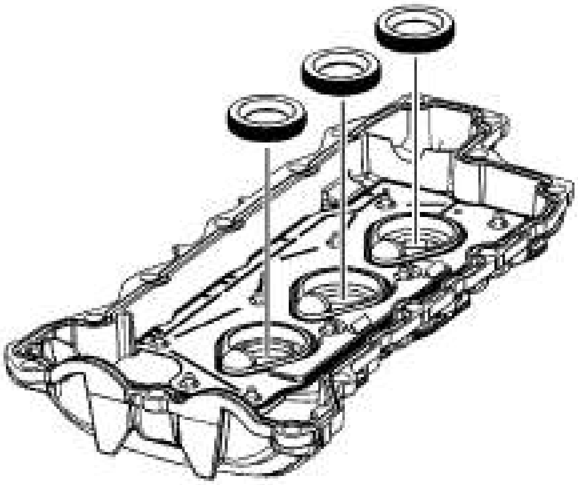


3. Remove the oil fill cap.



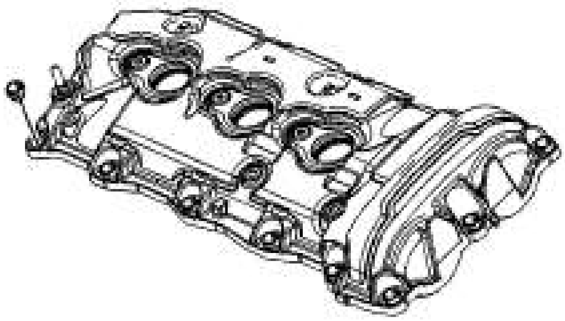
Important: Do not reuse the camshaft cover gasket and spark plug shield tube seals.

4. Remove and discard the left camshaft cover gasket.

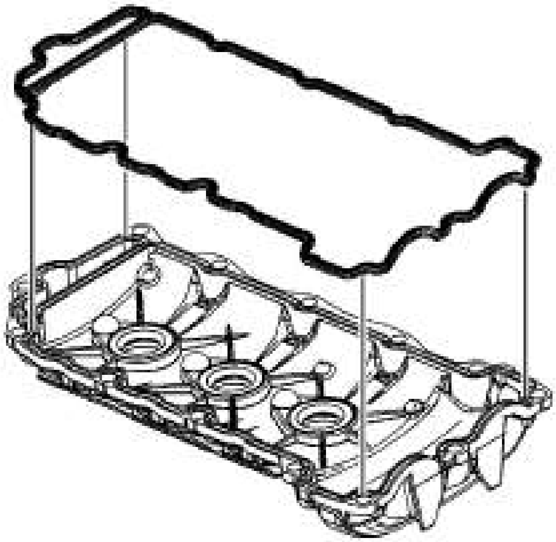


5. Remove and discard the left spark plug shield tube seals.

Right Camshaft Cover

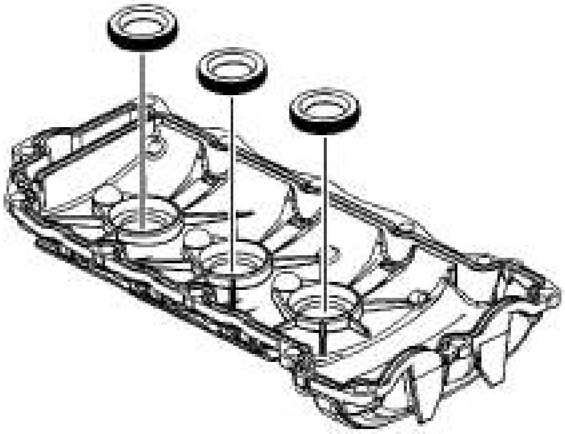


1. Remove and discard the right camshaft cover bolt grommets.



Important: Do not reuse the camshaft cover gasket and spark plug shield tube seals.

2. Remove and discard the right camshaft cover gasket.



3. Remove and discard the right spark plug shield tube seals.

Camshaft Cover Cleaning and Inspection (LLT)

Cleaning Procedure

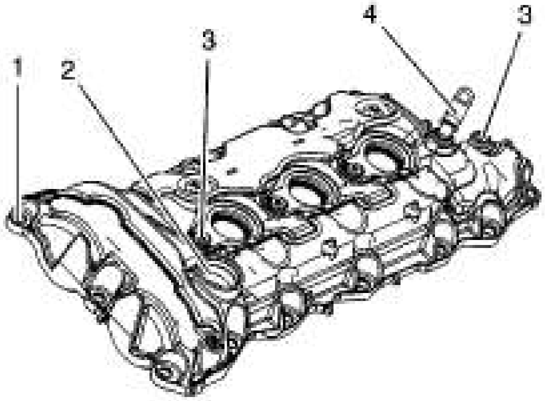
1. Clean the camshaft covers in solvent.

   Warning: Refer to Safety Glasses Warning in the Preface section.

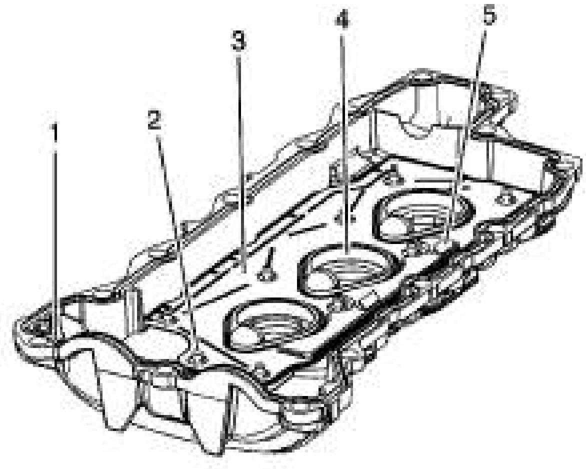
2. Dry the camshaft covers with compressed air.

Inspection Procedure

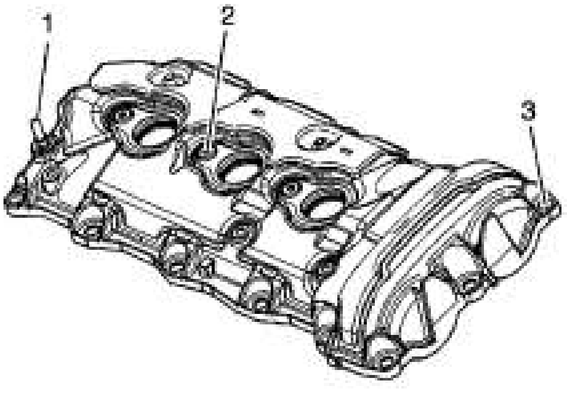
1. Inspect each camshaft cover for the dents or damage to the exterior. A dented or damaged camshaft cover may:
   - Leak engine oil
   - Effect crankcase ventilation
   - Interfere with the camshafts
   - Interfere with the ignition coil sealing
   - Allow water or condensation to enter the engine



2. Inspect the exterior of the left camshaft cover for the following conditions:
   - Damage to the camshaft cover bolt holes (1)
   - Damage to the oil fill hole (2)
   - Damage to the mounting holes (3) for the ignition coil assembly and fuel injector sight shield ballstud.
   - Damage to the positive crankcase ventilation (PCV) hose connector (4)--A damaged PCV hose connector is replaceable.

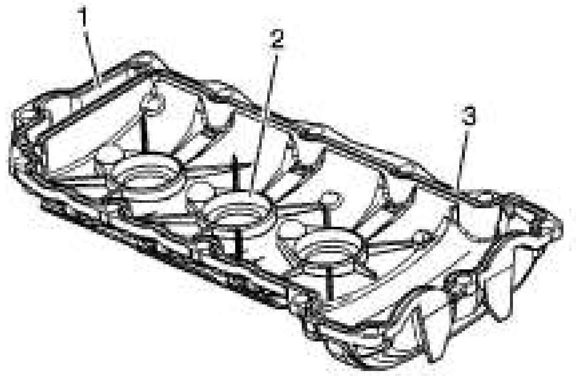


3. Inspect the interior of the left camshaft cover for the following conditions:
   - Gouges or damage to the camshaft cover sealing groove (1)
   - Damaged, loose or missing baffle fasteners (2)
   - Damaged, loose or missing baffle (3)
   - Gouges or damage to the spark plug shield seal bore (4)
   - Restrictions to the ventilation system (5)



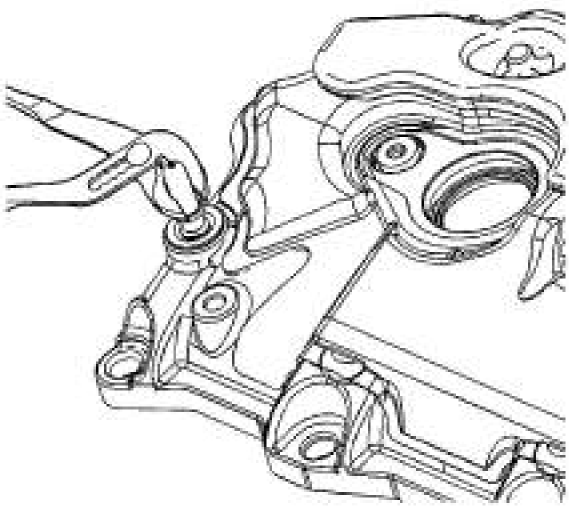
4. Inspect the exterior of the right camshaft cover for the following conditions:
   - Damage to the PCV orifice (1)--A damaged PCV orifice can be replaced. Refer to PCV Orifice Replacement.

- Damage to the mounting holes (2) for the ignition coil assembly
- Damage to the camshaft cover bolt holes (3)



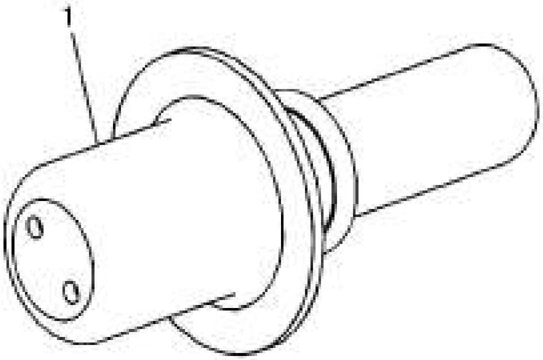
5. Inspect the interior of the right camshaft cover for the following conditions:
    - Restrictions to the ventilation system (1)
    - Gouges or damage to the spark plug shield seal bore (2)
    - Gouges or damage to the camshaft cover sealing groove (3)
6. Repair or replace the camshaft cover or covers as necessary.

PCV Orifice Replacement

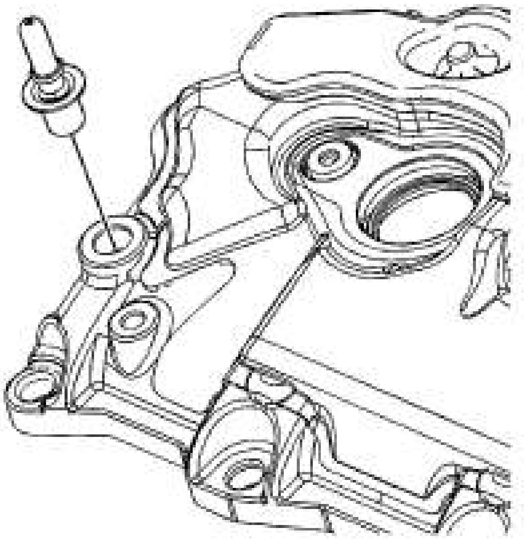


Note: If the PCV orifice is damaged or plugged and cannot be cleaned out, the PCV orifice can be replaced.

1. Remove the old PCV orifice by gripping the neck of the orifice with pliers and twisting and pulling out of the right camshaft cover.

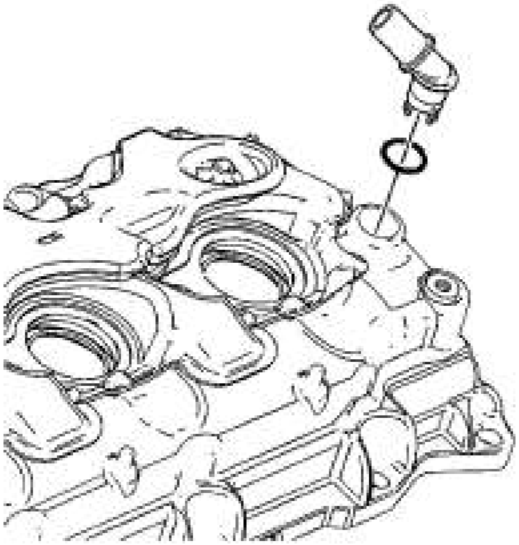


2. Apply sealant GM P/N 12378521 (Canadian P/N 88901148) or equivalent to the NEW PCV orifice (1).



3. Install the NEW PCV orifice into the right camshaft cover. After insertion, twist the PCV orifice in order to eliminate any vertical leak paths in the sealant.

PCV Fitting Replacement



Note: If the PCV fitting is damaged or plugged and cannot be cleaned out, the PCV fitting can be replaced.

1. Remove the old PCV fitting.
2. Install the new PCV fitting with a NEW O-ring.

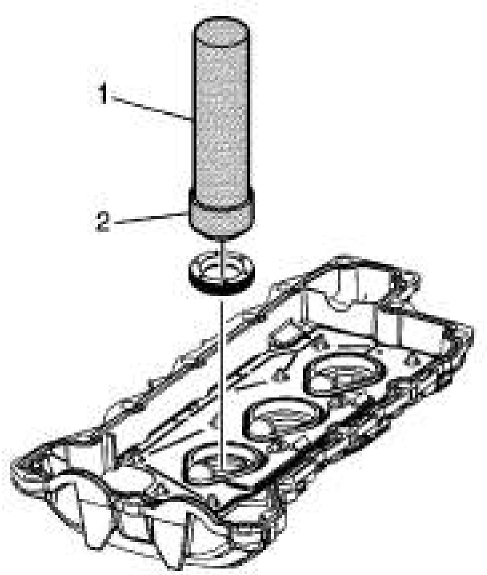
Camshaft Cover Assemble (LLT)

Special Tools

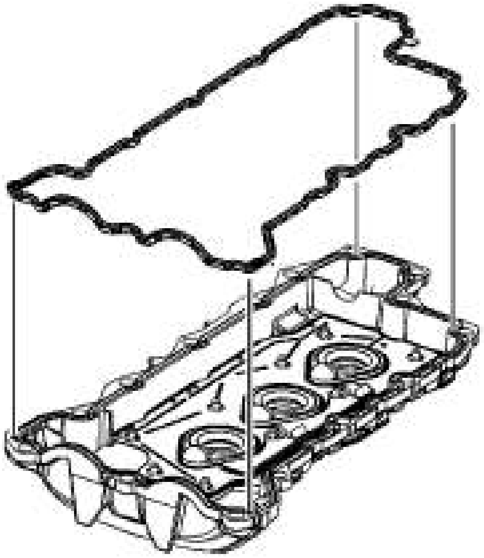
- *J 5590* Bearing and Seal Driver
- *J-25254-A* Oil Seal Installer

For equivalent regional tools, refer to Special Tools.

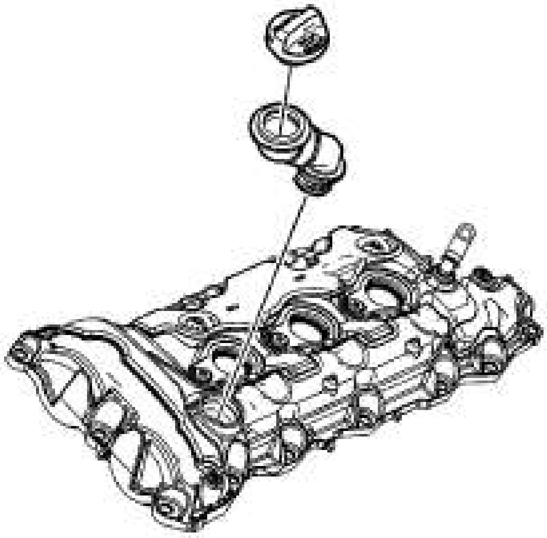
Left Camshaft Cover



1. Install the NEW left spark plug shield tube seals using the *J 5590* driver (1) and *J-25254-A* installer (2).

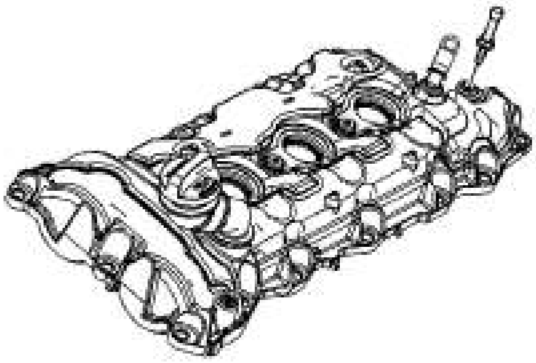


2. Install the NEW left camshaft cover gasket.

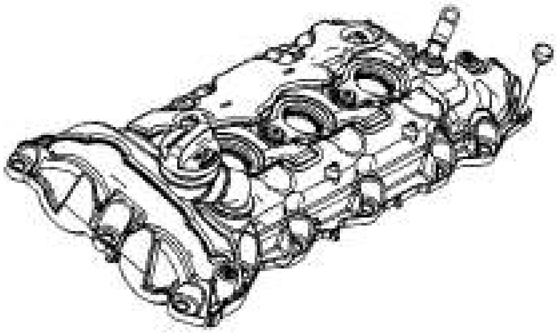


3. Install the oil fill cap.

Caution: Refer to Fastener Caution in the Preface section.



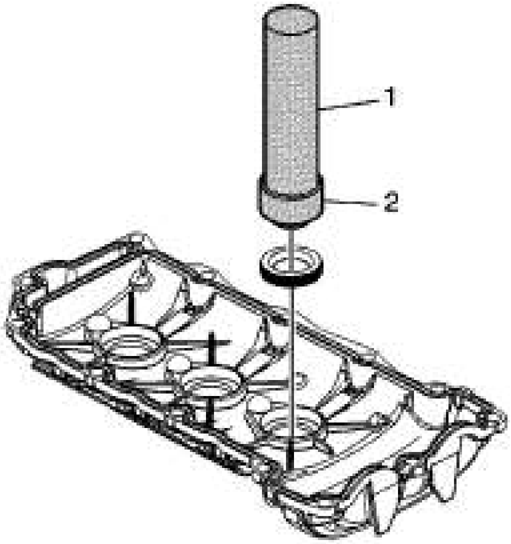
4. Install the fuel injector sight shield cover ballstud and tighten to **10 N·m (89 lb in)**.



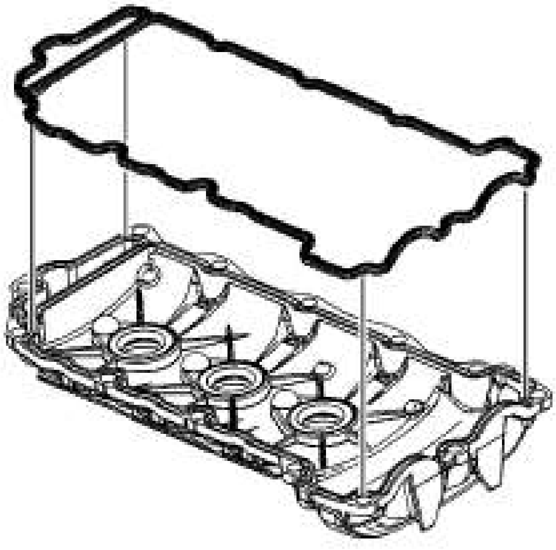
Note: The camshaft cover bolt grommet must be installed into the camshaft cover bolt hole before installing the camshaft cover bolt.

5. Install the NEW left camshaft cover bolt grommets.

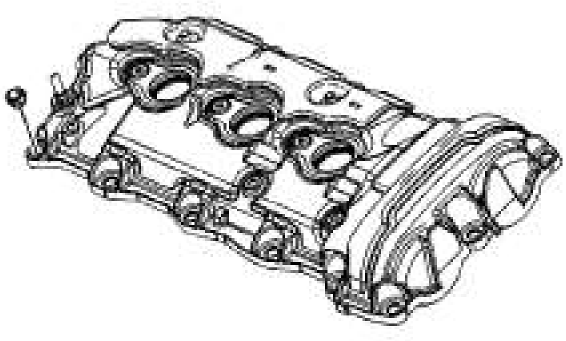
Right Camshaft Cover



1. Install the NEW right spark plug shield tube coil seals using the *J 5590* driver (1) and *J-25254-A* installer (2).



2. Install the NEW right camshaft cover gasket.



Note: The camshaft cover bolt grommet must be installed into the camshaft cover bolt hole before installing the camshaft cover bolt.

3. Install the NEW right camshaft cover bolt grommets.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | **Document ID: 1977532**

Crankshaft and Bearing Cleaning and Inspection

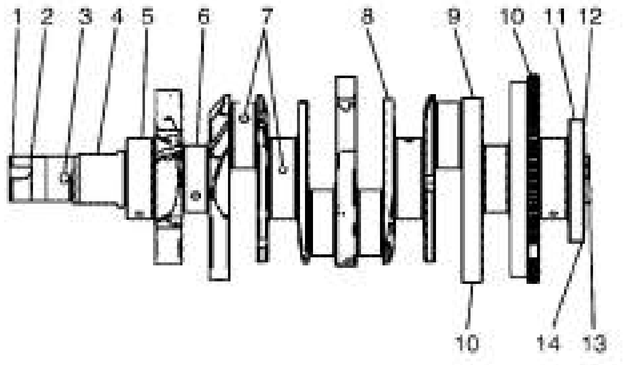
Cleaning Procedure

1. Clean the following components in solvent:
    - Crankshaft bearings
    - Connecting rod bearings
    - Crankshaft journals
    - Crankpin journals
    - Crankshaft oil passages
    - Crankshaft threaded holes

    Caution: Refer to Safety Glasses Caution in the Preface section.

2. Dry the following components with compressed air:
    - Crankshaft bearings
    - Connecting rod bearings
    - Crankshaft journals
    - Crankpin journals
    - Crankshaft oil passages
    - Crankshaft threaded holes

Visual Inspection

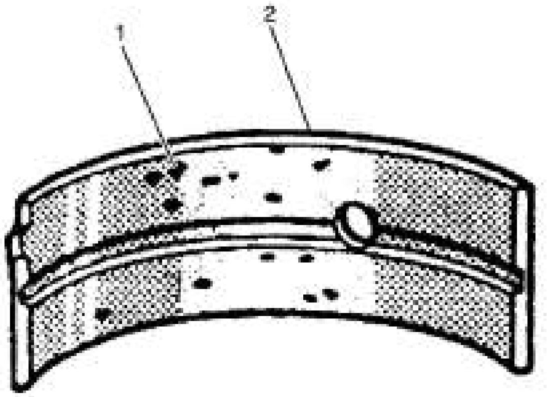


1. Perform the following visual inspections:

- Inspect the crankshaft balancer bolt hole (1) for thread damage.
- Inspect the crankshaft balancer mounting area (2) for damage.
- Inspect the crankshaft sprocket pin hole (3) for damage.
- Inspect the oil pump drive flats (4) for damage.
- Inspect the crankshaft main journals (5) for damage.
- Inspect the crankshaft connecting rod journals (6) for damage.
- Inspect the crankshaft oil passages (7) for obstructions.
- Inspect the crankshaft main bearing thrust wall surfaces (8) for damage.
- Inspect the crankshaft counterweights (9) for damage.
- Inspect the crankshaft reluctor ring teeth (10) for damage.
- Inspect the crankshaft rear main oil seal surface (11) for damage.
- Inspect the crankshaft engine flywheel mounting surface (12) for damage.
- Inspect the crankshaft pilot hole (13) for damage.
- Inspect the crankshaft engine flywheel bolt holes (14) for thread damage.

2. Repair or replace the crankshaft as necessary.

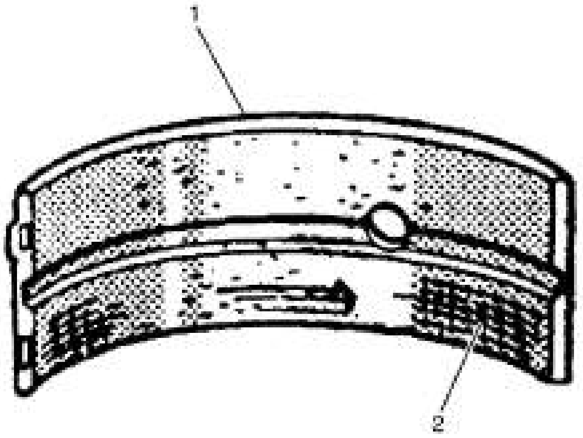
Crankshaft Bearing Inspection



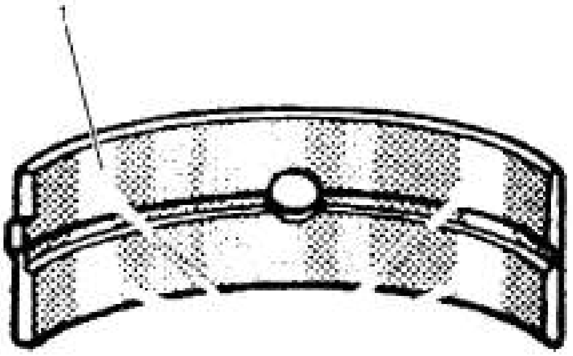
Important:

- All connecting rod and main journal bearings that have been used in a running engine must be replaced. Never re-use the crankshaft or connecting rod bearings.
- The following bearing wear conditions should be used to diagnose engine operating conditions or root cause of a condition.

1. Inspect for fatigue indicated by craters or pockets (1). Flattened sections on the bearing halves (2) also indicate fatigue.

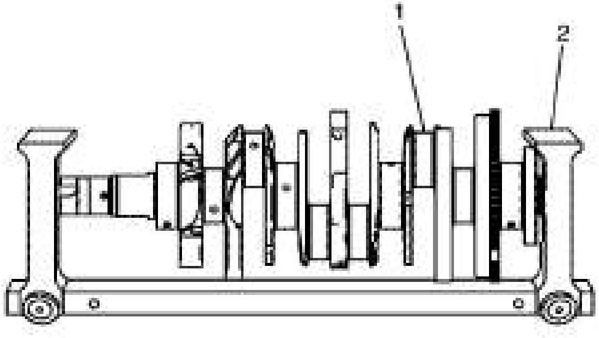


2. Inspect for scoring above acceptable tolerances or discoloration (2) on both front and back of the bearing halves (1).
3. Inspect the main bearings for dirt embedded into the bearing material.

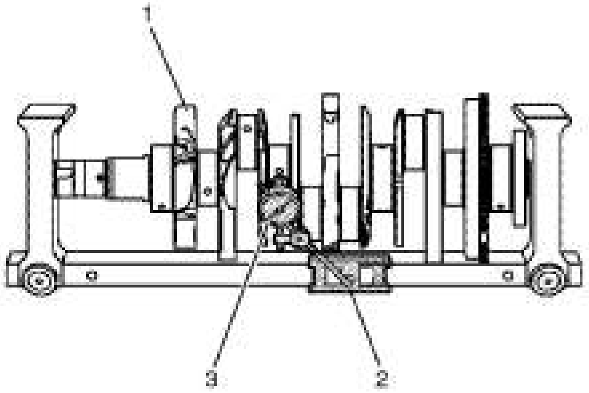


4. Inspect for incorrect seating indicated by bright, polished sections (1).

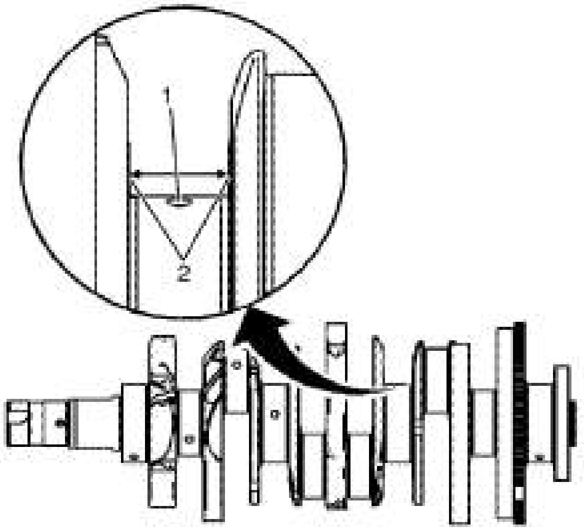
Crankshaft Measurement



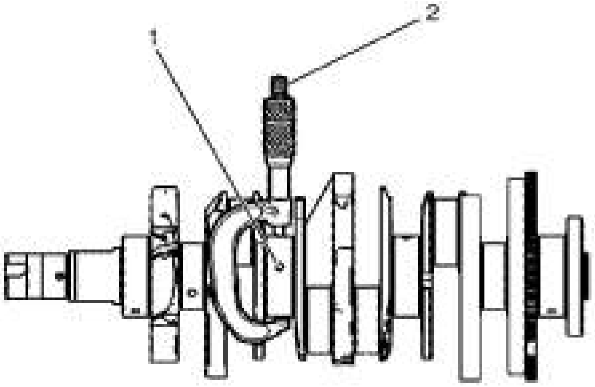
1. Using a suitable fixture (2), support the crankshaft (1).



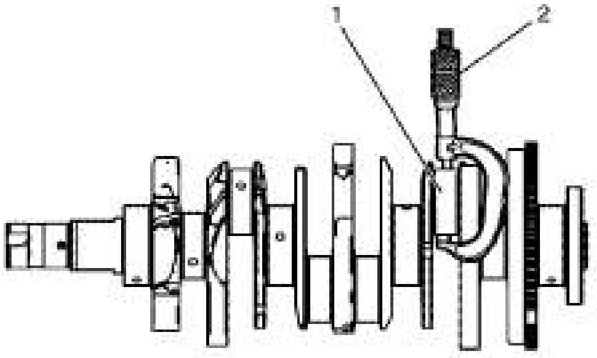
2. Set up a dial indicator (3) and magnetic base (2).
3. Rotate the crankshaft (1) to measure and record the crankshaft runout. Compare your results with the Engine Mechanical Specifications.



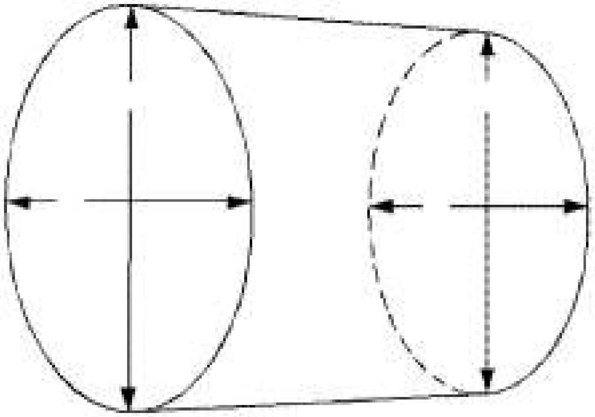
4. Measure and record the crankshaft thrust wall width (2) for wear using an inside micrometer. Compare your results with the Engine Mechanical Specifications.
5. Measure and record the crankshaft thrust wall surface (1) for runout using the dial indicator. Compare your results with the Engine Mechanical Specifications.
6. If the crankshaft journals are damaged or worn beyond specifications, the crankshaft may be ground 0.25 mm (0.010 in). There is only 1 size of oversized main bearings available for service.



7. Inspect the crankshaft main journals (1) for undersize, using an outside micrometer (2).



8. Inspect the crankpins (1) for undersize using an outside micrometer (2).
9. Compare your results with the Engine Mechanical Specifications. If the crankpin journals are worn beyond the specifications, the crankshaft may be ground 0.25 mm (0.010 in). There is only 1 size of oversized connecting rod bearings available for service.



10. Measure the main bearing and crankpin journals for out-of-round using the following procedure:
    - 10.1. Using an outside micrometer, measure the journal at the extreme front and rear locations on the journal. Call these points A and B.
    - 10.2. Measure the journal in 2 new locations exactly 90 degrees from the first points. Call these points C and D.
    - 10.3. Subtract A from C and B from D. The differences will indicate journal out-of-round.
    - 10.4. The out-of-round should not exceed 0.004 mm (0.00016 in) maximum.

- 10.5. If the journals are worn beyond the specifications, the crankshaft may be ground 0.25 mm (0.010 in). There is only 1 size of oversized crankshaft and connecting rod bearings available for service.

11. Measure the main bearing and crankpin journals for taper using the following procedure:
    - 11.1. Using an outside micrometer, measure the journal at the extreme front (A) and rear (B) of the journal parallel to the crankshaft centerline.
    - 11.2. Subtract the smallest from the largest measurement. The result will be the journal taper.
    - 11.3. If the main bearing journal taper exceeds 0.004 mm (0.00016 in), replace the crankshaft.
    - 11.4. If the journals are worn beyond the specifications, the crankshaft may be ground 0.25 mm (0.010 in). There is only 1 size of oversized crankshaft and connecting rod bearings available for service.

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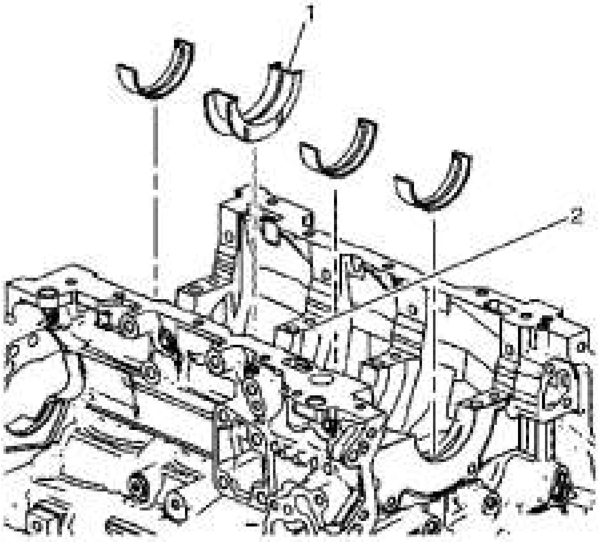
Crankshaft and Bearing Installation

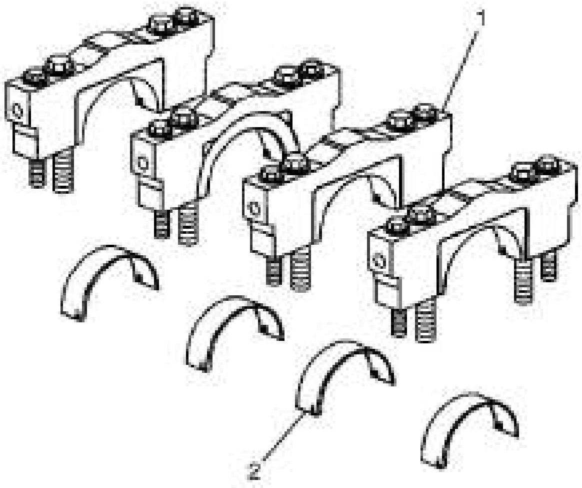
Crankshaft Bearing Installation Procedure

Important: If the crankshaft bearings have been used in a running engine, you must replace them with NEW crankshaft bearings for reassembly.

1. Clean the crankcase crank bore with a lint-free cloth.
2. Clean all the oil from the backside of new bearing halves.

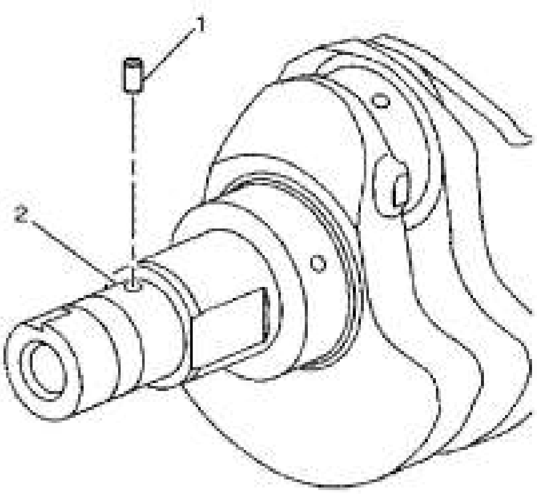


3. Install the new upper crankshaft bearings into position. The thrust bearing (1) belongs in the number 3 journal (2). Make sure that the upper bearing insert contains the oil transfer hole and groove. Roll the bearing into position so that the lock tang engages the crank slot. The bearing must fit flush with the upper crankcase.



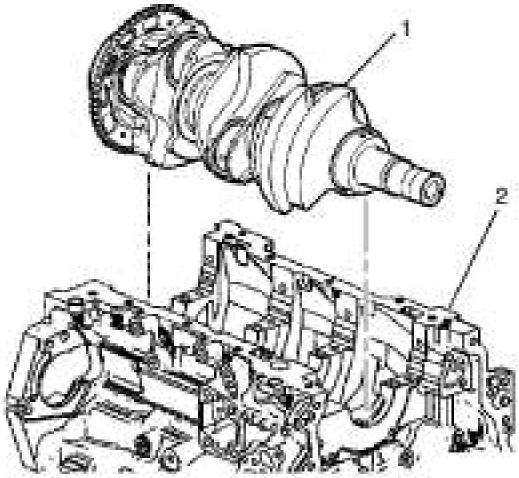
4. Install the new lower crankshaft bearings (2) into position in the crankshaft bearing caps (1). The lower crankshaft bearings (2) are identified by NO grooves or holes. The lower crankshaft bearings (2) must fit flush with the crankshaft bearing caps (1).

Crankshaft Installation Procedure



Notice: The crankshaft sprocket drive pin must be set to the proper depth. Installing the crankshaft sprocket drive pin too deep can lead to damage to the crankshaft sprocket and extensive engine damage.

1. If removed, install the crankshaft sprocket drive pin (1). Lightly tap the crankshaft sprocket drive pin (1) in place with a small soft face, bronze/plastic, hammer until it bottoms in the hole of the crankshaft (2).

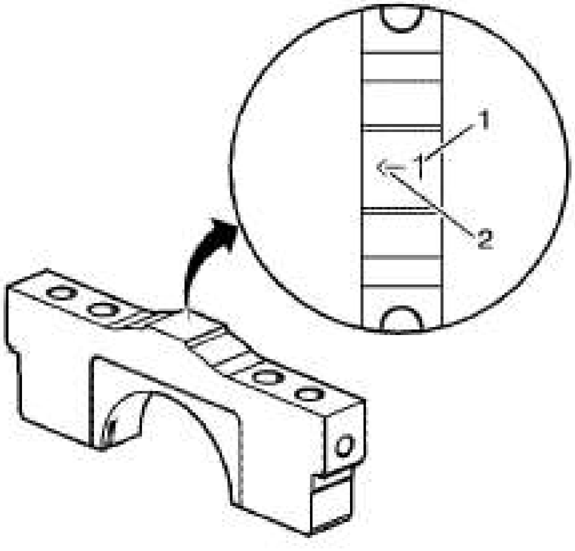


2. Gently lower the crankshaft (1) into position in the cylinder block (2).

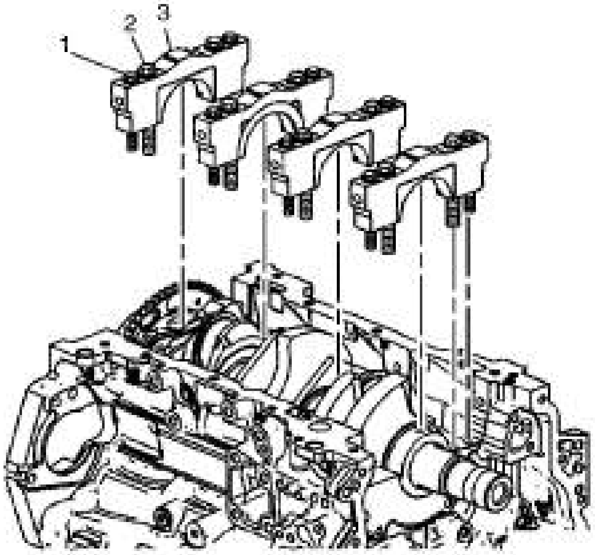
Crankshaft Bearing Clearance Measurement Procedure

Tools Required

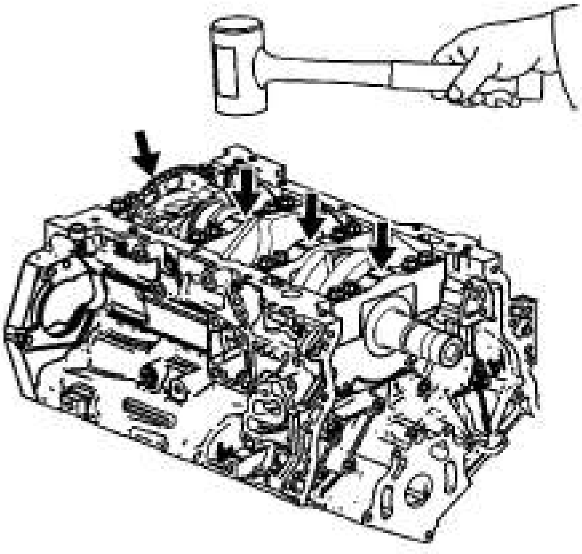
- J 6125-1B Slide Hammer Adapter
- J 41818 Crankshaft Bearing Cap Remover
- J 45059 Angle Meter



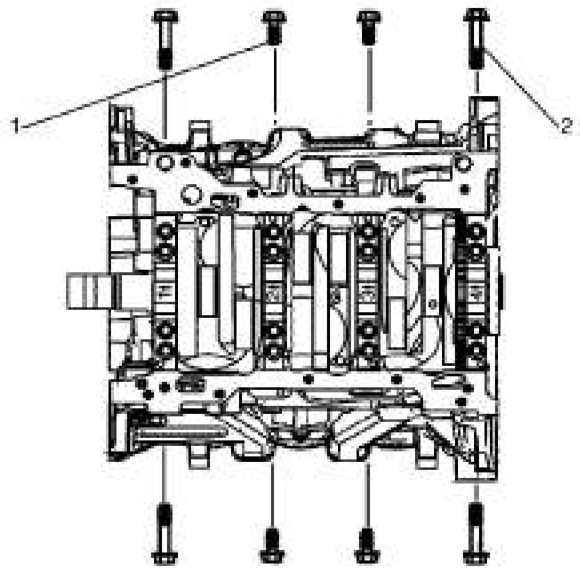
1. Place a length of fresh, room temperature plastic gauging material all the way across all the crankshaft bearing journals.
2. Identify the proper order of the crankshaft bearing caps. The crankshaft bearing caps are numbered 1 (1) through 4, with the front main bearing cap marked with the number 1. The arrow (2) is to be oriented to the front of the cylinder block.



3. Install the crankshaft bearing caps (3).
4. Loosely install the original inner crankshaft bearing cap to cylinder block retaining bolts (1).
5. Loosely install the original outer crankshaft bearing cap to cylinder block retaining bolts (2).

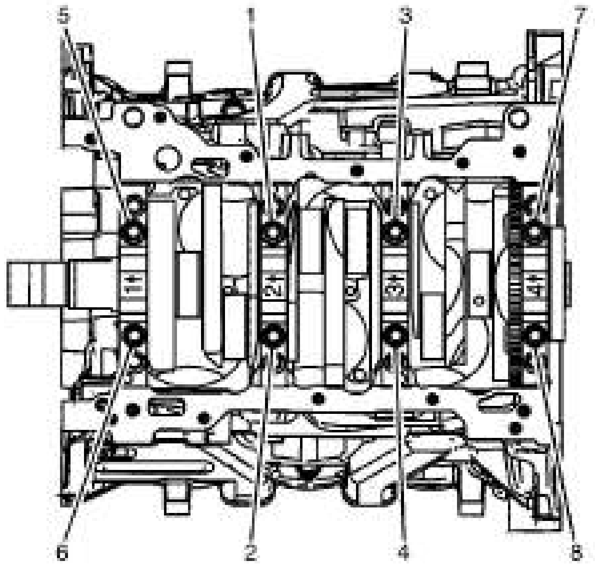


6. Tap the crankshaft bearing caps with a soft-faced hammer to help seat the crankshaft bearing caps.



7. Loosely install the original short/inner side crankshaft bearing cap to cylinder block retaining bolts (1).
8. Loosely install the original long/outer side crankshaft bearing cap to cylinder block retaining bolts (2).
9. Tighten the crankshaft bearing cap to cylinder block retaining bolts using the J 45059 in the following sequence:

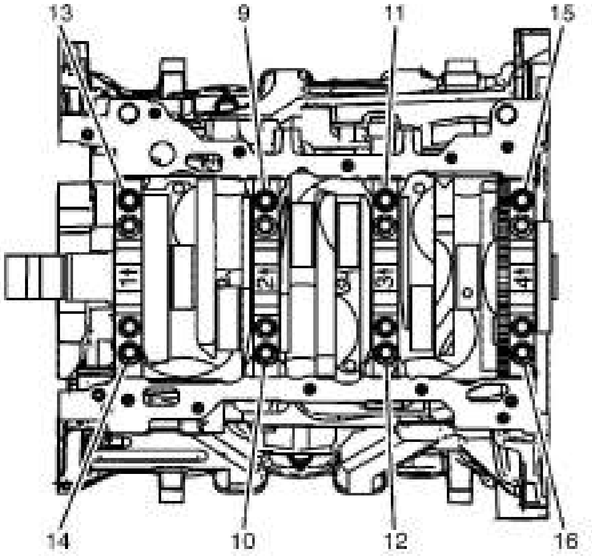
Notice: Refer to Fastener Notice in the Preface section.



10. Tighten the inboard crankshaft bearing cap to cylinder block retaining bolts (1-8).

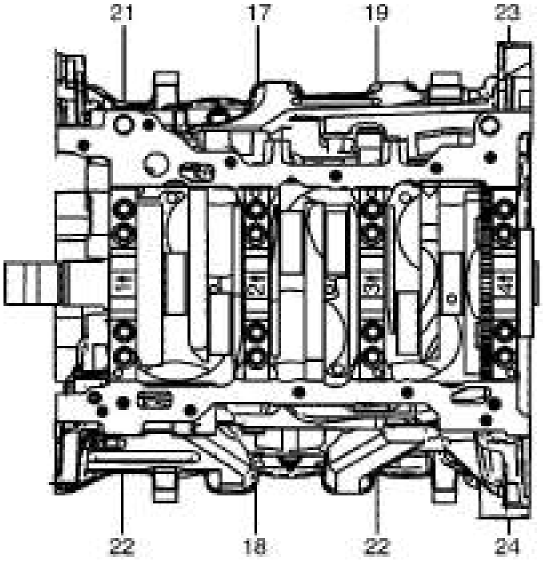
Tighten

Tighten the bolts to 20 N·m (15 lb ft) plus 80 degrees.



11. Tighten the outboard crankshaft bearing cap to cylinder block retaining bolts (9-16).

Tighten
Tighten the bolts to 15 N·m (11 lb ft) plus 110 degrees.



12. Tighten the short/inner crankshaft bearing cap to cylinder block retaining bolts (17-20).

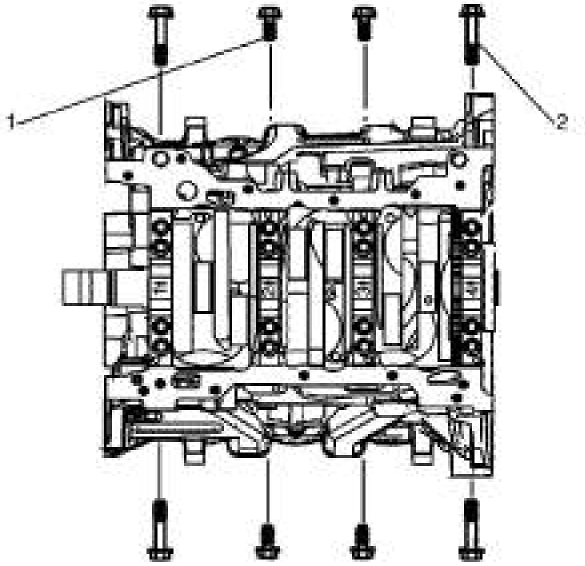
Tighten
Tighten the bolts to 30 N·m (22 lb ft) plus 60 degrees.

13. Tighten the long/outer crankshaft bearing cap to cylinder block retaining bolts (21-24).

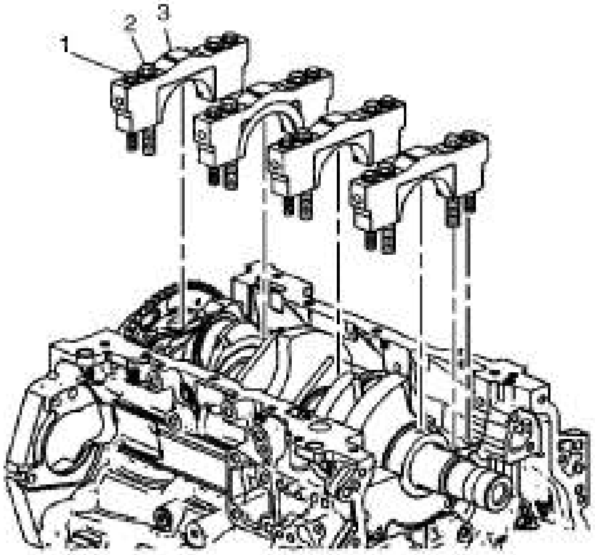
    Tighten
    Tighten the bolts to 30 N·m (22 lb ft) plus 60 degrees.

    Important: DO NOT rotate the crankshaft.

14. After reaching final torque, allow the assembly to sit for 2 minutes.



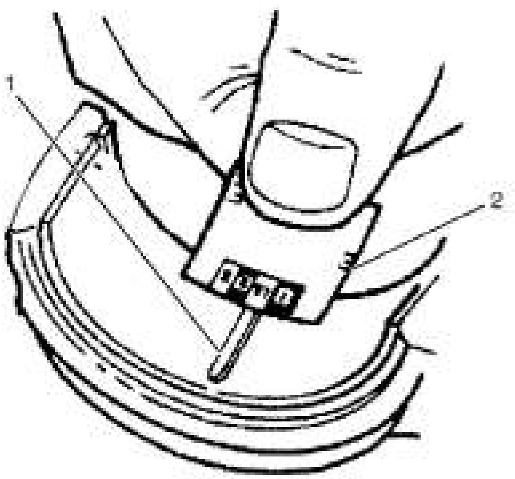
15. Remove the original short/inner side crankshaft bearing cap to cylinder block retaining bolts (1).
16. Remove the original long/outer side crankshaft bearing cap to cylinder block retaining bolts (2).



17. Remove the install the original outer crankshaft bearing cap to cylinder block retaining

bolts (2).

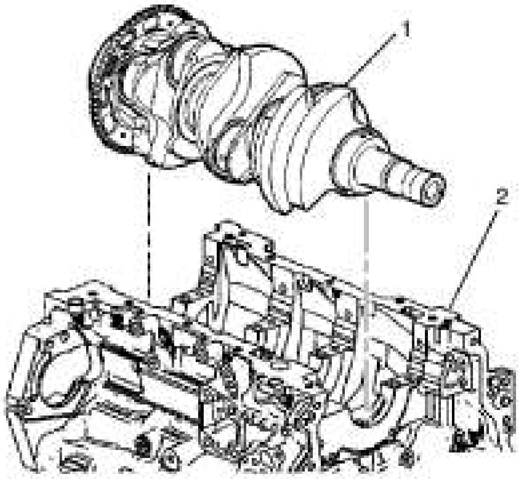
18. Remove the original inner crankshaft bearing cap to cylinder block retaining bolts (1).
19. Remove the crankshaft bearing caps (3) using the J 6125-1B and J 41818



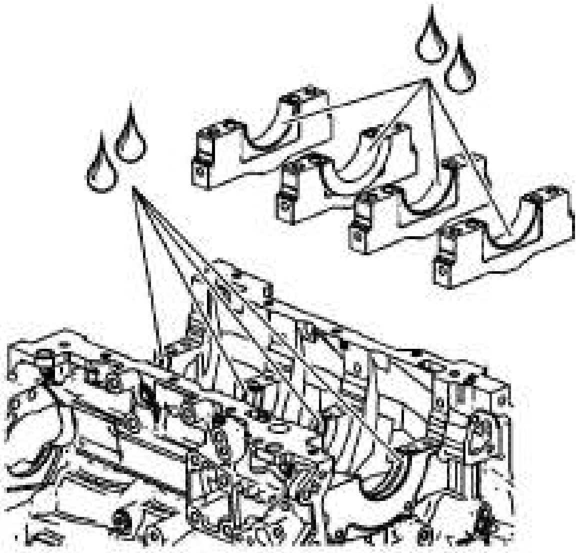
20. Determine the crankshaft bearing clearance by comparing the width of the flattened plastic gauging material (1) at its widest point with the graduation on the gauging material container (2).

Important: The crankshaft bearings CAN be reused after checking the clearance if the bearings have never been used in a running engine.

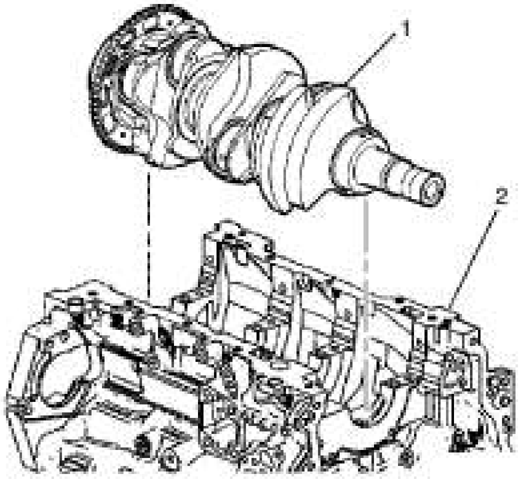
21. Compare your measurements with the engine mechanical specifications. Refer to Engine Mechanical Specifications . If the new bearings DO NOT provide the proper crankshaft to bearing clearance, inspect the following:
    - 21.1. Re-measure the crankshaft journals for the correct specified size and ensure the proper new bearings are being installed. If the crankshaft journals are incorrectly sized, replace or regrind the crankshaft. Crankshaft machining is permitted and undersized bearings are available.
    - 21.2. Re-measure the cylinder block crankshaft bearing bore diameter to ensure proper size. The cylinder block crankshaft bearing bore is not machinable and the block must be replaced if out of specification.
22. Clean the plastic gauging material from the crankshaft bearing journals with a soft, lint-free cloth.



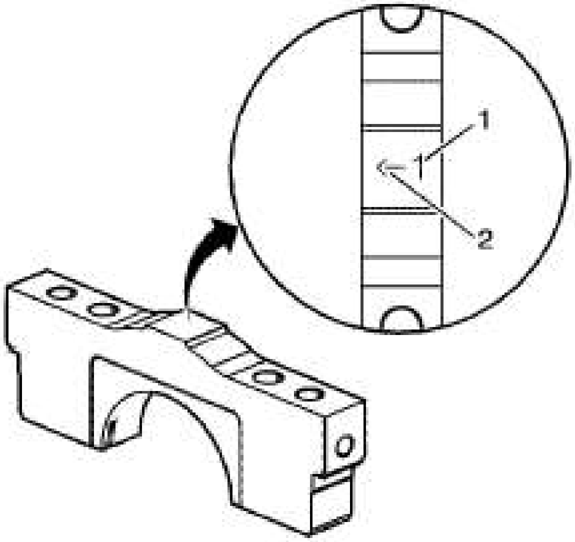
23. Lift the crankshaft (1) out of the cylinder block (2).



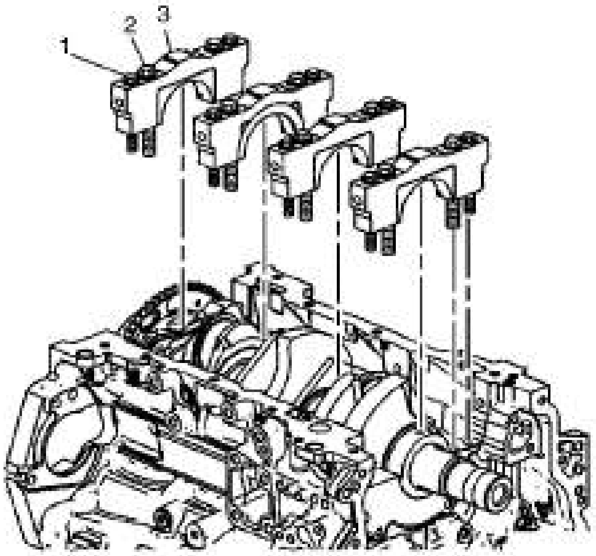
24. Apply a liberal amount of clean engine oil to the upper and lower bearing surfaces.



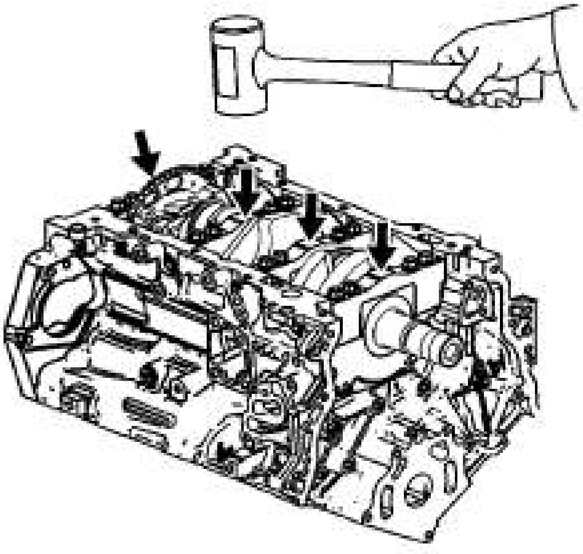
25. Gently lower the crankshaft (1) into position in the cylinder block (2).



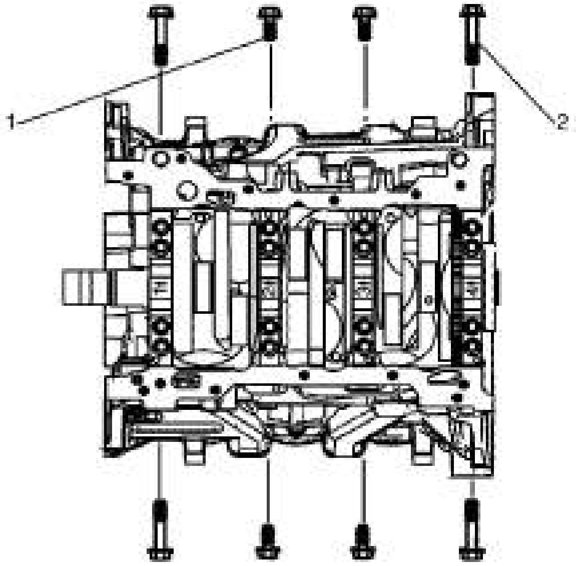
26. Identify the proper order of the crankshaft bearing caps. The crankshaft bearing caps are numbered 1 (1) through 4, with the front main bearing cap marked with the number 1. The arrow (2) is to be oriented to the front of the cylinder block.



27. Install the crankshaft bearing caps (3).
28. Loosely install the original inner crankshaft bearing cap to cylinder block retaining bolts (1).
29. Loosely install the NEW outer crankshaft bearing cap to cylinder block retaining bolts (2).



30. Tap the crankshaft bearing caps with a soft-faced hammer to help seat the crankshaft bearing caps.

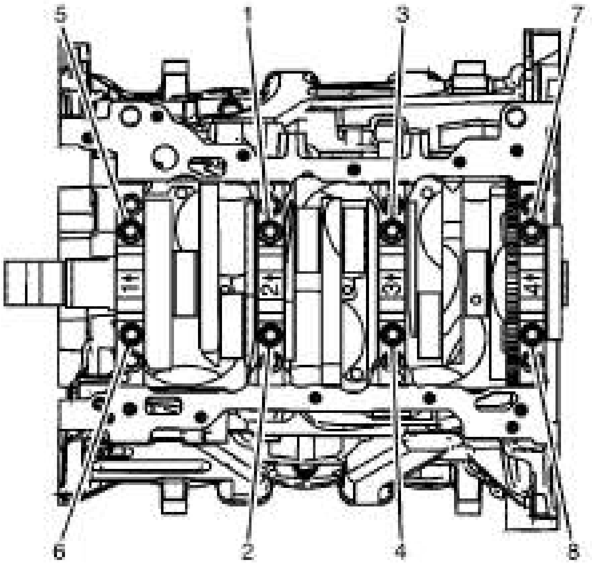


Important: The side main cap bolts originally have a sealant on the flange of the bolt head. NEW bolts must be used. If NEW bolts are not used, oil can leak from the crankcase past the bolts.

31. Loosely install the NEW short/inner side crankshaft bearing cap to cylinder block retaining bolts (1).
32. Loosely install the NEW long/outer side crankshaft bearing cap to cylinder block retaining bolts (2).

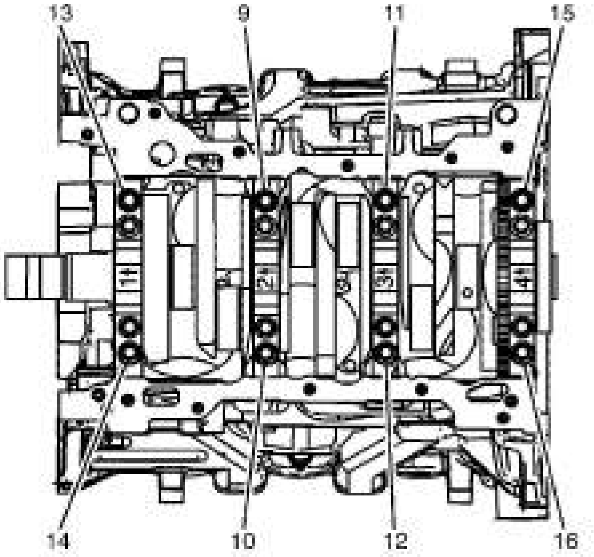
Notice: Refer to Fastener Notice in the Preface section.

33. Tighten the crankshaft bearing cap to cylinder block retaining bolts using the J 45059 in the following sequence:



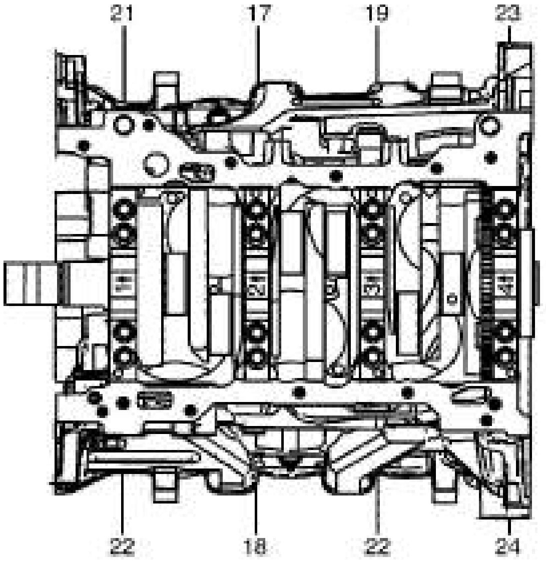
34. Tighten the inboard crankshaft bearing cap to cylinder block retaining bolts (1-8).

Tighten
Tighten the bolts to 20 N·m (15 lb ft) plus 80 degrees.



35. Tighten the outboard crankshaft bearing cap to cylinder block retaining bolts (9-16).

Tighten
Tighten the bolts to 15 N·m (11 lb ft) plus 110 degrees.



36. Tighten the short/inner crankshaft bearing cap to cylinder block retaining bolts (17-20).

    Tighten
    Tighten the bolts to 30 N·m (22 lb ft) plus 60 degrees.

37. Tighten the long/outer crankshaft bearing cap to cylinder block retaining bolts (21-24).

    Tighten
    Tighten the bolts to 30 N·m (22 lb ft) plus 60 degrees.

38. Make sure that the crankshaft turns without binding or noise.

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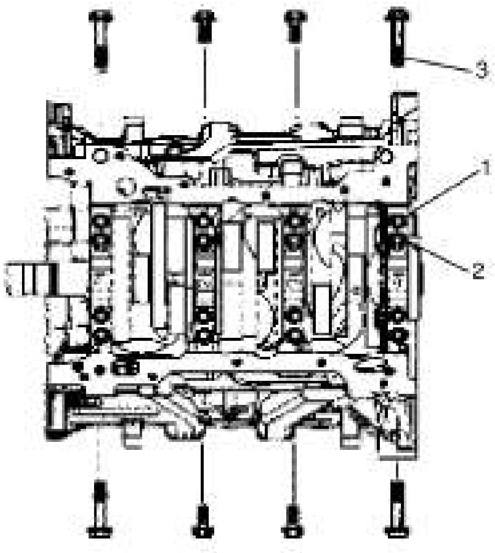
Crankshaft and Bearing Removal

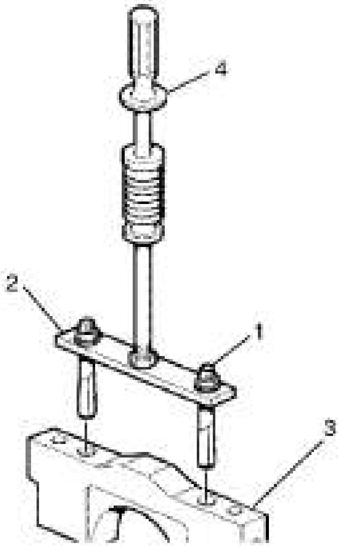
Tools Required

- J 41818 Crankshaft Bearing Cap Remover.
- J 6125-1B Slide Hammer with Adapter.

Crankshaft Removal



1. Remove the crankshaft bearing cap side bolts (3).
2. Remove the crankshaft bearing cap outer bolts (1).
3. Remove the crankshaft bearing cap inner bolts (2).



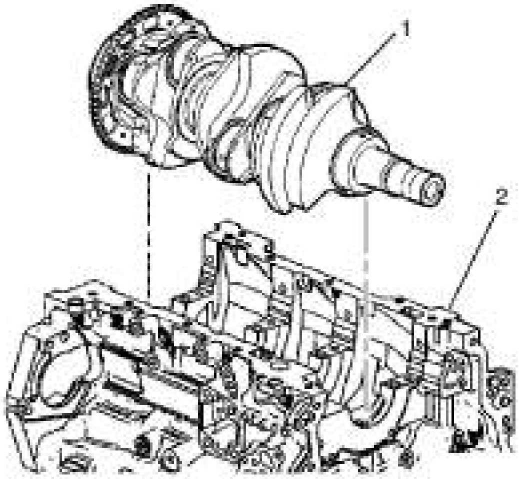
4. Install the J 41818 (2) to the inner bolt holes of the crankshaft bearing cap (3).

   Notice: Refer to Fastener Notice in the Preface section.

5. Tighten the J 41818 nuts (1).

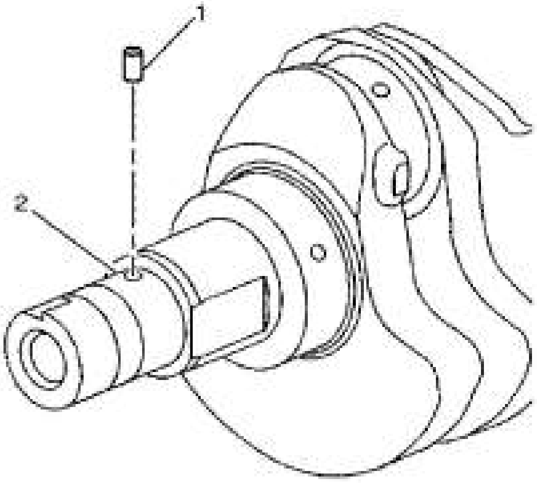
   Tighten
   Tighten the nuts to 11 N·m (97 lb in).

6. Install the J 6125-1B (4) onto the J 41818 (2).
7. Remove the crankshaft bearing cap

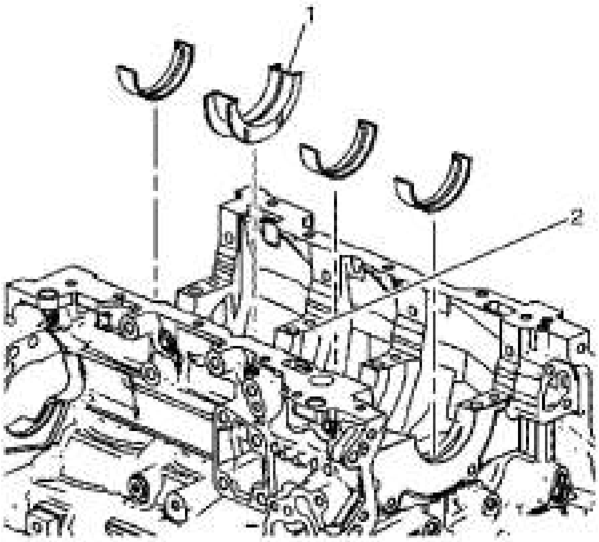


Important: Lift the crankshaft (1) straight up evenly to remove from the cylinder block (2).

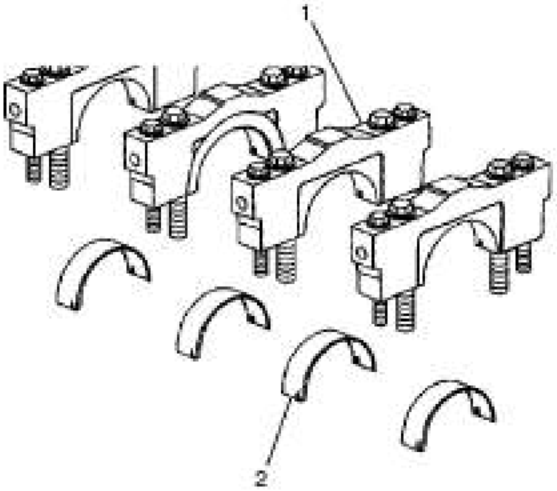
8. Remove the crankshaft (1).
9. Place the crankshaft in a secure place.



10. Remove the crankshaft sprocket drive pin (1) from the nose of the crankshaft (2), if required.
11. Prepare a piece of cardboard or equivalent, numbered 1-4 for bearing identification. Main bearing journals are numbered from the front of the cylinder block.



12. Remove the crankshaft upper bearing halves from the cylinder block. Note the position of the thrust bearing (1) at the number 3 journal (2).
13. Place the crankshaft upper bearing halves on the cardboard in the correct positions. Note that the number 3 bearing is the thrust bearing.



14. Remove the crankshaft lower bearing halves (2) from the crankshaft bearing caps (1).
15. Place the crankshaft lower bearing halves (2) in the correct positions on the cardboard.

Crankshaft Balancer Cleaning and Inspection

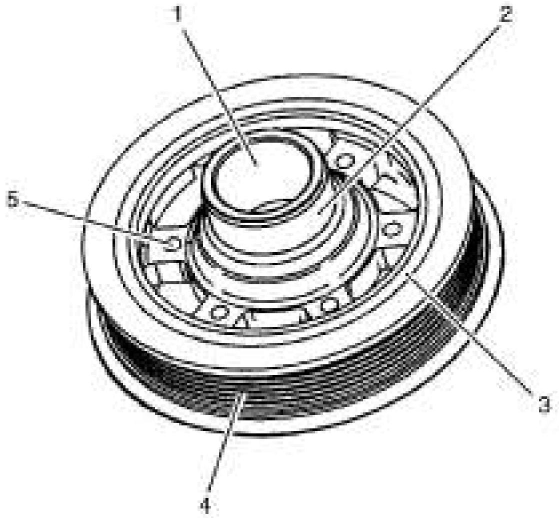
Cleaning Procedure

1. Clean the crankshaft balancer in solvent that is compatible with the rubber.

   Caution: Refer to Safety Glasses Caution in the Preface section.

2. Dry the crankshaft balancer with compressed air.

Inspection Procedure



1. Inspect the crankshaft balancer for the following:
   - Worn or damaged hub-to-crankshaft surface (1)
   - Worn, grooved or damaged hub seal surface (2).
   - Worn, chunking or deteriorated rubber between the hub and pulley (3)
   - Damaged drive belt ribs (4)
   - Damaged threaded holes (5)
2. Repair or replace the crankshaft balancer as required.

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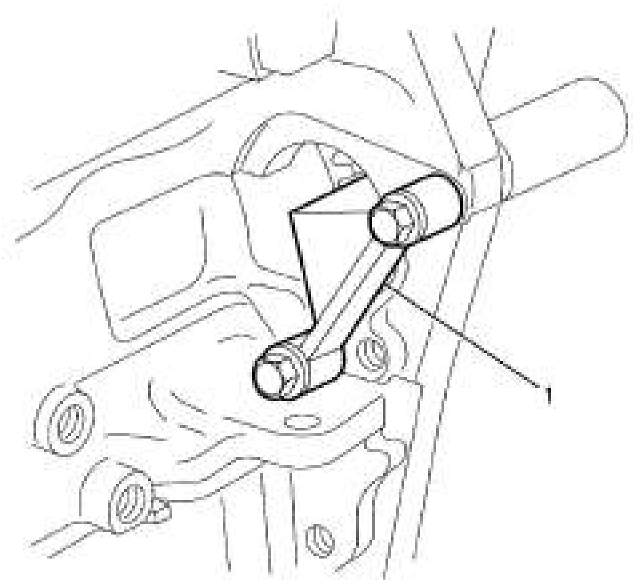
Crankshaft Balancer Installation

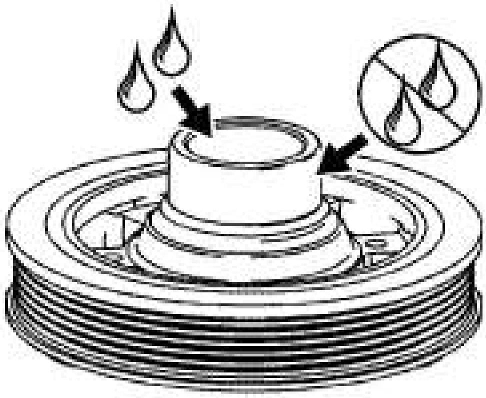
Installation - Up to xx/xx

Tools Required

- EN 46106 Engine Flywheel Holding Tool
- J 41998-B Crankshaft Balancer Installer
- J 45059 Angle Meter

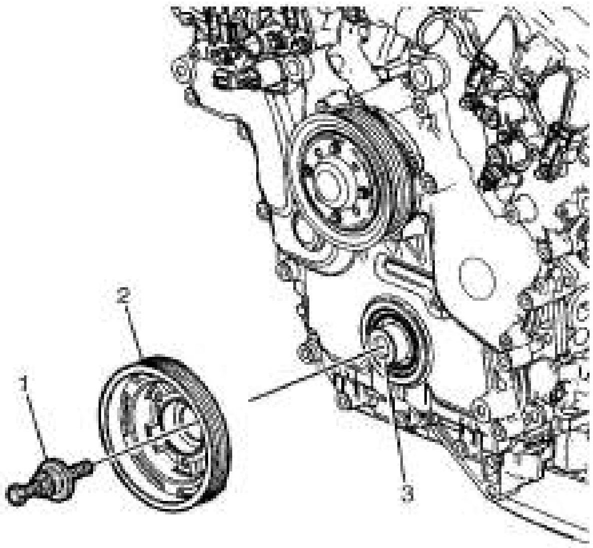


1. The EN 46106 (1) must be installed.



Important: DO NOT lubricate the crankshaft front oil seal or crankshaft balancer sealing surfaces. The crankshaft balancer is installed into a dry seal.

2. Apply lubricant to the inside of the crankshaft balancer hub bore.

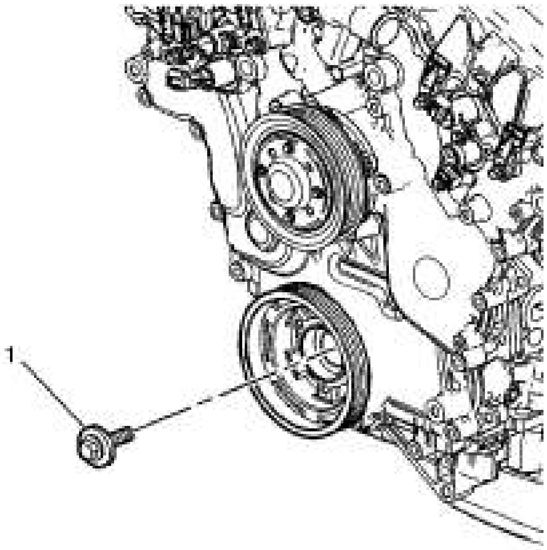


Important: Use the J 41998-B (1), nut, bearing and washer to install the crankshaft balancer (2).

Important: Make sure at least 10 threads of the J 41998-B (1) are engaged before pressing the crankshaft balancer (2) in place.

3. Thread the J 41998-B (1) in the crankshaft (3).

4. Push the crankshaft balancer (2) into position by tightening the nut on the J 41998-B (1) until the large washer bottoms out on the crankshaft (3) end.
5. Remove the J 41998-B (1).

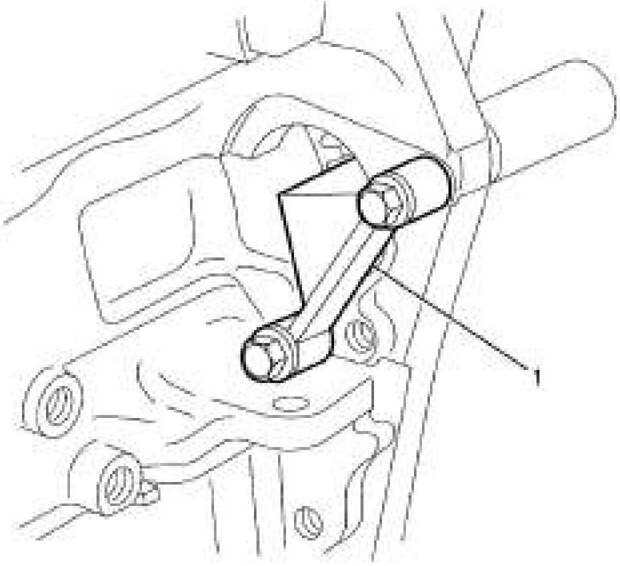


6. Install the crankshaft balancer to crankshaft retaining bolt (1).

   Notice: Refer to Fastener Notice in the Preface section.

7. Tighten the crankshaft balancer to crankshaft retaining bolt.

   Tighten
   - Tighten the bolt to 100 N·m (74 lb ft).
   - Tighten the crankshaft balancer to crankshaft retaining bolt an additional 150 degrees using the J 45059 .

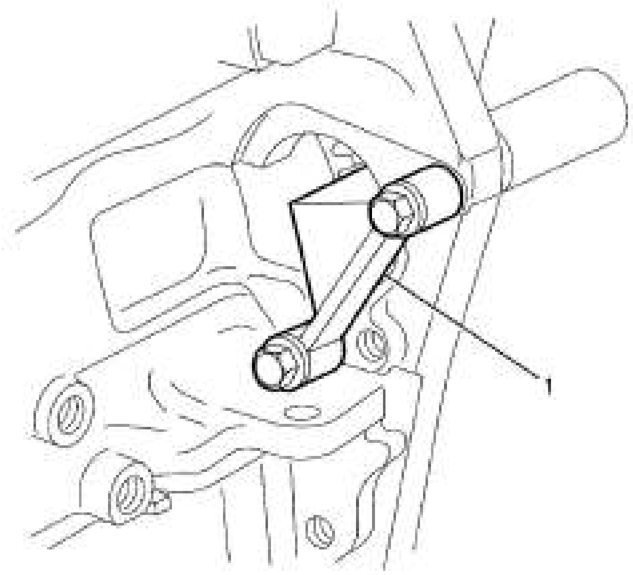


8. Remove the EN 46106 (1).

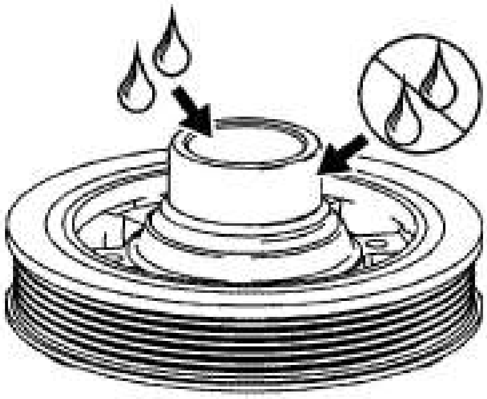
Installation After - xx/xx

Tools Required

- EN 46106 Engine Flywheel Holding Tool.
- J 45059 Angle Meter.

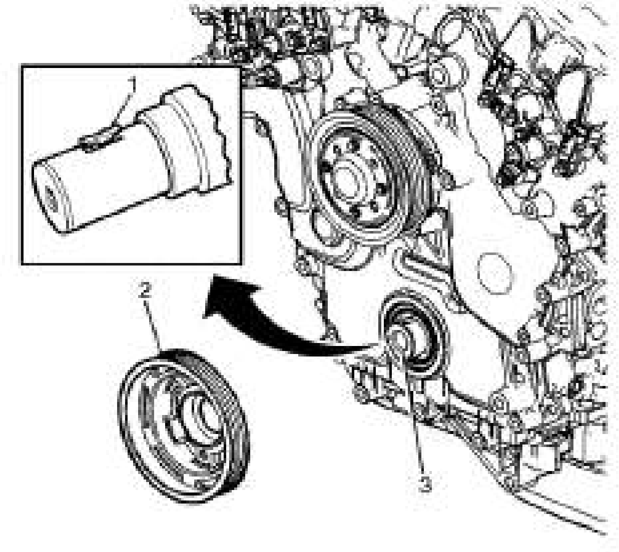


1. The EN 46106 (1) must be installed.



Important: DO NOT lubricate the crankshaft front oil seal or crankshaft balancer sealing surfaces. The crankshaft balancer is installed into a dry seal.

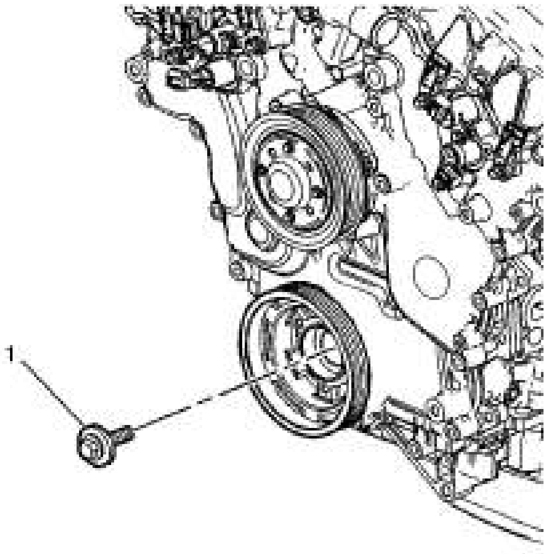
2. Apply lubricant to the inside of the crankshaft balancer hub bore.



Important: Make sure the key (1) located on the top of the crankshaft is correctly installed in the crankshaft. Failure to adhere to this may cause engine damage.

3. Install the crankshaft balancer (2) on to the crankshaft (3).

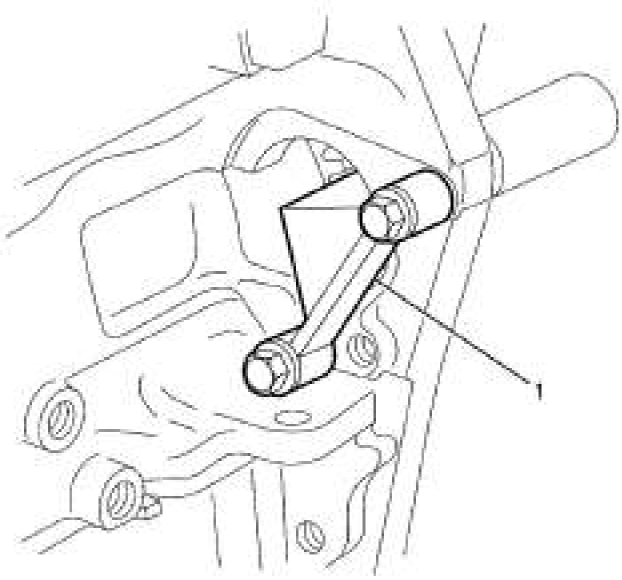
Notice: Refer to Fastener Notice in the Preface section.



4. Install the crankshaft balancer to crankshaft retaining bolt (1).

Tighten

- Tighten the bolt to 100 N·m (74 lb ft).
- Tighten the crankshaft balancer to crankshaft retaining bolt an additional 150 degrees using the J 45059 .

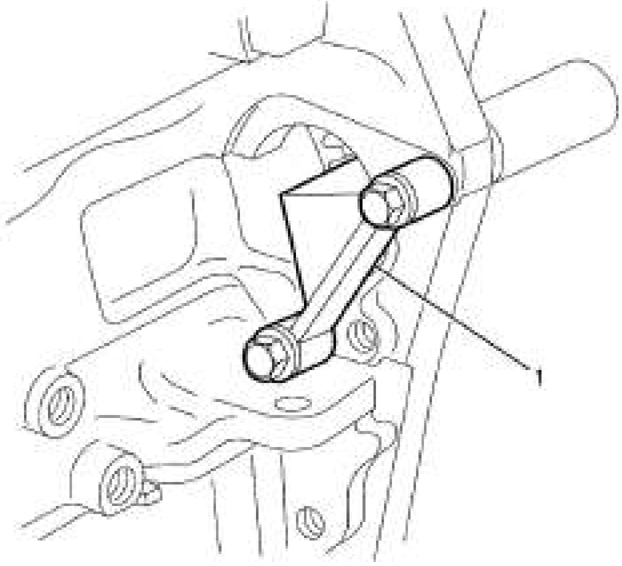


5. Remove the EN 46106 (1).

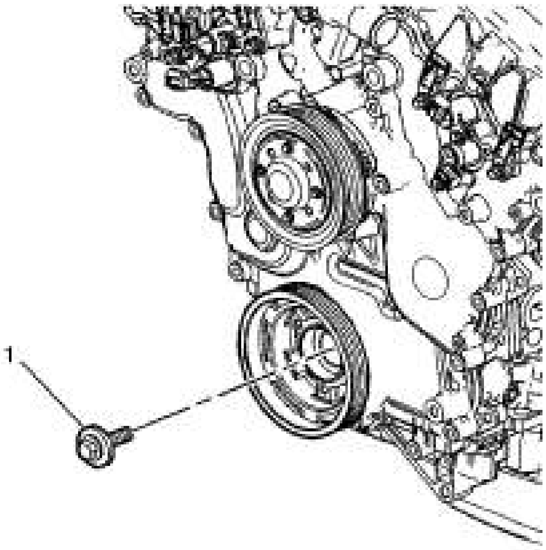
Crankshaft Balancer Removal

Tools Required

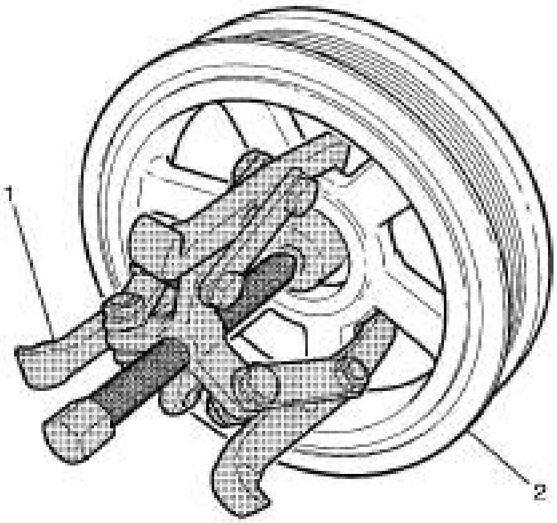
- EN 46106 Flywheel Holding Tool
- 303-642 Harmonic Balancer Puller



1. Install the EN 46106 (1) through the starter mounting hole.



2. Remove the crankshaft balancer to crankshaft retaining bolt (1).



3. Install the 303-642 (1).

   Important: Remove the crankshaft balancer off by tightening the center bolt on the 303-642 (1) until the crankshaft balancer (2) is removed from the crankshaft.

4. Remove the crankshaft balancer (2).
5. Remove the 303-642 (1) from the crankshaft balancer.

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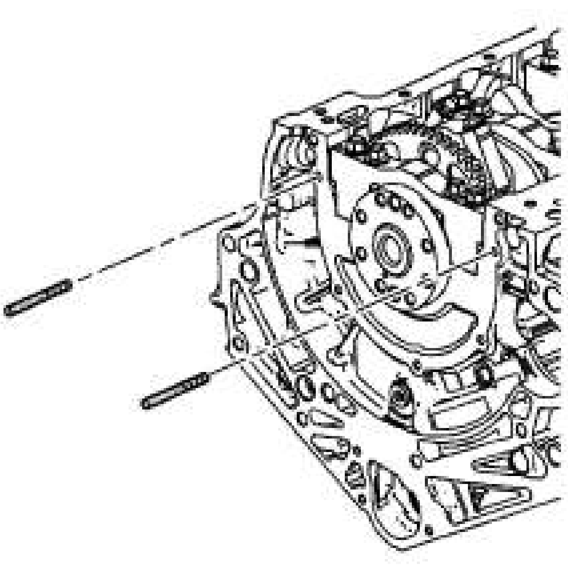
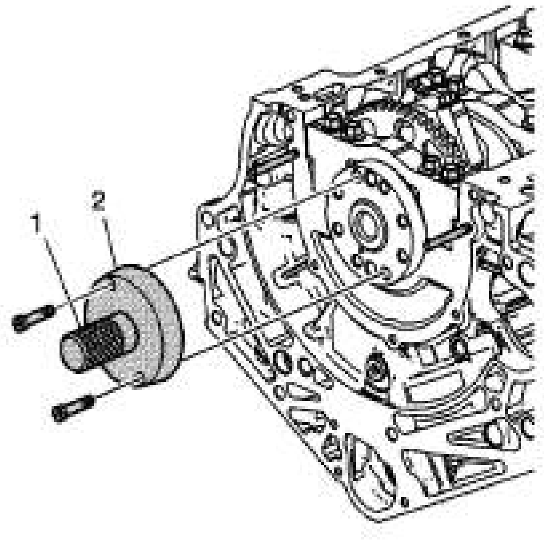
Crankshaft Rear Oil Seal and Housing Installation

Tools Required

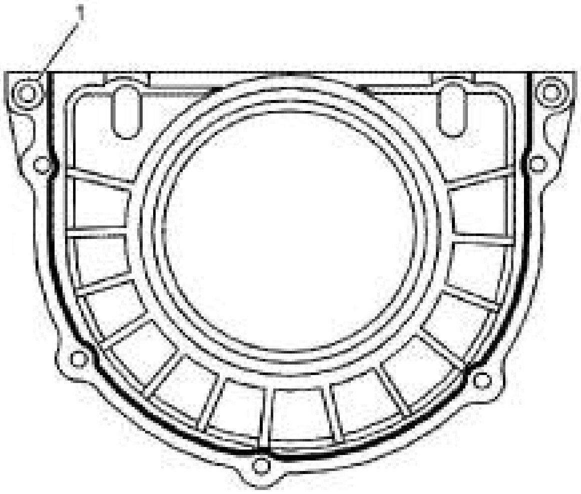
- EN 46109 Guide Pin Set
- EN-47839 Crankshaft Rear Oil Seal Installation Tool
- J 42183 Handle



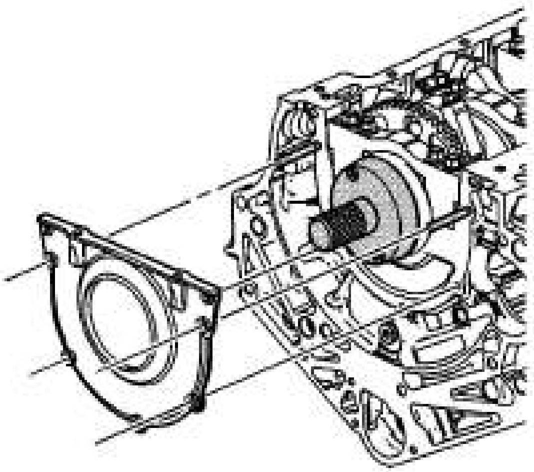
1. Install the 6 mm (0.236 in) guides from the EN 46109 into the 2 crankshaft rear oil seal housing corner bolt holes of the cylinder block.



2. Install the J 42183 (1) with the EN-47839 (2) onto the rear of the crankshaft flange.

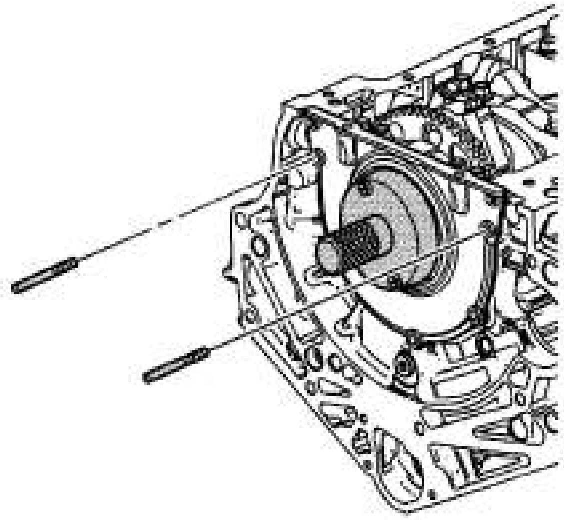


3. Place a 3 mm (0.118 in) bead of RTV sealant (1) to the NEW crankshaft rear oil seal housing as shown.



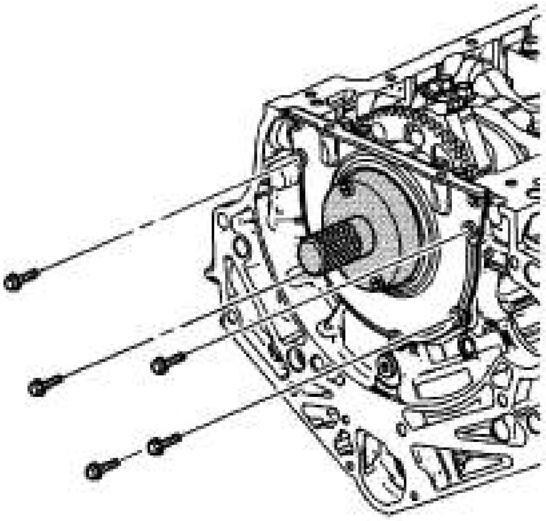
Important: DO NOT allow any engine oil on the area where the crankshaft rear oil seal housing is to be installed.

4. Install the crankshaft rear oil seal housing to the cylinder block.

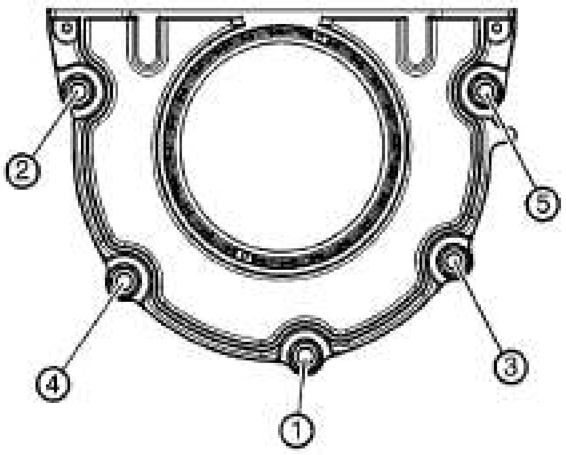


5. Remove the EN 46109 mm (0.236 in) guides from the cylinder block.

   Notice: Refer to Fastener Notice in the Preface section.

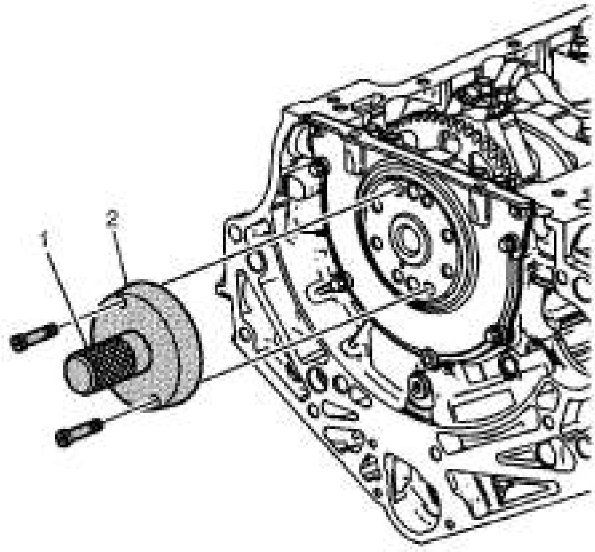


6. Install the crankshaft rear oil seal housing to cylinder block retaining bolts.



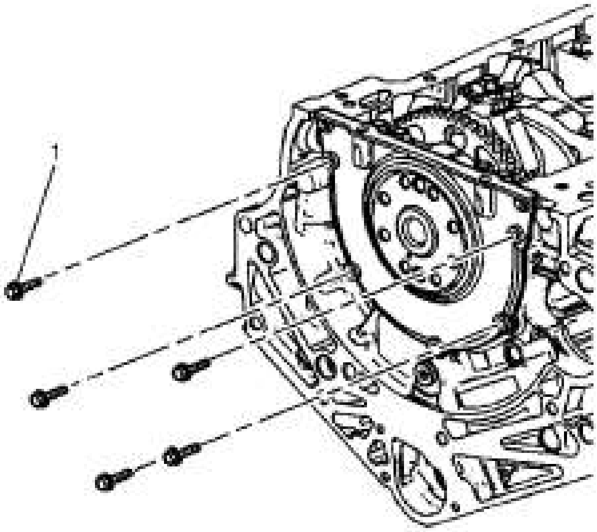
7. Tighten the crankshaft rear oil seal housing bolts in sequence.

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).

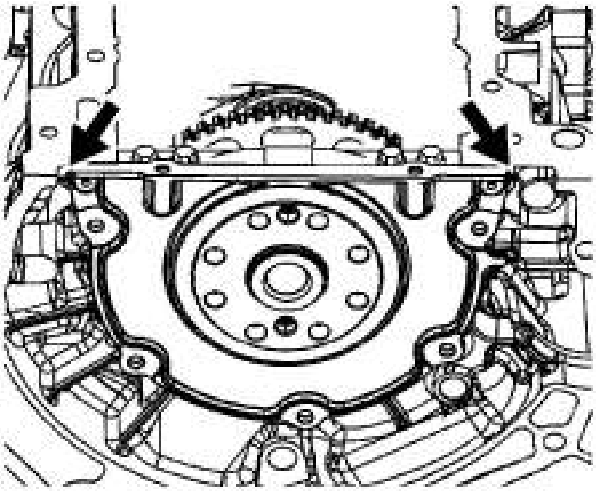


8. Remove the J 42183 (1) and EN-47839 (2) from the crankshaft flange.

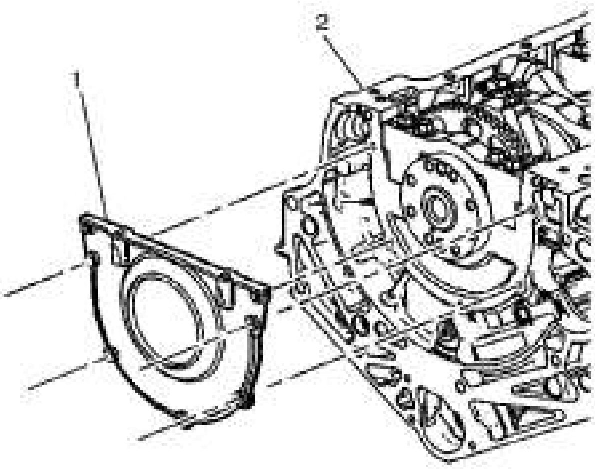
Crankshaft Rear Oil Seal and Housing Removal



1. Remove the crankshaft rear oil seal housing bolts (1).



2. Using the pry points located at the edge of the crankshaft rear oil seal housing shear the RTV sealant.



3. Remove and discard the crankshaft rear oil seal housing (1) from the cylinder block (2).

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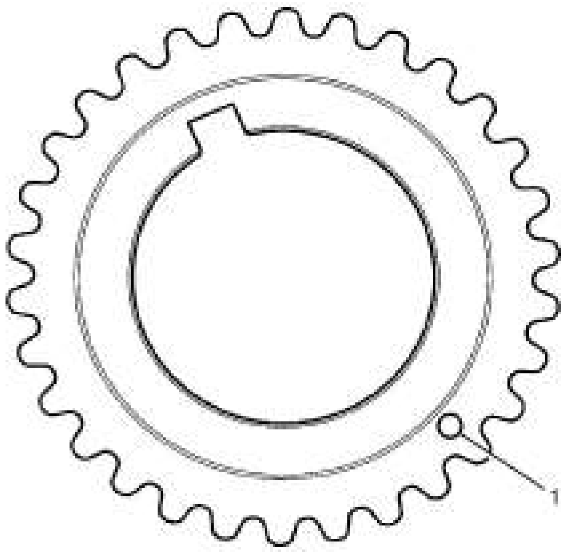
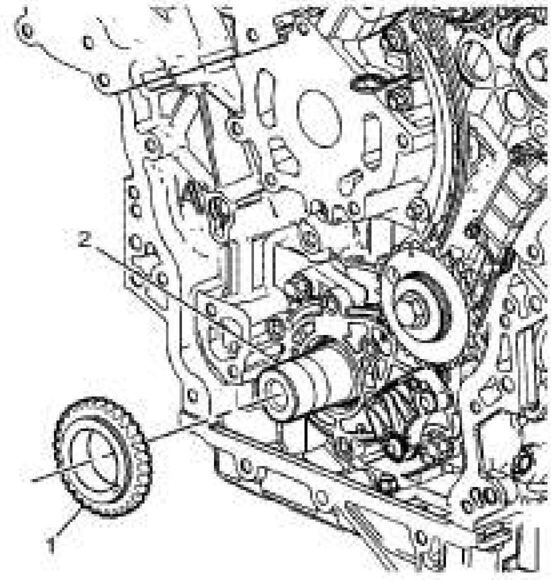
Crankshaft Sprocket Installation

Tools Required

EN 46111 Crankshaft Rotation Socket



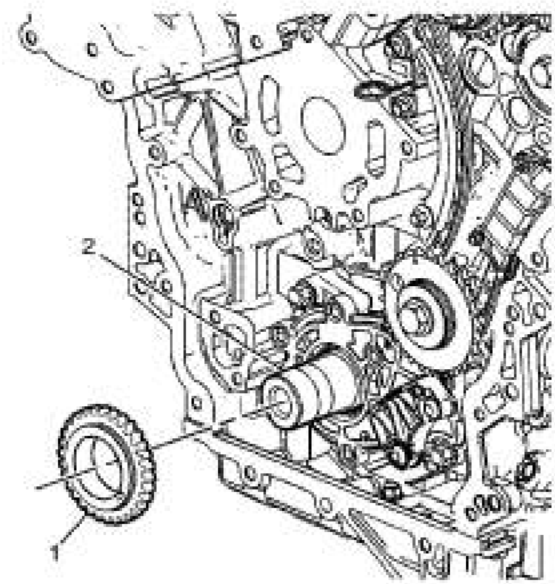
1. Make sure the crankshaft sprocket is installed with the timing mark (1) visible.



2. Install the crankshaft sprocket (1) on to the nose of the crankshaft (2).
3. Align the keyway in the crankshaft sprocket (1) with the key in the crankshaft (2).

4. Slide the crankshaft sprocket on the crankshaft (2) nose until the crankshaft sprocket (1) contacts the step in the crankshaft (2).
5. If necessary, align the crankshaft sprocket to the stage one timing drive assembly position using the EN 46111 . Refer to Camshaft Timing Drive Chain Alignment Diagram.

Crankshaft Sprocket Removal



Remove the crankshaft sprocket (1) from the nose of the crankshaft (2).

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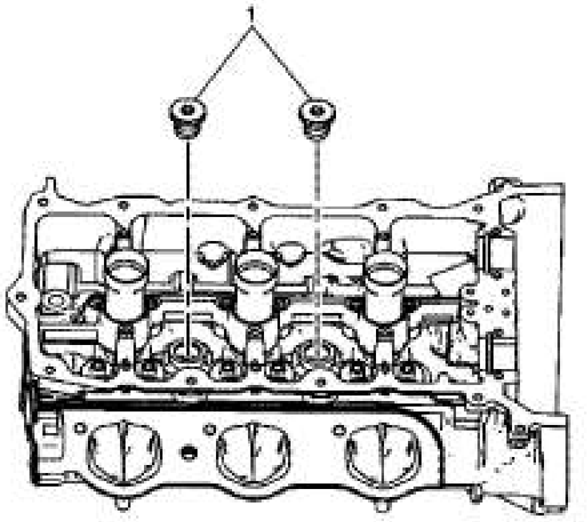
Cylinder Head Assemble

Tools Required

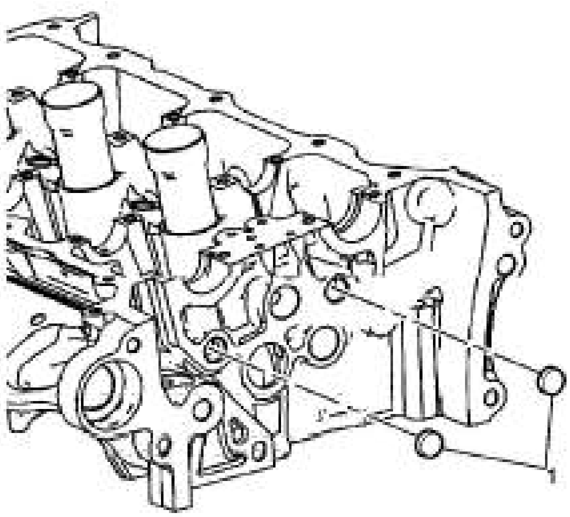
- J 8062 Valve Spring Compressor - Head Off
- EN 46116 Valve Stem Seal Remover/Installer
- EN 46117 Valve Stem Key Remover/Installer
- EN 46119 Off-Vehicle Valve Spring Compressor Adapter

Notice: Refer to Fastener Notice in the Preface section.

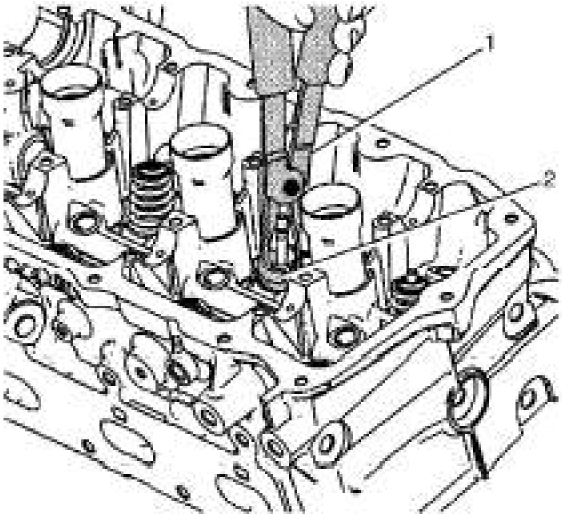


1. Install the cylinder head coolant threaded plugs (1).

   Tighten
   Tighten the threaded plug to 45 N·m (33 lb ft).



2. Install the NEW cylinder head oil gallery expansion plugs (1).



3. Place the valve stem oil seals (2) onto the guides.

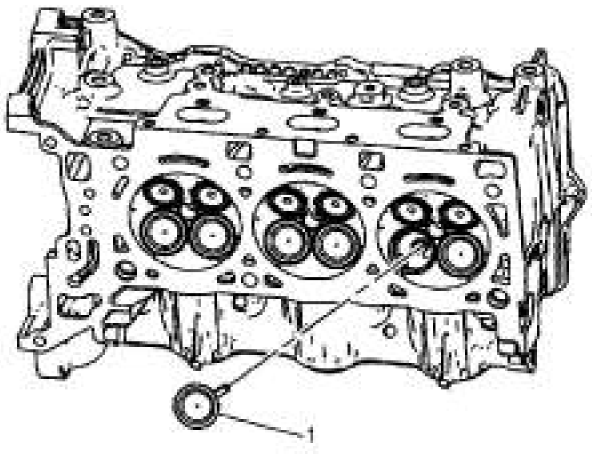
   Important: NEVER reuse a valve stem oil seal (2). Always use new seals when assembling the cylinder head.

4. Mount a new valve stem oil seal (2) using the EN 46116 (1).

   Important: Force should only be applied to the valve spring contact area of the new valve stem oil seal (2) during installation.

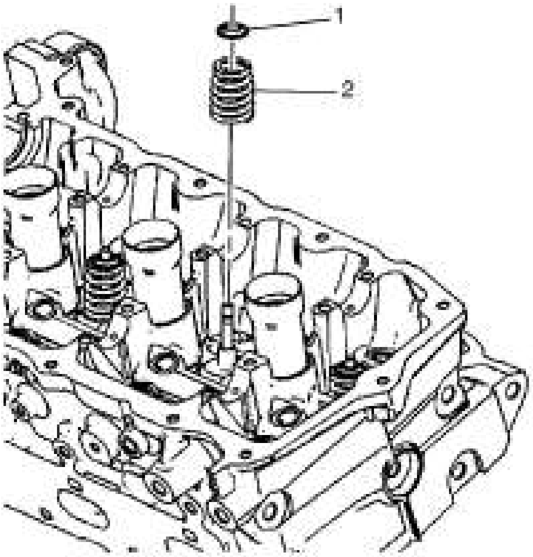
5. Push and twist the valve stem oil seal (2) into position on the valve guide until the seal positively locks on the guide using the EN 46116 (1).

6. Lubricate the valve stem and valve guide ID with clean engine oil.

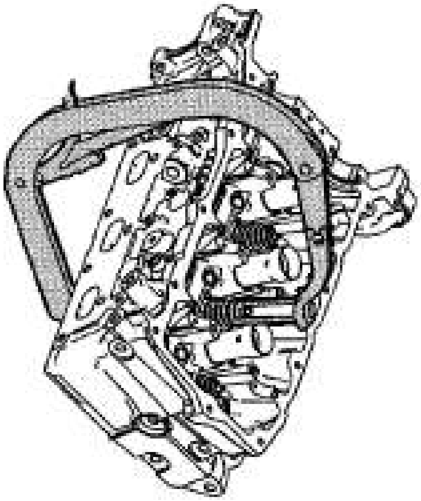


Important: The valve stem oil seal must not come loose from the valve guide when the valve is installed.

7. Insert the valve (1) into the valve guide until it bottoms on the valve seat.



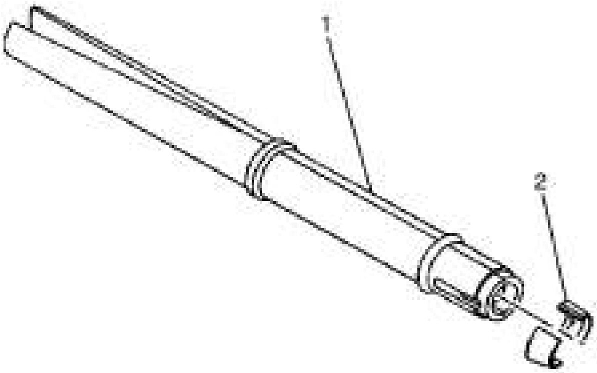
8. Install the valve spring (2).
9. Place the valve spring retainer (1) onto the valve spring (2).



Caution: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

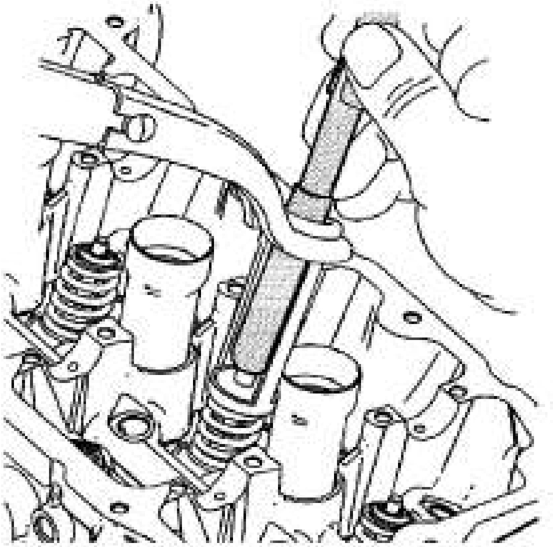
Notice: Do not compress the valve springs to less than 24.0 mm (0.943 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.

10. Compress the valve spring using the J 8062 and the EN 46119 .



Important: Ensure correct directional placement of valve collets (2) in the EN 46117 (1). The valve collets (2) must be installed with the tapered end towards the valve stem seal.

11. With the spring compressed, install the valve collets (2) into the EN 46117 (1).



12. Place the valve collets into position by pushing the EN 46117 downward and releasing tension on the EN 46119 and the J 8062 .
13. Verify that the valve collets are installed by placing a rag over the valve tip and tapping with a dead-blow hammer. The valve keepers and the spring should remain in place.

Cylinder Head Cleaning and Inspection

Tools Required

- EN 46122 Camshaft Position Actuator Check-Ball Valve Remover/Installer
- J 8001 Dial Indicator Set
- J 8358 Carbon Removal Brush
- J 28410 Gasket Remover
- J 42096 Valve Guide Reamer

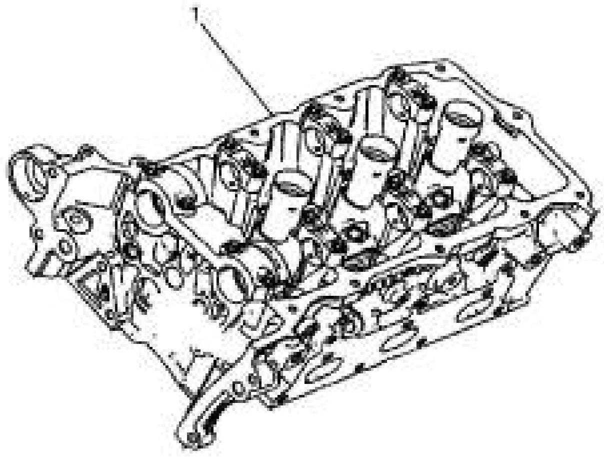
Cleaning Procedure

1. Remove any old thread sealant, gasket material or sealant using J 28410 .
2. Clean all cylinder head surfaces with non-corrosive solvent.

   Caution: Refer to Safety Glasses Caution in the Preface section.

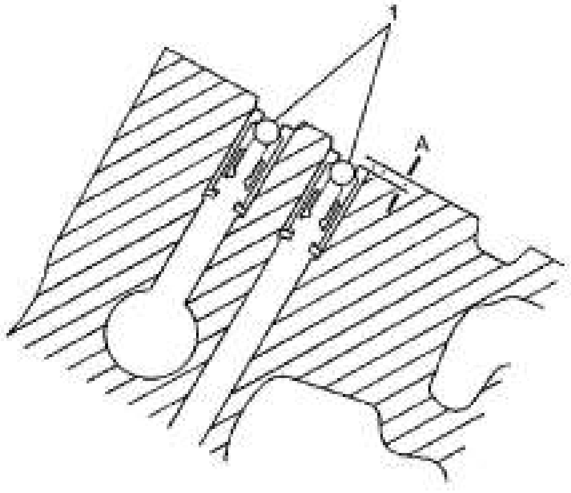
3. Blow out all the oil galleries using compressed air.
4. Remove any carbon deposits from the combustion chambers using the J 8358 .
5. Clean any debris or build-up from the lifter pockets.

Visual Inspection

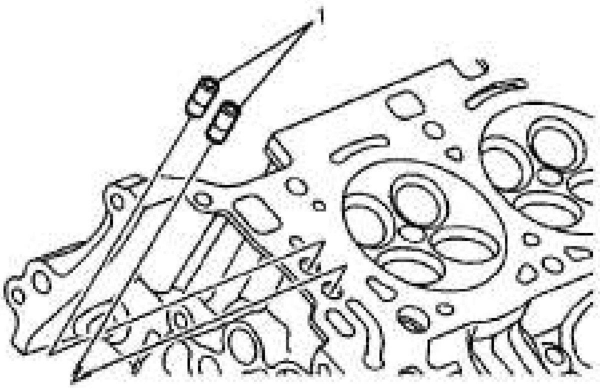


1. Inspect the cylinder head (1) camshaft bearing surfaces for the following conditions:
   - Scoring or pitting above acceptable tolerances
   - Discoloration from overheating

  - Deformation from wear above acceptable tolerances
  - If the camshaft bearing journals appear to be scored or damaged, you must replace the cylinder head. DO NOT machine the camshaft bearing journals.
2. If any of the above conditions exist on the camshaft bearing surfaces, replace the cylinder head.
3. Inspect the cylinder head for the following:
  - Cracks, damage or pitting in the combustion chambers
  - Debris in the oil galleries -- Continue to clean the galleries until all debris is removed.
  - Coolant leaks or damage to the deck face sealing surface -- If coolant leaks are present, measure the surface warpage as described under Cylinder Head Measurement - Deck Flatness Inspection.
  - Burrs or any defects that may degrade the sealing of the NEW secondary camshaft drive chain tensioner gasket
  - Damage to any gasket surfaces
  - Damage to any threaded bolt holes
  - Burnt or eroded areas in the combustion chamber
  - Cracks in the exhaust ports and combustion chambers
  - External cracks in the water passages
  - Restrictions in the intake or exhaust passages
  - Restrictions in the cooling system passages
  - Rusted, damaged or leaking core plugs
4. If the cylinder head is cracked or damaged, it must be replaced. No welding or patching of the cylinder head is recommended.



5. Inspect the camshaft position actuator oil feed check valves (1) in order to ensure they are correctly positioned in the cylinder head. The camshaft position actuator oil feed check valve should be flush to 2 mm (0.0787 in) below the cylinder head deck surface (A).



6. Damaged, restricted or clogged check valves (1) can be replaced using the EN 46122 .

Cylinder Head Measurement

Camshaft Journal Clearance

1. Install the camshaft bearing cap in the cylinder head without the camshaft.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the camshaft cap bolts.

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).

3. Measure the camshaft bearings using an inside micrometer.
4. Subtract the camshaft journal diameter from the camshaft bearing diameter. This will provide the running clearance. If the running clearance exceeds specifications and the camshaft journals are within specification, replace the cylinder head.

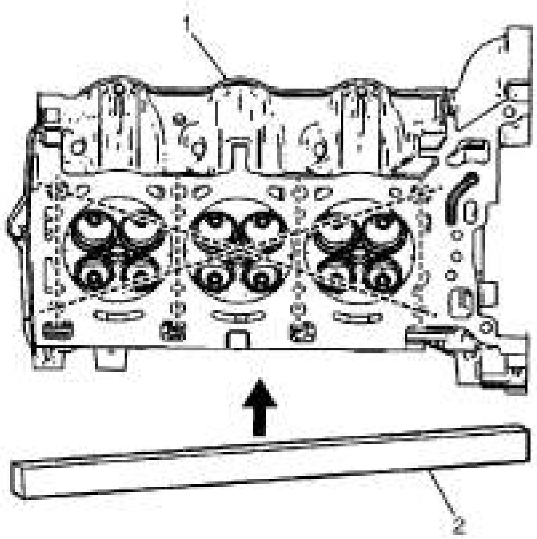
Camshaft Journal Alignment

1. Ensure the camshafts are serviceable.
2. Inspect the cylinder head camshaft bearing surfaces for any imperfections or scratches that may inhibit correct camshaft clearances. Repair minor imperfections or scratches.
3. Install the camshafts in the cylinder head.
4. Install the camshaft bearing caps.
5. Install the camshaft cap bolts.

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).

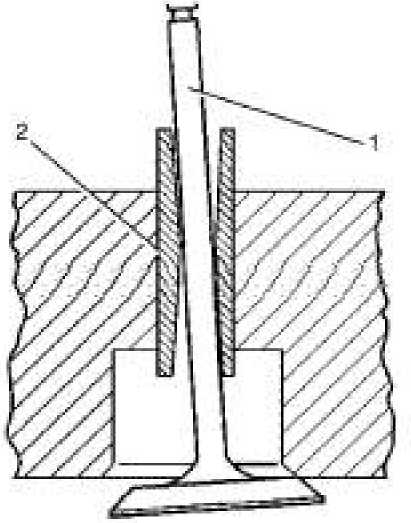
6. Ensure the camshafts spin freely in the cylinder head. If the camshaft does not run freely, replace the cylinder head.

Deck Flatness Inspection



1. Ensure the cylinder head (1) decks are clean and free of gasket material.
2. Inspect the surface for any imperfections or scratches that may inhibit correct cylinder head gasket sealing.
3. Place a straight-edge (2) diagonally across the cylinder head (1) deck face surface.
4. Measure the clearance between the straight-edge (2) and the cylinder head (1) deck face using a feeler gage at 4 points along the straight-edge (2).
5. If the warpage is less than 0.05 mm (0.002 in), the cylinder head (1) deck surface does not require resurfacing.
6. If the warpage is between 0.05-0.20 mm (0.002-0.008 in) or any imperfections or scratches that may inhibit correct cylinder head gasket sealing are present, the cylinder head (1) deck surface requires resurfacing.
7. If resurfacing is required the maximum amount that can be removed is 0.25 mm (0.010 in).
8. If the cylinder head (1) deck surface requires more than 0.25 mm (0.010 in) material removal the cylinder head (1) must be replaced.

Valve Guide Measurement

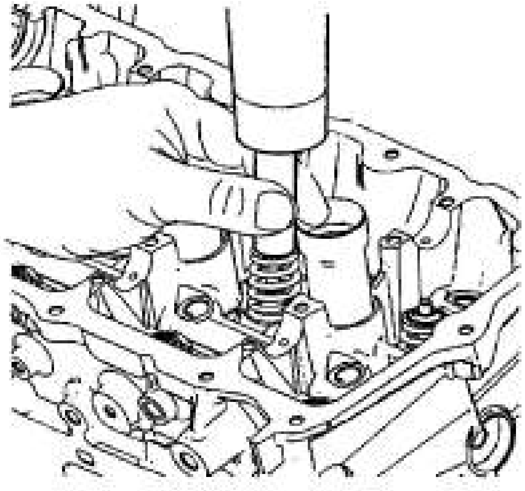


1. Measure the valve stem (1)-to-guide (2) clearance. Valve stem-to-guide clearance above acceptable tolerances may cause oil consumption above acceptable tolerances and may also cause a valve to break. Insufficient clearance will result in noisy and sticky functioning of the valve and will disturb the engine assembly smoothness.
2. Clamp the J 8001 to the cylinder head at the camshaft cover rail.
3. Locate the dial indicator so that the movement of the valve stem (1) from side to side, crossways to the cylinder head, will cause a direct movement of the indicator stem. The dial indicator stem must contact the side of the valve stem (1) just above the valve guide (2).
4. Drop the valve head about 0.064 mm (0.0025 in) off the valve seat.
5. Use light pressure when moving the valve stem (1) from side to side in order to obtain a clearance reading. Refer to Engine Mechanical Specifications .
    - If the clearance for the valve is greater than specifications and a new standard diameter valve stem will not bring the clearance within specifications, the valve guide may be oversized by 0.075 mm (0.003 in) using the J 42096 . There is 1 size of oversized valve stem available for service.
    - Valve guide wear at the bottom 10 mm (0.390 in) of the valve guide is not significant to normal operation.
    - If oversizing the guide does not bring the clearance within specifications, replace the cylinder head.

Cylinder Head Disassemble

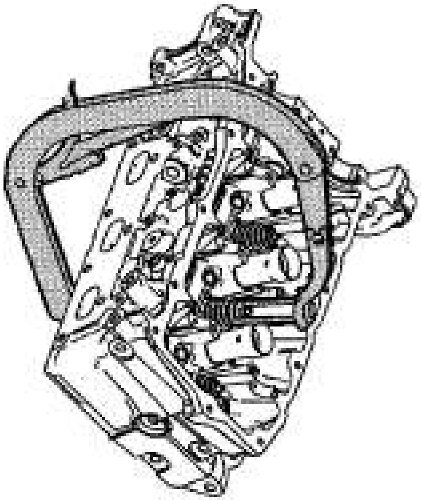
Tools Required

- EN 46116 Valve Stem Seal Remover/Installer
- EN 46117 Valve Stem Key Remover/Installer
- EN 46119 Off-Vehicle Valve Spring Compressor Adapter
- J 8062 Valve Spring Compressor - Head Off



Important: Make sure valve heads will not contact anything during the following step in order to avoid bending or damage.

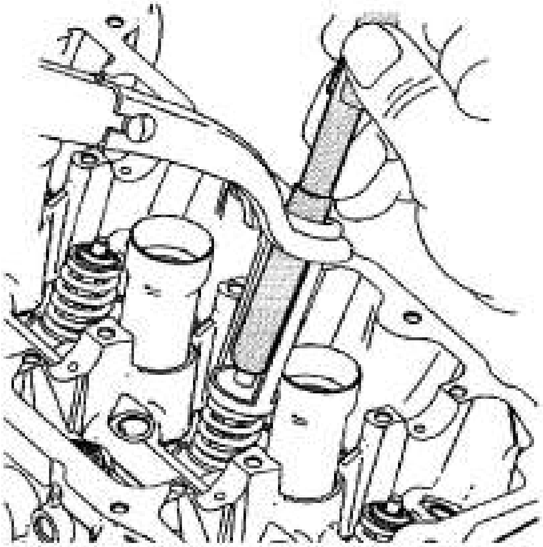
1. Using an appropriately sized deep socket and a plastic hammer, lightly tap on the valve spring retainer to loosen the valve collets.



Caution: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

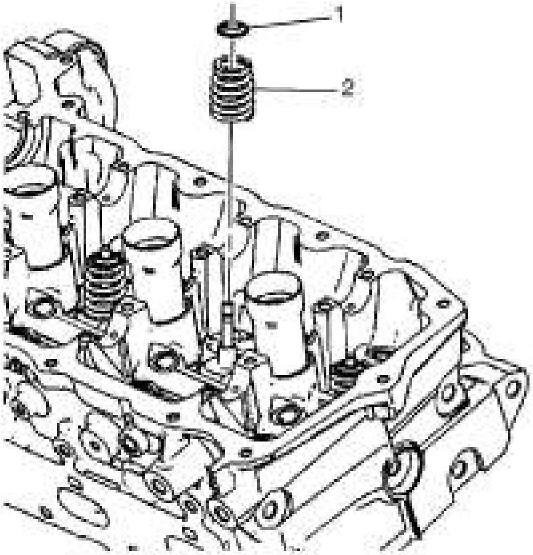
Notice: Do not compress the valve springs to less than 24.0 mm (0.943 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.

2. Compress the valve spring using the J 8062 and the EN 46119 .

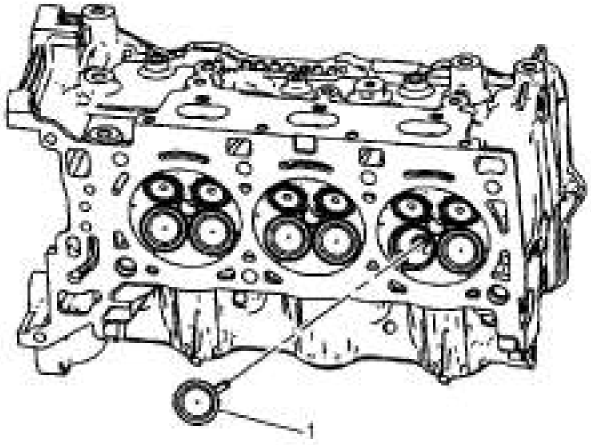


3. Use the magnet of the EN 46117 in order to remove the valve collets.

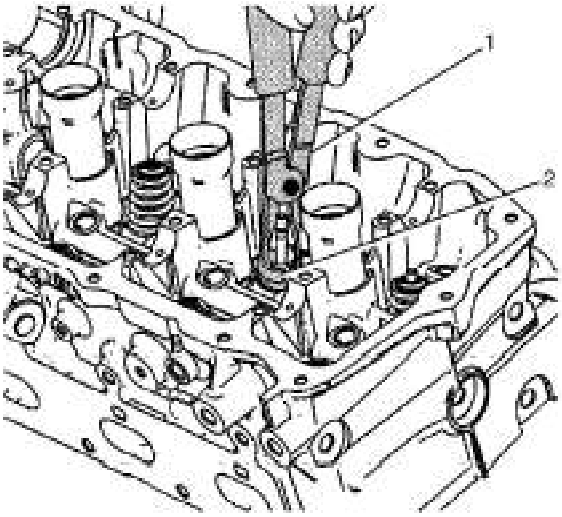
4. Remove the valve spring compressor and the adapter.



5. Remove the valve spring retainer (1).
6. Remove the valve spring (2).



7. Remove the valve (1).

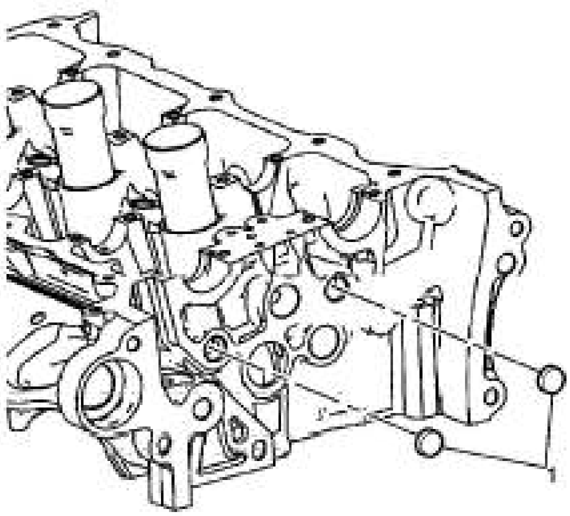


Important: NEVER reuse a valve stem oil seal.

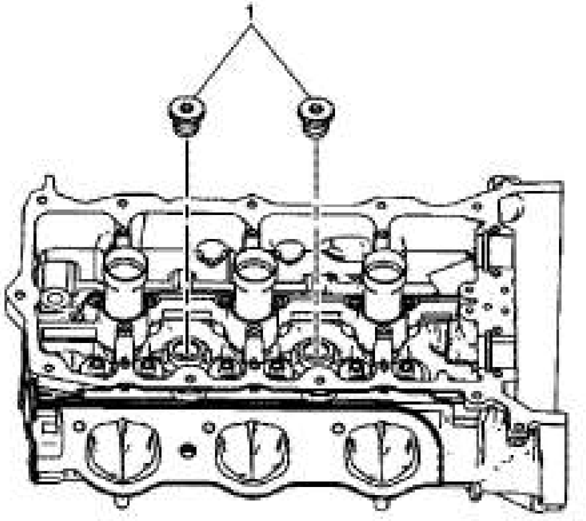
8. Remove the valve stem oil seal (2) using the EN 46116 (1).

   Discard the valve stem oil seals.

9. Repeat these procedures for the remaining valves.



10. Remove the cylinder head oil gallery expansion plugs (1).



11. Remove the cylinder head coolant threaded plugs (1).

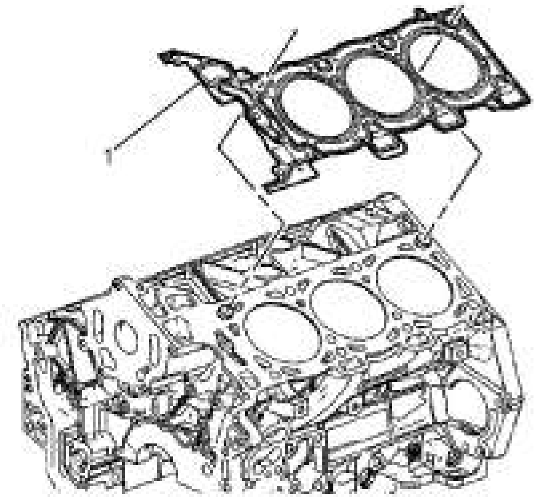
Cylinder Head Installation - Left Side

Tools Required

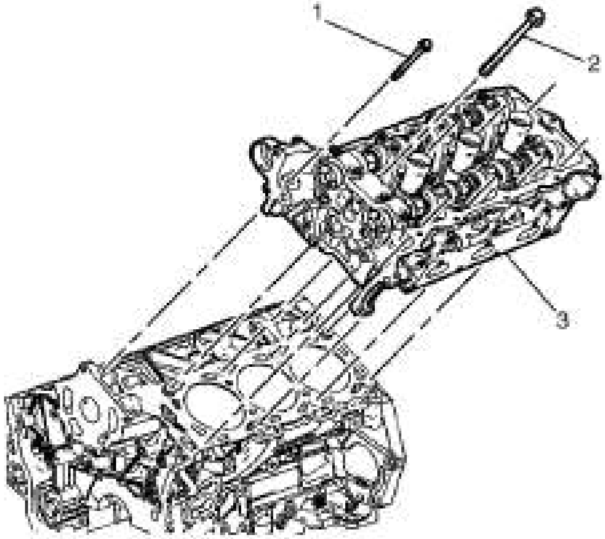
- EN 46111 Crankshaft Rotation Socket
- J 45059 Angle Meter

Important: Make sure that the crankshaft is in the timing drive assembly position using the EN 46111 .

1. Make sure the cylinder head locating pins are securely mounted in the cylinder block deck face.



2. Install a NEW left cylinder head gasket (1) using the deck face locating pins for retention.



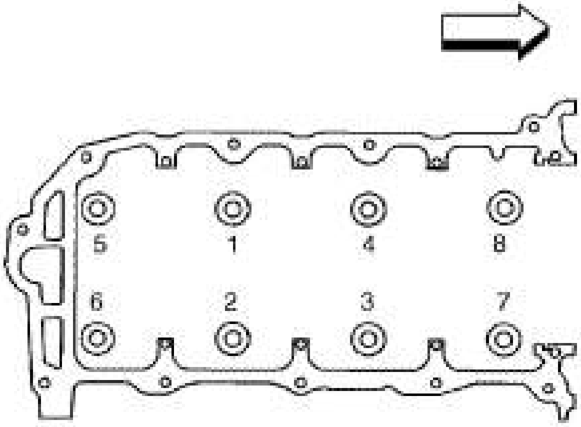
3. Align the left cylinder head (3) with the deck face locating pins.
4. Place the left cylinder head (3) in position on the deck face.

Important: DO NOT allow oil on the cylinder head bolt bosses.

Important: DO NOT reuse the old M11 cylinder head bolts.

5. Loosely install the NEW M11 cylinder head to cylinder block retaining bolts (2).
6. Loosely install the NEW M8 front cylinder head to cylinder block retaining bolts (1).

Notice: Refer to Fastener Notice in the Preface section.



7. Tighten the cylinder head to cylinder block retaining bolts in the sequence shown.

   Tighten
   Tighten the M11 cylinder head to cylinder block retaining bolts a first pass in sequence to 45 N·m (33 lb ft).

   7.1. Back off the M11 cylinder head to cylinder block retaining bolts 120 degrees using the J 45059 J 45059.
   7.2. Tighten the M11 cylinder head to cylinder block retaining bolts a second pass in sequence to 30 N·m (22 lb ft).
   7.3. Tighten the M11 cylinder head to cylinder block retaining bolts a third pass in sequence an additional 150 degrees using the J 45059 J 45059.
8. Install the 2 front M8 left cylinder head to cylinder block retaining bolts (9, 10).

   Tighten
   Tighten the M8 cylinder head to cylinder block retaining bolts (9, 10) a first pass to 15 N·m (11 lb ft).

   Tighten the M8 cylinder head to cylinder block retaining bolts (9, 10) a second pass in sequence an additional 60 degrees using the J 45059 .

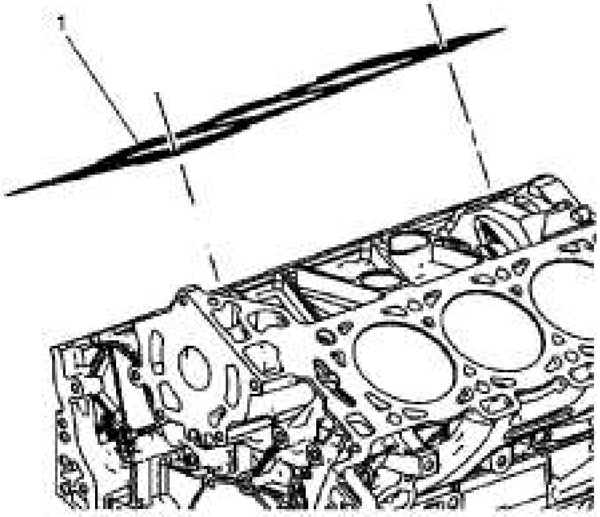
Cylinder Head Installation - Right Side

Tools Required

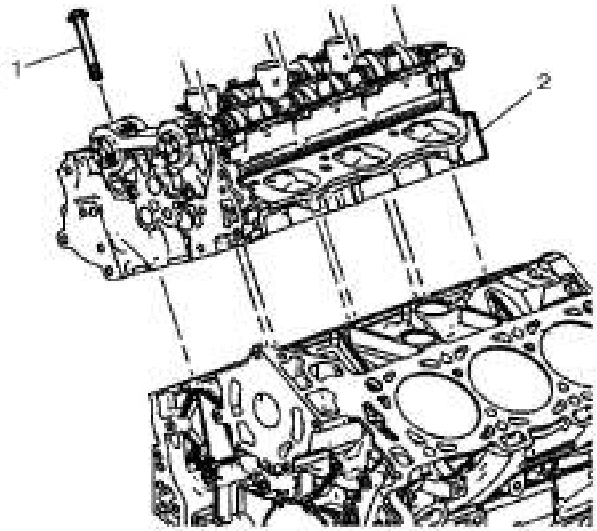
- EN 46111 Crankshaft Rotation Socket
- J 45059 Angle Meter

Important: Make sure that the crankshaft is in the timing drive assembly position using the EN 46111 .

1. Make sure the cylinder head locating pins are securely mounted in the cylinder block deck face.



2. Install a NEW right cylinder head gasket (1) using the deck face locating pins for retention.



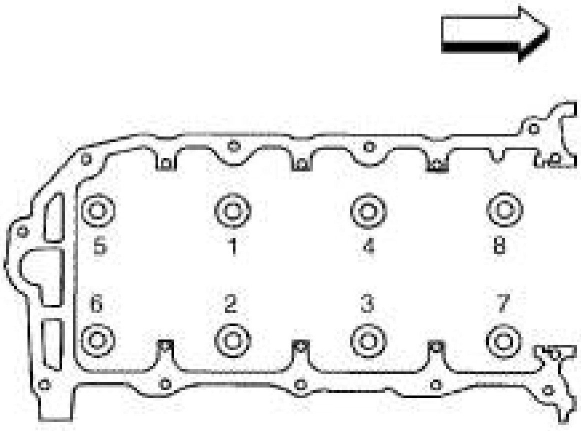
3. Align the right cylinder head (2) with the deck face locating pins.
4. Place the right cylinder head (2) in position on the deck face.

Important: DO NOT allow oil on the cylinder head bolt bosses.

Important: DO NOT reuse the old M11 cylinder head bolts.

5. Loosely install the NEW M11 and M8 cylinder head to cylinder block retaining bolts (1).

Notice: Refer to Fastener Notice in the Preface section.



6. Tighten the cylinder head to cylinder block retaining bolts in the sequence shown.

Tighten
Tighten the M11 cylinder head to cylinder block retaining bolts a first pass in sequence to 45 N·m (33 lb ft).

   6.1. Back off the M11 cylinder head to cylinder block retaining bolts 120 degrees using the J 45059 .
   6.2. Tighten the M11 cylinder head to cylinder block retaining bolts a second pass in sequence to 30 N·m (22 lb ft).
   6.3. Tighten the M11 cylinder head to cylinder block retaining bolts a third pass in sequence an additional 150 degrees using the J 45059 .

7. Install the 2 front M8 left cylinder head to cylinder block retaining bolts (9, 10).

Tighten
Tighten the M8 cylinder head to cylinder block retaining bolts (9, 10) a first pass to 15 N·m (11 lb ft).

Tighten the M8 cylinder head to cylinder block retaining bolts (9, 10) a second pass in sequence an additional 60 degrees using the J 45059 .

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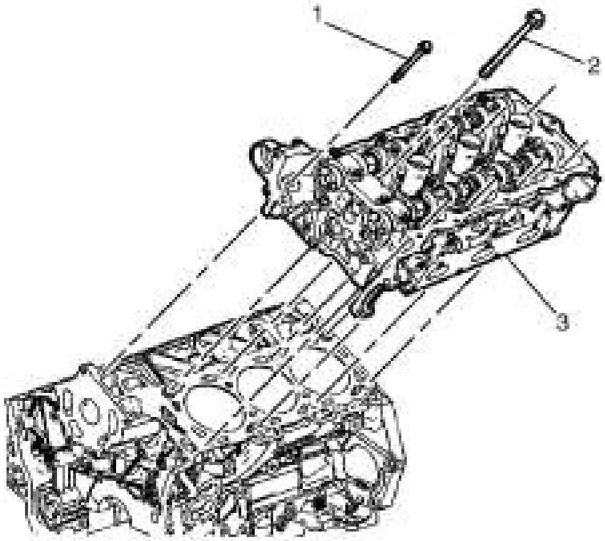
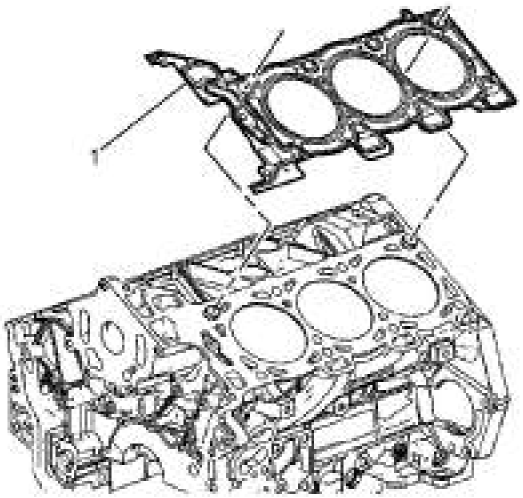
Cylinder Head Removal - Left Side

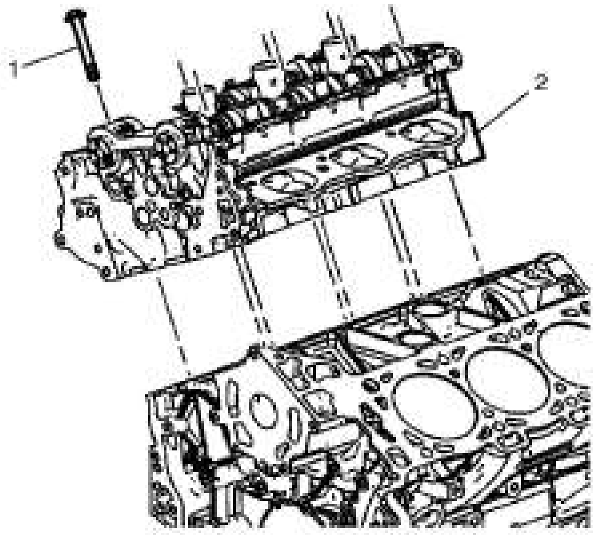


1. Remove the left bank cylinder head to cylinder block retaining bolts (1 and 2).
2. Remove the left bank cylinder head (3).

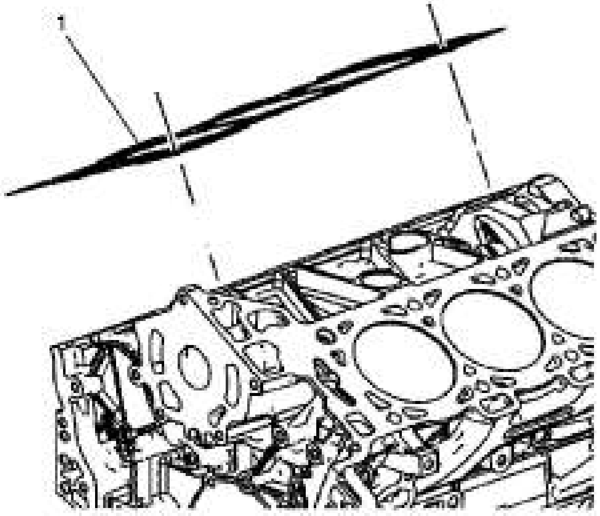


3. Remove and discard the left cylinder head gasket (1).

Cylinder Head Removal - Right Side

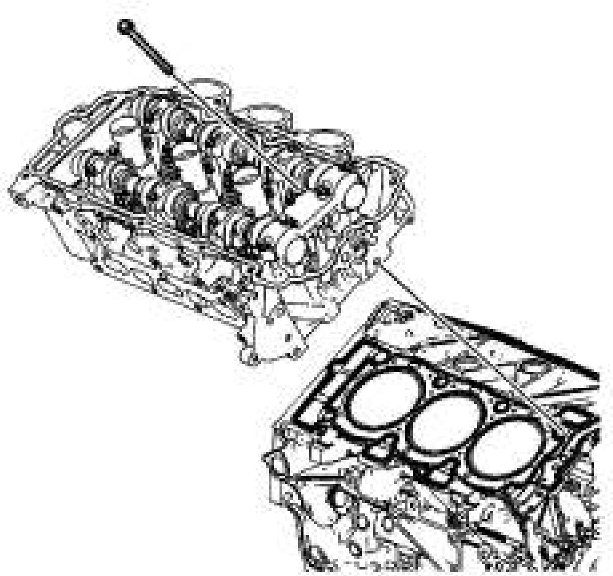


1. Remove the right bank cylinder head to cylinder block retaining bolts (1).
2. Remove the right bank cylinder head (2).

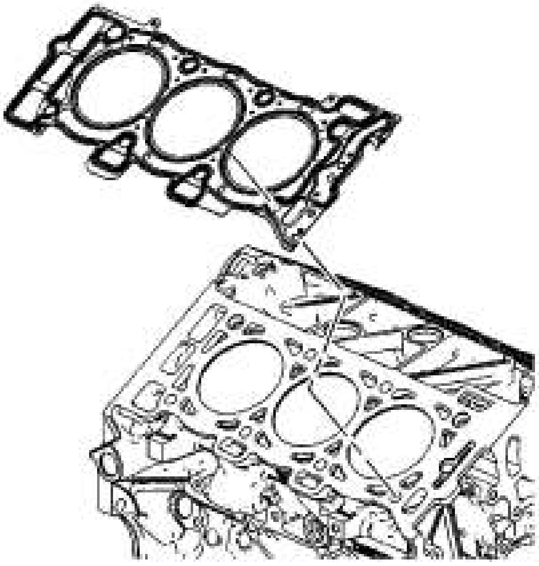


3. Remove and discard the right cylinder head gasket (1).

Cylinder Head Removal - Right Side (LLT)

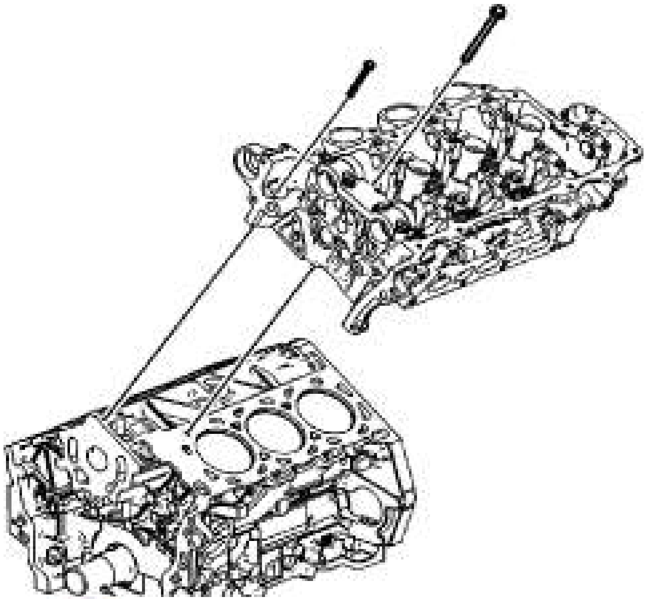


1. Remove the right cylinder head bolts.
2. Remove the right cylinder head.

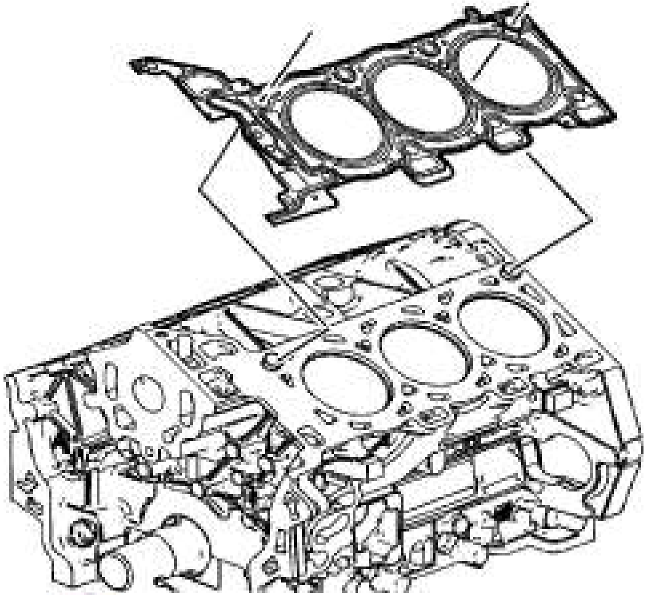


3. Remove and discard the right cylinder head gasket.

Cylinder Head Removal - Left Side (LLT)



1. Remove the two front M8 left cylinder head bolts.
2. Remove the left cylinder head bolts.
3. Remove the left cylinder head.



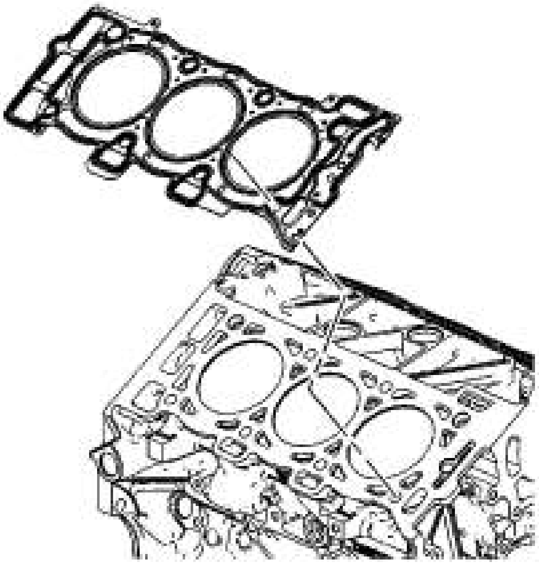
4. Remove and discard the left cylinder head gasket.

Cylinder Head Installation - Right Side (LLT)

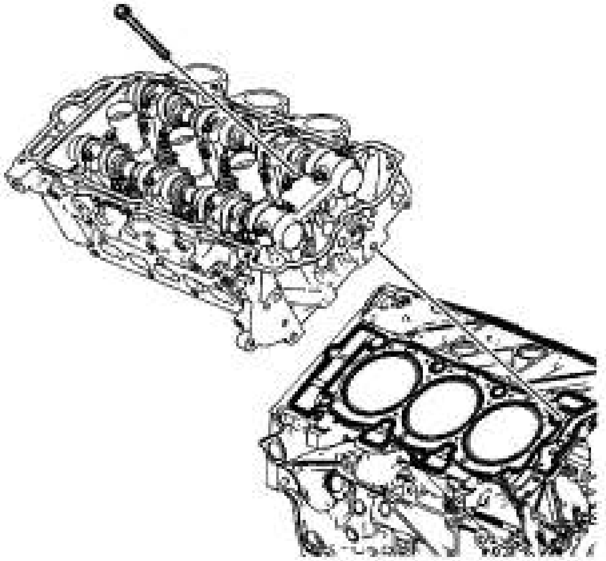
Special Tools

J 45059 Angle Meter

For equivalent regional tools, refer to Special Tools

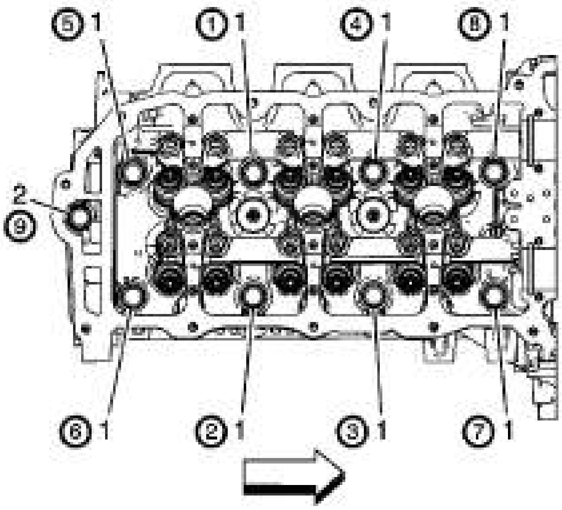


1. Ensure the cylinder head locating pins are securely mounted in the cylinder block deck face.
2. Install a NEW right cylinder head gasket using the deck face locating pins for retention.



3. Align the right cylinder head with the deck face locating pins.
4. Place the right cylinder head in position on the deck face.

Caution: Refer to Fastener Caution in the Preface section.



Note: DO NOT allow oil on the cylinder head bolt bosses.

Note: DO NOT reuse the old cylinder head bolts.

5. Install the NEW M11 cylinder head bolts (1).
   - 5.1. Tighten the M11 cylinder head bolts a first pass in sequence to **30 N·m (22 lb ft)**.
   - 5.2. Tighten the M11 cylinder head bolts a second pass in sequence an additional **150 degrees** using the *J 45059* meter .
6. Install the NEW M8 cylinder head bolt (2).
   - 6.1. Tighten the M8 cylinder head bolt a first pass to **15 N·m (11 lb ft).**
   - 6.2. Tighten the M8 cylinder head bolt a second pass an additional **75 degrees** using the *J 45059* meter .

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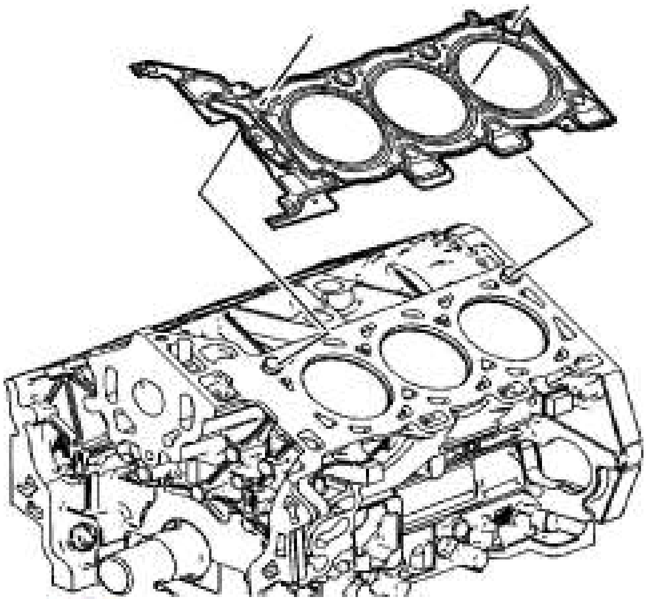
Cylinder Head Installation - Left Side (LLT)

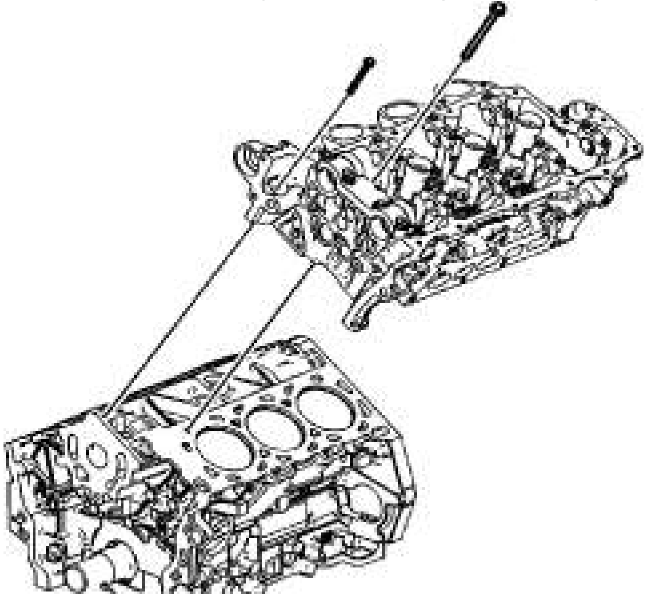
Special Tools

J 45059 Angle Meter

For equivalent regional tools, refer to Special Tools.

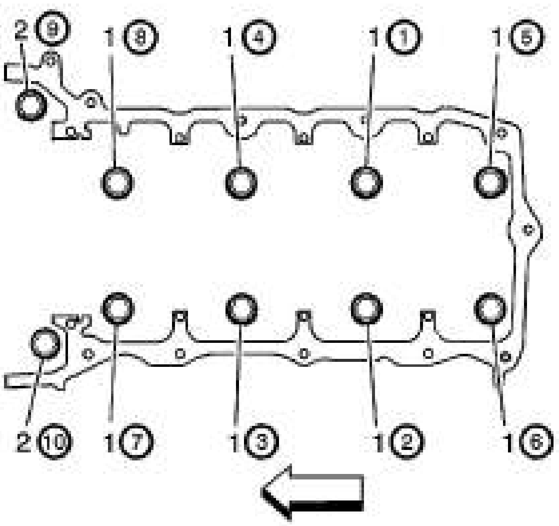


1. Ensure the cylinder head locating pins are securely mounted in the cylinder block deck face.
2. Install a NEW left cylinder head gasket using the deck face locating pins for retention.



3. Align the left cylinder head with the deck face locating pins.
4. Place the left cylinder head in position on the deck face.

Caution: Refer to Fastener Caution in the Preface section.



Note: DO NOT allow oil on the cylinder head bolt bosses.

Note: DO NOT reuse the old cylinder head bolts.

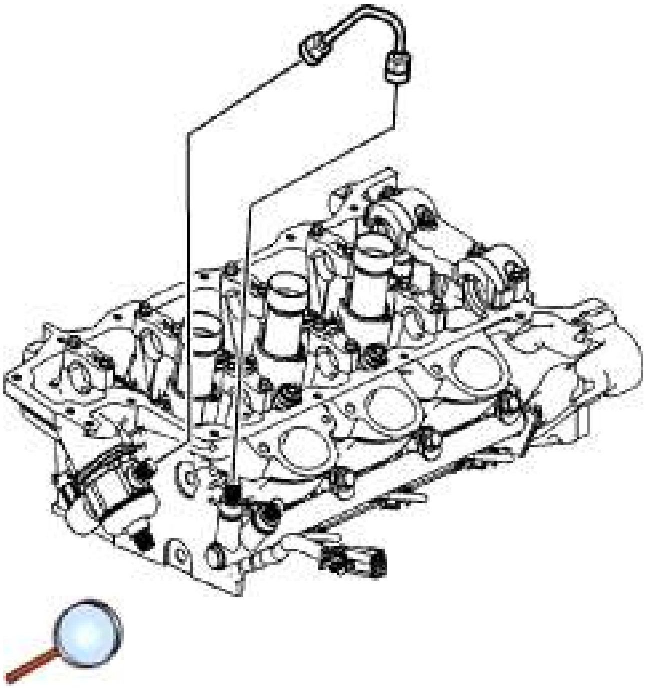
5. Install the NEW M11 cylinder head bolts (1).
   - 5.1. Tighten the M11 cylinder head bolts a first pass in sequence to **30 N·m (22 lb ft)**.
   - 5.2. Tighten the M11 cylinder head bolts a second pass in sequence an additional **150 degrees** using the *J 45059* meter .
6. Install the 2 NEW front M8 left cylinder head bolts (2).
   - 6.1. Tighten the M8 cylinder head bolts a first pass to **15 N·m (11 lb ft)**.
   - 6.2. Tighten the M8 cylinder head bolts a second pass in sequence an additional **75 degrees** using the *J 45059* meter .

Cylinder Head Disassemble (LLT)

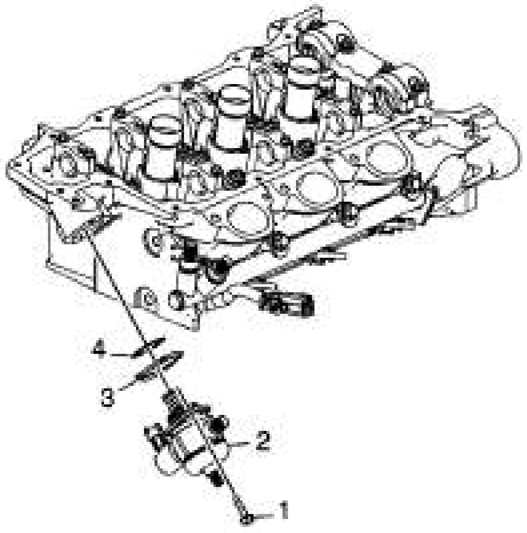
Special Tools

- *EN 46116* Valve Stem Seal Remover/Installer
- *EN 46117* Valve Stem Key Remover/Installer
- *EN 46119* Off-Vehicle Valve Spring Compressor Adapter
- *EN-46122* Camshaft Position Actuator Check-Ball Valve Remover/Installer
- *J 8062* Valve Spring Compressor - Head Off
- *J 2619-01* Slide Hammer
- *J-37281-A* Injector Remover

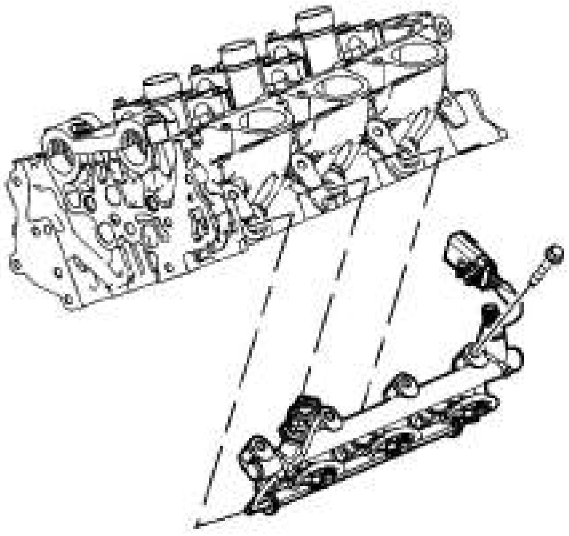
For equivalent regional tools, refer to Special Tools.



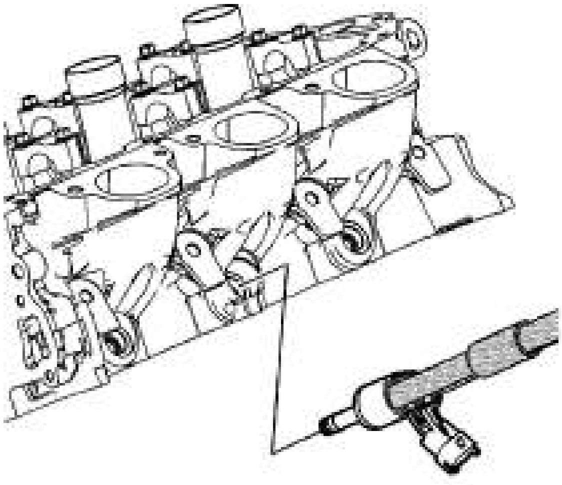
1. Remove and discard high pressure fuel line. - LH Cylinder Head



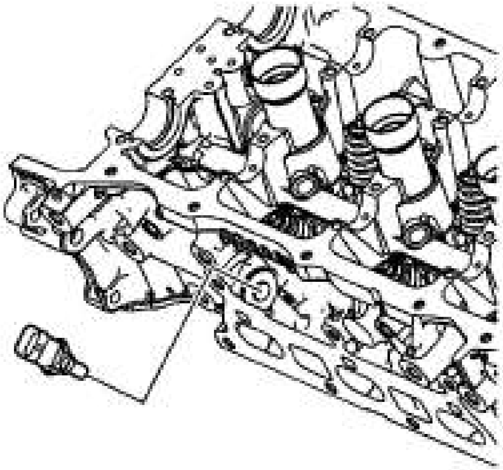
2. Remove and discard high pressure fuel pump bolts (1). - LH Cylinder Head
3. Remove the high pressure fuel pump (2). - LH Cylinder Head
4. Remove and discard the high pressure fuel pump gasket (3). - LH Cylinder Head
5. Remove and discard the high pressure fuel pump O-ring (4). - LH Cylinder Head



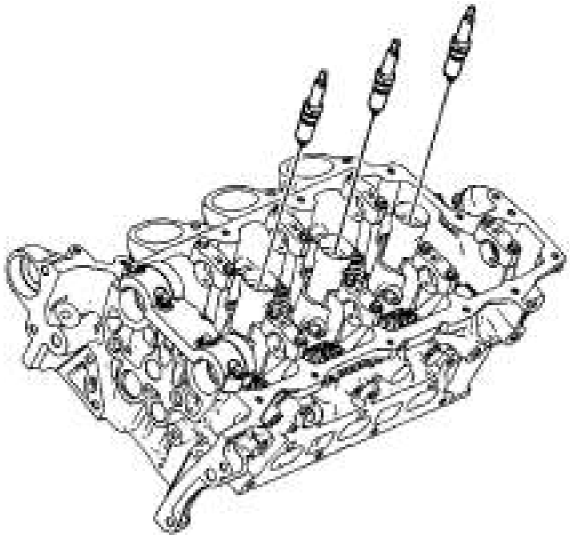
6. Remove the fuel rail bolts.
7. Remove the fuel rail and injectors.



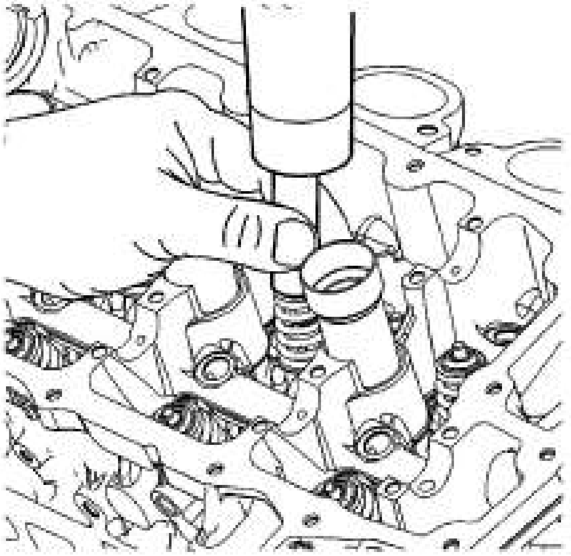
8. The injectors may stay in the cylinder head. Remove the fuel injector hold-down clamp before removing the injector.
9. Use the *J-37281-A* remover and the *J 2619-01* hammer to remove the injector.



10. Remove the engine coolant temperature (ECT) sensor. - LH Cylinder Head

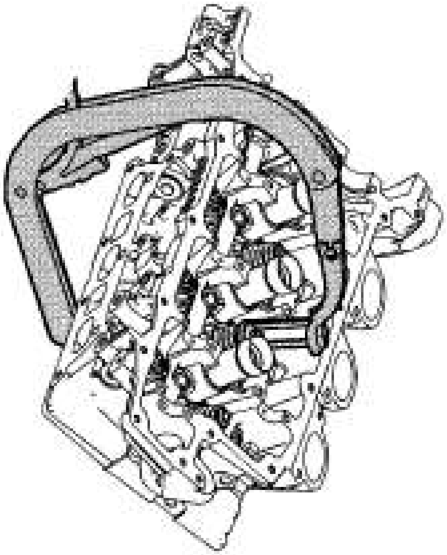


11. Remove the spark plugs.



Note: Ensure valve heads will not contact anything during the following step in order to avoid bending or damage.

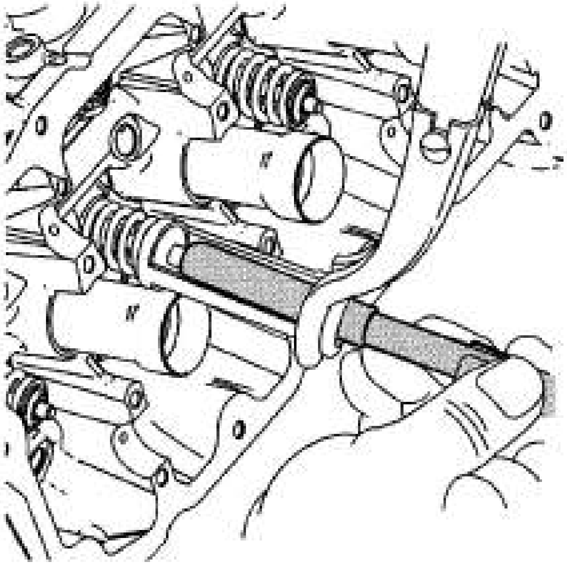
12. Using an appropriately sized deep socket and a plastic hammer, lightly tap on the valve spring retainer to loosen the valve keepers.



Warning: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

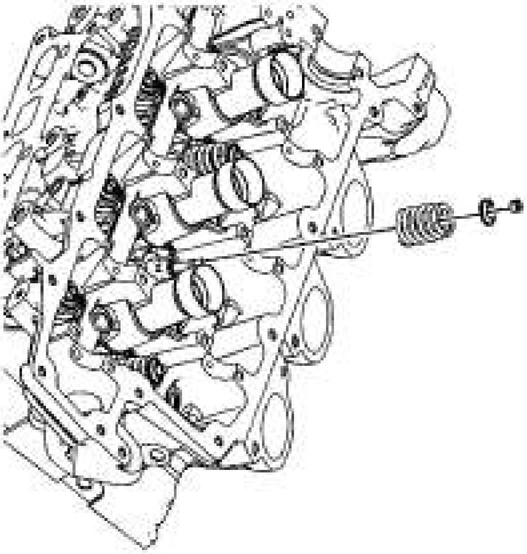
Caution: Do not compress the valve springs less than 24.0 mm (0.943 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.

13. Compress the valve spring using the *J 8062* compressor and the *EN 46119* adapter .

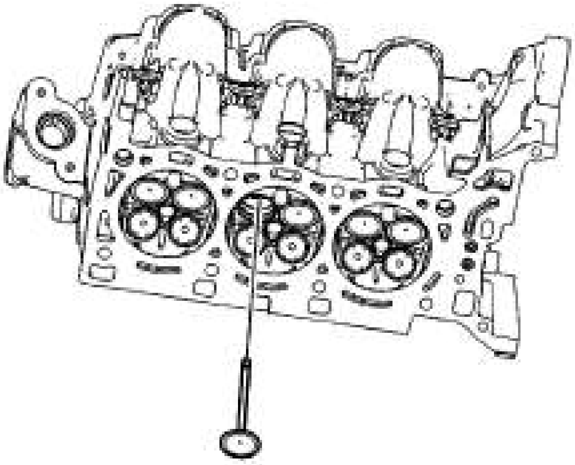


14. Use the magnet of the *EN 46117* remover/installer in order to remove the valve keepers.

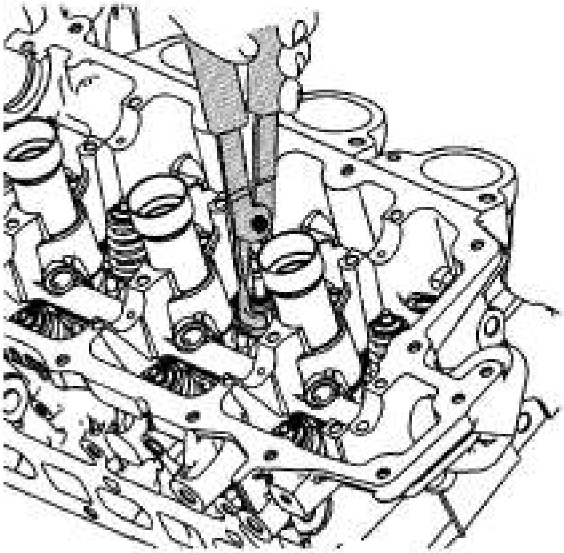
15. Remove the valve spring compressor and the adapter.



16. Remove the valve spring retainer.
17. Remove the valve spring.

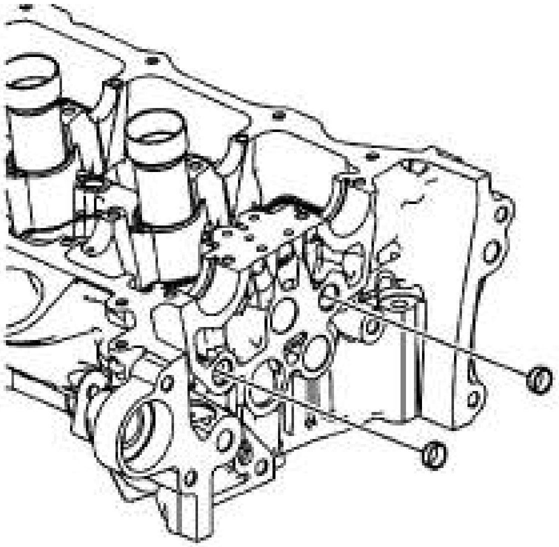


18. Remove the valve.

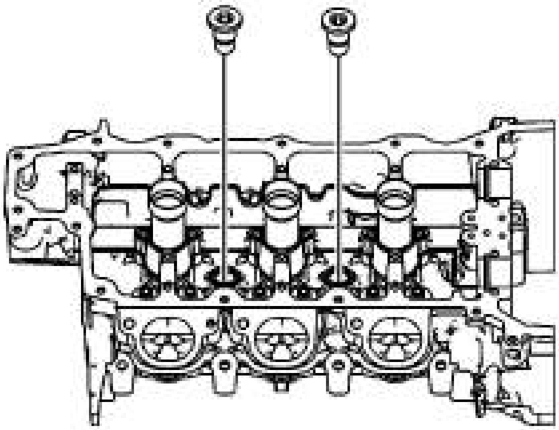


Note: NEVER reuse a valve stem oil seal.

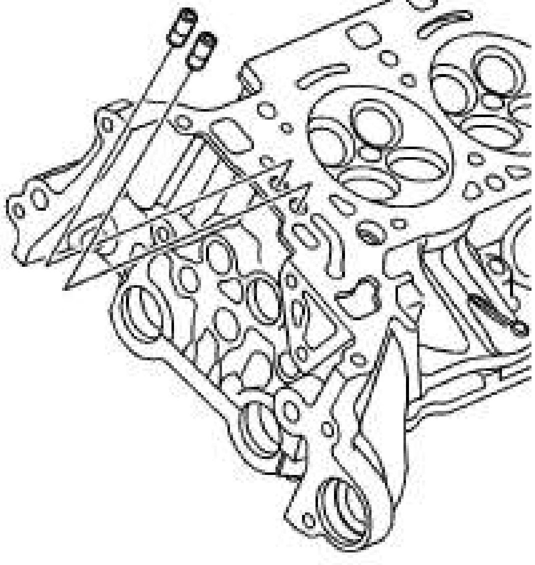
19. Remove the valve stem oil seal using the *EN 46116* remover/installer and discard.
20. Repeat these procedures for the remaining valves.



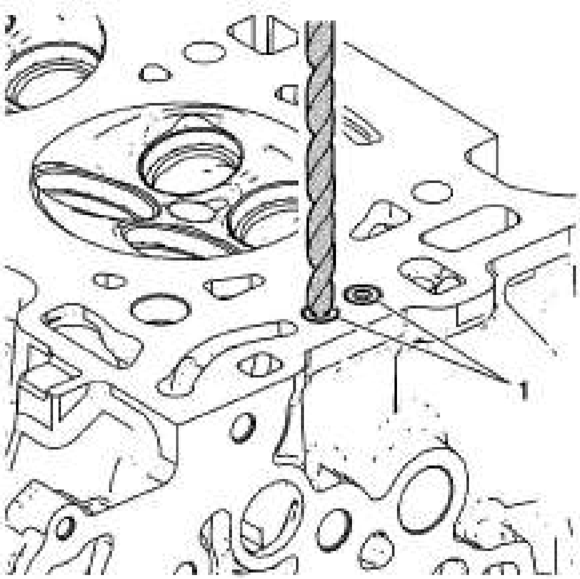
21. Remove the cylinder head oil gallery expansion plugs.



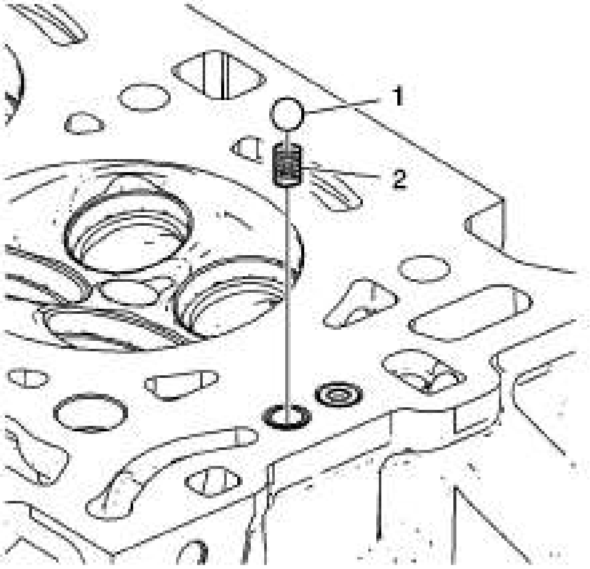
22. Remove the cylinder head coolant threaded plugs.



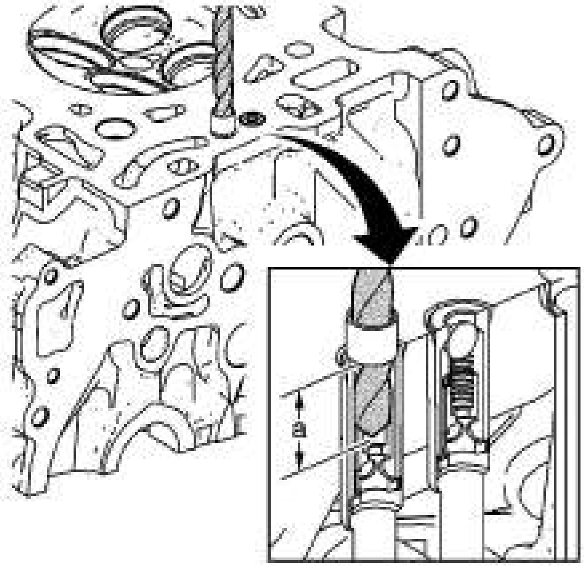
23. Inspect the camshaft position actuator oil feed check valves. Damaged, restricted or clogged check valves must be replaced.



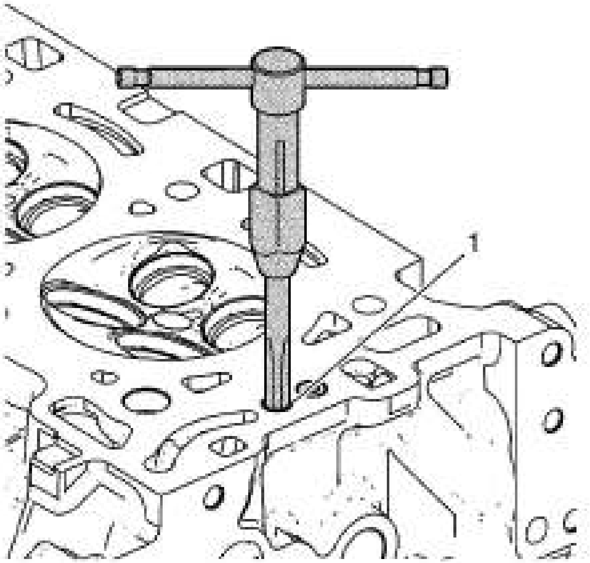
24. Place cylinder head on firm surface with check valves (1) facing up. Protect all cylinder head components and machined surfaces.
25. Using drill bit EN-46122-3, drill out top portion of check valve to expose internal check ball.



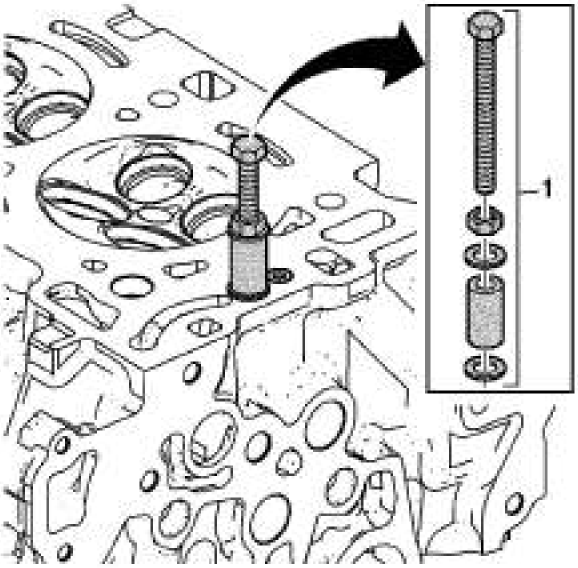
26. Remove check ball (1) and check ball spring (2) from inside of check valve.



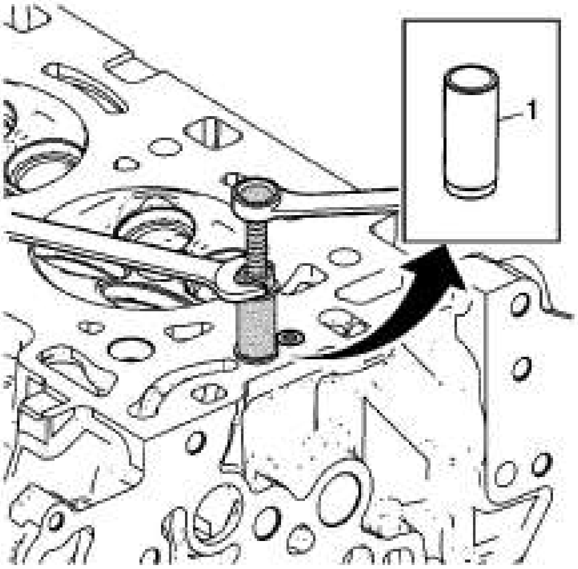
27. Continue drilling remainder of check valve sleeve to a depth of approximately 19 mm (0.75 in) (a) by placing tape on drill bit as a depth gauge. It is not necessary or desirable to drill completely through the bottom of the check valve.



28. Lubricate tap EN-46122-4 with lubricant included in *EN-46122* remover/installer . Tap drilled out portion of check valve (1) remaining in cylinder head. Tap to full depth possible until tap bottoms out in head.



29. Assemble bolt, nut, washers, and collar EN-46122-2 (1) as shown. Position collar with slightly-larger inside diameter DOWN toward the cylinder head.
30. Screw bolt by hand fully down into threaded check valve sleeve, then lightly tighten nut against washer.



31. Hold bolt with one wrench, and use another to tighten the nut until the check valve sleeve (1) is removed from the cylinder head.
32. Clean check valve bore and related passages thoroughly to remove any drilling chips or other debris.

2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | **Document ID: 2135557**

Cylinder Head Cleaning and Inspection (LLT)

Special Tools

- *EN-47909* Injector Bore and Sleeve Cleaning Kit
- *J 8001* Dial Indicator Set
- *J 8358* Carbon Removal Brush
- *J 28410* Gasket Remover
- *J 42096* Valve Guide Reamer

  For equivalent regional tools, refer to Special Tools.

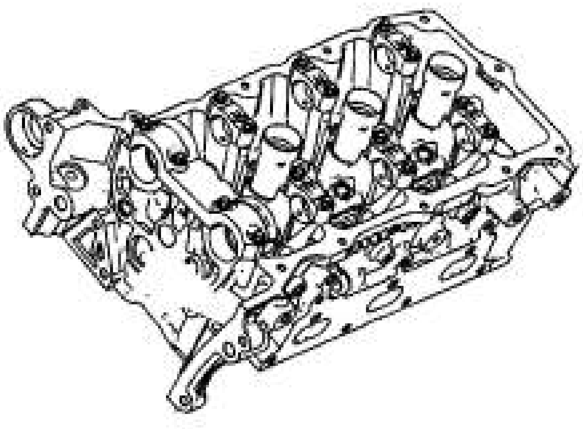
Cleaning Procedure

1. Remove any old thread sealant, gasket material or sealant using *J 28410* remover .
2. Clean all cylinder head surfaces with non-corrosive solvent.

   Warning: Refer to Safety Glasses Warning in the Preface section.

3. Blow out all the oil galleries using compressed air.
4. Remove any carbon deposits from the combustion chambers using the *J 8358* brush .
5. Clean any debris or build-up from the lifter pockets.

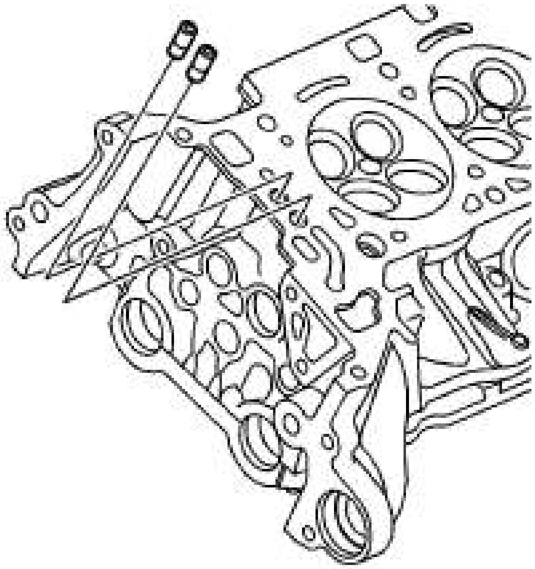
Visual Inspection



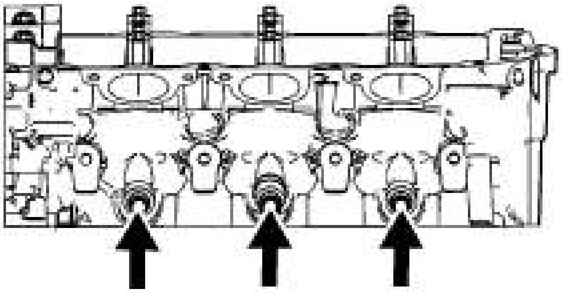
1. Inspect the cylinder head camshaft bearing surfaces for the following conditions:
   - Excessive scoring or pitting

- Discoloration from overheating
- Deformation from excessive wear
- If the camshaft bearing journals appear to be scored or damaged, you must replace the cylinder head. DO NOT machine the camshaft bearing journals.

2. If any of the above conditions exist on the camshaft bearing surfaces, replace the cylinder head.
3. Inspect the cylinder head for the following:
   - Cracks, damage or pitting in the combustion chambers
   - Debris in the oil galleries -- Continue to clean the galleries until all debris is removed.
   - Coolant leaks or damage to the deck face sealing surface -- If coolant leaks are present, measure the surface warpage as described under Cylinder Head Measurement - Deck Flatness Inspection.
   - Burrs or any defects that would degrade the sealing of the NEW secondary camshaft drive chain tensioner gasket
   - Damage to any gasket surfaces
   - Damage to any threaded bolt holes
   - Burnt or eroded areas in the combustion chamber
   - Cracks in the exhaust ports and combustion chambers
   - External cracks in the water passages
   - Restrictions in the intake or exhaust passages
   - Restrictions in the cooling system passages
   - Rusted, damaged or leaking core plugs
4. If the cylinder head is cracked or damaged, it must be replaced. No welding or patching of the cylinder head is recommended.



5. Inspect the camshaft position actuator oil feed check valves. Damaged, restricted or clogged check valves must be replaced. Refer to Cylinder Head Disassemble.



6. Inspect the fuel rail injector bores and clean with *EN-47909* kit , if required.

Cylinder Head Measurement

Camshaft Journal Clearance

1. Install the camshaft bearing cap in the cylinder head without the camshaft.

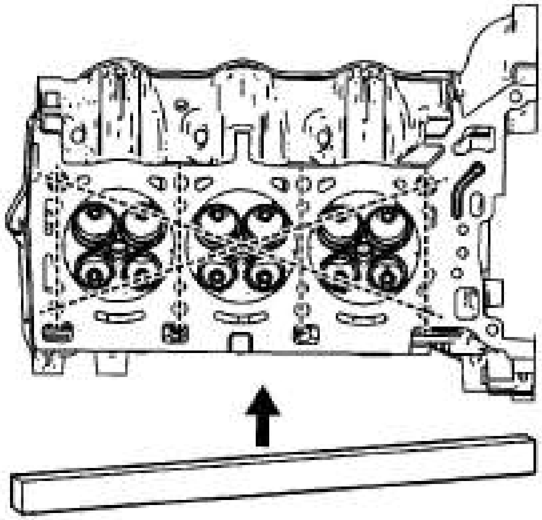
   Caution: Refer to Fastener Caution in the Preface section.

2. Install the camshaft cap bolts and tighten to **10 N·m (89 lb in)**.
3. Measure the camshaft bearings using an inside micrometer.
4. Subtract the camshaft journal diameter from the camshaft bearing diameter. This will provide the running clearance. If the running clearance exceeds specifications and the camshaft journals are within specification, replace the cylinder head.

Camshaft Journal Alignment

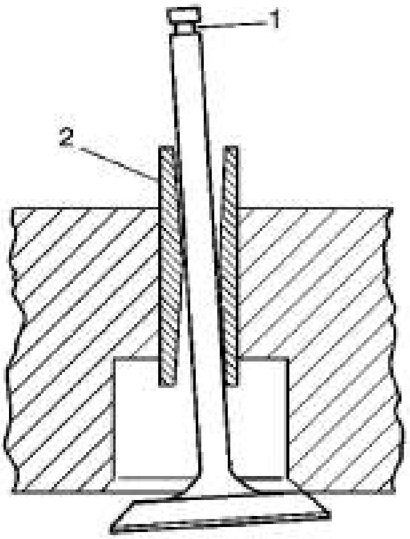
1. Ensure the camshafts are serviceable.
2. Inspect the cylinder head camshaft bearing surfaces for any imperfections or scratches that could inhibit proper camshaft clearances. Repair minor imperfections or scratches.
3. Install the camshafts in the cylinder head.
4. Install the camshaft bearing caps.
5. Install the camshaft cap bolts and tighten to **10 N·m (89 lb in)**.
6. Ensure the camshafts spin freely in the cylinder head. If the camshaft does not run freely, replace the cylinder head.

Deck Flatness Inspection



1. Ensure the cylinder head decks are clean and free of gasket material.
2. Inspect the surface for any imperfections or scratches that could inhibit proper cylinder head gasket sealing.
3. Place a straight-edge diagonally across the cylinder head deck face surface.
4. Measure the clearance between the straight-edge and the cylinder head deck face using a feeler gage at 4 points along the straight-edge.
5. If the warpage is less than 0.05 mm (0.002 in), the cylinder head deck surface does not require resurfacing.
6. If the warpage is between 0.05-0.20 mm (0.002-0.008 in) or any imperfections or scratches that could inhibit proper cylinder head gasket sealing are present, the cylinder head deck surface requires resurfacing.
7. If resurfacing is required the maximum amount that can be removed is 0.25 mm (0.010 in).
8. If the cylinder head deck surface requires more than 0.25 mm (0.010 in) material removal the head must be replaced.

Valve Guide Measurement



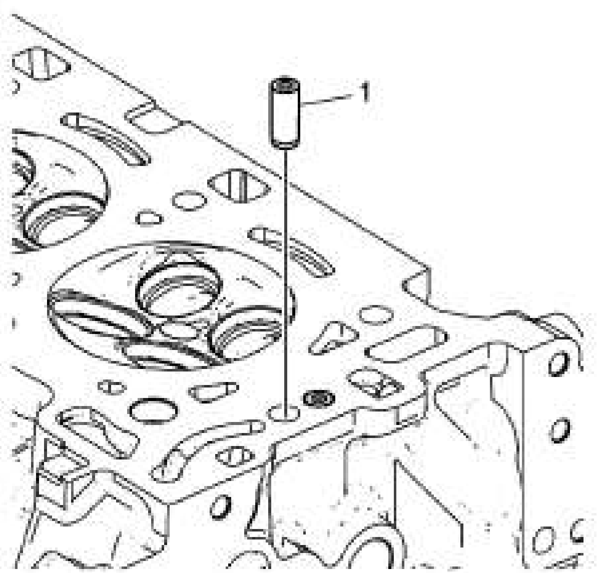
1. Measure the valve stem (1)-to-guide (2) clearance. Excessive valve stem-to-guide clearance may cause an excessive oil consumption and may also cause a valve to break. Insufficient clearance will result in noisy and sticky functioning of the valve and will disturb the engine assembly smoothness.
2. Clamp the *J 8001* set to the cylinder head at the camshaft cover rail.
3. Locate the dial indicator so that the movement of the valve stem from side to side, crossways to the cylinder head, will cause a direct movement of the indicator stem. The dial indicator stem must contact the side of the valve stem just above the valve guide.
4. Drop the valve head about 0.064 mm (0.0025 in) off the valve seat.
5. Use light pressure when moving the valve stem from side to side in order to obtain a clearance reading. Refer to Engine Mechanical Specifications for proper clearance.
    - If the clearance for the valve is greater than specifications and a new standard diameter valve stem will not bring the clearance within specifications, the valve guide may be oversized by 0.075 mm (0.003 in) using the *J 42096* reamer . There is 1 size of oversized valve stem available for service.
    - Valve guide wear at the bottom 10 mm (0.390 in) of the valve guide is not significant to normal operation.
    - If oversizing the guide does not bring the clearance within specifications, replace the cylinder head.

Cylinder Head Assemble (LLT)

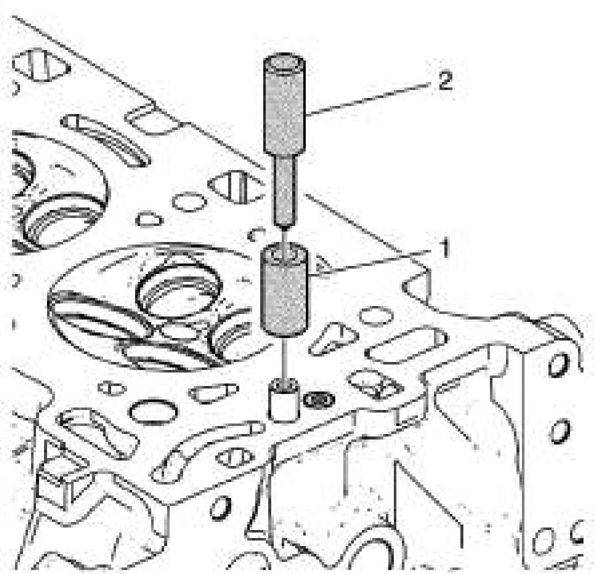
Special Tools

- *EN 46116* Valve Stem Seal Remover/Installer
- *EN 46117* Valve Stem Key Remover/Installer
- *EN 46119* Off-Vehicle Valve Spring Compressor Adapter
- *EN-46122* Camshaft Position Actuator Check-Ball Valve Remover/Installer
- *J 8062* Valve Spring Compressor - Head Off

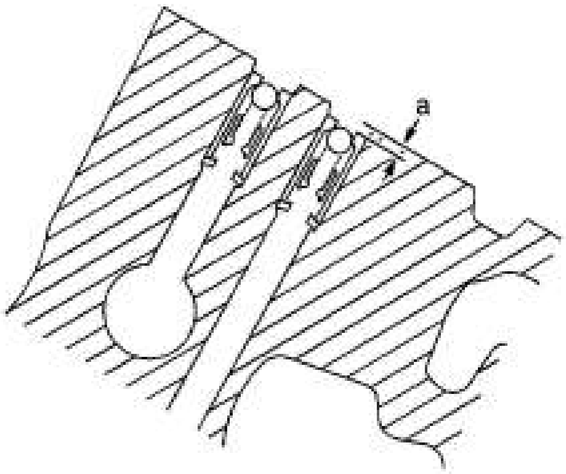
For equivalent regional tools, refer to Special Tools.



1. Use lubricant included with *EN-46122* remover/installer to lubricate outside of new check valve (1).
2. With the check ball end of the check valve facing UP, away from the head, insert the NEW check valve into the check valve bore in the cylinder head.

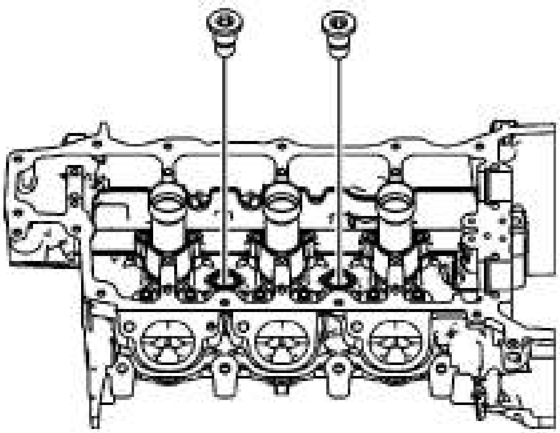


3. Place collar EN-46122-2 (1) over the new check valve with the slightly-larger inside diameter of the collar DOWN toward the cylinder head.
4. Using the driver EN-46122-1 (2), lightly tap the new check valve into place until the driver stops against the top of the collar.

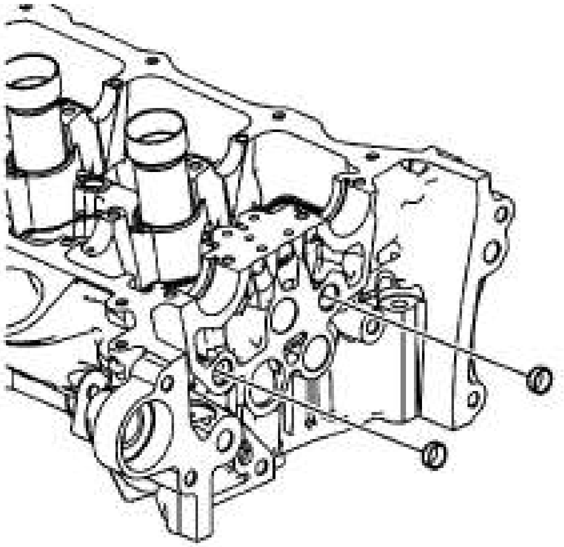


5. Inspect the camshaft position actuator oil feed check valves in order to ensure they are properly installed in the cylinder head. The camshaft position actuator oil feed check valve should be flush to 2 mm (0.0787 in) below the cylinder head deck surface (a).

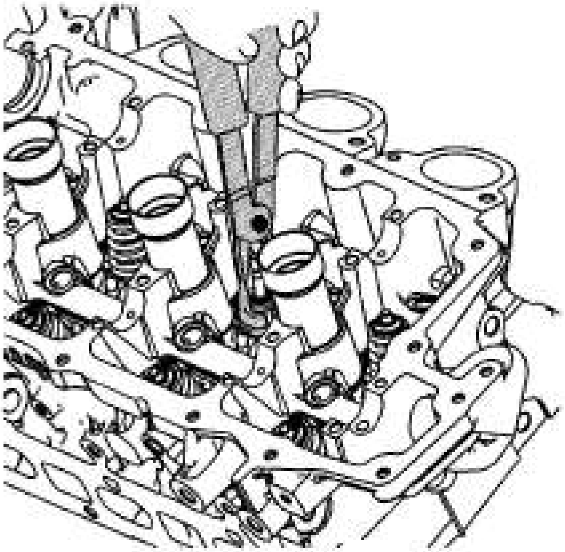
Caution: Refer to Fastener Caution in the Preface section.



6. Install the cylinder head coolant threaded plugs and tighten to **31 N·m (23 lb ft)**.



7. Install the NEW cylinder head oil gallery expansion plugs.



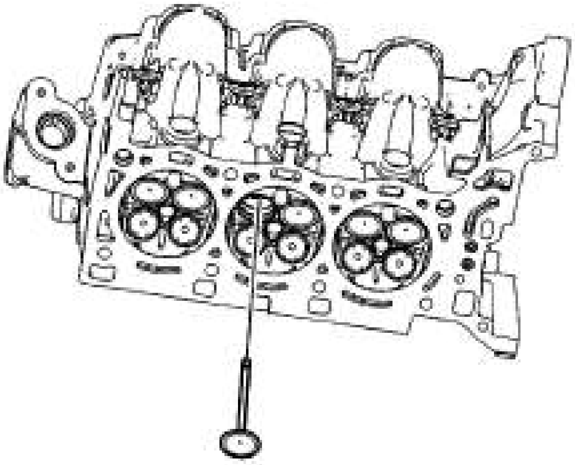
8. Place the valve stem oil seals onto the guides.

   Note: NEVER reuse a valve stem oil seal. Always use new seals when assembling the cylinder head.

9. Mount a new valve stem oil seal using the *EN 46116* remover/installer .

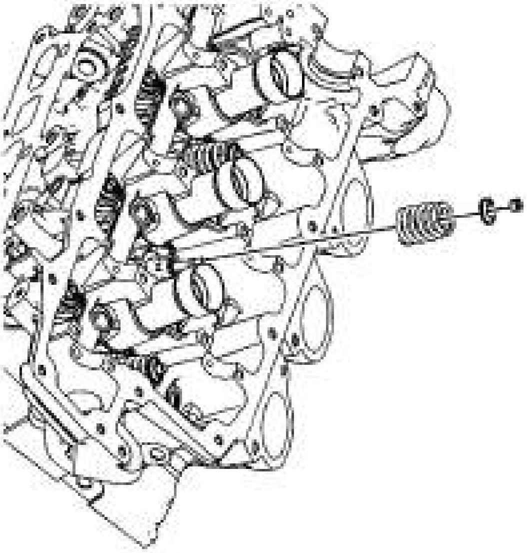
   Note: Force should only be applied to the valve spring contact area of the new valve stem oil seal during installation.

10. Push and twist the valve stem oil seal into position on the valve guide until the seal positively locks on the guide using the *EN 46116* remover/installer .
11. Lubricate the valve stem and valve guide ID with clean engine oil GM P/N 12345501 (Canadian P/N 992704) or equivalent.

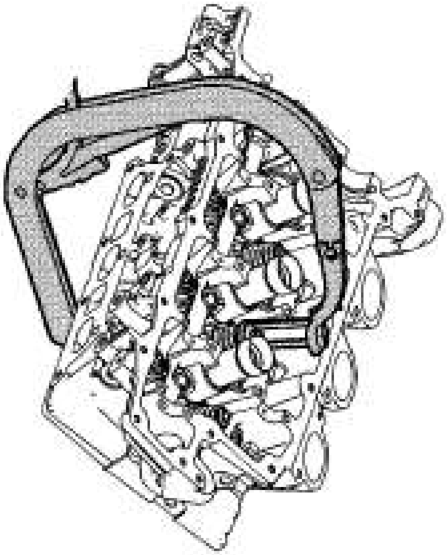


Note: The valve stem oil seal must not come loose from the valve guide when the valve is installed.

12. Insert the valve into the valve guide until it bottoms on the valve seat.



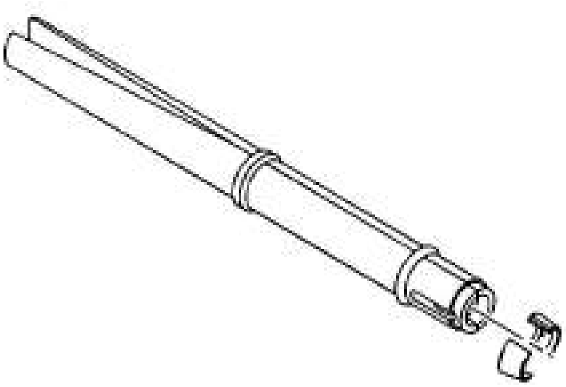
13. Position the valve spring on the spring seat.
14. Place the valve spring retainer onto the valve spring.



Warning: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

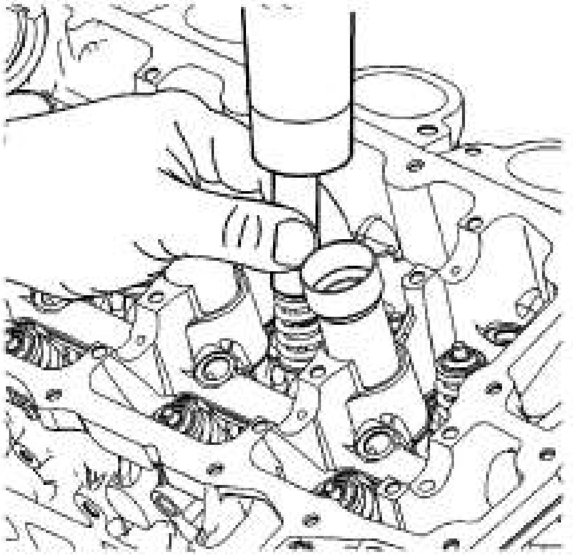
Caution: Do not compress the valve springs less than 24.0 mm (0.943 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.

15. Compress the valve spring using the *J 8062* Valve Spring compressor and the *EN 46119* adapter .

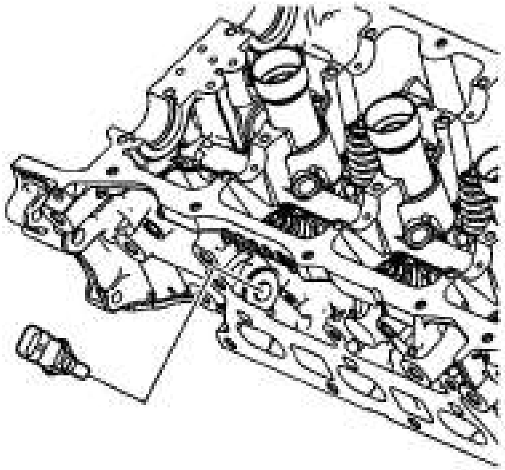


Note: Ensure proper directional placement of valve keepers in the *EN 46117* remover/installer . The valve keepers must be installed with the tapered end towards the valve stem seal.

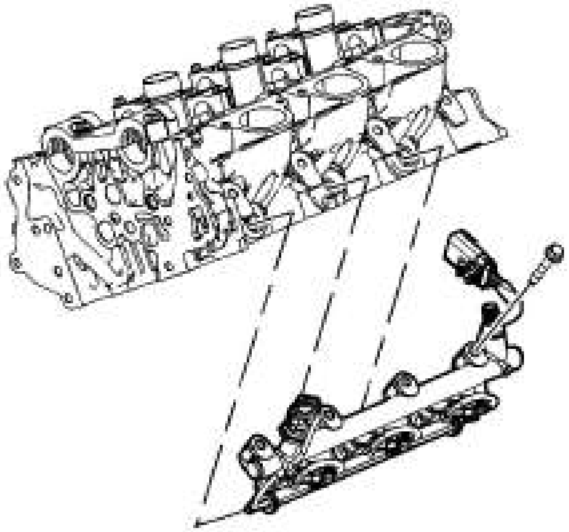
16. With the spring compressed, install the valve keepers into the *EN 46117* remover/installer .



17. Place the keepers into position by pushing the tool downward and releasing tension on the *EN 46119* adapter and the *J 8062* compressor .
18. Verify that the valve keepers are installed by placing a rag over the valve tip and tapping with a dead-blow hammer.



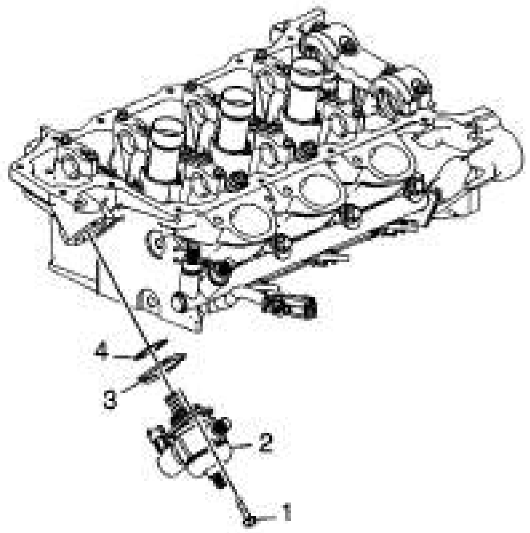
19. Install the engine coolant temperature (ECT) sensor. - LH Cylinder Head and tighten the ECT sensor to **30 N·m (22 lb ft)**.
20. Install the fuel rail with injectors into the cylinder head evenly.
21. Hand tighten the two outer fuel rail bolts to seat the injector in the injector bores.
22. Start and hand tighten the remaining fuel rail bolts.
    22.1. Tighten the fuel rail bolts in sequence to **22 N·m (16 lb ft)**.
    22.2. Tighten the fuel rail bolts in sequence a second time to **22 N·m (16 lb ft)**.



23. Lubricate the high pressure fuel pump cylinder head bore with 5W30 engine oil.

Note: Ensure that the high pressure fuel pump roller lifter is oriented properly, the camshaft is at base circle and the number 1 piston is at top dead center (TDC) on the exhaust stroke. The distance from the mounting flange surface to the camshaft at base circle should be 52 mm (2.05 in).

24. Lubricate the high pressure fuel pump roller lifter with 5W30 engine oil and install into the cylinder head bore.



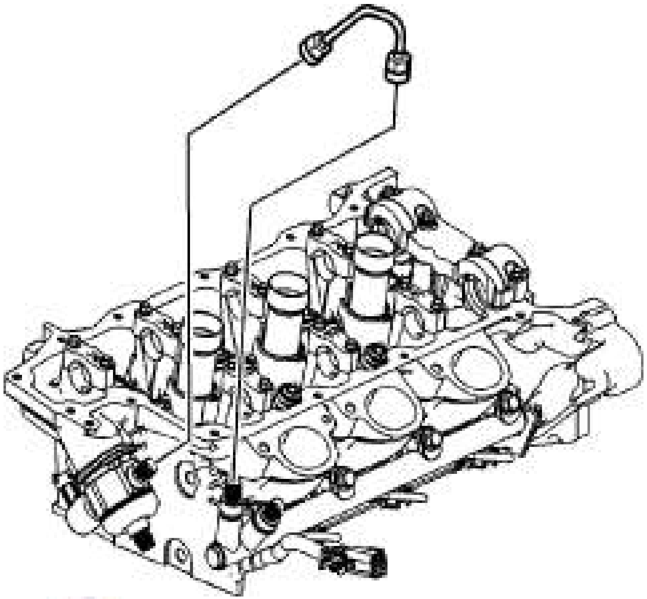
25. Install a NEW high pressure fuel pressure fuel pump gasket.
26. Install a NEW high pressure fuel pump O-ring.

Note: Ensure the plastic bolt retainers are installed in the high pressure fuel pump mounting holes before installing.

27. Install the high pressure fuel pump.

Caution: Alternately hand-tighten the fuel pump bolts one turn at a time until the pump is fully seated. Trying to draw down the pump without even side-to-side tightening may result in pump plunger damage.

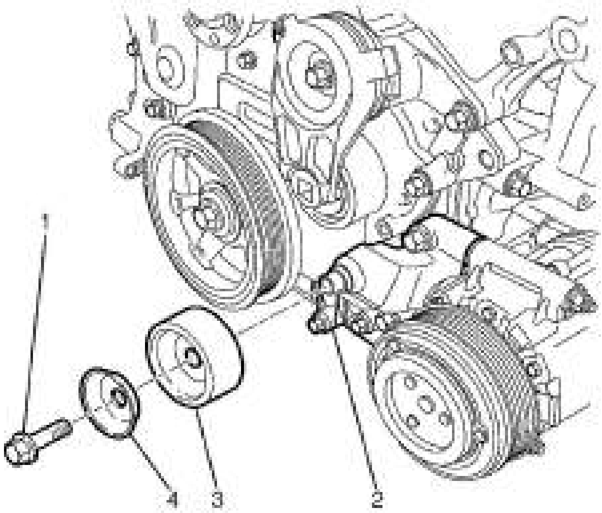
28. Start and hand-tighten the high pressure fuel pump bolts evenly and tighten the high pressure fuel pump bolts evenly to **15 N·m (11 lb ft)**.



29. Install and hand-tighten both ends of the NEW high pressure fuel line and tighten the high pressure fuel line fitting nuts to **30 N·m (22 lb ft)**.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | **Document ID: 2022811**

Drive Belt Idler Pulley Installation (With Air Condictioning)



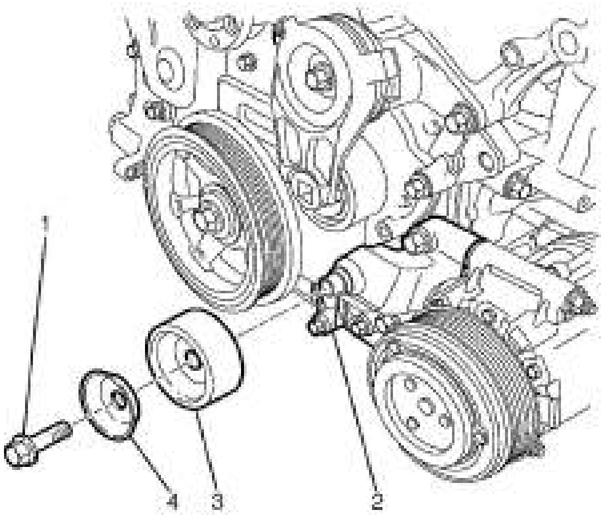
1. Install the dished washer (4) and drive belt idler pulley (3) to the accessory drive mounting bracket (2).
2. Hand tighten the drive belt idler pulley to accessory drive mounting bracket retaining bolt (1).

   Notice: Refer to Fastener Notice in the Preface section.

3. Tighten the drive belt idler pulley to accessory drive mounting bracket retaining bolt (1).

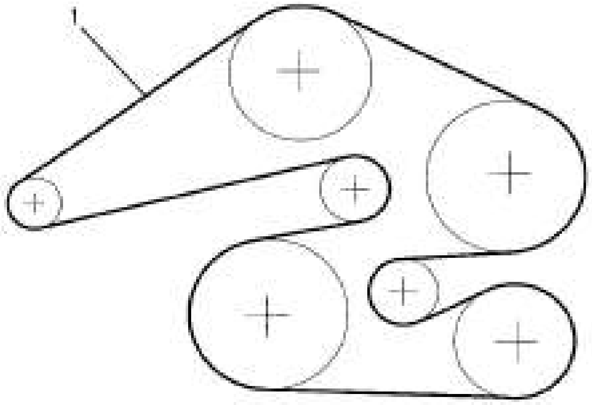
   Tighten
   Tighten the bolt to 22 N·m (16 lb ft).

Drive Belt Idler Pulley Removal (With Air Condictioning)

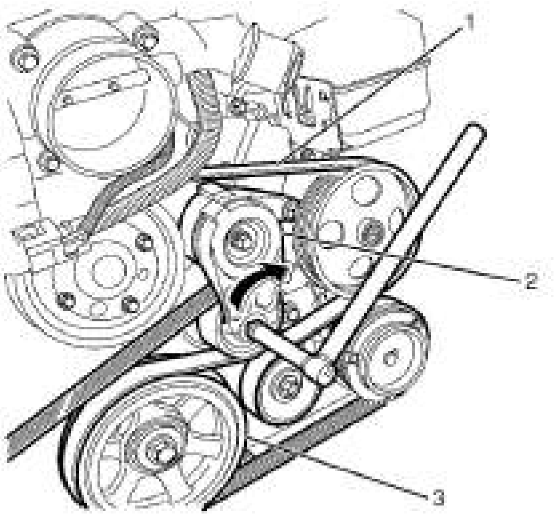


1. Remove the drive belt idler pulley to accessory drive mounting bracket retaining bolt (1).
2. Remove the dished washer (4) and drive belt idler pulley (3) from the accessory drive mounting bracket (2).

Drive Belt Installation (With Air Conditioning)



1. Install and correctly route the drive belt (1) around the following:
    - Water pump pulley
    - Generator
    - Drive belt tensioner
    - Crankshaft balancer
    - Air conditioning compressor
    - Idler pulley
    - Power steering pump



2. Using a suitable tool rotate the drive belt tensioner (2) clockwise.
3. Install the drive belt (1) to the crankshaft pulley (3).

   Important: Make sure the drive belt (1) is correctly aligned and seated into the grooves of the accessory drive pulleys.

4. Slowly release the drive belt tensioner (2).
5. Remove the suitable tool from the drive belt tensioner (2).

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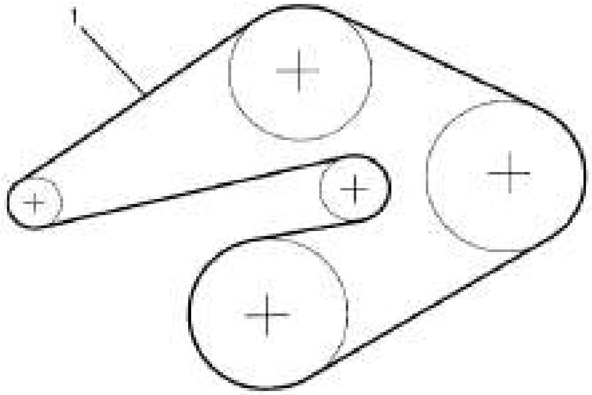
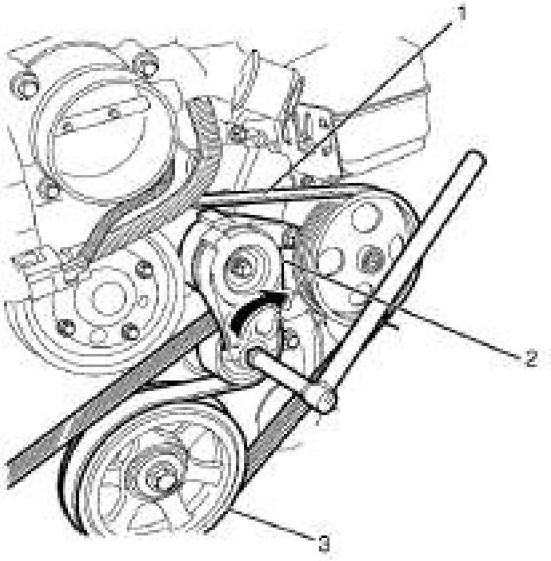
Drive Belt Installation (Without Air Conditioning)



1. Install and correctly route the drive belt (1) around the following:
   - Water pump pulley
   - Generator
   - Drive belt tensioner
   - Crankshaft balancer
   - Power steering pump



2. Using a suitable tool rotate the drive belt tensioner (2) clockwise.
3. Install the drive belt (1) to the crankshaft pulley (3).

   Important: Make sure the drive belt (1) is correctly aligned and seated into the grooves of the accessory drive pulleys.

4. Slowly release the drive belt tensioner (2).
5. Remove the suitable tool from the drive belt tensioner (2).

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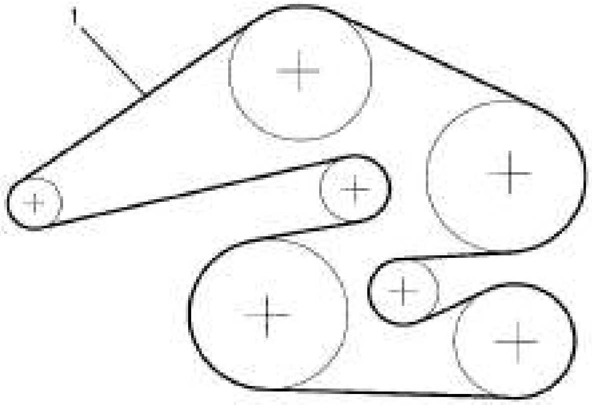
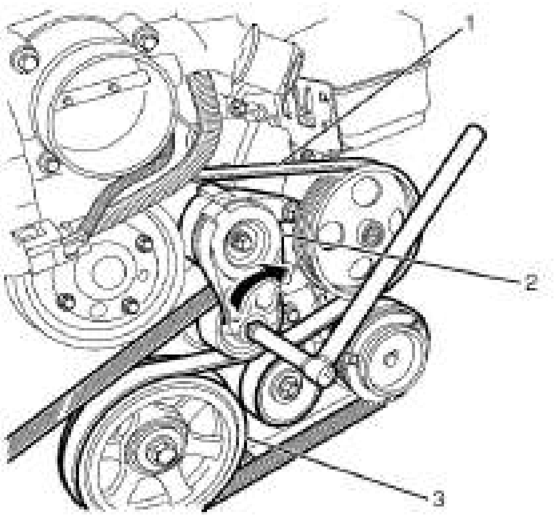
Drive Belt Removal (With Air Conditioning)



1. Note the routing of the drive belt (1).



Important: Using a suitable tool rotate the drive belt tensioner (2) clockwise.

2. Rotate the drive belt tensioner (2) clockwise in order to release tension on the drive belt (1).
3. Remove the drive belt (1) from the crankshaft pulley (3).
4. Slowly release the drive belt tensioner (2).

5. Remove the drive belt (1).

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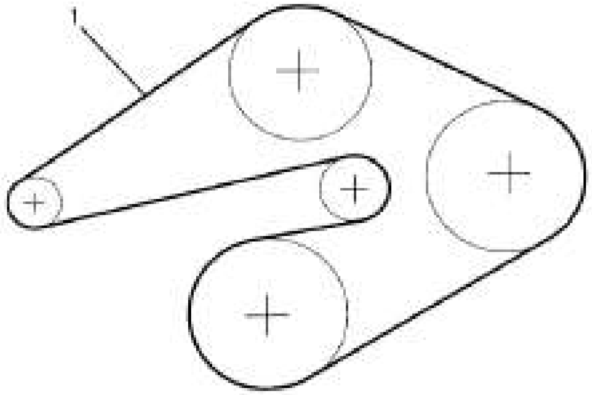
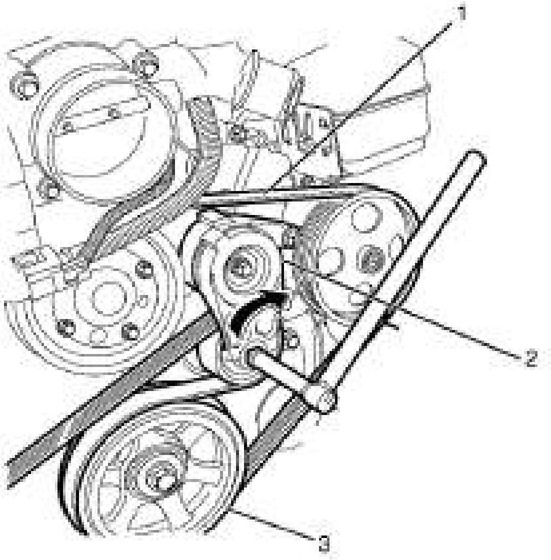
Drive Belt Removal (Without Air Conditioning)



1. Note the routing of the drive belt (1).

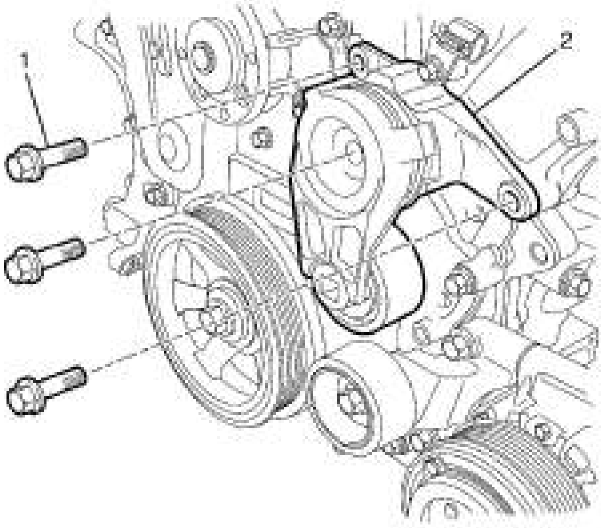


Important: Using a suitable tool rotate the drive belt tensioner (2) clockwise.

2. Rotate the drive belt tensioner (2) clockwise in order to release tension on the drive belt (1).
3. Remove the drive belt (1) from the crankshaft pulley (3).
4. Slowly release the drive belt tensioner (2).

5. Remove the drive belt (1).

Drive Belt Tensioner Installation (With Air Condictioning)



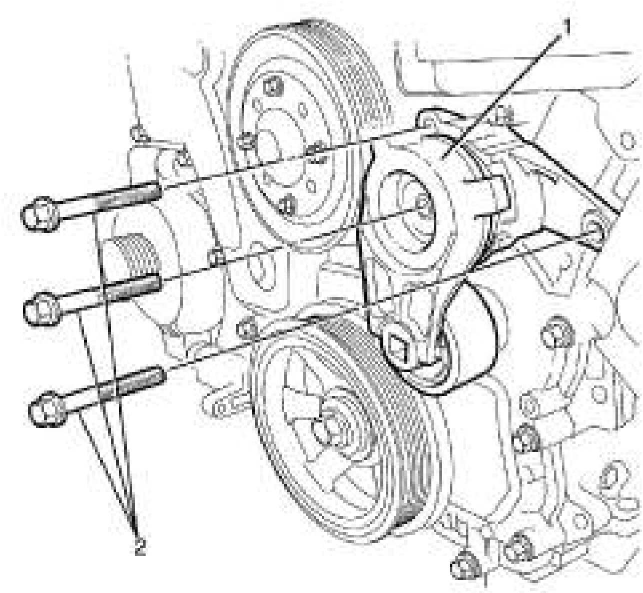
1. Install the drive belt tensioner (2) to the engine front cover.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the drive belt tensioner to engine front cover retaining bolts (1).

   Tighten
   Tighten the bolts to 22 N·m (16 lb ft).

Drive Belt Tensioner Installation (Without Air Condictioning)



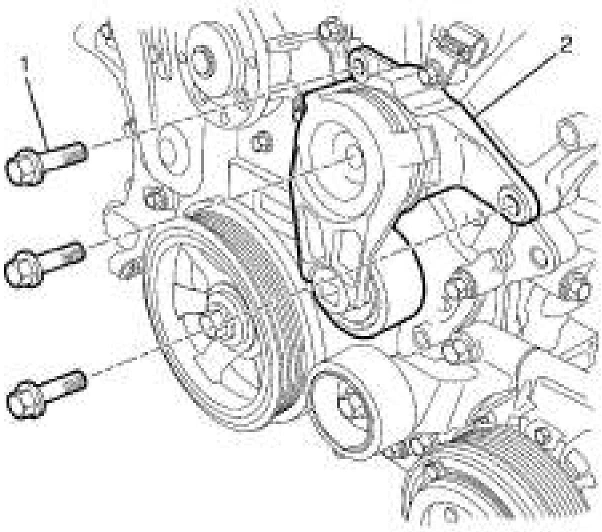
1. Install the drive belt tensioner (1) to the engine front cover.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the drive belt tensioner to engine front cover retaining bolts (2).

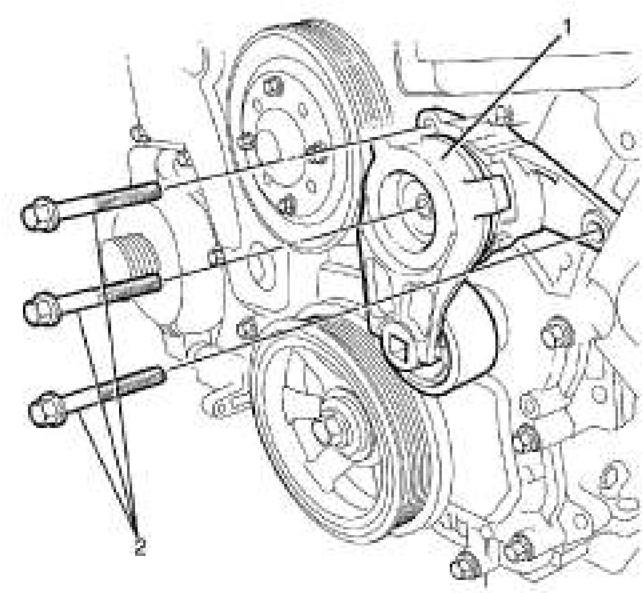
   Tighten
   Tighten the bolts to 50 N·m (37 lb ft).

Drive Belt Tensioner Removal (With Air Conditioning)



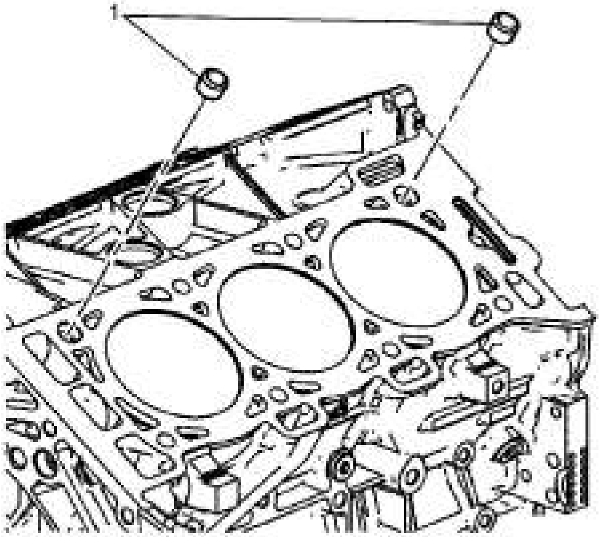
1. Remove the drive belt tensioner to engine front cover retaining bolts (1).
2. Remove the drive belt tensioner (2).

Drive Belt Tensioner Removal (Without Air Condictioning)

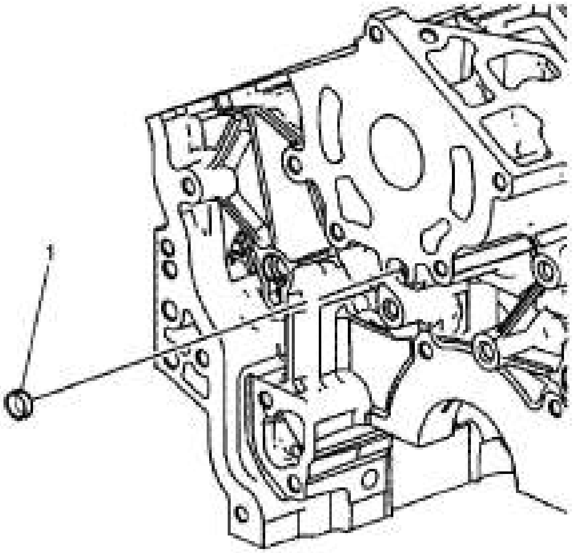


1. Remove the drive belt tensioner to engine front cover retaining bolts (2).
2. Remove the drive belt tensioner (1).

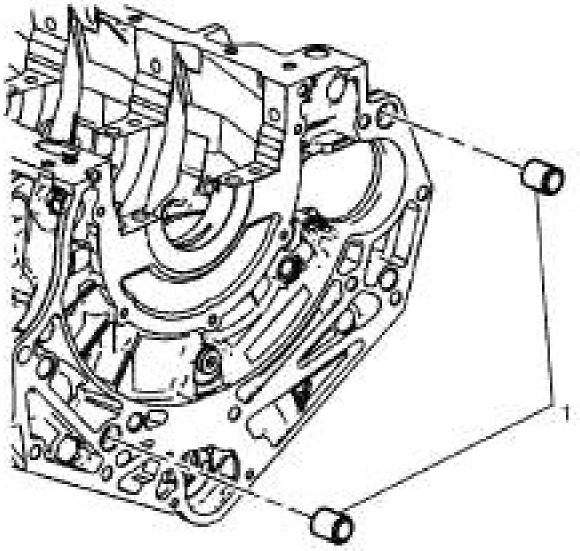
Engine Block Assemble



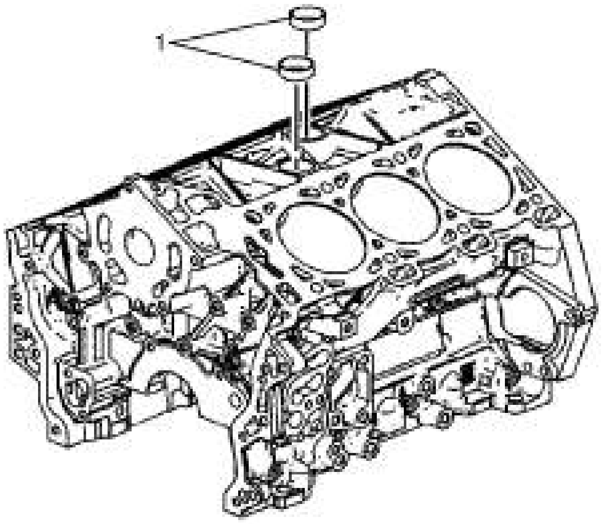
1. Install the cylinder block-to-cylinder head alignment dowels (1).



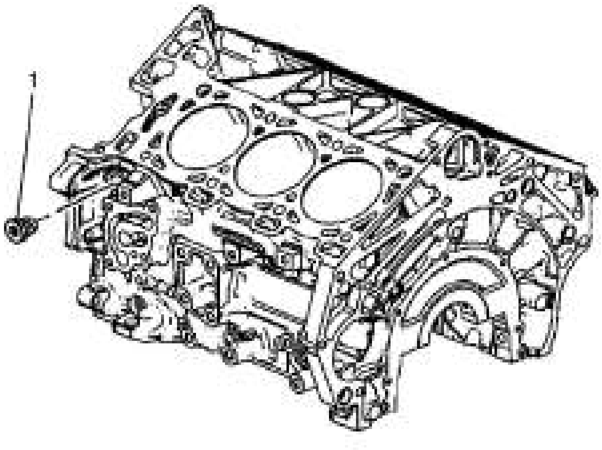
2. Install the NEW front oil gallery expansion plug (1).
3. Make sure the NEW front oil gallery expansion plug (1) is installed to the correct depth.



4. Install the cylinder block-to-transmission alignment dowels (1).



5. Apply RTV sealant on the NEW coolant expansion plugs (1).
6. Install the NEW coolant expansion plugs (1).
7. Make sure the NEW coolant expansion plugs (1) are installed to the correct depth.

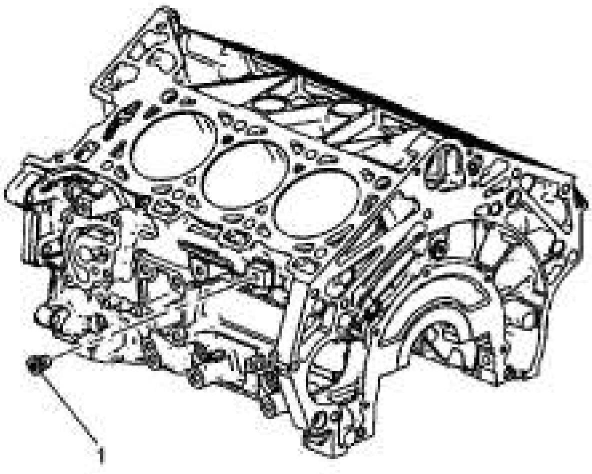


8. Apply thread sealant on the threads of the M20 left side oil gallery threaded plug (1).

   Notice: Refer to Fastener Notice in the Preface section.

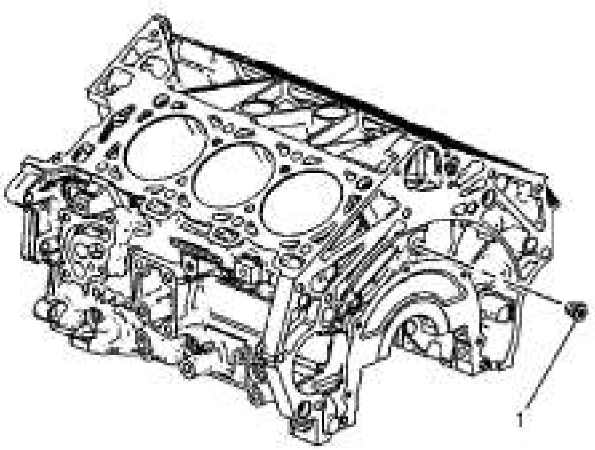
9. Install the M20 left side oil gallery threaded plug (1).

   Tighten
   Tighten the plug to 31 N·m (23 lb ft).



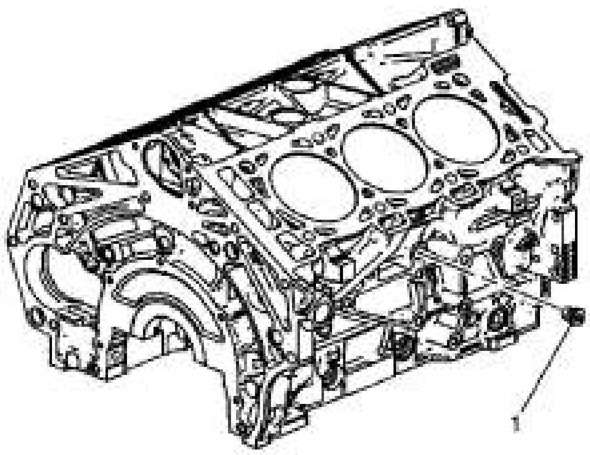
10. Apply thread sealant on the threads of the M14 left side coolant drain threaded plug (1).
11. Install the M14 left side coolant drain threaded plug (1).

Tighten
Tighten the threaded plug to 31 N·m (23 lb ft).



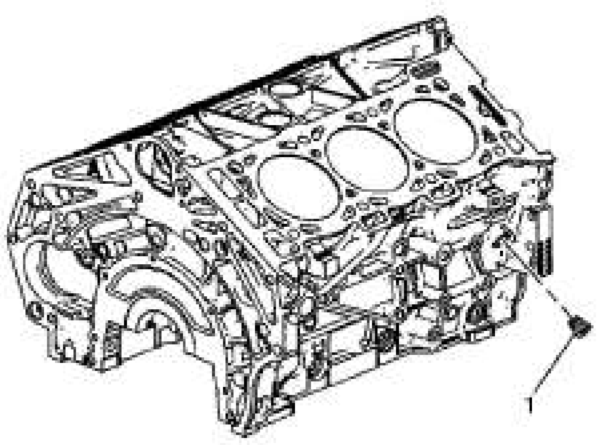
12. Apply thread sealant on the threads of the M14 rear oil gallery threaded plug (1).
13. Install the M14 rear oil gallery threaded plug (1).

Tighten
Tighten the plug to 31 N·m (23 lb ft).



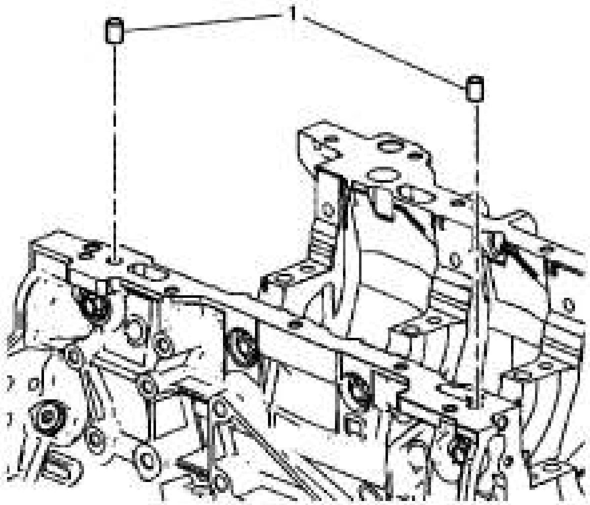
14. Apply thread sealant on the threads of the M14 right side coolant drain threaded plug (1).
15. Install the M14 right side coolant drain threaded plug (1).

Tighten
Tighten the plug to 31 N·m (23 lb ft).

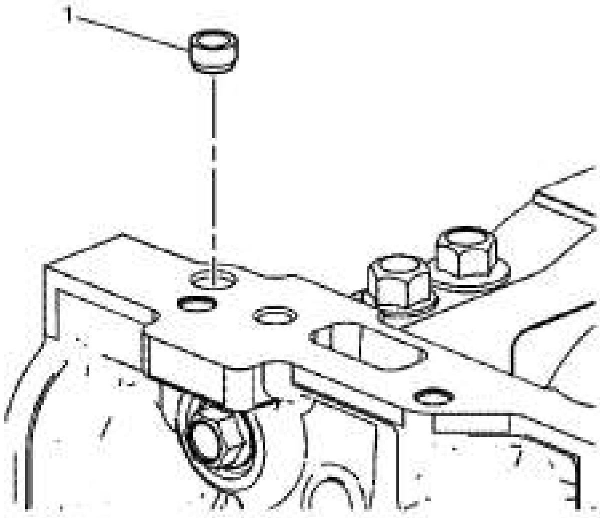


16. Apply thread sealant on the threads of the M14 right side oil gallery threaded plug (1).
17. Install the M14 right side oil gallery threaded plug (1).

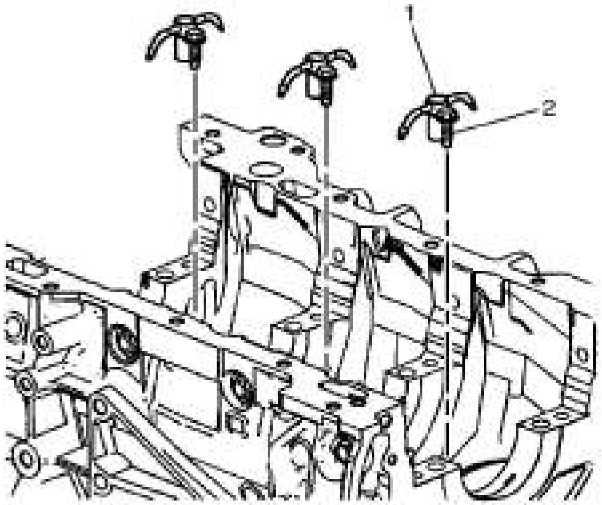
Tighten
Tighten the plug to 31 N·m (23 lb ft).



18. Install the cylinder block-to-oil pan alignment dowels (1).



19. Install the NEW right front oil pan rail oil gallery expansion plug (1).
20. Make sure the NEW right front oil pan rail oil gallery expansion plug (1) is installed to the correct depth.



21. Install the oil jets (1).
22. Install the oil jet to cylinder block retaining bolts (2).

    Tighten
    Tighten the bolts to 10 N·m (89 lb in).

Engine Block Cleaning and Inspection

Tools Required

- J 8087 Cylinder Bore Gage
- J 28410 Gasket Remover

Cleaning Procedure

1. Remove any old thread sealant, gasket material or sealant using J 28410 .
2. Clean all the following areas with solvent:
   - Sealing surfaces
   - Cooling passages
   - Oil passages
   - Bearing journals
3. Clean all threaded and through holes with solvent.

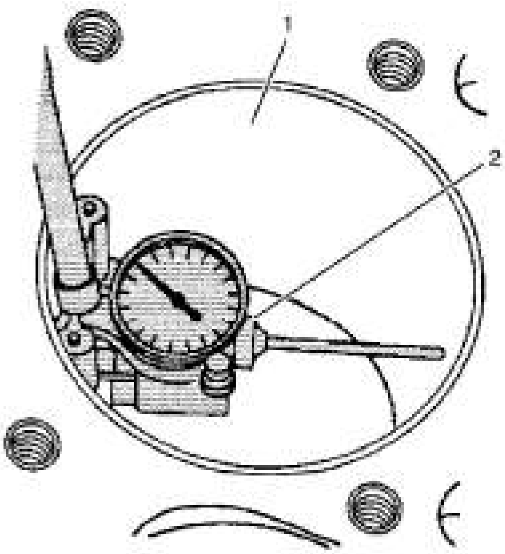
   Caution: Refer to Safety Glasses Caution in the Preface section.

4. Dry the cylinder block with compressed air.

Visual Inspection

1. Inspect the crankshaft bearings journals for damage or spun bearings. The crankshaft bearing journals are not repairable, if the crankshaft bearing journals are damaged the cylinder block assembly must be replaced.
2. Inspect the primary camshaft drive chain tensioner mounting surface on the cylinder block for burrs or any defects that may degrade the sealing of the NEW primary camshaft drive chain tensioner gasket.
3. Inspect all sealing and mating surfaces for damage, repair or replace the cylinder block assembly if necessary.
4. Inspect all threaded and through holes for damage or debris above acceptable tolerances.
5. Inspect all bolts for damage, if damaged replace with NEW bolts only.
6. Inspect the cylinder walls for cracks or damage. The cylinder sleeves are not serviced separately, if the cylinders are damaged the cylinder block assembly must be replaced.
7. Inspect the cylinder block for cracks. DO NOT repair any cracks. If cracks are found, the cylinder block assembly must be replaced.
8. Repair any damaged threaded holes. Refer to Thread Repair Specifications and Thread Repair .

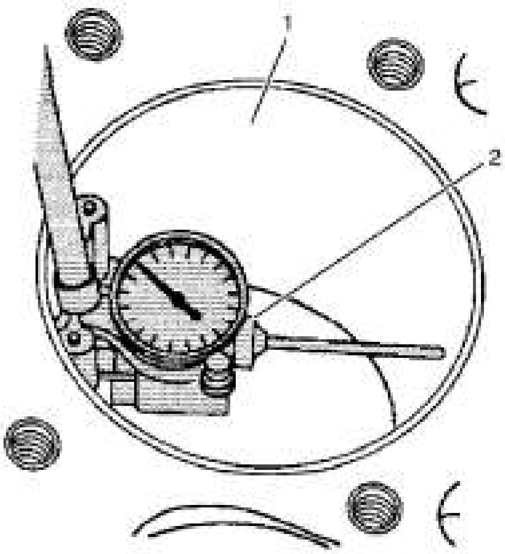
Measuring Cylinder Bore Diameter



1. Measure the cylinder bore diameter 42 mm (1.654 in) from the deck face (1) using the J 8087 (2).
2. Record and compare your results with the Engine Mechanical Specifications . If the cylinder diameter exceeds the specifications, the cylinder block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

   If the cylinder bore exceeds specification by more than 0.25 mm (0.010 in) the cylinder block must be replaced.

Measuring Cylinder Bore Taper



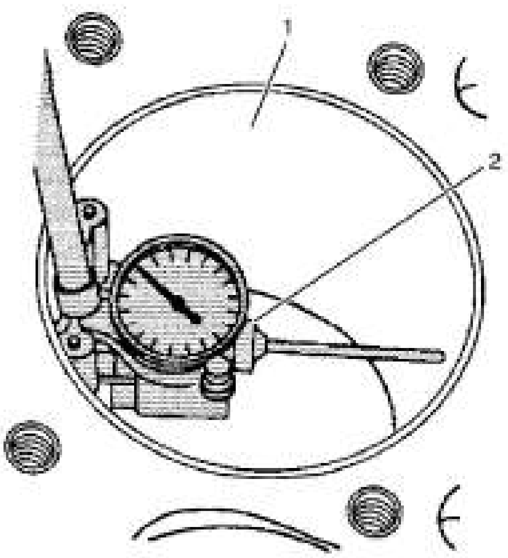
1. Measure the cylinder bore along the thrust surfaces, perpendicular to the crankshaft

centerline, at 10 mm (0.397 in) below the deck surface and record your measurement.

2. Measure the cylinder bore along the thrust surfaces, perpendicular to the crankshaft centerline, at 100 mm (3.976 in) below the deck surface and record your measurement.
3. Calculate the difference between the 2 measurements. The result will be the cylinder taper.
4. Compare your results with the Engine Mechanical Specifications . If the cylinders exceed the specifications, the cylinder block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

   If the cylinder bore exceeds specification by more than 0.25 mm (0.010 in) the cylinder block must be replaced.

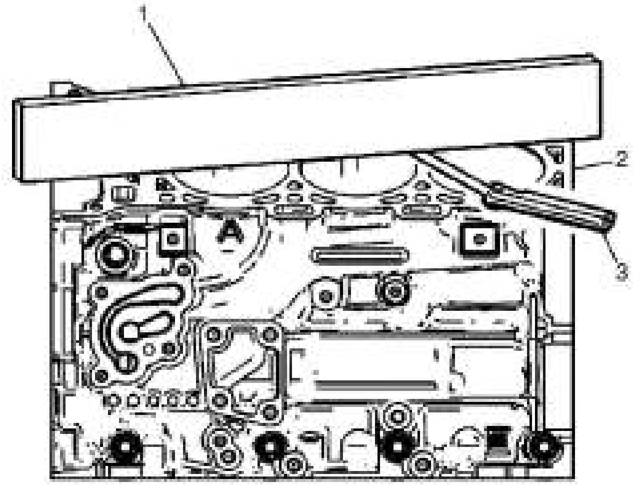
Measuring Cylinder Bore Out-of-Round



1. Measure both the thrust and non-thrust cylinder diameter at 10 mm (0.397 in) below the deck. Record your measurements.
2. Calculate the difference between the 2 measurements. The result will indicate out-of-round at the upper end of the cylinder.
3. Measure both the thrust and non-thrust cylinder diameter at 100 mm (3.976 in) below the deck surface. Record your measurements.
4. Calculate the difference between the 2 measurements. The result will indicate out-of-round at the lower end of the cylinder.
5. Compare your results with the Engine Mechanical Specifications . If the cylinders exceed the specifications, the cylinder block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

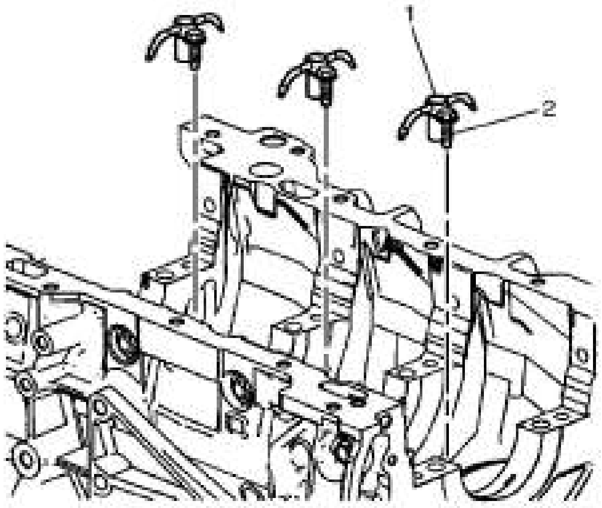
   If the cylinder bore exceeds specification by more than 0.25 mm (0.010 in) the cylinder block must be replaced.

Deck Flatness Inspection

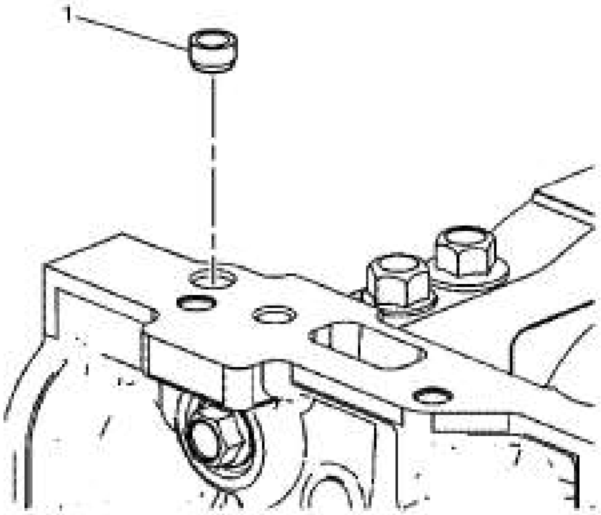


1. Make sure the cylinder block decks are clean and free of gasket material.
2. Inspect the surface for any imperfections or scratches that may inhibit correct cylinder head gasket sealing.
3. Place a straight-edge diagonally across the cylinder block deck face surface.
4. Measure the clearance between the straight-edge and the cylinder block deck face using a feeler gauge at 4 points along the straight-edge.
5. If the warpage is less than 0.05 mm (0.002 in), the cylinder block deck surface does not require resurfacing.
6. If the warpage is between 0.05-0.20 mm (0.002-0.008 in) or any imperfections or scratches that may inhibit correct cylinder head gasket sealing are present, the cylinder block deck surface requires resurfacing.
7. If resurfacing is required the maximum amount that can be removed is 0.25 mm (0.010 in).
8. If the cylinder block deck surface requires more than 0.25 mm (0.010 in) material removal the block must be replaced.

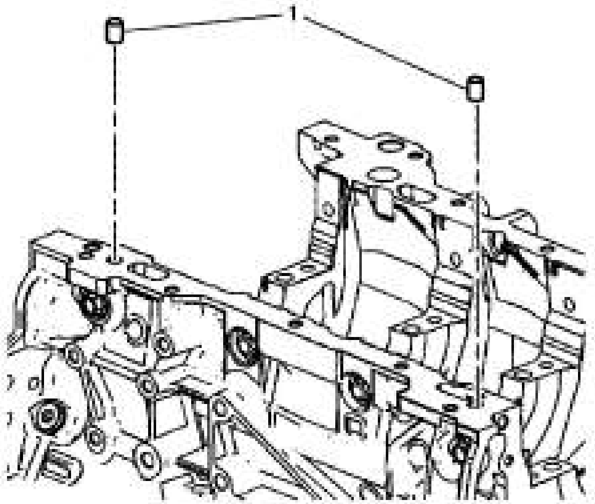
Engine Block Disassemble



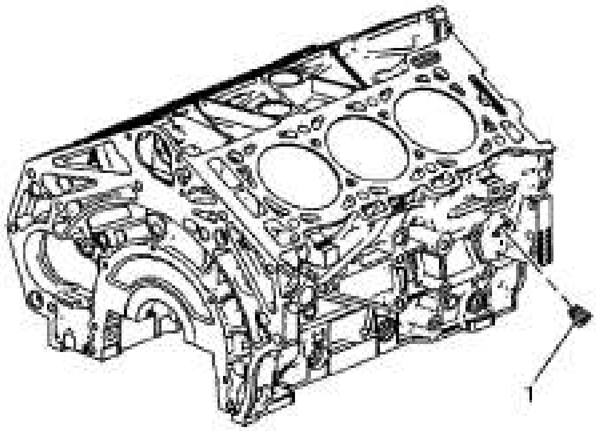
1. Remove oil jet to cylinder block retaining bolts (2).
2. Remove the oil jets (1).



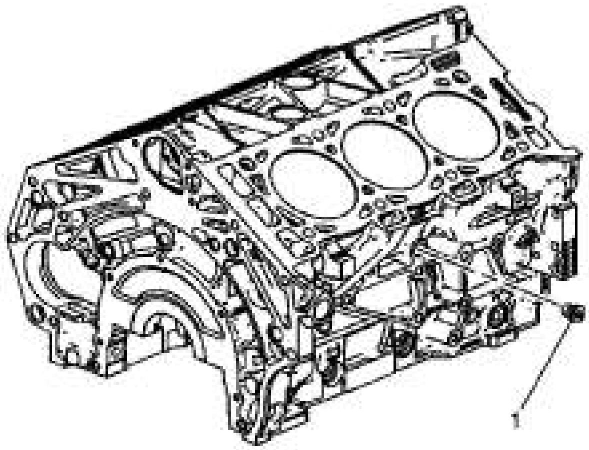
3. Remove the right front oil pan rail oil gallery expansion plug (1).



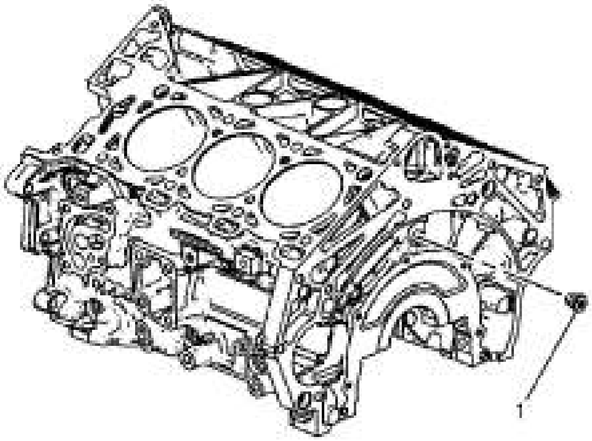
4. Remove the cylinder block-to-oil pan alignment dowels (1).



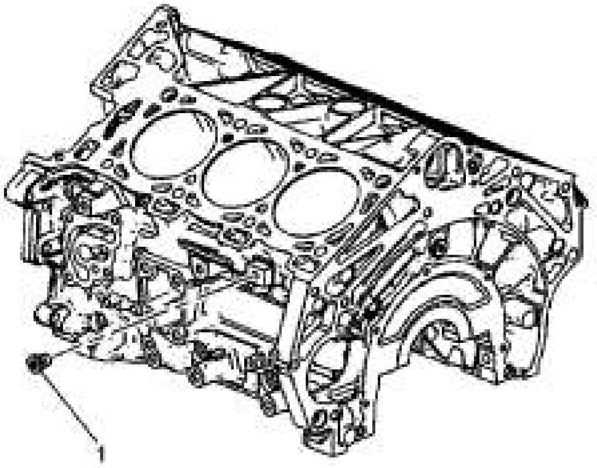
5. Remove the M14 right side oil gallery threaded plug (1).



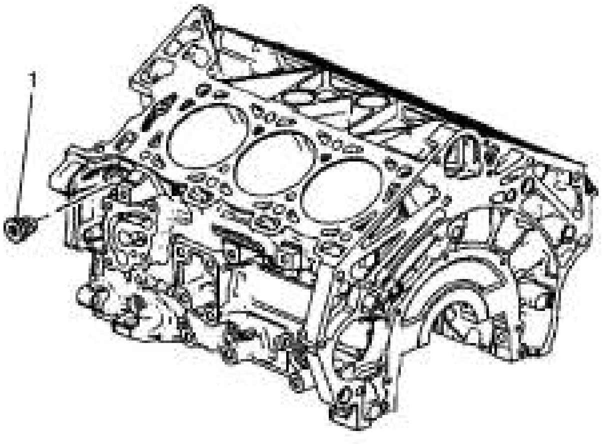
6. Remove the M14 right side coolant drain threaded plug (1).



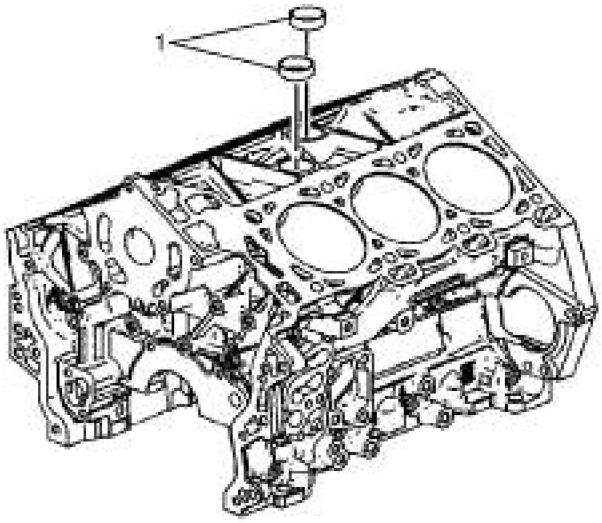
7. Remove the M14 rear oil gallery threaded plug (1).



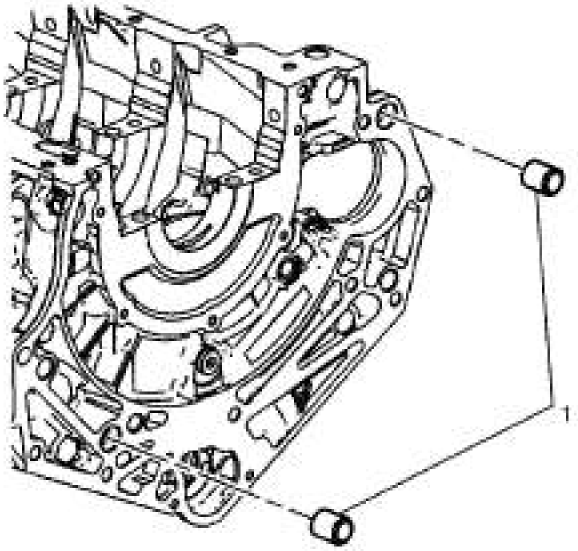
8. Remove the M14 left side coolant drain threaded plug (1).



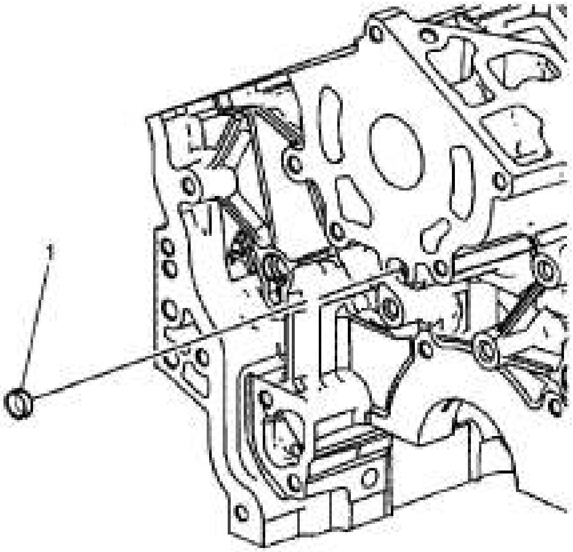
9. Remove the M20 left side oil gallery threaded plug (1).



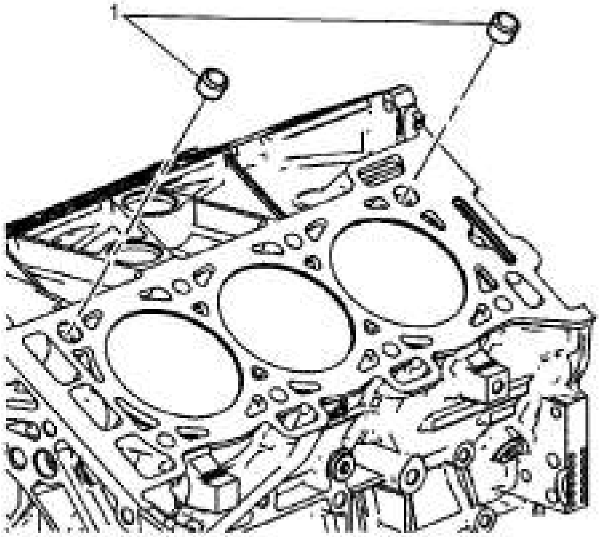
10. Remove the coolant expansion plugs (1).



11. Remove the cylinder block-to-transmission alignment dowels (1).



12. Remove the front oil gallery expansion plug (1).



13. Remove the cylinder block-to-cylinder head alignment dowels (2).

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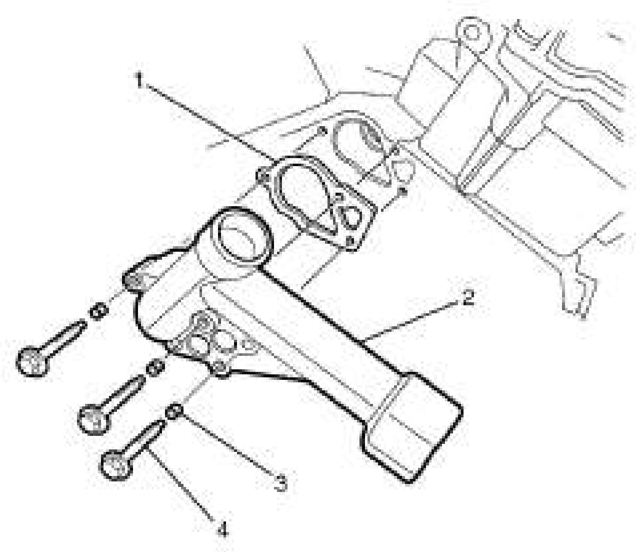
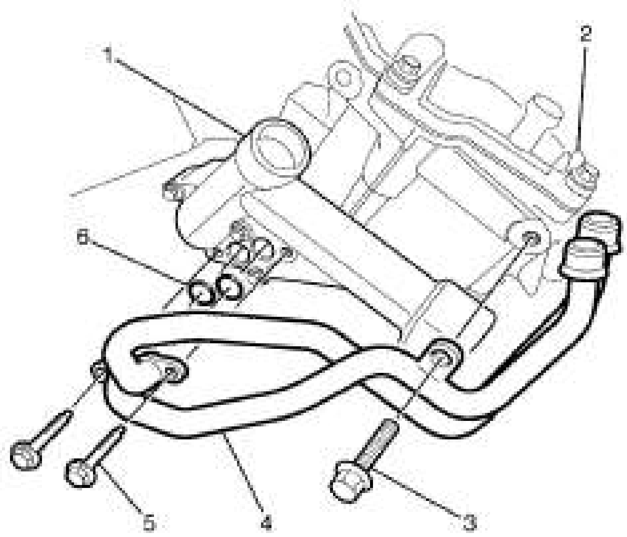
Engine Coolant Thermostat Housing Installation

Notice: Refer to Fastener Notice in the Preface section.



1. Install thermostat housing to cylinder block retaining bolts (4) ensuring a new block gasket (1) and rubber grommets (3) has been fitted.

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).



2. Install the heater pipe assembly to thermostat housing retaining bolts (5) ensuring new O-ring seals (6) have been fitted.

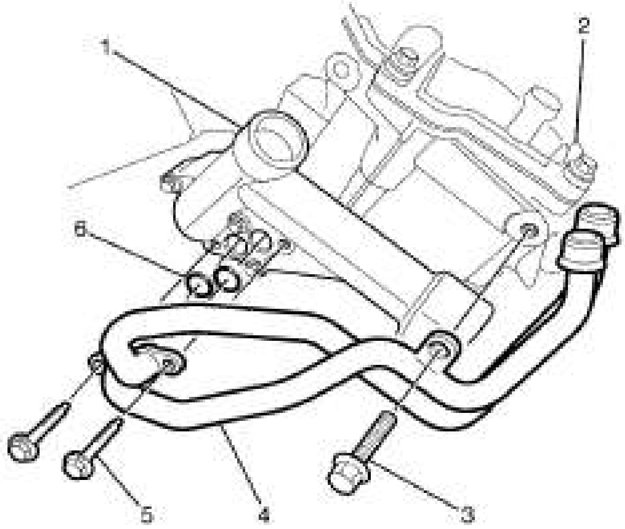
   Tighten
   Tighten the bolts to 10 N·m (89 lb in).

3. Install the heater pipe assembly (4) to cylinder head (2) retaining bolt (3).

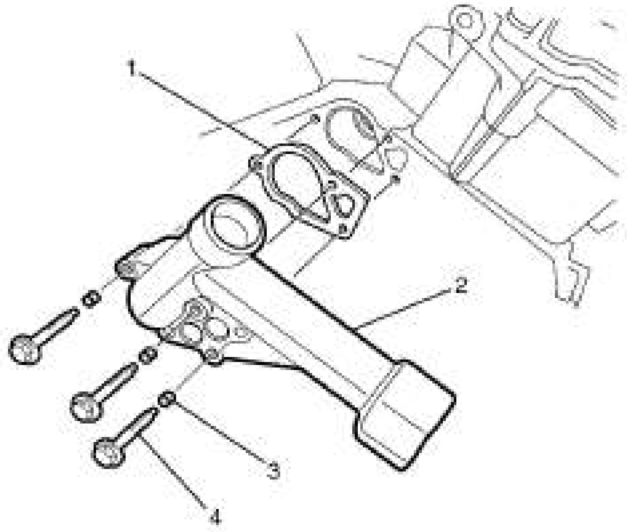
   Tighten
   Tighten the bolts to 35 N·m (26 lb ft).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | **Document ID: 1977577**

Engine Coolant Thermostat Housing Removal



1. Remove the heater hose assembly to right bank cylinder head retaining bolt (3).
2. Remove the heater hose assembly to thermostat housing retaining bolts (5).
3. Remove the heater hose assembly (4) from the right bank cylinder head (3) and thermostat housing (1).
4. Remove the O-ring seals (6).



Important: The thermostat housing has one longer bolt which is located in the upper left of the housing.

Important: When replacing thermostat housing always renew the block gasket (1).

5. Remove thermostat housing to cylinder block retaining bolts (4) and rubber grommets (3).
6. Remove thermostat housing (2).
7. Remove thermostat housing gasket (1).

Engine Flywheel Cleaning and Inspection (Automatic Transmission)

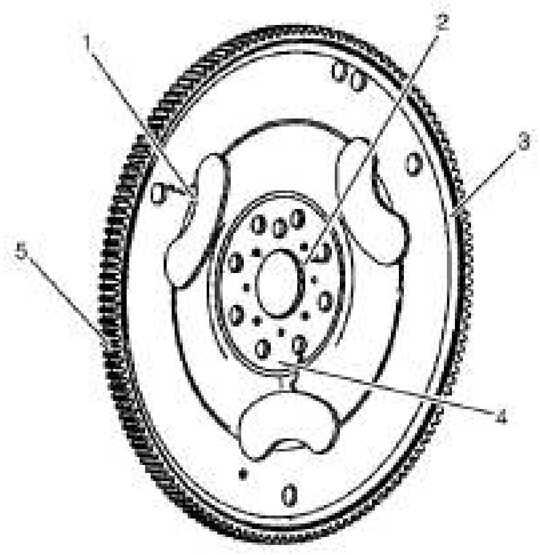
Cleaning Procedure

1. Clean the engine flywheel in solvent.

   Caution: Refer to Safety Glasses Caution in the Preface section.

2. Dry the engine flywheel with compressed air.

Inspection Procedure



1. Inspect the engine flywheel for the following conditions:
   - Stress cracks around the engine flywheel-to-torque converter mounting bolt hole locations (1) and/or engine flywheel-to-crankshaft (2 and 4)

     Important: DO NOT attempt to repair the welded areas that retain the ring gear to the engine flywheel plate. Install a new engine flywheel.

   - Cracks at welded areas that retain the ring gear onto the engine flywheel (3)
   - Damaged or missing ring gear teeth (5)
2. Replace the engine flywheel as necessary.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | Document ID: 1995322

Engine Flywheel Cleaning and Inspection (Manual Transmission)

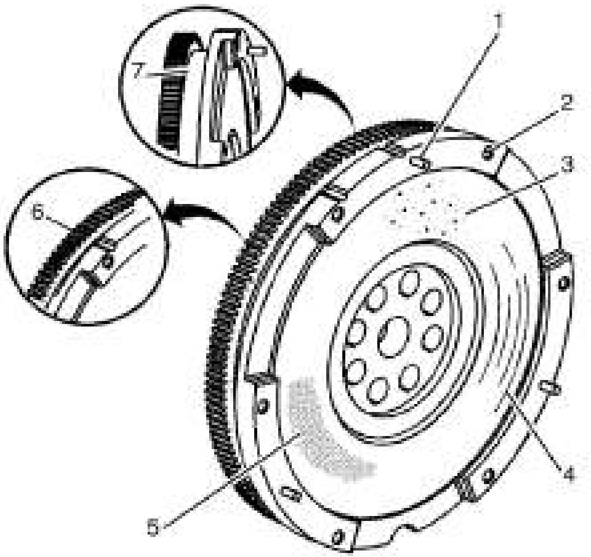
Cleaning Procedure

1. Clean the engine flywheel in solvent.

   Caution: Refer to Safety Glasses Caution in the Preface section.

2. Dry the engine flywheel with compressed air.

Inspection Procedure

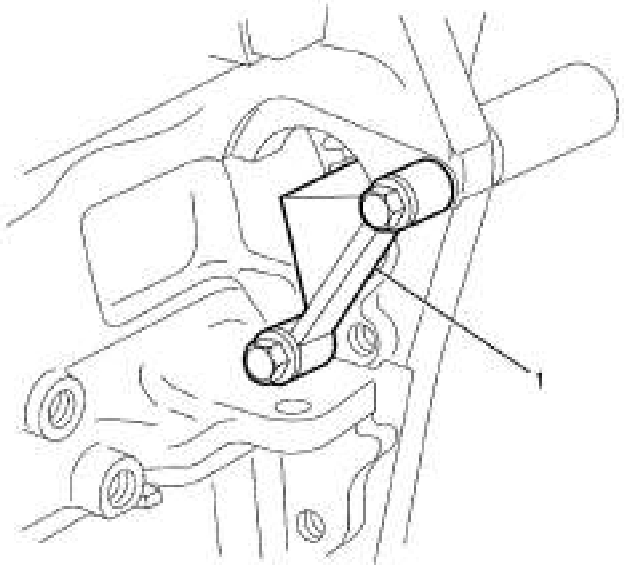


1. Inspect the manual transmission engine flywheel for the following conditions:
   - Missing and/or damaged alignment pins (1)
   - Damaged threaded holes (2)
   - Pitted surface (3)
   - Scoring or grooves (4)
   - Rust or other surface damaged (5)
   - Damaged ring gear teeth (6)
   - Loose or incorrectly positioned ring gear
   - The ring gear has an interference fit onto the engine flywheel and should be positioned completely against the flange of the engine flywheel (7).
2. Replace the engine flywheel as necessary.

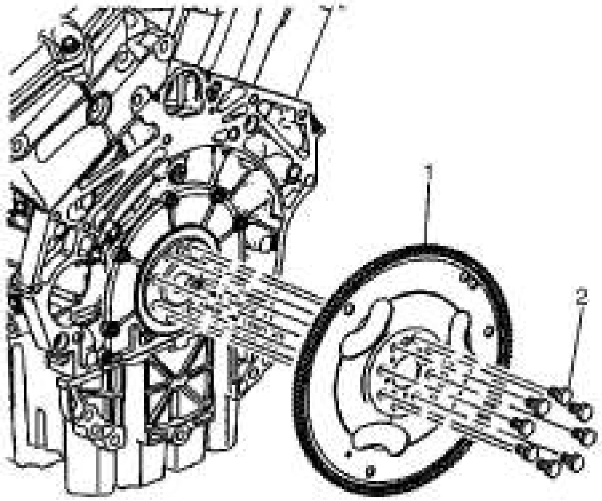
Engine Flywheel Installation

Tools Required

- EN 46106 Engine Flywheel Holding Tool
- J 45059 Angle Meter



1. Install the EN 46106 (1).



2. Place the automatic transmission flex plate (2) in position.
3. Install 2 NEW automatic transmission flex plate to crankshaft retaining bolts (1) in location at the top and bottom of the automatic transmission flex plate (2) bolt pattern allowing the automatic transmission flex plate (2) to hang in position.

   Notice: Refer to Fastener Notice in the Preface section.

4. Install the remaining NEW automatic transmission flex plate to crankshaft retaining bolts (1).

   Tighten
   Tighten the bolts to 30 N·m (22 lb ft).

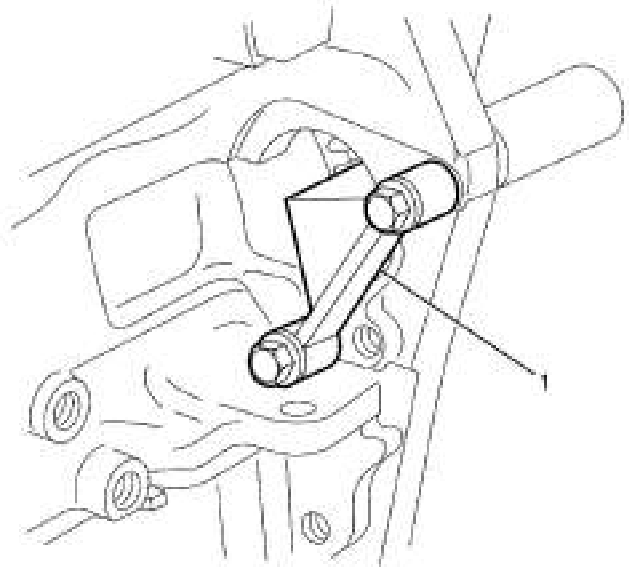
   Tighten the bolts an additional 45 degrees using the J 45059 .

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | Document ID: 1977652

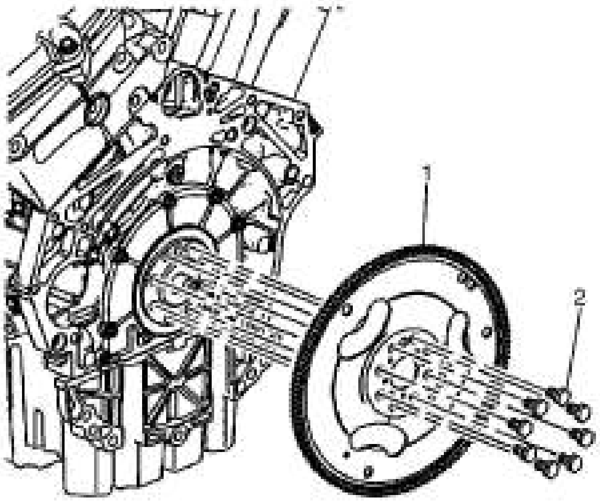
Engine Flywheel Removal (Automatic Transmission)

Tools Required

EN 46106 Flywheel Holding Tool



1. Install the EN 46106 (1) through the starter mounting hole.



Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

Important: Make sure all the bolt holes are thoroughly cleaned and all micro-encapsulated thread sealant is removed.

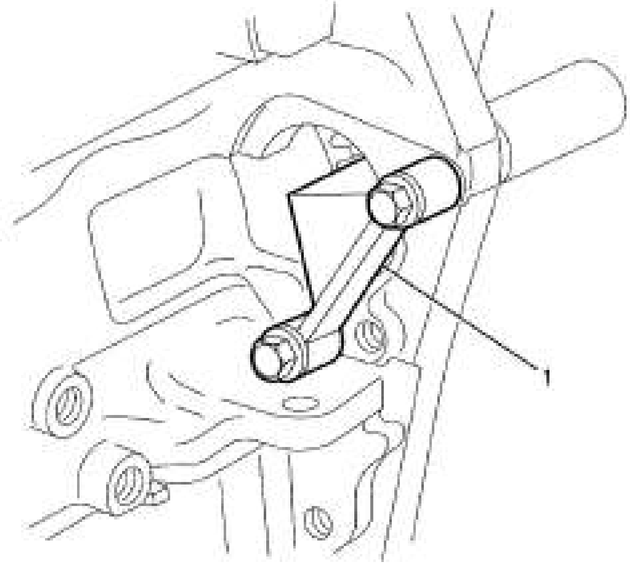
2. Remove the engine flywheel to crankshaft retaining bolts (1).
   - Discard the bolts.
   - Clean the bolt holes.
3. Remove the engine flywheel (2).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | **Document ID: 1995155**

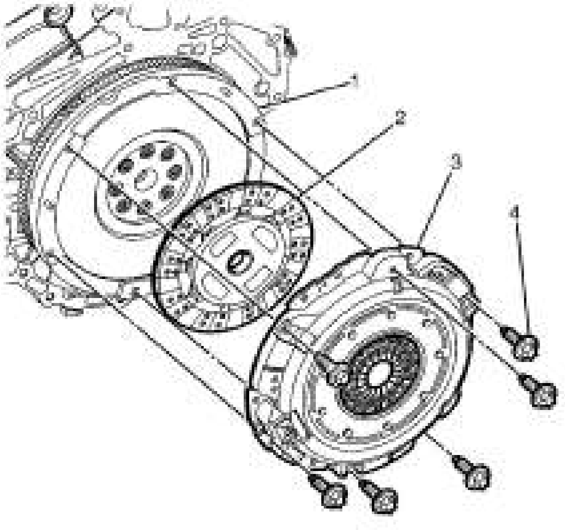
Engine Flywheel Removal (Manual Transmission)

Tools Required

EN 46106 Flywheel Holding Tool

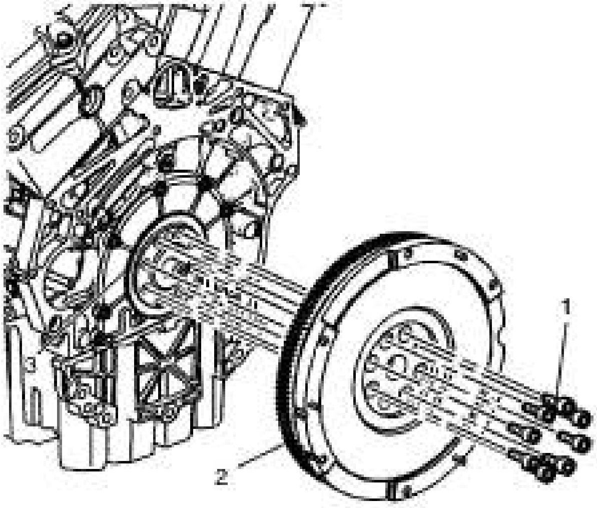


1. Install the EN 46106 (1) through the starter mounting hole.



2. Mark the relationship of the pressure plate (3) to the flywheel (1) to maintain the correct balance condition on reassembly.

3. Loosen all pressure plate to flywheel retaining bolts (4) working from opposite sides to avoid distortion.
4. Continue loosening pressure plate to flywheel retaining bolts (4) from opposite sides until all are removed.
5. Remove the pressure plate (3) and clutch driven plate (2) from the flywheel (1).



Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

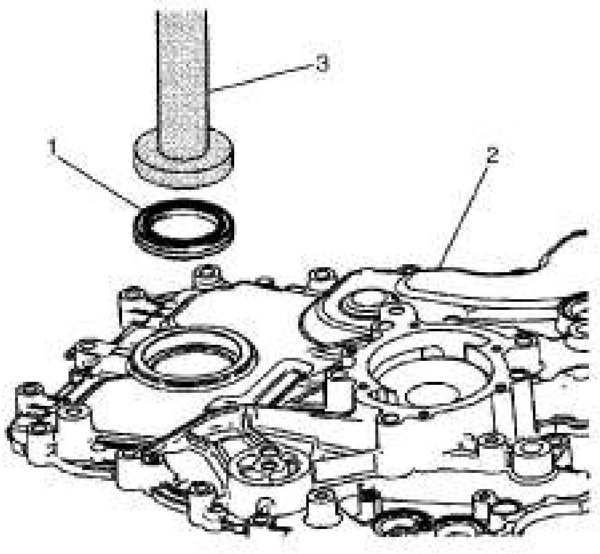
Important: Make sure all the bolt holes are thoroughly cleaned and all micro-encapsulated thread sealant is removed.

6. Remove the engine flywheel to crankshaft retaining bolts (1).
   - Discard the bolts.
   - Clean the bolt holes.
7. Remove the engine flywheel (2) from the crankshaft (3).

Engine Front Cover Assemble

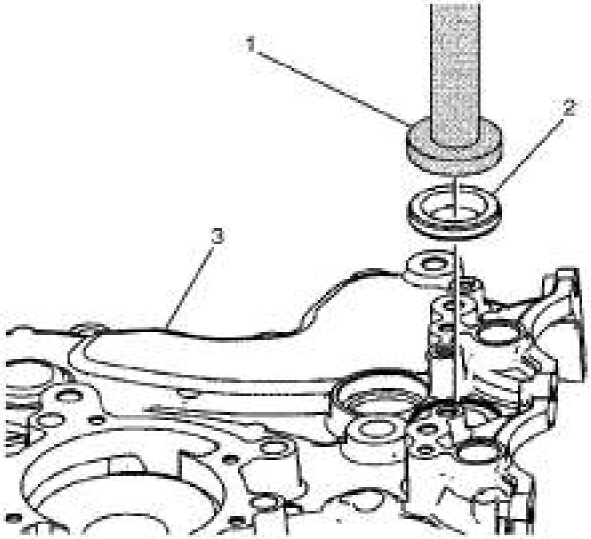
Tools Required

- EN-46103 Camshaft Actuator Valve Seal Remover/Installer
- J 29184 Oil Seal Installer



Important: DO NOT lubricate the crankshaft front oil seal or crankshaft balancer sealing surfaces. The crankshaft balancer is installed into a dry seal.

1. Install the NEW crankshaft front oil seal into the engine front cover using the J 29184 .



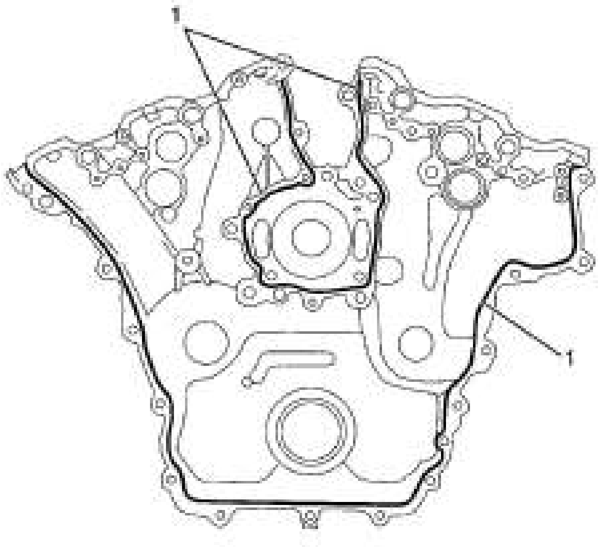
2. Install the NEW camshaft position actuator solenoid seals into the engine front cover using the EN-46103 .

Engine Front Cover Cleaning and Inspection

Tools Required

J 28410 Gasket Remover

Cleaning Procedure

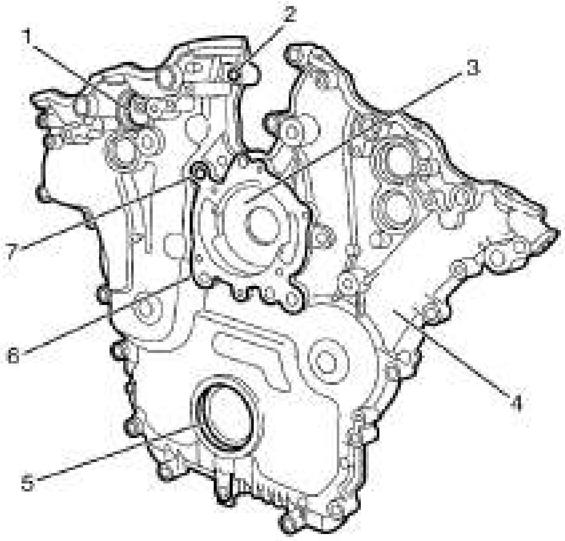


1. Remove any RTV sealant (1) from the engine front cover using J 28410 .
2. Clean out debris from the bolt holes.
3. Clean the engine front cover (1) in solvent.

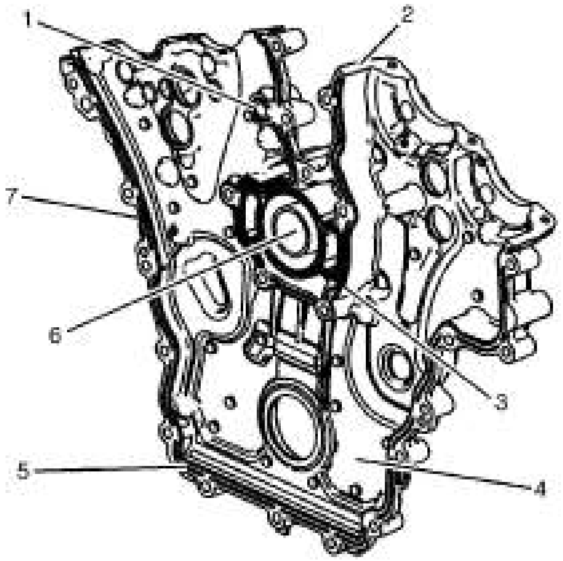
   Caution: Refer to Safety Glasses Caution in the Preface section.

4. Dry the engine front cover (1) with compressed air.

Inspection Procedure



1. Inspect the exterior of the engine front cover for the following conditions:
   - Damage to the water pump bolt hole threads (7).
   - Gouges or damage to the water pump sealing surfaces (6).
   - Damage to the crankshaft front oil seal bore (5).
   - Damage to the camshaft position actuator solenoid seal bores (1).
   - Damage to the engine front cover bolt holes (2).
   - Damage and/or corrosion to the engine coolant passage (3).
   - Dents or damage to the exterior (4).



2. Inspect the interior of the engine front cover for the following conditions:
   - Gouges or damage to the engine front cover sealing surfaces to the cylinder block (7), oil

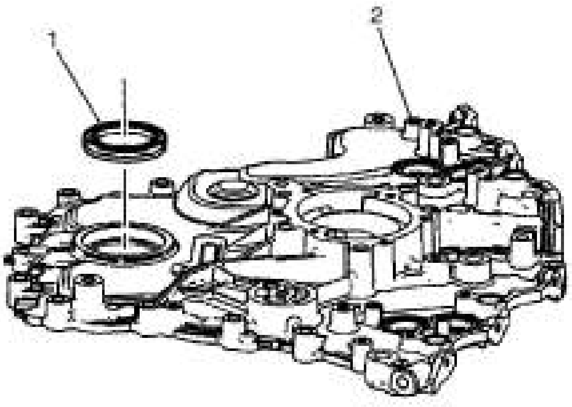
pan (5), and/or camshaft covers (2).
- Damage and/or corrosion to the engine coolant passage .(6)
- Damage to the crankshaft front oil seal bore.
- Gouges or damage to the O-ring sealing areas.
- Gouges or damage to the water pump seal area (3).
- Loose or damaged deadener plates (4).
- Damage to the engine front cover bolt holes (1).

3. Repair or replace the engine front cover as necessary.

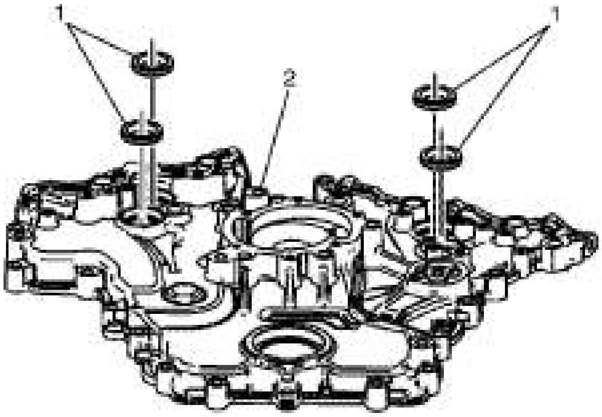
Engine Front Cover Disassemble

Tools Required

E-308 Seal Remover



1. Remove the crankshaft front oil (1) seal from the engine front cover (2) using the E-308 .

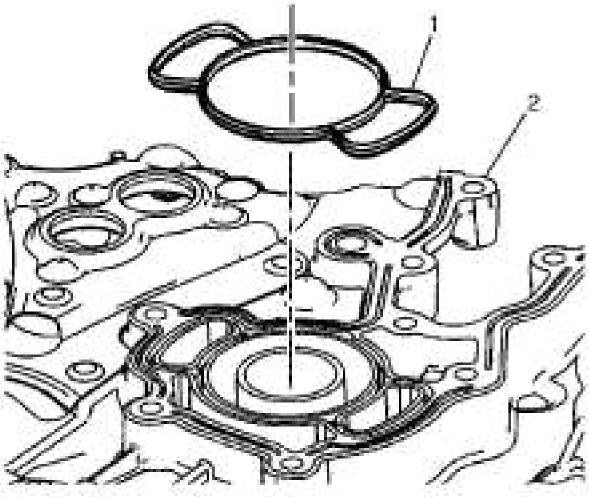


Important: LE0 and LW2 engines only have an intake camshaft position actuator solenoid.

Important: The camshaft position actuator solenoid valve oil seals (1) must be discarded whenever the camshaft position actuator solenoids have been removed from the front cover (2).

2. Remove the camshaft position actuator solenoid seals (1) from the engine front cover (2).

   Discard the seals



Important: The water pump seal (1) must be discarded whenever the water pump has been removed from the front cover (2).

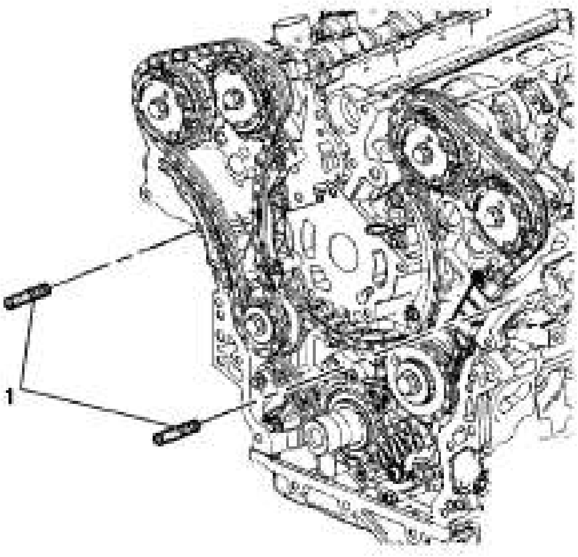
3. Remove the water pump seal (1) from the engine front cover (2).

   Discard the seal

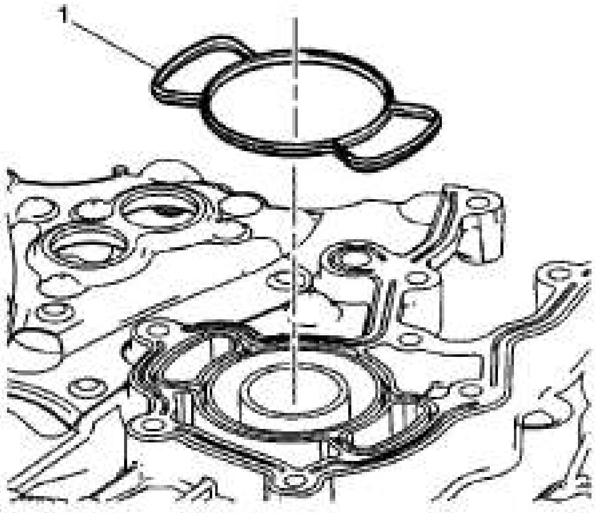
Engine Front Cover Installation

Tools Required

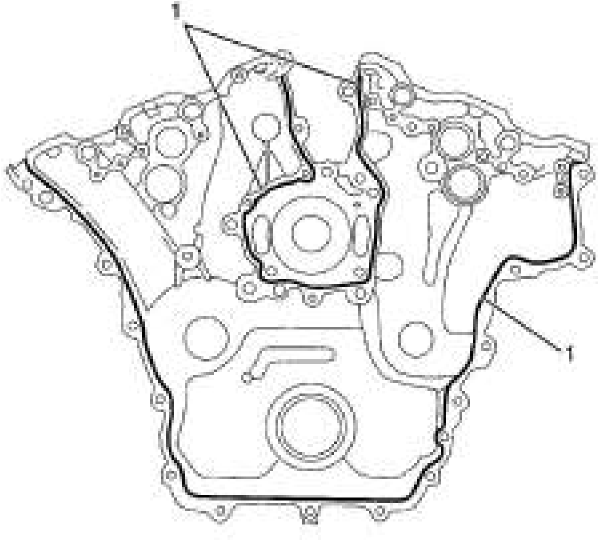
- EN 46109 Guide Pin Set
- J 45059 Angle Meter



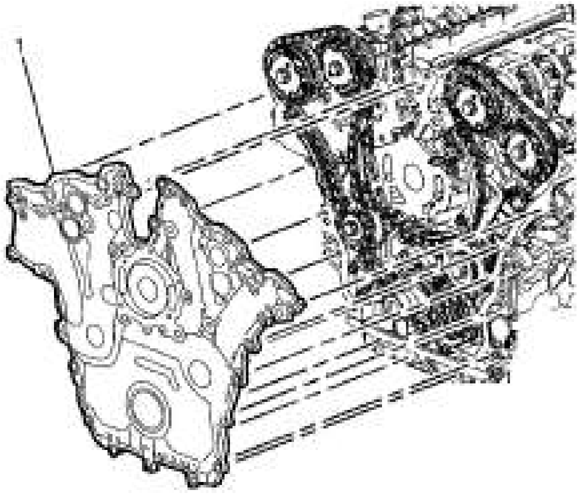
1. Install the 8 mm (0.315 in) guide from the EN 46109 (1) into the cylinder block positions as shown.



2. Install the NEW engine front cover to cylinder block seal (1).

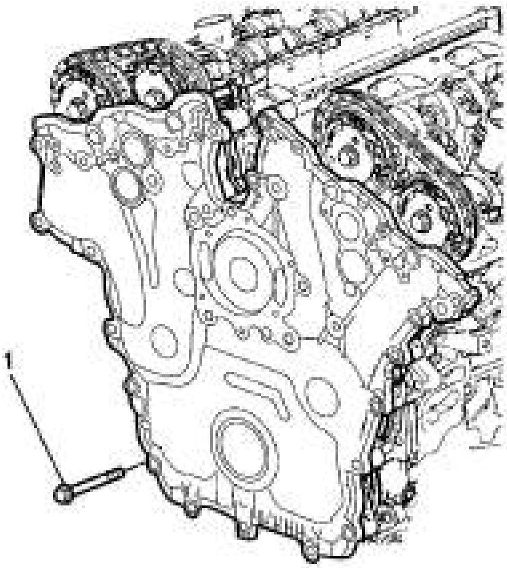


3. Place a 3 mm (0.118 in) bead of RTV sealant (1), on the engine front cover as shown.

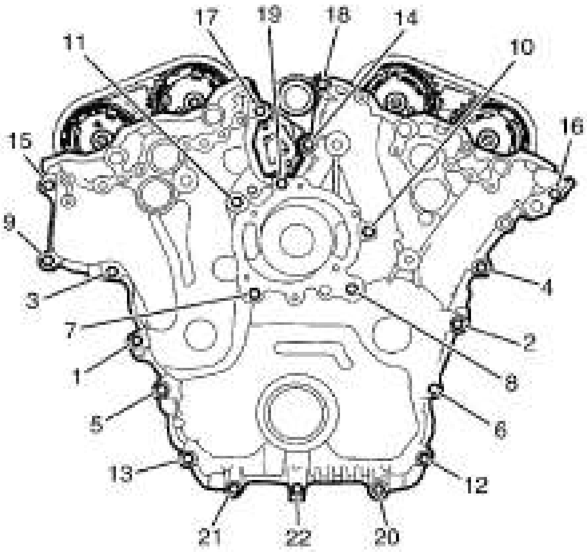


4. Place the engine front cover (1) onto the EN 46109 and slide into position.
5. Remove the EN 46109 from the cylinder block.

Notice: Refer to Fastener Notice in the Preface section.



6. Hand start all the engine front cover to cylinder block retaining bolts (1).

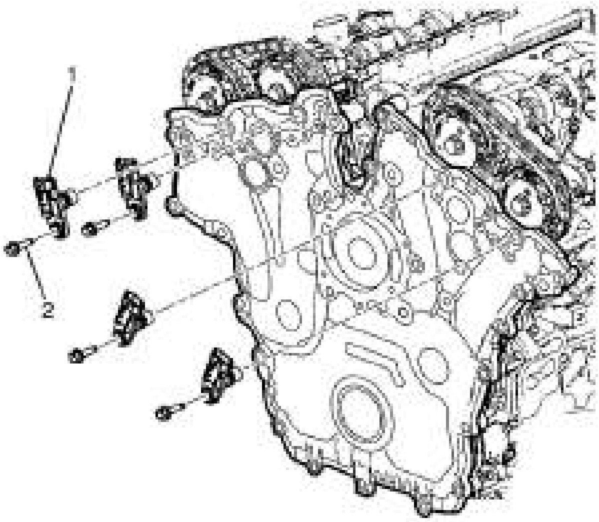


7. Tighten the engine front cover to cylinder block retaining bolts in the sequence shown.

   Tighten
   Tighten the bolts a first pass in sequence to 20 N·m (17 lb ft).

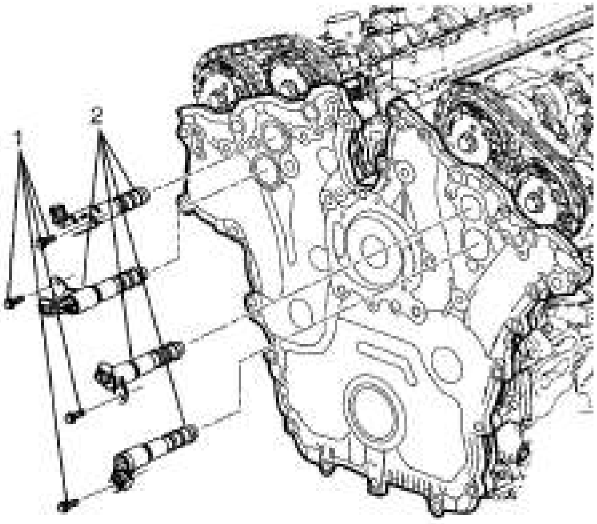
   Tighten the bolts a second pass in sequence an additional 60 degrees using the J 45059 .

8. Install NEW O-rings on the camshaft position sensors.



9. Install the camshaft position sensors (2).
10. Install the camshaft position sensor to front cover retaining bolts (1).

    Tighten
    Tighten the bolts to 10 N·m (89 lb in).



Important: LE0 and LW2 engines only have intake camshaft position actuator solenoids.

11. Install the camshaft position actuator solenoids (2).
12. Install the camshaft position actuator solenoid to front cover retaining bolts (1).

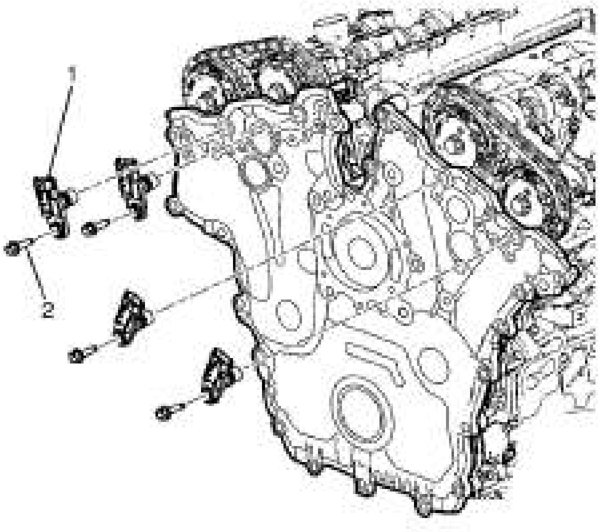
Tighten

1. Tighten the bolts to 10 N·m (89 lb in).
2. Tighten the bolts a second pass in sequence an additional 60 degrees using the J 45059 .

Engine Front Cover Removal

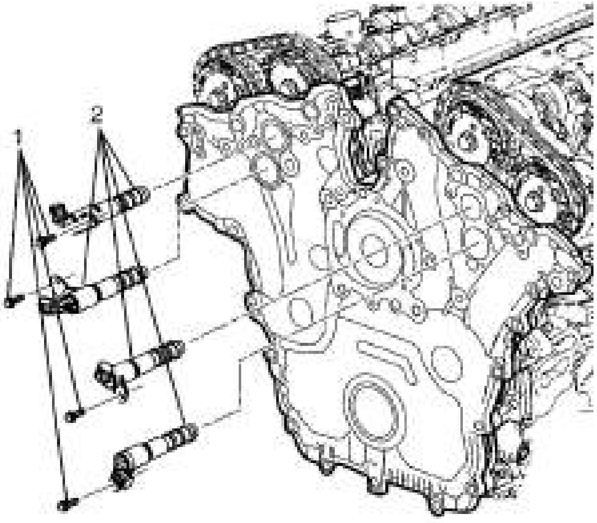
Tools Required

- EN 46105 Camshaft Locking Tools
- EN 46111 Crankshaft Rotation Socket



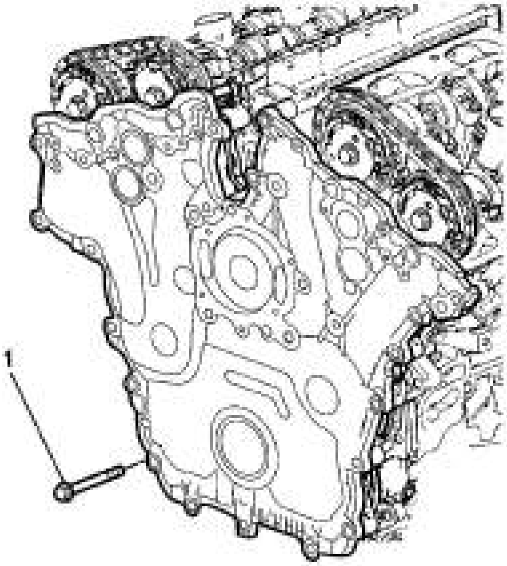
Important: LE0 and LW2 engines only have an intake camshaft position sensor.

1. Remove the camshaft position actuator sensor to engine front cover retaining bolts (2).
2. Remove the camshaft position sensors (1).

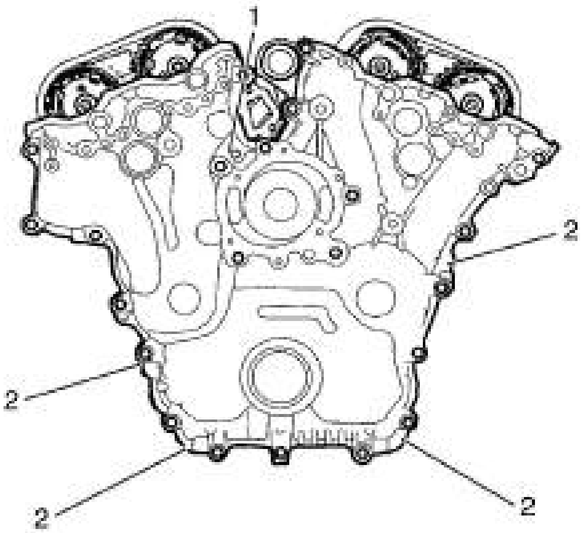


Important: LE0 and LW2 engines only have an intake camshaft position actuator valve.

3. Remove the camshaft position actuator valve to engine front cover retaining bolts (1).
4. Remove the camshaft position actuator valves (2).

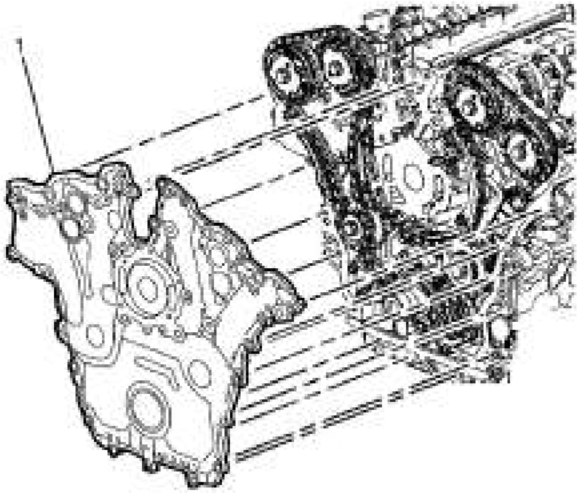


5. Remove the engine front cover to cylinder block retaining bolts (1).

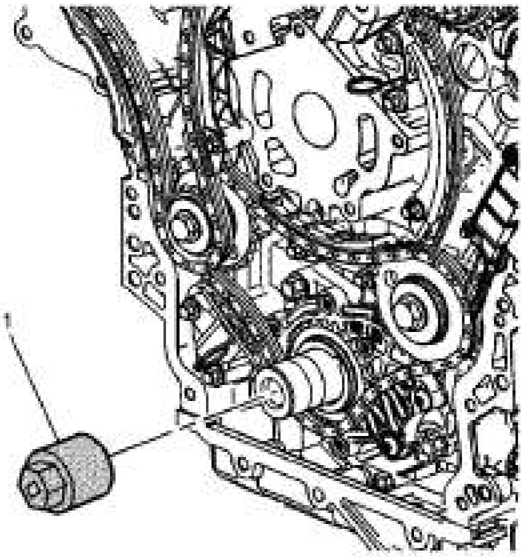


Notice: Do not pry between the engine front cover and the camshaft position sensors or the camshaft position actuators in order to separate the RTV. Use the pry points and a bolt in the jackscrew hole in order to remove the engine front cover. Damage to the camshaft position sensors or the camshaft position actuators may occur if the camshaft position sensors or the camshaft position actuators are used to pry against in order to remove the engine front cover.

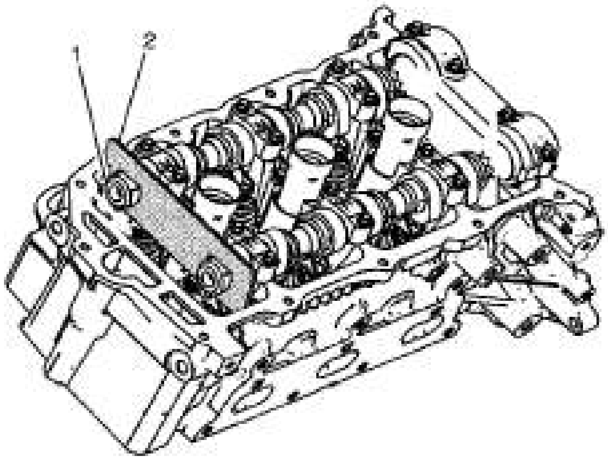
6. Loosely install a 10 x 1.5 mm bolt in the jackscrew hole (1).
7. Using the pry points (2) located at the edge of the front cover and the jackscrew, shear the Room Temperature Vulcanizing (RTV) sealant.



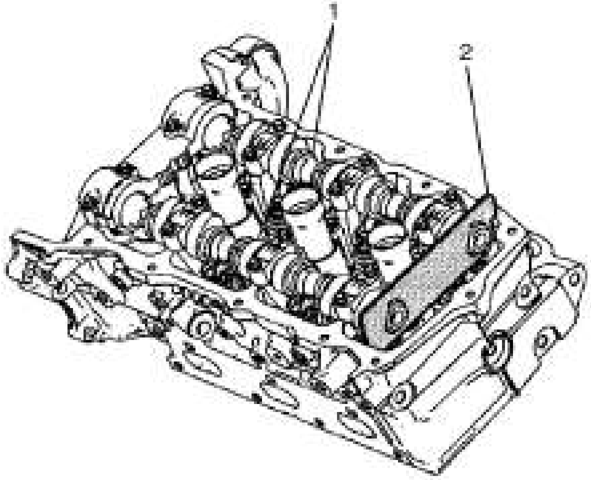
8. Remove the engine front cover (1).



9. Using the EN 46111 (1), rotate the crankshaft until the left cylinder head camshafts align with the EN 46105 and the right cylinder head camshafts align with the EN 46105 .



10. Install the EN 46105 (2) onto the rear of the right hand camshafts (1).



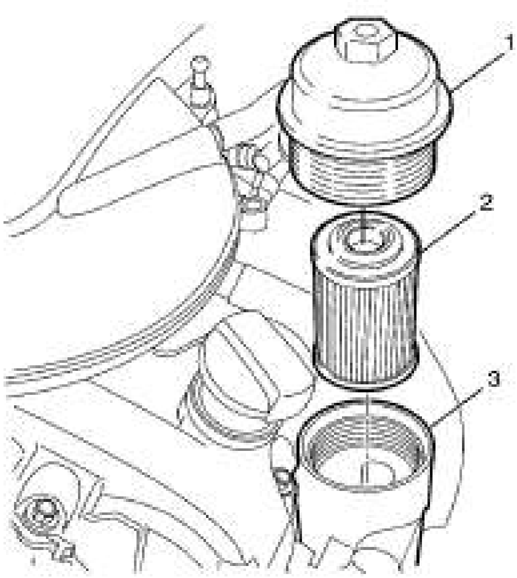
11. Install the EN 46105 (2) onto the rear of the left hand camshafts (1).

Engine Prelubing

Tools Required

J 45299 Engine Preluber

Important: A constant and continuous flow of clean engine oil is required in order to properly prime the engine. Be sure to use an approved engine oil as specified in the owners manual.

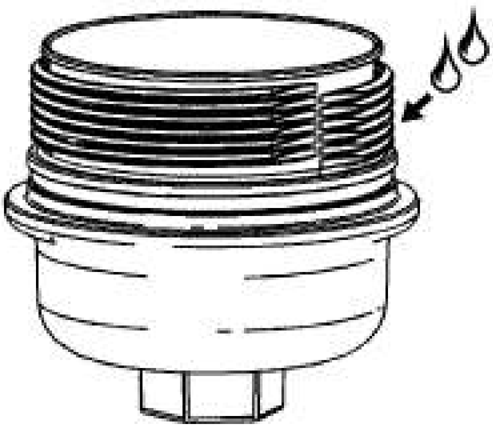


Important: Use a six-point socket to remove the oil filter cap (1).

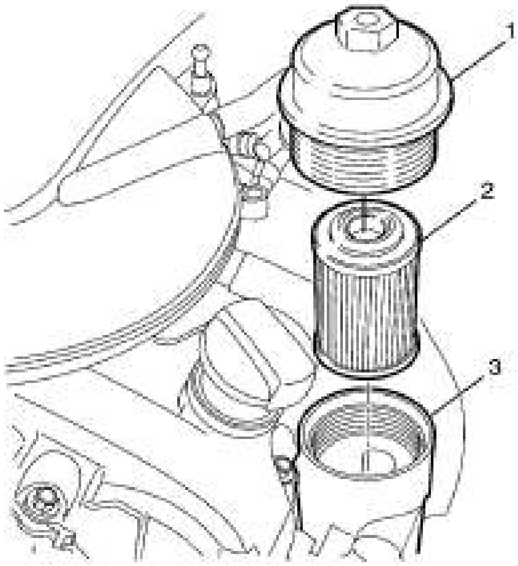
1. Remove the oil filter adapter cap (1) from the engine oil filter adapter (3).
2. Remove the oil filter cartridge (2).

   Discard the oil filter cartridge (2).

   Notice: Refer to General Repair Instructions in the Preface section.



3. Lubricate the oil filter cap threads with clean engine oil.



4. Install the NEW oil filter cartridge (2).

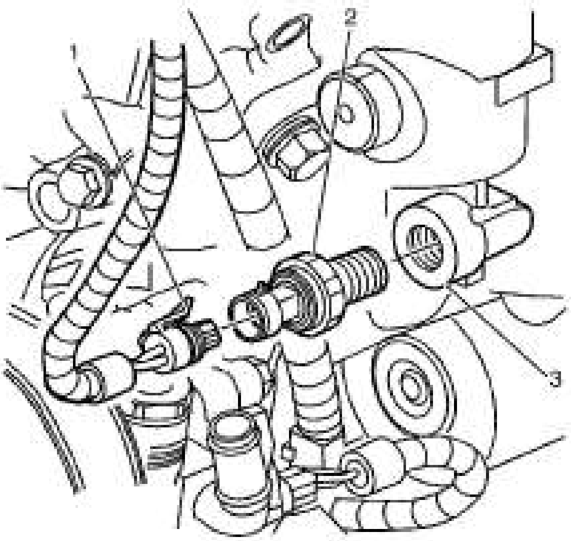
Notice: Refer to Fastener Notice in the Preface section.

Notice: Refer to General Repair Instructions in the Preface section.

Important: Use a six-point socket to install the oil filter cap.

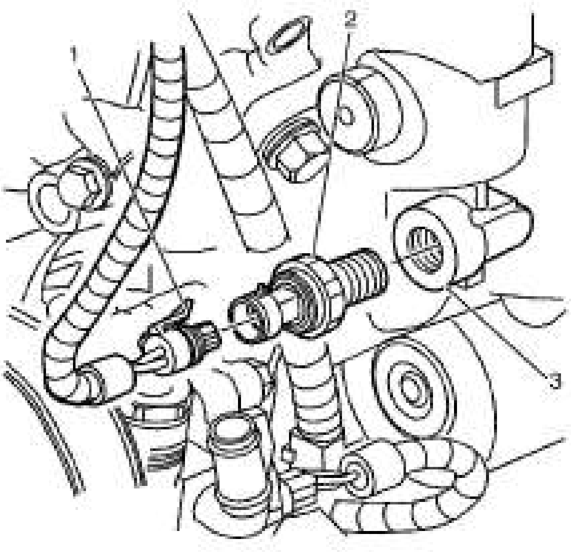
5. Install the oil filter adapter cap (1) to the engine oil filter adapter (3).

Tighten
Tighten the oil filter cap to 25 N·m (18 lb ft).



Important: A constant and continuous flow of clean engine oil is required in order to properly prime the engine. Be sure to use an approved engine oil as specified in the owners manual.

6. Remove the oil pressure sending unit (2) from the oil filter adapter (3).
7. Disconnect the oil pressure sending unit electrical connector (1).
8. Install a 14 x 1.5 mm adapter to the oil filter adapter (3).
9. Install the flexible hose to the adapter and open the valve.
10. Pump the handle on the J 45299 in order to flow a minimum of 1-1.9 liters (1-2 quarts) of engine oil. Observe the flow of engine oil through the flexible hose and into the engine assembly.
11. Close the valve and remove the flexible hose and adapter from the oil filter adapter.

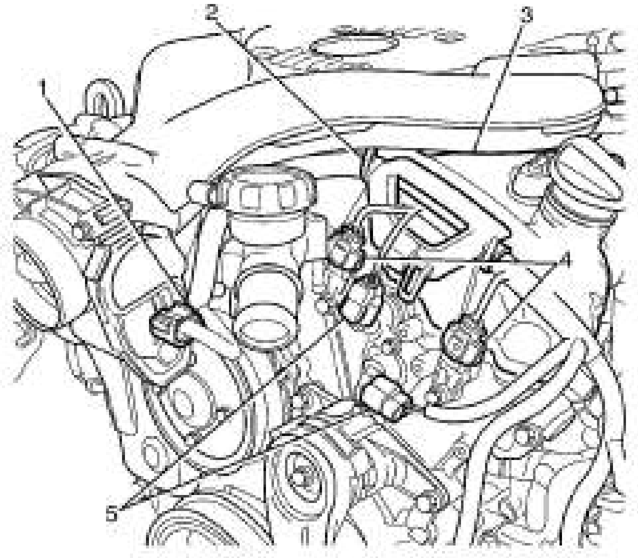


12. Install the oil pressure sending unit (2) to the oil filter adapter (3).

    Tighten
    Tighten the oil pressure sending unit to 20 N·m (15 lb ft).

13. Connect the oil pressure sending unit electrical connector (1).
14. Top-off the engine oil to the correct level.

Engine Wiring Harness Assembly Installation

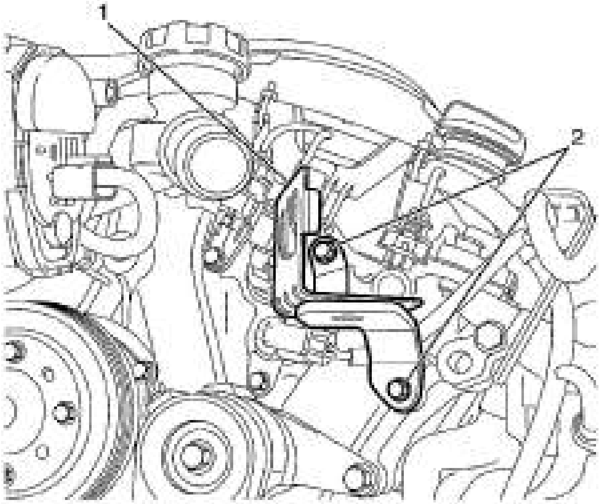


Important: Attach the engine wiring harness bracket (2) to the locating clip lug on the left bank camshaft cover (3) to avoid an induced rattle condition.

1. Attach the engine wiring harness bracket (2) to the left bank camshaft cover (3).
2. Connect the throttle position sensor electrical connector (1).

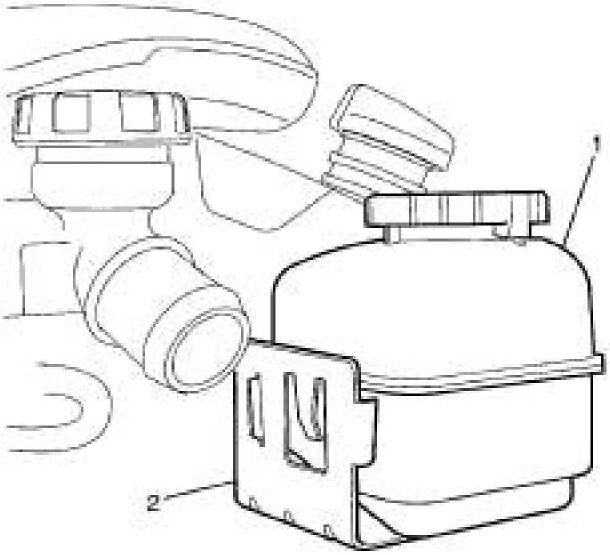
Important: LE0 and LW2 engines only have intake camshaft position actuator solenoids.

3. Connect the left bank intake and exhaust camshaft position actuator solenoid electrical connectors (5).
4. Connect the left camshaft position sensors electrical connectors (4).



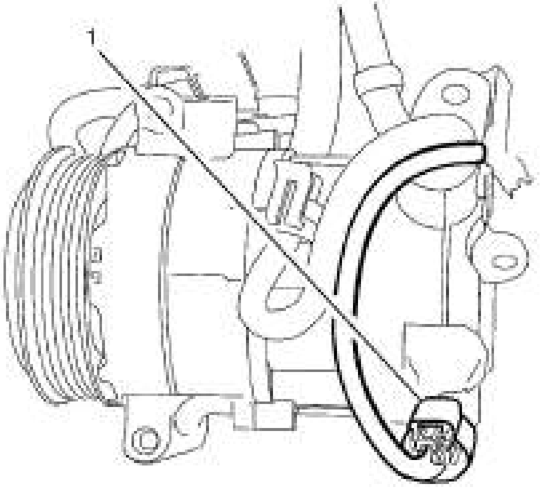
5. Install the power steering fluid reservoir bracket (1).
6. Install the power steering fluid reservoir bracket to engine front cover retaining bolts (2).

Tighten
Tighten the bolts to 9 N·m (80 lb in).

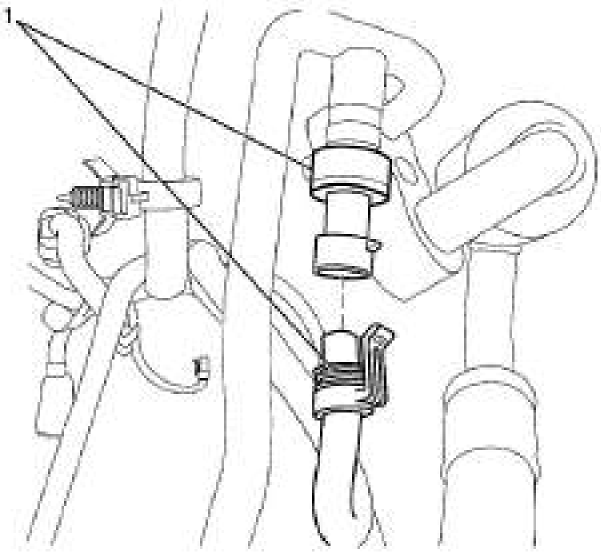


Important: Make sure the power steering reservoir (1) and the the locking tang on the power steering reservoir bracket (2) are engaged to avoid an induced rattle condition.

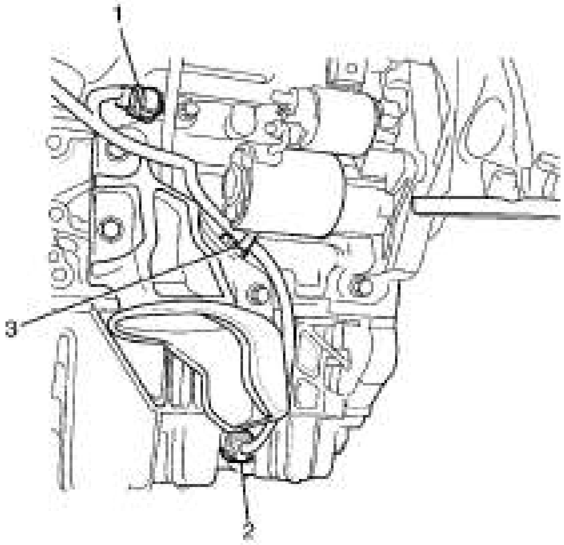
7. Install the power steering fluid reservoir to the power steering fluid reservoir bracket.



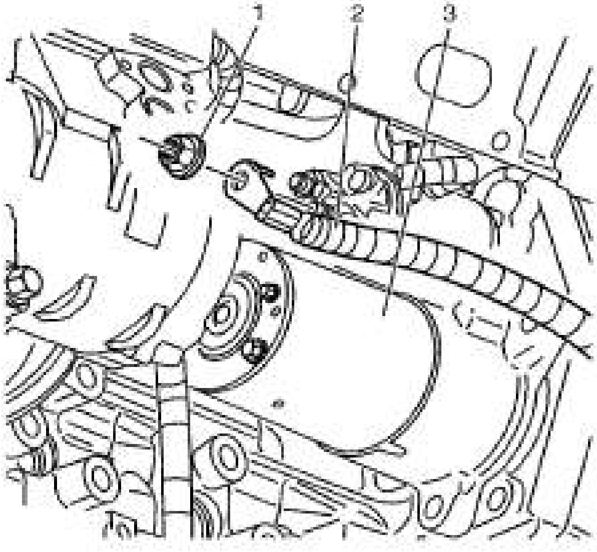
8. Connect the A/C compressor electrical connector (1).



9. Connect the A/C pressure transducer electrical connector (1).



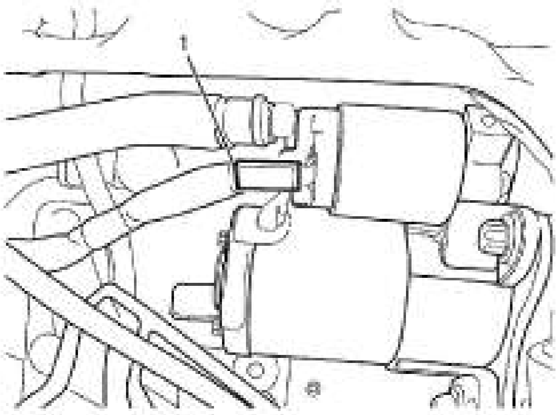
10. Attach the engine wiring harness to cylinder block retaining lug (3).
11. Connect the oil level sensor electrical connector (2).
12. Connect the left bank knock sensor electrical connector (1).



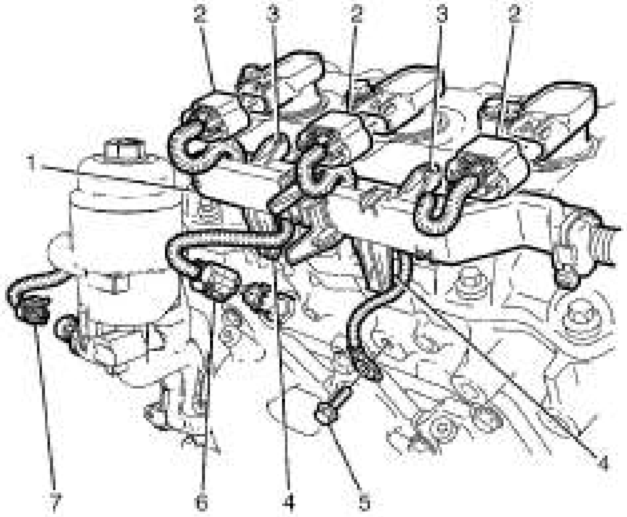
13. Install the battery cable harness to starter motor retaining nut (1).

    Tighten
    Tighten the nut to 20 N·m (14 lb ft).

14. Connect the battery cable harness (2) to the starter motor (3).



15. Connect the starter motor electrical connector (1).

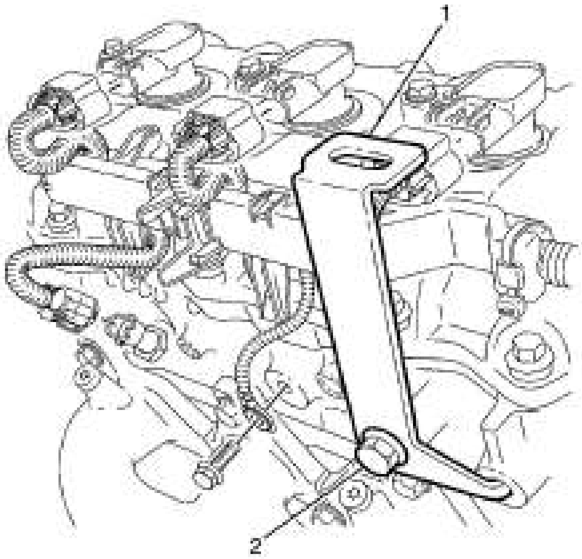


Important: Attach the engine wiring harness (1) clips to the right bank camshaft cover clips (4) and lugs (3) to avoid an induced rattle condition.

16. Attach the engine wiring harness bracket (1) to the right bank camshaft cover lugs (3).
17. Connect the oil pressure sensor electrical connector (7).
18. Connect the coolant temperature sensor electrical connector (6).
19. Install the engine wiring harness ground and engine wiring harness ground to left bank cylinder head retaining bolt (5).

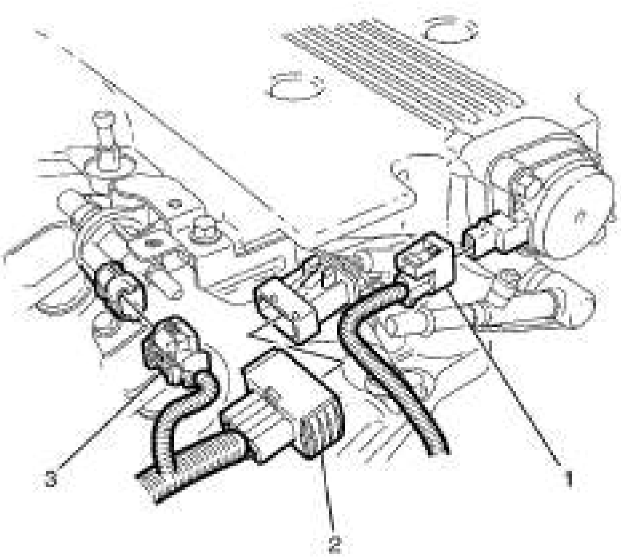
Tighten
Tighten the bolt to 10 N·m (89 lb in).

20. Connect the left bank ignition coil electrical connectors (2).

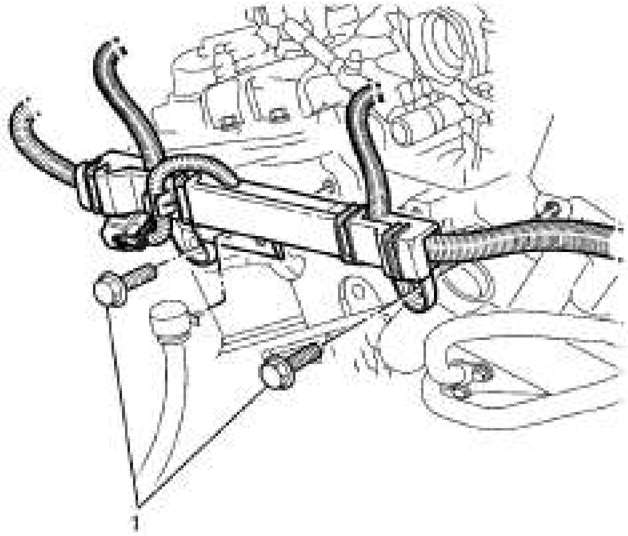


21. Install the engine cover bracket (1).
22. Install the engine cover bracket to cylinder head retaining bolt (2).

Tighten
Tighten the bolt to 35 N·m (26 lb ft).

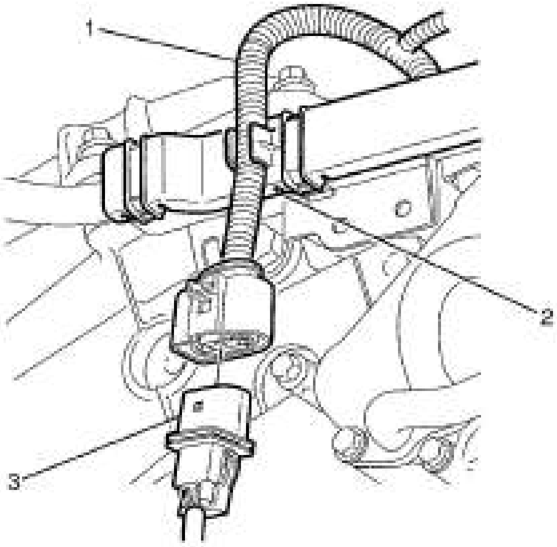


23. Connect the purge solenoid electrical connector (3).
24. Connect the injector harness electrical connector (2).
25. Connect the Intake Manifold Runner Control (IMRC) electrical connector (1).

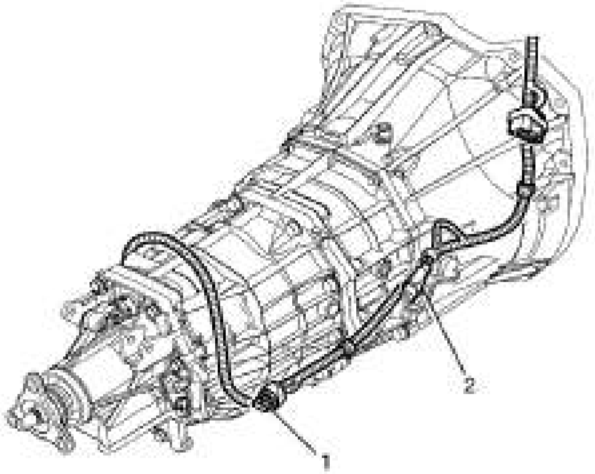


26. Install the engine wiring harness bracket to cylinder head rear retaining bolts (1).

    Tighten
    Tighten the nut to 40 N·m (30 lb ft).

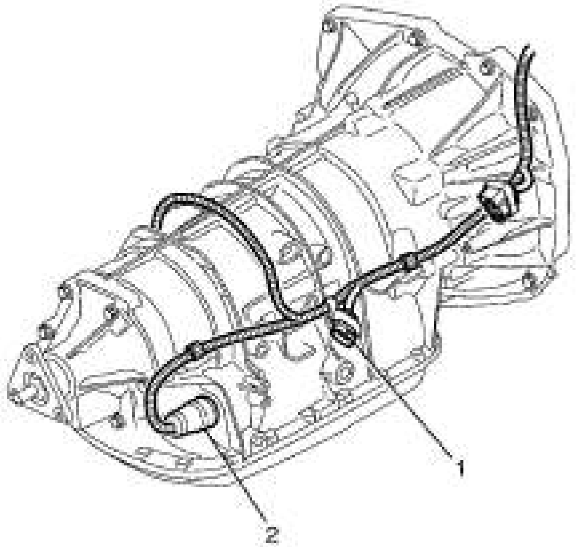


27. Attach the left hand Heated Oxygen Sensor 1 electrical harness (1) to the engine wiring harness bracket (2).
28. Connect the left hand Heated Oxygen Sensor 1 electrical connector (3).



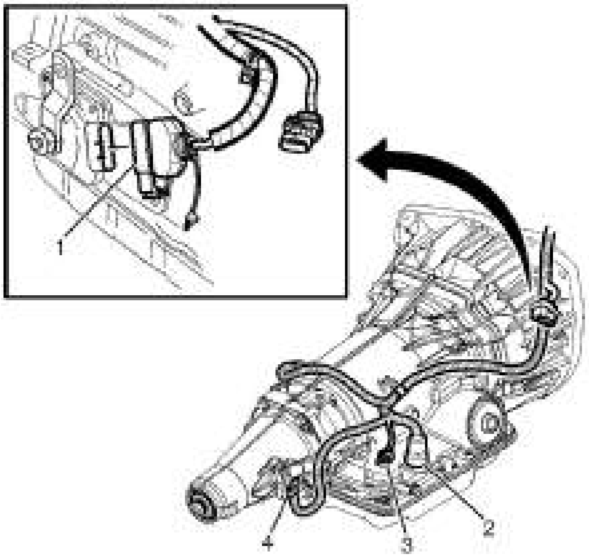
Important: This step and graphic refer to the 6 speed manual transmission only.

29. Connect the right hand Heated Oxygen Sensor 1 electrical connector (1).
30. Connect the reverse switch assembly electrical connector (2).



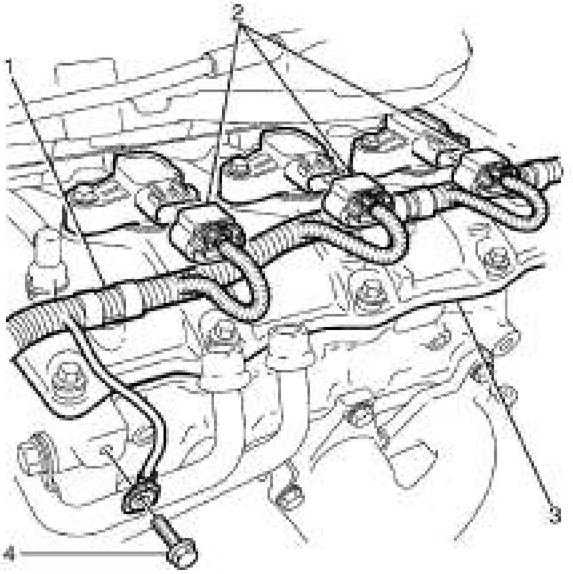
Important: This step and graphic refer to the 5 speed automatic transmission only

31. Connect the right hand Heated Oxygen Sensor 1 electrical connector (1).
32. Connect the main transmission electrical connector (2).



Important: This step and graphic refer to the 4 speed automatic transmission only

33. Connect the right hand Heated Oxygen Sensor 1 electrical connector (2).
34. Connect the main transmission electrical connector (3).
35. Connect the vehicle speed sensor electrical connector (4)
36. Connect the park/neutral switch electrical connector (1).

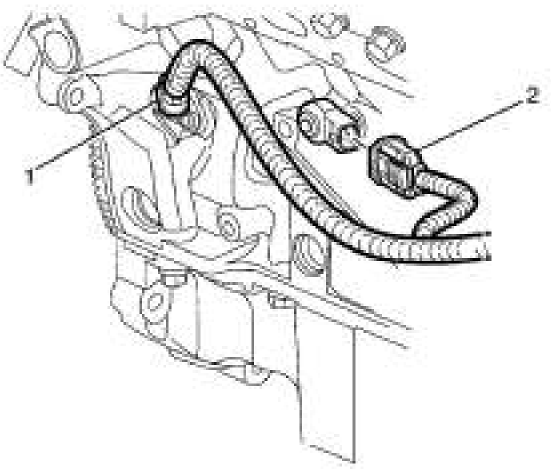


Important: Attach the engine wiring harness (1) clips to the right bank camshaft cover (4) to avoid an induced rattle condition.

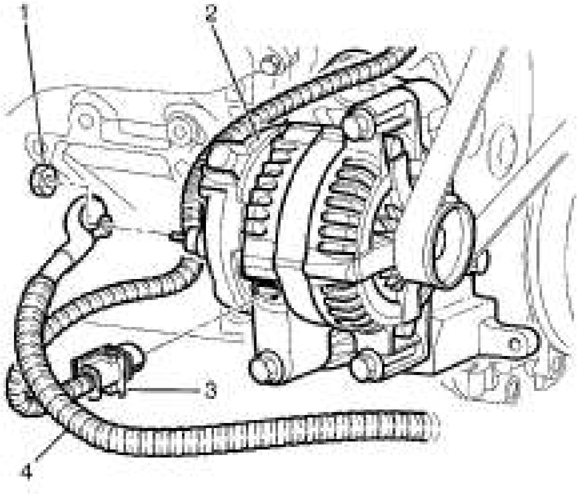
37. Attach the engine wiring harness (1) to the right bank camshaft cover (3).
38. Install the engine wiring harness ground to right bank cylinder head rear retaining bolt (4).

Tighten
Tighten the bolt to 10 N·m (89 lb in).

39. Connect the right bank ignition coil electrical connectors (2).

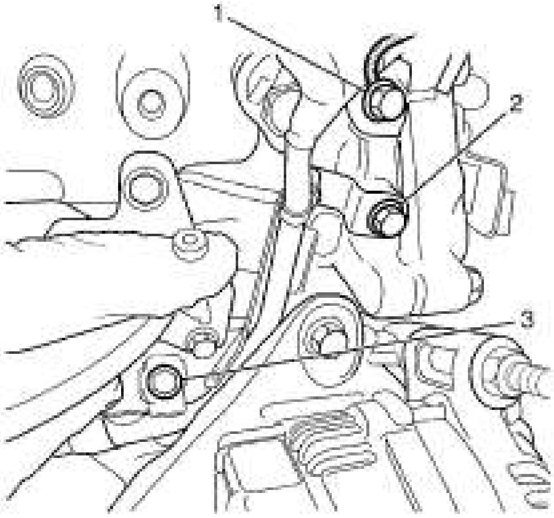


40. Connect the crankshaft position sensor electrical connector (1).
41. Connect the right bank knock sensor electrical connector (2).
42. Install the alternator and mounting bracket. Refer to Generator Installation .



43. Connect the alternator battery harness connector (3).
44. Connect the battery positive cable (4) from the alternator (2).
45. Install the battery positive cable to alternator retaining nut (1).

Tighten
Tighten the nut to 13 N·m (115 lb in).



46. Install the engine wiring harness bracket to cylinder block retaining bolt (3).

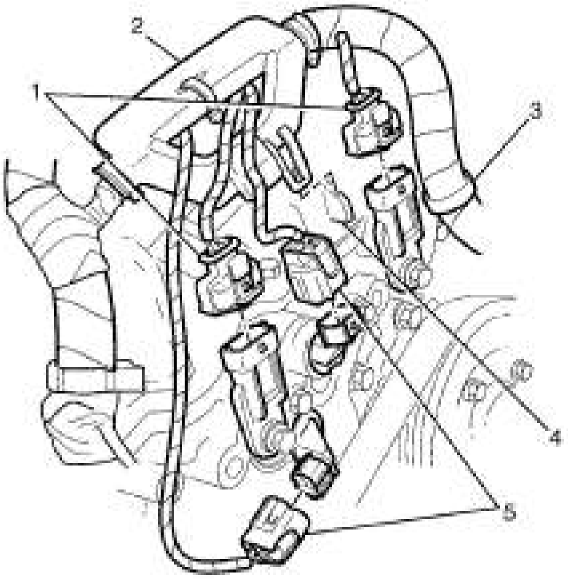
    Tighten
    Tighten the nut to 10 N·m (89 lb in).

47. Install the engine wiring harness bracket to right bank cylinder head retaining bolt (2).

    Tighten
    Tighten the nut to 10 N·m (89 lb in).

48. Install the engine wiring harness ground to right bank cylinder head front retaining bolt (1).

    Tighten
    Tighten the nut to 10 N·m (89 lb in).



Important: Attach the engine wiring harness bracket (2) to the locating clip lug on the right bank camshaft cover (4) to avoid an induced rattle condition.

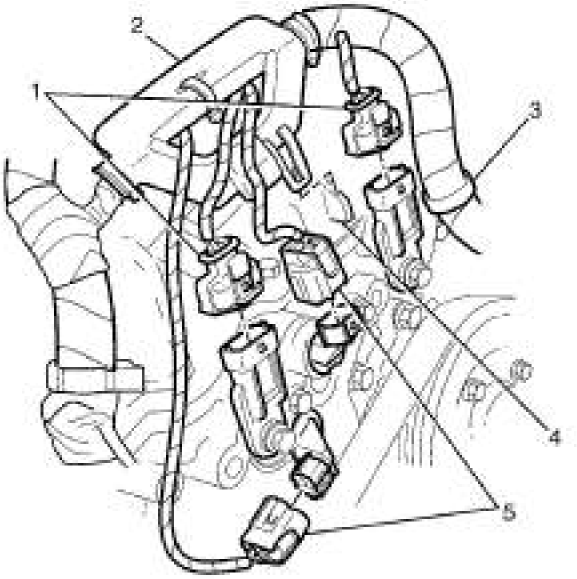
49. Attach the engine wiring harness bracket (2) from the right bank camshaft cover (4).
50. Attach the engine wiring harness to cylinder head retaining lug (3).

Important: LE0 and LW2 engines only have intake camshaft position actuator solenoids.

51. Connect the right bank intake and exhaust camshaft position actuator solenoid electrical connectors (5).
52. Connect the right camshaft position sensors electrical connectors (1).
53. Install the engine covers. Refer to Engine Cover Replacement .

Engine Wiring Harness Assembly Removal

1. Remove the engine covers. Refer to Engine Cover Replacement .



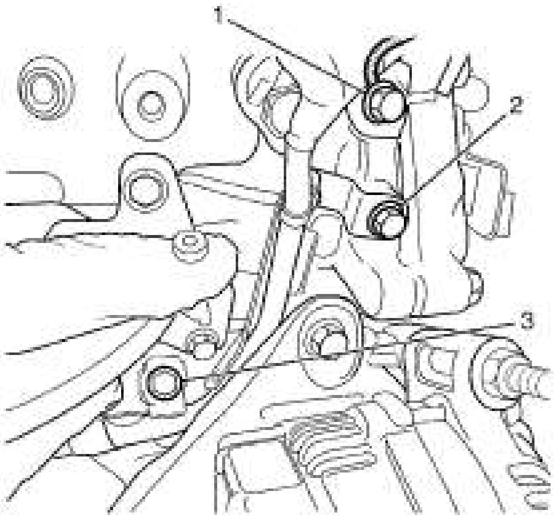
2. Disconnect the right camshaft position sensors electrical connectors (1).

Important: LE0 and LW2 engines only have an intake camshaft position actuator valve.

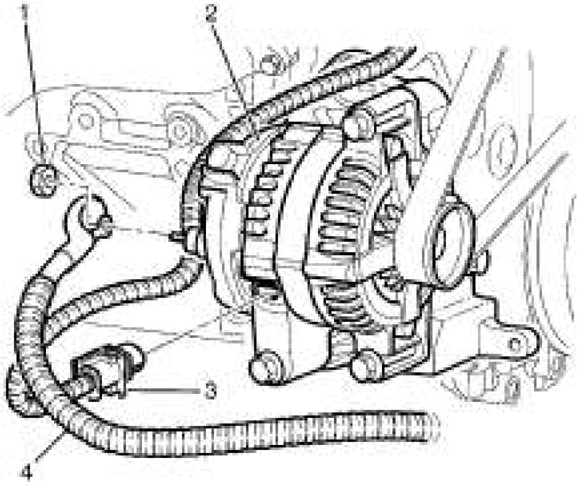
3. Disconnect the right bank intake and exhaust camshaft position actuator valve electrical connectors (5).
4. Detach the engine wiring harness to cylinder head retaining lug (3).

Important: Use a suitable tool to detach the engine wiring harness bracket (2) from the locating clip lug on the right bank camshaft cover (4) then slide the engine wiring harness bracket (2) upwards to detach from the right bank camshaft cover (4).

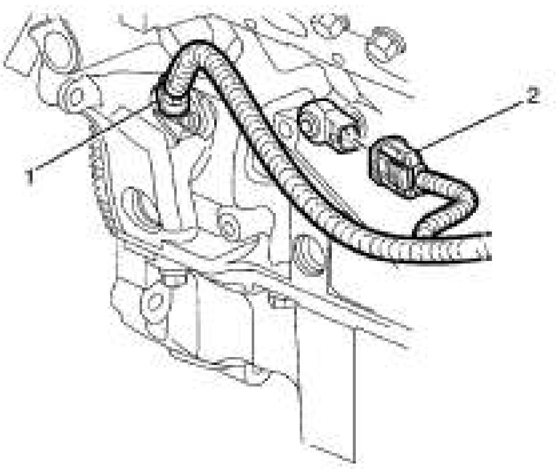
5. Detach the engine wiring harness bracket (2) from the right bank camshaft cover (4).



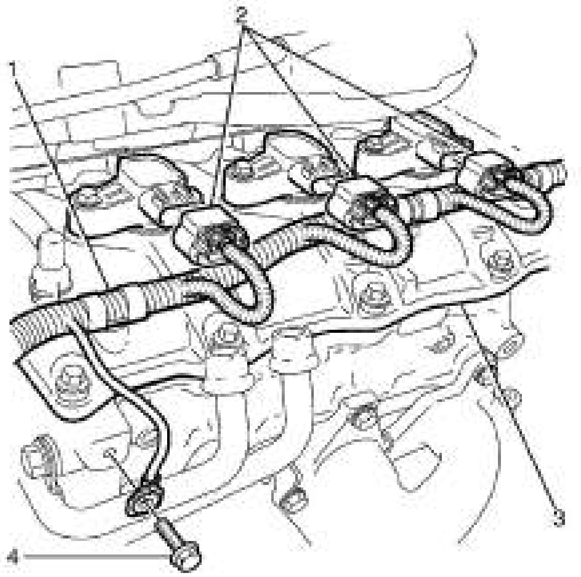
6. Remove the engine wiring harness ground to right bank cylinder head front retaining bolt (1).
7. Remove the engine wiring harness bracket to right bank cylinder head retaining bolt (2).
8. Remove the engine wiring harness bracket to cylinder block retaining bolt (3).



9. Remove the battery positive cable to alternator retaining nut (1).
10. Disconnect the battery positive cable (2) from the alternator (3).
11. Disconnect the alternator battery harness connector (4).
12. Remove the alternator and mounting bracket. Refer to Generator Removal .



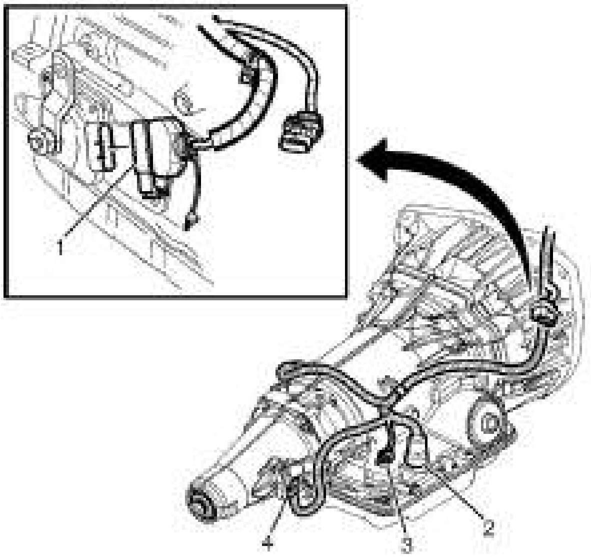
13. Disconnect the right bank knock sensor electrical connector (2).
14. Disconnect the crankshaft position sensor electrical connector (1).



15. Disconnect the right bank ignition coil electrical connectors (2).
16. Remove the engine wiring harness ground to right bank cylinder head rear retaining bolt (4).

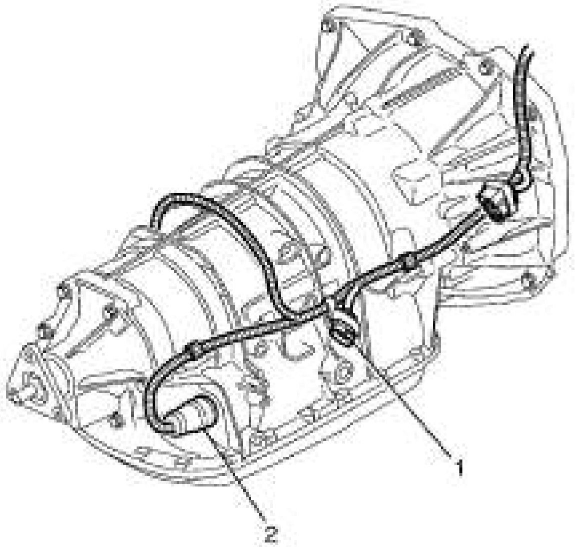
Important: Use a suitable tool to detach the engine wiring harness (1) clips from the right bank camshaft cover (4).

17. Detach the engine wiring harness (1) from the right bank camshaft cover (3).



Important: Steps 19 - 22 refer to the 4L60E 4 speed automatic transmission only

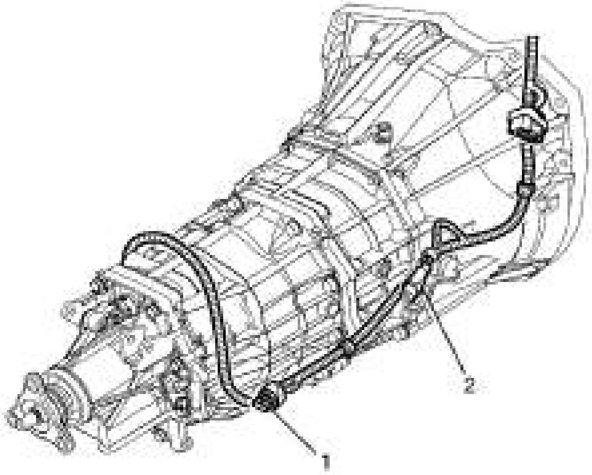
18. Disconnect the right hand Heated Oxygen Sensor 1 electrical connector (2) if still connected after engine removal.
19. Disconnect the main transmission electrical connector (3).
20. Disconnect the vehicle speed sensor electrical connector (4)
21. Disconnect the park/neutral switch electrical connector (1).



Important: Steps 24 and 25 refer to the 5L40E 5 speed automatic transmission only.

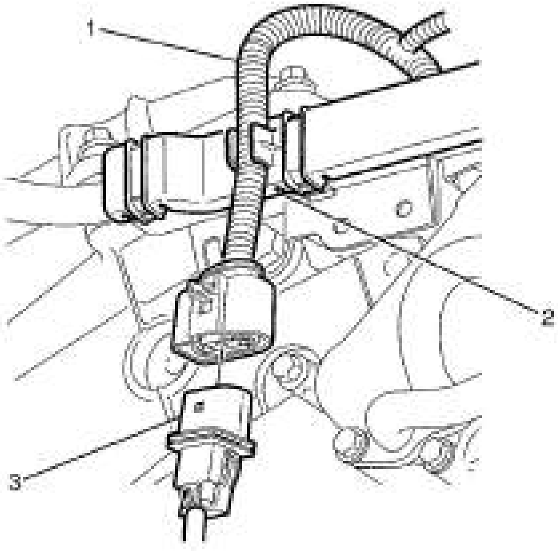
22. Disconnect the right hand Heated Oxygen Sensor 1 electrical connector (1) if still connected after engine removal.

23. Disconnect the main transmission electrical connector (2).

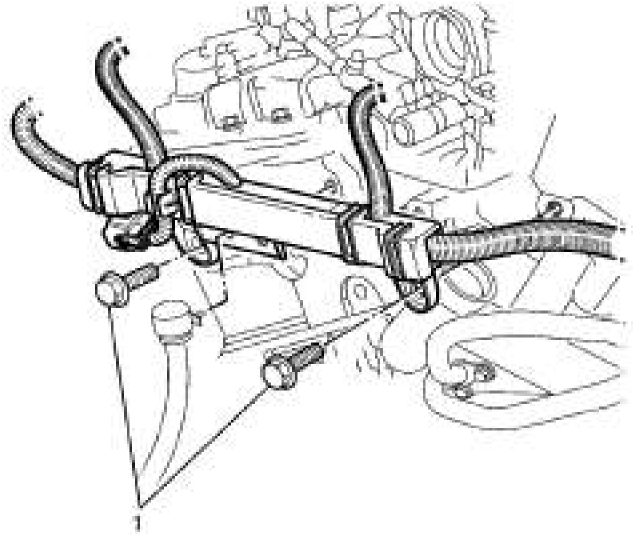


Important: Steps 27 and 28 refer to the D173 6 speed manual transmission only.

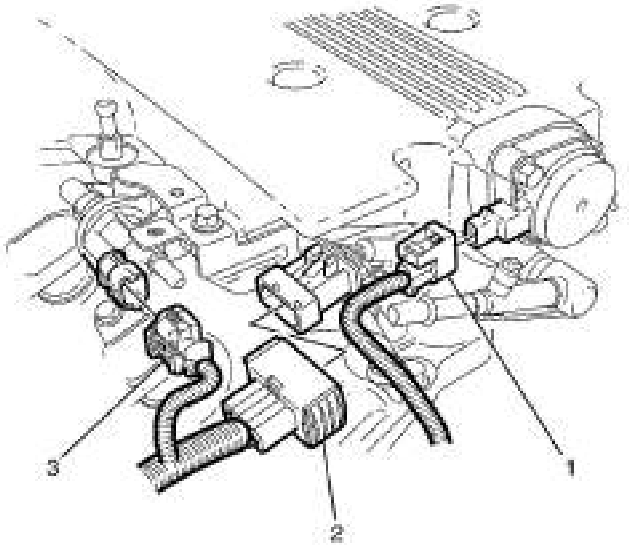
24. Disconnect the right hand Heated Oxygen Sensor 1 electrical connector (1) if still connected after engine removal.
25. Disconnect the reverse switch assembly electrical connector (2).



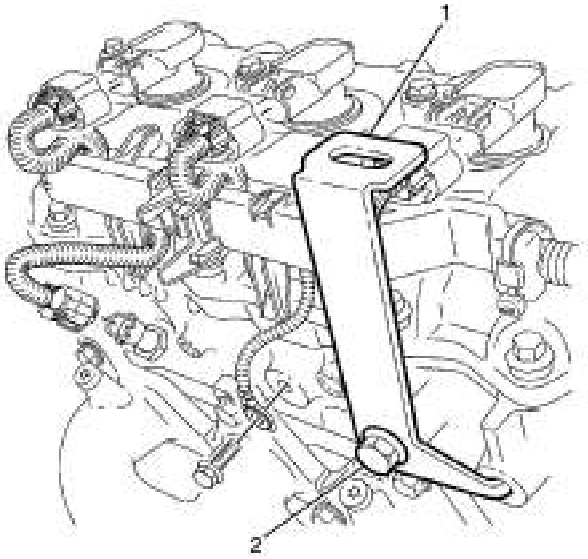
26. Disconnect the left hand Heated Oxygen Sensor 1 electrical connector (3) if still connected after engine removal.
27. Detach the left hand Heated Oxygen Sensor 1 electrical harness (1) from the engine wiring harness bracket (2).



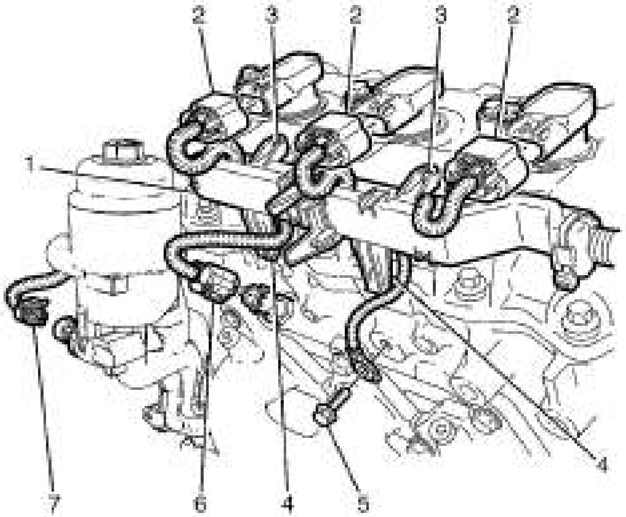
28. Remove the engine wiring harness bracket to cylinder head rear retaining bolts (1).



29. Disconnect the Intake Manifold Runner Control (IMRC) electrical connector (1).
30. Disconnect the injector harness electrical connector (2).
31. Disconnect the purge solenoid electrical connector (3).



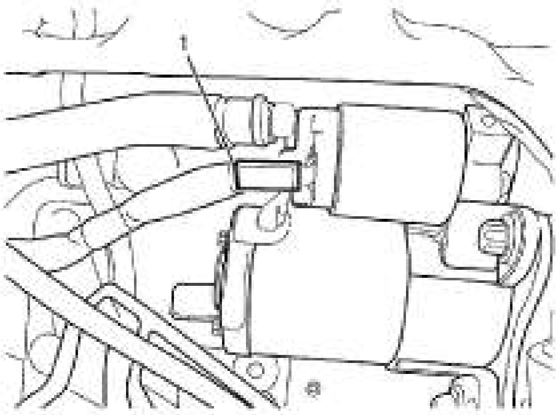
32. Remove the engine cover bracket to cylinder head retaining bolt (2).
33. Remove the engine cover bracket (1).



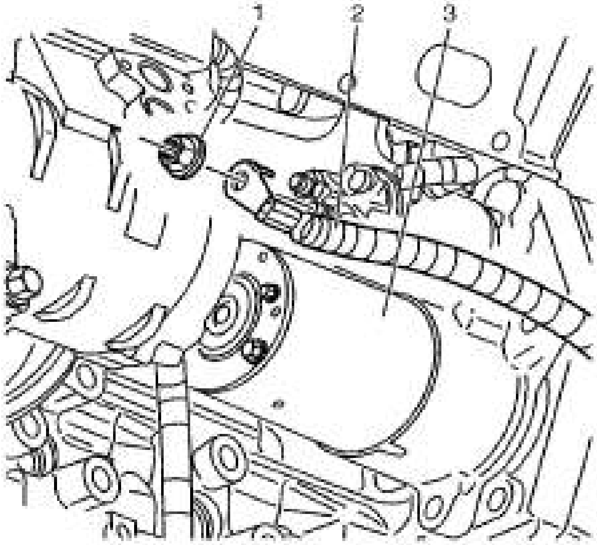
34. Disconnect the left bank ignition coil electrical connectors (2).
35. Remove the engine wiring harness ground to left bank cylinder head retaining bolt (5).
36. Disconnect the coolant temperature sensor electrical connector (6).
37. Disconnect the oil pressure sensor electrical connector (7).

Important: Use a suitable tool to detach the engine wiring harness (1) clips from the right bank camshaft cover clips (4) then lift upwards to detach the engine wiring harness (1) from the right bank camshaft cover lugs (3).

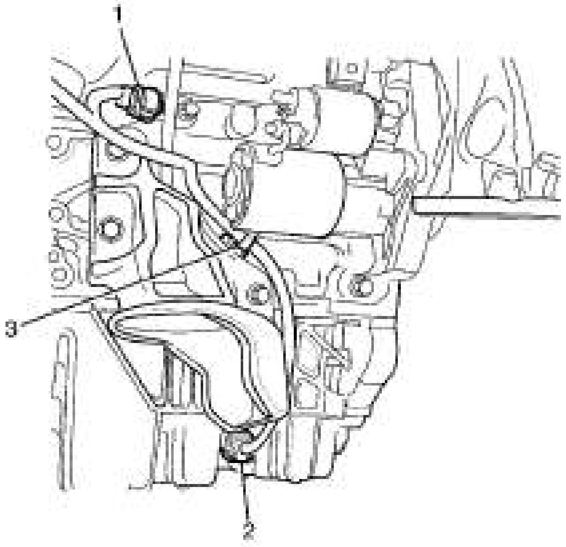
38. Detach the engine wiring harness bracket (1) from the right bank camshaft cover lugs (3) and position aside.



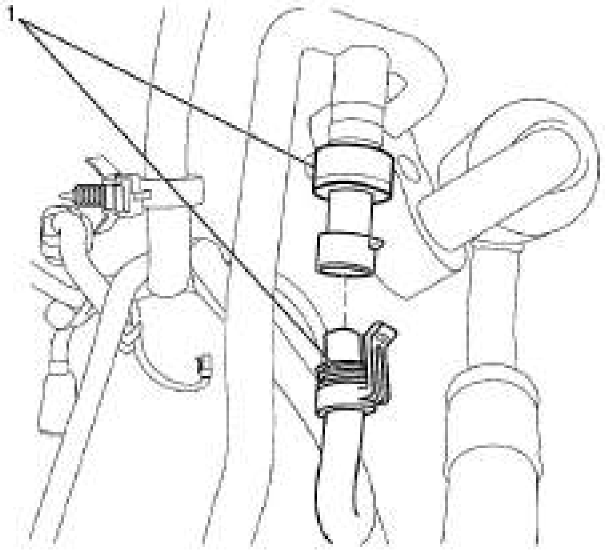
39. Disconnect the starter motor electrical connector (1).



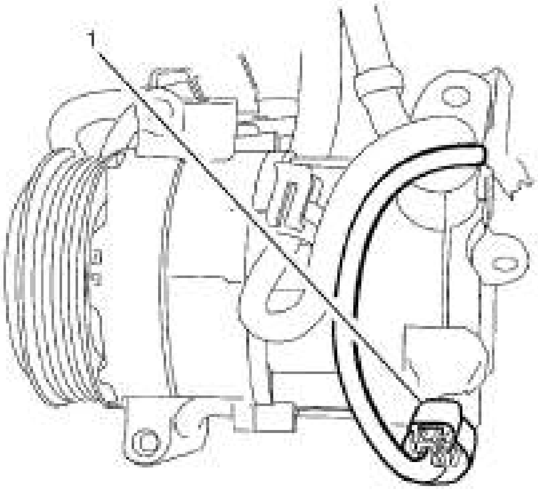
40. Disconnect the battery positive cable (2) from the starter motor (3).
41. Remove the battery positive cable to starter motor terminal retaining nut (1).



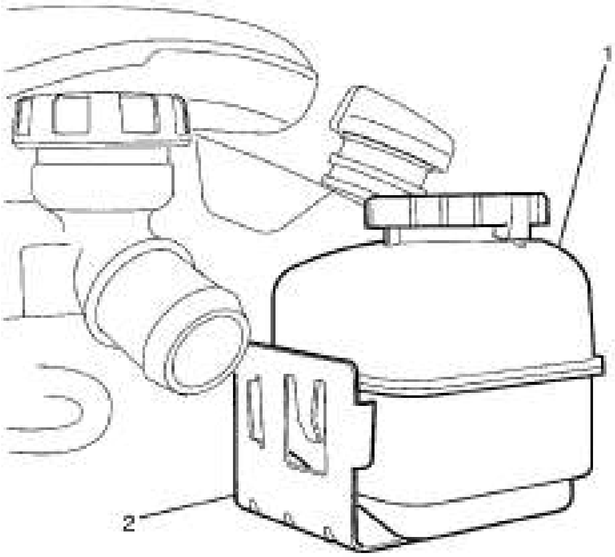
42. Disconnect the left bank knock sensor electrical connector (1).
43. Disconnect the oil level sensor electrical connector (2).
44. Detach the engine wiring harness to cylinder block retaining lug (3).



45. Disconnect the A/C pressure transducer electrical connector (1).



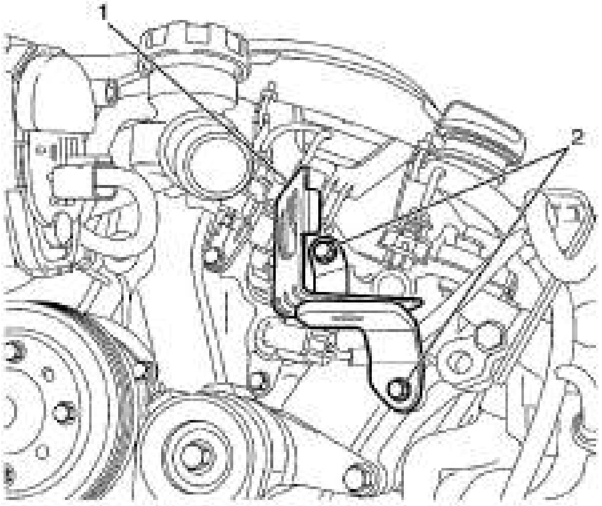
46. Disconnect the A/C compressor electrical connector (1).



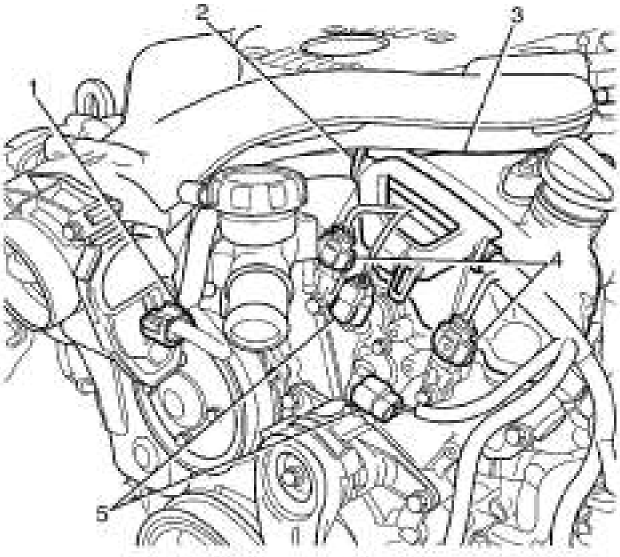
Important: DO NOT disconnect the power steering pipes or drain the power steering fluid.

Important: The locking tang on the power steering reservoir bracket (2) must be released before removing the power steering reservoir (1). Release the locking tang on the power steering reservoir bracket (2) with a suitable tool.

47. Separate power steering fluid reservoir (1) from the power steering fluid reservoir bracket (2).
48. Reposition and secure the power steering fluid reservoir away from the power steering fluid reservoir (1) bracket (2).



49. Remove the power steering fluid reservoir bracket to engine front cover retaining bolts (2).
50. Remove the power steering fluid reservoir bracket (1).



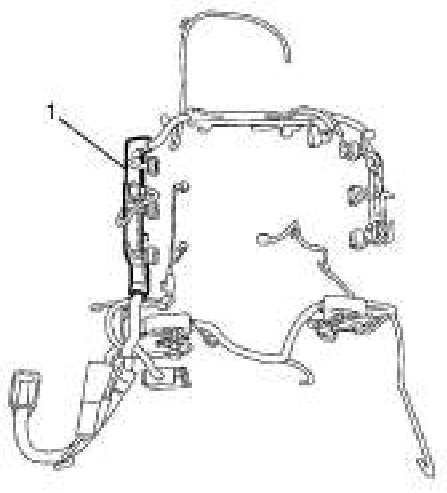
51. Disconnect the left camshaft position sensors electrical connectors (4).

Important: LE0 and LW2 engines only have an intake camshaft position actuator valve.

52. Disconnect the left bank intake and exhaust camshaft position actuator valve electrical connectors (5).
53. Disconnect the throttle position sensor electrical connector (1).

Important: Use a suitable tool to detach the engine wiring harness bracket (2) from the locating clip lug on the left bank camshaft cover (3) then slide the engine wiring harness bracket (2) upwards to detach from the left bank camshaft cover (3).

54. Detach the engine wiring harness bracket (2) from the left bank camshaft cover (3).



55. Remove the engine wiring harness (1).

Exhaust Manifold Cleaning and Inspection - Left Side (NT3)

Cleaning Procedure

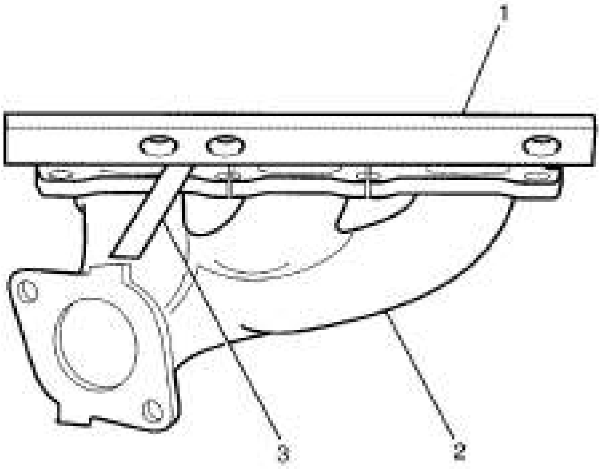
1. Clean the exhaust manifold in solvent.

   Caution: Refer to Safety Glasses Caution in the Preface section.

2. Dry the exhaust manifold with compressed air.

Inspection Procedure

1. Inspect the left exhaust manifold for the following:
   - Damage or corrosion above acceptable tolerances to the exhaust manifold exterior.
   - Damage to the exhaust manifold mounting holes.
   - Damage to the threaded holes for the heat shield.
   - Damage to the exhaust manifold flange bolt holes.
   - Damage to the gasket sealing surfaces.
   - Damage or restrictions within the exhaust passages.
2. Repair or replace the left exhaust manifold and/or components as necessary.



3. Measure the alignment or surface flatness of the exhaust manifold (2) flanges, using a straight edge (1) and a feeler gauge (3). Exhaust manifold surface flatness must not exceed 0.254 mm (0.010 in).
4. If the surface flatness is not within specifications, the exhaust manifold (2) is warped and must be replaced.

Exhaust Manifold Cleaning and Inspection - Right Side (NT3)

Cleaning Procedure

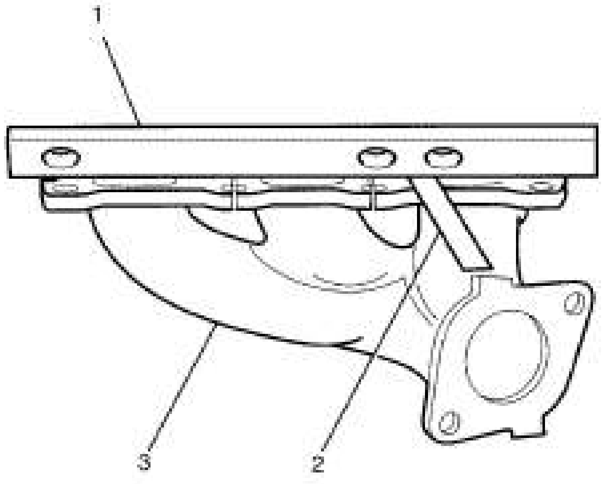
1. Clean the exhaust manifold in solvent.

   Caution: Refer to Safety Glasses Caution in the Preface section.

2. Dry the exhaust manifold with compressed air.

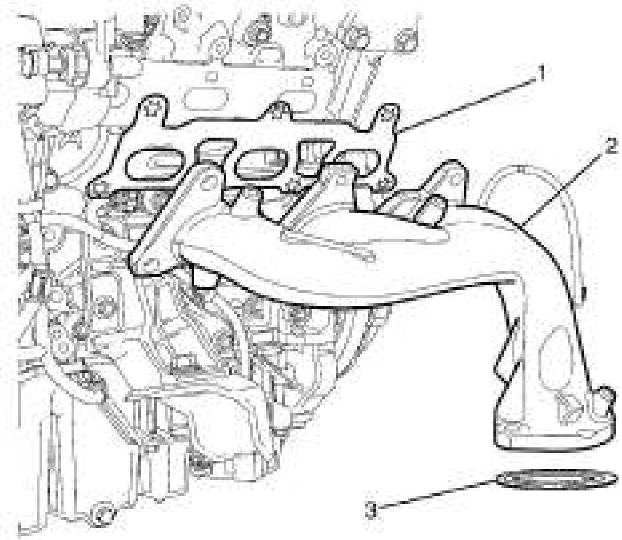
Inspection Procedure

1. Inspect the left exhaust manifold for the following:
   - Damage or corrosion above acceptable tolerances to the exhaust manifold exterior.
   - Damage to the exhaust manifold mounting holes.
   - Damage to the threaded holes for the heat shield.
   - Damage to the exhaust manifold flange bolt holes.
   - Damage to the gasket sealing surfaces.
   - Damage or restrictions within the exhaust passages.
2. Repair or replace the left exhaust manifold and/or components as necessary.



3. Measure the alignment or surface flatness of the exhaust manifold (3) flanges, using a straight edge (1) and a feeler gauge (2). Exhaust manifold surface flatness must not exceed 0.254 mm (0.010 in).
4. If the surface flatness is not within specifications, the exhaust manifold (3) is warped and must be replaced.

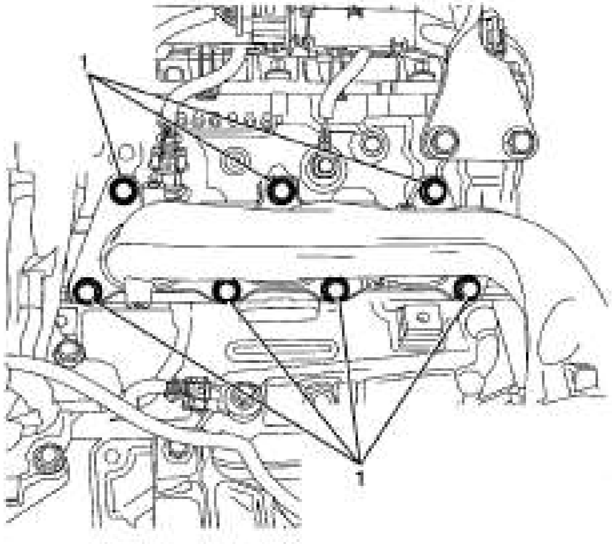
Exhaust Manifold Installation - Left Side (NT3)



1. Install a NEW exhaust manifold gasket (1) and NEW sealing ring (3) to the exhaust manifold (2).

   Notice: Refer to Exhaust System Inspection Notice in the Preface section.

2. Install the exhaust manifold assembly to the engine.



Important: DO NOT fully tighten the exhaust manifold to cylinder head retaining bolts (1) at this stage.

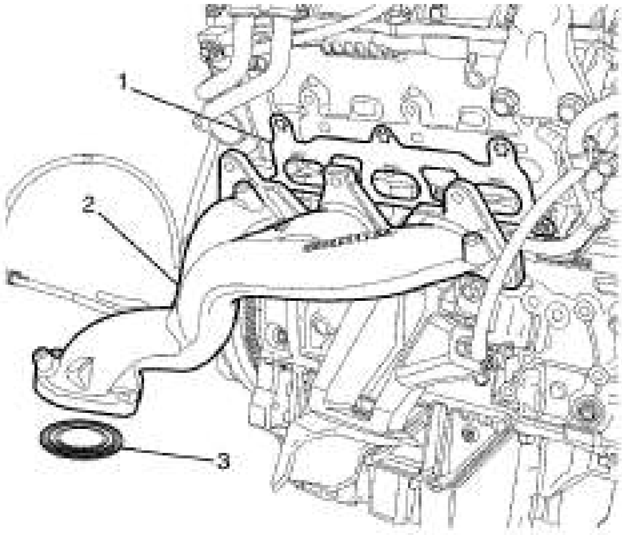
3. Install the NEW exhaust manifold to cylinder head retaining bolts (1).

   Notice: Refer to Fastener Notice in the Preface section.

4. Tighten the exhaust manifold to cylinder head retaining bolts (1) working from the centre to the outside.

   Tighten
   Tighten the bolts to 20 N·m (15 lb ft).

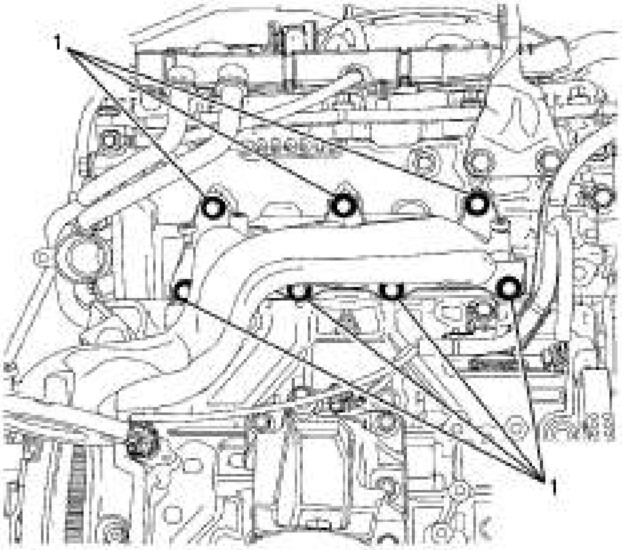
Exhaust Manifold Installation - Right Side (NT3)



1. Install a NEW exhaust manifold gasket (1) and NEW sealing ring (3) to the exhaust manifold (2).

   Notice: Refer to Exhaust System Inspection Notice in the Preface section.

2. Install the exhaust manifold assembly to the engine.



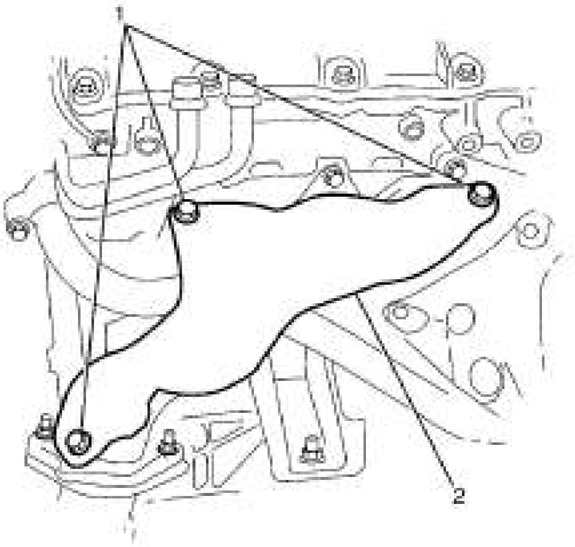
Important: DO NOT fully tighten the exhaust manifold to cylinder head retaining bolts (1) at this stage.

3. Install the NEW exhaust manifold to cylinder head retaining bolts (1).

Notice: Refer to Fastener Notice in the Preface section.

4. Tighten the exhaust manifold to cylinder head retaining bolts (1) working from the centre to the outside.

Tighten
Tighten the bolts to 20 N·m (15 lb ft).



5. Install the exhaust manifold heat shield (2).
6. Install the exhaust manifold heat shield to exhaust manifold retaining bolts (1).

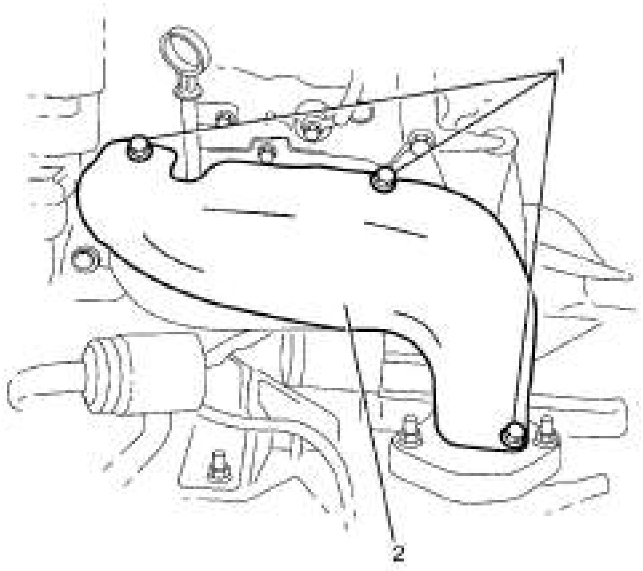
Tighten
Tighten the bolts to 10 N·m (89 lb in).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | **Document ID: 2195311**

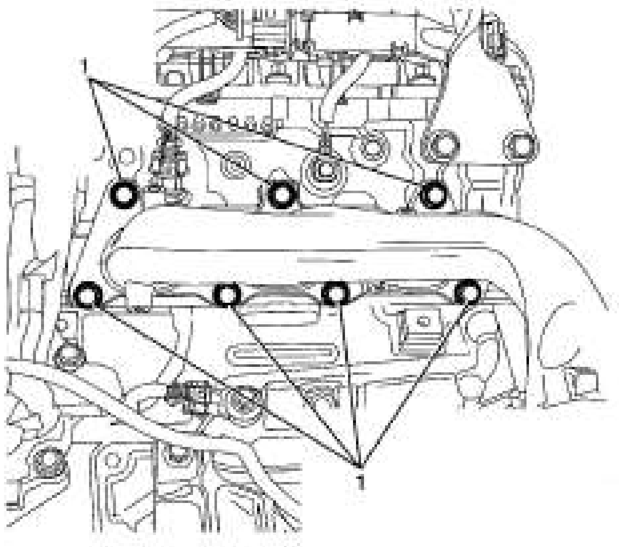
Exhaust Manifold Removal - Left Side (NT3)

Caution: Refer to Exhaust Service Caution in the Preface section.

Caution: Refer to Protective Goggles and Glove Caution in the Preface section.



1. Remove the exhaust manifold heat shield to exhaust manifold retaining bolts (1).
2. Remove the exhaust manifold heat shield (2).



3. Loosen the exhaust manifold to cylinder head retaining bolts (1) working from the outside to

the centre.

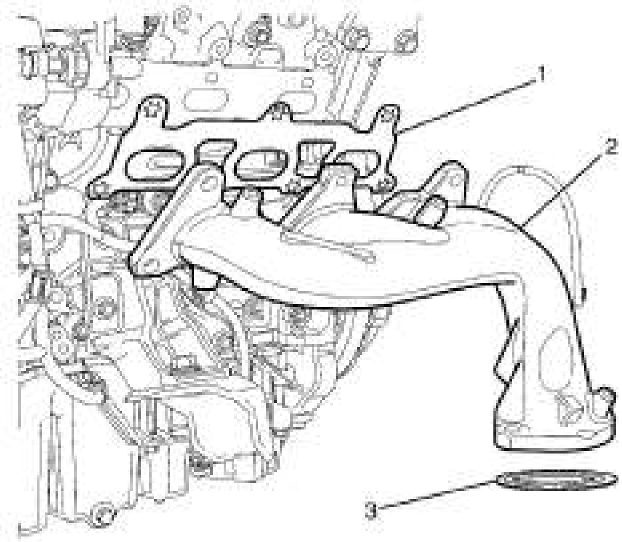
Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

Important: Make sure all the bolt holes are thoroughly cleaned and all micro-encapsulated thread sealant is removed.

4. Remove the exhaust manifold to cylinder head retaining bolts (1).

   Discard the bolts.

   Clean the bolt holes.



Important: The exhaust manifold gasket (1) and sealing ring (3) are single use parts. They must be discarded after removal.

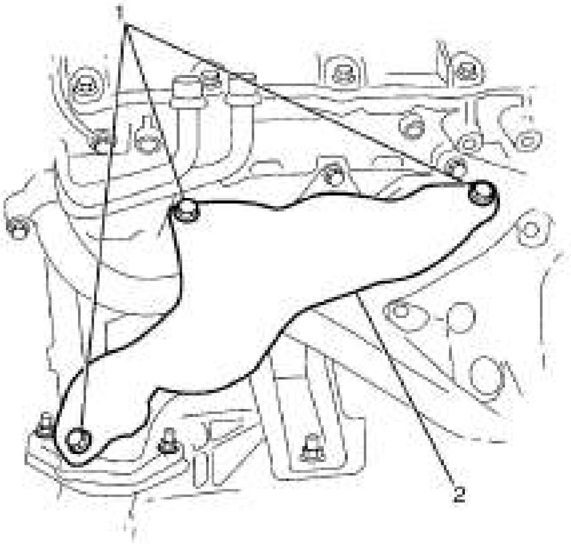
5. Remove the exhaust manifold (2).

   Discard the exhaust manifold gasket (1) and sealing ring (3).

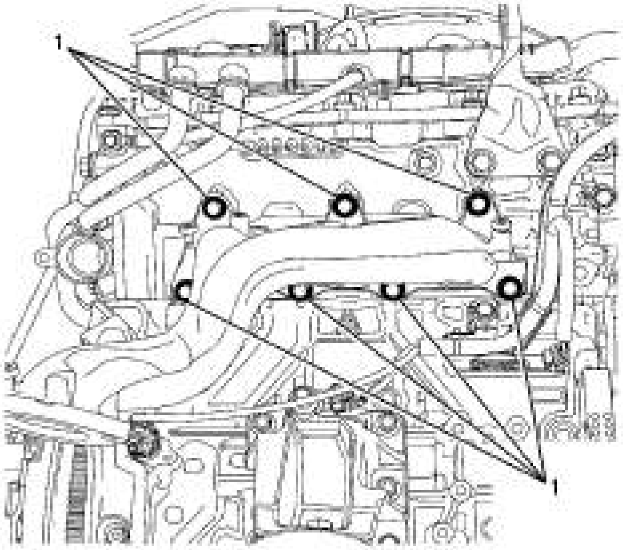
Exhaust Manifold Removal - Right Side (NT3)

Caution: Refer to Exhaust Service Caution in the Preface section.

Caution: Refer to Protective Goggles and Glove Caution in the Preface section.



1. Remove the exhaust manifold heat shield to exhaust manifold retaining bolts (1).
2. Remove the exhaust manifold heat shield (2).



3. Loosen the exhaust manifold to cylinder head retaining bolts (1) working from the outside to

the centre.

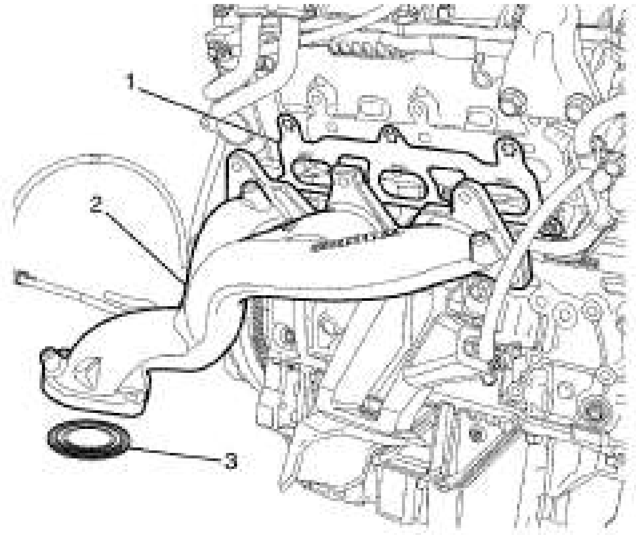
Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

Important: Make sure all the bolt holes are thoroughly cleaned and all micro-encapsulated thread sealant is removed.

4. Remove the exhaust manifold to cylinder head retaining bolts (1).

   Discard the bolts.

   Clean the bolt holes.



Important: The exhaust manifold gasket (1) and sealing ring (3) are single use parts. They must be discarded after removal.

5. Remove the exhaust manifold (2).

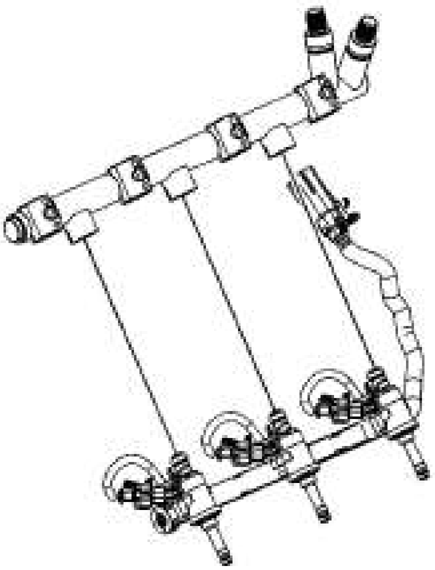
   Discard the exhaust manifold gasket (1) and sealing ring (3).

Fuel Rail and Injectors Cleaning and Inspection (LLT)

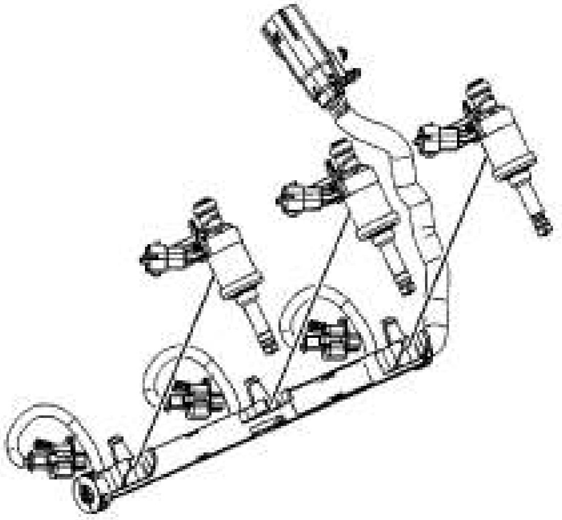
Special Tools

- *EN-47909* Injector Bore and Sleeve Cleaning Kit
- *EN-48266* Injector Seal Installer and Sizer

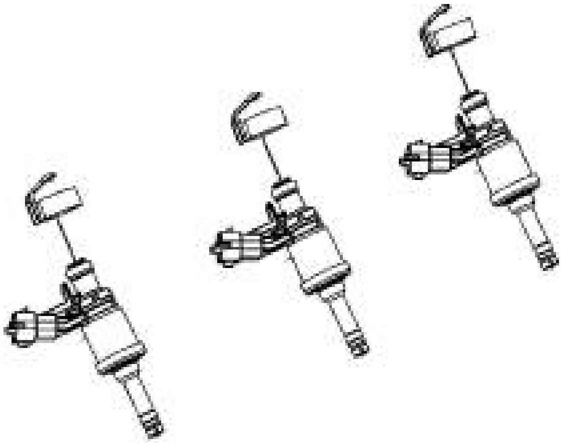
For equivalent regional tools, refer to Special Tools.



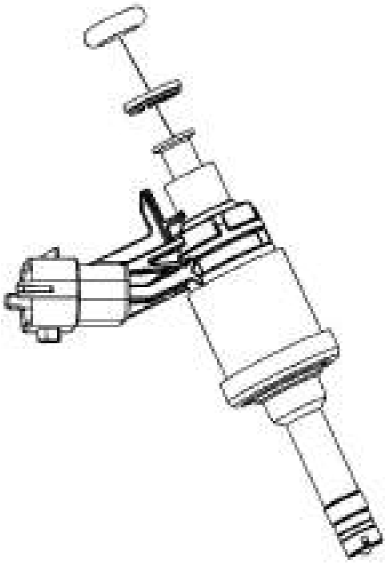
1. Remove the injectors from the fuel rail.



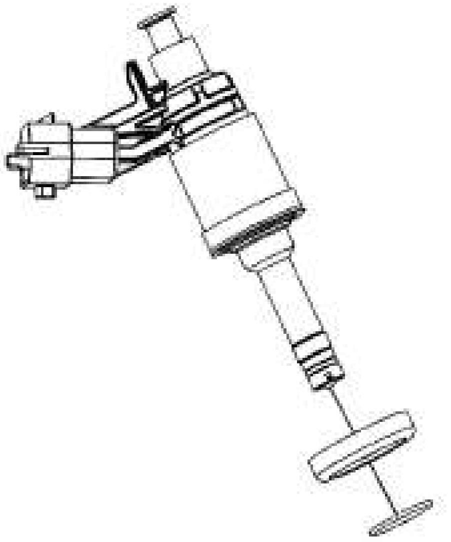
2. Remove the wiring harness from the fuel injectors.



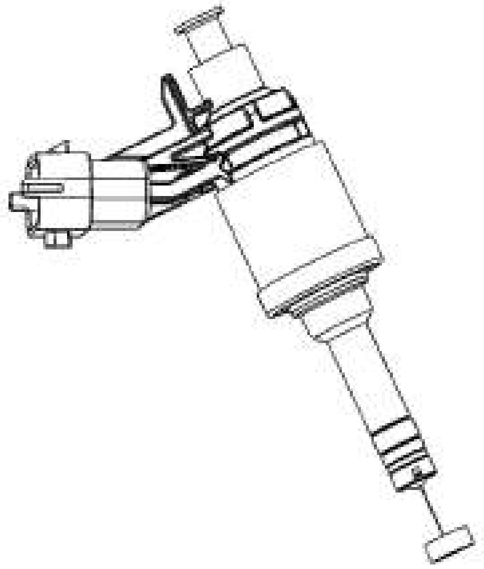
3. Remove and discard the fuel injector hold-down clamp.



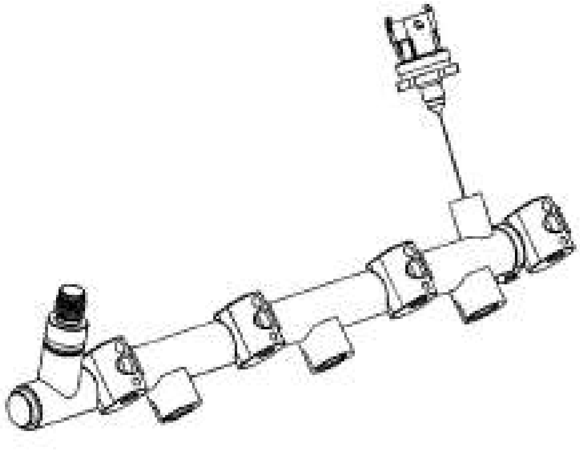
4. Remove and discard the fuel injector O-ring and plastic spacer.



5. Remove and discard the isolator cup and retainer.



6. Remove and discard the fuel injector seal.

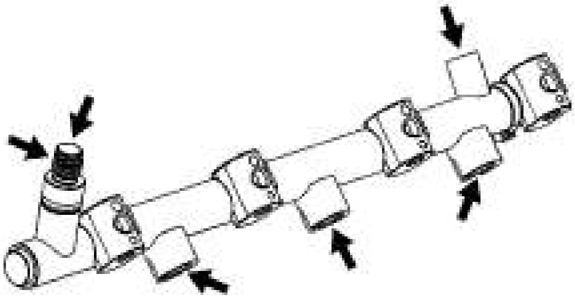


Note: Applying force to the plastic housing of the sensor will destroy the sensor. To tighten or loosen, only apply force to the attached hexagon.

7. Remove and discard the fuel pressure sensor.

   Note: Do not soak or submerge the fuel rail or injectors in solvent.

8. Clean the exterior of the fuel rail and injectors with solvent.



9. Inspect the fuel rail and components for the following conditions:
   - Damage, debris or restrictions to the fuel rail
   - Damage, debris or restrictions to the fuel ports in the fuel rail

- Damage to the mounting area for the fuel rail
- Damage to the fuel rail mounting bolts
- Damage to the threads on the fuel rail feed fitting
- Damage to the threads in the fuel pressure sensor bore

Note: Applying force to the plastic housing of the sensor will destroy the sensor. To tighten or loosen, only apply force to the attached hexagon.

10. Install the fuel pressure sensor.

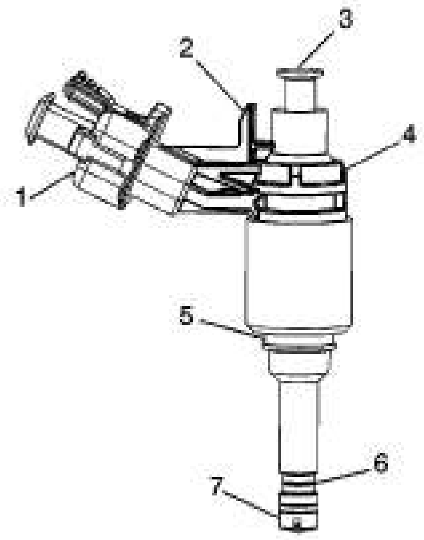
Note: Ensure that the fuel rail threads have been cleaned of any excess fuel, or the NEW fuel injection fuel rail fuel pressure sensor will NOT seal properly.

- Lubricate the threads and the sealing cone in the fuel rail with silicon free engine oil GM P/N 12345610, Canadian P/N 993193, or equivalent.
- Lubricate the threads and the sealing cone on the NEW fuel injection fuel rail fuel pressure sensor with silicon free engine oil GM P/N 12345610, Canadian P/N 993193, or equivalent.
- Install the NEW fuel injection fuel rail fuel pressure sensor hand tight.
- Remove the NEW fuel injection fuel rail fuel pressure sensor, re-lubricate following steps 1 and 2 above.

Caution: Refer to Fastener Caution in the Preface section.

- Install the NEW fuel injection fuel rail fuel pressure sensor.

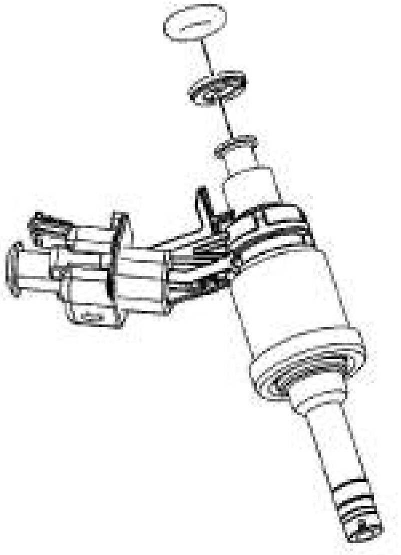
Tighten
Tighten the sensor to 33 N·m (25 lb ft).



11. Inspect the fuel injectors for the following conditions:

- Damage to the fuel injector connector (1)
- Damage to the injector locator tab (2)
- Damage to the fuel inlet cone (3)
- Damage the plastic fuel injector body (4)
- Damage to the isolator cup retainer groove (5)
- Damage to the teflon seal (6)
- Damage to the fuel injector tip (7)

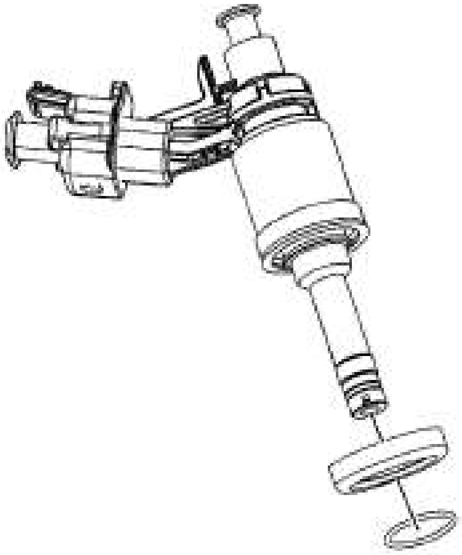
12. Replace the fuel rail or injector if any damage is found. Do not attempt to repair a fuel rail or injector.



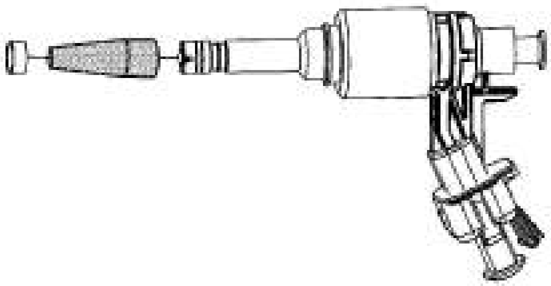
13. Lubricate the NEW O-ring with 5W30 engine oil.

Note: The plastic spacer has a top and a bottom. The top, O-ring sealing area, is wider.

14. Install the NEW plastic spacer and O-ring on the injector.

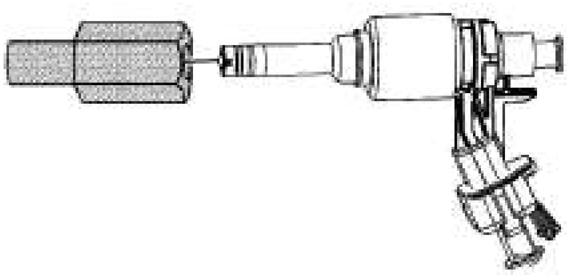


15. Install the isolator cup and retainer.

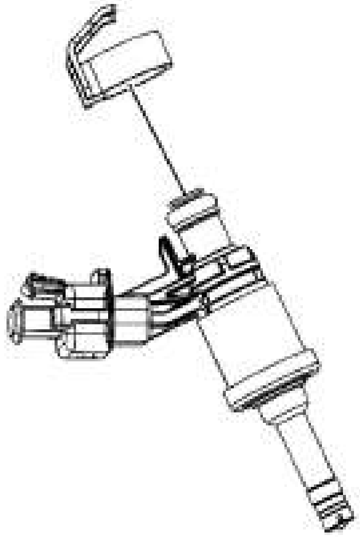


Note: Do not use any type of lubricant when installing the NEW seal.

16. Install a NEW seal on the injector using the EN-48266-1. The seal must be installed/slid into the recessed area of the fuel injector.

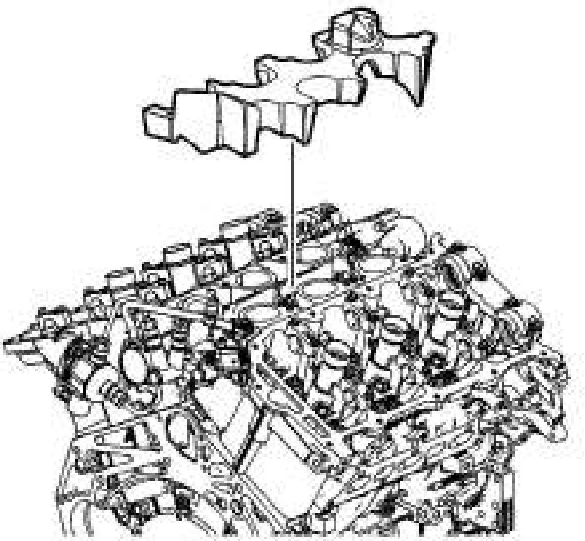


17. Compress the seal with your fingers before resizing the seal using the EN-48266-2.

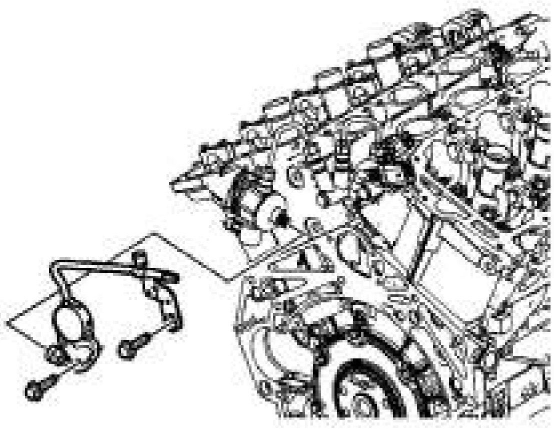


18. Install a NEW fuel injector hold-down clamp.

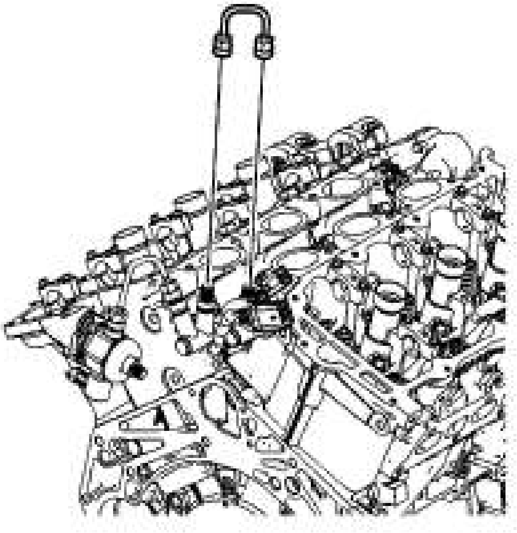
Fuel Feed Pipe Removal (LLT)



1. Remove the fuel rail noise shield.



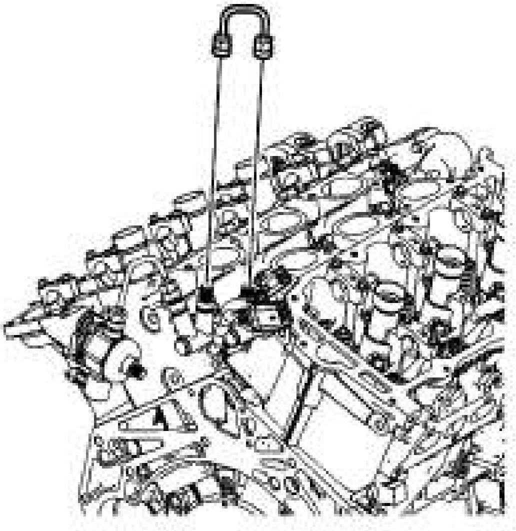
2. Remove the fuel rail wiring connectors from the fuel feed pipe bracket.
3. Remove the fuel feed pipe bolts.
4. Remove the fuel feed pipe.



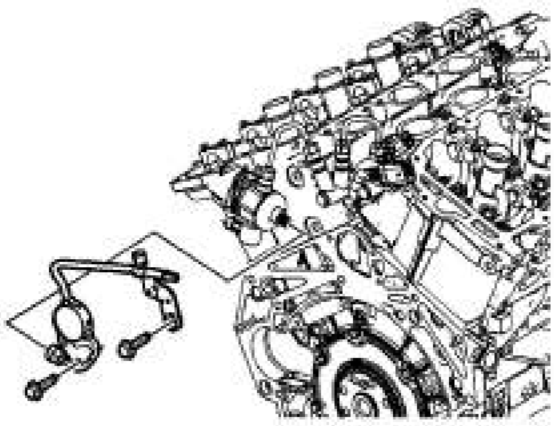
5. Remove the LH to RH fuel rail crossover pipe.

Fuel Feed Pipe Installation (LLT)

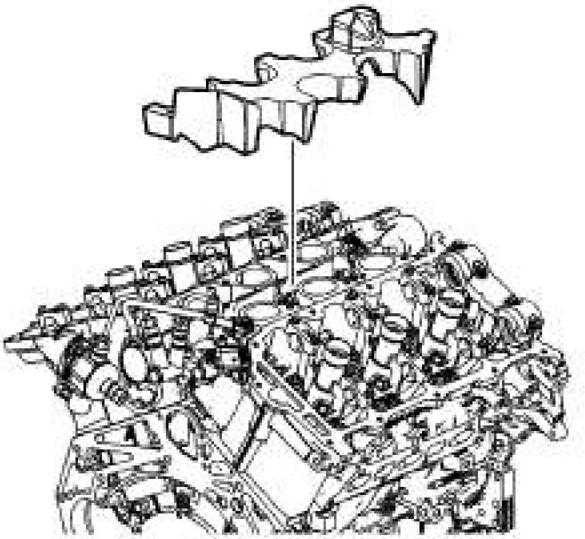
Caution: Refer to Fastener Caution in the Preface section.



1. Install the LH to RH fuel rail crossover pipe and tighten the fuel rail crossover pipe fittings to **30 N·m (22 lb ft)**.

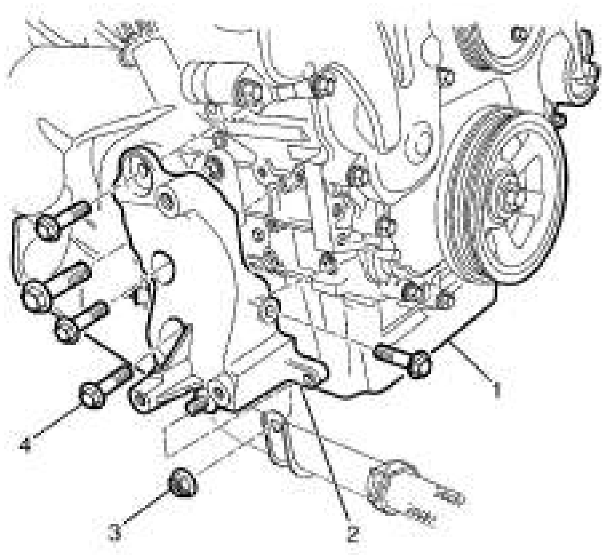


2. Install the fuel feed pipe.
3. Install the fuel feed pipe bolts and tighten to **10 N·m (89 lb in)**.
4. Install the fuel rail wiring connectors to the fuel feed pipe bracket.



5. Install the fuel rail noise shield.

Generator Installation



1. Install the alternator bracket (2) to the engine block.

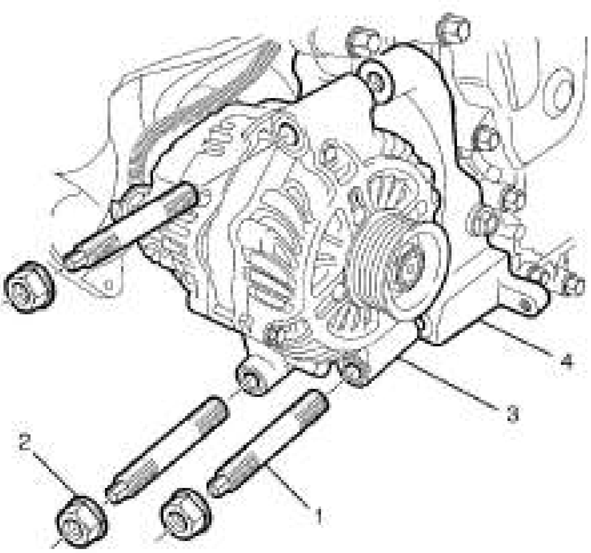
   Notice: Refer to Fastener Notice in the Preface section.

2. Install the alternator bracket to engine block retaining bolts.

   Tighten
   Tighten the bolts to 50 N·m (37 lb ft).

3. Install the coolant inlet pipe to alternator mounting bracket retaining nut (3).

   Tighten
   Tighten the bolts to 22 N·m (16 lb ft).



4. Position the alternator (3) on the alternator mounting bracket (4).

   Important: The alternator mounting studs (4) have hexagonal outer ends to assist with removal and installation.

5. Install the alternator to alternator bracket retaining studs (1) if required.

   Tighten
   Tighten the studs to 18 N·m (13 lb ft).

6. Install the alternator to alternator bracket stud retaining nuts (2).

   Tighten
   Tighten the nuts to 18 N·m (13 lb ft).

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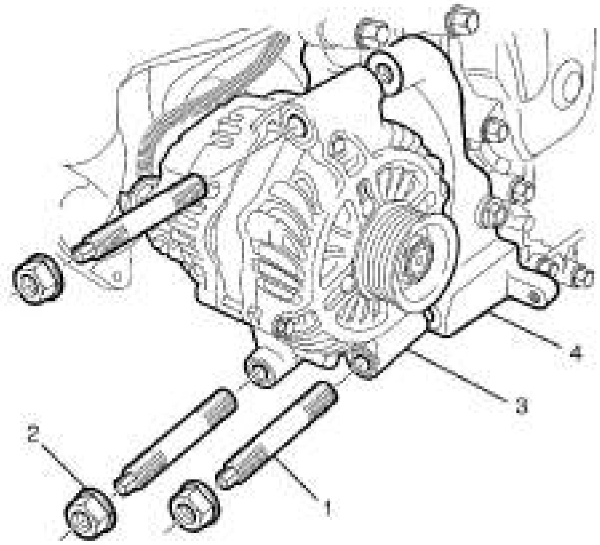
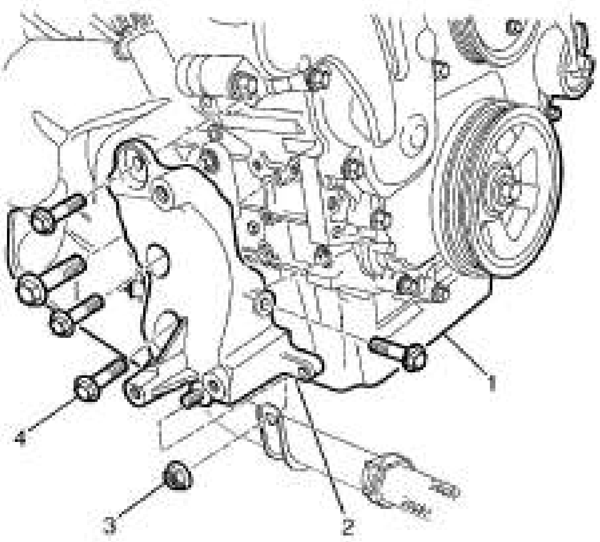
Generator Removal



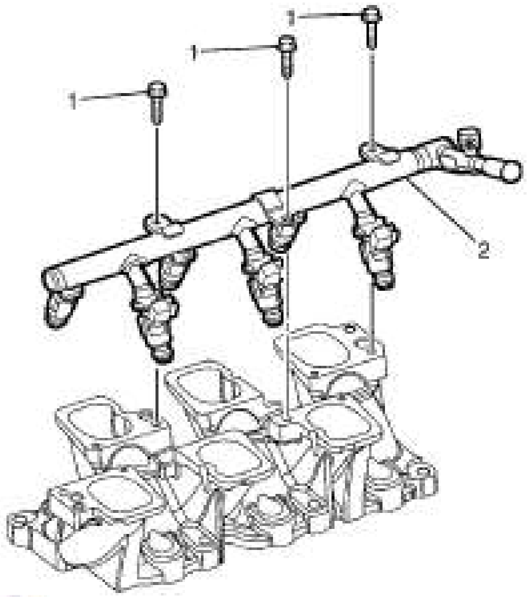
1. Remove the alternator to alternator bracket retaining nuts (2).
2. Remove the alternator to alternator bracket retaining studs (1).
3. Remove the alternator (3) from the alternator bracket (4).



4. Remove the coolant inlet pipe to alternator mounting bracket retaining nut (3)
5. Remove the alternator mounting bracket to cylinder block retaining bolts (4).
6. Remove the alternator mounting bracket (2) from the cylinder block (1).

Intake Manifold Assemble

Lower Intake Manifold Assemble Procedure

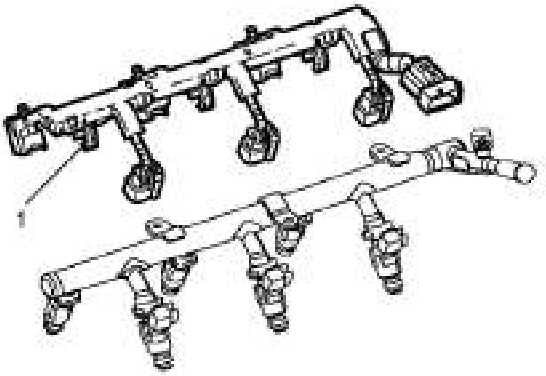


1. Install the fuel injector rail (2).

   Notice: Refer to Fastener Notice in the Preface section.

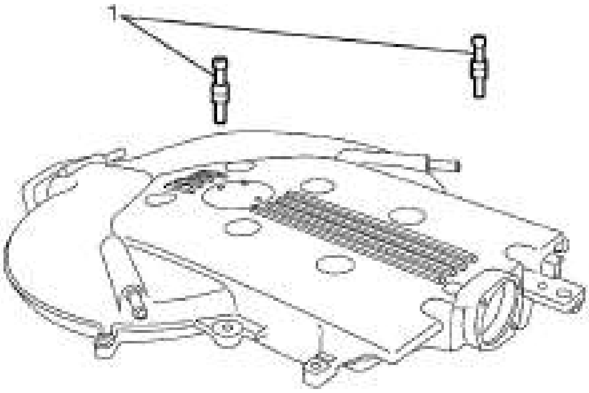
2. Install the fuel injector rail to lower intake manifold retaining bolts (1).

   Tighten
   Tighten the fuel injector rail bolts to 10 N·m (89 lb in).



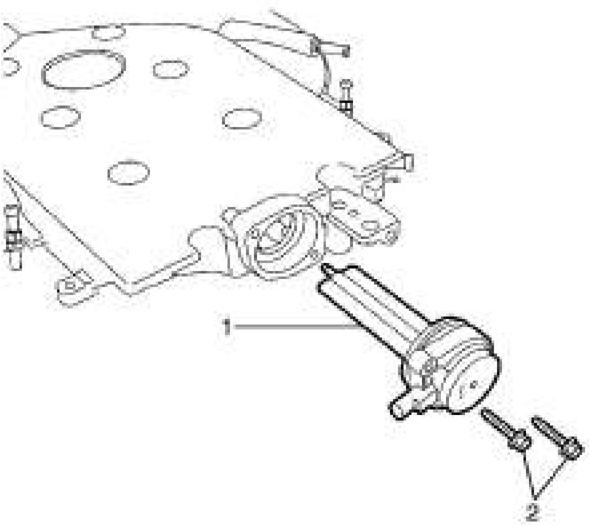
3. Install the fuel injector wiring harness (1).

Upper Intake Manifold Assemble Procedure



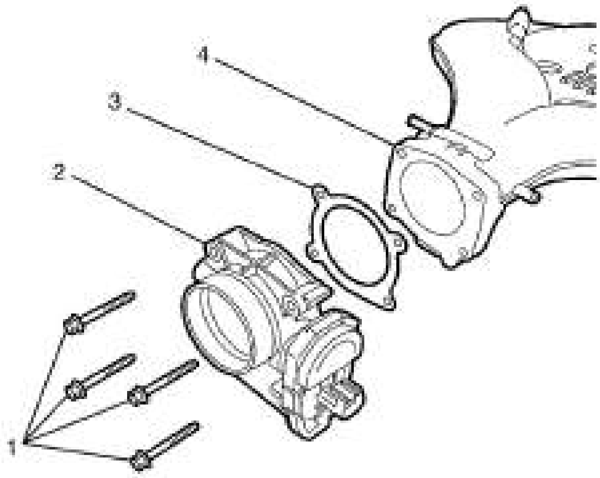
1. Install the engine cover ball studs (1).

   Tighten
   Tighten the engine cover ball studs to 7 N·m (62 lb in).



2. Install the Intake Manifold Runner Control (IMRC) flap (1).
3. Install the IMRC flap to upper intake manifold retaining bolts (2).

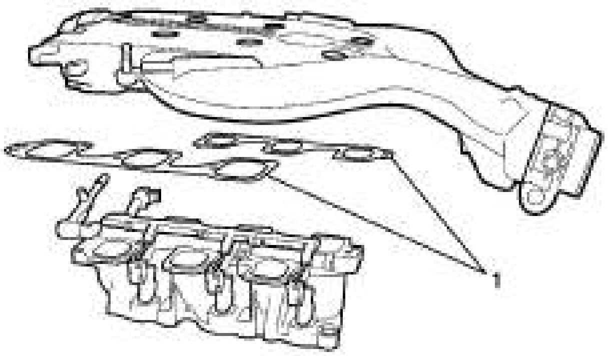
Tighten
Tighten the bolts to 10 N·m (89 lb in).



4. Install the NEW throttle body gasket (3) to the intake manifold (4).
5. Install the throttle body (2).
6. Install the throttle body bolts to upper intake manifold retaining bolts (1).

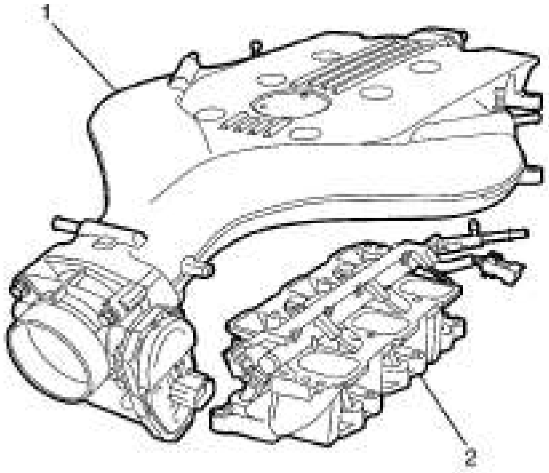
Tighten
Tighten the bolts to 10 N·m (89 lb in).

Upper to Lower Intake Manifold Assemble Procedure

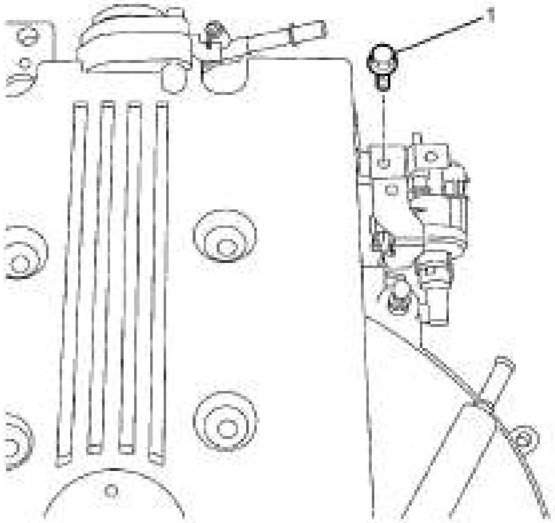


Important: DO NOT reuse the upper-to-lower intake manifold gasket and the intake manifold-to-cylinder head sealing gaskets.

1. Install the NEW upper-to-lower intake manifold gaskets (1).

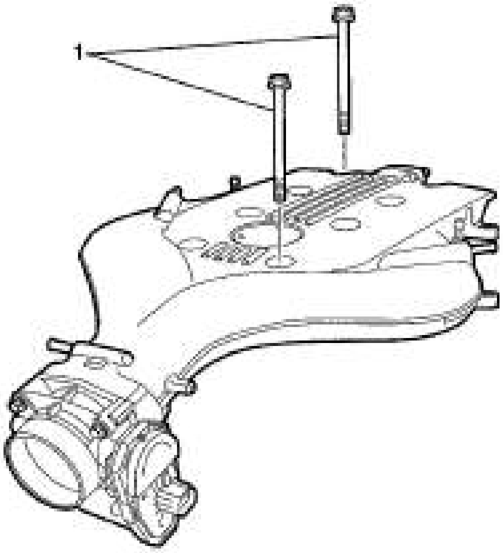


2. Install the upper intake manifold (1) to the lower intake manifold (2).



3. Install the fuel injector wiring harness bracket to upper intake manifold retaining bolt (1).

   Tighten
   Tighten the bolt to 10 N·m (89 lb in).



4. Install the upper-to-lower intake manifold retaining bolts (1).

   Tighten
   Tighten bolts to 23 N·m (17 lb ft).

Intake Manifold Cleaning and Inspection

Upper Intake Manifold Cleaning Procedure

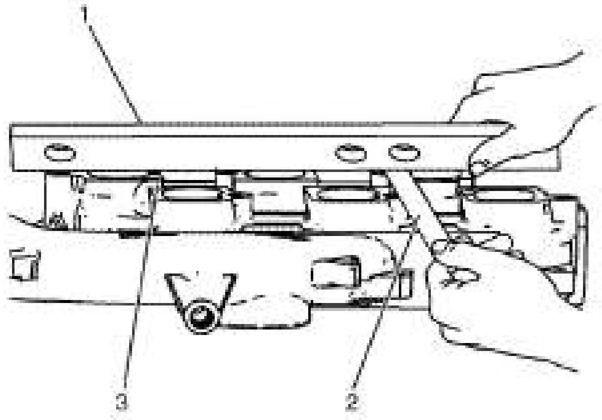
1. Remove any remaining gasket and/or gasket material from the following:
    - Throttle body.
    - Intake manifold.
2. Clean the following intake manifold areas in solvent.
    - Intake manifold gasket sealing areas.
    - Intake manifold passages.
    - Brake booster hose passage.
    - Evaporative emission (EVAP) solenoid passage.
    - Positive Crankcase Ventilation (PCV) vacuum hose passages.

Caution: Refer to Safety Glasses Caution in the Preface section.

3. Dry the upper intake manifold and throttle body with compressed air.

Inspection Procedure

1. Inspect the upper intake manifold for the following conditions:
    - Damage, debris or restrictions to the brake vacuum booster hose port.
    - Damage to the throttle body bolt holes.
    - Damage, debris or restrictions to the PCV system hose ports.
    - Damage to the intake manifold bolt bosses.
    - Damage to the EVAP purge solenoid mounting boss.
    - Damage, debris or restrictions to the EVAP purge solenoid port.
    - Damage, debris or restrictions in the vacuum passage.
    - Damage to the intake manifold runner control flap mounting bosses.
    - Damage, debris or restrictions to the intake manifold runner control flap port.
    - Damage to the intake manifold runner control flap components.
    - Gouges or damage to the upper intake manifold sealing surfaces.
    - Damage to the gasket sealing surface for the throttle body.



2. Inspect the upper intake manifold sealing surface for warpage.
    - 2.1. Locate a straight edge (1) across the upper-to-lower intake manifold sealing surface (3).
    - 2.2. Insert a feeler gauge (2) between the upper-to-lower intake manifold sealing surface (3) and the straight edge (1). An upper intake manifold with warpage in excess of 0.05 mm (0.020 in) must be replaced.
3. Repair or replace the upper intake manifold as necessary.

Lower Intake Manifold Cleaning Procedure

1. Remove any remaining gasket and/or gasket material from the following:
    - Upper-to-lower intake manifold sealing surface.
    - Cylinder head-to-lower intake manifold sealing surface.
2. Clean the following intake manifold areas in solvent.
    - Intake manifold gasket sealing surfaces.
    - Intake manifold passages.

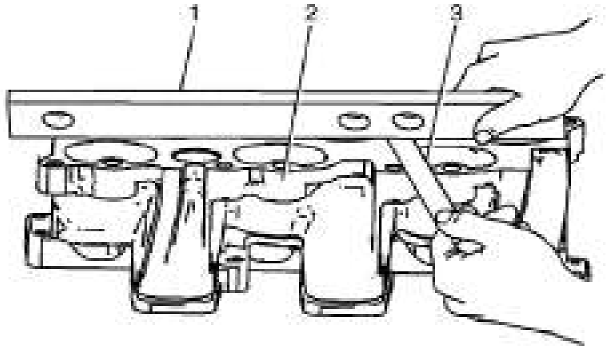
Caution: Refer to Safety Glasses Caution in the Preface section.

3. Dry the intake manifold with compressed air.

Inspection Procedure

1. Inspect the lower intake manifold for the following conditions:
    - Damage, debris or restrictions to the lower intake manifold ports
    - Damage to the fuel rail mounting bolt holes
    - Damage to the fuel rail
    - Gouges or damage to the intake manifold sealing surfaces
    - Damage to the lower intake manifold bolt bosses

- Damage to the fuel injector ports



2. Inspect the lower intake manifold sealing surfaces for warpage.
    2.1. Locate a straight edge (1) across the lower intake manifold sealing surfaces (2).
    2.2. Insert a feeler gauge (3) between the lower intake manifold sealing surfaces (2) and the straight edge (1). A lower intake manifold with warpage in excess of 0.5 mm (0.020 in) must be replaced.
3. Repair or replace the lower intake manifold as necessary.

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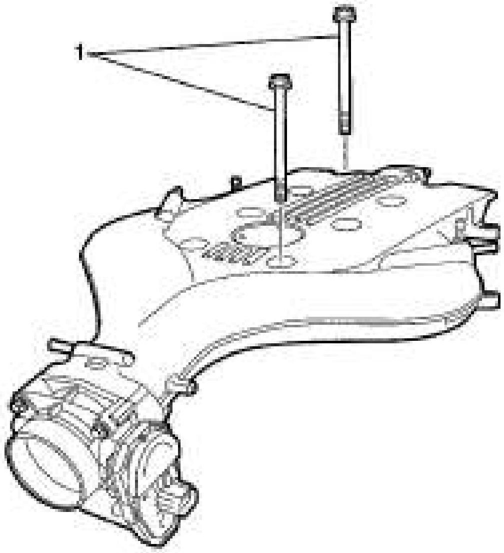
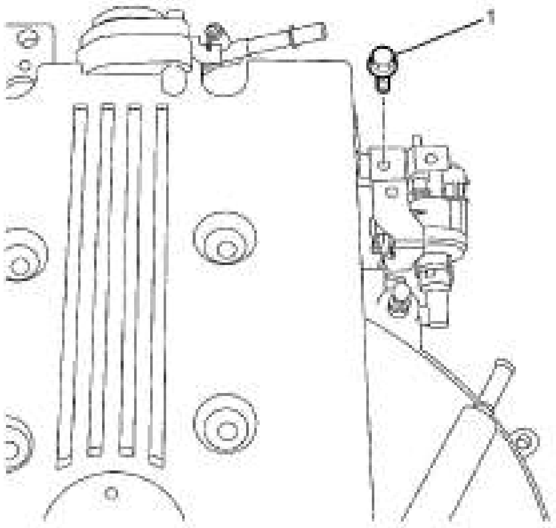
Intake Manifold Disassemble

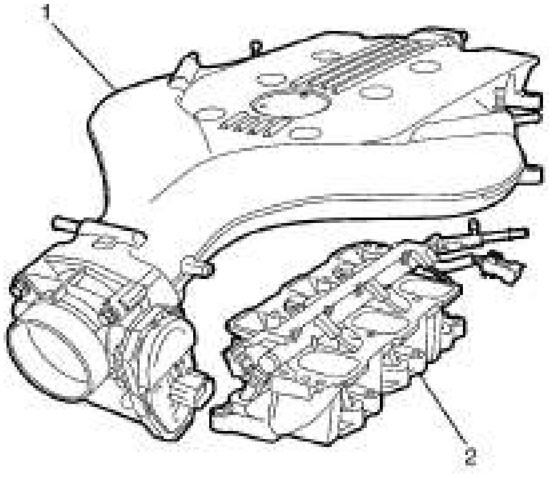
Upper to Lower Intake Manifold Disassemble Procedure



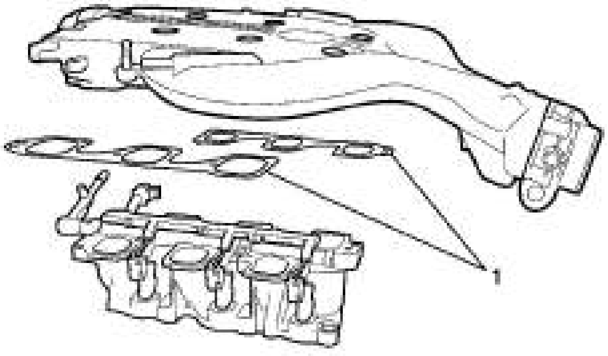
1. Remove the upper-to-lower intake manifold retaining bolts (1).



2. Remove the fuel injector wiring harness bracket to upper intake manifold retaining bolt (1).



3. Remove the upper intake manifold (1) from the lower intake manifold (2).

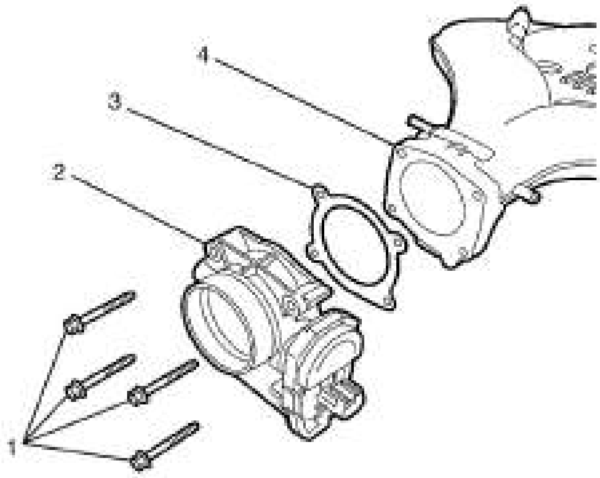


Important: DO NOT reuse the upper-to-lower intake manifold gasket and the intake manifold-to-cylinder head sealing gaskets.

4. Remove the upper-to-lower intake manifold gaskets (1).

   Discard the upper-to-lower intake manifold gaskets (1).

Upper Intake Manifold Disassemble Procedure

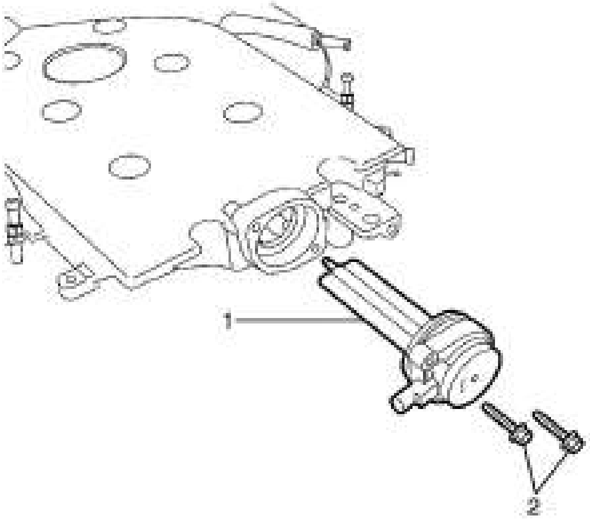


1. Remove the throttle body bolts to upper intake manifold retaining bolts (1).
2. Remove the throttle body (2).

   Important: The throttle body gasket (3) must be discarded whenever the throttle body (2) has been removed from the upper intake manifold (4).

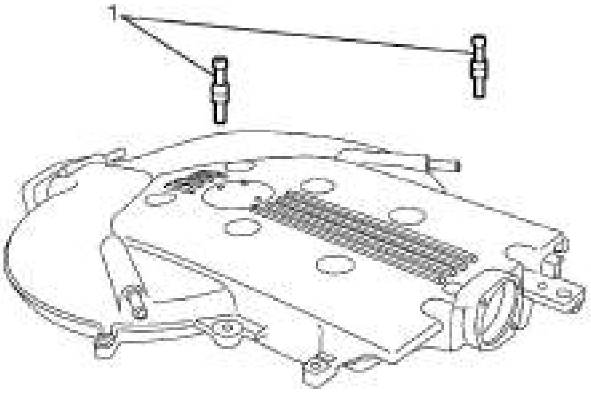
3. Remove the throttle body gasket (3).

   Discard the gasket



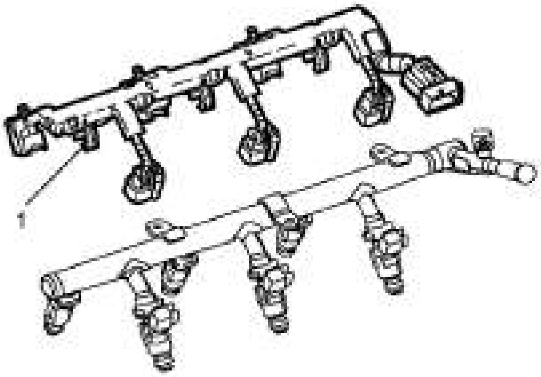
4. Remove the Intake Manifold Runner Control (IMRC) flap to upper intake manifold retaining bolts (2).

5. Remove the IMRC flap (1).

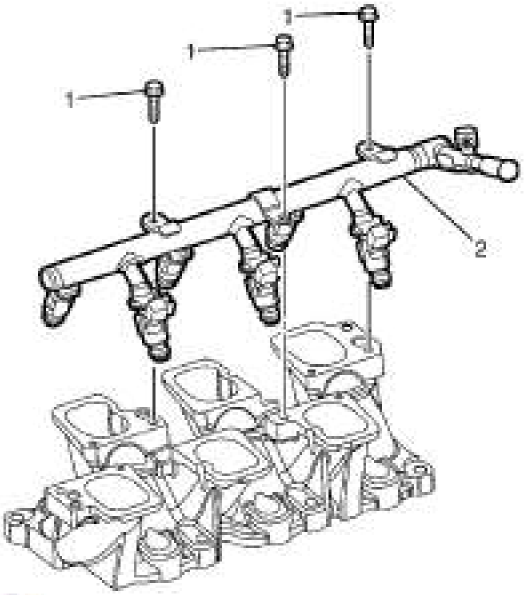


6. Remove the sight shield ball studs (1).

Lower Intake Manifold Disassemble Procedure



1. Remove the fuel injector wiring harness (1).



2. Remove the fuel injector rail to lower intake manifold retaining bolts (1).
3. Remove the fuel injector rail (2).

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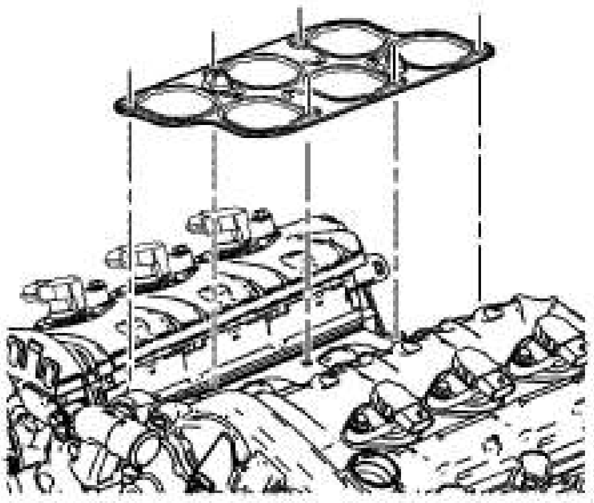
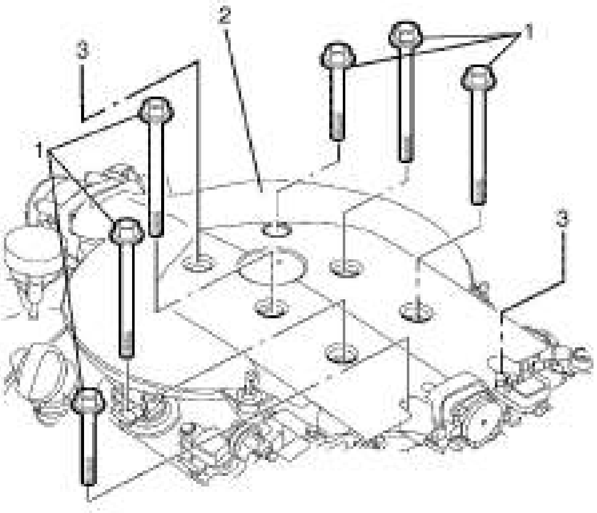
Intake Manifold Installation



1. Install the NEW intake manifold gasket.



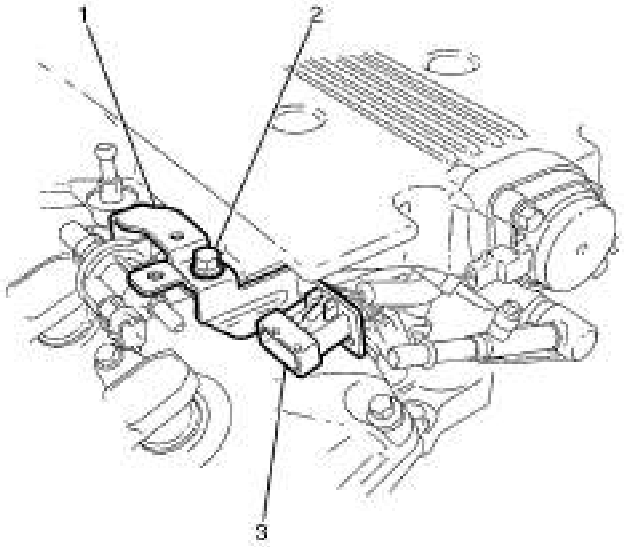
2. Install the intake manifold (2) and the throttle body (3) as an assembly as an assembly.

Notice: Refer to Fastener Notice in the Preface section.

Important: Tighten the intake manifold bolts (1) in a circular pattern starting at the center (long bolts) and moving outward.

3. Install the intake manifold bolts (1).

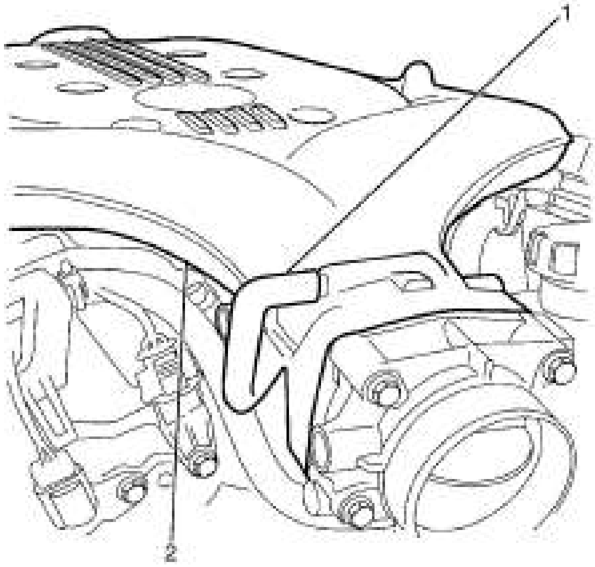
   Tighten
   Tighten the intake manifold bolts to 23 N·m (17 lb ft).



4. Install the fuel injector harness electrical connector/EVAP valve mounting bracket (1).
5. Install the fuel injector harness electrical connector/EVAP valve mounting bracket to intake manifold retaining bolt (2).

   Tighten
   Tighten the bolt to 10 N·m (89 lb in).

6. Attach the fuel injector harness electrical connector (3) to the fuel injector harness electrical connector/EVAP valve mounting bracket (1).



7. Connect the EVAP hose (1) to the upper intake manifold (2).
8. Install the PCV tube and PCV fresh air tubes. Refer to Positive Crankcase Ventilation Hose/Pipe/Tube Replacement .

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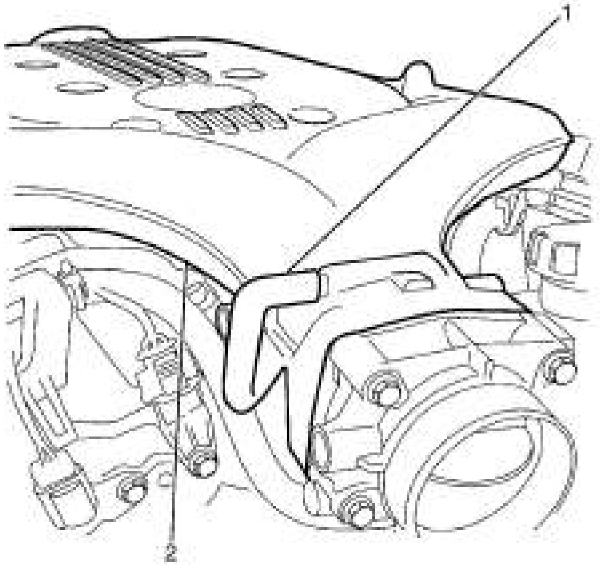
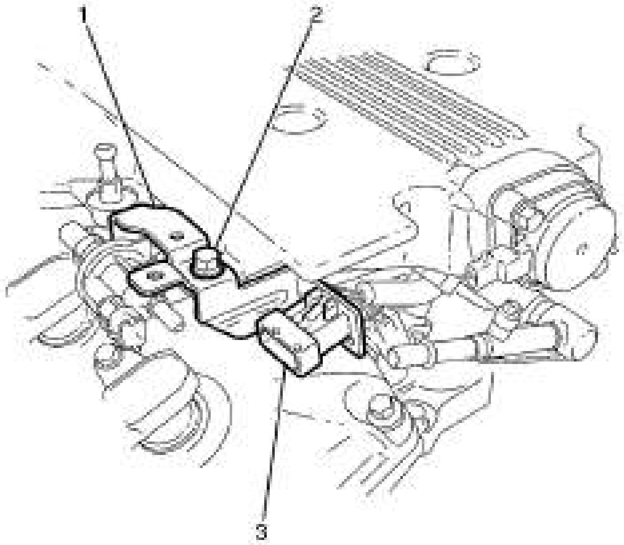
Intake Manifold Removal

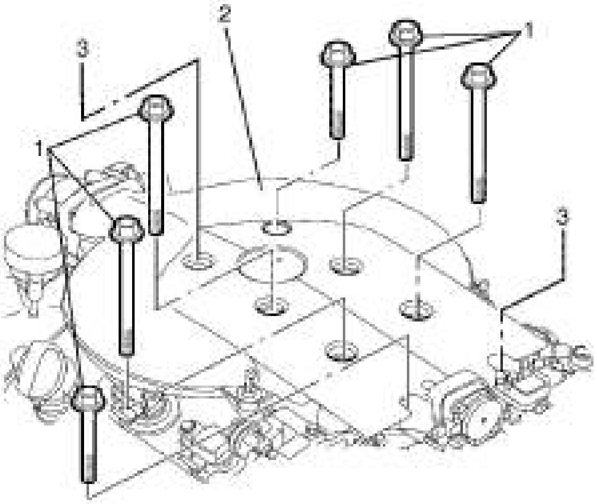
1. Remove the PCV tube and PCV fresh air tubes. Refer to Positive Crankcase Ventilation Hose/Pipe/Tube Replacement .



2. Disconnect the EVAP hose (1) from the intake manifold (2).



3. Remove the fuel injector harness electrical connector/EVAP valve mounting bracket to intake manifold retaining bolt (2).
4. Detach the fuel injector harness electrical connector (3) from the fuel injector harness electrical connector/EVAP valve mounting bracket (1).
5. Remove the fuel injector harness electrical connector/EVAP valve mounting bracket (1).



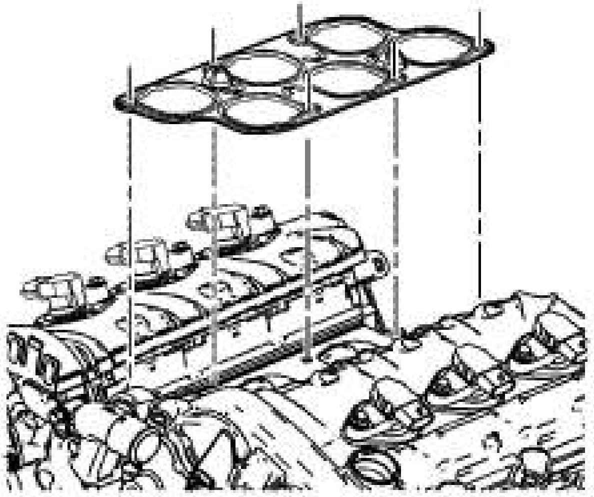
Important:

- DO NOT remove the upper intake manifold to lower intake manifold retaining bolts.
- DO NOT kink or damage the fuel pipe.

6. Remove the intake manifold bolts (1).
7. Remove the intake manifold (2) and the throttle body (3) as an assembly.

Important: The cylinder heads and engine valley must be plugged with a clean lint free cloth to prevent foreign matter entry into the engine.

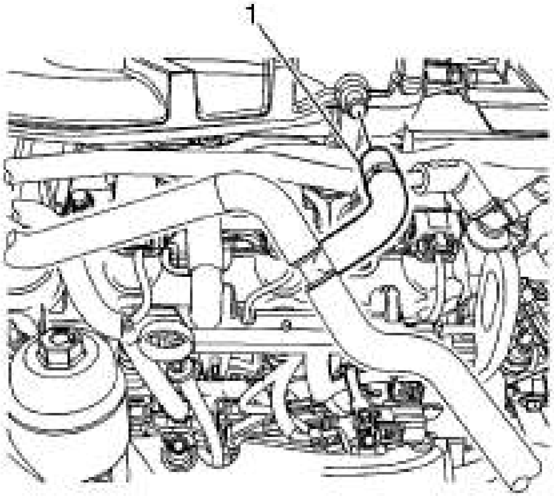
8. Plug the cylinder heads and engine valley with a clean lint free cloth.



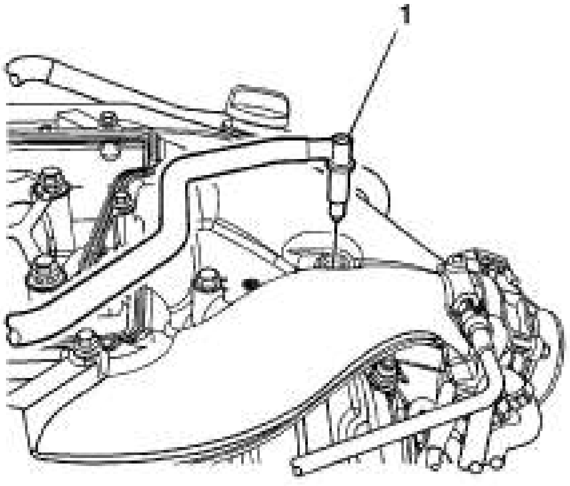
9. Remove the lower intake manifold gasket.

Intake Manifold Replacement (LLT)

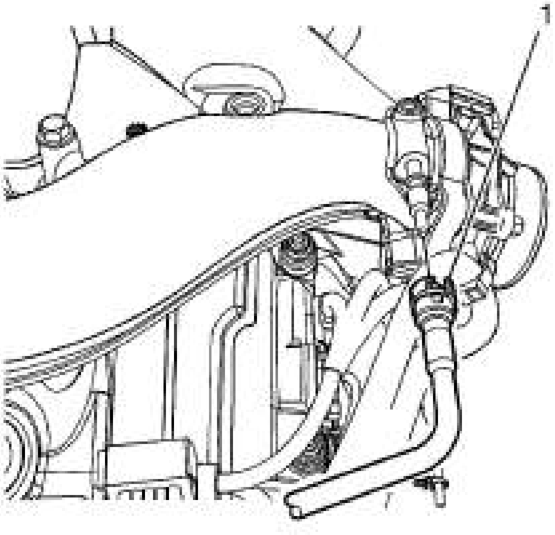
Removal Procedure



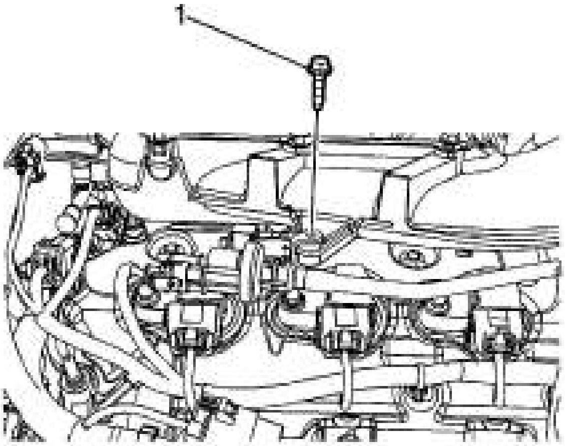
1. Remove the fuel pipe shield. Refer to Fuel Pipe Shield Replacement.
2. Remove the air outlet duct. Refer to Air Cleaner Outlet Duct Replacement.
3. Disconnect the brake booster vacuum hose (1) from the intake manifold.



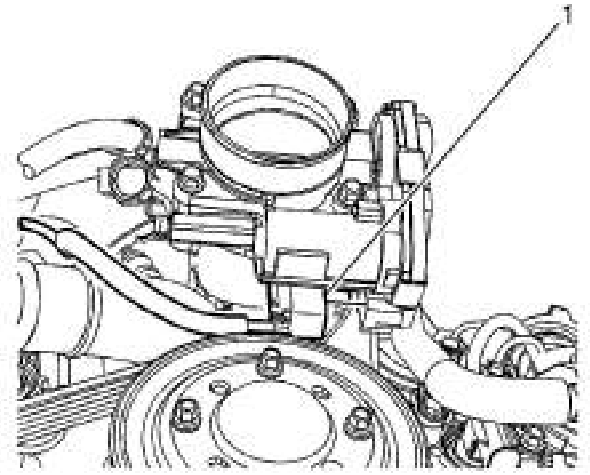
4. Disconnect the positive crankcase ventilation (PCV) hose (1) from the intake manifold.



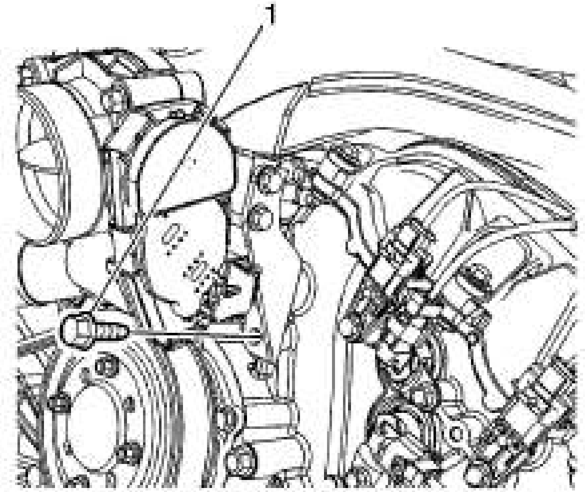
5. Disconnect the purge line (1) from the intake manifold.



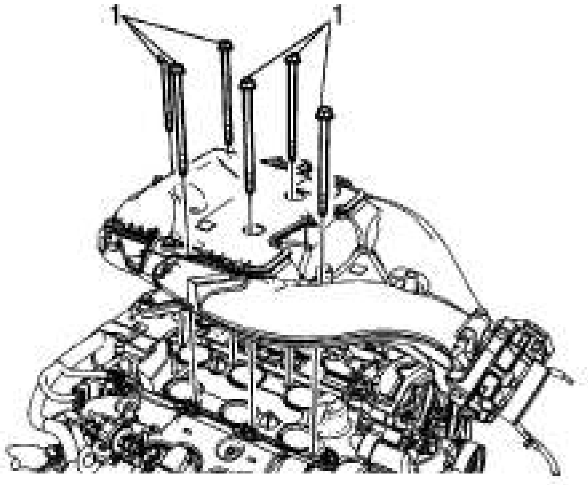
6. Remove the purge solenoid bolt (1) from the intake manifold and set the purge solenoid aside.



7. Disconnect the throttle body electrical connector (1).

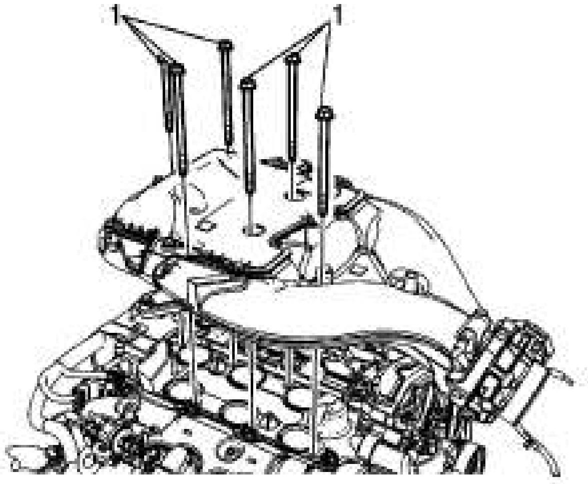


8. Remove the intake manifold bracket bolt (1).
9. Unclip the engine wiring harness from the intake manifold.



10. Remove the intake manifold bolts (1).
11. Remove the intake manifold and gasket.
12. If replacing the intake manifold, disassemble the intake manifold. Refer to Intake Manifold Disassemble.

Installation Procedure



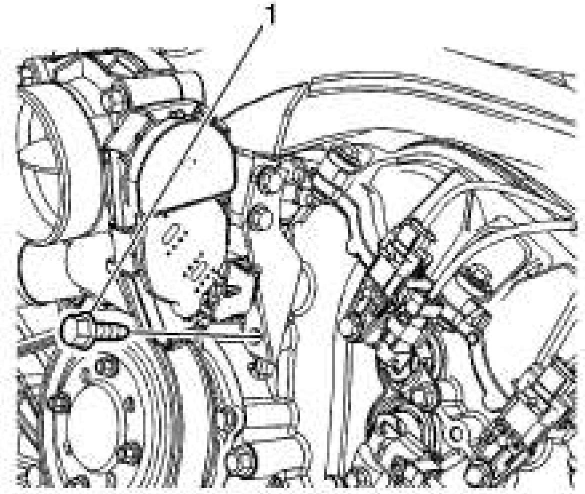
1. If installing a new intake manifold, assemble the intake manifold. Refer to Intake Manifold Assemble.

   Caution: Refer to Fastener Caution in the Preface section.

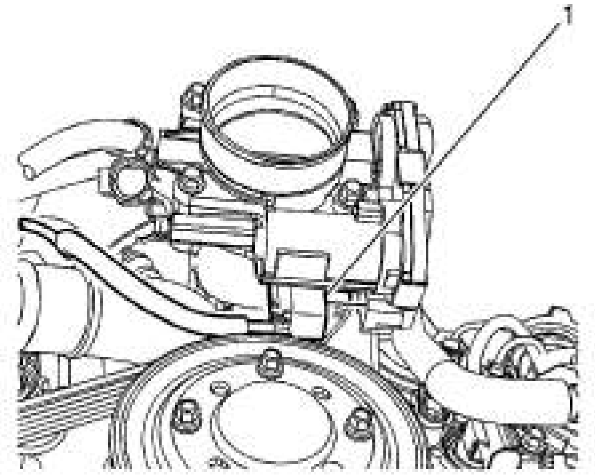
2. Install the NEW intake manifold gasket.

Note: Tighten the intake manifold bolts in a circular pattern starting at the center (long bolts) and moving outward.

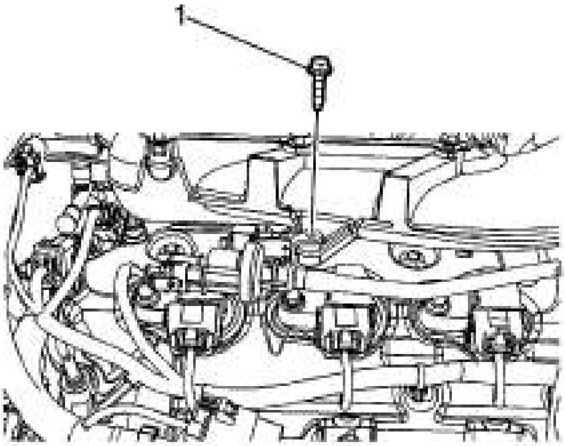
3. Install the intake manifold.
4. Install the intake manifold bolts (1) and tighten to **23 N·m (17 lb ft)**.



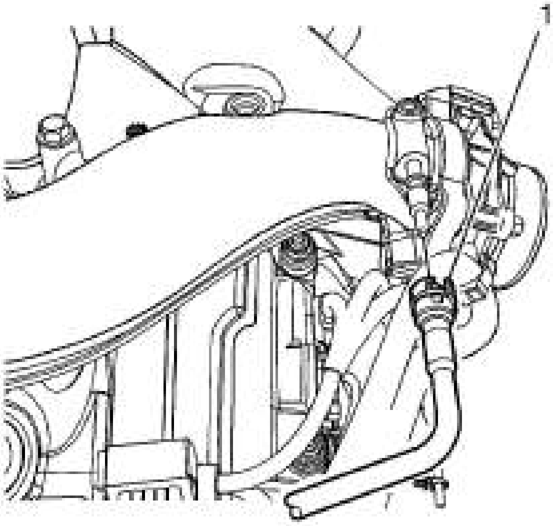
5. Clip the engine wiring harness from the intake manifold.
6. Install the intake manifold bracket bolt (1) and tighten to **23 N·m (17 lb ft)**.



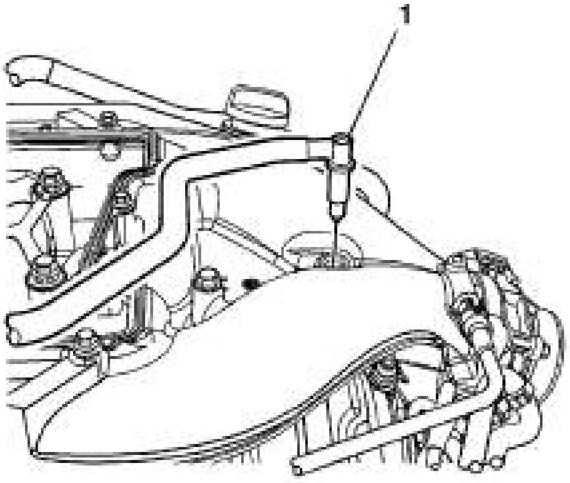
7. Connect the throttle body electrical connector (1).



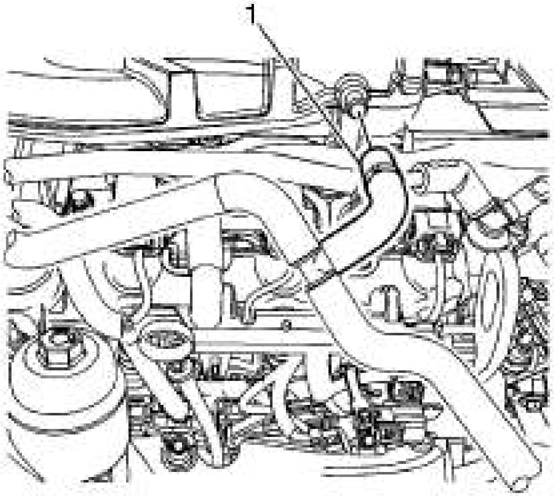
8. Install the purge solenoid bolt (1) to the intake manifold.



9. Connect the purge line (1) to the intake manifold.

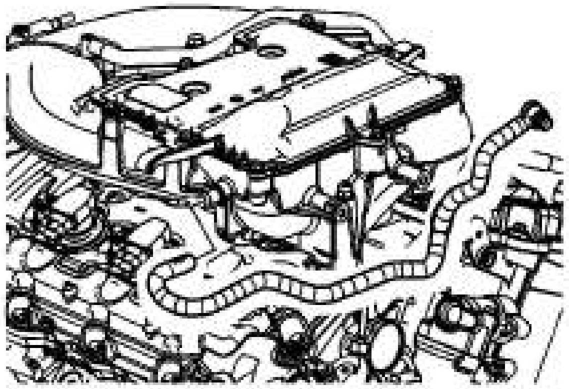


10. Connect the positive crankcase ventilation (PCV) hose (1) to the intake manifold.

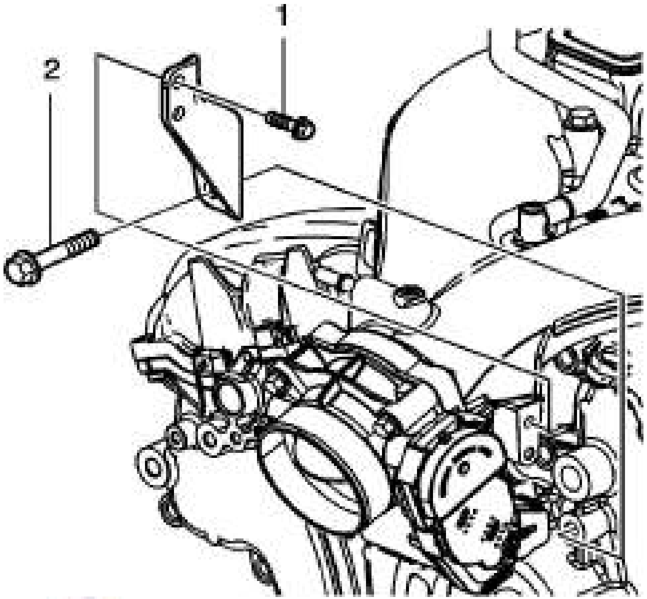


11. Connect the brake booster vacuum hose (1) from the intake manifold.
12. Install Remove the air outlet duct. Refer to Air Cleaner Outlet Duct Replacement.
13. Install the fuel pipe shield. Refer to Fuel Pipe Shield Replacement.

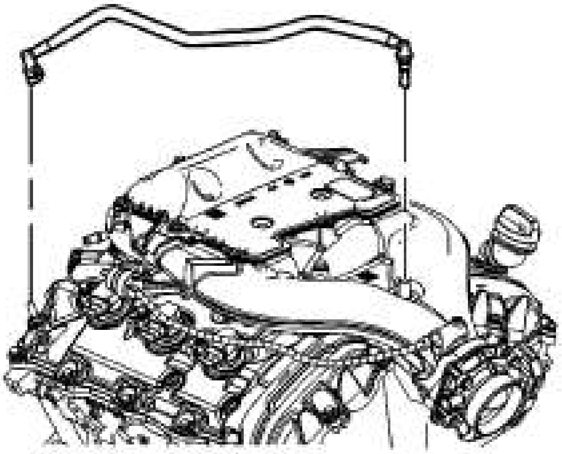
Intake Manifold Removal (LLT)



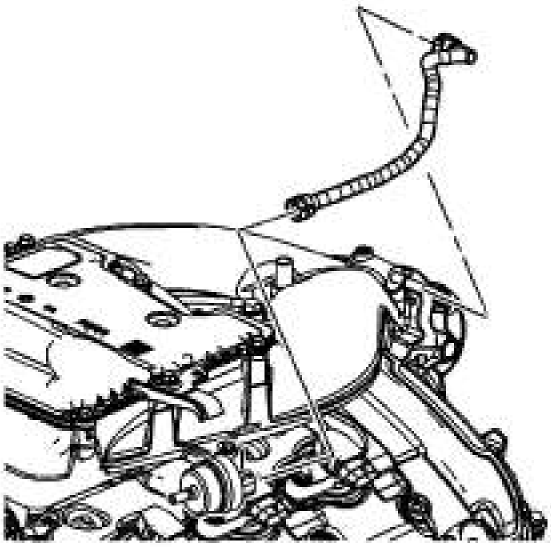
1. Disconnect and remove the brake booster hose from the intake manifold.



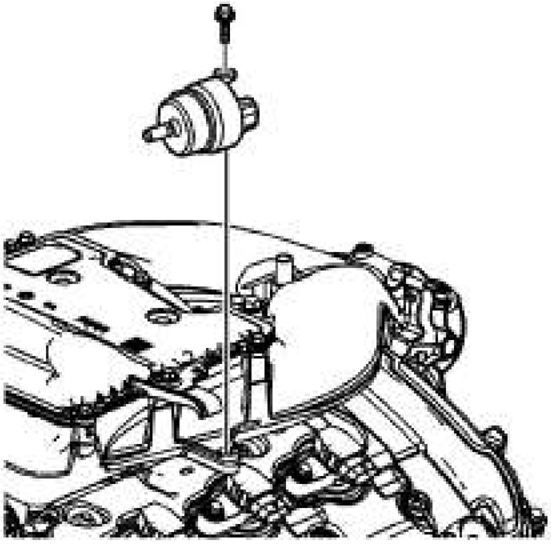
2. Remove the intake manifold brace bolts (1 and 2).
3. Remove the intake manifold brace.



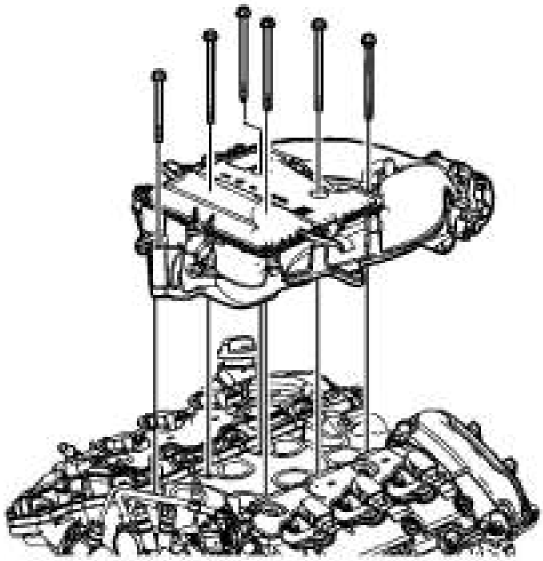
4. Disconnect and remove the positive crankcase ventilation (PCV) tube from the intake manifold and right camshaft cover.



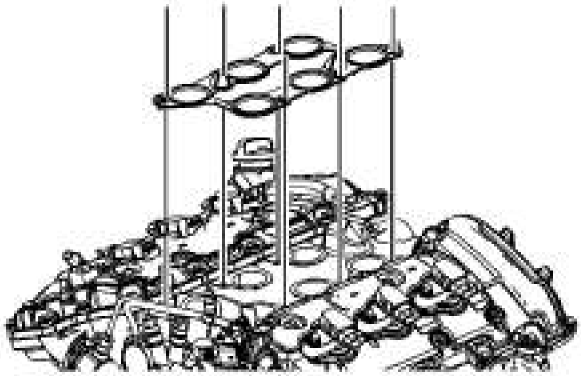
5. Remove the EVAP hose from the intake manifold and EVAP solenoid.



6. Remove the EVAP solenoid bolt.
7. Remove the EVAP solenoid.

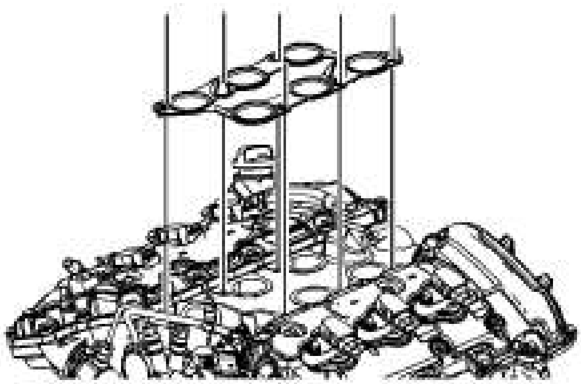


8. Remove the intake manifold bolts.
9. Remove the intake manifold assembly.

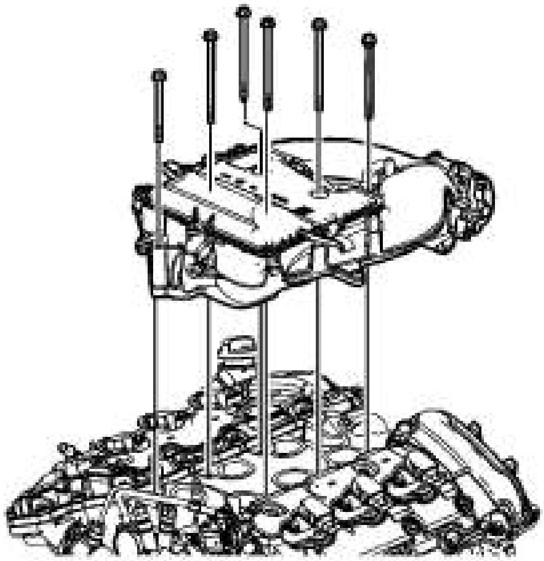


10. Remove and discard the lower intake manifold gasket.

Intake Manifold Installation (LLT)

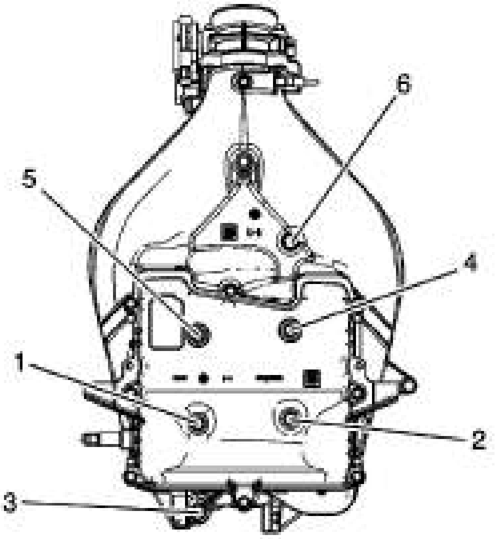


1. Install the NEW intake manifold gasket.

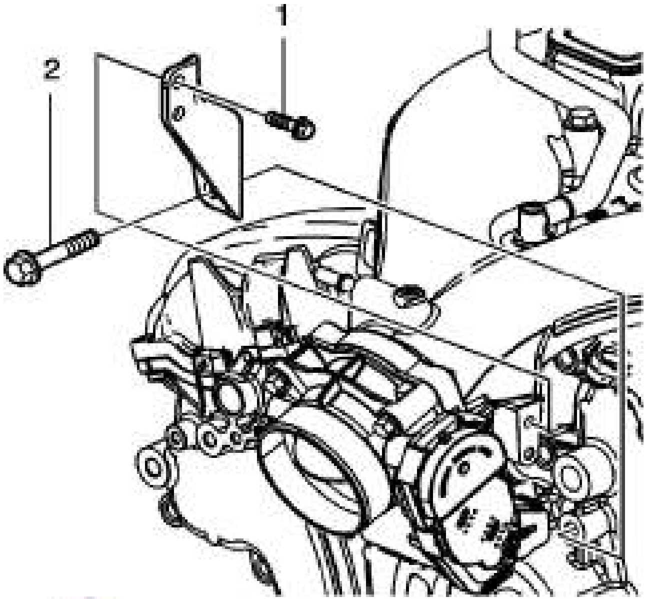


2. Install the intake manifold assembly.
3. Install the intake manifold bolts.

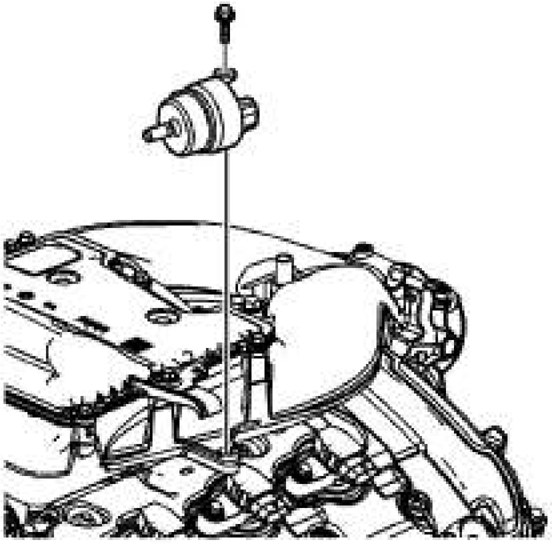
Caution: Refer to Fastener Caution in the Preface section.



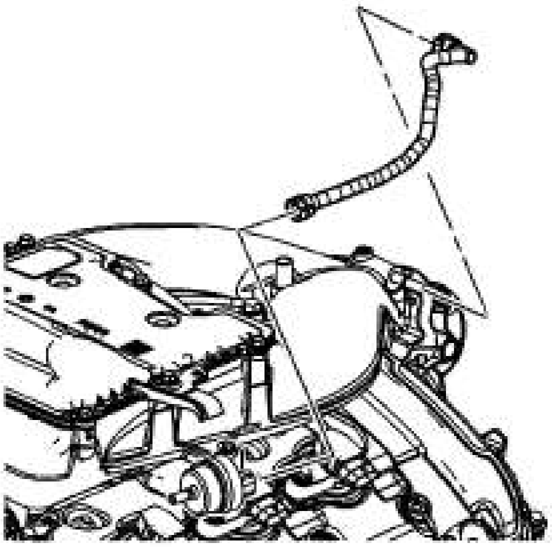
4. Tighten the intake manifold bolts in the sequence shown.
    - 4.1. Tighten the intake manifold bolts in sequence to **23 N·m (17 lb ft)**.
    - 4.2. Tighten the intake manifold bolts a second pass in sequence to **23 N·m (17 lb ft)**.



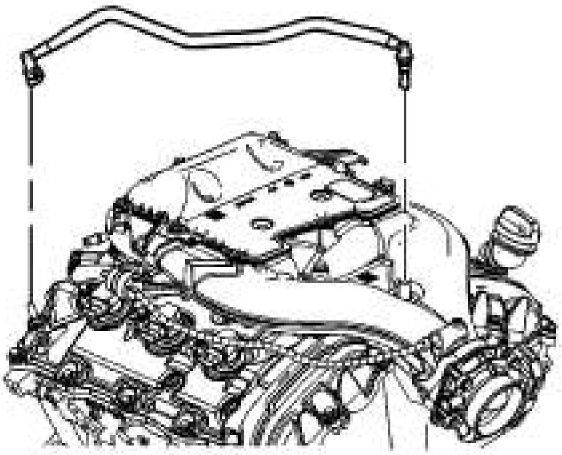
5. Place the intake manifold brace to the engine front cover and intake manifold.
6. Loosely install the bolts.
7. First tighten the intake manifold brace bolt (1) to the intake manifold and tighten to **10 N·m (89 lb in)**.
8. Finally tighten the intake manifold brace bolt (2) to the engine front cover and tighten to **65 N·m (48 lb ft)**.



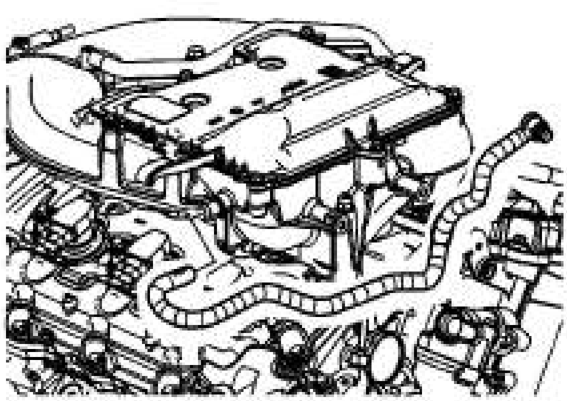
9. Install the evaporative (EVAP) solenoid.
10. Install the EVAP solenoid bolt and tighten to **10 N·m (89 lb in)**



11. Connect the EVAP hose to the upper intake manifold and EVAP solenoid.

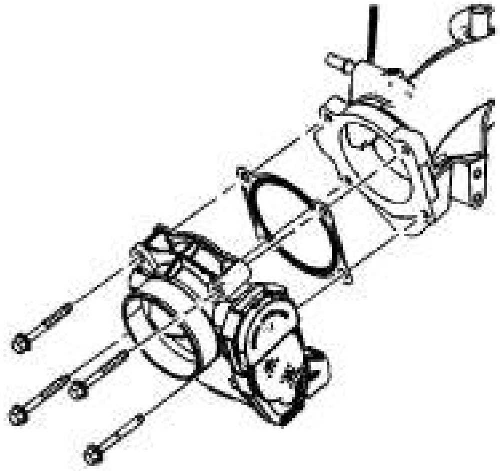


12. Connect the positive crankcase ventilation (PCV) tube assembly to the upper intake manifold and the right camshaft cover.
13. Install the PCV tube assembly bracket bolts and tighten to **10 N·m (89 lb in)**.

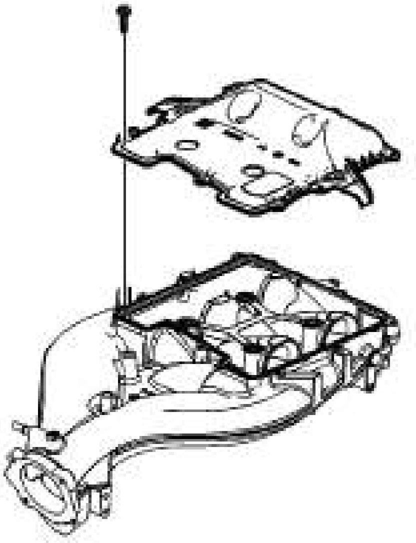


14. Install the brake booster hose to the upper intake manifold.

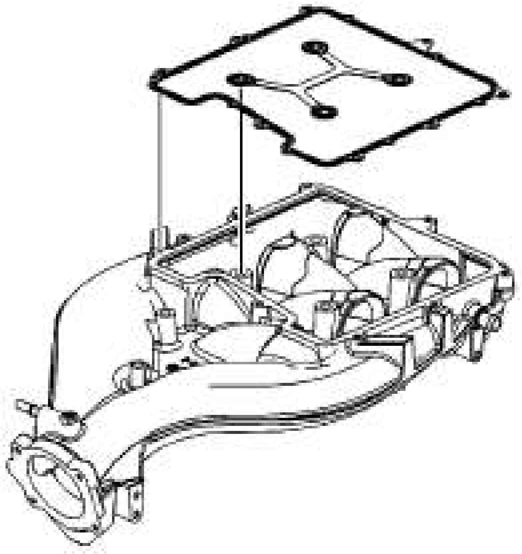
Intake Manifold Disassemble (LLT)



1. Remove the throttle body bolts.
2. Remove the throttle body.
3. Remove and discard the throttle body gasket.



4. Remove the intake manifold cover bolts.
5. Remove the intake manifold cover.



6. Remove and discard the intake manifold cover gaskets.

2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | **Document ID: 2134520**

Intake Manifold Cleaning and Inspection (LLt)

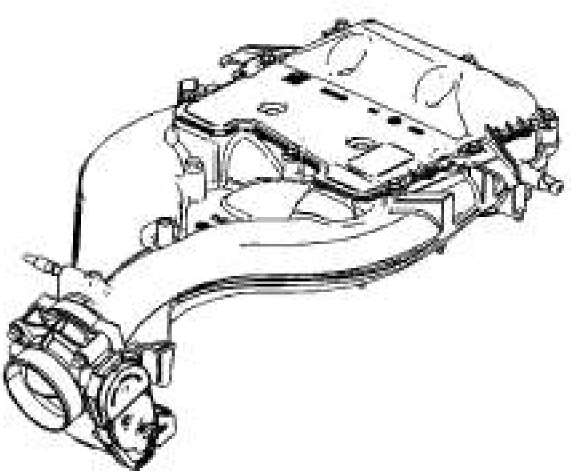
Upper Intake Manifold Cleaning Procedure

1. Remove any remaining gasket and/or gasket material from the following:
   - Throttle body
   - Intake manifold
2. Clean the following intake manifold areas in solvent.
   - Intake manifold gasket sealing areas
   - Intake manifold passages
   - Brake booster hose passage
   - Evaporative emission (EVAP) solenoid passage
   - Positive crankcase ventilation (PCV) vacuum hose passages

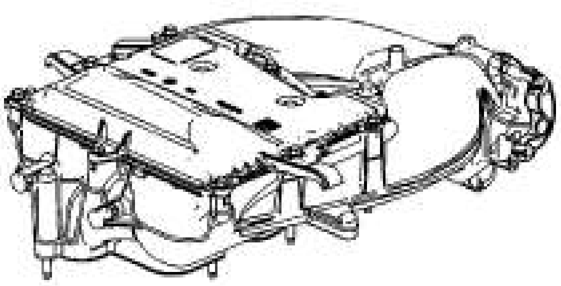
Warning: Refer to Safety Glasses Warning in the Preface section.

3. Dry the upper intake manifold and throttle body with compressed air.

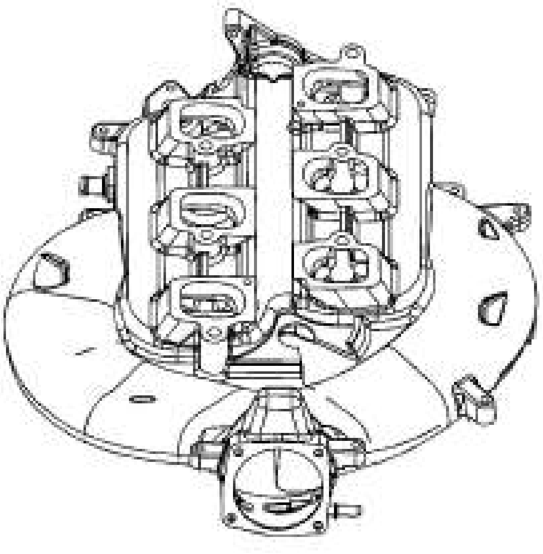
Inspection Procedure



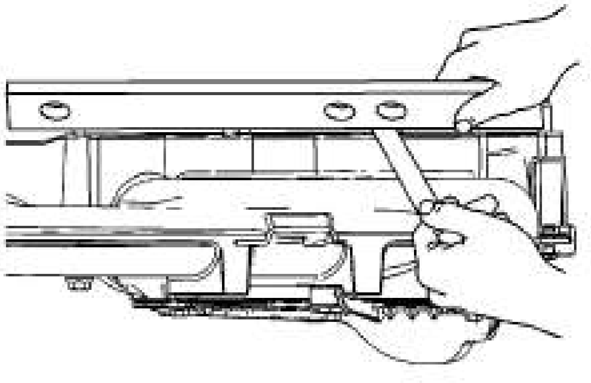
1. Inspect the upper intake manifold for the following conditions:
   - Damage, debris or restrictions to the brake vacuum booster hose port
   - Damage to the throttle body bolt holes
   - Damage, debris or restrictions to the PCV system hose ports
   - Damage to the gasket sealing surface for the intake manifold cover



2. Inspect the upper intake manifold for the following conditions:
   - Damage to the intake manifold bolt bosses
   - Damage to the EVAP purge solenoid mounting boss
   - Damage, debris or restrictions to the EVAP purge solenoid port
   - Damage, debris or restrictions in the vacuum passage

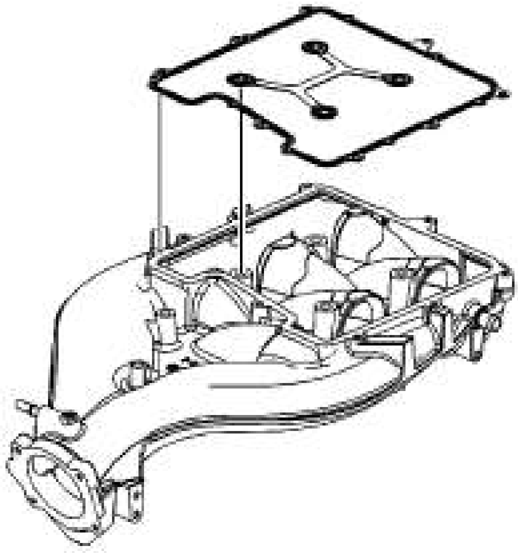


3. Inspect the intake manifold for the following conditions:
   - Gouges or damage to the intake manifold sealing surfaces
   - Damage to the gasket sealing surface for the throttle body

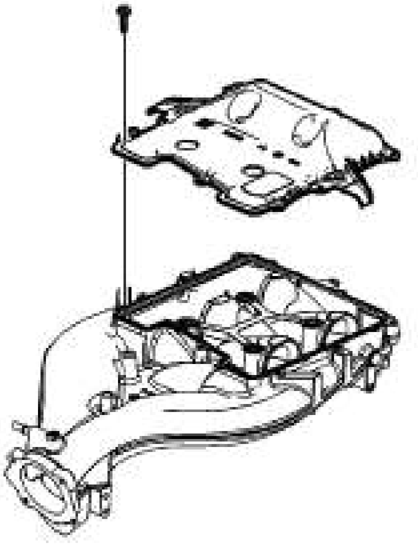


4. Inspect the upper intake manifold sealing surface for warpage.
    4.1. Locate a straight edge across the intake manifold sealing surface.
    4.2. Insert a feeler gage between the upper intake manifold and the straight edge. An intake manifold with warpage in excess of 0.50 mm (0.020 in) must be replaced.
5. Repair or replace the upper intake manifold as necessary.

Intake Manifold Assemble (LLT)



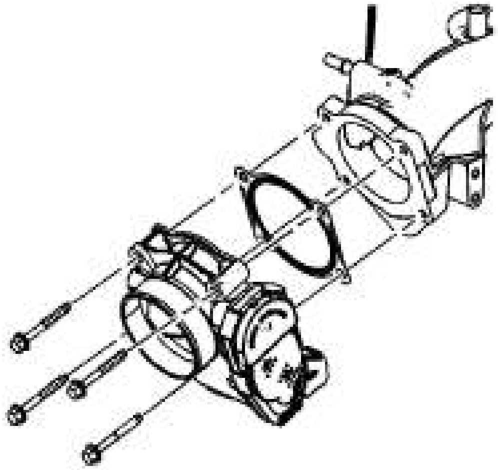
1. Install the NEW intake manifold cover gaskets.



2. Install the intake manifold cover.

Caution: Refer to Fastener Caution in the Preface section.

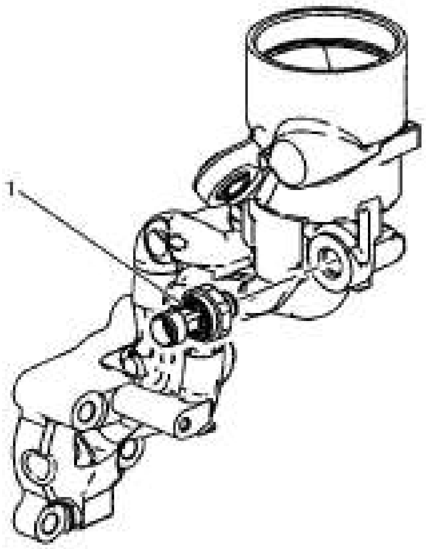
3. Install the intake manifold cover bolts and tighten to **10 N·m (89 lb in)**.



4. Install the NEW throttle body gasket.
5. Install the throttle body.
6. Install the throttle body bolts and tighten to **10 N·m (89 lb in).**.

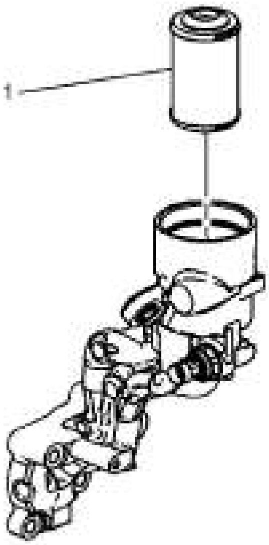
Oil Filter Adapter Assemble

Notice: Refer to Fastener Notice in the Preface section.



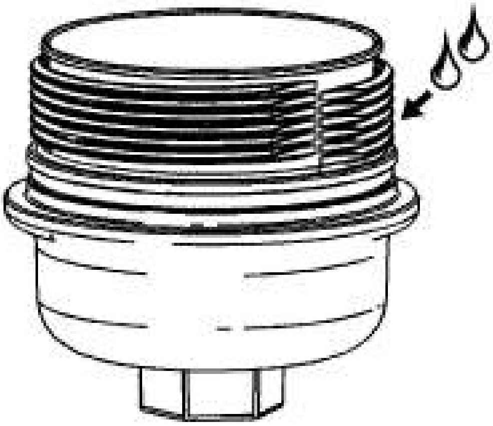
1. Install the oil pressure sender (1).

   Tighten
   Tighten the oil pressure sender to 20 N·m (15 lb in).

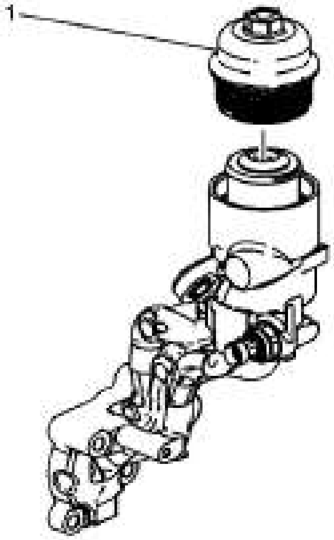


2. Install the NEW oil filter cartridge (1).

   Notice: Refer to General Repair Instructions in the Preface section.



3. Lubricate the oil filter cap threads with clean engine oil.



4. Install the oil filter cap (1).

   Tighten
   Tighten the oil filter cap to 25 N·m (18 lb in).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | Document ID: 1977609

Oil Filter Adapter Cleaning and Inspection

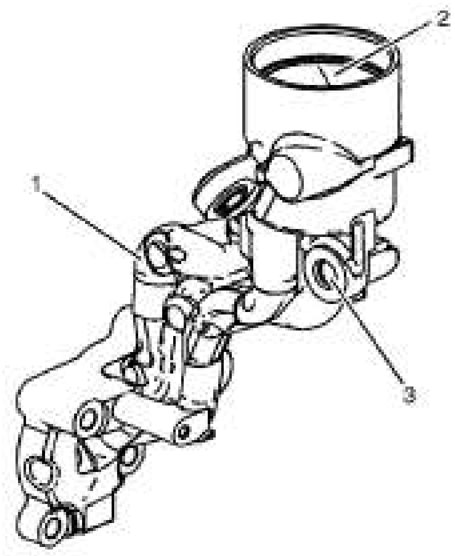
Cleaning Procedure

1. Clean the oil filter adapter components with non-corrosive solvent.

   Caution: Refer to Safety Glasses Caution in the Preface section.

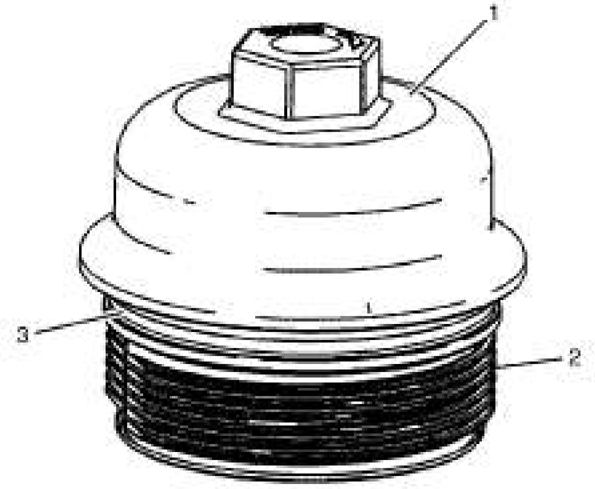
2. Dry the oil filter adapter components with compressed air.

Inspection Procedure

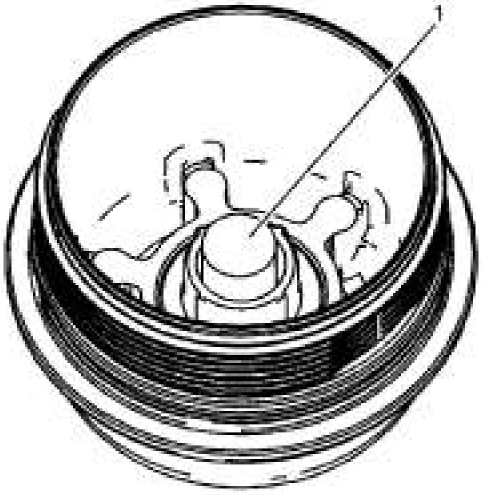


Important: The internal parts of the oil filter adapter are not serviced separately. If wear or damage is noted, replace the entire oil filter adapter assembly.

1. Inspect the oil filter housing for cracks, scoring, casting imperfections (1) and damaged threads (3).
2. Inspect the drain back valve (2) for damage or blockage.



3. Inspect the oil filter cap for cracks, scoring, casting imperfections (1) and damaged threads (2). Replace as necessary.
4. Inspect the oil filter cap O-ring (3) for damage. Replace as necessary.



5. Inspect the bypass valve (1) for damage or blockage.

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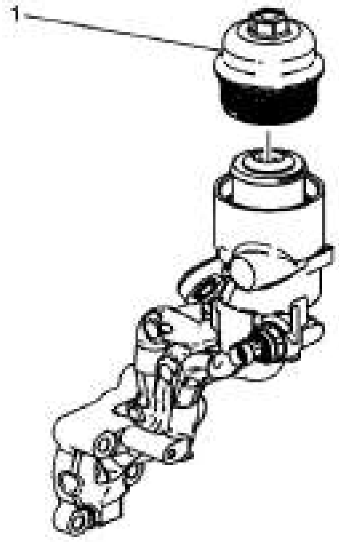
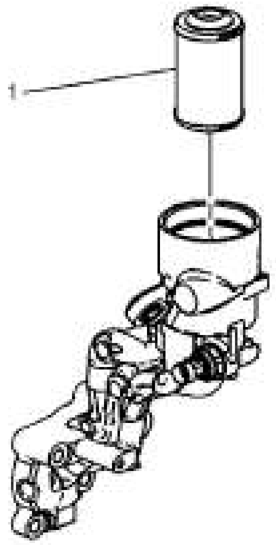
Oil Filter Adapter Disassemble

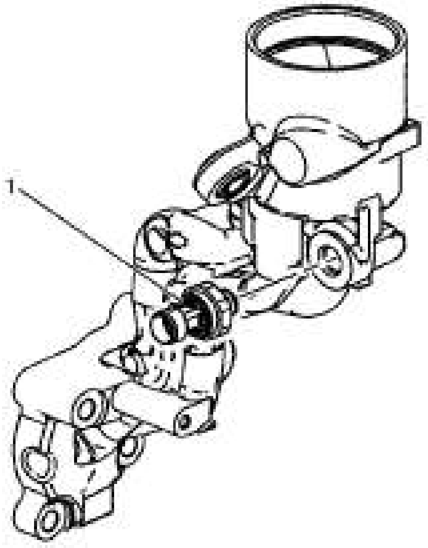


1. Remove the oil filter cap (1).



2. Remove the oil filter cartridge (1).

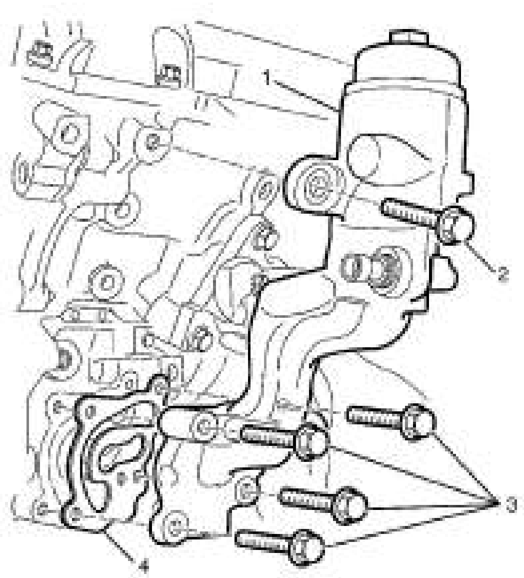
   Discard the oil filter cartridge (1).



3. Remove the oil pressure sender (1).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | **Document ID: 1995382**

Oil Filter Adapter Installation



1. Position a NEW oil filter adapter gasket (4) onto the oil filter adapter (1).
2. Install the M8 lower oil filter adapter to cylinder block retaining bolts (3).
3. Loosely tighten the M8 lower oil filter adapter to cylinder block retaining bolts (3).
4. Install the M10 upper oil filter adapter to cylinder head retaining bolt (2).
5. Loosely tighten the M10 upper oil filter adapter to cylinder head retaining bolt (2).

   Notice: Refer to Fastener Notice in the Preface section.

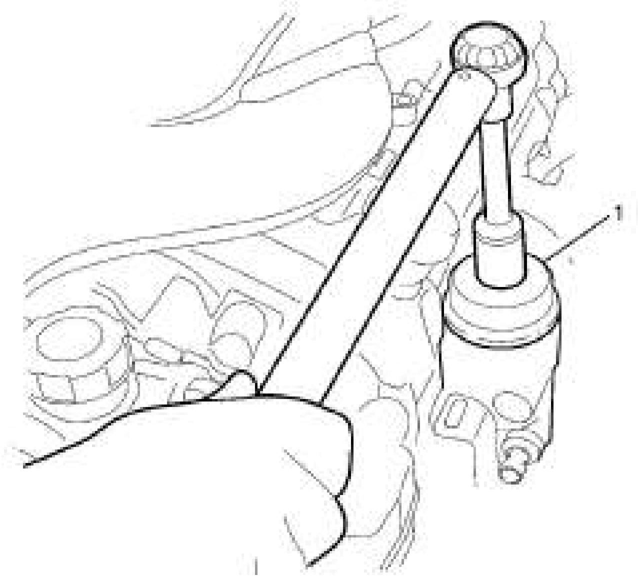
6. Tighten the M8 lower oil filter adapter to cylinder block retaining bolts (3).

   Tighten
   Tighten the bolts to 23 N·m (17 lb ft).

   Notice: Refer to Fastener Notice in the Preface section.

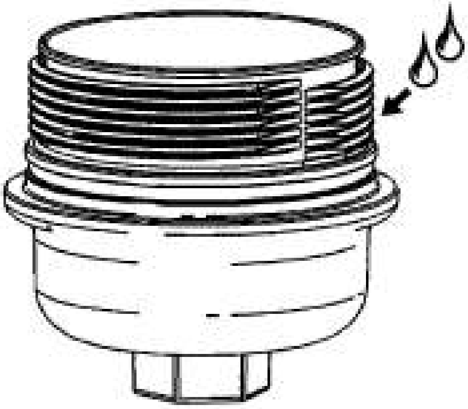
7. Tighten the M10 upper oil filter adapter to cylinder head retaining bolt (2).

   Tighten
   Tighten the bolt to 58 N·m (42 lb ft).

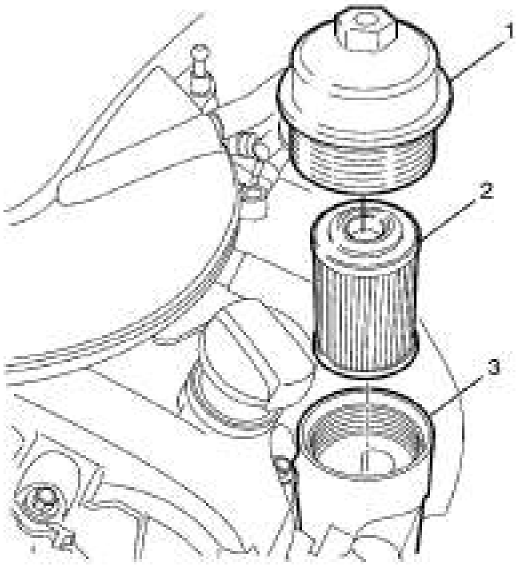


8. Remove the oil filter cap (1).

   Notice: Refer to General Repair Instructions in the Preface section.



9. Lubricate the oil filter cap threads with clean engine oil.



10. Install the NEW oil filter cartridge (2).

    Notice: Refer to General Repair Instructions in the Preface section.

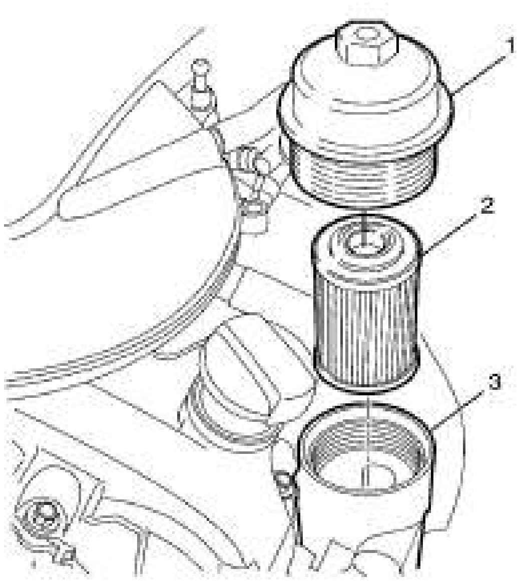
    Important: Use a six-point socket to install the oil filter cap.

11. Install the oil filter adapter cap (1) to the engine oil filter adapter (3).

    Tighten
    Tighten the oil filter cap to 25 N·m (18 lb ft).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | **Document ID: 1977650**

Oil Filter Adapter Removal

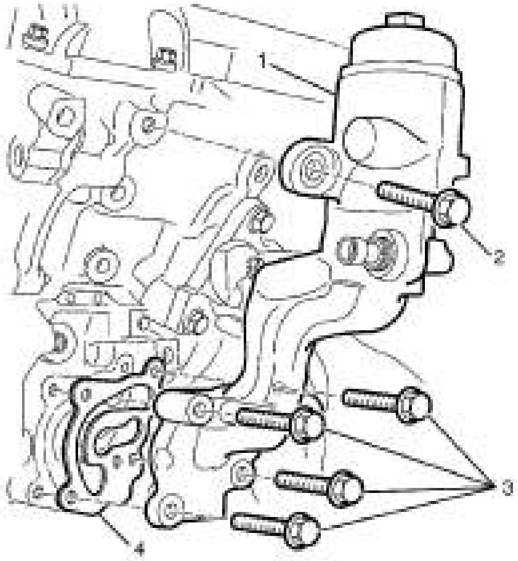


Important: Use a six-point socket to remove the oil filter cap (1).

1. Remove the oil filter adapter cap (1) from the engine oil filter adapter (3).
2. Remove the oil filter cartridge (2).

   Discard the oil filter cartridge (2).

3. Re-install the oil filter cap.



4. Remove the M8 oil filter adapter to cylinder block retaining bolts (3).
5. Remove the M10 oil filter adapter to cylinder head retaining bolt (2).
6. Remove the oil filter adapter (1).
7. Remove and discard the oil filter adapter gasket (4).

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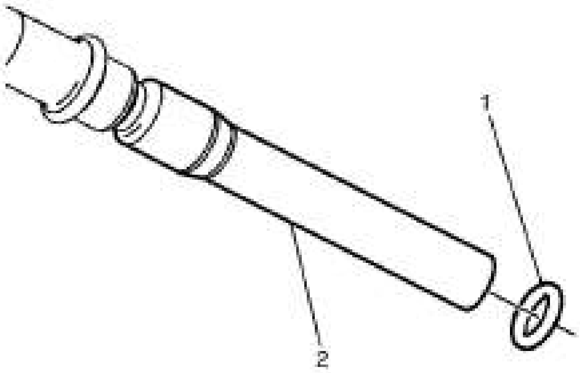
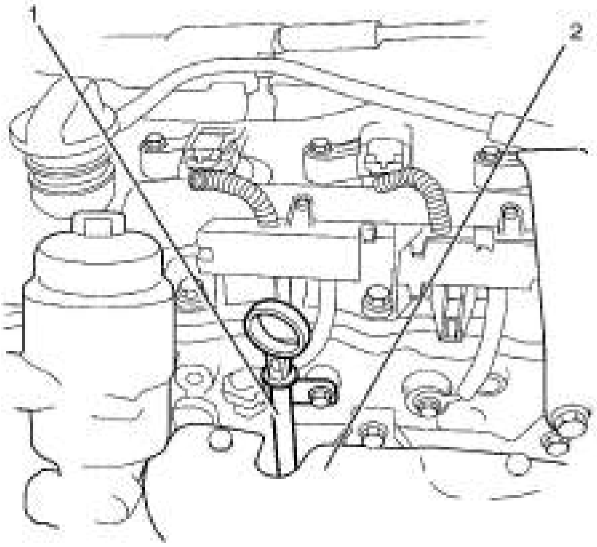
Oil Level Indicator and Tube Installation

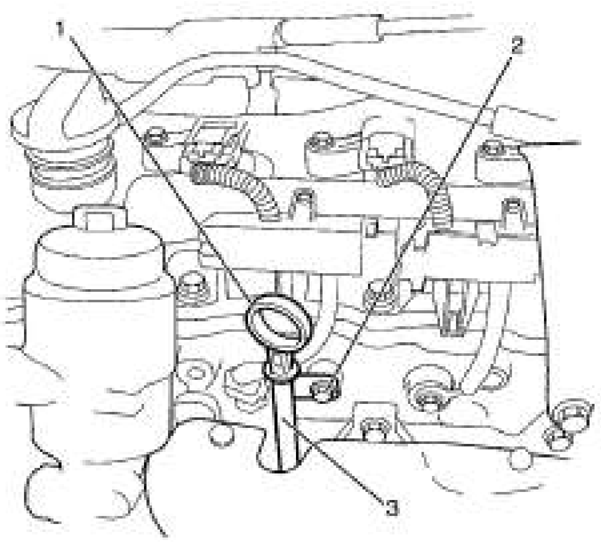


1. Install a NEW O-ring (2) on the oil level indicator tube (1).



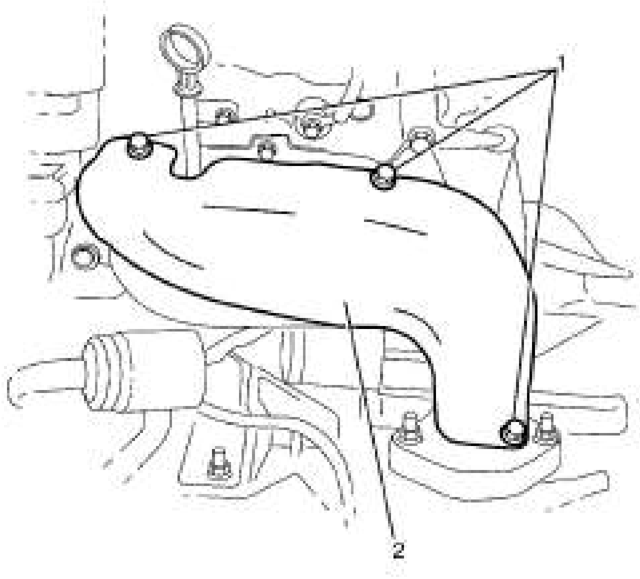
2. Install the oil level indicator and tube (1) by sliding the oil level indicator and tube (1) down through the exhaust manifold (2).

Notice: Refer to Fastener Notice in the Preface section.



3. Install the oil level indicator tube bracket to cylinder head retaining bolt (2).

   Tighten
   Tighten the bolt to 10 N·m (89 lb in).



4. Install the exhaust manifold heat shield (2).
5. Install the exhaust manifold heat shield to exhaust manifold retaining bolts (1).

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).

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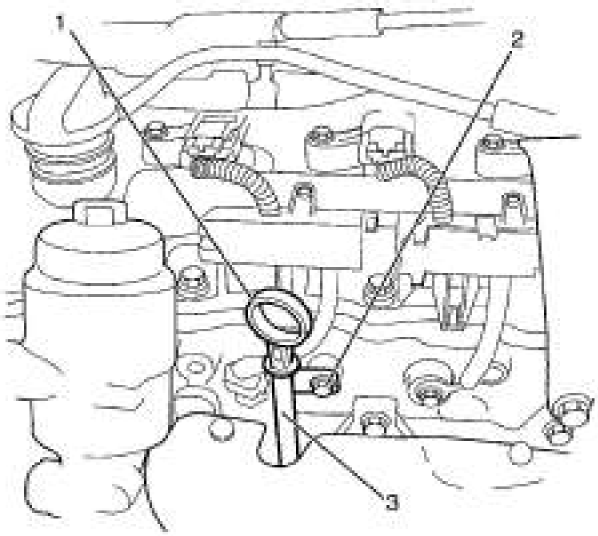
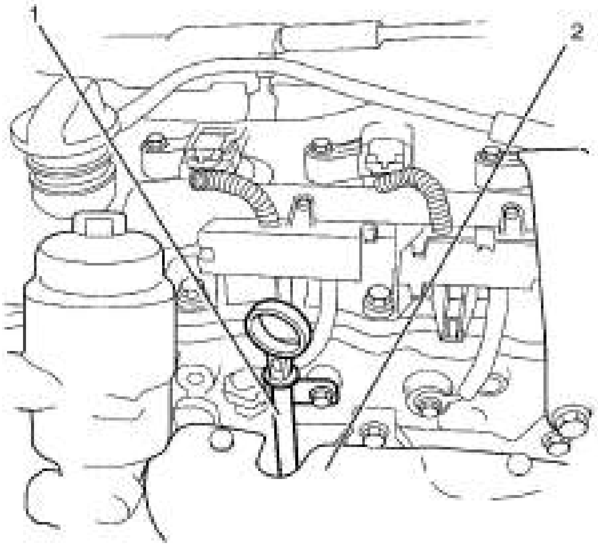
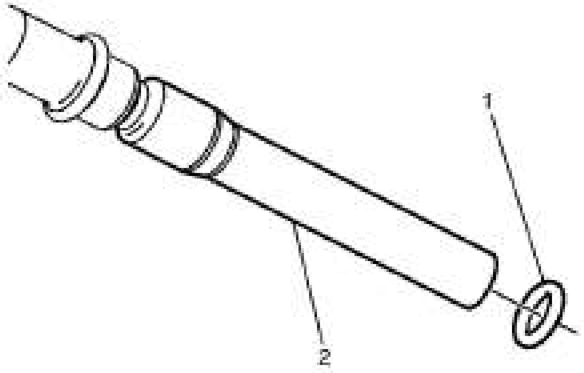
Oil Level Indicator and Tube Removal



1. Remove the oil level indicator tube bracket to cylinder head retaining bolt (2).
2. Remove the oil level indicator (1) from the oil level indicator tube (3).
3. Remove the knock sensor. Refer to Knock Sensor Replacement - Bank 2.

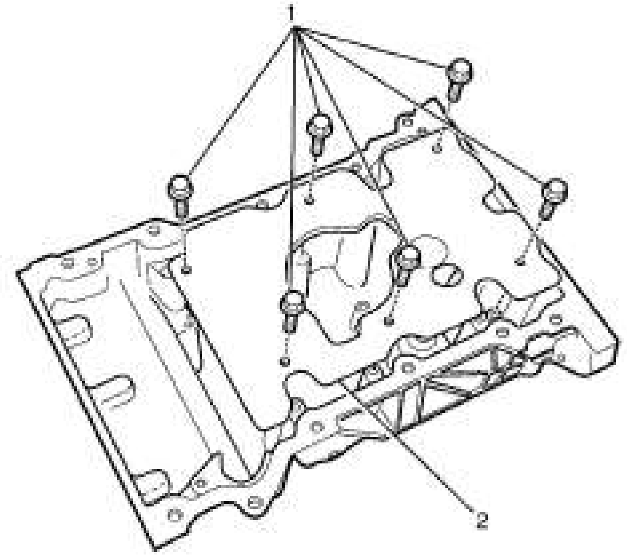


4. Remove the oil level indicator tube (1) up through the exhaust manifold (2).



5. Remove and discard the O-ring (1) from the oil level indicator tube (2) if damaged.

Oil Pan Assemble

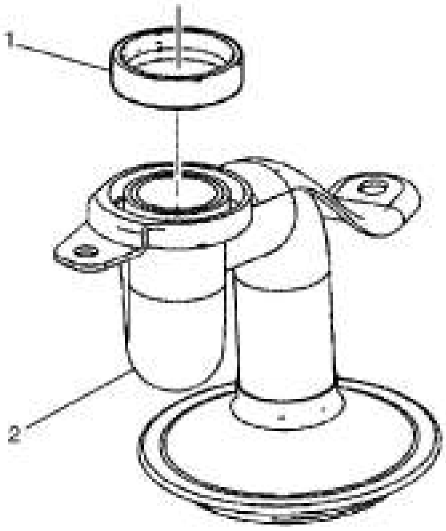


1. Install the oil pan baffle (2).

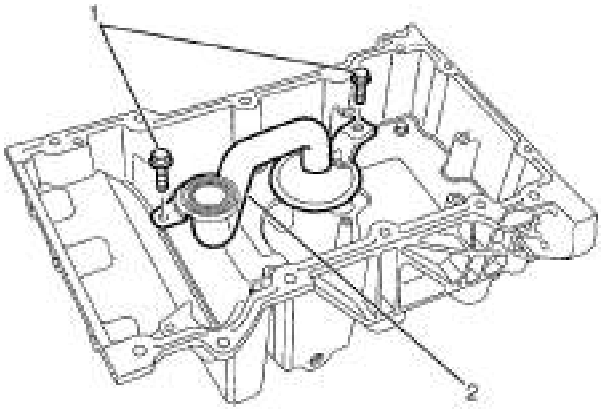
   Notice: Refer to Fastener Notice in the Preface section.

2. Install the oil pan baffle to oil pan retaining bolts (1).

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).

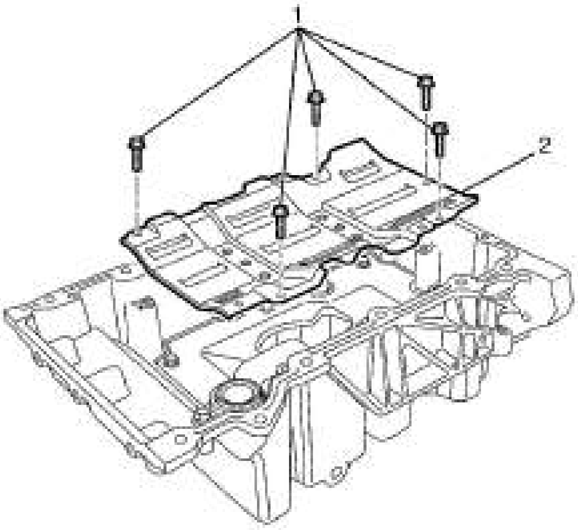


3. Install a NEW oil suction pipe seal (1) onto the oil suction pipe (2).



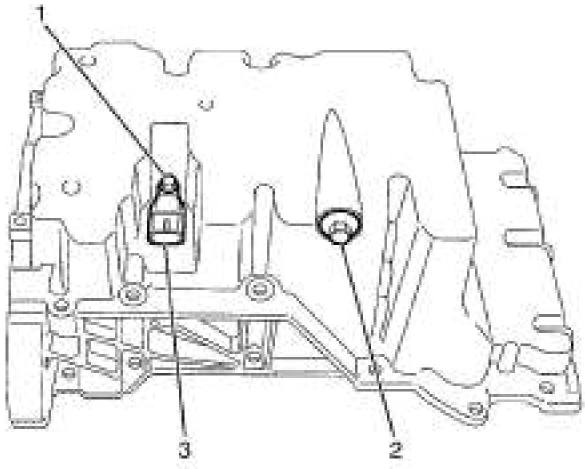
4. Install the oil suction pipe (2).
5. Install the oil suction pipe to oil pan retaining bolts (1).

Tighten
Tighten the bolts to 10 N·m (89 lb in).



6. Install the oil pan scraper (2).
7. Install the oil pan scraper to oil pan retaining bolts (1).

Tighten
Tighten the oil pan scraper bolts to 10 N·m (89 lb in).



8. Install the oil pan drain plug (2).

   Tighten
   Tighten the oil pan drain plug to 20 N·m (15 lb ft).

9. Install the oil level sensor (3).
10. Install the oil level sensor to oil pan retaining bolt (1).

    Tighten
    Tighten the bolt to 10 N·m (89 lb in).

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Oil Pan Cleaning and Inspection

Tools Required

J 28410 Gasket Remover

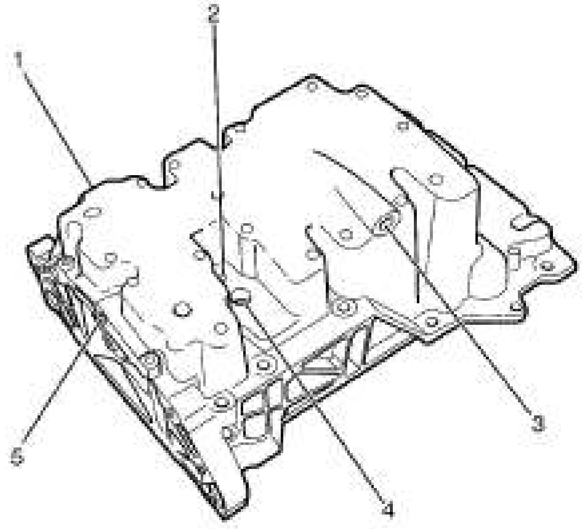
Cleaning Procedure

1. Remove any old thread sealant, gasket material or sealant using J 28410
2. Clean the oil pan and oil pan components in solvent.
3. Clean out any debris from the bolt holes.

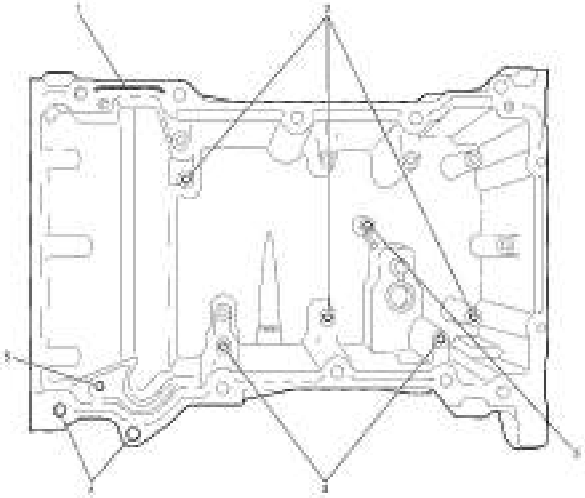
   Caution: Refer to Safety Glasses Caution in the Preface section.

4. Dry the oil pan and oil pan components with compressed air.

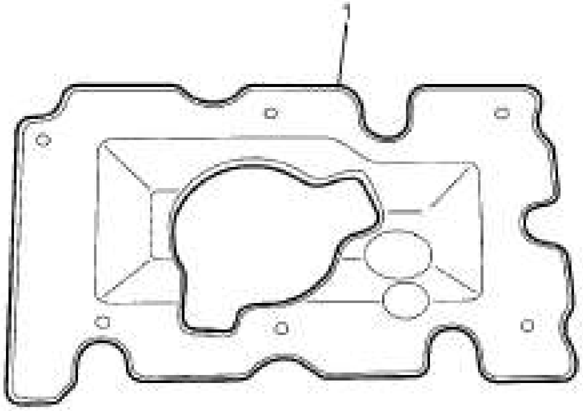
Inspection Procedure



1. Inspect the exterior of the oil pan for the following conditions:
   - Damage to the drain plug or drain plug hole (3).
   - Damage to the transmission mounting bosses (5).
   - Damage to the oil level/condition sensor bolt hole threads (2).
   - Damage to the oil level/condition sensor hole (4).
   - Dents or damage to the exterior (1).

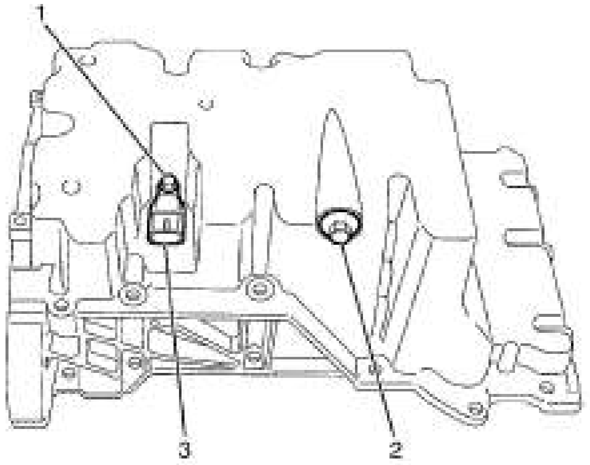


2. Inspect the interior of the oil pan for the following conditions:
   - Gouges or damage to the oil pan sealing surfaces (1).
   - Damage to the oil pan baffle mounting bosses (2).
   - Damage to the bolt holes (3).
   - Damage to the oil suction pipe mounting bosses (4).
   - Damage to the oil pan scraper mounting bosses (5).
3. Inspect the oil pan scraper for damage.

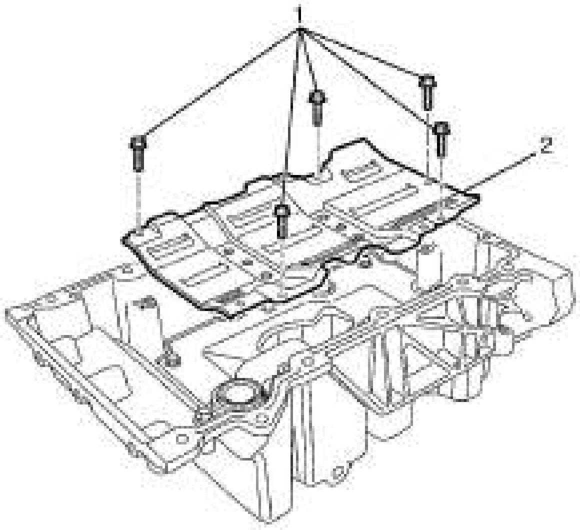


4. Inspect the oil pan baffle (1) for damage.
5. Repair or replace the oil pan and/or oil pan components as necessary.

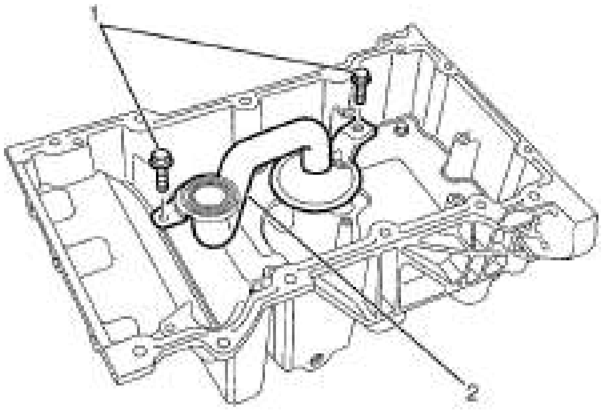
Oil Pan Disassemble



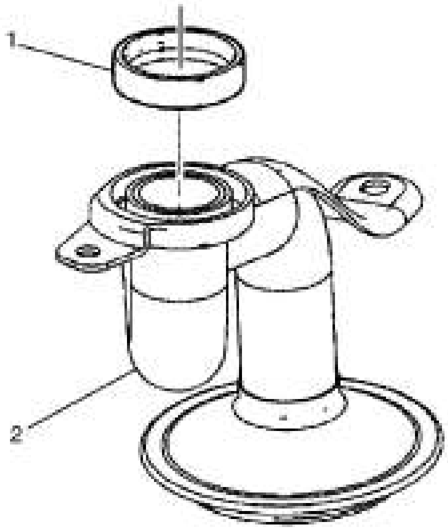
1. Remove the oil level sensor to oil pan retaining bolt (1).
2. Remove the oil level sensor (3).
3. Remove the oil pan drain plug (2).



4. Remove the oil pan scraper to oil pan retaining bolts (1).
5. Remove the oil pan scraper (2).



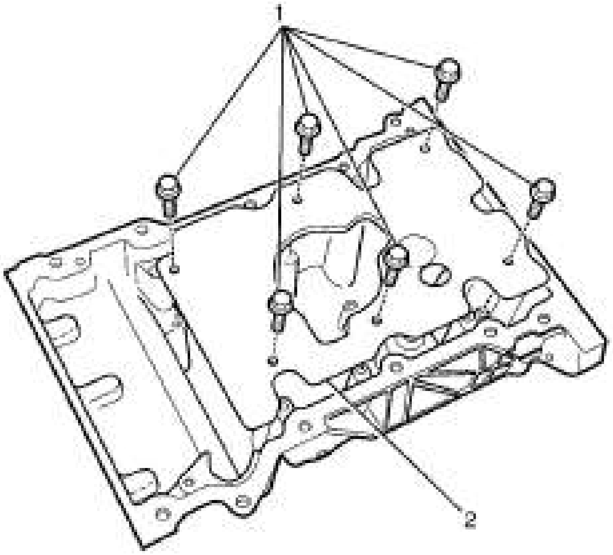
6. Remove the oil suction pipe to oil pan retaining bolts (1).
7. Remove the oil suction pipe (2).



Important: The oil suction pipe seal (1) is a single use component and must be discarded whenever the oil suction pipe (2) is removed.

8. Remove the oil suction pipe seal (1) from the oil suction pipe (2).

   Discard the oil suction pipe seal (1).



9. Remove the oil pan baffle to oil pan retaining bolts (1).
10. Remove the oil pan baffle (2).

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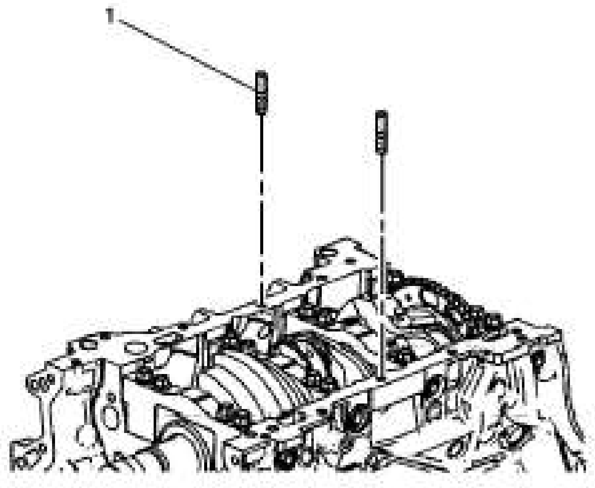
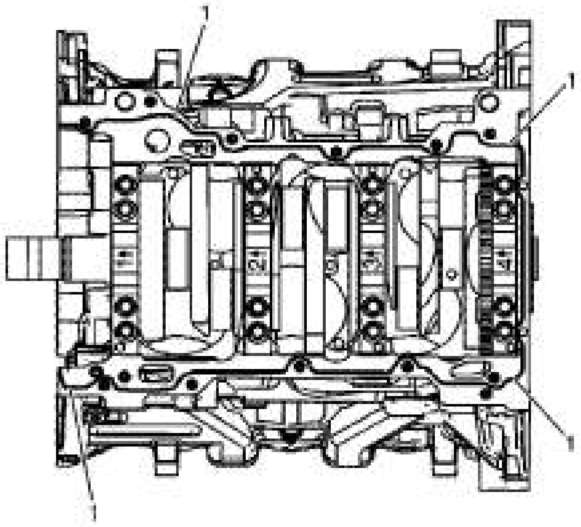
Oil Pan Installation

Tools Required

EN 46109 Guide Pin Set

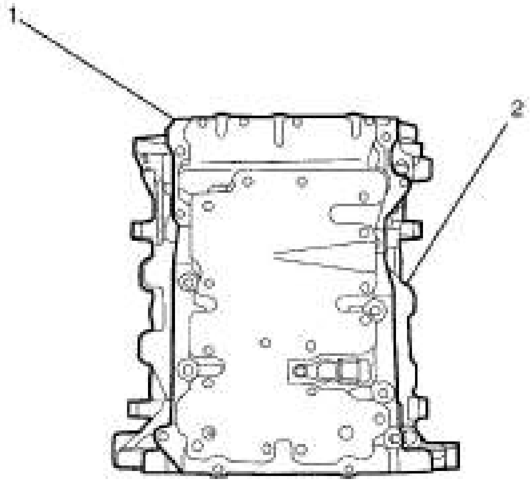


1. Install the 8 mm (0.315 in) guides from the EN 46109 (1) into the center oil pan rail bolt hole on each side of the cylinder block.

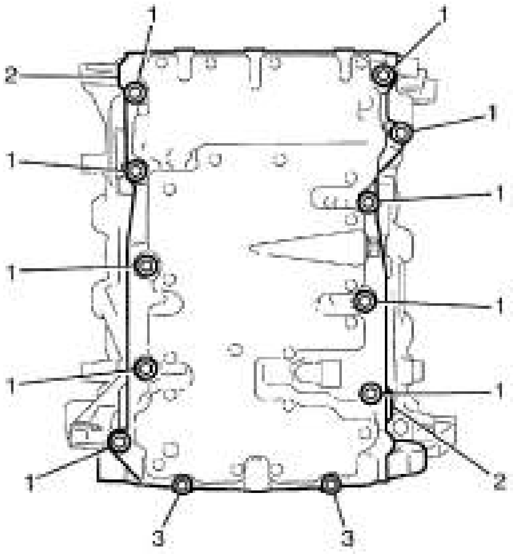


2. Place a 3 mm (0.118 in) bead of RTV sealant (1) on the block pan rail and the crankshaft

rear oil seal housing.

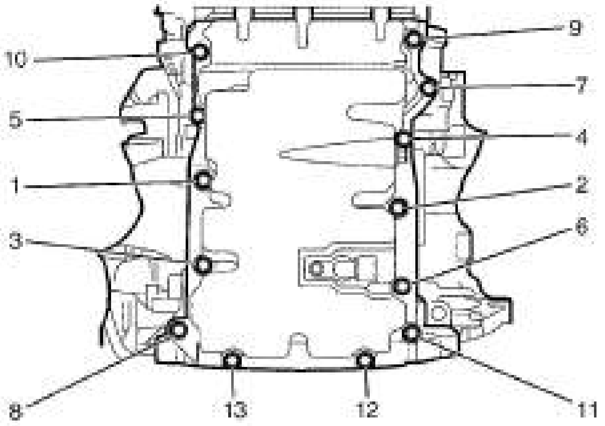


3. Position the oil pan (1) onto the block (2).
4. Remove the EN 46109 mm (0.315 in) guides from the cylinder block.



5. Loosely install the M8 oil pan to cylinder block retaining bolts (1).
6. Loosely install the M6 oil pan to crankshaft rear oil seal housing retaining bolts (3).

Notice: Refer to Fastener Notice in the Preface section.

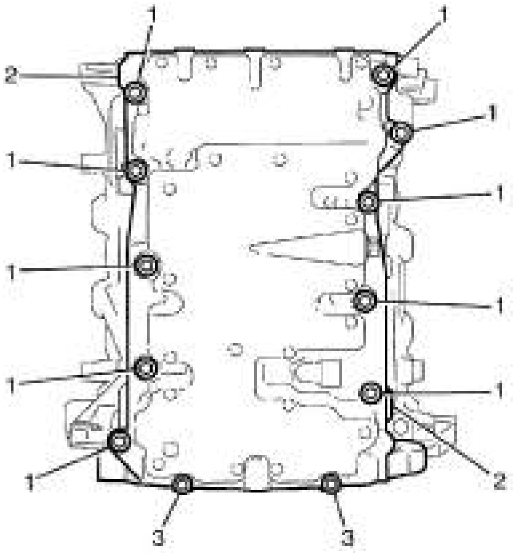


7. Install and tighten the M8 oil pan to cylinder block retaining bolts (1-11) and the M6 oil pan to crankshaft rear oil seal housing retaining bolts (12, 13) in the sequence shown.

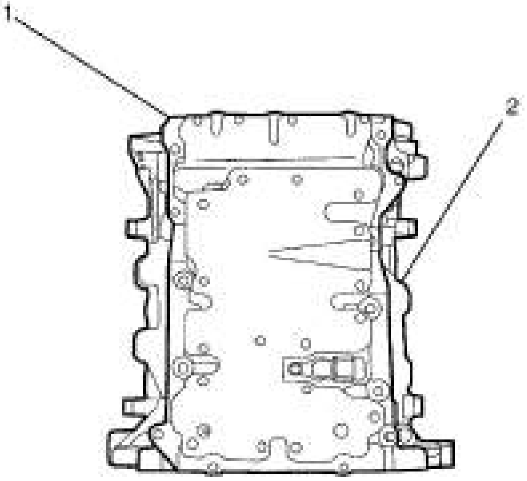
   Tighten

   1. Tighten the M8 bolts (1-11) to 23 N·m (17 lb ft).
   2. Tighten the M6 bolts (12, 13) to 10 N·m (89 lb in).

Oil Pan Removal

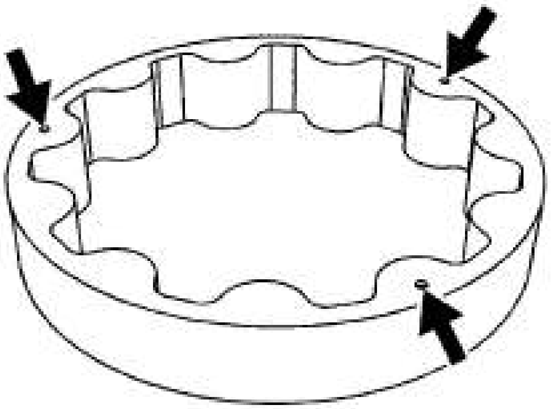


1. Remove the M8 oil pan to cylinder block retaining bolts (1).
2. Remove the M6 oil pan to crankshaft rear oil seal housing retaining bolts (3).
3. Using the pry points located at the edge of the oil pan (2) shear the RTV sealant.



4. Remove the oil pan (1) from the cylinder block (2).

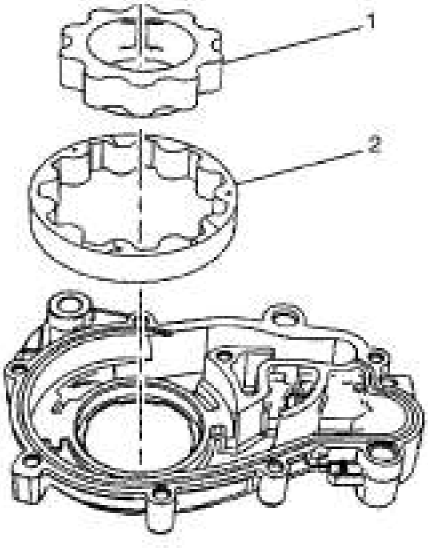
Oil Pump Assemble



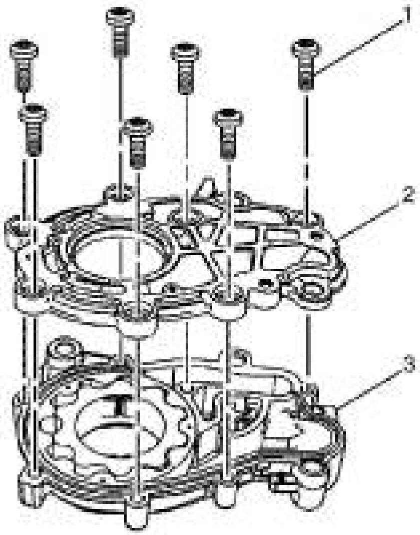
Important:

- There are no serviceable components within the oil pump. Disassemble the pump only to diagnose an oiling concern. A disassembled oil pump must be replaced. DO NOT reuse a disassembled oil pump or a serviceable oil pump with a primary camshaft drive chain lower guide that needs to be replaced.
- The primary camshaft drive chain lower guide is not a serviceable component. If the primary camshaft drive chain lower guide must be replaced, the oil pump must be replaced.

1. The dimpled surface must be face-up in the pump body.



2. Install the inner oil pump drive gear (1) and the outer oil pump driven gear (2) in the pump cover in the same orientation as removed.

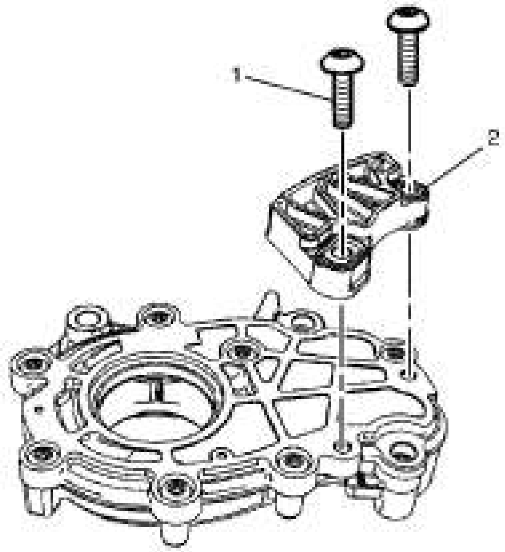


3. Install the oil pump cover (2) to the oil pump housing (3).

   Notice: Refer to Fastener Notice in the Preface section.

4. Install the oil pump cover to oil pump housing retaining bolts (1).

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).



Important: The primary camshaft drive chain lower guide is not a serviceable component. If the primary camshaft drive chain lower guide is to be reused, the primary camshaft drive chain lower guide is not to be removed from the oil pump cover. If the primary camshaft drive chain lower guide must be replaced, the oil pump must be replaced.

5. Install the primary camshaft drive chain lower guide (2).
6. Install the primary camshaft drive chain lower guide to oil pump retaining bolts (1).

Tighten
Tighten the bolts to 13 N·m (115 lb in).

Oil Pump Cleaning and Inspection

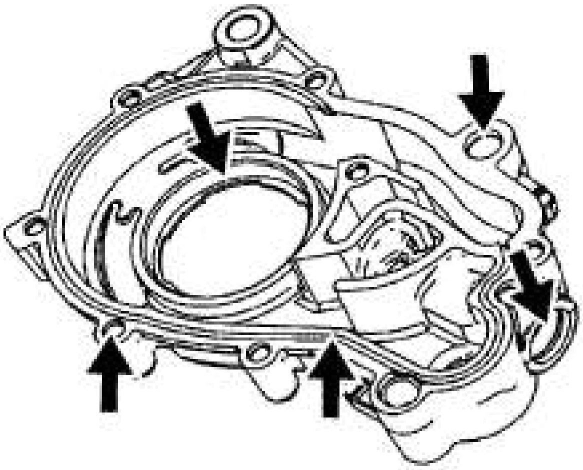
Cleaning Procedure

1. Clean the oil pump components with non-corrosive solvent.

   Caution: Refer to Safety Glasses Caution in the Preface section.

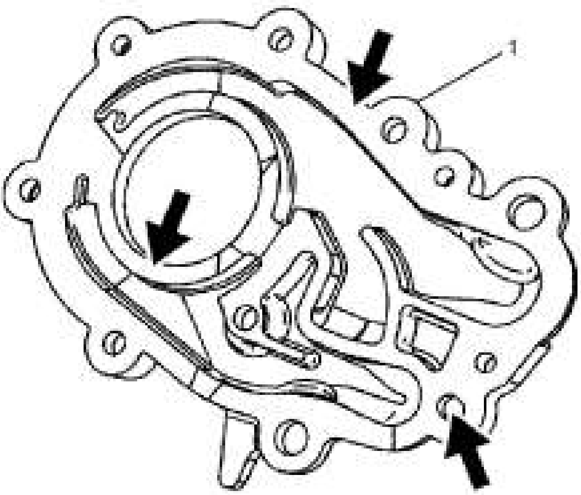
2. Dry the oil pump components with compressed air.

Inspection Procedure

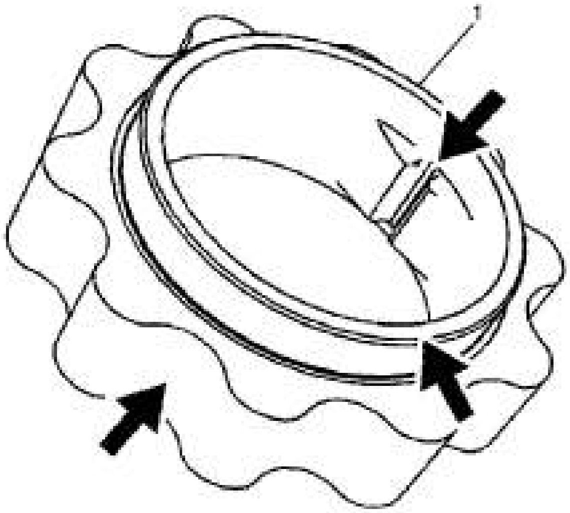


Important: There are no serviceable components within the oil pump. Disassemble the pump only to diagnose an oiling concern. A disassembled oil pump must not be reused. A disassembled oil pump must be replaced.

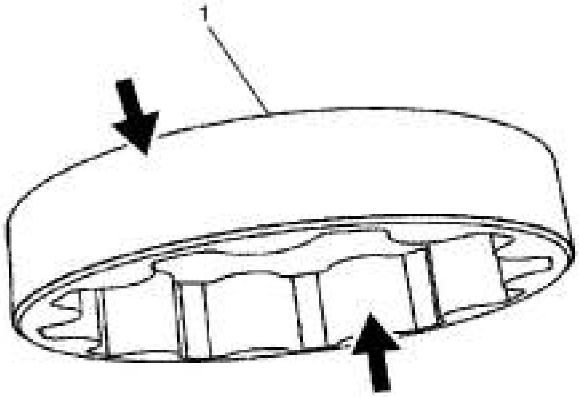
1. Inspect the oil pump housing for damage.



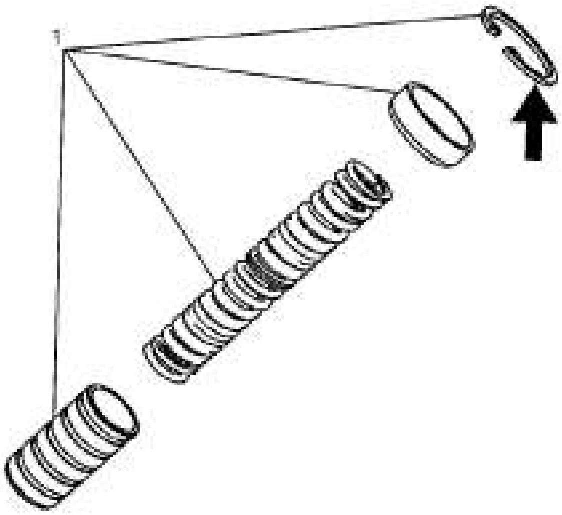
2. Inspect the oil pump cover (1) for damage.



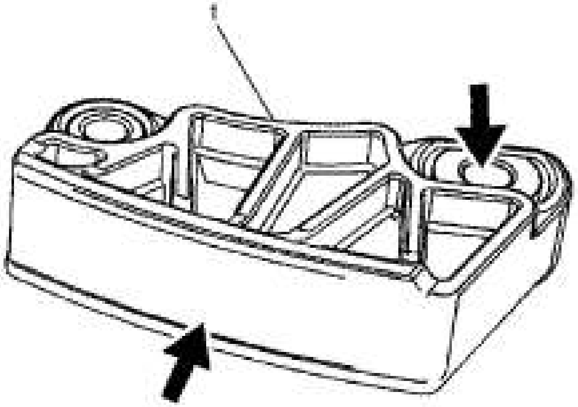
3. Inspect the inner drive gear (1) for damage. If inner diameter damage is found, ensure the crankshaft is also inspected.



4. Inspect the outer driven gear (1) for damage.



5. Inspect the oil pump relief valve components (1) for debris or damage.



6. Inspect the primary camshaft drive chain lower guide (1) for damage. If replacement of the primary camshaft drive chain lower guide (1) is necessary, replace the entire oil pump assembly. The primary camshaft drive chain lower guide (1) is not serviceable separately.
7. If debris or damage is present within the oil pump, further inspection of all of the engine components is necessary.

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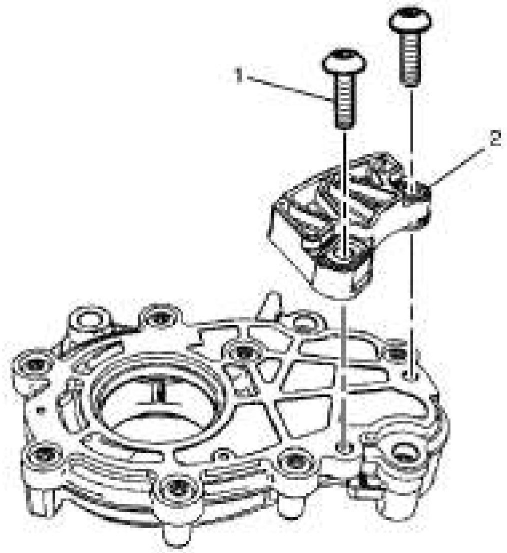
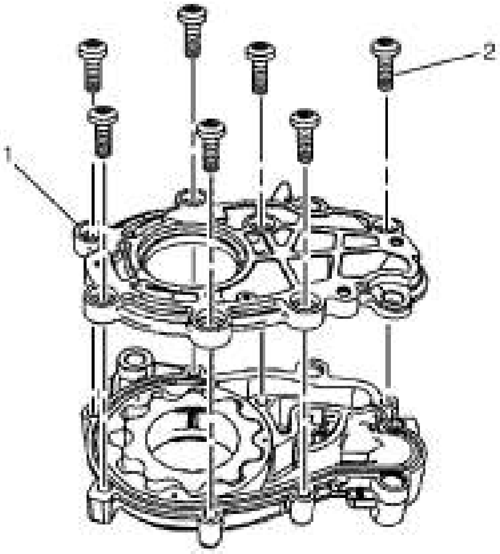
Oil Pump Disassemble

Important: There are no serviceable components within the oil pump. Disassemble the pump only to diagnose an oiling concern. A disassembled oil pump must not be reused. A disassembled oil pump must be replaced.

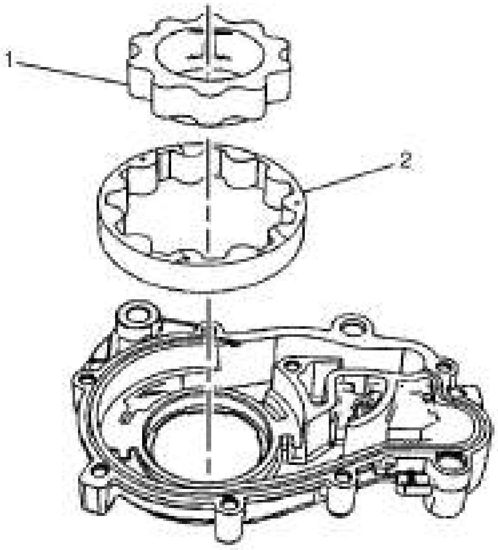


Important: The primary camshaft drive chain lower guide is not a serviceable component. If the primary camshaft drive chain lower guide is to be reused, the primary camshaft drive chain lower guide is not to be removed from the oil pump cover. If the primary camshaft drive chain lower guide must be replaced, the oil pump must be replaced.

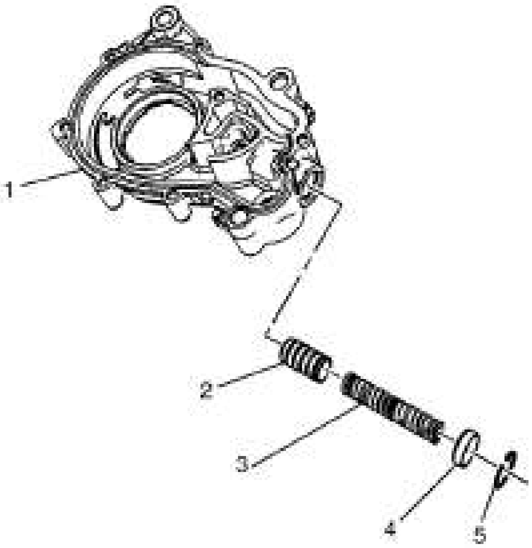
1. Remove the primary camshaft drive chain lower guide to oil pump retaining bolts (1).
2. Remove the primary camshaft drive chain lower guide (2).



3. Remove the oil pump cover to the oil pump housing retaining bolts (2).
4. Remove the oil pump cover (1).

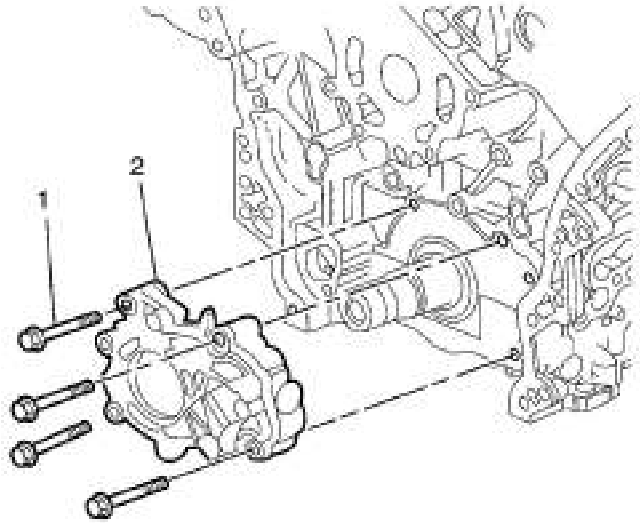


5. Remove the inner oil pump drive gear (1).
6. Remove the outer oil pump driven gear (2).



7. Remove the clip (5), holding the cap (4), for the oil relief valve components.
8. Remove the cap (4), spring (3) and plunger (2) from the oil pump housing (1).

Oil Pump Installation



1. Align the oil pump gerotor with the crankshaft flats and install the oil pump (2).
2. Align the oil pump (2) body mounting holes.

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the oil pump to cylinder block retaining bolts (1).

   Tighten
   Tighten bolts to 23 N·m (17 lb ft).

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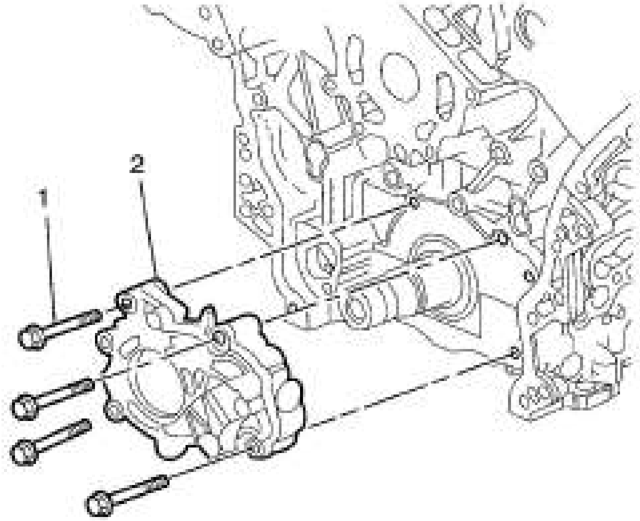
Oil Pump Removal



1. Remove the oil pump to cylinder block retaining bolts (1).
2. Remove the oil pump (2).

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Oil Pump Suction Pipe and Screen Cleaning and Inspection

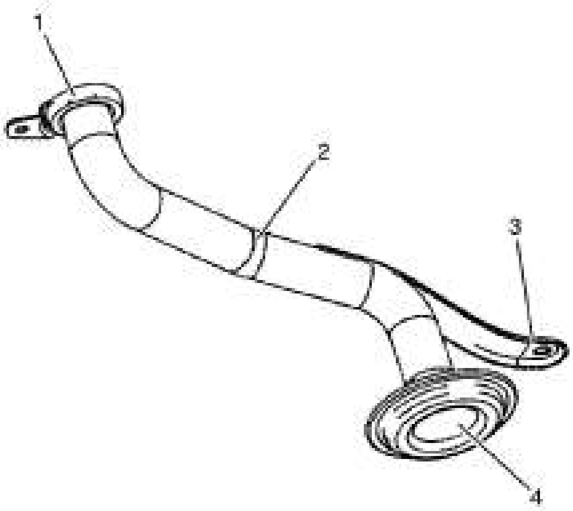
Cleaning Procedure

1. Clean the oil pump pipe and screen with solvent.

   Caution: Refer to Safety Glasses Caution in the Preface section.

2. Dry the oil pump pipe and screen with compressed air.

Inspection Procedure



1. Inspect the mounting surface (1) for possible leakage paths.
2. Inspect the oil pump pipe tube (2) for cracks, imperfections and/or damage.
3. Inspect the oil pump pipe support bracket (3) for cracks or damage.
4. Inspect the oil pump screen (4) for blockage, foreign material, tears, cracks and/or damage.

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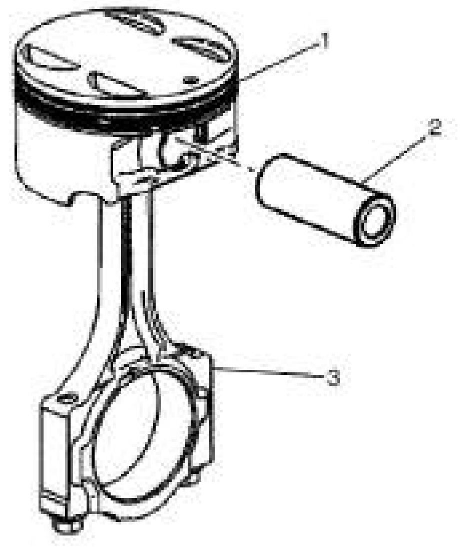
Piston and Connecting Rod Assemble

Tools Required

- EN 46121 Connecting Rod Guide Pin Set
- EN-46745 Piston Pin Clip Remover/Installer

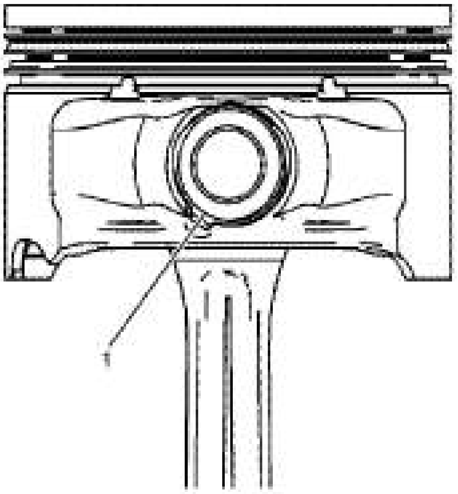
Piston and Piston Pin Installation Procedure



Important:

- The arrow located on top of the piston must point toward the front of the cylinder block.
- The connecting rod is non-directional and may be assembled/reassembled to the piston in either direction.

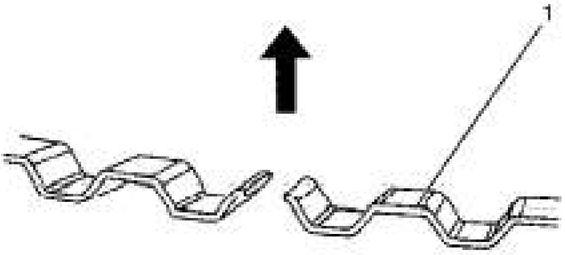
1. Lubricate the piston pin (2) bores in the piston (1) and the connecting rod (3) with clean engine oil.
2. Assemble the piston (1) and piston pin (2) to the connecting rod (3). Correctly orient the piston (1) when reusing a marked connecting rod (3).
3. Align the piston pin (2) bore with the connecting rod (1) pin bore.
4. Slide the piston pin (2) into the piston (1) and the connecting rod (3).



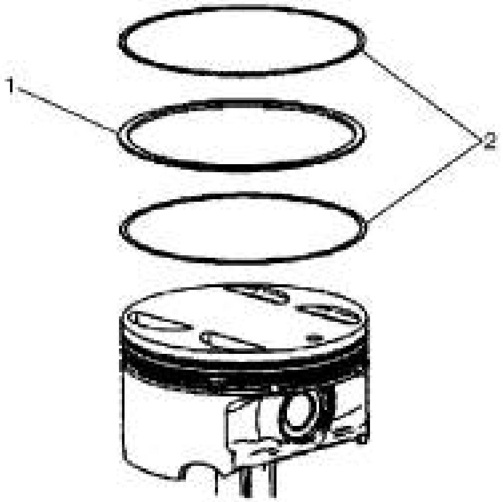
Important: New piston pin retainers must be used. Never reuse the piston pin retainers.

5. Install NEW piston pin retainers using the EN-46745 . Align the EN-46745 to the notch (1) in the piston.
6. Ensure that the piston pin retainers are fully seated in their grooves.
7. Repeat these procedures for the remaining pistons.

Piston Ring Installation Procedure



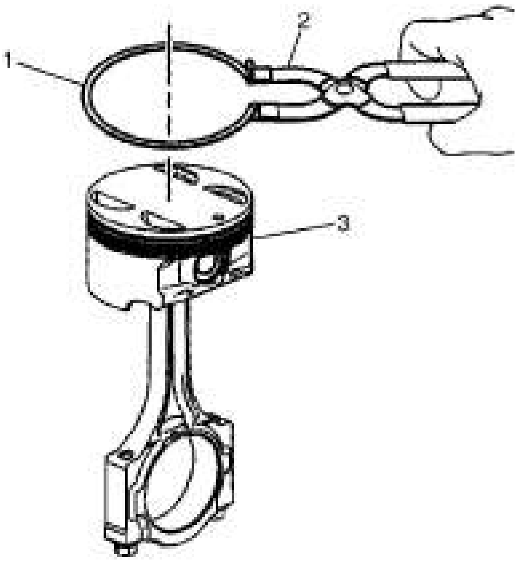
1. Correctly orient the oil control ring expander (1) as shown before installation. The ends of the oil control ring expander (1) must be facing toward the top of the piston.



2. Using a piston ring expander, install the oil control ring assembly using the following procedure:
   2.1. Install the expander ring (1).

   Important: Make sure that you DO NOT overexpand the piston ring. Overexpanding the piston rings will distort or crack the rings.

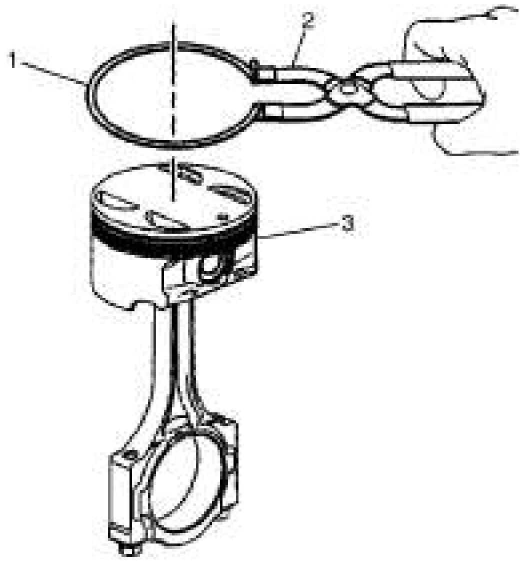
   2.2. Install the 2 oil scraper rings (2). Expand the rings only enough to clear the piston diameter.



Important: Make sure that you DO NOT overexpand the piston ring. Overexpanding the piston rings will distort or crack the rings.

Important: Install the second piston ring (1) onto the piston (3) using the ring expander (2).

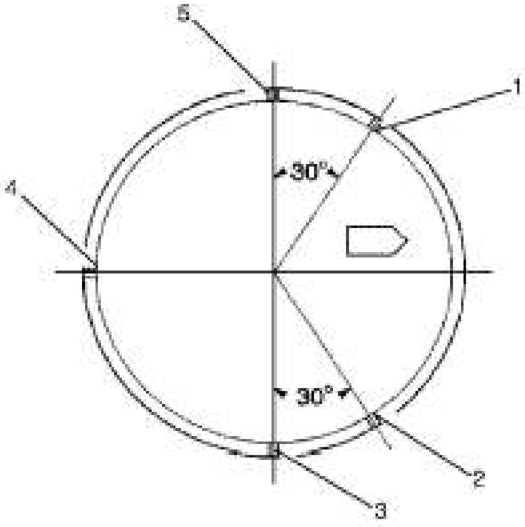
3. Install the second piston ring (1) onto the piston (3).



Important: Make sure that you DO NOT overexpand the piston ring. Overexpanding the piston rings will distort or crack the rings.

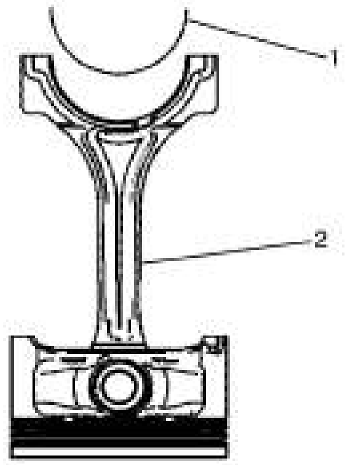
Important: Install the top piston ring (1) onto the piston (3) using the ring expander (2).

4. Install the top piston ring (1) onto the piston (3).



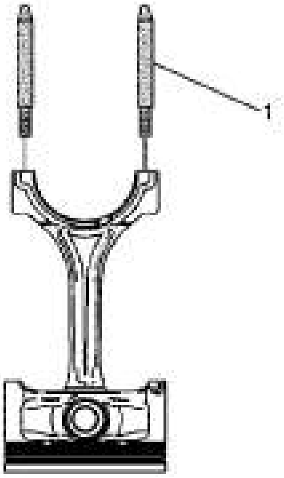
5. Once the rings are installed, set the ring gaps for the oil control, second and top ring as follows. Use the piston location arrow for reference.
    5.1. Lower oil control ring - position (1).
    5.2. Upper oil control ring - position (2).
    5.3. Top Ring - position (3).
    5.4. Oil control ring expander - position (4).
    5.5. Second ring - position (5).

Connecting Rod Bearing Installation Procedure

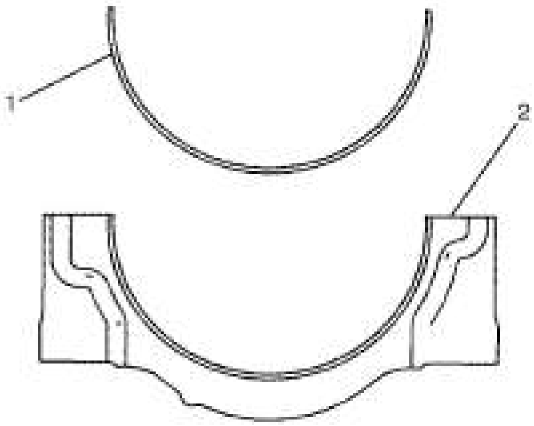


Important: If the connecting rod bearings (1) have been used in a running engine, you must replace them with NEW connecting rod bearings (1) for reassembly.

1. Clean the connecting rod (2) and the connecting rod cap bearing bore with a lint-free cloth.
2. Clean all the oil from behind the connecting rod bearing (1) halves.
3. Install new upper connecting rod bearings (1) into position. Roll the connecting rod bearings (1) into position so that the lock tang engages the alignment slot. The connecting rod bearings (1) must fit flush in the connecting rod (2).



4. Install the EN 46121 (1) into the connecting rod bolt holes.



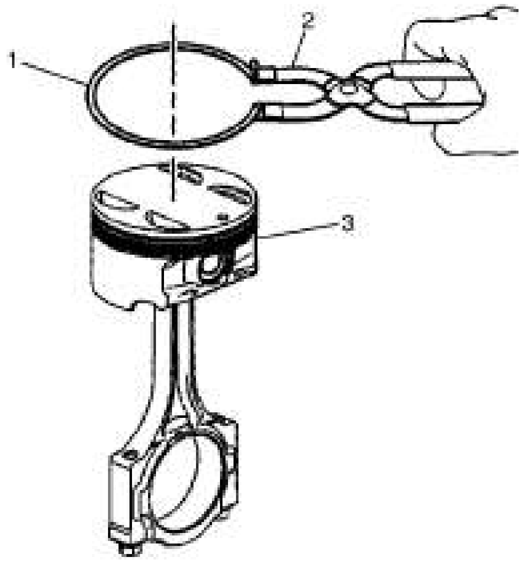
5. Install new lower connecting rod bearings (1) into position in the connecting rod cap (2). Roll the connecting rod bearings (1) into position so that the lock tang engages the alignment slot. The bearings must fit flush with the connecting rod cap (2).

Piston and Connecting Rod Disassemble

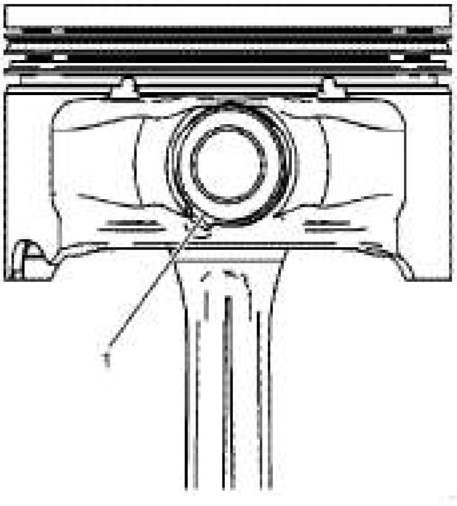
Tools Required

EN-46745 Piston Pin Clip Remover/Installer

> **Notice:** Refer to General Repair Instructions in the Preface section.



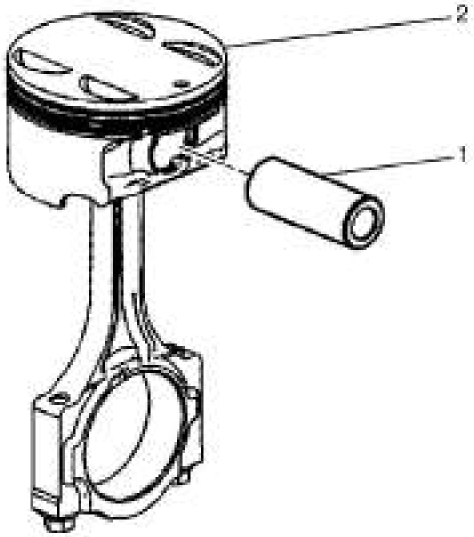
1. Remove the piston rings (2) from the piston (3) using a piston ring expander (1). Place each ring in a clean shop towel for storage.



Important:

- The connecting rod is non-directional and may be assembled/reassembled to the piston in either direction.
- DO NOT reuse the piston pin retainers.

2. Using the EN-46745 , remove the piston pin retainers by using the removal access notch (1) in the side of the piston. Discard the piston pin retainers.



3. Slide the piston pin (1) out of the piston (2). The piston will disconnect from the connecting rod.

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Piston, Connecting Rod, and Bearing Cleaning and Inspection

Cleaning Procedure

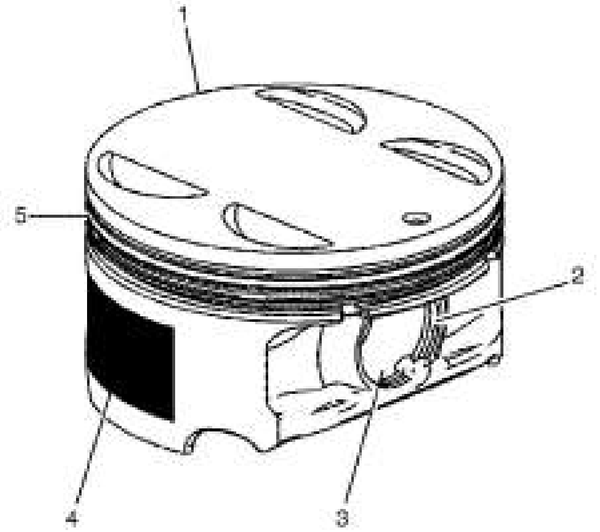
Important: DO NOT wire brush any part of the piston.

1. Clean the piston skirts and the pins with a cleaning solvent.
2. Clean the piston ring grooves with a groove cleaner. Ensure that the oil ring holes and slots are clean.

Caution: Refer to Safety Glasses Caution in the Preface section.

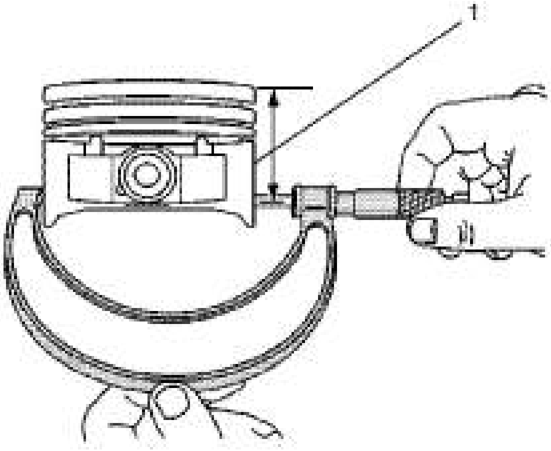
3. Dry the piston with compressed air.

Piston Inspection Procedure

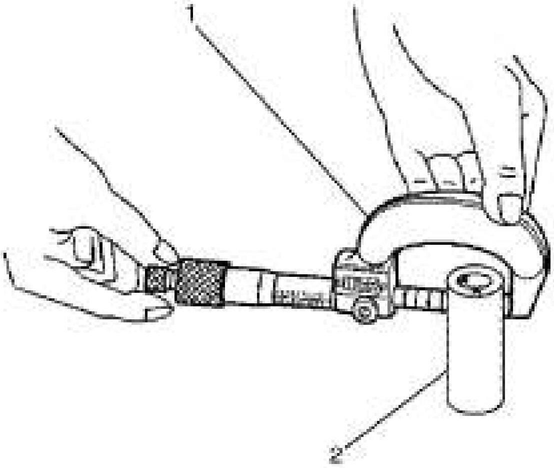


1. Inspect the pistons for the following conditions:
   - Cracked ring lands, skirts or pin bosses
   - Ring grooves for nicks, burrs that may cause binding (5)
   - Warped or worn ring lands (5)
   - Piston pin retainer grooves for burrs (2)
   - Eroded areas at the top of the piston (1)
   - Scuffed or damaged skirt coating (4)
   - Worn piston pin bores or worn piston pins (3)
2. Replace pistons that show any signs of damage or wear above acceptable tolerances.

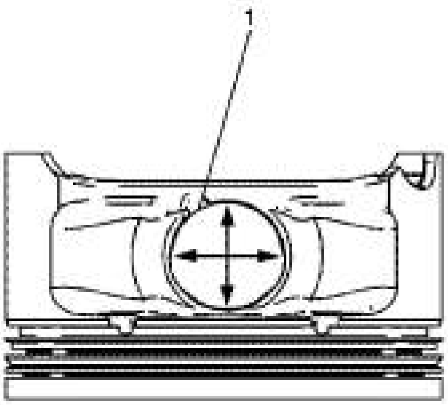
Piston Measurement Procedure



1. Measure piston width using the following procedure:
    1.1. Using an outside micrometer, measure the width of the piston at 30 mm (1.181 in) below the crown, top (1), at the thrust surfaces of the piston, perpendicular to the piston pin centerline.
    1.2. Compare the measurement of the piston to its original cylinder by subtracting the piston width from the cylinder diameter.
    1.3. Compare your results with the Engine Mechanical Specifications.
    1.4. If the clearance obtained through measurement is greater than the provided specifications and the cylinder bores are within specification, replace the piston.

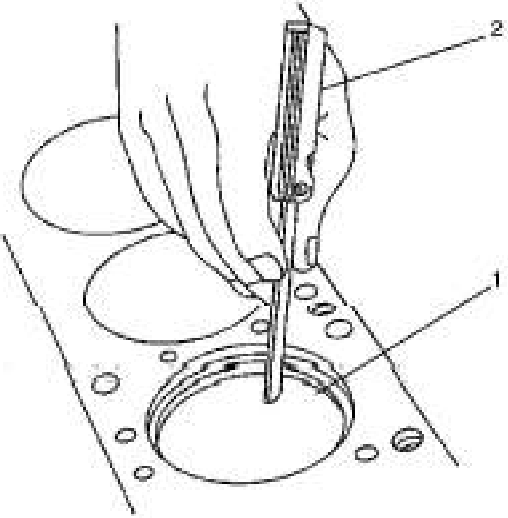


2. Measure the piston pin bore to piston pin (2) clearances using the following procedure:
    2.1. Piston pin bores and pins must be free of varnish or scuffing.
    2.2. Use an outside micrometer (1) to measure the piston pin in the piston contact areas.

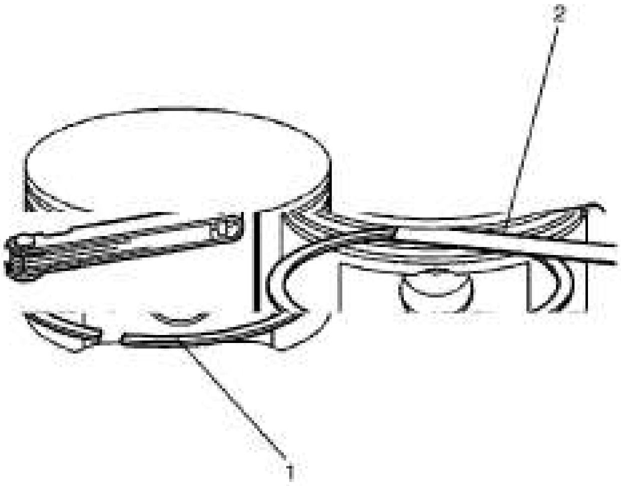


3. Using an inside micrometer, measure the piston pin bore (1). Compare your result with the piston pin diameter and piston pin to piston pin bore clearance listed in the Engine Mechanical Specifications.
4. If the clearance is above acceptable tolerances, determine which piece is out of specification and replace as necessary.
5. You must replace the piston if any of its dimensions are out of specification.
6. If the new piston does not meet clearance specifications, the cylinder block may need to be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

Piston Ring Measurement Procedure



1. Measure the piston ring end gap using the following procedure:
   1.1. Place the piston ring (1) in the area of the bore where the piston ring will travel approximately 25 mm (1 in) down from the deck surface. Make sure that the piston ring (1) is square with the cylinder bore by positioning the piston ring (1) with the piston head.
   1.2. Measure the end gap of the piston ring (1) with feeler gauges (2). Refer to Engine Mechanical Specifications.
   1.3. If the clearance exceeds the provided specifications, the piston rings (1) must be replaced.
   1.4. Repeat the procedure for all the piston rings (1).



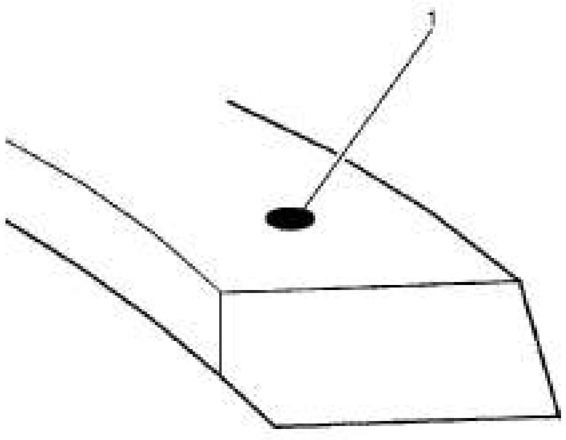
2. Measure the piston ring (1) side clearance using the following procedure:

2.1. Roll the piston ring (1) entirely around the piston ring groove. If any binding is caused by the ring groove, dress the groove with a fine file. If any binding is caused by a distorted piston ring (1), replace the piston ring (1).

2.2. With the piston ring (1) on the piston, use feeler gauges (2) to check clearance at multiple locations.

2.3. Compare the measurements with piston ring side clearance listed in the Engine Mechanical Specifications.

2.4. If the clearance is greater than specifications, replace the piston ring (1).



3. There is a locating dimple (1) on the compression rings near the end for identification. Install the compression rings with the dimple facing up.
4. If the new ring does not reduce the clearance to the correct specification, install a new piston.
5. If the new piston does not meet clearance specifications, the cylinder block may need to be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

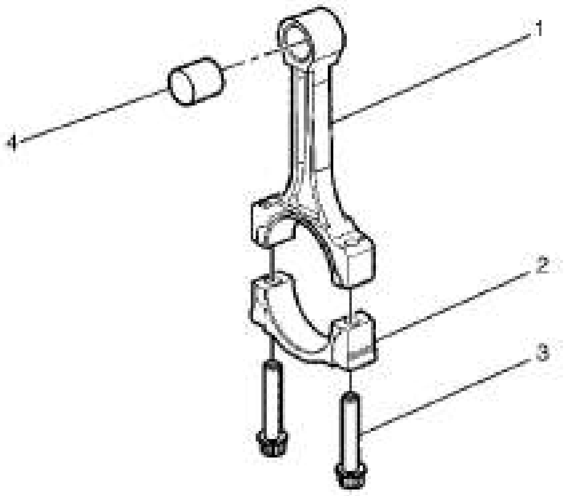
Connecting Rod Cleaning Procedure

1. Clean the connecting rods in solvent.

   Caution: Refer to Safety Glasses Caution in the Preface section.

2. Dry the connecting rod using compressed air.
3. Remove the connecting rod cap and clean the threads.
4. Remove the connecting rod bearing and discard. Never reuse a connecting rod bearing used in a running engine.

Connecting Rod Visual Inspection Procedure



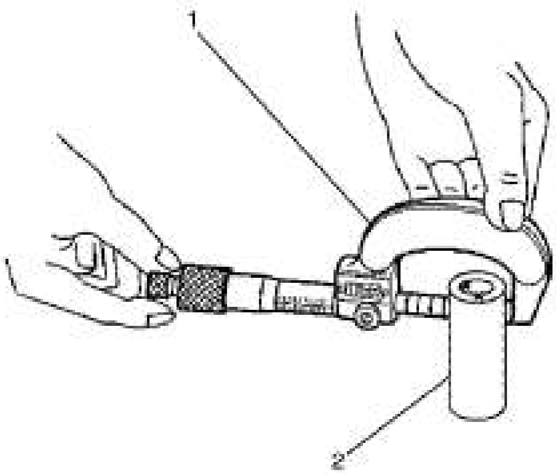
1. Inspect the piston pin bushing (4) for scoring or damage.
2. Inspect the connecting rod beam (1) for twisting or bending.
3. Inspect the rod cap (2) for any nicks or damage caused by possible interference.
4. Inspect for scratches or abrasion on the rod bearing seating surface.

   Important: DO NOT scrape the rod or rod cap.

5. If the connecting rod bores contain minor scratches or abrasions, clean the bores in a circular direction with a light emery paper.
6. Inspect the connecting rod bolts (3) for damage or stretching.

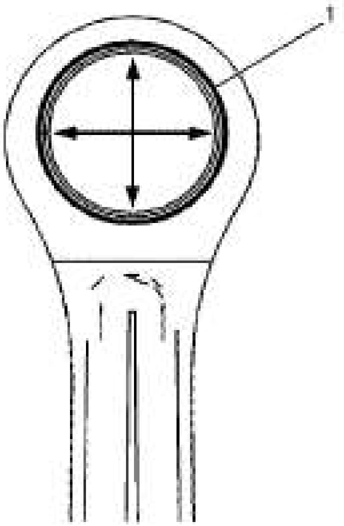
Connecting Rod Measurement Procedure

Piston Pin End



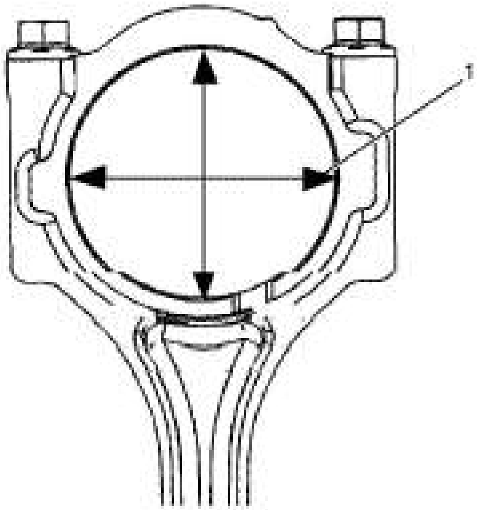
Important: Measurements of all components should be taken with the components at normal room temperature.

1. Using an outside micrometer (1), take 2 measurements of the piston pin (2) in the area of the connecting rod contact.



2. Using an inside micrometer, measure the connecting rod piston pin bore (1).
3. Subtract the piston pin diameter from the piston pin bore (1).
4. Compare the clearance measurements with the Engine Mechanical Specifications.
5. If the clearance is above acceptable tolerances, replace the piston pin. If a new pin does not resolve the clearance condition, replace the connecting rod.

Connecting Rod Crankshaft Bearing End

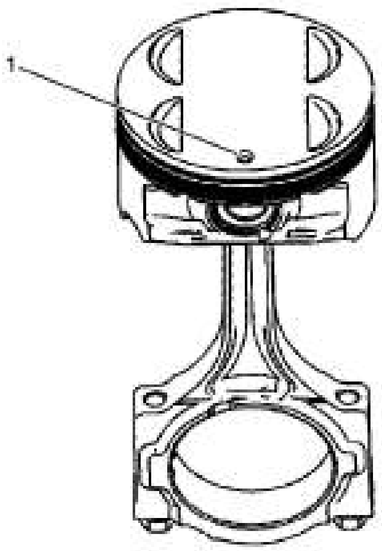


Important: Measurements of all components should be taken with the components at normal room temperature.

1. Using an inside micrometer, measure the connecting rod crankshaft bearing bore (1).
2. Compare the bore measurements with the Engine Mechanical Specifications.
3. Replace the connecting rod if the connecting rod crankshaft bearing bore (1) is out of specifications. DO NOT recondition the connecting rod.

Piston, Connecting Rod, and Bearing Installation

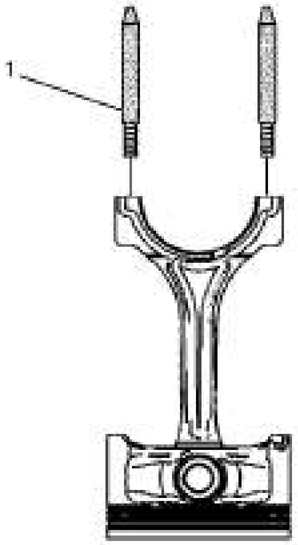
Piston and Connecting Rod Assembly Procedure



1. Liberally lubricate the cylinder walls, piston rings and piston skirts with engine oil.

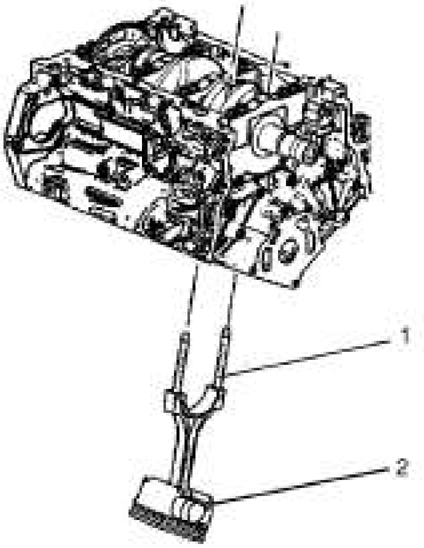
   Important: The piston is directional and must be installed in the cylinder block in the correct direction.

2. Select the correctly numbered piston/connecting rod assembly for the cylinder. A dot (1) showing proper piston orientation is located on the top of the piston.



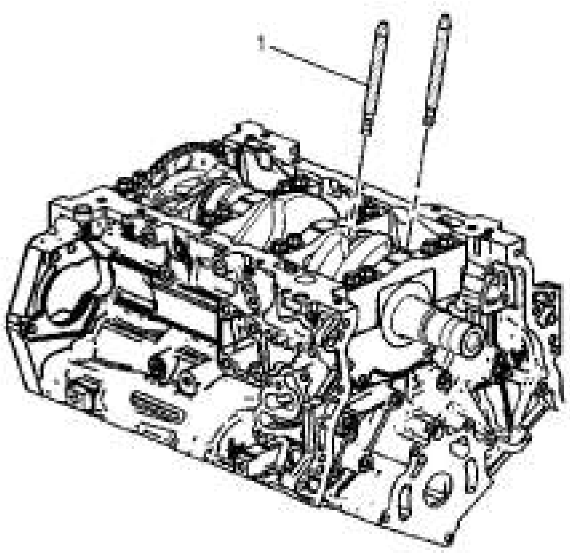
Important: If the connecting rod bearings have been used in a running engine, you must replace them with NEW connecting rod bearings for reassembly.

3. Install the connecting rod bearing into the connecting rod.
4. Install the EN 46121 (1) into the connecting rod bolt holes.
5. Compress the piston rings using a commercially available ring compressor.



Important: Extreme care must be used when installing the piston (2) and connecting rod in order to be sure the rod does not scrape or nick the cylinder bore, the oil jets, or the crankshaft surfaces.

6. Using both hands, slowly guide the piston (2) and connecting rod assembly into the cylinder from the top and bottom of the cylinder. DO NOT allow the connecting rod to contact the cylinder wall.
7. When the ring compressor contacts the deck surface, gently tap the piston (2) into the cylinder using the handle end of a dead-blow hammer. Guide the connecting rod onto the crankshaft bearing journal using the EN 46121 (1) while gently tapping the piston (2) into the cylinder with a soft-blow hammer.



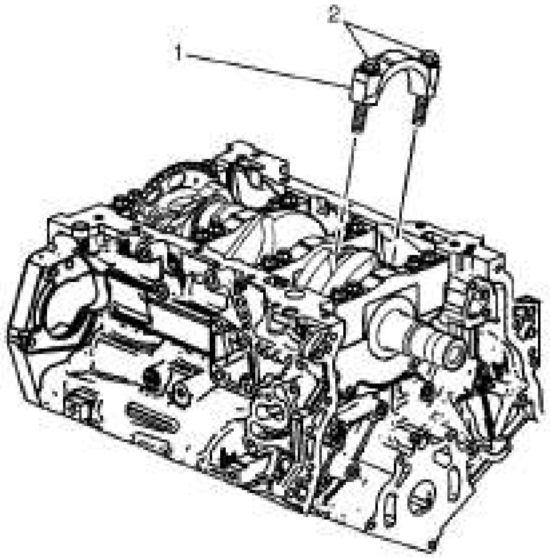
8. Remove the EN 46121 (1) from the connecting rod bolt holes.

Connecting Rod Bearing Clearance Measurement Procedure - Using Plastic Gaging

Important: Connecting rod bearings that have been run in an engine should NEVER be reused.

Important: Prior to final assembly it is the clearance of the new connecting rod bearings must be checked.

1. Place a length of fresh, room temperature plastic gauging material all the way across the connecting rod bearing journal.
2. Install the connecting rod bearing into the connecting rod cap.



Important: The connecting rod is non-directional therefore the connecting rod bearing lock tangs can face inboard or outboard.

3. Install the connecting rod end cap (1) on its original connecting rod and ensure the bearing lock tangs are aligned on the same side of the connecting rod.

   Notice: Refer to Fastener Notice in the Preface section.

   Notice: Refer to General Repair Instructions in the Preface section.

   Important: Reuse the old connecting rod bolts (2) ONLY for measuring the connecting rod bearing clearance.

4. Install the connecting rod bolts (2) into the connecting rod cap (1).

   Tighten
   Tighten the connecting rod bolts to 30 N·m (22 lb ft).

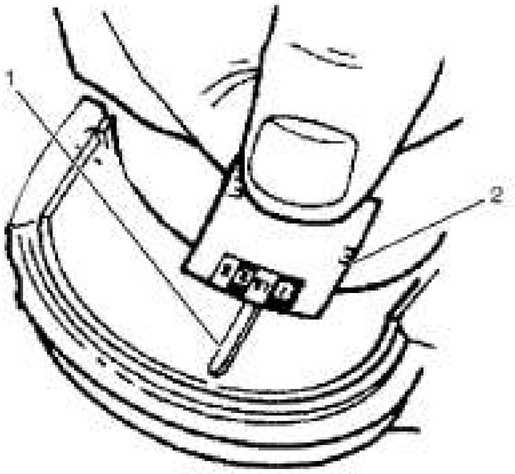
5. Loosen the connecting rod bolts (2) until the torque reading is zero.
6. Re-tighten the connecting rod bolts (2).
   6.1. First Pass

   Tighten
   Tighten the connecting rod bolts to 25 N·m (18 lb ft).

   6.2. Final Pass

   Tighten
   Tighten the connecting rod bolts an additional 110 degrees using the J 45059 .

7. Allow the assembly to sit for at least 2 minutes.
8. Remove the connecting rod cap bolts (2).
9. Remove the connecting rod cap (1).

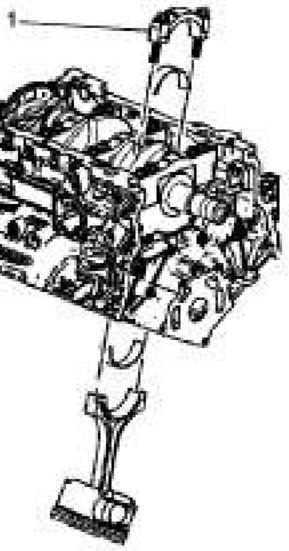


10. Determine the connecting rod bearing clearance by comparing the width of the flattened plastic gauging material (1) at its widest point with the graduation on the gauging material container (2).
11. Compare your measurements with the engine mechanical specifications. Refer to Engine Mechanical Specifications. If the new bearings DO NOT provide the proper crankshaft to connecting rod bearing clearance, inspect the following:
    - 11.1. Re-measure the crankshaft connecting rod journals for the correct specified size and ensure the proper new bearings are being installed. If the crankshaft connecting rod journals are incorrectly sized, replace or regrind the crankshaft. Crankshaft machining is permitted and undersized bearings are available.
    - 11.2. Re-measure the connecting rod bearing bore diameter to ensure proper size. The connecting rod is not machinable and the connecting rod must be replaced if out of specification.
12. Clean the plastic gaging material from the connecting rod bearing journals using a soft lint-free cloth.

Connecting Rod Final Assembly Procedure

1. Guide the connecting rod away from the crankshaft connecting rod journal in order to lubricate the crankshaft connecting rod bearing journal.
2. Apply a liberal amount of clean engine oil to the crankshaft connecting rod bearing journal.
3. Guide the connecting rod to the crankshaft connecting rod journal.
4. Install the connecting rod end cap on its original connecting rod and ensure the bearing lock tangs are aligned on the same side of the rod.

   Notice: Refer to Fastener Notice in the Preface section.



Important: DO NOT reuse the old connecting rod bolts.

5. Install the NEW connecting rod bolts into the connecting rod cap (1).

   Tighten
   Tighten the NEW connecting rod bolts to 30 N·m (22 lb ft).

6. Loosen the connecting rod bolts until the torque reading is zero.
7. Re-tighten the connecting rod bolts.
   7.1. First Pass

   Tighten
   Tighten the connecting rod bolts to 25 N·m (18 lb ft).

   7.2. Final Pass

   Tighten
   Tighten the connecting rod bolts an additional 110 degrees using the J 45059 .

8. During and after installation, ensure each piston is positioned properly in the correct cylinder. The locating arrow on the top of each piston must be pointing toward the front of the cylinder block.
9. Repeat these procedures for the remaining piston/connecting rod assemblies using the EN 46111 in order to rotate the crankshaft.

Piston, Connecting Rod, and Bearing Removal

Tools Required

EN 46121 Connecting Rod Guide Pin Set

Important:

- An arrow/dot showing correct piston orientation is located on the top of the piston.
- If the connecting rod bearings have been used in a running engine, you must replace them with NEW connecting rod bearings for reassembly.

1. Before removing the connecting rods, check the connecting rod side clearance using the following procedure:
    1.1. Tap the connecting rod to one end of the crankshaft journal with a dead-blow or wooden hammer.

    1.2. Using feeler gages, measure the clearance between the crankshaft counterweight and the connecting rod.

    1.3. The connecting rod side clearance should not exceed specifications. Refer to Engine Mechanical Specifications .

    1.4. If the end play exceeds the specified limits, measure the width of the crankpin end of the connecting rod. Refer to Piston, Connecting Rod, and Bearing Cleaning and Inspection .

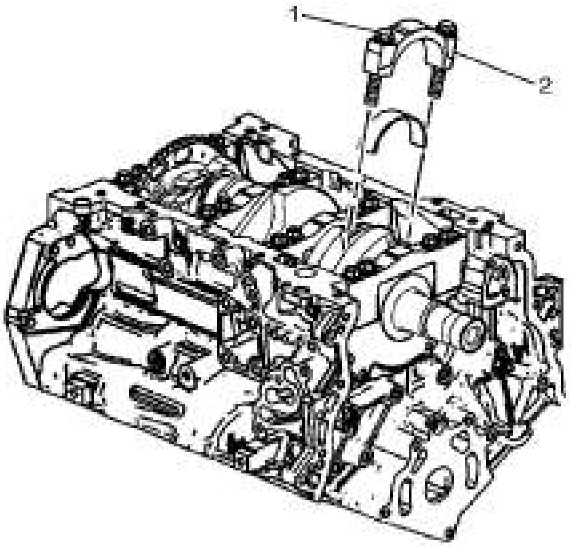
    1.5. If the connecting rod width is significantly smaller than specified and extreme wear is present on the side of the connecting rod, replace the connecting rod.

    1.6. If the connecting rod width is within specification and scoring above acceptable tolerances is present on the crankshaft journals, replace the crankshaft.
2. Using a marker, number each piston face. Draw an arrow along the centerline of the piston pointing toward the front of the cylinder block.

   Notice: Refer to General Repair Instructions in the Preface section.

3. Mark the cylinder number on the connecting rod and the connecting rod cap with a scribe, paint stick or permanent marker.

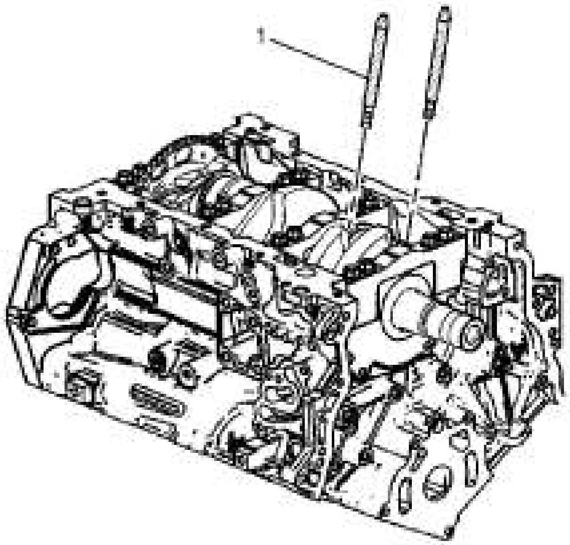
   Notice: Refer to General Repair Instructions in the Preface section.



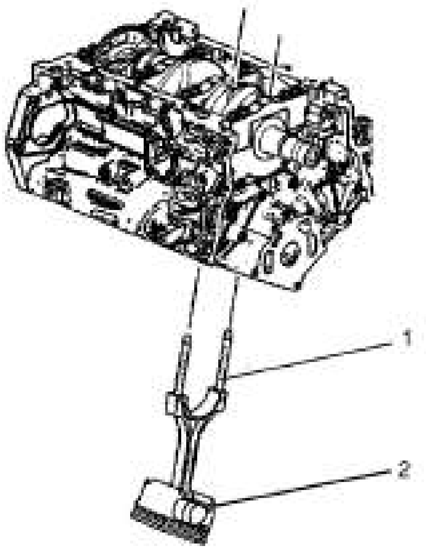
4. Remove the connecting rod bolts (1).

   Important: The connecting rod caps (2) must remain with the original connecting rod.

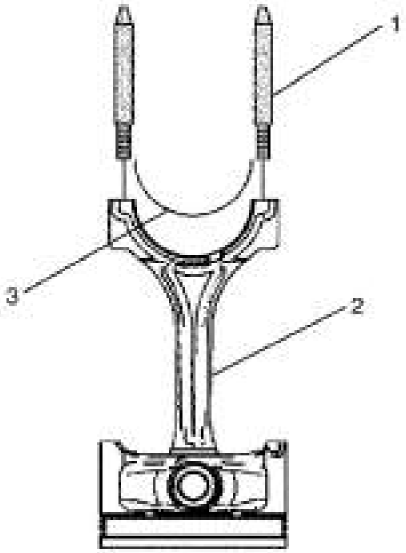
5. Remove the connecting rod cap (2).



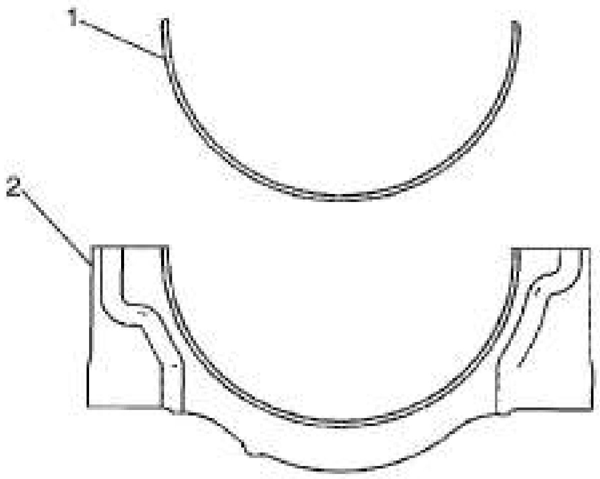
6. Install the EN 46121 (1) into the connecting rod bolt holes.



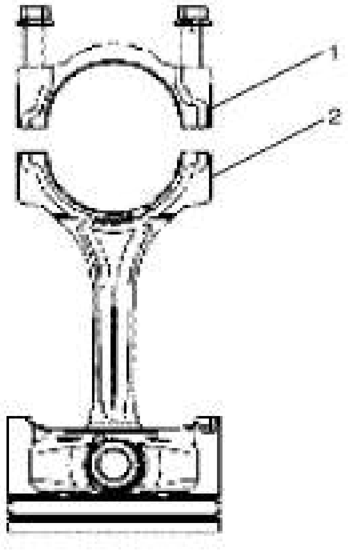
7. Using the EN 46121 1 (1), push the connecting rod and piston assembly (2) through the top of the cylinder. DO NOT scratch the crankshaft journal or cylinder wall and DO NOT damage the oil jets when removing the connecting rod and piston assembly (2).



8. Remove the EN 46121 (1) from the connecting rod bolt holes.
9. Remove the upper connecting rod bearing (3) from the connecting rod (2).

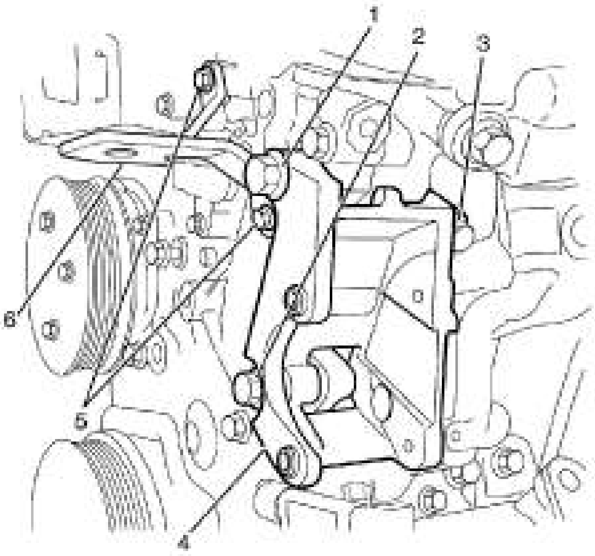


10. Remove the lower connecting rod bearing (1) from the connecting rod cap (2).



11. Reattach the connecting rod cap (1) to the connecting rod (2) to prevent damage to their mating surfaces. The connecting rod cap (1) and connecting rod (2) are a matched set and must be kept together.

Power Steering Pump Installation

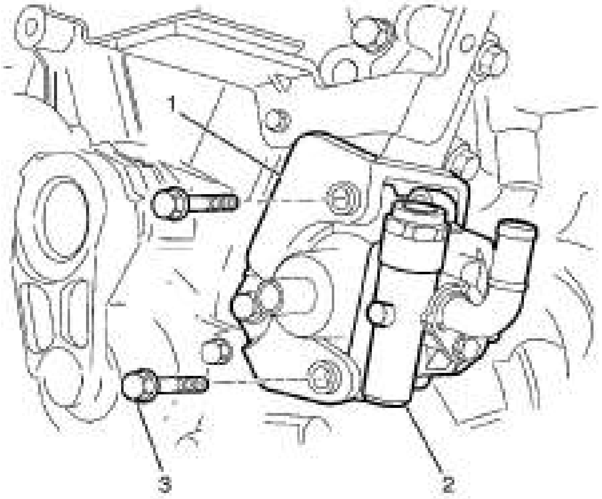


1. Install the power steering pump bracket (2).
2. Install the NEW power steering bracket to cylinder head retaining bolts (1).

   Tighten
   Tighten the bolts to 58 N·m (43 lb ft).

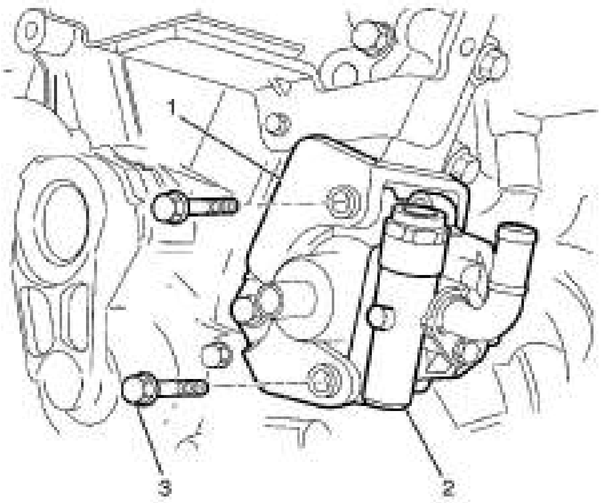
3. Install the power steering fluid reservoir bracket (4).
4. Install the NEW power steering fluid reservoir bracket to engine front cover retaining bolts (3).

   Tighten
   Tighten the bolts to 9 N·m (80 lb ft).

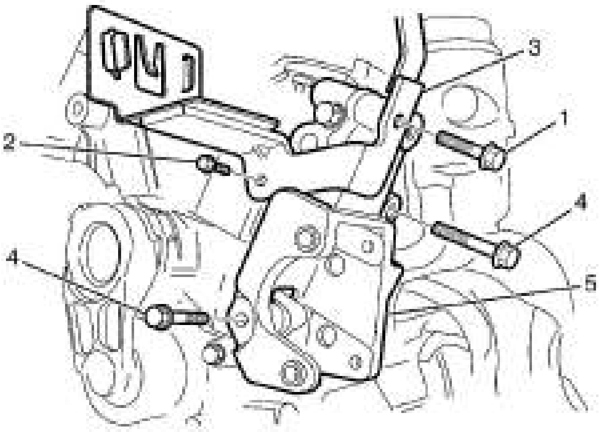


5. Install the power steering pump (2) to the power steering pump mounting bracket (3).
6. Install the power steering pump to mounting bracket retaining bolts (1).

Power Steering Pump Removal



1. Remove the power steering pump to mounting bracket retaining bolts (3).
2. Remove the power steering pump (2) from the power steering pump mounting bracket (1).



3. Remove the power steering reservoir bracket to cylinder head retaining bolt (1).
4. Remove the power steering reservoir bracket to engine front cover retaining bolt (2).
5. Remove the power steering reservoir bracket (3).
6. Remove the power steering pump bracket to cylinder head retaining bolts (4).
7. Remove the power steering pump bracket (5).

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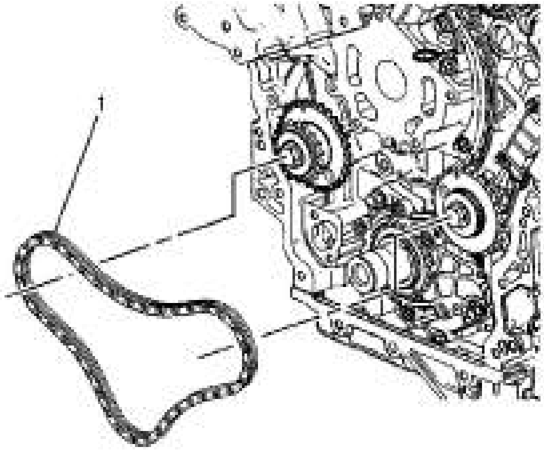
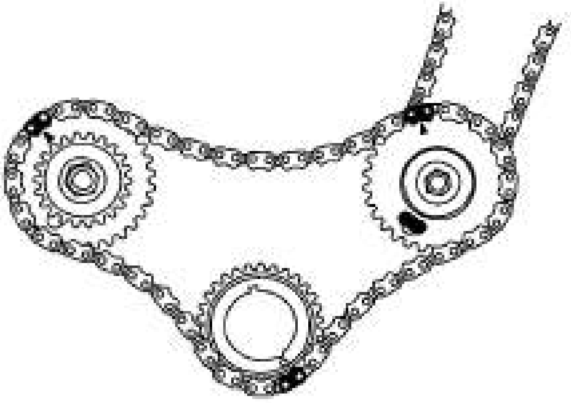
Primary Camshaft Intermediate Drive Chain Installation

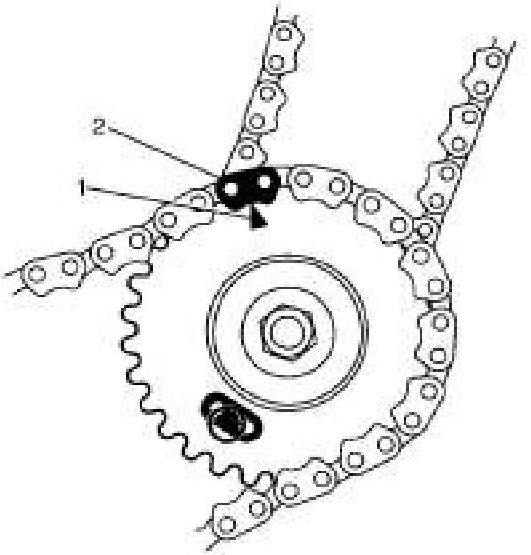


Important: Ensure that the crankshaft is in the stage one timing drive assembly position.

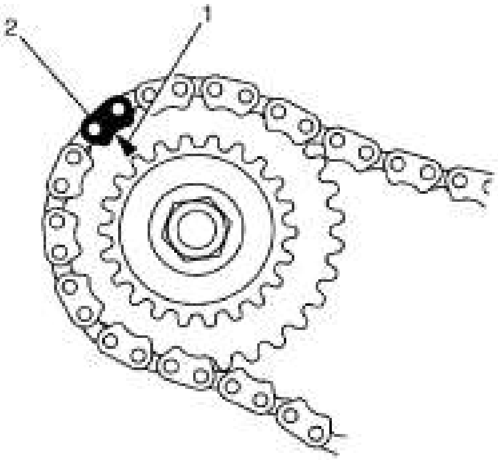
1. Install the primary camshaft drive chain (1).



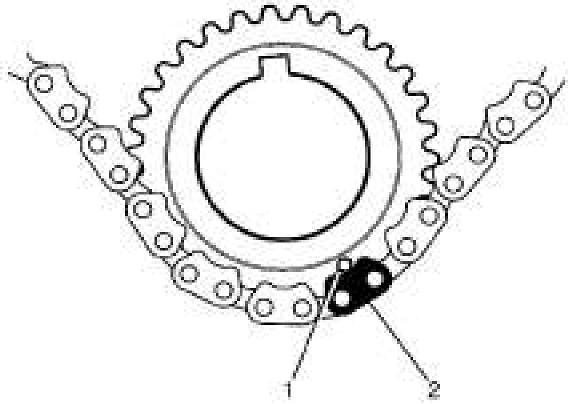
2. Wrap the primary camshaft drive chain around the large sprockets of each camshaft intermediate drive chain idler and the crankshaft sprocket.



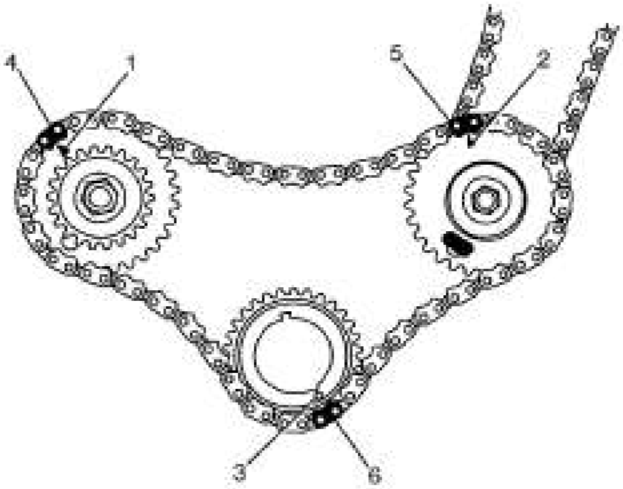
3. The left camshaft intermediate drive chain idler timing mark (1) will align with a timing camshaft drive chain link (2).



4. The right camshaft intermediate drive chain idler timing mark (2) will align with a timing camshaft drive chain link (1).



5. The crankshaft sprocket timing mark (2) will align with a timing camshaft drive chain link (1).



6. Ensure all the timing marks (2, 3, 6) are properly aligned with the timing camshaft drive chain links (1, 4, 5).

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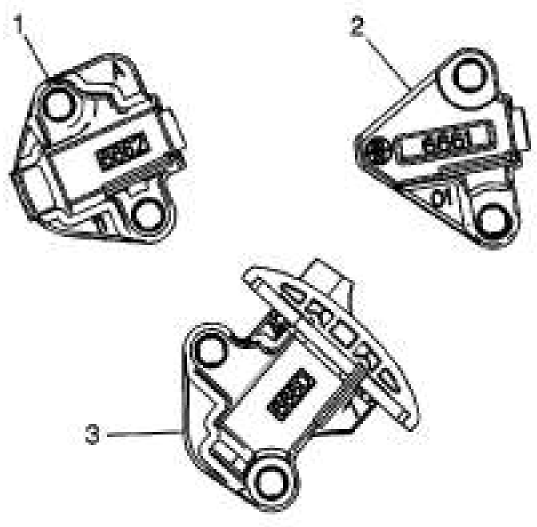
Primary Camshaft Intermediate Drive Chain Tensioner Installation (LLT)

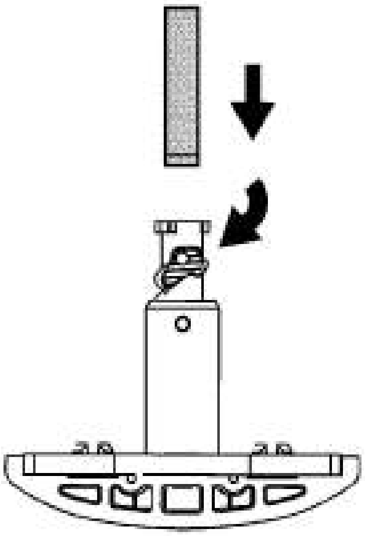
Special Tools

- *EN 46112* Tensioner Retraction Pins
- *EN-48383* Camshaft Retaining Tools
- *EN-48589* Crankshaft Rotation Socket
- *J 45027* Tensioner Tool

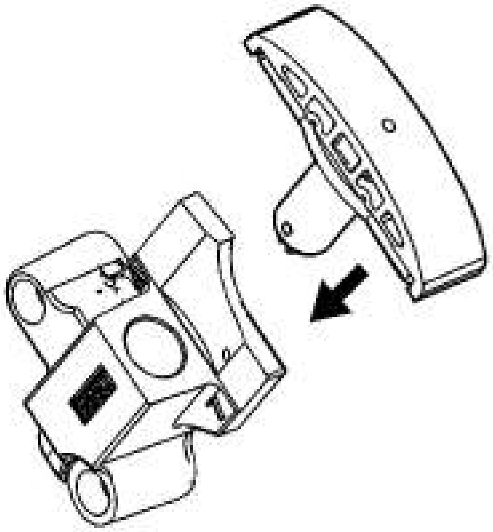
  For equivalent regional tools, refer to Special Tools.



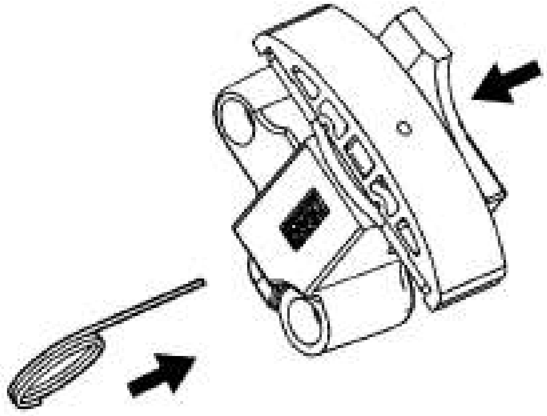
1. Ensure that the primary camshaft drive chain tensioner (3) is being installed.



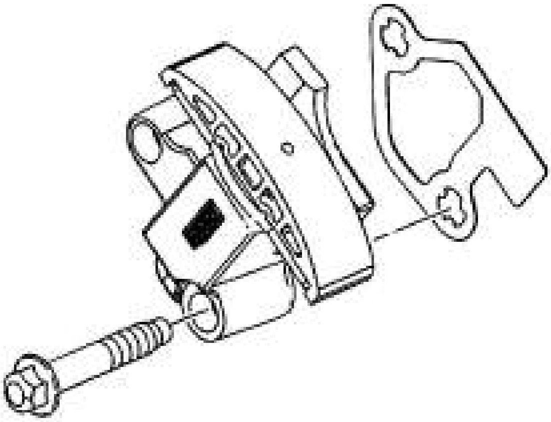
2. Using the *J 45027* tool , reset the primary camshaft drive chain tensioner plunger.



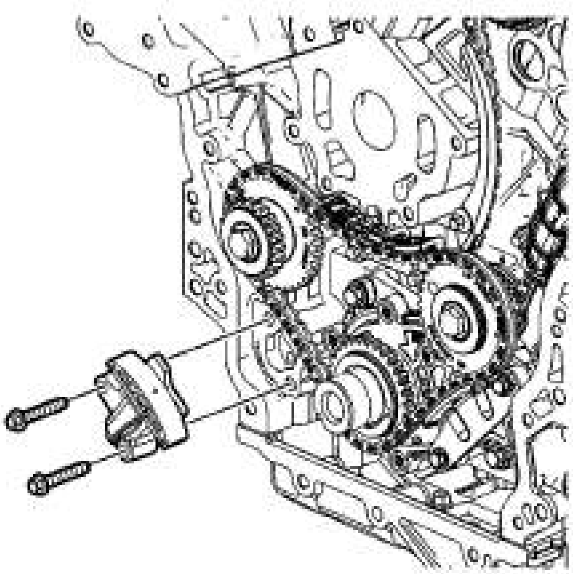
3. Install the plunger into the primary camshaft drive chain tensioner body.



4. Compress the plunger into the body and lock the primary camshaft drive chain tensioner by inserting the *EN 46112* pins into the access hole in the side of the primary camshaft drive chain tensioner body.
5. Slowly release pressure on the primary camshaft drive chain tensioner. The primary camshaft drive chain tensioner should remain compressed.

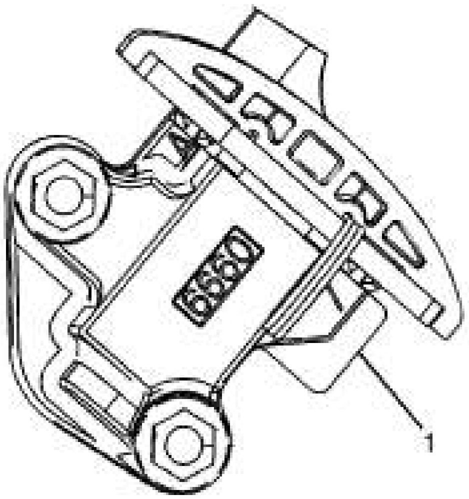


6. Install a NEW primary camshaft drive chain tensioner gasket to the primary camshaft drive chain tensioner.
7. Install the primary camshaft drive chain tensioner bolts through the primary camshaft drive chain tensioner and gasket.
8. Ensure the primary camshaft drive chain tensioner mounting surface on the engine block does not have any burrs or defects that would degrade the sealing of the NEW primary camshaft drive chain tensioner gasket.



9. Place the primary camshaft drive chain tensioner into position and loosely install the bolts to the block.

Caution: Refer to Fastener Caution in the Preface section.

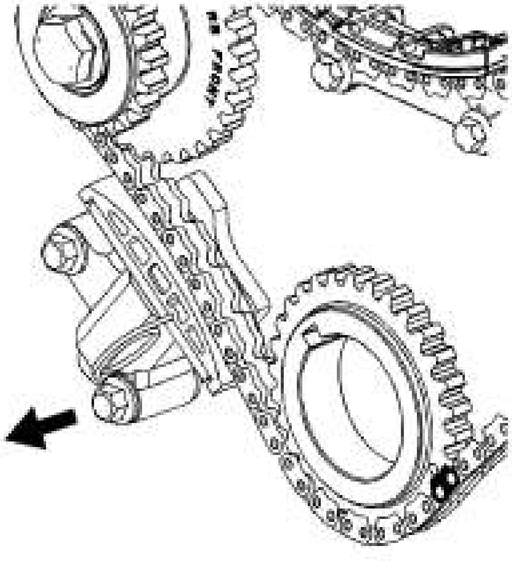


10. Verify the proper placement of the primary camshaft drive chain tensioner gasket tab (1).
    10.1. First Pass

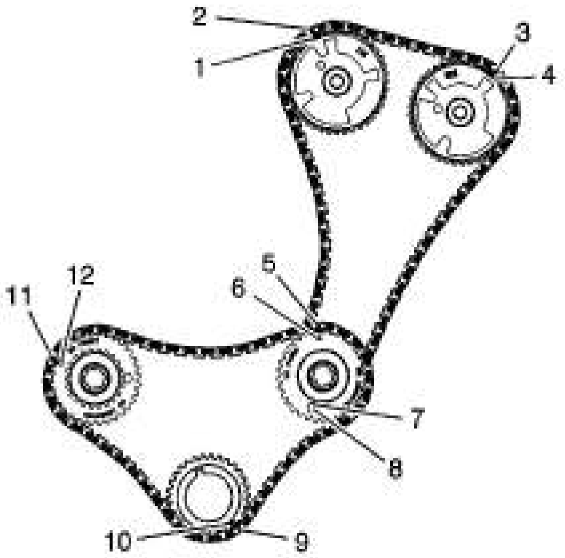
    Tighten the primary camshaft drive chain tensioner bolts to **5 N·m (44 lb in).**

    10.2. Final Pass

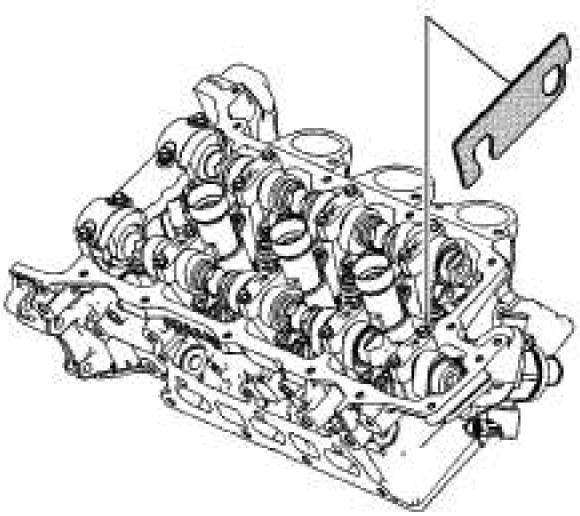
Tighten the primary camshaft drive chain tensioner bolts to **23 N·m (17 lb ft)**.



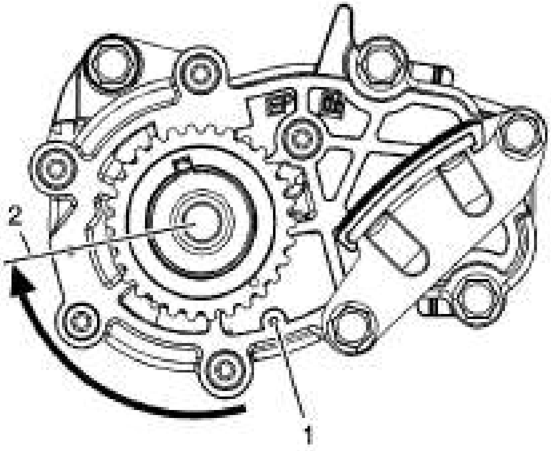
11. Release the primary camshaft drive chain tensioner by pulling out the *EN 46112* pins and unlocking the tensioner plunger.



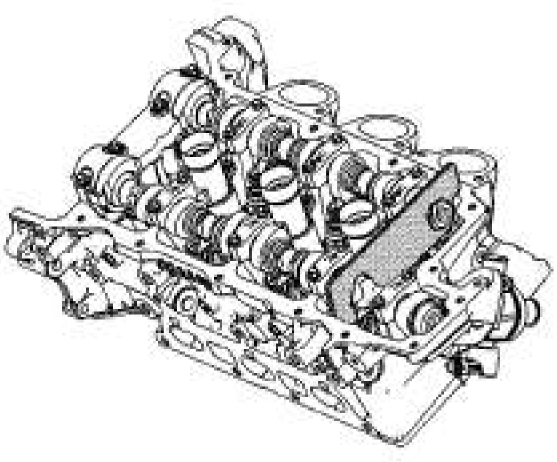
12. Verify the primary and left secondary camshaft drive chain timing mark alignments (1-12). Also refer to Camshaft Timing Drive Chain Alignment Diagram.



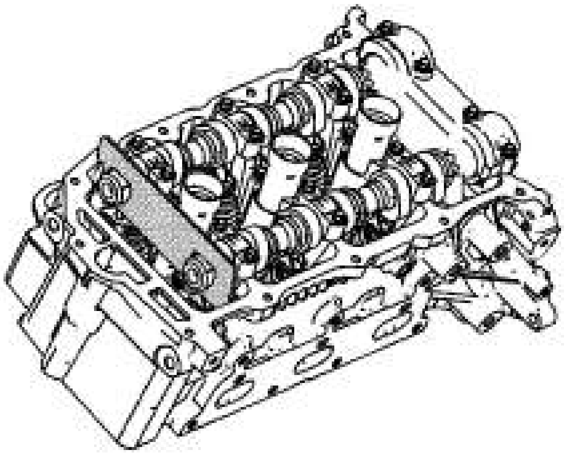
13. Remove the EN 48383-1 from the rear of the left camshafts.



14. Using the *EN-48589* socket , rotate the crankshaft and crankshaft sprocket from the stage 1 alignment position (1) to the stage 2 alignment position (2), 115 crankshaft degrees, in order to install the right secondary camshaft drive chain components.

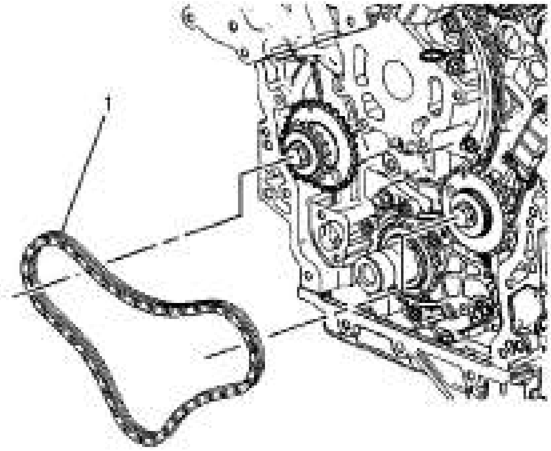


15. Install the EN 48383-2 onto the rear of the left camshafts.



16. Install the EN 48383-3 onto the rear of the right camshafts.

Primary Camshaft Intermediate Drive Chain Removal

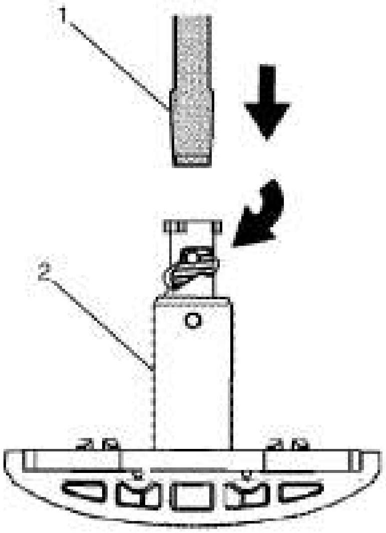


Remove the primary camshaft drive chain (1).

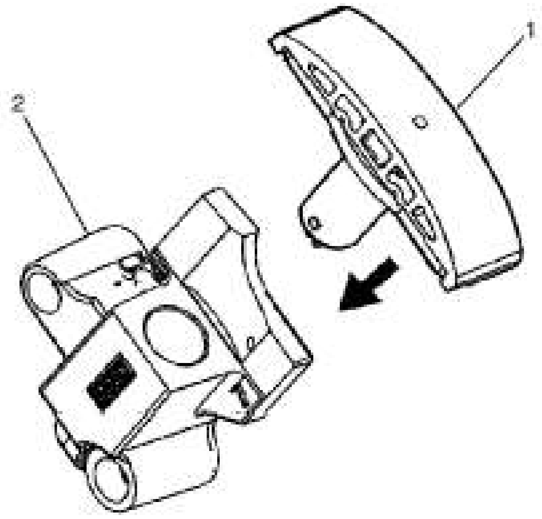
Primary Camshaft Intermediate Drive Chain Tensioner Installation

Tools Required

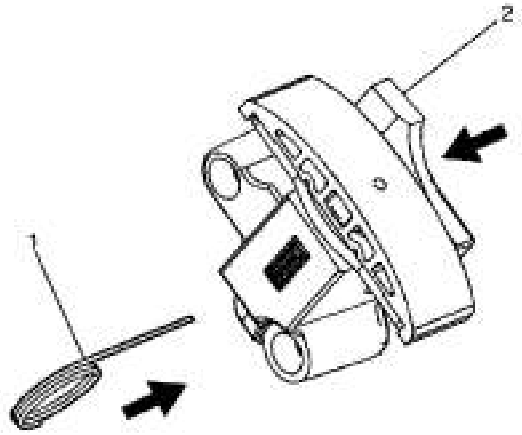
- EN 46105 Camshaft Locking Tools
- EN 46111 Crankshaft Rotation Socket
- EN 46112 Tensioner Retraction Pins
- J 45027 Tensioner Tool



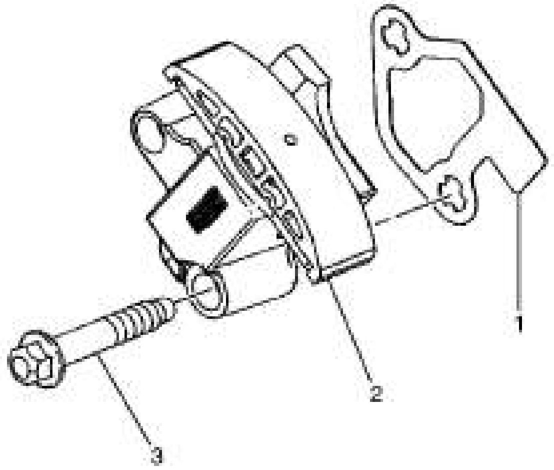
1. Using the J 45027 (1) reset the primary camshaft drive chain tensioner plunger (2).



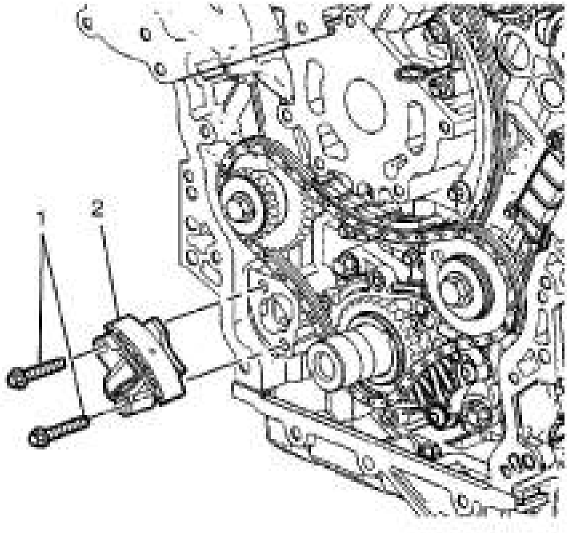
2. Install the plunger (1) into the primary camshaft drive chain tensioner body (2).



3. Compress the plunger into the body and lock the primary camshaft drive chain tensioner (2) by inserting the EN 46112 (1) into the access hole in the side of the primary camshaft drive chain tensioner (2).
4. Slowly release pressure on the primary camshaft drive chain tensioner. The primary camshaft drive chain tensioner should remain compressed.

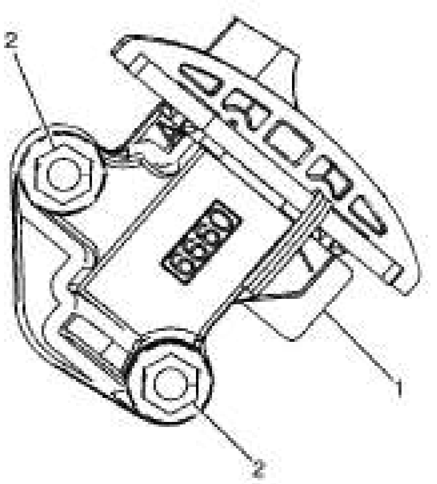


5. Install a NEW primary camshaft drive chain tensioner gasket (1) to the primary camshaft drive chain tensioner (2).
6. Install the primary camshaft drive chain tensioner bolts (3) through the primary camshaft drive chain tensioner (2) and gasket (1).
7. Ensure the primary camshaft drive chain tensioner mounting surface on the engine block does not have any burrs or defects that may degrade the sealing of the NEW primary camshaft drive chain tensioner gasket (1).



8. Place the primary camshaft drive chain tensioner (2) into position and loosely install the primary camshaft drive chain tensioner to cylinder block retaining bolts (1).

Notice: Refer to Fastener Notice in the Preface section.

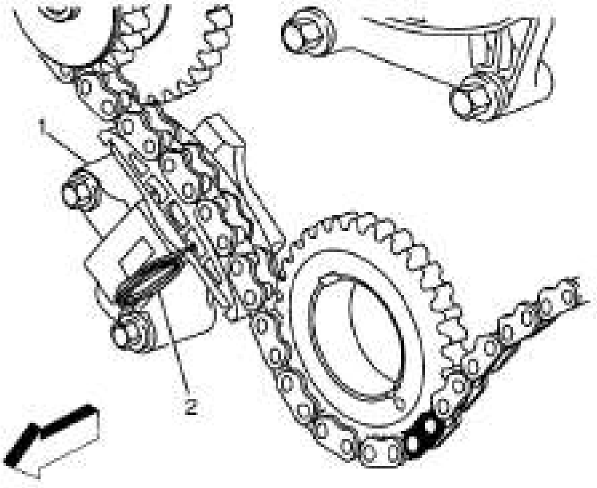


9. Verify the proper placement of the primary camshaft drive chain tensioner gasket tab (1).
10. Tighten the primary camshaft drive chain tensioner to cylinder block retaining bolts (2)
    10.1. First Pass

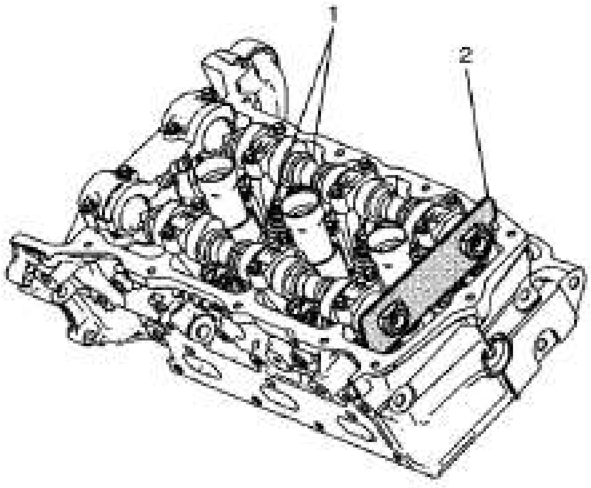
    Tighten
    Tighten the bolts to 5 N·m (44 lb in).

    10.2. Final Pass

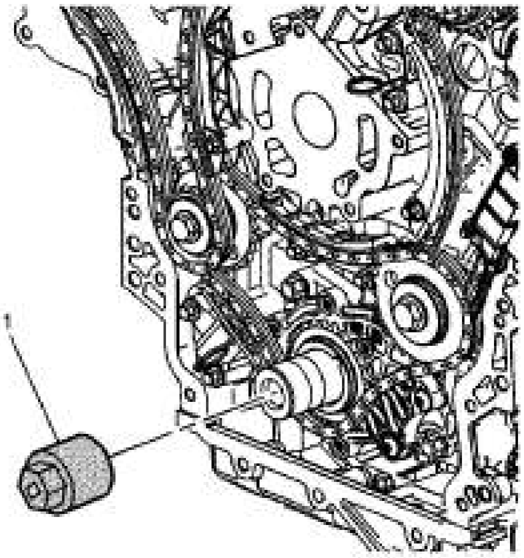
    Tighten
    Tighten the bolts to 23 N·m (17 lb ft).



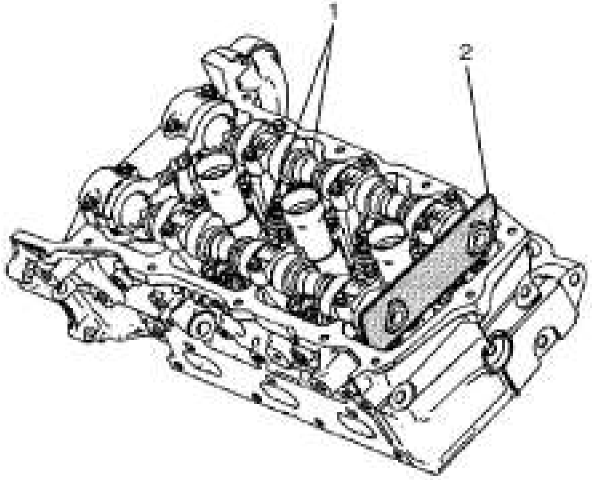
11. Release the primary camshaft drive chain tensioner (1) by pulling out the EN 46112 (2).
12. Verify the primary and left secondary camshaft drive chain timing mark alignments (1-12). Refer to Camshaft Timing Drive Chain Alignment Diagram .



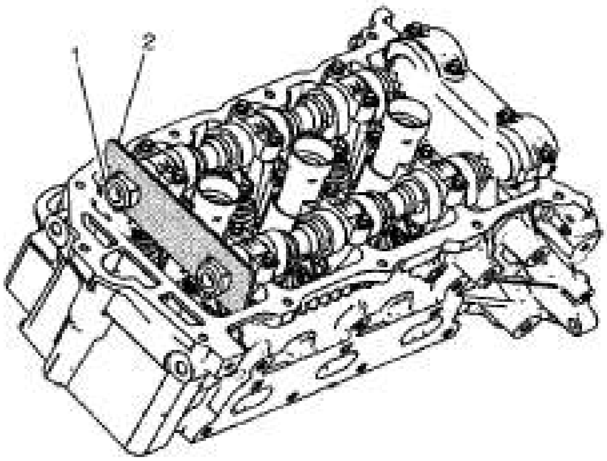
13. Remove the EN 46105 (2) from the rear of the left hand camshafts (1).



14. Using the EN 46111 (1) rotate the crankshaft and crankshaft sprocket from the stage one alignment position (1) to the stage two alignment position, 115 crankshaft degrees, in order to install the right secondary camshaft drive chain components.

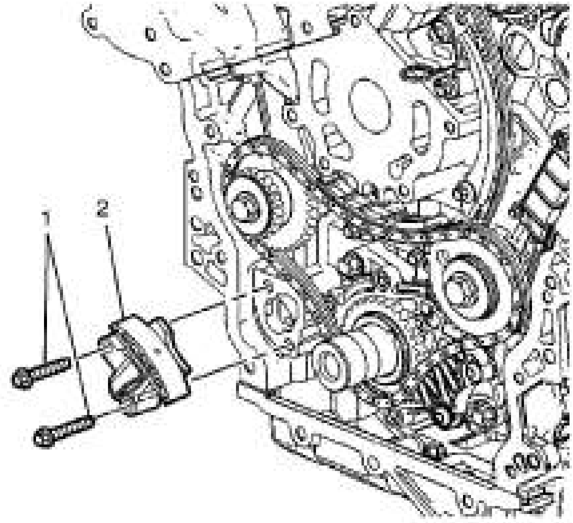


15. Install the EN 46105 (2) onto the rear of the left hand camshafts (1).

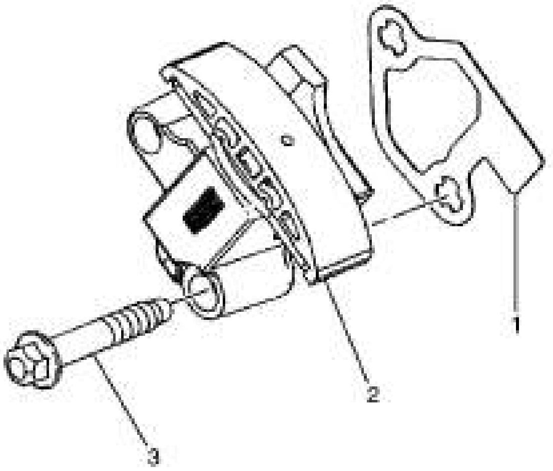


16. Install the EN 46105 (2) onto the rear of the right hand camshafts (1).

Primary Camshaft Intermediate Drive Chain Tensioner Removal



1. Remove the primary camshaft drive chain tensioner to cylinder block retaining bolts (1).
2. Remove the primary camshaft drive chain tensioner (2).



3. Remove the primary camshaft drive chain tensioner bolts (3) from the primary camshaft drive chain tensioner (2) and gasket (1).

Important: The primary camshaft drive chain tensioner gasket (1) must be discarded whenever the primary camshaft drive chain tensioner (2) has been removed from the cylinder block.

4. Remove the primary camshaft drive chain tensioner gasket (1) from the primary camshaft drive chain tensioner (2).

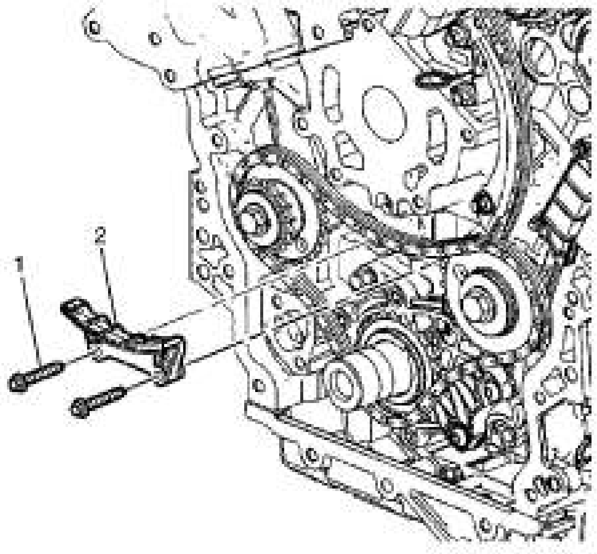
   Discard the gasket.

5. Inspect the primary camshaft drive chain tensioner mounting surface on the engine block for burrs or any defects that may degrade the sealing of the NEW primary camshaft drive chain tensioner gasket.

Primary Timing Chain Guide Installation - Lower

DO NOT remove the primary camshaft drive chain lower guide. The primary camshaft drive chain lower guide is not serviceable separately. If the primary camshaft drive chain lower guide must be replaced, the oil pump must be replaced.

Primary Timing Chain Guide Installation - Upper



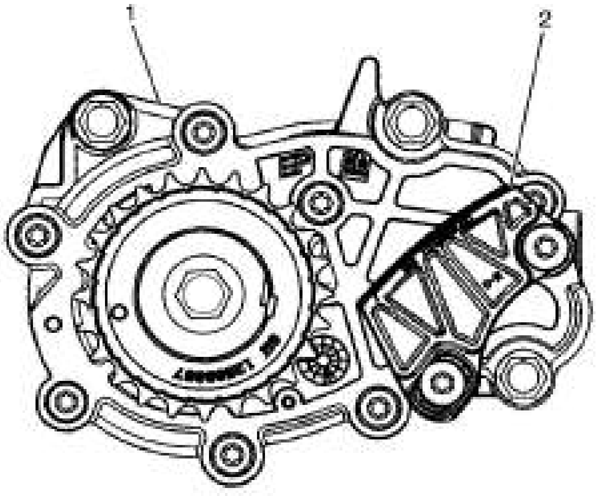
1. Install the primary camshaft drive chain upper guide (2).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the primary camshaft drive chain upper guide to cylinder block retaining bolts (1).

   Tighten
   Tighten the bolts to 23 N·m (17 lb ft).

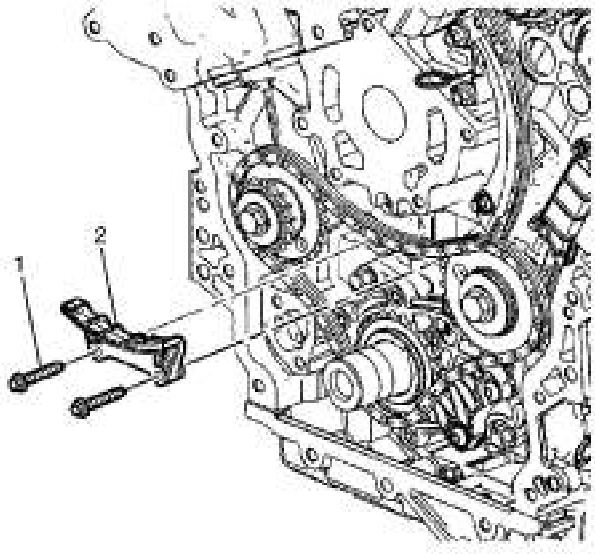
Primary Timing Chain Guide Removal - Lower



DO NOT remove the primary camshaft drive chain lower guide (2). The primary camshaft drive chain lower guide (2) is not serviceable separately. If the primary camshaft drive chain lower guide (2) must be replaced, the oil pump (1) must be replaced.

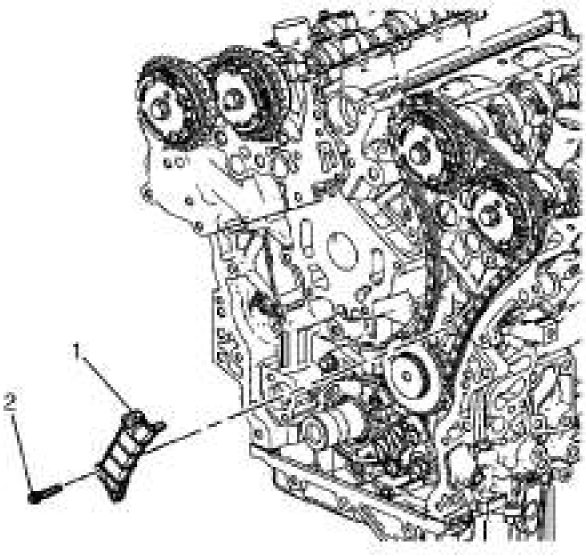
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | **Document ID: 1977586**

Primary Timing Chain Guide Removal - Upper



1. Remove the primary camshaft drive chain upper guide to cylinder block retaining bolts (1).
2. Remove the primary camshaft drive chain upper guide (2).

Secondary Camshaft Drive Chain Guide Installation - Left Side



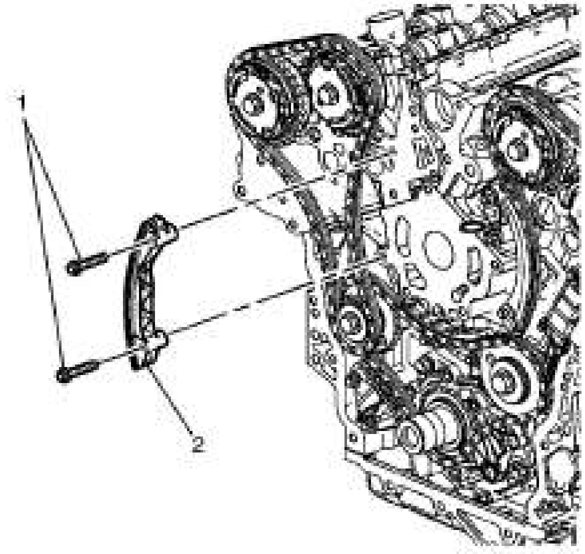
1. Install the left secondary camshaft drive chain guide (1).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the secondary camshaft drive chain guide to cylinder block retaining bolts (2).

   Tighten
   Tighten the bolts to 23 N·m (17 lb ft).

Secondary Camshaft Drive Chain Guide Installation - Right Side



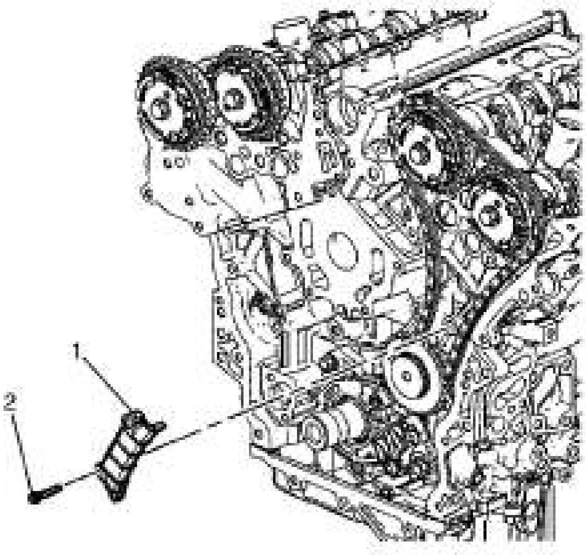
1. Position the right secondary camshaft drive chain guide (2).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the secondary camshaft drive chain guide to cylinder block retaining bolts (1).

   Tighten
   Tighten the bolts to 23 N·m (17 lb ft).

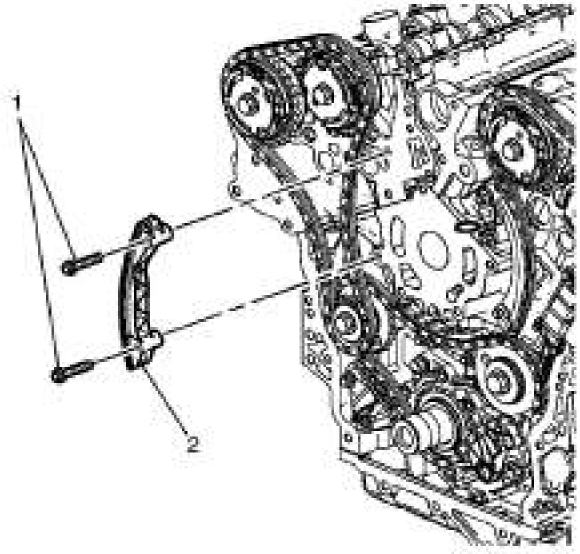
Secondary Camshaft Drive Chain Guide Removal - Left Side



1. Remove the left secondary camshaft drive chain guide to cylinder block retaining bolts (2).
2. Remove the left secondary camshaft drive chain guide (1).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | **Document ID: 1977584**

Secondary Camshaft Drive Chain Guide Removal - Right Side



1. Remove the right secondary camshaft drive chain guide to cylinder block retaining bolts (1).
2. Remove the right secondary camshaft drive chain guide (2).

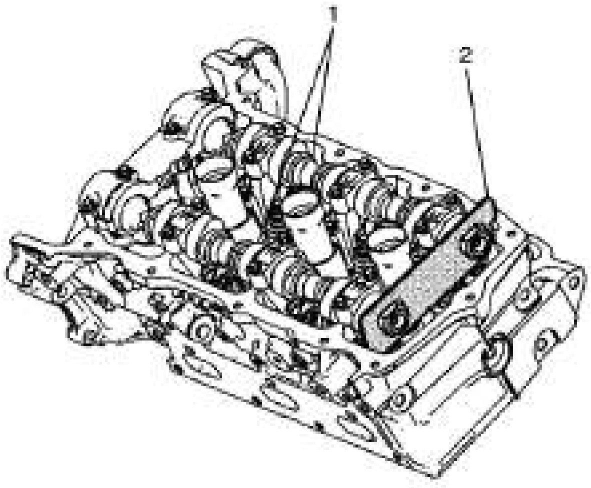
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | **Document ID: 1995364**

Secondary Camshaft Drive Chain Installation - Left Side

Secondary Camshaft Drive Chain Installation - Left Side (LY7)

Tools Required

- EN 46105 Camshaft Locking Tools
- EN 46111 Crankshaft Rotation Socket

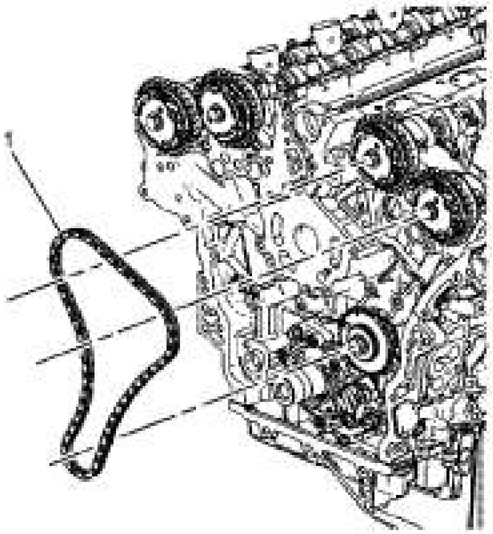


Important: There should be no need to rotate the camshafts (1) more than 10 degrees. Using the hex cast into the camshaft (1) rotate the camshaft (1) in order to install the EN 46105 (2).

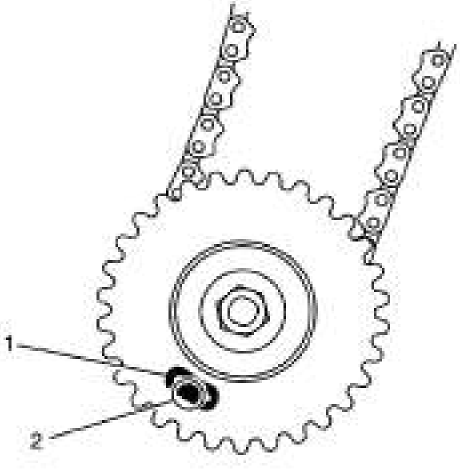
1. Install the EN 46105 (2) onto the rear of the left camshafts (1).

   Important: All camshafts (1) must be locked in place before installation of any camshaft drive chains.

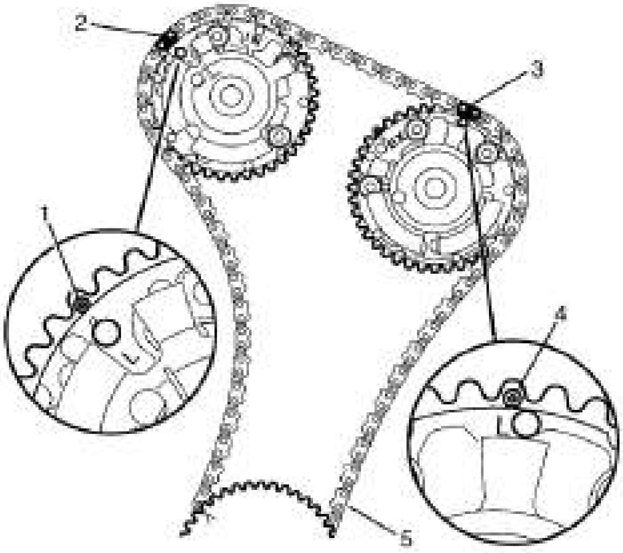
2. Make sure that the EN 46105 (2) is fully seated onto the camshafts (1).
3. Make sure that the crankshaft is in the stage one timing drive assembly position using the EN 46111 . Refer to Camshaft Timing Drive Chain Alignment Diagram Stage One.



4. Install the left secondary camshaft drive chain (1).



5. Place the left secondary camshaft drive chain around the inner sprocket of the left camshaft intermediate drive chain idler with the timing camshaft drive chain link (1) aligned to the alignment access hole (2) made in the left camshaft intermediate drive chain idler outer sprocket.
6. Wrap the secondary camshaft drive chain around both left actuator drive sprockets.
7. Make sure there are 10 links between the timing camshaft drive chain links for the camshaft position actuator solenoid sprockets.

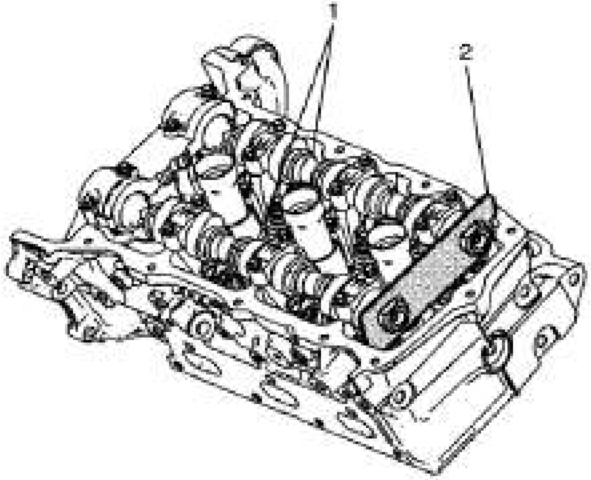


8. Align the left exhaust camshaft position actuator solenoid sprocket alignment circle mark (4) with the timing camshaft drive chain link (3).
9. Align the left intake camshaft position actuator solenoid sprocket alignment circle mark (1) with the timing camshaft drive chain link (2).
10. There will be 22 links between the left camshaft intermediate drive chain idler timing camshaft drive chain link and the left intake camshaft position actuator solenoid sprocket timing camshaft drive chain link.

Secondary Camshaft Drive Chain Installation - Left Side (LE0, LW2)

Tools Required

- EN 46105 Camshaft Locking Tools
- EN 46111 Crankshaft Rotation Socket

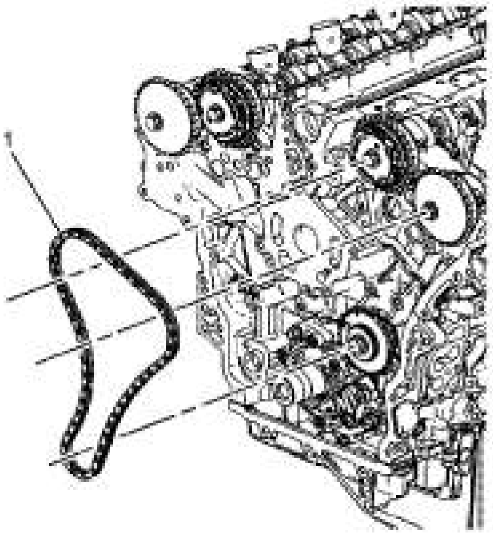


Important: There should be no need to rotate the camshafts (1) more than 10 degrees. Using the hex cast into the camshaft (1) rotate the camshaft (1) in order to install the EN 46105 (2).

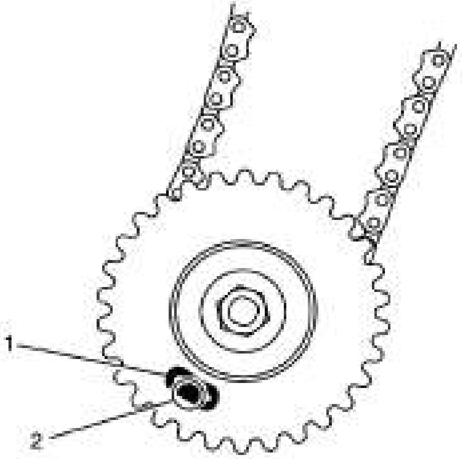
1. Install the EN 46105 (2) onto the rear of the left camshafts (1).

   Important: All camshafts (1) must be locked in place before installation of any camshaft drive chains.

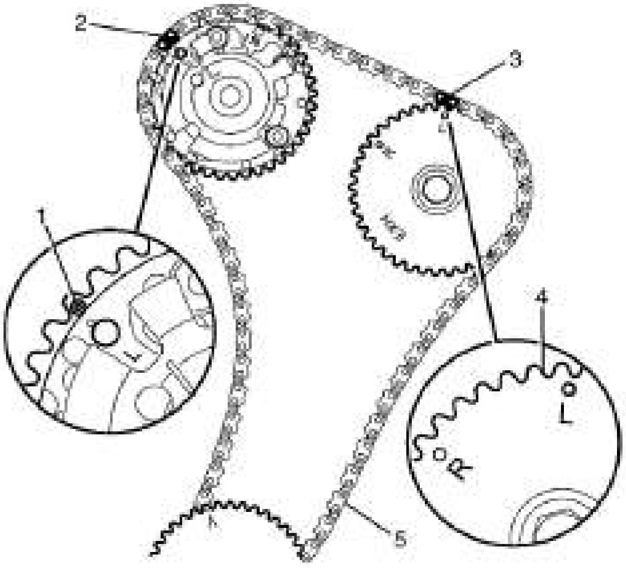
2. Make sure that the EN 46105 (2) is fully seated onto the camshafts (1).
3. Make sure that the crankshaft is in the stage one timing drive assembly position using the EN 46111 . Refer to Camshaft Timing Drive Chain Alignment Diagram Stage One.



4. Install the left secondary camshaft drive chain (1).



5. Place the left secondary camshaft drive chain around the inner sprocket of the left camshaft intermediate drive chain idler with the timing camshaft drive chain link (1) aligned to the alignment access hole (2) made in the left camshaft intermediate drive chain idler outer sprocket.
6. Wrap the secondary camshaft drive chain around the left intake camshaft position actuator solenoid sprocket and the left exhaust camshaft sprocket.
7. Make sure there are 10 links between the timing camshaft drive chain links for the left intake camshaft position actuator solenoid sprocket and the left exhaust camshaft sprocket.



8. Align the left exhaust camshaft sprocket alignment circle mark (4) with the timing camshaft drive chain link (3).
9. Align the left intake camshaft position actuator solenoid sprocket alignment circle mark (1) with the timing camshaft drive chain link (2).
10. There will be 22 links between the left camshaft intermediate drive chain idler timing

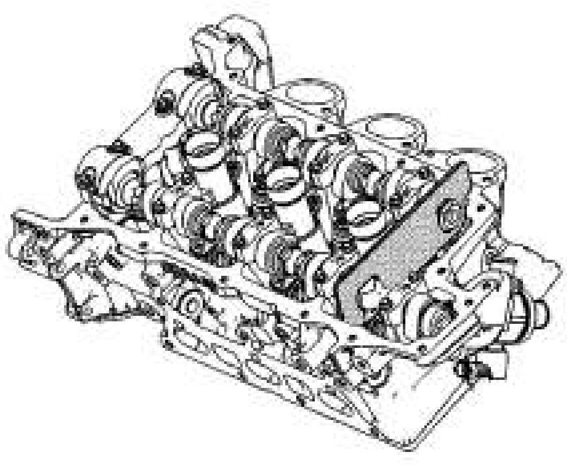
camshaft drive chain link and the left intake camshaft position actuator solenoid sprocket timing camshaft drive chain link.

2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | **Document ID: 2003834**

Secondary Camshaft Drive Chain Installation - Left Side (LLT or LCS)

Special Tools

- EN-48383 Camshaft Retaining Tools
- EN-48589 Crankshaft Rotation Socket

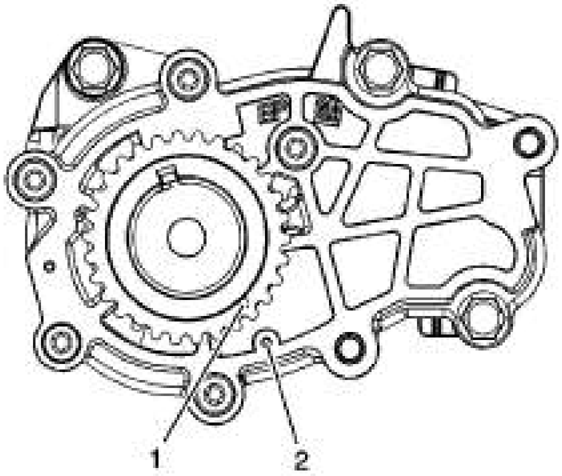


Important: There should be no need to rotate the camshaft more than 10 degrees. Using the hex cast into the camshaft rotate the camshaft in order to install the EN-48383 .

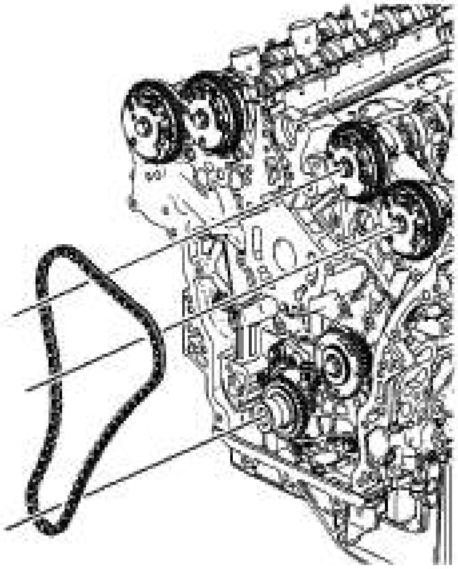
1. Install the EN 48383-1 onto the rear of the left camshafts.

   Important: All camshafts must be locked in place before installation of any camshaft drive chains.

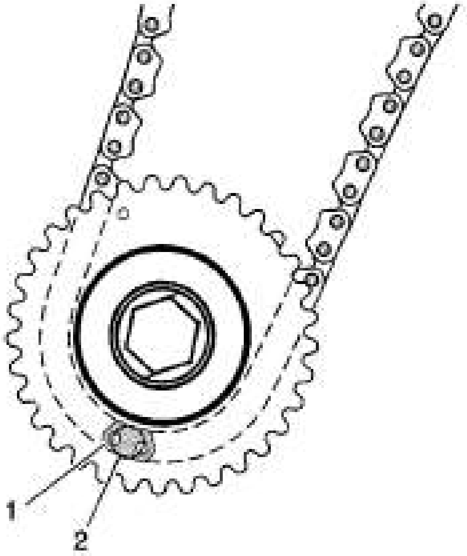
2. Ensure that the EN 48383-1 is fully seated onto the camshafts.



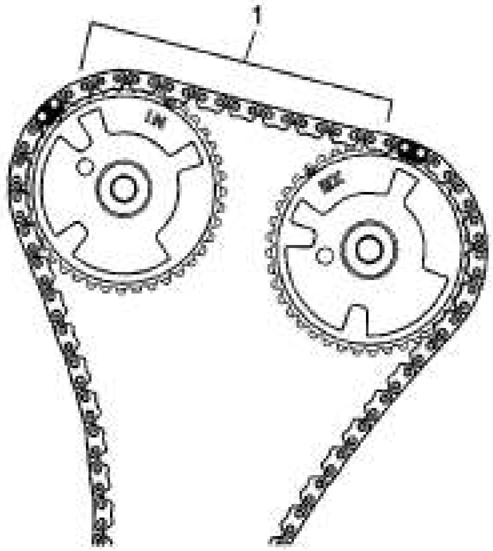
3. Ensure the crankshaft is in the stage one timing position with the crankshaft sprocket timing mark (1) aligned to the stage one timing mark on the oil pump cover (2) using the EN-48589 . Refer to Camshaft Timing Drive Chain Alignment Diagram.



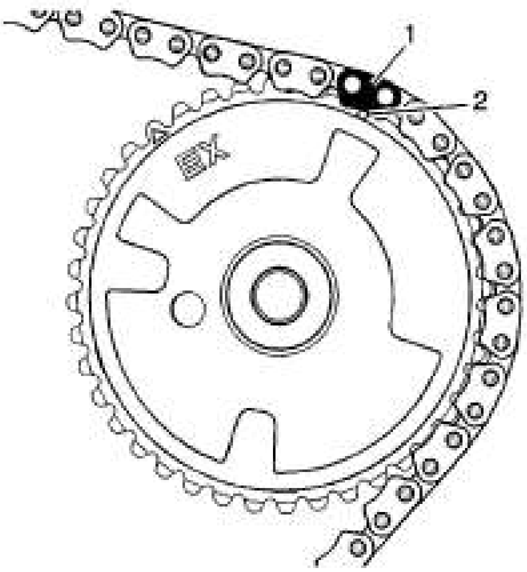
4. Install the left secondary camshaft drive chain.



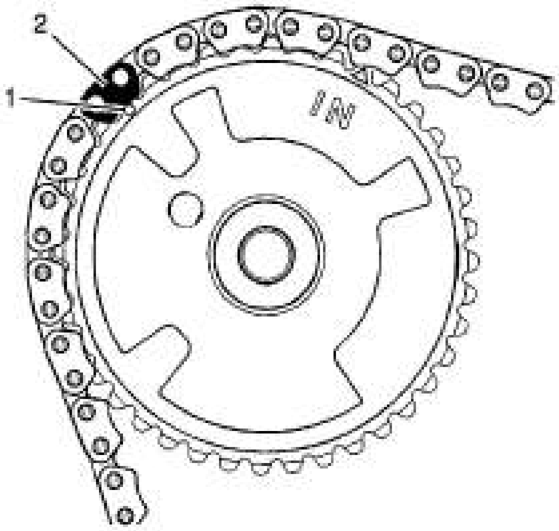
5. Place the left secondary camshaft drive chain around the inner sprocket of the left camshaft intermediate drive chain idler with the timing camshaft drive chain link (1) aligned to the alignment access hole (2) made in the left camshaft intermediate drive chain idler outer sprocket.



6. Wrap the secondary camshaft drive chain around both left actuator drive sprockets.
7. Ensure there are 10 links (1) between the timing camshaft drive chain links for the camshaft position actuator sprockets.



8. Align the left exhaust camshaft position actuator sprocket alignment circle mark (2) with the timing camshaft drive chain link (1).



9. Align the left intake camshaft position actuator sprocket alignment circle mark (1) with the timing camshaft drive chain link (2).

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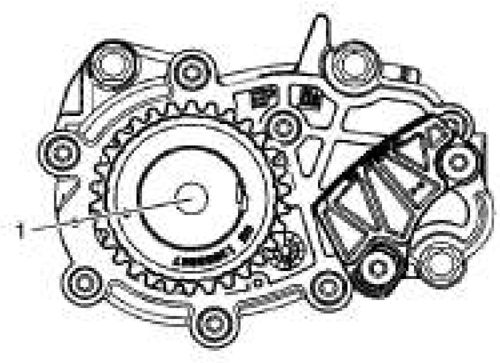
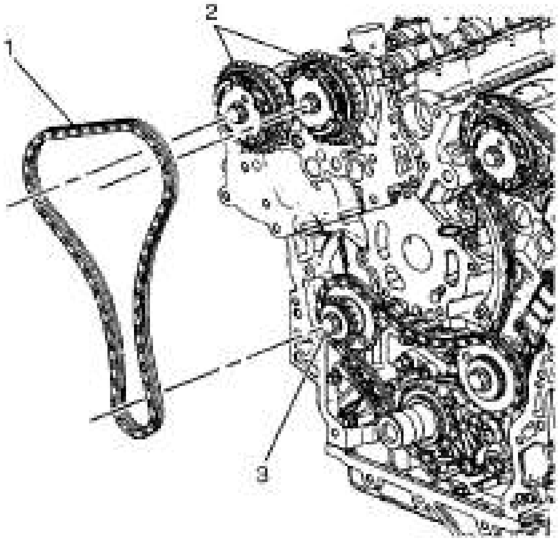
Secondary Camshaft Drive Chain Installation - Right Side

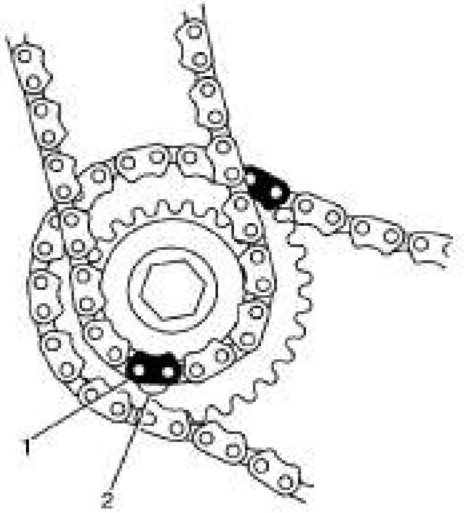
Secondary Camshaft Drive Chain Installation - Right Side (LY7)



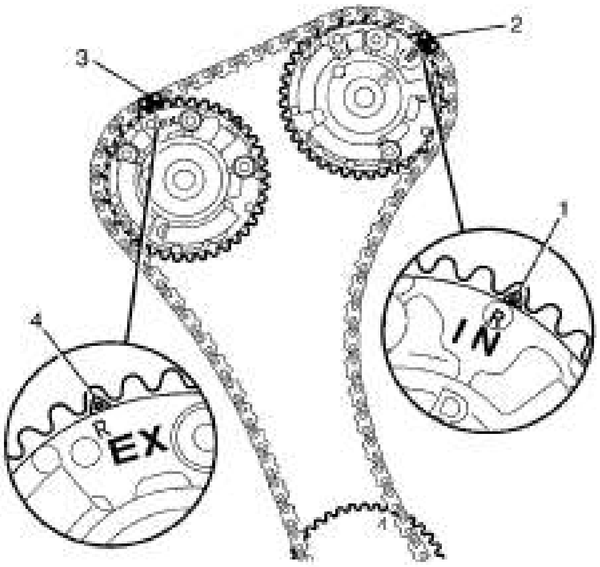
1. Ensure that the crankshaft is in the stage two timing drive assembly position (1).



2. Install the right secondary camshaft drive chain (1).



3. Place the secondary camshaft drive chain around the right camshaft intermediate drive chain idler outer sprocket, aligning the timing camshaft drive chain link (1) with the alignment access hole (2) made in the right camshaft intermediate drive chain idler inner sprocket.
4. Wrap the secondary camshaft drive chain around both right actuator drive sprockets.

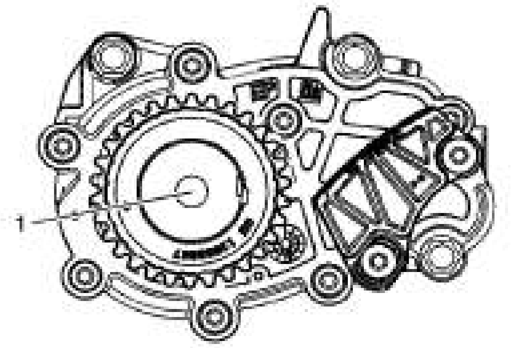


Important: Make sure there are 10 links between the timing camshaft drive chain links for the camshaft position actuator solenoid sprockets.

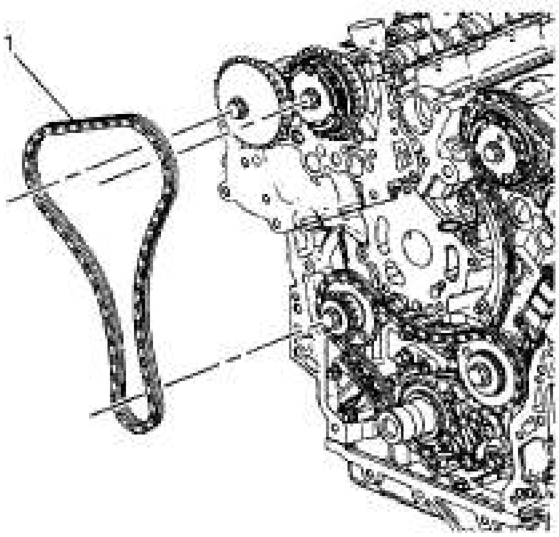
5. Align the right exhaust camshaft position actuator solenoid sprocket alignment triangle mark (1) with the timing camshaft drive chain link (2).
6. Align the right intake camshaft position actuator solenoid sprocket alignment triangle mark (4) with the timing camshaft drive chain link (3).
7. There will be 22 links between the right camshaft intermediate drive chain idler timing

camshaft drive chain link and the right exhaust camshaft position actuator solenoid sprocket timing camshaft drive chain link.

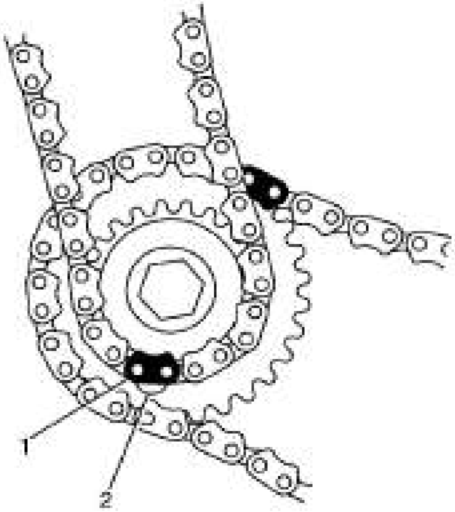
Secondary Camshaft Drive Chain Installation - Right Side (LE0, LW2)



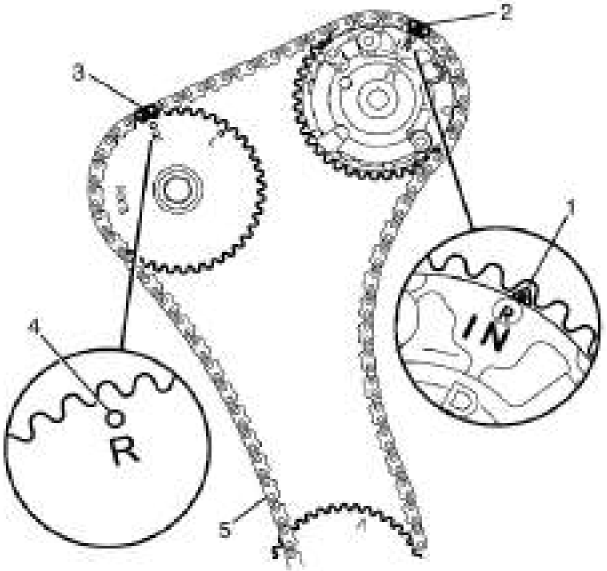
1. Ensure that the crankshaft is in the stage two timing drive assembly position (1).



2. Install the right secondary camshaft drive chain (1).



3. Place the secondary camshaft drive chain around the right camshaft intermediate drive chain idler outer sprocket, aligning the timing camshaft drive chain link (1) with the alignment access hole (2) made in the right camshaft intermediate drive chain idler inner sprocket.
4. Wrap the secondary camshaft drive chain around the right intake camshaft position actuator solenoid sprocket and the right exhaust camshaft sprocket.
5. Make sure there are 10 links between the timing camshaft drive chain links for the right intake camshaft position actuator solenoid sprocket and the right exhaust camshaft sprocket.



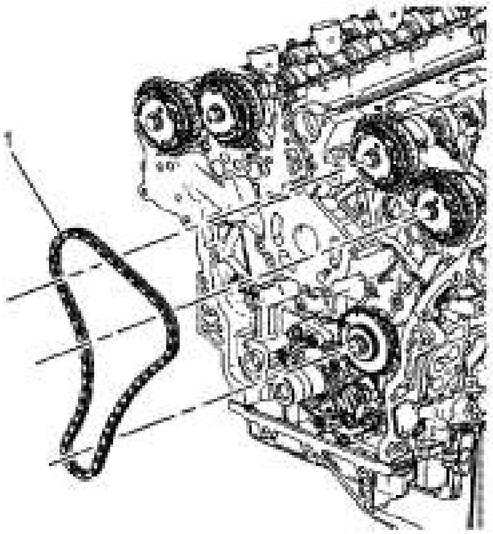
Important: Make sure there are 10 links between the timing camshaft drive chain links for the camshaft position actuator solenoid sprockets.

6. Align the right exhaust camshaft sprocket alignment circle mark (1) with the timing camshaft

drive chain link (2).

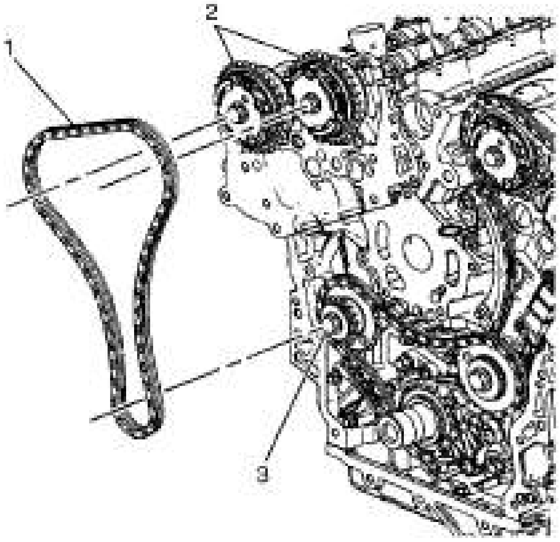
7. Align the right intake camshaft position actuator solenoid sprocket alignment triangle mark (4) with the timing camshaft drive chain link (3).
8. There will be 22 links between the right camshaft intermediate drive chain idler timing camshaft drive chain link and the right exhaust camshaft sprocket timing camshaft drive chain link.

Secondary Camshaft Drive Chain Removal - Left Side



Remove the left secondary camshaft drive chain (1).

Secondary Camshaft Drive Chain Removal - Right Side



Remove the right secondary camshaft drive chain (1) from the right camshaft position actuators (2) and the right camshaft intermediate drive chain idler sprocket (3).

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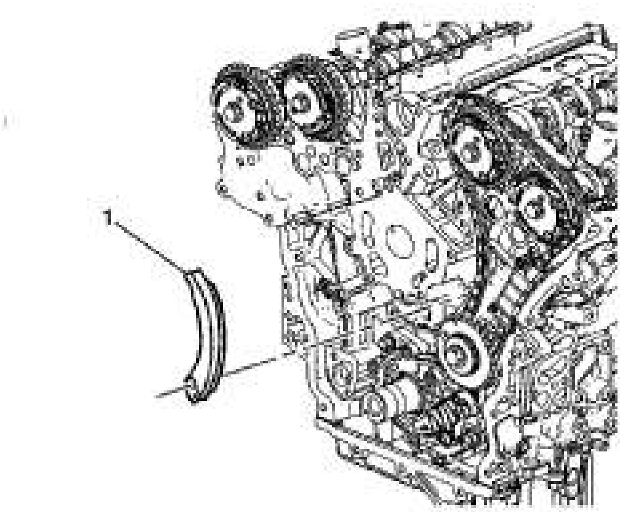
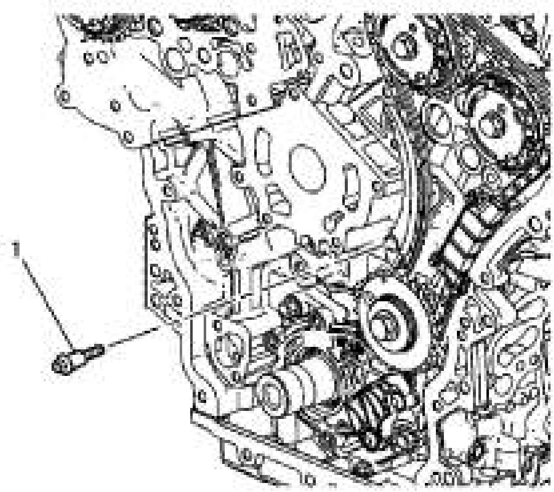
Secondary Camshaft Drive Chain Shoe Installation - Left Side



1. Install the left secondary camshaft drive chain shoe (1).

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the secondary camshaft drive chain shoe to cylinder block retaining bolt (1).

Tighten

Tighten the bolt to 23 N·m (17 lb ft).

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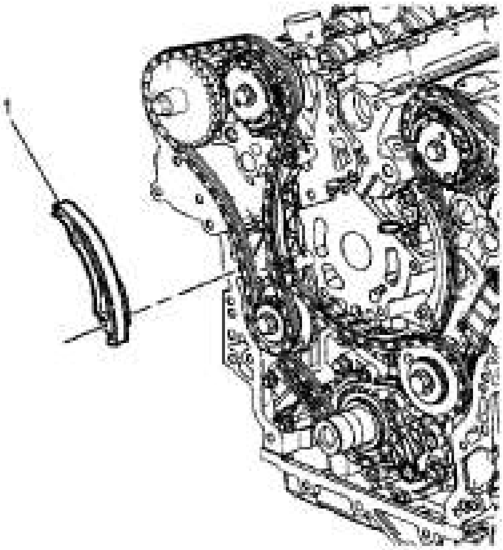
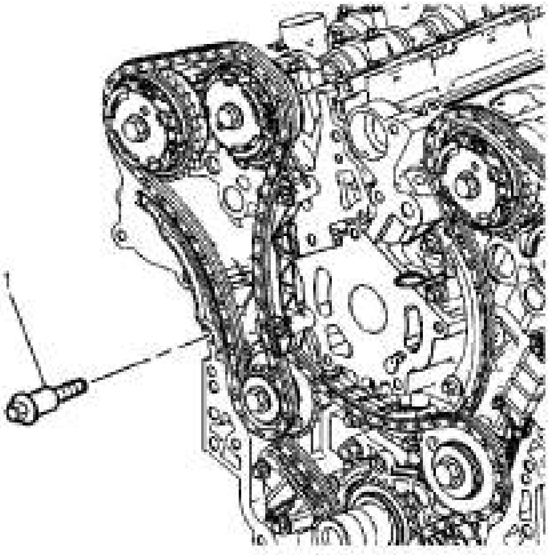
Secondary Camshaft Drive Chain Shoe Installation - Right Side



1. Position the right secondary camshaft drive chain shoe (1).

Notice: Refer to Fastener Notice in the Preface section.



2. Install the right secondary camshaft drive chain shoe to cylinder block retaining bolt (1).

Tighten

Tighten the bolt to 23 N·m (17 lb ft).

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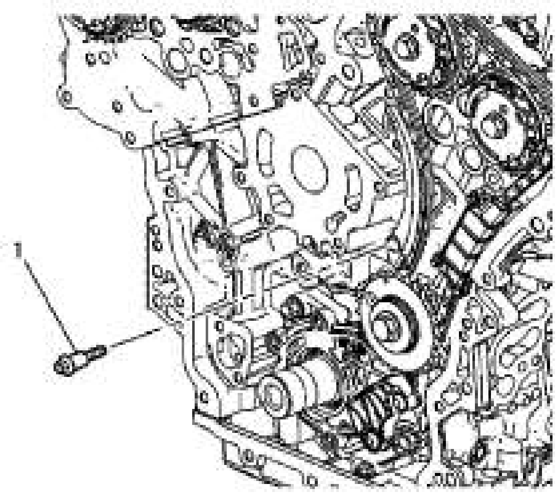
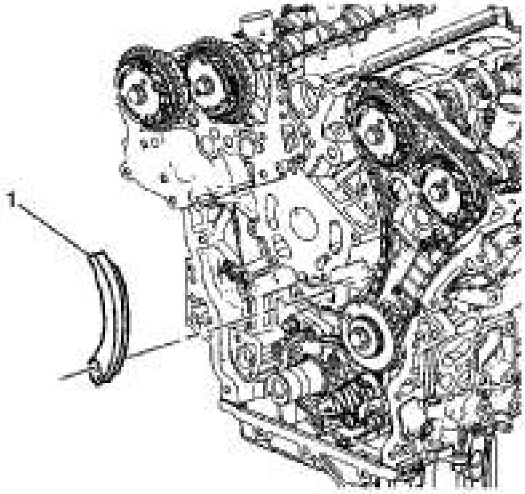
Secondary Camshaft Drive Chain Shoe Removal - Left Side

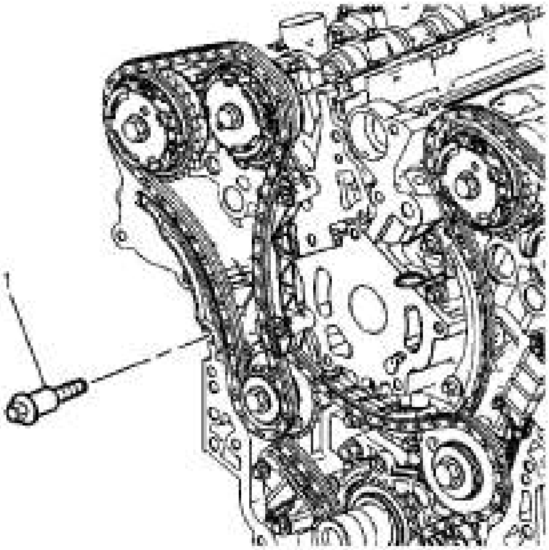


1. Remove the left secondary camshaft drive chain shoe to cylinder block retaining bolt (1).

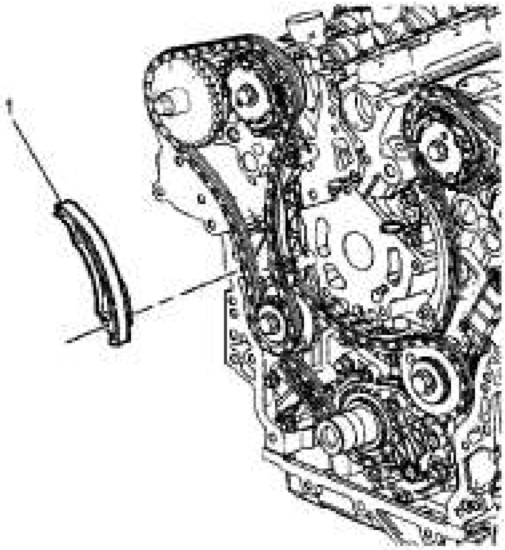


2. Remove the left secondary camshaft drive chain shoe (1).

Secondary Camshaft Drive Chain Shoe Removal - Right Side



1. Remove the right secondary camshaft drive chain shoe to cylinder block retaining bolt (1).



2. Remove the right secondary camshaft drive chain shoe (1).

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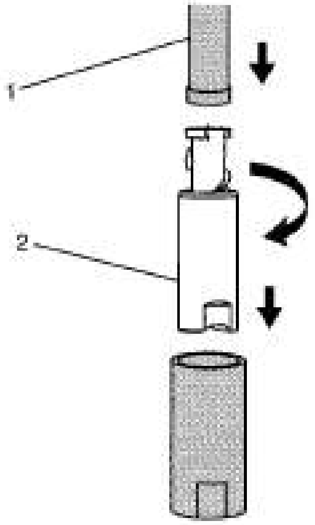
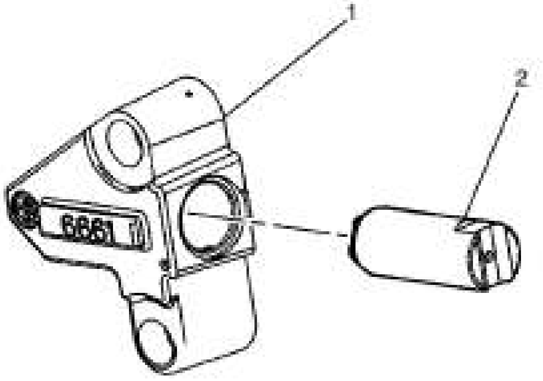
Secondary Camshaft Drive Chain Tensioner Installation - Left Side

Tools Required

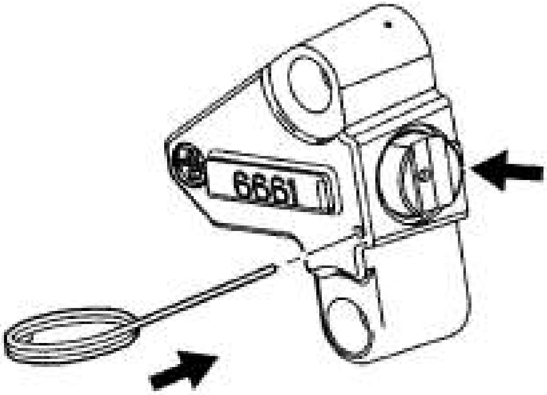
- EN 46112 Tensioner Retraction Pins
- J 45027 Tensioner Tool



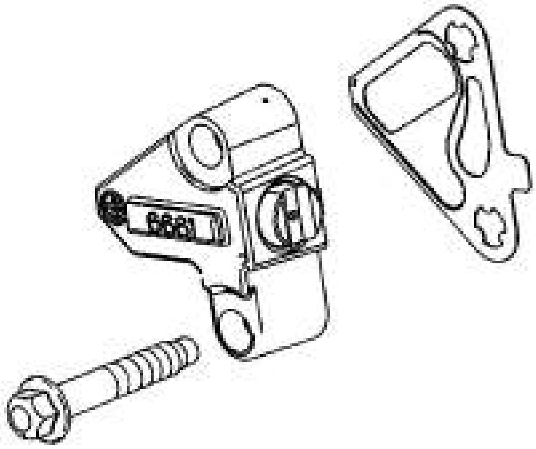
1. Using the J 45027 (1) reset the left secondary camshaft drive chain tensioner plunger (2).



2. Install the plunger (2) into the left secondary camshaft drive chain tensioner body (1).

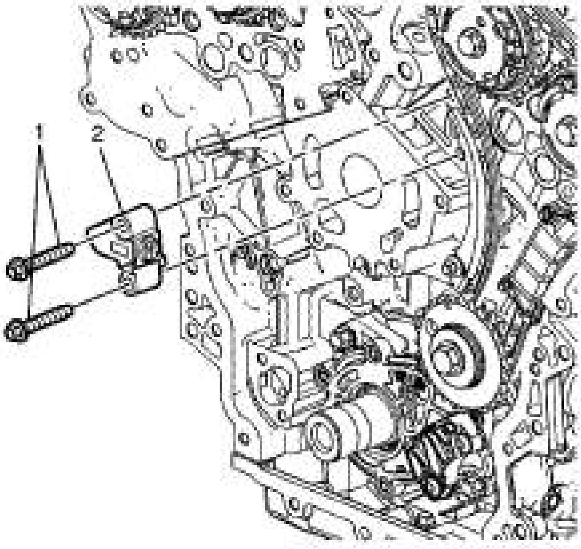


3. Compress the plunger into the body and lock the left secondary camshaft drive chain tensioner by inserting the EN 46112 into the access hole in the side of the left secondary camshaft drive chain tensioner body.
4. Slowly release pressure on the left secondary camshaft drive chain tensioner. The left secondary camshaft drive chain tensioner should remain compressed.



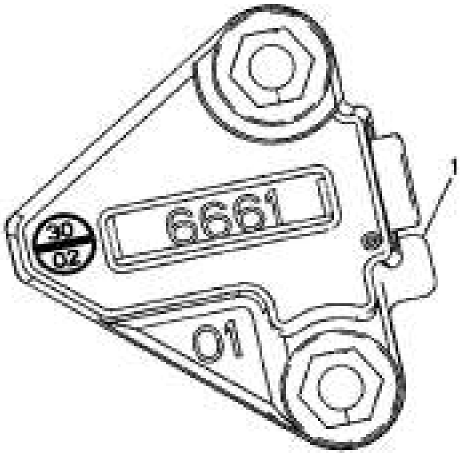
5. Install a NEW left secondary camshaft drive chain tensioner gasket to the left secondary camshaft drive chain tensioner.
6. Install the left secondary camshaft drive chain tensioner bolts through the left secondary camshaft drive chain tensioner and gasket.
7. Ensure the left secondary camshaft drive chain tensioner mounting surface on the left

cylinder head does not have any burrs or defects that may degrade the sealing of the NEW left secondary camshaft drive chain tensioner gasket.



8. Place the left secondary camshaft drive chain tensioner (2) into position and loosely install the secondary camshaft drive chain tensioner to cylinder block retaining bolts (1) to the block.

   Notice: Refer to Fastener Notice in the Preface section.

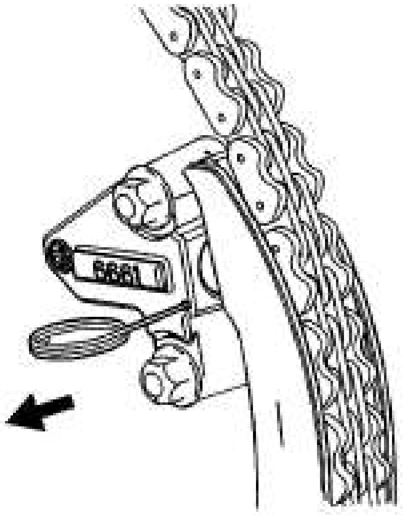


9. Verify the proper placement of the left secondary camshaft drive chain tensioner gasket tab (1).
   9.1. First Pass

Tighten
Tighten the left secondary camshaft drive chain tensioner bolts to 5 N·m (44 lb in).

9.2. Final Pass

Tighten
Tighten the left secondary camshaft drive chain tensioner bolts to 23 N·m (17 lb ft).



10. Release the left secondary camshaft drive chain tensioner by pulling out the EN 46112 and unlocking the tensioner plunger.
11. Verify the left secondary camshaft drive chain timing mark alignments. Refer to Camshaft Timing Drive Chain Alignment Diagram .

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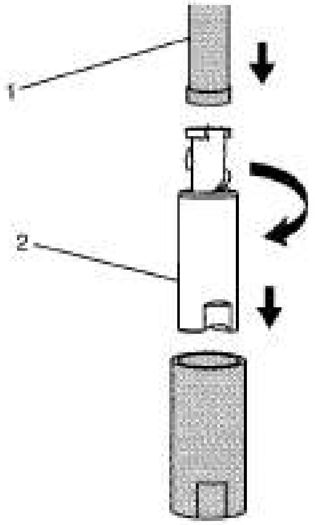
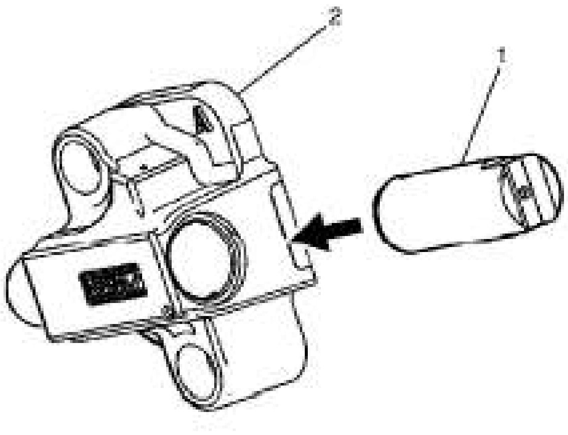
Secondary Camshaft Drive Chain Tensioner Installation - Right Side

Tools Required

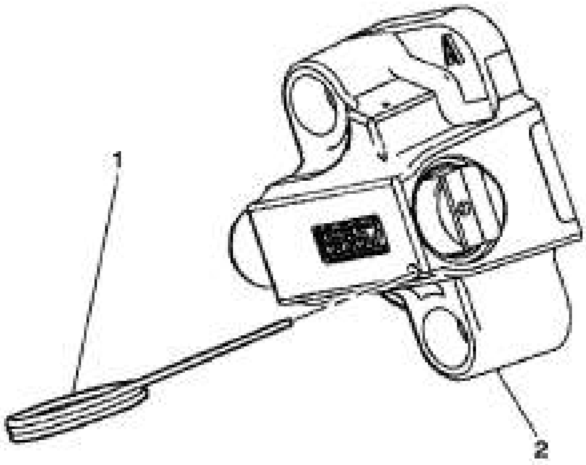
- EN 46112 Tensioner Retraction Pins
- J 45027 Tensioner Tool



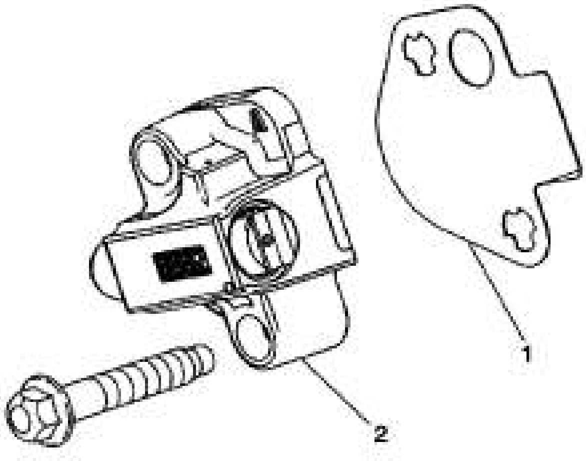
1. Using the J 45027 reset the right secondary camshaft drive chain tensioner plunger.



2. Install the plunger (1) into the right secondary camshaft drive chain tensioner body (2).

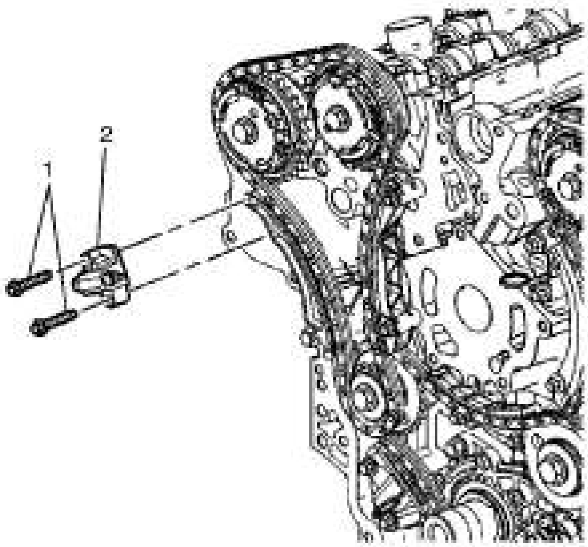


3. Compress the plunger into the body and lock the right secondary camshaft drive chain tensioner (2) by inserting the EN 46112 (1) into the access hole in the side of the right secondary camshaft drive chain tensioner (2).
4. Slowly release pressure on the right secondary camshaft drive chain tensioner (2). The right secondary camshaft drive chain tensioner (2) should remain compressed.



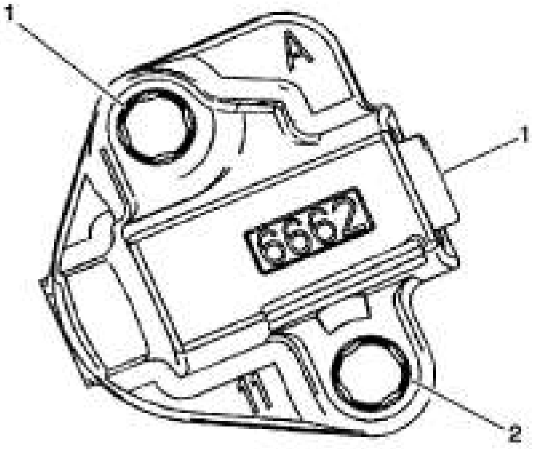
5. Install a NEW right secondary camshaft drive chain tensioner gasket (1) to the right secondary camshaft drive chain tensioner (2).
6. Install the right secondary camshaft drive chain tensioner bolts through the right secondary camshaft drive chain tensioner (2) and gasket (1).
7. Ensure the right secondary camshaft drive chain tensioner (2) mounting surface on the right

cylinder head does not have any burrs or defects that may degrade the sealing of the NEW right secondary camshaft drive chain tensioner gasket (1).



8. Place the right secondary camshaft drive chain tensioner (2) into position and loosely install right secondary camshaft drive chain tensioner to cylinder block retaining bolts (1).

   Notice: Refer to Fastener Notice in the Preface section.

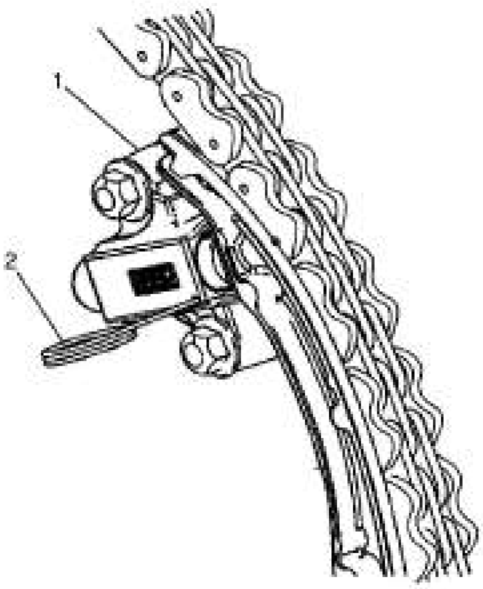


9. Verify the proper placement of the right secondary camshaft drive chain tensioner gasket tab (1).
10. Tighten the right secondary camshaft drive chain tensioner to cylinder block retaining bolts (2).
    10.1. First Pass

Tighten
Tighten the bolts to 5 N·m (44 lb in).

10.2. Final Pass

Tighten
Tighten the bolts to 23 N·m (17 lb ft).



11. Release the right camshaft drive chain tensioner by pulling out the EN 46112 and unlocking the tensioner plunger.

Notice: Refer to General Repair Instructions in the Preface section.

12. Verify all primary and secondary camshaft drive chain timing mark alignments. Refer to Camshaft Timing Drive Chain Alignment Diagram .

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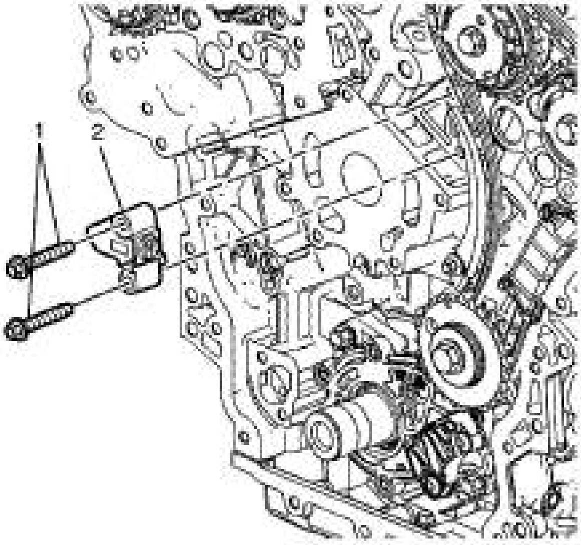
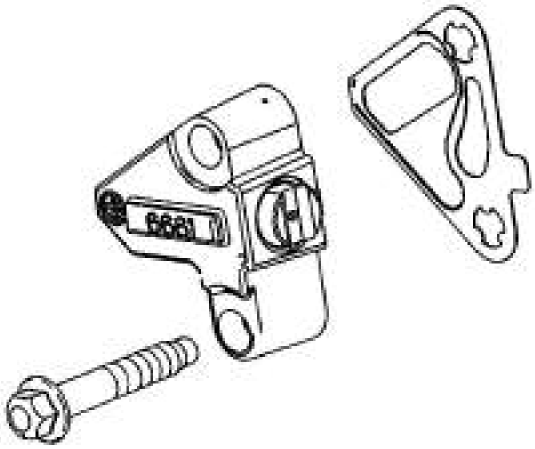
Secondary Camshaft Drive Chain Tensioner Removal - Left Side



1. Remove the left secondary camshaft drive chain tensioner to cylinder block retaining bolts (1).
2. Remove the left secondary camshaft drive chain tensioner (2).



Important: The left secondary camshaft drive chain tensioner gasket must be discarded whenever the left secondary camshaft drive chain tensioner has been removed from the cylinder block.

3. Remove left secondary camshaft drive chain tensioner gasket from the left secondary camshaft drive chain tensioner.

   Discard the gasket.

4. Inspect the left secondary camshaft drive chain tensioner mounting surface on the left cylinder head for burrs or any defects that may degrade the sealing of the NEW left secondary camshaft drive chain tensioner gasket.

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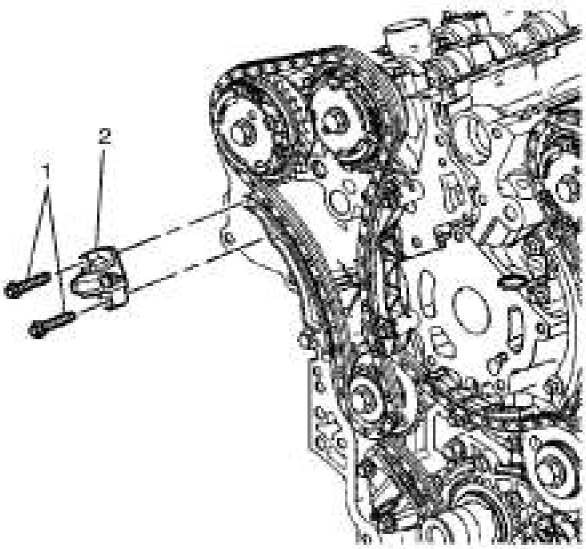
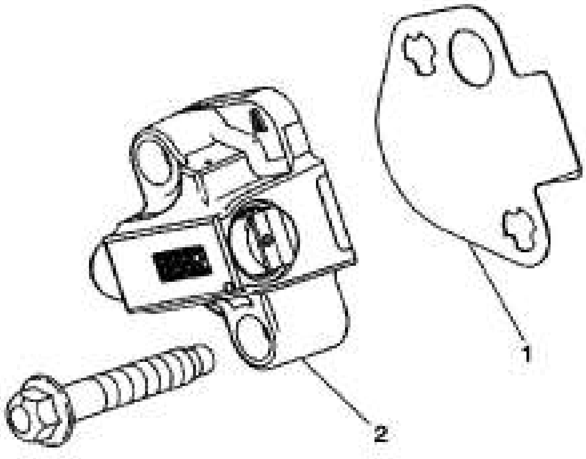
Secondary Camshaft Drive Chain Tensioner Removal - Right Side



1. Remove the right secondary camshaft drive chain tensioner to cylinder block retaining bolts (1).
2. Remove the right secondary camshaft drive chain tensioner (2).



Important: The right secondary camshaft drive chain tensioner gasket (2) must be discarded whenever the right secondary camshaft drive chain tensioner (1) has been removed from the cylinder block.

3. Remove the right secondary camshaft drive chain tensioner gasket (1) from the right secondary camshaft drive chain tensioner (2).

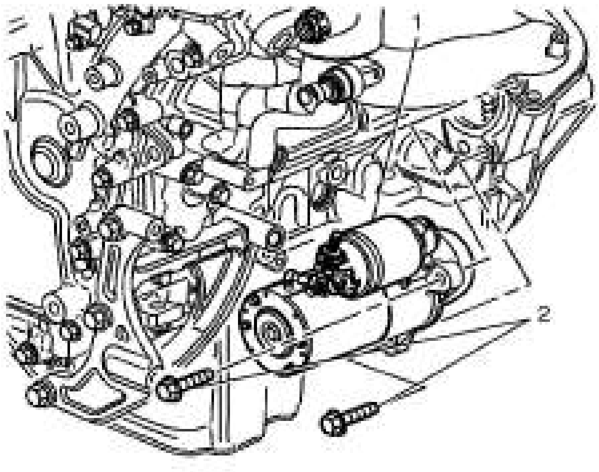
   Discard the gasket.

4. Inspect the right secondary camshaft drive chain tensioner mounting surface on the right cylinder head for burrs or any defects that may degrade the sealing of the NEW right secondary camshaft drive chain tensioner gasket.

Service Prior to Assembly

- Dirt will cause premature wear of the rebuilt engine. Clean all the components.
- Use the correct tools to measure the components when checking for wear above acceptable tolerances. Components not within the manufacturer's specification must be repaired or replaced.
- When the components are reinstalled into an engine, return the components to their original location, position, and direction.
- During assembly, lubricate all the moving parts with clean engine oil (unless otherwise specified). This will provide initial lubrication when the engine is first started.

Starter Installation



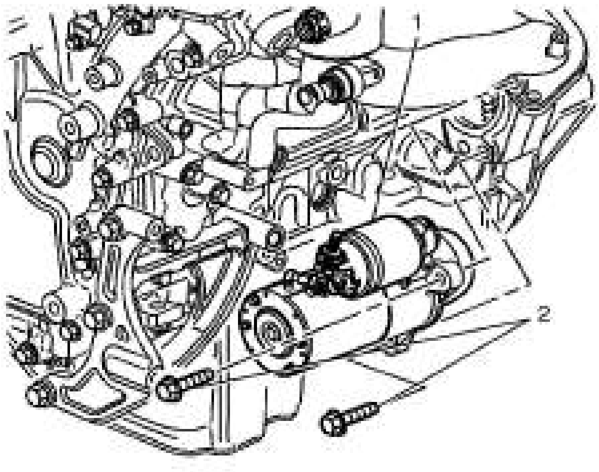
1. Install the starter motor (1).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the starter motor to cylinder block retaining bolts (2).

   Tighten
   Tighten the bolts to 58 N·m (42 lb ft).

Starter Removal

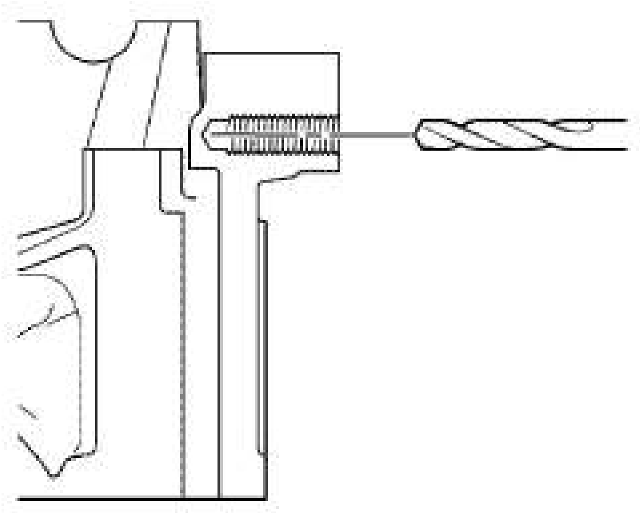


1. Remove the starter motor to cylinder block retaining bolts (2).
2. Remove the starter motor (1).

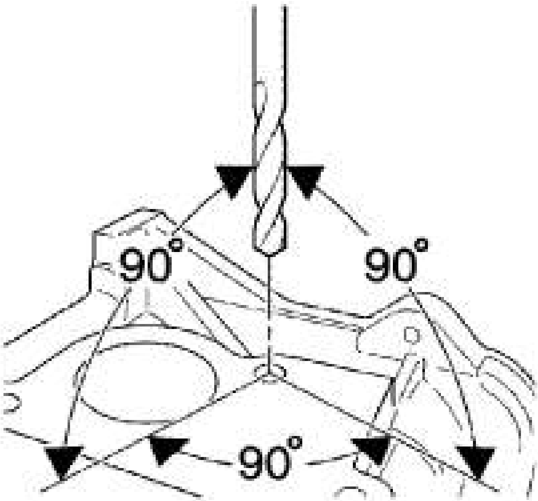
Thread Repair

Tools Required

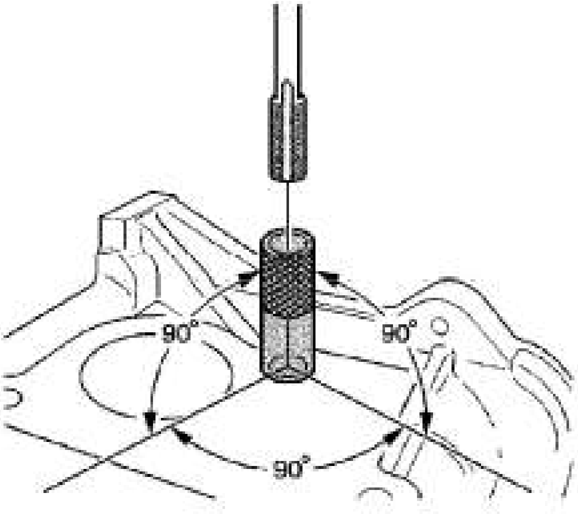
- J 42385-700 High Feature Thread Repair Kit
- J 42385-2000 Thread Insert Kit
- J 43965 Thread Repair Extension Kit
- The thread repair process involves a solid, thin walled, self-locking, carbon steel, bushing type insert. During the insert installation process, the installation driver tool cold-rolls the bottom internal threads and expands the bottom external threads of the insert into the base material. This action mechanically locks the insert into place.
- The drill bit and counter bore tool from the tool kit J 42385-700 and J 42385-2000 is designed for use with either a suitable tap wrench or drill motor. Limited access and larger hole repair may process better using a tap wrench. An extension from kit J 43965 may also be necessary to drive the thread repair tooling dependent on access to the hole being repaired. Use only a tap wrench when tapping the hole and during installation of the insert.



1. It is critical that the drilling, counterboring and tapping of the hole to be repaired follows the same centerline as the original hole.



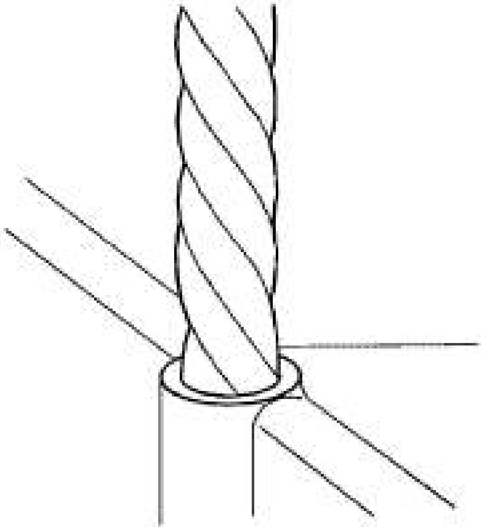
2. During the drilling and tapping of the hole being repaired ensure the tooling is consistently machining perpendicular to the surface of the base material.



3. If the threaded hole being repaired has a base surface perpendicular to the hole centerline, tapping guides are available to aid in tapping the hole.

Tap Size	Tap Guide	Tape Size	Tape Guide	Tap Size	Tape Guide
--	J 42385-	--	J 42385-	--	J 42385-
6 x 1.0	729	10 x 1.5	731	14 x 1.5	736
8 x 1.25	730	12 x 1.5	732	20 x 1.5	737

Standard Thread Repair - Flush Hole



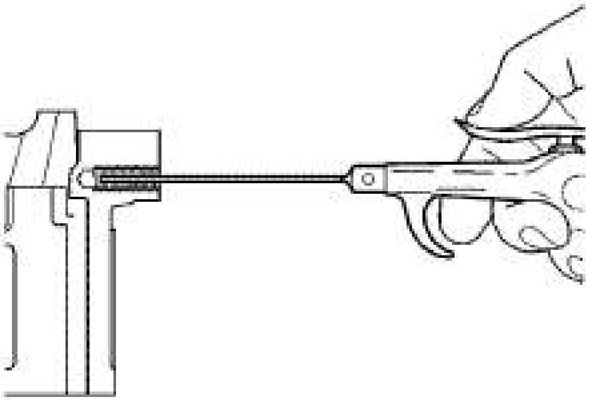
Important:

- During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.
- DO NOT drill any further than the original hole depth.

1. Drill out the threads of the damaged hole.

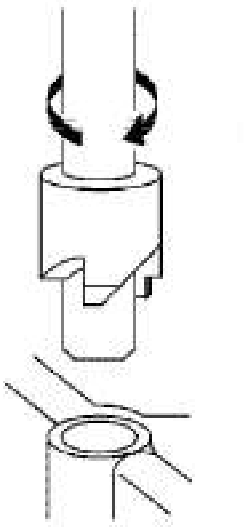
Specifications

- M6 inserts require a minimum drill depth of 15 mm (0.59 in).
- M8 inserts require a minimum drill depth of 20 mm (0.79 in).
- M10 inserts require a minimum drill depth of 23.5 mm (0.93 in).



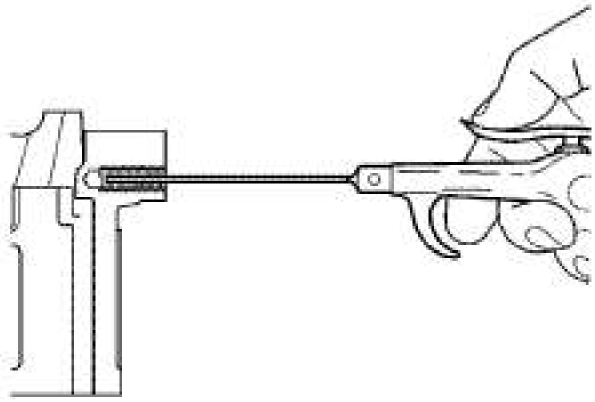
Important: All chips must be removed from the drilled hole prior to tapping.

2. Using compressed air, clean out any chips.



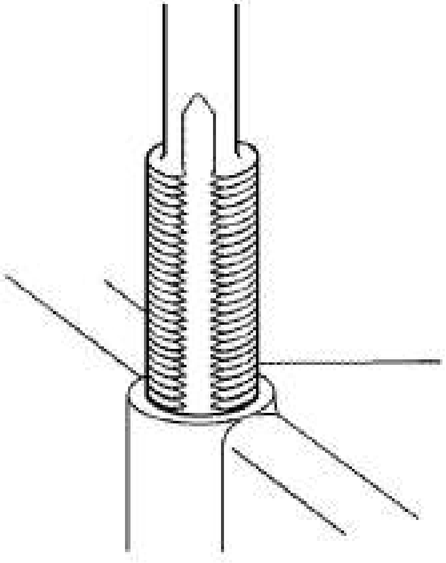
Important: A correctly counterbored hole will show a slight burnishing on the surface of the base material for 360 degrees around the drilled hole.

3. Counterbore the drilled hole to the full depth permitted by the tool (1).



Important: All chips must be removed from the drilled hole prior to tapping.

4. Using compressed air, clean out any chips.



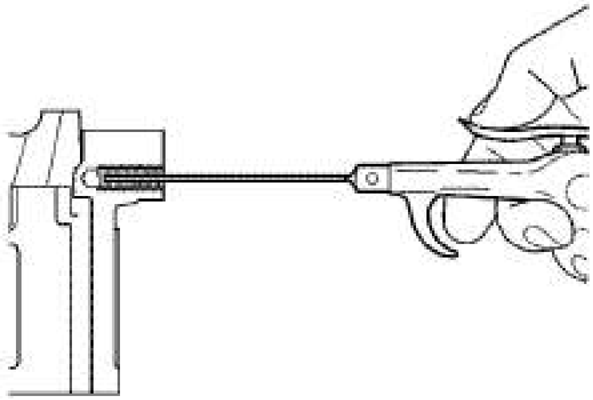
Important:

- During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.
- Make sure the tap has created full threads at least to the depth equal to the insert length.

5. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.

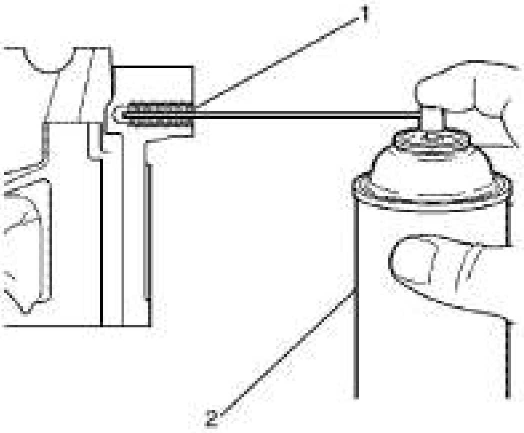
Specifications

- M6 inserts require a minimum tap depth of 15 mm (0.59 in).
- M8 inserts require a minimum tap depth of 20 mm (0.79 in).
- M10 inserts require a minimum tap depth of 23.5 mm (0.93 in).

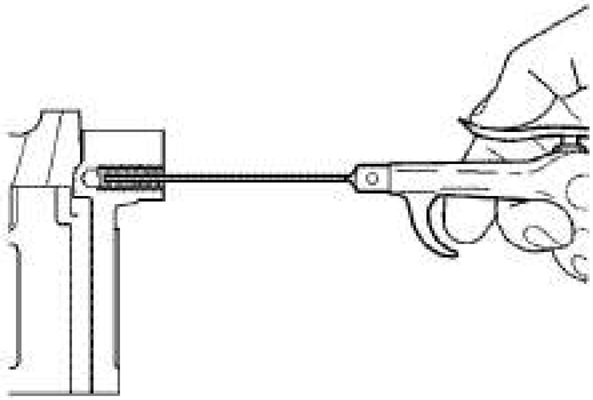


Important: All chips must be removed from the tapped hole prior to insert installation.

6. Using compressed air, clean out any chips.

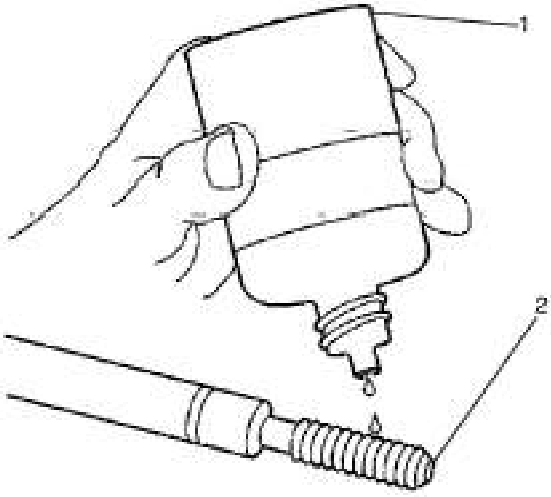


7. Spray a commercially available thread cleaner (2) into the tapped hole (1).



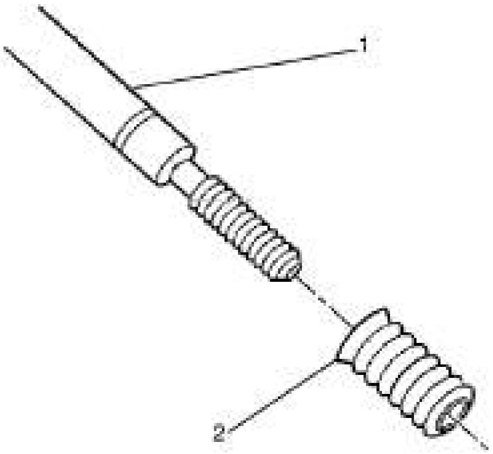
Important: All chips must be removed from the tapped hole prior to insert installation.

8. Using compressed air, clean out any chips.

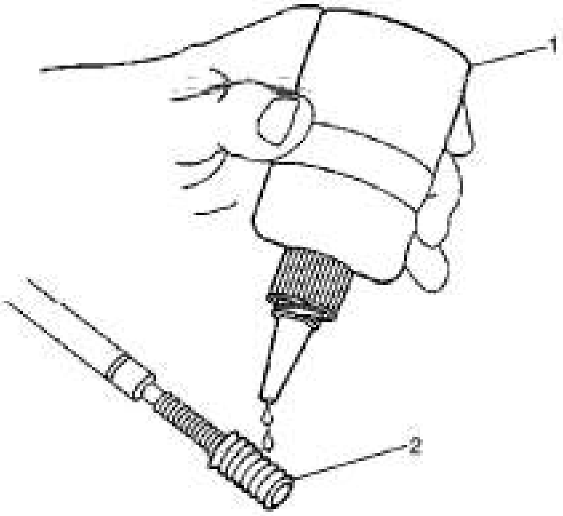


Important: DO NOT allow oil or other foreign material to contact the Outside Diameter (OD) of the insert.

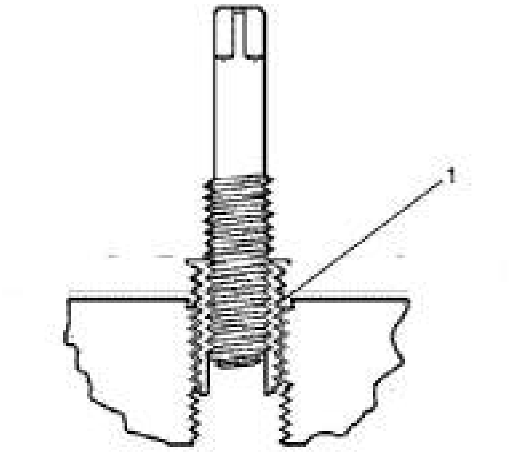
9. Lubricate the threads of the driver installation tool (2) with the driver oil (1).



10. Install the insert (2) onto the driver installation tool (1).



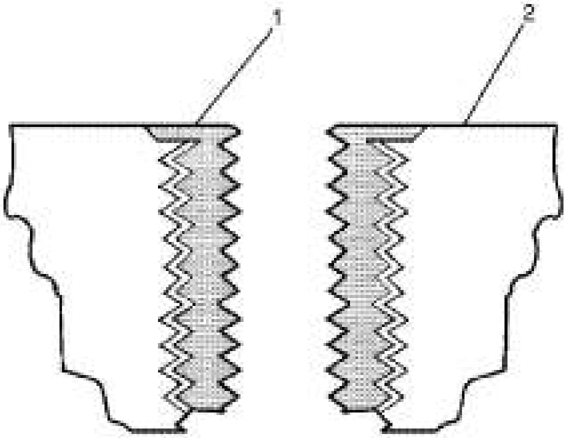
11. Apply threadlock sealant LOCTITE 277® or equivalent (1) to the insert OD threads (2).



12. Install the insert (1) into the tapped hole by hand only.

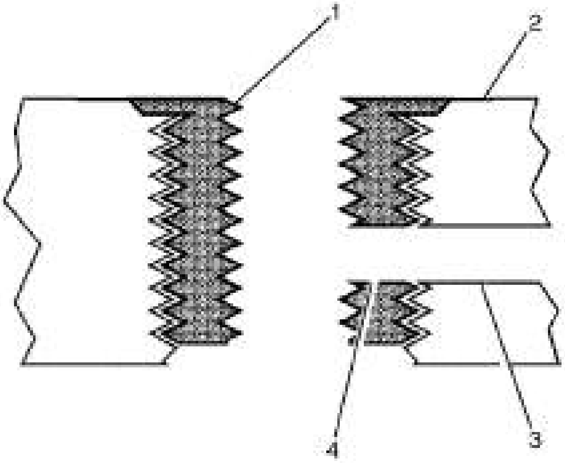
    Install the insert until the flange of the insert contacts the counterbored surface. Continue to rotate the installer tool (1) through the insert.

    The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.



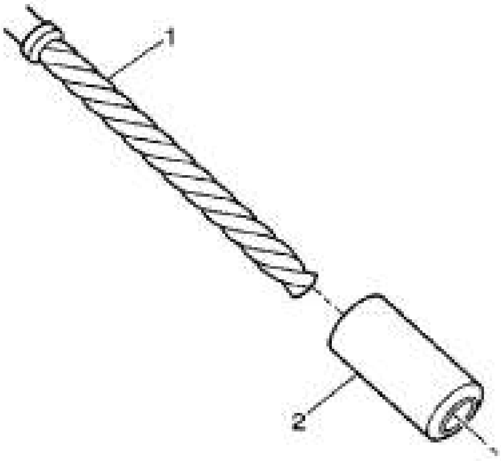
13. Inspect the insert for correct installation into the hole.

    A correctly installed insert (1) will be either flush or slightly below flush with the surface of the base material (2).

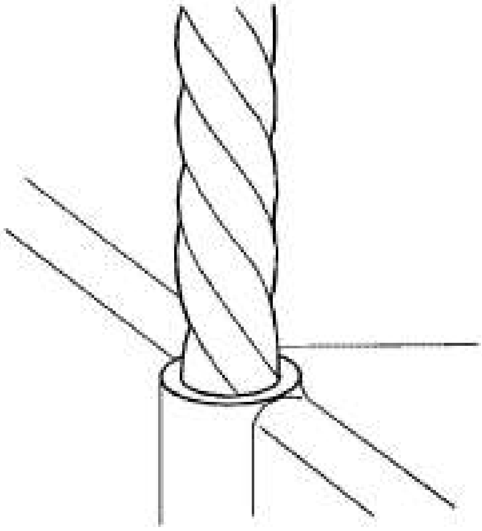


14. Any installed insert that restricts or blocks an oil or engine coolant passage (3) will need to have the oil or engine coolant passage drilled out (4) to the original size of the oil or engine coolant passage. After drilling the restriction or blockage, clean out any chips and thread the installation driver tool through the insert again to remove any burrs caused by the drilling of the oil or engine coolant passage.

Recessed Thread Repair



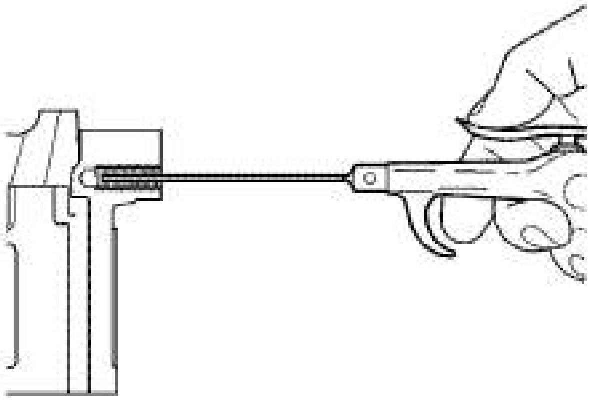
1. Install a stop collar (2) on the counterbore drill (1), if required.



Important:

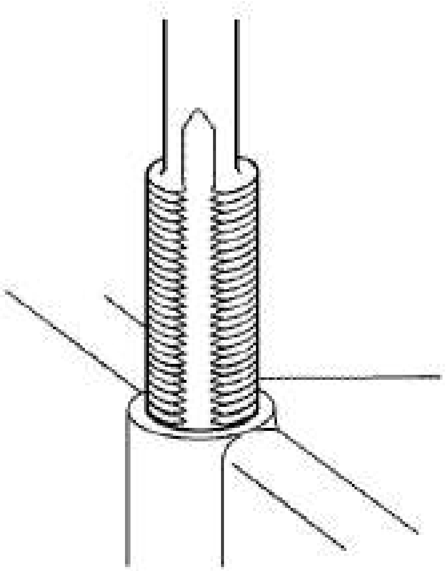
- During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.
- Drill the hole until the stop collar contacts the surface of the base material.

2. Drill out the threads of the damaged hole.



Important: All chips must be removed from the drilled hole prior to tapping.

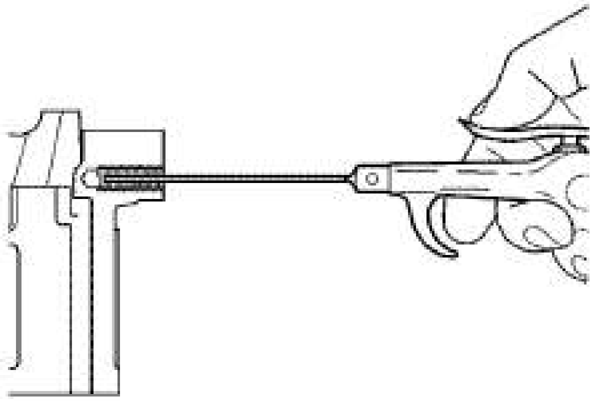
3. Using compressed air, clean out any chips.



Important:

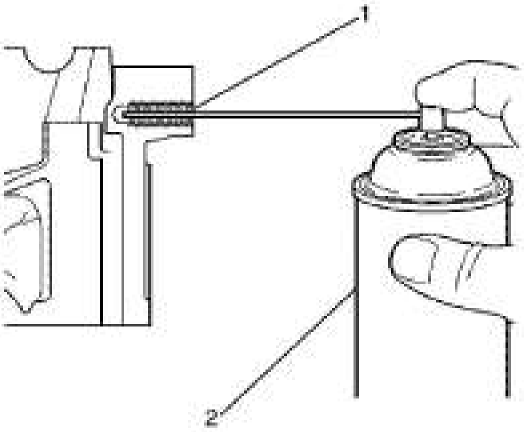
- During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.
- Make sure the tap has created full threads at least to the depth equal to the insert length.

4. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.

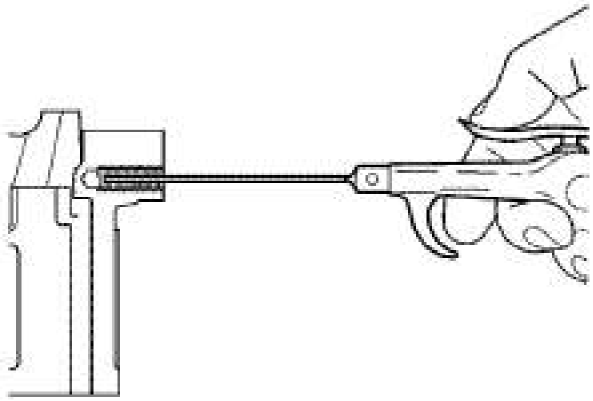


Important: All chips must be removed from the tapped hole prior to insert installation.

5. Using compressed air, clean out any chips.

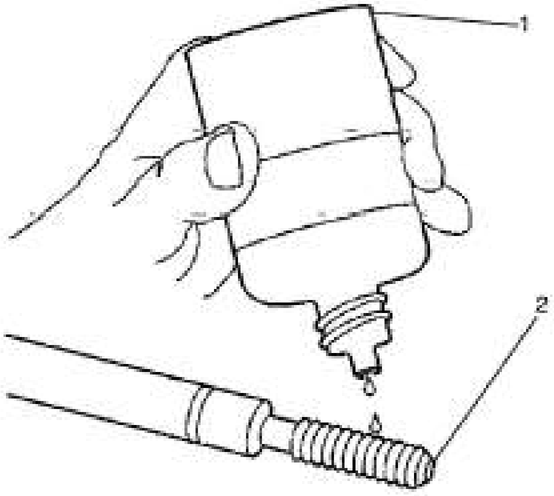


6. Spray a commercially available thread cleaner (2) into the tapped hole (1).



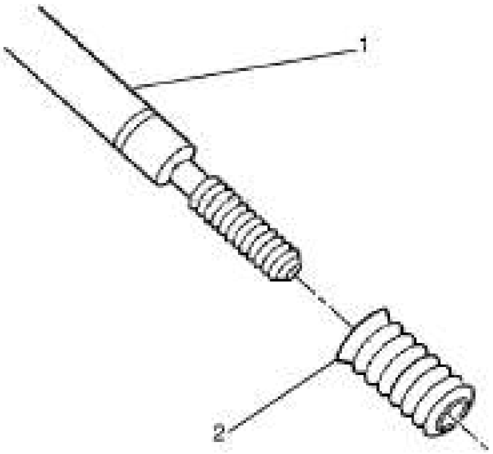
Important: All chips must be removed from the tapped hole prior to insert installation.

7. Using compressed air, clean out any chips.

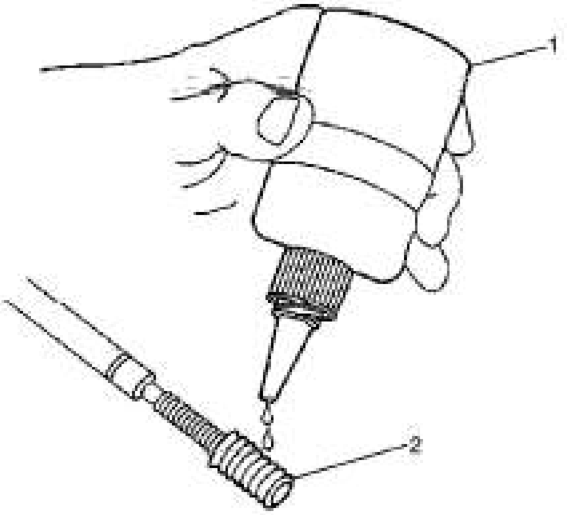


Important: DO NOT allow oil or other foreign material to contact the Outside Diameter (OD) of the insert.

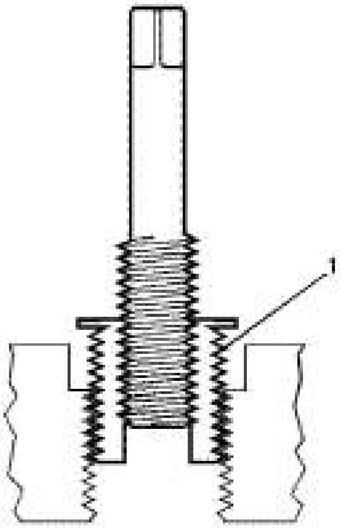
8. Lubricate the threads of the driver installation tool (2) with the driver oil (1).



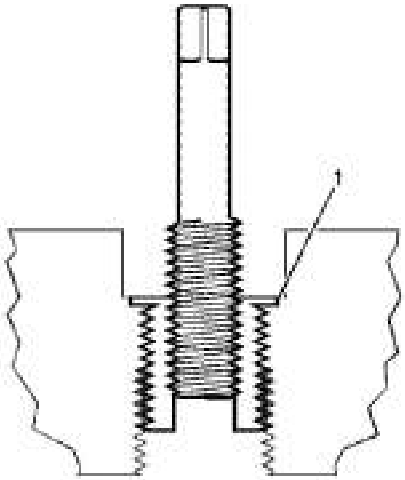
9. Install the insert (2) onto the driver installation tool (1).



10. Apply threadlock sealant LOCTITE 277® or equivalent (1) to the insert OD threads (2).

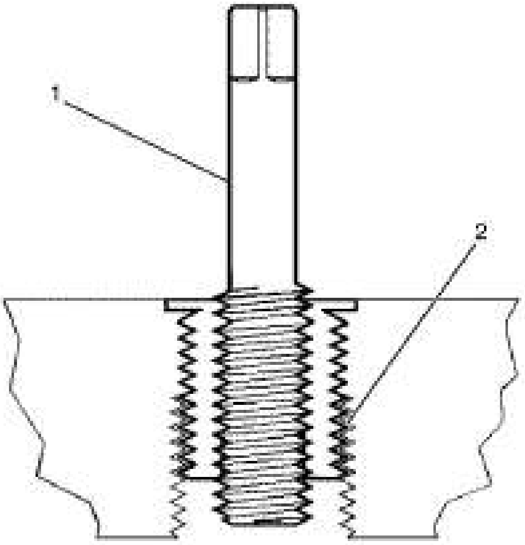


11. Install the insert (1) into the tapped hole by hand only.



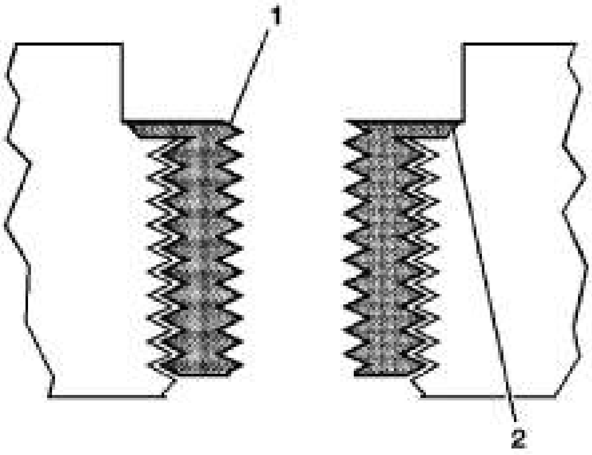
Important: If the insert will not thread down until the flange contacts the counterbored surface remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or incorrect tapping.

12. Install the insert until the flange (1) of the insert contacts the counterbored surface.

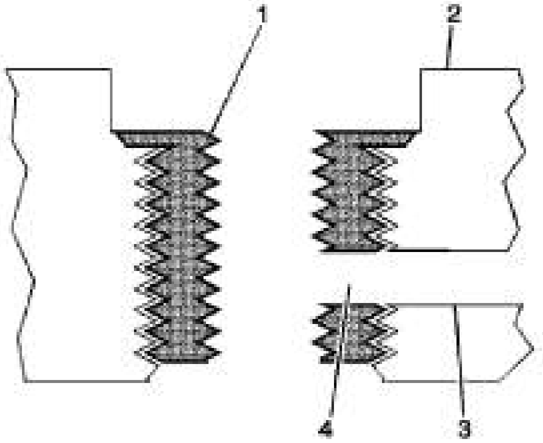


Important: The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

13. Continue to rotate the driver installation tool (1) through the insert (2).

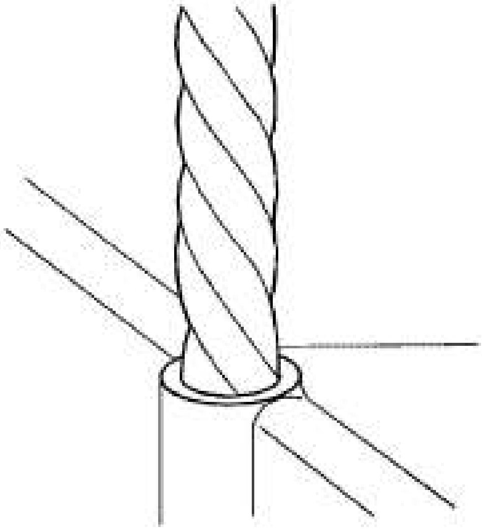


14. Inspect the insert (1) for correct installation (2) into the tapped hole.



15. Any installed insert that restricts or blocks an oil or engine coolant passage (3) will need to have the oil or engine coolant passage drilled out (4) to the original size of the oil or engine coolant passage. After drilling the restriction or blockage, clean out any chips and thread the installation driver tool through the insert again to remove any burrs caused by the drilling of the oil or engine coolant passage.

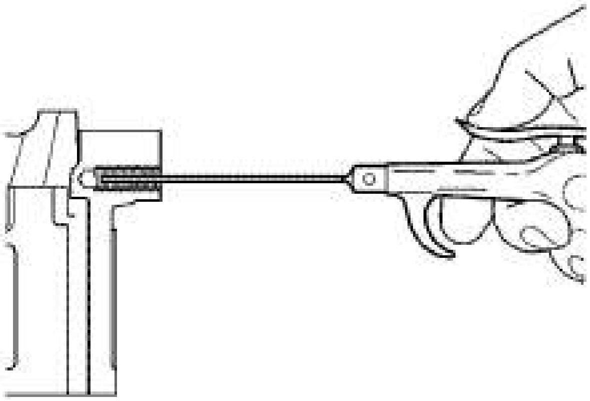
Tapered Pipe Thread Repair



Important:

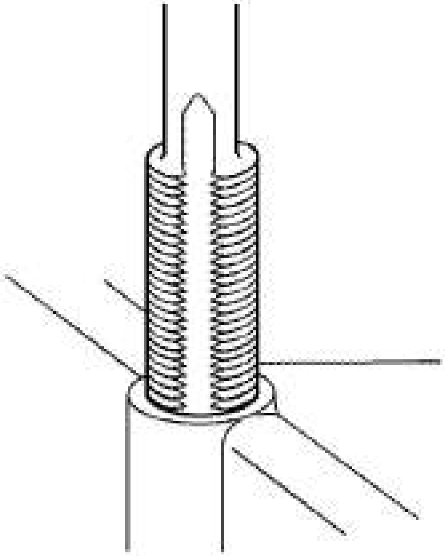
- The thread repair insert for tapered pipe threads is coated with a clear silver zinc coating.
- During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.
- Drill the hole until the stop collar contacts the surface of the base material.

1. Drill out the threads of the damaged hole.



Important: All chips must be removed from the drilled hole prior to tapping.

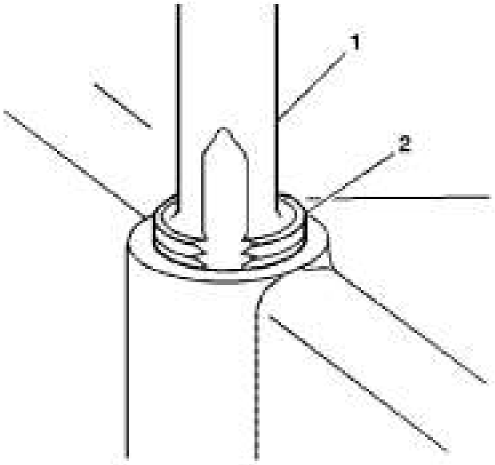
2. Using compressed air, clean out any chips.



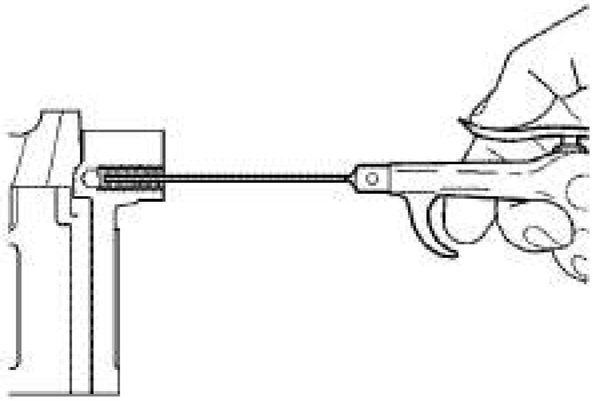
Important:

- During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.
- Make sure the tap has created full threads at least to the depth equal to the insert length.

3. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.

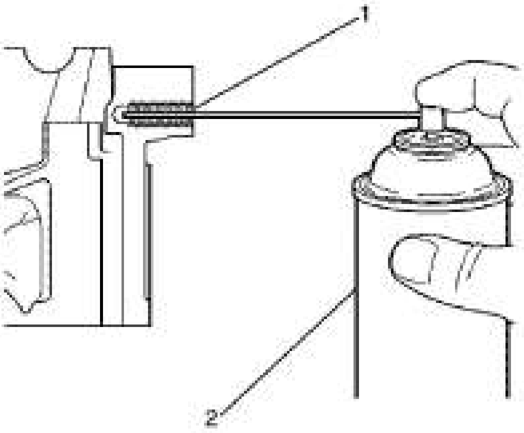


4. Tap the drilled hole until the threads at the top of the tap (1) are down to the surface of the base material (2).

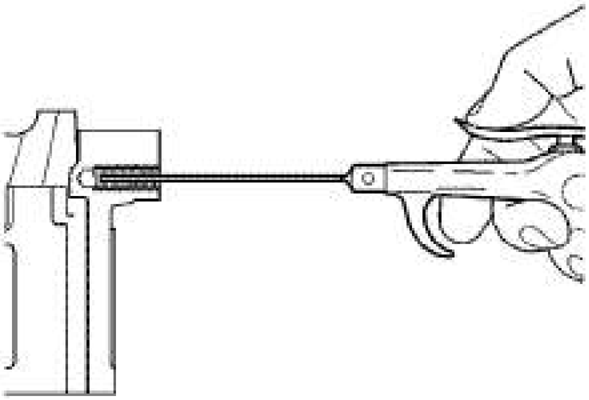


Important: All chips must be removed from the tapped hole prior to insert installation.

5. Using compressed air, clean out any chips.

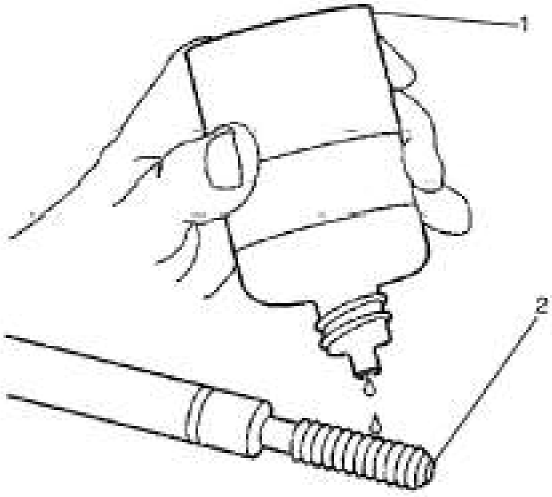


6. Spray a commercially available thread cleaner (2) into the tapped hole (1).



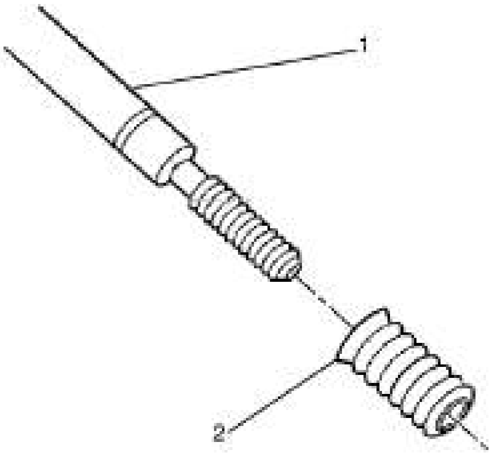
Important: All chips must be removed from the tapped hole prior to insert installation.

7. Using compressed air, clean out any chips.

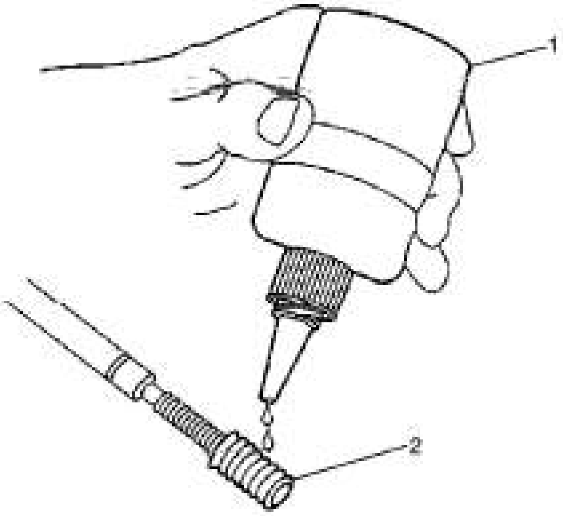


Important: DO NOT allow oil or other foreign material to contact the Outside Diameter (OD) of the insert.

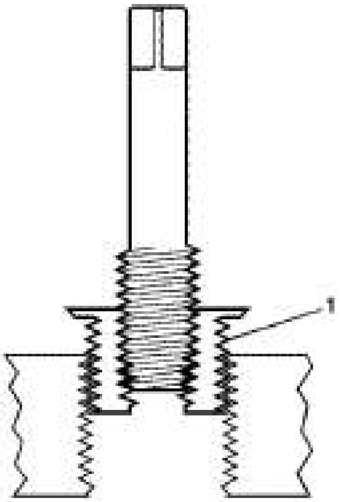
8. Lubricate the threads of the driver installation tool (2) with the driver oil (1).



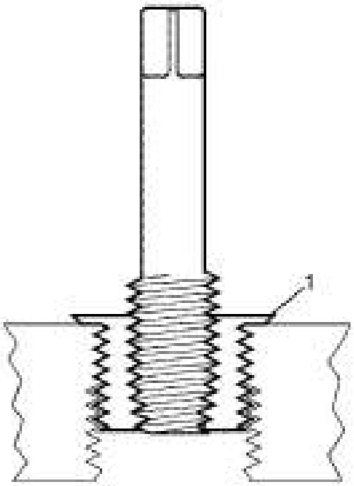
9. Install the insert (2) onto the driver installation tool (1).



10. Apply threadlock sealant LOCTITE 277® or equivalent (1) to the insert OD threads (2).

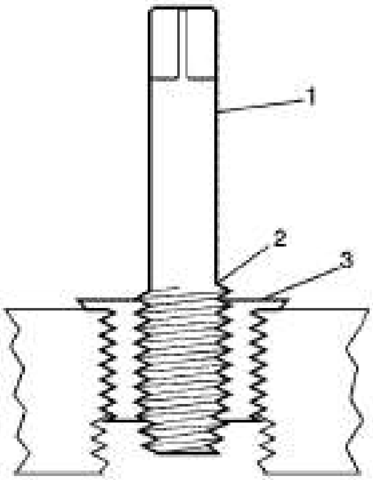


11. Install the insert (1) into the tapped hole by hand only.



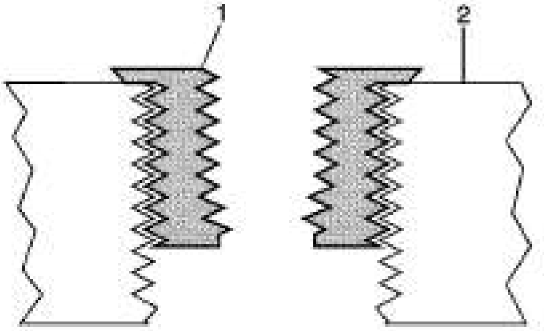
Important: If the insert will not thread down until the flange contacts the surface of the base material remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or incorrect tapping.

12. Install the insert until the flange (1) of the insert contacts the surface of the base material.

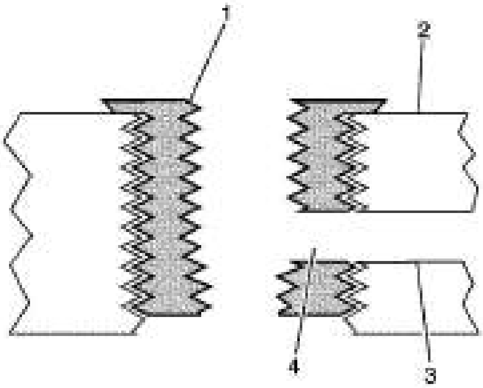


Important: The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

13. Continue to rotate the driver installation tool (1) until the top of the threaded section (2) is level with the top of the insert (3).



14. Inspect the insert (1) for correct installation (2) into the tapped hole.

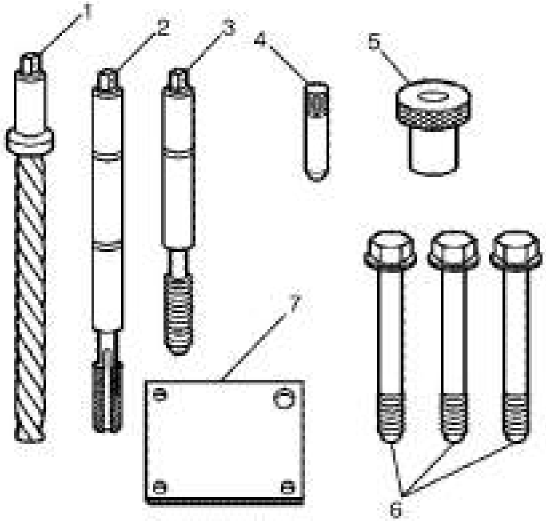


15. Any installed insert that restricts or blocks an oil or engine coolant passage (3) will need to have the oil or engine coolant passage drilled out (4) to the original size of the oil or engine coolant passage. After drilling the restriction or blockage, clean out any chips and thread the installation driver tool through the insert again to remove any burrs caused by the drilling of the oil or engine coolant passage.

Cylinder Head Bolt Hole Thread Repair

Tools Required

- J 42385-700 High Feature Thread Repair Kit
- J 42385-2000 Thread Insert Kit
-



- The cylinder head bolt hole thread repair tooling are in the kits J 42385-2000 and J 42385-700 . The cylinder head bolt hole thread repair components consist of the following:

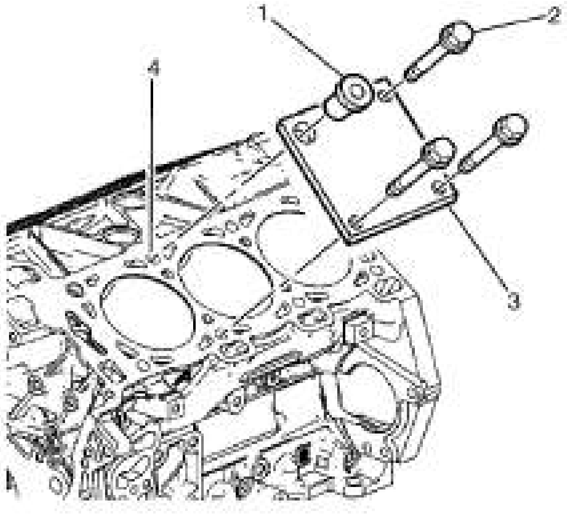
- J 42385-723 Drill (1)
- J 42385-724 Tap (2)
- J 42385-725 Installation driver (3)
- J 42385-303 Alignment pin (4)
- J 42385-302 Bushing (5)
- J 42385-733 Bolts (6)
- J 42385-401 Fixture plate (7)

Caution: Refer to Safety Glasses Caution in the Preface section.

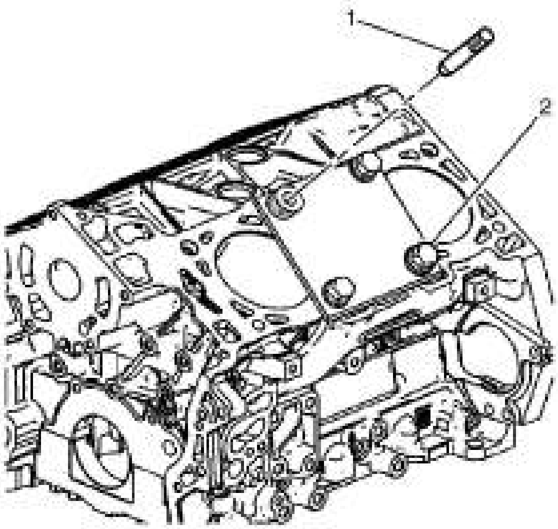
Important:

- Remove the fixture plate prior to installing the insert with the installer tool.
- The use of a cutting type fluid such as WD 40®; or equivalent is recommended when performing the drilling, counterboring and tapping procedures.

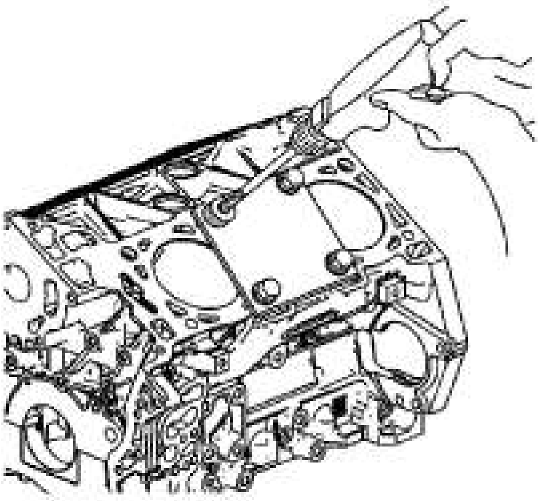
- When installed to the correct depth, the flange of the insert will be seated against the counterbore of the drilled/tapped hole.



1. Position the fixture plate (3) with the bushing (1) installed over the cylinder head bolt hole to be repaired (4).
2. Loosely install the fixture plate bolts (2) into the remaining cylinder head bolt holes.



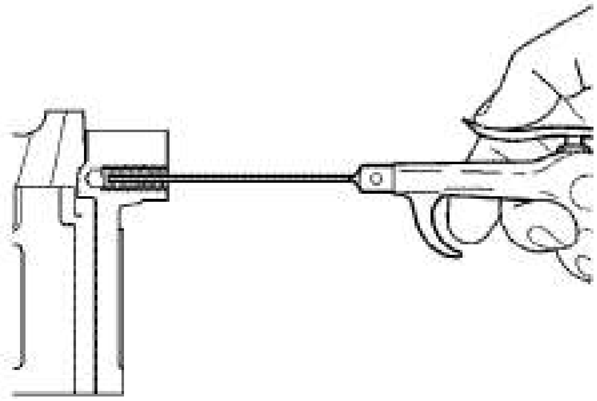
3. Position the alignment pin (1) through the bushing and into the cylinder head bolt hole.
4. With the alignment pin in the desired cylinder head bolt hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin (1) from the cylinder head bolt hole.



Important:

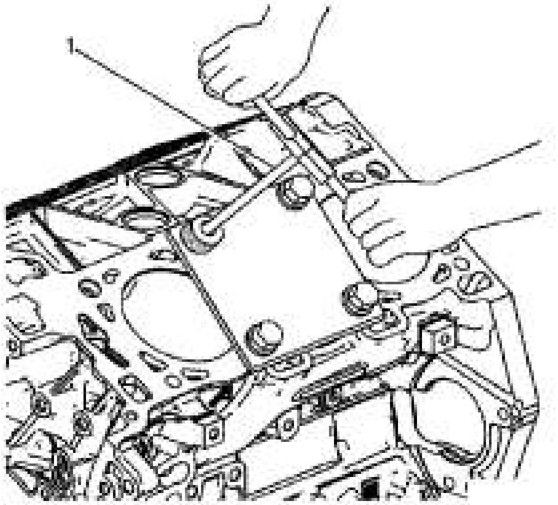
- During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.
- Drill the hole until the stop collar contacts the top of the drill bushing.

6. Drill out the threads of the damaged hole.



Important: All chips must be removed from the drilled hole prior to tapping.

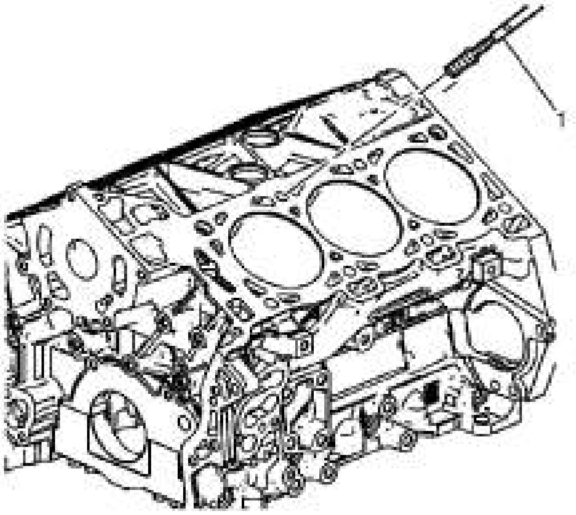
7. Using compressed air, clean out any chips.



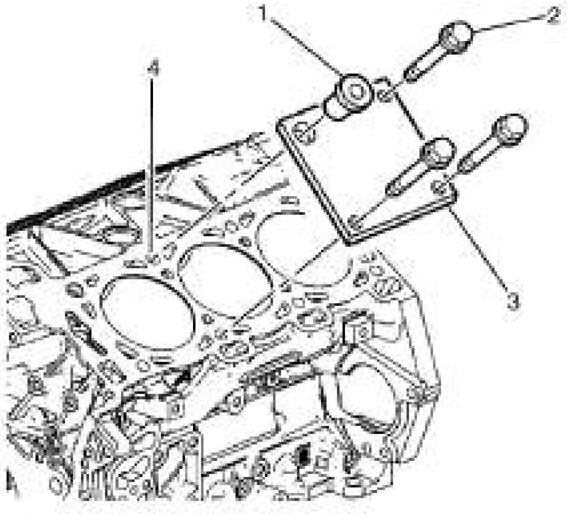
Important:

- During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.
- Make sure the tap has created full threads at least to the depth equal to the insert length.

8. Using a suitable tapping wrench (1), tap the threads of the drilled hole by hand only.

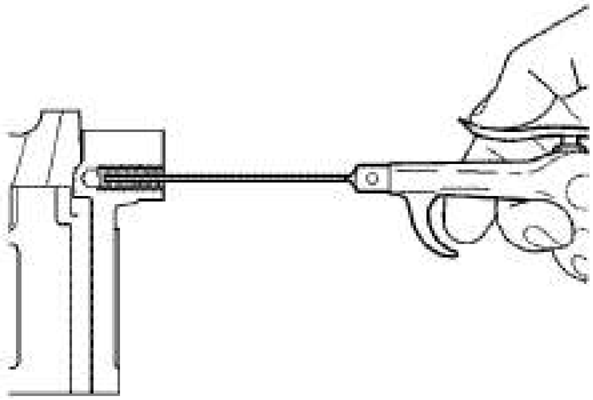


9. In order to tap the new threads for the insert to the correct depth, rotate the tap into the cylinder head bolt hole until the mark (1) on the tap aligns with the top of the drill bushing.



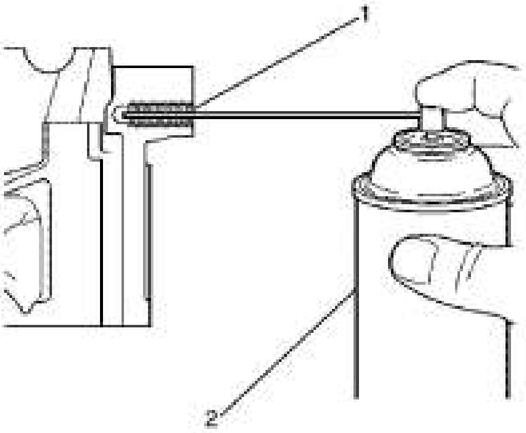
Important: Remove the fixture plate prior to installing the insert with the installer tool.

10. Remove the fixture plate bolts (2).
11. Remove the fixture plate (3) and bushing (1).

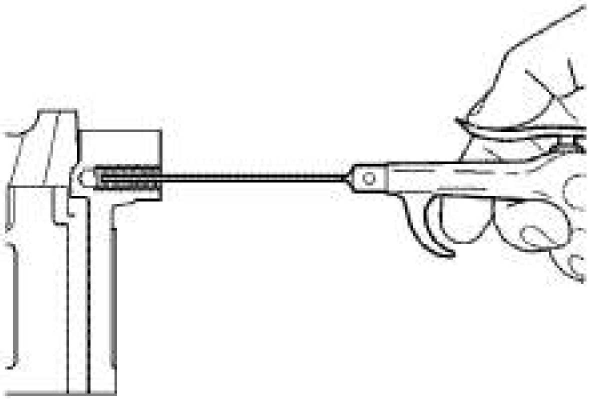


Important: All chips must be removed from the tapped hole prior to insert installation.

12. Using compressed air, clean out any chips.

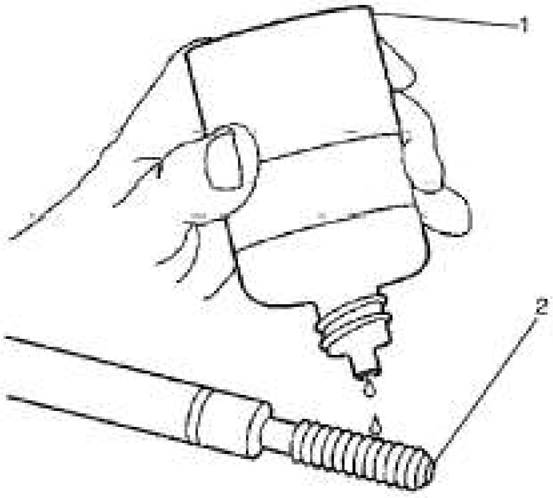


13. Spray a commercially available thread cleaner (2) into the tapped hole (1).



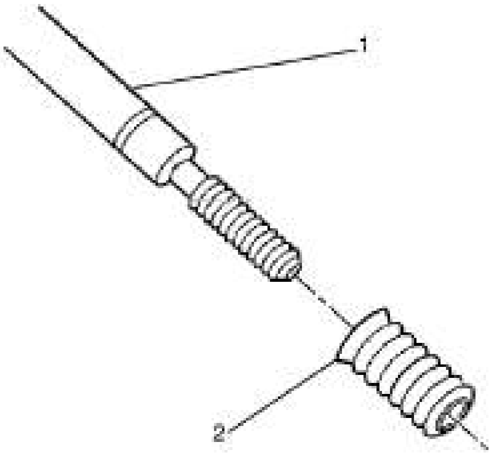
Important: All chips must be removed from the tapped hole prior to insert installation.

14. Using compressed air, clean out any chips.

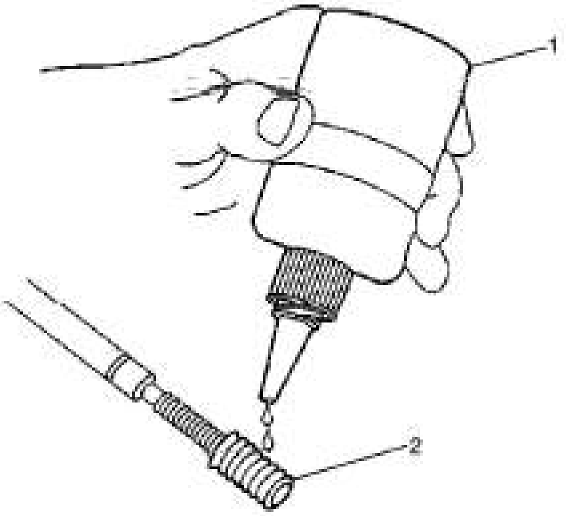


Important: DO NOT allow oil or other foreign material to contact the outside diameter (OD) of the insert.

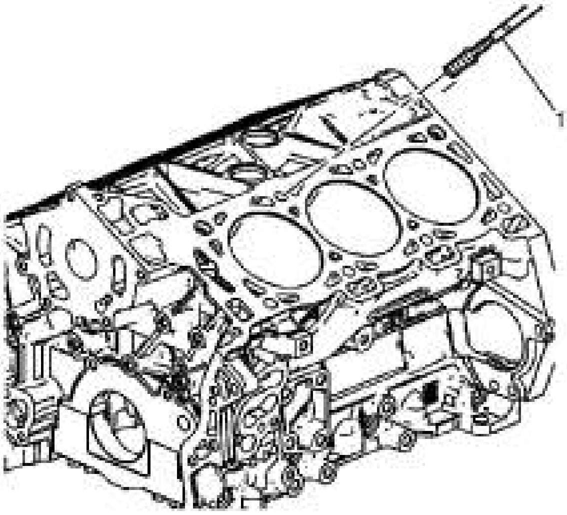
15. Lubricate the threads of the driver installation tool (2) with the driver oil (1).



16. Install the insert (2) onto the driver installation tool (1).



17. Apply threadlock sealant such as LOCTITE 277® ; or equivalent (1) to the insert OD threads (2).



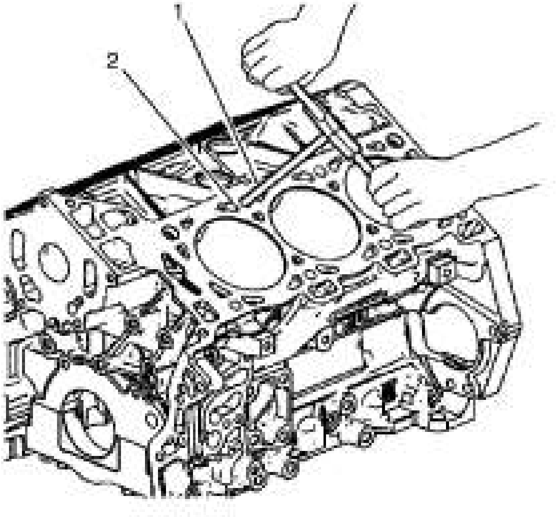
18. Install the insert and installation driver (1) into the tapped hole by hand only.
19. Start the insert into the threaded hole.

    Important: If the insert will not thread down until the flange contacts the counterbored surface remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or incorrect tapping.

20. Install the insert until the flange of the insert contacts the counterbored surface.

    Important: The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

21. Continue to rotate the driver installation tool through the insert.

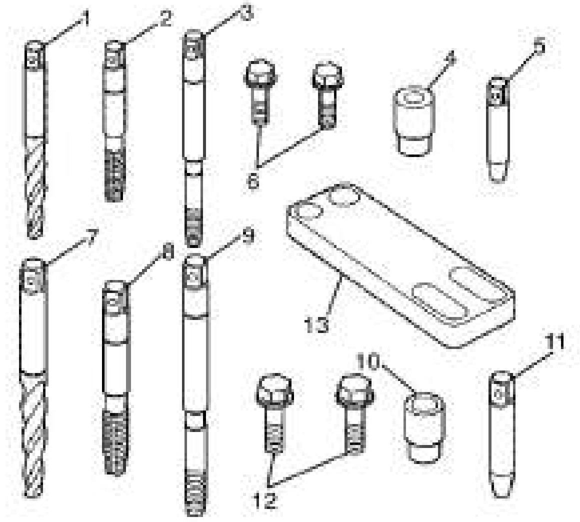


22. In order to completely form the new threads in the insert, rotate the driver installation tool through the insert until the mark (1) on the driver installation tool aligns with the surface of the cylinder block deck (2).
23. Inspect the insert for correct installation into the tapped hole.

Crankshaft Main Bolt Hole Thread Repair

Tools Required

- J 42385-700 High Feature Thread Repair Kit
- J 42385-2000 Thread Insert Kit



Important:

- In order to repair some crankshaft main bolt holes it will be necessary to mount the fixture plate upside down.
- DO NOT remove the fixture plate prior to installing the insert with the installation driver. The fixture plate remains in position throughout the thread repair process.

The crankshaft main bearing bolt hole thread repair tooling are in the kits J 42385-2000 and J 42385-700 . The crankshaft main bearing bolt hole thread repair components consist of the following:

- J 42385-702 Drill (1) for outboard holes
- J 42385-703 Tap (2) for outboard holes
- J 42385-704 Installation driver (3) for outboard holes
- J 42385-726 Bushing (4) for outboard holes
- J 42385-727 Alignment pin (5) for outboard holes

- J 42385-728 Bolts (6) for outboard holes
- J 42385-720 Drill (7) for inboard holes
- J 42385-721 Tap (8) for inboard holes
- J 42385-722 Installation driver (9) for inboard holes
- J 42385-713 Bushing (10)
- J 42385-308 Alignment pin (11)
- J 42385-734 Bolts (12)
- J 42385-712 Fixture plate (13)

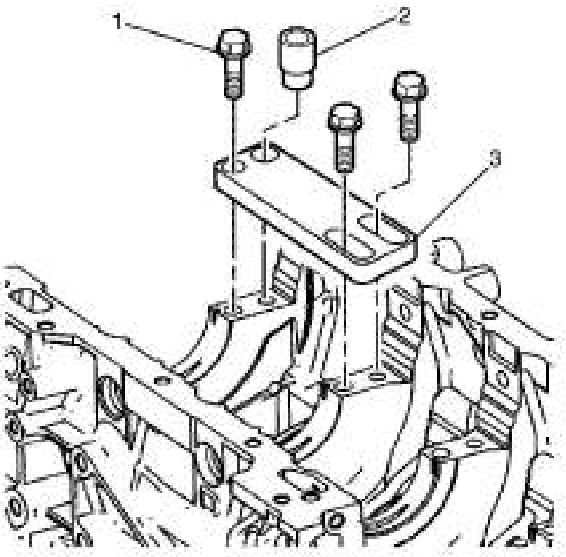
Outboard Bolt Holes

Caution: Refer to Safety Glasses Caution in the Preface section.

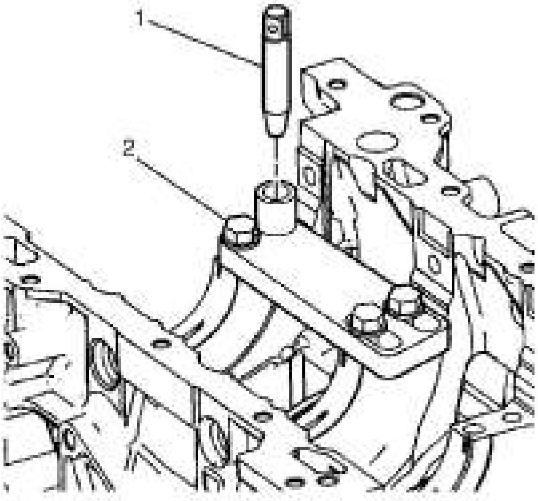
Important:

- Ensure the fixture plate is installed during the machining and installation processes of the insert.
- The use of a cutting type fluid such as WD 40® or equivalent is recommended when performing the drilling, counterboring and tapping procedures.

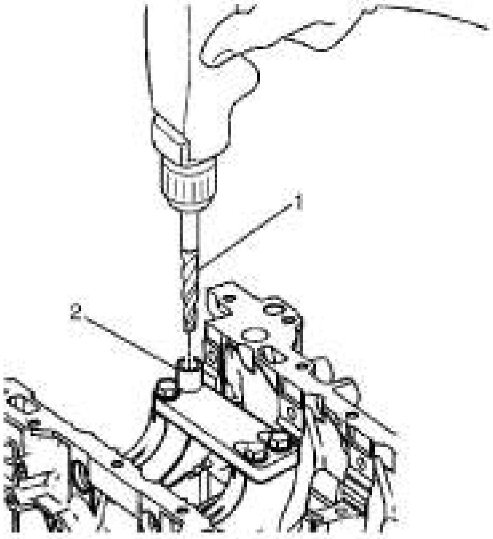
- When installed to the correct depth, the flange of the insert will be seated against the counterbore of the drilled/tapped hole.



1. Position the fixture plate (3) with the bushing (2) installed over the crankshaft main cap bolt hole to be repaired.
2. Loosely install the fixture plate bolts (1) into the remaining crankshaft main cap bolt holes.



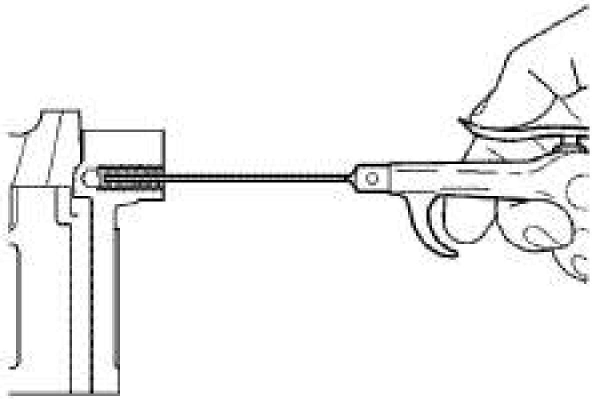
3. Position the alignment pin (1) through the bushing and into the crankshaft main cap bolt hole.
4. With the alignment pin in the desired crankshaft main cap bolt hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin (1) from the crankshaft main cap bolt hole.



Important:

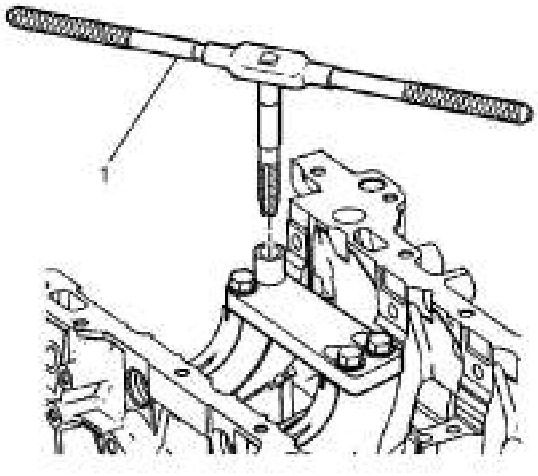
- During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.
- Drill the crankshaft main bolt hole until the mark (1) on the drill aligns with the top of the drill bushing (2).

6. Drill out the threads of the damaged hole.



Important: All chips must be removed from the drilled hole prior to tapping.

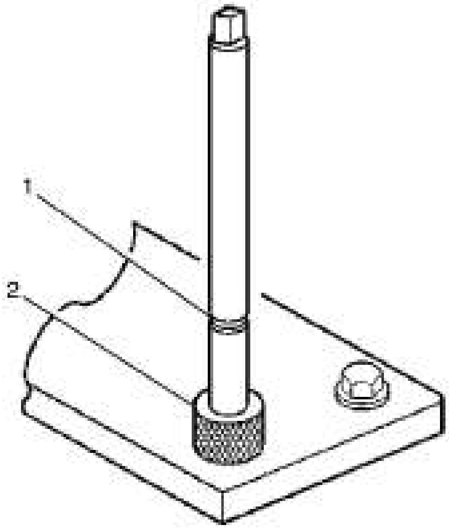
7. Using compressed air, clean out any chips.



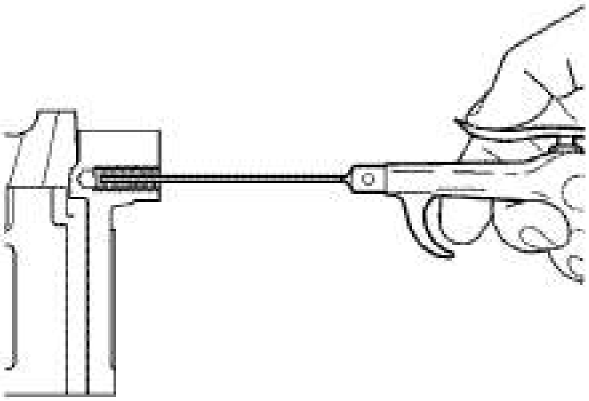
Important:

- DO NOT remove the fixture plate, ensure the fixture plate is installed during the machining and installation processes of the insert.
- During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.
- Make sure the tap has created full threads at least to the depth equal to the insert length.

8. Using a suitable tapping wrench (1), tap the threads of the drilled hole by hand only.

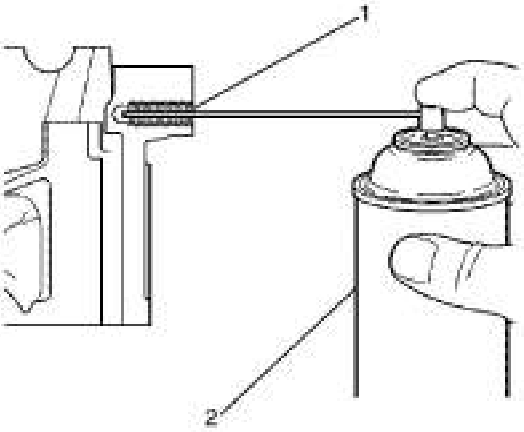


9. In order to tap the new threads for the insert to the correct depth, rotate the tap into the crankshaft main cap bolt hole until the mark (1) on the tap aligns with the top of the drill bushing (2).

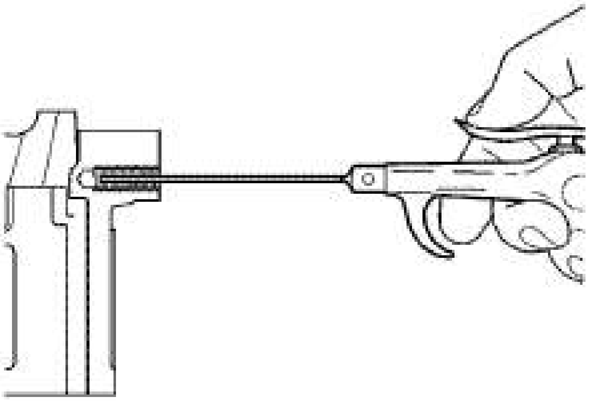


Important: All chips must be removed from the tapped hole prior to insert installation.

10. Using compressed air, clean out any chips.

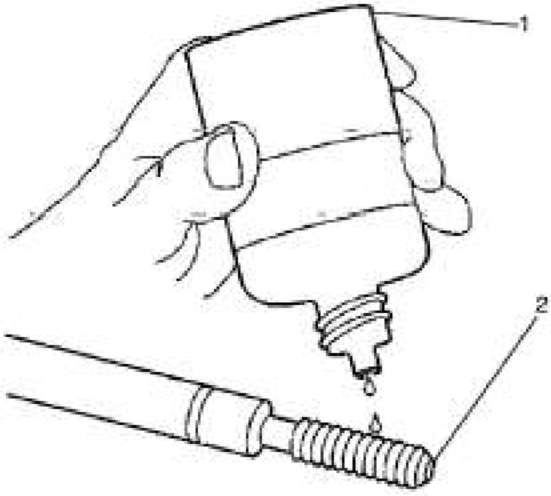


11. Spray a commercially available thread cleaner (2) into the tapped hole (1).



Important: All chips must be removed from the tapped hole prior to insert installation.

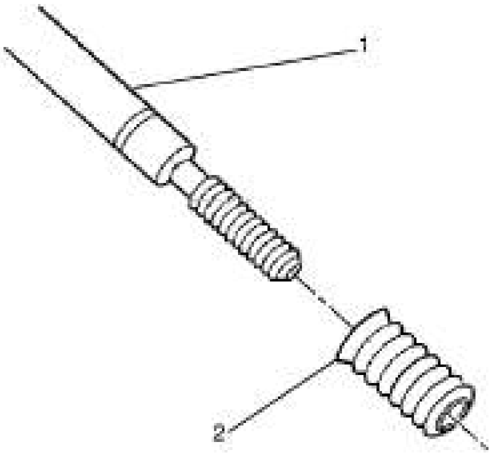
12. Using compressed air, clean out any chips.



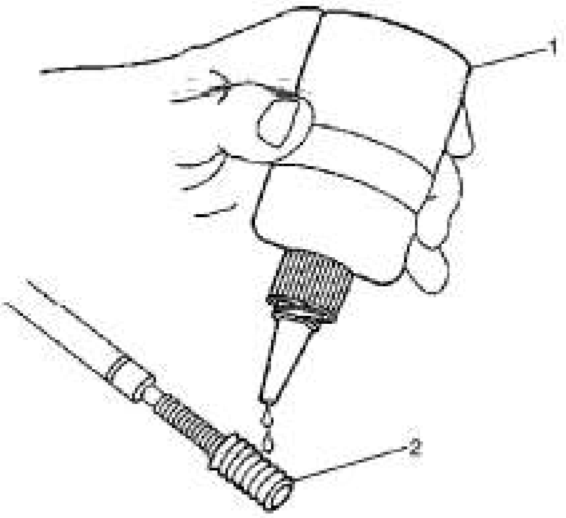
Important:

- DO NOT remove the fixture plate, make sure the fixture plate is installed during the installation process of the insert.
- DO NOT allow oil or other foreign material to contact the Outside Diameter (OD) of the insert.

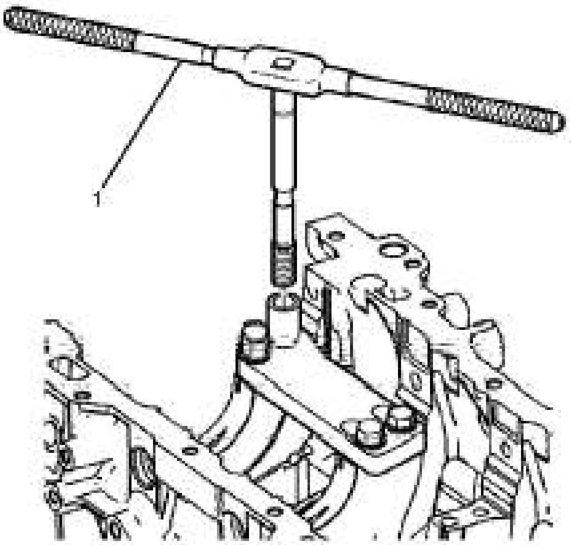
13. Lubricate the threads of the driver installation tool (2) with the driver oil (1).



14. Install the insert (2) onto the driver installation tool (1).



15. Apply threadlock sealant such as LOCTITE 277®, or equivalent (1) to the insert OD threads (2).



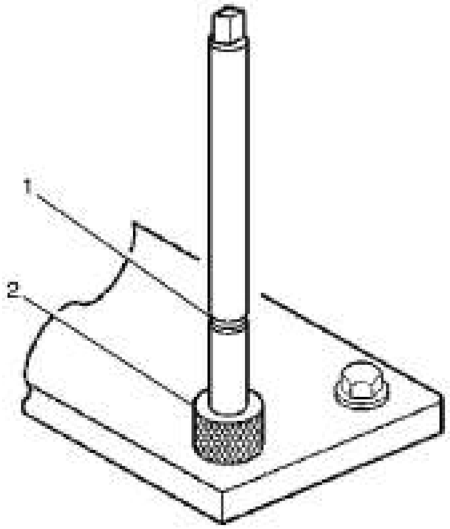
16. Install the insert and installation driver (1) into the tapped hole by hand only.
17. Start the insert into the threaded hole.

Important: If the insert will not thread down until the flange contacts the counterbored surface remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or incorrect tapping.

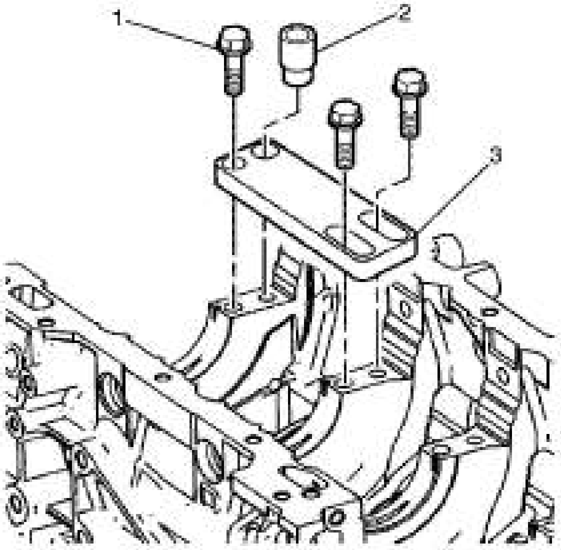
18. Install the insert until the flange of the insert contacts the counterbored surface.

Important: The driver installation tool (1) will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

19. Continue to rotate the driver installation tool (1) through the insert.



20. Rotate the driver installation tool until the mark (1) on the driver installation tool aligns with the top of the drill bushing (2).
21. Inspect the insert for correct installation into the tapped hole.



22. Remove the fixture plate bolts (1).
23. Remove the fixture plate (3) and bushing (2).

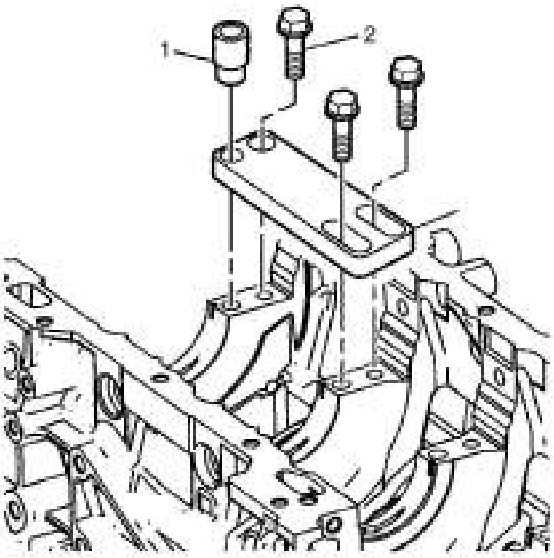
Inboard Bolt Holes

Caution: Refer to Safety Glasses Caution in the Preface section.

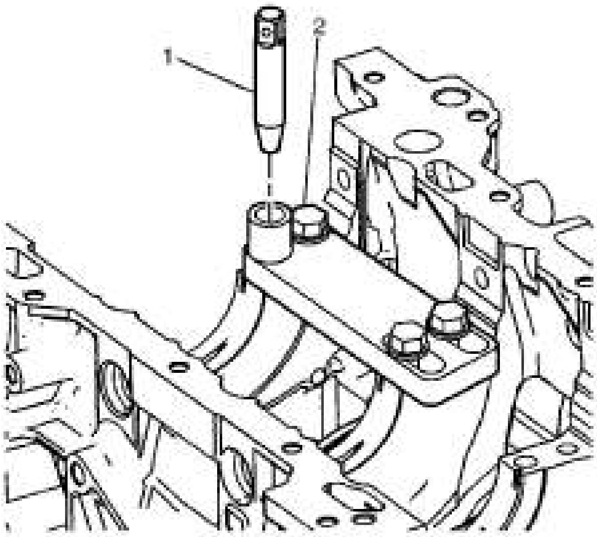
Important:

- Ensure the fixture plate is installed during the machining and installation processes of the insert.
- The use of a cutting type fluid such as WD 40® or equivalent is recommended when performing the drilling, counterboring and tapping procedures.

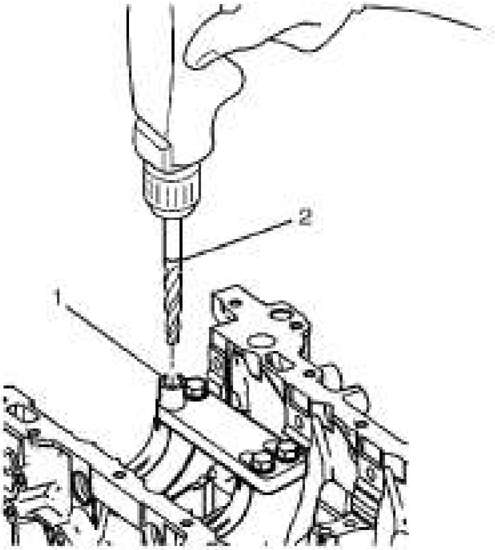
- When installed to the correct depth, the flange of the insert will be seated against the counterbore of the drilled/tapped hole.



1. Position the fixture plate (3) with the bushing (1) installed over the crankshaft main cap bolt hole to be repaired.
2. Loosely install the fixture plate bolts (2) into the remaining crankshaft main cap bolt holes.



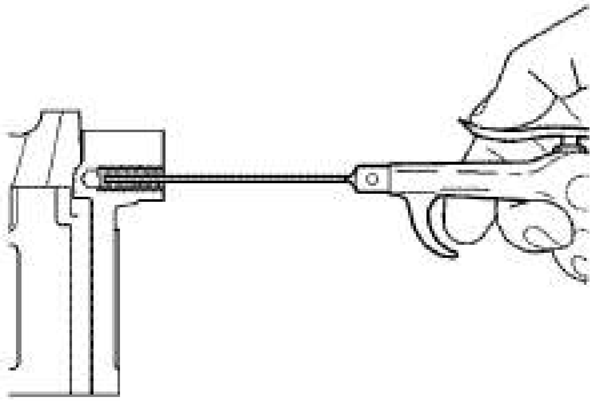
3. Position the alignment pin (1) through the bushing and into the crankshaft main cap bolt hole.
4. With the alignment pin in the desired crankshaft main cap bolt hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin (1) from the crankshaft main cap bolt hole.



Important:

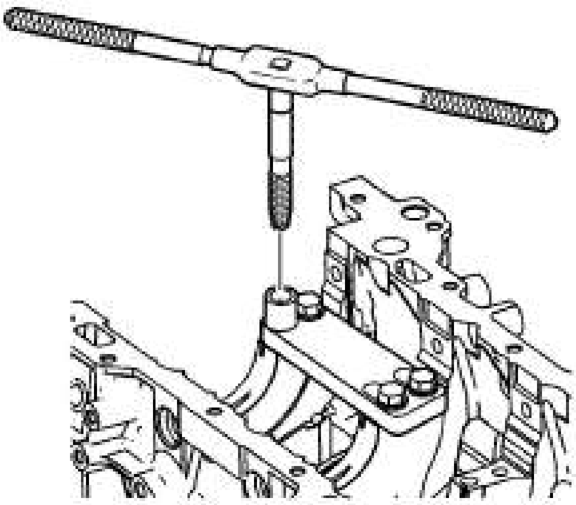
- During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.
- Drill the crankshaft main bolt hole until the mark (1) on the drill aligns with the top of the drill bushing (2).

6. Drill out the threads of the damaged hole.



Important: All chips must be removed from the drilled hole prior to tapping.

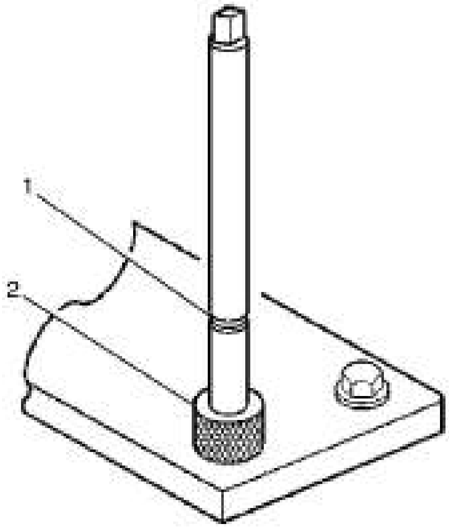
7. Using compressed air, clean out any chips.



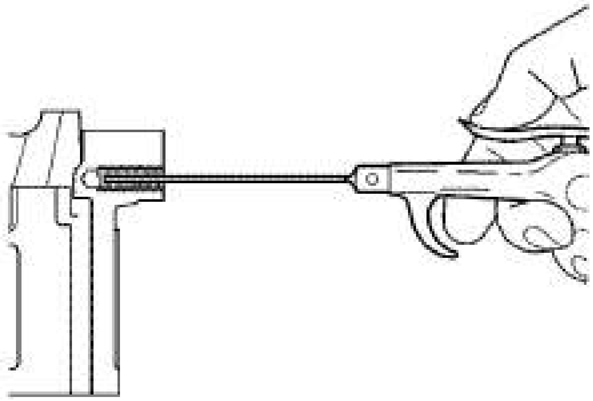
Important:

- DO NOT remove the fixture plate, ensure the fixture plate is installed during the machining and installation processes of the insert.
- During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.
- Make sure the tap has created full threads at least to the depth equal to the insert length.

8. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.

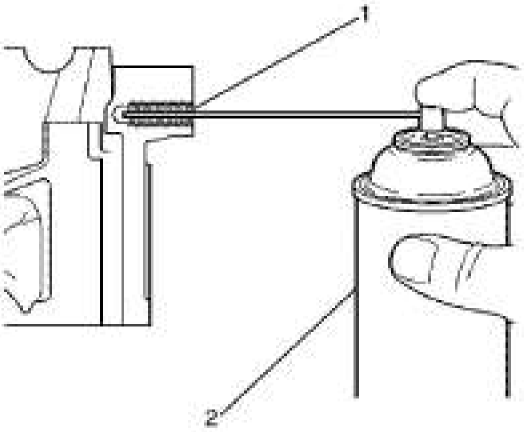


9. In order to tap the new threads for the insert to the correct depth, rotate the tap into the crankshaft main cap bolt hole until the mark (1) on the tap aligns with the top of the drill bushing (2).

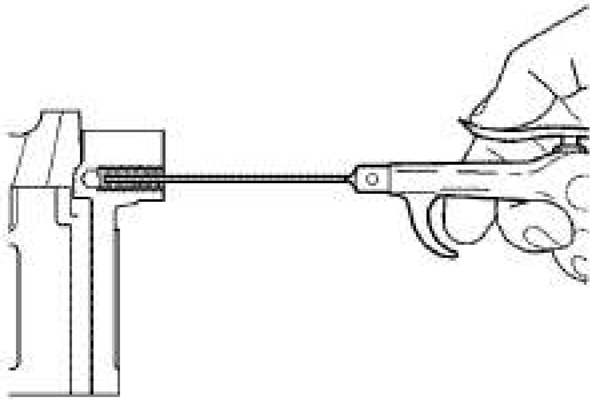


Important: All chips must be removed from the tapped hole prior to insert installation.

10. Using compressed air, clean out any chips.

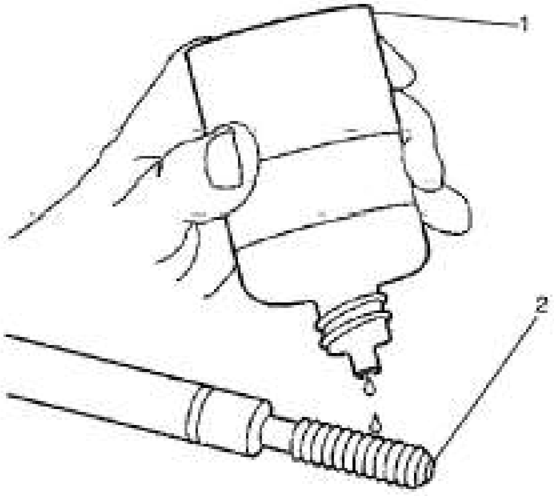


11. Spray a commercially available thread cleaner (2) into the tapped hole (1).



Important: All chips must be removed from the tapped hole prior to insert installation.

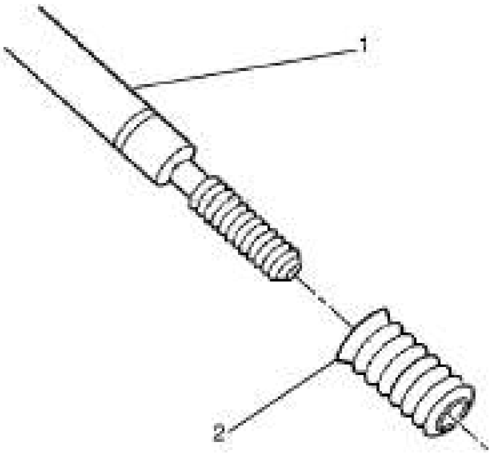
12. Using compressed air, clean out any chips.



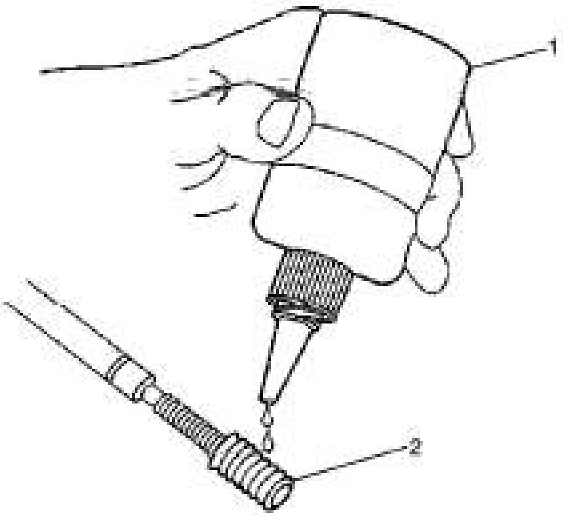
Important:

- DO NOTremove the fixture plate, make sure the fixture plate is installed during the installation process of the insert.
- DO NOT allow oil or other foreign material to contact the Outside Diameter (OD) of the insert.

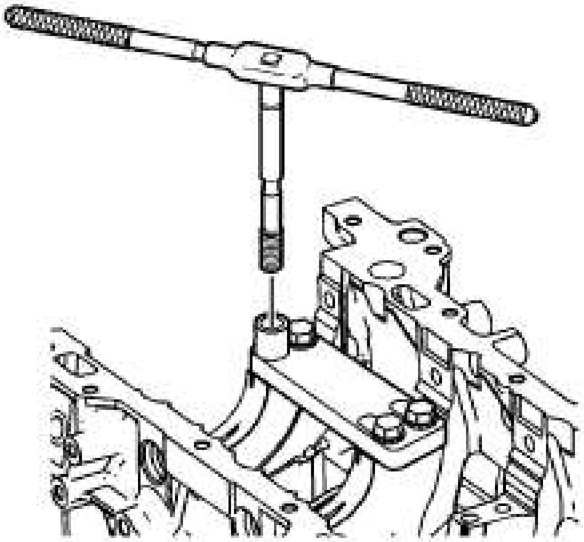
13. Lubricate the threads of the driver installation tool (2) with the driver oil (1).



14. Install the insert (2) onto the driver installation tool (1).



15. Apply threadlock sealant such as LOCTITE 277®, or equivalent (1) to the insert OD threads (2).



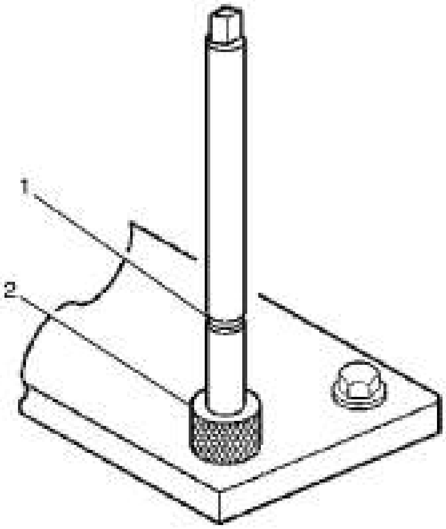
16. Install the insert and installation driver into the tapped hole by hand only.
17. Start the insert into the threaded hole.

Important: If the insert will not thread down until the flange contacts the counterbored surface remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or incorrect tapping.

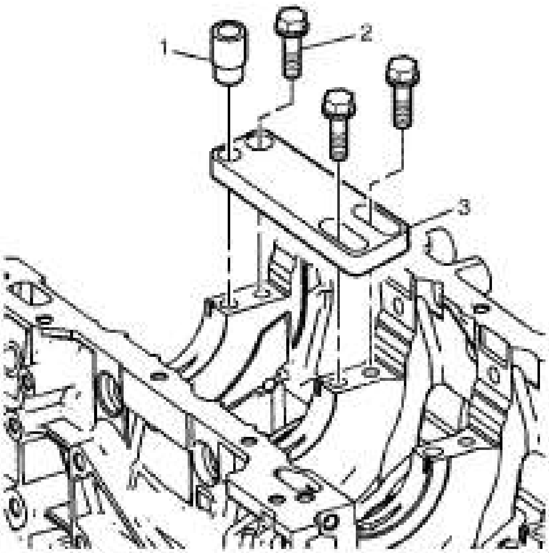
18. Install the insert until the flange of the insert contacts the counterbored surface.

Important: The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

19. Continue to rotate the driver installation tool through the insert.

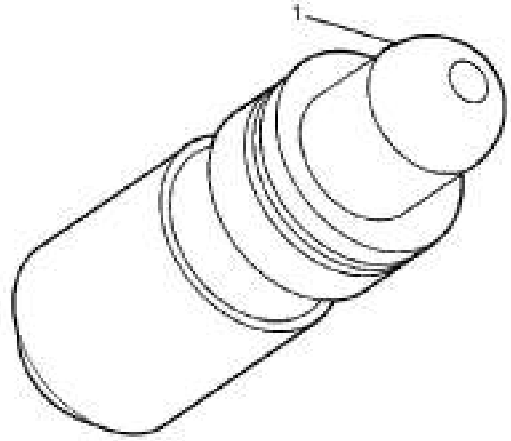


20. Rotate the driver installation tool until the mark (1) on the driver installation tool aligns with the top of the drill bushing (2).
21. Inspect the insert for correct installation into the tapped hole.



22. Remove the fixture plate bolts (2).
23. Remove the fixture plate (3) and bushing (1).

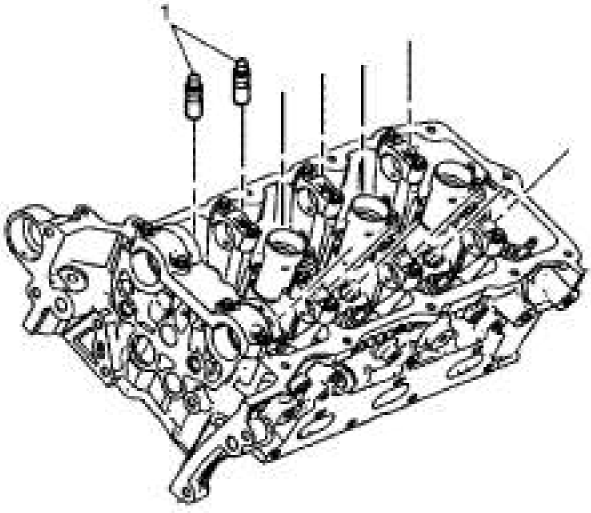
Valve Lifter Installation - Left Side



Important: DO NOT stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.

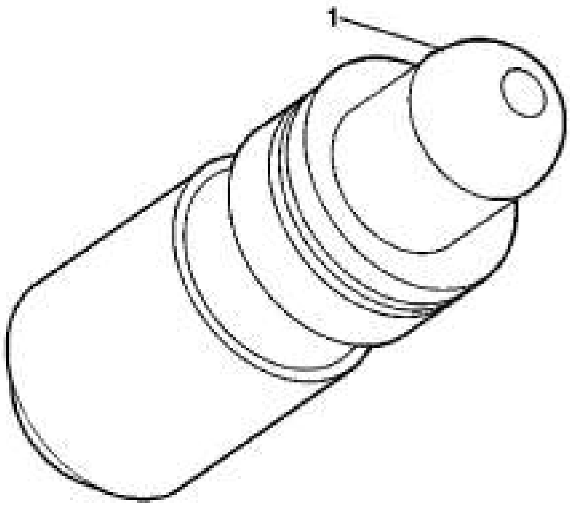
Important: DO NOT allow the stationary hydraulic lash adjuster to tip over, plunger down, after the oil fill.

1. Fill the Stationary Hydraulic Lash Adjuster (SHLA) with clean engine oil. Take precautions to prevent scratching the pivot sphere area (1) of the SHLA.
2. Lubricate the SHLA bores in the cylinder head with clean engine oil.



3. Install the SHLAs (1).
4. Apply a liberal amount of commercially available camshaft/lifter prelube to the SHLA (1) pivot spheres.

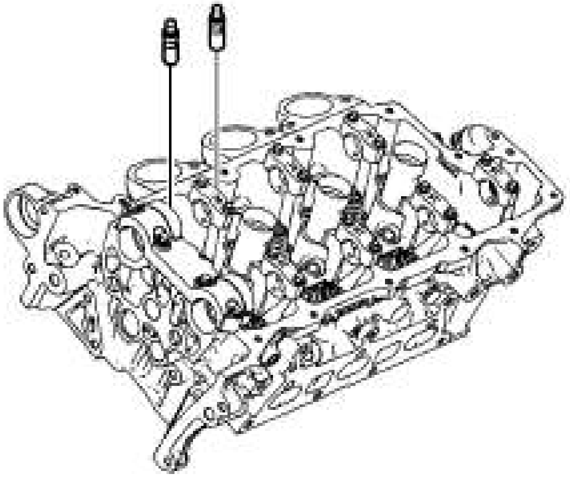
Valve Lifter Installation - Left Side (LLT)



Important: Do not stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.

Important: Do not allow the stationary hydraulic lash adjuster to tip over, plunger down, after the oil fill.

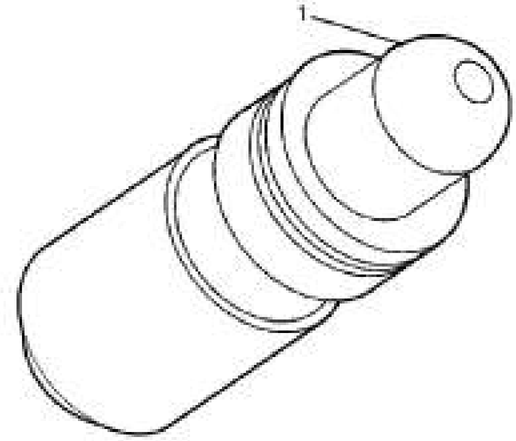
1. Fill the stationary hydraulic lash adjuster (SHLA) with clean engine oil GM P/N 12378006 or equivalent. Take precautions to prevent scratching the pivot sphere area (1) of the SHLA.
2. Lubricate the SHLA bores in the cylinder head with clean engine oil GM P/N 12378006 or equivalent.



3. Install the SHLAs in the cylinder head.
4. Apply a liberal amount of lubricant GM P/N 12345501 (Canadian P/N 992704) or equivalent to the SHLA pivot spheres.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Repair Instructions - Off Vehicle | **Document ID: 1985125**

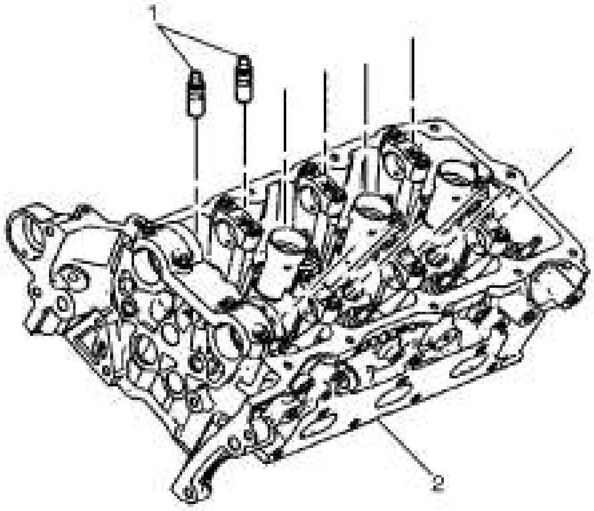
Valve Lifter Installation - Right Side



Important: DO NOT stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.

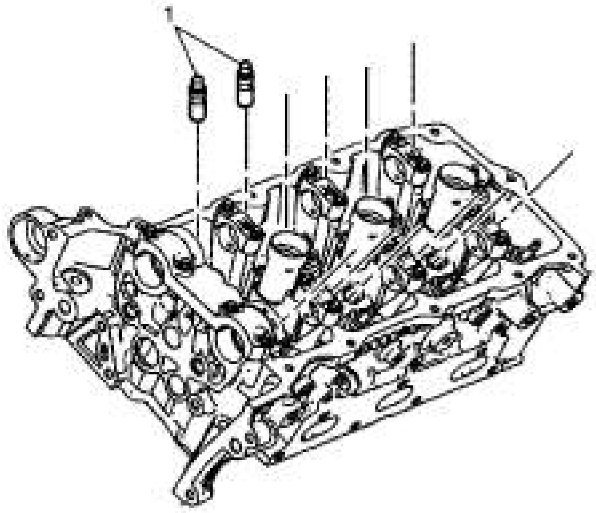
Important: DO NOT allow the stationary hydraulic lash adjuster to tip over, plunger down, after the oil fill.

1. Fill the Stationary Hydraulic Lash Adjuster (SHLA) with clean engine oil. Take precautions to prevent scratching the pivot sphere area (1) of the SHLA.
2. Lubricate the SHLA bores in the cylinder head with clean engine oil.



3. Install the SHLAs (1) in the cylinder head (2).
4. Apply a liberal amount of commercially available camshaft/lifter prelube to the SHLA pivot spheres.

Valve Lifter Removal - Left Side



Important:

- DO NOT stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.
- DO NOT allow the stationary hydraulic lash adjuster to tip over, plunger down, after the oil fill.

1. Remove the Stationary Hydraulic Lash Adjuster, (SHLAs) (valve lifters) (1).

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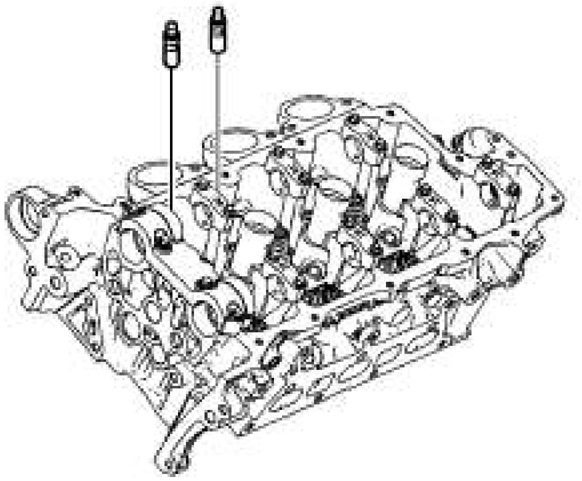
Valve Lifter Removal - Left Side (LLT)

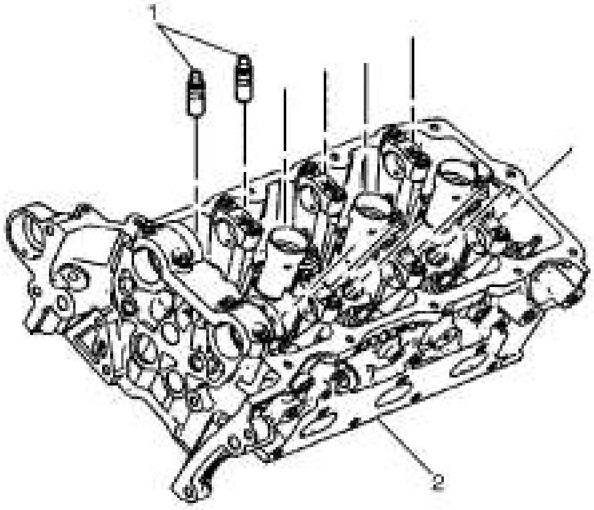


Important:

- Do not stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.
- Do not allow the stationary hydraulic lash adjuster to tip over, plunger down, after the oil fill.

Remove the valve lifters (SHLAs) from the cylinder head. If the lifters are to be reused, keep in order so they can be reinstalled in the same position.

Valve Lifter Removal - Right Side



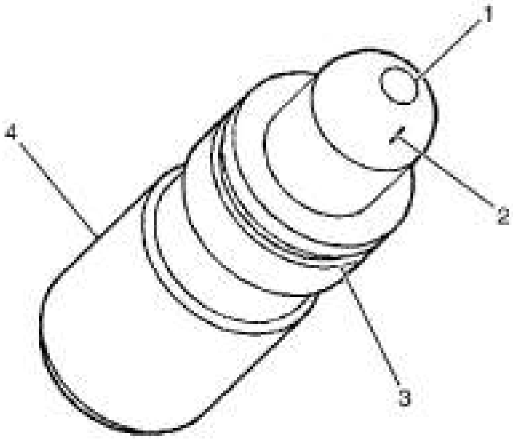
Important:

- DO NOT stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.
- DO NOT allow the stationary hydraulic lash adjuster to tip over, plunger down, after the oil fill.

1. Remove the Stationary Hydraulic Lash Adjuster, (SHLAs) (valve lifters) (1) from the right bank cylinder head (2).

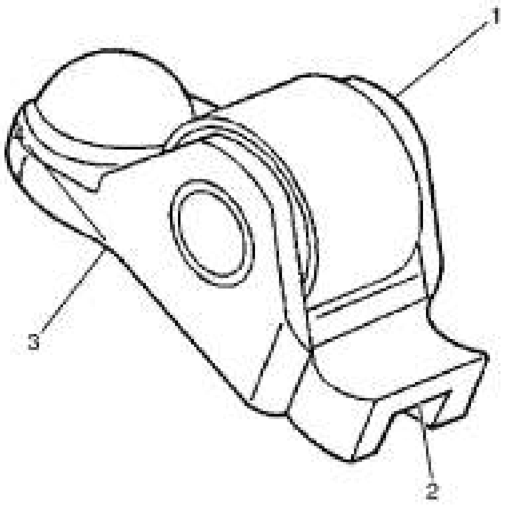
Valve Lifters Cleaning and Inspection

Notice: Refer to Valve Lifter Priming Notice in the Preface section.



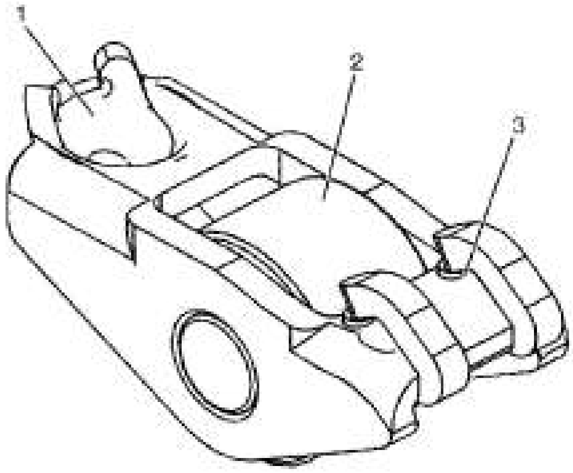
1. Inspect the stationary hydraulic lash adjuster (SHLA) in the following areas:
   - A plugged oil passage (1).
   - A scored or worn valve rocker arm pivot area (2).
   - A damaged or broken retainer (3).
   - A extremely scuffed or worn SHLA body (4).
2. Replace the SHLA or SHLAs as necessary.

Valve Rocker Arm Cleaning and Inspection

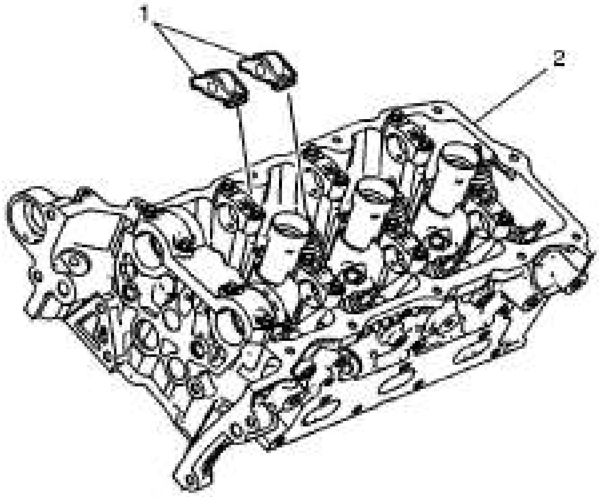


1. Inspect the valve rocker arm (1) for the following:
    - Flat spots.
    - Scoring and pitting above acceptable tolerances.
    - Ensure the roller spins freely.
2. Inspect the valve rocker arm valve tip area (2).
3. Inspect the valve rocker arm Stationary Hydraulic Lash Adjuster (SHLA) pivot area (3).
4. Replace the valve rocker arm or valve rocker arms as necessary.

Valve Rocker Arm Installation - Left Side



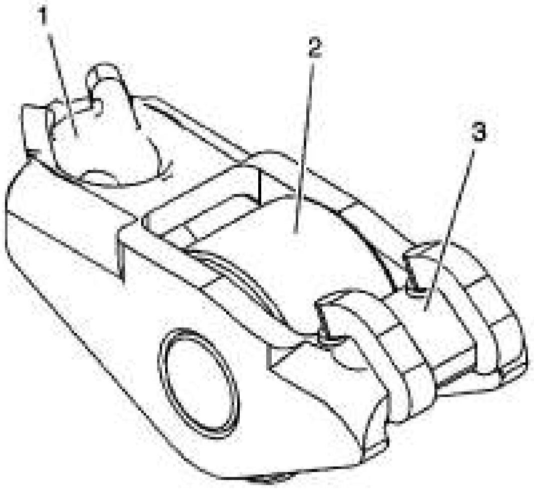
1. Apply a liberal amount of commercially available camshaft/lifter prelube to the pivot pocket (1), roller (2) and valve slot (3) areas of the valve rocker arms.



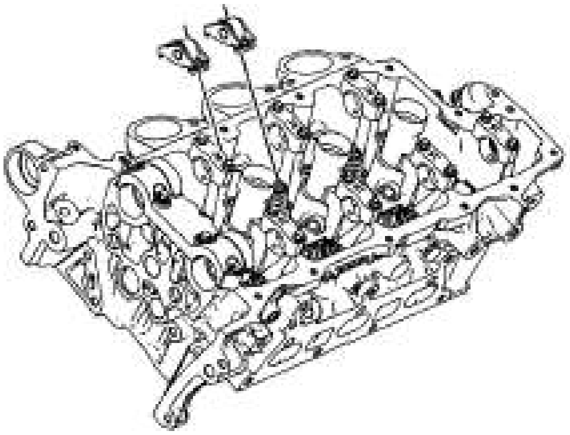
Important: The valve rocker arms (1) must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the valve rocker arms (1) are being reused you must put them back in their original location.

2. Place the valve rocker arms (1) in position on the valve tip and Stationary Hydraulic Lash Adjuster (SHLA).
3. The rounded head end of the valve rocker arms (1) go on the SHLA while the flat end goes on the valve tip.
4. Clean the camshaft journals and carriers with a clean, lint-free cloth.

Valve Rocker Arm Installation - Left Side (LLT)



1. Apply a liberal amount of lubricant GM P/N 12345501 (Canadian P/N 992704) or equivalent to the pivot pocket (1), roller (2) and valve slot (3) areas of the camshaft followers.



Important: The follower must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the followers are being reused you must put them back in their original location.

2. Place the camshaft followers in position on the valve tip and stationary hydraulic lash adjuster (SHLA).
3. The rounded head end of the follower goes on the SHLA while the flat end goes on the valve tip.
4. Clean the camshaft journals and carriers with a clean, lint-free cloth.

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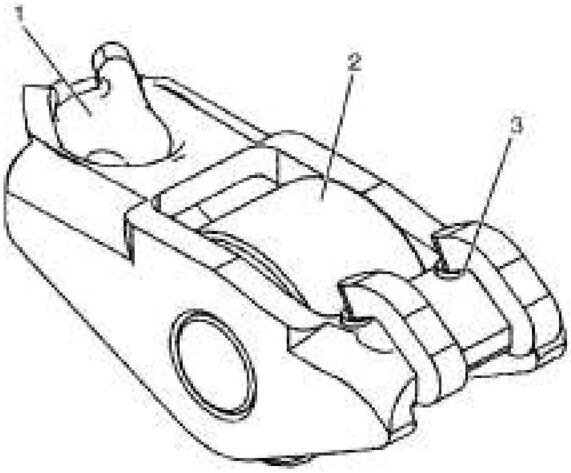
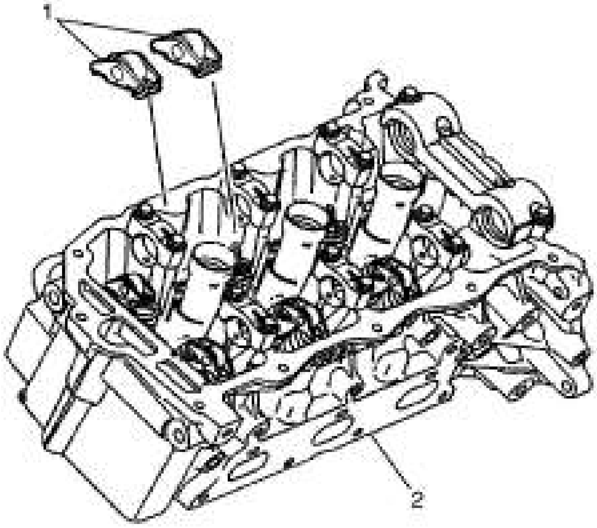
Valve Rocker Arm Installation - Right Side



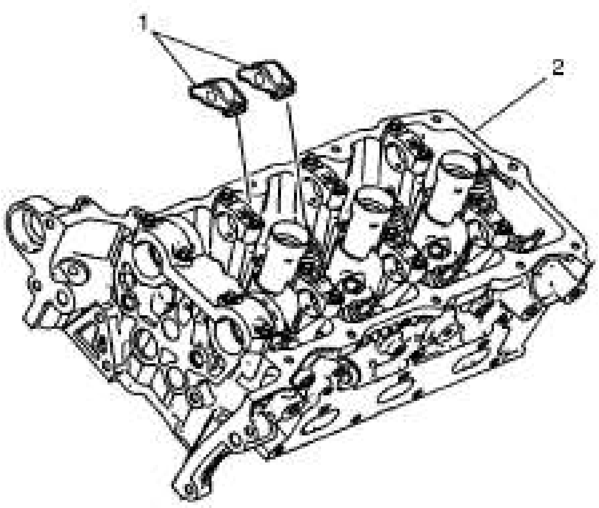
1. Apply a liberal amount of commercially available camshaft/lifter prelube to the pivot pocket (1), roller (2) and valve slot (3) areas of the valve rocker arms.



Important: The valve rocker arms (1) must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the valve rocker arms (1) are being reused you must put them back in their original location.

2. Place the valve rocker arms (1) in position on the valve tip and Stationary Hydraulic Lash Adjuster (SHLA).
3. The rounded head end of the valve rocker arms (1) go on the SHLA while the flat end goes on the valve tip.
4. Clean the camshaft journals and carriers with a clean, lint-free cloth.

Valve Rocker Arm Removal - Left Side



Important: The valve rocker arms (1) must be installed in their original locations.

1. Record the positions of the valve rocker arms (1).
2. Remove the valve rocker arms (1) from the cylinder head (2).

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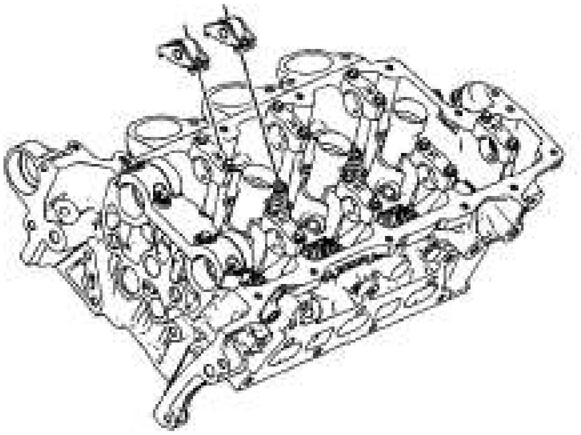
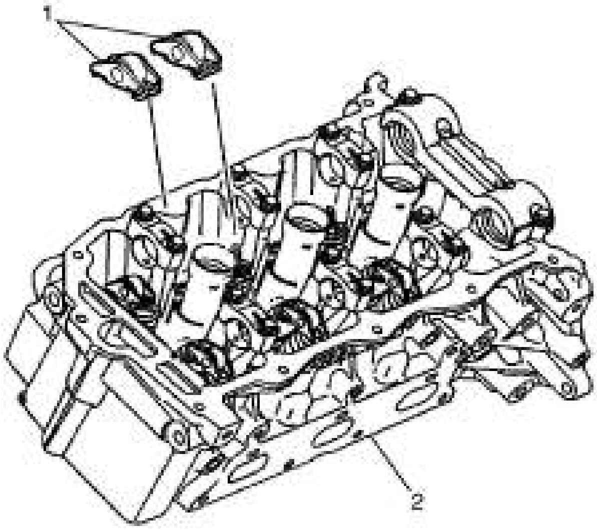
Valve Rocker Arm Removal - Left Side (LLT)



Remove the valve rocker arms from the cylinder head. If the rocker arms are to be reused, keep in order so they can be reinstalled in the same position.

Valve Rocker Arm Removal - Right Side



Important: The valve rocker arms (1) must be installed in their original locations.

1. Record the positions of the valve rocker arms (1).
2. Remove the valve rocker arms (1) from the right bank cylinder head (2).

Valve Spring Inspection and Measurement

Tools Required

J 22738-B Valve Spring Tester

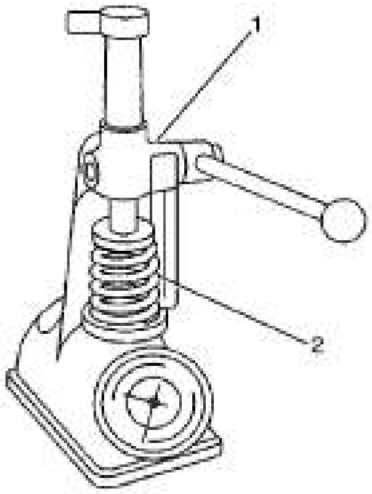
Inspection Procedure

1. Clean the valve springs in solvent.

   Caution: Refer to Safety Glasses Caution in the Preface section.

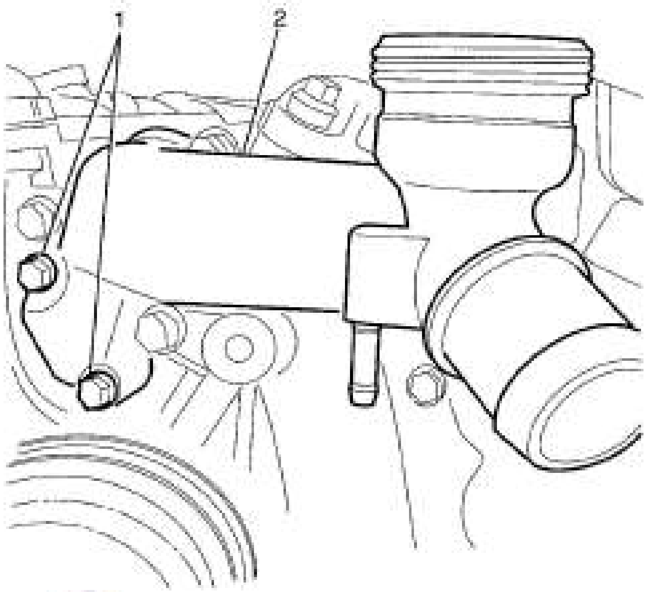
2. Dry the valve springs with compressed air.
3. Inspect the valve springs for broken coils or coil ends.

Measurement Procedure



1. Measure the valve spring tension using the J 22738-B . Refer to Engine Mechanical Specifications.
2. If low valve spring load is found, replace the valve springs. DO NOT use shims to increase spring load. The use of shims can cause the valve spring to bottom out before the camshaft lobe is at peak lift.

Water Outlet Installation



Important: Ensure a new rubber O-ring and seal is used when installing the water outlet housing.

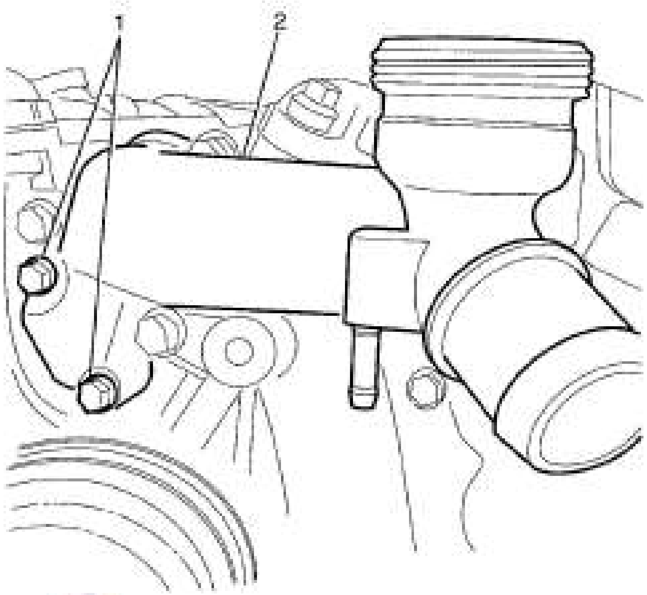
1. Install the coolant outlet housing (2) to the intake manifold.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the coolant outlet housing to intake manifold retaining bolts (1).

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).

Water Outlet Removal



1. Remove the coolant outlet housing to intake manifold retaining bolts (1).

   Important: Use of a soft hammer will aid in the removal of the coolant outlet housing.

2. Remove the coolant outlet housing (2).
3. Remove the rubber O-ring and seal.

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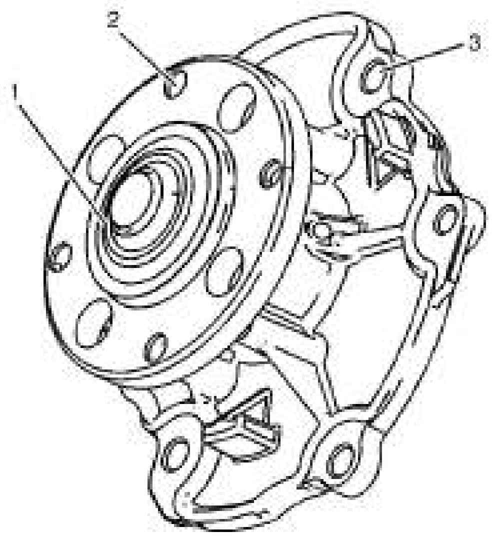
Water Pump Cleaning and Inspection

Cleaning Procedure

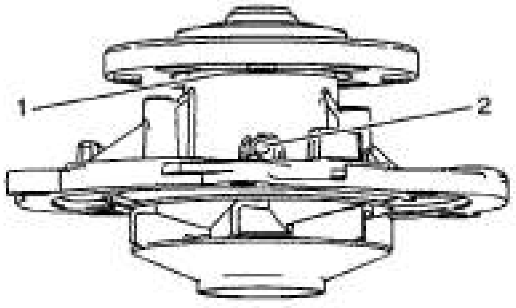
Notice: Refer to General Repair Instructions in the Preface section.

1. Remove the old gasket material from the water pump sealing surfaces.
2. Clean all excess dirt and debris from the water pump housing.

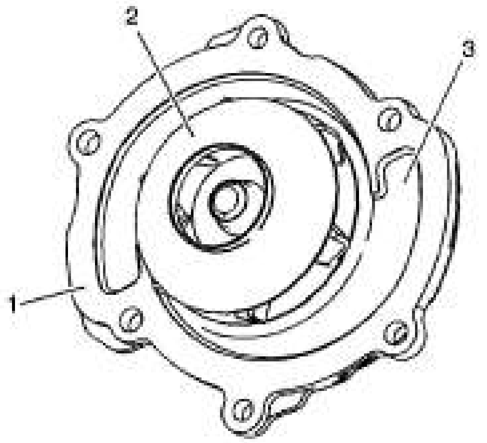
Inspection Procedure



1. Rotate the water pump hub (1). The water pump hub and impeller should turn straight and smoothly. If the hub wobbles, is noisy, or feels rough when rotated, replace the water pump.
2. Inspect the exterior of the water pump for the following:
   - Damage to the water pump hub bolt threads (2) for the water pump pulley
   - Damage to the water pump bolt holes (3)



3. Examine the water pump shaft (1) and the weep hole (2) in the water pump body for signs of leakage. If coolant leakage is evident, replace the water pump.



4. Inspect the interior of the water pump for the following:
   - Damage to the water pump gasket sealing surface (1)
   - Damage, corrosion or restrictions to the water pump impeller (2)
   - Damage, corrosion or restrictions to the coolant passages (3)
5. Repair or replace the water pump as necessary.

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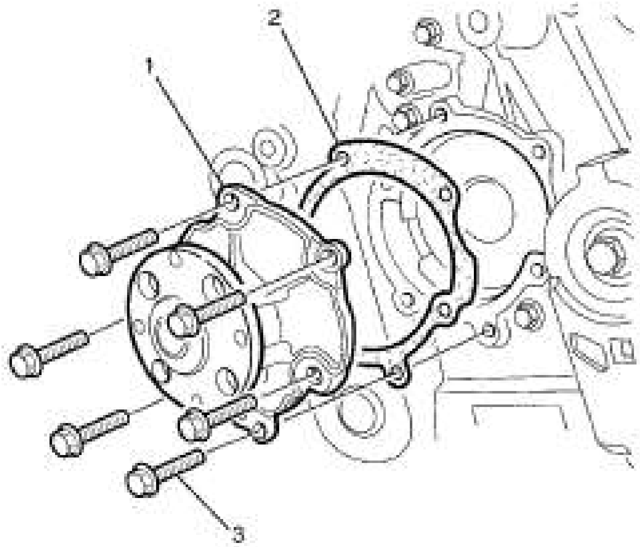
Water Pump Installation

Important: Make sure all mating surfaces are clean and free of grease.

1. Using a water sealant install the water pump and gasket to front engine cover.
2. Make sure all retaining bolts are clean and free of debris.

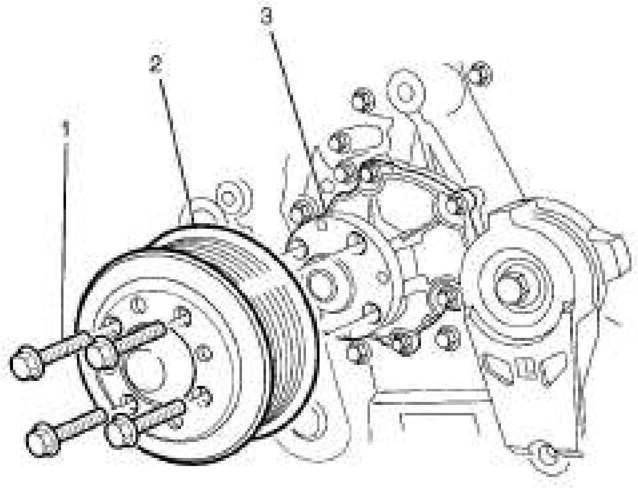


3. Install the water pump (1) and NEW gasket (2).

Notice: Refer to Fastener Notice in the Preface section.

4. Install the water pump to engine front cover retaining bolts (3).

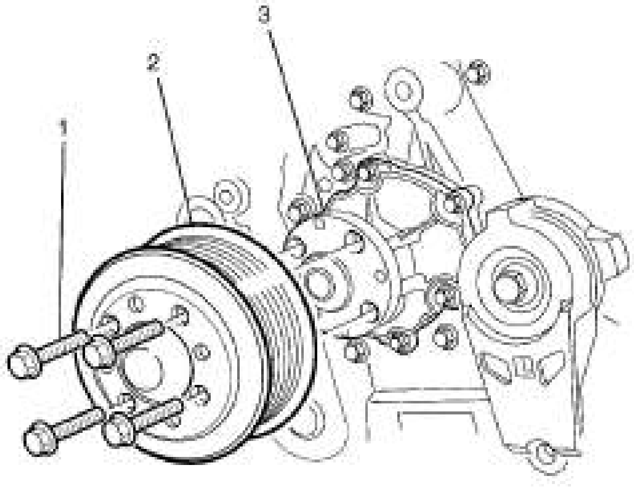
Tighten
Tighten the bolts to 10 N·m (89 lb in).



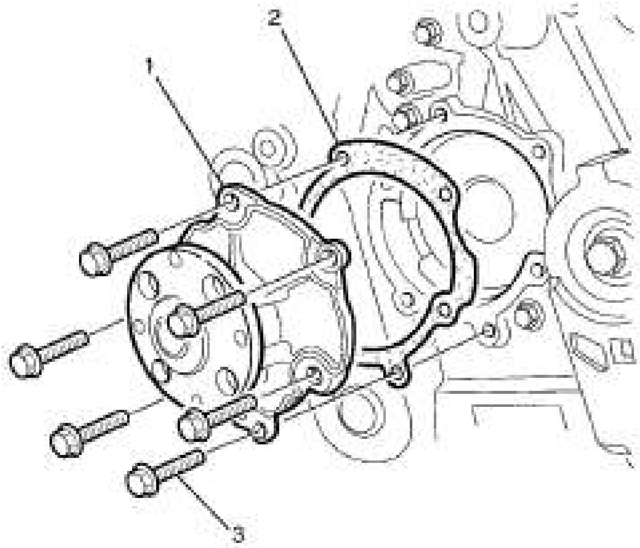
5. Install the water pump pulley (2) to the water pump (3)
6. Install the water pump pulley to water pump retaining bolts (1).

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).

Water Pump Removal



1. Remove the water pump pulley to water pump retaining bolts (1).
2. Remove the water pump pulley (2) from the water pump (3).



Important: Use a soft hammer to separate the water pump from the engine cover.

3. Remove the water pump to engine front cover retaining bolts (3).
4. Remove the water pump (1).

5. Remove the water pump gasket (2).

   Discard the gasket.

Cleanliness and Care

An automobile engine is a combination of many of the following surfaces:

- Machined
- Honed
- Polished
- Lapped

The tolerances of these surfaces are measured in the ten-thousandths of an inch. When you service any internal engine part, cleanliness and care are important. Apply a liberal coating of engine oil to the friction areas during assembly in order to protect and lubricate the surfaces on initial operation. Throughout this section, practice correct cleaning and protection procedures to the machined surfaces and to the friction areas.

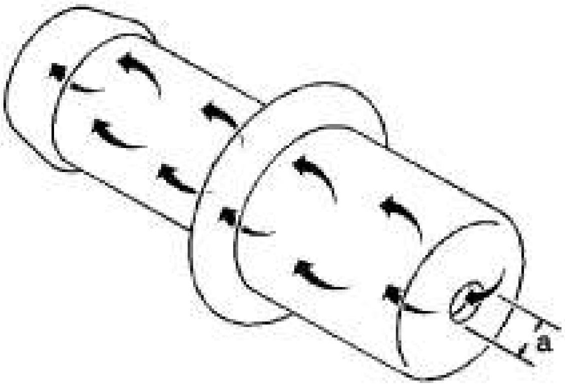
Notice: Engine damage may result if an abrasive paper, pad, or motorized wire brush is used to clean any engine gasket surfaces.

Whenever you remove the valve train components, keep the components in order. Follow this procedure in order to install the components in the same locations and with the same mating surfaces as when removed.

Caution: Refer to Battery Disconnect Caution in the Preface section.

Disconnect the negative battery cables before you perform any major work on the engine. For more information on the disconnection of the battery, refer to Engine Electrical.

Crankcase Ventilation System Description



A crankcase ventilation system is used to consume crankcase vapours created during the combustion process instead of venting them to the atmosphere.

Fresh air is supplied through a filter to the crankcase, the crankcase mixes the fresh air with the blow-by gases and then passed through a positive crankcase ventilation (PCV) orificed tube into the intake manifold.

The PCV orificed tube restricts the flow rate of the blow-by gases using a 3 mm (0.118 in) (a) orifice located at the end of the tube. If abnormal operating conditions arise, the system is designed to allow amounts of blow-by gases above acceptable tolerances to back flow through the crankcase vent tube into the throttle body in order to be consumed by normal combustion.

Drive Belt System Description

The drive belt system consists of the following components:

- The drive belt
- The drive belt tensioner
- The drive belt idler pulley
- The crankshaft balancer pulley
- The accessory drive component mounting brackets
- The accessory drive components
    - The power steering pump
    - The alternator
    - The A/C compressor
    - The water pump

The drive belt system uses 1 belt. The drive belt is thin so that it can bend backwards and has several ribs to match the grooves in the pulleys. The drive belts are made of different types of rubbers, chloroprene or EPDM, and have different layers or plies containing either fibre cloth or cords for reinforcement.

Both sides of the drive belt may be used to drive the different accessory drive components. When the back side of the drive belt is used to drive a pulley, the pulley is smooth.

The drive belt is pulled by the crankshaft balancer pulley across the accessory drive component pulleys. The spring loaded drive belt tensioner keeps constant tension on the drive belt to prevent the drive belt from slipping. The drive belt tensioner arm will move when loads are applied to the drive belt by the accessory drive components and the crankshaft.

The drive belt system may have an idler pulley, which is used to add wrap to the adjacent pulleys.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Description and Operation | **Document ID: 1974845**

Engine Component Description

The High Feature V6 RPO LY7 is a 3.6L engine incorporating two intake and two exhaust valves per cylinder. Individual intake and exhaust camshafts with camshaft position actuators are mounted on each cylinder head. The cylinder bore is 94 mm (3.7008 in) and the piston stroke is 85.6 mm (3.3701 in). The cylinders are arranged in two banks of three with a 60 degree included angle. The right bank of cylinders are number 1-3-5 and the left bank of cylinders are 2-4-6. The engine firing order is 1-2-3-4-5-6.

Crankcase

The cylinder block is constructed of aluminium alloy by precision sand-casting with cast in place iron cylinder liners. Each copper-infiltrated sintered steel main bearing cap incorporates six bolts bolting the cap into the cylinder block. Along with two outer and two inner bolts, two side bolts are used in the deep skirt block. To prevent aeration, oil return from the valvetrain and cylinder heads is channelled away from the rotating and reciprocating components through oil drain back passages incorporated into the cylinder heads and cylinder block. Pressure-actuated piston oil cooling jets are mounted between opposing cylinders. A knock sensor is located on the each side of the exterior of the cylinder block. The crankshaft position sensor is located on the left side of the exterior of the cylinder block.

Crankshaft

The crankshaft is a forged steel design with four main bearings. Crankshaft thrust is controlled by the number three main bearing. The crankshaft position reluctor wheel is pressed onto the rear of the crankshaft in front of the rear main journal. The crankshaft is internally balanced with an integral oil pump drive machined into the nose in front of the front main journal.

Connecting Rods and Pistons

The connecting rods are sinterforged steel and have full floating piston pins. The piston pins are a slip fit in the bronze bushed connecting rod. Round wire retainers are used to retain the piston pin into the piston. The cast aluminium pistons incorporate a polymer-coated skirt to reduce friction. The piston uses two low tension compression rings and one multi-piece oil control ring. The top compression ring is plasma sprayed. The second compression ring is cast iron napier. The oil control ring incorporates a steel expander and two chrome plated steel rails.

Camshaft Drive System

The camshaft drive system uses Inverted Tooth (IT) timing drive chains and consists of one primary timing drive chain driven by the crankshaft sprocket. The primary timing drive chain drives two intermediate drive shaft sprockets. Each oil pressure fed intermediate drive shaft sprocket drives separate secondary timing drive chains. Each secondary timing drive chain drives the respective cylinder head's intake and exhaust camshaft position actuators.

The primary timing drive chain uses two stationary timing drive chain guides and an oil pressure hydraulically actuated tensioner with built-in shoe. The tensioners minimize timing drive chain noise and provides accurate valve action by keeping slack out of the timing drive chains and continuously adjusting for timing drive chain wear. The tensioners incorporate a plunger that adjusts out with wear allowing only a minimal amount of backlash. The tensioners are equipped with oiling jets to spray oil onto the timing components during engine operation. The secondary timing drive chains use a stationary timing drive chain guide and movable timing drive chain shoe. The secondary timing drive chain shoe is under tension from an oil pressure hydraulically actuated tensioner. All tensioners are sealed to the head or block using a rubber coated steel gasket. The gasket traps an adequate oil reserve to ensure quiet start-up.

The primary timing drive system also uses an IT timing drive chain. The primary timing drive chain connects the crankshaft sprocket with the left and right side intermediate drive shaft sprockets.

Camshaft Position Actuator System

The engine incorporates a camshaft position actuator for each intake and exhaust camshaft. Camshaft phasing changes the inlet and exhaust valve timing within a range of 25 camshaft degrees as engine operating conditions vary. Dual camshaft phasing allows the further optimization of performance, fuel economy and emissions without compromising overall engine response and driveability. Variable valve timing also contributes to a reduction in exhaust emissions. It optimizes exhaust and inlet valve overlap and addresss the need for an Exhaust Gas Recirculation (EGR) system.

The camshaft position actuator is a hydraulic vane-type actuator that changes the camshaft lobe timing relative to the camshaft drive sprocket. Engine oil is directed by a camshaft position actuator oil control valve to the appropriate passages in the camshaft position actuator. Oil acting on the vane in the camshaft position actuator, rotates the camshaft relative to the sprocket. At idle, both camshafts are at the default or "home" position. At this position, the exhaust camshaft is fully advanced and the intake is fully retarded to minimize valve overlap for smooth idle. An internal lock pin locks the inner rotor to the outer camshaft position actuator housing at idle and maintains this position during start-up conditions. Under other engine operating conditions, the camshaft position actuator is controlled by the Engine Control Module (ECM) to deliver optimal intake and exhaust valve timing for performance, driveability and fuel economy. The camshaft position actuator incorporates an integral trigger wheel, which is sensed by the camshaft position sensor mounted in the front cover to accurately determine the position of each camshaft. Each camshaft position actuator has a specific timing drive mark for right or left bank application, as the camshaft position actuators are common bank to bank. The exhaust camshaft position actuator has a different internal configuration than the intake camshaft position actuator since the exhaust camshaft position actuator phases in the opposite direction relative to the inlet camshaft position actuator.

The camshaft position actuator oil control valve (OCV) directs oil from the oil feed in the head to the appropriate camshaft position actuator oil passages. There is one OCV for each camshaft position actuator. The OCV is sealed and mounted to the front cover. The ported end of the OCV is inserted into the cylinder head with a sliding fit. A filter screen protects each OCV oil port from any contamination in the oil supply.

The camshaft front journal has several drilled oil holes to allow camshaft position actuator control oil to transfer from the cylinder head to the camshaft position actuator. The center camshaft bolt hole is counterbored to allow oil to flow around the camshaft bolt and to the camshaft position actuator. Oil in this oil passage is used to move the camshaft position actuator to the default or home position. Radially outward from the center of the journal is a set of four drilled camshaft position actuator oil holes. Oil in this group of oil holes is used to move the camshaft from the default position to a specific set position as determined by the ECM. Seal rings are used at the front and rear of the front camshaft journal to prevent oil leakage from the camshaft position actuator hydraulic system. The seal is made from a plastic compound that resists wear and has a diagonal end gap to enhance sealing. The camshaft position actuator is mounted to the front end of the camshaft and the timing notch in the nose of the camshaft aligns with the dowel pin in the camshaft position actuator to ensure correct cam timing and camshaft position actuator oil hole alignment.

Cylinder Heads

The cylinder heads are semi permanent mould cast aluminium with powdered metal valve seat inserts and valve guides. Two 36.96 mm (1.4551 in) intake valves and two 30.60 mm (1.2047 in) exhaust valves are actuated by roller finger valve rocker arms pivoting on a Stationary Hydraulic Lash Adjuster (SHLA). Separate exhaust and intake camshafts are supported by four bearings machined into the cylinder head. The front camshaft bearing cap is used as a thrust control surface for each camshaft. Each spark plug is shielded by a tube that is pressed into the cylinder head. Each spark plug ignition coil is also mounted through the spark plug tube. The Engine Coolant Temperature (ECT) sensor is threaded into the left cylinder head.

Induction System

A dual-stage variable intake manifold is achieved through the use of a Intake Manifold Runner Control (IMRC) flap. The Engine Control Module (ECM) controlled valve changes the plenum volume available for resonance tuning of the inlet flow path. With the IMRC flap shut, the intake manifold is using dual plane flow with the cylinders feeding from two separate plenums. In this mode the system boosts cylinder charging in the low to mid speed range. At higher engine speeds the IMRC flap opens creating a single plane flow with the cylinders all feeding from a common large plenum. In this mode the system boosts charging in the high speed range. An electronically controlled throttle (ETC), through the ECM, coordinates the input from the driver with various control components.

Right and Left Bank Designation

Right side and left side designation through the engine mechanical section are viewed from the rear of the engine or from inside the vehicle.

2009 Cadillac CTS | CTS (VIN D) Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Description and Operation | Document ID: 1990148

Engine Component Description (LLT)

The High Feature V6 (VIN Code Identifier "V") RPO LLT is a 3.6 Litre VVT (Variable Valve Timing) engine with direct injection. The direct injection system places the high pressure injectors in the cylinder heads. This engine incorporates 2 intake and 2 exhaust valves per cylinder. A dual overhead cam design with individual intake and exhaust camshafts. A camshaft position actuator is mounted on each camshaft. The cylinder bore is 94 mm (3.7008 in) and the piston stroke is 85.6 mm (3.3701 in). The cylinders are arranged in 2 banks of 3 with a 60 degree included angle. The right bank of cylinders are number 1-3-5 and the left bank of cylinders are 2-4-6. The engine firing order is 1-2-3-4-5-6.

Crankcase

The cylinder block is constructed of aluminum alloy by precision sand-casting with cast in place iron cylinder liners. Each copper-infiltrated sintered steel main bearing cap incorporates 6 bolts bolting the cap into the engine block. Along with 2 outer and 2 inner bolts, 2 side bolts are used in the deep skirt block. To prevent aeration, oil return from the valvetrain and cylinder heads is channeled away from the rotating and reciprocating components through oil drain back passages incorporated into the cylinder heads and engine block. Pressure-actuated piston oil cooling jets are mounted between opposing cylinders. A knock sensor is located on the each side of the exterior of the engine block. The crankshaft position sensor is located on the right side of the exterior of the engine block.

Crankshaft

The crankshaft is a forged steel design with 4 main bearings. Crankshaft thrust is controlled by the number 3 main bearing. The crankshaft position reluctor wheel is pressed onto the rear of the crankshaft in front of the rear main journal. The crankshaft is internally balanced with an integral oil pump drive machined into the nose in front of the front main journal.

Connecting Rods and Pistons

The connecting rods are sinterforged steel and have full floating piston pins. The piston pins are a slip fit in the bronze bushed connecting rod. Round wire retainers are used to retain the piston pin into the piston. The cast aluminum pistons incorporate a polymer-coated skirt to reduce friction. The piston uses 2 low tension compression rings and one multi-piece oil control ring. The top compression ring is plasma sprayed. The second compression ring is cast iron napier. The oil control ring incorporates a steel expander and 2 chrome plated steel rails. The top of the piston contains a dished portion for the direct injection system to aid in fuel-air charge mixture and even combustion.

Camshaft Drive System

The camshaft drive system consists of one primary timing drive chain driven by the crankshaft sprocket. The primary timing drive chain drives two intermediate drive shaft sprockets. Each oil pressure fed intermediate drive shaft sprocket drives separate secondary timing drive chains. Each secondary timing drive chain drives the respective cylinder head's intake and exhaust camshaft position actuators.

The primary timing drive chain uses two stationary timing drive chain guides and an oil pressure hydraulically actuated tensioner with built-in shoe. The tensioner minimizes timing drive chain noise and provides accurate valve action by keeping slack out of the timing drive chains and continuously adjusting for timing drive chain wear. The tensioner incorporates a plunger that adjusts out with wear allowing only a minimal amount of backlash. The tensioner is equipped with an oiling jet to spray oil onto the timing components during engine operation. The secondary timing drive chains use a stationary timing drive chain guide and movable timing drive chain shoe. The secondary timing drive chain shoe is under tension from an oil pressure hydraulically actuated tensioner. All tensioners are sealed to the head or block using a rubber coated steel gasket. The gasket traps an adequate oil reserve to ensure quiet start-up.

Camshaft Position Actuator System

The engine incorporates a camshaft position actuator for each intake and exhaust camshaft. Camshaft phasing changes the inlet and exhaust valve timing within a range of 25 camshaft degrees as engine operating conditions vary. Dual camshaft phasing allows the further optimization of performance, fuel economy and emissions without compromising overall engine response and driveability. Variable valve timing also contributes to a reduction in exhaust emissions. It optimizes exhaust and inlet valve overlap and eliminates the need for an exhaust gas recirculation (EGR) system.

The camshaft position actuator is a hydraulic vane-type actuator that changes the camshaft lobe timing relative to the camshaft drive sprocket. Engine oil is directed by a camshaft position actuator oil control valve to the appropriate passages in the camshaft position actuator. Oil acting on the vane in the camshaft position actuator, rotates the camshaft relative to the sprocket. At idle, both camshafts are at the default or "home" position. At this position, the exhaust camshaft is fully advanced and the intake is fully retarded to minimize valve overlap for smooth idle. An internal lock pin locks the inner rotor to the outer camshaft position actuator housing at idle and maintains this position during start-up conditions. Under other engine operating conditions, the camshaft position actuator is controlled by the engine control module (ECM) to deliver optimal intake and exhaust valve timing for performance, driveability and fuel economy. The camshaft position actuator incorporates an integral trigger wheel, which is sensed by the camshaft position sensor mounted in the front cover to accurately determine the position of each camshaft. Each camshaft position actuator has a specific timing drive mark for right or left bank application, as the camshaft position actuators are common bank to bank. The exhaust camshaft position actuator has a different internal configuration than the intake camshaft position actuator since the exhaust camshaft position actuator phases in the opposite direction relative to the inlet camshaft position actuator.

The camshaft position actuator oil control valve (OCV) directs oil from the oil feed in the head to the appropriate camshaft position actuator oil passages. There is one OCV for each camshaft position actuator. The OCV is sealed and mounted to the front cover. The ported end of the OCV is inserted into the cylinder head with a sliding fit. A filter screen protects each OCV oil port from any contamination in the oil supply.

The camshaft front journal has several drilled oil holes to allow camshaft position actuator control oil to transfer from the cylinder head to the camshaft position actuator. The center camshaft bolt hole is counterbored to allow oil to flow around the camshaft bolt and to the camshaft position actuator. Oil in this oil passage is used to move the camshaft position actuator to the default or home position. Radially outward from the center of the journal is a set of 4 drilled camshaft position actuator oil holes. Oil in this group of oil holes is used to move the camshaft from the default position to a specific set position as determined by the ECM. Seal rings are used at the front and rear of the front camshaft journal to prevent oil leakage from the camshaft position actuator hydraulic system. The seal is made from a plastic compound that resists wear and has a diagonal end gap to enhance sealing. The camshaft position actuator is mounted to the front end of the camshaft and the timing notch in the nose of the camshaft aligns with the dowel pin in the camshaft position actuator to ensure proper cam timing and camshaft position actuator oil hole alignment.

Cylinder Heads

The cylinder heads are semi permanent mold cast aluminum with powdered metal valve seat inserts and valve guides. Two 36.96 mm (1.4551 in) intake valves and two 30.60 mm (1.2047 in) exhaust valves are actuated by roller finger followers pivoting on a stationary hydraulic lash adjuster (SHLA). Separate exhaust and intake camshafts are supported by 4 bearings machined into the cylinder head. The front camshaft bearing cap is used as a thrust control surface for each camshaft. Each spark plug is shielded by a tube that is pressed into the cylinder head. Each spark plug ignition coil is also mounted through the spark plug tube. The engine coolant temperature (ECT) sensor is threaded into the left cylinder head. Longer intake ports are designed into the head for better airflow and eliminate the need for a separate lower intake manifold. With direct injection, the high pressure injectors are located in machined bores below the intake ports. A stainless steel, high pressure fuel rail is attached to the intake side of the head.

Induction System

A one piece, all-aluminum intake manifold is used to deliver a dry-air charge to the combustion chamber. Fuel is introduced directly to the cylinder during the intake stroke. As the piston approaches top-dead center, the air-fuel mixture is ignited by the spark plug. An electronically controlled throttle (ETC), through the ECM, coordinates the input from the driver with various control components.

Right and Left Bank Designation

Right hand (RH) and left hand (LH) designation through the engine mechanical section are viewed from the rear of the engine or from inside the vehicle.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Description and Operation | **Document ID: 1974848**

Lubrication Description

A structural diecast aluminium oil pan incorporates an oil suction pipe, a baffle, a windage tray, and an oil level sensor. The oil suction pipe is bolted into the oil pan and seals to the bottom of the block with O-ring gasket. The baffle is mounted to the lower portion of the 6.5 litre (5.7 quart) capacity oil pan sump and ensures oil supply to the oil suction pickup. The windage tray is bolted to the upper portion of the oil pan and reduces friction losses at high speed. The oil level sensor is mounted through the bottom of the oil pan.

A crankshaft driven gerotor oil pump with internal pressure-relief valve is mounted to the front of the cylinder block and pulls oil from the oil suction pipe through the lower passage in the cylinder block. The oil pump then directs the flow of pressurized oil back through the upper passage in the block to the left side of the cylinder block where the oil filter adapter is mounted.

An oil filter adapter is mounted with a gasket to the left side of the cylinder block. The oil filter adapter incorporates a top-access, cartridge style oil filter. The filter is accessed through a screw on cap with an O-ring gasket. The oil filter adapter cap has a built-in oil bypass valve. The oil filter adapter housing incorporates a drain back control valve and a threaded oil pressure sending unit. Oil flows through the lower passage in the oil filter adapter up to and through the oil filter cartridge. Filtered oil travels back through the upper passage of the oil filter adapter and back into the cylinder block.

Oil is directed up and across the cylinder block front through several drilled passages. These front passages feed oil to each cylinder head, oil to the passage for the main bearings and piston oil jets, oil to the right and left secondary idler sprockets, and oil to the primary timing drive chain tensioner.

Each cylinder head passage directs oil into the cylinder head where it is directed to oiling circuits for the Stationary Hydraulic Lifter assemblies (SHLAs) and the camshaft bearing journals. Oil is also directed through 2 passages each with a spring-loaded check-ball valve to the 2 chambers where the camshaft position actuator oil control solenoid valves are mounted. Each chamber contains a camshaft position actuator oil control solenoid valve with built-in oil filter screen. One camshaft position actuator oil control solenoid valve is used to control the exhaust camshaft position actuator and 1 camshaft position actuator oil control solenoid valve is used to control the intake camshaft position actuator. The Engine Control Module (ECM) electrically controls each camshaft position actuator oil control solenoid valve. When energized by the ECM the camshaft position actuator oil control solenoid valve directs oil to pass up through the cylinder head front camshaft bearing cap. Oil passes through the camshaft bearing cap passage into oil holes drilled into the side of the front camshaft journal and onto the front of the camshaft mounting surface. Oil passes through to matching passages in the camshaft position actuator. Oil is directed by the camshaft position actuator oil control solenoid valve to the appropriate passage in the system to pressurize oil on the vanes on the inside of the of the camshaft position actuator. Oil acting on the vanes rotates the camshaft mounted to the inner camshaft position actuator rotor relative to the sprocket mounted to the outer camshaft position actuator housing. An internal lock pin locks the inner rotor to the outer camshaft position actuator housing at idle and maintains the camshaft position actuator in the home or default position during start-up conditions. Oil pressure directed by the camshaft position actuator oil control solenoid valve unlocks the pin and allows the camshaft position actuator to function. An additional passage in the cylinder head also directs oil to the secondary timing drive chain tensioner mounted to each cylinder head.

The oil passage that supplies oil to the main bearings also supplies oil to pressure-actuated piston-cooling oil jets. Each oil jet is mounted between opposing cylinder bores and directs oil to the

2 bores to provide extra cooling and control piston temperatures.

Oil is directed from the front passages to the front of the block where the right and left secondary idler sprockets and the primary timing drive chain tensioner are mounted. Each camshaft timing drive chain tensioner relies on a gasket in order to maintain an oil reserve after the engine is turned OFF. All camshaft timing drive chain tensioners incorporate a small oil jet to supply an oil spray onto the camshaft timing drive chain components.

Oil returns to the oil pan sump either through the camshaft timing drive chain area or through the cast oil drain back passages on the outboard walls of the cylinder heads and cylinder block.

Replacing Engine Gaskets

Gasket Reuse and Applying Sealant

- DO NOT reuse any gasket unless specified.
- Gaskets that can be reused will be identified in the service procedure.
- DO NOT apply sealant to any gasket or sealing surface unless specified in the service procedure.

Separating Components

- Use a rubber mallet in order to separate the components.
- Bump the part sideways in order to loosen the components.
- Bumping of the component should be done at bends or reinforced areas of the component to prevent distortion of the components.

Cleaning Gasket Surfaces

- Use care to avoid gouging or scraping the sealing surfaces.
- Use a plastic or wood scraper in order to remove all the sealant from the components.

  DO NOT use any other method or technique to remove the sealant or the gasket material from a part.
- DO NOT use abrasive pads, sand paper, or power tools to clean the gasket surfaces.
  - These methods of cleaning can cause damage to the component sealing surfaces.
  - Abrasive pads also produce a fine grit that the oil filter cannot remove from the engine oil.
  - This fine grit is an abrasive and can cause internal engine damage.

Assembling Components

- Assemble components using only the sealant (or equivalent) that is specified in the service procedure.
- Sealing surfaces must be clean and free of debris or oil.
- Specific components such as crankshaft oil seals or valve stem oil seals may require lubrication during assembly.
- Components requiring lubrication will be identified in the service procedure.
- Apply only the amount of sealant specified in the service procedure to a component.
- DO NOT allow the sealant to enter into any blind threaded holes, as the sealant may prevent the fastener from clamping correctly or cause component damage when tightened.

Important: DO NOT overtighten the fasteners.

- Tighten the fasteners to the correct specifications.

Separating Parts

In addition to the Room Temperature Vulcanizing (RTV) sealant's sealing capabilities, the RTV sealants may form an adhesive bond between the components. This may make the components difficult to remove or to separate. If possible, bump the components sideways rather than using prying tools in order to remove the components. This technique prevents damage when the bonding strength of the RTV sealant is stronger than the component itself. Perform bumping at the bends or at the reinforced areas in order to prevent part distortion.

Tools and Equipment

- Special tools are listed and illustrated throughout this section with a complete listing at the end of the section. These tools (or their equivalents) are specially designed to quickly and safely accomplish the operations for which they are intended. The use of these special tools will also minimize possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and a torque angle meter are necessary for the correct tightening of various fasteners.
- To correctly service the engine assembly, the following items should be readily available:
  - Approved eye protection and safety gloves
  - A clean, well-lit, work area
  - A suitable parts cleaning tank
  - A compressed air supply
  - Trays or storage containers to keep parts and fasteners organized
  - An adequate set of hand tools
  - Approved engine repair stand
  - An approved engine lifting device that will adequately support the weight of the components

Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant

Sealant Types

Important: The correct sealant and amount of sealant must be used in the correct location to prevent oil leaks, coolant leaks, or the loosening of the fasteners. DO NOT interchange the sealants. Use only the sealant, or equivalent, as specified in the service procedure.

The following 2 major types of sealant are commonly used in engines:

- Anaerobic sealant room temperature vulcanizing (RTV)
- Anaerobic sealant, which include the following:
  - Gasket eliminator
  - Pipe
  - Threadlock

Anaerobic Type Room Temperature Vulcanizing (RTV) Sealant

Anaerobic type room temperature vulcanizing (RTV) sealant cures in the absence of air. This type of sealant is used where 2 components, such as the intake manifold and the cylinder block, are assembled together.

Use the following information when using RTV sealant:

- DO NOT use RTV sealant in areas where extreme temperatures are expected. These areas include:
  - The exhaust manifold
  - The head gasket
  - Any other surfaces where a different type of sealant is specified in the service procedure
- Always follow all the safety recommendations and the directions that are on the RTV sealant container.
- Use a plastic or wood scraper in order to remove all the RTV sealant from the components.

Notice: Do not allow the RTV sealant to enter any blind threaded hole. RTV sealant that is allowed to enter a blind threaded hole can cause hydraulic lock of the fastener when the fastener is tightened. Hydraulic lock of a fastener can lead to damage to the fastener and/or the components. Hydraulic lock of a fastener can also prevent the proper clamping loads to be obtained when the fastener is tightened. Improper clamping loads can prevent proper sealing of the components allowing leakage to occur. Preventing proper fastener tightening can allow the components to loosen or separate leading to extensive engine damage.

- The surfaces to be sealed must be clean and dry.
- Use a RTV sealant bead size as specified in the service procedure.

- Apply the RTV sealant bead to the inside of any bolt holes areas.

  Important: DO NOT wait for the RTV sealant to skin over.

- Assemble the components while the RTV sealant is still wet to the touch, within 3 minutes.

  Important: DO NOT overtighten the fasteners.

- Tighten the fasteners in sequence, if specified, and to the correct torque specifications.

Anaerobic Type Gasket Eliminator Sealant

Anaerobic type gasket eliminator sealant cures in the absence of air. This type of sealant is used where 2 rigid parts, such as castings, are assembled together. When 2 rigid parts are disassembled and no sealant or gasket is readily noticeable, then the 2 parts were probably assembled using an anaerobic type gasket eliminator sealant.

Use the following information when using gasket eliminator sealant:

- Always follow all the safety recommendations and directions that are on the gasket eliminator sealant container.
- Apply a continuous bead of gasket eliminator sealant to one flange.

  The surfaces to be sealed must be clean and dry.

Notice: Refer to General Repair Instructions in the Preface section.

Important:

- Gasket eliminator sealed joint fasteners that are partially torqued and the gasket eliminator sealant allowed to cure more than 5 minutes, may result in incorrect shimming and sealing of the joint.
- DO NOT overtighten the fasteners.
  - Apply the gasket eliminator sealant evenly to get a uniform thickness of the gasket eliminator sealant on the sealing surface.
  - Tighten the fasteners in sequence, if specified, and to the correct torque specifications.
  - After correctly tightening the fasteners, remove the excess gasket eliminator sealant from the outside of the joint.

Anaerobic Type Threadlock Sealant

Anaerobic type threadlock sealant cures in the absence of air. This type of sealant is used for threadlocking and sealing of bolts, fittings, nuts, and studs. This type of sealant cures only when confined between 2 close fitting metal surfaces.

Use the following information when using threadlock sealant:

- Always follow all safety recommendations and directions that are on the threadlock sealant container.

- The threaded surfaces to be sealed must be clean and dry.
- Apply the threadlock sealant as specified on the threadlock sealant container.

Important:

- Fasteners that are partially torqued and then the threadlock sealant allowed to cure more than 5 minutes, may result in incorrect clamp load of assembled components.
- DO NOT overtighten the fasteners.

- Tighten the fasteners in sequence, if specified, and to the correct torque specifications.

Anaerobic Type Pipe Sealant

Anaerobic type pipe sealant cures in the absence of air and remains pliable when cured. This type of sealant is used where 2 parts are assembled together and require a leak proof joint.

Use the following information when using pipe sealant:

- DO NOT use pipe sealant in areas where extreme temperatures are expected. These areas include:
  - The exhaust manifold
  - The head gasket
  - Surfaces where a different sealant is specified
- Always follow all the safety recommendations and the directions that are on the pipe sealant container.
- The surfaces to be sealed must be clean and dry.
- Use a pipe sealant bead of the size or quantity as specified in the service procedure.

Notice: Refer to General Repair Instructions in the Preface section.

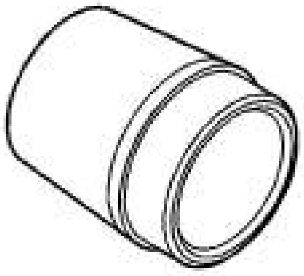
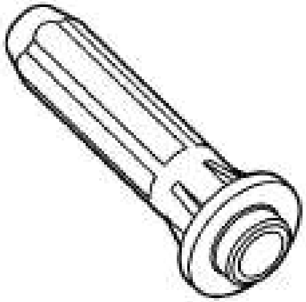
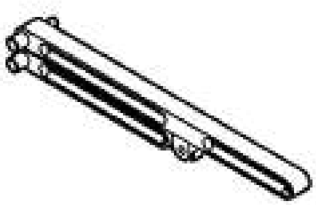
- Apply the pipe sealant bead to the inside of any bolt hole areas.
- Apply a continuous bead of pipe sealant to one sealing surface.

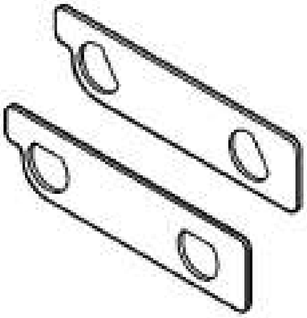
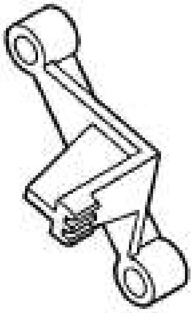
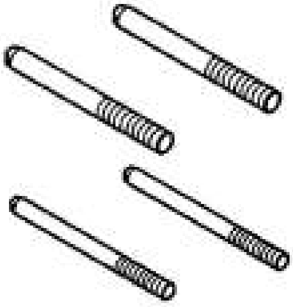
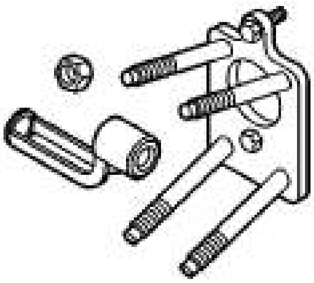
Important: DO NOT overtighten the fasteners.

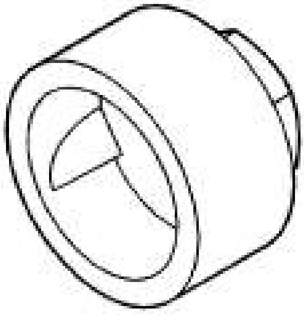
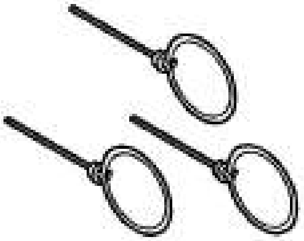
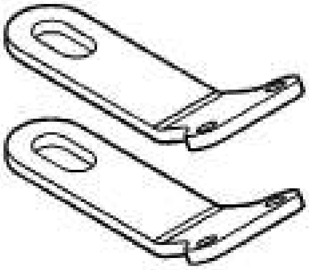
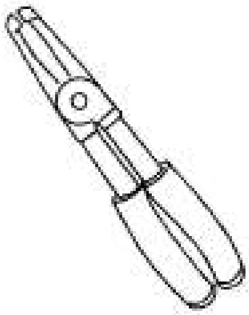
- Tighten the fasteners in sequence, if specified, and to the correct torque specifications.

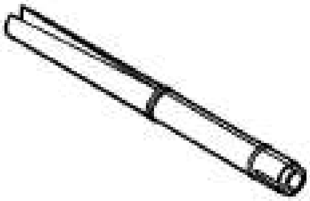
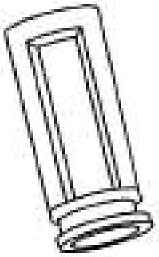
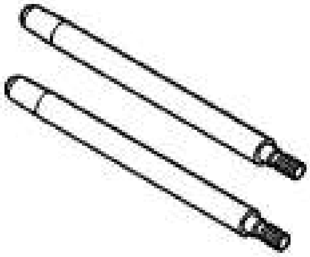
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L | Special Tools and Equipment | **Document ID: 1989459**

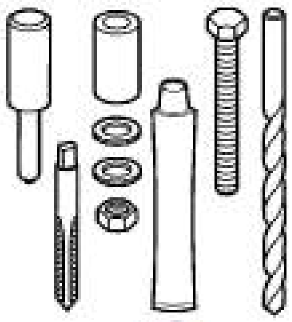
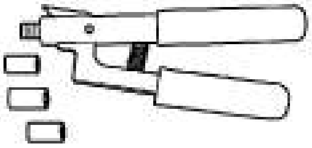
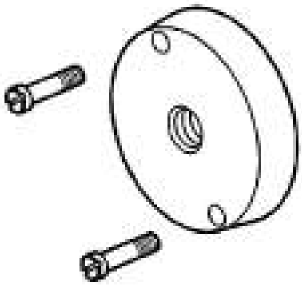
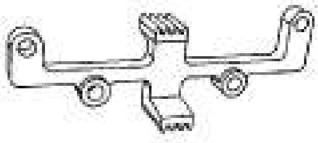
Special Tools

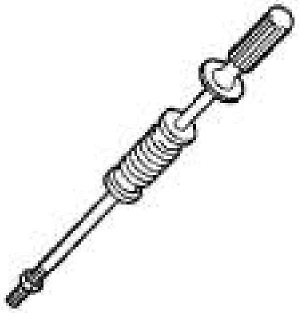
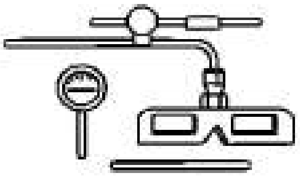
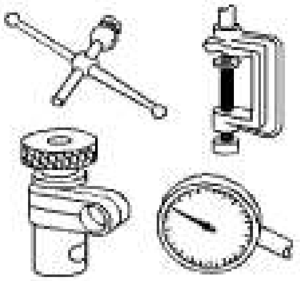
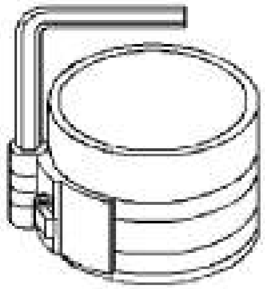
Illustration	Tool Number/Description
	EN 46101 Spark Plug Tube Seal Guide
	EN 46103 Camshaft Actuator Valve Seal Remover/Installer
	EN 46104 Water Pump Pulley Holding Tool
	EN 46105-1

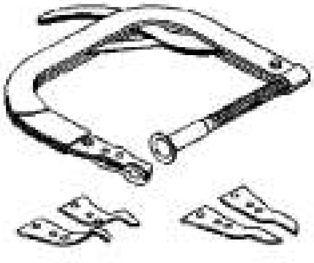
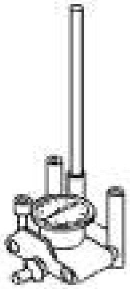
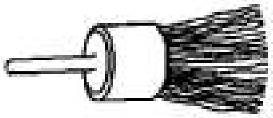
	EN 46105-2 Camshaft Locking Tools
	EN 46106 Flywheel Holding Tool
	EN 46109 Guide Pins
	EN 46110 On-Vehicle Valve Spring Compressor

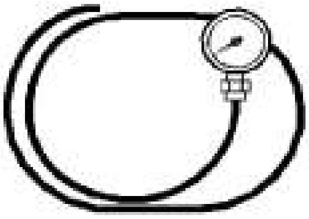
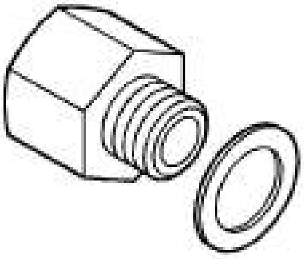
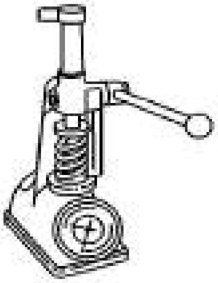
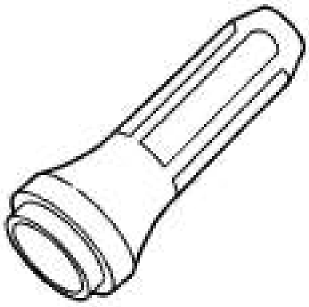
	EN 46111 Crankshaft Rotation Socket
	EN 46112 Tensioner Retraction Pins
	EN 46114 Engine Lift Brackets
	EN 46116 Valve Stem Seal Remover/Installer

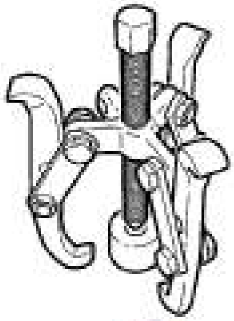
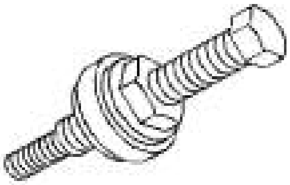
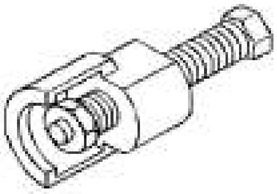
	EN 46117 Valve Stem Key Remover/Installer
	EN 46119 Off-Vehicle Valve Spring Compressor Adapter
	EN 46121 Connecting Rod Guide Pin Set
	EN 46122 Camshaft Position Actuator Check-Ball Valve Remover/Installer

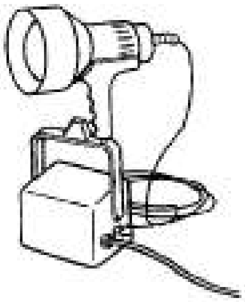
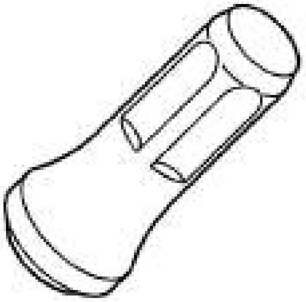
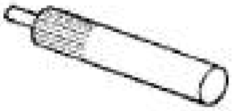
	
	EN 46745 Piston Pin Clip Remover/Installer
	EN 47839 Crankshaft Rear Oil Seal Installation Tool
	EN 48018 Flywheel Holding Tool

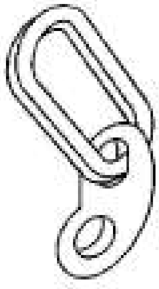
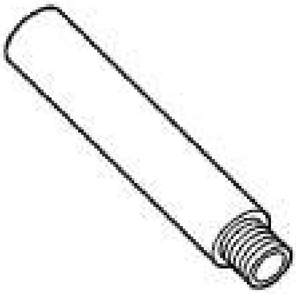
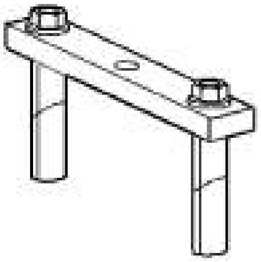
	J 6125-1B Slide Hammer with Adapter
	J 7872 Magnetic Base Dial Indicator
	J 8001 Dial Indicator Set
	J 8037 Ring Compressor

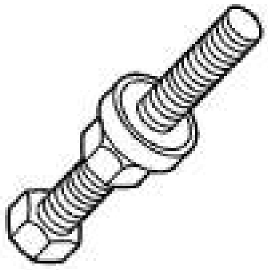
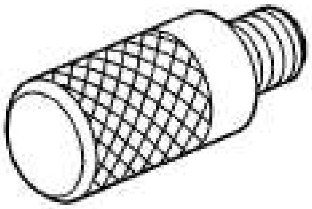
	J 8062 Valve Spring Compressor - Head Off
	J 8087 Cylinder Bore Gage
	J 8358 Carbon Removal Brush
	J 21867 Pressure Gage

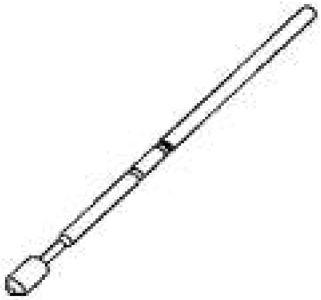
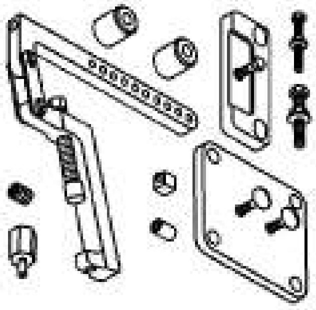
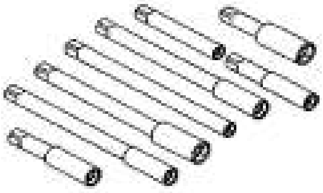
	
	J 21867-6 Oil Pressure Adapter Fitting
	J 22738-B Valve Spring Tester
	J 24254 Oil Seal Installer

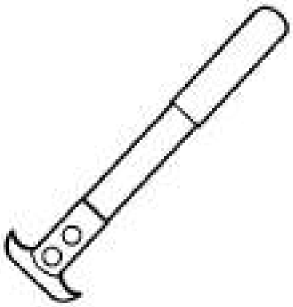
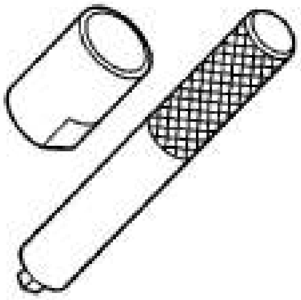
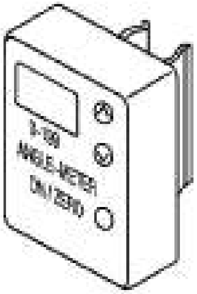
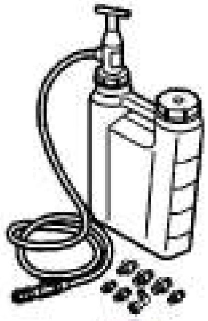
	303-642 Crankshaft Balancer Puller
	J 25033-C Pulley Installer
	J 25034-C Pulley Remover
	J 28410 Gasket Remover (Aluminium Components)

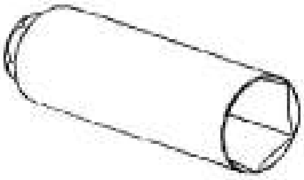
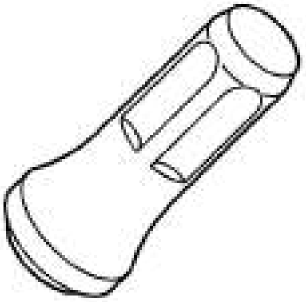
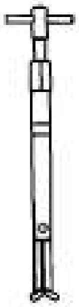
	J 28428-E High Intensity Black Light Kit
	J 29184 Oil Seal Installer
	J 33169 Clutch Alignment Arbor
	J 35667-A Cylinder Head Leakdown Tester

	J 36857 Engine Lift Bracket
	J 39313 Spark Plug Port Adapter
	J 41818 Crankshaft Bearing Cap Remover

	J 41998-B Crankshaft Balancer Installer
	J 42183 Handle
	J 42385-700 High Feature Thread Repair Kit
	J 42385-2000 Thread Insert Kit

	J 42640 Steering Column Anti-Rotation Pin
	J 43690-100 Rod Bearing Clearance Checking Tool - Adapter Kit
	J 43965 Thread Repair Extension Kit
	J 45000 Seal Remover

	
	J 45027 Tensioner Tool
 J-150 ANGLE-METER ON/ZERO	J 45059 Angle Meter
	J 45299 Engine Preluber

	J 41712 Oil Pressure Sensor Socket
	J 29184 Crankshaft Front Oil Seal Installer
	EN 48313 Timing Chain Retention Tool

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L | Specifications | **Document ID: 2177623**

Fastener Tightening Specifications

Application	Specification	
	Metric	English
A/C Bracket Bolt	58 N-m	43 lb ft
A/C Compressor Belt Idler Pulley Attaching Bolt	50 N-m	37 lb ft
A/C Compressor Belt Tensioner Attaching Bolts	22 N-m	16 lb ft
A/C Compressor Line-to-Condenser Bolt	16 N-m	12 lb ft
Air Intake Hose Clamp (L98, LS2)	7 N-m	62 lb in
Automatic Transmission Cooler Pipe Clamp to A/C Bracket Retaining Bolt	22 N-m	16 lb ft
Camshaft Position (CMP) Sensor Bolt	12 N-m	106 lb in
Camshaft Retainer Bolts - Hex Head Bolts	25 N-m	18 lb ft
Camshaft Retainer Bolts - TORX® Head Bolts	15 N-m	11 lb ft
Camshaft Sprocket Bolt		
- First Pass	75 N-m	55 lb ft
- Second Pass	+ 50 Degrees	
Clutch Pressure Plate Bolts (LS3)	70 N-m	52 lb ft
CMP Sensor Wire Harness Bolt (LS3)	12 N-m	106 lb in
Connecting Rod Bolts		
- First Pass	20 N-m	15 lb ft
- Second Pass	+ 85 Degrees	
Coolant Air Bleed Pipe and Cover Bolts	12 N-m	106 lb in
Coolant Temperature Sensor	20 N-m	15 lb ft
Crankshaft Balancer Bolt (L98, LS2)		
- First Pass (Install a new bolt after the installation	50 N-m	37 lb ft
- Second Pass (Install a new bolt after the installation	+ 140 Degrees	
- Crankshaft Balancer Bolt-Installation Pass to Ensure the Balancer is Completely Installed (L98, LS2)	330 N-m	243 lb ft
Crankshaft Balancer Bolt (LS3)		
- First Pass	150 N-m	111 lb ft
- Second Pass	Loosen 360 Degrees	
- Third Pass	50 N-m	37 lb ft
- Fourth Pass	+ 230 Degrees	
Crankshaft Bearing Cap M8 Bolts	25 N-m	18 lb ft
Crankshaft Bearing Cap M10 Bolts		
- First Pass in Sequence	20 N-m	15 lb ft
- Second Pass in Sequence	+ 80 Degrees	

Crankshaft Bearing Cap M10 Studs		
• First Pass in Sequence	20 N-m	15 lb ft
• Second Pass in Sequence	+ 50 Degrees	
Crankshaft Oil Deflector Nuts	25 N-m	18 lb ft
Crankshaft Position(CKP) Sensor Bolt	25 N-m	18 lb ft
Crankshaft Rear Oil Seal Housing Bolts	30 N-m	22 lb ft
Cylinder Head Coolant Plug	20 N-m	15 lb ft
Cylinder Head M8 Bolts - in sequence	30 N-m	22 lb ft
Cylinder Head M11 Bolts		
• First Pass in sequence	30 N-m	22 lb ft
• Second Pass in sequence	+ 90 Degrees	
• Third Pass in sequence	+ 70 Degrees	
Engine Block Coolant Drain Hole Plug	60 N-m	44 lb ft
Engine Block Coolant Heater (LS3)	50 N-m	37 lb ft
Engine Block Oil Gallery Plug	60 N-m	44 lb ft
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Bolt	50 N-m	37 lb ft
Exhaust Manifold Bolts		
• First Pass	15 N-m	11 lb ft
• Second Pass	20 N-m	15 lb ft
Exhaust Manifold Heat Shield Bolts (L98, LS2)	10 N-m	89 lb in
Exhaust Manifold Heat Shield Bolts (LS3)	9 N-m	80 lb in
Exhaust Manifold Stud (LS3)	20 N-m	15 lb ft
Flywheel Bolts		
• First Pass	20 N-m	15 lb ft
• Second Pass	50 N-m	37 lb ft
• Third Pass	100 N-m	74 lb ft
Front Cover Bolts	25 N-m	18 lb ft
Fuel Injection Fuel Rail Bolts	10 N-m	89 lb in
Ignition Coil Bracket-to-Valve Rocker Arm Cover Studs	12 N-m	106 lb in
Ignition Coil-to-Bracket Bolts	10 N-m	89 lb in
Intake Manifold Bolts		
• First Pass in sequence	5 N-m	44 lb in
• Second Pass in sequence	10 N-m	89 lb in
J41798 M10 Bolts	50 N-m	37 lb ft
J41798 M8 Bolt	25 N-m	18 lb ft
Knock Sensor Bolts (L98, LS2)	25 N-m	18 lb ft
Knock Sensor Bolts (LS3)	20 N-m	15 lb ft
Motor Mount Bracket Bolts (LS3)	50 N-m	37 lb ft
Oil Filter	30 N-m	22 lb ft
Oil Filter Fitting	55 N-m	41 lb ft

Oil Level Indicator Tube Bolt	25 N-m	18 lb ft
Oil Level Sensor (L98, LS2)	20 N-m	15 lb ft
Oil Level Sensor (LS3)	13 N-m	115 lb in
Oil Pan Baffle Bolts (L98, LS2)	12 N-m	106 lb in
Oil Pan Closeout Cover Bolt (LS3)	9 N-m	80 lb in
Oil Pan Closeout Cover Bolt (L98, LS2)	12 N-m	106 lb in
Oil Pan Cover Bolts (LS3)	12 N-m	106 lb in
Oil Pan Drain Plug	25 N-m	18 lb ft
Oil Pan M6 Bolts - Oil Pan-to-Rear Oil Seal Housing	12 N-m	106 lb in
Oil Pan M8 Bolts - Oil Pan-to-Engine Block and Oil Pan-to-Front Cover	25 N-m	18 lb ft
Oil Pressure Sensor	35 N-m	26 lb ft
Oil Pump Cover Bolts	12 N-m	106 lb in
Oil Pump Relief Valve Plug (L98, LS2)	14 N-m	124 lb in
Oil Pump Relief Valve Plug (LS3)	12 N-m	106 lb in
Oil Pump Screen Nuts	25 N-m	18 lb ft
Oil Pump Screen-to-Oil Pump Bolt	12 N-m	106 lb in
Oil Pump-to-Engine Block Bolts	25 N-m	18 lb ft
Spark Plugs	15 N-m	11 lb ft
Throttle Body Bolts	10 N-m	89 lb in
Timing Chain Tensioner Bolts	25 N-m	18 lb ft
Valley Cover Bolts	25 N-m	18 lb ft
Valve Lifter Guide Bolts (L98, LS2)	10 N-m	89 lb in
Valve Lifter Guide Bolts (LS3)	12 N-m	106 lb in
Valve Rocker Arm Bolts	30 N-m	22 lb ft
Valve Rocker Arm Cover Bolts	12 N-m	106 lb in
Water Inlet Housing Bolts	15 N-m	11 lb ft
Water Pump Bolts		
• First Pass	15 N-m	11 lb ft
• Second Pass	30 N-m	22 lb ft

Engine Mechanical Specifications (L98, LS2)

Application	Specification	
	Metric	English
General		
Engine Type	V8	
Displacement	6.0L	364 CID
RPO	L98	
Bore	101.618 mm 101.636 mm	4.0007 in 4.0017 in
Stroke	92.0 mm	3.622 in
Compression Ratio	10.4:1	
Idle Speed RPM (AT) Idle Speed RPM (MT)	-- --	
Firing Order	1-8-7-2-6-5-4-3	
Spark Plug Gap	1.02 mm	0.04 in
Block		
Camshaft Bearing Bore Number 1 and 5 Diameter	59.58 mm 59.63 mm	2.345 in 2.347 in
Camshaft Bearing Bore Number 2 and 4 Diameter	59.08 mm 59.13 mm	2.325 in 2.327 in
Camshaft Bearing Bore Number 3 Diameter	58.58 mm 58.63 mm	2.306 in 2.308 in
Crankshaft Main Bearing Bore Diameter	69.871 mm 69.889 mm	2.75 in 2.751 in
Crankshaft Main Bearing Bore Out - of - Round	0.006 mm	0.0002 in
Cylinder Bore Diameter	101.618 mm 101.636 mm	4.0007 in 4.0017 in
Cylinder Head Deck Height (Measuring from the Centre line of Crankshaft to the Deck Face)	234.57 mm 234.82 mm	9.235 in 9.245 in
Cylinder Head Deck Surface Flatness (Measured within a 152.4 mm (6.0 in) Area)	0.11 mm	0.004 in
Cylinder Head Deck Surface Flatness (Measuring the Overall Length of the Block Deck)	0.22 mm	0.008 in
Valve Lifter Bore Diameter	21.417 mm 21.443 mm	0.843 in 0.844 in
Camshaft		
Camshaft End Play	0.025 mm 0.305 mm	0.001 in 0.012 in
Camshaft Journal Diameter	54.99 mm 55.04 mm	2.164 in 2.166 in
Camshaft Journal Out - of - Round	0.025 mm	0.001 in

Camshaft Lobe Lift - Intake	7.78 mm	0.306 in
Camshaft Lobe Lift - Exhaust	7.77 mm	0.305 in
Camshaft Runout (Measured at the Intermediate Journals)	0.05 mm	0.002 in
Connecting Rod		
Connecting Rod Bearing Clearance - Production	0.023 mm 0.065 mm	0.0009 in 0.0025 in
Connecting Rod Bearing Clearance - Service	0.023 mm 0.076 mm	0.0009 in 0.003 in
Connecting Rod Bore Diameter - Bearing End	56.505 mm 56.525 mm	2.224 in 2.225 in
Connecting Rod Bore Out - of - Round - Bearing End - Production	0.004 mm 0.008 mm	0.00015 in 0.0003 in
Connecting Rod Bore Out - of - Round - Bearing End - Service	0.004 mm 0.008 mm	0.00015 in 0.0003 in
Connecting Rod Side Clearance	0.11 mm 0.51 mm	0.00433 in 0.02 in
Crankshaft		
Connecting Rod Journal Diameter - Production	53.318 mm 53.338 mm	2.0991 in 2.0999 in
Connecting Rod Journal Diameter - Service	53.308 mm	2.0987 in
Connecting Rod Journal Out - of - Round - Production	0.005 mm	0.0002 in
Connecting Rod Journal Out - of - Round - Service	0.01 mm	0.0004 in
Connecting Rod Journal Taper (Maximum for 1/2 of Journal Length - Production)	0.005 mm	0.0002 in
Connecting Rod Journal Taper (Maximum for 1/2 of Journal Length - Service)	0.02 mm	0.00078 in
Crankshaft End Play	0.04 mm 0.2 mm	0.0015 in 0.0078 in
Crankshaft Main Bearing Clearance - Production	0.02 mm 0.052 mm	0.0008 in 0.0021 in
Crankshaft Main Bearing Clearance - Service	0.02 mm 0.065 mm	0.0008 in 0.0025 in
Crankshaft Main Journal Diameter - Production	64.992 mm 65.008 mm	2.558 in 2.559 in
Crankshaft Main Journal Diameter - Service	64.992 mm	2.558 in
Crankshaft Main Journal Out - of - Round - Production	0.003 mm	0.000118 in
Crankshaft Main Journal Out - of - Round - Service	0.008 mm	0.0003 in
Crankshaft Main Journal Taper - Production	0.01 mm	0.0004 in

• Crankshaft Main Journal Taper - Service	0.02 mm	0.00078 in
• Crankshaft Rear Flange Runout	0.05 mm	0.002 in
• Crankshaft Reluctor Ring Runout (Measured 1.0 mm (0.04 in) Below Tooth Diameter)	0.7 mm	0.028 in
• Crankshaft Thrust Surface - Production	26.14 mm 26.22 mm	1.029 in 1.0315 in
• Crankshaft Thrust Surface - Service	26.22 mm	1.0315 in
• Crankshaft Thrust Surface Runout	0.025 mm	0.001 in
Cylinder Head		
• Cylinder Head Height/Thickness (Measured from the Cylinder Head Deck to the Valve Rocker Arm Cover Seal Surface)	120.2 mm	4.732 in
• Surface Flatness - Block Deck (Measured within a 152.4 mm (6.0 in) Area)	0.08 mm	0.003 in
• Surface Flatness - Block Deck (Measuring the Overall Length of the Cylinder Head)	0.1 mm	0.004 in
• Surface Flatness - Exhaust Manifold Deck	0.13 mm	0.005 in
• Surface Flatness - Intake Manifold Deck	0.08 mm	0.0031 in
• Valve Guide Installed Height (Measured from the Spring Seat Surface to the Top of the Guide)	17.32 mm	0.682 in
Intake Manifold		
• Surface Flatness (Measured at Gasket Sealing Surfaces and Measured Within a 200 mm (7.87 in) Area that Includes 2 Runner Port Openings)	0.3 mm	0.118 in
Lubrication System		
• Oil Capacity - with Filter	8.2 litres	8.6 quarts
• Oil Capacity - without Filter	7.7 litres	8.1 quarts
• Oil Pressure - Minimum - Hot	90 kPa at 1,000 engine RPM 124 kPa at 2,000 engine RPM 165 kPa at 4,000 engine RPM	13 psig at 1,000 engine RPM 18 psig at 2,000 engine RPM 24 psig at 4,000 engine RPM
Relief Valve Oil Pressure (Measured at Oil	379 - 517 kPa	55 - 75 psig

Pressure Sensor Location)	Maximum	Maximum
Oil Pan		
- Front Cover Alignment - at Oil Pan Surface	0.0 mm 0.5 mm	0.0 in 0.02 in
- Crankshaft Rear Oil Seal Housing Alignment - at Oil Pan Surface	0.0 mm 0.5 mm	0.0 in 0.02 in
- Oil Pan Alignment - to Rear of Engine Block at Transmission Bell Housing Mounting Surface	0.0 mm 0.1 mm	0.0 in 0.004 in
Piston Rings		
- Piston Ring End Gap - First Compression Ring (Measured in Cylinder Bore - Production)	0.20 mm 0.41 mm	0.008 in 0.016 in
- Piston Ring End Gap - First Compression Ring (Measured in Cylinder Bore - Service)	0.20 mm 0.41 mm	0.008 in 0.016 in
- Piston Ring End Gap - Second Compression Ring (Measured in Cylinder Bore - Production)	0.37 mm 0.69 mm	0.015 in 0.027 in
- Piston Ring End Gap - Second Compression Ring (Measured in Cylinder Bore - Service)	0.37 mm 0.69 mm	0.015 in 0.027 in
- Piston Ring End Gap - Oil Control Ring (Measured in Cylinder Bore - Production)	0.22 mm 0.79 mm	0.009 in 0.031 in
- Piston Ring End Gap - Oil Control Ring (Measured in Cylinder Bore - Service)	0.22 mm 0.79 mm	0.009 in 0.031 in
- Piston Ring to Groove Clearance - First Compression Ring - Production	0.030 mm 0.10 mm	0.0012 in 0.0040 in
- Piston Ring to Groove Clearance - First Compression Ring - Service	0.030 mm 0.10 mm	0.0012 in 0.0040 in
- Piston Ring to Groove Clearance - Second Compression Ring - Production	0.035 mm 0.078 mm	0.0014 in 0.0031 in
- Piston Ring to Groove Clearance - Second Compression Ring - Service	0.035 mm 0.078 mm	0.0014 in 0.0031 in
- Piston Ring to Groove Clearance - Oil Control Ring - Production	0.013 mm 0.201 mm	0.0005 in 0.0079 in
- Piston Ring to Groove Clearance - Oil Control Ring - Service	0.013 mm 0.201 mm	0.0005 in 0.0079 in
Pistons and Pins		
- Pin - Piston Pin Clearance to Piston Pin Bore - Production	0.002 mm 0.01 mm	0.0008 in 0.0004 in
- Pin - Piston Pin Clearance to Piston Pin Bore - Service	0.002 mm 0.015 mm	0.0008 in 0.0006 in

Pin - Piston Pin Diameter	23.952 mm 23.955 mm	0.943 in 0.943 in
Pin - Piston Pin Fit in Connecting Rod Bore - Production	0.007 mm 0.02 mm	0.00027 in 0.00078 in
Pin - Piston Pin Fit in Connecting Rod Bore - Service	0.007 mm 0.0022 mm	0.00027 in 0.00086 in
Piston - Piston Diameter - Measured Over Skirt Coating	101.611 mm 101.642 mm	4.0 in 4.001 in
Piston - Piston to Bore Clearance - Production	-0.022 mm 0.08 mm	-0.0009 in 0.0012 in
Piston - Piston to Bore Clearance (Service Limit with Skirt Coating Worn Off)	0.024 mm 0.08 mm	0.00094 in 0.0031 in
Valve System		
Valves - Valve Face Angle	45 degrees	
Valves - Valve Face Width	1.25 mm	0.05 in
Valves - Valve Lash	Net Lash - No Adjustment	
Valves - Valve Lift - Intake	13.23 mm	0.52 in
Valves - Valve Lift - Exhaust	13.22 mm	0.52 in
Valves - Valve Seat Angle	46 degrees	
Valves - Valve Seat Runout	0.05 mm	0.002 in
Valves - Valve Seat Width - Exhaust	1.78 mm	0.07 in
Valves - Seat Width - Intake	1.02 mm	0.04 in
Valves - Valve Stem Diameter - Production	7.955 mm 7.976 mm	0.313 in 0.314 in
Valves - Valve Stem Diameter - Service	7.95 mm	0.313 in
Valves - Valve Stem - to - Guide Clearance - Production - Intake	0.025 mm 0.066 mm	0.001 in 0.0026 in
Valves - Valve Stem - to - Guide Clearance - Service - Intake	0.093 mm	0.0037 in
Valves - Valve Stem - to - Guide Clearance - Production - Exhaust	0.025 - 0.066 mm	0.001 - 0.0026 in
Valves - Valve Stem - to - Guide Clearance - Service - Exhaust	0.093 mm	0.0037 in
Rocker Arms - Valve Rocker Arm Ratio	1.70:1	
Valve Springs - Valve Spring Free Length	52.9 mm	2.08 in
Valve Springs - Valve Spring Installed Height	45.75 mm	1.8 in
Valve Springs - Valve Spring Load - Closed	340 N at 45.75 mm	76 lb at 1.8 in
Valve Springs - Valve Spring Load - Open	980 N at 33.55 mm	220 lb at 1.32 in

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L | Specifications | Document ID: 2093557

Engine Mechanical Specifications (LS3)

Application	Specification	
	Metric	English
General		
• Engine Type	V8	
• Displacement	6.2L	376 CID
• RPO	LS3	
• VIN	W	
• Bore	103.241-103.259 mm	4.0065-4.0065 in
• Stroke	92.0 mm	3.622 in
• Compression Ratio	10.7:1	
• Firing Order	1-8-7-2-6-5-4-3	
• Spark Plug Gap	1.02 mm	0.04 in
Block		
• Camshaft Bearing Bore 1 and 5 Diameter	59.58-59.63 mm	2.345-2.347 in
• Camshaft Bearing Bore 2 and 4 Diameter	59.08-59.13 mm	2.325-2.327 in
• Camshaft Bearing Bore 3 Diameter	58.58-58.63 mm	2.306-2.308 in
• Crankshaft Main Bearing Bore Diameter	69.871-69.889 mm	2.75-2.751 in
• Crankshaft Main Bearing Bore Out-of-Round	0.006 mm	0.0002 in
• Cylinder Bore Diameter	103.241-103.259 mm	4.0065-4.0065 in
• Cylinder Head Deck Height - Measuring from the Centerline of Crankshaft to the Deck Face	234.57-234.82 mm	9.235-9.245 in
• Cylinder Head Deck Surface Flatness - Measured within a 152.4 mm (6.0 in) Area	0.11 mm	0.004 in
• Cylinder Head Deck Surface Flatness - Measuring the Overall Length of the Block Deck	0.22 mm	0.008 in
• Valve Lifter Bore Diameter	21.417-21.443 mm	0.843-0.844 in
Camshaft		
• Camshaft End Play	0.025-0.305 mm	0.001-0.012 in
• Camshaft Journal Diameter	54.99-55.04 mm	2.164-2.166 in
• Camshaft Journal Out-of-Round	0.025 mm	0.001 in
• Camshaft Lobe Lift - Intake	8.24 mm	0.324 in
• Camshaft Lobe Lift - Exhaust	7.77 mm	0.306 in
• Camshaft Runout - Measured at the Intermediate Journals	0.05 mm	0.002 in
Connecting Rod		

Connecting Rod Bearing Clearance - Production	0.023-0.065 mm	0.0009-0.0025 in
Connecting Rod Bearing Clearance - Service	0.023-0.076 mm	0.0009-0.003 in
Connecting Rod Bore Diameter - Bearing End	56.505-56.525 mm	2.224-2.225 in
Connecting Rod Bore Out-of-Round - Bearing End - Production	0.004-0.008 mm	0.00015-0.0003 in
Connecting Rod Bore Out-of-Round - Bearing End - Service	0.004-0.008 mm	0.00015-0.0003 in
Connecting Rod Side Clearance	0.11-0.51 mm	0.00433-0.02 in
Crankshaft		
Connecting Rod Journal Diameter - Production	53.318-53.338 mm	2.0991-2.0999 in
Connecting Rod Journal Diameter - Service	53.308 mm	2.0987 in
Connecting Rod Journal Out-of-Round - Production	0.005 mm	0.0002 in
Connecting Rod Journal Out-of-Round - Service	0.01 mm	0.0004 in
Connecting Rod Journal Taper - Maximum for 1/2 of Journal Length - Production	0.005 mm	0.0002 in
Connecting Rod Journal Taper - Maximum for 1/2 of Journal Length - Service	0.02 mm	0.00078 in
Crankshaft End Play	0.04-0.2 mm	0.0015-0.0078 in
Crankshaft Main Bearing Clearance - Production	0.02-0.052 mm	0.0008-0.0021 in
Crankshaft Main Bearing Clearance - Service	0.02-0.065 mm	0.0008-0.0025 in
Crankshaft Main Journal Diameter - Production	64.992-65.008 mm	2.558-2.559 in
Crankshaft Main Journal Diameter - Service	64.992 mm	2.558 in
Crankshaft Main Journal Out-of-Round - Production	0.003 mm	0.000118 in
Crankshaft Main Journal Out-of-Round - Service	0.008 mm	0.0003 in
Crankshaft Main Journal Taper - Production	0.01 mm	0.0004 in
Crankshaft Main Journal Taper - Service	0.02 mm	0.00078 in
Crankshaft Rear Flange Runout	0.05 mm	0.002 in
Crankshaft Reluctor Ring Runout - Measured 1.0 mm (0.04 in) Below Tooth Diameter	0.7 mm	0.028 in
Crankshaft Thrust Surface - Production	26.14-26.22 mm	1.029-1.0315 in
Crankshaft Thrust Surface - Service	26.22 mm	1.0315 in
Crankshaft Thrust Surface Runout	0.025 mm	0.001 in
Cylinder Head		
Cylinder Head Height/Thickness - Measured from the Cylinder Head Deck to the Valve Rocker Arm Cover Seal Surface	120.2 mm	4.732 in
Surface Flatness - Block Deck - Measured within a	0.08 mm	0.003 in

152.4 mm (6.0 in) Area		
- Surface Flatness - Block Deck - Measuring the Overall Length of the Cylinder Head	0.1 mm	0.004 in
- Surface Flatness - Exhaust Manifold Deck	0.13 mm	0.005 in
- Surface Flatness - Intake Manifold Deck	0.08 mm	0.0031 in
- Valve Guide Installed Height - Measured from the Spring Seat Surface to the Top of the Guide	17.32 mm	0.682 in
Intake Manifold		
- Surface Flatness - Measured at Gasket Sealing Surfaces and Measured Within a 200 mm (7.87 in) Area that Includes 2 Runner Port Openings	0.3 mm	0.118 in
Lubrication System		
- Oil Capacity - with Filter	5.7 liters	6.0 quarts
- Oil Capacity - without Filter	5.4 liters	5.7 quarts
- Oil Capacity - with Filter - RPO KPS	5.7 liters	6.0 quarts
- Oil Pressure - Minimum - Hot	41 kPa at 1,000 engine RPM 124 kPa at 2,000 engine RPM 165 kPa at 4,000 engine RPM	6 psig at 1,000 engine RPM 18 psig at 2,000 engine RPM 24 psig at 4,000 engine RPM
Oil Pan		
- Front Cover Alignment - at Oil Pan Surface	0.0-0.5 mm	0.0-0.02 in
- Crankshaft Rear Oil Seal Housing Alignment - at Oil Pan Surface	0.0-0.5 mm	0.0-0.02 in
- Oil Pan Alignment - to Rear of Engine Block at Transmission Bell Housing Mounting Surface	0.0-0.1 mm	0.0-0.004 in
Piston Rings		
- Piston Ring End Gap - First Compression Ring - Measured in Cylinder Bore - Production	0.17-0.38 mm	0.0067-0.0150 in
- Piston Ring End Gap - First Compression Ring - Measured in Cylinder Bore - Service	0.17-0.44 mm	0.0067-0.0173 in
- Piston Ring End Gap - Second Compression Ring - Measured in Cylinder Bore - Production	0.32-0.63 mm	0.0126-0.0248 in
- Piston Ring End Gap - Second Compression Ring - Measured in Cylinder Bore - Service	0.32-0.69 mm	0.0126-0.0272 in
- Piston Ring End Gap - Oil Control Ring - Measured in Cylinder Bore - Production	0.22-0.79 mm	0.0086-0.0311 in
- Piston Ring End Gap - Oil Control Ring - Measured in Cylinder Bore - Service	0.22-0.85 mm	0.0086-0.0335 in
- Piston Ring to Groove Clearance - First Compression Ring - Production	0.030-0.083 mm	0.0012-0.0033 in
- Piston Ring to Groove Clearance - First Compression Ring - Service	0.030-0.083 mm	0.0012-0.0033 in

Piston Ring to Groove Clearance - Second Compression Ring - Production	0.040-0.083 mm	0.0016-0.0033 in
Piston Ring to Groove Clearance - Second Compression Ring - Service	0.040-0.083 mm	0.0016-0.0033 in
Piston Ring to Groove Clearance - Oil Control Ring - Production	0.013-0.201 mm	0.0005-0.0079 in
Piston Ring to Groove Clearance - Oil Control Ring - Service	0.013-0.201 mm	0.0005-0.0079 in
Pistons and Pins		
Pin - Piston Pin Clearance to Piston Pin Bore - Production	0.002-0.01 mm	0.00008-0.0004 in
Pin - Piston Pin Clearance to Piston Pin Bore - Service	0.002-0.015 mm	0.00008-0.0006 in
Pin - Piston Pin Diameter	23.952-23.955 mm	0.9430-0.9431 in
Pin - Piston Pin Fit in Connecting Rod Bore - Production	0.007-0.02 mm	0.00027-0.00078 in
Pin - Piston Pin Fit in Connecting Rod Bore - Service	0.007-0.022 mm	0.00027-0.00086 in
Piston - Piston Diameter - Measured Over Skirt Coating	103.258-103.289 mm	4.0653-4.0665 in
Piston - Piston to Bore Clearance - Production	-0.048 to +0.001 mm	-0.0019 to +0.000 in
Piston - Piston to Bore Clearance - Service Limit with Skirt Coating Worn Off	0.055 mm	0.0022 in
Valve System		
Valves - Valve Face Angle	45 degrees	
Valves - Valve Face Width	1.25 mm	0.05 in
Valves - Valve Lash	Net Lash - No Adjustment	
Valves - Valve Lift - Intake	13.97 mm	0.55 in
Valves - Valve Lift - Exhaust	13.22 mm	0.52 in
Valves - Valve Seat Angle	46 degrees	
Valves - Valve Seat Runout	0.05 mm	0.002 in
Valves - Valve Seat Width - Exhaust	1.78 mm	0.07 in
Valves - Seat Width - Intake	1.02 mm	0.04 in
Valves - Valve Stem Diameter - Production	7.955-7.976 mm	0.313-0.314 in
Valves - Valve Stem Diameter - Service	7.95 mm	0.313 in
Valves - Valve Stem-to-Guide Clearance - Production - Intake	0.025-0.066 mm	0.001-0.0026 in
Valves - Valve Stem-to-Guide Clearance - Service - Intake	0.093 mm	0.0037 in
Valves - Valve Stem-to-Guide Clearance - Production - Exhaust	0.025-0.066 mm	0.001-0.0026 in
Valves - Valve Stem-to-Guide Clearance - Service - Exhaust	0.093 mm	0.0037 in

- Rocker Arms - Valve Rocker Arm Ratio	1.70:1	
- Valve Springs - Valve Spring Free Length	52.9 mm	2.08 in
- Valve Springs - Valve Spring Installed Height	45.75 mm	1.8 in
- Valve Springs - Valve Spring Load - Closed	400 N at 45.75 mm	90 lb at 1.8 in
- Valve Springs - Valve Spring Load - Open	1175 N at 33.05 mm	264 lb at 1.30 in

Adhesives, Fluids, Lubricants, and Sealers (L98, LS2, LS3)

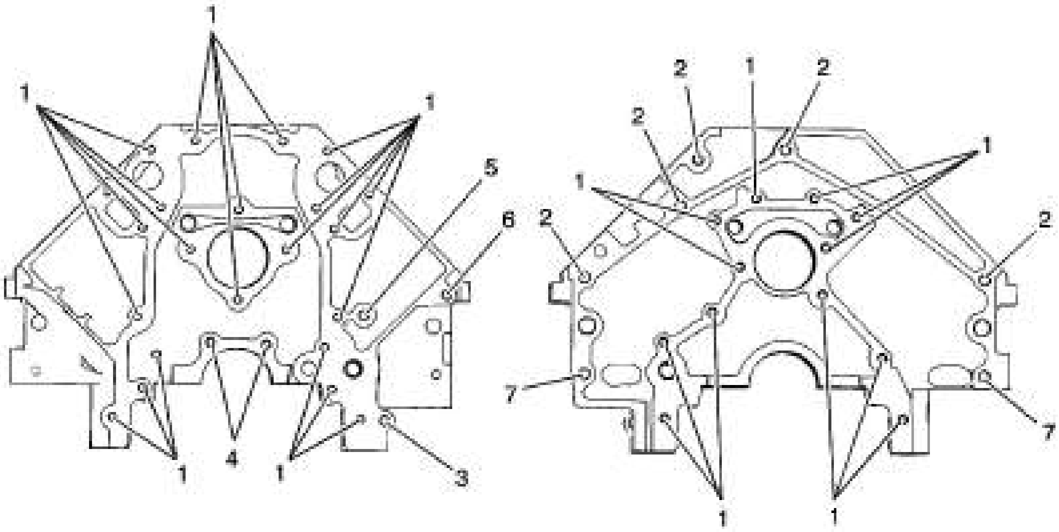
Application	Type of Material
Coolant Sensor Threads	LOCTITE 565 ™ or equivalent
Cylinder Head Core Hole Plug	LOCTITE 242 ™ or equivalent
Cylinder Head Expansion Plug	LOCTITE 242 ™ or equivalent
Cylinder Block Coolant Drain Hole Plug Sealing Washer	LOCTITE 565 ™ or equivalent
Cylinder Block Front Oil Gallery Plug	LOCTITE 242 ™ or equivalent
Cylinder Block Oil Gallery Plug Sealing Washers	LOCTITE 565 ™ or equivalent
Oil Pressure Sensor Threads	LOCTITE 565 ™ or equivalent
Engine Oil Supplement	Fluorescent Dye
Exhaust Manifold Bolt Threads	LOCTITE 272 ™ or equivalent
Flywheel/Flex Plate Bolts	LOCTITE 242 ™ or equivalent
Fuel Rail Bolt Threads	LOCTITE 242 ™ or equivalent
Ignition Coil and Bracket Assembly Bolt Threads	LOCTITE 242 ™ or equivalent
Intake Manifold Bolt Threads	LOCTITE 242 ™ or equivalent
Oil Pan Oil Gallery Plug Threads	LOCTITE 565 ™ or equivalent
Oil Pan Surface at Front Cover and Rear Covers	LOCTITE 565 ™ or equivalent
Thread Repair Component Cleaner	Cleaner
Thread Repair Component Cleaner	Cleaner
Thread Repair Cutting Oil	Lubricant

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L | Specifications | **Document ID: 2078264**

Thread Repair Specifications (L98, LS2)

Table 1: Engine Block - Front/Rear Views
Table 2: Engine Block - Left/Right Side Views
Table 3: Engine Block - Top/Bottom Views
Table 4: Cylinder Head - Top/End Views
Table 5: Cylinder Head - Intake/Exhaust Side Views

Engine Block - Front/Rear Views

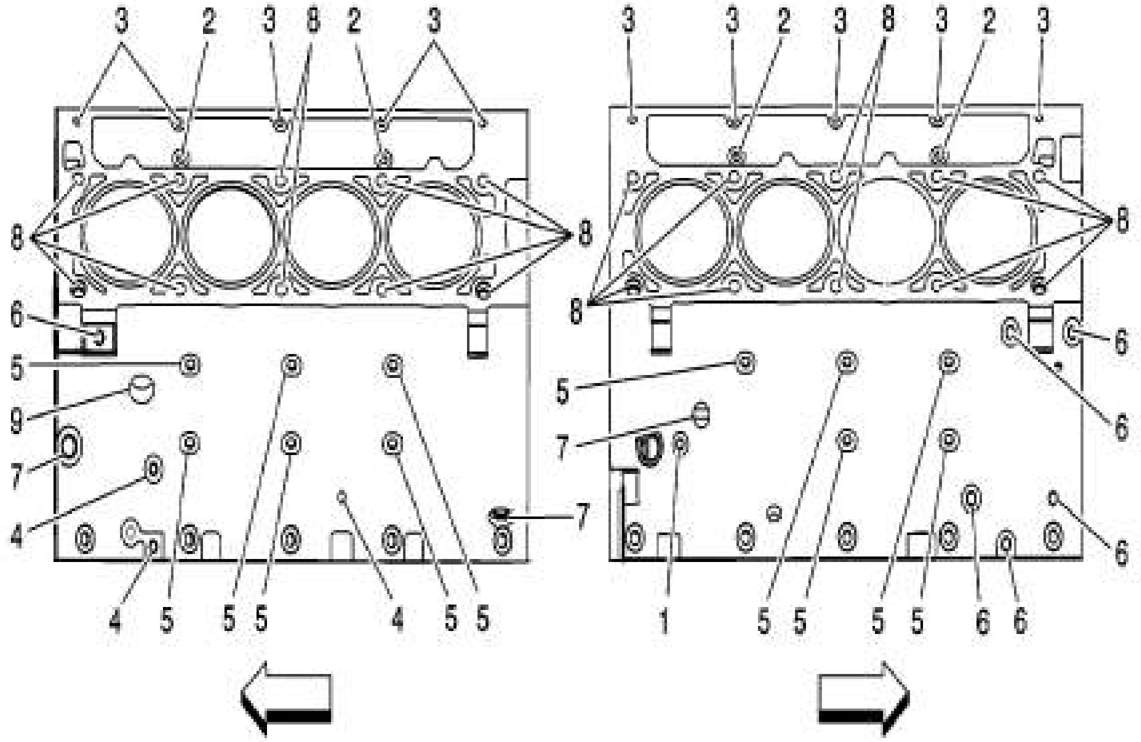


Engine Block - Front/Rear Views

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	22.5	(0.885)	17.5	(0.688)
2	M10 x 1.5	211	212	N/A	213	214	215	27.5	(1.08)	22.0	(0.866)
3	M10 x 1.5	211	212	N/A	213	214	215	Through		Through	

4	M8 x 1.25	206	207	N/A	208	209	210	Through		Through	
5	M10 x 1.5	211	212	N/A	213	214	215	25.0	(0.984)	19.5	(0.767)
6	M10 x 1.5	211	212	N/A	213	214	215	32.5	(1.279)	25.0	(0.984)
7	M10 x 1.5	211	212	N/A	213	214	215	Through		Through	
Bolt hole 6 is drilled and tapped for aluminium block applications only.											

Engine Block - Left / Right Side Views

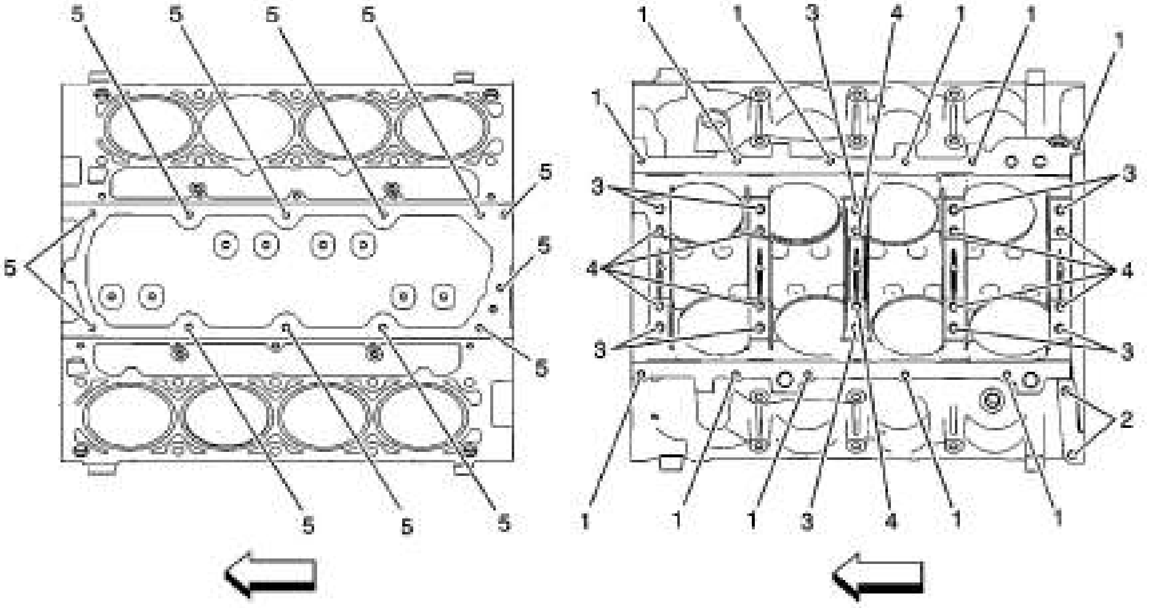


Engine Block - Left / Right Side Views

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	22.5	(0.885)	17.5	(0.688)
2	M8 x 1.25	206	207	N/A	208	209	210	28.5	(1.122)	23.0	(0.905)
	M8 x										

3	1.25	206	207	N/A	208	209	210	21.5	(0.846)	16.0	(0.629)
4	M10 x 1.25	211	212	N/A	213	214	215	29.0	(1.141)	23.0	(0.905)
5	M10 x 1.5	211	212	N/A	213	214	215	27.0	(1.062)	21.5	(0.846)
6	M16 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	
7	M11 x 2.0	105	N/A	N/A	106	107	108	69.0	(2.72)	60.0	(2.36)
8	M28 x 1.25	N/A	N/A	N/A	N/A	N/A	N/A	Through		Through	
Bolt hole 7 has a 30 mm (1.18 in) counterbore included in the 69.0 mm (2.72 in) drill depth. Use sleeve J 42385-315 with the drill and tap.											

Engine Block - Top/Bottom Views



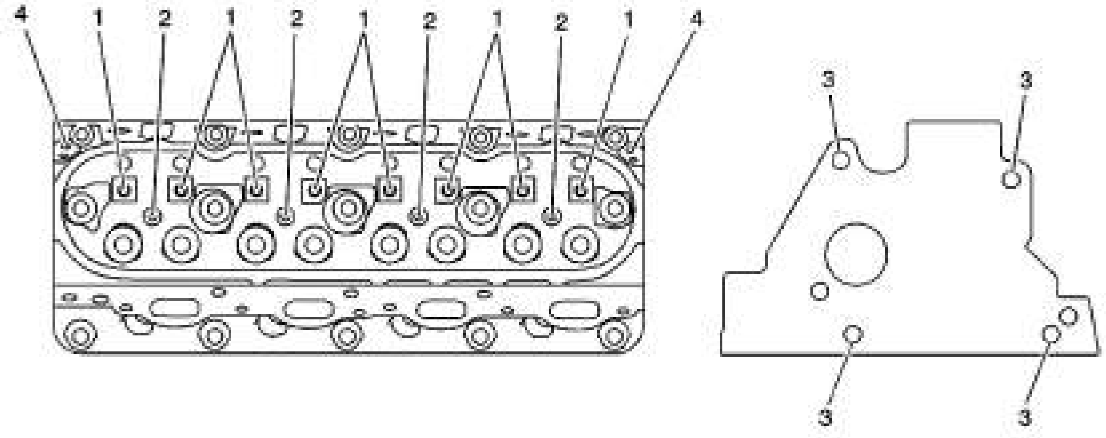
Engine Block - Top/Bottom Views

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	22.5	(0.885)	17.5	(0.688)

2	M10 x 1.5	211	212	N/A	213	214	215	42.5	(1.67)	37.0	(1.45)
3	M10 x 2.0	101	N/A	N/A	102	103	104	31.0	(1.22)	25.5	(1.0)
4	M10 x 2.0	101	N/A	N/A	102	103	104	53.5	(2.10)	44.0	(1.73)
5	M8 x 1.25	206	207	N/A	208	209	210	26.5	(1.043)	19.0	(0.748)

- Bolt hole 2 has an 11.5 mm (0.452 in) counterbore included in the 42.5 mm (1.67 in) drill depth. Use sleeve J 42385-311 with the drill and tap.
- Bolt hole 3 has a 1.5 mm (0.059 in) counterbore included in the 31.0 mm (1.22 in) drill depth. Use sleeve J 42385-316 with the drill and tap.
- Bolt hole 4 has a 20.5 mm (0.807 in) counterbore included in the 53.5 mm (2.10 in) drill depth.

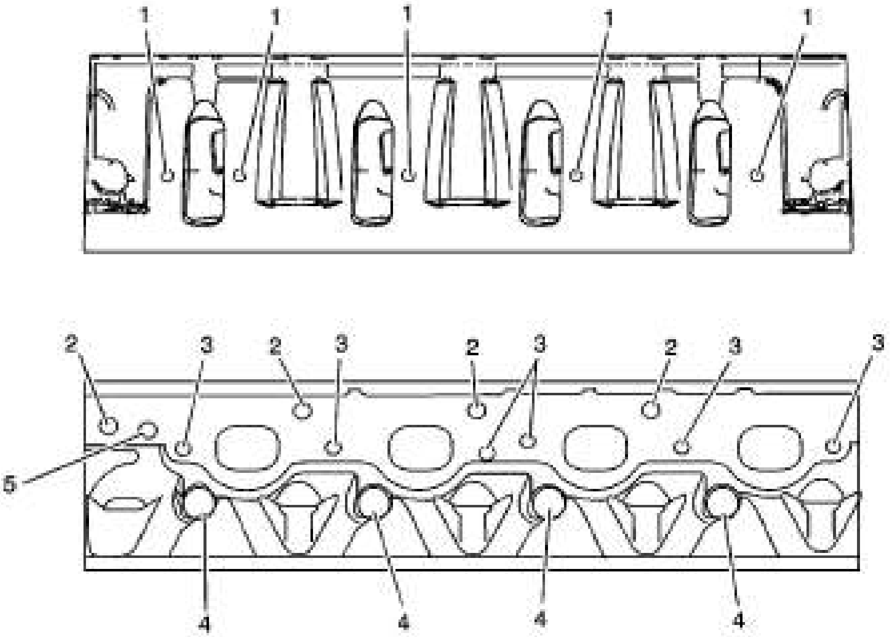
Cylinder Head - Top/End Views



Cylinder Head - Top/End Views

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	26.5	(1.04)	19.0	(0.784)
2	M6 x 1.0	201	202	N/A	203	204	205	20.05	(0.789)	16.05	(0.632)
3	M10 x 1.5	211	212	N/A	213	214	215	28.0	(1.10)	20.0	(0.787)
4	M6 x 1.0	201	202	N/A	203	204	205	22.5	(0.885)	15.0	(0.688)

Cylinder Head - Intake/Exhaust Side Views



Cylinder Head - Intake/Exhaust Side Views

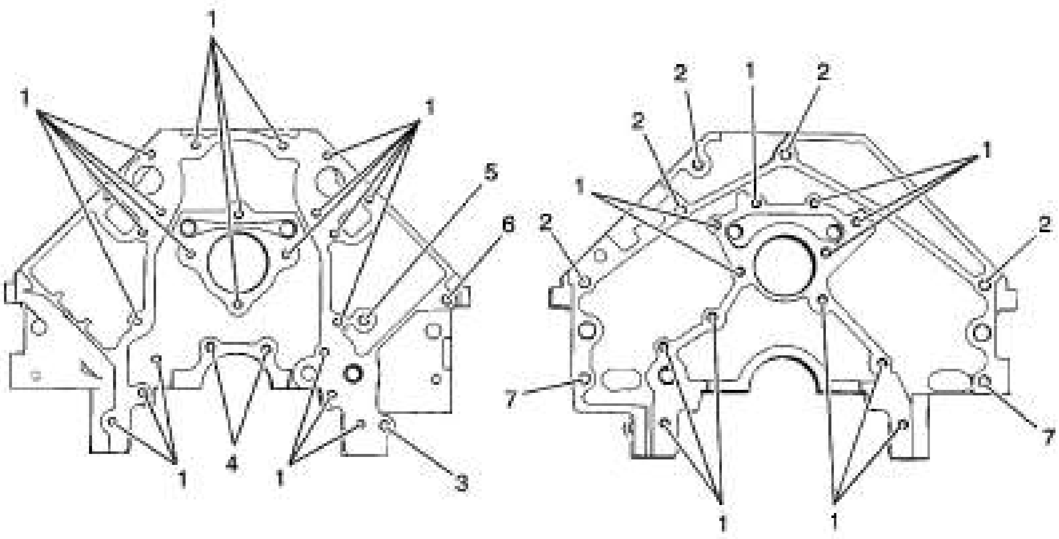
Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	Through		Through	
2	M10 x 1.5	211	212	N/A	213	214	215	28.0	(1.10)	20.0	(0.787)
3	M8 x 1.25	206	207	N/A	208	209	210	21.0	(0.826)	16.0	(0.629)
4	M14 x 1.25	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	
5	M12 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L | Specifications | **Document ID: 2090681**

Thread Repair Specifications (LS3)

Table 1: Engine Block - Front/Rear Views
Table 2: Engine Block - Left/Right Side Views
Table 3: Engine Block - Top/Bottom Views
Table 4: Cylinder Head - Top/End Views
Table 5: Cylinder Head - Intake/Exhaust Side Views

Engine Block - Front/Rear Views

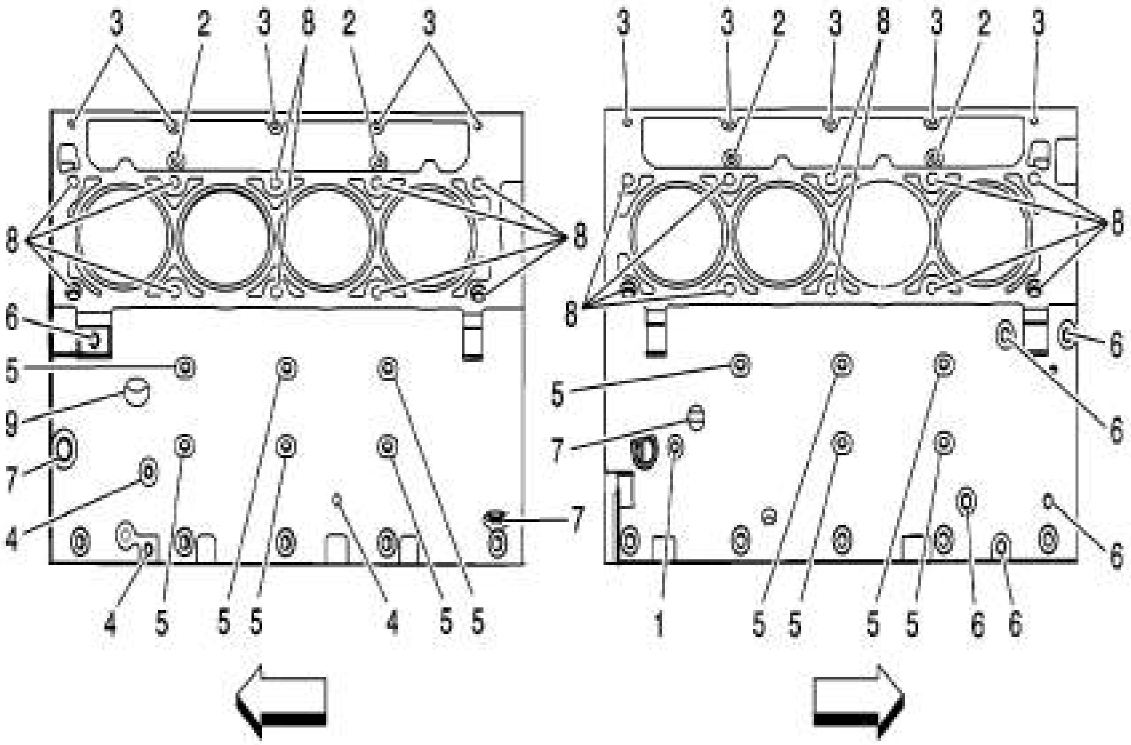


Engine Block - Front/Rear Views

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth - Maximum mm (in)	Tap Depth - Maximum mm (in)
J 42385-								
1	M8 x 1.25	210	206	207	208	209	22.5 (0.885)	17.5 (0.688)
2	M10 x 1.5	215	211	212	213	214	27.5 (1.08)	22.0 (0.866)
3	M10 x 1.5	215	211	212	213	214	Thru	Thru

4	M8 x 1.25	210	206	207	208	209	Thru	Thru
5	M10 x 1.5	215	211	212	213	214	25.0 (0.984)	19.5 (0.767)
6	M10 x 1.5	215	211	212	213	214	32.5 (1.279)	25.0 (0.984)
7	M10 x 1.5	215	211	212	213	214	Thru	Thru
Bolt hole 6 is drilled and tapped for aluminum block applications only.								

Engine Block - Left / Right Side Views

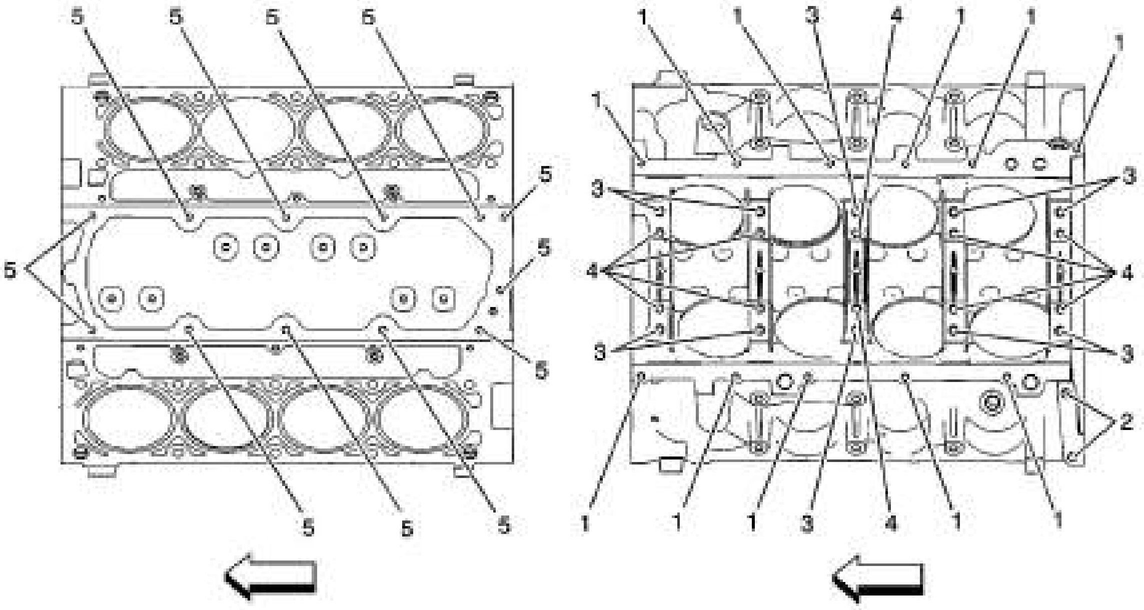


Engine Block - Left / Right Side Views

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth - Maximum mm (in)	Tap Depth - Maximum mm (in)
J 42385-								
1	M8 x 1.25	210	206	207	208	209	22.5 (0.885)	17.5 (0.688)
2	M8 x 1.25	210	206	207	208	209	28.5 (1.122)	23.0 (0.905)
3	M8 x 1.25	210	206	207	208	209	21.5 (0.846)	16.0 (0.629)

4	M10 x 1.25	215	211	212	213	214	29.0 (1.141)	23.0 (0.905)
5	M10 x 1.5	215	211	212	213	214	27.0 (1.062)	21.5 (0.846)
6	M16 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	M11 x 2.0	108	105	N/A	106	107	69.0 (2.72)	60.0 (2.36)
8	M28 x 1.25	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bolt hole 7 has a 30 mm (1.18 in) counterbore included in the 69.0 mm (2.72 in) drill depth. Use sleeve J 42385-315 with the drill and tap.								

Engine Block - Top/Bottom Views



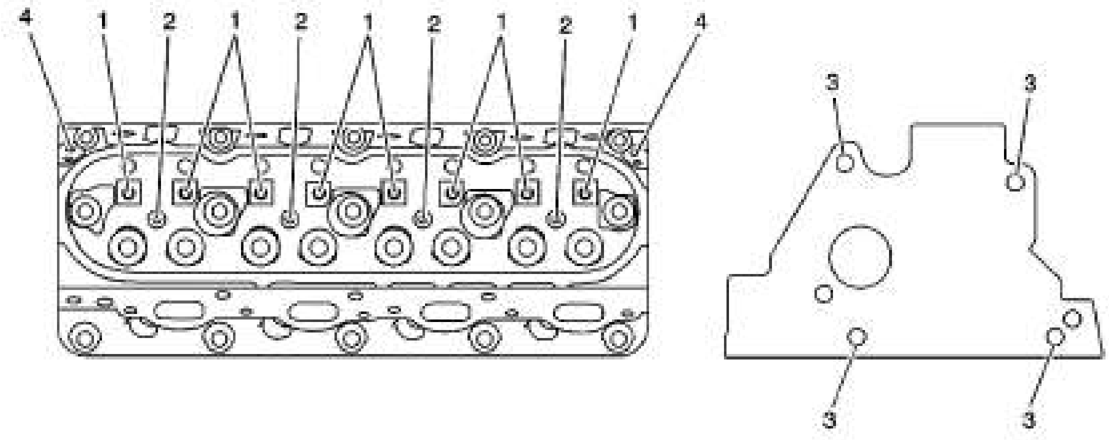
Engine Block - Top/Bottom Views

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth - Maximum mm (in)	Tap Depth - Maximum mm (in)
J 42385-								
1	M8 x 1.25	210	206	207	208	209	22.5 (0.885)	17.5 (0.688)
2	M10 x	215	211	212	213	214	42.5 (1.67)	37.0 (1.45)

	1.5							
3	M10 x 2.0	104	101	N/A	102	103	31.0 (1.22)	25.5 (1.0)
4	M10 x 2.0	104	101	N/A	102	103	53.5 (2.10)	44.0 (1.73)
5	M8 x 1.25	210	206	207	208	209	26.5 (1.043)	19.0 (0.748)

- Bolt hole 2 has an 11.5 mm (0.452 in) counterbore included in the 42.5 mm (1.67 in) drill depth. Use sleeve J 42385-311 with the drill and tap.
- Bolt hole 3 has a 1.5 mm (0.059 in) counterbore included in the 31.0 mm (1.22 in) drill depth. Use sleeve J 42385-316 with the drill and tap.
- Bolt hole 4 has a 20.5 mm (0.807 in) counterbore included in the 53.5 mm (2.10 in) drill depth.

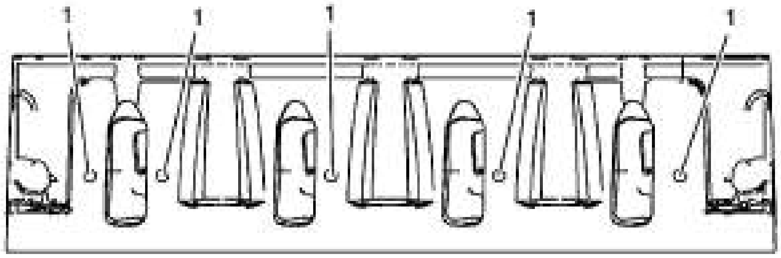
Cylinder Head - Top/End Views

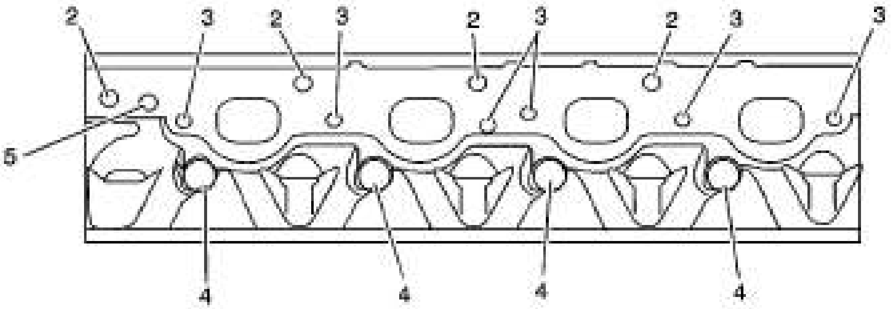


Cylinder Head - Top/End Views

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth - Maximum mm (in)	Tap Depth - Maximum mm (in)
J 42385-								
1	M8 x 1.25	210	206	207	208	209	26.5 (1.04)	19.0 (0.784)
2	M6 x 1.0	205	201	202	203	204	20.05 (0.789)	16.05 (0.632)
3	M10 x 1.5	215	211	212	213	214	28.0 (1.10)	20.0 (0.787)
4	M6 x 1.0	205	201	202	203	204	22.5 (0.885)	15.0 (0.688)

Cylinder Head - Intake/Exhaust Side Views

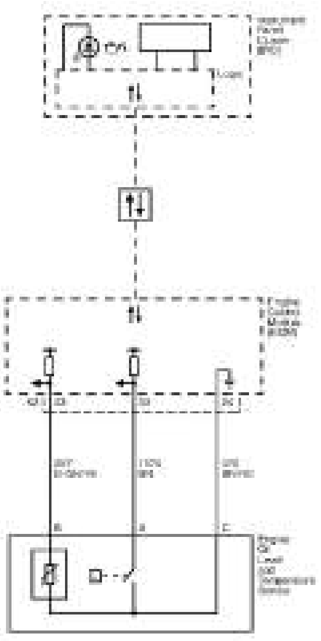




Cylinder Head - Intake/Exhaust Side Views

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth - Maximum mm (in)	Tap Depth - Maximum mm (in)
J 42385-								
1	M6 x 1.0	205	201	202	203	204	Thru	Thru
2	M10 x 1.5	215	211	212	213	214	28.0 (1.10)	20.0 (0.787)
3	M8 x 1.25	210	206	207	208	209	21.0 (0.826)	16.0 (0.629)
4	M14 x 1.25	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	M12 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Engine Mechanical Schematics


Instrument Panel Cluster (IPC)
Low
Engine Control Module (ECM)
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A
C
Engine Oil Level and Temperature Sensor

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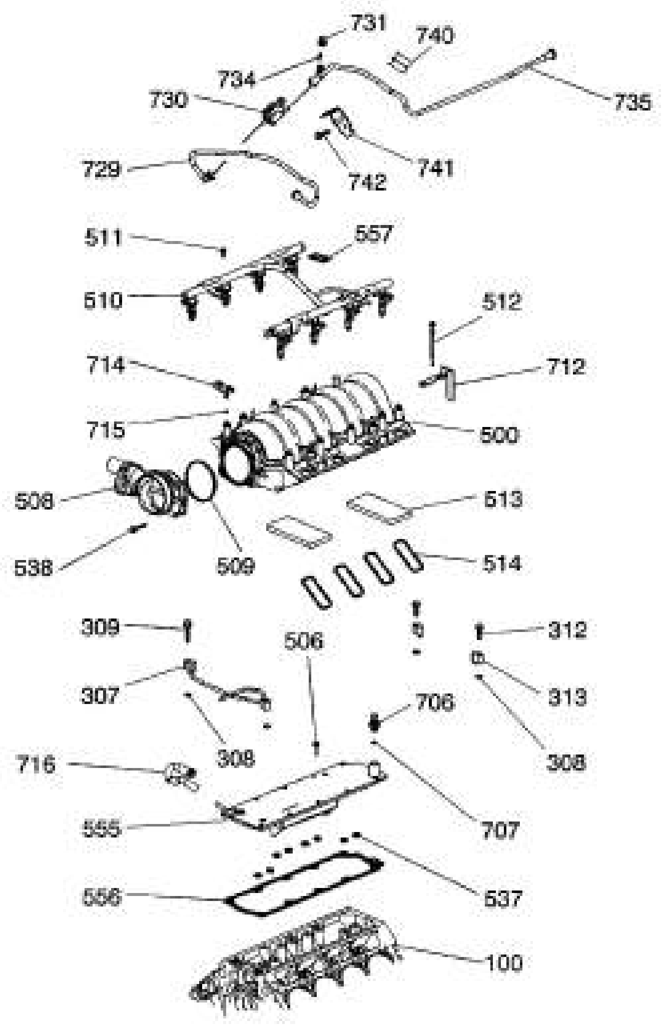
Intake Manifold / Upper Engine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(1) Evaporative Emission (EVAP) Canister Purge Tube
(2) EVAP Canister Purge Solenoid Valve
(3) Service Valve
(4) Service Valve Cap
(5) EVAP Tube Clip
(6) EVAP Canister Purge Tube
(7) EVAP Purge Valve Bracket
(8) EVAP Purge Valve Bracket Retaining Bolt
(9) Fuel Rail Ground Strap
(10) Fuel Injection Fuel Rail Stop Bracket Retaining Bolt
(11) Fuel Injection Fuel Rail Stop Bracket

(12) Intake Manifold
(13) Intake Manifold Gasket
(14) Engine Coolant Air Bleed Cover Retaining Bolt
(15) Engine Coolant Air Bleed Cover
(16) Engine Coolant Air Bleed Cover Seal
(17) Oil Pressure Sensor
(18) Oil Pressure Sensor Washer
(19) Engine Block
(20) Valley Cover Gasket
(21) Valley Cover
(22) Positive Crankcase Ventilation (PCV) Hose - Dirty Air
(23) Engine Coolant Air Bleed Pipe Seal
(24) Valley Cover Retaining Bolt
(25) Engine Coolant Air Bleed Pipe
(26) Engine Coolant Air Bleed Pipe Retaining Bolt
(27) Throttle Body Gasket
(28) Throttle Body Retaining Bolt
(29) Throttle Body
(30) Manifold Absolute Pressure (MAP) Sensor Seal
(31) Manifold Absolute Pressure (MAP) Sensor
(32) Fuel Rail with Injectors
(33) Fuel Rail Bolt

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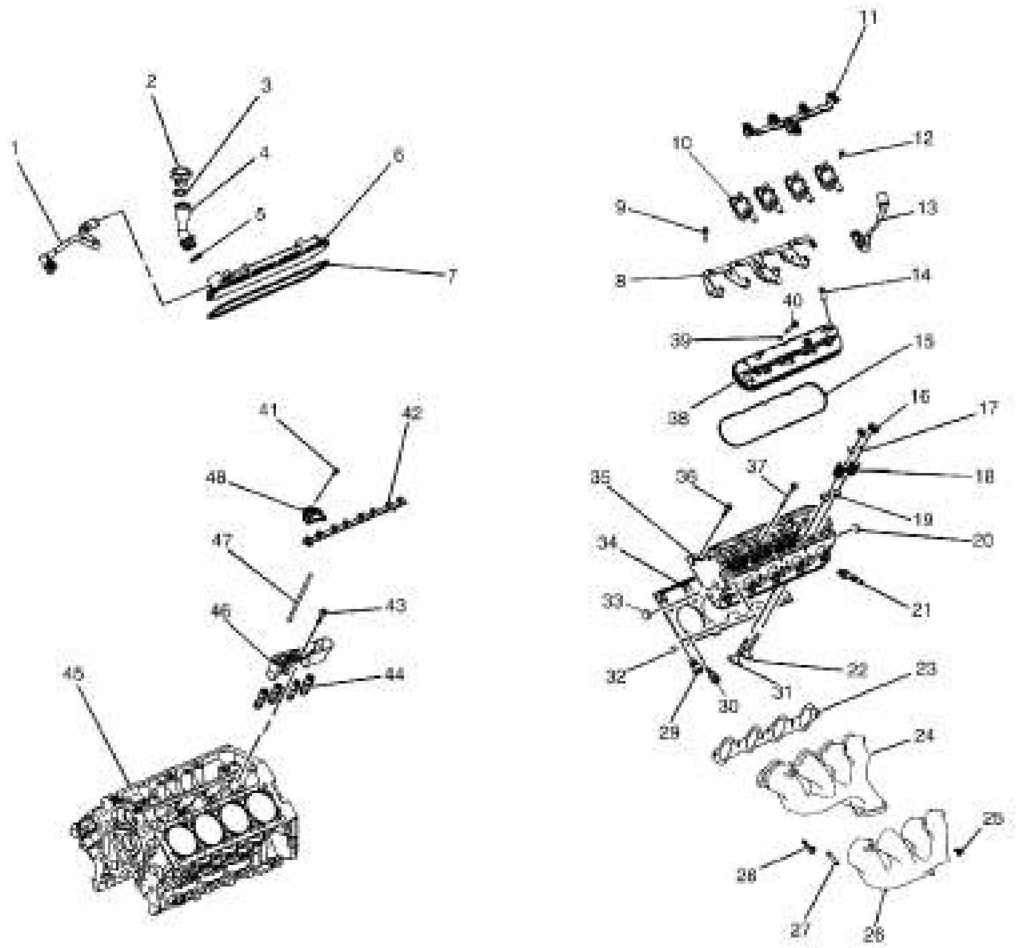
Cylinder Head / Upper Engine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(1) Positive Crankcase Ventilation (PCV) Hose - Fresh Air
(2) Oil Fill Cap
(3) Oil Fill Cap O-Ring
(4) Oil Fill Tube
(5) Oil Fill Tube O-Ring
(6) Valve Rocker Arm Cover
(7) Valve Rocker Arm Cover Gasket
(8) Ignition Coil Bracket
(9) Ignition Coil Bracket Stud
(10) Ignition Coil
(11) Ignition Coil Wire Harness Assembly

(12) Ignition Coil Retaining Bolt
(13) Spark Plug Wire
(14) Valve Rocker Arm Cover Cap Plug
(15) Valve Rocker Arm Cover Gasket
(16) Valve Stem Key
(17) Valve Spring Cap
(18) Valve Spring
(19) Valve Stem Oil Seal
(20) Cylinder Head Core Hole Plug
(21) Spark Plug
(22) Intake Valve
(23) Exhaust Manifold Gasket
(24) Exhaust Manifold
(25) Exhaust Manifold Retaining Bolt
(26) Exhaust Manifold Heat Shield
(27) Exhaust Manifold Stud
(28) Exhaust Manifold Retaining Bolt
(29) Cylinder Head Plug
(30) Engine Coolant Temperature Sensor
(31) Exhaust Valve
(32) Cylinder Head Locating Pin
(33) Core Hole Plug
(34) Cylinder Head Gasket
(35) Cylinder Head
(36) Cylinder Head Bolt - M8
(37) Cylinder Head Bolt - M11
(38) Valve Rocker Arm Cover
(39) Valve Rocker Arm Cover Bolt Grommet
(40) Valve Rocker Arm Cover Bolt
(41) Valve Rocker Arm Retaining Bolt
(42) Valve Rocker Arm Pivot Support
(43) Valve Lifter Guide Retaining Bolt
(44) Valve Lifter
(45) Engine Block
(46) Valve Lifter Guide
(47) Pushrod
(48) Valve Rocker Arm

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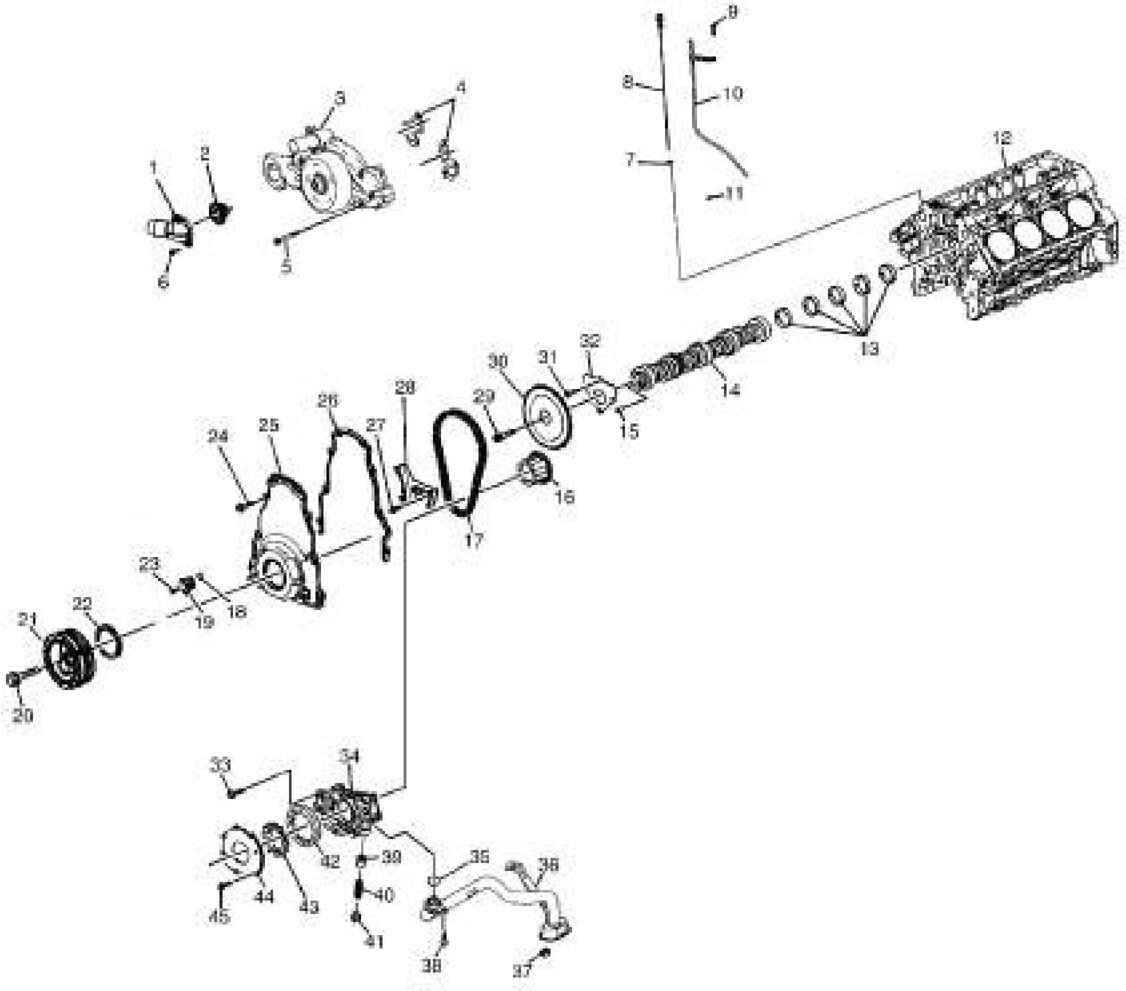
Front of Engine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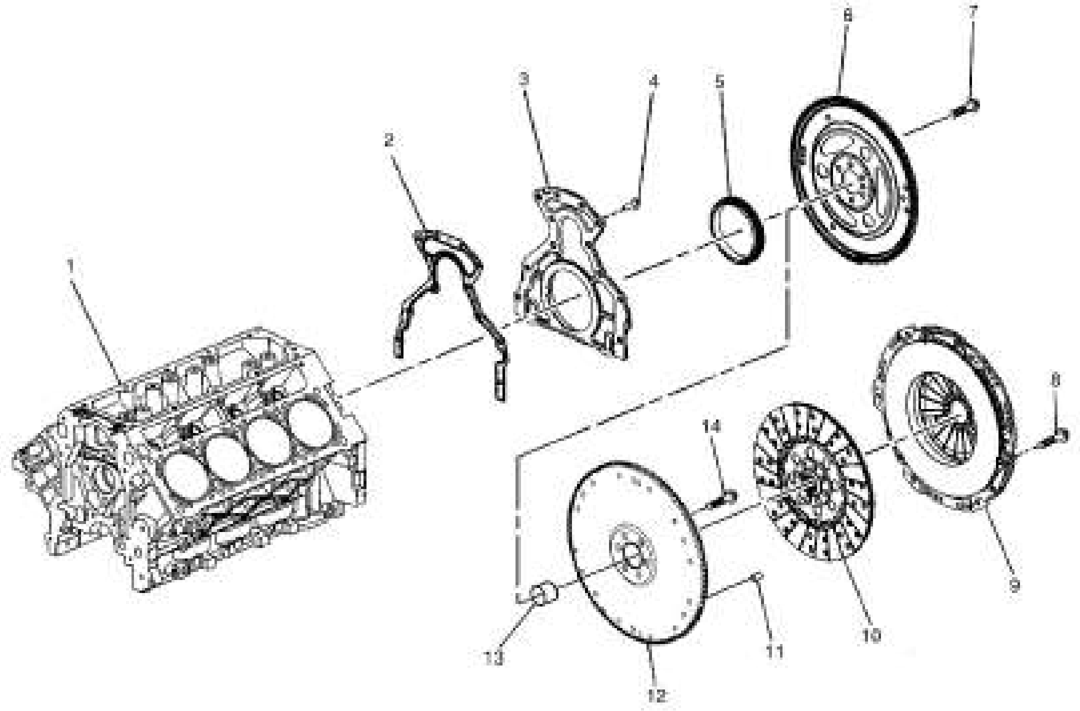
(1) Thermostat Housing
(2) Thermostat
(3) Water Pump
(4) Water Pump Gasket
(5) Water Pump Retaining Bolt
(6) Thermostat Housing Retaining Bolt
(7) Oil Level Indicator O-Ring
(8) Oil Level Indicator
(9) Oil Level Indicator Tube Retaining Bolt
(10) Oil Level Indicator Tube
(11) Oil Level Indicator Tube O-Ring

(12) Engine Block
(13) Camshaft Bearings
(14) Camshaft
(15) Camshaft Sprocket Locating Pin
(16) Crankshaft Sprocket
(17) Timing Chain
(18) Camshaft Position (CMP) Sensor O-Ring Seal
(19) CMP Sensor
(20) Crankshaft Balancer Retaining Bolt
(21) Crankshaft Balancer
(22) Crankshaft Front Oil Seal
(23) CMP Sensor Retaining Bolt
(24) Engine Front Cover Retaining Bolt
(25) Engine Front Cover
(26) Engine Front Cover Gasket
(27) Timing Chain Tensioner Bolt
(28) Timing Chain Tensioner
(29) Camshaft Retaining Bolt
(30) Camshaft Sprocket
(31) Camshaft Retainer Retaining Bolt
(32) Camshaft Retainer
(33) Oil Pump Retaining Bolt
(34) Oil Pump
(35) Oil Pump O-Ring Seal
(36) Oil Pump Suction Pipe
(37) Oil Pump Suction Pipe Retaining Nut
(38) Oil Pump Suction Pipe Retaining Bolt
(39) Oil Pressure Relief Valve
(40) Oil Pressure Relief Valve Spring
(41) Oil Pressure Relief Valve Bore Plug
(42) Oil Pump Driven Gear
(43) Oil Pump Drive Gear
(44) Oil Pump Cover
(45) Oil Pump Cover Bolt

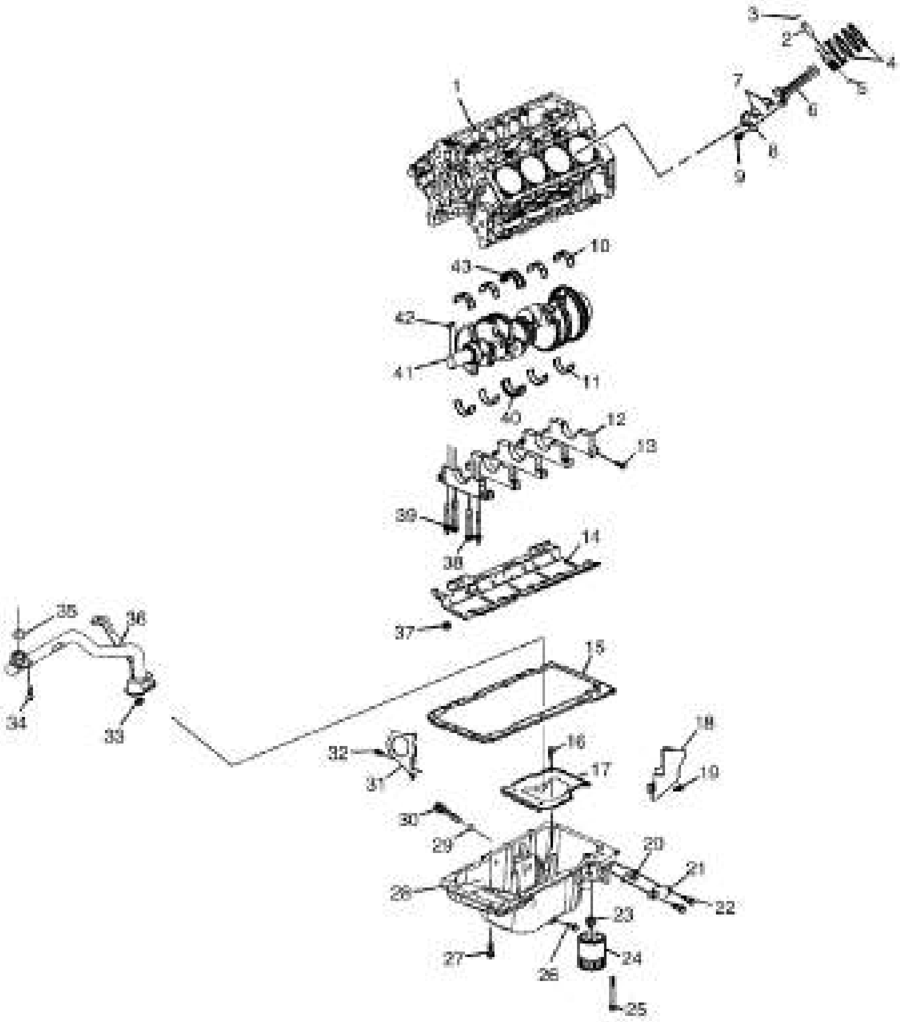
Rear of Engine



(1) Engine Block
(2) Crankshaft Rear Oil Seal Housing Gasket
(3) Crankshaft Rear Oil Seal Housing
(4) Crankshaft Rear Oil Seal Housing Retaining Bolt
(5) Crankshaft Rear Oil Seal
(6) Flex Plate - Automatic Transmission
(7) Flex Plate - Automatic Transmission Retaining Bolt
(8) Clutch Pressure Plate Retaining Bolt - Manual Transmission
(9) Clutch Pressure Plate - Manual Transmission
(10) Clutch Plate - Manual Transmission
(11) Clutch Pressure Plate Locating Pin - Manual Transmission

(12) Flywheel - Manual Transmission
(13) Clutch Pilot Bearing - Manual Transmission
(14) Flywheel Retaining Bolt - Manual Transmission

Lower Engine Assembly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(100) Engine Block
(2) Piston Pin
(3) Piston Pin Retainer
(4) Piston Ring Set
(5) Piston
(6) Connecting Rod
(7) Connecting Rod Bearing
(8) Connecting Rod Cap
(9) Connecting Rod Bolt
(10) Crankshaft Bearing
(11) Crankshaft Bearing

(12) Crankshaft Bearing Cap
(13) Crankshaft Bearing Cap Bolt - M8
(14) Crankshaft Oil Deflector
(15) Oil Pan Gasket
(16) Oil Pan Baffle Retaining Bolt
(17) Oil Pan Baffle
(18) Left Side Close Out Cover
(19) Left Side Close Out Cover Retaining Bolt
(20) Oil Pan Cover Gasket
(21) Oil Pan Cover
(22) Oil Pan Cover Retaining Bolt
(23) Oil Filter Fitting
(24) Oil Filter
(25) Oil Pan Retaining Bolt
(26) Oil Pan Drain Plug
(27) Oil Pan Retaining Bolt
(28) Oil Pan
(29) Engine Oil Level Indicator Switch O-Ring
(30) Engine Oil Level Indicator Switch
(31) Right Side Close Out Cover
(32) Right Side Close Out Cover Retaining Bolt
(33) Oil Pump Suction Pipe Retaining Nut
(34) Oil Pump Suction Pipe Retaining Bolt
(35) Oil Pump O-Ring Seal
(36) Oil Pump Suction Pipe
(37) Crankshaft Oil Deflector Retaining Nut
(38) Crankshaft Bearing Cap Bolt - M10
(39) Crankshaft Bearing Cap Stud - M10
(40) Crankshaft Thrust Bearing
(41) Crankshaft
(42) Crankshaft Balancer Key
(43) Crankshaft Thrust Bearing

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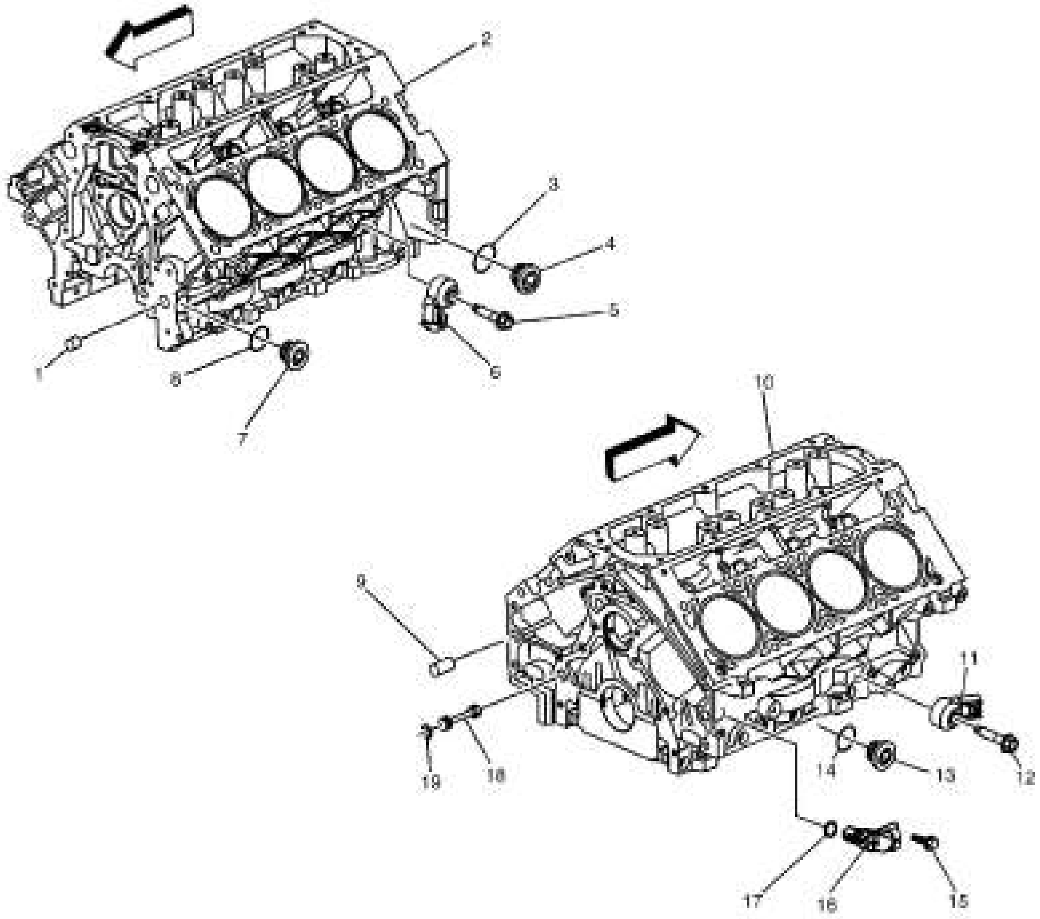
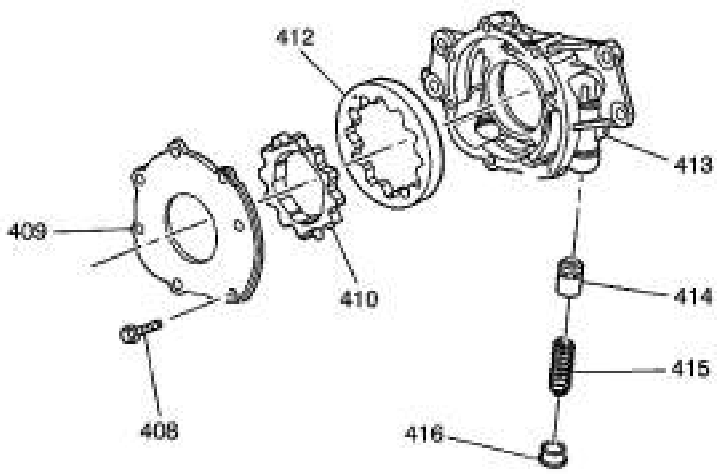
Engine Block Plugs/Sensors



(1) Oil Gallery Plug - Front
(2) Engine Block
(3) Oil Gallery Plug Washer - Side
(4) Oil Gallery Plug - Side
(5) Knock Sensor Retaining Bolt - Left
(6) Knock Sensor - Left
(7) Oil Gallery Plug - Side
(8) Oil Gallery Plug Washer - Side
(9) Transmission Housing Locating Pin
(10) Engine Block
(11) Knock Sensor - Right

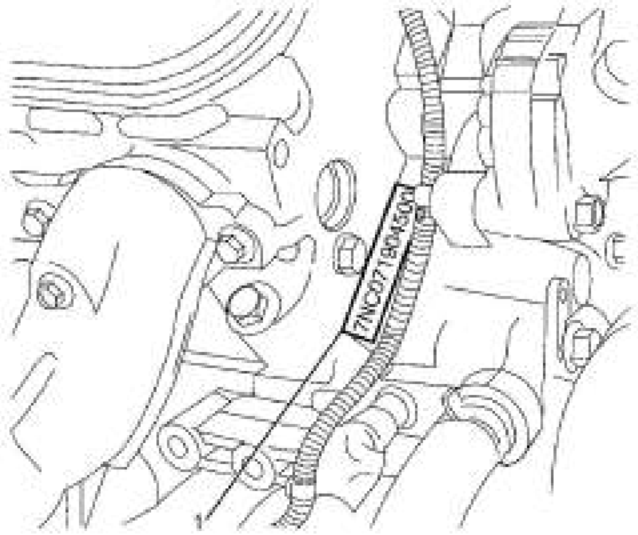
(12) Knock Sensor Retaining Bolt - Right
(13) Engine Block Coolant Drain Hole Plug
(14) Engine Block Coolant Drain Hole Plug Washer
(15) Crankshaft Position (CKP) Sensor Bolt
(16) CKP Sensor
(17) CKP Sensor O-Ring
(18) Oil Gallery Plug - Rear
(19) Oil Gallery Plug O-Ring - Rear

Oil Pump Assembly



(1) Oil Pump Housing Cover
(2) Oil Pump Driven Gear
(3) Oil Pump
(4) Oil Pump Pressure Relief Valve
(5) Oil Pump Pressure Relief Valve Spring
(6) Oil Pump Housing Plug
(7) Oil Pump Drive Gear
(8) Oil Pump Housing Cover Retaining Bolt

Engine Identification (L98, LS2)



The Engine Serial Number is located on the right-hand side at the front of the engine cylinder block (1) and is stamped or laser etched onto the block at the assembly plant. The number is prefixed by the engine model number. As an example 7NC is used. When reading the Engine Serial Number the following information can be obtained:

Engine Serial Number 7NC071904500 is used as an example:

- The first three digits, 7NC, identify the engine model.
- The next two digits, 07, identify the engine model year as 2007.
- The next three digits, 190, identify the Julian date the engine was manufactured as day 190.
- The next four digits, 4500, identify the assembly plant sequence number as 4500.

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Document ID: 2037292

Base Engine Misfire with Abnormal Internal Lower Engine Noises

Cause	Correction
Abnormalities, such as extreme cracking, bumps or missing areas in the accessory drive belt. Abnormalities in the accessory drive system and/or components may cause engine RPM variations, noises similar to a faulty lower engine and also lead to a misfire condition. A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to Drive Belt Replacement - Accessory.
Worn, damaged, or mis-aligned accessory drive components or above acceptable pulley runout. A misfire code may be present without an actual misfire condition.	Inspect the components and repair or replace, as required.
Loose or incorrectly installed engine flywheel or crankshaft balancer. A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer, as required. Refer to Engine Flywheel Replacement or Crankshaft Balancer Replacement.
Worn piston rings. Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. Refer to Spark Plug Inspection. • Inspect the cylinders for a loss of compression. Refer to Engine Compression Test. • Perform cylinder leak down and compression testing to identify the cause. Refer to Cylinder Leakage Test. • Repair or replace, as required.
Worn crankshaft thrust bearings. Severely worn thrust surfaces on the crankshaft and/or thrust bearing may permit fore and aft movement of the crankshaft and create a DTC without an actual misfire condition.	Replace the crankshaft and bearings, as required. Refer to Crankshaft and Bearing Removal.

Base Engine Misfire with Abnormal Valve Train Noise

Cause	Correction
Worn or loose rocker arms. The rocker arm bearing end caps and/or needle bearings should be intact within the rocker arm assembly.	Replace the valve rocker arms, as required. Refer to Base Engine Misfire with Abnormal Valve Train Noise.
Worn or bent pushrods.	Replace the pushrods, as required. Refer to Valve Rocker Arm and Push Rod Replacement.
Stuck valves. Carbon buildup on the valve stem can cause the valve not to close correctly.	Repair or replace, as required. Refer to Cylinder Head Disassemble.
A worn or mis-aligned timing chain above acceptable tolerances.	Replace the timing chain and sprockets, as required. Refer to Cylinder Head Disassemble.
Worn camshaft lobes	Replace the camshaft and valve lifters. Refer to Camshaft Replacement.
Sticking lifters	Replace the camshaft and valve lifters. Refer to Camshaft Replacement.

Base Engine Misfire with Coolant Consumption

Cause	Correction
Failed cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. Coolant consumption may or may not cause the engine to overheat.	• Perform a cylinder leak down test. Refer to Cylinder Leakage Test. • Inspect the cylinder heads and engine block for damage to the coolant passages and/or a faulty head gasket. Refer to Coolant in Combustion Chamber. • Repair or replace, as required.

Base Engine Misfire with Excessive Oil Consumption

Cause	Correction
Worn valves, valve guides and/or valve stem oil seals.	1. Inspect the spark plugs for oil deposits. Refer to Spark Plug Inspection. 2. Inspect the valves, valve guides and/or valve stem oil seals. Refer to Valve Stem Oil Seal and Valve Spring Replacement. 3. Repair or replace, as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. Refer to Spark Plug Inspection. • Inspect the cylinders for a loss of compression. Refer to Engine Compression Test. • Perform a cylinder leak down test. Refer to Cylinder Leakage Test. • Repair or replace, as required.

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Document ID: 2037291

Base Engine Misfire without Internal Engine Noises

Cause	Correction
Abnormalities, such as extreme cracking, bumps, or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations and lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to Drive Belt Replacement - Accessory .
Worn, damaged, or mis-aligned accessory drive components or above acceptable pulley runout May lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Inspect the components and repair or replace, as required.
Loose or incorrectly installed engine flywheel or crankshaft balancer. A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer, as required. Refer to Engine Flywheel Replacement or Crankshaft Balancer Replacement .
Restricted exhaust system. An extreme restriction in the exhaust flow can cause significant loss of engine performance and may set a DTC. Possible causes of restrictions include collapsed or dented pipes or plugged mufflers and/or catalytic converters.	Inspect the exhaust system for restrictions. Refer to Restricted Exhaust .
Incorrectly installed or damaged vacuum hoses.	Inspect the vacuum hose routing, Refer to Evaporative Emissions Hose Routing Diagram .
Incorrect sealing between the intake manifold and cylinder heads or throttle body.	Replace the intake manifold, gaskets, cylinder heads, and/or throttle body, as required. Refer to Intake Manifold Replacement .
Incorrectly installed or damaged MAP sensor. The sealing grommet of the MAP sensor should not be torn or damaged.	Repair or replace the MAP sensor, as required. Refer to Manifold Absolute Pressure Sensor Replacement
Worn or loose rocker arms. The rocker arm bearing end caps and/or needle bearings should be intact and the rocker arm in the correct position.	Replace the valve rocker arms, as required. Refer to Valve Rocker Arm and Push Rod Replacement .
Worn or bent pushrods.	Replace the valve rocker arms, as required. Refer to Valve Rocker Arm

	and Push Rod Replacement .
Stuck valves. Carbon buildup on the valve stem can cause the valve not to close correctly.	Repair or replace, as required. Refer to Cylinder Head Disassemble .
A worn or mis-aligned timing chain above acceptable tolerances.	Replace the timing chain and sprockets, as required. Refer to Camshaft Timing Chain and Sprocket Replacement .
Worn camshaft lobes.	Replace the camshaft and valve lifters. Refer to Camshaft Replacement .
Oil pressure above acceptable tolerances. A lubrication system with oil pressure above acceptable tolerances may lead to above acceptable valve lifter pump-up and loss of compression.	1. Perform an oil pressure test. Refer to Oil Pressure Diagnosis and Testing . 2. Repair or replace the oil pump, as required. Refer to Oil Pump, Screen, and Crankshaft Oil Deflector Replacement .
Failed cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. Coolant consumption may or may not cause the engine to overheat.	• Inspect for spark plugs saturated by coolant. Refer to Spark Plug Inspection . • Inspect the cylinder heads, engine block, and/or head gaskets. Refer to Coolant in Combustion Chamber . • Refer to Cylinder Head Replacement - Left Side . or Refer to Cylinder Head Replacement - Right Side . • Repair or replace, as required.
Worn piston rings. Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. Refer to Spark Plug Inspection . • Inspect the cylinders for a loss of compression. Refer to Engine Compression Test . • Perform a cylinder leak down test. Refer to Cylinder Leakage Test . • Repair or replace, as required.
A damaged crankshaft reluctor wheel. A damaged crankshaft reluctor wheel can result in different symptoms depending on the severity and location of the damage. • Severe reluctor ring damage may exhibit	Replace the sensor and/or crankshaft, as required. Refer to Crankshaft and Bearing Removal . or Crankshaft Position Sensor

periodic loss of crankshaft position, stop delivering a signal, and then sync the crankshaft position. • Slight reluctor ring damage may exhibit no loss of crankshaft position and no misfire may occur. However, a P0300 DTC may be set.	Replacement .

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Document ID: 2038196

Coolant in Combustion Chamber

<table>
<tr><th>Cause</th><th>Correction</th></tr>
<tr><td colspan="2">DEFINITION: White smoke and/or coolant type odour above acceptable tolerances coming from the exhaust pipe may indicate coolant in the combustion chamber. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an over-temperature condition which may cause engine component damage.
1. A slower than normal cranking speed may indicate coolant entering the combustion chamber. Refer to Engine Will Not Crank - Crankshaft Will Not Rotate .
2. Remove the spark plugs and inspect for spark plugs saturated by coolant or coolant in the cylinder bore. Refer to Spark Plug Inspection .
3. Inspect by performing a cylinder leak-down test. During this test, above acceptable air bubbles within the coolant may indicate a faulty gasket or damaged component. Refer to Cylinder Leakage Test .
4. Inspect by performing a cylinder compression test. 2 cylinders side-by-side on the engine block, with low compression, may indicate a failed cylinder head gasket. Refer to Engine Compression Test .</td></tr>
<tr><td>Failed cylinder head gasket.</td><td>Replace the head gasket and components, as required. Refer to Cylinder Head Cleaning and Inspection and Cylinder Head Replacement - Left Side and Cylinder Head Replacement - Right Side .</td></tr>
<tr><td>Warped cylinder head.</td><td>Machine the cylinder head to the correct flatness, if applicable and replace the cylinder head gasket. Refer to Cylinder Head Cleaning and Inspection .</td></tr>
<tr><td>Cracked cylinder head.</td><td>Replace the cylinder head and gasket. Refer to Cylinder Head Replacement - Left Side
or
Refer to Cylinder Head Replacement - Right Side .</td></tr>
<tr><td>Cracked cylinder liner or engine block.</td><td>Replace the components, as required.</td></tr>
<tr><td>Cylinder head or engine block porosity.</td><td>Replace the components, as required.</td></tr>
</table>

Coolant in Engine Oil (L98, LS2)

Cause	Correction
DEFINITION: Foamy or discoloured oil or an engine oil overfill condition may indicate coolant entering the engine crankcase. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an over-temperature condition which may cause engine component damage. Contaminated engine oil and oil filter should be changed. 1. Inspect the oil for above acceptable foaming or an overfill condition. Oil diluted by coolant may not correctly lubricate the crankshaft bearings and may lead to component damage. Refer to Lower Engine Noise, Regardless of Engine Speed. 2. Inspect by performing a cylinder leak-down test. During this test, above acceptable air bubbles within the cooling system may indicate a faulty gasket or damaged component. Refer to Cylinder Leakage Test. 3. Inspect by performing a cylinder compression test. 2 cylinders side-by-side on the engine block with low compression may indicate a failed cylinder head gasket. Refer to Engine Compression Test.	
Failed cylinder head gasket	Replace the head gasket and components, as required. Refer to Cylinder Head Cleaning and Inspection and Cylinder Head Replacement - Left Side. Refer to Cylinder Head Replacement - Right Side.
Warped cylinder head.	Machine the cylinder head to the correct flatness, if applicable and replace the cylinder head gasket. Refer to Cylinder Head Cleaning and Inspection.
Cracked cylinder head.	Replace the cylinder head and gasket. Refer to Cylinder Head Replacement - Left Side or Cylinder Head Replacement - Right Side.
Cracked cylinder liner or engine block.	Replace the components, as required. Refer to Engine Block Disassemble in Engine Mechanical - 6.0L.
Cylinder head or engine block porosity.	Replace the components, as required. Refer to Engine Block Disassemble or Cylinder Head Replacement - Left Side or Cylinder Head Replacement - Right Side

Coolant in Engine Oil (LS3)

Cause	Correction
DEFINITION: Foamy or discolored oil or an engine oil overfill condition may indicate coolant entering the engine crankcase. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an overtemperature condition which may cause engine component damage. Contaminated engine oil and oil filter should be changed. 1. Inspect the oil for excessive foaming or an overfill condition. Oil diluted by coolant may not properly lubricate the crankshaft bearings and may lead to component damage. Refer to Lower Engine Noise, Regardless of Engine Speed. 2. Inspect by performing a cylinder leak-down test. During this test, excessive air bubbles within the cooling system may indicate a faulty gasket or damaged component. 3. Inspect by performing a cylinder compression test. 2 cylinders side-by-side on the engine block with low compression may indicate a failed cylinder head gasket. Refer to Engine Compression Test.	
Faulty external engine oil cooler	Replace the components, as required.
Faulty cylinder head gasket	Replace the head gasket and components, as required. Refer to Cylinder Head Cleaning and Inspection and Cylinder Head Replacement - Left Side or Cylinder Head Replacement - Right Side.
Warped cylinder head	Machine the cylinder head to proper flatness, if applicable, and replace the cylinder head gasket. Refer to Cylinder Head Cleaning and Inspection.
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components, as required.
Cylinder head, block, or manifold porosity	Replace the components, as required.

Crankcase Ventilation System Inspection / Diagnosis

Concern	Action
External oil leak.	Inspect for any of the following conditions: • Plugged positive crankcase ventilation (PCV). • Plugged or kinked PCV hose(s). • Damaged or incorrectly installed PCV or hose(s). • Above acceptable crankcase pressure.
Rough Idle.	Inspect for any of the following conditions: • Plugged PCV. • Plugged or kinked PCV hose(s). • Leaking (damaged) PCV or hose(s).
Stalling or slow idle speed.	Inspect for any of the following conditions: • Plugged PCV. • Plugged or kinked PCV hose(s). • Leaking (damaged) PCV or hose(s).
High idle speed.	Inspect for a leaking (damaged) PCV or hose(s).
Sludge in the engine.	Inspect for any of the following conditions: • Plugged PCV. • Plugged or kinked PCV hose(s).

Cylinder Leakage Test

Tools Required

J 35667-A Cylinder Head Leakdown Tester, or equivalent

Important: A leakage test may be performed in order to measure cylinder/combustion chamber leakage. High cylinder leakage may indicate one or more of the following conditions:

- Worn or burnt valves.
- Broken valve springs.
- Stuck valve lifters.
- Incorrect valve lash.
- Damaged piston.
- Worn piston rings.
- Worn or scored cylinder bore.
- Damaged cylinder head gasket.
- Cracked or damaged cylinder head.
- Cracked or damaged engine block.

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground negative cable.
2. Remove the spark plugs. Refer to Spark Plug Inspection.
3. Rotate the crankshaft to place the piston in the cylinder being tested at top dead centre (TDC) of the compression stroke.
4. Install the J 35667-A or equivalent.

   Important: It may be necessary to hold the crankshaft balancer bolt to prevent the crankshaft from rotating.

5. Apply compressed air pressure to the J 35667-A and adjust according to the manufacturers instructions.
6. Record the cylinder leakage value. Cylinder leakage that exceeds 25 percent is considered above acceptable and may require component service. In above acceptable leakage situations, inspect for the following conditions:
   - Air leakage noise at the throttle body or air inlet hose that may indicate a worn or burnt intake valve or a broken valve spring.
   - Air leakage noise at the exhaust system tail-pipe that may indicate a worn or burnt exhaust valve or a broken valve spring.
   - Air leakage noise from the crankcase, oil level indicator tube, or oil fill tube that may indicate worn piston rings, a damaged piston, a worn or scored cylinder bore, a damaged engine block or a damaged cylinder head.
   - Air bubbles in the cooling system may indicate a damaged cylinder head or a damaged cylinder head gasket.
7. Perform the leakage test on the remaining cylinders and record the values.

Diagnostic Starting Point - Engine Mechanical

Begin the system diagnosis by reviewing the Disassembled Views and Engine Component Descriptionand Lubrication Description and Drive Belt System Description. Reviewing the description and operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the description and operation information will also help you determine if the condition described by the customer is normal operation. Refer to Symptoms - Engine Mechanical, in order to identify the correct procedure for diagnosing the system and where the procedure is located.

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Drive Belt Chirping, Squeal, and Whine Diagnosis

Drive Belt Chirping Diagnosis

Diagnostic Aids

The chirping noise may be intermittent due to moisture on the drive belts or the accessory drive pulleys. in order to duplicate the customer concern, It may be necessary to spray a small amount of water onto the drive belts. If spraying water on the drive belts duplicates the symptom, cleaning the accessory drive pulleys may be the most probable solution.

A loose or incorrect installation of a body or suspension component, or other items on the vehicle may cause the chirping noise.

Test Description

The numbers below refer to the steps in the diagnostic table.

2. The chirping noise may not be engine related. This step is to verify that the engine is making the noise. If the engine is not making the noise do not proceed further in this table.
3. The noise may be an internal engine noise. Remove the drive belts and operate the engine for a few seconds, this will verify if the chirping noise is related to the drive belts or not. With the drive belts removed the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belts removed.
4. Inspect the drive belts for signs of pilling. Pilling is the small balls, pills, or strings in the drive belt grooves caused by the accumulation of rubber dust.
6. Misalignment of the accessory drive pulleys may be caused from incorrect mounting or incorrect installation of an accessory drive component, or the pulley may be bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across 2 or 3 pulleys. If a misaligned pulley is found refer to that accessory drive component for the correct removal and installation procedure for that pulley.
10. Inspection of the fasteners can address the possibility that a incorrect bolt, nut, spacer, or washer was installed.
12. Inspection the accessory drive pulleys should include inspecting for bends, dents or other damage to the pulleys that May prevent the drive belts from seating correctly in the pulley grooves or on the smooth surface of a pulley when the back side of the drive belt is used to drive the pulley.
14. Replacing the drive belts when it is not damaged or there is not above acceptable pilling will only be a temporary repair.

Step	Action	Yes	No

Notice: Refer to Belt Dressing Notice in the Preface section.

DEFINITION: The following items are indications of chirping:

- A high pitched noise that is heard once per revolution of the drive belts or an accessory drive pulley.
- Chirping may occur on cold damp start-up conditions and will subside once the vehicle reaches normal operating temperature.

1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical.
2	Verify that there is a chirping noise. Does the engine make the chirping noise?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement. 2. Operate the engine for no longer than 30-40 seconds. Does the chirping noise still exist?	Go to Engine Noise on Start-Up, but Only Lasting a Few Seconds or Upper Engine Noise, Regardless of Engine Speed or Lower Engine Noise, Regardless of Engine Speed.	Go to Step 4
4	Inspect for extreme drive belt pilling exceeding 1/3 of the drive belt groove depth. Do the drive belt grooves have pilling?	Go to Step 5	Go to Step 6
5	Clean the accessory drive pulleys with a suitable wire brush. Were the accessory drive pulleys cleaned?	Go to Step 14	--
6	Inspect for a misaligned accessory drive pulleys. Is there a misaligned accessory drive pulleys?	Go to Step 7	Go to Step 8
7	Replace and/or repair the misaligned accessory drive pulleys. Refer to Power Steering Pump Pulley Replacement. Refer to Drive Belt Idler Pulley Replacement or Drive Belt Tensioner Replacement - Accessory or Drive Belt Tensioner Replacement - Air Conditioning. Were the misaligned accessory drive pulleys replaced and/or repaired?	Go to Step 15	--
8	Inspect for a bent or cracked accessory drive brackets.		

	Did you find any bent or cracked accessory drive brackets?	Go to Step 9	Go to Step 10
9	Replace the bent and/or cracked accessory drive brackets. Refer to Compressor Mounting Bracket Replacement. Refer to Generator Bracket Replacement. Was the bent and/or cracked accessory drive brackets replaced?	Go to Step 15	--
10	Inspect for incorrect, loose, and/or missing fasteners. Were there any incorrect, loose, and/or missing fasteners found?	Go to Step 11	Go to Step 12
11	1. Replace any incorrect and/or missing fasteners. 2. Tighten any loose fasteners. Refer to Fastener Tightening Specifications. Were the fasteners replaced and/or tightened?	Go to Step 15	--
12	Inspect for a bent accessory drive pulleys. Refer to Power Steering Pump Pulley Replacement. Refer also to Drive Belt Idler Pulley Replacement or Drive Belt Tensioner Replacement - Accessory or Drive Belt Tensioner Replacement - Air Conditioning. Was a bent accessory drive pulleys found?	Go to Step 13	Go to Step 14
13	Replace the bent accessory drive pulleys. Refer to Power Steering Pump Pulley Replacement. Refer also to Drive Belt Idler Pulley Replacement or Drive Belt Tensioner Replacement - Accessory or Drive Belt Tensioner Replacement - Air Conditioning. Was the bent accessory drive pulleys replaced?	Go to Step 15	--
14	Replace the drive belts. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement. Was the drive belts replaced?	Go to Step 15	--
15	1. Clear any codes. 2. Run the engine in order to verify the repair. Does the chirping noise still exist?	Go to Step 3	System OK

Drive Belt Squeal Diagnosis

Diagnostic Aids

A loose or incorrect installation of the body, suspension component, or other items on the vehicle may cause the squealing noise.

If the noise is intermittent, verify that the accessory drive components, by varying their loads, are operating to their maximum capacity. An overcharged air conditioning (A/C) system, power steering system restriction, incorrect fluid, or a failing alternator are suggested items to inspect.

Test Description

The numbers below refer to the step numbers in the diagnostic table.

2. The squeal may not be engine related. This step is to verify that the engine is making the noise. If the engine is not making the noise, do not proceed further in this table.
3. The noise may be an internal engine noise. Remove the drive belts and operate the engine for a few seconds; this will verify if the squealing noise is related to the drive belts or an accessory drive component. With the drive belts removed, the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belts removed.
4. This test is to verify that an accessory drive component does not have a seized bearing. With the belts removed, test the bearings in the accessory drive components for smooth operation. Also, test the accessory drive components with the engine operating by varying the load on the accessory drive components to verify that the components are operating correctly.
5. This test is to verify that the drive belt tensioners are operating correctly. If the drive belt tensioners are not operating correctly, correct belt tension may not be achieved to keep the drive belt from slipping, which may cause a belt squeal noise.
6. This test is to verify that the drive belt is not too long, which May prevent the drive belt tensioners from operating correctly. Also, if an incorrect length drive belt was installed, it may not be routed correctly and may be turning an accessory drive component in the incorrect direction.
7. Misalignment of the accessory drive pulleys may be caused from incorrect mounting or incorrect installation of an accessory drive component, or the pulley may be bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves, across 2 or 3 pulleys. If a misaligned pulley is found, refer to that accessory drive component for the correct removal and installation procedure for that pulley.
8. Inspect the accessory drive pulleys to verify that they are the correct diameter or width. Using a known good vehicle, compare the pulley sizes.

Step	Action	Yes	No
Notice: Refer to Belt Dressing Notice in the Preface section. DEFINITION: The following items are indications of drive belt squeal:			

- A loud screeching noise that is caused by slipping drive belts; this is unusual for a drive belt with multiple ribs.
- The noise occurs when a heavy load is applied to the drive belts, such as an air conditioning (A/C) compressor engagement, snapping the throttle, or slipping on a seized pulley, or a faulty accessory drive component.

1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical.
2	Verify that there is a squealing noise. Does the engine make the squealing noise?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement. 2. Operate the engine for no longer than 30 - 40 seconds. Does the squealing noise still exist?	Go to Engine Noise on Start-Up, but Only Lasting a Few Seconds or Upper Engine Noise, Regardless of Engine Speed or Lower Engine Noise, Regardless of Engine Speed.	Go to Step 4
4	Inspect for a seized accessory drive component bearing or a faulty accessory drive component. Did you find and correct the condition?	Go to Step 9	Go to Step 5
5	Inspect the drive belt tensioner for correct operation. Refer to Drive Belt Tensioner Diagnosis. Did you find and correct the condition?	Go to Step 9	Go to Step 6
6	Check the drive belt is the correct length . Did you find and correct the condition?	Go to Step 9	Go to Step 7
7	Inspect for a misaligned pulleys. Did you find and correct the condition?	Go to Step 9	Go to Step 8
8	Inspect for an incorrect size pulley. Did you find and correct the condition?	Go to Step 9	--
	1. Install the drive belts. Refer		

9	to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement. 2. Clear any codes. 3. Run the engine in order to verify the repair. Does the squealing noise still exist?	--	System OK

Drive Belt Whine Diagnosis

Diagnostic Aids

The drive belts will not cause the whine. If the whine is intermittent, verify that it is not the accessory drive components by varying their loads, making sure they are operating to their maximum capacity. An overcharged air conditioning (A/C) system, a power steering system restriction, or the incorrect fluid, or a failing alternator are suggested items to inspect.

Test Description

The numbers below refer to the steps in the diagnostic table.

3. This test is to verify that the whine is being caused by the accessory drive components. Remove the drive belts and operate the engine for a few seconds, this will verify if the whining noise is related to the accessory drive component. With the drive belts removed the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belts removed.

4. The inspection should include checking the drive belt tensioner and the drive belt idler pulley bearings. The drive belts may have to be installed and the accessory drive components operated separately by varying their loads. Refer to the suspected accessory drive component for the correct removal and installation procedure.

Step	Action	Yes	No
Notice: Refer to Belt Dressing Notice in the Preface section. DEFINITION: A high pitched continuous noise that may be caused by an accessory drive component failed bearing.			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical.
2	Verify that there is a whining noise. Does the engine make the whining noise?	Go to Step 3	Go to Diagnostic Aids
	1. Remove the drive belts.		

3	Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement. 2. Operate the engine for no longer than 30 - 40 seconds. Does the whining noise still exist?	Go to Engine Noise on Start-Up, but Only Lasting a Few Seconds or Upper Engine Noise, Regardless of Engine Speed or Lower Engine Noise, Regardless of Engine Speed.	Go to Step 4
4	1. Inspect for a failed accessory drive component bearing. 2. Install the drive belts. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement. Did you find and correct the condition?	Go to Step 5	--
5	1. Clear any codes. 2. Run the engine in order to verify the repair. Does the whining still exist?	--	System OK

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Drive Belt Falls Off and Excessive Wear Diagnosis

Drive Belt Falls Off Diagnosis

Diagnostic Aids

If the drive belts repeatedly fall off the accessory drive pulleys, this may be caused by pulley misalignment.

If the drive belts repeatedly fall off the accessory drive pulleys, this may be caused by pulley misalignment.

If the drive belts are the incorrect length, the drive belt tensioners may not maintain the correct tension on the drive belts.

Test Description

The numbers below refer to the steps in the diagnostic table.

2. This inspection is to verify the condition of the drive belts. Damage may have occurred to the drive belts when the drive belts fell off the pulley. Inspect the drive belts for cuts, tears, sections of ribs missing, or damaged belt plies.
4. Misalignment of the accessory drive pulleys may be caused from incorrect mounting or incorrect installation of an accessory drive component, or the pulley may be bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across 2 or 3 pulleys. If a misaligned pulley is found, refer to that accessory drive component for the correct removal and installation procedure of that pulley.
5. Inspection of the accessory drive pulleys should include inspecting for bends, dents or other damage that May prevent the drive belt from seating correctly in the pulley grooves or on the smooth surface of a pulley when the back side of the drive belts are used to drive the pulley.
6. Accessory drive component brackets that are bent or cracked will also cause the drive belts to fall off.
7. Inspection of the fasteners can address the possibility that an incorrect bolt, nut, spacer, or washer was installed. Missing, loose, or incorrect fasteners may cause pulley misalignment from the accessory drive brackets moving under load. Over tightening the fasteners may cause misalignment of the accessory component brackets.

Step	Action	Yes	No
Notice: Refer to Belt Dressing Notice in the Preface section. DEFINITION: The drive belts fall off the pulleys or may not ride correctly on the pulleys.			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary	Go to	Go to Symptoms - Engine

	inspections?	Step 2	Mechanical .
2	Inspect the drive belts for wear, damage, debris build-up and missing drive belt ribs. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement . Was a damaged drive belt found?	Go to Step 3	Go to Step 4
3	Install new drive belts. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement . Do the drive belts continue to fall off?	Go to Step 4	System OK
4	Inspect for misaligned drive pulleys. Did you find and correct the condition?	Go to Step 12	Go to Step 5
5	Inspect for a bent or dented accessory drive pulley. Did you find and correct the condition?	Go to Step 12	Go to Step 6
6	Inspect for a bent or a cracked accessory drive bracket. Did you find and correct the condition?	Go to Step 12	Go to Step 7
7	Inspect for incorrect, loose or missing fasteners. Were there any incorrect, loose and/or missing fasteners?	Go to Step 8	Go to Step 9
8	1. Replace any incorrect and/or missing fasteners. 2. Tighten any loose fasteners. Refer to Fastener Tightening Specifications. Does the drive belt continue to fall off?	Go to Step 9	System OK
9	Inspect the drive belt tensioner for correct operation. Refer to Drive Belt Tensioner Diagnosis . Does the drive belt tensioner operate correctly?	Go to Step 11	Go to Step 10
10	Replace the drive belt tensioner. Refer to Drive Belt Tensioner Replacement - Accessory or Drive Belt Tensioner Replacement - Air Conditioning . Does the drive belt continue to fall off?	Go to Step 11	System OK
11	Inspect for a failed drive belt idler and drive belt tensioner pulley bearing. Refer to Drive Belt Tensioner Diagnosis . Did you find and repair the condition?	Go to Step 12	--
12	Run the engine in order to verify the repair. Does the drive belt still fall off?	--	System OK

Drive Belt Excessive Wear Diagnosis

Diagnostic Aids

Above acceptable wear on a drive belt is usually caused by incorrect installation or the wrong drive belts for the application.

Minor misalignment of the drive belt pulleys will not cause above acceptable wear, but will probably cause the drive belts to make a noise or to fall off the pulleys.

Major misalignment of the drive belt pulleys will cause above acceptable wear and may also make the drive belts fall off the pulleys.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. The inspection is to verify that the drive belts are correctly installed over all of the drive belt pulleys. Wear on the drive belts may be caused by misalignment the drive belts by one groove on a pulley.
3. The installation of a drive belt that is to wide or to narrow will cause wear on the drive belts. The drive belt ribs should match all of the grooves on the pulleys.
4. This inspection is to verify the drive belts is not contacting any parts of the engine or body while the engine is operating. There should be sufficient clearance when the drive belt accessory drive components load varies. The drive belts should not come in contact with an engine or a body component when snapping the throttle.

Step	Action	Yes	No
Notice: Refer to Belt Dressing Notice in the Preface section. DEFINITION: Wear at the outside ribs of the drive belts due to an incorrectly installed drive belts			
1	Did you review the Symptoms - Engine Mechanical diagnostic information and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical .
2	Inspect the drive belts for the correct installation. Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement . Did you find this condition?	Go to Step 5	Go to Step 3
3	Inspect for the correct drive belt. Did you find this condition?	Go to Step 5	Go to Step 4
4	Inspect for the drive belt rubbing against a bracket, hose, or wiring harness. Did you find and repair the condition?	Go to Step 6	Go to Diagnostic Aids
5	Replace the drive belt. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement .		

	Did you complete the replacement?	Go to Step 6	--
6	Run the engine in order to verify the repair. Is there still above acceptable drive belt wear?	--	System OK

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Drive Belt Rumbling and Vibration Diagnosis

Drive Belt Rumbling Diagnosis

Diagnostic Aids

Vibration from the engine operating may cause a body component or another part of the vehicle to produce a rumbling noise.

The drive belts may have a condition that can not be seen or felt. Sometimes replacing the drive belts may be the only repair for the symptom.

If after replacing the drive belts and completing the diagnostic table, the noise is only heard with the drive belts installed, there might be an accessory drive component inoperative. Varying the load on the accessory drive components may aid in identifying which accessory drive component is causing the rumbling noise.

Test Description

The numbers below refer to the steps in the diagnostic table.

2. This test is to verify that the symptom is present during diagnosing. Other vehicle components may cause a similar symptom.

3. This test is to verify that the drive belts are causing the rumbling. Rumbling may be confused with an internal engine noise due to the similarity in the description. Remove only one drive belt at a time if the vehicle has multiple drive belts. Operate the engine for a few seconds, this will verify if the rumbling noise is related to the drive belts or not. With the drive belts removed the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belts removed.

4. Inspect the drive belts to ensure that the drive belts are not the cause of the noise. Small cracks across the ribs of the drive belts will not cause the noise. Belt separation is identified by the plies of the belt separating, this may be seen at the edge of the belt or felt as a lump in the belt.

5. Small amounts of pilling is a normal condition and acceptable. When the pilling is extreme the drive belts does not have a smooth surface for correct operation.

Step	Action	Yes	No
Notice: Refer to Belt Dressing Notice in the Preface section. DEFINITION: • A low pitch tapping, knocking, or thumping noise heard at or just above idle. • Heard once per revolution of the drive belts or pulleys.			

- Rumbling may be caused from:
  - Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belts pulley groove.
  - The separation of the drive belts.
  - A damaged drive belt.

1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical.
2	Verify that there is a rumbling noise. Does the engine make the rumbling noise?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belts. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement. 2. Operate the engine for no longer than 30 - 40 seconds. Does the rumbling noise still exist?	Go to Engine Noise on Start-Up, but Only Lasting a Few Seconds or Upper Engine Noise, Regardless of Engine Speed or Lower Engine Noise, Regardless of Engine Speed.	Go to Step 4
4	Inspect the drive belts for damage, separation, or sections of missing ribs. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement. Were any of these conditions found?	Go to Step 7	Go to Step 5
5	Inspect for extreme pilling of more than 1/3 of the drive belt groove depth. Do the drive belt grooves have pilling?	Go to Step 6	Go to Step 7
6	1. Clean the drive belt pulleys using a suitable wire brush. 2. Install the drive belts. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement. Did you complete the repair?	Go to Step 8	Go to Step 7
7	Install a new drive belt. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement. Did you complete the replacement?	Go to Step 8	--
8	1. Clear any codes. 2. Run the engine in order to verify the repair.		

	Does the rumbling noise still exist?	--	System OK

Drive Belt Vibration Diagnosis

Diagnostic Aids

The accessory drive components may have an affect on engine vibration. An overcharged air conditioning (A/C) system, a power steering system restriction, or the incorrect fluid, or an extra load placed on the alternator are suggested items to inspect. To help identify an intermittent or an incorrect condition, vary the loads on the accessory drive components.

Test Description

The numbers below refer to the steps in the diagnostic table.

2. This test is to verify that the vibration is present during diagnosing. Other vehicle components may cause a similar symptom such as the exhaust system or the drivetrain.
3. This test is to verify that the drive belts or accessory drive components may be causing the vibration. Remove the drive belts and operate the engine for a few seconds, this will verify if the vibration is related to the drive belts or not. With the drive belts removed the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belts removed.
4. The drive belts may cause a vibration. While the drive belts are removed this is the best time to inspect the condition of the drive belts.
6. Inspection of the fasteners can address the possibility that a incorrect bolt, nut, spacer, or washer was installed.
9. Inspect the water pump drive shaft for being bent. Also inspect the water pump bearings for smooth operation and above acceptable play. Compare the water pump with a known, good water pump.
10. Accessory drive component brackets that are bent, cracked, or loose may put an extra strain on that accessory component causing it to vibrate.

Step	Action	Yes	No
Notice: Refer to Belt Dressing Notice in the Preface section. DEFINITION: The following items are indications of drive belt vibration: • The vibration is engine-speed related. • The vibration may be sensitive to accessory load.			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical .
2	Verify that the vibration is engine related.		

	Does the engine make the vibration?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belts. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement . 2. Operate the engine for no longer than 30 - 40 seconds. Does the engine still make the vibration?	Go to Drive Belt Rumbling and Vibration Diagnosis .	Go to Step 4
4	Inspect the drive belts for wear, damage, debris build-up and missing drive belt ribs. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement . Were any of these conditions found?	Go to Step 5	Go to Step 6
5	Install new drive belts. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement . Did you complete the replacement?	Go to Step 11	--
6	Inspect for incorrect, loose or missing fasteners. Were any of these conditions found?	Go to Step 7	Go to Step 8
7	1. Replace the incorrect or missing fasteners. 2. Tighten any loose fasteners. Refer to Fastener Tightening Specifications . Were the fasteners replaced and/or tightened?	Go to Step 11	--
8	Inspect for a bent water pump drive shaft. Refer to Water Pump Cleaning and Inspection . Did you find and correct the condition?	Go to Step 11	Go to Step 9
9	Inspect for a bent or cracked accessory drive brackets. Did you find and correct the condition?	Go to Step 10	--
10	Replace the bent and/or cracked accessory drive brackets. Refer to Compressor Mounting Bracket Replacement . Refer to Generator Bracket Replacement . Was the bent and/or cracked accessory drive brackets replaced?	Go to Step 11	--
11	1. Clear any codes. 2. Run the engine in order to verify the repair. Does the vibration still exist?	--	System OK

Drive Belt Tensioner Diagnosis

Notice: Allowing the drive belt tensioner to snap into the free position may result in damage to the tensioner.

Important: When the engine is operating, the belt tensioner arm will move. Do not replace the belt tensioner because of movement in the belt tensioner arm.

1. Remove the drive belt. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor Belt Replacement.
2. Position a hex-head socket on the belt tensioner pulley bolt.
3. Move the belt tensioner through its full travel.
   - The movement should feel smooth.
   - There should be no binding.
   - The belt tensioner should return freely.
4. If any binding is observed, replace the drive belt tensioner. Refer to Drive Belt Tensioner Replacement - Accessory or Drive Belt Tensioner Replacement - Air Conditioning.
5. Install the drive belt. Refer to Drive Belt Tensioner Replacement - Accessory or Drive Belt Tensioner Replacement - Air Conditioning.

Engine Balancing

During the powertrain build process, balance weights may be added to the crankshaft balancer and/or manual transmission flywheel, as required.

In order to maintain engine/clutch assembly balance, it may be necessary to install or remove balance weights as detailed below:

Crankshaft Balancer

- Existing RPO-LS3/LS7 balancer onto existing engine: The balancer position must be marked prior to removal and installed to the original position. Refer to Crankshaft Balancer Removal.
- Existing RPO-LS9 balancer onto existing engine: It is not necessary to mark the balancer prior to removal. The balancer is positioned by a key located in the front of crankshaft.
- New balancer onto an existing engine: Install the same size balance weights into the new balancer in the same location as the old balancer. Refer to Crankshaft Balancer Cleaning and Inspection.

Note:

Engine Flywheel

- The RPO-LS3/LS7 flywheel, clutch disc, and pressure plate are each individually balanced components and are available separately. The pressure plate mounts, or locates, onto the flywheel dowel pins in the flywheel. If the pressure plate is not aligned properly onto the dowel pins and tightened down, the pins may bend and the plate may be incorrectly positioned, which will affect component balance. Refer to Engine Flywheel Removal.
- The RPO-LS9 clutch discs and pressure plate are a balanced assembly and not available separately. The pressure plate mounts, or locates, onto the six flywheel dowel pins. If the pressure plate is not aligned properly onto the dowel pins and tightened down, the pins may bend and the plate may be incorrectly positioned, which will affect component balance.
- Existing flywheel, clutch, and pressure plate onto the existing engine: Pressure plate position to flywheel must be marked prior to removal and installed to the original position. Flywheel position to crankshaft must be marked prior to removal and installed to the original position. Refer to Engine Flywheel Removal.
- Existing flywheel, clutch, and pressure plate onto a new engine: Pressure plate position to flywheel must be marked prior to removal and installed to the original position. Flywheel position to crankshaft must be marked prior to removal and installed to the similar position on the new engine. Do not remove balance weights from flywheel, if applicable.
- New flywheel onto an existing engine: Install the same size balance weights into the new flywheel in the same location as the old flywheel. Install the new flywheel to a similar position on the new engine.
- New flywheel, clutch, and pressure plate onto a new engine: Do not install balance weights.

Engine Compression Test

1. Charge the battery if the battery is not fully charged.
2. Disable the ignition system.
3. Disable the fuel injection system.
4. Remove all spark plugs.
5. Turn the ignition to the ON position.
6. Depress the accelerator pedal to position the throttle plate wide open.
7. Start with the compression gauge at zero and while observing the gauge, crank the engine through 4 compression strokes. Record the reading and repeat for the remaining cylinders.

   Important: The minimum compression in any 1 cylinder should not be less than 70 percent of the highest cylinder. No cylinder should read less than 690 kPa (100 psi). For example, if the highest pressure in any 1 cylinder is 1035 kPa (150 psi), the lowest allowable pressure for any other cylinder is 725 kPa (105 psi). (1035 x 70% = 725) (150 x 70% = 105).

8. If a cylinder has low compression, inject approximately 15 ml (1 tablespoon) of engine oil into the combustion chamber through the spark plug hole. Measure the compression again and record the reading.
   - Normal - Compression builds up quickly and evenly to the specified compression for each cylinder.
   - Piston Rings Leaking - Compression is low on the first stroke. Compression builds up with the following strokes, but does not reach normal. Compression improves considerably when you add oil.
   - Valves Leaking - Compression is low on the first stroke. Compression usually does not build up on the following strokes. Compression does not improve much when you add oil.
   - If 2 adjacent cylinders have lower than normal compression, and injecting oil into the cylinders does not increase the compression, the cause may be a head gasket leaking between the cylinders.

Engine Noise on Start-Up, but Only Lasting a Few Seconds (L98, LS2)

Cause	Correction
Incorrect oil filter without anti-drainback feature.	Install the correct oil filter. Refer to Engine Oil and Oil Filter Replacement.
Incorrect oil viscosity.	Install the correct viscosity oil. Refer to Engine Oil and Oil Filter Replacement.
High valve lifter leak down rate.	Replace the lifters, as required. Refer to Cylinder Head Replacement - Right Side.
Worn crankshaft thrust bearing.	1. Check the crankshaft end play. Refer to Engine Mechanical Specifications. 2. Inspect the thrust bearing and crankshaft. Refer to Crankshaft and Bearing Cleaning and Inspection. 3. Repair or replace, as required. Refer to Crankshaft and Bearing Removal. or Refer to Crankshaft and Bearing Installation.

Engine Noise on Start-Up, but Only Lasting a Few Seconds (LS3)

Cause	Correction
Incorrect oil filter without anti-drainback feature	Install the correct oil filter.
Incorrect oil viscosity	1. Drain the oil. 2. Install the correct viscosity oil.
High valve lifter leak down rate	Replace the lifters as required.
Worn crankshaft thrust bearing	1. Check the crankshaft end play. 2. Inspect the thrust bearing and crankshaft. 3. Repair or replace as required.
Faulty oil filter bypass valve. The valve is now internal to the oil filter.	Replace the oil filter as required.

Engine Noise Under Load (L98, LS2)

Cause	Correction
Low oil pressure.	Perform an oil pressure test. Refer to Oil Pressure Diagnosis and Testing.
Detonation or spark knock.	Verify the correct operation of the ignition controls system. Refer to Diagnostic Starting Point - Engine Controls.
Loose torque converter bolts.	1. Inspect the torque converter bolts and flex plate. Refer to Flex Plate/Torque Converter Vibration Test for 5L40-E/5L50-E. or Refer to Flex Plate/Torque Converter Vibration Test for 6L50/6L80/6L90. 2. Repair or replace, as required. Refer to Torque Converter Replacement for 5L40-E/5L50-E. or Refer to Torque Converter Replacement for 6L50/6L80/6L90. or Refer to Engine Flywheel Replacement.
Cracked flywheel - automatic transmission.	Repair or replace the flywheel. Refer to Engine Flywheel Replacement.
Above acceptable connecting rod bearing clearance.	Inspect the following components and repair, as required: • The connecting rod bearings • The connecting rods • The crankshaft Refer to Piston, Connecting Rod, and Bearing Removal.
Above acceptable crankshaft bearing clearance.	Inspect the following components and repair, as required: • The crankshaft bearings • The crankshaft journals • The cylinder block crankshaft bearing bore Refer to Piston, Connecting Rod, and Bearing Removal.

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Engine Will Not Crank - Crankshaft Will Not Rotate

Cause	Correction
Seized accessory drive system component.	1. Remove the accessory drive belts. Refer to Drive Belt Replacement - Accessory . 2. Confirm that the engine will rotate. Rotate the crankshaft by hand at the crankshaft balancer or flywheel location. 3. Repair or replace the components, as required.
Seized automatic transmission torque converter.	1. Remove the torque converter-to-flywheel bolts. 2. Confirm that the engine will rotate. Rotate the crankshaft by hand at the crankshaft balancer or flywheel location. 3. Repair or replace the components, as required.
Broken timing chain.	1. Inspect the timing chain and gears. Refer to Camshaft Timing Chain and Sprocket Cleaning and Inspection . 2. Repair or replace the components, as required. Refer to Camshaft Timing Chain and Sprocket Replacement .
Seized timing chain or timing gears.	1. Inspect the timing chain and gears for foreign material or a seized chain. Refer to Camshaft Timing Chain and Sprocket Cleaning and Inspection . 2. Repair or replace the components, as required. Refer to Camshaft Timing Chain and Sprocket Replacement .
Seized or broken camshaft.	1. Inspect the camshaft and the camshaft bearings. Refer to Camshaft and Bearings Cleaning and Inspection . 2. Repair or replace the components, as required. Refer to Camshaft Replacement .
Bent valve in the cylinder head.	1. Inspect the valves and the cylinder heads. Refer to Cylinder Head Disassemble . 2. Repair or replace the components, as required. Refer to Cylinder Head Disassemble .
Seized oil pump.	1. Inspect the oil pump assembly. Refer to Oil Pump Cleaning and Inspection . 2. Repair or replace, as required. Refer to Oil Pump, Screen, and Crankshaft Oil Deflector Replacement .
Hydraulically locked cylinder. • Coolant/antifreeze in the cylinder. • Oil in the cylinder. • Fuel in the cylinder.	1. Inspect for spark plugs saturated by coolant. Refer to Spark Plug Inspection . 2. Remove spark plugs and check for fluid in the cylinder. When rotating the engine with the spark plugs removed, the piston, on compression stroke, will push fluid from the combustion chamber. Refer to Coolant in Combustion Chamber . 3. Inspect the spark plugs for oil deposits. Refer to Spark Plug Inspection . 4. Inspect for failed head gaskets. Perform a cylinder leak down test. Refer to Cylinder Leakage Test 5. Inspect for a cracked engine block or cylinder head. Refer to Engine Compression Test . 6. Inspect for a sticking fuel injector. Refer to Fuel Injector Replacement .

	7. Repair or replace the components, as required.
Material in the cylinder. • Broken valve. • Broken piston rings. • Piston material. • Foreign material.	1. Inspect the cylinder for damaged components and/or foreign materials. 2. Repair or replace the components, as required.
Seized crankshaft or connecting rod bearings.	1. Inspect crankshaft and connecting rod bearings. 2. Repair or replace the components, as required.
Bent or broken connecting rod.	1. Inspect the connecting rods. 2. Replace the piston and pin as an assembly, as required.
Broken crankshaft.	1. Inspect the crankshaft. 2. Repair or replace the components, as required.

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Lower Engine Noise, Regardless of Engine Speed (L98, LS2)

Cause	Correction
Worn valves, valve guides and/or valve stem oil seals.	1. Inspect the spark plugs for oil deposits. Refer to Spark Plug Inspection. 2. Inspect the valves, valve guides and/or valve stem oil seals. Refer to Valve Stem Oil Seal and Valve Spring Replacement. 3. Repair or replace, as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. Refer to Spark Plug Inspection. • Inspect the cylinders for a loss of compression. Refer to Engine Compression Test. • Perform a cylinder leak down test. Refer to Cylinder Leakage Test. • Repair or replace, as required.

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Oil Consumption Diagnosis

Checks	Causes
Above acceptable oil consumption, not due to leaks, is the use of 1 L (1 qt) or more of engine oil within 3200 kilometers (2,000 miles).	
Preliminary	The causes of above acceptable oil consumption may include the following conditions: • External oil leaks Refer to Oil Leak Diagnosis. • Incorrect oil level or incorrect reading of the oil level indicator. With the vehicle on a level surface, run the engine for a few minutes, allow adequate drain down time, 2 - 3 minutes, and check for the correct engine oil level. • Incorrect oil viscosity. Refer to the vehicle owners manual and use the recommended SAE grade and viscosity for the prevailing temperatures. • Continuous high speed driving and/or extreme usage. • Crankcase ventilation system restrictions or malfunctioning components. • Worn valve guides and/or valve stems. • Worn or incorrectly installed valve stem oil seals. • Piston rings broken, worn, or not seated correctly Allow adequate time for the rings to seat. Replace worn piston rings as necessary. • Piston and rings incorrectly installed or not fitted to the cylinder bore.

Oil Leak Diagnosis

Step	Action	Yes	No
Important: You can repair most fluid leaks by first visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. Once the leak is identified, determine the cause of the leak. Repair the cause of the leak as well as the leak itself.			
1	1. Operate the vehicle until it reaches normal operating temperature. 2. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 3. Wait 15 minutes. 4. Inspect for drippings. Are drippings present?	Go to Step 2	System OK
2	Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 3
3	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations: • Sealing surfaces. • Fittings. • Cracked or damaged components. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 4
4	1. Completely clean the entire engine and surrounding components. 2. Operate the vehicle for several kilometres (miles) at normal operating temperature and at varying speeds. 3. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 4. Wait 15 minutes. 5. Identify the type of fluid, and the approximate location of the leak. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 5
5	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations: • Sealing surfaces. • Fittings. • Cracked or damaged components. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 6

6	1. Completely clean the entire engine and surrounding components. 2. Apply an aerosol-type powder, baby powder, foot powder, etc. to the suspected area. 3. Operate the vehicle for several kilometres (miles) at normal operating temperature and at varying speeds. 4. Identify the type of fluid, and the approximate location of the leak, from the discolorations in the powder surface. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 7
7	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations: • Sealing surfaces. • Fittings. • Cracked or damaged components. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 8
8	Use the J 28428-E high-intensity black light kit in order to identify the type of fluid, and the approximate location of the leak. Refer to the manufacturer's instructions when using the tool. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 9
9	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations: • Sealing surfaces. • Fittings. • Cracked or damaged components. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	System OK
10	1. Inspect the engine for mechanical damage. Special attention should be shown to the following areas: • Higher than recommended fluid levels. • Higher than recommended fluid pressures. • Plugged or malfunctioning fluid filters or pressure bypass valves. • Plugged or malfunctioning engine ventilation system. • Incorrectly tightened or damaged fasteners. • Cracked or porous components. • Incorrect sealants or gaskets, where required. • Incorrect sealant or gasket installation. • Damaged or worn gaskets or seals.		

	- Damaged or worn sealing surfaces. 2. Inspect the engine for customer modifications. Is there mechanical damage, or customer changes to the engine?	Go to Step 11	System OK
11	Repair or replace all damaged components. Does the engine still leak oil?	Go to Step 1	System OK

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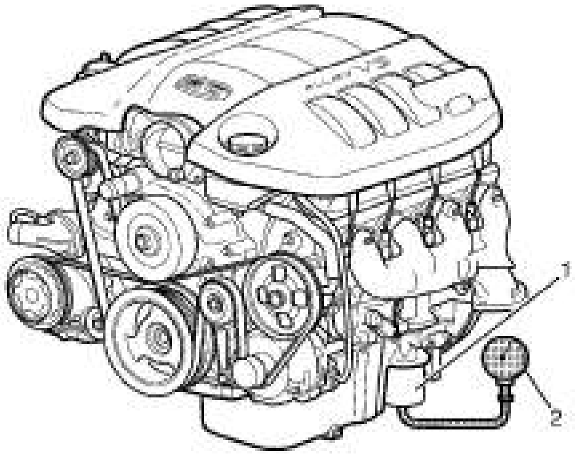
Oil Pressure Diagnosis and Testing (L98, LS2)

Tools Required

- J 21867 Pressure Gage
- EN-47971 Oil Pressure Gage Adapter

1. With the vehicle on a level surface, run the vehicle for a few minutes, allow adequate drain down time, 2 - 3 minutes, and measure the oil level.
2. If required, add the recommended grade engine oil and fill the crankcase until the oil level measures full on the oil level indicator.
3. Run the engine briefly, 10 - 15 seconds, and verify low or no oil pressure on the vehicle gauge or light.
4. Listen for a noisy valve train or a knocking noise.
5. Inspect for the following conditions:
    - Oil diluted by water or glycol anti freeze
    - Foamy oil



6. Remove the oil filter and install the EN-47971 (1).
7. Install J 21867 (2), or equivalent, to the EN-47971 (1).
8. Run the engine and measure the engine oil pressure.
9. Compare the readings to Engine Mechanical Specifications.
10. If the engine oil pressure is below specifications, inspect the engine for one or more of the following conditions:
    - Oil pump worn or dirty.
    - Refer to Oil Pump Cleaning and Inspection .
    - Oil pump-to-engine block bolts loose.

- Refer to Oil Pump, Screen and Crankshaft Oil Deflector Installation.
- Oil pump screen loose, plugged, or damaged. Refer to Oil Pump Cleaning and Inspection .
- Oil pump screen O-ring seal missing or damaged. Refer to Oil Pump Cleaning and Inspection .
- Oil filter loose or a leaking or damaged gasket. Refer to Oil Filter, Adapter, and Pan Cover Installation.
- Malfunctioning oil pump pressure relief valve. Refer to Oil Filter, Adapter, and Pan Cover Installation .
- Above acceptable bearing clearance. Refer to Engine Block Disassemble in Engine Mechanical - 6.0L
- Cracked, porous, or restricted oil galleries. Refer to Engine Block Disassemble in Engine Mechanical - 6.0L.
- Oil gallery plugs missing or incorrectly installed.
- Refer to Engine Block Assemble.
- Broken valve lifters. Refer to Valve Lifter Replacement.
- Repair as necessary.

11. If the oil pressure reading on the J 21867 (2), or equivalent, is within specifications, inspect for the following conditions:
    - Plugged or incorrect oil filter and/or malfunctioning oil filter bypass valve. Refer to Engine Oil and Oil Filter Replacement.
    - Malfunctioning engine oil pressure sensor or switch. Refer to Engine Oil Pressure Sensor and/or Switch Replacement.

Symptoms - Engine Mechanical

Strategy Based Diagnostics

1. Perform the Diagnostic System Check - Vehicle , before using the symptom tables, if applicable.
2. Review the system operations in order to familiarize yourself with the system functions. Refer to Disassembled Views and Engine Component Description and Lubrication Description and Drive Belt System Description.

All diagnosis on a vehicle should follow a logical process. Strategy based diagnostics is a uniform approach for repairing all systems. The diagnostic flow may always be used in order to resolve a system condition. The diagnostic flow is the place to start when repairs are necessary. For a detailed explanation, refer to Strategy Based Diagnosis.

Visual/Physical Inspection

- Inspect for aftermarket devices which may affect the operation of the Engine. Refer to Checking Aftermarket Accessories.
- Inspect the easily accessible or visible system components for obvious damage or conditions which may cause the symptom.
- Check for the correct oil level, correct oil viscosity, and correct oil filter.
- Verify the exact operating conditions under which the concern exists. Note factors such as engine RPM, ambient temperature, engine temperature, amount of engine warm-up time, and other specifics.
- Compare the engine sounds, if applicable, to a known good engine and make sure you are not trying to correct a normal condition.

Intermittent

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating correctly.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Base Engine Misfire without Internal Engine Noises.
- Base Engine Misfire with Abnormal Internal Lower Engine Noises.
- Base Engine Misfire with Abnormal Valve Train Noise.
- Base Engine Misfire with Coolant Consumption.
- Base Engine Misfire with Excessive Oil Consumption.
- Engine Noise on Start-Up, but Only Lasting a Few Seconds.
- Upper Engine Noise, Regardless of Engine Speed.

- Lower Engine Noise, Regardless of Engine Speed.
- Engine Noise Under Load.
- Engine Will Not Crank - Crankshaft Will Not Rotate.
- Coolant in Combustion Chamber.
- Coolant in Engine Oil.
- Engine Compression Test.
- Cylinder Leakage Test.
- Oil Consumption Diagnosis.
- Oil Pressure Diagnosis and Testing.
- Oil Leak Diagnosis.
- Drive Belt Chirping, Squeal, and Whine Diagnosis.
- Drive Belt Chirping, Squeal, and Whine Diagnosis.
- Drive Belt Chirping, Squeal, and Whine Diagnosis.
- Drive Belt Rumbling and Vibration Diagnosis.
- Drive Belt Rumbling and Vibration Diagnosis.
- Drive Belt Falls Off and Excessive Wear Diagnosis.
- Drive Belt Falls Off and Excessive Wear Diagnosis.
- Drive Belt Tensioner Diagnosis.

Upper Engine Noise, Regardless of Engine Speed (L98, LS2)

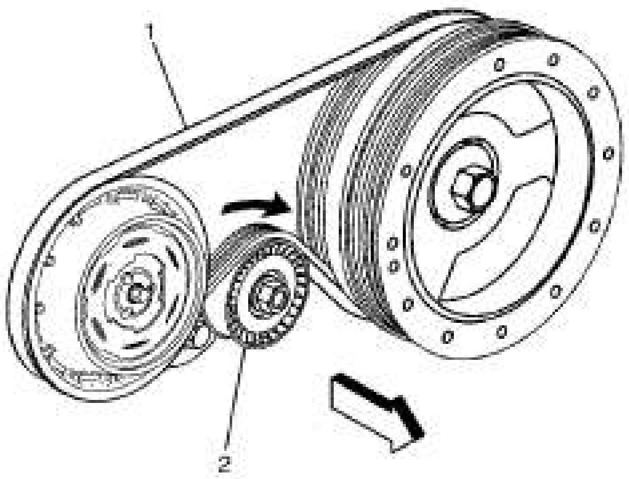
Cause	Correction
Low oil pressure.	Perform an oil pressure test. Refer to Oil Pressure Diagnosis and Testing.
Loose and/or worn valve rocker arm attachments.	1. Inspect the valve rocker arm, bolt, and pedestal. 2. Replace the valve rocker arms, as required. Refer to Valve Rocker Arm and Push Rod Replacement.
Worn or damaged valve rocker arm.	1. Inspect the rocker arm for wear or missing needle bearings 2. Replace the valve rocker arms, as required. Refer to Valve Rocker Arm and Push Rod Replacement.
Bent or damaged push rod.	Inspect the following components and replace, as required: - The valve rocker arm. Replace the valve rocker arms, as required. Refer to Valve Rocker Arm and Push Rod Replacement. - The valve push rod. Replace the valve push rods, as required. Refer to Valve Rocker Arm and Push Rod Replacement. - The valve lifter. Replace the camshaft and valve lifters. Refer to Camshaft Replacement. - The valve lifter guide. Replace the valve lifter guides. Refer to Valve Lifter Replacement. - Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly. Replace the piston and pin assembly. Refer to Piston, Connecting Rod, and Bearing Removal.
Incorrect lubrication to the valve rocker arms.	Inspect the following components and repair or replace, as required: - The valve rocker arm. Replace the valve rocker arms, as required. Refer to Valve Rocker Arm and Push Rod Replacement. - The valve push rod. Replace the valve push rods, as required. Refer to Valve Rocker Arm and Push Rod Replacement. - The valve lifter.

	Replace the camshaft and valve lifters. Refer to Camshaft Replacement. - The oil filter bypass valve. Replace the oil filter. Refer to Engine Oil and Oil Filter Replacement. - The oil pump and pump screen. Replace the oil pump and pump screen. Refer to Oil Pump, Screen, and Crankshaft Oil Deflector Replacement. - The engine block oil galleries. Refer to Engine Block Cleaning and Inspection.
Broken valve spring.	Replace the valve spring and spring shim. Refer to Valve Stem Oil Seal and Valve Spring Replacement.
Worn or dirty valve lifters.	Replace the valve lifters. Refer to Valve Lifter Replacement.
Stretched or broken timing chain and/or damaged sprocket teeth.	Replace the timing chain and sprockets. Refer to Camshaft Timing Chain and Sprocket Replacement.
Worn engine camshaft lobes.	1. Inspect the engine camshaft lobes. 2. Replace the camshaft and valve lifters, as required. Refer to Camshaft Replacement.
Worn valve guides or valve stems.	Inspect the following components and repair, as required: - The valves. Refer to Cylinder Head Disassemble. - The valve guides. Refer to Cylinder Head Disassemble.
Stuck valves. Carbon on the valve stem or valve seat may cause the valve to stay open.	Inspect the following components and repair, as required: - The valves. Refer to Cylinder Head Disassemble. - The valve guides. Refer to Cylinder Head Disassemble.

Air Conditioning Compressor Belt Replacement

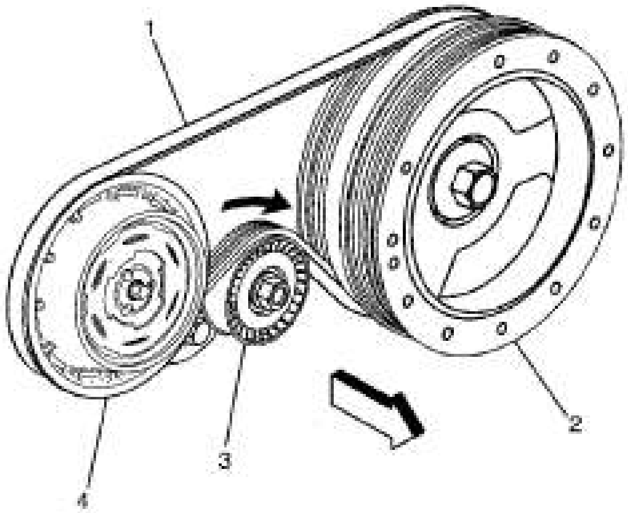
Removal Procedure

1. Remove the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
2. Raise the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Remove the Front Air Deflector. Refer to Front Air Deflector Replacement.



4. Using a suitable tool, rotate the air conditioner (A/C) belt tensioner (2) clockwise.
5. Remove the A/C belt (1).
6. Slowly release the A/C belt tensioner (2).
7. Clean and inspect the belt surfaces of all the pulleys.

Installation Procedure



1. Install the A/C belt (1) around the crankshaft balancer (2).
2. Using a suitable tool, rotate the A/C belt tensioner (3) clockwise.
3. Install the A/C belt (1) over the A/C belt tensioner (3) idler pulley.
4. Install the A/C belt (1) around the A/C compressor pulley (4).
5. Slowly release the tension on the A/C belt tensioner (3).
6. Inspect the A/C belt (1) for correct installation and alignment.
7. Install the Front Air Deflector. Refer to Front Air Deflector Replacement.
8. Lower the vehicle.
9. Install the accessory drive belt. Refer to Drive Belt Replacement - Accessory.

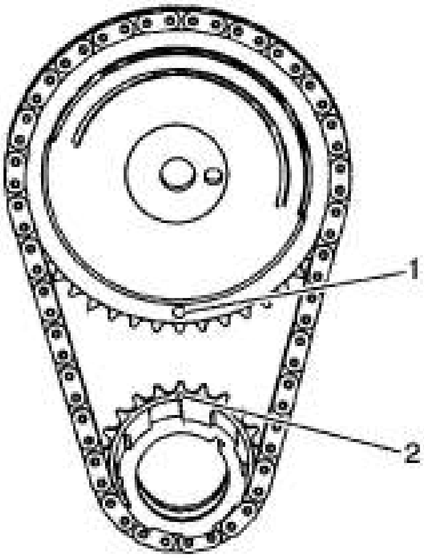
Camshaft Replacement

Tools Required

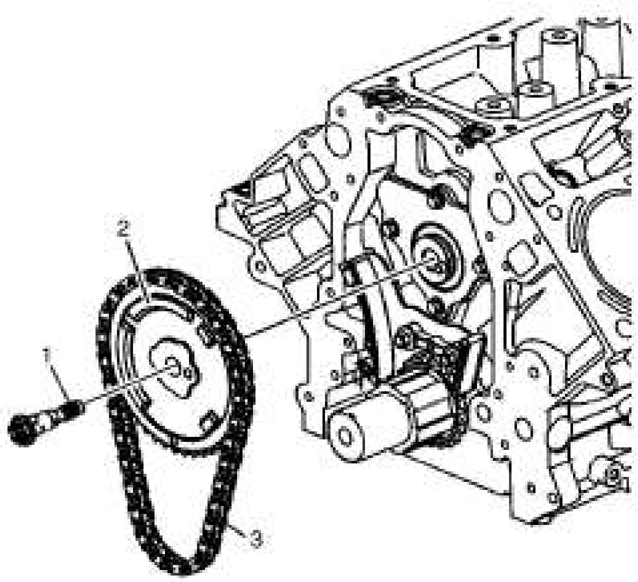
J 41476 J 41476 Front and Rear Cover Alignment Tool

Removal Procedure

1. Remove the engine assembly. Refer to Engine Replacement.
2. Remove the oil level indicator tube. Refer to Oil Level Indicator and Tube Removal.
3. Remove the left and right exhaust manifolds. Refer to Exhaust Manifold Replacement - Left Side and Exhaust Manifold Replacement - Right Side.
4. Remove the intake manifold. Refer to Intake Manifold Removal.
5. Remove the coolant air bleed pipe. Refer to Coolant Air Bleed Pipe Assembly Replacement.
6. Remove the left and right valve rocker arm covers. Refer to Valve Rocker Arm and Push Rod Replacement and Valve Stem Oil Seal and Valve Spring Replacement.
7. Remove the valve rocker arms and push rods. Refer to Oil Level Indicator and Tube Replacement.
8. Remove the left and right cylinder heads. Refer to Cylinder Head Replacement - Left Side and Cylinder Head Replacement - Right Side.
9. Remove the valve lifters. Refer to Valve Lifter Replacement.
10. Remove the water pump. Refer to Water Pump Removal.
11. Remove the crankshaft balancer. Refer to Crankshaft Balancer Removal.
12. Remove the engine front cover. Refer to Engine Front Cover Replacement.



13. Inspect the sprockets for correct alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.



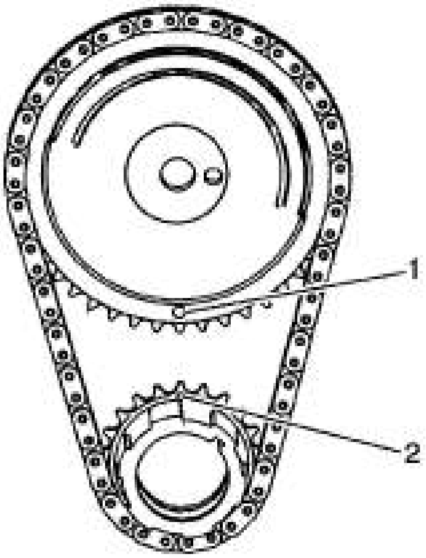
Notice: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

14. Remove the camshaft sprocket bolt (1).
15. Remove the camshaft sprocket (2) and timing chain (3).
16. Remove the camshaft. Refer to Camshaft Removal.

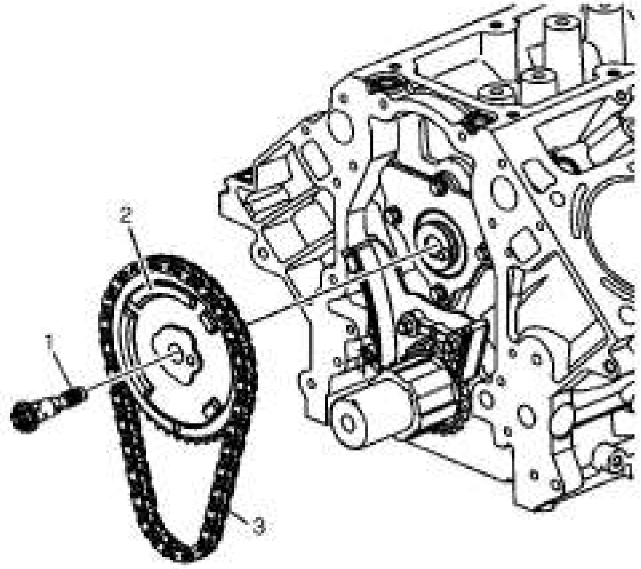
Installation Procedure

Important: If camshaft replacement is required, the valve lifters must also be replaced.

1. Install the camshaft. Refer to Camshaft Installation.



2. Align the camshaft sprocket alignment mark (1, 2), in the 6 o'clock position.



3. Install the camshaft sprocket (1) and timing chain (2).

   Notice: Refer to Fastener Notice in the Preface section.

4. Install the camshaft sprocket to camshaft retaining bolt (1).

   Tighten
   Tighten the bolt to 25 N·m(18 lb ft).

5. Install the engine front cover. Refer to Engine Front Cover Replacement.
6. Install a NEW crankshaft front oil seal. Refer to Crankshaft Front Oil Seal Installation.
7. Install the crankshaft balancer. Refer to Crankshaft Balancer Installation.
8. Install the valve lifters. Refer to Valve Lifter Replacement.
9. Install the right side and left side cylinder heads. Refer to Cylinder Head Installation - Left Side and Cylinder Head Installation - Right Side.
10. Install the valve rocker arms and push rods. Refer to Valve Rocker Arm and Push Rod Replacement.
11. Install the right and left valve rocker arm covers. Refer to Valve Rocker Arm Cover Replacement - Left Side and Valve Rocker Arm Cover Replacement - Right Side.
12. Install the coolant air bleed pipe. Refer to Coolant Air Bleed Pipe Assembly Replacement.
13. Install the intake manifold. Refer to Intake Manifold Installation.
14. Install the water pump. Refer to Water Pump Installation.
15. Install the left and right exhaust manifolds. Refer to Exhaust Manifold Replacement - Left Side and Exhaust Manifold Replacement - Right Side.
16. Install the oil level indicator tube. Refer to Oil Level Indicator and Tube Installation.
17. Install the engine assembly. Refer to Engine Replacement.

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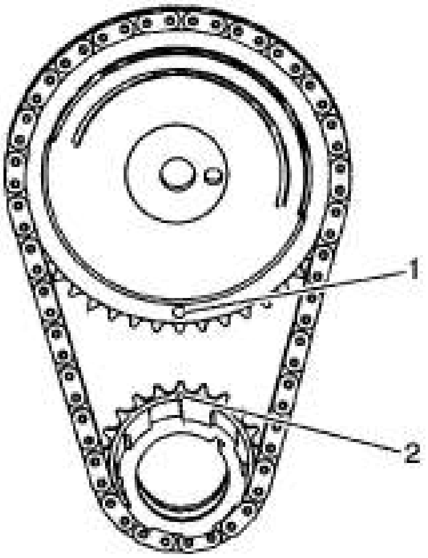
Camshaft Timing Chain and Sprocket Replacement

Tools Required

- EN 46330 EN 46330 Timing Chain Tensioner Retaining Pin
- J 8433-1 Puller Bar
- J 41478 Crankshaft Front Oil Seal Installer
- J 41558 Crankshaft Sprocket Remover
- J 41665 Crankshaft Balancer and Sprocket Installer
- J 41816-2 Crankshaft End Protector
- J 45059 Angle Meter

Removal Procedure

1. Remove the crankshaft balancer. Refer to Crankshaft Balancer Replacement.
2. Remove the engine front cover. Refer to Engine Front Cover Replacement.
3. Remove the oil pump. Refer to Oil Pump, Screen, and Crankshaft Oil Deflector Replacement.



Notice: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

4. Inspect the sprockets for correct alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.
5. Remove the timing chain and sprockets. Refer to Timing Chain and Sprocket Removal.

Installation Procedure

1. Install the timing chain and sprockets. Refer to Timing Chain and Sprocket Installation.
2. Install the oil pump. Refer to Oil Pump, Screen, and Crankshaft Oil Deflector Replacement.
3. Install the engine front cover. Refer to Engine Front Cover Replacement.
4. Install the crankshaft balancer. Refer to Crankshaft Balancer Replacement.

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Crankshaft Balancer Replacement

Tools Required

- J 41816-A Crankshaft Balancer Remover
- J 41816-2 Crankshaft End Protector
- J 42386-A Flywheel Holding Tool
- J 41665 Crankshaft Balancer and Sprocket Installer

Removal Procedure

1. Disconnect the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the radiator. Refer to Radiator Replacement.
3. Remove the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
4. Remove the air conditioning (A/C) drive belt. Refer to Air Conditioning Compressor Belt Replacement.
5. Remove the starter motor. Refer to Starter Motor Replacement.
6. Remove the crankshaft balancer. Refer to Crankshaft Balancer Removal.

Installation Procedure

1. Install the crankshaft balancer. Refer to Crankshaft Balancer Installation.
2. Install the starter motor. Refer to Starter Motor Replacement.
3. Install the air conditioning (A/C) drive belt. Refer to Air Conditioning Compressor Belt Replacement.
4. Install the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
5. Install the radiator. Refer to Radiator Replacement.
6. Connect the battery. Refer to Battery Negative Cable Disconnection and Connection.

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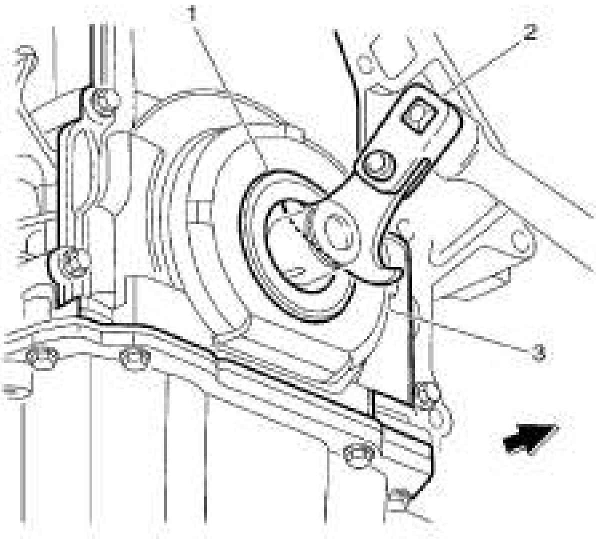
Crankshaft Front Oil Seal Replacement

Tools Required

- J 41478 Crankshaft Front Oil Seal Installer
- E-308 Crankshaft Front Oil Seal Remover.

Removal Procedure

1. Disconnect the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the radiator. Refer to Radiator Replacement.
3. Remove the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
4. Remove the air conditioning (A/C) drive belt. Refer to Air Conditioning Compressor Belt Replacement.
5. Remove the starter motor. Refer to Starter Motor Replacement.
6. Remove the crankshaft balancer. Refer to Crankshaft Balancer Removal.



7. Using tool E-308 (2) gently pry the crankshaft oil seal (1) from the front engine cover (3).

Installation Procedure

1. Install the crankshaft front oil seal installation. Refer to Crankshaft Front Oil Seal Installation.
2. Install the crankshaft balancer. Refer to Crankshaft Balancer Installation.
3. Install the starter motor. Refer to Starter Motor Replacement.
4. Install the air conditioning (A/C) drive belt. Refer to Air Conditioning Compressor Belt Replacement.
5. Install the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
6. Install the radiator. Refer to Radiator Replacement.
7. Connect the battery. Refer to Battery Negative Cable Disconnection and Connection.

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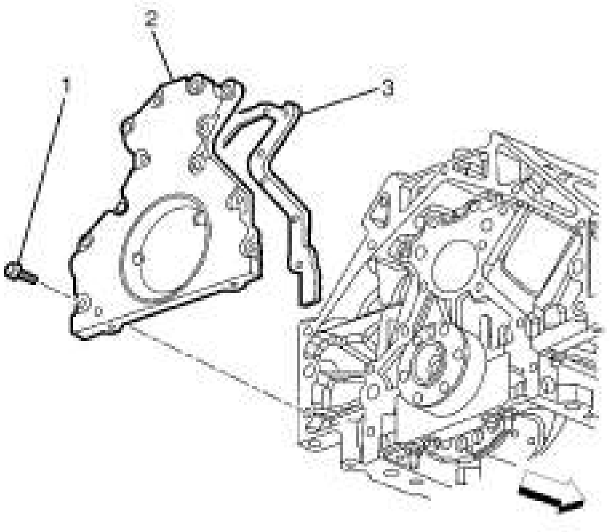
Crankshaft Rear Oil Seal Housing Replacement

Tools Required

- J 41476 Front and Rear Cover Alignment
- J 41479 Crankshaft Rear Oil Seal Installer

Removal Procedure

1. Remove the engine assembly. Refer to Engine Replacement .
2. Remove the oil pan. Refer to Oil Pan Replacement .
3. Remove the engine flywheel. Refer to Engine Flywheel Replacement .



4. Remove the engine rear cover to cylinder block retaining bolts (1).
5. Remove the engine rear cover (2) and engine rear cover gasket (3).
6. Discard the engine rear cover gasket (3).
7. Clean and inspect the engine rear cover (2). Refer to Engine Rear Cover Cleaning and Inspection .

Installation Procedure

1. Install the engine rear cover. Refer to Engine Rear Cover Installation .
2. Install the crankshaft rear seal. Refer to Crankshaft Rear Oil Seal Replacement .
3. Install the engine flywheel. Refer to Engine Flywheel Replacement .
4. Install the oil pan. Refer to Oil Pan Replacement .
5. Install the engine assembly. Refer to Engine Replacement .

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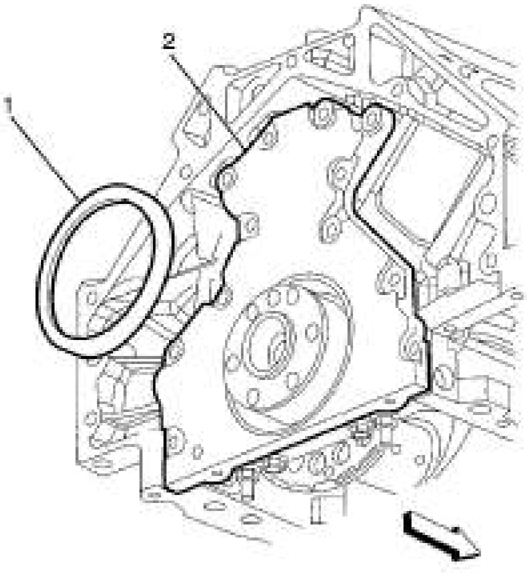
Crankshaft Rear Oil Seal Replacement

Tools Required

J 41479 Crankshaft Rear Oil Seal Installer

Removal Procedure

1. Remove the engine flywheel. Refer to Engine Flywheel Replacement.



2. Gently pry the crankshaft rear oil seal (1) from the rear cover (2).

Installation Procedure

1. Install the crankshaft rear seal. Refer to Crankshaft Rear Oil Seal Installation.
2. Install the engine flywheel. Refer to Engine Flywheel Replacement.

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Cylinder Head Replacement - Left Side

Tools Required

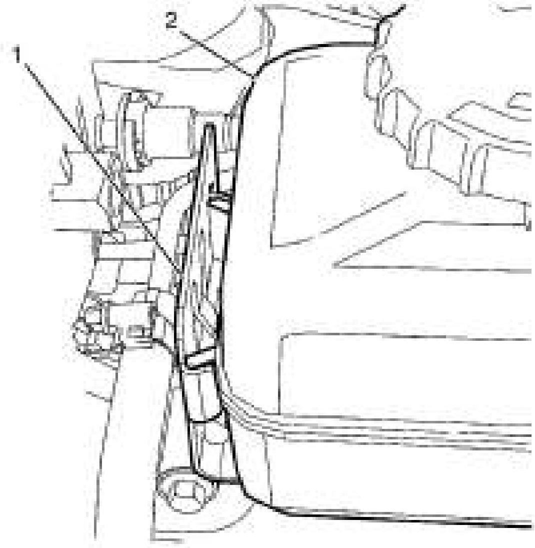
- J 45059 Angle Meter
- J 42385-100 Head/Main Bolt Thread Repair Kit

Removal Procedure

1. Remove the air inlet grille panel. Refer to Air Inlet Grille Panel Replacement.
2. Remove the engine cover. Refer to Engine Cover Replacement .
3. Depressurize the fuel system. Refer to Fuel Pressure Relief.

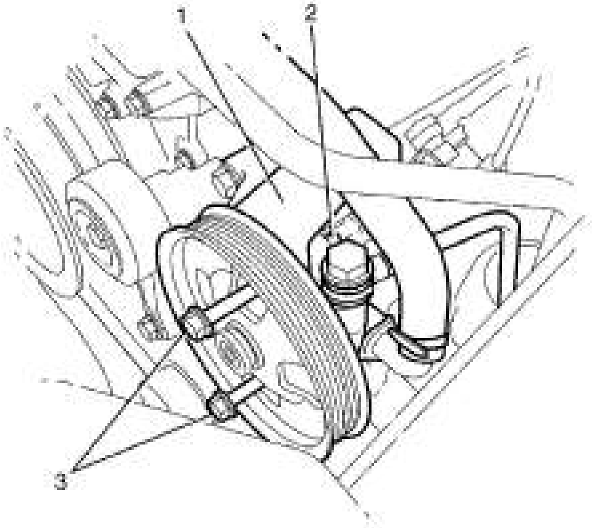
Caution: Refer to Battery Disconnect Caution in the Preface section.

4. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
5. Drain the cooling system. Refer to Cooling System Draining and Filling.
6. Remove the intake manifold assembly. Refer to Intake Manifold Replacement.
7. Remove the engine coolant air bleed pipe and cover. Refer to Engine Coolant Air Bleed Hose Replacement.
8. Remove the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
9. Remove the left side ignition coils. Refer to Ignition Coil Replacement .
10. Remove the spark plugs. Refer to Spark Plug Replacement.
11. Remove the left side exhaust manifold. Refer to Exhaust Manifold Replacement - Left Side.

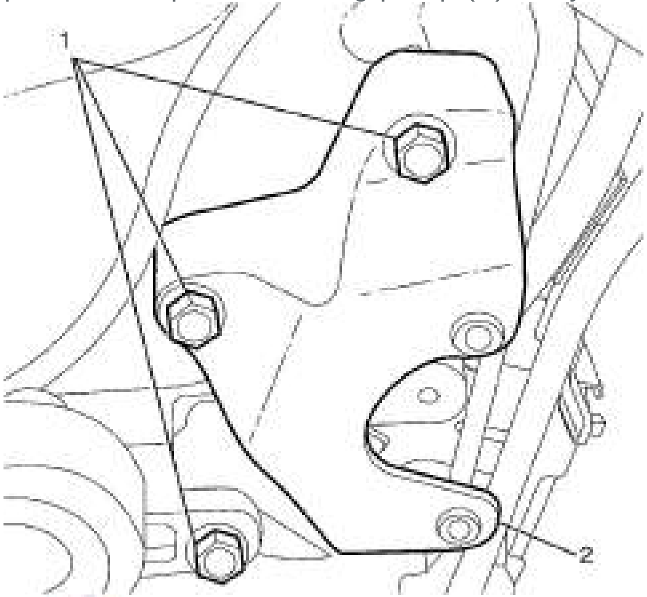


Important: The locking tang on the power steering reservoir bracket (1) must be released before removing the power steering reservoir (2).

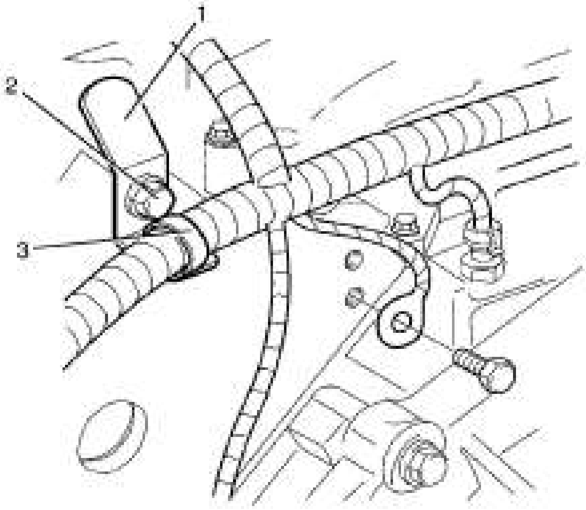
12. Remove the power steering reservoir (2) from the power steering pump power steering reservoir bracket (1) and position the power steering reservoir (2) aside.



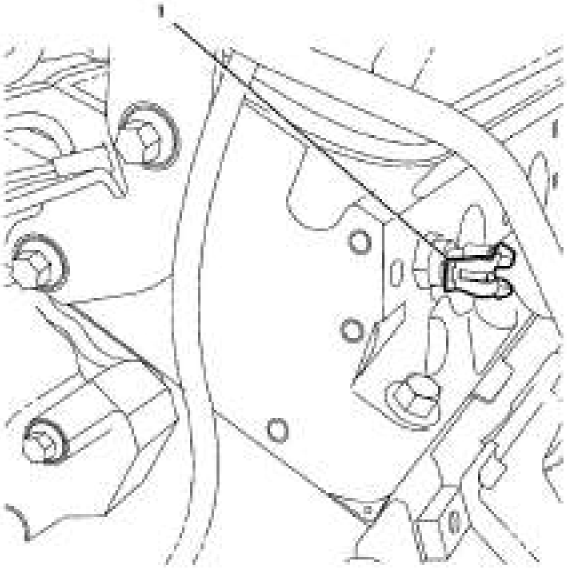
13. Remove the power steering pump (2) to power steering pump bracket retaining bolts (3) and position the power steering pump (2) away from the power steering pump bracket (1).



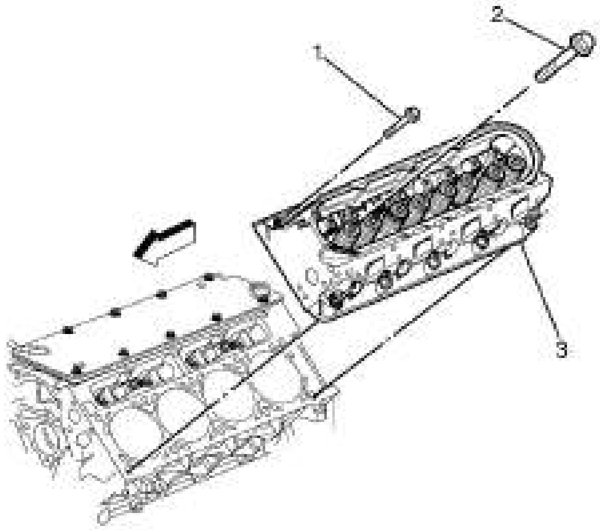
14. Remove the power steering pump bracket to engine retaining bolts (1).
15. Remove the power steering pump bracket (2).



16. Detach the powertrain wiring harness strap (3) from the rear cylinder head bracket (1).
17. Remove the powertrain wiring harness ground cable to cylinder head retaining bolt (2).



18. Disconnect the coolant temperature sensor electrical connector (1).
19. Remove the left side valve rocker arm cover. Refer to Valve Rocker Arm Cover Replacement - Left Side.
20. Remove the left side valve rocker arms and pushrods. Refer to Valve Rocker Arm and Push Rod Replacement.



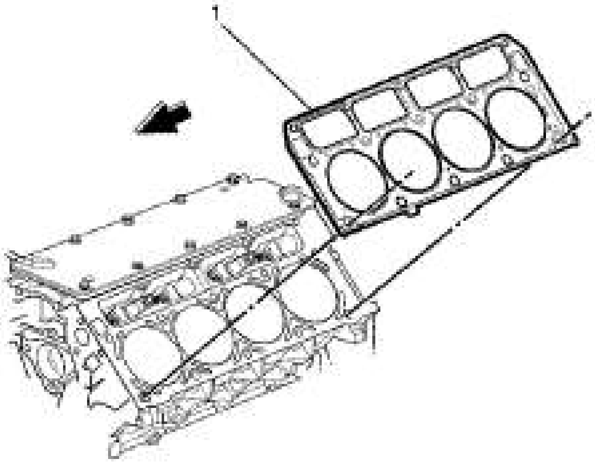
Important: The cylinder head bolts are torque to yield bolts and are single use only fasteners.

21. Remove and discard the cylinder head bolts (1) 10 places, (2) 5 places.

Discard the bolts.

Notice: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

22. Remove the cylinder head (3).



Important: Cylinder head gaskets must be discarded whenever the cylinder head has been removed from the cylinder block.

23. Remove the cylinder head gasket (1).

    Discard the gasket.

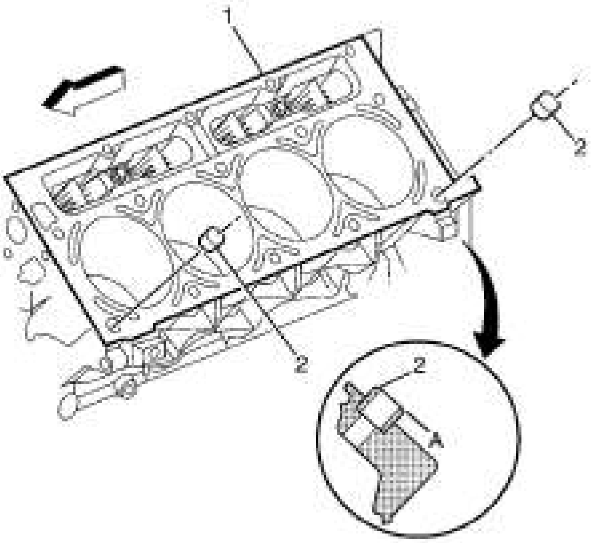
24. Clean and inspect the cylinder head and the cylinder block sealing surfaces. Refer to Cylinder Head Cleaning and Inspection and Engine Block Cleaning and Inspection.
25. If necessary, perform the following steps:

    Disassemble the cylinder head. Refer to Cylinder Head Disassemble.

Installation Procedure

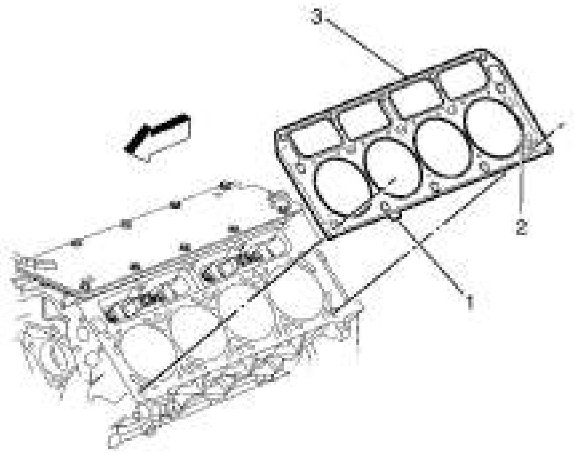
1. If necessary, perform the following steps:

   Assemble the cylinder head. Refer to Cylinder Head Assemble.



Important: Make sure the locating sleeves (2) are correctly installed to the maximum height (A) of 8.3 mm (0.33 in).

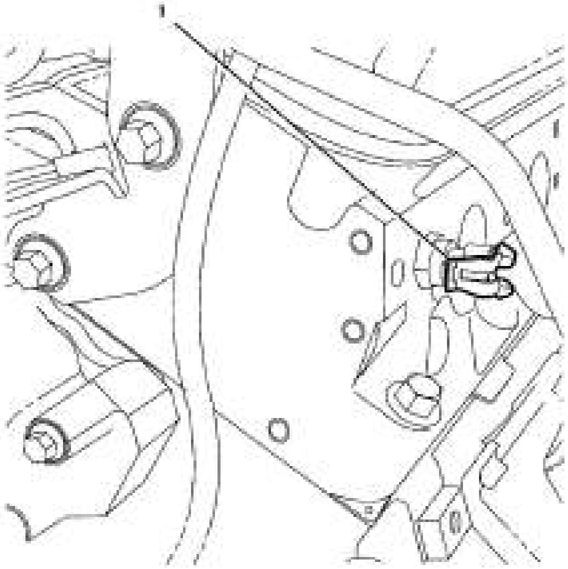
2. Install the locating sleeves (2) into the cylinder block (1).



Important: The cylinder head gasket (3) will fit on either side of the engine. Make sure the tab on the cylinder head gasket (1) is located towards the front half point and the stamping FRONT on the cylinder head gasket (2) is facing the front of the engine.

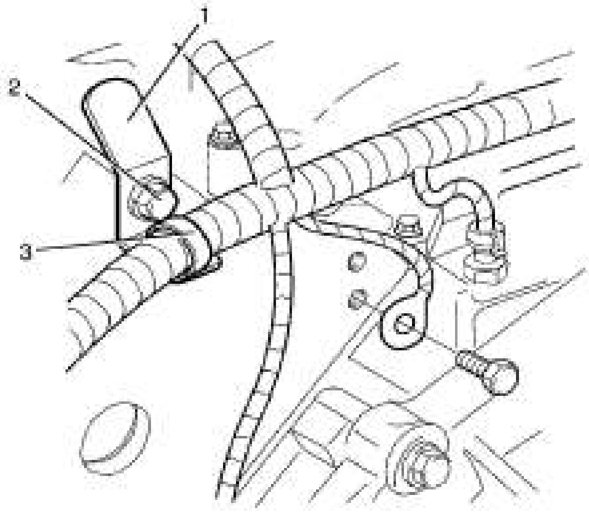
Important: Do not use any type of sealant on the cylinder head gasket (3), unless specified.

3. Install the NEW cylinder head gasket (3) correctly over the locating sleeves.
4. Install the cylinder head with the exhaust manifold to the engine. Refer to Cylinder Head Installation - Left Side.
5. Install the left side valve rocker arms and pushrods. Refer to Valve Rocker Arm and Push Rod Replacement.
6. Install the left side valve rocker arm cover. Refer to Valve Rocker Arm Cover Replacement - Left Side.



7. Connect the coolant temperature sensor electrical connector (1).

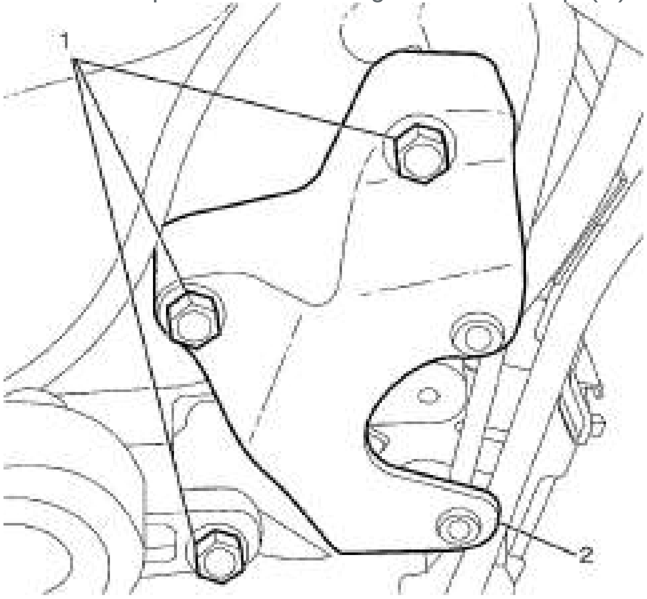
   Notice: Refer to Fastener Notice in the Preface section.



8. Install the engine wiring harness ground connector to cylinder head retaining bolt (2).

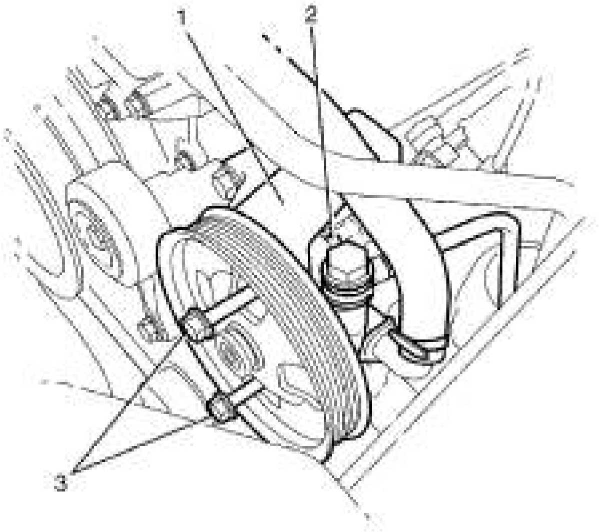
   Tighten
   Tighten the bolt to 10 N·m (89 lb in).

9. Attach the powertrain wiring harness strap (3) to the rear cylinder head bracket (1).



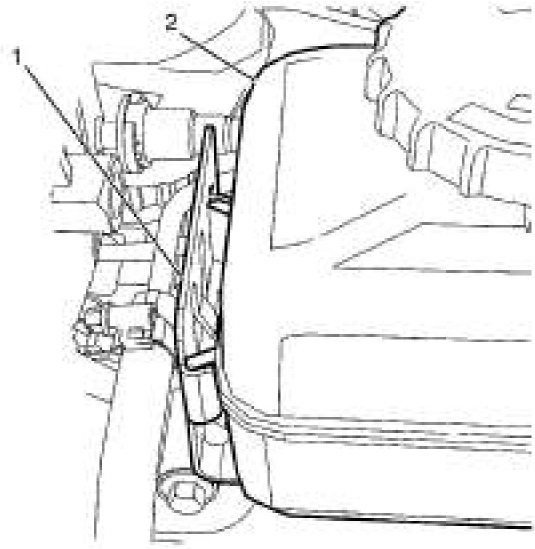
10. Install the power steering pump bracket (2).
11. Install the power steering pump bracket to engine retaining bolts (1).

Tighten
Tighten the bolts to 58 N·m (43 lb ft).



12. Position the power steering pump (2) on the power steering pump bracket (1).
13. Install the power steering pump to power steering pump bracket retaining bolts (3).

Tighten
Tighten the bolts to 30 N·m (22 lb ft).



Important: Make sure the power steering reservoir (2) and the locking tang on the power steering reservoir bracket (1) are engaged to avoid an induced rattle condition.

14. Install the power steering reservoir (2) to the power steering pump power steering reservoir bracket (1).
15. Install the left side exhaust manifold. Refer to Exhaust Manifold Replacement - Left Side.
16. Install the spark plugs. Refer to Spark Plug Replacement.
17. Install the left side ignition coils. Refer to Ignition Coil Replacement .
18. Install the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
19. Install the engine coolant air bleed pipe and cover. Refer to Engine Coolant Air Bleed Hose Replacement.
20. Install the intake manifold assembly. Refer to Intake Manifold Replacement.
21. Refill the cooling system. Refer to Cooling System Draining and Filling.
22. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
23. Install the engine cover. Refer to Engine Cover Replacement .
24. Install the air inlet grille panel. Refer to Air Inlet Grille Panel Replacement.

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Cylinder Head Replacement - Right Side

Tools Required

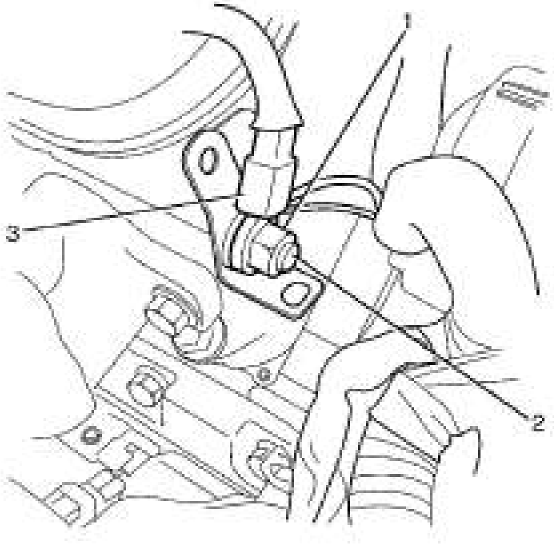
- J 45059 Angle Meter
- J 42385-100 Head/Main Bolt Thread Repair Kit

Removal Procedure

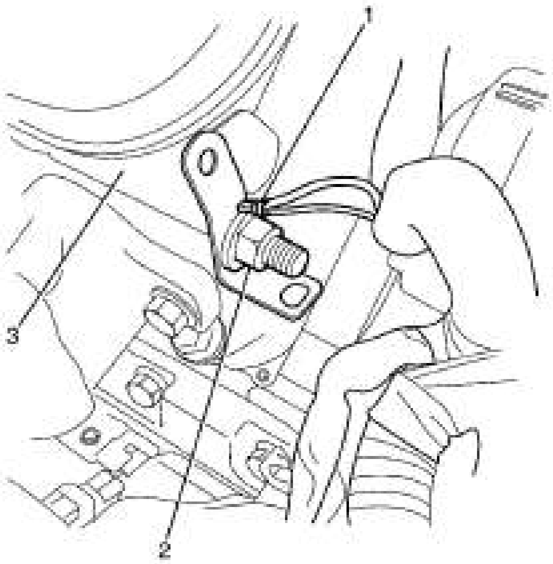
1. Remove the air inlet grille panel. Refer to Air Inlet Grille Panel Replacement.
2. Remove the engine cover. Refer to Engine Cover Replacement .
3. Depressurize the fuel system. Refer to Fuel Pressure Relief.

Caution: Refer to Battery Disconnect Caution in the Preface section.

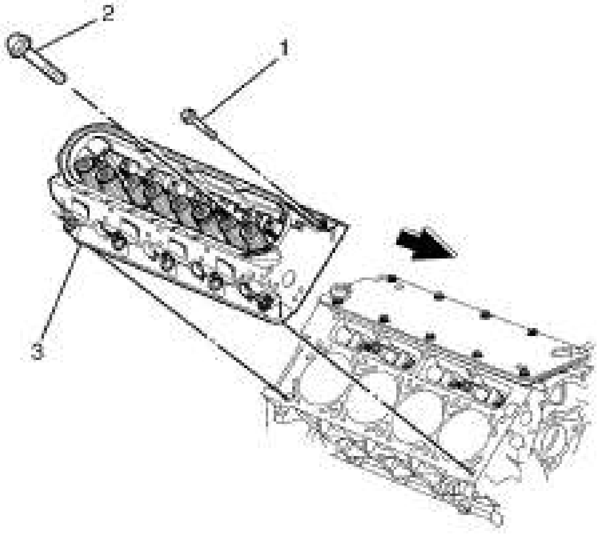
4. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
5. Drain the cooling system. Refer to Cooling System Draining and Filling.
6. Remove the intake manifold assembly. Refer to Intake Manifold Replacement.
7. Remove the engine coolant air bleed pipe and cover. Refer to Engine Coolant Air Bleed Hose Replacement.
8. Remove the right side ignition coils. Refer to Ignition Coil Replacement .
9. Remove the spark plugs. Refer to Spark Plug Replacement.
10. Remove the oil level indicator and tube. Refer to Oil Level Indicator and Tube Replacement.



11. Remove the vehicle body ground cable to cylinder head retaining nut (1).
12. Remove the vehicle body ground cable (3) from the cylinder head stud (2).



13. Remove the cylinder head stud (3) from the cylinder head (2) and secure the wiring harness ground (1) away from the cylinder head (2).
14. Remove the right side exhaust manifold. Refer to Exhaust Manifold Replacement - Right Side.
15. Remove the right side valve rocker arm cover. Refer to Valve Rocker Arm Cover Replacement - Right Side.
16. Remove the right side valve rocker arms and pushrods. Refer to Valve Rocker Arm and Push Rod Replacement.



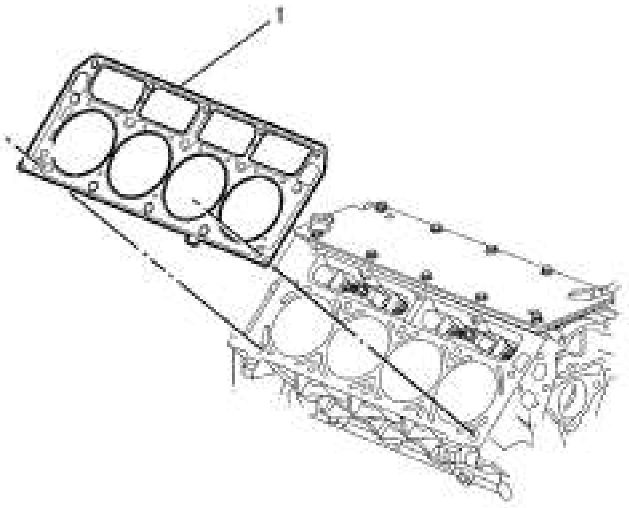
Important: The cylinder head bolts are torque to yield bolts and are single use only fasteners.

17. Remove and discard the cylinder head bolts (1) 10 places, (2) 5 places.

Discard the bolts.

Notice: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

18. Remove the cylinder head (3).



Important: Cylinder head gaskets must be discarded whenever the cylinder head has been removed from the cylinder block.

19. Remove the cylinder head gasket (1).

    Discard the gasket.

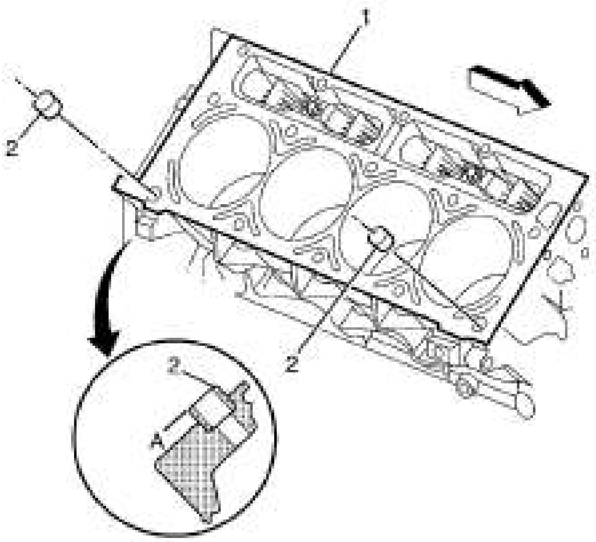
20. Clean and inspect the cylinder head and the cylinder block sealing surfaces. Refer to Cylinder Head Cleaning and Inspection and Engine Block Cleaning and Inspection.
21. If necessary, perform the following steps:

    Disassemble the cylinder head. Refer to Cylinder Head Disassemble.

Installation Procedure

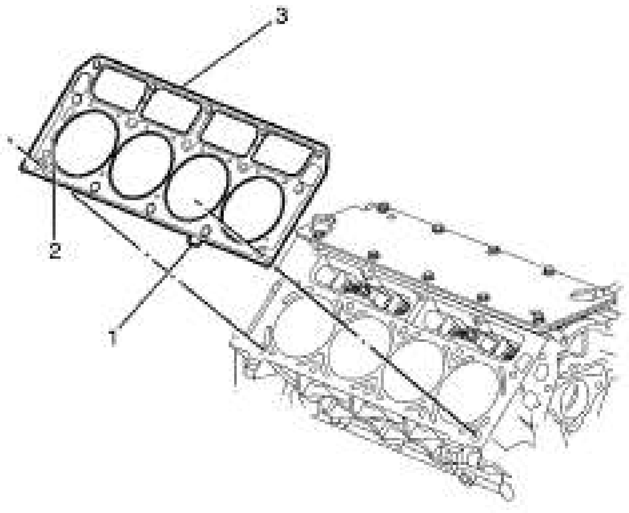
1. If necessary, perform the following steps:

   Assemble the cylinder head. Refer to Cylinder Head Assemble.



Important: Make sure the locating sleeves (2) are correctly installed to the maximum height (A) of 8.3 mm (0.33 in).

2. Install the locating sleeves (2) into the cylinder block (1).

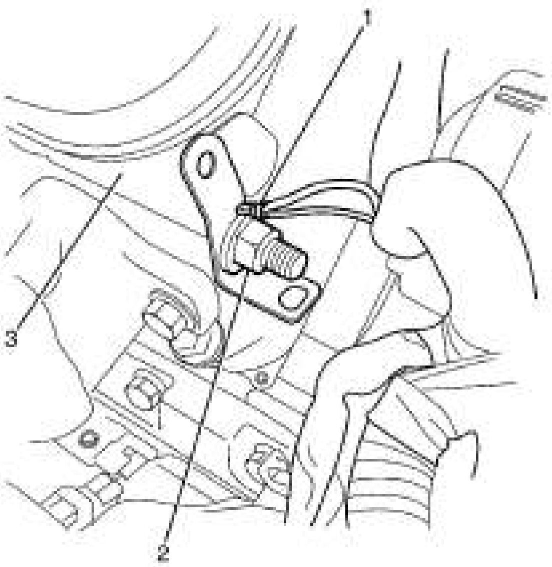


Important: The cylinder head gasket (3) will fit on either side of the engine. Make sure the tab on the cylinder head gasket (1) is located towards the front half point and the stamping FRONT on the cylinder head gasket (2) is facing the front of the engine.

Important: Do not use any type of sealant on the cylinder head gasket (1), unless specified.

3. Install the NEW cylinder head gasket (3) correctly over the locating sleeves.

4. Install the cylinder head with the exhaust manifold to the engine. Refer to Cylinder Head Installation - Right Side.
5. Install the right side valve rocker arms and pushrods. Refer to Valve Rocker Arm and Push Rod Replacement.
6. Install the right side valve rocker arm cover. Refer to Valve Rocker Arm Cover Replacement - Right Side.
7. Remove the right side exhaust manifold. Refer to Exhaust Manifold Replacement - Right Side.

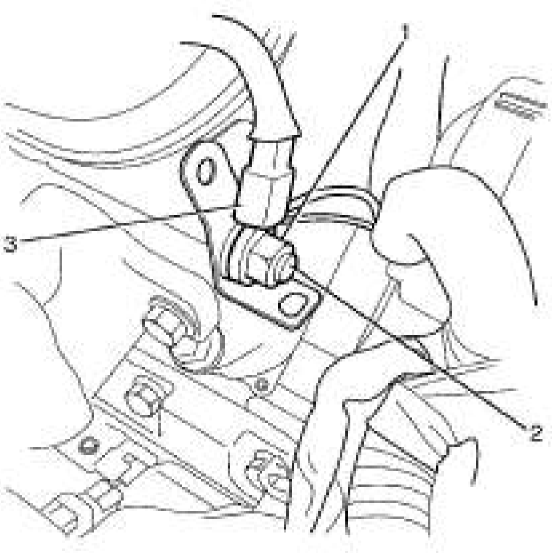


8. Position the wiring harness ground (1) on the cylinder head (2).

Notice: Refer to Fastener Notice in the Preface section.

9. Install the cylinder head stud (3) to the cylinder head (2).

Tighten
Tighten the stud to 30 N·m(22 lb ft).



10. Position the vehicle body ground cable (3) on the cylinder head stud (2).
11. Install the vehicle body ground cable to cylinder head retaining nut (1).

    Tighten
    Tighten the nut to 12 N·m(106 lb ft).

12. Install the oil level indicator and tube. Refer to Oil Level Indicator and Tube Replacement.
13. Install the spark plugs. Refer to Spark Plug Replacement.
14. Install the right side ignition coils. Refer to Ignition Coil Replacement .
15. Install the engine coolant air bleed pipe and cover. Refer to Engine Coolant Air Bleed Hose Replacement.
16. Install the intake manifold assembly. Refer to Intake Manifold Replacement.
17. Refill the cooling system. Refer to Cooling System Draining and Filling.
18. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
19. Install the engine cover. Refer to Engine Cover Replacement .
20. Install the air inlet grille panel. Refer to Air Inlet Grille Panel Replacement.

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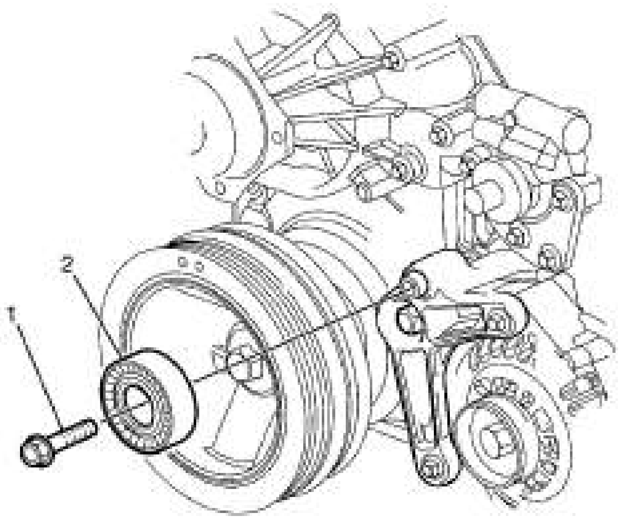
Drive Belt Idler Pulley Replacement

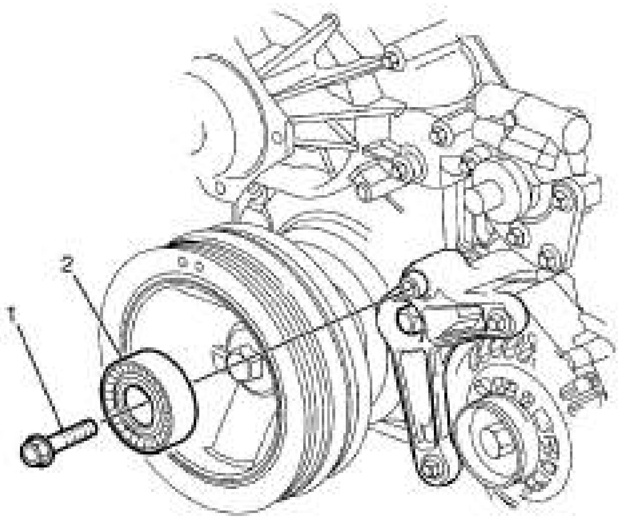
Removal Procedure

1. Remove the air intake duct. Refer to Air Cleaner Assembly Replacement.
2. Remove the accessory drive belt. Refer to Drive Belt Replacement - Accessory.



3. Remove the drive belt idler pulley to alternator bracket retaining bolt (1).
4. Remove the drive belt idler pulley (2).

Installation Procedure



1. Install the drive belt idler pulley (2).
2. Hand tighten the drive belt idler pulley to alternator bracket retaining bolt (1).

   Notice: Refer to Fastener Notice in the Preface section.

3. Tighten the drive belt idler pulley bolt.

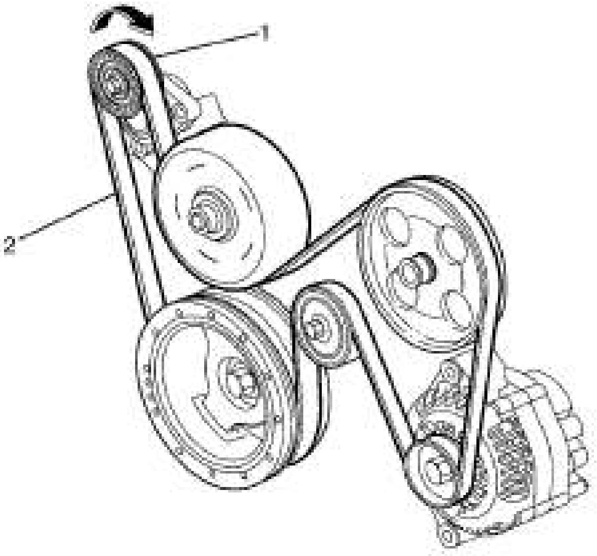
   Tighten
   Tighten the bolt to 58 N·m (43 lb ft).

4. Install the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
5. Install the air intake duct. Refer to Air Cleaner Assembly Replacement.

Drive Belt Replacement - Accessory

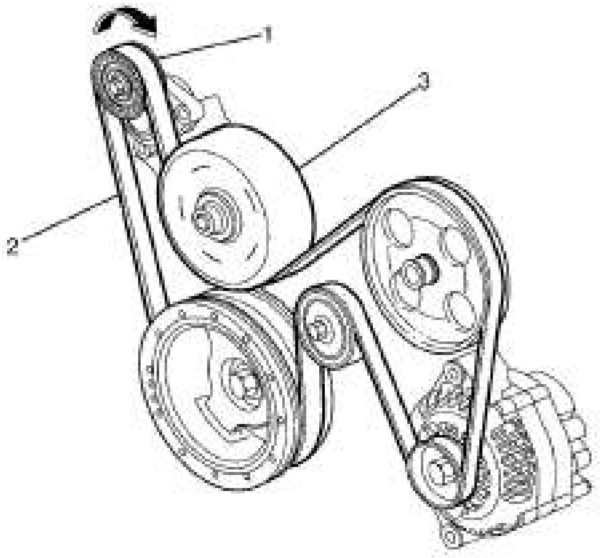
Removal Procedure

1. Remove the air intake duct. Refer to Air Cleaner Assembly Replacement.



2. Using a suitable tool, rotate the drive belt tensioner (1) clockwise to relieve the tension on the accessory drive belt (2).
3. Remove the accessory drive belt (2).
4. Slowly release tension on the drive belt tensioner (1).
5. Clean and inspect the drive belt surfaces of all the pulleys.

Installation Procedure

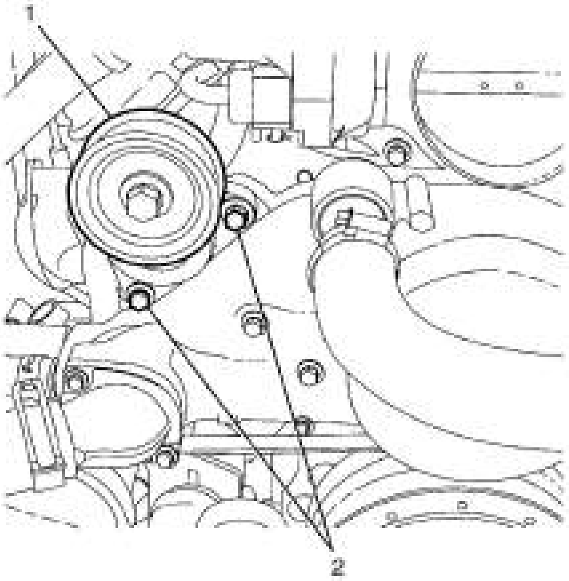


1. Route the accessory drive belt (2) around all the pulleys except the water pump pulley (3).
2. Using a suitable tool, rotate the drive belt tensioner (1) clockwise.
3. Install the accessory drive belt under the water pump pulley (3).
4. Slowly release the drive belt tensioner (1).
5. Install the air intake duct. Refer to Air Cleaner Assembly Replacement.
6. Inspect the accessory drive belt (2) for correct alignment.

Drive Belt Tensioner Replacement - Accessory

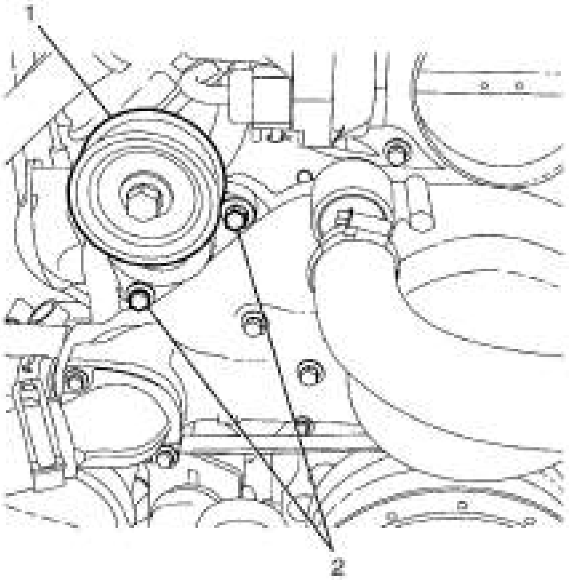
Removal Procedure

1. Remove the air intake duct. Refer to Air Cleaner Assembly Replacement.
2. Remove the accessory drive belt. Refer to Drive Belt Replacement - Accessory.



3. Remove the accessory drive belt tensioner to cylinder head retaining bolts (2).
4. Remove the accessory drive belt tensioner (1).

Installation Procedure



1. Install the accessory drive belt tensioner (1).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the accessory drive belt tensioner to cylinder head retaining bolts (2).

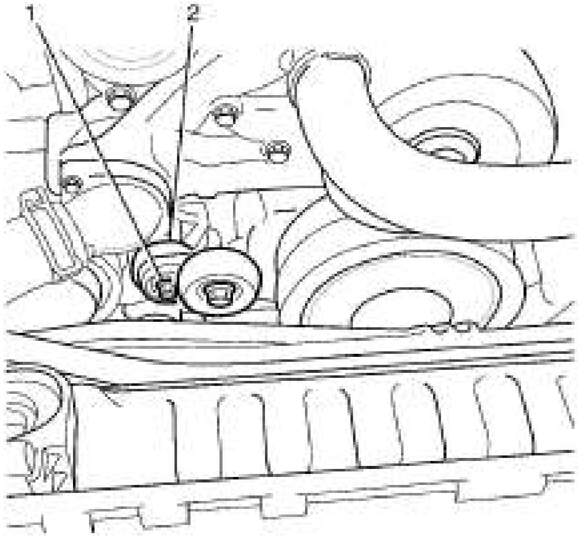
   Tighten
   Tighten the bolts to 58 N·m (43 lb ft).

3. Install the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
4. Install the air intake duct. Refer to Air Cleaner Assembly Replacement.

Drive Belt Tensioner Replacement - Air Conditioning

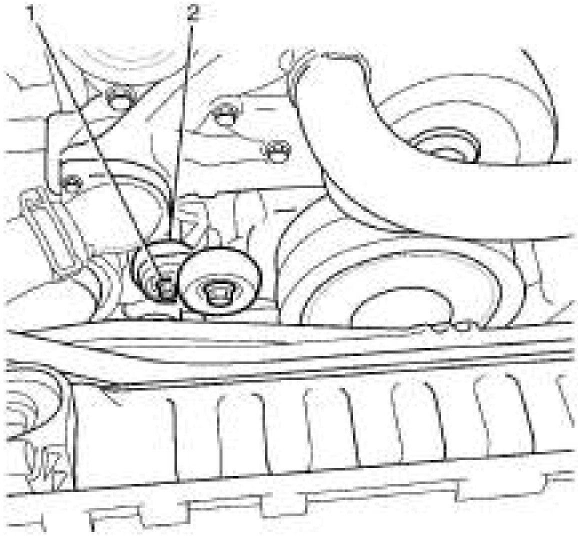
Removal Procedure

1. Remove the air intake duct. Refer to Air Cleaner Assembly Replacement.
2. Remove the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
3. Remove the air conditioning (A/C) drive belt. Refer to Air Conditioning Compressor Belt Replacement.



4. Remove the A/C drive belt tensioner to A/C compressor bracket retaining bolt (1).
5. Remove the A/C drive belt tensioner (2).

Installation Procedure



1. Install the A/C drive belt tensioner (2).

   Notice: Refer to Fastener Notice in the Preface section.

2. Tighten the A/C drive belt tensioner to A/C compressor bracket retaining bolt (1).

   Tighten
   Tighten the bolt to 22 N·m (16 lb ft).

3. Install the air conditioning (A/C) drive belt. Refer to Air Conditioning Compressor Belt Replacement.
4. Install the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
5. Install the air intake duct. Refer to Air Cleaner Assembly Replacement.

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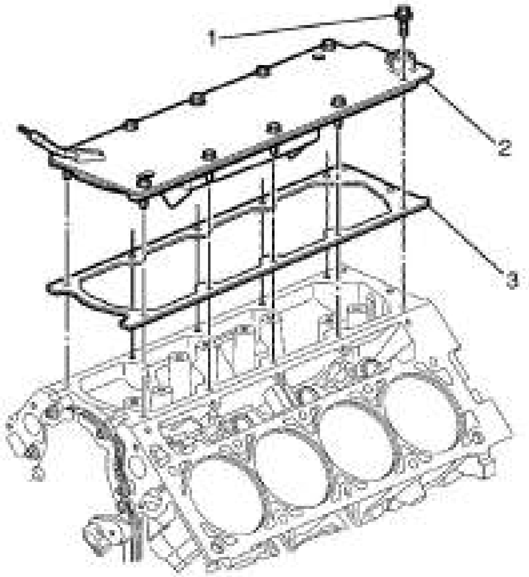
Engine Block Valley Cover Replacement

Removal Procedure

1. Remove the intake manifold. Refer to Intake Manifold Replacement.
2. Remove the oil pressure sensor. Refer to Engine Oil Pressure Sensor and/or Switch Replacement.



3. Remove the valley cover to cylinder block retaining bolts (1).
4. Remove the valley cover (2).

Important: The valley cover gasket (3) is a single use only component and must be replaced whenever the valley cover gasket (3) is removed from the engine.

5. Remove the valley cover gasket (3).

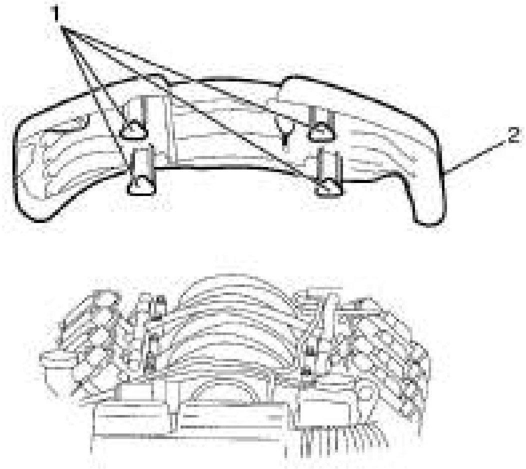
   Discard the valley cover gasket (3).

Installation Procedure

1. Install the valley cover. Refer to Engine Block Valley Cover Installation.
2. Install the oil pressure sensor. Refer to Engine Oil Pressure Sensor and/or Switch Replacement.
3. Install the intake manifold. Refer to Intake Manifold Replacement.

Engine Cover Replacement

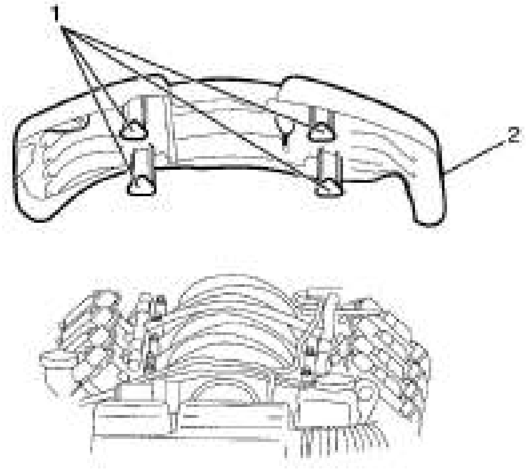
Removal Procedure



Important: Detach the engine cover to fuel rail retaining clips (1) by pulling upward on the engine cover.

1. Detach the engine cover from the fuel rail retaining clips (1).
2. Remove the engine cover (2).

Installation Procedure



1. Align the engine cover to fuel rail retaining clips (1).

   Important: Make sure the engine cover retaining clips (1) are fully engaged to prevent causing an induced rattle condition.

2. Install the engine cover (2).

Engine Flywheel Replacement

Removal Procedure

1. Remove the automatic transmission. Refer to Transmission Replacement .
2. Remove the engine flywheel. Refer to Engine Flywheel Removal .

Installation Procedure

1. Install the engine flywheel. Refer to Engine Flywheel Installation .
2. Install the automatic transmission. Refer to Transmission Replacement .

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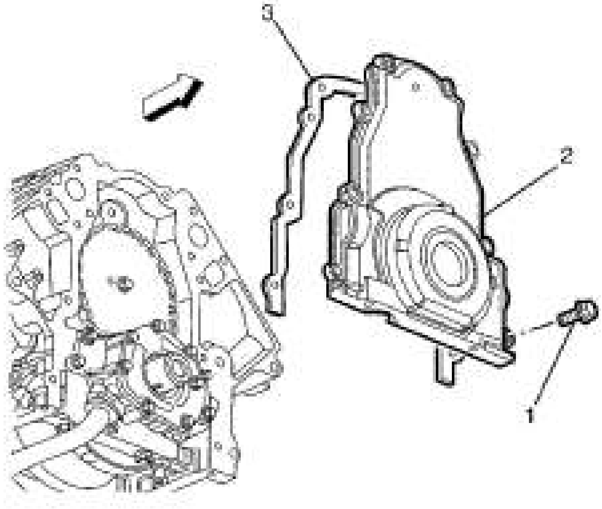
Engine Front Cover Replacement

Tools Required

- J 41480 Front and Rear Cover Alignment
- J 41476 Front and Rear Cover Alignment Tool

Removal Procedure

1. Remove the oil pan. Refer to Oil Pan Replacement.
2. Remove the crankshaft balancer. Refer to Crankshaft Balancer Removal.



3. Remove the engine front cover to cylinder block retaining bolts (1).

   Important: The engine front cover gasket (3) is a single use only component and must be replaced whenever the engine front cover (2) is removed.

4. Remove the engine front cover (2) and gasket (3).
5. Remove the engine front cover gasket (3).

   Discard the engine front cover gasket (3).

6. Clean and inspect the engine front cover. Refer to Engine Front Cover Cleaning and Inspection.

Installation Procedure

1. Install the engine front cover. Refer to Engine Front Cover Installation.
2. Install the crankshaft balancer. Refer to Crankshaft Balancer Removal.

3. Install the oil pan. Refer to Oil Pan Replacement.

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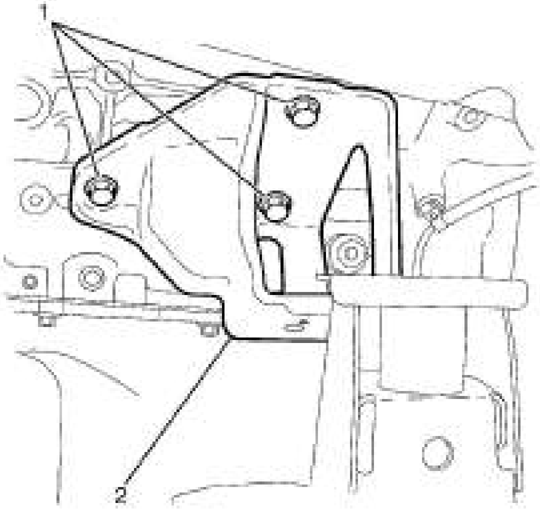
Engine Mount Bracket Replacement - Left Side

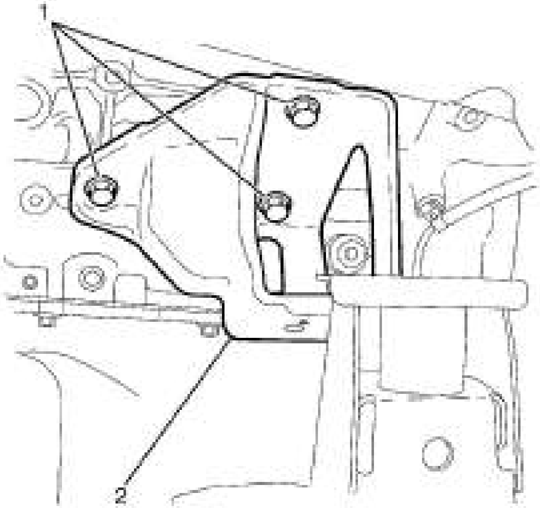
Removal Procedure

1. Remove the left side engine mount. Refer to Engine Mount Replacement - Left Side.



2. Remove the left side engine mount bracket to cylinder block retaining bolts (1).
3. Remove the left side engine mount bracket (2).

Installation Procedure



1. Install the left side engine mount bracket (2).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the left side engine mount bracket to cylinder block retaining bolts (1).

   Tighten
   Tighten the bolt to 50 N·m (37 lb ft).

3. Install the left side engine mount. Refer to Engine Mount Replacement - Left Side.

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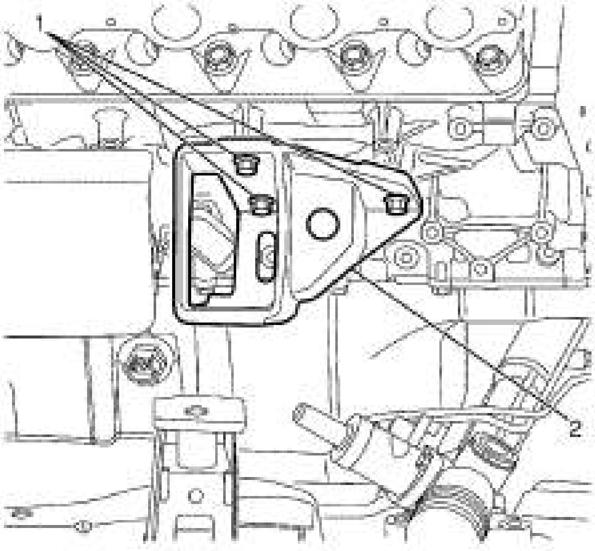
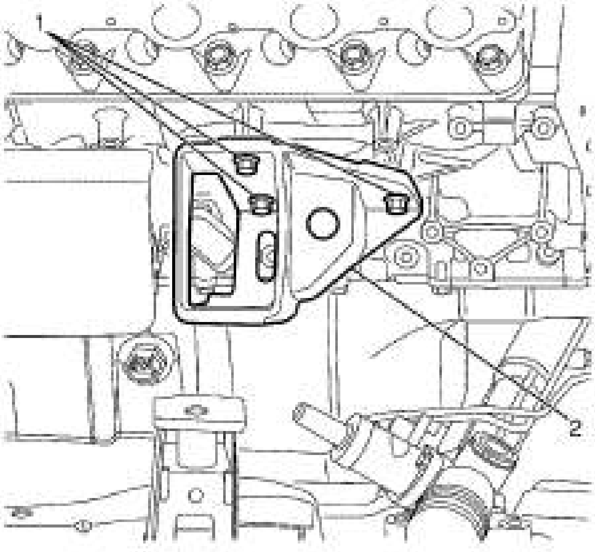
Engine Mount Bracket Replacement - Right Side

Removal Procedure



1. Remove the right side engine mount. Refer to Engine Mount Replacement - Right Side .
2. Remove the right side engine mount bracket to cylinder block retaining bolts (1).
3. Remove the right side engine mount bracket (2).

Installation Procedure



1. Install the right side engine mount bracket (2).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the right side engine mount bracket to cylinder block retaining bolts (1).

   Tighten
   Tighten the bolts to 50 N·m (37 lb ft).

3. Install the right side engine mount. Refer to Engine Mount Replacement - Right Side .

Engine Mount Inspection

Notice: Broken or deteriorated mounts can cause misalignment and destruction of certain drive train components. When a single mount breaks, the remaining mounts are subjected to abnormally high stresses.

Important: Raising the engine, will remove the weight from the engine mount and create a slight tension in the rubber mount.

1. Use a suitable engine lifting tool to raise the engine until the weight of the engine is removed from the engine mounts.

   Important: Before replacing any engine mount due to suspected fluid loss, verify that the source of the fluid is actually the engine mount, not the engine or other accessories.

2. Observe the engine mount while raising the engine. Replace the engine mount if the mount exhibits any of the following conditions:
   - The hard rubber surface is covered with heat check cracks.
   - The rubber is separated from the metal plate of the engine mount.
   - The rubber is split through the centre of the engine mount.
   - The GLYCOL™ fluid is leaking from the engine mount.
3. If there is movement between the metal plate of the engine mount and its attaching points, lower the engine on the engine mount. Tighten the bolts or nuts attaching the engine mount to the frame or engine mount bracket. Refer to Engine Mount Replacement - Left Side or Engine Mount Replacement - Right Side.

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Engine Mount Replacement - Left Side

Tools Required

- J 28467-B Universal Engine Support Fixture
- J 41803 Engine Support Fixture
- J 41798 Engine Lift Bracket

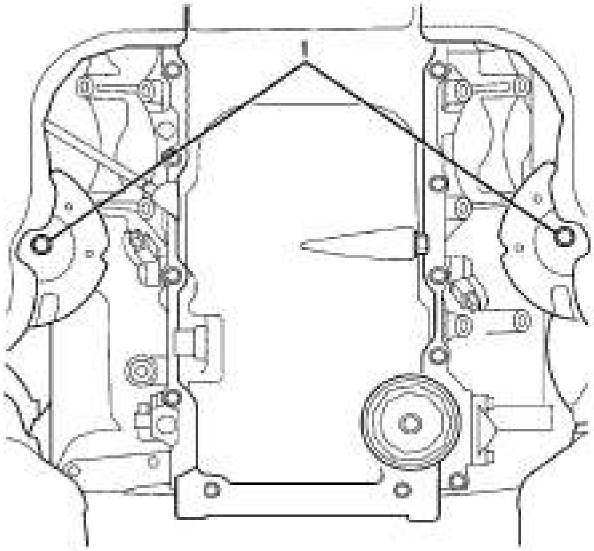
Removal Procedure

1. Remove the engine cover. Refer to Engine Cover Replacement .

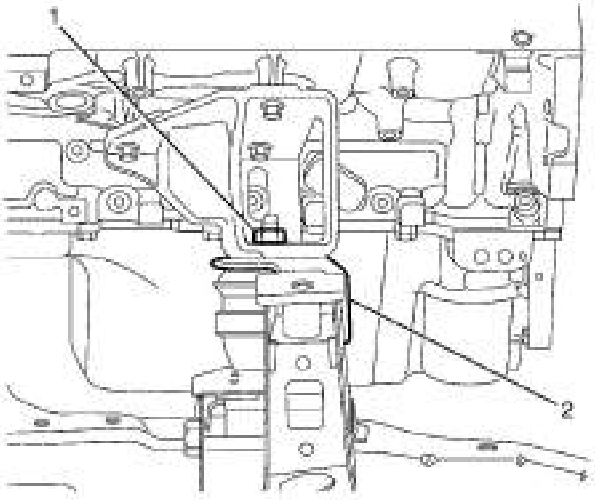
   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

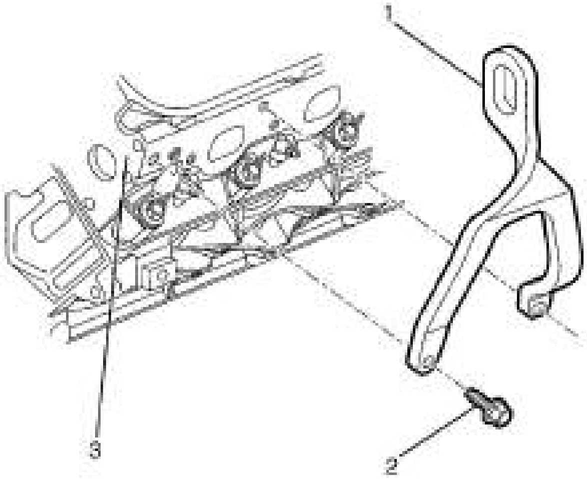
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
3. Remove the engine splash shield. Refer to Engine Splash Shield Replacement .



4. Remove the lower engine mount to front subframe retaining nut (1) from both engine mounts.
5. Lower the vehicle.



6. Remove the upper left side engine mount to engine mount bracket retaining nut (1).

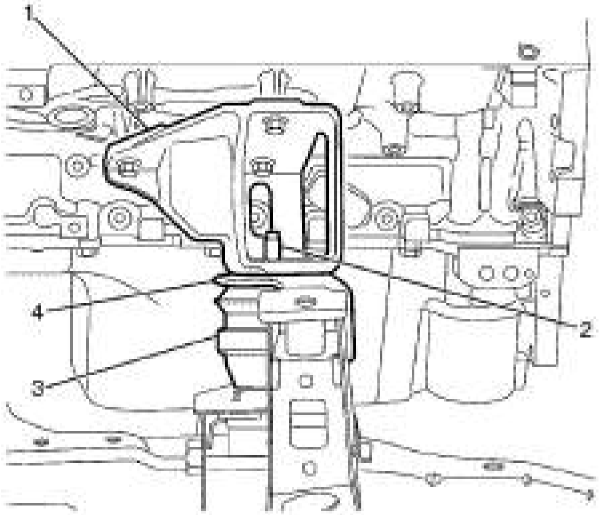


7. Position the J 41798 (1) on the cylinder head (3).

   Notice: Refer to Fastener Notice in the Preface section.

8. Install the J 41798 to cylinder head retaining bolts (2).

   Tighten
   Tighten the bolts to 50 N·m (36 lb ft).



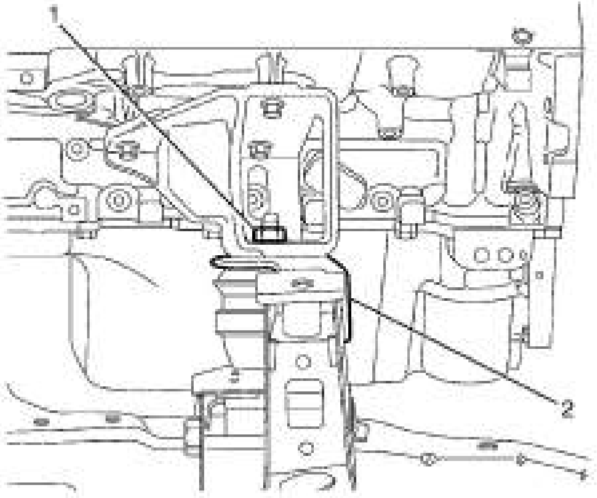
Important: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

9. Install J 41803 and J 28467-B and raise the engine assembly until the left side engine mount bracket (1) is clear of the left side engine mount retaining stud (2).

Important: DO NOT bend or distort the right side engine mount heat shield (4).

10. Remove the left side engine mount assembly (3).

Installation Procedure



Important: DO NOT bend or distort the right side engine mount heat shield (4).

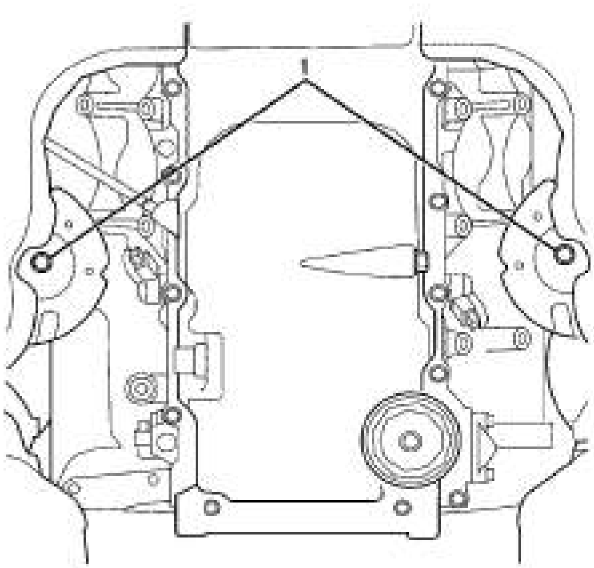
1. Position the left side engine mount assembly (3).
2. Lower the engine and remove J 41803 , J 28467-B and J 41798 from the engine.

Notice: Refer to Fastener Notice in the Preface section.

3. Install the upper engine mount to engine mount bracket retaining nut (1).

Tighten
Tighten the nut to 80 N·m (59 lb ft).

Caution: Refer to Vehicle Lifting Caution in the Preface section.



4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

Notice: Refer to Fastener Notice in the Preface section.

5. Install the lower engine mount to front subframe retaining nut (1) on both engine mounts.

Tighten
Tighten the nut to 80 N·m (59 lb ft).

6. Install the engine splash shield. Refer to Engine Splash Shield Replacement .
7. Lower the vehicle.
8. Install the engine splash shield. Refer to Engine Cover Replacement .

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Engine Mount Replacement - Right Side

Tools Required

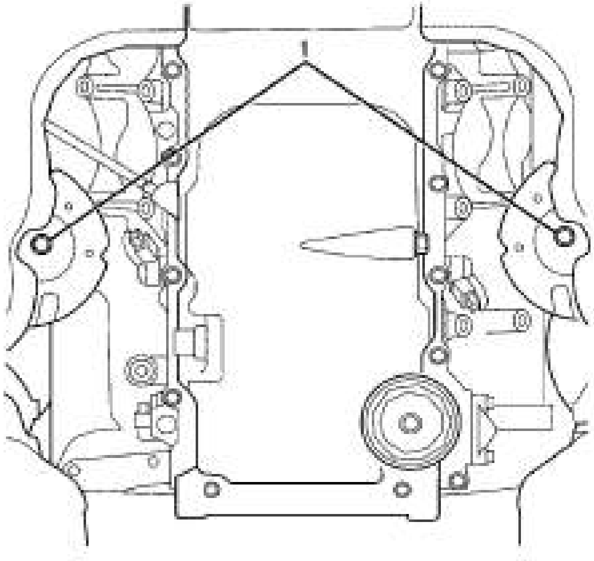
- J 28467-B Universal Engine Support Fixture
- J 41803 Engine Support Fixture
- J 41798 Engine Lift Bracket

Removal Procedure

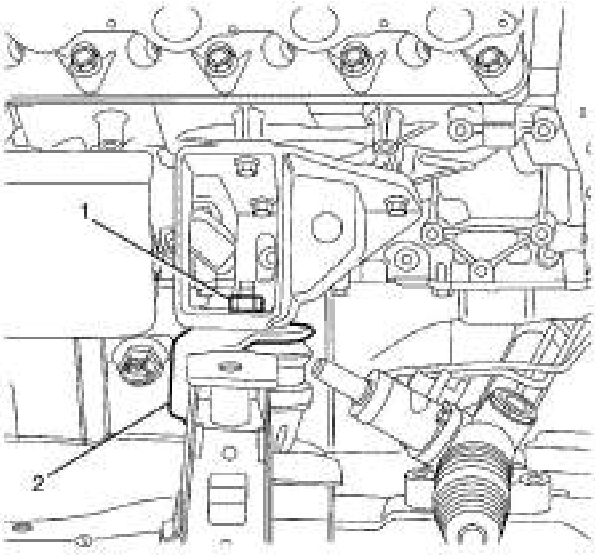
1. Remove the engine cover. Refer to Engine Cover Replacement .
2. Remove the Oil Level Indicator and Tube. Refer to Oil Level Indicator and Tube Replacement .

Caution: Refer to Vehicle Lifting Caution in the Preface section.

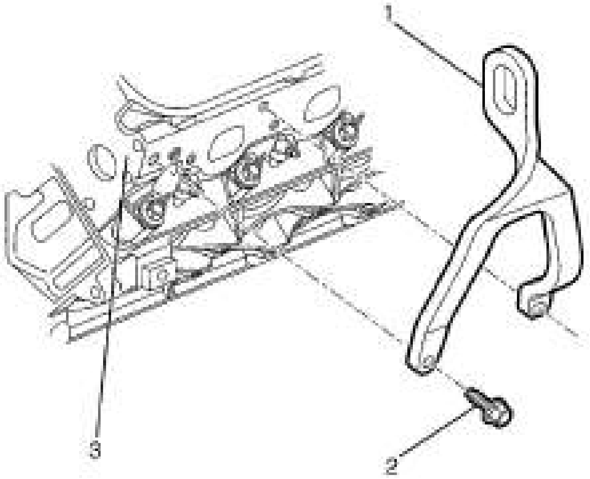
3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
4. Remove the engine splash shield. Refer to Engine Splash Shield Replacement .



5. Remove the lower engine mount to front subframe retaining nut (1) from both engine mounts.
6. Lower the vehicle.



7. Remove the upper right side engine mount to engine mount bracket retaining nut 1).

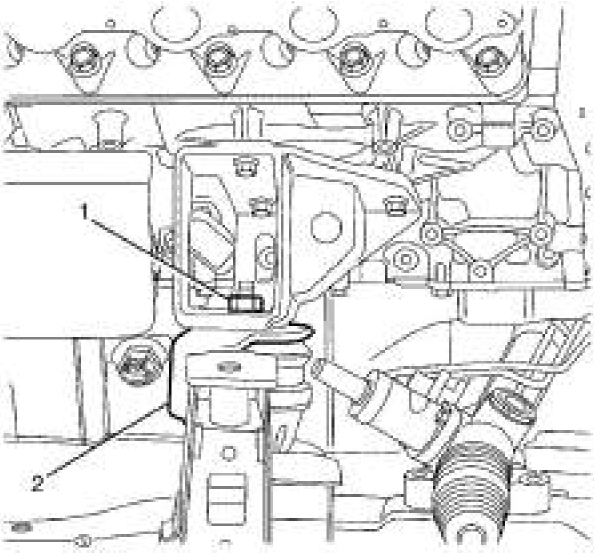


8. Position the J 41798 (1) on the cylinder head (3).

   Notice: Refer to Fastener Notice in the Preface section.

9. Install the J 41798 to cylinder head retaining bolts (2).

   Tighten
   Tighten the bolts to 50 N·m (36 lb ft).



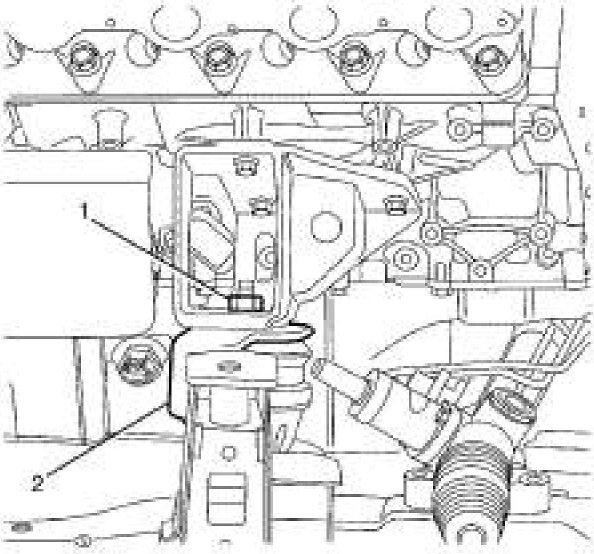
Important: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

10. Install J 41803 and J 28467-B and raise the engine assembly until the right side engine mount bracket (1) is clear of the right side engine mount retaining stud (2).

Important: DO NOT bend or distort the right side engine mount heat shield (4).

11. Remove the right side engine mount assembly (3).

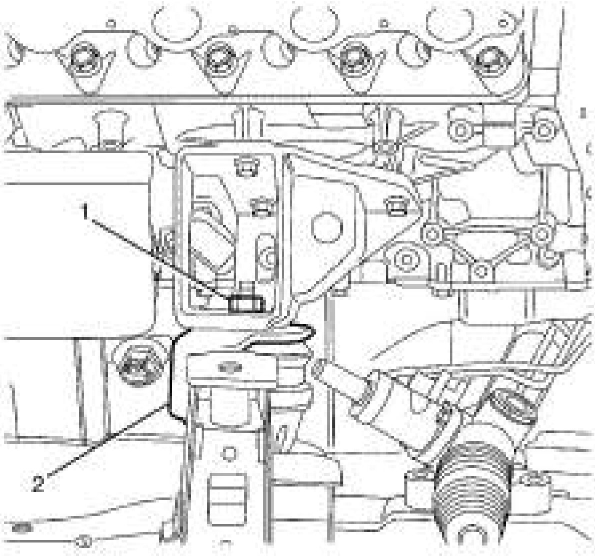
Installation Procedure



Important: DO NOT bend or distort the right side engine mount heat shield (4).

1. Install the right side engine mount assembly (3).
2. Lower the engine assembly until the right side engine mount retaining stud (2) is installed through the right side engine mount bracket (1).
3. Remove J 41803 , J 28467-B and J 41798 from the engine.

Notice: Refer to Fastener Notice in the Preface section.



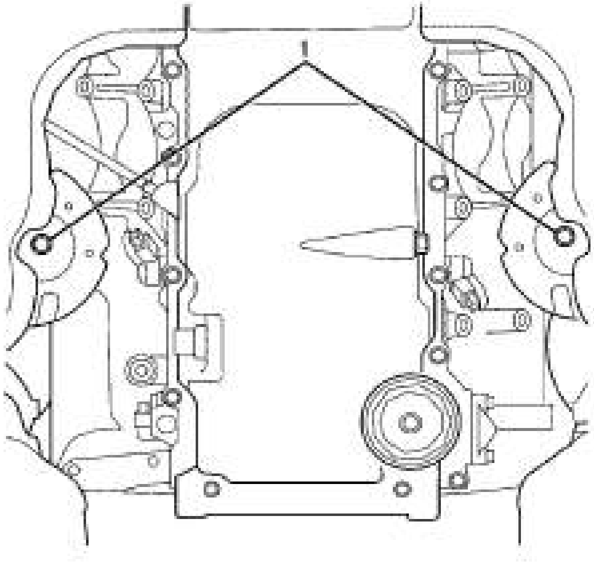
4. Install the upper right side engine mount to engine mount bracket retaining nut (1).

Tighten
Tighten the nut to 80 N·m (59 lb ft).

Caution: Refer to Vehicle Lifting Caution in the Preface section.

5. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

Notice: Refer to Fastener Notice in the Preface section.



6. Install the lower engine mount to front subframe retaining nut (1) on both engine mounts.

   Tighten
   Tighten the nut to 80 N·m (59 lb ft).

7. Install the engine splash shield. Refer to Engine Splash Shield Replacement .
8. Lower the vehicle.
9. Install the Oil Level Indicator and Tube. Refer to Oil Level Indicator and Tube Replacement .
10. Install the engine cover. Refer to Engine Cover Replacement .

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Engine Oil and Oil Filter Replacement (L98, LS2)

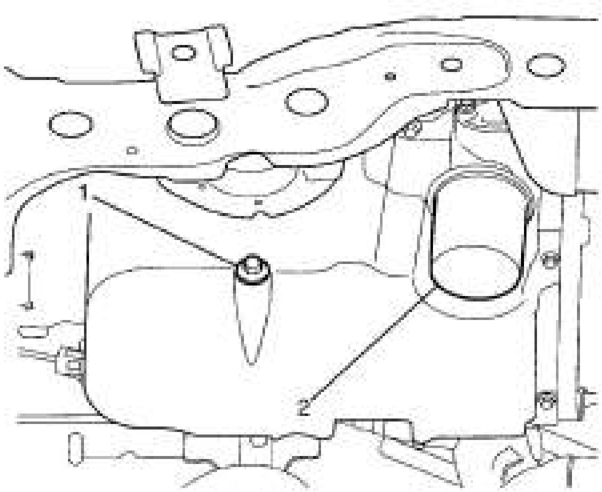
Removal Procedure

1. Remove the oil fill cap.

   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

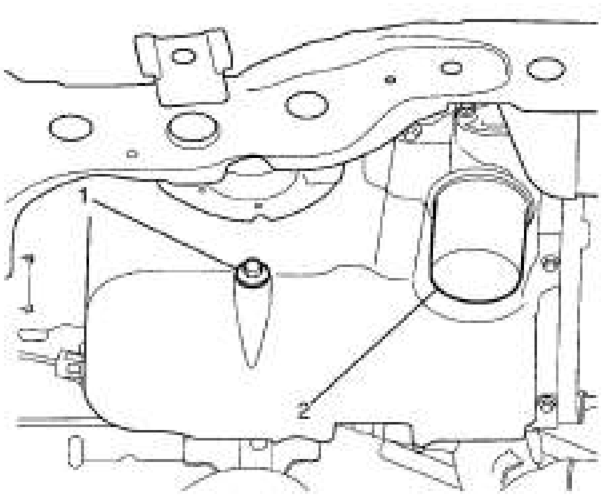
2. Raise the vehicle. Refer to Lifting and Jacking the Vehicle.



3. Remove the oil pan drain plug (1).
4. Drain the engine oil into an appropriate container.
5. Remove the engine oil filter (2).

Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



Important: Before installing the new oil filter, ensure that the old oil filter gasket has been removed. If not, remove the old gasket.

1. Install the oil filter (2).

   Tighten
   Tighten the filter to 30 N·m (22 lb ft).

2. Install the oil pan drain plug (1).

   Tighten
   Tighten the plug to 25 N·m (18 lb ft).

3. Lower the vehicle.
4. Fill the engine with a suitable amount and type of engine oil. Refer to Approximate Fluid Capacities and Fluid and Lubricant Recommendations.
5. Check the oil level.
6. Install the oil fill cap.
7. Reset the service reminder display. Refer to Service Display Reminders.

Engine Oil Level Sensor and/or Switch Replacement

Removal Procedure

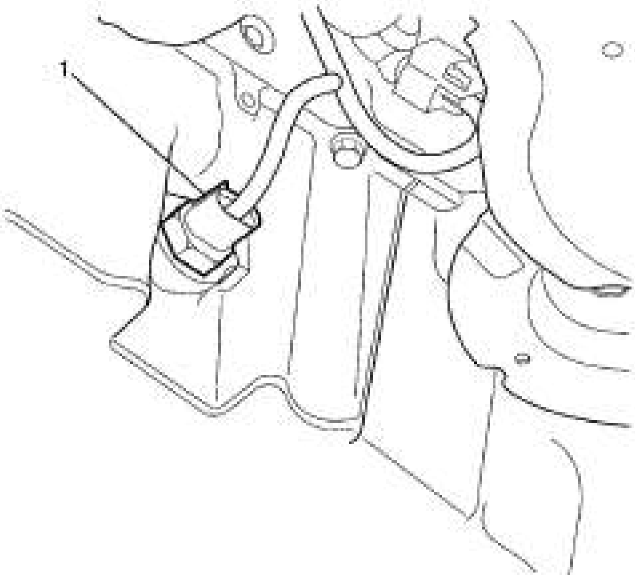
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

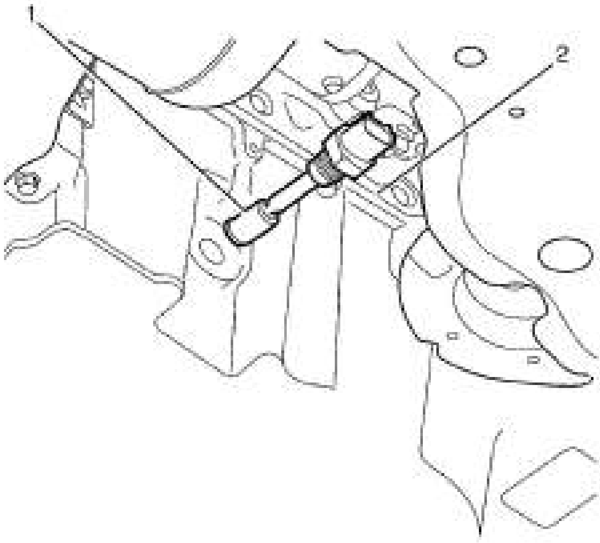
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Drain the engine oil. Refer to Engine Oil and Oil Filter Replacement.



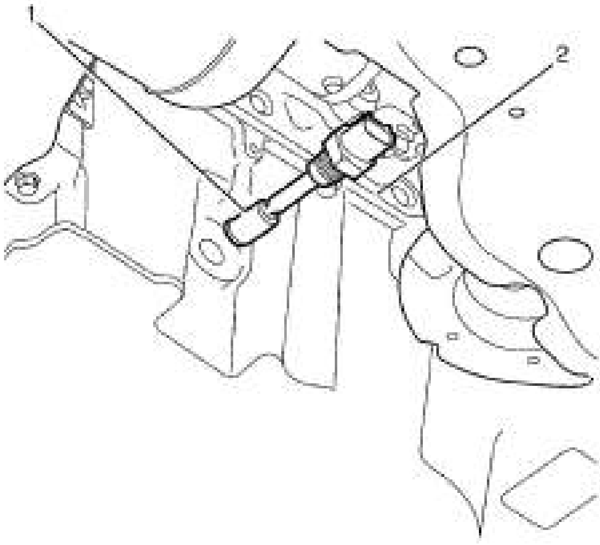
4. Disconnect the oil level/temperature sensor electrical connector (1).



5. Remove the engine oil lever sensor (1) from the oil pan (2).

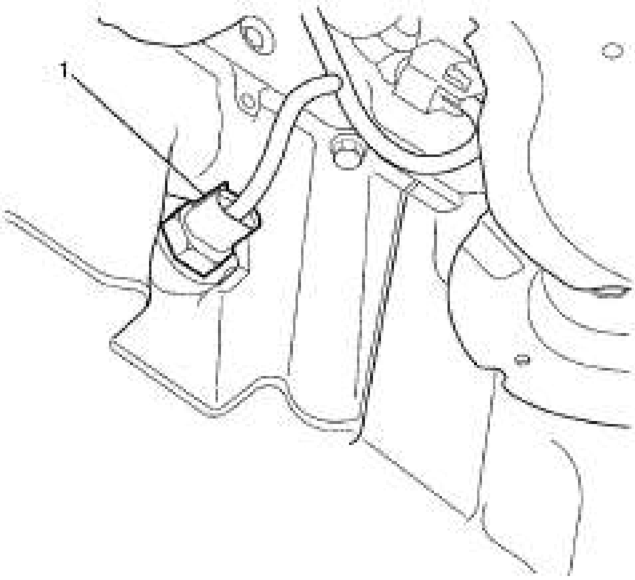
Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



1. Install the engine oil level sensor (1) to the oil pan (2).

Tighten
Tighten the sensor to 20 N·m (15 lb ft).



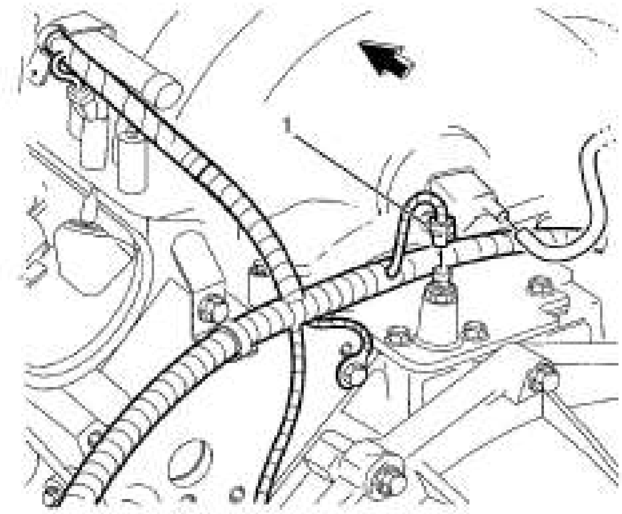
2. Connect the oil level/temperature sensor electrical connector (1).
3. Lower the vehicle.
4. Replace the engine oil and oil filter. Refer to Engine Oil and Oil Filter Replacement.

Engine Oil Pressure Sensor and / or Switch Replacement

Tools Required

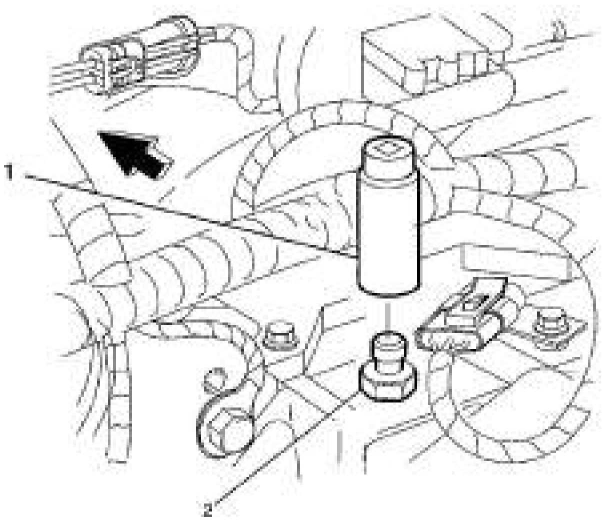
J 41712 Oil Pressure Switch Socket

Removal Procedure



1. Disconnect the oil pressure sensor wiring harness connector (1).

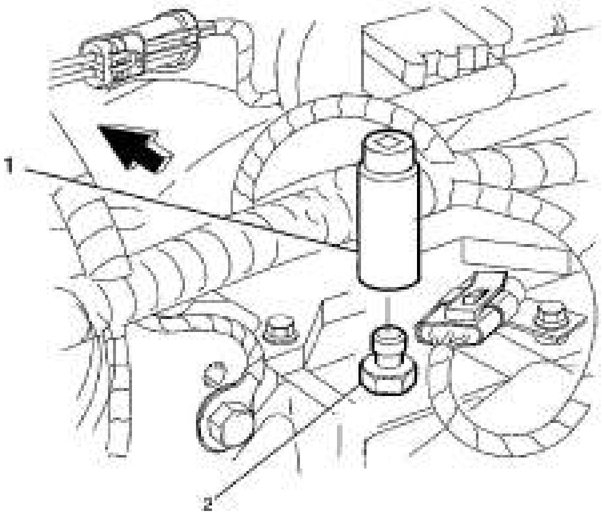
   Important: Clean the area around the sensor before removal. This prevents debris from entering the engine.



2. Use the J 41712 (1) to remove the oil pressure sensor (2).

Installation Procedure

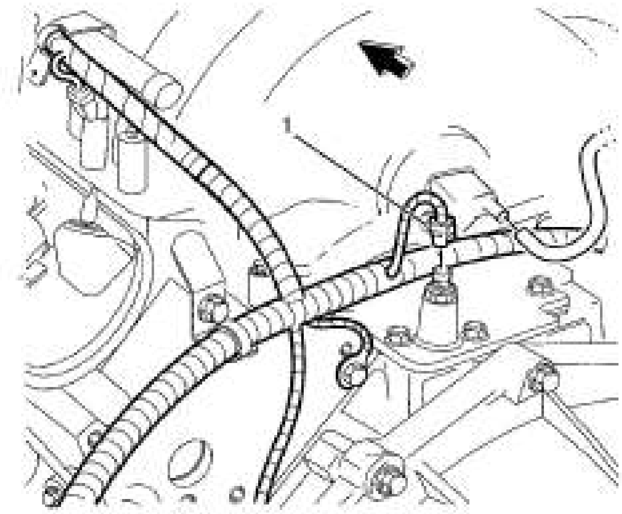
Notice: Refer to Fastener Notice in the Preface section.



Important: If installing the old oil pressure sensor (2), apply LOCTITE 565 ™ or equivalent to the cleaned oil pressure sensor (2) thread.

1. Install the oil pressure sensor (2) using the J 41712 J 41712.

Tighten
Tighten the sensor to 35 N·m (26 lb ft).



2. Connect the oil pressure sensor electrical connector (1).

Engine Replacement (RHD)

Tools Required

J 41798 Engine Lifting Brackets

Removal Procedure

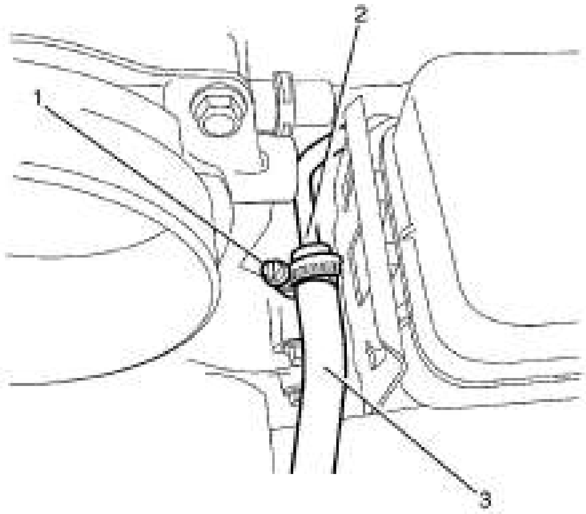
Important: Observing the orientation of the intermediate steering shaft (1) with reference to the pinion shaft (3) will minimise the potential of incorrect steering column assembly alignment.

Important: The front wheels of the vehicle must be maintained in the straight ahead position and the steering column must be in the LOCK position before disconnecting the steering column or intermediate shaft. If these procedures are not followed incorrect alignment of some components during installation will result and damage to the SIR coil assembly will occur.

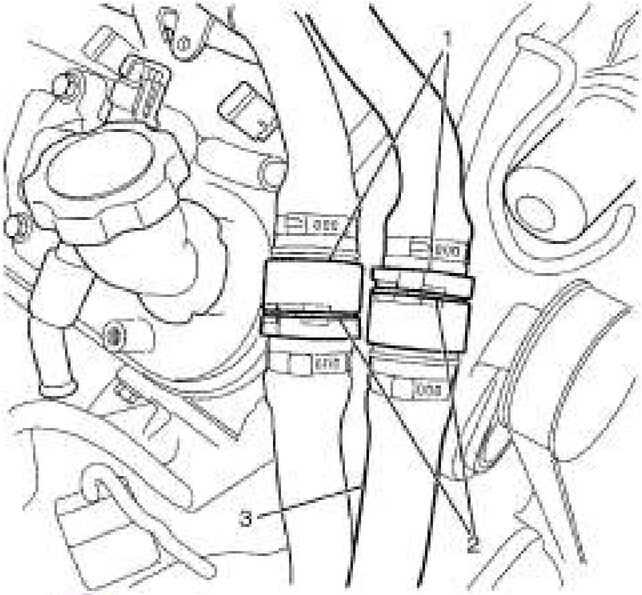
1. Turn the ignition key to the LOCK position.

Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the engine cover. Refer to Engine Cover Replacement.
4. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.
5. Recover the air conditioning (A/C) refrigerant. Refer to Refrigerant Recovery and Recharging.
6. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.
7. Depressurize the fuel system. Refer to Fuel Pressure Relief.
8. Drain the cooling system. Refer to Cooling System Draining and Filling.
9. Remove the radiator outlet hose. Refer to Radiator Outlet Hose Replacement.



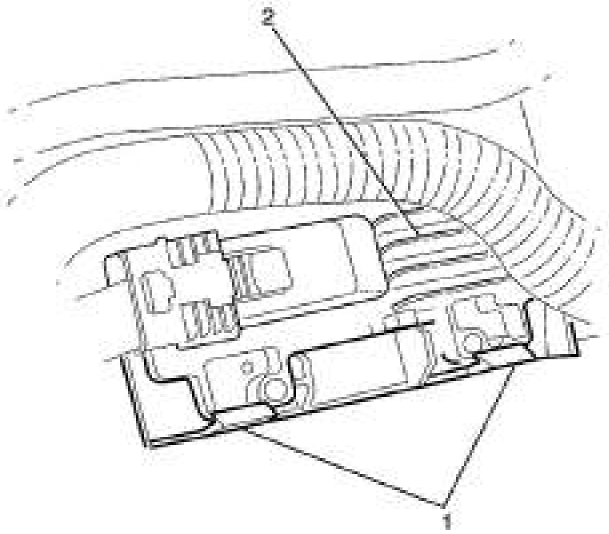
10. Loosen the coolant bleed hose retaining clamp (1) at the cylinder head end and slide 50 mm (2 in) along the coolant bleed hose (3).
11. Disconnect the coolant air bleed hose (3) from the coolant bleed pipe (2).



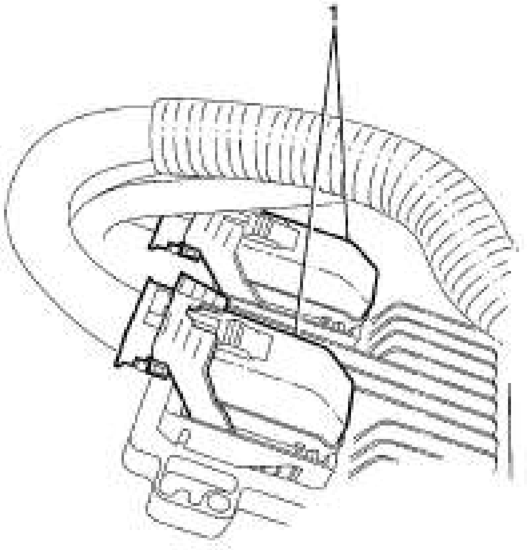
Important: Disconnect the heater hose assembly quick connect fittings (1) by releasing the retaining clips (2) using a suitable tool.

12. Disconnect the inlet and outlet heater hoses (3) from the heater hose assembly quick connect fittings (1).

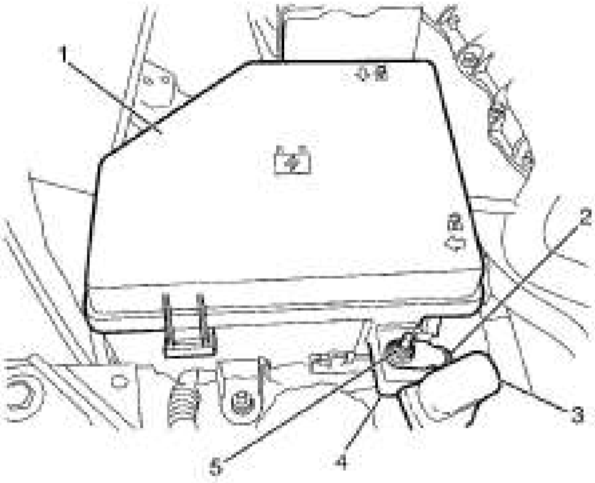
Notice: Do not touch the connector pins or soldered components on the circuit board in order to prevent possible electrostatic discharge (ESD) damage to the PCM.



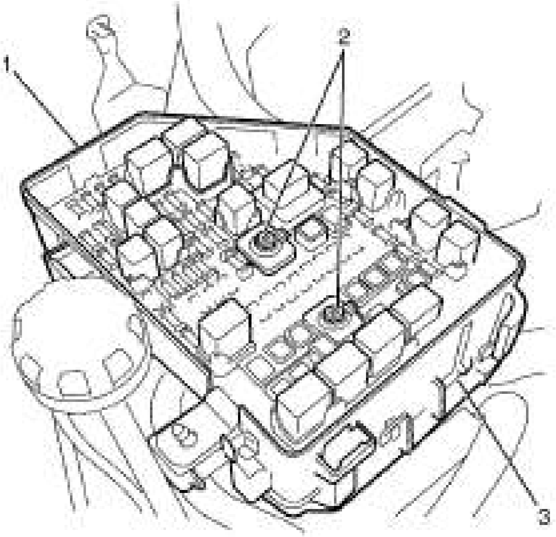
13. Release the ECM retaining clips (1) and detach the ECM (2).



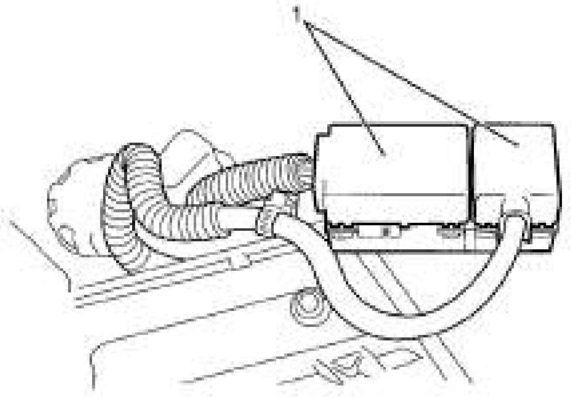
14. Move the connector lock levers to the unlock position and disconnect the ECM electrical connectors (1).



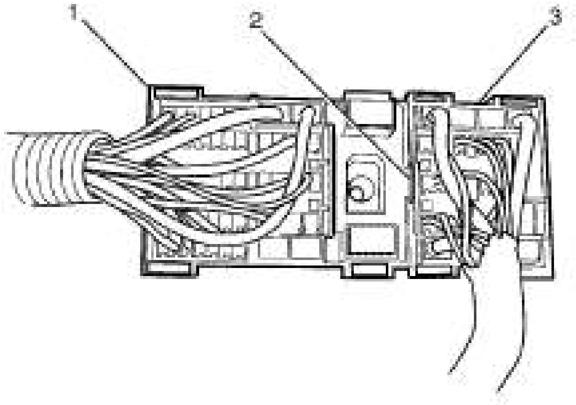
15. Remove the under hood body electrical centre (BEC) cover (1).
16. Remove the positive cable protective cover (3).
17. Remove the positive cable to under hood BEC plate retaining bolt (5).
18. Disconnect the positive cable (2) from the upper under hood BEC plate (4).



19. Remove the under hood BEC upper plate to lower plate retaining bolts (2).
20. Raise the upper under hood BEC plate (1) from the lower under hood BEC plate (3).

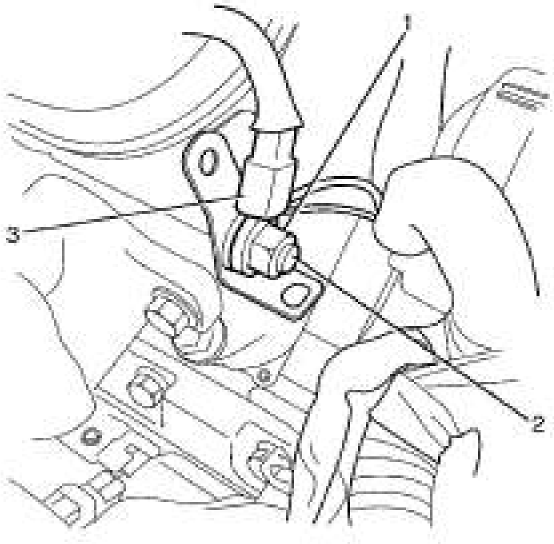


21. Detach the protector (1) from the base of the under hood BEC connector (2).

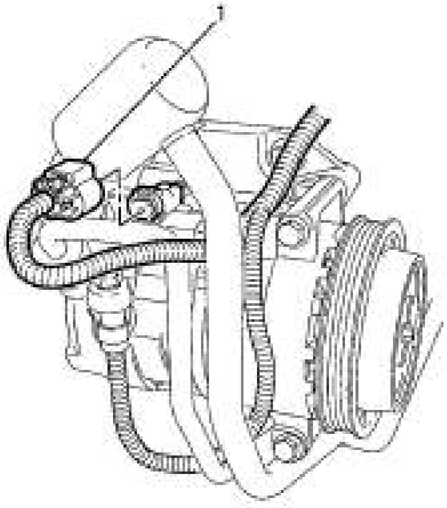


Important: Use a suitable tool to depress the connector locking tang (2), then pull the body harness connector (1) upward and the engine connector (3) downward to separate the body harness connector (1) from the engine connector (3).

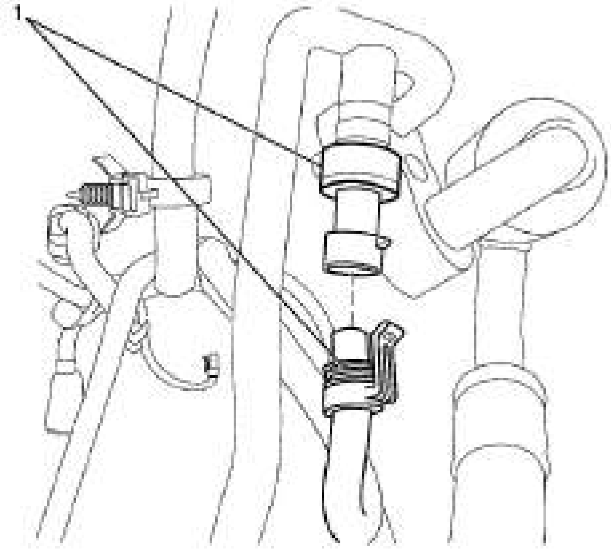
22. Separate the body harness connector (1) from the engine connector (3).
23. Reposition and secure the engine wiring harness and connector (3) on the engine.



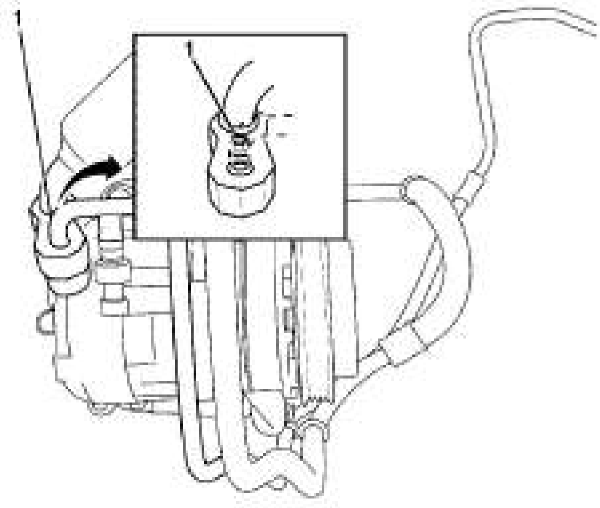
24. Remove the vehicle body ground cable to cylinder head retaining nut (1).
25. Remove the vehicle body ground cable (3) from the cylinder head stud (2).



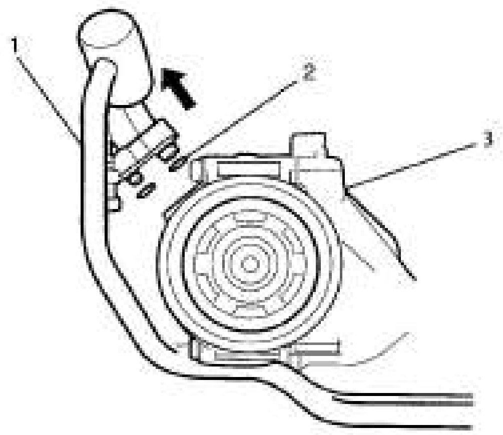
26. Disconnect the A/C electrical connector (1) from the A/C compressor.



27. Disconnect the electrical connector from the A/C Refrigerant Pressure Sensor (1).



28. Remove the suction/discharge pipes pad (1) to compressor retaining bolt (2).



29. Disconnect the suction/discharge pipes (1) from the compressor (3).

    Important: Sealing washers are single use and must be discarded after use.

    Important: Seal pipes immediately to prevent absorption of moisture from the atmosphere.

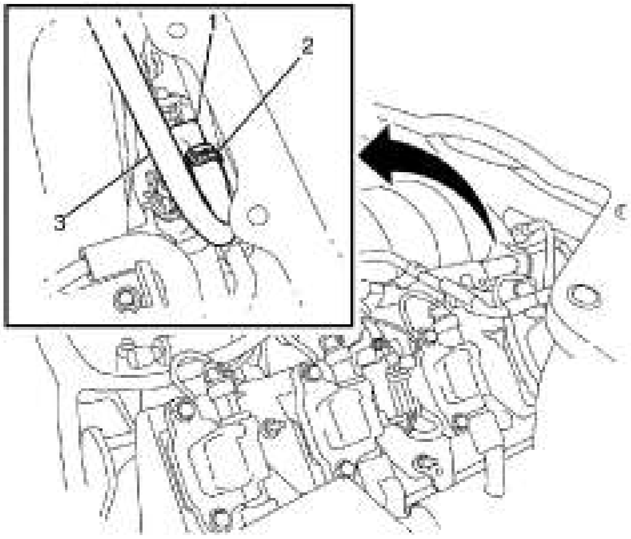
    Important: The plugs for A/C compressor ports must be sufficient to stop oil escaping when tilting A/C compressor for removal.

30. Remove and discard the port sealing washers (2).

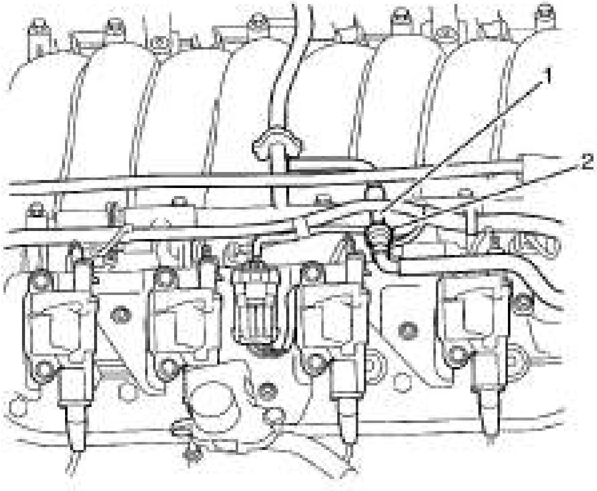
    Discard the port sealing washers (2).

    Important: Cap or plug the ports immediately to prevent absorption of moisture from the atmosphere.

31. Cap or plug the A/C compressor (3) ports.
32. Cap or plug the A/C hoses (1).

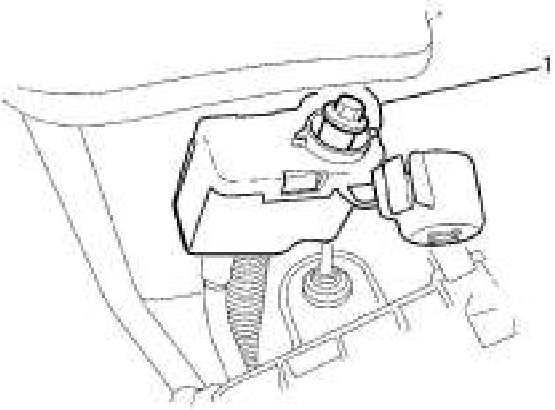


33. Compress the vacuum brake booster hose retaining clamp (2) at the intake manifold vacuum port (1) and slide 50 mm (2 in) back along the vacuum brake booster hose (3).
34. Disconnect the vacuum brake booster hose (3) from the intake manifold vacuum port (1).

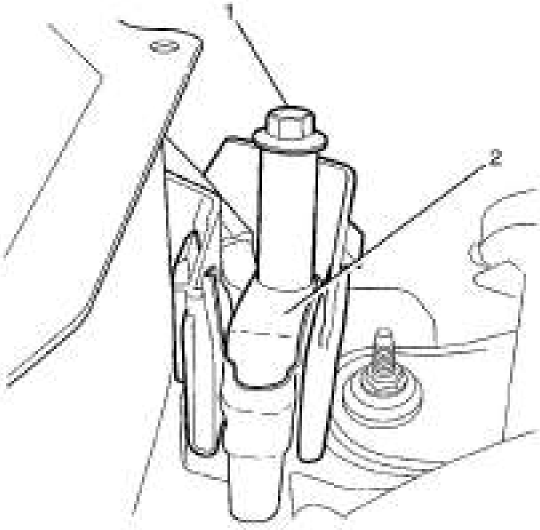


Important: Plug or cap the fuel feed pipe (2) and fuel rail tube (1) ends to prevent fuel leaks and/or contamination.

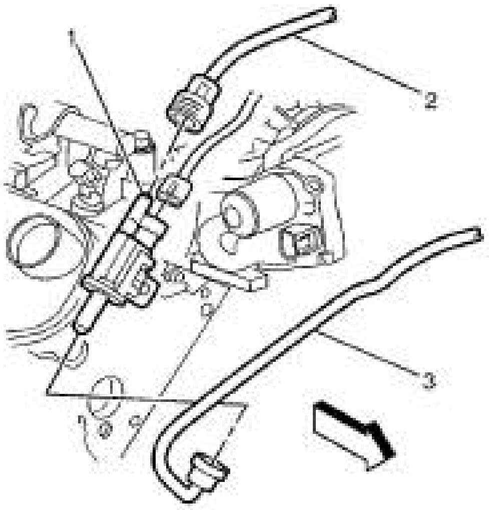
35. Disconnect the fuel rail feed pipe (2) quick connect fitting. Refer to Metal Collar Quick Connect Fitting Service or Plastic Collar Quick Connect Fitting Service.



36. Remove the remote positive battery post cover (1) from the remote positive battery post.



37. Remove the remote positive battery post to wiring harness retaining bolt (1).
38. Remove the wiring harness (2) from the remote positive battery post.

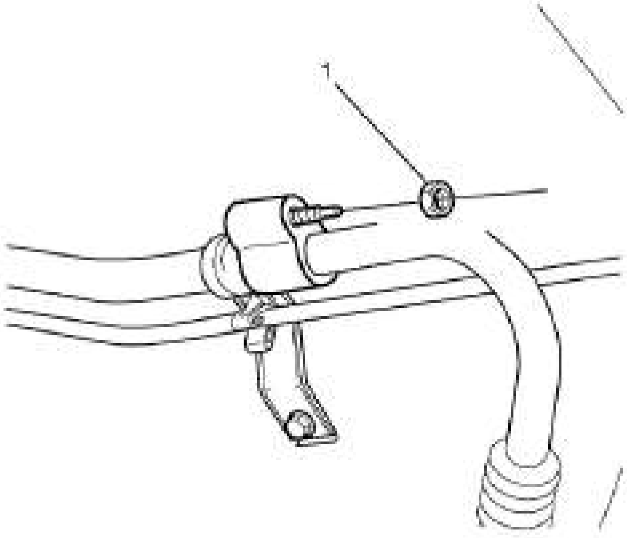


Important: Plug or cap the throttle body to EVAP purge valve hose (3) and EVAP purge valve (1) ends to prevent fuel leaks and/or contamination.

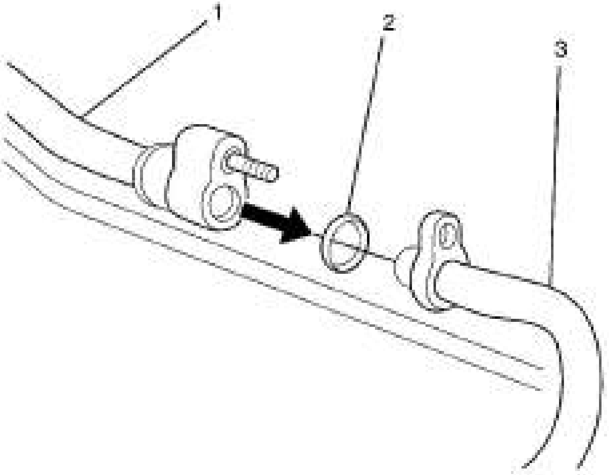
39. Disconnect the throttle body to EVAP purge valve hose (3) from the EVAP purge valve (1).

    Important: Plug or cap the EVAP purge valve to fuel tank hose (2) and EVAP purge valve (1) ends to prevent fuel leaks and/or contamination.

40. Disconnect the EVAP purge valve to fuel tank hose (2) from the EVAP purge valve (1).



41. Remove the A/C suction pipe pad to lower A/C suction pipe retaining nut (1).



42. Disconnect the upper A/C suction pipe (1) from the lower A/C suction pipe (3).

    Important: Plug or cap the A/C suction pipe ends (1 and 3) immediately to prevent contamination and absorption of moisture from the atmosphere.

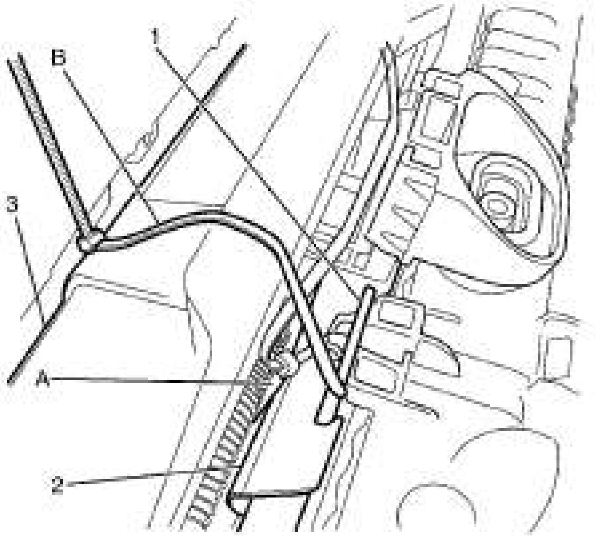
43. Plug or cap the A/C suction pipe ends.

    Important: The A/C suction pipe sealing O-ring (2) is a single use component and will not reseal. Install a NEW A/C suction pipe sealing O-ring (2) whenever the upper A/C suction pipe (1) is removed from the lower A/C suction pipe (3).

44. Remove and discard the A/C suction pipe sealing O-ring (2).

    Discard the A/C suction pipe sealing O-ring (2).

45. Reposition and retain the A/C suction/discharge pipes away from the engine.



Important: It is necessary to secure the radiator and condenser assembly (2) to the front end assembly (3) as the radiator and condenser assembly is supported to the subframe.

Important: Thread zip tie A around the front end assembly and zip tie B through the radiator and condenser mount (1). Insert zip tie A into the retainer of zip tie B and insert zip tie B into the retainer of zip tie A.

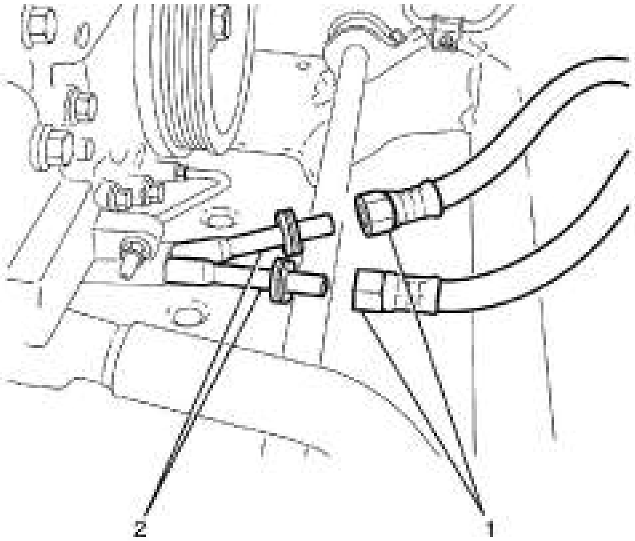
46. Secure radiator and condenser assembly (2) to the front end assembly (3) with large zip ties or equivalent.

Important: Ignore steps 47 - 49 for vehicles equipped with a manual transmission.

Important: The flexible hoses are not serviced separately. Therefore if the hose's require replacement, then the hose and radiator to hose cooler hose assembly must be fitted.

Important: When removal is complete plug hose openings with a clean lint free cloth to prevent foreign matter entry.

47. Place a suitable container beneath the radiator and engine.

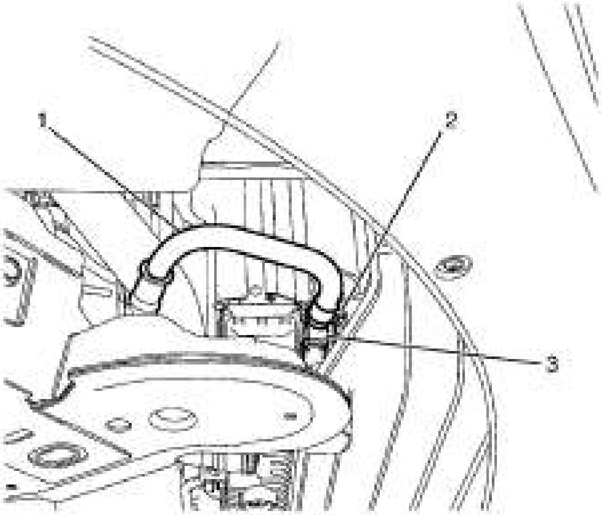


48. Disconnect the automatic transmission cooler pipe (2) from the flexible hose (1) at the quick connect fitting using tool. AU525.
    - Open release tool AU525 then close and clip around the hose to be disconnected.
    - While holding the flexible hose (1) push the hose inwards with one hand, then pull back to separate from the steel hose piping (2).
    - Repeat for the second fitting if required.
49. Reposition and secure the flexible hoses (1) away from the engine and subframe.

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

50. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
51. Remove the front air deflector. Refer to Front Air Deflector Replacement.
52. Remove the engine splash shield. Refer to Engine Splash Shield Replacement.

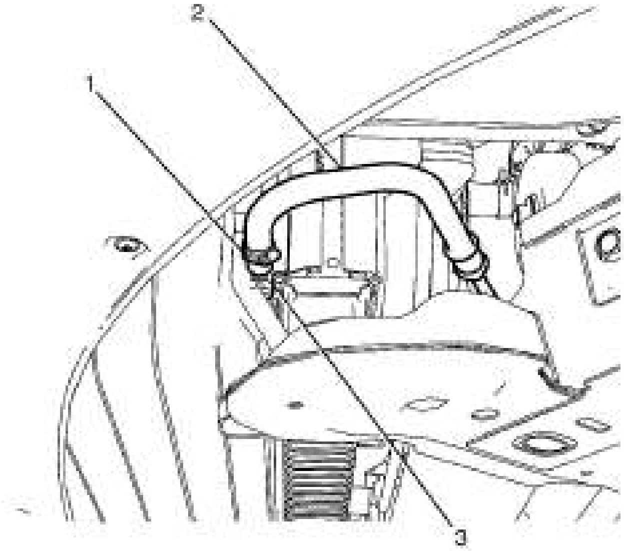


53. Place a suitable container under the power steering cooler.

Important: The power steering cooler (3) must be plugged to prevent the entry of foreign particles into the power steering system.

54. Release the power steering gear outlet hose spring clamp (2) and disconnect the power steering gear outlet hose (1) from the power steering cooler (3).

    Plug the power steering cooler (3) and power steering gear outlet hose (1).

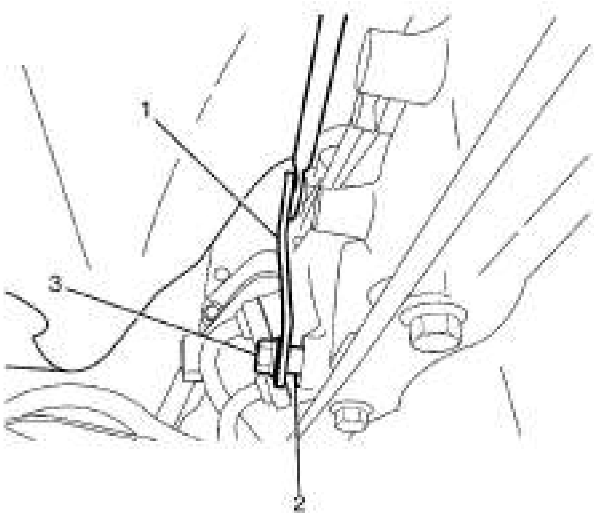


Important: The power steering cooler (3) must be plugged to prevent the entry of foreign particles into the power steering system.

55. Release the power steering reservoir inlet pipe/hose spring clamp (1) and disconnect the power steering reservoir inlet hose (2) from the power steering cooler (3).

    Plug the power steering cooler (3) and power steering reservoir inlet hose (2).

56. Remove the exhaust system. Refer to Exhaust System Replacement.
57. Remove the centre heat shield. Refer to Exhaust Heat Shield Replacement - Center.
58. Remove the propeller shaft. Refer to Propeller Shaft Replacement.
59. Remove the starter. Refer to Starter Motor Replacement.

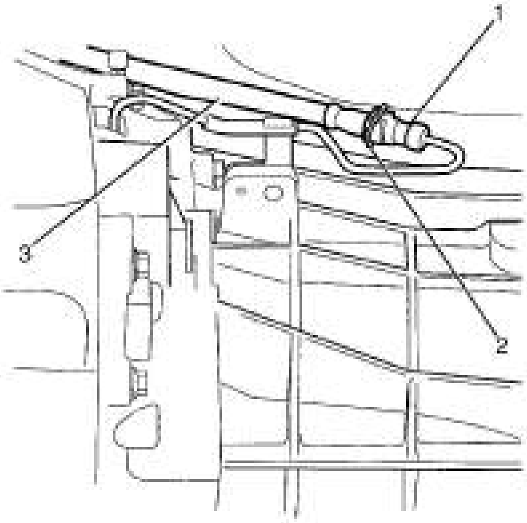


Important: Ignore steps 60 to 62 for vehicles fitted with an manual transmission.

60. Remove the shift selector linkage rod to shift selector shaft retaining nut (3).
61. Remove the shift selector linkage rod (1) from the shift selector shaft (2).

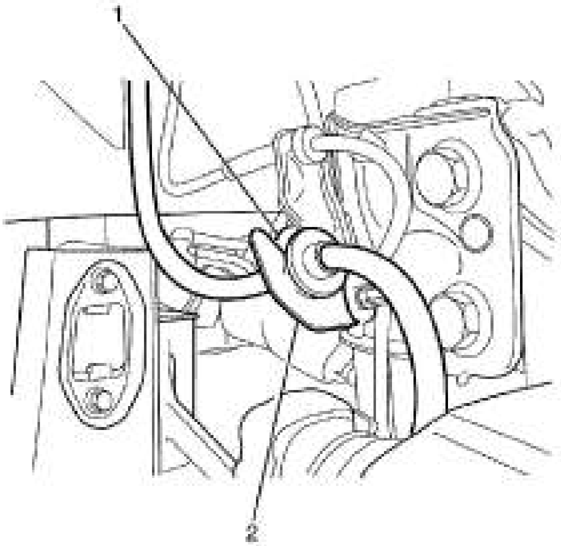
Important: Ignore steps 63 to 65 for vehicles fitted with an automatic transmission.

62. Remove the shift control assembly. Refer to Shift Control Assembly Replacement.

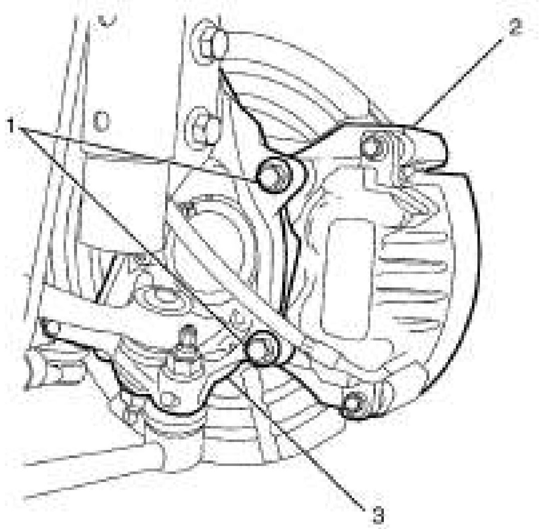


Important: Use a suitable tool to remove the flexible hose securing clip (2), take care not to lose the flexible hose securing clip (2) on removal.

63. Remove the flexible hose securing clip (2).
64. Disconnect the to concentric actuator cylinder feed hose (3) from the concentric actuator cylinder feed pipe (1).
65. Remove the front wheels. Refer to Tire and Wheel Removal and Installation.



66. Detach the front brake hose (1) from the front strut mounted brake hose retaining bracket (2). Repeat for opposite side.



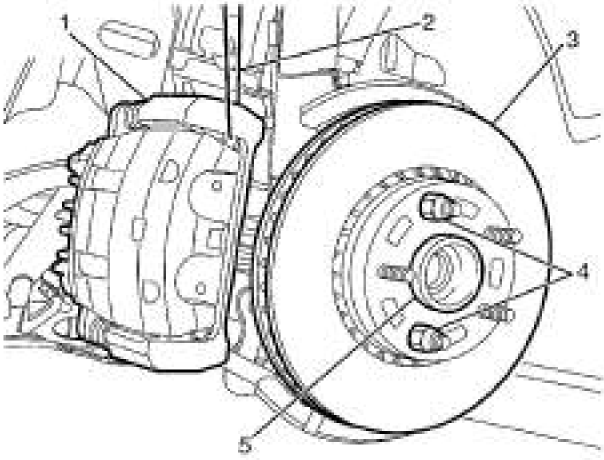
Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

67. Remove the front brake caliper anchor plate to knuckle retaining bolts (1). Repeat for opposite side.

    Discard the bolts.

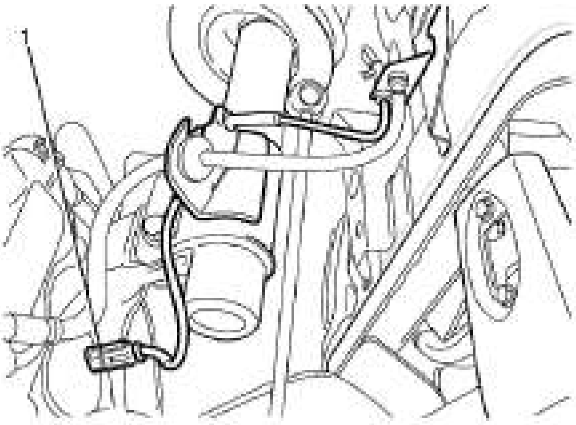
Important: DO NOT disconnect the hydraulic brake flexible hose from the brake caliper otherwise complete bleeding of the braking system will be necessary.

68. Remove the front brake caliper (2) from the front steering knuckle (3). Repeat for opposite side.

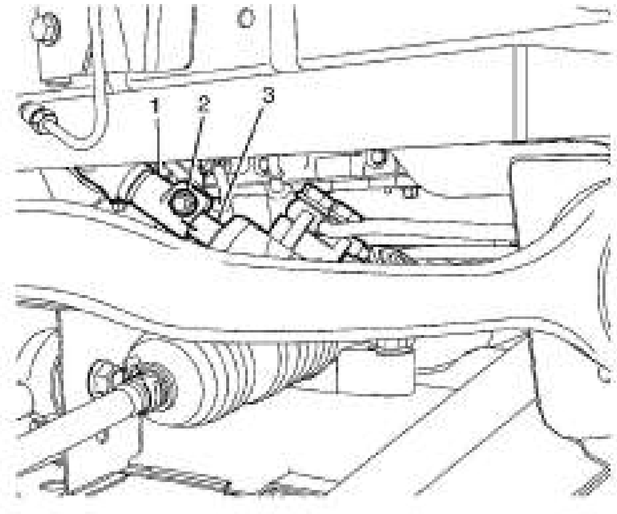


Notice: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

69. Support the brake caliper (1) with heavy mechanic's wire, or equivalent (2).
70. Remove the two wheel nuts (4) retaining the front brake disc (3) to the hub (5). Repeat for opposite side.



71. Disconnect the front wheel speed sensor jumper harness electrical connector (1) and secure away from the front subframe and suspension components. Repeat for opposite side.



Important: Observing the orientation of the intermediate steering shaft (1) with reference to the pinion shaft (3) will minimise the potential of incorrect steering column assembly alignment.

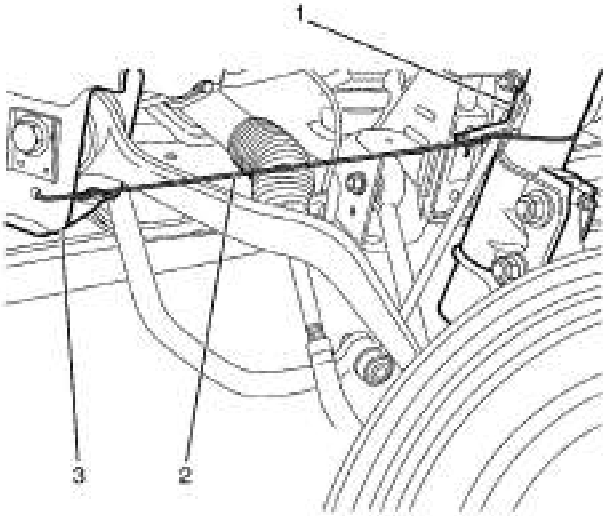
72. Mark the intermediate steering shaft (1) in relation to the pinion shaft (3).
73. Remove the intermediate steering shaft to pinion shaft retaining bolt (2).

Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

74. Disconnect the intermediate shaft (2) from the pinion shaft (3).

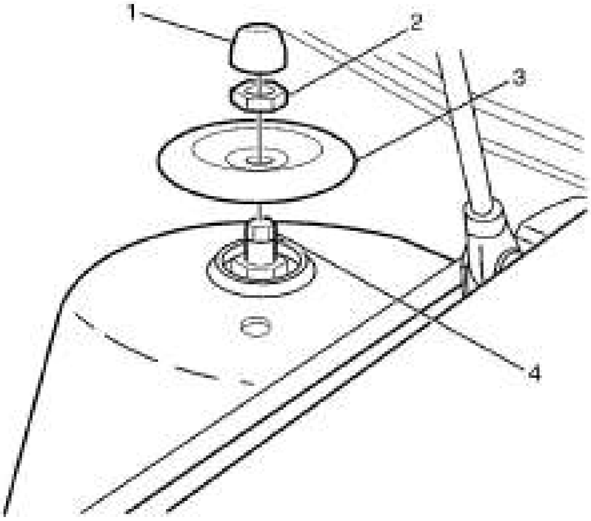
Discard the bolt.

75. Lower the vehicle.



Important: The strut assembly (1) must be secured to the subframe (3) to prevent damage to the front wheelhouse liner, fenders and suspension components.

76. Retain the front strut assembly (1) to the front subframe (3) using heavy mechanics wire or equivalent (2). Repeat for opposite side.



77. Remove the stud dust cover (1) from the strut assembly to front wheelhouse retaining nut (2). Repeat for opposite side.

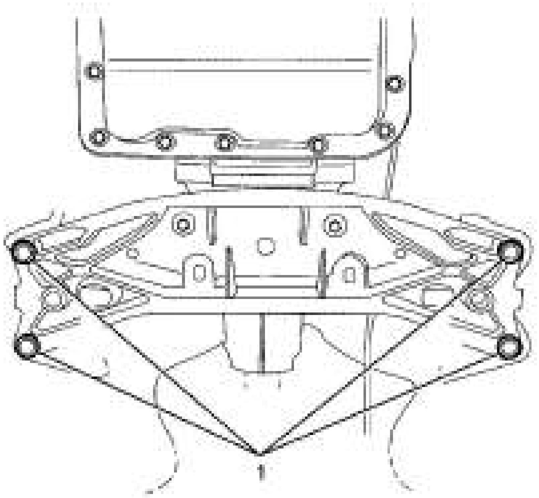
Important: The strut assembly (4) must be supported from underneath before the strut assembly to body retaining nut (2) is removed.

78. Remove the strut assembly to front wheelhouse retaining nut (2) while holding the strut

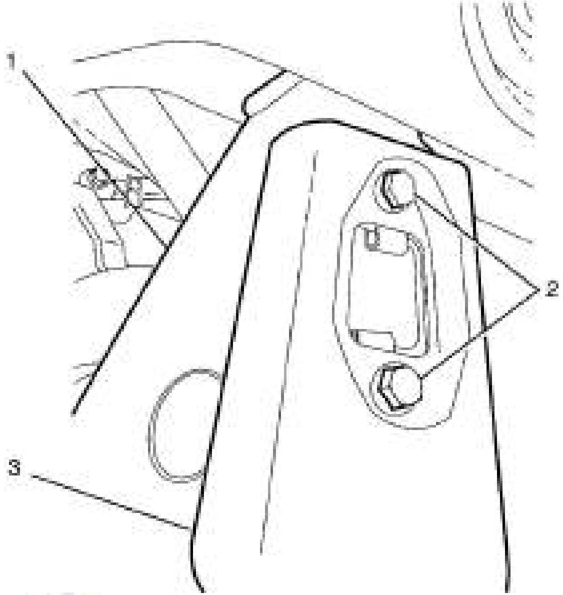
piston shaft (4). Repeat for opposite side.

Discard the nut.

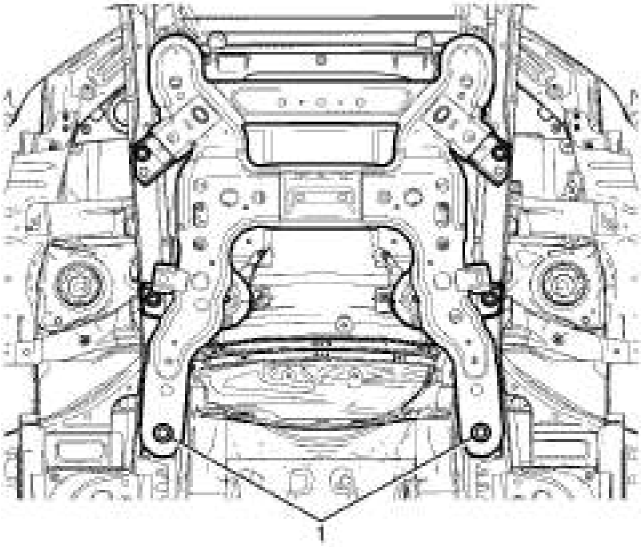
79. Remove the strut assembly to front wheelhouse retaining plate (3). Repeat for opposite side.
80. Position a suitable powertrain and/or engine lift table below the frame, engine and transmission.
81. Raise the lift table and/or lower the vehicle to support the frame, engine and transmission.



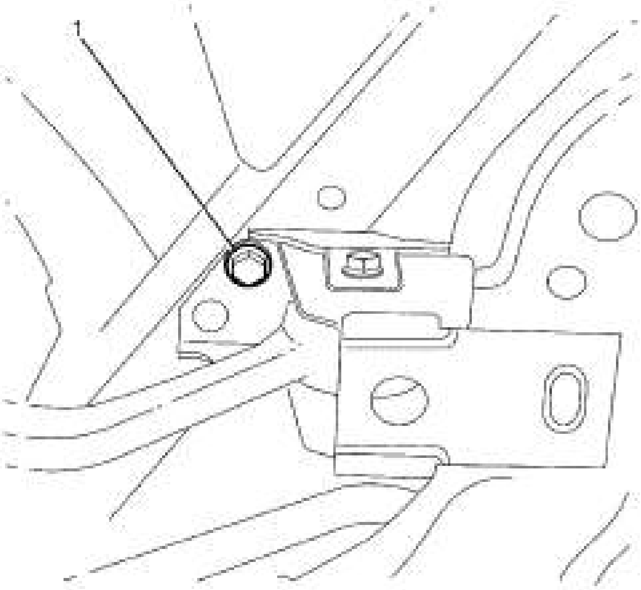
82. Remove the transmission support to body retaining bolts (1).



83. Remove the front subframe reinforcement plate to front subframe retaining bolts (2).
84. Remove the front subframe reinforcement plate (3) from the front subframe (1).

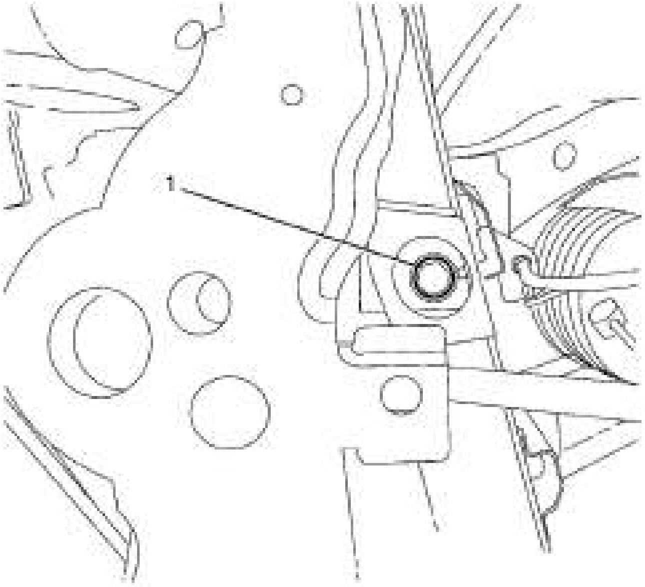


85. Remove the front subframe to body rear retaining bolts (1).



Important: Only right side depicted in graphic, left side similar.

86. Remove the front subframe to body front retaining bolt (1). Repeat for opposite side.

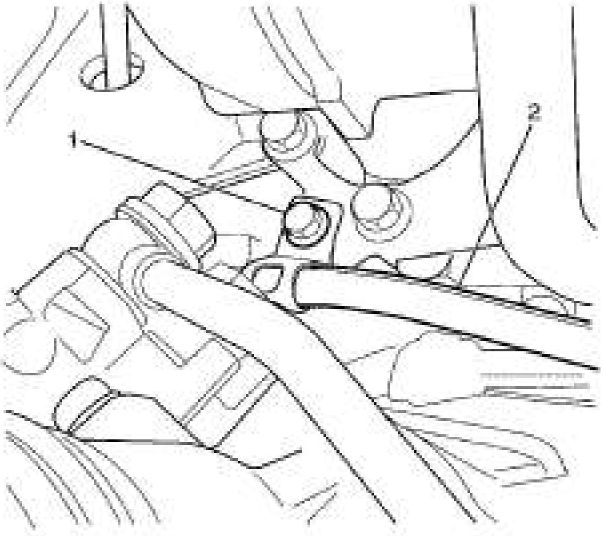


Important: Only right side depicted in graphic, left side similar.

87. Remove the front subframe to body retaining bolt (1). Repeat for opposite side.

    Important: Make sure that all the hoses, wires, pipes and front struts clear the vehicle during the removal process.

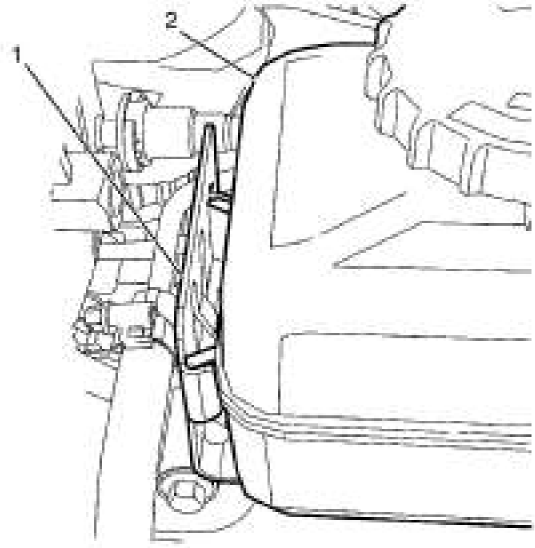
88. With the aid of an assistant, lower the table and/or raise the vehicle to remove the engine, transmission, front suspension and subframe assembly from the vehicle.
89. Remove the engine and transmission wiring harness and related components. Refer to Engine Wiring Harness Assembly Removal.



90. Remove the automatic transmission cooler pipe clamp to A/C bracket bolt (1) and position

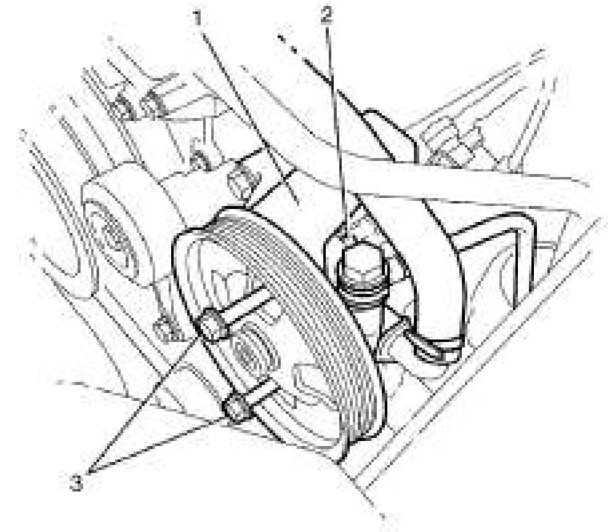
the automatic transmission cooler pipes (2) aside.

91. Connect a suitable lifting crane to the engine lift brackets and raise the suitable lifting crane to support the engine.
92. Position a second powertrain lift table below the transmission.
93. Remove the transmission. Refer to one of the following procedures:
    - Transmission Replacement in Manual Transmission -- Tremec 6-speed.
    - Transmission Replacement in Automatic Transmission -- 4L60-E/4L65-E/4L70-E.
    - Transmission Replacement in Automatic Transmission -- 5L40-E/5L50-E
    - Transmission Replacement in Automatic Transmission -- 6L50/6L80/6L90.
94. Remove the engine flywheel. Refer to Engine Flywheel Removal.
95. Remove the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
96. Remove the A/C drive belt. Refer to Air Conditioning Compressor Belt Replacement.

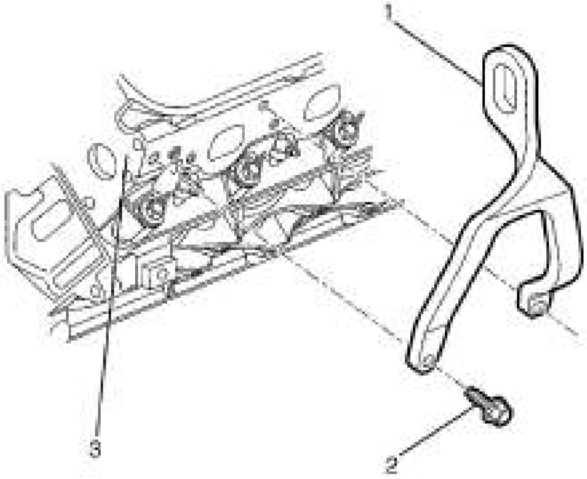


Important: The locking tang on the power steering reservoir bracket (1) must be released before removing the power steering reservoir (2).

97. Remove the power steering reservoir (2) from the power steering pump power steering reservoir bracket (1) and position the power steering reservoir (2) aside.



98. Remove the power steering pump (2) to power steering pump bracket retaining bolts (3) and position the power steering pump (2) away from the power steering pump bracket (1).



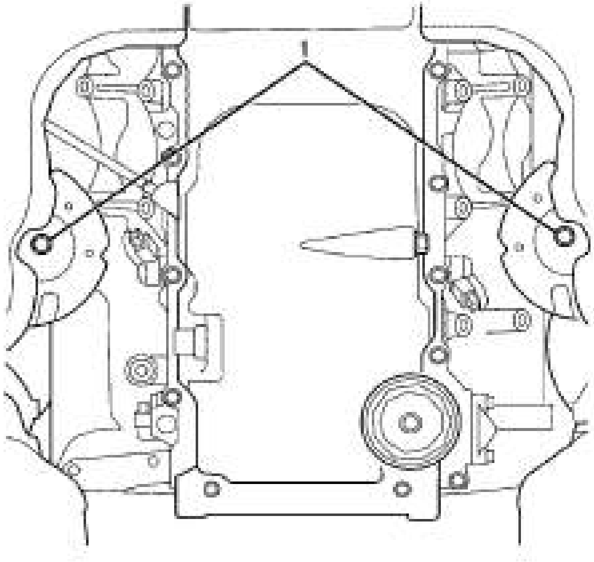
99. Position the J 41798 J 41798 (1) on the cylinder head (3).

Notice: Refer to Fastener Notice in the Preface section.

100. Install the J 41798 J 41798 to cylinder head retaining bolts (2).

Tighten
Tighten the bolts to 50 N·m (36 lb ft).

101. Attach a suitable lifting chain and hooks to the engine lifting brackets (1).



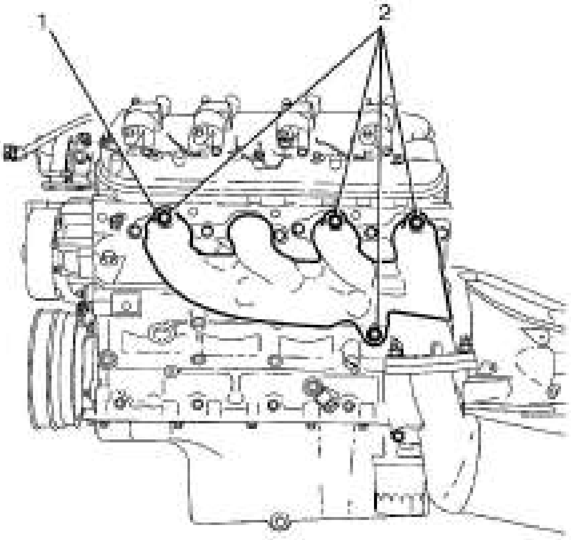
102. Remove the lower engine mount to front subframe retaining nut (1) from both engine mounts.
103. Using a suitable lifting crane, raise the engine to clear the engine mount stud.
104. Remove the engine from the subframe

If required mount the engine on a suitable engine stand.

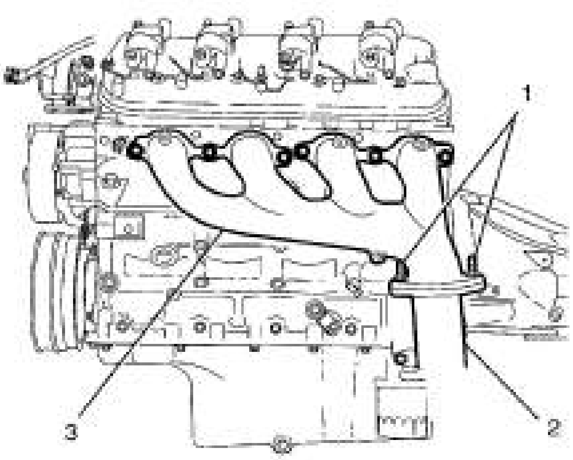
105. Remove the left side spark plug leads. Refer to Spark Plug Wire Replacement.
106. Remove the left side spark plugs from the cylinder head. Refer to Spark Plug Replacement.

Caution: Refer to Exhaust Service Caution in the Preface section.

Caution: Refer to Protective Goggles and Glove Caution in the Preface section.



107. Remove the exhaust manifold heat shield to exhaust manifold retaining bolts (2).
108. Remove the left side exhaust manifold heat shield (1).



Important: The left side catalytic converter to exhaust manifold retaining nuts (1) are single use parts. They must be discarded after removal.

109. Remove the left side catalytic converter to exhaust manifold retaining nuts (1).

     Discard the nuts.

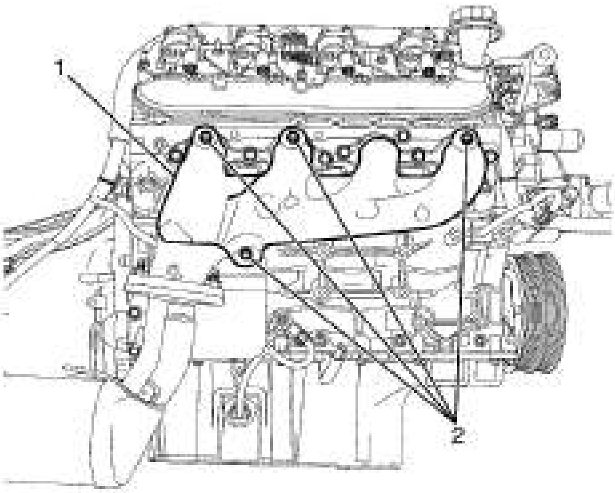
110. Disconnect the left side catalytic converter (2) from the exhaust manifold (3).

     Discard the gasket.

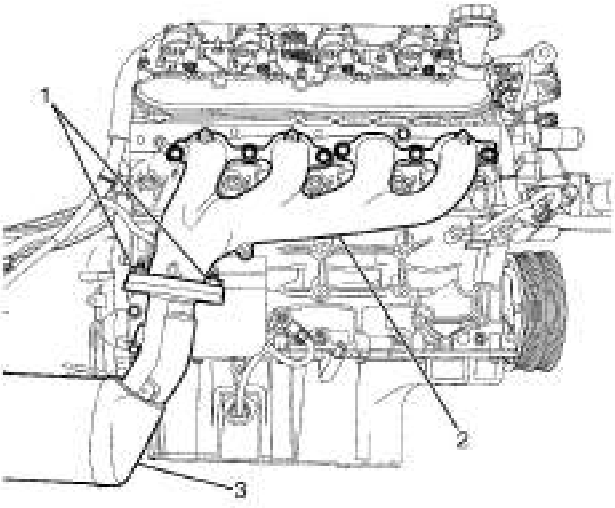
111. Remove the right side spark plug leads. Refer to Spark Plug Wire Replacement.
112. Remove the right side spark plugs from the cylinder head. Refer to Spark Plug Replacement.

Caution: Refer to Exhaust Service Caution in the Preface section.

Caution: Refer to Protective Goggles and Glove Caution in the Preface section.



113. Remove the right side exhaust manifold heat shield to right side exhaust manifold retaining bolts (2).
114. Remove the right side exhaust manifold heat shield (1).



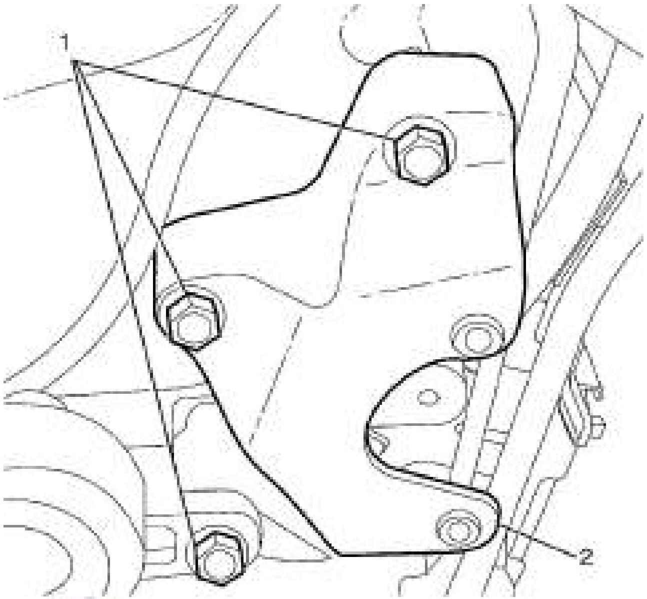
Important: The right side catalytic converter to exhaust manifold retaining nuts (1) are single use parts. They must be discarded after removal.

115. Remove the right side catalytic converter to exhaust manifold retaining nuts (1).

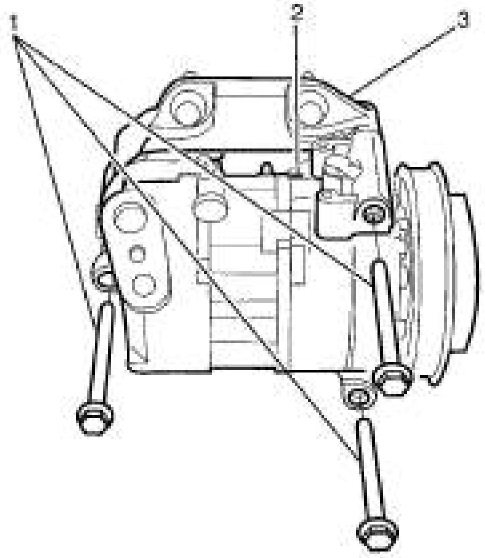
     Discard the nuts.

116. Disconnect the right side catalytic converter (3) from the exhaust manifold (2).

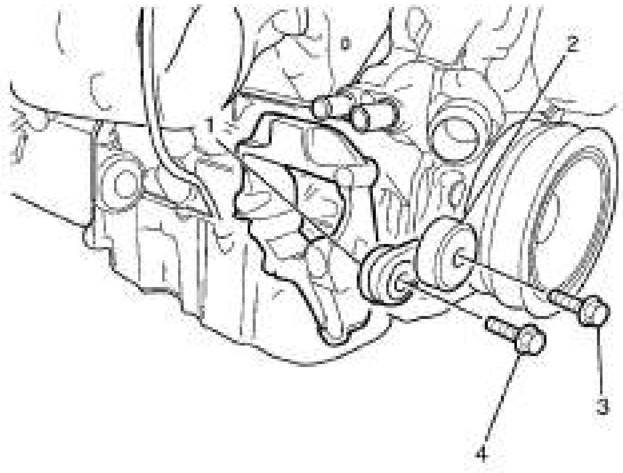
Discard the gasket.



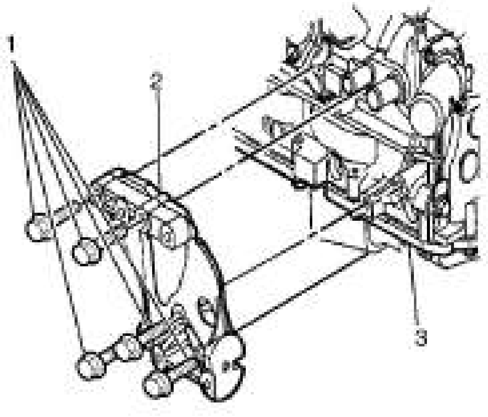
117. Remove the power steering pump bracket to engine retaining bolts (1).
118. Remove the power steering pump bracket (2).



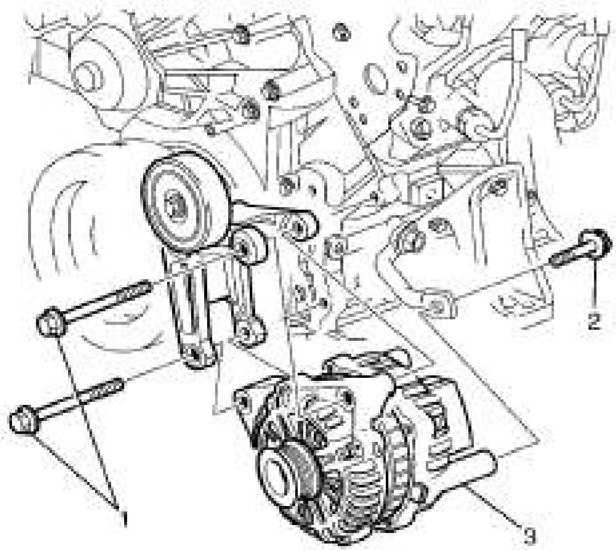
119. Remove the compressor to A/C compressor bracket retaining bolts (1).
120. Remove the compressor (2) to the A/C compressor bracket (3).



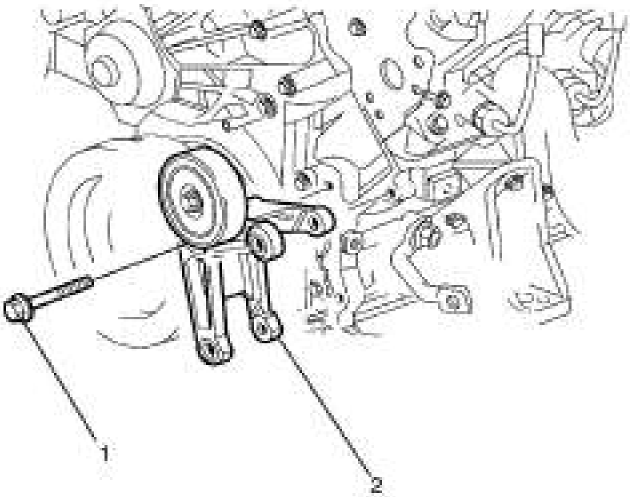
121. Remove the A/C tensioner pulley to A/C tensioner retaining bolt (3).
122. Remove the A/C tensioner pulley (2).
123. Remove the A/C drive belt tensioner to A/C compressor bracket retaining bolt (4).
124. Remove the A/C drive belt tensioner (1).



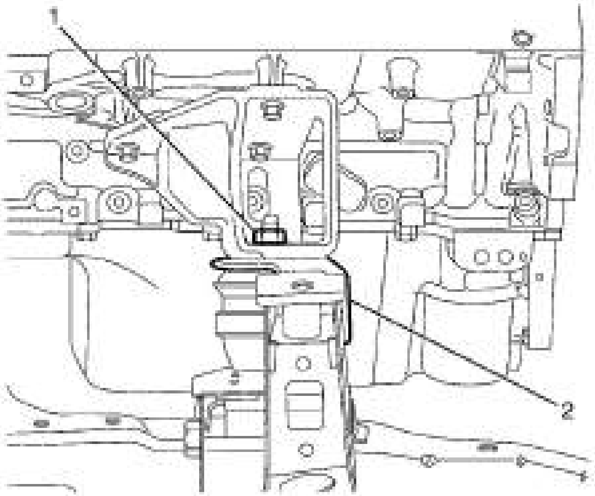
125. Remove the A/C compressor bracket to cylinder head retaining bolts (1).
126. Remove the A/C compressor bracket (2).



127. Remove alternator to alternator bracket retaining bolts (1 and 2).
128. Remove the alternator (3) from the alternator bracket.

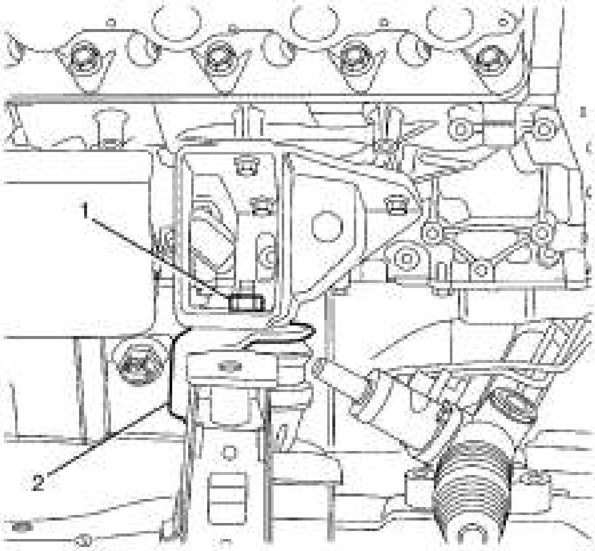


129. Remove the alternator bracket to engine block mounting bolt (1).
130. Remove the alternator bracket (2) from the engine.



Important: DO NOT bend or distort the left side engine mount heat shield (2).

131. Remove the left side engine mount to engine mount bracket retaining nut (1).



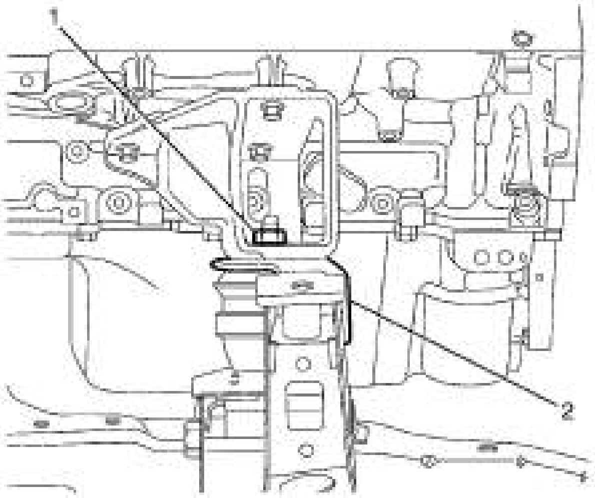
Important: DO NOT bend or distort the right side engine mount heat shield (2).

132. Remove the right side engine mount to engine mount bracket retaining nut (1).
133. Attach a suitable lifting chain and hooks to the 2 J 41798 J 41798, engine lifting brackets.
134. Using a suitable lifting crane, remove the engine from the subframe.

If required, mount engine to a suitable engine stand.

135. Remove the lifting equipment as required.

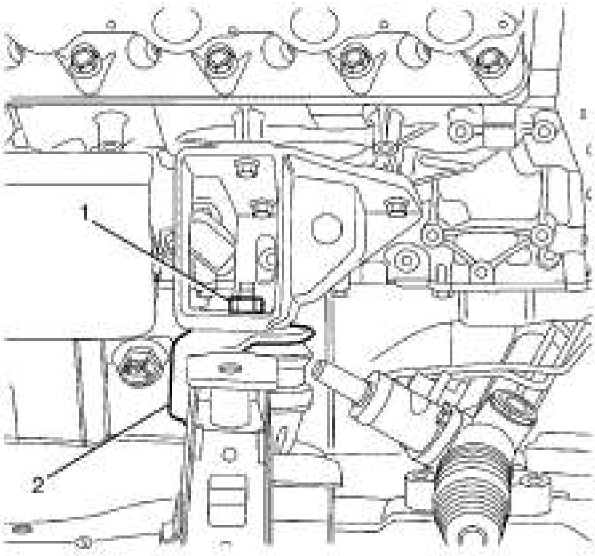
Installation Procedure



Important: DO NOT bend or distort the left side engine mount heat shield (4).

1. Install the left side engine mount to engine mount bracket retaining nut (1)

   Tighten
   Tighten the nut to 80 N·m (59 lb ft).

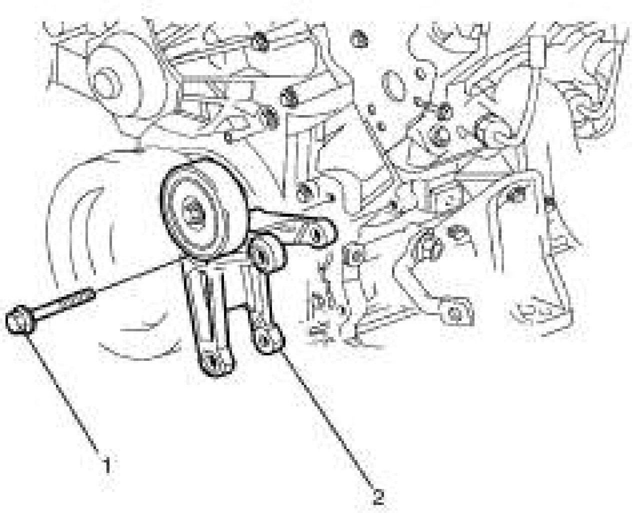


Important: DO NOT bend or distort the right side engine mount heat shield (4).

2. Install the right side engine mount to engine mount bracket retaining nut (1).

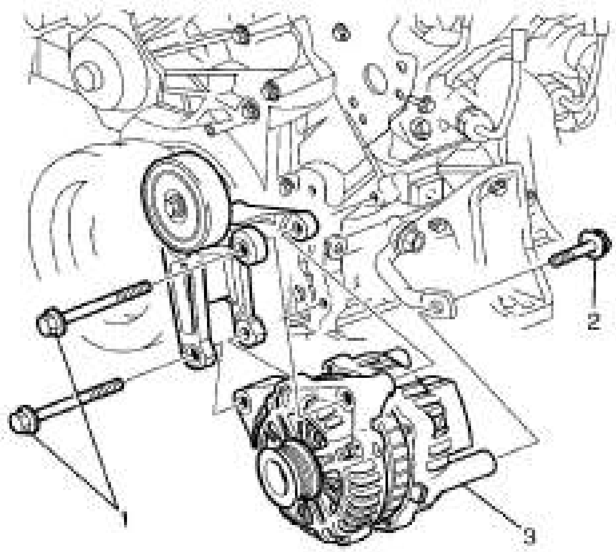
   Tighten
   Tighten the nut to 80 N·m (59 lb ft).

3. Remove the lifting equipment as required and the J 41798 J 41798 from the cylinder heads.



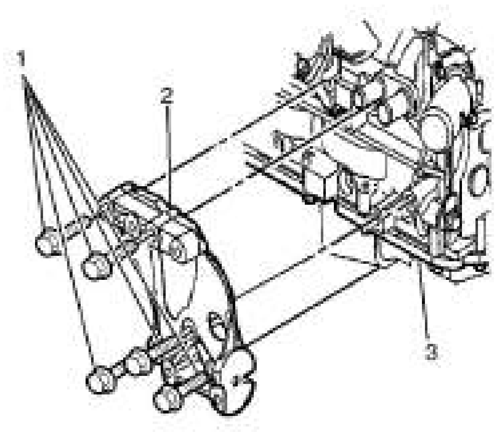
4. Install the alternator bracket (2) to the engine.
5. Install the alternator bracket to engine block mounting bolt (1).

   Tighten
   Tighten the bolt to 50 N·m (37 lb ft).



6. Install the alternator (3) to the alternator bracket.
7. Install alternator to alternator bracket retaining bolts (1 and 2).

   Tighten
   Tighten the bolts to 34 N·m (25 lb in).

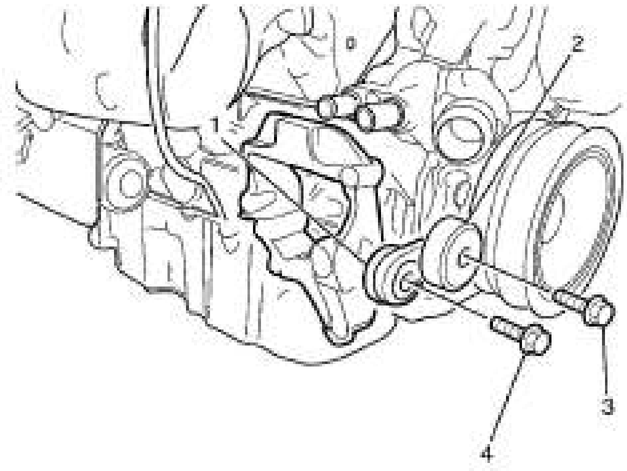


8. Install the A/C compressor bracket (2) to the engine.

   Notice: Refer to Fastener Notice in the Preface section.

9. Install the A/C compressor bracket to the cylinder block retaining bolts (1).

Tighten
Tighten the bolts to 58 N·m(43 lb ft).



10. Install the A/C drive belt tensioner (1) to the engine.

    Notice: Refer to Fastener Notice in the Preface section.

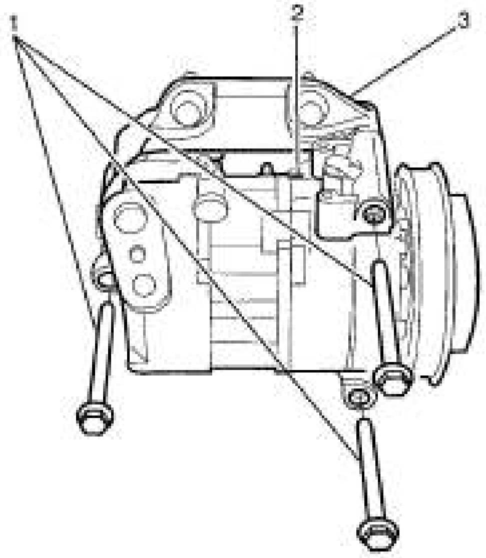
11. Tighten the A/C drive belt tensioner to A/C compressor bracket retaining bolt (4).

    Tighten
    Tighten the bolt to 22 N·m (16 lb ft).

12. Install the A/C tensioner pulley (2) to the A/C tensioner.
13. Install the A/C tensioner pulley to A/C tensioner retaining bolt (3).

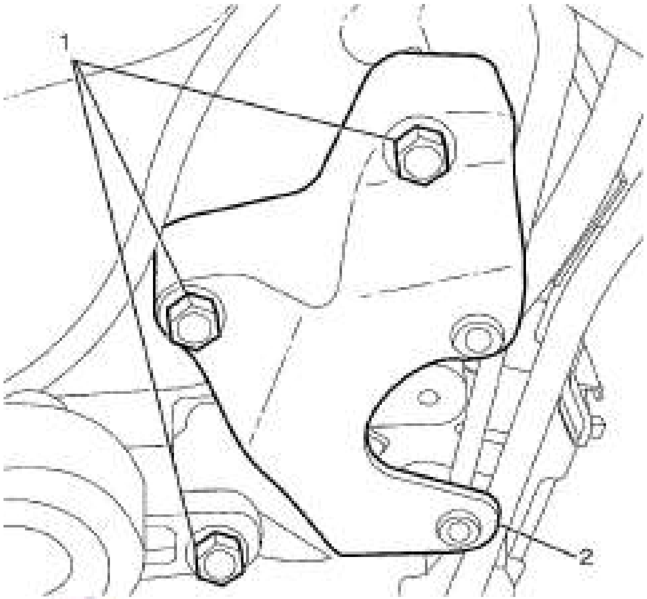
    Tighten
    Tighten the bolt to 50 N·m (37 lb ft).

14. If you are replacing the compressor, balance the compressor oil. Refer to Air Conditioning Compressor Oil Balancing.



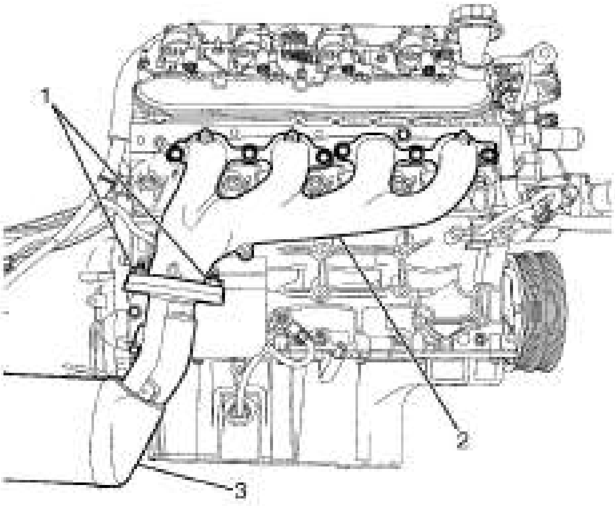
15. Install the compressor (2) to the compressor mounting bracket (3).
16. Install the compressor to compressor mounting bracket retaining bolts (1).

    Tighten
    Tighten the bolts to 22 N·m (16 lb ft).



17. Install the power steering pump bracket (2).
18. Install the power steering pump bracket to engine retaining bolts (1).

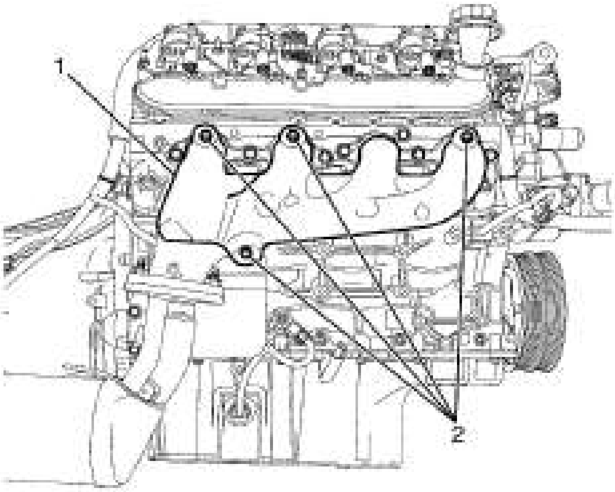
    Tighten
    Tighten the bolts to 58 N·m (43 lb ft).



Important: Make sure that a new sealing ring is fitted prior to installation. If not the exhaust system may perform poorly.

19. Install a NEW sealing ring to the right side catalytic converter.
20. Connect the right side catalytic converter (3) to the right side exhaust manifold (2).
21. Install the right side catalytic converter to right side exhaust manifold retaining nuts (1).

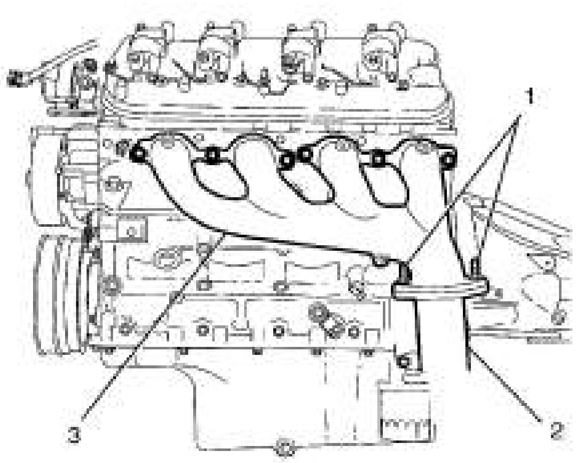
Tighten
Tighten the nuts to 45 N·m (33 lb ft).



22. Install the right side exhaust manifold heat shield (1) to the right side exhaust manifold.
23. Install the right side exhaust manifold heat shield to right side exhaust manifold retaining bolts (2).

    Tighten
    Tighten the bolts to 10 N·m (89 lb in).

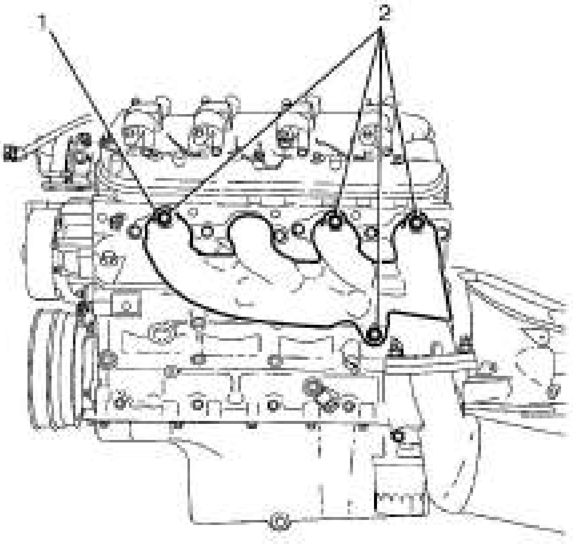
24. Install the right side spark plugs to the cylinder head. Refer to Spark Plug Replacement.
25. Install the right side spark plug leads. Refer to Spark Plug Wire Replacement



Important: Make sure that a new sealing ring is fitted prior to installation. If not the exhaust system may perform poorly.

26. Install a NEW sealing ring to the left side catalytic converter.
27. Connect the left side catalytic converter (2) to the left side exhaust manifold (3).
28. Install the left side catalytic converter to left side exhaust manifold retaining nuts (1).

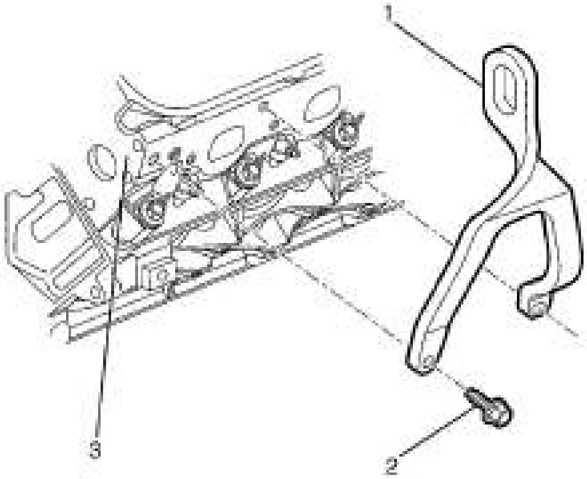
    Tighten
    Tighten the nuts to 45 N·m (33 lb ft).



29. Install the left side exhaust manifold heat shield (1) to the left side exhaust manifold.
30. Install the left side exhaust manifold heat shield to left side exhaust manifold retaining bolts (2).

    Tighten
    Tighten the bolts to 10 N·m (89 lb in).

31. Install the left side spark plugs to the cylinder head. Refer to Spark Plug Replacement.
32. Install the left side spark plug leads. Refer to Spark Plug Wire Replacement



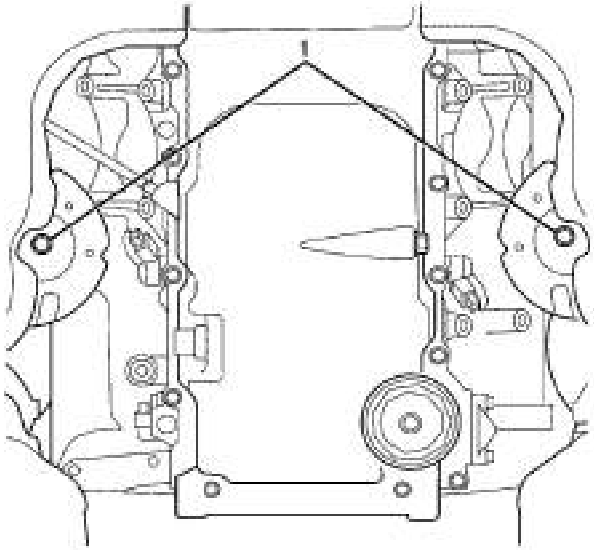
33. Position the J 41798 J 41798 (1) on the cylinder heads (3).

    Notice: Refer to Fastener Notice in the Preface section.

34. Install the J 41798 J 41798 to cylinder head retaining bolts (2).

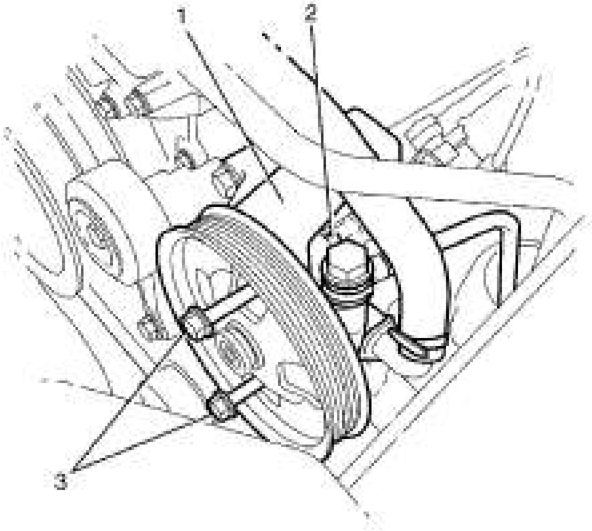
    Tighten
    Tighten the bolts to 50 N·m (36 lb ft).

35. Using a suitable lifting crane and the J 41798 J 41798 raise the engine slightly.
36. Remove the engine from the engine stand.
37. Lower the engine onto the front subframe.
38. Position the engine mounts to the front subframe.



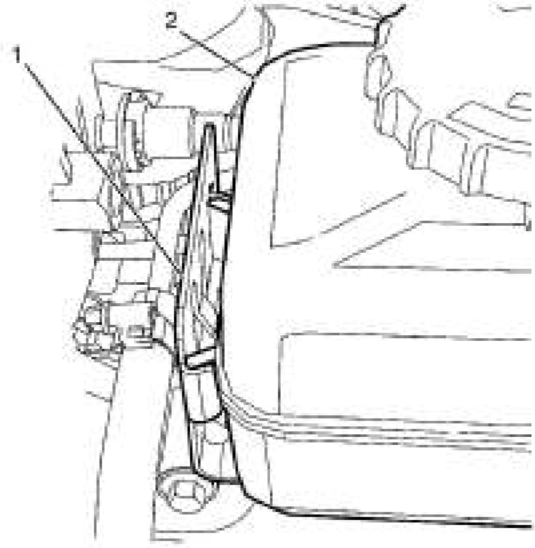
39. Install the lower engine mount to front subframe retaining nuts (1) on both engine mounts.

    Tighten
    Tighten the nuts to 80 N·m (59 lb ft).



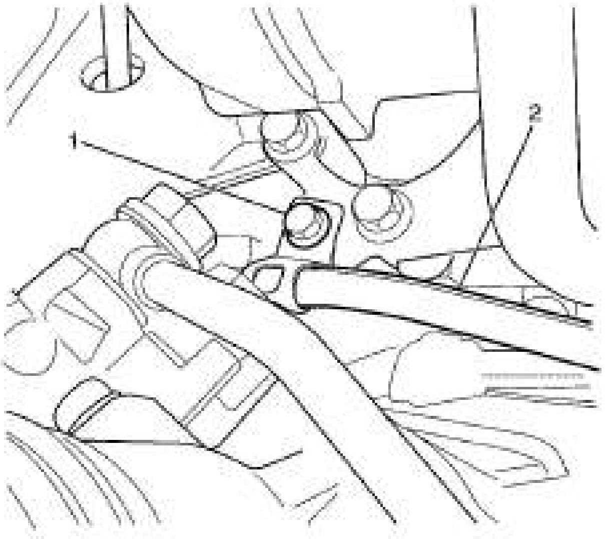
40. Position the power steering pump (2) to the power steering pump bracket (1).
41. Install NEW power steering pump to power steering pump bracket retaining bolts (3).

Tighten
Tighten the bolts to 30 N·m (23 lb ft).



Important: Make sure the power steering reservoir (2) and the power steering reservoir bracket locking tang (1) are engaged to avoid an induced rattle condition.

42. Install the power steering reservoir (2) to the power steering pump power steering reservoir bracket (1).
43. Install the A/C drive belt. Refer to Air Conditioning Compressor Belt Replacement.
44. Install the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
45. Install the engine flywheel. Refer to Engine Flywheel Installation.
46. Connect a suitable lifting crane to the engine lift brackets and raise the suitable lifting crane to support the engine.
47. Install the transmission. Refer to one of the following procedures:
    - Transmission Replacement in Manual Transmission -- Tremec 6-speed.
    - Transmission Replacement in Automatic Transmission -- 4L60-E/4L65-E/4L70-E.
    - Transmission Replacement in Automatic Transmission -- 5L40-E/5L50-E
    - Transmission Replacement in Automatic Transmission -- 6L50/6L80/6L90.



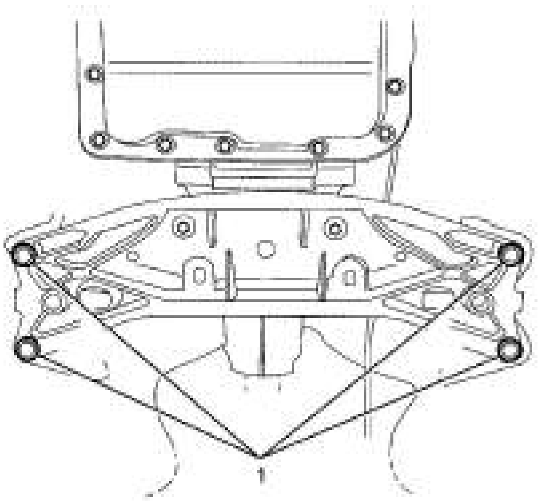
48. Position the automatic transmission cooler pipes (2) to the engine.
49. Install the automatic transmission cooler pipe clamp to A/C bracket bolt (1).

Tighten
Tighten the bolt to 22 N·m (16 lb ft).

50. Install the engine and transmission wiring harness and related components. Refer to Engine Wiring Harness Assembly Removal.

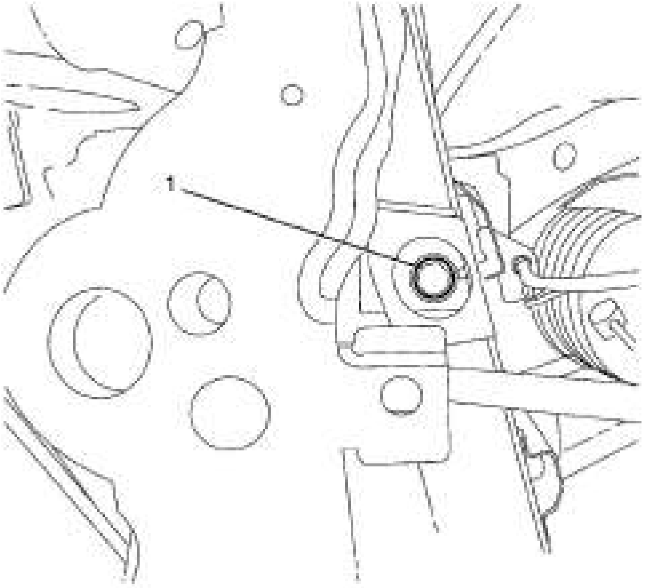
Important: Make sure that all the hoses, wires, pipes and shock modules clear the vehicle during the installation process.

51. With the aid of an assistant, raise the table and/or lower the vehicle to install the engine, transmission, front suspension and subframe assembly to the vehicle.



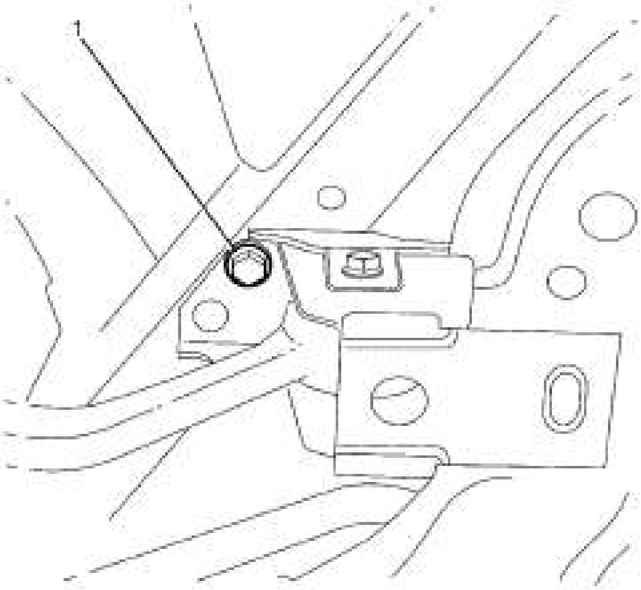
52. Install the transmission support to body retaining bolts (1).

Tighten
Tighten the bolts to 58 N·m (42 lb ft).



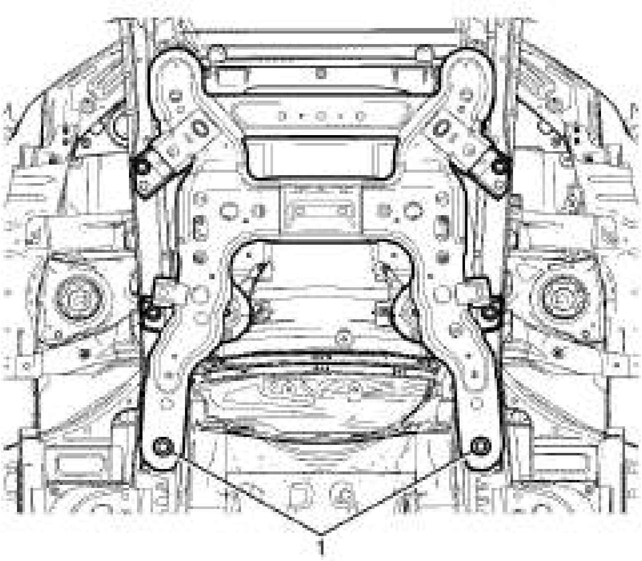
53. Install the front subframe to body centre retaining bolt (1). Repeat for opposite side.

Tighten
Tighten the bolts to 160 N·m (118 lb ft).



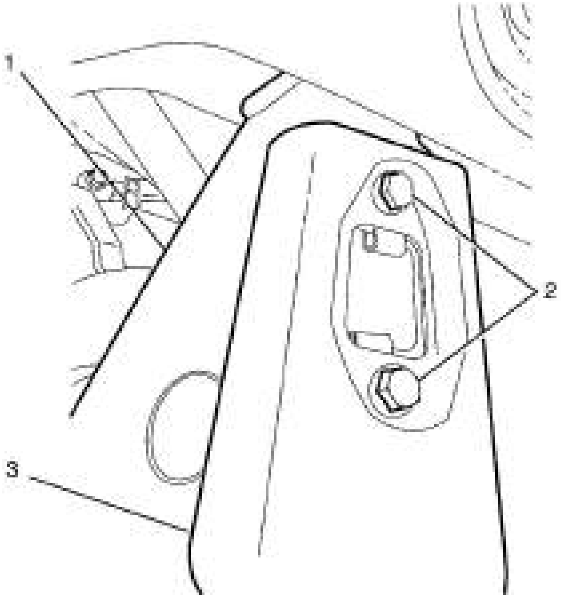
54. Install the front subframe to body front retaining bolt (1). Repeat for opposite side.

    Tighten
    Tighten the bolts to 160 N·m (118 lb ft).



55. Install the subframe to body rear retaining bolts (1).

    Tighten
    Tighten the bolts to 240 N·m (177 lb ft).

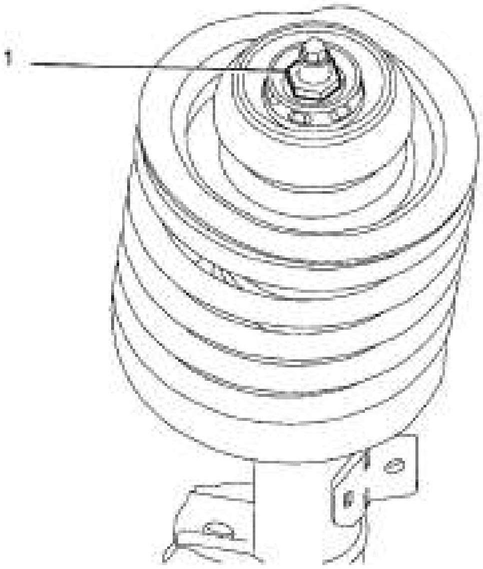


56. Install the front subframe reinforcement plate (3) to the subframe (1).
57. Install the front subframe reinforcement plate to front subframe retaining bolts (2).

Tighten
Tighten the bolts to 17 N·m (11 lb ft).

58. Lower the lift table and/or raise the vehicle to remove the support from the frame, engine and transmission.
59. Remove the powertrain and/or engine lift table from the frame, engine and transmission.
60. Lower the vehicle.

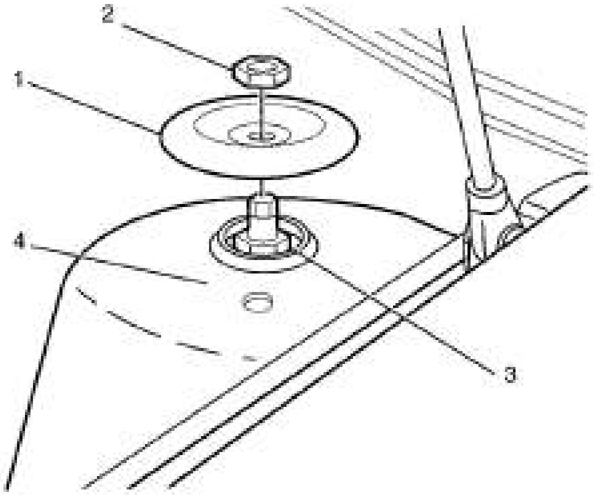
Notice: Refer to Fastener Notice in the Preface section.



Important: The strut assembly retaining nut (1) must be checked for correct torque before installing the strut assembly into the vehicle. The strut assembly retaining nut torque must be 75 N·m (55 lb ft).

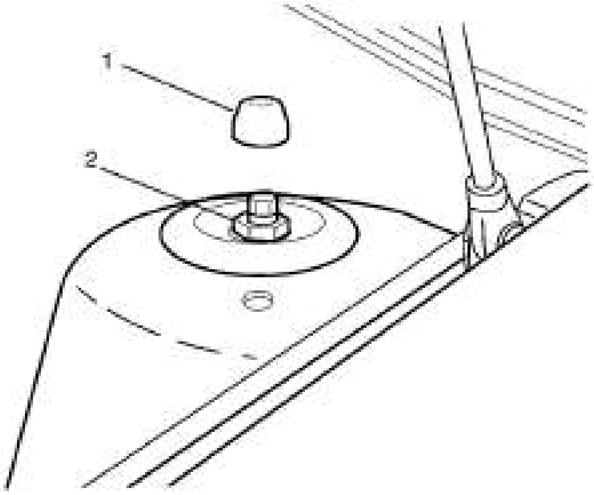
61. Check the torque of the strut assembly retaining nut (1), correct if necessary. Repeat for opposite side.

Tighten
Tighten the nut to 75 N·m (55 lb ft).

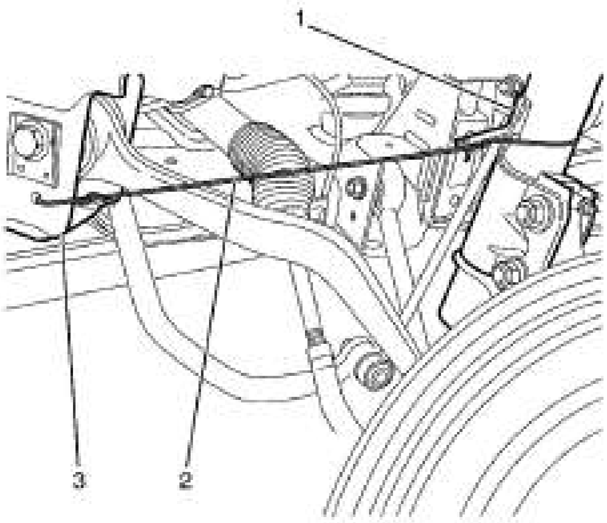


62. Install the front strut assembly (3) to the front wheelhouse (4). Repeat for opposite side.
63. Install front strut assembly to front wheelhouse retaining plate (1). Repeat for opposite side.
64. Tighten the NEW front strut assembly to front wheelhouse retaining nut (2). Repeat for opposite side.

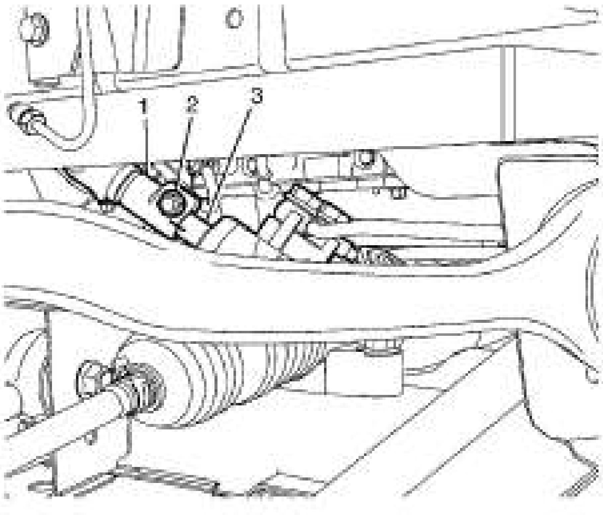
Tighten
Tighten the nut to 55 N·m (40 lb ft).



65. Install the dust cover (1) to the front strut assembly to front wheelhouse retaining nut (2).
66. Raise the vehicle.



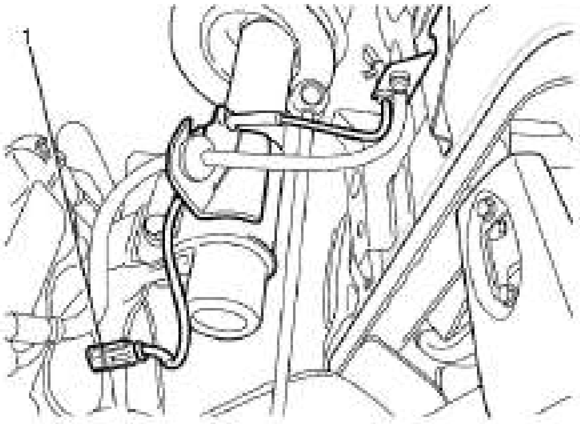
67. Remove the heavy mechanics wire or equivalent (2) retaining the front strut assembly (1) to the front subframe (3).



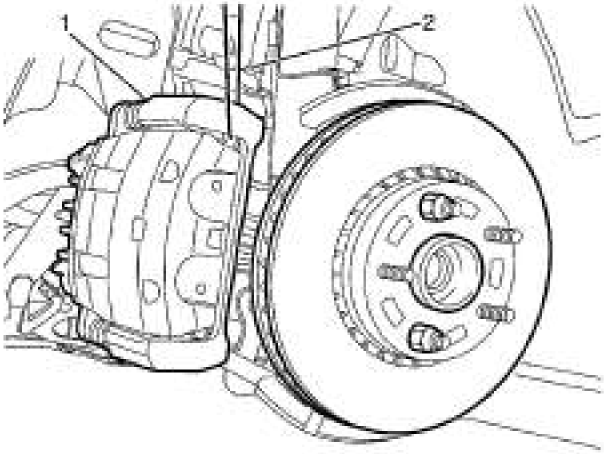
Important: The intermediate steering shaft and pinion shaft splines must be installed in the position recorded during removal and aligned with the marks previously made.

68. Connect the intermediate steering shaft (1) to the pinion shaft (3).
69. Install NEW the intermediate steering shaft to pinion shaft retaining bolt (2).

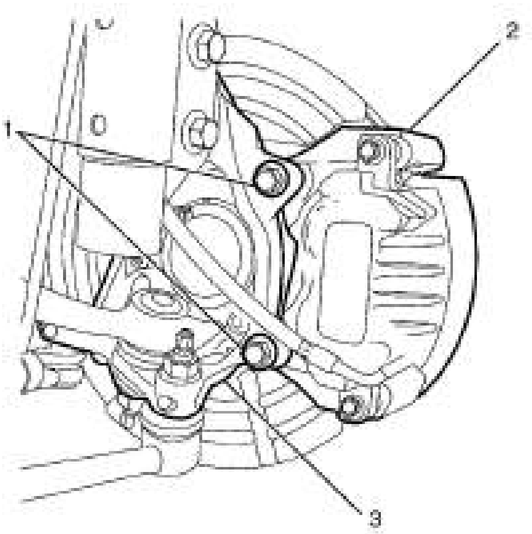
Tighten
Tighten the bolt to 25 N·m (18 lb ft).



70. Connect the front wheel speed sensor jumper harness electrical connector (1) to the front wheel speed sensor. Repeat for opposite side.



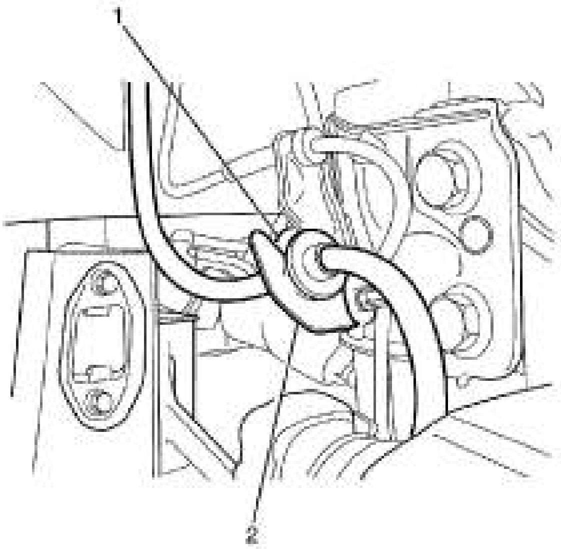
71. Remove the heavy mechanic's wire, or equivalent support (2) from the brake caliper (1). Repeat for opposite side.



Notice: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

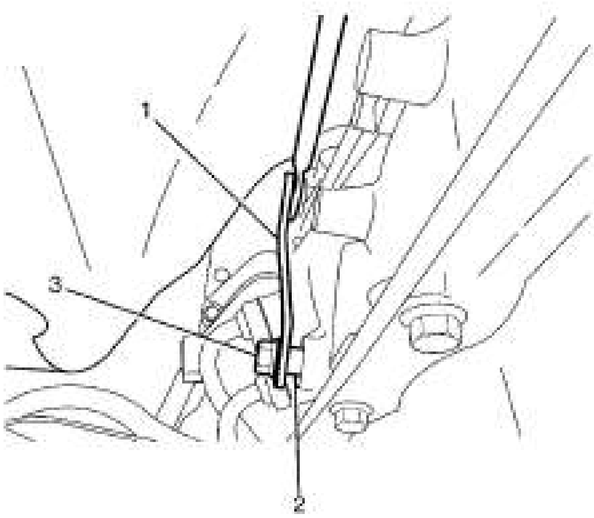
72. Install the front brake caliper assembly (2) to the front steering knuckle (3). Repeat for opposite side.
73. Install the NEW brake caliper anchor plate to knuckle retaining bolts (1).

Tighten
Tighten the bolts to 60 N·m +120° (44 lb in +120°).



Notice: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

74. Attach the front brake hose (1) to the strut mounted brake hose retaining bracket (2). Repeat for opposite side.
75. Install the front wheels. Refer to Tire and Wheel Removal and Installation.



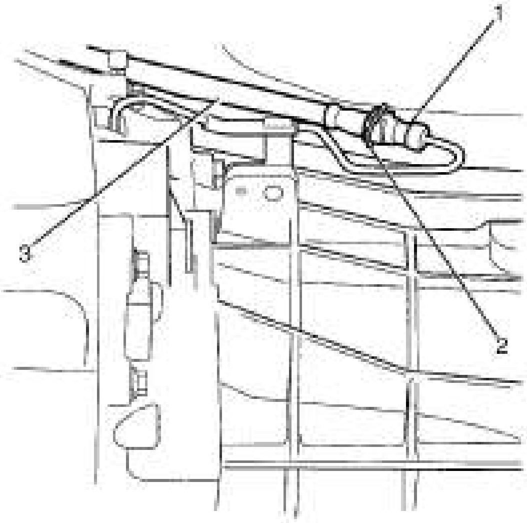
Important: Ignore steps 73 and 74 for vehicles fitted with an manual transmission.

76. Install the shift selector linkage rod (1) to the shift selector shaft (2).
77. Install the shift selector linkage rod to shift selector shaft retaining nut (3).

Tighten
Tighten the nut to 25 N·m (18 lb ft).

Important: Ignore steps 75 through to 77 for vehicles fitted with an automatic transmission.

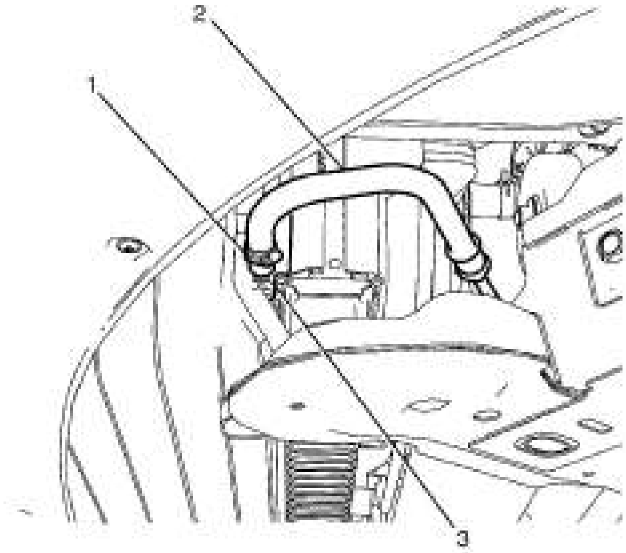
78. Install the shift control assembly. Refer to Shift Control Assembly Replacement.



79. Connect the to concentric actuator cylinder feed hose (3) to the concentric actuator cylinder feed pipe (1).

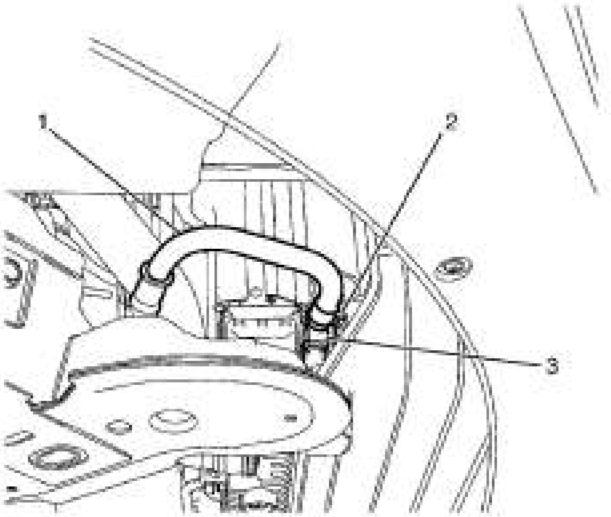
    Important: Listen for an audible click to confirm fitting.

80. Install the flexible hose securing clip (2).
81. Install the starter motor. Refer to Starter Motor Replacement.
82. Install the propeller shaft. Refer to Propeller Shaft Replacement.
83. Install the centre exhaust heat shield. Refer to Exhaust Heat Shield Replacement - Center.
84. Install the Exhaust system. Refer to Exhaust System Replacement.



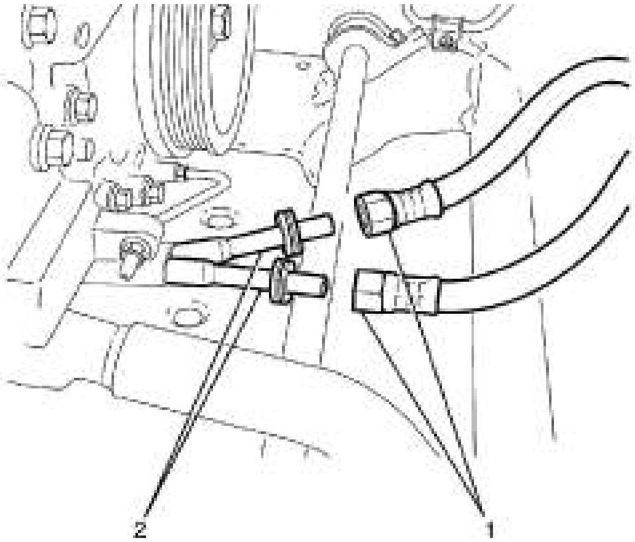
85. Remove the plug from the power steering cooler (3) and power steering reservoir inlet hose (2).
86. Connect the power steering reservoir inlet hose (2) to the power steering cooler (3).

87. Install the power steering reservoir inlet hose spring clamp (1) to its original location



88. Remove the plug from the power steering cooler (3) and power steering reservoir inlet hose (1).
89. Connect the power steering reservoir inlet hose (1) to the power steering cooler (3).
90. Install the power steering reservoir inlet hose spring clamp (2) to its original location
91. Install the engine splash shield. Refer to Engine Splash Shield Replacement.
92. Install the front air deflector. Refer to Front Air Deflector Replacement.
93. Lower the vehicle.

Important: Ignore steps 91 through to 94 for vehicles equipped with a manual transmission.



94. Remove the clean lint free cloth at the automatic transmission cooler pipes (2) and the

flexible hoses (1).

Important: The flexible hoses are not serviced separately. Therefore if the hose's require replacement, then the hose and radiator to hose cooler hose assembly must be fitted.

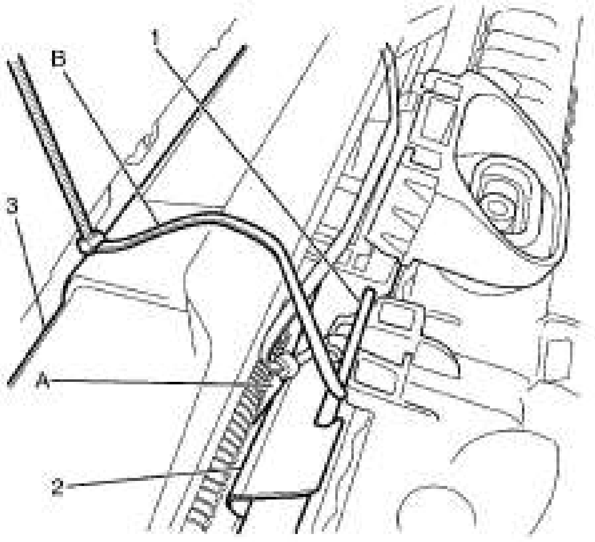
95. Align both flexible hose's with both steel cooler lines.

Important: Listen for an audible click to confirm fitting.

96. Hold the cooler line (2) and connect the flexible hose (1) by pushing together. Repeat procedure for other hose.

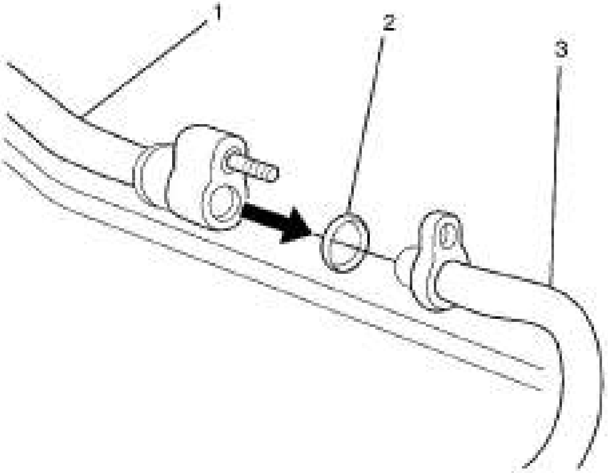
Important: When adding or changing transmission fluid use only recommend automatic transmission fluid.

97. Check and top up transmission fluid level if required. Refer to Transmission Fluid Level Inspection. Refer to Transmission Fluid Level Inspection.



Important: Cut zip tie A and zip tie B and remove from around the front end assembly (3) and the radiator and condenser mount (1).

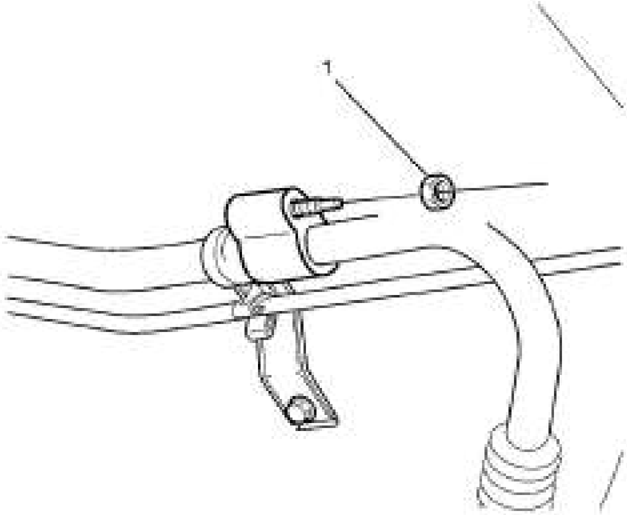
98. Remove the large zip ties or equivalent securing the radiator and condenser assembly (2) to the front end assembly (3).



99. Remove the plug or cap at the A/C suction pipe ends (1 and 3)

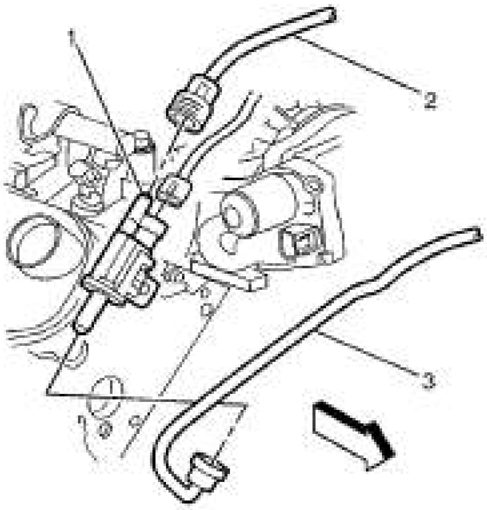
Important: The A/C sealing O-rings must be fitted dry. DO NOT lubricate the A/C sealing O-rings.

100. Fit the NEW A/C suction pipe sealing O-ring (2) to the suction tube.
101. Install the upper A/C suction pipe (1) to the lower A/C suction pipe (3).

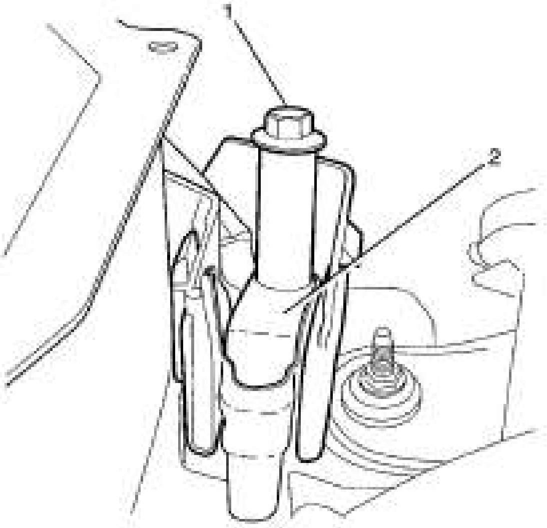


102. Install the A/C suction pipe pad to A/C suction pipe retaining nut (1).

Tighten
Tighten the nut to 22 N·m(16 lb ft).



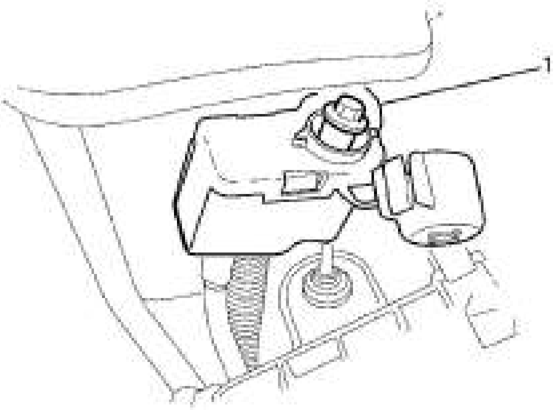
103. Remove the plug from the throttle body to EVAP purge valve tube (3) and EVAP purge valve (1) ends.
104. Connect the throttle body to EVAP purge valve tube (3) to the EVAP purge valve (1).
105. Remove the plug from the EVAP purge valve to fuel tank tube (2) and EVAP purge valve (1) ends.
106. Connect the EVAP purge valve to fuel tank tube (2) to the EVAP purge valve (1).



107. Install the wiring harness (2) to the remote positive battery post.
108. Install the remote positive battery post to wiring harness retaining bolt (1).

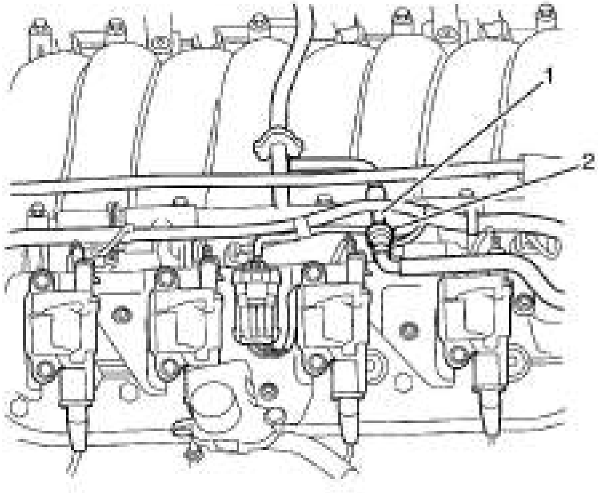
Tighten

Tighten the bolt to 15 N·m (11 lb ft).

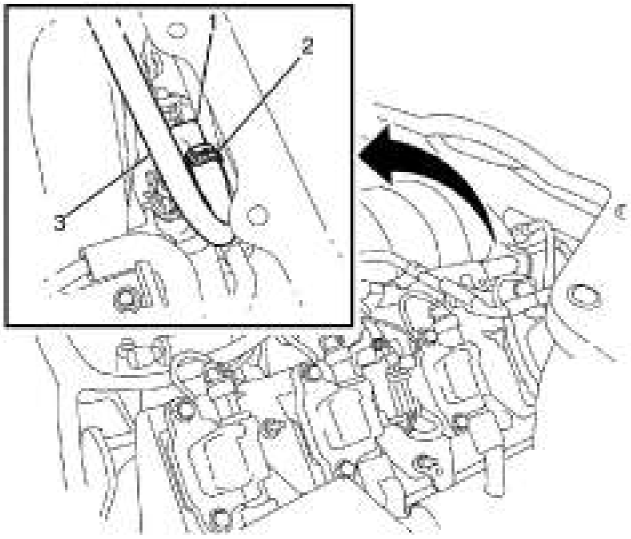


Important: Make sure the clips on the remote positive battery post cover (1) are engaged to avoid an induced rattle condition.

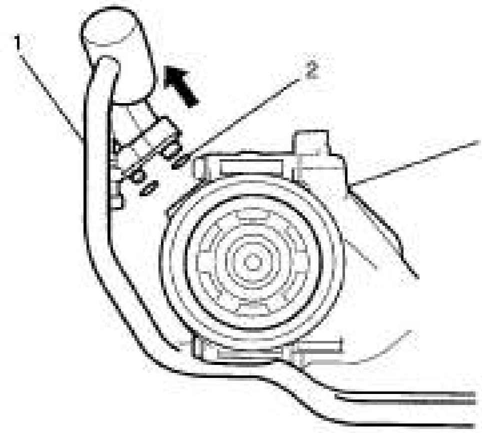
109. Install the remote positive battery post cover (1).



110. Remove the plug from the fuel feed pipe (2) and fuel rail pipe (1) ends.
111. Connect the fuel rail feed pipe (2) quick connect fitting. Refer to Metal Collar Quick Connect Fitting Service or Plastic Collar Quick Connect Fitting Service.



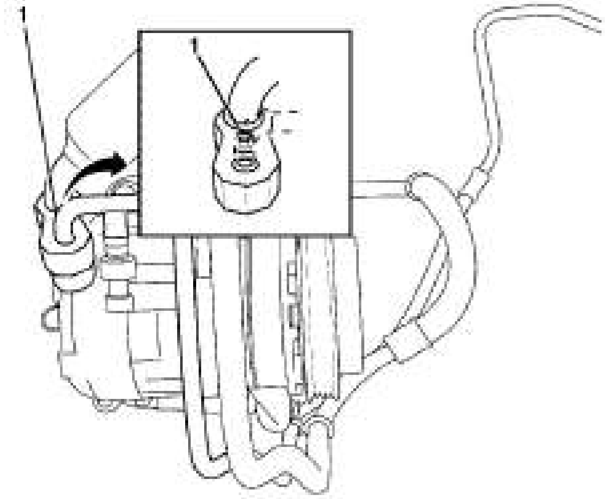
112. Connect the vacuum brake booster hose (3) from the intake manifold vacuum port (1).
113. Compress the vacuum brake booster hose retaining clamp (2) and return to its original position on the vacuum brake booster hose (3).



114. Remove the plug from the compressor (3) ports.
115. Remove the plug from the pipes (1).

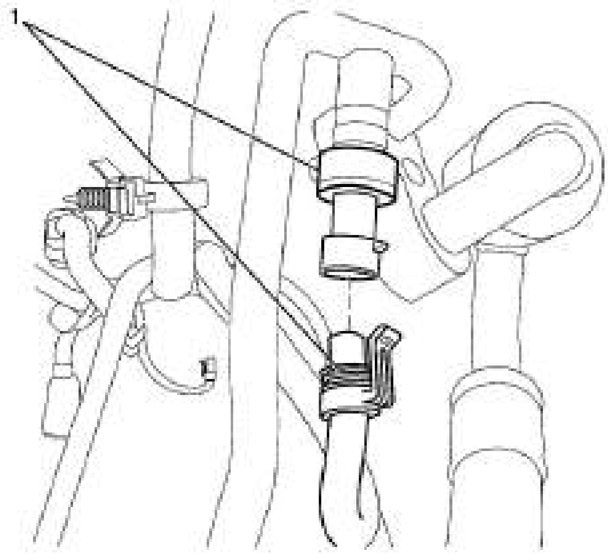
Important: The A/C sealing O-rings must be fitted dry. DO NOT lubricate the A/C sealing O-rings.

116. Fit the NEW A/C suction/discharge pipe O-rings (2) to the suction/discharge pipes (1).
117. Connect the A/C suction/discharge line pad (1) to the A/C compressor (3).

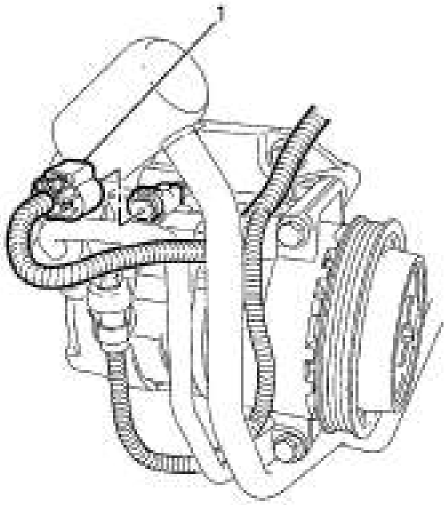


118. Install the suction/discharge line pad (1) to compressor and tighten the retaining bolt (1) to the correct torque specification.

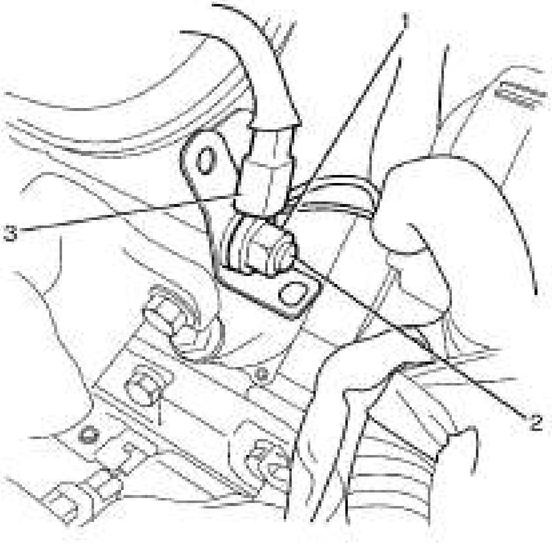
     Tighten
     Tighten the bolt to 22 N·m (16 lb ft).



119. Connect the electrical connector to the A/C Refrigerant Pressure Sensor (1).

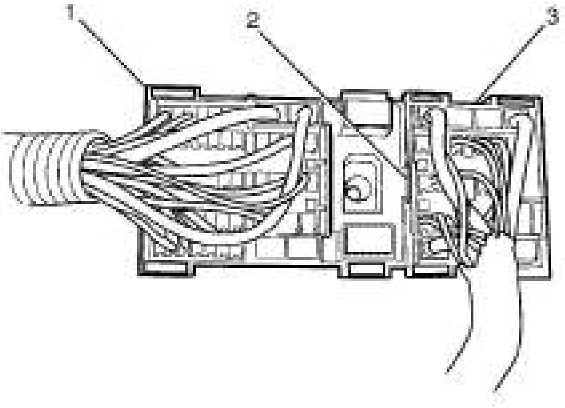


120. Connect the A/C electrical connector (1) to the A/C compressor.



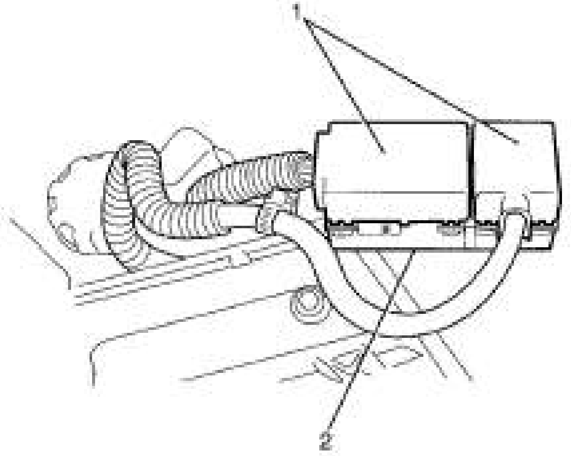
121. Install the vehicle body ground cable (3) to the cylinder head stud (2).
122. Install the vehicle body ground cable to cylinder head retaining nut (1).

Tighten
Tighten the nut to 10 N·m (89 lb ft).

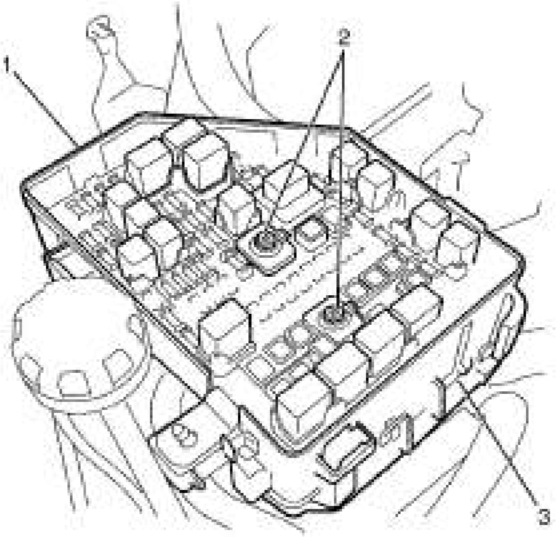


Important: Listen for a audible click from the locking tang (2) to confirm fitting.

123. Slide the engine connector (3) into the body harness connector (1) to join.



124. Attach the protector (1) to the base of the under hood BEC connector (2).

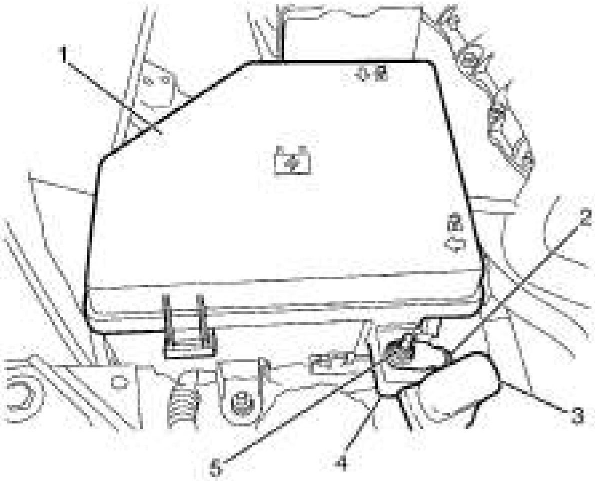


125. Install the upper under hood BEC plate (1) to the lower under hood BEC plate (3).

Important: The under hood BEC upper plate to lower plate retaining bolts (2) DO NOT have a torque specification. Listen for an audible clicking sound whilst tightening the under hood BEC upper plate to lower plate retaining bolts (2) to confirm correct fitting.

126. Install the under hood BEC upper plate to lower plate retaining bolts (2).

Listen for an audible click for correct tension.

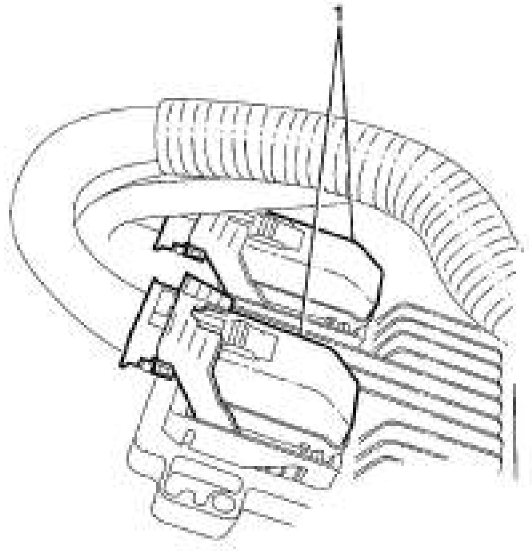


127. Connect the positive cable (2) to the upper under hood BEC plate (4).
128. Install the positive cable to under hood BEC plate retaining bolt (5).

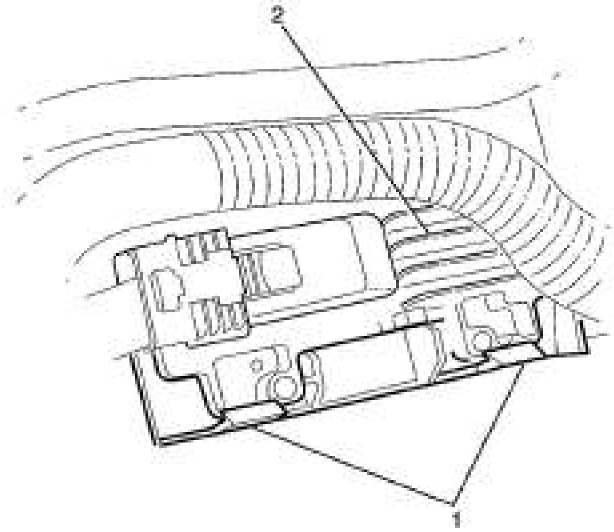
Tighten
Tighten the bolt to 10 N·m (89 lb ft).

129. Install the positive cable protective cover (3).
130. Install the under hood body electrical centre (BEC) cover (1).

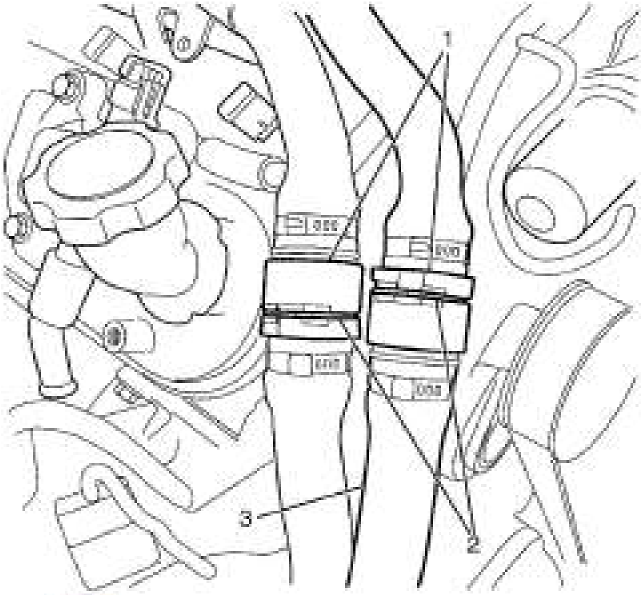
Notice: Do not touch the connector pins or soldered components on the circuit board in order to prevent possible electrostatic discharge (ESD) damage to the PCM.



131. Connect the ECM electrical connectors (1) to the ECM.

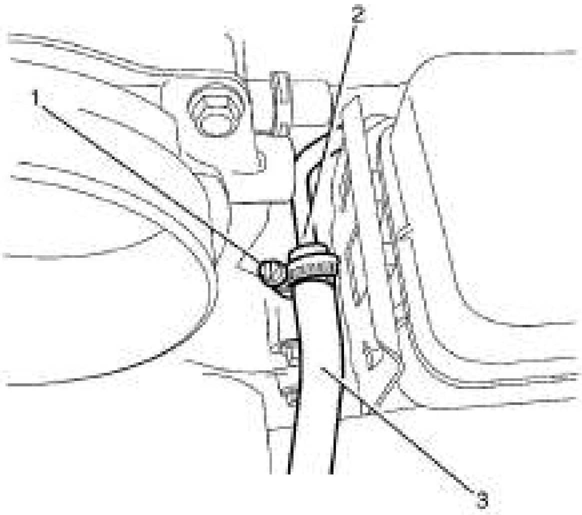


132. Engage the ECM retaining clips (1) to secure the ECM (2).



Important: Listen for a audible click to confirm fitting.

133. Connect the inlet and outlet heater hoses (3) at the heater hose assembly quick connect fittings (1).



134. Connect the coolant air bleed hose (3) to the coolant bleed pipe (2).
135. Reposition the coolant bleed hose retaining clamp (1) to its original position on the coolant bleed hose (3).
136. Tighten the coolant bleed hose retaining clamp (1).
137. Install the radiator outlet hose. Refer to Radiator Outlet Hose Replacement.
138. Fill the cooling system. Refer to Cooling System Draining and Filling.
139. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.
140. Recharge the air conditioning (A/C) system. Refer to Refrigerant Recovery and Recharging.

141. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.
142. Install the engine cover. Refer to Engine Cover Replacement.
143. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
144. Bleed The clutch. Refer to Hydraulic Clutch Bleeding.
145. Disable the ignition system.
146. Crank the engine several times. Listen for any unusual noises or evidence that parts are binding.
147. Enable the ignition system.
148. Start the engine and listen for unusual noises.
149. Check the vehicle oil pressure gauge and confirm that the engine has acceptable oil pressure.

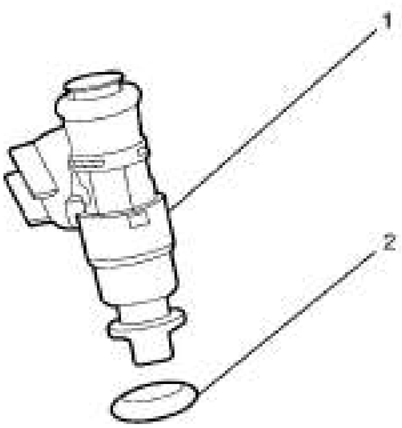
     If necessary, install an oil pressure gauge and measure the engine oil pressure.

150. Run the engine speed at about 1,000 RPM until the engine has reached normal operating temperature.
151. Listen for sticking lifters and other unusual noises.
152. Inspect for fuel, oil, and/or other coolant leaks while the engine is running.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L | Repair Instructions - On Vehicle | **Document ID: 2079343**

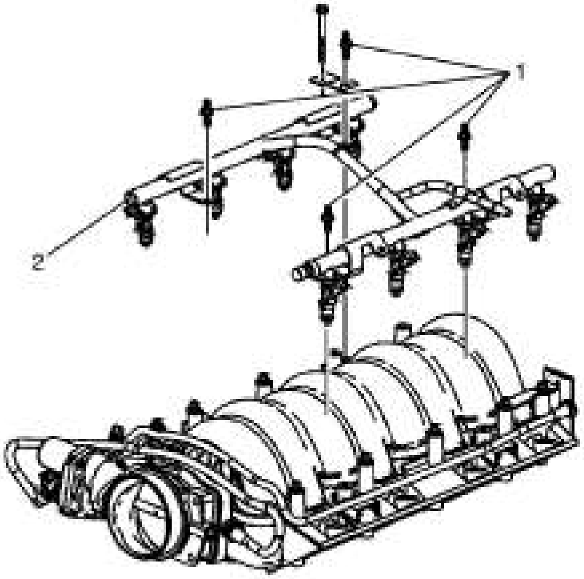
Fuel Rail and Injectors Installation (L98, LS2)

Caution: Refer to Fuel Rail Stop Bracket Installation Caution in the Preface section.



Important: DO NOT use the fuel injector O-ring seals again. Install NEW fuel injector O-ring seals during assembly.

1. Lubricate the NEW fuel injector O-ring seals with clean engine oil.
2. Install the O-ring seals to the fuel injectors.

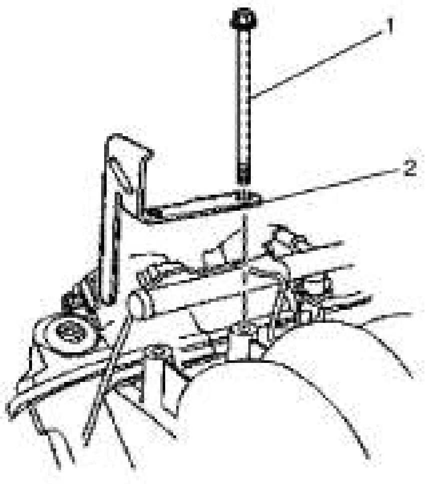


3. Install the fuel rail (3) to the manifold. Push firmly on both sides of the rail until all injectors have entered their bores.
4. Apply a 5 mm (0.2 in) band of threadlock to the threads of the fuel rail bolts (2). Refer to Adhesives, Fluids, Lubricants, and Sealers.

Notice: Refer to Fastener Notice in the Preface section.

5. Install the fuel rail bolts (2) and fuel rail ground strap (1).

Tighten
Tighten the bolts to 10 N·m (89 lb in).



Important: The fuel rail stop bracket (2) must be installed. The fuel rail stop bracket (2) serves as a protective shield in the event of a vehicle frontal collision.

6. Install the fuel rail stop bracket (2).
7. Install the fuel rail stop bracket to intake manifold retaining bolt (1).

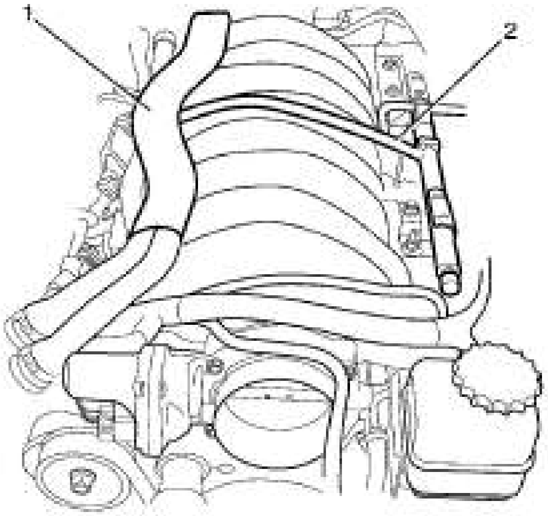
Tighten
Tighten the bolts to 10 N·m (89 lb in).

Intake Manifold Replacement

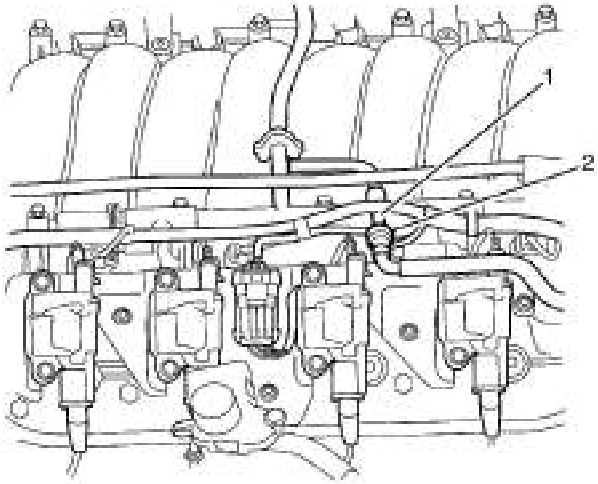
Removal Procedure

Important: The intake manifold, throttle body, fuel injection rail, and injectors may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.

1. Remove the engine cover. Refer to Engine Cover Replacement.
2. Depressurize the fuel system. Refer to Fuel Pressure Relief.
3. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
4. Drain the cooling system. Refer to Cooling System Draining and Filling.
5. Remove the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.

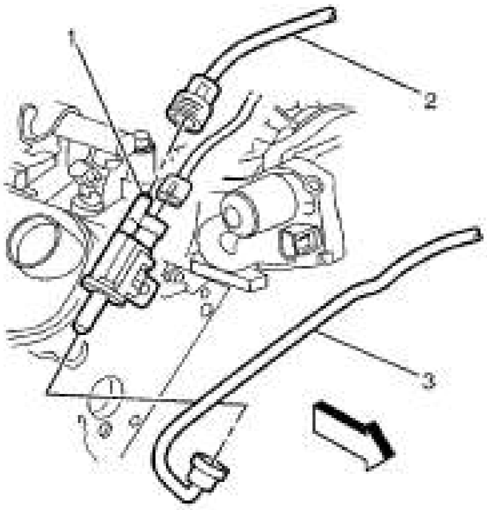


6. Reposition and secure the heater hoses (1) away from the intake manifold (2).



Important: Plug or cap the fuel feed pipe (2) and fuel rail tube (1) ends to prevent fuel leaks and/or contamination.

7. Disconnect the fuel rail feed pipe (2) quick connect fitting. Refer to Metal Collar Quick Connect Fitting Service or Plastic Collar Quick Connect Fitting Service.

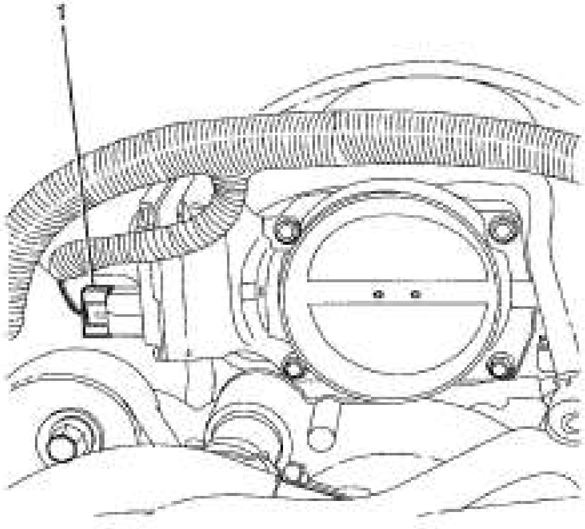


Important: Plug or cap the throttle body to EVAP purge valve hose (3) and EVAP purge valve (1) ends to prevent fuel leaks and/or contamination.

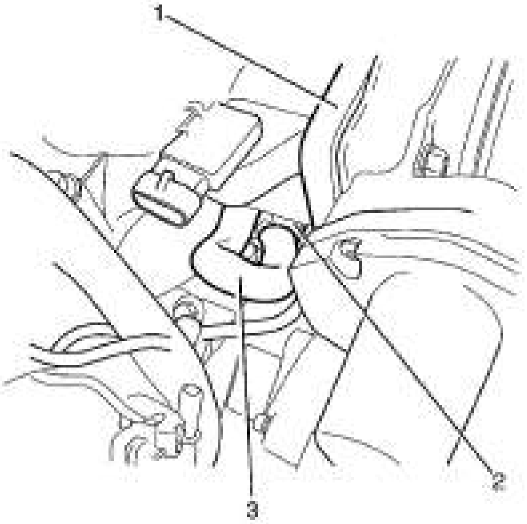
8. Disconnect the throttle body to EVAP purge valve hose (3) from the EVAP purge valve (1).

Important: Plug or cap the EVAP purge valve to fuel tank hose (2) and EVAP purge valve (1) ends to prevent fuel leaks and/or contamination.

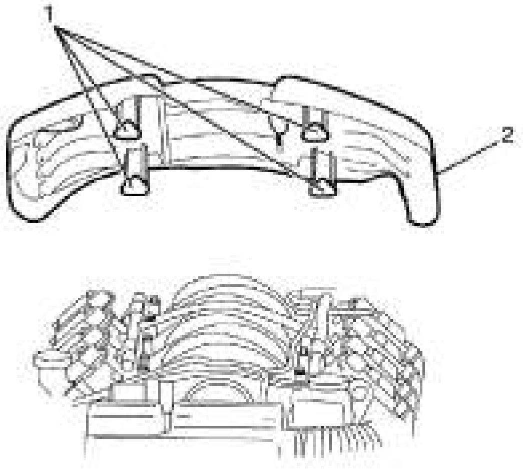
9. Disconnect the EVAP purge valve to fuel tank hose (2) from the EVAP purge valve (1).



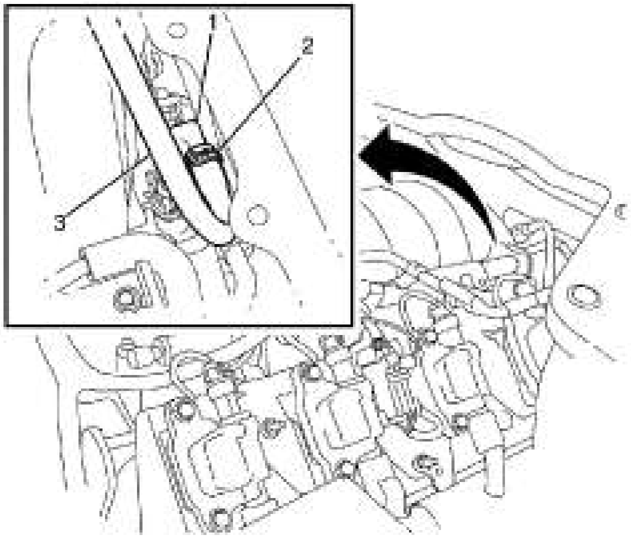
10. Disconnect the electronic throttle body wiring harness connector (1).



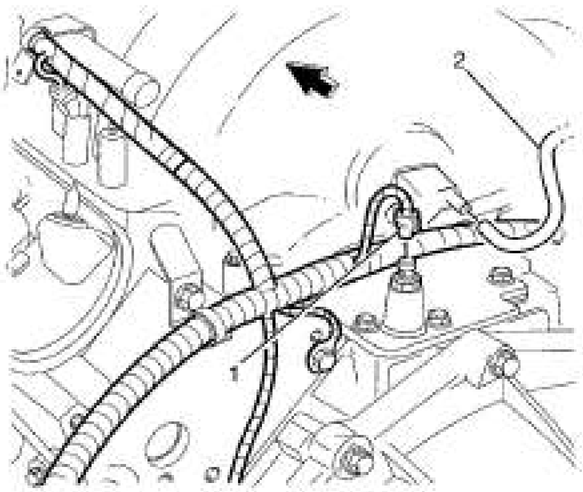
11. Disconnect the (PCV) Positive Crankcase Ventilation hose (3) from the intake manifold (1) and the valley cover (2).



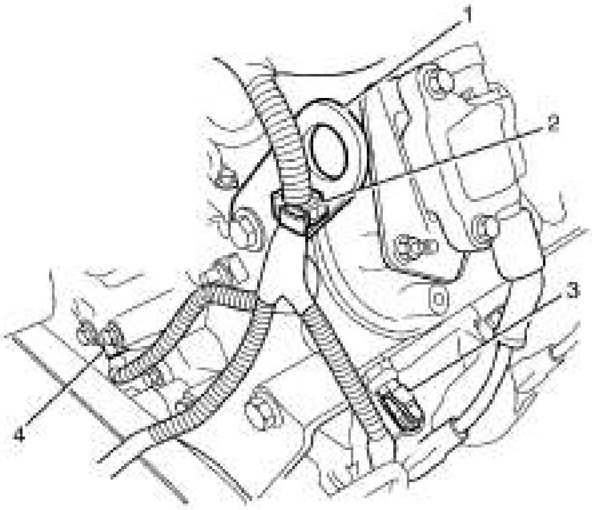
12. Disconnect the alternator wiring harness connector (1) from the alternator.



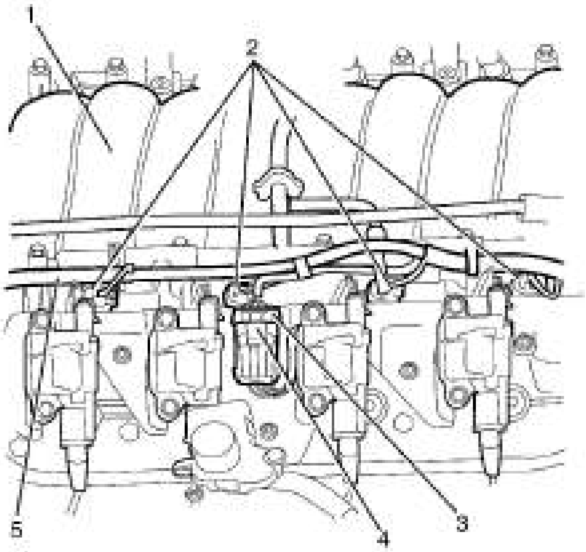
13. Compress the vacuum brake booster hose retaining clamp (2) at the intake manifold vacuum port (1) and slide 50 mm (2 in) back along the vacuum brake booster hose (3).
14. Disconnect the vacuum brake booster hose (3) from the intake manifold vacuum port (1).



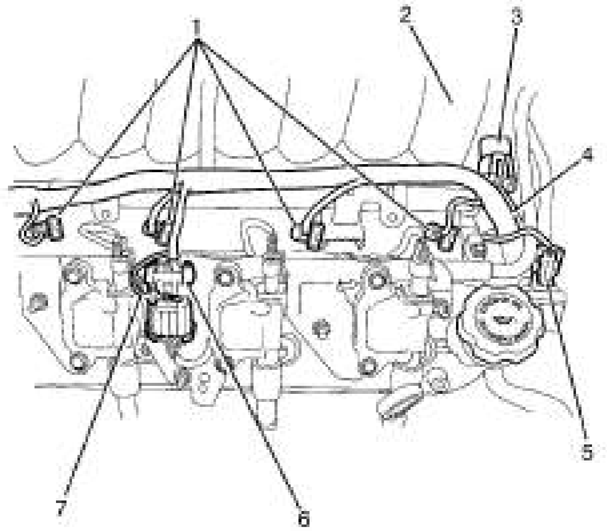
15. Disconnect the oil pressure sensor wiring harness connector (1) from the oil pressure sensor.
16. Disconnect the HVAC vacuum hose (2) from the intake manifold.



17. Disconnect the camshaft position sensor connector (4) from the camshaft position sensor.
18. Disconnect the coolant temperature sensor connector (3) from the coolant temperature sensor.
19. Detach the wiring harness retaining clip (2) from the engine lifting bracket (1).



20. Disconnect the left side fuel injector wiring harness connectors (2) from the fuel injectors.
21. Remove the Connector Position Assurance (CPA) lock (4) from the left side ignition coil main connector (3).
22. Disconnect the left side ignition coil main connector (3) from the ignition coil wiring harness.
23. Reposition and secure the left side fuel injector wiring harness (5) away from the intake manifold (1).



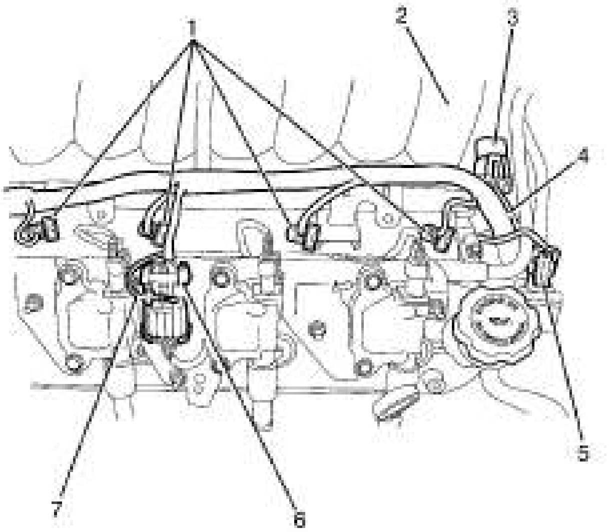
24. Disconnect the right side fuel injector wiring harness connectors (1) from the fuel injectors.
25. Remove the CPA lock (7) from the right side ignition coil main connector (6).
26. Disconnect the right side ignition coil main connector (6) from the ignition coil wiring harness.
27. Disconnect the canister purge valve (5) wiring harness connector.
28. Disconnect the manifold absolute pressure (MAP) sensor wiring harness connector (3) from the MAP sensor.
29. Reposition and secure the right side fuel injector wiring harness (4) away from the intake

manifold (2).

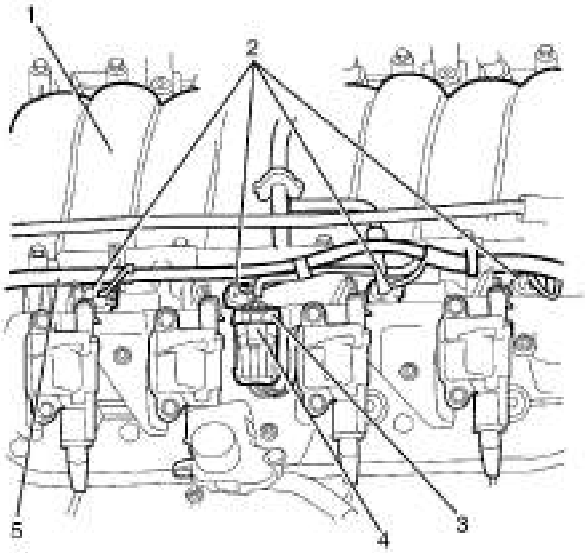
30. Remove the intake manifold. Refer to Intake Manifold Installation.
31. Clean and inspect the intake manifold. Refer to Intake Manifold Cleaning and Inspection.

Installation Procedure

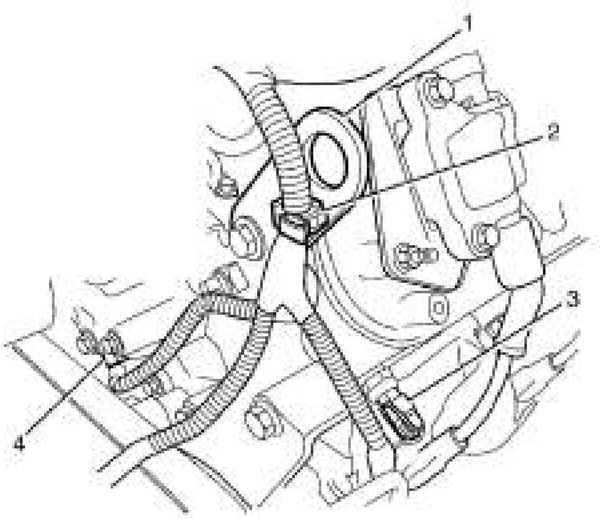
1. Install the intake manifold. Refer to Intake Manifold Installation.



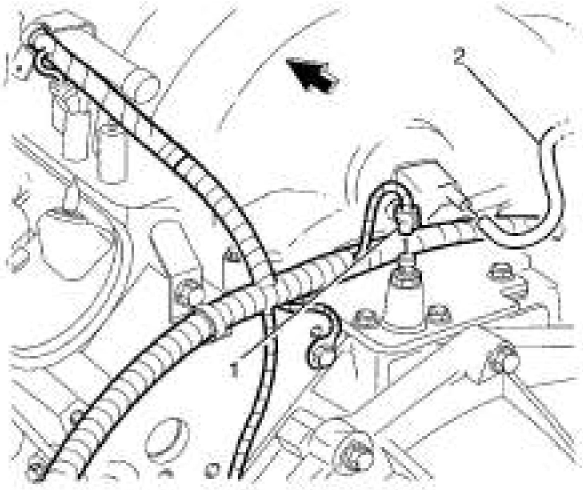
2. Position the right side fuel injector wiring harness (4) on the intake manifold (2).
3. Connect the Manifold Absolute Pressure (MAP) sensor wiring harness connector (3) to the MAP sensor.
4. Connect the canister purge valve wiring harness connector (5).
5. Connect the right side ignition coil main connector (6) to the ignition coil wiring harness.
6. Install the Connector Position Assurance (CPA) lock (7) from the right side ignition coil main connector (6).
7. Connect the right side fuel injector wiring harness connectors (1) to the fuel injectors.



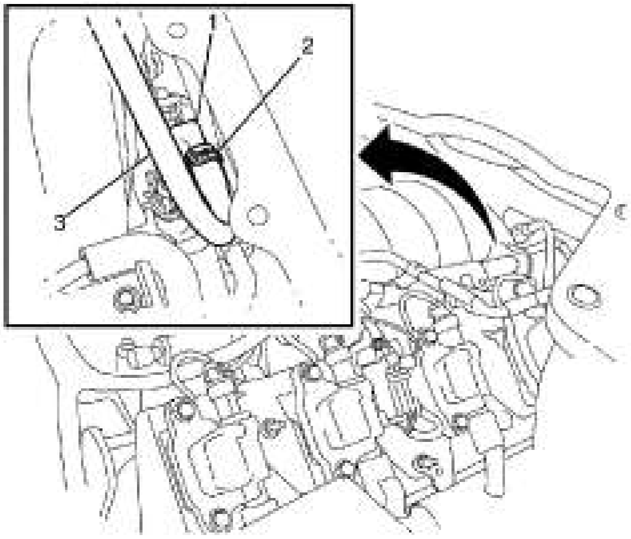
8. Position the left side fuel injector wiring harness (5) back to its original location the intake manifold (1).
9. Connect the left side ignition coil main connector (3) ignition coil wiring harness.
10. Install the CPA lock (4) from the left side ignition coil main connector (3).
11. Connect the left side fuel injector wiring harness connectors (2) to the fuel injectors.



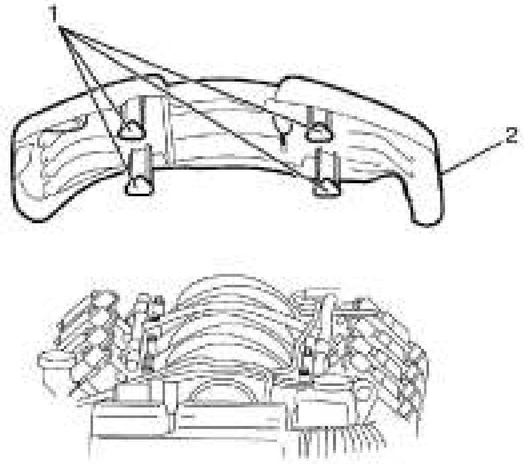
12. Connect the camshaft position sensor connector (4) to the camshaft sensor.
13. Connect the coolant temperature sensor connector (3) to the coolant sensor.
14. Attach the wiring harness retaining clip (2) to the engine lifting bracket (1).



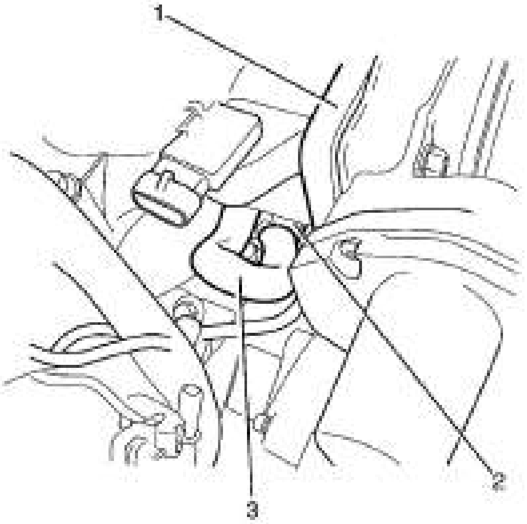
15. Connect the oil pressure sensor wiring harness connector (1) to the oil pressure sensor.
16. Connect the HVAC vacuum hose (2) to the intake manifold.



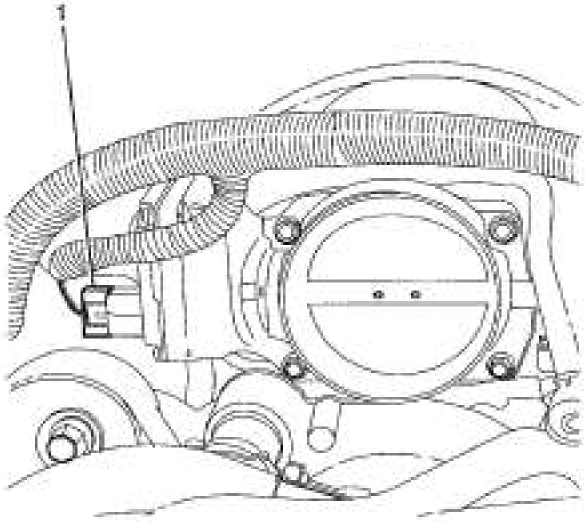
17. Connect the vacuum hose (3) to the intake manifold vacuum port (1).
18. Compress the vacuum hose retaining clamp (2) and slide along the vacuum hose (3) to the correct location to secure the vacuum hose (3) to the intake manifold vacuum port (1).



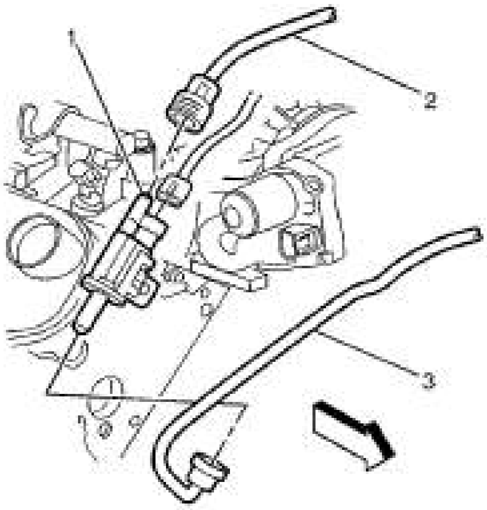
19. Connect the alternator wiring harness connector (1) to the alternator.



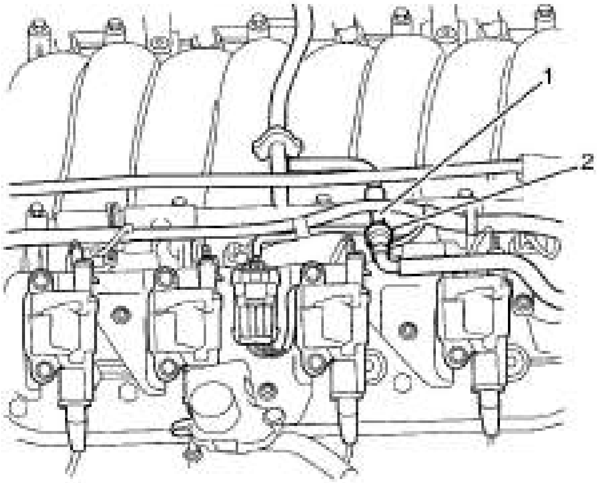
20. Connect the PCV hose (3) to the intake manifold (1) and the valley cover (2).



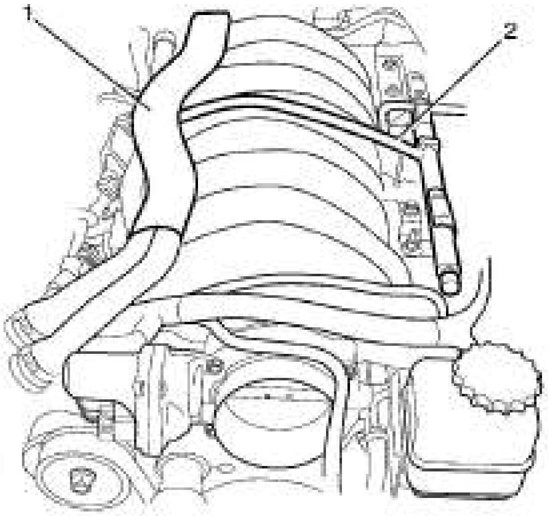
21. Connect the electronic throttle body wiring harness connector (1) to the throttle body.



22. Remove the plug on the throttle body to EVAP purge valve hose (3) and EVAP purge valve (1) ends.
23. Connect the throttle body to EVAP purge valve hose (3) to the EVAP purge valve (1).
24. Remove the plug on the throttle body to the EVAP purge valve to fuel tank hose (2) and EVAP purge valve (1) ends.
25. Connect the EVAP purge valve to fuel tank hose (2) to the EVAP purge valve (1).



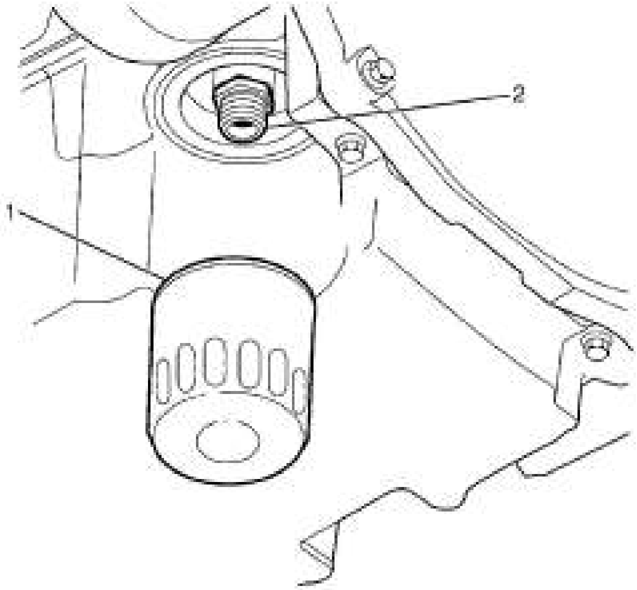
26. Remove the plug on the fuel feed pipe (2) and fuel rail tube (1) end.
27. Connect the fuel rail feed pipe (2) quick connect fitting. Refer to Metal Collar Quick Connect Fitting Service or Plastic Collar Quick Connect Fitting Service.



28. Position the heater hoses (1) correctly on the intake manifold (2).
29. Install the air intake duct. Refer to Air Cleaner Inlet Duct Replacement.
30. Fill the cooling system. Refer to Cooling System Draining and Filling.
31. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
32. Run engine and check for leaks.
33. Install the engine cover. Refer to Engine Cover Replacement.

Oil Filter Adapter Replacement

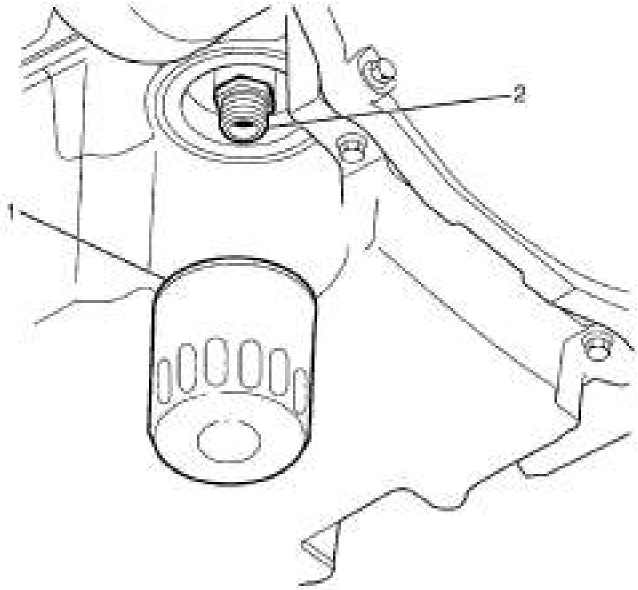
Removal Procedure



1. Remove the oil filter (1).
2. Remove the oil filter adapter (2).

Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



1. Install the oil filter adapter (2).

   Tighten
   Tighten the adapter to 55 N·m (40 lb ft).

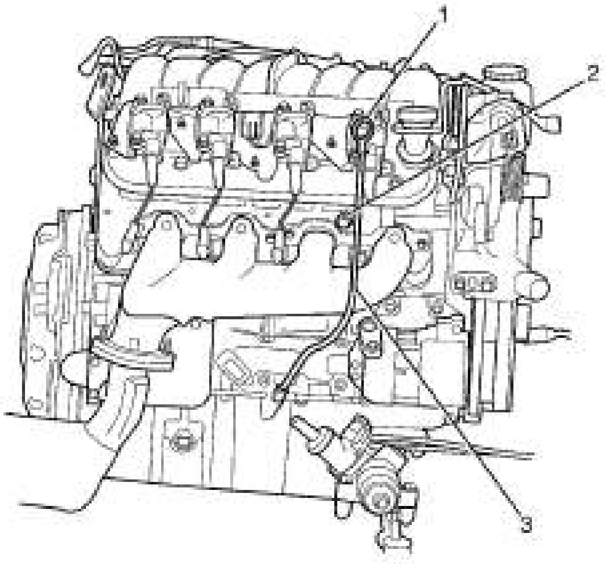
2. Install the oil filter (1).

   Tighten
   Tighten the filter to 30 N·m (22 lb ft).

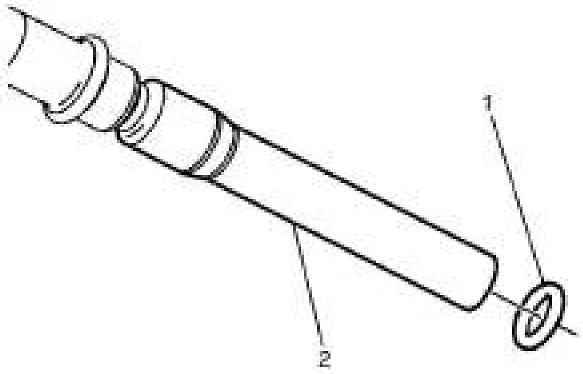
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L | Repair Instructions - On Vehicle | **Document ID: 2086108**

Oil Level Indicator Tube Replacement (L98)

Removal Procedure



1. Remove the oil level indicator (1) from the oil level indicator tube (3).
2. Remove the oil level indicator tube bracket to cylinder head retaining bolt (2).
3. Remove the oil lever indicator tube (3) from the engine.



Important: Inspect the O-ring seal for cuts or damage. The O-ring seal may be re-used if not cut or damaged.

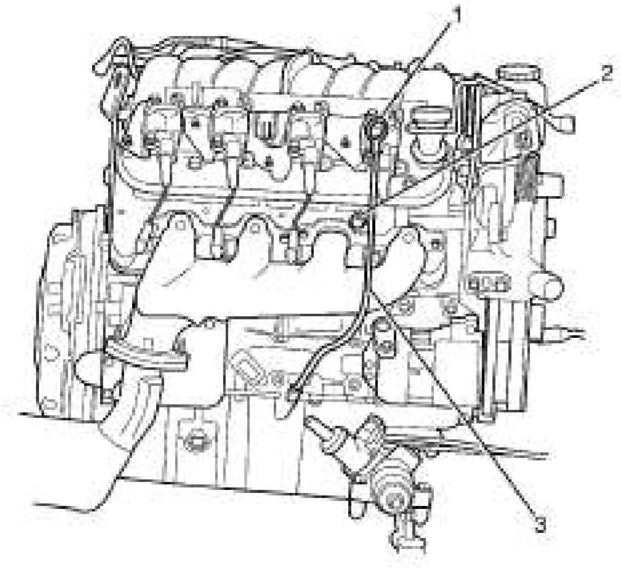
Important: If the oil level indicator tube is not to be reinstalled immediately, plug the opening to prevent dirt entry.

4. Remove and discard the O-ring (1) from the oil level indicator tube (2) if damaged.

Installation Procedure

Important: Fitment of a new O-ring is only necessary if the old O-ring is damaged

1. Lubricate the O-ring seal with clean engine oil.



2. Install the oil level indicator tube (3) into the cylinder block until the collar is flush with the engine block.

Notice: Refer to Fastener Notice in the Preface section.

3. Install the oil level indicator tube to cylinder head retaining bolt (2).

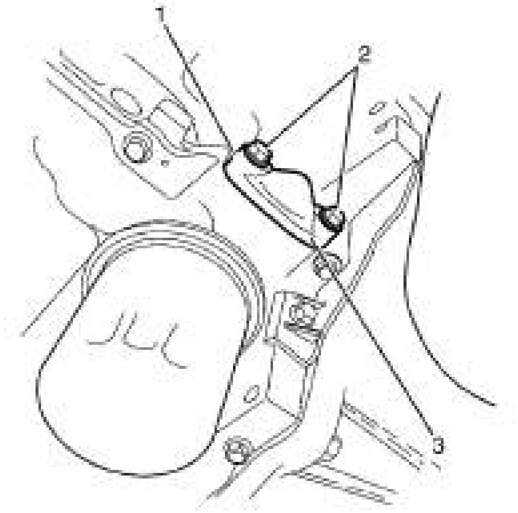
Tighten
Tighten the bolt to 25 N·m (18 lb ft).

4. Install the oil level indicator (1) to the oil level indicator tube.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L | Repair Instructions - On Vehicle | **Document ID: 1986517**

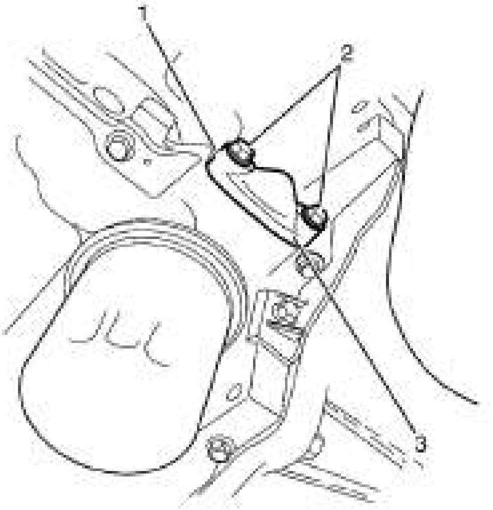
Oil Pan Cover Replacement

Removal Procedure



1. Raise the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the oil pan cover to oil pan retaining bolts (2).
3. Remove the cover (1).
4. Remove the gasket (3).

Installation Procedure



1. Position the gasket (3) and cover (1) on the engine block.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the retaining bolts (2) for the cover.

   Tighten
   Tighten the bolts to 12 N·m (106 lb in).

3. Lower the vehicle.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Engine | Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L | Repair Instructions - On Vehicle | **Document ID: 2037365**

Oil Pan Replacement

Removal Procedure

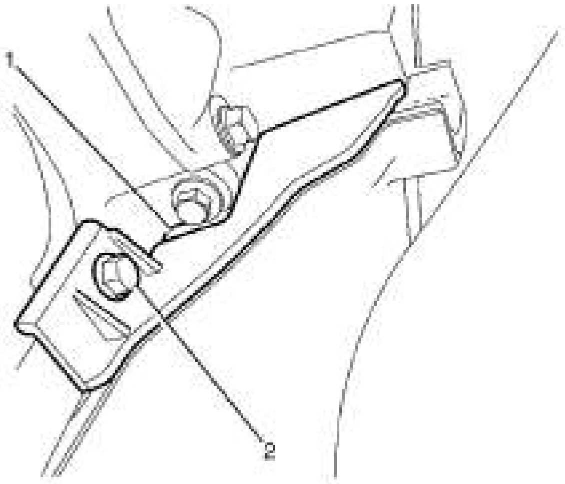
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

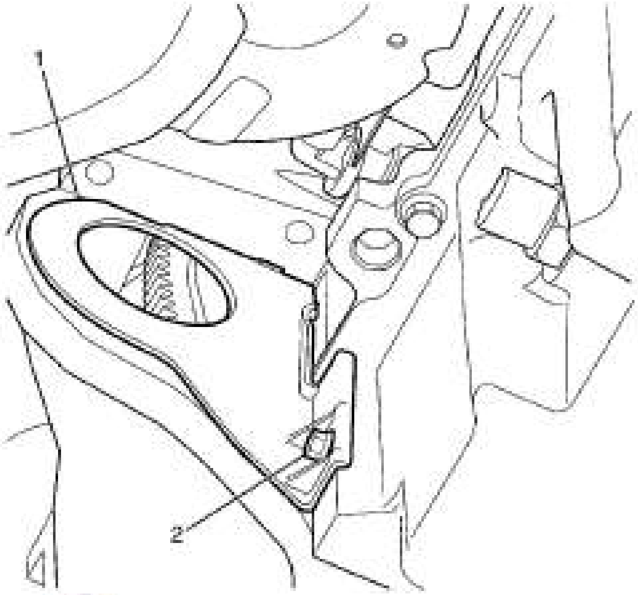
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

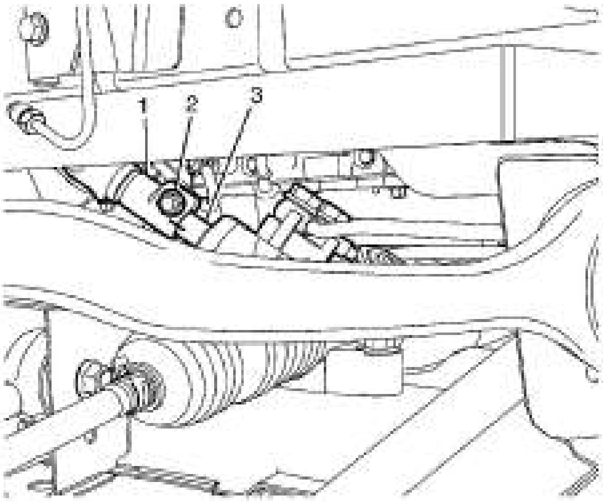
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Remove the air deflector. Refer to Front Air Deflector Replacement.
4. Drain the engine oil and remove the oil filter. Refer to Engine Oil and Oil Filter Replacement.
5. Remove the engine splash shield. Refer to Engine Splash Shield Replacement.
6. Remove the starter motor. Refer to Starter Motor Replacement.



7. Remove the left side close out cover to cylinder block retaining bolt (2).
8. Remove the left side close out cover (1).



9. Remove the right side close out cover to cylinder block retaining bolt (2).
10. Remove the right side close out cover (1).



Important: Observing the orientation of the intermediate steering shaft (1) with reference to the pinion shaft (3) will minimise the potential of incorrect steering column assembly alignment.

11. Mark the intermediate steering shaft (1) in relation to the pinion shaft (3).

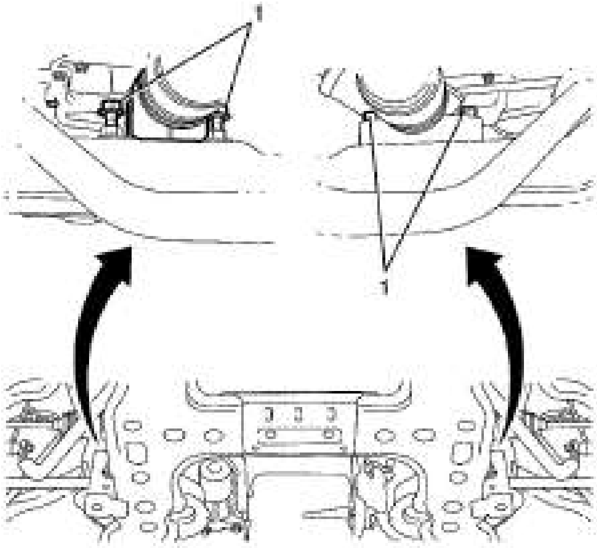
Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

Important: Make sure the bolt hole is thoroughly cleaned and all micro-encapsulated thread sealant is removed.

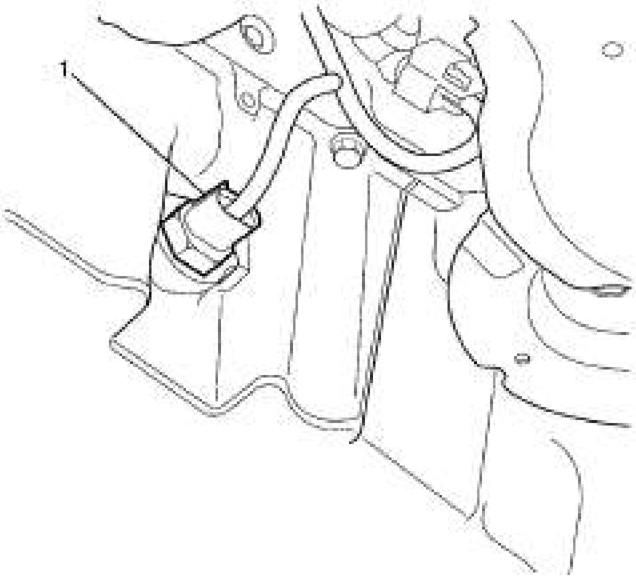
12. Remove the intermediate steering shaft to pinion shaft retaining bolt (2).

    Discard the bolt.

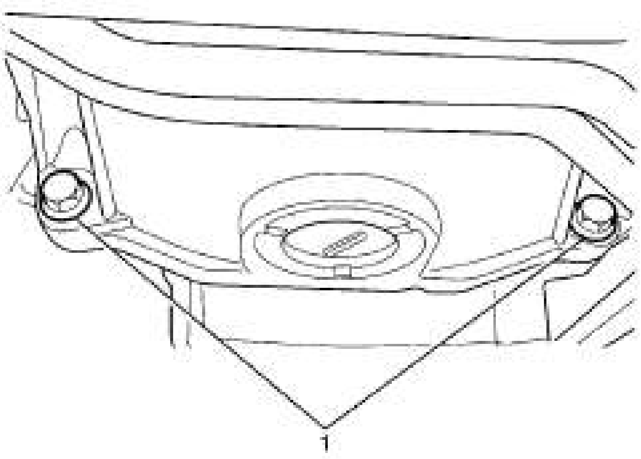
13. Disconnect the intermediate shaft (2) from the pinion shaft (3).



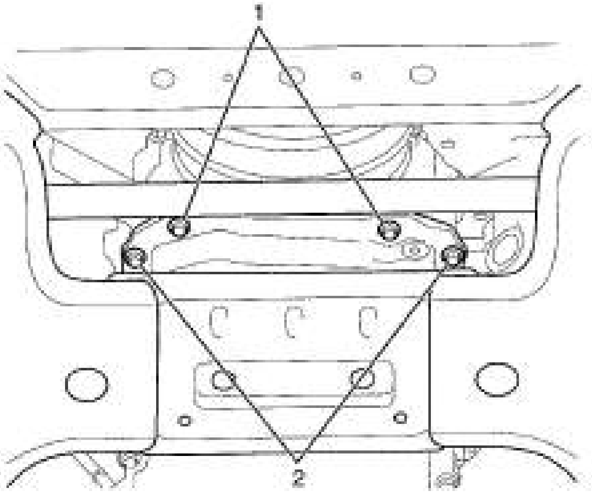
14. Remove the steering gear to subframe retaining bolts (1).
15. Slide the steering gear forward to gain full access to the sump.



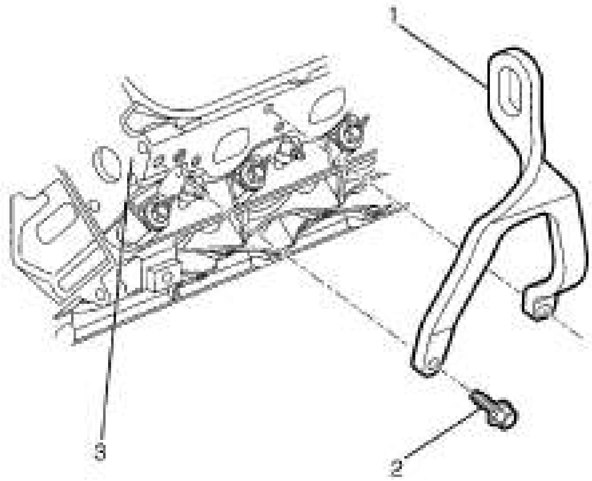
16. Disconnect the oil level/temperature sensor electrical connector (1) from the oil level/temperature sensor.



17. Remove the transmission to oil pan retaining bolts (1).



18. Remove the oil pan to front cover retaining bolts (1).
19. Remove the oil pan to cylinder block front retaining bolts (2).
20. Lower the vehicle.



21. Position the J 41798 (1) on the cylinder head (3).

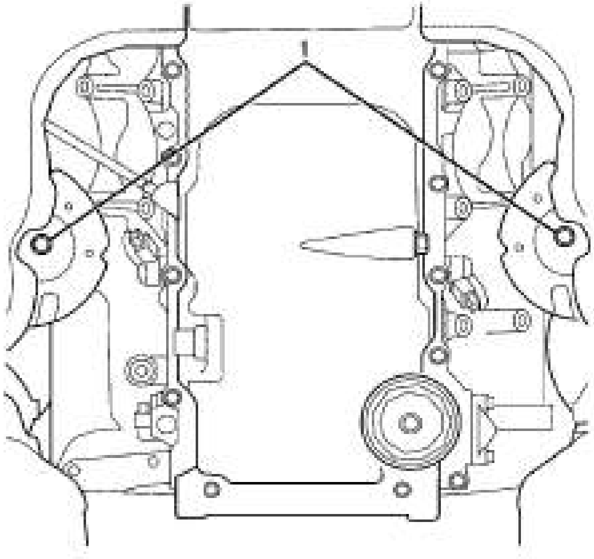
    Notice: Refer to Fastener Notice in the Preface section.

22. Install the J 41798 to cylinder head retaining bolts (2).

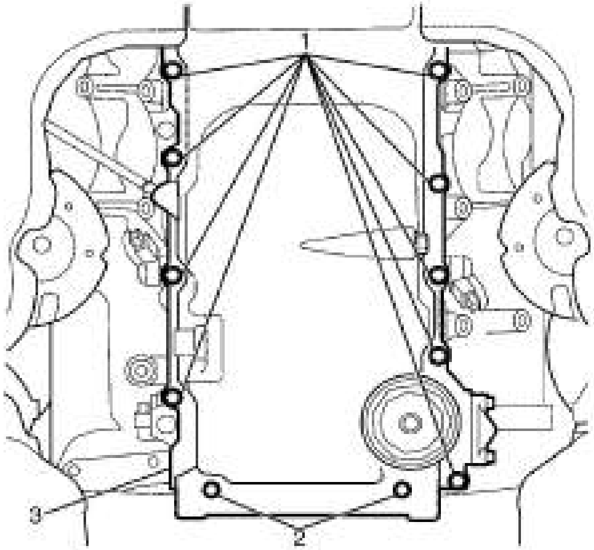
    Tighten
    Tighten the bolts to 50 N·m (36 lb ft).

    Important: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

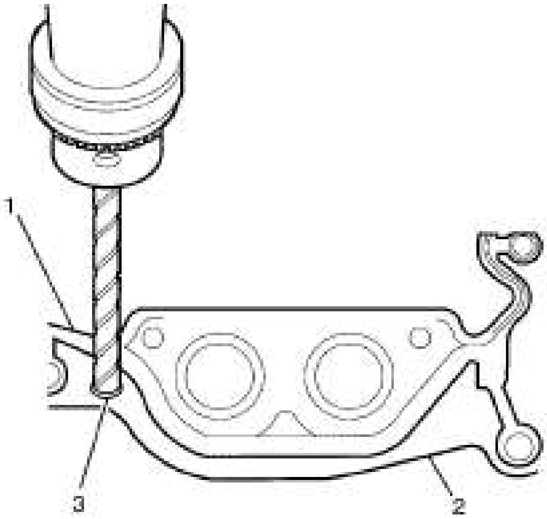
23. Install J 41803 and J 28467-B and raise the engine assembly 20mm.
24. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



25. Remove the lower engine mount to crossmember retaining nut (1) from both engine mounts.
26. Lower the vehicle.



27. Remove the oil pan to engine rear cover retaining bolts (2).
28. Remove the oil pan to cylinder block retaining bolts (1).
29. Remove the oil pan (3).



Important: DO NOT allow foreign material to enter the oil passages of the oil pan, cap, or cover the openings, as required.

Important: Take care not to gouge, score, or damage the oil pan sealing surface.

30. Drill out the retaining rivets (3) from the oil pan, if required.

    Important: The oil pan gasket and rivets are single use only components and must be replaced whenever the oil pan is removed from the cylinder block.

31. Remove the oil pan gasket (1) from the oil pan (2).

    Discard the gasket and rivets.

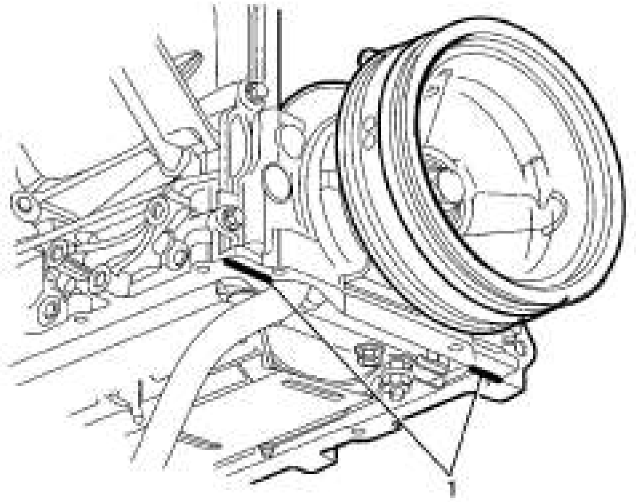
32. Clean and inspect the oil pan as necessary. Refer to Oil Pan Cleaning and Inspection.
33. Clean the base of the engine block. Refer to Replacing Engine Gaskets.

Installation Procedure

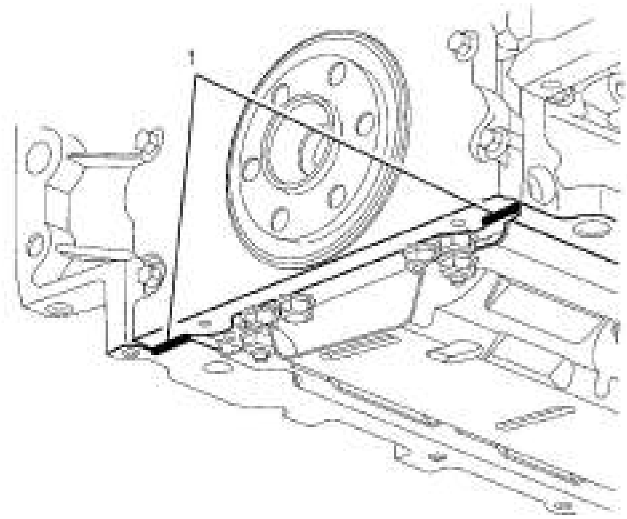
Important: The alignment of the structural oil pan is critical. The rear bolt hole locations of the oil pan provide mounting points for the transmission housing. To ensure the rigidity of the powertrain and correct transmission alignment, it is important that the rear of the block and the rear of the oil pan are flush. The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing plane.

Important: The original oil pan gasket is retained and aligned to the oil pan by rivets. When installing a new gasket, it is not necessary to install new oil pan gasket rivets.

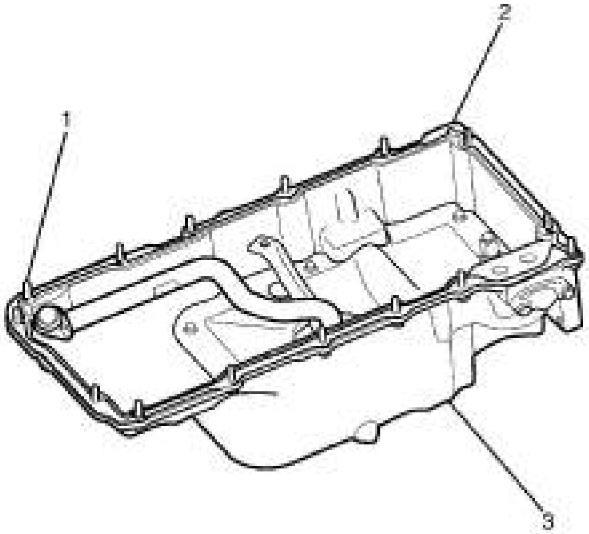
It is not necessary to rivet the NEW gasket to the oil pan.



1. Apply a five mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the engine block (1). Apply the sealant directly onto the tabs of the front cover gasket that protrude into the oil pan surface. Refer to Adhesives, Fluids, Lubricants, and Sealers.

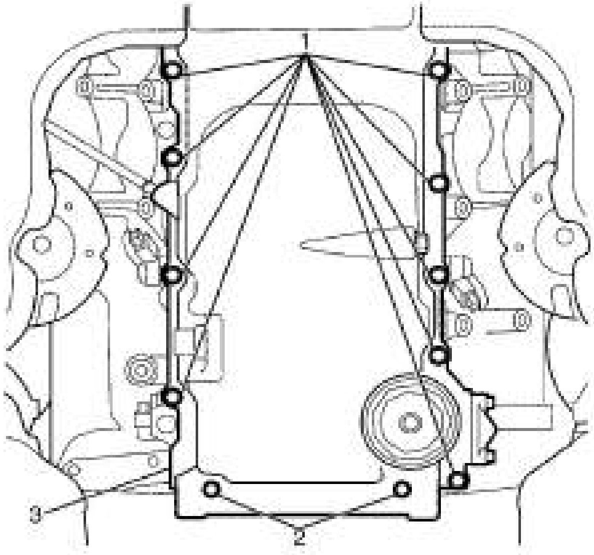


2. Apply a five mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the engine block (1). Apply the sealant directly onto the tabs of the rear cover gasket that protrude into the oil pan surface. Refer to Adhesives, Fluids, Lubricants, and Sealers.

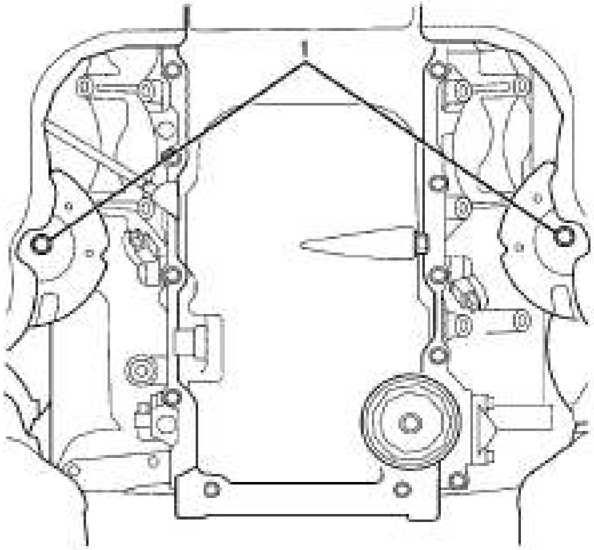


Important: Make sure to align the oil gallery passages in the oil pan and engine block correctly, with the oil pan gasket.

3. Preassemble the oil pan gasket (2) to the oil pan (3).
    - 3.1. Install the oil pan gasket (2) to the oil pan (3).
    - 3.2. Install the oil pan retaining bolts (1) to the oil pan (3) and through the oil pan gasket (2).



4. Install the oil pan assembly (3).
5. Install the oil pan to cylinder block retaining bolts (1) finger tight. Do not over tighten.
6. Install the oil pan to engine rear cover retaining bolts (2) finger tight. Do not over tighten.
7. Lower the vehicle.
8. Lower the engine to engage the engine mounts to the front subframe.



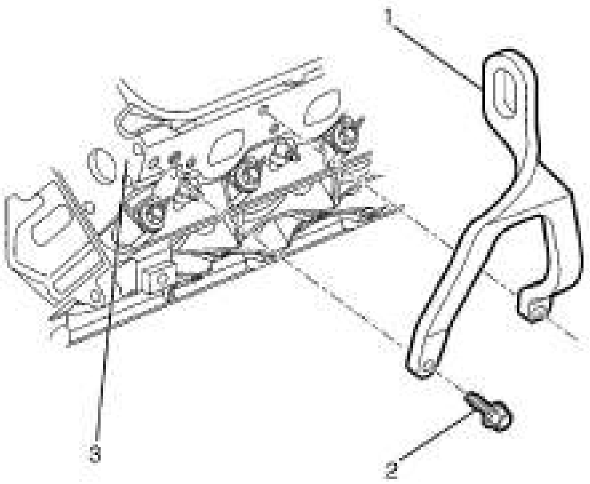
9. Raise the vehicle.

Notice: Refer to Fastener Notice in the Preface section.

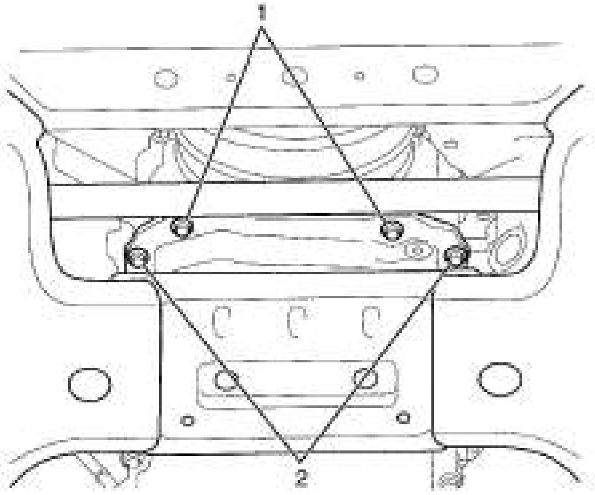
10. Install the lower engine mount to front subframe retaining nuts (1) on both engine mounts.

Tighten
Tighten the nut to 80 N·m (59 lb ft).

11. Lower the vehicle.
12. Remove J 41803 and J 28467-B from the engine.



13. Remove the J 41798 (1) from the cylinder head (2).



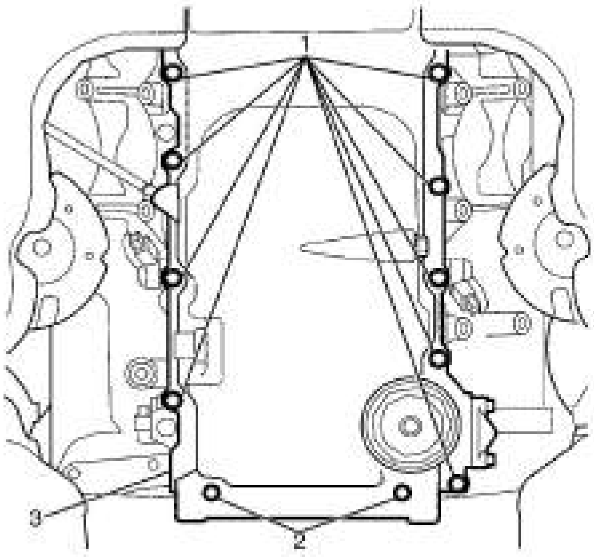
14. Install the oil pan to front cover retaining bolts (1) finger tight. Do not over tighten.
15. Install the oil pan to cylinder block retaining bolts (2) finger tight. Do not over tighten.
16. Place a straight edge across the rear of the engine block and the rear of the oil pan at the transmission housing mounting surfaces.
17. Align the oil pan until the rear of engine block and the rear of oil pan are flush or even.
18. Measure the oil pan-to-engine block alignment.
    - 18.1. Place a straight edge across the rear of the engine block and rear of the oil pan at the transmission housing mounting surfaces.

Important: The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing mounting surfaces.

18.2. Insert a feeler gauge between the straight edge and the oil pan transmission housing mounting surface and check to make sure that there is no more than a 0.25 mm (0.01 in) gap between the pan and the straight edge.

18.3. If the oil pan alignment is not within specifications, remove the oil pan and repeat procedures 17 through to 19.

Notice: Refer to Fastener Notice in the Preface section.

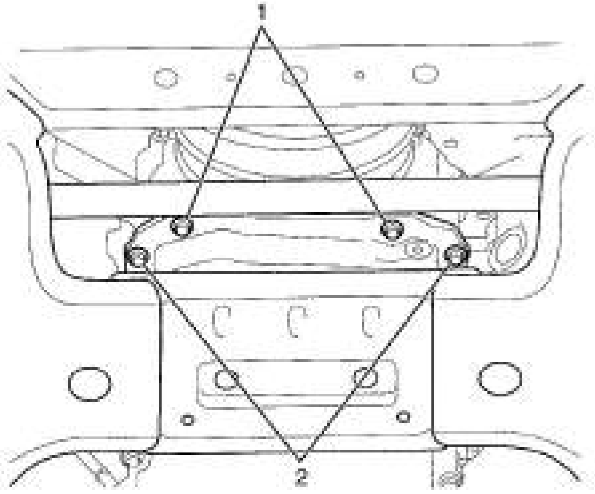


19. Tighten the M8 oil pan to cylinder block retaining bolts (1).

Tighten
Tighten the bolt to 25 N·m (18 lb ft).

20. Tighten the M6 oil pan to engine rear oil seal housing retaining bolts (2).

Tighten
Tighten the bolt to 12 N·m (106 lb in).



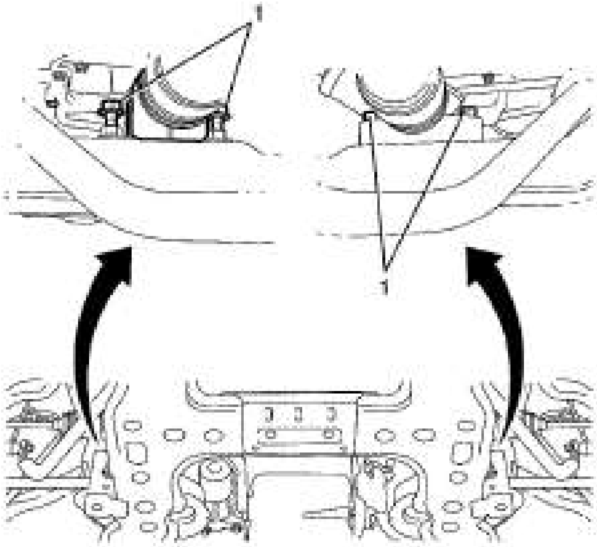
21. Tighten the oil pan to cylinder block retaining bolts (2).

    Tighten
    Tighten the bolt to 25 N·m (18 lb ft).

22. Tighten the oil pan to front cover retaining bolts (1).

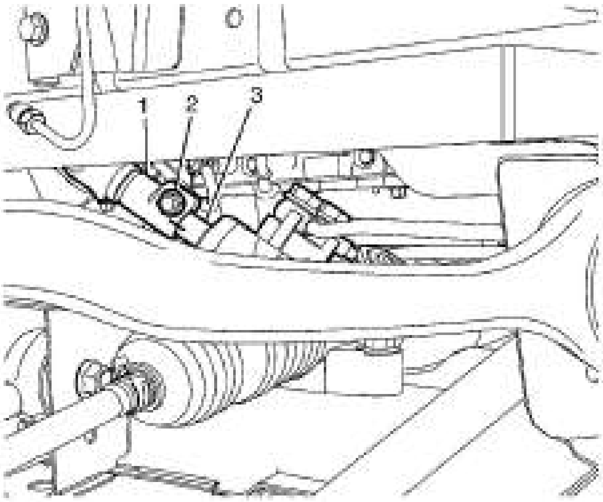
    Tighten
    Tighten the bolt to 25 N·m (18 lb ft).

23. Position the steering gear in the correct location.



24. Install the steering gear to subframe retaining bolts (1).

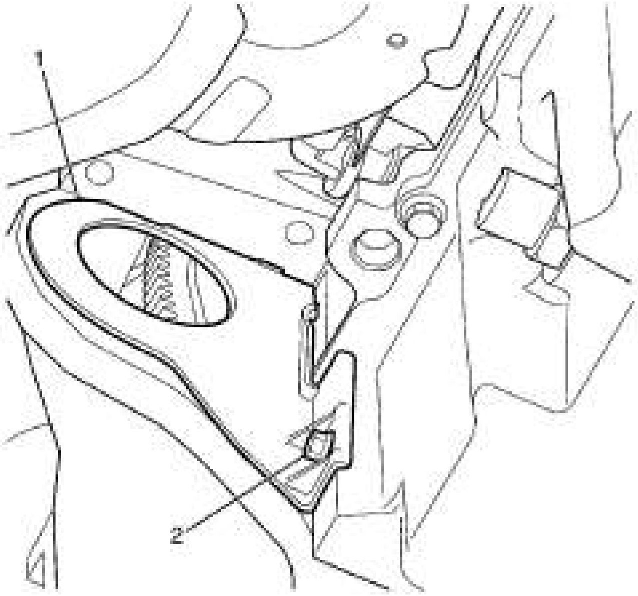
Tighten
Tighten the bolts to 65 N·m (48 lb ft).



Important: The intermediate steering shaft and pinion shaft splines must be installed in the position recorded during removal and aligned with the marks previously made.

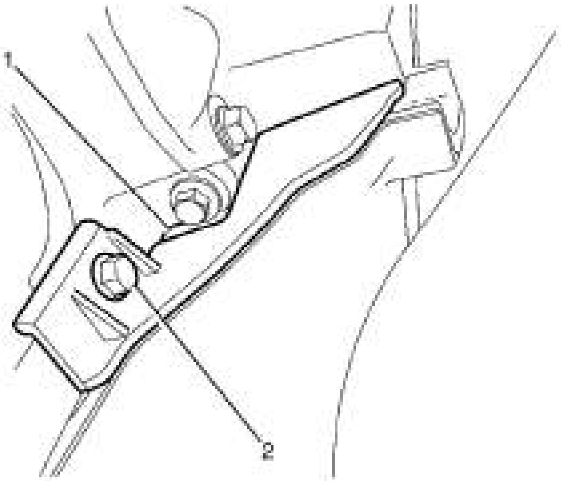
25. Connect the intermediate steering shaft (1) to the pinion shaft (3).
26. Install the intermediate steering shaft to pinion shaft NEW retaining bolt (2).

Tighten
Tighten the bolt to 25 N·m (18 lb ft).



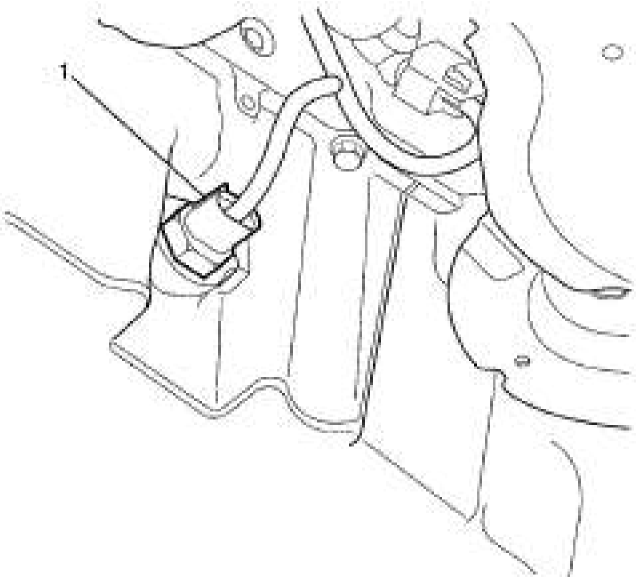
27. Install the right side close out cover (1).
28. Install the right side close out cover to cylinder block retaining bolt (2).

Tighten
Tighten the bolt to 12 N·m (106 lb in).



29. Install the left side close out cover (1).
30. Install the left side close out cover to cylinder block retaining bolt (2).

Tighten
Tighten the bolt to 12 N·m (106 lb in).



31. Connect the oil level/temperature sensor electrical connector (1) to the oil level/temperature sensor.
32. Install the starter motor. Refer to Starter Motor Replacement.
33. Install the air deflector. Refer to Front Air Deflector Replacement.
34. Install the engine splash shield. Refer to Engine Splash Shield Replacement.
35. Lower the vehicle to the ground
36. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
37. Replace the engine oil and oil filter. Refer to Engine Oil and Oil Filter Replacement.

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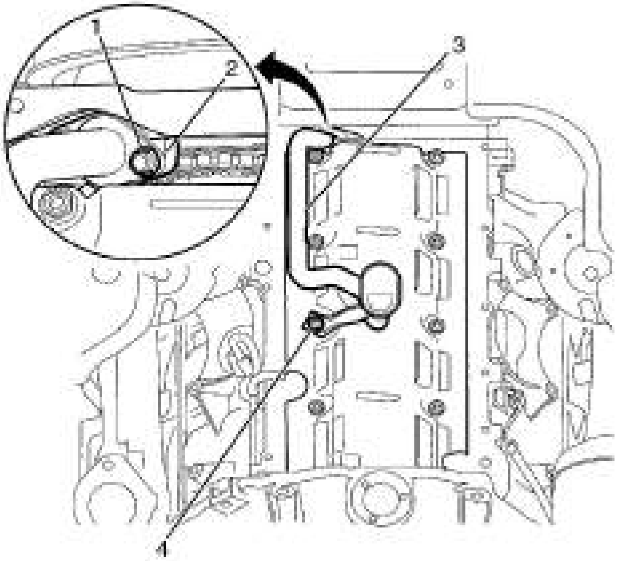
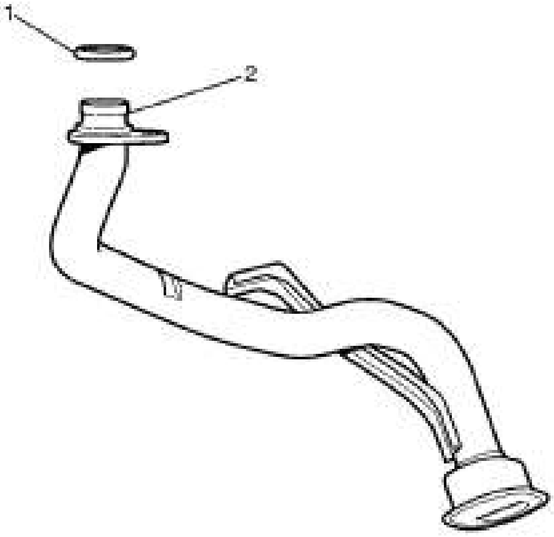
Oil Pump, Screen, and Crankshaft Oil Deflector Replacement

Removal Procedure

1. Remove the engine oil pan. Refer to Oil Pan Replacement.
2. Remove the engine front cover. Refer to Engine Front Cover Replacement.



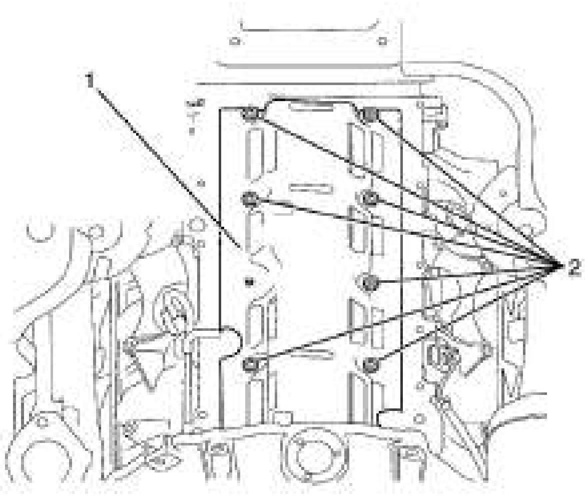
3. Remove the oil pump screen and tube assembly to oil pump retaining bolt (1).
4. Remove the oil pump screen and tube assembly to crankshaft oil deflector retaining nut (4).
5. Remove the oil pump screen and tube assembly (3) from the oil pump (2).



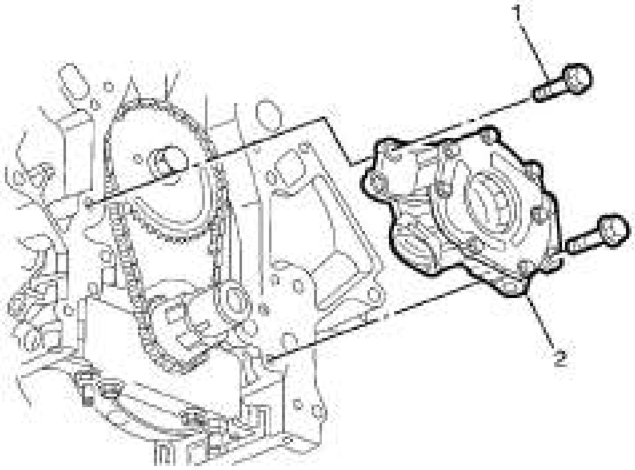
Important: The oil pump screen and tube assembly O-ring seal (1) is a single use only component and must be replaced whenever the oil pump screen and tube assembly (2) is removed.

6. Remove the oil pump screen and tube assembly O-ring seal (1) from the oil pump screen and tube assembly (2).

   Discard the oil pump screen and tube assembly O-ring seal (1).



7. Remove the remaining crankshaft oil deflector retaining nuts (2).
8. Remove the crankshaft oil deflector (1).



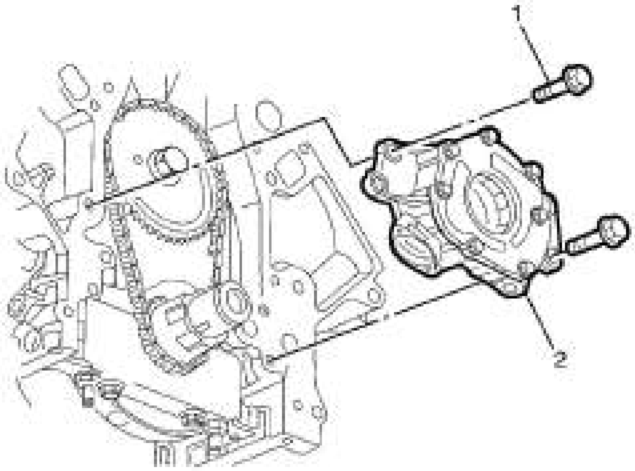
9. Remove the oil pump bolts (1).

   Important: Do not allow dirt or debris to enter the oil pump, cap the ends as necessary.

10. Remove the oil pump (2).
11. Clean and inspect the oil pump. Refer to Oil Pump Cleaning and Inspection.

Installation Procedure

Important: Inspect the engine block oil gallery passages. These surfaces must be clear and free of debris or restrictions.

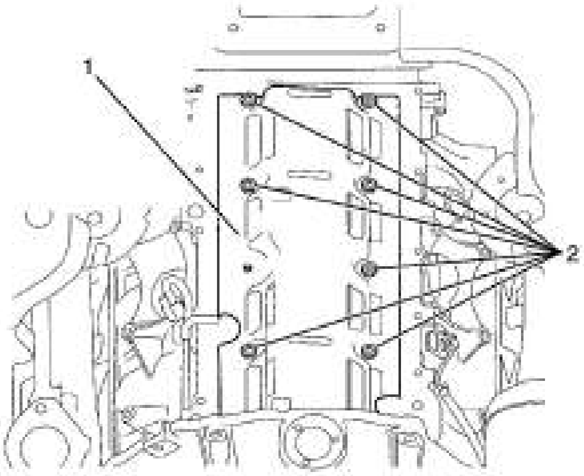


1. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump (1).

   Notice: Refer to Fastener Notice in the Preface section.

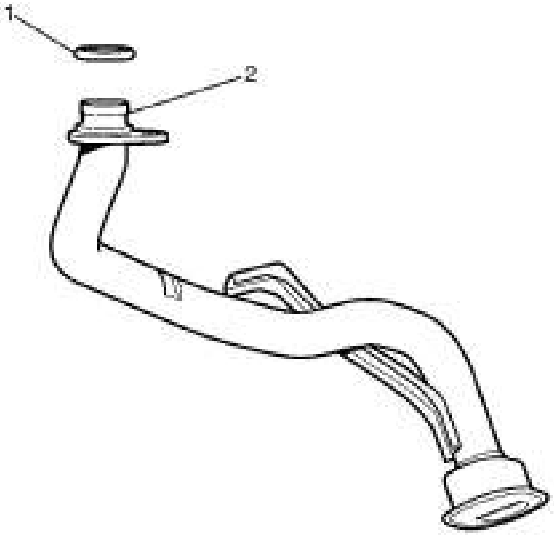
2. Install the oil pump to engine block retaining bolts (2).

   Tighten
   Tighten the bolts to 25 N·m (18 lb ft).



3. Install the crankshaft oil deflector (1).
4. Install the crankshaft oil deflector retaining nuts (2).

Tighten
Tighten the nuts to 25 N·m (18 lb ft).



5. Lubricate a NEW oil pump screen and tube assembly O-ring seal (1) with clean engine oil.
6. Install the NEW oil pump screen and tube assembly O-ring seal (1) onto the oil pump screen and tube assembly (2).

Important: Push the oil pump screen and tube assembly (3) completely into the oil pump (2) prior to tightening the oil pump screen and tube assembly to oil pump retaining bolt (1). Do not allow the oil pump screen and tube assembly to oil pump retaining bolt (1) to pull the oil pump screen and tube assembly (3) into the oil pump (2).

Important: Align the oil pump screen brackets with the correct crankshaft bearing cap studs.

7. Install the oil pump screen and tube assembly (3).
8. Install the oil pump screen and tube assembly to oil pump retaining bolt (1).

   Tighten
   Tighten the bolt to 12 N·m (106 lb in).

9. Install the oil pump screen and tube assembly to crankshaft oil deflector retaining nut (4).

   Tighten
   Tighten the nut to 25 N·m (18 lb ft).

10. Install the engine front cover. Refer to Engine Front Cover Replacement.
11. Install the engine oil pan. Refer to Oil Pan Replacement.

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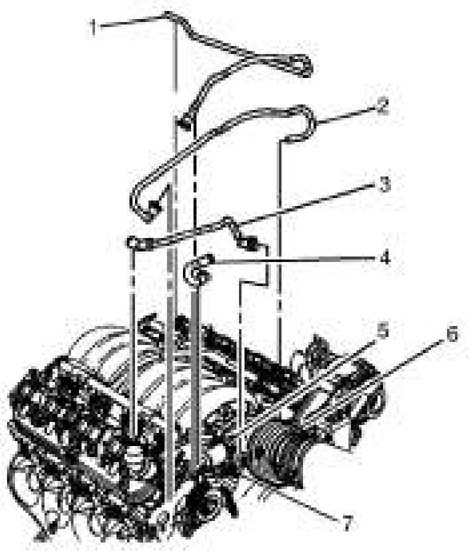
Positive Crankcase Ventilation Hose / Pipe / Tube Replacement

Removal Procedure

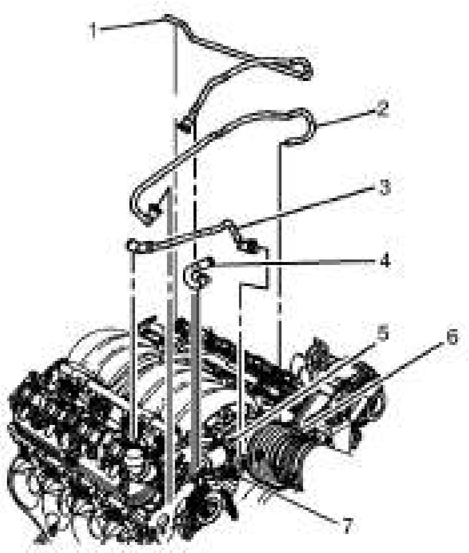


1. Remove the engine cover. Refer to Engine Cover Replacement.

   Important: In the following service procedure, it maybe necessary to remove the evaporative emission (EVAP) valve assembly to gain access to the positive crankcase ventilation hose.

2. Remove the evaporative emission canister purge valve (5). Refer to Evaporative Emission Canister Purge Solenoid Valve Replacement.
3. Remove the EVAP pipes (1) and (2).
4. Remove the EVAP pipe (3) from the air intake duct (6) and the valve cover.
5. Remove the hose (4) from the throttle body (7) and the engine valley cover.

Installation Procedure



1. Install the hose (4) from the throttle body (7) and the engine valley cover.
2. Install the EVAP pipe (3) from the air intake duct (6) and the valve cover.
3. Install the evaporative emission canister purge valve (5). Refer to Evaporative Emission Canister Purge Solenoid Valve Replacement.
4. Install the EVAP pipes (1) and (2).
5. Install the engine cover. Refer to Engine Cover Replacement.

Valve Lifter Replacement

Removal Procedure

1. Remove the cylinder head. Refer to Cylinder Head Replacement - Left Side or Cylinder Head Replacement - Right Side.
2. Remove the valve lifters. Refer to Valve Lifter Removal.

Installation Procedure

1. Install the valve lifters. Refer to Valve Lifter Installation.
2. Install the cylinder head. Refer to Cylinder Head Replacement - Left Side or Cylinder Head Replacement - Right Side.

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Valve Rocker Arm and Push Rod Replacement

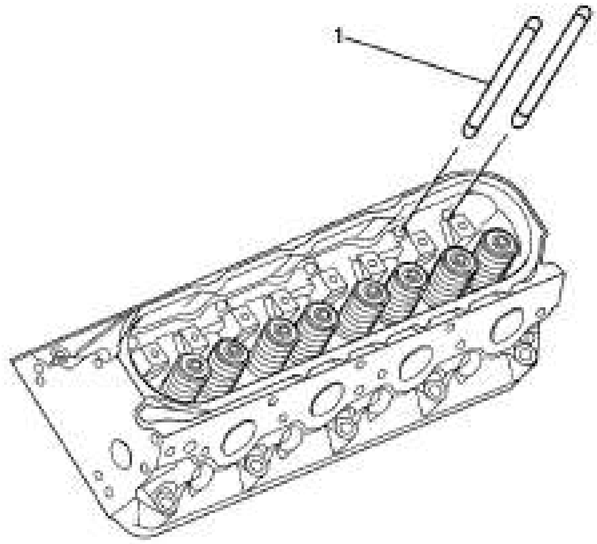
Removal Procedure

1. Remove the valve rocker arm covers. Refer to Valve Rocker Arm Cover Replacement - Left Side or Valve Rocker Arm Cover Replacement - Right Side.
2. Remove the valve rocker arm and push rods. Refer to Valve Rocker Arm and Push Rod Removal.
3. Clean and inspect the valve rocker arms and pushrods. Refer to Valve Rocker Arm and Push Rod Cleaning and Inspection.

Installation Procedure

Important:

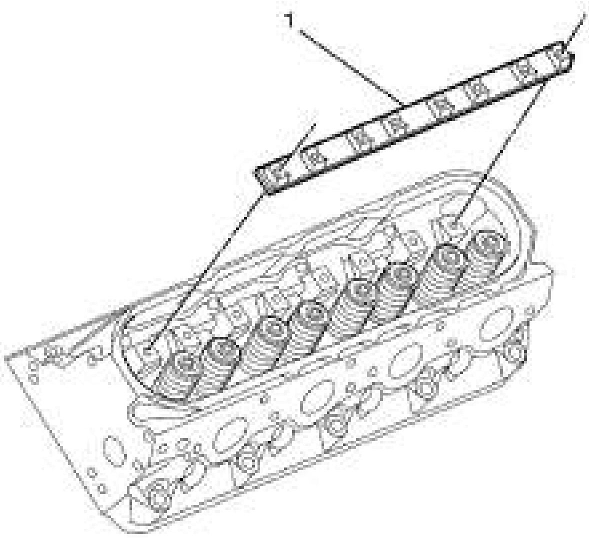
- When using the valve train components again, always install the components to the original location and position.
- Valve lash is net build, no valve adjustment is required.



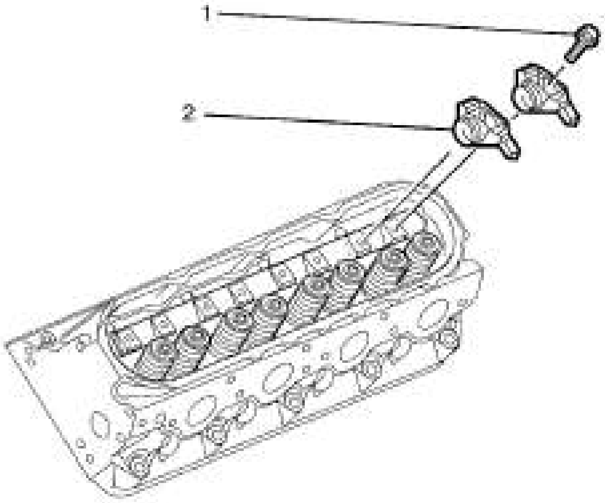
1. Lubricate the pushrods (1) with clean engine oil.

Important: Make sure the pushrods (1) seat correctly to the valve lifter sockets.

2. Install the pushrods (1).



3. Install the valve rocker arm pivot support (1).

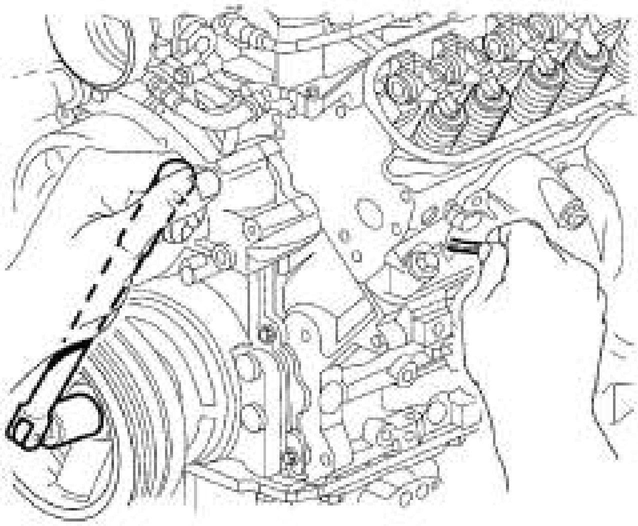


4. Lubricate the valve rocker arms (2) and pushrods with clean engine oil.
5. Lubricate the flange of the valve rocker arm bolts (1) with clean engine oil.

Important:

- Make sure the pushrods seat correctly to the ends of the rocker arms.
- DO NOT tighten the rocker arm bolts at this time.

6. Install the rocker arms and rocker arm retaining bolts.



Important: The Number 1 piston is at the compression stroke when the Number 6 cylinder inlet and exhaust valves are rocking, that is when the exhaust valve is at the end of its upward travel while the intake valve starts its downward movement.

Important: The engine firing order is 1-8-7-2-6-5-4-3. Cylinder numbers are 1-3-5-7 are on the left bank and 2-4-6-8 are on the right bank.

7. Rotate the crankshaft until number one piston is at top dead centre of compression stroke.

   Notice: Refer to Fastener Notice in the Preface section.

8. With the engine in the number one firing position, tighten the following valve rocker arm retaining bolts:

   Tighten
   - Tighten exhaust valve rocker arm retaining bolts 1, 2, 7, and 8 to 30 N·m (22 lb ft).
   - Tighten intake valve rocker arm retaining bolts 1, 3, 4, and 5 to 30 N·m (22 lb ft).
9. Rotate the crankshaft 360 degrees.
10. Tighten the following valve rocker arm retaining bolts:

    Tighten
    - Tighten exhaust valve rocker arm retaining bolts 3, 4, 5, and 6 to 30 N·m (22 lb ft).
    - Tighten intake valve rocker arm retaining bolts 2, 6, 7, and 8 to 30 N·m (22 lb ft).
11. Install the valve rocker arm covers. Refer to Valve Rocker Arm Cover Replacement - Left Side or Valve Rocker Arm Cover Replacement - Right Side..

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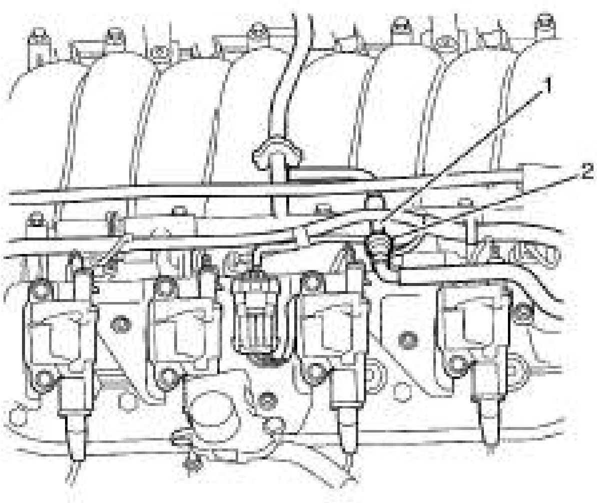
Valve Rocker Arm Cover Replacement - Left Side

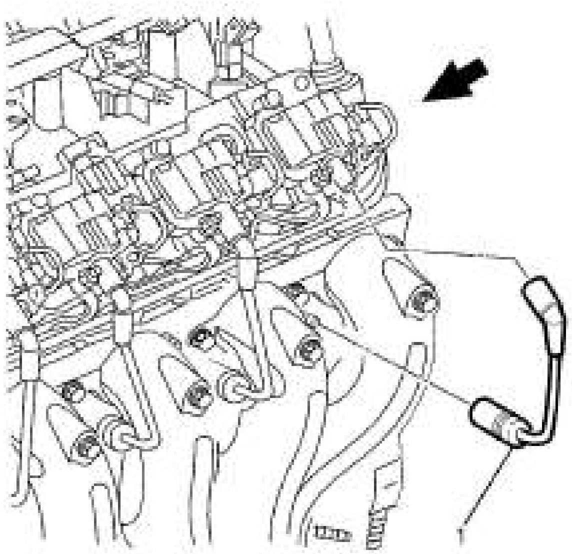
Removal Procedure

1. Remove the dress engine cover. Refer to Engine Cover Replacement .
2. Depressurize the fuel system. Refer to Fuel Pressure Relief.
3. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

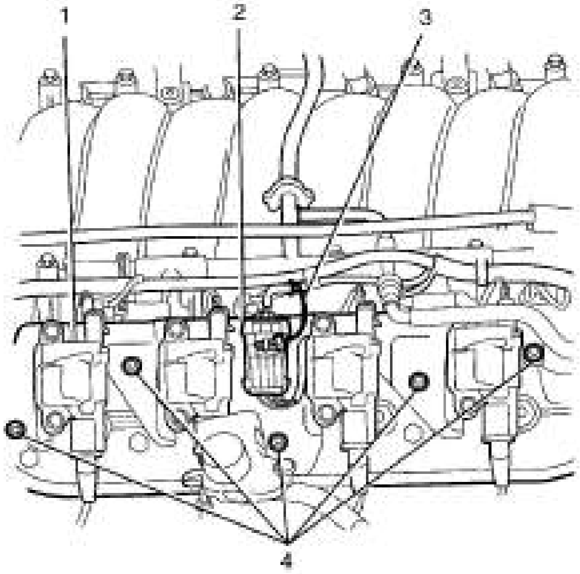


Important: Plug or cap the fuel feed pipe (2) and fuel rail tube (1) ends to prevent fuel leaks and/or contamination.

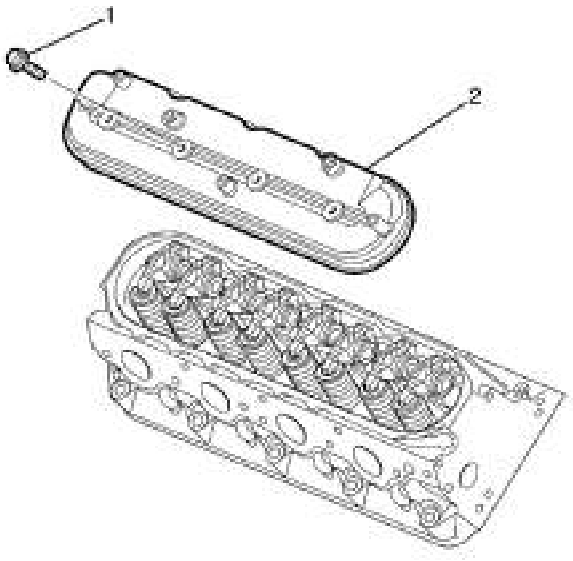
4. Disconnect the fuel rail feed pipe (2) quick connect fitting. Refer to Metal Collar Quick Connect Fitting Service or Plastic Collar Quick Connect Fitting Service.



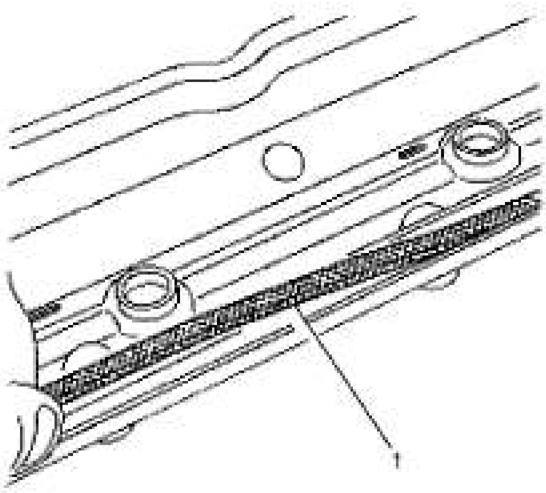
5. Remove the spark plug leads (1).



6. Remove the Connector Position Assurance (CPA) lock (3) from the ignition coil main connector (2).
7. Disconnect the ignition coil main connector (2).
8. Remove the ignition coil assembly to valve rocker arm cover retaining studs (4).
9. Remove the ignition coil assembly (1).



10. Loosen the valve rocker arm cover to cylinder head retaining bolts (1).
11. Remove the valve rocker arm cover (2).



Important: The valve rocker arm cover gasket is a single use only component and must be replaced whenever the valve rocker arm cover is removed from the cylinder head.

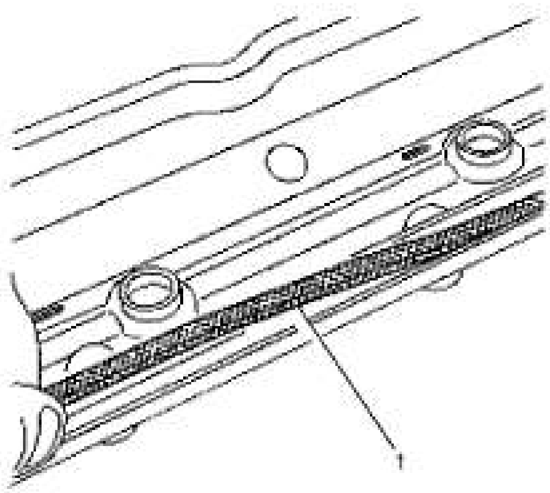
12. Remove the valve rocker arm cover gasket (1).

    Discard the valve rocker arm cover gasket (1).

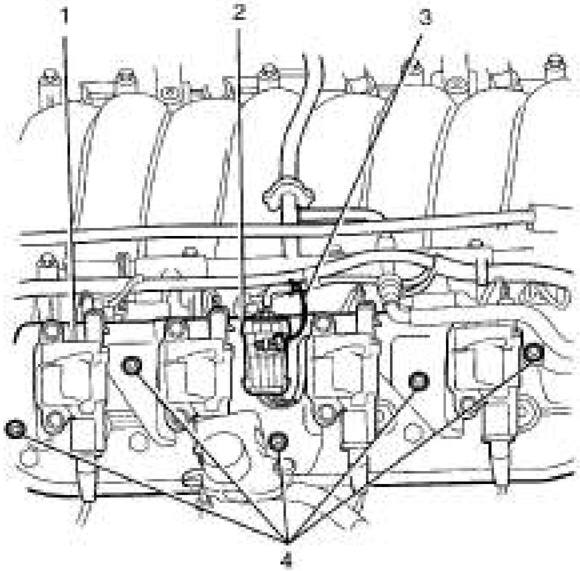
Installation Procedure

Important:

- All gasket surfaces should be free of oil and other foreign material during assembly.
- DO NOT reuse the valve rocker arm cover gasket.
- The valve rocker arm cover bolt grommets may be reused.
- If the positive crankcase ventilation (PCV) valve grommet has been removed from the rocker arm cover, install a NEW grommet during assembly.



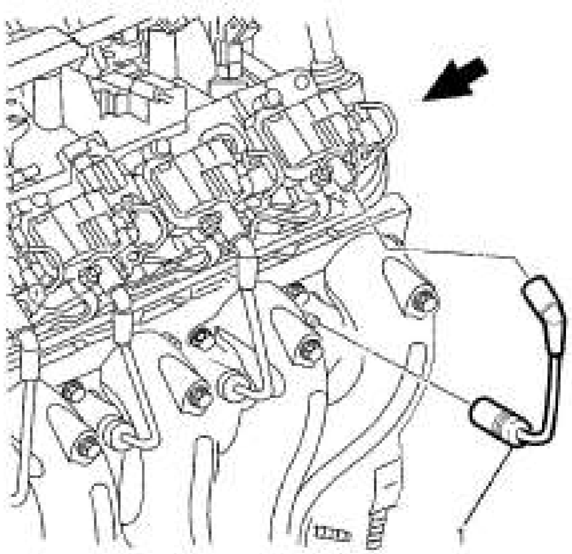
1. Install a NEW valve rocker arm cover gasket (1).
2. Install the valve rocker arm cover. Refer to Valve Rocker Arm Cover Installation - Left Side.



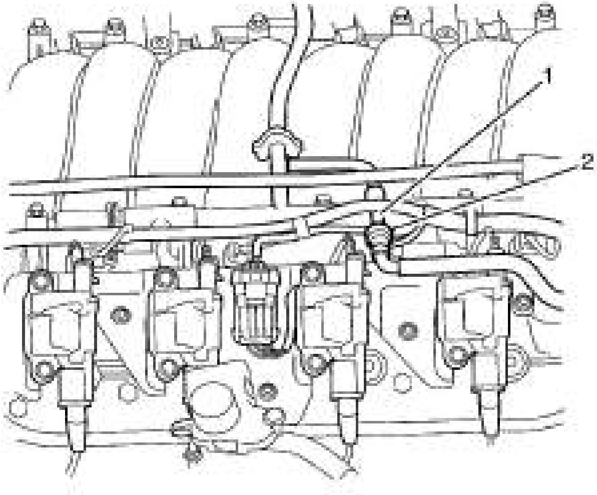
3. Install the ignition coil assembly (1).
4. Install the ignition coil bracket to valve rocker arm cover retaining studs (4).

Tighten
Tighten the studs to 12 N·m (106 lb in).

5. Connect the ignition coil main connector (2).
6. Install the Connector Position Assurance (CPA) lock (3) from the ignition coil main connector (2).



7. Install the spark plug leads (1).



8. Remove the plug on the fuel feed pipe (2) and fuel rail tube (1) ends.
9. Connect the fuel rail feed pipe (2) quick connect fitting. Refer to Metal Collar Quick Connect Fitting Service or Plastic Collar Quick Connect Fitting Service.
10. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
11. Install the dress engine cover. Refer to Engine Cover Replacement .

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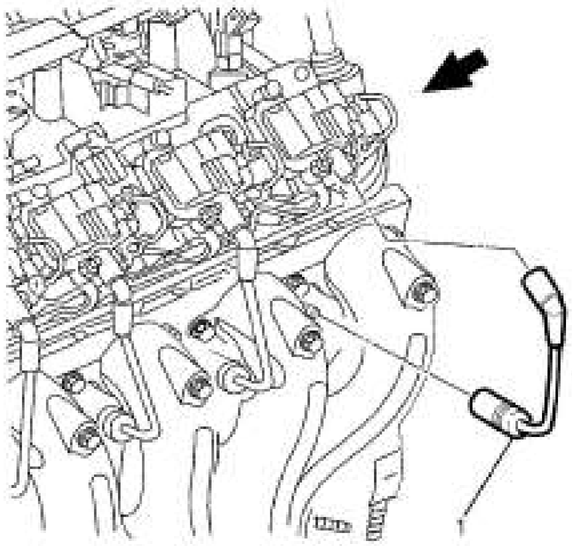
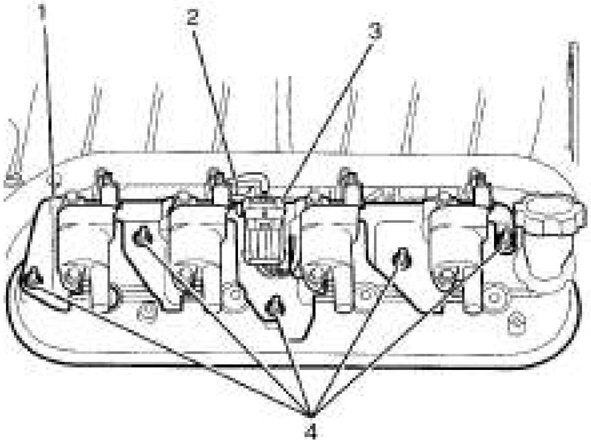
Valve Rocker Arm Cover Replacement - Right Side

Removal Procedure

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove the engine cover. Refer to Engine Cover Replacement .

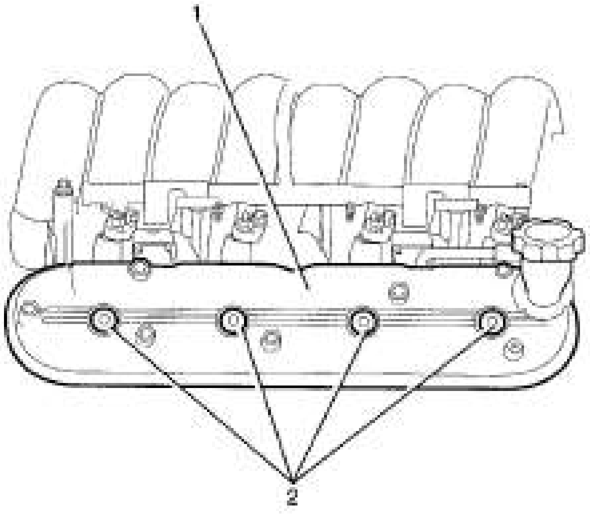


3. Remove the spark plug leads (1).

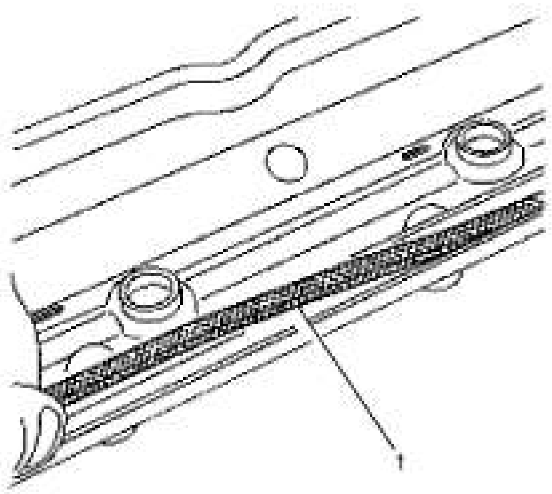


4. Remove the CPA lock (2) from the ignition coil main connector (3).
5. Disconnect the ignition coil main connector (3).

6. Remove the ignition coil assembly to valve rocker arm cover retaining studs (4).
7. Remove the ignition coil assembly (1).



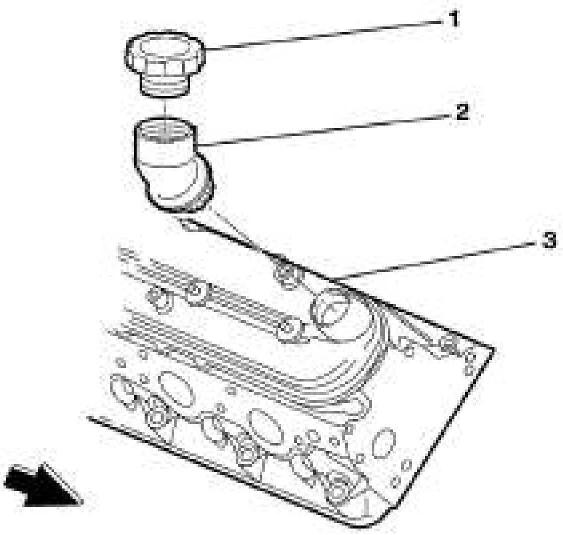
8. Remove the valve rocker arm cover retaining bolts (2) and valve rocker arm cover (1).
9. Remove the valve rocker arm cover (1). Refer to Valve Rocker Arm Cover Installation - Right Side.



Important: The valve rocker arm cover gasket is a single use only component and must be replaced whenever the valve rocker arm cover is removed from the cylinder head.

10. Remove the valve rocker arm cover gasket (1).

    Discard the valve rocker arm cover gasket (1).



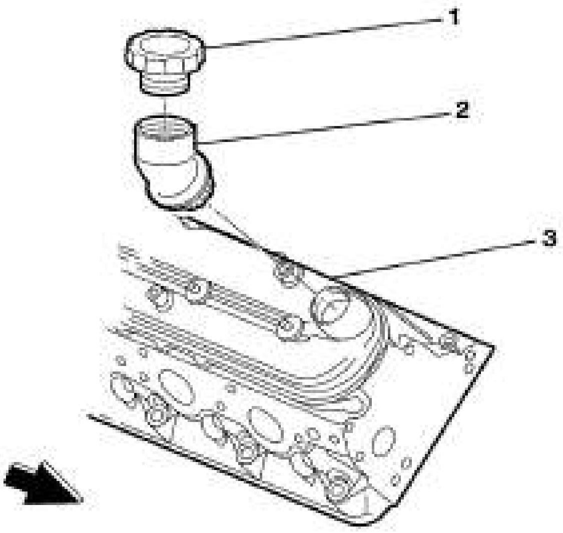
11. Remove the oil fill cap (1) from the oil fill tube (2).

    Important: Do not remove the oil fill tube from the cover, unless service is required. If the oil fill tube has been removed from the cover, install a NEW tube during assembly.

12. Remove the oil fill tube (2), from the right hand valve rocker arm cover (3) if required.

    Discard the oil fill tube (2).

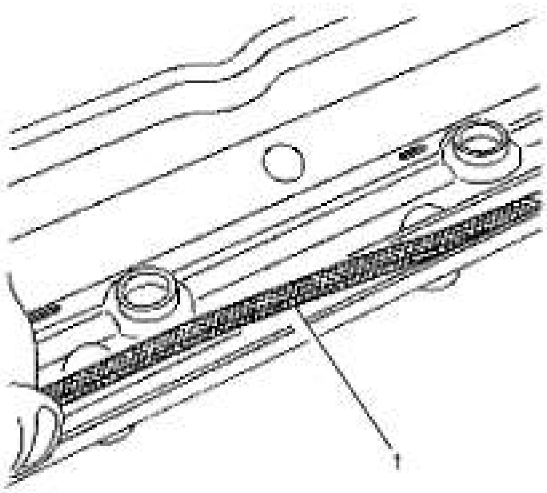
Installation Procedure



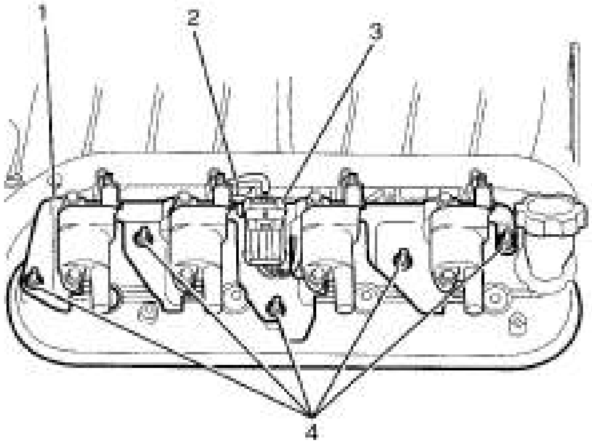
1. Install the NEW oil fill tube (2), to the right hand valve rocker arm cover (3) if required.
2. Install the oil fill cap (1) to the oil fill tube (2).

Important:

- All gasket surfaces should be free of oil and other foreign material during assembly.
- DO NOT reuse the valve rocker arm cover gasket.
- The valve rocker arm cover bolt grommets may be reused.



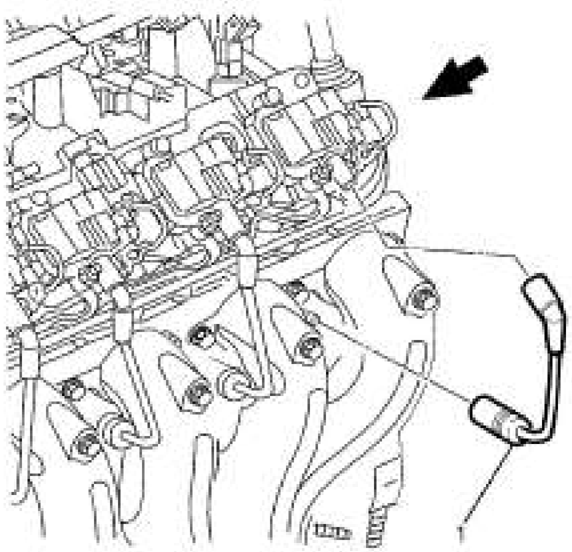
3. Install a NEW valve rocker arm cover gasket (1).
4. Install the valve rocker arm cover. Refer to Valve Rocker Arm Cover Installation - Right Side.



5. Install the ignition coil assembly (1).
6. Install the ignition coil bracket to valve rocker arm cover retaining studs (4).

   Tighten
   Tighten the studs to 12 N·m (106 lb in).

7. Connect the ignition coil main connector (3).
8. Install the CPA lock (2) from the ignition coil main connector (3).



9. Install the spark plug leads (1).
10. Install the engine cover. Refer to Engine Cover Replacement .

Valve Stem Oil Seal and Valve Spring Replacement

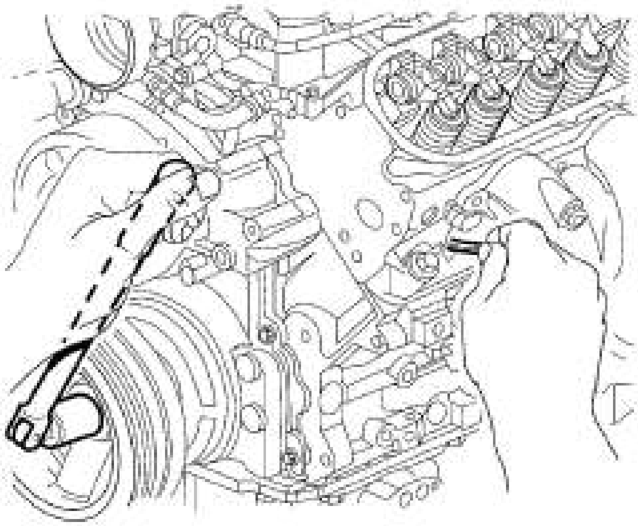
Tools Required

- J 22794 Spark Plug Port Adapter
- J 38606 Valve Spring Compressor (Head-on)

Removal Procedure

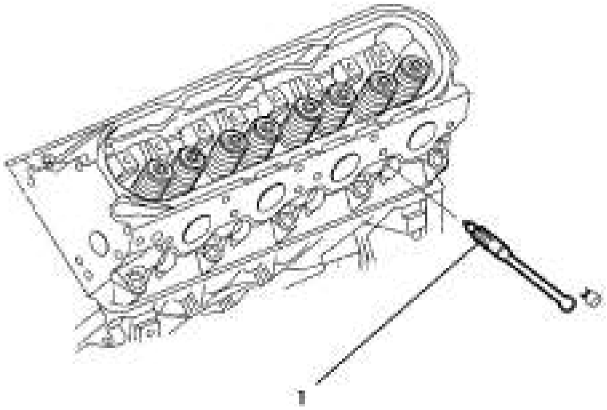
Important: Store all valve train components in the same order they are removed. Make sure all valve train components are installed in the same location as on removal.

1. Remove the valve rocker arms. Refer to Valve Rocker Arm and Push Rod Cleaning and Inspection.
2. Remove the spark plug. Refer to Spark Plug Replacement.

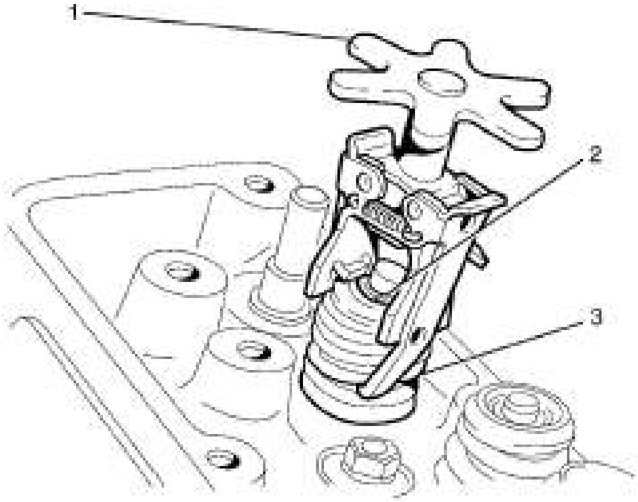


Important: This operation can be performed with the cylinder at the bottom of its stroke, however with the piston at TDC the valve will not fall into the cylinder if the air supply is accidentally disconnected during the operation.

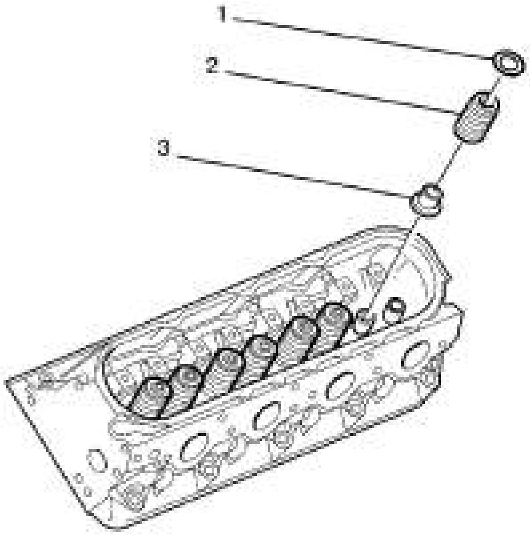
3. Using a socket and handle on the crankshaft pulley retaining bolt, rotate the crankshaft until the piston of the cylinder being serviced is at the Top Dead Centre (TDC) of the compression stroke.



4. Install the J 22794 (1) or equivalent into the spark plug hole of the cylinder being serviced.
5. Attach a compressed air line to J 22794 (1) and apply a constant supply of air pressure to the cylinder being serviced.
6. Tap the end of the valve stem with a soft face hammer in order to dislodge the valve spring cap retaining collets.

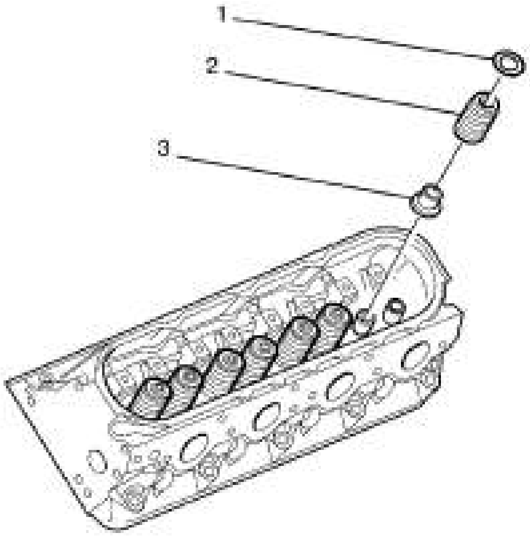


7. Use J 38606 (1) in order to compress the valve spring (3).
8. Remove the valve spring retaining cap collets (2).
9. Carefully release the valve spring (3) tension.
10. Remove the J 38606 (1).



11. Remove the valve spring cap (1).
12. Remove the valve spring (2).
13. Remove the valve stem oil seal (3).

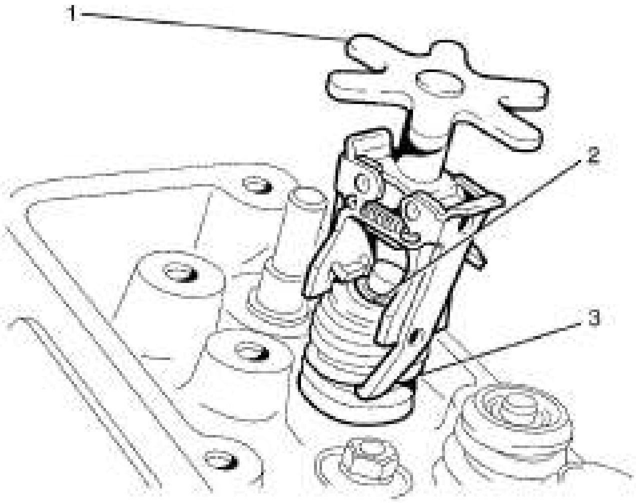
Installation Procedure



1. Clean the cylinder head valve spring seat and/or shim area.

   Important: The valve stem oil seal alignment and position on the valve guide is critical. An incorrectly installed valve stem oil seal may lead to above acceptable oil consumption and increased vehicle emissions.

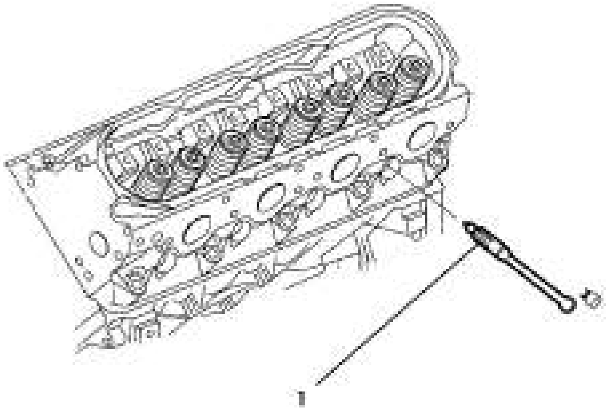
2. Install the valve stem oil seal (3). onto the guide.
3. Install the valve spring (2).
4. Install the valve spring cap (1).



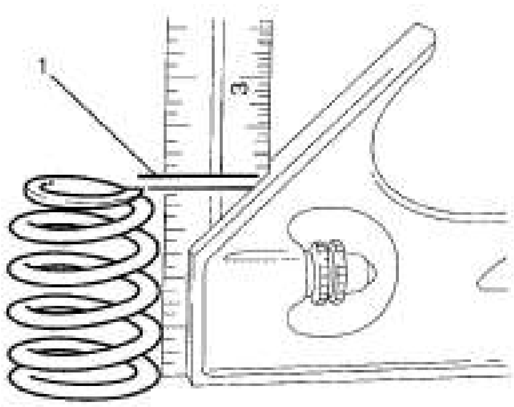
5. Use J 38606 (1) in order to compress the valve spring (3).
6. Compress the valve spring using the J 38606 (1).

   Important: Use clean grease or petroleum jelly to retain the valve spring retaining collets (2)

7. Install the valve spring retaining collets (2).
8. Release the J 38606 (1) making sure both valve spring retaining collets have seated correctly.
9. Lightly tap the valve stem with a soft faced hammer to seat the valve stem collets.



10. Disconnect and remove the compressed air supply from the J 22794 (1).
11. Remove the J 22794 (1) from the spark plug hole.

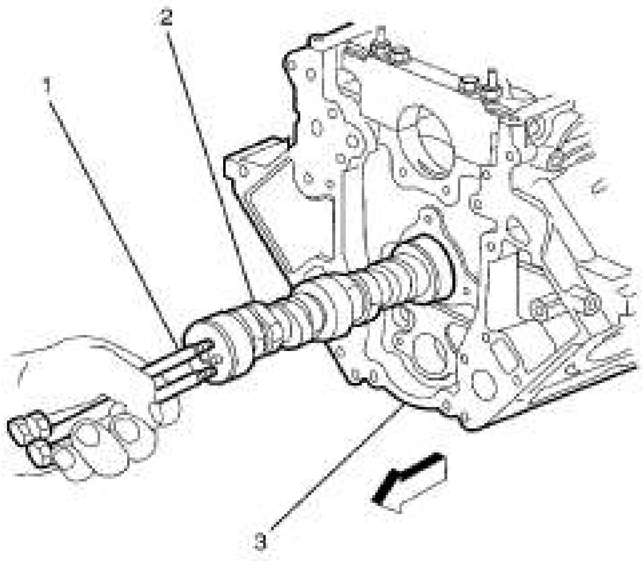


12. Measure the valve spring installed height using a ruler.

    Measure from the base of the valve spring to the top of the valve spring.

    - If the installed height exceeds 46.25 mm (1.82 in), install a valve spring shim of approximately 0.5 mm (0.02 in) thick.
    - Do not shim the valve spring to obtain less than the specified height.
    - Do not assemble the components without a spring shim on the cylinder head.
13. Install the spark plug. Refer to Spark Plug Replacement.
14. Install the valve rocker arms. Refer to Valve Rocker Arm and Push Rod Cleaning and Inspection.

Camshaft Installation (L98, LS2)

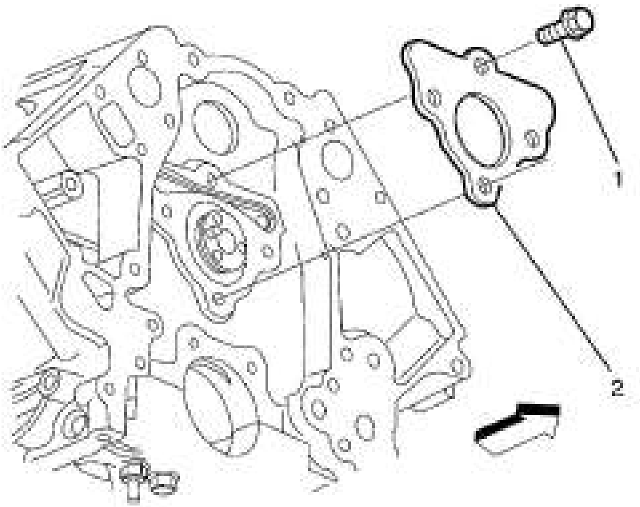


1. Lubricate the camshaft (2) journals and bearings with clean engine oil.
2. Install M8 -1.25 x 100 mm (M8 -1.25 x 4.0 in) bolts (1) in the front of the camshaft (2).

   Important: All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.

3. Using the bolts (1) as a handle, carefully install the camshaft (2) into the cylinder block (3).
4. Remove the bolts (1) from the front of the camshaft (2).

   Notice: Refer to Fastener Notice in the Preface section.



Important: The gasket surface on the engine block should be clean and free of dirt or debris.

5. Install the camshaft retainer (2).
6. Install the camshaft retainer to cylinder block retaining bolts (1).

Tighten
Tighten the bolts to 25 N·m (18 lb ft).

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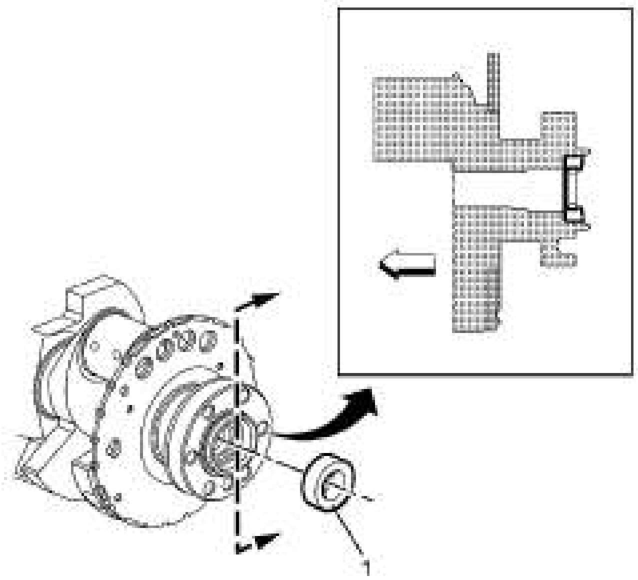
Clutch Pilot Bearing Installation

Tools Required

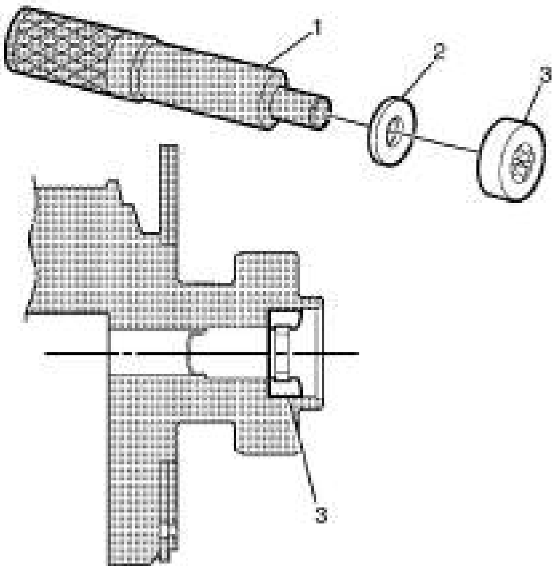
J 38836 Bushing Installer and Clutch Arbor



Important: Make sure that the crankshaft rear oil gallery plug (1) is not a loose fit, damaged or leaking.

Important: The correct depth (a) for the oil gallery plug is 31.2 to 31.6 mm.

1. Apply sealant LOCTITE R 242 and install it to the correct depth, If replacing the oil gallery plug (1).



Important: Use a 5/8 inch flat washer (2) against the tool to support the bearing races.

Important: When installed correctly the bearing should be flush with the crankshaft counter-bore.

2. Install the clutch pilot bearing (3) to the rear of the crankshaft, using J 38836 (1).

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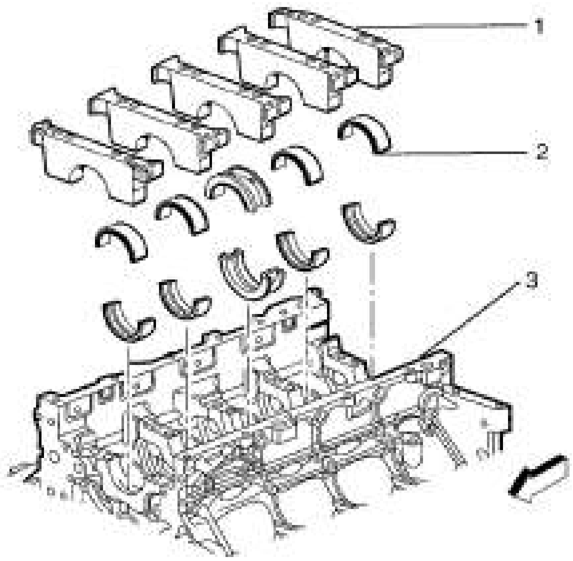
Crankshaft and Bearing Installation

Tools Required

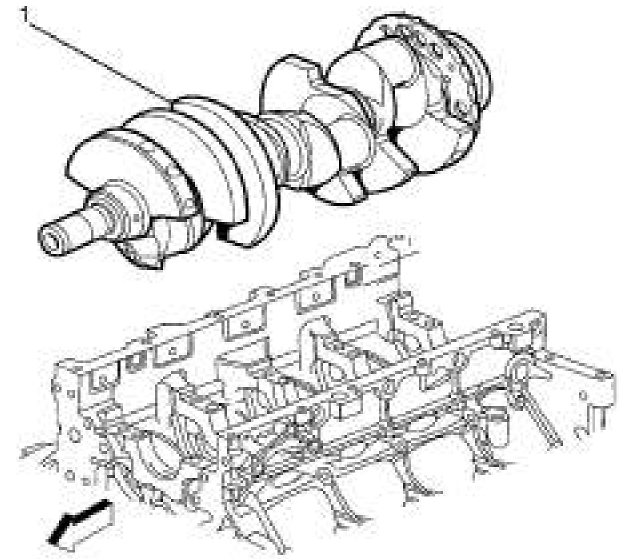
J 45059 Angle Meter



Important: The crankshaft bearings (2) MUST be installed to their original position after performing an oil clearance check.

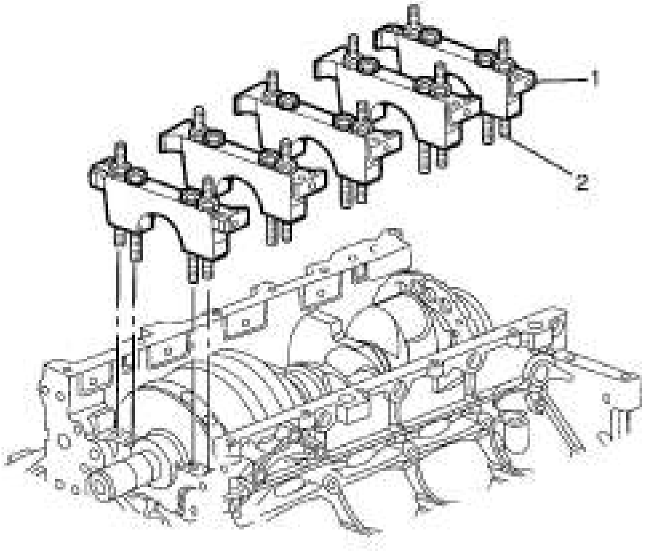
Important: Do not apply engine oil to the back of the crankshaft bearings (2).

1. Install the crankshaft bearings (2) into the bearing caps (1) and the cylinder block (3).
2. Apply clean engine oil to the bearing halves and crankshaft journals.



Important: Make sure the crankshaft (1) is held square to avoid damaging the centre main thrust bearing or the reluctor ring teeth. Nicks, burrs or other damage to the teeth may effect on-board diagnostics (OBD) II system performance.

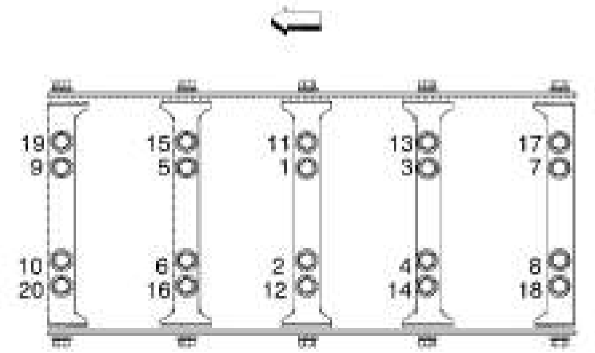
3. Install the crankshaft (1).



Important: The crankshaft bearing caps are machined with the engine block for the correct clearances. The crankshaft bearing caps MUST be installed to their original position and direction.

4. Install the crankshaft bearing caps (1).
5. Install the crankshaft bearing cap bolts and studs (2).

Notice: Refer to Fastener Notice in the Preface section.



Important: Perform the Stage 1 for bolts and studs 1-20 and then continue with Stage 2. Use the J 45059 to achieve an accurate second reading, noting the different turn angles for the bolts and the studs.

6. Tighten the crankshaft bearing cap bolts and studs (2) in the sequence shown.

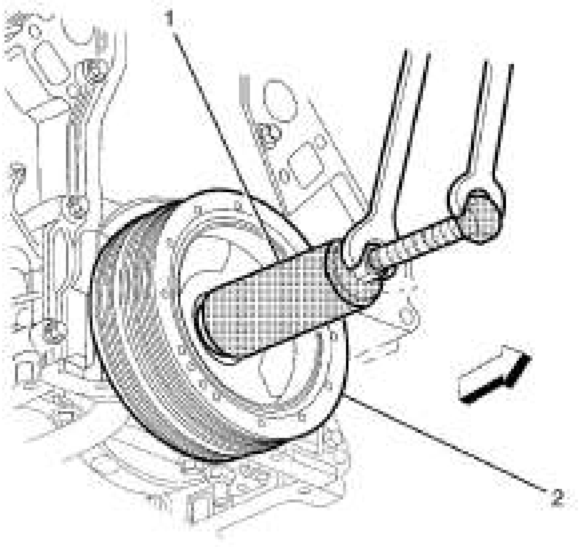
Tighten

1. Tighten the crankshaft bearing cap to cylinder block inner retaining bolts (1 - 10) a first pass in sequence to 20 N·m (14 lb ft).
2. Tighten the crankshaft bearing cap to cylinder block inner retaining bolts (11 - 20) a first pass in sequence to 20 N·m (14 lb ft).
3. Tighten the crankshaft bearing cap to cylinder block inner retaining bolts (1 - 10) a second pass in sequence an additional 80 degrees using the J 45059 .
4. Tighten the crankshaft bearing cap to cylinder block inner retaining bolts (11 - 20) a second pass in sequence an additional 53 degrees using the J 45059 .

Crankshaft Balancer Installation (L98, LS2)

Tools Required

- J 41478 Crankshaft Front Oil Seal Installer
- J 41665 Crankshaft Balancer and Sprocket Installer
- J 42386-A Flywheel Holding Tool
- J 45059 Angle Meter



1. Use J 41665 (1) to install the crankshaft balancer (2).
   1.1. Assemble the threaded rod, nut, washer and installer.

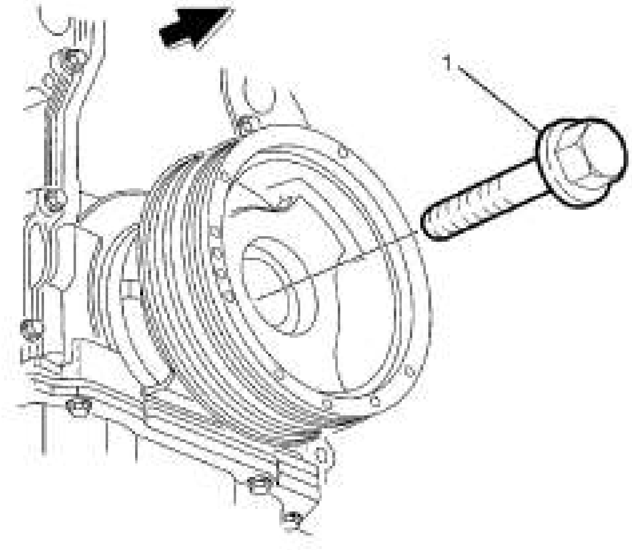
   Insert the smaller end of the installer into the front of the crankshaft balancer (2).

   1.2. Use a wrench and hold the hex end of the threaded rod.
   1.3. Use a second wrench and rotate the installation tool nut clockwise, until the crankshaft balancer (2) is started onto the crankshaft.
   1.4. Remove the tool and reverse the installation tool.

   Position the larger end of the installer against the front of the crankshaft balancer (2).

   1.5. Use a wrench and hold the hex end of the threaded rod.
   1.6. Use a second wrench and rotate the installation tool nut clockwise, until the crankshaft balancer (2) is installed onto the crankshaft.
   1.7. Remove the J 41665 (1).

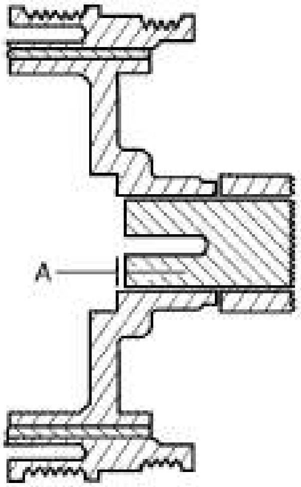
Notice: Refer to Fastener Notice in the Preface section.



2. Install the used crankshaft balancer retaining bolt (1).

   Tighten
   Tighten the bolt to 330 N·m (240 lb ft).

3. Remove the used crankshaft balancer retaining bolt (1).



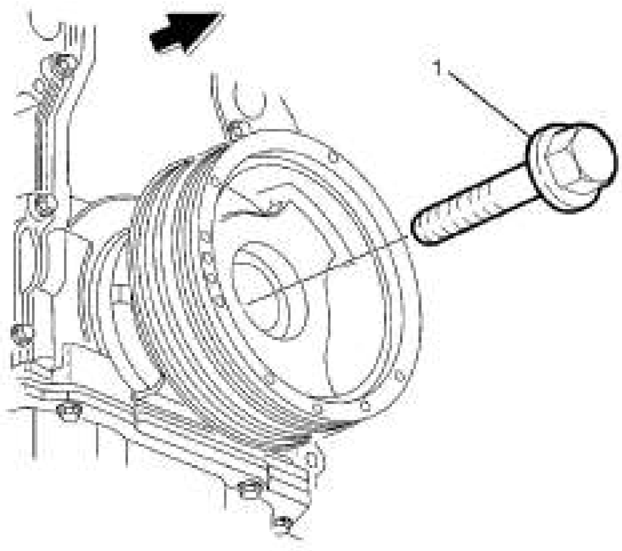
4. Measure the distance the balancer protrudes from the crankshaft nose and ensure dimension (A) is to specification

   Specification

Dimension (A): 2.4-4.48 mm (0.094-0.176 in)

If the balancer is not installed to the correct dimensions, install the J 41665 and repeat the installation procedure.

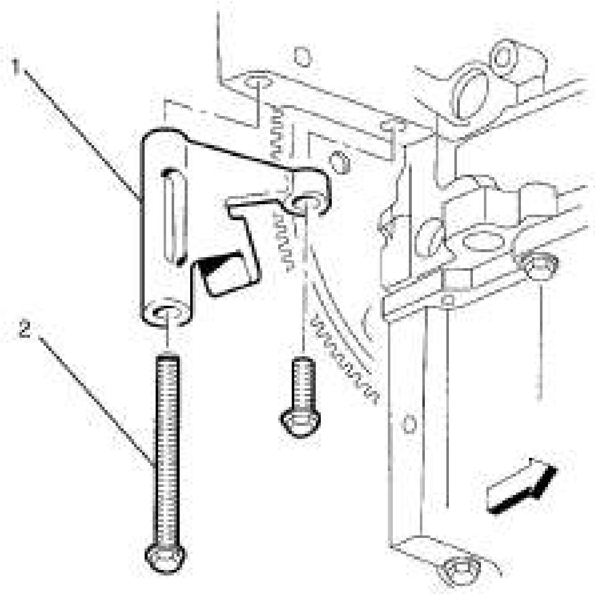
Notice: Refer to Fastener Notice in the Preface section.



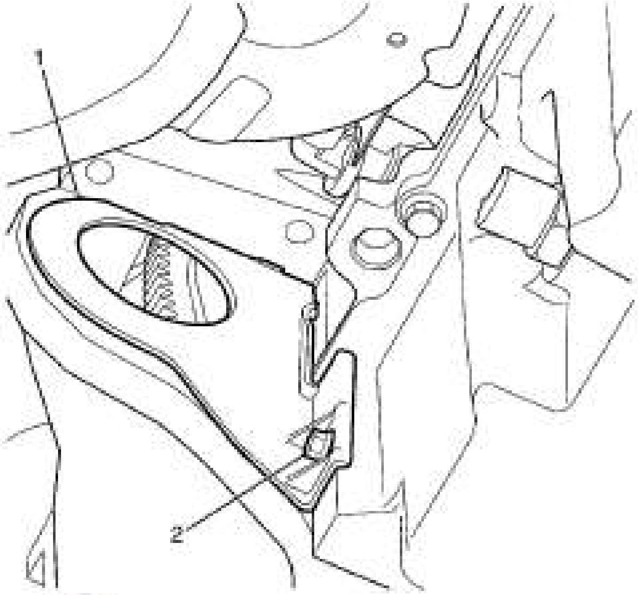
5. Install the NEW crankshaft balancer retaining bolt (1).

Tighten

- First Pass: Tighten the bolts to 50 N·m (37 lb ft).
- Final Pass: Tighten an additional 140 degrees using the J 45059 .



6. Remove the J 42386-A to cylinder block retaining bolts (2).
7. Remove the J 42386-A (1).



8. Install the right transmission cover (1).

Notice: Refer to Fastener Notice in the Preface section.

9. Install the right transmission cover (1) to engine oil pan retaining bolt (2).

Tighten
Tighten the bolt to 12 N·m(106 lb in).

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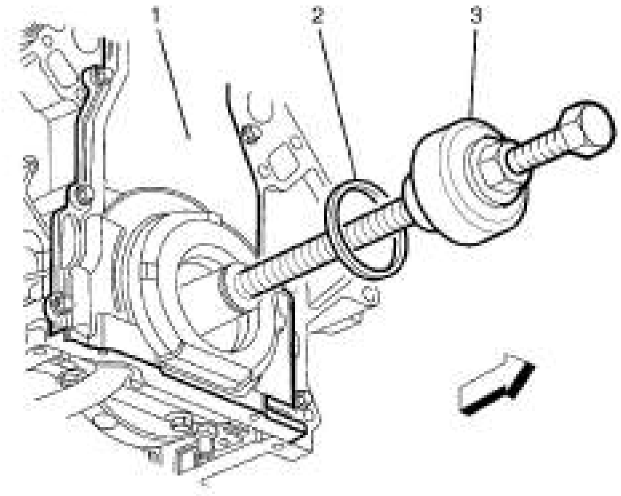
Crankshaft Front Oil Seal Installation (L98, LS2)

Tools Required

J 41478 Crankshaft Front Oil Seal Installer

Important:

- Do not lubricate the oil seal sealing surface.
- Do not reuse the crankshaft oil seal.
- Lubricate the outer edge of the oil seal with clean engine oil.
- Lubricate the front engine cover oil seal bore with clean engine oil.



1. Install the crankshaft front oil seal onto the J 41478 (3) guide.
2. Install the J 41478 (3) threaded rod (with nut, washer, guide, and oil seal) into the end of the crankshaft.
3. Use the J 41478 (3) in order to install the oil seal (2) into the front engine cover (1) bore.
    - 3.1. Use a wrench and hold the hex on the installer tool.
    - 3.2. Use a second wrench and rotate the installer nut clockwise until the seal bottoms in the front engine cover (1) bore.
    - 3.3. Remove the tool.
    - 3.4. Inspect the oil seal for correct installation. The oil seal should be installed evenly and completely into the front cover bore.

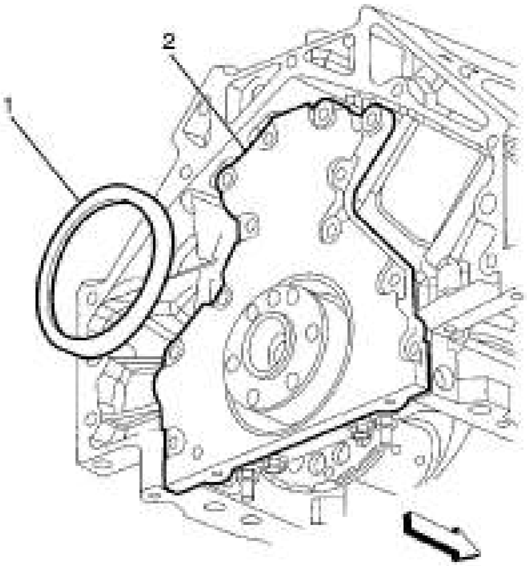
Crankshaft Rear Oil Seal Installation (L98, LS2)

Tools Required

J 41479 Crankshaft Rear Oil Seal Installer

Important:

- Do not lubricate the oil seal (1) inside diameter (ID) of the crankshaft surface.
- Do not reuse the crankshaft rear oil seal (1).

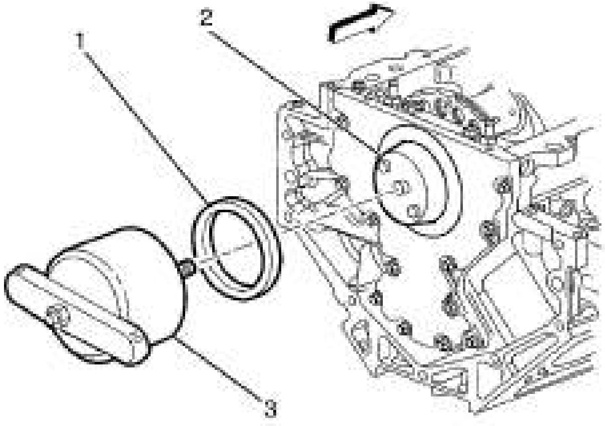


1. Lubricate the outside diameter (OD) of the oil seal (1) with clean engine oil.

   DO NOT allow oil or other lubricants to contact the seal surface.

2. Lubricate the rear cover (2) oil seal bore with clean engine oil.

   DO NOT allow oil or other lubricants to contact the crankshaft surface.



3. Install the J 41479 (3) cone and bolts onto the rear of the crankshaft.

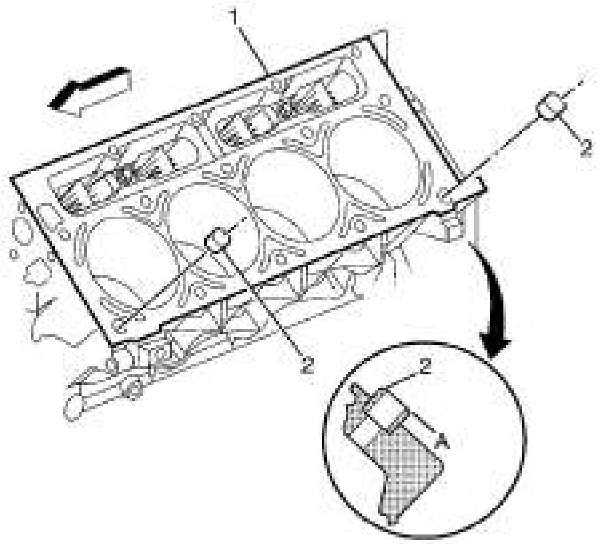
   Important: Do not over tighten the bolts.

4. Tighten the bolts.
5. Install the rear oil seal (1) onto the J 41479 (3) and push the seal to the rear cover bore (2).
6. Thread the J 41479 (3) threaded rod into the tapered cone until the J 41479 (3) contacts the rear oil seal (1).
7. Align the rear oil seal (1) onto the J 41479 (3).
8. Rotate the handle of the J 41479 (3) clockwise until the rear oil seal (1) enters and bottoms into the rear cover bore (2).
9. Remove the J 41479 (3).

Cylinder Head Installation - Left Side (L98, LS2)

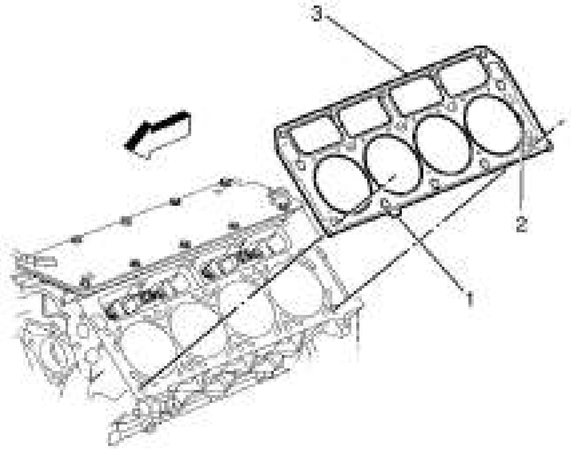
Tools Required

- J 42385-100 Thread Repair Kit
- J 45059 Angle Meter



Important: Make sure the locating sleeves (2) are correctly installed to the maximum height (A) of 8.3 mm (0.33 in).

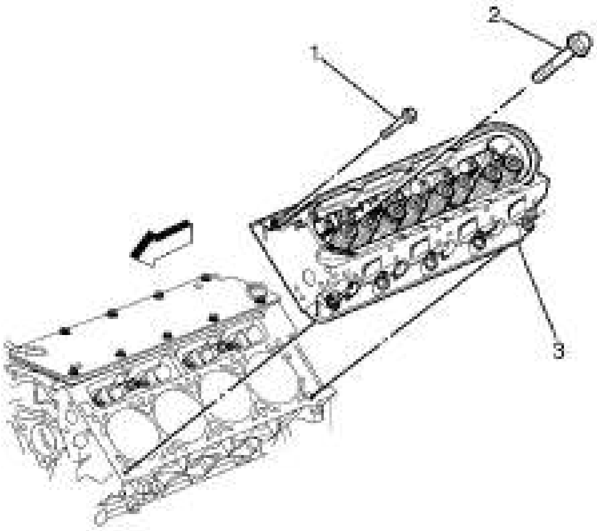
1. Install the locating sleeves (2) into the cylinder block (1).



Important: The cylinder head gasket (3) will fit on either side of the engine. Make sure the tab on the cylinder head gasket (1) is located towards the front half point and the stamping FRONT on the cylinder head gasket (2) is facing the front of the engine.

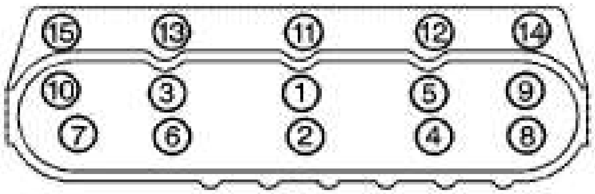
Important: Do not use any type of sealant on the cylinder head gasket (3), unless specified.

2. Install the NEW cylinder head gasket (1) correctly over the locating sleeves.



3. Install the cylinder head (3) onto the locating pins and the gasket.
4. Install the NEW cylinder head bolts (1,2).

Notice: Refer to Fastener Notice in the Preface section.



5. Tighten the cylinder head bolts.

Tighten

- First Pass: Tighten the M11 cylinder head bolts (1-10) in sequence to 30 N·m (22 lb ft).
- Second Pass: Tighten the M11 cylinder head bolts (1-10) in sequence to 90 degrees using the J 45059 .
- Final Pass: Tighten the M11 cylinder head bolts (1-10) in sequence to 70 degrees using the J 45059 .
- Tighten the M8 cylinder head bolts (11-15) to 30 N·m (22 lb ft). Begin with the centre bolt (11) and alternating side-to-side, work outward tightening all of the bolts.

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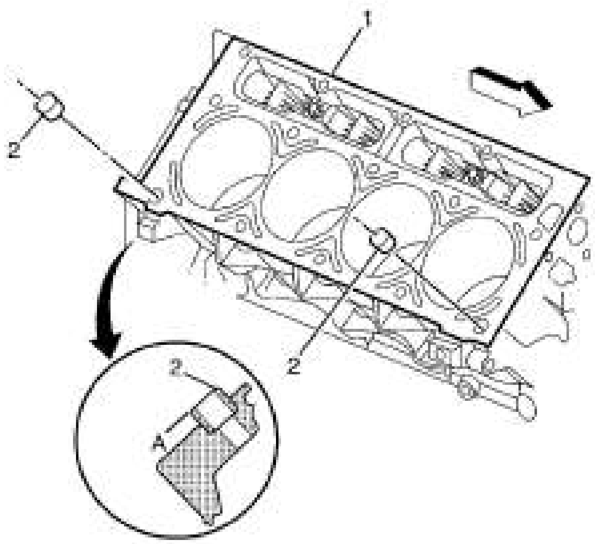
Cylinder Head Installation - Right Side (L98, LS2)

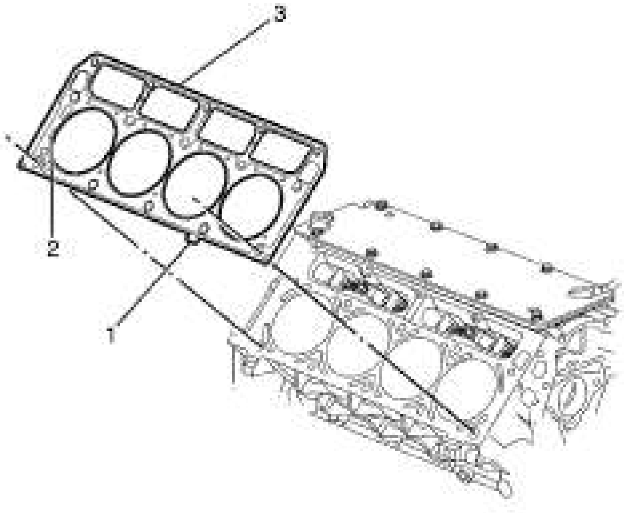
Tools Required

- J 42385-100 Thread Repair Kit
- J 45059 Angle Meter



Important: Make sure the locating sleeves (2) are correctly installed to the maximum height (A) of 8.3 mm (0.33 in).

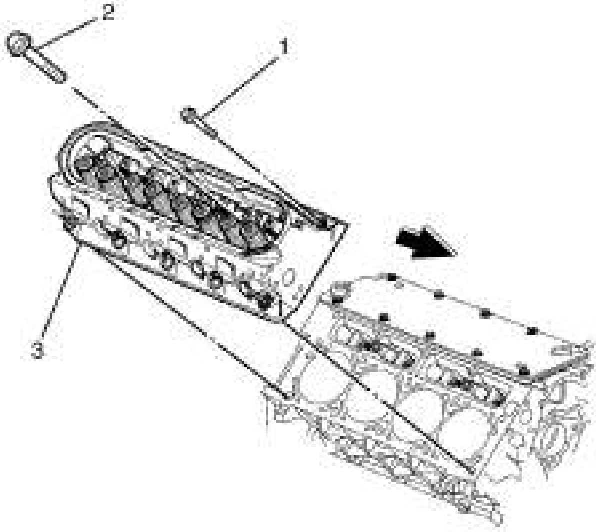
1. Install the locating sleeves (2) into the cylinder block (1).



Important: The cylinder head gasket (3) will fit on either side of the engine. Make sure the tab on the cylinder head gasket (1) is located towards the front half point and the stamping FRONT on the cylinder head gasket (2) is facing the front of the engine.

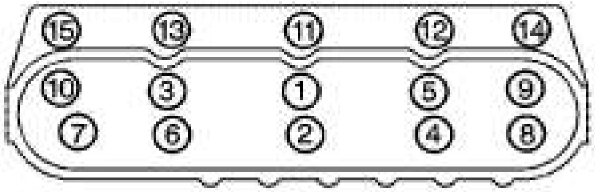
Important: Do not use any type of sealant on the cylinder head gasket (1), unless specified.

2. Install the NEW cylinder head gasket (1) correctly over the locating sleeves.



3. Install the cylinder head (3) onto the locating pins and the gasket.
4. Install the NEW cylinder head bolts (1,2).

Notice: Refer to Fastener Notice in the Preface section.

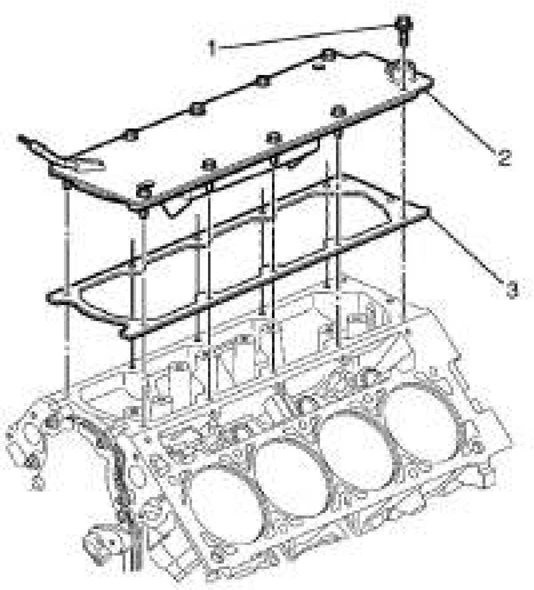


5. Tighten the cylinder head bolts.

Tighten

- First Pass: Tighten the M11 cylinder head bolts (1-10) in sequence to 30 N·m (22 lb ft).
- Second Pass: Tighten the M11 cylinder head bolts (1-10) in sequence to 90 degrees using the J 45059 .
- Final Pass: Tighten the M11 cylinder head bolts (1-10) in sequence to 70 degrees using the J 45059 .
- Tighten the M8 cylinder head bolts (11-15) to 30 N·m (22 lb ft). Begin with the centre bolt (11) and alternating side-to-side, work outward tightening all of the bolts.

Engine Block Valley Cover Installation (L98, LS2)



Important: All gasket surfaces should be free of oil or other foreign material during assembly.

1. Install the NEW valley cover gasket (3).
2. Install the valley cover (2).

Notice: Refer to Fastener Notice in the Preface section.

3. Install the valley cover to cylinder block retaining bolts (1).

Tighten
Tighten the bolts to 25N·m (18 lb ft).

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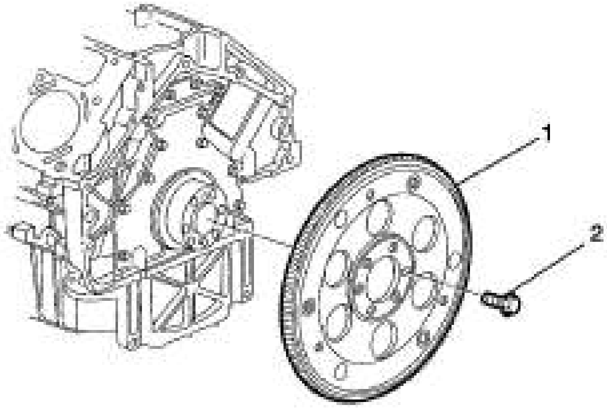
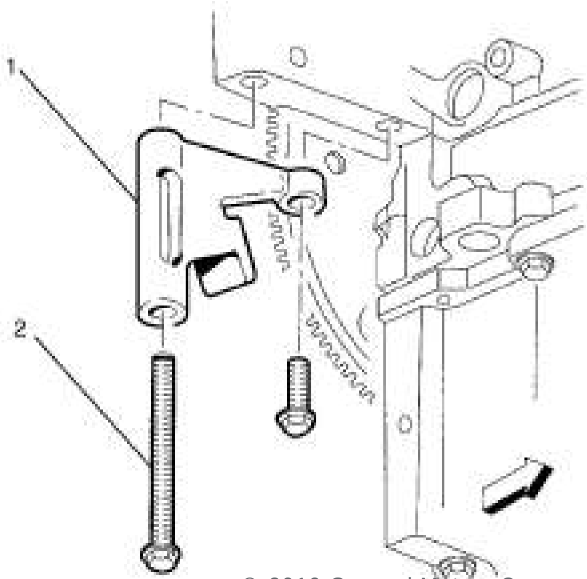
Engine Flywheel Installation (L98, LS2)



Important: The flexplate (1) will not initially seat against the crankshaft flange, but will be pulled onto the crankshaft by the flexplate to crankshaft retaining bolts (2). This procedure requires a 3 stage tightening process.

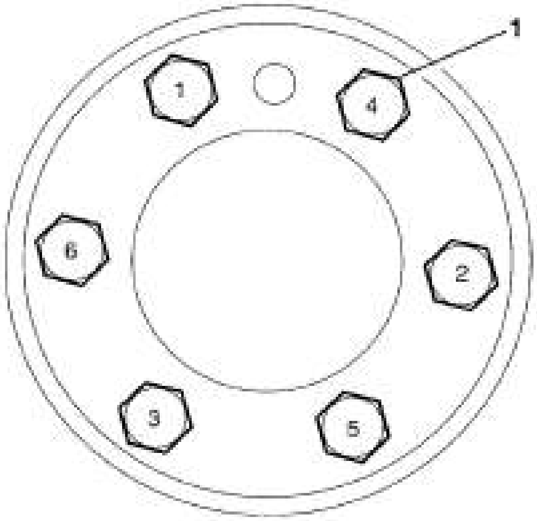
1. Install the flexplate (1).

Notice: Refer to Fastener Notice in the Preface section.



Important: Make sure the teeth of the J 42386-A J 42386-A (1) engage correctly with the ring gear teeth, before tightening the flexplate bolts.

2. Install the J 42386-A J 42386-A (1), using the two starter motor to cylinder block retaining bolts (2).



3. Install the NEW flexplate to crankshaft retaining bolts.

Tighten

- Tighten a first pass in sequence to 20 N·m (15 lb ft).
- Tighten a second pass in sequence to 50 N·m (37 lb ft).
- Tighten a final pass in sequence to 100 N·m (74 lb ft).

Engine Front Cover Installation

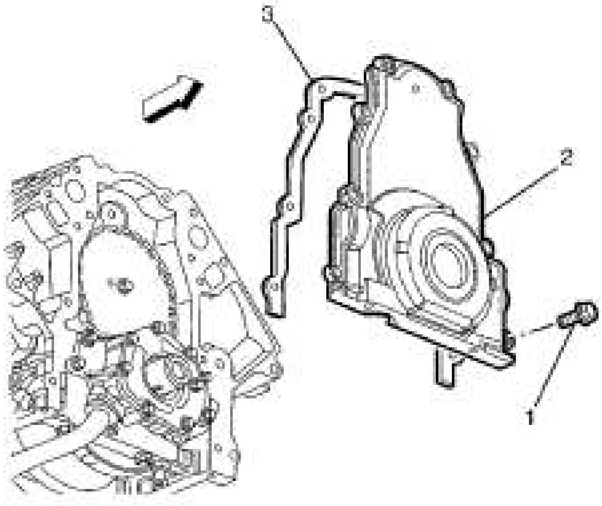
Tools Required

- J 41480 Front and Rear Cover Alignment
- J 41476 Front and Rear Cover Alignment Tool

Installation Procedure

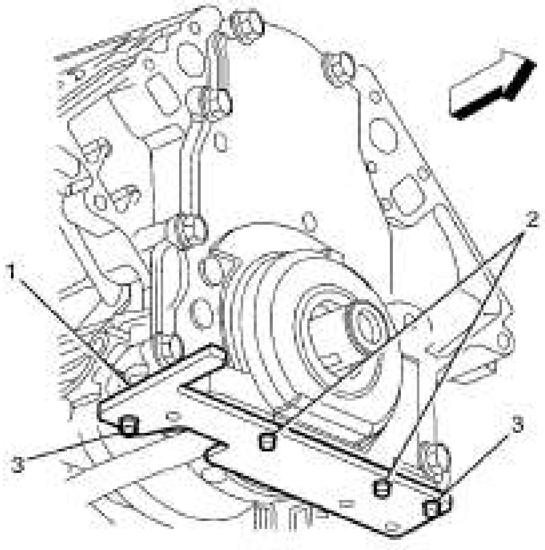
Important:

- Do not use the crankshaft oil seal or the engine front cover gasket again.
- Do not apply any type of sealant to the front cover gasket, unless specified.
- The special tools in this procedure are used to correctly align the engine front cover at the oil pan surface and to centre the crankshaft front oil seal.
  - All gasket surfaces should be free of oil or other foreign material during assembly.
  - The crankshaft front oil seal MUST be centred in relation to the crankshaft.
  - The oil pan sealing surface at the front cover and engine block MUST be aligned within specifications.
  - An incorrectly aligned front cover may cause premature front oil seal wear and/or engine assembly oil leaks.



1. Install the engine front cover gasket (3) and engine front cover (2).
2. Install the engine front cover retaining bolts (1).

DO NOT fully tighten at this stage.



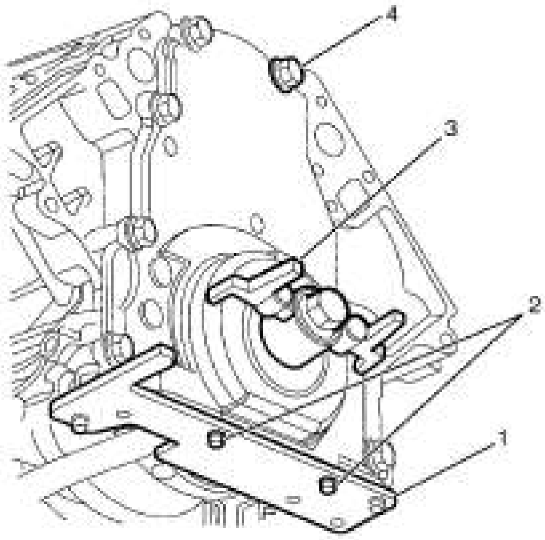
3. Position the J 41480 (1), and start the engine front cover aligning tool to front cover bolts (2).

   DO NOT fully tighten at this stage.

   Notice: Refer to Fastener Notice in the Preface section.

4. Install the engine front cover aligning tool to cylinder block retaining bolts (3).

   Tighten
   Tighten the bolts to 25 N·m (18 lb ft).



Important: Align the tapered legs of the J 41476 (3) with the machined alignment surfaces on the front cover.

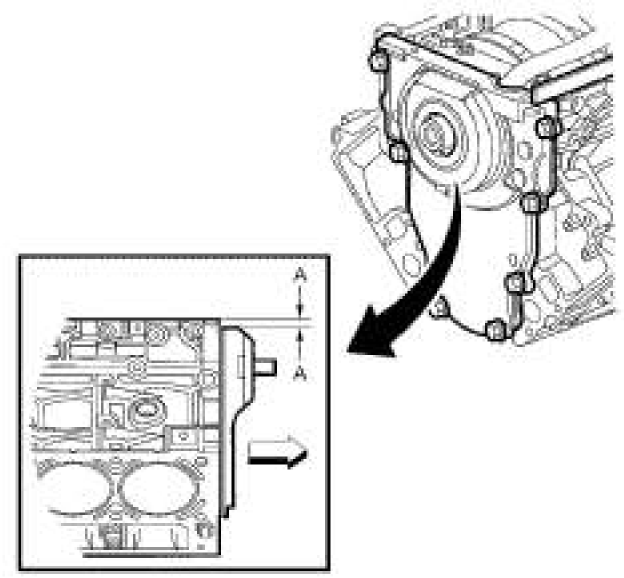
5. Install the J 41476 (3).
6. Install the crankshaft balancer retaining bolt and tighten the crankshaft balancer bolt by hand until firm. Do not over tighten.
7. Tighten the engine front cover aligning tool to front cover bolts (2).

Tighten
Tighten the bolts to 25 N·m (18 lb ft).

8. Tighten the engine front cover to cylinder block retaining bolts (4).

Tighten
Tighten the bolts to 25 N·m (18 lb ft).

9. Remove the J 41476 (3).
10. Remove the J 41480 (1).



11. Measure the oil pan surface flatness, front cover-to-engine block.
    - 11.1. Place a straight edge across the engine block and front cover oil pan sealing surfaces.

Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

    - 11.2. Insert a feeler gauge between the front cover and the straight edge tool. The cover must be flush with the oil pan surface, or no greater than (A) below flush.

Specification
Dimension (A): 0.5 mm (0.02 in)

12. If the front cover-to-engine block oil pan surface alignment is not within specifications, repeat the cover alignment procedure.
13. If the correct front cover-to-engine block alignment cannot be obtained, replace the front cover.

Engine Prelubing (L98, LS2)

Tools Required

J 45299 Engine Pre-Luber

> **Important:** A constant and continuous flow of clean engine oil is required in order to correctly prime the engine. Be sure to use an approved engine oil as specified in the owners manual.

1. Remove the engine oil filter and fill with clean engine oil.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the oil filter.

   Tighten
   Tighten the filter to 30 N·m (22 lb ft).

3. Remove the engine block left front oil gallery plug.
4. Install the M16 x 1.5 adapter.
5. Install the flexible hose to the adapter and open the valve.
6. Pump the handle on the J 45299 in order to flow a minimum of 1-1.9 litres (1-2 quarts) engine oil. Observe the flow of engine oil through the flexible hose and into the engine assembly.
7. Close the valve and remove the flexible hose and adapter from the engine.
8. Install the gallery plug to the engine.

   Tighten
   Tighten the plug to 60 N·m (44 lb ft).

9. Top-off the engine oil to the correct level.

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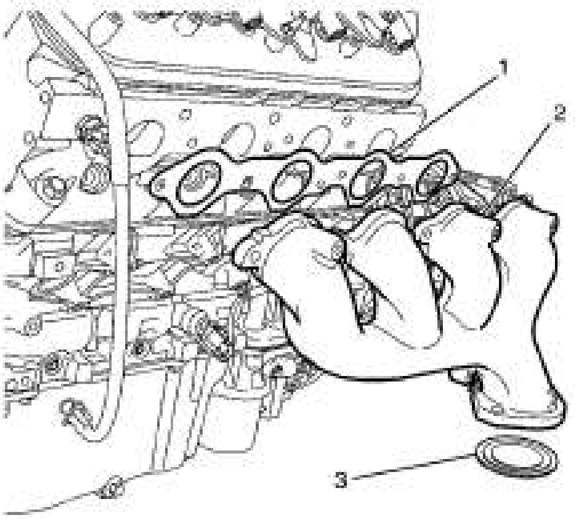
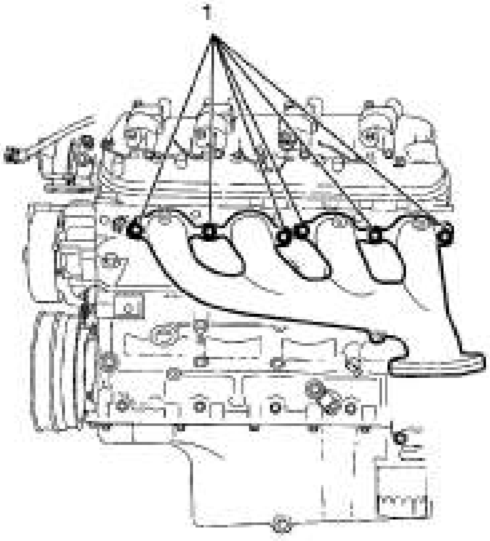
Exhaust Manifold Installation - Left Side (LWB SWB)

Notice: Refer to Hot Exhaust System Caution in the Preface section.



1. Install the exhaust manifold (2), NEW exhaust manifold gasket (1) and sealing ring (3).



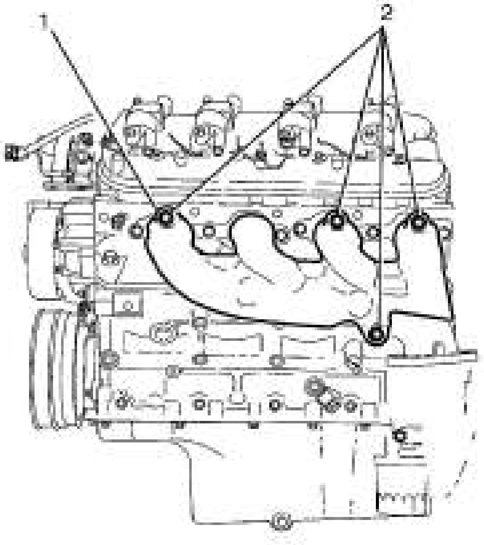
2. Apply a 5 mm (0.2 in) wide band of threadlock, or equivalent, to the threads of the exhaust manifold to cylinder head retaining bolts (1). Refer to Adhesives, Fluids, Lubricants, and Sealers.

Notice: Refer to Fastener Notice in the Preface section.

3. Install the exhaust manifold to cylinder head retaining bolts (1).

   Tighten

   - First Pass: Tighten the bolts to 15 N·m (11 lb ft). Tighten the exhaust manifold bolts beginning with the centre 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
   - Final Pass: Tighten the bolts to 20 N·m (15 lb ft). Tighten the exhaust manifold bolts beginning with the centre 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
4. Using a flat punch, bend over the exposed edge of the exhaust manifold gasket at the rear of the left cylinder head.



5. Install the exhaust manifold heat shield (1).
6. Install the exhaust manifold heat shield to exhaust manifold retaining bolts (2).

   Tighten

   Tighten the bolts to 10 N·m (89 lb in).

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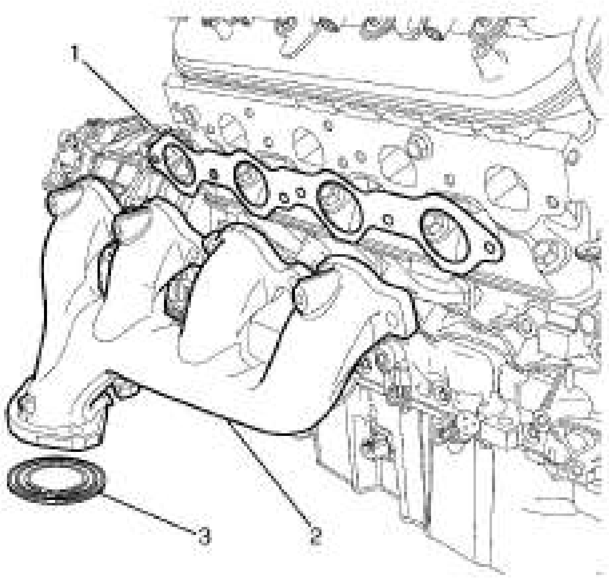
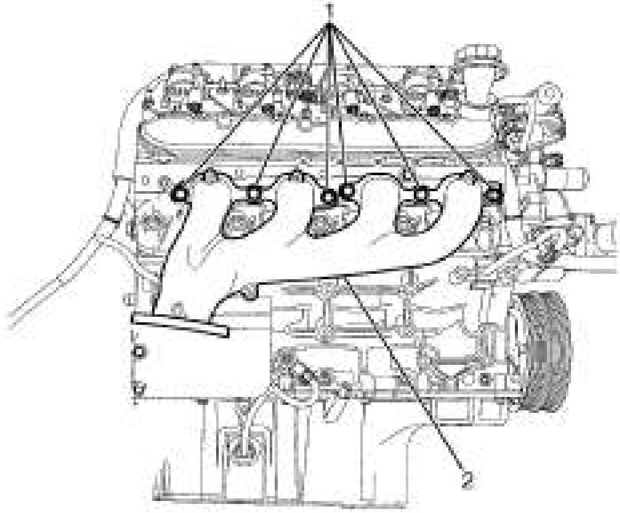
Exhaust Manifold Installation - Right Side (LWB SWB)

Notice: Refer to Hot Exhaust System Caution in the Preface section.



1. Install NEW exhaust manifold gasket (1) and NEW sealing ring (3) to the exhaust manifold (2).
2. Install the exhaust manifold assembly to engine.

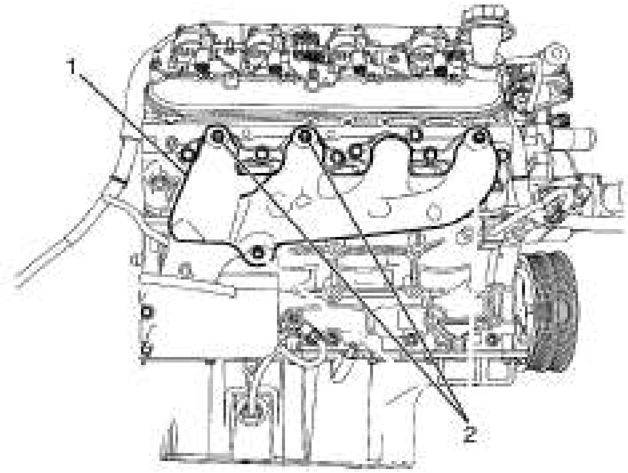


Important: Do not fully tighten the exhaust manifold to cylinder head retaining bolts (1) at this stage.

3. Install the NEW exhaust manifold to cylinder head retaining bolts (1).
4. Tighten the exhaust manifold to cylinder head retaining bolts (1) working from the centre to the outside.

Tighten

- First Pass: Tighten the bolts to 15 N·m (11 lb ft). Tighten the exhaust manifold bolts beginning with the centre 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
- Final Pass: Tighten the bolts to 20 N·m (15 lb ft). Tighten the exhaust manifold bolts beginning with the centre 2 bolts. Alternate from side-to-side, and work toward the outside bolts.

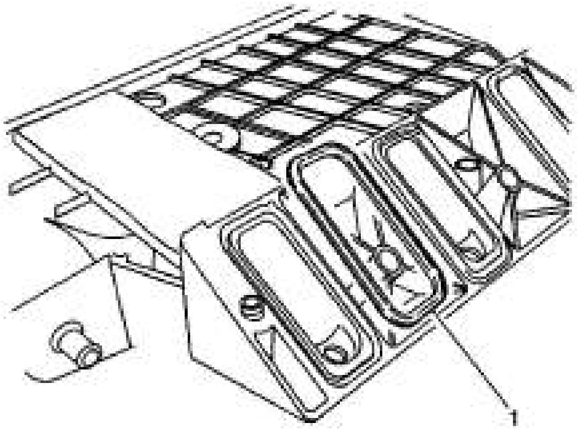


5. Install the exhaust manifold heat shield (1).
6. Install the exhaust manifold heat shield to exhaust manifold retaining bolts (2).

Tighten

Tighten the bolts to 10 N·m (89 lb in).

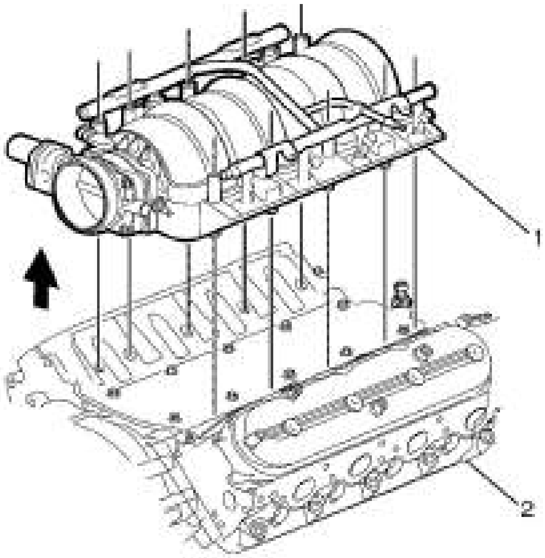
Intake Manifold Installation (L98, LS2)



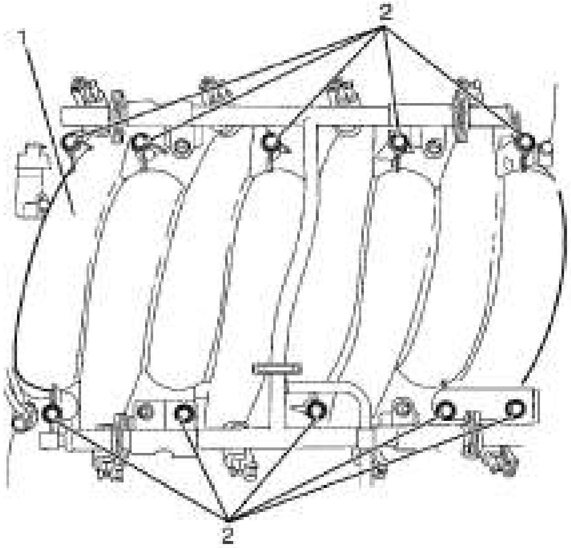
Important: DO NOT reuse the intake manifold gaskets. Install NEW intake manifold gaskets.

Important: The intake manifold, throttle body, fuel injection rail and fuel injectors may be installed as an assembly. If not servicing the individual components, install the intake manifold as a complete assembly.

1. Install NEW intake manifold to cylinder head gaskets (1).

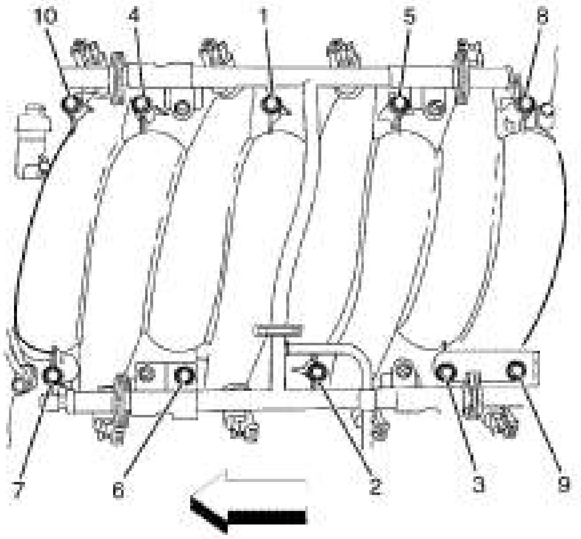


2. Remove the lint free cloth from the engine (2).
3. Install the intake manifold (1) to the engine (2).



4. Apply a 5 mm bead of thread sealant such as LOCTITE 242™ or equivalent to the cleaned threads of the intake manifold to cylinder head retaining bolts (2).
5. Install the intake manifold to cylinder head retaining bolts (2).

   Notice: Refer to Fastener Notice in the Preface section.



6. Tighten the intake manifold to cylinder head retaining bolts (2).

Tighten

- First Pass: Tighten in sequence to 5 N·m (44 lb in).
- Final Pass: Tighten in sequence to 10 N·m (89 lb in).

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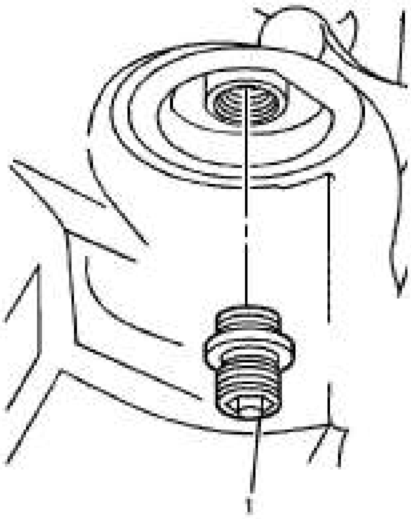
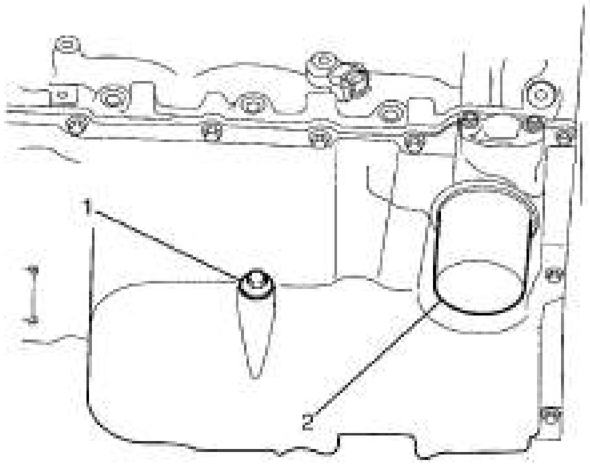
Oil Filter, Adapter, and Pan Cover Installation

Notice: Refer to Fastener Notice in the Preface section.



1. Install the oil filter fitting (2).

Tighten
Tighten the fitting to 55 N·m (40 lb ft).

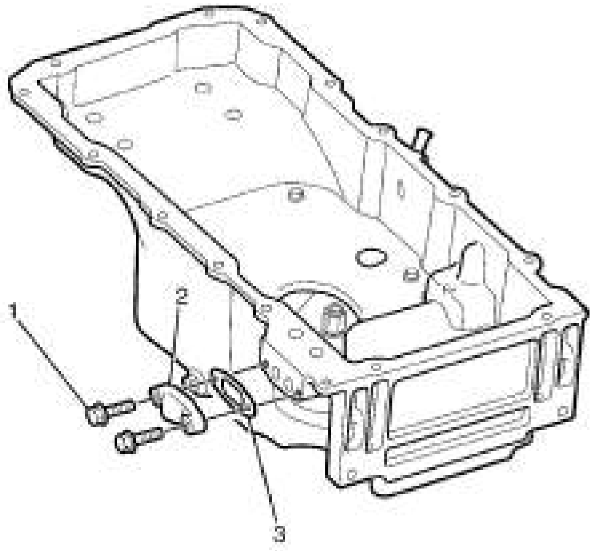


2. Lubricate the oil filter seal with clean engine oil.
3. Install the oil filter (2).

   Tighten
   Tighten the filter to 30 N·m (22 lb ft).

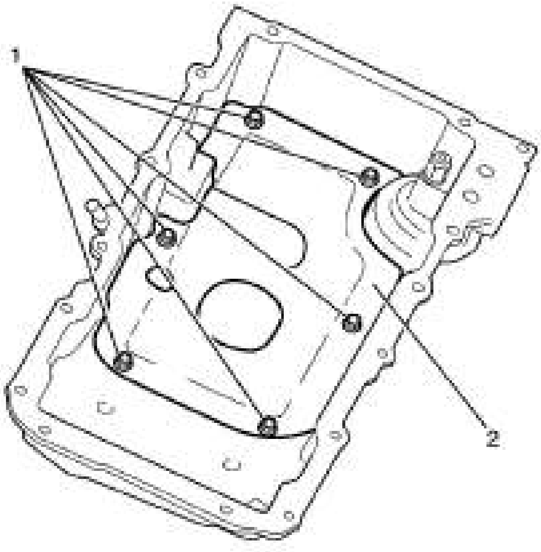
4. Install the oil pan drain plug (1).

   Tighten
   Tighten the plug to 25 N·m (18 lb ft).



5. Install the gasket (3), cover (2), and bolts (1).

   Tighten
   Tighten the bolts to 12 N·m (106 lb in).



6. Install the oil pan baffle (2).
7. Install the oil pan baffle to oil pan retaining bolts (1).

   Tighten
   Tighten the bolts to 12 N·m (106 lb in).

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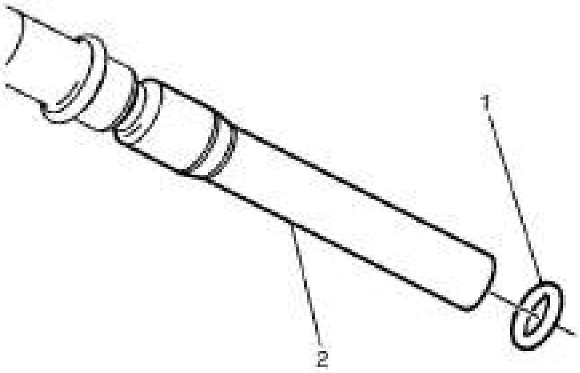
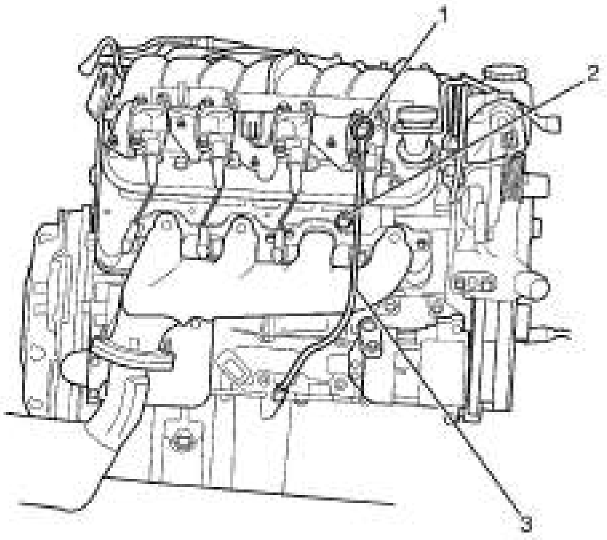
Oil Level Indicator and Tube Installation



1. Inspect the O-ring seal (1) for cuts or damage. If the O-ring seal (1) is not cut or damaged, it may be used again.
2. Lubricate the O-ring seal (1) with clean engine oil.
3. Install the O-ring seal (1) onto the oil level indicator tube (2).



4. Install the oil level indicator tube (2) to the engine and rotate into correct position.

Notice: Refer to Fastener Notice in the Preface section.

5. Install oil level indicator tube to cylinder head bracket retaining bolt (3).

   Tighten
   Tighten the bolt to 25 N·m (18 lb ft).

6. Install the oil level indicator (1) to the oil level indicator tube (2).

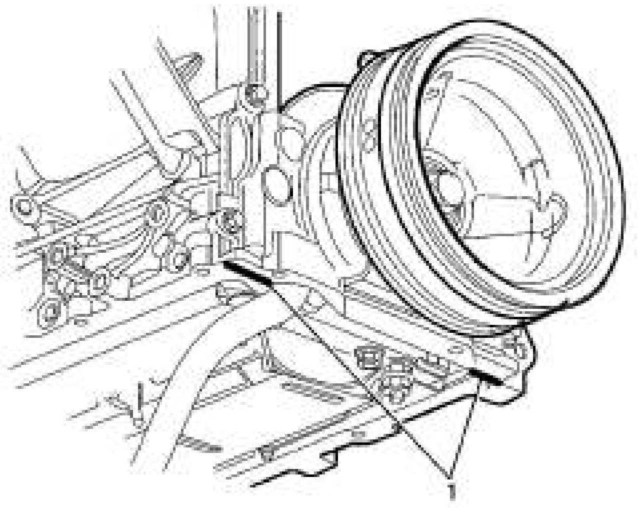
Oil Pan Installation

Installation Procedure

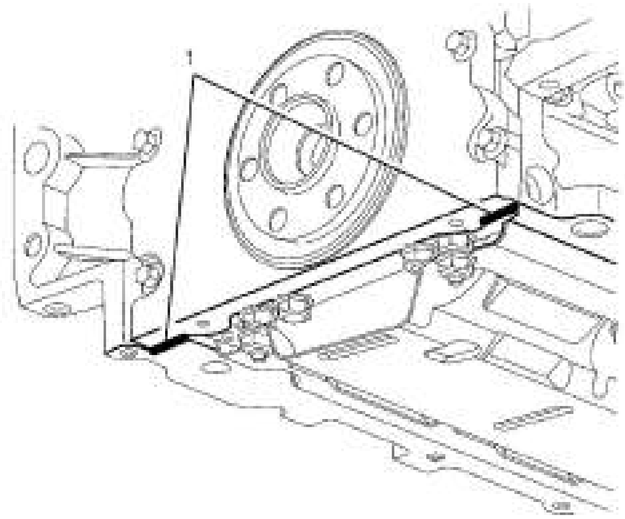
Important: The alignment of the structural oil pan is critical. The rear bolt hole locations of the oil pan provide mounting points for the transmission housing. To ensure the rigidity of the powertrain and correct transmission alignment, it is important that the rear of the block and the rear of the oil pan are flush or even. The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing plane.

Important: The original oil pan gasket is retained and aligned to the oil pan by rivets. When installing a new gasket, it is not necessary to install new oil pan gasket rivets.

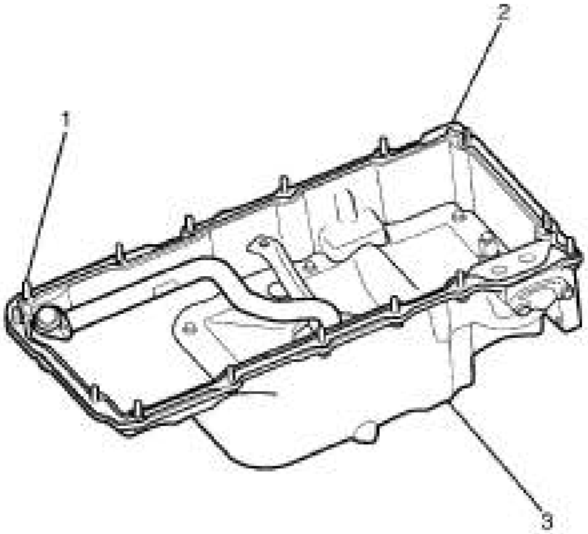
It is not necessary to rivet the NEW gasket to the oil pan.



1. Apply a 5 mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the engine block (1). Apply the sealant directly onto the tabs of the front cover gasket that protrude into the oil pan surface. Refer to Adhesives, Fluids, Lubricants, and Sealers.

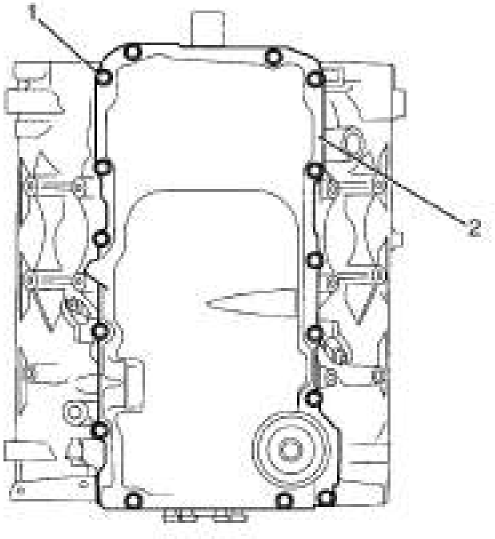


2. Apply a 5 mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the engine block (1). Apply the sealant directly onto the tabs of the rear cover gasket that protrude into the oil pan surface. Refer to Adhesives, Fluids, Lubricants, and Sealers.



Important: Be sure to align the oil gallery passages in the oil pan and engine block correctly, with the oil pan gasket.

3. Preassemble the oil pan gasket (2) to the oil pan (3).
   - 3.1. Install the oil pan gasket (2) to the oil pan (3).
   - 3.2. Install the oil pan retaining bolts (1) to the oil pan (3) and through the oil pan gasket (2).

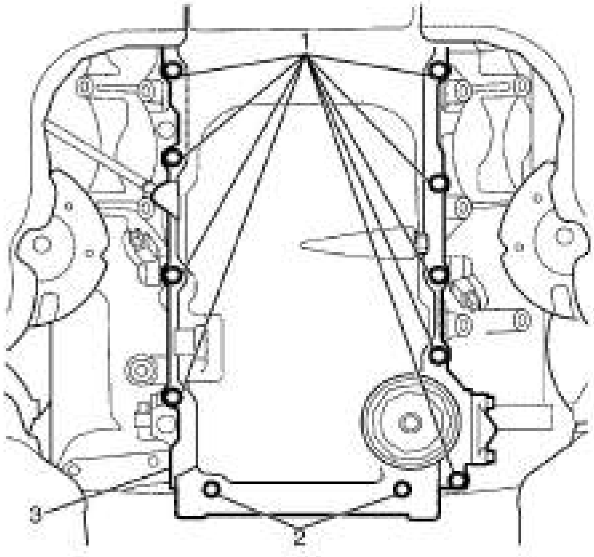


4. Tighten the oil pan to cylinder block retaining bolts (1) finger tight. Do not over tighten.
5. Tighten the oil pan to engine rear cover retaining bolts (2) finger tight. Do not over tighten.
6. Place a straight edge across the rear of the engine block and the rear of the oil pan at the transmission housing mounting surfaces.
7. Align the oil pan until the rear of engine block and the rear of oil pan are flush or even.
8. Measure the oil pan-to-engine block alignment.
   8.1. Place a straight edge across the rear of the engine block and rear of the oil pan at the transmission housing mounting surfaces.

   Important: The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing mounting surfaces.

   8.2. Insert a feeler gauge between the straight edge and the oil pan transmission housing mounting surface and check to make sure that there is no more than a 0.25 mm (0.01 in) gap between the pan and the straight edge.
   8.3. If the oil pan alignment is not within specifications, remove the oil pan and repeat the above procedure.

Notice: Refer to Fastener Notice in the Preface section.

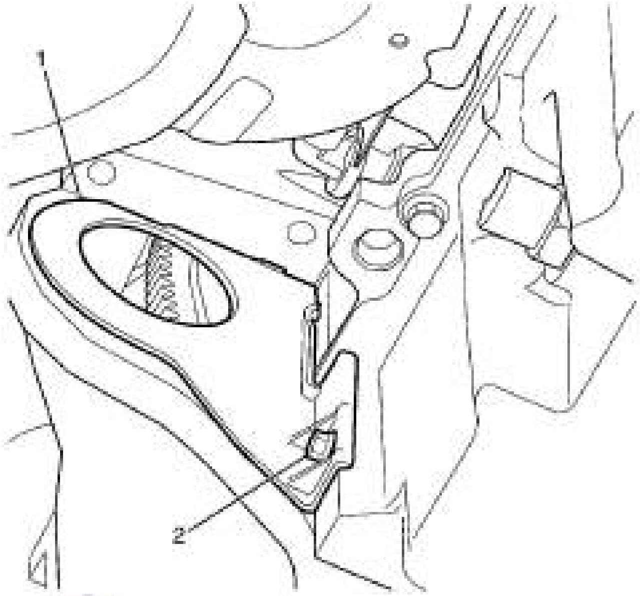


9. Tighten the oil pan to cylinder block retaining bolts (1).

   Tighten
   Tighten the bolt to 25 N·m (18 lb ft).

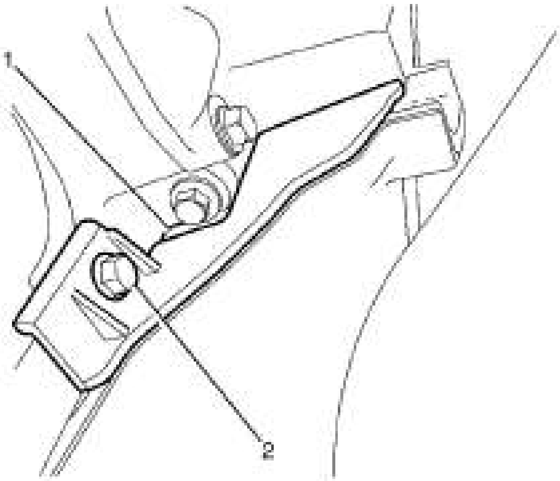
10. Tighten the oil pan to engine rear cover retaining bolts (2).

    Tighten
    Tighten the bolt to 12 N·m (106 lb in).



11. Install the right side close out (1).
12. Install the right side close out cover to cylinder block retaining bolt (2).

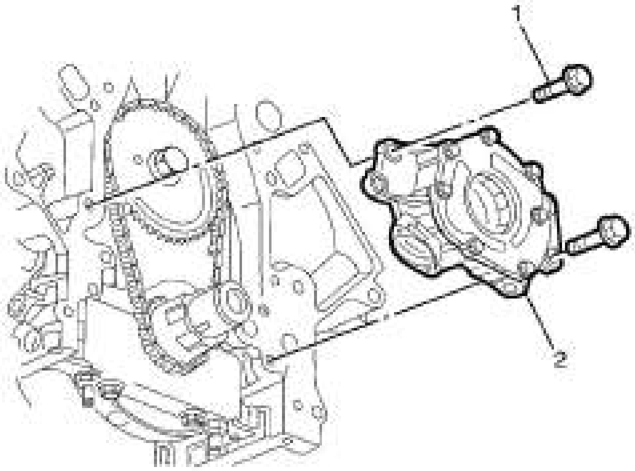
Tighten
Tighten the bolt to 12 N·m (106 lb in).



13. Install the left side close out (1).
14. Install the left side close out cover to cylinder block retaining bolt (2).

Tighten
Tighten the bolt to 12 N·m (106 lb in).

Oil Pump, Screen and Crankshaft Oil Deflector Installation (L98, LS2)



Important: Inspect the oil pump and engine block oil gallery passages. These surfaces must be clear and free of debris or restrictions.

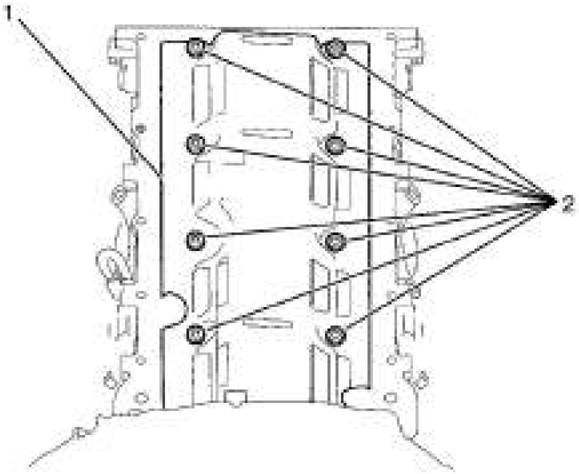
Important: Install the oil pump (1) onto the crankshaft sprocket until the pump housing contacts the face of the engine block.

1. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump (2).

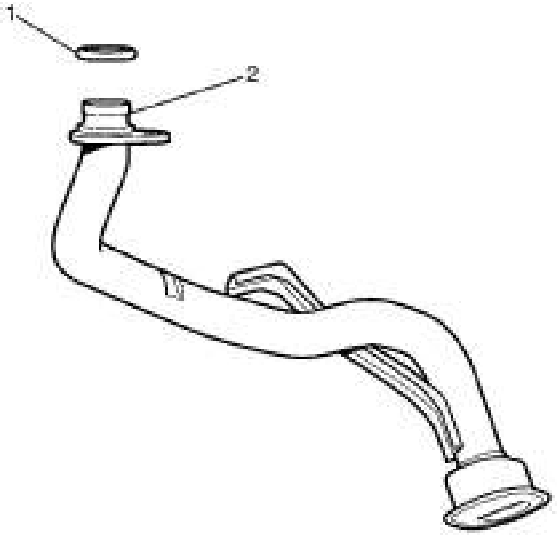
   Notice: Refer to Fastener Notice in the Preface section.

2. Install the oil pump retaining bolts (1).

   Tighten
   Tighten the oil pump retaining bolts to 25 N·m (18 lb ft).



3. Install the crankshaft oil deflector (1).



4. Lubricate a NEW oil pump screen O-ring seal with clean engine oil.
5. Install the NEW O-ring seal onto the oil pump screen.

Important:

- Push the oil pump screen tube completely into the oil pump prior to tightening the bolt. Do not allow the retaining bolt to pull the tube into the pump.
- Align the oil pump screen mounting brackets with the correct crankshaft bearing cap bolt/studs.

6. Install the oil pump screen.
7. Install the oil pump screen retaining bolt and the deflector retaining nuts.

Tighten

1. Tighten the bolt to 12 N·m (106 lb in).
2. Tighten the nuts to 25 N·m (18 lb ft).

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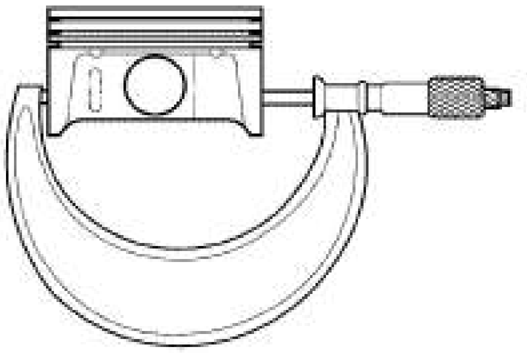
Piston, Connecting Rod, and Bearing Installation (L98, LS2)

Tools Required

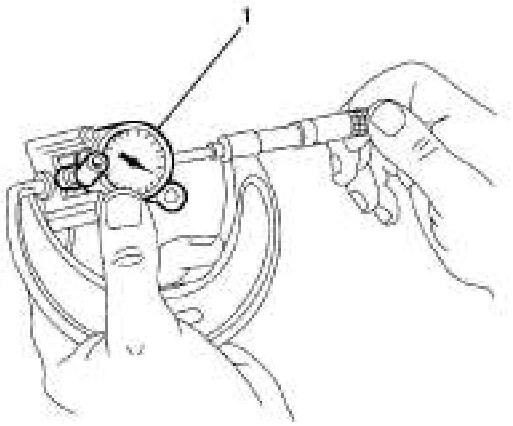
- J 8037 Ring Compressor
- J 8087 Cylinder Bore Gage
- J 41556 Connecting Rod Guide
- J 45059 Angle Meter

Piston Selection

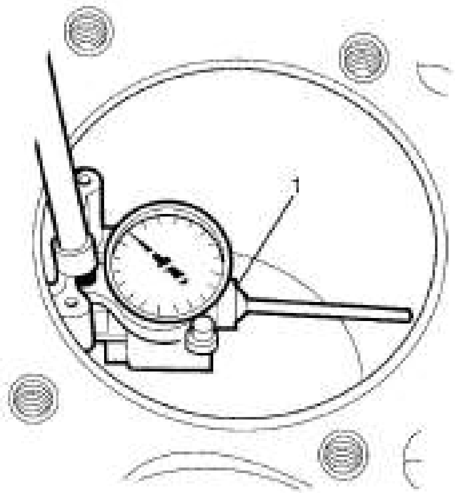


Important: Measurements of all components should be taken with the components at normal room temperature. For correct piston fit, the engine block cylinder bores must not have above acceptable wear or taper. A used piston, pin, and connecting rod assembly may be installed if, after inspection is within specifications.

1. With a micrometer at a right angle, measure the piston outside diameter (OD). Measure the diameter 43 mm (1.69 in) from the top of the piston. Refer to Engine Mechanical Specifications.
2. Record the piston OD.

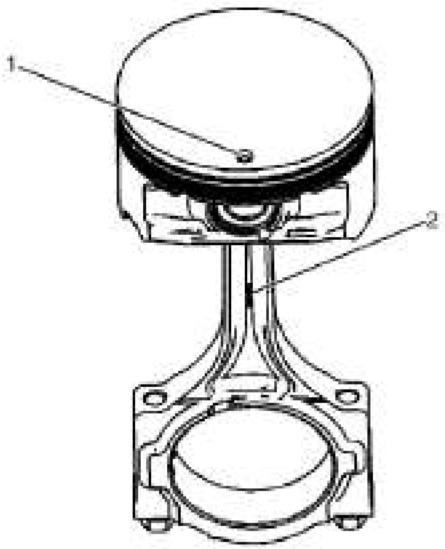


3. Adjust the micrometer to the recorded piston OD.
4. Insert the J 8087 (1) into the micrometer and zero the gage dial.



5. Using the J 8087 (1), measure the cylinder bore inside diameter (ID). Measure at a point 64 mm (2.5 in) from the top of the cylinder.
6. Record the cylinder bore ID.
7. Subtract the piston OD from the cylinder bore ID to determine the piston-to-bore clearance. Refer to Engine Mechanical Specifications.
8. If the correct clearance cannot be obtained, select another piston, pin, and connecting rod assembly and again measure the clearances. If the correct fit cannot be obtained, the cylinder bore may require honing for an oversize piston.

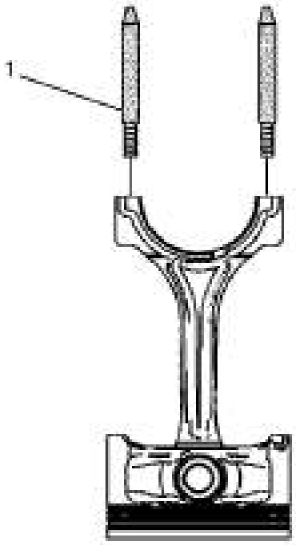
Piston, Pin, and Connecting Rod Installation



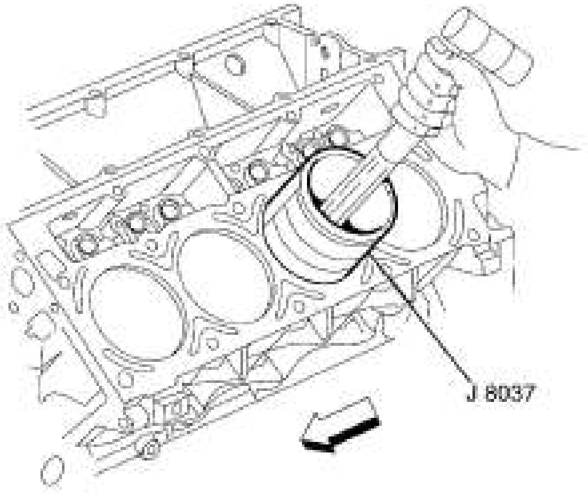
1. Liberally lubricate the cylinder walls, piston rings and piston skirts with engine oil.

   Important: The piston is directional and must be installed in the cylinder block in the correct direction.

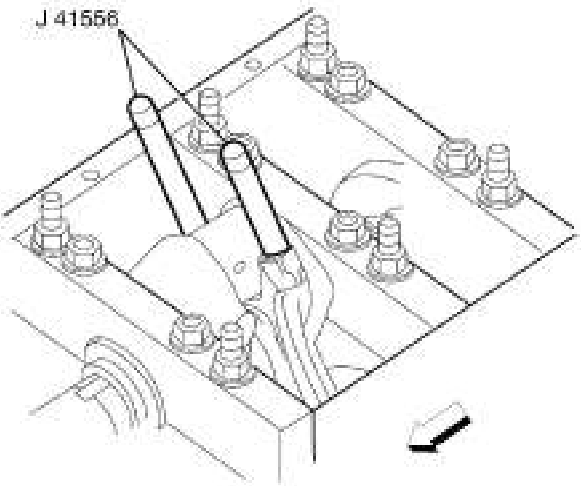
2. Select the correctly numbered piston/connecting rod assembly for the cylinder. A dot (1) showing proper piston orientation is located on the top of the piston.



3. Install the J 41556 to the connecting rod.

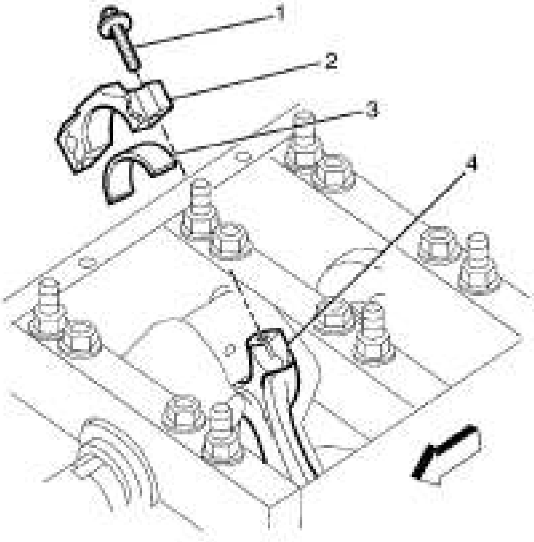


4. Install the J 8037 onto the piston and compress the piston rings.
5. Install the piston, pin, and connecting rod assembly into the cylinder bore. Hold the piston ring compressor firmly against the engine block. Using a soft hammer handle, lightly tap the top of the piston until all the piston rings have entered the cylinder bore.



6. Use the J 41556 (1) to guide the connecting rod onto the crankshaft journal.
7. Remove the J 41556 (1) from the connecting rod.

Notice: Refer to Fastener Notice in the Preface section.

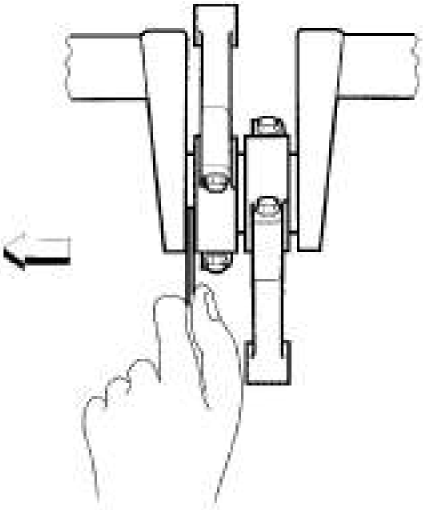


Important: The connecting rod and cap must be assembled with the mating surfaces correctly aligned.

8. Install the bearing cap (3), bearing half (2), and connecting rod bolts (1) to the connecting rod (4).

Tighten

1. Tighten the bolts a first pass to 20 N·m (15 lb ft).
2. Tighten the bolts a final pass to 75 degrees using the J 45059 .

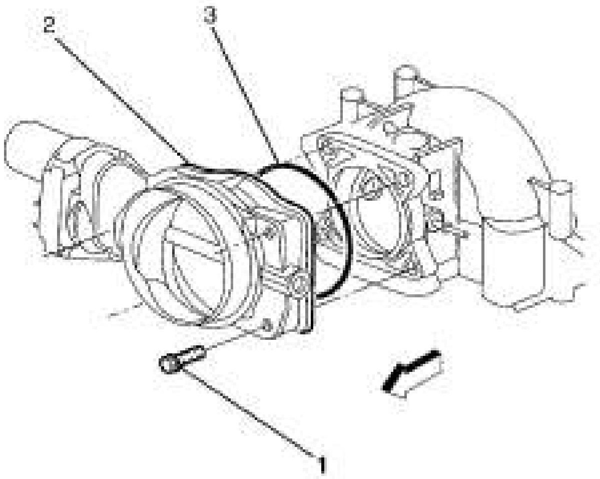


9. Measure the connecting rods for the correct side clearance. Refer to Engine Mechanical Specifications.

Service Prior to Assembly

- Dirt or debris will cause premature wear of the rebuilt engine. Clean all components. Refer to Cleanliness and Care.
- Use the correct tools to measure components when inspecting for above acceptable wear. Components that are not within the manufacturers specifications must be repaired or replaced.
- When the components are installed into an engine, return the components to their original location, position and direction. Refer to Separating Parts.
- During assembly, lubricate all moving parts with clean engine oil. This provides initial lubrication when the engine is first started.

Throttle Body Installation (L98, LS2)



Important: DO NOT use the throttle body gasket again. Install a NEW gasket during assembly.

Important: Align the locating tab of the gasket with the notch in the manifold.

1. Install the throttle body gasket (2).
2. Install the throttle body (1).

Notice: Refer to Fastener Notice in the Preface section.

3. Install the throttle body to intake manifold retaining bolts (3).

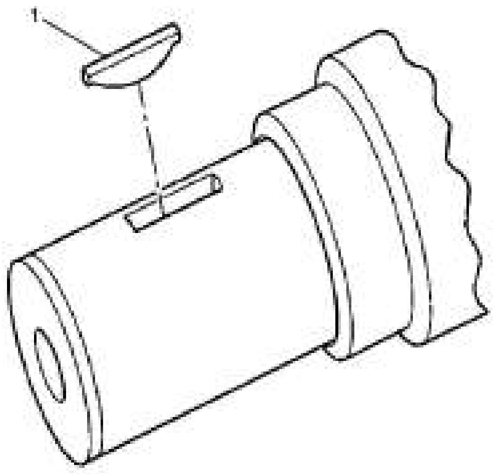
Tighten
Tighten the bolts to 10 N·m (89 lb in).

Timing Chain and Sprocket Installation (L98, LS2)

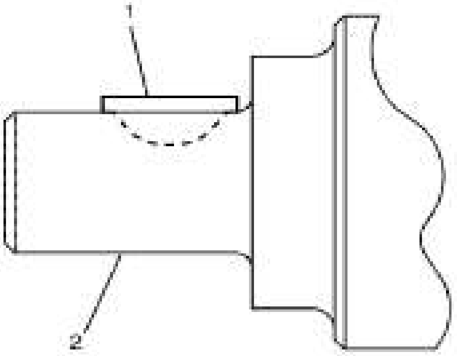
Tools Required

- EN 46330 Timing Chain Tensioner Retaining Pin
- J 41478 Crankshaft Front Oil Seal Installer
- J 41665 Crankshaft Balancer and Sprocket Installer
- J 45059 Angle Meter

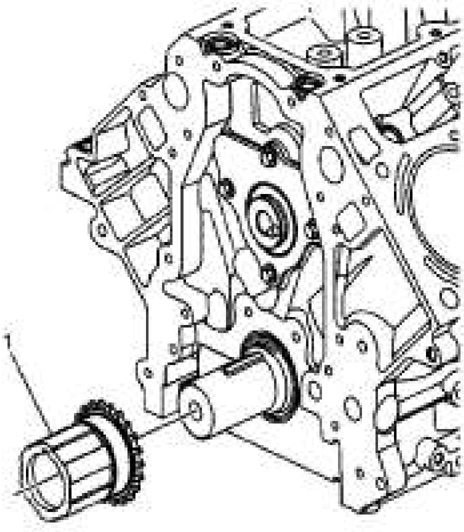
Installation Procedure



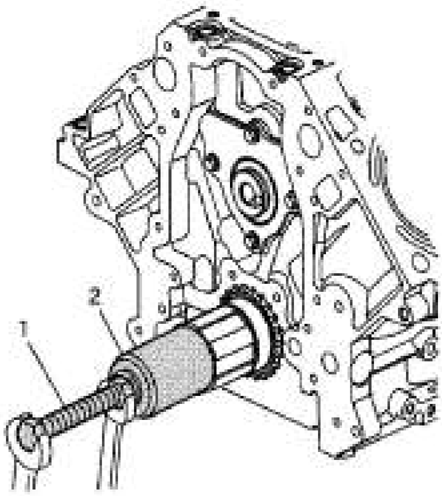
1. Install the crankshaft sprocket key (1) if removed.



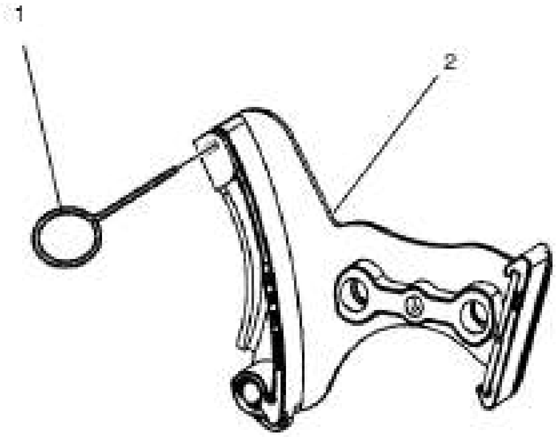
2. Tap the key (1) into the key way until both ends of the key bottom onto the crankshaft (2).



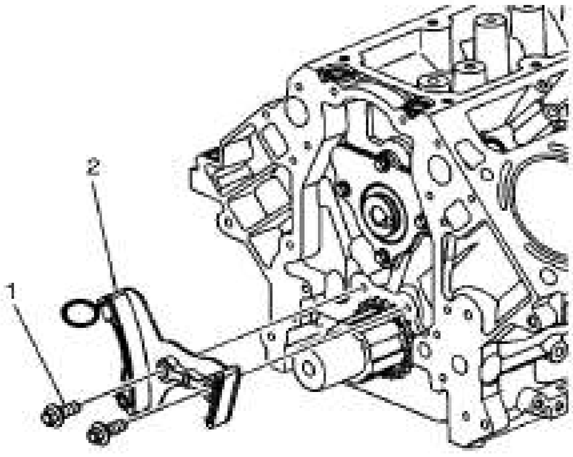
3. Install the crankshaft sprocket (1) onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket key way.



4. Use the J 41478 (1) and the J 41665 (2) in order to install the crankshaft sprocket. Install the sprocket onto the crankshaft until fully seated against the crankshaft flange.

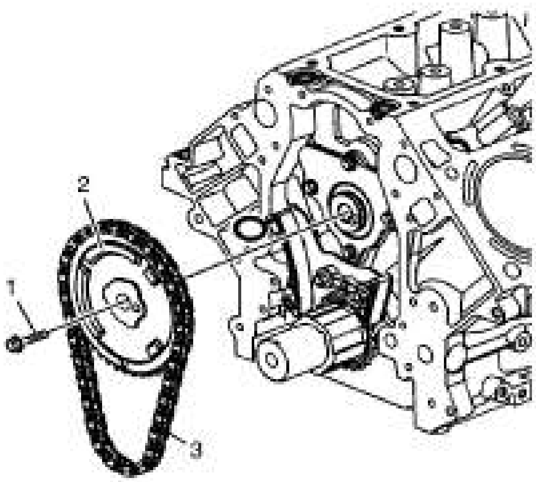


5. Compress the timing chain tensioner guide (2) and install the EN 46330 (1).



6. Install the timing chain tensioner (2) and bolts (1).

   Tighten
   Tighten the bolts to 25 N·m (18 lb ft).

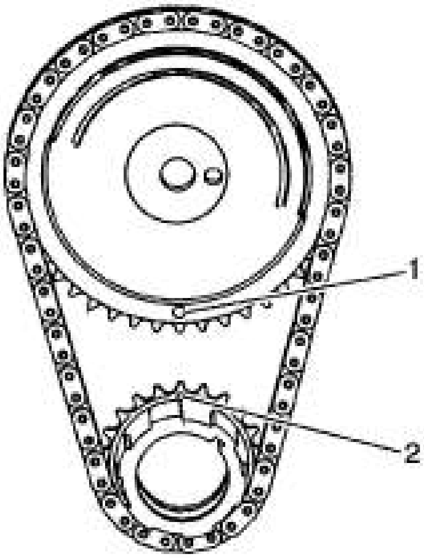


7. Position the camshaft sprocket (2) so the timing mark is in the 6 o'clock position.

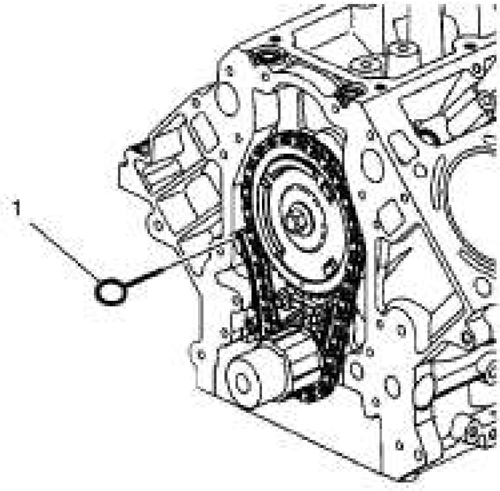
   Important: The sprocket teeth and timing chain must mesh.

   Important: The camshaft and the crankshaft sprocket alignment marks MUST be aligned correctly.

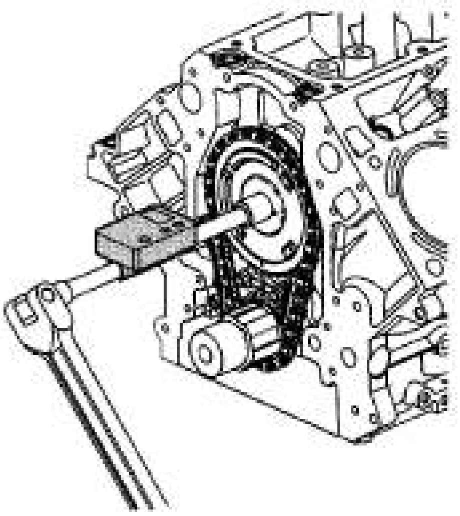
8. Install the camshaft sprocket (2), timing chain (3) and bolt (1).



9. Inspect the sprockets for correct alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.



10. Remove the EN 46330 (1).

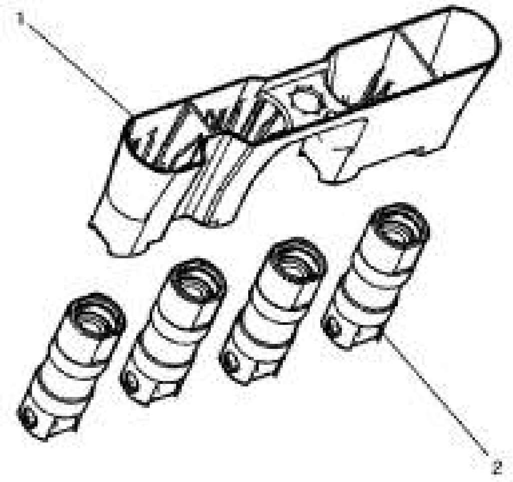


11. Tighten the camshaft sprocket bolt.

    Tighten
    Tighten a first pass to 75 N·m (55 lb ft).

    Tighten an additional 50 degrees using J 45059 .

Valve Lifter Installation

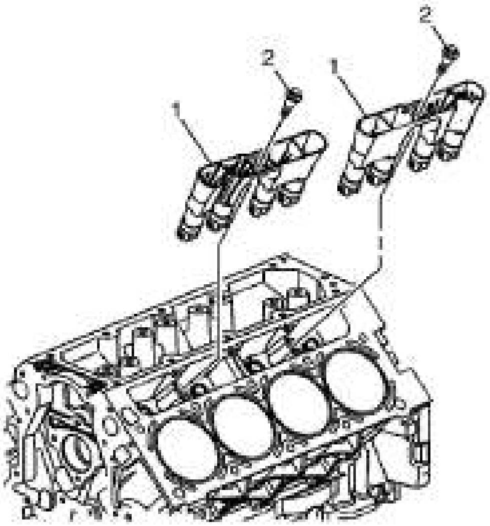


Important:

- If camshaft replacement is required, the valve lifters must also be replaced.
- When using the valve train components again, always install the components to the original location and position. Refer to Separating Parts.

1. Lubricate the valve lifters (1) and the engine block valve lifter bores with clean engine oil.
2. Insert the valve lifters (1) into the valve lifter guides (2).

   Align the flat area on the top of the valve lifter with the flat area in the valve lifter guide bore. Push the valve lifter completely into the valve lifter guide bore.



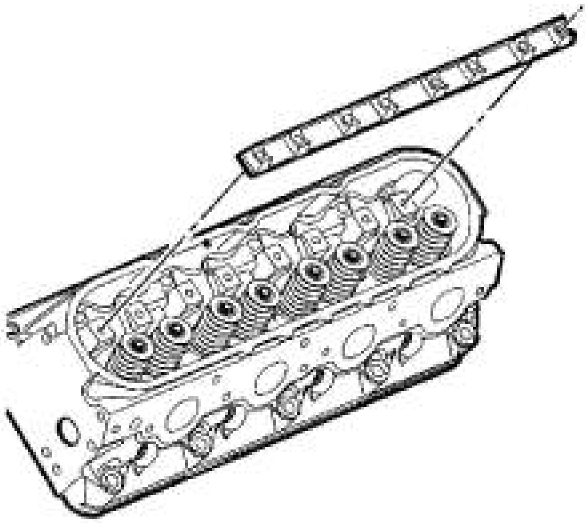
3. Install the valve lifter and guide assembly (1) to the engine block.

   Notice: Refer to Fastener Notice in the Preface section.

4. Install the valve lifter guide retaining bolts (2).

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).

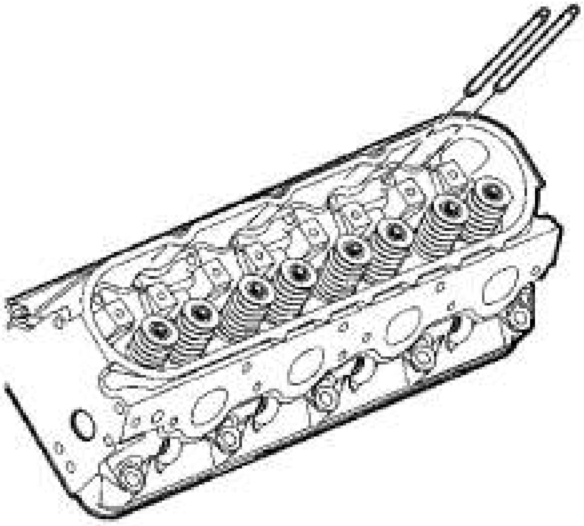
Valve Rocker Arm and Push Rod Installation (LS3)



Important:

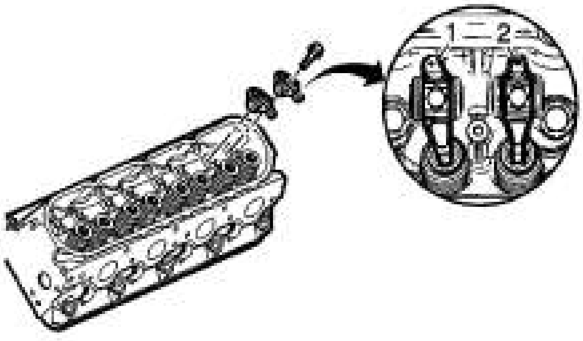
- When using the valve train components again, always install the components to the original location and position.
- Valve lash is net build. No valve adjustment is required.

1. Lubricate the valve rocker arms and pushrods with clean engine oil.
2. Lubricate the flange of the valve rocker arm bolts with clean engine oil.
3. Install the valve rocker arm pivot support.



Important: Ensure the pushrods seat properly to the valve lifter sockets.

4. Install the pushrods.

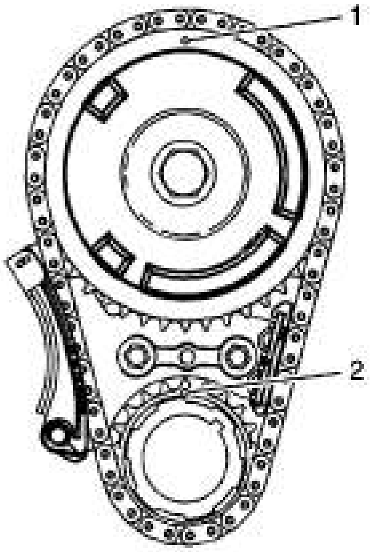


Important:

- Ensure the pushrods seat properly to the ends of the rocker arms.
- DO NOT tighten the rocker arm bolts at this time.

5. Install the rocker arms and bolts.

The intake rocker arms (1) have an offset design.



6. Rotate the crankshaft until number 1 piston is at top dead center of compression stroke.

   In this position, cylinder number 1 rocker arms will be off lobe lift, and the crankshaft sprocket key will be at the 1:30 position. The camshaft and crankshaft sprocket alignment marks (1, 2) will be in the 12 o'clock position. If viewing from the rear of the engine, the additional crankshaft pilot hole, non-threaded, will be in the 10:30 position.

   The engine firing order is 1, 8, 7, 2, 6, 5, 4, 3.

   Cylinders 1, 3, 5 and 7 are left bank.

   Cylinders 2, 4, 6, and 8 are right bank.

   Notice: Refer to Fastener Notice in the Preface section.

7. With the engine in the number 1 firing position, tighten the following valve rocker arm bolts:

   Tighten
   - Tighten the exhaust valve rocker arm bolts 1, 2, 7, and 8 to 30 N·m (22 lb ft).
   - Tighten the intake valve rocker arm bolts 1, 3, 4, and 5 to 30 N·m (22 lb ft).
8. Rotate the crankshaft 360 degrees.
9. Tighten the following valve rocker arm bolts:

   Tighten
   - Tighten the exhaust valve rocker arm bolts 3, 4, 5, and 6 to 30 N·m (22 lb ft).
   - Tighten the intake valve rocker arm bolts 2, 6, 7, and 8 to 30 N·m (22 lb ft).

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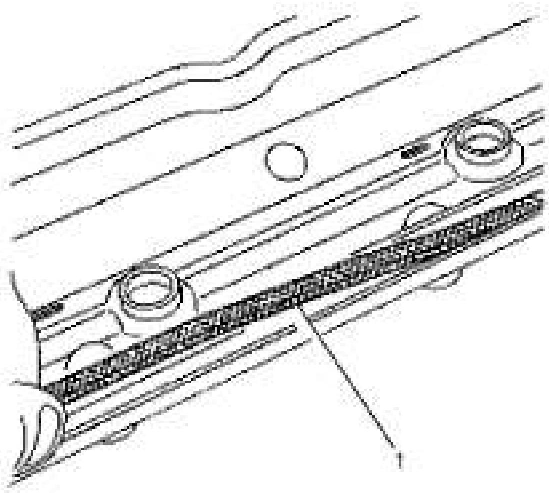
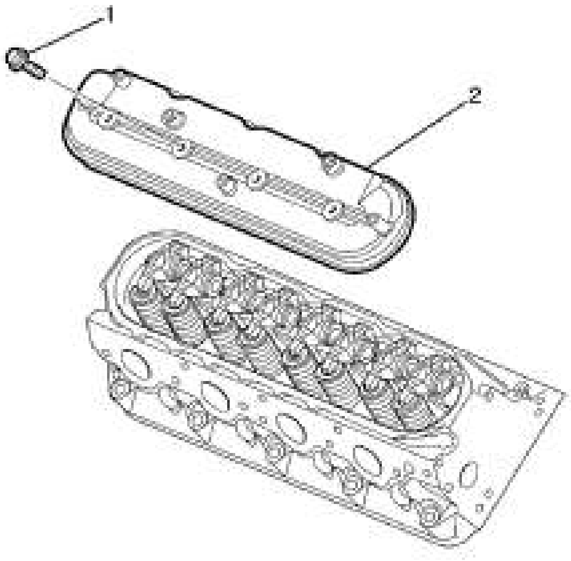
Valve Rocker Arm Cover Installation - Left Side (L98, LS2)



Important:

- All gasket surfaces should be free of oil or other foreign material during assembly.
- DO NOT use the valve rocker arm cover gasket again.
- The valve rocker arm cover bolt grommets may be used again if not damaged.

1. Install a NEW gasket (1) into the valve rocker arm cover.



2. Install the valve rocker arm cover (2).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the valve rocker arm cover to cylinder head retaining bolts (1) with grommets.

   Tighten
   Tighten the bolts to 12 N·m (106 lb in).

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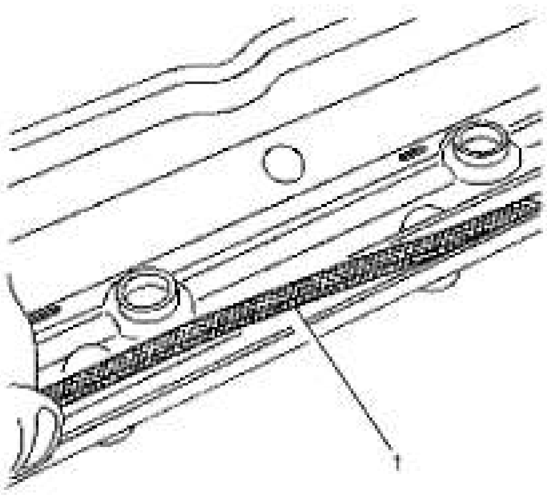
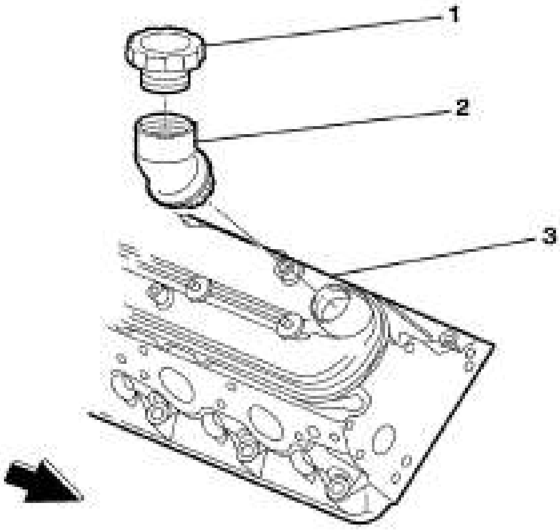
Valve Rocker Arm Cover Installation - Right Side (L98, LS2)



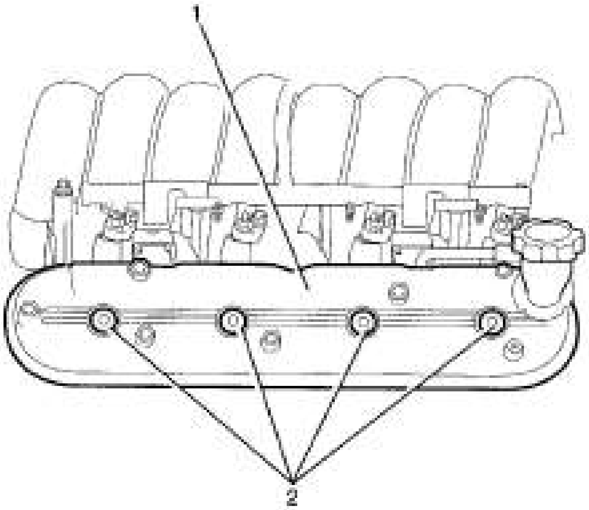
Important:

- All gasket surfaces should be free of oil or other foreign material during assembly.
- DO NOT use the valve rocker arm cover gasket again.
- The valve rocker arm cover bolt grommets may be used again if not damaged.

1. Install a NEW gasket (1) into the valve rocker arm cover.



2. Install a NEW oil fill tube (2) to the valve rocker arm cover (3).
3. Install the oil fill cap (1) to the oil fill tube (2).



4. Install the valve rocker arm cover (1).

   Notice: Refer to Fastener Notice in the Preface section.

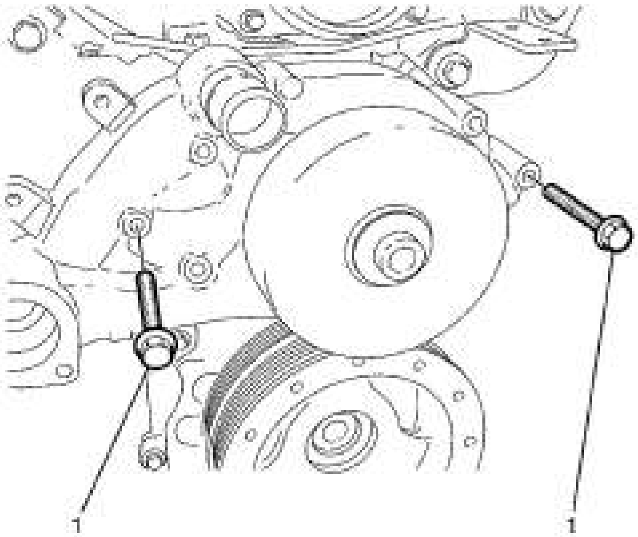
5. Install the valve rocker arm cover retaining bolts (2) with grommets.

   Tighten
   Tighten the bolts to 12 N·m (106 lb in).

Water Pump Installation (L98, LS2)

Notice: DO NOT use cooling system seal tabs, or similar compounds, unless otherwise instructed. The use of cooling system seal tabs, or similar compounds, may restrict coolant flow through the passages of the cooling system or the engine components. Restricted coolant flow may cause engine overheating and/or damage to the cooling system or the engine components/assembly.

Important: Ensure all mating surfaces are clean and free of grease.



1. Insert two retaining bolts (1) at each end of the pump, place the new gasket of the bolts and use this as a guide to install the pump.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install and tighten the remaining bolts.

   Tighten
   Tighten the water pump pulley bolts to 25 N·m (18 lb ft).

Cleanliness and Care

- Throughout this section, it should be understood that correct cleaning and protection of machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice even if not specifically stated.
- When any internal engine parts are serviced, care and cleanliness is important.
- When components are removed for service, they should be marked, organized or retained in a specific order for assembly. Refer to Separating Parts in Engine Mechanical - 6.0L.
- At the time of installation, components should be installed in the same location and with the same mating surface as when removed.
- An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in millimetres or thousandths of an inch. These surfaces should be covered or protected to avoid component damage.
- A liberal coating of clean engine oil should be applied to friction areas during assembly.
- Correct lubrication will protect and lubricate friction surfaces during initial operation.

Crankcase Ventilation System Description

A closed crankcase ventilation system is used in order to provide a more complete scavenging of crankcase vapours. Filtered air from the air induction system duct is supplied to the crankcase, mixed with blow-by vapours, and passes through a crankcase ventilation metering device before entering the intake manifold. The primary component in the positive crankcase ventilation (PCV) system is the PCV flow metering device (or orifice). Vacuum changes within the intake manifold result in flow variations of the blow-by vapours. If abnormal operating conditions occur, the design of the PCV system permits above acceptable amounts of blow-by vapours to back flow through the crankcase vent tube and into the engine induction system to be consumed during normal combustion. This engine ventilation system design minimizes oil consumption and significantly reduces the potential for oil ingestion during vehicle limit handling manoeuvres.

L98 Engine

The L98 engine utilizes an integral positive crankcase ventilation (PCV) system which is located in the engines valley cover beneath the intake manifold. The engine valley cover contains composite oil separating baffles and PCV plumbing. Filtered fresh air is routed from up stream of the throttle plate to the front of the right valve rocker arm cover through a formed nylon tube. The design of the rocker cover shields rocker arm oil spray thereby reducing the potential for oil being drawn into the throttle bore area during back flow of the ventilation system. Blow-by vapours are routed from the valley cover through a fixed orifice (2.5 mm) within a steel PCV tube, then through a formed rubber hose before entering the intake manifold behind the throttle body.

Drive Belt System Description

The drive belt system consists of the following components:

- The drive belt
- The drive belt tensioner
- The drive belt idler pulley
- The crankshaft balancer pulley
- The accessory drive component mounting brackets
- The accessory drive components
  - The power steering pump
  - The alternator
  - The A/C compressor
  - The water pump

The drive belt system may use 1 belt or 2 belts. The drive belt is thin so that it can bend backwards and has several ribs to match the grooves in the pulleys. The drive belts are made of different types of rubbers -- chloroprene or EPDM -- and have different layers or plies containing either fibre cloth or cords for reinforcement.

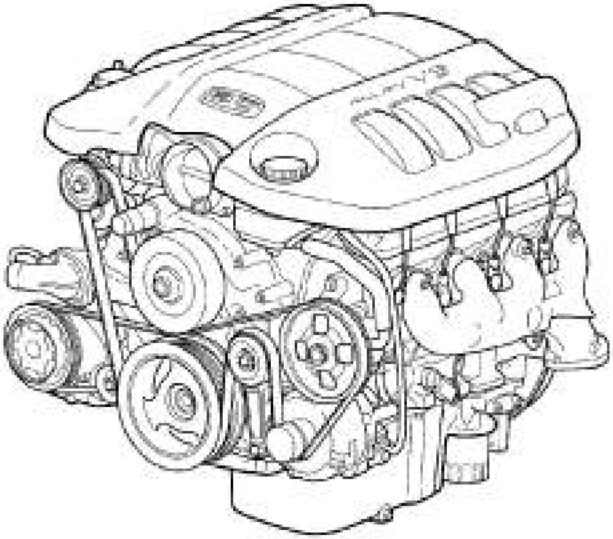
Both sides of the drive belt may be used to drive the different accessory drive components. When the back side of the drive belt is used to drive a pulley, the pulley is smooth.

The drive belt is pulled by the crankshaft balancer pulley across the accessory drive component pulleys. The spring loaded drive belt tensioner keeps constant tension on the drive belt to prevent the drive belt from slipping. The drive belt tensioner arm will move when loads are applied to the drive belt by the accessory drive components and the crankshaft.

The drive belt system may have an idler pulley, which is used to add wrap to the adjacent pulleys. Some systems use an idler pulley in place of an accessory drive component when the vehicle is not equipped with the accessory.

Engine Component Description (L98, LS2)

The 6.0 Litre V8 Engine



Camshaft and Drive System

A billet steel 1-piece camshaft is supported by 5 bearings pressed into the engine block. The camshaft timing sprocket is mounted to the front of the camshaft and is driven by the crankshaft sprocket through the camshaft timing chain. The camshaft position (CMP) sensor lobes are incorporated into the front face of the camshaft sprocket with the CMP sensor mounted in the engine front cover. A timing chain tensioner is mounted to the front of the engine block above the crankshaft sprocket. The externally splined crankshaft sprocket is positioned to the crankshaft by a key and key way. The crankshaft sprocket external splines drive the oil pump drive gear. A retaining plate mounted to the front of the engine block maintains camshaft location.

Crankshaft

The crankshaft is cast nodular iron. The crankshaft is supported by 5 crankshaft bearings. The bearings are retained by crankshaft bearing caps which are machined with the engine block for correct alignment and clearance. The crankshaft journals are undercut and rolled. The centre main journal is the thrust journal. A crankshaft position (CKP) reluctor ring is press fit mounted at the rear of the crankshaft. The reluctor ring is not serviceable separately.

Cylinder Heads

The cylinder heads are cast aluminium and have pressed in place powdered metal valve guides and valve seats. Passages for the engine coolant air bleed system are at the front of each cylinder head. The valve rocker arm covers are retained to the cylinder heads by 4 centre mounted rocker arm cover bolts.

Engine Block

The engine block is a cam-in-block deep skirt 90 degree V configuration with 5 crankshaft bearing caps. The engine block is cast aluminium. The 5 crankshaft bearing caps each have 4 vertical M10 and 2 horizontal M8 mounting bolts. The camshaft is supported by 5 camshaft bearings pressed into the block.

Exhaust Manifolds

The exhaust manifolds are a 1-piece cast iron design. The exhaust manifolds direct exhaust gasses from the combustion chambers to the exhaust system. Each manifold also has an externally mounted heat shield that is retained by bolts.

Intake Manifold

The intake manifold is a 1-piece composite design that incorporates brass threaded inserts for mounting the fuel rail, throttle body, and wire harness studs. Each side of the intake manifold is sealed to the cylinder head by a non-reusable push-in-place silicone sealing gasket. The electronically actuated throttle body bolts to the front of the intake manifold. The throttle body is sealed by a 1-piece push-in-place silicone gasket. The fuel rail assembly, with 8 separate fuel injectors, is retained to the intake by 4 bolts. The injectors are seated into their individual manifold bores with O-ring seals to provide sealing. A fuel rail stop bracket is retained to the rear left of the intake manifold by mounting bolts. The manifold absolute pressure (MAP) sensor is installed and retained to the top front of the intake manifold and sealed by an O-ring seal. The evaporative emission (EVAP) canister purge solenoid valve is mounted to the front of the right cylinder head. There are no coolant passages within the intake manifold.

Oil Pan

The structural rear-sump oil pan is cast aluminium. Incorporated into the design is the oil filter mounting boss, drain plug opening, baffle, oil filter bypass valve, and oil level indicator tube opening. The oil pressure relief valve is also internal to the oil filter. Alignment of the structural oil pan to the rear of the engine block and transmission housing is critical.

Piston and Connecting Rod Assembly

The pistons are cast aluminium. The pistons use 2 compression rings and 1 oil control ring assembly. The piston is a low friction, lightweight design with a flat or recessed top and barrel shaped skirt. The piston pins are chromium steel and are a full-floating design. The connecting rods are powdered metal. The connecting rods are fractured at the connecting rod journal and then machined for the correct clearance. All applications use a piston with a graphite coated skirt. The piston and pin are to be serviced as an assembly.

Valve Rocker Arm Cover Assemblies

The valve rocker arm covers are cast aluminium and use a pre-moulded silicon gasket for sealing. Mounted to each rocker cover are the coil and bracket assemblies. Incorporated into the right cover is the oil fill tube and the positive crankcase ventilation (PCV) fresh air passage.

Valve Train

Motion is transmitted from the camshaft through the hydraulic roller valve lifters and tubular pushrods to the roller type rocker arms. The nylon valve lifter guides position and retain the valve lifters. The valve rocker arms for each bank of cylinders are mounted on pedestals or pivot supports. Each rocker arm is retained on the pivot support and cylinder head by a bolt. Valve lash is net build.

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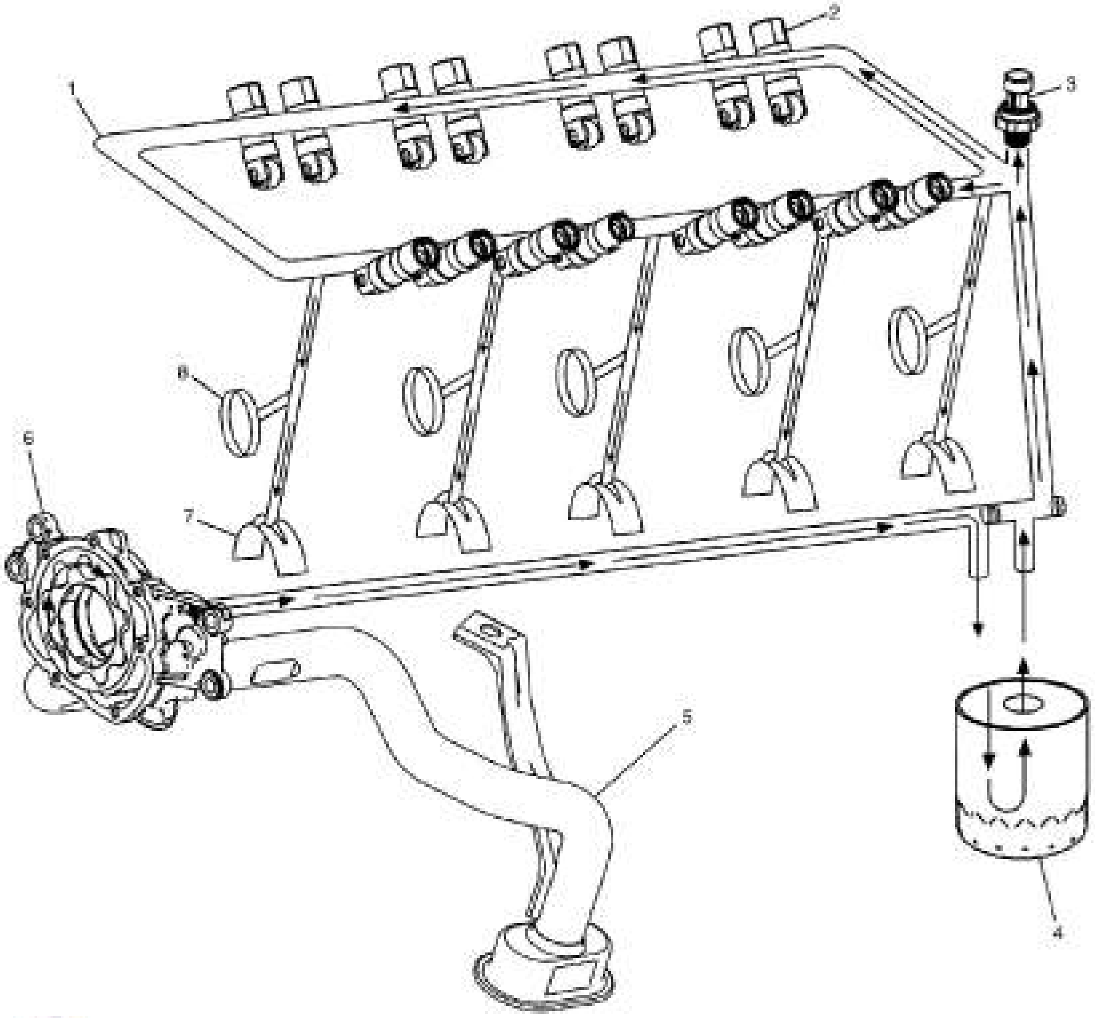
Lubrication Description (L98, LS2)



Engine lubrication is supplied by a gerotor type oil pump assembly (6). The pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe (5). The oil is pressurized as it passes through the pump and is sent through the engine block lower oil gallery. Contained within the oil pump assembly (6) is a pressure relief valve that maintains oil pressure within a specified range.

Pressurized oil is directed through the engine block oil gallery (1) to the full flow oil filter (4) where harmful contaminants are removed. A bypass valve is incorporated into the oil pan at the oil filter, which permits oil flow in the event the filter becomes restricted.

Oil is then directed from the filter to the upper main oil galleries (1). Oil from the left upper oil gallery is directed to the crankshaft bearings (7) and camshaft bearings (8). Oil that has entered both the upper main oil galleries also pressurizes the valve lifter assemblies (2) and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil returning to the pan is directed by the crankshaft oil deflector. The oil pressure sensor (3) is located at the top rear of the engine.

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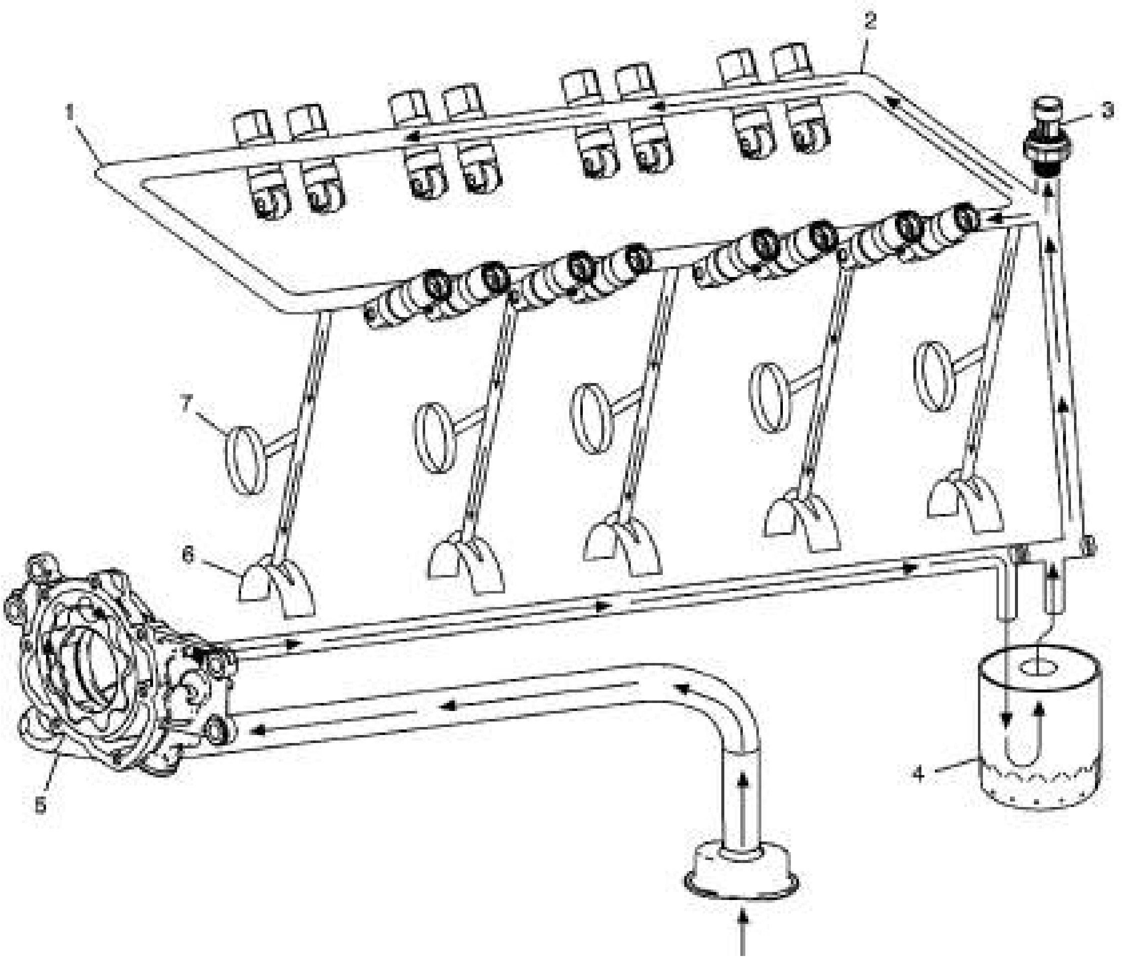
Lubrication Description (LS3)



Engine lubrication is supplied by a gerotor type oil pump assembly (5). The pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the pump and is sent through the engine block lower oil gallery. Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range.

Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter (4) where harmful contaminants are removed. A bypass valve is incorporated into the new design oil filter, which permits oil flow in the event the filter becomes restricted.

Oil is then directed from the filter to the upper main oil galleries (1). Oil from the left upper oil gallery is directed to the crankshaft bearings (6) and camshaft bearings (7). Oil that has entered both the upper main oil galleries also pressurizes the valve lifter assemblies (2) and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil returning to the pan is directed by the crankshaft oil deflector. The oil pressure sensor (3) is located at the top rear of the engine.

Replacing Engine Gaskets

Tools Required

J 28410 Gasket Remover

Gasket Use and Applying Sealants

- Do not use any gasket again unless specified.
- Gaskets that can be used again will be identified in the service procedure.
- Do not apply sealant to any gasket or sealing surface unless called out in the service information.

Separating Components

- Use a rubber mallet to separate components.
- Bump the part sideways to loosen the components.
- Bumping should be done at bends or reinforced areas to prevent distortion of parts.

Cleaning Gasket Surfaces

- Remove all gasket and sealing material from the part using the J 28410 .
- Care must be used to avoid gouging or scraping the sealing surfaces.
- Do not use any other method or technique to remove sealant or gasket material from a part.
- Do not use abrasive pads, sand paper, or power tools to clean the gasket surfaces.
  - These methods of cleaning can cause damage to the component sealing surfaces.
  - Abrasive pads also produce a fine grit that the oil filter cannot remove from the oil.
  - This grit is abrasive and has been known to cause internal engine damage.

Assembling Components

Notice: Refer to Sealant Notice in the Preface section.

- When assembling components, use only the sealant specified or equivalent in the service procedure.
- Sealing surfaces should be clean and free of debris or oil.
- Specific components such as crankshaft oil seals or valve stem oil seals may require lubrication during assembly.
- Components requiring lubrication will be identified in the service procedure.
- When applying sealant to a component, apply the amount specified in the service procedure.
- Tighten bolts to specifications. Do not over tighten.

Separating Parts

Important:

- Many internal engine components will develop specific wear patterns on their friction surfaces.
- When disassembling the engine, internal components MUST be separated, marked, or organized in such a way as to make sure installation to their original location and position.

Separate, mark, or organize the following components:

- Piston and the piston pin
- Piston to the specific cylinder bore
- Piston rings to the piston
- Connecting rod location and orientation to the crankshaft journal
- Connecting rod to the bearing cap

  A paint stick or etching/engraving type tool are recommended. Stamping the connecting rod or cap near the bearing bore may affect component geometry.
- Crankshaft main and connecting rod bearings
- Camshaft and valve lifters
- Valve lifters, lifter guides, pushrods and rocker arm assemblies
- Valve to the valve guide
- Valve spring to the cylinder head location
- Engine block main bearing cap location and direction
- Oil pump drive and driven gears

Tools and Equipment

Special tools are listed and illustrated throughout this section, with a complete listing at the end of the section. These tools, or their equivalents, are specially designed to quickly and safely accomplish the operations for which they are intended. The use of these special tools also minimize possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and a torque angle meter are necessary for the correct tightening of various fasteners.

To correctly service the engine assembly, the following items should be readily available:

- Approved eye protection and safety gloves
- A clean, well lit, work area
- A suitable parts cleaning tank
- A compressed air supply
- Trays or storage containers to keep parts and fasteners organized
- An adequate set of hand tools
- Approved engine repair stand
- An approved engine lifting device that will adequately support the weight of the components

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Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant

Pipe Joint Compound

Important: Three types of sealer are commonly used in engines. These are room temperature vulcanizing (RTV) sealer, anaerobic gasket eliminator sealer, and pipe joint compound. The correct sealer and amount must be used in the correct location to prevent oil leaks. DO NOT interchange the 3 types of sealers. Use only the specific sealer or the equivalent as recommended in the service procedure.

- Pipe joint compound is a pliable sealer that does not completely harden. This type of sealer is used where two non-rigid parts, such as the oil pan and the engine block, are assembled together.
- Do not use pipe joint compound in areas where extreme temperatures are expected. These areas include: exhaust manifold, head gasket, or other surfaces where gasket eliminator is specified.
- Follow all safety recommendations and directions that are on the container.

  To remove the sealant or the gasket material, refer to Replacing Engine Gaskets.

Notice: Refer to Sealant Notice in the Preface section.

- Apply the pipe joint compound to a clean surface. Use a bead size or quantity as specified in the procedure. Run the bead to the inside of any bolt holes.
- Apply a continuous bead of pipe joint compound to one sealing surface. Sealing surfaces to be resealed must be clean and dry.
- Tighten the bolts to specifications. Do not over tighten.

RTV Sealer

- RTV sealant hardens when exposed to air. This type of sealer is used where two non-rigid parts, such as the intake manifold and the engine block, are assembled together.
- Do not use RTV sealant in areas where extreme temperatures are expected. These areas include: exhaust manifold, head gasket, or other surfaces where a gasket eliminator is specified.
- Follow all safety recommendations and directions that are on the container.

  To remove the sealant or the gasket material, refer to Replacing Engine Gaskets.

Notice: Refer to Sealant Notice in the Preface section.

- Apply RTV sealant to a clean surface. Use a bead size as specified in the procedure. Run the bead to the inside of any bolt holes.
- Assemble components while the RTV sealant is still wet, within 3 minutes. Do not wait for the RTV sealant to skin over.
- Tighten bolts to specifications. Do not over tighten.

Anaerobic Sealer

- Anaerobic gasket eliminator hardens in the absence of air. This type of sealer is used where two rigid parts, such as castings, are assembled together. When two rigid parts are disassembled and no sealer or gasket is readily noticeable, the parts were probably assembled using a gasket eliminator.
- Follow all safety recommendations and directions that are on the container.

  To remove the sealant or the gasket material, refer to Replacing Engine Gaskets.
- Apply a continuous bead of gasket eliminator to one flange. Surfaces to be sealed must be clean and dry.

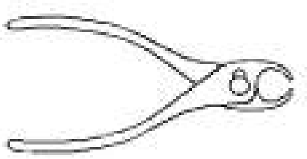
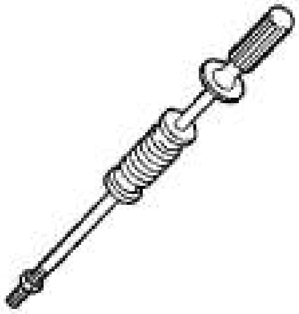
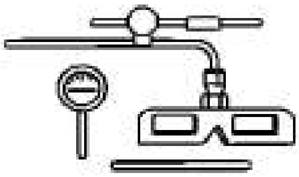
Notice: Refer to Sealant Notice in the Preface section.

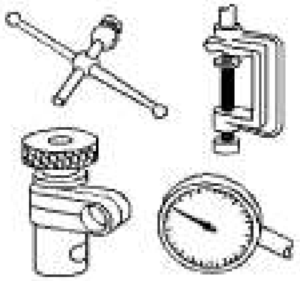
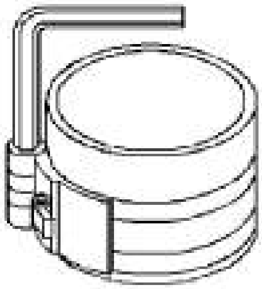
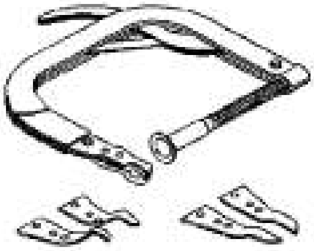
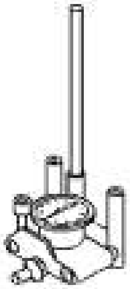
- Spread the sealer evenly with your finger to get a uniform coating on the sealing surface.

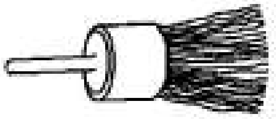
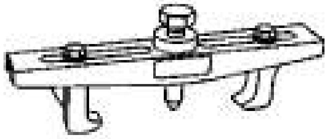
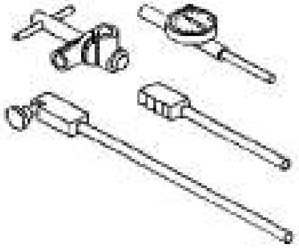
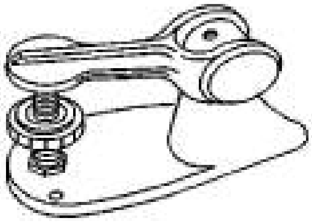
  Important: Anaerobic sealed joints that are partially torqued and allowed to cure more than five minutes may result in incorrect shimming and sealing of the joint.

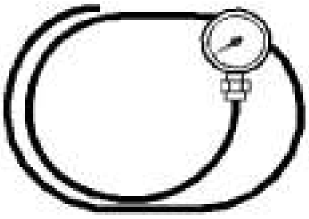
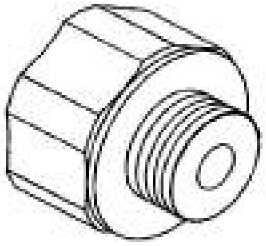
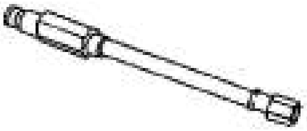
- Tighten bolts to specifications. Do not over tighten.
- After correctly tightening the fasteners, remove the excess sealer from the outside of the joint.

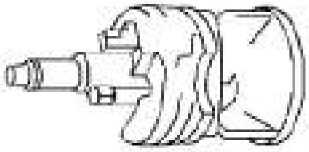
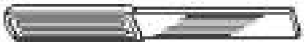
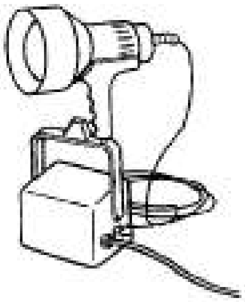
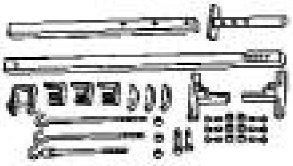
Special Tools (L98, LS2)

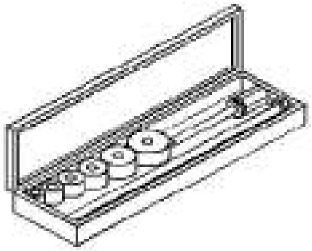
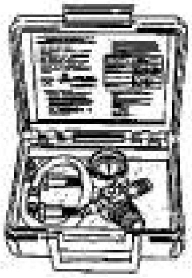
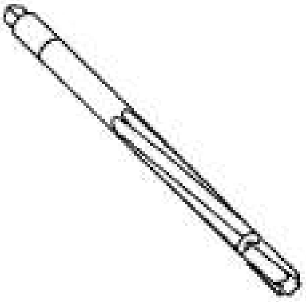
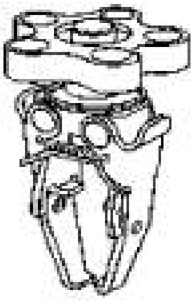
Illustration	Tool Number / Description
	J 3049-A Valve Lifter Remover
	J 6125-1B Slide Hammer with Adapter
	J 7872 Magnetic Base Dial Indicator
	J 8001

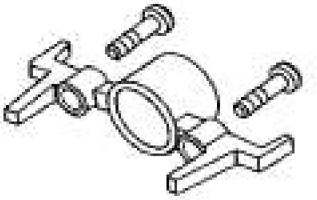
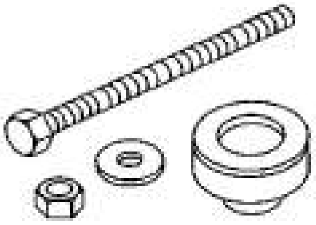
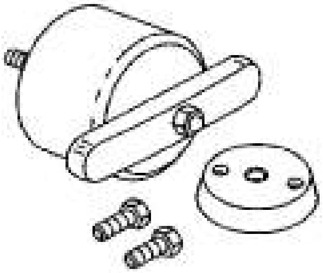
	Dial Indicator Set
	J 8037 Ring Compressor
	J 8062 Valve Spring Compressor - Head Off
	J 8087 Cylinder Bore Gage

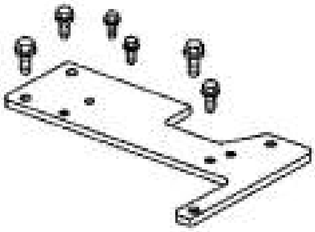
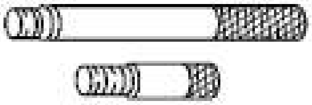
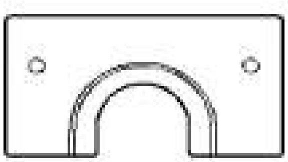
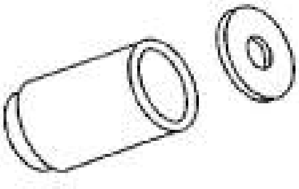
	J 8089 Carbon Removal Brush
	J 8433 Two Jaw Puller
	J 8520 Cam Lobe Lift Indicator
	J 9666 Valve Spring Tester

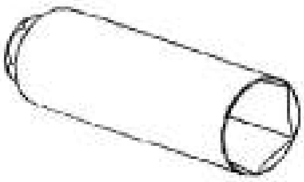
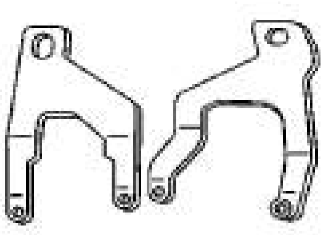
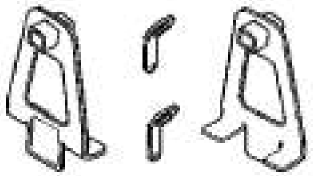
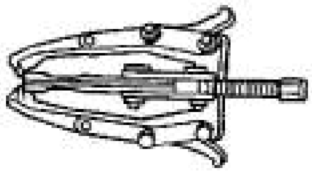
	J 21867 Pressure Gage
	J 21867-16 Oil Pressure Adapter
	J 22794 Spark Plug Port Adapter
	J 24270 Cylinder Bore Ridge Reamer

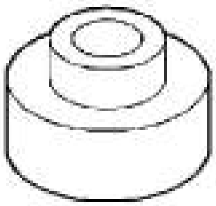
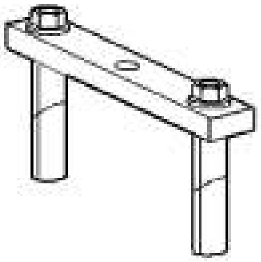
	
	J 28410 Gasket Remover
	J 28428-E High-Intensity Black Light Kit
	J 28467-B Universal Engine Support Fixture

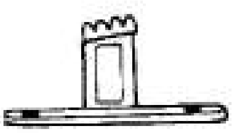
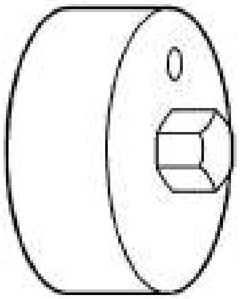
	J 33049 Camshaft Bearing Service Set
	J 35667-A Cylinder Leakdown Tester
	J 37378-1 Valve Guide Reamer
	J 38606 Valve Spring Compressor

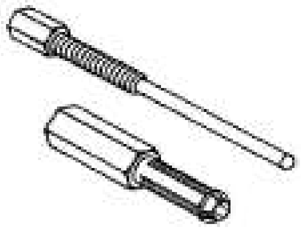
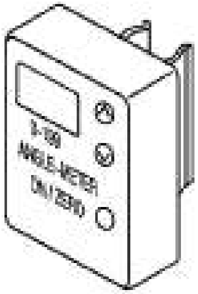
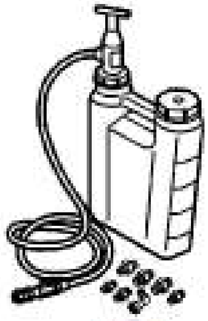
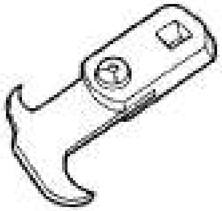
	J 41476 Front and Rear Cover Alignment Tool
	J 41478 Crankshaft Front Oil Seal Installer
	J 41479 Crankshaft Rear Oil Seal Installer
	J 41480 Front and Rear Cover Alignment

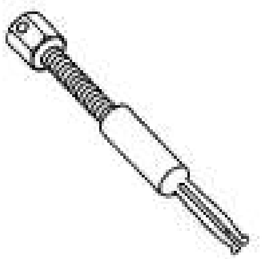
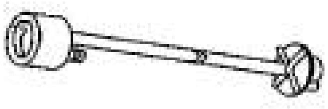
	
	J 41556 Connecting Rod Guide
	J 41558 Crankshaft Sprocket Remover
	J 41665 Crankshaft Balancer and Sprocket Installer

	J 41712 Oil Pressure Switch Socket
	J 41798 Engine Lift Bracket
	J 41803 Engine Support Fixture
	J 41816 Crankshaft Balancer Remover

	J 41816-2 Crankshaft End Protector
	J 41818 Crankshaft Bearing Cap Remover
	J 42385-100 Head/Main Bolt Thread Repair Kit
	J 42385-200 Common Threads Repair Kit

	J 42385-300 Fixtures and Hardware Kit
	J 42386-A Flywheel Holding Tool
	J 42907 Oil Pressure Tester

	J 43276 Clutch Pilot Bearing Remover
	J 45059 Angle Meter
	J 45299 Engine Preluber
	E 308 Universal Seal Remover

	J 23907 Slide Hammer
	J 41415-40 Fuel Tank Cap Adaptor

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Fastener Tightening Specifications

Application	Specification	
	Metric	English
Air Inlet Assembly to HVAC Module Assembly Retaining Screws	9 N-m	80 lb in
Air Outlet Duct to Instrument Panel (I/P) Upper Trim Pad Retaining Screws	2 N-m	18 lb in
Automatic Transmission Cooler Pipe Clamp to A/C Bracket Retaining Bolt	23 N-m	17 lb ft
Blower Motor to Blower Assembly Retaining Screws	1.2 N-m	11 lb in
Blower Scroll to HVAC Case Retaining Screws	1 N-m	9 lb in
Compressor Drive Belt Tensioner to Compressor Mounting Bracket Retaining Bolt (3.6L)	58 N-m	43 lb ft
Compressor Drive Belt Tensioner to Compressor Mounting Bracket Retaining Bolt (6.0L)	58 N-m	43 lb ft
Compressor Mounting Bracket to Cylinder Block Retaining Bolts (3.6L)	58 N-m	43 lb ft
Compressor Mounting Bracket to Cylinder Block Retaining Bolts (6.0L)	58 N-m	43 lb ft
Compressor to Compressor Mounting Bracket Retaining Bolts (3.6L)	22 N-m	16 lb ft
Compressor to Compressor Mounting Bracket Retaining Bolts (6.0L)	22 N-m	16 lb ft
Condenser Discharge Hose Bolt	22 N-m	16 lb ft
Condenser Mounting Bolts	11 N-m	97 lb in
Discharge Pipe to Condenser Retaining Nut	22 N-m	16 lb ft
Evaporator Tube to Fan Shroud Screw	2 N-m	18 lb in
Floor Air Outlet Duct to I/P Retaining Screws	2 N-m	18 lb in
Heater Core Pipe Locating Plate to HVAC Module Assembly Retaining Screw	1 N-m	9 lb in
Heater Core Retaining Plate to HVAC Module Assembly Retaining Screw	1 N-m	9 lb in
Heater Hose Bracket Screws	2 N-m	18 lb in
HVAC Module Assembly to Bulkhead Retaining Bolts	7 N-m	62 lb in
HVAC Module Assembly to I/P Carrier Retaining Screws	9 N-m	80 lb in
I/P Center Air Outlet Deflector to I/P Upper Trim Panel Retaining Screws	2 N-m	18 lb in
Left Engine Cover Mounting Bracket to Cylinder Head Retaining Bolt	35 N-m	26 lb ft
Liquid Pipe Bracket Screw	22 N-m	16 lb ft
Rear Air Outlet Duct Nut	1 N-m	9 lb in
Refrigerant Pressure Sensor	6 N-m	53 lb in
Remote Battery Positive Post to Wiring Harness Retaining Bolt	15 N-m	11 lb ft
Suction Pipe Upper to Suction Pipe Lower Retaining Nut	22 N-m	16 lb ft
Suction Pipe/Liquid Pipe Pad to TX Valve Retaining Nut	22 N-m	16 lb ft
Suction Pipe/Liquid Pipe Retaining Clip to Left Front Chassis Rail Retaining Bolt	22 N-m	16 lb ft
Suction/Discharge Pipe to Compressor Retaining Bolt	22 N-m	16 lb ft
TX Valve Retaining Bolts	4 N-m	35 lb in

Compressor Specifications

Component	Application	Specification
A/C System Refrigerant Oil	Type	PAG Oil Denso ND 8
Refrigerant	Type	HFC R-134a
Compressor	Make Type	Denso 6SEU16C Variable Stroke, Clutch-less, Electronic Control Valve

Refrigerant System Capacities

Refrigerant System Capacities

Application	Specification	
	Metric	Imperial
PAG Oil Denso ND 8		
Compressor Replacement		
- The Denso Service Compressor is precharged with the total system specified amount of PAG Oil	Refer to Air Conditioning Compressor Oil Balancing	
Condenser Replacement	30-40 ml	1 -- 1.4 oz
Filter Drier Replacement	15-20 ml	0.5 --0.7 oz
Evaporator Replacement	30-40 ml	1 -- 1.4 oz
- Total System PAG Oil Capacity	100-140 ml	3.3 -- 4.7 oz
HFC R-134a		
- Refrigerant Charge	580 g	20.5 oz
If more than the specified amount of PAG oil was drained from a component, add the equal amount of oil drained.		

Symptoms - Heating, Ventilation, and Air Conditioning

Important: Review the system operation in order to familiarise yourself with the system functions. Refer to:

- Air Delivery Description and Operation Manual or Air Delivery Description and Operation Automatic.
- Air Temperature Description and Operation Manual or Air Temperature Description and Operation Automatic.

Visual/Physical Inspection

- Inspect for aftermarket devices which may affect the operation of the HVAC System. Refer to Checking Aftermarket Accessories.
- Inspect the easily accessible or visible system components for obvious damage or conditions which may cause the symptom.
- Verify the A/C compressor turns freely and is not seized.
- The A/C compressor will not operate in cold outside air temperatures. Refer to Air Temperature Description and Operation.
- The following conditions may cause window fogging:
  - Wet carpet or mats
  - High humidity
  - Interior water leak
  - Blocked A/C evaporator drain tube
  - Maximum passenger capacity
  - Blocked body pressure relief valves
- Inspect the air distribution system for causes of reduced air flow:

  Blocked or damaged air inlet or outlet vents

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Blower Motor Malfunction.
- Leak Testing.
- Defrosting Insufficient.
- Noise Diagnosis - Blower Motor.
- Noise Diagnosis - Air Conditioning (A/C) System.
- Noise Diagnosis - HVAC Module

- Odor Diagnosis.

Diagnostic Starting Point - Heating, Ventilation and Air Conditioning

The Heating, Ventilation and Air Conditioning (HVAC) system is divided into 3 separate sections. The first, Heating, Ventilation and Air Conditioning, has all procedures that pertain to a HVAC component or function that is not specifically associated with the manual or automatic control system. The second, HVAC Systems - Manual, has procedures specific to the Manual control system and the third, HVAC systems - Automatic, has procedures specific to the automatic control system. The DTCs and scan tool data that support the manual HVAC system are also relevant for the automatic HVAC system. To minimise data duplication this information is located in HVAC Systems - Automatic.

Begin the system diagnosis with the Diagnostic System Check - Vehicle . The diagnostic system check will provide the following information:

- The identification of the control modules which command the system.
- The ability of the control modules to communicate through the serial data circuit.
- The identification of any stored diagnostic trouble codes (DTCs) and their status.

The use of the diagnostic system check will identify the correct procedure for diagnosing the system and where the procedure is located.

Review the description and operation information to help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the description and operation information will also help you determine if the condition described by the customer is an abnormal operation. The HVAC description and operation information is divided into the following:

- Air Delivery Description and Operation -- Manual or Air Delivery Description and Operation -- Automatic.
- Air Temperature Description and Operation -- Manual or Air Temperature Description and Operation -- Automatic.

The air delivery description and operation contains the following topics:

- HVAC control components.
- Air speed.
- Air distribution.
- Recirculation operation.

The air temperature description and operation contains the following topics:

- HVAC control components.
- Heating and A/C operation.
- Engine coolant.
- A/C cycle.

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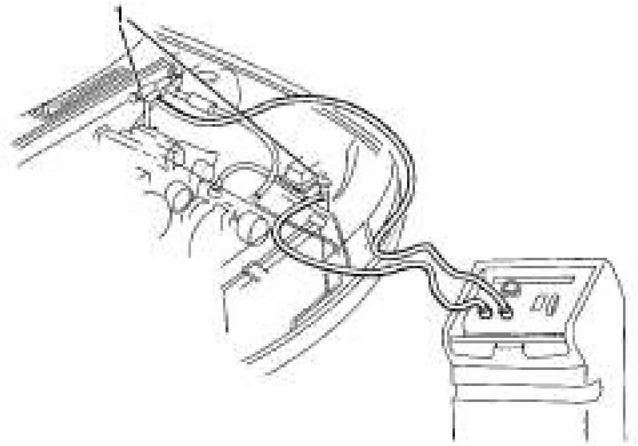
Air Conditioning (A/C) System Performance Test

Table 1: A/C Performance Table

Table 2: Refrigerant-134a Pressure-Temperature Relationship

Important:

- Before carrying out the high/low pressure and centre vent temperature testing, make sure that the vehicles A/C system has no visual or operational defects and that all refrigerant recovery and recharging safety requirements are adhered to. Refer to Refrigerant Recovery and Recharging.
- Before commencing the testing follow the vehicle set up procedure. Failure to correctly set the vehicle up for testing will provide inaccurate diagnosis when comparing actual pressure readings to the table below.



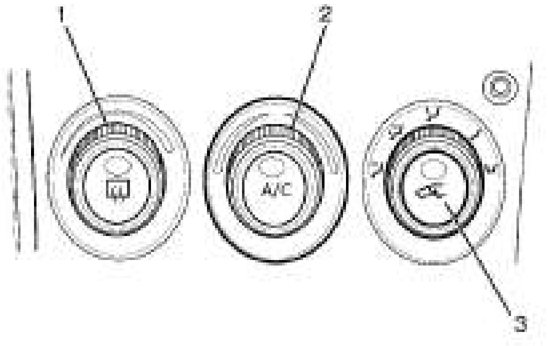
1. Connect the calibrated high/low pressure gauges to the A/C system (1).

   Important: Both high and low pressures should be within 50kPa of each other, if not a blockage may be present in the system.

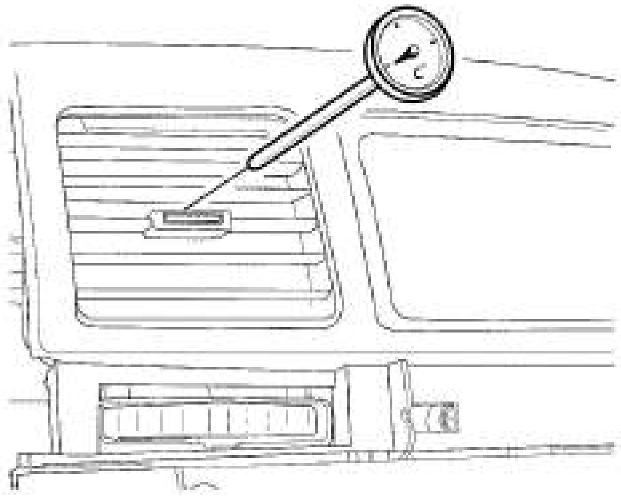
2. Confirm that the static pressures (vehicle not started or A/C engaged) are correct.

   Important: When possible the vehicle should be tested in direct sunlight, especially in the case of climate control vehicles using solar sensors.

3. Record the ambient temperature conditions and the relative humidity at the time of the test.
4. DO NOT test the vehicle with the condenser air flow restricted, such as against a wall.



5. Set the blower motor speed control (1) to the highest blower motor speed.
6. Set the temperature control (2) to the maximum cold setting.
7. Set the air intake mode control (3) to fresh air intake mode.



8. Set the mode outlet control to the face position with the instrument panel louvres open and facing straight ahead.

   Important: Make sure that the thermometer probe is inserted to a length of approximately 50mm.

9. Insert a thermometer centrally into the face vent.
10. Turn the engine ON and run at idle speed.
11. Close all vehicle doors and windows.
12. Close the vehicle engine hood.

Important: For Accurate testing the relative humidity percentage (RH%) should be known, as you will see the pressures and vent temperatures alter as RH% changes. Refer to the A/C performance table below.

13. Make sure accurate pressure gauges are connected to the A/C system.
14. Turn the engine OFF and compare the readings with the data in the A/C performance table. A normally operating A/C system should not exceed levels shown. If the readings exceed the table limits, refer to Symptoms - HVAC Systems - Manual.

A/C Performance Table

Engine Speed (RPM)	Relative Humidity (%)	Ambient Air Temperature		Centre Air Outlet Temperature		Gauge Pressure Low Side Pressure		Gauge Pressure High Side Pressure	
		°F	°C	°F	°C	psi	kPa	psi	kPa
Idle	20	59	15	37	3.00	27	162	142	943
		68	20	37	3.00	31	185	168	1106
		77	25	40	4.64	36	209	191	1296
		86	30	47	8.60	42	236	225	1494
		95	35	54	12.49	50	265	266	1653
		104	40	62	16.45	58	300	304	1864
		113	45	69	20.47	63	334	323	2155
	40	59	15	37	3.00	25	171	139	956
		68	20	38	3.50	28	197	164	1129
		77	25	44	6.79	32	222	192	1323
		86	30	52	11.27	36	252	209	1445
		95	35	61	15.94	42	288	248	1709
		104	40	69	20.76	48	329	279	1925
		113	45	77	25.18	54	375	306	2110
	60	59	15	37	3.00	26	177	140	966
		68	20	40	4.47	30	205	166	1146
		77	25	48	8.92	34	233	192	1326
		86	30	57	13.93	39	269	215	1480
		95	35	66	19.11	45	310	249	1718
		104	40	76	24.59	52	358	300	2072
		113	45	86	29.82	59	406	318	2196
	80	59	15	37	3.00	27	186	142	976
		68	20	43	6.11	31	214	168	1160
		77	25	52	11.15	36	250	191	1320
		86	30	62	16.95	42	289	225	1551
		95	35	74	23.23	50	342	266	1833
		104	40	85	29.27	58	398	304	2096
		113	45	96	35.65	63	436	323	2226

Refrigerant-134a Pressure-Temperature Relationship

°C	°F	kPa	psig	°C	°F	kPa	psig
DEFINITION: This table indicates the pressure of the Refrigerant-134a at various temperatures. For instance, a drum of refrigerant at room temperature of 26.6°C (80°F) will have a pressure of 595.6 kPa (86.4 psi). If the refrigerant is heated to 51.6°C (125°F), the pressure will increase to 1278.8 kPa (185.5 psi). The refrigerant also can be used conversely in order to determine the temperature at which the Refrigerant-134a boils under various pressures. For example, at a pressure of 188.2 kPa (27.3 psi), the Refrigerant-134a boils at 0°C (32°F).							
				15.5	60	392.3	56.9
-23.3	-10	12.4	1.8	18.3	65	438.2	63.6
-20.5	-5	27.0	3.9	21.1	70	487.3	70.7
-17.7	0	43.2	6.3	23.8	75	539.7	78.3
15.0	5	60.8	8.8	26.6	80	595.6	86.4
-12.2	10	80.1	11.6	29.4	85	655.1	95.0
9.4	15	101.3	14.7	32.2	90	718.5	104.2
-6.6	20	124.3	18.0	35.0	95	785.6	113.9
-3.8	25	149.4	21.7	37.7	100	856.9	124.3
-1.1	30	176.6	25.6	40.5	105	932.3	135.2
0.0	32	188.2	27.3	43.3	110	1012.1	146.8
1.6	35	206.2	29.9	46.1	115	1096.4	159.0
4.4	40	238.0	34.5	48.8	120	1185.2	171.9
7.2	45	272.5	39.5	51.6	125	1278.8	185.5
10.0	50	309.5	44.9	54.4	130	1377.3	199.8
12.7	55	349.4	50.7	60.0	140	1589.6	230.5

Heating Performance Diagnostic

Step	Action	Yes	No
DEFINITION: Heating system performance.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to Step 2	Go to Symptoms - Heating, Ventilation, and Air Conditioning in HVAC
2	1. Start the engine. 2. Allow the engine to idle. Does the engine reach normal operating temperature?	Go to Step 3	Go to Step 9
3	**Caution:** Refer to Moving Parts and Hot Surfaces Caution in the Preface section. 1. Select the FLOOR mode. 2. Select the minimum blower speed. 3. Select the warmest temperature setting. 4. Feel the temperature of the inlet and outlet heater hoses at the heater core. Does the inlet heater hose feel warmer than the outlet heater hose?	Go to Step 7	Go to Step 4
4	1. Place a thermometer in the centre air outlet. 2. Secure a thermometer to the heater core outlet heater hose. 3. Select the maximum blower speed. 4. Select the warmest temperature setting. 5. Record the temperature at the following locations: • The centre I/P PANEL air outlet. • The heater core outlet heater hose. 6. Compare the recorded temperatures. Are the 2 temperature readings about equal?	Go to Step 5	Go to Step 6
5	1. Inspect and repair the following areas of the vehicle for cold air leaks: • The cowl. • The recirculation door. • The HVAC module case. 2. Perform the necessary repairs. Are the repairs complete?	Go to Step 10	--
	1. Inspect the temperature door operation. Refer to Diagnostic System Check - Vehicle.		

6	2. Perform any necessary repairs. Are the repairs complete?	Go to Step 10	--
7	1. Turn OFF the engine. 2. Backflush the heater core. 3. Start the engine. 4. Select the FLOOR mode. 5. Select the minimum blower speed. 6. Select the warmest temperature setting. 7. Feel the temperature of the inlet and outlet heater hoses at the heater core. Does the inlet heater hose feel warmer than the outlet heater hose?	Go to Step 8	Go to Step 10
8	Replace the heater core. Refer to Heater Core Replacement. Is the repair complete?	Go to Step 10	--
9	Repair the low engine temperature concern. Refer to Engine Fails To Reach Normal Operating Temperature. Is the repair complete?	Go to Step 10	--
10	Operate the system in order to verify the repair. Did you find and correct the condition?	System OK	Go to Step 2

Leak Testing

Tools Required

- J 41447 R-134a A/C Tracer Dye Box of 24.
- J 42220 Universal 12 V Leak Detection Lamp.
- J 43872 Fluorescent Dye Cleaner.
- J 43872 Soapy Water Solution.
- J-46053 Electronic Leak Detector.
- J 46297 A/C Dye Injector Kit.
- J 46297-12 Replacement Dye Cartridges.

Refrigerant Leak Testing

Caution: Refer to Safety Glasses Caution in the Preface section.

Verifying some passive leaks may require using the electronic leak detector, and the addition of fluorescent dye. The fluorescent dye mixes and flows with the polyalkylene glycol (PAG) oil throughout the refrigerant system. The only time that adding additional fluorescent dye is required is after flushing the A/C system.

Fluorescent Leak Detector

Important: Always use the coloured glasses provided with your ultra violet lamp as these enhance the fluorescent dye colour.

Fluorescent dye will assist in locating any leaks from the A/C system.

Important: PAG oil is water soluble.

- Condensation on the evaporator core or the refrigerant lines may wash the PAG oil and fluorescent dye away from the actual leak. Condensation may also carry the fluorescent dye through the HVAC module drain.
- Leaks in the A/C system will be indicated in a light green or yellow colour when using the leak detection lamp.

  Use the leak detection lamp in the following areas:
  - All fittings or connections that use seal washers or an O-ring.
  - All of the A/C components.
  - The A/C compressor shaft seal.
  - The A/C hoses and pressure switches.
  - The HVAC module drain pipe (if the evaporator core is suspected of leaking).
  - The service port sealing caps (the sealing cap is the primary seal for the service ports).
- Follow the instructions supplied with the J 42220 .

- To prevent false diagnosis in the future, thoroughly clean the residual dye from any area where leaks were found. Use a rag and the approved J 43872 containing fluorescent dye cleaner.

Fluorescent Dye Injection

Important: Avoid spilling fluorescent dye on the vehicle paint work, clean off straight away using an approved fluorescent dye cleaning agent.

Important: Use only fluorescent dye approved by the vehicle manufacturer.

- J 41447 can be poured directly into a removed A/C component.
- J 46297-12 is injected into the low side port using J 46297 .
- Not all fluorescent dyes are compatible with PAG oil. Some types of fluorescent dye decrease the oil viscosity or may chemically react with the oil.
- R-134a leak detection dye requires time to work. Depending upon the leak rate, a leak may not become visible for a duration between 15 minutes and 7 days.

Important: Do NOT overcharge the A/C system with dye. Use only one 7.39 ml (0.25 oz) charge.

- To prevent false diagnosis, thoroughly clean any residual dye from the service port with a shop cloth and the approved J 43872 containing fluorescent dye cleaner.

Electronic Leak Detector

Make sure that the vehicle has at least 0.2 kg of refrigerant in the A/C refrigeration system in order to perform a leak test. Refer to Refrigerant Recovery and Recharging , for the recharging of the A/C system.

Make sure that fresh batteries are installed at regular intervals, false readings may occur as a result of the batteries not being fully charged.

Make sure that the sensing tip inlet is free of dirt, also make sure that the sensing tip is kept at a distance of 5mm from the components/areas being tested.

Important: Follow a continuous path in order to make sure that all possible leaks are detected. Test all areas of the system for leaks.

Follow the instructions supplied with the electronic leak detector.

Soapy Water

Fill the approved J 43872 with a solution of 50% water and 50% dish washing liquid. Operate the A/C system and spray the soapy solution over the joints and components. When a leak is evident the solution will bubble up.

This is an ideal method for hose and joint leaks.

Noise Diagnosis - Air Conditioning (A/C) System

Step	Action	Yes	No
DEFINITION: Noise originating from the A/C compressor, drive belt or the A/C lines.			
1	Were you sent here from HVAC Symptoms or another diagnostic table?	Go to Step 2	Go to Diagnostic System Check - Vehicle.
2	Inspect and if necessary rectify any faults with the accessory drive belt and drive belt tensioner.	Go to Step 3	
3	Run the engine and check for possible compressor noise. Does the noise last longer than 30 seconds?	Go to Step 5	Go to Step 4
4	• Allow the engine to run for a few minutes. • Stop engine and let it rest for a minute. • Restart engine. Is any noise detected using this procedure?	Go to Step 6	It is normal to observe a liquid sludging condition. This may occur after extended system shut down at warmer ambient temperatures, followed by an overnight ambient temperature drop
5	Check if the system has a low refrigerant charge. Is there enough system gas?	Go to Step 7	Go to Step 8
6	Check if the thermostatic expansion (TX) valve is stuck closed or open. Is the TX valve stuck?	Carry out TX valve diagnosis. Refer to Air Conditioning Evaporator Thermal Expansion Valve Replacement.	Go to Step 7
7	Check for any loose compressor bolt and/or A/C plumbing contacting the bodywork. Is there any A/C plumbing contacting the bodywork or mounting bolts loose?	Tighten bolts and/or relocate plumbing	Go to Step 8
	1. Recover refrigerant and replace compressor.		

8	2. Recharge the system Are the gas pressures within specification?	System checks complete	Go to Step 1

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Noise Diagnosis - Blower Motor

Step	Action	Yes	No
DEFINITION: Noise originating from the blower motor.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to Step 2	Go to Symptoms - HVAC Systems - Manual.
2	Inspect the air inlet grille for debris. Is debris present?	Go to Step 8	Go to Step 3
3	1. Sit inside the vehicle. 2. Close the vehicle doors and windows. 3. Turn ON the ignition, with the engine OFF. 4. Cycle the blower motor through all of the speeds and modes in order to determine where and when the noise occurs. Is a noise evident during the blower operation?	Go to Step 4	Go to Step 11
4	Inspect for vibration at each blower motor speed by feeling the blower case. Is excess vibration present?	Go to Step 6	Go to Step 5
5	Listen to the blower motor at each speed. Is the blower motor making a squeaking or chirping noise?	Go to Step 9	Go to Step 11
6	1. Remove the blower motor. Refer to Blower Motor Replacement. 2. Inspect the blower motor impeller for deposits of foreign material. 3. Inspect the blower motor for deposits of foreign material. Did you find any foreign material on the blower motor or blower motor impeller?	Go to Step 8	Go to Step 7
7	Inspect the blower motor for the following conditions: - Cracked blades. - A loose impeller retainer. - Incorrect impeller alignment. Did you find any of these conditions?	Go to Step 9	Go to Step 10
8	Remove the foreign material. Is the action complete?	Go to Step 10	--
	Replace the blower motor. Refer to Blower Motor		

9	Replacement. Is the repair complete?	Go to Step 11	--
10	Install the blower motor. Refer to Blower Motor Replacement. Is the action complete?	Go to Step 11	--
11	Operate the system in order to verify the repair. Did you find and correct the condition?	System OK	Go to Step 2

Noise Diagnosis - HVAC Module

Step	Action	Yes	No
DEFINITION: Noise originating from the HVAC module assembly.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to Step 2	Go to Diagnostic System Check - Vehicle.
2	1. Start the engine. 2. Cycle through all of the following: • Blower motor speeds. • HVAC modes. • Temperature control settings. 3. Determine the type of noise: • Scrape, pop. • Tick/click, chirp or groaning. • Air rush/whistle. Is a scrape or pop noise evident when selecting modes or temperature settings?	Go to Step 6	Go to Step 3
3	Is a tick/click, chirping, groaning or scraping noise present, but decreases as blower motor speed is decreased?	Go to Step 6	Go to Step 4
4	Is an air rush/whistle noise evident in all modes but not all temperature settings?	Go to Step 6	Go to Step 5
5	Is an air rush/whistle noise evident only in defrost or floor mode?	Go to Step 6	Go to Step 6
6	Remove the I/P carrier. Refer to Instrument Panel Retainer Replacement. 1. Inspect the air flow doors for correct operation. 2. Inspect the ducts for obstructions or foreign materials. Were any of these conditions found?	Go to Step 9	Go to Step 7
7	Inspect the mode and temperature doors and seals for warping or cracking. Are the doors in normal condition?	Go to Step 10	Go to Step 8
8	Replace the appropriate door and/or seals. Is the repair complete?	Go to Step 10	--
9	Remove any obstructions or foreign material found. Is the action complete?	Go to Step 10	--
	Install the I/P carrier. Refer to Instrument Panel		

10	Retainer Replacement. Is the action complete?	Go to Step 11	--
11	Operate the system to verify the repair. Did you find and correct the condition?	System OK	Go to Step 2

Odor Diagnosis

Step	Action	Yes	No
DEFINITION: Noise originating from the HVAC module assembly.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to Step 2	Go to Diagnostic System Check - Vehicle .
2	1. Start the engine. 2. Cycle through all of the following: • Blower motor speeds. • HVAC modes. • Temperature control settings. 3. Determine the type of noise: • Scrape, pop. • Tick/click, chirp or groaning. • Air rush/whistle. Is a scrape or pop noise evident when selecting modes or temperature settings?	Go to Step 6	Go to Step 3
3	Is a tick/click, chirping, groaning or scraping noise present, but decreases as blower motor speed is decreased?	Go to Step 6	Go to Step 4
4	Is an air rush/whistle noise evident in all modes but not all temperature settings?	Go to Step 6	Go to Step 5
5	Is an air rush/whistle noise evident only in defrost or floor mode?	Go to Step 6	Go to Step 6
6	Remove the I/P carrier. Refer to Instrument Panel Retainer Replacement . 1. Inspect the air flow doors for correct operation. 2. Inspect the ducts for obstructions or foreign materials. Were any of these conditions found?	Go to Step 9	Go to Step 7
7	Inspect the mode and temperature doors and seals for warping or cracking. Are the doors in normal condition?	Go to Step 10	Go to Step 8
8	Replace the appropriate door and/or seals. Is the repair complete?	Go to Step 10	--
9	Remove any obstructions or foreign material found. Is the action complete?	Go to Step 10	--
	Install the I/P carrier. Refer to Instrument Panel		

10	Retainer Replacement . Is the action complete?	Go to Step 11	--
11	Operate the system to verify the repair. Did you find and correct the condition?	System OK	Go to Step 2

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Air Conditioning (A/C) Refrigerant Pressure Sensor Replacement

Tools Required

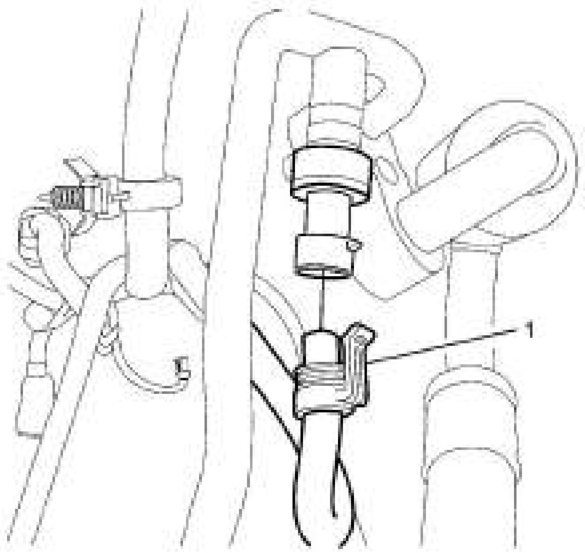
J 39400 Halogen Leak Tester

Removal Procedure

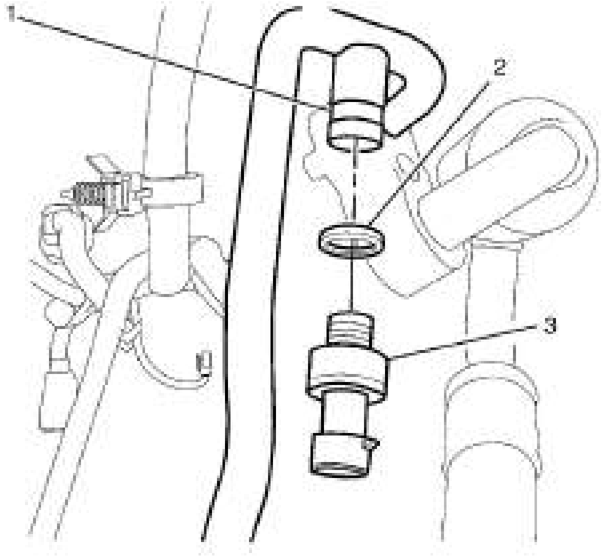
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



2. Disconnect the A/C refrigerant pressure sensor electrical connector (2).



Important: A Schrader valve is fitted to the A/C refrigerant pressure sensor port (1). Upon removal of the A/C refrigerant pressure sensor (3) you will, for a very short period, hear refrigerant escape until the Schrader valve reseats. If refrigerant continues to escape while removing the A/C refrigerant pressure sensor (3) STOP IMMEDIATELY. The Schrader valve has a fault and the refrigerant will have to be recovered.

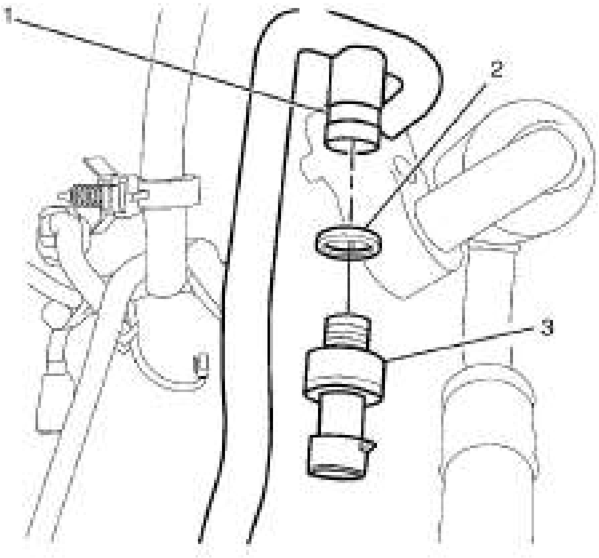
3. Remove the A/C refrigerant pressure sensor (3) from the A/C refrigerant pressure sensor port (1).

   Important: The O-ring seal (2) is a single use item and must be discarded after use.

4. Remove the O-ring seal (2). Refer to O-Ring Replacement .

   Discard the O-ring seal.

Installation Procedure

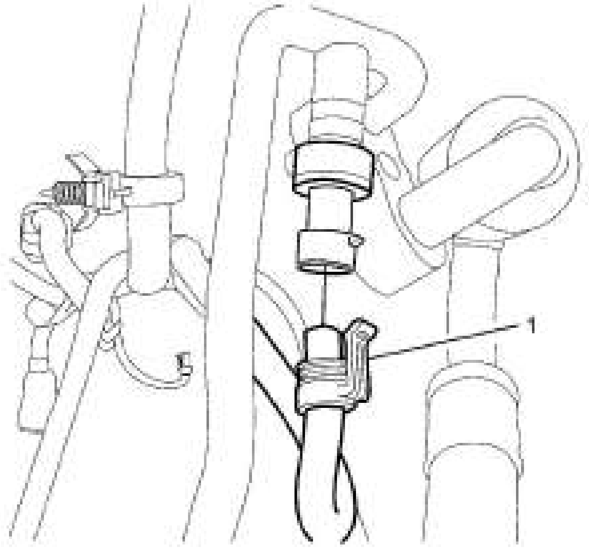


1. Install the NEW O-ring seal (2). Refer to O-Ring Replacement .

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the A/C refrigerant pressure sensor to the A/C refrigerant pressure sensor port (1).

   Tighten
   Tighten the sensor to 6 N·m(53 lb ft).



3. Connect the A/C refrigerant pressure sensor electrical connector (1).
4. Lower the vehicle to the ground.
5. Leak test the fittings of the component using the J 39400 .

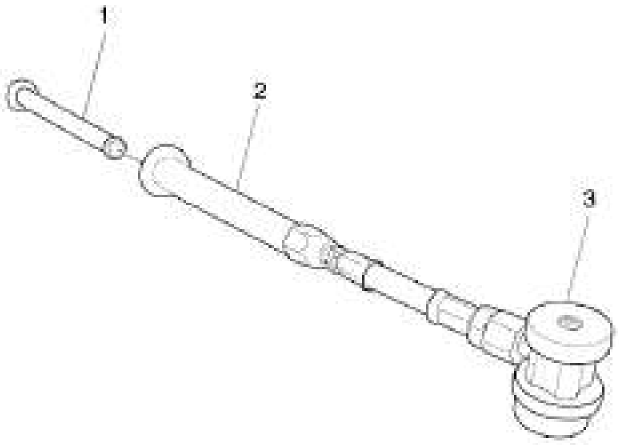
Air Conditioning (A/C) System Oil Charge Replenishing

Tools Required

J 41459 A/C Oil Injector

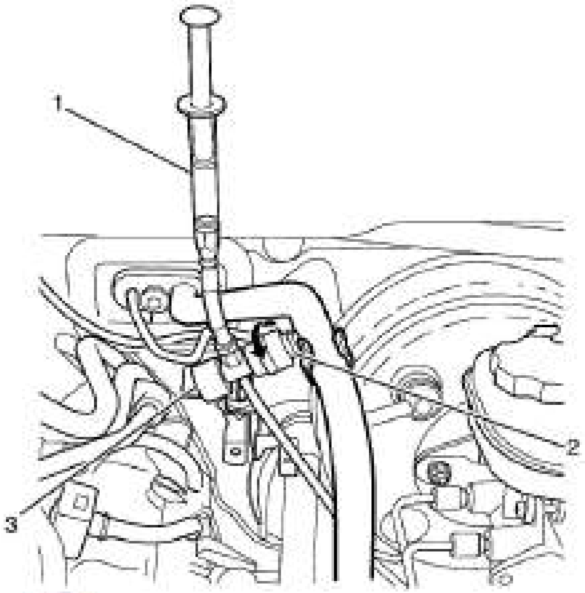
Important: The addition of lubricating oil must be carried out whenever any component is replaced in the A/C system to compensate for oil trapped in the removed component. Carrying out this procedure ensures the A/C system always has the correct amount of oil as specified by the manufacturer.

1. Evacuate the A/C system for a minimum of 30 minutes and to minus 100 kPa negative gauge pressure. Refer to Refrigerant Recovery and Recharging.



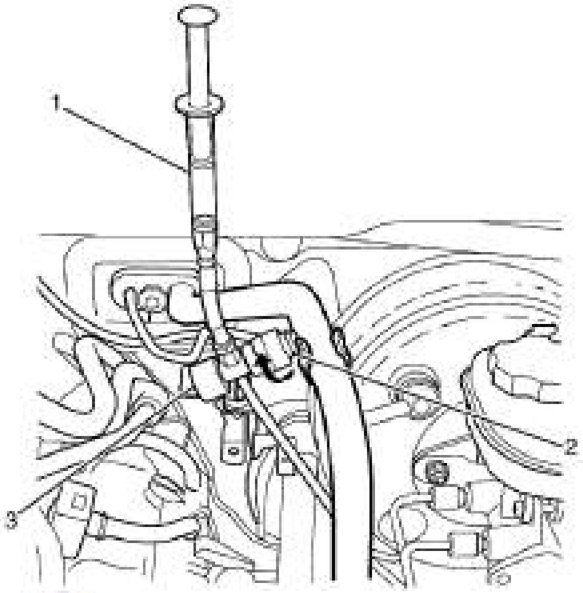
Important: Make sure the valve (3) is in the closed position.

2. Remove the plunger (1) from the J 41459 (2) and pour in the appropriate amount of polyalkylene glycol (PAG) oil specified for the replaced component. Refer to Refrigerant System Capacities.
3. Jiggle the plunger (1) to remove any air in the J 41459 (2).



4. With the A/C system still evacuated, connect the J 41459 (1) to the low side charging port (2).
5. Turn the J 41459 shut off valve tap (3) to the open position to depress the low side charging port (2) schrader valve.

   The oil should now be drawn into the A/C system due to the low pressure in the A/C system.



6. Once all the oil in the J 41459 (1) has moved into the A/C system, turn the shut off valve tap (3) to the closed position.
7. Remove the J 41459 (1) from the low side charging port (2).
8. Repeat steps 2 to 7 if more oil is required.

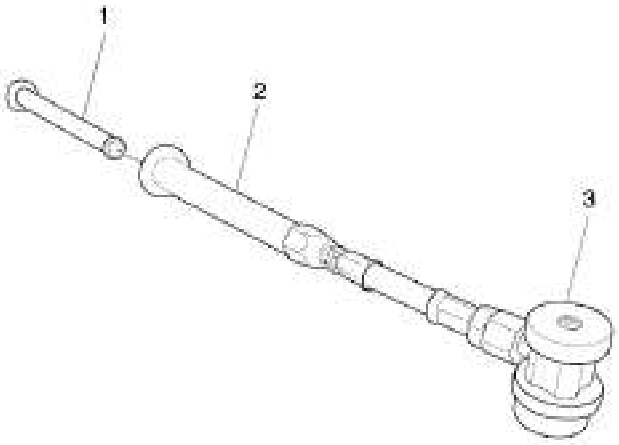
Air Conditioning Clutch Coil Replacement

Tools Required

J 41459 A/C Oil Injector

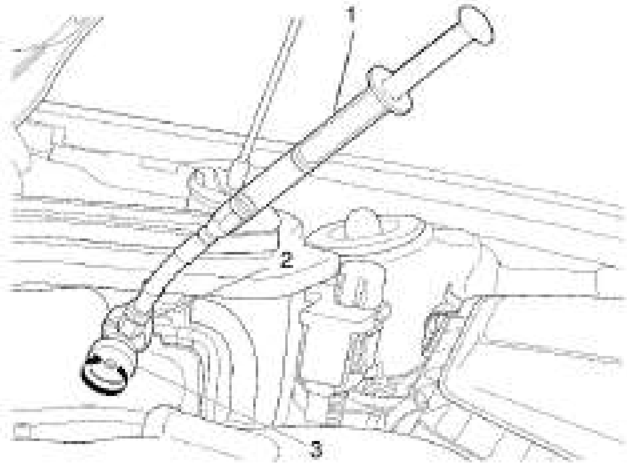
> **Important:** The addition of lubricating oil must be carried out whenever any component is replaced in the A/C system to compensate for oil trapped in the removed component. Carrying out this procedure ensures the A/C system always has the correct amount of oil as specified by the manufacturer.

1. Evacuate the A/C system for a minimum of 30 minutes and to minus 100 kPa negative gauge pressure. Refer to Refrigerant Recovery and Recharging.



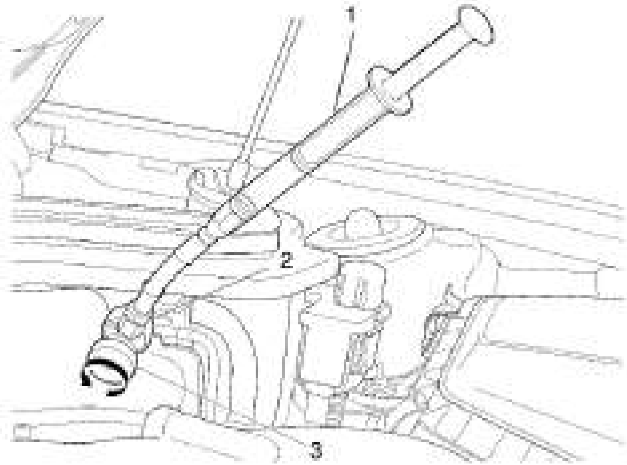
> **Important:** Make sure the valve (3) is in the closed position.

2. Remove the plunger (1) from the J 41459 (2) and pour in the appropriate amount of polyalkylene glycol (PAG) oil specified for the replaced component. Refer to Refrigerant System Capacities.
3. Jiggle the plunger (1) to remove any air in the J 41459 (2).



4. With the A/C system still evacuated, connect the J 41459 (1) to the low side charging port (2).
5. Turn the J 41459 shut off valve tap (3) to the open position to depress the low side charging port (2) schrader valve.

   The oil should now be drawn into the A/C system due to the low pressure in the A/C system.



6. Once all the oil in the J 41459 (1) has moved into the A/C system, turn the shut off valve tap (3) to the closed position.
7. Remove the J 41459 (1) from the low side charging port (2).
8. Repeat steps 2 to 7 if more oil is required.

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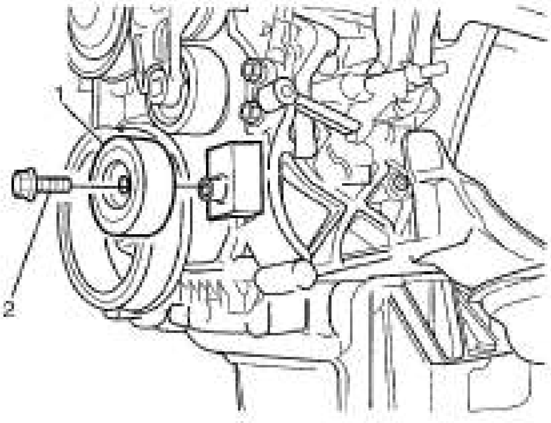
Air Conditioning Compressor Bracket Replacement (3.6L Engine)

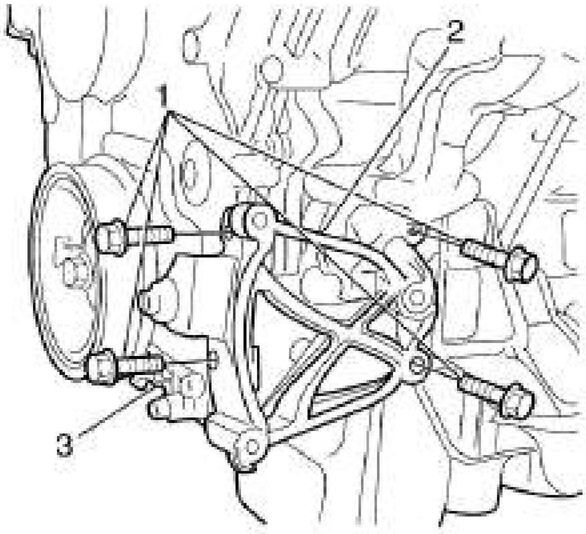
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Remove the compressor. Refer to Air Conditioning Compressor Replacement.

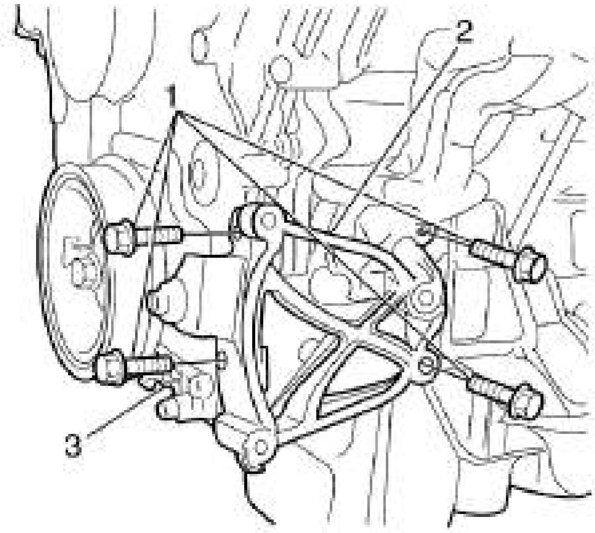


2. Remove the compressor drive belt idler pulley to compressor mounting bracket retaining bolt (2).
3. Remove the compressor drive belt idler pulley (1).



4. Remove the compressor mounting bracket to cylinder block retaining bolts (1).
5. Remove the compressor mounting bracket (2) from the cylinder block (3).

Installation Procedure

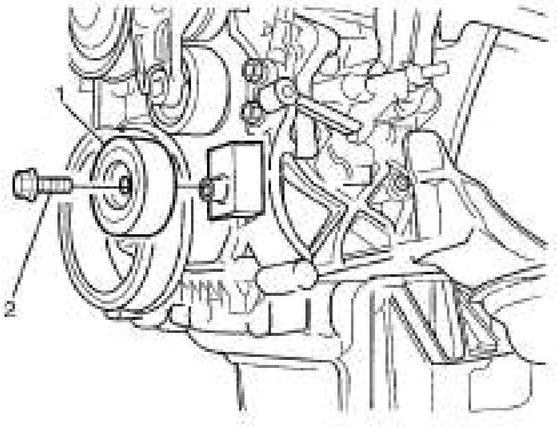


1. Position the compressor mounting bracket (2) to the cylinder block (3).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the compressor mounting bracket to cylinder block retaining bolts (1).

   Tighten
   Tighten the bolts to 58 N·m (43 lb ft).



3. Install the compressor drive belt idler pulley (1).
4. Install the compressor drive belt idler pulley to compressor mounting bracket retaining bolt (2).

   Tighten
   Tighten the bolt to 58 N·m (43 lb ft).

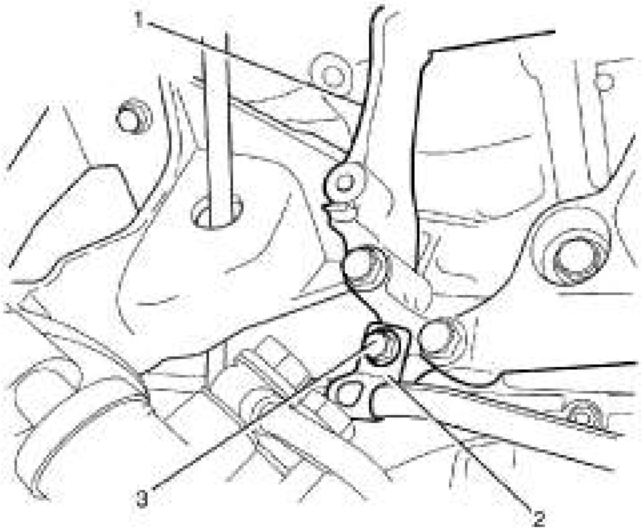
5. Install the compressor. Refer to Air Conditioning Compressor Replacement.

Air Conditioning Compressor Bracket Replacement (6.0L Engine)

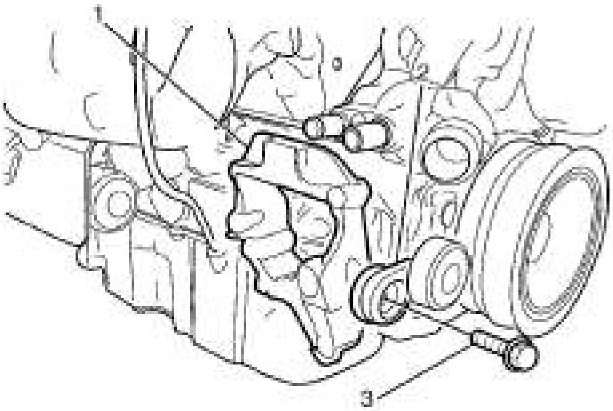
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

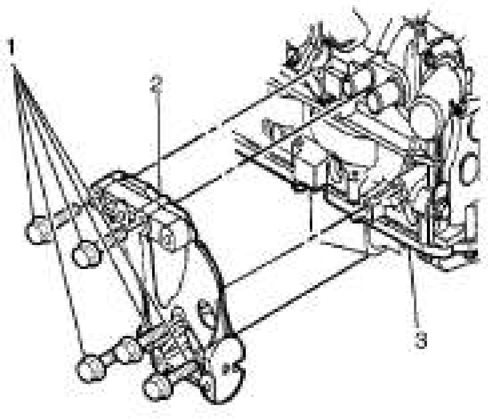
1. Remove the compressor. Refer to Air Conditioning Compressor Replacement.



2. Remove the automatic transmission cooler pipe clamp to A/C bracket retaining bolt (3) if fitted.
3. Position the automatic transmission cooler pipe retaining bracket (2) if fitted, away from the compressor mounting bracket (1).

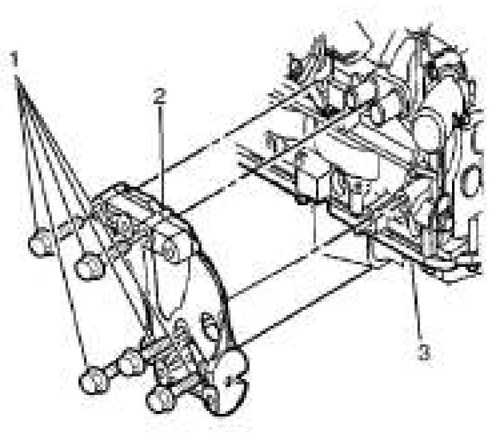


4. Remove the compressor drive belt tensioner to compressor mounting bracket retaining bolt (3).
5. Remove drive belt tensioner (2) from compressor mounting bracket (1).



6. Remove the compressor mounting bracket to cylinder block retaining bolts (1).
7. Remove the compressor bracket (2) from the cylinder block (3).

Installation Procedure

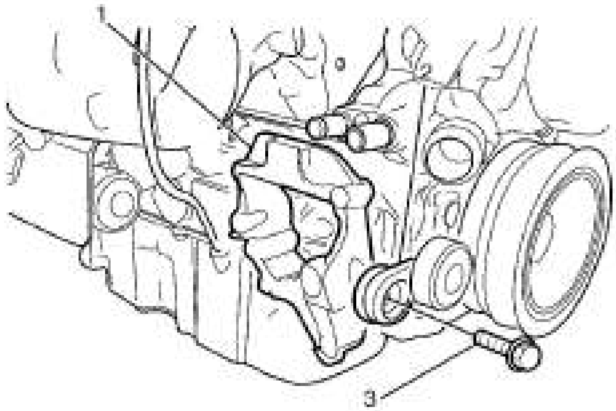


1. Position the compressor mounting bracket (2) to the cylinder block (3).

Notice: Refer to Fastener Notice in the Preface section.

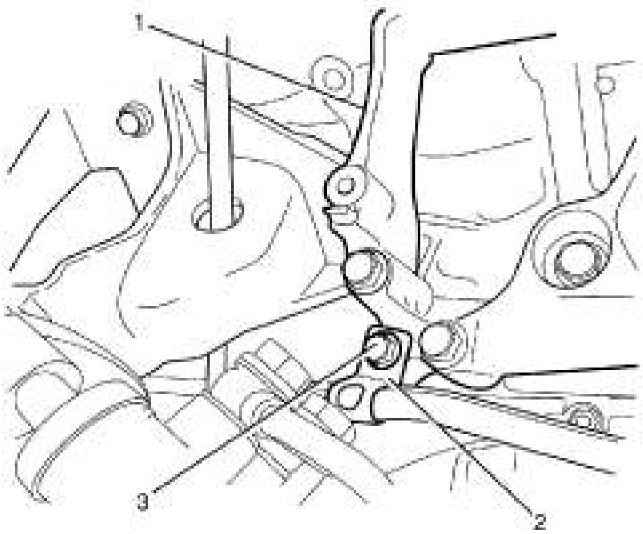
2. Install the compressor mounting bracket to cylinder block retaining bolts (1).

Tighten
Tighten the bolts to 58 N·m (43 lb ft).



3. Position the compressor drive belt tensioner (2) to the compressor mounting bracket (1).
4. Install the compressor drive belt tensioner to compressor mounting bracket retaining bolt (3).

Tighten
Tighten the bolts to 58 N·m (43 lb ft).



5. Position the automatic transmission cooler pipe retaining bracket (2) on the compressor mounting bracket (1) if fitted.
6. Install the automatic transmission cooler pipe clamp to A/C bracket retaining bolt (3).

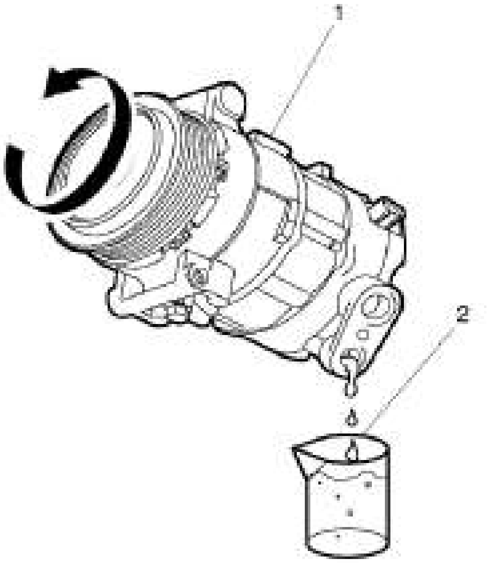
   Tighten
   Tighten the bolt to 22 N·m (16 lb ft).

7. Install the compressor. Refer to Air Conditioning Compressor Replacement.

Air Conditioning Compressor Oil Balancing

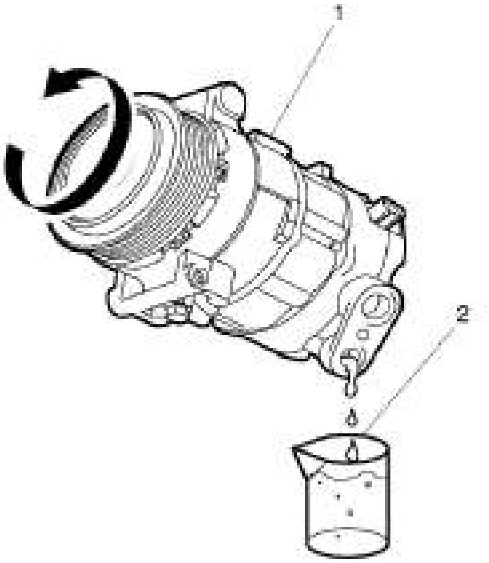
Draining Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.



Important: Rotate the compressor (1) while draining to assist in polyalkylene glycol (PAG) oil removal.

1. Drain and measure the PAG oil from the original compressor (1) into a clean, graduated container (2).
2. Record the amount of PAG oil drained from the removed compressor (1). This measurement will be used during installation of the replacement compressor.
3. Correctly discard the used PAG oil.
4. Clean the graduated cylinder.

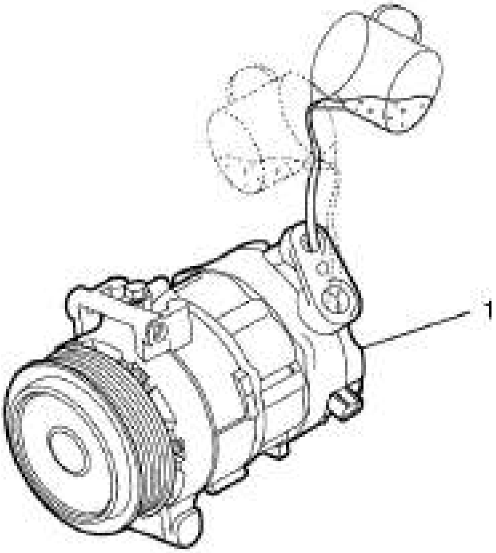


Important: Drain and measure as much of the PAG oil as possible from the NEW compressor (1).

Important: Rotate the compressor (1) while draining to assist in PAG oil removal.

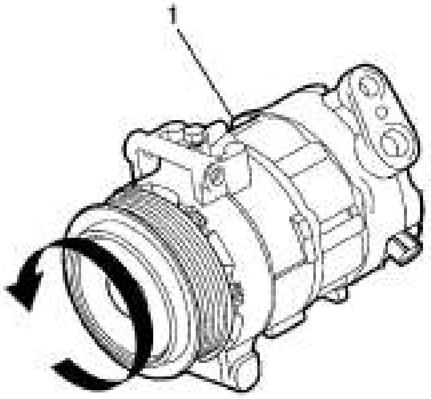
5. Drain the PAG oil from the NEW compressor (1) into a clean, graduated container (2).

Balancing Procedure



Important: If the amount of PAG oil recorded from the removed compressor is less than 60 ml (2.0 fl. oz), disregard the recorded amount and pour a total of 60 ml (2.0 fl. oz) of the NEW PAG oil back into the NEW compressor (1).

1. Add back the same quantity of PAG oil to the NEW compressor (1) that was recorded from the removed compressor.



2. Rotate the NEW compressor (1) three times to lubricate the internal compressor components.
3. If necessary, refer to Refrigerant System Capacities.

Air Conditioning Compressor Replacement (3.6L Engine)

Tools Required

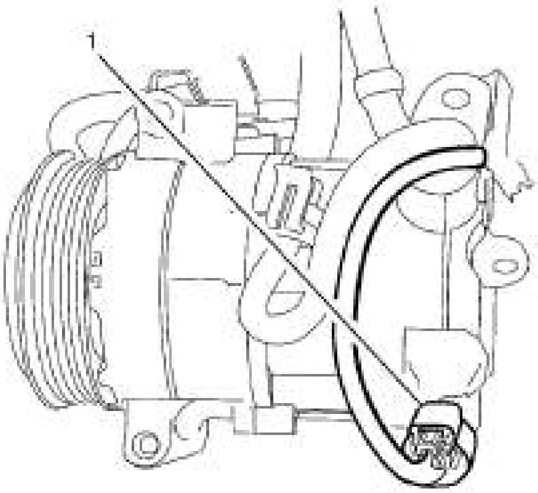
J 39400 Halogen Leak Tester

Removal Procedure

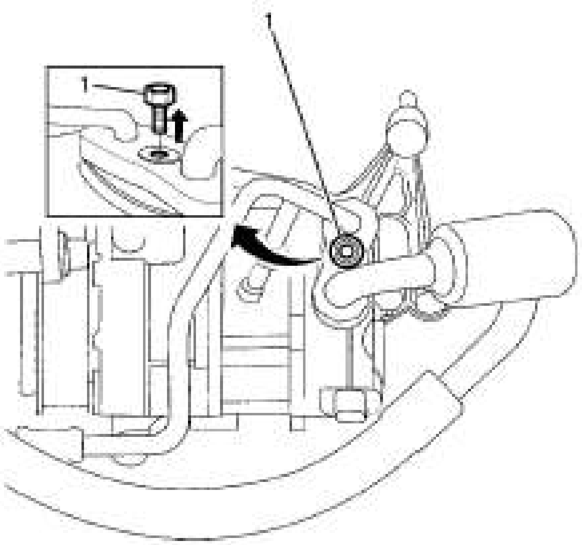
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Battery Disconnect Caution in the Preface section.

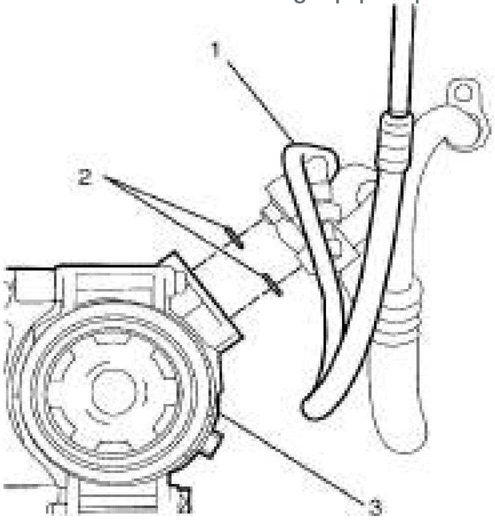
1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection .
2. Recover the refrigerant. Refer to Refrigerant Recovery and Recharging .
3. Remove the air filter assembly. Refer to Air Cleaner Assembly Replacement .
4. Remove the accessory drive belt or air conditioning drive belt. Refer to Drive Belt Replacement .



5. Disconnect the compressor electrical connector (1).



6. Remove the suction/discharge pipes pad to compressor retaining bolt (1).



7. Disconnect the suction/discharge pipe pad (1) from the compressor (3).

Important: The sealing washers (2) are a single use item and must be discarded after use.

8. Remove the sealing washers (2). Refer to Sealing Washer Replacement .

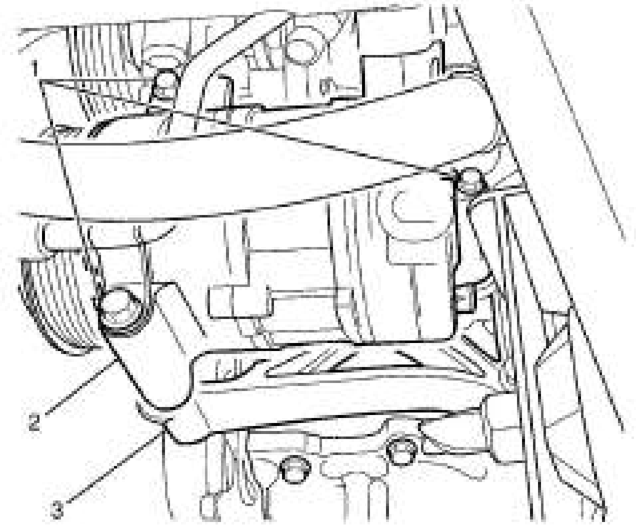
   Discard the sealing washers.

   Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

9. Cap or plug the suction/discharge pipe pad (1) and the ports on the compressor (3).

Caution: Refer to Vehicle Lifting Caution in the Preface section.

10. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



Important: The compressor (2) must be supported before removing the compressor to compressor mounting bracket retaining bolts (1).

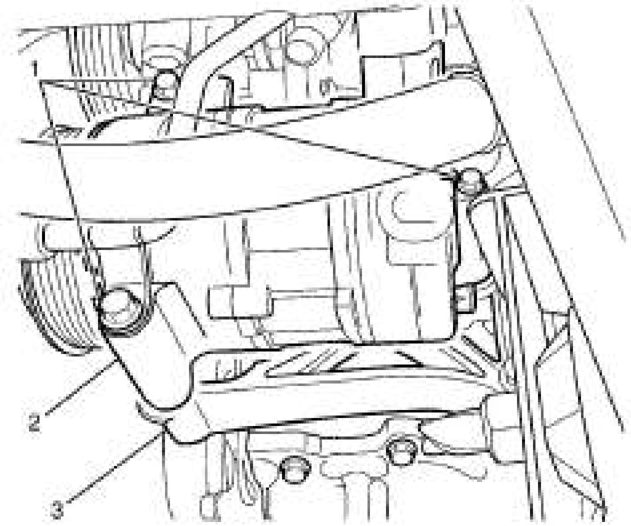
11. Remove the compressor to compressor mounting bracket retaining bolts (1).

Important: Remove the compressor (2) from the compressor mounting bracket (3) by sliding forwards and then upwards out of the engine compartment.

12. Remove the compressor (2) from compressor mounting bracket (3).

Installation Procedure

1. If you are replacing the compressor, balance the compressor oil. Refer to Air Conditioning Compressor Oil Balancing .



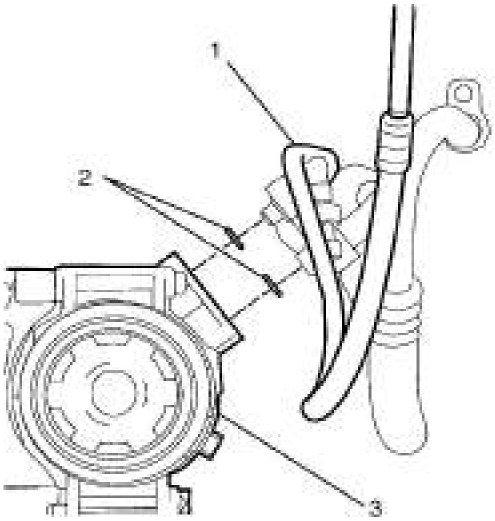
2. Install the compressor (2) to the compressor mounting bracket (3).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the compressor to compressor mounting bracket retaining bolts (1).

   Tighten
   Tighten the bolts to 22 N·m (16 lb ft).

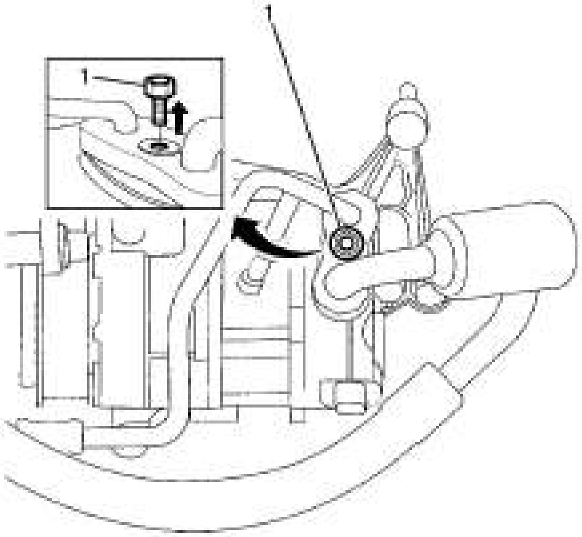
4. Lower the vehicle.



5. Remove the plugs or caps from the suction/discharge pipe pad (1) and the ports on the compressor (3).

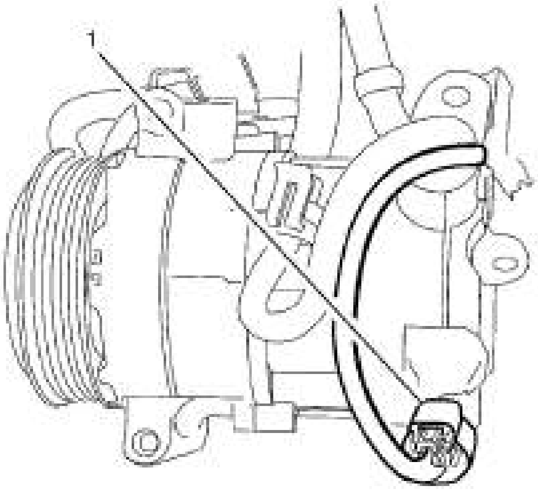
Important: DO NOT coat the NEW sealing washers (2) with oil, they must be fitted dry. The use of mineral oil will render the sealing washers (2) useless, as the sealing washers (2) WILL swell causing refrigerant to leak out.

6. Install two NEW sealing washers (2). Refer to Sealing Washer Replacement .
7. Connect the suction/discharge pipes (1) to the compressor (3).



8. Install the suction/discharge pipe pad to compressor retaining bolt (1).

Tighten
Tighten the bolt to 22 N·m (16 lb ft).



9. Install the compressor electrical connector (1).

10. Install the accessory drive belt or air conditioning drive belt. Refer to Drive Belt Replacement .
11. Install the air filter assembly. Refer to Air Cleaner Assembly Replacement .
12. Evacuate and recharge the refrigerant system. Refer to Refrigerant Recovery and Recharging .
13. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection l.
14. Leak test the fitting of the repaired or reinstalled component using the J 39400 .

Air Conditioning Compressor Replacement (6.0L Engine)

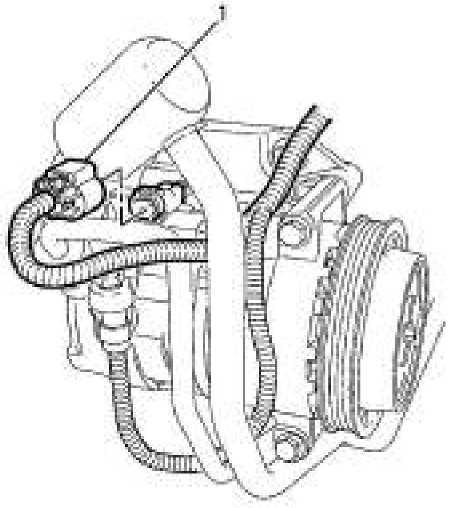
Tools Required

J 39400 Halogen Leak Tester

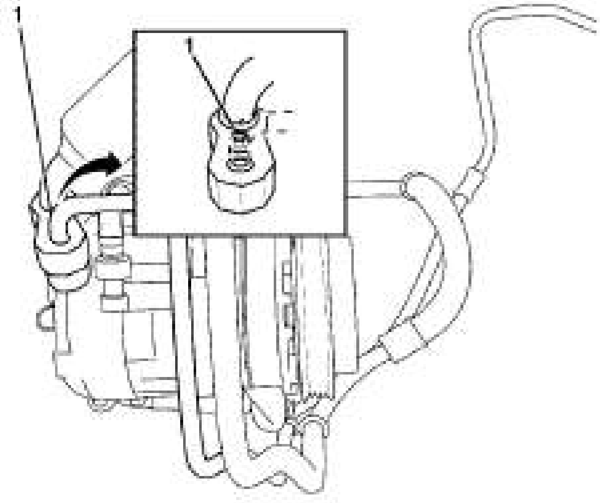
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

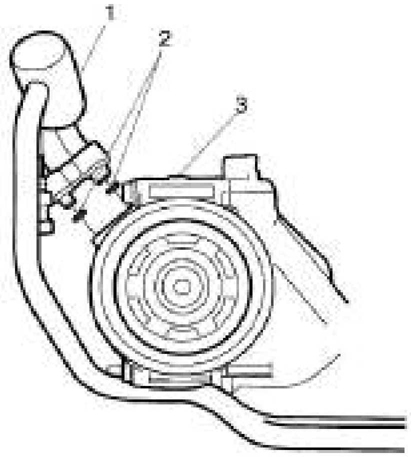
1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Recover the refrigerant. Refer to Refrigerant Recovery and Recharging.
3. Remove the radiator air deflector. Refer to Cooling Fan and Shroud Replacement.
4. Remove the air filter assembly. Refer to Air Cleaner Assembly Replacement.
5. Remove the A/C drive belt. Refer to Air Conditioning Compressor Belt Replacement.



6. Disconnect the compressor electrical connector (1).



7. Remove the suction/discharge pipes pad to compressor retaining bolt (1).



8. Disconnect the suction/discharge pipes (1) from the compressor (3).

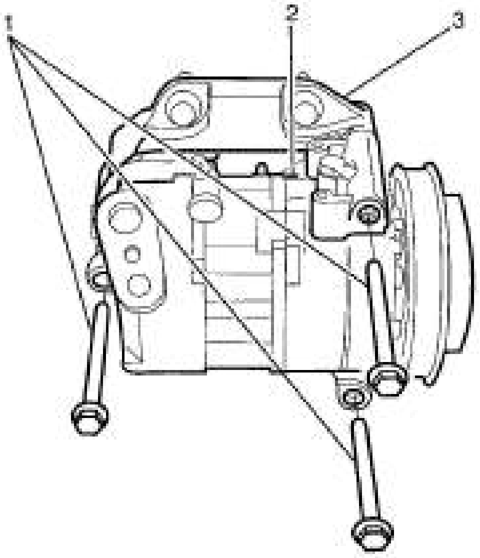
Important: The sealing washers (2) are a single use item and must be discarded after use.

9. Remove the sealing washers (2). Refer to Sealing Washer Replacement .

   Discard the sealing washers

   Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

10. Cap or plug the suction/discharge pipes (1) and the ports on the compressor (3).



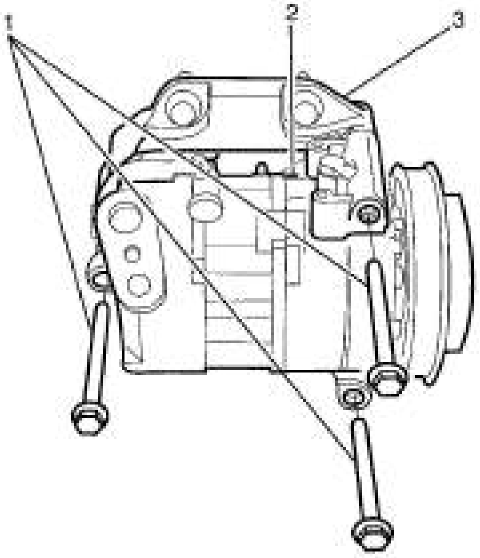
11. Remove the compressor to compressor bracket retaining bolts (1).

    Important: Remove the compressor (2) from the compressor mounting bracket (3) by sliding forwards and than tilting upwards out of the engine compartment.

12. Remove the compressor (2) from the compressor bracket (3).

Installation Procedure

1. If you are replacing the compressor, balance the compressor oil. Refer to Air Conditioning Compressor Oil Balancing.

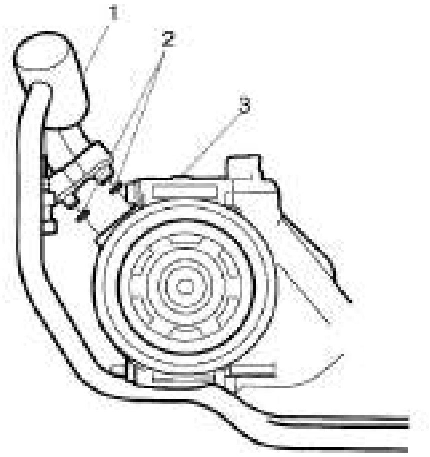


2. Install the compressor (2) to the compressor mounting bracket (3).

Notice: Refer to Fastener Notice in the Preface section.

3. Install the compressor to compressor mounting bracket retaining bolts (1).

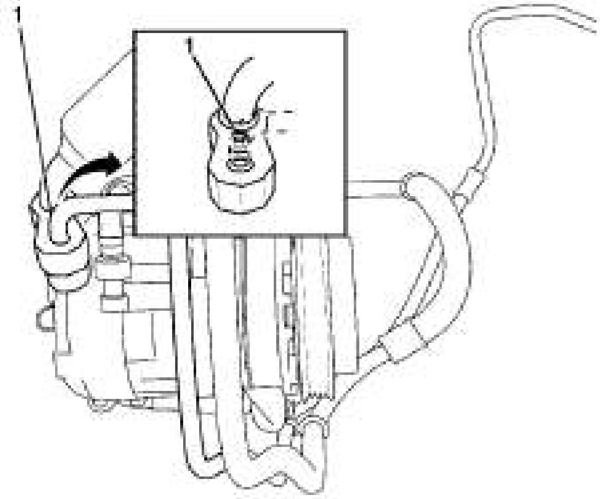
   Tighten
   Tighten the bolts to 22 N·m (16 lb ft).



4. Remove the plugs or caps from the suction/discharge pipes (1) and the ports on the compressor (3).

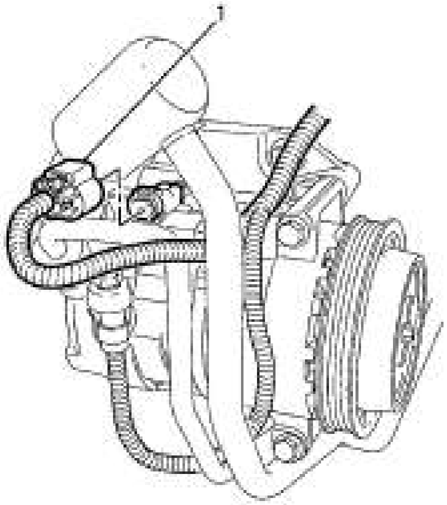
   Important: DO NOT coat the NEW sealing washers (2) with oil, they must be fitted dry. The use of mineral oil will render the sealing washers (2) useless, as the sealing washers (2) WILL swell causing refrigerant to leak out.

5. Install two NEW sealing washers (2). Refer to Sealing Washer Replacement.
6. Connect the suction/discharge pipes (1) to the compressor (3)



7. Install the suction/discharge pipes pad to compressor retaining bolt (1).

   Tighten
   Tighten the bolt to 22 N·m (16 lb ft).



8. Connect the compressor electrical connector (1).
9. Install the drive belt, Refer to Air Conditioning Compressor Belt Replacement.
10. Install the radiator air deflector. Refer to Cooling Fan and Shroud Replacement.
11. Install the air filter assembly. Refer to Air Cleaner Assembly Replacement.
12. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
13. Evacuate and recharge the refrigerant system. Refer to Refrigerant Recovery and

Recharging.

14. Leak test the fitting of the repaired or reinstalled component using the J 39400 .

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Air Conditioning Condenser Replacement

Tools Required

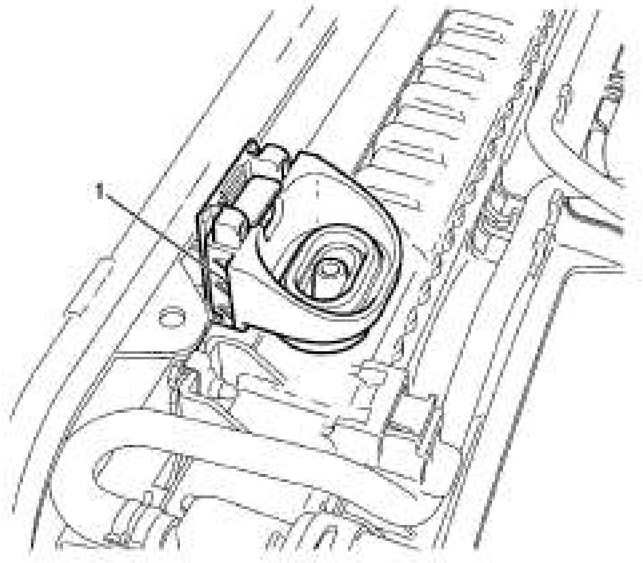
J 39400 Halogen Leak Detector

Removal Procedure

1. Remove the air filter assembly. Refer to Air Cleaner Assembly Replacement for 3.6L engine, or Air Cleaner Assembly Replacement for 6.0L engine.
2. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement

   Caution: Refer to Safety Glasses Caution in the Preface section.

3. Recover the refrigerant. Refer to Refrigerant Recovery and Recharging .

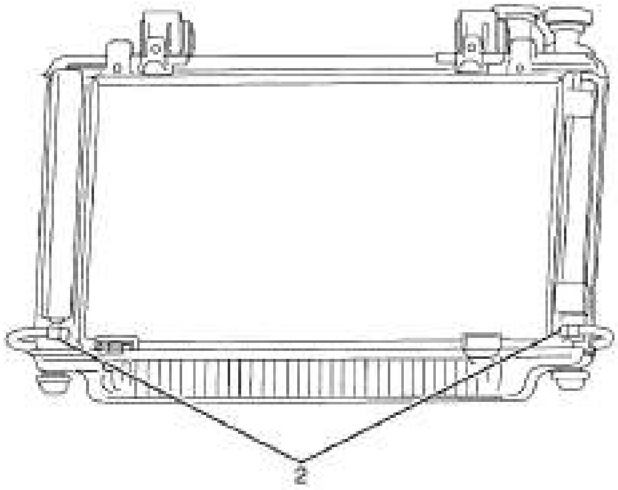


Important: Remove the upper radiator support brackets by raising the securing lock upwards 10mm and slide the bracket out of the radiator slide pin.

4. Remove the upper radiator support brackets (1).

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

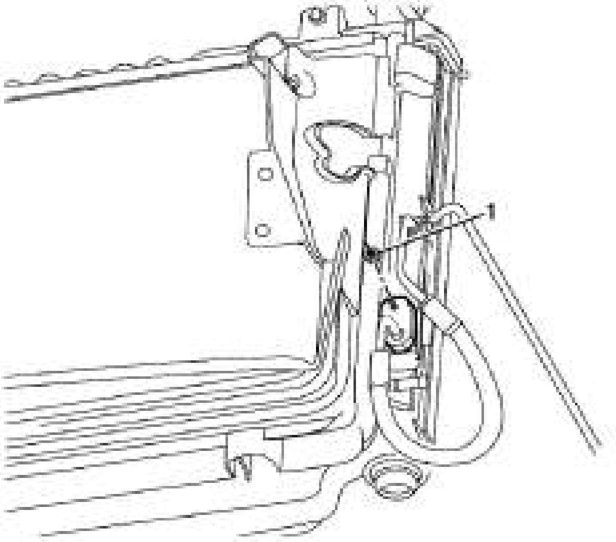
5. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
6. Remove the air deflector front. Refer to Front Air Deflector Replacement.
7. Place a large suitable container under the condenser.



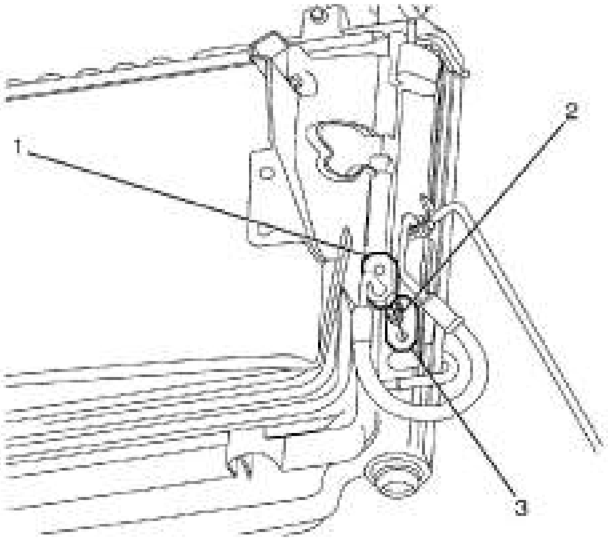
8. Disconnect the power steering cooler hoses (1).

Important: Plug or cap the power steering cooler hose (1) ends to prevent leaks and/or contamination.

9. Plug or cap the power steering cooler hose (1) ends.



10. Remove the liquid pipe to the condenser port retaining nut (1).
11. Lower the vehicle.



12. Disconnect the liquid pipe (1) from the condenser port (3).

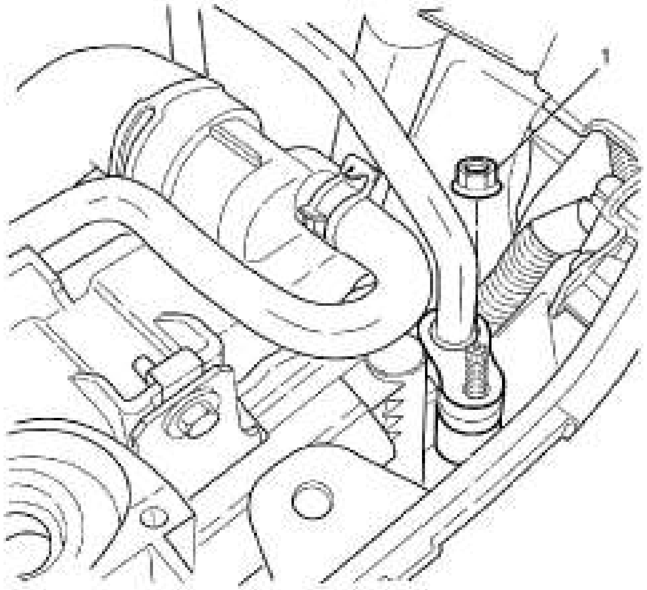
    Important: The sealing washer (2) is a single use item and must be discarded after use.

13. Remove the sealing washer (2). Refer to Sealing Washer Replacement.

    Discard the sealing washer

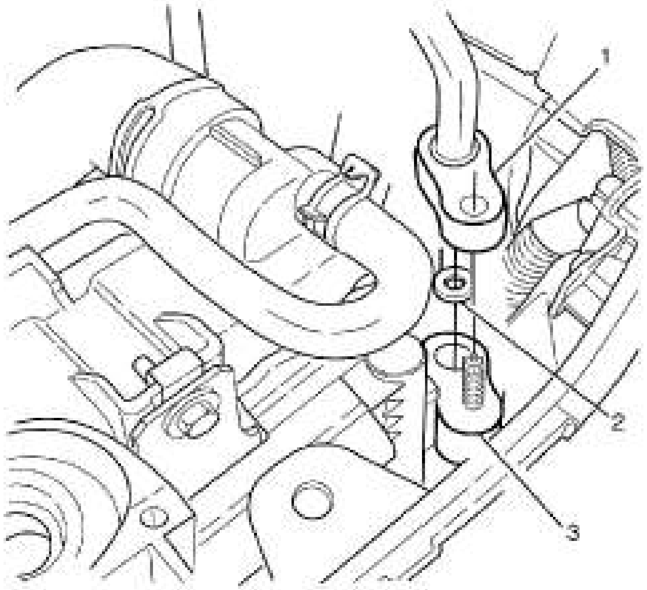
    Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

14. Cap or plug the liquid pipe (1) and the condenser port (3).
15. Lower the vehicle.



Important: Gently push the radiator and condenser towards the engine to allow removal of the discharge pipe to condenser retaining nut (1).

16. Remove the discharge pipe to condenser retaining nut (1).

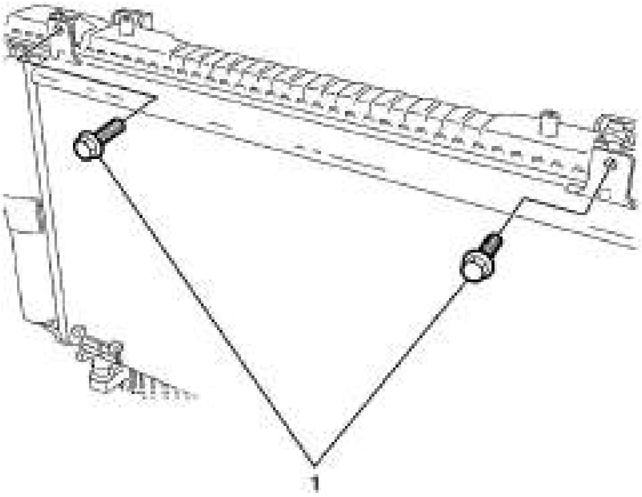


17. Disconnect the discharge pipe (1) from condenser (3) and position aside.
18. Remove the sealing washer (2). Refer to Sealing Washer Replacement.

Discard the sealing washer.

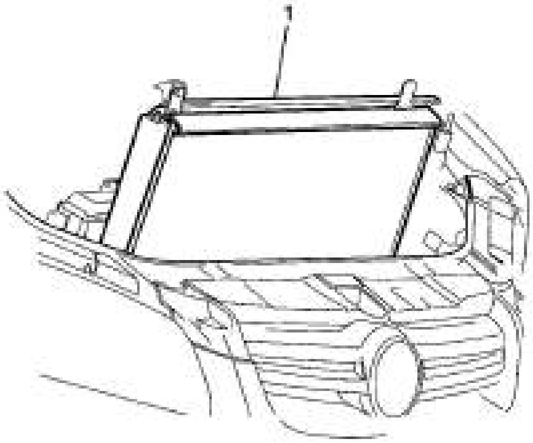
Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

19. Cap or plug the discharge pipe (1) and the condenser (3).



Important: Gently push the radiator and condenser towards the engine to allow removal of the condenser to radiator retaining bolts (1).

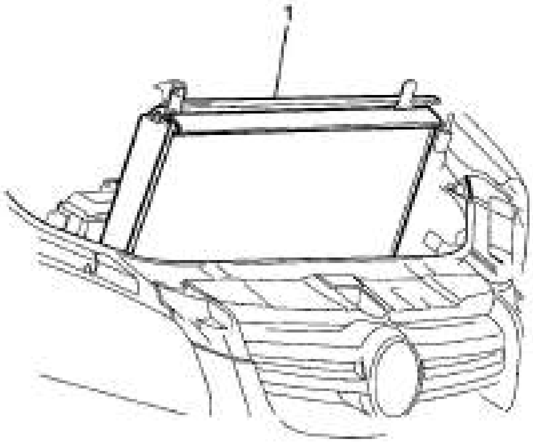
20. Remove the condenser to radiator retaining bolts (1).



Important: Remove the condenser (1) by lifting it up between the radiator and radiator support.

21. Remove the condenser (1) from the engine compartment.

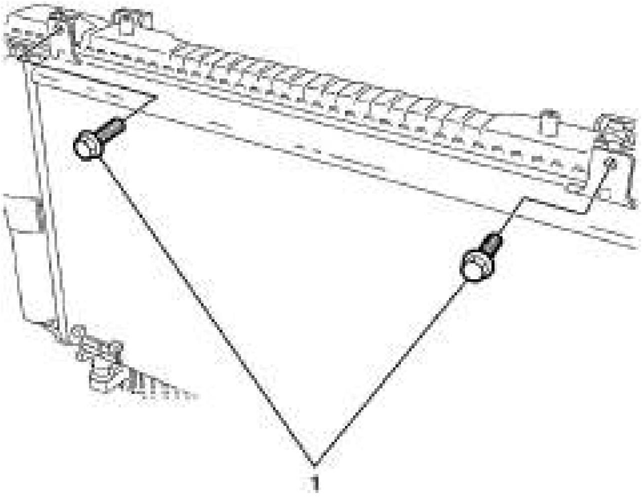
Installation Procedure



Important: Install the condenser (1) by lowering down between the radiator and radiator support.

1. Install the condenser (1) to the engine compartment.

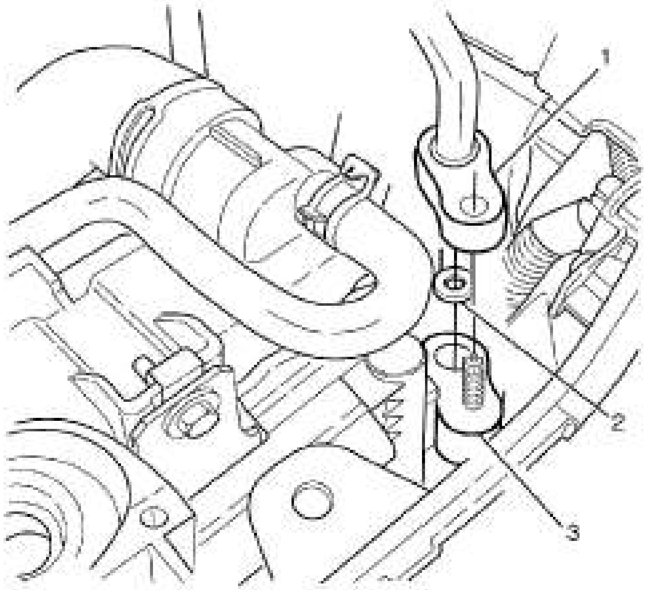
   Notice: Refer to Fastener Notice in the Preface section.



Important: Gently push the radiator and condenser towards the engine to allow installation of the condenser to radiator retaining bolts (1).

2. Install the condenser to radiator retaining bolts (1).

   Tighten
   Tighten the bolts to 11 N·m (97 lb in).

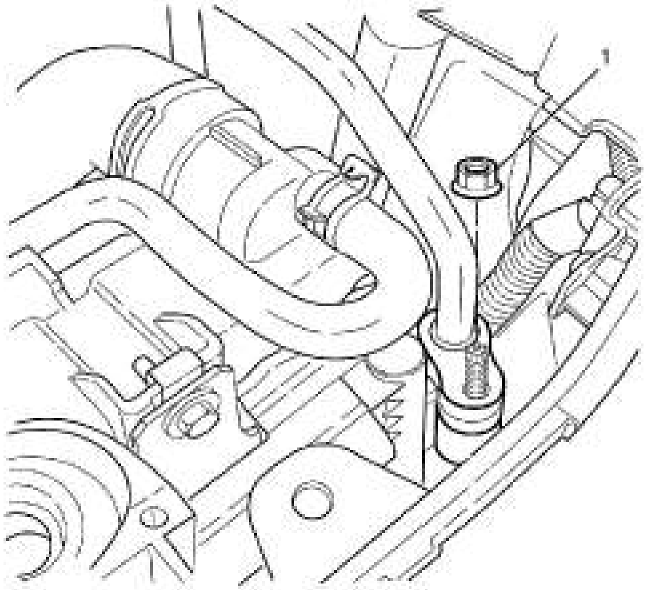


3. Remove the plugs or caps from the discharge pipe (1) and the condenser (3).

   Important: DO NOT coat the NEW sealing washer (2) with oil, they must be fitted dry. The use of mineral oil will render the sealing washer (2) useless, as the sealing washer (2) WILL swell causing refrigerant to leak out.

4. Install a NEW sealing washer (2). Refer to Sealing Washer Replacement.
5. Install the discharge pipe (1) to condenser (3).

   Notice: Refer to Fastener Notice in the Preface section.

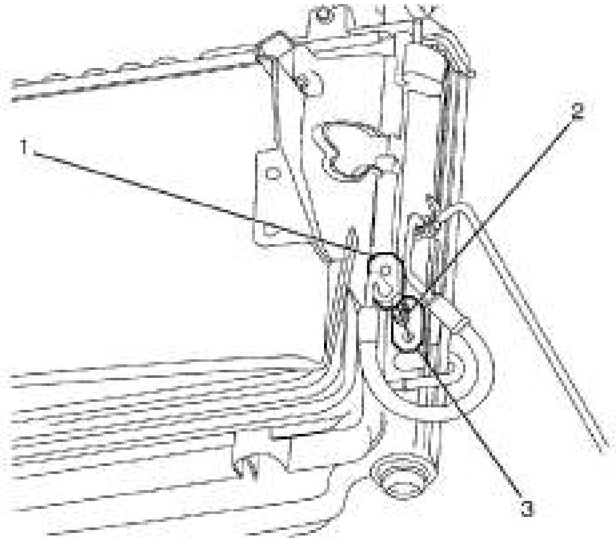


Important: Gently push the radiator and condenser towards the engine to allow installation of the discharge pipe to condenser retaining nut (1).

6. Install the discharge pipe to condenser retaining nut (1).

   Tighten
   Tighten the nut to 22 N·m(16 lb ft).

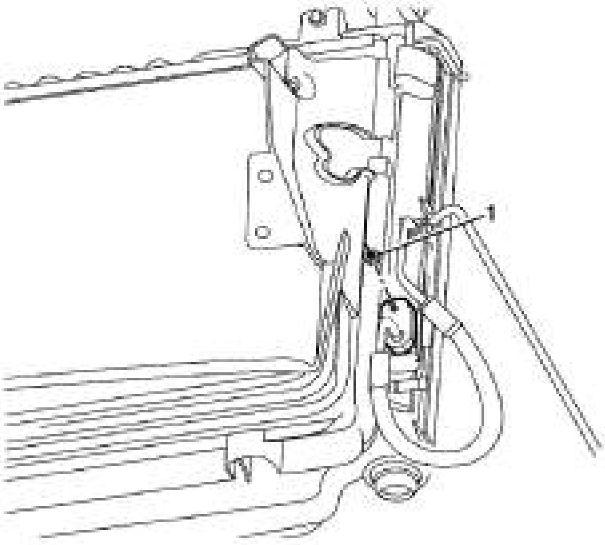
7. Raise the vehicle.



8. Remove the plugs or caps from the suction pipe liquid pipe (1) and the condenser port (3).

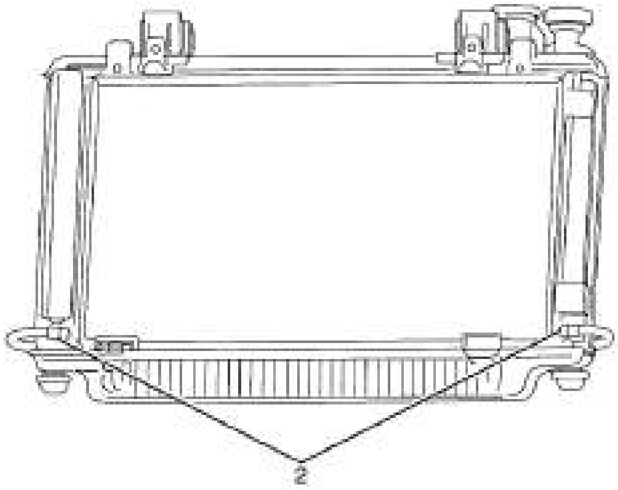
   Important: DO NOT coat the NEW sealing washer (3) with oil, they must be fitted dry. The use of mineral oil will render the sealing washer (3) useless, as the sealing washer (3) WILL swell causing refrigerant to leak out.

9. Install a NEW sealing washer (3). Refer to Sealing Washer Replacement.
10. Connect the liquid pipe (1) to the condenser port (3).

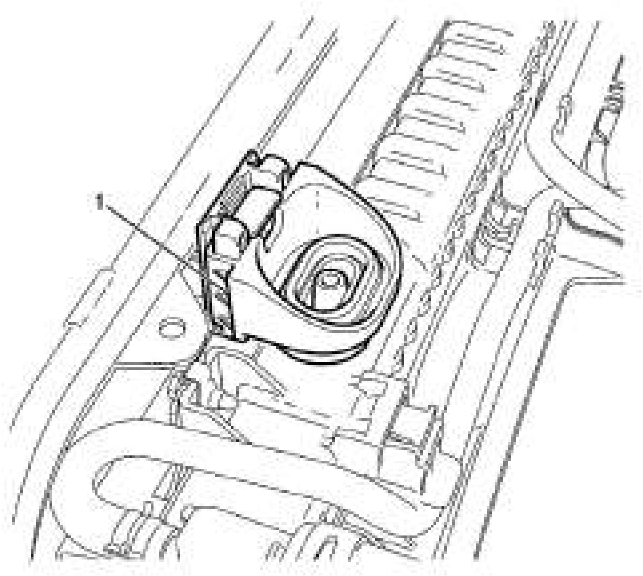


11. Install the liquid pipe to condenser port retaining nut (1).

Tighten
Tighten the nut to 22 N·m(16 lb ft).



12. Remove the plug or cap at the power steering cooler hose (1) ends.
13. Connect the power steering cooler hoses (1).
14. Install the air deflector front. Refer to Front Air Deflector Replacement.
15. Lower the vehicle.



16. Install radiator upper retaining brackets (1).
17. Fill the power steering fluid reservoir as necessary. Refer to Checking and Adding Power Steering Fluid.
18. Evacuate and recharge the A/C system. Refer to Refrigerant Recovery and Recharging.
19. Install the air filter assembly. Refer to Air Cleaner Assembly Replacement for 3.6L engine, or Air Cleaner Assembly Replacement for 6.0L engine.
20. Leak test the fittings of the component using J 39400 .
21. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.

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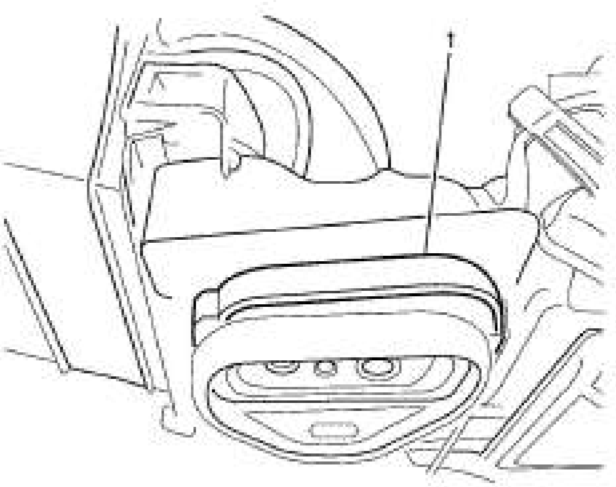
Air Conditioning Evaporator Core Replacement (RHD)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

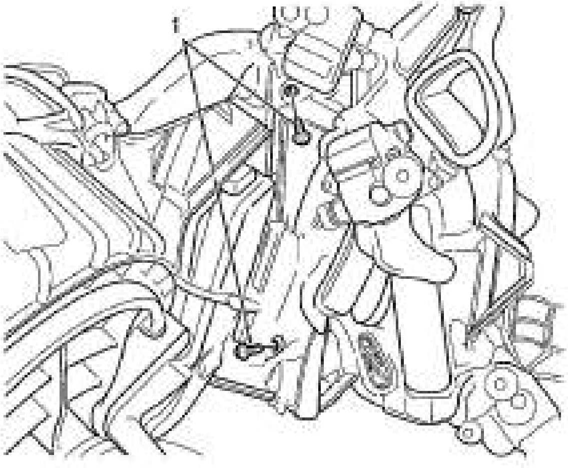
1. Remove the HVAC module assembly. Refer to HVAC Module Assembly Replacement.



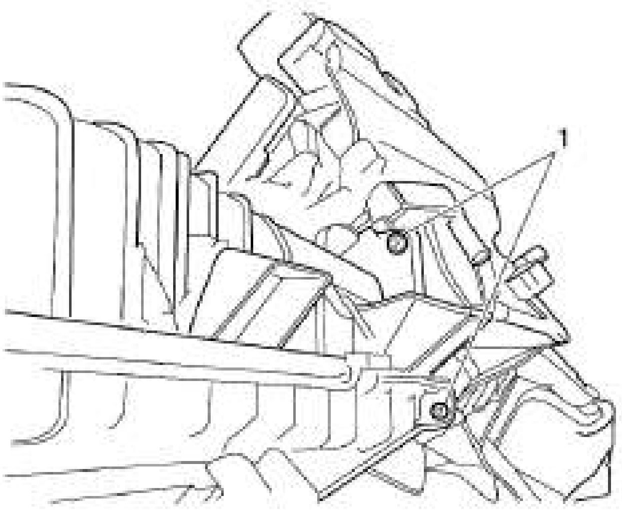
2. With the HVAC module assembly on a bench locate the thermal expansion (TX) valve retaining upper plastic cover (1).

   Important: Unclip the TX valve retaining upper plastic cover (1) and remove by lifting upwards.

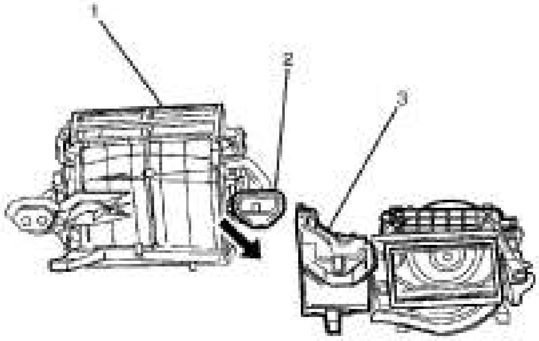
3. Remove the TX valve retaining upper plastic cover (1).



4. Remove the air inlet assembly to HVAC module assembly retaining screws (1).

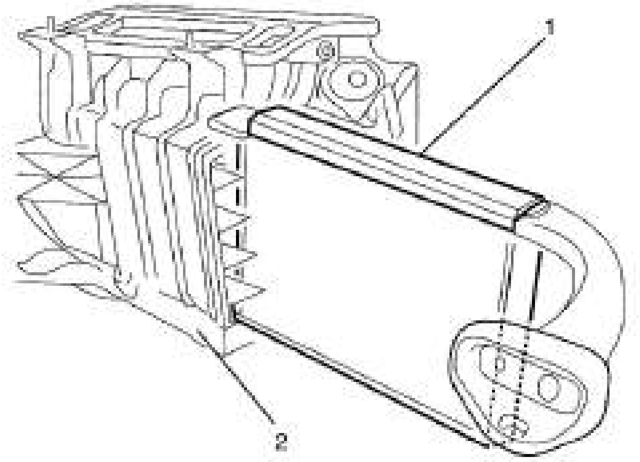


5. Remove the air inlet assembly to HVAC module assembly retaining screws (1).



Important: Unclip the air inlet assembly (3) and carefully tilt downwards past the TX valve (2)

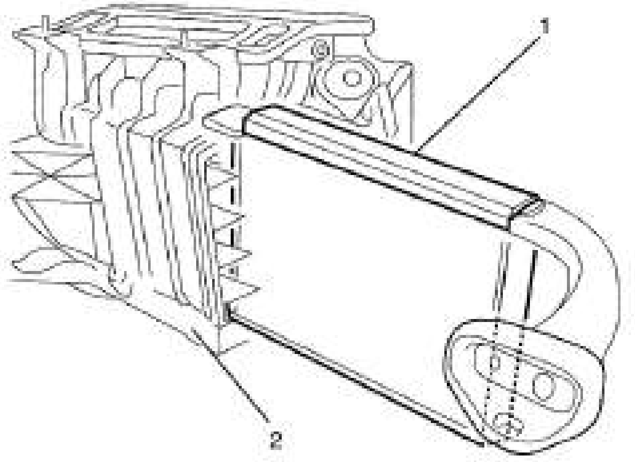
6. Remove the air inlet assembly (3) from the HVAC module assembly (1).



Important: Gently grasp the evaporator (1) pipes and slowly withdraw the evaporator from the HVAC module assembly (2).

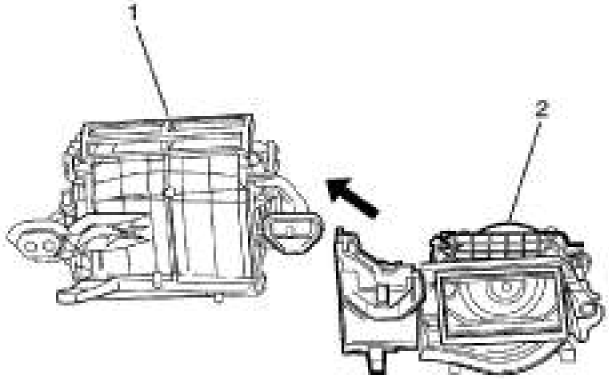
7. Remove the evaporator (1) from the HVAC module assembly (2).
8. While the evaporator (1) is out of the HVAC module assembly (2), remove any contaminates from the housing such as hair, leaves or dust with a moist rag.

Installation Procedure



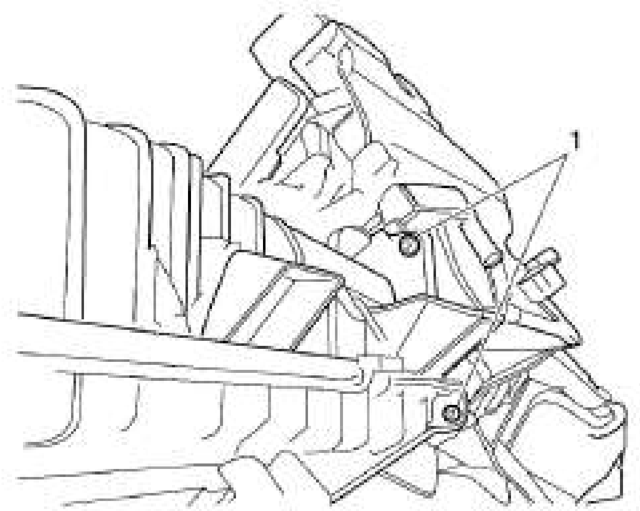
Important: Install the evaporator core (1) by gently sliding into HVAC module assembly housing (2).

1. Install the evaporator core (1) to the HVAC module assembly housing (2).



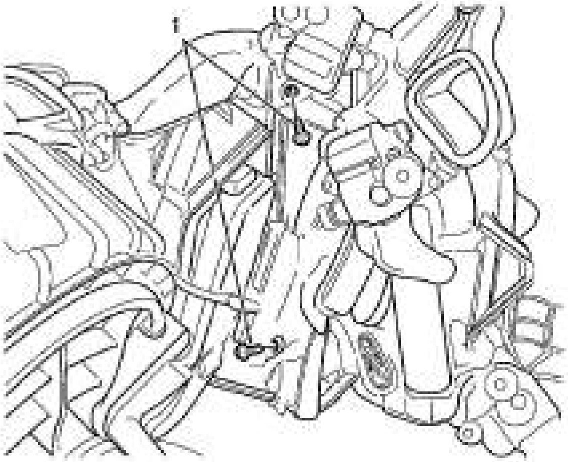
2. Install the air inlet assembly (2) to the HVAC module assembly (1).

   Notice: Refer to Fastener Notice in the Preface section.



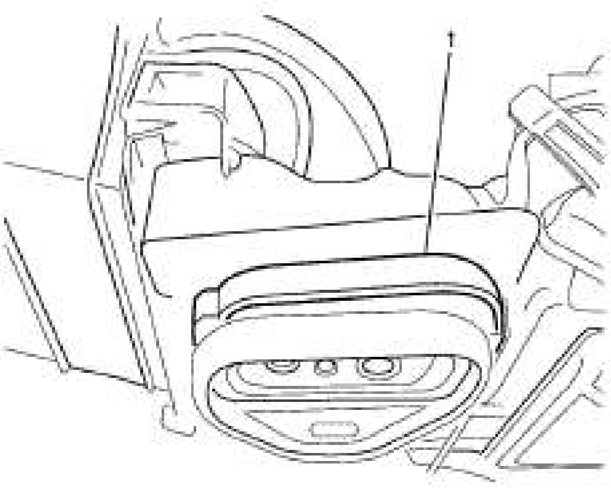
3. Install the air inlet assembly to HVAC module assembly retaining screws (1).

   Tighten
   Tighten the screws to 1 N·m (8 lb in.)



4. Install the air inlet assembly to HVAC module assembly retaining screws (1).

   Tighten
   Tighten the screws to 1 N·m (8 lb in.)



Important: Make sure all the clips on the thermal expansion (TX) valve retaining upper plastic cover (1) are engaged to avoid an induced rattle condition.

5. Install the TX valve retaining upper plastic cover (1).
6. Install the HVAC module assembly. Refer to HVAC Module Assembly Replacement.

Air Conditioning Evaporator Thermal Expansion Valve Replacement (RHD)

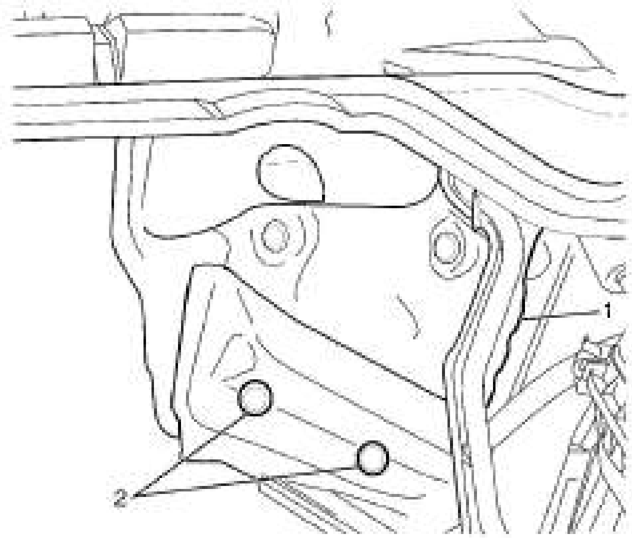
Tools Required

J 39400 Halogen Leak Detector

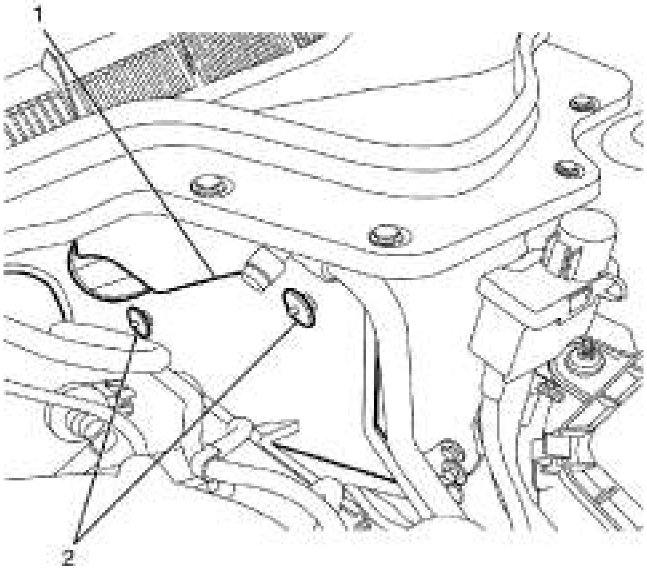
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

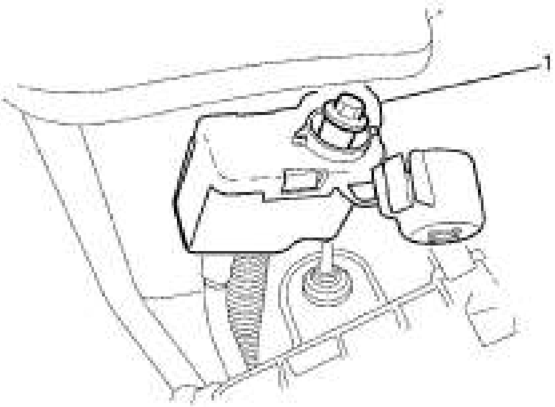
1. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.
2. Remove the engine cover. Refer to Engine Cover Replacement for 3.6L engine, or Engine Cover Replacement for 6.0L engine.
3. Recover the refrigerant Refer to Refrigerant Recovery and Recharging.
4. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
5. Remove windscreen wiper arms. Refer to Windshield Wiper Arm Replacement.
6. Remove the air inlet grill panel. Refer to Air Inlet Grille Panel Replacement.
7. Remove the air filter assembly. Refer to Air Cleaner Assembly Replacement for 3.6L engine, or Air Cleaner Assembly Replacement for 6.0L engine.



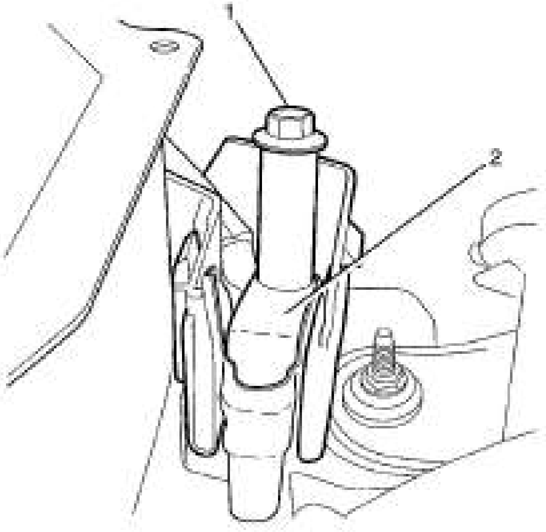
8. Remove the exhaust manifold heat shield to air box retaining clips (2).
9. Remove the exhaust manifold heat shield (1).



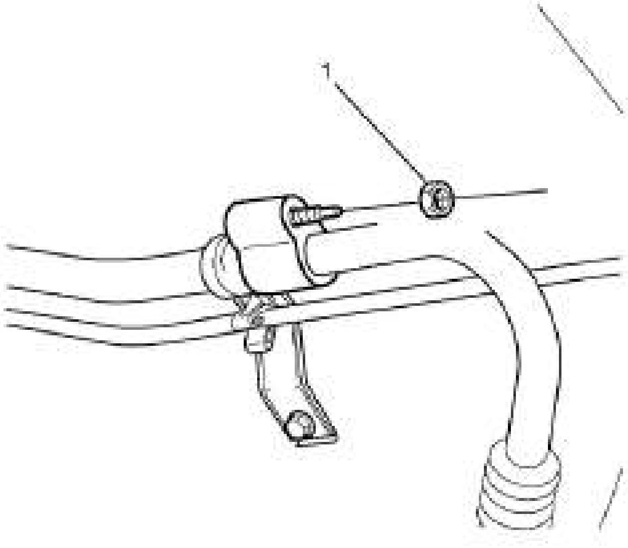
10. Remove the insulation panel to air box retaining clips (2).
11. Remove the insulation panel (1) from the engine compartment.



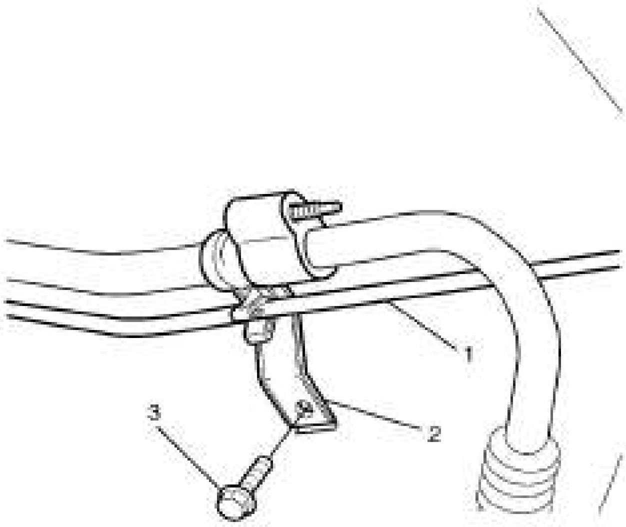
12. Remove the remote battery positive post cover (1).



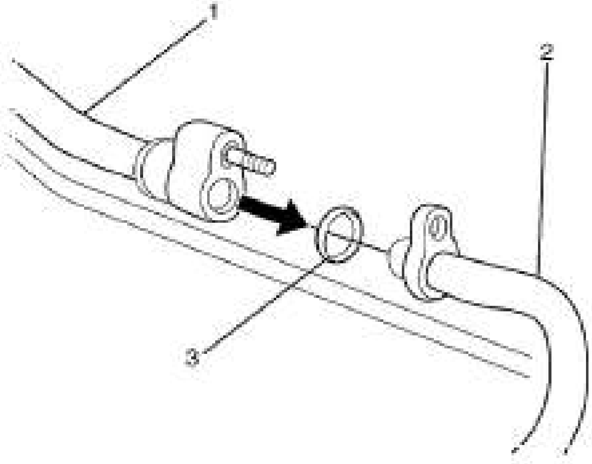
13. Remove the remote battery positive post to wiring harness retaining bolt (1).
14. Remove the starter motor power cable (2) and position aside.



15. Remove the suction pipe upper to suction pipe lower retaining nut (1).



16. Remove the suction pipe/liquid pipe retaining clip to left front chassis rail retaining bolt (3).
17. Detach the liquid pipe (1) from the suction pipe/liquid pipe retaining clip (2).



18. Disconnect the suction pipe upper (1) from suction pipe lower (2).

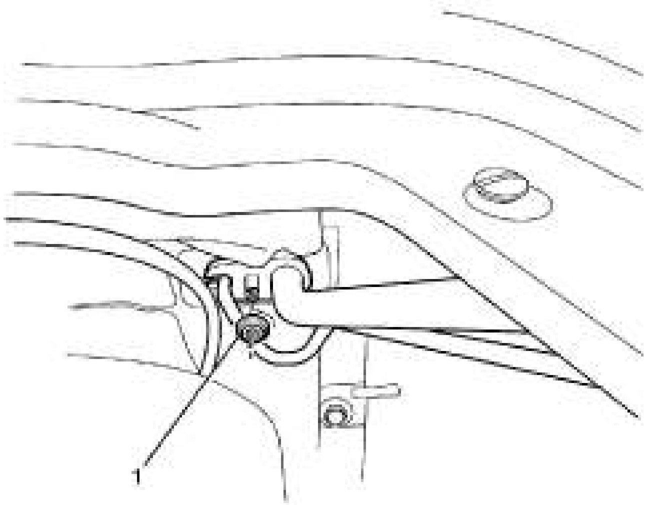
Important: The sealing washer (3) is a single use item and must be discarded after use.

19. Remove the sealing washer (3). Refer to Sealing Washer Replacement .

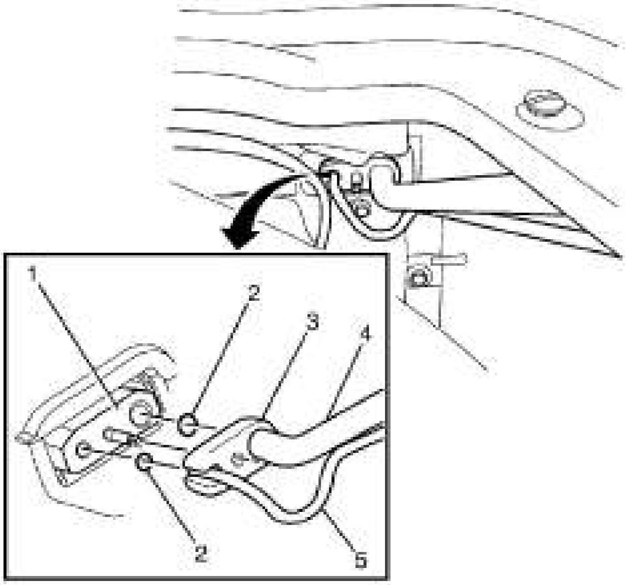
Discard the sealing washer

Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

20. Cap or plug the suction pipe upper (1) and the suction pipe lower (2).



21. Remove the suction pipe/liquid pipe pad to thermal expansion (TX) valve retaining nut (1).



22. Disconnect the suction pipe/liquid pipe pad (3) from the TX valve (1).

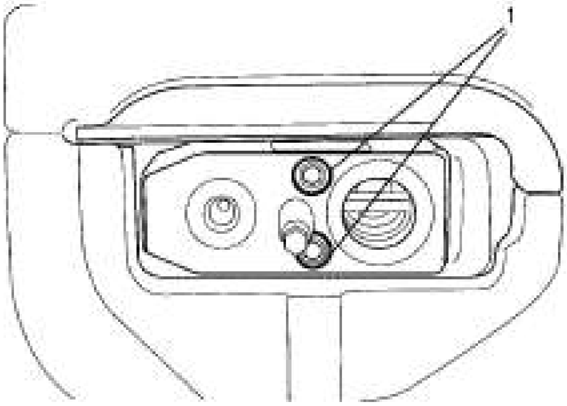
Important: The sealing washers (2) are a single use item and must be discarded after use.

23. Remove the sealing washers (2). Refer to Sealing Washer Replacement .

Discard the sealing washers

Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

24. Cap or plug the suction pipe (4), liquid pipe (5) and the TX valve (1).

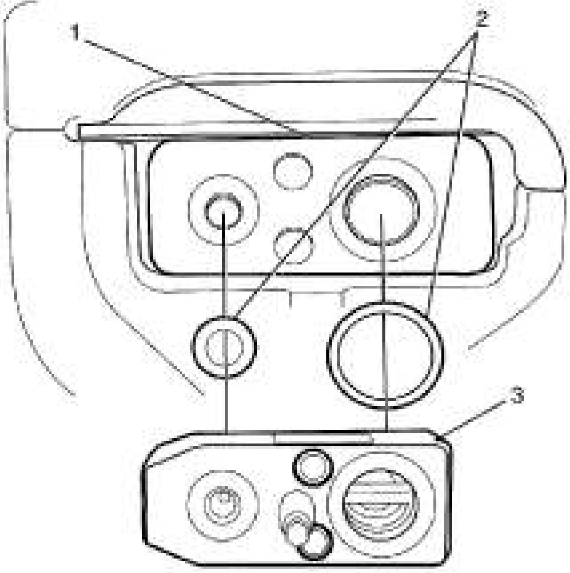


Important: Using a suitable tool, unscrew the TX valve to evaporator pad retaining hex screws (1).

25. Remove the TX valve to evaporator pad retaining screws (1).

Important: Reinstall the suction pipe/liquid pipe to TX valve retaining nut to assist in the removal of the TX valve.

26. Reinstall the suction pipe/liquid pipe to TX valve retaining nut (2).



Important: Place the TX Valve in a plastic bag to avoid any contamination from air born dirt or moisture.

27. Remove the TX valve (3) from the evaporator pad (1).

    Important: The sealing washers (2) are a single use item and must be discarded after use.

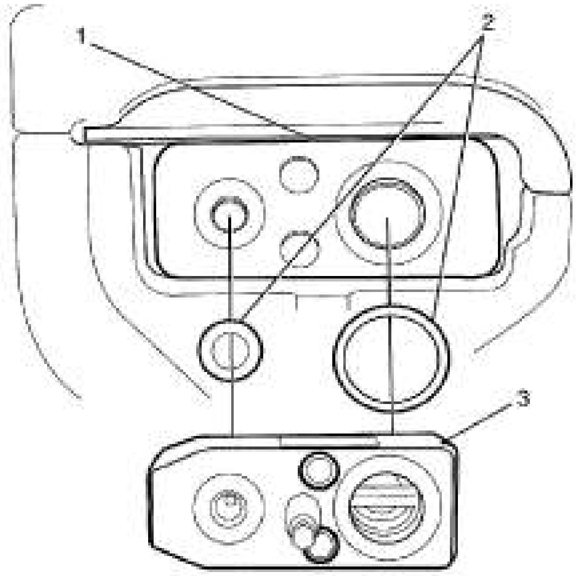
28. Remove the sealing washers (2) from the evaporator pad (1). Refer to Sealing Washer Replacement .

    Discard the sealing washers

    Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

29. Cap or plug the suction pipe (4), liquid pipe (5) and the TX valve (1).

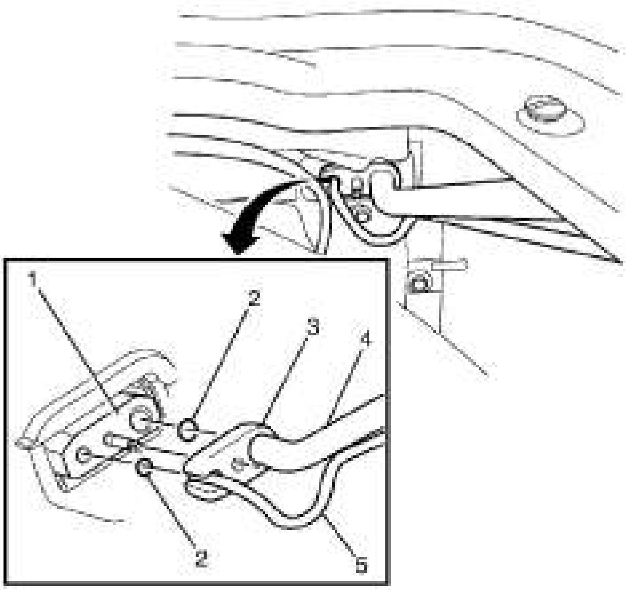
Installation Procedure



1. Remove the plugs or caps from the thermal expansion (TX) valve (3) and the evaporator pad (1).

   Important: DO NOT coat the NEW sealing washers (2) with oil, they must be fitted dry. The use of mineral oil will render the sealing washers (2) useless, as the sealing washers (2) WILL swell causing refrigerant to leak out.

2. Install NEW sealing washers (2) to the evaporator pad (1). Refer to Sealing Washer Replacement .
3. Connect the TX valve (3) to the evaporator pad (1).

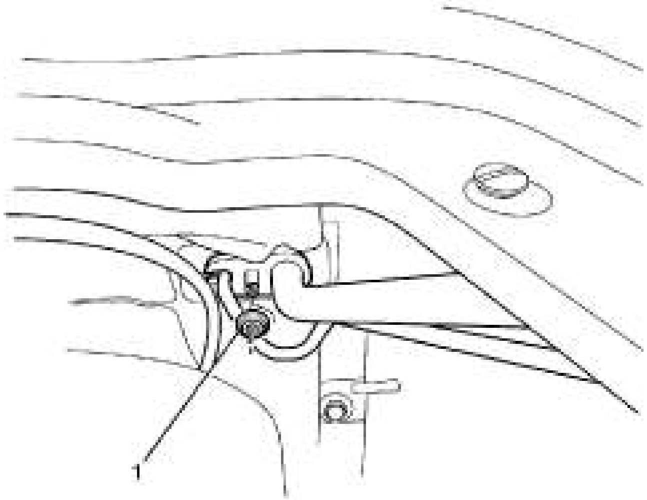


4. Remove the plugs or caps from the suction pipe (4), liquid pipe (5) and the TX valve (1).

   Important: DO NOT coat the NEW sealing washers (2) with oil, they must be fitted dry. The use of mineral oil will render the sealing washers (2) useless, as the sealing washers (2) WILL swell causing refrigerant to leak out.

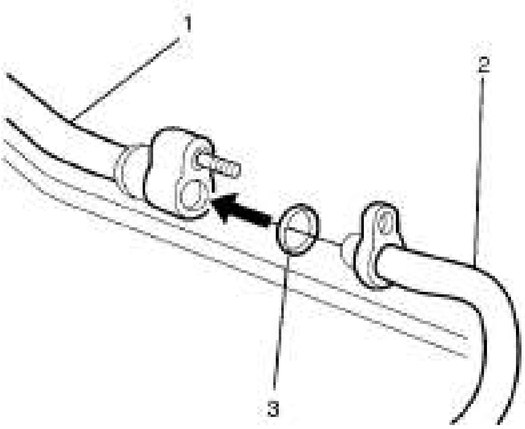
5. Install NEW sealing washers (2). Refer to Sealing Washer Replacement .
6. Connect the suction pipe/liquid pipe pad (3) to the TX Valve (1).

   Notice: Refer to Fastener Notice in the Preface section.



7. Install the suction pipe/liquid pipe pad to TX valve retaining nut (1).

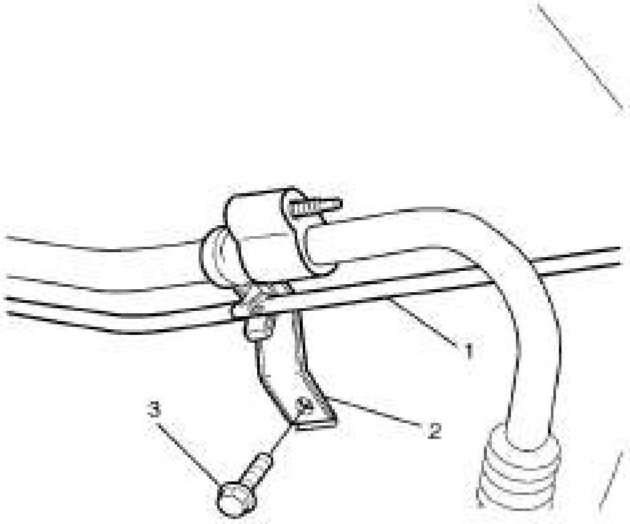
Tighten
Tighten the nut to 22 N·m(16 lb ft).



8. Remove the plugs or caps from the suction pipe upper (1) and the suction pipe lower (2).

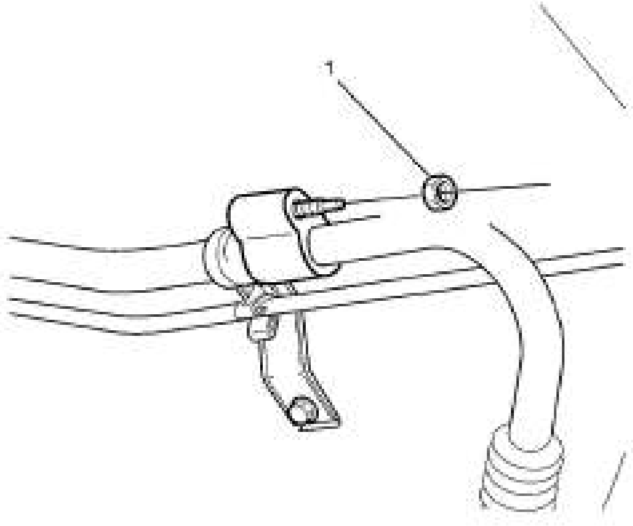
   Important: DO NOT coat the NEW sealing washer (3) with oil, they must be fitted dry. The use of mineral oil will render the sealing washer (3) useless, as the sealing washer (3) WILL swell causing refrigerant to leak out.

9. Install a NEW sealing washer (3). Refer to Sealing Washer Replacement .
10. Install the suction pipe upper (1) to the suction pipe lower (2).



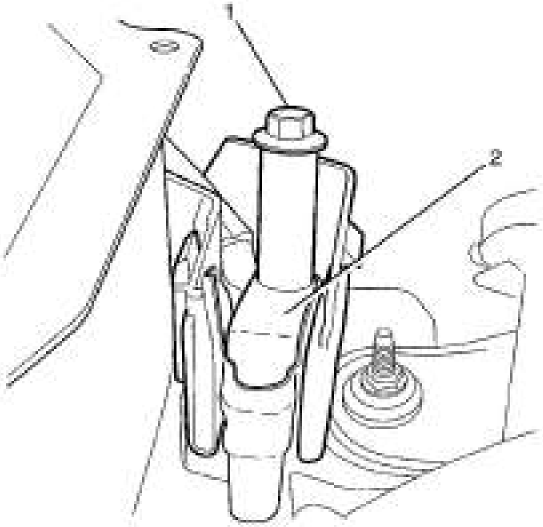
11. Attach the liquid pipe (1) from the suction pipe/liquid pipe retaining clip (2).

12. Install the suction pipe/liquid pipe retaining clip to left front chassis rail retaining bolt (3).



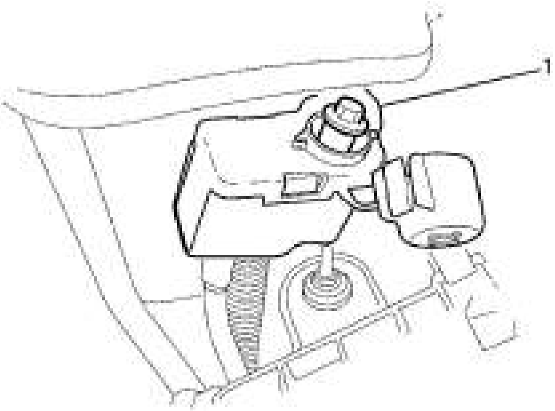
13. Install the suction pipe upper to suction pipe lower retaining nut (1).

Tighten
Tighten the nut to 22 N·m(16 lb ft).



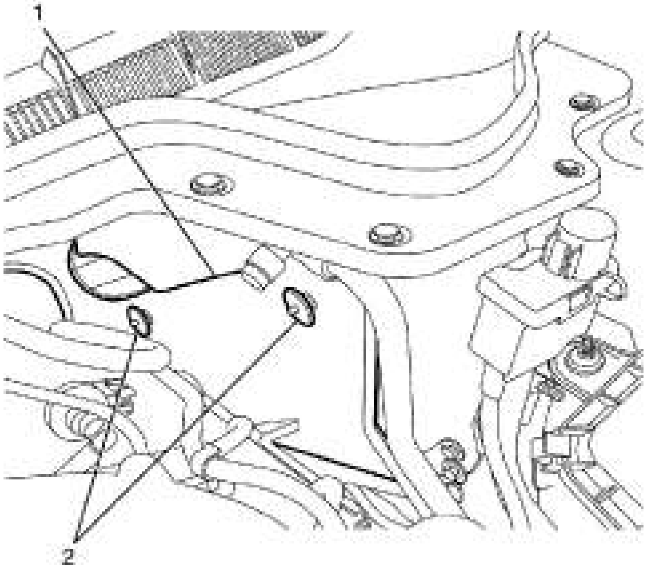
14. Install the starter motor positive cable (2) to the remote battery positive post.
15. Install the remote battery positive post to wiring harness retaining bolt (1).

Tighten
Tighten the bolt to 15 N·m (11 lb ft).

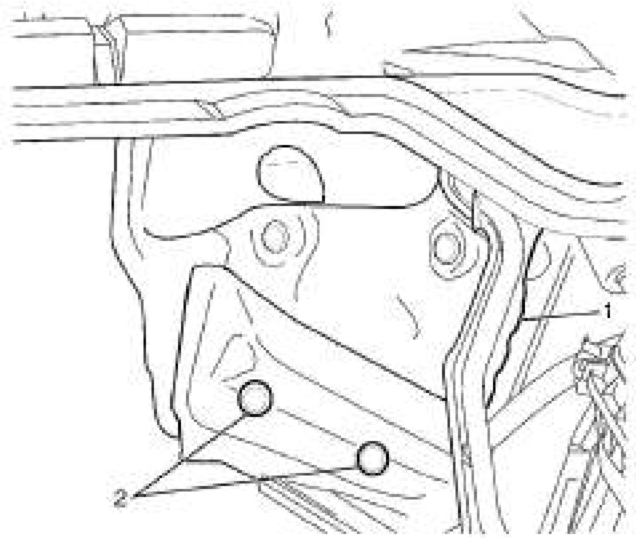


Important: Make sure the clips on the remote battery positive post cover (1) are engaged to avoid an induced rattle condition.

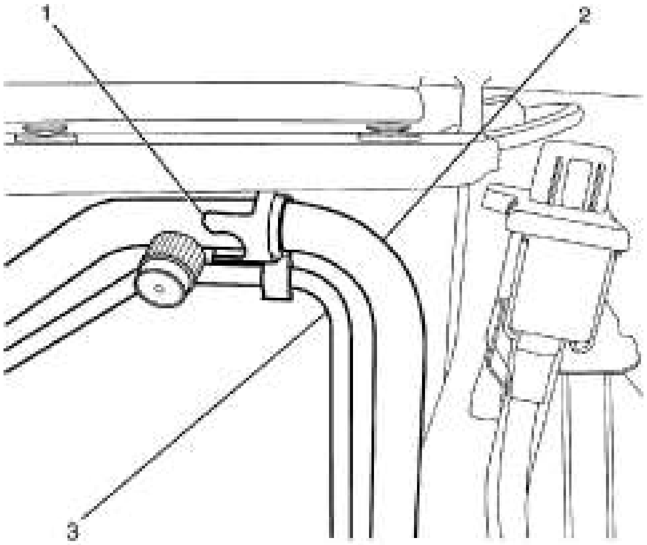
16. Install the remote battery positive post cover (1) to the remote battery positive post.



17. Install the insulation panel (1) to the left rear side engine compartment.
18. Install the insulation panel to air box retaining clips (2).



19. Install the exhaust manifold heat shield (1).
20. Install the exhaust manifold heat shield to air box retaining clips (2).



21. Attach the suction pipe (2) and the liquid pipe (3) from the suction pipe/liquid pipe retaining clip (1).
22. Evacuate and recharge the A/C system. Refer to Refrigerant Recovery and Recharging.
23. Install the radiator air baffle and deflector. . Refer to Radiator Air Upper Baffle and Deflector Replacement.
24. Install the air filter assembly. Refer to Air Cleaner Assembly Replacement for 3.6L engine, or Air Cleaner Assembly Replacement for 6.0L engine.
25. Install the engine cover. Refer to Engine Cover Replacement for 3.6L engine, or Engine Cover Replacement for 6.0L engine.
26. Install the plenum chamber cover panel. Refer to Air Inlet Grille Panel Replacement.
27. Install the windscreen wiper arms. Refer to Windshield Wiper Arm Replacement.
28. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and

Connection.

29. Leak test the fittings of the component using J 39400 .

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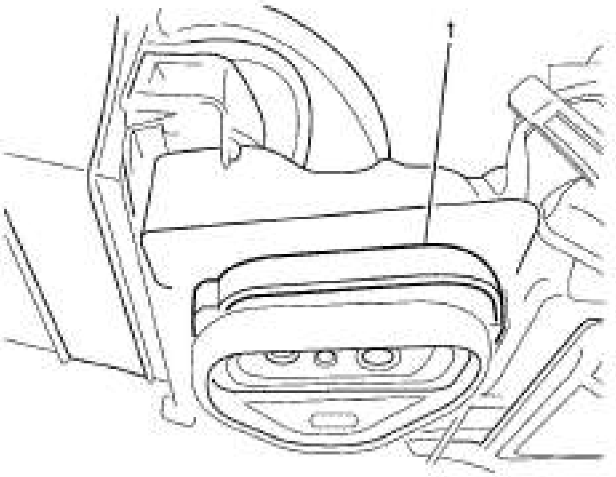
Air Inlet Assembly Replacement (RHD)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

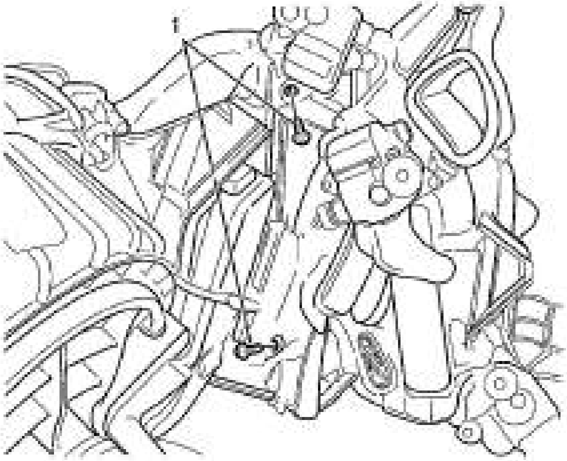
1. Remove the instrument panel (I/P). Refer to Instrument Panel Center Trim Panel Replacement .
2. Remove the thermal expansion (TX) valve. Refer to Air Conditioning Evaporator Thermal Expansion Valve Replacement
3. Remove the HVAC module assembly. Refer to HVAC Module Assembly Replacement .



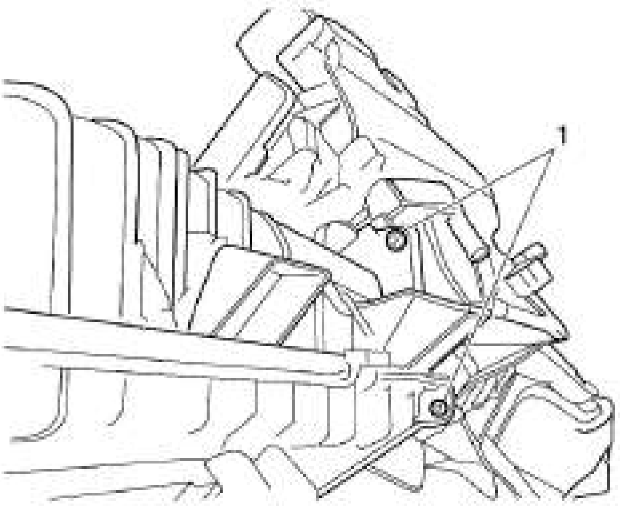
4. With the HVAC module assembly on a bench locate the TX valve retaining upper plastic cover (1).

Important: Unclip the TX valve retaining upper plastic cover (1) and remove by lifting upwards.

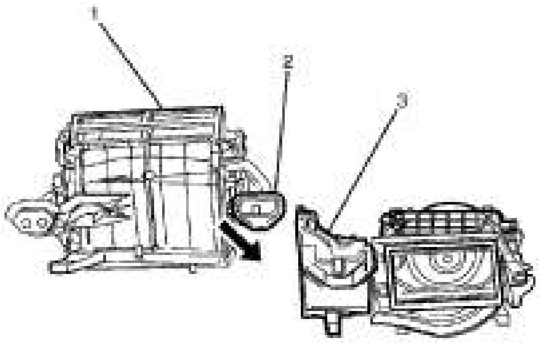
5. Remove the TX valve retaining upper plastic cover (1).



6. Remove the air inlet assembly to HVAC module assembly retaining screws (1).



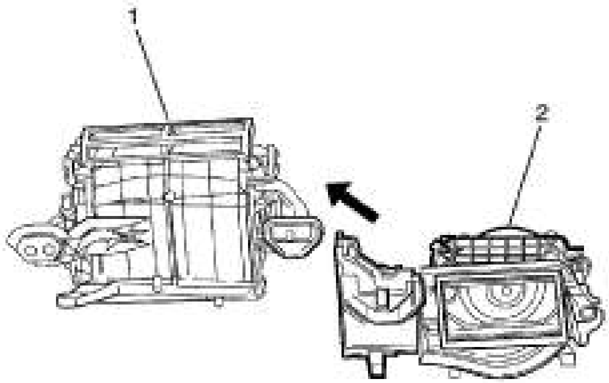
7. Remove the air inlet assembly to HVAC module assembly retaining screws (1).



Important: Unclip the air inlet assembly (3) and carefully tilt downwards past the TX valve (2)

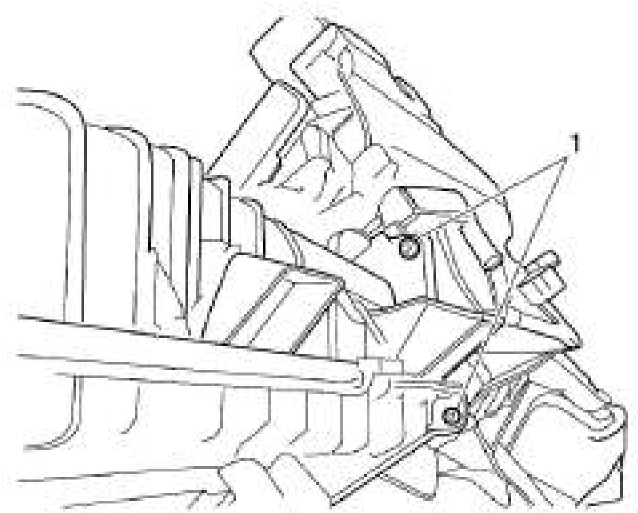
8. Remove the air inlet assembly (3) from the HVAC module assembly (1).

Installation Procedure



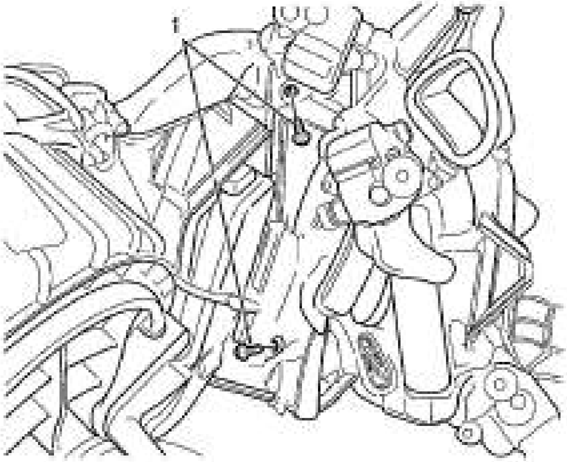
1. Install the air inlet assembly (2) to the HVAC module assembly (1).

   Notice: Refer to Fastener Notice in the Preface section.



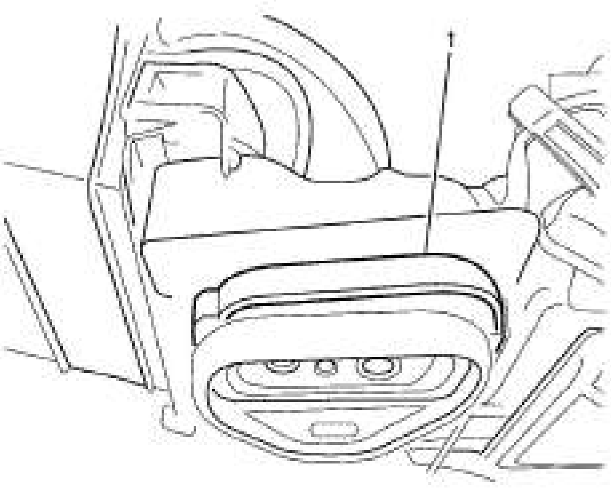
2. Install the air inlet assembly to HVAC module assembly retaining screws (1).

   Tighten
   Tighten the screws to 1 N·m (8 lb in.)



3. Install the air inlet assembly to HVAC module assembly retaining screws (1).

   Tighten
   Tighten the screws to 1 N·m (8 lb in.)



Important: Make sure all the clips on the thermal expansion (TX) valve retaining upper plastic cover (1) are engaged to avoid an induced rattle condition.

4. Install the TX valve retaining upper plastic cover (1).
5. Install the HVAC module assembly. Refer to HVAC Module Assembly Replacement .
6. Install the TX valve. Refer to Air Conditioning Evaporator Thermal Expansion Valve Replacement
7. Install the instrument panel (I/P). Refer to Instrument Panel Center Trim Panel Replacement .

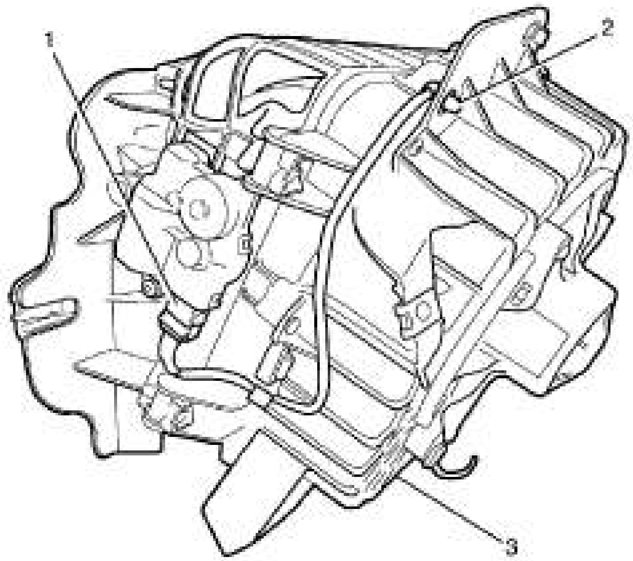
Air Valve Actuator Control Module Harness Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Important: The evaporator temperature sensor is part of the wiring harness.

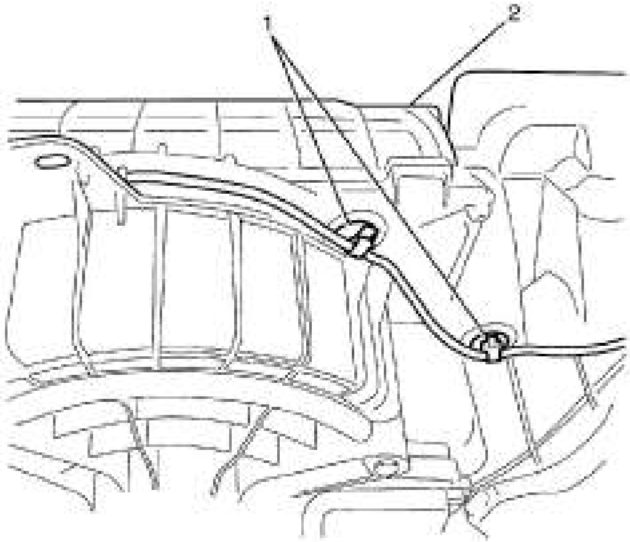
1. Remove the HVAC module assembly. Refer to HVAC Module Assembly Replacement.



2. Disconnect the air intake fresh/recirculation actuator electrical connector (1).

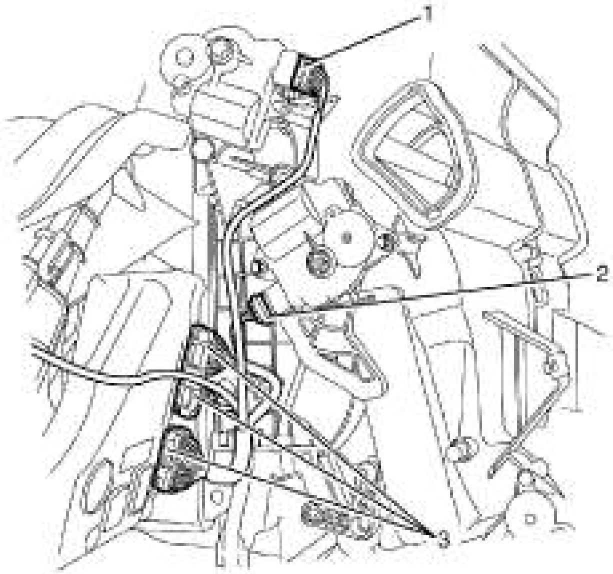
Important: Use a pair of long nose pliers to close the wiring harness retaining clip (2) ends to remove the wiring harness retaining clips (2) from the HVAC module assembly (3)

3. Detach the wiring harness retaining clips (2) from the HVAC module assembly (3).



Important: Use a pair of long nose pliers to close the wiring harness retaining clip (1) ends to remove the wiring harness retaining clips (1) from the HVAC module assembly (2)

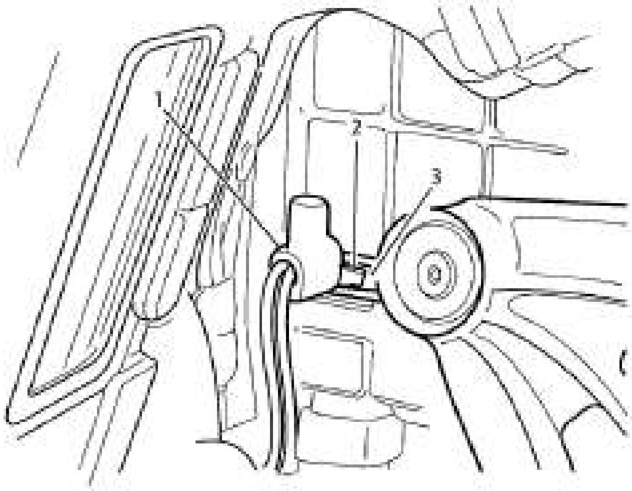
4. Detach the wiring harness retaining clips (1) from the HVAC module assembly (2).



5. Disconnect the defrost actuator air intake fresh/recirculation electrical connector (1).
6. Disconnect the air mix actuator electrical connector (2).

Important: The single zone HVAC module only has the one 22 pin connector. The dual zone HVAC module has a 22 pin connector and a 7 pin connector. The tri zone HVAC module has a 22 pin connector, a 7 pin connector and a 10 pin connector.

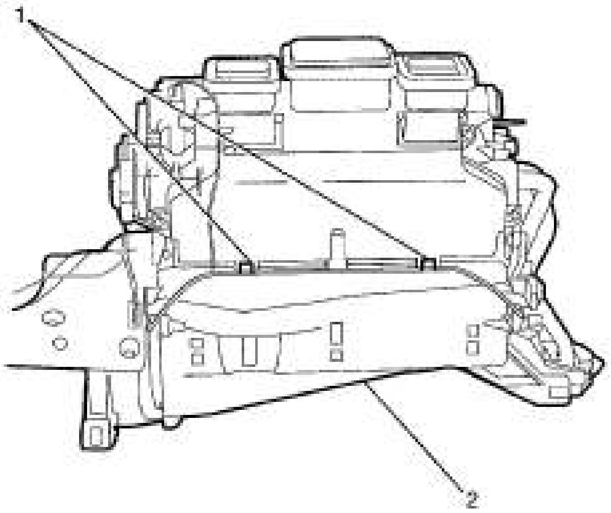
7. Disconnect the HVAC module electrical connectors (3) as required.



Important: The evaporator temperature sensor is part of the wiring harness.

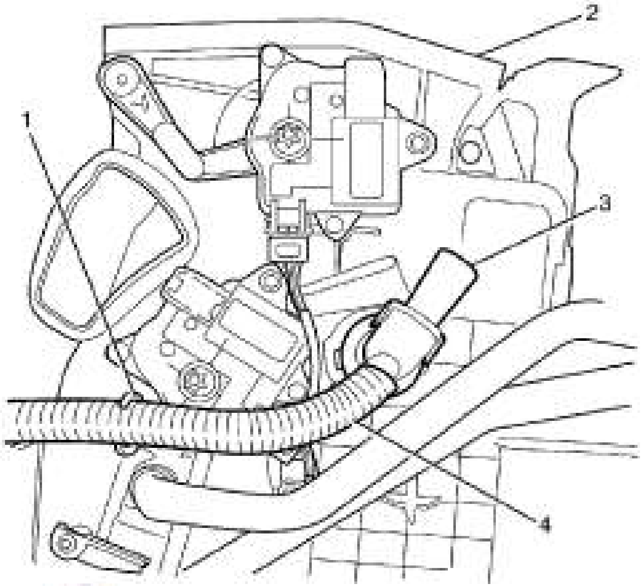
Important: Using a suitable tool, raise the evaporator temperature sensor locating clip (2) to clear the locking recess in the HVAC module assembly (3) and turn the evaporator temperature sensor (1) 45 degrees clockwise to remove evaporator temperature sensor (1) from the HVAC module assembly (3).

8. Remove evaporator temperature sensor (1) from the HVAC module assembly (3).



Important: Use a pair of long nose pliers to close the wiring harness retaining clip (1) ends to remove the wiring harness retaining clips (1) from the HVAC module assembly (2)

9. Detach the wiring harness retaining clips (1) from the under side of the HVAC module assembly (2).

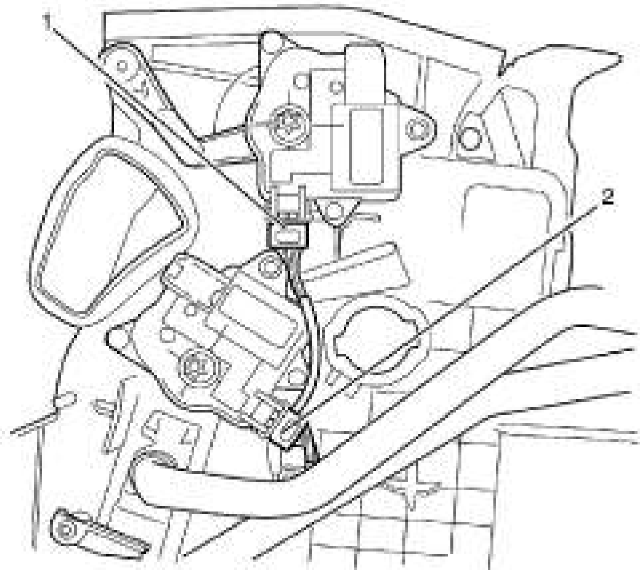


Important: The inside air temperature sensor aspirator venturi is only fitted to dual and tri zone HVAC module assemblies. Ignore steps 11 and 12 if working on a single zone HVAC equipped vehicle.

10. Detach the inside air temperature sensor aspirator venturi tube (4) from the HVAC module assembly retaining clip (1)

Important: Rotate the inside air temperature sensor aspirator venturi (3) clockwise to disengage the inside air temperature sensor aspirator venturi (3) retaining clips from the HVAC module assembly (2).

11. Remove the inside air temperature sensor aspirator venturi (3) and inside air temperature sensor aspirator venturi tube (4) from the HVAC module assembly (2).

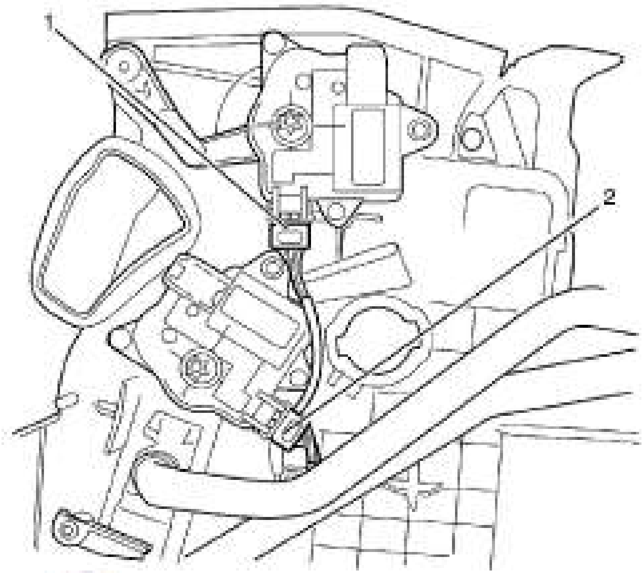


12. Disconnect the face/floor actuator electrical connector (1).

    Important: The drivers side air mix actuator is only fitted to dual and tri zone HVAC module assemblies. Ignore this step if working on a single zone HVAC equipped vehicle.

13. Disconnect the drivers side air mix actuator electrical connector (2) if equipped.

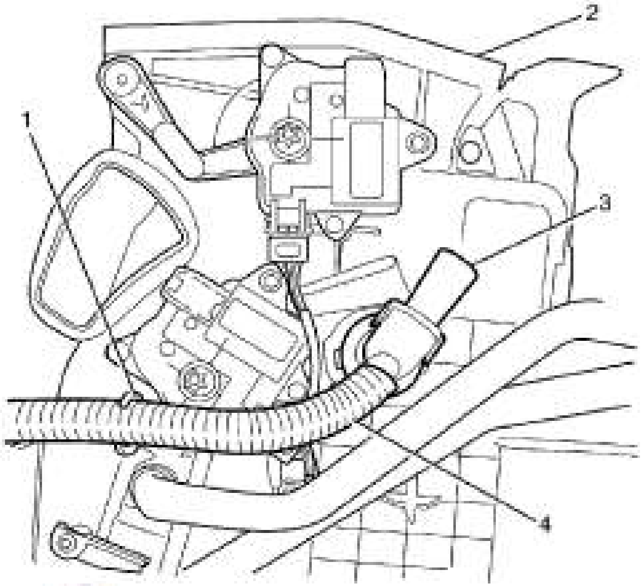
Installation Procedure



1. Connect the face/floor actuator electrical connector (1).

    Important: The drivers side air mix actuator is only fitted to dual and tri zone HVAC module assemblies. Ignore this step if working on a single zone HVAC equipped vehicle.

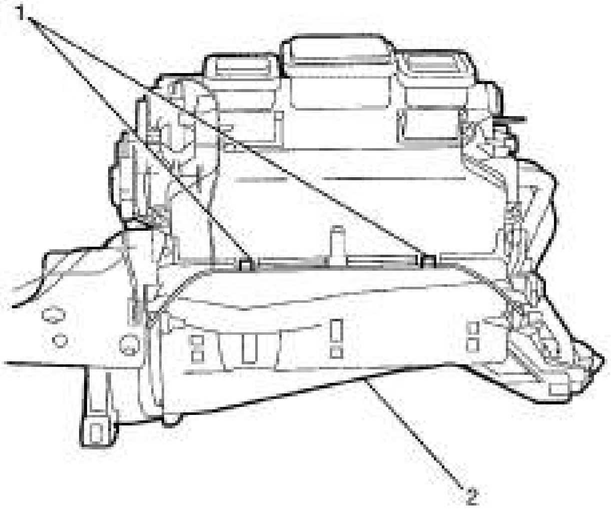
2. Connect the drivers side air mix actuator electrical connector (2) if equipped.



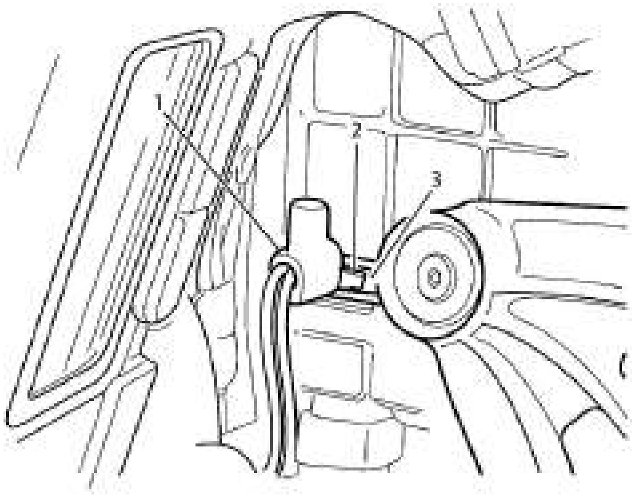
Important: The inside air temperature sensor aspirator venturi is only fitted to dual and tri zone HVAC module assemblies. Ignore steps 3 and 4 if working on a single zone HVAC equipped vehicle.

Important: Rotate the inside air temperature sensor aspirator venturi (3) counterclockwise to engage the inside air temperature sensor aspirator venturi (3) retaining clips.

3. Install the inside air temperature sensor aspirator venturi (3) and inside air temperature sensor aspirator venturi tube (4) to the HVAC module assembly (2).
4. Attach the inside air temperature sensor aspirator venturi tube (4) to the HVAC module assembly retaining clip (1)

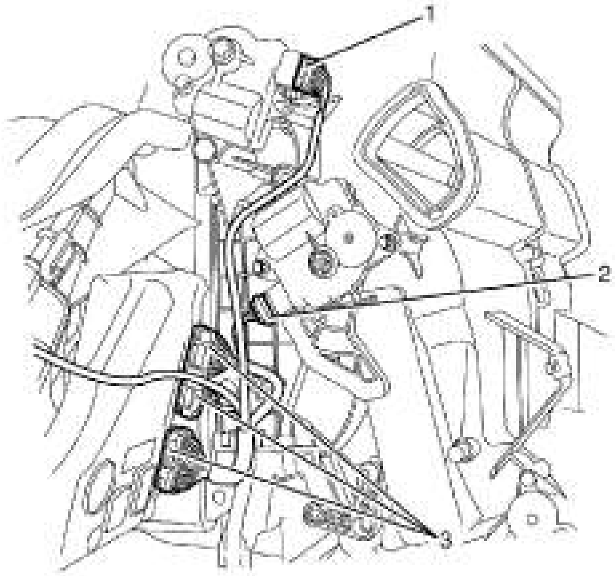


5. Install the clips (1) to the under side of the HVAC module assembly (2).



Important: Install the evaporator temperature sensor (1) to the HVAC module assembly (3) and turn the evaporator temperature sensor (1) 45 degrees counterclockwise to engage the evaporator temperature sensor locating clip (2) in the locking recess in the HVAC module assembly (3).

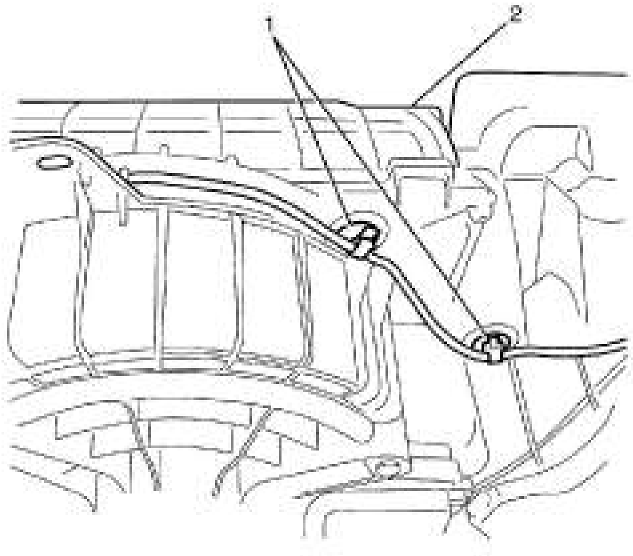
6. Remove evaporator temperature sensor (1) from the HVAC module assembly (3).



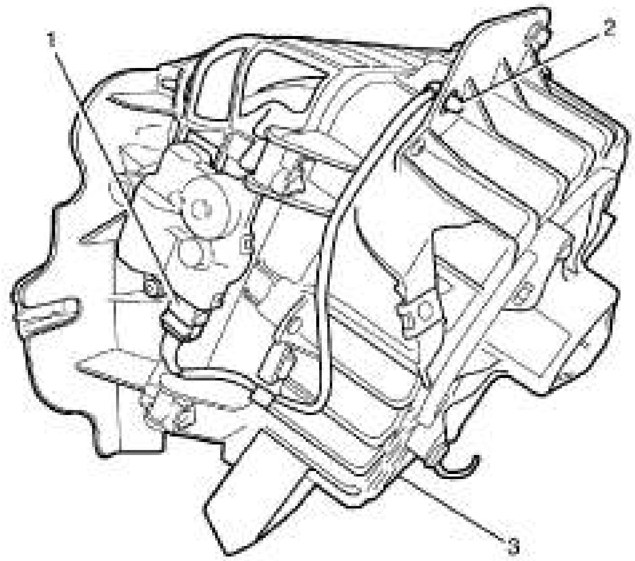
Important: The single zone HVAC module only has the one 22 pin connector. The dual zone HVAC module has a 22 pin connector and a 7 pin connector. The tri zone HVAC module has a 22 pin connector, a 7 pin connector and a 10 pin connector.

7. Connect the HVAC module electrical connectors (3) as required.

8. Connect the air mix actuator electrical connector (2).
9. Connect the defrost actuator air intake fresh/recirculation electrical connector (1).



10. Attach the wiring harness retaining clips (1) from the HVAC module assembly (2).



11. Attach the wiring harness retaining clips (2) from the HVAC module assembly (3).
12. Connect the air intake fresh/recirculation actuator electrical connector (1).
13. Install the HVAC module assembly. Refer to HVAC Module Assembly Replacement.

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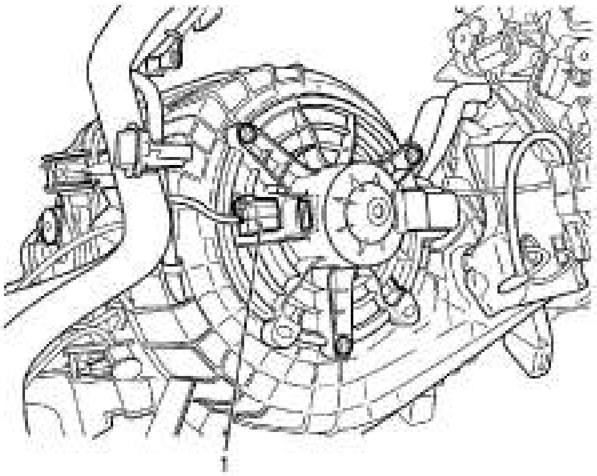
Blower Motor Replacement (RHD)

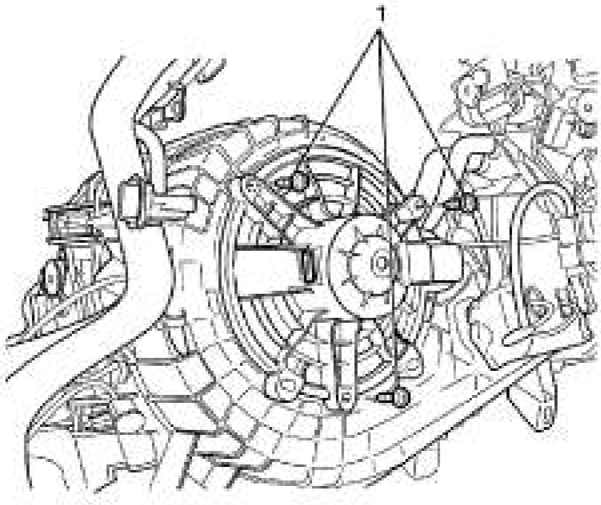
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

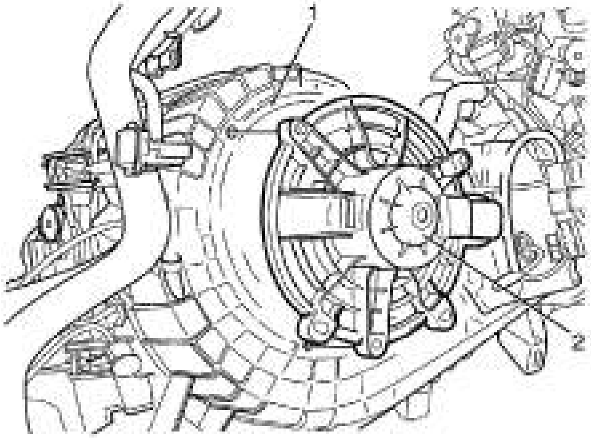
1. Remove the glove box assembly. Refer to Instrument Panel Compartment Replacement .
2. Remove the left floor air outlet duct. Refer to Floor Air Outlet Duct Replacement - Left Side .



3. Disconnect the blower motor electrical connector (1).

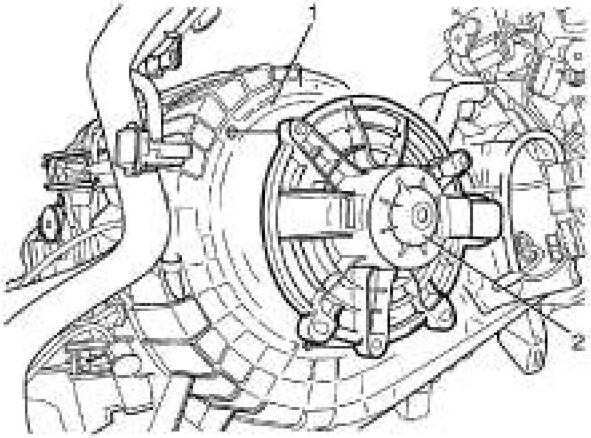


4. Remove the blower motor to blower assembly retaining screws (1).



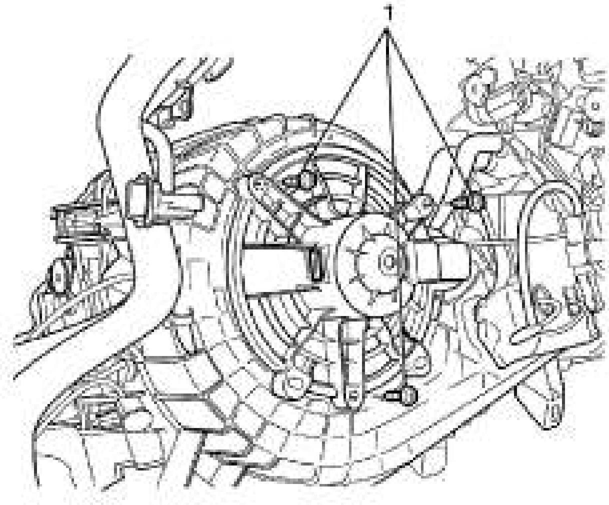
5. Remove the blower motor (2) from the blower assembly (1).

Installation Procedure



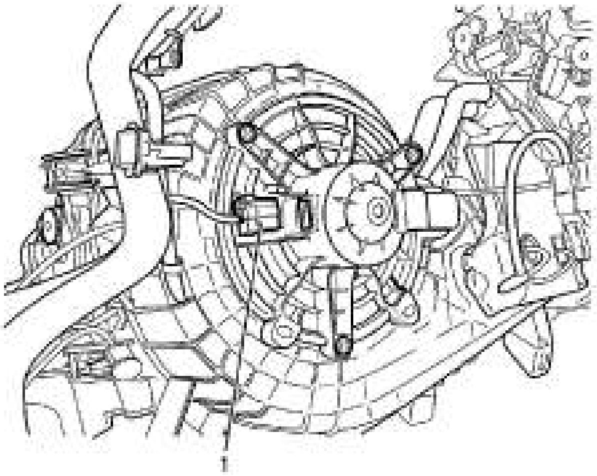
1. Install the blower motor (2) to the blower assembly (1).

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the blower motor to blower assembly retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m(18lb in).



3. Connect the blower motor electrical connector (1).
4. Install the left floor air outlet duct. Refer to Floor Air Outlet Duct Replacement - Left Side .
5. Install the glove box assembly. Refer to Instrument Panel Compartment Replacement .

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Discharge Hose Replacement (3.6L Engine)

Tools Required

J 39400 Halogen Leak Tester

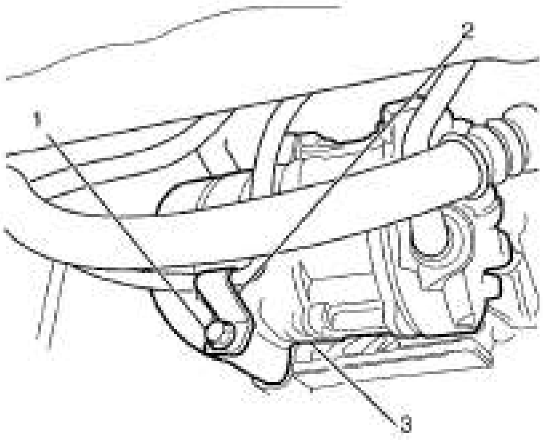
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

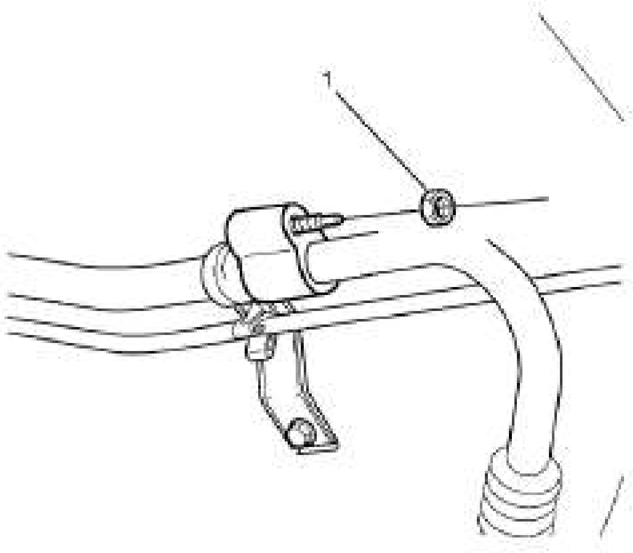
1. Recover the refrigerant Refer to Refrigerant Recovery and Recharging .
2. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove the air filter assembly. Refer to Air Cleaner Assembly Replacement .
4. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement
5. Remove the passenger side engine cover. Refer to Engine Cover Replacement .

Caution: Refer to Vehicle Lifting Caution in the Preface section.

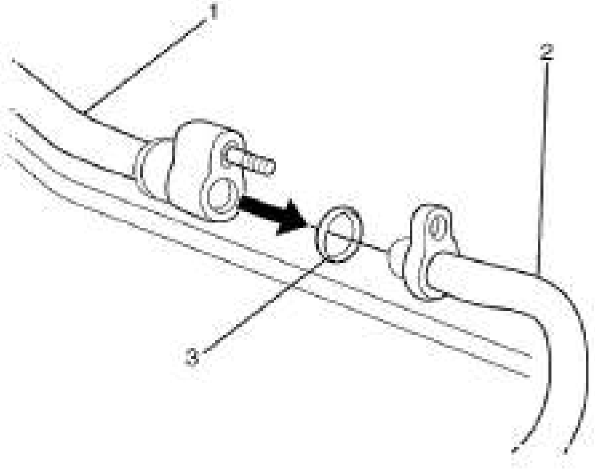
6. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



7. Remove the compressor to compressor mounting bracket retaining bolt (1).
8. Position the discharge hose retaining bracket (2) away from the compressor (3).
9. Lower the vehicle



10. Remove the suction pipe upper to suction pipe lower retaining nut (1).



11. Disconnect the suction pipe upper (1) from suction pipe lower (2).

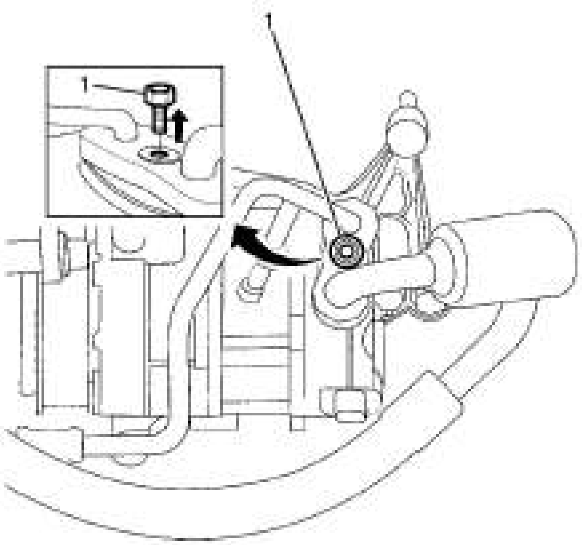
    Important: The sealing washer (3) is a single use item and must be discarded after use.

12. Remove the sealing washer (3). Refer to Sealing Washer Replacement .

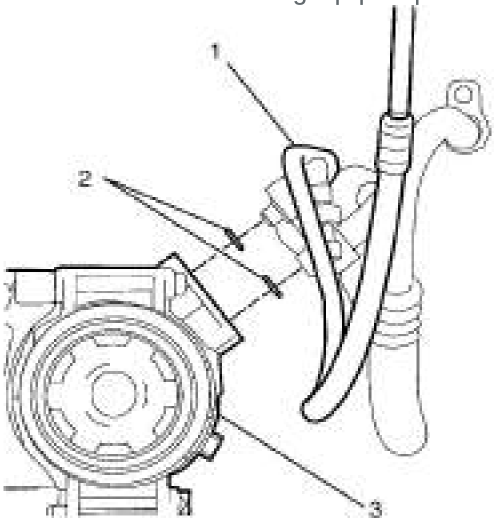
    Discard the sealing washer

    Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

13. Cap or plug the suction pipe upper (1) and the suction pipe lower (2).



14. Remove the suction/discharge pipes pad retaining bolt (1).



15. Disconnect the suction/discharge pipes (1) from the compressor (3).

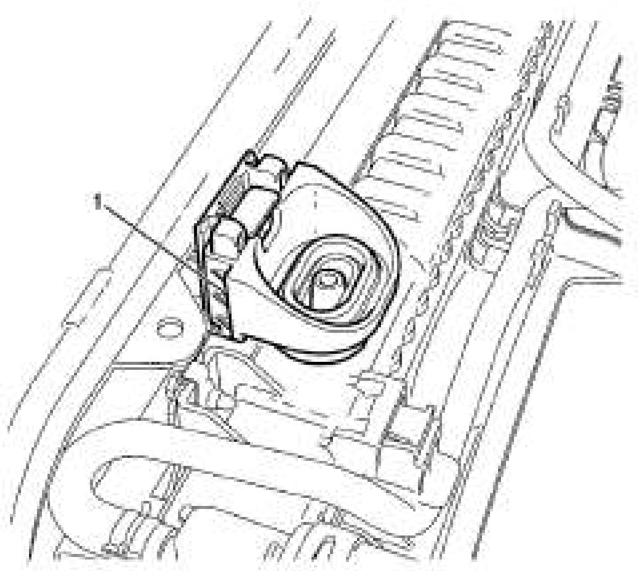
Important: The sealing washers (2) are a single use item and must be discarded after use.

16. Remove the sealing washers (2). Refer to Sealing Washer Replacement .

Discard the sealing washers

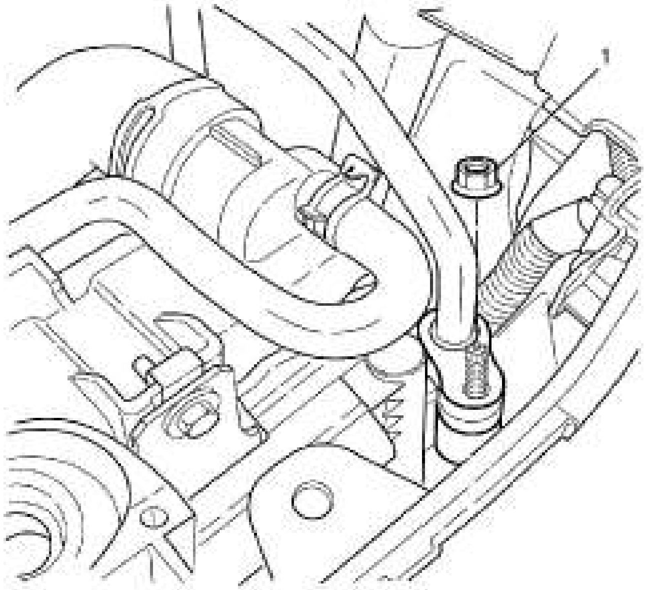
Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

17. Cap or plug the suction/discharge pipes (1) and the ports on the compressor (3).



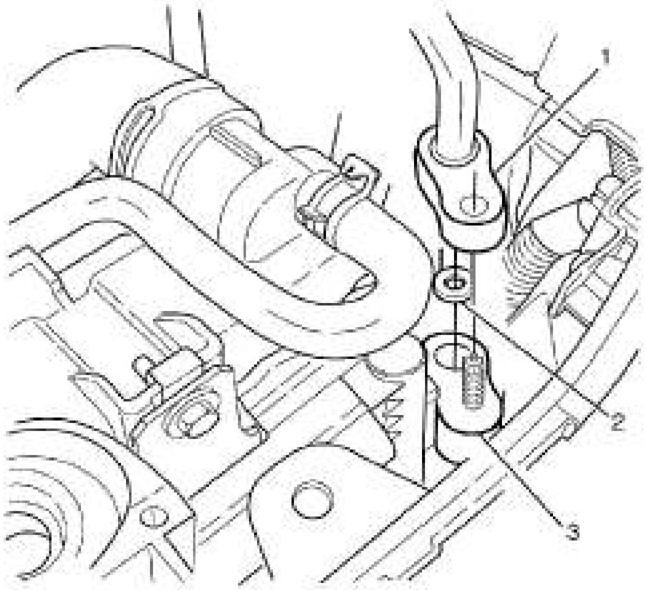
Important: Remove the upper radiator support brackets by raising the securing lock upwards 10mm and slide the bracket of the radiator slide pin.

18. Remove the upper radiator support brackets (1).



Important: Gently push the radiator and condenser towards the engine to allow removal of the discharge pipe to condenser retaining nut (1).

19. Remove the discharge pipe to condenser retaining nut (1).



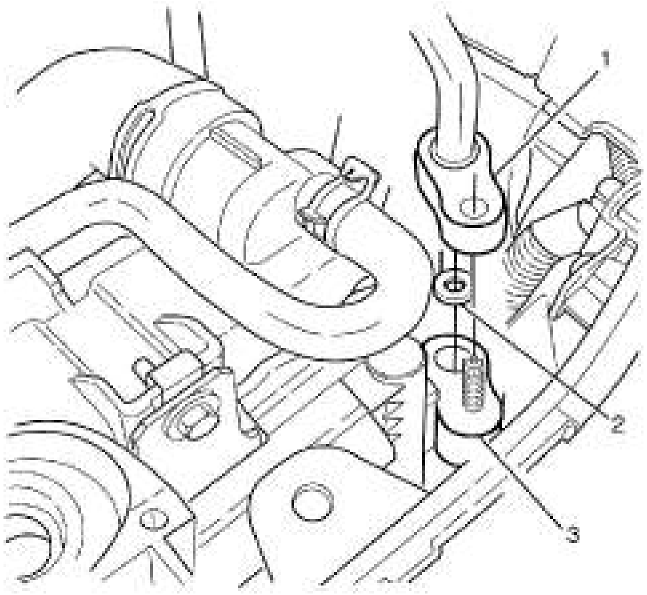
20. Disconnect the discharge pipe (1) from condenser (3).
21. Remove the sealing washer (2). Refer to Sealing Washer Replacement .

    Discard the sealing washer.

    Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

22. Cap or plug the discharge pipe (1) and the condenser (3).

Installation Procedure

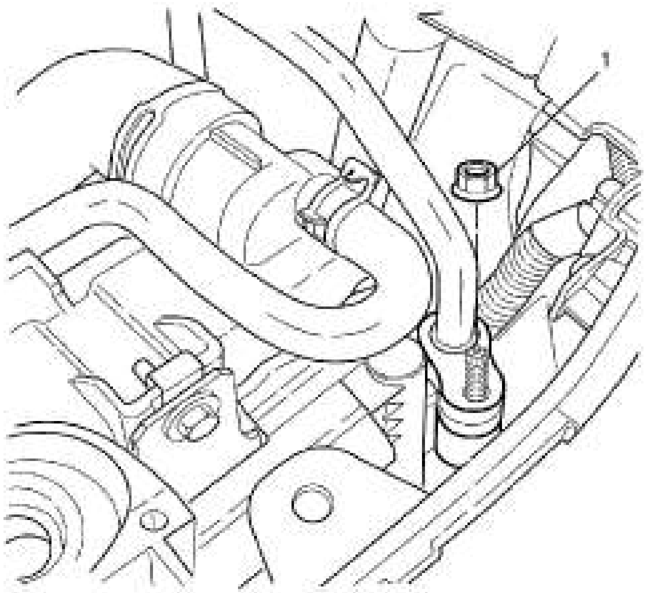


1. Remove the plugs or caps from the discharge pipe (1) and the condenser (3).

   Important: DO NOT coat the NEW sealing washer (2) with oil, they must be fitted dry. The use of mineral oil will render the sealing washer (2) useless, as the sealing washer (2) WILL swell causing refrigerant to leak out.

2. Install a NEW sealing washer (2). Refer to Sealing Washer Replacement .
3. Install the discharge pipe (1) to condenser (3).

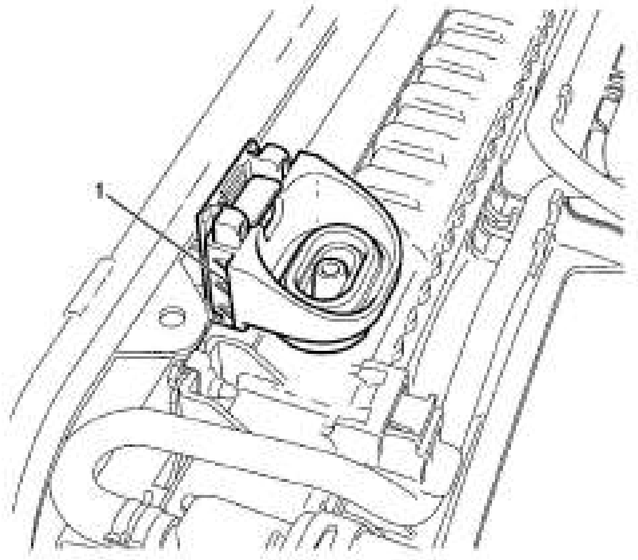
   Notice: Refer to Fastener Notice in the Preface section.



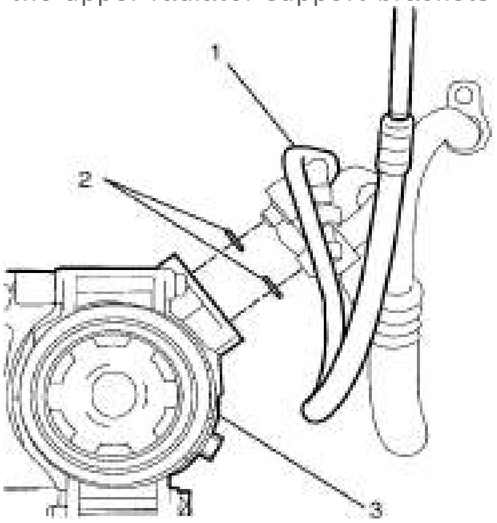
Important: Gently push the radiator and condenser towards the engine to allow installation of the discharge pipe to condenser retaining nut (1).

4. Install the discharge pipe to condenser retaining nut (1).

   Tighten
   Tighten the nut to 22 N·m(16 lb ft).



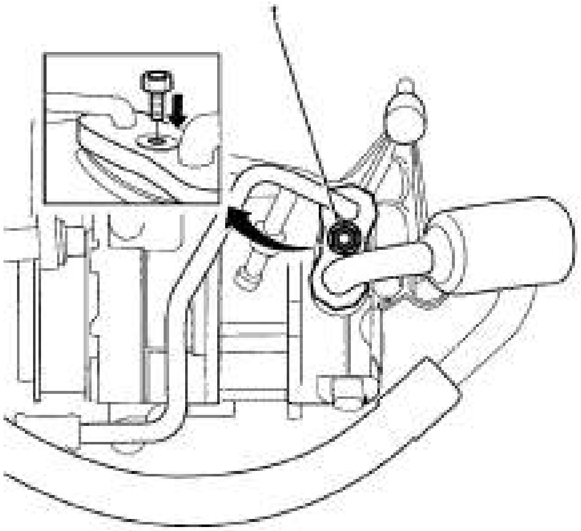
5. Install the upper radiator support brackets (1).



6. Remove the plugs or caps from the suction/discharge pipes (1) and the ports on the compressor (3).

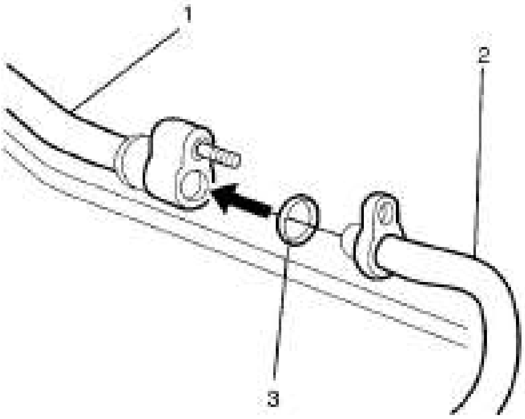
   Important: DO NOT coat the NEW sealing washers (2) with oil, they must be fitted dry. The use of mineral oil will render the sealing washers (2) useless, as the sealing washers (2) WILL swell causing refrigerant to leak out.

7. Install two NEW sealing washers (2). Refer to Sealing Washer Replacement .
8. Connect the suction/discharge pipes (1) to the compressor (3)



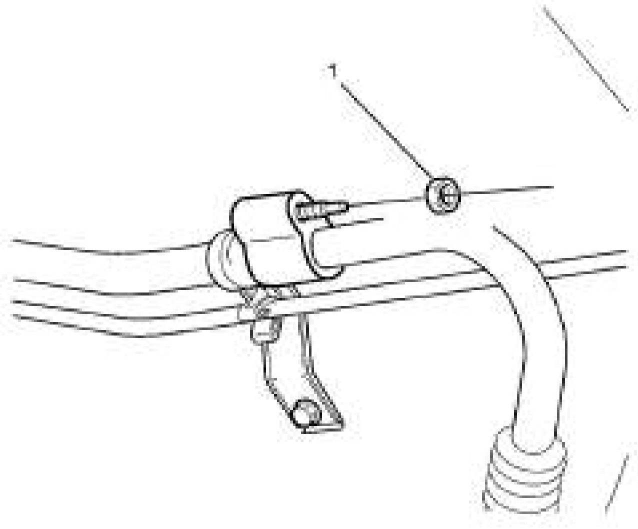
9. Install the suction/discharge pipe to compressor retaining bolt (1).

   Tighten
   Tighten the bolt to 22 N·m(16 lb ft).



Important: DO NOT coat the NEW sealing washer (3) with oil, they must be fitted dry. The use of mineral oil will render the sealing washer (3) useless, as the sealing washer (3) WILL swell causing refrigerant to leak out.

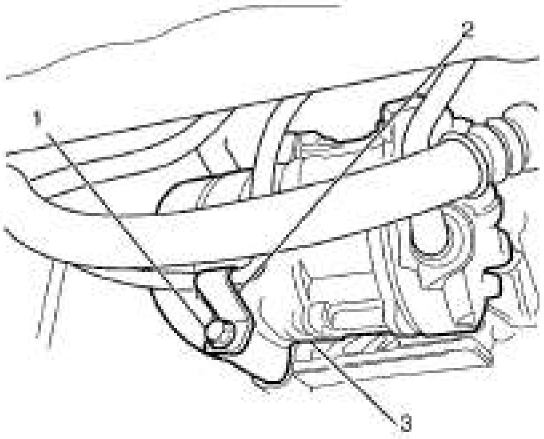
10. Install a NEW sealing washer (3). Refer to Sealing Washer Replacement .
11. Install the suction pipe upper (1) to the suction pipe lower (2).



12. Install the suction pipe upper to suction pipe lower retaining nut (1).

    Tighten
    Tighten the nut to 22 N·m(16 lb ft).

13. Raise the vehicle.



14. Position the discharge hose retaining bracket (2) to the compressor (3).
15. Install the compressor to compressor mounting bracket bolt (1).

    Tighten
    Tighten the bolt to 22 N·m (16 lb ft).

16. Lower the vehicle to the ground.

17. Install the passenger side engine dress cover. Refer to Engine Cover Replacement .
18. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement
19. Install the air filter assembly. Refer to Air Cleaner Assembly Replacement .
20. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection .
21. Evacuate and recharge the A/C system. Refer to Refrigerant Recovery and Recharging .
22. Leak test the fittings of the component using J 39400 .

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Discharge Hose Replacement (6.0L Engine)

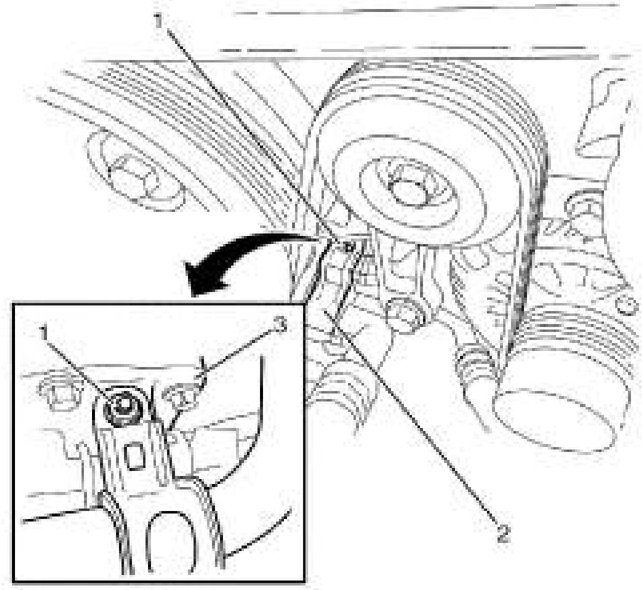
Tools Required

J 39400-A Halogen Leak Tester

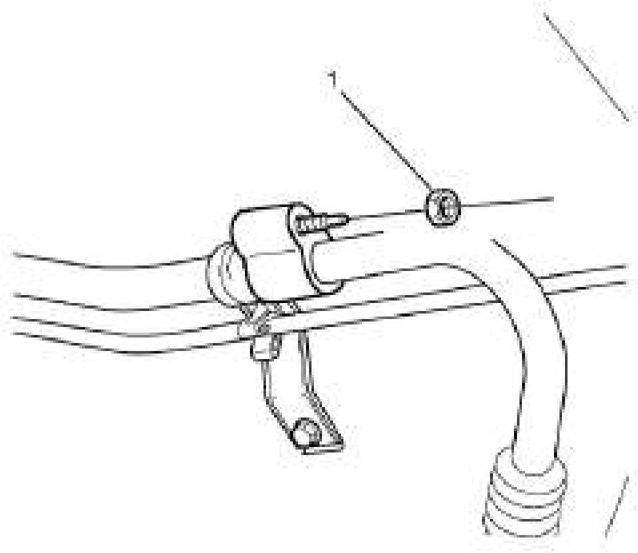
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

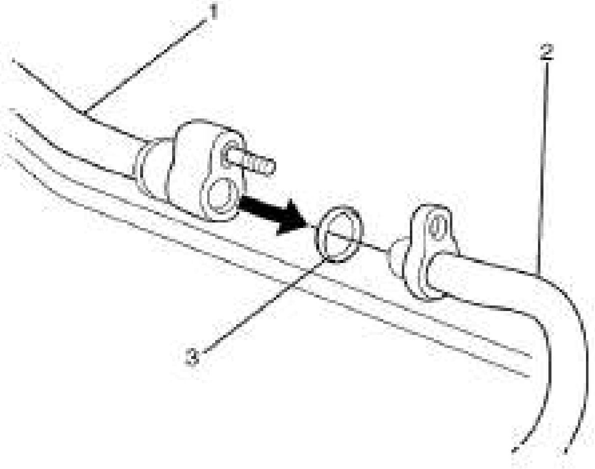
1. Recover the refrigerant. Refer to Refrigerant Recovery and Recharging.
2. Disconnect battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the air filter assembly. Refer to Air Cleaner Assembly Replacement.
4. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement
5. Remove the engine cover. Refer to Engine Cover Replacement.



6. Remove the discharge hose retaining bracket to oil pan retaining bolt (1).
7. Position the discharge hose retaining bracket (2) away from the oil pan (3).



8. Remove the suction pipe upper to suction pipe lower retaining nut (1).



9. Disconnect the suction pipe upper (1) from suction pipe lower (2).

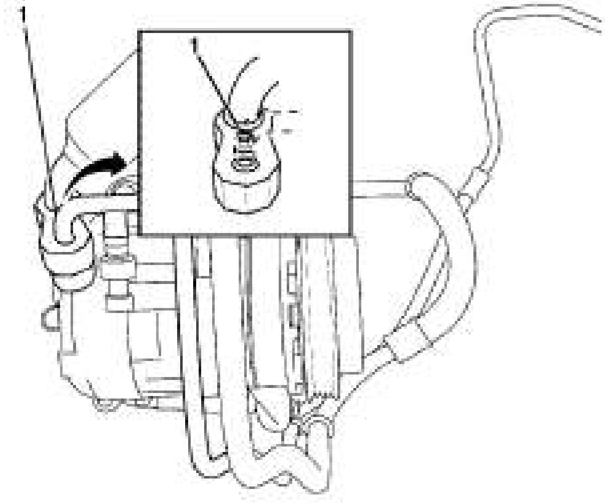
Important: The sealing washer (3) is a single use item and must be discarded after use.

10. Remove the sealing washer (3). Refer to Sealing Washer Replacement.

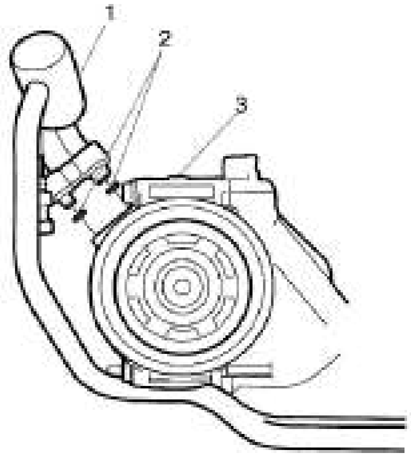
Discard the sealing washer

Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

11. Cap or plug the suction pipe upper (1) and the suction pipe lower (2).



12. Remove the suction/discharge pipe to compressor retaining bolt (2).



13. Disconnect the suction/discharge pipes (1) from the compressor (3).

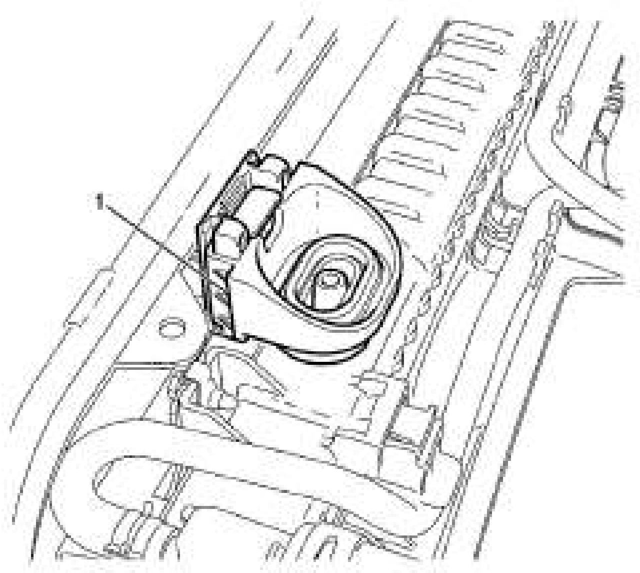
    Important: The sealing washers (2) are a single use item and must be discarded after use.

14. Remove the sealing washers (2). Refer to Sealing Washer Replacement.

    Discard the sealing washers.

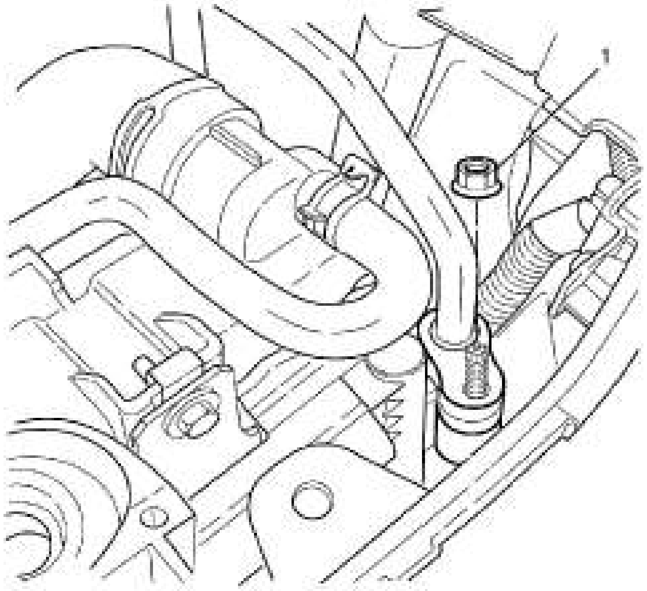
    Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

15. Cap or plug the suction/discharge pipes (1) and the ports on the compressor (3).



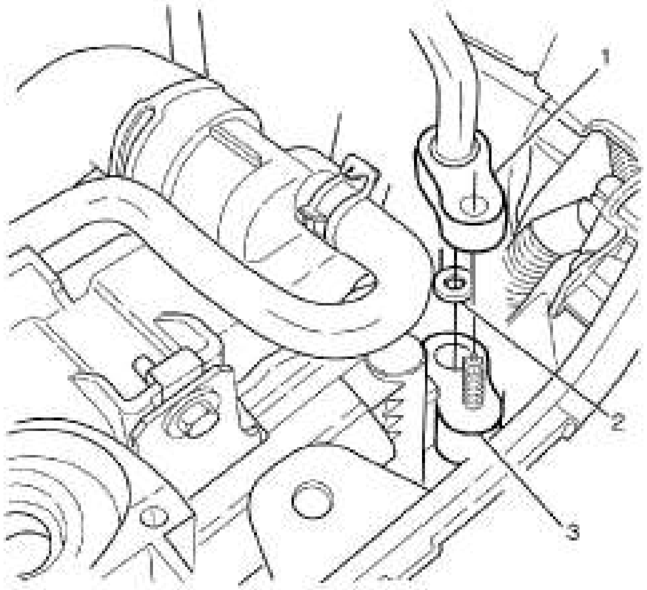
Important: Remove the upper radiator support brackets by raising the securing lock upwards 10mm and slide the bracket of the radiator slide pin.

16. Remove the upper radiator support brackets (1).



Important: Gently push the radiator and condenser towards the engine to allow removal of the discharge pipe to condenser retaining nut (1).

17. Remove the discharge pipe to condenser retaining nut (1).



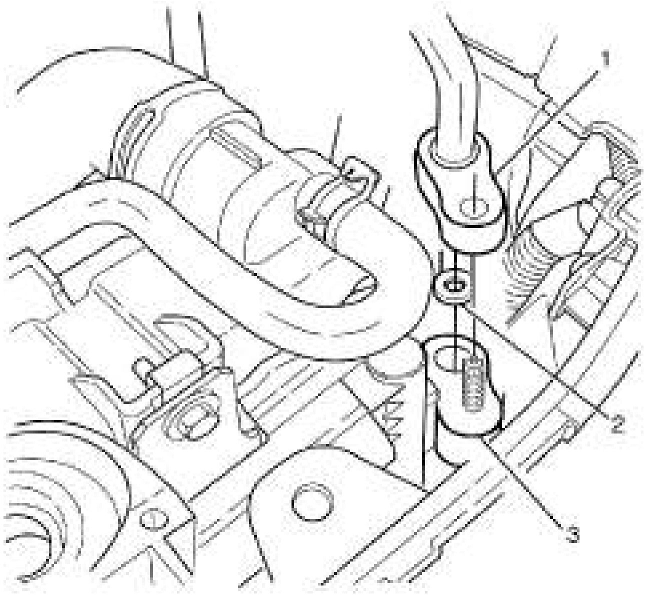
18. Disconnect the discharge pipe (1) from condenser (3).
19. Remove the sealing washer (2). Refer to Sealing Washer Replacement.

    Discard the sealing washer.

    Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

20. Cap or plug the discharge pipe (1) and the condenser (3).

Installation Procedure

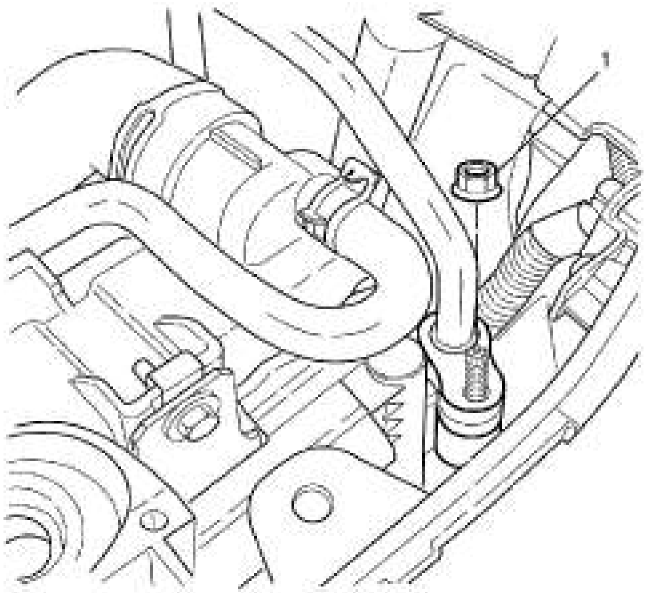


1. Remove the plugs or caps from the discharge pipe (1) and the condenser (3).

   Important: DO NOT coat the NEW sealing washers (2) with oil, they must be fitted dry. The use of mineral oil will render the sealing washers (2) useless, as the sealing washers (2) WILL swell causing refrigerant to leak out.

2. Install a NEW sealing washer (2). Refer to Sealing Washer Replacement.
3. Install the discharge pipe (1) to condenser (3).

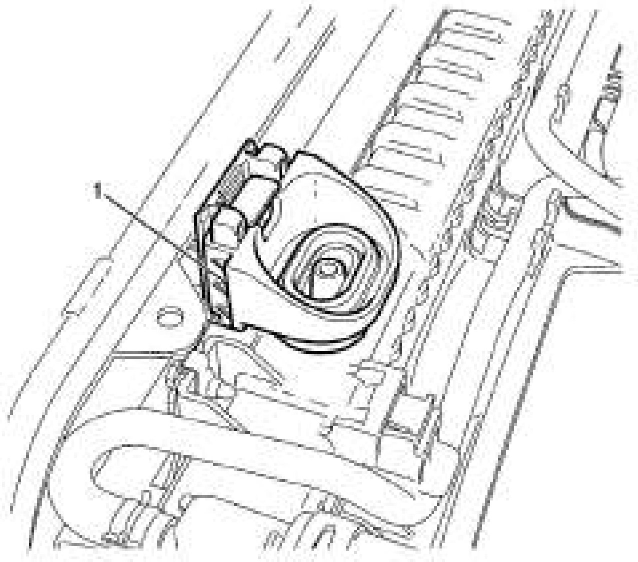
   Notice: Refer to Fastener Notice in the Preface section.



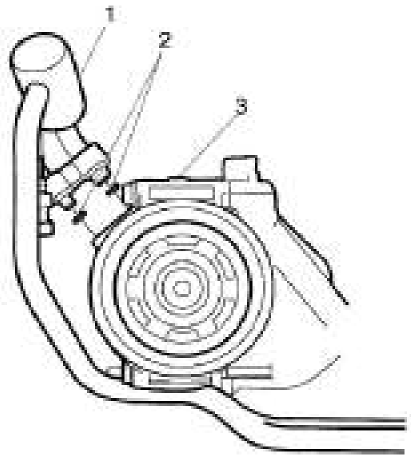
   Important: Gently push the radiator and condenser towards the engine to allow installation of the discharge pipe to condenser retaining nut (1).

4. Install the discharge pipe to condenser retaining nut (1).

   Tighten
   Tighten the nut to 22 N·m (16 lb ft).



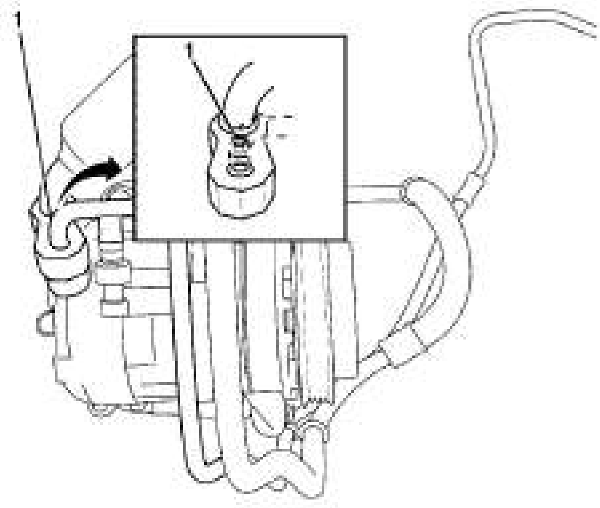
5. Install the upper radiator support brackets (1).



6. Remove the plugs or caps from the suction/discharge pipes (1) and the ports on the compressor (3).

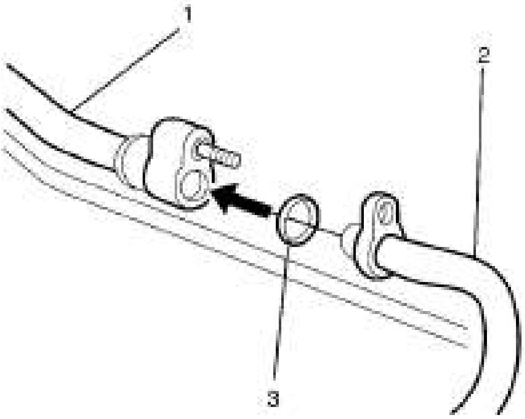
Important: DO NOT coat the sealing washers (2) with oil, they must be fitted dry. The use of mineral oil will render the washer useless, as the sealing washers (2) WILL swell causing refrigerant to leak out.

7. Install two NEW sealing washers (2). Refer to Sealing Washer Replacement.
8. Connect the suction/discharge pipes (1) to the compressor (3).



9. Install the suction/discharge pipe to the compressor retaining bolt (2).

   Tighten
   Tighten the bolt to 22 N·m(16 lb ft).

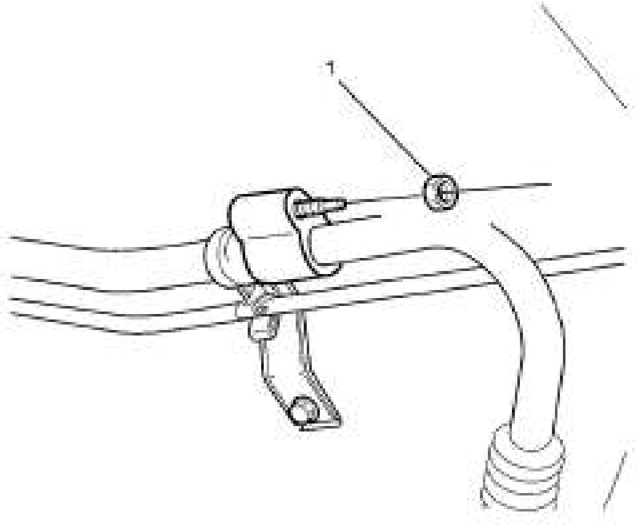


10. Remove the plugs or caps from the suction pipe upper (1) and the suction pipe lower (2).

    Important: DO NOT coat the NEW sealing washer (3) with oil, they must be fitted dry. The use of mineral oil will render the sealing washer (3) useless, as the sealing washer (3) WILL swell causing refrigerant to leak out.

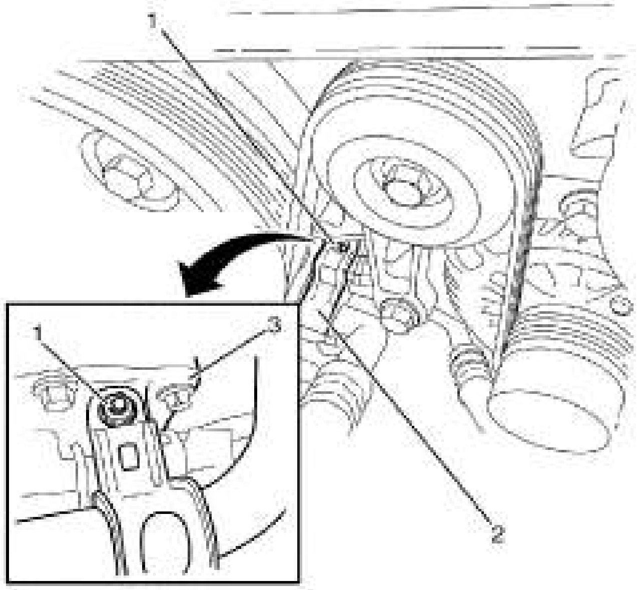
11. Install a NEW sealing washer (3). Refer to Sealing Washer Replacement.

12. Install the suction pipe upper (1) to the suction pipe lower (2).



13. Install the suction pipe upper to suction pipe lower retaining nut (1).

Tighten
Tighten the nut to 22 N·m(16 lb ft).



14. Position the discharge hose retaining bracket (2) to the oil pan (3).
15. Install the discharge hose retaining bracket to oil pan retaining nut (1).

Tighten
Tighten the nut to 22 N·m (16 lb ft).

16. Install the engine cover. Refer to Engine Cover Replacement.
17. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.
18. Install the air filter assembly. Refer to Air Cleaner Assembly Replacement.
19. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
20. Evacuate and recharge the A/C system. Refer to Refrigerant Recovery and Recharging.
21. Leak test the fittings of the components using J 39400-A .

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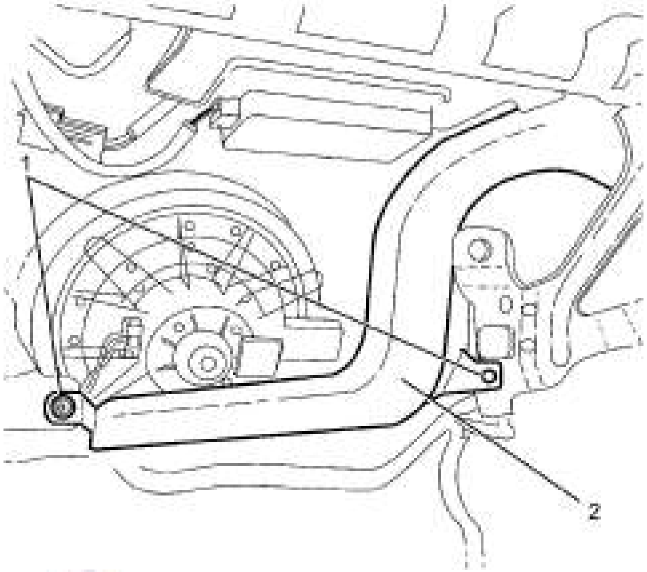
Floor Air Outlet Duct Replacement - Left Side

Removal Procedure

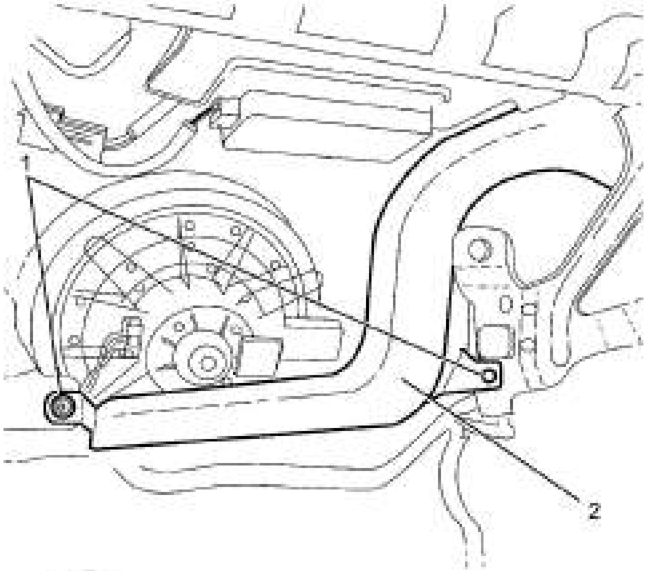
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Remove the glove box assembly. Refer to Instrument Panel Compartment Replacement .



2. Remove the floor air outlet duct to instrument panel (I/P) retaining screws (1).
3. Remove floor air outlet duct (2) from the I/P.

Installation Procedure



1. Install the floor air outlet duct 2 to the instrument panel (I/P).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the floor air outlet duct to I/P retaining screws (1) .

   Tighten
   Tighten the screws to 2 N·m(18lb in).

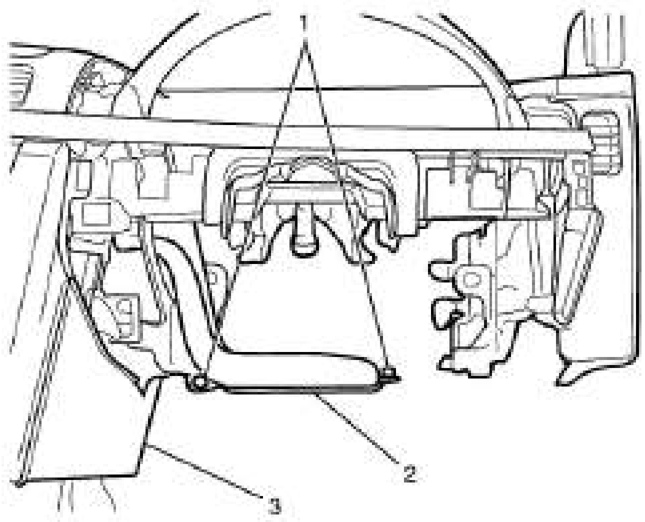
3. Install the glove box assembly. Refer to Instrument Panel Compartment Replacement .

Floor Air Outlet Duct Replacement - Right Side

Removal Procedure

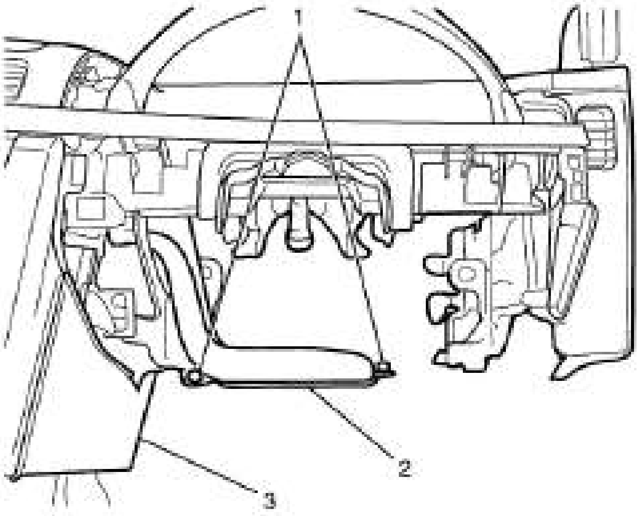
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Remove the knee bolster. Refer to Knee Bolster Replacement .



2. Remove the floor air outlet duct to instrument panel (I/P) retaining screws (1).
3. Remove the floor air outlet duct (3) from the I/P (2).

Installation Procedure



1. Install the floor air outlet duct (3) to the instrument panel (I/P) (2).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the floor air outlet duct to I/P retaining screws (1)

   Tighten
   Tighten the screws to 2 N·m(18 lb in).

3. Install the knee bolster. Refer to Knee Bolster Replacement .

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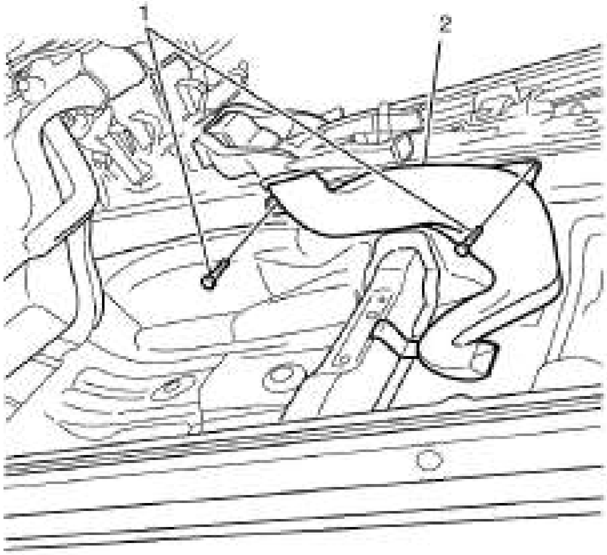
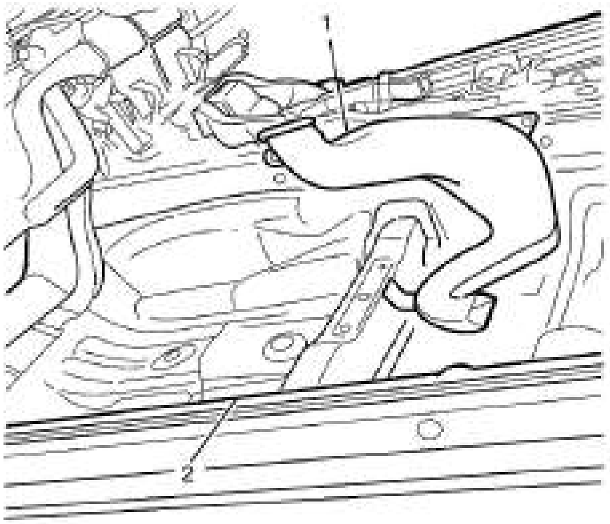
Floor Rear Air Outlet Duct Replacement - Left Side (RHD)

Removal Procedure

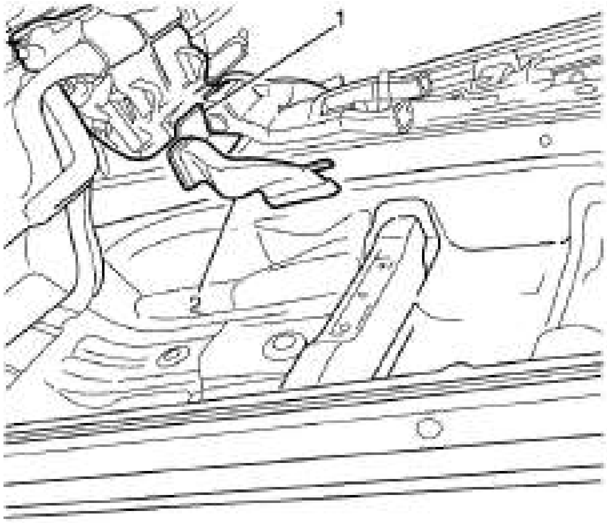
1. Remove the centre console. Refer to Front Floor Console Replacement.
2. Remove the front carpet. Refer to Front Floor Panel Carpet Replacement.



3. Remove the push pin (1) from the rear floor air outlet duct (2).

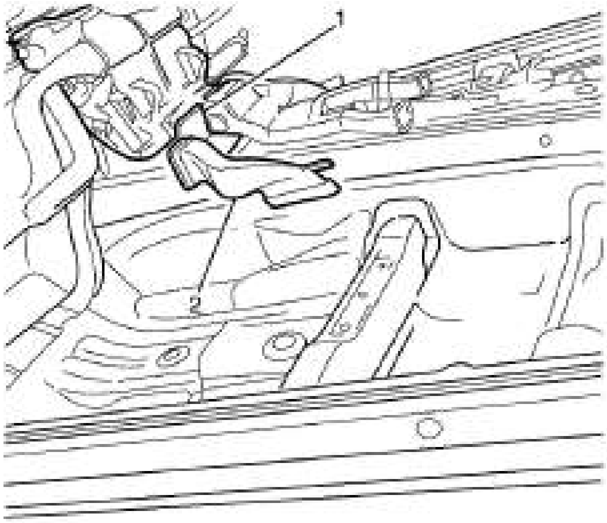


4. Remove the rear floor air outlet duct (1) from the floor (2).

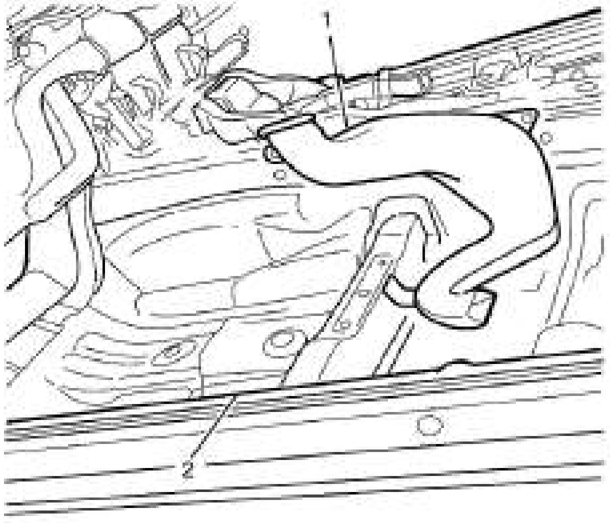


5. Disconnect the rear floor air outlet duct (2) from the HVAC module assembly (1).

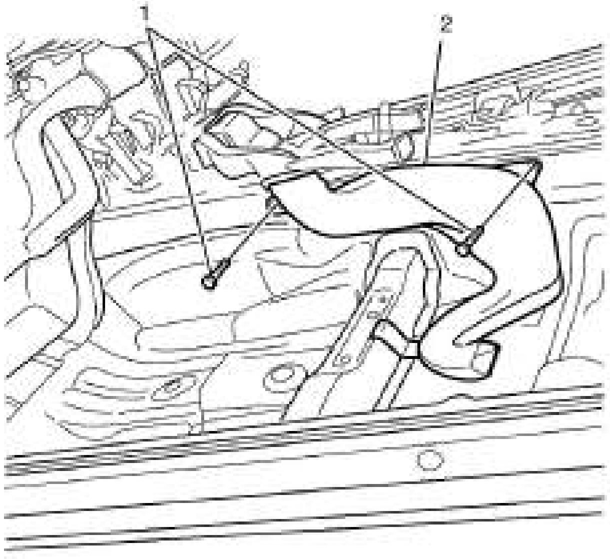
Installation Procedure



1. Install the rear floor air outlet duct (2) to the HVAC module assembly (1).



2. Install the rear floor air outlet duct (1) to the floor (2).



3. Install the push pins (1) to the rear floor air outlet duct (2).
4. Install the centre console. Refer to Front Floor Console Replacement.
5. Install the front carpet. Refer to Front Floor Panel Carpet Replacement.

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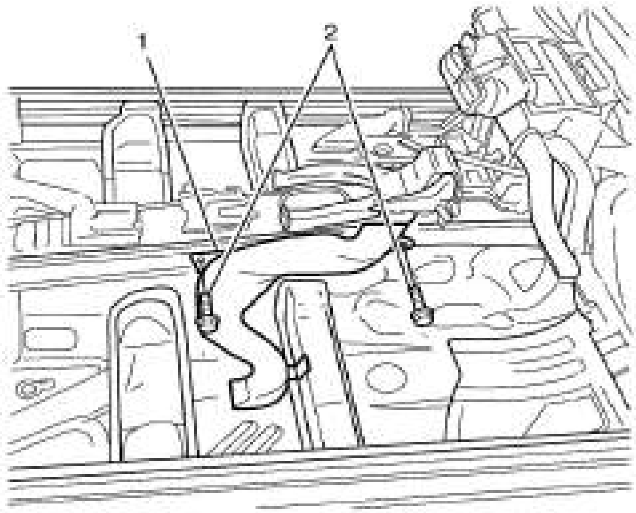
Floor Rear Air Outlet Duct Replacement - Right Side (RHD)

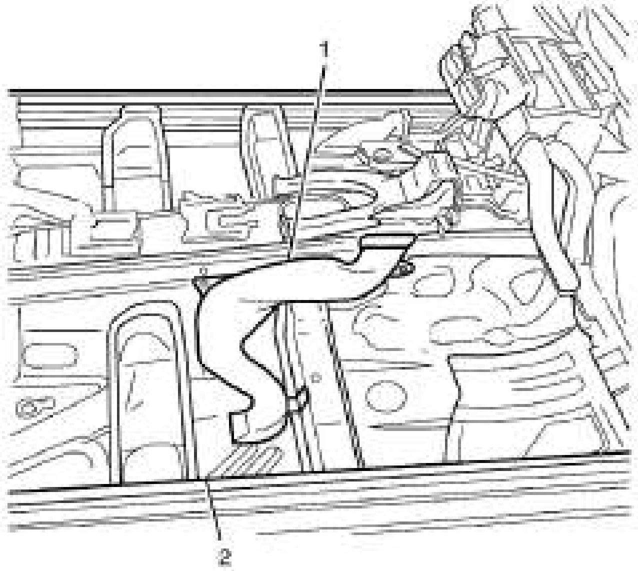
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

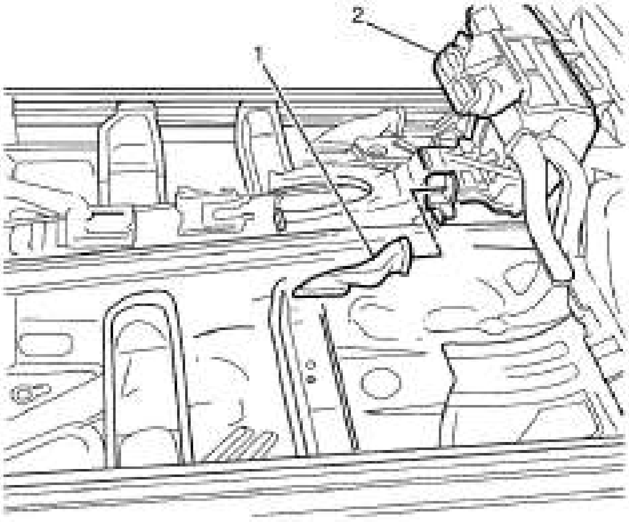
1. Remove the front carpet. Refer to Front Floor Panel Carpet Replacement.
2. Remove the centre console. Refer to Front Floor Console Replacement.



3. Remove the push pins (2) from the rear floor air outlet duct (1).

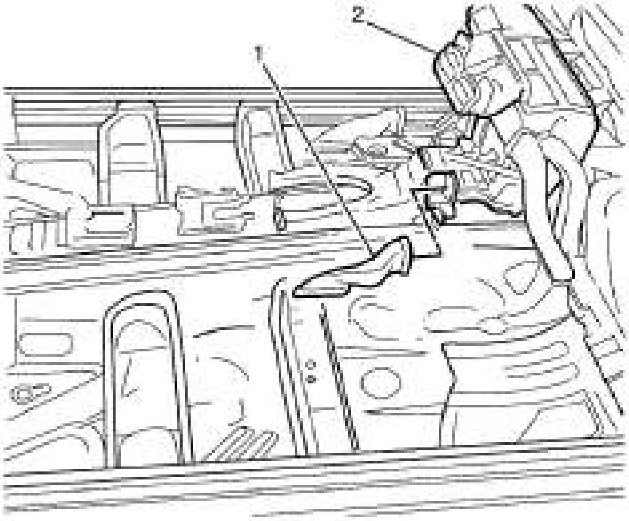


4. Remove the rear floor air outlet duct (1) from the floor (2).

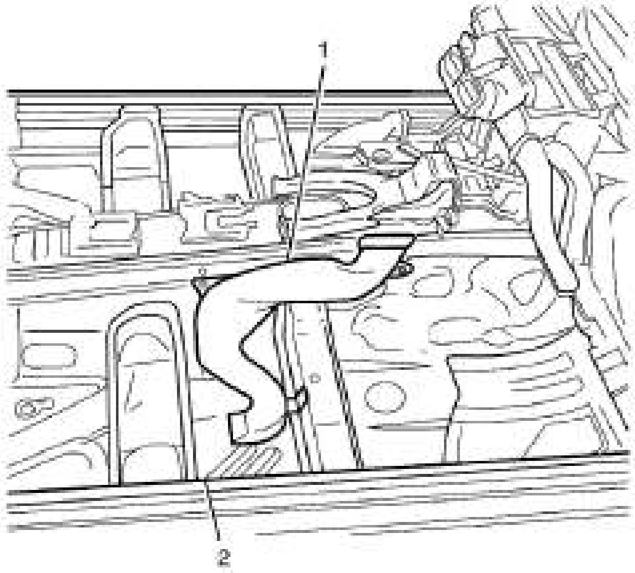


5. Disconnect the rear floor air outlet duct (1) from the HVAC module assembly (2).

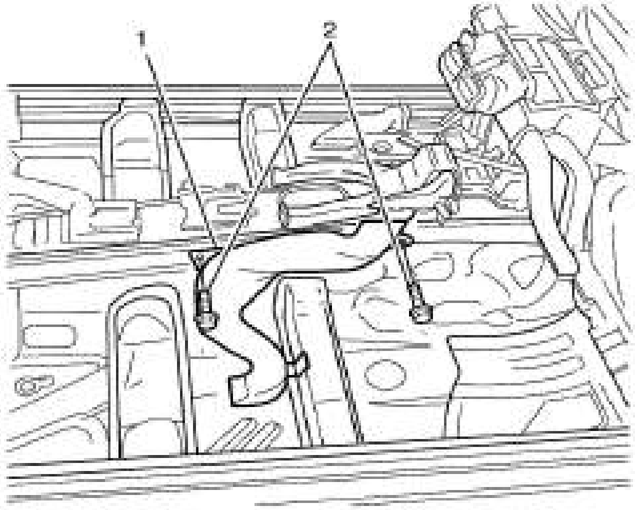
Installation Procedure



1. Install the rear floor air outlet duct (1) to the HVAC module assembly (2).



2. Install the rear floor air outlet duct (1) to the floor (2).



3. Install the push pins (2) to the rear floor air outlet duct (1).
4. Install the centre console. Refer to Front Floor Console Replacement.
5. Install the front carpet. Refer to Front Floor Panel Carpet Replacement.

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Flushing

Tools Required

- R-134a - A/C Tracer Dye Box of 24
- Universal 12 V Leak Detection Lamp
- Air Conditioning Service Centre
- A/C Flush Adapter Kit

The A/C system and in particular the heat exchangers (evaporator and condenser) will need to be flushed (cleaned internally) if the following issues have occurred:

- A/C system "over lubricated". This normally occurs after a compressor has been replaced and the oil balancing procedure has not been carried correctly. This condition shows up as an extremely high high pressure (HP) reading.
- Contamination such as aluminium particles in the A/C system which cause blockages in the condenser, receiver dehydrator and TX valve. The most common component causing contamination through the A/C system is a compressor that has internally collapsed.

Flush Procedure

Important: It is imperative that all safety rules and first aid is followed for the specific flushing solvent being used. Consult with your solvent supplier and ask for an MSDS (Material Safety Data Sheet) which will outline all safety precautions.

1. Recover the refrigerant. Refer to Refrigerant Recovery and Recharging .

Important: The recommended method of flushing is the open loop. Read the instructions regarding health, safety and environmental issues prior to commencing the flushing procedure.

2. Remove the compressor. Refer to Air Conditioning Compressor Replacement .
3. Drain all the oil through the compressor drain plug then through the rear hose pad ports. DO NOT flush through the compressor.

Important: It is important to follow the process found in Receiver Dehydrator Replacement for correct removal of receiver dehydrator

Important: DO NOT reuse the receiver dehydrator after removal.

4. Remove the receiver dehydrator.

Discard the receiver dehydrator

Important: Place the TX valve in a plastic bag to avoid any contamination from air born dirt or moisture.

5. Disconnect all hose/pipe fittings from the TX valve. Refer to Air Conditioning Evaporator

Thermal Expansion Valve Replacement . Refer to Air Conditioning Condenser Replacement .

6. Remove the TX valve. Refer to Air Conditioning Evaporator Thermal Expansion Valve Replacement .
7. Fill the flushing vessel with solvent. Connect the pressure hose and the flush gun handle to the outlet side of the component being flushed.
8. Connect a clear plastic hose (simply wedge the hose in place or use worm drive clips) to the outlet port for discharging solvent waste to the collection container.
9. Connect the solvent container to a pressure source such as dry workshop compressed air or dry Nitrogen (NO2). This pressure is required to force the solvent through the A/C components.
10. Activate flush gun and force solvent through the component.
11. On the same component being flushed, reverse direction flush.
12. View through the clear plastic discharge hose to see when the liquid become clear, this indicates the level of cleanliness of the component internals. Repeat this operation on the evaporator, condenser, hoses and pipes.
13. After flushing is finished, allow 30 minutes with the system still open to atmosphere, to "boil off" any solvent residue left in the components. Then reconnect all parts using NEW sealing washers.
14. Add the total specified amount of PAG oil (used for the complete system) to the compressor, through the drain plug and by turning the front pulley.

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Heater Core Replacement (RHD)

Removal Procedure

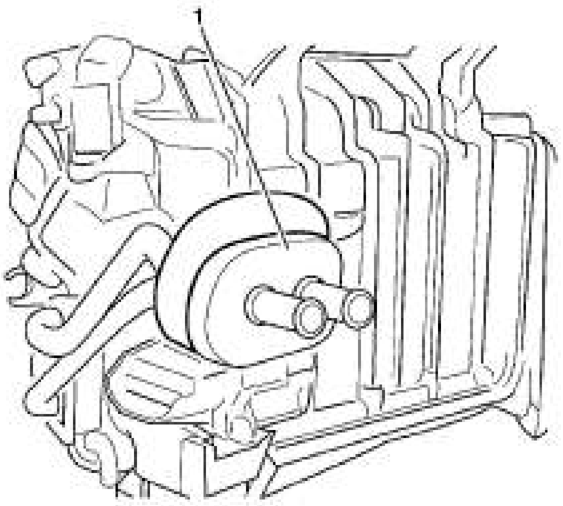
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Recover the refrigerant. Refer to Refrigerant Recovery and Recharging.

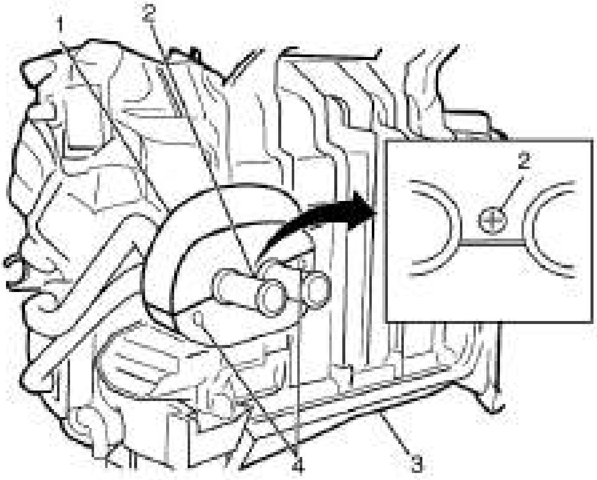
   Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

   Important: Apply tape or blanking plugs to the heater core pipes to contain any coolant left in the heater core, This is to avoid a coolant spill onto the carpet during HVAC removal.

2. Remove the HVAC module assembly. Refer to HVAC Module Assembly Replacement.

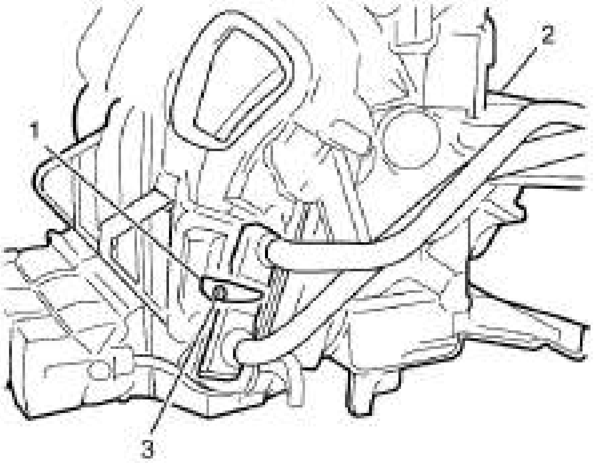


3. Remove the foam seal (1) from the heater core pipes (2).

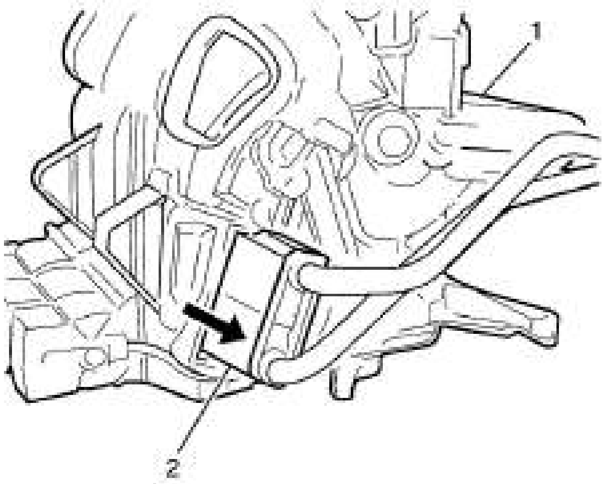


Important: The heater core pipe locating plate (1) incorporates two guide pins (4) to locate the heater core pipe locating plate (1) to the HVAC module assembly (3). Care must be taken not to damage the guide pins (4).

4. Remove the heater core pipe locating plate to HVAC module assembly retaining screw (2).
5. Remove the heater core pipe locating plate (1) from the HVAC module assembly (3).



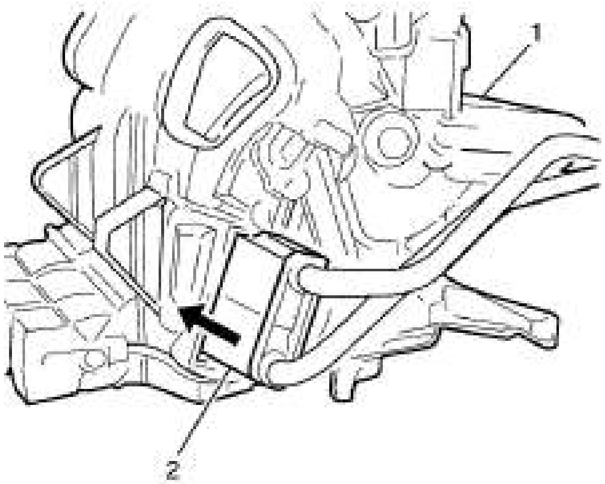
6. Remove the heater core retaining plate to HVAC module assembly retaining screw (3).
7. Remove the heater core retaining plate (1) from the HVAC module assembly (2).



Important: Carefully slide the heater core (2) out of the HVAC module assembly (1).

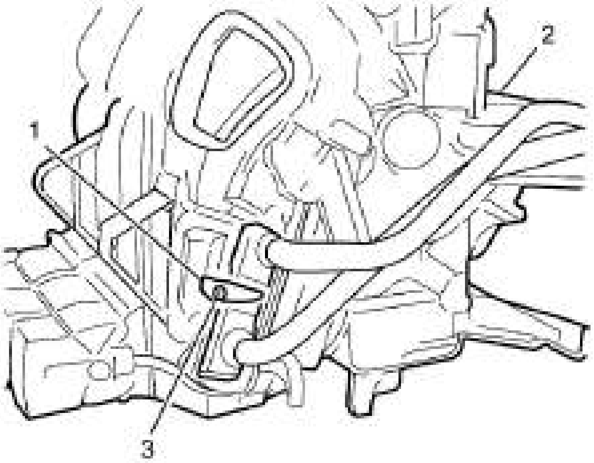
8. Remove the heater core (2) from the HVAC module assembly (1).

Installation Procedure



Important: Make sure that all the foam seals are fitted when installing the heater core (2). If a foam seal is missing do not fit the heater core (2).

1. Install the heater core (2) into the HVAC module assembly (1).

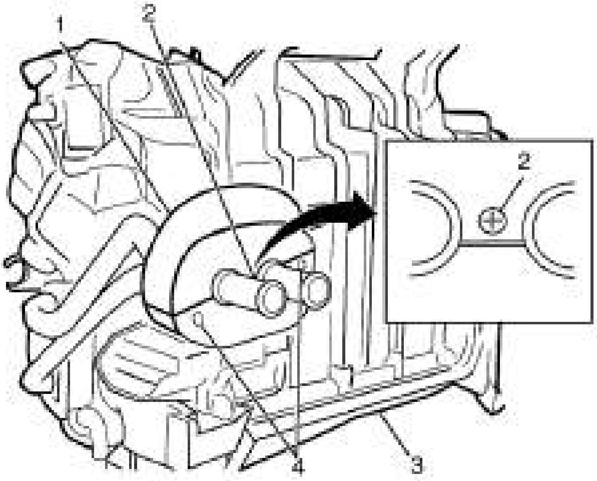


2. Install the heater core retaining plate (1) to the HVAC module assembly (2).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the heater core retaining plate to HVAC module assembly retaining screw (3).

   Tighten
   Tighten the screw to 1 N·m (9 lb in).



Important: The heater core pipe locating plate (2) incorporates two guide pins (4) to locate the heater core pipe locating plate (2) to the HVAC module assembly (3). Care must be taken not to damage the guide pins (4).

4. Install the heater core pipe locating plate (2) to the HVAC module assembly (3).
5. Install the heater core pipe locating plate to HVAC module assembly retaining screw (1).

   Tighten
   Tighten the screw to 1 N·m (9 lb in).

6. Install the HVAC module assembly. Refer to HVAC Module Assembly Replacement.
7. Refill the coolant system, Refer to Cooling System Draining and Filling.
8. Recharge the refrigerant Refer to Refrigerant Recovery and Recharging.

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Heater Hose Assembly Replacement (6.0L Engine)

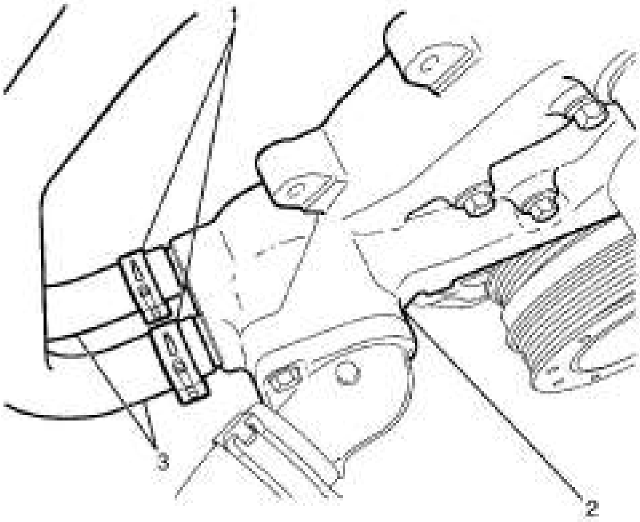
Tools Required

J 38185 Hose Clamp Pliers

Removal Procedure

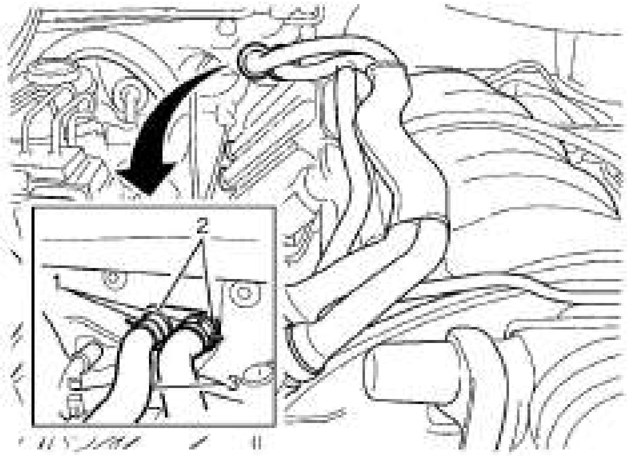
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Remove the engine cover. Refer to Engine Cover Replacement
2. Drain the cooling system. Refer to Cooling System Draining and Filling .



Important: Mark position of heater hoses (3) and heater hose retaining clamps (1) before removal to make sure of correct alignment during assembly.

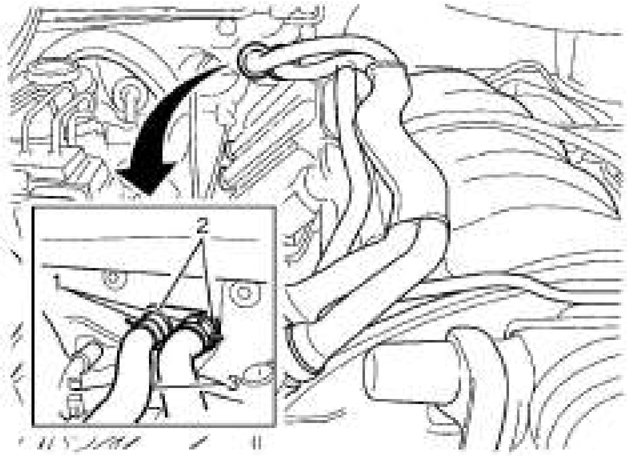
3. Using J 38185 compress the heater hose retaining clamps (1) and slide 50 mm (2 in) along the heater hose (3).
4. Disconnect the heater hoses (3) from the water pump housing (2).



Important: Mark position of heater hoses (3) and heater hose retaining clamps (1) before removal to make sure of correct alignment during assembly.

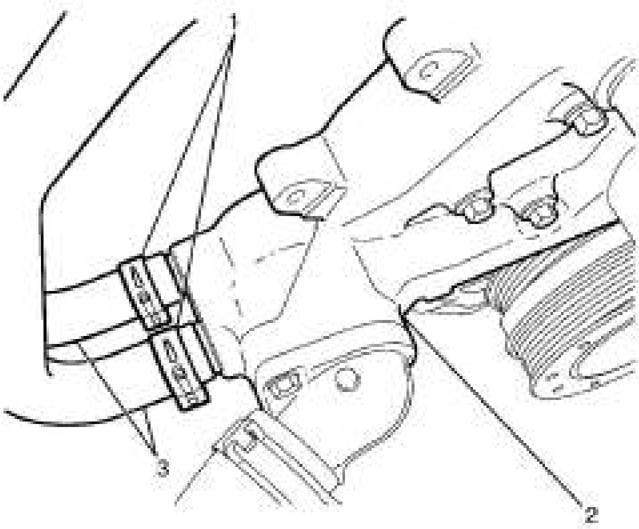
5. Using J 38185 compress the heater hose retaining clamps (1) and slide 50 mm (2 in) along the heater hose (3).
6. Disconnect the heater hoses (3) from the heater core pipes (2).
7. Remove the heater hose assembly.

Installation Procedure



1. Connect the heater hoses (3) to the heater core pipes (2).

2. Using J 38185 slide the heater hose retaining clamps (1) back into the original position on the heater hoses (3).



3. Connect the heater hoses (1) to the water pump housing (2).
4. Using J 38185 slide the heater hose retaining clamps (1) back into the original position on the heater hoses (3).
5. Fill the cooling system. Refer to Cooling System Draining and Filling .
6. Install the engine cover.Refer to Engine Cover Replacement

Heater Inlet Hose Replacement

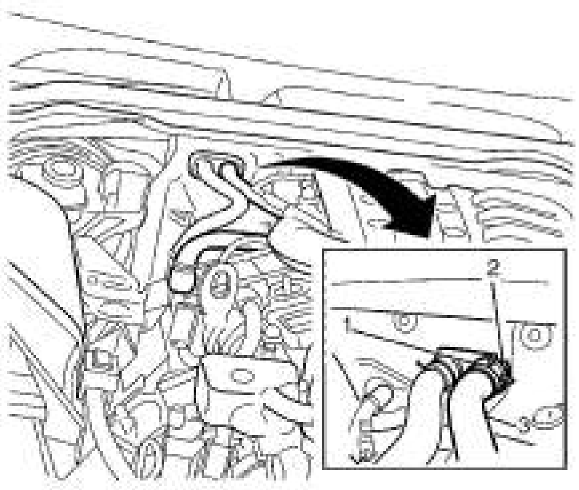
Tools Required

J 38185	Hose Clamp Pliers

Removal Procedure

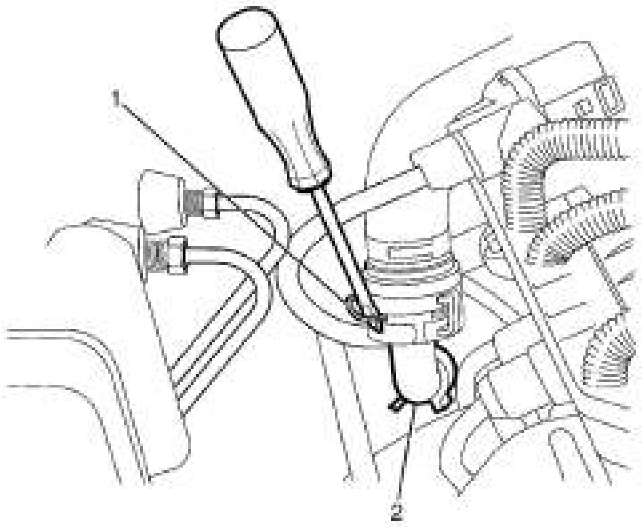
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Drain the cooling system. Refer to Cooling System Draining and Filling .
2. Remove the engine cover. Refer to Engine Cover Replacement

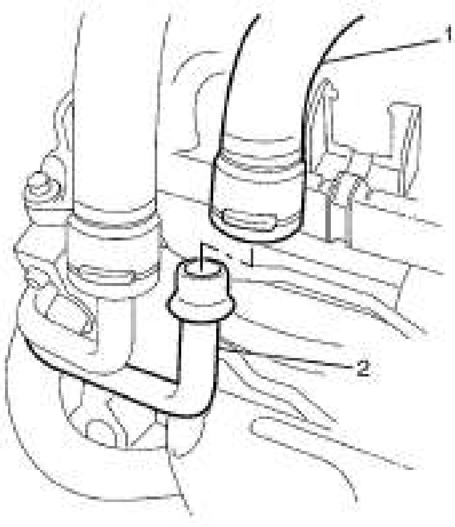


Important: Mark position of the heater inlet hose (3) and the heater inlet hose retaining clamp (1) before removal to make sure of correct alignment during assembly.

3. Using J 38185 slide the heater inlet hose retaining clamp (1) and slide 50 mm (2 in) along the heater inlet hose (3).
4. Disconnect the heater inlet hose (3) from the heater core pipe (2).



5. Detach the heater inlet hose quick connect fitting by releasing the retaining clip (1) with a suitable tool, from the heater pipe (2).

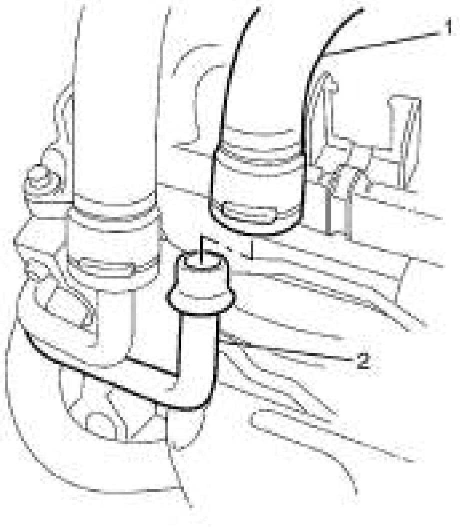


6. Disconnect the heater inlet hose (1) from the heater inlet pipe (2).

Installation Procedure

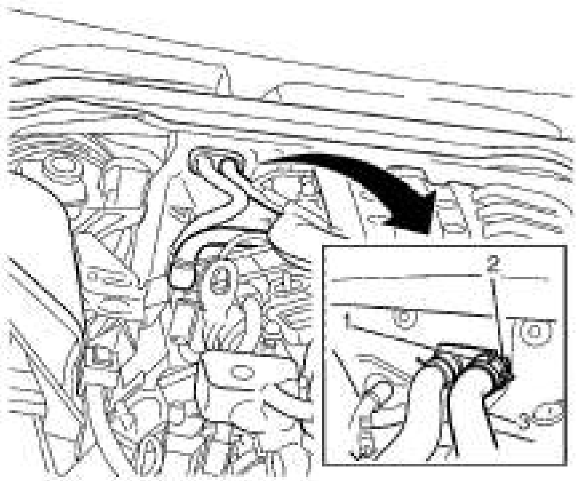
Caution: Refer to Installing Hoses without Twists or Bends Notice in the Preface section.

1. Install the heater inlet hose.



Important: Listen for an audible click to confirm fitting.

2. Connect the heater inlet hose (1) to the heater inlet pipe (2).



3. Connect the heater inlet hose (3) to the heater core pipe (2).
4. Using J 38185 slide the heater inlet hose retaining clamp (1) back into the original position on the heater inlet hose (3).
5. Refit the right side engine cover. Refer to Engine Cover Replacement
6. Fill the cooling system. Refer to Cooling System Draining and Filling .

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Heater Outlet Hose Replacement

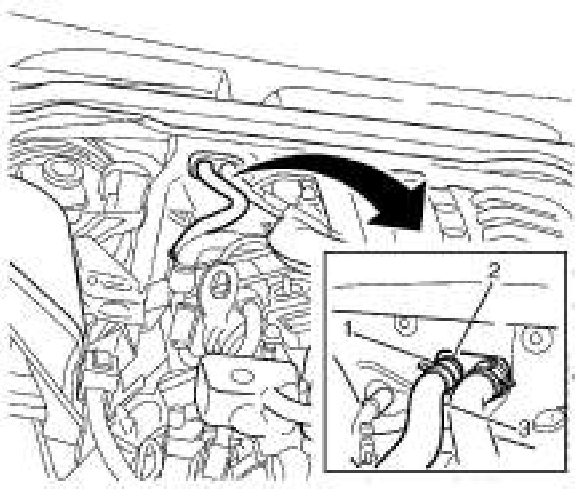
Tools Required

J 38185	Hose Clamp Pliers

Removal Procedure

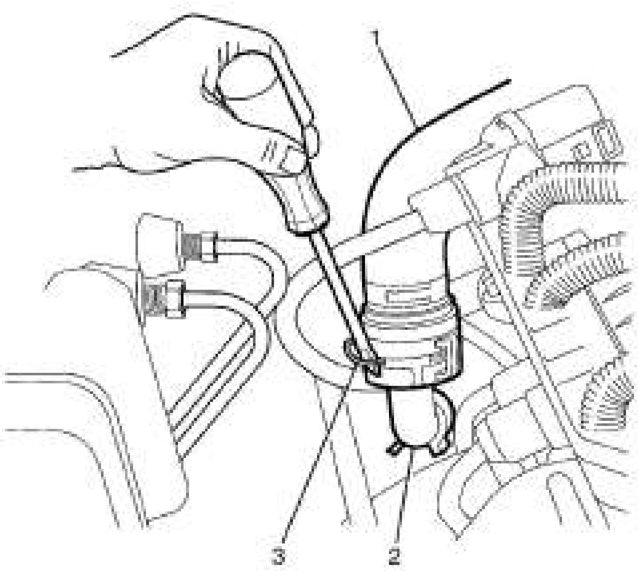
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Drain the cooling system. Refer to Cooling System Draining and Filling .
2. Remove the engine cover. Refer to Engine Cover Replacement

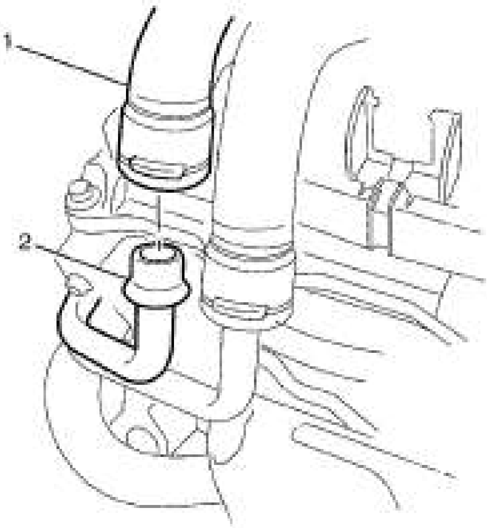


Important: Mark position of the heater outlet hose (3) and the heater outlet hose retaining clamp (1) before removal to make sure of correct alignment during assembly.

3. Using J 38185 compress the heater outlet hose retaining clamp (1) and slide 50 mm (2 in) along the heater outlet hose (3).
4. Disconnect the heater outlet hose (3) from the heater core pipe (2).



5. Detach the heater hose (1) quick connect fitting by releasing the retaining clip (3) with a suitable tool, from the heater pipe (2).

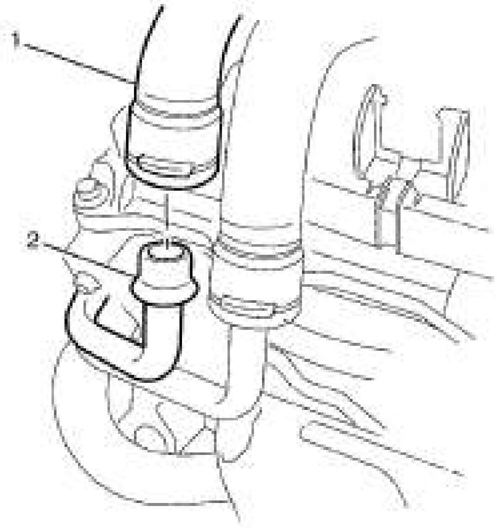


6. Remove the heater outlet hose (1) from the heater outlet pipe (2).

Installation Procedure

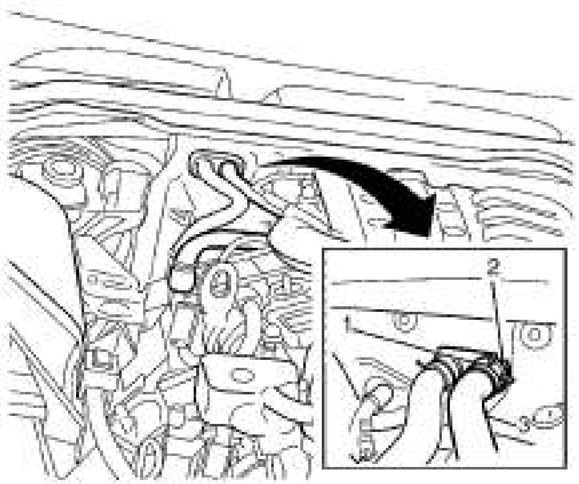
Caution: Refer to Installing Hoses without Twists or Bends Notice in the Preface section.

1. Install the heater inlet hose.



Important: Listen for an audible click to confirm fitting.

2. Connect the heater outlet hose (1) to the heater outlet pipe (2).



3. Connect the heater outlet hose (3) to the heater core pipe (2).
4. Using J 38185 slide the heater outlet hose retaining clamp (1) back into the original position on the heater outlet hose (3).
5. Refit the right side engine cover. Refer to Engine Cover Replacement
6. Fill the cooling system. Refer to Cooling System Draining and Filling .

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HVAC Module Assembly Replacement (RHD)

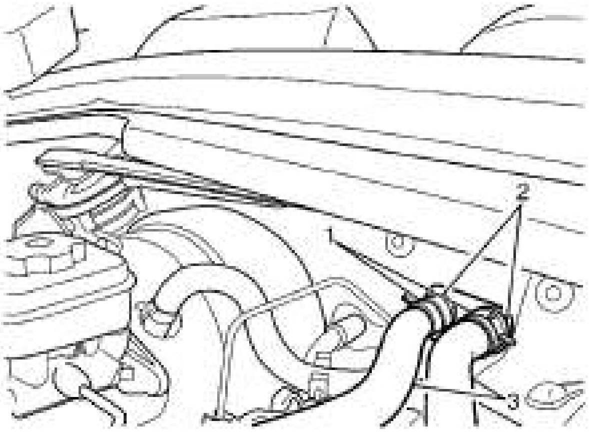
Tools Required

- J 38185 Hose Clamp Pliers
- J 39400 Halogen Leak Detector

Removal Procedure

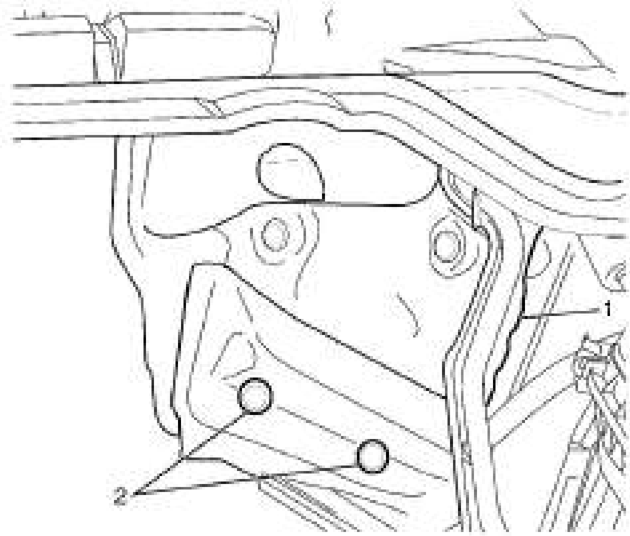
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Recover the refrigerant. Refer to Refrigerant Recovery and Recharging .
2. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove the engine cover. Refer to Engine Cover Replacement in Engine Mechanical - 3.6L or Engine Cover Replacement Engine Mechanical - 6.0L
4. Drain the cooling system. Refer to Cooling System Draining and Filling.

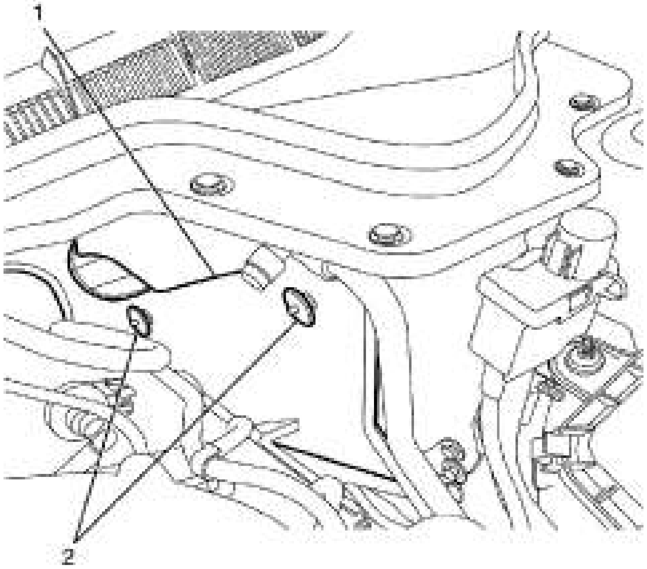


Important: Mark position of heater hoses (3) and heater hose retaining clamps (1) before removal to make sure of correct alignment during assembly.

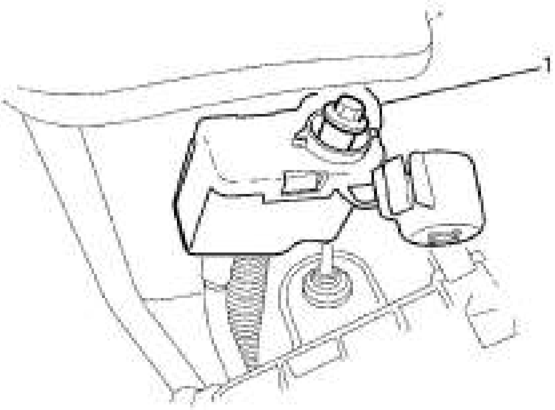
5. Using J 38185 compress the heater hose retaining clamps (1) and slide 50 mm (2 in) along the heater hose (3).
6. Remove the heater hoses (3) from the heater core pipes (2).



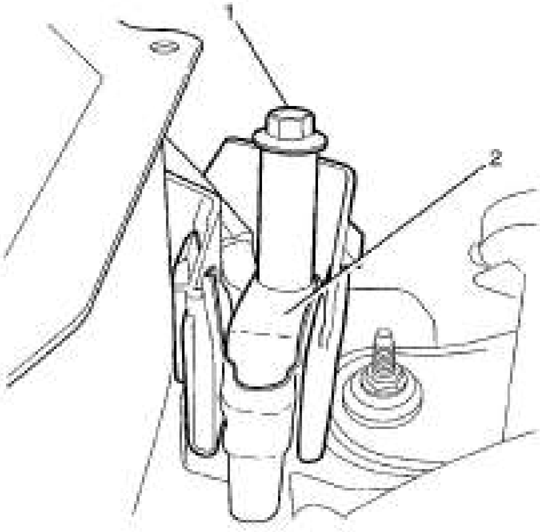
7. Remove the exhaust manifold heat shield to air box retaining clips (2).
8. Remove the exhaust manifold heat shield (1).



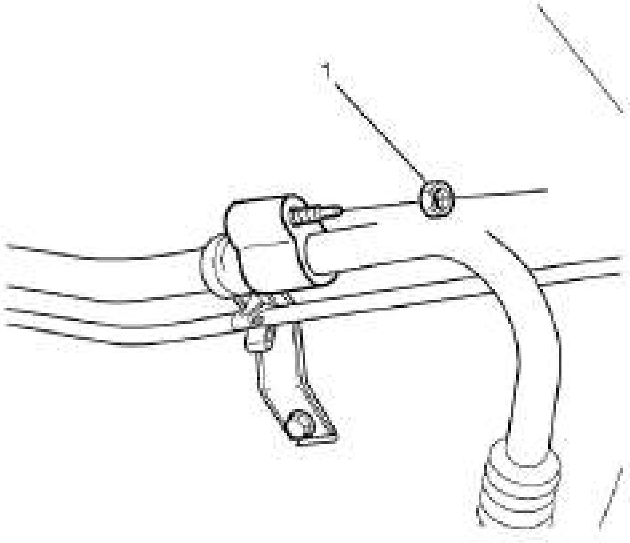
9. Remove the insulation panel to air box retaining clips (2).
10. Remove the insulation panel (1) from the engine compartment.



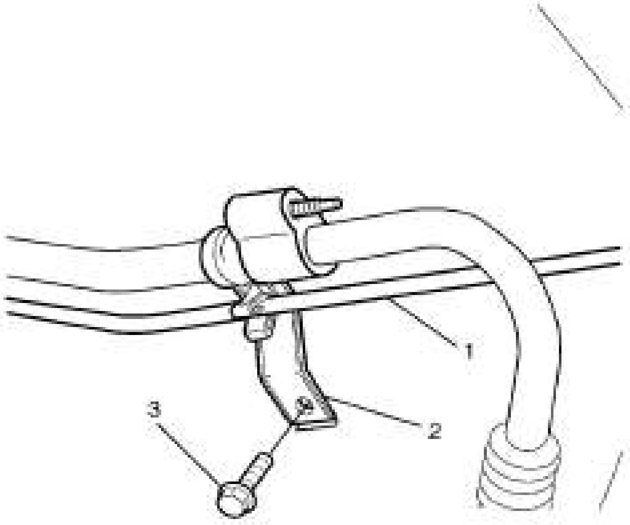
11. Remove the remote battery positive post cover (1).



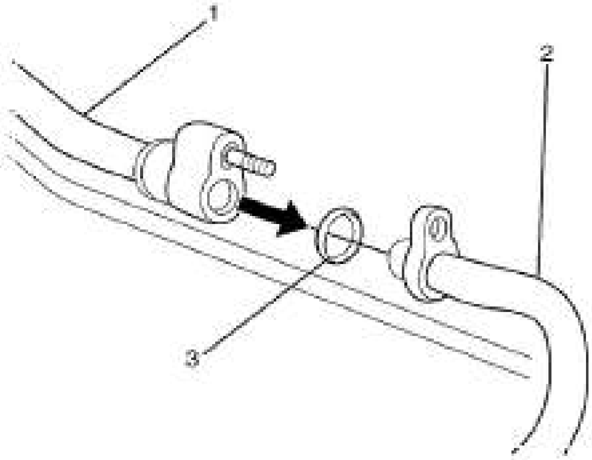
12. Remove the remote battery positive post to wiring harness retaining bolt (1).
13. Remove the starter motor power cable (2) and position aside.



14. Remove the suction pipe upper to suction pipe lower retaining nut (1).



15. Remove the suction pipe/liquid pipe retaining clip to left front chassis rail retaining bolt (3).
16. Detach the liquid pipe (1) from the suction pipe/liquid pipe retaining clip (2).



17. Disconnect the suction pipe upper (1) from the suction pipe lower (2).

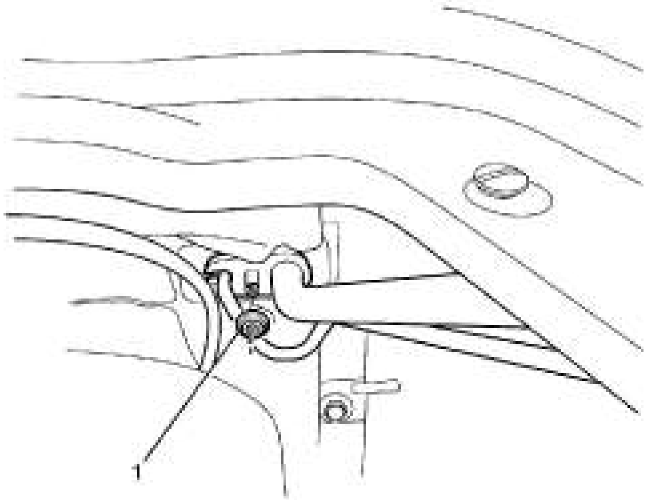
    Important: The sealing washer (3) is a single use item and must be discarded after use.

18. Remove the sealing washer (3). Refer to Sealing Washer Replacement .

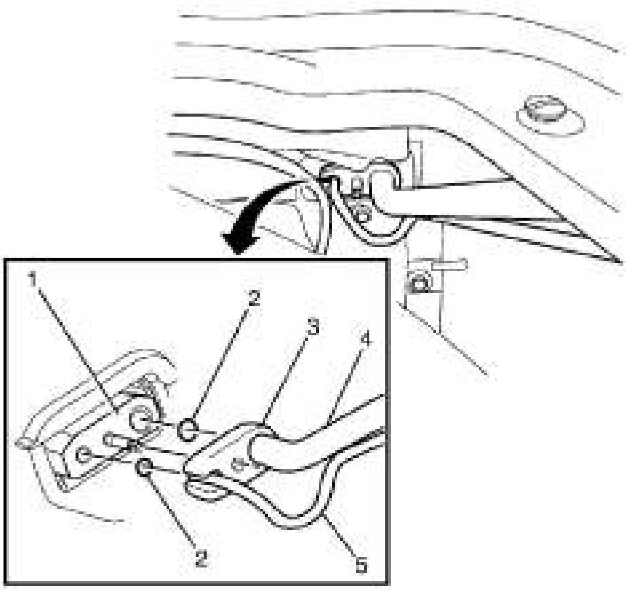
    Discard the sealing washer

    Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

19. Cap or plug the suction pipe upper (1) and the suction pipe lower (2).



20. Remove the suction pipe/liquid pipe pad to thermal expansion (TX) valve retaining nut (1).



21. Disconnect the suction pipe/liquid pipe pad (3) from the TX valve (1).

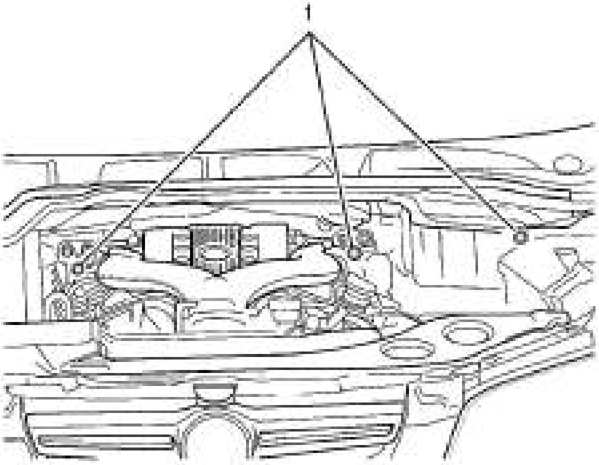
Important: The sealing washers (2) are a single use item and must be discarded after use.

22. Remove the sealing washers (2). Refer to Sealing Washer Replacement.

Discard the sealing washers

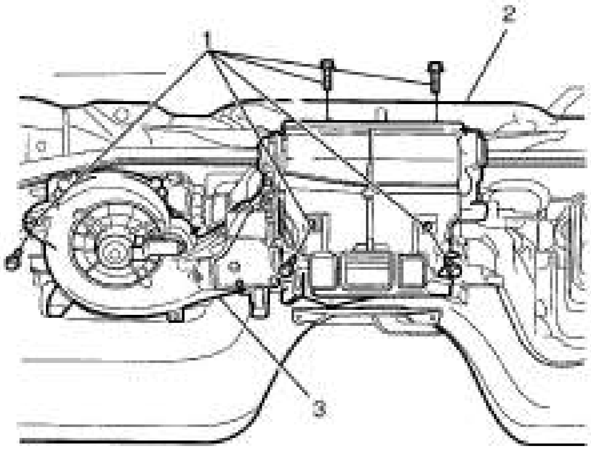
Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

23. Cap or plug the suction pipe (4), liquid pipe (5) and the TX valve (1).



24. Remove the HVAC module assembly to bulkhead retaining bolts (1).

25. Remove the I/P centre support bracket. Refer to Instrument Panel Retainer Replacement.
26. Remove the I/P upper trim pad. Refer to Instrument Panel Upper Trim Pad Replacement.

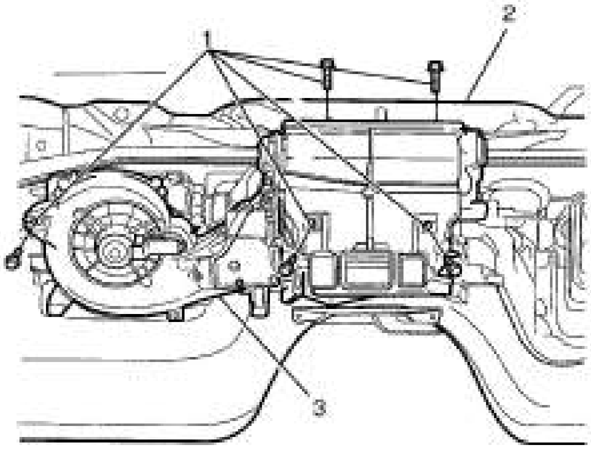


27. Remove the HVAC module assembly to vehicle body retaining screws (1).
28. Remove the I/P carrier. Refer to Instrument Panel Carrier Replacement.

Important: To remove the HVAC module assembly from the vehicle move the HVAC module assembly towards the back of the car off the drain assembly and downwards to clear locating pins from datum bracket.

29. Remove the HVAC module assembly (3) from the vehicle body (2).

Installation Procedure



Important: Make sure the HVAC module assembly (3) fits into the drain assembly

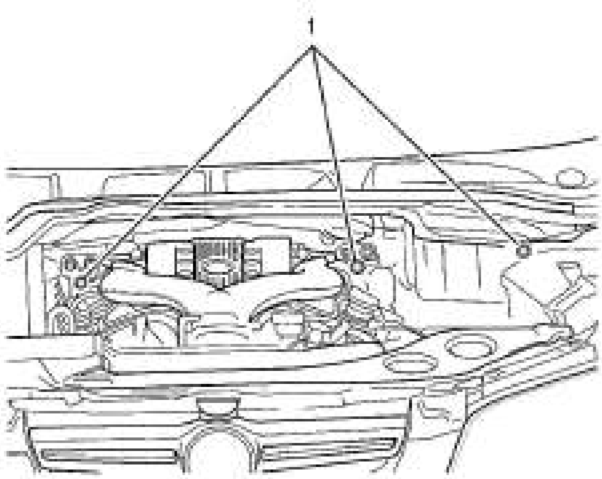
1. Install the HVAC module assembly to the vehicle (2).
2. Install the instrument panel (I/P) carrier. Refer to Instrument Panel Carrier Replacement.

Notice: Refer to Fastener Notice in the Preface section.

3. Install the HVAC module assembly to I/P carrier retaining screws (1).

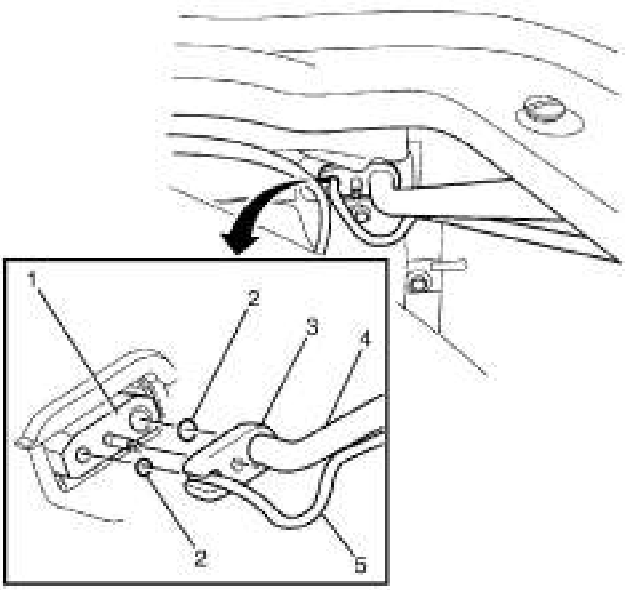
Tighten
Tighten the screws to 9 N·m.80 lb in.

4. Install the I/P upper trim pad. Refer to Instrument Panel Upper Trim Pad Replacement.
5. Install the I/P retainer bracket. Refer to Instrument Panel Retainer Replacement .



6. Install the HVAC module assembly to bulkhead retaining bolts (1).

Tighten
Tighten the nuts to 7 N·m.62 lb in.

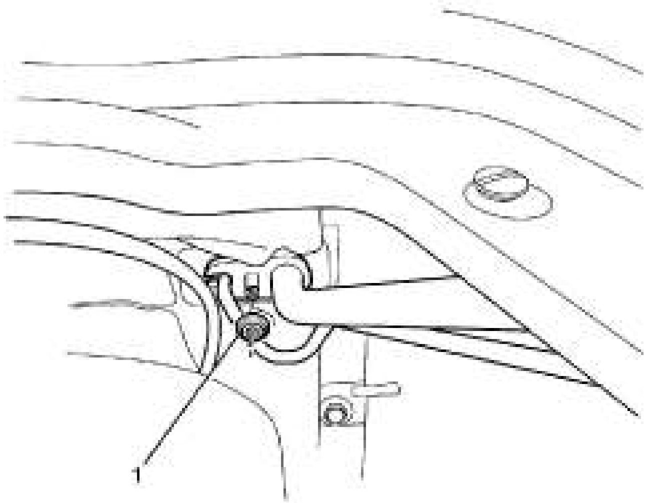


7. Remove the plugs or caps from the suction pipe (4), liquid pipe (5) and the thermal expansion (TX) valve (1).

Important: DO NOT coat the NEW sealing washers (2) with oil, they must be fitted dry. The use of mineral oil will render the sealing washers (2) useless, as the sealing washers (2) WILL swell causing refrigerant to leak out.

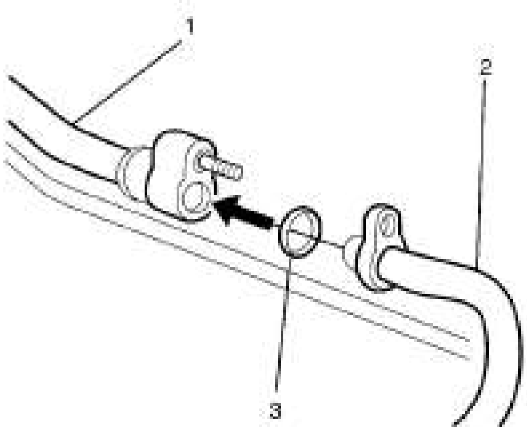
8. Install NEW sealing washers (2). Refer to Sealing Washer Replacement.
9. Connect the suction pipe/liquid pipe pad (3) to the TX Valve (1).

Notice: Refer to Fastener Notice in the Preface section.



10. Install the suction pipe/liquid pipe pad to TX valve retaining nut (1).

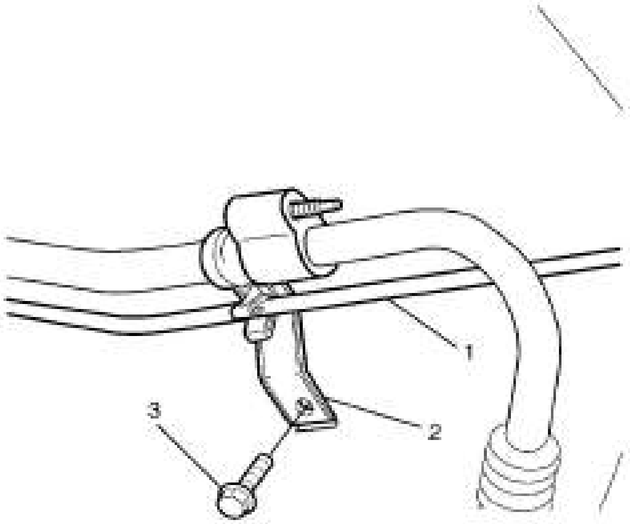
    Tighten
    Tighten the nut to 22 N·m(16 lb ft).



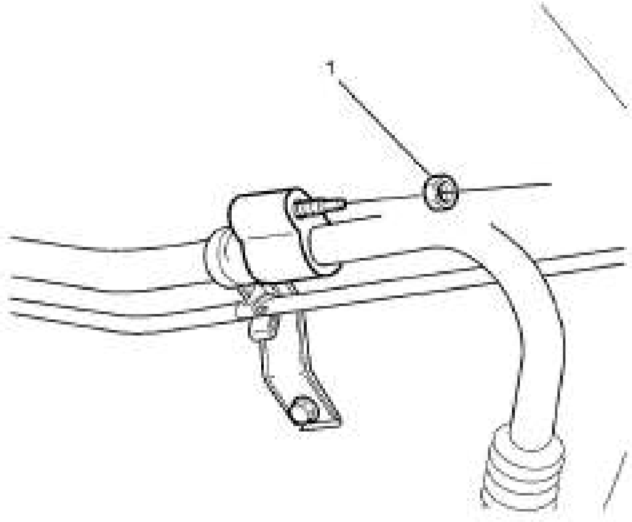
11. Remove the plugs or caps from the suction pipe upper (1) and the suction pipe lower (2).

    Important: DO NOT coat the NEW sealing washer (3) with oil, they must be fitted dry. The use of mineral oil will render the sealing washer (3) useless, as the sealing washer (3) WILL swell causing refrigerant to leak out.

12. Install a NEW sealing washer (3). Refer to Sealing Washer Replacement.
13. Install the suction pipe upper (1) to the suction pipe lower (2).

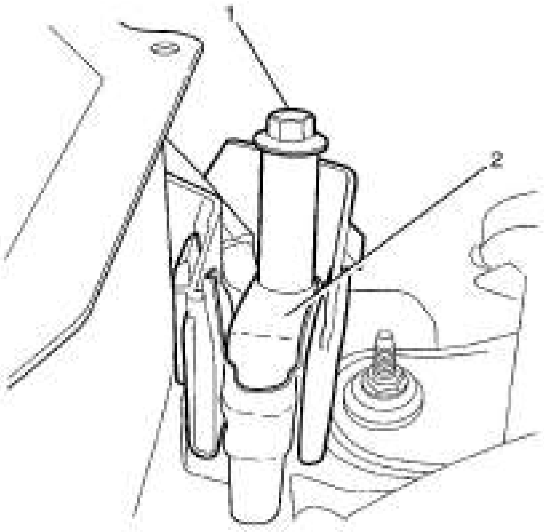


14. Attach the liquid pipe (1) from the suction pipe/liquid pipe retaining clip (2).
15. Install the suction pipe/liquid pipe retaining clip to left front chassis rail retaining bolt (3).



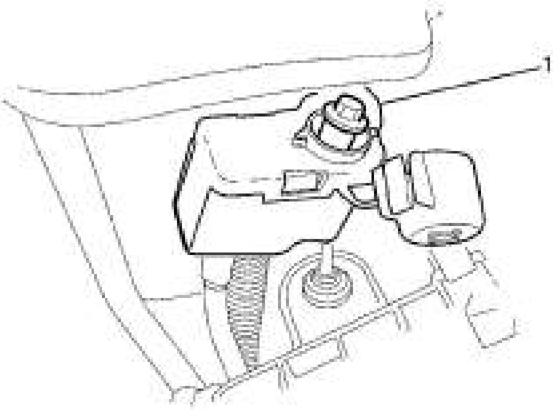
16. Install the suction pipe upper to suction pipe lower retaining nut (1).

Tighten
Tighten the nut to 22 N·m(16 lb ft).



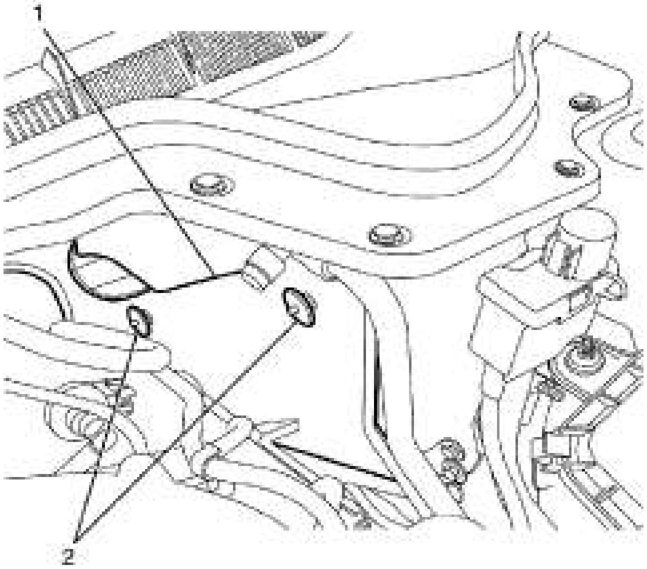
17. Install the starter motor positive cable (2) to the remote battery positive post.
18. Install the remote battery positive post to wiring harness retaining bolt (1).

Tighten
Tighten the bolt to 15 N·m (11 lb ft).

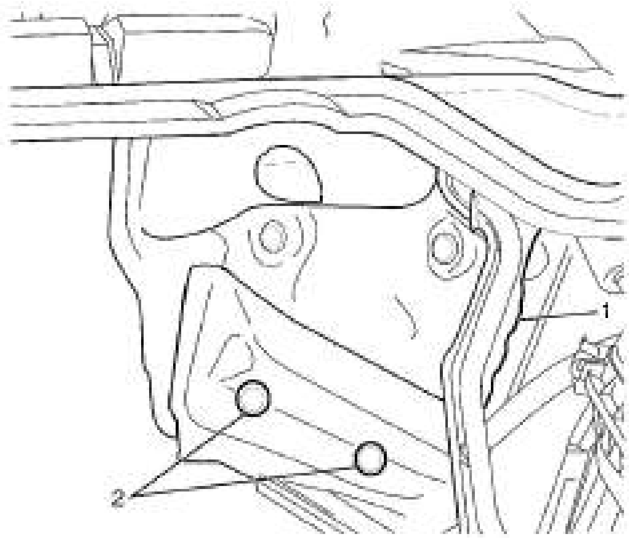


Important: Make sure the clips on the remote battery positive post cover (1) are engaged to avoid an induced rattle condition.

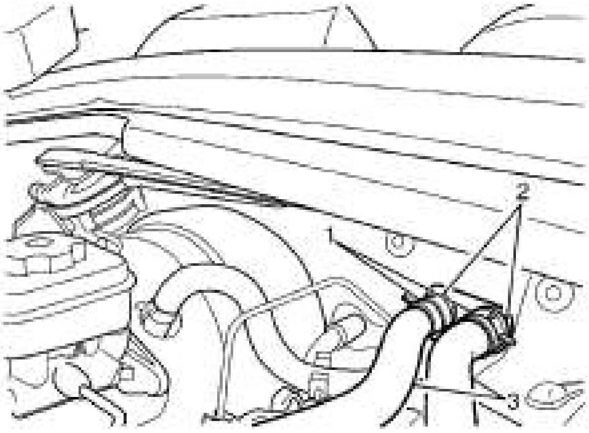
19. Install the remote battery positive post cover (1) to the remote battery positive post.



20. Install the insulation panel (1) to the left rear side engine compartment.
21. Install the insulation panel to air box retaining clips (2).



22. Install the exhaust manifold heat shield (1).
23. Install the exhaust manifold heat shield to air box retaining clips (2).

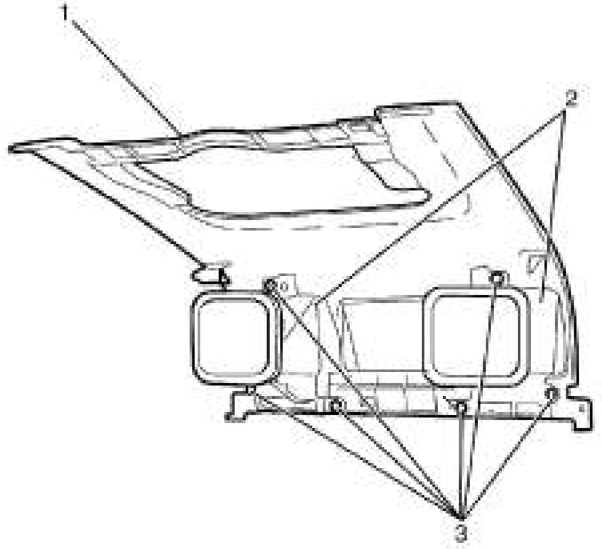


24. Connect the heater hoses (3) to the heater core pipes (2).
25. Using J 38185 , slide the heater hose retaining clamps (1) back into the original position on the heater hoses (3).
26. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection .
27. Fill the cooling system. Refer to Cooling System Draining and Filling .
28. Evacuate and recharge the A/C system. Refer to Refrigerant Recovery and Recharging .
29. Leak test the fittings of the component using J 39400 .
30. Install the engine cover. Refer to Engine Cover Replacement for 3.6L engine or Engine Cover Replacement for 6.0L engine.

Instrument Panel Center Air Outlet Deflector Replacement

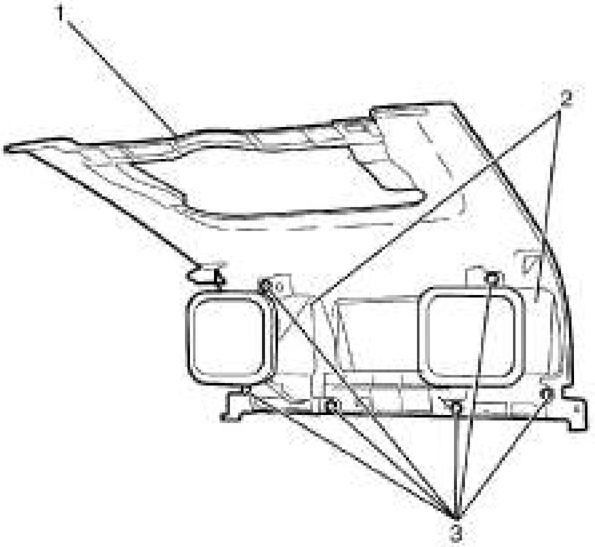
Removal Procedure (Type A)

1. Remove the I/P upper trim panel. Refer to Instrument Panel Upper Trim Panel Replacement .
2. Remove the secondary information centre. Refer to Secondary Driver Information Display Replacement .



3. Remove the I/P center air outlet deflector to I/P upper trim panel retaining screws (3).
4. Remove the I/P center air outlet deflector (2) from the I/P upper trim panel (1).

Installation Procedure (Type A)



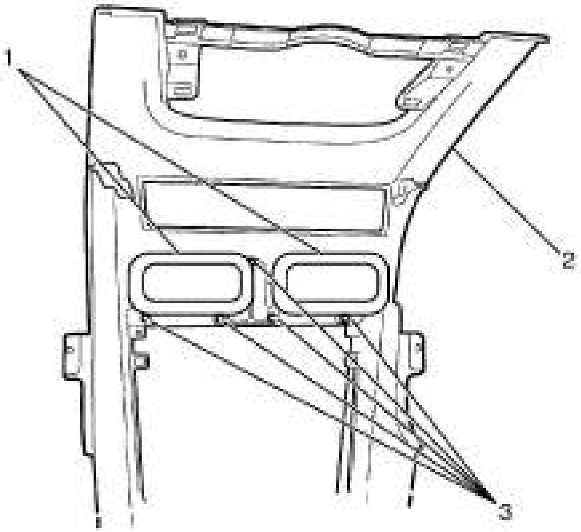
1. Install the I/P center air outlet deflector (2) to the I/P upper trim panel (1).
2. Install the I/P center air outlet deflector to I/P upper trim panel retaining screws (3).

   Tighten
   Tighten the screws to 2 N·m (18 lb in.)

3. Install the secondary information centre. Refer to Secondary Driver Information Display Replacement .
4. Install the I/P upper trim panel. Refer to Instrument Panel Upper Trim Panel Replacement .

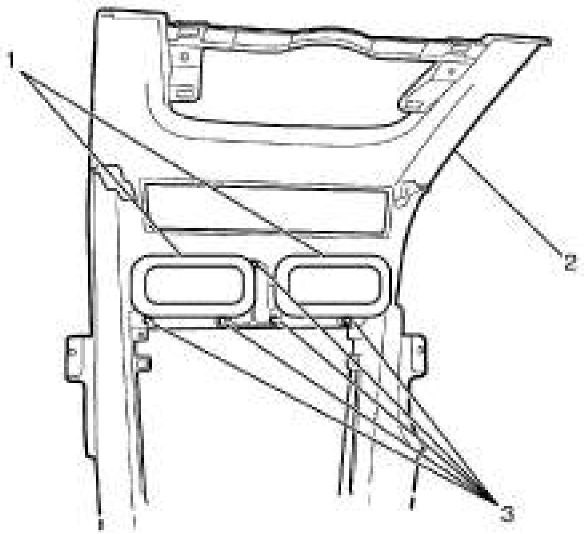
Removal Procedure (Type B)

1. Remove the I/P upper trim panel. Refer to Instrument Panel Upper Trim Panel Replacement .
2. Remove the secondary information centre. Refer to Secondary Driver Information Display Replacement .



3. Remove the I/P center air outlet deflector to I/P upper trim panel retaining screws (3).
4. Remove the I/P center air outlet deflector (1) from the I/P upper trim panel (2).

Installation Procedure (Type B)



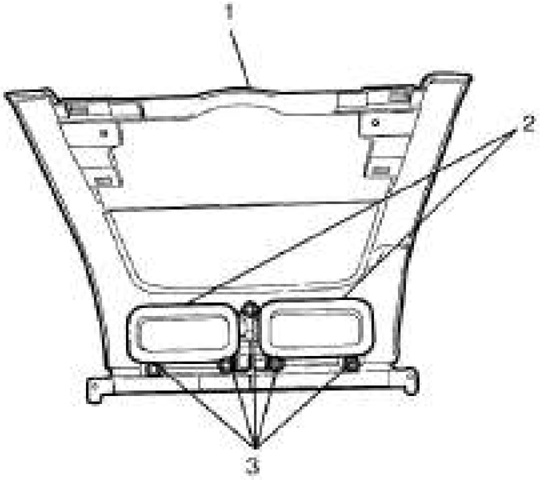
1. Install the I/P center air outlet deflector (1) to the I/P upper trim panel (2).
2. Install the I/P center air outlet deflector to I/P upper trim panel retaining screws (3).

   Tighten
   Tighten the screws to 2 N·m (18 lb in.)

3. Install the secondary information centre. Refer to Secondary Driver Information Display Replacement .
4. Install the I/P upper trim panel. Refer to Instrument Panel Upper Trim Panel Replacement .

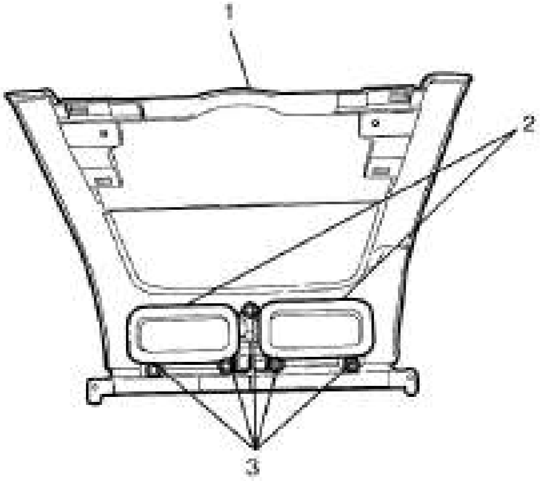
Removal Procedure (Type C)

1. Remove the I/P upper trim panel. Refer to Instrument Panel Upper Trim Panel Replacement .



2. Remove the I/P center air outlet deflector to I/P upper trim panel retaining screws (3).
3. Remove the I/P center air outlet deflector (2) from the I/P upper trim panel (1).

Installation Procedure (Type C)



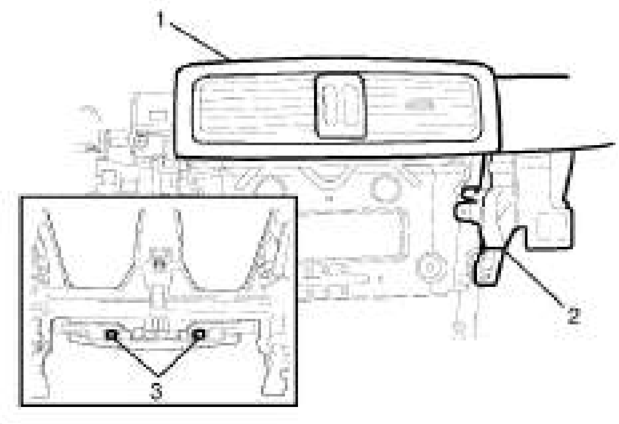
1. Install the I/P center air outlet deflector (2) to the I/P upper trim panel (1).
2. Install the I/P center air outlet deflector to I/P upper trim panel retaining screws (3).

   Tighten
   Tighten the screws to 2 N·m (18 lb in.)

3. Install the I/P upper trim panel. Refer to Instrument Panel Upper Trim Panel Replacement .

Removal Procedure (Type D)

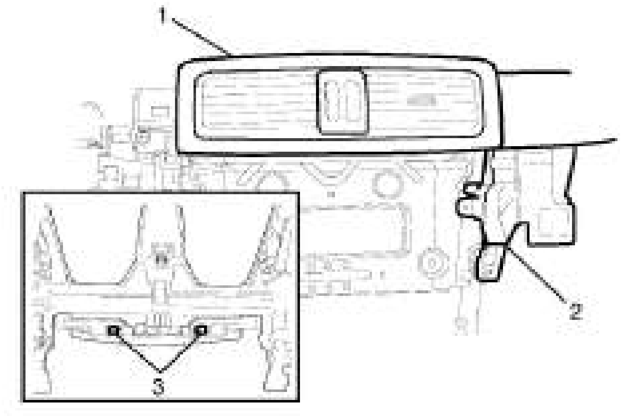
1. Remove the console centre trim plate. Refer to Console Trim Plate Replacement .
2. Remove the instrument panel centre trim plate. Refer to Instrument Panel Center Trim Panel Replacement .
3. Remove the infotainment unit. Refer to Radio Replacement .



Important: Depress the I/P center air outlet deflector to I/P upper trim pad retaining clips (3) to disengage the I/P center air outlet deflector (1) from the I/P upper trim pad (2).

4. Disengage the I/P center air outlet deflector to I/P upper trim pad retaining clips (3).
5. Remove the I/P center air outlet deflector (1) from the I/P upper trim pad (2).

Installation Procedure (Type D)



Important: Make sure the I/P center air outlet deflector to I/P upper trim pad retaining clips (3) are engaged to avoid an induced rattle condition.

1. Install the I/P center air outlet deflector (1) to the I/P upper trim pad (2).
2. Install the infotainment unit. Refer to Radio Replacement .
3. Install the instrument panel centre trim plate. Refer to Instrument Panel Center Trim Panel Replacement .
4. Install the console centre trim plate. Refer to Console Trim Plate Replacement .

Instrument Panel Outer Air Outlet Deflector Replacement - Left Side

Removal Procedure

Important: The deflector vent is part of the door trim, if it requires replacement the whole door trim is to be replaced.

Refer to Front Side Door Trim Panel Replacement.

Instrument Panel Outer Air Outlet Deflector Replacement - Right Side

Removal Procedure

Important: The deflector vent is part of the door trim, if it requires replacement the whole door trim is to be replaced.

Refer to Front Side Door Trim Panel Replacement.

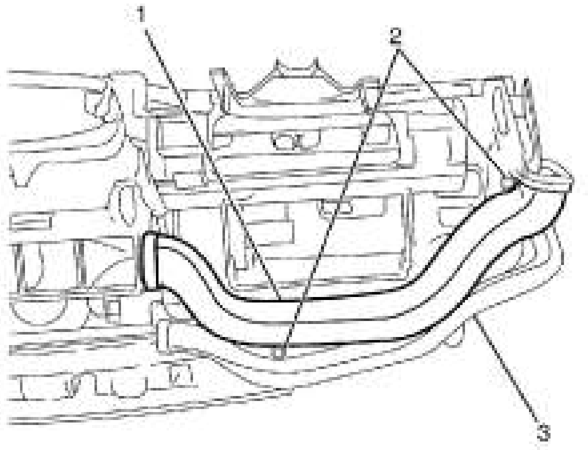
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | HVAC | Heating, Ventilation, and Air Conditioning | Repair Instructions | Document ID: 1994739

Instrument Panel Outer Air Outlet Upper Duct Replacement - Left Side

Removal Procedure

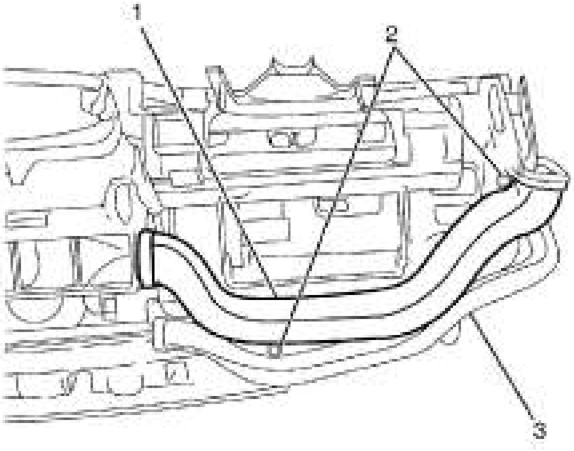
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Remove the instrument panel (I/P) upper trim pad. Refer to Instrument Panel Upper Trim Pad Replacement.



2. Remove the air outlet duct to I/P upper trim pad retaining screws (2).
3. Remove the air outlet duct (1) from the I/P upper trim pad (3).

Installation Procedure



1. Install the air outlet duct (1) to the instrument panel (I/P) upper trim pad (3).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the air outlet duct to I/P upper trim pad retaining screws (2).

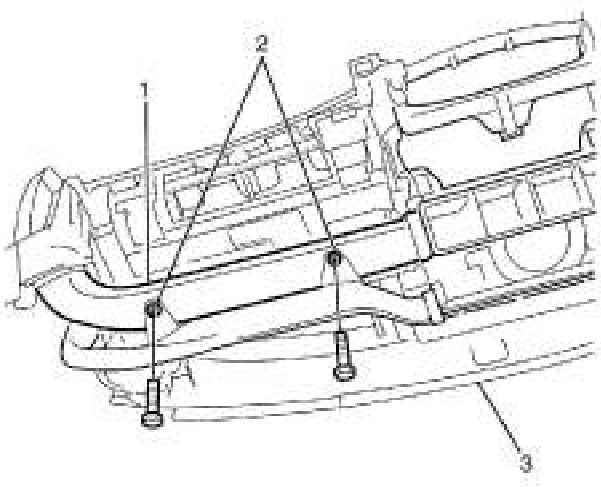
   Tighten
   Tighten the screws to 2 N·m(18 lb in).

3. Install the I/P upper trim pad. Refer to Instrument Panel Upper Trim Pad Replacement.

Instrument Panel Outer Air Outlet Upper Duct Replacement - Right Side

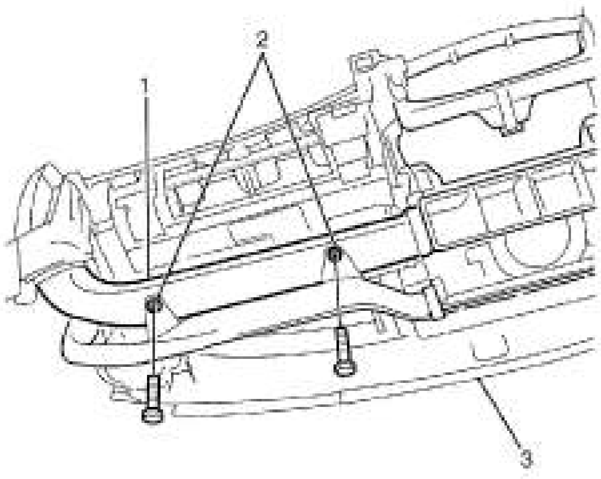
Removal Procedure

1. Remove the instrument panel (I/P) upper trim pad. Refer to Instrument Panel Upper Trim Pad Replacement.



2. Remove the air outlet duct to I/P upper trim pad retaining screws (2).
3. Remove the air outlet duct (1) from the I/P upper trim pad (3).

Installation Procedure



1. Install the air outlet duct (1) to the instrument panel (I/P) upper trim pad (3).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the air outlet duct to I/P upper trim pad retaining screws (2).

   Tighten
   Tighten the screws to 2 N·m(18lb in).

3. Install the I/P upper trim pad. Refer to Instrument Panel Upper Trim Pad Replacement.

Liquid Line Replacement (3.6L Engine)

Tools Required

J 39400 Halogen Leak Detector

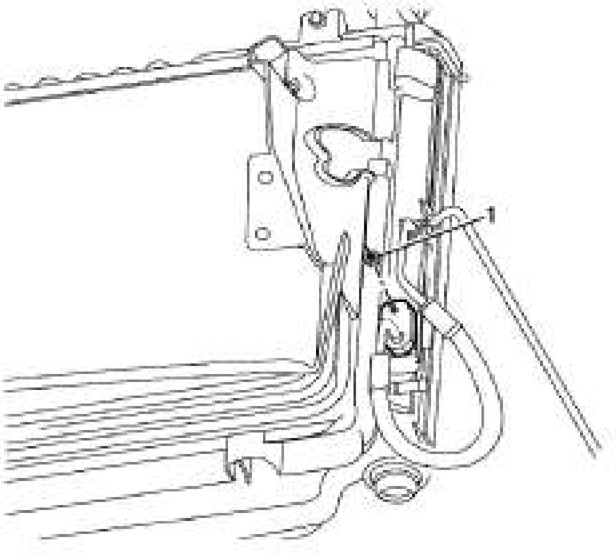
Removal Procedure

1. Recover the refrigerant Refer to Refrigerant Recovery and Recharging .
2. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove windscreen wiper arms. Refer to Windshield Wiper Arm Replacement .
4. Remove the air inlet grill panel. Refer to Air Inlet Grille Panel Replacement .
5. Remove the air filter assembly. Refer to Air Cleaner Assembly Replacement .
6. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement

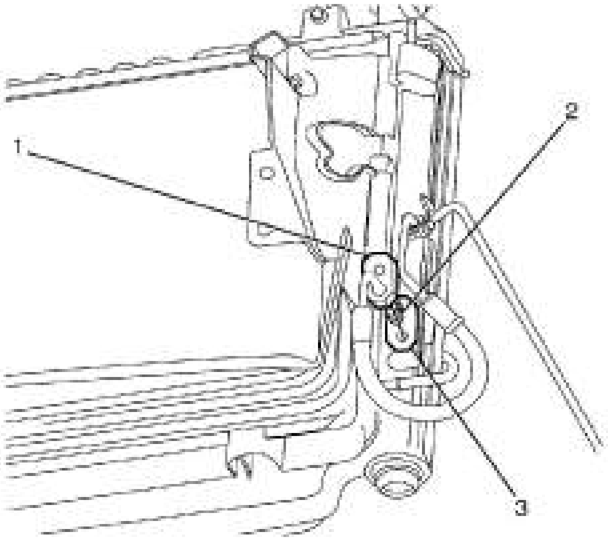
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

7. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
8. Remove the front air deflector. Refer to Front Air Deflector Replacement .



9. Remove the liquid pipe to the condenser port retaining nut (1).
10. Lower the vehicle.



11. Disconnect the liquid pipe (1) from the condenser port (3).

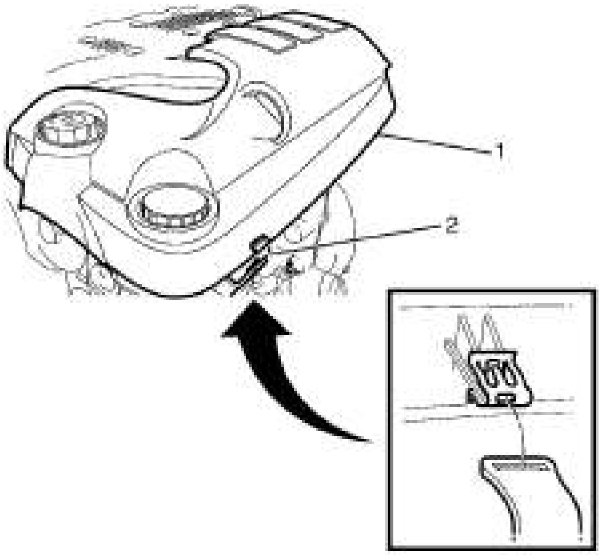
    Important: The sealing washer (2) is a single use item and must be discarded after use.

12. Remove the sealing washer (2). Refer to Sealing Washer Replacement .

    Discard the sealing washer

    Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

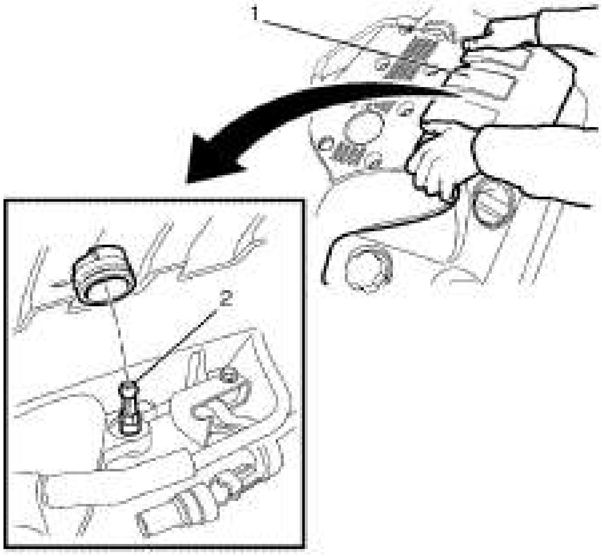
13. Cap or plug the liquid pipe (1) and the condenser port (3).
14. Remove the cross car brace, if fitted. Refer to Front End Panel Module Carrier Assembly Replacement



Important: The left engine cover has one front and one rear outer retaining clip.

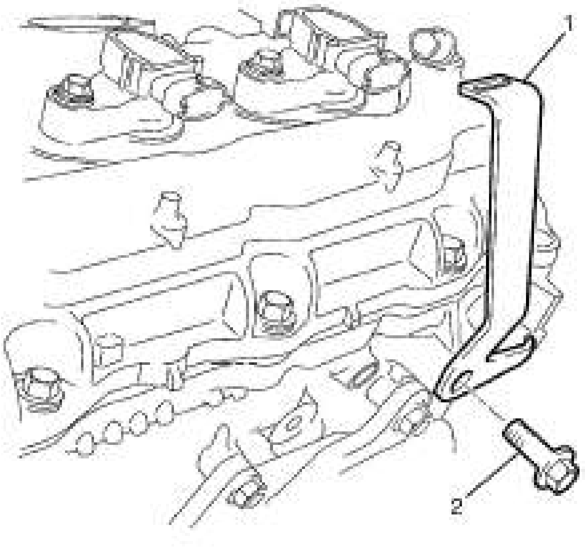
Important: Grasp and pry the left engine cover (1) upwards to detach the left engine cover (1) from the outer retaining clip (2).

15. Detach the left engine cover (1) from the outer retaining clip (2).

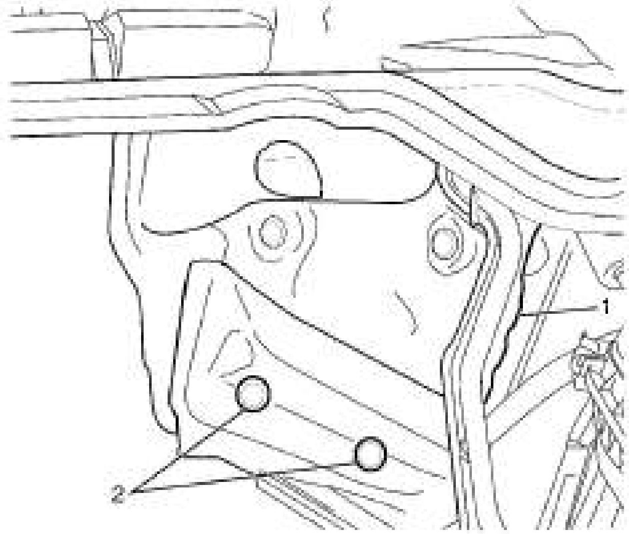


Important: Disengage the left engine cover (1) from the ball stud (2) by pulling up firmly on the rear and front of the left engine cover (1).

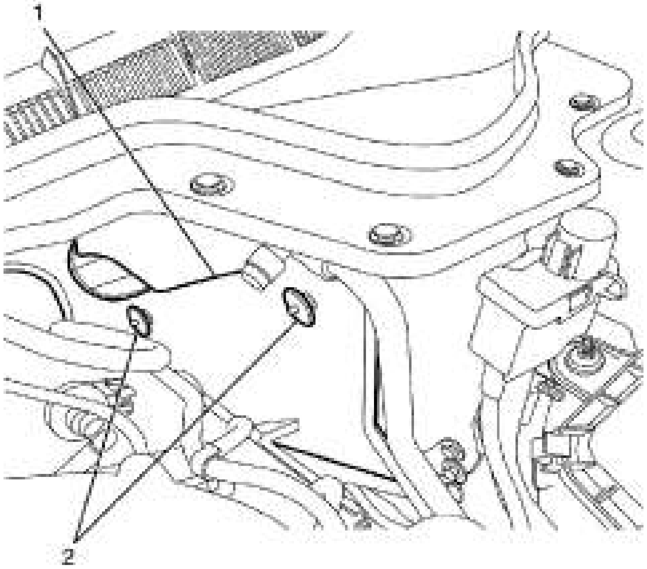
16. Detach the left engine cover (1) from the ball stud (2).
17. Remove the left engine cover (1).



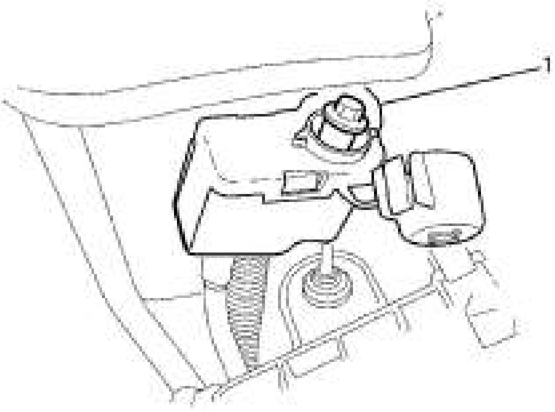
18. Remove the left engine cover mounting bracket to cylinder head retaining bolt (2).
19. Remove the left engine cover mounting bracket (1) from the cylinder head.



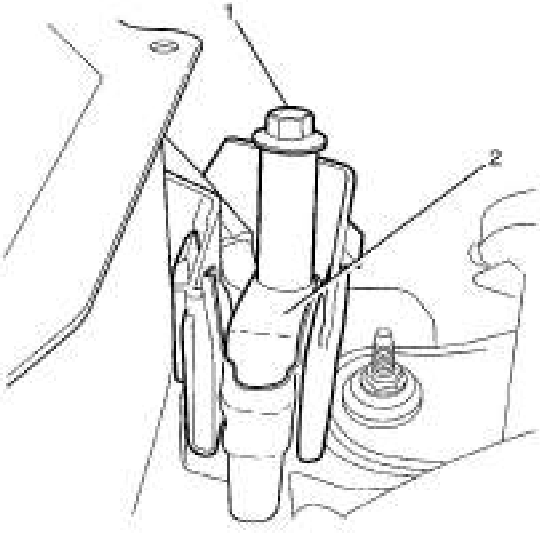
20. Remove the exhaust manifold heat shield to air box retaining clips (2).
21. Remove the exhaust manifold heat shield (1).



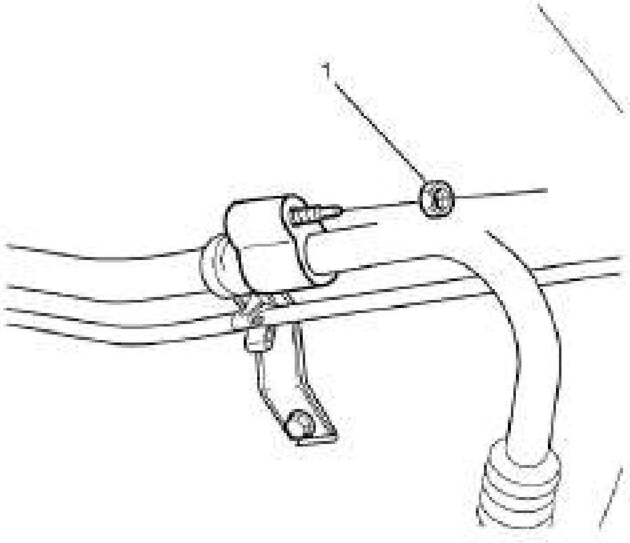
22. Remove the insulation panel to air box retaining clips (2).
23. Remove the insulation panel (1) from the engine compartment.



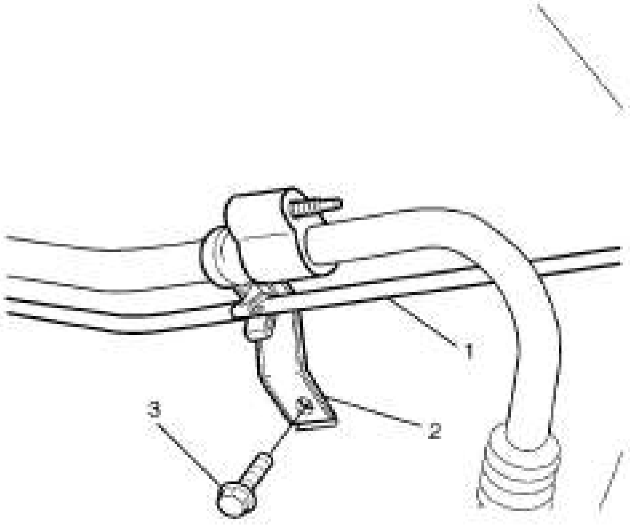
24. Remove the remote battery positive post cover (1).



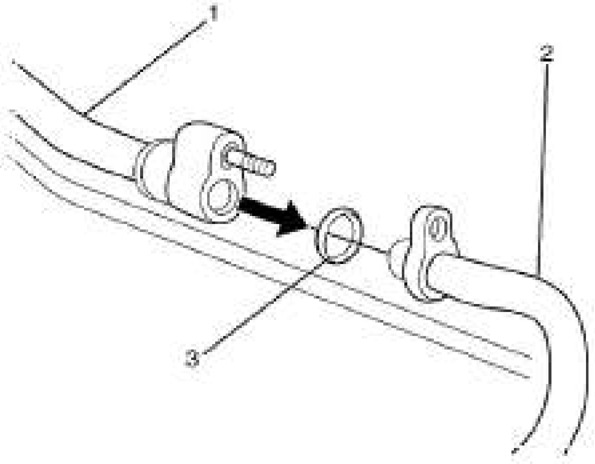
25. Remove the remote battery positive post to wiring harness retaining bolt (1).
26. Remove the starter motor power cable (2) and position aside.



27. Remove the suction pipe upper to suction pipe lower retaining nut (1).



28. Remove the suction pipe/liquid pipe retaining clip to left front chassis rail retaining bolt (3).
29. Detach the liquid pipe (1) from the suction pipe/liquid pipe retaining clip (2).



30. Disconnect the suction pipe upper (1) from suction pipe lower (2).

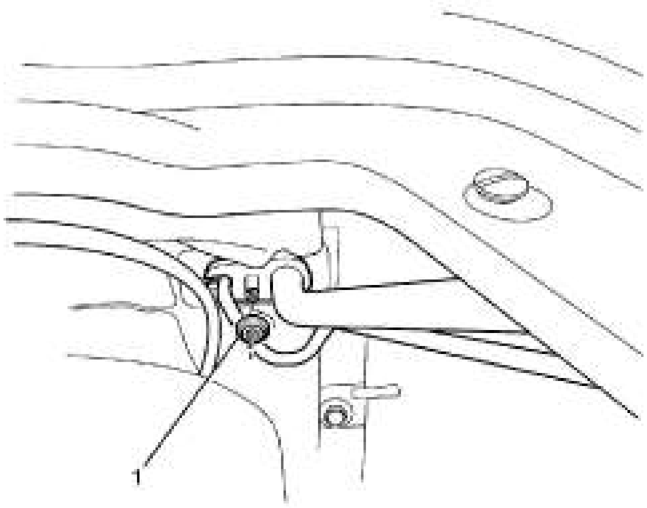
    Important: The sealing washer (3) is a single use item and must be discarded after use.

31. Remove the sealing washer (3). Refer to Sealing Washer Replacement .

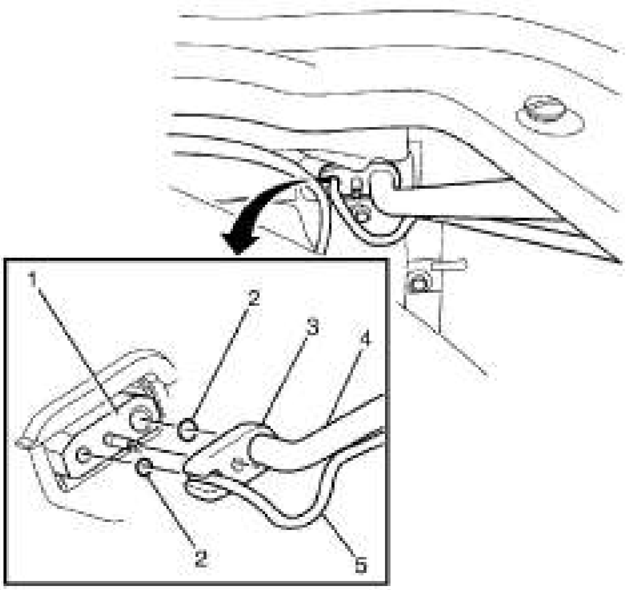
    Discard the sealing washer

    Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

32. Cap or plug the suction pipe upper (1) and the suction pipe lower (2).



33. Remove the suction pipe/liquid pipe pad to TX valve retaining nut (1).



34. Disconnect the suction pipe/liquid pipe pad (3) from the TX valve (1).

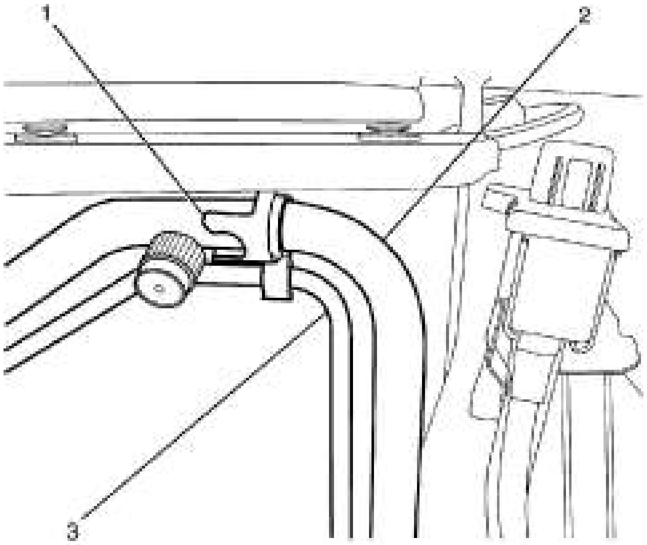
    Important: The sealing washers (2) are a single use item and must be discarded after use.

35. Remove the sealing washers (2). Refer to Sealing Washer Replacement .

    Discard the sealing washers

    Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

36. Cap or plug the suction pipe (4), liquid pipe (5) and the TX valve (1).
37. Remove the liquid pipe (5) from the suction pipe/liquid pipe pad (3).

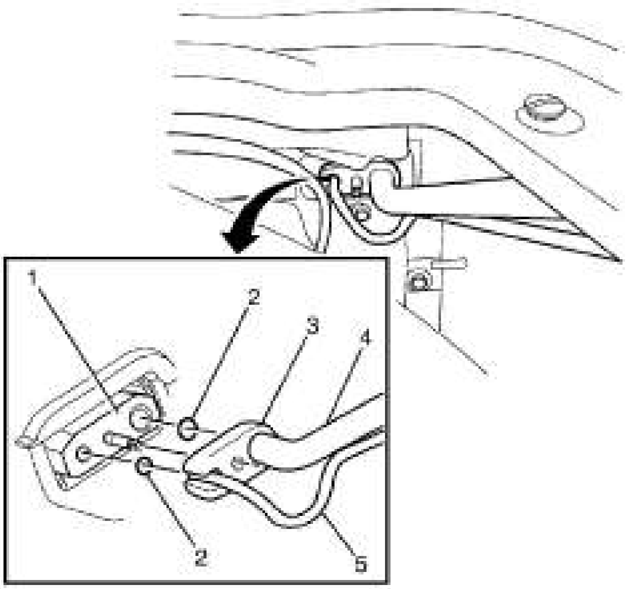


38. Detach the liquid pipe (3) and the suction pipe (2) from the suction pipe/liquid pipe retaining clip (1).

    Important: Have an assistant ensure that the liquid tube flexible hose at the condenser end clears all the vehicle body work and condenser on removal from the engine compartment.

39. Remove the liquid pipe (3) from the engine compartment.

Installation Procedure

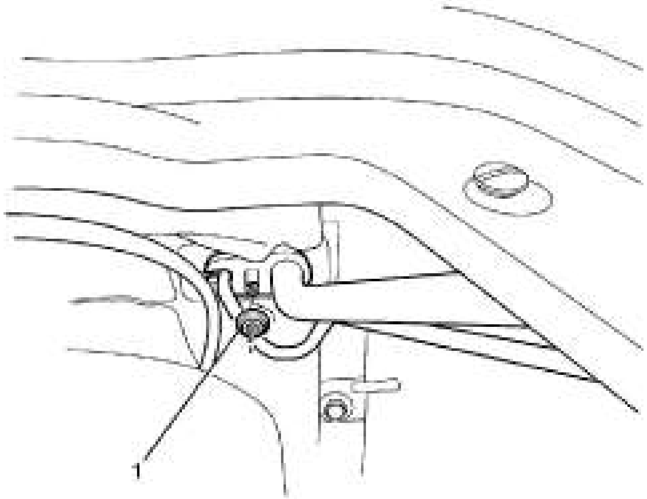


1. Install the liquid pipe (5) to the suction pipe/liquid pipe pad (3).
2. Remove the plugs or caps from the suction pipe (4), liquid pipe (5) and the TX valve (1).

    Important: DO NOT coat the NEW sealing washers (2) with oil, they must be fitted dry. The use of mineral oil will render the sealing washers (2) useless, as the sealing washers (2) WILL swell causing refrigerant to leak out.

3. Install NEW sealing washers (2). Refer to Sealing Washer Replacement .
4. Position the suction pipe/liquid pipe pad (3) to the TX Valve (1).

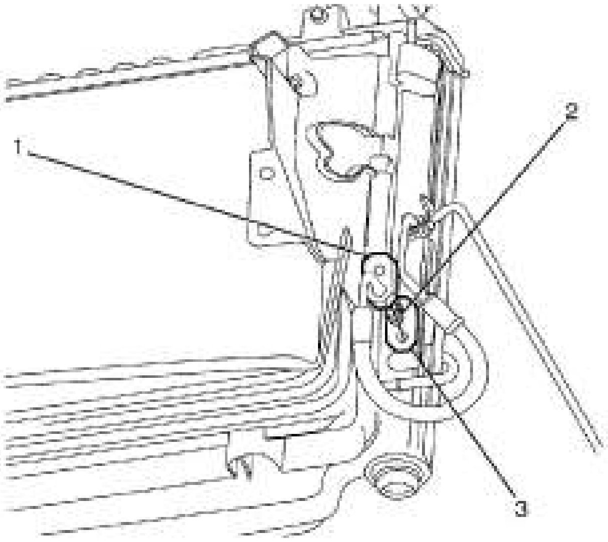
    Notice: Refer to Fastener Notice in the Preface section.



5. Install the suction pipe/liquid pipe pad to TX valve retaining nut (1).

   Tighten
   Tighten the nut to 22 N·m(16 lb ft).

6. Raise the vehicle.

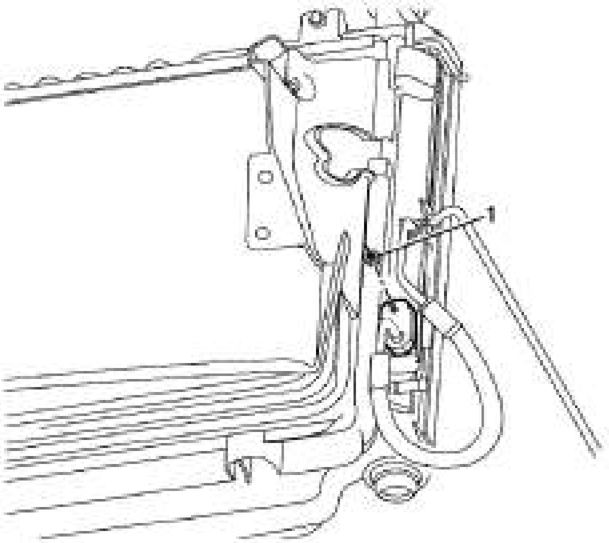


7. Remove the plugs or caps from the suction pipe liquid pipe (1) and the condenser port (3).

   Important: DO NOT coat the NEW sealing washer (3) with oil, they must be fitted dry. The use of mineral oil will render the sealing washer (3) useless, as the sealing washer (3) WILL swell causing refrigerant to leak out.

8. Install a NEW sealing washer (3). Refer to Sealing Washer Replacement .

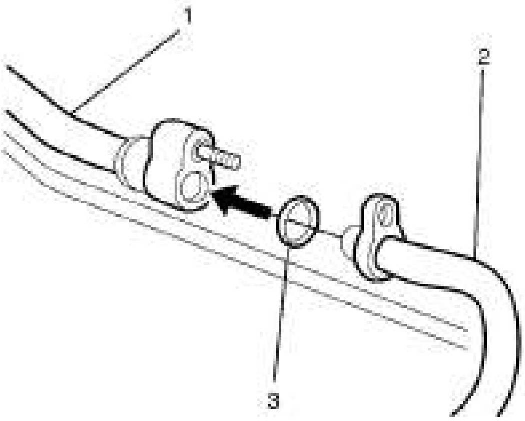
9. Connect the liquid pipe (1) to the condenser port (3).



10. Install the liquid pipe to condenser port retaining nut (1).

    Tighten
    Tighten the nut to 22 N·m(16 lb ft).

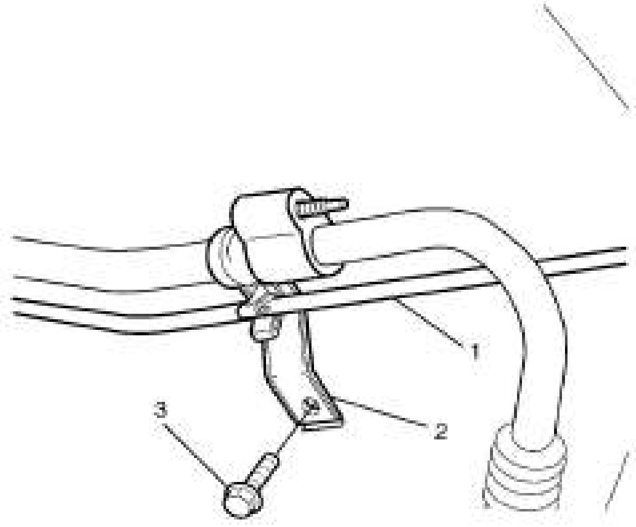
11. Install the air deflector front. Refer to Front Air Deflector Replacement .



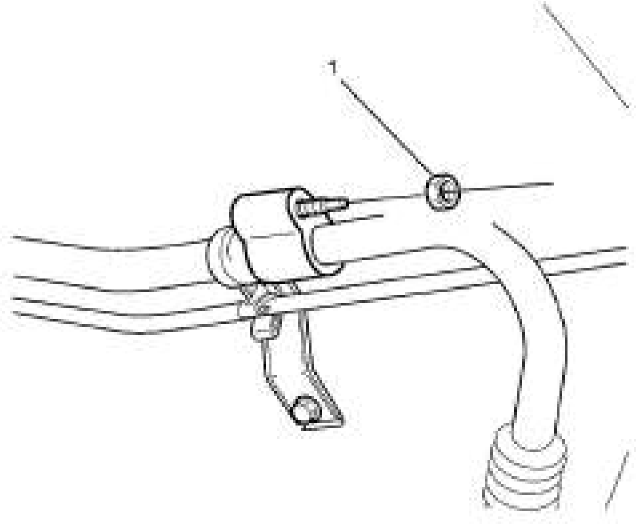
12. Remove the plugs or caps from the suction pipe upper (1) and the suction pipe lower (2).

    Important: DO NOT coat the NEW sealing washer (3) with oil, they must be fitted dry. The use of mineral oil will render the sealing washer (3) useless, as the sealing washer (3) WILL swell causing refrigerant to leak out.

13. Install a NEW sealing washer (3). Refer to Sealing Washer Replacement .
14. Install the suction pipe upper (1) to the suction pipe lower (2).

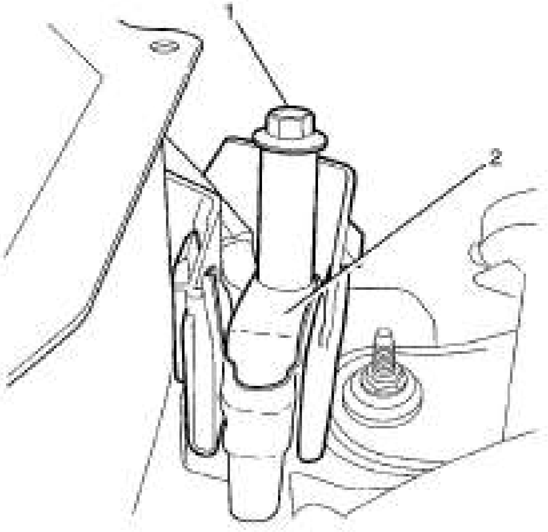


15. Attach the liquid pipe (1) from the suction pipe/liquid pipe retaining clip (2).
16. Install the suction pipe/liquid pipe retaining clip to left front chassis rail retaining bolt (3).



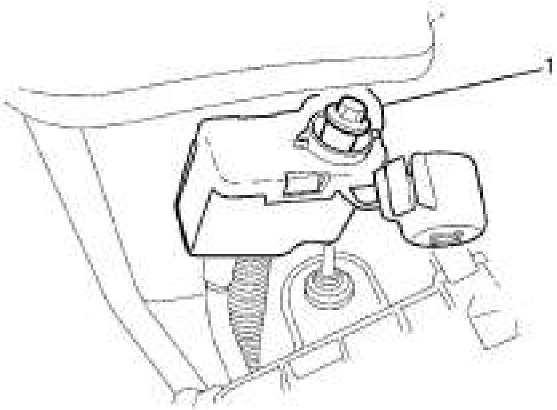
17. Install the suction pipe upper to suction pipe lower retaining nut (1).

Tighten
Tighten the nut to 22 N·m(16 lb ft).



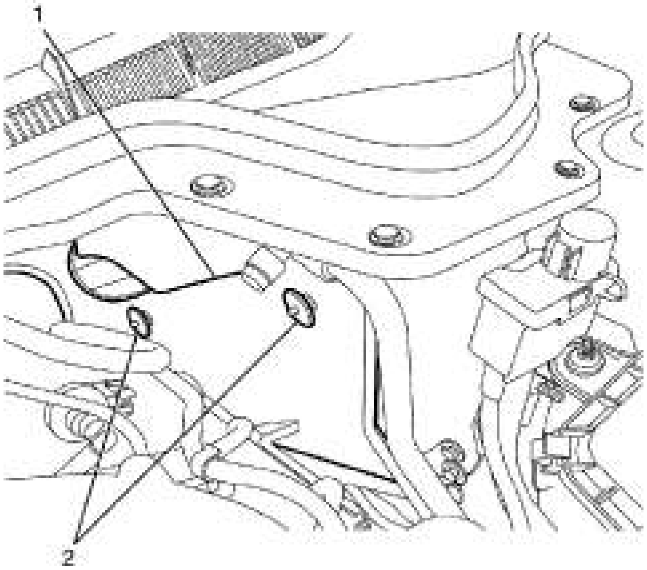
18. Install the starter motor positive cable (2) to the remote battery positive post.
19. Install the remote battery positive post to wiring harness retaining bolt (1).

    Tighten
    Tighten the bolt to 15 N·m (11 lb ft).

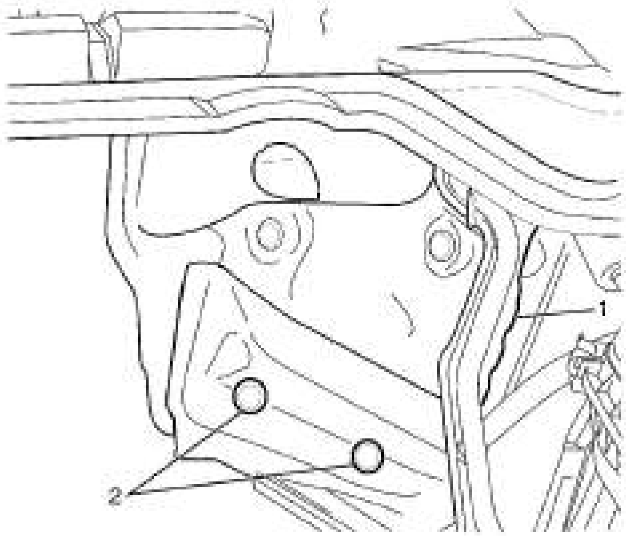


Important: Make sure the clips on the remote battery positive post cover (1) are engaged to avoid an induced rattle condition.

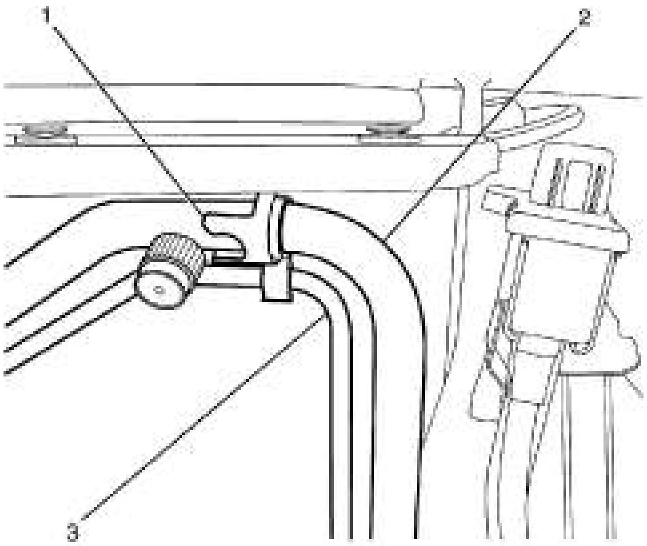
20. Install the remote battery positive post cover (1) to the remote battery positive post.



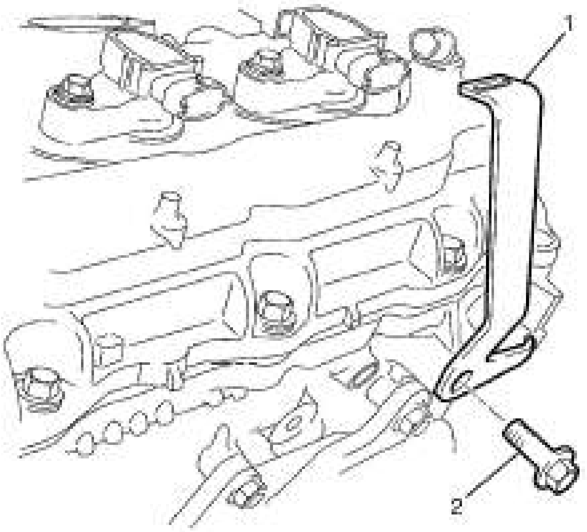
21. Install the insulation panel (1) to the left rear side engine compartment.
22. Install the insulation panel to air box retaining clips (2).



23. Install the exhaust manifold heat shield (1).
24. Install the exhaust manifold heat shield to air box retaining clips (2).

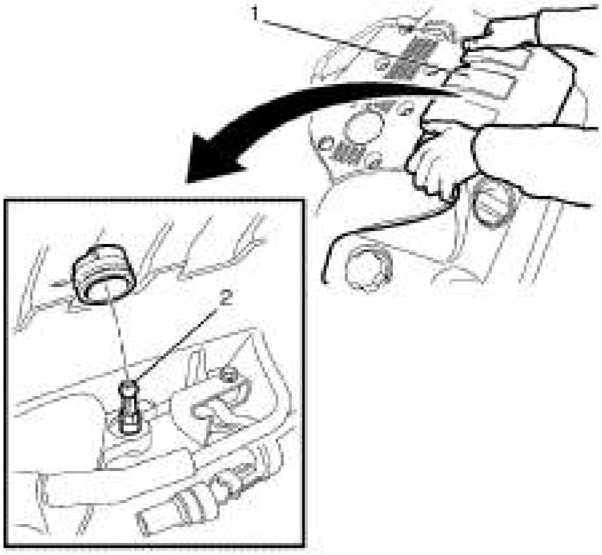


25. Attach the suction pipe (2) and the liquid pipe (3) from the suction pipe/liquid pipe retaining clip (1).



26. Install the left engine cover mounting bracket (1)
27. Install the left engine cover mounting bracket to cylinder head retaining bolt (2).

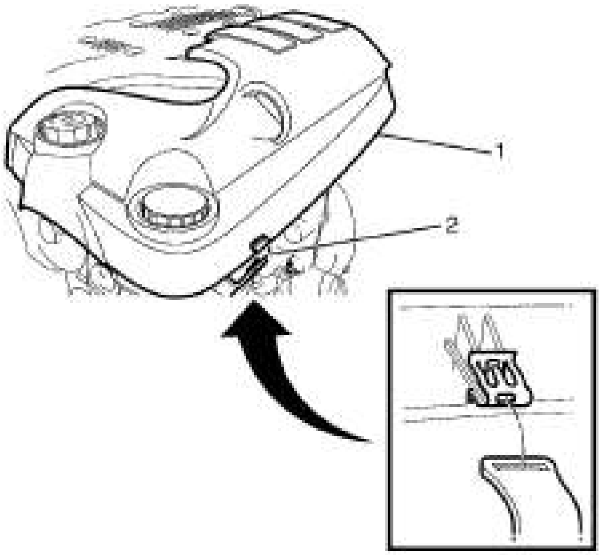
Tighten
Tighten the bolt to 35 N·m (26 lb in).



28. Position the left engine cover (1) over the intake manifold so the grommet is aligned with the ball stud (2).

Important: Press the left engine cover (1) down firmly near the ball stud to attach the left engine cover (1) to the ball stud (2).

29. Attach the left engine cover (1) to the ball stud (2).



Important: The left engine cover has one front and one rear outer retaining clip.

Important: Press the left engine cover (1) down firmly near the outer retaining clips to attach the left engine cover (1) to the outer retaining clip (2).

30. Attach the left engine cover (1) to the outer retaining clip (2).
31. Install the cross car brace, if fitted. Refer to Front End Panel Module Carrier Assembly Replacement
32. Install the air filter assembly. Refer to Air Cleaner Assembly Replacement .
33. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement
34. Install the plenum chamber cover panel. Refer to Air Inlet Grille Panel Replacement .
35. Install the windscreen wiper arms. Refer to Windshield Wiper Arm Replacement .
36. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection .
37. Evacuate and recharge the A/C system. Refer to Refrigerant Recovery and Recharging .
38. Leak test the fittings of the component using J 39400 .

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | HVAC | Heating, Ventilation, and Air Conditioning | Repair Instructions | **Document ID: 2038172**

Liquid Line Replacement (6.0L Engine)

Tools Required

J 39400 Halogen Leak Detector

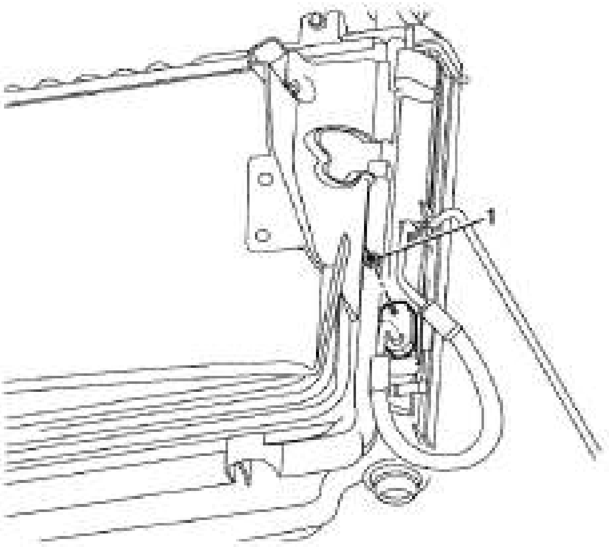
Removal Procedure

1. Recover the refrigerant Refer to Refrigerant Recovery and Recharging.
2. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove windscreen wiper arms. Refer to Windshield Wiper Arm Replacement.
4. Remove the air inlet grill panel. Refer to Air Inlet Grille Panel Replacement.
5. Remove the air filter assembly. Refer to Air Cleaner Assembly Replacement.
6. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.
7. Remove the engine cover. Refer to Engine Cover Replacement.

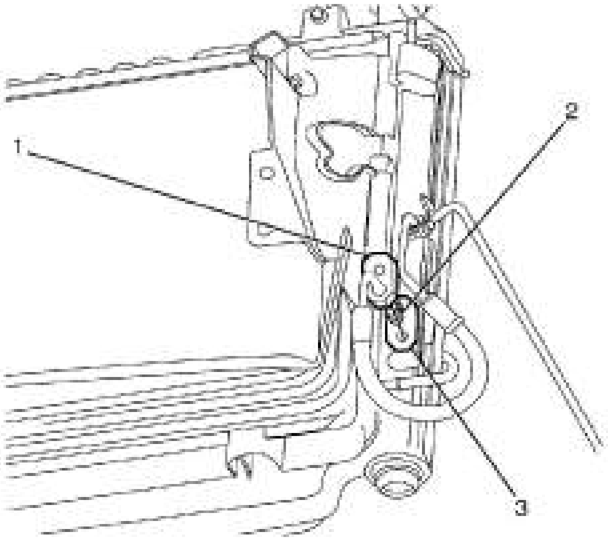
   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

8. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
9. Remove the front air deflector. Refer to Front Air Deflector Replacement.



10. Remove the liquid pipe to the condenser port retaining nut (1).
11. Lower the vehicle.



12. Disconnect the liquid pipe (1) from the condenser port (3).

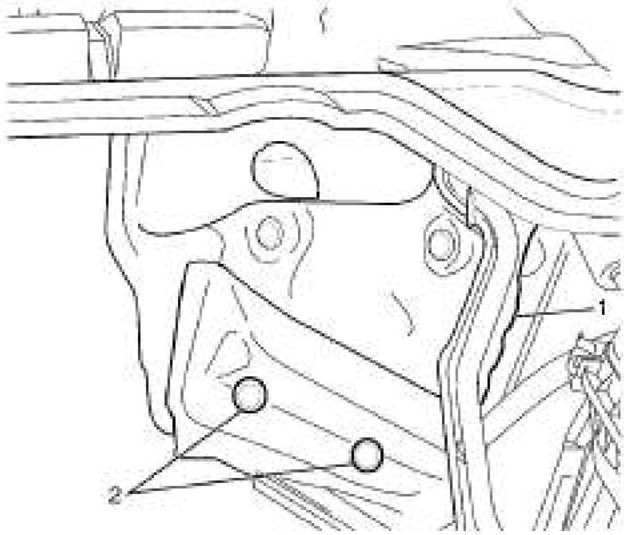
    Important: The sealing washer (2) is a single use item and must be discarded after use.

13. Remove the sealing washer (2). Refer to Sealing Washer Replacement.

    Discard the sealing washer

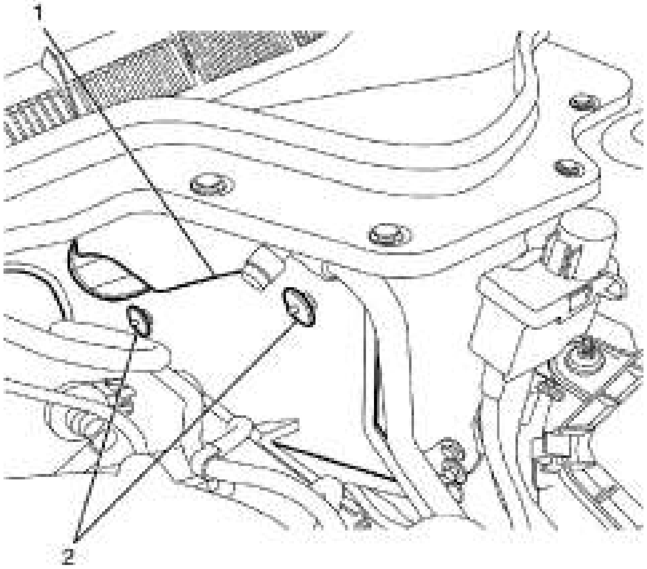
    Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

14. Cap or plug the liquid pipe (1) and the condenser port (3).

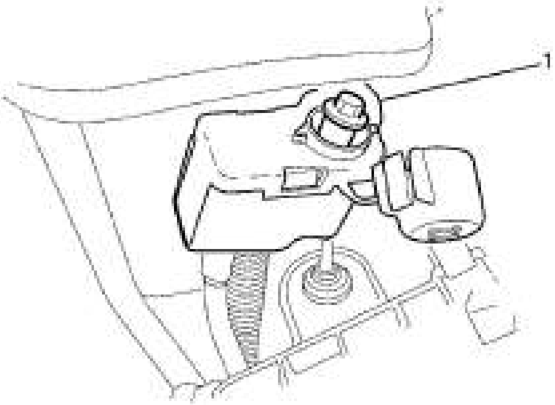


15. Remove the exhaust manifold heat shield to air box retaining clips (2).

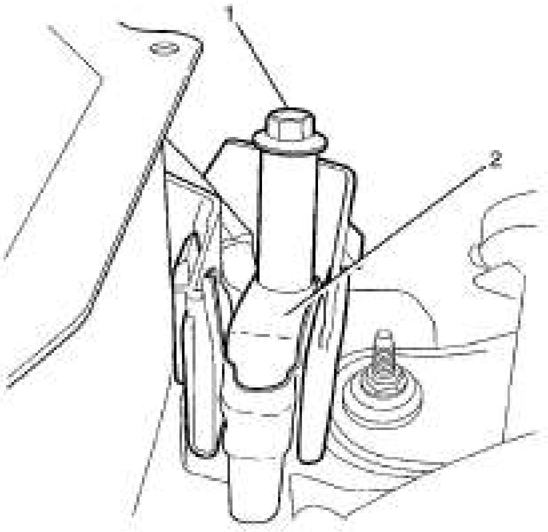
16. Remove the exhaust manifold heat shield (1).



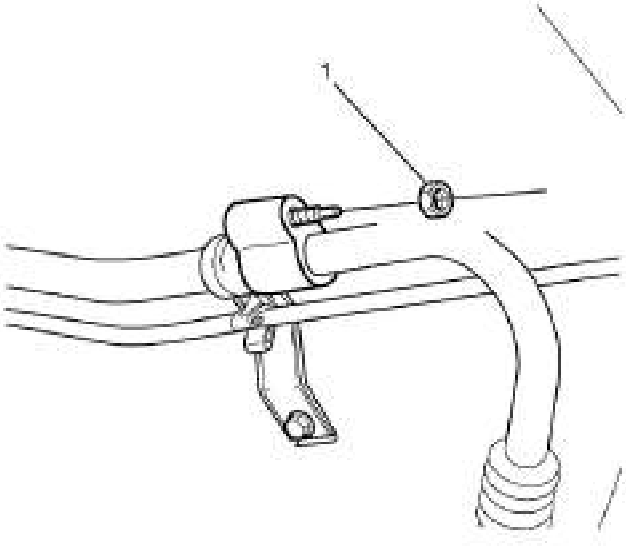
17. Remove the insulation panel to air box retaining clips (2).
18. Remove the insulation panel (1) from the engine compartment.



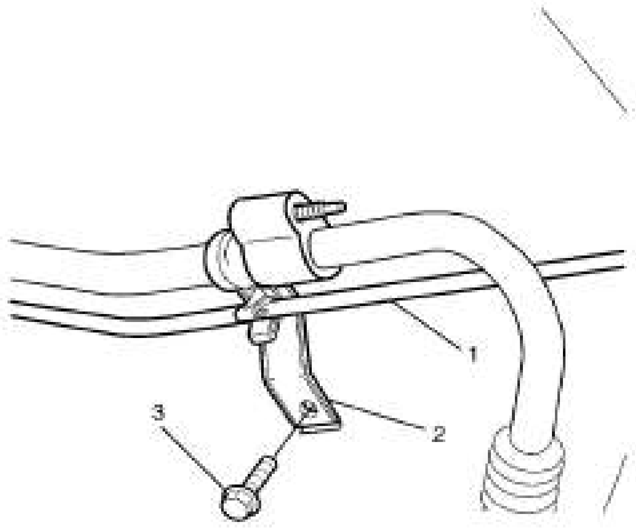
19. Remove the remote battery positive post cover (1).



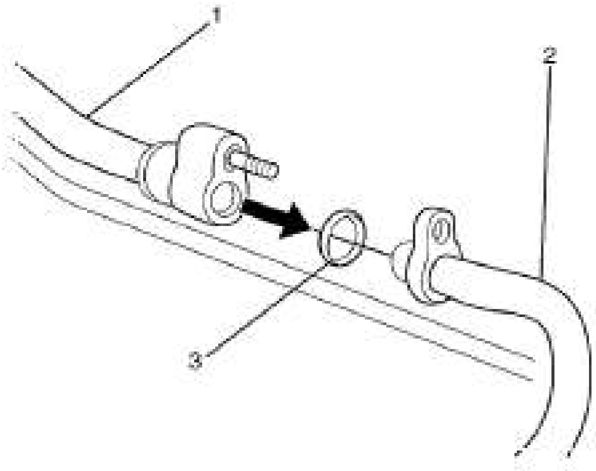
20. Remove the remote battery positive post to wiring harness retaining bolt (1).
21. Remove the starter motor power cable (2) and position aside.



22. Remove the suction pipe upper to suction pipe lower retaining nut (1).



23. Remove the suction pipe/liquid pipe retaining clip to left front chassis rail retaining bolt (3).
24. Detach the liquid pipe (1) from the suction pipe/liquid pipe retaining clip (2).



25. Disconnect the suction pipe upper (1) from suction pipe lower (2).

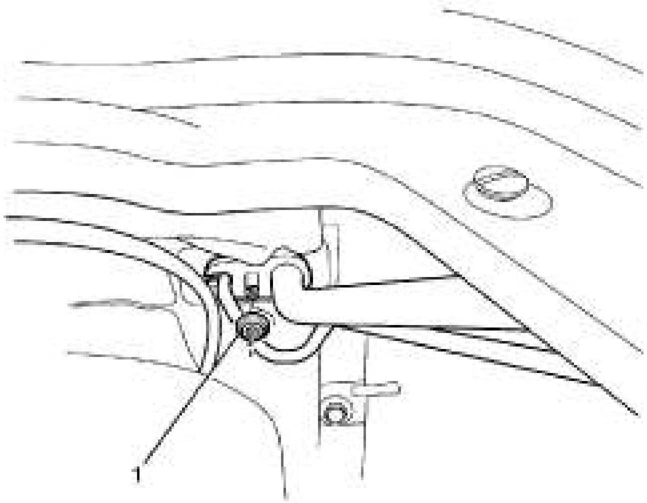
Important: The sealing washer (3) is a single use item and must be discarded after use.

26. Remove the sealing washer (3). Refer to Sealing Washer Replacement.

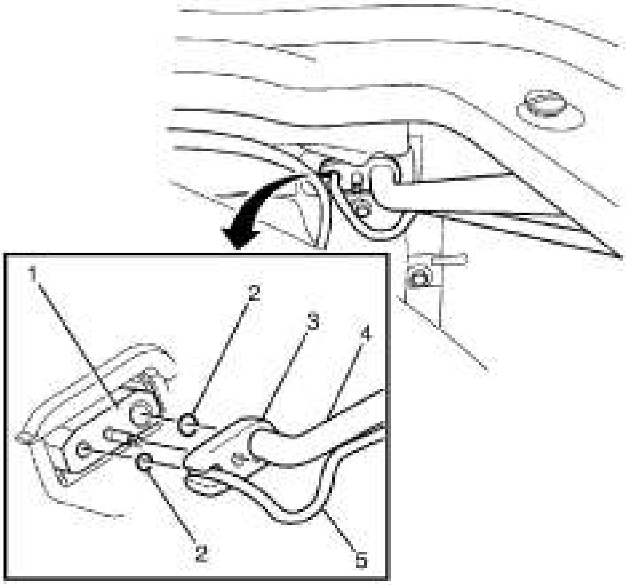
Discard the sealing washer

Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

27. Cap or plug the suction pipe upper (1) and the suction pipe lower (2).



28. Remove the suction pipe/liquid pipe pad to thermal expansion (TX) valve retaining nut (1).



29. Disconnect the suction pipe/liquid pipe pad (3) from the TX valve (1).

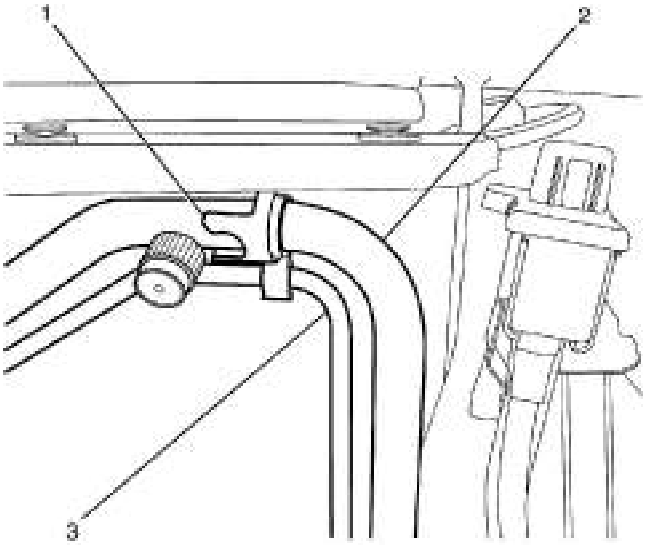
Important: The sealing washers (2) are a single use item and must be discarded after use.

30. Remove the sealing washers (2). Refer to Sealing Washer Replacement.

Discard the sealing washers

Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

31. Cap or plug the suction pipe (4), liquid pipe (5) and the TX valve (1).
32. Remove the liquid pipe (5) from the suction pipe/liquid pipe pad (3).

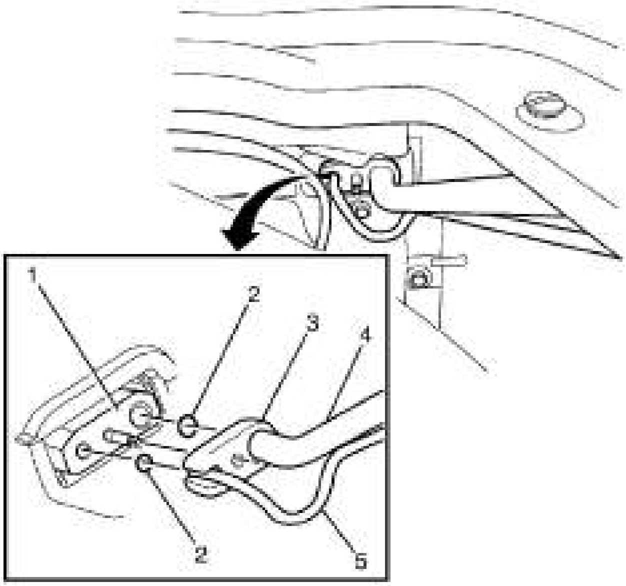


33. Detach the liquid pipe (3) and the suction pipe (2) from the suction pipe/liquid pipe retaining clip (1).

Important: Have an assistant ensure that the liquid tube flexible hose at the condenser end clears all the vehicle body work and condenser on removal from the engine compartment.

34. Remove the liquid pipe (3) from the engine compartment.

Installation Procedure

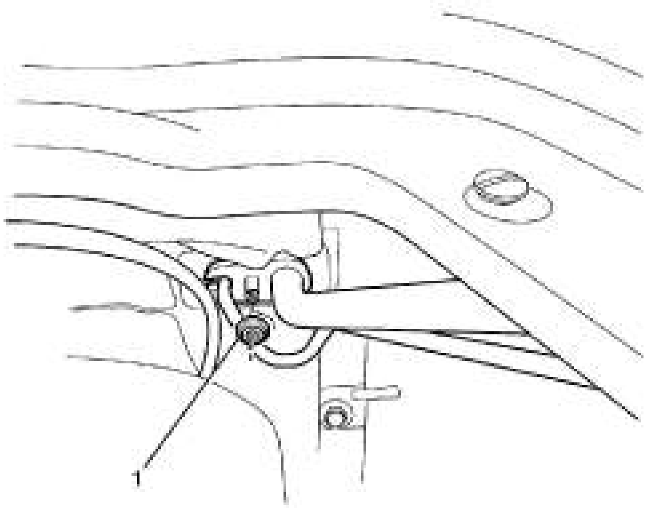


1. Install the liquid pipe (5) to the suction pipe/liquid pipe pad (3).
2. Remove the plugs or caps from the suction pipe (4), liquid pipe (5) and the thermal expansion (TX) valve (1).

   Important: DO NOT coat the NEW sealing washers (2) with oil, they must be fitted dry. The use of mineral oil will render the sealing washers (2) useless, as the sealing washers (2) WILL swell causing refrigerant to leak out.

3. Install NEW sealing washers (2). Refer to Sealing Washer Replacement.
4. Position the suction pipe/liquid pipe pad (3) to the TX valve (1).

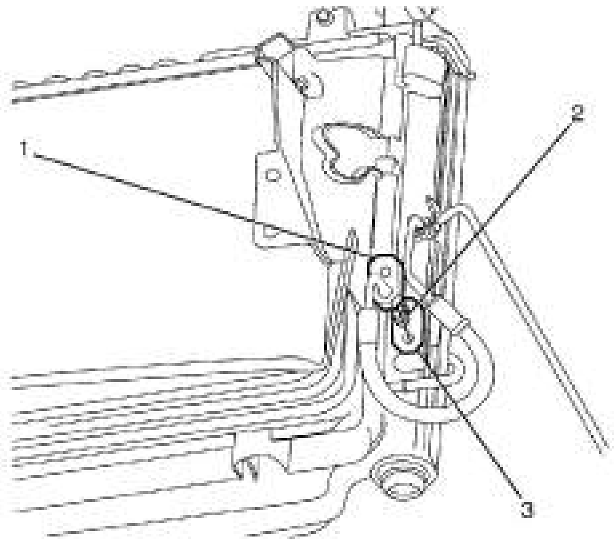
   Notice: Refer to Fastener Notice in the Preface section.



5. Install the suction pipe/liquid pipe pad to TX valve retaining nut (1).

   Tighten
   Tighten the nut to 22 N·m(16 lb ft).

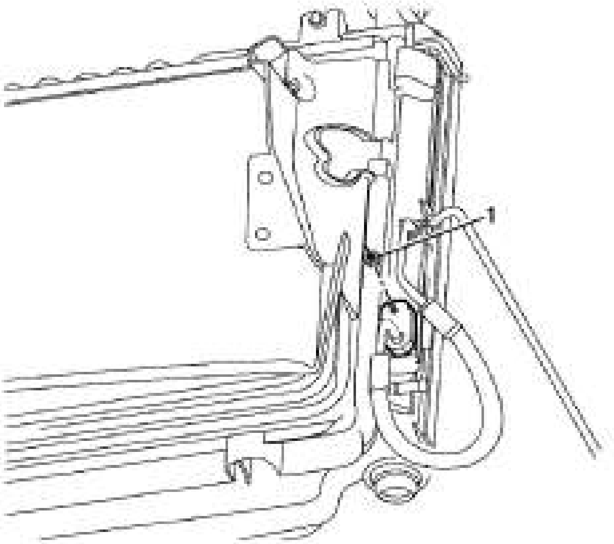
6. Raise the vehicle.



7. Remove the plugs or caps from the suction pipe liquid pipe (1) and the condenser port (3).

   Important: DO NOT coat the NEW sealing washer (3) with oil, they must be fitted dry. The use of mineral oil will render the sealing washer (3) useless, as the sealing washer (3) WILL swell causing refrigerant to leak out.

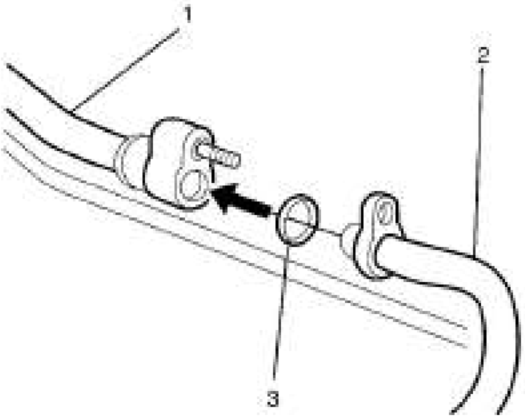
8. Install a NEW sealing washer (3). Refer to Sealing Washer Replacement.
9. Connect the liquid pipe (1) to the condenser port (3).



10. Install the liquid pipe to condenser port retaining nut (1).

    Tighten
    Tighten the nut to 22 N·m(16 lb ft).

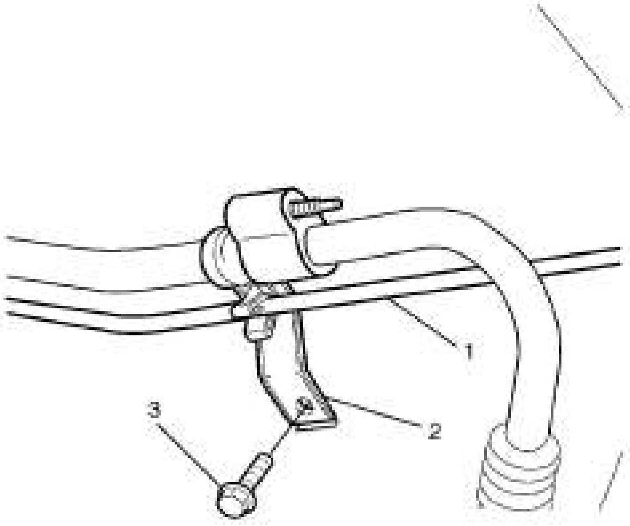
11. Install the air deflector front. Refer to Front Air Deflector Replacement .



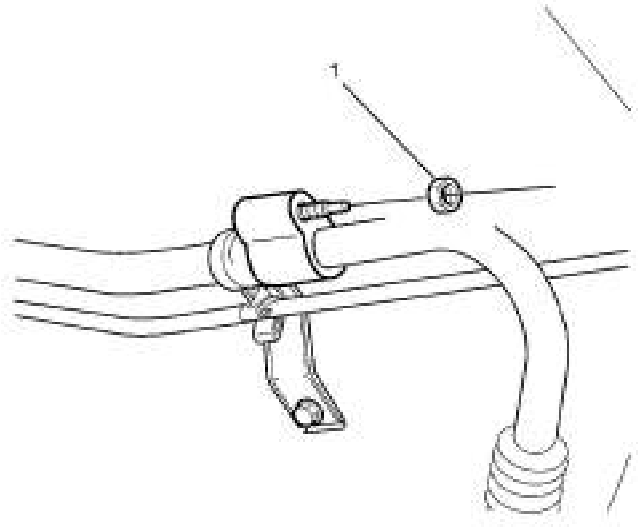
12. Remove the plugs or caps from the suction pipe upper (1) and the suction pipe lower (2).

Important: DO NOT coat the NEW sealing washer (3) with oil, they must be fitted dry. The use of mineral oil will render the sealing washer (3) useless, as the sealing washer (3) WILL swell causing refrigerant to leak out.

13. Install a NEW sealing washer (3). Refer to Sealing Washer Replacement.
14. Install the suction pipe upper (1) to the suction pipe lower (2).

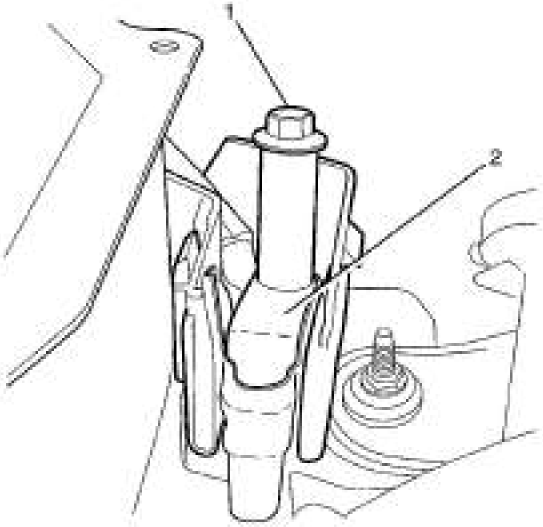


15. Attach the liquid pipe (1) from the suction pipe/liquid pipe retaining clip (2).
16. Install the suction pipe/liquid pipe retaining clip to left front chassis rail retaining bolt (3).



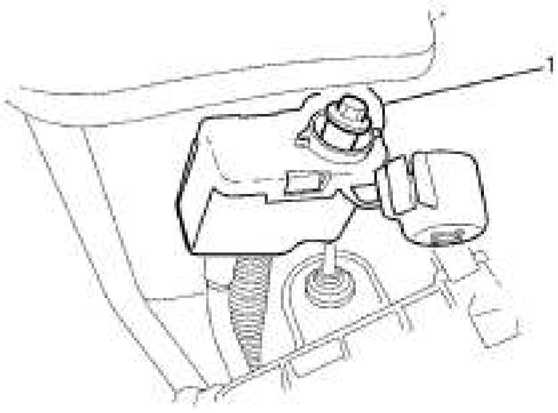
17. Install the suction pipe upper to suction pipe lower retaining nut (1).

    Tighten
    Tighten the nut to 22 N·m(16 lb ft).



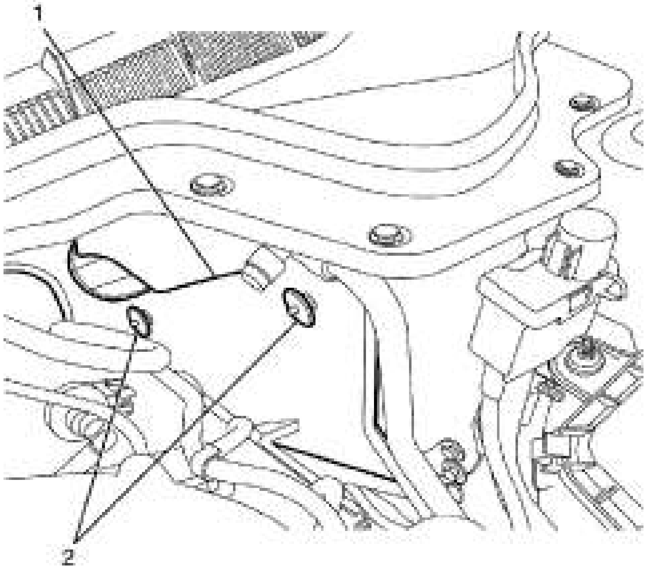
18. Install the starter motor positive cable (2) to the remote battery positive post.
19. Install the remote battery positive post to wiring harness retaining bolt (1).

    Tighten
    Tighten the bolt to 15 N·m (11 lb ft).

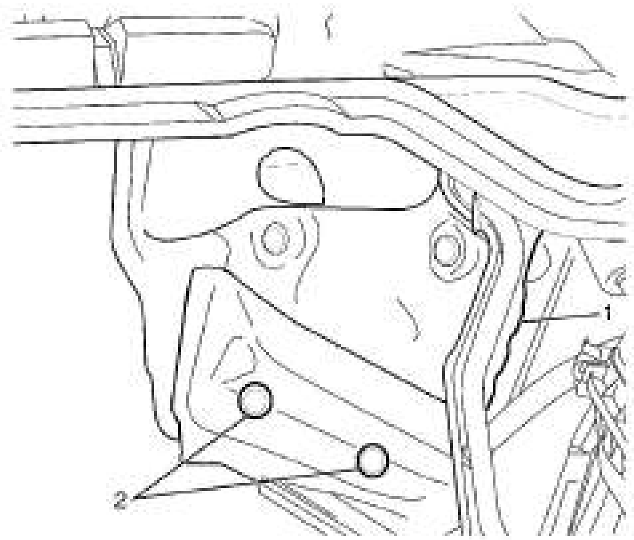


Important: Make sure the clips on the remote battery positive post cover (1) are engaged to avoid an induced rattle condition.

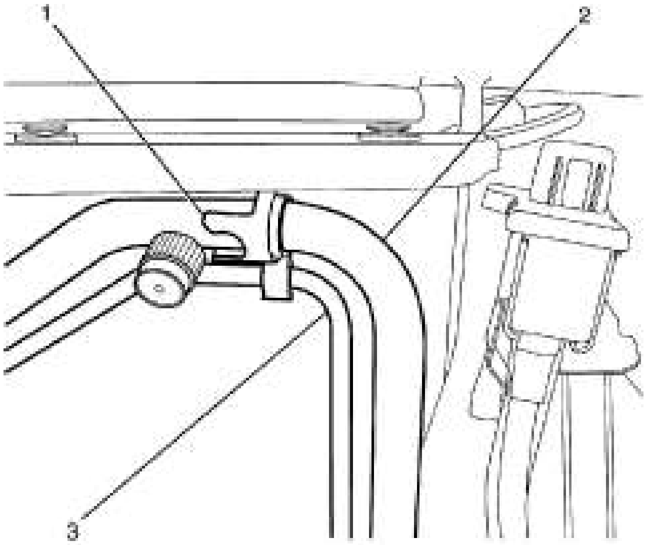
20. Install the remote battery positive post cover (1) to the remote battery positive post.



21. Install the insulation panel (1) to the left rear side engine compartment.
22. Install the insulation panel to air box retaining clips (2).



23. Install the exhaust manifold heat shield (1).
24. Install the exhaust manifold heat shield to air box retaining clips (2).



25. Attach the suction pipe (2) and the liquid pipe (3) from the suction pipe/liquid pipe retaining clip (1).
26. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.
27. Install the air filter assembly. Refer to Air Cleaner Assembly Replacement.
28. Install the engine cover. Refer to Engine Cover Replacement.
29. Install the plenum chamber cover panel. Refer to Air Inlet Grille Panel Replacement.
30. Install the windscreen wiper arms. Refer to Windshield Wiper Arm Replacement.
31. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
32. Evacuate and recharge the A/C system. Refer to Refrigerant Recovery and Recharging.
33. Leak test the fittings of the component using J 39400 .

Odor Correction

Eliminating Air Conditioning Odour

1. Odours may be emitted from the air conditioning system primarily at start up in hot, humid climates. The following conditions may cause the odour:
   - Debris is present in the HVAC module assembly.
   - Microbial growth on the evaporator core.
2. When the blower motor fan is turned on, the microbial growth may release an unpleasant musty odour into the passenger compartment. To remove odours of this type, the microbial growth must be addressed. Perform the following procedure:
   - Remove evaporator core. Refer to Air Conditioning Evaporator Core Replacement.
   - Clean evaporator core with a solution of 40% vinegar and 60% water.
   - Refit evaporator core. Refer to Air Conditioning Evaporator Core Replacement.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | HVAC | Heating, Ventilation, and Air Conditioning | Repair Instructions | **Document ID: 1976240**

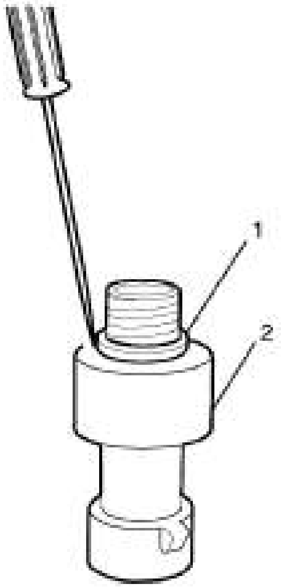
O-Ring Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Important: This procedure applies to all 'O-ring throughout the A/C system.

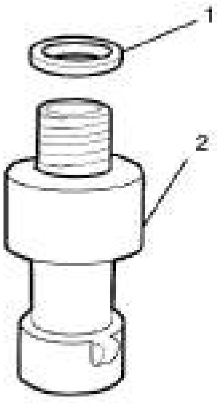
1. Disassemble the A/C refrigerant components. Refer to the appropriate repair procedure.



Important: The O-ring seal (1) is a single use item and must be discarded after use.

Important: Using a suitable tool, gently insert the end of the tool under the O-ring seal (1) and lift O-ring seal (1), evenly all the way around, off the A/C refrigerant component (2).

2. Remove the O-ring seal (1) from the A/C refrigerant component (2).

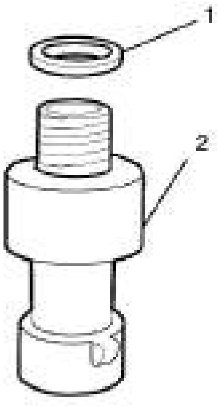


3. Inspect the O-ring seal (1) for signs of damage.
4. Inspect the A/C refrigerant component (2) for damage or burrs. Repair if necessary.

   Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

5. Cap or tape the A/C refrigerant component (2).
6. Discard the O-ring seal.

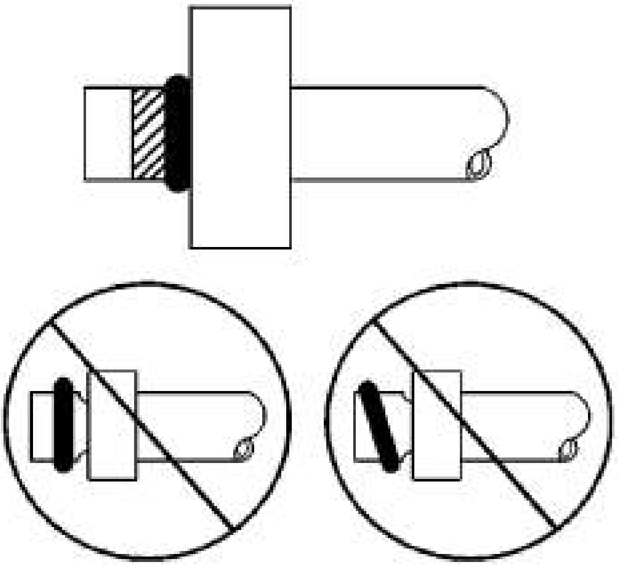
Installation Procedure



1. Inspect the NEW O-ring seal (1) for any sign or cracks, cuts, or damage. Replace if

necessary.

2. Remove the cap or tape from the A/C refrigerant component (2).
3. Using a lint-free clean, dry cloth, carefully clean the sealing surfaces of the A/C refrigerant component (2).
4. Coat the NEW O-ring (1) with refrigerant oil.
5. Carefully slide the NEW O-ring seal (1) onto the A/C refrigerant component.



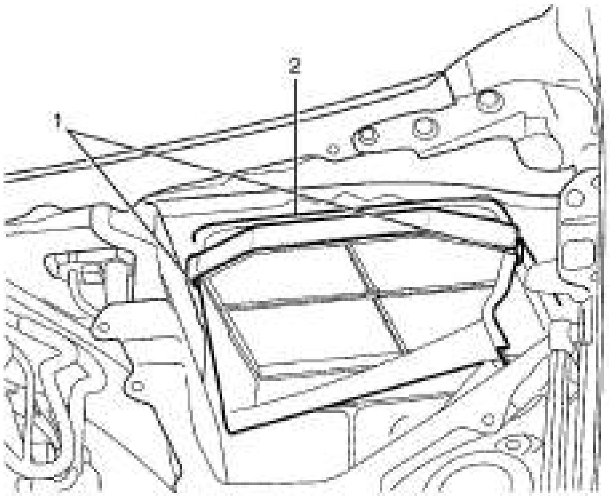
6. The O-ring seal must be fully seated.
7. Assemble the A/C components. Refer to the appropriate repair procedure.

Passenger Compartment Air Filter Housing Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

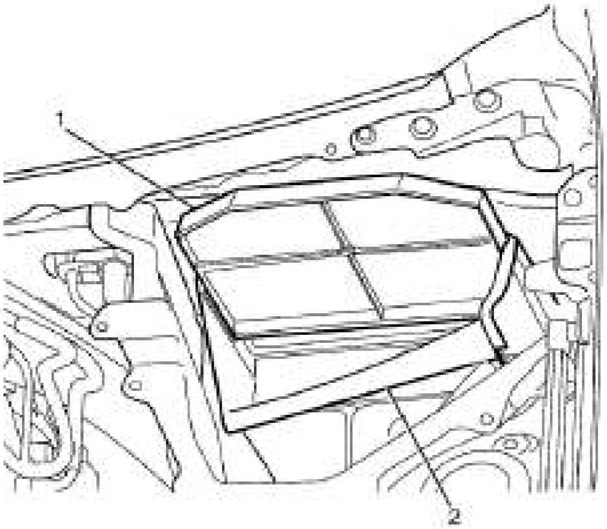
1. Remove the plenum chamber cover panel. Refer to Air Inlet Grille Panel Replacement.



2. Detach the leaf screen housing retainer (1) from the leaf screen housing (2).

   Important: Remove the leaf screen housing retainer (1) from the leaf screen housing (2), by lifting the leaf screen housing retainer (1) upwards.

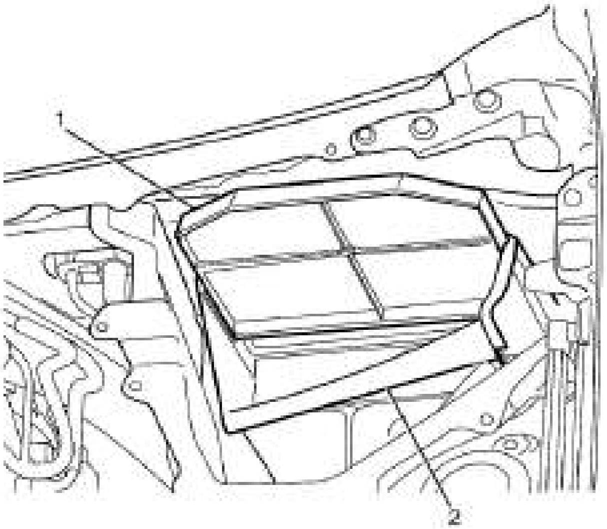
3. Remove the leaf screen housing retainer (1).



Important: Remove the leaf screen (1) from the leaf screen housing (2), by lifting the leaf screen (1) upwards.

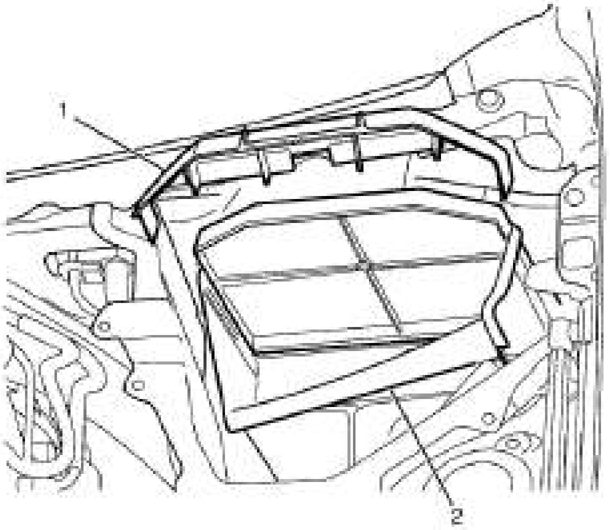
4. Remove the leaf screen (1) from the leaf screen housing (2).

Installation Procedure



Important: To install the leaf screen (1), slide the leaf screen (1) downwards into the leaf screen housing (2).

1. Install the leaf screen (1) into the leaf screen housing (2).



Important: Make sure that the rear tang on the leaf screen housing retainer (1) is correctly positioned in the leaf screen housing (2) and the leaf screen housing retainer (1) is correctly attached to the leaf screen housing (2) to avoid an induced rattle condition.

2. Install the leaf screen housing retainer (1) to the leaf screen housing (2).
3. Install the plenum chamber cover panel. Refer to Air Inlet Grille Panel Replacement.

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Receiver and Dehydrator Replacement

Tools Required

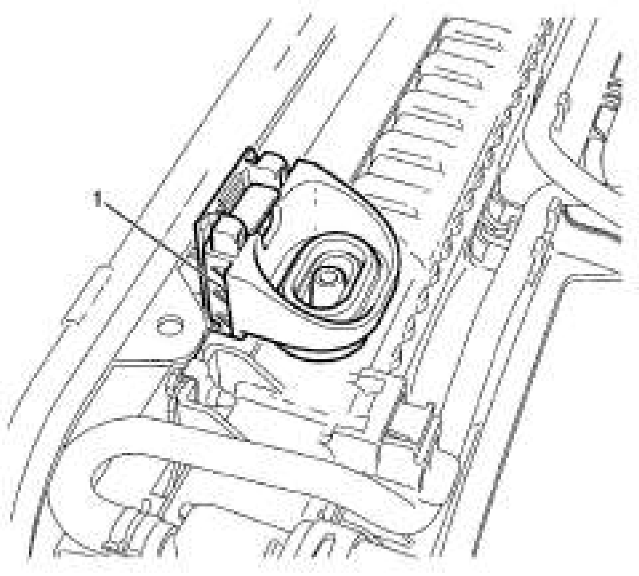
J 39400 Halogen Leak Detector

Removal Procedure

1. Remove the air filter assembly. Refer to Air Cleaner Assembly Replacement for 3.6L engine, or Air Cleaner Assembly Replacement for 6.0L engine.
2. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement

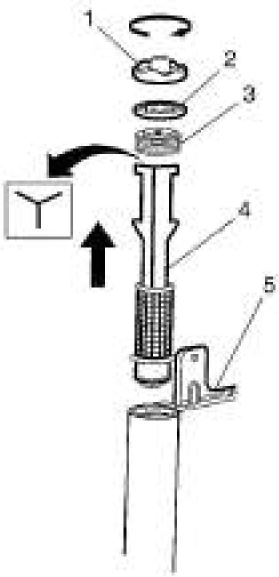
Caution: Refer to Safety Glasses Caution in the Preface section.

3. Recover the refrigerant. Refer to Refrigerant Recovery and Recharging .



Important: Remove the upper radiator support brackets by raising the securing lock upwards 10mm and slide the bracket out of the radiator slide pin.

4. Remove the upper radiator support brackets (1).



Important: Gently push the radiator and condenser towards the engine to allow removal of the plastic screw cap (1) on the right side of the condenser (5).

5. Remove the receiver dehydrator plastic screw cap (1) from the condenser (5).

Important: The circlip (2) cannot be removed if any gas pressure is present in A/C system.

Important: To gain adequate clearance for removal of the circlip (2), use a suitable tool to gently tap the receiver dehydrator bottle plug (3) downwards.

6. Remove the circlip (2).

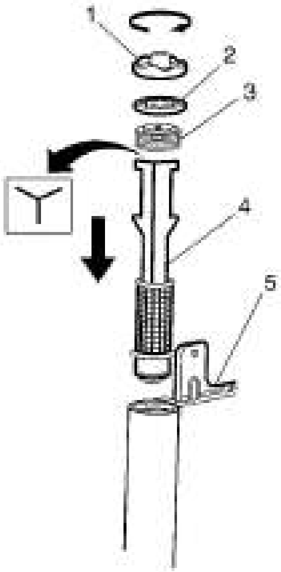
Important: Screw a suitable bolt into the threaded hole in the receiver dehydrator bottle plug (3). Pull upwards on the bolt to remove the receiver dehydrator bottle plug (3) from the condenser (5).

7. Remove the receiver dehydrator bottle plug (3) from the condenser (5).

Important: Using a suitable tool, grip the lower lip on the receiver dehydrator cartridge (4) and pull upwards to remove the receiver dehydrator cartridge (4) from the condenser (5).

8. Remove the receiver dehydrator cartridge (4) from the condenser (5).

Installation Procedure



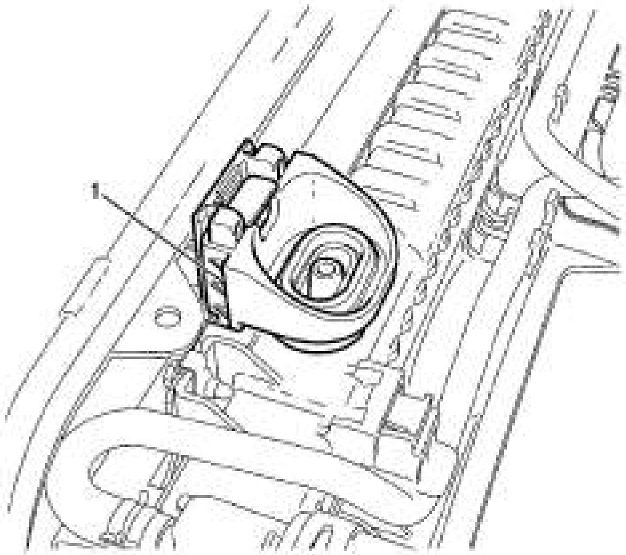
1. Install the receiver dehydrator cartridge (4) into the condenser (5).

   Important: Make sure the receiver dehydrator bottle plug (3) is fitted below the circlip groove

2. Install the receiver dehydrator bottle plug (3).

   Important: Make sure the circlip (2) is fitted correctly seated in the circlip groove.

3. Install the circlip (2).
4. Install the receiver dehydrator plastic screw cap (1) to the condenser (5).



5. Install the upper radiator support brackets (1).
6. Install the air filter assembly. Refer to Air Cleaner Assembly Replacement for 3.6L engine, or

Air Cleaner Assembly Replacement for 6.0L engine

7. Evacuate and recharge the A/C system. Refer to Refrigerant Recovery and Recharging .
8. Leak test the fittings of the component using J 39400
9. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement

Refrigerant Recovery and Recharging

Tools Required

Air Conditioning Service Centre.

Caution: Avoid breathing the A/C Refrigerant 134a (R-134a) and the lubricant vapor or the mist. Exposure may irritate the eyes, nose, and throat. Work in a well ventilated area. In order to remove R-134a from the A/C system, use service equipment that is certified to meet the requirements of SAE J 2210 (R-134a recycling equipment). If an accidental system discharge occurs, ventilate the work area before continuing service. Additional health and safety information may be obtained from the refrigerant and lubricant manufacturers.

Caution: For personal protection, goggles and lint-free gloves should be worn and a clean cloth wrapped around fittings, valves, and connections when doing work that includes opening the refrigerant system. If refrigerant comes in contact with any part of the body severe frostbite and personal injury can result. The exposed area should be flushed immediately with cold water and prompt medical help should be obtained.

Notice: R-134a is the only approved refrigerant for use in this vehicle. The use of any other refrigerant may result in poor system performance or component failure.

Notice: To avoid system damage use only R-134a dedicated tools when servicing the A/C system.

Notice: Use only Polyalkylene Glycol Synthetic Refrigerant Oil (PAG) for internal circulation through the R-134a A/C system and only 525 viscosity mineral oil on fitting threads and O-rings. If lubricants other than those specified are used, compressor failure and/or fitting seizure may result.

Notice: R-12 refrigerant and R-134a refrigerant must never be mixed, even in the smallest of amounts, as they are incompatible with each other. If the refrigerants are mixed, compressor failure is likely to occur. Refer to the manufacturer instructions included with the service equipment before servicing.

Important: As of December 2006 only personnel holding the federal government refrigerant handling licence are to carry out repairs to the A/C system and handle refrigerant HFC R134a, unlicensed personnel may be subject to a fine from a government appointed body.

Preliminary A/C Service Centre Inspection Before Commencing

1. Make sure that the A/C Service Centre refrigerant storage container has sufficient refrigerant for charging the A/C system.
2. Drain the oil collection reservoir.
3. Turn both high pressure (HP) and low pressure (LP) hand valves to the OFF or closed direction.
4. Connect the HP (Red) and LP (Blue) hoses from the A/C Service Centre to the vehicles A/C system charging ports, using the shut off valves fitted to the end of the hoses. Turn the shut off valve taps to the open position to depress the charge port schrader valves.

Refrigerant Recovery

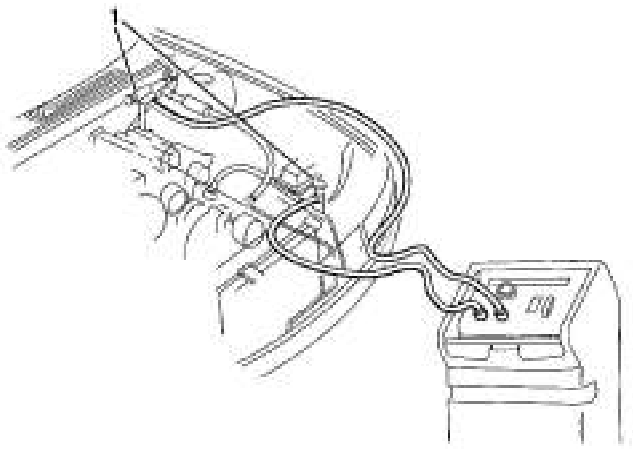
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Turn the A/C Service Centre to the ON position.
2. Select the refrigerant recovery program at the control panel.
3. Open both the HP and LP hand valves on the device.
4. The A/C Service Centre will now start to recover both the refrigerant and lubricating oil from the A/C system. The refrigerant will go to the storage bottle and the oil will be separated into a removable oil reservoir.

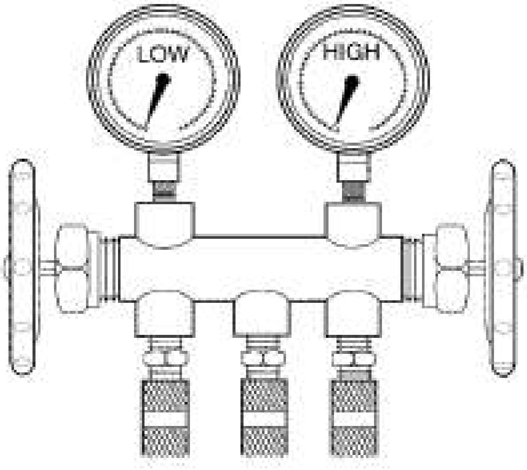
   Important: Although the A/C system does pull into a partial vacuum, this is only to aid in refrigerant recovery. The A/C will still have to be evacuated for the specified duration of time.

5. The A/C Service Centre will remove all the refrigerant from the A/C system then pull into a partial vacuum around 34 kPa (10 inhg).
6. Once the partial vacuum is reached it is advisable to turn the A/C Service Centre OFF and close both the hand valves, take note of the pressure readings. If after 2 minutes the vacuum readings rise to a positive pressure that indicates that refrigerant (boiling off) still remains in the receiver dehydrator, if so continue the recovery process until no rise to positive pressure is evident.
7. Inspect the recovered oil reservoir and take a note of the quantity removed as you will need to add the same quantity back into the A/C system later.

Evacuation

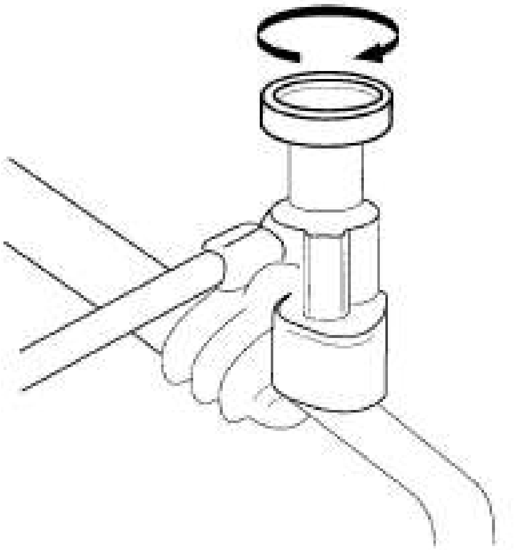


1. Connect the HP (Red) and LP (Blue) hoses from the A/C Service Centre to the vehicles A/C system charging ports (1), using the shut off valves fitted to the end of the hoses. Turn the shut off valve taps open to depress the charge port Schrader valves.
2. Turn the A/C Service Centre to the ON position.
3. Select the A/C system evacuation program at the control panel.
4. Select the duration time for evacuation. The recommendation is 30 minutes and longer for high temperature and humidity states.
5. Open both the HP and LP hand valves on the A/C Service Centre.



6. Note both the HP and LP negative pressure readings.
7. After waiting 5 minutes, check the LP reading for a rise in pressure. If the pressure has risen this indicates a leak is present in the system. Carry out leak test and repair leakage point. If no pressure rise has taken place the A/C system is correctly evacuated and no leak is present.

Refrigerant Recharging



1. Make sure that the HP and LP hand valves are in the OFF position.
2. Turn the A/C Service Centre to the ON position.
3. Connect the HP (Red) and LP (Blue) hoses from the A/C Service Centre to the vehicles A/C system charging ports, using the shut off valves fitted to the end of the hoses. Turn the shut

off valve taps open to depress the charge port Schrader valves.

4. Select the A/C refrigerant charging program at the control panel and set the specified charge quantity of 580 grams (20.5 oz).

   Important: DO NOT Start the engine as all automated A/C Service Centres have a pump that will force the refrigerant into the A/C system.

   Important: If you have to start the engine to complete the charging through the low side, make sure that you do not exceed 275 kPa this is to make sure that the refrigerant, entering the compressor is vaporised.

   Important: If the ambient temperature is low you may also have to hold the engine RPM at 2000 to assist in filling the remaining refrigerant.

5. Open both the HP and LP hand valves on the A/C Service Centre. The A/C Service Centre will now start filling the A/C system with refrigerant. If the total specified quantity cannot be filled into the A/C system (especially in cooler weather), CLOSE the HP hand valve, leave the LP hand valve OPEN, start the engine and engage the A/C. The action of the "suction" side of the compressor will draw the remaining refrigerant into the A/C system.

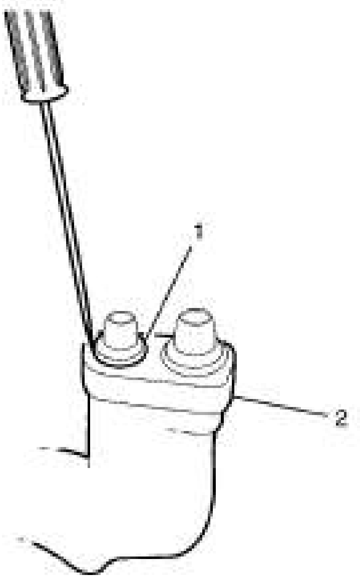
Sealing Washer Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Important: This procedure applies to all sealing washers throughout the A/C system

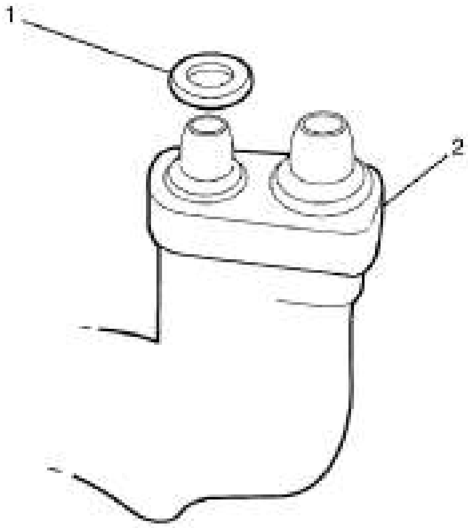
1. Disassemble the appropriate A/C refrigerant components. Refer to the appropriate repair procedure.



Important: The sealing washers (1) are a single use item and must be discarded after use.

Important: Using a suitable tool, gently insert the end of the tool under the sealing washer (1) and lift sealing washer (1), evenly all the way around, off the A/C refrigerant component (2).

2. Remove the sealing washer (1) from the A/C refrigerant component (2).

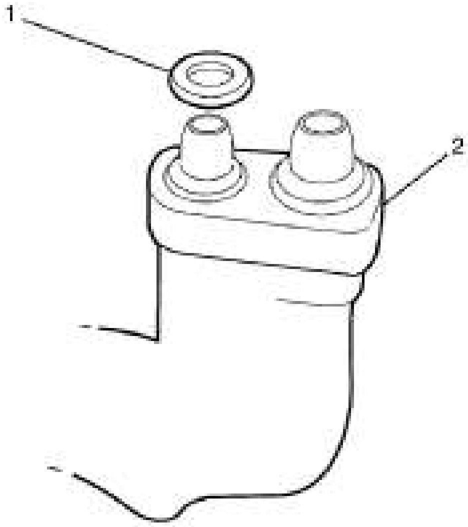


3. Inspect the sealing washer (1) for signs of damage.
4. Inspect the A/C refrigerant component (2) for damage or burrs. Repair if necessary.

Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

5. Cap or tape the A/C refrigerant component (2).
6. Discard the sealing washer (1).

Installation Procedure



Important: DO NOT coat the NEW sealing washer (1) with oil, they must be fitted dry. The use of mineral oil will render the washer useless, as the sealing washer (1) will swell causing refrigerant to leak out.

1. Inspect the NEW sealing washer (1) for any sign or cracks, cuts, or damage. Replace if necessary.
2. Remove the cap or tape from the A/C refrigerant component (2).
3. Using a lint-free clean, dry cloth, carefully clean the sealing surfaces of the A/C refrigerant component (2).
4. Carefully slide the NEW sealing washer (1) onto the A/C refrigerant component (2).
5. The sealing washer (1) must be fully seated.
6. Assemble the A/C components. Refer to the appropriate repair procedure.

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Suction Hose Replacement (3.6L Engine)

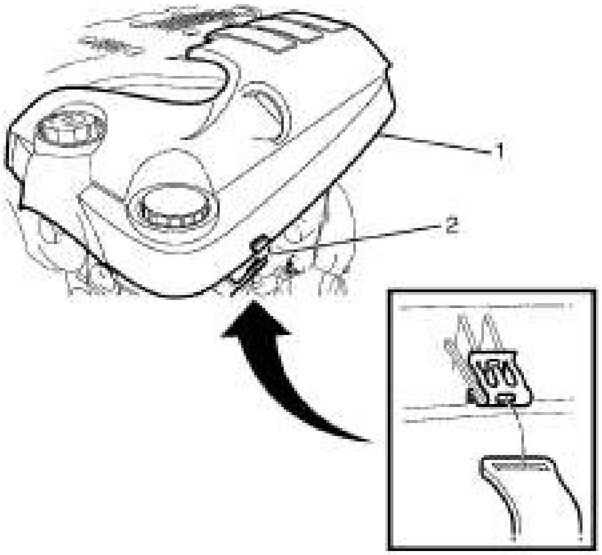
Tools Required

J 39400 Halogen Leak Detector

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

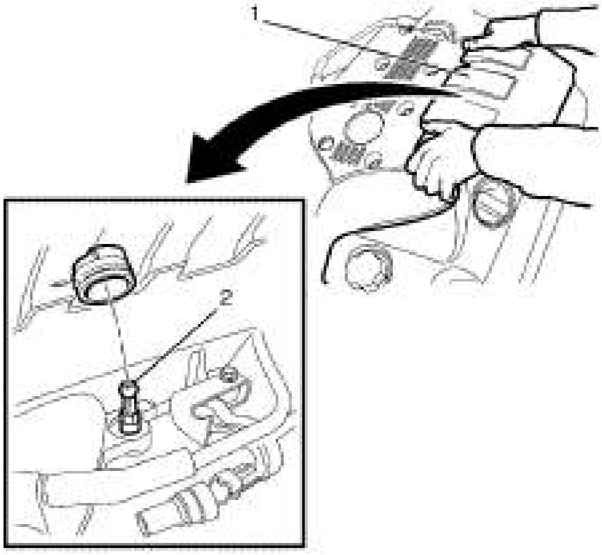
1. Recover the refrigerant. Refer to Refrigerant Recovery and Recharging .
2. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection I.
3. Remove the air filter assembly. Refer to Air Cleaner Assembly Replacement .
4. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement
5. Remove the cross car brace, if fitted. Refer to Front End Panel Module Carrier Assembly Replacement



Important: The left engine cover has one front and one rear outer retaining clip.

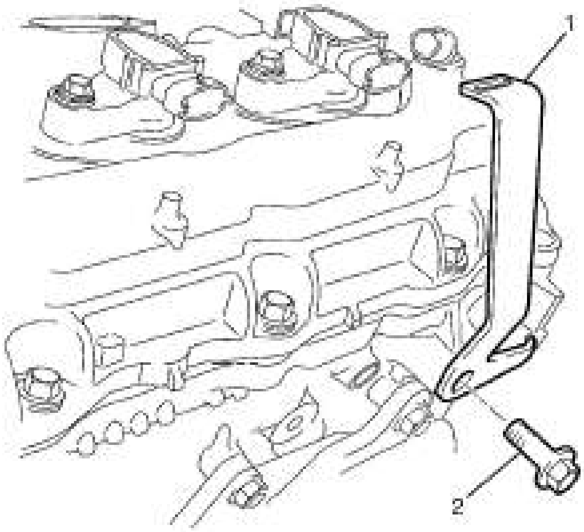
Important: Grasp and pry the left engine cover (1) upwards to detach the left engine cover (1) from the outer retaining clip (2).

6. Detach the left engine cover (1) from the outer retaining clip (2).

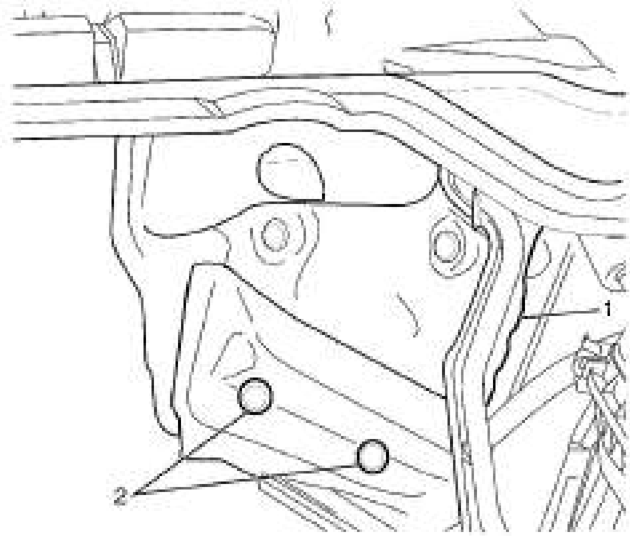


Important: Disengage the left engine cover (1) from the ball stud (2) by pulling up firmly on the rear and front of the left engine cover (1).

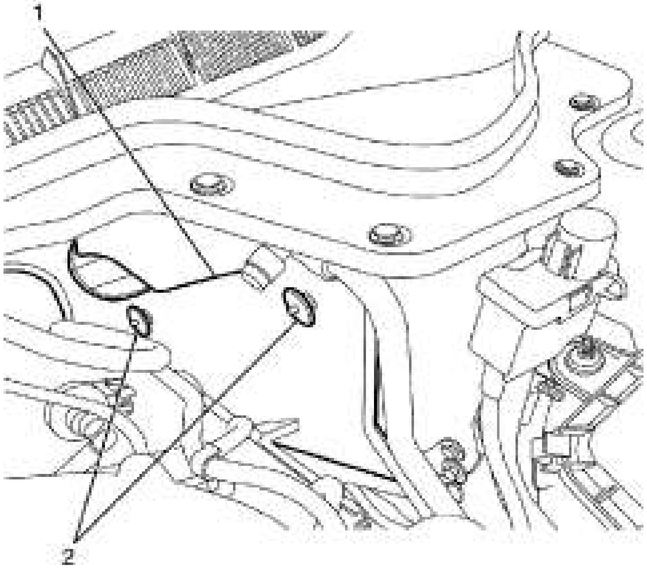
7. Detach the left engine cover (1) from the ball stud (2).
8. Remove the left engine cover (1).



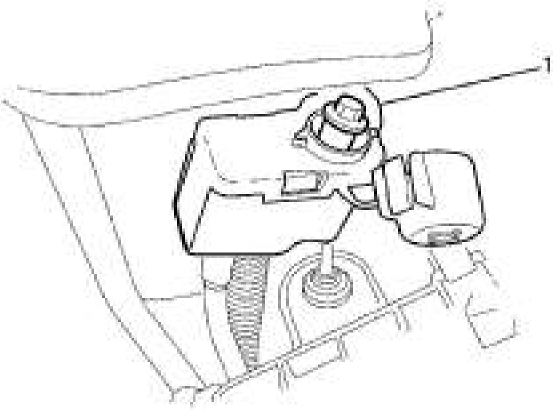
9. Remove the left engine cover mounting bracket to cylinder head retaining bolt (2).
10. Remove the left engine cover mounting bracket (1) from the cylinder head.



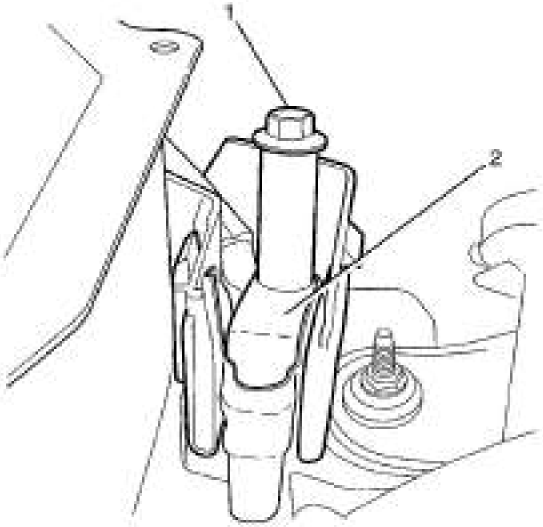
11. Remove the exhaust manifold heat shield to air box retaining clips (2).
12. Remove the exhaust manifold heat shield (1).



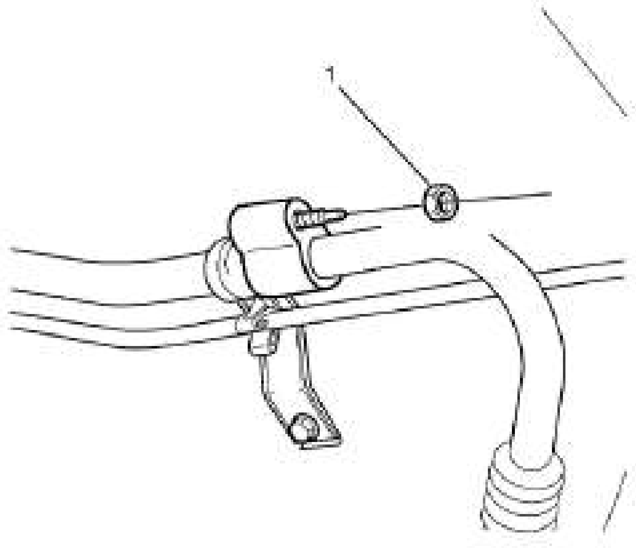
13. Remove the insulation panel to air box retaining clips (2).
14. Remove the insulation panel (1) from the engine compartment.



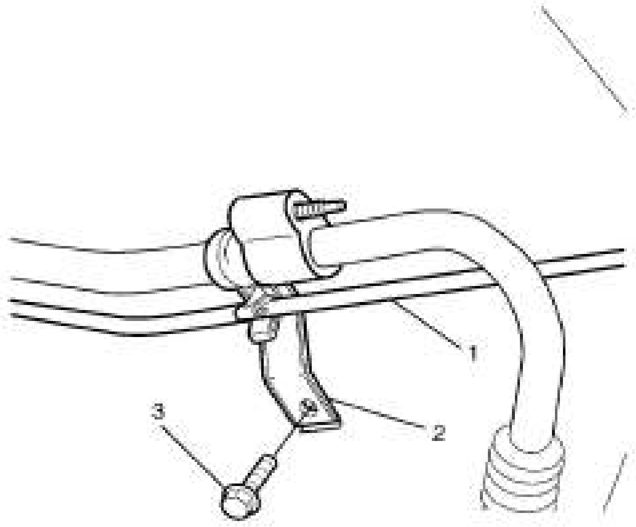
15. Remove the remote battery positive post cover (1).



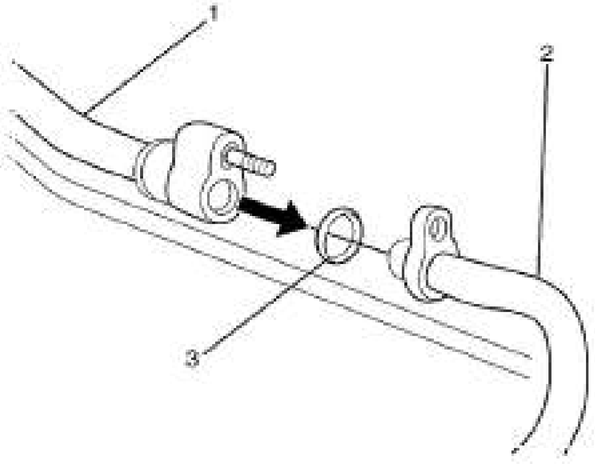
16. Remove the remote battery positive post to wiring harness retaining bolt (1).
17. Remove the starter motor power cable (2) and position aside.



18. Remove the suction pipe upper to suction pipe lower retaining nut (1).



19. Remove the suction pipe/liquid pipe retaining clip to left front chassis rail retaining bolt (3).
20. Detach the liquid pipe (1) from the suction pipe/liquid pipe retaining clip (2).



21. Disconnect the suction pipe upper (1) from the suction pipe lower (2).

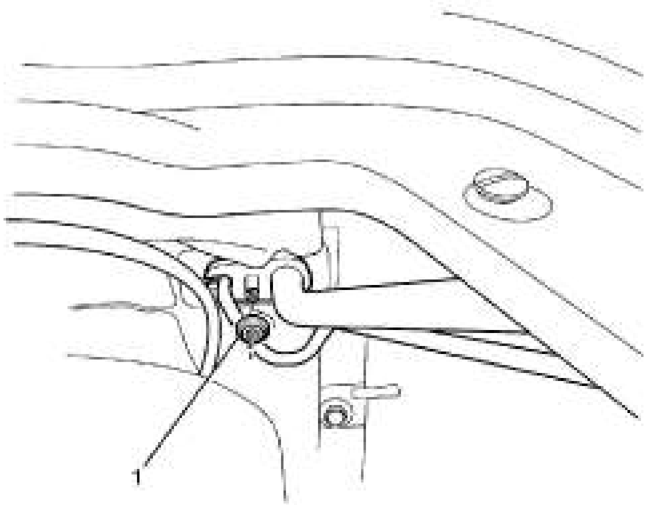
Important: The sealing washer (3) is a single use item and must be discarded after use.

22. Remove the sealing washer (3). Refer to Sealing Washer Replacement .

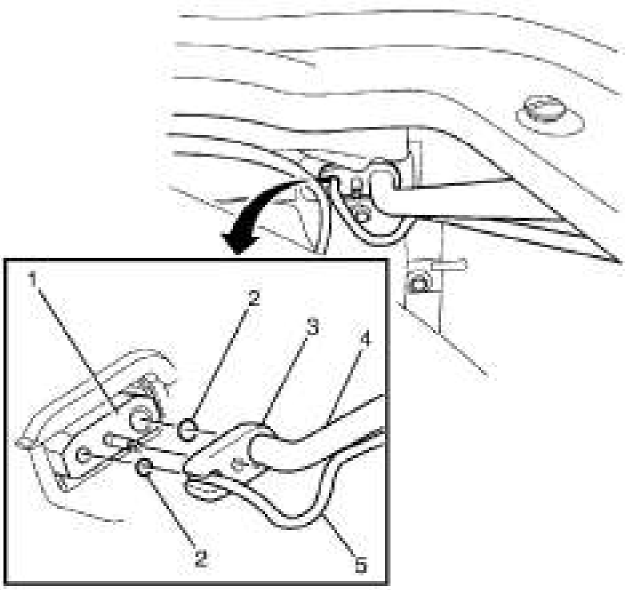
Discard the sealing washer

Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

23. Cap or plug the suction pipe upper (1) and the suction pipe lower (2).



24. Remove the suction pipe/liquid pipe pad to TX valve retaining nut (1).



25. Disconnect the suction pipe/liquid pipe pad (3) from the TX valve (1).

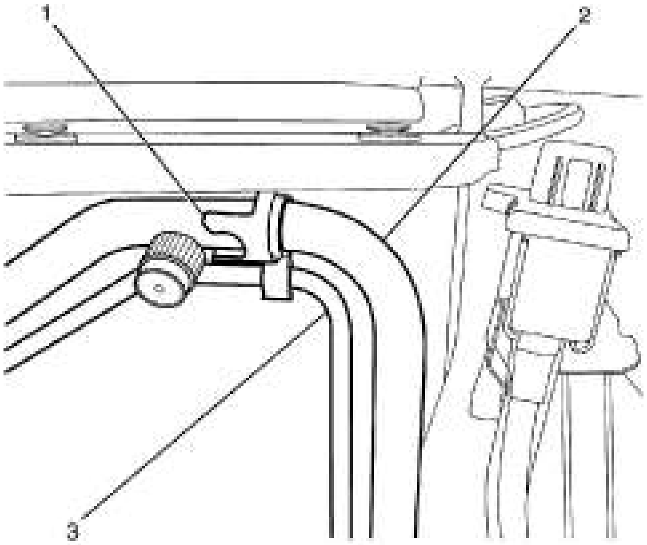
    Important: The sealing washers (2) are a single use item and must be discarded after use.

26. Remove the sealing washers (2). Refer to Sealing Washer Replacement .

    Discard the sealing washers

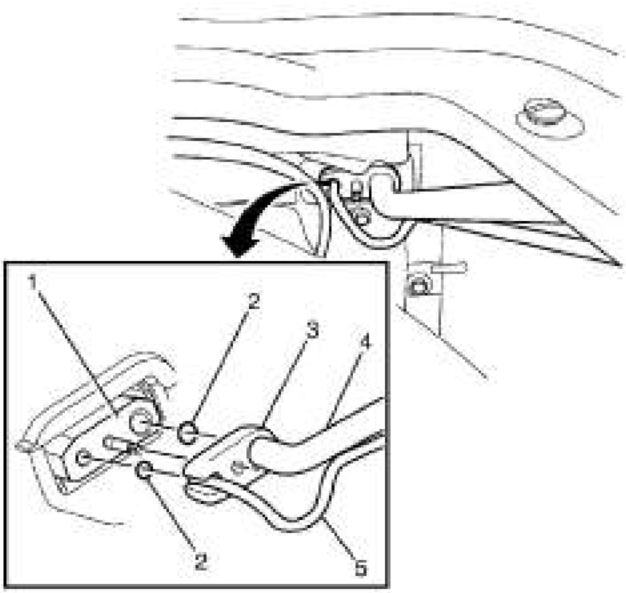
    Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

27. Cap or plug the suction pipe (4), liquid pipe (5) and the TX valve (1).
28. Remove the liquid pipe (5) from the suction pipe/liquid pipe pad (3).



29. Detach the suction pipe (2) and the liquid pipe (3) from the suction pipe/liquid pipe retaining clip (1).
30. Remove the suction pipe (2) from the engine compartment.

Installation Procedure

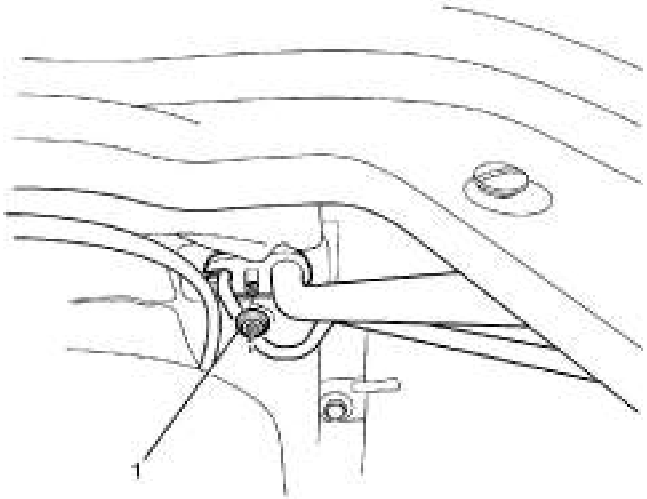


1. Install the liquid pipe (5) to the suction pipe/liquid pipe pad (3).
2. Remove the plugs or caps from the suction pipe (4), liquid pipe (5) and the TX valve (1).

Important: DO NOT coat the NEW sealing washers (2) with oil, they must be fitted dry. The use of mineral oil will render the sealing washers (2) useless, as the sealing washers (2) WILL swell causing refrigerant to leak out.

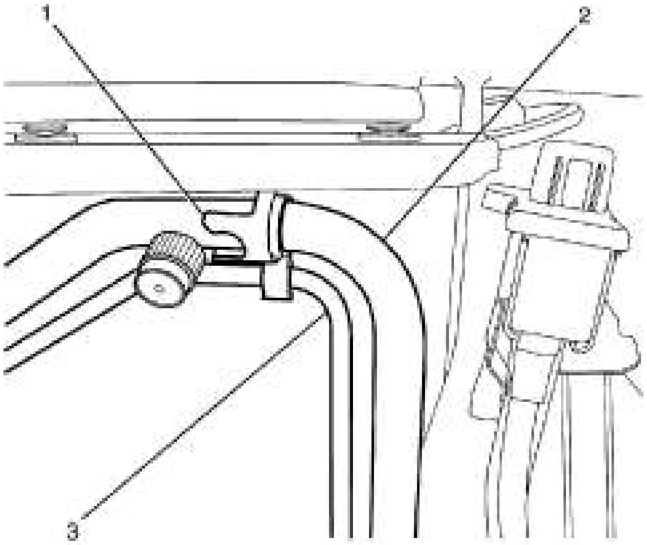
3. Install NEW sealing washers (2). Refer to Sealing Washer Replacement .
4. Position the suction pipe/liquid pipe pad (3) to the TX Valve (1).

Notice: Refer to Fastener Notice in the Preface section.

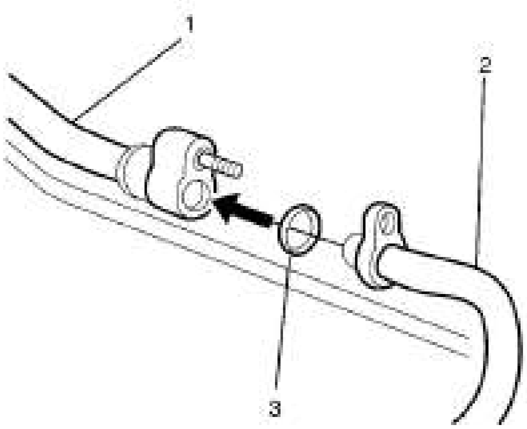


5. Install the suction pipe/liquid pipe pad to TX valve retaining nut (1).

   Tighten
   Tighten the nut to 22 N·m(16 lb ft).



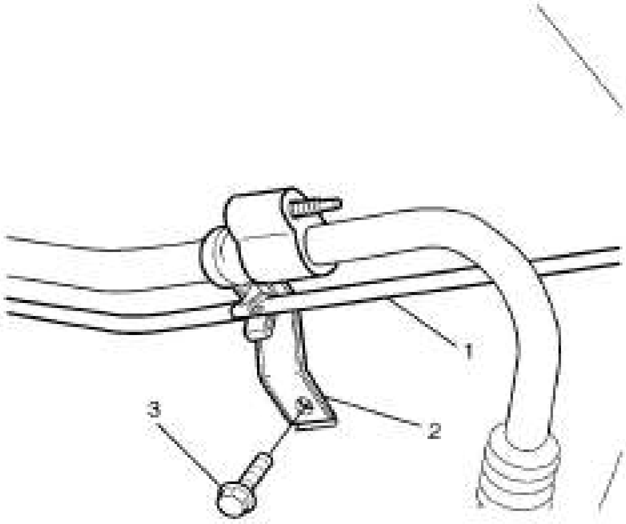
6. Attach the suction pipe (2) and the liquid pipe (3) from the suction pipe/liquid pipe retaining clip (1).



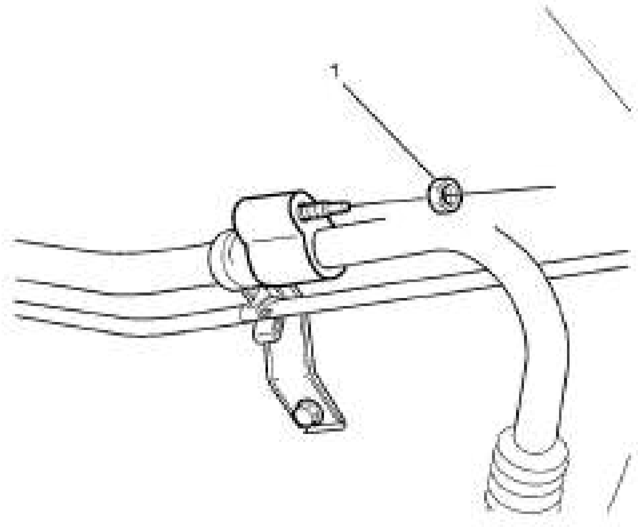
7. Remove the plugs or caps from the suction pipe upper (1) and the suction pipe lower (2).

Important: DO NOT coat the NEW sealing washer (3) with oil, they must be fitted dry. The use of mineral oil will render the sealing washer (3) useless, as the sealing washer (3) WILL swell causing refrigerant to leak out.

8. Install a NEW sealing washer (3). Refer to Sealing Washer Replacement .
9. Install the suction pipe upper (1) to the suction pipe lower (2).

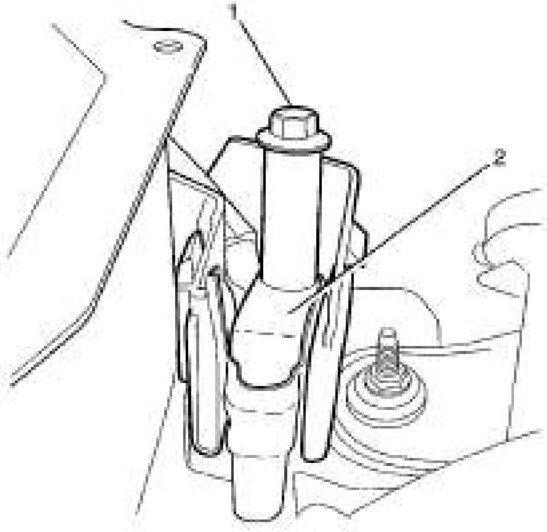


10. Attach the liquid pipe (1) from the suction pipe/liquid pipe retaining clip (2).
11. Install the suction pipe/liquid pipe retaining clip to left front chassis rail retaining bolt (3).



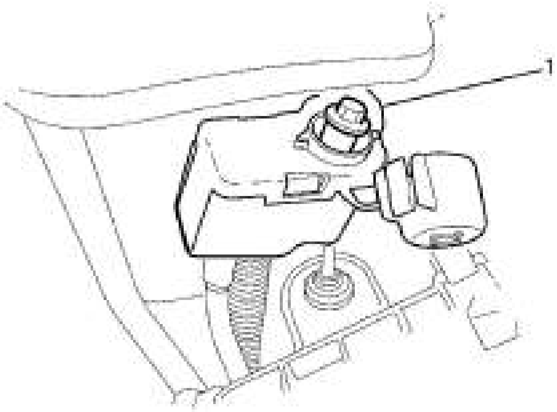
12. Install the suction pipe upper to suction pipe lower retaining nut (1).

    Tighten
    Tighten the nut to 22 N·m(16 lb ft).



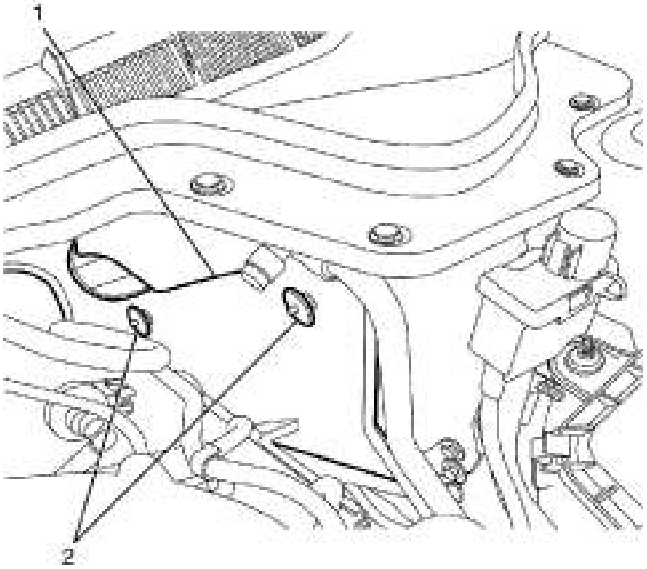
13. Install the starter motor positive cable (2) to the remote battery positive post.
14. Install the remote battery positive post to wiring harness retaining bolt (1).

    Tighten
    Tighten the bolt to 15 N·m (11 lb ft).

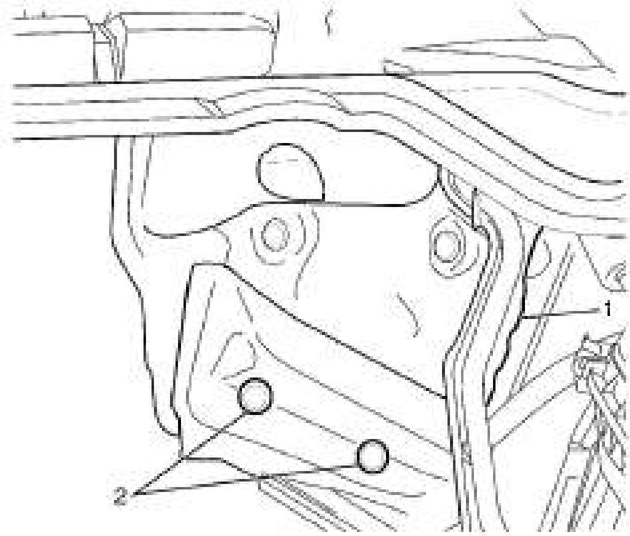


Important: Make sure the clips on the remote battery positive post cover (1) are engaged to avoid an induced rattle condition.

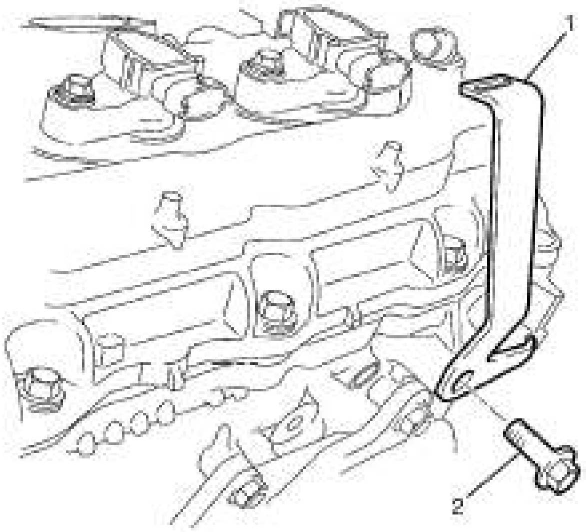
15. Install the remote battery positive post cover (1) to the remote battery positive post.



16. Install the insulation panel (1) to the left rear side engine compartment.
17. Install the insulation panel to air box retaining clips (2).

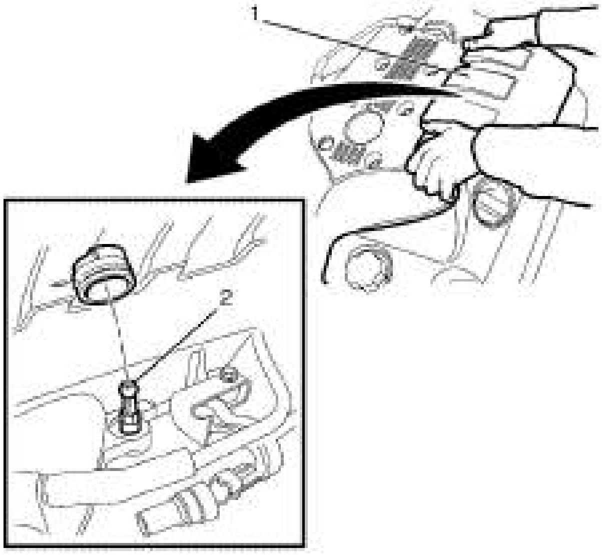


18. Install the exhaust manifold heat shield (1).
19. Install the exhaust manifold heat shield to air box retaining clips (2).



20. Install the left engine cover mounting bracket (1)
21. Install the left engine cover mounting bracket to cylinder head retaining bolt (2).

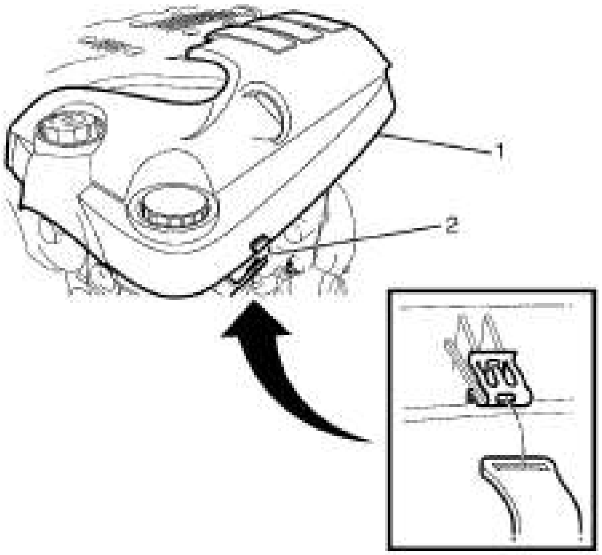
Tighten
Tighten the bolt to 35 N·m (26 lb in).



22. Position the left engine cover (1) over the intake manifold so the grommet is aligned with the ball stud (2).

    Important: Press the left engine cover (1) down firmly near the ball stud to attach the left engine cover (1) to the ball stud (2).

23. Attach the left engine cover (1) to the ball stud (2).



Important: The left engine cover has one front and one rear outer retaining clip.

Important: Press the left engine cover (1) down firmly near the outer retaining clips to attach the left engine cover (1) to the outer retaining clip (2).

24. Attach the left engine cover (1) to the outer retaining clip (2).
25. Install the cross car brace, if fitted. Refer to Front End Panel Module Carrier Assembly Replacement
26. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement
27. Install the air filter assembly. Refer to Air Cleaner Assembly Replacement .
28. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection .
29. Evacuate and recharge the A/C system. Refer to Refrigerant Recovery and Recharging .
30. Leak test the fittings of the component using electronic leak detector.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | HVAC | Heating, Ventilation, and Air Conditioning | Repair Instructions | **Document ID: 2038171**

Suction Hose Replacement (6.0L Engine)

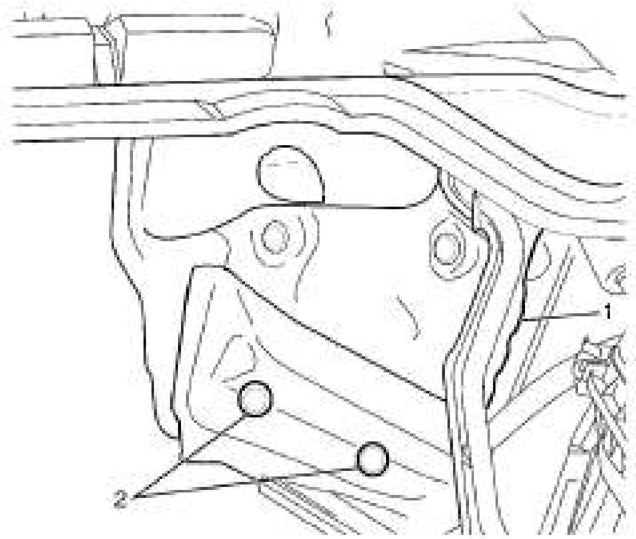
Tools Required

J 39400 Halogen Leak Detector

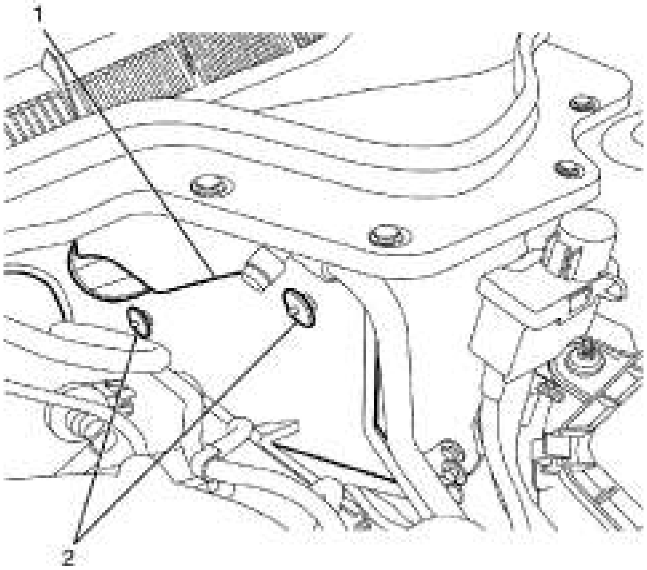
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

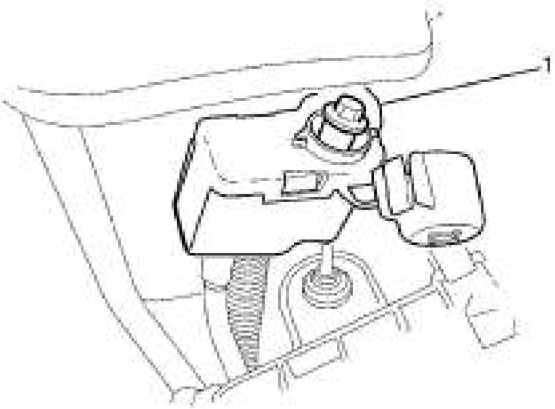
1. Recover the refrigerant Refer to Refrigerant Recovery and Recharging.
2. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the air filter assembly. Refer to Air Cleaner Assembly Replacement.
4. Remove the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.
5. Remove the engine cover. Refer to Engine Cover Replacement.



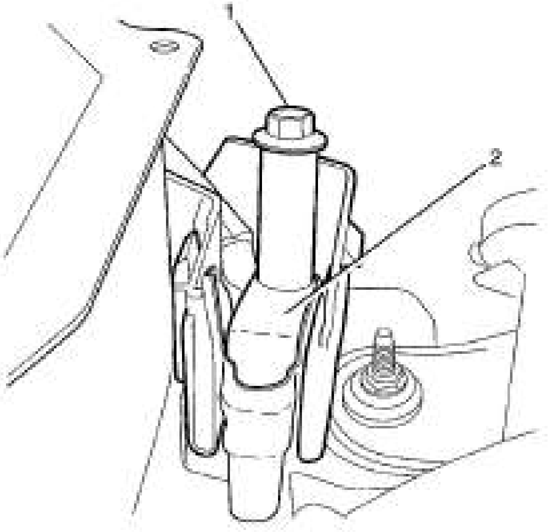
6. Remove the exhaust manifold heat shield to air box retaining clips (2).
7. Remove the exhaust manifold heat shield (1).



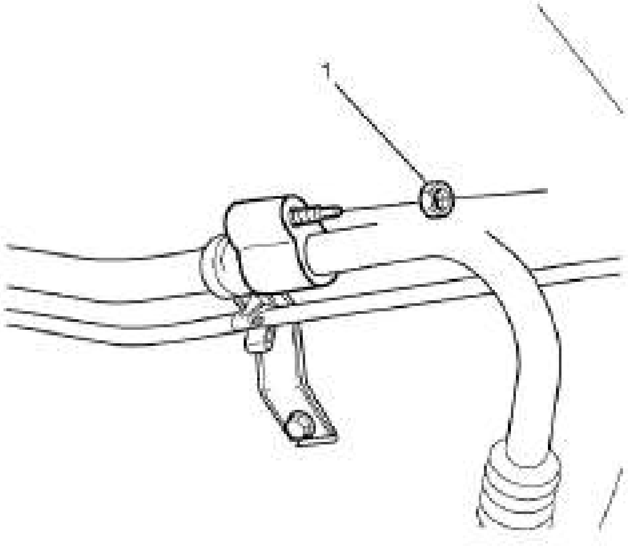
8. Remove the insulation panel to air box retaining clips (2).
9. Remove the insulation panel (1) from the engine compartment.



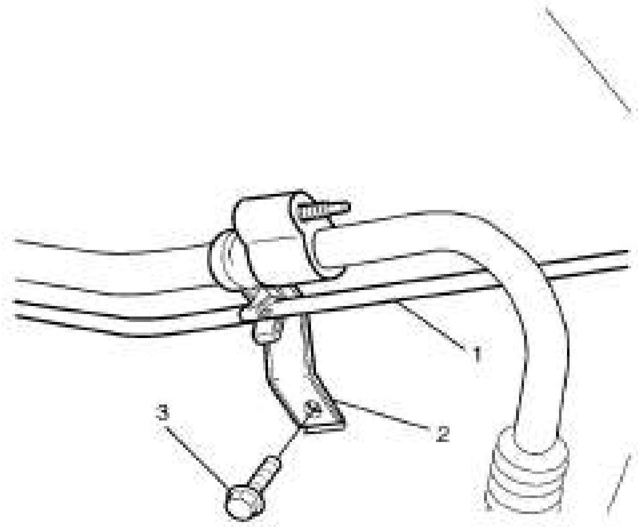
10. Remove the remote battery positive post cover (1).



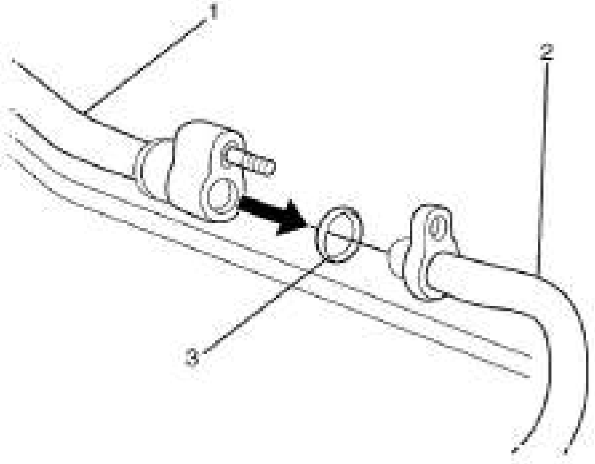
11. Remove the remote battery positive post to wiring harness retaining bolt (1).
12. Remove the starter motor power cable (2) and position aside.



13. Remove the suction pipe upper to suction pipe lower retaining nut (1).



14. Remove the suction pipe/liquid pipe retaining clip to left front chassis rail retaining bolt (3).
15. Detach the liquid pipe (1) from the suction pipe/liquid pipe retaining clip (2).



16. Disconnect the suction pipe upper (1) from suction pipe lower (2).

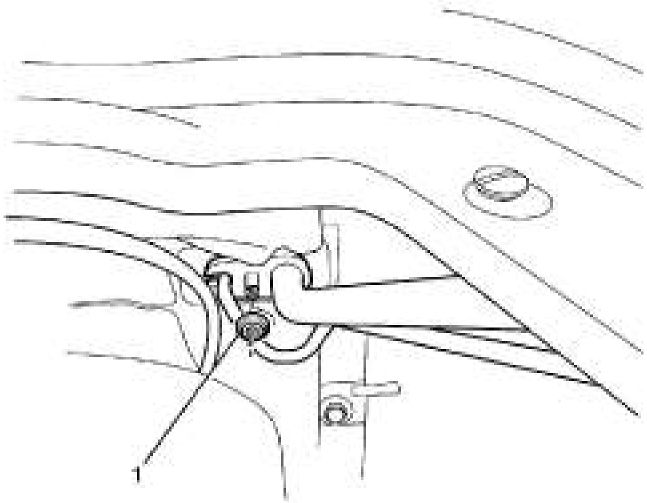
Important: The sealing washer (3) is a single use item and must be discarded after use.

17. Remove the sealing washer (3). Refer to Sealing Washer Replacement.

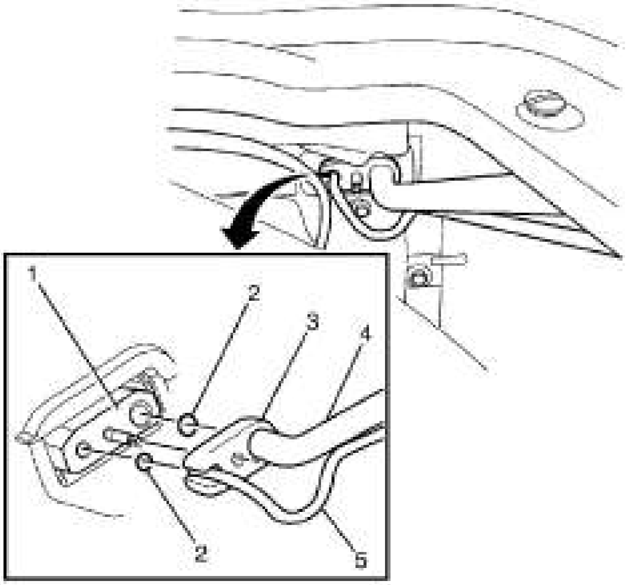
Discard the sealing washer

Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

18. Cap or plug the suction pipe upper (1) and the suction pipe lower (2).



19. Remove the suction pipe/liquid pipe pad to TX Valve retaining nut (1).



20. Disconnect the suction pipe/liquid pipe pad (3) from the TX valve (1).

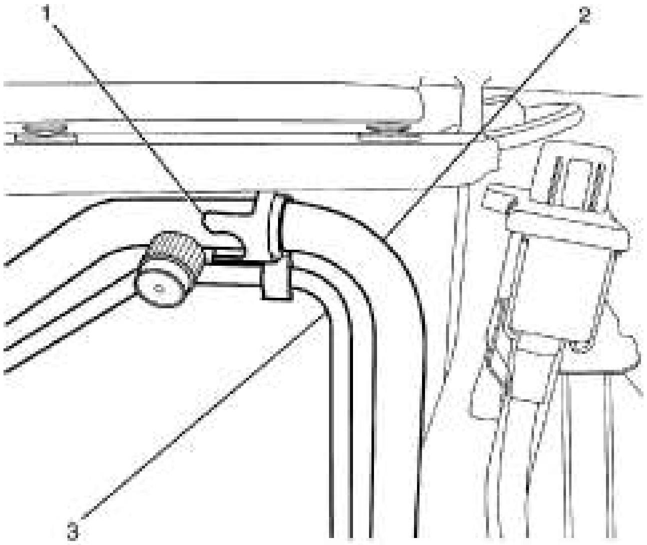
Important: The sealing washers (2) are a single use item and must be discarded after use.

21. Remove the sealing washers (2). Refer to Sealing Washer Replacement.

Discard the sealing washers

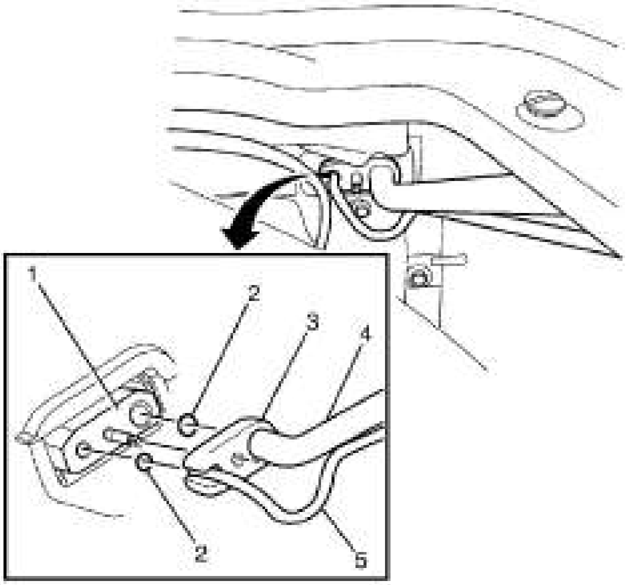
Important: Cover any opening of the A/C system with a suitable cap or tape immediately, to prevent absorption of moisture from the atmosphere.

22. Cap or plug the suction pipe (4), liquid pipe (5) and the TX valve (1).
23. Remove the liquid pipe (5) from the suction pipe/liquid pipe pad (3).



24. Detach the suction pipe (2) and the liquid pipe (3) from the suction pipe/liquid pipe retaining clip (1).
25. Remove the suction pipe (2) from the engine compartment

Installation Procedure

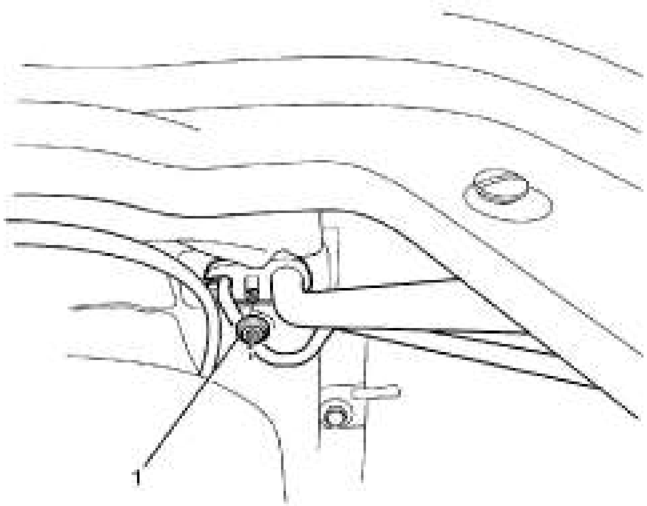


1. Install the liquid pipe (5) to the suction pipe/liquid pipe pad (3).
2. Remove the plugs or caps from the suction pipe (4), liquid pipes (5) and the TX valve (1).

Important: DO NOT coat the NEW sealing washers (2) with oil, they must be fitted dry. The use of mineral oil will render the sealing washers (2) useless, as the sealing washers (2) WILL swell causing refrigerant to leak out.

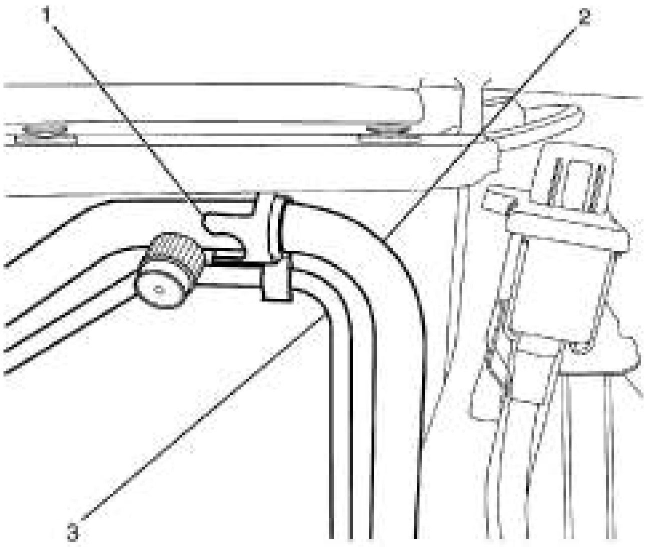
3. Install NEW sealing washers (2). Refer to Sealing Washer Replacement.
4. Position the suction pipe/liquid pipe pad (3) to the TX Valve (1).

   Notice: Refer to Fastener Notice in the Preface section.

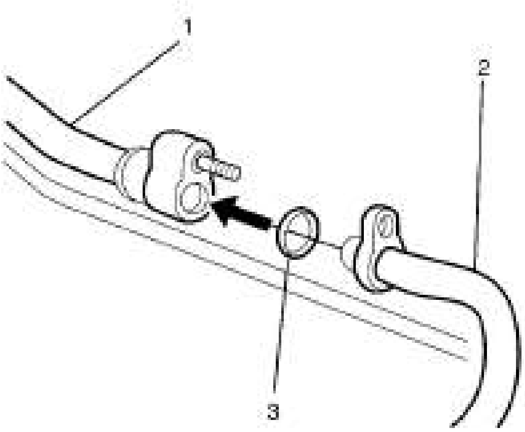


5. Install the suction pipe/liquid pipe pad to TX valve retaining nut (1).

   Tighten
   Tighten the nut to 22 N·m(16 lb ft).



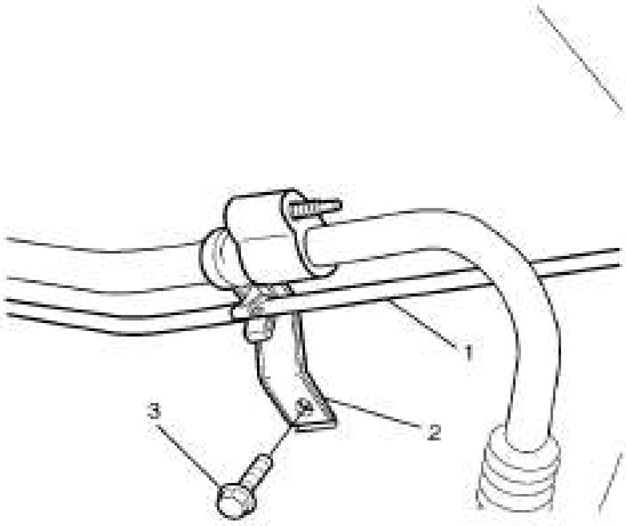
6. Attach the suction pipe (2) and the liquid pipe (3) from the suction pipe/liquid pipe retaining clip (1).



7. Remove the plugs or caps from the suction pipe upper (1) and the suction pipe lower (2).

Important: DO NOT coat the NEW sealing washer (3) with oil, they must be fitted dry. The use of mineral oil will render the sealing washer (3) useless, as the sealing washer (3) WILL swell causing refrigerant to leak out.

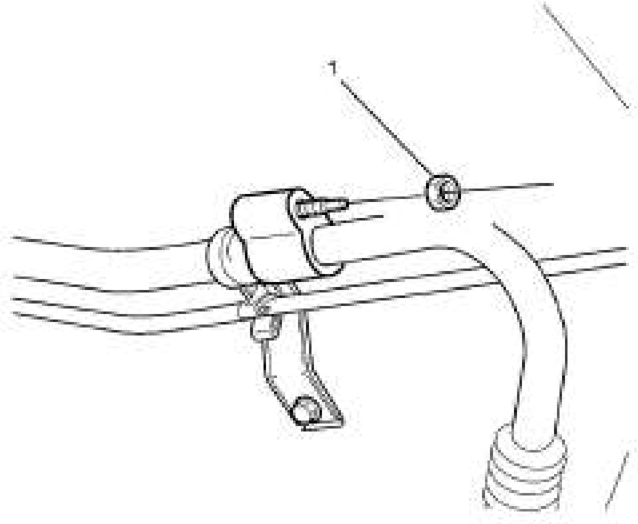
8. Install a NEW sealing washer (3). Refer to Sealing Washer Replacement.
9. Install the suction pipe upper (1) to the suction pipe lower (2).



10. Attach the liquid pipe (1) from the suction pipe/liquid pipe retaining clip (2).

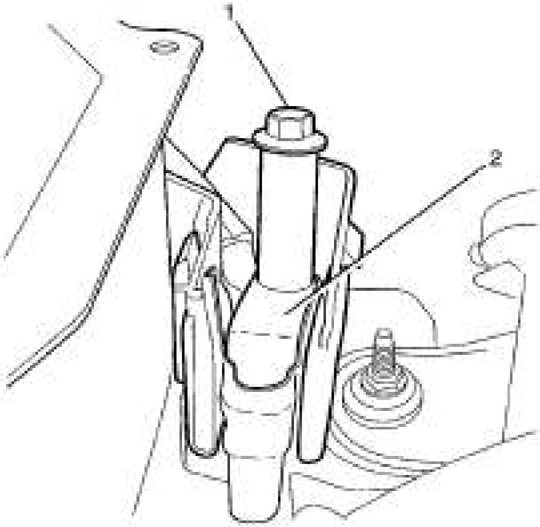
11. Install the suction pipe/liquid pipe retaining clip to left front chassis rail retaining bolt (3).

    Tighten
    Tighten the bolt to 22 N·m(16 lb ft).



12. Install the suction pipe upper to suction pipe lower retaining nut (1).

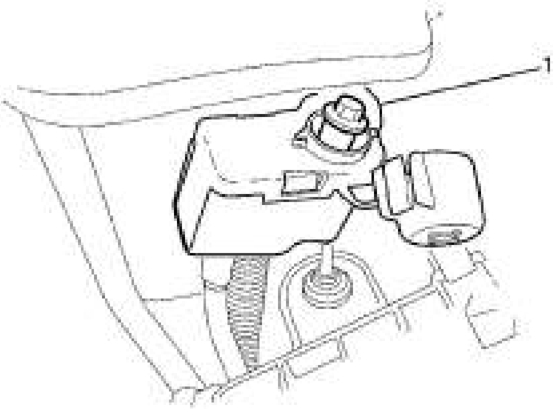
    Tighten
    Tighten the nut to 22 N·m(16 lb ft).



13. Install the starter motor positive cable (2) to the remote battery positive post.

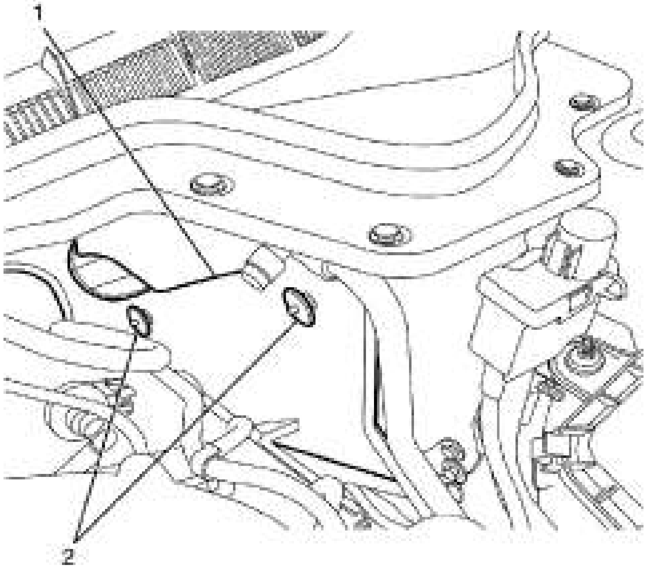
14. Install the remote battery positive post to wiring harness retaining bolt (1).

Tighten
Tighten the bolt to 15 N·m (11 lb ft).

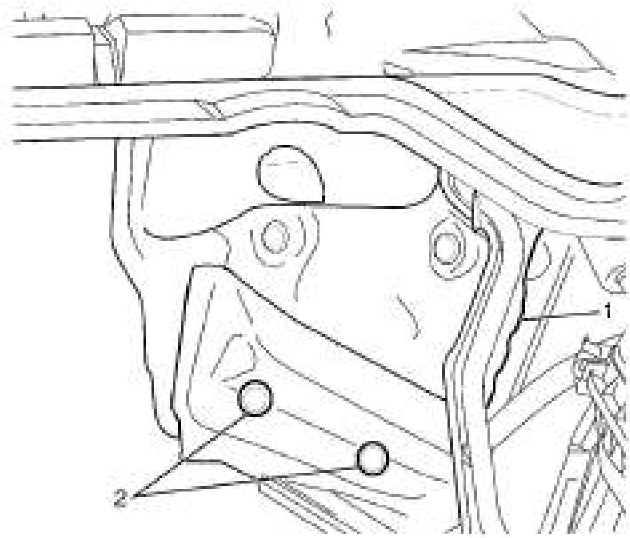


Important: Make sure the clips on the remote battery positive post cover (1) are engaged to avoid an induced rattle condition.

15. Install the remote battery positive post cover (1) to the remote battery positive post.



16. Install the insulation panel (1) to the left rear side engine compartment.
17. Install the insulation panel to air box retaining clips (2).



18. Install the exhaust manifold heat shield (1).
19. Install the exhaust manifold heat shield to air box retaining clips (2).
20. Install the radiator air baffle and deflector. Refer to Radiator Air Upper Baffle and Deflector Replacement.
21. Install the air filter assembly. Refer to Air Cleaner Assembly Replacement.
22. Install the engine cover. Refer to Engine Cover Replacement.
23. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.
24. Evacuate and recharge the A/C system. Refer to Refrigerant Recovery and Recharging.
25. Leak test the fittings of the component using electronic leak detector.

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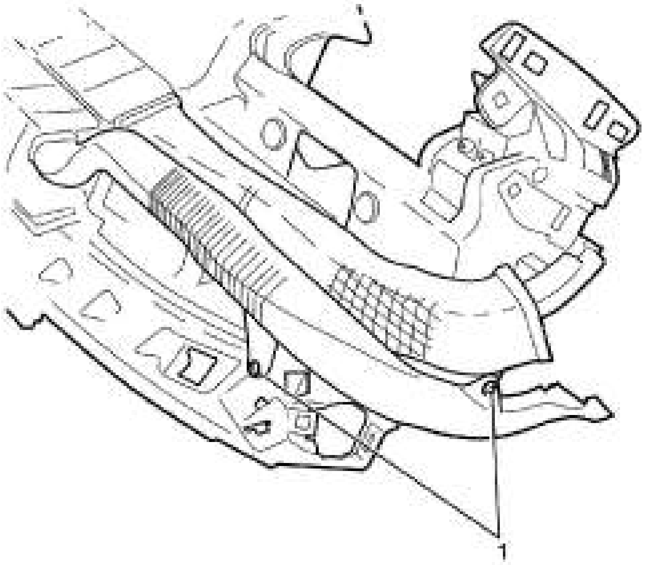
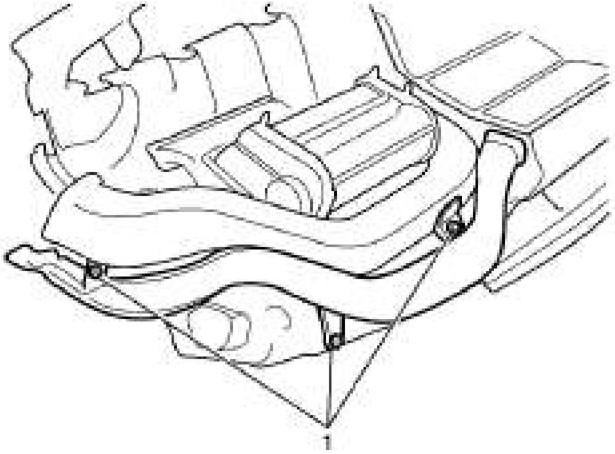
Windshield Defroster Duct Replacement

Removal Procedure

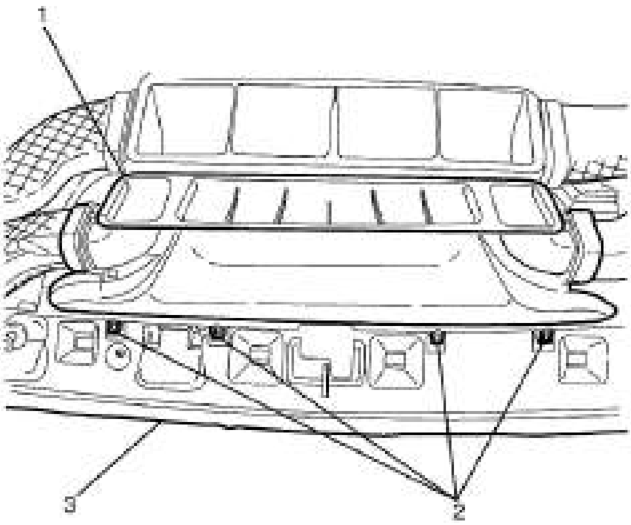
1. Remove the instrument panel (I/P) upper trim pad. Refer to Instrument Panel Upper Trim Pad Replacement .



2. Remove the air outlet duct to I/P upper trim pad retaining screws (1).

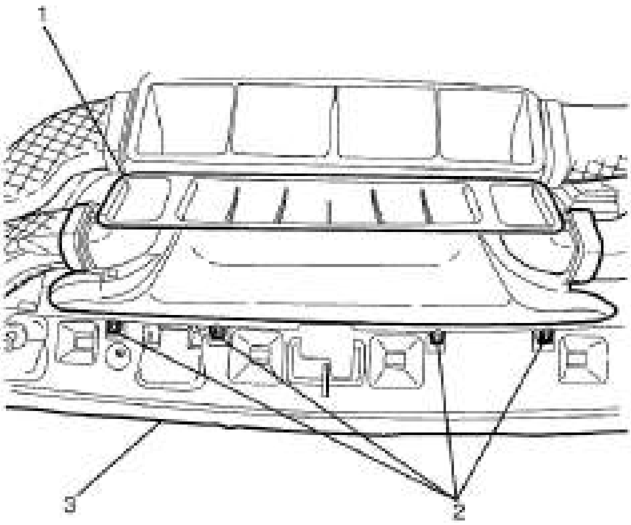


3. Remove the air outlet duct to I/P upper trim pad retaining screws (1).



4. Disengage the defroster duct to instrument panel (I/P) upper trim pad retaining clips (2)
5. Remove the defroster duct assembly (1) from the I/P upper trim pad (3).

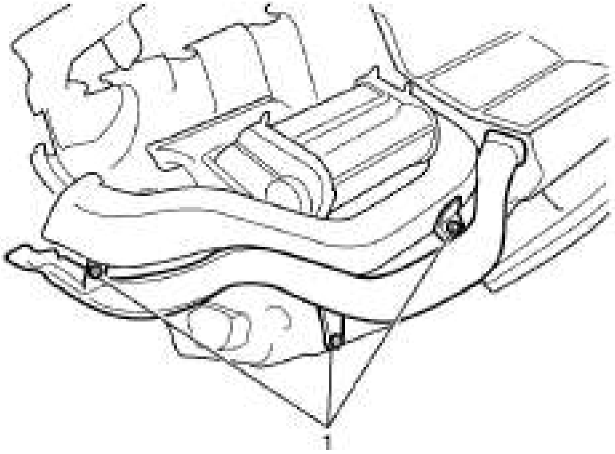
Installation Procedure



Important: Make sure the defroster duct to instrument panel (I/P) upper trim pad retaining clips (2) are engaged to avoid an induced rattle condition.

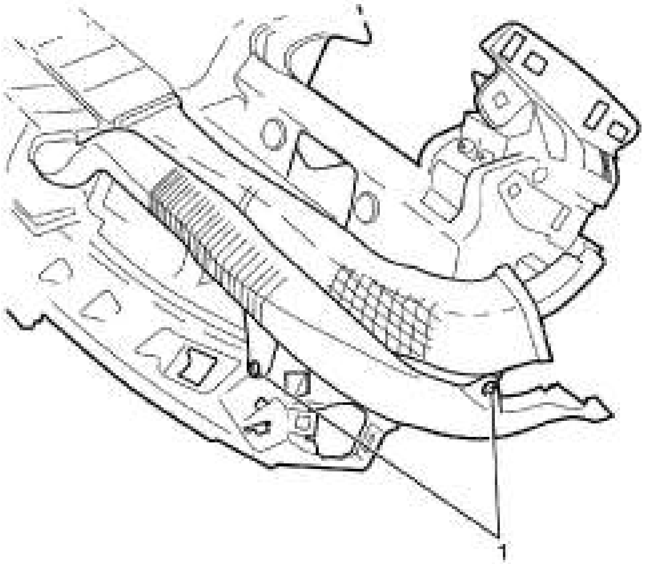
1. Install the defroster duct assembly (1) to the instrument panel (I/P) upper trim pad (3).

Notice: Refer to Fastener Notice in the Preface section.



2. Install the air outlet duct to I/P upper trim pad retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m(18lb in).



3. Install the air outlet duct to I/P upper trim pad retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m(18lb in).

4. Install the I/P upper trim pad. Refer to Instrument Panel Upper Trim Pad Replacement .

Heating and Air Conditioning System Description and Operation

The air temperature controls are divided into 4 areas:

- HVAC Control Components
- Heating and A/C Operation
- Engine Coolant
- A/C Cycle

HVAC Control Components

HVAC Control Module

The HVAC control module is a GMLAN device that interfaces between the operator and the HVAC system to maintain air temperature and distribution settings. The HVAC module assembly is operated manually by a combination of electrical and mechanical components. The case is of a 3-piece, plastic construction. The left and right cases are assembled with a centre divider that houses the doors and are secured together with screws. The case sump is secured to the upper case assembly with screws. The blower resistor is integrated into the HVAC control module which is screwed to the HVAC blower motor fan assembly, which in turn is secured to the HVAC unit with a combination of pivot pins and screws.

A/C Pressure Sensor

The A/C refrigerant pressure sensor is a 3-wire piezoelectric pressure transducer. A 5-volt reference, low reference, and signal circuits enable the sensor to operate. The A/C pressure signal can be between 0-5 volts. When the A/C refrigerant pressure is low, the signal value is near 0 volts. When the A/C refrigerant pressure is high, the signal value is near 5 volts. The engine control module (ECM) converts the voltage signal to a pressure value.

It provides a 0-5 volt output and requires a 5-volt regulated power supply. In operation, the transducer senses applied pressure via the deflection of a 2 piece ceramic diaphragm with one half being a parallel plate capacitor. Changes in capacitance influenced by the refrigerant pressure under the ceramic diaphragm are converted to an analogue output by the transducers integral signal electronics. The pressure transducer's electronics are on a flexible circuit board contained in the upper section of the transducer. They provide linear calibration of the capacitance signal from the ceramic sensing diaphragm. Benefits of using the pressure transducer over a normal type pressure switch is that the transducer is constantly monitoring pressures and sending signals to the ECM. The normal type pressure switch only has an upper and lower cut out point. The ECM will disengage the A/C compressor at low or high refrigerant pressures and electronic diagnostic equipment can be used to extract system pressure information making it easier when diagnosing concerns. As well as acting as an input to the ECM for A/C operation, the ECM also uses the information provided by the pressure transducer to determine when to turn ON and OFF the 2nd Stage cooling fan operation.

A/C Pressure Sensor Operation

Low Pressure Cut Out 180 kPa (26 psi)
Low Pressure Cut In 240 kPa (35 psi)
High Pressure Cut Out 2900 kPa (420 psi)
High Pressure Cut In 2000 kPa (290 psi)
1st Stage Fan Operation On 1517 kPa (220 psi)
1st Stage Fan Operation Off 1214 kPa (176 psi)
2nd Stage Fan Operation On 1758 kPa (255 psi)
2nd Stage Fan Operation Off 1517 kPa (220 psi)

Heating and A/C Operation

The purpose of the heating and A/C system is to provide heated and cooled air to the interior of the vehicle. The A/C system will also remove humidity from the interior and reduce windshield fogging. The vehicle operator can determine the compartment temperature by adjusting the air temperature switch. Regardless of the temperature setting, the following can affect the rate that the HVAC system can achieve the desired temperature:

- Recirculation actuator setting.
- Difference between inside and desired temperature.
- Difference between ambient and desired temperature.
- Blower motor speed setting.
- Mode setting.

The A/C system can be engaged by pressing the A/C switch. The A/C switch will illuminate when the A/C switch is pressed to the ON position. Pressing the A/C switch, the IRC (Radio) sends switch information via GMLAN to the HVAC. The HVAC unit then requests permission to engage the compressor from the ECM. Upon receiving permission from the ECM, the HVAC then engages the compressor.

- A/C Pressure is between 196 kPa (28 psi) and 3250 kPa (470 psi).
- Engine coolant temperature (ECT) is less than 119°C (250°F)..
- Engine RPM is more than 400 RPM.
- The A/C request signal is set to engage.

Once engaged, the compressor will be disengaged for the following conditions:

- A/C Pressure is more than 3250kPa (470 psi)..
- A/C Pressure is less than 196 kPa (28 psi).
- ECT is more than 119°C (246°F).
- Throttle position is over 95 percent.
- Transmission shift
- ECM detects higher than predicted torque load.
- ECM detects insufficient idle quality.
- ECM detects a hard launch condition.

A/C Request Signal and A/C Control

The compressor is an externally controlled variable displacement (ECVD) compressor. The HVAC controls the compressor displacement with a pulse width modulated (PWM) signal. When the A/C switch is pressed, the HVAC requests permission to engage the compressor from the ECM. The ECM must grant this permission before the HVAC can engage the compressor. The BCM acts as a gateway to pass these messages on GMLAN between the HVAC (LS bus) and ECM (HS bus). If the conditions listed above are not met, the engine will not grant this permission and A/C will remain at approximately 4 cc (OFF). The A/C indication (LED/Icon) will remain ON. If A/C pressure is below 196 kPa the A/C will be reduced back to approximately 4 cc (turned OFF) and the A/C indication (LED/Icon) will turn OFF. This is a normal condition in very cold ambient temperatures. While the compressor is running the HVAC transmits a Normalised Load value (representing compressor torque) to the ECM. The ECM uses this value to manage engine torque requirements and maintain idle stability. The A/C will be reduced back to approximately 4 cc (turned OFF) if the HVAC fan is turned to zero (OFF).

Heater Core

The heater core is located within the HVAC case. The engine coolant flows through the heater core providing heat to warm the vehicle interior and to provide windscreen defogging. The heater core is of a tube and fin design and is constructed of aluminium. It is fitted with a detachable inlet and outlet pipe assembly. Each pipe is attached and sealed to the heater core. Sealing foam is bonded to the sides and around the top of the heater core to prevent air leakage from the HVAC case and to make sure that all air passes through the heater core in the full hot mode.

Radiator

The radiator is a heat exchanger. It consists of a core and 2 tanks. The aluminium core is a down flow tube and fin design. This is a series of tubes that extend vertically down from the inlet tank to the outlet tank. Fins are placed around the outside of the tubes to increase heat transfer from the coolant to the atmosphere. The inlet and outlet tanks are moulded with a high temperature, nylon reinforced plastic. A high temperature rubber gasket seals the tank flange edge. The tanks are clamped to the core with clinch tabs. The tabs are part of the aluminium header at each end of the core.

The radiator removes heat from the coolant passing through it. The fins on the core absorb heat from the coolant passing through the tubes. As air passes between the fins, it absorbs heat and cools the coolant.

During vehicle use, the coolant heats and expands. The coolant that is displaced by this expansion flows into the recovery reservoir bottle. As the coolant circulates, air is allowed to exit. This is an advantage to the cooling system. Coolant without bubbles absorbs heat much better than coolant with bubbles.

Evaporator

The evaporator is located inside the vehicle housed behind the instrument panel fascia in the HVAC case. It is constructed of aluminium and is of a plate and fin design. The evaporator core is the actual cooling unit of the A/C system. As the low pressure, low temperature refrigerant enters the evaporator, it begins to boil and evaporate. This evaporation process absorbs heat from the air being circulated through the evaporator core by the blower fan. Due to the evaporator being so cold, condensation forms on the surface. This condensation is moisture taken from the air (humidity). Also any dust particles in the air passing through the evaporator become lodged in the condensate water droplets, thus filtering the air from contaminants. The evaporator is constructed of aluminium and is fitted with a detachable inlet and outlet pipe assembly. It is attached and sealed to the evaporator by a single bolt and sealing washers.

Condenser

The purpose of the condenser is the opposite of the evaporator. The condenser receives high pressure, high temperature refrigerant vapour from the compressor. It is exposed to a flow of ram air from the movement of the vehicle and as the high pressure high temperature vapour flows inside the condenser tubes, heat is given off to the cooler ambient air flowing past the condenser core. The vapour then condenses into a high pressure, high temperature liquid. Two cooling fans fitted to the rear of the radiator, are activated when required to assist in drawing cool air through the condenser.

Receiver Dehydrator

The receiver dehydrator acts as a particle filter, refrigerant storage container and most importantly, a moisture absorber. Moisture, temperature and R-134a causes hydrofluoric and hydrochloric acid. The silica gel beads (desiccant) located in the filter drier receiver absorb small quantities of moisture thus preventing acid establishment.

Thermal Expansion Valve (TXV)

The thermal expansion valve (TXV) controls refrigerant gas flow to the evaporator and make sure that complete evaporation takes place. It has 2 refrigerant passages. One is in the refrigerant line from the condenser to the evaporator and contains a ball and spring valve. The other passage is in the refrigerant line from the evaporator to the compressor and contains the temperature sensing element.

TXV Opening

As the non-cooled refrigerant from the evaporator core flows through the TXV outlet (suction), it makes contact with the underside of the thin metallic diaphragm and reacts on the refrigerant contained above that diaphragm. This refrigerant then expands, forcing the pin downwards and moving the ball off its seat, then compressing the spring and allowing more refrigerant to enter the evaporator.

TXV Closing

Operation is similar to opening but now the refrigerant from the evaporator is cold. The refrigerant contained above the diaphragm now contracts. The ball moves towards the seat aided by the compressed spring, reducing refrigerant flow. Low pressure liquid R-134a passing through the evaporator should be completely vaporized by the time it reaches the TXV outlet side. The TXV is installed in the engine bay to the right side of the instrument panel.

Compressor

The Denso compressor can match the air conditioning demand under all conditions without cycling. The basic compressor mechanism is a variable angle swash-plate with 6 axially oriented cylinders. The compressor has a pumping capacity of 160 cc.

The electronic control valve is installed in the compressor rear head. The swash-plate angle of the compressor and the resultant compressor displacement, are determined by the compressor crankcase to suction pressure differential which is governed by the control valve.

When the A/C capacity demand is low, the crankcase pressure behind the pistons is equal to the pressure in front of the pistons. This forces the swash plate to change its angle to towards vertical which reduces the stroke of the pistons and reduces the output of the compressor to approximately 4 cc. The evaporator cooling load is reduced, ambient temperature or blower fan speed is reduced and therefore, the suction pressure is reduced until it reaches the control point. To reach the control point, the electronic control valve assembly allows discharge pressure to bleed past the control valve ball valve seat and into the compressor crankcase. This crankcase pressure acts as an opposing force behind the compressor pistons to cause the swash plate to change its angle towards vertical and therefore, reduce piston stroke.

When the A/C capacity demand is high, the crankcase pressure behind the pistons is less than the pressure in front of the pistons. This forces the swash plate to change its angle away from vertical which increase the stroke of the pistons. The compressor will then have a corresponding increase in its displacement.

Engine Coolant

The engine coolant is a solution made up of a 50-50 mixture of DEX-COOL and clean fresh water. The coolant solution carries excess heat away from the engine to the radiator, where the heat is dissipated to the atmosphere.

Cooling Fan Operation

The cooling fans operate in two stages; in both stages both fans run. In stage 1 the two fan motors are connected in series so both fans run at low speed. In stage 2 each fan motor is connected to battery voltage so both fans run at high speed. Cooling fan operation is controlled by the engine control module (ECM) based on inputs from the following:

- The A/C request signal
- The vehicle speed sensor (VSS)
- The A/C refrigerant pressure sensor
- The engine coolant temperature (ECT) sensor

Stage One - Both Fans Operate at Low Speed

When the conditions for Stage 1 operation are met the ECM provides a ground to the coil of engine cooling fan relay 1, causing it to operate (turn ON). The fan current path is then from the battery via the large radiator fan fuse, through the large fan motor, cooling fan relay 2, the small fan motor and cooling fan relay 1 to ground.

The conditions for Stage 1 operation are:

- There is an A/C request and:
- Vehicle speed is less than 30 km/h (19 mph)
- A/C refrigerant pressure is greater than 1517 kPa (220 psi).
- ECT is greater than 98°C (208°F).

- ECT is greater than 113°C (235°F) when the engine is switched off (in this case stage 1 will operate for approximately four minutes - this is referred to as low fan run-on).
- An ECT sensor fault is detected and a DTC is set.

Stage 1 operation will cease when:

- There is no A/C request and the ECT is less than 95°C (203°F).
- There is an A/C request and the vehicle speed is greater than 50 km/h (31 mph) and the A/C pressure is less than 1214 kPa (176 psi) and the ECT is less than 95°C (203°F).
- The vehicle speed is greater than 104 km/h (65 mph).

Stage Two - Both Fans Operate at High Speed

When the conditions for Stage 2 operation are met the ECM provides - in addition to that already provided for the coil of engine cooling fan relay 1 - a ground to the coils of engine cooling fan relays 2 and 3, causing them to operate (turn ON). For the large fan, the current path is then from the battery via the large radiator fan fuse, through the large fan motor and engine cooling fan relay 2 to ground. For the small fan, the current path is from the battery via the small radiator fan fuse, through engine cooling fan relay 3, through the small fan motor and engine cooling fan relay 1 to ground. The conditions for Stage 2 operation are:

- The A/C refrigerant pressure is greater than 1758 kPa (255 psi).
- The ECT is greater than 108°C (226°F).
- An ECT sensor fault is detected and a DTC is set.

If stage 1 operation is off when the conditions for stage 2 operation are met, stage 2 operation will be initiated five seconds after initiation of Stage 1 operation.

Stage 2 operation will cease and revert to Stage 1 operation when:

- The ECT is less than 102°C (216°F).
- There is no A/C request.
- There is an A/C request and the A/C refrigerant pressure is less than 1517 kPa (220 psi).
- The vehicle speed is greater than 104 km/h (65 mph).

A/C Cycle

Refrigerant is the key element in an air conditioning system. R-134a is a very low temperature gas that can transfer the undesirable heat and moisture from the passenger compartment to the outside air.

The A/C system used on this vehicle is a non-cycling system. Non-cycling A/C systems use a high pressure switch to protect the A/C system from a predetermined pressure. The high pressure switch will OPEN the electrical signal to the compressor if the refrigerant pressure becomes higher than required. After the high and the low sides of the A/C system pressure equalise, the high pressure switch will CLOSE. This completes the electrical circuit to the compressor . The A/C system is also mechanically protected with the use of a high pressure relief valve. If the high pressure switch were to fail or if the refrigerant system becomes restricted and refrigerant pressure continues to rise, the high pressure relief will pop open and release refrigerant from the system.

The A/C compressor is belt driven . The compressor builds pressure on the vapour refrigerant. Compressing the refrigerant also adds heat. The refrigerant is discharged from the compressor through the discharge hose, and forced through the condenser and then through the balance of the A/C system.

Compressed refrigerant enters the condenser at a high-temperature, high-pressure vapour state. As the refrigerant flows through the condenser, the heat is transferred to the ambient air passing through the condenser. Cooling causes the refrigerant to condense and change from a vapour to a liquid state.

The condenser is located in front of the radiator for maximum heat transfer. The condenser is made of aluminium tubing and aluminium cooling fins, which allows rapid heat transfer for the refrigerant. The semi-cooled liquid refrigerant exits the condenser and flows through the liquid line to the thermal expansion valve (TXV).

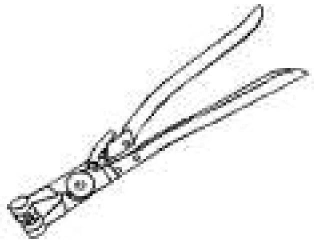
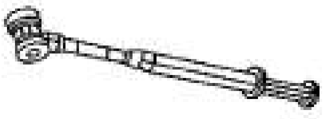
The TXV is located at the evaporator inlet. The TXV is the dividing point for the high and the low pressure sides of the A/C system. As the refrigerant passes through the TXV, the pressure on the refrigerant is lowered, causing the refrigerant to vaporise at the TXV. The TXV also measures the amount of liquid refrigerant that can flow into the evaporator.

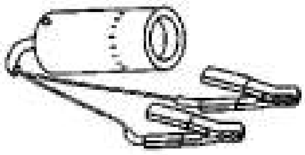
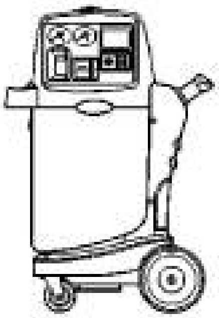
Refrigerant exiting the TXV flows into the evaporator core in a low-pressure, liquid state. Ambient air is drawn through the HVAC module and passes through the evaporator core. Warm and moist air will cause the liquid refrigerant to boil inside the evaporator core. The boiling refrigerant absorbs heat from the ambient air and draws moisture onto the evaporator. The refrigerant exits the evaporator through the suction line and flows back to the compressor in a vapour state, completing the A/C cycle of heat removal. At the compressor, the refrigerant is compressed again and the cycle of heat removal is repeated.

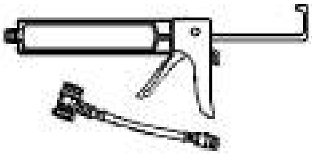
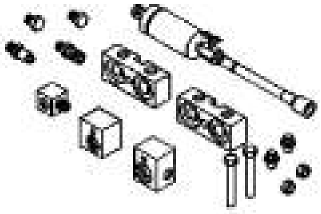
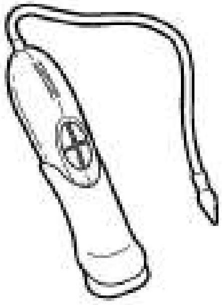
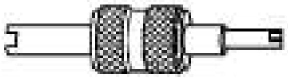
The conditioned air is distributed through the HVAC module for passenger comfort. The heat and moisture removed from the passenger compartment condenses, and discharges from the HVAC module as water.

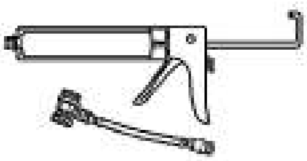
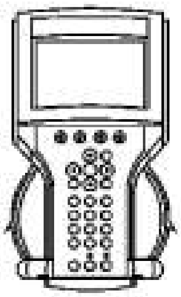
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | HVAC | Heating, Ventilation, and Air Conditioning | Special Tools and Equipment | **Document ID: 1989532**

Special Tools

Illustration	Tool Number / Description
	J 38185 Hose Clamp Pliers
	J 41447 R-134a A/C Tracer Dye - Box of 24
	J 41459 A/C Oil Injector
	J 42220

	Universal 12V Leak Detection Lamp
	J 43600 ACR 2000 Air Conditioning Service Center
	J 43872 Fluorescent Dye Cleaner
	J 43872 Soapy Water Solution

	J 45037 A/C Oil Injector
	J 45268 A/C Flushing Adapter Kit
	J 46053 Electronic Leak Detector
	J 46246 Charge Port Valve Core Remover/Installer

	J 46297 A/C Dye Injector Kit
	J 46297-12 Replacement Dye Cartridges
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

Fastener Tightening Specifications

Application	Specification	Specification
	Metric	Imperial
Auxiliary Air Temperature Actuator to HVAC Module Assembly Retaining Screws	1 N·m	9 lb in
Auxiliary Mode Door Actuator to HVAC Module Assembly Retaining Screws	1 N·m	9 lb in
Defrost Mode Actuator to HVAC Module Assembly Retaining Screws	1 N·m	9 lb in
Driver Air Mix Actuator to HVAC Module Assembly Retaining Screws	1 N·m	9 lb in
Face/Floor Mode Actuator to HVAC Module Assembly Retaining Screws	1 N·m	9 lb in
HVAC Control Module to HVAC Module Assembly Retaining Screws	2 N·m	18 lb in
Passenger Air Mix Actuator to HVAC Module Assembly Retaining Screws	1 N·m	9 lb in
Recirculation Actuator to Air Inlet Assembly Retaining Screws	1 N·m	9 lb in

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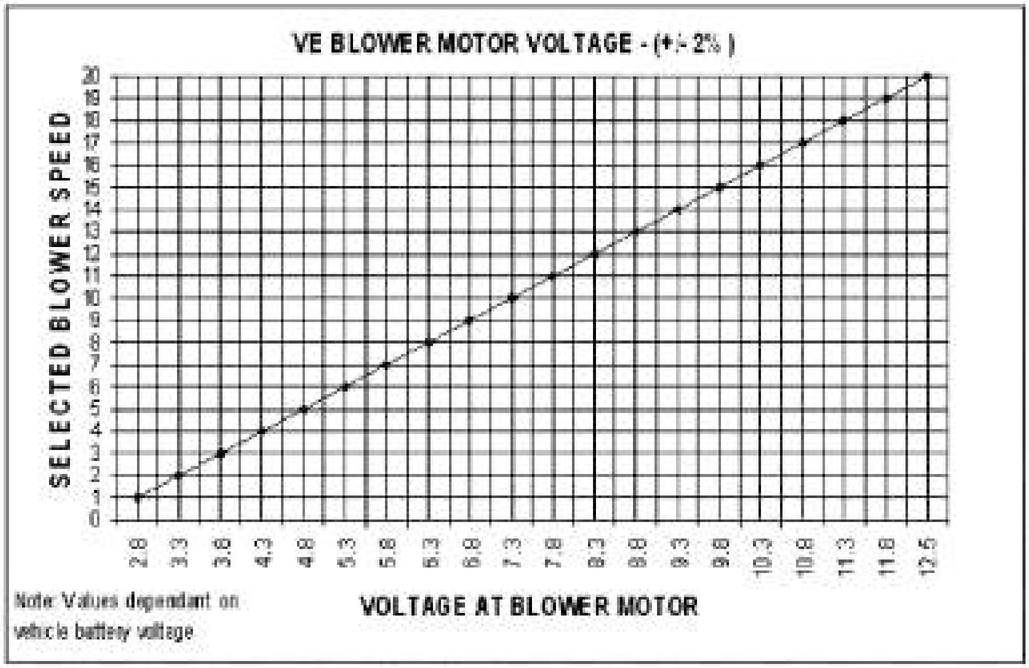
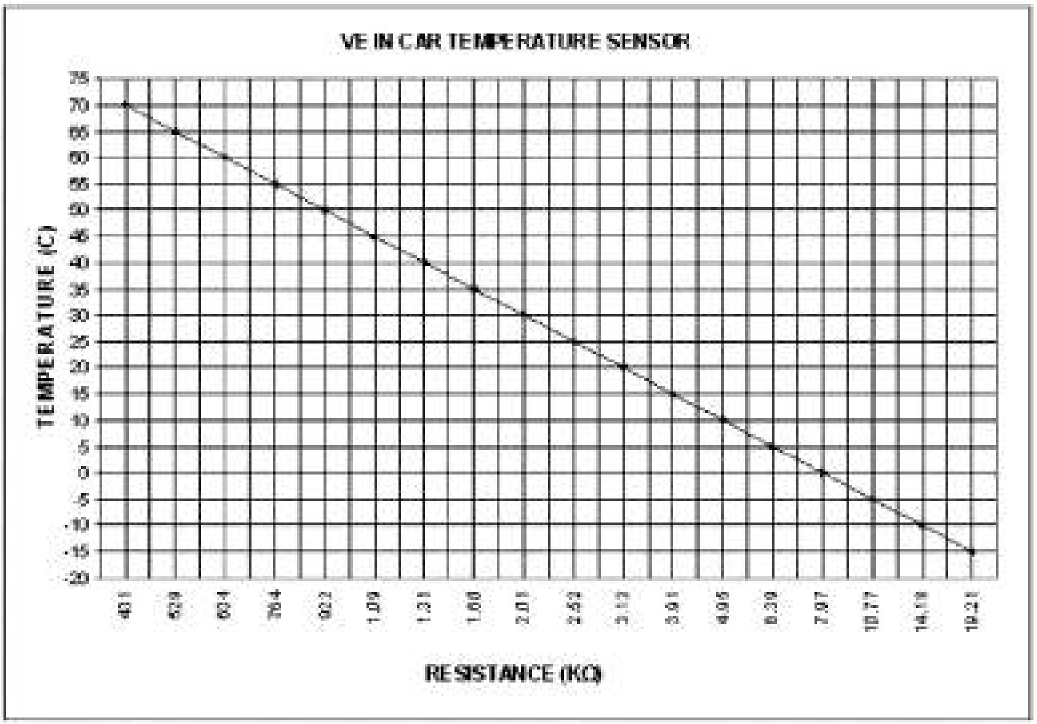
Sensor Resistance Table

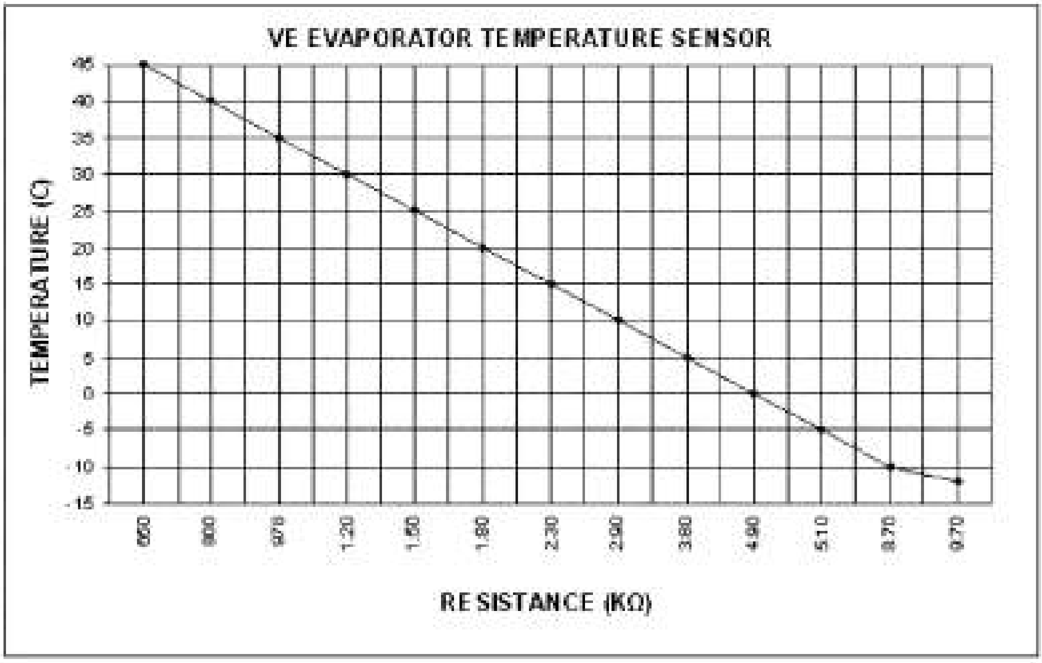
Blower Fan Speeds - Speed / Voltage Comparison



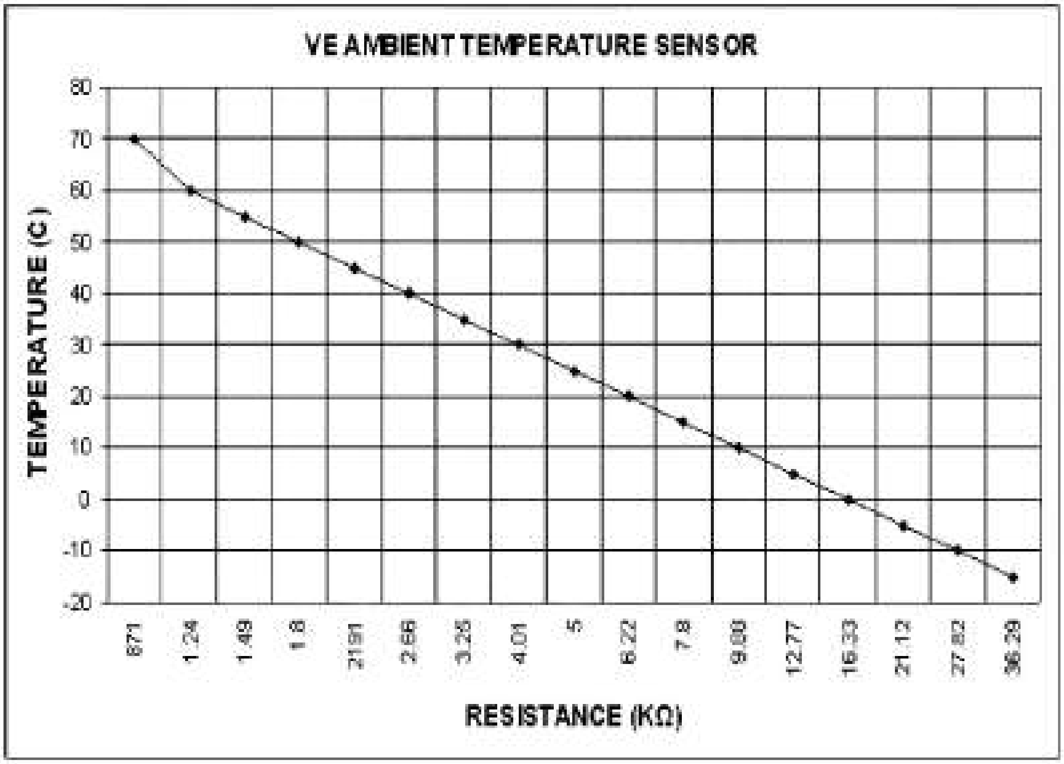
Inside Air Temperature Sensor - Temperature / Resistance Comparison



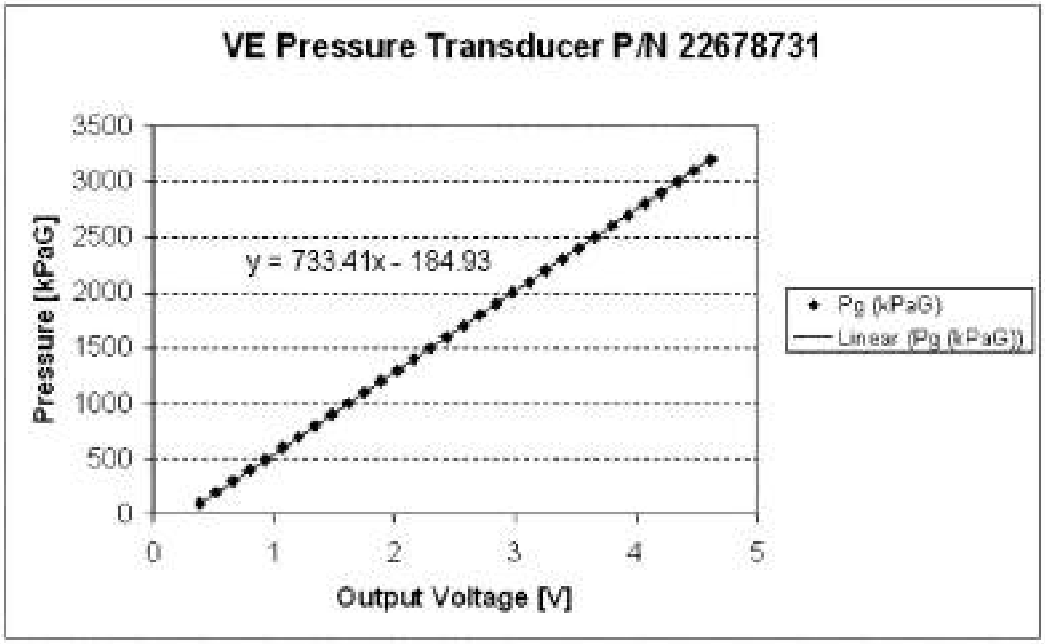
Evaporator Sensor - Temperature / Resistance Comparison



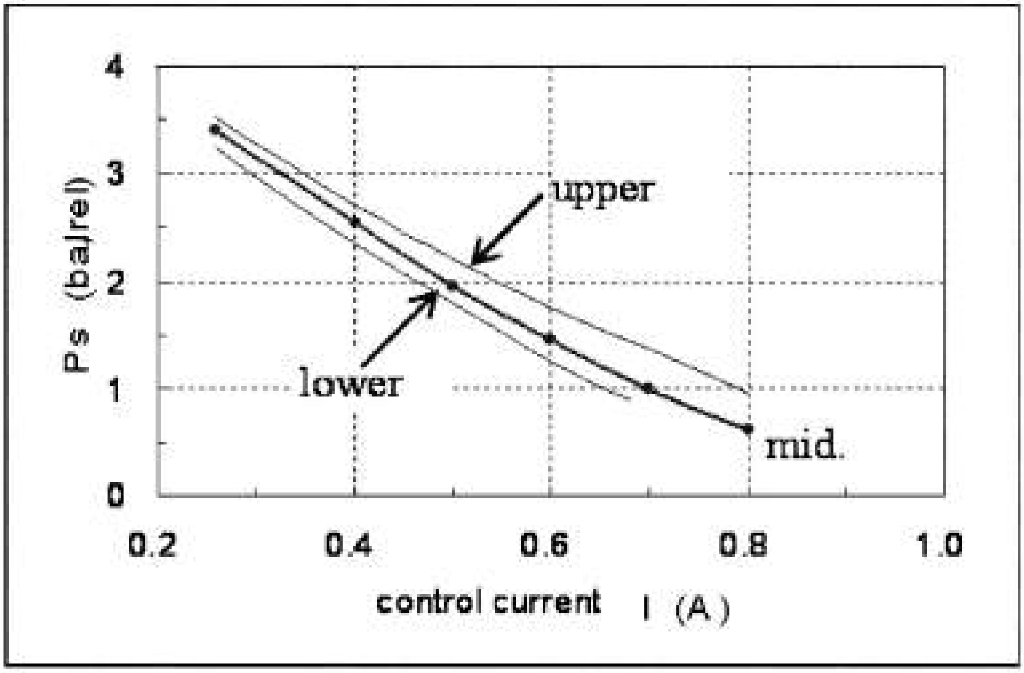
Ambient Air Temperature Sensor - Temperature/Resistance Comparison



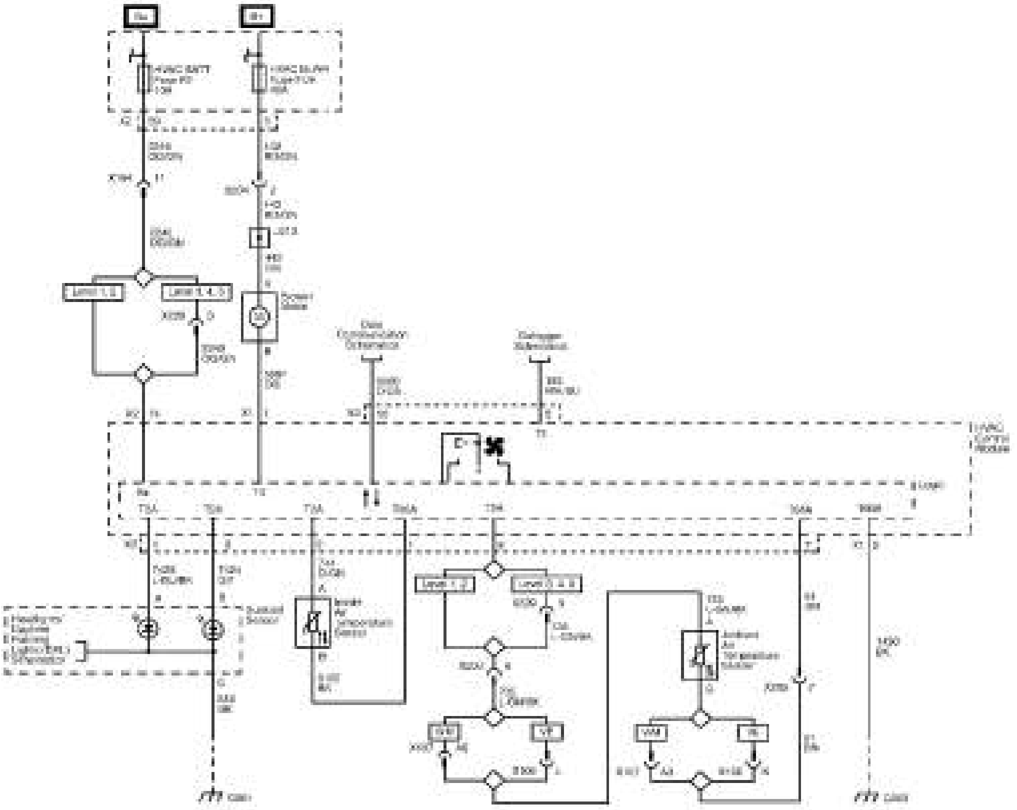
Pressure Transducer - Pressure / Voltage Comparison



Compressor ECVD - Current / Suction Pressure Comparison


4
3
2
1
0
Ps (bar,rel)
0.2
0.4
0.6
0.8
1.0
control current I (A)
upper
lower
mid.

HVAC Module, Power, Ground, Serial Data, Temperature Sensors, and Blower Control


Data Communication Schematics
Defogger Schematics
HVAC Control Module
Level 1, 2
Sunload Sensor
Inside Air Temperature Sensor
Ambient Air Temperature Sensor

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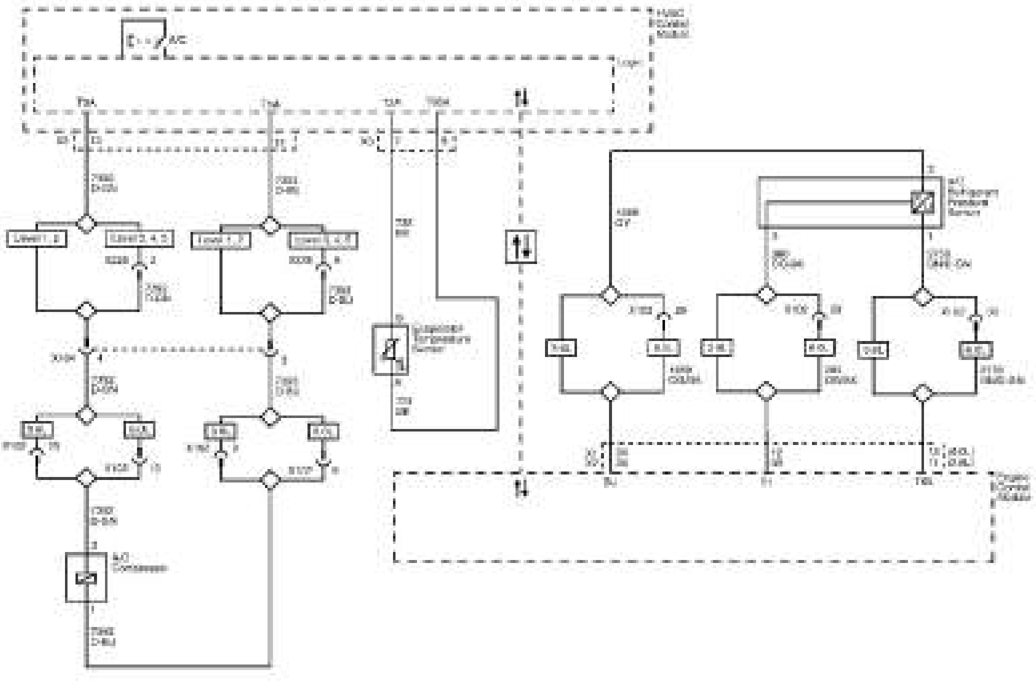
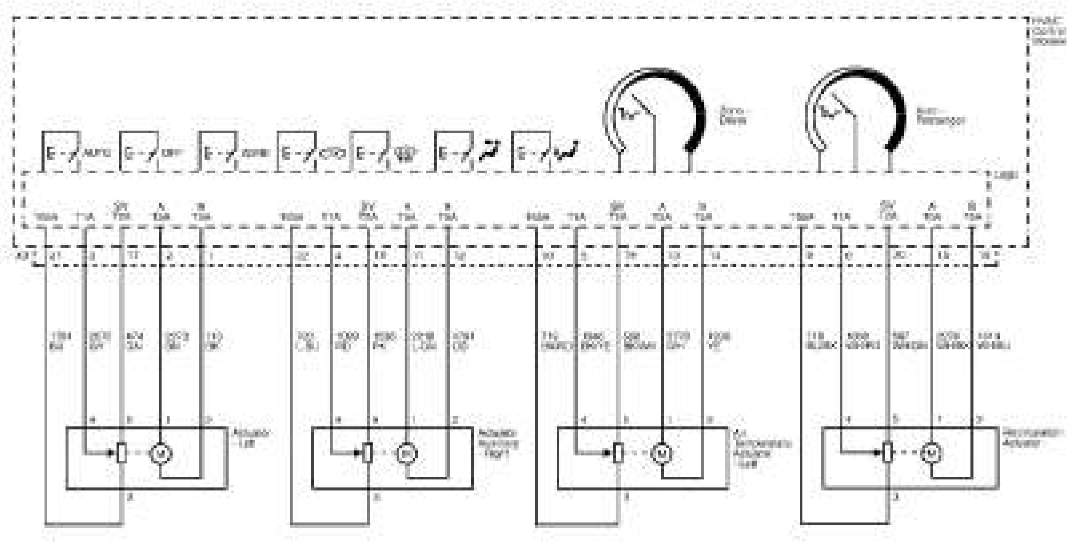
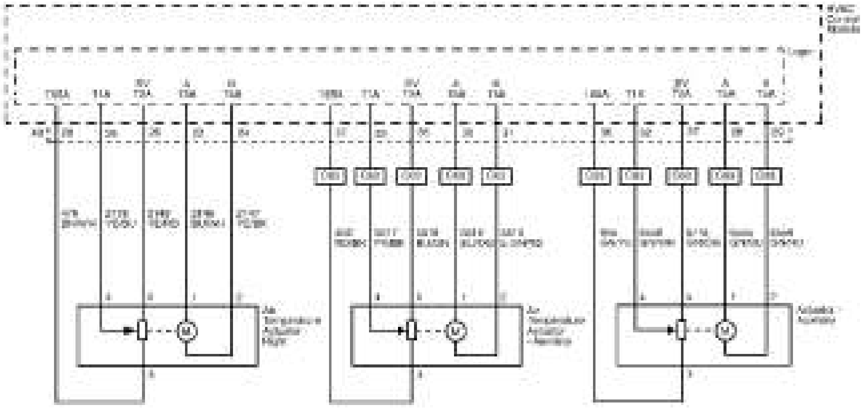
Compressor Controls


HVAC Control Module
A/C
Logic
Evaporator Temperature Sensor
A/C Refrigerant Pressure Sensor
A/C Compressor
Engine Control Module

Air Delivery Controls - 1 of 2



Air Delivery Controls - 2 of 2


HVAC Control Module
Logic
5V
M
M
M

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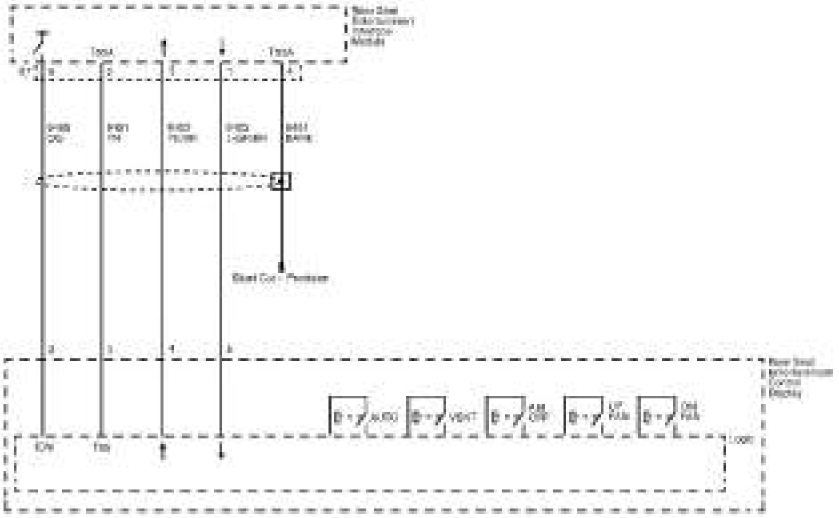
Rear Seat Controls



Diagnostic System Check - HVAC Systems - Automatic

Perform the Diagnostic System Check - Vehicle , prior to using this diagnostic procedure.

Important: The following steps must be completed before using the symptom tables.

1. Confirm the customer concern.
   - Review the service/repair history of the HVAC for prior work carried out.
   - Note the positions of the HVAC control settings.
   - Does the concern happen at certain speeds, rpm or length of driving?
2. Carry out Visual Inspection.
   - Broken, jammed or disconnected HVAC levers or gears.
   - HVAC case damage.
   - A/C system oil stains.
   - Noisy operating components.
   - Accessories blocking airflow.
   - Evidence of vehicle/component abuse.
   - Contamination, such as leaves in blower.
3. Check the battery voltage with a multimeter as the minimum voltage for the HVAC Control Module (HCM) operation is 9 volts and the maximum is 16 volts.
4. Take A/C System Pressure and Face Vent Temperature Readings.
   - Information to be used when diagnosing poor outlet temperature, either hot or cold.
   - A/C performance - Take readings at idle and at 2,000 rpm. Compressor High side pressure should increase at higher rpm.
5. Connect the Scan Tool.
   - Select appropriate vehicle and HVAC level.
   - Check that the HVAC is configured correctly for the vehicle. Refer to Instrument Cluster Programming and Setup .
6. Go to Function 1: Normal Mode - F1, F2, F3, F4. Check and Note any DTC's both current and history for all modules.

   Important: The HVAC control module receives and uses information from the other modules within the vehicle. This information is communicated via GMLAN. Poor performance of the GMLAN or another module can affect the function of the HVAC control module.

7. Go to F4: Miscellaneous Tests - F1 Switch Data. Carry out component activation via scan tool.

   Important: This test will activate the component or function directly from the scan tool and if the component will activate during this test, but not by using the Infotainment facia. This will indicate a faulty Infotainment facia , GMLAN error, sub system module or wiring fault.

DTC B013B

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B013B 00: Coil Compressor Stroke Control Circuit

Circuit / System Description

The A/C system uses a clutchless variable stroke compressor with an electrical control valve which is used to alter the displacement of the compressor, this process is known as electronic control valve displacement (ECVD). ECVD at the compressor is controlled by pulse width modulated (PWM) signal supplied by the HVAC control module via the A/C compressor supply voltage circuit. When the A/C button is pressed, the HVAC control module grounds the A/C compressor low reference circuit completing the circuit and in turn allowing the compressor to operate. The signal returned to the HVAC control module via the A/C low reference circuit is also used in comparison to the supplied signal to confirm correct compressor operation and ECVD positioning.

Conditions for Running the DTC

- System voltage is between 9 - 16 Volts.
- Ignition switch is in the ON position.

Conditions for Setting the DTC

The DTC will set when the A/C compressor is operating and the evaporator temperature fails to drops 5 degrees or more within a 30 second time period.

Action Taken When the DTC Sets

The A/C compressor circuits are deactivated.

Conditions for Clearing the DTC

- The DTC becomes history after the condition for setting the DTC is no longer present.
- The history DTC clears after 50 fault-free ignition cycles.
- The DTC can be cleared using a scan tool.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Verification

Ignition ON, A/C ON, blower speed HIGH, temperature set to COLD, mode set to PANEL. Using a scan tool, observe that the evaporator temperature drops by more than 5° C over a 1 minute period. Useing the scan tool command the ECVD compressor ON it will engage at maximum displacement - this should register on the scan tool display as a PWM of approximately 82%, after 6 seconds the ECVD compressor will automatically disengage and PWM will return to 0%.

Circuit/System Testing

1. Disconnect the HVAC control module X1 electrical connector.
2. Test the A/C compressor clutch low reference circuit terminal 6 for a short to ground, voltage or an open/high resistance.
3. Test the A/C compressor clutch supply voltage circuit terminal 7 for a short to ground, voltage or an open/high resistance.

   If all circuits test normal, replace the HVAC control module.

Component Testing

Ignition OFF, disconnect the ECVD compressor harness connector and measure the component resistance. Verify that 8.5Ω - 15.7Ω is displayed. If outside of the specified range, replace the ECVD compressor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Air Conditioning Compressor Replacement
- Control Module References for HVAC control module replacement, setup, and programming.

DTC B0158 or B0168 (Current)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B0158 03: Outside Air Temperature Sensor Circuit Voltage Below Threshold

DTC B0158 07: Outside Air Temperature Sensor Circuit Voltage Above Threshold

DTC B0168 03: Passenger Compartment Temperature Sensor Voltage Below Threshold

DTC B0168 07: Passenger Compartment Temperature Sensor Voltage Above Threshold

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ambient Air Temperature Sensor Circuit	B0158 03	B0158 07	B0158 07	--
Inside Air Temperature Sensor Circuit	B0168 03	B0168 07	B0158 07	--

Circuit Description

The HVAC control module monitors the air temperature sensors with a low reference circuit and 5-volt signal circuit. The HVAC control module monitors the voltage drop across the sensor. When the ambient air temperatures are cold, the resistance of the sensor is high and the voltage signals are high. When the ambient air temperatures are hot, the resistance of the sensors is low and the voltage signals are low.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

- The HVAC control module detects the sensor signal circuit is less than -35°C (-39°F).
- The HVAC control module detects the sensor signal circuit is greater than 85°C (185°F).

Action Taken When the DTC Sets

B0158

- The DIC display will display "-" for outside air temperature.
- The system operates using a default value.
- A warning will display on the Driver Information Center (DIC) "Service Air Conditioning System ".

B0168

- The system operates using a default value.
- A warning will display on the Driver Information Center (DIC) "Service Air Conditioning System ".

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The HVAC control module automatically clears the history DTC when a current DTC is not detected in 50 fault-free ignition cycles.
- The DTC can be cleared using a scan tool.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Verification

Ignition ON, observe the appropriate scan tool Air Temp Sensor parameter. The reading should be between -35°C (-39°F) and 85°C (185°F) and change with air temperature changes.

Circuit / System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate air temperature sensor.
2. Ignition OFF, test for less than 10 ohms between the following low reference circuit terminal and ground.
   - Outside air temperature sensor terminal A
   - Inside air temperature sensor terminal B

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the HVAC control module.
3. Ignition ON, verify the appropriate scan tool Air Temp Sensor parameter is less than -35°C (-39°F).

   If greater than the specified range, test the following signal circuit terminal for a short to ground. If the circuit tests normal, replace the HVAC control module.
   - Outside air temperature sensor terminal B
   - Inside air temperature sensor terminal A
4. Install a 3A fused jumper wire between the following signal circuit terminal and the low reference circuit terminal. Verify the scan tool Air Temp Sensor parameter is greater than 85° C (185°F).
   - Inside air temperature sensor terminal Aand B.
   - Ambient temperature sensor terminal B and A.

   If less than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the HVAC control module.
5. If all circuits test normal, test or replace the air temperature sensor.

Component Testing

Ignition OFF, remove the appropriate temperature sensor and perform a resistance test across the sensor terminals. Verify that the resistance readings correspond with those in the sensor resistance tables. If outside of the specified range, replace the appropriate sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Ambient Air Temperature Sensor Replacement
- Inside Air Temperature Sensor Replacement
- Control Module References for HVAC control module replacement, setup, and programming.

DTC B0183 or B0188

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B0183 03: Left Solar Load Sensor 1 Circuit Voltage Below Threshold

DTC B0183 07: Left Solar Load Sensor 1 Circuit Voltage Above Threshold

DTC B0188 03: Right Solar Load Sensor 2 Circuit Voltage Below Threshold

DTC B0188 07: Right Solar Load Sensor 2 Circuit Voltage Above Threshold

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Left Solar Load Sensor 1 Circuit	B0183 03	B0183 07	B0183 07	--
Right Solar Load Sensor 2 Circuit	B0188 03	B0188 07	B0188 07	--

Circuit Description

The sunload sensor is a photo diode. The vehicle uses left and right sunload sensors. The two sensors are integrated into the sunload sensor assembly along with the ambient light sensor. Ground and signal circuits enable the sensors to operate. As the sunload increases, the sensor signal decreases. The sensor signal varies between 0 and 5 volts. The HVAC control module converts the signal to a range between 0 and 3906.6 W/m². The sunload sensor provides the HVAC control module with a measurement of the amount of light shining on the vehicle. Bright or high intensity light causes the vehicles interior temperature to increase. The HVAC system compensates for the increased temperature by diverting additional cool air into the vehicle. The following DTCs are for the left and right sunload sensors.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The HVAC control module detects the signal circuit is less than 0 W/m² or greater than 3900

W/m².

Action Taken When the DTC Sets

- If the DTC is set the system will act as if no sunload condition exists.
- A warning will display on the Driver Information Center (DIC) "Service Air Conditioning System"

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.
- The DTC can be cleared using a scan tool.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the sunload sensor.
2. Ignition OFF, test for less than 10 ohms between the low reference circuit terminal C and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the HVAC control module.
3. Ignition ON, verify the scan tool Sun Load Sensor parameter is greater than 3900.0 W/m².

   If less than the specified range, test the signal circuit terminal listed below for a short to ground. If the circuit tests normal, replace the HVAC control module.

   - Left solar load sensor circuit terminal A.

  - Right solar load sensor circuit terminal B.
4. Install a 3A fused jumper wire between the signal circuit terminal A or B and the low reference circuit terminal C. Verify the scan tool Sun Load Sensor Parameter is less than 1 W/m².

   If greater than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the HVAC control module.
5. If all circuits test normal, test or replace the sunload sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Sunload and Twilight Sentinel Sensor Replacement
- Control Module References for HVAC control module replacement, setup, and programming.

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DTC B0193

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B0193 06: Blower Motor not Operating, Short to Ground or Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Blower Motor control	B0193 06	B0193 06	--	--

Circuit Description

The blower motor speed control, battery positive and ground circuits enable the control module to operate. The HVAC control module provides a pulse width modulation signal to the blower motor in order to command the blower motor speed.

Conditions for Running the DTC

- The ignition is ON.
- Ignition voltage is between 9-16 volts.
- The HVAC module is ON.

Conditions for Setting the DTC

The blower motor draws more amperage than the HVAC control module is calibrated for.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The DTC can be cleared using a scan tool.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit / System Verification

Ignition ON, operate the blower fan speed(s).

Circuit / System Testing

1. Ignition OFF, disconnect the harness connector at the blower motor.
2. Ignition ON, connect test lamp at the battery positive voltage terminal A and ground.

   If the test lamp does not illuminate, test the battery positive voltage circuit for short to ground or an open/high resistance.
3. Connect test lamp between the battery positive voltage terminal A and the control circuit terminal B. The test lamp should dimly illuminate at high speeds and reduce in intensity as the blower speed is reduced.

   If the test lamp does not illuminate. Test the control circuit for short to voltage or an open/high resistance. If the circuit tests normal, replace the HVAC control module.

   If the test lamp stays illuminated all the time. Test the control circuit for short to ground. If the circuit tests normal, replace the HVAC control module.

   If the test lamp does illuminate and change intensity. Test or replace the blower motor..

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Refer to Blower Motor Replacement
- Control Module References for HVAC control module replacement, setup, and programming

DTC B0198 (RHD)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B0193 06: Blower Motor not Operating, Short to Ground or Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Blower Motor Control	B0193 06	B0193 06	--	--

Circuit Description

The blower motor speed control, battery positive and ground circuits enable the control module to operate. The HVAC control module provides a pulse width modulation signal to the blower motor in order to command the blower motor speed.

Conditions for Running the DTC

- The ignition is ON.
- Ignition voltage is between 9-16 volts.
- The HVAC module is ON.

Conditions for Setting the DTC

The blower motor draws more amperage than the HVAC control module is calibrated for.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The DTC can be cleared using a scan tool.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Verification

Ignition ON, operate the blower fan speed(s).

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the blower motor.
2. Ignition ON, connect test lamp at the battery positive voltage terminal A and ground.

   If the test lamp does not illuminate, test the battery positive voltage circuit for short to ground or an open/high resistance.
3. Connect test lamp between the battery positive voltage terminal A and the control circuit terminal B. The test lamp should dimly illuminate at high speeds and reduce in intensity as the blower speed is reduced.

   If the test lamp does not illuminate. Test the control circuit for short to ground or an open/high resistance. If the circuit tests normal, replace the HVAC control module.

   If the test lamp does illuminate. Test or replace the blower motor..

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Refer to Blower Motor Replacement
- Control Module References for HVAC control module replacement, setup, and programming

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DTC B0228, B0238, B0253, B0408, B0418, B0428, or B3531 (RHD)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B0228 29 : Recirculation Door Motor Circuit Too Few Pulses

DTC B0228 2A : Recirculation Door Motor Circuit Too Many Pulses

DTC B0228 61 : Recirculation Door Motor Circuit Stuck

DTC B0238 29 : Defogger Door Motor Circuit Too Few Pulses

DTC B0238 2A : Defogger Door Motor Circuit Too Many Pulses

DTC B0238 61 : Defogger Door Motor Circuit Stuck

DTC B0253 29 : Vent/Floor Door Motor Circuit Too Few Pulses

DTC B0253 2A : Vent/Floor Door Motor Circuit Too Many Pulses

DTC B0253 61 : Vent/Floor Door Motor Circuit Stuck

DTC B0408 29 : Drivers Air Mix Door Motor Circuit Too Few Pulses

DTC B0408 2A : Drivers Air Mix Door Motor Circuit Too Many Pulses

DTC B0408 61 : Drivers Air Mix Door Motor Circuit Stuck

DTC B0418 29 : Passengers Air Mix Door Motor Circuit Too Few Pulses

DTC B0418 2A : Passengers Air Mix Door Motor Circuit Too Many Pulses

DTC B0418 61 : Passengers Air Mix Door Motor Circuit Stuck

DTC B0428 29 : Rear Air Mix Door Motor Circuit Too Few Pulses

DTC B0428 2A : Rear Air Mix Door Motor Circuit Too Many Pulses

DTC B0428 61 : Rear Air Mix Door Motor Circuit Stuck

DTC B3531 29 : Rear Air Mode Door Motor Circuit Too Few Pulses

DTC B3531 2A : Rear Air Mode Door Motor Circuit Too Many Pulses

DTC B3531 61 : Rear Air Mode Door Motor Circuit Stuck

Circuit / System Description

The actuators operate using 5 circuits. A 12-volt reference, low reference, signal circuit and two bi-directional 0 or 12 volt control circuits. The HVAC control module supplies a low reference and 12-volt reference to the potentiometer. The HVAC control module monitors the voltage drop across the potentiometer on the door position signal circuit. As the actuator door changes position the door position signal circuit voltage also changes. The two bi-directional control circuits enable the actuator to operate. Both circuits are set to 0 volts when the HVAC control module detects, from the feedback potentiometer, that the actuator is in the desired position. In order to move the actuator, the HVAC control module switches the appropriate control circuit to 12 volts.

Conditions for Running the DTC

- The ignition is ON.
- Ignition voltage is between 9-16 volts.
- The HVAC module is ON.

Conditions for Setting the DTC

Sub Code: 29

- The HVAC control module detects the door position signal circuit is supplying too few pulses.
- Door position signal circuit has an open/high resistance.
- Actuator door control lever is jammed.

Sub Code: 2A

- The HVAC control module detects the door position signal circuit is supplying too many pulses.
- Actuator door control lever is disconnected.

Sub Code: 61

- The HVAC control module fails to detect any signal from the door position signal circuit.
- Door position signal circuit has an open/high resistance.
- Actuator position sensor failure.
- Actuator door control lever is jammed.

Action Taken When the DTC Sets

- The actuator driver circuits are deactivated.
- The HVAC control module will set the appropriate code.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.
- The DTC can be cleared with a scan tool.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Verification

- Access the appropriate actuator door and visually inspect movement when requested from the infotainment fascia.
- Using a scan tool, select actuator testing and visually inspect actuator door movement.
- Visually inspect actuator door pivots for evidence of breakage or damage.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate actuator.
2. Ignition OFF, test for less than 10 ohms between the low reference circuit terminal 3 and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the HVAC control module.
3. Ignition ON, test for 11.5-13.5 volts between the 12-volt reference circuit terminal 5 and ground.

   If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the HVAC control module.

   If greater than the specified range, test the 12-volt reference circuit for a short to voltage.

If the circuit tests normal, replace the HVAC control module.

4. Verify the scan tool Door Position parameter is greater than 250 counts.

   If less than the specified range, test the signal circuit terminal 4 for a short to ground. If the circuit tests normal, replace the HVAC control module.

5. Install a 3A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 3. Verify the scan tool Door Position parameter is less than 3 counts.

   If greater than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the HVAC control module.

6. Ignition OFF, test for less than 10 ohms between the control circuit terminal 1 and ground.

   If greater than the specified range, test the control circuit for a short to voltage or an open/high resistance. If circuit tests normal, replace the HVAC control module.

7. Ignition OFF, test for less than 10 ohms between the control circuit terminal 2 and ground.

   If greater than the specified range, test the control circuit for a short to voltage or an open/high resistance. If circuit tests normal, replace the HVAC control module.

8. Connect a test lamp between control circuit terminal 1 and control circuit terminal 2.
9. Ignition ON, command the appropriate actuator door in both directions with a scan tool. The test lamp should turn ON and OFF when commanded in both directions.

   If the test lamp remains OFF during either of the commands, test for a short to ground on either control circuit. If the circuits test normal, replace the HVAC control module.

10. If both circuits test normal, test or replace the actuator.

Repair Instructions

Important: Always perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- HVAC Control Module Programming and Setup
- Recirculation Actuator Replacement
- Temperature Valve Actuator Replacement - Left Side
- Temperature Valve Actuator Replacement - Right Side
- Auxiliary Temperature Valve Actuator Replacement
- Defroster Valve Actuator Replacement
- Floor Air Valve Actuator Replacement
- Auxiliary Mode Valve Actuator Replacement

DTC B1325

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B1325: Device Power Circuit

Circuit/System Description

With the ignition in either the ACC or ON positions, the HVAC control module should receive a 12V power supply. DTC B1325 will set to indicate the B+ positive supplied to the AHLL control module is below the threshold.

Conditions for Setting the DTCs

This DTC runs continuously once the following condition is met:

The supplied power to the HVAC control module is between 9 - 16V.

Action Taken When the DTC Sets

A warning lamp will illuminate.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The DTC can be cleared using a scan tool.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

Component Connector End Views

Scan Tool Reference

Control Module References

Circuit/System Testing

1. Ignition OFF, wait for 30 seconds.
2. Ignition ON, using the scan tool, select the DTC display function. Verify that DTC B1325 is set to current.
3. Ignition OFF, disconnect the HVAC control module harness connector.
4. Ignition ON, test for B+ between the battery positive voltage circuit at the HVAC control module harness connector and a known ground.

   If not within specified range, test the battery positive voltage circuit for an open/high resistance. If the circuit tests normal replace the HVAC control module.

Repair Instructions

Perform the Diagnostic Repair Verification , after completing the diagnostic procedure.

HVAC Control Module Replacement

DTC B3933

DTC Descriptors

DTC B3933 03: Evaporator Temperature Sensor Voltage Below Threshold

DTC B3933 07: Evaporator Temperature Sensor Voltage Above Threshold

Diagnostic Fault Information

Perform the Diagnostic System Check - Vehicle , prior to using this diagnostic procedure.

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Evaporator Temperature Sensor Signal	B0183 03	B0183 03	B0183 07	--
Low Reference	--	B0183 07	B0183 07	--

Circuit Description

The HVAC control module monitors the evaporator temperature via the evaporator temperature sensor. When the air is cold, the sensor resistance and signal voltage are high. When the air is warm, the sensor resistance and signal voltage are low.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The HVAC control module detects the evaporator temperature sensor signal circuit is less than 0.09 volt (5 counts) or greater than 4.90 volts (250 counts).

Action Taken When the DTC Sets

- A warning will display on the Driver Information Centre (DIC) "SERVICE A/C SYSTEM"
- The A/C compressor will be disabled.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.
- The DTC can be cleared with a scan tool.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Verification

Ignition ON, using a scan tool, observe the evaporator temperature sensor parameter. The scan tool should display between 0.09 and 4.90 volts.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the evaporator air temperature sensor.
2. Ignition OFF, test for less than 10 ohms between the low reference circuit terminal A and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the HVAC control module.
3. Ignition ON, test for 4.8-5.2 volts between the signal circuit terminal A and low reference circuit terminal B.

   If less than the specified range, test the signal circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the HVAC control module.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the HVAC control module.
4. If all circuits test normal, test or replace the evaporator air temperature sensor.

Repair Instructions

Important: Always perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- HVAC Control Module Programming and Setup
- Air Valve Actuator Control Module Harness Replacement

DTC P0532 or P0533

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC P0532: Air Conditioning A/C Refrigerant Pressure Sensor Circuit Low Voltage

DTC P0533: Air Conditioning A/C Refrigerant Pressure Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference	P0532	P0532	P0533	--
A/C Refrigerant Pressure Sensor Signal	P0532	P0533	P0533	--
Low Reference	--	P0532	P0533	--

Circuit/System Description

The engine control module (ECM) monitors the high side refrigerant pressure through the A/C refrigerant pressure sensor. The ECM supplies a 5-volt reference and a low reference to the sensor. Changes in the A/C refrigerant pressure cause the sensor signal to the ECM to vary. When the pressure is high, the signal voltage is high. When the pressure is low, the signal voltage is low. When pressure is high, the ECM commands the cooling fans on. When pressure is too high or too low, the ECM will not allow the A/C compressor clutch to engage.

Conditions for Running the DTC

- Engine is running.
- Any of the conditions for setting the DTC are met for 15 seconds.
- Battery voltage is between 11-18 volts.

Conditions for Setting the DTC

- The ECM detects that the A/C pressure is less than 1 psi (0.01 volt).
- The ECM detects that the A/C pressure is more than 428 psi (4.92 volts).

Action Taken when the DTC Sets

DTCs P0532 or P0533 are type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0532 or P0533 are type B DTCs.

Diagnostic Aids

A malfunction within the refrigerant system causing high pressure can cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Automatic HVAC Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Verification

Ignition ON, observe the scan tool A/C High Side Pressure Sensor parameter. The reading should be between 1 psi and 428 psi.

Circuit/System Testing

1. Ignition OFF, disconnect the A/C pressure sensor harness connector.
2. Ignition OFF, test for less than 1 ohm of resistance between the low reference circuit terminal and ground.

   If greater than 1 ohm, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.

3. Ignition ON, test for 4.8-5.2 volts between the 5-volt reference circuit terminal and ground.

   If less than 4.8 volts, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

   If greater than 5.2 volts, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.

4. Verify the scan tool A/C High Side Pressure Sensor parameter is less than 428 psi.

   If greater than 428 psi, test the signal circuit terminal for a short to voltage. If the circuit tests normal, replace the ECM.

5. Install a 3-A fusible link wire between the signal circuit terminal 3 and the 5-volt reference circuit terminal 2. Verify the scan tool A/C High Side Pressure Sensor parameter is greater than 428 psi.

   If less than 428 psi, test the signal circuit for short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

6. If all circuits test normal, test or replace the A/C Pressure Sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Air Conditioning (A/C) Refrigerant Pressure Sensor Replacement
- Control Module References

Air Delivery Improper

Step	Action	Yes	No
Schematic Reference: HVAC Schematics . DEFINITION: Air does not flow correctly from the air distribution outlets.			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to Diagnostic System Check - Vehicle .
2	Did you read Air Delivery Description and Operation?	Go to Step 3	Go to Air Delivery Description and Operation Manual or Air Delivery Description and Operation Automatic.
3	1. Start the engine. 2. Place the mode switch in the OFF position. Is the blower motor OFF?	Go to Step 4	Go to Blower Motor Always On .
4	Check for a jammed or broken actuator Is a door broken or jammed	Go to HVAC Module Assembly Replacement .	Go to Step 5
5	1. Place the mode switch in the vent position. 2. Place the blower motor switch in each speed position. Does the blower motor operate in any of the speed positions?	Go to Step 6	Go to Blower Motor Inoperative .
6	Does the blower motor operate at the desired speed?	Go to Testing for Intermittent Conditions and Poor Connections .	Go to Blower Motor Malfunction .

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Air Recirculation Malfunction

Diagnostic Aid

- If the control A circuit of the recirculation actuator is shorted to ground, the following conditions will occur.
  - The recirculation actuator will operate properly when recirculation is requested.
  - The recirculation actuator will continually modulate between the outside air and recirculation positions when outside air is requested.
- If the control B circuit of the recirculation actuator is shorted to ground, the following conditions will occur.
  - The recirculation actuator will operate properly when outside air is requested.
  - The recirculation actuator will continually modulate between the outside air and recirculation positions when recirculation is requested.
- The condition may be intermittent. Refer to Testing for Intermittent Conditions and Poor Connections .
- Inspect the recirculation door and the recirculation actuator for the following conditions:
  - A misaligned recirculation actuator.
  - Refer to Recirculation Actuator Replacement .
  - Broken or binding linkages.
  - A broken or binding recirculation door.
  - An obstruction that prevents the recirculation door from operating within its full range of motion.
  - Missing seals to the recirculation door.
  - Misaligned seals to the recirculation door.

Step	Action	Yes	No
Schematic Reference: HVAC Schematics . *Connector End View Reference:* Component Connector End Views . DEFINITION: Air recirculation is inoperative or is always ON.			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Turn ON the ignition, with the engine OFF. 2. Place the blower motor switch in the maximum speed position. 3. Place the mode switch in the bi-level position. 4. Place the recirculation switch in the outside air position. 5. Place the recirculation switch in the recirculation position. Do you hear an audible difference in the airflow when	Go to	

	the recirculation switch is placed in the recirculation position?	Diagnostic Aids	Go to Step 3
3	1. Place the recirculation switch in the outside air position. 2. Observe the drive shaft of the recirculation actuator. 3. Place the recirculation switch in the recirculation position. Does the drive shaft of the recirculation actuator rotate?	Go to Diagnostic Aids	Go to Step 4
4	1. Observe the drive shaft of the recirculation actuator. 2. With a scan tool, command the recirculation actuator to the recirculation position and to the outside air position. Does the drive shaft of the recirculation actuator rotate?	Go to Step 12	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the recirculation actuator. 3. Turn ON the ignition, with the engine OFF. 4. Probe the ignition 3 voltage circuit of the recirculation actuator with a test lamp that is connected to a good ground. Does the test lamp illuminate?	Go to Step 6	Go to Step 13
6	1. Connect a test lamp between the ignition 3 voltage circuit and the door control A circuit of the recirculation actuator. 2. With a scan tool, command the recirculation actuator to the recirculation position and to the outside air position. Does the test lamp illuminate with either command?	Go to Step 7	Go to Step 8
7	1. Connect a test lamp between the ignition 3 voltage circuit and the door control B circuit of the recirculation actuator. 2. With a scan tool, command the recirculation actuator to the recirculation position and to the outside air position. Does the test lamp illuminate with either command?	Go to Step 10	Go to Step 9
8	Test the control A circuit of the recirculation actuator for an open, a high resistance, a short to ground or a short to voltage. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	Go to Step 16	Go to Step 12
	Test the control B circuit of the recirculation actuator for an open, a high resistance, a short to ground or a short to voltage. Refer to Circuit Testing and Wiring		

9	Repairs . Did you find and correct the condition?	Go to Step 16	Go to Step 12
10	Inspect the recirculation door and the recirculation actuator for the following conditions: • A misaligned recirculation actuator. Refer to Recirculation Actuator Replacement . • Broken or binding linkages. • A broken or binding recirculation door. • An obstruction that prevents the recirculation door from operating within its full range of motion. • Missing seals to the recirculation door. • Misaligned seals to the recirculation door. Did you find and correct the condition?	Go to Step 16	Go to Step 11
11	Inspect for poor connections at the harness connector of the recirculation actuator. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	Go to Step 16	Go to Step 14
12	Inspect for poor connections at the harness connector of the HVAC control module. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	Go to Step 16	Go to Step 15
13	Repair the ignition 3 voltage circuit of the recirculation actuator. Refer to Wiring Repairs . Did you complete the repair?	Go to Step 16	--
14	Replace the recirculation actuator. Refer to Recirculation Actuator Replacement . Did you complete the replacement?	Go to Step 16	--
15	Replace the HVAC control module. Refer to Control Module References . Did you complete the replacement?	Go to Step 16	--
16	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

Symptoms - HVAC Systems - Automatic

Important: Review the system operation in order to familiarise yourself with the system functions. Refer to:

- Air Delivery Description and Operation .
- Air Temperature Description and Operation .

Visual/Physical Inspection

- Inspect for aftermarket devices which may affect the operation of the HVAC System. Refer to Checking Aftermarket Accessories .
- Inspect the easily accessible or visible system components for obvious damage or conditions which may cause the symptom.
- Verify the A/C compressor turns and is not seized.
- The A/C compressor will not operate in cold outside air temperatures. Refer to Air Temperature Description and Operation .
- The following conditions may cause window fogging:
  - Wet carpet or mats.
  - High humidity.
  - Interior water leak.
  - Blocked A/C evaporator drain tube.
  - Maximum passenger capacity.
  - Blocked body pressure relief valves.
- Inspect the air distribution system for causes of reduced air flow:

  Blocked or damaged air inlet or outlet vents.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Too Cold in Vehicle .
- Too Hot in Vehicle .

Too Cold in Vehicle

Step	Action	Values	Yes	No
Schematic Reference: HVAC Schematics . *Connector End View Reference:* Component Connector End Views . DEFINITION: The temperature cannot be adjusted, or heating is insufficient.				
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle .
2	Check operation of air mix doors to make sure they are not jammed or broken Is the air mix door broken or jammed?	-	Go to HVAC Module Assembly Replacement .	Go to Step 3
3	Place the blower motor switch in each speed position. Does the blower motor operate in any speed position?	--	Go to Step 4	Go to Blower Motor Inoperative .
4	Does the blower motor operate at the desired speeds?	--	Go to Step 5	Go to Blower Motor Malfunction .
5	1. Start the engine. 2. Place the mode switch in the face position. 3. Place the recirculation switch in the ON position. 4. Observe the recirculation door. 5. Place the recirculation switch in the OFF position. Does the recirculation door move from the recirculation position to the outside air position?	--	Go to Step 6	Go to Air Recirculation Malfunction .
6	Place the passenger temperature switch in the OFF position. Does the Too Cold in vehicle condition occur when heating or defrosting is desired?	--	Go to Step 7	Go to Step 9
7	1. Start the engine. 2. Turn OFF the HVAC controls. Does the A/C compressor operate?	--	Go to Air Conditioning Compressor Replacement .	Go to Step 8

8	Inspect the cooling system for the following conditions: - A low coolant level. - A loose or worn accessory drive belt. - A leaking radiator hose or heater hose. - A kinked radiator hose or heater hose. - A missing radiator cap pressure seal. - A leaking radiator cap. Refer to Heating Performance Diagnostic . Did you find and correct the condition?	--	Go to Step 24	Go to Step 9
9	1. Place the mode switch in face position. 2. Turn ON the ignition, with the engine OFF. 3. Place the blower motor switch in the maximum speed position. 4. Inspect for airflow through the inside air temperature sensor by placing a 5 cm (2 in) square piece of paper over the sensor air inlet. Does the paper stay in place?	--	Go to Step 10	Go to Step 17
10	1. Install a thermometer near the inside air temperature sensor. 2. With a scan tool, observe the Inside Air Temp parameter in the Climate Control Panel data list. Does the scan tool indicate the sensor temperatures is within 3° C (5°F) of the thermometer temperature?	--	Go to Step 11	Go to Step 14
11	1. Turn OFF the ignition. 2. Cover the sunload sensor. 3. Turn ON the ignition. 4. With a scan tool, observe the Driver and Passenger Solar Sensor parameter in the Climate Control Panel	220 Counts		

	Open/Short data list. Is the Sunload Sensor parameter greater than the specified value?		Go to Step 12	Go to Step 18
12	1. Uncover the sunload sensor. 2. Direct a light source at the sunload sensor. 3. Observe the Driver and Passenger Sunload parameter. Do the counts change?	--	Go to Step 13	Go to Step 18
13	Test the resistance of the ambient air temperature sensor. Refer to Sensor Resistance Table . Is the resistance near the value in the Sensor Resistance Table?	--	Go to Testing for Intermittent Conditions and Poor Connections .	Go to Step 15
14	Test the resistance of the inside air temperature sensor. Refer to Sensor Resistance Table . Is the resistance near the value in the Sensor Resistance Table?	--	Go to Step 19	Go to Step 17
15	Inspect for poor connections at the harness connector of the ambient air temperature sensor. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	--	Go to Step 24	Go to Step 17
16	Inspect the aspirator tube for a air leak or obstruction. Did you find and correct the condition?	--	Go to Step 24	--
17	Inspect for poor connections at the harness connector of the inside air temperature sensor. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	--	Go to Step 24	Go to Step 20
18	Inspect for poor connections at the harness connector of the sunload sensor. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the	--		

	condition?		Go to Step 24	Go to Step 22
19	Inspect for poor connections at the harness connector of the HVAC control module. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	--	Go to Step 24	Go to Step 23
20	Replace the inside air temperature sensor. Refer to Inside Air Temperature Sensor Replacement . Did you complete the replacement?	--	Go to Step 24	--
21	Replace the sunload sensor. Refer to Sun Load Sensor Replacement . Did you complete the replacement?	--	Go to Step 24	--
22	Replace the ambient air temperature sensor. Refer to Ambient Air Temperature Sensor Replacement . Did you complete the replacement?	--	Go to Step 24	--
23	Replace the HVAC control module. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 24	--
24	Operate the system in order to verify the repair. Did you correct the condition?	--	System OK	Go to Step 2

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Too Hot in Vehicle

Test Description

The numbers below refer to the step numbers on the diagnostic table.

Step	Action	Values	Yes	No
Schematic Reference: HVAC Schematics. *Connector End View Reference:* Component Connector End Views. DEFINITION: The temperature cannot be adjusted, or cooling is insufficient during A/C operation.				
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle.
2	Check operation of air mix doors to make sure they are not jammed or broken Is the air mix door broken or jammed?	-	Go to HVAC Module Assembly Replacement.	Go to Step 3
3	**Important:** All DTCs that are set must be diagnosed first unless you were sent to this diagnostic from a specific DTC diagnostic. 1. Turn ON the ignition, with the engine OFF. 2. Place the blower motor switch in each speed position. Does the blower motor operate in any speed position?	--	Go to Step 4	Go to Blower Motor Inoperative.
4	Does the blower motor operate at the desired speeds?	--	Go to Step 5	Go to Blower Motor Malfunction
5	1. Start the engine. 2. Place the mode switch in the face position. 3. Place the recirculation switch in the ON position. 4. Observe the recirculation door. 5. Place the recirculation switch in the OFF position. Does the recirculation door move from the recirculation position to the	--		Go to Symptoms - HVAC Systems

	outside air position?		Go to Step 6	- Automatic.
6	**Important:** The ambient air temperature must be above 3° C (38°F). 1. Start the engine. 2. With a scan tool clear any DTCs that are stored in the HVAC control module. 3. Place the left air temperature switch in the coldest position. 4. Place the mode switch in the bi-level position. 5. Place the blower motor on high speed. Does the A/C compressor operate?	--	Go to Step 7	Go to Air Conditioning Compressor Replacement.
7	Perform the A/C system performance test. Refer to Air Conditioning (A/C) System Performance Test. Did you find and correct the condition?	--	Go to Step 24	Go to Step 8
8	Inspect the inside air temperature sensor for proper installation. Refer to Inside Air Temperature Sensor Replacement. Did you find and correct the condition?	--	Go to Step 24	Go to Step 9
9	1. Turn ON the ignition, with the engine OFF. 2. Place the mode switch in face position. 3. Place the blower motor switch in maximum speed position. 4. Inspect for airflow through the inside air temperature sensor by placing a 5 cm (2 in) square piece of paper over the sensor air inlet. Does the paper stay in place?	--	Go to Step 10	Go to Step 17
10	1. Install a thermometer near the inside air temperature sensor. 2. With a scan tool, observe the Inside Air Temp parameter in the Climate Control Panel data list. Does the scan tool indicate the	--		

	sensor temperatures is within 3° C (5°F) of the thermometer temperature?		Go to Step 11	Go to Step 14
11	1. Turn OFF the ignition. 2. Cover the sunload sensor. 3. Start the engine. 4. Adjust driver side temperature to 22°C (72°F). 5. With a scan tool, observe the Driver and Passenger Solar Sensor parameter in the Climate Control Panel Open/Short data list. Is the Solar Sensor parameter greater than the specified value?	220 Counts	Go to Step 12	Go to Step 18
12	1. Uncover the sunload sensor. 2. Direct a light source at the sunload sensor. 3. Observe the Driver and Passenger Sunload parameter. Do the counts change?	--	Go to Step 13	Go to Step 18
13	Test the resistance of the ambient air temperature sensor. Refer to Sensor Resistance Table. Is the resistance near the value in the Sensor Resistance Table?	--	Go to Testing for Intermittent Conditions and Poor Connections.	Go to Step 15
14	Test the resistance of the inside air temperature sensor. Refer to Sensor Resistance Table. Is the resistance near the value in the Sensor Resistance Table?	--	Go to Step 19	Go to Step 17
15	Inspect for poor connections at the harness connector of the ambient air temperature sensor. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs. Did you find and correct the condition?	--	Go to Step 24	Go to Step 17
16	Inspect the aspirator tube for an air leak or obstruction. Did you find and correct the condition?	--	Go to Step 24	--
	Inspect for poor connections at the harness connector of the inside air temperature sensor. Refer to			

17	Testing for Intermittent Conditions and Poor Connections and Connector Repairs. Did you find and correct the condition?	--	Go to Step 24	Go to Step 20
18	Inspect for poor connections at the harness connector of the sunload sensor. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs. Did you find and correct the condition?	--	Go to Step 24	Go to Step 21
19	Inspect for poor connections at the harness connector of the HVAC control module. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs. Did you find and correct the condition?	--	Go to Step 24	Go to Step 23
20	Replace the inside air temperature sensor. Refer to Inside Air Temperature Sensor Replacement. Did you complete the replacement?	--	Go to Step 24	--
21	Replace the sunload sensor. Refer to Sun Load Temperature Sensor Replacement. Did you complete the replacement?	--	Go to Step 24	--
22	Replace the ambient air temperature sensor. Refer to Ambient Air Temperature Sensor Replacement. Did you complete the replacement?	--	Go to Step 24	--
23	Replace the HVAC control module. Refer to Control Module References. Did you complete the replacement?	--	Go to Step 24	--
24	Operate the system in order to verify the repair. Did you correct the condition?	--	System OK	Go to Step 2

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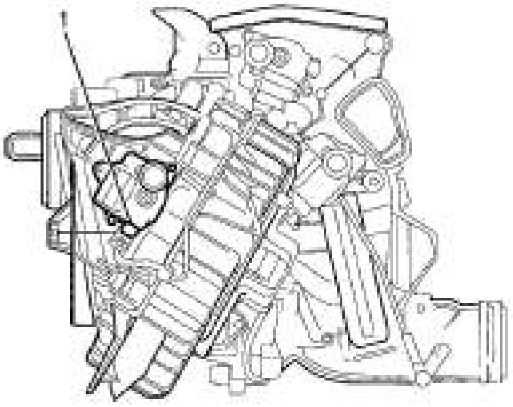
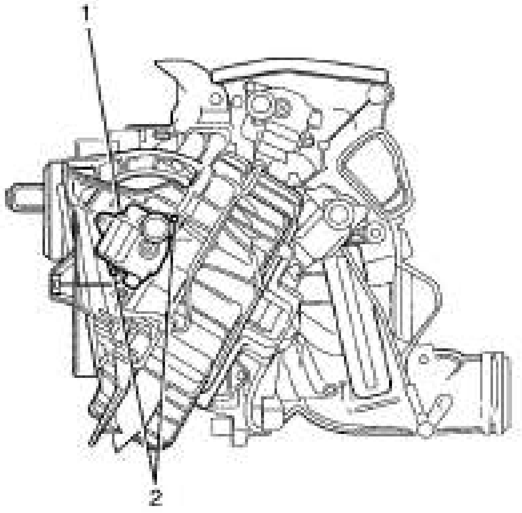
Air Inlet Valve Actuator Replacement (RHD)

Removal Procedure

1. Remove the I/P lower trim plate assembly. Refer to Instrument Panel Insulator Panel Replacement - Left Side.
2. Remove the I/P compartment assembly. Refer to Instrument Panel Compartment Replacement.



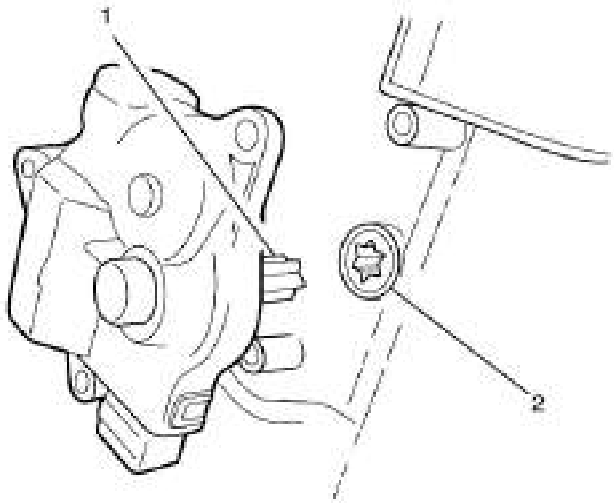
3. Disconnect the recirculation actuator electrical connector (1).



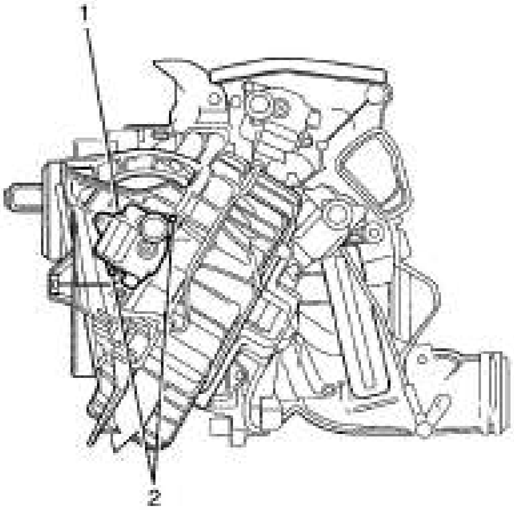
4. Remove the recirculation actuator to HVAC module assembly retaining screws (2).

5. Remove the recirculation actuator (1) from the HVAC module assembly (3).
6. Inspect air intake door shaft end for damage, also check the air intake door for full movement, open/close. If damage is evident, replace the air intake housing. Refer to Air Inlet Assembly Replacement.

Installation Procedure



1. Align the actuator drive gear (1) with the door shaft spline (2).

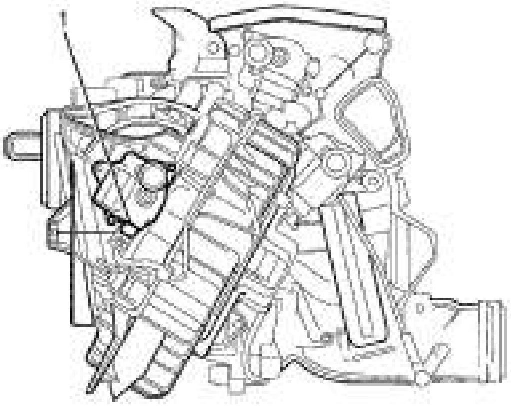


2. Install the air intake recirculation actuator (1) to the HVAC module assembly (3).

Notice: Refer to Fastener Notice in the Preface section.

3. Install the recirculation actuator to HVAC module assembly retaining screws (2).

   Tighten
   Tighten the screws to 1.2 N·m (9 lb ft).



4. Connect the recirculation actuator electrical connector (1).
5. Install the I/P lower trim plate assembly. Refer to Instrument Panel Insulator Panel Replacement - Left Side.
6. Install the I/P compartment assembly. Refer to Instrument Panel Compartment Replacement.
7. Perform HVAC system relearn. Refer to HVAC Control Module Programming and Setup.

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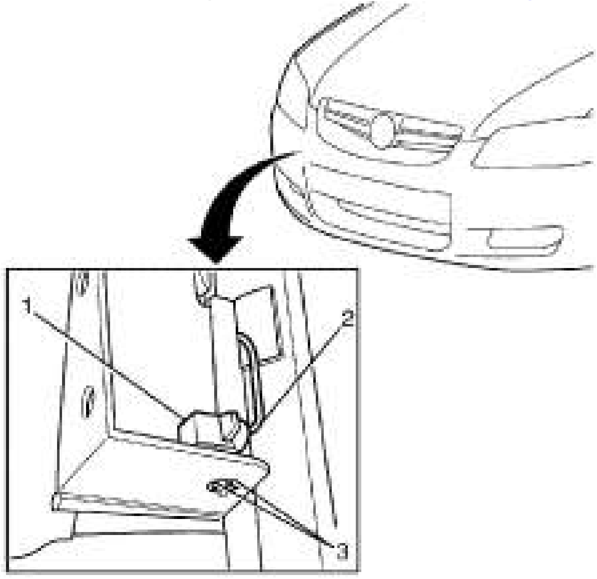
Ambient Air Temperature Sensor Replacement

Removal Procedure

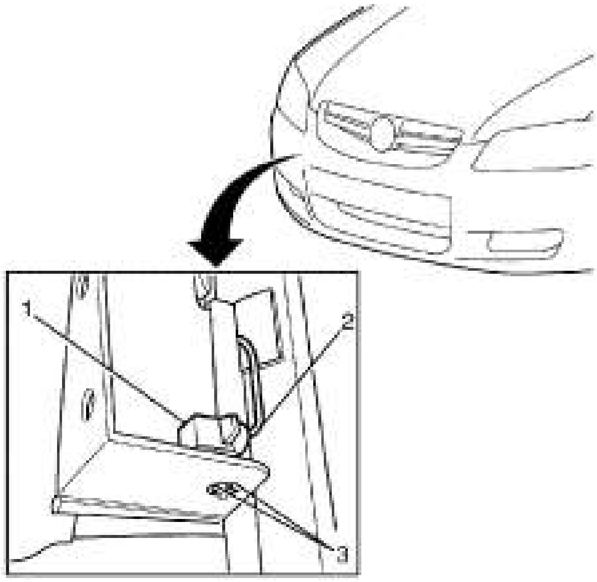
1. Remove front bumper. Refer to Front Bumper Fascia Replacement.



Important: To remove the ambient temperature sensor (1) squeeze the locking tabs (3) and push free from the bracket.

2. Detach the ambient air temperature sensor (1) from the bracket.
3. Disconnect the ambient temperature sensor electrical connector (2).
4. Remove the ambient air temperature sensor (1).

Installation Procedure



1. Connect the ambient temperature sensor electrical connector (2).

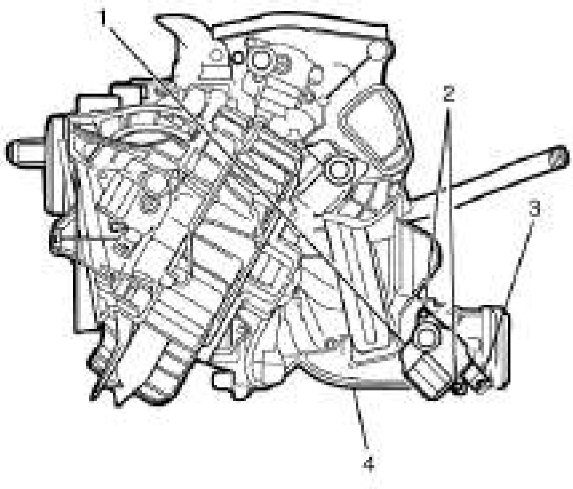
   Important: Make sure that the locking tabs (3) and are correctly located.

2. Install the ambient temperature sensor (1) to the bracket.
3. Install the front bumper fascia. Refer to Front Bumper Fascia Replacement.

Auxiliary Mode Valve Actuator Replacement

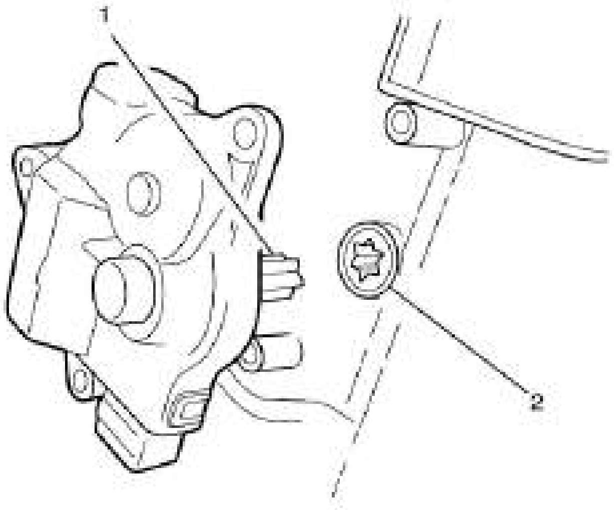
Removal Procedure

1. Remove the Instrument Panel Centre Trim Panel. Refer to Instrument Panel Center Trim Panel Replacement.

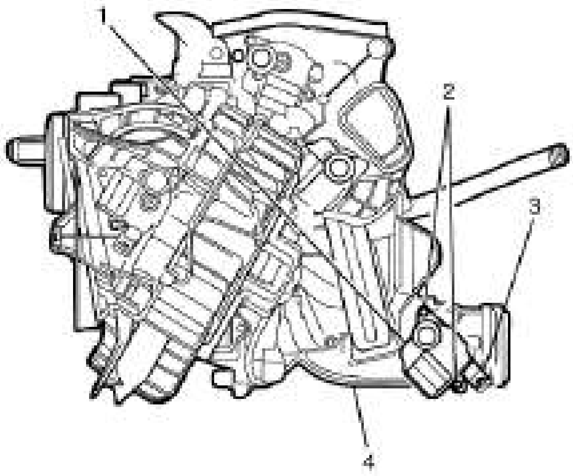


2. Disconnect the auxiliary mode door actuator electrical connector (3).
3. Remove the auxiliary mode door actuator to HVAC module assembly retaining screws (2).
4. Remove the auxiliary mode door actuator (3) from the HVAC module assembly (4).

Installation Procedure



1. Align the actuator drive gear (1) with the door shaft spline (2).



2. Install the auxiliary mode door actuator (3) to the HVAC module assembly (4)..

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the auxiliary mode door actuator to HVAC module assembly retaining screws (2).

   Tighten
   Tighten the bolts to 1.2 N·m (9 lb ft).

4. Connect the auxiliary mode door actuator electrical connector (3).
5. Install the Instrument Panel Centre Trim Panel. Refer to Instrument Panel Center Trim Panel Replacement.

6. Perform HVAC system relearn. Refer to HVAC Control Module Programming and Setup.

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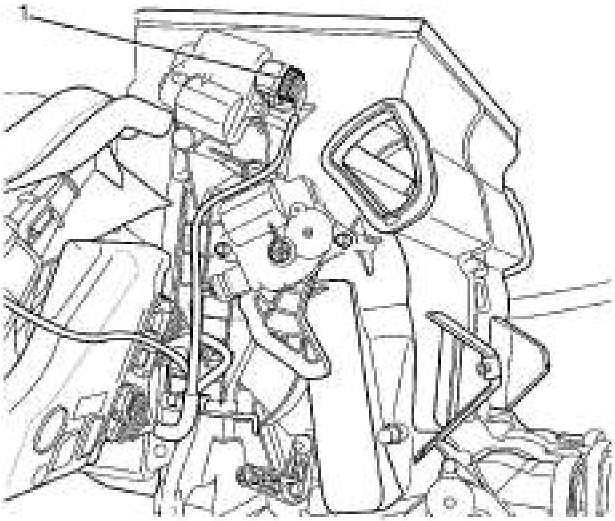
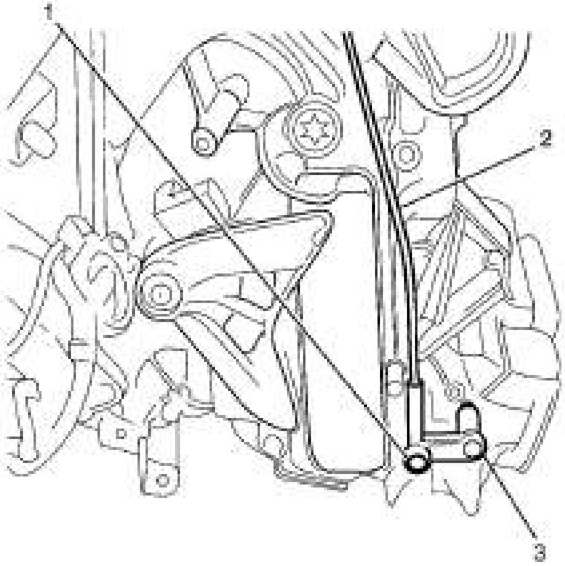
Defroster Valve Actuator Replacement

Removal Procedure

1. Remove the I/P lower trim plate assembly. Refer to Instrument Panel Insulator Panel Replacement - Left Side.
2. Remove the instrument panel outer trim cover. Refer to Instrument Panel Outer Trim Cover Replacement.
3. Remove the I/P compartment assembly. Refer to Instrument Panel Compartment Replacement.
4. Remove the left side floor duct. Refer to Floor Air Outlet Duct Replacement - Left Side.

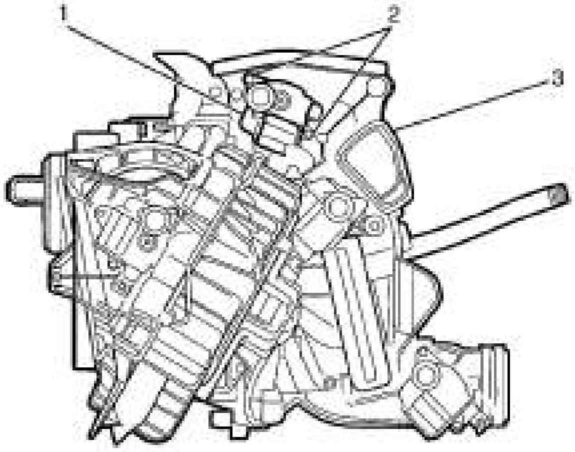


5. Disconnect the defrost mode actuator electrical connector (1).

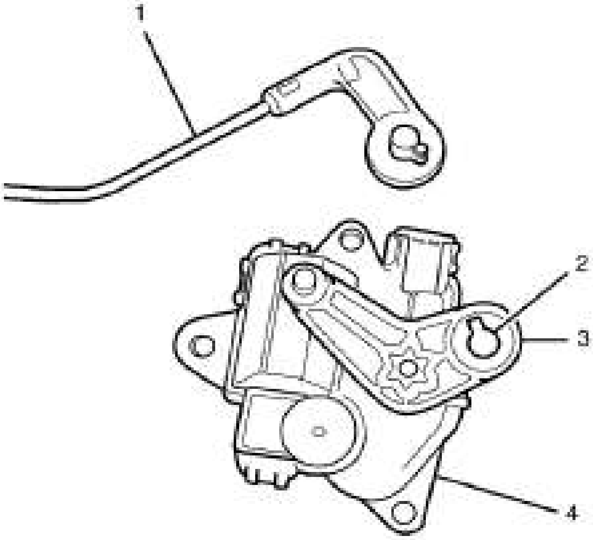


Important: Using a suitable tool, squeeze the rear passenger mode rod to rear passenger mode door lever retaining clip (1) to detach the rear passenger mode rod (2) from the rear passenger mode door lever (3).

6. Detach the rear passenger mode rod (2) from the mode door lever (3).



7. Remove the defrost mode actuator to HVAC module assembly retaining screws (2).
8. Remove the defrost mode actuator and the rear passenger mode lever (1) from the HVAC module assembly (3).



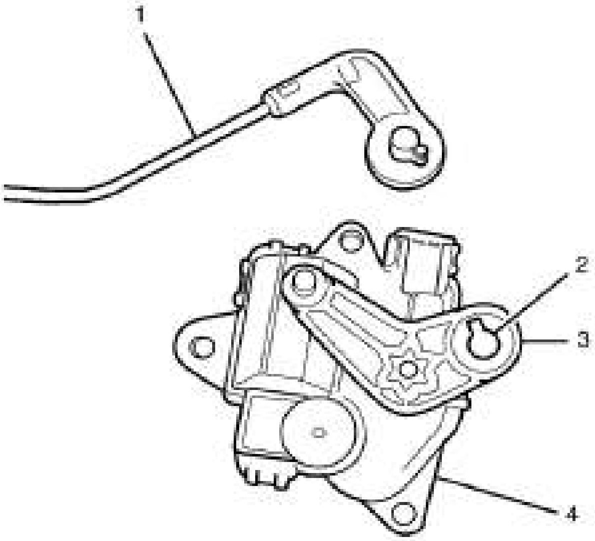
Important: Rotate the rear passenger mode rod (1) to match the actuator lever locking position opening (2), then remove rear passenger mode rod (1).

9. Detach the rear passenger mode rod (1) from the defrost mode actuator (4).

   Important: Take note of the rear passenger mode lever (3) position in relation to the actuator housing (4).

10. Gently remove the rear passenger mode lever (3) from the defrost mode actuator (4).

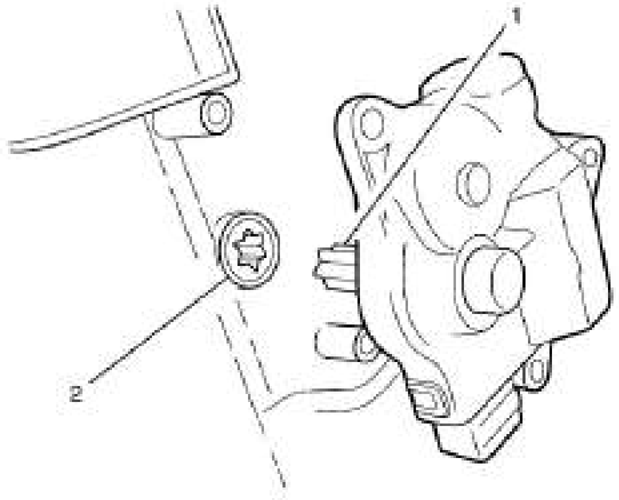
Installation Procedure



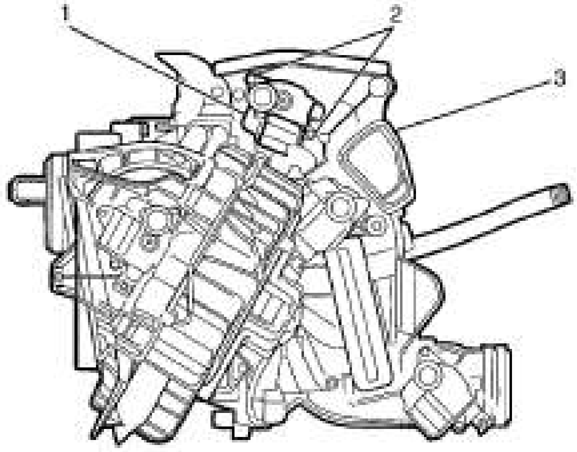
1. Install the rear passenger mode lever (3) to the defrost mode actuator (4).

   Important: Rotate the rear passenger mode rod (1) to match the actuator lever locking position opening (2), to install the rear passenger mode rod (1).

2. Attach the rear passenger mode rod (1) to the actuator (4).



3. Align the actuator drive gear (1) with the door shaft spline (2).

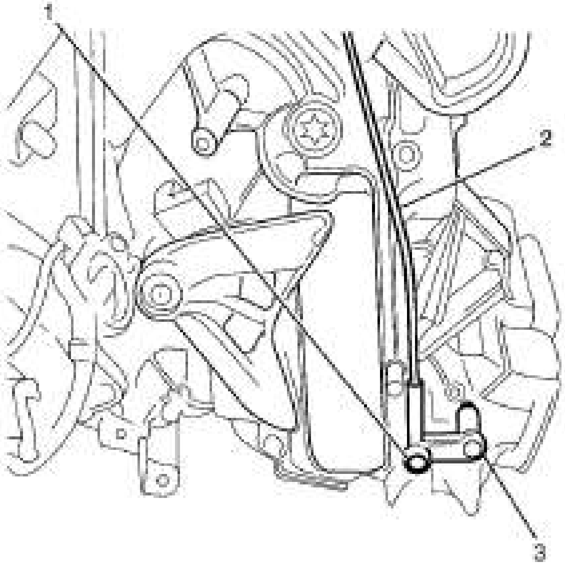


4. Install the and the rear passenger mode lever (1) to the HVAC module assembly (3).

   Notice: Refer to Fastener Notice in the Preface section.

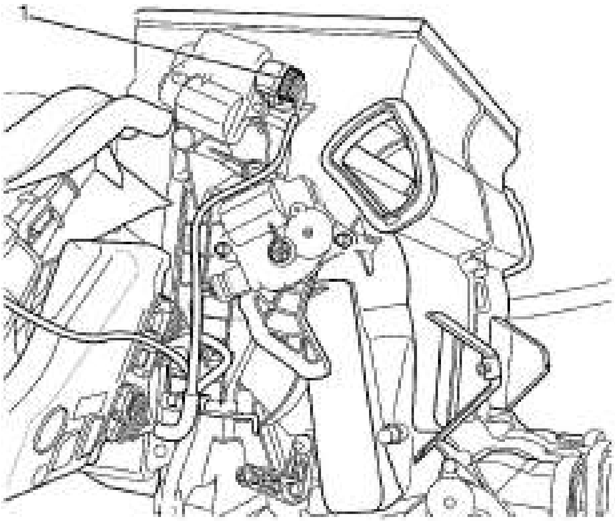
5. Install the defrost mode actuator to HVAC module assembly retaining screws (2).

   Tighten
   Tighten the screws to 1 N·m (9 lb in).



Important: Make sure the rear passenger mode rod to rear passenger mode door lever retaining clip (1) is correctly engaged to prevent the rear passenger mode door lever (3) from functioning incorrectly.

6. Attach the rear passenger mode rod (2) to the mode door lever (3).



7. Connect the defrost mode actuator electrical connector (1).
8. Install left side floor duct. Refer to Floor Air Outlet Duct Replacement - Left Side.
9. Install the I/P compartment assembly. Refer to Instrument Panel Compartment Replacement.
10. Install instrument panel outer trim cover. Refer to Instrument Panel Outer Trim Cover Replacement.
11. Install the I/P lower trim plate assembly. Refer to Instrument Panel Insulator Panel Replacement - Left Side.

12. Perform HVAC system relearn. Refer to HVAC Control Module Programming and Setup.

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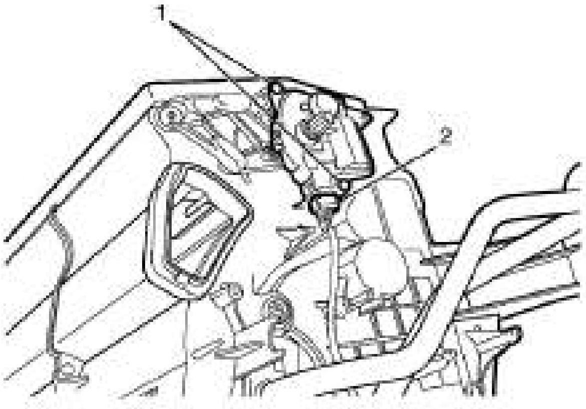
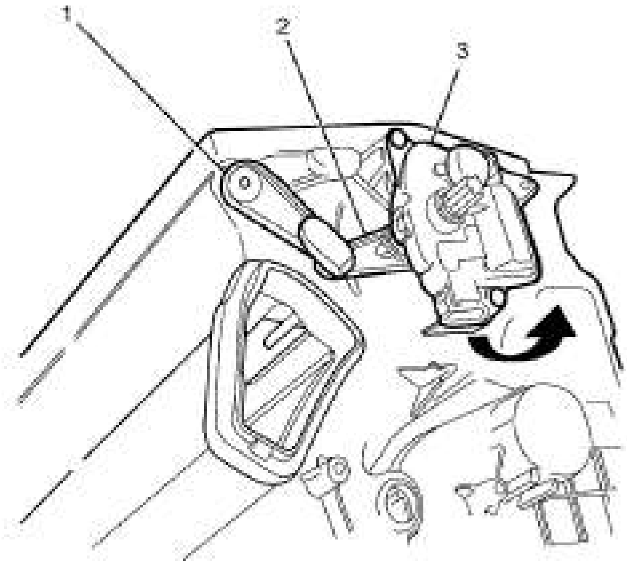
Floor Air Valve Actuator Replacement

Removal Procedure

1. Remove the right side console lower extension. Refer to Instrument Panel Extension Replacement.
2. Remove the instrument panel lower right trim plate assembly. Refer to Instrument Panel Insulator Panel Replacement - Right Side.
3. Remove right side floor duct. Refer to Floor Air Outlet Duct Replacement - Right Side .

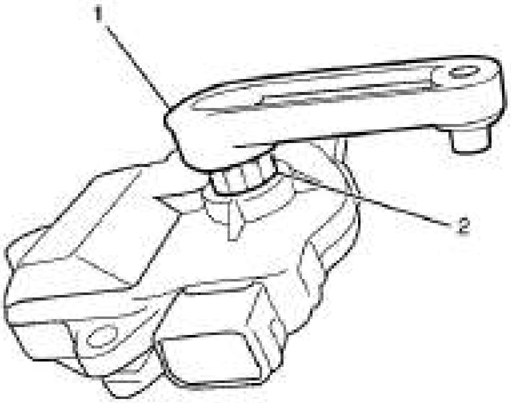


4. Disconnect the face/floor actuator electrical connector (3).
5. Remove the face/floor actuator to HVAC module assembly retaining screws (1).



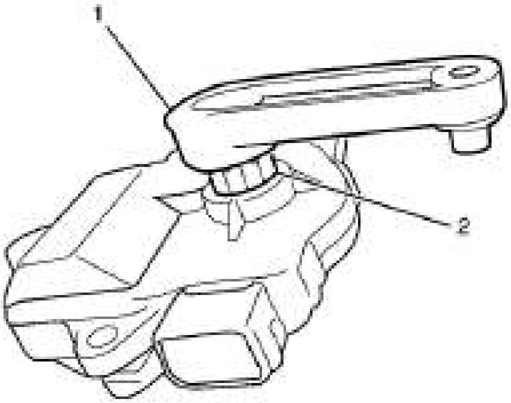
Important: Pivot the face/floor mode actuator (3) upwards and remove the face/floor mode actuator lever (2) from the face door mode lever (1).

6. Remove the face/floor mode actuator lever (2) from the face door mode lever (1).

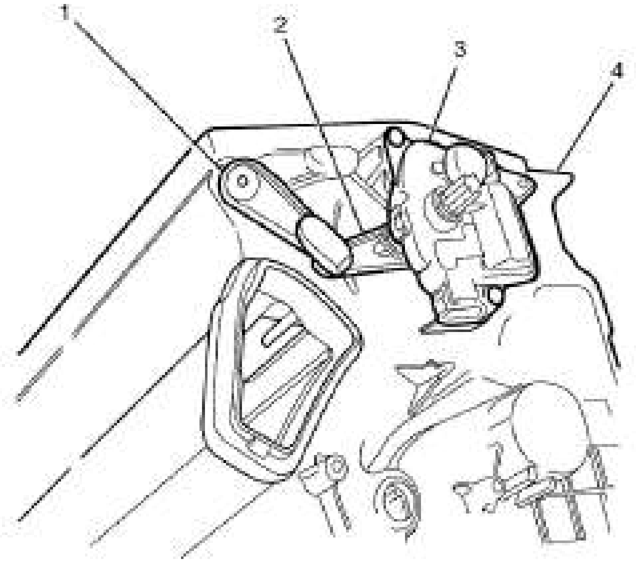


7. Record where the face/floor mode actuator lever (1) is located onto the face/floor actuator drive spline (2) for installation.

Installation Procedure

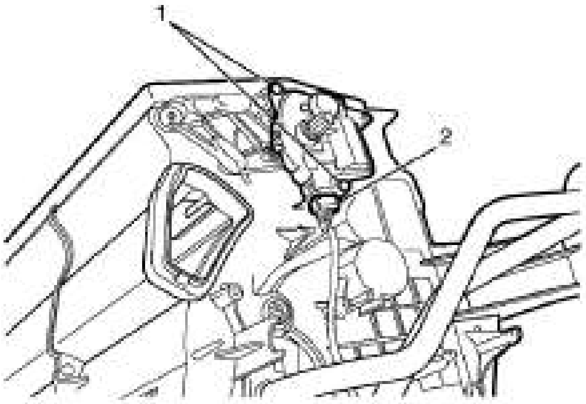


1. Detach and move the face/floor mode actuator lever (1) to the recorded position on the face/floor actuator drive spline (2) as required.



2. Install the actuator lever (2) to the face door mode lever (1) and pivot the face/floor mode actuator (3) into position on the HVAC module assembly (4).

   Notice: Refer to Fastener Notice in the Preface section.



3. Install the face/floor mode actuator to HVAC module assembly retaining screws (1).

Tighten
Tighten the bolts to 1.2 N·m (9 lb ft).

4. Connect the face/floor mode actuator electrical connector (3).
5. Install the instrument panel lower right trim plate assembly. Refer to Instrument Panel Insulator Panel Replacement - Right Side.
6. Install right side floor duct. Refer to Floor Air Outlet Duct Replacement - Right Side.
7. Perform HVAC system relearn. Refer to HVAC Control Module Programming and Setup.

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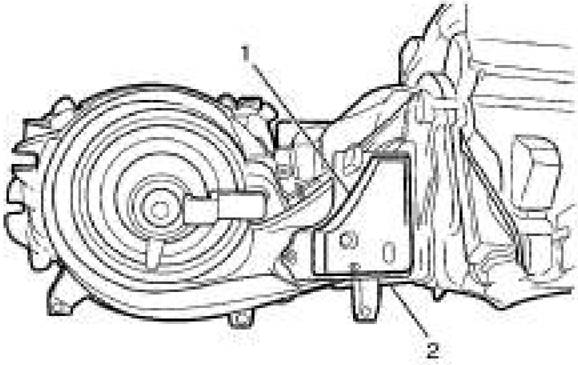
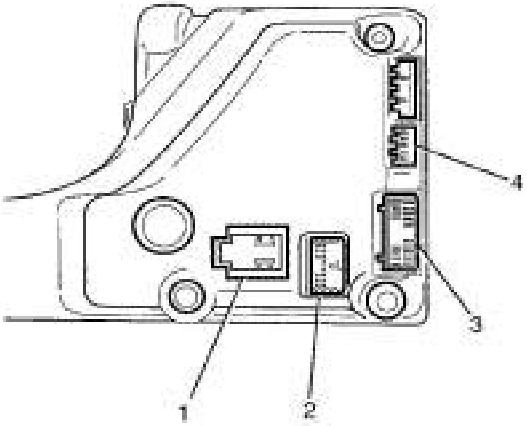
HVAC Control Module Replacement (RHD)

Removal Procedure

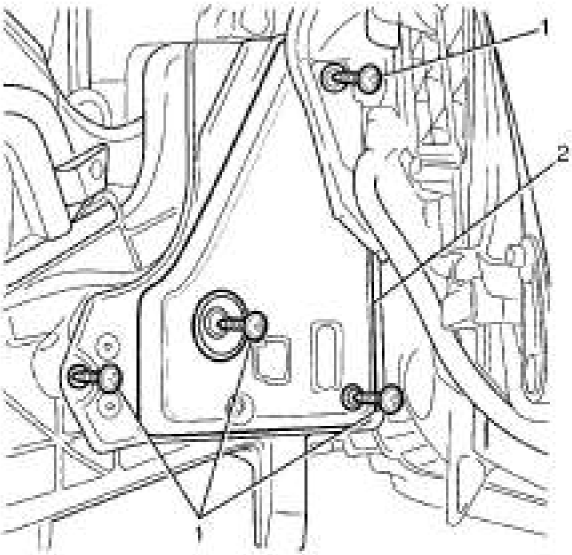
1. Remove the glove box assembly. Refer to Instrument Panel Compartment Replacement .
2. Remove left side floor duct. Refer to Floor Air Outlet Duct Replacement - Left Side .



3. Locate the HVAC control module (1) on the left side of the HVAC module assembly (2).



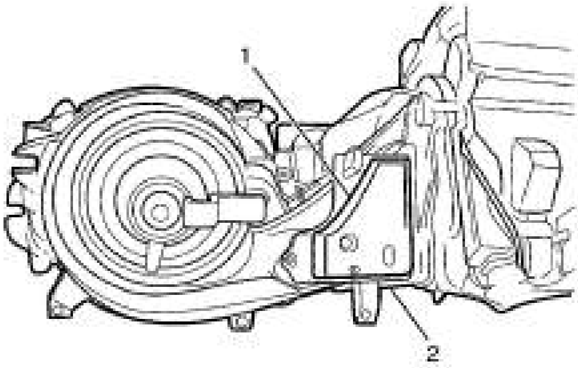
4. Disconnect the HVAC control module electrical connectors (1 - 4).



Important: Make sure the HVAC control module electrical connectors are disconnected before removing the HVAC control module to HVAC module assembly retaining screws (1). The HVAC control module to HVAC module assembly retaining screws (1) contact the HVAC control module (2) circuit board and can short on removal.

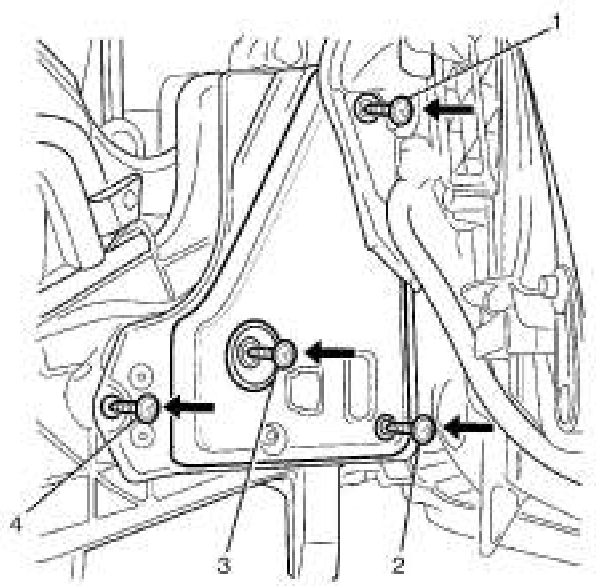
5. Remove the HVAC control module to HVAC module assembly retaining screws (1).
6. Remove HVAC control module (2).

Installation Procedure



1. Install the HVAC control module (1) to the HVAC module assembly (2).

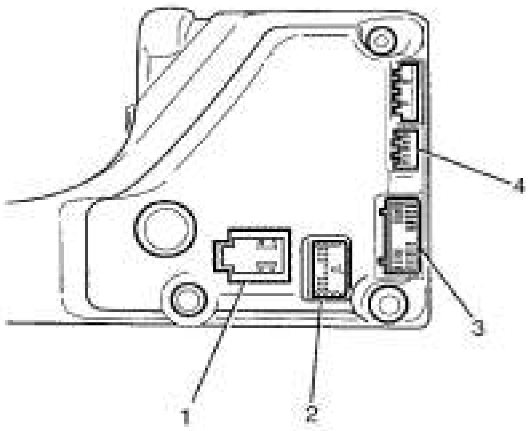
Notice: Refer to Fastener Notice in the Preface section.



Important: The HVAC control module to HVAC module assembly retaining screws (1 - 4) should be tightened in the sequence shown to prevent damage to HVAC control module circuit board.

2. Install the HVAC control module to HVAC module assembly retaining screws (1 - 4).

Tighten
Tighten the screws to 2 N·m (18 lb in).



3. Connect the electrical connectors (1 - 4) to the HVAC control module.
4. Install Left side floor duct. Refer to Floor Air Outlet Duct Replacement - Left Side .
5. Install the glove box assembly. Refer to Instrument Panel Compartment Replacement .
6. If re-programming is required. Refer to Control Module References .
7. Perform HVAC system relearn. Refer to HVAC Control Module Programming and Setup .

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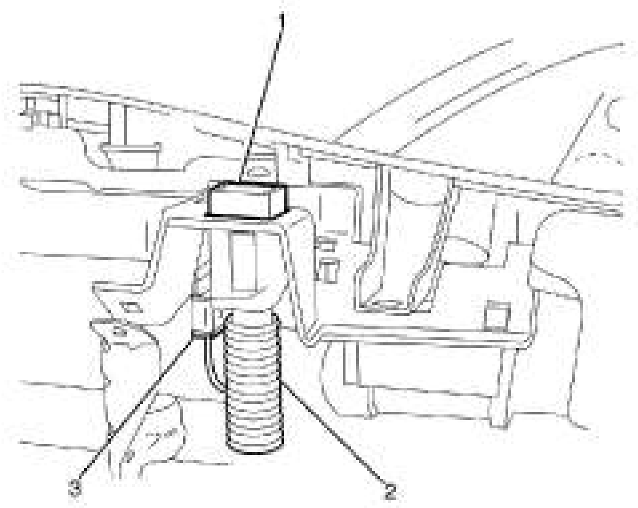
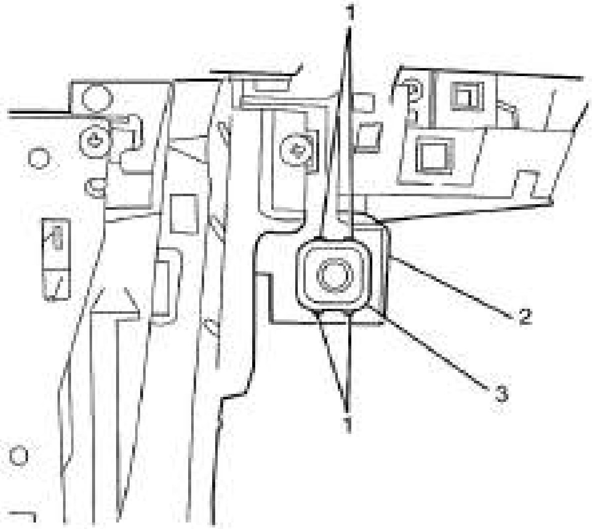
Inside Air Temperature Sensor Replacement

Removal procedure

1. Remove the driver side instrument panel lower trim. Refer to Instrument Panel Insulator Panel Replacement - Right Side.



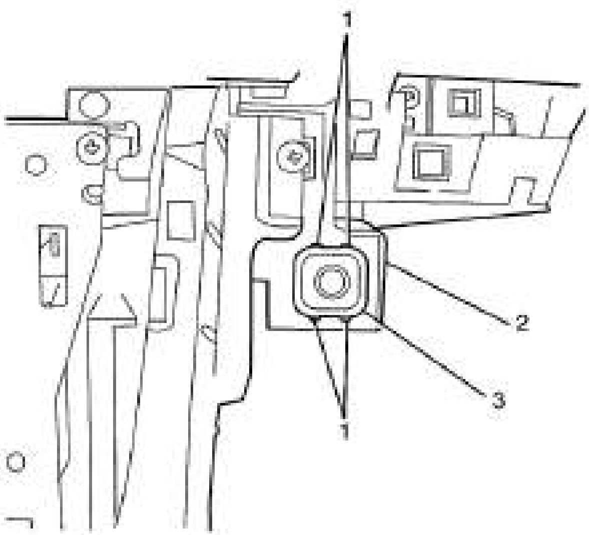
2. Remove the aspirator tube (2) from the rear of the inside air temperature sensor (1).
3. Disconnect the inside air temperature sensor electrical connector (3).



Important: From the front of the inside air temperature sensor (3) use a suitable tool to push down on the four inside air temperature sensor to instrument panel carrier retaining clips (1). Withdraw the inside air temperature sensor (1) rearwards towards the bulkhead from the instrument panel carrier (3) .

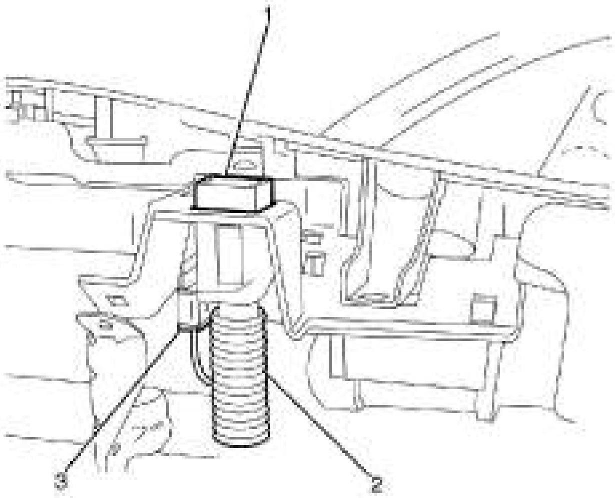
4. Remove the inside air temperature sensor (3) from the instrument panel carrier (2).

Installation Procedure



Important: Make sure the inside air temperature sensor to instrument panel carrier retaining clips (1) are correctly engaged to avoid an induced rattle condition.

1. Install the inside air temperature sensor (3) to the instrument panel carrier (2).



2. Connect the inside air temperature sensor electrical connector (3).
3. Install the aspirator tube (2) to the rear of the inside air temperature sensor (1).
4. Install the driver side instrument panel lower trim cover. Refer to Instrument Panel Insulator Panel Replacement - Right Side.

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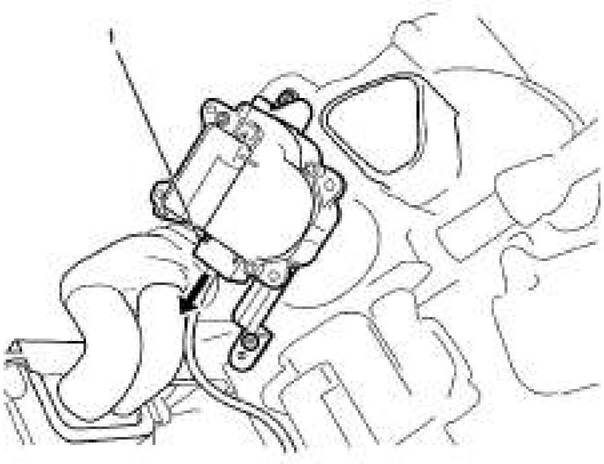
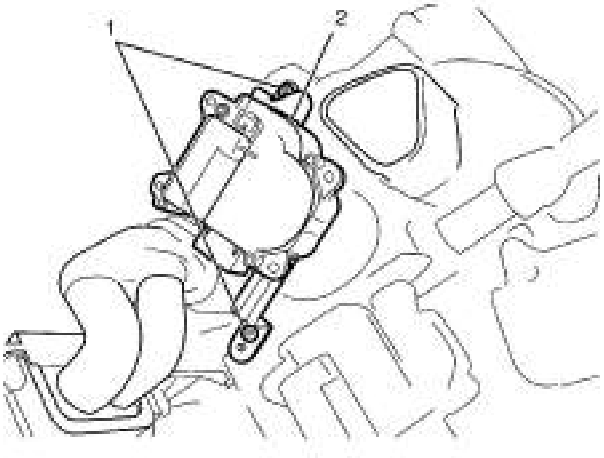
Mode Valve Actuator Replacement

Removal Procedure

1. Remove the instrument panel (I/P) carrier. Refer to Instrument Panel Retainer Replacement.

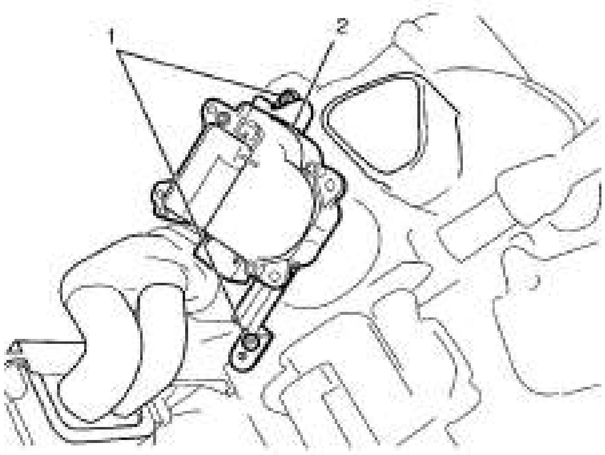


2. Disconnect the mode actuator electrical connector (1).



3. Remove the mode actuator (2) to HVAC unit retaining screws (1).
4. Remove the mode actuator (2) from the HVAC unit.

Installation Procedure

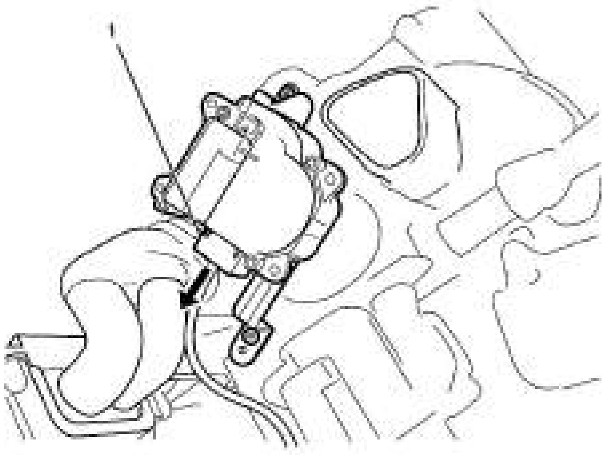


1. Install the mode actuator (1) to the HVAC unit.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the mode actuator (2) to HVAC unit retaining screws (1).

   Tighten
   Tighten the screws to 1 N·m (9 lb in).



3. Connect the electrical connector (1) to the mode actuator.
4. Install the I/P carrier. Refer to Instrument Panel Retainer Replacement.

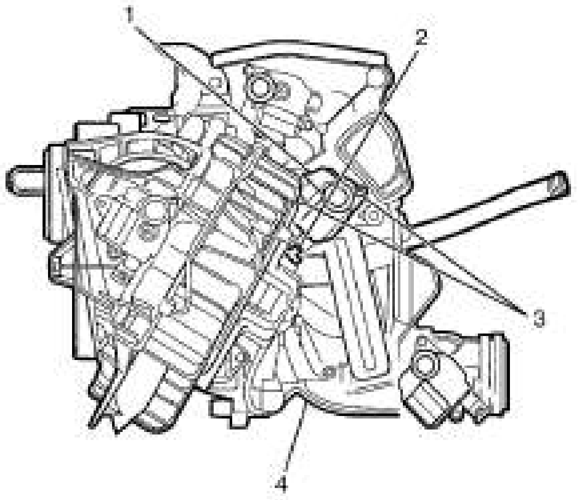
Sun Load Temperature Sensor Replacement

Refer to Sunload and Twilight Sentinel Sensor Replacement.

Temperature Valve Actuator Replacement - Left Side (RHD)

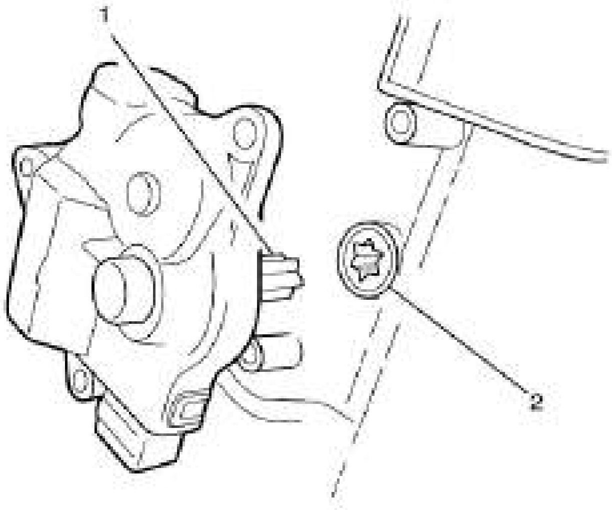
Removal Procedure

1. Remove the I/P lower trim plate assembly. Refer to Instrument Panel Insulator Panel Replacement - Left Side.
2. Remove the I/P compartment assembly. Refer to Instrument Panel Compartment Replacement.
3. Remove left side floor duct. Refer to Floor Air Outlet Duct Replacement - Left Side.

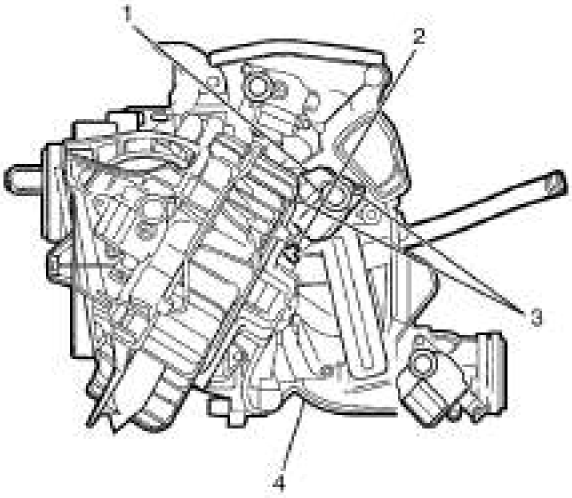


4. Disconnect the passenger air mix mode actuator electrical connector (2).
5. Remove the passenger air mix mode actuator to HVAC module assembly retaining screws (3).
6. Remove the passenger air mix actuator (1) from the HVAC module assembly (4).

Installation Procedure



1. Align the actuator drive gear (1) with the door shaft spline (2).



2. Install the passenger air mix actuator (1) to the HVAC module assembly (4).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the passenger air mix actuator to HVAC module assembly retaining screws (3).

   Tighten
   Tighten the screws to 1 N·m (9 lb ft).

4. Connect the passenger air mix actuator electrical connector (2).
5. Install left side floor duct. Refer to Floor Air Outlet Duct Replacement - Left Side.
6. Install the I/P compartment assembly. Refer to Instrument Panel Compartment Replacement.

7. Install the I/P lower trim plate assembly. Refer to Instrument Panel Insulator Panel Replacement - Left Side.
8. Perform HVAC system relearn. Refer to HVAC Control Module Programming and Setup.

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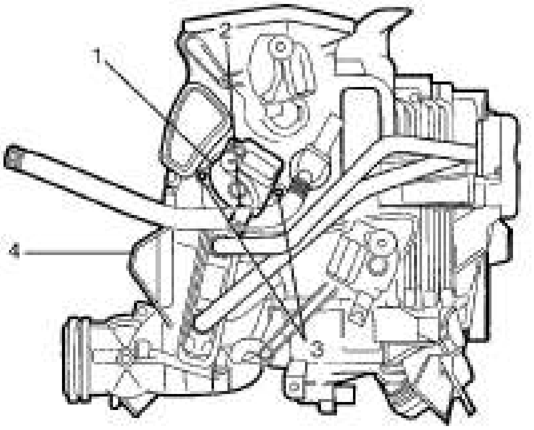
Temperature Valve Actuator Replacement - Right Side (RHD)

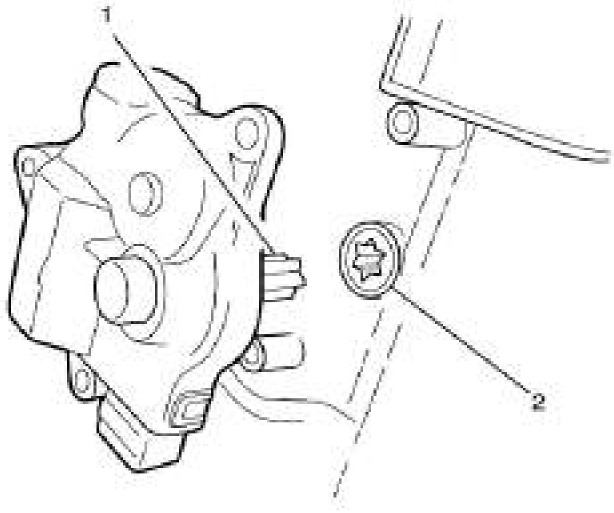
Removal Procedure

1. Remove the right side console lower extension. Refer to Instrument Panel Extension Replacement.
2. Remove right side floor duct. Refer to Floor Air Outlet Duct Replacement - Right Side.

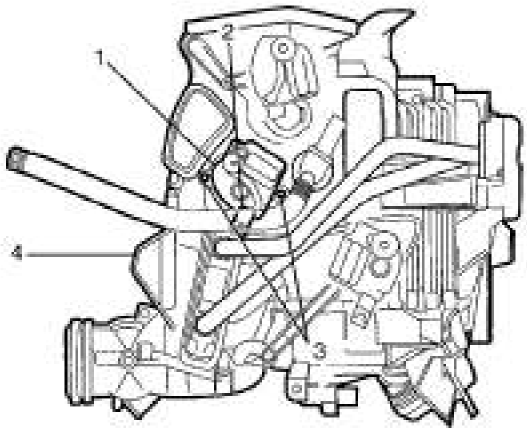


3. Disconnect the driver air mix actuator electrical connector (2).
4. Remove the driver air mix actuator to HVAC module assembly retaining screws (3).
5. Remove the driver air mix actuator from the HVAC module assembly (4).

Installation Procedure



1. Align the actuator drive gear (1) with the door shaft spline (2).



2. Install the driver air mix actuator (1) to HVAC module assembly (4).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the driver air mix actuator to HVAC module assembly retaining screws (3).

   Tighten
   Tighten the screws to 1 N·m (9 lb ft).

4. Connect the driver air mix actuator electrical connector (2).
5. Install the right side floor duct. Refer to Floor Air Outlet Duct Replacement - Right Side.
6. Install the right side console lower extension. Refer to Instrument Panel Extension

Replacement.

7. Perform HVAC system relearn. Refer to HVAC Control Module Programming and Setup.

Air Delivery Description and Operation (SWB)

The Air Delivery Description and Operation is divided into 6 primary areas:

- HVAC Control Components.
- Air Speed.
- Air Speed Auxiliary.
- Air Distribution.
- Recirculation.
- Automatic Operation.

HVAC Control Components

HVAC Control Module

The HVAC control module is a GMLAN device that interfaces between the operator and the HVAC System to maintain air temperature and distribution settings. The battery positive voltage circuit provides power that the control module uses for keep alive memory (KAM). The Body Control Module (BCM), which is the vehicle power mode master, provides a device on signal. The control module supports the following features:

Feature	Availability
Purge	Yes
Personalisation	Yes
Actuator Calibration	Yes

Personalisation

If the personalisation feature for climate control is selected through the radio, the HVAC control module will receive information that defines the current driver of the vehicle from the BCM module through GMLAN communication. This information will be stored inside the HVAC control module memory. When a different key is selected, the HVAC control module will recall the appropriate driver settings. Upon a battery reset, the HVAC control module shall also set the driver ID to Driver 1. The HVAC system will memorise the following system configurations for up to 2 unique drivers:

- Driver set temperature
- Passenger set temperature
- Mode
- Blower motor speed
- A/C compressor request, auto ON or A/C OFF

Mode Actuator

The mode actuator consists of a DC drive motor, reduction gears, printed circuit board (PCB) and a photo electric cell. The DC motors are provided with a supply voltage of 12 Volts from the HCM. The photo interrupter counts the revolutions of the DC motor drive shaft, these counts are then used by the HCM for reference to the actuator position. When the ignition is cycled from OFF to ON the mode and temperature actuators (doors) are driven to their 0% positions which for the temperature door is full cold and the mode doors are to the closed position. The actuators are then driven to the previous settings before the ignition was turned OFF by using the same amount of counts recorded.

Recirculation Actuator

The recirculation actuator consists of a DC drive motor, reduction gears, printed circuit board (PCB) and a photo electric cell. The DC motors are provided with a supply voltage of 12 Volts from the HCM. The photo interrupter counts the revolutions of the DC motor drive shaft, these counts are then used by the HCM for reference to the actuator position. When the ignition is cycled from OFF to ON the mode and temperature actuators (doors) are driven to their 0% positions which for the temperature door is full cold and the mode doors are to the closed position. The actuators are then driven to the previous settings before the ignition was turned OFF by using the same amount of counts recorded.

Blower Motor Control Processor

The blower motor control processor is an interface between the HVAC control module and the blower motor. The blower motor speed control, blower motor supply voltage and ground circuits enable the control processor to operate. The HVAC control module provides a pulse width modulation (PWM) signal to the control processor in order to command the blower motor speed. The control processor uses the blower motor ground as a low side control to adjust the blower motor speed.

Air Speed

The blower motor forces air to circulate within the vehicle's interior. The vehicle operator determines the blower motors speed by placing the blower motor switch in a desired speed position or by selecting automatic operation. In manual operation, once a blower speed is selected, the blower speed remains constant, until a new speed is selected. In automatic operation, the HVAC control module will determine what blower speed is necessary in order to achieve or maintain a desired temperature.

As the requested blower speed increases, the following conditions occur:

- The HVAC control module increases the amount of time that the blower motor speed control circuit is modulated to ground.
- The voltage and duty cycle, measured between the blower motor speed control circuit and ground, decrease.

As the requested blower speed decreases, the following conditions occur:

- The HVAC control module decreases the amount of time that the blower motor speed control circuit is modulated to ground.
- The voltage and duty cycle, measured between the blower motor speed control circuit and ground, increase.

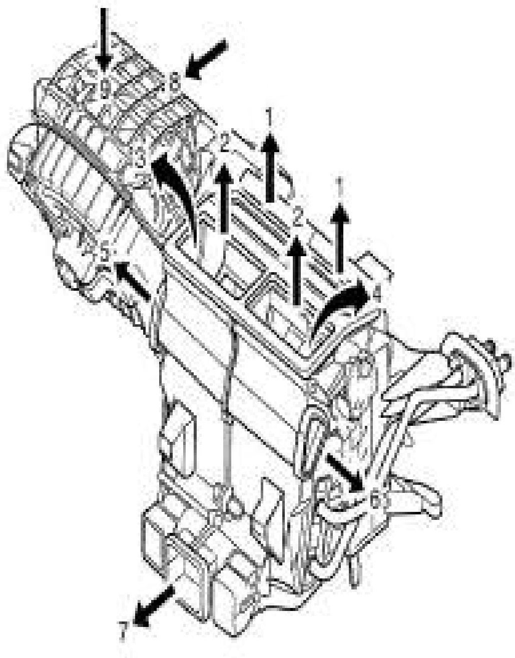
Air Distribution

The HVAC control module controls the mode actuator in order to distribute airflow to a desired outlet. The mode switch provides the vehicle operator with the ability to override the automatic setting. When the mode door is moved to the defrost position, the A/C compressor piston stroke is increased and the recirculation actuator will be moved to the outside air position.

Important: The HVAC system allows air to the outboard face outlets in all air distribution modes. This allows air to be circulated higher in the cabin under any operating condition. The face outlets have three operating positions, open, side window deflector and closed. To reduce air from these outlets, the individual outlet thumbwheel must be turned to the OFF or side window deflector position.

HVAC Air Flow Direction

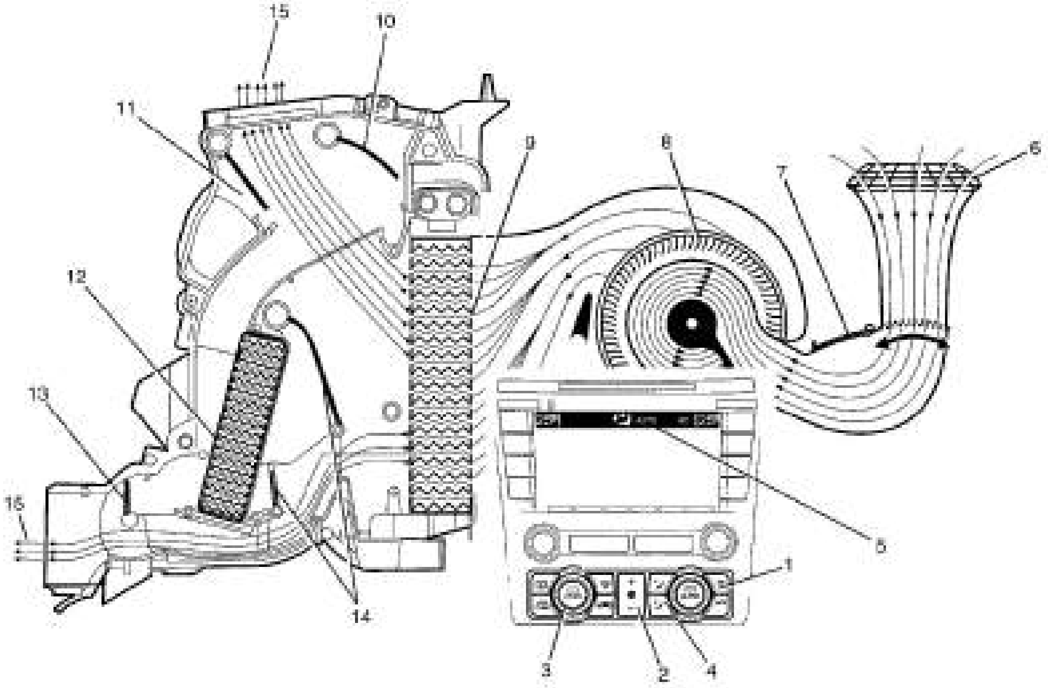
HVAC Air Flow Direction



(1) Defrost to Windscreen
(2) Face Vent Outlet
(3) Passenger Side I/P Outlet
(4) Driver Side I/P Outlet
(5) Passenger Side Floor Outlet
(6) Drivers Side Floor Outlet
(7) Centre Console Rear Passengers Outlet

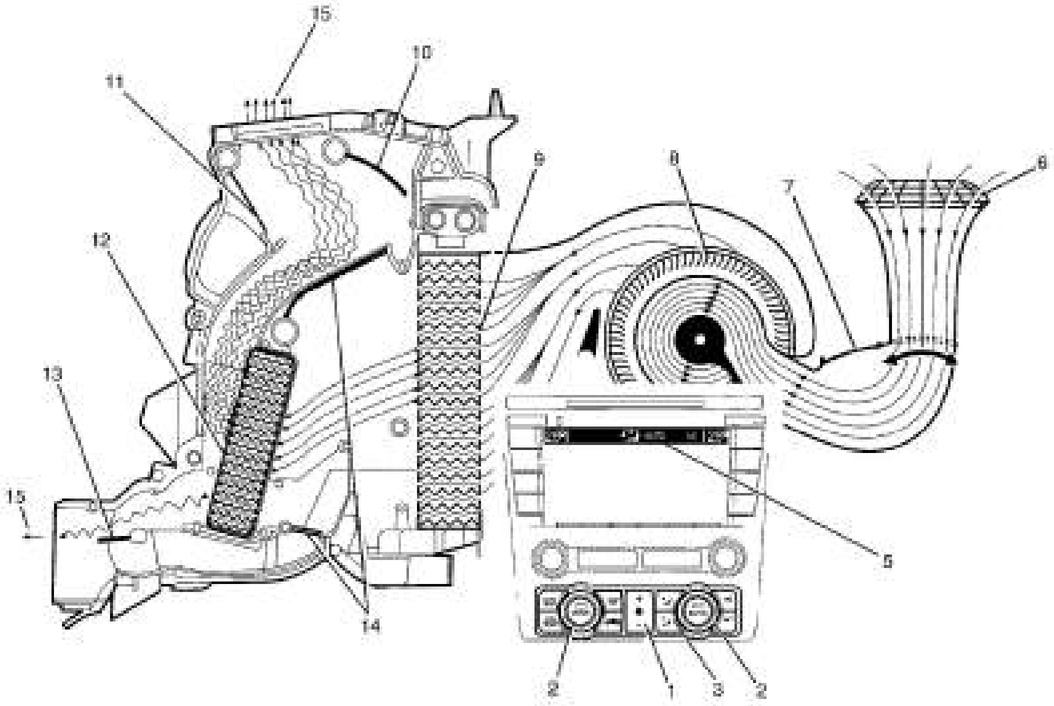
(8) Fresh Air Intake

(9) Recirculation Air Intake



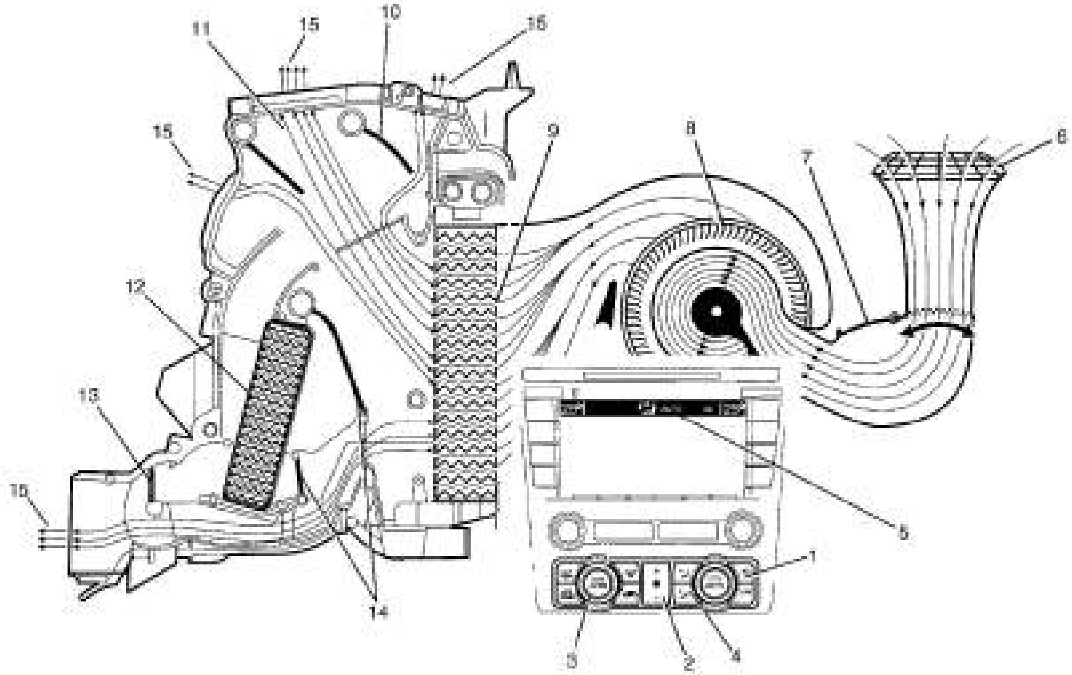
Face Mode Full Cold

The A/C switch is on (1) or auto button is pressed. The fan switch is set to any one of twenty speeds (2). The temperature is set to the full cold position (3). The mode control switch is set to face mode (4). The recirculation door (7) is closed allowing outside air (6) to enter and flow into the HVAC module assembly via the plenum chamber inlet. Air is drawn into the HVAC module assembly by the blower motor (8), and is then forced through the cold evaporator fins (9). In full cold mode, the air mix doors (14) are fully closed sealing off the passage through the heater core (12). The air travels through the open face door (11). The cold air (15) is then directed through the centre and side vents.



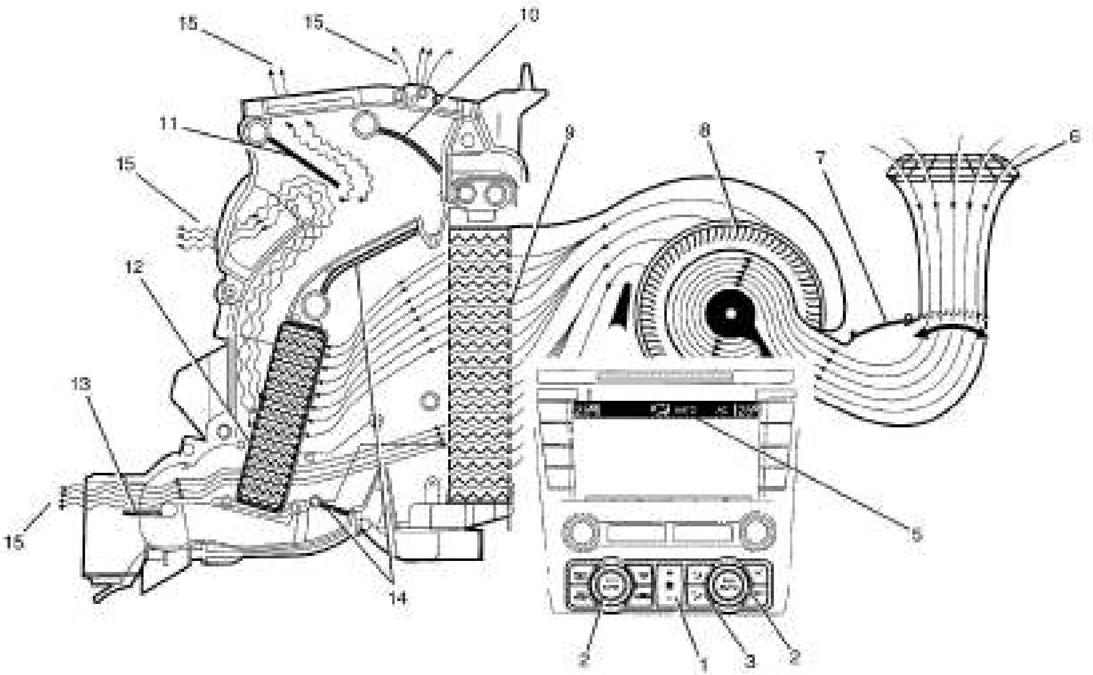
Face Mode Full Hot

The fan switch is set to any one of twenty speeds (1). The temperature switch is set to the full hot position (2). The mode control switch is set to face mode (3). The recirculation door (7) is closed allowing outside air (6) to enter and flow into the HVAC module assembly via the plenum chamber inlet. Air is drawn into the HVAC module assembly by the blower motor (8). This air is then forced through the evaporator core fins (9). In full heat mode, the air mix doors (14) are fully open directing all incoming air through the heater core (12). The air travels through the open face door (11). The heated air (15) is then directed out of the HVAC module assembly to the centre and side vents.



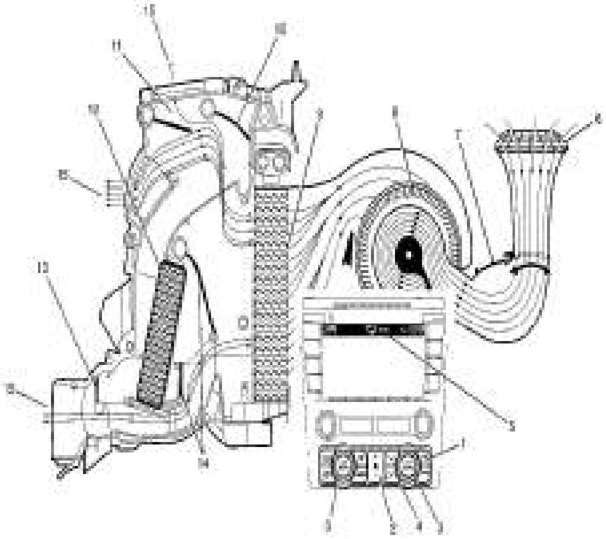
Bi-level Mode Full Cold

The A/C switch is on (1) or auto button is pressed. The fan switch is set to any one of twenty speeds (2). The temperature switch is set to the full cold position (3). The mode control switch is set to bi-level mode (4). The recirculation door (7) is closed allowing outside air (6) to enter and flow into the HVAC module assembly via the plenum chamber inlet. Air is drawn into the HVAC module assembly by the blower motor (8), and is then forced through the cold evaporator fins (9). In full cold mode, the air mix doors (14) are fully closed sealing off the passage through the heater core (12). The air travels through the half opened face door (11) and the through the face/floor door (15) which is open to both face and floor. The cold air (15) is then directed through the centre and side vents as well as the floor ducts.



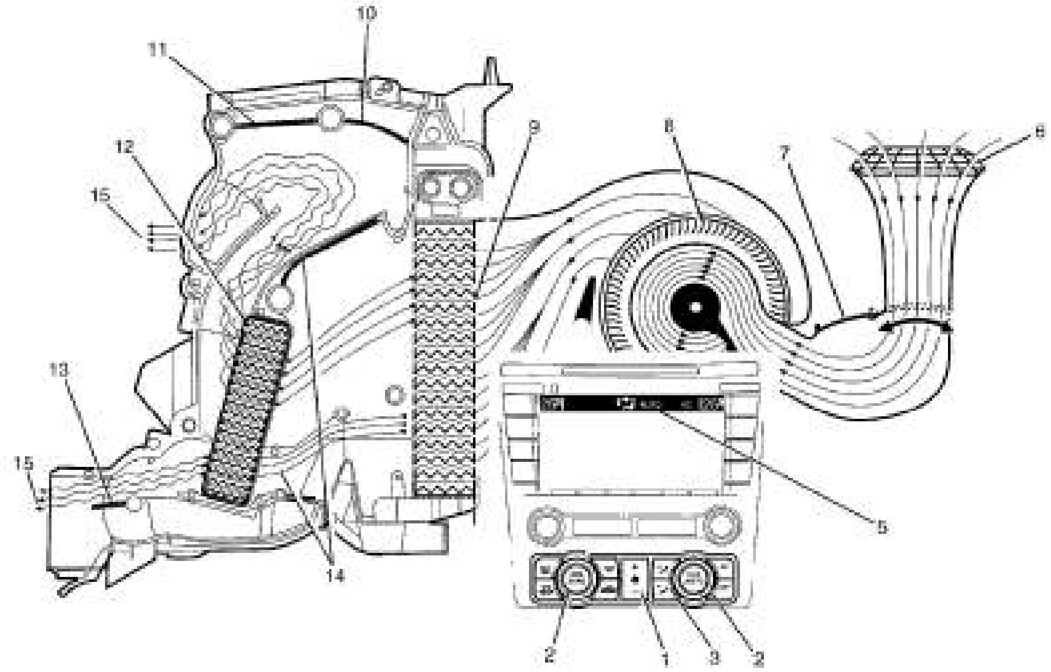
Bi-level Mode Full Hot

The fan switch is set to any one of twenty speeds (1). The temperature switch is set to the full hot position (2). The mode control switch is set to bi-level mode (3). The recirculation door (7) is closed allowing outside air (6) to enter and flow into the HVAC module assembly via the plenum chamber inlet. Air is drawn into the HVAC module assembly by the blower motor (8). This air is then forced through the evaporator core fins (9). In full heat mode, the air mix doors (14) are fully open directing all incoming air through the heater core (12). The air travels through the half opened face door (11) and through the face/floor door (10), which is fully open to face and floor. The heated air (15) is then directed through the centre and side vents as well as to the floor ducts.



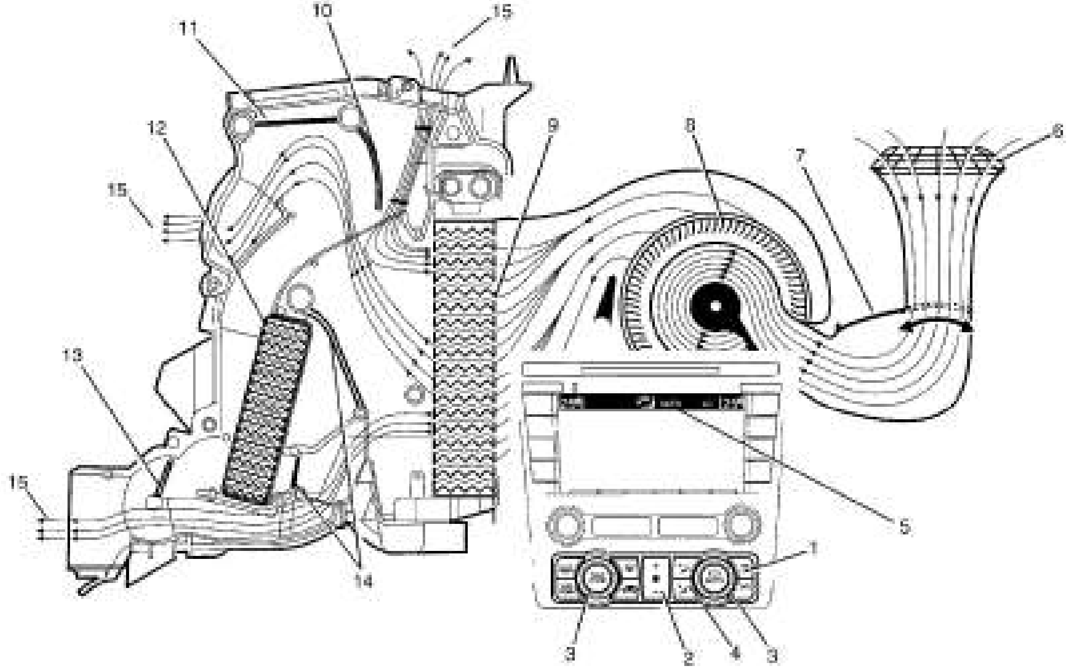
Floor Mode Full Cold

The A/C switch is on (1) or the auto button is pressed. The fan switch is set to any one of twenty speeds (2). The temperature switch is set to the full cold position (3). The mode control switch is set to floor mode (4). The recirculation door (7) is closed allowing outside (6) air to enter and flow into the HVAC module assembly via the plenum chamber inlet (7). Air is drawn into the HVAC module assembly by the blower motor (8), and is then forced through the cold evaporator fins (9). In full cold mode, the air mix doors (10) are fully closed sealing off the passage through the heater core (11). The air travels through the face/floor door (12), which is fully open in the floor mode. The cold air (13) is then directed to floor ducts.



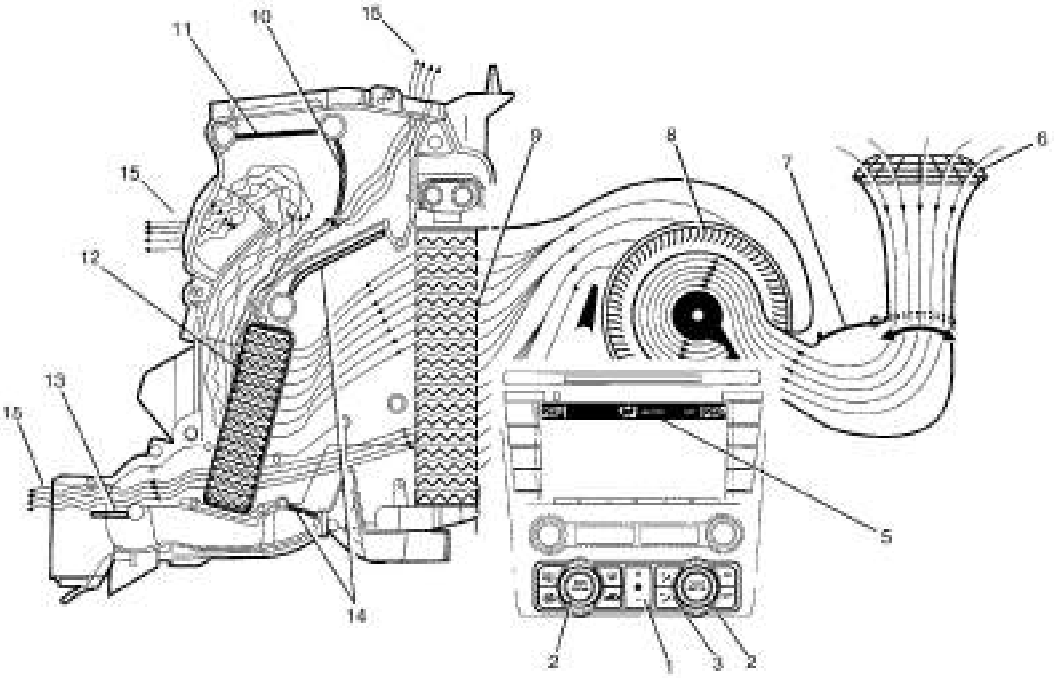
Floor Mode Full Hot

The fan switch is set to any one of twenty speeds (1). The temperature switch is set to the full hot position (2). The mode control switch is set to floor mode (3). The recirculation door (7) is closed allowing outside air (6) to enter and flow into the HVAC module assembly via the plenum chamber inlet (6). Air is drawn into the HVAC module assembly by the blower motor (7). This air is then forced through the evaporator core fins (8). In full heat mode, the air mix doors (9) are fully open directing all incoming air through the heater core (10). The air travels through the face/floor door (11), which is fully open in the floor mode. The heated air (12) is then directed to the floor ducts and rear (15).



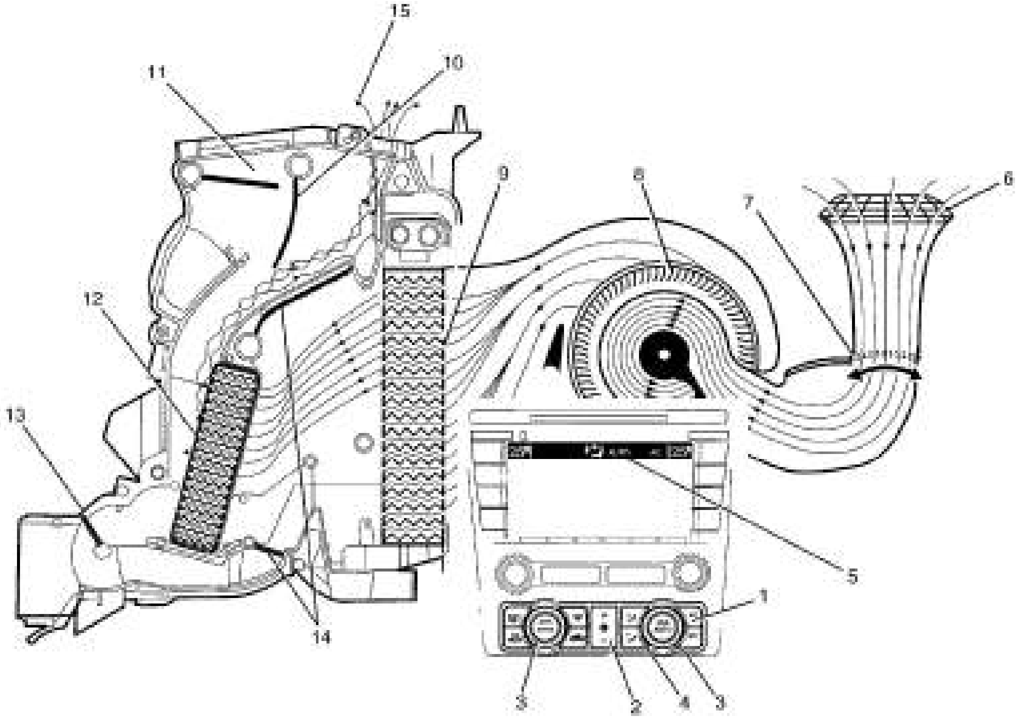
Blend Mode Full Cold

The A/C switch is on (1) or the auto button is pressed. The fan switch is set to any one of twenty speeds (2). The temperature switch is set to the full cold position (3). The mode control switch is set to blend mode (4). The recirculation door (7) is closed allowing outside air (6) to enter and flow into the HVAC module assembly via the plenum chamber inlet. Air is drawn into the HVAC module assembly by the blower motor (8), and is then forced through the cold evaporator fins (9). In full cold mode, the air mix doors (14) are fully closed sealing off the passage through the heater core (12). The air travels through the defrost/floor door (10), which is positioned half way between, defrost and floor modes. The cold air (15) is then directed to both the front windscreen, floor ducts and rear passengers.



Blend Mode Full Hot

The fan switch is set to any one of twenty speeds (1). The temperature switch is set to the full hot position (2). The mode control switch is set to blend mode (3). The recirculation door (7) is closed allowing outside air (6) to enter and flow into the HVAC module assembly via the plenum chamber inlet . Air is drawn into the HVAC module assembly by the blower motor (8). This air is then forced through the evaporator core fins (9). In full heat mode, the air mix doors (14) are fully open directing all incoming air through the heater core (12). The air travels through the defrost/floor door (11), which is positioned half way between defrost and floor modes. The heated air (15) is then directed to both the front windscreen and the floor ducts and rear passengers.



Defrost Mode

The A/C switch is on (1) or the auto button is pressed. The fan switch is set to any one of twenty speeds (2). The temperature switch is set to the full hot position (3). The mode control switch is set to defrost mode (4). The recirculation door (7) is closed allowing outside air (6) to enter and flow into the HVAC module assembly via the plenum chamber inlet. Air is drawn into the HVAC module assembly by the blower motor (8). This air is then forced through the cold evaporator core fins (9) removing moisture from the air. In full heat mode, the air mix doors (14) are fully open allowing dehumidified incoming air through the heater core (12). The air travels through the defrost/floor door (10) which is fully open in the defrost mode. The heated air (15) is then directed to the front windscreen via the defrost outlets.

Recirculation

The HVAC control module controls the air intake through the recirculation actuator. Recirculation is not available when the mode is in defrost.

Pollution mode

The system can be set to pollution mode which selects recirculation when the vehicle speed is less than 15 km/h. This helps to prevent exhaust fumes entering the interior in heavy, stop/start traffic. To switch pollution mode on or off, press and hold the recirculation button for four seconds. When pollution mode is activated, the display shows Pollution Mode Activated. When it is switched off, the display shows Pollution Mode Inactive.

Automatic Operation

In automatic operation, the HVAC control module will maintain the comfort level inside of the vehicle by controlling the A/C compressor piston stroke, the blower motor, the air temperature actuators, mode actuator and recirculation.

To place the HVAC system in full automatic operation, the AUTO selection must be activated.

Once the desired temperature is reached, the blower motor, mode, recirculation and temperature actuators will automatically adjust to maintain the temperature selected. The HVAC control module performs the following functions to maintain the desired air temperature:

- Regulate blower motor speed
- Position the air temperature actuator
- Position the mode actuator
- Position the recirculation actuator
- Request A/C operation

When the warmest position is selected in automatic operation the blower speed will increase gradually until the vehicle reaches normal operating temperature. When normal operating temperature is reached the blower will stay on high speed and the air temperature actuators will stay in the full heat position. The mode actuator will remain in the floor position.

When the coldest position is selected in automatic operation the blower will stay on high and the air temperature actuators will stay in the full cold position. The mode actuator will remain in the face position and the recirculation actuator will remain in the recirculation position.

In cold temperatures, the automatic HVAC system will provide heat in the most efficient manner. The vehicle operator can select an extreme temperature setting, but the system will not warm the vehicle any faster. In warm temperatures, the automatic HVAC system will also provide air conditioning in the most efficient manner. Selecting an extreme cool temperature will not cool the vehicle any faster.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | HVAC | HVAC - Automatic | Description and Operation | Document ID: 1994769

Air Temperature Description and Operation (LWB)

The air temperature controls are divided into 4 primary areas:

- Automatic Operation.
- The Heating and Air Conditioning System.
- The A/C Cycle.
- Auxiliary heating and A/C system.

HVAC Control Components

HVAC Control Module

The HVAC control module is a GMLAN device that interfaces between the operator and the HVAC system to maintain air temperature and distribution settings. The battery positive voltage circuit provides power that the control module uses for keep alive memory (KAM). The instrument panel module (IPM), which is the vehicle power mode master, provides a device on signal. The control module supports the following features:

Feature	Availability
Purge	Yes
Personalisation	Yes
Actuator Calibration	No

Air Temperature Actuators

The air temperature actuator consists of a DC drive motor, reduction gears, printed circuit board (PCB) and a photo electric cell. The DC motors are provided with a supply voltage of 12 Volts from the HCM. The photo interrupter counts the revolutions of the DC motor drive shaft, these counts are then used by the HCM for reference to the actuator position. When the ignition is cycled from OFF to ON the mode and temperature actuators (doors) are driven to their 0% positions which for the temperature door is full cold and the mode doors are to the closed position. The actuators are then driven to the previous settings before the ignition was turned OFF by using the same amount of counts recorded

Air Temperature Sensors

The air temperature sensors are 2-wire negative temperature co-efficient thermistors. The vehicle uses the following air temperature sensors:

- Ambient.
- Inside.

A signal and low reference circuit enables the sensor to operate. As the air temperature surrounding the sensor increases, the sensor resistance decreases. The sensor signal decreases as the resistance decreases. The sensor signal varies between 0-5 volts.

The inside temperature sensor operates within a temperature range between -40 to +90°C (-40 to +194). If the sensor is shorted to ground, voltage, or an open, the system will operate using an estimated default value to allow the system to operate. The ambient sensor operates within a temperature range between -30 to +70°C (-22 to +158°F). If the HVAC control has determined that the ambient temperature sensor has failed, the driver information centre (DIC) display shall display - - - - in place of the outside air temperature. If the sensor is shorted to ground, voltage, or an open, the system will operate using an estimated default value to allow the system to operate. If the engine coolant temperature is not more than 3°C (5.4°F) above the sensor reading, or if the engine has not been started in 3 hours, then the actual ambient air temperature sensor reading is displayed. Also at vehicle speeds greater than 35 km/h (22 m.p.h.), the ambient air temperature displayed may be allowed to increase, but only at a slow, filtered rate. The DIC displays the ambient air temperature value that it receives from the HVAC control module through a GMLAN message.

Sunload Sensor

The sunload sensor is a 2-wire photo diode. The vehicle uses left and right sunload sensors. The 2 sensors are integrated into the sunload sensor assembly along with the ambient light sensor. Low reference and signal circuits enable the sensor to operate. As the sunload increases, the sensor signal decreases. The sensor operates within an intensity range between completely dark and bright. The sensor signal varies between 0-5 volts. The HVAC control module converts the signal to a range between 0-255 counts. The sunload sensor provides the HVAC control module a measurement of the amount of light shining on the vehicle. Bright or high intensity light causes the vehicle's inside temperature to increase. The HVAC system compensates for the increased temperature by diverting additional cool air into the vehicle. If the sensor is open or shorted, no sunload adjustment occurs and the SERVICE VEHICLE SOON message is displayed.

Evaporator Temperature Sensor

The HVAC control module monitors the temperature of the air passing through the evaporator by the A/C evaporator air temperature sensor. This sensor is located on the evaporator core. The temperature is used to cycle the A/C compressor ON and OFF to prevent the evaporator core from freezing. A thermistor inside the sensor varies its resistance to monitor the evaporator air temperature. The HVAC control module monitors the voltage drop across the thermistor when supplied with a 5-volt reference signal. The HVAC control module will send a LS GMLAN message to the engine control module (ECM) to request the A/C compressor piston stroke to minimum stroke if the temperature drops below 2°C (37°F).

The sensor operates within a temperature range between -40 to +215°C (-40 to +355°F). If the HVAC control module detects an open in the evaporator temperature sensor or circuit, the class 2 message sent to the ECM will not submit the A/C ON request. The HVAC control module will then send a request to the infotainment unit for display of the SERVICE A/C SYSTEM that will be displayed on the DIC. The HVAC control module will also display A/C OFF on the module as long as the condition is present.

A/C Refrigerant Pressure Sensor

The A/C refrigerant pressure sensor is a 3-wire piezoelectric pressure transducer. A 5-volt reference, low reference, and signal circuits enable the sensor to operate. The A/C pressure signal can be between 0-5 volts. When the A/C refrigerant pressure is low, the signal value is near 0 volts. When the A/C refrigerant pressure is high, the signal value is near 5 volts.

The A/C refrigerant pressure sensor prevents the A/C system from operating when a pressure exceeds a predetermined value.

If the ECM detects a failure in the A/C refrigerant pressure sensor or circuit, the class 2 message sent to the HVAC control module will be invalid. The HVAC control module will then send a request to the infotainment unit for display of the SERVICE A/C SYSTEM that will be displayed on the infotainment facia The HVAC control module will also display A/C OFF on the module as long as the condition is present.

Heating and A/C Operation

The purpose of the heating and A/C System is to provide the following:

- Heated air.
- Cooled air.
- Remove humidity from the interior of the vehicle.
- Reduce windshield fogging.

Regardless of the temperature setting, the following can effect the rate that the HVAC system can achieve a desired temperature:

- Recirculation actuator setting.
- Difference between inside and desired temperature.
- Difference between ambient and desired temperature.
- Blower motor speed setting.
- Mode setting.

The HVAC control module commands or monitors the following actions when an air temperature setting is selected.

- WARMEST POSITION - The air temperature actuator door position directs maximum air flow through the heater core.
- COLDEST POSITION - The air temperature actuator door position directs maximum air flow around the heater core.
- BETWEEN THE WARMEST AND COLDEST POSITION - The following sensors are monitored to direct the appropriate amount of air through the heater core to achieve the desired temperature:
  - Sunload.
  - Ambient temperature.
  - Inside temperature.

The A/C system is engaged by selecting any switch on the HVAC control module except the A/C switch. The A/C switch will illuminate A/C OFF when the A/C switch is selected. The control module sends a GMLAN A/C request message to the engine control module (ECM) for A/C compressor operation. The following conditions must be met in order for the HVAC to turn on the compressor :

- HVAC control module:
  - Evaporator Temperature more than 4°C (39°F).
  - Control module operating range 9-16 volts.
- ECM:

  - Engine coolant temperature (ECT) is less than 125°C (257°F) or 120°C (248°F).
  - Engine RPM is between 450-6,000 RPM.
  - A/C pressure is between 196 and 3200 kPa.

Once engaged, the compressor will be disengaged for the following conditions:

- Throttle position is 100 percent.
- A/C pressure is more than 3 137 kPa (455 psi) or 2 850 kPa (413 psi).
- A/C pressure is less than 193 kPa (28 psi) or 200 kPa (29 psi).
- Engine coolant temperature (ECT) is more than 125°C (257°F) or 120°C (248°F).
- Engine speed is more than 5,500 RPM.
- Transmission shift.
- ECM detects high torque load.
- ECM detects insufficient idle quality.
- ECM detects a hard launch condition.

Dual Zone Operation

Dual-zone (DZ) mode Dual-zone mode allows different temperatures to be set for the left and right sides or to link them. When linked, the passenger's side temperature setting mirrors whatever the driver's side temperature is set to. To set a different temperature for the passenger's side, adjust the passenger's temperature control. To link the passenger's side temperature to the driver's side, press and hold the AUTO button for at least three seconds. Note Linking automatically occurs if the passenger's and driver's sides are set to the same temperature when the ignition is turned on. On a tri-zone climate control 3, the rear temperature setting mirrors whatever the driver's side temperature is set to.

Tri Zone Operation

Selecting tri-zone (TZ) mode activates the rear passenger controls. The climate control can still be operated as described in section Dual-zone (DZ) mode. Note The rear passenger controls are only activated when tri-zone (TZ) is selected. Refer to Rear passenger controls further on in this section.

Automatic Operation

In automatic operation, the HVAC control module will maintain the comfort level inside of the vehicle by controlling the A/C compressor piston stroke, the blower motor, the air temperature actuators, mode actuator and recirculation.

To place the HVAC system in automatic mode, the following is required:

- The blower motor switch must be in the AUTO position.
- The air temperature switch must be in any other position other than full hot or cold.
- The mode switch must be in the AUTO position.

Once the desired temperature is reached, the blower motor, mode, recirculation and temperature actuators will automatically adjust to maintain the temperature selected. The HVAC control module performs the following functions to maintain the desired air temperature:

- Regulate blower motor speed.
- Position the air temperature actuator.
- Position the mode actuator.
- Position the recirculation actuator.
- Request A/C operation.

When the warmest position is selected in automatic operation, the blower speed will stay on high speed and the air temperature actuators will stay in the full heat position. When the coldest position is selected in automatic operation, the blower will stay on high and the air temperature actuators will stay in the full cold position.

In cold temperatures, the automatic HVAC system will provide heat in the most efficient manner. The vehicle operator can select an extreme temperature setting, but the system will not warm the vehicle any faster. In warm temperatures, the automatic HVAC system will also provide air conditioning in the most efficient manner. Selecting an extremely cool temperature will not cool the vehicle any faster.

Auxiliary HVAC Control Module

Turn the rear temperature control L clockwise (warmer) or counterclockwise (cooler) to set the temperature for the rear. The rear temperature setting is shown in the front and rear displays when adjusting it. Note The rear temperature is dependent on the driver’s side temperature. When the pointer is set to the centre of the bar graphic in the display, the rear temperature is set to approximately the same setting as for the driver’s side. Press + or - on the fan button to increase or decrease the fan speed. The fan speed is shown in the display. Note This will affect the fan speed for all three zones. Press the mode button to switch between the following positions for the rear: Floor mode directs air to the floor-level outlets located under the front seats. Face mode directs air to the vents in the rear of the centre console Bi-level mode directs air to the floor-level outlets and the vents in the rear of the centre console The setting is shown in the display. Note If windscreen defrost is set, no air will come out of the rear vents. Pressing the AUTO button switches the system to full automatic control. Note When pressing the AUTO button, all functions (including the fan speed) are controlled automatically. Press the ON button P to switch the air to the rear off or on. FAN OFF appears in the display when it is off.

Auxiliary Air Temperature Actuator

The auxiliary air temperature actuator consists of a DC drive motor, reduction gears, printed circuit board (PCB) and a photo electric cell. The DC motors are provided with a supply voltage of 12 Volts from the HCM. The photo interrupter counts the revolutions of the DC motor drive shaft, these counts are then used by the HCM for reference to the actuator position. When the ignition is cycled from OFF to ON the mode and temperature actuators (doors) are driven to their 0% positions which for the temperature door is full cold and the mode doors are to the closed position. The actuators are then driven to the previous settings before the ignition was turned OFF by using the same amount of counts recorded.

Air Temperature Description and Operation (SWB)

The air temperature controls are divided into 4 primary areas:

- Automatic Operation.
- The Heating and Air Conditioning System.
- The A/C Cycle.
- Auxiliary heating and A/C system.

HVAC Control Components

HVAC Control Module

The HVAC control module is a GMLAN device that interfaces between the operator and the HVAC system to maintain air temperature and distribution settings. The battery positive voltage circuit provides power that the control module uses for keep alive memory (KAM). The instrument panel module (IPM), which is the vehicle power mode master, provides a device on signal. The control module supports the following features:

Feature	Availability
Purge	Yes
Personalisation	Yes
Actuator Calibration	No

Air Temperature Actuators

The air temperature actuator consists of a DC drive motor, reduction gears, printed circuit board (PCB) and a photo electric cell. The DC motors are provided with a supply voltage of 12 Volts from the HCM. The photo interrupter counts the revolutions of the DC motor drive shaft, these counts are then used by the HCM for reference to the actuator position. When the ignition is cycled from OFF to ON the mode and temperature actuators (doors) are driven to their 0% positions which for the temperature door is full cold and the mode doors are to the closed position. The actuators are then driven to the previous settings before the ignition was turned OFF by using the same amount of counts recorded

Air Temperature Sensors

The air temperature sensors are 2-wire negative temperature co-efficient thermistors. The vehicle uses the following air temperature sensors:

- Ambient.
- Inside.

A signal and low reference circuit enables the sensor to operate. As the air temperature surrounding the sensor increases, the sensor resistance decreases. The sensor signal decreases as the resistance decreases. The sensor signal varies between 0-5 volts.

The inside temperature sensor operates within a temperature range between -40 to +90°C (+20.3 to +135.5°F). If the sensor is shorted to ground, voltage, or an open, the system will operate using an estimated default value to allow the system to operate. The ambient sensor operates within a temperature range between -30 to +70°C. If the HVAC control module has determined that the ambient temperature sensor has failed, the driver information centre (DIC) display shall display - - - - in place of the outside air temperature. If the sensor is shorted to ground, voltage, or an open, the system will operate using an estimated default value to allow the system to operate. If the engine coolant temperature is not more than 3°C (5.4°F) above the sensor reading, or if the engine has not been started in 3 hours, then the actual ambient air temperature sensor reading is displayed. Also at vehicle speeds greater than 35 km/h (22 m.p.h.), the ambient air temperature displayed may be allowed to increase, but only at a slow, filtered rate. The DIC displays the ambient air temperature value that it receives from the HVAC control module through a GMLAN message.

Sunload Sensor

The sunload sensor assembly, located centrally on the top of the instrument panel near the windscreen is a 2-wire photo diode, effectively houses two sunlight sensors one for the left side and one for the right side. The 2 sensors are integrated into the sunload sensor assembly along with the ambient light sensor. Low reference and signal circuits enable the sensor to operate. As the sunload increases, the sensor signal decreases. The sensor operates within an intensity range between completely dark and bright. The sensor signal varies between 0-5 volts. The HVAC control module converts the signal to a range between 0-255 counts. The sunload sensor provides the HVAC control module a measurement of the amount of light shining on the vehicle. Bright or high intensity light causes the vehicle's inside temperature to increase. The HVAC system compensates for the increased temperature by diverting additional cool air into the vehicle. If the sensor is open or shorted, no sunload adjustment occurs and the SERVICE VEHICLE SOON message is displayed.

Evaporator Temperature Sensor

The HVAC control module monitors the temperature of the air passing through the evaporator by the A/C evaporator air temperature sensor. This sensor is located on the evaporator core. The temperature is used to cycle the A/C compressor ON and OFF to prevent the evaporator core from freezing. A thermistor inside the sensor varies its resistance to monitor the evaporator air temperature. The HVAC control module monitors the voltage drop across the thermistor when supplied with a 5-volt reference signal. The HVAC control module will send a LS GMLAN message to the engine control module (ECM) to request the A/C compressor piston stroke to minimum stroke if the temperature drops below 2°C (37°F).

The sensor operates within a temperature range between -40 to +215°C (-40 to +355°F). If the HVAC control module detects an open in the evaporator temperature sensor or circuit, the GMLAN message sent to the ECM will not submit the A/C ON request. The HVAC control module will then send a request to the infotainment unit for display of the SERVICE A/C SYSTEM that will be displayed on the DIC. The HVAC control module will also display A/C OFF on the module as long as the condition is present.

A/C Refrigerant Pressure Sensor

The A/C refrigerant pressure sensor is a 3-wire piezoelectric pressure transducer. A 5-volt reference, low reference, and signal circuits enable the sensor to operate. The A/C pressure signal can be between 0-5 volts. When the A/C refrigerant pressure is low, the signal value is near 0 volts. When the A/C refrigerant pressure is high, the signal value is near 5 volts.

The A/C refrigerant pressure sensor prevents the A/C system from operating when a pressure exceeds a predetermined value.

If the ECM detects a failure in the A/C refrigerant pressure sensor or circuit, the GMLAN message sent to the HVAC control module will be invalid. The HVAC control module will then send a request to the infotainment unit for display of the SERVICE A/C SYSTEM that will be displayed on the infotainment facia The HVAC control module will also display A/C OFF on the module as long as the condition is present.

Heating and A/C Operation

The purpose of the heating and A/C System is to provide the following:

- Heated air.
- Cooled air.
- Remove humidity from the interior of the vehicle.
- Reduce windshield fogging.

Regardless of the temperature setting, the following can effect the rate that the HVAC system can achieve a desired temperature:

- Recirculation actuator setting.
- Difference between inside and desired temperature.
- Difference between ambient and desired temperature.
- Blower motor speed setting.
- Mode setting.

The HVAC control module commands or monitors the following actions when an air temperature setting is selected.

- WARMEST POSITION--The air temperature actuator door position directs maximum air flow through the heater core.
- COLDEST POSITION--The air temperature actuator door position directs maximum air flow around the heater core.
- BETWEEN THE WARMEST AND COLDEST POSITION--The following sensors are monitored to direct the appropriate amount of air through the heater core to achieve the desired temperature:
  - Sunload.
  - Ambient temperature.
  - Inside temperature.

The A/C system is engaged by selecting any switch on the HVAC control module except the A/C switch. The A/C switch will illuminate A/C OFF when the A/C switch is selected. The control module sends a GMLAN A/C request message to the engine control module (ECM) for A/C compressor operation. The following conditions must be met in order for the HVAC to turn on the compressor :

- HVAC control module:
  - Evaporator Temperature more than 4°C (39°F).

  - Control module operating range 9-16 volts.
- ECM:
  - Engine coolant temperature (ECT) is less than 125°C (257°F) or 120°C (248°F).
  - Engine RPM is between 450-6,000 RPM.
  - A/C pressure is between 196 and 3200 kPa .

Once engaged, the compressor will be disengaged for the following conditions:

- Throttle position is 100 percent.
- A/C pressure is more than 3 137 kPa (455 psi) or 2 850 kPa (413 psi).
- A/C pressure is less than 193 kPa (28 psi) or 200 kPa (29 psi) .
- Engine coolant temperature (ECT) is more than 125°C (257°F) or 120°C (248°F).
- Engine speed is more than 5,500 RPM.
- Transmission shift
- ECM detects high torque load.
- ECM detects insufficient idle quality.
- ECM detects a hard launch condition.

Dual Zone Operation

Dual-zone (DZ) mode Dual-zone mode allows different temperatures to be set for the left and right sides or to link them. When linked, the passenger's side temperature setting mirrors whatever the driver's side temperature is set to. To set a different temperature for the passenger's side, adjust the passenger's temperature control. To link the passenger's side temperature to the driver's side, press and hold the AUTO button for at least three seconds. Note Linking automatically occurs if the passenger's and driver's sides are set to the same temperature when the ignition is turned on.

Automatic Operation

In automatic operation, the HVAC control module will maintain the comfort level inside of the vehicle by controlling the A/C compressor piston stroke, the blower motor, the air temperature actuators, mode actuator and recirculation.

To place the HVAC system in automatic mode, the following is required:

- The blower motor switch must be in the AUTO position.
- The air temperature switch must be in any other position other than full hot or cold.
- The mode switch must be in the AUTO position.

Once the desired temperature is reached, the blower motor, mode, recirculation and temperature actuators will automatically adjust to maintain the temperature selected. The HVAC control module performs the following functions to maintain the desired air temperature:

- Regulate blower motor speed.
- Position the air temperature actuator.
- Position the mode actuator.

- Position the recirculation actuator.
- Request A/C operation.

When the warmest position is selected in automatic operation, the blower speed will stay on high speed and the air temperature actuators will stay in the full heat position. When the coldest position is selected in automatic operation, the blower will stay on high and the air temperature actuators will stay in the full cold position.

In cold temperatures, the automatic HVAC system will provide heat in the most efficient manner. The vehicle operator can select an extreme temperature setting, but the system will not warm the vehicle any faster. In warm temperatures, the automatic HVAC system will also provide air conditioning in the most efficient manner. Selecting an extremely cool temperature will not cool the vehicle any faster.

Automatic HVAC Description and Operation (SWBRHD)

1. Mode directions UP - Defrost, Bi-Level, Blend, Face, Floor
2. A/C Compressor output - OFF/output increase
3. Occupant climate control ON/OFF - Sleep mode, the air mix actuators are still operating in the back ground to try and maintain the selected set temperatures, which means at ON (wake up) the temperature output will be near the selected set temperatures.
4. Fully automatic mode - auto text is illuminated when in fully automatic mode. auto text is off, the occupant climate control is in semi automatic mode.
5. Temperature adjustment Driver Side - Set Temperature Range - Full cold to full hot, 17 to 30 in 1 (one) degree increments.
6. Mode directions Down - Floor, Face, Blend, Bi-Level, Defrost.
7. Blower speeds - Semi automatic mode Twenty (20) speeds. Fully automatic mode infinite speeds.
8. Fresh / Recirculation - When in recirculation mode, will automatically go to fresh air after Thirty (30) minutes depending on ambient temperature.
9. Temperature adjustment Passenger side - Set temperature range - Full cold to full hot, 17 to 30 in 1 (one) degree increments.
10. Ambient temperature display - The ambient temperature is displayed on the infotainment facia when the button is pressed.
11. Rear window defrost - Automatically turns off after 15 minutes the first time then every 5 minutes.
12. Front windscreen defrost - In this mode the A/C is automatically ON, Recirculation is not allowed.

General Description

The VE occupant climate control HVAC will be provided in Two (2) Variants: Dual Zone (DZ) - Temperature adjustment is independent for both Passenger and Drivers side.

A module called the HVAC control module (HCM) is attached to the HVAC on the Passenger side is the micro processor used to monitor inputs, process data, calculate changes to operating functions and control HVAC outputs.

The Inputs are:

- Can Bus information - Priority key user, Engine RPM, Vehicle road speed, Coolant temperature, A/C system pressure via the pressure transducer.
- In-car temperature sensor.
- Ambient temperature sensor.
- Evaporative temperature sensor.
- Electric mode actuators (DC motors) voltage, position feed back via photo interrupters.
- Blower fan voltage.
- Ignition voltage.
- Sun load sensor.
- Variable stroke compressor electronic control valve displacement (ECVD) actual position.

The Outputs are:

- Air distribution mode - Face, Floor, Defrost, Blend, Bi-Level, Air intake and Rear Passenger.
- Vent temperatures by adjusting the air mixing doors, including the rear passenger.
- Blower fan speeds.
- infotainment facia for display changes and Ambient temperature reading.
- Rear window defrost relay.
- Compressor displacement (output) via the ECVD. From OFF to Maximum output.
- Variable stroke compressor ECVD (electronic control valve) target position.
- Maximum blower fan speed relay.

Recommended Settings:

The vehicle owner should be encouraged to use the occupant climate control in fully Automatic mode and at a set temperature of between 22-24 degrees. Changing the set temperature to suit different conditions may cause the occupant climate control to behave differently from what the customer expects (eg. Setting to 17°C on a hot day may cause the customer to complain that the blower fan speed is too high).

Occupant Climate Control (OCC) When OFF is Selected:

The vehicle owner should be made aware that if the occupant climate control system is turned OFF, the following will occur:

- The air mixing (temperature) electric actuators will continue to operate (motor movement noise) in the background so as to make sure that when the occupant climate control system is re-activated it will be closer to the set temperature before the occupant climate control system was turned OFF.
- Default mode for the air inlet is fresh air, which will mean to the vehicle owner that even though the blower fan is not operating, when driving Ram air will forced into the HVAC. Depending on the set temperature before turning the occupant climate control OFF the vehicle owner may feel either too Hot or too Cold. If this is the case we suggest that they manually select Recirculation mode, this will prevent the Ram air from entering the HVAC

Automatic and Semi Automatic Mode - DZ and TZ:

The occupant climate control system should be set to automatic mode as in this mode the occupant climate control system will automatically control the vehicles interior temperature to the selected set temperature by the vehicles owner. The vehicle owner has the option of selecting semi automatic mode to "over rule" a function used in automatic mode. They might not like the blower fan speed selected in automatic mode, so they have the option of adjusting the Blower fan speed by operating that function on the infotainment facia, This will then take the occupant climate control system into semi automatic mode. This means that the occupant climate control system is still monitoring all the sensor readings and making automatic changes to mode and temperature, but - it can no longer use the blower motor as part of it’s calculations for altering the system, as the vehicle owner now has control of that function. The occupant climate control will try and compensate for having no blower fan speed control by altering another component to aid in meeting the required set interior temperature

Points to Remember on DZ Occupant Climate Control (OCC) Systems:

The occupant climate control system will alter mode positions, blower fan speeds and temperature in either automatic or semi automatic mode. These modes are face and floor. The passenger cannot have an individual blower speed from the driver as there is only one (1) blower motor in the HVAC.

Solar Load

The solar load sensor is located in the defrost panel of the crash pad. The sensor body houses two solar sensors, one for the passenger side and one for the driver side of the vehicle interior. These sensors are positioned at an approximate angle of 40 degrees so the side windows are also covered for solar load changes. A twilight sensor for automatic headlamp function is also contained in the solar sensor body.

Side Window Defrost Air Bleed from the HVAC - DZ :

As a design intention there is a constant bleed of air to the side windows in face mode. This air bleed is used to keep the side windows clear of any fogging that may be caused by the vehicle owner's breath exhaling, especially at low ambient temperatures. There is also an air bleed to defrost in floor mode

Evaporator Temperature Control

As the A/C system uses a Denso variable stroke and "clutchless" compressor that utilises an ECVD (electronic control valve) operated via the HVAC Control Module to increase or decrease the crankcase pressure in the compressor, which then alters the compressor output (displacement). The evaporator temperature sensor has no bearing on the cycling of the compressor as there is no direct or indirect electrical connection to the compressor from the vehicles wiring harness, as no clutch exists on the compressor. The compressor is operating constantly when the engine is operating, only the compressor output is adjusted. The evaporator temperature sensor is located in the lower section of the HVAC in the air intake stream after the evaporator and is used for sensing the incoming air temperature after the evaporator into the HVAC, to be used as part of the output calculation by the evaporator temperature sensor values are also required to operate the ECVD (electronic control valve) of the compressor to alter the stroke (displacement / output) for the A/C system.

Blower Fan Control:

- Automatic Mode - There are stepless and varying Blower fan speeds available. These are selected by the dependant on the input signals.
- Semi Automatic Mode - There are twenty (20) blower fan speeds available for selection by the vehicle owner.

  The blower fan speeds are will vary according to:
- Vehicle road speed - When the vehicle is travelling down the highway, the ram air effect into the HVAC, in fresh air mode will increase the air force coming from the vents, so will decrease the blower fan speed to compensate for this ram air.
- In car temperature sensor.
- Ambient air temperature sensor.
- Solar load sensor - If the cabin temperature is at or near the set temperature, the blower fan will be at the minimum. An increase in sun load will cause the blower fan speed to increase. Example: Ambient temperature 30 degree, high sun load, the blower fan will be on maximum to provide more cooling. If the vehicle enters a tunnel, all of a sudden the sun load has dramatically reduced, causing the vehicle owner to feel colder, The blower fan speed is reduced until the vehicle emerges from the tunnel.

- Drivers set temperature.
- Coolant temperature.
- Air distribution mode i.e.. Fresh or Recirculation mode.
- Ignition voltage.

Air Distribution Control

There are six distribution air modes that can be selected, either automatically or Semi Automatically. These are:

- Defrost.
- Blend (Floor and Defrost).
- Bi-Level (Floor and Face).
- Face.
- Floor.
- Centre console rear outlet.

When in Automatic mode and a set temperature above 25°C, only Floor and Defrost will be selected. If the set temperature is below 25°C, Face will be selected. If the vehicle interior temperature is at the desired temperature, the occupant climate control will select either Bi-Level (floor/face) or Face only, dependant on if the cabin temperature is required to warm up or cooled down. If cooling of the cabin is required, Floor mode may be selected for a short time (A/C purge), followed by Face mode. If heating of the cabin is required, Defrost mode will be selected until the engine coolant temperature is warm enough, this is called Defrost delay, then followed by Blend (floor/defrost). Then as the in car temperature increases, the mode should change to Bi-Level (floor/face). If heating is required and the coolant temperature is warm, Floor mode may be selected for a short time (Purge), followed by Bi-Level (floor/face) or Blend (floor/defrost), depending on conditions.

Air Inlet Control:

When Recirculation mode is selected either automatically or manually, the occupant climate control will return the air inlet to Fresh air mode after approximately 30 minutes, briefly and then will return to recirculation mode, this is to avoid a Carbon Dioxide build up in the cabin through exhaling by the vehicle occupants, which will cause drowsiness.

Automatic Mode:

The air inlet mode selected will vary according to:

- In car temperature.
- Ambient temperature.
- Solar load.
- Drivers set temperature.
- Start up conditions.
- Evaporator temperature.
- A/C High pressure.
- Engine coolant temperature.

If the vehicle cabin does not require cooling, fresh air will be selected. If extreme cooling of the vehicle cabin is required, such as when the ambient temperature is high and the vehicle has been standing in direct sunlight for an extended period, fresh may be selected for a short time (fresh delay), then recirculation mode until the vehicle cabin has cooled down. The Fresh air the engine bay cooling temperature becomes very high, Recirculation may be selected to increase cooling of the Vehicle Radiator.

Vent Air Temperature Control

The vent temperatures will vary between approximately 5 degrees C (Maximum cooling) and 70 degrees C (maximum heating). The temperature coming from the vent positions may / will be higher or lower than what is selected by the vehicle owner as a set temperature.

Semi Automatic Mode

This mode is where the passenger can adjust their set temperature, independent of the driver side set temperature. To access this mode when the driver set temp is in "locked mode", meaning that when the driver alters the set temperature, it alters both sides. For "unlocking mode", the passenger simply adjusts their temperature and the set temperature then becomes independent from the driver side set temperature. If the occupant climate control was in automatic mode the AUTO button LED illuminated, it will then go to semi automatic mode AUTO button LED not illuminated.

Automatic Mode

When a set temperature of between 17degrees C and 30 degrees C is selected, the air temperature will be controlled automatically. The Vent temperature will vary according to:

- In car temperature.
- Ambient temperature.
- Solar load.
- Driver or Passenger side set temperature.

When the vehicle cabin is at the desired temperature, the average vent air temperature should be the same as the set temperature. If the vehicle cabin requires cooling, the occupant climate control will try to control the vent temperature to less than the set temperature. If the vehicle cabin requires heating, the occupant climate control will try to control the vent temperature to be more than the set temperature. The more cooling required, the higher the vent temperature. Generally, the Blower fan speed will be low (less than 50%) before the occupant climate control starts to control the temperature. (e.g. When extreme cooling is required, the blower fan will start at maximum and the air mix will start at minimum. As the vehicle cabin temperature cools downs, the blower speed will decrease gradually.

- Increasing the set temperature will increase the vent temperature (providing air mix is not at maximum).
- Decreasing the set temperature will decrease the vent temperature (providing air mix is not at minimum).
- As the In car temperature increases, the vent temperature will decrease.
- As the Solar load decreases, the vent temperature will increase.
- As the Solar load increases, the vent temperature will decrease.
- As the Ambient temperature increases, the vent temperature will decrease.

- As the Ambient temperature decreases, the vent temperature will increase.

Occupant Climate Control (OCC) Cold Start Routines.

There are Four cold start routines incorporated into the occupant climate control system logic to cater for various conditions on first "key on" in the morning, typically at low ambient temperatures.

Each routine has its own respective set of criteria to satisfy before the routine is executed:

- Recirculation Delay: Automatically defaults to recirculation mode to prevent further ingress of cold air into the vehicle cabin.
- Defrost Delay: To reduce cold air at the floor during warm-up and prevents the driver breath from "fogging up" the front windscreen.
- HVAC Purge: Allows engine coolant to heat up the heater core and avoid humidity to face and windscreen when the blower fan is activated.
- A/C Purge: To avoid hot air blowing on face when the blower fan is activated.
- Fresh Delay: Uses cooler outside air to purge hot air from the vehicle.

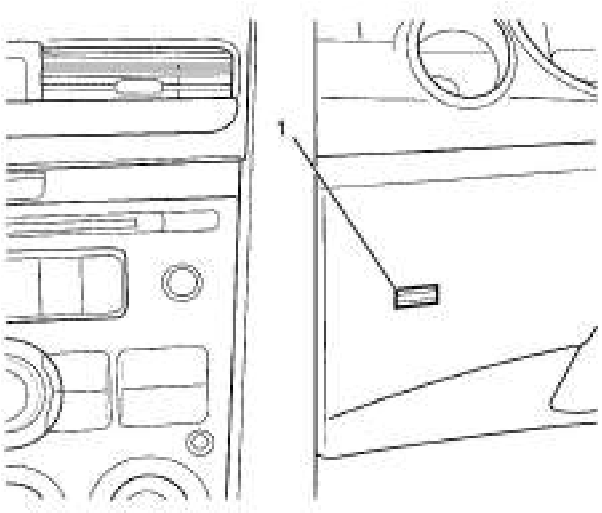
HVAC Unit Construction, Components and Associated Sensors

General Description

There is one type of Occupant Climate Control (OCC) HVAC module assemblies fitted across the VE Series Vehicle range:

Dual zone system-HVAC (OCC)

In-Car Temperature Sensor

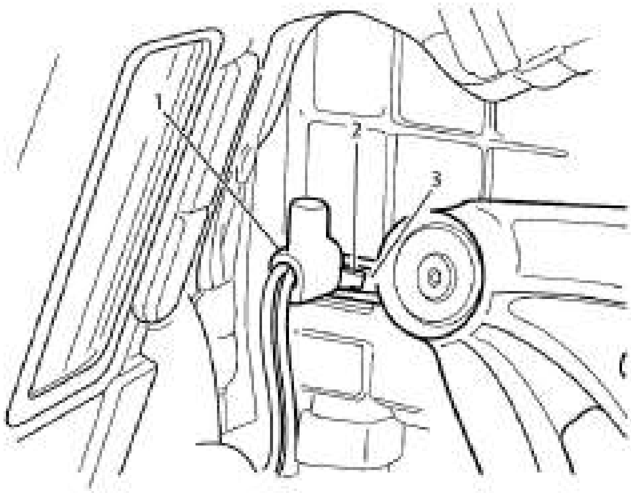


The in-car temperature sensor is an negative temperature coefficient (NTC) thermistor used to monitor the vehicles's interior temperature. Resistance signals are constantly monitored by the OCC module and are used for subsequent control of the OCC system.

It is essential that the venturi and aspirator tube assembly by properly connected to the in-car temperature sensor if the sensor is to provide correct information to the OCC module.

The in-car temperature sensor is located on the left-hand side of the steering column behind the sensor inlet air holes (1) on the instrument cluster trim assembly.

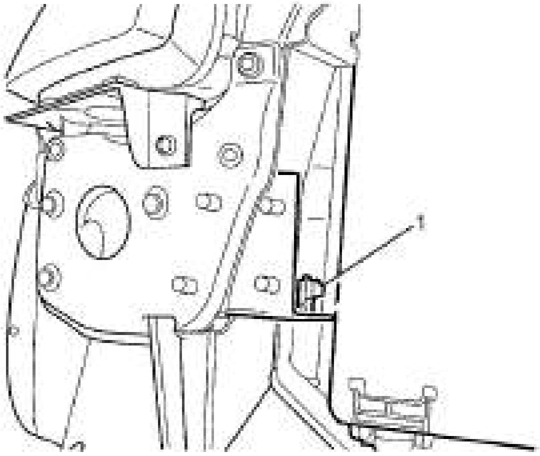
Evaporator Temperature Sensor



The evaporative temperature sensor is a negative temperature coefficient (NTC) thermistor used to monitor the temperature of the air into the HVAC module assembly after it has passed through the evaporator core. Resistance values are constantly monitored by the OCC module and are used for subsequent control of the OCC system.

The evaporative temperature sensor (1) is located on the HVAC case by a plastic retaining clip in the down stream air flow of the evaporator.

Ambient Temperature Sensor

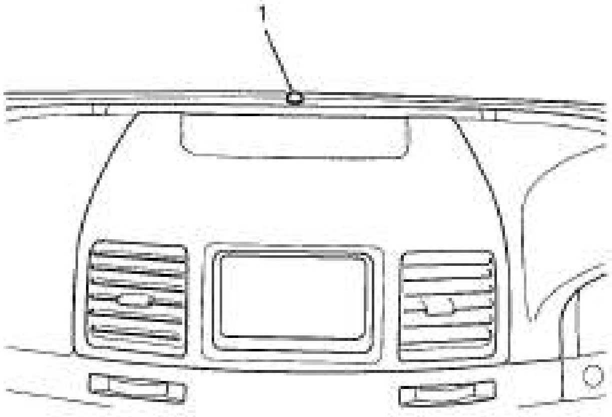


The ambient temperature sensor (1) is installed on a bracket (2) that is located at the front of the A/C condenser (3), on the lower right-hand side.

It is a negative temperature coefficient NTC thermistor used to monitor the ambient (outside) temperature. This sensor is slow reacting, due to the dense plastic housing surrounding it. The OCC takes into account road speed before updating the temperature display to avoid false readings in heavy traffic or extended idle conditions.

Resistance signals are sent directly from the ambient temperature sensor to the OCC module for interpretation.

Sun Load Sensor



The sun load sensor (1) is located in the centre of the defrost panel to monitor the sun's heating load upon the vehicle.

It is a photochemical type sensor, where a small electrical current will be generated, which depending on the sun load (strength) over it. When the sun's intensity is high, the OCC module will select a higher blower fan speed and increased vehicle cooling automatically. Likewise, when the sun load is low, such as going into an underground car park, the OCC module will automatically reduce the fan speeds and increase heating slightly.

Signals are sent from the sun load senor directly to the BCM, then to the OCC module via the serial data line input.

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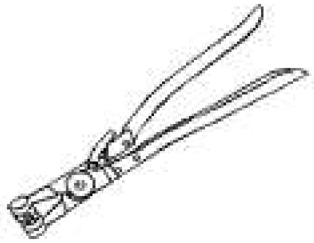
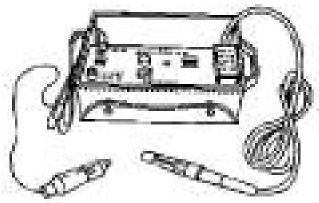
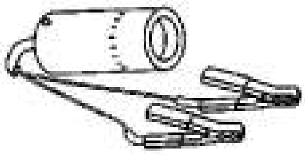
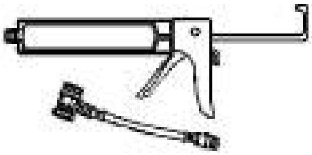
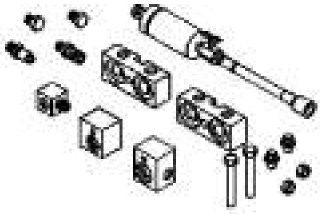
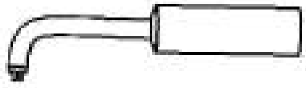
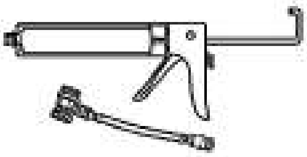
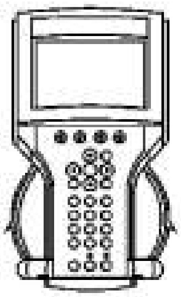
Special Tools

Illustration	Tool Number / Description
	J 38185 Hose Clamp Pliers
	J 39400-A Halogen Leak Detector
	J 42220 Universal 12V Leak Detection Lamp
	J 41447

	R-134a A/C Tracer Dye - Box of 24
	J 43600 ACR 2000 Air Conditioning Service Centre
	J 43872 Fluorescent Dye Cleaner
	J 45037 A/C Oil Injector

	J 45268 A/C Flushing Adapter Kit
	J 45689 A/C Quick Joint Tool
	J 46297 A/C Dye Injector Kit
	J 46297-12 Replacement Dye Cartridges

	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

Fastener Tightening Specifications

Application	Specification	Specification
	Metric	Imperial
Defrost Mode Actuator to HVAC Module Assembly Retaining Screws	1 N·m	9 lb in
Air Mix Actuator to HVAC Module Assembly Retaining Screws	1 N·m	9 lb in
Face/Floor Mode Actuator to HVAC Module Assembly Retaining Screws	1 N·m	9 lb in
HVAC Control Module to HVAC Module Assembly Retaining Screws	2 N·m	18 lb in
Recirculation Actuator to Air Inlet Assembly Retaining Screws	1 N·m	9 lb in

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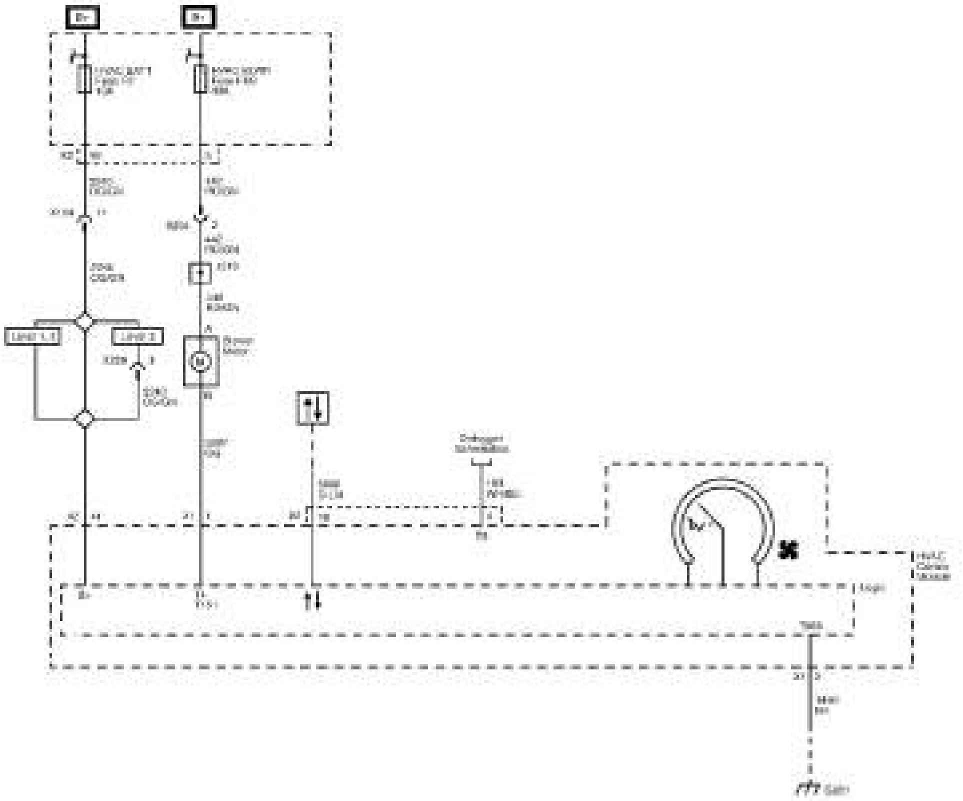
HVAC Module, Power, Ground, Serial Data, and Blower Controls


B+
B+
A
M
B
Blower Motor
Defogger Schematics
HVAC Control Module
Logic

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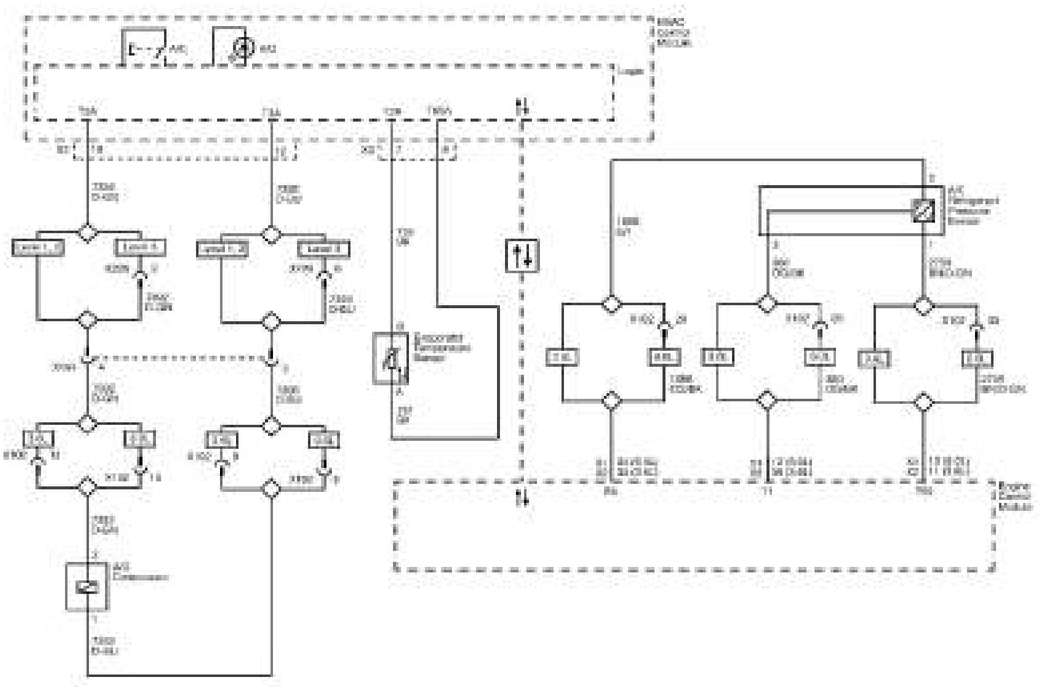
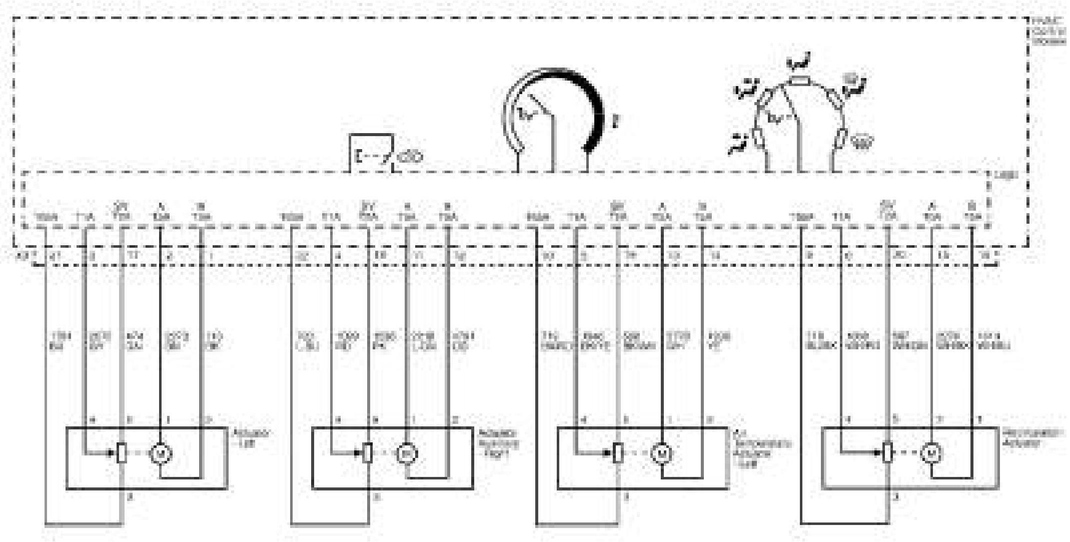
Compressor Controls

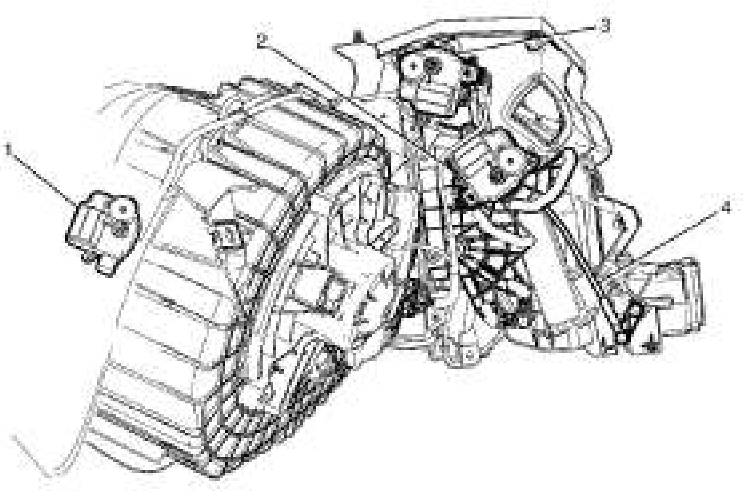

HVAC Control Module
Logic
A/C
A/C Compressor
Evaporator Temperature Sensor
A/C Refrigerant Pressure Sensor
Engine Control Module

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | HVAC | HVAC - Manual | Schematic and Routing Diagrams | Document ID: 2153994

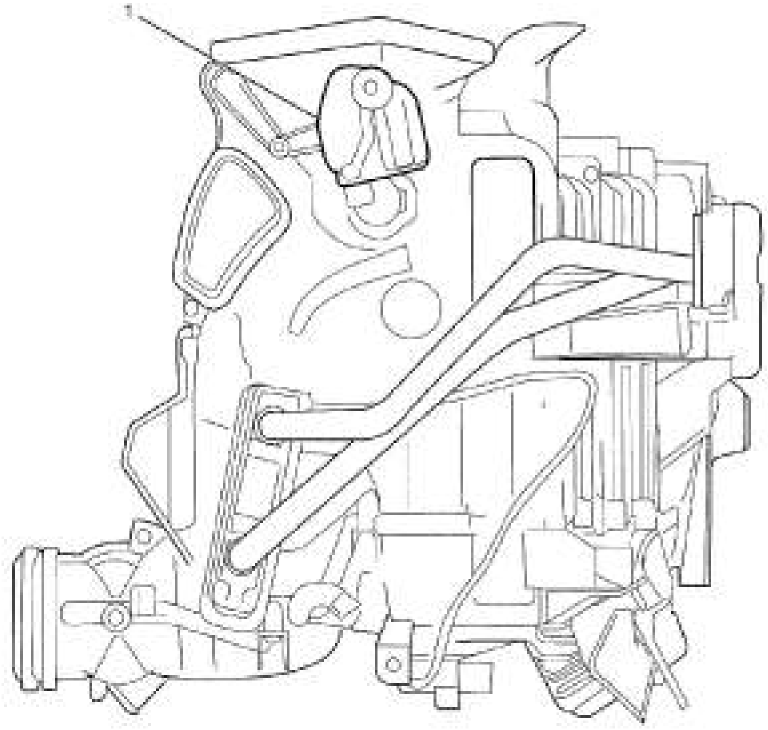
Air Delivery and Temperature Controls



HVAC Module Components



(1) Air Intake Fresh/Recirculation Mode Actuator
(2) Air Mix Temperature Passenger and Driver Side Mode Actuator
(3) Defrost Mode Actuator
(4) Rear Passenger Outlet Control Rod/Lever



(1) Face/Floor Mode Actuator

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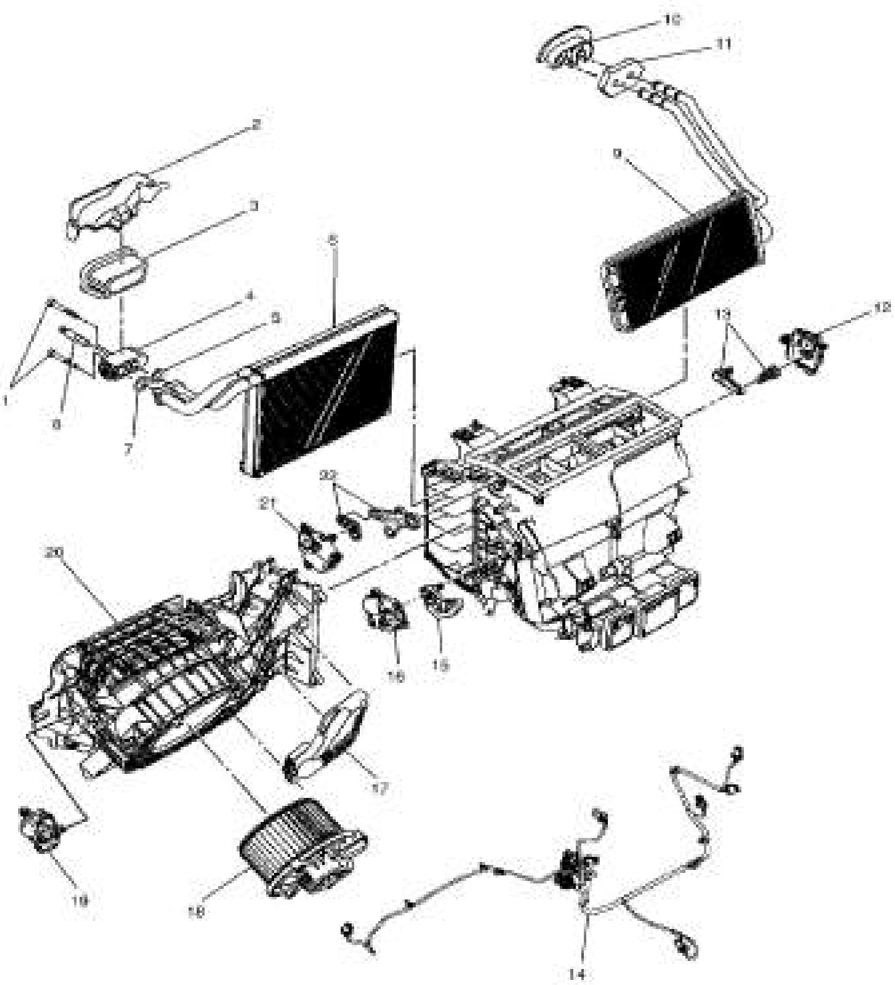

(1) TX Valve Retaining Screws
(2) TX Valve Upper Retaining Plastic Retaining Cover
(3) TX Valve Insulator
(4) TX Valve
(5) Sealing Washer
(6) Evaporator
(7) Sealing Washer
(8) TX Valve Pipe Pad Retaining Stud
(9) Pipe Core Pipe Locating Plate
(10) Heater Core
(11) Heater Pipe Pass Through Seal
(12) Face/Floor Actuator
(13) Actuator Levers

(14) Wiring Harness
(15) Actuator Levers
(16) Air Mix Actuator
(17) HVAC Control Module
(18) Blower Motor And Fan Assembly
(19) Recirculation Actuator
(20) Blower Motor Housing
(21) Defrost Actuator
(22) Defrost Linkage

Symptoms - HVAC Systems - Manual

Important: Review the system operation in order to familiarise yourself with the system functions. Refer to:

- Air Delivery Description and Operation.
- Air Temperature Description and Operation.

Visual/Physical Inspection

- Inspect for aftermarket devices which may affect the operation of the HVAC System. Refer to Checking Aftermarket Accessories.
- Inspect the easily accessible or visible system components for obvious damage or conditions which may cause the symptom.
- Verify the A/C compressor turns freely and is not seized.
- The A/C compressor will not operate in cold outside air temperatures. Refer to Air Temperature Description and Operation.
- The following conditions may cause window fogging:
  - Wet carpet or mats
  - High humidity
  - Interior water leak
  - Blocked A/C evaporator drain tube
  - Maximum passenger capacity
  - Blocked body pressure relief valves
- Inspect the air distribution system for causes of reduced air flow:

  Blocked or damaged air inlet or outlet vents

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Blower Motor Malfunction.
- Heating Performance Diagnostic.

Blower Motor Always On

If the blower motor is always on one of the following DTC's should set. Refer to DTC diagnosis first.

Causes	Actions
Can bus message fault	**DTC test U0073, U0020, U0140, U0155, U0184 AND U0249**
HCM Issue	DTC test B0193

Blower Motor Inoperative

Step	Action	Yes	No
Schematic Reference: HVAC Schematics . *Connector End View Reference:* Component Connector End Views . DEFINITION: The blower motor is inoperative in all speed positions.			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to Diagnostic System Check - Vehicle .
2	1. Turn ON the ignition, with the engine OFF. 2. Place the blower motor switch in each speed position. Does the blower motor operate in any speed position?	Go to Blower Motor Malfunction .	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the blower motor. 3. Connect a test lamp between the blower motor supply voltage circuit and the blower motor control circuit. 4. Turn ON the ignition, with the engine OFF. 5. Place the blower motor switch in each speed position. Does the test lamp illuminate in any speed position?	Go to Step 10	Go to Step 4
4	Test the blower motor supply voltage circuit for an open or high resistance. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	Go to Step 16	Go to Step 5
5	Test the blower motor control circuit for an open or high resistance between the blower motor and X124. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	Go to Step 16	Go to Step 6
6	1. Turn OFF the ignition. 2. Connect the blower motor. 3. HVAC control module. 4. Turn ON the ignition, with the engine OFF. 5. Place the blower motor switch in each speed position. Does the blower motor operate in any speed position?	Go to Step 11	Go to Step 7

7	Check for any serial data codes or faults Did you find a fault?	Go to Step 8	Go to Step 9
8	Test GMLAN wiring. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	Go to Step 16	Go to Step 9
9	**Important:** The blower motor switch is part of the infotainment unit facia and communicates via GMLAN Test the blower motor switch control circuit for an open or high resistance. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	Go to Step 16	Go to Step 12
10	Inspect for poor connections at the blower motor. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	Go to Step 16	Go to Step 13
11	Inspect for poor connections at the HVAC control module. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	Go to Step 16	Go to Step 14
12	**Important:** The blower motor switch is part of the infotainment unit facia and communicates via GMLAN Inspect for poor connections at the infotainment unit facia . Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	Go to Step 16	Go to Step 15
13	Replace the blower motor. Refer to Blower Motor Replacement . Did you complete the replacement?	Go to Step 16	--
14	Replace the HVAC control module. Refer to HVAC Control Module Replacement . Did you complete the replacement?	Go to Step 16	--
15	Replace the blower switch. Refer to Radio Replacement . Did you complete the replacement?	Go to Step 16	--
	Operate the system in order to verify the repair.		

16	Did you correct the condition?	System OK	Go to Step 2

Blower Motor Malfunction

Step	Action	Yes	No
Schematic Reference: HVAC Schematics . *Connector End View Reference:* Component Connector End Views . DEFINITION: The blower motor operates in at least one, but not all, speed positions.			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to Diagnostic System Check - Vehicle .
2	1. Turn ON the ignition, with the engine OFF. 2. Place the blower motor switch in each speed position. Are any blower speeds available?	Go to Step 4	Go to Step 3
3	Check for blown blower motor fuse 9 Was the fuse blown?	Replace the fuse with the correct amperage fuse.	Go to Step 4
4	Check for power at the blower motor. Circuit Testing and Wiring Repairs . Is voltage available, but the blower motor will not operate?	Replace the blower motor. Refer to Blower Motor Replacement .	Go to Step 5
5	1. Operate all the blower speeds, one at a time at the IRC blower control. 2. There should be 20 blower speeds available. Are all blower speeds available?	Go to Step 9	Go to Step 6
6	1. Back probe the 2 pin connector at the blower motor. 2. Activate the 20 blower fan speeds one at a time starting from the lowest, using the IRC blower control. 3. Compare the voltages to the graph. Refer to Sensor Resistance Table . Were the voltages approximate to the graph?	Go to Step 9	Go to Step 7
	Connect scan tool.		

7	Go to miscellaneous test, switch data. Select all 20 blower fan speeds using the scan tool increase / decrease soft keys Were all speeds available?	Carry out IRC test for blower switch function.	Go to Step 8
8	Replace the HVAC control module. Refer to HVAC Control Module Replacement . Did you find and correct the condition?	Go to Step 9	--
9	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 2

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Too Hot in Vehicle

Test Description

The numbers below refer to the step numbers on the diagnostic table.

5. The ambient air temperature must be above 3°C (38°F) for this A/C compressor test.

6. The specified values are from the A/C System Performance Test.

Step	Action	Values	Yes	No
Schematic Reference: HVAC Schematics. *Connector End View Reference:* Component Connector End Views. DEFINITION: The temperature cannot be adjusted, or cooling is insufficient during A/C operation.				
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle.
2	**Important:** All DTCs that are set must be diagnosed first unless you were sent to this diagnostic from a specific DTC diagnostic. 1. Turn ON the ignition, with the engine OFF. 2. Place the blower motor switch in each speed position. Does the blower motor operate in any speed position?	--	Go to Step 3	Go to Blower Motor Inoperative.
3	Does the blower motor operate at the desired speeds?	--	Go to Step 4	Go to Blower Motor Malfunction.
4	1. Start the engine. 2. Place the mode switch in the face position. 3. Place the recirculation switch in the ON position. 4. Observe the recirculation door. 5. Place the recirculation switch in the OFF position. Does the recirculation door move from the recirculation position to the outside air position?	--	Go to Step 5	Go to Symptoms - HVAC Systems - Manual
	Important: The ambient air temperature must be above 3°C (38°F).			

5	1. Start the engine. 2. With scan tool, clear any DTCs that are stored in the HVAC control module. 3. Place the air temperature switch in the coldest position. 4. Place the mode switch in the bi-level position. 5. Place the blower motor on high speed. Does the A/C compressor operate?	--	Go to Step 6	Go to Air Conditioning Compressor Replacement
6	Perform the A/C system performance test. Refer to Air Conditioning (A/C) System Performance Test. Did you find and correct the condition?	--	Go to Step 8	Go to Step 1
7	Replace the HVAC control module. Refer to Control Module References. Did you complete the replacement?	--	Go to Step 8	--
8	Operate the system in order to verify the repair. Did you correct the condition?	--	System OK	Go to Step 2

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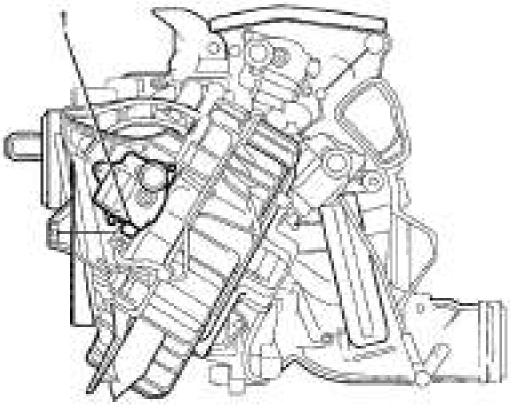
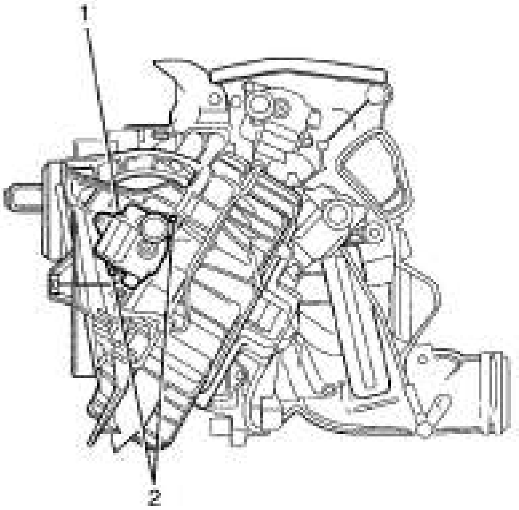
Air Inlet Valve Actuator Replacement (RHD)

Removal Procedure

1. Remove the I/P lower trim plate assembly. Refer to Instrument Panel Insulator Panel Replacement - Left Side.
2. Remove the I/P compartment assembly. Refer to Instrument Panel Compartment Replacement.



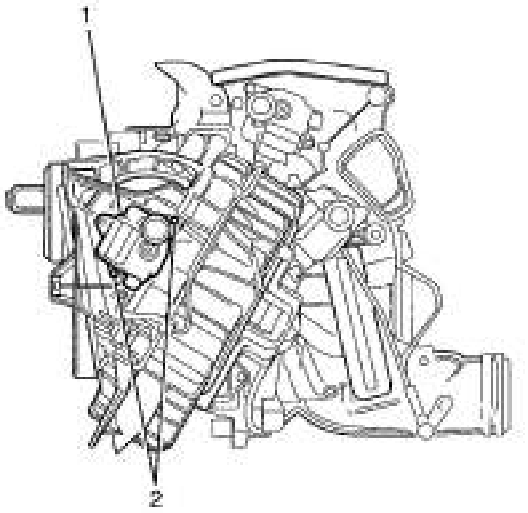
3. Disconnect the recirculation actuator electrical connector (1).



4. Remove the recirculation actuator to HVAC module assembly retaining screws (2).

5. Remove the recirculation actuator (1) from the HVAC module assembly (3).
6. Inspect air intake door shaft end for damage, also check the air intake door for full movement, open/close. If damage is evident, replace the air intake housing. Refer to Air Inlet Assembly Replacement.

Installation Procedure

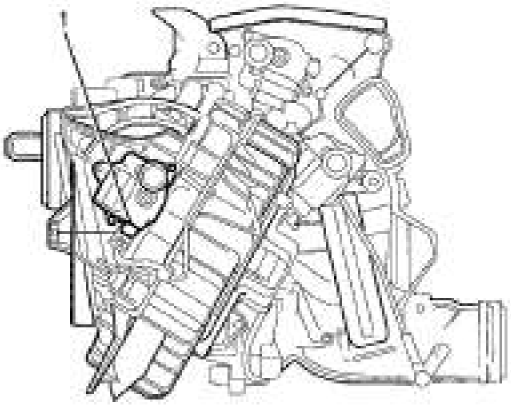


1. Install the air intake recirculation actuator (1) to the HVAC module assembly (3).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the recirculation actuator (1) to HVAC module assembly retaining screws (2).

   Tighten
   Tighten the screws to 1.2 N·m (9 lb ft).



3. Connect the recirculation actuator electrical connector (1).
4. Install the I/P lower trim plate assembly. Refer to Instrument Panel Insulator Panel Replacement - Left Side.
5. Install the I/P compartment assembly. Refer to Instrument Panel Compartment Replacement.
6. Perform HVAC system relearn. Refer to HVAC Control Module Programming and Setup.

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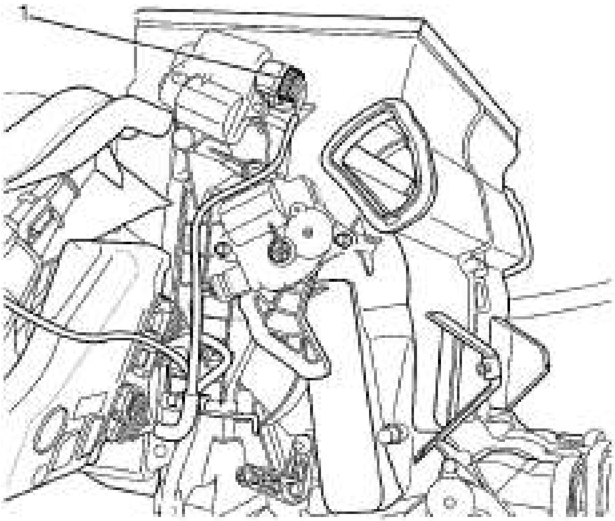
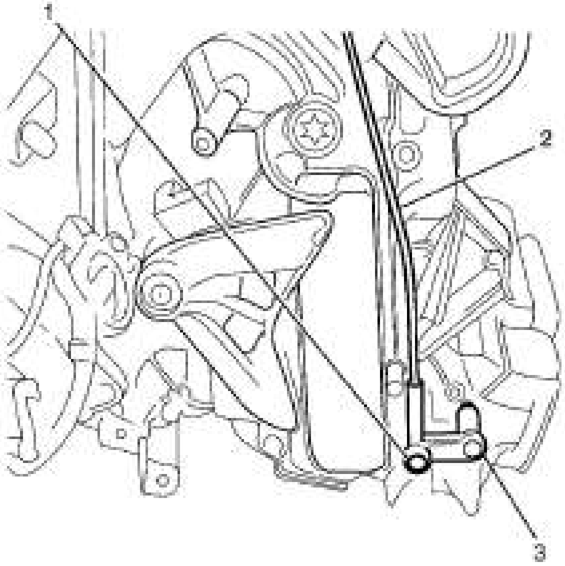
Defroster Valve Actuator Replacement (RHD)

Removal Procedure

1. Remove the I/P lower trim plate assembly. Refer to Instrument Panel Insulator Panel Replacement - Left Side .
2. Remove the instrument panel outer trim cover. Refer to Instrument Panel Outer Trim Cover Replacement .
3. Remove the I/P compartment assembly. Refer to Instrument Panel Compartment Replacement .
4. Remove the left side floor duct. Refer to Floor Air Outlet Duct Replacement - Left Side .

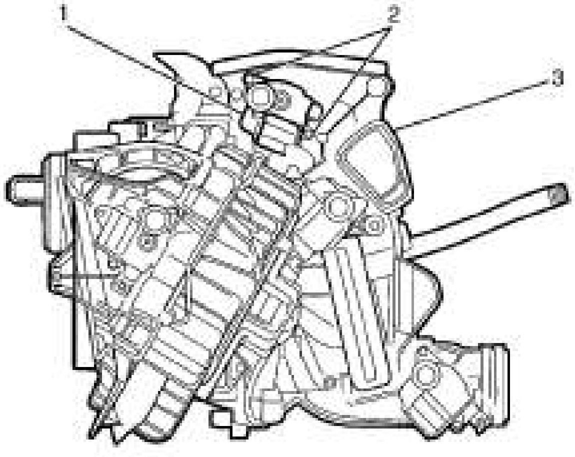


5. Disconnect the defrost mode actuator electrical connector (1).

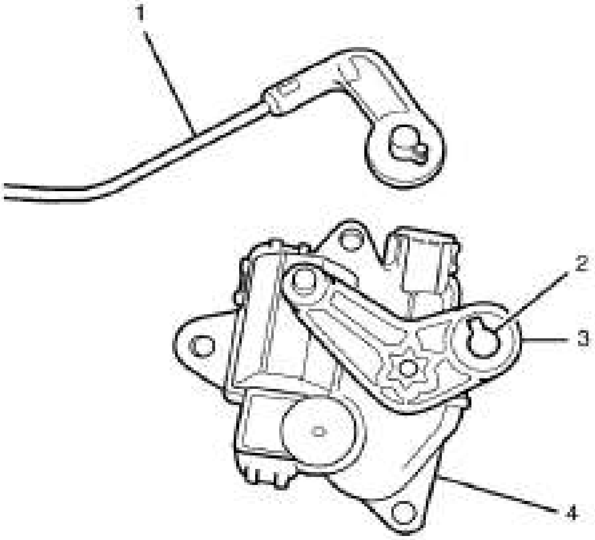


Important: Using a suitable tool, squeeze the rear passenger mode rod to rear passenger mode door lever retaining clip (1) to detach the rear passenger mode rod (2) from the rear passenger mode door lever (3).

6. Detach the rear passenger mode rod (2) from the mode door lever (3).



7. Remove the defrost mode actuator to HVAC module assembly retaining screws (2).
8. Remove the defrost mode actuator and the rear passenger mode lever (1) from the HVAC module assembly (3).



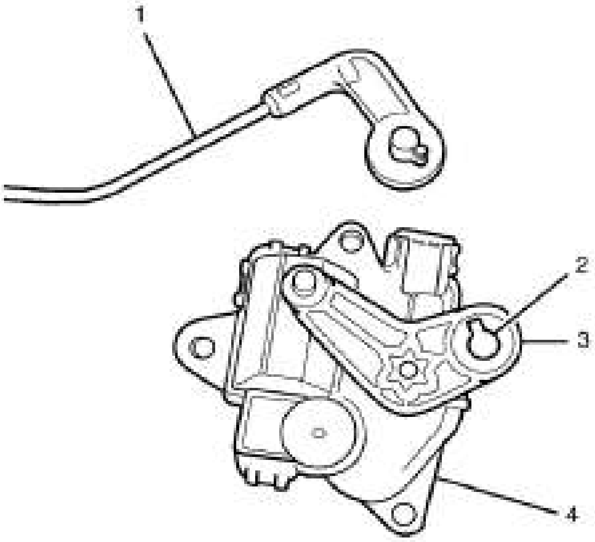
Important: Rotate the rear passenger mode rod (1) to match the actuator lever locking position opening (2), then remove rear passenger mode rod (1).

9. Detach the rear passenger mode rod (1) from the defrost mode actuator (4).

   Important: Take note of the rear passenger mode lever (3) position in relation to the defrost mode actuator (4).

10. Gently remove the rear passenger mode lever (3) from the defrost mode actuator (4).

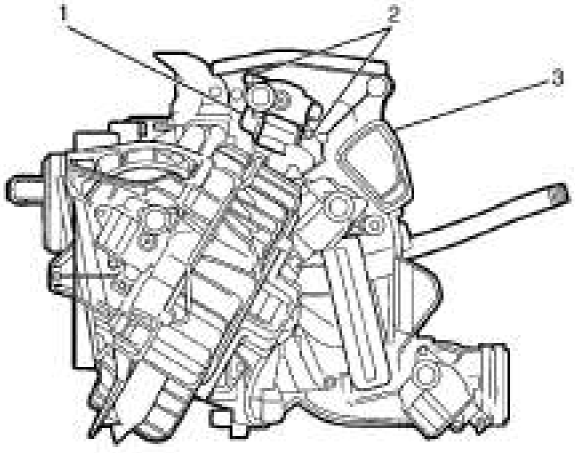
Installation Procedure



1. Install the rear passenger mode lever (3) to the defrost mode actuator (4).

   Important: Rotate the rear passenger mode rod (1) to match the actuator lever locking position opening (2), to install the rear passenger mode rod (1).

2. Attach the rear passenger mode rod (1) to the actuator (4).

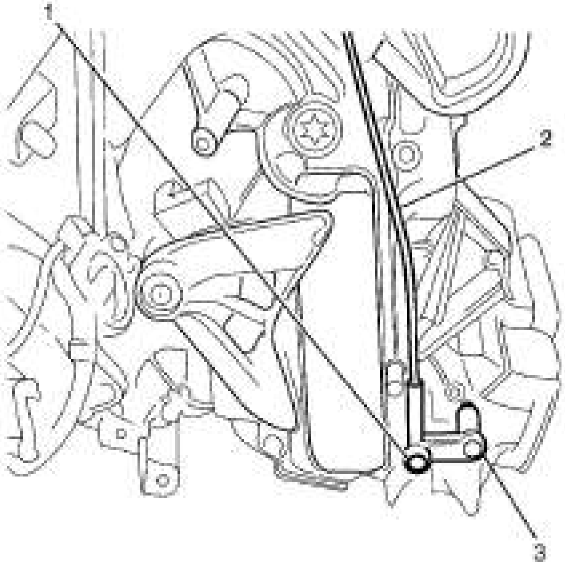


3. Install the and the rear passenger mode lever (1) to the HVAC module assembly (3).

   Notice: Refer to Fastener Notice in the Preface section.

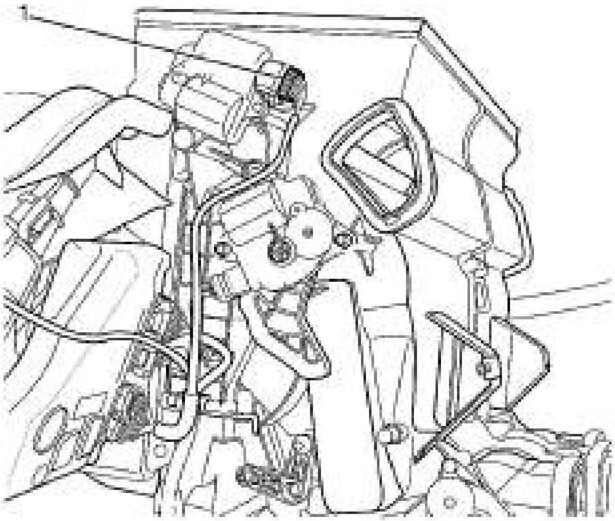
4. Install the defrost mode actuator to HVAC module assembly retaining screws (2).

   Tighten
   Tighten the screws to 1 N·m (9 lb in).



Important: Make sure the rear passenger mode rod to rear passenger mode door lever retaining clip (1) is correctly engaged to prevent the rear passenger mode door lever (3) from functioning incorrectly.

5. Attach the rear passenger mode rod (2) to the mode door lever (3).

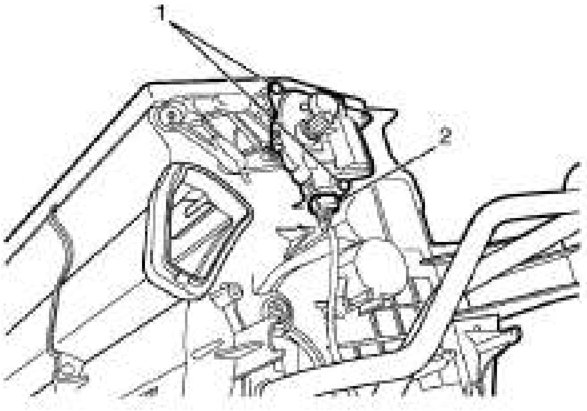


6. Connect the defrost mode actuator electrical connector (1).
7. Install left side floor duct. Refer to Floor Air Outlet Duct Replacement - Left Side .
8. Install the I/P compartment assembly. Refer to Instrument Panel Compartment Replacement .
9. Install instrument panel outer trim cover. Refer to Instrument Panel Outer Trim Cover Replacement .
10. Install the I/P lower trim plate assembly. Refer to Instrument Panel Insulator Panel Replacement - Left Side .
11. Perform HVAC system relearn. Refer to HVAC Control Module Programming and Setup .

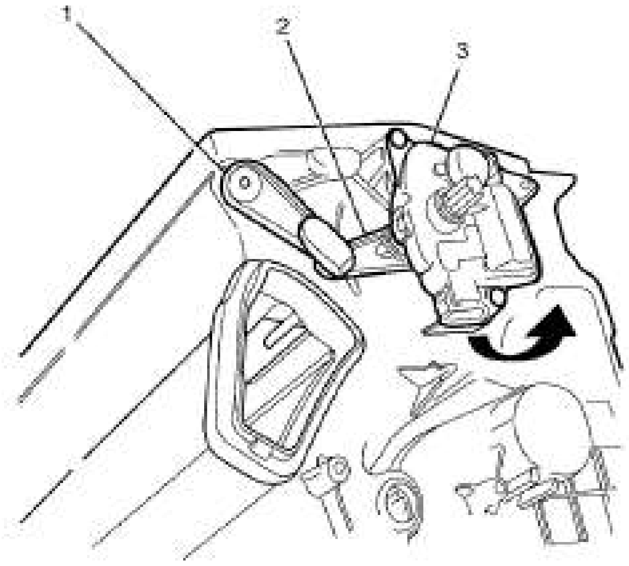
Floor Air Valve Actuator Replacement

Removal Procedure

1. Remove the right side console lower extension. Refer to Instrument Panel Extension Replacement.
2. Remove the instrument panel lower right trim plate assembly. Refer to Instrument Panel Insulator Panel Replacement - Right Side.
3. Remove right side floor duct. Refer to Floor Air Outlet Duct Replacement - Right Side.

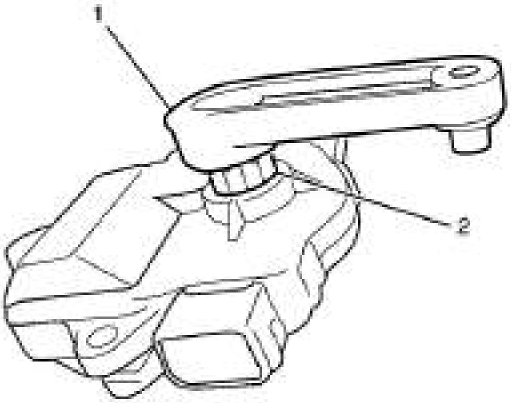


4. Disconnect the face/floor actuator electrical connector (2).
5. Remove the face/floor actuator to HVAC module assembly retaining screws (1).



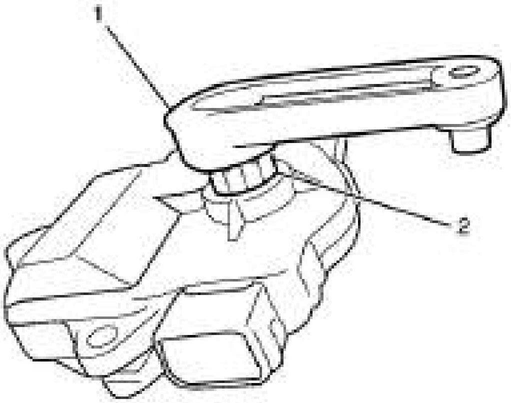
Important: Pivot the face/floor mode actuator (3) upwards and remove the face/floor mode actuator lever (2) from the face door mode lever (1).

6. Remove the face/floor mode actuator lever (2) from the face door mode lever (1).

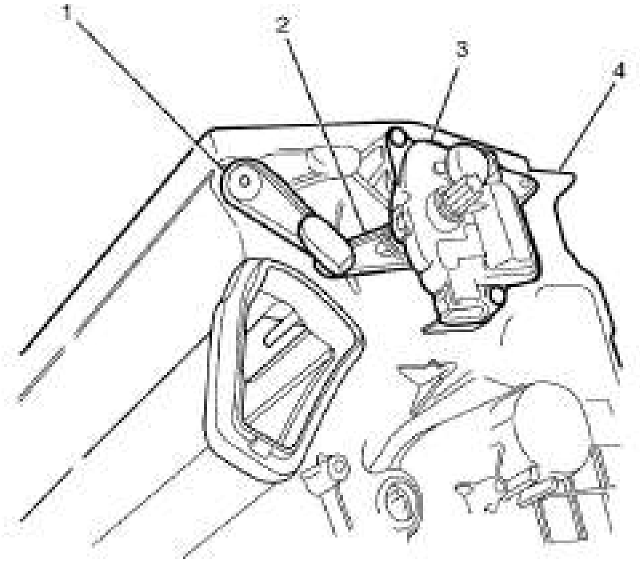


7. Record where the face/floor mode actuator lever (1) is located onto the face/floor actuator drive spline (2) for installation.

Installation Procedure

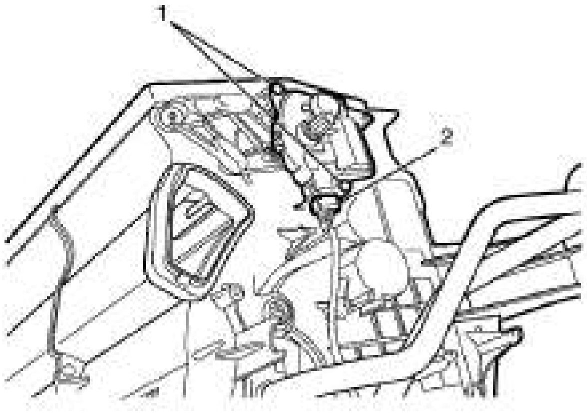


1. Detach and move the face/floor mode actuator lever (1) to the recorded position on the face/floor actuator drive spline (2) as required.



2. Install the actuator lever (2) to the face door mode lever (1) and pivot the face/floor mode actuator (3) into position on the HVAC module assembly (4).

   Notice: Refer to Fastener Notice in the Preface section.



3. Install the face/floor mode actuator to HVAC module assembly retaining screws (1).

Tighten
Tighten the bolts to 1.2 N·m (9 lb ft).

4. Connect the face/floor mode actuator electrical connector (2).
5. Install the instrument panel lower right trim plate assembly. Refer to Instrument Panel Insulator Panel Replacement - Right Side.
6. Install right side floor duct. Refer to Floor Air Outlet Duct Replacement - Right Side.
7. Perform HVAC system relearn. Refer to HVAC Control Module Programming and Setup.

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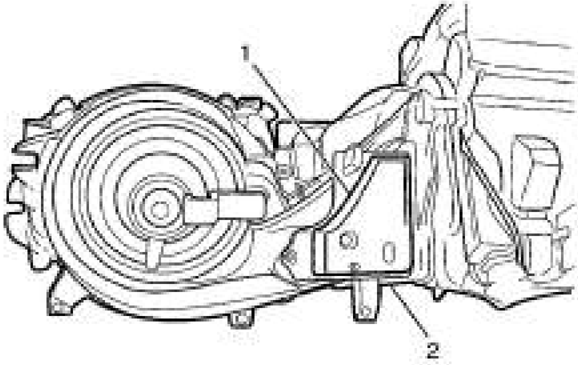
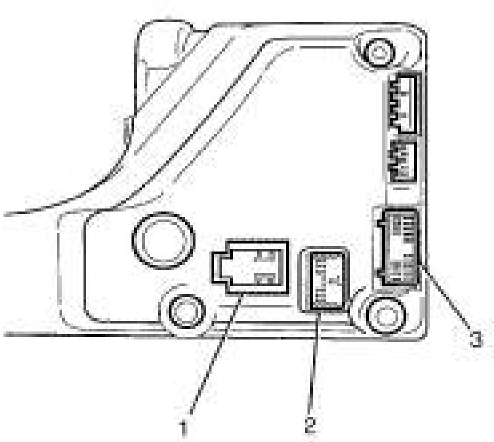
HVAC Control Module Replacement (RHD)

Removal Procedure

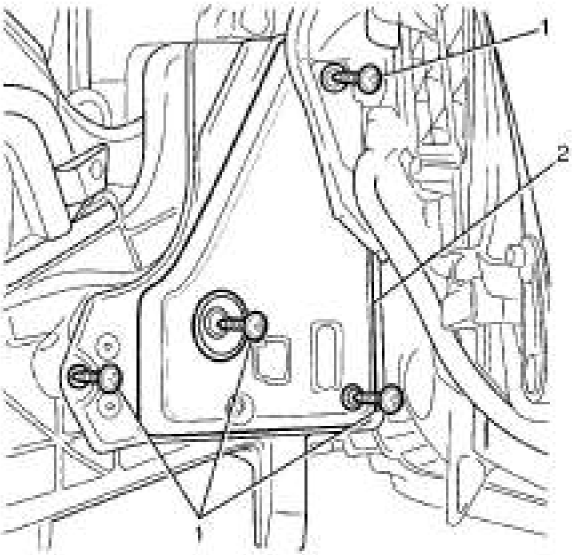
1. Remove the glove box assembly. Refer to Instrument Panel Compartment Replacement .
2. Remove left side floor duct. Refer to Floor Air Outlet Duct Replacement - Left Side .



3. Locate the HVAC control module (1) on the left side of the HVAC module assembly (2).



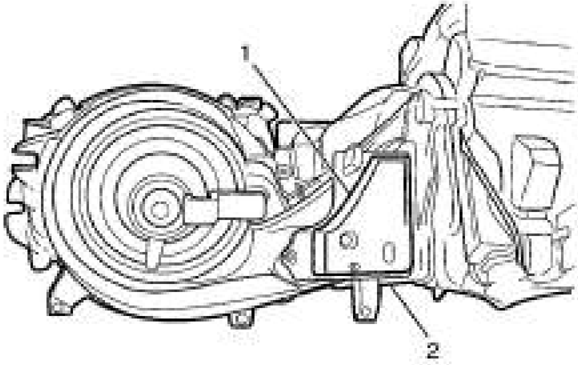
4. Disconnect the HVAC control module electrical connectors (1 - 3).



Important: Make sure the HVAC control module electrical connectors are disconnected before removing the HVAC control module to HVAC module assembly retaining screws (1). The HVAC control module to HVAC module assembly retaining screws (1) contact the HVAC control module (2) circuit board and can short on removal.

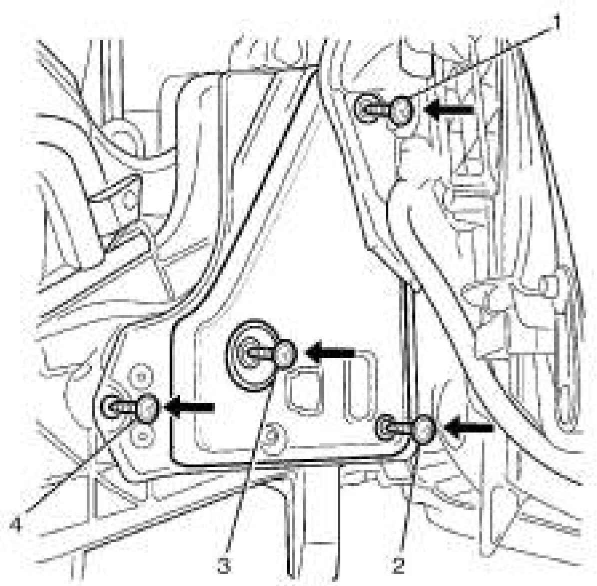
5. Remove the HVAC control module to HVAC module assembly retaining screws (1).
6. Remove HVAC control module (2).

Installation Procedure



1. Install the HVAC control module (1) to the HVAC module assembly (2).

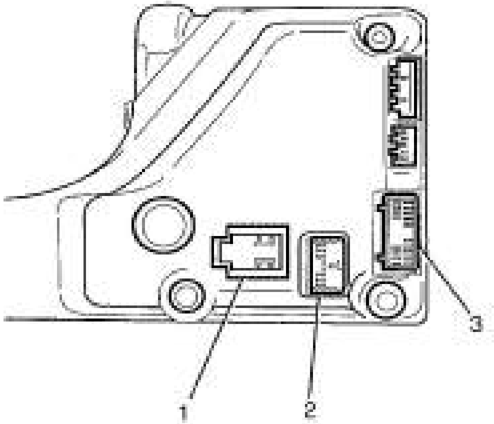
Notice: Refer to Fastener Notice in the Preface section.



Important: The HVAC control module to HVAC module assembly retaining screws (1 - 4) should be tightened in the sequence shown to prevent damage to HVAC control module circuit board.

2. Install the HVAC control module to HVAC module assembly retaining screws (1 - 4).

Tighten
Tighten the screws to 2 N·m (18 lb in).

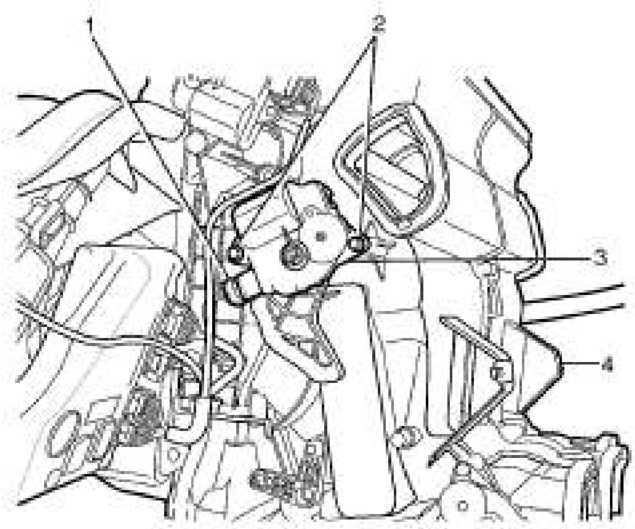


3. Connect the electrical connectors (1 - 3) to the HVAC control module.
4. Install left side floor duct. Refer to Floor Air Outlet Duct Replacement - Left Side .
5. Install the glove box assembly. Refer to Instrument Panel Compartment Replacement .
6. If re-programming is required. Refer to Control Module References .
7. Perform HVAC system relearn. Refer to HVAC Control Module Programming and Setup .

Mode Valve Actuator Replacement - Left Side (SWB RHD)

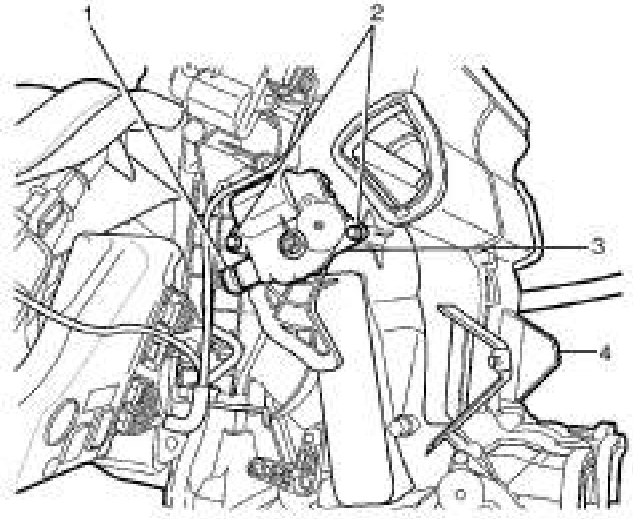
Remove Procedure

1. Remove the I/P lower trim plate assembly. Refer to Instrument Panel Insulator Panel Replacement - Left Side.
2. Remove the instrument panel outer trim cover. Refer to Instrument Panel Outer Trim Cover Replacement in Instrument Panel, Gages, and Console.
3. Remove the I/P compartment assembly. Refer to Instrument Panel Compartment Replacement.
4. Remove the left side floor duct. Refer to Floor Air Outlet Duct Replacement - Left Side.



5. Disconnect the air mix actuator electrical connector (1).
6. Remove the air mix actuator to HVAC module assembly retaining screws (2).
7. Remove the air mix actuator (3) from the HVAC module assembly (4).

Installation Procedure



1. Install the air mix actuator (3) to the HVAC module assembly (4).

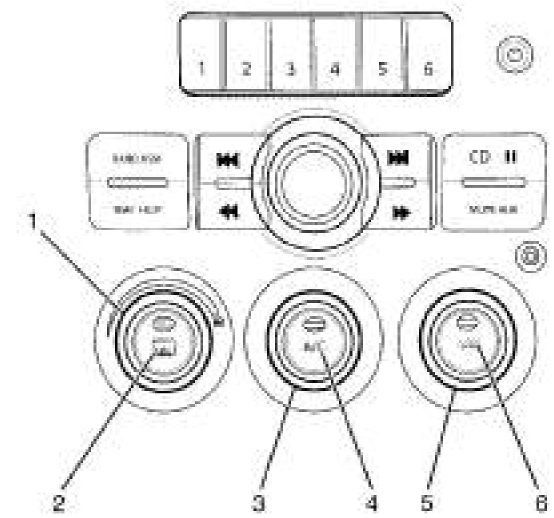
   Notice: Refer to Fastener Notice in the Preface section.

2. Install the air mix actuator to HVAC module assembly screws (2).

   Tighten
   Tighten the screws to 1.5 N·m (13 lb ft).

3. Connect the air mix actuator electrical connector (1).
4. Install left side floor duct. Refer to Floor Air Outlet Duct Replacement - Left Side.
5. Install the I/P compartment assembly. Refer to Instrument Panel Compartment Replacement.
6. Install instrument panel outer trim cover. Refer to Instrument Panel Outer Trim Cover Replacement in Instrument Panel, Gages, and Console.
7. Install the I/P lower trim plate assembly. Refer to Instrument Panel Insulator Panel Replacement - Left Side.
8. Perform HVAC system relearn. Refer to HVAC Control Module Programming and Setup.

Air Delivery Description and Operation



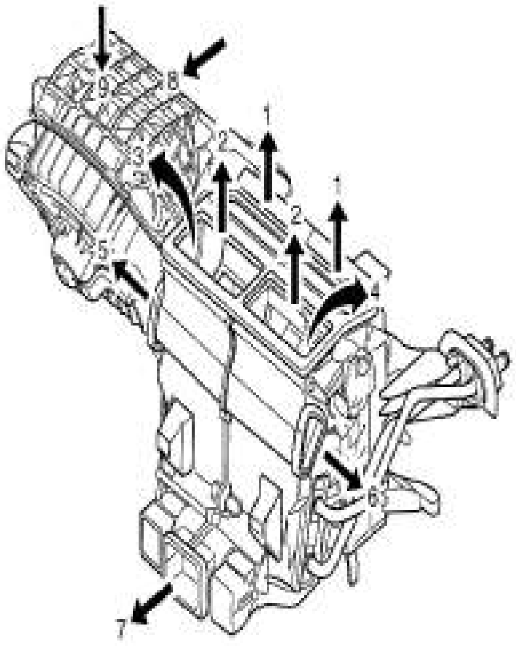
1. Blower motor speeds - There are 20 speeds available. The outer button ring (1) is used to alter speeds, clockwise speed increases, anti-clockwise speed decreases.
2. Heated rear window (HRW) button (2)- Activates the rear window defrosting. When activated, the LED is illuminated. When deactivated, the LED is not illuminated. The HRW has a timer to automatically deactivate the HRW.
3. Temperature control - Temperature adjustment from cold to hot via the outer ring of the control (3). Anti-clockwise cold, clockwise hot.
4. A/C button (4)- Push the button and the A/C is ON and the LED is illuminated. When the LED is not illuminated, the A/C is OFF. The A/C can be engaged in all mode positions.

   Important: It is possible for the A/C to disengage while the LED is on in the following conditions, wide open throttle or a A/C system over pressure situation.

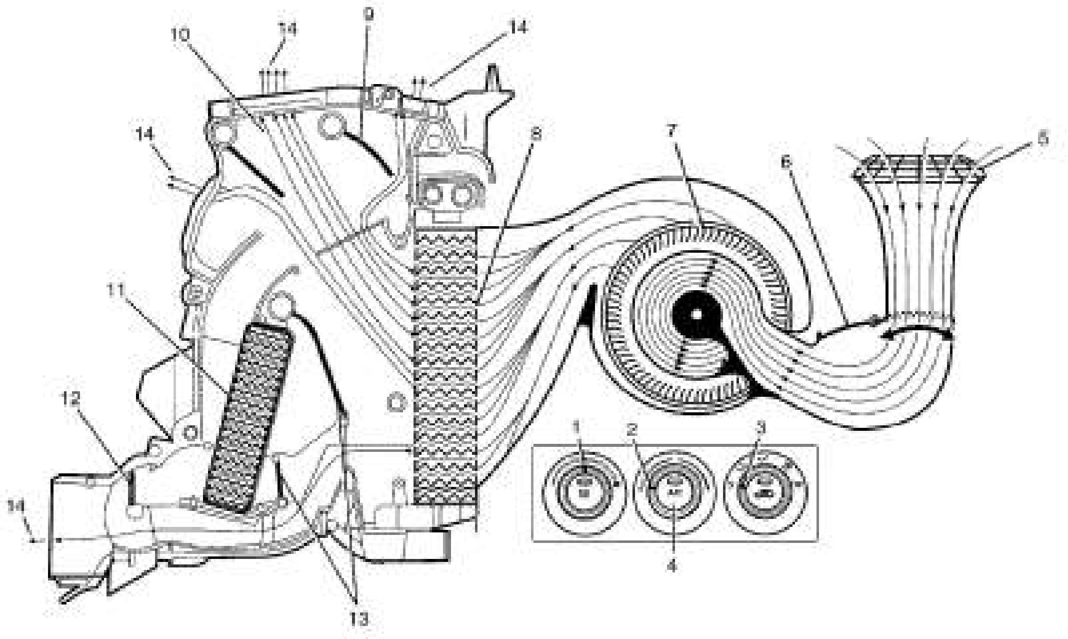
5. Mode outlet positions - Five mode outlet positions are available, via the outer ring (5) of the control. These are: Face, Bi-level (face/foot), Foot (floor), Blend (defrost/foot), Defrost. In the defrost mode, the A/C is automatically engaged, LED illuminated
6. Air intake mode to HVAC - Recirculation mode can be selected by pushing the button (6), the LED will illuminate. In recirculation mode, the air entering the HVAC will come from the vehicle interior and no fresh air will enter. Recirculation mode can be activated in: Face, Bi-level, and Foot outlet modes. If moving the control from Foot to Blend mode, the recirculation will be deactivate (LED Off), but it can be reactivated by pushing the recirculation button (LED On). Recirculation mode can not be selected in Defrost mode.

   Important: Recirculation reuses interior air and is therefore not recommended for long periods owing to a build up of carbon dioxide from occupants exhaling. If recirculation mode is used for an extended period of time about 30 minutes, the system will automatically select fresh air mode to let some fresh air into the cabin for ventilation then return to recirculation mode.

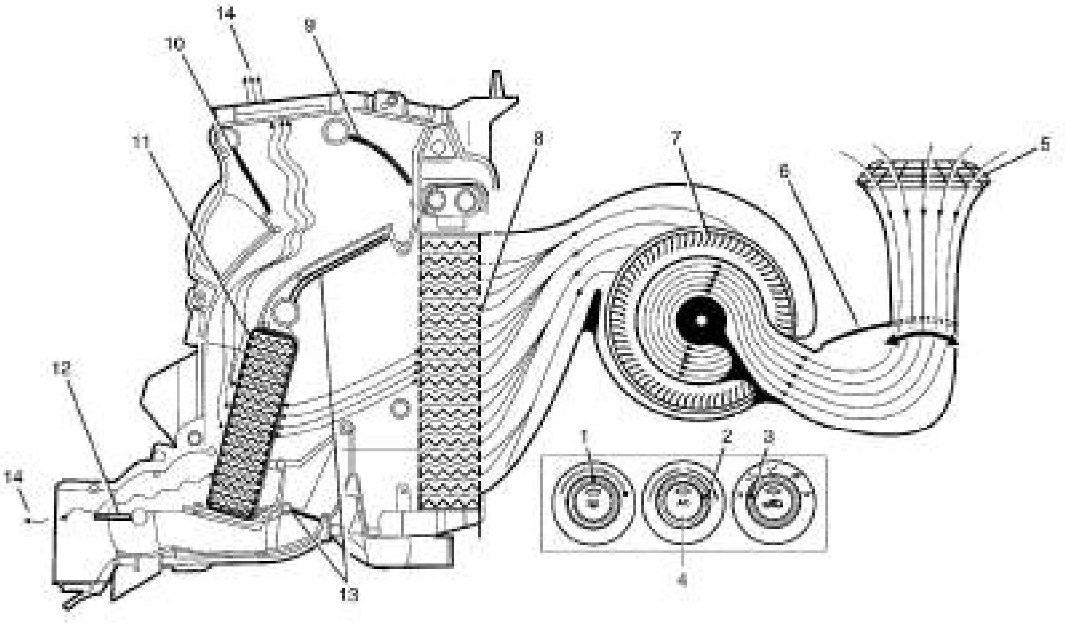
HVAC Air Flow Direction



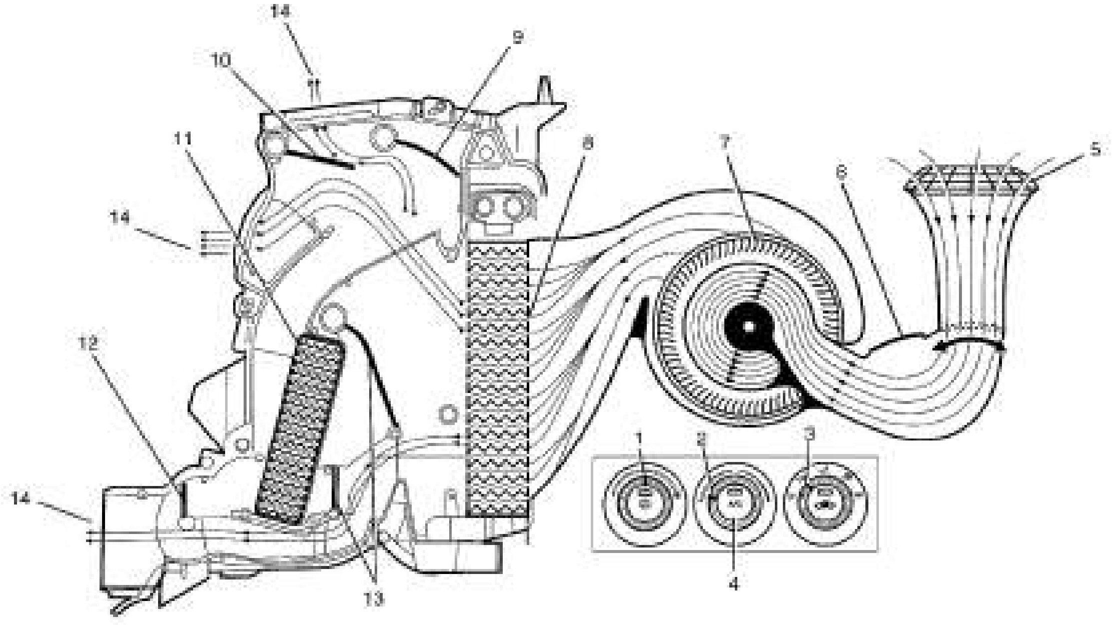
(1) Defrost to Windscreen
(2) Face Vent Outlet
(3) Passenger Side I/P Outlet
(4) Driver Side I/P Outlet
(5) Passenger Side Floor Outlet
(6) Drivers Side Floor Outlet
(7) Centre Console Rear Passengers Outlet
(8) Fresh Air Intake
(9) Recirculation Air Intake



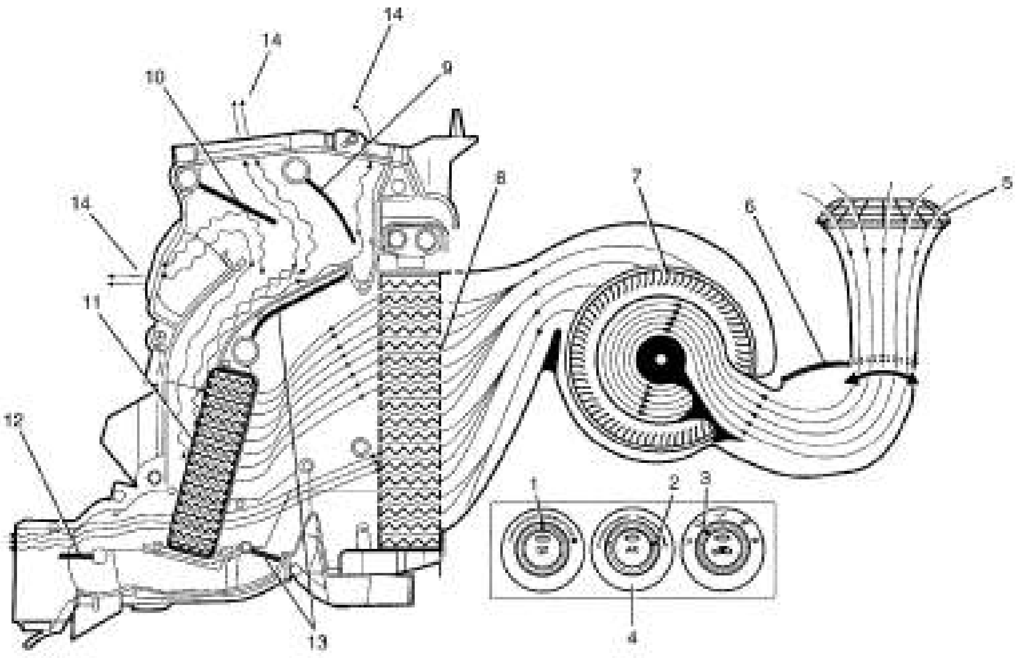
The A/C switch is on (4). The fan switch is set to any one of twenty speeds (1). The temperature switch is set to the full cold position (2). The mode control switch is set to face mode (3). The recirculation door (6) is closed, allowing outside air (5) to enter and flow into the HVAC module assembly via the plenum chamber inlet. Air is drawn into the HVAC module assembly by the blower motor (7) and is then forced through the cold evaporator fins (8). In full cold mode, the air mix doors (13) are fully closed, sealing off the passage through the heater core (11). The air travels through the open face/foot door (10). The cold air (14) is then directed through the centre and side vents.



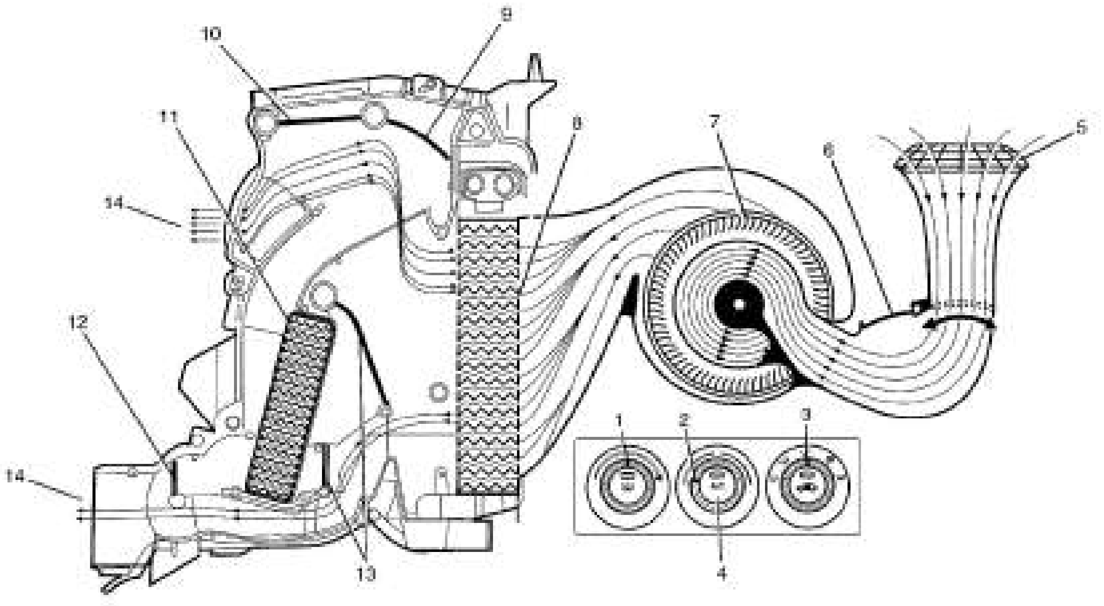
The fan switch is set to any one of twenty speeds (1). The temperature switch is set to the full hot position (2). The mode control switch is set to face mode (3). The recirculation door (6) is closed, allowing outside air (5) to enter and flow into the HVAC module assembly via the plenum chamber inlet . Air is drawn into the HVAC module assembly by the blower motor (7). This air is then forced through the evaporator core fins (8). In full heat mode, the air mix doors (13) are fully open, directing all incoming air through the heater core (11). The air travels through the open face/foot door (10). The heated air (14) is then directed out of the HVAC module assembly to the centre and side vents.



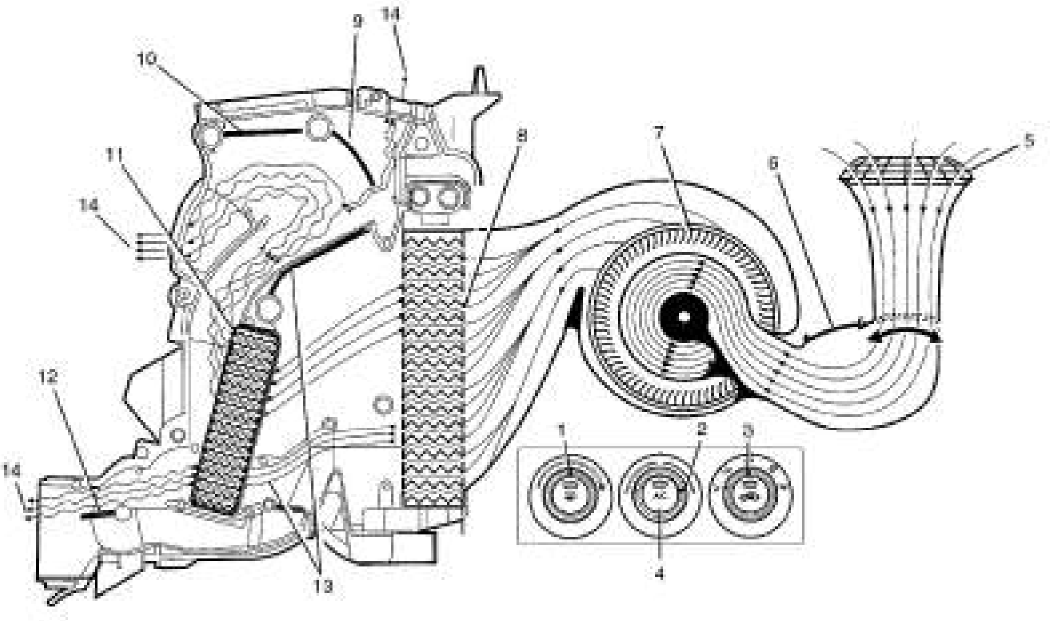
The A/C switch is on (4). The fan switch is set to any one of twenty speeds (1). The temperature switch is set to the full cold position (2). The mode control switch is set to bi-level mode (3). The recirculation door (6) is closed allowing outside air (5) to enter and flow into the HVAC module assembly via the plenum chamber inlet . Air is drawn into the HVAC module assembly by the blower motor (7), and is then forced through the cold evaporator fins (8). In full cold mode, the air mix doors (13) are fully closed sealing off the passage through the heater core (11). The air travels through the opened face/foot door (10) and then through the defrost/floor door (9), which is fully open in the floor mode. The cold air (14) is then directed through the centre and side vents as well as the floor ducts.



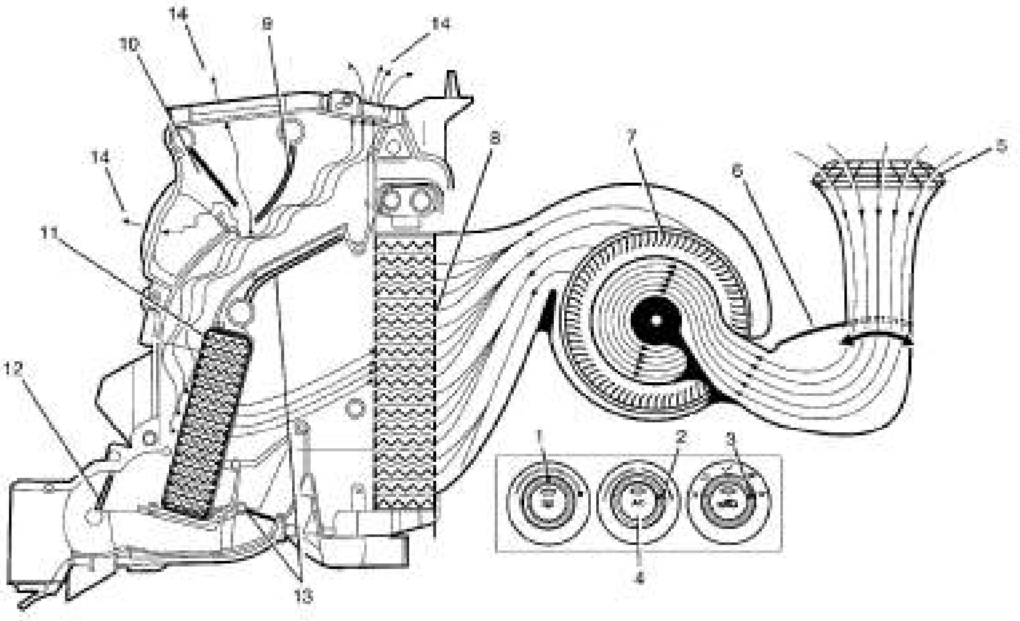
The fan switch is set to any one of twenty speeds (1). The temperature switch is set to the full hot position (2). The mode control switch is set to bi-level mode (3). The recirculation door (6) is closed, allowing outside air (5) to enter and flow into the HVAC module assembly via the plenum chamber inlet. Air is drawn into the HVAC module assembly by the blower motor (7). This air is then forced through the evaporator core fins (8). In full heat mode, the air mix doors (13) are fully open, directing all incoming air through the heater core (11). The air travels through the half opened face door (10) and through the defrost / floor door (9), which is fully open in the floor mode. The heated air (14) is then directed through the centre and side vents as well as to the floor ducts.



The A/C switch is on (4). The fan switch is set to any one of twenty speeds (1). The temperature switch is set to the full cold position (2). The mode control switch is set to floor mode (3). The recirculation door (6) is closed, allowing outside (5) air to enter and flow into the HVAC module assembly via the plenum chamber inlet. Air is drawn into the HVAC module assembly by the blower motor (7), and is then forced through the cold evaporator fins (8). In full cold mode, the air mix doors (13) are fully closed, sealing off the passage through the heater core (11). The air travels through the face/ floor door (10), which is fully open in the floor mode. The cold air (14) is then directed to floor ducts.



The fan switch is set to any one of twenty speeds (1). The temperature switch is set to the full hot position (2). The mode control switch is set to floor mode (3). The recirculation door (4) is closed, allowing outside air (5) to enter and flow into the HVAC module assembly via the plenum chamber inlet. Air is drawn into the HVAC module assembly by the blower motor (7). This air is then forced through the evaporator core fins (8). In full heat mode, the air mix doors (13) are fully open, directing all incoming air through the heater core (11). The air travels through the face/ floor door (10), which is fully open in the floor mode. The heated air (14) is then directed to the floor ducts.



The A/C switch is on (4). The fan switch is set to any one of twenty speeds (1). The temperature switch is set to the full hot position (2). The mode control switch is set to defrost mode (3). The recirculation door (6) is closed, allowing outside air (5) to enter and flow into the HVAC module assembly via the plenum chamber inlet. Air is drawn into the HVAC module assembly by the blower motor (7). This air is then forced through the cold evaporator core fins (8) removing moisture from the air. In full heat mode, the air mix doors (13) are fully open, allowing dehumidified incoming air through the heater core (11). The air travels through the defrost door (9), which is fully open in the defrost mode. The heated air (14) is then directed to the front windscreen via the defrost outlets.

Air Temperature Description and Operation

HVAC Control Components

HVAC Control Module

The HVAC control module is a GMLAN device that interfaces between the operator and the HVAC system to maintain air temperature and distribution settings. The HVAC module assembly is operated manually by a combination of electrical and mechanical components. The case is of a 3-piece, plastic construction. The left and right cases are assembled with a centre divider that houses the doors and are secured together with screws. The case sump is secured to the upper case assembly with screws. The blower resistor is integrated into the HVAC control module which is screwed to the HVAC blower motor fan assembly, which in turn is secured to the HVAC unit with a combination of pivot pins and screws.

Cold Operation

When the temperature switch is turned to the Full Cold position, it locates the air mix door in a position that does not allow any air to flow through the heater core. The result is that all air entering the vehicle cabin will be external air temperature.

Warm Operation

When the temperature switch is turned from the Full Cold position, it pulls the air mix doors open. When the temperature switch is turned to a warm position, the air mix doors will be partially open. This will cause some incoming air to pass through the heater core and some air to bypass the heater core. The mixture of heated and cool air will result in warm air entering the vehicle cabin.

Hot Operation

When the temperature switch is turned to the Full Hot position, the air mix doors will be in a position that directs all incoming air through the heater core. Therefore, all air entering the vehicle cabin will be heated air.

Mode Actuators

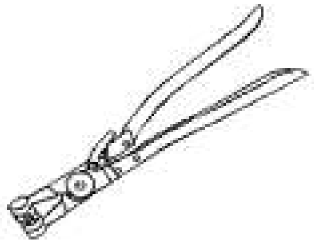
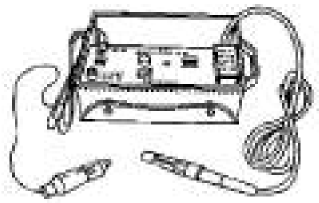
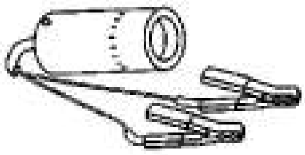
The mode actuators are used to adjust the mode positions and temperature. The mode actuators consist of a DC drive motor, reduction gears, printed circuit board (PCB) and a photo electric cell. The DC motors are provided with a supply voltage of 12 Volts from the HCM. The photo interrupter counts the revolutions of the DC motor drive shaft, these counts are then used by the HCM for reference to the actuator position.

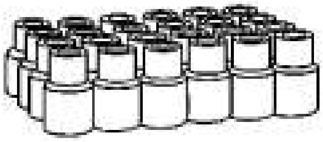
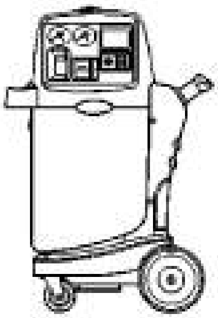
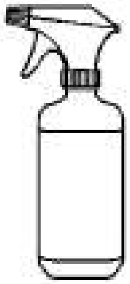
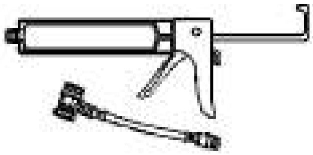
Recirculation Actuator

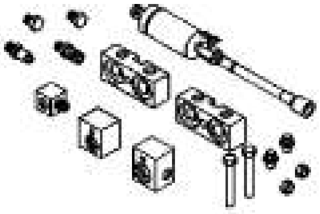
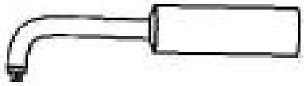
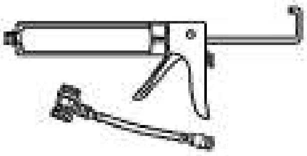
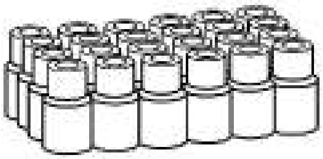
The recirculation actuator is used to adjust the fresh air inlet/recirculation door. The recirculation actuator consists of a DC drive motor, reduction gears, printed circuit board (PCB) and a photo electric cell. The DC motors are provided with a supply voltage of 12 Volts from the HCM. The photo interrupter counts the revolutions of the DC motor drive shaft, these counts are then used by the HCM for reference to the actuator position.

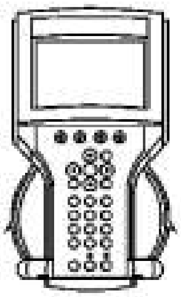
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | HVAC | HVAC - Manual | Special Tools and Equipment | **Document ID: 1989548**

Special Tools

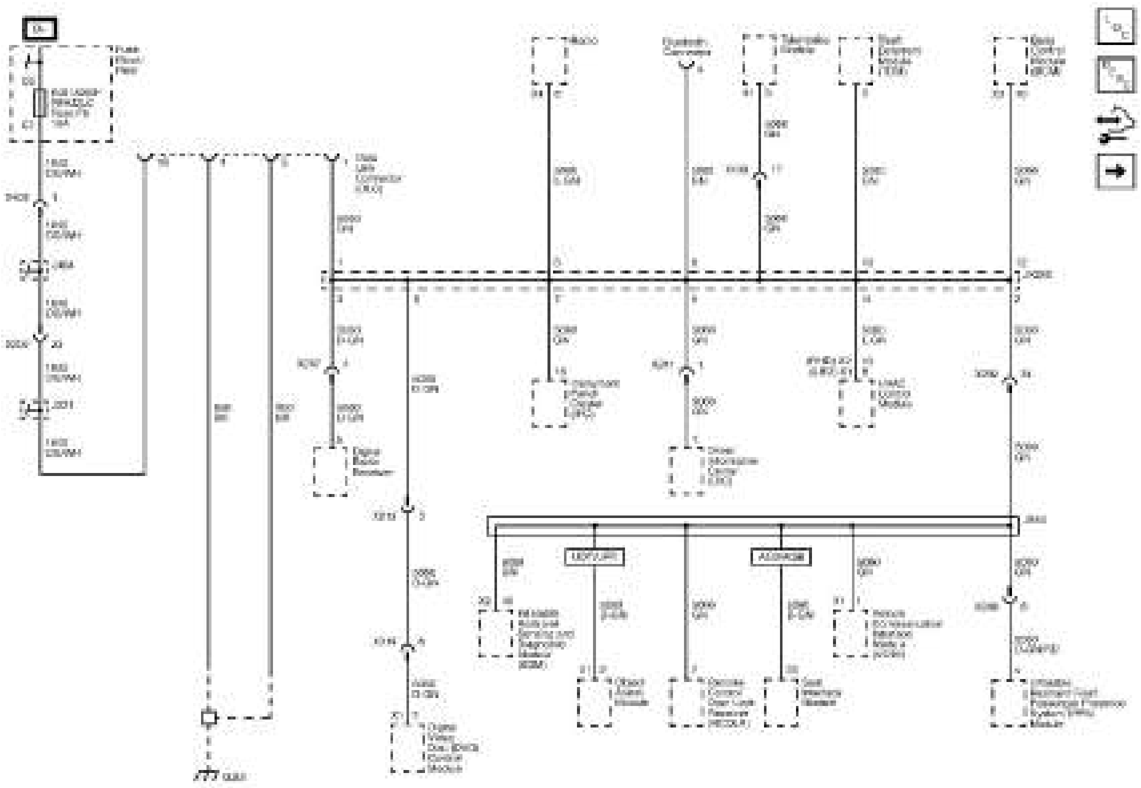
Illustration	Tool Number / Description
	J 38185 Hose Clamp Pliers
	J 39400-A Halogen Leak Detector
	J 42220 Universal 12V Leak Detection Lamp
	J 41447

	R-134a A/C Tracer Dye - Box of 24
	J 43600 ACR 2000 Air Conditioning Service Center
	J 43872 Fluorescent Dye Cleaner
	J 45037 A/C Oil Injector

	J 45268 A/C Flushing Adapter Kit
	J 45689 A/C Quick Joint Tool
	J 46297 A/C Dye Injector Kit
	J 46297-12 Replacement Dye Cartridges

	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

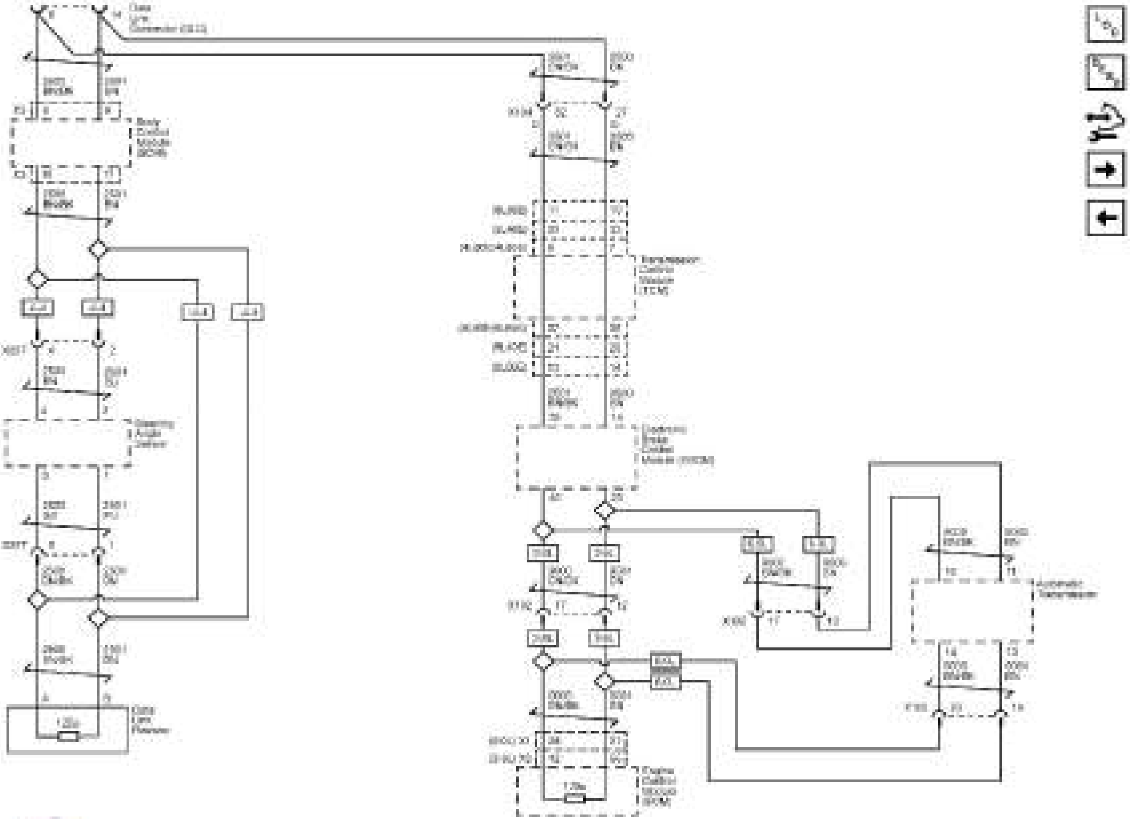
Low Speed


Radio
Data Link Connector (DLC)
Digital Radio Receiver
Body Control Module (BCM)
Instrument Panel Cluster (IPC)
HVAC Control Module
Remote Control Door Lock Receiver (RCDLR)

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Power and Signal Distribution | Data Communications | Schematic and Routing Diagrams |

Document ID: 2154005

High Speed


Data Link Connector (DLC)
Body Control Module (BCM)
Steering Angle Sensor
Data Link Resistor
120Ω
Transmission Control Module (TCM)
Electronic Brake Control Module (EBCM)
Automatic Transmission
Engine Control Module (ECM)
120Ω

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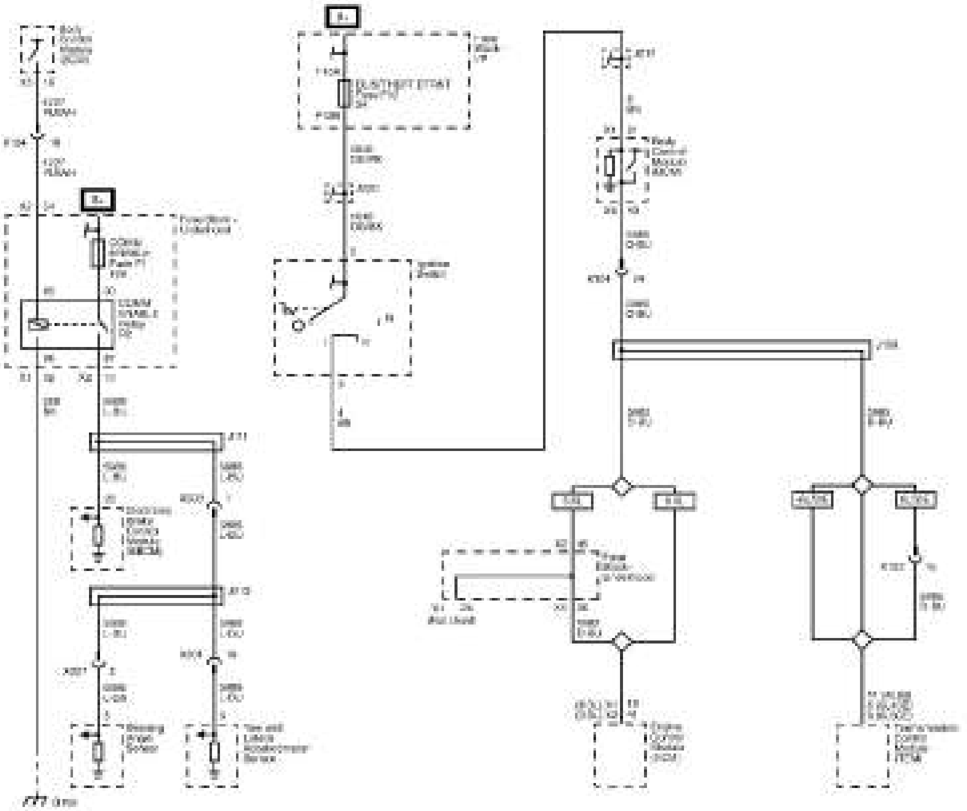
Document ID: 2154012

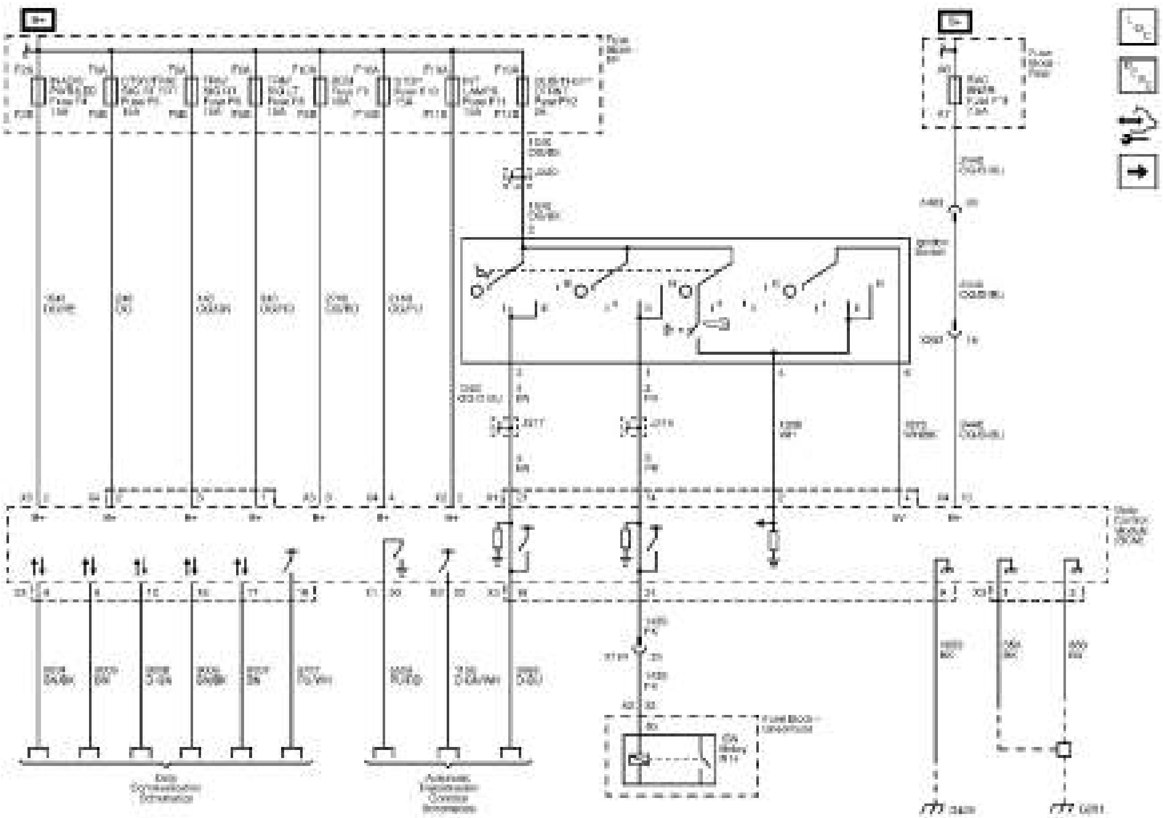
Accessory Wakeup Serial Data



2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Power and Signal Distribution | Data Communications | Schematic and Routing Diagrams |

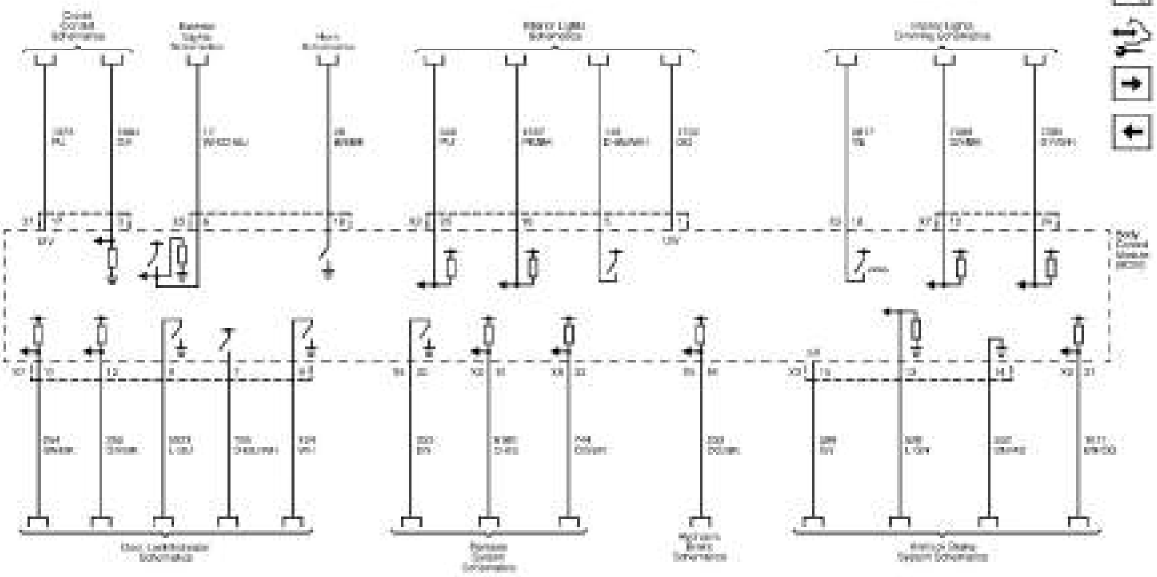
Document ID: 2154014

Module Power, Ground, Serial Data, and Transmission Subsystem References



2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Power and Signal Distribution | Data Communications | Schematic and Routing Diagrams |
Document ID: 2154015

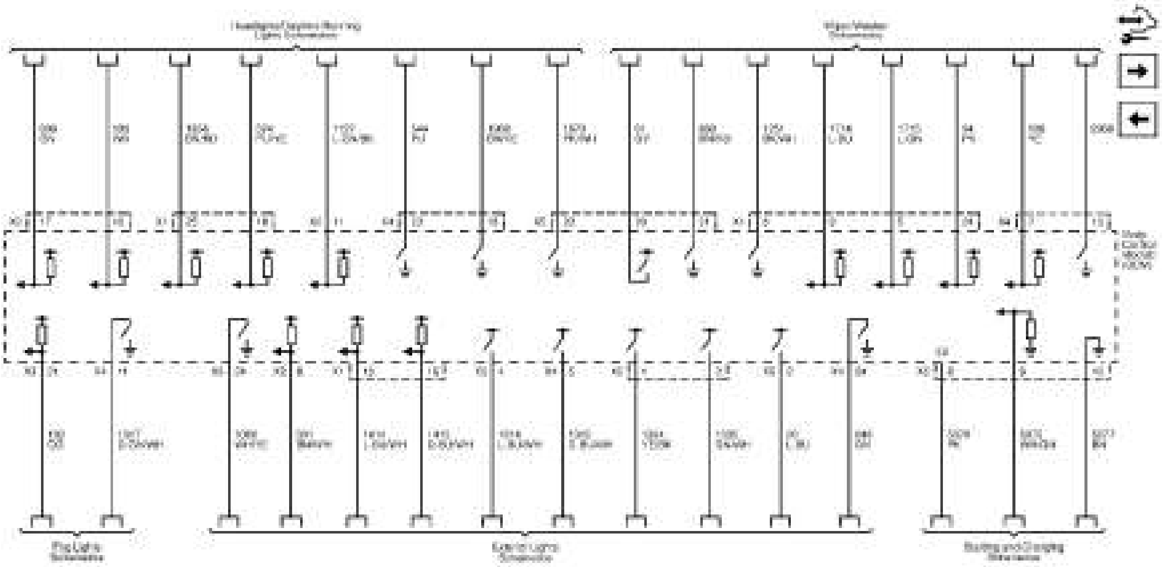
Cruise Control, Exterior Lights, Interior Lights, Horn, Door Lock, Release System, Hydraulic Brakes, and Antilock Brake Subsystem References



2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Power and Signal Distribution | Data Communications | Schematic and Routing Diagrams |

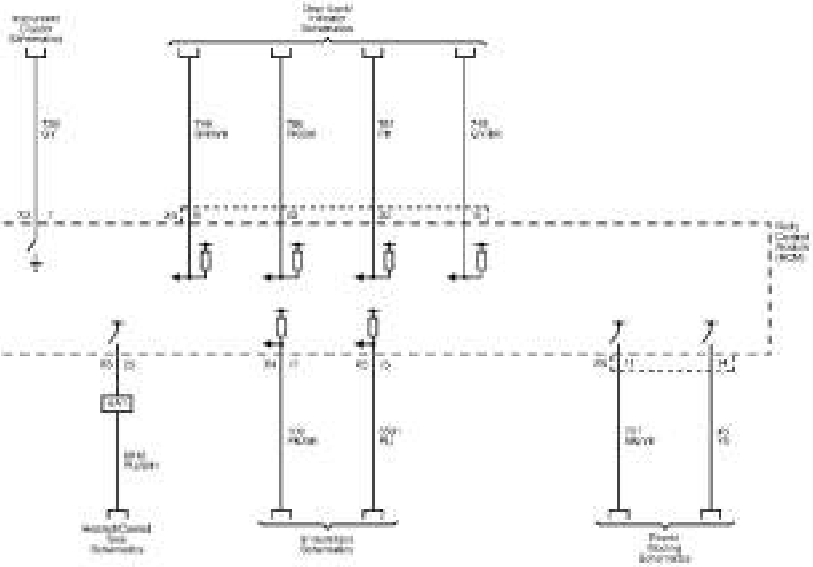
Document ID: 2154016

Headlight, Wiper / Washer, Fog Light, Exterior Lights, and Starting and Charging Subsystem References


Wiper/Washer Schematics
Fog Lights Schematics
Exterior Lights Schematics
Starting and Charging Schematics

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Power and Signal Distribution | Data Communications | Schematic and Routing Diagrams |
Document ID: 2154017

Instrument Cluster, Door Lock, Heated/Cooled Seat, Immobilizer, and Power Moding Subsystem References


Instrument Cluster Schematics
Body Control Module (BCM)
BAT
Heated/Cooled Seat Schematics
Immobilizer Schematics
Power Moding Schematics

DTC B1000

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC B1000 XX: Electronic Control Unit

Circuit/System Description

The internal fault detection is handled inside the control module. The symptom byte listed in the DTC Descriptor is for engineering reference only. No external circuit diagnosis is involved.

Conditions for Running the DTC

The module runs the program to detect an internal fault when power up is commanded. The only requirements are voltage and ground. This program runs even if the voltage is out of the valid operating range.

Conditions for Setting the DTC

The module has detected an internal malfunction.

Action Taken When the DTC Sets

The module refuses all additional inputs.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- This DTC may be stored as a history DTC without affecting the operation of the module.
- If stored only as a history DTC and not retrieved as a current DTC, do not replace the module.
- If this DTC is retrieved as both a current and history DTC, replace the module that set the

DTC.

Circuit/System Verification

If this DTC is retrieved as a current DTC, replace the module that set the DTC.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Control Module References for module replacement, setup, and programming

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Document ID: 2169333

DTC B1001

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC B1001 XX: Option Configuration

Circuit/System Description

Some control modules must be configured with serial numbers, vehicle options, or other information. If a control module was not properly configured after installation that module may set DTC B1001. The symptom byte listed in the DTC Descriptor is for engineering reference only. No external circuit diagnosis is involved.

Conditions for Running the DTC

Battery voltage is between 9-16 volts and data link communications operate normally.

Conditions for Setting the DTC

The control module is not configured properly.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold, without a repeat of the malfunction.

Reference Information

Schematic Reference

Data Communication Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool References

Control Module References for scan tool information

Circuit / System Verification

1. Verify DTC B1001 is not set.
   If the DTC is set, program the control module.
2. With a scan tool, clear the DTCs.
3. Ignition OFF, remove the scan tool, open and close the drivers door.
4. Wait 60 seconds, then verify DTC B1001 is not set.
   If the DTC is set, replace the control module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for control module replacement, setup, and programming

DTC B1010

DTC Descriptor

DTC B1010 5A: System Sensor Data Mismatch Invalid Odometer Signal.

Diagnostic Fault Information

Perform the Diagnostic System Check - Vehicle- Vehicle prior to using this diagnostic procedure.

Circuit / System Description

The navigation interface module (NIM) communicates with the body control module (BCM) to receive odometer data via the GMLAN. When there is an error regarding data supplied, this DTC will set in the NIM.

Conditions for Running the DTC

The radio must detect one of the following power modes:

- System voltage is between 9-16 volts.
- Engine is running.

Conditions for Setting the DTC

No change in the odometer pulse counter for 100 seconds while the vehicle is driven at speed above 40Km/h.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The DTC can be cleared using a scan tool.

Diagnostic Aids

The odometer signal is provided via GMLAN message sent from the BCM, any corresponding set BCM DTCs should be tested prior to diagnosing DTC B1010 5A.

Reference Information

Description and Operation

Navigation System Description and Operation.

Schematic Reference

Radio/Navigation System Schematics.

Connector End View Reference

Component Connector End Views.

Electrical Information Reference

- Circuit Testing.
- Connector Repairs.
- Testing for Intermittent Conditions and Poor Connections.
- Wiring Repairs.
- GMLAN Wiring Repairs.

Scan Tool Reference

Control Module References.

Circuit/System Testing

1. Using the scan tool, select the DTC display function. Verify that DTC B1010 5A is set.
2. If DTC B1010 5A is set, turn OFF the navigation system for 5 seconds.
3. Ignition ON, navigation system ON, verify that the neither of the following messages are displayed: "System Sensors Data Mismatch - Invalid Odometer Signal", "Invalid Speed Signal" or "Plausibility Failure".
4. Ignition ON, use the scan tool to clear the DTCs. Verify that DTC B1010 5A is cleared.

   If DTC B1010 5A is still current, replace the NIM.

Repair Instructions

Perform the Diagnostic Repair Verification.

Control Module References.

DTC B1016

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B1016: Vehicle Identification Number Not Programmed

Circuit/System Description

The body control module (BCM) performs a self test and vehicle identification number (VIN) verification. This DTC indicates that a VIN is not programmed or that the BCM has an internal fault. The internal fault detection is handled inside the control module, no external circuits are involved.

Conditions for Running DTC

The only requirements are that voltage and ground are supplied to the BCM.

Conditions for Setting the DTC

The BCM has detected that the VIN is not programmed.

Action Taken When DTC Sets

The vehicle will not start.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The history DTC will clear after 50 fault-free ignition cycles.
- The DTC can be cleared using a scan tool.

Reference Information

Schematic Reference

Body Control System Schematics

Connector End View Reference

Component Connector End Views

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Verify DTC B1016 is not set.
   If the DTC is set, program the control module.
2. With a scan tool, clear the DTCs.
3. Ignition OFF, remove the scan tool, open and close the drivers door.
4. Wait 60 seconds, then verify DTC B1016 is not set.
   If the DTC is set, replace the control module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Body Control Module Programming and Setup for BCM replacement, setup and programming

DTC U0073

DTC Descriptor

DTC U0073: High Speed Communication Bus

Diagnostic Fault Information

Perform the Diagnostic System Check - Vehicle.

Circuit / System Description

The high speed GMLAN serial data circuits are high speed serial data buses used to communicate information between the control modules. Typical data transmission speeds must be high enough to ensure that a required real-time response is maintained. The high speed GMLAN serial data circuits also connect directly to the data link connector (DLC).

Conditions for Running the DTCs

- Supply voltage to the modules are in the normal operating range.
- The vehicle power mode requires serial data communications.

Conditions for Setting the DTC

The module setting the DTC has attempted to establish communications on the GMLAN circuits more than 3 times.

Action Taken When the DTCs Sets

- The module suspends all message transmission.
- The module uses default values for all parameters received on the serial data circuits.
- The module inhibits the setting of all other communication DTCs.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- An intermittent condition is likely to be caused by a short on the high speed GMLAN serial data circuits.

- This DTC cannot be retrieved with a current status. Diagnosis is accomplished using the symptom Scan Tool Does Not Communicate with High Speed GMLAN Device.
- Refer to Data Link References.

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Document ID: 2187987

DTC U0100-U0249

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Module B+	U0100-U0249	U0100-U0249	--	--
Module Ignition	U0100-U0249	U0100-U0249	--	--
Module Ground	U0100-U0249	U0100-U0249	--	--
Accessory Wake Up Serial Data	U1814	U0100-U0249	--	--
High Speed GMLAN Serial Data Wake Up	U2099	U0100-U0249	--	--
High Speed GMLAN Serial Data (+)	2	U0100-U0249	2	--
High Speed GMLAN Serial Data (-)	2	U0100-U0249	2	--
Low Speed GMLAN Serial Data	1	U0100-U0249	1	--
1. Scan tool does not communicate with low speed GMLAN device 2. Scan tool does not communicate with high speed GMLAN device				

Circuit/System Description

The serial data circuit is the means by which the control modules in the vehicle communicate with each other. Once the scan tool is connected to the serial data circuit through the DLC, the scan tool can be used to monitor each module for diagnostic purposes and to check for diagnostic trouble codes (DTCs). When the ignition switch is in RUN, each control module communicating on the serial data circuit sends a state of health (SOH) message to ensure that the control module is operating properly. When a control module stops communicating on the serial data circuit, for example if the module loses power or ground, the SOH message it normally sends on the serial data circuit disappears. Other control modules on the serial data circuit, which expect to receive that SOH message, detect its absence; those control modules in turn sets a DTC associated with the loss of SOH of the non-communicating control module. The DTC is unique to the control module which is not communicating. Note: a loss of serial data communications DTC does not represent a failure of the module that set it.

Conditions for Running the DTC

The system voltage is between 9-16 volts.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter module availability has not been received.

Action Taken When the DTC Sets

Specific subsystems will not function.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they're transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
    - A control module on the data communication circuit was disconnected while the communication circuit is awake.
    - Power to one or more modules was interrupted during diagnosis.
    - A low battery condition was present, so some control modules stop communicating when battery voltage drops below a certain threshold.
    - Battery power was restored to the vehicle and control modules on the communication circuit did not all re-initialize at the same time.
    - If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- A control module may have a U code stored in history that does not require any repairs. Issues with late or corrupted messages between control modules can be temporary with no apparent symptom or complaint; this does not mean the control module is faulty. Do not replace a control module based only on a history U code.
- Do not replace a control module reporting a U-code. The U-code identifies which control module needs to be diagnosed for a communication issue.
- Communication may be available between the BCM and the scan tool with either the low or high speed GMLAN serial data system inoperative. This condition is due to the BCM using both the low and high speed GMLAN systems.

- Use Data Link References to determine if the module uses high or low speed GMLAN serial data communications.
- Some control modules may not have internal protection for specific control circuits and may open a B+ or ignition fuse. If a fuse is open and the B+ or ignition circuit is not shorted to ground, ensure none of the control circuits are shorted to ground before replacing the control module.
- This diagnostic can be used for any control module that is not communicating, regardless of the type of serial data circuit it is connected to, providing the vehicle is equipped with the control module.

Reference Information

Schematic Reference

- Data Communication Schematics
- Control Module References

Connector End View Reference

Component Connector End Views

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Verify that following BCM DTCs are not present:

- U1814
- U2099
- B1428
- B1370
- B1380
- B1440

- B1441

  If any listed DTC is present, refer to Diagnostic Trouble Code (DTC) List - Vehicle to diagnose that DTC prior to this diagnostic.

Circuit/System Testing

Note: Use the schematic to identify the following:

- Control modules the vehicle is equipped with
- Control module locations on the low and high speed GMLAN serial data circuits
- The control modules B+, ignition, ground, communication enable and serial data circuit terminals

1. Determine the module that is not communicating. Refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. Ignition OFF, disconnect the necessary harness connector of the module that is not communicating.
3. Test for less than 5 Ω between each ground circuit terminal and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
4. If equipped, verify that a test lamp illuminates between each B+ circuit terminal and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit fuse is open, test the control circuits of the control module for a short to ground. If the circuits test normal, replace the control module.
5. If equipped, ignition ON, verify that a test lamp illuminates between each ignition circuit terminal and ground.

   If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit fuse is open, test the control circuits of the control module for a short to ground. If the circuits test normal, replace the control module.

   Note: Only the high speed GMLAN modules have a serial data communication enable circuit OR an accessory wakeup serial data circuit, and the BCM is the output for these circuits. Refer to the module schematics to identify which modules have these circuits.
6. If equipped, ignition ON, verify that a test lamp illuminates between the communication enable circuit terminal OR the accessory wakeup circuit terminal and ground.

   If the test lamp does not illuminate, test the circuit for an open/high resistance. If the circuits test normal, replace the BCM.
7. Ignition OFF for 60 seconds, test for less than 5 Ω between the serial data circuit terminals and the DLC terminal listed below:
   - Low speed GMLAN serial data terminal 1
   - High speed GMLAN serial data terminal 6 or 14

   If greater than the specified range, test the serial data circuit for an open/high resistance between the non communicating control module and a module setting the DTC or a serial data splice pack.
8. If all circuits test normal, replace the control module that is not communicating.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- GMLAN Wiring Repairs
- Control Module References for module replacement, setup, and programming

DTC U1304

DTC Descriptors

DTC U1304: CAN-Bus No Communication with SIM (Seat Interface Module)

Diagnostic Fault Information

Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.

Circuit / System Description

Modules connected to the high and low speed GMLAN serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the modules. The modules have prerecorded information about what messages are needed to be exchanged on the serial data circuits, for each virtual network. The messages are supervised and also, some periodic messages are used by the receiver module as an availability indication of the transmitter module. Each message contains the identification number of the transmitter module.

The seat interface module (SIM) acts as a gateway module between the GMLAN and UART data communication systems. The SIM receives information such as the driver ID from the BCM via the GMLAN, the SIM then processes the data and transmits to the memory seat module (MSM) via a UART data connection.

Conditions for Running the DTC

- The system voltage is between 9-16 volts.
- The vehicle power mode master requires serial data communication to occur.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter module availability has not been received.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Reference Information

Schematic Reference

Data Communication Schematics

Connector End View Reference

Master Electrical Component List.

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the SIM harness connector.
2. Test for less than 1 ohm between the module ground circuits and ground.

   If greater than 1 ohm, repair the ground circuit for an open/high resistance.
3. Ignition ON, verify that a test lamp illuminates between all battery positive voltage circuits and ground.

   If the test lamp does not illuminate, repair the circuit for a short to ground or an open/high resistance. If the circuit fuse is open, also test the positive voltage outputs of the module for a short to ground. If the circuits test normal, replace the SIM.
4. Verify that a test lamp illuminates between all ignition voltage circuits and ground.

   If the test lamp does not illuminate, repair the circuit for a short to ground or an open/high resistance. If the circuit fuse is open, also test the positive voltage outputs of the SIM for a short to ground. If the circuits test normal, replace the SIM.
5. Ignition ON, verify that a test lamp illuminates between the serial data communication enable circuit OR the accessory wakeup serial data circuit and ground.

   If the test lamp does not illuminate, repair the circuit for an open/high resistance. If the circuits test normal, replace the BCM.
6. Test for less than 1 ohm in the low speed GMLAN serial data circuit between the SIM and the module that displays the DTC.

   If greater than 1 ohm, test the low speed GMLAN serial data circuit for open/high resistance.
7. If all circuits test normal, replace the SIM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- GMLAN Wiring Repairs
- Control Module References for module replacement, setup, and programming

DTC U1814

Diagnostic Instructions

- Perform the Diagnostic System Check - VehicleDiagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based DiagnosisStrategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure InstructionsDiagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC U1814 00: Powertrain High Speed Communication Enable Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Accessory Wakeup Serial Data	U 1814	U 0100	--	--

Circuit/System Description

The accessory wakeup serial data circuit is a positive voltage signal to wake up the engine control module (ECM) and the transmission control module (TCM). The signal is activated in 2 ways; any time the ignition switch is in the ACC or RUN position, or anytime the body control module (BCM) determines that communication is needed from the powertrain. When the ignition switch is in the ACC or RUN position, the accessory voltage circuit input to the BCM is internally connected to the accessory wakeup serial data circuit output, and voltage is supplied to the modules. The BCM also supplies voltage to the accessory wakeup serial data circuit when it determines that communication is necessary with the powertrain and the ignition is not in the ACC or RUN position such as during remote start.

Conditions for Running the DTC

- The system voltage is between 9-16 volts.
- The vehicle power mode master requires serial data communication to occur.

Conditions for Setting the DTC

The BCM senses a short to ground on the accessory wakeup serial data circuit.

Action Taken When the DTC Sets

- The modules use a default value for the missing parameters until the next ignition cycle.
- The module(s) is never signaled, therefore the specific subsystem(s) will not function.
- The vehicle may not start.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- Use the DMM MIN/MAX function to capture/locate intermittent conditions.
- Short to ground may also set multiple no communication codes for GMLAN high speed modules.

Reference Information

Schematic Reference

- Body Control System SchematicsBody Control System Schematics
- Data Communication Schematics

Connector End View Reference

Component Connector End ViewsComponent Connector End Views

Electrical Information Reference

- Circuit TestingCircuit Testing
- Connector RepairsConnector Repairs
- Testing for Intermittent Conditions and Poor ConnectionsTesting for Intermittent Conditions and Poor Connections
- Wiring RepairsWiring Repairs

Scan Tool Reference

Control Module ReferencesControl Module References

Circuit/System Testing

1. With the ignition OFF, disconnect the harness connector at the ECM and TCM one at a time. After each disconnect, retest for current DTCs. DTC U 1814 should remain current.

   If the DTC becomes history, replace the module disconnected before the DTC became history.
2. Ignition OFF, disconnect the harness connector at the BCM.

3. Test for infinite resistance between the accessory wakeup serial data circuit and ground.
   If less than infinite resistance, repair the serial data circuit for a short to ground.
4. If all circuits test normal, replace the BCM.

Repair Instructions

Perform the Diagnostic Repair VerificationDiagnostic Repair Verification .

Refer to Control Module ReferencesControl Module References .

DTC U2099

DTC Descriptor

DTC U2099 00: High Speed Communication Enable Circuit

Diagnostic Fault Information

Perform the Diagnostic System Check - VehicleDiagnostic System Check - Vehicle .

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
High Speed GMLAN Serial Data Wake Up	U2099, U0100-U0249[1]	U0100-U0249	U0100-U0249[2]	--
[1] Vehicle will not start. [2] May be history only. If cleared the DTC should return after several ignition cycles.				

Circuit/System Description

The body control module (BCM) applies voltage to the high speed GMLAN serial data wake up circuit, when the ignition key is in ACC, ON or START to enable several modules for bus communication.

Depending on option content, modules that may receive the signal are as follows:

- Electronic brake control module (EBCM)
- Electronic suspension control (ESC) module

Conditions for Running the DTC

- The system voltage is between 9-16 volts.
- The BCM attempts to enable the modules connected to the high speed GMLAN serial data wake up circuit.

Conditions for Setting the DTC

The BCM senses a short to ground on the high speed GMLAN serial data wake up circuit.

Action Taken When the DTC Sets

- The output command is turned off while the malfunction is present.
- The modules use a default value for the missing parameters.

- The module(s) is never signaled, therefore the specific subsystem(s) will not function.
- The vehicle will not start while the circuit is shorted to ground.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- Use the DMM MIN/MAX function to capture/locate intermittent conditions.
- Short to ground will also set multiple history no communication codes for GMLAN high speed modules

Reference Information

Schematic Reference

- Body Control System SchematicsBody Control System Schematics
- Data Communication Schematics

Connector End View Reference

Component Connector End ViewsComponent Connector End Views

Electrical Information Reference

- Circuit TestingCircuit Testing
- Connector RepairsConnector Repairs
- Testing for Intermittent Conditions and Poor ConnectionsTesting for Intermittent Conditions and Poor Connections
- Wiring RepairsWiring Repairs

Scan Tool Reference

Control Module ReferencesControl Module References

Circuit/System Testing

1. With the ignition OFF, disconnect the harness connector at the EBCM and ESC module one at a time. After each disconnect, clear the DTC, cycle the ignition key 3 times, then retest for the DTC. DTC U2099 should reset.

   If the DTC does not reset, replace the last module disconnected.
2. Ignition OFF, disconnect the harness connector at the BCM.
3. With all modules disconnected, test for infinite resistance between the high speed GMLAN

serial data wake up circuit and ground.

If less than infinite resistance, repair the wake up circuit for a short to ground.

4. If all tests normal and DTC is current, replace the BCM.

Repair Instructions

Perform the Diagnostic Repair VerificationDiagnostic Repair Verification .

Refer to Control Module ReferencesControl Module References .

DTC U2100

DTC Descriptor

DTC U2100 00: CAN-Bus Circuit Malfunction

Diagnostic Fault Information

Perform the Diagnostic System Check - Vehicle.

Circuit Description

The GMLAN serial data circuits are controller area network (CAN) serial data buses used to communicate information between the control modules. Typical data transmission speeds must be high enough to ensure that a required real-time response is maintained. On this vehicle there are 2 totally different types of GMLAN serial data circuits, the High speed 2-wire circuit and Low speed single wire circuit. Refer to Data Link Communications Description and Operation for the complete description of these buses. The GMLAN serial data circuits also communicate directly to the DLC connector. Messages are interpreted by the externally connected CANdi module which acts as a transceiver for the scan tool.

Modules connected to the GMLAN serial data circuits monitor communications during normal vehicle operation, where operation information is exchanged among the modules. All the modules on the GMLAN networks, maintain a transmit error counter (TEC) and a receive error counter (REC). The counter values increase with detected errors and will decrease with error-free messages. If the TEC value exceeds 255, the controller removes itself from the network and DTC U2100 will result.

Conditions for Running the DTCs

- Supply voltage to the modules are in the normal operating range.
- The vehicle is in the RUN power mode.

Conditions for Setting the DTC

The module setting the DTC has attempted to establish communications on the GMLAN circuits for more than 7 times.

Action Taken When the DTCs Sets

- The module suspends all message transmission.
- The module uses default values for all parameters received on the serial data circuits.
- The module inhibits the setting of all other communication DTCs.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- This DTC cannot be retrieved with a current status. Diagnosis of a current DTC is accomplished via the symptom refer to Scan Tool Does Not Communicate with High Speed GMLAN Deviceor Scan Tool Does Not Communicate with Low Speed GMLAN Device depending on the module serial data communication.
- An intermittent condition is likely to be caused by a short on the GMLAN serial data circuits. Use the Scan Tool Does Not Communicate with High Speed GMLAN Deviceor Scan Tool Does Not Communicate with Low Speed GMLAN Device procedure in order to isolate an intermittent condition.

Data Link References

This table identifies which serial data link that a particular module uses for in-vehicle data transmission. Some modules may use more than one data link to communicate. Some modules may have multiple communication circuits passing through them without actively communicating on that data link. This table is used to assist in correcting a communication malfunction. For the description and operation of these serial data communication circuits refer to Data Link Communications Description and OperationData Link Communications Description and Operation.

Control Module	Data Link Type	Diagnostic Procedure
***Schematic Reference:* Data Communication Schematics.**		
Automatic Headlamp Levelling Control Module	High Speed GMLAN	Scan Tool Does Not Communicate with High Speed GMLAN Device
Bluetooth Module	Non-GMLAN	--
Body Control Module (BCM)	• High Speed GMLAN • Low Speed GMLAN	Scan Tool Does Not Communicate with High Speed GMLAN Device
Electronic Brake Control Module (EBCM)	High Speed GMLAN	Scan Tool Does Not Communicate with High Speed GMLAN Device
Electronic Suspension Control Module	High Speed GMLAN	Scan Tool Does Not Communicate with High Speed GMLAN Device
Engine Control Module (ECM)	High Speed GMLAN	Scan Tool Does Not Communicate with High Speed GMLAN Device
HVAC Control Module	Low Speed GMLAN	Scan Tool Does Not Communicate with Low Speed GMLAN Device
Inflatable Restraint Sensing and Diagnostic Module (SDM)	Low Speed GMLAN	Scan Tool Does Not Communicate with Low Speed GMLAN Device
Instrument Panel Cluster (IPC)	Low Speed GMLAN	Scan Tool Does Not Communicate with Low Speed GMLAN Device
Memory Mirror Module	Non-GMLAN	--
Memory Seat Module (MSM)	Non-GMLAN	--
Navigation Unit	Non-GMLAN	--
Navigation Interface Module	Low Speed GMLAN	Scan Tool Does Not Communicate with Low Speed GMLAN Device
Object Alarm Module	Low Speed GMLAN	Scan Tool Does Not Communicate with Low Speed GMLAN Device
Rear Seat Entertainment Interface Module	Low Speed GMLAN	Scan Tool Does Not Communicate with Low Speed GMLAN Device
Remote Function Actuator (RFA)	Low Speed GMLAN	Scan Tool Does Not Communicate with Low Speed GMLAN Device
Secondary Information Centre	Low Speed GMLAN	Scan Tool Does Not Communicate with Low Speed GMLAN Device

Seat Interface Module	Low Speed GMLAN	Scan Tool Does Not Communicate with Low Speed GMLAN Device
Steering Angle Sensor	High Speed GMLAN	Scan Tool Does Not Communicate with High Speed GMLAN Device
Theft Deterrent Control Module	Low Speed GMLAN	Scan Tool Does Not Communicate with Low Speed GMLAN Device
Transmission Control Module (TCM)	High Speed GMLAN	Scan Tool Does Not Communicate with High Speed GMLAN Device
Telematics Module	Low Speed GMLAN	Scan Tool Does Not Communicate with Low Speed GMLAN Device

Scan Tool Does Not Communicate with High Speed GMLAN Device

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
High Speed GMLAN Serial Data (+)	1	U0100-U0249*	1	--
High Speed GMLAN Serial Data (-)	1	U0100-U0249*	1	--
Ground (DLC, terminal 5)	--	1	--	--
* No communications with one or more high speed GMLAN modules. An open in only one high speed GMLAN serial data circuit may allow degraded communication between the modules. An open between the data link connector (DLC) and the first splice will only effect the communication with the scan tool. The vehicle modules will still communicate. 1. No communication with any high speed GMLAN module				

Circuit/System Description

The serial data is transmitted on two twisted wires that allow speeds up to 500 Kb/s. The twisted pair is terminated with two 120 ohms resistors, one is internal to the engine control module (ECM) and the other can be a separate resistor in a connector assembly or in another control module. The resistors are used as the load for the High Speed GMLAN buss during normal vehicle operation. The high speed GMLAN is a differential bus. The high speed GMLAN serial data bus (+) and high speed GMLAN serial data (-) are driven to opposite extremes from a rest or idle level of approximately 2.5 V. Driving the lines to their extremes, adds one volt to the high speed GMLAN serial data bus (+) circuit and subtracts one volt from the high speed GMLAN serial data bus (-) circuit. If serial data is lost, control modules will set a no communication code against the non-communicating control module. Note that a loss of serial data DTC does not represent a failure of the module that set it.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they're transparent to the vehicle operator and technician, and/or have no associated symptoms.

Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:

- A control module on the data communication circuit was disconnected while the communication circuit is awake.
- Power to one or more modules was interrupted during diagnosis
- A low battery condition was present, so some control modules stop communicating when battery voltage drops below a certain threshold.
- Battery power was restored to the vehicle and control modules on the communication circuit did not all re-initialize at the same time.
- If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.

- Do not replace a control module reporting a U code. The U code identifies which control module needs to be diagnosed for a communication issue.
- Communication may be available between the BCM and the scan tool with the high speed GMLAN serial data system inoperative. This condition is due to the BCM using both the high and low speed GMLAN systems.
- An open in the DLC ground circuit terminal 5 will allow the scan tool to operate but not communicate with the vehicle. When the scan tool attempts to communicate with the vehicle a message "no CANdi module detected" will be displayed.
- The engine will not start when there is a total malfunction of the high speed GMLAN serial data bus.
- Technicians may find various Local Area Network (LAN) communication Diagnostic Trouble Codes (DTC) and no low speed GMLAN communications with the scan tool.
- The engine will not start when there is a total malfunction of the high speed GMLAN serial data bus.

  These conditions may be caused by the installation of an aftermarket navigation radio module (see bulletins). Some customers may comment of one or more of the following concerns:

  - Vehicle will not crank.
  - Vehicle cranks but will not start.
  - Vehicle stability enhancement system warning lights and messages.
  - PRNDL gear indicator position errors.
  - Tire Pressure Monitor (TPM) system warning lights.

Reference Information

Schematic Reference

- Data Communication Schematics
- Control Module References

Connector End View Reference

Component Connector End Views

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

Note: Each control module may need to be disconnected to isolate a circuit fault. Use the schematic to identify the following:

- Control modules the vehicle is equipped with
- High speed GMLAN serial data circuit terminating resistors
- Control module locations on the high speed GMLAN serial data circuits
- Each control module's high speed GMLAN serial data circuit terminals

1. Attempt to communicate with all control modules on the high speed GMLAN serial data circuit, refer to Data Link References. Communications should not be available with two or more control modules on the high speed GMLAN serial data circuit.

   If only one control module is not communicating, diagnose that control module only; refer to DTC U0100-U0249.
2. Disconnect the scan tool from the DLC. The following tests will be done at the DLC connector.
3. All access doors closed, ignition OFF for 60 seconds, test for less than 10 Ω between the ground circuit terminal 5 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
4. Ignition ON, test for less than 4.5 V between the serial data circuits listed below and ground:
   - Terminal 6
   - Terminal 14

   If greater than the specified range, test the serial data circuit for a short to voltage; refer to Testing the Serial Data Circuits for a Short to Voltage.
5. Ignition OFF for 60 seconds, test for greater than 100 Ω between the serial data circuits listed below and ground:
   - Terminal 6
   - Terminal 14

   If not the specified value, test the serial data circuit for a short to ground; refer to Testing the Serial Data Circuits for a Short to ground.
6. Test for 50-70 Ω between the serial data circuits terminal 6 and terminal 14.

   If less than 35 Ω, test for a short between the serial data circuits; refer to Testing the Serial Data Circuits for a Short between the Circuits.

If 35-50 Ω there may be a third terminating resistor between the serial data circuits. This can happen if the incorrect control module is installed. Some control modules are available with and without the terminating resistors installed to reduce the need of terminating resistors in the wiring harness.

If greater than 70 Ω but less than infinite, test the serial data circuit for an open/high resistance; refer to Testing the Serial Data Circuits for an Open/High Resistance.

If infinite, test the serial data circuits between the DLC and the first connection to the serial data circuit for an open/high resistance.

Testing the Serial Data Circuits for a Short to Voltage

1. Ignition OFF, disconnect the harness connectors with the high speed GMLAN serial data circuits at an easily accessible control module.
2. Ignition ON, test for greater than 4.5 V between each serial data circuit at the control module connector that was just disconnected and ground. Verify that one or more serial data circuits are greater than 4.5 V.

   If all serial data circuits are less than the specified range, replace the control module that was disconnected.
3. Ignition OFF, disconnect the harness connectors with the high speed GMLAN serial data circuits at another control module, in the direction of the circuit shorted to voltage.
4. Ignition ON, test for greater than 4.5 V between the serial data circuits at the control module connector that was just disconnected and ground. Verify that one or more serial data circuits are greater than 4.5 V.

   If all serial data circuits are less than the specified range, replace the control module that was just disconnected.
5. Repeat step 3 until one of the follow conditions are isolated:
   - A short to voltage on the serial data circuit between 2 control modules
   - A short to voltage on the serial data circuit between a control module and a terminating resistor.

Testing the Serial Data Circuits for a Short to Ground

1. Ignition OFF, disconnect the harness connectors with the high speed GMLAN serial data circuits at an easily accessible control module.
2. Ignition OFF for 60 seconds, test for less than 1k Ω between each serial data circuit at the control module connector that was just disconnected and ground. Verify that one or more serial data circuits are less than 1k Ω.

   If all serial data circuits are greater than the specified range, replace the control module that was disconnected.
3. Disconnect the harness connectors with the high speed GMLAN serial data circuits at another control module, in the direction of the circuit shorted to ground.
4. Ignition OFF for 60 seconds, test for less than 1k Ω between the serial data circuits at the control module connector that was just disconnected and ground. Verify that one or more serial data circuits are less than 1k Ω.

   If greater than the specified range for all serial data circuits, replace the control module that was just disconnected.
5. Repeat step 3 until one of the follow conditions are isolated:
   - A short to ground on the serial data circuit between 2 control modules
   - A short to ground on the serial data circuit between a control module and a terminating resistor.

Testing the Serial Data Circuits for a Short between the Circuits

1. Ignition OFF, disconnect the harness connectors with the high speed GMLAN serial data circuits at an easily accessible control module that is not communicating.
2. Ignition OFF for 60 seconds, test for less than 35 Ω between each pair of serial data circuits at the control module connector that was just disconnected. Verify that one pair of serial data circuits are less than 35 Ω.

   If each pair of serial data circuits is greater than the specified range, replace the control module that was disconnected.
3. Connect the harness connectors at the control module that was disconnected.
4. Disconnect the harness connectors with the high speed GMLAN serial data circuits at another control module, in the direction of the circuits shorted together.
5. Ignition OFF for 60 seconds, test for less than 35 Ω between each pair of serial data circuits at the control module connector that was just disconnected. Verify that one pair of serial data circuits are less than 35 Ω.

   If each pair of serial data circuits is within the specified range, replace the control module that was just disconnected.
6. Repeat step 3 until one of the following conditions are isolated:
   - Serial data circuits shorted together between 2 control modules
   - Serial data circuits shorted together between a control module and a terminating resistor
   - A shorted terminating resistor

Testing the Serial Data Circuits for an Open / High Resistance

1. Ignition OFF, disconnect the harness connectors with the high speed GMLAN serial data circuits at an easily accessible control module that is not communicating.
2. Ignition OFF for 60 seconds, test for greater than 100k Ω between each pair of serial data circuits at the control module connector that was just disconnected. Verify that one pair of serial data circuits are greater than 100k Ω.

   If each pair of serial data circuits is less than the specified range, replace the control module that was disconnected.
3. Connect the harness connectors at the control module that was disconnected.
4. Disconnect the harness connectors with the high speed GMLAN serial data circuits at another control module, in the direction of the open circuit.
5. Ignition OFF for 60 seconds, test for greater than 100k Ω between each pair of serial data circuits at the control module connector that was just disconnected. Verify that one pair of serial data circuits are greater than 100k Ω.

   If each pair of serial data circuits is less than the specified range, replace the control module that was just disconnected.
6. Repeat step 3 until one of the following conditions are isolated:
   - An open/high resistance on the serial data circuit between 2 control modules
   - An open/high resistance on the serial data circuit between a control module and a terminating resistor
   - An open/high resistance terminating resistor

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- GMLAN Wiring Repairs

- Control Module References for control module replacement, setup, and programming

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Document ID: 2186607

Scan Tool Does Not Communicate with Low Speed GMLAN Device

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Low Speed GMLAN Serial Data	1	U0100-U0249*	1	--
Ground (DLC, terminal 5)	--	1*	--	--
* An open between the data link connector serial data circuit terminal 1 or ground circuit terminal 5 and the BCM circuit will only effect the communication with the scan tool. 1. No communication on any low speed GMLAN module				

Circuit/System Description

The serial data is transmitted over a single wire to the appropriate control modules. The transmission speed for GMLAN low speed is up to 83.33 Kb/s. Under normal vehicle operating conditions, the speed of the buss is 33.33 Kb/s. The control modules toggle the serial data circuit between 0-5 V during normal communications. To wake the control modules connected to the GMLAN low speed serial data circuit, a voltage wake up pulse of 10 V is sent out. If serial data is lost, control modules will set a no communication code against the non-communicating control module. Note: a loss of serial data communications DTC does not represent a failure of the module that set it.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they're transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
  - A control module on the data communication circuit was disconnected while the communication circuit is awake.
  - Power to one or more modules was interrupted during diagnosis

  - A low battery condition was present, so some control modules stop communicating when battery voltage drops below a certain threshold.
  - Battery power was restored to the vehicle and control modules on the communication circuit did not all re-initialize at the same time.
  - If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- Do not replace a control module reporting a U-code. The U-code identifies which control module needs to be diagnosed for a communication issue.
- Communication may be available between the BCM and the scan tool with the low speed GMLAN serial data system inoperative. This condition is due to the BCM using both the high and low speed GMLAN systems.
- An open in the low speed GMLAN serial data circuit between the splice pack and a module will only affect that specific module. This type of failure will set a loss of communication DTC for each module effected, and the other modules will still communicate.
- An open in the DLC ground circuit terminal 5 will allow the scan tool to operate but not communicate with the vehicle. When the scan tool attempts to communicate with the vehicle a No CANdi Module Detected message will be displayed.
- An open between the DLC and JX 200 will only effect the communication with the scan tool. The vehicle modules will still communicate, and the vehicle will start.
- The engine will not start when there is a total malfunction of the low speed GMLAN serial data circuit.
- Technicians may find various Local Area Network (LAN) communication Diagnostic Trouble Codes (DTC) and no low speed LAN communications with the scan tool.

  These conditions may be caused by the installation of an aftermarket navigation radio module (see bulletins). Some customers may comment of one or more of the following concerns:

  - Vehicle will not crank.
  - Vehicle cranks but will not start.
  - Vehicle stability enhancement system warning lights and messages.
  - PRNDL gear indicator position errors.
  - Tire Pressure Monitor (TPM) system warning light.

Reference Information

Schematic Reference

Data Communication Schematics

Connector End View Reference

- Component Connector End Views
- Splice Pack Connector End Views

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Circuit/System Testing

Note: Use the schematic to identify the following:

- Control modules the vehicle is equipped with
- Control module locations on the low speed GMLAN serial data circuit
- The low speed GMLAN serial data circuit terminals for each control module

1. Attempt to communicate with all control modules on the low speed GMLAN serial data circuit, refer to Data Link References . Communications should not be available with two or more control modules on the low speed GMLAN serial data circuit.

   If only one control module is not communicating, diagnose that control module only, refer to DTC U0100-U0249 .

   If one or more control modules are communicating but not all, refer to Testing the Serial Data Circuit for an Open/High Resistance.
2. Disconnect the scan tool from the DLC. The following tests will be done at the DLC connector.
3. All access doors closed, ignition OFF for 60 seconds, test for less than 10 Ω between the ground circuit terminal 5 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
4. Ignition ON, test for less than 4.5 V between the serial data circuit terminal 1 and ground.

   If greater than the specified range, test the serial data circuit for a short to voltage, refer to Testing the Serial Data Circuit for a Short to Voltage.
5. Ignition OFF for 60 seconds, test for greater than 100 Ω between the serial data circuit terminal 1 and ground.

   If less than the specified range, test the serial data circuit for a short to ground, refer to Testing the Serial Data Circuits for a Short to ground.
6. Disconnect the appropriate harness connector at the JX 200 splice pack.
7. Test for less than 2 Ω between the DLC serial data circuit terminal 1 and the JX200 splice pack terminal 1.

   If greater than the specified range, test the serial data circuit for an open/high resistance. If the circuits test normal, replace the splice pack.

Testing the Serial Data Circuits for a Short to Voltage

1. Ignition OFF, disconnect the appropriate harness connectors at the JX 200 splice pack.
2. Ignition ON, test for less than 4.5 V between the DLC serial data circuit terminal 1 and ground.

   If greater than the specified range, repair the short to voltage.
3. Test for less than 4.5 V between each serial data circuit at the splice pack connector and ground.

   If greater than the specified range, perform the appropriate test listed below:

   - Serial data circuits with one control module, test the serial data circuit for a short to voltage. If the circuit tests normal replace the control module.

- Serial data circuits with 2 or more control modules, test each section of the serial data circuit for a short to voltage. If the circuits test normal, replace the control module that causes the short to voltage when connected.

Testing the Serial Data Circuits for a Short to Ground

1. Ignition OFF, disconnect the appropriate harness connectors at the JX 200 splice pack.
2. Test for infinite resistance between the DLC serial data circuit terminal 1 and ground.

   If not the specified value, repair the short to ground.
3. Ignition OFF for 60 seconds, test for greater than 100 Ω between each serial data circuit at the splice pack and ground.

   If less than the specified range, perform the appropriate test listed below:

   - Serial data circuits with one control module, test the serial data circuit for a short to ground. If the circuit tests normal replace the control module.
   - Serial data circuits with 2 or more control modules, test each section of the serial data circuit for a short to voltage. If the circuits test normal, replace the control module that causes the short to ground when connected.

Testing the Serial Data Circuit for an Open / High Resistance

1. Ignition OFF, disconnect the appropriate harness connectors at the JX 200 splice pack.
2. Install a 3 A fused jumper wire between the disconnected splice pack connector terminal 1 and a low speed GMLAN serial data circuit terminal that is not communicating.
3. Ignition ON, verify the scan tool communicates with the control modules connected to the low speed GMLAN serial data circuit.

   If any control module does not communicate, test each section of the serial data circuit for an open/high resistance. If the circuits test normal, replace the control module that does not communicate when connected.
4. If all circuits test normal, replace the splice pack.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- GMLAN Wiring Repairs
- Control Module References for module replacement, setup, and programming

Scan Tool Does Not Power Up

Circuit / System Description

The data link connector (DLC) is a standardized 16 cavity connector. Connector design and location is dictated by an industry wide standard, and is required to provide the following:

- Scan tool power battery positive voltage at terminal 16
- Scan tool power ground at terminal 4
- Common signal ground at terminal 5

Diagnostic Aids

- The scan tool will power up with the ignition OFF. Some modules however, will not communicate unless the ignition is ON and the power mode master (PMM) module sends the appropriate power mode message.
- If the battery positive voltage, ground circuits and connections of the DLC are functioning properly, the malfunction must be due to the scan tool/CANdi module.
- Use the DMM MIN/MAX function to capture/locate intermittent conditions.

Reference Information

Schematic Reference

Data Communication Schematics

Connector End View Reference

Component Connector End ViewsComponent Connector End Views

Electrical Information Reference

- Circuit TestingCircuit Testing
- Connector RepairsConnector Repairs
- Testing for Intermittent Conditions and Poor ConnectionsTesting for Intermittent Conditions and Poor Connections
- Wiring RepairsWiring Repairs

Circuit / System Testing

1. Ignition ON, test for battery voltage between the battery positive voltage circuit of the DLC and ground.

   If less than battery voltage, repair the voltage supply circuit for a short to ground or an open/high resistance.

2. Test for less than 1.0 ohm of resistance between the ground circuit of the DLC and ground.
   If greater than 1.0 ohm, repair the ground circuit for an open/high resistance.
3. If all tests normal, refer to the scan tool/CANdi module user guide.

Repair Instructions

Perform the Diagnostic Repair VerificationDiagnostic Repair Verification .

Symptoms - Data Communications

Important: The following steps must be completed before using the symptom tables.

1. Perform the Diagnostic System Check - Vehicle before using the symptom tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data links.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to Data Link Communications Description and Operation .

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the systems. Refer to Checking Aftermarket Accessories .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections .

Symptom List

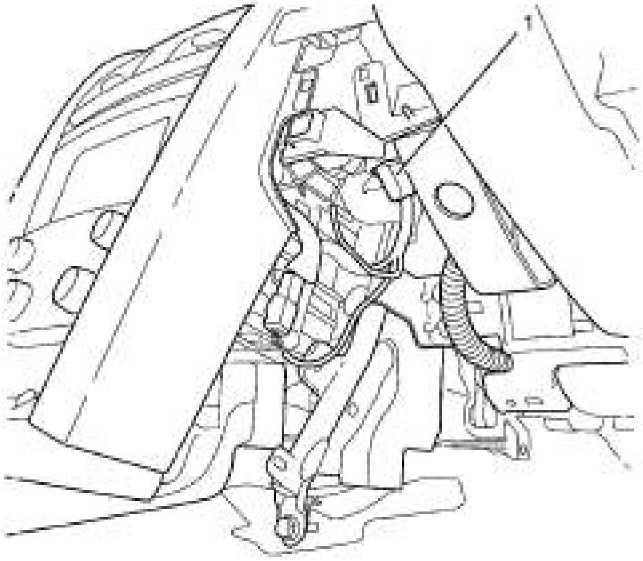
Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Scan Tool Does Not Power Up
- Scan Tool Does Not Communicate with High Speed GMLAN Device
- Scan Tool Does Not Communicate with Low Speed GMLAN Device

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Power and Signal Distribution | Data Communications | Repair Instructions | **Document ID: 2146796**

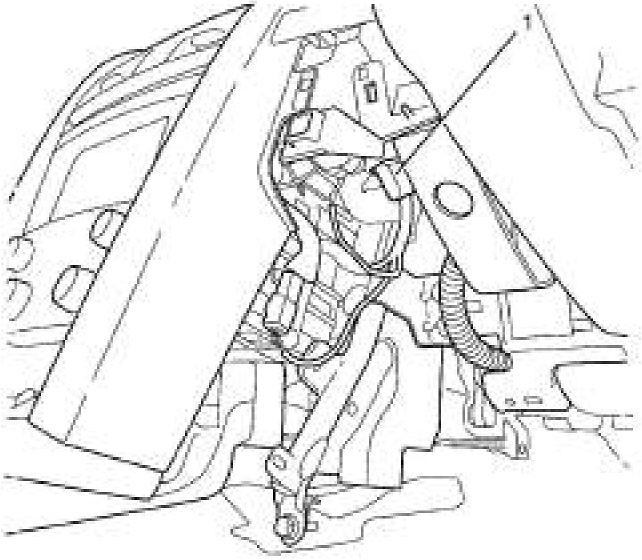
Data Link Connector Replacement (RHD)

Removal Procedure



1. Remove the knee bolster. Refer to Knee Bolster Replacement.
2. Remove the front floor console side trim panel. Refer to Front Floor Console Side Trim Panel Replacement - Right Side.
3. Remove the instrument panel extension trim panel. Refer to Instrument Panel Extension Replacement.
4. Remove the tape from the data link resistor (1).
5. Disconnect the data link resistor (1) from the instrument panel harness.

Installation Procedure



1. Connect the data link resistor (1) to the instrument panel harness.
2. Tape the data link resistor (1) to the instrument panel harness.
3. Install the instrument panel extension trim panel. Refer to Instrument Panel Extension Replacement.
4. Install the front floor console side trim panel. Refer to Front Floor Console Side Trim Panel Replacement - Right Side.
5. Install the knee bolster. Refer to Knee Bolster Replacement.

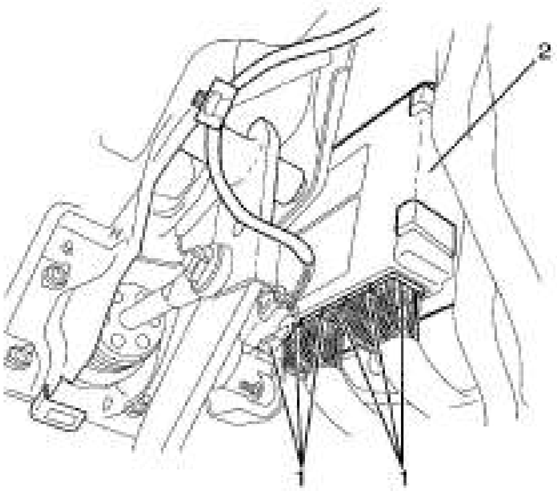
Body Control Module Replacement (RHD)

Removal Procedure

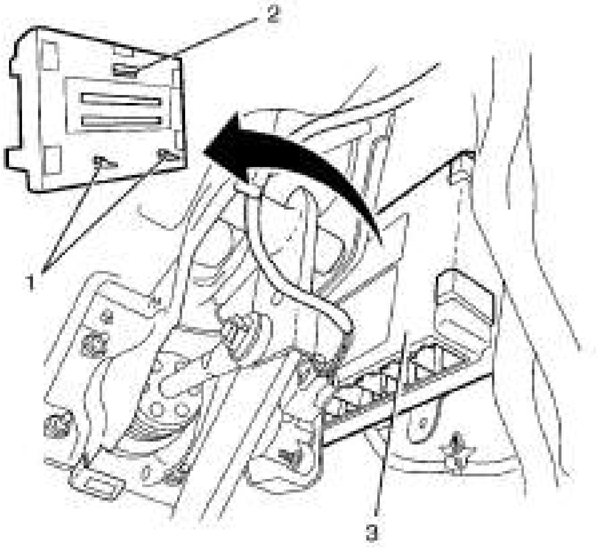
1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .

   Caution: Refer to SIR Caution in the Preface section.

2. Disable the SIR system. Refer to SIR Disabling and Enabling .
3. Remove the right closeout insulator panel. Refer to Instrument Panel Insulator Panel Replacement - Right Side .
4. Remove the knee bolster. Refer to Knee Bolster Replacement .
5. Remove the instrument panel retainer. Refer to Instrument Panel Retainer Replacement .



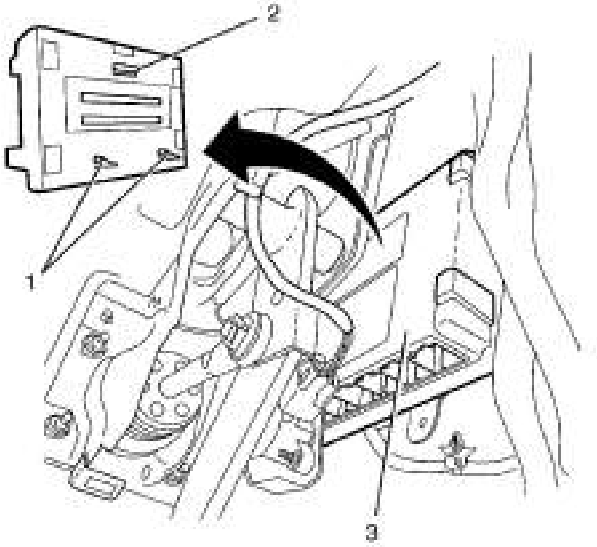
6. Disconnect the body control module (BCM) electrical connectors (1) from the BCM (2).



Important: Release the lower retaining clips (1), lift the BCM and unhook the upper retaining clip (2).

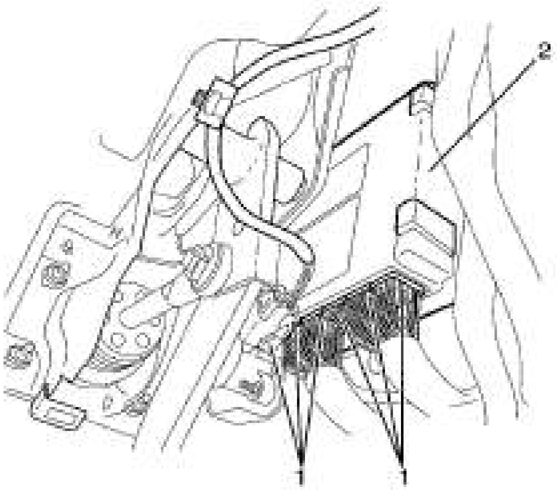
7. Remove the BCM (3).

Installation Procedure



Important: Locate the upper retaining clip (2) and engage the lower retaining clips (1).

1. Install the BCM (3).



2. Connect the body control module (BCM) electrical connectors (1) to the BCM (2).
3. Install the instrument panel retainer. Refer to Instrument Panel Retainer Replacement .
4. Install the knee bolster. Refer to Knee Bolster Replacement .
5. Install the right closeout insulator panel. Refer to Instrument Panel Insulator Panel Replacement - Right Side .

   Caution: Refer to SIR Caution in the Preface section.

6. Enable the SIR system. Refer to SIR Disabling and Enabling .
7. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
8. Re-programme the (BCM). Refer to Body Control Module Programming and Setup .

Body Control System Description and Operation

The body control system consists of the body control module (BCM), communications, and various input and outputs. Some inputs, outputs and messages require other modules to interact with the BCM. The BCM also has discrete input and output terminals to control the vehicle's body functions. The BCM is wired to the GMLAN High speed serial data buss and the GMLAN Low speed serial data buss and acts as a gateway between them. If the BCM does not communicate the vehicle will not start due to the inability of the engine control module (ECM) and theft deterrent module (TDM) to communicate without the BCM providing the gateway function.

Power Mode Master

This vehicles BCM functions as the power mode master (PMM). The ignition switch is a low current switch with multiple discrete ignition switch signals to the PMM for determination the power mode that will be sent over the serial data circuits to the other modules that need this information, and so the PMM will activate relays and other direct outputs of the PMM as needed. Refer to Power Mode Description and Operation for a complete description of power mode functions.

Serial Data Gateway

The BCM in this vehicle functions as a gateway or translator. The purpose of the gateway is to translate serial data messages between the GMLAN high speed buss and the GMLAN low speed buss for communication between the various modules. The gateway will interact with each network according to that network's transmission protocol.

One example of this necessary communication is the communication between the ECM which is high speed serial data and TDM which is low speed serial data. If these modules can not exchange information, the vehicle will not start.

Communication between the BCM and a scan tool can be on the high speed GMLAN network or low speed GMLAN network. If one network is lost, the BCM can still communicate with the scan tool. A lost communication DTC typically is set in modules other than the module with a communication failure.

Body Control Module

The various BCM input and output circuits are described in the corresponding functional areas indicated on the BCM electrical schematics. Some BCM functions with the subsystems may be as a gateway only or as an enable for the system. The BCM related systems/subsystems include, but are not limited to the following:

- Antilock Brake System (ABS) - Refer to ABS Description and Operation .
- Automatic Day-Night Mirror - Refer to Inside Rearview Mirror Description and Operation .
- Cruise Control System - Refer to Cruise Control Description and Operation .
- Exterior Lighting - Refer to Exterior Lighting Systems Description and Operation .
- Horn System - Refer to Horns System Description and Operation .
- HVAC - Refer to Air Delivery Description and Operation and Air Temperature Description and Operation .

- Instrument Cluster Indicator Control - Refer to Instrument Cluster Description and Operation .
- Interior Lighting - Refer to Interior Lighting Systems Description and Operation .
- Power Door Lock System - Refer to Power Door Locks Description and Operation .
- Rear Window Defogger System - Refer to Rear Window Defogger Description and Operation .
- Redundant Steering Wheel Controls - Refer to Radio/Audio System Description and Operation .
- Remote Function Actuation (RFA) control - Refer to Keyless Entry System Description and Operation .
- Retained Accessory Power (RAP) - Refer to Retained Accessory Power (RAP) Description and Operation .
- Shift Lock Control System - Refer to Automatic Transmission Shift Lock Control Description and Operation .
- Starting System - Refer to Starting System Description and Operation .
- Supplemental Inflatable Restraint (SIR) System - Refer to SIR System Description and Operation .
- Suspension System - Refer to Electronic Suspension Control Description and Operation .
- Tire Pressure Monitor (TPM) System - Refer to Tire Pressure Monitor Description and Operation .
- Vehicle Theft Deterrent - Refer to Theft Systems Description and Operation .
- Wiper/Washer System Functions - Refer to Wiper/Washer System Description and Operation .

Data Link Communications Description and Operation

Circuit Description

The communication among control modules is performed through the High speed GMLAN serial data circuits and the Low speed GMLAN serial data circuit. The modules that need real time communication are attached to the High Speed GMLAN network. The body control module (BCM) is the gateway between the high and low speed networks. Refer to Body Control System Description and OperationBody Control System Description and Operation for more information about the gateway.

Signal supervision is the process of determining whether an expected signal is being received or not. Some messages are sent on a periodic basis and are interpreted as a heartbeat of a device. If such a signal is lost, the signal supervision part of the software will set a no communication DTC (U. code) against the missing device. This code is mapped on the scan tool screen as a code against the physical device. A lost communication DTC typically is set in modules other than the module with a communication failure.

GMLAN High Speed Circuit Description

The data link connector (DLC) allows a scan tool to communicate with the high speed GMLAN serial data circuit. The serial data is transmitted on two twisted wires that allow speed up to 500 Kb/s. The twisted pair is terminated with two 120 ohms resistors, the location of these resistors is listed in the Master Electrical Component ListMaster Electrical Component List. The high speed GMLAN is a differential bus. The high speed GMLAN serial data bus (+) and high speed GMLAN serial data (-) are driven to opposite extremes from a rest or idle level. The idle level, which is approximately 2.5 volts, is considered recessive transmitted data and is interpreted as a logic 1. Driving the lines to their extremes, adds one volt to the high speed GMLAN serial data bus (+) and subtracts one volt from the high speed GMLAN serial data bus (-) wire. If a communication signal is lost, the application will set a no communication code against the respective control module. This code is mapped on the sacn tool screen as a code against the physical device. Note: a loss of serial data DTC does not represent a failure of the module that the code is set in.

The high speed GMLAN serial data allows communication between the BCM, ECM, transmission control module (TCM), steering angle sensor (SAS), EBCM, automatic headlamp levelling module (AHLL) and the electronic suspension control module (ESCM) depending on RPO.

GMLAN Low Speed Circuit Description

The data link connector (DLC) allows a scan tool to communicate with the low speed GMLAN serial data circuit. The serial data is transmitted over a single wire to the appropriate control modules. Under normal vehicle operating conditions, the speed of the buss is 33.33 Kb/s. This protocol produces a simple pulse train sent out over the GMLAN low speed serial data bus. When a module pulls the buss high, 5 volts, this creates a logic state of 0 on the buss. When the buss is pulled low, 0 volts, it is translated as a logic state of 1. To wake the control modules connected to the GMLAN low speed serial data buss, a high voltage wake up pulse is sent out over the buss, the voltage level of the pulse is +10 volts. Modules connected to the GMLAN low speed buss can be part of a virtual network as described in GMLAN High Speed Circuit Description above. The modules on the GMLAN low speed serial data buss are connected to the buss using several splice or "star" connectors separating groups of modules. Refer to Data Communication Schematics for specific schematics information.

The following lists state the splices and modules connected to the low speed serial data circuits:

I / P Splice

- BCM
- Secondary information centre (SIC)
- Instrument panel cluster (IPC)
- Inflatable Restraint Sensing and Diagnostic Module (SDM)
- Theft deterrent module (TDM)
- Infotainment unit - integrated radio chassis (IRC)
- Heating ventilation and cooling (HVAC) control module
- Remote function actuator (RFA)
- Rear seat entertainment (RSE) control module
- Navigation interface module (NIM)
- Seat interface module (SIM)
- Object detection module - ultrasonic park assist (UPA)
- Telematics control module

Data Link Connector (DLC)

The data link connector (DLC) is a standardized 16-cavity connector. The DLC low speed serial data circuit is connected directly to the I/P splice then to all other splices or modules. Connector design and location is dictated by an industry wide standard, and is required to provide the following:

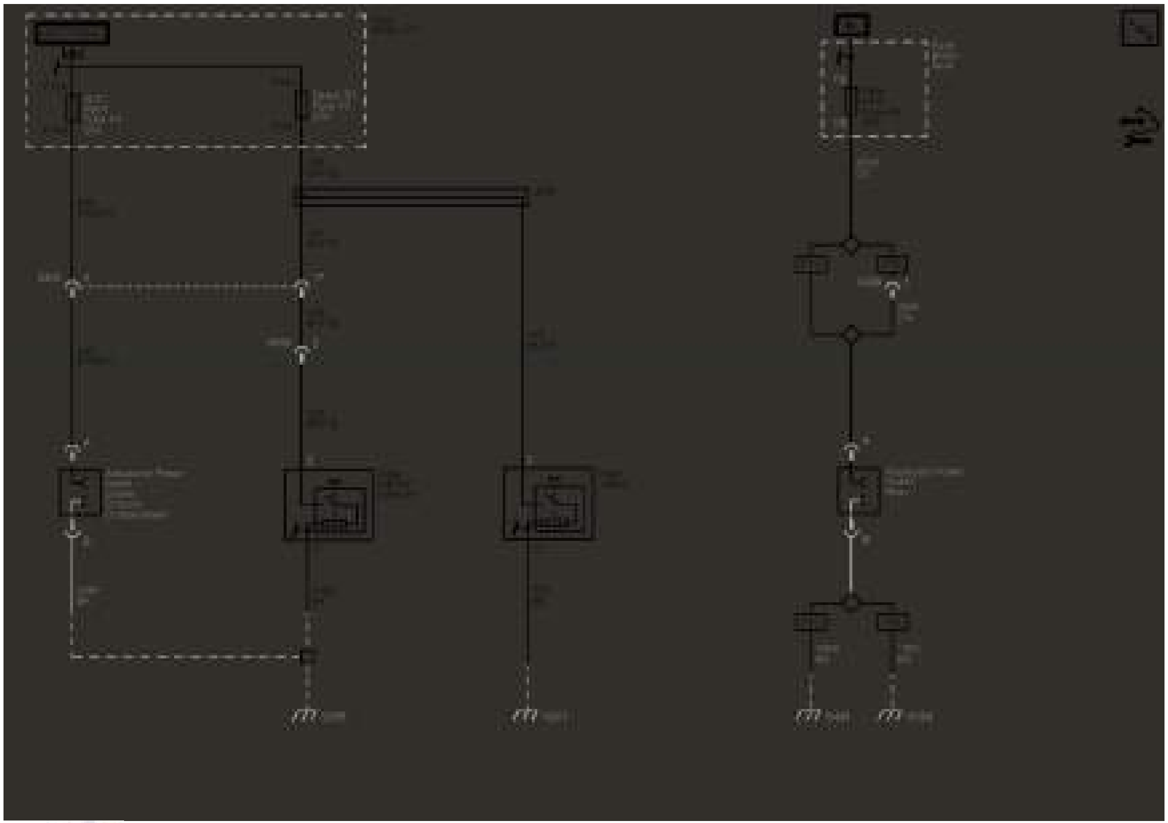
- Pin 1 GMLAN low speed communications terminal
- Pin 4 Scan tool power ground terminal
- Pin 5 Common signal ground terminal
- Pin 6 High speed GMLAN serial data bus (+) terminal
- Pin 14 High speed GMLAN serial data bus (-) terminal
- Pin 16 Scan tool power, battery positive voltage terminal

Serial Data Reference

The scan tool communicates over the various busses on the vehicle. When a scan tool is installed on a vehicle, the scan tool will try to communicate with every module that could be optioned into the vehicle. If an option is not installed on the vehicle, the scan tool will display No Comm for that options specific control module.

In order to avert misdiagnoses of No Communication with a specific module, refer to Data Link ReferencesData Link References for a list of modules, the busses they communicate with, and the RPO codes for a specific module.

Cigar Lighter / Power Outlet Schematics



Diagnostic Starting Point - Power Outlets

Begin the system diagnosis by reviewing the system Description and Operation. Reviewing the Description and Operation information will help you determine the correct symptom diagnostic procedure to use when a malfunction exists. Reviewing the Description and Operation information will also help you determine if the condition is a fault or part of normal operation.

Symptoms - Power Outlets

Review the system operation in order to familiarize yourself with the system functions. Refer to Diagnostic Starting Point - Power Outlets .

Visual/Physical Inspection

Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

Power Outlet Receptacle Inoperative

Power Outlet Receptacle Inoperative

1. Perform the Diagnostic System Check - Vehicle.
2. Using a test lamp, test the power outlet socket supply voltage circuit.

   If test lamp does not illuminate, repair or replace the supply voltage circuit.
3. Using a DMM, test the power outlet socket ground circuit to a known good ground.

   If DMM indicates that the circuit is not intact, repair or replace the ground circuit.

   If DMM indicates that the circuit is intact, replace the power outlet socket.

Cigar Lighter Receptacle or 12-Volt Accessory Power Receptacle Replacement (LWBLHD)

Instrument Panel

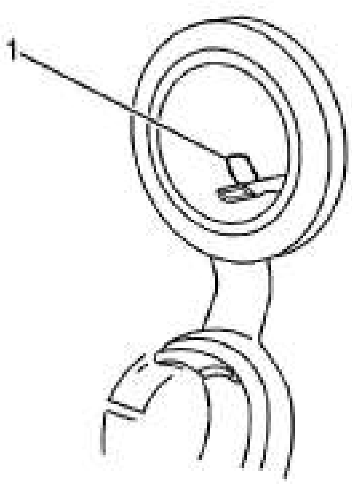
Tools Required

J 42059 Cigar Lighter Socket Remover

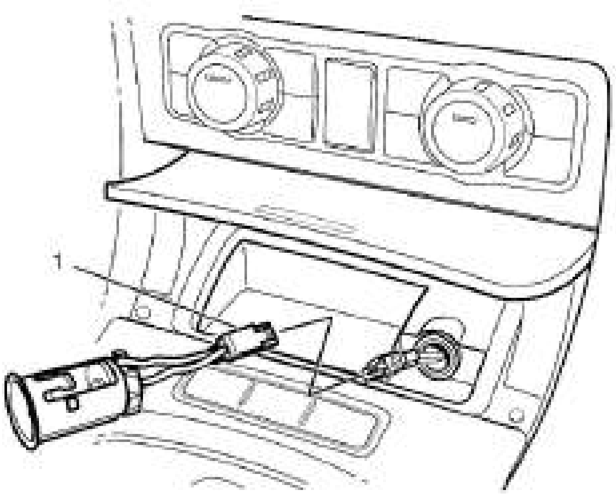
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

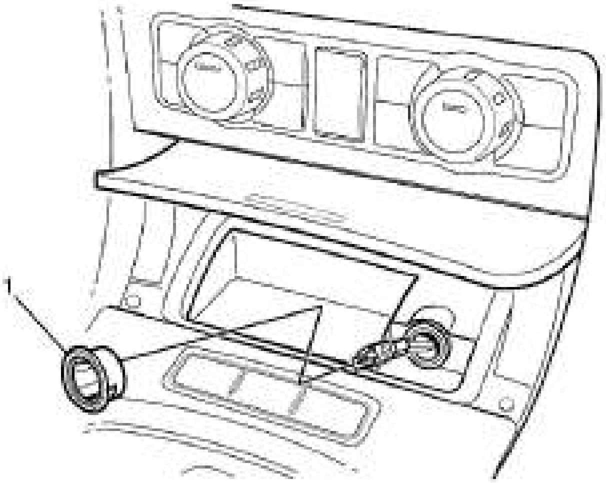
1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.



2. With any accessories removed, place the T receptacle of J 42059 into one of the retaining tabs (1). Angle the other side into the opposite retaining tab. Pull the power accessory receptacle straight out.

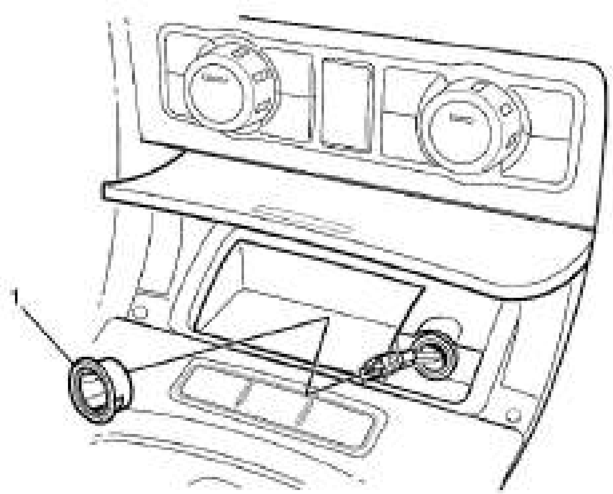


3. Disconnect the power accessory receptacle electrical connector (1).

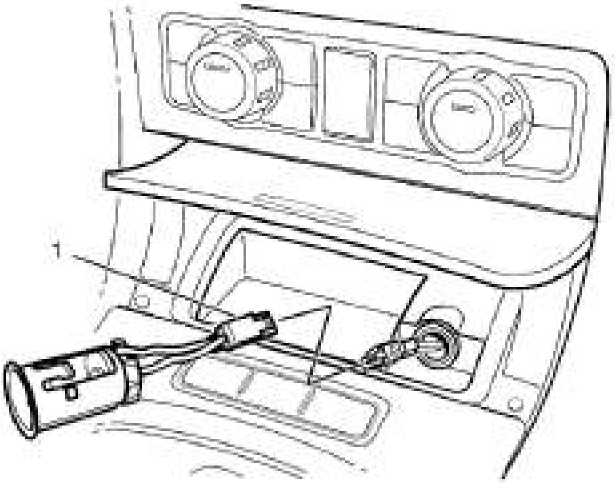


4. Remove the bezel (1).

Installation Procedure



1. Install the bezel (1).



2. Connect the power accessory receptacle electrical connector (1).
3. Install the accessory power receptacle to the receptacle bezel.
4. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.

Centre Console -- Rear

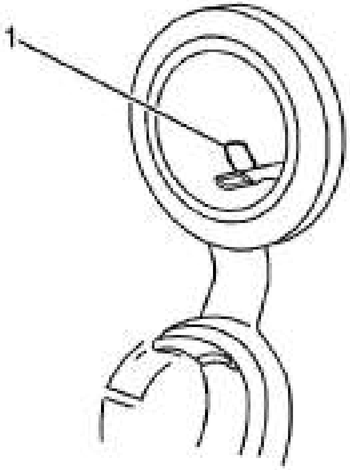
Tools Required

J 42059 J 42059 Cigar Lighter Socket Remover

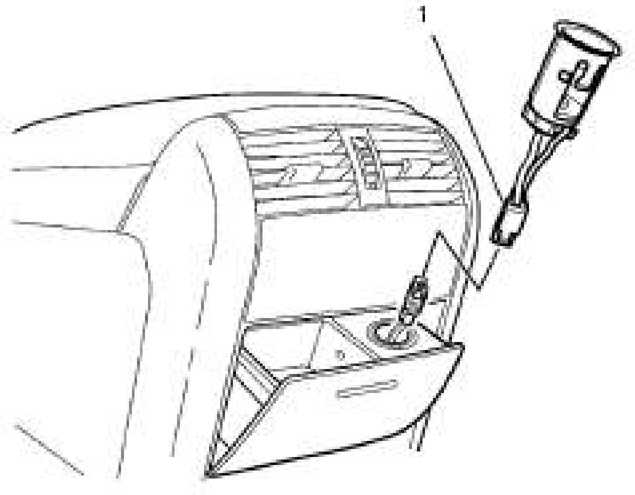
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

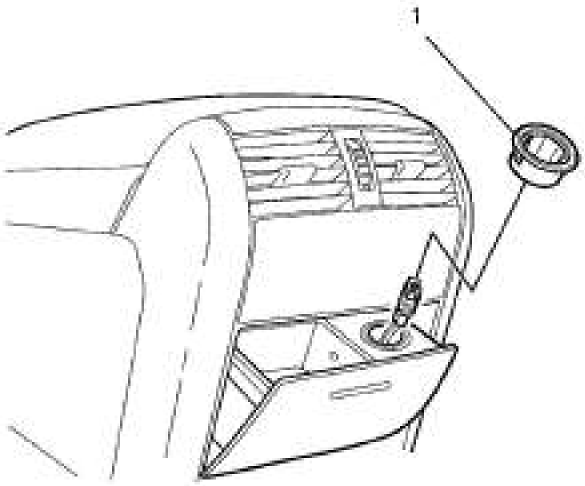
1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.



2. With any accessories removed, place the T receptacle of J 42059 into one of the retaining tabs (1). Angle the other side into the opposite retaining tab. Pull the power accessory receptacle straight out.

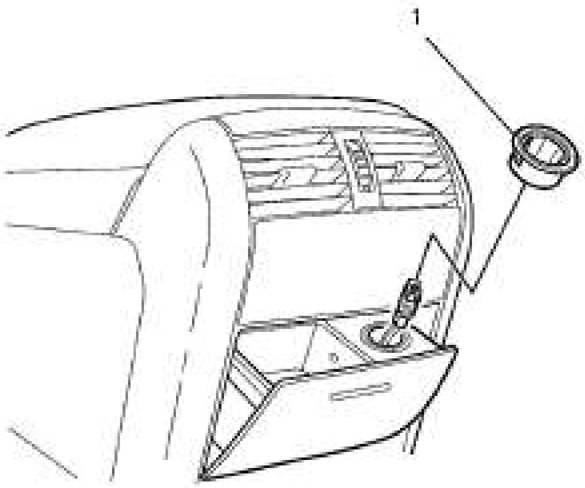


3. Disconnect the power accessory receptacle electrical connector (1).

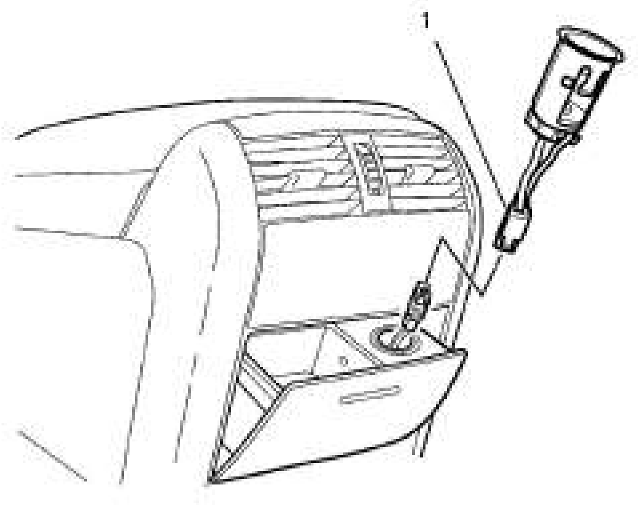


4. Remove the bezel (1).

Installation Procedure



1. Install the bezel (1).



2. Connect the power accessory receptacle electrical connector (1).
3. Install the accessory power receptacle to the receptacle bezel.
4. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.

Centre Console

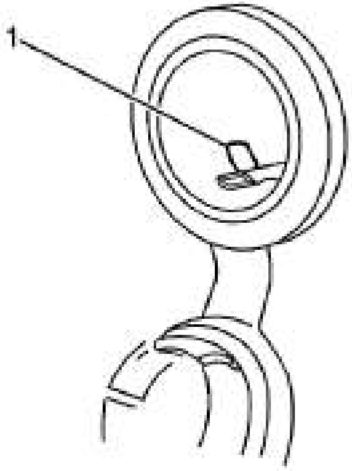
Tools Required

J 42059 Cigar Lighter Socket Remover

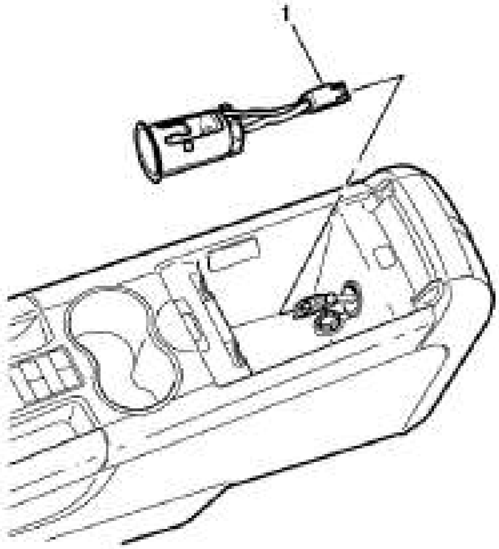
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

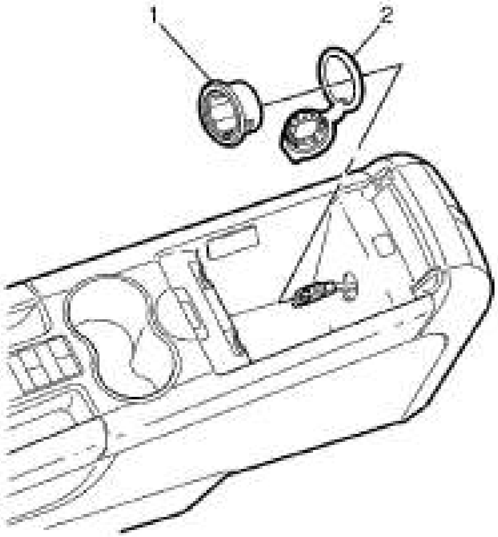
1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.



2. Place the T receptacle of J 42059 into one of the retaining tabs (1). Angle the other side into the opposite retaining tab. Pull the power accessory receptacle straight out.

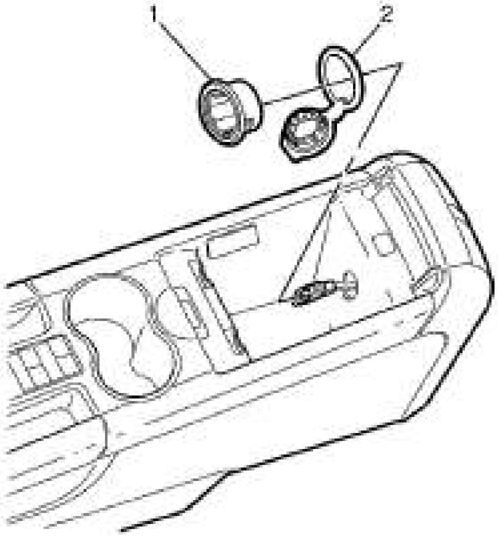


3. Disconnect the power accessory receptacle electrical connector (1).

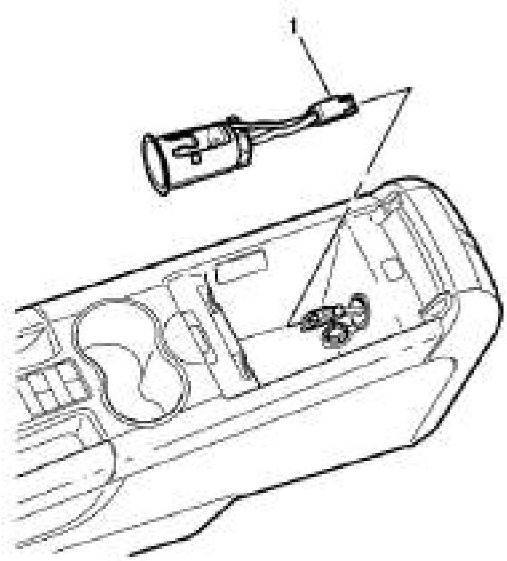


4. Remove the bezel (1) and the cover (2).

Installation Procedure



1. Install the cover (2) and the bezel (1).



2. Connect the power accessory receptacle electrical connector (1).
3. Install the accessory power receptacle to the receptacle bezel.
4. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.

Rear Compartment

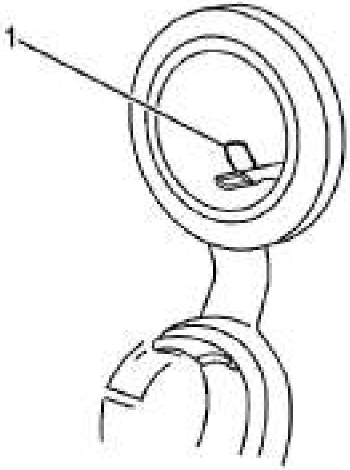
Tools Required

J 42059 Cigar Lighter Socket Remover

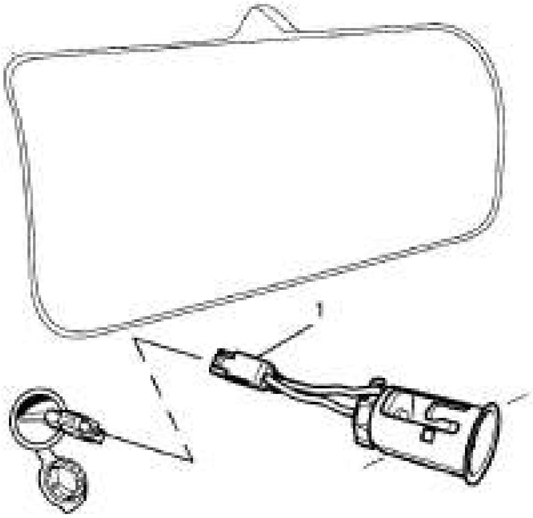
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

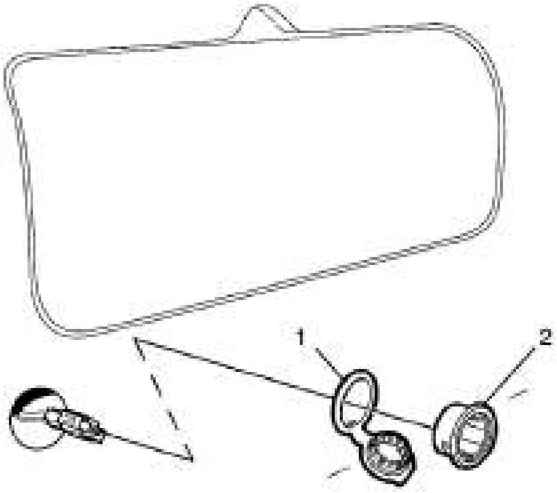
1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.



2. Place the T receptacle of J 42059 into one of the retaining tabs (1). Angle the other side into the opposite retaining tab. Pull the power accessory receptacle straight out.

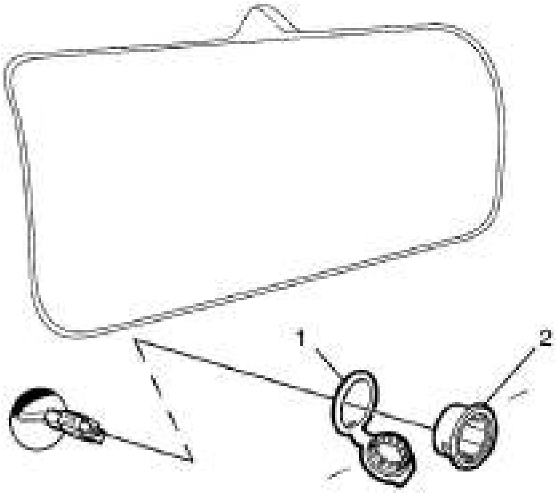


3. Disconnect the power accessory receptacle electrical connector (1).

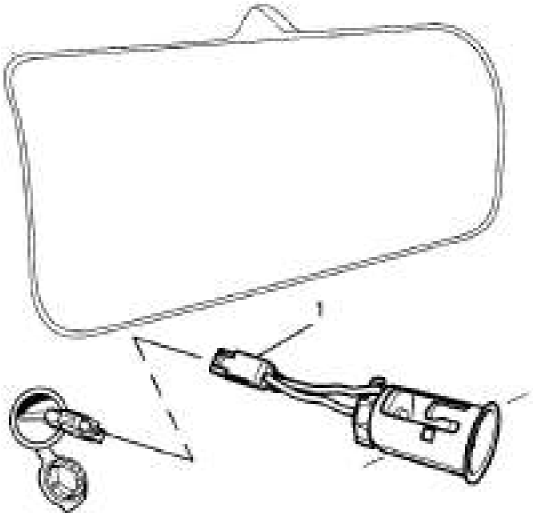


4. Remove the cover (1) and the bezel(2).

Installation Procedure



1. Install the cover (2) and the bezel (1).



2. Connect the power accessory receptacle electrical connector (1).
3. Install the accessory power receptacle to the receptacle bezel.
4. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.

Cigar Lighter Receptacle or 12-Volt Accessory Power Receptacle Replacement (LWBRHD)

Centre Console

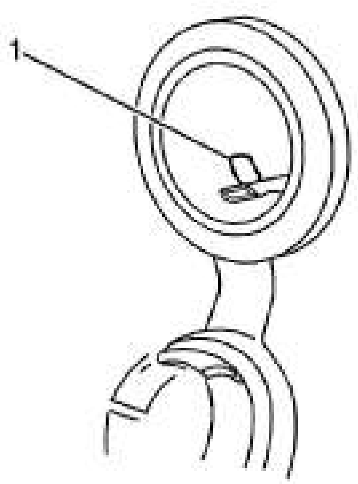
Tools Required

J 42059 Cigar Lighter Socket Remover

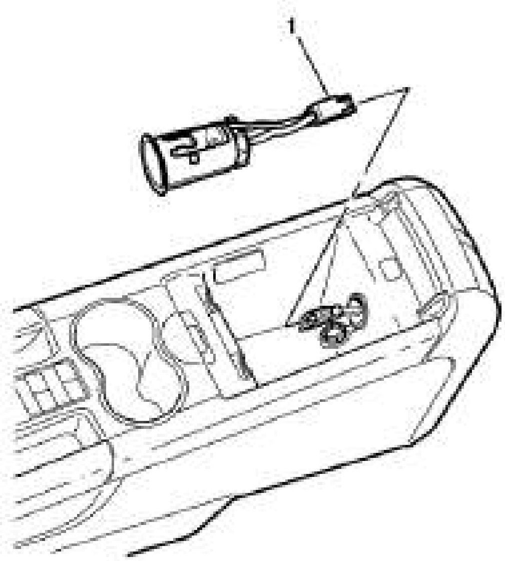
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

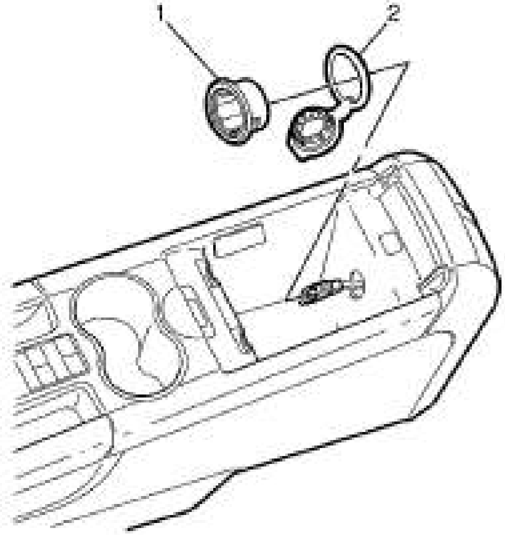
1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.



2. With any accessories removed, place the T receptacle of J 42059 into one of the retaining tabs (1). Angle the other side into the opposite retaining tab. Pull the power accessory receptacle straight out.

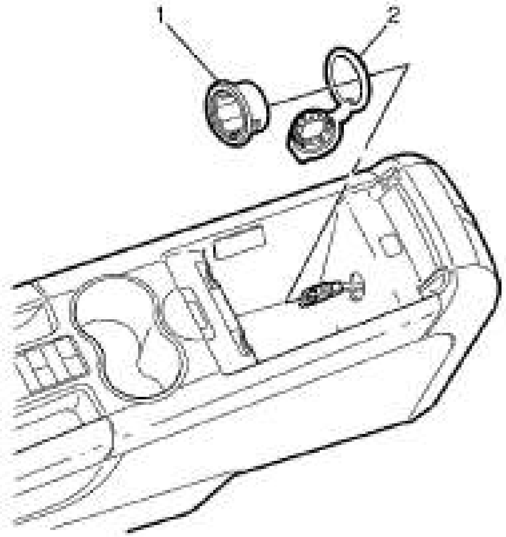


3. Disconnect the power accessory receptacle electrical connector (1).

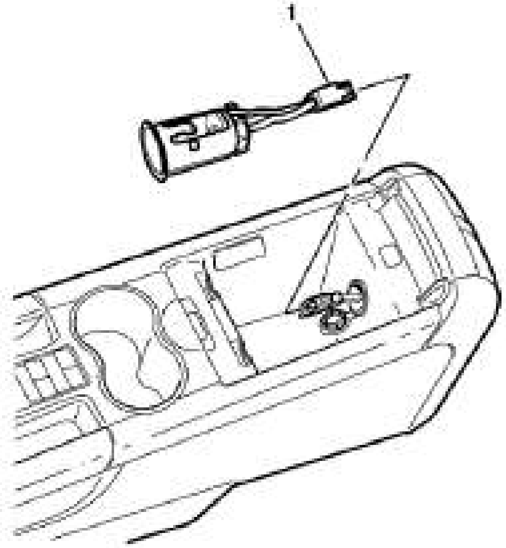


4. Remove the bezel (1) and the cover (2).

Installation Procedure



1. Install the cover (2) and the bezel (1).



2. Connect the power accessory receptacle electrical connector (1).
3. Install the accessory power receptacle to the receptacle bezel.
4. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.

Rear Compartment

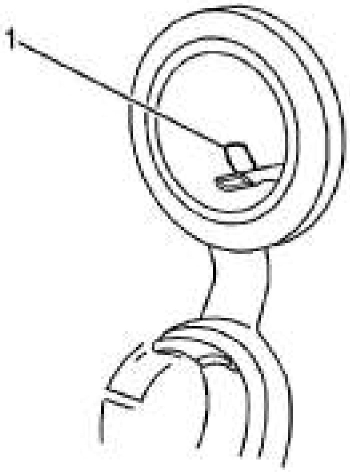
Tools Required

J 42059 J 42059 Cigar Lighter Socket Remover

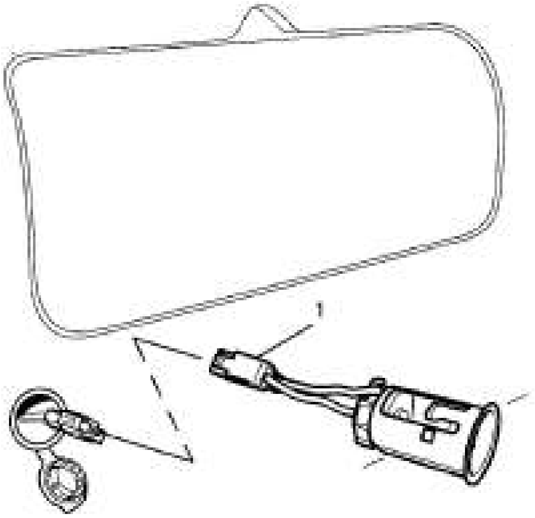
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

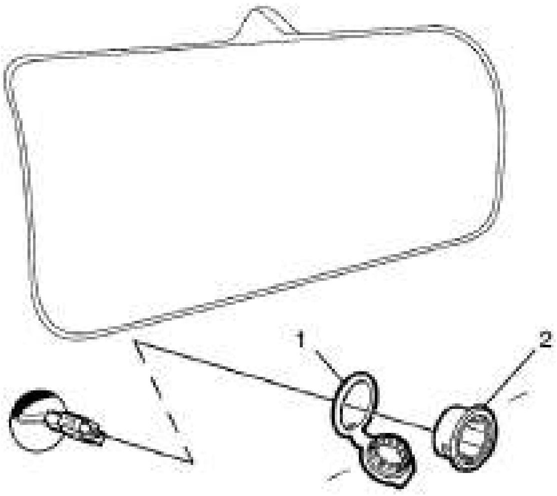
1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.



2. Place the T receptacle of J 42059 into one of the retaining tabs (1). Angle the other side into the opposite retaining tab. Pull the power accessory receptacle straight out.

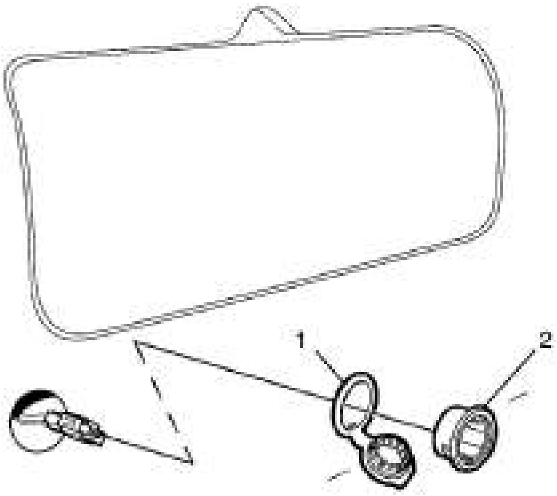


3. Disconnect the power accessory receptacle electrical connector (1).

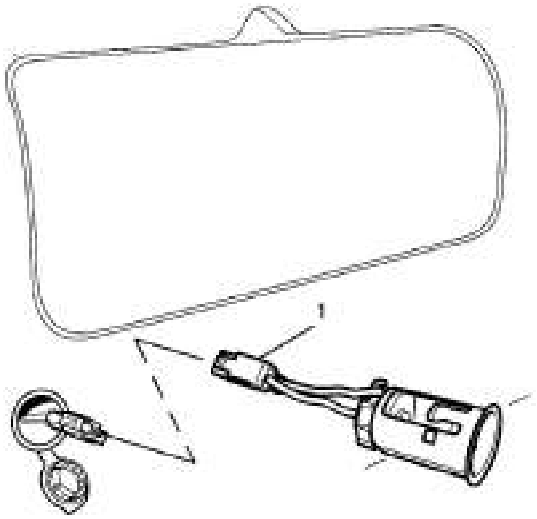


4. Remove the cover (1) and the bezel(2).

Installation Procedure



1. Install the cover (2) and the bezel (1).



2. Connect the power accessory receptacle electrical connector (1).
3. Install the accessory power receptacle to the receptacle bezel.
4. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.

Cigar Lighter Receptacle or 12-Volt Accessory Power Receptacle Replacement (Sportwagon)

Centre Console

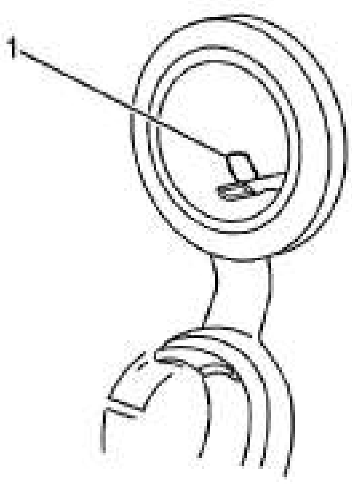
Tools Required

J 42059 Cigar Lighter Socket Remover

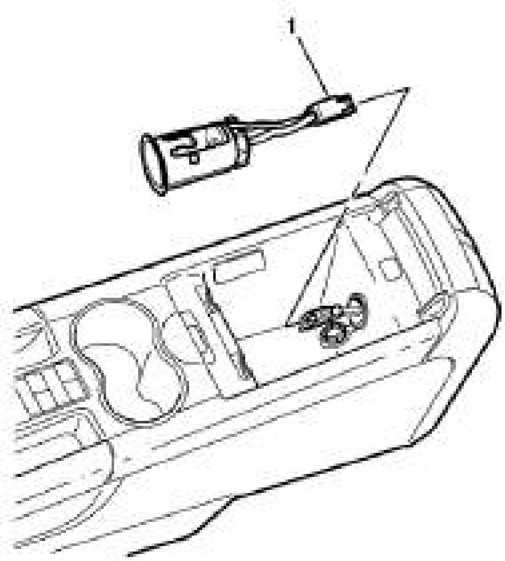
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

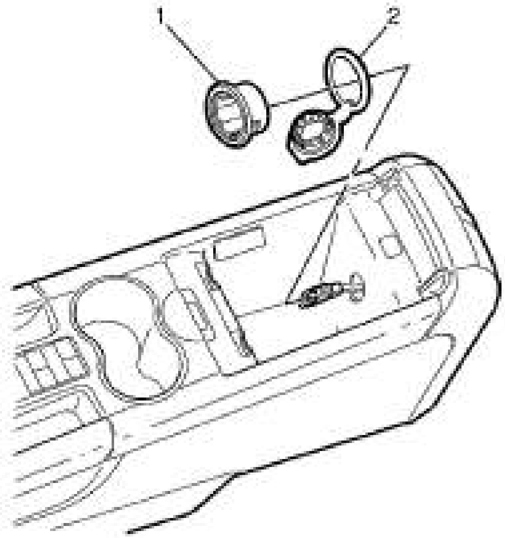
1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.



2. Release the accessory power receptacle by placing special tool J 42059 onto the accessory power receptacle retaining tab (1). Angle the other side of the tool onto the opposite accessory power receptacle retaining tab.

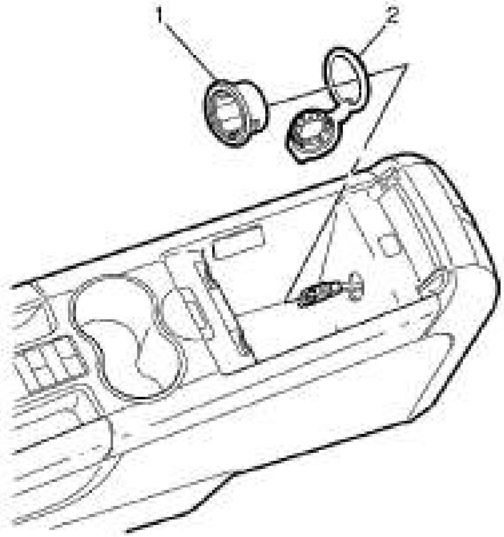


3. Detach the accessory power receptacle from the accessory power receptacle bezel.
4. Disconnect the accessory power receptacle electrical connector (1).
5. Remove the accessory power receptacle from the accessory power receptacle bezel.

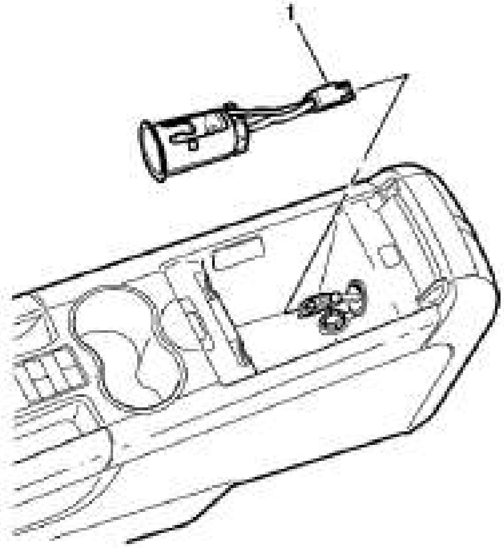


6. Remove the accessory power receptacle bezel (1) and the accessory power receptacle cover (2) from the front floor console.

Installation Procedure



1. Install the accessory power receptacle cover (2) and the accessory power receptacle bezel (1) to the front floor console.



2. Connect the accessory power receptacle electrical connector (1).
3. Install the accessory power receptacle to the accessory power receptacle bezel.
4. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.

Rear Compartment

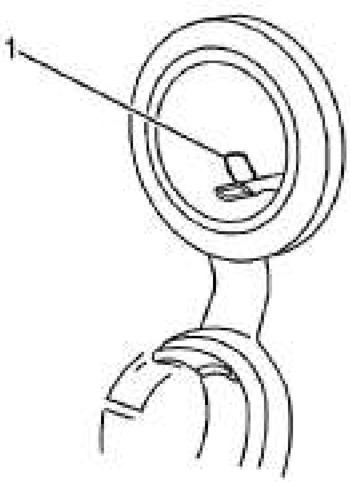
Tools Required

J 42059 Cigar Lighter Socket Remover

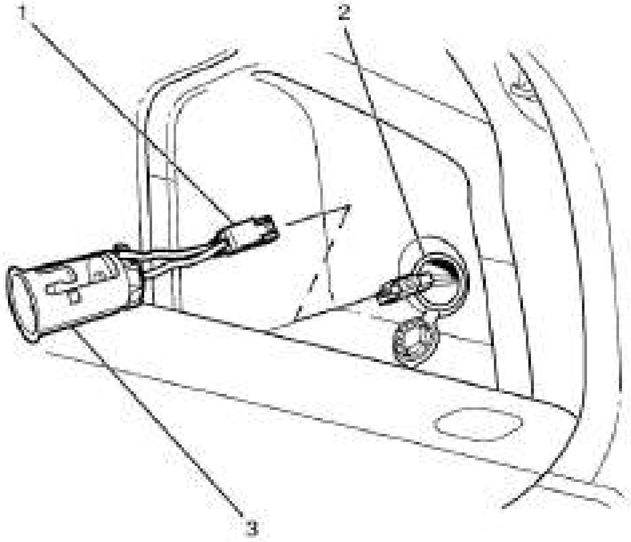
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

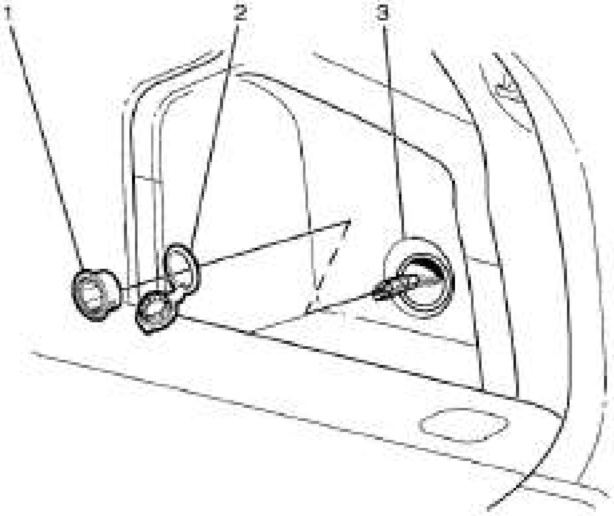
1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.



2. Release the accessory power receptacle by placing special tool J 42059 onto the accessory power receptacle retaining tab (1). Angle the other side of the tool onto the opposite power receptacle retaining tab.

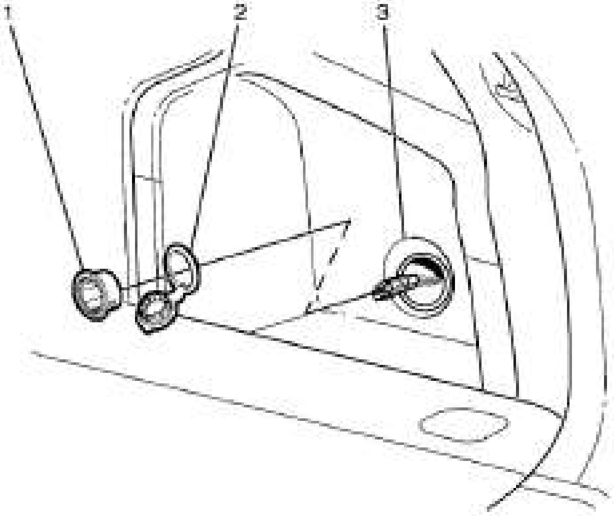


3. Detach the accessory power receptacle (3) from the accessory power receptacle bezel (2).
4. Disconnect the accessory power receptacle electrical connector (1).
5. Remove the accessory power receptacle (3).

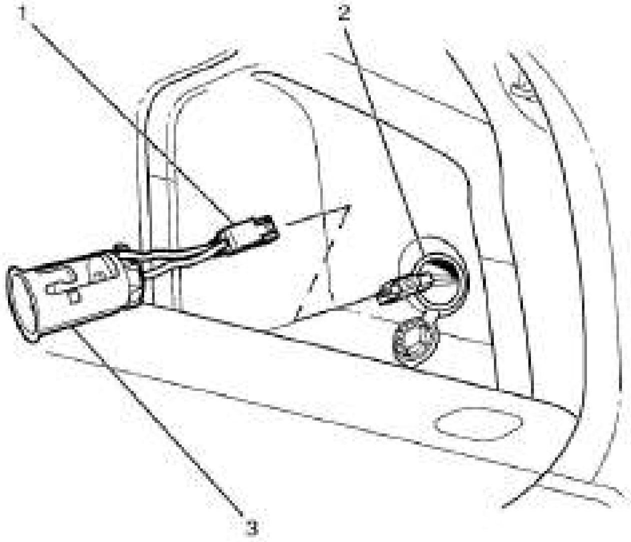


6. Remove the accessory power receptacle bezel (1) and the accessory power receptacle cover (2) from the quarter inner trim finish panel (3).

Installation Procedure



1. Install the accessory power receptacle bezel (1) and the accessory power receptacle cover (2) to the quarter inner trim finish panel (3)



2. Connect the accessory power receptacle electrical connector (1).
3. Install the accessory power receptacle (3) to the receptacle bezel (2).
4. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.

Cigar Lighter Receptacle or 12-Volt Accessory Power Receptacle Replacement (SWBLHD)

Instrument Panel

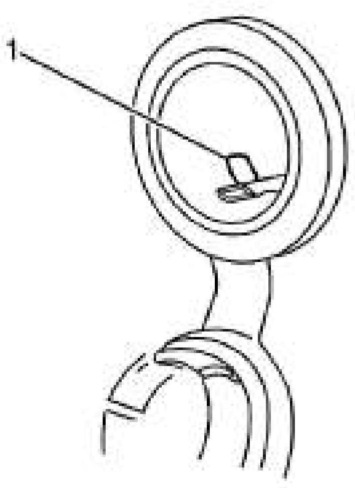
Tools Required

J 42059 Cigar Lighter Socket Remover

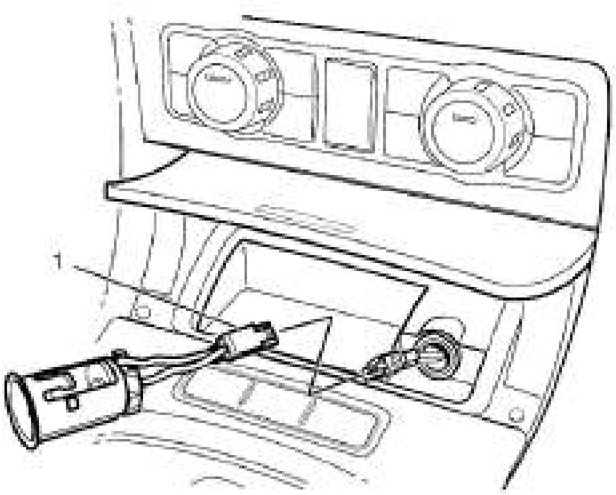
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

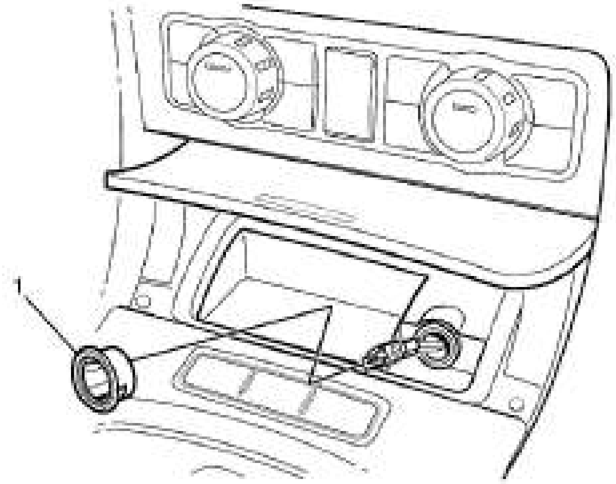
1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.



2. With any accessories removed, place the T receptacle of J 42059 into one of the retaining tabs (1). Angle the other side into the opposite retaining tab. Pull the power accessory receptacle straight out.

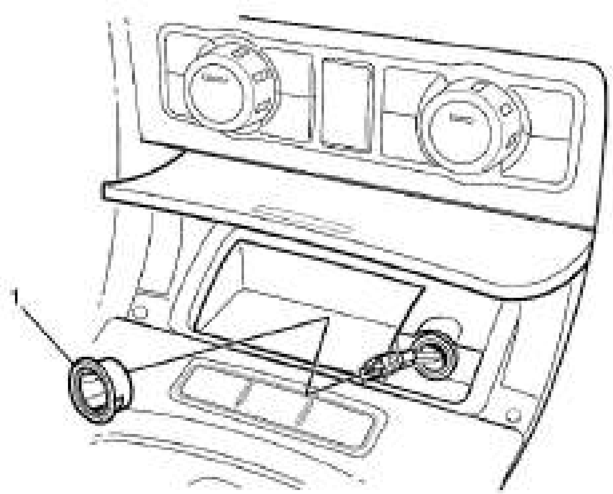


3. Disconnect the power accessory receptacle electrical connector (1).

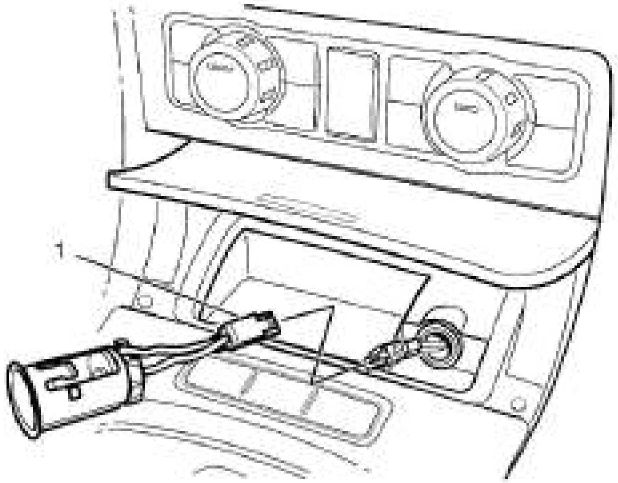


4. Remove the bezel (1).

Installation Procedure



1. Install the bezel (1).



2. Connect the power accessory receptacle electrical connector (1).
3. Install the accessory power receptacle to the receptacle bezel.
4. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.

Centre Console -- Rear

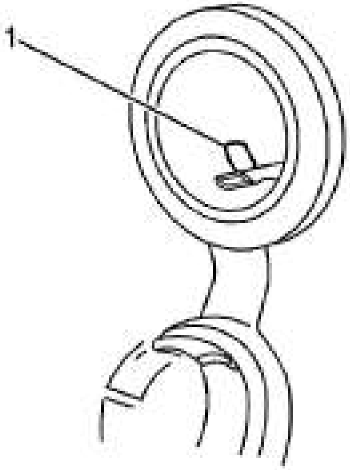
Tools Required

J 42059 J 42059 Cigar Lighter Socket Remover

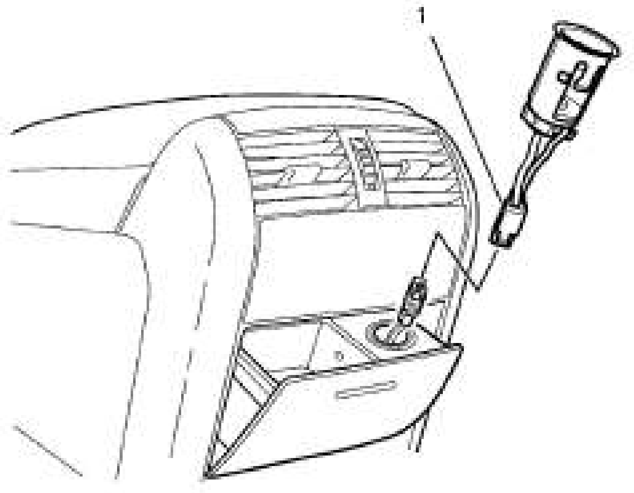
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

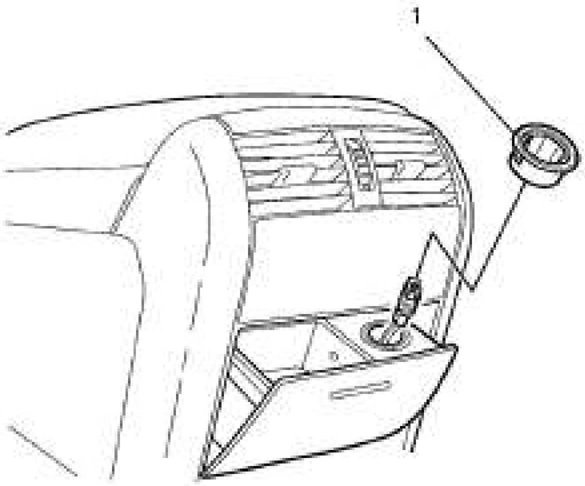
1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.



2. With any accessories removed, place the T receptacle of J 42059 into one of the retaining tabs (1). Angle the other side into the opposite retaining tab. Pull the power accessory receptacle straight out.

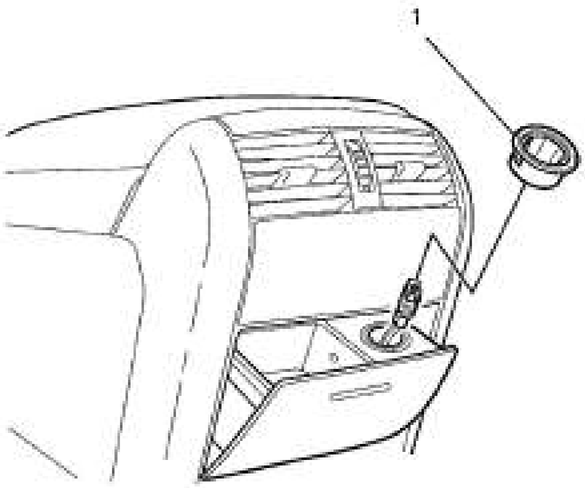


3. Disconnect the power accessory receptacle electrical connector (1).

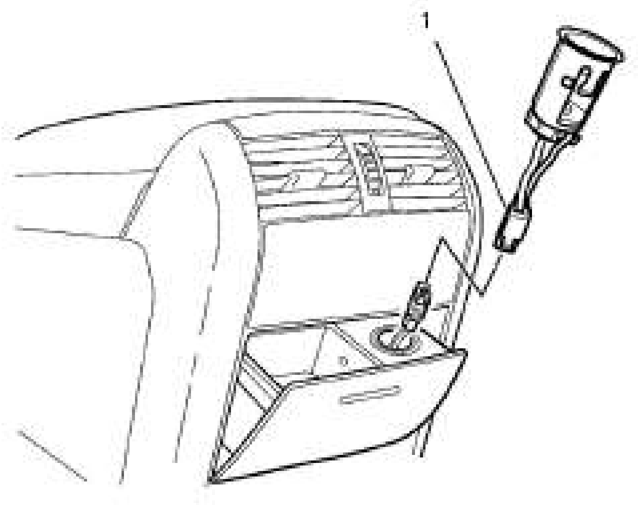


4. Remove the bezel (1).

Installation Procedure



1. Install the bezel (1).



2. Connect the power accessory receptacle electrical connector (1).
3. Install the accessory power receptacle to the receptacle bezel.
4. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.

Centre Console

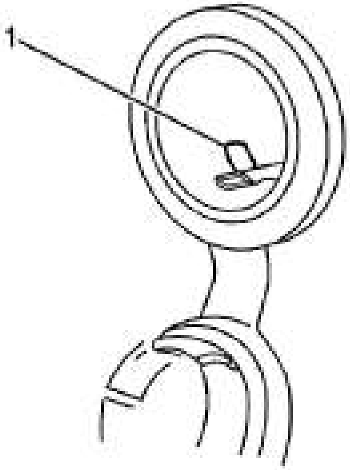
Tools Required

J 42059 J 42059 Cigar Lighter Socket Remover

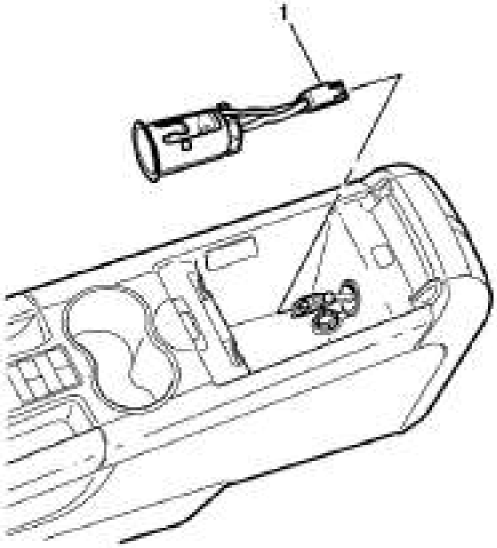
Removal Procedure

> **Caution:** Refer to Battery Disconnect Caution in the Preface section.

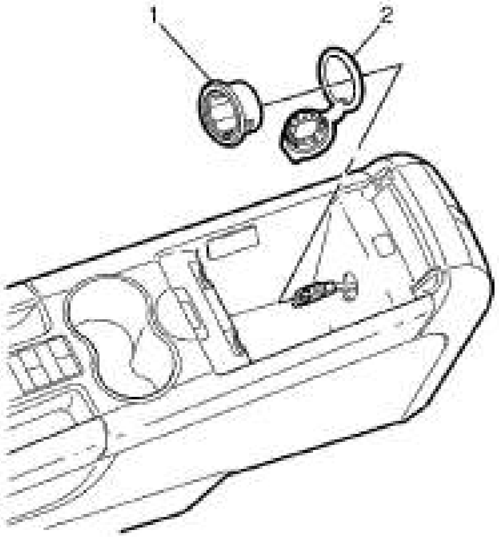
1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.



2. Place the T receptacle of J 42059 into one of the retaining tabs (1). Angle the other side into the opposite retaining tab. Pull the power accessory receptacle straight out.

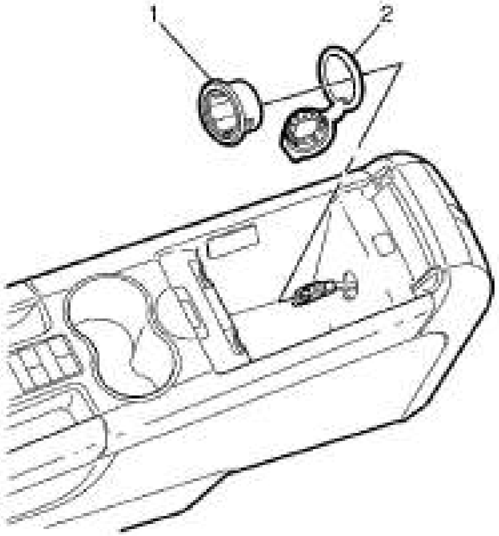


3. Disconnect the power accessory receptacle electrical connector (1).

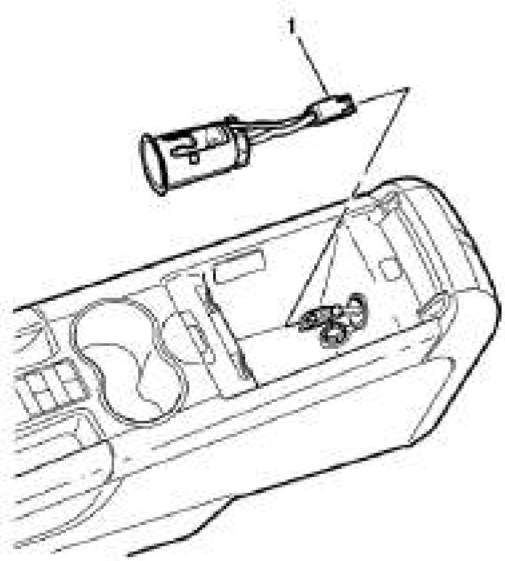


4. Remove the bezel (1) and the cover (2).

Installation Procedure



1. Install the cover (2) and the bezel (1).



2. Connect the power accessory receptacle electrical connector (1).
3. Install the accessory power receptacle to the receptacle bezel.
4. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.

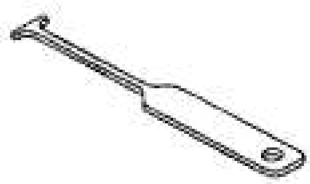
Power Outlets Description and Operation (Sportwagon)

The vehicle is fitted with two power outlet located in the centre console and the luggage compartment. The power outlets are operational when the ignition is turned to either the On or the Accessories position, and will provide 120 W of power at 12 V (10 A).

Power Outlets Description and Operation (SWBRHD)

The vehicle is fitted with a centre console power outlet. The power outlet is operational when the ignition is turned to either the On or the Accessories position, and will provide 120 W of power at 12 V (10 A).

Special Tools

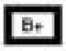
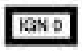
Illustration	Tool Number / Description
	J 42059 Cigar Lighter Socket Remover

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Power and Signal Distribution | Wiring Systems and Power Management | Schematic and Routing Diagrams |
Document ID: 2087480

Electrical Schematic Symbols

Table 1: Voltage Indicators
Table 2: General Icons
Table 3: Switch Position Icons
Table 4: Module Circuit Function Icons
Table 5: Harness Components
Table 6: Component Parts
Table 7: Switches and Relays
Table 8: Devices and Sensors

Voltage Indicators

Symbol	Description
	Battery Voltage
	Ignition Switch - Off Position
	Ignition Switch - Accessory Position

IGN I 🔍	
IGN II 🔍	Ignition Switch - Run Position
IGN III 🔍	Ignition Switch - Start Position

General Icons

Symbol	Description
LOC	Master Component List Icon This icon is used on the schematic to link to the Master Electrical Component List.

🔍	
DESC 🔍	Description and Operation Icon This icon is used on the schematic to link to the Description and Operation of that particular system.
🔍	Computer Programming Icon This icon is used on the schematic to link to Control Module References, which identifies which components need programming upon replacement.
→ 🔍	Next Schematic Page Icon This icon is used on the schematic to navigate to the next schematic in the subsystem.
	Previous Schematic Page Icon

← 🔍	This icon is used on the schematic to navigate to the previous schematic in the subsystem.
⚠ 🔍	Supplemental Inflatable Restraint (SIR) or Supplemental Restraint System (SRS) Icon This icon is used to alert the technician that the system contains SIR/SRS components that require certain precautions before servicing.
ℹ 🔍	Information Icon This icon is used to alert the technician that there is additional information that will aid in servicing a system.
⚡	Danger - High Voltage Icon This icon is used to alert the technician that a component/system contains 300 volt circuits.

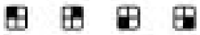
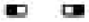
🔍	
⚡ 🔍	High Voltage Icon This icon is used to alert the technician that a component/system contains voltage greater than 42 volts but less than 300 volts.
⚠ 🔍	Caution Icon This icon is used to advise the technician to use caution when servicing this component.
⇅ 🔍	Functional Serial Data Communication This icon is used to show the technician that the serial data circuit detail is shown incomplete. It also provides an active link to the Data Communication Schematics were the circuit is shown complete.

Switch Position Icons

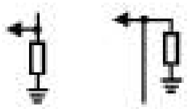
Symbol	Description

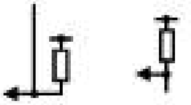
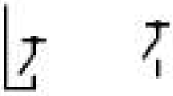
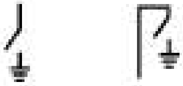
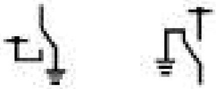
↑ ∧ △	Generic Up Arrows
↓ ∨ ▽	Generic Down Arrows
← < ◁	Generic Left Arrows
→ > ▷	Generic Right Arrows

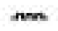
⇊	Generic Express Down Arrows
⏻	On/Off Icon
🔒	Generic Lock Icon
🔓	Generic Unlock Icon

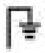
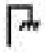
	Generic Window Switch Positions - 4 Door
	Generic Window Switch Positions - 2 Door

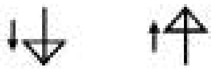
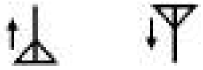
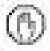
Module Circuit Function Icons

Symbol	Description
	I/O Pull-Down Resistors (-)
	I/O Pull-Up Resistors (+)

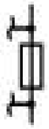
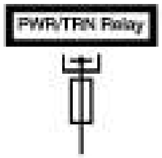
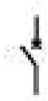
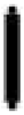
	
	I/O High-Side Drive Switch (+)
	I/O Low-Side Drive Switch (+)
	I/O Bidirectional Switch (+/-)

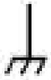
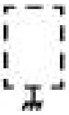
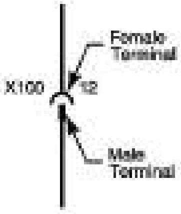
	Pulse-Width Modulation Symbol
B+	Battery Voltage
IGN	Ignition Voltage
5V	Voltage Reference

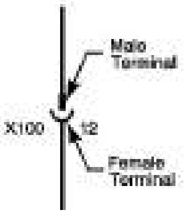
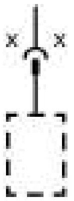
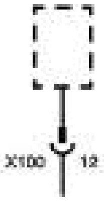
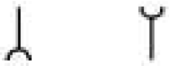
5V AC	A/C Voltage
	Low Reference
	Ground
	Serial Data

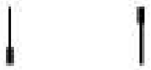
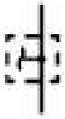
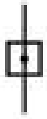
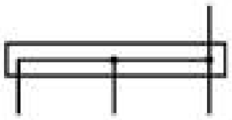
	Antenna Signal - In
	Antenna Signal - Out
	Brake Apply

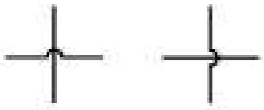
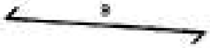
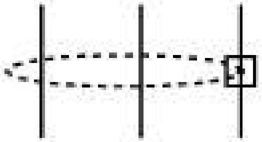
Harness Components

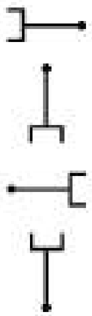
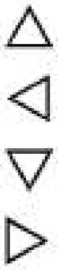
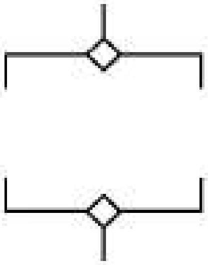
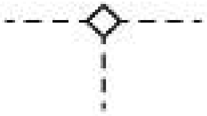
Symbol	Description
	Fuse
	Fuse Supplied by a Relay
	Circuit Breaker
	Fusible Link

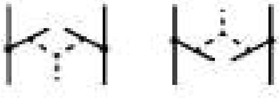
	Ground
	Case Ground
 Female Terminal X100 12 Male Terminal	Inline Harness Connector
	Inline Harness Connector

 Male Terminal X100 12 Female Terminal	
	Pigtail Connection
	Pigtail Connection
	Provisional or Diagnostic Connector

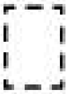
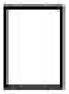
	Blunt Cut Wire
	Incomplete Physical Splice
	Complete Physical Splice - 2 Wires
	Complete Physical Splice - 3 or more wires

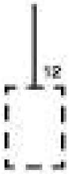
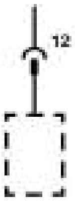
	Wire Crosses
	Twisted Wires
	Shield
	Circuit References

	
	Circuit Continuation Arrowheads
	Option Breakpoint
	Ground Circuit Connection

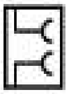
	Connector Shorting Clip

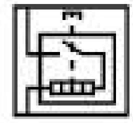
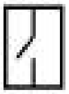
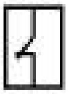
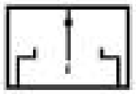
Component Parts

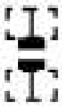
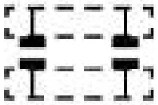
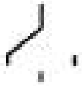
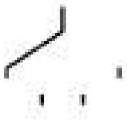
Symbol	Description
	Partial Component When a component is represented in a dashed box, the component or its wiring is not shown in its entirety.
	Entire Component When a component is represented in a solid box the component or its wiring is shown in its entirety.
	Connector Directly Attached to Component

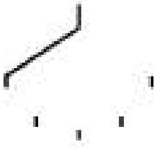
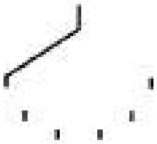
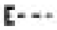
	
	Pigtail Connector

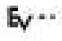
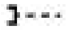
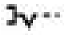
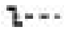
Switches and Relays

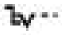
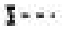
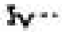
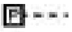
Symbol	Description
	Accessory Power Outlet
	Cigar Lighter

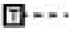
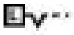
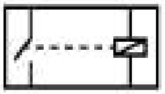
	
	Switch - 2 Position Normally Open
	Switch - 2 Position Normally Closed
	Switch - Rocker

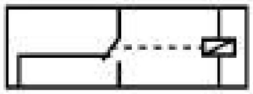
	Switch - Contact Plate (1 Wire)
	Switch - Contact Plate (2 Wire)
	Switch - 3 Position
	Switch - 4 Position

	Switch - 5 Position
	Switch - 6 Position
	Switch Actuator - Push (Momentary)
	Switch Actuator - Push (Latching)

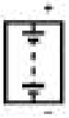
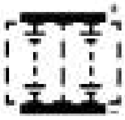
	
	Switch Actuator - Pull (Momentary)
	Switch Actuator - Pull (Latching)
	Switch Actuator - Rotate (Momentary)

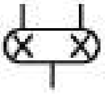
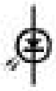
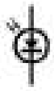
	Switch Actuator - Rotate (Latching)
	Switch Actuator - Slide (Momentary)
	Switch Actuator - Slide (Latching)
	Switch Actuator - Pressure (Momentary)

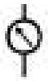
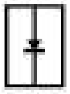
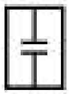
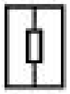
	Switch Actuator - Temperature (Momentary)
	Switch Actuator - Volume (Latching)
	4-Pin Single Pole/Throw Relay - Normally Open
	5-Pin Relay - Normally Closed

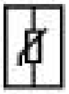
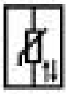
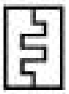
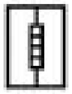
	

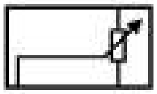
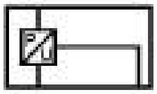
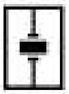
Devices and Sensors

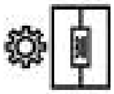
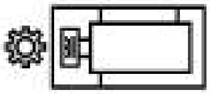
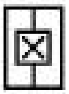
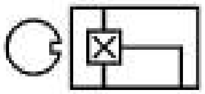
Symbol	Description
	Battery
	Battery Assembly - Hybrid
	Single Filament Light Bulb

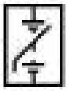
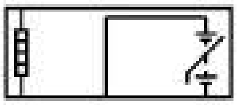
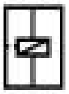
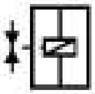
	Double Filament Light Bulb
	Light Emitting Diode (LED)
	Photo Sensor
	Gage

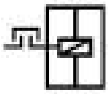
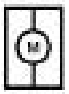
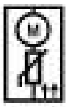
	
	Diode
	Capacitor
	Resistor

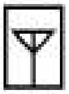
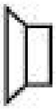
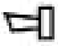
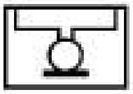
	Variable Resistor
	Variable Resistor - NTC
	Breakable Wire
	Heating Element

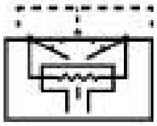
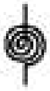
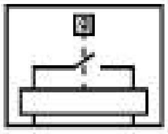
	Position Sensor
	Pressure Sensor
	Knock Sensor
	Inductive Type Sensor - 2-Wire

	
	Inductive Type Sensor - 3-Wire
	Hall Effect Sensor - 2-Wire
	Hall Effect Sensor - 3-Wire

	Oxygen Sensor - 2-Wire
	Heated Oxygen Sensor - 4-Wire
	Solenoid - Actuator
	Solenoid - Valve

	Clutch
	Motor
	Motor with PTC
	Antenna

	
	Speaker
	Horn
	Microphone

	Airbag
	SIR Coil
	SIR Impact Sensor

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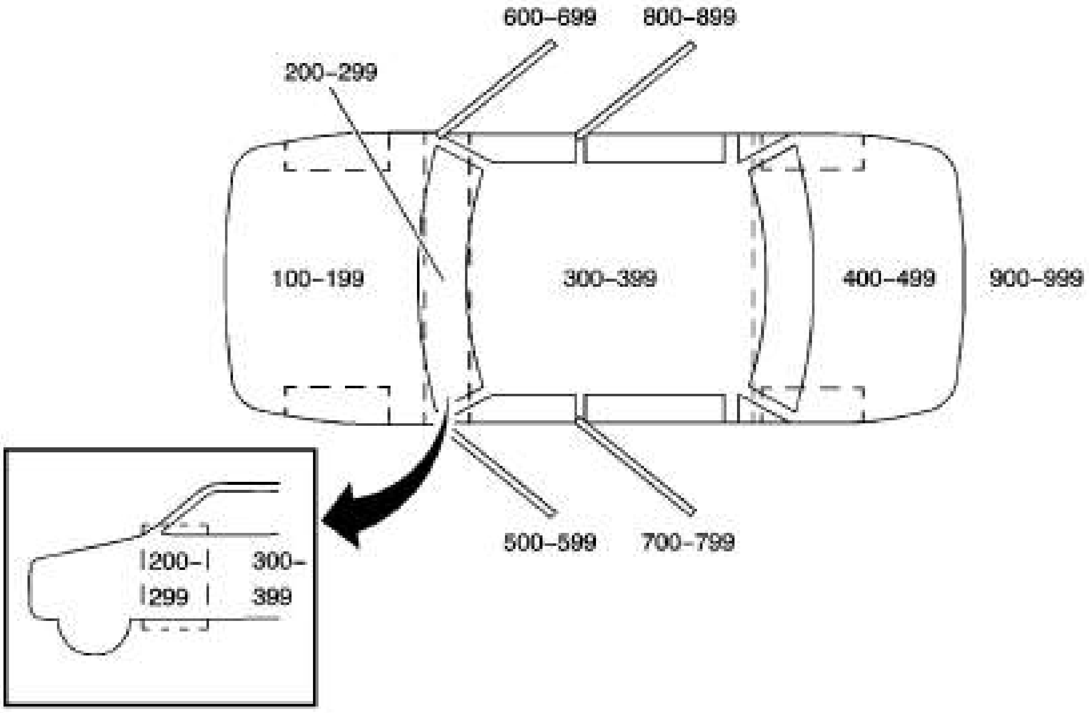
Vehicle Zoning Strategy

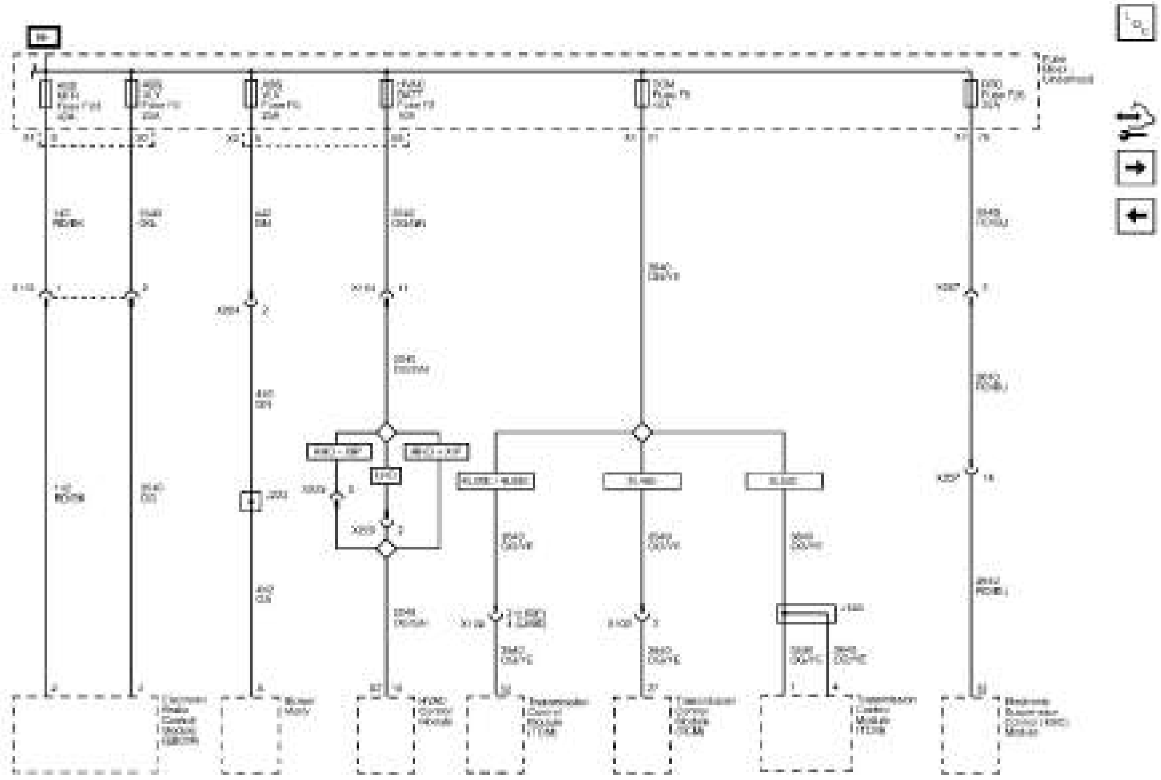
All grounds, in-line connectors, pass-through grommets, and splices have identifying numbers that correspond to where they are located in the vehicle. The following table explains the numbering system.



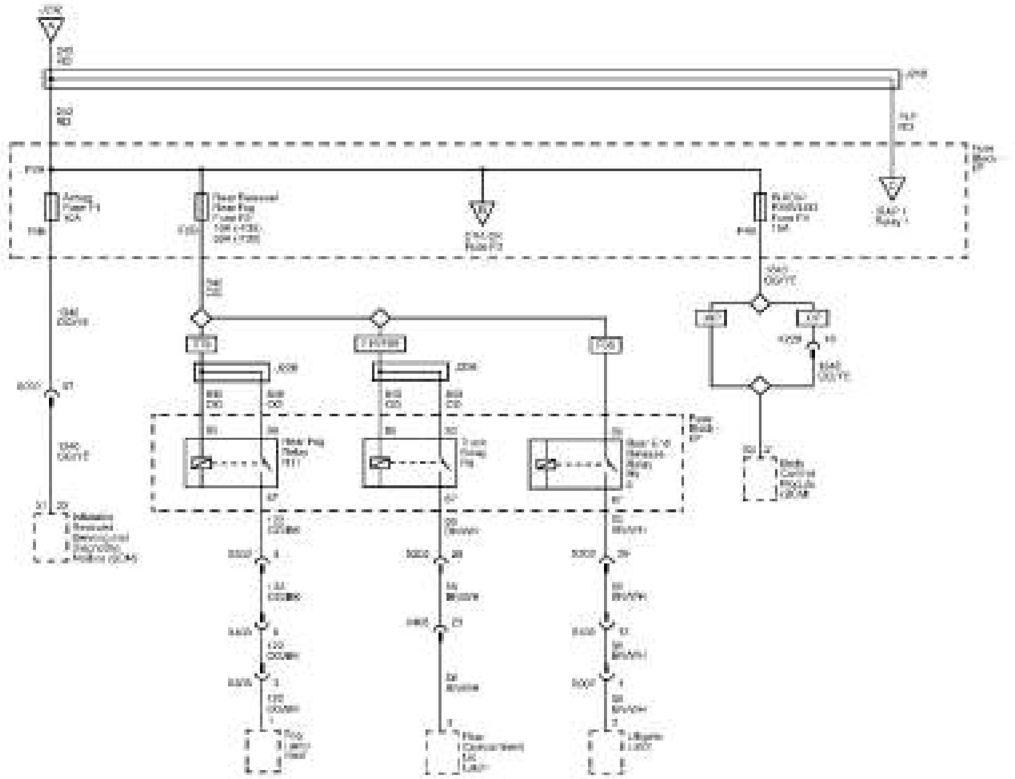
Callout Numbers	Zone Description
100-199	Engine compartment- All forward of the dash panel Note: 001-099 are additional for the engine compartment - ONLY to be used if all 100-199 items are used
200-299	Within the instrument panel area
300-399	Passenger compartment - From the instrument panel to the rear wheelhouse
400-499	Luggage compartment - From the rear wheelhouse to the rear of the vehicle
500-599	Within the left front door
600-699	Within the right front door
700-799	Within the left rear door
800-899	Within the right rear door

900-999	Within the luggage compartment lid or hatch

ABS MTR, ABS VLV, HVAC BLWR, HVAC BATT, TCM, and RTD Fuses



AIRBAG, REAR RELEASE / REAR FOG, and INADV / PWR / LED Fuses



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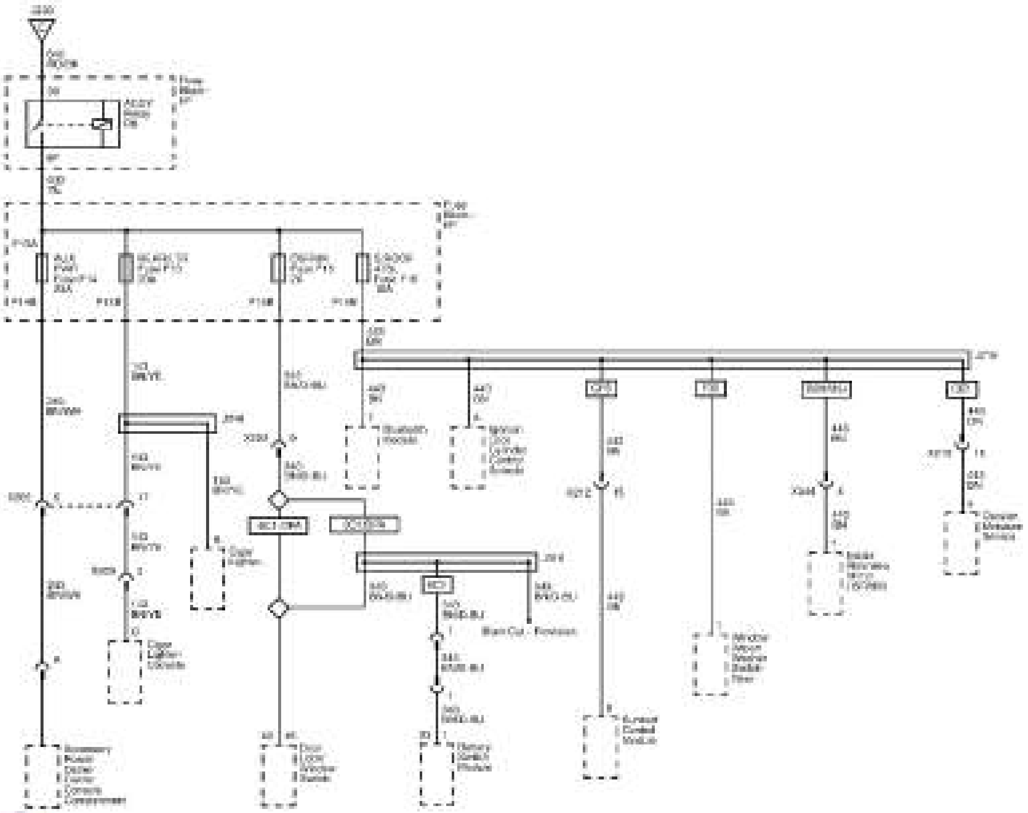
AUX PWR, REAR / LTR, OSRVM, and S / ROOF ATSL Fuses



Power Distribution Schematics

Figure 1: B+ Bus-1 of 2

Figure 2: B+ Bus-2 of 2

Figure 3: BATT 1, REAR WIPER, and S/ROOF Fuses, and WNDW MTR and SEAT Circuit Breakers

Figure 4: AIRBAG, REAR RELEASE/REAR FOG, and INADV/PWR/LED Fuses

Figure 5: DR/LCK AND WNDW CNTRL Fuses and WNDW MTR Circuit Breaker

Figure 6: BATT 2, CTSY/TRN RT FRT, TRN/SIG RT, TRN SIG LT, BCM, STOP, INT LAMPS, and DLIS/THEFT DTRNT Fuses

Figure 7: ABS MTR, ABS VLV, HVAC BLWR, HVAC BATT, TCM, and RTD Fuses

Figure 8: REAR SEAT ENT, AMP, AND NAVIGATION TELEMATICS Fuses

Figure 9: INST/DISP/RFA/DLC, RDO, REAR APO Fuses

Figure 10: TRAILER, ECM BATT, RVC SNSR, and FUEL PUMP

Figure 11: PF1, PF2, PF3, PF4, PF5, PF6, PF7, PF8, PF9, and PF10 Fuses

Figure 12: PF11, PF12, PF13, PF14, PF15, PF16, PF17, PF18, PF19, PF20 Fuses

Figure 13: Ignition Switch

Figure 14: AUX PWR, REAR/LTR, OSRVM, and S/ROOF ATSL Fuses

Figure 15: ECM 1, REV/LOCK, EMISSION 1

Figure 16: EMISSION 2 and ODD COILS Fuses

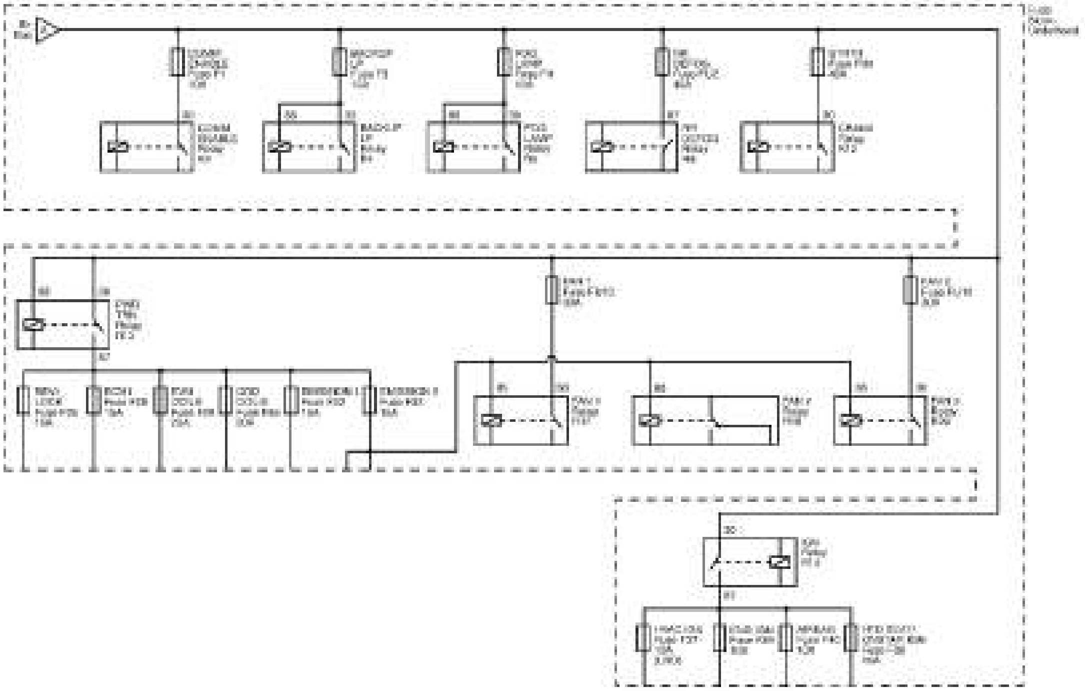
Figure 17: EVEN COIL Fuse

Figure 18: ENG IGN, AIRBAG, HTD SEAT, HVAC IGN Fuses

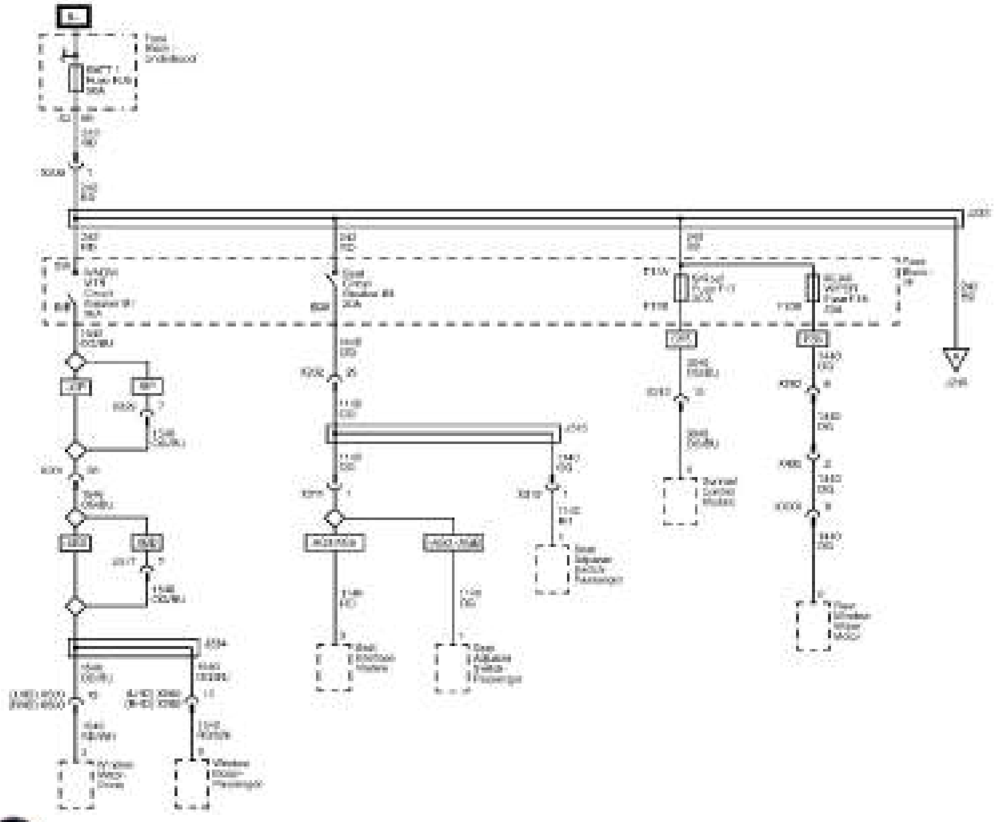
Figure 19: LT LO BEAM, LT HI BEAM, RT HI BEAM, RT LO BEAM, WSW. HORN, THEFT HORN

Figure 20: LT PRK and RT PRK Fuses

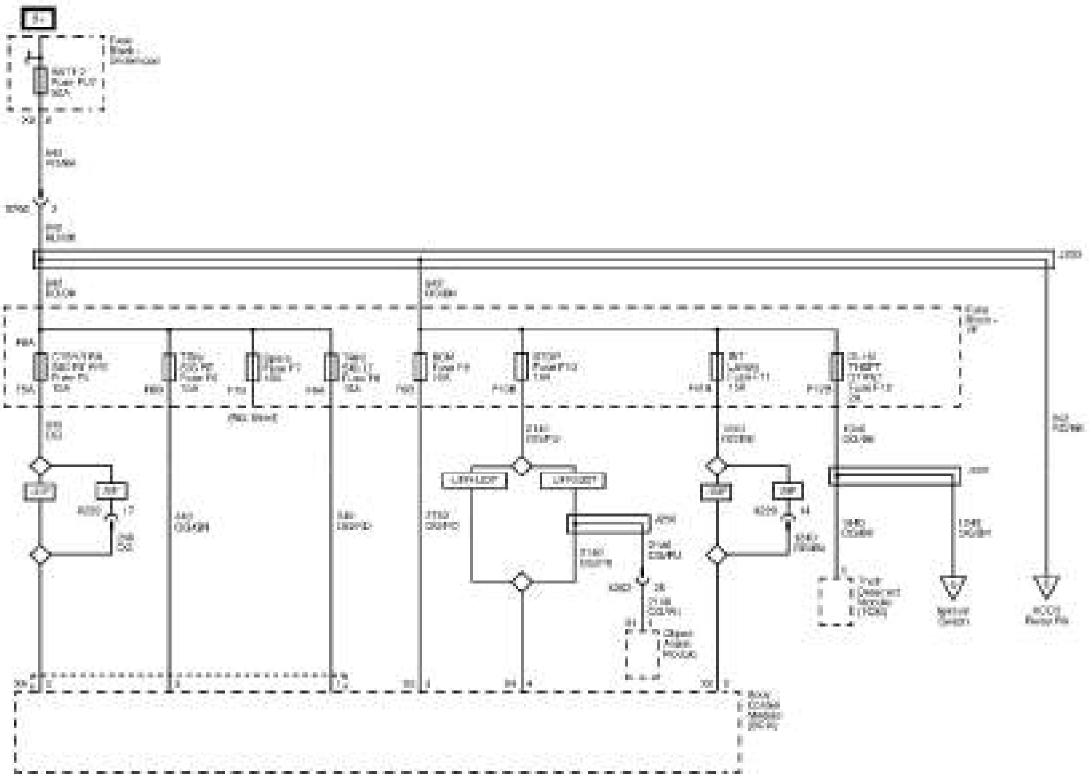
B+ Bus - 2 of 2



BATT 1, REAR WIPER, and S/ROOF Fuses, and WNDW MTR and SEAT Circuit Breakers



BATT 2, CTSY/TRN RT FRT, TRN/SIG RT, TRN SIG LT, BCM, STOP, INT LAMPS, and DLIS/THEFT DTRNT Fuses



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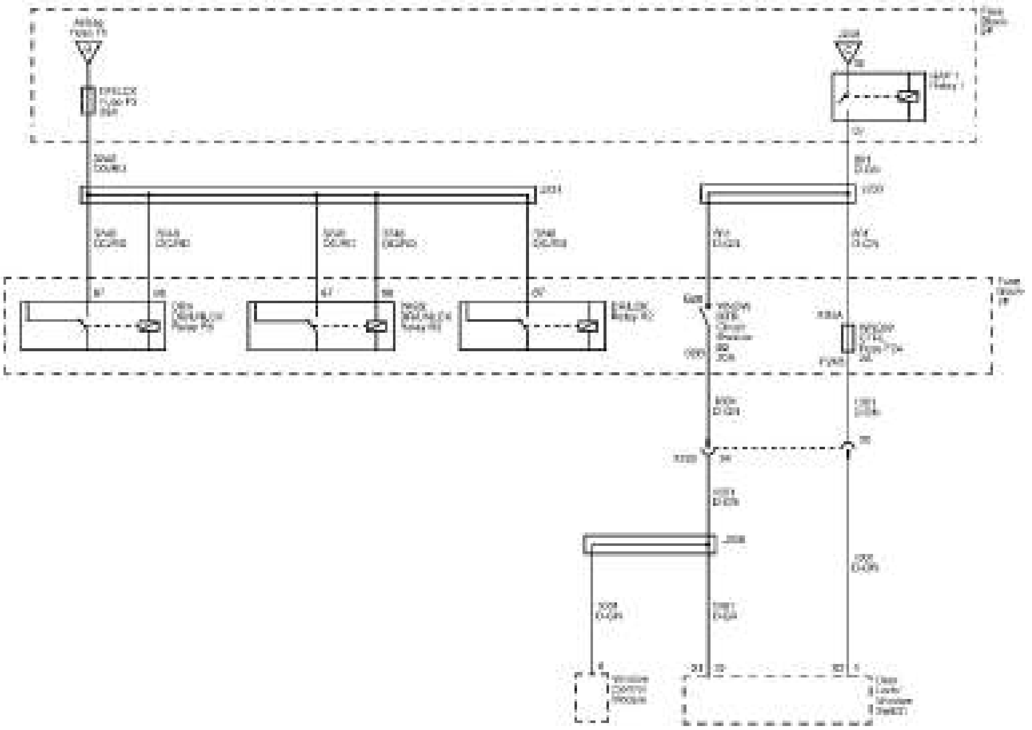
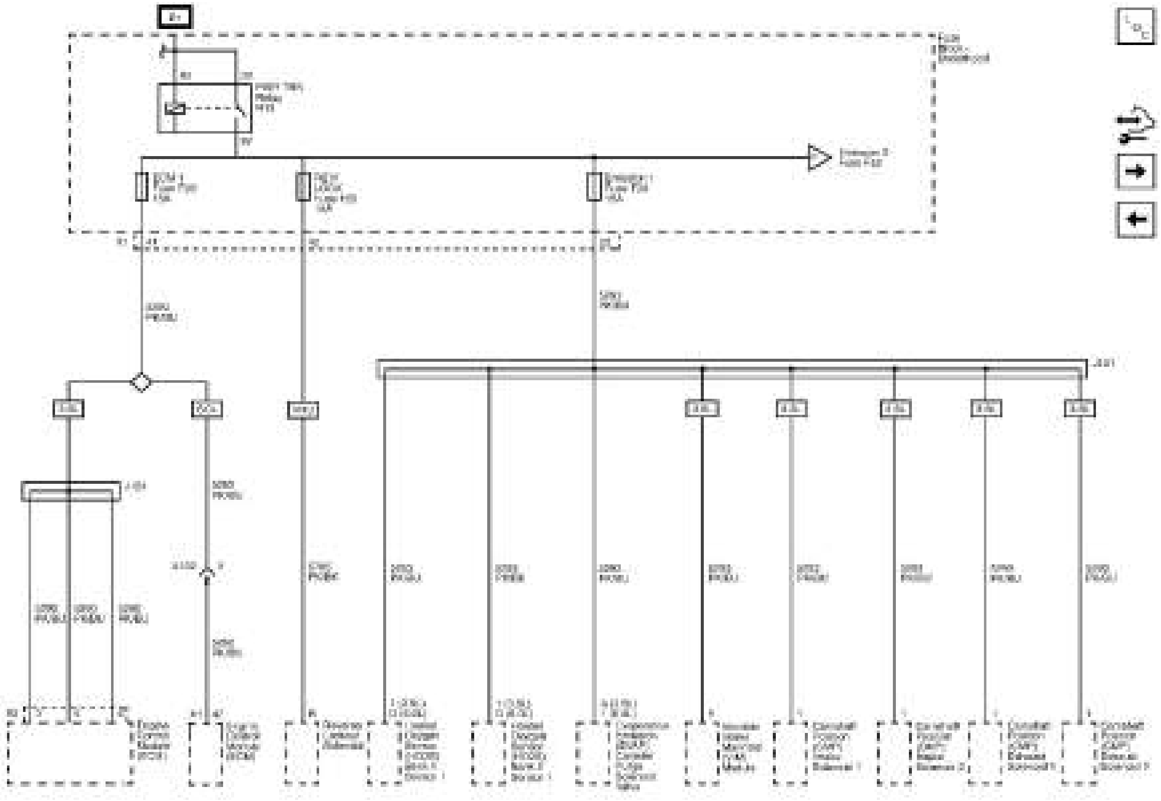
Document ID: 2154028

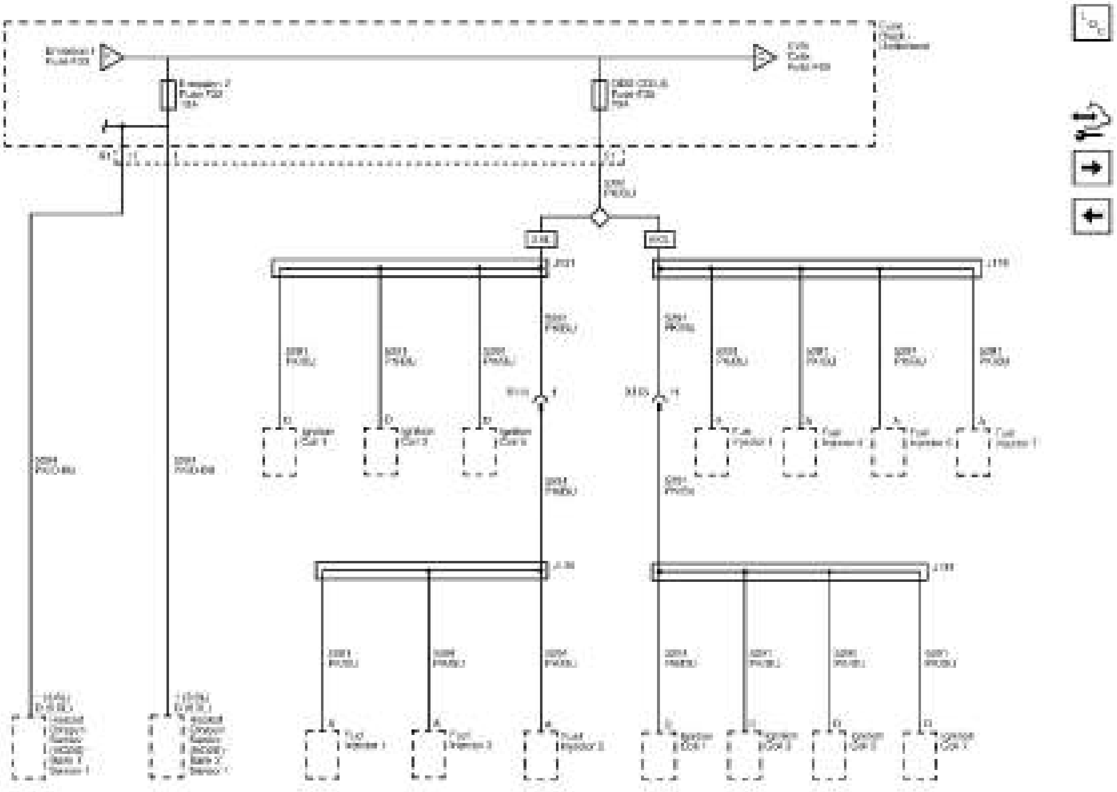
DR/LCK AND WNDW CNTRL Fuses and WNDW MTR Circuit Breaker


Fuse Block
Window Control Module
Door Lock Window Switch

ECM 1, REV / LOCK, EMISSION 1



EMISSION 2 and ODD COILS Fuses


Emission 2
ODD COILS
Ignition Coil 1
Ignition Coil 3
Fuel Injector 1
Fuel Injector 3
Heated Oxygen Sensor (HO2S) Bank 1 Sensor 1
Heated Oxygen Sensor (HO2S) Bank 2 Sensor 1

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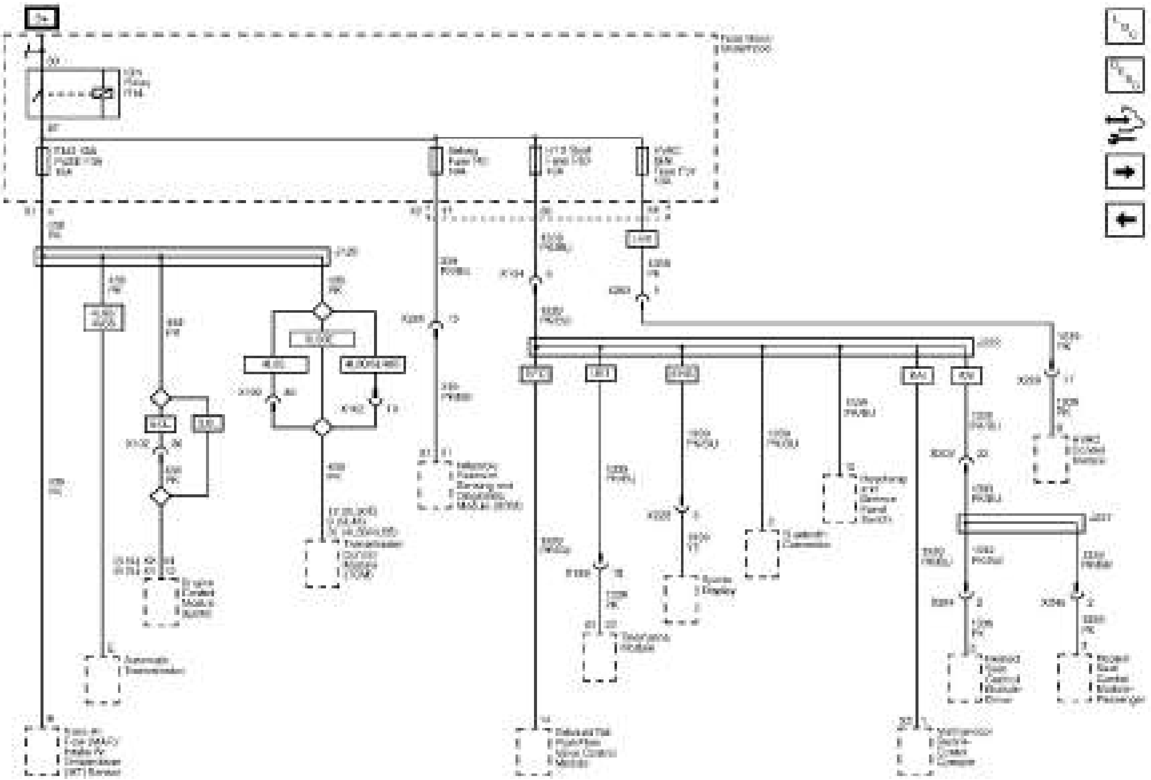
Document ID: 2154055

ENG IGN, AIRBAG, HTD SEAT, HVAC IGN Fuses



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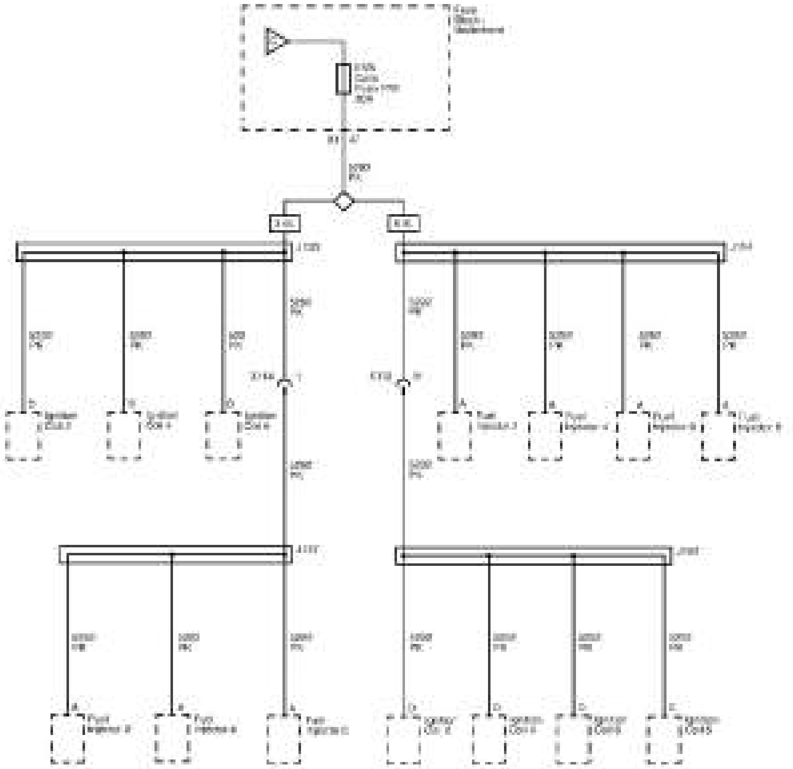
Document ID: 2154053

EVEN COIL Fuse



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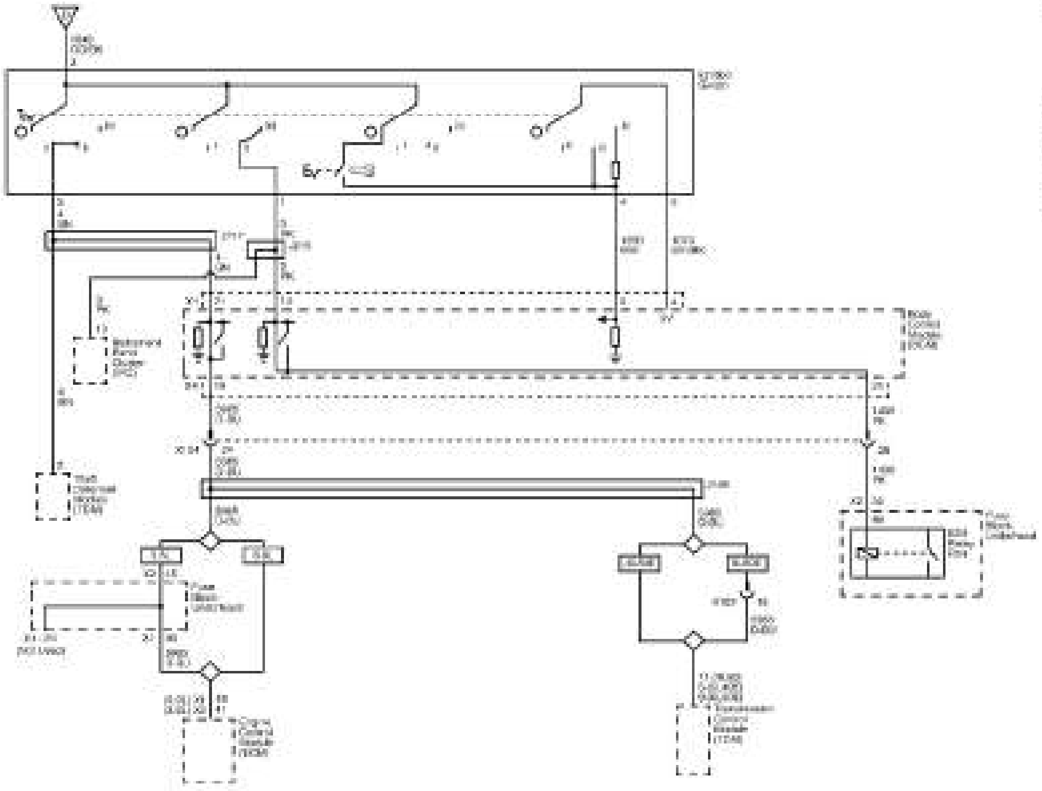
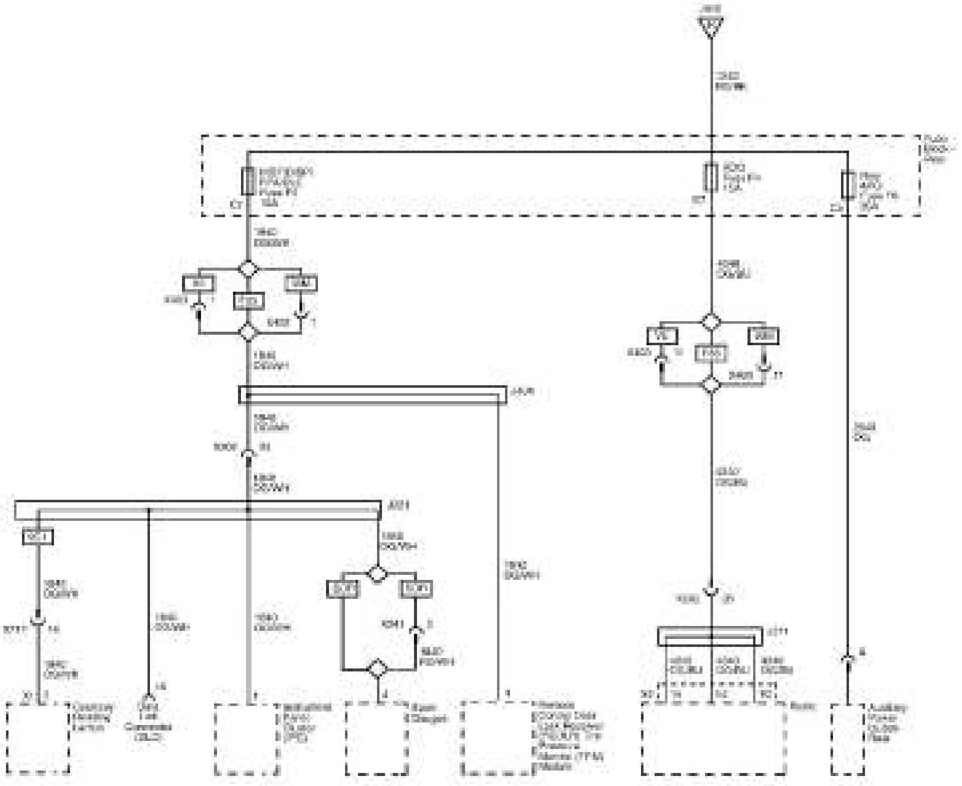
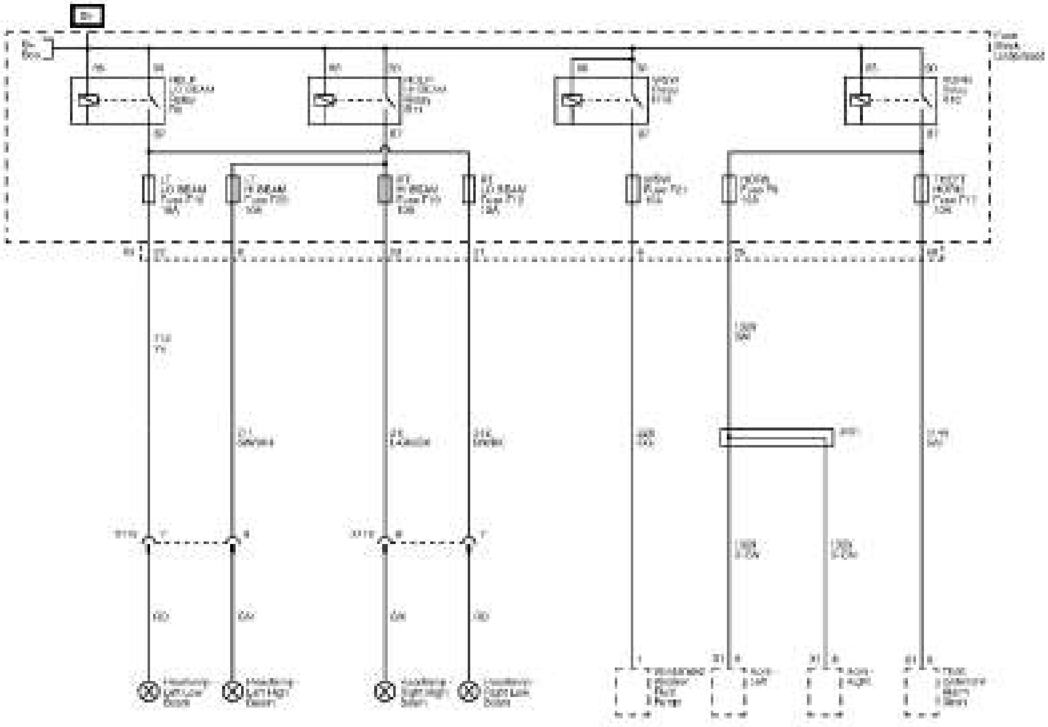
Ignition Switch



INST / DISP / RFA / DLC, RDO, REAR APO Fuses


Data Link Connector (DLC)
Instrument Panel Cluster (IPC)
Radio
Auxiliary Power Outlet - Rear

LT LO BEAM, LT HI BEAM, RT HI BEAM, RT LO BEAM, WSW. HORN, THEFT HORN



Power Distribution Schematics

Figure 1: B+ Bus-1 of 2

Figure 2: B+ Bus-2 of 2

Figure 3: BATT 1, REAR WIPER, and S/ROOF Fuses, and WNDW MTR and SEAT Circuit Breakers

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Figure 6: BATT 2, CTSY/TRN RT FRT, TRN/SIG RT, TRN SIG LT, BCM, STOP, INT LAMPS, and DLIS/THEFT DTRNT Fuses

Figure 7: ABS MTR, ABS VLV, HVAC BLWR, HVAC BATT, TCM, and RTD Fuses

Figure 8: REAR SEAT ENT, AMP, AND NAVIGATION TELEMATICS Fuses

Figure 9: INST/DISP/RFA/DLC, RDO, REAR APO Fuses

Figure 10: TRAILER, ECM BATT, RVC SNSR, and FUEL PUMP

Figure 11: PF1, PF2, PF3, PF4, PF5, PF6, PF7, PF8, PF9, and PF10 Fuses

Figure 12: PF11, PF12, PF13, PF14, PF15, PF16, PF17, PF18, PF19, PF20 Fuses

Figure 13: Ignition Switch

Figure 14: AUX PWR, REAR/LTR, OSRVM, and S/ROOF ATSL Fuses

Figure 15: ECM 1, REV/LOCK, EMISSION 1

Figure 16: EMISSION 2 and ODD COILS Fuses

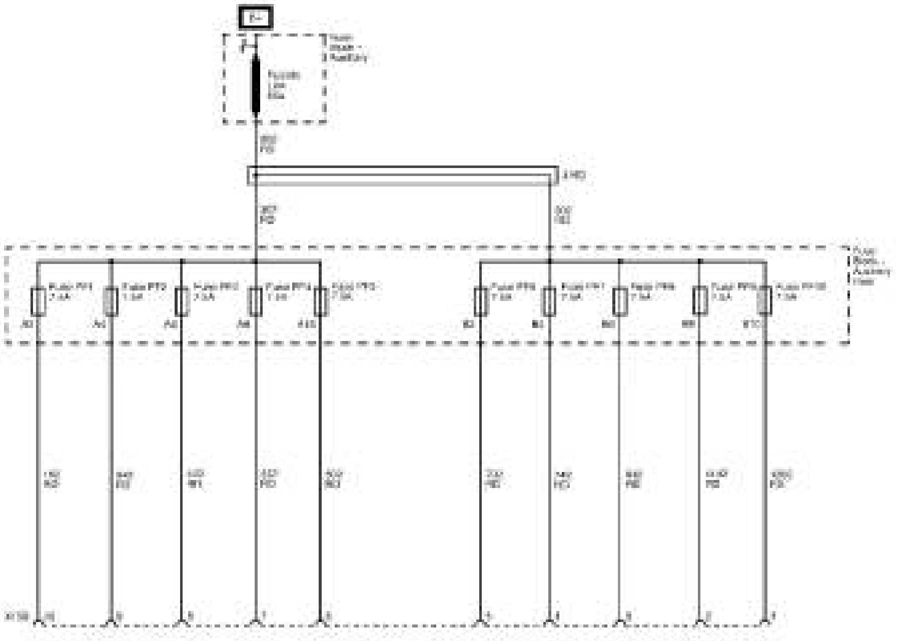
Figure 17: EVEN COIL Fuse

Figure 18: ENG IGN, AIRBAG, HTD SEAT, HVAC IGN Fuses

Figure 19: LT LO BEAM, LT HI BEAM, RT HI BEAM, RT LO BEAM, WSW. HORN, THEFT HORN

Figure 20: LT PRK and RT PRK Fuses

PF1, PF2, PF3, PF4, PF5, PF6, PF7, PF8, PF9, and PF10 Fuses



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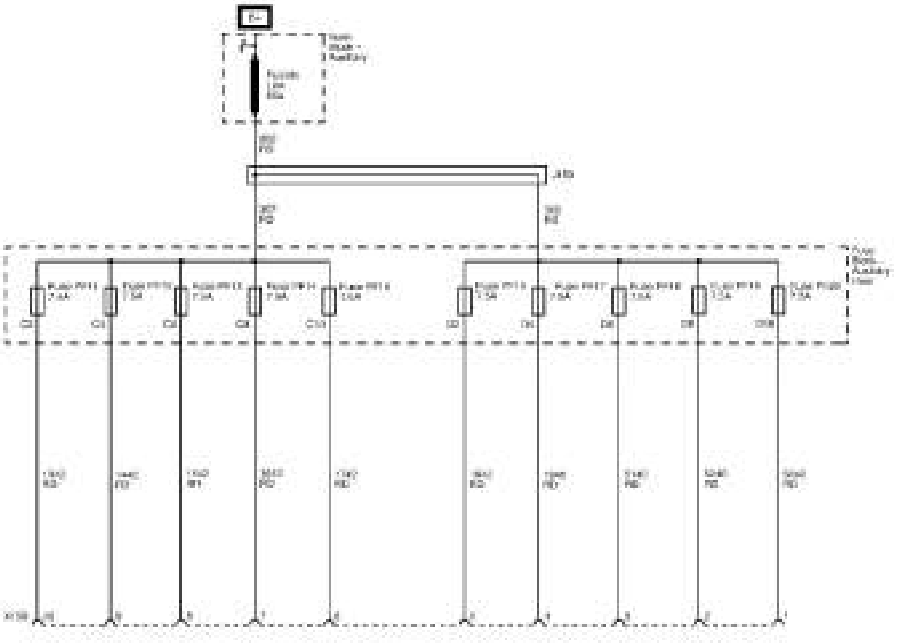
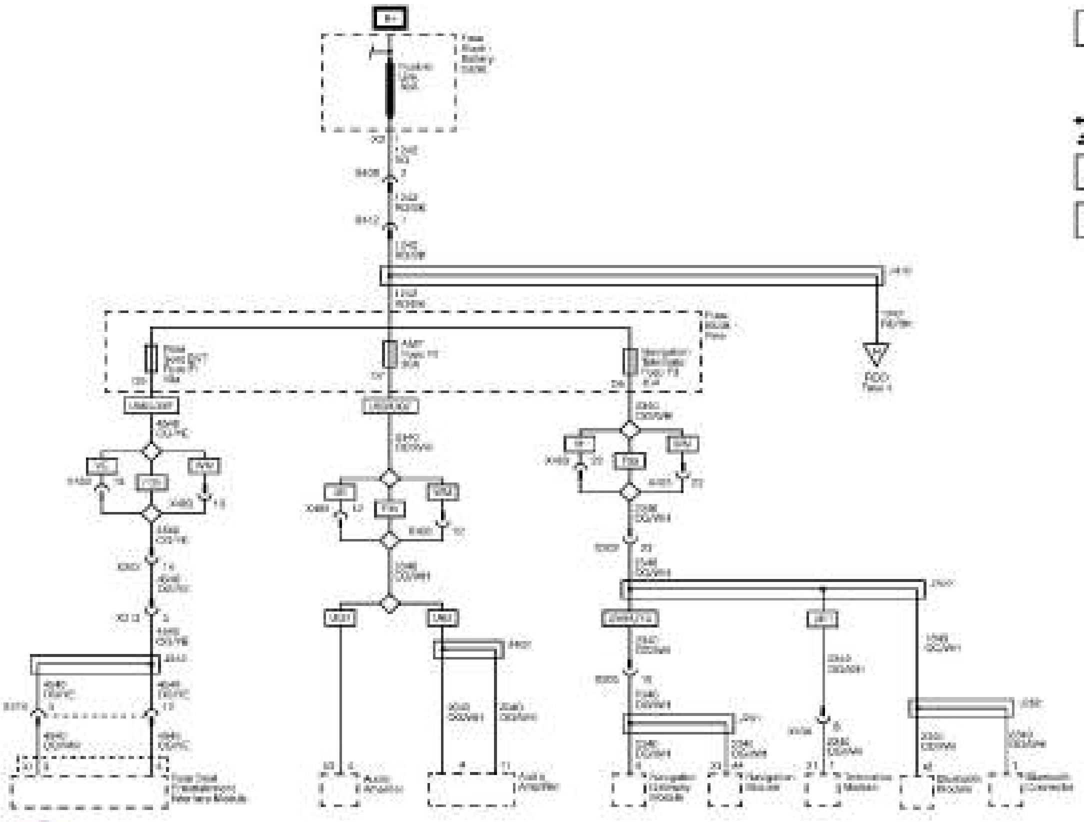
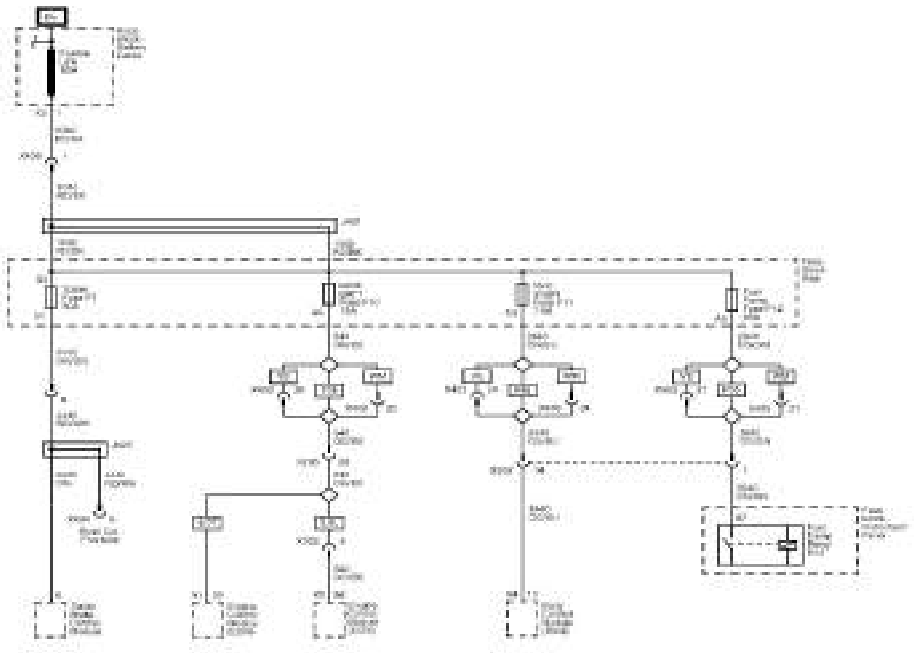
PF11, PF12, PF13, PF14, PF15, PF16, PF17, PF18, PF19, PF20 Fuses


Fuse PF11
Fuse PF12
Fuse PF13
Fuse PF14
Fuse PF15
Fuse PF16
Fuse PF17
Fuse PF18
Fuse PF19
Fuse PF20
X158

REAR SEAT ENT, AMP, AND NAVIGATION TELEMATICS Fuses



TRAILER, ECM BATT, RVC SNSR, and FUEL PUMP

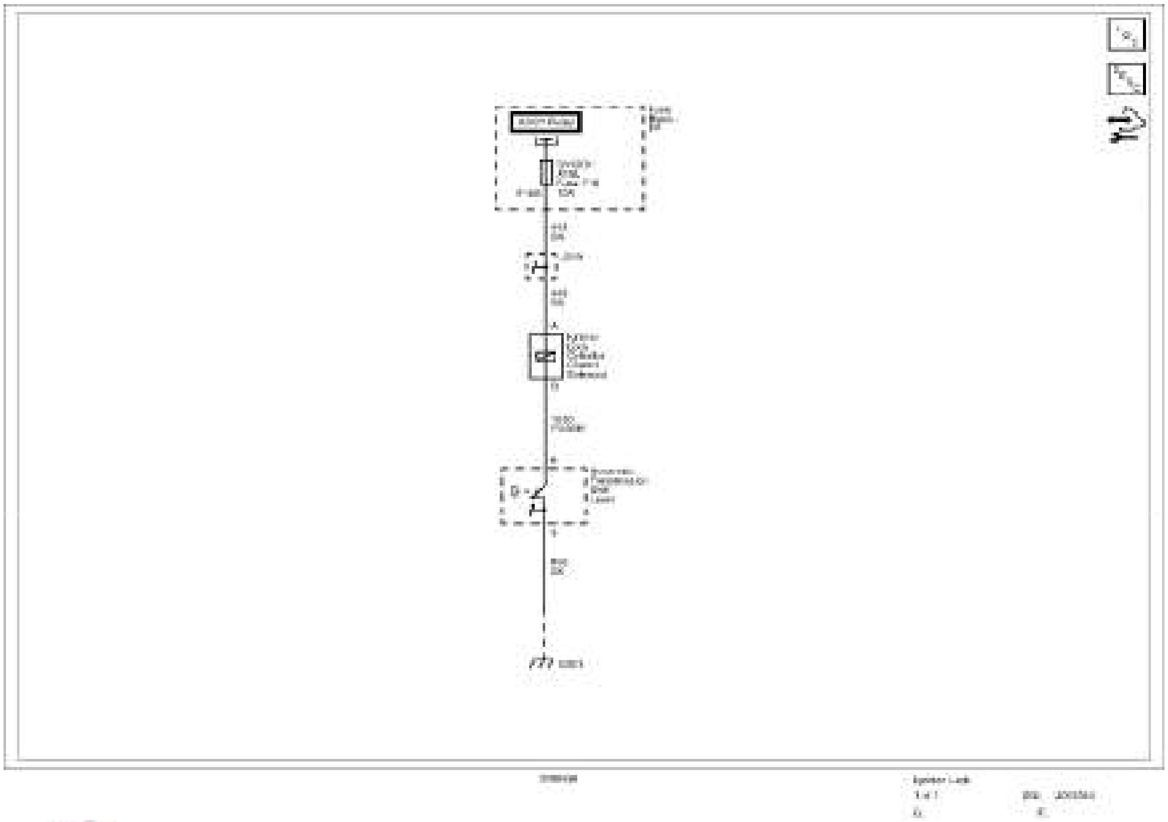


Power Moding Schematics

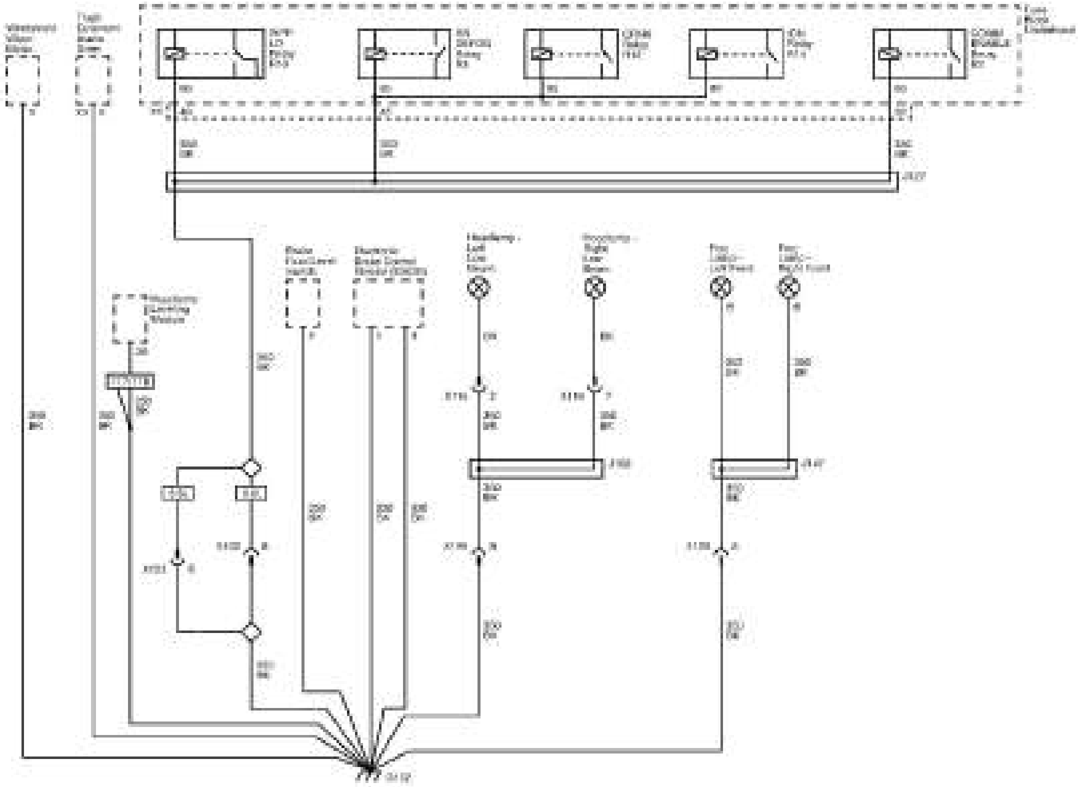
Figure 1: ACCY and RAP 1 Control
Figure 2: IGN Control

Ignition Lock Schematics

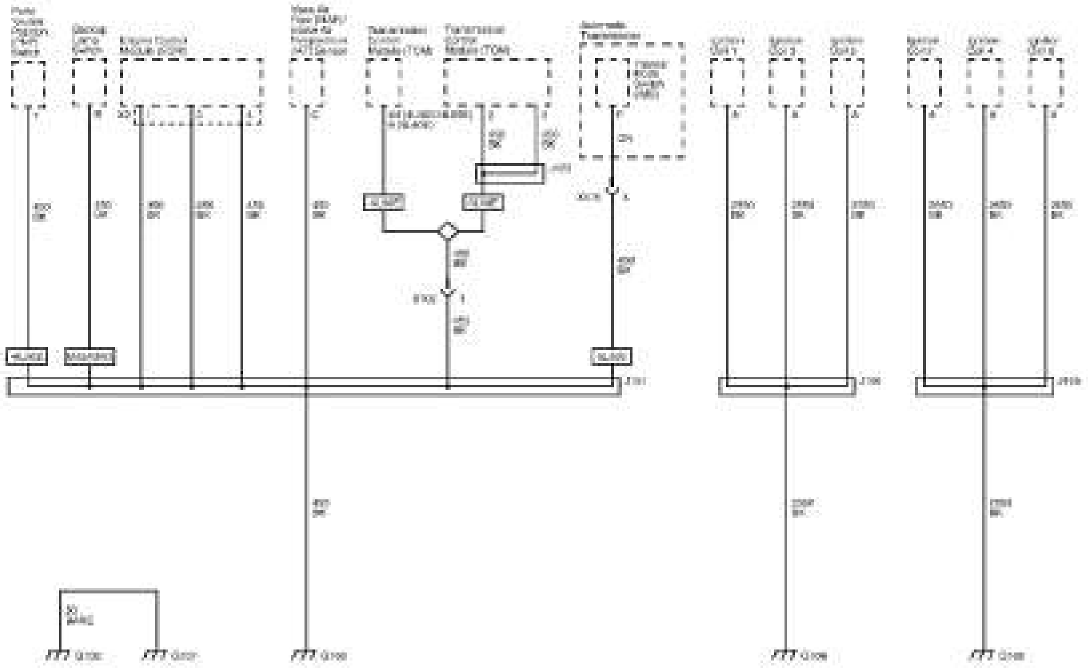
Ignition Lock



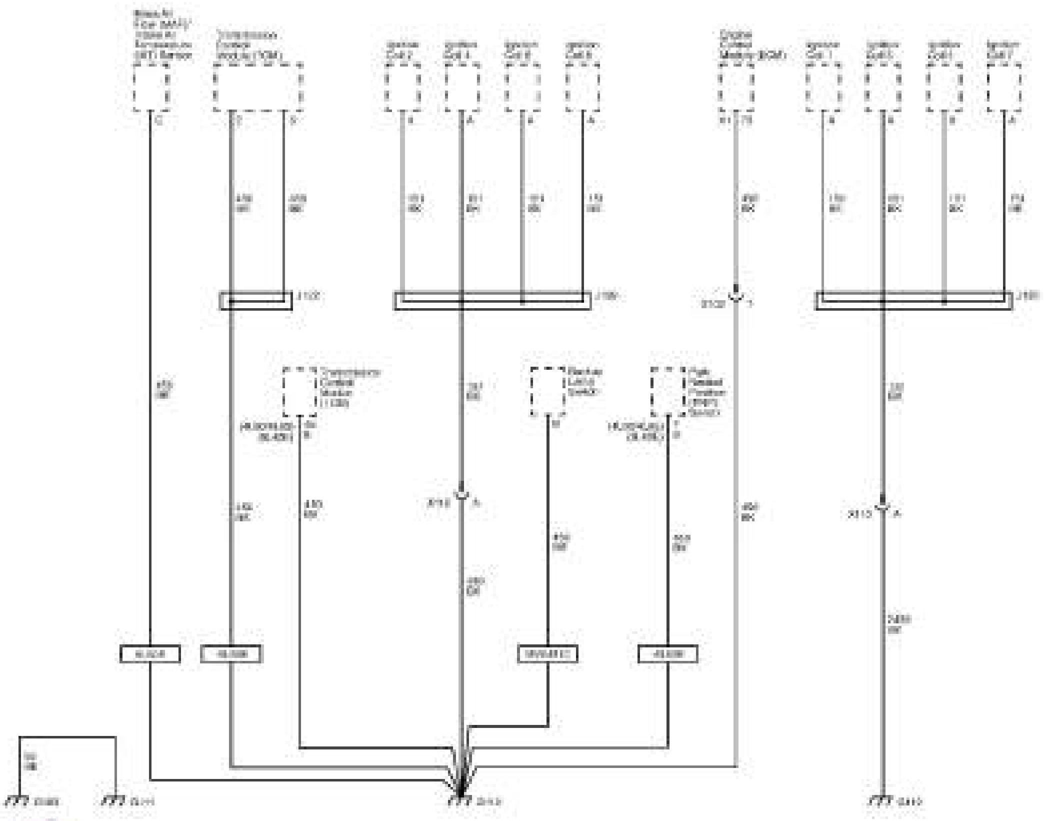
G102


Windshield Wiper Motor
Fuse Block - Underhood
Headlamp Leveling Module
Brake Fluid Level Switch
Electronic Brake Control Module (EBCM)
Headlamp - Left Low Beam
Headlamp - Right Low Beam
Fog Lamp - Left Front
Fog Lamp - Right Front
G102

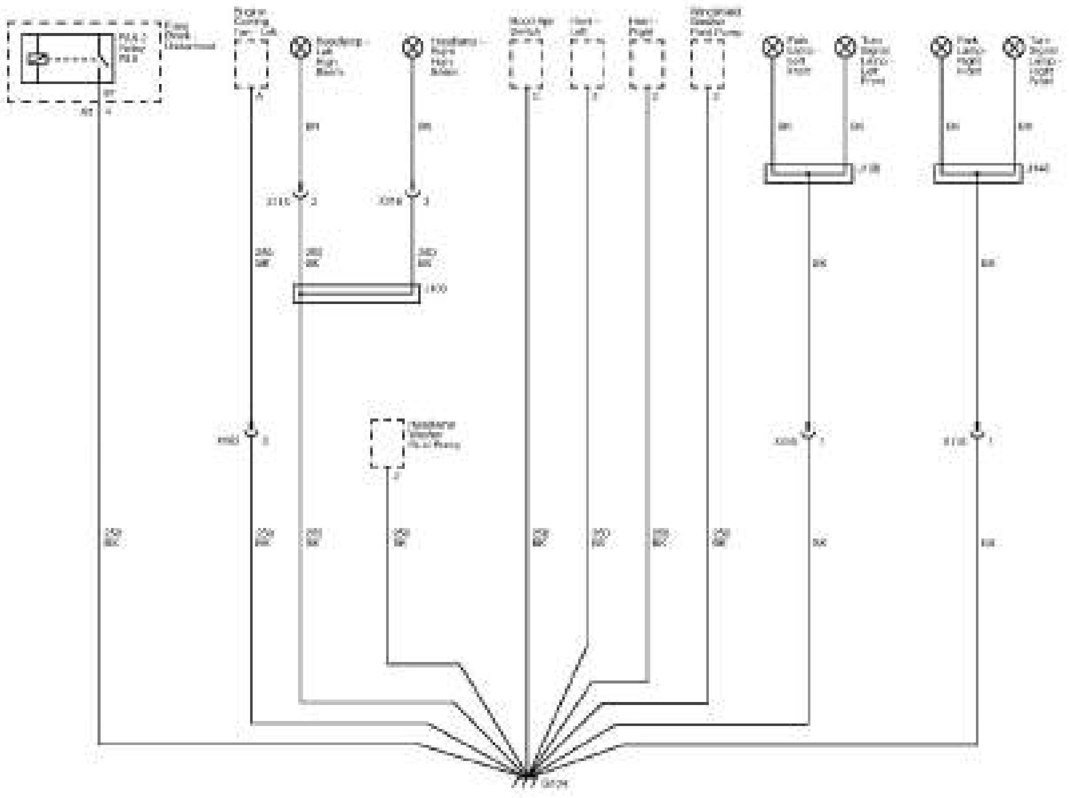
G103, G106, G107, G108 and G109 (LY7)



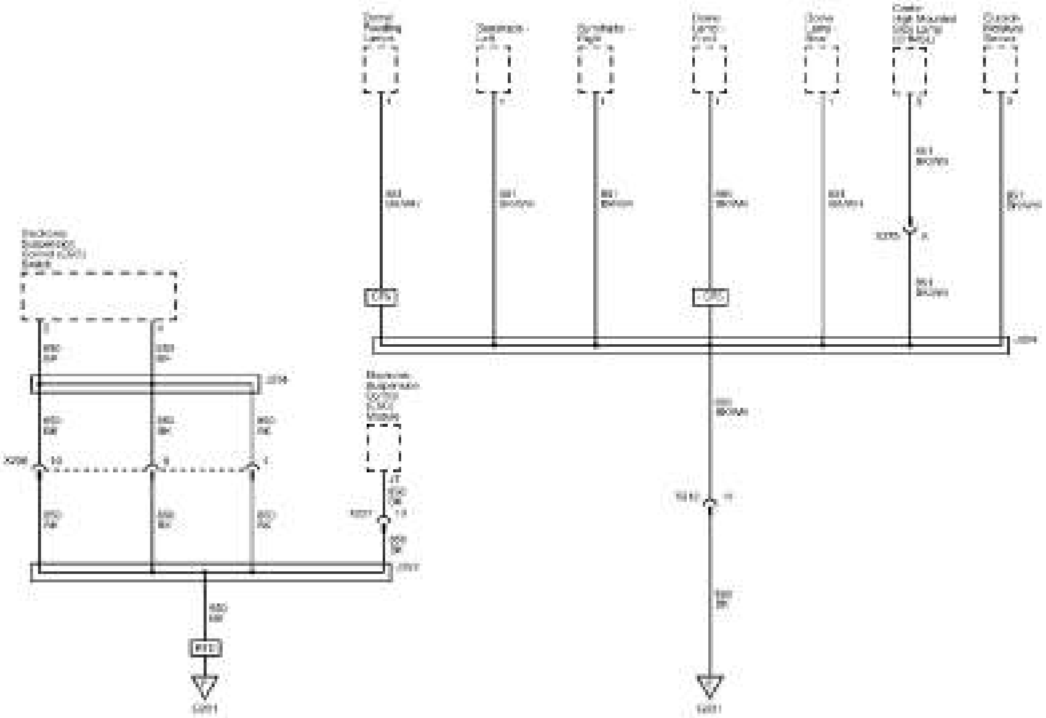
G103, G110, G111 and G112 (L76)



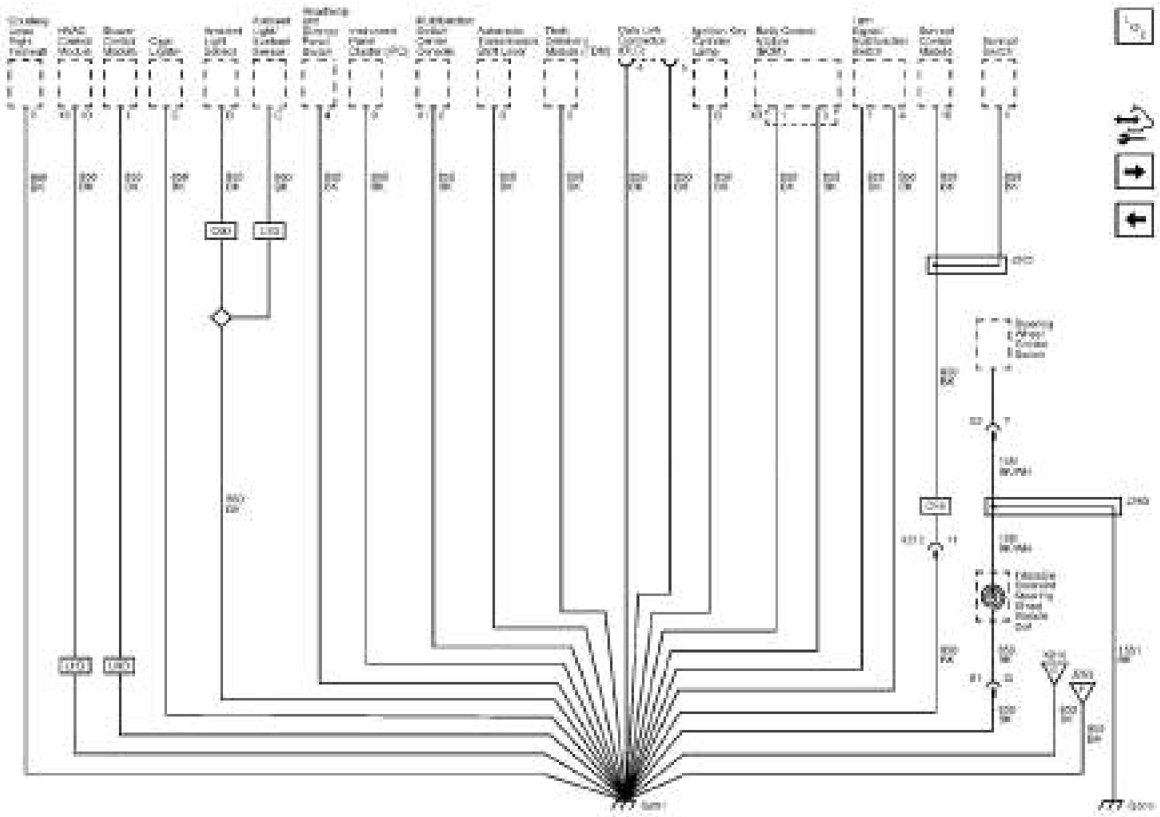
G104


Fuse Block - Underhood
Engine Cooling Fan - Left
Headlamp - Left High Beam
Headlamp - Right High Beam
Hood Ajar Switch
Horn - Left
Horn - Right
Windshield Washer Fluid Pump
Park Lamp - Left Front
Turn Signal Lamp - Left Front
Park Lamp - Right Front
Turn Signal Lamp - Right Front
Headlamp Washer Fluid Pump
G104

G201 - 1 of 2



G201 - 2 of 2



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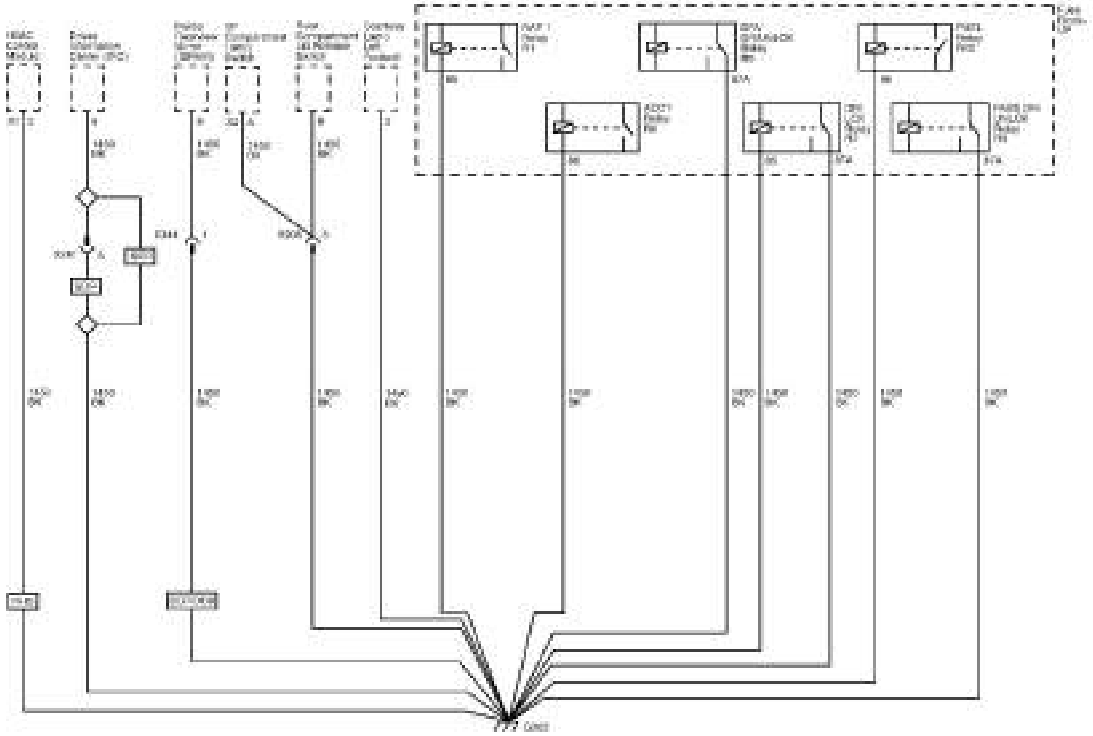
G202



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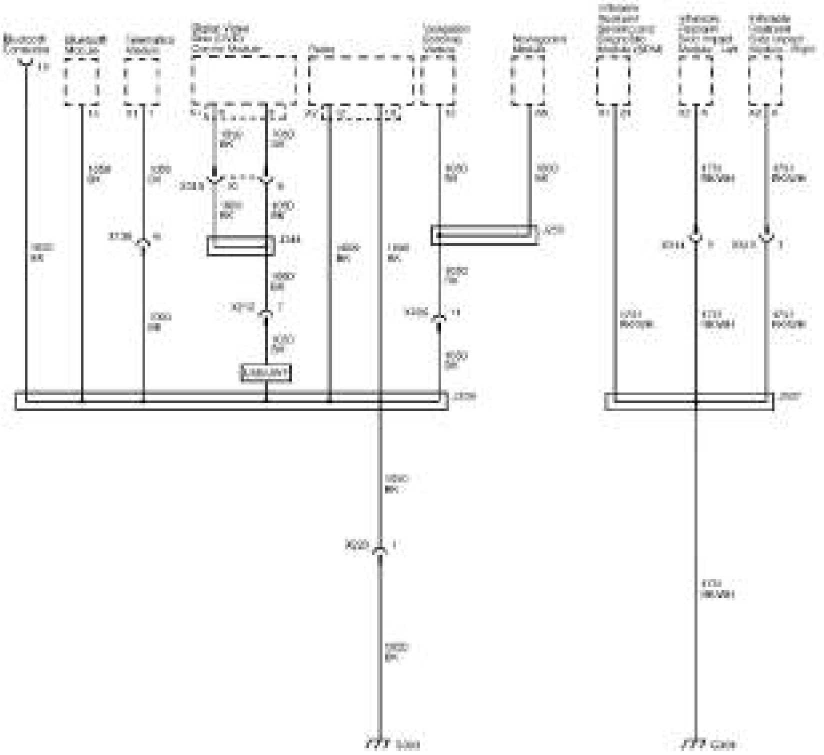
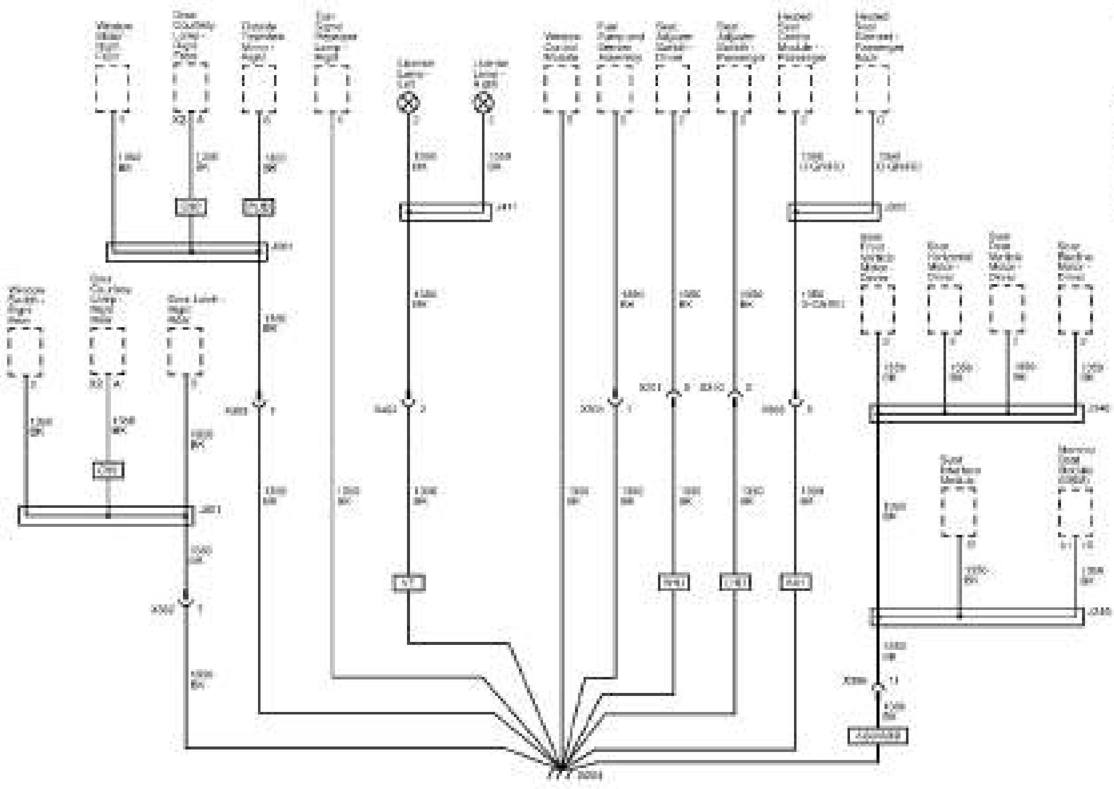
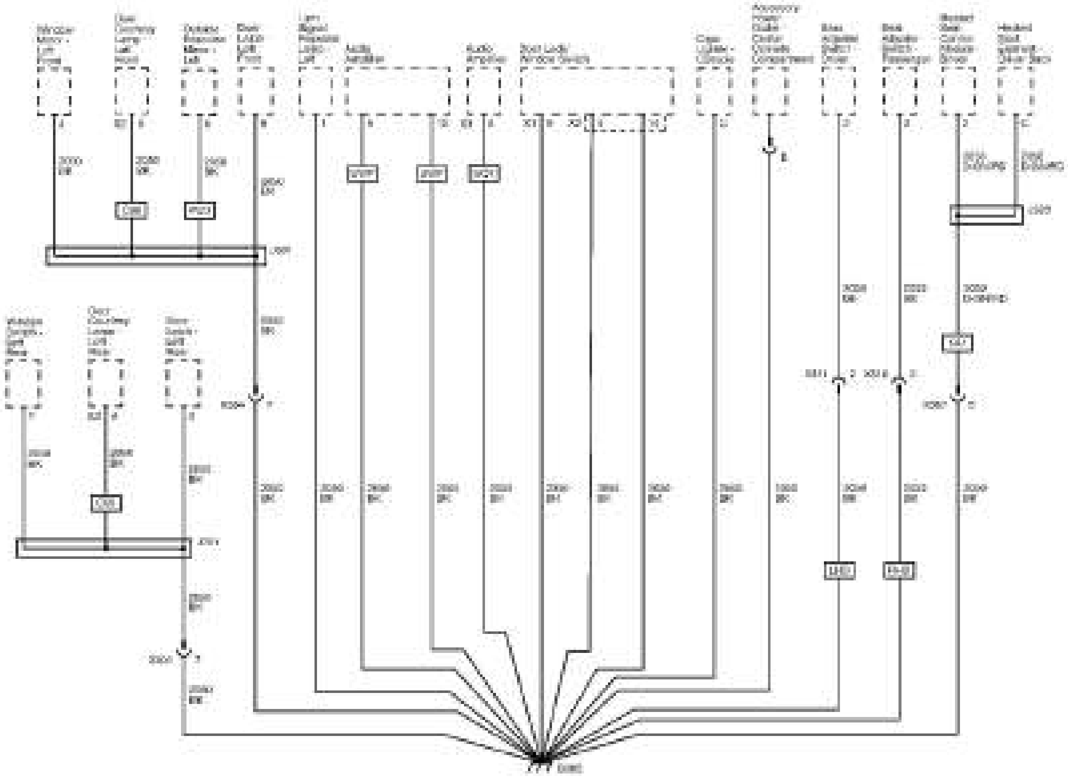
G303, G308 and G407



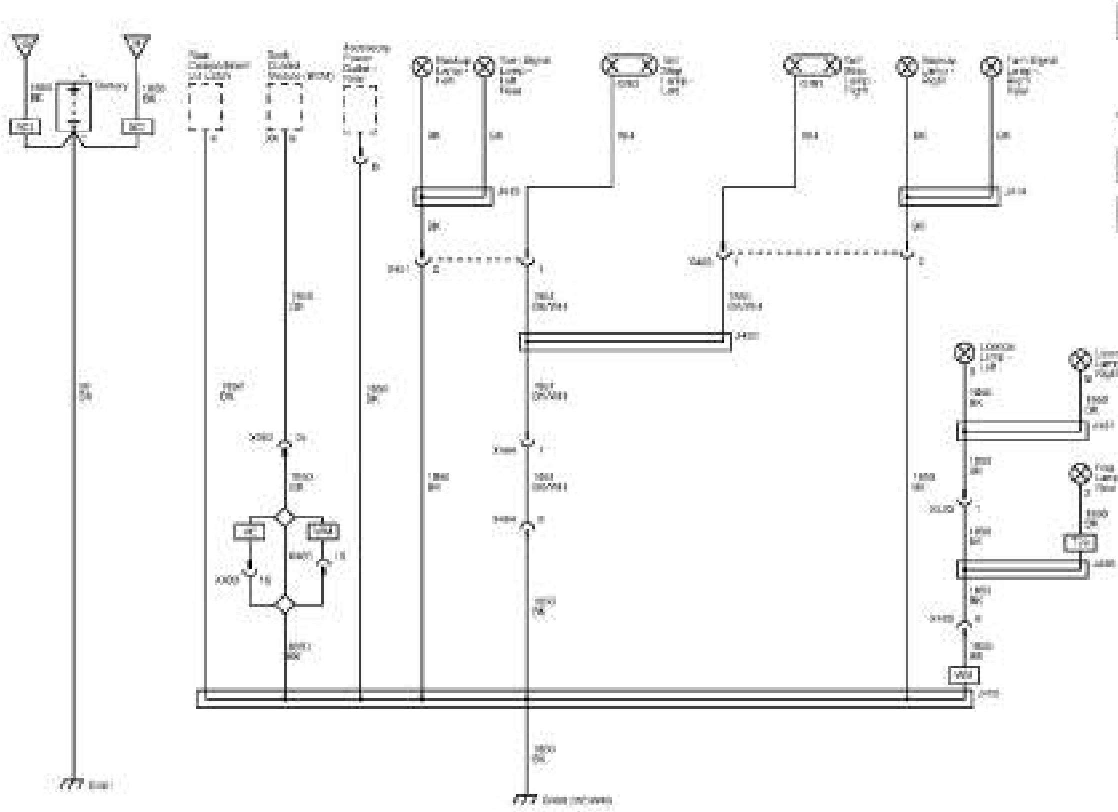
G304



G305



G401 and G409 (Except F35)



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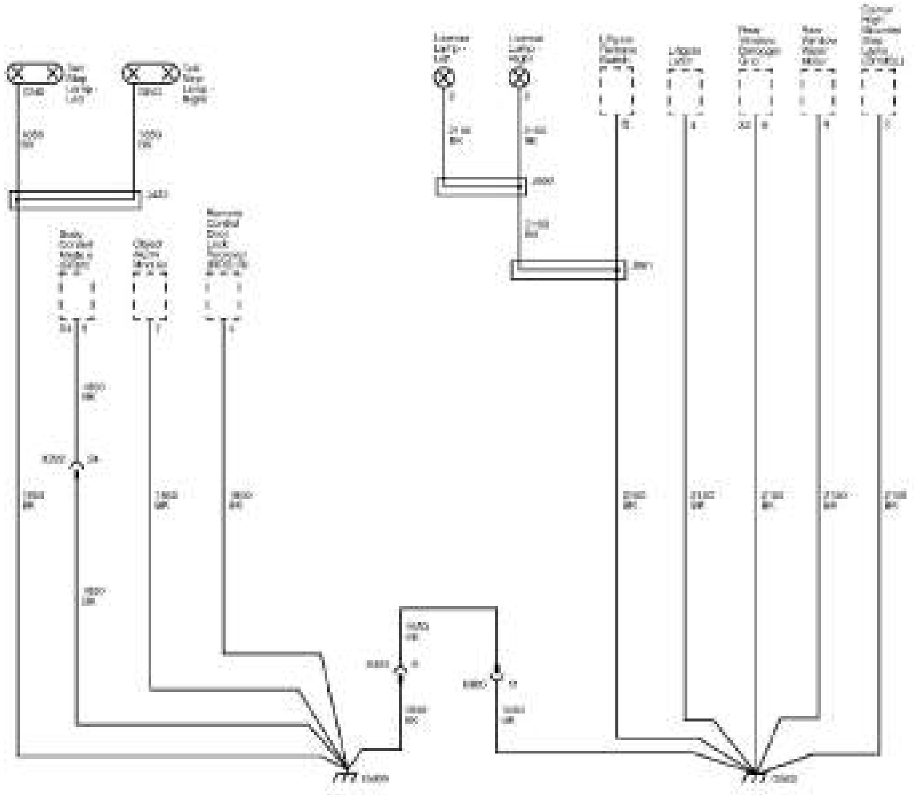
G409 and G900 (F35)



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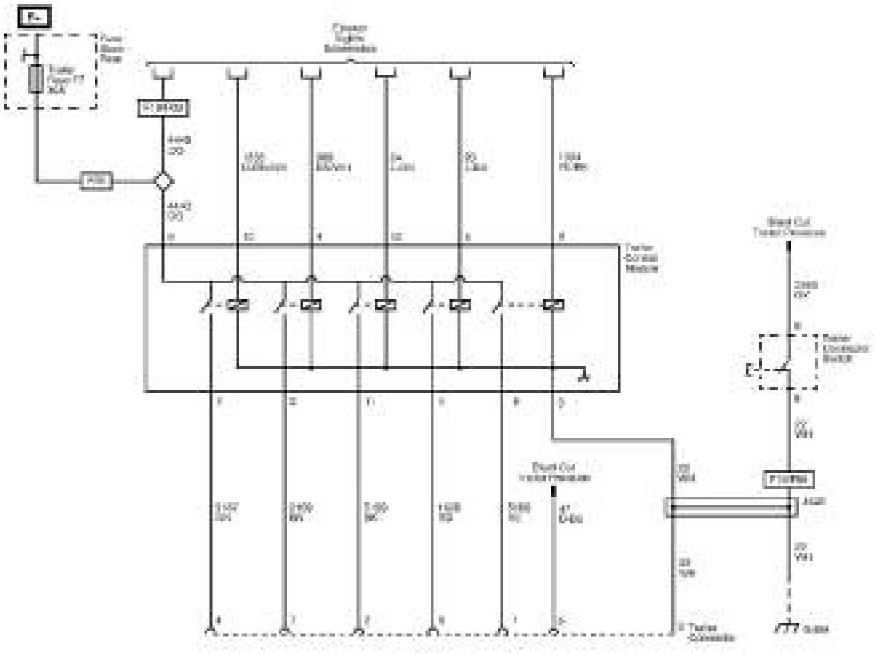
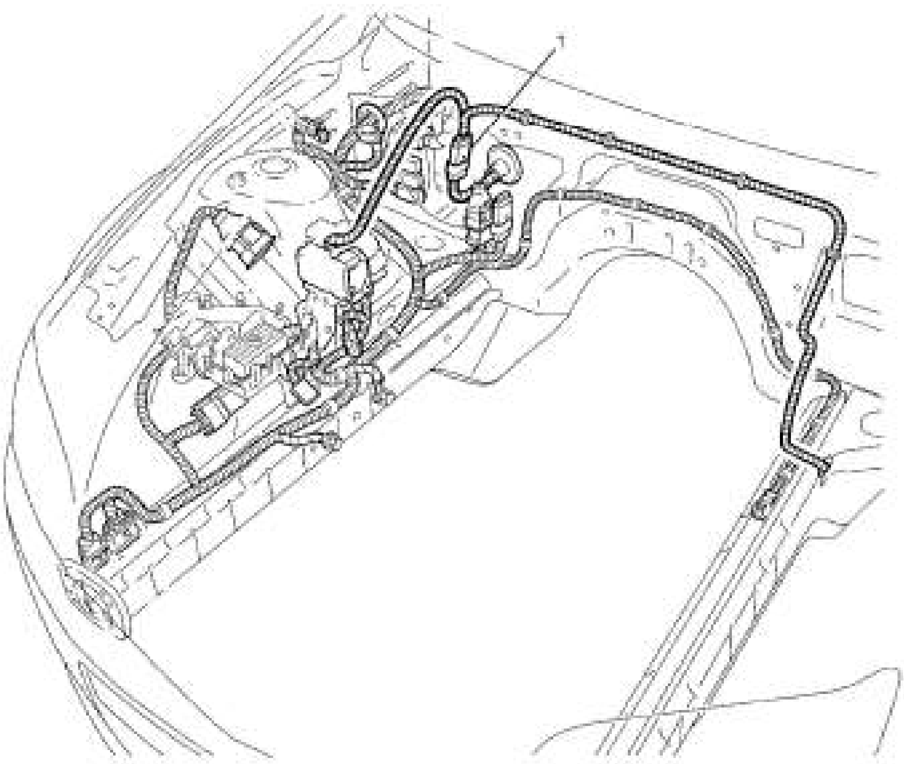
Trailer Connector / Provision Schematics

Trailer Connector Provision / Schematics



Electronic Suspension Control Wiring -- Front



(1) I/P Harness to Electronic Suspension Control Front Harness -- X207

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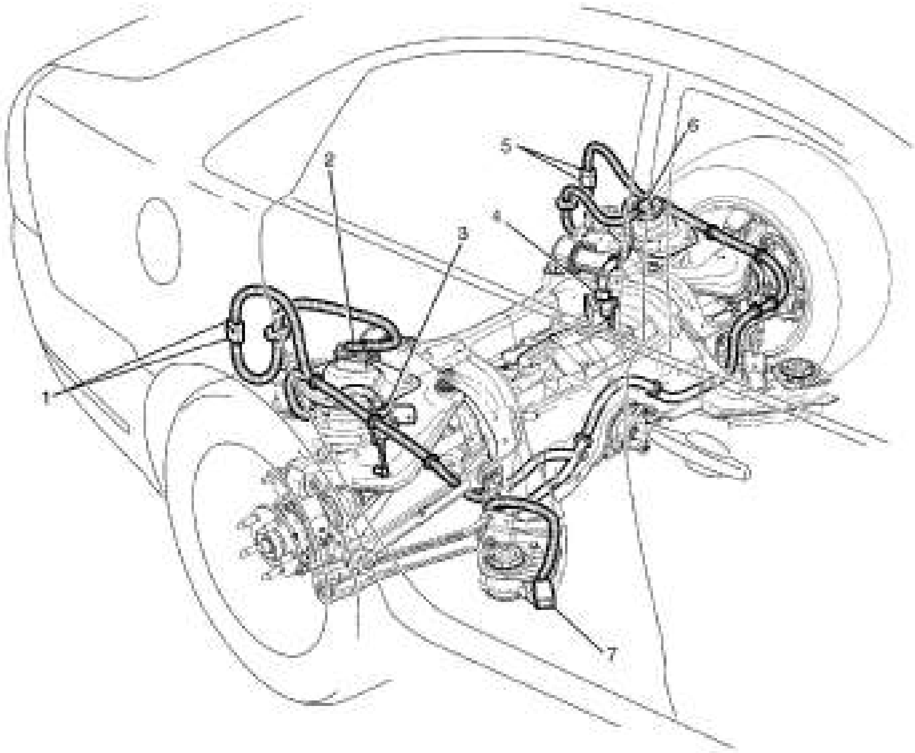
Electronic Suspension Control Wiring - Rear (Long Wheel Base HSV)



(1) Electronic Suspension Control Rear Harness to Right Rear Suspension Patch Harness -- X417
(2) Suspension Damper Actuator - RR -- Y156
(3) Suspension Position Sensor - RR -- B37
(4) Suspension Position Sensor - LR -- B37
(5) Electronic Suspension Control Rear Harness to Left Rear Suspension Patch Harness -- X416
(6) Suspension Damper Actuator - LR -- Y156
(7) Body Harness to Electronic Suspension Control Rear Harness -- X413

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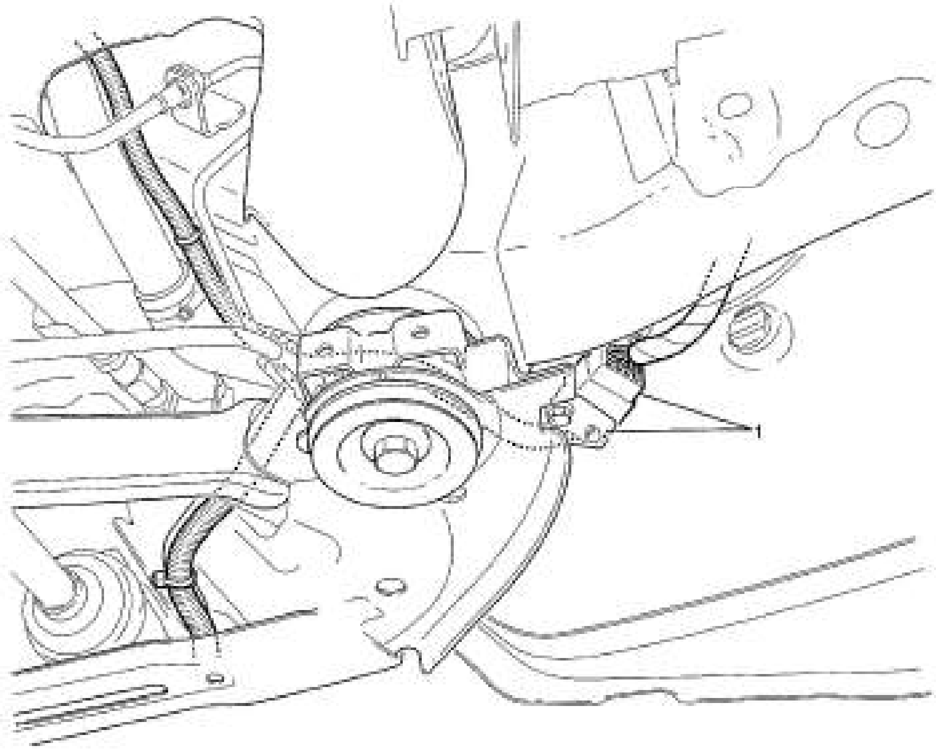
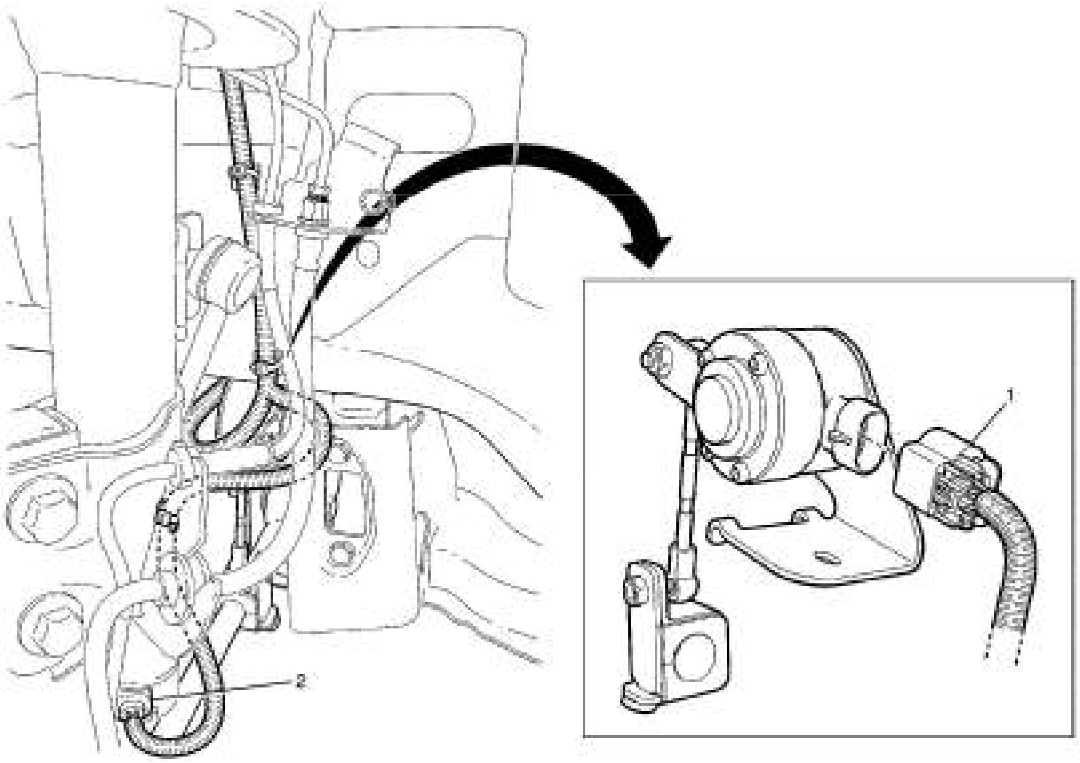
Electronic Suspension Control Wiring -- Rear Body



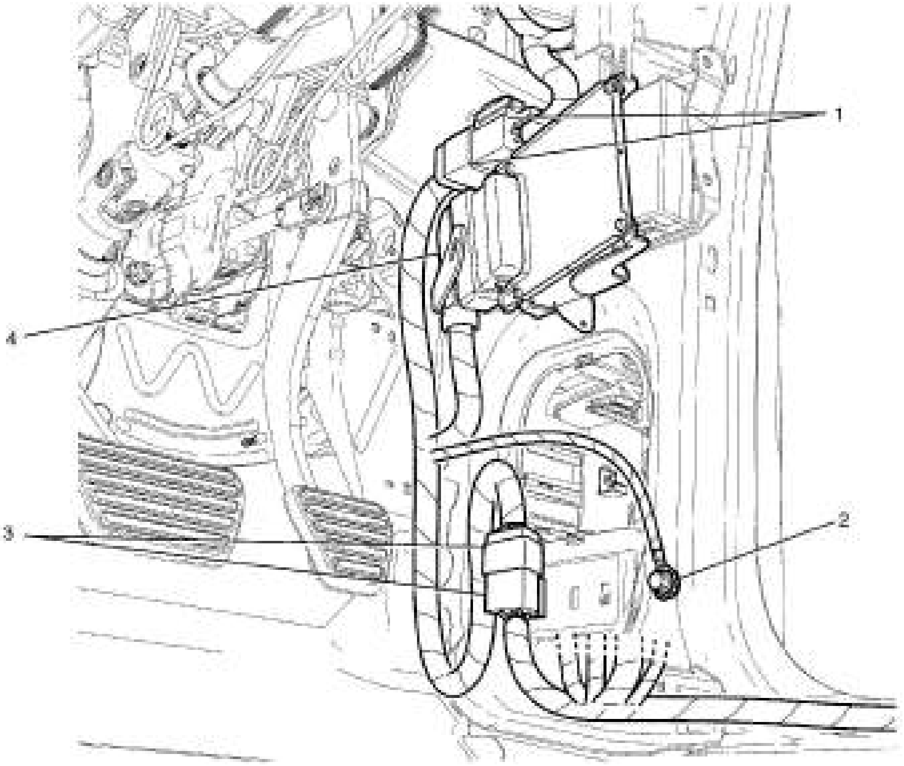
(1) Body Harness to Electronic Suspension Control Rear Harness -- X413

Electronic Suspension Control Wiring -- Right Hand Front



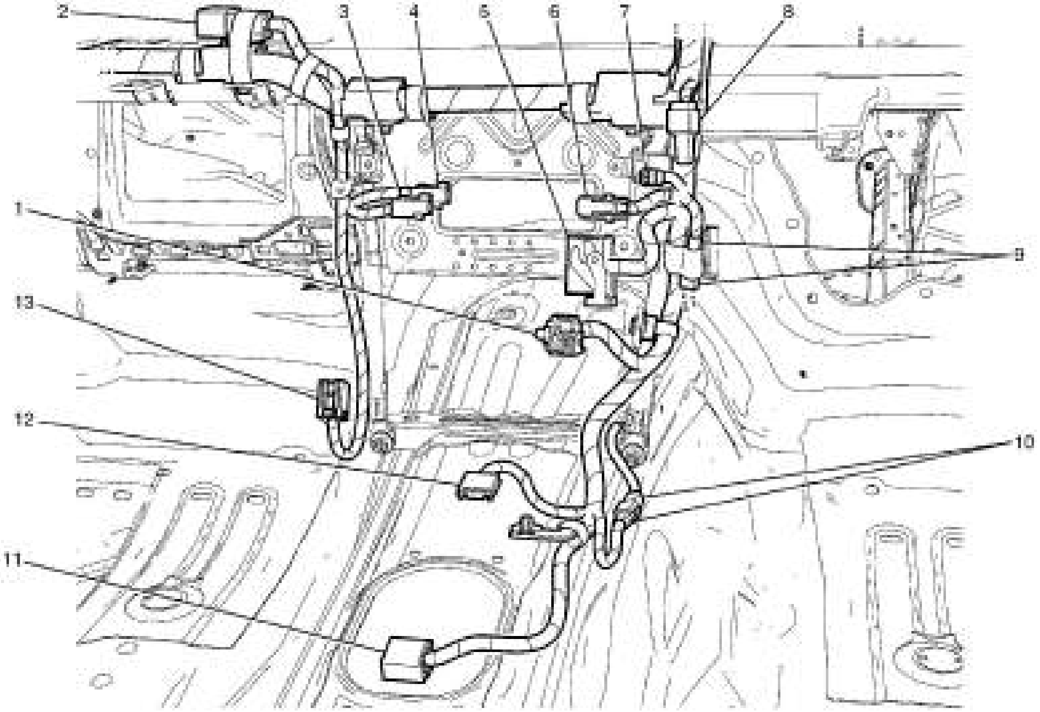
(1) Suspension Position Sensor - RF -- B36
(2) Suspension Damper Actuator - RF -- Y155

Electronic Suspension Control Wiring -- Right Hand Kick Panel



(1) I/P Harness to Electronic Suspension Control Patch Harness -- X237
(2) Right Cockpit Endplate Ground -- G201
(3) Body Harness to Electronic Suspension Control Patch Harness -- X236
(4) Electronic Suspension Control (ESC) Module -- A6

Instrument Panel Wiring -- Centre



(1) Front Cigar Lighter Connector -- X113
(2) I/P Harness to Electronic Suspension Control Console Harness -- X238
(3) Diversity Antenna Connector -- N3
(4) AM/FM Antenna Connector -- W6
(5) Radio Connectors 1, 2, 3, 4 -- A133
(6) Radio Connector 7 -- A133
(7) Ambient Air Temperature Sensor Connector -- B59
(8) Resistor Terminator
(9) Kill Switch Interconnect
(10) Earth Connector
(11) Automatic Transmission Shift Lever Connector -- S22
(12) Multifunction Centre Console Switch Connector -- S73
(13) I/P Harness to Secondary Information Cluster Patch Harness -- X226

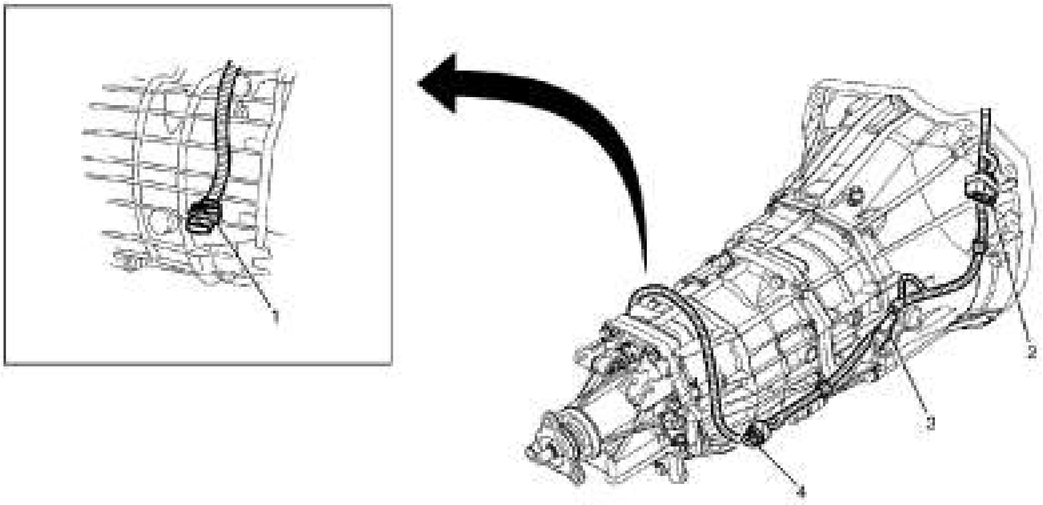
Harness Routing Views (SWBRHD)

Figure 1: Engine and Transmission Harness (3.6L) - 1 of 9
Figure 2: Engine and Transmission Harness (3.6L) - 2 of 9
Figure 3: Engine and Transmission Harness (3.6L) - 3 of 9
Figure 4: Engine and Transmission Harness (3.6L) - 4 of 9
Figure 5: Engine and Transmission Harness (3.6L) - 5 of 9
Figure 6: Engine and Transmission Harness (3.6L) - 6 of 9
Figure 7: Engine and Transmission Harness (3.6L) - 7 of 9
Figure 8: Engine and Transmission Harness (3.6L) - 8 of 9
Figure 9: Engine and Transmission Harness (3.6L) - 9 of 9
Figure 10: 4 Speed Automatic Transmission Harness (3.6L)
Figure 11: 5 Speed Automatic Transmission Harness (3.6L)
Figure 12: 6 Speed Manual Transmission Harness (3.6L)
Figure 13: Engine and Transmission Harness (6.0L) - 1 of 7
Figure 14: Engine and Transmission Harness (6.0L) - 2 of 7
Figure 15: Engine and Transmission Harness (6.0L) - 3 of 7
Figure 16: Engine and Transmission Harness (6.0L) - 4 of 7
Figure 17: Engine and Transmission Harness (6.0L) - 5 of 7
Figure 18: Engine and Transmission Harness (6.0L) - 6 of 7
Figure 19: Engine and Transmission Harness (6.0L) - 7 of 7
Figure 20: 6 Speed Automatic Transmission Harness (6.0L)
Figure 21: 6 Speed Manual Transmission Harness (6.0L)
Figure 22: Forward Lamps Harness
Figure 23: Body Front Wiring (3.6L)
Figure 24: Body Front Wiring (6.0L)
Figure 25: Battery Wiring (3.6L)
Figure 26: Battery Wiring (6.0L)

Figure 27: Battery Wiring (Short Wheel Base)
Figure 28: Battery Wiring
Figure 29: Body Wiring - Rear (Short Wheel Base)
Figure 30: Body Wiring - Right Kick Panel
Figure 31: Body Wiring - Left Kick Panel (Right Hand Drive)
Figure 32: Body Wiring - Right Hand Side
Figure 33: Body Wiring - Left Hand Side
Figure 34: Body Wiring - Centre Console
Figure 35: Body Wiring - Rear Seat and Fuel Tank Wiring
Figure 36: Body Wiring - Rear Parcel Shelf Right Side
Figure 37: Body Wiring - Rear Parcel Shelf 2
Figure 38: Body Wiring and Decklid Wiring - Rear Compartment (Short Wheel Base except HSV)
Figure 39: Instrument Panel Wiring - Right Kick Panel (Right Hand Drive)
Figure 40: Instrument Panel Wiring - Left Kick Panel (Right Hand Drive)
Figure 41: Instrument Panel Wiring - Centre (Right Hand Drive, up to Dec 06)
Figure 42: Instrument Panel Wiring - Centre (Right Hand Drive, as of Dec 06)
Figure 43: Instrument Panel Wiring - Right Side (Right Hand Drive)
Figure 44: Instrument Panel Wiring - Left Side (Up to Dec 06)
Figure 45: Instrument Panel Wiring - Left Side (From Dec 06)
Figure 46: Instrument Panel Wiring - Steering Column (Right Hand Drive)
Figure 47: Front Door Wiring (Right Hand Drive)
Figure 48: Rear Door Wiring (Short Wheel Base Right Hand Drive)
Figure 49: Console Wiring (Right Hand Drive)
Figure 50: Front Object Alarm Sensor Wiring
Figure Headliner Wiring (Right Hand Drive)

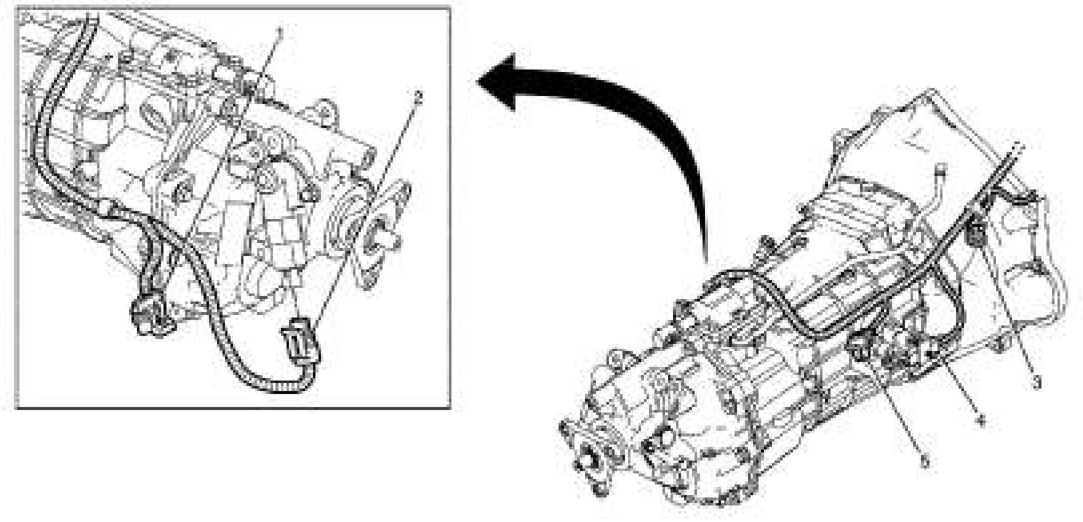
51:
Figure 52: Instrument Panel Compartment Wiring
Figure 53: Rear Axle Wiring (Short Wheel Base)
Figure 54: Genuine Accessory Alarm System Harness - Siren
Figure 55: Genuine Accessory Alarm System Harness - Alarm Control Module/Disable Switch
Figure 56: Genuine Accessory Alarm System Harness - Tilt Sensor
Figure 57: Genuine Accessory Alarm System Harness - Ultrasonic Module/Option Programming Connector
Figure 58: Genuine Accessory Alarm System Harness - Ultrasonic Sensors
Figure 59: Genuine Accessory Rear Park Assist Harness - Control Module, Warning Buzzer
Figure 60: Aftermarket Accessory Rear Park Assist Harness - Body Rear Wiring
Figure 61: Genuine Accessory Trailer Harness
Figure 62: Genuine Accessory Trailer Harness - Trailer Harness Connector

6 Speed Manual Transmission Harness (3.6L)



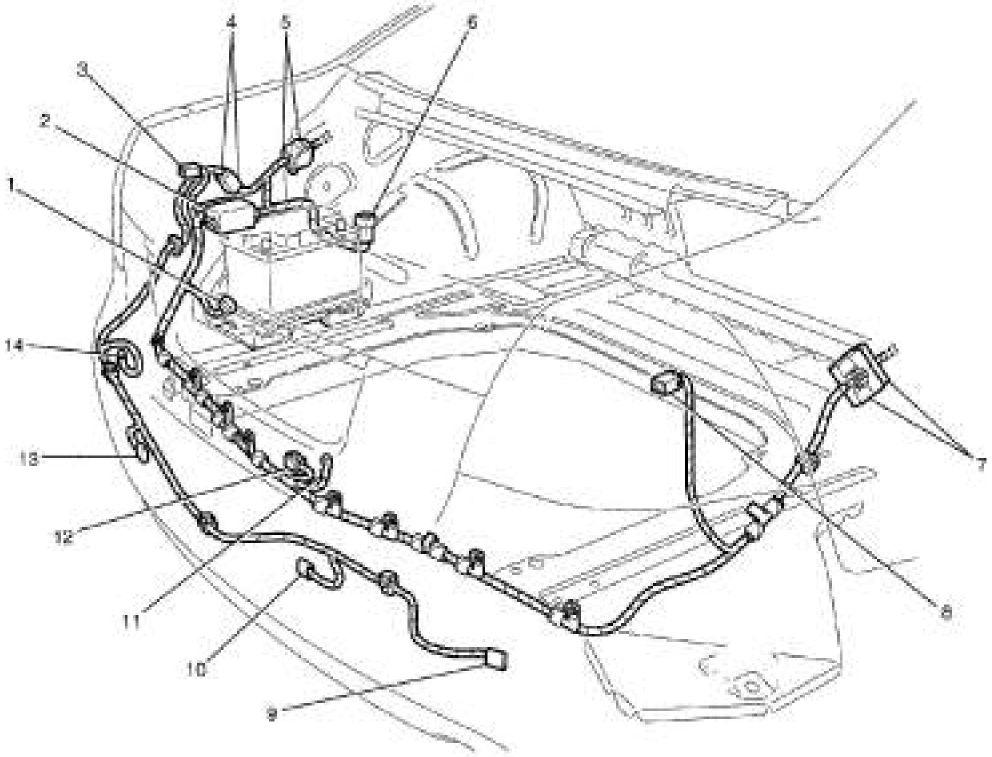
(1) Heated Oxygen Sensor (HO2S) Bank 2 Sensor 2 Connector -- B58
(2) Heated Oxygen Sensor (HO2S) Bank 1 Sensor 1 Connector -- B166
(3) Backup Lamp Switch Connector -- S32
(4) Heated Oxygen Sensor (HO2S) Bank 1 Sensor 2 Connector -- B56

6 Speed Manual Transmission Harness (6.0L)



(1) Heated Oxygen Sensor (HO2S) Bank 2 Sensor 2 Connector -- B57
(2) Reverse Lockout Solenoid Connector -- Y144
(3) Heated Oxygen Sensor (HO2S) Bank 1 Sensor 1 Connector -- B166
(4) Backup Lamp Switch Connector -- S32
(5) Heated Oxygen Sensor (HO2S) Bank 1 Sensor 2 Connector -- B57

Body Rear Wiring -- Rear Object Alarm Sensor Wiring



(1) Battery Current Sensor Connector -- B168
(2) Fuse Block - Rear -- X131
(3) Tail Lamp Assembly - Left Connector -- X451
(4) Body Rear to Rear Fascia Wiring Connector -- X405
(5) Left Hand Body Wiring Connector -- X403
(6) Battery Cable to Body Rear Harness -- X408
(7) Right Hand Body Wiring Connector -- X404
(8) Tail Lamp Assembly - Right Connector -- X450
(9) Rear Object Alarm Sensor - RR Corner Connector -- B133
(10) Rear Object Alarm Sensor - RR Middle Connector -- B133
(11) Rear Compartment Lid Latch Bracket Ground -- G409
(12) Rear Compartment Lid Latch Assembly Connector -- Y23
(13) Rear Object Alarm Sensor - LR Middle Connector -- B133
(14) Rear Object Alarm Sensor - LR Corner Connector -- B133

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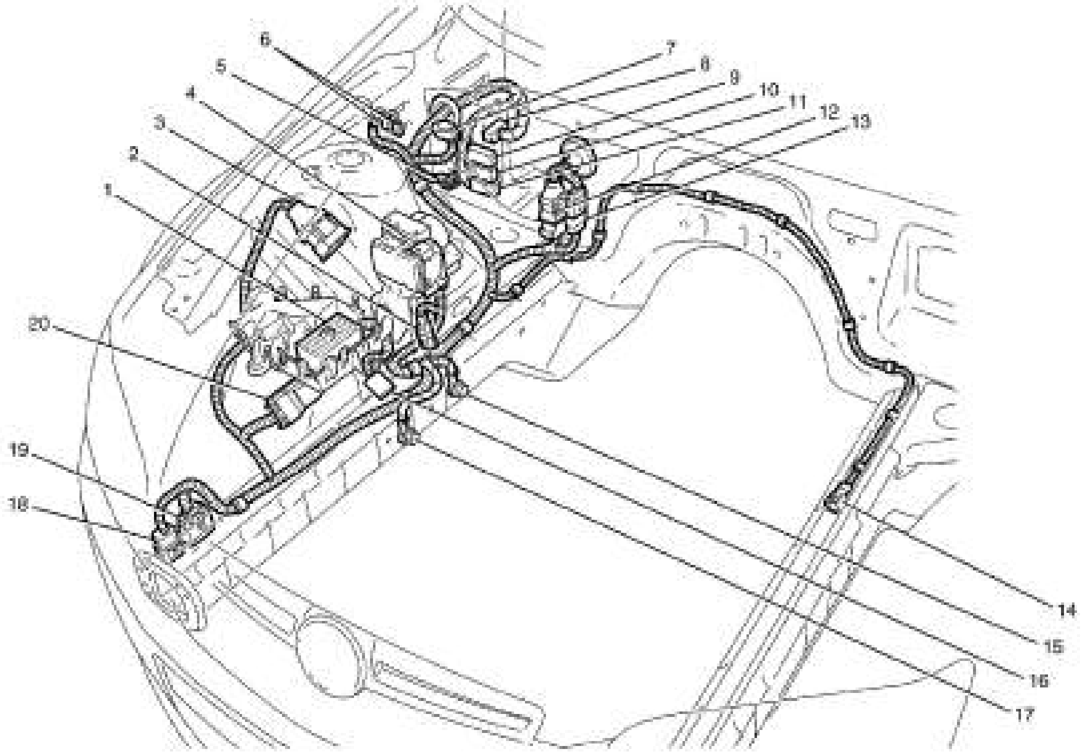
Body Front Wiring (6.0L)



(1) Fuse Block - Underhood -- X124
(2) Body Front Harness to RF Wheel Speed Sensor Connector -- X161
(3) Engine and Transmission Wiring Harness Connector 1 -- X102
(4) Electronic Brake Control Module (EBCM) Connector -- A38/A116
(5) Brake Fluid Level Switch Connector -- S36
(6) Theft Horn Connector -- B9
(7) Windshield Wiper Motor Connector -- M17
(8) Body Wiring Harness 1 Connector -- X206
(9) Instrument Panel Wiring Harness Connector 3 -- X200
(10) Instrument Panel Wiring Harness Connector 4 -- X204
(11) Instrument Panel Wiring Harness Connector 5 -- X207
(12) Instrument Panel Wiring Harness Connector 1 -- X104
(13) Instrument Panel Wiring Harness Connector 2 -- X203
(14) Body Front Harness to LF Wheel Speed Sensor Connector -- X160
(15) Right Chassis Rail Ground -- G102
(16) Engine and Transmission Wiring Harness Connector 2 -- X110
(17) Right Chassis Rail Ground -- G101

(18) Body Front to Front Fascia Wiring Harness Connector -- X108
(19) Front Compartment Wiring Harness Connector 1 -- X106
(20) Engine Control Module Connector 1 -- A43-X1

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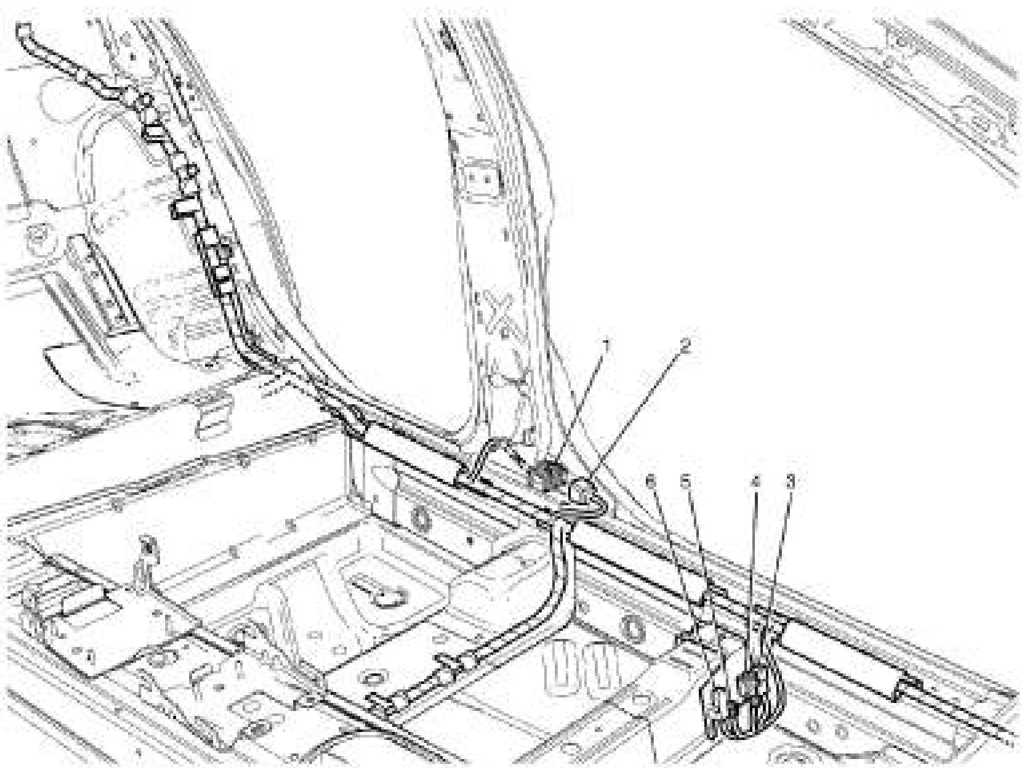
Body Wiring -- Left Hand Side



(1) Left Hand Rear Door Connector -- X301
(2) Inflatable Restraint Side Impact Sensor (SIS) (LF) Connector -- B63
(3) Body Harness to Passenger Seat Harness Connector -- X322
(4) Body Harness to Passenger Seat Harness Connector -- X310
(5) Body Harness to Pretensioner Passenger Harness Connector -- X355
(6) Body Harness to Passenger Seat Harness Connector -- X314

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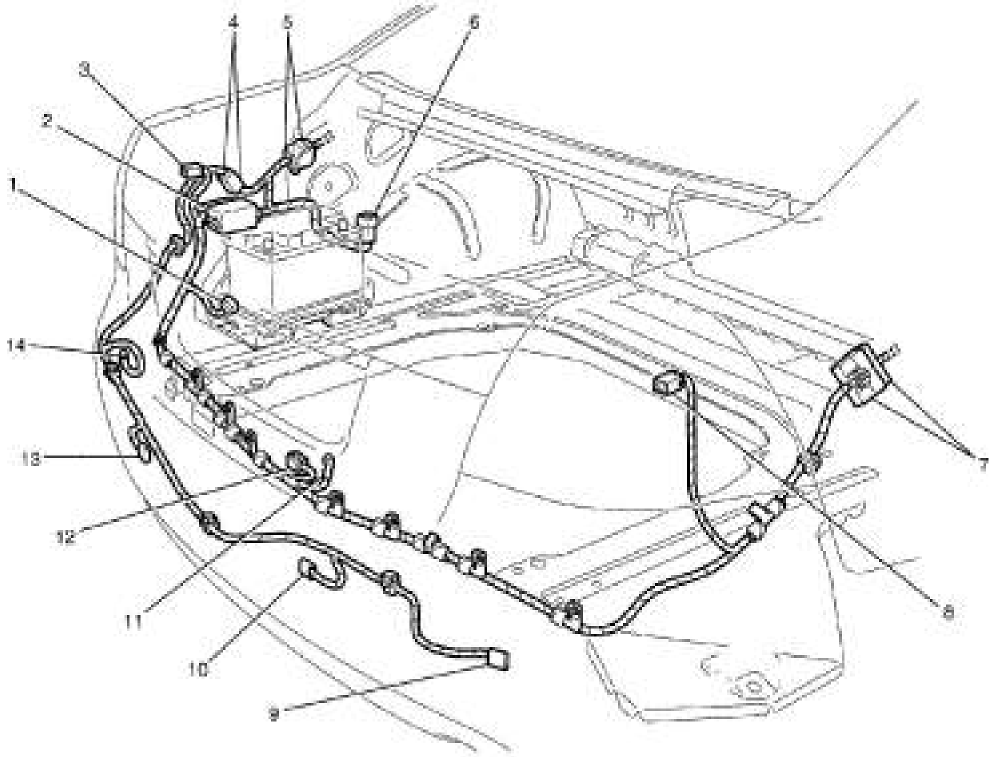
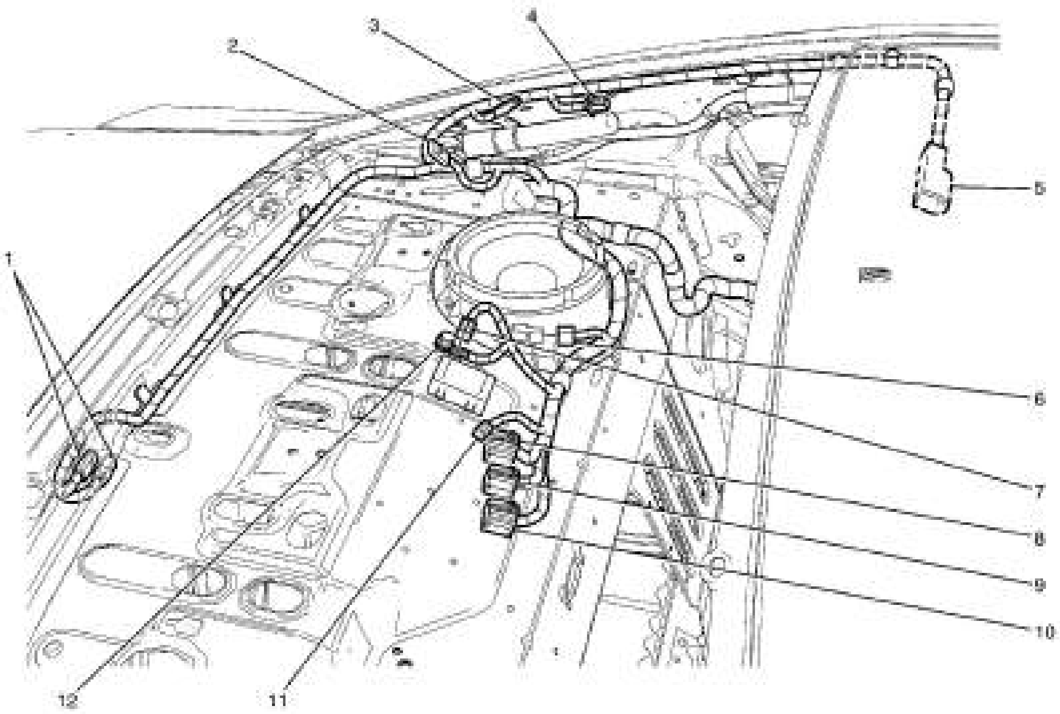
Body Wiring - Rear (Short Wheel Base)



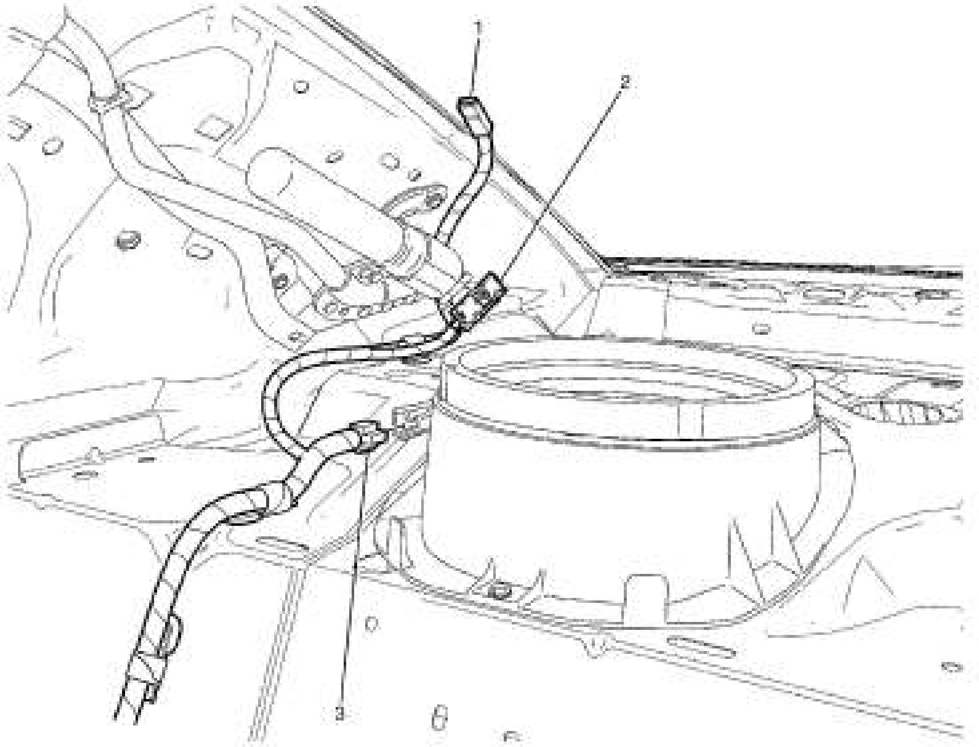
(1) Battery Current Sensor Connector -- B168
(2) Fuse Block - Rear -- X131
(3) Tail Lamp Assembly - Left Connector -- X451
(4) Body Rear to Rear Fascia Wiring Connector -- X405
(5) Left Hand Body Wiring Connector -- X403
(6) Battery Cable to Body Rear Harness -- X408
(7) Right Hand Body Wiring Connector -- X404
(8) Tail Lamp Assembly - Right Connector -- X450
(9) Rear Object Alarm Sensor - RR Corner Connector -- B133
(10) Rear Object Alarm Sensor - RR Middle Connector -- B133
(11) Rear Compartment Lid Latch Bracket Ground -- G409
(12) Rear Compartment Lid Latch Assembly Connector -- Y23
(13) Rear Object Alarm Sensor - LR Middle Connector -- B133
(14) Rear Object Alarm Sensor - LR Corner Connector -- B133

Body Wiring -- Rear Parcel Shelf 2



(1) Rear Compartment Lid Lamp Connectors-- E36-X1 and E36-X2
(2) Inflatable Restraint Roof Rail Module (Left) Connector -- A96
(3) Rear Window Defogger Grid Connector -- R22-X2
(4) Diversity Antenna Connector -- N3
(5) Radio Antenna Connector -- W6
(6) Speaker Rear Subwoofer Connector -- B131
(7) Remote Function Actuator Connector -- A157
(8) Front and Rear Object Alarm Module Connector -- A98-X1
(9) Front and Rear Object Alarm Module Connector -- A98-X2
(10) Front and Rear Object Alarm Module Connector -- A98-X3
(11) Front and Rear Object Alarm Connector -- H31
(12) Parcel Shelf Ground -- G407

Body Wiring -- Rear Parcel Shelf Right Side



(1) Rear Window Defogger Grid Connector -- R22-X1
(2) Inflatable Restraint Roof Rail Module (Right) Connector -- A96
(3) Speaker Rear Subwoofer Connector -- B131

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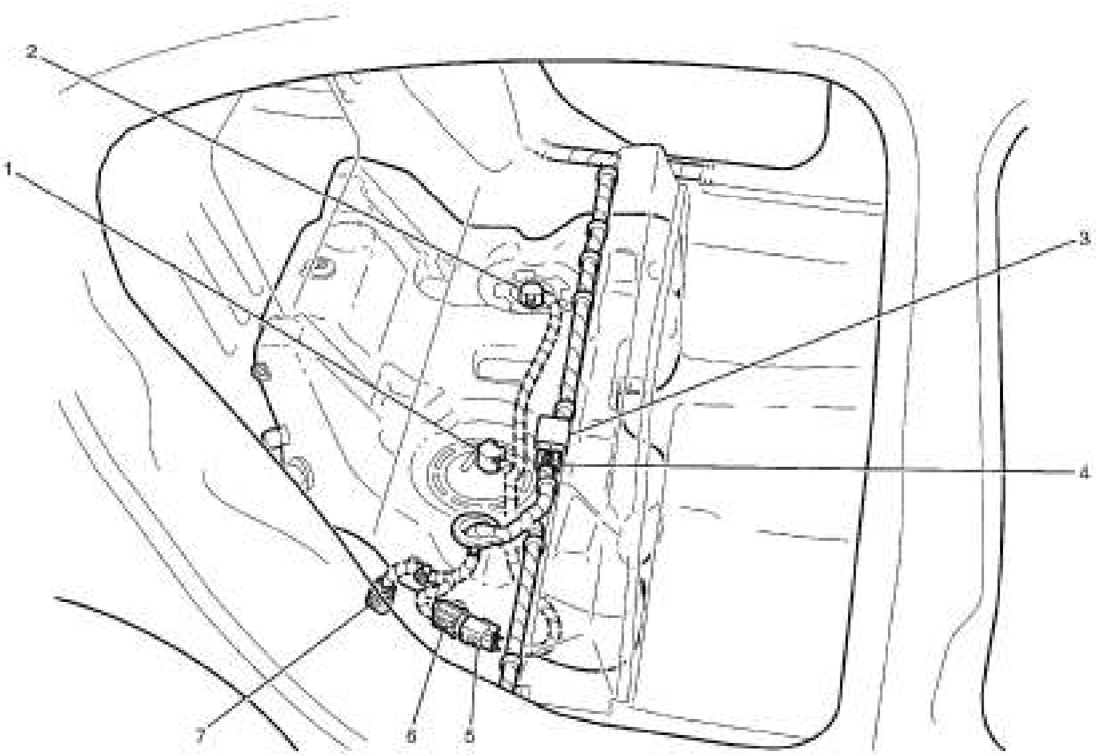
Body Wiring -- Rear Seat and Fuel Tank Wiring



(1) Fuel Pump and Sender Assembly Connector -- M8
(2) Fuel Level Sensor (Secondary) Connector -- B53
(3) Left hand Body Wiring Harness Crossover Connector -- X317
(4) Right hand Body Wiring Harness Crossover Connector -- X317
(5) Fuel Tank Harness to Body Wiring Harness Connector -- X305
(6) Body Wiring Harness to Fuel Tank Harness Connector -- X305
(7) Body to Rear Axle Harness Connector -- X360

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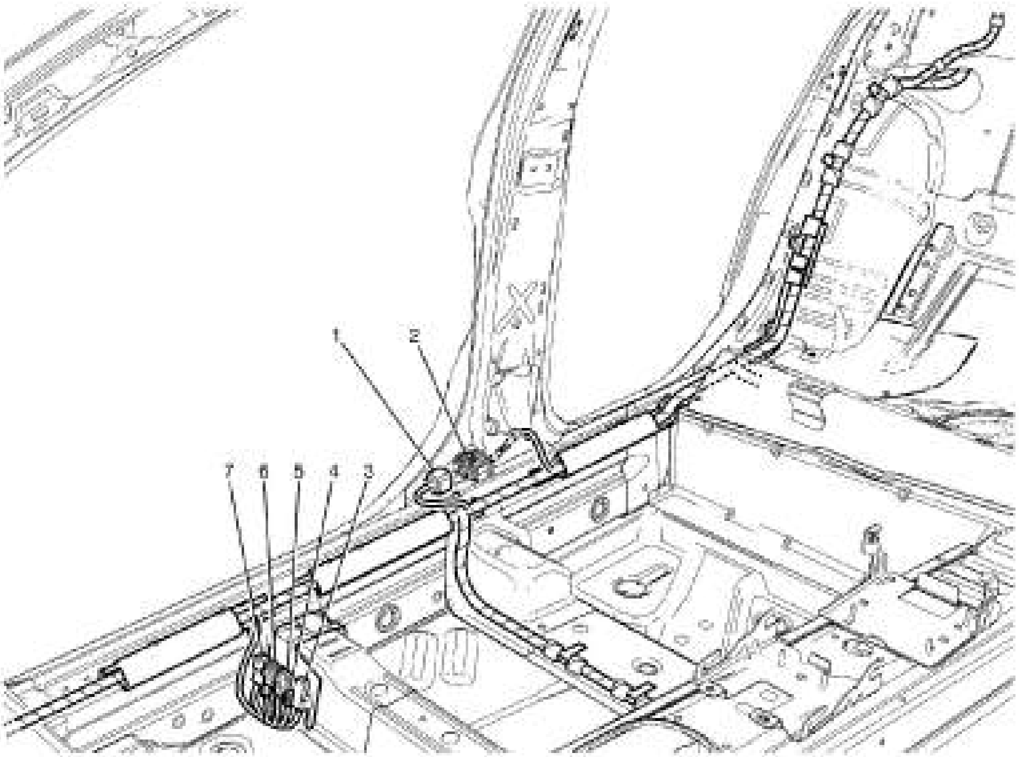
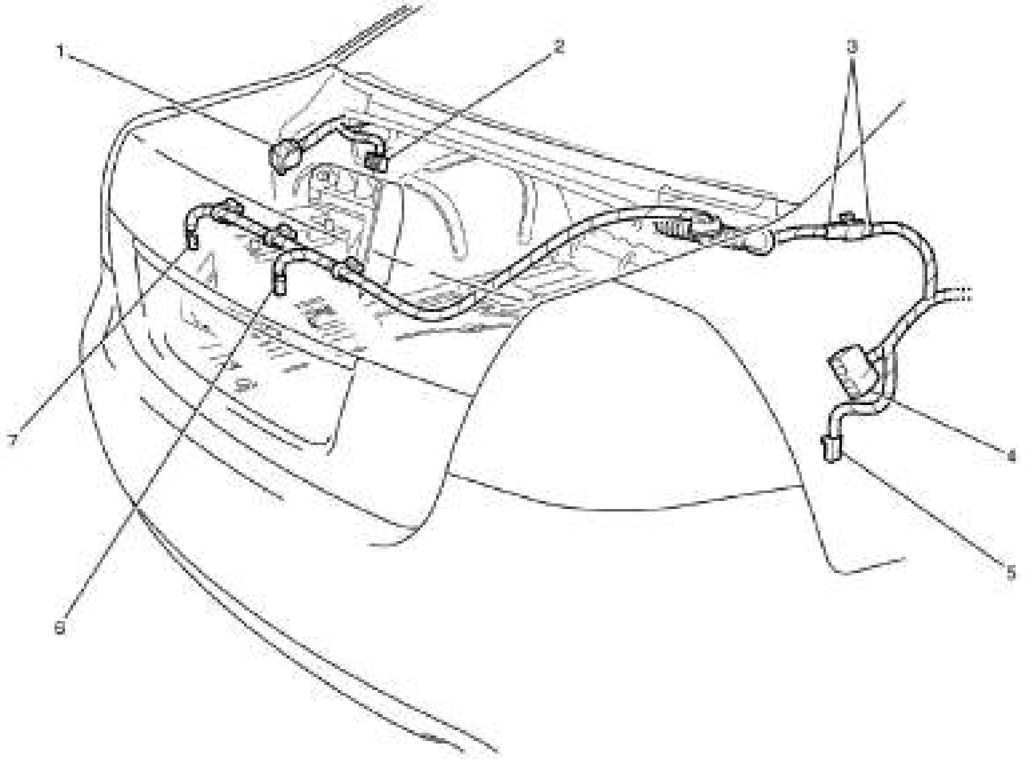
Body Wiring -- Right Hand Side



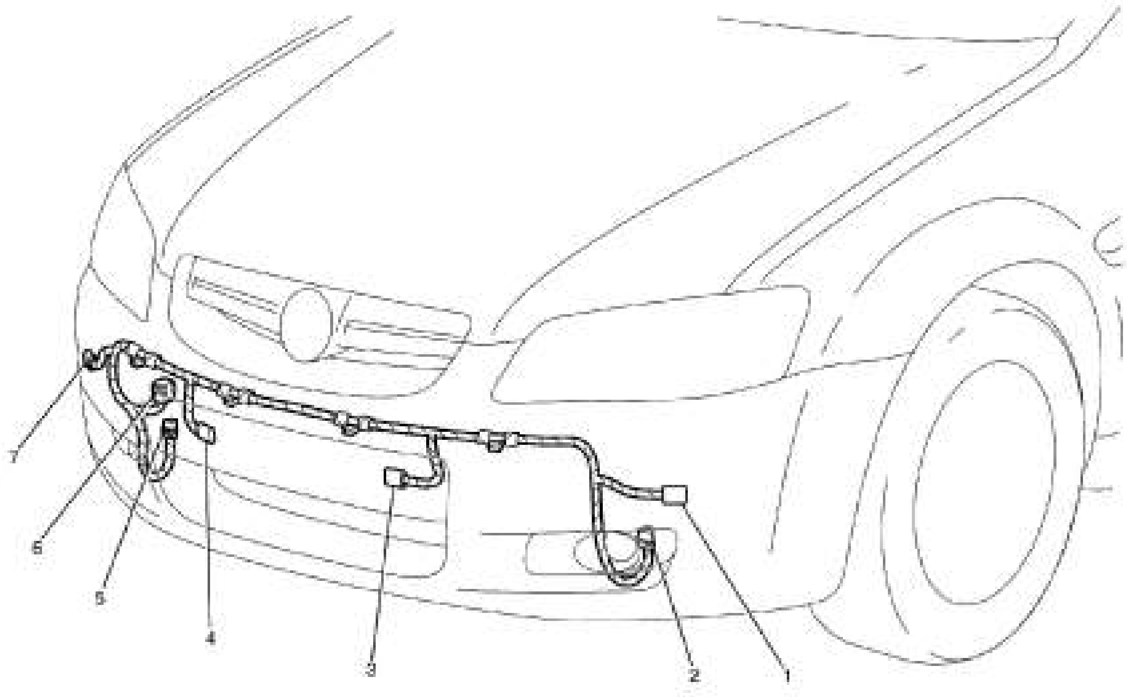
(1) Inflatable Restraint Side Impact Sensor (SIS) (RF) Connector -- B63
(2) Body Harness to Right Hand Rear Door Harness Connector -- X302
(3) Body Harness to Pretensioner Driver Harness Connector -- X356
(4) Body Harness to Driver Seat Harness Connector -- X313
(5) Body Harness to Driver Seat Harness Connector -- X315
(6) Body Harness to Driver Seat Harness Connector -- X306
(7) Body Harness to Driver Seat Harness Connector -- X311

Body Wiring and Decklid Wiring - Rear Compartment (Short Wheel Base except HSV)



(1) Left Hand Body Rear Wiring Connector -- X403
(2) Audio Amplifier Module Connector -- N6
(3) Decklid Wiring to Body Wiring Connector -- X402
(4) Right Hand Body Rear Wiring Connector -- X404
(5) Fuel Filler Door Latch Connector -- Y10
(6) Right License Plate Lamp Connector -- E44
(7) Left License Plate Lamp Connector -- E44

Front Object Alarm Sensor Wiring



(1) Front Object Alarm Sensor - LF Corner Connector -- B133
(2) Left Fog Lamp Connector -- E69
(3) Front Object Alarm Sensor - LF Middle Connector -- B133
(4) Front Object Alarm Sensor - RF Middle Connector -- B133
(5) Right Fog Lamp Connector -- E69
(6) Body Front to Front Fascia Wiring Harness Connector -- X108
(7) Front Object Alarm Sensor - RF Corner Connector -- B133

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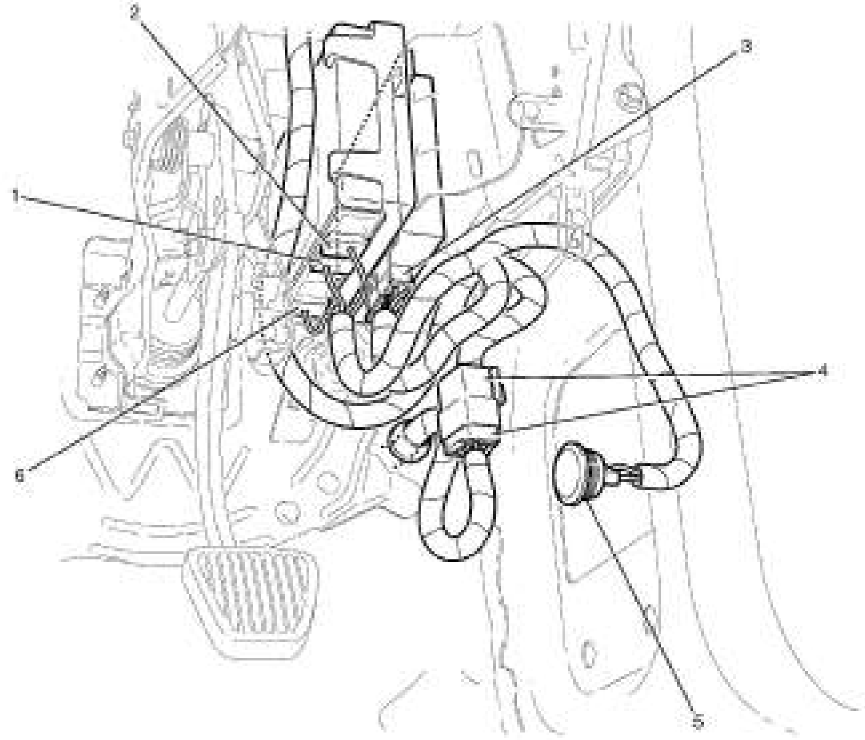
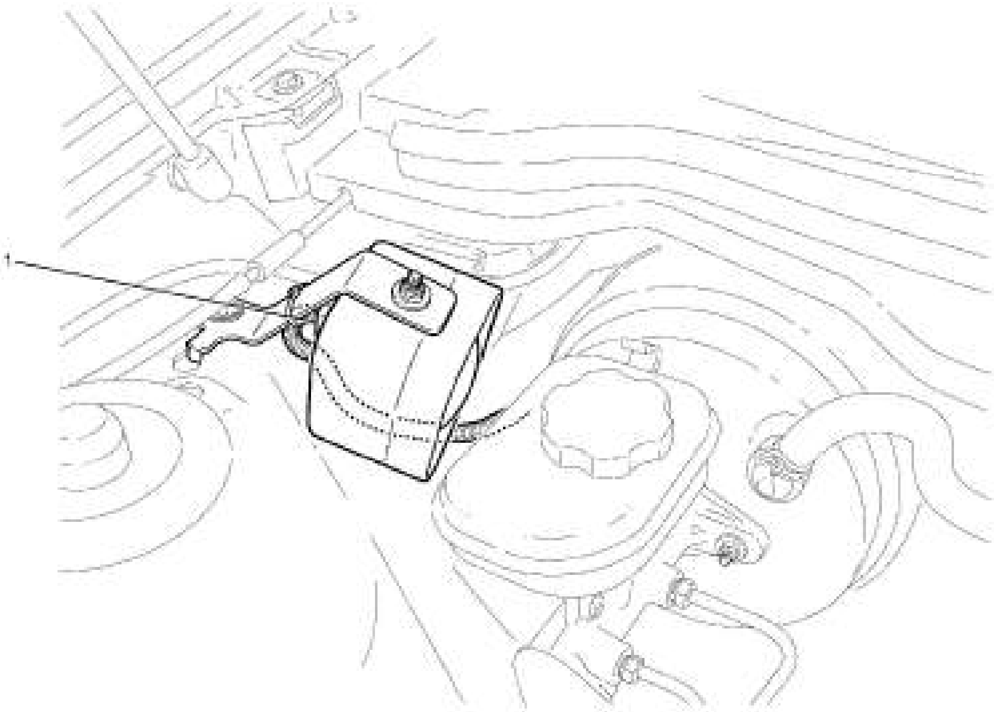
Genuine Accessory Alarm System Harness - Alarm Control Module / Disable Switch



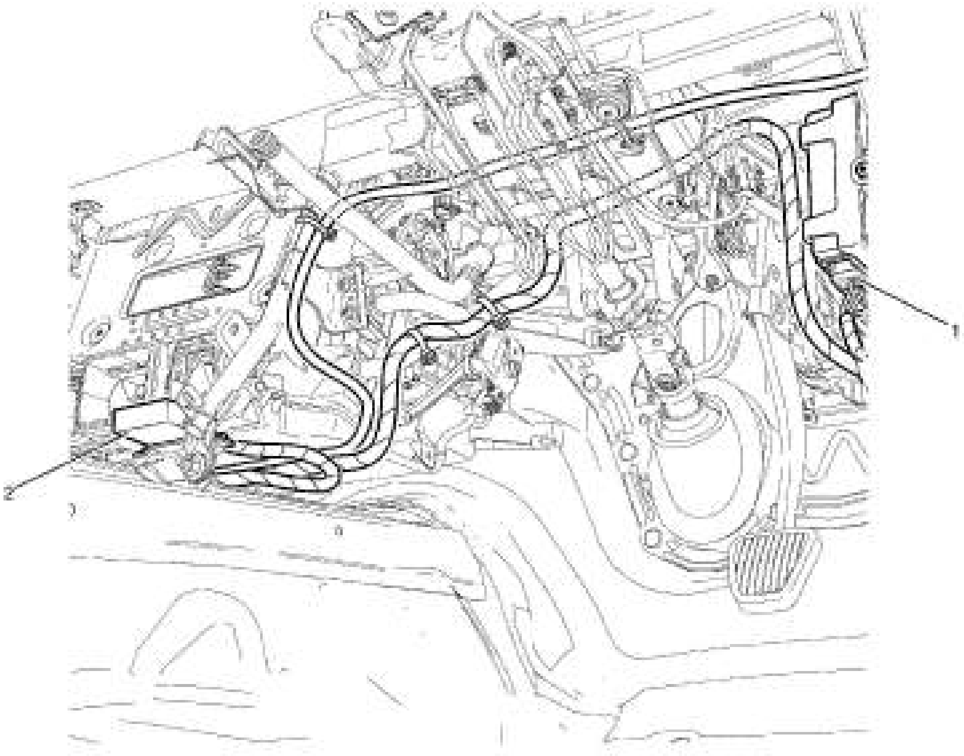
(1) Body Control Module Connector A15 -- X5
(2) Body Control Module Connector A15 -- X6
(3) Alarm Control Module Connector -- A38/A116
(4) Siren Inline Connector
(5) Disable Switch
(6) Body Control Module Connector A15 -- X2

Genuine Accessory Alarm System Harness - Siren



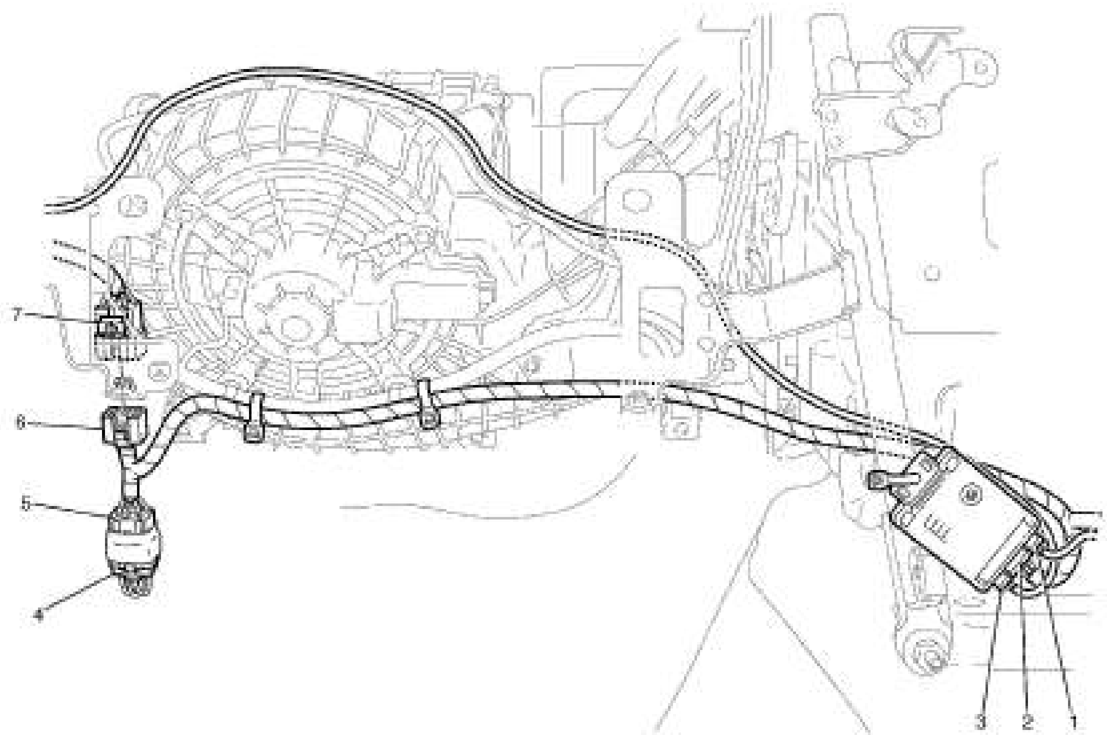
(1) Siren Connector

Genuine Accessory Alarm System Harness - Tilt Sensor



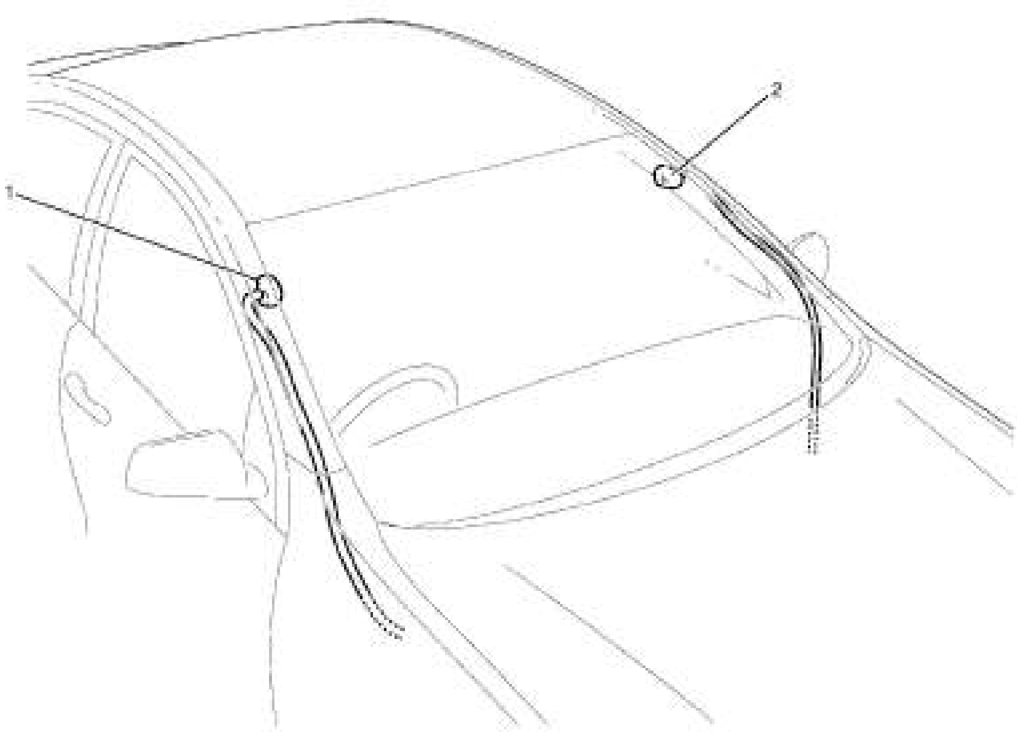
(1) Body Control Module Connector A15 -- X6
(2) Tilt Sensor

Genuine Accessory Alarm System Harness - Ultrasonic Module / Option Programming Connector



(1) Split Eye Ultrasonic Module (Black) -- X2
(2) Split Eye Ultrasonic Module -- X1
(3) Split Eye Ultrasonic Module (Red) -- X3
(4) Dealer Option Programming Jumper Connector
(5) Alarm Harness to Dealer Option Programming Jumper Connector
(6) Alarm Harness to Instrument Panel Harness Connector (X137)
(7) Instrument Panel Dealer Option Connector (X137)

Genuine Accessory Alarm System Harness - Ultrasonic Sensors



(1) Ultrasonic Sensor -- 1

(2) Ultrasonic Sensor -- 2

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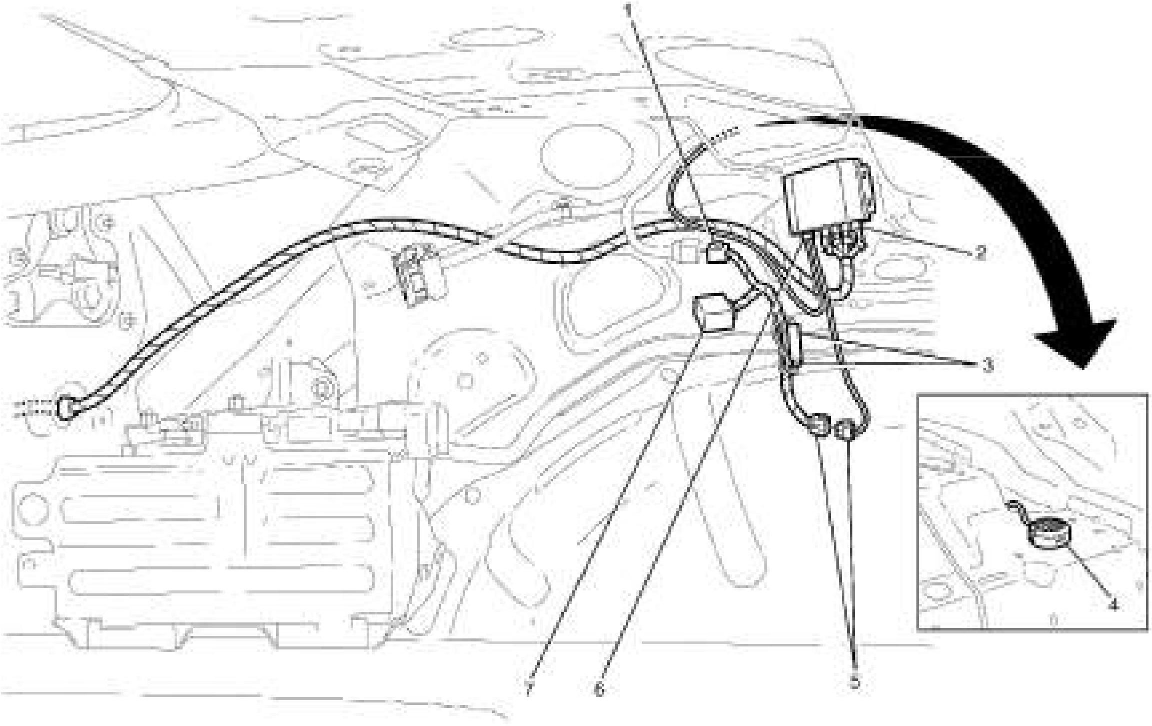
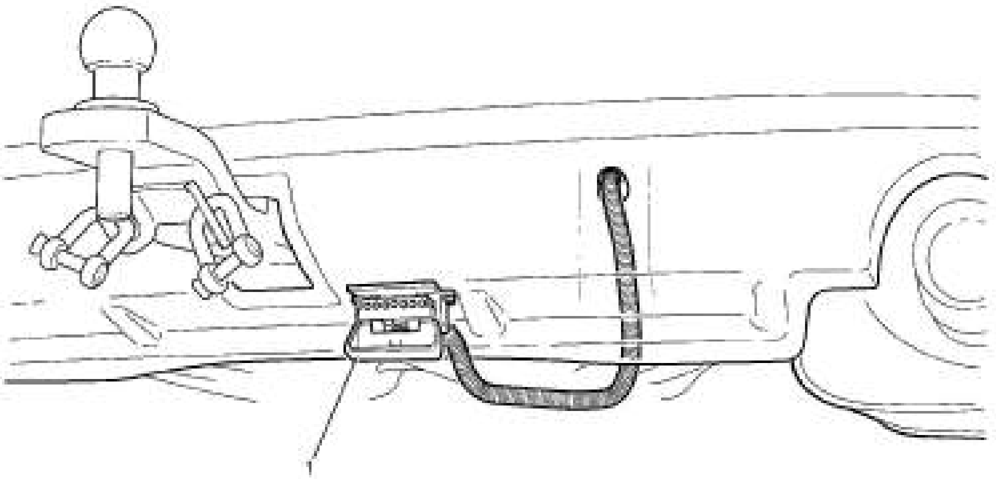
Genuine Accessory Rear Park Assist Harness, Control Module, Warning Buzzer



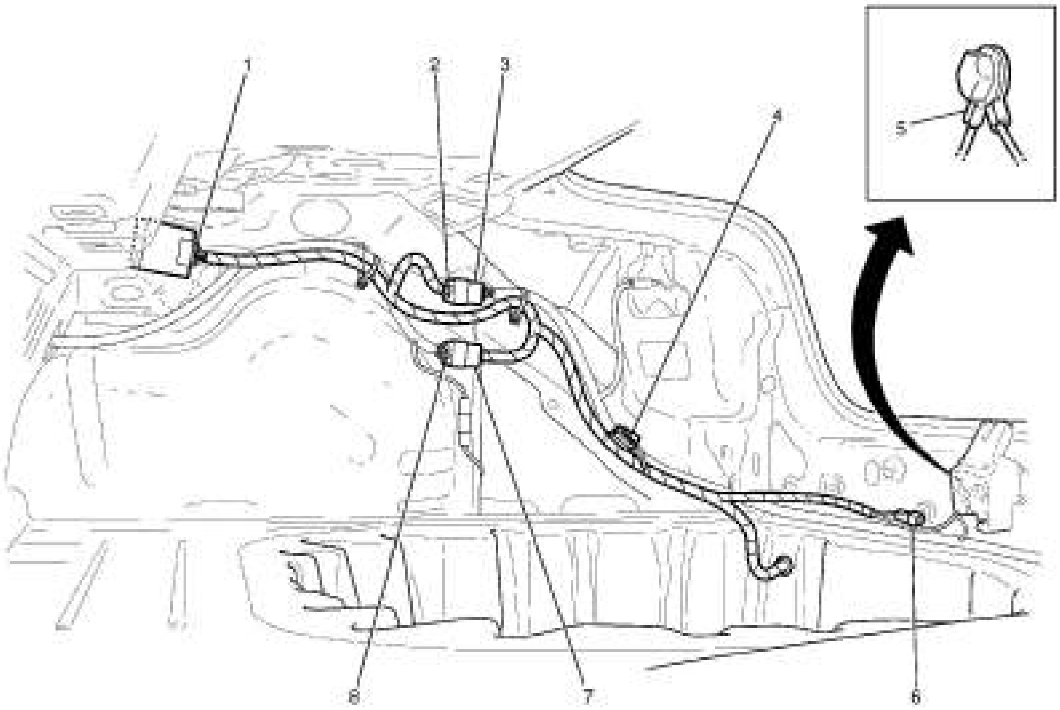
(1) Rear Park Assist Connector (X156)
(2) Rear Park Assist Module Connectors (A98 -- X2 to X5)
(3) Ground Break in Connector (XA)
(4) Rear Park Assist Warning Buzzer (H13)
(5) Rear Park Assist Patch Harness to Rear Park Assist Power/Warning Buzzer Connector (XB)
(6) Rear Park Assist Module Connector (A98 -- X1)
(7) External Relay

Genuine Accessory Trailer Harness- Accessory Trailer Harness Connector



(1) Trailer Harness Connector -- X109

Genuine Accessory Trailer Wiring Harness



(1) Trailer Harness Control Module Connector

(2) Trailer Patch Wiring Harness to Body Rear Wiring Harness Connector

(3) Body Rear Wiring Harness Connector -- X404

(4) Electronic Trailer Brake Connector

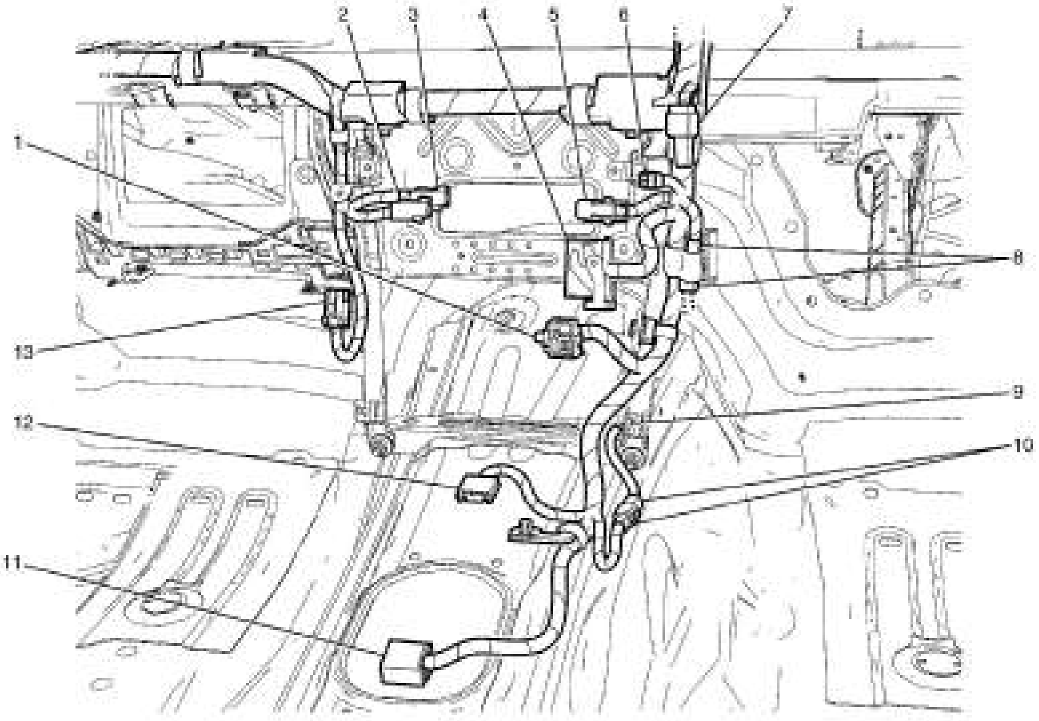
(5) Ground

(6) Rear Park Assist Ground Connector

(7) Body Rear Wiring Harness to Trailer Patch Wiring Harness Connector

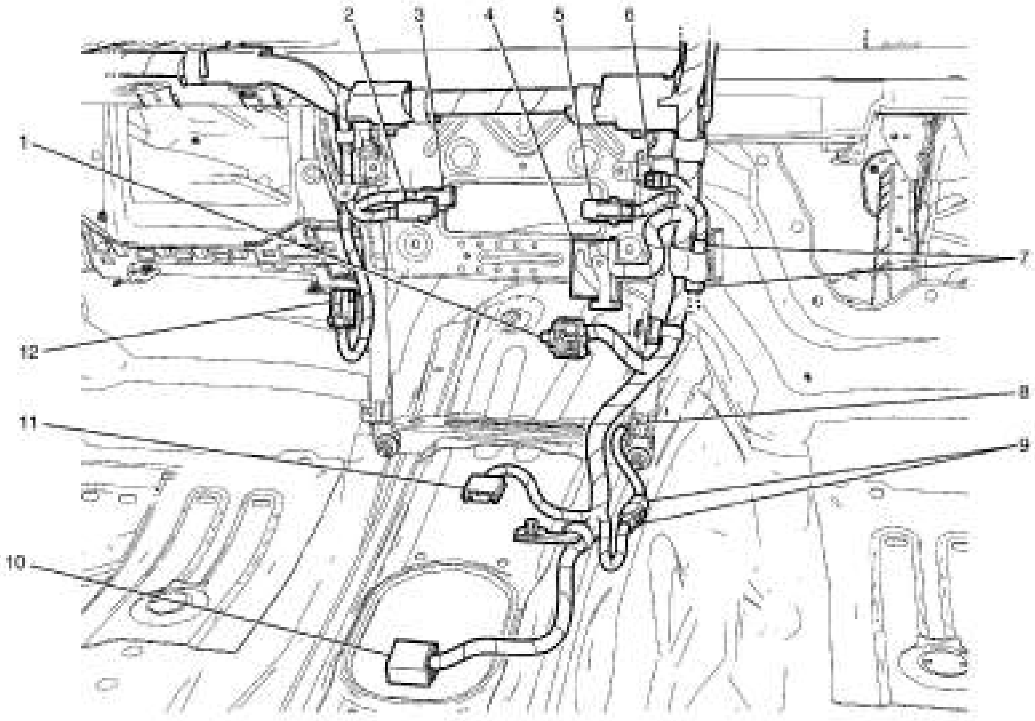
(8) Body Wiring Harness Connector -- X404

Instrument Panel Wiring -- Centre (Right Hand Drive, as of Dec 06)



(1) Cigar Lighter - Front Connector -- X113
(2) Radio Connector 6 -- A133
(3) Radio Connector 5-- A133
(4) Radio Connectors 1, 2, 3, 4 -- A133
(5) Radio Connector 7 -- A133
(6) Inside Air Temperature Sensor Connector -- B59
(7) Resistor Terminator
(8) Kill Switch Interconnect
(9) Console Bracket Ground -- G303
(10) I/P Harness to Console Bracket -- X223
(11) Automatic Transmission Shift Lever Connector -- S22
(12) Multifunction Centre Console Switch Connector -- S73
(13) Sport Gauges Connector -- P6 (SV6), X241 (SS)

Instrument Panel Wiring -- Centre (Right Hand Drive, up to Dec 06)



(1) Cigar Lighter - Front Connector -- X113
(2) Radio Connector 6 -- A133
(3) Radio Connector 5-- A133
(4) Radio Connectors 1, 2, 3, 4 -- A133
(5) Radio Connector 7 -- A133
(6) Inside Air Temperature Sensor Connector -- B59
(7) Kill Switch Interconnect
(8) Console Bracket Ground -- G303
(9) I/P Harness to Console Bracket -- X223
(10) Automatic Transmission Shift Lever Connector -- S22
(11) Multifunction Centre Console Switch Connector -- S73
(12) Sport Gauges Connector -- P6 (SV6), X241 (SS)

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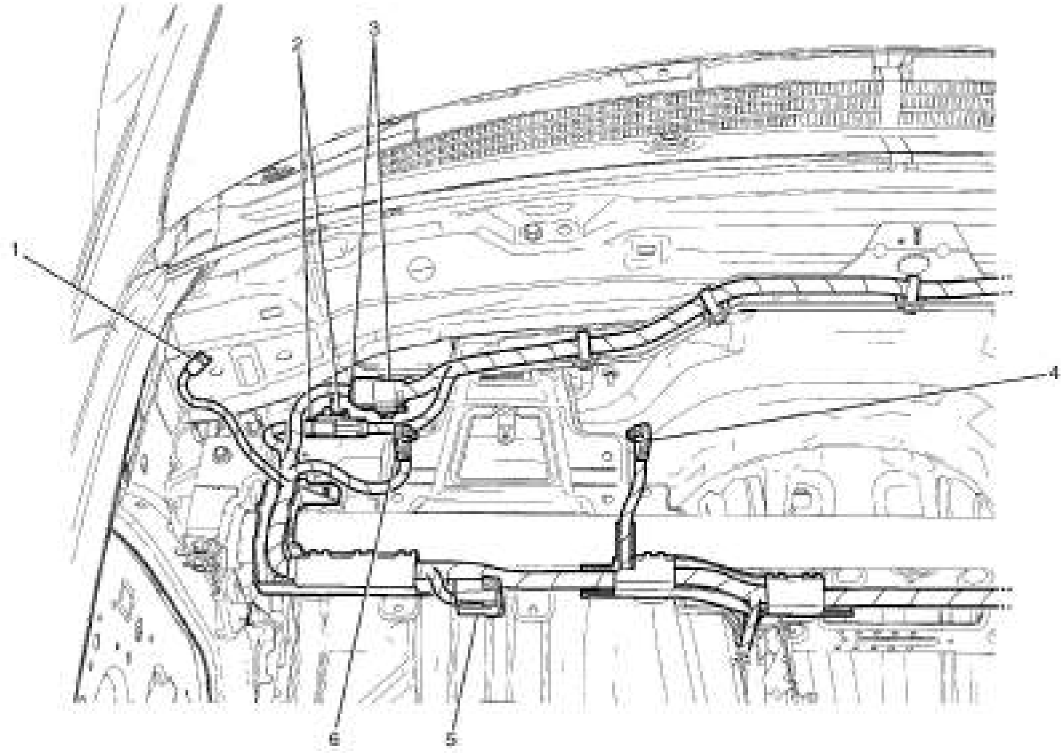
Instrument Panel Wiring -- Left Side (After 12/06)



(1) Speaker - LF Tweeter Connector -- B112

(2) RHS and LHS I/P Harness Crossover Connector 2 -- X228

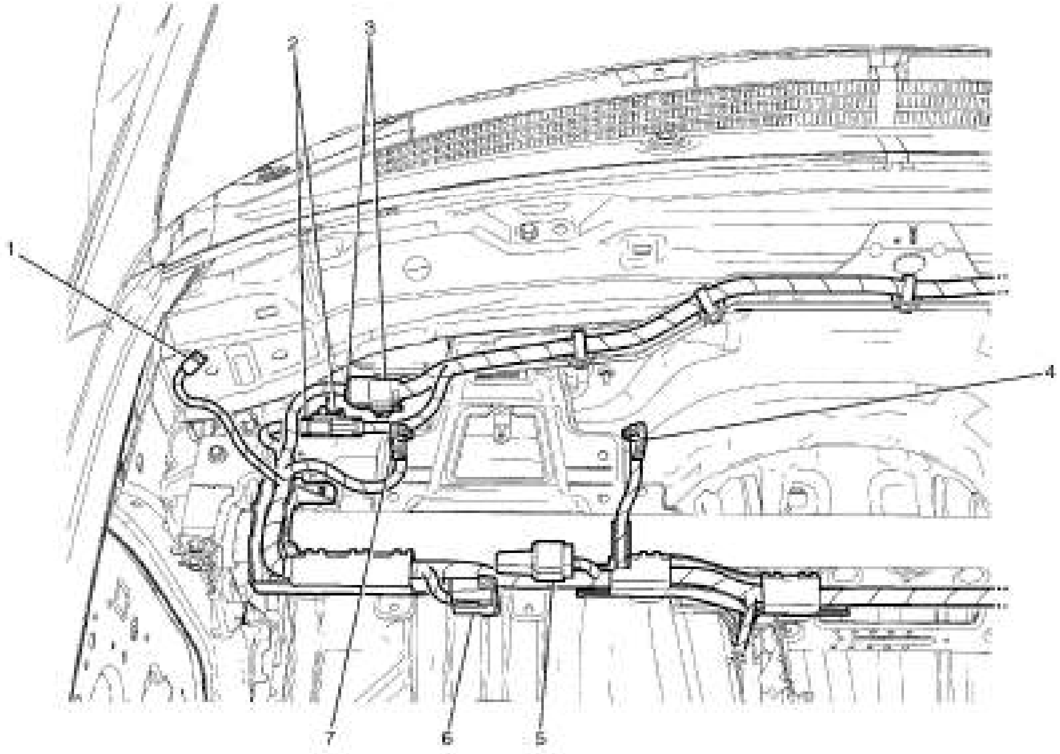
(3) RHS and LHS I/P Harness Crossover Connector 1 -- X229

(4) Inflatable Restraint I/P Module Connector 1 -- A62-X1

(5) I/P Data link Connector -- X95

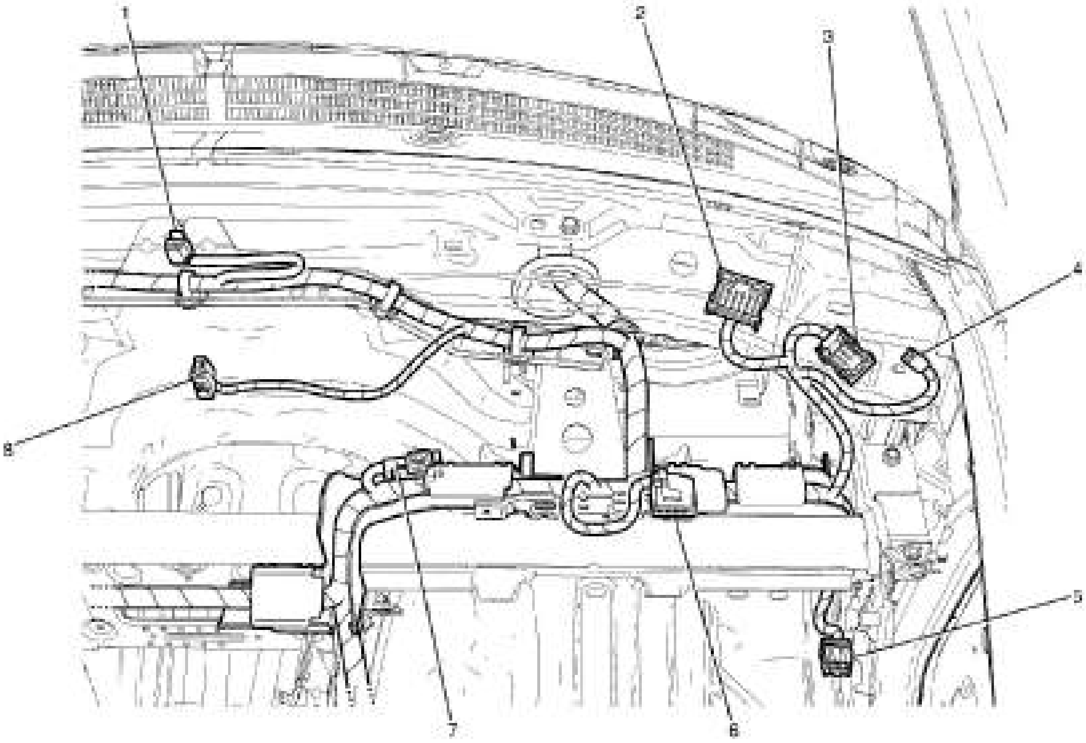
(6) Inflatable Restraint I/P Module Connector 2 -- A62-X2

Instrument Panel Wiring -- Left Side (Up to 12/06)



(1) Speaker - LF Tweeter Connector -- B112
(2) RHS and LHS I/P Harness Crossover Connector 2 -- X228
(3) RHS and LHS I/P Harness Crossover Connector 1 -- X229
(4) Inflatable Restraint I/P Module Connector 1 -- A62-X1
(5) Resistor Terminator
(6) I/P Data link Connector -- X95
(7) Inflatable Restraint I/P Module Connector 2 -- A62-X2

Instrument Panel Wiring - Right Side (Right Hand Drive)



(1) Ambient Light/Sun Load Sensor Connector -- B55
(2) I/P Harness to Headliner Harness Connector 1 -- X212
(3) I/P Harness to Headliner Harness Connector 2 -- X213
(4) Speaker - RF Tweeter Connector -- B112
(5) Headlamp and Dimmer Panel Switch Connector -- S125
(6) Instrument Panel Cluster (IPC) Connector -- P3
(7) Clutch Jumper Harness Connector -- X210 (Manual Transmission Only)
(8) Speaker -- Centre Connector -- B121

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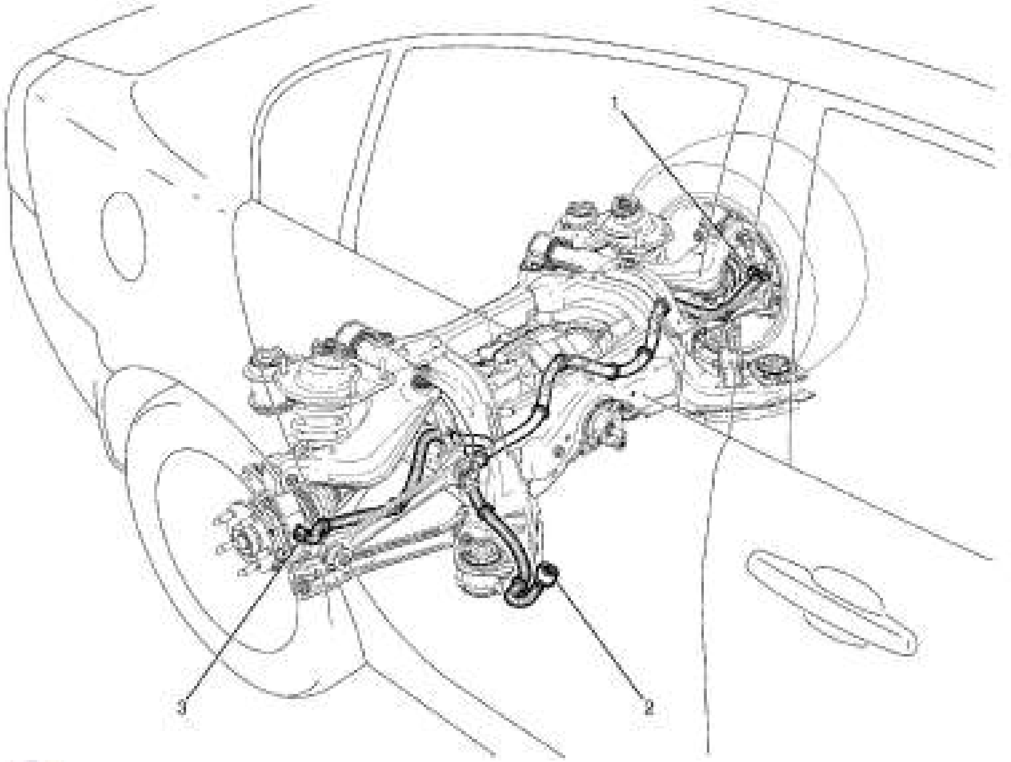
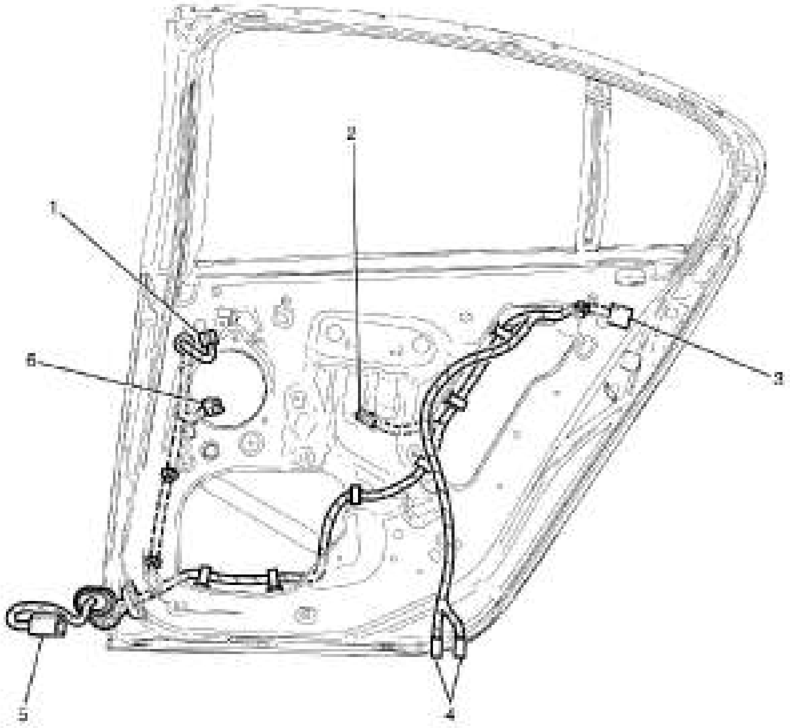
Rear Axle Wiring (Short Wheel Base)



(1) Wheel Speed Sensor (WSS) LR Connector -- B76
(2) Body to Rear Axle Harness Connector -- X360
(3) Wheel Speed Sensor (WSS) RR Connector -- B76

Rear Door Wiring (Short Wheel Base Right Hand Drive)



(1) Rear Window Switch Connector -- S221
(2) Window Motor Connector -- M14
(3) Door Latch Assembly Connector -- Y31
(4) Courtesy Lamp - Door Connector -- E99
(5) Body Harness to Right Hand Rear Door Harness Connector -- X302
(6) Speaker - Door Connector 1 -- B117

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Document ID: 2157553

Master Electrical Component List

Name	Location	Locator View	Connector End View
A/C Refrigerant Pressure Sensor (3.6L)	Part of the A/C compressor, on the right of the engine	Harness Routing Views	Component Connector End Views
A/C Refrigerant Pressure Sensor (6.0L)	Part of the A/C compressor, on the left of the engine	Harness Routing Views	Component Connector End Views
Accelerator Pedal Position (APP) Sensor	Under right side of instrument panel (I/P) to the right of the brake pedal	Harness Routing Views	Component Connector End Views
Air Mix Actuator	Part of the HVAC unit under the I/P	HVAC Component Views	Component Connector End Views
Ambient Light Sensor	On top of the I/P in the centre near the windshield	Harness Routing Views	Component Connector End Views
Automatic Transmission (4L60-E)	At the rear of the engine assembly, under the vehicle	Lighting Systems Component Views	Component Connector End Views
Automatic Transmission (5L40E)	At the rear of the engine assembly, under the vehicle	Lighting Systems Component Views	Component Connector End Views
Automatic Transmission (6L80)	At the rear of the engine assembly, under the vehicle	Lighting Systems Component Views	Component Connector End Views
Automatic Transmission Shift Lever (4L60-E)	In the passenger compartment in front of the centre console	Harness Routing Views	Component Connector End Views
Automatic Transmission Shift Lever (5L40E)	In the passenger compartment in front of the centre console	Harness Routing Views	Component Connector End Views
Automatic Transmission Shift Lever (6L80)	In the passenger compartment in front of the centre console	Harness Routing Views	Component Connector End Views
Auxiliary Power Outlet - Console	Inside the centre console	Harness Routing Views	Component Connector End Views
Backup Lamp Switch (3.6L)	Right side of the manual transmission case		Component Connector End Views
Backup Lamp Switch	Right side of the manual transmission		Component Connector

(6.0L)	case		End Views
Battery	Inside the rear compartment on the left hand side		Component Connector End Views
Battery Current Sensor	Inside the rear compartment on the left hand side	--	Component Connector End Views
Blower Motor	In the passenger compartment, under the I/P	Harness Routing Views	Component Connector End Views
Bluetooth Connector	On the left side of the centre console	Harness Routing Views	Component Connector End Views
Bluetooth Microphone	Located in the driver's side A pillar	Entertainment/Communication Component Views	Component Connector End Views
Bluetooth Module	Located in the I/P beneath the passenger's side airbag	Entertainment/Communication Component Views	Component Connector End Views
Body Control Module	Below the right side of the I/P	Theft Deterrent System Component Views	Component Connector End Views
Brake Fluid Level Switch (3.6L)	Located inside the master cylinder	Hydraulic Brake Component Views	Component Connector End Views
Brake Fluid Level Switch (6.0L)	Located inside the master cylinder	Hydraulic Brake Component Views	Component Connector End Views
Brake Pedal Position (BPP) Sensor	In the passenger compartment, attached to the top of the brake pedal assembly	Cruise Control Component Views	Component Connector End Views
Camshaft Position (CMP) Exhaust Sensor (3.6L)	In the engine compartment, on the front of the right cylinder head, on the right side, and on the front of the left cylinder head, on the left side		Component Connector End Views
Camshaft Position (CMP) Exhaust Solenoid (3.6L)	In the engine compartment, on the front of the right and left cylinder head, upper centre position		Component Connector End Views
Camshaft Position	In the engine compartment, on the front of the left		Component

(CMP) Intake Sensor (3.6L)	cylinder head, on the right side, and on the front of the right cylinder head, on the left side		Connector End Views
Camshaft Position (CMP) Intake Solenoid (3.6L)	In the engine compartment, on the front of the right and left cylinder head, upper centre position		Component Connector End Views
Camshaft Position Sensor (6.0L)	In the engine compartment, on the front of the right cylinder head, on the right side, and on the front of the left cylinder head, on the left side	Harness Routing Views	Component Connector End Views
Centre High Mounted Stop Lamp (CHMSL)	Centre of the rear window panel	Lighting Systems Component Views	Component Connector End Views
Cigar Lighter - Console	In the rear of the centre console	Harness Routing Views	Component Connector End Views
Console Compartment Lamp	Inside the centre console	Harness Routing Views	Component Connector End Views
Console Compartment Lamp Switch	Inside the centre console	Harness Routing Views	Component Connector End Views
Courtesy Lamp - Left Footwell	Below the passenger knee bolster next to the kick panel	Harness Routing Views	Component Connector End Views
Courtesy Lamp - LF Door	Lower rear of left front door	Harness Routing Views	Component Connector End Views
Courtesy Lamp - RF Door	Lower rear of right front door	Harness Routing Views	Component Connector End Views
Courtesy Lamp - Right Footwell	Below the driver knee bolster next to the kick panel	Harness Routing Views	Component Connector End Views
Crankshaft Position (CKP) Sensor (3.6L)	Right front side of the engine, next to the knock sensor	Harness Routing Views	Component Connector End Views
Crankshaft Position (CKP) Sensor (6.0L)	Right front side of the engine, next to the knock sensor	Harness Routing Views	Component Connector End Views
Cruise Control Switch (Part of the Turn	Attached to the right side of the steering	Cruise Control Component	Component Connector

Signal Multifunction Switch)	column	Views	End Views
Data Link Connector (DLC)	On the bottom of the I/P, under the steering column	Harness Routing Views	Component Connector End Views
Dome Lamp	Centre front of the headliner	Lighting Systems Component Views	Component Connector End Views
Door Latch Assembly - LF	Rear of the left front door	Harness Routing Views	Component Connector End Views
Door Latch Assembly - RF	Rear of the right front door	Harness Routing Views	Component Connector End Views
ECVD Solenoid (3.6L)	Left side of the engine compartment mounted on the A/C line near the accumulator	Harness Routing Views	Component Connector End Views
ECVD Solenoid (6.0L)	Left side of the engine compartment mounted on the A/C line near the accumulator	Harness Routing Views	Component Connector End Views
Electronic Brake Control Module (EBCM) (3.6L)	Right side of the engine compartment, part of the brake pressure modulator valve, mounted to the right strut tower	Antilock Brake System Component Views	Component Connector End Views
Electronic Brake Control Module (EBCM) (6.0L)	Right side of the engine compartment, part of the brake pressure modulator valve, mounted to the right strut tower	Antilock Brake System Component Views	Component Connector End Views
Engine Control Module (3.6L)	Beneath the underhood fuse block on the right side of the engine bay		Component Connector End Views
Engine Control Module (6.0L)	Beneath the underhood fuse block on the right side of the engine bay	Harness Routing Views	Component Connector End Views
Engine Coolant Temperature (ECT) Sensor (3.6L)	In the engine compartment, in the left side of the left cylinder head, between cylinders #2 and #4		Component Connector End Views
Engine Coolant Temperature (ECT) Sensor (6.0L)	Left front of the engine above the #1 spark plug	Harness Routing Views	Component Connector End Views

Engine Cooling Fans	Front of the engine compartment, mounted to the radiator		Component Connector End Views
Engine Oil Level/Temperature Sensor (3.6L)	Under the engine, in the bottom left of the engine oil pan		Component Connector End Views
Engine Oil Level/Temperature Sensor (6.0L)	At the base of the engine block in the sump	Harness Routing Views	Component Connector End Views
Engine Oil Pressure (EOP) Sensor (3.6L)	In the engine compartment, on the left side of the engine, in the oil filter housing		Component Connector End Views
Engine Oil Pressure (EOP) Sensor (6.0L)	Top rear of the engine behind the intake manifold	Harness Routing Views	Component Connector End Views
Evaporative Emission (EVAP) Canister Purge Solenoid Valve (3.6L)	In the engine compartment, on the right side of the engine, above the valve cover		Component Connector End Views
Evaporative Emission (EVAP) Canister Purge Solenoid Valve (6.0L)	Front left side of the engine above the ignition coils	Harness Routing Views	Component Connector End Views
Express Down Window Module	Below the right side of the instrument panel behind the kick panel	Harness Routing Views	Component Connector End Views
Fog Lamp - Left	Left front of the vehicle	Lighting Systems Component Views	Component Connector End Views
Fog Lamp - Right	Right front of the vehicle	Lighting Systems Component Views	Component Connector End Views
Fuel Filler Door Latch	Right rear quarter panel	Harness Routing Views	Component Connector End Views
Fuel Injectors (3.6L)	Top of the engine, part of the fuel rail above each cylinder	Harness Routing Views	Component Connector End Views
Fuel Injectors - Even (6.0L)	Top of the engine, part of the fuel rail above each cylinder	Harness Routing Views	Component Connector End Views
Fuel Injectors - Odd (6.0L)	Top of the engine, part of the fuel rail above each cylinder	Harness Routing Views	Component Connector End Views
Fuel Level Sensor - Secondary	In the left side of the fuel tank beneath the rear compartment	Harness Routing Views	Component Connector End Views
	Under the rear of the		

Fuel Pump and Sender Assembly	vehicle, in the top right side of the fuel tank	Harness Routing Views	Component Connector End Views
Fuse Block - Instrument Panel	Behind the left hand kick panel	--	Component Connector End Views
Fuse Block - Underhood (3.6L)	Right side of the engine bay		Component Connector End Views
Fuse Block - Underhood (6.0L)	Right side of the engine bay		Component Connector End Views
Generator (3.6L)	Lower front left side of the engine		Component Connector End Views
Generator (6.0L)	Lower front left side of the engine		Component Connector End Views
Headlamp and Dimmer Panel Switch	In I/P to the right of the steering wheel	Lighting Systems Component Views	Component Connector End Views
Headlamp Assembly - Left	Left front of the vehicle	Lighting Systems Component Views	Component Connector End Views
Headlamp Assembly - Right	Right front of the vehicle	Lighting Systems Component Views	Component Connector End Views
Heated Oxygen Sensor (HO2S) Bank 1 Sensor 1 (3.6L - 4spd Auto)	In the exhaust system, in front of the catalytic converter		Component Connector End Views
Heated Oxygen Sensor (HO2S) Bank 1 Sensor 1 (3.6L - 5spd Auto)	In the exhaust system, in front of the catalytic converter		Component Connector End Views
Heated Oxygen Sensor (HO2S) Bank 1 Sensor 1 (3.6L - 6spd Manual)	In the exhaust system, in front of the catalytic converter		Component Connector End Views
Heated Oxygen Sensor (HO2S) Bank 1 Sensor 2 (3.6L - 4spd Auto)	In the exhaust system, behind the catalytic converter		Component Connector End Views
Heated Oxygen Sensor (HO2S) Bank 1 Sensor 2 (3.6L - 5spd Auto)	In the exhaust system, behind the catalytic converter		Component Connector End Views
Heated Oxygen Sensor (HO2S) Bank 1 Sensor 2 (3.6L -	In the exhaust system, behind the catalytic		Component Connector

6spd Manual)	converter		End Views
Heated Oxygen Sensor (HO2S) Bank 2 Sensor 1 (3.6L)	In the exhaust system, in front of the catalytic converter		Component Connector End Views
Heated Oxygen Sensor (HO2S) Bank 2 Sensor 2 (3.6L - 4spd Auto)	In the exhaust system, behind the catalytic converter		Component Connector End Views
Heated Oxygen Sensor (HO2S) Bank 2 Sensor 2 (3.6L - 5spd Auto)	In the exhaust system, behind the catalytic converter		Component Connector End Views
Heated Oxygen Sensor (HO2S) Bank 2 Sensor 2 (3.6L - 6spd Manual)	In the exhaust system, behind the catalytic converter		Component Connector End Views
Heated Oxygen Sensor (HO2S) Bank 1 Sensor 1 (6.0L - 6spd Auto)	In the exhaust system, in front of the catalytic converter		Component Connector End Views
Heated Oxygen Sensor (HO2S) Bank 1 Sensor 1 (6.0L - 6spd Manual)	In the exhaust system, in front of the catalytic converter		Component Connector End Views
Heated Oxygen Sensor (HO2S) Bank 1 Sensor 2 (6.0L - 6spd Auto)	In the exhaust system, behind the catalytic converter		Component Connector End Views
Heated Oxygen Sensor (HO2S) Bank 1 Sensor 2 (6.0L - 6spd Manual)	In the exhaust system, behind the catalytic converter	Harness Routing Views	Component Connector End Views
Heated Oxygen Sensor (HO2S) Bank 2 Sensor 1 (6.0L)	In the exhaust system, in front of the catalytic converter		Component Connector End Views
Heated Oxygen Sensor (HO2S) Bank 2 Sensor 2 (6.0L - 6spd Auto)	In the exhaust system, behind the catalytic converter		Component Connector End Views
Heated Oxygen Sensor (HO2S) Bank 2 Sensor 2 (6.0L - 6spd Manual)	In the exhaust system, behind the catalytic converter		Component Connector End Views
Hood Ajar Switch	Located on the underside of the front centre of the hood	Theft Deterrent System Component Views	Component Connector End Views
Horn - Left	Behind the bumper on the front left of the vehicle	Horn Component Views	Component Connector End Views
	Behind the bumper on		Component

Horn - Right	the front right of the vehicle	Horn Component Views	Connector End Views
HVAC Control Module	In the passenger compartment, in the centre of the I/P, below the radio	Harness Routing Views	Component Connector End Views
I/P Compartment Lamp	Right side of the I/P compartment opening	Harness Routing Views	Component Connector End Views
I/P Compartment Lamp Switch	Right side of the I/P compartment opening	Harness Routing Views	Component Connector End Views
I/P Data link Connector	On the left side of the I/P, above the I/P compartment	Harness Routing Views	Component Connector End Views
Ignition Coils (3.6L)	On the left and right valve cover, at the top of each cylinder	Harness Routing Views	Component Connector End Views
Ignition Coils - Even (6.0L)	On the left and right valve cover, at the top of each cylinder	Harness Routing Views	Component Connector End Views
Ignition Coils - Odd (6.0L)	On the left and right valve cover, at the top of each cylinder	Harness Routing Views	Component Connector End Views
Ignition Key Cylinder Lamp	In the upper steering column at the key cylinder	Theft Deterrent System Component Views	Component Connector End Views
Ignition Switch	In the upper steering column at the key cylinder	Theft Deterrent System Component Views	Component Connector End Views
Inflatable Restraint Front Sensor - LF	In the front of the engine bay on the left of the radiator	SIR Component Views	Component Connector End Views
Inflatable Restraint Front Sensor - RF	In the front of the engine bay on the right of the radiator	SIR Component Views	Component Connector End Views
Inflatable Restraint I/P Module	Right side of the I/P above the I/P compartment	SIR Component Views	Component Connector End Views
Inflatable Restraint Seat Position Sensor (SPS) - Driver	Beneath the drivers seat	SIR Component Views	Component Connector End Views
Inflatable Restraint Sensing and Diagnostic Module	Beneath the centre console	SIR Component Views	Component Connector End Views
Inflatable Restraint Steering Wheel Module	Centre of the steering wheel	SIR Component Views	Component Connector End Views
Inflatable Restraint	In the steering column	Antilock Brake System	Component

Steering Wheel Module Coil	behind the steering wheel	Component Views	Connector End Views
Instrument Panel Cluster (IPC)	Right side of the I/P	Entertainment/Communication Component Views	Component Connector End Views
Knock Sensor (KS) Bank 1 (3.6L)	In the engine compartment, on the right side of the engine block		Component Connector End Views
Knock Sensor (KS) Bank 2 (3.6L)	In the engine compartment, on the left side of the engine block		Component Connector End Views
Knock Sensor (KS) Left (6.0L)	In the engine compartment, on the left side of the engine block	Harness Routing Views	Component Connector End Views
Knock Sensor (KS) Right (6.0L)	In the engine compartment, on the right side of the engine block	Harness Routing Views	Component Connector End Views
License Plate Lamp - Left	Rear of the vehicle above the left side of the license plate	Lighting Systems Component Views	Component Connector End Views
License Plate Lamp - Right	Rear of the vehicle above the right side of the license plate	Lighting Systems Component Views	Component Connector End Views
Liftgate Latch (F35)	In the rear of the vehicle at the base of the liftgate	--	Component Connector End Views
Liftgate Release Switch (F35)	On the lower left side of the Instrument Panel	--	Component Connector End Views
Manifold Absolute Pressure (MAP) Sensor	In the engine compartment, on the top, rear of the intake manifold	Harness Routing Views	Component Connector End Views
Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor (3.6L)	In the left front side of the engine compartment, attached to the air cleaner assembly	--	Component Connector End Views
Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor (6.0L)	In the left front side of the engine compartment, attached to the air cleaner assembly	Harness Routing Views	Component Connector End Views
Mode Actuator - 1	Part of the HVAC unit under the I/P	HVAC Component Views	Component Connector End Views

Mode Actuator - 2	Part of the HVAC unit under the I/P	HVAC Component Views	Component Connector End Views
Navigation Gateway Module	In the I/P behind the instrument panel compartment	Harness Routing Views	Component Connector End Views
Navigation Module	Within the instrument panel compartment	Harness Routing Views	Component Connector End Views
Outside Rear View Mirror - Left	Upper front of the front left door panel	Harness Routing Views	Component Connector End Views
Outside Rear View Mirror - Right	Upper front of the front right door panel	Harness Routing Views	Component Connector End Views
Park Brake Switch	Centre console attached to the park brake assembly	Hydraulic Brake Component Views	Component Connector End Views
Park/Neutral Position (PNP) Switch (4L60-E)	Left side front of the transaxle	Harness Routing Views	Component Connector End Views
Radio	Centre of the I/P	Entertainment/Communication Component Views	Component Connector End Views
Rear Window Defogger Grid - Right Side	On the right side of the rear window	Harness Routing Views	Component Connector End Views
Rear Window Defogger Grid - Left Side	On the left side of the rear window	Harness Routing Views	Component Connector End Views
Rear Window Wiper Control Module (F35)	In the rear of the vehicle, in the center of the liftgate	--	Component Connector End Views
Rear Window Wiper Motor (F35)	In the rear of the vehicle, in the center of the liftgate	--	Component Connector End Views
Recirculation Actuator (Automatic HVAC)	Part of the HVAC unit under the I/P	HVAC Component Views	Component Connector End Views
Remote Function Actuator	Located on the rear cab panel	Remote Function Component Views	Component Connector End Views
Repeater Lamp - Left	On the left front quarter panel	Lighting Systems Component Views	Component Connector End Views
Repeater Lamp - Right	On the right front quarter panel	Lighting Systems Component Views	Component Connector End Views
	Under the vehicle,		Component

Reverse Lockout Solenoid	towards the rear, on top LH side of the manual transmission		Connector End Views
Seat Adjuster Switch - Driver	On the outboard side of the driver's seat	Remote Function Component Views	Component Connector End Views
Seat Adjuster Switch - Passenger	On the outboard side of the passenger's seat		Component Connector End Views
Seat Belt Pretensioner - LF	Inboard side of the passenger seat between the seat and centre console	SIR Component Views	Component Connector End Views
Seat Belt Pretensioner - RF	Inboard side of the driver seat between the seat and centre console	SIR Component Views	Component Connector End Views
Seat Belt Switch - Driver	In the driver seat belt buckle pretensioner	--	Component Connector End Views
Seat Front Vertical Motor - Driver	Beneath the driver's seat		Component Connector End Views
Seat Rear Vertical Motor - Driver	Beneath the driver's seat		Component Connector End Views
Speaker - Centre	In the centre of the I/P alongside the windshield	Entertainment/Communication Component Views	Component Connector End Views
Speaker - LF Door	At the front of the left front door	Entertainment/Communication Component Views	Component Connector End Views
Speaker - LF Tweeter	Left side of the I/P	Entertainment/Communication Component Views	Component Connector End Views
Speaker - RF Door	At the front of the right front door	Entertainment/Communication Component Views	Component Connector End Views
Speaker - RF Tweeter	Right side of the I/P	Entertainment/Communication Component Views	Component Connector End Views
Starter (3.6L)	Lower right rear of the engine		Component Connector End Views
Starter (6.0L)	Lower right rear of the engine		Component Connector End Views
Steering Angle Sensor	Behind the steering wheel	Antilock Brake System Component Views	Component Connector End Views

Steering Wheel Controls Switch Assembly - Left	Left side of the steering wheel	Entertainment/Communication Component Views	Component Connector End Views
Steering Wheel Controls Switch Assembly - Right	Right side of the steering wheel	Entertainment/Communication Component Views	Component Connector End Views
Tail Lamp Assembly - Left	Rear of the vehicle, in the left rear lamp assembly	Lighting Systems Component Views	Component Connector End Views
Tail Lamp Assembly - Right	Rear of the vehicle, in the right rear lamp assembly	Lighting Systems Component Views	Component Connector End Views
Terminating Resistor - After 12/06	Top centre of the I/P	Harness Routing Views	Component Connector End Views
Theft Deterrent Control Module	Within the steering column behind the steering wheel	Theft Deterrent System Component Views	Component Connector End Views
Theft Horn (3.6L)	On the right hand side at the rear of the engine bay just behind the right strut tower	Horn Component Views	Component Connector End Views
Theft Horn (6.0L)	On the right hand side at the rear of the engine bay just behind the right strut tower	Horn Component Views	Component Connector End Views
Throttle Body (3.6L)	In the engine compartment, on the front centre of the intake manifold		Component Connector End Views
Throttle Body (6.0L)	In the engine compartment, on the front centre of the intake manifold	Harness Routing Views	Component Connector End Views
Transmission Control Module (4L60-E)	In the passenger compartment behind the right hand kick panel	Harness Routing Views	Component Connector End Views
Transmission Control Module (5L40-E)	In the passenger compartment behind the right hand kick panel	Harness Routing Views	Component Connector End Views
Turn Signal Multifunction Switch	On the right side of the steering column	Lighting Systems Component Views	Component Connector End Views
Variable Intake Manifold (VIM) Solenoid (3.6L)	At the rear of the intake manifold	Harness Routing Views	Component Connector End Views
Vehicle Speed Sensor	Rear right hand side of the transmission	Harness Routing Views	Component Connector

(VSS) (4L60-E)	assembly		End Views
Wheel Speed Sensor (WSS) - LF (3.6L)	Inside the left front wheel hub	Antilock Brake System Component Views	Component Connector End Views
Wheel Speed Sensor (WSS) - LF (6.0L)	Inside the left front wheel hub	Antilock Brake System Component Views	Component Connector End Views
Wheel Speed Sensor (WSS) - LR	Top left side of the differential carrier	Antilock Brake System Component Views	Component Connector End Views
Wheel Speed Sensor (WSS) - RF (3.6L)	Inside the right front wheel hub	Antilock Brake System Component Views	Component Connector End Views
Wheel Speed Sensor (WSS) - RF (6.0L)	Inside the right front wheel hub	Antilock Brake System Component Views	Component Connector End Views
Wheel Speed Sensor (WSS) - RR	Top right side of the differential carrier	Antilock Brake System Component Views	Component Connector End Views
Window Motor - LF	Centre of the front left door	Harness Routing Views	Component Connector End Views
Window Motor - RF	Centre of the front right door	Harness Routing Views	Component Connector End Views
Window/Door Lock/Outside Rearview Mirror Switch	In the centre console area, just behind the transmission selector	Harness Routing Views	Component Connector End Views
Windshield Washer Fluid Pump	At the right hand end of the washer fluid reservoir at the front of the engine bay	Harness Routing Views	Component Connector End Views
Windshield Wiper Motor (3.6L)	In the plenum chamber in front of the windshield	Harness Routing Views	Component Connector End Views
Windshield Wiper Motor (6.0L)	In the plenum chamber in front of the windshield	Harness Routing Views	Component Connector End Views
Windshield Wiper/Washer Switch	Left side of the steering column	Harness Routing Views	Component Connector End Views
Yaw Rate and Lateral Acceleration Sensor	In the passenger compartment, under the centre console, in front of the SDM	Harness Routing Views	Component Connector End Views
X102 (42 Cavities)	Front Body Harness to Engine Harness	Harness Routing Views	Inline Harness Connector End Views

X103 (8 Cavities)	Forward Lamp Harness to the Engine Harness	Harness Routing Views	Inline Harness Connector End Views
X104 (42 Cavities)	Front Body Harness to I/P Harness	Harness Routing Views	Inline Harness Connector End Views
X106 (12 Cavities)	Forward Lamp Harness to the Front Body Harness	Harness Routing Views	Inline Harness Connector End Views
X107 (24 Cavities)	Forward Lamp Harness to the Front Compartment Harness	Harness Routing Views	Inline Harness Connector End Views
X108 (8 Cavities)	Fog Lamp Harness to the Front Body Harness	Harness Routing Views	Inline Harness Connector End Views
X110 (2 Cavities)	Engine Harness to the Front Body Harness	Harness Routing Views	Inline Harness Connector End Views
X112 (7 Cavities)	Engine Harness to the Ignition Coil Harness	Harness Routing Views	Inline Harness Connector End Views
X113 (7 Cavities)	Engine Harness to the Ignition Coil Harness	Harness Routing Views	Inline Harness Connector End Views
X114 (10 Cavities)	Engine Harness to the Fuel Injector Harness	Harness Routing Views	Inline Harness Connector End Views
X115 (10 Cavities)	Forward Lamp Harness to the Left Headlamp	Harness Routing Views	Inline Harness Connector End Views
X116 (10 Cavities)	Forward Lamp Harness to the Right Headlamp	Harness Routing Views	Inline Harness Connector End Views
X160 (2 Cavities)	Left Front Wheel Speed Sensor Harness to the Front Body Harness	Harness Routing Views	Inline Harness Connector End Views
X161 (2 Cavities)	Right Front Wheel Speed Sensor Harness to the Front Body	Harness Routing Views	Inline Harness Connector

	Harness		End Views
X162 (4 Cavities)	Forward Lamp Harness to the Cooling Fan Assembly	Harness Routing Views	Inline Harness Connector End Views
X165 (8 Cavities)	Front Body Harness to the I/P Harness	Harness Routing Views	Inline Harness Connector End Views
X175 (20 Cavities) (M82)	Engine Harness to the Automatic Transmission	Harness Routing Views	Inline Harness Connector End Views
X200 (2 Cavities)	I/P Harness to the Front Body Harness	Harness Routing Views	Inline Harness Connector End Views
X201 (43 Cavities)	I/P Harness to the Front Body Harness	Harness Routing Views	Inline Harness Connector End Views
X202 (38 Cavities)	I/P Harness to the Body Harness	Harness Routing Views	Inline Harness Connector End Views
X204 (2 Cavities)	I/P Harness to the Front Body Harness	Harness Routing Views	Inline Harness Connector End Views
X205 (15 Cavities)	Glove Box Assembly to the I/P Harness	Harness Routing Views	Inline Harness Connector End Views
X206 (38 Cavities)	Front Body Harness to the Body Harness	Harness Routing Views	Inline Harness Connector End Views
X207 (12 Cavities)	I/P Harness to the Body Harness	Harness Routing Views	Inline Harness Connector End Views
X208 (2 Cavities)		Harness Routing Views	Inline Harness Connector End Views
X210 (4 Cavities)	Rear Body Harness to the Rear Latch Assembly Harness	Harness Routing Views	Inline Harness Connector End Views
			Inline

X212 (18 Cavities)	Headliner Harness to the I/P Harness	Harness Routing Views	Harness Connector End Views
X213 (9 Cavities)	Headliner Harness to the Instrument Panel Harness	Harness Routing Views	Inline Harness Connector End Views
X218 (16 Cavities)	Body Harness to the Body Harness	Harness Routing Views	Inline Harness Connector End Views
X220 (6 Cavities) (LHD)	I/P Harness to the Body Harness	Harness Routing Views	Inline Harness Connector End Views
X223 (1 Cavities)	I/P Harness to the Console Ground	Harness Routing Views	Inline Harness Connector End Views
X225 (10 Cavities)		Harness Routing Views	Inline Harness Connector End Views
X226 (6 Cavities) (HSV)	Gauge Assembly to the I/P Harness	Harness Routing Views	Inline Harness Connector End Views
X227 (6 Cavities)	Steering Angle Sensor Assembly to the I/P Harness	Harness Routing Views	Inline Harness Connector End Views
X228 (2 Cavities)	I/P Harness to the I/P Harness	Harness Routing Views	Inline Harness Connector End Views
X229 (19 Cavities)	I/P Harness to the I/P Harness	Harness Routing Views	Inline Harness Connector End Views
X236 (12 Cavities) (HSV)	Electronic Suspension Assembly to the Body Harness	Harness Routing Views	Inline Harness Connector End Views
X237 (24 Cavities) (HSV)	Electronic Suspension Assembly to the I/P Harness	Harness Routing Views	Inline Harness Connector End Views
X238 (10 Cavities) (HSV)	Indicator Assembly to the I/P Harness	Harness Routing Views	Inline Harness Connector End Views

X241 (4 Cavities)	I/P Harness to the Driver Information Center Harness	Harness Routing Views	Inline Harness Connector End Views
X253 (4 Cavities)	I/P Harness to the Body Harness	Harness Routing Views	Inline Harness Connector End Views
X254 (4 Cavities)	I/P Harness to the Body Harness	Harness Routing Views	Inline Harness Connector End Views
X255 (12 Cavities)	Digital Video Disc (DVD) Control Module to the Video Display	Harness Routing Views	Inline Harness Connector End Views
X305 (5 Cavities)	Body Harness to the Fuel Tank Harness	Harness Routing Views	Inline Harness Connector End Views
X306 (12 Cavities) (A45)	Driver Seat Harness to the Body Harness	Harness Routing Views	Inline Harness Connector End Views
X307 (6 Cavities)	Body Harness to the Left Front Door Harness	Harness Routing Views	Inline Harness Connector End Views
X308 (6 Cavities)	Body Harness to the Right Front Door Harness	Harness Routing Views	Inline Harness Connector End Views
X309 (6 Cavities)	Body Harness to the I/P Harness	Harness Routing Views	Inline Harness Connector End Views
X310 (4 Cavities)	Passenger Seat Harness to the Body Harness	Harness Routing Views	Inline Harness Connector End Views
X311 (4 Cavities)	Driver Seat Harness to the Body Harness	Harness Routing Views	Inline Harness Connector End Views
X312 (2 Cavities)	Body Harness to the Passenger Seat Harness	Harness Routing Views	Inline Harness Connector End Views
X313 (3 Cavities)	Body Harness to the Passenger Seat	Harness Routing Views	Inline Harness Connector

	Harness		End Views
X314 (3 Cavities)	Body Harness to the Driver Seat Harness	Harness Routing Views	Inline Harness Connector End Views
X315 (2 Cavities)	Body Harness to the Driver Seat Harness	Harness Routing Views	Inline Harness Connector End Views
X316 (24 Cavities)	Body Harness to the Digital Video Disc (DVD) Control Module	Harness Routing Views	Inline Harness Connector End Views
X317 (16 Cavities)	Body Harness to the Body Harness	Harness Routing Views	Inline Harness Connector End Views
X319 (12 Cavities)	Headliner Harness to the Digital Video Disc (DVD) Control Module	Harness Routing Views	Inline Harness Connector End Views
X322 (12 Cavities)	Passenger Seat Harness to the Body Harness	Harness Routing Views	Inline Harness Connector End Views
X324 (4 Cavities) (AH5)	Driver Seat Back to the Driver Seat Harness	Harness Routing Views	Inline Harness Connector End Views
X324 (8 Cavities) (AGB)	Driver Seat Back to the Driver Seat Harness	Harness Routing Views	Inline Harness Connector End Views
X330 (24 Cavities)	Left Seat Harness to the Body Harness	Harness Routing Views	Inline Harness Connector End Views
X331 (24 Cavities)	RIght Seat Harness to the Body Harness	Harness Routing Views	Inline Harness Connector End Views
X332 (20 Cavities)	Video Display to the Right Seat Harness	Harness Routing Views	Inline Harness Connector End Views
X333 (24 Cavities)	Left Seat Harness to the Body Harness	Harness Routing Views	Inline Harness Connector End Views
	Video Display		Inline

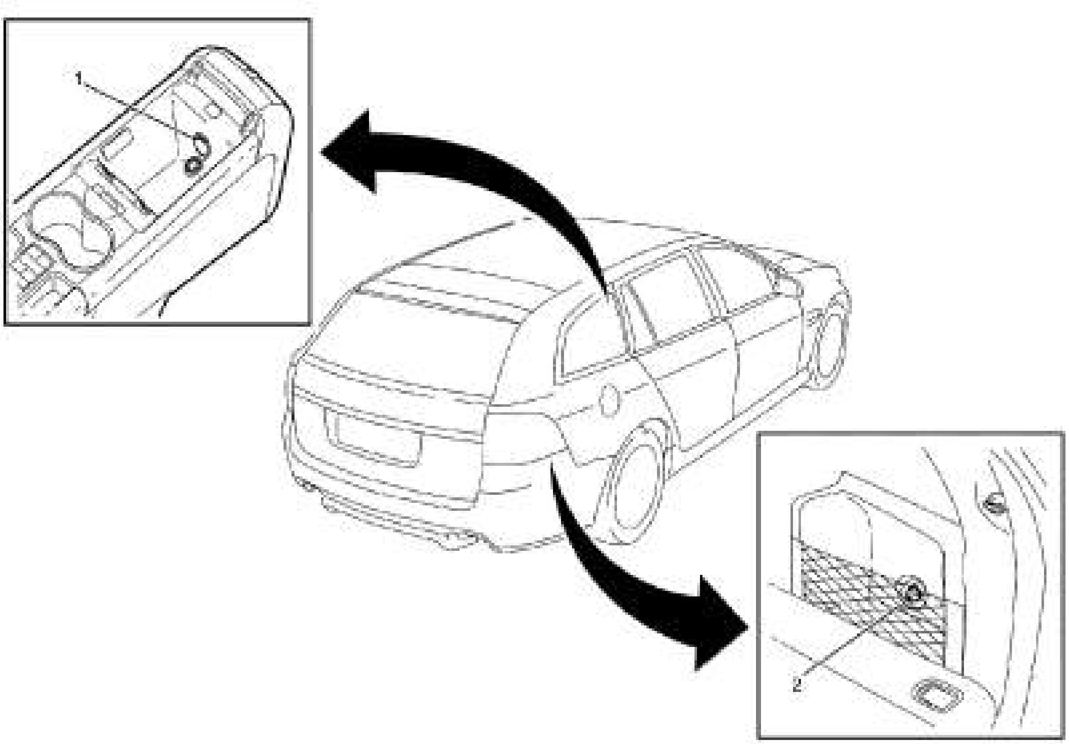
X335 (20 Cavities)	Assembly to the Body Harness	Harness Routing Views	Harness Connector End Views
X344 (9 Cavities)	Inside Rearview Mirror Harness to the I/P Harness	Harness Routing Views	Inline Harness Connector End Views
X355 (2 Cavities)	Body Harness to the Seat Harness	Harness Routing Views	Inline Harness Connector End Views
X356 (2 Cavities)	Body Harness to the Passenger Seat Harness	Harness Routing Views	Inline Harness Connector End Views
X360 (4 Cavities)	Body Harness to the Rear Wheel Speed Sensors	Harness Routing Views	Inline Harness Connector End Views
X361 (8 Cavities)	Rear Axle Harness to the Body Harness	Harness Routing Views	Inline Harness Connector End Views
X402 (2 Cavities)	Body Harness to the Decklid Harness	Harness Routing Views	Inline Harness Connector End Views
X403 (26 Cavities)	Rear Body Harness to the Body Harness	Harness Routing Views	Inline Harness Connector End Views
X404 (12 Cavities)	Body Harness to the Rear Body Harness	Harness Routing Views	Inline Harness Connector End Views
X405 (8 Cavities) (F19)	X405 Body Harness to the Rear Compartment Harness	Harness Routing Views	Inline Harness Connector End Views
X405 (6 Cavities) (F69 without T79)	X405 Body Harness to the Rear Compartment Harness	Harness Routing Views	Inline Harness Connector End Views
X408 (2 Cavities)	Battery Cable to the Body Harness	Harness Routing Views	Inline Harness Connector End Views
X412 (2 Cavities)	Rear Body Harness to the Rear Body Harness	Harness Routing Views	Inline Harness Connector End Views

X413 (12 Cavities) (HSV)	Electronic Stability Control Harness to the Fuel Tank Harness	Harness Routing Views	Inline Harness Connector End Views
X415 (2 Cavities) (HSV)	Pigtail?	Harness Routing Views	Inline Harness Connector End Views
X416 (2 Cavities) (HSV)	Pigtail?	Harness Routing Views	Inline Harness Connector End Views
X433 (2 Cavities) (WM)	Rear Fascia Harness to the License Lamp Harness	Harness Routing Views	Inline Harness Connector End Views
X450 (6 Cavities)	Rear Body Harness to the Right Rear Tail Lamp Assembly	Harness Routing Views	Inline Harness Connector End Views
X451 (6 Cavities)	Rear Body Harness to the Left Rear Tail Lamp Assembly	Harness Routing Views	Inline Harness Connector End Views
X500 (16 Cavities)	Body Harness to the Left Front Door Harness	Harness Routing Views	Inline Harness Connector End Views
X600 (16 Cavities)	Body Harness to the Right Front Door Harness	Harness Routing Views	Inline Harness Connector End Views
X700 (16 Cavities)	Body Harness to the Left Rear Door Harness	Harness Routing Views	Inline Harness Connector End Views
X800 (16 Cavities)	Body Harness to the Right Rear Door Harness	Harness Routing Views	Inline Harness Connector End Views
G101	In the engine compartment on the right hand rail	Harness Routing Views	--
G102	In the engine compartment on the right hand rail	Harness Routing Views	--
G103 (3.6L)	In the engine compartment on the ABS bracket	Harness Routing Views	--
	In the engine		

G103 (6.0L)	compartment on the ABS bracket	Harness Routing Views	--
G104	In the engine compartment on the jump start post	Harness Routing Views	--
G106	On the right side of the engine block near the front	Harness Routing Views	--
G107	On the right side of the engine block near the middle	Harness Routing Views	--
G109	On the left side of the engine block near the rear face	Harness Routing Views	--
G110	On the right side of the engine block near the front face	Harness Routing Views	--
G111	On the right side of the engine block near the front face	Harness Routing Views	--
G112	On the left side of the engine block near the rear face	Harness Routing Views	--
G201	Right hand Instrument Panel end plate	Harness Routing Views	--
G202	Left hand Instrument Panel end plate	Harness Routing Views	--
G303	In the passenger compartment along the transmission tunnel	Harness Routing Views	--
G304	At the end of the I/P on the right hand A pillar	Harness Routing Views	--
G305	At the end of the I/P on the left hand A pillar	Harness Routing Views	--
G308	In the passenger compartment on the SDM bracket	Harness Routing Views	--
G310	In the steering wheel assembly	Harness Routing Views	--
G401	In the rear compartment on the left hand rear beam	Harness Routing Views	--
G407	In the passenger compartment on the rear parcel shelf	Harness Routing Views	--

Luggage Compartment / Rear of Vehicle Component Views

Power Outlets

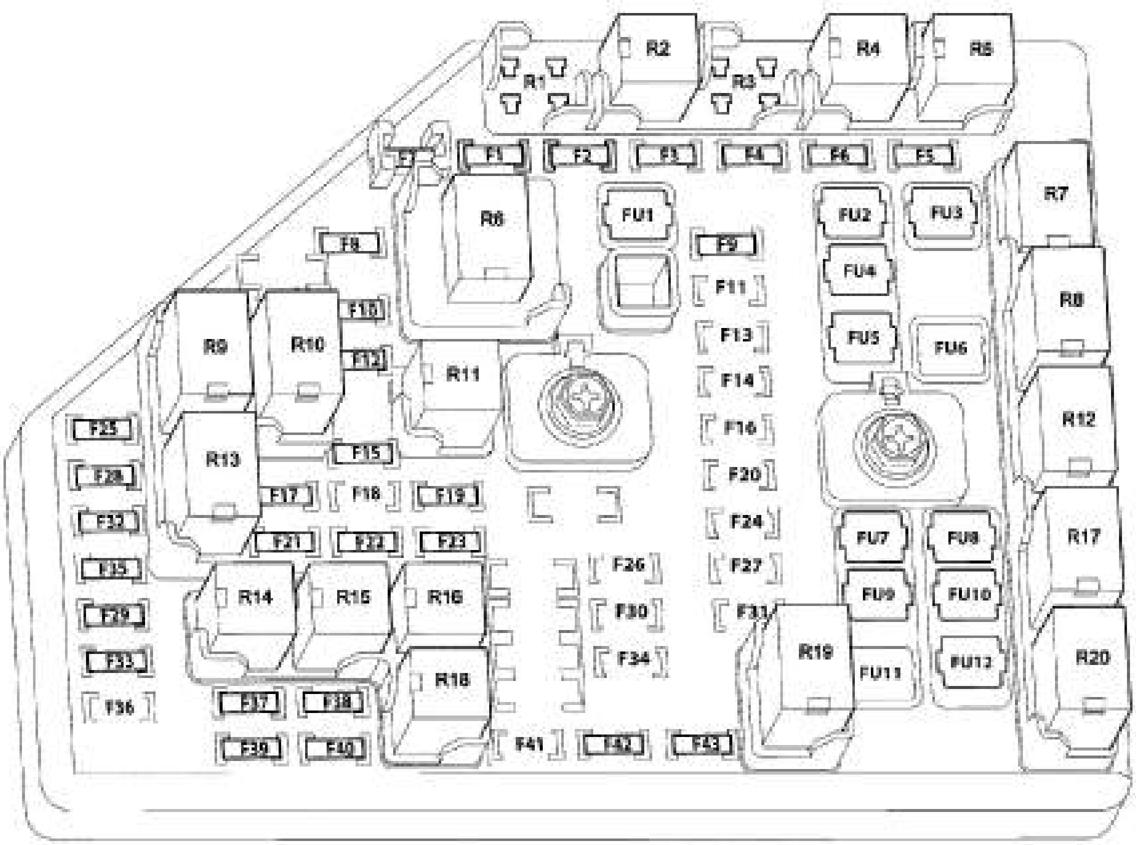


(1) Power Outlet - Centre Console
(2) Power Outlet - Rear Compartment

Electrical Center Identification Views (LWB SWB)

Connector 1:	Fuse Block - Underhood
Connector 2:	Fuse Block - Underhood X1
Connector 3:	Fuse Block - Underhood X2
Connector 4:	Fuse Block - Underhood X3
Connector 5:	Fuse Block - Underhood X4 (Battery Positive Cable)
Connector 6:	Fuse Block - Instrument Panel
Connector 7:	Fuse Block - I/P
Connector 8:	Fuse Block - Battery Cable X1
Connector 9:	Fuse Block - Battery Cable X2
Connector 10:	Fuse Block - Battery Cable X3
Connector 11:	Junction Block - Battery Cable - Engine X1
Connector 12:	Junction Block - Battery Cable - Engine X3
Connector 13:	Junction Block - Battery Cable - I/P
Connector 14:	Fuse Block - Rear

Fuse Block - Underhood


R1
R2
R3
R4
R5
F7
F1
F2
F3
F4
F6
F5
R6
FU1
F8
F9
F11
FU2
FU3
R7
FU4
R8
F10
F12
F13
R9
R10
R11
F14
FU5
FU6
R12
F25
F15
R13
F16
F20
F28
F17
F18
F19
F32
F21
F22
F23
F24
FU7
FU8
R17
F35
F26
F27
R14
R15
R16
F30
FU9
FU10
F29
F31
R19
F33
F34
R18
FU11
FU12
R20
F36
F37
F38
F39
F40
F41
F42
F43

Fuse Block - Underhood, Device Usage

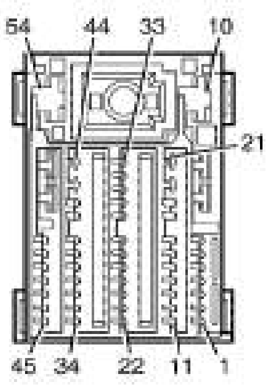
No.	Device	Rating	Description
			Primary Fuses
FU1	BATT MAIN 4 Fuse	50A	Supply to Instrument Panel fuse box and BCM.
FU2	REAR DEFOG Fuse	40A	Rear defog relay R8
FU3	ABS MOTOR Fuse	40A	Retained accessory power (RAP) relay, SIR, door lock fuses and ABS module.
FU4	BATT MAIN 3 Fuse	50A	Evaporative Emissions (EVAP) Canister Purge Solenoid Valve, Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor, Valve Lifter Oil Manifold (VLOM) Assembly (DOD)
FU5	BATT MAIN 1 Fuse	50A	Supply voltage to instrument panel fuse box
FU6	SPARE Fuse		Trailer Wiring, Auxiliary Body Control Module (XBCM) (Export)
FU7	BATT MAIN 2 Fuse	50A	Accessory power feed relay (R8) and power seat circuit breaker
FU8	STARTER Fuse	40A	Starter relay R12

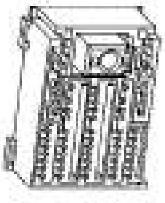
FU9	HVAC BLOWER MOTOR Fuse	40A	HVAC module
FU10	FAN 1 ENGINE COOLING (RIGHT) Fuse	30A	Engine cooling fan relay R17
FU11	SPARE Fuse		
FU12	FAN 2 ENGINE COOLING (LEFT) Fuse	30A	Engine cooling fan R20
Secondary Fuses			
F1	COMM ENABLE Fuse	10A	
F2	A/C CONTROL-HVAC CONTROL MODULE Fuse	10A	HVAC
F3	BACK UP LAMP Fuse	15A	Backup Lamp - Left, Backup Lamp - Right
F4	FOG LAMPS (FRONT) Fuse	15A	Foglamp relay R5
F5	ABS VALVES Fuse	25A	ABS module
F6	SPARE Fuse		
F7	HEADLAMP WASHER Fuse	30A	Headlamp wash relay R7
F8	HORN MAIN Fuse	15A	Horn
F9	TCM Fuse	15A	TCM
F10	LEFT LOW BEAM (BASE/HID) Fuse	10/20A	Left hand low beam
F11	SPARE Fuse		
F12	RIGHT LOW BEAM (BASE/HID) Fuse	10/20A	Right hand low beam
F13	SPARE Fuse		
F14	SPARE Fuse		
F15	FRONT WIPER Fuse	30A	Wiper relays
F16	SPARE Fuse		
F17	HORN THEFT Fuse	10A	Alarm system
F18	SPARE Fuse		
F19	RIGHT HIGH BEAM Fuse	10A	Right hand high beam
F20	SPARE Fuse		
F21	FRONT WASHER (WSW) Fuse	15A	Windscreen Washers
F22	SPARE Fuse		
F23	LEFT HI BEAM Fuse	10A	Left hand high beam
F24	SPARE Fuse		
F25	REVERSE LOCKOUT Fuse	15A	Reverse Lockout Solenoid (Y144)
F26	REAL TIME DAMPING Fuse	25A	Active suspension, electronic suspension control (ESC) module
F27	SPARE Fuse		

F28	ECM 1 Fuse	15A	Engine Control Module (ECM A43)
F29	EVEN COILS/INJECTORS Fuse	20A	Ignition coils and Fuel Injectors
F30	SPARE Fuse		
F31	SPARE Fuse		
F32	EMISSION DEV 2 Fuse	15A	Oxygen Sensors
F33	EMISSION DEV 1 Fuse	15A	Heated Oxygen Sensors, EVAP, IMRC, CMP Solenoids
F34	SPARE Fuse		
F35	ODD COILS/INJECTORS Fuse	20A	Ignition Coils and Fuel Injectors
F36	SPARE Fuse		
F37	HVAC--IGN (LHD ONLY) Fuse	10A	
F38	PHONE CRUISE Fuse	10A	CPP Switch, Telematics Module, Bluetooth connector & Headlamp/Dimmer Switch
F39	IGNITION ENGINE Fuse	10A	MAF, IAT, ECM (A43) &TCM
F40	AIRBAGS Fuse	10A	SIR Module
F41	SPARE Fuse	--	
F42	RIGHT PARK LAMP Fuse	10A	Right park lamps
F43	LEFT PARK LAMP Fuse	10A	Left park lamps
R1	SPARE Relay	--	
R2	COMMS ENABLE Relay	--	AXH VLV Fuse
R3	SPARE Relay	--	
R4	BACK UP LAMPS Relay	--	FOG LAMP Fuse
R5	FOG LAMP-FRONT Relay	--	FUEL PUMP Fuse
R6	HEADLAMP-LO BEAM Relay/(HID)	--	LO HDLP - LT Fuse, LO HDLP - RT Fuse, DRL 2 Fuse
R7	HEADLAMP WASHER Relay	--	LT PRK Fuse, RT PRK Fuse, TRLR PRK Fuse
R8	RR-DEFOG Relay	--	ECM/THROT CONT Fuse, ENG Fuse, INJ-A Fuse, INJ-B Fuse, O2-A SNSR Fuse, O2-B SNSR Fuse, FAN CNRTL PCB Relay, FAN HI PCB Relay, FAN LO PCB Relay
R9	FRONT WIPER HIGH Relay	--	REAR DEFOG Fuse
R10	FRONT WIPER LOW Relay	--	AIRBAG Fuse, AUX HVAC-IGN Fuse, IGN Fuse, ECM-IGN Fuse, MISC IGN Fuse, SEO/ALC Fuse, TRANS IGN 1 Fuse
R11	HEADLAMP-HI BEAM Relay/(HID)	--	STRTR Fuse
R12	CRANK Relay	--	VEH BCK/UP Fuse, TRLR BCK/UP Fuse
R13	POWER TRAIN Relay	--	DRL Fuse
R14	IGNITION MAIN Relay	--	Adjustable Pedals Assembly (JF4 Except AN3)
R15	WSW PUMP FRT Relay	--	Cooling Fan - Right

R16	HORN Relay	--	Cooling Fan - Right, FAN CNTRL Relay
R17	FAN 1 Relay (ENGINE COOLING)	--	Cooling Fan - Left
R18	PARK LAMPS Relay	--	FRT WASH Fuse
R19	FAN 2 Relay (ENGINE COOLING)	--	HI HEADLAMP - LT Fuse, HI HEADLAMP - RT Fuse
R20	FAN 3 Relay (ENGINE COOLING)	--	HORN Fuse

Fuse Block - Underhood X1





Connector Part Information

- OEM: 7283-9457-3W
- Service: See Catalog
- Description: 54-Way F YESC Kaizen Series (BK)

Terminal Part Information

- Pins: 3, 5, 7, 23, 34, 36, 49
- Terminal/Tray: 7116-4101-08/9
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12094430/J-35616-2A (GY)

- Pins: 1, 11, 25, 31, 32, 41, 45-47, 51
- Terminal/Tray: 7116-4101-08/9
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 12094430/J-35616-2A (GY)

- Pins: 8, 9
- Terminal/Tray: 7116-4122-02/10
- Core/Insulation Crimp: A/B
- Release Tool/Test Probe: 12094430/J-35616-42 (RD)

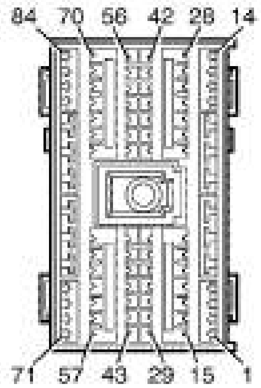
- Pins: 20
- Terminal/Tray: 7116-4112-02/9

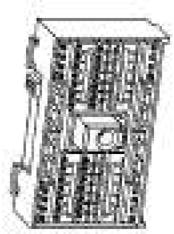
- Core/Insulation Crimp: C/D
- Release Tool/Test Probe: 12094430/J-35616-35 (VT)

Fuse Block - Underhood X1

Pin	Wire Color	Circuit No.	Function
1	0.75 PK/BU	5294	Ignition 1 Voltage
2	--	--	Not Used
3	0.5 D-GN	335	Low Speed Cooling Fan Relay Control
4	--	--	Not Used
5	0.5 PK	439	Ignition 1 Voltage
6	--	--	Not Used
7	0.5 YE	447	Starter Relay Coil Control
8	3 RD/BK	142	Battery Positive Voltage
9	3 PU	6	Starter Solenoid Crank Voltage
10-19	--	--	Not Used
20	2 OG	3540	Battery Positive Voltage
21-22	--	--	Not Used
23	0.5 D-BU/BK	473	High Speed Cooling Fan Relay Control
24	--	--	Not Used
25	0.75 PK/BU	5293	Ignition 1 Voltage
26-30	--	--	Not Used
31	0.75 OG/YE	3640	Battery Positive Voltage
32	1.25 BK	350	Ground
33	--	--	Not Used
34	0.5 WH/BU	17	Stop Lamp Switch Signal
35	--	--	Not Used
36	0.5 D-BU	5985	Accessory Wakeup Serial Data
37-40	--	--	Not Used
41	0.75 PK/BU	5290	Ignition 1 Voltage
42	0.75 PK/BK	5705	Ignition 1 Voltage
43-44	--	--	Not Used
45	1.25 BK	350	Ground
46	1.25 BK	350	Ground
47	1.25 PK	5292	Ignition 1 Voltage
48	--	--	Not Used
49	0.5 BN	5069	Main Relay Control
50	--	--	Not Used
51	1.25 PK/BU	5291	Ignition 1 Voltage
52-54	--	--	Not Used

Fuse Block - Underhood X2





Connector Part Information

- OEM: 7283-9464-3W
- Service: See Catalog
- Description: 84-Way F YESC Kaizen Series (BK)

Terminal Part Information

- Pins: 5-7, 80
- Terminal/Tray: 7116-4122-02/10
- Core/Insulation Crimp: D/G
- Release Tool/Test Probe: 12094430/J-35616-42 (RD)

- Pin: 13
- Terminal/Tray: 7116-4111-02/9
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 12094430/J-35616-4A (PU)

- Pin: 8
- Terminal/Tray: 7116-4122-02/10
- Core/Insulation Crimp: A/B
- Release Tool/Test Probe: 12094430/J-35616-42 (RD)

- Pins: 15, 17, 24-32, 40, 43, 45, 52, 54-56, 58, 68-70
- Terminal/Tray: 7116-4100-08/9
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12094430/J-35616-2A (GY)

- Pins: 18, 23, 41, 59, 60, 65
- Terminal/Tray: 7116-4101-08/9
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 12094430/J-35616-2A (GY)

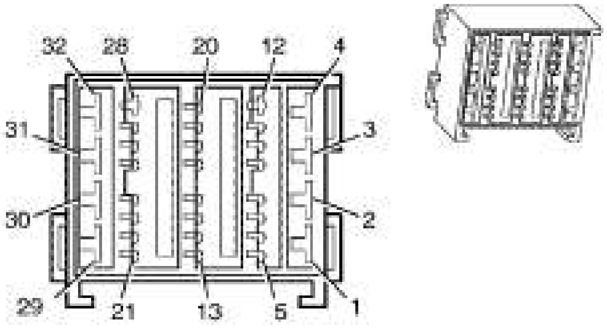
- Pins: 74, 83
- Terminal/Tray: 7116-4112-02/9
- Core/Insulation Crimp: C/D
- Release Tool/Test Probe: 12094430/J-35616-35 (VT)

Fuse Block - Underhood X2

Pin	Wire Color	Circuit No.	Function
1-4	--	--	Not Used
5	5 RD/GN	442	Battery Positive Voltage
6	5 RD/BK	642	Battery Positive Voltage
7	5 RD/WH	842	Battery Positive Voltage
8	3 PU	293	Rear Defog Element Supply Voltage
9	5 RD/YE		Battery Positive Voltage
10-12	--	--	Not Used
13	0.75 L-BU	5986	Communication Enable Relay Supply Voltage
14	2 BN/WH	6724	Washer Pump Relay Supply Voltage
15	0.3 WH/YE	1080	Park Lamp Relay Control
16	--	--	Not Used
17	0.5 PK/BU	339	Ignition 1 Voltage
18	0.75 PU	34	Roof Off-Road Lamps Supply Voltage 2
19-22	--	--	Not Used
23	0.75 PU	709	Left Park Lamp Supply Voltage
24	0.3 WH/BU	193	Rear Defog Relay Control
25	0.3 PK/WH	1970	Headlamp Low Beam Relay Control
26	0.3 BN/RD	860	Front Windshield Wiper Switch High Signal
27	0.3 D-GN/WH	1317	Fog Lamps Relay Control
28	0.3 BN/YE	1969	Headlamp High Beam Relay Control
29	0.3 BN/BK	28	Horn Relay Control
30	--	--	Not Used
31	0.5 OG	2268	Windshield Washer Relay Control
32	0.3 PK	1439	Ignition 1 Voltage
33-37	--	--	Not Used
38	0.3 WH	2282	Headlamp Washer Relay Control
39	0.3 BN	185	Low Washer Fluid Indicator Signal
40	0.5 D-BU/WH	1315	Right Front Turn Signal Lamp Supply Voltage
41	0.75 L-GN	24	Backup Lamp Supply Voltage
42	--	--	Not Used
43	0.5 WH/BU	17	Stop Lamp Switch Signal
44	--	--	Not Used
45	0.3 D-BU	5985	Accessory Wakeup Serial Data
46-51	--	--	Not Used
52	0.5 L-BU/WH	1314	Left Front Turn Signal Lamp Supply Voltage
53	--	--	Not Used
54	0.3 PU/WH	5727	Communication Enable Relay Control
55	0.3 D-GN	646	Reverse Relay Control
56	0.3 GY	91	Windshield Wiper Switch Signal 2

57	--	--	Not Used
58	0.5 PK	1039	Ignition 1 Voltage
59	0.75 OG/GN	2240	Battery Positive Voltage
60	0.75 D-GN	1149	Content Theft Horn Control
61-64	--	--	Not Used
65	0.75 BN/WH	309	Right Park Lamp Supply Voltage
66-67	--	--	Not Used
68	0.5 PK/BU	1339	Ignition 1 Voltage
69	0.3 PU	5531	Hood Closed Switch Signal
70	0.3 PK/BK	109	Hood Ajar Switch Signal
71-73	--	--	Not Used
74	2 BN/WH	92	Windshield Wiper Motor High Speed
75-77	--	--	Not Used
78	2 RD/BU	2640	Battery Positive Voltage
79	--	--	Not Used
80	5 RD	242	Battery Positive Voltage
81-82	--	--	Not Used
83	2 D-GN	95	Windshield Wiper Motor Low Speed
84	--	--	Not Used

Fuse Block - Underhood X3



Connector Part Information

- OEM: 7283-9458-30
- Service: See Catalog
- Description: 32-Way F YESC Kaizen Series (BK)

Terminal Part Information

- Pins: 1, 4, 29, 32
- Terminal/Tray: 7116-4122-02/10

- Core/Insulation Crimp: A/B
- Release Tool/Test Probe: 12094430/J-35616-42 (RD)

- Pins: 6, 25
- Terminal/Tray: 7116-4101-08/9
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 12094430/J-35616-2A (GY)

- Pins: 7-10, 14, 15, 18, 20-23
- Terminal/Tray: 7116-4100-08/9
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12094430/J-35616-2A (GY)

Fuse Block - Underhood X3

Pin	Wire Color	Circuit No.	Function
1	3 WH	504	Cooling Fan Low Reference
2-3	--	--	Not Used
4	3 BK	250	Ground
5	--	--	Not Used
6	0.75 OG	228	Windshield Washer Pump Control
7	--	--	Not Used
8	0.5 D-GN/WH	711	Left Headlamp High Beam Supply Voltage
9	0.5 PK/BK	109	Hood Ajar Switch Signal
10	0.5 PU	709	Left Park Lamp Supply Voltage
11-13	--	--	Not Used
14	0.5 L-BU/WH	1314	Left Front Turn Signal Lamp Supply Voltage
15	0.5 D-BU/WH	1315	Right Front Turn Signal Lamp Supply Voltage
16	0.3 BN		Low Washer Fluid Indicator Signal
17	--	--	Not Used
18	0.5 BN/WH	309	Right Park Lamp Supply Voltage
19	--	--	Not Used
20	0.3 PU	5531	Hood Closed Switch Signal
21	0.5 BN/BK	312	Right Headlamp Low Beam Supply Voltage
22	0.5 YE	712	Left Headlamp Low Beam Supply Voltage
23	0.5 L-GN/BK	311	Right Headlamp High Beam Supply Voltage
24	--	--	Not Used
25	0.75 D-GN	1329	Horn Fuse Supply Voltage
26-28	--	--	Not Used
29	3 GY	532	Cooling Fan Motor Supply Voltage
30-31	--	--	Not Used
32	3 D-BU	409	Cooling Fan Motor Supply Voltage

Fuse Block - Underhood X4 (Battery Positive Cable)

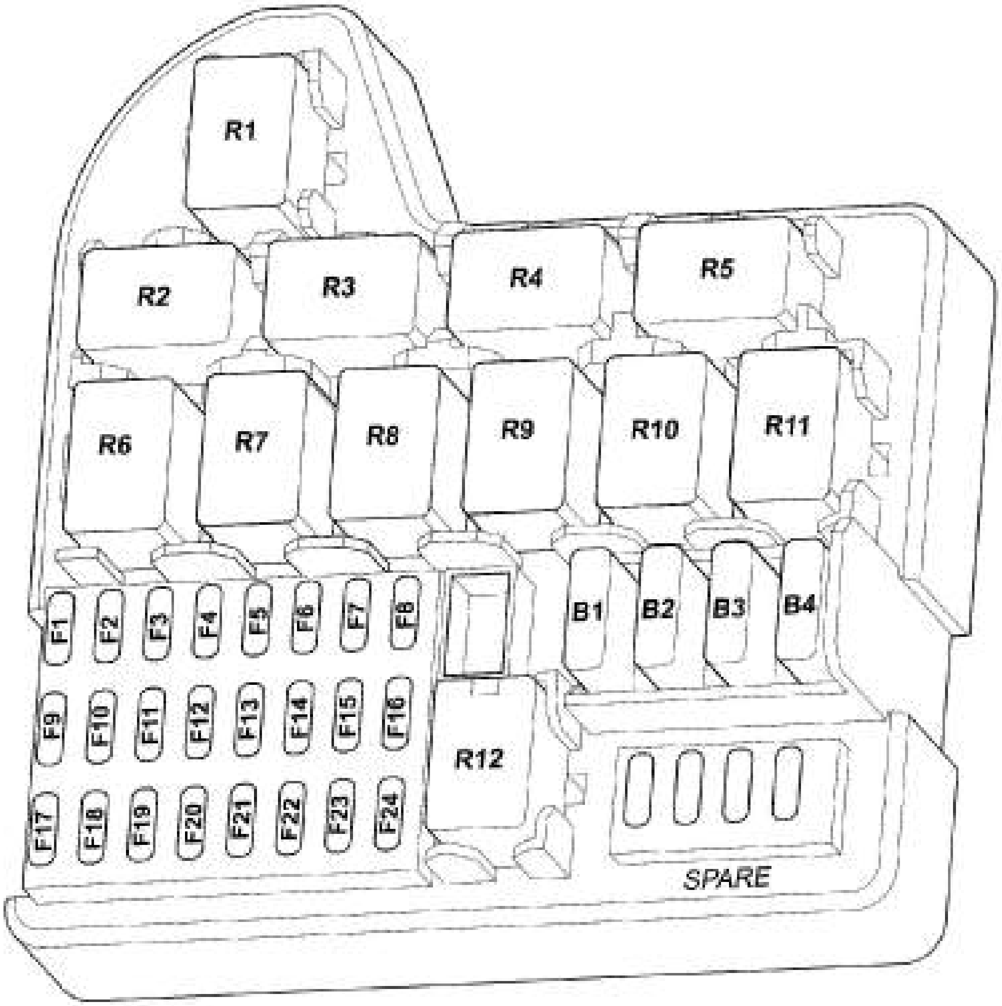
Terminal Part Information

- Harness: Battery Positive Cable
- Terminal: 7003-2327-02
- Core/Insulation Crimp: N/A
- Description: Ring Terminal

Fuse Block - Underhood X4 (Battery Positive Cable)

Pin	Wire Color	Circuit No.	Function
+	19 RD	2	Battery Positive Voltage

Fuse Block - Instrument Panel


R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
B1
B2
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F11
F12
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F14
F15
F16
F17
F18
F19
F20
F21
F22
F23
F24
SPARE

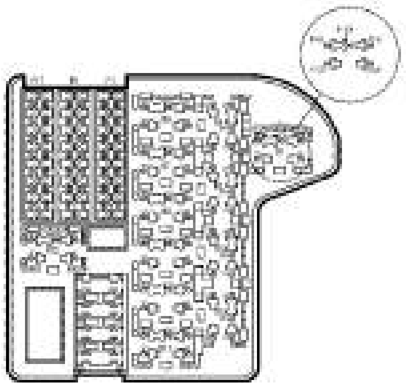
Fuse Block - Instrument Panel

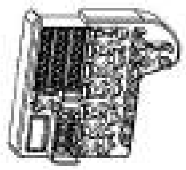
No.	Device	Rating	Description
Circuit Breakers			

B1	WINDOW BATTERY	20A	Not Used
B2	POWER WINDOWS	20A	Automatic Level Control (ALC) Compressor (G69), Electronic Suspension Control (ESC) Module (Z55)
B3	POWER SEATS	20A	Trailer Wiring, Auxiliary Body Control Module (XBCM) (Export)
B4	SPARE		Evaporative Emissions (EVAP) Canister Purge Solenoid Valve, Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor, Valve Lifter Oil Manifold (VLOM) Assembly (DOD)
Fuses			
1	SIR (SIR) Fuse	10A	SIR module (A65)
2	BOOT RELEASE Fuse	10A	Boot release relay (R5)
3	DOOR LOCKS Fuse	25A	Door lock relays R6, R2 & R3
4	INADVERT POWER/LED DIM Fuse	15A	BCM
5	COURTESY LIGHTS/RT FT TURN SIGNAL Fuse	15A	Courtesy light fuse (BCM)
6	TURN SIGNALS RIGHT-LAMPS Fuse	15A	RH turn signal (BCM)
7	INST/CNTR DISP/RFA/DLC Fuse	10A	Courtesy lamps, DLC, IPC, TPM, Sports gauges (if fitted)
8	TURN SIGNALS LEFT-LAMPS Fuse	15A	LH turn signal (BCM)
9	BCM LOGIC Fuse	10A	Body Control Module (BCM)
10	STOP LAMPS/PARK ASSIST Fuse	15A	Body Control Module (BCM)
11	CONSOLE LIGHTING Fuse	15A	Body Control Module (BCM)
12	IGN SW/THEFT Fuse	2A	Theft Deterrent Control Module (TDCM), IGN Switch (S149)
13	CIGAR LIGHTER Fuse	20A	12V/120W AUX power supply
14	FRONT APO Fuse	20A	AUX power outlet
15	EXTERIOR MIRRORS Fuse	2A	Exterior Mirrors Switch
16	PHONE/KEY LK/ISRVM/RAIN SENS Fuse	10A	Phone, key lock, electrochromatic mirror and rain sensor
17	SUNROOF Fuse	20A	Sunroof Control Module (A108)
18	SPARE Fuse	--	
19	SPARE Fuse	--	
20	SPARE Fuse	--	
21	SPARE Fuse	--	
22	SPARE Fuse	--	
23	STEERING WHEEL ILLUM Fuse	2A	

24	RAP CONTROL PWR WDO Fuse	10A	Window, Door lock & Window Switch (S169), Left & RIght Front Window Motor
R1	RAP-RETAIN ACCESSORY POWER Relay	--	A/C CMPRSR Fuse
R2	ALL DOORS LOCK Relay	--	AXH VLV Fuse
R3	PAS DOOR UNLCOK Relay	--	FOG LAMP Fuse
R4	SPARE Relay	--	
R5	BOOT RELEASE Relay	--	FUEL PUMP Fuse
R6	DRIVERS DOOR UNLOCK Relay	--	LO HDLP - LT Fuse, LO HDLP - RT Fuse, DRL 2 Fuse
R7	SPARE Relay	--	
R8	ACCESSORY POWER Relay	--	ECM/THROT CONT Fuse, ENG Fuse, INJ-A Fuse, INJ-B Fuse, O2-A SNSR Fuse, O2-B SNSR Fuse, FAN CNRTL PCB Relay, FAN HI PCB Relay, FAN LO PCB Relay
R9	BLOWER (LHD ONLY) Relay	--	REAR DEFOG Fuse
R10	SPARE Relay	--	
R11	SPARE Relay	--	
R12	FUEL PUMP Relay	--	Cooling Fan - Right

Fuse Block - I/P





Connector Part Information

- OEM: 7154-5842-30
- Service: See Catalog
- Description: 117-Way (BK)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit

- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Fuse Block - I/P

Pin	Wire Color	Circuit No.	Function
B1-A	5 RD	--	Battery Positive Voltage
B1-B	2 OG/BU	--	Battery Positive Voltage
B2-A	5 D-GN	801	RAP Supply Voltage
B2-B	2 D-GN	1001	RAP Supply Voltage
B3-A	5 RD/BK	242	Battery Positive Voltage
B3-B	2 OG	1140	Battery Positive Voltage
F1-A	0.5 OG/YE	1340	Battery Positive Voltage
F1-B	--	242	Battery Positive Voltage
F2-A	5 RD/WH	242	Battery Positive Voltage
F2-B	0.5 OG	840	Battery Positive Voltage
F3-A	--	242	Battery Positive Voltage
F3-B	1.25 OG/RD	3240	Battery Positive Voltage
F4-A	--	242	Battery Positive Voltage
F4-B	0.85 OG/YE	1640	Battery Positive Voltage
F5-A	--	642	Battery Positive Voltage
F5-B	1.25 OG	240	Battery Positive Voltage
F6-A	5 RD	642	Battery Positive Voltage
F6-B	0.85 OG/GN	440	Battery Positive Voltage
B4-A	--	--	Not Used
B4-B	--	--	Not Used
F7-A	--	642	Battery Positive Voltage
F7-B	0.5 OG/WH	--	Battery Positive Voltage
F8-A	--	642	Battery Positive Voltage
F8-B	0.85 OG/RD	340	Battery Positive Voltage
F9-A	--	642	Battery Positive Voltage
F9-B	0.85 OG/RD	2740	Battery Positive Voltage
F10-A	5 RD/YE	642	Battery Positive Voltage
F10-B	0.85 OG/PU	2140	Battery Positive Voltage
F11-A	--	642	Battery Positive Voltage
F11-B	0.85 OG/BU	1240	Battery Positive Voltage
F12-A	--	642	Battery Positive Voltage
F12-B	0.3 OG/BK	1040	Battery Positive Voltage
F13-A	--	--	Not Used
F13-B	1.25 BN/YE	9101	Accessory Voltage
F14-A	5 YE	9801	Accessory Voltage
F14-B	0.5 BN/WH	9301	Accessory Voltage

F15-A	--	643	Not Used
F15-B	0.5 BN/BU	343	Accessory Voltage
F16-A	--	643	Accessory Voltage
F16-B	0.5 BN	443	Accessory Voltage
F17-A	5 RD	242	Battery Positive Voltage
F17-B	1.25 OG/BU	3040	Battery Positive Voltage
F23-A	0.3 YE	6817	Interior Lights Dimming Switch
F23-B	0.3 PU/WH	7005	I/P Dimming Control
F24-A	5 D-GN	801	RAP Fuse Supply Voltage
F24-B	0.5 D-GN	1301	RAP Fuse Supply Voltage
R1-30	5 RD/WH	242	Battery Positive Voltage
R1-85	0.3 BN/YE	707	RAP Relay Control
R1-86	1.25 BK	1450	Ground
R1-87	5 D-GN	801	RAP Fuse Supply Voltage
R2-30	1.25 D-GN/WH	295	Door Lock Actuator Lock Control
R2-85	1.25 BK	1450	Ground
R2-86	0.3 L-BU	195	Door Lock Relay Control
R2-87	1.25 OG/RD	3240	Battery Positive Voltage
R2-87A	1.25 BK	1450	Ground
R3-30	1.25 BN/RD	294	Door Lock Actuator Unlock Control
R3-85	0.3 WH	194	Door Unlock Control
R3-86	1.25 OG/RD	3240	Battery Positive Voltage
R3-87	1.25 OG/RD	3240	Battery Positive Voltage
R3-87A	1.25 BK	1450	Ground
R5-30	0.5 OG	840	Battery Positive Voltage
R5-85	0.5 OG	840	Battery Positive Voltage
R5-86	0.3 BN	253	Trunk Release Relay Control
R5-87	0.85 BN/WH	56	Rear Compartment Lid Release Actuator
R6-30	1.25 BN/RD	9351	Driver Door Lock Actuator Unlock Control
R6-85	0.3 L-BU	5921	Door Unlock Supply Voltage
R6-86	1.25 OG/RD	3240	Battery Positive Voltage
R6-87	1.25 OG/RD	3240	Battery Positive Voltage
R6-87A	1.25 BK	1450	Ground
R8-30	5 RD/BK	642	Battery Positive Voltage
R8-85	0.3 YE	43	Accessory Voltage
R8-86	1.25 BK	1450	Ground
R8-87	5 YE	643	Accessory Voltage
R12-30	3 GY	120	Fuel Pump Supply Voltage
R12-85	0.3 D-GN/WH	465	Fuel Pump Relay Control [- Primary]
R12-86	1.25 BK	1450	Fuel Pump Control

R12-87	3 OG/GN	2840	Battery Positive Voltage

Fuse Block - Battery Cable X1

Terminal Part Information

- Terminal: 7003-1669-02
- Core/Insulation Crimp: N/A
- Description: Battery Terminal

Fuse Block - Battery Cable X1

Pin	Wire Color	Circuit No.	Function
+	19 RD	1	Battery Positive Voltage

Fuse Block - Battery Cable X2

Terminal Part Information

- Terminal: 7009-1846
- Core/Insulation Crimp: N/A
- Description: Battery Terminal

Fuse Block - Battery Cable X2

Pin	Wire Color	Circuit No.	Function
+	5 RD/BK	1242	Battery Positive Voltage

Fuse Block - Battery Cable X3

Terminal Part Information

- Terminal: 7009-1813-02
- Core/Insulation Crimp: N/A
- Description: Battery Terminal

Fuse Block - Battery Cable X3

Pin	Wire Color	Circuit No.	Function
+	8 RD/BK	1042	Battery Positive Voltage

Junction Block - Battery Cable - Engine X1

Terminal Part Information

- Harness: Battery Positive Cable
- Terminal: 7003-2639-02
- Core/Insulation Crimp: N/A
- Description: Ring Terminal

Junction Block - Battery Cable - Engine X1

Pin	Wire Color	Circuit No.	Function
+	50 RD	1	Battery Positive Voltage

Junction Block - Battery Cable - Engine X3

Terminal Part Information

- Harness: Battery Positive Cable
- Terminal: 7003-2071-02
- Core/Insulation Crimp: N/A
- Description: Ring Terminal

Junction Block - Battery Cable - Engine X3

Pin	Wire Color	Circuit No.	Function
+	19 RD	2	Battery Positive Voltage

Junction Block - Battery Cable - I / P

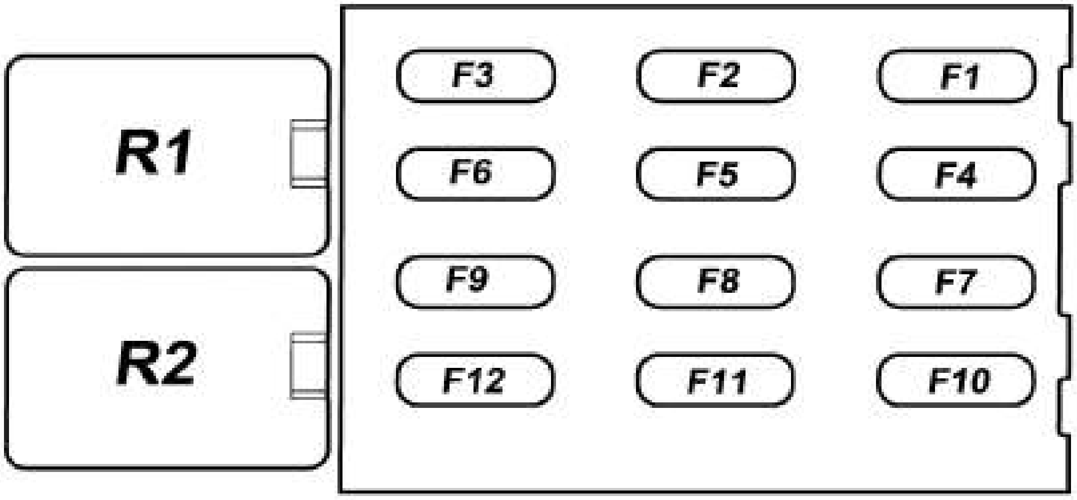
Terminal Part Information

- Harness: Battery Positive Cable
- Terminal: 7003-1200-02
- Core/Insulation Crimp: N/A
- Description: Ring Terminal

Junction Block - Battery Cable - I / P

Pin	Wire Color	Circuit No.	Function
+	50 RD	1	Battery Positive Voltage

Fuse Block - Rear



Fuse Block - Rear, Device Usage

No.	Device	Rating	Description
1	REAR SEAT ENTERTAINMENT Fuse	10A	Video Splitter Box (VSB)
2	AMPLIFIER Fuse	30A	Amplifier (N6)
3	NAVIGATION/TELEMATICS/PHONE Fuse	10A	Navigation module, Telematics module and Bluetooth module
4	RADIO & INFOTAINMENT Fuse	15A	Audio unit (A133)
5	SPARE Fuse	--	
6	REAR APO Fuse	20A	12V/120W AUX power outlet
7	TRAILER Fuse	30A	
8	SPARE Fuse	--	
9	SPARE Fuse	--	
10	ECM BATT Fuse	15A	ECM power supply
11	RVC SENSE Fuse	7.5A	Body Control Module (BCM)
12	FUEL PUMP Fuse	20A	Fuel pump relay (R12)
--	SPARE Relay	--	

--	SPARE Relay	--	

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Power and Signal Distribution | Wiring Systems and Power Management | Component Locator |

Document ID: 2033766

Component Connector End Views

Connector 1: 1-2 Shift Solenoid (SS) Valve
Connector 2: 3-4 Shift Solenoid (SS) Valve
Connector 3: 4-5 Shift Solenoid (SS) Valve
Connector 4: A/C Compressor
Connector 5: A/C Refrigerant Pressure Sensor
Connector 6: Accelerator Pedal Position (APP) Sensor
Connector 7: Accessory Power Outlet - Center Console Compartment
Connector 8: Accessory Power Outlet - I/P
Connector 9: Air Temperature Actuator (C60)
Connector 10: Air Temperature Actuator - Left
Connector 11: Air Temperature Actuator - Right
Connector 12: Air Temperature Actuator - Auxiliary (C63)
Connector 13: Air Temperature Sensor
Connector 14: Air Temperature Sensor - Inside
Connector 15: Alarm Module Connector
Connector 16: Ambient Air Temperature Sensor
Connector 17: Ambient Light Sensor (C60)
Connector 18: Audio Amplifier (UWP)
Connector 19: Audio Amplifier X1 (UQ7 and LHD)
Connector 20: Audio Amplifier X1 (UQ7 and RHD)
Connector 21: Audio Amplifier X2 (UQ7 and LHD)
Connector 22: Audio Amplifier X2 (UQ7 and RHD)
Connector 23: Audio Amplifier X3 (LHD and UQ7)
Connector 24: Audio Amplifier X3 (RHD and UQ7)
Connector 25: Automatic Transmission (MYC)
Connector 26: Automatic Transmission (M30 or M32)
Connector 27: Automatic Transmission Input Shaft Speed (ISS) Sensor
Connector 28: Automatic Transmission Output Shaft Speed (OSS) Sensor
Connector 29: Automatic Transmission Shift Lever
Connector 30: Backup Lamp - Left
Connector 31: Backup Lamp - Right
Connector 32: Backup Lamp Switch (M10 or MV5)
Connector 33: Battery (-)
Connector 34: Battery (+)
Connector 35: Battery Current Sensor
Connector 36: Battery Voltage Gauge
Connector 37: Blower Motor (LHD)
Connector 38: Blower Motor (RHD)
Connector 39: Blower Motor Control Module
Connector 40: Bluetooth Connector

Connector 41: Bluetooth Microphone
Connector 42: Bluetooth Module
Connector 43: Body Control Module (BCM) X1
Connector 44: Body Control Module (BCM) X2
Connector 45: Body Control Module (BCM) X3
Connector 46: Body Control Module (BCM) X4
Connector 47: Body Control Module (BCM) X5
Connector 48: Body Control Module (BCM) X6
Connector 49: Body Control Module (BCM) X7
Connector 50: Brake Fluid Level Switch
Connector 51: Brake Pedal Position (BPP) Sensor
Connector 52: Camshaft Position (CMP) Actuator Solenoid Valve - Bank 1 Exhaust (LY7)
Connector 53: Camshaft Position (CMP) Actuator Solenoid Valve - Bank 1 Intake (LY7)
Connector 54: Camshaft Position (CMP) Actuator Solenoid Valve - Bank 2 Exhaust (LY7)
Connector 55: Camshaft Position (CMP) Actuator Solenoid Valve - Bank 2 Intake (LY7)
Connector 56: Camshaft Position (CMP) Sensor - Bank 1 Exhaust (LY7)
Connector 57: Camshaft Position (CMP) Sensor - Bank 1 Intake (LY7)
Connector 58: Camshaft Position (CMP) Sensor - Bank 2 Exhaust (LY7)
Connector 59: Camshaft Position (CMP) Sensor - Bank 2 Intake (LY7)
Connector 60: Camshaft Position (CMP) Sensor (LS2 or HSV or L98)
Connector 61: Center Console Compartment Lamp X1
Connector 62: Center Console Compartment Lamp X2
Connector 63: Center Console Compartment Lamp Switch X1
Connector 64: Center Console Compartment Lamp Switch X2
Connector 65: Center High Mounted Stop Lamp (CHMSL)
Connector 66: Clutch Pedal Position (CPP) Switch
Connector 67: Clutch Safety Switch (not an approved name)
Connector 68: Clutch Start Switch
Connector 69: Courtesy Lamp - Left Footwell
Connector 70: Courtesy Lamp - Right Footwell
Connector 71: Cruise Control Clutch Pedal Release Switch
Connector 72: Crankshaft Position (CKP) Sensor (LY7)
Connector 73: Crankshaft Position (CKP) Sensor (without LY7)
Connector 74: Data Link Connector (DLC)
Connector 75: Data Link Resistor
Connector 76: Diagnostic Connector (LPG)
Connector 77: Digital Radio Receiver (U2K)
Connector 78: Digital Video Disc (DVD) Control Module X1
Connector 79: Digital Video Disc (DVD) Control Module X2
Connector 80: Digital Video Disc (DVD) Control Module X3
Connector 81: Digital Video Disc (DVD) Control Module X4
Connector 82: Digital Video Disc (DVD) Control Module X5
Connector 83: Digital Video Disc (DVD) Control Module X6
Connector 84: Digital Video Disc (DVD) Control Module X7
Connector 85: Digital Video Disc (DVD) Control Module X8

Connector 86: Digital Video Disc (DVD) Display X1
Connector 87: Digital Video Disc (DVD) Display X2
Connector 88: Digital Video Disc (DVD) Player X1
Connector 89: Digital Video Disc (DVD) Player X2
Connector 90: Disable Switch
Connector 91: Dome Lamp (without TRV)
Connector 92: Dome/Reading Lamps - Front (C74 without 9C1)
Connector 93: Dome/Reading Lamps (9C1)
Connector 94: Dome/Reading Lamps - Rear (TRV)
Connector 95: Dome/Reading Lamps - Rear (without TRV)
Connector 96: Door Courtesy Lamp - Driver X1
Connector 97: Door Courtesy Lamp - Driver X2
Connector 98: Door Courtesy Lamp - Left Rear X1
Connector 99: Door Courtesy Lamp - Left Rear X2
Connector 100: Door Courtesy Lamp - Passenger X1
Connector 101: Door Courtesy Lamp - Passenger X2
Connector 102: Door Courtesy Lamp - Right Rear X1
Connector 103: Door Courtesy Lamp - Right Rear X2
Connector 104: Door Latch - Driver
Connector 105: Door Latch - Left Rear
Connector 106: Door Latch - Passenger
Connector 107: Door Latch - Right Rear
Connector 108: Door Lock/Window Switch X1
Connector 109: Door Lock/Window Switch X2
Connector 110: Driver Information Center (DIC) (ERG)
Connector 111: Driver Information Center (DIC) (without ERG)
Connector 112: Driving Lamp - Left (HSV or VXR8)
Connector 113: Driving Lamp - Right (HSV or VXR8)
Connector 114: Driving Lamp - HSVDR 1 (HSV or VXR8)
Connector 115: Electronic Brake Control Module (EBCM) (JL4)
Connector 116: Electronic Brake Control Module (EBCM) (JL9)
Connector 117: Electronic Suspension Control (ESC) Switch (HSV)
Connector 118: Electronic Suspension Control (ESC) Module (HSV)
Connector 119: Engine Control Module (ECM) (L98 or HSV or LS2) X1
Connector 120: Engine Control Module (ECM) (L98 or HSV or LS2) X2
Connector 121: Engine Control Module (ECM) (LY7) X1
Connector 122: Engine Control Module (ECM) (LY7) X2
Connector 123: Engine Coolant Temperature (ECT) Sensor (L98 or HSV)
Connector 124: Engine Coolant Temperature (ECT) Sensor (LY7)
Connector 125: Engine Cooling Fan - Left
Connector 126: Engine Cooling Fan - Right
Connector 127: Engine Oil Level and Temperature Sensor
Connector 128: Engine Oil Pressure (EOP) Sensor
Connector 129: Evaporative Emission (EVAP) Canister Purge Solenoid Valve (L98 or HSV)
Connector 130: Evaporative Emission (EVAP) Canister Purge Solenoid Valve (LY7)

Connector 131: Evaporative Emission (EVAP) Canister Vent Solenoid Valve
Connector 132: Fog Lamp - Left Front
Connector 133: Fog Lamp - Rear (T79)
Connector 134: Fog Lamp - Right Front
Connector 135: Front and Rear Object Alarm Module X1
Connector 136: Front and Rear Object Alarm Module X2
Connector 137: Front and Rear Object Alarm Module X3
Connector 138: Front and Rear Object Alarm
Connector 139: Fuel Door Release Actuator
Connector 140: Fuel Injector 1 (LY7)
Connector 141: Fuel Injector 1 (L98 or HSV)
Connector 142: Fuel Injector 2 (LY7)
Connector 143: Fuel Injector 2 (L98 or HSV)
Connector 144: Fuel Injector 3 (LY7)
Connector 145: Fuel Injector 3 (L98 or HSV)
Connector 146: Fuel Injector 4 (LY7)
Connector 147: Fuel Injector 4 (L98 or HSV)
Connector 148: Fuel Injector 5 (LY7)
Connector 149: Fuel Injector 5 (L98 or HSV)
Connector 150: Fuel Injector 6 (LY7)
Connector 151: Fuel Injector 6 (L98 or HSV)
Connector 152: Fuel Injector 7 (L98 or HSV)
Connector 153: Fuel Injector 8 (L98 or HSV)
Connector 154: Fuel Level Sensor - Secondary
Connector 155: Fuel Tank Pressure (FTP) Sensor
Connector 156: Fuel Pump and Sender Assembly
Connector 157: Generator X1 (L76)
Connector 158: Generator X1 (LY7)
Connector 159: Generator X2
Connector 160: Headlamp and Panel Dimmer Switch
Connector 161: Headlamp - Left
Connector 162: Headlamp - Right
Connector 163: Headlamp Washer Fluid Pump
Connector 164: Heated Oxygen Sensor (HO2S) Bank 1 Sensor 1 (LY7)
Connector 165: Heated Oxygen Sensor (HO2S) Bank 1 Sensor 1 (L98 or HSV)
Connector 166: Heated Oxygen Sensor (HO2S) Bank 1 Sensor 2 (LY7)
Connector 167: Heated Oxygen Sensor (HO2S) Bank 1 Sensor 2 (L98 or HSV or LS2)
Connector 168: Heated Oxygen Sensor (HO2S) Bank 2 Sensor 1 (LY7)
Connector 169: Heated Oxygen Sensor (HO2S) Bank 2 Sensor 1 (L98 or HSV)
Connector 170: Heated Oxygen Sensor (HO2S) Bank 2 Sensor 2 (LY7)
Connector 171: Heated Oxygen Sensor (HO2S) Bank 2 Sensor 2 (L98 or HSV)
Connector 172: Heated Seat Control Module - Driver (KA1)
Connector 173: Heated Seat Control Module - Passenger (KA1)
Connector 174: Hood Ajar Switch
Connector 175: Horn - Left X1

Connector 176: Horn - Left X2
Connector 177: Horn - Right X1
Connector 178: Horn - Right X2
Connector 179: HVAC Control Module X1 (LHD)
Connector 180: HVAC Control Module X1 (RHD)
Connector 181: HVAC Control Module X2 (LHD)
Connector 182: HVAC Control Module X3 (RHD)
Connector 183: HVAC Control Module (RHD) X4
Connector 184: HVAC Control Module (RHD) X5
Connector 185: Ignition Coil 1 (LY7)
Connector 186: Ignition Coil 1 (L98 or HSV)
Connector 187: Ignition Coil 2 (LY7)
Connector 188: Ignition Coil 2 (L98 or HSV)
Connector 189: Ignition Coil 3 (LY7)
Connector 190: Ignition Coil 3 (L98 or HSV)
Connector 191: Ignition Coil 4 (LY7)
Connector 192: Ignition Coil 4 (L98 or HSV)
Connector 193: Ignition Coil 5 (LY7)
Connector 194: Ignition Coil 5 (L98 or HSV)
Connector 195: Ignition Coil 6 (LY7)
Connector 196: Ignition Coil 6 (L98 or HSV)
Connector 197: Ignition Coil 7 (L98 or HSV)
Connector 198: Ignition Coil 8 (L98 or HSV)
Connector 199: Ignition Key Cylinder Lamp
Connector 200: Ignition Lock Cylinder Control Solenoid
Connector 201: Ignition Switch
Connector 202: Inflatable Restraint Front End Sensor - Left
Connector 203: Inflatable Restraint Front End Sensor - Right
Connector 204: Inflatable Restraint Front Passenger Presence System (PPS) Module X1
Connector 205: Inflatable Restraint Front Passenger Presence System (PPS) Module X2
Connector 206: Inflatable Restraint I/P Module X1
Connector 207: Inflatable Restraint I/P Module X2
Connector 208: Inflatable Restraint Roof Rail Module - Left
Connector 209: Inflatable Restraint Roof Rail Module - Right
Connector 210: Inflatable Restraint Seat Position Sensor - Driver
Connector 211: Inflatable Restraint Seat Position Sensor - Passenger
Connector 212: Inflatable Restraint Sensing and Diagnostic Module (SDM) X1
Connector 213: Inflatable Restraint Sensing and Diagnostic Module (SDM) X2
Connector 214: Inflatable Restraint Side Impact Module - Left X1
Connector 215: Inflatable Restraint Side Impact Module - Left X2
Connector 216: Inflatable Restraint Side Impact Module - Right X1
Connector 217: Inflatable Restraint Side Impact Module - Right X2
Connector 218: Inflatable Restraint Side Impact Sensor (SIS) - Left
Connector 219: Inflatable Restraint Side Impact Sensor (SIS) - Right
Connector 220: Inflatable Restraint Steering Wheel Module Coil X1

Connector 221: Inflatable Restraint Steering Wheel Module Coil X2 (RHD)
Connector 222: Inflatable Restraint Steering Wheel Module Coil X2 (LHD)
Connector 223: Inflatable Restraint Steering Wheel Module X1
Connector 224: Inflatable Restraint Steering Wheel Module X2
Connector 225: Inside Rearview Mirror (ISRVM) (UE1)
Connector 226: Inside Rearview Mirror (ISRVM) (without UE1)
Connector 227: Instrument Panel Cluster
Connector 228: I/P Compartment Lamp X1
Connector 229: I/P Compartment Lamp X2
Connector 230: I/P Compartment Lamp Switch X1
Connector 231: I/P Compartment Lamp Switch X2
Connector 232: Intake Manifold Tuning (IMT) Solenoid Valve (LY7)
Connector 233: Internal Mode Switch (IMS)
Connector 234: Knock Sensor (KS) 1 (LY7)
Connector 235: Knock Sensor (KS) 1 (L98 or HSV)
Connector 236: Knock Sensor (KS) 2 (LY7)
Connector 237: Knock Sensor (KS) 2 (L98 or HSV)
Connector 238: License Lamp - Left
Connector 239: License Lamp - Right
Connector 240: LPG Control Module
Connector 241: LPG Fuel Injector 1
Connector 242: LPG Fuel Injector 2
Connector 243: LPG Fuel Injector 3
Connector 244: LPG Fuel Injector 4
Connector 245: LPG Fuel Injector 5
Connector 246: LPG Fuel Injector 6
Connector 247: LPG Lock-Off
Connector 248: LPG Relay
Connector 249: LPG Switch/Fuel Display
Connector 250: Manifold Absolute Pressure (MAP) Sensor (L98)
Connector 251: Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor
Connector 252: Memory Seat Module - Driver X1
Connector 253: Memory Seat Module - Driver X2
Connector 254: Memory Seat Module - Driver X3
Connector 255: Memory Seat Module - Driver X4
Connector 256: Mode Actuator - Left
Connector 257: Mode Actuator - Right
Connector 258: Mode Actuator - Auxiliary (C63)
Connector 259: Multifunction Switch - Center Console
Connector 260: Navigation Gateway Module (RHD)
Connector 261: Navigation Module X1 (RHD)
Connector 262: Navigation Module X2 (RHD)
Connector 263: Navigation Module X3 (RHD)
Connector 264: Navigation Module X4 (RHD)
Connector 265: Navigation Module X5 (RHD)

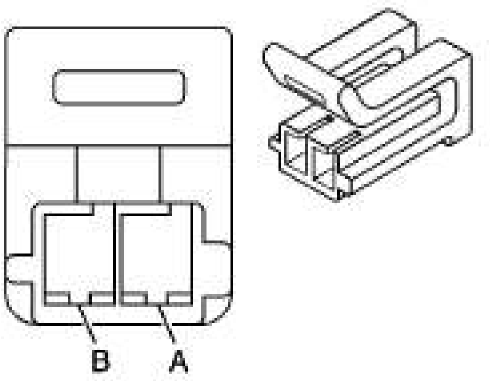
Connector 266: Navigation Module X6 (RHD)
Connector 267: Navigation Module X7 (RHD)
Connector 268: Object Alarm Sensor - Left Front Corner
Connector 269: Object Alarm Sensor - Left Front Middle
Connector 270: Object Alarm Sensor - Left Rear Corner
Connector 271: Object Alarm Sensor - Left Rear Middle
Connector 272: Object Alarm Sensor - Right Front Corner
Connector 273: Object Alarm Sensor - Right Front Middle
Connector 274: Object Alarm Sensor - Right Rear Corner
Connector 275: Object Alarm Sensor - Right Rear Middle
Connector 276: Oil Pressure Gauge
Connector 277: Oil Temperature Gauge
Connector 278: Outside Moisture Sensor
Connector 279: Outside Rearview Mirror - Driver
Connector 280: Outside Rearview Mirror - Passenger
Connector 281: Outside Rearview Mirror Switch
Connector 282: Park Brake Switch
Connector 283: Park/Neutral Position (PNP) Switch (M30 or M32)
Connector 284: Pressure Control (PC) Solenoid Valve
Connector 285: Radio X1
Connector 286: Radio X2
Connector 287: Radio X3
Connector 288: Radio X4
Connector 289: Rail Pressure/Temperature Sensor (LPG)
Connector 290: Rear Compartment Courtesy Lamp X1
Connector 291: Rear Compartment Courtesy Lamp X2
Connector 292: Rear Compartment Lid Latch
Connector 293: Rear Compartment Lid Release Switch
Connector 294: Rear Lock-Off/Service Solenoid Assembly (LPG)
Connector 295: Rear Object Sensor Control Module Connector
Connector 296: Rear Park Assist Module X2
Connector 297: Rear Park Assist Module X3
Connector 298: Rear Park Assist Module X4
Connector 299: Rear Park Assist Module X5
Connector 300: Rear Park Assist Ground Connector X1
Connector 301: Rear Park Assist Ground Connector X2
Connector 302: Rear Window Defogger Grid X1
Connector 303: Rear Window Defogger Grid X2
Connector 304: Recirculation Actuator
Connector 305: Regulator Temperature Sensor (LPG)
Connector 306: Remote Control Door Lock Receiver (RCDLR)
Connector 307: Reverse Lockout Solenoid (L98 or HSV)
Connector 308: Seat Adjuster Switch - Driver (AG3 or AGB)
Connector 309: Seat Adjuster Switch - Driver (AH6 or AJ6)
Connector 310: Seat Adjuster Switch - Passenger

Connector 311: Seat Belt Buckle Pretensioner - Driver
Connector 312: Seat Belt Retractor Pretensioner - Driver
Connector 313: Seat Belt Buckle Pretensioner - Passenger
Connector 314: Seat Belt Retractor Pretensioner - Passenger
Connector 315: Seat Belt Switch - Driver
Connector 316: Seat Belt Switch - Passenger
Connector 317: Seat Front Vertical Motor - Driver (AG1 or AG3)
Connector 318: Seat Front Vertical Motor - Passenger (AG1)
Connector 319: Seat Horizontal Motor - Driver (AG1 or AG3)
Connector 320: Seat Horizontal Motor - Passenger (AG1)
Connector 321: Memory Seat Module (MSM)
Connector 322: Seat Lumbar Motor - Driver X1 (AG3)
Connector 323: Seat Lumbar Motor - Driver X2 (AG3)
Connector 324: Seat Rear Vertical Motor - Driver (AG1 or AG3)
Connector 325: Seat Rear Vertical Motor - Passenger (AG1)
Connector 326: Seat Recline Motor - Driver (AG1 or AG3)
Connector 327: Seat Recline Motor - Passenger (AG1)
Connector 328: Shock Absorber Actuator - Left Front (HSV)
Connector 329: Shock Absorber Actuator - Left Rear (HSV)
Connector 330: Shock Absorber Actuator - Right Front (HSV)
Connector 331: Shock Absorber Actuator - Right Rear (HSV)
Connector 332: Side Marker Lamp - Left Front
Connector 333: Side Marker Lamp - Left Rear
Connector 334: Side Marker Lamp - Right Front
Connector 335: Side Marker Lamp - Right Rear
Connector 336: Siren Connector
Connector 337: Speaker - Center I/P X1 (UW5)
Connector 338: Speaker - Center I/P X2 (UW5)
Connector 339: Speaker - Center I/P (without UW5)
Connector 340: Speaker - Left Front (UQ7)
Connector 341: Speaker - Left Front (UW5 or U65)
Connector 342: Speaker - Left Front Tweeter (U65 or UW5)
Connector 343: Speaker - Left Front Tweeter (UQ7)
Connector 344: Speaker - Left Rear (U65 or UW5)
Connector 345: Speaker - Left Rear (UQ7)
Connector 346: Speaker - Left Subwoofer (UQ7)
Connector 347: Speaker - Right Front (UQ7)
Connector 348: Speaker - Right Front (UW5 or U65)
Connector 349: Speaker - Right Front Tweeter (U65 or UW5)
Connector 350: Speaker - Right Front Tweeter (UQ7)
Connector 351: Speaker - Right Rear (U65 or UW5)
Connector 352: Speaker - Right Rear (UQ7)
Connector 353: Speaker - Right Subwoofer (UQ7)
Connector 354: Starter Motor X1
Connector 355: Starter Motor X2

Connector 356: Steering Angle Sensor
Connector 357: Steering Wheel Controls Switch Assembly
Connector 358: Sunload Sensor (CJ2 or C63)
Connector 359: Sunroof Control Module (RHD)
Connector 360: Sunroof Switch (RHD)
Connector 361: Sunshade - Left
Connector 362: Sunshade - Right
Connector 363: Suspension Position Sensor - Left Front (HSV)
Connector 364: Suspension Position Sensor - Left Rear (HSV)
Connector 365: Suspension Position Sensor - Right Front (HSV)
Connector 366: Suspension Position Sensor - Right Rear (HSV)
Connector 367: Tail Lamp - Left (without HSV or VXR8)
Connector 368: Tail Lamp - Left (HSV or VXR8)
Connector 369: Tail Lamp - Right (without HSV or VXR8)
Connector 370: Tail Lamp - Right (HSV or VXR8)
Connector 371: Telematics Module X1 (RHD)
Connector 372: Telematics Module X2 (RHD)
Connector 373: Theft Deterrent Alarm Siren X1
Connector 374: Theft Deterrent Alarm Siren X2
Connector 375: Theft Deterrent Module (TDM)
Connector 376: Throttle Body
Connector 377: Tilt Sensor
Connector 378: Trailer Connector
Connector 379: Trailer Harness Control Module
Connector 380: Trailer Patch Harness Electrical Brake Connector
Connector 381: Trailer Presence Conncetor
Connector 382: Torque Converter Clutch (TCC) Pulse Width Modulation (PWM) Solenoid Valve
Connector 383: Transmission Control Module (TCM) (M30 or M32)
Connector 384: Turn Signal/Multifunction Switch
Connector 385: Ultrasonic Sensor Control Module
Connector 386: Valve Lifter Oil Manifold (VLOM) Assembly
Connector 387: Variable Intake Manifold (VIM) Module
Connector 388: Vehicle Communication Interface Module (VCIM) X1
Connector 389: Vehicle Communication Interface Module (VCIM) X2
Connector 390: Vehicle Communication Interface Module (VCIM) Battery
Connector 391: Vehicle Speed Sensor (VSS)
Connector 392: Video Display
Connector 393: Video Display - Left Seat Headrest X1
Connector 394: Video Display - Left Seat Headrest X2
Connector 395: Video Display - Right Seat Headrest X1
Connector 396: Video Display - Right Seat Headrest X2
Connector 397: Wheel Speed Sensor (WSS) - Left Front
Connector 398: Wheel Speed Sensor (WSS) - Left Rear
Connector 399: Wheel Speed Sensor (WSS) - Right Front
Connector 400: Wheel Speed Sensor (WSS) - Right Rear

Connector 401: Window Control Module
Connector 402: Window Motor - Driver (AXB)
Connector 403: Window Motor - Driver (AXC)
Connector 404: Window Motor - Left Rear
Connector 405: Window Motor - Passenger (AXB)
Connector 406: Window Motor - Passenger (AXC)
Connector 407: Window Motor - Right Rear
Connector 408: Window Switch - Left Rear
Connector 409: Window Switch - Right Rear
Connector 410: Windshield Washer Fluid Level Switch (TT7 or TT8 or EF7)
Connector 411: Windshield Washer Fluid Pump
Connector 412: Windshield Wiper Motor
Connector 413: Windshield Wiper/Washer Switch
Connector 414: Yaw and Lateral Accelerometer Sensor

1-2 Shift Solenoid (SS) Valve



Connector Part Information

- OEM: 12146094
- Service: See Catalog
- Description: 2-Way F Metri-Pack 150.2 Series, Sealed, Pull To Seat (GY)

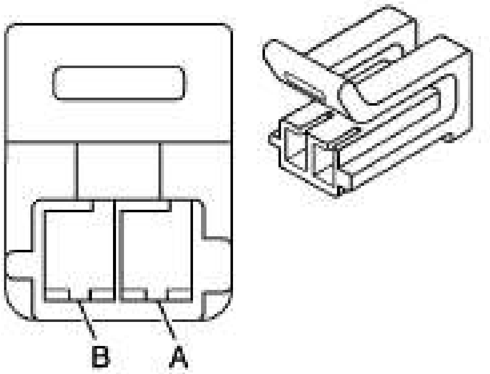
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

1-2 Shift Solenoid (SS) Valve

Pin	Wire Color	Circuit No.	Function
A	0.5 BK	1222	Shift Solenoid A Valve Control
B	0.5 WH	1525	Clutch Pressure Control Solenoid Valve 1 High Control

3-4 Shift Solenoid (SS) Valve



Connector Part Information

- OEM: 12146094
- Service: See Catalog
- Description: 2-Way F Metri-Pack 150.2 Series, Sealed, Pull To Seat (GY)

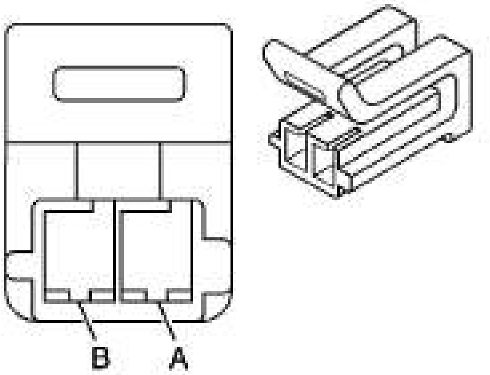
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

3-4 Shift Solenoid (SS) Valve

Pin	Wire Color	Circuit No.	Function
A	0.5 GY	898	Shift Solenoid C Valve Control
B	0.5 WH	1525	Clutch Pressure Control Solenoid Valve 1 High Control

4-5 Shift Solenoid (SS) Valve



Connector Part Information

- OEM: 12146094
- Service: See Catalog
- Description: 2-Way F Metri-Pack 150.2 Series, Sealed, Pull To Seat (GY)

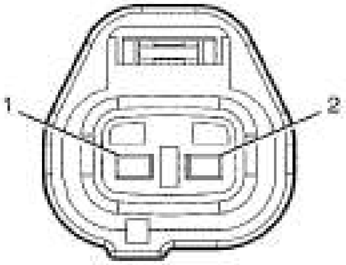
Terminal Part Information

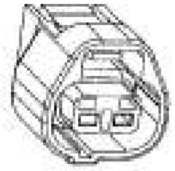
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

4-5 Shift Solenoid (SS) Valve

Pin	Wire Color	Circuit No.	Function
A	0.5 D-BU	1223	Shift Solenoid B Valve Control
B	0.5 WH	1525	Clutch Pressure Control Solenoid Valve 1 High Control

A/C Compressor





Connector Part Information

- OEM: 7283-8125-30
- Service: See Catalog
- Description: 2-Way F (BK)

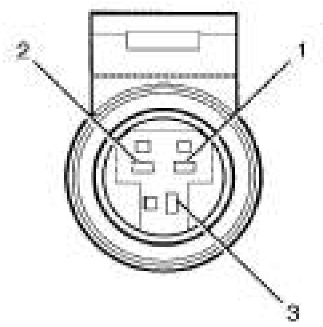
Terminal Part Information

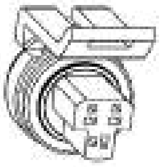
- Terminal/Tray: 7116-4025/11
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 15313892/J-35616-18 (BK)

A/C Compressor

Pin	Wire Color	Circuit No.	Function
1	0.5 D-BU	7393	A/C Compressor Clutch Low Reference
2	0.5 D-GN	7392	A/C Compressor Clutch Supply Voltage

A/C Refrigerant Pressure Sensor





Connector Part Information

- OEM: 7283-2429
- Service: See Catalog
- Description: 3-Way F (BK)

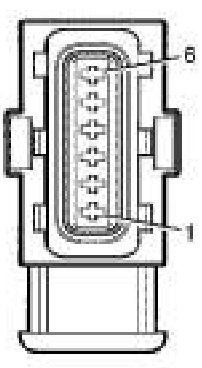
Terminal Part Information

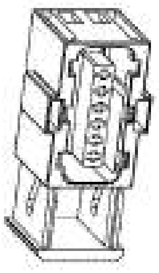
- Terminal/Tray: 15326267/19
- Core/Insulation Crimp: E/4
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

A/C Refrigerant Pressure Sensor

Pin	Wire Color	Circuit No.	Function
1	0.5 BN/GN	2759	Low Reference
2	0.5 GY	1688	5-Volt Reference
3	0.5 OG/BK	380	A/C Refrigerant Pressure Sensor Signal

Accelerator Pedal Position (APP) Sensor





Connector Part Information

- OEM: 7283-6463-30
- Service: See Catalog
- Description: 6-Way F (BK)

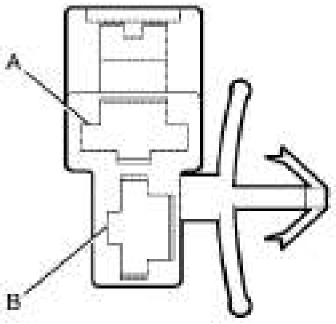
Terminal Part Information

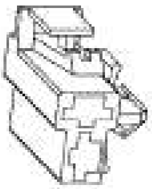
- Terminal/Tray: 4-964274-1/25
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: J-38125-560/J-35616-33 (YE)

Accelerator Pedal Position (APP) Sensor

Pin	Wire Color	Circuit No.	Function
1	0.5 BN/YE	1274	5-Volt Reference
2	0.5 WH/BK	1164	5-Volt Reference
3	0.5 D-BU/WH	1161	APP Sensor 1 Signal
4	0.5 BN	1271	Low Reference
5	0.5 PU	1272	Low Reference
6	0.5 L-BU	1162	APP Sensor 2 Signal

Accessory Power Outlet - Center Console Compartment





Connector Part Information

- OEM: 7123-5125-30
- Service: See Catalog
- Description: 2-Way F (BK)

Terminal Part Information

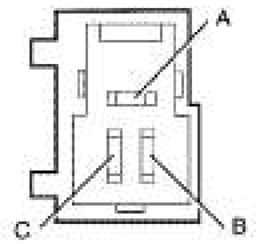
- Terminal/Tray: 7116-2641-02/12
- Core/Insulation Crimp: C/B

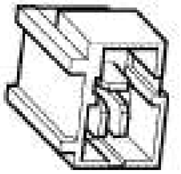
- Release Tool/Test Probe: 12094430/J-35616-42 (RD)

Accessory Power Outlet - Center Console Compartment

Pin	Wire Color	Circuit No.	Function
A	1.25 BN/WH	9301	Accessory Voltage
B	1.25 BK	2050	Ground

Accessory Power Outlet - I/P





Connector Part Information

- OEM: 7122-6030
- Service: See Catalog
- Description: 3-Way (BK)

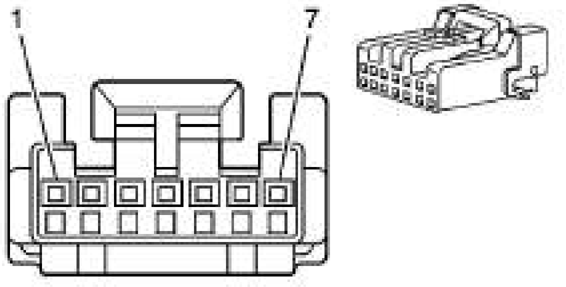
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Accessory Power Outlet - I/P

Pin	Wire Color	Circuit No.	Function
A	1.25 GY	8	Instrument Panel Lamp Supply Voltage
B	1.25 BN/WH	143	Accessory Voltage
C	1.25 BK	850	Ground

Air Temperature Actuator (C60)



Connector Part Information

- OEM: IL-AG5-7S-S3C1
- Service: See Catalog
- Description: 7-Way F (GN)

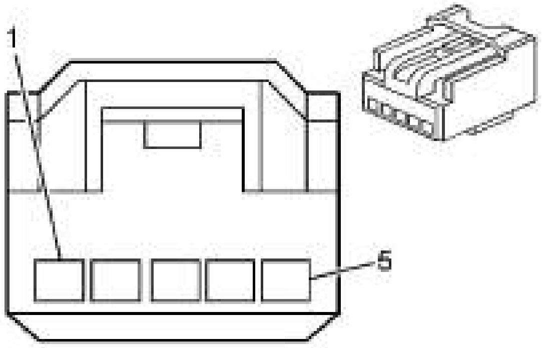
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Air Temperature Actuator (C60)

Pin	Wire Color	Circuit No.	Function
1	0.5 YE	598	5-Volt Reference
2	--	--	Not Used
3	0.5 GY	1791	Low Reference
4	--	--	Not Used
5	0.5 WH	733	Air Temperature Door Position Signal
6	0.5 D-BU/WH	5954	Air Temperature Motor Control
7	0.5 RD/WH	2210	Air Temperature Door Control

Air Temperature Actuator - Left



Connector Part Information

- OEM: 7283-5830-30
- Service: See Catalog
- Description: 5-Way F Yazaki (BK)

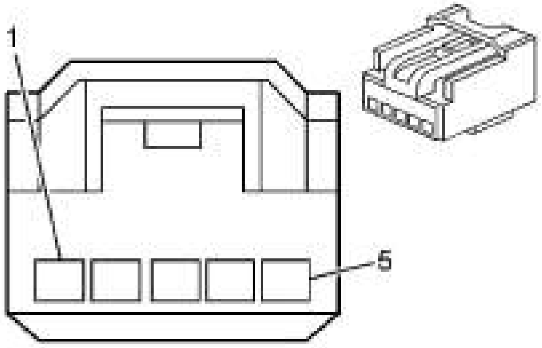
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Air Temperature Actuator - Left

Pin	Wire Color	Circuit No.	Function
1	0.3 WH	2778	Passenger Air Temperature Motor Control
2	0.3 YE	1236	Passenger Air Temperature Door Control
3	0.3 BK/RD	719	Low Reference
4	0.3 BK/YE	1646	Passenger Air Temperature Door Position Signal
5	0.3 BK/WH	598	5-Volt Reference

Air Temperature Actuator - Right



Connector Part Information

- OEM: 7283-5830-30
- Service: See Catalog
- Description: 5-Way F Yazaki (BK)

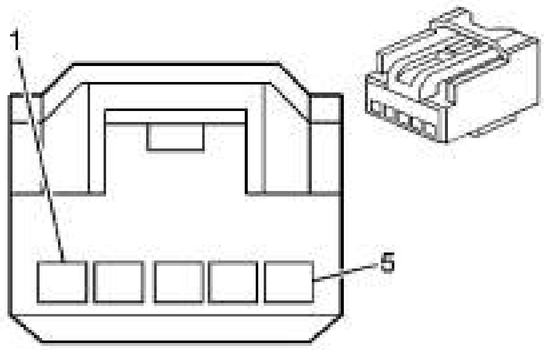
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Air Temperature Actuator - Right

Pin	Wire Color	Circuit No.	Function
1	0.3 D-BU/WH	2148	Passenger Temp B Signal
2	0.3 YE/BK	2147	Passenger Temp A Signal
3	0.3 BN/WH	476	Low Reference
4	0.3 YE/BU	2178	Passenger Temp D Signal
5	0.3 YE/RD	2149	Passenger Temp C Signal

Air Temperature Actuator - Auxiliary (C63)



Connector Part Information

- OEM: 7283-5830-30
- Service: See Catalog
- Description: 5-Way F Yazaki (BK)

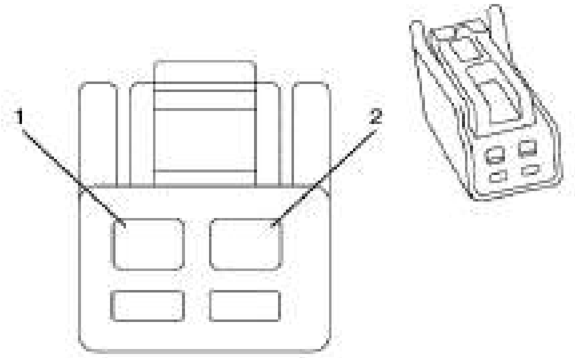
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Air Temperature Actuator - Auxiliary (C63)

Pin	Wire Color	Circuit No.	Function
1	0.3 L-GN/RD	5515	Inside Air Temperature Sensor Assembly Control
2	0.3 D-BU/OG	5516	Inside Air Temperature Sensor Assembly Control
3	0.3 RD/BK	552	Low Reference
4	0.3 PK/BK	5517	Low Reference
5	0.3 D-BU/GN	5518	Auxiliary Inside Air Temperature Sensor Signal

Air Temperature Sensor



Connector Part Information

- OEM: 7283-5845
- Service: See Catalog
- Description: 2-Way F 040-III (NA)

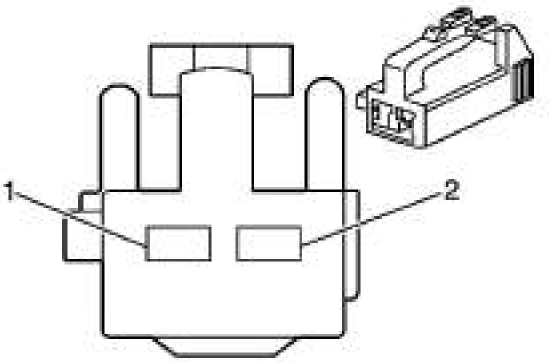
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Air Temperature Sensor

Pin	Wire Color	Circuit No.	Function
A	0.5 GY	1791	Low Reference
B	0.5 GY	1199	Air Temperature Door Control

Air Temperature Sensor - Inside



Connector Part Information

- OEM: 7123-1520
- Service: 88988450
- Description: 2-Way F 090 Series (NA)

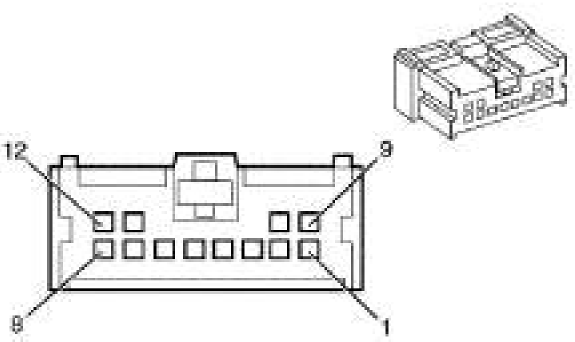
Terminal Part Information

- Terminal/Tray: 7116-1180/11
- Core/Insulation Crimp: C/E/C
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

Air Temperature Sensor - Inside

Pin	Wire Color	Circuit No.	Function
A	0.3 D-GN	734	Inside Ambient Temperature Sensor Low Reference
B	0.3 BN	61	Outside Air Temperature Sensor Signal

Alarm Module Connector



Connector Part Information

- OEM:

- Service: See Catalog
- Description: 12-Way F

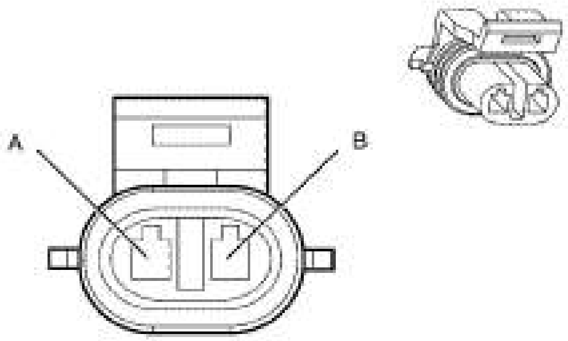
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Alarm Module Connector

Pin	Wire Color	Circuit No.	Function
1	0.35 BK		Battery Power
2	0.35 BK		Horn Signal Input
3	0.35 BK		Siren Battery Test Output
4	0.35 BK		Inclination Sensor Signal
5	0.35 BK		Siren Control Signal
6	0.35 BK		Ground
7	0.35 BK		Intrusion Sensor Signal
8	0.35 BK		Alarm System Status
9	0.35 BK		Alarm Control Module Power Control
10	--	--	Not Used
11	0.35 BK		Disable Signal
12	--	--	Not Used

Ambient Air Temperature Sensor



Connector Part Information

- OEM: 7223-9725-30
- Service: 88987920
- Description: 2-Way F (BK)

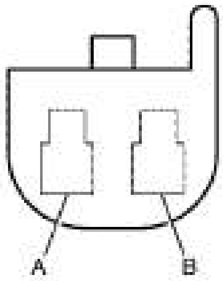
Terminal Part Information

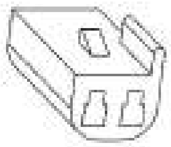
- Terminal/Tray: 12048074/2
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Ambient Air Temperature Sensor

Pin	Wire Color	Circuit No.	Function
A	0.3 BN	61	Low Reference
B	0.3 L-GN/BK	735	5-Volt Reference

Ambient Light Sensor (C60)





Connector Part Information

- OEM: 7123-8328-30
- Service: 12085535
- Description: 2-Way F (BK)

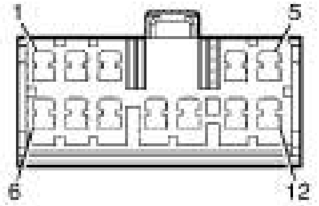
Terminal Part Information

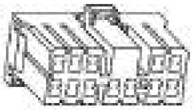
- Terminal/Tray: 12064971/5
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Ambient Light Sensor (C60)

Pin	Wire Color	Circuit No.	Function
A	0.3 L-GN/BK	1137	DRL Ambient Light Sensor Signal
B	0.3 BK	850	Ground

Audio Amplifier (UWP)





Connector Part Information

- OEM: 7123-1423
- Service: See Catalog
- Description: 12-Way F

Terminal Part Information

- Pins: 1, 2, 6, 7
- Terminal/Tray: 173630-7/7
- Core/Insulation Crimp: E/4
- Release Tool/Test Probe: 15315247/J-35616-33 (YE)

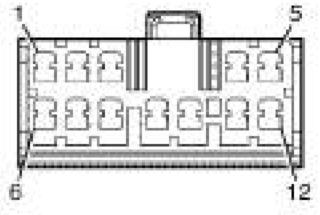
- Pins: 3-5, 8-12
- Terminal/Tray: 173630-7/7
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-33 (YE)

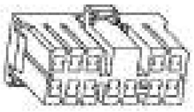
Audio Amplifier (UWP)

Pin	Wire Color	Circuit No.	Function
1	0.5 BN	199	Left Rear Speaker Output (+)
2	0.5 D-BU	46	Right Rear Speaker Output (+)
3	1.25 D-BU/WH	346	Left or Rear Subwoofer Speaker Output (+)
4	1.25 RD/WH	2040	Battery Positive Voltage (LHD)
	1.25 OG/WH	2040	Battery Positive Voltage (RHD)
5	1.25 BK	2050	Ground
6	0.5 YE	116	Left Rear Speaker Output (-) (LHD)
	0.5 YE/RD	116	Left Rear Speaker Output (-) (RHD)
7	0.5 L-BU	115	Right Rear Speaker Output (-)
8	1.25 L-GN/BK	1794	[Left or Rear] Subwoofer Speaker Output (-)
9	1.25 D-GN	1795	Right Subwoofer Speaker Output (+)
10	1.25 L-BU/BK	315	Right Subwoofer Speaker Output (-)
11	1.25 RD/WH	2040	Battery Positive Voltage
	1.25 OG/WH	2040	Battery Positive Voltage

12	1.25 BK	2050	Ground

Audio Amplifier X1 (UQ7 and LHD)





Connector Part Information

- OEM: 7123-1423
- Service: See Catalog
- Description: 12-Way F

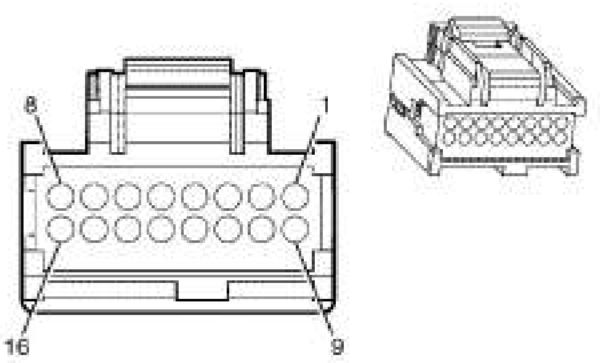
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Audio Amplifier X1 (UQ7 and LHD)

Pin	Wire Color	Circuit No.	Function
1	0.5 BN	--	Left Rear Speaker Output (+)
2	0.5 D-BU	--	Right Rear Speaker Output (+)
3	1 D-BU/WH	--	Left or Rear Subwoofer Speaker Output (+)
4	2 RD/WH	--	Battery Positive Voltage
5	2 BK	--	Ground
6	0.5 YE	--	Left Rear Speaker Output (-)
7	0.5 L-BU	--	Right Rear Speaker Output (-)
8	1 L-GN/BK	--	Subwoofer Speaker Output (-)
9	1 D-GN	--	Right Subwoofer Speaker Output (+)
10	1 L-BU/BK	--	Right Subwoofer Speaker Output (-)
11	2 RD/WH	--	Battery Positive Voltage
12	2 BK	--	Ground

Audio Amplifier X1 (UQ7 and RHD)



Connector Part Information

- OEM: 15394150
- Service: See Catalog
- Description: 16-Way F (BK)

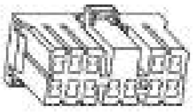
Terminal Part Information

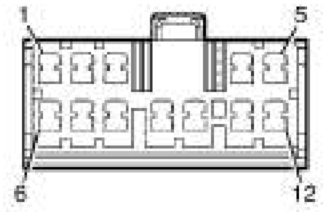
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Audio Amplifier X1 (UQ7 and RHD)

Pin	Wire Color	Circuit No.	Function
1-3	--	--	Not Used
4	0.3 BN/BU	1946	Right Rear Low Level Audio Signal (-)
5	0.3 BN	1999	Left Rear Low Level Audio Signal (-)
6	0.3 L-GN	1948	Right Front Low Level Audio Signal (-)
7	0.3 D-GN	1947	Left Front Low Level Audio Signal (-)
8	0.3 WH	7066	Amplifier Enable Signal
9-10	--	--	Not Used
11	0.3 OG	6978	Amplifier Mute Control
12	0.3 D-BU	546	Right Rear Low Level Audio Signal (+)
13	0.3 BN/WH	599	Left Rear Low Level Audio Signal (+)
14	0.3 L-GN/WH	512	Right Front Low Level Audio Signal (+)
15	0.3 BN/OG	511	Left Front Low Level Audio Signal (+)
16	--	--	Not Used

Audio Amplifier X2 (UQ7 and LHD)





Connector Part Information

- OEM: 7123-1423
- Service: See Catalog
- Description: 12-Way F

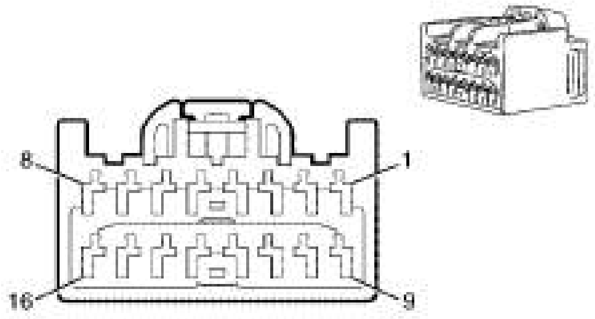
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Audio Amplifier X2 (UQ7 and LHD)

Pin	Wire Color	Circuit No.	Function
1	0.5 BN	--	Left Rear Speaker Output (+)
2	0.5 D-BU	--	Right Rear Speaker Output (+)
3	1 D-BU/WH	--	Rear Subwoofer Speaker Output (+)
4	2 RD/WH	--	Battery Positive Voltage
5	2 BK	--	Ground
6	0.5 YE	--	Left Rear Speaker Output (-)
7	0.5 L-BU	--	Right Rear Speaker Output (-)
8	1 L-GN/BK	--	Subwoofer Speaker Output (-)
9	1 D-GN	--	Right Subwoofer Speaker Output (+)
10	1 L-BU/BK	--	Right Subwoofer Speaker Output (-)
11	2 RD/WH	--	Battery Positive Voltage
12	2 BK	--	Ground

Audio Amplifier X2 (UQ7 and RHD)



Connector Part Information

- OEM: 7283-5534-60
- Service: See Catalog
- Description: 16-Way F

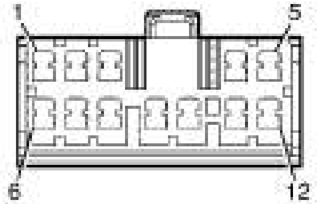
Terminal Part Information

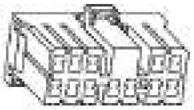
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Audio Amplifier X2 (UQ7 and RHD)

Pin	Wire Color	Circuit No.	Function
1	0.85 L-BU	115	Right Rear Speaker Output (-)
2	0.85 D-BU	46	Right Rear Speaker Output (+)
3	0.85 L-BU	1960	Front Center Speaker Output (-)
4	0.85 YE	1860	Front Center Speaker Output (+)
5	0.5 OG/BK	5766	Front Center Speaker Output (+)
6	0.5 OG	5756	Roof Center Speaker Output (-)
7	0.85 D-GN	117	Right Front Speaker Output (-)
8	0.85 L-GN	200	Right Front Speaker Output (+)
9-14	--	--	Not Used
15	0.85 BN	199	Left Front Speaker Output (-)
16	0.85 YE/RD	116	Left Front Speaker Output (+)

Audio Amplifier X3 (LHD and UQ7)





Connector Part Information

- OEM: 7123-1423
- Service: See Catalog
- Description: 12-Way F

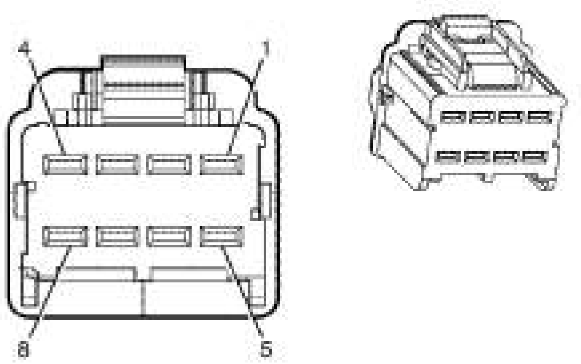
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Audio Amplifier X3 (LHD and UQ7)

Pin	Wire Color	Circuit No.	Function
1	0.5 BN	--	Left Rear Speaker Output (+)
2	0.5 D-BU	--	Right Rear Speaker Output (+)
3	1 D-BU/WH	--	Left or Rear Subwoofer Speaker Output (+)
4	2 RD/WH	--	Battery Positive Voltage
5	2 BK	--	Ground
6	0.5 YE	--	Left Rear Speaker Output (-)
7	0.5 L-BU	--	Right Rear Speaker Output (-)
8	1 L-GN/BK	--	Subwoofer Speaker Output (-)
9	1 D-GN	--	Right Subwoofer Speaker Output (+)
10	1 L-BU/BK	--	Right Subwoofer Speaker Output (-)
11	2 RD/WH	--	Battery Positive Voltage
12	2 BK	--	Ground

Audio Amplifier X3 (RHD and UQ7)



Connector Part Information

- OEM: 6098-4713
- Service: See Catalog
- Description: 8-Way F (BK)

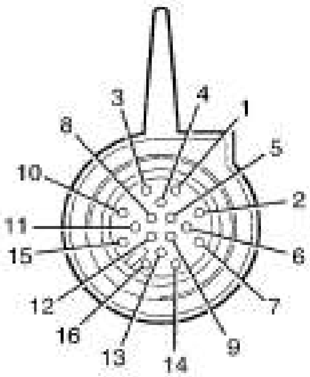
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Audio Amplifier X3 (RHD and UQ7)

Pin	Wire Color	Circuit No.	Function
1	0.85 GY	118	Left Front Speaker Output (-)
2	1.25 L-BU/BK	315	Right Subwoofer Speaker Output (-)
3	1.25 L-GN/BK	1794	Left Subwoofer Speaker Output (-)
4	3 OG/WH	2040	Battery Positive Voltage
5	0.85 TN	201	Left Front Speaker Output (+)
6	1.25 D-GN	1795	Right Subwoofer Speaker Output (+)
7	1.25 D-BU/WH	346	Left Subwoofer Speaker Output (+)
8	3 BK	351	Ground

Automatic Transmission (MYC)



Connector Part Information

- OEM: 7229-4189-30
- Service: See Catalog
- Description: 16-Way F

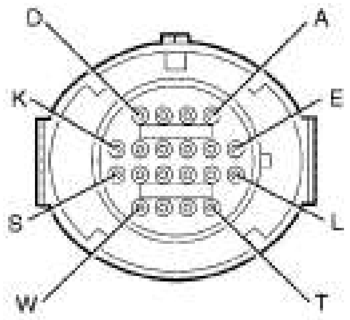
Terminal Part Information

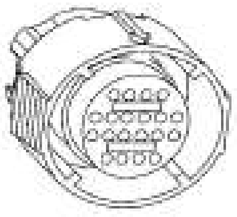
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Automatic Transmission (MYC)

Pin	Wire Color	Circuit No.	Function
1	0.75 OG/YE	3640	Battery Positive Voltage
2	0.75 BK	450	Ground
3	0.5 OG/BK	1786	Park/Neutral Signal
4	0.75 OG/YE	3640	Battery Positive Voltage
5	0.75 BK	450	Ground
6	0.5 WH/BU	17	Stop Lamp Switch Signal
7-8	--	--	Not Used
9	0.5 D-BU	5985	Accessory Wakeup Serial Data
10	0.5 BN/BK	9002	High Speed GMLAN Serial Data Bus+
11	0.5 BN	9003	High Speed GMLAN Serial Data Bus-
12	0.5 PK	439	Ignition 1 Voltage
13	0.5 BN	9001	High Speed GMLAN Serial Data Bus-
14	0.5 BN/BK	9000	High Speed GMLAN Serial Data Bus+
15-16	--	--	Not Used

Automatic Transmission (M30 or M32)





Connector Part Information

- OEM: 15463921
- Service: See Cataolg
- Description: 20-Way F (BK)

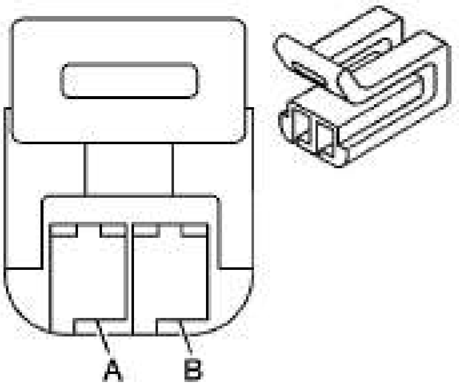
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Automatic Transmission (M30 or M32)

Pin	Wire Color	Circuit No.	Function
A	0.5 L-GN	1222	Shift Solenoid A Valve Control
B	0.5 YE/BK	1223	Shift Solenoid B Valve Control
C	0.5 OG/BK	1228	PC Solenoid Valve High Control
D	0.5 L-BU/WH	1229	PC Solenoid Valve Low Control
E	0.5 PK	439	Ignition 1 Voltage
F-J	--	--	Not Used
K	0.5 OG	1983	Transmission Turbine Speed Switch Signal
L	0.5 YE/BK	1227	TFT Sensor Signal
M	0.5 TN	2762	Low Reference
N	0.5 PK	1224	Transmission Fluid Pressure Switch Signal A
P	0.5 OG	1226	Transmission Fluid Pressure Switch Signal B
R	0.5 D-BU	1225	Transmission Fluid Pressure Switch Signal C
S	0.5 WH/GN	687	3-2 Shift Solenoid Valve Control
T	0.5 BN/OG	422	TCC Solenoid Valve Control
U	0.5 BN	418	TCC PWM Solenoid Valve Control
V	0.5 L-BU	1984	Transmission Turbine Speed Switch Low Reference
W	--	--	Not Used

Automatic Transmission Input Shaft Speed (ISS) Sensor



Connector Part Information

- OEM: 10768934
- Service: See Catalog
- Description: 2-Way F (BK)

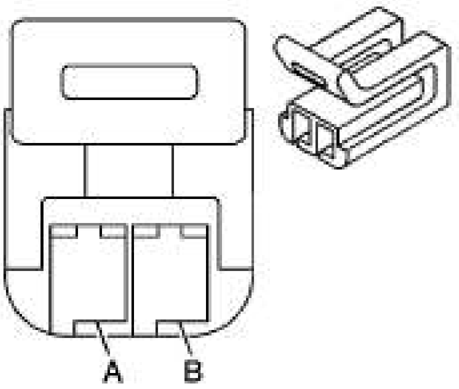
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Automatic Transmission Input Shaft Speed (ISS) Sensor

Pin	Wire Color	Circuit No.	Function
A	0.5 YE	1983	Transmission Turbine Speed Switch Signal
B	0.5 WH	1984	Transmission Turbine Speed Switch Low Reference

Automatic Transmission Output Shaft Speed (OSS) Sensor



Connector Part Information

- OEM: 12162201
- Service: See Catalog
- Description: 2-Way F Metri-Pack 150.2 Series, Pull To Seat (BK)

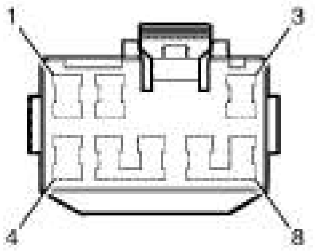
Terminal Part Information

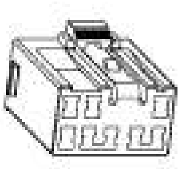
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Automatic Transmission Output Shaft Speed (OSS) Sensor

Pin	Wire Color	Circuit No.	Function
A	0.5 OG	822	VSS Low Signal
B	0.5 WH	821	VSS High Signal

Automatic Transmission Shift Lever





Connector Part Information

- OEM: 7283-7087
- Service: See Catalog
- Description: 8-Way F (BK)

Terminal Part Information

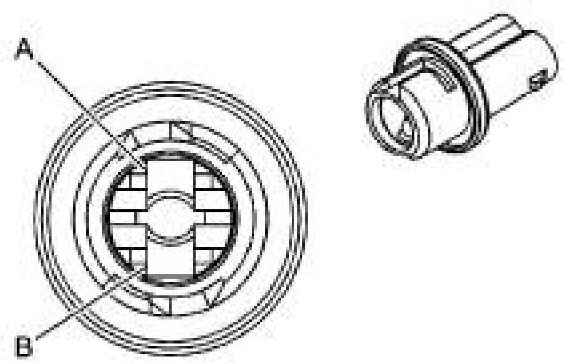
- Terminal/Tray: 7116-4020/11
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

Automatic Transmission Shift Lever

Pin	Wire Color	Circuit No.	Function
1	0.3 PU	1375	Transmission Cruise Switch Reference
2	0.3 D-GN/WH	1135	A/T Shift Lock Control Solenoid Supply Voltage
3	0.3 BK	850	Ground
4	0.3 PU/RD	5526	Transmission Range Select Reference

5	--	--	Not Used
6	0.3 PU/WH	1630	Steering Column Key Cylinder Lock Solenoid Control
7	--	--	Not Used
8	0.3 PU/WH	6817	LED Backlight Diming Control

Backup Lamp - Left



Connector Part Information

- OEM: 15317651
- Service: See Catalog
- Description: 2-Way F Bulb Socket (WH)

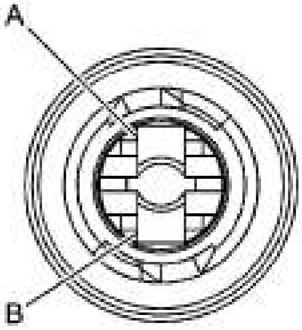
Terminal Part Information

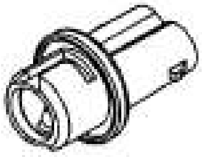
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Backup Lamp - Left

Pin	Wire Color	Circuit No.	Function
1	0.85 L-GN	--	Backup Lamp Supply Voltage
2	0.85 BK	--	Ground

Backup Lamp - Right





Connector Part Information

- OEM: 15317651
- Service: See Catalog
- Description: 2-Way F Bulb Socket (WH)

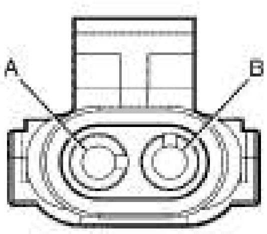
Terminal Part Information

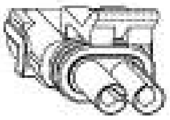
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Backup Lamp - Right

Pin	Wire Color	Circuit No.	Function
1	0.85 L-GN	--	Backup Lamp Supply Voltage
2	0.85 BK	--	Ground

Backup Lamp Switch (M10 or MV5)





Connector Part Information

- OEM: 7282-7420-40

- Service: See Catalog
- Description: 2-way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Backup Lamp Switch (M10 or MV5)

Pin	Wire Color	Circuit No.	Function
A	0.5 L-GN	5007	Backup Lamp Switch Signal
B	0.5 BK	450	Ground

Battery (-)

Terminal Part Information

- Terminal: 7306-2055-03
- Core/Insulation Crimp: N/A
- Description: Battery Terminal

Battery (-)

Pin	Wire Color	Circuit No.	Function
-	50 BK	50	Ground

Battery (+)

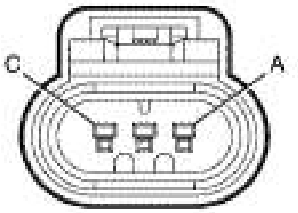
Terminal Part Information

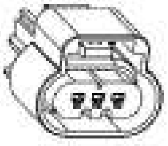
- Terminal: 7306-3053-06
- Core/Insulation Crimp: N/A
- Description: Battery Terminal

Battery (+)

Pin	Wire Color	Circuit No.	Function
+	50 RD	1	Battery Positive

Battery Current Sensor





Connector Part Information

- OEM: 7283-6579-30
- Service: See Catalog
- Description: 3-Way F (BK)

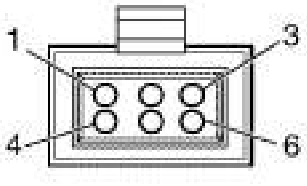
Terminal Part Information

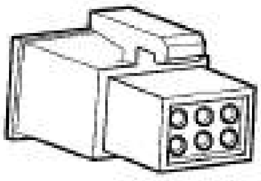
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Battery Current Sensor

Pin	Wire Color	Circuit No.	Function
A	0.3 PK	5076	5-Volt Reference
B	0.3 BN	5077	Low Reference
C	0.3 WH/GN	5075	Battery Current Signal

Battery Voltage Gauge





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 6-Way F

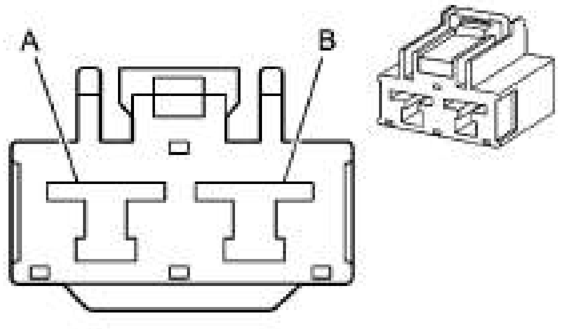
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Battery Voltage Gauge

Pin	Wire Color	Circuit No.	Function
1	0.3 YE		Low Speed GMLAN Serial Data
2	0.3 D-BU		Ground
3	0.3 D-BU/RD		Battery Positive Voltage
4	0.3 YE		Low Speed GMLAN Serial Data
5	0.3 D-BU		Ground
6	0.3 D-BU/RD		Battery Positive Voltage

Blower Motor (LHD)



Connector Part Information

- OEM: 7283-3123
- Service: See Catalog
- Description: 2-Way F (WH)

Terminal Part Information

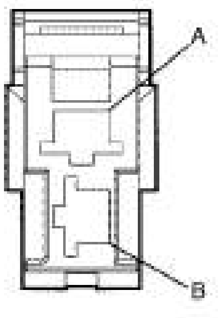
- Terminal/Tray: 7116-6041/11
- Core/Insulation Crimp: A/B
- Release Tool/Test Probe: 12094430/J-35616-44 (YE)

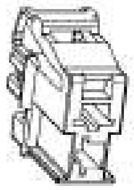
Blower Motor (LHD)

Pin	Wire Color	Circuit No.	Function

A	3 OG	5987	Ground
B	3 PU	65	Blower Motor Supply Voltage

Blower Motor (RHD)





Connector Part Information

- OEM:7123-6020
- Service: See Cataolg
- Description: 2-Way F

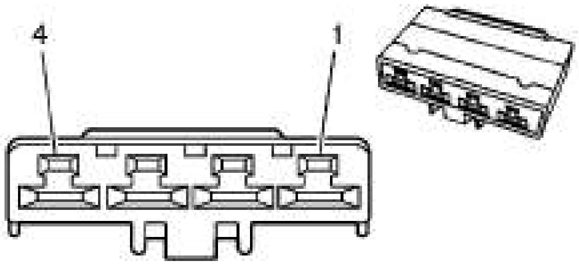
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Blower Motor (RHD)

Pin	Wire Color	Circuit No.	Function
A	3 D-GN	442	Battery Positive Voltage
B	3 OG	5987	HVAC Blower Motor Control Circuit

Blower Motor Control Module



Connector Part Information

- OEM: 7283-3141-30
- Service: See Catalog
- Description: 4-Way F (BK)

Terminal Part Information

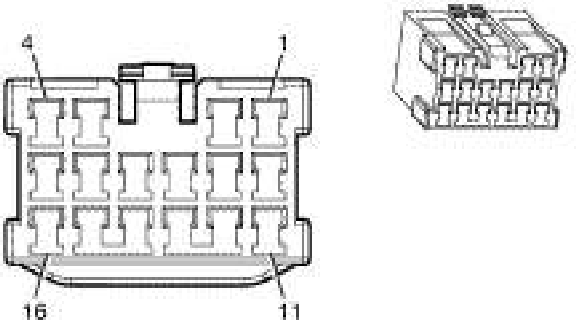
- Pins: 1, 3, 4
- Terminal/Tray: 7116-6041/11
- Core/Insulation Crimp: A/B
- Release Tool/Test Probe: 12094430/J-35616-44 (YE)

- Pin: 2
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Blower Motor Control Module

Pin	Wire Color	Circuit No.	Function
1	3 BK	850	Ground
2	0.5 GY/BK	754	Blower Motor Speed Control
3	3 PU	65	Blower Motor Supply Voltage
4	3 OG	5987	Blower Motor Low Reference

Bluetooth Connector



Connector Part Information

- OEM: 1318386
- Service: See Catalog
- Description: 16-Way F

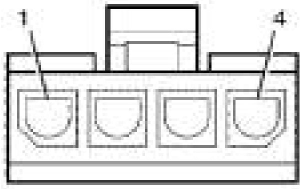
Terminal Part Information

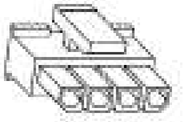
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Bluetooth Connector

Pin	Wire Color	Circuit No.	Function
1	0.5 OG/WH		Battery Positive Voltage
2	0.5 PK/BU		Ignition 1 Voltage
3	0.5 L-GN		Backup Lamp Supply Voltage
4	0.3 D-GN		Low Speed GMLAN Serial Data
5	0.3 BN		Accessory Voltage
6	0.3 D-BU		Bluetooth Connector
7	0.3 OG/BK		Remote Playback Device Left Audio Signal
8	0.3 L-BU		Remote Playback Device Audio Common Signal
9	0.3 WH		Mute Signal
10	0.3 BK		Ground
11	0.3 D-BU		Cellular Telephone Voice Signal
12	0.3 L-BU/BK		Cellular Telephone Voice Low Reference
13	0.3 YE/BK		Cellular Telephone Mute Signal
14	0.5 GY		Left Front Speaker Output (-)
	0.85 L-BU		Front Center Speaker Output (-)
15	0.5 TN		Left Front Speaker Output (+)
	0.85 YE		Front Center Speaker Output (+)
16	--	--	Not Used

Bluetooth Microphone





Connector Part Information

- OEM: 4365-0400
- Service: See Catalog
- Description: 4-Way

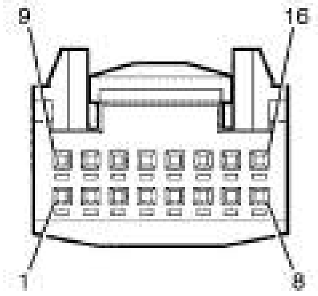
Terminal Part Information

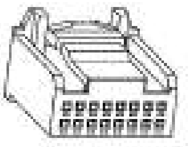
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Bluetooth Microphone

Pin	Wire Color	Circuit No.	Function
1	0.3 D-BU	7043	Microphone Signal
2-3	--	--	Not Used
4	0.3 PK/BK	7044	Microphone Return

Bluetooth Module





Connector Part Information

- OEM: 1318386-1
- Service: See Catalog
- Description: 16-Way F

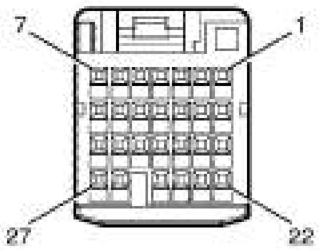
Terminal Part Information

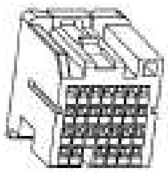
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Bluetooth Module

Pin	Wire Color	Circuit No.	Function
1	0.3 L-BU/BK	659	Cellular Telephone Voice Low Reference
2-3	--	--	Not Used
4	0.3 D-BU	7148	Not Used
5	0.3 D-BU	7043	Microphone Signal
6	0.3 YE/BK	693	Cellular Telephone Mute Signal
7	0.3 YE	443	Accessory Voltage
8	--	--	Not Used
9	0.3 D-BU	658	Cellular Telephone Voice Signal
10-11	--	--	Not Used
12	0.3 PK/BK	7044	Microphone Return
13-14	--	--	Not Used
15	0.5 BK	1050	Ground
16	0.5 OG/WH	2340	Battery Positive Voltage

Body Control Module (BCM) X1





Connector Part Information

- OEM: 7283-9177-60
- Service: See Catalog
- Description: 27-Way F (GN)

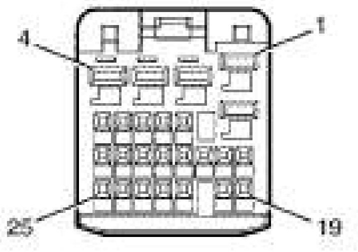
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Body Control Module (BCM) X1

Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used
2	0.3 WH	1390	Ignition Key Resistor Low Reference
3	0.5 GY	1884	Cruise Control Switch Signal
4	0.3 WH/BK	1073	Ignition Key Resistor Signal
5	0.3 L-GN	1715	Windshield Wiper Switch High Signal
6-7	--	--	Not Used
8	0.3 BK/WH	1251	Wiper Switch Low Reference
9	0.3 L-BU	1714	Windshield Wiper Switch Low Signal
10-13	--	--	Not Used
14	0.3 PK	3	Run/Crank Voltage
15	0.3 L-BU/WH	1414	Left Turn Signal Switch Signal
16	0.3 D-BU/WH	1415	Right Turn Signal Switch Signal
17	0.3 PU	1375	Remote Radio Control Supply Voltage
18	PU/YE	524	Headlamp Dimmer Switch High Beam Signal
19	--	--	Not Used
20	0.3 PU/RD	5526	Transmission Electronic Range Select Signal
21	0.3 BN	4	Ignition 1 Voltage
22	--	--	Not Used
23	0.5 YE	5356	Left Tail Lamp Monitoring (HSV)
24	0.3 OG	94	Windshield Washer Switch Signal
25	0.3 BN/RD	1356	Flash To Pass Switch Signal
26-27	--	--	Not Used

Body Control Module (BCM) X2



Connector Part Information

- OEM: 7283-1373
- Service: See Catalog
- Description: 25-Way F (WH)

Terminal Part Information

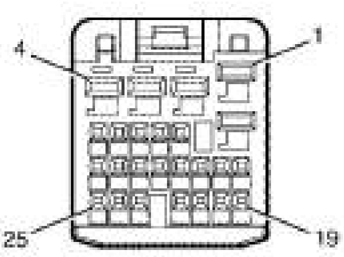
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Body Control Module (BCM) X2

Pin	Wire Color	Circuit No.	Function
1	0.85 OG	1732	Inadvertent Power Supply Voltage
2	0.85 OG/BU	1240	Battery Positive Voltage
3	0.85 GY	8	Instrument Panel Lamp Supply Voltage
4	--	--	Not Used
5	0.85 D-BU/WH	149	Courtesy Lamp Supply Voltage
6-7	--	--	Not Used
8	0.3 BN/WH	301	Park Lamp Switch On Signal
9	--	--	Not Used
10	0.3 D-BU	6189	Rear Compartment Relay Switch
11	0.3 L-GN/BK	1137	DRL Ambient Light Sensor Signal
12	0.3 WH	103	Headlamp Switch Headlamps On Signal
13-16	--	--	Not Used
17	0.3 D-GN	306	Headlamp Switch Headlamps Off Signal
18	0.3 PK/BK	1597	Courtesy Lamps Switch Signal
19	--	--	Not Used
20	0.5 L-BU	553	Tow/Haul Switch Signal
21	0.3 BN/OG	1571	Traction Control Switch Signal
22	0.3 D-GN/WH	1135	A/T Shift Lock Control Solenoid Supply Voltage
23-24	--	--	Not Used

25	0.3 PU	328	Interior Lamp Switch Signal

Body Control Module (BCM) X3



Connector Part Information

- OEM: 7283-1374-90
- Service: See Catalog
- Description: 25-Way F (BU)

Terminal Part Information

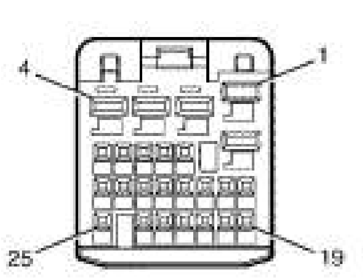
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Body Control Module (BCM) X3

Pin	Wire Color	Circuit No.	Function
1	0.85 BK	850	Ground
2	0.85 OG/YE	1640	Battery Positive Voltage
3	0.85 OG/RD	2740	Battery Positive Voltage
4	--	--	Not Used
5	0.85 BK	850	Ground
6	--	--	Not Used
7	0.3 GY	728	Security Indicator Control
8	0.5 BN/BK	9004	High Speed GMLAN Serial Data Bus+
9	0.5 BN	9005	High Speed GMLAN Serial Data Bus-
10	D-GN	9208	Low Speed GMLAN Serial Data
11-12	--	--	Not Used
13	0.5 L-GN	526	Stop Lamp Switch Signal
14	0.5 BN/RD	552	Low Reference
15	0.5 GY	598	5-Volt Reference

16	0.5 BN/BK	9006	High Speed GMLAN Serial Data Bus+
17	0.5 BN	9007	High Speed GMLAN Serial Data Bus-
18	0.3 YE	6817	LED Backlight Dimming Control
19	0.3 PU/WH	5727	Communication Enable Relay Control
20	--	--	Not Used
21	0.3 OG	192	Fog Lamp Switch
22-24	--	--	Not Used
25	0.3 PU/WH	6816	RPA Switch LED Backlight Dimming Control

Body Control Module (BCM) X4



Connector Part Information

- OEM: 7283-1375-30
- Service: See Catalog
- Description: 25-Way F (BK)

Terminal Part Information

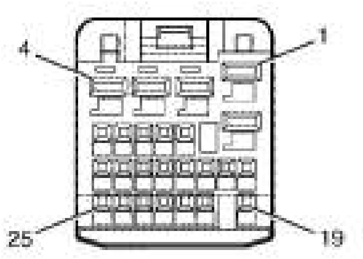
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

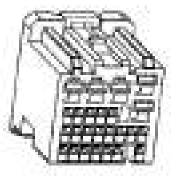
Body Control Module (BCM) X4

Pin	Wire Color	Circuit No.	Function
1	0.85 OG/RD	340	Battery Positive Voltage
2	0.85 OG	240	Battery Positive Voltage
3	0.85 OG/PU	440	Battery Positive Voltage
4	0.85 OG/PU	2140	Battery Positive Voltage
5	0.75 D-BU/WH	1315	Right Front Turn Signal Lamp Supply Voltage
6	--	--	Not Used
7	0.3 YE	196	Windshield Wiper Motor Park Switch Signal

8	--	--	Not Used
9	0.3 BK	1850	Ground
10	0.3 OG/BU	2440	Battery Positive Voltage
11	0.3 D-GN/WH	1317	Fog Lamp Relay Control
12-13	--	--	Not Used
14	0.5 OG	482	Outside Moisture Sensor Signal 2
15	0.5 OG	2268	Washer Fluid Pump Relay Control
16	0.3 BN/YE	1969	Headlamp High Beam Relay Control
17	0.3 PK/BK	109	Hood Ajar Switch Signal
18	0.3 BN	481	Outside Moisture Sensor Signal 1
19	0.3 D-BU	5985	Accessory Wakeup Serial Data
20	--	--	Not Used
21	0.3 PK	1439	Run/Crank Control
22	0.3 BN	253	Trunk Release Relay Control
23	--	--	Not Used
24	0.3 D-GN	646	Backup Lamp Relay Control
25	--	--	Not Used

Body Control Module (BCM) X5





Connector Part Information

- OEM: 7283-1377-80
- Service: See Catalog
- Description: 25-Way F (BN)

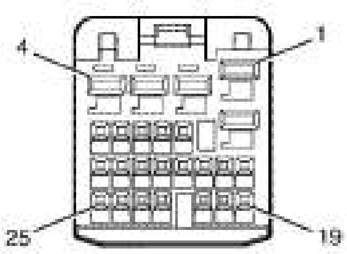
Terminal Part Information

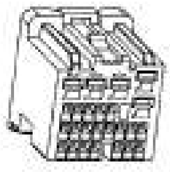
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Body Control Module (BCM) X5

Pin	Wire Color	Circuit No.	Function
1	0.85 YE/BK	1334	Left Rear Turn Signal Lamp Supply Voltage
2	0.85 D-GN/WH	1335	Right Rear Turn Signal Lamp Supply Voltage
3	--	--	Not Used
4	0.75 L-BU/WH	1314	Left Front Turn Signal Lamp Supply
5	0.85 BN	5998	Puddle Lamp Supply Voltage
6	0.5 WH/BU	17	Stop Lamp Switch Signal
7	--	--	Not Used
8	0.3 PK	5076	5-Volt Reference
9	0.3 WH/GN	5075	Battery Current Signal
10	0.3 BN	5077	Low Reference
11	0.3 BN/YE	707	RAP Relay Coil Supply Voltage
12-13	--	--	Not Used
14	0.3 YE	43	Accessory Power Relay Control
15	0.3 PU	5531	Hood Closed Switch Signal
16	0.5 OG/BK	233	Park Brake Switch Signal
17	0.5 PU	5357	Right Tail Lamp Monitoring (HSV)
18	0.3 BN/BK	28	Horn Relay Control
19	--	--	Not Used
20	0.3 GY	91	Windshield Wiper Switch Signal 2
21	0.3 BN/RD	860	Front Windshield Wiper Switch High Signal
22	--	--	Not Used
23	0.3 PK/WH	1970	Headlamp Low Beam Relay Control
24	0.3 WH/YE	1080	Park Lamp Relay Control
25	--	--	Not Used

Body Control Module (BCM) X6





Connector Part Information

- OEM: 7283-1376-50
- Service: See Catalog
- Description: 25-Way F (PK)

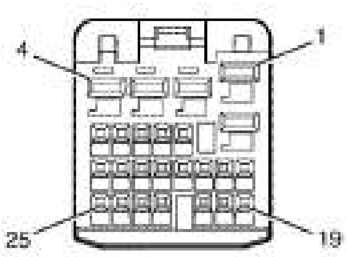
Terminal Part Information

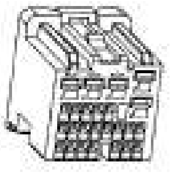
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Body Control Module (BCM) X6

Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used
2	1.25 L-BU	20	Stop Lamp Supply Voltage
3-7	--	--	Not Used
8	0.3 BN/WH	746	Passenger Front Door Ajar Switch Signal
9	--	--	Not Used
10	0.3 GY/BK	745	Driver Door Ajar Switch Signal
11-19	--	--	Not Used
20	0.3 PK	781	Driver Door Lock Switch Unlock Signal
21	--	--	Not Used
22	0.3 OG/BK	744	Liftgate Ajar Switch Signal
23	0.3 PK/BK	780	Driver Door Lock Switch Lock Signal
24-25	--	--	Not Used

Body Control Module (BCM) X7





Connector Part Information

- OEM: 7283-1376-50
- Service: See Catalog

- Description: 25-Way F (GY)

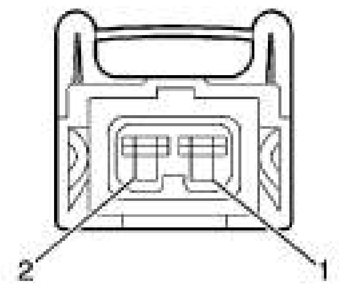
Terminal Part Information

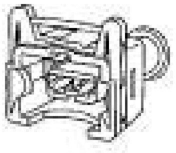
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Body Control Module (BCM) X7

Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used
2	0.3 WH	2282	Headlamp Washer Relay Control
3-5	--	--	Not Used
6	0.3 L-BU	5921	Door Unlock Supply Voltage
7	0.3 D-BU/WH	195	Door Lock Control
8	--	--	Not Used
9	0.3 WH	194	Door Unlock Control
10	0.3 GY/BU	7388	Headlamp Dimming Switch Up
11	0.3 BN/BK	254	Power Door Unlock Fuse Supply Voltage
12	0.3 GY/BK	255	Power Door Lock Fuse Supply Voltage
13-15	--	--	Not Used
16	0.35 L-BU	187	Fog Lamp Switch - Output - Rear
17-23	--	--	Not Used
24	0.3 GY/WH	7389	Headlamp Dimming Switch Down
25-28	--	--	Not Used

Brake Fluid Level Switch





Connector Part Information

- OEM: 7219-5226-30
- Service: See Catalog

- Description: 2-Way F (BK)

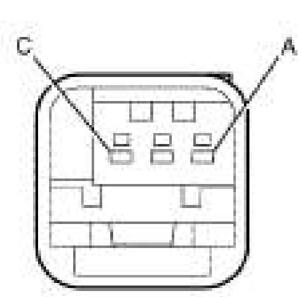
Terminal Part Information

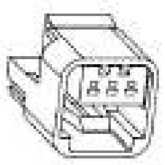
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Brake Fluid Level Switch

Pin	Wire Color	Circuit No.	Function
1	0.3 BN/WH	33	Brake Warning Indicator Control
2	0.3 BK	350	Ground

Brake Pedal Position (BPP) Sensor





Connector Part Information

- OEM: 7283-2525-30
- Service: 88953364
- Description: 3-Way F (BK)

Terminal Part Information

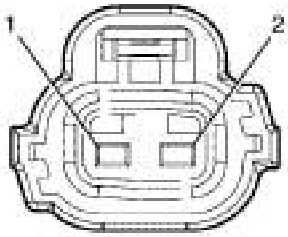
- Terminal/Tray: 12191812/19
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

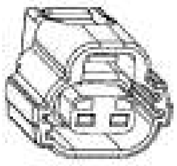
Brake Pedal Position (BPP) Sensor

Pin	Wire Color	Circuit No.	Function
A	0.5 GY	598	5-Volt Reference
B	0.5 L-GN	526	Stop Lamp Switch Signal
C	0.5 BN/RD	552	Low Reference

Camshaft Position (CMP) Actuator Solenoid Valve - Bank 1

Exhaust (LY7)





Connector Part Information

- OEM: 7283-7526-30
- Service: 88988588
- Description: 2-Way F Sealed (BK)

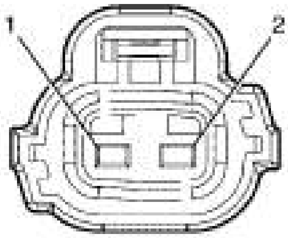
Terminal Part Information

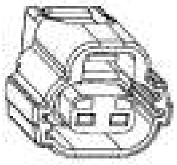
- Terminal/Tray: 7116-4026/11
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 15313892/J-35616-18 (BK)

Camshaft Position (CMP) Actuator Solenoid Valve - Bank 1 Exhaust (LY7)

Pin	Wire Color	Circuit No.	Function
1	0.75 PK/BU	5293	Ignition 1 Voltage
2	0.75 L-GN	5282	CMP Actuator Solenoid Control - Exhaust Bank 1

Camshaft Position (CMP) Actuator Solenoid Valve - Bank 1 Intake (LY7)





Connector Part Information

- OEM: 7283-7526-30
- Service: 88988588
- Description: 2-Way F Sealed (BK)

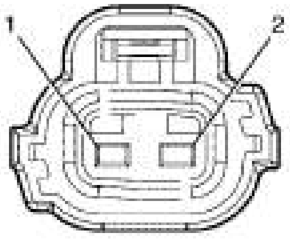
Terminal Part Information

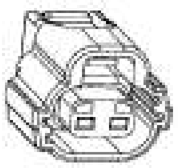
- Terminal/Tray: 7116-4026/11
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 15313892/J-35616-18 (BK)

Camshaft Position (CMP) Actuator Solenoid Valve - Bank 1 Intake (LY7)

Pin	Wire Color	Circuit No.	Function
1	0.75 PK/BU	5293	Ignition 1 Voltage
2	0.75 PU	5284	CMP Actuator Solenoid Control - Intake Bank 1

Camshaft Position (CMP) Actuator Solenoid Valve - Bank 2 Exhaust (LY7)





Connector Part Information

- OEM: 7283-7526-30
- Service: 88988588
- Description: 2-Way F Sealed (BK)

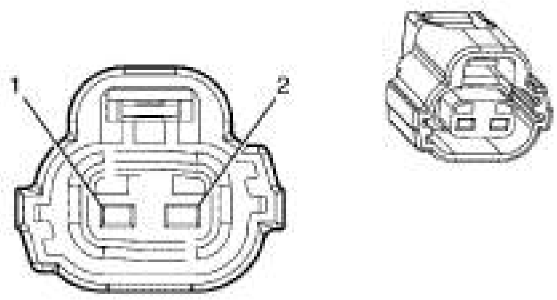
Terminal Part Information

- Terminal/Tray: 7116-4026/11
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 15313892/J-35616-18 (BK)

Camshaft Position (CMP) Actuator Solenoid Valve - Bank 2 Exhaust (LY7)

Pin	Wire Color	Circuit No.	Function
1	0.75 PK/BU	5293	Ignition 1 Voltage
2	0.75 WH/BK	5283	CMP Actuator Solenoid Control - Exhaust Bank 2

Camshaft Position (CMP) Actuator Solenoid Valve - Bank 2 Intake (LY7)



Connector Part Information

- OEM: 7283-7526-30
- Service: 88988588
- Description: 2-Way F Sealed (BK)

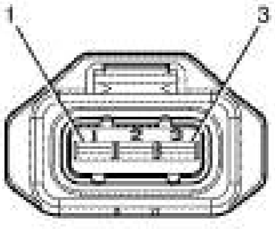
Terminal Part Information

- Terminal/Tray: 7116-4026/11
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 15313892/J-35616-18 (BK)

Camshaft Position (CMP) Actuator Solenoid Valve - Bank 2 Intake (LY7)

Pin	Wire Color	Circuit No.	Function
1	0.75 PK/BU	5293	Ignition 1 Voltage
2	0.75 OG/BK	5272	CMP Actuator Solenoid Control - Intake Bank 2

Camshaft Position (CMP) Sensor - Bank 1 Exhaust (LY7)



Connector Part Information

- OEM: 7283-6206-30
- Service: See Catalog
- Description: 3-Way F (BK)

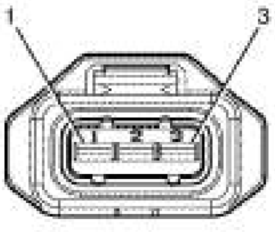
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Camshaft Position (CMP) Sensor - Bank 1 Exhaust (LY7)

Pin	Wire Color	Circuit No.	Function
1	0.75 PK/BK	632	Low Reference
2	0.5 D-GN	5273	CMP Sensor Signal - Exhaust Bank 1
3	0.75 GY	705	5-Volt Reference

Camshaft Position (CMP) Sensor - Bank 1 Intake (LY7)



Connector Part Information

- OEM: 7283-6206-30
- Service: See Catalog
- Description: 3-Way F (BK)

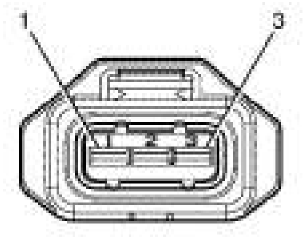
Terminal Part Information

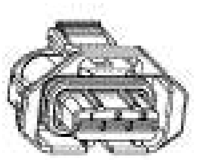
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Camshaft Position (CMP) Sensor - Bank 1 Intake (LY7)

Pin	Wire Color	Circuit No.	Function
1	0.5 PK/BK	632	Low Reference
2	0.5 OG/BU	5275	CMP Sensor Signal - Intake Bank 1
3	0.5 GY	705	5-Volt Reference

Camshaft Position (CMP) Sensor - Bank 2 Exhaust (LY7)





Connector Part Information

- OEM: 7283-6206-30
- Service: See Catalog
- Description: 3-Way F (BK)

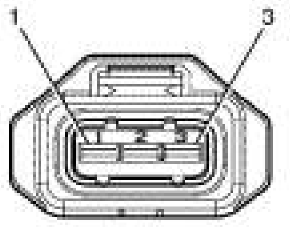
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Camshaft Position (CMP) Sensor - Bank 2 Exhaust (LY7)

Pin	Wire Color	Circuit No.	Function
1	0.5 PK/BK	632	Low Reference
2	0.5 PU	5274	CMP Sensor Signal - Exhaust Bank 2
3	0.5 GY	705	5-Volt Reference

Camshaft Position (CMP) Sensor - Bank 2 Intake (LY7)



Connector Part Information

- OEM: 7283-6206-30
- Service: See Catalog
- Description: 3-Way F

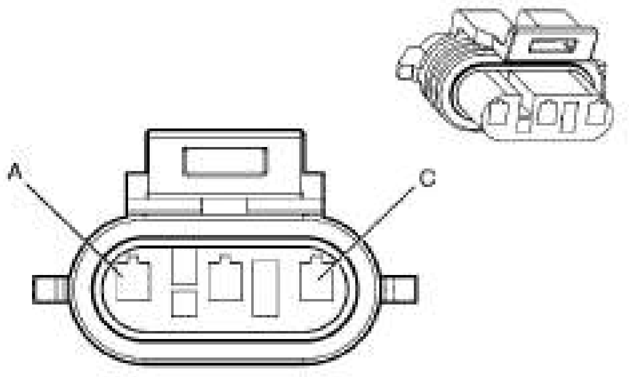
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Camshaft Position (CMP) Sensor - Bank 2 Intake (LY7)

Pin	Wire Color	Circuit No.	Function
1	0.5 PK/BK	632	Low Reference
2	0.5 PU	5276	CMP Sensor Signal - Intake Bank 2
3	0.5 GY	705	5-Volt Reference

Camshaft Position (CMP) Sensor (LS2 or HSV or L98)



Connector Part Information

- OEM: 7223-9735-30
- Service: 88986451
- Description: 3-Way F

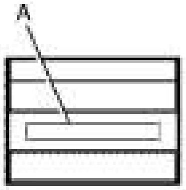
Terminal Part Information

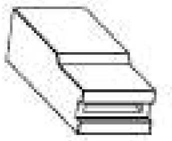
- Terminal/Tray: 12048074/2
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Camshaft Position (CMP) Sensor (LS2 or HSV or L98)

Pin	Wire Color	Circuit No.	Function
A	0.5 OG	631	5-Volt Reference
B	0.5 PK/BK	632	Low Reference
C	0.5 BN/WH	633	CMP Sensor Signal

Center Console Compartment Lamp X1





Connector Part Information

- OEM: 7123-0073-30
- Service: See Catalog
- Description: 1-Way F (BK)

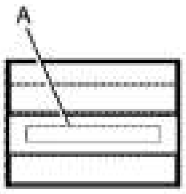
Terminal Part Information

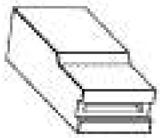
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Center Console Compartment Lamp X1

Pin	Wire Color	Circuit No.	Function
A	0.85 OG	1732	Courtesy Lamps Supply Voltage

Center Console Compartment Lamp X2





Connector Part Information

- OEM: 7123-0073-30
- Service: See Catalog
- Description: 1-Way F (BK)

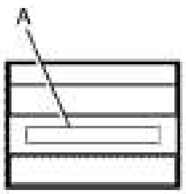
Terminal Part Information

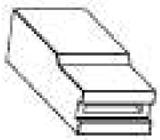
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Center Console Compartment Lamp X2

Pin	Wire Color	Circuit No.	Function
A	0.5 GY	157	Courtesy Lamp Control

Center Console Compartment Lamp Switch X1





Connector Part Information

- OEM: 7123-0073-30
- Service: See Catalog
- Description: 1-Way F (BK)

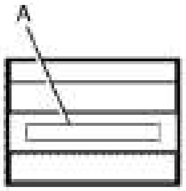
Terminal Part Information

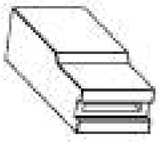
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Center Console Compartment Lamp Switch X1

Pin	Wire Color	Circuit No.	Function
A	0.5 GY	157	Courtesy Lamp Control

Center Console Compartment Lamp Switch X2





Connector Part Information

- OEM: 7123-0073-30
- Service: See Catalog
- Description: 1-Way F (BK)

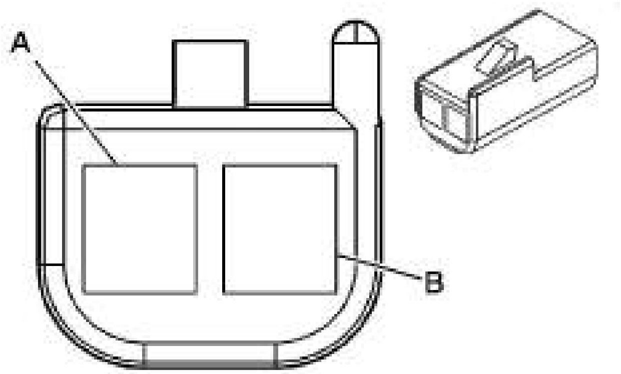
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Center Console Compartment Lamp Switch X2

Pin	Wire Color	Circuit No.	Function
A	0.5 BK	850	Ground

Center High Mounted Stop Lamp (CHMSL)



Connector Part Information

- OEM: 12047662
- Service: 12085535
- Description: 2-Way F Metri-Pack 150 Series (BK)

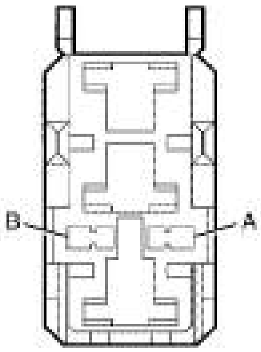
Terminal Part Information

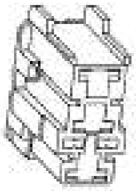
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Center High Mounted Stop Lamp (CHMSL)

Pin	Wire Color	Circuit No.	Function
A	0.5 L-BU	20	Stop Lamp Supply Voltage
B	0.5 BK/WH	851	Ground

Clutch Pedal Position (CPP) Switch





Connector Part Information

- OEM:
- Service:
- Description:

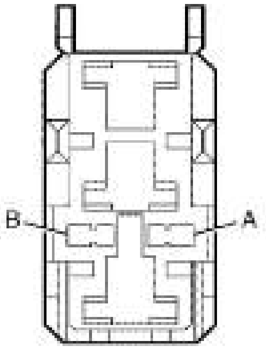
Terminal Part Information

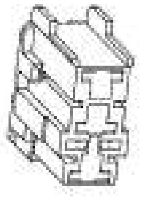
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Clutch Pedal Position (CPP) Switch

Pin	Wire Color	Circuit No.	Function
A	0.5 BN/WH		CPP Switch Signal
B	0.5 PK		Ignition 1 Voltage

Clutch Safety Switch (not an approved name)





Connector Part Information

- OEM:
- Service:
- Description:

Terminal Part Information

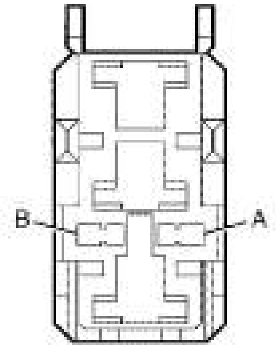
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

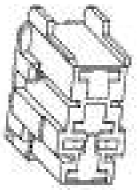
Clutch Safety Switch (not an approved name)

Pin	Wire Color	Circuit No.	Function
A	0.5 D-GN		Clutch Start/Neutral Start (without LY7)
	0.5 OG/BK		Clutch Start/Neutral Start (LY7)

B	0.5 BK		Ground

Clutch Start Switch





Connector Part Information

- OEM:
- Service:
- Description:

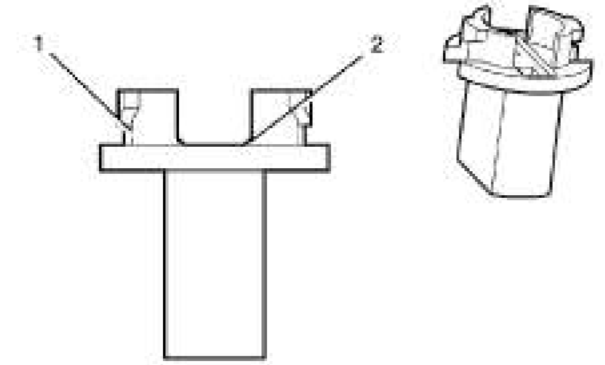
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Clutch Start Switch

Pin	Wire Color	Circuit No.	Function
A	0.5 D-GN		Clutch Start/Neutral Start (without LY7)
	0.5 OG/BK		Clutch Start/Neutral Start (LY7)
B	0.5 BK		Ground

Courtesy Lamp - Left Footwell



Connector Part Information

- OEM: 7141-5030-80
- Service: See Catalog
- Description:

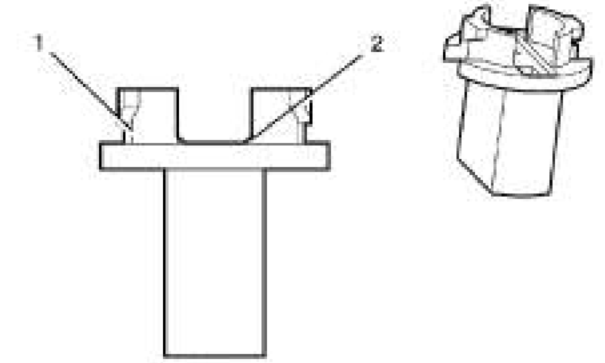
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Courtesy Lamp - Left Footwell

Pin	Wire Color	Circuit No.	Function
1	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage
2	0.5 BK	1450	Ground

Courtesy Lamp - Right Footwell



Connector Part Information

- OEM: 7141-5030-80

- Service: See Catalog
- Description:

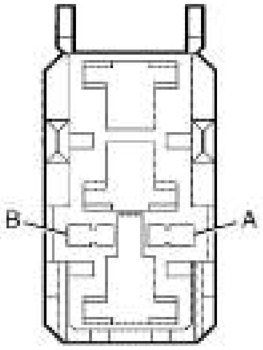
Terminal Part Information

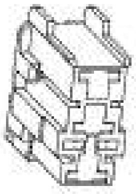
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Courtesy Lamp - Right Footwell

Pin	Wire Color	Circuit No.	Function
1	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage
2	0.5 BK	850	Ground

Cruise Control Clutch Pedal Release Switch





Connector Part Information

- OEM:
- Service:
- Description:

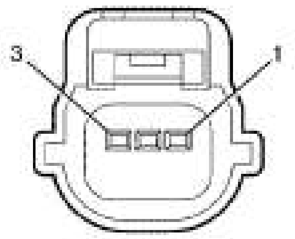
Terminal Part Information

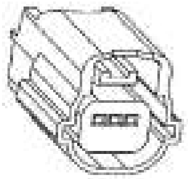
- Terminal/Tray:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

Cruise Control Clutch Pedal Release Switch

Pin	Wire Color	Circuit No.	Function
A	0.5 BN/WH		Clutch Disable Clutch SW Signal
B	0.5 PK		Ignition 1 Voltage (LY7)
	0.5 PK/BU		Ignition 1 Voltage (without LY7)

Crankshaft Position (CKP) Sensor (LY7)





Connector Part Information

- OEM: 7283-0283-30
- Service: See Catalog
- Description: 3-Way F (BK)

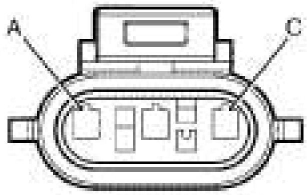
Terminal Part Information

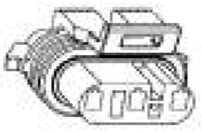
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Crankshaft Position (CKP) Sensor (LY7)

Pin	Wire Color	Circuit No.	Function
1	0.5 PU	574	Low Reference
2	0.5 YE/BU	573	CKP Sensor Signal
3	0.5 PU/WH	605	5-Volt Reference

Crankshaft Position (CKP) Sensor (without LY7)





Connector Part Information

- OEM: 7223-9736-40
- Service: 88987997
- Description: 3-Way F

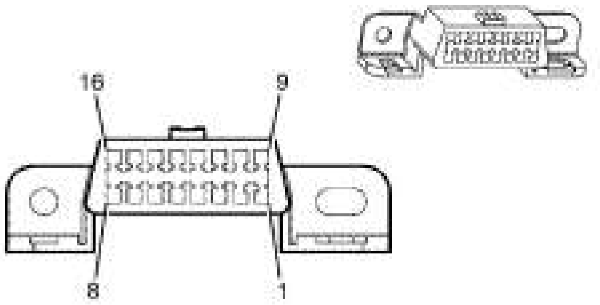
Terminal Part Information

- Terminal/Tray: 12048074/2
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Crankshaft Position (CKP) Sensor (without LY7)

Pin	Wire Color	Circuit No.	Function
1	0.5 D-BU/WH	1869	CKP Sensor Signal
2	0.5 YE/BK	1868	Low Reference
3	0.5 L-GN	1867	12-Volt Reference

Data Link Connector (DLC)



Connector Part Information

- OEM: 7123-9265-30
- Service: See Catalog
- Description: 16-Way F (BK)

Terminal Part Information

- Pins: 1, 4, 5, 16
- Terminal/Tray: 12129484/19
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

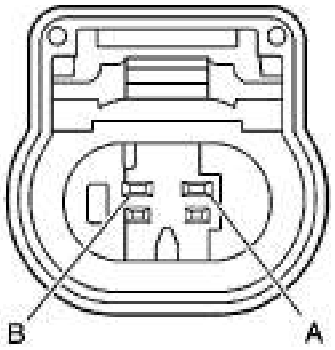
- Pins: 6, 14
- Terminal/Tray: 12129484/19
- Core/Insulation Crimp: E/C

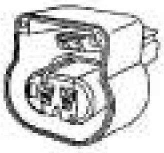
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Data Link Connector (DLC)

Pin	Wire Color	Circuit No.	Function
1	0.35 L-GN	9200	Low Speed GMLAN Serial Data
2-3	--	--	Not Used
4	0.3 BK	850	Ground
5	0.3 BK	850	Ground
6	0.5 BN/BK	9004	High Speed GMLAN Serial Data Bus+
7-13	--	--	Not Used
14	0.5 BN	9005	High Speed GMLAN Serial Data Bus-
15	--	--	Not Used
16	0.5 OG/WH	1840	Battery Positive Voltage

Data Link Resistor





Connector Part Information

- OEM: 7282-9913-30
- Service: See Catalog
- Description: 2-Way F (BK)

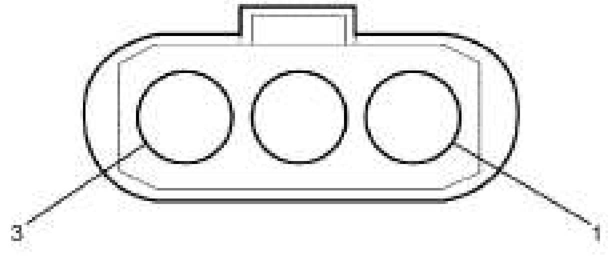
Terminal Part Information

- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Data Link Resistor

Pin	Wire Color	Circuit No.	Function
A	0.5 BN/BK	9010	High Speed GMLAN Serial Data Bus+
B	0.5 BN	9011	High Speed GMLAN Serial Data Bus-

Diagnostic Connector (LPG)



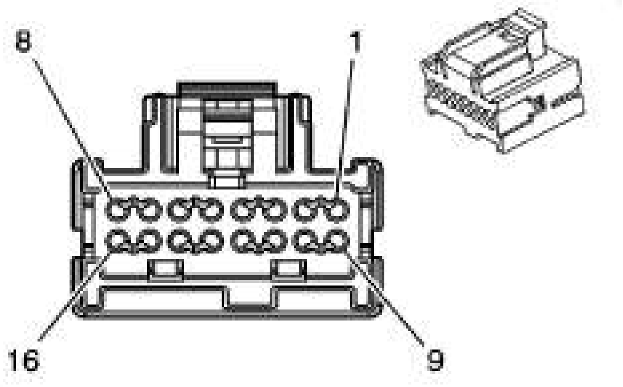
Connector Part Information

Terminal Part Information

Diagnostic Connector (LPG)

Pin	Wire Color	Circuit No.	Function
1	0.5 BK	--	Ground
2	0.5 BK	--	Ground
3	0.75 PK/BU	--	Ignition Voltage

Digital Radio Receiver (U2K)



Connector Part Information

- OEM: 7229-3239-30
- Service: See Catalog
- Description: 16-Way F Micro-Pack 64 Series (BK)

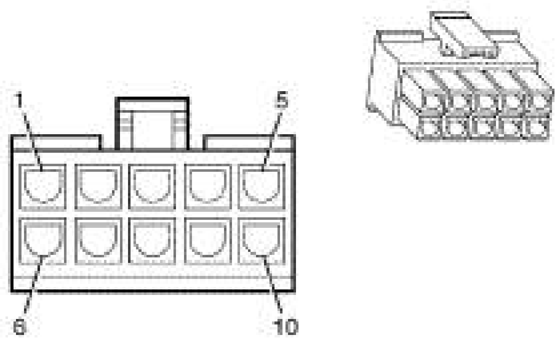
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Digital Radio Receiver (U2K)

Pin	Wire Color	Circuit No.	Function
1	0.5 BN/WH	372	Remote Radio Audio Output (-)
2	0.5 D-GN	7007	Left Radio Audio Output
3	0.5 GY/BK	7008	Right Radio Audio Output
4	0.5 GY	388	Remote Radio Right Audio Signal
5	0.35 D-GN	9213	--
6-8	--	--	Not Used
9	0.5 BN	1050	Ground
10-15	--	--	Not Used
16	0.5 OG/WH	2340	Battery Positive Voltage

Digital Video Disc (DVD) Control Module X1



Connector Part Information

- OEM: 3046-10
- Service: See Catalog
- Description: 10-Way

Terminal Part Information

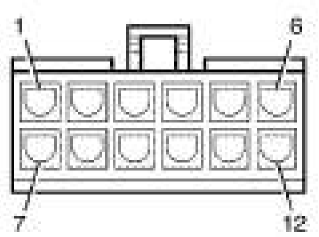
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

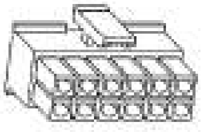
Digital Video Disc (DVD) Control Module X1

Pin	Wire Color	Circuit No.	Function

1	--	--	Not Used
2	0.3 D-GN	5060	Low Speed GMLAN Serial Data
3	0.5 RD/WH	4540	Battery Positive Voltage (RHD)
	0.5 OG/YE	4540	Battery Positive Voltage (LHD)
4	0.5 RD/WH	4540	Battery Positive Voltage (RHD)
	0.5 OG/YE	4540	Battery Positive Voltage (LHD)
5-7	--	--	Not Used
8	0.5 BK	1050	Ground
9	0.5 BK	1050	Ground
10	--	--	Not Used

Digital Video Disc (DVD) Control Module X2





Connector Part Information

- OEM: 3046-12
- Service: See Catalog
- Description: 12-Way

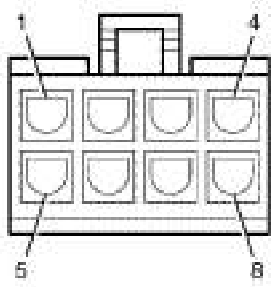
Terminal Part Information

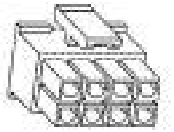
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Digital Video Disc (DVD) Control Module X2

Pin	Wire Color	Circuit No.	Function
1	0.5 D-BU	5841	Auxiliary Audio Right Signal (+) (UWF)
2	0.5 BN/WH	5839	Auxiliary Audio Left Signal (+) (UWF)
3-7	--	--	Not Used
8	0.5 D-BU	7001	Common Auxiliary Audio Signal (-) (UWF)
9-12	--	--	Not Used

Digital Video Disc (DVD) Control Module X3





Connector Part Information

- OEM: 3046-8
- Service: See Catalog
- Description: 8-Way

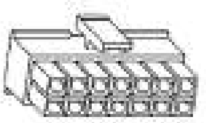
Terminal Part Information

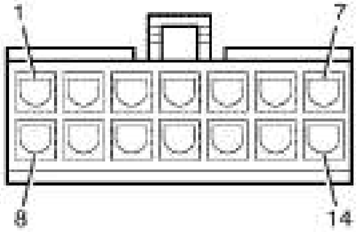
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Digital Video Disc (DVD) Control Module X3

Pin	Wire Color	Circuit No.	Function
1	0.18 PU	5842	Auxiliary Video Signal (-) (RHD)
	0.18 BARE	5842	Auxiliary Video Signal (-)(LHD)
2	0.18 WH/RD	2058	Auxiliary Audio Right Signal (+) (RHD)
	0.18 RD	2058	Auxiliary Audio Right Signal (+) (LHD)
3	0.18 YE	2059	Auxiliary Audio Left Signal (+) (RHD)
	0.18 WH	2059	Auxiliary Audio Left Signal (+) (LHD)
4	--	--	Not Used
5	0.18 PU	5843	Auxiliary Video Signal (+) (RHD)
	0.18 BK	5843	Auxiliary Video Signal (+) (LHD)
6	0.18 WH/RD	5841	Auxiliary Audio Right Signal (-) (RHD)
	0.18 D-GN	5841	Auxiliary Audio Right Signal (-) (LHD)
7	0.18 YE	5839	Auxiliary Audio Left Signal (-) (RHD)
	0.18 PK	5839	Auxiliary Audio Left Signal (-) (LHD)
8	--	--	Not Used

Digital Video Disc (DVD) Control Module X4





Connector Part Information

- OEM: 3046-14
- Service: See Catalog
- Description: 14-Way

Terminal Part Information

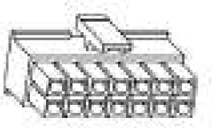
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

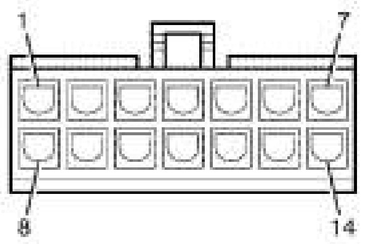
Digital Video Disc (DVD) Control Module X4

Pin	Wire Color	Circuit No.	Function
1	0.3 WH	9412	DVD Video Signal (-) (RHD and U56)
	0.3 GY	9412	DVD Video Signal (-) (without RHD and U56)
2	0.3 D-GN/WH	9410	DVD Audio Right Signal (+) (RHD and U56)
	0.3 WH	9410	DVD Audio Right Signal (+) (without RHD and U56)
3	0.3 L-GN	9408	DVD Audio Left Signal (+) (RHD and U56)
	0.3 L-BU	9408	DVD Audio Left Signal (+) (without RHD and U56)
4	--	--	Not Used
5	0.3 YE	9407	DVRX DVD IN (RHD and U56)
	0.3 YE/BK	9407	DVRX DVD IN (without RHD and U56)
6	0.3 L-BU	6871	DVD0V 1 DVD-1
7	0.3 OG	9405	DVD_IN_! DVD+1
8	0.3 WH	6975	DVD Video Signal (+) (RHD and U56)
	0.3 D-GN	6975	DVD Video Signal (+) (without RHD and U56)
9	0.3 D-GN/WH	9411	DVD Audio Right Signal (-) (RHD and U56)
	0.3 D-GN	9411	DVD Audio Right Signal (-) (without RHD and U56)
10	0.3 L-GN	9409	DVD Audio Left Signal (-) (RHD and U56)
	0.3 WH/BK	9409	DVD Audio Left Signal (-) (without RHD and U56)
11	--	--	Not Used

12	0.3 D-GN	1096	DVTX DVD IN (without LHD and U56)
	0.3 GY	1096	Passenger Door Lock Switch Low Reference (LHD and U56)
13	0.3 D-BU	9406	DVD0V 2 DVD-2
14	0.3 PK	6875	DVD_IN 2 DVD+2

Digital Video Disc (DVD) Control Module X5





Connector Part Information

- OEM: 34046-14
- Service: See Catalog
- Description: 14-Way

Terminal Part Information

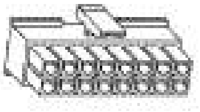
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

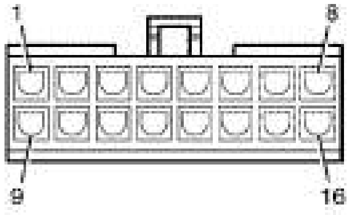
Digital Video Disc (DVD) Control Module X5

Pin	Wire Color	Circuit No.	Function
1	0.18 WH	6975	DVD Video Signal (-) (without LHD and U56)
	0.18 BK	6975	DVD Video Signal (-) (LHD and U56)
2	0.18 D-GN/WH	5828	DVD Audio Right Signal (+) (without LHD and U56)
	0.18 RD	5828	DVD Audio Right Signal (+) (LHD and U56)
3	0.18 L-GN	5826	DVD Audio Left Signal (+) (without LHD and U56)
	0.18 WH	5826	DVD Audio Left Signal (+) (LHD and U56)
4	0.18 BARE	5339	Shield (without LHD and U56)
	0.18 BARE	5339	Drain Wire (LHD and U56)
5	0.18 YE	5485	RS485 TX (without LHD and U56)
	0.18 GY	5485	RS485 TX (LHD and U56)
6	0.18 L-BU	6873	Ground (without LHD and U56)

	0.18 PU	6873	Ground (LHD and U56)
7	0.18 OG	6849	Battery Positive (without LHD and U56)
	0.18 YE	6849	Battery Positive (LHD and U56)
8	0.18 WH	6976	DVD Video Signal (+) (without LHD and U56)
	0.18 BK	6976	Battery Positive (LHD and U56)
9	0.18 D-GN/WH	5827	DVD Audio Right Signal (-) (without LHD and U56)
	0.18 RD	5827	DVD Audio Right Signal (-) (LHD and U56)
10	0.18 L-GN	5825	DVD Audio Left Signal (-) (without LHD and U56)
	0.18 WH	5825	DVD Audio Left Signal (-) (LHD and U56)
11	--	--	Not Used
12	0.18 D-GN	1098	RS485 RX (without LHD and U56)
	0.18 D-BU	1098	RS485 RX (LHD and U56)
13-14	--	--	Not Used

Digital Video Disc (DVD) Control Module X6





Connector Part Information

- OEM: 3046-16
- Service: See Catalog
- Description: 16-Way

Terminal Part Information

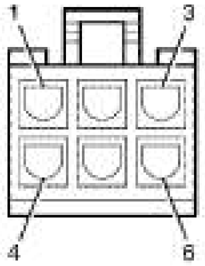
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

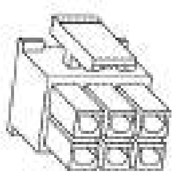
Digital Video Disc (DVD) Control Module X6

Pin	Wire Color	Circuit No.	Function
1	0.18 WH	6976	DVD Video Signal (-)
2	0.18 D-GN/WH	5828	DVD Audio Right Signal (+)

3	0.18 L-GN	5826	DVD Audio Left Signal (+)
4	0.18 BARE	5339	Shield
5	0.18 YE	5845	RS485TX
6	0.18 L-BU	6873	Ground
7	0.18 OG	6849	Battery Positive
8	--	--	Not Used
9	0.18 WH	6975	DVD Video Signal (+)
10	0.18 D-GN/WH	5827	DVD Audio Right Signal (-)
11	0.18 L-GN	5825	DVD Audio Left Signal (-)
12	--	--	Not Used
13	0.18 D-GN	1098	RS485RX
14-16	--	--	Not Used

Digital Video Disc (DVD) Control Module X7





Connector Part Information

- OEM: 3046-6
- Service: See Catalog
- Description: 6-Way

Terminal Part Information

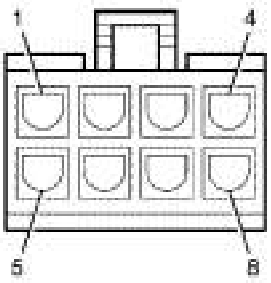
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

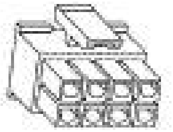
Digital Video Disc (DVD) Control Module X7

Pin	Wire Color	Circuit No.	Function
1	0.18 D-GN	9403	RX (U56 and RHD)
	0.18 D-BU	9403	RX (U56 and LHD)
	0.18 L-GN/BK	9403	RX (UWF)

2	0.18 L-BU	9401	Ground (U56)
	0.18 TN	9401	Ground (UW5)
3	--	--	Not Used
4	0.18 BARE	9404	Shield
5	0.18 YE	9402	TX (U56 and RHD)
	0.18 GY	9402	TX (U56 and LHD)
	0.18 YE/BK	9402	TX (UWF)
6	0.18 OG	9400	Video In (+) (without U56 and LHD)
	0.18 RD	9400	Video In (+) (U56 and LHD)

Digital Video Disc (DVD) Control Module X8





Connector Part Information

- OEM: 34046-8
- Service: See Catalog
- Description: 8-Way

Terminal Part Information

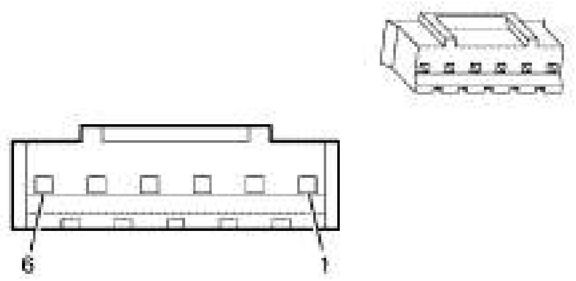
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Digital Video Disc (DVD) Control Module X8

Pin	Wire Color	Circuit No.	Function
1	0.5 BK	5335	DVD Video Signal (-)
2	--	--	Not Used
3	0.5 RD	368	Right Audio Signal (+) (without RHD and U56)
	0.5 D-BU	368	Right Audio Signal (+) (RHD and U56)
4	0.5 WH	367	Left Audio Signal (+) (without RHD and U56)
	0.5 BN/WH	367	Left Audio Signal (+) (RHD and U56)

5	--	--	Not Used
6	0.5 BK	5334	DVD Video Signal (+)
7	--	--	Not Used
8	0.5 WH/RD	1547	Common Audio Signal (-) (without RHD and U56)
	0.5 D-GN	1547	Common Audio Signal (-) (RHD and U56)

Digital Video Disc (DVD) Display X1



Connector Part Information

- OEM: LMA0150600A
- Service: See Catalog
- Description: 6-Way F

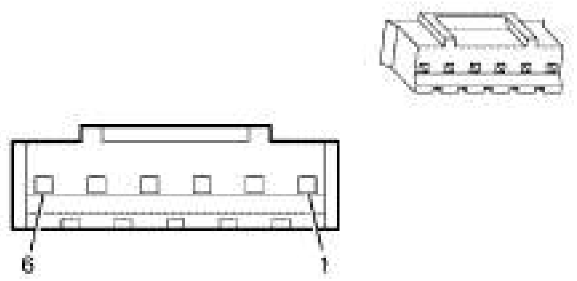
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Digital Video Disc (DVD) Display X1

Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used
2	0.18 OG	9400	Video In (+)
3	0.18 TN	9401	Ground (UWF)
	0.18 L-BU	9401	Ground (U56)
4	0.18 YE/BK	9402	TX (UWF)
	0.18 YE	9402	TX (U56)
5	0.18 L-GN/BK	9403	RX (UWF)
	0.18 D-GN	9403	RX (U56)
6	--	--	Not Used

Digital Video Disc (DVD) Display X2



Connector Part Information

- OEM: LMA0150600A
- Service: See Catalog
- Description: 6-Way F

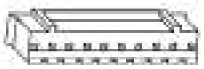
Terminal Part Information

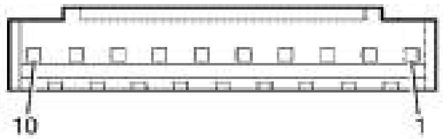
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Digital Video Disc (DVD) Display X2

Pin	Wire Color	Circuit No.	Function
1	0.18 PU	5483	Auxiliary Video Signal (+) (RHD)
	0.18 WH	5483	Auxiliary Audio Left Signal (+) (LHD)
2	0.18 WH/RD	2058	Auxiliary Audio Right Signal (+) (RHD)
	0.18 PK	2058	Auxiliary Audio Left Signal (-) (LHD)
3	0.18 YE	2059	Auxiliary Audio Left Signal (+) (RHD)
	0.18 RD	2059	Auxiliary Audio Right Signal (+) (LHD)
4	0.18 YE	5389	Auxiliary Audio Left Signal (-) (RHD)
	0.18 D-GN	5389	Auxiliary Audio Right Signal (-) (LHD)
5	0.18 PU	5842	Auxiliary Audio Signal (-) (RHD)
	0.18 BARE	5842	Auxiliary Video Signal (-) (LHD)
6	0.18 WH/RD	5841	Auxiliary Video Right Signal (-) (RHD)
	0.18 BK	5841	Auxiliary Video Signal (+) (LHD)

Digital Video Disc (DVD) Player X1





Connector Part Information

- OEM: CALMA0150400A
- Service: See Catalog
- Description:

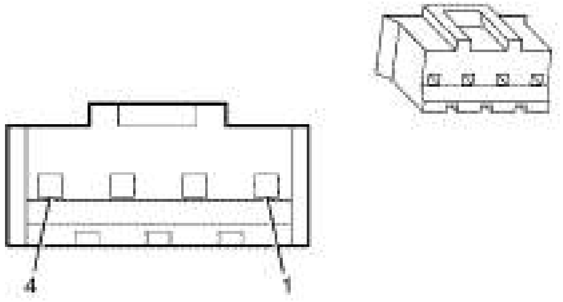
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Digital Video Disc (DVD) Player X1

Pin	Wire Color	Circuit No.	Function
1	0.3 D-GN	1096	DVTX DVDIN (RHD)
	0.3 GY	1096	DVTX DVDIN
2	0.3 YE	9407	DVRX DVDIN (RHD)
	0.3 YE/BK	9407	DVRX DVDIN
3	--	--	Not Used
4	0.3 BARE	9413	Shield
5	0.3 L-GN	9408	DVD Audio Left Signal (+) (RHD)
	0.3 L-BU	9408	DVD Audio Left Signal (+)
6	0.3 L-GN	9409	DVD Audio Left Signal (-) (RHD)
	0.3 L-BU	9409	DVD Audio Left Signal (-) (RHD)
	0.3 WH/BK	9409	DVD Audio Left Signal (-) (LHD)
7	0.3 D-GN/WH	9410	DVD Audio Right Signal (+) (RHD)
	0.3 WH	9410	DVD Audio Right Signal (+)
8	0.3 D-GN/WH	9411	DVD Audio Right Signal (-) (RHD)
	0.3 D-GN	9411	DVD Audio Right Signal (-)
9	0.3 WH	9412	DVD Video Signal (-) (RHD)
	0.3 GY	9412	DVD Video Signal (-)
10	0.3 WH	6975	DVD Video Signal (+) (RHD)
	0.3 D-GN	6975	DVD Video Signal (+)

Digital Video Disc (DVD) Player X2



Connector Part Information

- OEM: CALMA0151000A
- Service: See Catalog
- Description:

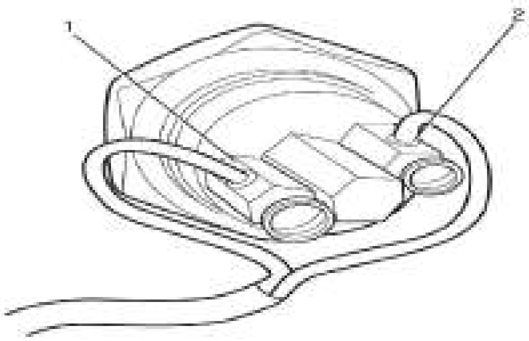
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Digital Video Disc (DVD) Player X2

Pin	Wire Color	Circuit No.	Function
1	0.3 OG	9405	DVD IN 1 DVD+1
2	0.3 PK	6875	DVD IN 2 DVD+2
3	0.3 L-BU	6871	DVD IN 1 DVD-1
4	0.3 D-BU	9406	DVD IN 2 DVD-2

Disable Switch



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 2-Way

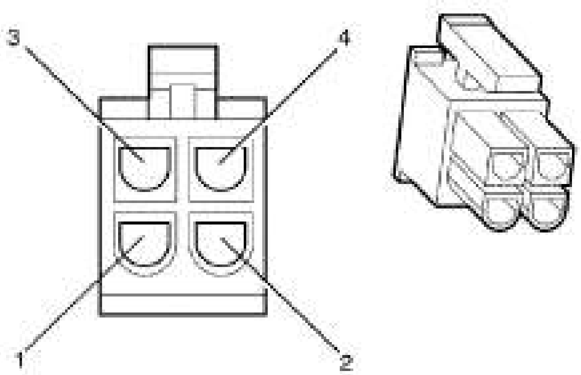
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Disable Switch

Pin	Wire Color	Circuit No.	Function
1	0.35 BK	6	Ground
2	0.35 BK	11	Disable Signal

Dome Lamp (without TRV)



Connector Part Information

- OEM: 0039-01-2045
- Service: See Catalog
- Description: 4-Way F (WH)

Terminal Part Information

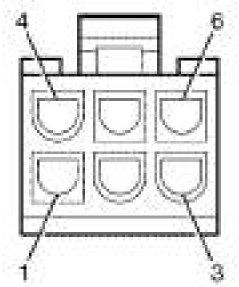
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

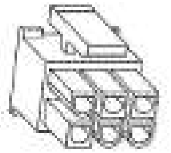
Dome Lamp (without TRV)

Pin	Wire Color	Circuit No.	Function

1	0.5 BK/WH	851	Ground
2	0.3 PK/BK	1597	Courtesy Lamp Supply Voltage
3	0.3 PU	328	Interior Lamp Switch Signal
4	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage

Dome/Reading Lamps - Front (C74 without 9C1)





Connector Part Information

- OEM: 0039-01-2065
- Service: See Catalog
- Description: 6-Way F (WH)

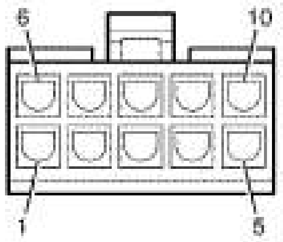
Terminal Part Information

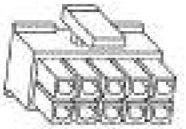
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Dome/Reading Lamps - Front (C74 without 9C1)

Pin	Wire Color	Circuit No.	Function
1	0.5 BK/WH	851	Ground
2	0.3 PK/BK	1597	Courtesy Lamps Switch on signal
3	0.3 PU	328	Interior Lamp Switch Signal
4	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage
5	0.5 OG	1732	Courtesy Lamp Supply Voltage
6	0.3 YE	6817	LED Backlight Dimming Control

Dome/Reading Lamps (9C1)





Connector Part Information

- OEM:
- Service: See Catalog
- Description:

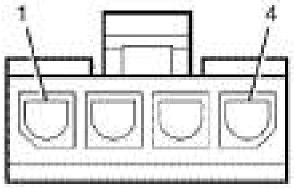
Terminal Part Information

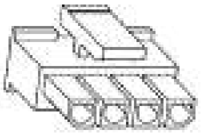
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Dome/Reading Lamps (9C1)

Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used
2	0.3 PK/BK	1597	Courtesy Lamps Switch On Signal
3	0.5 OG/WH	1840	Battery Positive Voltage
4	0.3 WH/RD	6821	Courtesy Lamps Switch On Signal
5-6	--	--	Not Used
7	0.3 PU	328	Interior Lamp Switch Signal
8	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage
9	0.85 OG	1732	Courtesy Lamps Supply Voltage
10	0.5 BK/WH	851	Ground

Dome/Reading Lamps - Rear (TRV)





Connector Part Information

- OEM: 43645-0400
- Service: See Catalog
- Description: 4-Way F (WH)

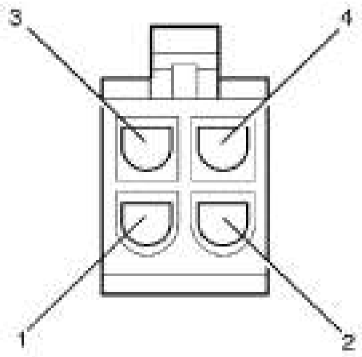
Terminal Part Information

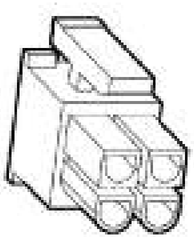
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Dome/Reading Lamps - Rear (TRV)

Pin	Wire Color	Circuit No.	Function
1	0.5 BK/WH	851	Ground
2	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage
3	0.5 OG	1732	Courtesy Lamp Supply Voltage
4	0.3 YE	6817	LED Backlight Dimming Control

Dome/Reading Lamps - Rear (without TRV)





Connector Part Information

- OEM: 0039-01-2045
- Service: See Catalog
- Description: 4-Way F (WH)

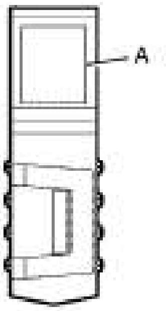
Terminal Part Information

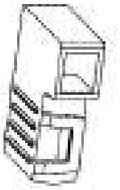
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Dome/Reading Lamps - Rear (without TRV)

Pin	Wire Color	Circuit No.	Function
1	0.5 BK/WH	851	Ground
2	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage
3-4	--	--	Not Used

Door Courtesy Lamp - Driver X1





Connector Part Information

- OEM: 180984-5
- Service: See Catalog
- Description:

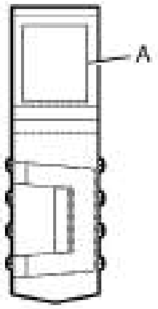
Terminal Part Information

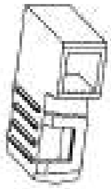
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Door Courtesy Lamp - Driver X1

Pin	Wire Color	Circuit No.	Function
A	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage

Door Courtesy Lamp - Driver X2





Connector Part Information

- OEM: 180984-5
- Service: See Catalog
- Description:

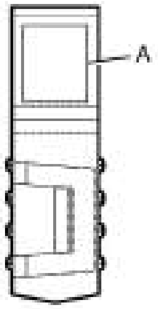
Terminal Part Information

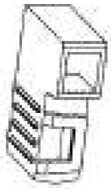
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Door Courtesy Lamp - Driver X2

Pin	Wire Color	Circuit No.	Function
A	0.5 BK	2050	Ground

Door Courtesy Lamp - Left Rear X1





Connector Part Information

- OEM: 180984-5
- Service: See Catalog
- Description:

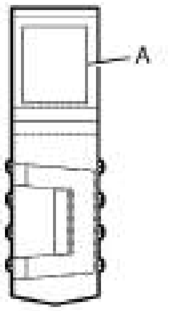
Terminal Part Information

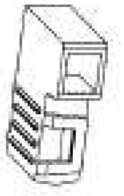
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Door Courtesy Lamp - Left Rear X1

Pin	Wire Color	Circuit No.	Function
A	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage

Door Courtesy Lamp - Left Rear X2





Connector Part Information

- OEM: 180984-5
- Service: See Catalog
- Description:

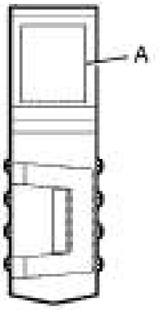
Terminal Part Information

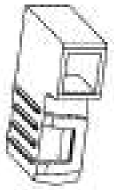
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Door Courtesy Lamp - Left Rear X2

Pin	Wire Color	Circuit No.	Function
A	0.5 BK	2050	Ground

Door Courtesy Lamp - Passenger X1





Connector Part Information

- OEM: 180984-5
- Service: See Catalog
- Description:

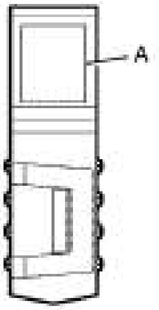
Terminal Part Information

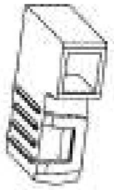
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Door Courtesy Lamp - Passenger X1

Pin	Wire Color	Circuit No.	Function
A	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage

Door Courtesy Lamp - Passenger X2





Connector Part Information

- OEM: 180984-5
- Service: See Catalog

- Description:

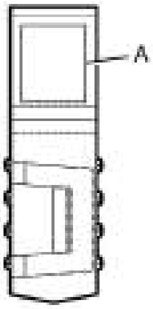
Terminal Part Information

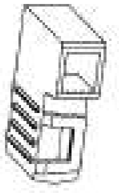
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Door Courtesy Lamp - Passenger X2

Pin	Wire Color	Circuit No.	Function
A	0.5 BK	1350	Ground

Door Courtesy Lamp - Right Rear X1





Connector Part Information

- OEM: 180984-5
- Service: See Catalog
- Description:

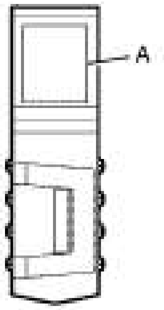
Terminal Part Information

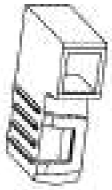
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Door Courtesy Lamp - Right Rear X1

Pin	Wire Color	Circuit No.	Function
A	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage

Door Courtesy Lamp - Right Rear X2





Connector Part Information

- OEM: 180984-5
- Service: See Catalog
- Description:

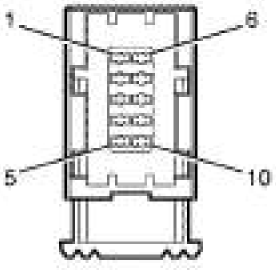
Terminal Part Information

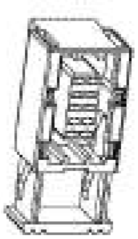
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Door Courtesy Lamp - Right Rear X2

Pin	Wire Color	Circuit No.	Function
A	0.5 BK	1350	Ground

Door Latch - Driver





Connector Part Information

- OEM: 7283-6930-30
- Service: See Catalog

- Description: 10-Way F (BK)

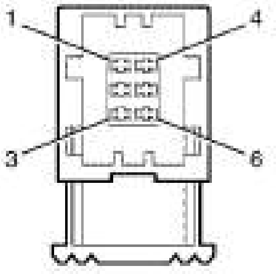
Terminal Part Information

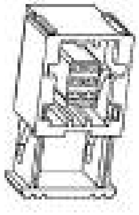
- Pins: 2, 3
- Terminal/Tray: 964274-2/16
- Pins: 6, 8, 9
- Terminal/Tray: 4-969005-1/16
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: J-38125-560/J-35616-33 (YE)

Door Latch - Driver

Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used
2	0.75 BN/RD	294	Door Lock Actuator Unlock Control
3	0.75 GN/WH	295	Door Lock Actuator Lock Control
4-5	--	--	Not Used
6	0.3 BN/WH	746	Driver Door Ajar Switch Signal
7	--	--	Not Used
8	0.5 BK	2050	Ground
9-10	--	--	Not Used

Door Latch - Left Rear





Connector Part Information

- OEM: 7283-6931-30
- Service: 88986251
- Description: 6-Way F Sealed (BK)

Terminal Part Information

- Pins: 2, 3
- Terminal/Tray: 964274-2/16
- Core/Insulation Crimp: E/1

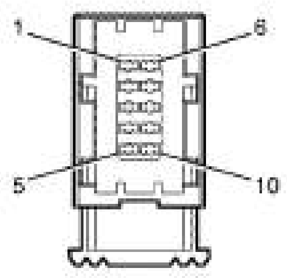
- Release Tool/Test Probe: J-38125-560/J-35616-33 (YE)

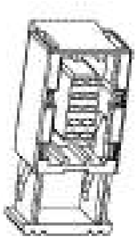
- Pins: 4, 6
- Terminal/Tray: 4-969005-1/16
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: J-38125-560/J-35616-33 (YE)

Door Latch - Left Rear

Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used
2	0.75 BN/RD	294	Door Lock Actuator Unlock Control
3	0.75 GN/WH	295	Door Lock Actuator Lock Control
4	0.3 BN/WH	746	Passengers Door Ajar Switch Signal
5	--	--	Not Used
6	0.5 BK	2050	Ground

Door Latch - Passenger





Connector Part Information

- OEM: 7283-6930-30
- Service: See Catalog
- Description: 10-Way F (BK)

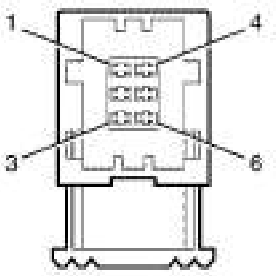
Terminal Part Information

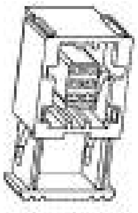
- Pins: 7, 8
- Terminal/Tray: 964274-2/16
- Pins: 1, 3
- Terminal/Tray: 4-969005-1/16
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: J-38125-560/J-35616-33 (YE)

Door Latch - Passenger

Pin	Wire Color	Circuit No.	Function
1	0.3 GY/BK	745	Passengers Door Ajar Switch Signal
2	--	--	Not Used
3	0.5 BK	1350	Ground
4	0.3 PK	781	Driver Door Lock Switch Unlock Signal
5-6	--	--	Not Used
7	0.75 BN/RD	694	Driver Door Lock Actuator Unlock Control
8	0.75 GN/WH	295	Door Lock Actuator Lock Control
9	0.3 PK/BK	780	Driver Door Lock Switch Lock Signal
10	--	--	Not Used

Door Latch - Right Rear





Connector Part Information

- OEM: 7283-6931-30
- Service: 88986251
- Description: 6-Way F Sealed (BK)

Terminal Part Information

- Pins: 5, 6
- Terminal/Tray: 964274-2/16
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: J-38125-560/J-35616-33 (YE)

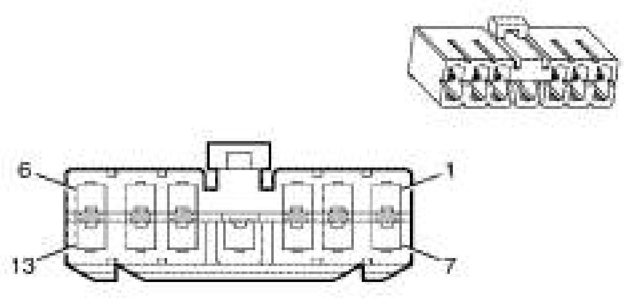
- Pins: 1, 3
- Terminal/Tray: 4-969005-1/16
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: J-38125-560/J-35616-33 (YE)

Door Latch - Right Rear

Pin	Wire Color	Circuit No.	Function
1	0.3 BN/WH	746	Passengers Door Ajar Switch Signal

2	--	--	Not Used
3	0.5 BK	1350	Ground
4	--	--	Not Used
5	0.75 BN/RD	294	Door Lock Actuator Unlock Control
6	0.75 GN/WH	295	Door Lock Actuator Lock Control

Door Lock / Window Switch X1



Connector Part Information

- OEM: 7119-3130
- Service: See Catalog
- Description: 13-Way F (WH)

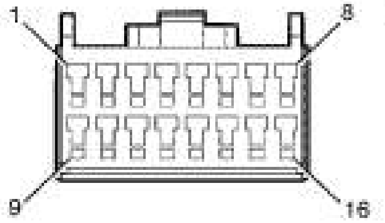
Terminal Part Information

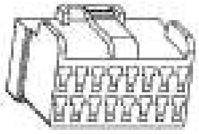
- Terminal/Tray: 7116-1050/27
- Core/Insulation Crimp: C/A
- Release Tool/Test Probe: 12094430/J-35616-4A (PU)

Door Lock / Window Switch X1

Pin	Wire Color	Circuit No.	Function
1-6	--	--	Not Used
7	2 PU	169	Power Window Master Switch Left Rear Down Signal
8	2 D-GN	168	Power Window Master Switch Left Rear Up Signal
9	2 BK	2050	Ground
10	2 D-GN	1001	RAP [X] Fuse Supply Voltage
11	2 D-BU	1307	Power Window Master Switch Lockout Signal
12	2 PU/WH	171	Power Window Master Switch Right Rear Down Signal
13	2 L-GN	170	Power Window Master Switch Right Rear Up Signal

Door Lock / Window Switch X2





Connector Part Information

- OEM: 7123-1765-30
- Service: See Catalog
- Description: 16-Way F (BK)

Terminal Part Information

- Terminal/Tray: 173681-2/17
- Core/Insulation Crimp: E/4
- Release Tool/Test Probe: 15315247/J-35616-16 (L-GN)

Door Lock / Window Switch X2

Pin	Wire Color	Circuit No.	Function
1	0.5 D-GN	1301	RAP [X] Fuse Supply Voltage
2	0.5 BN	1300	Power Window Master Switch Left Front Up Signal
3	0.5 GY/BU	1136	Power Window Master Switch Left Front Down Signal
4	0.5 BK	2050	Ground
5	0.5 BN/BK	254	Power Door Unlock Fuse Supply Voltage
6	0.5 WH/BK	81	Driver Mirror Motor Right Control
7	0.5 L-GN/BK	89	Driver Mirror Motor Down Control
8	0.5 WH/BU	7391	Power Window Switch Right and Up
9	0.5 L-BU	166	Power Window Master Switch Right Front Up Signal
10	0.5 GN/BK	167	Power Window Master Switch Right Front Down Signal
11	0.3 YE	6817	LED Backlight Diming Control
12	0.5 PU/WH	889	Passenger Mirror Motor Down Control
13	0.5 OG/WH	881	Passenger Mirror Motor Right Control
14	0.5 BK	2050	Ground
15	0.3 GY/BK	255	Power Door Lock Fuse Supply Voltage
16	0.5 BN/BU	343	Accessory Voltage

Driver Information Center (DIC) (ERG)

Connector Part Information

- OEM: 7282-1060
- Service: See Catalog
- Description: 26-Way

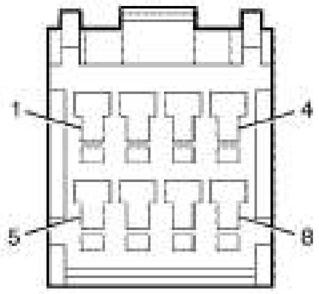
Terminal Part Information

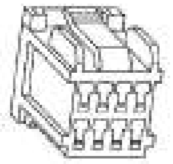
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Driver Information Center (DIC) (ERG)

Pin	Wire Color	Circuit No.	Function
1	0.35 YE	2501	High Speed GMLAN Serial Data Bus-
2	0.35 YE	2501	High Speed GMLAN Serial Data Bus-
3	0.35 YE	2500	High Speed GMLAN Serial Data Bus+
4	0.35 YE		--
5-7	--	--	Not Used
8	0.35 BK/BU		Steering Wheel Position Sensor Low Reference
9-15	--	--	Not Used
16	0.35 YE	2500	High Speed GMLAN Serial Data Bus+
17	0.35 YE		--
18-26	--	--	Not Used

Driver Information Center (DIC) (without ERG)





- OEM: 7123-1685
- Service: See Catalog
- Description: 8-Way F (WH)

Terminal Part Information

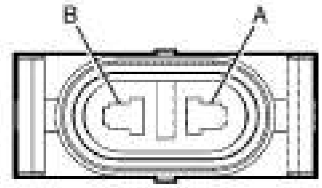
- Terminal/Tray: See Terminal Repair Kit

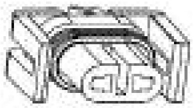
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Driver Information Center (DIC) (without ERG)

Pin	Wire Color	Circuit No.	Function
1	0.3 D-GN	5060	Low Speed GMLAN Serial Data
2-3	--	--	Not Used
4	0.5 RD/WH	1840	Battery Positive Voltage
5-7	--	--	Not Used
8	0.3 BK	1450	Ground

Driving Lamp - Left (HSV or VXR8)





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 2-Way F

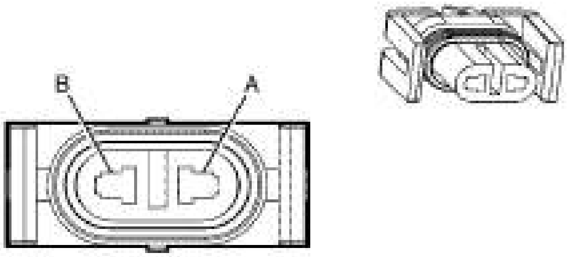
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Driving Lamp - Left (HSV or VXR8)

Pin	Wire Color	Circuit No.	Function
A	0.75 PU		Front Driving Lamp Relay Supply Voltage
B	0.75 BK		Ground

Driving Lamp - Right (HSV or VXR8)



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 2-Way F

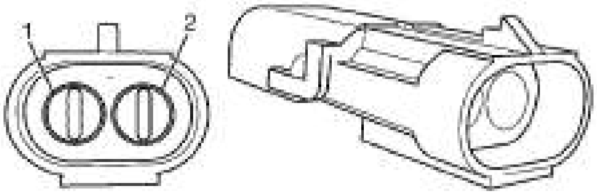
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Driving Lamp - Right (HSV or VXR8)

Pin	Wire Color	Circuit No.	Function
A	0.75 PU		Front Driving Lamp Relay Supply Voltage
B	0.75 BK		Ground

Driving Lamp - HSVDR 1 (HSV or VXR8)



Connector Part Information

- OEM:

- Service: See Catalog
- Description: 2-Way F

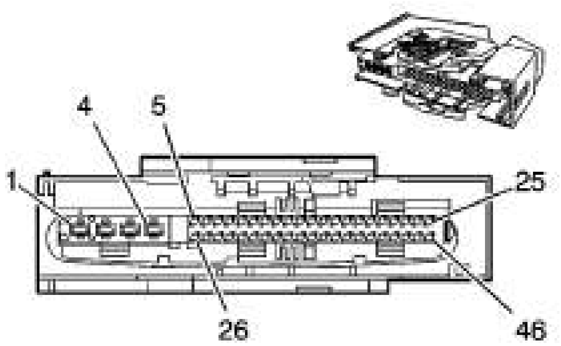
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Driving Lamp - HSVDR 1 (HSV or VXR8)

Pin	Wire Color	Circuit No.	Function
A	0.3 D-BU		Ground
B	0.3 RD/BU		Voltage Supply

Electronic Brake Control Module (EBCM) (JL4)



Connector Part Information

- OEM: 7229-2512-30
- Service: See Catalog
- Description: 46-Way F (BK)

Terminal Part Information

- Pins: 1, 2
- Terminal/Tray: 1-968859-3/7
- Core/Insulation Crimp: A/3
- Release Tool/Test Probe: 12093647/J-35616-4A (PU)

- Pins: 3, 4
- Terminal/Tray: 1-968857-3/7
- Core/Insulation Crimp: C/1
- Release Tool/Test Probe: 12093647/J-35616-4A (PU)

- Pins: 5-10, 14-16, 18, 20, 25-27, 35, 37. 45
- Terminal/Tray: 1928498014/17
- Core/Insulation Crimp: N/N

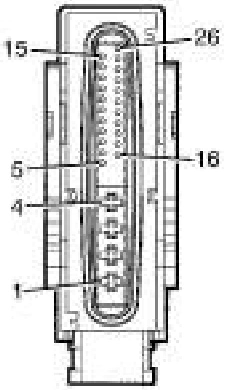
- Release Tool/Test Probe: J-38125-560/J-35616-64B (L-BU)

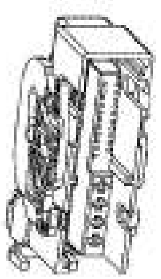
- Pins: 28
- Terminal/Tray: 1928498014/17
- Core/Insulation Crimp: N/N
- Release Tool/Test Probe: J-38125-560/J-35616-64B (L-BU)

Electronic Brake Control Module (EBCM) (JL4)

Pin	Wire Color	Circuit No.	Function
1	3 BK	350	Ground
2	3 RD/BK	142	Battery Positive Voltage
3	2 OG	3540	Battery Positive Voltage
4	2 BK	350	Ground
5	0.5 L-BU	830	Left Front Wheel Speed Sensor Signal
6	0.5 GY	7127	Wheel Speed Sensor Supply Voltage Left Rear
7	0.5 GY	7128	Wheel Speed Sensor Supply Voltage Right Rear
8	0.5 BN	882	Right Rear Wheel Speed Sensor Signal
9	0.5 GY	7065	Wheel Speed Sensor Supply Voltage Right Front
10	0.5 D-GN	872	Wheel Speed Sensor Signal Right Front
11-13	--	--	Not Used
14	0.5 BN	9003	High Speed GMLAN Serial Data Bus-
15	0.5 BK/BU	2088	Steering Wheel Position Sensor Low Reference
16	0.5 BN/WH	2086	Yaw Rate Sensor Test Control
17	--	--	Not Used
18	0.5 D-GN	2087	Steering Wheel Position Sensor 5-V Reference
19	--	--	Not Used
20	0.5 PU/WH	1699	Combined Vehicle Inertial Sensor Signal
21-24	--	--	Not Used
25	0.5 BN	9001	High Speed GMLAN Serial Data Bus-
26	0.5 GY	7064	Wheel Speed Sensor Supply Voltage Left Front
27	0.5 BN/BK	884	Left Rear Wheel Speed Sensor Signal
28	0.75 L-BU	5986	Communication Enable Relay Supply Voltage
29-34	--	--	Not Used
35	0.5 BN/BK	9002	High Speed GMLAN Serial Data Bus+
36	--	--	Not Used
37	0.5 L-GN/BK	5352	Yaw Rate Sensor Test Control
38-44	--	--	Not Used
45	0.5 BN/BK	9000	High Speed GMLAN Serial Data Bus+ (LY7)
46	--	--	Not Used

Electronic Brake Control Module (EBCM) (JL9)





Connector Part Information

- OEM: 1928404406
- Service: See Catalog
- Description:

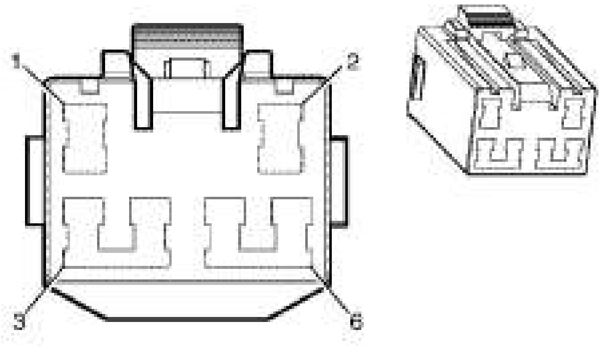
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Electronic Brake Control Module (EBCM) (JL9)

Pin	Wire Color	Circuit No.	Function
1	3 BK	350	Ground
2	3 RD/BK	142	Battery Positive Voltage
3	2 OG	3540	Battery Positive Voltage
4	2 BK	350	Ground
5	0.5 L-BU	830	Left Front Wheel Speed Sensor Signal
6	0.5 GY	7127	Left Rear Wheel Speed Sensor Supply Voltage
7	0.5 GY	7128	Right Rear Wheel Speed Sensor Supply Voltage
8	0.5 BN	882	Right Rear Wheel Speed Sensor Signal
9	0.5 GY/WH	7065	Right Front Wheel Speed Sensor Supply Voltage
10	0.5 D-GN	872	Right Front Wheel Speed Sensor Signal
11-13	--	--	Not Used
14	0.5 BN	2501	High Speed GMLAN Serial Data Bus-
15	0.5 BN	2501	High Speed GMLAN Serial Data Bus-
16	0.5 GY	7064	Left Front Wheel Speed Sensor Supply Voltage
17	0.5 BN/BK	884	Left Rear Wheel Speed Sensor Signal
18	0.5 L-BU	5986	Communication Enable Relay Supply Voltage
19-24	--	--	Not Used
25	0.5 BN/BK	2500	High Speed GMLAN Serial Data Bus+
25	0.5 BN/BK	2500	High Speed GMLAN Serial Data Bus+

Electronic Suspension Control (ESC) Switch (HSV)



Connector Part Information

- OEM: 7282-1060
- Service: See Catalog
- Description: 6-Way F

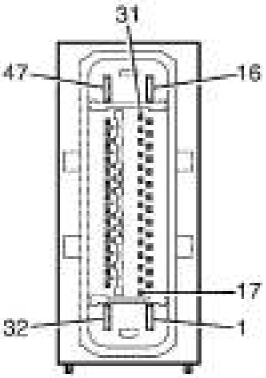
Terminal Part Information

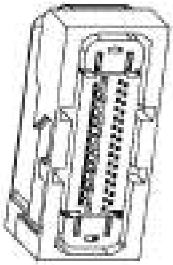
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Electronic Suspension Control (ESC) Switch (HSV)

Pin	Wire Color	Circuit No.	Function
1	0.35 L-BU	5986	Communication Enable Relay Supply Voltage
2	0.35 BK	850	Ground
3	0.35 YE/GN	1437	Firm LED Supply Voltage
4	0.35 BK	850	Ground
5	0.35 YE/RD	1384	Electronic Suspension Control Switch Signal
6	0.35 BK	6817	Ground

Electronic Suspension Control (ESC) Module (HSV)





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 47-Way F

Terminal Part Information

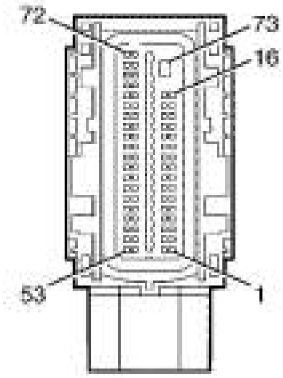
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

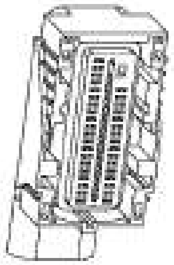
Electronic Suspension Control (ESC) Module (HSV)

Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used
2	0.3 D-BU/WH	1205	Left Front Suspension Position Sensor Voltage Reference
3	0.3 D-GN/WH	1211	Right Front Suspension Position Sensor Voltage Reference
4	0.3 GY/WH	1208	Left Rear Suspension Position Sensor Voltage Reference
5	0.3 BN/WH	1214	Right Rear Suspension Position Sensor Voltage Reference
6-7	--	--	Not Used
8	0.3 YE/BK	370	Module Signal Error
9	0.3 YE/GN	1437	Firm LED Supply Voltage
10	--	--	Not Used
11	0.3 BN/BK	1215	Right Rear Suspension Position Sensor Low Reference
12-16	--	--	Not Used
17	0.3 D-BU	1207	Left Front Suspension Position Sensor Signal
18	0.3 D-GN	1213	Right Front Suspension Position Sensor Signal
19	0.3 BN	1216	Right Rear Suspension Position Sensor Signal
20	--	--	Not Used
21	0.35 YE/RD	1384	Electronic Suspension Control Switch Signal
22-23	--	--	Not Used
24	0.3 BN	2501	High Speed GMLAN Serial Data Bus-
25	0.3 BN/BK	2500	High Speed GMLAN Serial Data Bus+

26	0.3 D-GN/BK	1212	Right Front Suspension Position Sensor Low Reference
27	0.3 GY/BK	1209	Left Rear Suspension Position Sensor Low Reference
28	0.85 WH/BK	1115	Left Rear Damper Low Reference
29	0.85 PU/WH	1117	Right Front Damper Low Reference
30	0.85 PK/BK	1113	Left Front Damper Low Reference
31	0.5 L-BU	5986	Communication Enable Relay Supply Voltage
32	2 RD/BU	2640	Battery Positive Voltage
33	0.3 GY	1210	Left Rear Suspension Position Sensor Signal
34-38	--	--	Not Used
39	0.3 BN	2501	High Speed GMLAN Serial Data Bus-
40	0.3 BN/BK	2500	High Speed GMLAN Serial Data Bus+
41	0.3 D-BU/BK	1206	Left Front Suspension Position Sensor Low Reference
42	0.85 L-GN/BK	1119	Right Rear Damper Control
43	0.85 WH/RD	1114	Left Rear Damper Control
44	0.85 L-GN/BK	1118	Right Rear Damper Low Reference
45	0.85 PU	1116	Right Front Damper Control
46	0.85 PK	1107	Left Front Damper Control
47	2 BK	850	Ground

Engine Control Module (ECM) (L98 or HSV or LS2) X1





Connector Part Information

- OEM: 7283-9139-30
- Service: See Catalog
- Description: 73-Way F

Terminal Part Information

- Pins: 1-72
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit

- Release Tool/Test Probe: See Terminal Repair Kit

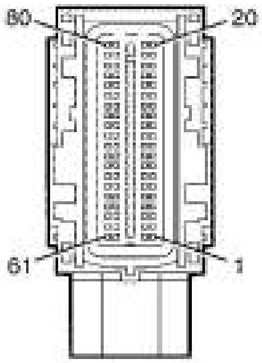
- Pin: 73
- Terminal/Tray: 7116-4152-02/9
- Core/Insulation Crimp: 2/5
- Release Tool/Test Probe: 12094430/J-35616-35 (VT)

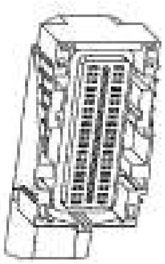
Engine Control Module (ECM) (L98 or HSV or LS2) X1

Pin	Wire Color	Circuit No.	Function
1	0.5 OG/BK	1786	Park/Neutral Signal
2-5	--	--	Not Used
6	0.5 BN/WH		Cruise Control Disable Clutch Switch Signal
7	--	--	Not Used
8	0.5 L-GN	5007	Backup Lamp Switch Signal
9	0.5 WH/BU	17	Stop Lamp Switch Signal
10	0.5 PU/WH	1668	HO2S High Signal (Bank 1 Sensor 2)
11	0.5 BN/WH	1669	HO2S Low Signal (Bank 1 Sensor 2)
12	0.5 OG/BK	380	A/C Refrigerant Pressure Sensor Signal
13	0.5 BN/GN	2759	Low Reference
14-15	--	--	Not Used
16	0.5 PU	1589	Fuel Level Sensor Signal (Primary)
17	0.5 D-BU/BK	473	High Speed Cooling Fan Relay Control (L98)
	0.5 D-BU	473	High Speed Cooling Fan Relay Control (HSV)
18	0.5 D-BU	5985	Accessory Wakeup Serial Data
19	0.5 PK	439	Ignition 1 Voltage
20	0.75 OG/BK	540	Battery Positive Voltage
21-22	--	--	Not Used
23	0.5 PU	1272	Low Reference
24-26	--	--	Not Used
27	0.5 BN	9001	High Speed GMLAN Serial Data Bus-
28	0.5 BN/BK	9000	High Speed GMLAN Serial Data Bus+
29	0.5 D-BU/WH	1161	APP Sensor 1 Signal
30	0.5 BN	1271	Low Reference
31	0.5 BN/YE	452	Low Reference
32	0.5 L-BU	1162	APP Sensor 2 Signal
33	--	--	Not Used
34	0.5 GY	1688	5-Volt Reference
35	--	--	Not Used
36	0.5 BN/YE	1274	5-Volt Reference
37	0.5 BN/RD	472	IAT Sensor Signal
38	0.5 BN/WH	2760	Low Reference
39-40	--	--	Not Used

41	0.5 YE	492	MAF Sensor Signal
42	--	--	Not Used
43			High Speed Cooling Fan Relay Control
44-46	--	--	Not Used
47	0.75 PK/BK	5290	Ignition 1 Voltage (L98)
	0.75 BK	5290	Ignition 1 Voltage (HSV)
48	--	--	Not Used
49	0.5 BN/WH	1671	HO2S Low Signal (Bank 2 Sensor 2)
50	0.5 D-GN/WH	465	Fuel Pump Relay Control (Primary)
51	--	--	Not Used
52	0.5 YE	447	Starter Relay Coil Control
53-55	--	--	Not Used
56	0.5 WH/BK	1164	5-Volt Reference
57	--	--	Not Used
58	0.5 D-GN	335	Low Speed Cooling Fan Relay Control
59	0.5 BN	5069	Main Relay Control
60-63	--	--	Not Used
64	0.5 OG/WH	3223	HO2S Heater Low Control (Bank 2 Sensor 2)
65	0.5 BN	2391	HO2S Heater Low Control (Bank 1 Sensor 2)
66-67	--	--	Not Used
68	0.5 BN/WH	419	MIL Control
69	0.5 PU	1670	HO2S High Signal (Bank 2 Sensor 2)
70	0.5 L-BU	1937	Fuel Level Sensor Signal (Secondary)
71-72	--	--	Not Used
73	2 BK	450	Ground

Engine Control Module (ECM) (L98 or HSV or LS2) X2





Connector Part Information

- OEM: 7283-9623-40
- Service: See Catalog
- Description: 80-Way F

Terminal Part Information

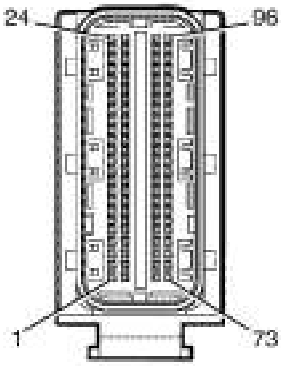
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

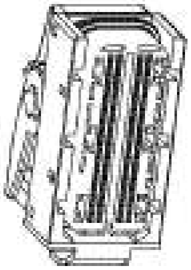
Engine Control Module (ECM) (L98 or HSV or LS2) X2

Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used
2	0.5 L-GN	1867	5-Volt Reference
3	0.5 GY	2701	5-Volt Reference
4	--	--	Not Used
5	0.75 BN	582	TAC Motor Control - 2
6	0.75 YE	581	TAC Motor Control - 1
7	--	--	Not Used
8	0.75 D-GN/WH	428	EVAP Canister Purge Solenoid Control
9-10	--	--	Not Used
11	0.75 L-GN	5494	Reverse Lockout Solenoid Control
12	0.5 GY/WH	3113	HO2S Heater Low Control (Bank 1 Sensor 1)
13	0.5 L-GN	3212	HO2S Heater Low Control (Bank 2 Sensor 1)
14-16	--	--	Not Used
17	0.75 D-BU/WH	878	Fuel Injector 8 Control
18	0.75 BN/WH	845	Fuel Injector 5 Control
19	0.75 YE/BK	846	Fuel Injector 6 Control
20	0.75 BN/BK	1744	Fuel Injector 1 Control
21	0.5 YE/GN	410	ECT Sensor Signal
22	0.5 BN/WH	2761	Low Reference
23	0.5 D-GN/YE	357	Oil Temperature Sensor Signal
24	0.5 BN/RD	470	Low Reference
25	--	--	Not Used
26	0.5 D-BU	496	Knock Sensor 1 Signal
27	0.5 GY	1716	Low Reference Knock Sensor Signal Return
28	--	--	Not Used
29	0.5 L-BU	1876	Knock Sensor 2 Signal
30	0.5 TN	407	Low Reference
31	--	--	Not Used
32	0.5 PU/WH	23	Generator Field Duty Cycle Signal
33	0.5 BN	1174	Oil Level Switch Signal
34	0.5 BK	2755	Low Reference

35	0.5 BN/BK	2752	Low Reference
36	--	--	Not Used
37	0.75 L-GN/BK	1745	Fuel Injector 2 Control
38	0.75 PK/BK	1746	Fuel Injector 3 Control
39	0.75 L-BU/BK	844	Fuel Injector 4 Control
40	0.75 OG/BK	877	Fuel Injector 7 Control
41	0.5 GY	2705	5-Volt Reference
42	--	--	Not Used
43	0.5 GY	2704	5-Volt Reference
44	0.5 OG	631	5-Volt Reference
45-49	--	--	Not Used
50	0.5 BN/WH	331	Oil Pressure Sensor Signal
51-52	--	--	Not Used
53	0.5 OG/BK	469	Low Reference
54-55	--	--	Not Used
56	0.5 BN/YE	1664	HO2S Low Signal (Bank 1 Sensor 1)
57	0.5 PU/WH	1665	HO2S High Signal (Bank 1 Sensor 1)
58	0.5 L-GN	432	MAP Sensor Signal
59	0.5 PU	1666	HO2S High Signal (Bank 2 Sensor 1)
60	0.5 BN/RD	1667	HO2S Low Signal (Bank 2 Sensor 1)
61	0.5 OG/WH	225	Generator Turn On Signal
62	--	--	Not Used
63	0.5 PU	486	TP Sensor 2 Signal
64	0.5 BN/WH	633	CMP Sensor Signal
65	0.5 D-GN	485	TP Sensor 1 Signal
66	0.5 PK/BK	632	Low Reference
67	--	--	Not Used
68	0.5 D-BU/WH	1869	CKP Sensor Signal
69	0.5 YE/BK	1868	Low Reference
70	0.5 PU	2121	IC 1 Control
71	0.5 PU/WH	2128	IC 8 Control
72	0.5 OG	2127	IC 7 Control
73	0.5 OG/WH	2122	IC 2 Control
74	0.5 L-BU/WH	2126	IC 6 Control
75	0.5 D-GN/RD	2125	IC 5 Control
76	0.5 D-GN/WH	2124	IC 4 Control
77	0.5 L-BU	2123	IC 3 Control
78	0.5 BN	2129	Low Reference
79	0.5 BN/WH	2130	Low Reference
80	--	--	Not Used

Engine Control Module (ECM) (LY7) X1





Connector Part Information

- OEM: 7283-3389-30
- Service: See Catalog
- Description: 96-Way F (BK)

Terminal Part Information

- Terminal/Tray: 1928498135/19
- Core/Insulation Crimp: J/J
- Release Tool/Test Probe: J-38125-213/J-35616-64B (L-BU)

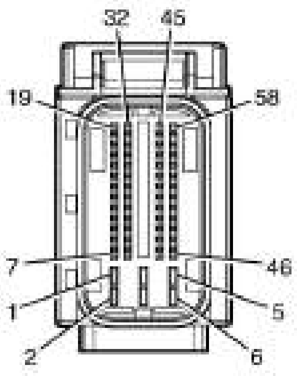
Engine Control Module (ECM) (LY7) X1

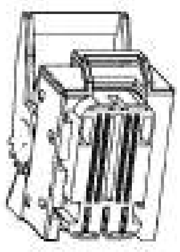
Pin	Wire Color	Circuit No.	Function
1	0.75 L-GN	5282	Cam Phaser Exhaust 1 Signal
2	0.75 PU	5284	Cam Phaser Intake 1 Signal
3	--	--	Not Used
4	0.75 YE/BK	846	Fuel Injector 6 Control
5	0.75 D-GN/WH	428	EVAP Canister Purge Solenoid Control
6	--	--	Not Used
7	0.5 OG/BU	5275	Intake 1 Cam Position Sensor Signal
8	--	--	Not Used
9	0.5 PU	5274	Exhaust 2 Cam Position Sensor Signal
10	0.5 OG/WH	225	Generator Turn On Signal
11	0.5 BN	1174	Oil Level Switch Signal
12	0.75 L-BU/WH		VIM PWM Signal
13	0.5 PK	6414	Low Reference
14	--	--	Not Used
15	0.75 GY	705	5-Volt Reference
16-23	--	--	Not Used

24	0.75 YE	581	TAC Motor Control - 1
25	0.75 WH/BK	5283	Cam Phaser Exhaust 2 Signal
26	0.75 PK/BK	1746	Fuel Injector 3 Control
27	--	--	Not Used
28	0.75 BN/WH	845	Fuel Injector 5 Control
29	--	--	Not Used
30	0.5 PU/WH	23	Generator Field Duty Cycle Signal
31-32	--	--	Not Used
33	0.5 YE/RD	5276	Intake 2 Cam Position Sensor Signal
34	0.5 D-GN	5273	Exhaust 1 Cam Position Sensor Signal
35	0.5 YE/BU	573	CKP Sensor 1 Signal
36-38	--	--	Not Used
39	0.5 GY	2701	5-Volt Reference
40	0.5 GY	596	5-Volt Reference
41	0.75 PK/BK	632	Low Reference
42	--	--	Not Used
43	0.5 BN/RD	470	Low Reference
44	0.5 BK	2755	Low Reference
45	0.5 PU/WH	605	5-Volt Reference
46	0.5 PU	574	Low Reference
47	--	--	Not Used
48	0.75 BN	582	TAC Motor Control - 2
49	0.75 OG/BK	5272	Cam Phaser Intake 2 Signal
50	0.75 L-BU/BK	844	Fuel Injector 4 Control
51	0.75 BN/BK	1744	Fuel Injector 1 Control
52	0.75 L-GN/BK	1745	Fuel Injector 2 Control
53-54	--	--	Not Used
55	0.5 PU	2121	IC 1 Control
56	0.5 L-BU	2123	IC 3 Control
57	0.5 D-GN/RD	2125	IC 5 Control
58	--	--	Not Used
59	0.5 D-BU	496	Knock Sensor 1 Signal
60	0.5 BN	407	Low Reference
61	0.5 BN/WH	331	Oil Pressure Sensor Signal
62-66	--	--	Not Used
67	0.5 BN/YE	1664	HO2S Low Signal (Bank 1 Sensor 1)
68	0.5 WH		HO2S Output Pump Current (Bank 1 Sensor 1)
69	0.5 OG		HO2S Input Pump Current (Bank 2 Sensor 1)
70	0.5 PU	1666	HO2S High Signal (Bank 2 Sensor 1)
71	--	--	Not Used

72	0.75 L-GN	3212	HO2S Low Signal (Bank 2 Sensor 1)
73-77	--	--	Not Used
78	0.5 PU	6413	Low Reference
79	0.5 OG/WH	2122	IC 2 Control
80	0.5 D-GN/WH	2124	IC 4 Control
81	0.5 L-BU/WH	2126	IC 6 Control
82	0.5 YE/GN	410	ECT Sensor Signal
83	0.5 GY	1716	Low Reference
84	0.5 L-BU	1876	Knock Sensor 2 Signal
85	0.5 D-GN/YE	357	Oil Temperature Sensor Signal
86-87	--	--	Not Used
88	0.5 BN/BK	2752	Low Reference
89	0.5 PU	486	TP Sensor 2 Signal
90	0.5 D-GN	485	TP Sensor 1 Signal
91	0.5 L-GN		HO2S Input Pump Current (Bank 1 Sensor 1)
92	0.5 PU/WH	1665	HO2S High Signal (Bank 1 Sensor 1)
93	0.5 BN/RD	1667	HO2S Low Signal (Bank 2 Sensor 1)
94	0.5 PU/WH		HO2S Output Pump Current (Bank 2 Sensor 1)
95	--	--	Not Used
96	0.75 GY/WH	3113	HO2S Heater Low Control (Bank 1 Sensor 1)

Engine Control Module (ECM) (LY7) X2





Connector Part Information

- OEM: 7283-3487-30
- Service: See Catalog
- Description: 58-Way F (BK)

Terminal Part Information

- Pins: 1-6
- Terminal/Tray: 1928498056/8
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: J-38125-561/J-35616-35 (VT)

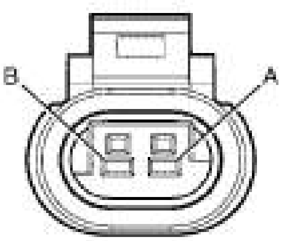
- Pins: 7, 9-11, 13-15, 17, 19-27, 34-39, 41, 42, 45-52, 54-58
- Terminal/Tray: 1928498135/19
- Core/Insulation Crimp: J/J
- Release Tool/Test Probe: J-38125-213/J-35616-64B (L-BU)

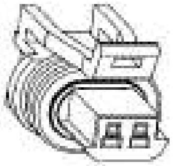
Engine Control Module (ECM) (LY7) X2

Pin	Wire Color	Circuit No.	Function
1	0.5 BK	450	Ground
2	0.5 BK	450	Ground
3	0.75 PK/BU	5290	Ignition 1 Voltage
4	0.5 BK	450	Ground
5	0.75 PK/BK	5290	Ignition 1 Voltage
6	0.75 PK/BU	5290	Ignition 1 Voltage
7	0.75 GY/WH	3122	HO2S Heater Low Control (Bank 1 Sensor 2)
8	--	--	Not Used
9	0.5 BN/YE	452	Low Reference
10	0.5 D-GN/WH	465	Fuel Pump Relay Control (Primary)
11	0.5 BN/GN	2759	Low Reference
12	--	--	Not Used
13	0.5 YE	492	MAF Sensor Signal
14	--	--	Not Used
15	0.5 D-BU/WH	1161	APP Sensor 1 Signal
16	0.5 BN/WH		CPP Switch Signal
17	0.5 D-GN		Park/Neutral/Clutch Safety Switch Signal
18	0.5 L-GN		Backup Lamp Switch Signal
19	--	--	Not Used
20	0.75 OG/WH	3223	HO2S Heater Low Control (Bank 2 Sensor 2)
21	0.5 BN/WH	419	MIL Control
22	0.5 BN/WH	2760	Low Reference
23	0.5 BN/GN	3121	HO2S Low Signal (Bank 1 Sensor 2)
24	0.5 BN/RD	3221	HO2S Low Signal (Bank 2 Sensor 2)
25	0.5 L-BU	1162	APP Sensor 2 Signal
26	0.5 L-BU	1937	Fuel Level Sensor Signal (1)
27-33	--	--	Not Used
34	0.5 BN	1271	Low Reference
35	0.5 GY	2709	5-Volt Reference
36	0.5 PU	1589	Fuel Level Sensor Signal (2)
37	--	--	Not Used

38	0.5 PU	3120	HO2S High Signal (Bank 1 Sensor 2)
39	0.5 OG/BK	380	A/C Refrigerant Pressure Sensor Signal
40	--	--	Not Used
41	0.5 D-BU	5985	Accessory Wakeup Serial Data
42	0.5 BN/BK	9000	High Speed GMLAN Serial Data Bus+
43-44	--	--	Not Used
45	0.5 D-BU/BK	473	High Speed Cooling Fan Relay Control
46	0.5 D-GN	335	Low Speed Cooling Fan Relay Control
47	0.5 PU	1272	Low Reference
48	0.5 BN/YE	1274	5-Volt Reference
49	0.5 WH/BK	1164	5-Volt Reference
50	0.5 BN/RD	472	IAT Sensor Signal
51	0.5 PU	3220	HO2S High Signal (Bank 2 Sensor 2)
52	0.5 WH/BU	17	Stop Lamp Switch Signal
53	--	--	Not Used
54	0.5 PK	439	Ignition 1 Voltage
55	0.5 BN	9001	High Speed GMLAN Serial Data Bus-
56	0.75 OG/BK	540	Battery Positive Voltage
57	0.5 YE	447	Starter Relay Coil Control
58	0.5 BN	5069	Main Relay Control

Engine Coolant Temperature (ECT) Sensor (L98 or HSV)





Connector Part Information

- OEM: 7283-0370-30
- Service: See Catalog
- Description: 2-Way F

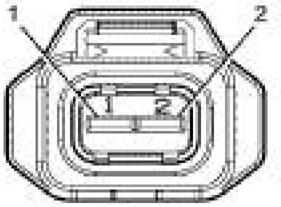
Terminal Part Information

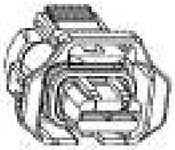
- Terminal/Tray: 15326267/19
- Core/Insulation Crimp: E/4
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Engine Coolant Temperature (ECT) Sensor (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.5 BN/WH	2761	Low Reference
B	0.5 YE/GN	410	ECT Sensor Signal

Engine Coolant Temperature (ECT) Sensor (LY7)





Connector Part Information

- OEM: 7283-6205-30
- Service: See Catalog
- Description: 2-Way F (BK)

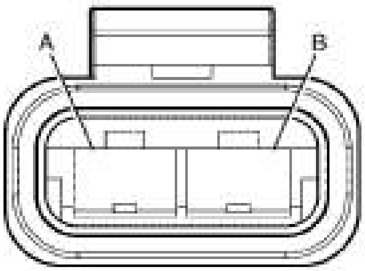
Terminal Part Information

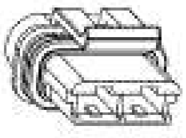
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Engine Coolant Temperature (ECT) Sensor (LY7)

Pin	Wire Color	Circuit No.	Function
1	0.5 YE/GN	410	ECT Sensor Signal
2	0.5 BK	2755	Low Reference

Engine Cooling Fan - Left





Connector Part Information

- OEM: 12020341
- Service: See Catalog
- Description: 2-Way F Metri-Pack 630 Series Sealed (BK)

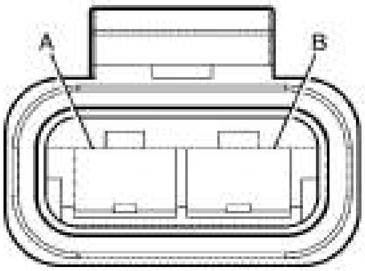
Terminal Part Information

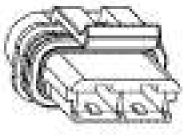
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Engine Cooling Fan - Left

Pin	Wire Color	Circuit No.	Function
A	3 BK	250	Ground
B	3 D-BU	409	Left Cooling Fan Motor Supply Voltage

Engine Cooling Fan - Right





Connector Part Information

- OEM: 12020341

- Service: See Catalog
- Description: 2-Way F Metri-Pack 630 Series Sealed (BK)

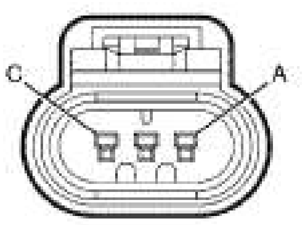
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Engine Cooling Fan - Right

Pin	Wire Color	Circuit No.	Function
A	3 GY	532	Right Cooling Fan Motor Low Reference
B	3 WH	504	Right Cooling Fan Motor Supply Voltage

Engine Oil Level and Temperature Sensor



Connector Part Information

- OEM: 7283-6579-30
- Service: See Catalog
- Description: 3-Way F (BK)

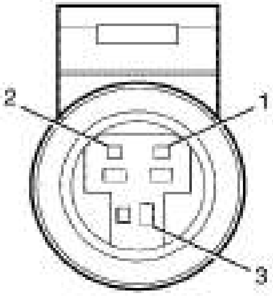
Terminal Part Information

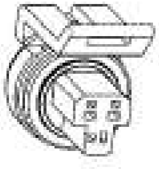
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Engine Oil Level and Temperature Sensor

Pin	Wire Color	Circuit No.	Function
A	0.5 BN	1174	Oil Level Switch Signal
B	0.5 D-GN/YE	357	Oil Temperature Sensor Signal (L98 or LY7)
	0.5 YE	357	Oil Temperature Sensor Signal (HSV)
C	0.5 BN/RD	470	Low Reference (L98 or HSV)
	0.5 BK	2755	Low Reference (LY7)

Engine Oil Pressure (EOP) Sensor





Connector Part Information

- OEM: 7283-2429
- Service: See Catalog
- Description: 3-Way F (BK)

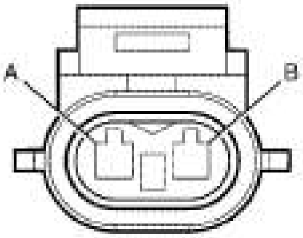
Terminal Part Information

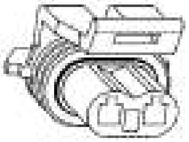
- Terminal/Tray: 15326267/19
- Core/Insulation Crimp: E/4
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Engine Oil Pressure (EOP) Sensor

Pin	Wire Color	Circuit No.	Function
1	0.5 BK	2755	Low Reference (L98 or HSV)
	0.5 BN/RD	470	Low Reference (LY7)
2	0.5 GY	2705	5-Volt Reference (L98 or HSV)
	0.5 GY	596	5-Volt Reference (LY7)
3	0.5 BN/WH	331	Oil Pressure Sensor Signal (L98 or HSV)
	0.5 BN/WH	331	Oil Pressure Sensor Signal (LY7)

Evaporative Emission (EVAP) Canister Purge Solenoid Valve (L98 or HSV)





Connector Part Information

- OEM: 7223-9922-50
- Service: 12101858
- Description: 2-Way F

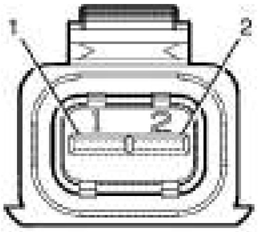
Terminal Part Information

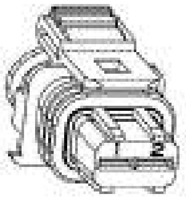
- Terminal/Tray: 12048074/2
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Evaporative Emission (EVAP) Canister Purge Solenoid Valve (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.75 PK/BU	5293	Ignition 1 Voltage
B	0.75 D-GN/WH	428	EVAP Canister Purge Solenoid Control

Evaporative Emission (EVAP) Canister Purge Solenoid Valve (LY7)





Connector Part Information

- OEM: 7283-5483-30
- Service: See Catalog
- Description: 2-Way F (BK)

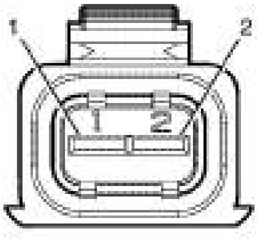
Terminal Part Information

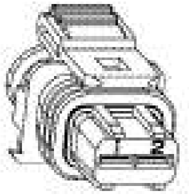
- Terminal/Tray: 1928498056/8
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: J-38125-561/J-35616-35 (VT)

Evaporative Emission (EVAP) Canister Purge Solenoid Valve (LY7)

Pin	Wire Color	Circuit No.	Function
1	0.75 PK/BU	5293	Ignition 1 Voltage
2	0.75 D-GN/WH	428	EVAP Canister Purge Solenoid Control

Evaporative Emission (EVAP) Canister Vent Solenoid Valve





Connector Part Information

- OEM: 12052643
- Service: 12101858
- Description: 2-Way F Metri-Pack 150 Series Sealed (RD)

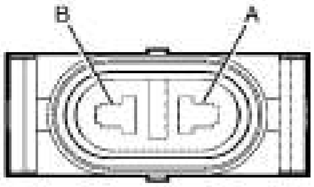
Terminal Part Information

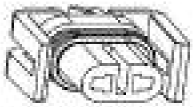
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Evaporative Emission (EVAP) Canister Vent Solenoid Valve

Pin	Wire Color	Circuit No.	Function
A	0.5 OG	3140	Battery Positive Voltage
B	0.5 WH	1310	EVAP Canister Vent Solenoid Control

Fog Lamp - Left Front





Connector Part Information

- OEM: 7223-9928-30
- Service: See Catalog
- Description: 2-Way F 150 Series (BK)

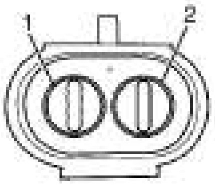
Terminal Part Information

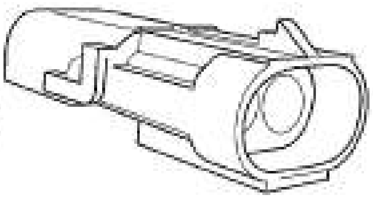
- Terminal/Tray: 12077411/2
- Core/Insulation Crimp: 2/5
- Release Tool/Test Probe: 12094430/J-35616-4A (PU)

Fog Lamp - Left Front

Pin	Wire Color	Circuit No.	Function
A	0.75 PU	34	Fog Lamps Supply Voltage
B	0.75 BK	350	Ground

Fog Lamp - Rear (T79)





Connector Part Information

- OEM: 1418893-1
- Service: See Catalog
- Description: 2-Way F

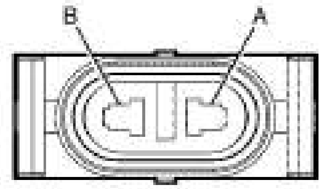
Terminal Part Information

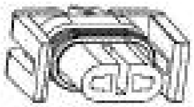
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Fog Lamp - Rear (T79)

Pin	Wire Color	Circuit No.	Function
1	0.5 OG	122	Rear Fog Lamp Supply Voltage
2	0.5 BK	1850	Ground

Fog Lamp - Right Front





Connector Part Information

- OEM: 7223-9928-30
- Service: See Catalog
- Description: 2-Way F 150 Series (BK)

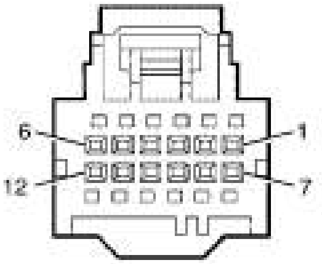
Terminal Part Information

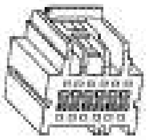
- Terminal/Tray: 12077411/2
- Core/Insulation Crimp: 2/5
- Release Tool/Test Probe: 12094430/J-35616-4A (PU)

Fog Lamp - Right Front

Pin	Wire Color	Circuit No.	Function
A	0.75 PU	34	Fog Lamps Supply Voltage
B	0.75 BK	350	Ground

Front and Rear Object Alarm Module X1





Connector Part Information

- OEM: 7283-9783-30
- Service: See Catalog
- Description: 12-Way F

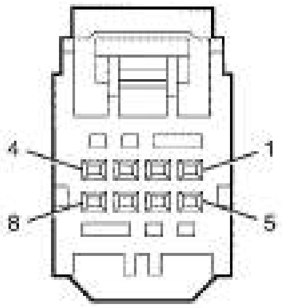
Terminal Part Information

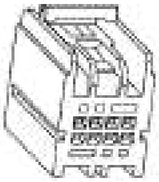
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Front and Rear Object Alarm Module X1

Pin	Wire Color	Circuit No.	Function
1	0.85 OG/PU	2140	Battery Positive Voltage
2	0.3 YE	5247	Object Detection Alarm Signal A
3	0.3 BN	5852	Instrument Panel Lamp Supply Voltage
4	--	--	Not Used
5	0.3 GY	5248	Object Detection Alarm Signal B
6	0.35 D-GN	5060	Low Speed GMLAN Serial Data
7	0.5 BK	1850	Ground
8	0.3 GY	2555	Object Detection Disable Signal
9-12	--	--	Not Used

Front and Rear Object Alarm Module X2





Connector Part Information

- OEM: 7283-9029-40
- Service: See Catalog
- Description: 8-Way F

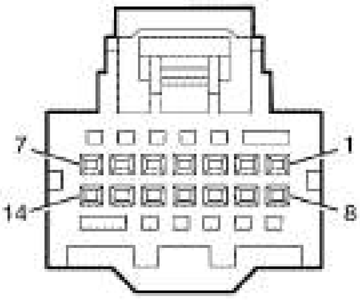
Terminal Part Information

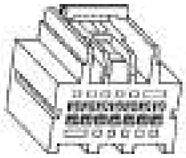
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Front and Rear Object Alarm Module X2

Pin	Wire Color	Circuit No.	Function
1	0.3 PU	2378	RR Corner Object Sensor Signal
2	0.3 D-GN	2377	RR Middle Object Sensor Signal
3	0.3 OG	2376	LR Middle Object Sensor Signal
4	0.3 D-BU	2374	Object Sensor Supply Voltage
5	0.3 YE	2375	LR Corner Object Sensor Signal
6-7	--	--	Not Used
8	0.3 GY	2379	Object Sensor Low Reference

Front and Rear Object Alarm Module X3





Connector Part Information

- OEM: 7283-9068-90
- Service: See Catalog
- Description: 14-Way F

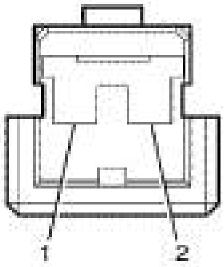
Terminal Part Information

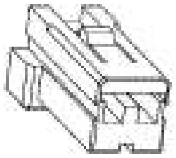
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Front and Rear Object Alarm Module X3

Pin	Wire Color	Circuit No.	Function
1	0.3 BN	6581	Object Sensor Supply Voltage
2-3	--	--	Not Used
4	0.3 PU/WH	5215	LF Corner Object Sensor Signal
5	0.3 WH	5216	LF Middle Object Sensor Signal
6-7	--	--	Not Used
8	0.3 OG/BK	5214	Object Sensor Low Reference
9	--	--	Not Used
10	0.3 WH	5218	RF Middle Object Sensor Signal
11	0.3 BN/WH	5217	RF Corner Object Sensor Signal
12-14	--	--	Not Used

Front and Rear Object Alarm





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 2-Way

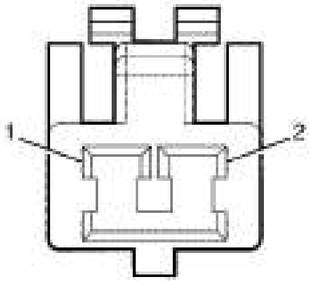
Terminal Part Information

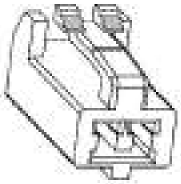
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Front and Rear Object Alarm

Pin	Wire Color	Circuit No.	Function
1	0.3 YE	5247	Object Detection Alarm Signal A
2	0.3 GY	5248	Object Detection Alarm Signal B

Fuel Door Release Actuator





Connector Part Information

- OEM: 7283-1020

- Service: 88953305
- Description: 2-Way F 2.3 Series (WH)

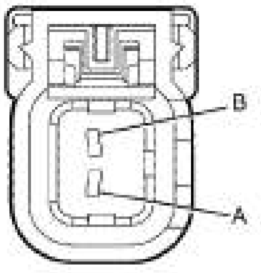
Terminal Part Information

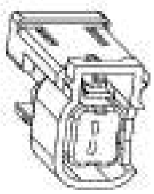
- Terminal/Tray: 7116-4021/11
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

Fuel Door Release Actuator

Pin	Wire Color	Circuit No.	Function
1	1.25 D-GN/WH	295	Door Lock Actuator Lock Control
2	1.25 BN/RD	694	Driver Door Lock Actuator Unlock Control

Fuel Injector 1 (LY7)





Connector Part Information

- OEM: 1-0190667-3
- Service: See Catalog
- Description: 2-way F (GY)

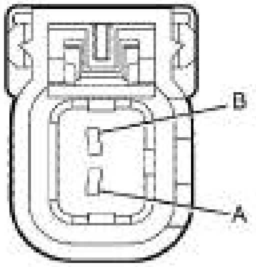
Terminal Part Information

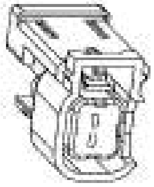
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Fuel Injector 1 (LY7)

Pin	Wire Color	Circuit No.	Function
A	0.8 PK/BU	5291	Ignition 1 Voltage
B	0.5 BN/BK	1744	Fuel Injector 1 Control

Fuel Injector 1 (L98 or HSV)





Connector Part Information

- OEM: 7283-8756
- Service: 15306318
- Description: 2-way F

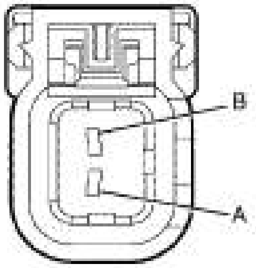
Terminal Part Information

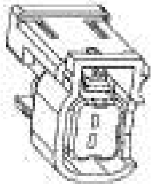
- Terminal/Tray:12176636/19
- Core/Insulation Crimp: C/1
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Fuel Injector 1 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.75 PK/BU	5291	Ignition 1 Voltage
B	0.75 BN/BK	1744	Fuel Injector 1 Control

Fuel Injector 2 (LY7)





Connector Part Information

- OEM: 1-0190667-3
- Service: See Catalog
- Description: 2-Way F (GY)

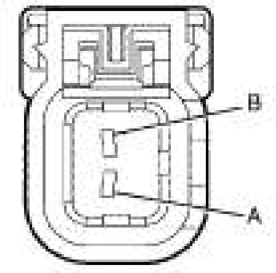
Terminal Part Information

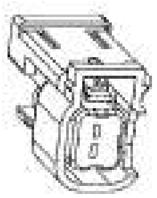
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Fuel Injector 2 (LY7)

Pin	Wire Color	Circuit No.	Function
A	0.8 PK	5292	Ignition 1 Voltage
B	0.8 L-GN/BK	1745	Fuel Injector 2 Control

Fuel Injector 2 (L98 or HSV)





Connector Part Information

- OEM: 7283-8756
- Service: 15306318
- Description: 2-Way F

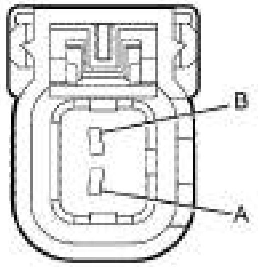
Terminal Part Information

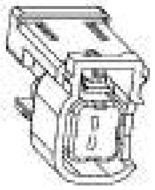
- Terminal/Tray:12176636/19
- Core/Insulation Crimp: C/1
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Fuel Injector 2 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.75 PK	5292	Ignition 1 Voltage
B	0.75 L-GN/BK	1745	Fuel Injector 2 Control

Fuel Injector 3 (LY7)





Connector Part Information

- OEM: 1-0190667-3
- Service: See Catalog
- Description: 2-Way F (GY)

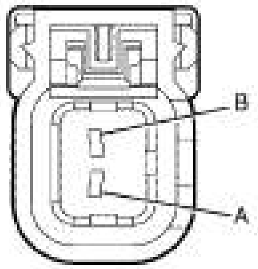
Terminal Part Information

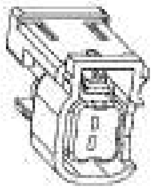
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Fuel Injector 3 (LY7)

Pin	Wire Color	Circuit No.	Function
A	0.8 PK/BU	5291	Ignition 1 Voltage
B	0.8 PK/BK	1746	Fuel Injector 3 Control

Fuel Injector 3 (L98 or HSV)





Connector Part Information

- OEM: 7283-8756
- Service: 15306318
- Description: 2-Way F

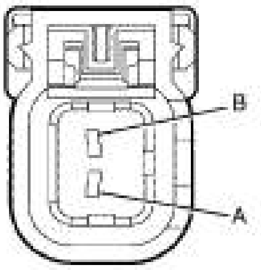
Terminal Part Information

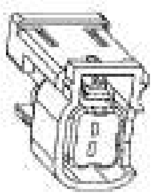
- Terminal/Tray:12176636/19
- Core/Insulation Crimp: C/1
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Fuel Injector 3 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.75 PK/BU	5291	Ignition 1 Voltage
B	0.75 PK/BK	1746	Fuel Injector 3 Control

Fuel Injector 4 (LY7)





Connector Part Information

- OEM: 1-0190667-3
- Service: See Catalog
- Description: 2-Way F (GY)

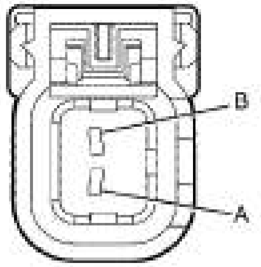
Terminal Part Information

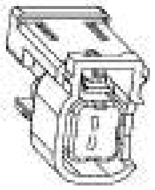
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Fuel Injector 4 (LY7)

Pin	Wire Color	Circuit No.	Function
A	0.8 PK	5292	Ignition 1 Voltage
B	0.8 L-BU/BK	844	Fuel Injector 4 Control

Fuel Injector 4 (L98 or HSV)





Connector Part Information

- OEM: 7283-8756
- Service: 15306318
- Description: 2-Way F

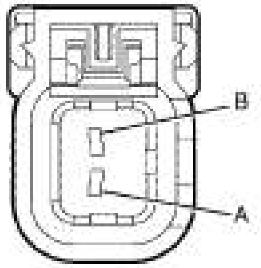
Terminal Part Information

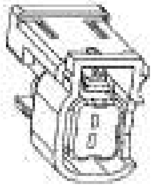
- Terminal/Tray:12176636/19
- Core/Insulation Crimp: C/1
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Fuel Injector 4 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.75 PK	5292	Ignition 1 Voltage
B	0.75 L-BU/BK	844	Fuel Injector 4 Control

Fuel Injector 5 (LY7)





Connector Part Information

- OEM: 1-0190667-3
- Service: See Catalog
- Description: 2-Way F (GY)

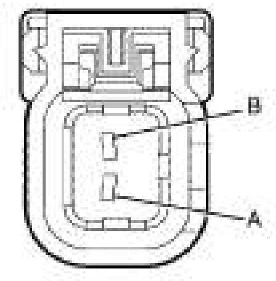
Terminal Part Information

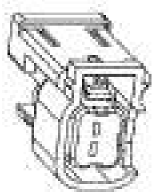
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Fuel Injector 5 (LY7)

Pin	Wire Color	Circuit No.	Function
A	0.8 PK/BU	5291	Ignition 1 Voltage
B	0.8 BN/WH	845	Fuel Injector 5 Control

Fuel Injector 5 (L98 or HSV)





Connector Part Information

- OEM: 7283-8756
- Service: 15306318
- Description: 2-Way F

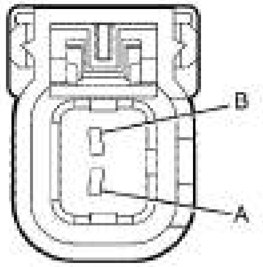
Terminal Part Information

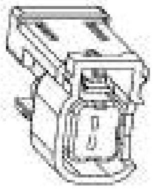
- Terminal/Tray:12176636/19
- Core/Insulation Crimp: C/1
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Fuel Injector 5 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.75 PK/BU	5291	Ignition 1 Voltage
B	0.75 BN/WH	845	Fuel Injector 5 Control

Fuel Injector 6 (LY7)





Connector Part Information

- OEM: 1-0190667-3
- Service: See Catalog
- Description: 2-Way F (GY)

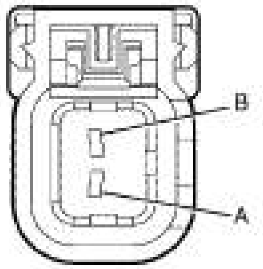
Terminal Part Information

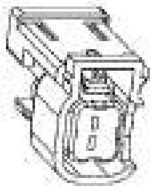
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Fuel Injector 6 (LY7)

Pin	Wire Color	Circuit No.	Function
A	0.8 PK	5292	Ignition 1 Voltage
B	0.8 YE/BK	846	Fuel Injector 6 Control

Fuel Injector 6 (L98 or HSV)





Connector Part Information

- OEM: 7283-8756
- Service: 15306318
- Description: 2-Way F

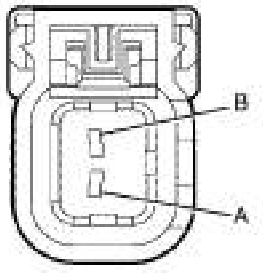
Terminal Part Information

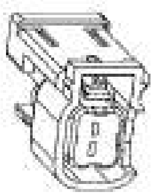
- Terminal/Tray:12176636/19
- Core/Insulation Crimp: C/1
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Fuel Injector 6 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.75 PK	5292	Ignition 1 Voltage
B	0.75 YE/BK	846	Fuel Injector 6 Control

Fuel Injector 7 (L98 or HSV)





Connector Part Information

- OEM: 7283-8756
- Service: 15306318
- Description: 2-Way F

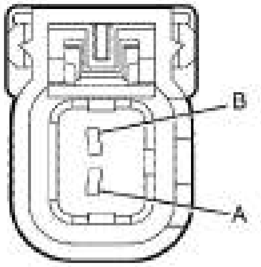
Terminal Part Information

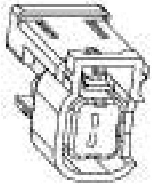
- Terminal/Tray:12176636/19
- Core/Insulation Crimp: C/1
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Fuel Injector 7 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.75 PK/BU	5291	Ignition 1 Voltage
B	0.75 OG/BK	877	Fuel Injector 7 Control

Fuel Injector 8 (L98 or HSV)





Connector Part Information

- OEM: 7283-8756
- Service: 15306318
- Description: 2-Way F

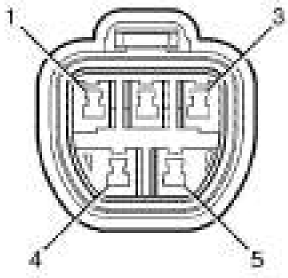
Terminal Part Information

- Terminal/Tray:12176636/19
- Core/Insulation Crimp: C/1
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Fuel Injector 8 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.75 PK	5292	Ignition 1 Voltage
B	0.75 D-BU/WH	878	Fuel Injector 8 Control

Fuel Level Sensor - Secondary



Connector Part Information

- OEM: 7283-1156
- Service: See Catalog
- Description: 5-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Fuel Level Sensor - Secondary

Pin	Wire Color	Circuit No.	Function
1	0.3 BN/YE	452	Fuel Return
2	0.5 L-BU	1937	Fuel Level
3-5	--	--	Not Used

Fuel Tank Pressure (FTP) Sensor

Connector Part Information

- OEM: 13511996
- Service: 19149288
- Description: 3-Way

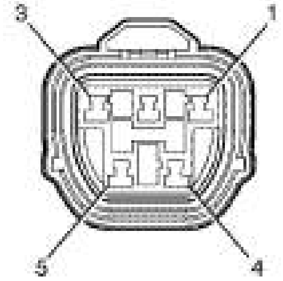
Terminal Part Information

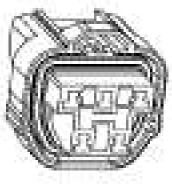
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Fuel Tank Pressure (FTP) Sensor

Pin	Wire Color	Circuit No.	Function
A	0.5 D-GN	890	Fuel Tank Pressure Sensor Signal
B	0.5 BN/YE	452	Low Reference
C	0.5 GY	2709	5-Volt Reference

Fuel Pump and Sender Assembly





Connector Part Information

- OEM: 15326631
- Service: 19152589
- Description: 4-Way F GT 280 5.8 Series Sealed (BK)

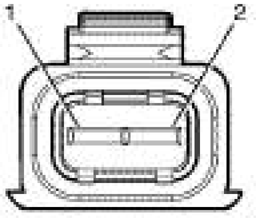
Terminal Part Information

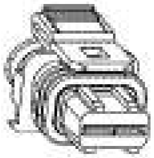
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Fuel Pump and Sender Assembly

Pin	Wire Color	Circuit No.	Function
1	2 GY	120	Fuel Pump Supply Voltage
2	0.5 PU	1589	Fuel Level Sensor Signal (Primary)
3	2 BK	1350	Ground
4	0.5 BN/YE	452	Low Reference
5	--	--	Not Used

Generator X1 (L76)





Connector Part Information

- OEM: 7283-5483-30
- Service: See Catalog
- Description: 2-Way F

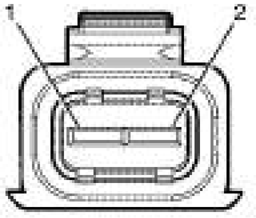
Terminal Part Information

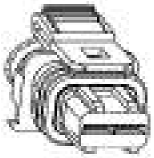
- Terminal/Tray: 1928498056/8
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: J-38125-561/J-35616-35 (VT)

Generator X1 (L76)

Pin	Wire Color	Circuit No.	Function
1	0.5 OG/WH	225	Generator Turn On Signal
2	0.5 PU/WH	23	Generator Field Duty Cycle Signal

Generator X1 (LY7)





Connector Part Information

- OEM: 7183-5344-30

- Service: See Catalog
- Description: 2-Way F (BK)

Terminal Part Information

- Terminal/Tray: 4-964286-1/16
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12093647/J-35616-4A (PU)

Generator X1 (LY7)

Pin	Wire Color	Circuit No.	Function
1	0.5 OG/WH	225	Generator Turn On Signal
2	0.5 PU/WH	23	Generator Field Duty Cycle Signal

Generator X2

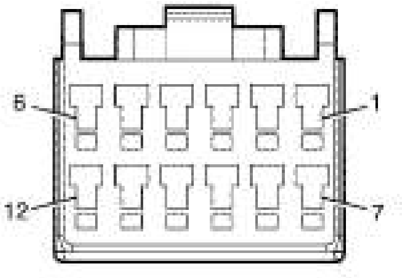
Terminal Part Information

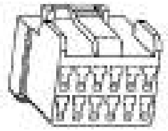
- Terminal: 7003-1190-02-DC
- Core/Insulation Crimp: N/A
- Description: Ring Terminal

Generator X2

Pin	Wire Color	Circuit No.	Function
+	19 RD	2	Battery Positive Voltage
	19 RD	2	Battery Positive Voltage

Headlamp and Panel Dimmer Switch





Connector Part Information

- OEM: 7123-1725-30
- Service: See Catalog
- Description: 12-Way F (BK)

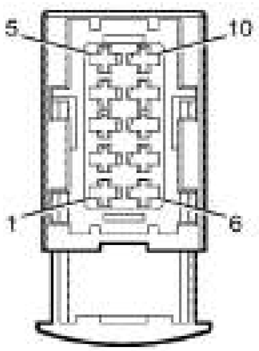
Terminal Part Information

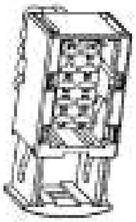
- Terminal/Tray: 173681-2/17
- Core/Insulation Crimp: E/4
- Release Tool/Test Probe: 15315247/J-35616-16 (L-GN)

Headlamp and Panel Dimmer Switch

Pin	Wire Color	Circuit No.	Function
1	0.3 WH	103	Headlamp Switch Headlamps On Signal
2	--	--	Not Used
3	0.3 D-GN	306	Headlamp Switch Headlamps Off Signal
4	0.3 BK	850	Ground
5	0.3 BN/WH	301	Park Lamp Switch On Signal
6	0.3 OG	192	Front Fog Lamp Switch Signal
7	0.3 GY/WH	7389	Headlamp Dimming Switch Down
8	0.3 YE	6817	Interior Lights Dimming Switch
9	--	--	Not Used
10	0.5 PK/BU	1339	Ignition 1 Voltage
11	--	--	Not Used
12	0.3 GY/BU	7388	Headlamp Dimming Switch Up

Headlamp - Left





Connector Part Information

- OEM: 7283-7109-30
- Service: See Catalog
- Description: 10-Way F (BK)

Terminal Part Information

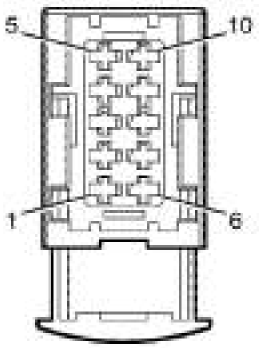
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit

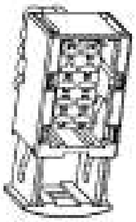
- Release Tool/Test Probe: See Terminal Repair Kit

Headlamp - Left

Pin	Wire Color	Circuit No.	Function
1	0.5 BK	250	Ground (-TT7-TT8)
	1.25 BK	250	Ground (TT7/TT8)
2	2 BK	350	Ground
3	0.5 BK	250	Ground
4-5	--	--	Not Used
6	0.5 PU	709	Left Park Lamp Supply Voltage
7	0.5 YE	712	Left Headlamp Low Beam Supply Voltage (-TT7-TT8)
	1.25 YE	712	Left Headlamp Low Beam Supply Voltage (TT7/TT8)
8	0.5 D-GN/WH	711	Left Headlamp High Beam Supply Voltage
9	0.5 L-BU/WH	1314	Left Front Turn Signal Lamp Supply Voltage
10	--	--	Not Used

Headlamp - Right





Connector Part Information

- OEM: 7283-7109-30
- Service: See Catalog
- Description: 10-Way F (BK)

Terminal Part Information

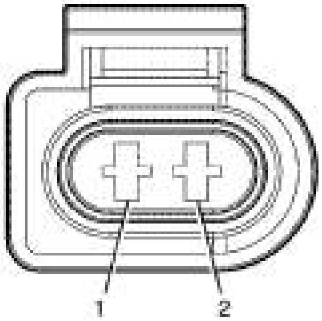
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

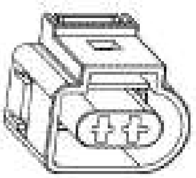
Headlamp - Right

Pin	Wire Color	Circuit No.	Function

1	0.5 BK	250	Ground (-TT7-TT8)
	1.25 BK	250	Ground (TT7/TT8)
2	2 BK	350	Ground
3	0.5 BK	250	Ground
4-5	--	--	Not Used
6	0.5 BN/WH	309	Right Park Lamp Supply Voltage
7	0.5 BN/BK	312	Right Headlamp Low Beam Supply Voltage (-TT7-TT8)
	1.25 BN/WH	312	Right Headlamp Low Beam Supply Voltage (TT7/TT8)
8	0.5 L-GN/WH	311	Right Headlamp High Beam Supply Voltage
9	0.5 D-BU/WH	1315	Right Front Turn Signal Lamp Supply Voltage
10	--	--	Not Used

Headlamp Washer Fluid Pump





Connector Part Information

- OEM: 2-1355200-2
- Service: See Catalog
- Description: 2-Way F

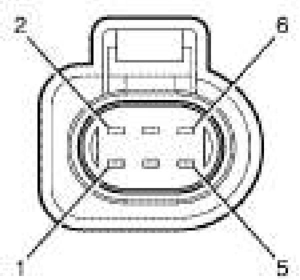
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Headlamp Washer Fluid Pump

Pin	Wire Color	Circuit No.	Function
1	2 BN/WH	6724	Headlamp Washer Fluid Pump
2	0.85 BK	250	Ground

Heated Oxygen Sensor (HO2S) Bank 1 Sensor 1 (LY7)



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 6-Way

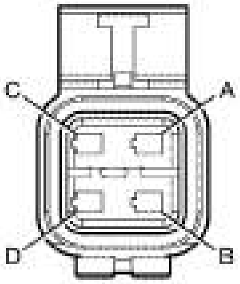
Terminal Part Information

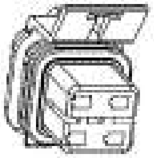
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Heated Oxygen Sensor (HO2S) Bank 1 Sensor 1 (LY7)

Pin	Wire Color	Circuit No.	Function
1	0.5 WH		HO2S Output Pump Current (Bank 1 Sensor 1)
2	0.5 BN/YE		HO2S Low Signal (Bank 1 Sensor 1)
3	0.75 GY/WH		HO2S Heater Low Control (Bank 1 Sensor 1)
4	0.75 PK/BU		Ignition 1 Voltage
5	0.5 L-GN		HO2S Input Pump Current (Bank 1 Sensor 1)
6	0.5 PU/WH		HO2S High Signal (Bank 1 Sensor 1)

Heated Oxygen Sensor (HO2S) Bank 1 Sensor 1 (L98 or HSV)





Connector Part Information

- OEM: 7219-1744-40
- Service: See Catalog
- Description: 4-Way F

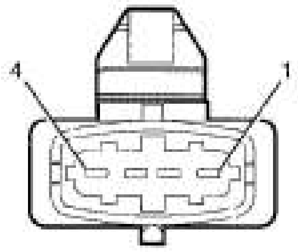
Terminal Part Information

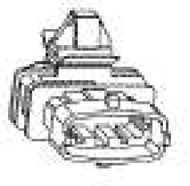
- Terminal/Tray: 12048074/2
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Heated Oxygen Sensor (HO2S) Bank 1 Sensor 1 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.5 BN/RD	1664	HO2S Low Signal [- Bank 1 Sensor 1]
B	0.5 PU/WH	1665	HO2S High Signal [- Bank 1 Sensor 1]
C	0.5 GY/WH	3113	HO2S Heater Low Control [- Bank 1 Sensor 1]
D	0.8 PK/BK	5293	Ignition 1 Voltage

Heated Oxygen Sensor (HO2S) Bank 1 Sensor 2 (LY7)





Connector Part Information

- OEM: 7182-8145-30
- Service: 88952839
- Description: 4-Way M (BK)

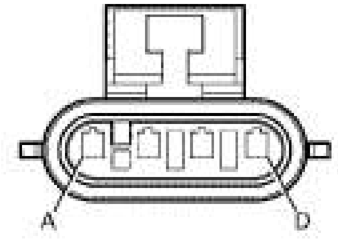
Terminal Part Information

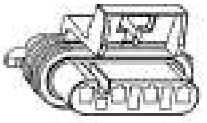
- Terminal/Tray: 1-962915-3/15
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12093647/J-35616-5 (PU)

Heated Oxygen Sensor (HO2S) Bank 1 Sensor 2 (LY7)

Pin	Wire Color	Circuit No.	Function
1	0.75 PK/BU	5294	Ignition 1 Voltage
2	0.75 OG/WH	3122	HO2S Heater Low Control (Bank 1 Sensor 2)
3	0.5 BN/RD	3121	HO2S Low Signal (Bank 1 Sensor 2)
4	0.5 PU	3120	HO2S High Signal (Bank 1 Sensor 2)

Heated Oxygen Sensor (HO2S) Bank 1 Sensor 2 (L98 or HSV or LS2)





Connector Part Information

- OEM: 7223-9845-30
- Service: See Catalog
- Description: 4-Way F

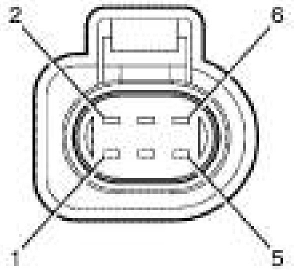
Terminal Part Information

- Terminal/Tray: 12048074/2
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Heated Oxygen Sensor (HO2S) Bank 1 Sensor 2 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.5 BN/WH	1669	HO2S Low Signal [- Bank 1 Sensor 2]
B	0.5 PU/WH	1668	HO2S High Signal [- Bank 1 Sensor 2]
C	0.5 BN	2391	HO2S Heater Low Control [- Bank 1 Sensor 2]
D	0.78 PK/BU	5294	Ignition 1 Voltage

Heated Oxygen Sensor (HO2S) Bank 2 Sensor 1 (LY7)



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 6-Way

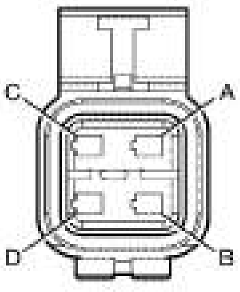
Terminal Part Information

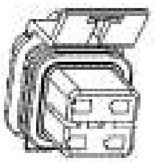
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Heated Oxygen Sensor (HO2S) Bank 2 Sensor 1 (LY7)

Pin	Wire Color	Circuit No.	Function
1	0.5 PU/WH		HO2S Pump Output Current (Bank 2 Sensor 1)
2	0.5 BN/RD		HO2S Low Signal (Bank 2 Sensor 1)
3	0.75 L-GN		HO2S Heater Low Control (Bank 2 Sensor 1)
4	0.75 PK/BU		Battery 1 Voltage
5	0.5 OG		HO2S Input Pump Current (Bank 2 Sensor 1)
6	0.5 PU		HO2S High Signal (Bank 2 Sensor 1)

Heated Oxygen Sensor (HO2S) Bank 2 Sensor 1 (L98 or HSV)





Connector Part Information

- OEM: 7219-1744-40
- Service: See Catalog
- Description: 4-Way F

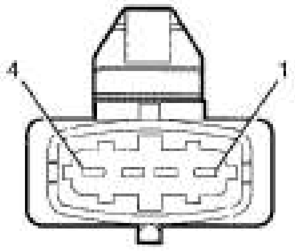
Terminal Part Information

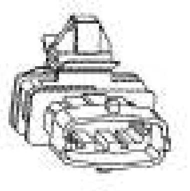
- Terminal/Tray: 12048074/2
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Heated Oxygen Sensor (HO2S) Bank 2 Sensor 1 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.5 BN/RD	1667	HO2S Low Signal [- Bank 2 Sensor 1]
B	0.5 PU	1666	HO2S High Signal [- Bank 2 Sensor 1]
C	0.5 L-GN	3212	HO2S Heater Low Control [- Bank 2 Sensor 1]
D	0.8 PK/BU	5293	Ignition 1 Voltage

Heated Oxygen Sensor (HO2S) Bank 2 Sensor 2 (LY7)





Connector Part Information

- OEM: 7182-8145-30
- Service: See Catalog
- Description: 4-Way M (GY)

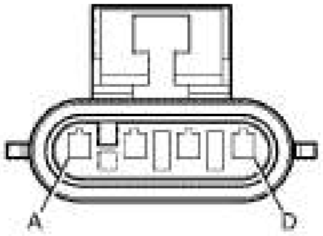
Terminal Part Information

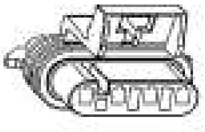
- Terminal/Tray: 1-962915-3/15
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12093647/J-35616-5 (PU)

Heated Oxygen Sensor (HO2S) Bank 2 Sensor 2 (LY7)

Pin	Wire Color	Circuit No.	Function
1	0.75 PK/BU	5294	Battery 1 Voltage
2	0.75 GY/WH	3223	HO2S Heater Low Control (Bank 2 Sensor 2)
3	0.5 BN/GN	3221	HO2S Low Signal (Bank 2 Sensor 2)
4	0.5 PU	3220	HO2S High Signal (Bank 2 Sensor 2)

Heated Oxygen Sensor (HO2S) Bank 2 Sensor 2 (L98 or HSV)





Connector Part Information

- OEM: 7223-9845-30
- Service: See Catalog
- Description: 4-Way F

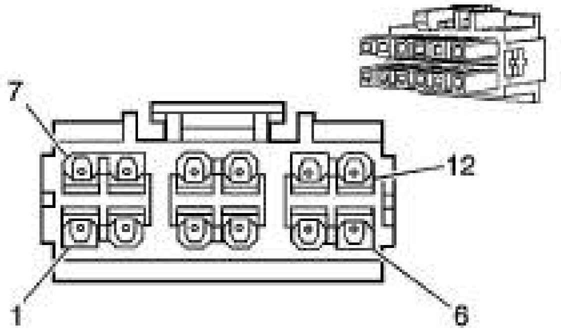
Terminal Part Information

- Terminal/Tray: 12048074/2
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Heated Oxygen Sensor (HO2S) Bank 2 Sensor 2 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.5 BN/WH	1671	HO2S Low Signal [- Bank 2 Sensor 2]
B	0.5 PU	1670	HO2S High Signal [- Bank 2 Sensor 2]
C	0.5 OG/WH	3223	HO2S Heater Low Control (Bank 2 Sensor 2)
D	0.78 PK/BU	5294	Ignition 1 Voltage

Heated Seat Control Module - Driver (KA1)



Connector Part Information

- OEM: 15-97-5121
- Service: See Catalog
- Description: 12-Way F Mini-Fit Series (BK)

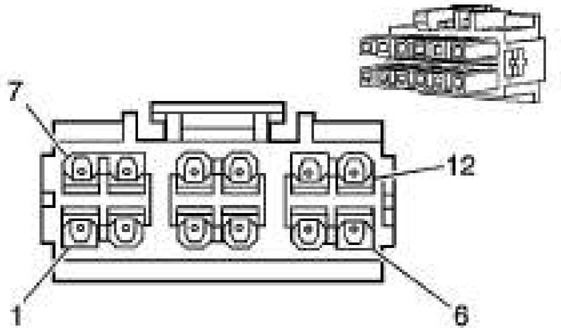
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Heated Seat Control Module - Driver (KA1)

Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used
2	0.5 RD/YE	2050	Low Reference
3	0.5 PK	1339	Ignition 1 Voltage
4	PU/GN	--	Low Reference
5	0.35 BN	1661	Driver Heated Seat High Temperature Indicator Control
6	0.35 OG/BK	6177	Passenger Heated Seat Intermediate Signal
7	--	--	Not Used
8	0.5 D-GN/RD	2077	Heated Seat Cushion Element Supply Voltage
9	0.35 PK/OG	1501	Driver Heated Seat High/Low Signal
10	--	--	Not Used
11	0.35 WH/YE	1662	Driver Heated Seat Low Temperature Indicator Control
12	0.35 WH/BK	2079	Heated Seat Cushion Temperature Sensor Signal

Heated Seat Control Module - Passenger (KA1)



Connector Part Information

- OEM: 15-97-5121
- Service: See Catalog
- Description:12-Way F Mini-Fit Series (BK)

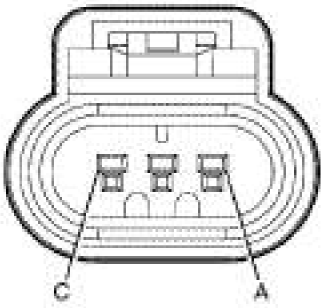
Terminal Part Information

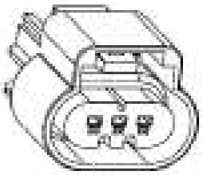
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Heated Seat Control Module - Passenger (KA1)

Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used
2	0.5 RD/YE	2050	Low Reference
3	0.5 PK	1339	Ignition 1 Voltage
4	PU/GN	--	Low Reference
5	0.35 BN	1661	Driver Heated Seat High Temperature Indicator Control
6	0.35 OG/BK	6177	Passenger Heated Seat Intermediate Signal
7	--	--	Not Used
8	0.5 D-GN/RD	2077	Heated Seat Cushion Element Supply Voltage
9	0.35 PK/OG	1501	Driver Heated Seat High/Low Signal
10	--	--	Not Used
11	0.35 WH/YE	1662	Driver Heated Seat Low Temperature Indicator Control
12	0.35 WH/BK	2079	Heated Seat Cushion Temperature Sensor Signal

Hood Ajar Switch





Connector Part Information

- OEM: 7283-6579
- Service: See Catalog
- Description: 3-Way F (BK)

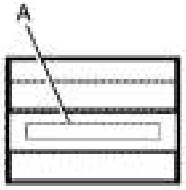
Terminal Part Information

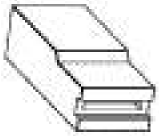
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Hood Ajar Switch

Pin	Wire Color	Circuit No.	Function
A	0.3 PK/BK	109	Hood Ajar Switch Signal
B	0.3 PU	5531	Hood Closed Switch Signal
C	0.3 BK	250	Ground

Horn - Left X1





- OEM: 7183-0073-30
- Service: See Catalog

- Description: 1-Way F (BK)

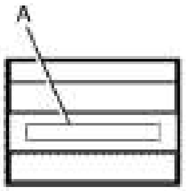
Terminal Part Information

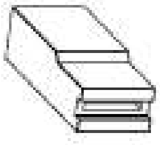
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Horn - Left X1

Pin	Wire Color	Circuit No.	Function
A	0.75 D-GN	1329	Content Left Horn Control

Horn - Left X2





- OEM: 7183-0073-30
- Service: See Catalog
- Description: 1-Way F (BK)

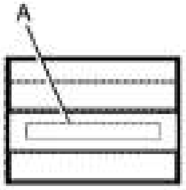
Terminal Part Information

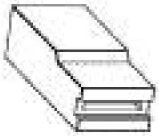
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Horn - Left X2

Pin	Wire Color	Circuit No.	Function
A	0.75 BK	250	Ground

Horn - Right X1





- OEM: 7183-0073-30
- Service: See Catalog
- Description: 1-Way F (BK)

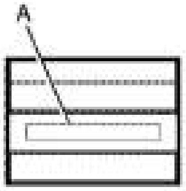
Terminal Part Information

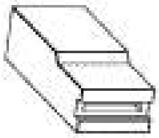
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Horn - Right X1

Pin	Wire Color	Circuit No.	Function
A	0.75 D-GN	1329	Content Right Horn Control

Horn - Right X2





- OEM: 7183-0073-30
- Service: See Catalog
- Description: 1-Way F (BK)

Terminal Part Information

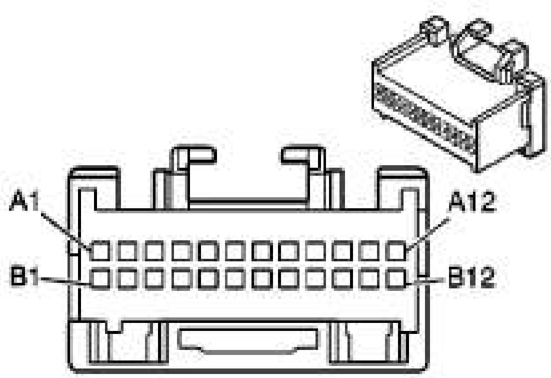
- Terminal/Tray: See Terminal Repair Kit

- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Horn - Right X2

Pin	Wire Color	Circuit No.	Function
A	0.75 BK	250	Ground

HVAC Control Module X1 (LHD)



Connector Part Information

- OEM: 12160778
- Service: 12160778
- Description: 24-Way F Micro-Pack 100 Series (BN)

Terminal Part Information

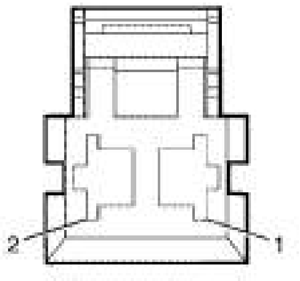
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

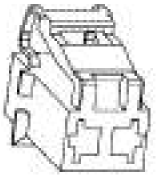
HVAC Control Module X1 (LHD)

Pin	Wire Color	Circuit No.	Function
A1	0.3 RD/WH	340	Battery Positive Voltage
A2	0.3 YE	6817	LED Backlight Dimming Control
	0.3 YE	6817	LED Backlight Dimming Control
A3	--	--	Not Used
A4	0.3 L-GN	1478	Coolant Level Switch Signal
A5	0.3 BN	247	Medium Blower Motor Control
A6	--	--	Not Used
A7	0.3 PU/WH	5203	Air Quality HC Sensor Signal (K14)
A8	0.3 L-GN/BK	735	Outside Ambient Air Temperature Sensor Signal
A9	0.3 GY	731	A/C Refrigerant Low Temperature Sensor Signal

A10	0.3 L-BU/BK	590	Solar Sensor Driver Signal
A11	0.3 WH	278	Ambient Light Sensor Signal
A12	0.3 GY	705	5-Volt Reference
B1	0.3 PK	1539	Run/Crank Ignition 1 Voltage
B2-B4	--	--	Not Used
B5	0.3 D-GN	5060	Low Speed GMLAN Serial Data
B6	0.3 GY/BK	754	Blower Motor Speed Control
B7	0.3 L-GN/WH	6845	Air Quality NOX Sensor Signal (K14)
B8	--	--	Not Used
B9	0.3 D-GN	734	Inside Air Temperature Sensor Signal
B10	0.3 GY	1548	Passenger Solar Sensor Signal
B11	0.3 BK/WH	451	Ground
B12	0.3 YE	61	Outside Ambient Temperature Sensor Low Reference

HVAC Control Module X1 (RHD)





Connector Part Information

- OEM: 7123-6023-30
- Service: See Catalog
- Description: 2-Way F

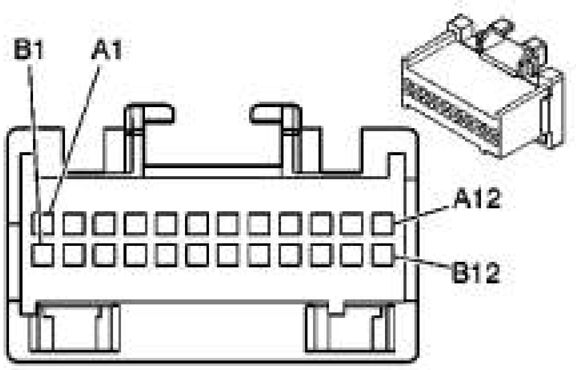
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

HVAC Control Module X1 (RHD)

Pin	Wire Color	Circuit No.	Function
1	3 OG	5987	HVAC Blower Motor Control Circuit
2	3 BK	1450	Ground

HVAC Control Module X2 (LHD)



Connector Part Information

- OEM: 12110088
- Service: See Catalog
- Description: 24-Way F Micro-Pack 100 Series (GY)

Terminal Part Information

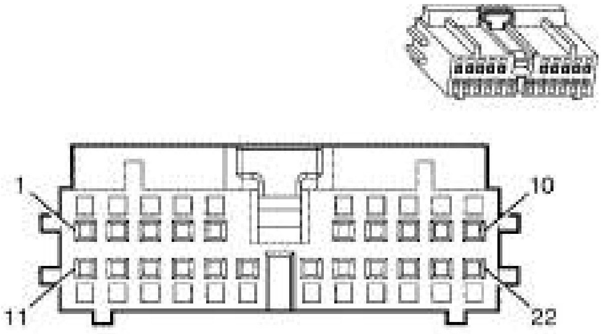
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

HVAC Control Module X2 (LHD)

Pin	Wire Color	Circuit No.	Function
A1	0.3 L-BU	733	Air Temperature Door Position Signal
A2	0.3 YE/BK	1814	Mode Door Position Signal
A3	0.3 BN	1838	Recirculation Door Position Signal
A4	0.3 GY	2599	Rear Mode Door Position Signal
A5	--	--	Not Used
A6	0.3 L-BU	2776	Rear Passenger Air Temperature Door Control A
A7	0.3 L-GN/WH	5729	Rear Mode Door Control A
A8	0.3 YE	1791	Air Temperature Door Control Low Reference
A9	0.3 GY/BK	2778	Passenger Air Temperature Motor Control
A10	0.3 YE	1318	Mode Door Control B
A11	0.3 GY	5127	After Boil Coolant Pump Relay Control
A12	0.3 PU	1648	Recirculation Door Control A
B1	0.3 D-BU	1646	Passenger Air Temperature Door Position Signal
B2	--	--	Not Used
B3	0.3 D-GN	2600	Rear Passenger Air Temperature Door Position Signal
B4	0.3 PU	73	Rear Mode Switch Signal (KA6)

B5	0.3 L-BU	72	Rear Temperature Switch Signal (KA6)
B6	0.3 BN	2775	Rear Passenger Air Temperature Door Control B
B7	0.3 L-GN/BK	5730	Rear Mode Door Control B
B8	0.3 D-BU	1199	Air Temperature Door Control
B9	0.3 WH/BK	1236	Passenger Air Temperature Door Control
B10	0.3 TN	2273	Mode Door Control A
B11	--	--	Not Used
B12	0.3 D-GN	1614	Recirculation Door Control B

HVAC Control Module X3 (RHD)



Connector Part Information

- OEM: 13003501
- Service: See Catalog
- Description: 22-Way F

Terminal Part Information

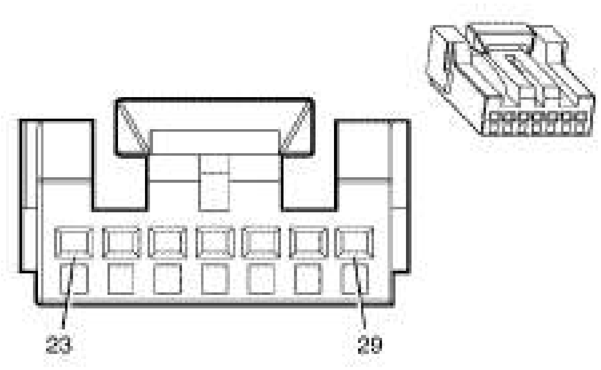
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

HVAC Control Module X3 (RHD)

Pin	Wire Color	Circuit No.	Function
1	0.3 BK	119	Mode Actuator 1 - Control
2	0.3 BN	2273	Mode Actuator 1 - Power
3	0.3 GY	2275	Mode Actuator 1 - Feedback
4	0.3 RD	1199	Mode Actuator 2 - Feedback
5	0.3 BK/YE	1646	Air Mix Actuator - Feedback
6	0.3 WH/RD	1838	Recirculation Actuator - Feedback
7	0.35 BK	732	Evaporator Temperature Sensor Signal

8	0.35 BK	731	Evaporator Temperature Sensor Low Reference
9	0.3 D-BU/BK	718	Low Reference
10	0.3 BK/RD	719	Low Reference
11	0.3 L-GN	2210	Mode Actuator 2 - Power
12	0.3 OG	1791	Mode Actuator 2 - Control
13	0.3 WH	2778	Air Mix Actuator - Power
14	0.3 YE	1236	Air Mix Actuator - Control
15	0.3 WH/BK	2274	Recirculation Actuator - Power
16	0.3 WH/BU	1614	Recirculation Actuator - Control
17	0.3 D-GN	474	5-Volt Reference
18	0.3 PK	1236	5-Volt Reference
19	0.3 BK/WH	598	5-Volt Reference
20	0.3 WH/GN	597	5-Volt Reference
21	0.3 D-BU	1791	Low Reference
22	0.3 L-BU	720	Low Reference

HVAC Control Module (RHD) X4



Connector Part Information

- OEM: 13003497
- Service: See Catalog
- Description: 7-Way F

Terminal Part Information

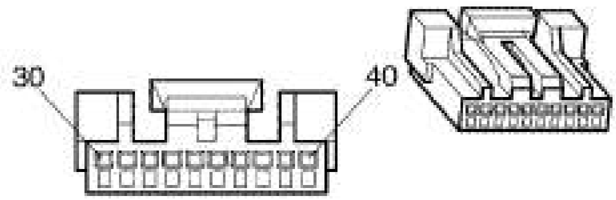
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

HVAC Control Module (RHD) X4

Pin	Wire Color	Circuit No.	Function

23	0.3 D-BU/WH	2148	Dual Zone Air Mix Actuator Power
24	0.3 YE/BK	2147	Dual Zone Air Mix Actuator Control
25	0.3 YE/BU	2178	Dual Zone Air Mix Actuator Feedback
26	0.3 YE/RD	2149	5-Volt Reference
27	--	--	Not Used
28	0.3 BN/WH	476	Low Reference
29	--	--	Not Used

HVAC Control Module (RHD) X5



Connector Part Information

- OEM: 13001498
- Service: See Catalog
- Description: 10-Way F

Terminal Part Information

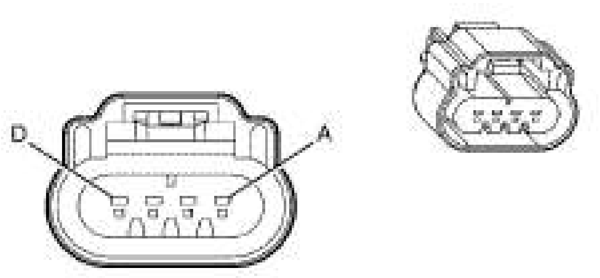
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

HVAC Control Module (RHD) X5

Pin	Wire Color	Circuit No.	Function
28	0.3 D-GN/BU	6555	Mode Actuator Rear Power
29	0.3 D-GN/RD	6556	Mode Actuator Rear Control
30	0.3 D-BU/OG	5516	Tri-Zone Air Mix Actuator Control
31	0.3 L-GN/RD	5515	Tri-Zone Air Mix Actuator Power
32	0.3 D-GN/WH	6558	Mode Actuator Rear Feedback
33	0.3 PK/BK	5517	Tri-Zone Air Mix Actuator Feedback
34	0.3 D-GN/OG	6718	5-Volt Reference
35	0.3 D-BU/GN	5518	5-Volt Reference

36	0.3 D-GN/YE	645	Low Reference
37	0.3 RD/BK	552	Low Reference

Ignition Coil 1 (LY7)



Connector Part Information

- OEM: 7283-9394-30
- Service: See Catalog
- Description: 4-Way F (BK)

Terminal Part Information

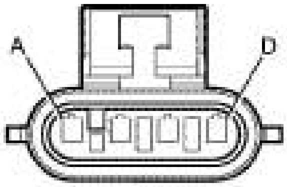
- Pins: A, D
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

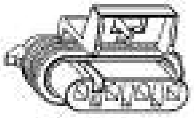
- Pins: B, C
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Ignition Coil 1 (LY7)

Pin	Wire Color	Circuit No.	Function
A	0.75 BK	2550	Ground
B	0.5 PU	6413	Low Reference
C	0.5 PU	2121	IC 1 Control
D	0.75 PK/BU	5291	Ignition 1 Voltage

Ignition Coil 1 (L98 or HSV)





Connector Part Information

- OEM: 7283-9394-30
- Service: See Catalog
- Description: 4-Way F

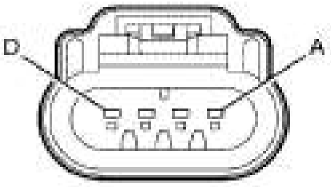
Terminal Part Information

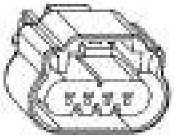
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Ignition Coil 1 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.8 BK	151	Ground
B	0.5 BN	2129	IC 1 Control
C	0.5 PU	2121	IC 1 Control
D	0.8 PK/BK	39	Ignition 1 Voltage

Ignition Coil 2 (LY7)





Connector Part Information

- OEM: 7283-9394-30
- Service: See Catalog
- Description: 4-Way F (BK)

Terminal Part Information

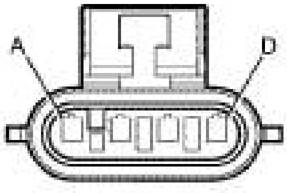
- Pins: A, D
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

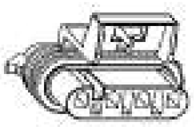
- Pins: B, C
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Ignition Coil 2 (LY7)

Pin	Wire Color	Circuit No.	Function
A	0.75 BK	2650	Ground
B	0.5 PK	6414	Low Reference
C	0.5 OG/WH	2122	IC 2 Control
D	0.75 PK	5292	Ignition 1 Voltage

Ignition Coil 2 (L98 or HSV)





Connector Part Information

- OEM: 7283-9394-30
- Service: See Catalog
- Description: 4-Way F

Terminal Part Information

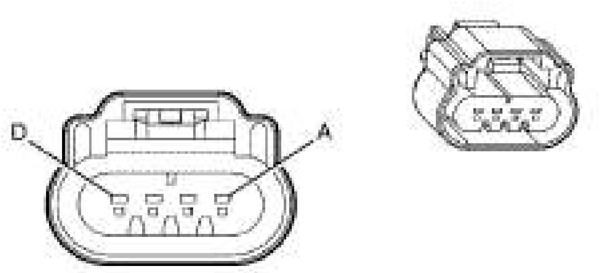
- Terminal/Tray: See Terminal Repair Kit

- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Ignition Coil 2 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.8 BK	151	Ground
B	0.5 BN/WH	2129	IC 2 Control
C	0.5 OG/WH	2127	IC 2 Control
D	0.8 PK/BK	39	Ignition 1Voltage

Ignition Coil 3 (LY7)



Connector Part Information

- OEM: 7283-9394-30
- Service: See Catalog
- Description: 4-Way F (BK)

Terminal Part Information

- Pins: A, D
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

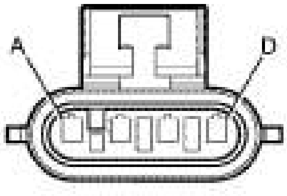
- Pins: B, C
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

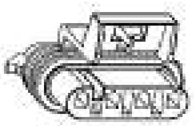
Ignition Coil 3 (LY7)

Pin	Wire Color	Circuit No.	Function
A	0.75 BK	2550	Ground
B	0.5 PU	6413	Low Reference

C	0.5 L-BU	2123	IC 3 Control
D	0.75 PK/BU	5291	Ignition 1 Voltage

Ignition Coil 3 (L98 or HSV)





Connector Part Information

- OEM: 7283-9394-30
- Service: See Catalog
- Description: 4-Way F

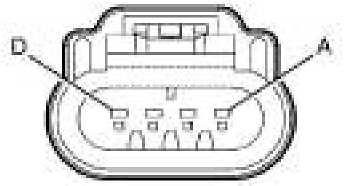
Terminal Part Information

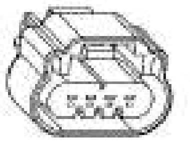
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Ignition Coil 3 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.8 BK	151	Ground
B	0.5 BN	2129	IC 3 Control
C	0.5 L-BU	2123	IC 3 Control
D	0.8 PK/BK	39	Ignition 1Voltage

Ignition Coil 4 (LY7)





Connector Part Information

- OEM: 7283-9394-30
- Service: See Catalog
- Description: 4-Way F (BK)

Terminal Part Information

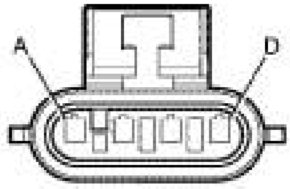
- Pins: A, D
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

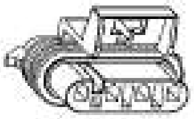
- Pins: B, C
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Ignition Coil 4 (LY7)

Pin	Wire Color	Circuit No.	Function
A	0.75 BK	2650	Ground
B	0.5 PK	6414	Low Reference
C	0.5 D-GN/WH	2124	IC 4 Control
D	0.75 PK	5292	Ignition 1 Voltage

Ignition Coil 4 (L98 or HSV)





Connector Part Information

- OEM: 7283-9394-30
- Service: See Catalog
- Description: 4-Way F

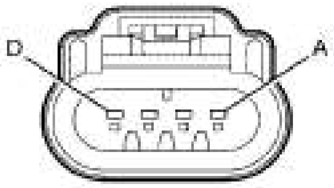
Terminal Part Information

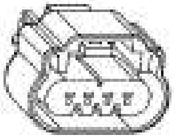
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Ignition Coil 4 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.8 BK	151	Ground
B	0.5 BN/WH	2129	IC 4 Control
C	0.5 D-GN/WH	2125	IC 4 Control
D	0.8 PK/BK	39	Ignition 1Voltage

Ignition Coil 5 (LY7)





Connector Part Information

- OEM: 7283-9394-30
- Service: See Catalog
- Description: 4-Way F (BK)

Terminal Part Information

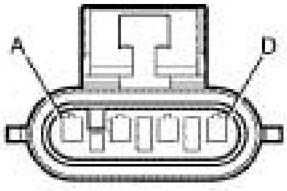
- Pins: A, D
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

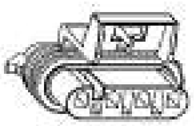
- Pins: B, C
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Ignition Coil 5 (LY7)

Pin	Wire Color	Circuit No.	Function
A	0.75 BK	2550	Ground
B	0.5 PU	6413	Low Reference
C	0.5 D-GN/RD	2125	IC 5 Control
D	0.75 PK/BU	5291	Ignition 1 Voltage

Ignition Coil 5 (L98 or HSV)





Connector Part Information

- OEM: 7283-9394-30
- Service: See Catalog
- Description: 4-Way F

Terminal Part Information

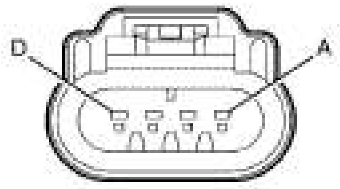
- Terminal/Tray: See Terminal Repair Kit

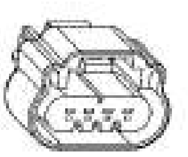
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Ignition Coil 5 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.8 BK	151	Ground
B	0.5 BN	2129	IC 5 Control
C	0.5 D-GN	2125	IC 5 Control
D	0.8 PK/BK	39	Ignition 1Voltage

Ignition Coil 6 (LY7)





Connector Part Information

- OEM: 7283-9394-30
- Service: See Catalog
- Description: 4-Way F (BK)

Terminal Part Information

- Pins: A, D
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

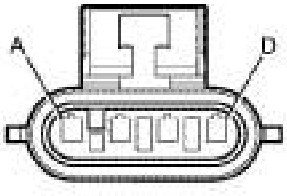
- Pins: B, C
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

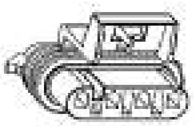
Ignition Coil 6 (LY7)

Pin	Wire Color	Circuit No.	Function
A	0.75 BK	2650	Ground
B	0.5 PK	6414	Low Reference

C	0.5 L-BU/WH	2126	IC 6 Control
D	0.75 PK	5292	Ignition 1 Voltage

Ignition Coil 6 (L98 or HSV)





Connector Part Information

- OEM: 7283-9394-30
- Service: See Catalog
- Description: 4-Way F

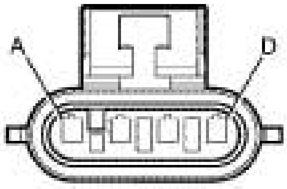
Terminal Part Information

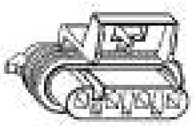
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Ignition Coil 6 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.8 BK	151	Ground
B	0.5 BN/WH	2129	IC 6 Control
C	0.5 L-BU/WH	2123	IC 6 Control
D	0.8 PK/BK	39	Ignition 1Voltage

Ignition Coil 7 (L98 or HSV)





Connector Part Information

- OEM: 7283-9394-30
- Service: See Catalog
- Description: 4-Way F

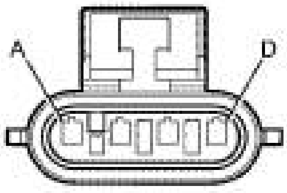
Terminal Part Information

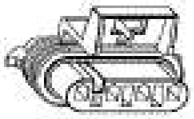
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Ignition Coil 7 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.8 BK	151	Ground
B	0.5 BN	2129	IC 7 Control
C	0.5 OG	2127	IC 7 Control
D	0.8 PK/BK	39	Ignition 1Voltage

Ignition Coil 8 (L98 or HSV)





Connector Part Information

- OEM: 7283-9394-30
- Service: See Catalog
- Description: 4-Way F

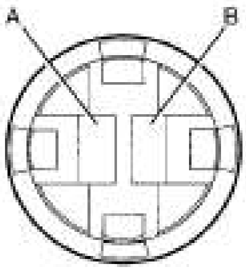
Terminal Part Information

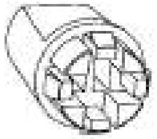
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Ignition Coil 8 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
A	0.8 BK	151	Ground
B	0.5 BN/WH	2129	IC 8 Control
C	0.5 PU/WH	2121	IC 8 Control
D	0.8 PK/BK	39	Ignition 1 Voltage

Ignition Key Cylinder Lamp





Connector Part Information

- OEM: 7141-5191-30
- Service: See Catalog
- Description: 2-Way F (BK)

Terminal Part Information

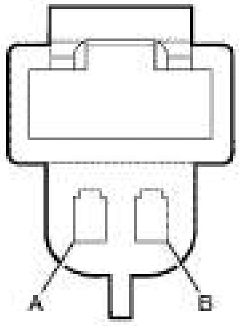
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

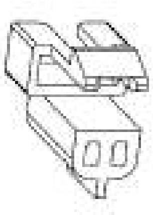
Ignition Key Cylinder Lamp

Pin	Wire Color	Circuit No.	Function

A	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage
B	0.5 BK	850	Ground

Ignition Lock Cylinder Control Solenoid





- OEM: 7123-9722-30
- Service: 12101825
- Description: 2-Way F (BK)

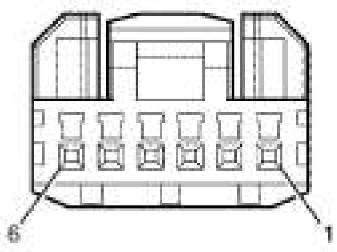
Terminal Part Information

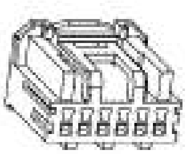
- Terminal/Tray: 12064971/5
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Ignition Lock Cylinder Control Solenoid

Pin	Wire Color	Circuit No.	Function
A	0.5 BN	443	Accessory Voltage
B	0.3 PU/WH	1630	Steering Column Key Cylinder Lock Solenoid Control

Ignition Switch





Connector Part Information

- OEM: 7283-9467-30
- Service: See Catalog
- Description: 6-Way F (BK)

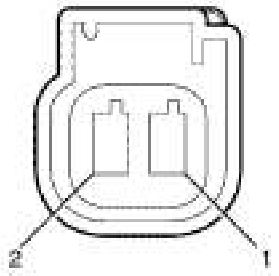
Terminal Part Information

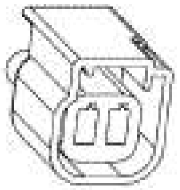
- Terminal/Tray: SHCM-A03T-P025/20
- Core/Insulation Crimp: J/J
- Release Tool/Test Probe: 12094429/J-35616-64B (L-BU)

Ignition Switch

Pin	Wire Color	Circuit No.	Function
1	0.3 PK	3	Run/Crank Voltage
2	0.5 OG/BK	1040	Battery Positive Voltage
3	0.3 BN	4	Ignition 1 Voltage
4	0.3 WH	1390	Ignition Key Resistor Low Reference
5	--	--	Not Used
6	0.3 WH/BK	1073	Ignition Key Resistor Signal

Inflatable Restraint Front End Sensor - Left





Connector Part Information

- OEM: 7283-6291-30
- Service: See Catalog
- Description: 2-Way F (BK)

Terminal Part Information

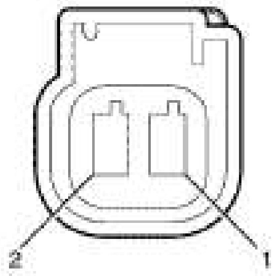
- Terminal/Tray: 7116-4102-08/9
- Core/Insulation Crimp: E/1

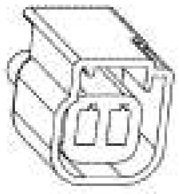
- Release Tool/Test Probe: 12094430/J-35616-2A (GY)

Inflatable Restraint Front End Sensor - Left

Pin	Wire Color	Circuit No.	Function
1	0.3 YE	354	Discriminating Sensor - Signal
2	0.3 BN/YE	5045	Discriminating Sensor - Low Reference

Inflatable Restraint Front End Sensor - Right





Connector Part Information

- OEM: 7283-6291-30
- Service: See Catalog
- Description: 2-Way F (BK)

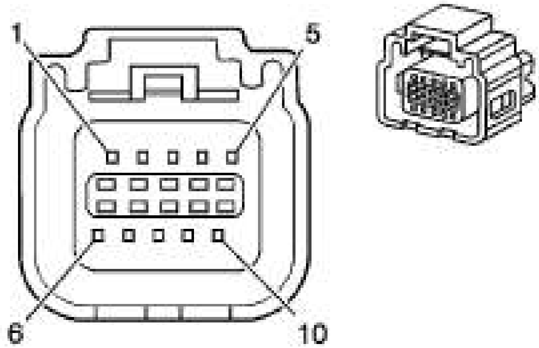
Terminal Part Information

- Terminal/Tray: 7116-4102-08/9
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12094430/J-35616-2A (GY)

Inflatable Restraint Front End Sensor - Right

Pin	Wire Color	Circuit No.	Function
1	0.3 D-GN	1409	Discriminating Sensor - Right Signal
2	0.3 GY	5600	Discriminating Sensor - Low Reference

Inflatable Restraint Front Passenger Presence System (PPS) Module X1



Connector Part Information

- OEM: 28032115
- Service: See Catalog
- Description: 10-Way F (BK)

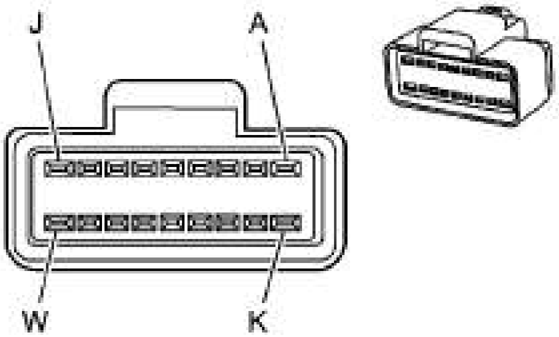
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Inflatable Restraint Front Passenger Presence System (PPS) Module X1

Pin	Wire Color	Circuit No.	Function
1	0.35 WH/PK	3940	PPS Supply Voltage
2	0.5 BK/WH	1751	Ground
3	--	--	Not Used
4	0.35 D-GN/RD	5060	Low Speed GMLAN Serial Data
5-10	--	--	Not Used

Inflatable Restraint Front Passenger Presence System (PPS) Module X2



Connector Part Information

- OEM: 15326082
- Service: Serviced as part of an assembly
- Description: 18-Way F (BK)

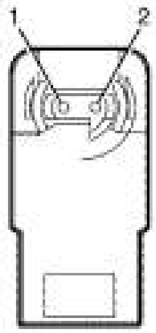
Terminal Part Information

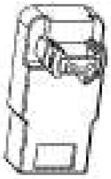
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Inflatable Restraint Front Passenger Presence System (PPS) Module X2

Pin	Wire Color	Circuit No.	Function
1	CLR	--	--
2	CLR	--	--
3	CLR	--	--
4	CLR	--	--
5	CLR	--	--

Inflatable Restraint I/P Module X1





Connector Part Information

- OEM: 7335-4222
- Service: See Catalog
- Description: 2-Way M (YE)

Terminal Part Information

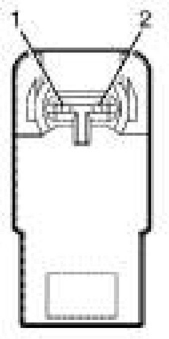
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit

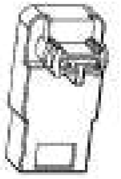
- Release Tool/Test Probe: See Terminal Repair Kit

Inflatable Restraint I/P Module X1

Pin	Wire Color	Circuit No.	Function
1	0.5 D-BU	3024	I/P Module - Stage 1 - Low Control
2	0.5 YE	3025	I/P Module - Stage 1 - High Control

Inflatable Restraint I/P Module X2





Connector Part Information

- OEM: 7335-4221
- Service: See Catalog
- Description: 2-Way M (GN)

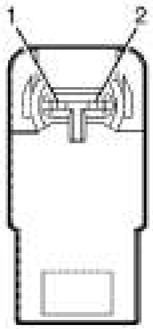
Terminal Part Information

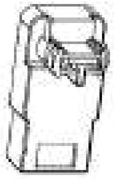
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Inflatable Restraint I/P Module X2

Pin	Wire Color	Circuit No.	Function
1	0.5 PU	3026	I/P Module - Stage 2 - Low Control
2	0.5 D-GN	3027	I/P Module - Stage 2 - High Control

Inflatable Restraint Roof Rail Module - Left





Connector Part Information

- OEM: 7335-6470
- Service: See Catalog
- Description: 2-Way M (GN)

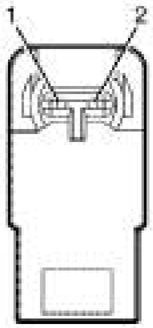
Terminal Part Information

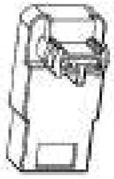
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Inflatable Restraint Roof Rail Module - Left

Pin	Wire Color	Circuit No.	Function
1	0.5 BN/BK	5019	Roof Rail Module - Left - High Control
2	0.5 PK	5020	Roof Rail Module - Left - Low Control

Inflatable Restraint Roof Rail Module - Right





Connector Part Information

- OEM: 7335-6471

- Service: See Catalog
- Description: 2-Way M (GN)

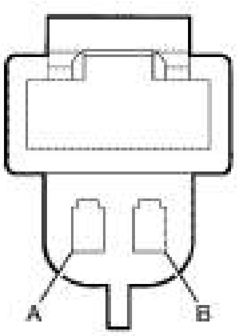
Terminal Part Information

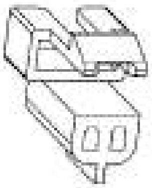
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Inflatable Restraint Roof Rail Module - Right

Pin	Wire Color	Circuit No.	Function
1	0.5 PU/YE	5021	Roof Rail Module - Right - High Control
2	0.5 WH/BK	5022	Roof Rail Module - Right - Low Control

Inflatable Restraint Seat Position Sensor - Driver





Connector Part Information

- OEM: 12052832
- Service: 12052832
- Description: 2-Way F Metri-Pack 150 Series (BK)

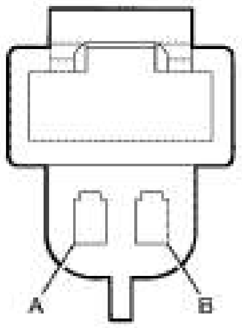
Terminal Part Information

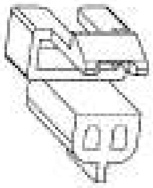
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Inflatable Restraint Seat Position Sensor - Driver

Pin	Wire Color	Circuit No.	Function
A	0.3 PK/BU	5055	Seat Position Sensor- Left - Signal
B	0.3 PU/WH	5057	Seat Belt Switch - Right Front - Low Reference

Inflatable Restraint Seat Position Sensor - Passenger





Connector Part Information

- OEM: 12052832
- Service: 12052832
- Description: 2-Way F Metri-Pack 150 Series (BK)

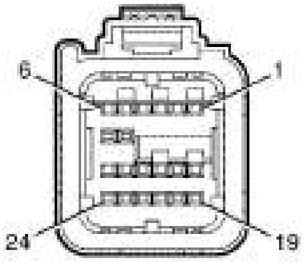
Terminal Part Information

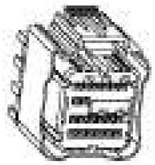
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Inflatable Restraint Seat Position Sensor - Passenger

Pin	Wire Color	Circuit No.	Function
A	0.3 PK/BU	5056	Seat Position Sensor- Right - Signal
B	0.3 PU/WH	5057	Seat Belt Switch - Right Front - Low Reference

Inflatable Restraint Sensing and Diagnostic Module (SDM) X1





Connector Part Information

- OEM: 7287-1849-30
- Service: See Catalog
- Description: 24-Way F (BK)

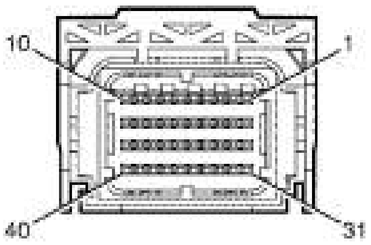
Terminal Part Information

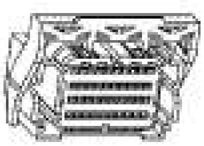
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Inflatable Restraint Sensing and Diagnostic Module (SDM) X1

Pin	Wire Color	Circuit No.	Function
1	0.3 BN	3020	Steering Wheel Module - Stage1 - Low Control
2	0.3 BN/RD	3021	Steering Wheel Module - Stage1 - High Control
3	0.3 WH	3023	Steering Wheel Module - Stage2 - High Control
4	0.3 PK	3022	Steering Wheel Module - Stage2 - Low Control
5	0.3 YE/BK	2138	Side Impact Module -LF - Low Control
6	0.3 BN	2137	Side Impact Module -LF - High Control
7-18	--	--	Not Used
19	0.3 GY	5045	Discriminating Sensor - Low Reference
20	0.3 D-GN	354	Discriminating Sensor - Signal
21	0.5 PK/BU	339	Ignition 1 Voltage
22	0.5 OG/YE	1340	Battery Positive Voltage
23	--	--	Not Used
24	0.5 BK/WH	1751	Ground

Inflatable Restraint Sensing and Diagnostic Module (SDM) X2





Connector Part Information

- OEM: 7287-1850-30
- Service: See Catalog
- Description: 40-Way F (BK)

Terminal Part Information

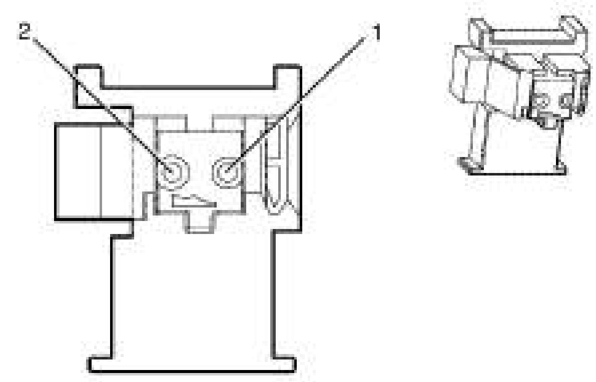
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Inflatable Restraint Sensing and Diagnostic Module (SDM) X2

Pin	Wire Color	Circuit No.	Function
1	0.5 BN/BK	5019	Roof Rail Module - Left - High Control (LHD)
	0.5 PU/YE	5021	Roof Rail Module - Right - High Control (RHD)
2	0.5 PK	5020	Roof Rail Module - Left - Low Control (LHD)
	0.5 WH/BK	5022	Roof Rail Module - Right - Low Control (RHD)
3	0.5 WH/BK	5022	Roof Rail Module - Right - Low Control (LHD)
	0.5 PK	5020	Roof Rail Module - Left - Low Control (RHD)
4	0.5 PU/YE	5021	Roof Rail Module -Right - High Control (LHD)
	0.5 BN/BK	2019	(RHD)
5	0.3 BK/WH	2135	Side Impact Module -RF - High Control
6	0.3 L-GN	2136	Side Impact Module - RF - Low Control
7	0.3 PU	3026	I/P Module - Stage 2 - Low Control
8	0.3 D-GN	3027	I/P Module - Stage 2 - High Control (LHD)
9	0.3 YE	3025	I/P Module - Stage 1 - High Control
10	0.3 D-BU	3024	I/P Module - Stage 1 - Low Control
11-14	--	--	Not Used
15	0.3 BK/WH	2118	Seat Belt Pretensioner - Left High Control
16	0.3 OG/BK	2119	Seat Belt Pretensioner - Left Low Control
17	0.3 OG	2117	Seat Belt Pretensioner - Right Low Control
18	0.3 L-GN	2116	Seat Belt Pretensioner - Right High Control
19-22	--	--	Not Used
23	0.3 D-GN	1409	Discriminating Sensor - Right Signal (LHD)
	0.3 YE	354	Discriminating Sensor - Signal (RHD)
24	0.3 GY	5600	Discriminating Sensor - Low Reference (LHD)
	0.3 BN/YE	5045	Discriminating Sensor - Low Reference (RHD)
25	0.3 PU/WH	6628	Side Impact Sensing Module - Right - Low Reference (LHD)
	0.3 WH/BK	6629	Side Impact Sensing Module - Right - Low Reference (RHD)
26	0.3 WH	2132	Side Impact Sensing Module - Left - Signal (LHD)
	0.3 D-GN	2134	Side Impact Sensing Module - Right - Signal (RHD)
27	0.3 D-GN	2134	Side Impact Sensing Module - Right - Signal (LHD)
	0.3 WH	2132	Side Impact Sensing Module - Left - Signal (RHD)
28	0.3 WH/BK	6629	Side Impact Sensing Module - Left - Low Reference (LHD)
	0.3 PU/WH	6628	Side Impact Sensing Module - Left - Low Reference (RHD)
29-34	--	--	Not Used
35	0.3 L-GN	5055	Seat Position Sensor - Left - Signal (LHD)

36	0.3 BK/WH	238	Seat Belt Switch - Left (LHD)
37	--	--	Not Used
38	0.3 D-BU	1363	Seat Belt Switch - Left - Low Reference (LHD)
39	--	--	Not Used
40	0.35 D-GN	5060	Low Speed GMLAN Serial Data (LHD)

Inflatable Restraint Side Impact Module - Left X1



Connector Part Information

- OEM: CA-252-92-5-Q
- Service: See Catalog
- Description: 2-Way F (YE)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Inflatable Restraint Side Impact Module - Left X1

Pin	Wire Color	Circuit No.	Function
1	0.3 BK/WH	2137	Side Impact Module - Left Front - High Control
2	0.3 L-GN	2138	Side Impact Module - Left Front - Low Control

Inflatable Restraint Side Impact Module - Left X2

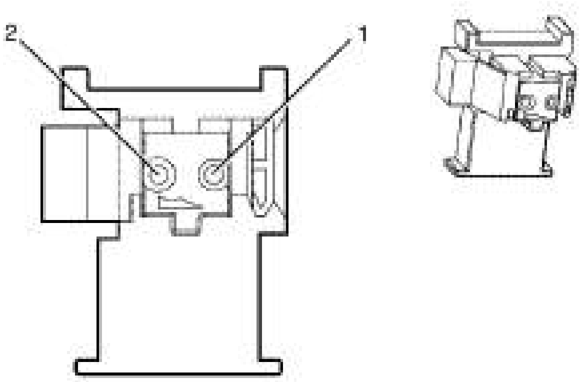
Terminal Part Information

- Terminal:
- Core/Insulation Crimp: N/A
- Release Tool/Test Probe: Ring Terminal

Inflatable Restraint Side Impact Module - Left X2

Pin	Wire Color	Circuit No.	Function
A	0.3 BK/WH	1751	Ground

Inflatable Restraint Side Impact Module - Right X1



Connector Part Information

- OEM: CA-252-92-5-Q
- Service: See Catalog
- Description: 2-Way F (YE)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Inflatable Restraint Side Impact Module - Right X1

Pin	Wire Color	Circuit No.	Function
1	0.3 BN	2135	Side Impact Module - Right Front - High Control
2	0.3 YE/BK	2136	Side Impact Module - Right Front - Low Control

Inflatable Restraint Side Impact Module - Right X2

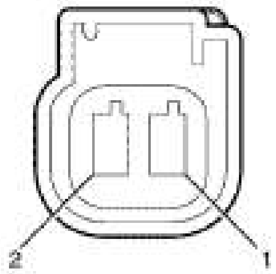
Terminal Part Information

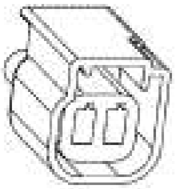
- Terminal:
- Core/Insulation Crimp: N/A
- Release Tool/Test Probe: Ring Terminal

Inflatable Restraint Side Impact Module - Right X2

Pin	Wire Color	Circuit No.	Function
A	0.3 BK/WH	1751	Ground

Inflatable Restraint Side Impact Sensor (SIS) - Left





Connector Part Information

- OEM: 7283-6291-30
- Service: See Catalog
- Description: 2-Way F (BK)

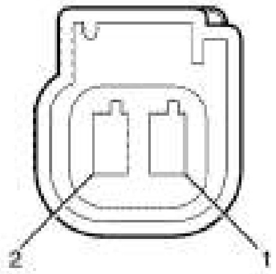
Terminal Part Information

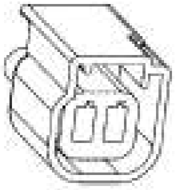
- Terminal/Tray: 7116-4102-08/9
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12094430/J-35616-2A (GY)

Inflatable Restraint Side Impact Sensor (SIS) - Left

Pin	Wire Color	Circuit No.	Function
1	0.3 WH	2132	Side Impact Sensing Module - Left - Signal
2	0.3 PU/WH	6628	Side Impact Sensing Module - Left - Low Reference

Inflatable Restraint Side Impact Sensor (SIS) - Right





Connector Part Information

- OEM: 7283-6291-30
- Service: See Catalog
- Description: 2-Way F (BK)

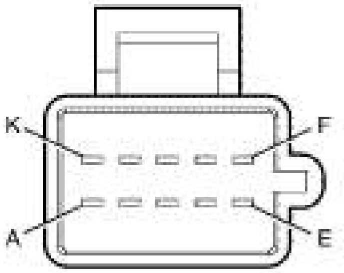
Terminal Part Information

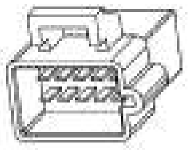
- Terminal/Tray: 7116-4102-08/9
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12094430/J-35616-2A (GY)

Inflatable Restraint Side Impact Sensor (SIS) - Right

Pin	Wire Color	Circuit No.	Function
1	0.3 D-GN	2134	Side Impact Sensing Module - Right - Signal
2	0.3 WH/BK	6629	Side Impact Sensing Module - Right - Low Reference

Inflatable Restraint Steering Wheel Module Coil X1





Connector Part Information

- OEM: 7182-6974
- Service: See Catalog
- Description: 10-Way M (NA)

Terminal Part Information

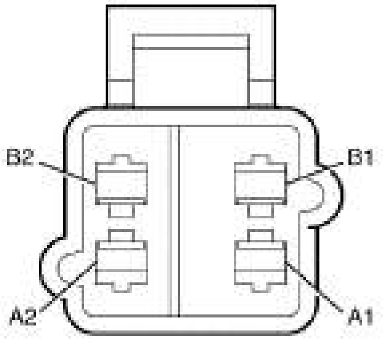
- Terminal/Tray: 12047581/2
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12094429/J-35616-3 (GY)

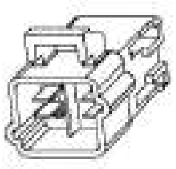
Inflatable Restraint Steering Wheel Module Coil X1

Pin	Wire Color	Circuit No.	Function
A	0.3 GY/BU	7367	Steering Wheel Resistor Ladder Right Signal #2
B	0.3 BN/GN	7364	Steering Wheel Resistor Ladder Right Signal #1

C	0.3 BN	7312	Steering Wheel Resistor Ladder Left Signal #1
D	0.3 L-BU	7313	Steering Wheel Resistor Ladder Left Signal #2
E	0.3 BN/WH	897	DIC Switch Low Reference
F	0.3 OG/BK	5201	Steering Wheel Controls Signal
G	0.3 BK	850	Ground
H	0.3 PU/WH	7005	I/P Dimming Control
J	0.3 BN/BK	28	Horn Relay Control
K	--	--	Not Used

Inflatable Restraint Steering Wheel Module Coil X2 (RHD)





Connector Part Information

- OEM: 7182-7297-70
- Service: See Catalog
- Description: 4-Way M (YE)

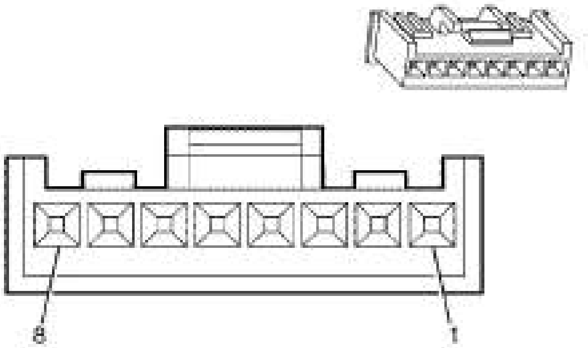
Terminal Part Information

- Terminal/Tray: 12034047/2
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 12094430/J-35616-5 (PU)

Inflatable Restraint Steering Wheel Module Coil X2 (RHD)

Pin	Wire Color	Circuit No.	Function
A1	0.3 BN/RD	3021	Steering Wheel Module - Stage1 - High Control
A2	0.3 BN	3020	Steering Wheel Module - Stage1 - Low Control
B1	0.3 WH	3023	Steering Wheel Module - Stage2 - High Control
B2	0.3 PK	3022	Steering Wheel Module - Stage2 - Low Control

Inflatable Restraint Steering Wheel Module Coil X2 (LHD)



- OEM: XMR-08V
- Service: See Catalog
- Description: 8-Way F (WH)

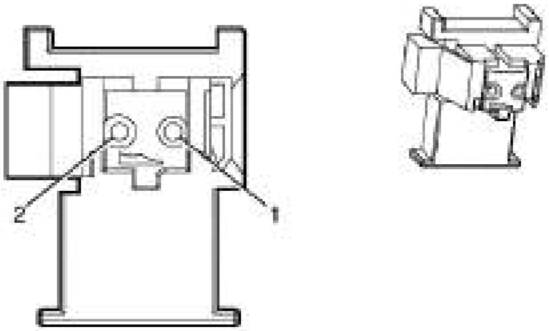
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Inflatable Restraint Steering Wheel Module Coil X2 (LHD)

Pin	Wire Color	Circuit No.	Function
1	0.3 GY/BU	7367	Steering Wheel Resistor Ladder Right Signal #2
2	0.3 YE	7364	Steering Wheel Resistor Ladder Right Signal #1
3	0.3 BN	7312	Steering Wheel Resistor Ladder Left Signal #1
4	0.3 L-BU	7313	Steering Wheel Resistor Ladder Left Signal #2
5	0.3 D-GN	897	DIC Switch Low Reference
6	0.3 OG/BK	5201	Steering Wheel Controls Signal
7	0.3 BK	1551	Ground

Inflatable Restraint Steering Wheel Module X1



Connector Part Information

- OEM: CA-252-92-5-Q
- Service: See Catalog
- Description: 2-Way M (OG)

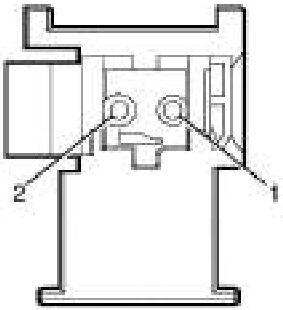
Terminal Part Information

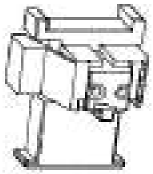
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Inflatable Restraint Steering Wheel Module X1

Pin	Wire Color	Circuit No.	Function
1	0.3 BN	3020	Steering Wheel Module - Stage1 - Low Control
2	0.3 TN	3021	Steering Wheel Module - Stage1 - High Control

Inflatable Restraint Steering Wheel Module X2





Connector Part Information

- OEM: CA-252-92-5-Q
- Service: See Catalog
- Description: 2-Way M (BU)

Terminal Part Information

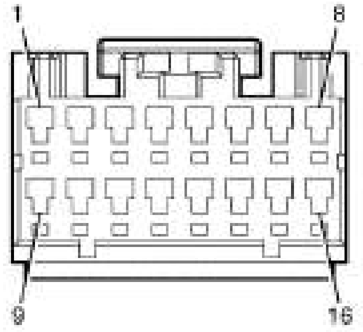
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

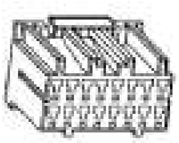
Inflatable Restraint Steering Wheel Module X2

Pin	Wire Color	Circuit No.	Function

1	0.3 PK	3022	Steering Wheel Module - Stage2 - Low Control
2	0.3 WH	3023	Steering Wheel Module - Stage2 - High Control

Inside Rearview Mirror (ISRVM) (UE1)





Connector Part Information

- OEM: 7283-1766-30
- Service: See Catalog
- Description: 16-Way F (BK)

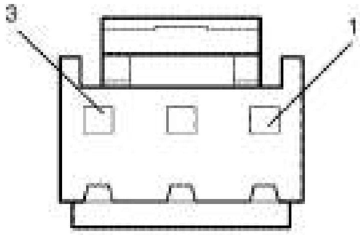
Terminal Part Information

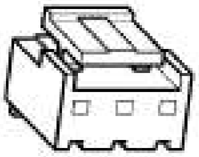
- Terminal/Tray: 175266-5/15
- Core/Insulation Crimp: J/J
- Release Tool/Test Probe: 15315247/J-35616-16 (L-GN)

Inside Rearview Mirror (ISRVM) (UE1)

Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used
2	0.3 D-GN	654	Cellular Telephone Microphone Low Reference
3-7	--	--	Not Used
8	0.3 BK	1450	Ground
9	0.5 L-GN	24	Backup Lamp Supply Voltage
10	0.3 GY	655	Cellular Microphone Signal
11	0.3 D-GN/WH	2514	Keypad Signal
12	0.3 L-GN/BK	2515	Keypad Supply Voltage
13	0.5 BN	1339	Ignition Voltage 1
14	0.3 YE/BK	2516	Keypad Green LED Signal
15	0.3 BN/WH	2517	Keypad Red LED Signal
16	--	--	Not Used

Inside Rearview Mirror (ISRVM) (without UE1)





Connector Part Information

- OEM: 12124239
- Service: See Catalog
- Description: 3-Way F

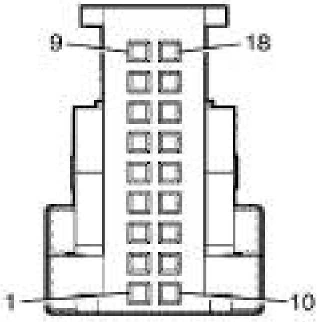
Terminal Part Information

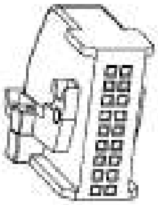
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Inside Rearview Mirror (ISRVM) (without UE1)

Pin	Wire Color	Circuit No.	Function
1	0.5 BN	443	Ignition Voltage 1
2	0.3 BK	1450	Ground
3	0.5 L-GN	24	Backup Lamp Supply Voltage

Instrument Panel Cluster





Connector Part Information

- OEM: 7219-1198-30
- Service: See Catalog
- Description: 18-Way F (BK)

Terminal Part Information

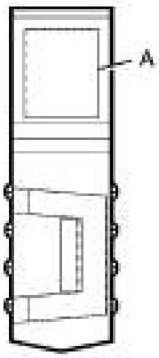
- Pins: 1, 9
- Terminal/Tray: 928999-5/15
- Core/Insulation Crimp: J/J
- Release Tool/Test Probe:12094429/J-35616-64B (L-BU)

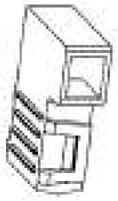
- Pins: 2-8, 10-18
- Terminal/Tray: 928999-5/15
- Core/Insulation Crimp: H/H
- Release Tool/Test Probe:12094429/J-35616-64B (L-BU)

Instrument Panel Cluster

Pin	Wire Color	Circuit No.	Function
1	0.5 OG/WH	1840	Battery Positive Voltage
2	0.3 GY	728	Security Indicator Control
3	0.3 D-BU	7148	Bluetooth Signal
4	--	--	Not Usedl
5	0.5 BN	185	Low Washer Fluid Indicator Signal
6	0.3 BN	7312	Left Steering Wheel Scroll 1
7	0.3 GY/BU	7367	Right Steering Wheel Scroll 2
8	0.3 BN/GN	7364	Right Steering Wheel Scroll 1
9	0.5 BK	850	Ground
10	0.3 PK	3	Ignition 1 Voltage
11	0.3 BN/WH	419	MIL Control
12	0.3 OG/BK	5201	Steering Wheel Controls Signal
13	0.3 BN/WH	33	Brake Warning Indicator Control
14	--	--	Not Used
15	0.35 L-GN	9203	Low Speed GMLAN Serial Data
16	--	--	Not Used
17	0.3 L-BU	7313	Left Steering Wheel Scroll 2
18	0.3 BN/WH	897	DIC Switch Low Reference

I/P Compartment Lamp X1





Connector Part Information

- OEM: 180984-5
- Service: See Catalog
- Description: 1-Way F

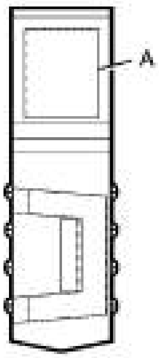
Terminal Part Information

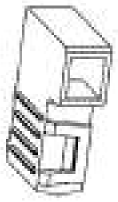
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

I/P Compartment Lamp X1

Pin	Wire Color	Circuit No.	Function
A	0.85 OG	1732	Courtesy Lamps Supply Voltage

I/P Compartment Lamp X2





Connector Part Information

- OEM: 180984-5
- Service: See Catalog

- Description: 1-Way F

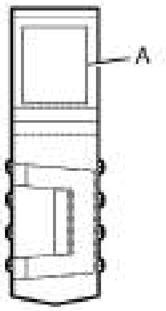
Terminal Part Information

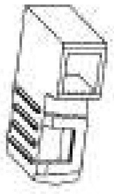
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

I/P Compartment Lamp X2

Pin	Wire Color	Circuit No.	Function
A	0.5 PU	175	Glove Box Lamp Control

I/P Compartment Lamp Switch X1





Connector Part Information

- OEM: 180984-5
- Service: See Catalog
- Description: 1-Way F

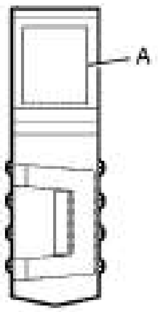
Terminal Part Information

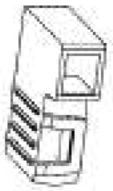
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

I/P Compartment Lamp Switch X1

Pin	Wire Color	Circuit No.	Function
A	0.5 PU	175	Glove Box Lamp Control

I/P Compartment Lamp Switch X2





Connector Part Information

- OEM: 180984-5
- Service: See Catalog
- Description: 1-Way F

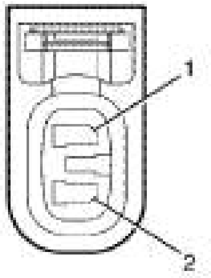
Terminal Part Information

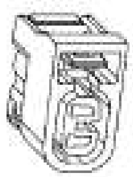
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

I/P Compartment Lamp Switch X2

Pin	Wire Color	Circuit No.	Function
A	0.5 BK/WH	1450	Ground

Intake Manifold Tuning (IMT) Solenoid Valve (LY7)





Connector Part Information

- OEM: 7283-8226-30
- Service: 88988587

- Description: 2-Way F 090 Class II Series Sealed (BK)

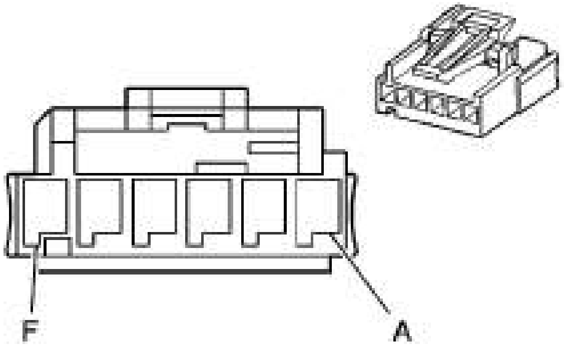
Terminal Part Information

- Terminal/Tray: 7116-4026/11
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 15313892/J-35616-18 (BK)

Intake Manifold Tuning (IMT) Solenoid Valve (LY7)

Pin	Wire Color	Circuit No.	Function
1	0.75 PU/BK	5293	Ignition 1 Voltage
2	0.75 BN	1997	EVAP Canister Vent Solenoid Valve Low Reference

Internal Mode Switch (IMS)



Connector Part Information

- OEM: 15493189
- Service: See Catalog
- Description: 6-Way F (NA)

Terminal Part Information

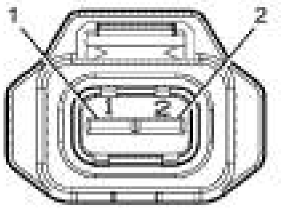
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

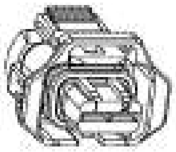
Internal Mode Switch (IMS)

Pin	Wire Color	Circuit No.	Function
A	0.5 BN	1786	Park/Neutral Signal
B	0.5 GY	776	Transmission Range Switch Signal P
C	0.5 BK	772	Transmission Range Switch Signal B
D	0.5 RD	771	Transmission Range Switch Signal A
E	0.5 D-BU	773	Transmission Range Switch Signal C

F	0.5 D-GN	450	Ground

Knock Sensor (KS) 1 (LY7)





Connector Part Information

- OEM: 7283-6205-30
- Service: See Catalog
- Description: 2-Way F (BK)

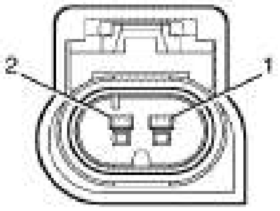
Terminal Part Information

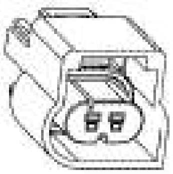
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Knock Sensor (KS) 1 (LY7)

Pin	Wire Color	Circuit No.	Function
1	0.5 D-BU	496	Knock Sensor 1 Signal
2	0.5 GY	1716	Low Reference Knock Sensor Signal Return

Knock Sensor (KS) 1 (L98 or HSV)





Connector Part Information

- OEM: 7283-3954
- Service: See Catalog
- Description: 2-Way F

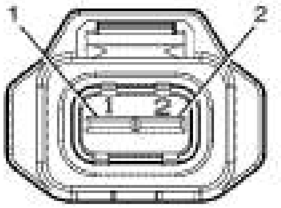
Terminal Part Information

- Terminal/Tray: 15326427/5
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Knock Sensor (KS) 1 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
1	0.5 D-BU	496	Knock Sensor 1 Signal
2	0.5 GY	1716	Low Reference Knock Sensor Signal Return

Knock Sensor (KS) 2 (LY7)



Connector Part Information

- OEM: 7283-6205-30
- Service: See Catalog
- Description: 2-Way F (BK)

Terminal Part Information

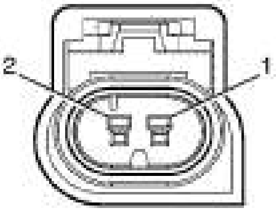
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

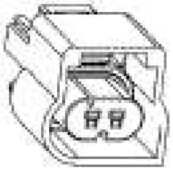
Knock Sensor (KS) 2 (LY7)

Pin	Wire Color	Circuit No.	Function

1	0.5 L-BU	1876	Knock Sensor 2 Signal
2	0.5 BN	407	Low Reference Knock Sensor Signal Return

Knock Sensor (KS) 2 (L98 or HSV)





Connector Part Information

- OEM: 7283-3954
- Service: See Catalog
- Description: 2-Way F

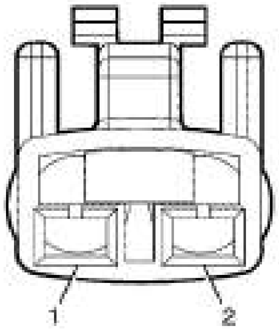
Terminal Part Information

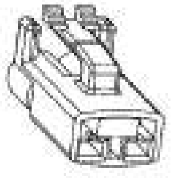
- Terminal/Tray: 15326427/5
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Knock Sensor (KS) 2 (L98 or HSV)

Pin	Wire Color	Circuit No.	Function
1	0.5 L-BU	1876	Knock Sensor 2 Signal
2	0.5 TN	407	Low Reference Knock Sensor Signal Return

License Lamp - Left





Connector Part Information

- OEM: 1897280-2
- Service: See Catalog
- Description: 2-Way F (BK)

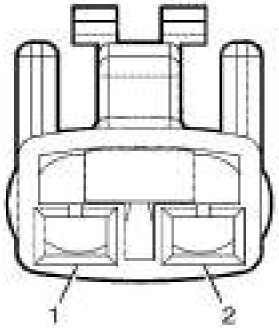
Terminal Part Information

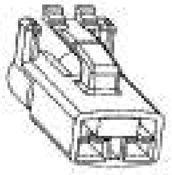
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

License Lamp - Left

Pin	Wire Color	Circuit No.	Function
1	0.5 BN/WH	309	Right Park Lamp Supply Voltage
2	0.5 BK	1350	Ground

License Lamp - Right





Connector Part Information

- OEM: 1897280-2

- Service: See Catalog
- Description: 2-Way F (BK)

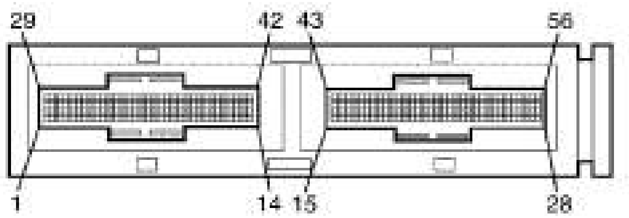
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

License Lamp - Right

Pin	Wire Color	Circuit No.	Function
1	0.5 BN/WH	309	Right Park Lamp Supply Voltage
2	0.5 BK	1350	Ground

LPG Control Module



Connector Part Information

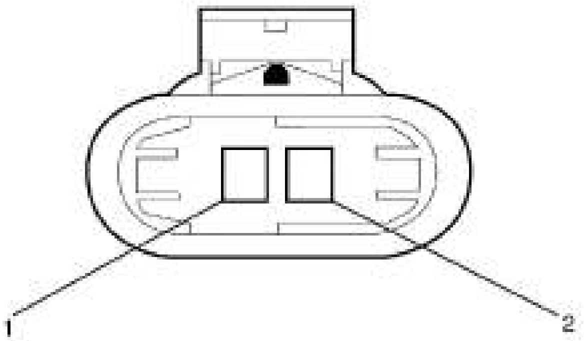
Terminal Part Information

LPG Control Module

Pin	Wire Color	Circuit No.	Function
1	0.5 YE	--	Regulator Temperature Signal
2	0.5 BK	--	Sensor Signal Supply +5V
3	0.5 GN	--	Gas Temperature Signal
4-7	--	--	Not Used
8	0.5 GN/WH	--	Power Relay Control
9	0.5 WH	--	Serial Diagnostic Connector
10	--	--	Not Used
11	0.5 GY	--	TACHO Signal
12	0.5 RD	--	Battery Voltage Positive
13	0.5 GN	--	Switch
14	0.5 BK/GN	--	Front Lock-Off Control

15	0.5 BK/BU	--	LPG Injector 1 Control
16	0.5 BK/GN	--	LPG Injector 2 Control
17	0.5 BK/YE	--	LPG Injector 3 Control
18	0.5 BK/RD	--	LPG Injector 4 Control
19	0.5 BK	--	LPG Injector Ground 1
20	0.5 GN	--	Actuator Current Blow By
21	0.5 BK/PU	--	LPG Injector 5 Control
22	0.5 BK/OG	--	LPG Injector 6 Control
23-24	--	--	Not Used
25	0.5 GN	--	Petrol Injector 5 Control
26	0.5 OG	--	Petrol Injector 6 Control
27-29	--	--	Not Used
30	0.5 WH	--	Gas Temperature Signal
31-35	--	--	Not Used
36	0.5 PU/WH	--	Throttle Position Sensor Signal
37-38	--	--	Not Used
39	0.5 BK	--	Battery Ground
40	0.5 GN/WH	--	Petrol Injector Power
41	0.5 BN	--	+12V Key Contact
42	0.5 BK/GN	--	Rear Lock-Off Control
43	0.5 YE/WH	--	Petrol Injector 1 ECU Power Output
44	0.5 YE	--	Petrol Injector 1 Control
45	0.5 BK/WH	--	Petrol Injector 2 ECU Power Output
46	0.5 BK	--	Petrol Injector 2 Control
47	0.5 BK	--	LPG Injector Ground 2
48	0.5 GN	--	Actuator Current Blow By
49	0.5 BN/WH	--	Petrol Injector 3 ECU Power Output
50	0.5 BN	--	Petrol Injector 3 Control
51	0.5 BU/WH	--	Petrol Injector 4 ECU Power Output
52	0.5 BU	--	Petrol Injector 4 Control
53	0.5 GN/WH	--	Petrol Injector 5 ECU Power Output
54	0.5 OG/WH	--	Petrol Injector 5 Control
55-56	--	--	Not Used

LPG Fuel Injector 1



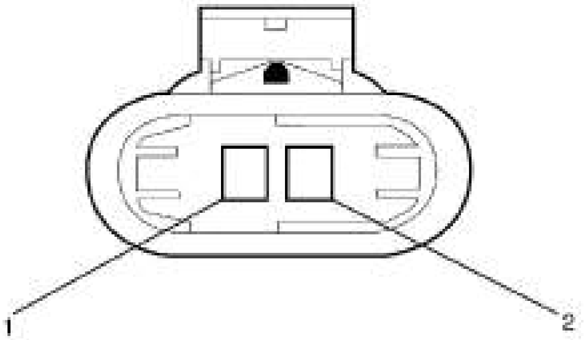
Connector Part Information

Terminal Part Information

LPG Fuel Injector 1

Pin	Wire Color	Circuit No.	Function
1	0.5 BK/BU	--	LPG Fuel Injector 1 Control
2	0.5 GN	--	Ignition Voltage

LPG Fuel Injector 2



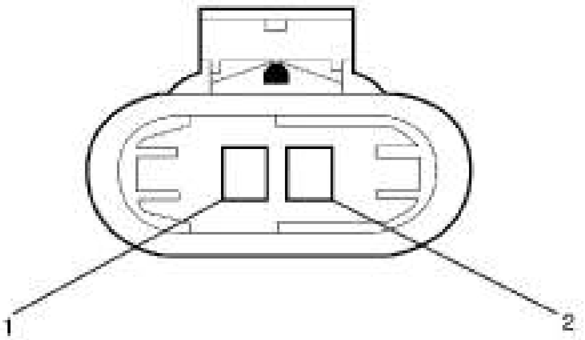
Connector Part Information

Terminal Part Information

LPG Fuel Injector 2

Pin	Wire Color	Circuit No.	Function
1	0.5 BK/GN	--	LPG Fuel Injector 2 Control
2	0.5 GN	--	Ignition Voltage

LPG Fuel Injector 3



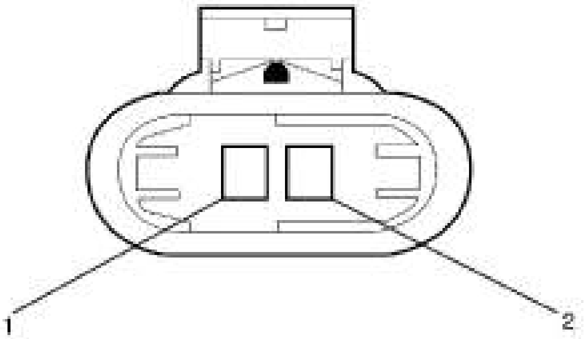
Connector Part Information

Terminal Part Information

LPG Fuel Injector 3

Pin	Wire Color	Circuit No.	Function
1	0.5 BK/YE	--	LPG Fuel Injector 3 Control
2	0.5 GN	--	Ignition Voltage

LPG Fuel Injector 4



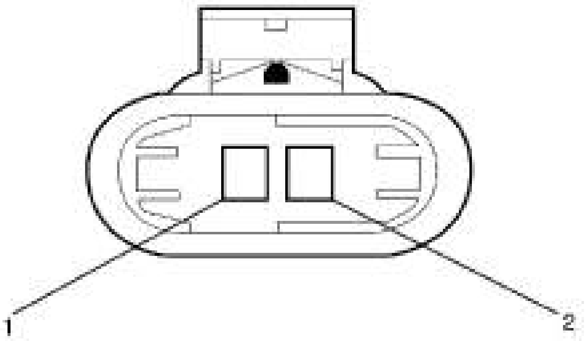
Connector Part Information

Terminal Part Information

LPG Fuel Injector 4

Pin	Wire Color	Circuit No.	Function
1	0.5 BK/RD	--	LPG Fuel Injector 4 Control
2	0.5 GN	--	Ignition Voltage

LPG Fuel Injector 5



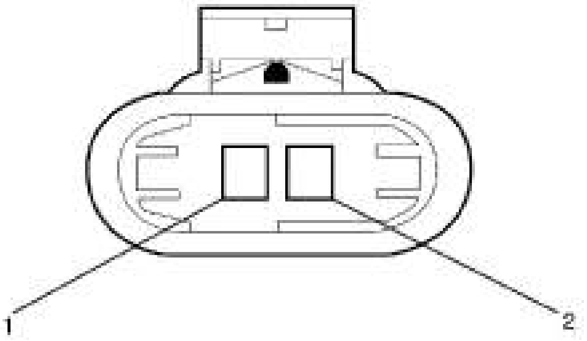
Connector Part Information

Terminal Part Information

LPG Fuel Injector 5

Pin	Wire Color	Circuit No.	Function
1	0.5 BK/PU	--	LPG Fuel Injector 5 Control
2	0.5 GN	--	Ignition Voltage

LPG Fuel Injector 6



Connector Part Information

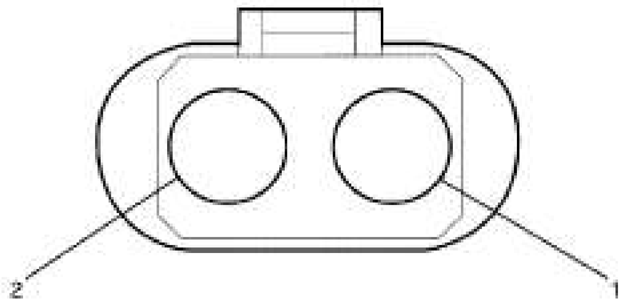
Terminal Part Information

LPG Fuel Injector 6

Pin	Wire Color	Circuit No.	Function
1	0.5 BK/OG	--	LPG Fuel Injector 6 Control

2	0.5 GN	--	Ignition Voltage

LPG Lock-Off



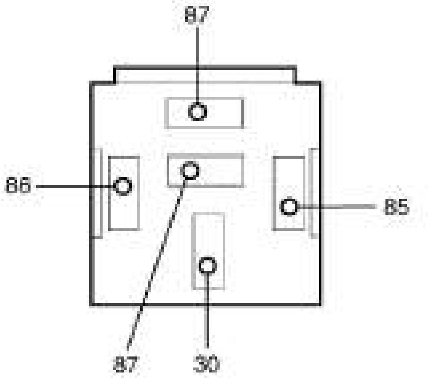
Connector Part Information

Terminal Part Information

LPG Lock-Off

Pin	Wire Color	Circuit No.	Function
1	0.5 BK/GN	--	Front Lock-Off Control
2	0.5 GN	--	Ignition Voltage

LPG Relay



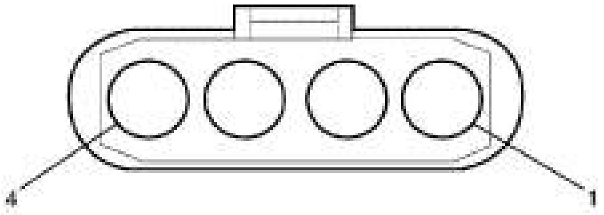
Connector Part Information

Terminal Part Information

LPG Relay

Pin	Wire Color	Circuit No.	Function
30	0.5 RD	--	Battery Voltage
85	0.5 GN/WH	--	Power Relay Control
86	0.75 RD	--	Battery Voltage
87	0.5 GN	--	Relay Controlled Voltage

LPG Switch / Fuel Display



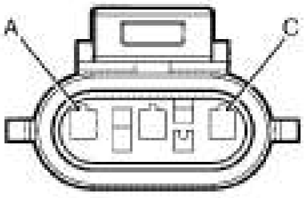
Connector Part Information

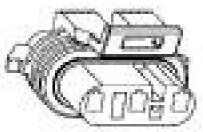
Terminal Part Information

LPG Switch / Fuel Display

Pin	Wire Color	Circuit No.	Function
1	0.5 RD	--	+5 Voltage Input
2	0.5 BK	--	Ground
3	0.75 GN	--	Switch Signal
4	0.5 WH	--	Fuel Level Input

Manifold Absolute Pressure (MAP) Sensor (L98)





Connector Part Information

- OEM: 7283-7938-30
- Service: See Catalog
- Description:

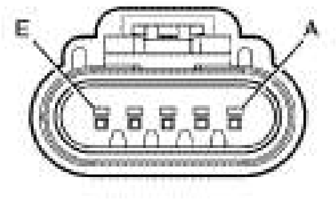
Terminal Part Information

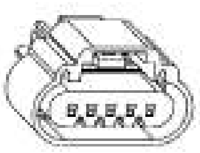
- Terminal/Tray: 1928498056/8
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: J-38125-561/J-35616-35 (VT)

Manifold Absolute Pressure (MAP) Sensor (L98)

Pin	Wire Color	Circuit No.	Function
A	0.5 OG/BK	469	Low Reference
B	0.5 L-GN	432	MAP Sensor Signal
C	0.5 GY	2704	5-Volt Reference

Mass Air Flow (MAF) / Intake Air Temperature (IAT) Sensor





Connector Part Information

- OEM: 7283-6997-30
- Service: See Catalog
- Description: 5-Way F (BK)

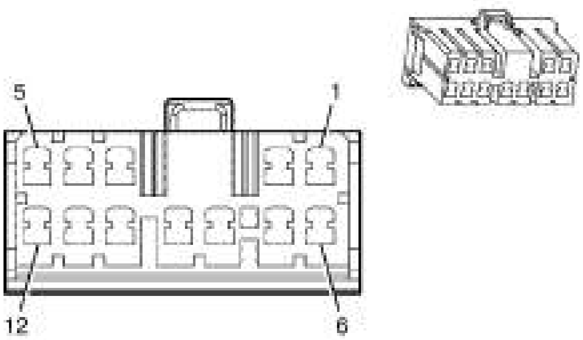
Terminal Part Information

- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Mass Air Flow (MAF) / Intake Air Temperature (IAT) Sensor

Pin	Wire Color	Circuit No.	Function
A	0.5 YE	492	MAF Sensor Signal
B	0.5 PK	439	Ignition 1 Voltage
C	0.5 BK	450	Ground
D	0.5 BN/RD	472	IAT Sensor Signal
E	0.5 BN/WH	2760	Low Reference

Memory Seat Module - Driver X1



Connector Part Information

- OEM: 173851-1
- Service: See Catalog
- Description: 12-Way F

Terminal Part Information

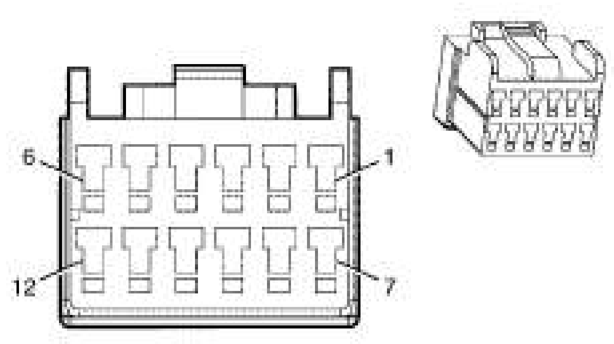
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Memory Seat Module - Driver X1

Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used
2	0.85 GY/RD	285	Driver Seat Horizontal Motor Forward Control
3	0.85 D-BU	283	Driver Seat Rear Vertical Motor Down Control
4	0.85 D-GN/YE	282	Driver Seat Rear Vertical Motor Up Control
5	1.25 RD/BK	4740	Seat Module Supply Voltage
6	--	--	Not Used
7	0.85 BN	286	Driver Seat Front Vertical Motor Up Control
8	0.85 D-BU/RD	287	Driver Seat Front Vertical Motor Down Control
9	0.85 GY	284	Driver Seat Horizontal Motor Rearward Control

10	0.5 BK/OG	1350	Ground
11	1.25 BK	1350	Ground
12	0.3 D-BU/GN	1674	Driver Power Seat Select Switch Signal

Memory Seat Module - Driver X2



Connector Part Information

- OEM: 174045-2
- Service: See Catalog
- Description: 12-Way

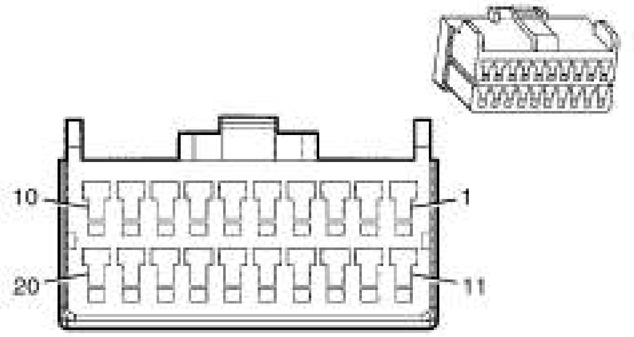
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Memory Seat Module - Driver X2

Pin	Wire Color	Circuit No.	Function
1	0.3 D-GN/BN	570	Driver Seat Recline Motor Position Sensor Signal
2-5	--	--	Not Used
6	0.85 YE	276	Recline Forward Switch Signal
7-10	--	--	Not Used
11	0.85 PU/GN	277	Recline Rearward Switch Signal
12	0.85 D-GN/RD	767	Driver Seat Lumbar Down Switch Signal

Memory Seat Module - Driver X3



Connector Part Information

- OEM: 175967-2
- Service: See Catalog
- Description: 20-Way F

Terminal Part Information

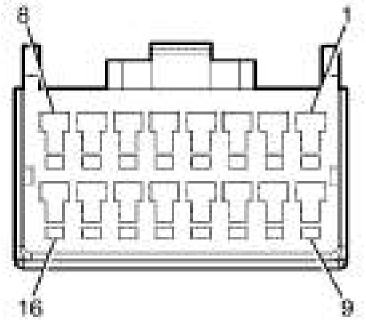
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

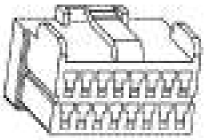
Memory Seat Module - Driver X3

Pin	Wire Color	Circuit No.	Function
1	0.5 RD/OG	6839	Memory Mirror Voltage
2	0.3 BN/WH	1270	Power Seat Recline Rearward Switch Signal
3	0.3 TN	1522	Power Seat Horizontal Rearward Switch Signal
4	0.3 D-GN/BU	1523	Power Seat Horizontal Forward Switch Signal
5	0.3 BK/BU	1518	Power Seat Front Vertical Up Switch Signal
6	0.3 OG/BN	1064	Driver Seat Lumbar Rearward Switch Signal
7	0.3 RD/WH	1520	Power Seat Front Vertical Down Switch Signal
8	0.3 D-GN/PK	5979	Memory 2 Switch Control Signal
9	0.3 TN/BK	5978	Memory 1 Switch Control Signal
10	0.3 PK/BU	7363	MOD_WK
11	0.3 D-BU/WH	7006	Mirror Control Signal
12	0.3 D-BU/BK	1065	Driver Seat Lumbar Forward Switch Signal
13	0.3 YE/BU	1521	Power Seat Rear Vertical Down Switch Signal
14	0.3 BN/RD	1269	Power Seat Recline Forward Switch Signal
15	--	--	Not Used
16	0.3 PK	1519	Power Seat Rear Vertical Up Switch Signal
17	--	--	Not Used
18	0.3 WH/RD	612	Right Front Adaptive Seat Switch / Mirror Dip Control Signal
19	0.3 YE/RD	782	Memory 3 Switch Control Signal

20	0.3 PU/WH	1061	UART Serial Data

Memory Seat Module - Driver X4





Connector Part Information

- OEM: 175966-2
- Service: See Catalog
- Description: 16-Way F

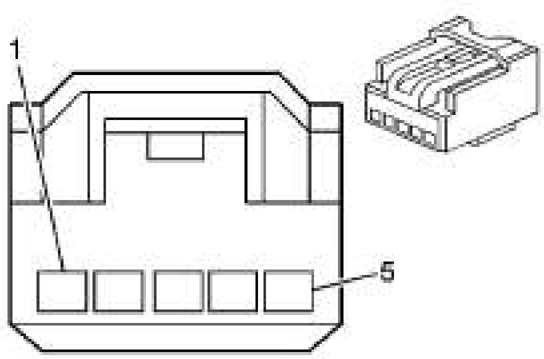
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Memory Seat Module - Driver X4

Pin	Wire Color	Circuit No.	Function
1-4	--	--	Not Used
5	0.3 WH/GY	569	Horizontal Seat Motor Position Sensor Signal
6	--	--	Not Used
7	0.3 D-GN/PU	2940	Rear Vertical Seat Motor Position Sensor Voltage Reference
8	0.3 D-GN/WH	3040	Front Vertical Seat Motor Position Sensor Voltage Reference
9	0.3 RD/GN	568	Rear Vertical Seat Motor Position Sensor Signal
10	0.3 BN/BU	557	Front Vertical Seat Motor Position Sensor Signal
11-15	--	--	Not Used
16	0.5 BK/GY	2851	Memory Mirror Ground

Mode Actuator - Left



Connector Part Information

- OEM: 7283-5830-30
- Service: See Catalog
- Description: 5-Way F Yazaki (BK)

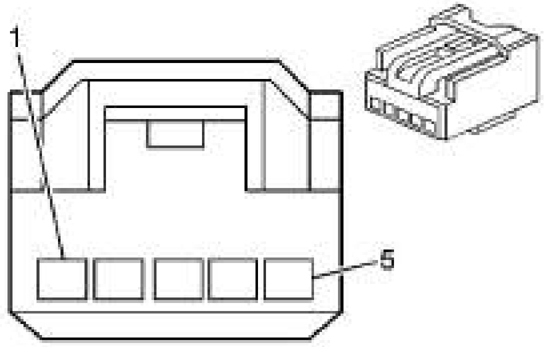
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Mode Actuator - Left

Pin	Wire Color	Circuit No.	Function
1	0.3 BN	2273	Mode Actuator 1 - Power
2	0.3 BK	119	Mode Actuator 1 - Control
3	0.3 D-BU	1791	Low Reference
4	0.3 GY	2275	Mode Actuator 1 - Feedback
5	0.3 D-GN	474	5-Volt Reference

Mode Actuator - Right



Connector Part Information

- OEM: 7283-5830-30
- Service: See Catalog
- Description: 5-Way F Yazaki (BK)

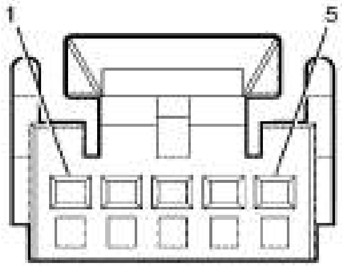
Terminal Part Information

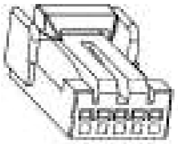
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Mode Actuator - Right

Pin	Wire Color	Circuit No.	Function
1	0.3 L-GN	2210	Mode Actuator 2 - Power
2	0.3 OG	1791	Mode Actuator 2 - Control
3	0.3 L-BU	720	Low Reference
4	0.3 RD	1899	Mode Actuator 2 - Feedback
5	0.3 PK	1236	5-Volt Reference

Mode Actuator - Auxiliary (C63)





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 5-Way F

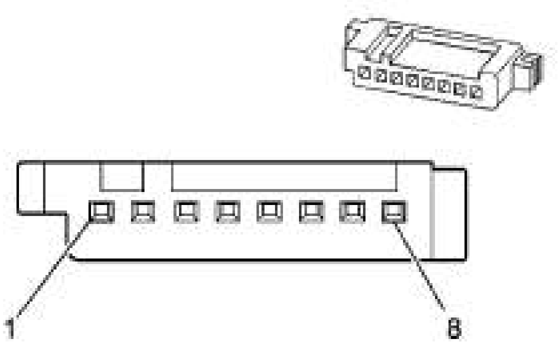
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Mode Actuator - Auxiliary (C63)

Pin	Wire Color	Circuit No.	Function
1	0.3 D-GN/BU	6555	Mode Actuator Rear - Power
2	0.3 D-GN/RD	6556	Mode Actuator Rear - Control
3	0.3 D-GN/YE	645	Low Reference
4	0.3 D-GN/WH	6558	Mode Actuator Rear - Feedback
5	0.3 D-GN/OG	5718	5-Volt Reference

Multifunction Switch - Center Console



Connector Part Information

- OEM: 7119-1306
- Service: See Catalog
- Description: 8-Way F (WH)

Terminal Part Information

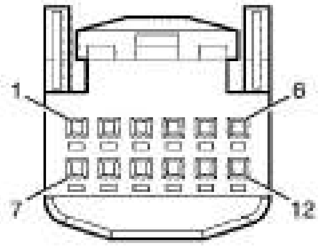
- Terminal/Tray: 928999-5/15
- Core/Insulation Crimp: H/H
- Release Tool/Test Probe: 12094429/J-35616-64B (L-BU)

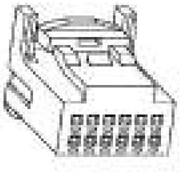
Multifunction Switch - Center Console

Pin	Wire Color	Circuit No.	Function
1	0.3 YE	6817	LED Backlight Dimming Control
2	0.3 BK	850	Ground
3	0.3 L-BU	553	Tow/Haul Switch Signal
4	--	--	Not Used
5	0.3 BN/OG	1571	Traction Control Switch Signal
6	0.3 GY	2555	Object Detection Disable Signal
7	0.3 BN	5852	Instrument Panel Lamp Supply Voltage

8	0.3 PU/WH	6816	Object Detection Disable Signal

Navigation Gateway Module (RHD)





Connector Part Information

- OEM: 1318774-1
- Service: See Catalog
- Description: 12-Way F

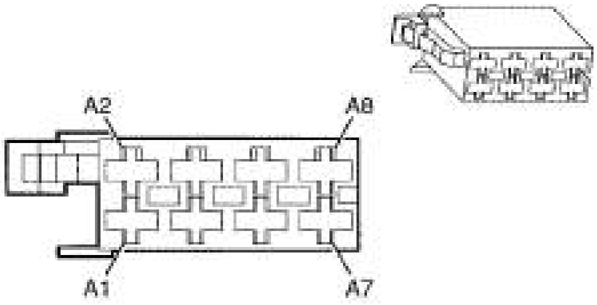
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Navigation Gateway Module (RHD)

Pin	Wire Color	Circuit No.	Function
1	0.3 BN	1171	Navigation Display Serial Data High
2	0.3 OG	2354	Navigation Display Serial Data High
3	0.85 OG	5748	Mute Signal
4	--	--	Not Used
5	0.5 L-GN	5060	Low Speed GMLAN Serial Data
6	0.85 OG/WH	2340	Battery Positive Voltage
7	0.3 YE	1219	Navigation Display Serial Data Low
8	0.3 YE	1491	Backlight Lamps Control
9-11	--	--	Not Used
12	0.5 BK/WH	1050	Ground

Navigation Module X1 (RHD)



Connector Part Information

- OEM: 962189-1
- Service: See Catalog
- Description: 8-Way F (GY)

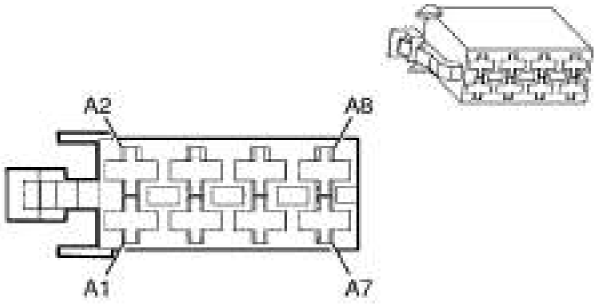
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Navigation Module X1 (RHD)

Pin	Wire Color	Circuit No.	Function
A1-A3	--	--	Not Used
A4	0.85 OG/WH	2340	Battery Positive Voltage
A5	--	--	Not Used
A6	0.3 YE	1491	Backlight Lamps Control
A7	0.3 OG	2354	Navigation Control Signal
A8	0.85 BK/WH	1050	Ground

Navigation Module X2 (RHD)



Connector Part Information

- OEM: 962191-1
- Service: See Catalog
- Description: 8-Way F (TN)

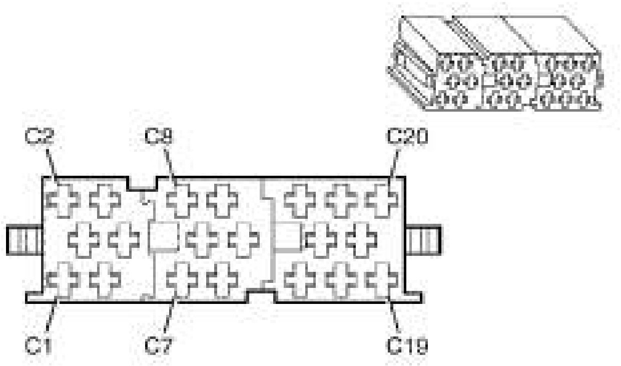
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp:See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Navigation Module X2 (RHD)

Pin	Wire Color	Circuit No.	Function
A1-A4	--	--	Not Used
A5	0.3 PK/BK	2062	Navigation Mono Audio Signal (+)
A6	0.3 OG/BK	2061	Navigation Mono Audio Signal (-)
A7-A8	--	--	Not Used

Navigation Module X3 (RHD)



Connector Part Information

- OEM: 30220317
- Service: See Catalog
- Description: 20-Way F

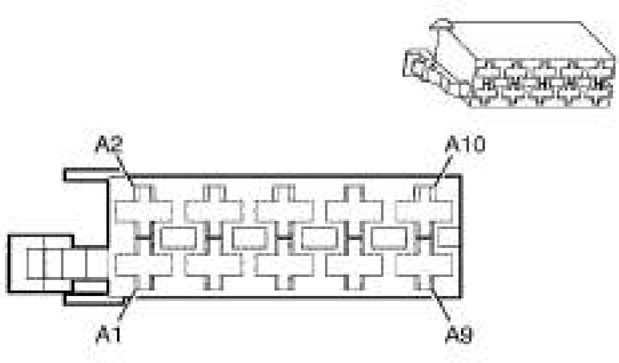
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Navigation Module X3 (RHD)

Pin	Wire Color	Circuit No.	Function
C1-C6	--	--	Not Used
C7	0.3 BN	1171	Navigation Display Serial Data High
C8	0.3 YE	1219	Navigation Display Serial Data Low
C9-C20	--	--	Not Used

Navigation Module X4 (RHD)



Connector Part Information

- OEM: 962190-1
- Service: See Catalog
- Description:10-Way F (BK)

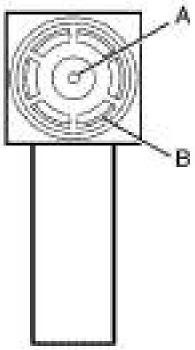
Terminal Part Information

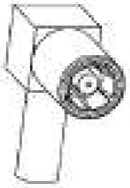
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Navigation Module X4 (RHD)

Pin	Wire Color	Circuit No.	Function
A1-A3	--	--	Not Used
A4	0.85 OG	5748	Mute Signal
A5-A10	--	--	Not Used

Navigation Module X5 (RHD)





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 2-Way

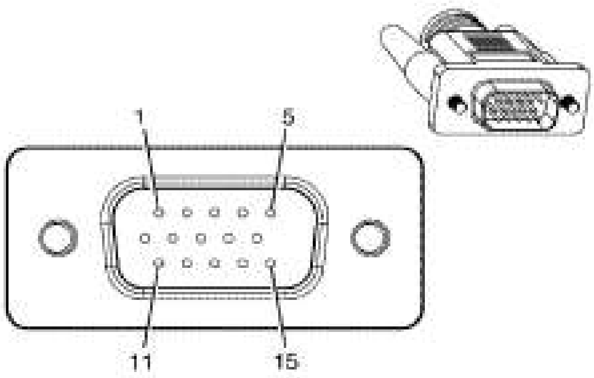
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp:See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Navigation Module X5 (RHD)

Pin	Wire Color	Circuit No.	Function
A	0.5 OG	5174	Antenna Signal
B	0.5 GY	5175	Drain Wire

Navigation Module X6 (RHD)



Connector Part Information

- OEM: 06031501440

- Service: See Catalog
- Description: 15-Way

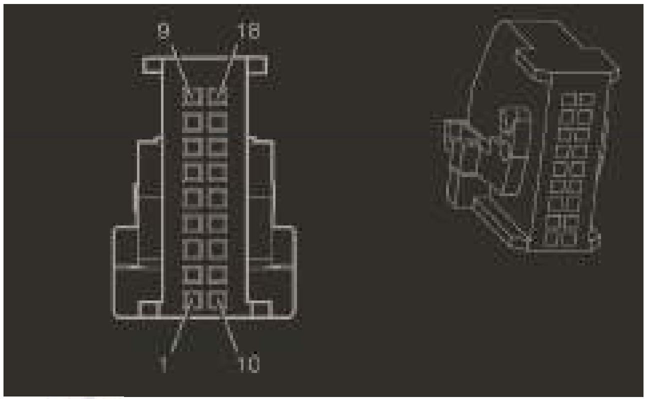
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Navigation Module X6 (RHD)

Pin	Wire Color	Circuit No.	Function
1	0.3 RD	2047	Video Connector - R
2	0.3 D-GN	2048	Video Connector - G
3	0.3 WH	2049	Video Connector - B
4	0.3 BK	5231	Ground
5	0.3 YE	2045	Video Connector - Sync
6	0.3 BK	5346	Drain Wire

Navigation Module X7 (RHD)



Connector Part Information

- OEM: 7219-1198-30
- Service: See Catalog
- Description:

Terminal Part Information

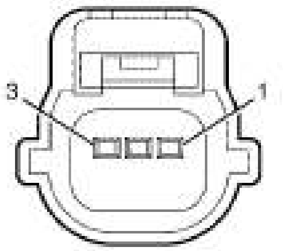
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

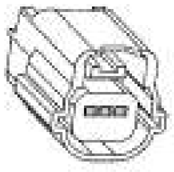
Navigation Module X7 (RHD)

Pin	Wire Color	Circuit No.	Function
1	0.3 WH		Video Connector - B

2	--	--	Not Used
3	0.3 RD	2047	Video Connector - R
4-9	--	--	Not Used
10	0.3 BK	5231	Ground
11	0.3 D-GN	2048	Video Connector - G
12	--	--	Not Used
13	0.3 YE	2045	Video Connector - Sync
14-18	--	--	Not Used

Object Alarm Sensor - Left Front Corner





Connector Part Information

- OEM: 31404-3710
- Service: See Catalog
- Description: 3-Way F

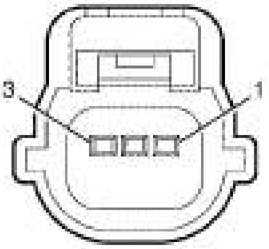
Terminal Part Information

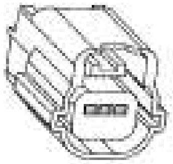
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Object Alarm Sensor - Left Front Corner

Pin	Wire Color	Circuit No.	Function
1	0.3 BN	6581	Object Sensor Supply Voltage
2	0.3 OG/BK	5214	Object Sensor Low Reference
3	0.3 PU/WH	5215	LF Corner Object Sensor Signal

Object Alarm Sensor - Left Front Middle





Connector Part Information

- OEM: 31404-3710
- Service: See Catalog
- Description: 3-Way F

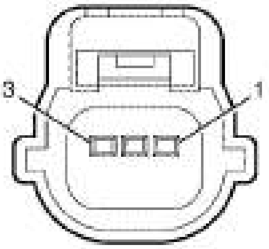
Terminal Part Information

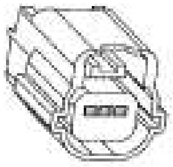
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Object Alarm Sensor - Left Front Middle

Pin	Wire Color	Circuit No.	Function
1	0.3 BN	6581	Object Sensor Supply Voltage
2	0.3 OG/BK	5214	Object Sensor Low Reference
3	0.3 WH	5216	LF Middle Object Sensor Signal

Object Alarm Sensor - Left Rear Corner





Connector Part Information

- OEM: 31404-3710
- Service: See Catalog
- Description: 3-Way F

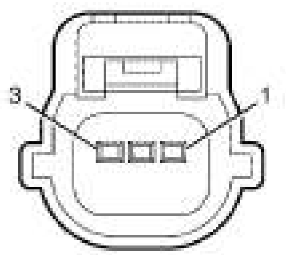
Terminal Part Information

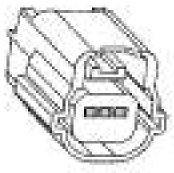
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Object Alarm Sensor - Left Rear Corner

Pin	Wire Color	Circuit No.	Function
1	0.3 D-BU	2374	Object Sensor Supply Voltage
2	0.3 GY	2379	Object Sensor Low Reference
3	0.3 YE	2375	LR Corner Object Sensor Signal

Object Alarm Sensor - Left Rear Middle





Connector Part Information

- OEM: 31404-3710
- Service: See Catalog
- Description: 3-Way F

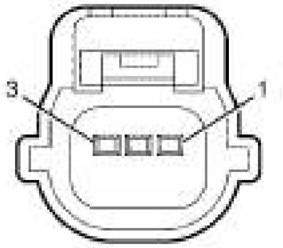
Terminal Part Information

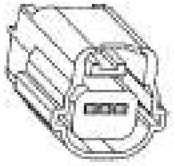
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Object Alarm Sensor - Left Rear Middle

Pin	Wire Color	Circuit No.	Function
1	0.3 D-BU	2374	Object Sensor Supply Voltage
2	0.3 GY	2379	Object Sensor Low Reference
3	0.3 OG	2376	LR Middle Object Sensor Signal

Object Alarm Sensor - Right Front Corner





Connector Part Information

- OEM: 31404-3710
- Service: See Catalog
- Description: 3-Way F

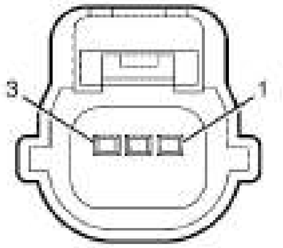
Terminal Part Information

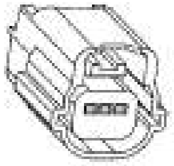
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Object Alarm Sensor - Right Front Corner

Pin	Wire Color	Circuit No.	Function
1	0.3 BN	6581	Object Sensor Supply Voltage
2	0.3 OG/BK	5214	Object Sensor Low Reference
3	0.3 BN/WH	5217	RF Corner Object Sensor Signal

Object Alarm Sensor - Right Front Middle





Connector Part Information

- OEM: 31404-3710
- Service: See Catalog
- Description: 3-Way F

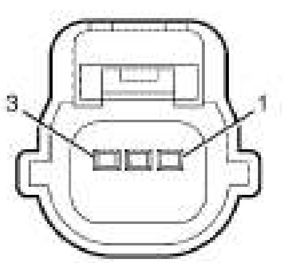
Terminal Part Information

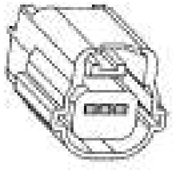
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Object Alarm Sensor - Right Front Middle

Pin	Wire Color	Circuit No.	Function
1	0.3 BN	6581	Object Sensor Supply Voltage
2	0.3 OG/BK	5214	Object Sensor Low Reference
3	0.3 PU/BK	5218	RF Middle Object Sensor Signal

Object Alarm Sensor - Right Rear Corner





Connector Part Information

- OEM: 31404-3710
- Service: See Catalog
- Description: 3-Way F

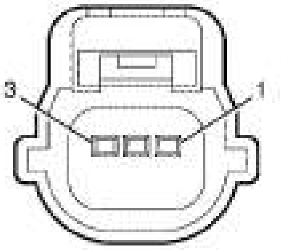
Terminal Part Information

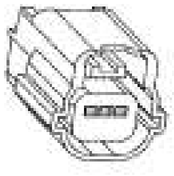
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Object Alarm Sensor - Right Rear Corner

Pin	Wire Color	Circuit No.	Function
1	0.3 D-BU	2374	Object Sensor Supply Voltage
2	0.3 GY	2379	Object Sensor Low Reference
3	0.3 PU	2378	RR Corner Object Sensor Signal

Object Alarm Sensor - Right Rear Middle





Connector Part Information

- OEM: 31404-3710
- Service: See Catalog
- Description: 3-Way F

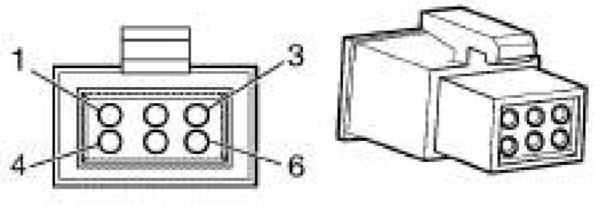
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Object Alarm Sensor - Right Rear Middle

Pin	Wire Color	Circuit No.	Function
1	0.3 D-BU	2374	Object Sensor Supply Voltage
2	0.3 GY	2379	Object Sensor Low Reference
3	0.3 D-GN	2377	RR Middle Object Sensor Signal

Oil Pressure Gauge



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 6-Way F

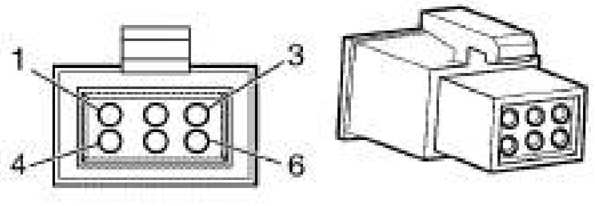
Terminal Part Information

- Terminal/Tray: See Terminal Repai Kit
- Core/Insulation Crimp: See Terminal Repai Kit
- Release Tool/Test Probe: See Terminal Repai Kit

Oil Pressure Gauge

Pin	Wire Color	Circuit No.	Function
1	0.3 YE		Low Speed GMLAN Serial Data
2	0.3 D-BU		Ground
3	0.3 D-BU/RD		Battery Positive Voltage
4	0.3 YE		Low Speed GMLAN Serial Data
5	0.3 D-BU		Ground
6	0.3 D-BU/RD		Battery Positive Voltage

Oil Temperature Gauge



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 6-Way F

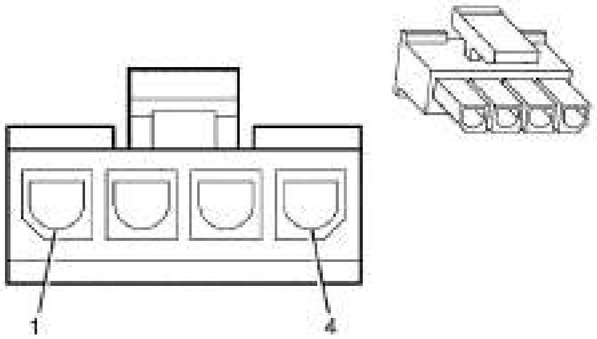
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Oil Temperature Gauge

Pin	Wire Color	Circuit No.	Function
1	0.3 YE		Low Speed GMLAN Serial Data
2	0.3 D-BU		Ground
3	0.3 D-BU/RD		Battery Positive Voltage
4	0.3 YE		Low Speed GMLAN Serial Data
5	0.3 D-BU		Ground
6	0.3 D-BU		Battery Positive Voltage

Outside Moisture Sensor



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 4-Way

Terminal Part Information

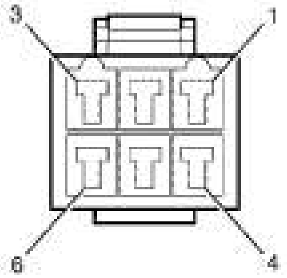
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit

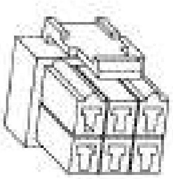
- Release Tool/Test Probe: See Terminal Repair Kit

Outside Moisture Sensor

Pin	Wire Color	Circuit No.	Function
1	0.3 L-GN		Outside Moisture Sensor Signal 2
2	0.3 BN		Outside Moisture Sensor Signal 1
3	0.5 BK/WH		Ground
4	0.5 BN		Ignition Voltage 1

Outside Rearview Mirror - Driver





Connector Part Information

- OEM: 7183-9618
- Service: See Catalog
- Description: 6-Way F (WH)

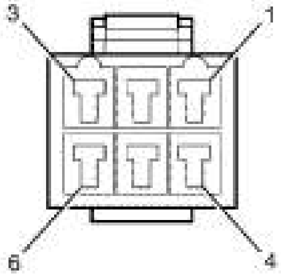
Terminal Part Information

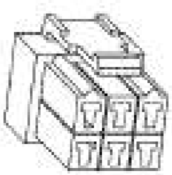
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Outside Rearview Mirror - Driver

Pin	Wire Color	Circuit No.	Function
1	0.5 WH	7391	Power Window Switch Right and Up
2	0.5 WH/BK	81	Driver Mirror Motor Right Control
3	0.5 BN	5998	Puddle Lamp Supply Voltage
4	0.5 L-GN/BK	89	Driver Mirror Motor Down Control
5	--	--	Not Used
6	0.5 BK	2050	Ground

Outside Rearview Mirror - Passenger





Connector Part Information

- OEM: 7183-9618
- Service: See Catalog
- Description: 6-Way F (WH)

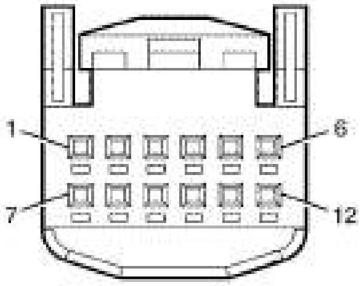
Terminal Part Information

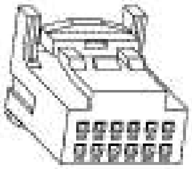
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Outside Rearview Mirror - Passenger

Pin	Wire Color	Circuit No.	Function
1	0.5 WH/BU	7391	Power Window Switch Right and Up
2	0.5 OG/WH	881	Passenger Mirror Motor Right Control
3	0.5 BN	5998	Puddle Lamp Supply Voltage
4	0.5 PU/WH	889	Passenger Mirror Motor Down Control
5	--	--	Not Used
6	0.5 BK	1350	Ground

Outside Rearview Mirror Switch





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 12-Way F

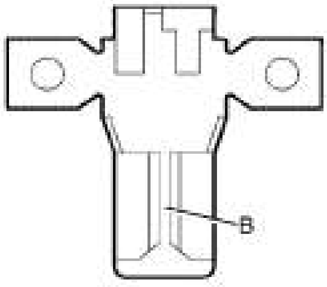
Terminal Part Information

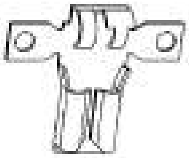
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Outside Rearview Mirror Switch

Pin	Wire Color	Circuit No.	Function
1	0.3 YE/GN	7006	Mirror Control Signal
2	--	--	Not Used
3	0.5 WH	1514	Left Mirror Switch Down Signal
4	0.5 D-BU	1513	Right Mirror Switch Right Signal
5	0.5 RD	5477	Switch Voltage
6	0.5 BK	5478	Ground
7	0.5 OG	1512	Left Mirror Switch Right Signal
8	0.3 YE	5636	Left/Right Mirror Selector Switch Signal
9	0.5 D-GN	1515	Right Mirror Switch Down Signal
10	0.5 BK/GN	2851	Memory Mirror Ground
11	--	--	Not Used
12	0.5 RD/BU	6839	Memory Mirror Voltage

Park Brake Switch





Connector Part Information

- OEM: 175193-1
- Service: See Catalog
- Description: 2-Way F (SR)

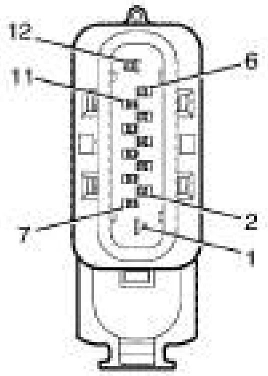
Terminal Part Information

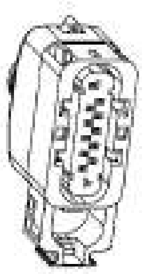
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Park Brake Switch

Pin	Wire Color	Circuit No.	Function
B	0.85 OG/BK	233	Park Brake Switch Signal

Park/Neutral Position (PNP) Switch (M30 or M32)





Connector Part Information

- OEM: 15416722
- Service: See Catalog
- Description: 12-Way F

Terminal Part Information

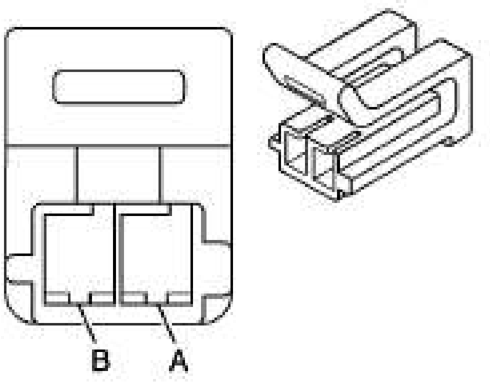
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Park/Neutral Position (PNP) Switch (M30 or M32)

Pin	Wire Color	Circuit No.	Function
1-2	--	--	Not Used
3	0.5 OG/BK	1786	Park/Neutral Signal
4	0.5 YE	772	Transmission Range Switch Signal B
5	0.5 BN/YE	771	Transmission Range Switch Signal A
6	0.5 GY	773	Transmission Range Switch Signal C

7	0.75 BK	450	Ground
8	0.5 WH	776	Transmission Range Switch Signal P
9-12	--	--	Not Used

Pressure Control (PC) Solenoid Valve



Connector Part Information

- OEM: 12146094
- Service: See Catalog
- Description: 2-Way F Metri-Pack 150.2 Series, Sealed, Pull To Seat (GY)

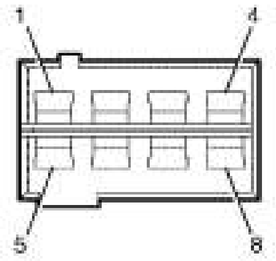
Terminal Part Information

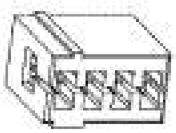
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Pressure Control (PC) Solenoid Valve

Pin	Wire Color	Circuit No.	Function
A	0.5 D-GN	1228	PC Solenoid Valve High Control
B	0.5 WH	1229	PC Solenoid Valve Low Control

Radio X1





Connector Part Information

- OEM: 7183-2325-30
- Service: See Catalog
- Description: 8-Way F (BK)

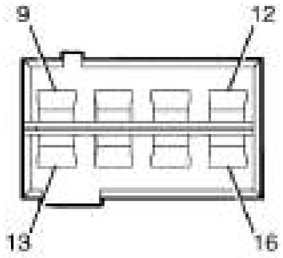
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Radio X1

Pin	Wire Color	Circuit No.	Function
1	0.5 L-BU	115	Right Rear Speaker Output (-) (U65 or UW5)
	0.5 BN/BU	1946	Right Rear Speaker Output (-) (UQ7)
2	0.5 D-GN	117	Right Front Speaker Output (-) (U65 or UW5)
	0.5 L-GN	1948	Right Front Speaker Output (-) (UQ7)
3	0.5 GY	118	Left Front Speaker Output (-) (U65 or UW5)
	0.5 D-GN	1947	Left Front Speaker Output (-) (UQ7)
4	0.5 YE/RD	116	Left Rear Speaker Output (-) (U65 or UW5)
	0.5 BN	1999	Left Rear Speaker Output (-) (UQ7)
5	0.5 D-BU	46	Right Rear Speaker Output (+) (U65 or UW5)
	0.5 D-BU	546	Right Rear Speaker Output (+) (UQ7)
6	0.5 L-GN	200	Right Front Speaker Output (+) (U65 or UW5)
	0.5 L-GN/WH	512	Right Front Speaker Output (+) (UQ7)
7	0.5 BN	201	Left Front Speaker Output (+) (U65 or UW5)
	0.5 BN/OG	511	Left Front Speaker Output (+) (UQ7)
8	0.5 BN	199	Left Rear Speaker Output (+) (U65 or UW5)
	0.5 BN/WH	599	Left Rear Speaker Output (+) (UQ7)

Radio X2



Connector Part Information

- OEM: 7283-8776-30
- Service: See Catalog
- Description: 8-Way F (BK)

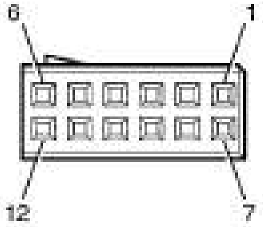
Terminal Part Information

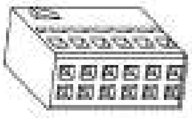
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Radio X2

Pin	Wire Color	Circuit No.	Function
9	0.5 L-BU	1860	Front Center Speaker Output (+)
10	0.85 OG/BU	4340	Battery Positive Voltage (RHD)
	0.85 RD/WH	4340	Battery Positive Voltage (LHD)
11	--	--	Not Used
12	1.25 BK	1050	Ground
13	0.5 OG	1860	Front Center Speaker Output (+)
14	0.85 OG/BU	4340	Battery Positive Voltage (RHD)
	0.85 RD/WH	4340	Battery Positive Voltage (LHD)
15	--	--	Not Used
16	1.25 BK	1050	Ground

Radio X3





Connector Part Information

- OEM: 7119-1013-30
- Service: See Catalog
- Description: 12-Way F (BK)

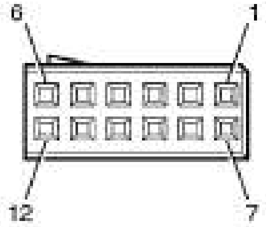
Terminal Part Information

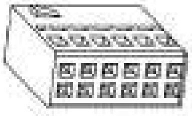
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Radio X3

Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used
2	0.3 D-BU/WH	7001	Common Auxiliary Audio Signal (-) (UQ7)
3	0.3 RD	5839	Auxiliary Audio Left Signal (+) (UQ7)
4	0.3 OG/BK	2061	Navigation Mono Audio Signal (-)
5	0.3 PK	367	Left Audio Signal (+)
6	0.3 D-GN/WH	1547	Common Audio Signal (-)
7-8	--	--	Not Used
9	0.3 D-GN	5841	Auxiliary Audio Right Signal (+) (UQ7)
10	0.3 PK/BK	2062	Navigation Mono Audio Signal (+)
11	0.3 D-BU	368	Right Audio Signal (+)
12	--	--	Not Used

Radio X4





Connector Part Information

- OEM: 7119-1013-30
- Service: See Catalog
- Description: 12-Way F (BK)

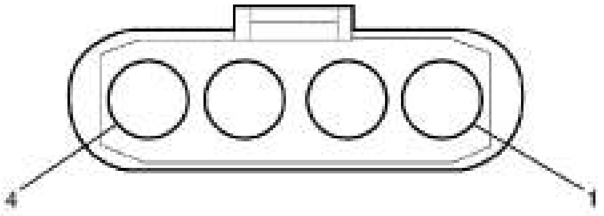
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Radio X4

Pin	Wire Color	Circuit No.	Function
1	0.3 L-BU	659	Telephone Audio Signal (-)
2-3	--	--	Not Used
4	0.85 OG/BU	1573	Battery Positive Voltage (RHD)
	0.85 RD/WH	1573	Battery Positive Voltage (LHD)
5	0.3 WH	700	Telephone Audio Signal Mute
6	0.35 D-GN	5060	Low Speed GMLAN Serial Data
7	0.3 OG/BK	658	Telephone Audio Signal (+)
8-9	--	--	Not Used
10	0.5 OG	6978	Amplifier Mute Control (UQ7)
11	0.5 WH	7066	Amplifier Enable Signal (UQ7)
12	--	--	Not Used

Rail Pressure/Temperature Sensor (LPG)



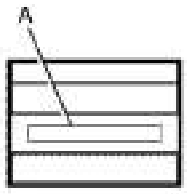
Connector Part Information

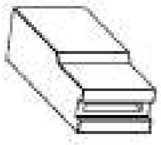
Terminal Part Information

Rail Pressure / Temperature Sensor (LPG)

Pin	Wire Color	Circuit No.	Function
1	0.5 BK	--	Ground
2	0.5 GN	--	Relay Controlled Voltage
3	0.75 RD	--	+5 Voltage Input
4	0.5 WH	--	Gas Temperature Signal

Rear Compartment Courtesy Lamp X1





Connector Part Information

- OEM: 7123-0073-30
- Service: See Catalog
- Description: 1-Way F (BK)

Terminal Part Information

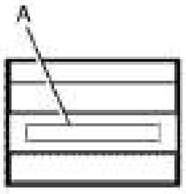
- Terminal/Tray: See Terminal Repair Kit

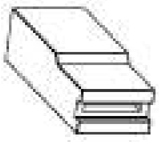
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Rear Compartment Courtesy Lamp X1

Pin	Wire Color	Circuit No.	Function
A	0.85 OG	1732	Courtesy Lamps Supply Voltage

Rear Compartment Courtesy Lamp X2





Connector Part Information

- OEM: 7123-0073-30
- Service: See Catalog
- Description: 1-Way F (BK)

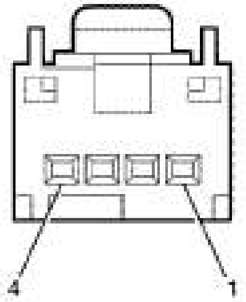
Terminal Part Information

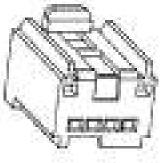
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Rear Compartment Courtesy Lamp X2

Pin	Wire Color	Circuit No.	Function
A	0.5 D-BU	737	Rear Compartment Lamp Control

Rear Compartment Lid Latch





Connector Part Information

- OEM: 7283-9909-30
- Service: See Catalog
- Description: 4-Way F (BK)

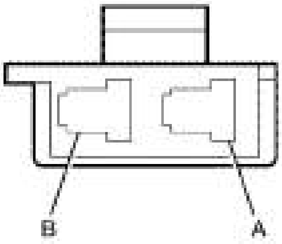
Terminal Part Information

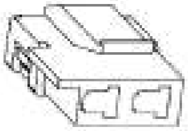
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Rear Compartment Lid Latch

Pin	Wire Color	Circuit No.	Function
1	0.3 OG/BK	744	Rear Compartment Lid Ajar Switch Signal
2	0.5 D-BU	737	Rear Compartment Lamp Control
3	0.85 BN/WH	56	Rear Compartment Lid Release Actuator
4	0.85 BK	1850	Ground

Rear Compartment Lid Release Switch





Connector Part Information

- OEM: 7123-9610
- Service: See Catalog
- Description: 2-Way F (WH)

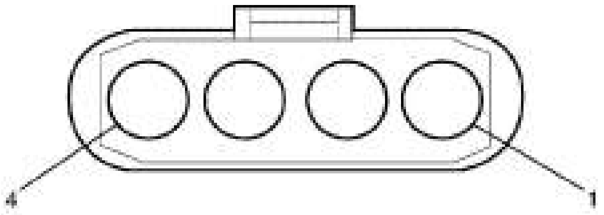
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Rear Compartment Lid Release Switch

Pin	Wire Color	Circuit No.	Function
A	0.5 D-BU	6189	Rear Compartment Relay Switch
B	0.5 BK/WH	1450	Ground

Rear Lock-Off/Service Solenoid Assembly (LPG)



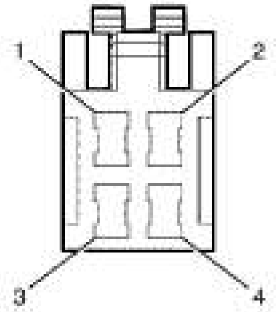
Connector Part Information

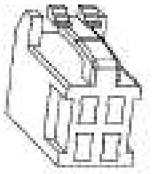
Terminal Part Information

Rear Lock-Off/Service Solenoid Assembly (LPG)

Pin	Wire Color	Circuit No.	Function
1	0.5 BK	--	Ground
2	0.5 GN	--	Relay Controlled Voltage
3	0.75 WH	--	Fuel Level Output
4	0.5 BKGN	--	Rear Lock-Off Control

Rear Object Sensor Control Module Connector





Connector Part Information

- OEM: 7282-1040
- Service: See Catalog
- Description: 4-Way M 090 II Series (NA)

Terminal Part Information

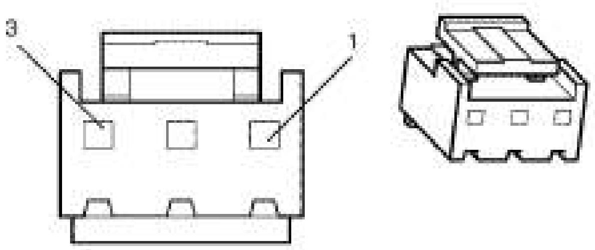
- Pins: 1, 3
- Terminal/Tray: 7114-4020/10
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pin: 2
- Terminal/Tray: 7114-4021/10
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

Rear Object Sensor Control Module Connector

Pin	Wire Color	Circuit No.	Function
1	0.5 BN/BU	343	Accessory Voltage
2	0.85 L-GN	24	Backup Lamp Supply Voltage
3	0.5 BK	1650	Ground
4	--	--	Not Used

Rear Park Assist Module X2



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 3-Way F

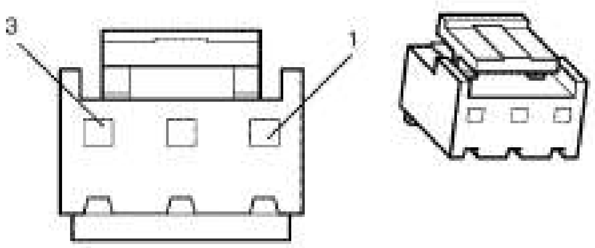
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Rear Park Assist Module X2

Pin	Wire Color	Circuit No.	Function
1	1 BK		Ground
2	2 RD		Ultrasonic signal
3	--	--	Not Used

Rear Park Assist Module X3



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 3-Way F

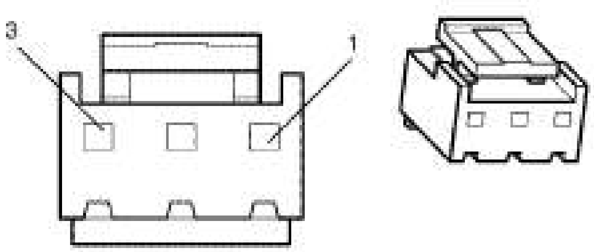
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Rear Park Assist Module X3

Pin	Wire Color	Circuit No.	Function
1	3 BK		Ground
2	4 RD		Ultrasonic signal
3	--	--	Not Used

Rear Park Assist Module X4



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 3-Way F

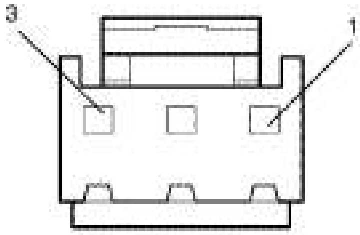
Terminal Part Information

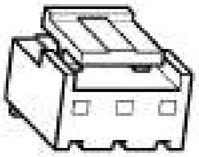
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Rear Park Assist Module X4

Pin	Wire Color	Circuit No.	Function
1	5 BK		Ground
2	6 RD		Ultrasonic signal
3	--	--	Not Used

Rear Park Assist Module X5





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 3-Way F

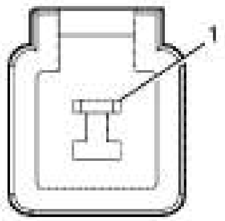
Terminal Part Information

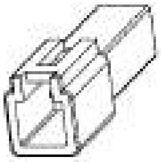
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Rear Park Assist Module X5

Pin	Wire Color	Circuit No.	Function
1	7 BK		Ground
2	8 RD		Ultrasonic signal
3	--	--	Not Used

Rear Park Assist Ground Connector X1





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 1-Way F

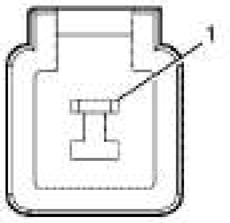
Terminal Part Information

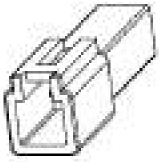
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Rear Park Assist Ground Connector X1

Pin	Wire Color	Circuit No.	Function
1	8 BK		Ground

Rear Park Assist Ground Connector X2





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 1-Way F

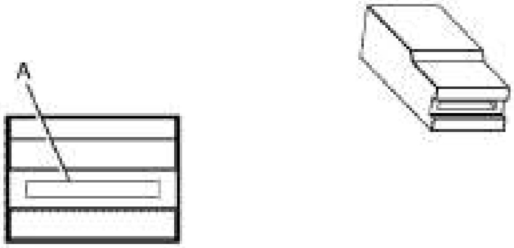
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Rear Park Assist Ground Connector X2

Pin	Wire Color	Circuit No.	Function
1	8 BK		Ground

Rear Window Defogger Grid X1



Connector Part Information

- OEM: 7183-0073-30
- Service: See Catalog
- Description: 1-Way F (BK)

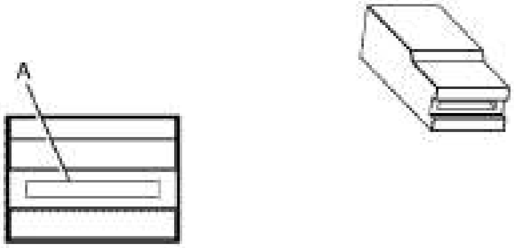
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Rear Window Defogger Grid X1

Pin	Wire Color	Circuit No.	Function
A	3 PU	293	Rear Defog Element Supply Voltage

Rear Window Defogger Grid X2



Connector Part Information

- OEM: 7183-0073-30
- Service: See Catalog
- Description: 1-Way F (BK)

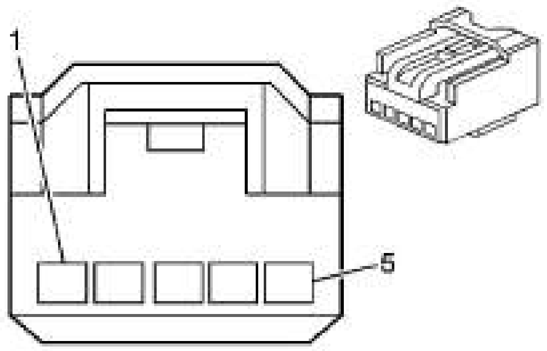
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Rear Window Defogger Grid X2

Pin	Wire Color	Circuit No.	Function
A	3 BK	1650	Ground

Recirculation Actuator



Connector Part Information

- OEM: 7283-5830-30
- Service: See Catalog
- Description: 5-Way F Yazaki (BK)

Terminal Part Information

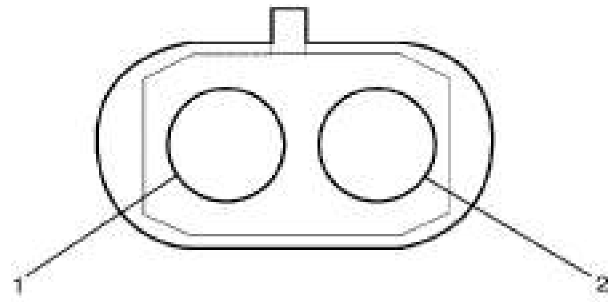
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Recirculation Actuator

Pin	Wire Color	Circuit No.	Function
1	0.3 WH/BU	1614	Recirculation Door Control B
2	0.3 WH/BK	2274	Recirculation Door Control Circuit
3	0.3 D-BU/BK	718	Low Reference
4	0.3 WH/RD	1838	Recirculation Door Position Signal

5	0.3 WH/GN	597	5-Volt Reference

Regulator Temperature Sensor (LPG)



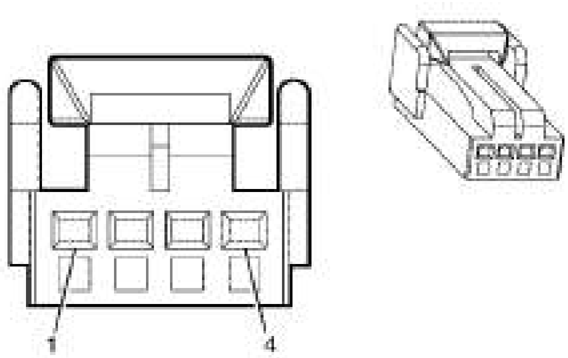
Connector Part Information

Terminal Part Information

Regulator Temperature Sensor (LPG)

Pin	Wire Color	Circuit No.	Function
1	0.5 BU	--	Ground
2	0.5 YE	--	Regulator Temperature Signal

Remote Control Door Lock Receiver (RCDLR)



Connector Part Information

- OEM: 7119-1142-60
- Service: See Catalog
- Description: 4-Way F (GN)

Terminal Part Information

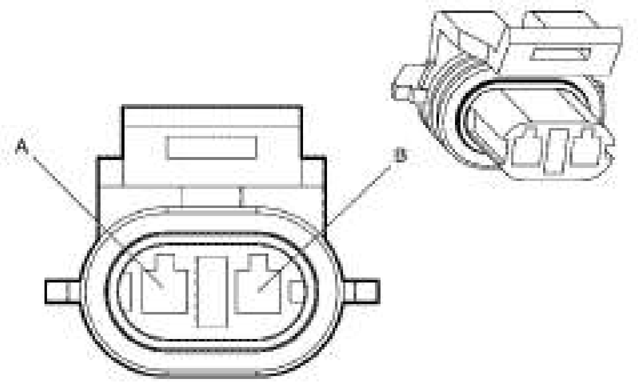
- Pins: 1, 4
- Terminal/Tray: IL-AG5-C1-5000/20
- Core/Insulation Crimp: J/J
- Release Tool/Test Probe: J-38125-211/J-35616-64B (L-BU)

- Pin: 2
- Terminal/Tray: IL-AG5-C1-5000/20
- Core/Insulation Crimp: K/K
- Release Tool/Test Probe: J-38125-211/J-35616-64B (L-BU)

Remote Control Door Lock Receiver (RCDLR)

Pin	Wire Color	Circuit No.	Function
1	0.5 OG/WH	1840	Battery Positive Voltage
2	0.35 D-GN	5060	Low Speed GMLAN Serial Data
3	--	--	Not Used
4	0.5 BK	1650	Ground

Reverse Lockout Solenoid (L98 or HSV)



Connector Part Information

- OEM: 12052646
- Service: See Catalog
- Description: 2-Way F

Terminal Part Information

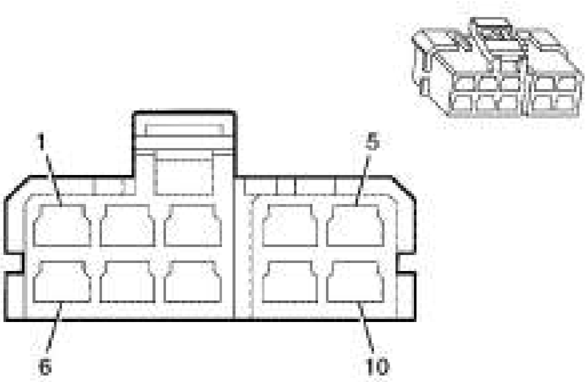
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Reverse Lockout Solenoid (L98 or HSV or LS2)

Pin	Wire Color	Circuit No.	Function

A	0.75 L-GN	1652	Reverse Lockout Solenoid Control
B	0.75 PK/BK	5705	Reverse Lockout Solenoid Battery Power

Seat Adjuster Switch - Driver (AG3 or AGB)



Connector Part Information

- OEM: PH56510040
- Service: See Catalog
- Description: 10-Way F

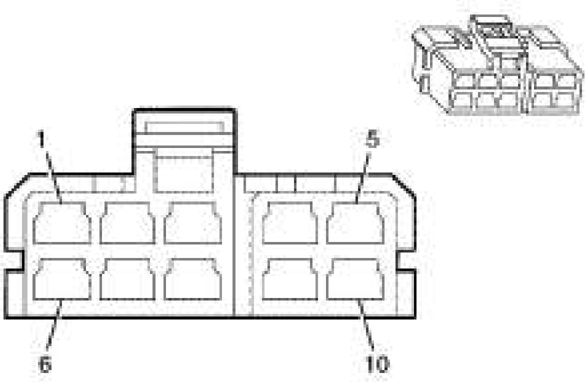
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Seat Adjuster Switch - Driver (AG3 or AGB)

Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used
2	0.3 BN/RD	1269	Driver Seat Recline Motor Forward Control
3	0.3 TN	1522	Driver Seat Horizontal Motor Rearward Control
4	0.3 BN/WH	1270	Driver Seat Recline Motor Rearward Control
5	0.3 BN/GN	1674	Reference Voltage
6	0.3 D-GN/BU	1523	Driver Seat Horizontal Motor Forward Control
7	0.3 RD/WH	1520	Driver Seat Front Vertical Motor Down Control
8	0.3 YE/BU	1521	Driver Seat Rear Vertical Motor Down Control
9	0.3 PK	1519	Driver Seat Rear Vertical Motor Up Control
10	0.3 BK/BU	1518	Driver Seat Front Vertical Motor Up Control

Seat Adjuster Switch - Driver (AH6 or AJ6)



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 10-Way

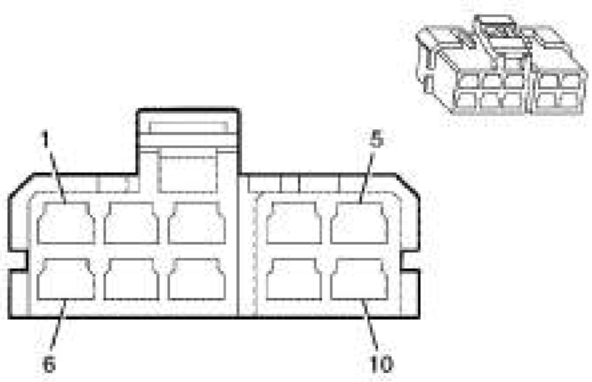
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Seat Adjuster Switch - Driver (AH6 or AJ6)

Pin	Wire Color	Circuit No.	Function
1	2 OG	1140	Battery Positive Voltage
2	2 BK	2050	Ground (LHD)
	2 BK	1350	Ground (RHD)
3	2 D-GN	286	Driver Seat Front Vertical Motor Up Control
4	2 D-BU	287	Driver Seat Front Vertical Motor Down Control
5	2 YE	282	Driver Seat Rear Vertical Motor Up Control
6	2 L-BU	283	Driver Seat Rear Vertical Motor Down Control
7	2 TN	285	Driver Seat Horizontal Motor Forward Control
8	2 L-GN	284	Driver Seat Horizontal Motor Rearward Control
9	2 L-GN	276	Driver Seat Recline Motor Forward Control
10	2 L-BU	277	Driver Seat Recline Motor Rearward Control

Seat Adjuster Switch - Passenger



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 10-Way F

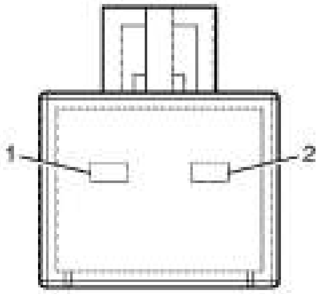
Terminal Part Information

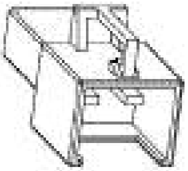
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Seat Adjuster Switch - Passenger

Pin	Wire Color	Circuit No.	Function
1	2 OG	1140	Battery Positive Voltage
2	2 BK	1350	Ground (LHD)
	2 BK	2050	Ground (RHD)
3	2 D-GN	297	Passenger Seat Front Vertical Motor Up Control
4	2 D-BU	298	Passenger Seat Front Vertical Motor Down Control
5	2 YE	288	Passenger Seat Rear Vertical Motor Up Control
6	2 L-BU	289	Passenger Seat Rear Vertical Motor Down Control
7	2 TN	296	Passenger Seat Horizontal Motor Forward Control
8	2 L-GN	290	Passenger Seat Horizontal Motor Rearward Control
9	2 D-GN	76	Passenger Seat Recline Motor Forward
10	2 D-BU	77	Passenger Seat Recline Motor Rearward

Seat Belt Buckle Pretensioner - Driver





Connector Part Information

- OEM: 7183-9857-70
- Service: 15306012
- Description: 2-Way M 280 Series (YE)

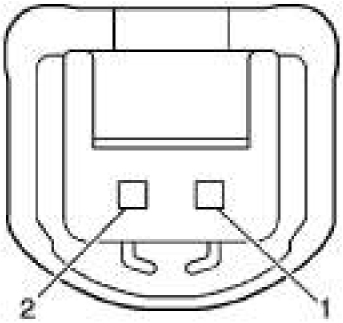
Terminal Part Information

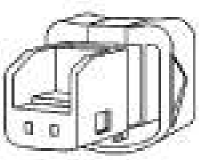
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Seat Belt Buckle Pretensioner - Driver

Pin	Wire Color	Circuit No.	Function
1	0.3 L-GN	2118	Seat Belt Pretensioner - Left - High Control
2	0.3 OG	2119	Seat Belt Pretensioner - Left - Low Control

Seat Belt Retractor Pretensioner - Driver





Connector Part Information

- OEM: 7283-5494-60

- Service: See Catalog
- Description: 2-Way F (GN)

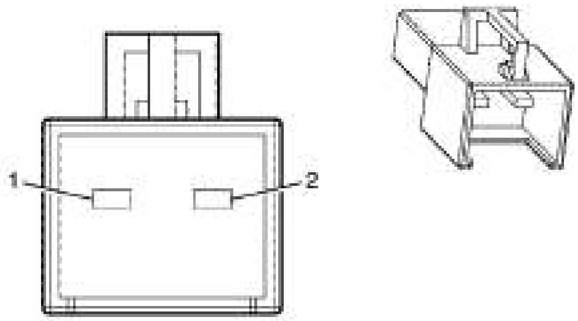
Terminal Part Information

- Terminal/Tray: 1411560-2/25
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12094429/J-35616-64B (L-BU)

Seat Belt Retractor Pretensioner - Driver

Pin	Wire Color	Circuit No.	Function
1	0.3 WH	7206	Driver Seat Belt Pretensioner Retractor - Low Control
2	0.3 OG/GN	7203	Driver Seat Belt Pretensioner Retractor - High Control

Seat Belt Buckle Pretensioner - Passenger



Connector Part Information

- OEM: 7183-9857-70
- Service: 15306012
- Description: 2-Way M 280 Series (YE)

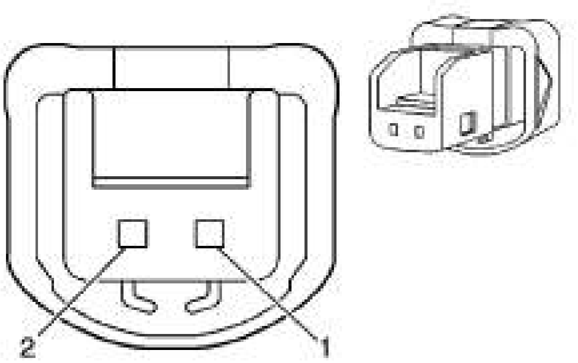
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Seat Belt Buckle Pretensioner - Passenger

Pin	Wire Color	Circuit No.	Function
1	0.3 BK/WH	2116	Seat Belt Pretensioner - Right - High Control
2	0.3 OG/BK	2117	Seat Belt Pretensioner - Right - Low Control

Seat Belt Retractor Pretensioner - Passenger



Connector Part Information

- OEM: 7283-5494-60
- Service: See Catalog
- Description: 2-Way F (GN)

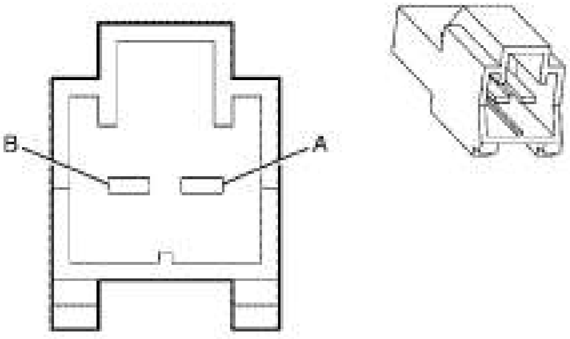
Terminal Part Information

- Terminal/Tray: 1411560-2/25
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12094429/J-35616-64B (L-BU)

Seat Belt Retractor Pretensioner - Passenger

Pin	Wire Color	Circuit No.	Function
1	0.3 PU/GN	7205	Passenger Seat Belt Pretensioner Retractor - High Control
2	0.3 OG/BU	7204	Passenger Seat Belt Pretensioner Retractor - Low Control

Seat Belt Switch - Driver



Connector Part Information

- OEM: H12
- Service: See Catalog
- Description: 2-Way M (WH)

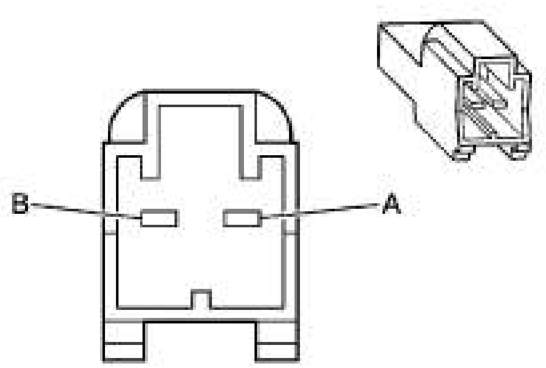
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Seat Belt Switch - Driver

Pin	Wire Color	Circuit No.	Function
A	0.3 D-BU	238	Seat Belt Switch - Left - Low Reference
B	0.3 BK/WH	1363	Seat Belt Switch - Left
	0.3 TN/WH	1363	Seat Belt Switch - Left

Seat Belt Switch - Passenger



Connector Part Information

- OEM: H12
- Service: See Catalog
- Description: 2-Way F (WH)

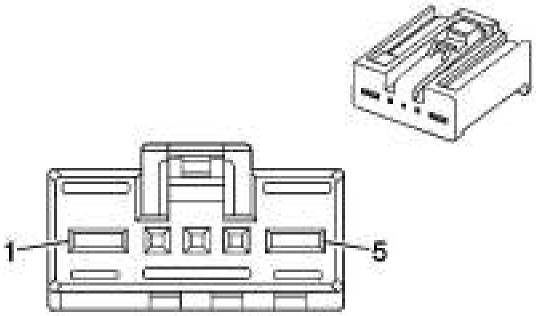
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Seat Belt Switch - Passenger

Pin	Wire Color	Circuit No.	Function
A	0.3 BK/WH	1362	Seat Belt Switch - Right - Signal
B	0.3 BK	1363	Seat Belt Switch - Left - Low Reference

Seat Front Vertical Motor - Driver (AG1 or AG3)



Connector Part Information

- OEM: 0-1379217-4
- Service: See Catalog
- Description: 5-Way F (BK)

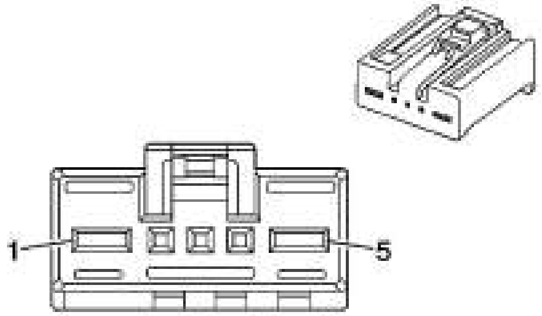
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Seat Front Vertical Motor - Driver (AG1 or AG3)

Pin	Wire Color	Circuit No.	Function
1	0.85 D-BU/RD	287	Driver Seat Front Vertical Motor Down Control (AG3)
	2 D-GN	286	Driver Seat Front Vertical Motor Up Control (AG1)
2	0.3 BK/OG	1350	Ground (AG3)
3	0.3 BN/BU	557	Front Vertical Seat Motor Position Sensor Signal (AG3)
4	0.3 D-GN/WH	3040	Battery Positive Voltage (AG3)
5	0.85 BN	286	Driver Seat Front Vertical Motor Up Control (AG3)
	2 D-BU	287	Driver Seat Front Vertical Motor Down Control (AG1)

Seat Front Vertical Motor - Passenger (AG1)



Connector Part Information

- OEM: 1379218
- Service: See Catalog
- Description: 5-Way F (BK)

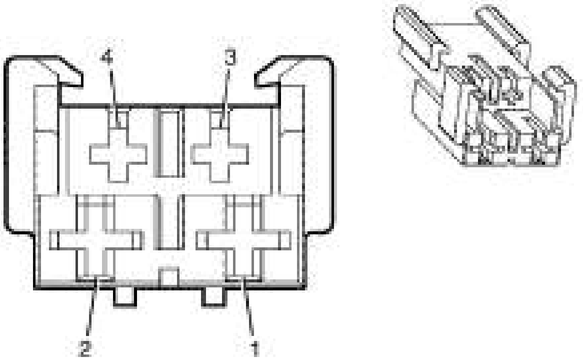
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Seat Front Vertical Motor - Passenger (AG1)

Pin	Wire Color	Circuit No.	Function
1	2 D-GN	297	Passenger Seat Front Vertical Motor Up Control
2-4	--	--	Not Used
5	2 D-BU	298	Passenger Seat Front Vertical Motor Down Control

Seat Horizontal Motor - Driver (AG1 or AG3)



Connector Part Information

- OEM: 0-968182-1
- Service: See Catalog
- Description: 2-Way F (BK)

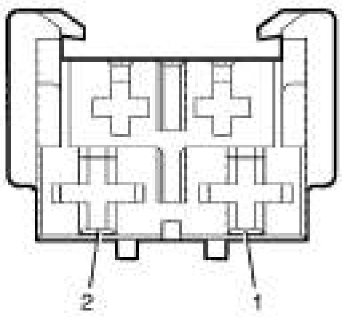
Terminal Part Information

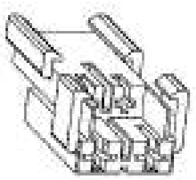
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Seat Horizontal Motor - Driver (AG1 or AG3)

Pin	Wire Color	Circuit No.	Function
1	0.85 GY	284	Driver Seat Horizontal Motor Rearward Control (AG3)
	2 TN	285	Driver Seat Horizontal Motor Forward Control (AG1)
2	0.85 GY/RD	285	Driver Seat Horizontal Motor Forward Control (AG3)
	2 L-GN	284	Driver Seat Horizontal Motor Rearward Control (AG1)
3	0.3 BK/OG	1350	Ground (AG3)
4	0.3 WH/GY	569	Horizontal Seat Motor Position Sensor Signal (AG3)

Seat Horizontal Motor - Passenger (AG1)





Connector Part Information

- OEM: 968182
- Service: See Catalog
- Description: 2-Way F (BK)

Terminal Part Information

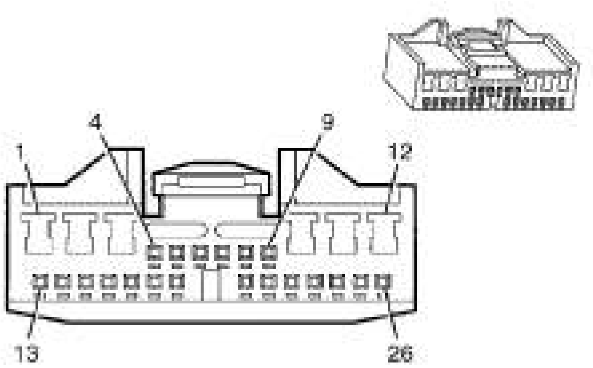
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Seat Horizontal Motor - Passenger (AG1)

Pin	Wire Color	Circuit No.	Function

1	2 TN	296	Passenger Seat Horizontal Motor Forward Control
2	2 L-GN	290	Passenger Seat Horizontal Motor Rearward Control

Memory Seat Module (MSM)



Connector Part Information

- OEM: 173851-1
- Service: See Catalog
- Description: 26-Way

Terminal Part Information

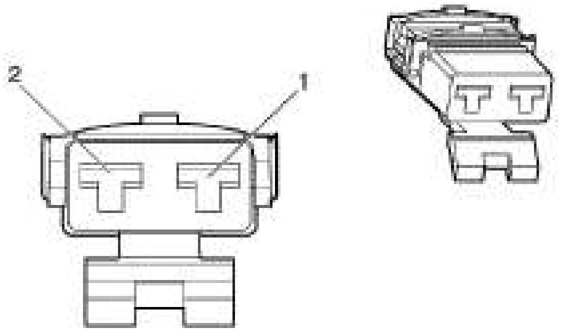
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Memory Seat Module (MSM)

Pin	Wire Color	Circuit No.	Function
1	1.25 RD/BK	4740	Seat Module Supply Voltage
2	0.3 D-BU/WH	1985	5-Volt Reference
3	2 RD	1140	Battery Positive Voltage
4	0.3 WH/BK	2293	Right Front Adaptive Seat Switch / Mirror Dip Signal
5	0.3 PU	615	Memory 1 Switch Signal
6	--	--	Not Used
7	0.3 YE/WH	616	Memory 2 Switch Signal
8	--	--	Not Used
9	0.3 D-BU/OG	614	Memory 3 Switch Signal
10-11	--	--	Not Used
12	0.5 BK/OG	1350	Ground

13	0.3 PK/BU	7363	MOD_WK
14	--	--	Not Used
15	0.3 OG/BK	1061	UART Serial Data
16-17	--	--	Not Used
18	0.3 WH/RD	612	Right Front Adaptive Seat Switch / Mirror Dip Control Signal
19	0.3 TN/BK	5978	Memory 1 Switch Control Signal
20	0.3 D-GN/PK	5979	Memory 2 Switch Control Signal
21	0.3 YE/RD	782	Memory 3 Switch Control Signal
22-24	--	--	Not Used
25	0.3 L-GN/BK	5060	Low Speed GMLAN Serial Data
26	--	--	Not Used

Seat Lumbar Motor - Driver X1 (AG3)



Connector Part Information

- OEM: 12020556
- Service: See Catalog
- Description: 2-Way

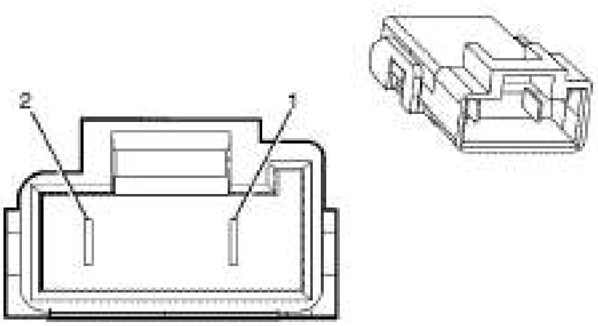
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Seat Lumbar Motor - Driver X1 (AG3)

Pin	Wire Color	Circuit No.	Function
1	0.85 D-GN/RD	767	Driver Seat Lumbar Motor Down Control
2	0.3 RD/YE	768	Driver Seat Lumber Horizontal Position Sensor Signal

Seat Lumbar Motor - Driver X2 (AG3)



Connector Part Information

- OEM: 12034344
- Service: See Catalog
- Description: 2-Way

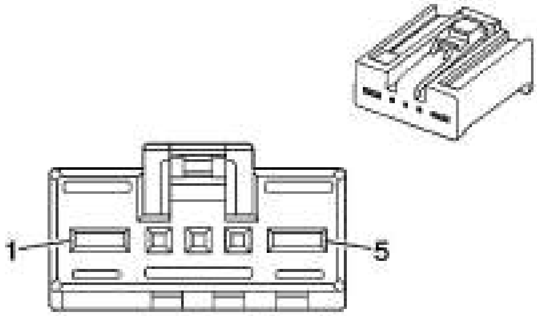
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Seat Lumbar Motor - Driver X2 (AG3)

Pin	Wire Color	Circuit No.	Function
1	0.3 PU/BU	1062	Driver Seat Lumbar Vertical Position Sensor Signal
2	0.85 D-BU/YE	1063	Driver Seat Lumbar Motor Up Control

Seat Rear Vertical Motor - Driver (AG1 or AG3)



Connector Part Information

- OEM: 1379218
- Service: See Catalog
- Description: 5-Way F (WH)

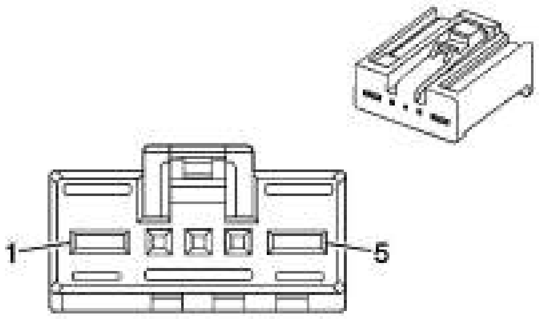
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Seat Rear Vertical Motor - Driver (AG1 or AG3)

Pin	Wire Color	Circuit No.	Function
1	0.85 D-BU	283	Driver Seat Rear Vertical Motor Down Control (AG3)
	2 YE	282	Driver Seat Rear Vertical Motor Up Control (AG1)
2	0.3 BK/OG	1350	Ground (AG3)
3	0.3 RD/GN	568	Rear Vertical Seat Motor Position Sensor Signal (AG3)
4	0.3 D-GN/PU	2940	Battery Positive Voltage (AG3)
5	0.85 D-GN/YE	282	Driver Seat Rear Vertical Motor UP Control (AG3)
	2 L-BU	283	Driver Seat Rear Vertical Motor Down Control (AG1)

Seat Rear Vertical Motor - Passenger (AG1)



Connector Part Information

- OEM: 1379218
- Service: See Catalog
- Description: 5-Way F (WH)

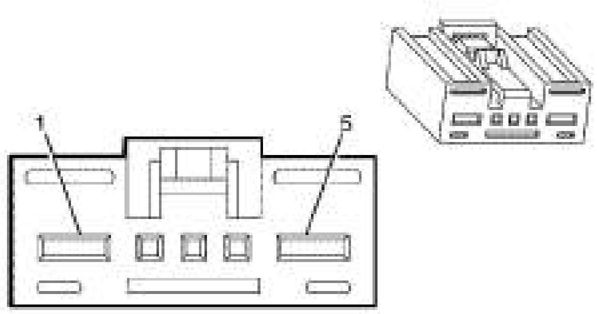
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Seat Rear Vertical Motor - Passenger (AG1)

Pin	Wire Color	Circuit No.	Function
1	2 YE	288	Passenger Seat Rear Vertical Motor Up Control
2-4	--	--	Not Used
5	2 L-BU	289	Passenger Seat Rear Vertical Motor Down Control

Seat Recline Motor - Driver (AG1 or AG3)



Connector Part Information

- OEM: 0-1379217-3
- Service: See Catalog
- Description: 5-Way

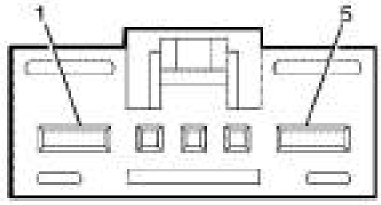
Terminal Part Information

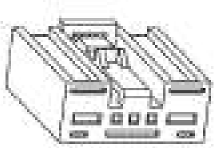
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Seat Recline Motor - Driver (AG1 or AG3)

Pin	Wire Color	Circuit No.	Function
1	0.85 YE	276	Driver Seat Recline Motor Forward Control (AG3)
	2 L-GN	276	Driver Seat Recline Motor Forward Control (AG1)
2	0.3 BK/OG	1350	Ground (AG3)
3	--	--	Not Used
4	0.3 D-GN/BN	570	Driver Seat Recline Motor Position Sensor Signal (AG3)
5	0.85 PU/GN	277	Driver Seat Recline Motor Rearward Control (AG3)
	2 L-BU	277	Driver Seat Recline Motor Rearward Control (AG1)

Seat Recline Motor - Passenger (AG1)





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 5-Way

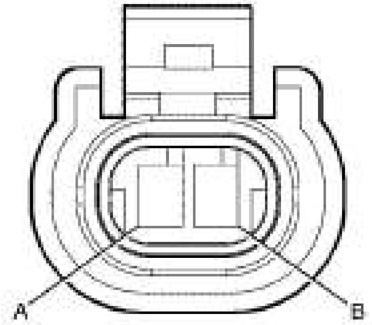
Terminal Part Information

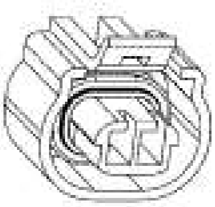
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Seat Recline Motor - Passenger (AG1)

Pin	Wire Color	Circuit No.	Function
1	2 D-GN	76	Passenger Seat Recline Motor Forward
2-4	--	--	Not Used
5	2 D-BU	77	Passenger Seat Recline Motor Rearward

Shock Absorber Actuator - Left Front (HSV)





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 2-Way F

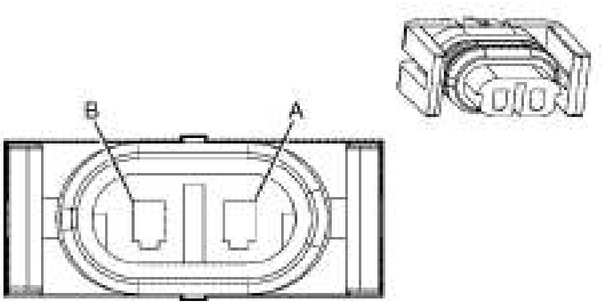
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Shock Absorber Actuator - Left Front (HSV)

Pin	Wire Color	Circuit No.	Function
A	0.35 PK	1107	Left Front Damper Control
B	0.35 PK/BK	1113	Left Front Damper Low Reference

Shock Absorber Actuator - Left Rear (HSV)



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 2-Way F

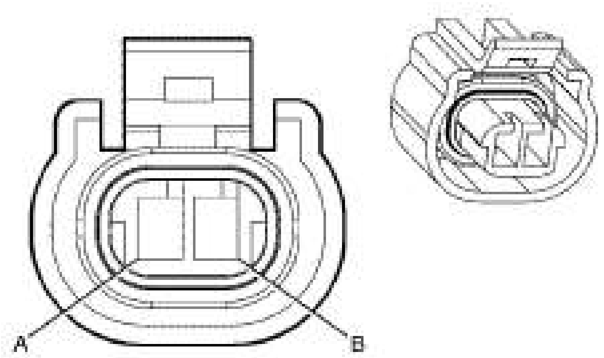
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Shock Absorber Actuator - Left Rear (HSV)

Pin	Wire Color	Circuit No.	Function
A	0.35 WH/RD	1114	Left Rear Damper Control
B	0.35 WH/BK	1115	Left Rear Damper Low Reference

Shock Absorber Actuator - Right Front (HSV)



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 2-Way F

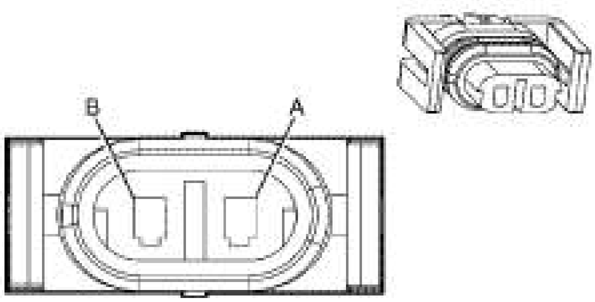
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Shock Absorber Actuator - Right Front (HSV)

Pin	Wire Color	Circuit No.	Function
A	0.35 PU	1116	Right Front Damper Control
B	0.35 PU/WH	1117	Right Front Damper Low Reference

Shock Absorber Actuator - Right Rear (HSV)



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 2-Way F

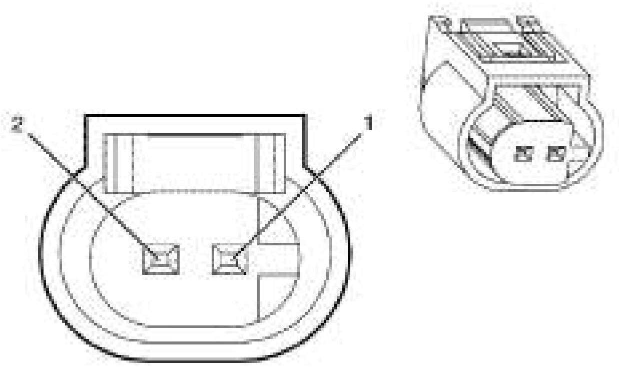
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Shock Absorber Actuator - Right Rear (HSV)

Pin	Wire Color	Circuit No.	Function
A	0.35 WH/RD	1118	Right Rear Damper Control
B	0.35 WH/BK	1119	Right Rear Damper Low Reference

Side Marker Lamp - Left Front



Connector Part Information

- OEM: 967644-1
- Service: See Catalog
- Description: 2-Way F MQS Series Sealed (BK)

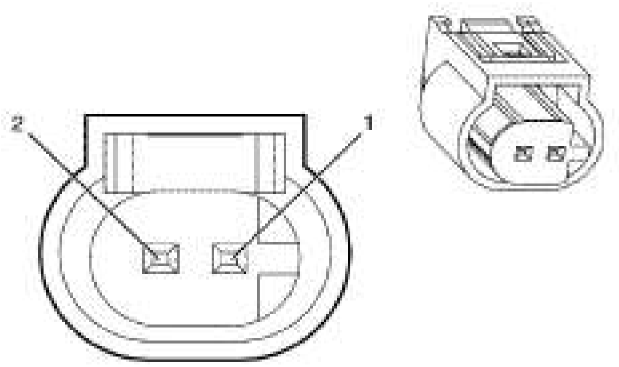
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Side Marker Lamp - Left Front

Pin	Wire Color	Circuit No.	Function
1	0.5 BK	350	Ground
2	0.5 PU	309	Left Park Lamp Supply Voltage

Side Marker Lamp - Left Rear



Connector Part Information

- OEM: 967644-1
- Service: See Catalog
- Description: 2-Way F MQS Series Sealed (BK)

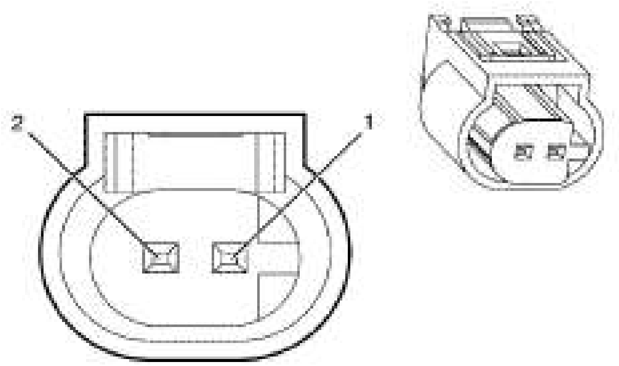
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Side Marker Lamp - Left Rear

Pin	Wire Color	Circuit No.	Function
1	0.5 BN	709	Left Park Lamp Supply Voltage
2	0.5 WH	20	Stop Lamp Supply Voltage

Side Marker Lamp - Right Front



Connector Part Information

- OEM: 967644-1
- Service: See Catalog
- Description: 2-Way F MQS Series Sealed (BK)

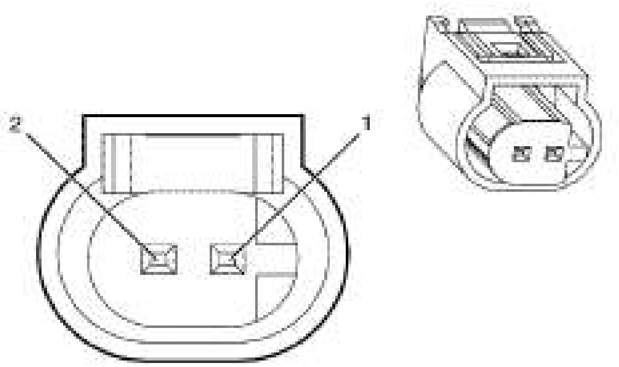
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Side Marker Lamp - Right Front

Pin	Wire Color	Circuit No.	Function
1	0.5 BK	350	Ground
2	0.5 BN/WH	709	Right Park Lamp Supply Voltage

Side Marker Lamp - Right Rear



Connector Part Information

- OEM: 967644-1
- Service: See Catalog
- Description: 2-Way F MQS Series Sealed (BK)

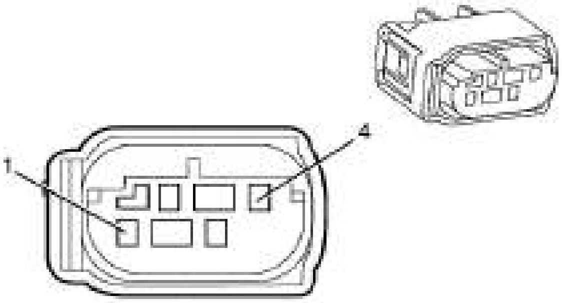
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Side Marker Lamp - Right Rear

Pin	Wire Color	Circuit No.	Function
1	0.5 BN	309	Right Park Lamp Supply Voltage
2	0.5 WH	20	Stop Lamp Supply Voltage

Siren Connector



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 4-Way F

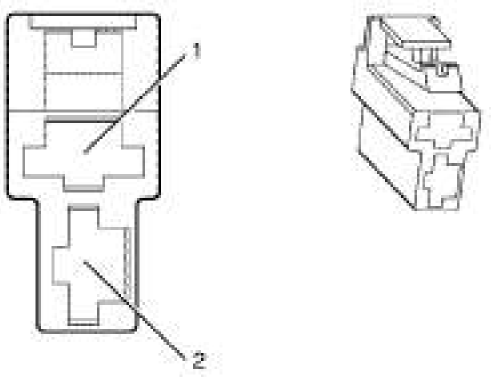
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Siren Connector

Pin	Wire Color	Circuit No.	Function
1	0.35 BK	31	Accessory Power
2	0.35 BK	32	Battery Power
3	0.35 BK	33	Siren Control Signal
4	0.35 BK	34	Ground

Speaker - Center I/P X1 (UW5)



Connector Part Information

- OEM: 7123-2825
- Service: See Catalog
- Description: 2-Way F (WH)

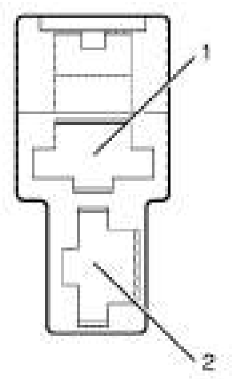
Terminal Part Information

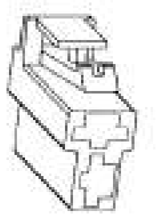
- Terminal/Tray: 7116-2640-02/12
- Core/Insulation Crimp: C/B
- Release Tool/Test Probe: 12094430/J-35616-42 (RD)

Speaker - Center I/P X1 (UW5)

Pin	Wire Color	Circuit No.	Function
1	0.5 GY	118	Left Front Speaker Output (-)
2	0.5 BN	201	Left Front Speaker Output (+)

Speaker - Center I/P X2 (UW5)





Connector Part Information

- OEM: 7123-2825
- Service: See Catalog
- Description: 2-Way F (WH)

Terminal Part Information

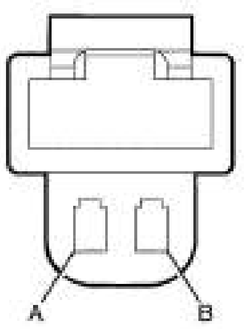
- Terminal/Tray: 7116-2640-02/12
- Core/Insulation Crimp: C/B
- Release Tool/Test Probe: 12094430/J-35616-42 (RD)

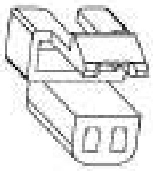
Speaker - Center I/P X2 (UW5)

Pin	Wire Color	Circuit No.	Function

1	0.5 D-GN	117	Right Front Speaker Output (-)
2	0.5 L-GN	200	Right Front Speaker Output (+)

Speaker - Center I/P (without UW5)





Connector Part Information

- OEM: 7123-2825
- Service: See Catalog
- Description: 2-Way F

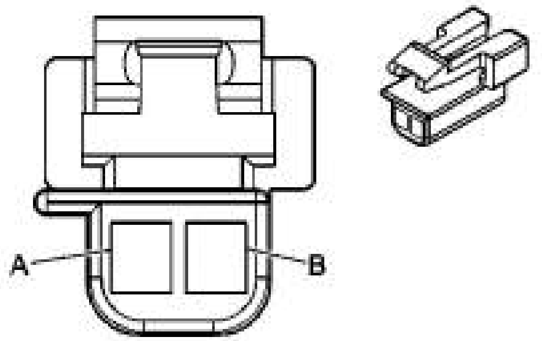
Terminal Part Information

- Terminal/Tray: 7116-2640-02/12
- Core/Insulation Crimp: C/B
- Release Tool/Test Probe: 12094430/J-35616-42 (RD)

Speaker - Center I/P (without UW5)

Pin	Wire Color	Circuit No.	Function
A	0.5 L-BU	1960	Front Center Speaker Output (-)
B	0.5 YE	1860	Front Center Speaker Output (+)

Speaker - Left Front (UQ7)



Connector Part Information

- OEM: 12064869
- Service: See Catalog
- Description: 2-Way F

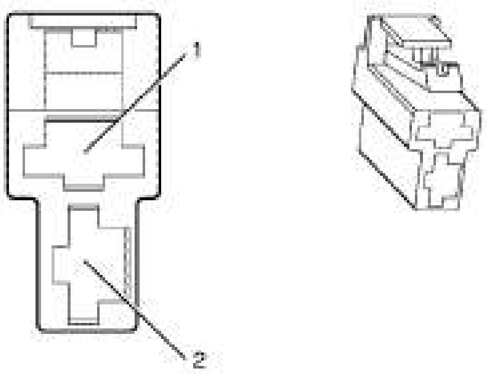
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Speaker - Left Front (UQ7)

Pin	Wire Color	Circuit No.	Function
A	0.5 GY	118	Left Front Speaker Output (-)
B	0.5 BN	201	Left Front Speaker Output (+) (RHD)
	0.5 TN	201	Left Front Speaker Output (+) (LHD)

Speaker - Left Front (UW5 or U65)



Connector Part Information

- OEM: 7123-2825
- Service: See Catalog
- Description: 2-Way F (WH)

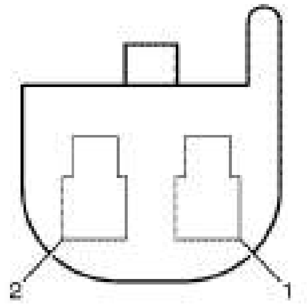
Terminal Part Information

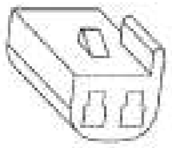
- Terminal/Tray: 7116-2640-02/12
- Core/Insulation Crimp: C/B
- Release Tool/Test Probe: 12094430/J-35616-42 (RD)

Speaker - Left Front (UW5 or U65)

Pin	Wire Color	Circuit No.	Function
1	0.5 GY	118	Left Front Speaker Output (-)
2	0.5 BN	201	Left Front Speaker Output (+)

Speaker - Left Front Tweeter (U65 or UW5)





- OEM: 15493098
- Service: See Catalog
- Description: 2-Way F (BK)

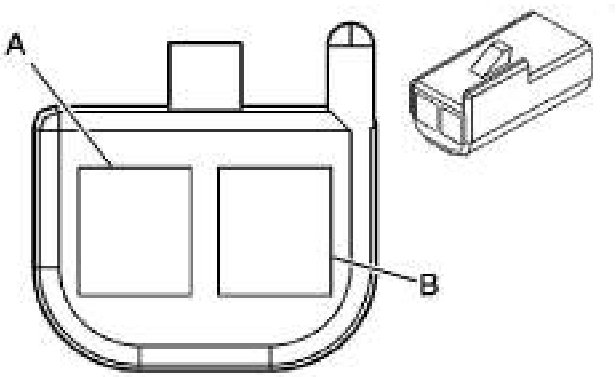
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Speaker - Left Front Tweeter (U65 or UW5)

Pin	Wire Color	Circuit No.	Function
1	0.5 BN	201	Left Front Speaker Output (+)
2	0.3 GY	118	Left Front Speaker Output (-)

Speaker - Left Front Tweeter (UQ7)



Connector Part Information

- OEM: 12047662
- Service: See Catalog
- Description: 2-Way F

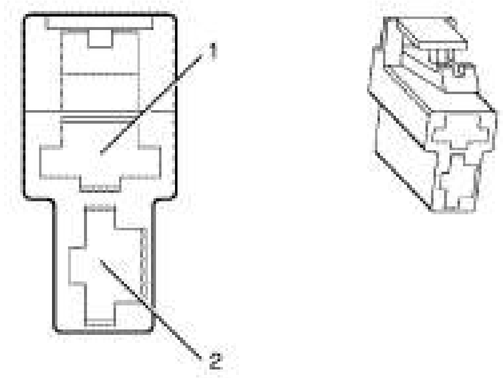
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Speaker - Left Front Tweeter (UQ7)

Pin	Wire Color	Circuit No.	Function
A	0.85 GY	118	Left Front Speaker Output (+)
B	0.85 TN	201	Left Front Speaker Output (-)

Speaker - Left Rear (U65 or UW5)



Connector Part Information

- OEM: 7123-2825

- Service: See Catalog
- Description: 2-Way F (WH)

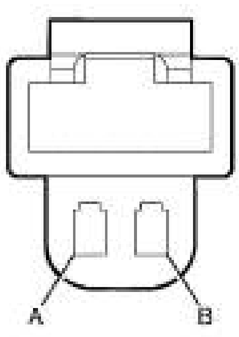
Terminal Part Information

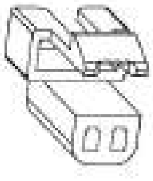
- Terminal/Tray: 7116-2640-02/12
- Core/Insulation Crimp: C/B
- Release Tool/Test Probe: 12094430/J-35616-42 (RD)

Speaker - Left Rear (U65 or UW5)

Pin	Wire Color	Circuit No.	Function
1	0.5 YE/RD	116	Left Rear Speaker Output (-)
2	0.5 BN	199	Left Rear Speaker Output (+)

Speaker - Left Rear (UQ7)





Connector Part Information

- OEM: 15434358
- Service: See Catalog
- Description: 2-Way F

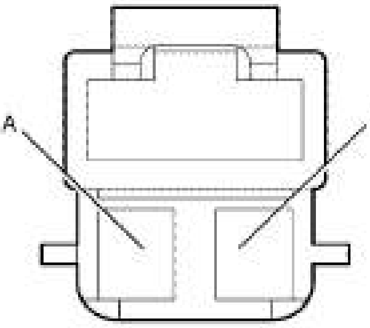
Terminal Part Information

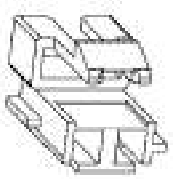
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Speaker - Left Rear (UQ7)

Pin	Wire Color	Circuit No.	Function
A	0.5 YE/RD	116	Left Rear Speaker Output (-)
B	0.5 BN	199	Left Rear Speaker Output (+)

Speaker - Left Subwoofer (UQ7)





Connector Part Information

- OEM: 7283-1020
- Service: See Catalog
- Description: 2-Way F 090 II Series (NA)

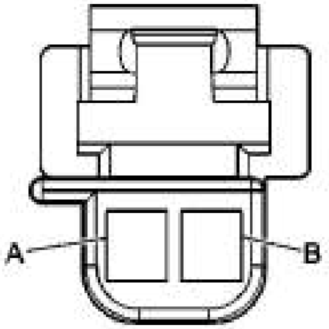
Terminal Part Information

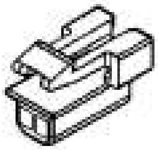
- Terminal/Tray: 7116-4021/11
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

Speaker - Left Subwoofer (UQ7)

Pin	Wire Color	Circuit No.	Function
A	1.25 D-BU/WH	346	Left Rear Subwoofer Speaker Output (+)
B	1.25 L-GN/BK	1794	Left Rear Subwoofer Speaker Output (-)

Speaker - Right Front (UQ7)





Connector Part Information

- OEM: 12064869
- Service: See Catalog
- Description: 2-Way F

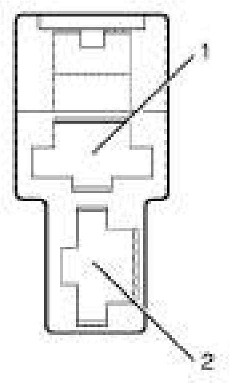
Terminal Part Information

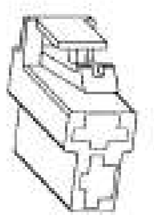
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Speaker - Right Front (UQ7)

Pin	Wire Color	Circuit No.	Function
A	0.5 D-GN	117	Right Front Speaker Output (-)
B	0.5 L-GN	200	Right Front Speaker Output (+) (LHD)

Speaker - Right Front (UW5 or U65)





Connector Part Information

- OEM: 7123-2825
- Service: See Catalog
- Description: 2-Way F (WH)

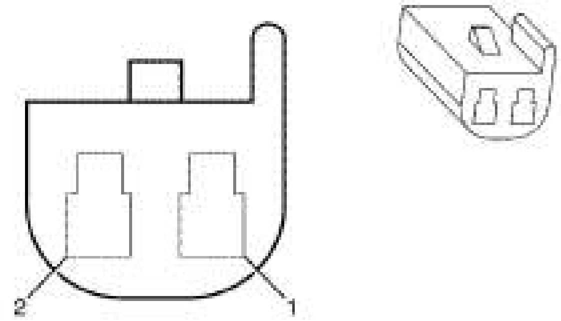
Terminal Part Information

- Terminal/Tray: 7116-2640-02/12
- Core/Insulation Crimp: C/B
- Release Tool/Test Probe: 12094430/J-35616-42 (RD)

Speaker - Right Front (UW5 or U65)

Pin	Wire Color	Circuit No.	Function
1	0.5 D-GN	117	Right Front Speaker Output (-)
2	0.5 L-GN	200	Right Front Speaker Output (+)

Speaker - Right Front Tweeter (U65 or UW5)



- OEM: 15493098
- Service: See Catalog
- Description: 2-Way F (BK)

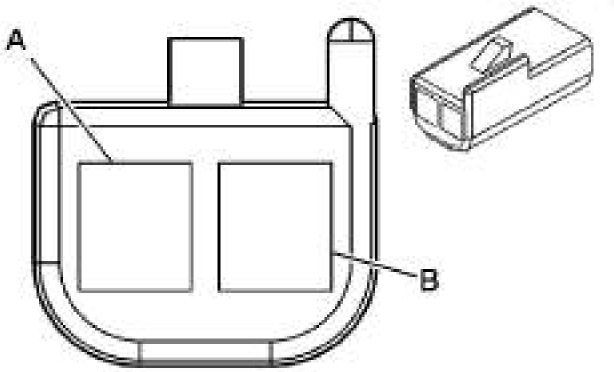
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Speaker - Right Front Tweeter (U65 or UW5)

Pin	Wire Color	Circuit No.	Function
1	0.5 BN	201	Right Front Speaker Output (+)
2	0.3 GY	118	Right Front Speaker Output (-)

Speaker - Right Front Tweeter (UQ7)



Connector Part Information

- OEM: 12047662
- Service: See Catalog

- Description: 2-Way F

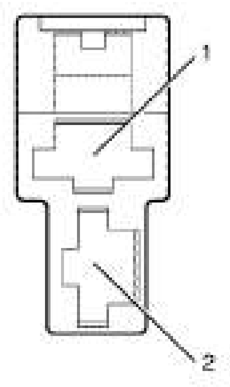
Terminal Part Information

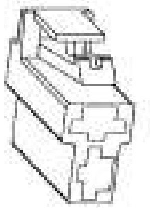
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Speaker - Right Front Tweeter (UQ7)

Pin	Wire Color	Circuit No.	Function
A	0.85 D-GN	117	Right Front Speaker Output (+)
B	0.85 L-GN	200	Right Front Speaker Output (-)

Speaker - Right Rear (U65 or UW5)





Connector Part Information

- OEM: 7123-2825
- Service: See Catalog
- Description: 2-Way F (WH)

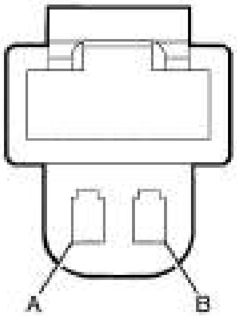
Terminal Part Information

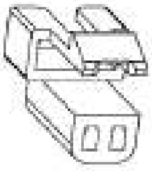
- Terminal/Tray: 7116-2640-02/12
- Core/Insulation Crimp: C/B
- Release Tool/Test Probe: 12094430/J-35616-42 (RD)

Speaker - Right Rear (U65 or UW5)

Pin	Wire Color	Circuit No.	Function
1	0.5 L-BU	115	Right Rear Speaker Output (-)
2	0.5 D-BU	46	Right Rear Speaker Output (+)

Speaker - Right Rear (UQ7)





Connector Part Information

- OEM: 15434358
- Service: See Catalog
- Description: 2-Way F

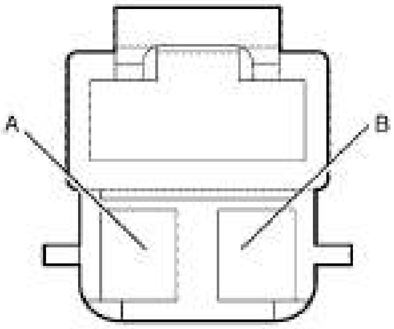
Terminal Part Information

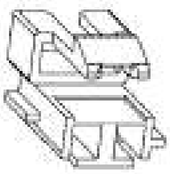
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Speaker - Right Rear (UQ7)

Pin	Wire Color	Circuit No.	Function
A	0.5 L-BU	115	Right Rear Speaker Output (-)
B	0.5 D-BU	46	Right Rear Speaker Output (+)

Speaker - Right Subwoofer (UQ7)





Connector Part Information

- OEM: 7283-1020

- Service: See Catalog
- Description: 2-Way F 090 II Series (NA)

Terminal Part Information

- Terminal/Tray: 7116-4021/11
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

Speaker - Right Subwoofer (UQ7)

Pin	Wire Color	Circuit No.	Function
A	1.25 L-BU/BK	315	Right Rear Subwoofer Speaker Output (+)
B	1.25 D-GN	1795	Right Rear Subwoofer Speaker Output (-)

Starter Motor X1

Terminal Part Information

- Terminal: 7009-1333-02
- Core/Insulation Crimp: N/A
- Description: Ring Terminal

Starter Motor X1

Pin	Wire Color	Circuit No.	Function
A	3 PU	6	Starter Solenoid Crank Voltage

Starter Motor X2

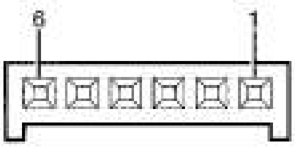
Terminal Part Information

- Terminal: 7003-2601
- Core/Insulation Crimp: N/A
- Description: Ring Terminal

Starter Motor X2

Pin	Wire Color	Circuit No.	Function
A	50 RD	1	Battery Voltage

Steering Angle Sensor



- OEM: 7282-7166
- Service: See Catalog
- Description: 6-Way F (BK)

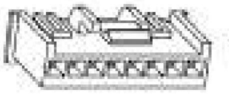
Terminal Part Information

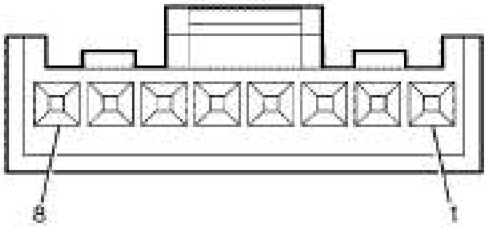
- Terminal/Tray: 7114-4020/10
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

Steering Angle Sensor

Pin	Wire Color	Circuit No.	Function
1	0.5 PU/BN	2501	High Speed GMLAN Serial Data Bus (-) (without HSV)
	0.35 BN	2501	High Speed GMLAN Serial Data Bus- (HSV)
2	0.5 D-BU/BN	2501	High Speed GMLAN Serial Data Bus (-) (without HSV)
	0.35 BN	2501	High Speed GMLAN Serial Data Bus- (HSV)
3	0.5 GY	2500	High Speed GMLAN Serial Data Bus (+) (without HSV)
	0.35 BN/BK	2500	High Speed GMLAN Serial Data Bus+ (HSV)
4	0.5 BN	2500	High Speed GMLAN Serial Data Bus (+) (without HSV)
	0.35 BN/BK	2500	High Speed GMLAN Serial Data Bus+ (HSV)
5	0.5 L-BU	5986	Communication Enable Relay Supply Voltage (without HSV)
	0.5 L-BU	5986	Communication Enable Relay Supply Voltage (HSV)
6	0.5 OG	2088	Steering Wheel Position Sensor Low Reference (without HSV)
	0.5 BK/BU	2088	Steering Wheel Position Sensor Low Reference (HSV)

Steering Wheel Controls Switch Assembly





- OEM: XMR-08V
- Service: See Catalog
- Description: 8-Way F (WH)

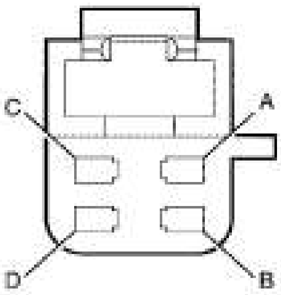
Terminal Part Information

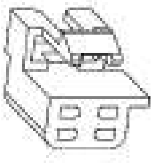
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Steering Wheel Controls Switch Assembly

Pin	Wire Color	Circuit No.	Function
1	0.3 GY/BU	7367	Steering Wheel Resistor Ladder Right Signal #2
2	0.3 YE	7364	Steering Wheel Resistor Ladder Right Signal #1
3	0.3 BN	7312	Steering Wheel Resistor Ladder Left Signal #1
4	0.3 L-BU	7313	Steering Wheel Resistor Ladder Left Signal #2
5	0.3 D-GN	897	Steering Wheel Controls Low Reference
6	0.3 OG/BK	5201	Steering Wheel Controls Signal
7	0.3 BK	1551	Ground
8	0.3 PU	7005	I/P Dimming Control

Sunload Sensor (CJ2 or C63)





Connector Part Information

- OEM: 7123-9843-30
- Service: 12085208
- Description: 4-Way F

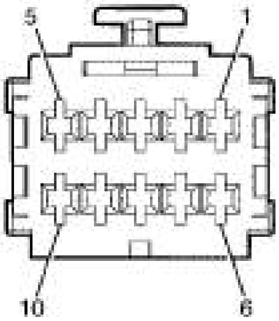
Terminal Part Information

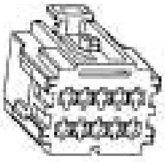
- Terminal/Tray: 12064971/5
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Sunload Sensor (CJ2 or C63)

Pin	Wire Color	Circuit No.	Function
A	0.3 L-BU/BK	7425	Left Solar Sensor
B	0.3 GY	7424	Right Solar Sensor
C	0.3 BK	61	Ground
D	0.3 L-GN/BK	1137	DRL Ambient Light Sensor Signal

Sunroof Control Module (RHD)





- OEM: 18101EV
- Service: See Catalog
- Description: 10-Way F

Terminal Part Information

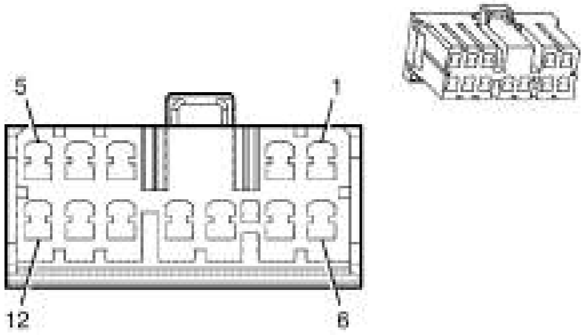
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Sunroof Control Module (RHD)

Pin	Wire Color	Circuit No.	Function

1	0.5 GY		Sunroof Switch Low Reference
2	0.3 D-GN	5027	Sunroof Switch - Data 1
3	0.3 YE	5028	Sunroof Switch - Data 2
4	0.3 OG	5029	Sunroof Switch - Data 3
5	0.3 WH	5030	Sunroof Switch - Data 4
6	--	--	Not Used
7	1.25 OG/BU	3040	Battery Positive Voltage
8	--	--	Not Used
9	0.5 YE	443	Ignition Voltage 1
10	1.25 BK	850	Ground

Sunroof Switch (RHD)



- OEM: 49901221
- Service: 88953365
- Description: 6-Way F 0.635 Series (BK)

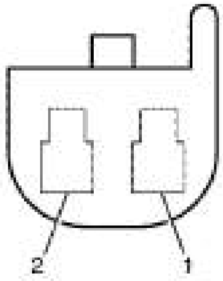
Terminal Part Information

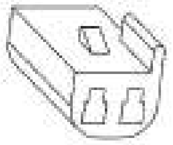
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Sunroof Switch (RHD)

Pin	Wire Color	Circuit No.	Function
1	0.5 BK	850	Ground
2	0.3 D-GN	5027	Sunroof Switch - Data 1
3	0.3 YE	5028	Sunroof Switch - Data 2
4	--	--	Not Used
5	0.3 OG	5029	Sunroof Switch - Data 3
6	0.3 WH	5030	Sunroof Switch - Data 4

Sunshade - Left





- OEM: 12047662
- Service: See Catalog
- Description: 2-Way F (BK)

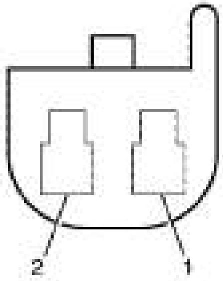
Terminal Part Information

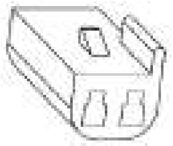
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Sunshade - Left

Pin	Wire Color	Circuit No.	Function
1	0.5 BK/WH	851	Ground
2	0.5 OG	1732	Courtesy Lamps Supply Voltage

Sunshade - Right





- OEM: 12047662
- Service: See Catalog

- Description: 2-Way F (BK)

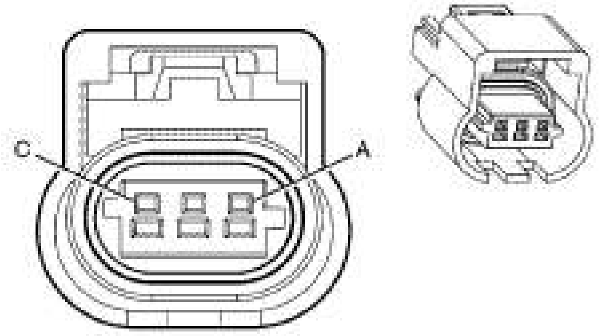
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Sunshade - Right

Pin	Wire Color	Circuit No.	Function
1	0.5 BK/WH	851	Ground
2	0.5 OG	1732	Courtesy Lamps Supply Voltage

Suspension Position Sensor - Left Front (HSV)



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 3-Way F

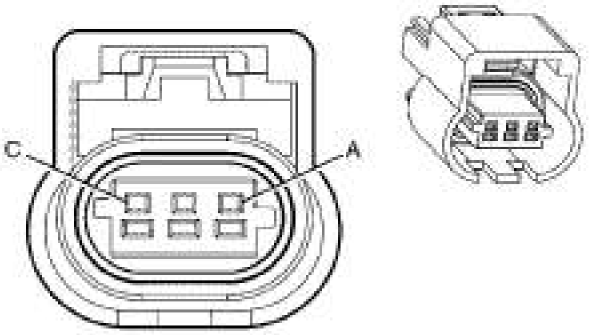
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Suspension Position Sensor - Left Front (HSV)

Pin	Wire Color	Circuit No.	Function
A	0.35 D-BU/WH	1205	Left Front Suspension Position Sensor Voltage Reference
B	0.35 D-BU	1207	Left Front Suspension Position Sensor Signal
C	0.35 D-BU/BK	1206	Left Front Suspension Position Sensor Low Reference

Suspension Position Sensor - Left Rear (HSV)



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 3-Way F

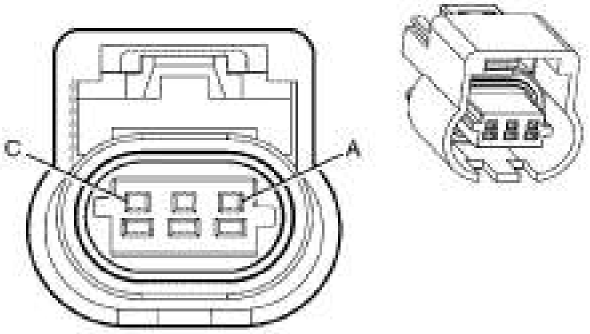
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Suspension Position Sensor - Left Rear (HSV)

Pin	Wire Color	Circuit No.	Function
A	0.35 GY/WH	1208	Left Rear Suspension Position Sensor Voltage Reference
B	0.35 GY	1210	Left Rear Suspension Position Sensor Signal
C	0.35 GY/BK	1209	Left Rear Suspension Position Sensor Low Reference

Suspension Position Sensor - Right Front (HSV)



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 3-Way F

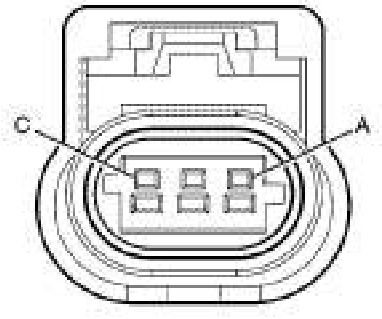
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Suspension Position Sensor - Right Front (HSV)

Pin	Wire Color	Circuit No.	Function
A	0.35 D-GN/WH	1211	Right Front Suspension Position Sensor Voltage Reference
B	0.35 D-GN	1213	Right Front Suspension Position Sensor Signal
C	0.35 D-GN/BK	1212	Right Front Suspension Position Sensor Low Reference

Suspension Position Sensor - Right Rear (HSV)



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 3-Way F

Terminal Part Information

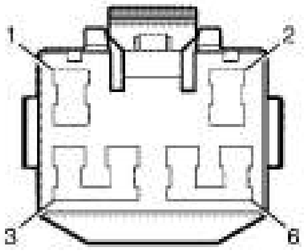
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

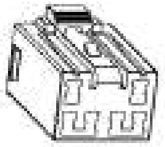
Suspension Position Sensor - Right Rear (HSV)

Pin	Wire Color	Circuit No.	Function
A	0.35 BN/WH	1214	Right Rear Suspension Position Sensor Voltage Reference

B	0.35 BN	1216	Right Rear Suspension Position Sensor Signal
C	0.35 BN/BK	1215	Right Rear Suspension Position Sensor Low Reference

Tail Lamp - Left (without HSV or VXR8)





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 6-Way F

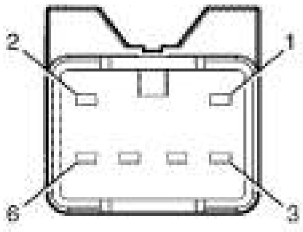
Terminal Part Information

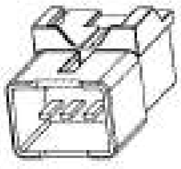
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Tail Lamp - Left (without HSV or VXR8)

Pin	Wire Color	Circuit No.	Function
1	0.85 BK/WH	1851	Ground
2	0.85 BK	1850	Ground
3	0.85 PU	709	Left Park Lamp Supply Voltage
4	0.85 L-BU	20	Stop Lamp Switch Signal
5	0.85 L-GN	24	Backup Lamp Supply Voltage
6	0.85 YE/BK	1334	Left Rear Turn Signal Lamp Supply Voltage

Tail Lamp - Left (HSV or VXR8)





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 6-Way F

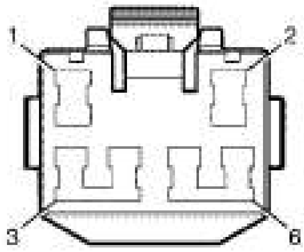
Terminal Part Information

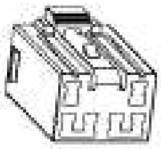
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Tail Lamp - Left (HSV or VXR8)

Pin	Wire Color	Circuit No.	Function
1	0.85 BK/WH	1851	Ground
2	0.85 BK	1850	Ground
3	0.85 PU	709	Left Park Lamp Supply Voltage
4	0.85 L-BU	20	Stop Lamp Switch Signal
5	0.85 L-GN	24	Backup Lamp Supply Voltage
6	0.85 YE/BK	1334	Left Rear Turn Signal Lamp Supply Voltage

Tail Lamp - Right (without HSV or VXR8)





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 6-Way F

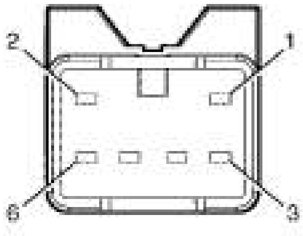
Terminal Part Information

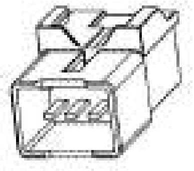
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Tail Lamp - Right (without HSV or VXR8)

Pin	Wire Color	Circuit No.	Function
1	0.85 BK/WH	1851	Ground
2	0.85 BK	1850	Ground
3	0.85 BN/WH	709	Right Park Lamp Supply Voltage
4	0.85 L-BU	20	Stop Lamp Switch Signal
5	0.85 L-GN	24	Backup Lamp Supply Voltage
6	0.85 D-GN/WH	1335	Right Rear Turn Signal Lamp Supply Voltage

Tail Lamp - Right (HSV or VXR8)





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 6-Way F

Terminal Part Information

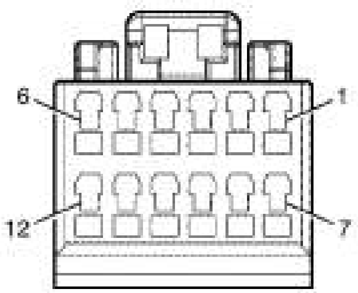
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit

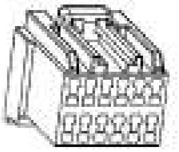
- Release Tool/Test Probe: See Terminal Repair Kit

Tail Lamp - Right (HSV or VXR8)

Pin	Wire Color	Circuit No.	Function
1	0.85 BK/WH	1851	Ground
2	0.85 BK	1850	Ground
3	0.85 BN/WH	709	Right Park Lamp Supply Voltage
4	0.85 L-BU	20	Stop Lamp Switch Signal
5	0.85 L-GN	24	Backup Lamp Supply Voltage
6	0.85 D-GN/WH	1335	Right Rear Turn Signal Lamp Supply Voltage

Telematics Module X1 (RHD)





Connector Part Information

- OEM: 175965-2
- Service: See Catalog
- Description: 12-Way F

Terminal Part Information

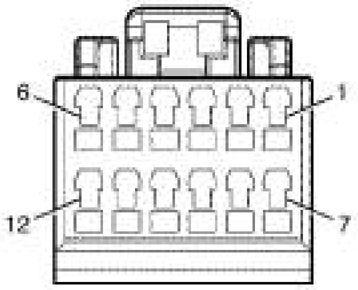
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

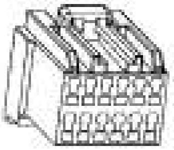
Telematics Module X1 (RHD)

Pin	Wire Color	Circuit No.	Function
1	0.5 BK	1050	Ground
2	--	--	Not Used
3	0.3 L-GN	5060	Low Speed GMLAN Serial Data
4-6	--	--	Not Used
7	0.5 OG/WH	2340	Battery Positive Voltage

8	0.3 YE/BK	2516	Keypad Green LED Signal
9	0.3 BN/WH	2517	Keypad Red LED Signal
10-12	--	--	Not Used

Telematics Module X2 (RHD)





Connector Part Information

- OEM: 175966-2
- Service: See Catalog
- Description: 16-Way F

Terminal Part Information

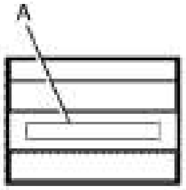
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

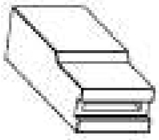
Telematics Module X2 (RHD)

Pin	Wire Color	Circuit No.	Function
13	0.3 D-GN/WH	2514	Keypad Signal
14	--	--	Not Used
15	0.3 L-BU	1405	Telephone Audio Signal (+)
16	0.3 OG/BK	1406	Telephone Audio Signal (-)
17	0.3 L-BU	1405	Telephone Audio Signal (+)
18	0.3 PK	654	Cellular Telephone Microphone Low Reference
19	0.3 D-GN	655	Cellular Microphone Signal
20	0.5 TN	1860	Left Front Speaker Output (+)
	0.5 OG	1860	Front Center Speaker Output (+)
21	0.3 L-GN/BK	2515	Keypad Supply Voltage
22	0.5 PK	1339	Ignition 1 Voltage
23	0.3 WH	700	Telephone Audio Signal Mute

24	--	--	Not Used
25	0.3 OG/BK	1406	Telephone Audio Signal (-)
26-27	--	--	Not Used
28	0.5 GY	1960	Left Front Speaker Output (-)
	0.5 L-BU	1960	Front Center Speaker Output (-)

Theft Deterrent Alarm Siren X1





- OEM: 7183-0073-30
- Service: See Catalog
- Description: 1-Way F (BK)

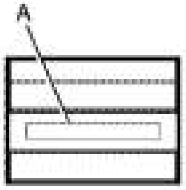
Terminal Part Information

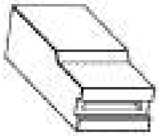
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Theft Deterrent Alarm Siren X1

Pin	Wire Color	Circuit No.	Function
A	0.75 D-GN	1149	Content Theft Horn Control

Theft Deterrent Alarm Siren X2





- OEM: 7183-0073-30
- Service: See Catalog
- Description: 1-Way F (BK)

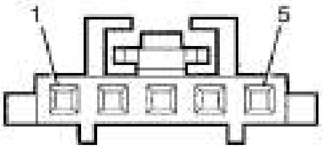
Terminal Part Information

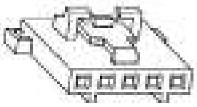
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Theft Deterrent Alarm Siren X2

Pin	Wire Color	Circuit No.	Function
A	0.75 BK	350	Ground

Theft Deterrent Module (TDM)





- OEM: 7183-2179-30
- Service: See Catalog
- Description: 5-Way F (BK)

Terminal Part Information

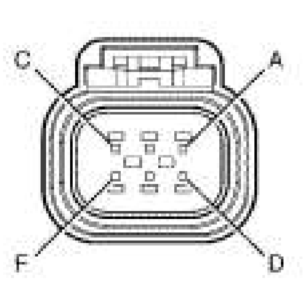
- Terminal/Tray: 16-02-1110/20

- Core/Insulation Crimp: H/H
- Release Tool/Test Probe: J-38125-213/J-35616-64B (L-BU)

Theft Deterrent Module (TDM)

Pin	Wire Color	Circuit No.	Function
1	0.3 OG/BK	1040	Battery Positive Voltage
2	0.3 BN	4	Ignition 1 Voltage
3	0.3 BK	850	Ground
4	--	--	Not Used
5	0.35 D-GN	9206	Low Speed GMLAN Serial Data

Throttle Body



- OEM: 7283-3529-30
- Service: 19115594
- Description: 6-Way F (BK)

Terminal Part Information

- Pins: A, B
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

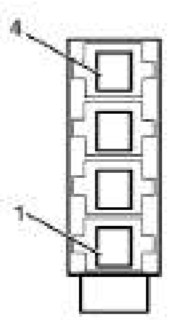
- Pins: C-F
- Terminal/Tray: 15326427/5
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

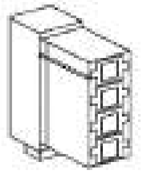
Throttle Body

Pin	Wire Color	Circuit No.	Function
A	0.75 BN	582	TAC Motor Control - 2
B	0.75 YE	581	TAC Motor Control - 1
C	0.5 BN/BK	2752	Low Reference

D	0.5 D-GN	485	TP Sensor 1 Signal
E	0.5 GY	2701	5-Volt Reference
F	0.5 PU	486	TP Sensor 2 Signal

Tilt Sensor





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 4-Way F

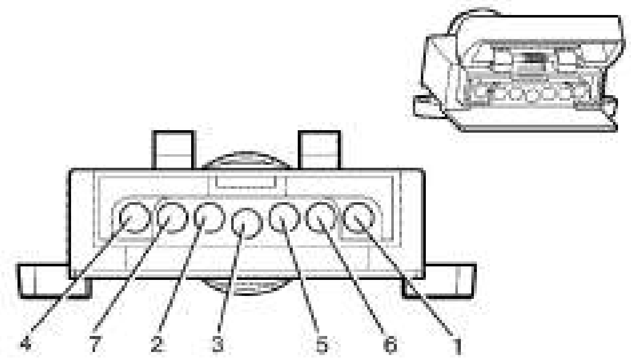
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Tilt Sensor

Pin	Wire Color	Circuit No.	Function
1	0.35 BK	9	Alarm Control Module Power Control
2	--	--	Not Used
3	0.35 BK	4	Inclination Sensor Signal
4	0.35 BK	6	Ground

Trailer Connector



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 7-Way F

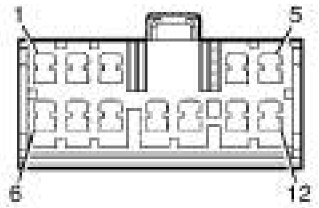
Terminal Part Information

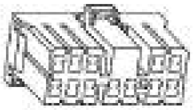
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Trailer Connector

Pin	Wire Color	Circuit No.	Function
1	0.35 YE	1	Left Indicator Output
2	0.35 BK	2	Backup Output
3	0.35 WH	19	Ground
4	0.35 D-GN	19	Right Indicator Output
5	0.35 D-BU	4	Trailer Brake Output
6	0.35 RD	5	Stop Output
7	0.35 BN	6	Park Output
8	0.35 WH	7	Ground
9	0.35 GY	30	Object Detection/Rear Park Assist Ground

Trailer Harness Control Module





Connector Part Information

- OEM: 7123-1423
- Service: See Catalog
- Description: 12-Way F

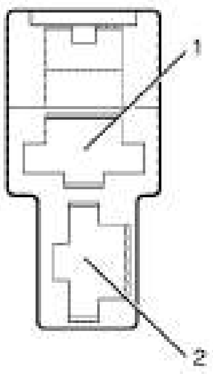
Terminal Part Information

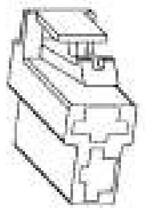
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Trailer Harness Control Module

Pin	Wire Color	Circuit No.	Function
1	0.35 RD	6	Stop Output
2	0.35 BN	7	Park Output
3	0.35 WH	19	Ground
4	0.35 BN/WH	309	Right Park lamp Supply Voltage
5	0.35 L-BU	20	Stop Lamp Supply Voltage
6	0.35 RD/WH	4440	Battery Positive Voltage
7	0.35 D-GN	4	Right Indicator Output
8	0.35 YE	1	Left Indicator Output
9	0.35 YE/BK	1334	Left Rear Turn Signal Lamp Supply Voltage
10	0.35 D-GN/WH	1335	Right Rear Turn Signal Supply Voltage
11	0.35 BK	2	Backup Output
12	0.35 L-GN	24	Backup Supply Voltage

Trailer Patch Harness Electrical Brake Connector





Connector Part Information

- OEM: 7123-2825
- Service: See Catalog
- Description: 2-Way F (WH)

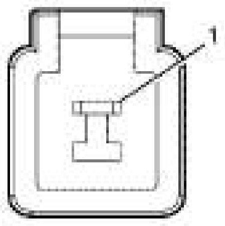
Terminal Part Information

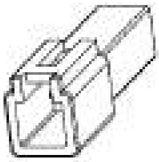
- Terminal/Tray: 7116-2640-02/12
- Core/Insulation Crimp: C/B
- Release Tool/Test Probe: 12094430/J-35616-42 (RD)

Trailer Patch Harness Electrical Brake Connector

Pin	Wire Color	Circuit No.	Function
1	0.35 BK	5	Electric Brakes
2	0.35 RD	6	Trailer Stop

Trailer Presence Conncetor





Connector Part Information

- OEM: 7282-7014

- Service: See Catalog
- Description: 1-Way M (WH)

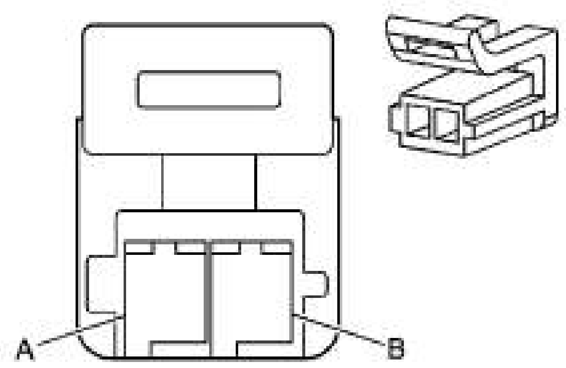
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Trailer Presence Conncetor

Pin	Wire Color	Circuit No.	Function
1	0.35 GY	30	Object Detection/Rear Park Assist Ground

Torque Converter Clutch (TCC) Pulse Width Modulation (PWM) Solenoid Valve



Connector Part Information

- OEM: 12162202
- Service: See Catalog
- Description: 2-Way F Metri-Pack 150.2 Series, Pull To Seat (BU)

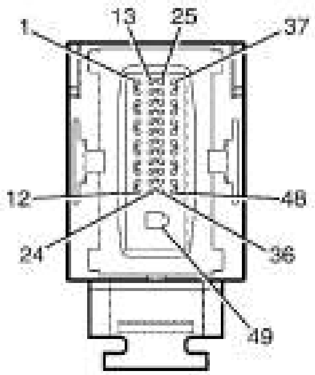
Terminal Part Information

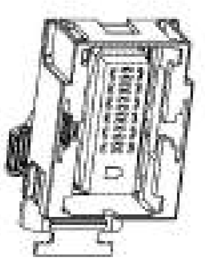
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Torque Converter Clutch (TCC) Pulse Width Modulation (PWM) Solenoid Valve

Pin	Wire Color	Circuit No.	Function
A	0.5 YE	418	TCC PWM Solenoid Valve Control
B	0.5 WH	1525	Clutch Pressure Control Solenoid Valve 1 High Control

Transmission Control Module (TCM) (M30 or M32)





- OEM: 15463921
- Service: See Catalog
- Description: 49-Way F

Terminal Part Information

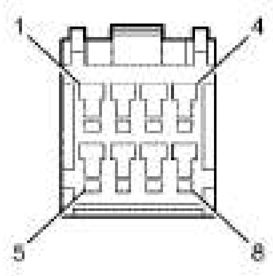
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

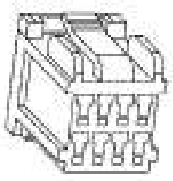
Transmission Control Module (TCM) (M30 or M32)

Pin	Wire Color	Circuit No.	Function
1	0.5 BN	418	TCC PWM Solenoid Valve Control
2	0.5 L-GN	1222	Shift Solenoid A Valve Control
3	0.5 OG	1983	Transmission Turbine Speed Switch Signal
4-5	--	--	Not Used
6	0.5 BN	2501	High Speed GMLAN Serial Data Bus-
7	0.5 BN/BK	2500	High Speed GMLAN Serial Data Bus+
8-10	--	--	Not Used
11	0.5 D-BU	5985	TCM Accessory Signal
12-13	--	--	Not Used
14	0.5 WH/GN	687	3-2 Shift Solenoid Valve Control
15	--	--	Not Used
16	0.5 L-GN/BK	822	OSS Low Signal
17	0.5 L-BU/WH	1229	PC Solenoid Valve Low Control
18-19	--	--	Not Used
20	0.5 YE/BK	1223	Shift Solenoid B Valve Control
21-22	--	--	Not Used
23	0.5 GY	773	Transmission Range Switch Signal C
24	0.5 PK	1224	Transmission Fluid Pressure Switch Signal A
25	0.5 BN/OG	422	TCC Solenoid Valve Control
26-28	--	--	Not Used

29	0.5 BN/YE	771	Transmission Range Switch Signal A
30	0.5 BN/WH	2762	Low Reference
31	0.5 PK	439	Ignition 1 Voltage
32	0.75 OG/YE	3640	Battery Positive Voltage
33	0.5 OG	1226	Transmission Fluid Pressure Switch Signal C
34	--	--	Not Used
35	0.5 YE/BK	1227	TFT Sensor Signal
36	--	--	Not Used
37	0.5 BN	2501	High Speed GMLAN Serial Data Bus-
38	0.5 BN/BK	2500	High Speed GMLAN Serial Data Bus+
39	0.5 WH	776	Transmission Range Switch Signal P
40	0.5 OG/BK	1228	PC Solenoid Valve High Control
41	0.5 PU/WH	821	OSS High Signal
42	0.5 WH/BU	17	Stop Lamp Switch Signal
43	--	--	Not Used
44	0.5 D-BU	1225	Transmission Fluid Pressure Switch Signal B
45	0.5 L-BU	1984	Transmission Turbine Speed Switch Low Reference
46	0.5 YE	772	Transmission Range Switch Signal B
47-48	--	--	Not Used
49	0.75 BK	450	Ground

Turn Signal/Multifunction Switch





Connector Part Information

- OEM: 7123-1685
- Service: See Catalog
- Description: 8-Way F 040 Multilock Series (WH)

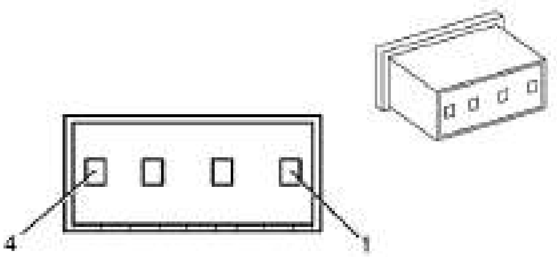
Terminal Part Information

- Terminal/Tray: 173681-2/17
- Core/Insulation Crimp: E/4
- Release Tool/Test Probe: 15315247/J-35616-16 (L-GN)

Turn Signal/Multifunction Switch

Pin	Wire Color	Circuit No.	Function
1	0.3 BK	850	Ground
2	0.3 BN/RD	1356	Flash To Pass Switch Signal
3	0.3 PU/YE	524	Headlamp Dimmer Switch High Beam Signal
4	0.3 BK	850	Ground
5	0.5 GY	1884	Cruise Control Switch Signal
6	0.3 PU	1375	Steering Wheel Control Supply Voltage
7	0.3 D-BU/WH	1415	Right Front Turn Signal Switch Signal
8	0.3 L-BU/WH	1414	Left Front Turn Signal Switch Signal

Ultrasonic Sensor Control Module



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 4-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Ultrasonic Sensor Control Module

Pin	Wire Color	Circuit No.	Function
1	0.35 BK	9	Alarm Control Module Power Control
2	0.35 BK	7	Intrusion Sensor Signal

3	0.35 BK	6	Gound
4	--	--	Not Used

Valve Lifter Oil Manifold (VLOM) Assembly

Connector Part Information

- OEM: 7287-1418
- Service: See Catalog
- Description: 5-Way F

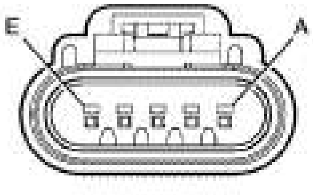
Terminal Part Information

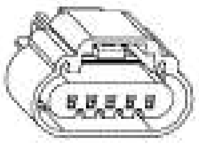
- Terminal/Tray: 12124075/5
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12180559-1/J-35616-14 (GN)

Valve Lifter Oil Manifold (VLOM) Assembly

Pin	Wire Color	Circuit No.	Function
A	0.75 OG	5494	Cylinder Shut Off Solenoid 4
B	0.75 GY	5493	Cylinder Shut Off Solenoid 3
C	0.75 D-BU	5491	Cylinder Shut Off Solenoid 1
D	0.75 D-GN/BK	5492	Cylinder Shut Off Solenoid 2
E	0.75 PK/BU	5293	Ignition 1 Voltage

Variable Intake Manifold (VIM) Module





Connector Part Information

- OEM: 7283-6997-30
- Service: See Catalog
- Description: 5-Way F (BK)

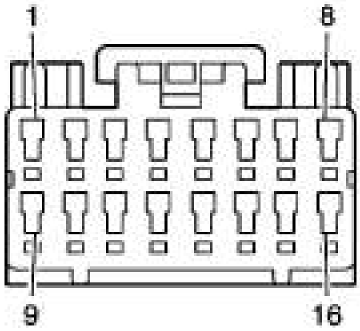
Terminal Part Information

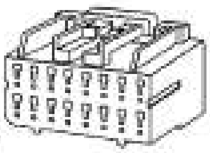
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Variable Intake Manifold (VIM) Module

Pin	Wire Color	Circuit No.	Function
A	0.75 PK/BU		Ignition 1 Voltage
B	0.75 BN		PWM_OUT
C	0.75 PU/BK		PWR_RTN
D	0.75 L-BU/WH		PWM
E	0.75 BK		Ground

Vehicle Communication Interface Module (VCIM) X1





Connector Part Information

- OEM: 7283-1766
- Service: See Catalog
- Description: 16-Way F (WH)

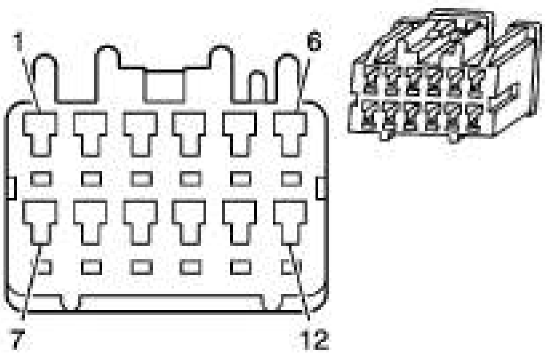
Terminal Part Information

- Terminal/Tray: 175266-5/15
- Core/Insulation Crimp: K/K
- Release Tool/Test Probe: 15315247/J-35616-16 (L-GN)

Vehicle Communication Interface Module (VCIM) X1

Pin	Wire Color	Circuit No.	Function
1	0.35 D-GN	5060	Low Speed GMLAN Serial Data
2	0.3 BN/WH	2517	Keypad Red LED Signal
3	0.3 YE/BK	2516	Keypad Green LED Signal
4-5	--	--	Not Used
6	0.3 L-GN/BK	2515	Keypad Supply Voltage
7	0.5 BK	1050	Ground
8-9	--	--	Not Used
10	0.5 BN/BK	9008	High Speed GMLAN Serial Data Bus+
11	0.3 GN/WH	2514	Keypad Signal
12	0.5 BN	9009	High Speed GMLAN Serial Data Bus-
13	0.5 YE/BK	950	VCIM Battery Low Reference
14	0.5 BN/WH	9940	VCIM Battery Power
15	0.5 OG	3340	Battery Positive Voltage
16	--	--	Not Used

Vehicle Communication Interface Module (VCIM) X2



Connector Part Information

- OEM: 7283-8621
- Service: See Catalog
- Description: 12-Way F (WH)

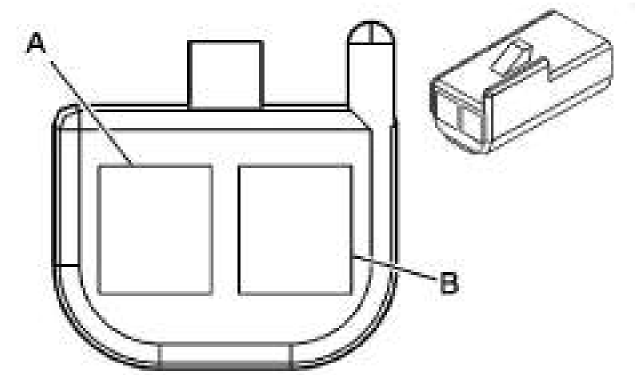
Terminal Part Information

- Terminal/Tray: 175266-5/15
- Core/Insulation Crimp: J/J
- Release Tool/Test Probe: 15315247J-35616-16 (L-GN)

Vehicle Communication Interface Module (VCIM) X2

Pin	Wire Color	Circuit No.	Function
1	0.3 D-BU	658	Cellular Telephone Voice Signal
2	0.3 L-BU	659	Cellular Telephone Voice Low Reference
3	0.5 BN/BK	9010	High Speed GMLAN Serial Data Bus+
4	0.5 BN	9011	High Speed GMLAN Serial Data Bus-
5-7	--	--	Not Used
8	0.5 BK	--	Ground
9	0.3 D-GN	0655	Cellular Microphone Signal
10	0.3 BK	1782	Drain Wire
11	--	--	Not Used
12	0.3 WH	700	Telephone Audio Signal Mute

Vehicle Communication Interface Module (VCIM) Battery



Connector Part Information

- OEM: 7123-8328-30
- Service: 12085535

- Description: 2-Way F (BK)

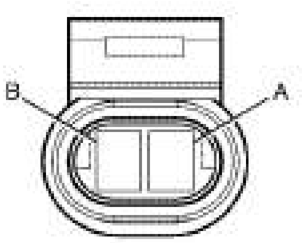
Terminal Part Information

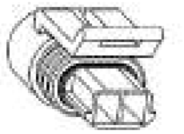
- Terminal/Tray: 12064971/5
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Vehicle Communication Interface Module (VCIM) Battery

Pin	Wire Color	Circuit No.	Function
A	0.5 BN/WH	9940	VCIM Battery Power
B	0.5 YE/BK	950	VCIM Battery Low Reference

Vehicle Speed Sensor (VSS)





Connector Part Information

- OEM: 12162195
- Service: See Catalog
- Description: 2-Way F

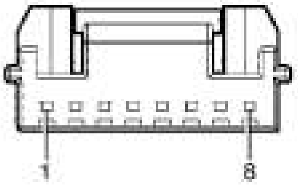
Terminal Part Information

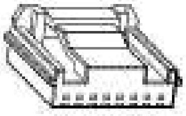
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Vehicle Speed Sensor (VSS)

Pin	Wire Color	Circuit No.	Function
A	0.5 PU/WH	821	OSS High Signal
B	0.5 L-GN/BK	822	OSS Low Signal

Video Display





Connector Part Information

- OEM: LMAO151400A
- Service: See Catalog
- Description:

Terminal Part Information

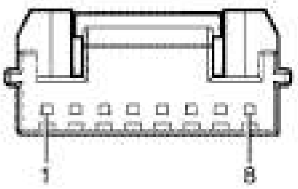
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

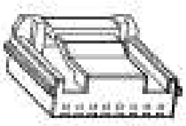
Video Display

Pin	Wire Color	Circuit No.	Function
1	0.18 YE	6889	Battery Positive (LHD)
	0.18 OG	6889	Battery Positive (RHD)
2	--	--	Not Used
3	0.18 PU	6903	Ground (LHD)
	0.18 L-BU	6903	Ground (RHD)
4	--	--	Not Used
5	0.18 GY	6900	RSTX / DVTX DVDIN / TX (LHD)
	0.18 YE	6900	RSTX / DVTX DVDIN / TX (RHD)
6	0.18 D-BU	6901	RSRX / RS485RX / RX (LHD)
	0.18 D-GN	6901	RSRX / RS485RX / RX (RHD)
7	0.18 BARE	6904	Drain Wire (LHD)
8	--	--	Not Used
9	0.18 WH	6890	DVD Audio Left Signal (+) (LHD)
	0.18 L-GN	6890	DVD Audio Left Signal (+) (RHD)
10	0.18 WH	6892	DVD Audio Left Signal (-) (LHD)
	0.18 L-GN	6892	DVD Audio Left Signal (-)
11	0.18 RD	6891	DVD Audio Right Signal (+) (LHD)
	0.18 D-GN/WH	6891	DVD Audio Right Signal (+) (RHD)
	0.18 RD	6979	DVD Audio Right Signal (-) (LHD)

12	0.18 D-GN/WH	6979	DVD Audio Right Signal (-) (RHD)
13	0.18 BK	7394	DVD Video Signal (-) (LHD)
	0.18 WH	7394	DVD Video Signal (-) (RHD)
14	0.18 BK	7396	DVD Video Signal (+) (LHD)
	0.18 WH	7396	DVD Video Signal (+) (RHD)

Video Display - Left Seat Headrest X1





Connector Part Information

- OEM: LMAO151400A
- Service: See Catalog
- Description:

Terminal Part Information

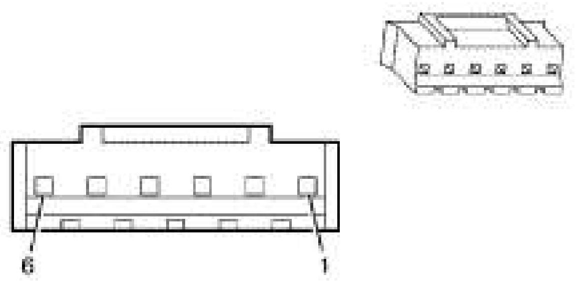
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Video Display - Left Seat Headrest X1

Pin	Wire Color	Circuit No.	Function
1	0.18 OG	6849	Battery Positive
2	--	--	Not Used
3	0.18 L-BU	6873	Ground
4	--	--	Not Used
5	0.18 YE	5845	RS485TX
6	0.18 D-GN	1098	RS485RX
7	0.18 BARE	5339	Shield
8	--	--	Not Used
9	0.18 L-GN	5826	DVD Audio Left Signal (+)
10	0.18 L-GN	5825	DVD Audio Left Signal (-)

11	0.18 D-GN/WH	5828	DVD Audio Right Signal (+)
12	0.18 D-GN/WH	5827	DVD Audio Right Signal (-)
13	0.18 WH	6976	DVD Video Signal (-)
14	0.18 WH	6975	DVD Video Signal (+)

Video Display - Left Seat Headrest X2



Connector Part Information

- OEM: LMAO150600A
- Service: See Catalog
- Description:

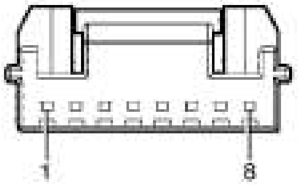
Terminal Part Information

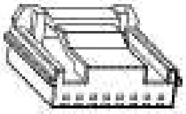
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Video Display - Left Seat Headrest X2

Pin	Wire Color	Circuit No.	Function
1	0.18 YE	2059	Auxiliary Audio Left Signal (+)
2	0.18 YE/BK	5843	Auxiliary Audio Left Signal (-)
3	0.18 WH/RD	2058	Auxiliary Audio Right Signal (+)
4	0.18 WH/RD	5345	Auxiliary Audio Right Signal (-)
5	0.18 PU	2057	Auxiliary Video Signal (-)
6	0.18 PU	2056	Auxiliary Video Signal (+)

Video Display - Right Seat Headrest X1





Connector Part Information

- OEM: LMAO151400A
- Service: See Catalog
- Description:

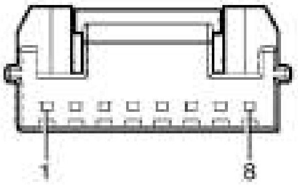
Terminal Part Information

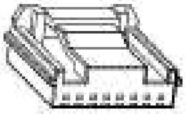
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Video Display - Right Seat Headrest X1

Pin	Wire Color	Circuit No.	Function
1	0.18 OG	6889	Battery Positive Voltage
2	--	--	Not Used
3	0.18 L-BU	6903	Ground
4	--	--	Not Used
5	0.18 YE	6900	RS485TX
6	0.18 D-GN	6901	RS485RX
7	0.18 BARE	6904	Shield
8	--	--	Not Used
9	0.18 L-GN	6890	DVD Audio Left Signal (+)
10	0.18 L-GN	6892	DVD Audio Left Signal (-)
11	0.18 D-GN/WH	6891	DVD Audio Right Signal (+)
12	0.18 D-GN/WH	6979	DVD Audio Right Signal (-)
13	0.18 WH	7394	DVD Video Signal (-)
14	0.18 WH	7396	DVD Video Signal (+)

Video Display - Right Seat Headrest X2





Connector Part Information

- OEM: LMAO150600A
- Service: See Catalog
- Description:

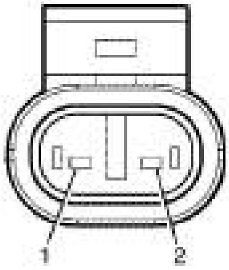
Terminal Part Information

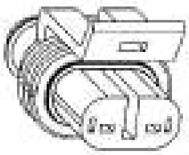
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Video Display - Right Seat Headrest X2

Pin	Wire Color	Circuit No.	Function
1	0.18 YE	2059	Auxiliary Audio Left Signal (+)
2	0.18 YE/BK	5843	Auxiliary Audio Left Signal (-)
3	0.18 WH/RD	2058	Auxiliary Audio Right Signal (+)
4	0.18 WH/RD	5345	Auxiliary Audio Right Signal (-)
5	0.18 PU	2057	Auxiliary Video Signal (-)
6	0.18 PU	2056	Auxiliary Video Signal (+)

Wheel Speed Sensor (WSS) - Left Front





Connector Part Information

- OEM: 282080-1
- Service: See Catalog
- Description: 2-Way F (BK)

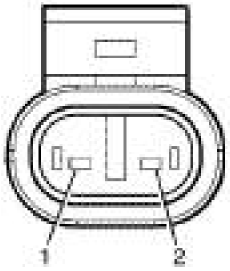
Terminal Part Information

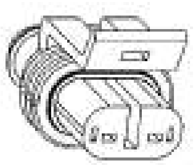
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Wheel Speed Sensor (WSS) - Left Front

Pin	Wire Color	Circuit No.	Function
1	0.75 BN	830	Wheel Speed Sensor Signal Left Front
2	0.75 BK	7064	Wheel Speed Sensor Supply Voltage Left Front

Wheel Speed Sensor (WSS) - Left Rear





Connector Part Information

- OEM: 282080-1
- Service: See Catalog
- Description: 2-Way F (BK)

Terminal Part Information

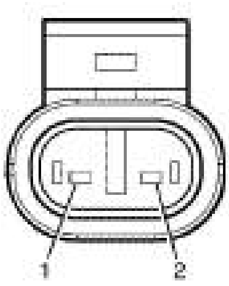
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

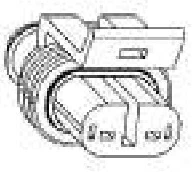
Wheel Speed Sensor (WSS) - Left Rear

Pin	Wire Color	Circuit No.	Function

1	0.5 BN/BK	884	Wheel Speed Sensor Signal Left Rear
2	0.5 GY	7127	Wheel Speed Sensor Supply Voltage Left Rear

Wheel Speed Sensor (WSS) - Right Front





Connector Part Information

- OEM: 282080-1
- Service: See Catalog
- Description: 2-Way F (BK)

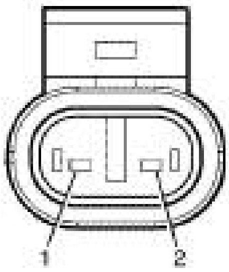
Terminal Part Information

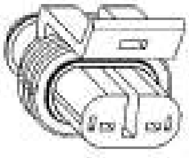
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Wheel Speed Sensor (WSS) - Right Front

Pin	Wire Color	Circuit No.	Function
1	0.75 BN	872	Wheel Speed Sensor Signal Right Front
2	0.75 BK	7065	Wheel Speed Sensor Supply Voltage Right Front

Wheel Speed Sensor (WSS) - Right Rear





Connector Part Information

- OEM: 282080-1
- Service: See Catalog
- Description: 2-Way F (BK)

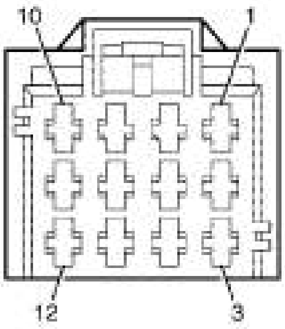
Terminal Part Information

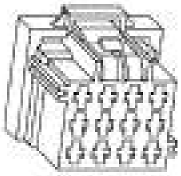
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Wheel Speed Sensor (WSS) - Right Rear

Pin	Wire Color	Circuit No.	Function
1	0.5 BN	882	Wheel Speed Sensor Signal Right Rear
2	0.5 GY	7128	Wheel Speed Sensor Supply Voltage Right Rear

Window Control Module





Connector Part Information

- OEM: 7283-4417-60

- Service: See Catalog
- Description: 12-Way F (GN)

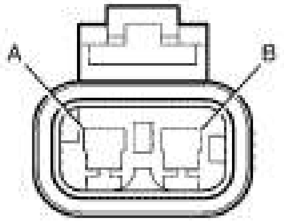
Terminal Part Information

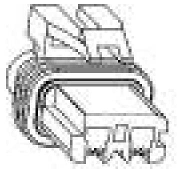
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Window Control Module

Pin	Wire Color	Circuit No.	Function
1	2 BU/WH	666	Power Window Motor Right Front Up Control
2	2 BN/OG	165	Power Window Motor Left Front Down Control
3	0.5 L-BU	166	Power Window Master Switch Right Front Up Signal
4	--	--	Not Used
5	2 BK	1350	Ground
6	0.5 BN	1300	Power Window Master Switch Left Front Up Signal
7	--	--	Not Used
8	2 D-GN	1001	RAP Supply Voltage
9	0.5 TN	167	Power Window Master Switch Right Front Down Signal
10	2 BN	667	Power Window Motor Right Front Down Control
11	2 D-BU	164	Power Window Motor Left Front Up Control
12	0.5 GY	1136	Power Window Master Switch Left Front Down Control Signal

Window Motor - Driver (AXB)





Connector Part Information

- OEM: 7283-2176-40
- Service: See Catalog
- Description: 2-Way F Metri-Pack 280 Series Flexlock Sealed (GY)

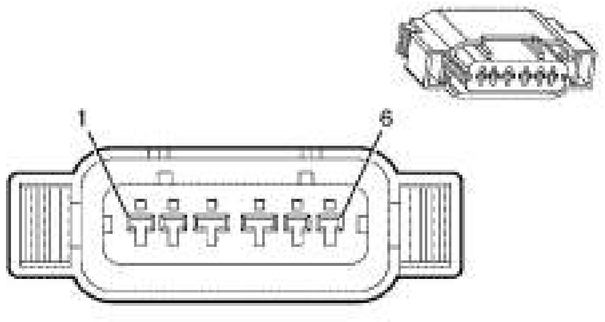
Terminal Part Information

- Terminal/Tray: 12110845/4
- Core/Insulation Crimp: A/5
- Release Tool/Test Probe: 15315247/J-35616-4A (PU)

Window Motor - Driver (AXB)

Pin	Wire Color	Circuit No.	Function
A	2 BN/OG	165	Power Window Motor Left Front Down Control
B	2 D-BU	164	Power Window Motor Left Front Up Control

Window Motor - Driver (AXC)



Connector Part Information

- OEM: 902970-00
- Service: See Catalog
- Description: 6-Way F

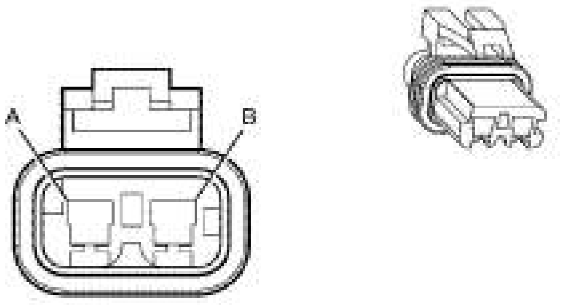
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Window Motor - Driver (AXC)

Pin	Wire Color	Circuit No.	Function
1	0.5 BN/RD	1300	Power Window Master Switch Left Front Up Signal
2	0.5 D-GN	1301	RAP [X] Fuse Supply Voltage
3	2 RD/WH	1540	Battery Positive Voltage
4	0.5 BK	2050	Ground
5	--	--	Not Used
6	0.5 GY/BU	1136	Power Window Motor Left Front Down Control

Window Motor - Left Rear



Connector Part Information

- OEM: 7283-2176-40
- Service: 88988609
- Description: 2-Way F Metri-Pack 280 Series Flexlock Sealed (GY)

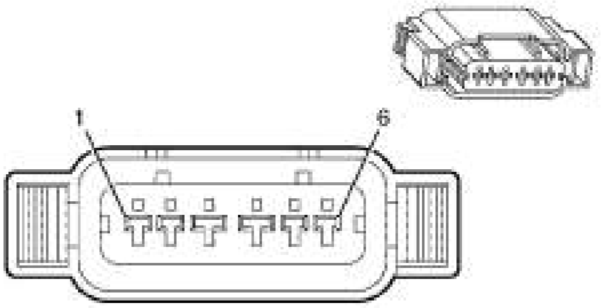
Terminal Part Information

- Terminal/Tray: 12110845/4
- Core/Insulation Crimp: A/5
- Release Tool/Test Probe: 15315247/J-35616-4A (PU)

Window Motor - Left Rear

Pin	Wire Color	Circuit No.	Function
A	2 BN	669	Power Window Motor Left Rear Down Control
B	2 D-BU	668	Power Window Motor Left Rear Up Control

Window Motor - Passenger (AXB)



Connector Part Information

- OEM:
- Service: See Catalog
- Description: 6-Way F

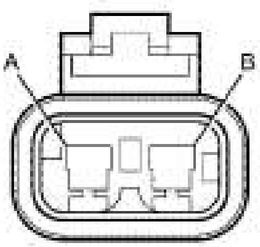
Terminal Part Information

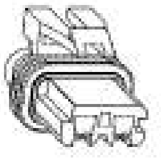
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Window Motor - Passenger (AXB)

Pin	Wire Color	Circuit No.	Function
1	0.5 L-BU	166	Power Window Master Switch Right Front Up Signal
2	0.5 D-GN	1301	RAP [X] Fuse Supply Voltage
3	2 RD/WH	1540	Battery Positive Voltage
4	2 BK	1350	Ground
5	--	--	Not Used
6	0.5 D-GN/BK	167	Power Window Master Switch Right Front Down Signal

Window Motor - Passenger (AXC)





Connector Part Information

- OEM: 7283-2176-40
- Service: See Catalog
- Description: 2-Way F Metri-Pack 280 Series Flexlock Sealed (GY)

Terminal Part Information

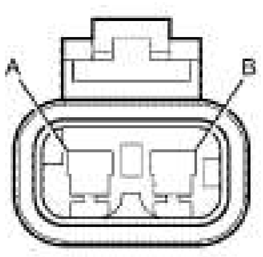
- Terminal/Tray: 12110845/4
- Core/Insulation Crimp: A/5
- Release Tool/Test Probe: 15315247/J-35616-4A (PU)

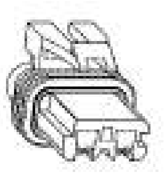
Window Motor - Passenger (AXC)

Pin	Wire Color	Circuit No.	Function

A	2 BN	667	Power Window Motor Right Front Down Control
B	2 D-BU/WH	666	Power Window Motor Right Front Up Control

Window Motor - Right Rear





Connector Part Information

- OEM: 7283-2176-40
- Service: 88988609
- Description: 2-Way F Metri-Pack 280 Series Flexlock Sealed (GY)

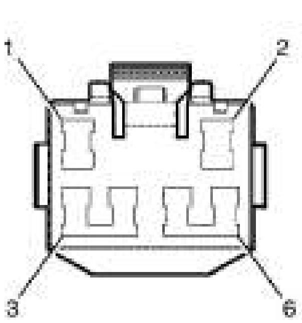
Terminal Part Information

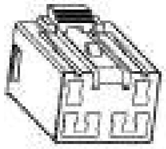
- Terminal/Tray: 12110845/4
- Core/Insulation Crimp: A/5
- Release Tool/Test Probe: 15315247/J-35616-4A (PU)

Window Motor - Right Rear

Pin	Wire Color	Circuit No.	Function
A	2 BN	671	Power Window Motor Right Rear Down Control
B	2 D-BU	670	Power Window Motor Right Rear Up Control

Window Switch - Left Rear





Connector Part Information

- OEM: 7283-1060
- Service: See Catalog
- Description: 6-Way F (WH)

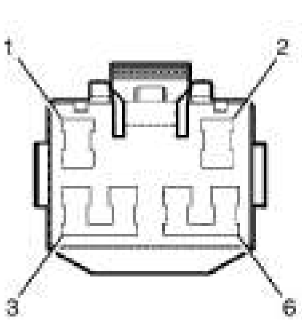
Terminal Part Information

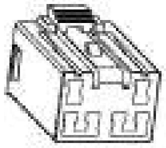
- Terminal/Tray: 7116-4022/11
- Core/Insulation Crimp: 4/A
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

Window Switch - Left Rear

Pin	Wire Color	Circuit No.	Function
1	2 D-BU	668	Power Window Motor Left Rear Up Control
2	0.3 BK		Ground
3	2 D-GN	168	Power Window Master Switch Left Rear Up Signal
4	2 D-BU	1307	Power Window Master Switch Lockout Signal
5	2 BN	669	Power Window Motor Left Rear Down Control
6	2 PU	169	Power Window Master Switch Left Rear Down Signal

Window Switch - Right Rear





Connector Part Information

- OEM: 7283-1060
- Service: See Catalog
- Description: 6-Way F (WH)

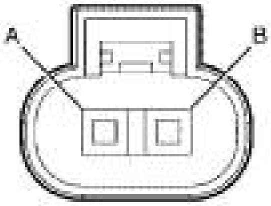
Terminal Part Information

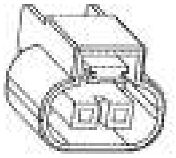
- Terminal/Tray: 7116-4022/11
- Core/Insulation Crimp: 4/A
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

Window Switch - Right Rear

Pin	Wire Color	Circuit No.	Function
1	2 D-BU	670	Power Window Motor Right Rear Up Control
2	0.3 BK		Ground
3	2 L-GN	170	Power Window Master Switch Right Rear Up Signal
4	2 D-BU	1307	Power Window Master Switch Lockout Signal
5	2 BN	671	Power Window Motor Right Rear Down Control
6	2 PU/WH	171	Power Window Master Switch Right Rear Down Signal

Windshield Washer Fluid Level Switch (TT7 or TT8 or EF7)





Connector Part Information

- OEM: PB625-02027
- Service: See Catalog
- Description: 2-Way F

Terminal Part Information

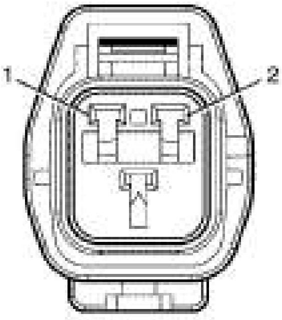
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit

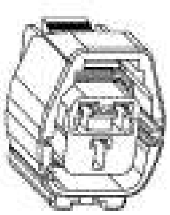
- Release Tool/Test Probe: See Terminal Repair Kit

Windshield Washer Fluid Level Switch (TT7 or TT8 or EF7)

Pin	Wire Color	Circuit No.	Function
A	0.3 BK	250	Ground
B	0.3 BN	185	Low Washer Fluid Indicator Signal

Windshield Washer Fluid Pump





Connector Part Information

- OEM: 7283-7031-10
- Service: See Catalog
- Description: 2-Way F (BK)

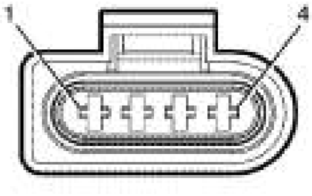
Terminal Part Information

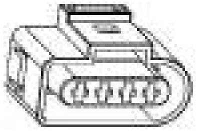
- Terminal/Tray: 7116-4026/11
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 15313892/J-35616-18 (BK)

Windshield Washer Fluid Pump

Pin	Wire Color	Circuit No.	Function
1	0.75 OG	228	Windshield Washer Pump Control
2	0.75 BK	250	Ground

Windshield Wiper Motor





Connector Part Information

- OEM: 7283-2043-30
- Service: See Catalog
- Description: 4-Way F (BK)

Terminal Part Information

- Pins: 1-2
- Terminal/Tray: 4-964273-1/15
- Core/Insulation Crimp: C/5
- Release Tool/Test Probe: 12093647/J-35616-4A (PU)

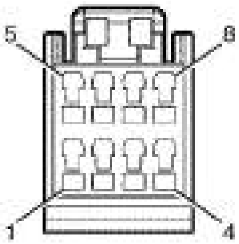
- Pin: 3
- Terminal/Tray: 4-964273-1/15
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12093647/J-35616-4A (PU)

- Pin: 4
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Windshield Wiper Motor

Pin	Wire Color	Circuit No.	Function
1	2 YE	196	Windshield Wiper Motor Park Switch Signal
2	2 BK	350	Ground
3	1.25 BN/WH	92	Windshield Wiper Motor High Speed
4	0.3 D-GN	95	Windshield Wiper Motor Low Speed

Windshield Wiper / Washer Switch



Connector Part Information

- OEM: 7283-7387-30
- Service: See Catalog
- Description: 8-Way F (BK)

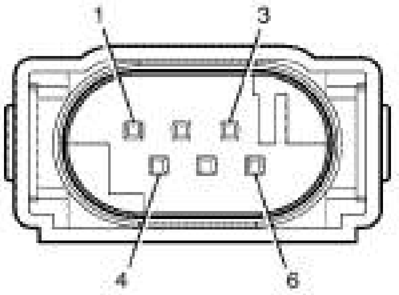
Terminal Part Information

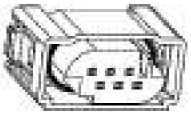
- Terminal/Tray: 173681-2/17
- Core/Insulation Crimp: E/4
- Release Tool/Test Probe: 15315247/J-35616-16 (L-GN)

Windshield Wiper/Washer Switch

Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used
2	0.3 OG	94	Windshield Washer Switch Signal (LHD)
3	0.3 L-BU	1714	Windshield Wiper Switch Low Signal (LHD)
4	0.3 BK/WH	1715	Windshield Wiper Switch High Signal (RHD)
	0.3 L-GN	1715	Windshield Wiper Switch High Signal (LHD)
5	--	--	Not Used
6	0.3 OG	94	Windshield Washer Switch Signal (RHD)
7	0.3 L-BU	1714	Windshield Wiper Switch Low Signal (RHD)
8	0.3 BK/WH	1251	Ground (RHD)
	0.3 L-GN	1251	Windshield Wiper Switch High Signal (LHD)

Yaw and Lateral Accelerometer Sensor





Connector Part Information

- OEM: 7219-1764-30
- Service: See Catalog
- Description: 6-Way F (BK)

Terminal Part Information

- Terminal/Tray: 962885-5/15
- Core/Insulation Crimp: 6/6
- Release Tool/Test Probe: 12094429/J-35616-64B (L-BU)

Yaw and Lateral Accelerometer Sensor

Pin	Wire Color	Circuit No.	Function
1	0.5 D-GN	2087	5-V Reference
2	0.5 L-GN/BK	5352	Yaw Rate Sensor Test Control
3	0.5 L-BU	5986	Communication Enable Relay Supply Voltage
4	0.5 BN/WH	2086	Yaw Rate Signal
5	0.5 PU/WH	1699	Combined Vehicle Inertial Sensor Signal
6	0.5 BK/BU	2088	Low Reference

Inline Harness Connector End Views

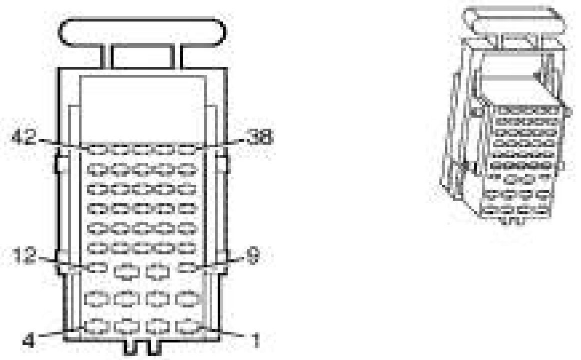
Connector 1: X102 Front Body Harness to Engine Harness
Connector 2: X103 Forward Lamp Harness to the Engine Harness
Connector 3: X104 Front Body Harness to I/P Harness
Connector 4: X106 Forward Lamp Harness to the Front Body Harness
Connector 5: X107 Forward Lamp Harness to the Front Compartment Harness
Connector 6: X108 Fog Lamp Harness to the Front Body Harness
Connector 7: X110 Engine Harness to the Front Body Harness
Connector 8: X112 Engine Harness to the Ignition Coil Harness (L98)
Connector 9: X113 Engine Harness to the Ignition Coil Harness (L98)
Connector 10: X114 Engine Harness to the Fuel Injector Harness (LY7)
Connector 11: X115 Forward Lamp Harness to the Left Headlamp
Connector 12: X116 Forward Lamp Harness to the Right Headlamp
Connector 13: X160 Left Front Wheel Speed Sensor Harness to the Front Body Harness
Connector 14: X161 Right Front Wheel Speed Sensor Harness to the Front Body Harness
Connector 15: X162 Forward Lamp Harness to the Cooling Fan Assembly
Connector 16: X165 Front Body Harness to the I/P Harness
Connector 17: X175 Engine Harness to the Automatic Transmission (M82)
Connector 18: X200 I/P Harness to the Front Body Harness
Connector 19: X201 I/P Harness to the Front Body Harness
Connector 20: X202 I/P Harness to the Body Harness
Connector 21: X204 I/P Harness to the Front Body Harness
Connector 22: X205 Glove Box Assembly to the I/P Harness
Connector 23: X206 Front Body Harness to the Body Harness
Connector 24: X207 I/P Harness to the Body Harness
Connector 25: X208
Connector 26: X210 Rear Body Harness to the Rear Latch Assembly Harness
Connector 27: X212 Headliner Harness to the I/P Harness
Connector 28: X213 Headliner Harness to the Instrument Panel Harness
Connector 29: X218 Body Harness to the Body Harness
Connector 30: X220 I/P Harness to the Body Harness (LHD)
Connector 31: X223 I/P Harness to the Console Ground
Connector 32: X225
Connector 33: X226 Gauge Assembly to the I/P Harness (HSV)
Connector 34: X227 Steering Angle Sensor Assembly to the I/P Harness
Connector 35: X228 I/P Harness to the I/P Harness
Connector 36: X229 I/P Harness to the I/P Harness
Connector 37: X236 Electronic Suspension Assembly to the Body Harness (HSV)
Connector 38: X237 Electronic Suspension Assembly to the I/P Harness (HSV)
Connector 39: X238 Indicator Assembly to the I/P Harness (HSV)
Connector 40: X241 I/P Harness to the Driver Information Center Harness

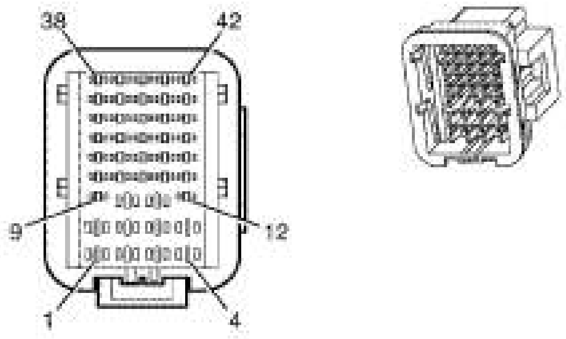
Connector 41: X253 I/P Harness to the Body Harness
Connector 42: X254 I/P Harness to the Body Harness
Connector 43: X255 Digital Video Disc (DVD) Control Module to the Video Display
Connector 44: X305 Body Harness to the Fuel Tank Harness
Connector 45: X306 Driver Seat Harness to the Body Harness (A45)
Connector 46: X307 Body Harness to the Left Front Door Harness
Connector 47: X308 Body Harness to the Right Front Door Harness
Connector 48: X309 Body Harness to the I/P Harness
Connector 49: X310 Passenger Seat Harness to the Body Harness
Connector 50: X311 Driver Seat Harness to the Body Harness
Connector 51: X312 Body Harness to the Passenger Seat Harness
Connector 52: X313 Body Harness to the Passenger Seat Harness
Connector 53: X314 Body Harness to the Driver Seat Harness
Connector 54: X315 Body Harness to the Driver Seat Harness
Connector 55: X316 Body Harness to the Digital Video Disc (DVD) Control Module
Connector 56: X317 Body Harness to the Body Harness
Connector 57: X319 Headliner Harness to the Digital Video Disc (DVD) Control Module
Connector 58: X322 Passenger Seat Harness to the Body Harness
Connector 59: X324 Driver Seat Back to the Driver Seat Harness (AH5)
Connector 60: X324 Driver Seat Back to the Driver Seat Harness (AGB)
Connector 61: X330 Left Seat Harness to the Body Harness
Connector 62: X331 Right Seat Harness to the Body Harness
Connector 63: X332 Video Display to the Right Seat Harness
Connector 64: X333 Left Seat Harness to the Body Harness
Connector 65: X335 Video Display Assembly to the Body Harness
Connector 66: X344 Inside Rearview Mirror Harness to the I/P Harness
Connector 67: X355 Body Harness to the Driver Seat Harness
Connector 68: X356 Body Harness to the Passenger Seat Harness
Connector 69: X360 Body Harness to the Rear Wheel Speed Sensors
Connector 70: X361 Rear Axle Harness to the Body Harness
Connector 71: X402 Body Harness to the Decklid Harness
Connector 72: X403 Rear Body Harness to the Body Harness
Connector 73: X404 Body Harness to the Rear Body Harness
Connector 74: X405 X405 Body Harness to the Rear Compartment Harness (F19)
Connector 75: X405 Body Harness to the Rear Compartment Harness (F69 without T79)
Connector 76: X408 Battery Cable to the Body Harness
Connector 77: X412 Rear Body Harness to the Rear Body Harness
Connector 78: X413 Electronic Stability Control Harness to the Fuel Tank Harness (HSV)
Connector 79: X415 (HSV) (Pigtail?)
Connector 80: X416 (HSV) (Pigtail?)
Connector 81: X433 Rear Fascia Harness to the License Lamp Harness (WM)
Connector 82: X450 Rear Body Harness to the Right Rear Tail Lamp Assembly
Connector 83: X451 Rear Body Harness to the Left Rear Tail Lamp Assembly
Connector 84: X500 Body Harness to the Left Front Door Harness
Connector 85: X600 Body Harness to the Right Front Door Harness

Connector 86: X700 Body Harness to the Left Rear Door Harness

Connector 87: X800 Body Harness to the Right Rear Door Harness

X102 Front Body Harness to Engine Harness





Connector Part Information

- OEM: 7283-9911-30
- Service: See Catalog
- Description: 42-Way F (BK)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7282-0680-30
- Service: See Catalog
- Description: 42-Way M (BK)

Terminal Part Information

- Pins: 1-6, 8, 10, 11
- Terminal/Tray: 1-962915-3/15
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12093647/J-35616-5 (PU)

- Pins: 9, 12-24, 25-28, 31-42
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X102 Front Body Harness to Engine Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.5 BK	450	Ground (LY7)	1	0.5 BK	450	Ground (LY7)
	2 BK	450	Ground (without LY7)		2 BK	450	Ground (without LY7)
	0.75 OG/YE	3640	Battery Positive Voltage (M30 or M32)		0.75 OG/YE	3640	Battery Positive Voltage (M30 or M32)

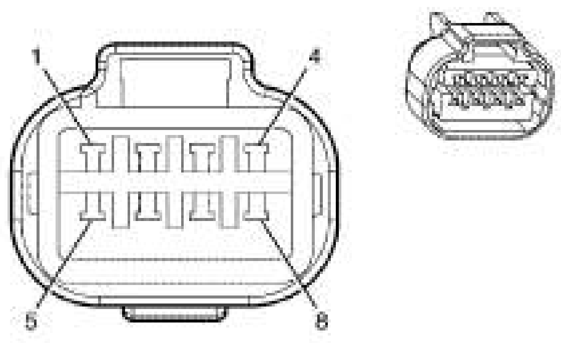
2	0.5 D-GN	335	Low Speed Cooling Fan Relay Control (without LY7)	2	0.5 D-GN	335	Low Speed Cooling Fan Relay Control (without LY7)
3	0.5 D-BU	2709	Transmission Fluid Pressure Switch Signal B (M30)	3	0.5 D-BU	2709	Transmission Fluid Pressure Switch Signal B (M30)
	0.5 BN	5069	Main Relay Control (without LY7)		0.5 BN	5069	Main Relay Control (without LY7)
4	0.75 OG/YE	2709	Battery Positive Voltage (M32)	4	0.75 OG/YE	2709	Battery Positive Voltage (M32)
5	0.5 OG/BK	540	Battery Positive Voltage (LY7)	5	0.5 OG/BK	540	Battery Positive Voltage (LY7)
	0.75 PK/BK	5290	Ignition 1Voltage (without LY7)		0.75 PK/BK	5290	Ignition 1Voltage (without LY7)
6	1.25 BK	350	Ground (LY7)	6	1.25 BK	350	Ground (LY7)
7	0.75 OG	1525	Clutch Pressure Control Solenoid Valve 1 High Control (M30 or M32 or M82)	7	0.75 OG	1525	Clutch Pressure Control Solenoid Valve 1 High Control (M30 or M32 or M82)
8	0.5 L-BU/WH	1310	PC Solenoid Valve Low Control (LY7)	8	0.5 L-BU/WH	1310	PC Solenoid Valve Low Control (LY7)
	1.25 BK	350	Ground (without LY7)		1.25 BK	350	Ground (without LY7)
9	0.5 D-BU	7393	A/C Compressor Clutch Low Reference	9	0.5 D-BU	7393	A/C Compressor Clutch Low Reference
10	0.5 PK	439	Ignition 1 Voltage	10	0.5 PK	439	Ignition 1 Voltage
11	0.5 BN/WH	2762	Low Reference (M30)	11	0.5 BN/WH	2762	Low Reference (M30)
	0.5 D-BU	1225	Transmission Fluid Pressure Switch B (M82)		0.5 D-BU	1225	Transmission Fluid Pressure Switch B (M82)
12	0.5 BN	9001	High Speed GMLAN Serial Data Bus - (LY7)	12	0.5 BN	9001	High Speed GMLAN Serial Data Bus - (LY7)
	0.5 L-GN/BK	401	OSS Low Signal (M32)		0.5 L-GN/BK	401	OSS Low Signal (M32)
13	0.5 D-GN	7392	A/C Compressor Clutch Supply Voltage	13	0.5 D-GN	7392	A/C Compressor Clutch Supply Voltage
14	0.5 L-BU	1937	Fuel Level Sensor (LY7)	14	0.5 L-BU	1937	Fuel Level Sensor (LY7)
	0.5 OG/BK	1786	Park/Neutral Signal (without LY7)		0.5 OG/BK	1786	Park/Neutral Signal (without LY7)
15	0.5 D-GN/WH	465	Fuel Pump Relay Control (LY7)	15	0.5 D-GN/WH	465	Fuel Pump Relay Control (LY7)
	0.5 D-BU	5985	TCM Accessory Signal (without LY7)		0.5 D-BU	5985	TCM Accessory Signal (without LY7)
16	0.5 BN/YE	452	Low Reference (LY7)	16	0.5 BN/YE	452	Low Reference (LY7)
	0.5		HO2S Heater Low		0.5		HO2S Heater Low

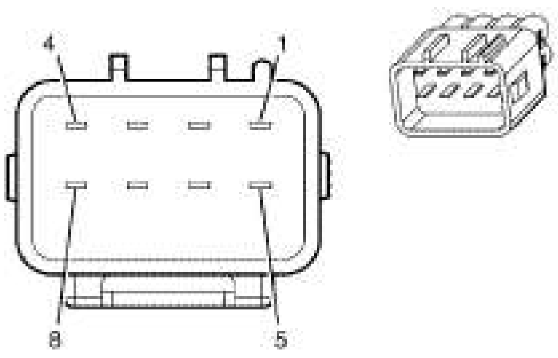
	OG/WH	3223	Control (Bank 2 Sensor 2) (without LY7)		OG/WH	3223	Control (Bank 2 Sensor 2) (without LY7)
17	0.5 BN/BK	9000	High Speed GMLAN Serial Data Bus+ (LY7)	17	0.5 BN/BK	9000	High Speed GMLAN Serial Data Bus+ (LY7)
	0.5 PU/WH	400	OSS High Signal (M32)		0.5 PU/WH	400	OSS High Signal (M32)
18	0.5 PU	1589	Fuel Level Sensor Signal (LY7)	18	0.5 PU	1589	Fuel Level Sensor Signal (LY7)
	0.5 BN	9001	High Speed GMLAN Serial Data Bus- (LY7)		0.5 BN	9001	High Speed GMLAN Serial Data Bus- (LY7)
	0.5 L-BU	1984	Transmission Turbine Speed Switch Low Reference (M32)		0.5 L-BU	1984	Transmission Turbine Speed Switch Low Reference (M32)
19	0.5 BN	1271	Low Reference (LY7)	19	0.5 BN	1271	Low Reference (LY7)
	0.5 WH/BU	20	Stop Lamp Switch Signal (LY7)		0.5 WH/BU	20	Stop Lamp Switch Signal (LY7)
20	0.5 BU/WH	1161	APP Sensor 1 Signal (LY7)	20	0.5 BU/WH	1161	APP Sensor 1 Signal (LY7)
	0.5 BN	2391	HO2S Heater Low Control (Bank 1 Sensor 2) (without LY7)		0.5 BN	2391	HO2S Heater Low Control (Bank 1 Sensor 2) (without LY7)
21	0.5 WH/BK	1164	5-Volt Reference (LY7)	21	0.5 WH/BK	1164	5-Volt Reference (LY7)
	0.5 PU	1670	HO2S High Signal (Bank 2 Sensor 2) (without LY7)		0.5 PU	1670	HO2S High Signal (Bank 2 Sensor 2) (without LY7)
22	0.5 L-BU	1162	APP Sensor 2 Signal (LY7)	22	0.5 L-BU	1162	APP Sensor 2 Signal (LY7)
	0.5 BN/WH	1671	HO2S Low Signal (Bank 2 Sensor 2) (without LY7)		0.5 BN/WH	1671	HO2S Low Signal (Bank 2 Sensor 2) (without LY7)
23	0.5 BN/YE	1274	5-Volt Reference (LY7)	23	0.5 BN/YE	1274	5-Volt Reference (LY7)
	0.5 BN/BK	9000	High Speed GMLAN Serial Data Bus+ (LY7)		0.5 BN/BK	9000	High Speed GMLAN Serial Data Bus+ (LY7)
	0.5 OG	1983	Transmission Turbine Speed Switch Signal (M32)		0.5 OG	1983	Transmission Turbine Speed Switch Signal (M32)
24	0.5 PU	1272	Low Reference (LY7)	24	0.5 PU	1272	Low Reference (LY7)
	0.5 PU/WH	1668	HO2S High Signal (Bank 1 Sensor 2) (without LY7)		0.5 PU/WH	1668	HO2S High Signal (Bank 1 Sensor 2) (without LY7)
25	0.5 BN/WH	419	MIL Control (LY7)	25	0.5 BN/WH	419	MIL Control (LY7)
	0.5 BN/WH	1669	HO2S Low Signal (Bank 1 Sensor 2) (without LY7)		0.5 BN/WH	1669	HO2S Low Signal (Bank 1 Sensor 2) (without LY7)

26	0.5 OG/BK	1228	PC Solenoid Valve High Control (M82)	26	0.5 OG/BK	1228	PC Solenoid Valve High Control (M82)
	0.5 D-GN		Clutch Start/Neutral Start (LY7)		0.5 D-GN		Clutch Start/Neutral Start (LY7)
	0.5 BN/RD	472	IAT Sensor Signal (without LY7)		0.5 BN/RD	472	IAT Sensor Signal (without LY7)
27	0.5 L-BU/WH	1229	PC Solenoid Valve Low Control (M82)	27	0.5 L-BU/WH	1229	PC Solenoid Valve Low Control (M82)
	0.5 BN/WH		Cruise Control Disable Clutch Switch Signal (LY7)		0.5 BN/WH		Cruise Control Disable Clutch Switch Signal (LY7)
	0.5 YE	492	MAF Sensor Signal (without LY7)		0.5 YE	492	MAF Sensor Signal (without LY7)
28	0.5 PU/WH	401	OSS High Signal (M30)	28	0.5 PU/WH	401	OSS High Signal (M30)
	0.5 PU/WH	401	VSS High Signal (M82)		0.5 PU/WH	401	VSS High Signal (M82)
	0.5 OG/BK	380	A/C Refrigerant Pressure Sensor Signal (without LY7)		0.5 OG/BK	380	A/C Refrigerant Pressure Sensor Signal (without LY7)
29	0.5 PK	1224	Transmission Fluid Pressure Switch Signal A (M30)	29	0.5 PK	1224	Transmission Fluid Pressure Switch Signal A (M30)
	0.5 GY	1688	5-Volt Reference (without LY7)		0.5 GY	1688	5-Volt Reference (without LY7)
30	0.5 WH/BU	17	Stop Lamp Supply Voltage (M82)	30	0.5 WH/BU	17	Stop Lamp Supply Voltage (M82)
	0.5 BN/OG	422	TCC Solenoid Valve Control (M30)		0.5 BN/OG	422	TCC Solenoid Valve Control (M30)
	0.5 PK	439	Ignition 1 Voltage (without LY7)		0.5 PK	439	Ignition 1 Voltage (without LY7)
31	0.5 YE/BK	1227	TFT Sensor Signal (M30 or M82)	31	0.5 YE/BK	1227	TFT Sensor Signal (M30 or M82)
	0.5 BN/WH	2760	Low Reference (without LY7)		0.5 BN/WH	2760	Low Reference (without LY7)
32	0.5 L-BU	1984	Transmission Turbine Speed Switch Low Reference (M30 or M82)	32	0.5 L-BU	1984	Transmission Turbine Speed Switch Low Reference (M30 or M82)
	0.5 L-GN	5007	Backup Lamp Switch Signal (without LY7)		0.5 L-GN	5007	Backup Lamp Switch Signal (without LY7)
	0.5 PK	1224	Transmission Fluid Pressure Switch Signal A (M32)		0.5 PK	1224	Transmission Fluid Pressure Switch Signal A (M32)
33	0.5 L-GN/BK	401	OSS Low Signal (M30)	33	0.5 L-GN/BK	401	OSS Low Signal (M30)
	0.5 L-GN/BK	401	VSS Low Signal (M82)		0.5 L-GN/BK	401	VSS Low Signal (M82)

	0.5 BN/GN	2759	Low Reference (without LY7)		0.5 BN/GN	2759	Low Reference (without LY7)
34	0.5 WH	898	Shift Solenoid C Valve Control (M82)	34	0.5 WH	898	Shift Solenoid C Valve Control (M82)
	0.5 WH/GN	687	2-3 Shift Solenoid Valve Control (M30 or M32)		0.5 WH/GN	687	2-3 Shift Solenoid Valve Control (M30 or M32)
35	0.5 YE/BK	1223	Shift Solenoid B Valve Control (M30 or M32 or M82)	35	0.5 YE/BK	1223	Shift Solenoid B Valve Control (M30 or M32 or M82)
36	0.5 L-GN	1222	Shift Solenoid A Valve Control (M30 or M32 or M82)	36	0.5 L-GN	1222	Shift Solenoid A Valve Control (M30 or M32 or M82)
37	0.5 OG	1983	Transmission Turbine Speed Switch Signal (M30 or M82)	37	0.5 OG	1983	Transmission Turbine Speed Switch Signal (M30 or M82)
	0.5 BN/OG	422	TCC Solenoid Valve Control (M32)		0.5 BN/OG	422	TCC Solenoid Valve Control (M32)
38	0.5 WH	776	Transmission Range Switch Signal P (M30 or M32 or M82)	38	0.5 WH	776	Transmission Range Switch Signal P (M30 or M32 or M82)
39	0.5 GY	773	Transmission Range Switch Signal C (M30 or M32 or M82)	39	0.5 GY	773	Transmission Range Switch Signal C (M30 or M32 or M82)
40	0.5 YE	772	Transmission Range Switch Signal B (M30 or M32 or M82)	40	0.5 YE	772	Transmission Range Switch Signal B (M30 or M32 or M82)
41	0.5 BN/YE	771	Transmission Range Switch Signal A (M30 or M32 or M82)	41	0.5 BN/YE	771	Transmission Range Switch Signal A (M30 or M32 or M82)
42	0.5 BN	418	TCC PWM Solenoid Valve Control (M30 or M32 or M82)	42	0.5 BN	418	TCC PWM Solenoid Valve Control (M30 or M32 or M82)

X103 Forward Lamp Harness to the Engine Harness





Connector Part Information

- OEM: 7283-1081-30
- Service: See Catalog
- Description: 8-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe:See Terminal Repair Kit

Connector Part Information

- OEM: 7282-1081-30
- Service: See Catalog
- Description: 8-Way M

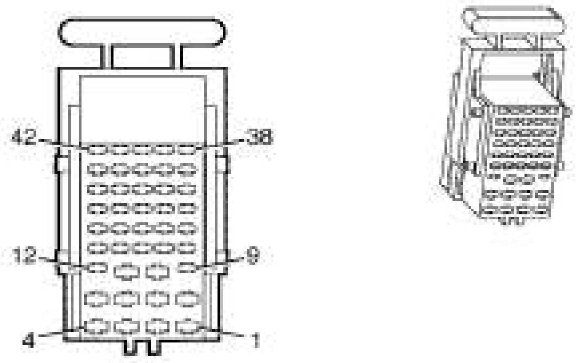
Terminal Part Information

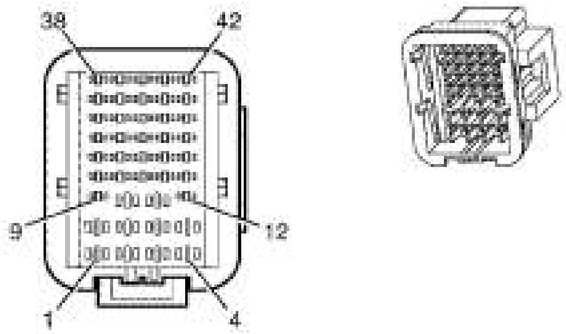
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X103 Forward Lamp Harness to the Engine Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1-2	--	--	Not Used	1-2	--	--	Not Used
3	0.5 YE/BK	1227	TFT Sensor Signal	3	0.5 YE/BK	1227	TFT Sensor Signal
4	0.5 OG/BK	1228	PC Solenoid Valve High Control	4	0.5 OG/BK	1228	PC Solenoid Valve High Control
5-6	--	--	Not Used	5-6	--	--	Not Used
7	0.5 BN/WH	2762	Low Reference	7	0.5 BN/WH	2762	Low Reference
8	0.5 L-BU/WH	1229	PC Solenoid Valve Low Control	8	0.5 L-BU/WH	1229	PC Solenoid Valve Low Control

X104 Front Body Harness to I/P Harness





Connector Part Information

- OEM: 7283-9911-30
- Service: See Catalog
- Description: 42-way F (BK)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7282-0680-30
- Service: See Catalog
- Description: 42-Way M (BK)

Terminal Part Information

- Pins: 3-5, 11
- Terminal/Tray: 1-962915-3/15
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12093647/J-35616-5 (PU)

- Pins: 9-10, 12-30, 32-35, 38-42
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

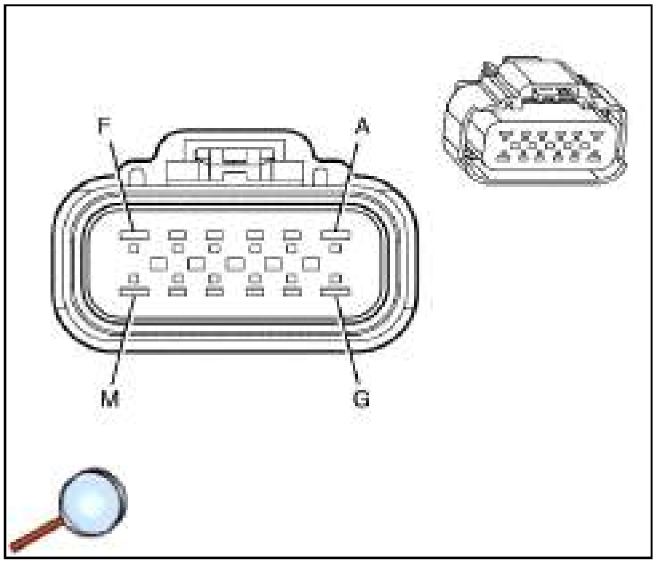
X104 Front Body Harness to I/P Harness

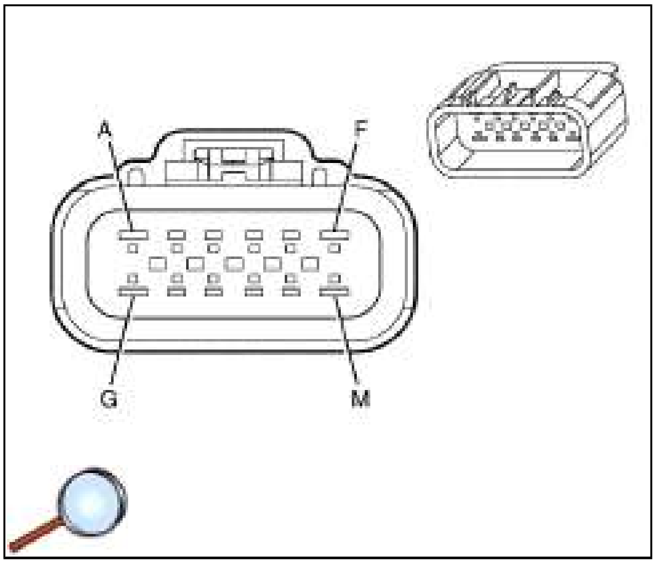
Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1-2	--	--	Not Used	1-2	--	--	Not Used
3	0.5 D-BU	7393	A/C Compressor Clutch Low Reference	3	0.5 D-BU	9357	A/C Compressor Clutch Low Reference
4	0.5 D-GN	7392	A/C Compressor Clutch Supply Voltage	4	0.5 D-GN	9358	A/C Compressor Clutch Supply Voltage
5	0.5 PK/BU	1339	Ignition 1 Voltage	5	0.5 PK/BU	1339	Ignition 1 Voltage
6	--	--	Not Used	6	--	--	Not Used
7	0.5 OG/BK		Park/Neutral Signal (without LY7)	7	0.5 OG/BK		Park/Neutral Signal (without LY7)
	0.5 D-GN		Clutch Start/Neutral Start (LY7)		0.5 OG/BK		Clutch Start/Neutral Start (LY7)
8	0.5 BN/WH		Cruise Control Disable Clutch Switch Signal	8	0.5 BN/WH		Cruise Control Disable Clutch Switch Signal
9	0.3 BN/YE	1969	Headlamp High Beam Relay Control	9	0.3 BN/YE	1969	Headlamp High Beam Relay Control
10	0.5 L-BU	1162	APP Sensor 2 Signal	10	0.5 L-BU	1162	APP Sensor 2 Signal
11	0.75 OG/GN	2240	Battery Positive Voltage	11	0.75 OG/GN	9359	Battery Positive Voltage
12	0.3 WH/YE	1080	Park Lamp Relay Control	12	0.3 WH/YE	1080	Park Lamp Relay Control
13	0.3 PK/WH	1970	Headlamp Low Beam Relay Control	13	0.3 PK/WH	1970	Headlamp Low Beam Relay Control
14	0.5 D-GN/WH	465	Fuel Pump Relay Control	14	0.3 D-GN/WH	465	Fuel Pump Relay Control

15	0.3 D-GN	646	Reverse Relay Control	15	0.3 D-GN	646	Reverse Relay Control
16	0.3 PU	5531	Hood Closed Switch Signal	16	0.3 PU	5531	Hood Closed Switch Signal
17	0.3 BN/BK	28	Horn Relay Control	17	0.3 BN/BK	28	Horn Relay Control
18	0.3 PK/BK	109	Hood Ajar Switch Signal	18	0.3 PK/BK	109	Hood Ajar Switch Signal
19	0.3 PU/WH	5727	Communication Enable Relay Control	19	0.3 PU/WH	5727	Communication Enable Relay Control
20	0.3 GY	91	Windshield Wiper Switch Signal 2	20	0.3 GY	91	Windshield Wiper Switch Signal 2
21	0.3 BN/WH	33	Brake Warning Indicator Control	21	0.3 BN/WH	33	Brake Warning Indicator Control
22	0.3 YE	196	Windshield Wiper Motor Park Switch Signal	22	YE	0.3 196	Windshield Wiper Motor Park Switch Signal
23	0.3 BN/RD	860	Front Windshield Wiper Switch High Signal	23	0.3 BN/RD	860	Front Windshield Wiper Switch High Signal
24	0.3 D-BU	5985	Accessory Wakeup Serial Data	24	0.3 D-BU	5985	Accessory Wakeup Serial Data
25	0.3 PK	1439	Ignition 1 Voltage	25	0.3 PK	1439	Ignition 1 Voltage
26	0.3 WH/BU	193	Rear Defog Relay Control	26	0.3 WH/BU	9356	Rear Defog Relay Control
27	0.5 BN	9005	High Speed GMLAN Serial Data Bus-	27	0.5 BN	9005	High Speed GMLAN Serial Data Bus-
28	0.5 BN/WH	419	MIL Control	28	0.3 BN/WH	419	MIL Control
29	0.5 OG	2268	Washer Fluid Pump Relay Control	29	0.5 OG	2268	Washer Fluid Pump Relay Control
30	0.5 L-BU/WH	1314	Left Front Turn Signal Lamp Supply Voltage	30	0.75 L-BU/WH	1314	Left Front Turn Signal Lamp Supply Voltage
31	--	--	Not Used	31	--	--	Not Used
32	0.5 BN/BK	9004	High Speed GMLAN Serial Data Bus+	32	0.5 BN/BK	9004	High Speed GMLAN Serial Data Bus+
33	0.5 D-BU/WH	1315	Right Front Turn Signal Lamp Supply Voltage	33	0.75 D-BU/WH	1315	Right Front Turn Signal Lamp Supply Voltage
34	0.5 WH/BU	17	Stop Lamp Switch Signal	34	0.5 WH/BU	17	Stop Lamp Switch Signal
35	0.5 BN/YE	1274	5-Volt Reference	35	0.5 BN/YE	1274	5-Volt Reference
36-37	--	--	Not Used	36-37	--	--	Not Used
38	0.5 PU	1272	Low Reference	38	0.5 PU	1272	Low Reference
	0.5 D-				0.5 D-		

39	BU/WH	1161	APP Sensor 1 Signal	39	BU/WH	1161	APP Sensor 1 Signal
40	0.5 WH/BK	1164	5-Volt Reference	40	0.5 WH/BK	1164	5-Volt Reference
41	0.5 BN	1271	Low Reference	41	0.5 BN	1271	Low Reference
42	--	--	Not Used	42	--	--	Not Used

X106 Forward Lamp Harness to the Front Body Harness





Connector Part Information

- OEM: 7283-6865-30
- Service: See Catalog
- Description: 12-Way F (BK)

Terminal Part Information

- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Connector Part Information

- OEM: 7282-6865-30
- Service: See Catalog
- Description: 12-Way M (BK)

Terminal Part Information

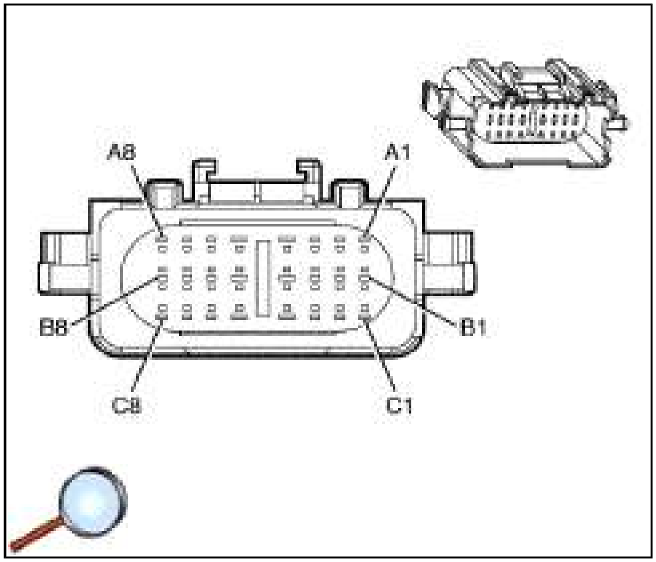
- Terminal/Tray: 15326269/19
- Core/Insulation Crimp: E/4
- Release Tool/Test Probe: 15315247/J-35616-3 (GY)

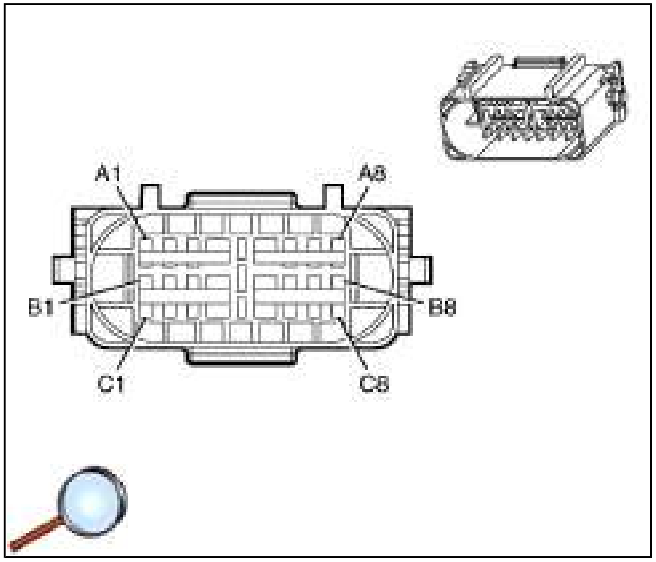
X106 Forward Lamp Harness to the Front Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
A	--	--	Not Used	A	--	--	Not Used
B	0.5 BK	350	Ground	B	0.5 BK	350	Ground
C	--	--	Not Used	C	--	--	Not Used
D	0.3 D-GN	1409	Discriminating Sensor - Signal	D	0.3 D-GN	1409	Discriminating Sensor - Signal
E	0.3 GY	5600	Discriminating Sensor - Low Reference	E	0.3 GY	5600	Discriminating Sensor - Low Reference

F-G	--	--	Not Used	F-G	--	--	Not Used
H	0.3 YE	354	Discriminating Sensor - Signal	H	0.3 YE	354	Discriminating Sensor - Signal
J	0.3 BN/YE	5045	Discriminating Sensor - Low Reference	J	0.3 BN/YE	5045	Discriminating Sensor - Low Reference
K	0.3 BN	61	Low Reference	K	0.3 BN	61	Low Reference
L	0.3 L-GN/BK	735	Ambient Air Temperature Sensor Signal	L	0.3 L-GN/BK	735	Ambient Air Temperature Sensor Signal
M	-	-	Not Used	M	-	-	Not Used

X107 Forward Lamp Harness to the Front Compartment Harness





Connector Part Information

- OEM: 15366099
- Service: See Catalog
- Description: 24-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 15336173
- Service: See Catalog
- Description: 24-Way M

Terminal Part Information

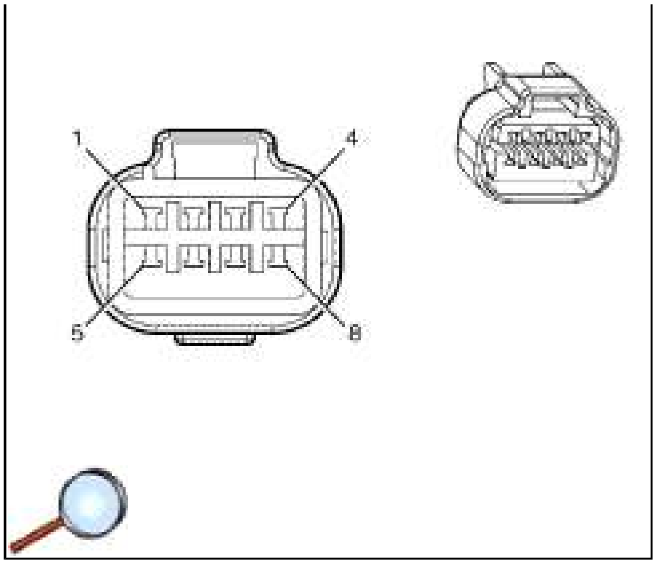
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

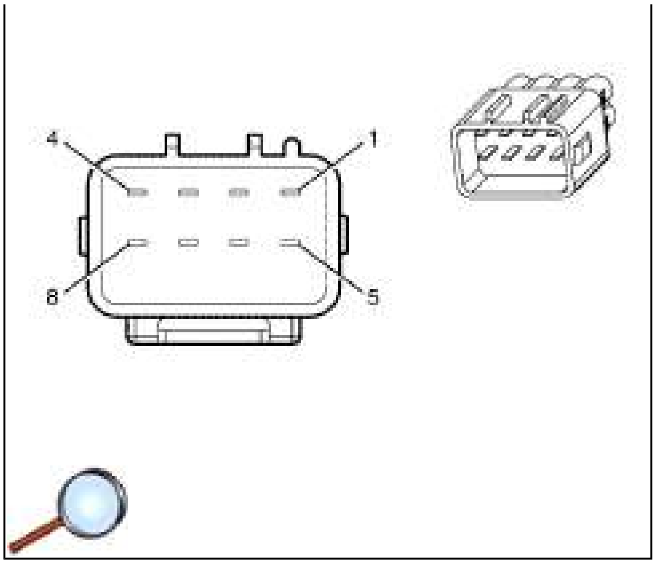
X107 Forward Lamp Harness to the Front Compartment Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
A1	0.3 YE	354	Discriminating Sensor - Signal	A1	0.3 YE	354	Discriminating Sensor - Signal

A2	0.3 BN/YE	5045	Discriminating Sensor - Low Reference	A2	0.3 BN/YE	5045	Discriminating Sensor - Low Reference
A3	0.3 BN	6102	Low Reference	A3	0.3 BN	6102	Low Reference
A4	2 BN/WH	5724	Washer Pump Relay Supply Voltage	A4	2 BN/WH	5724	Washer Pump Relay Supply Voltage
A5	--	--	Not Used	A5	--	--	Not Used
A6	0.3 L-GN/BK	735	Ambient Air Temperature Sensor Signal	A6	0.3 L-GN/BK	735	Ambient Air Temperature Sensor Signal
A7	0.3 D-GN	1409	Discriminating Sensor - Signal	A7	0.3 D-GN	1409	Discriminating Sensor - Signal
A8	0.5 GY	5600	Discriminating Sensor - Low Reference	A8	0.5 GY	5600	Discriminating Sensor - Low Reference
B1	0.3 YE/BK	5176	LH Headlamp Leveling Motor (+)	B1	0.3 YE/BK	5176	LH Headlamp Leveling Motor (+)
B2	0.5 PU/WH	5178	LH Headlamp Leveling Motor Signal (+)	B2	0.5 PU/WH	5178	LH Headlamp Leveling Motor Signal (+)
B3	0.5 BN/WH	5180	RH Headlamp Leveling Motor (+)	B3	0.5 BN/WH	5180	RH Headlamp Leveling Motor (+)
B4-B5	--	--	Not Used	B4-B5	--	--	Not Used
B6	0.5 OG/BK	5177	LH Headlamp Leveling Motor (-)	B6	0.5 OG/BK	5177	LH Headlamp Leveling Motor (-)
B7	0.5 GY	5179	LH Headlamp Leveling Motor Signal (-)	B7	0.5 GY	5179	LH Headlamp Leveling Motor Signal (-)
B8	0.5 PK/BK	5181	RH Headlamp Leveling Motor (-)	B8	0.5 PK/BK	5181	RH Headlamp Leveling Motor (-)
C1	--	--	Not Used	C1	--	--	Not Used
C2	0.5 OG/WH	5182	RH Headlamp Leveling Motor Signal (+)	C2	0.5 OG/WH	5182	RH Headlamp Leveling Motor Signal (+)
C3	--	--	Not Used	C3	--	--	Not Used
C4	1.25 BK	350	Ground	C4	1.25 BK	350	Ground
C5-C6	--	--	Not Used	C5-C6	--	--	Not Used
C7	0.5 GY/BK	5183	RH Headlamp Leveling Motor Signal (-)	C7	0.5 GY/BK	5183	RH Headlamp Leveling Motor Signal (-)
C8	--	--	Not Used	C8	--	--	Not Used

X108 Fog Lamp Harness to the Front Body Harness





Connector Part Information

- OEM: 7283-1081-30
- Service: See Catalog
- Description: 8-Way F 090 II Series (BK)

Terminal Part Information

- Terminal/Tray: 7116-4026/11
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 15313892/J-35616-18 (BK)

Connector Part Information

- OEM: 7282-1081-30
- Service: See Catalog
- Description: 8-Way M 090 II Series Sealed (BK)

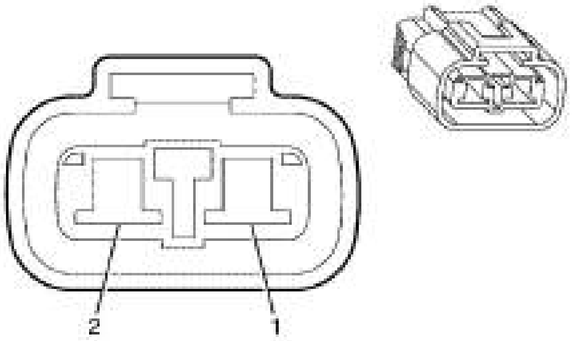
Terminal Part Information

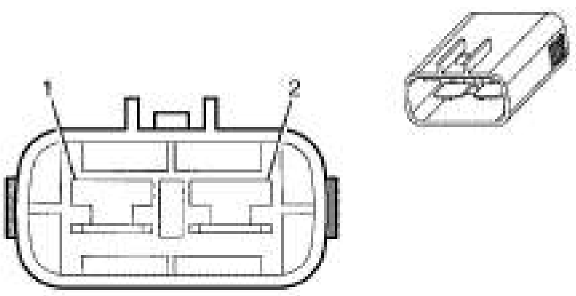
- Terminal/Tray: 7114-4026/11
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

X108 Fog Lamp Harness to the Front Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.3 BN	6581	Object Sensor Supply Voltage	1	0.3 BN	6581	Object Sensor Supply Voltage
2	0.3 PU/WH	5215	LF Corner Object Sensor Signal	2	0.3 PU/WH	5215	LF Corner Object Sensor Signal
3	0.3 PU/BK	5218	RF Middle Object Sensor Signal	3	0.3 PU/BK	5218	RF Middle Object Sensor Signal
4	0.75 PU	34	Fog Lamps Supply Voltage	4	0.75 PU	34	Fog Lamps Supply Voltage
5	0.3 OG/BK	5214	Object Sensor Low Reference	5	0.3 OG/BK	5214	Object Sensor Low Reference
6	0.3 WH	5216	LF Middle Object Sensor Signal	6	0.3 WH	5216	LF Middle Object Sensor Signal
7	0.3 BN/WH	5217	RF Corner Object Sensor Signal	7	0.3 BN/WH	5217	RF Corner Object Sensor Signal
8	0.75 BK	350	Ground	8	0.75 BK	350	Ground

X110 Engine Harness to the Front Body Harness





Connector Part Information

- OEM: 7283-3036-10
- Service: See Catalog
- Description: 2-Way F (GY)

Terminal Part Information

- Terminal/Tray: 7116-4112-02/9
- Core/Insulation Crimp: C/D
- Release Tool/Test Probe: 12094430/J-35616-35 (VT)

Connector Part Information

- OEM: 7182-7519-10
- Service: See Catalog
- Description: 2-Way M (GY)

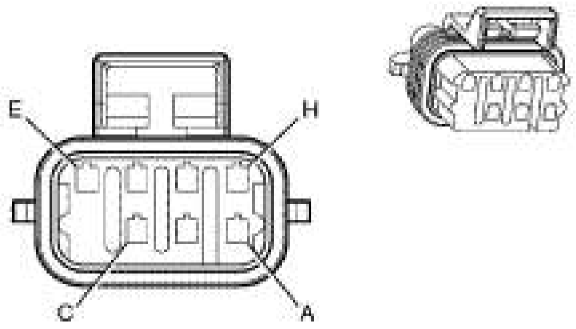
Terminal Part Information

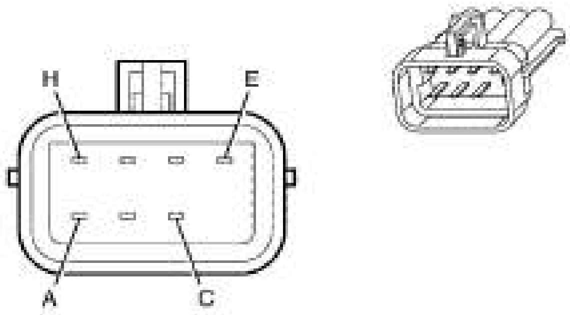
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X110 Engine Harness to the Front Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	2 RD/BK	142	Battery Positive Voltage	1	2 RD/BK	142	Battery Positive Voltage
2	3 OG	3540	Battery Positive Voltage	2	3 OG	3540	Battery Positive Voltage

X112 Engine Harness to the Ignition Coil Harness (L98)





Connector Part Information

- OEM: 7129-3170
- Service: 12102754
- Description: 7-Way F

Terminal Part Information

- Terminal/Tray: 12048074/2
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Connector Part Information

- OEM: 12047933
- Service: 12047933
- Description: 7-Way M Metri-Pack 150 Series (GY)

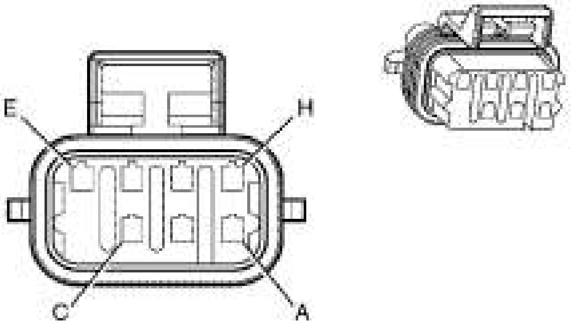
Terminal Part Information

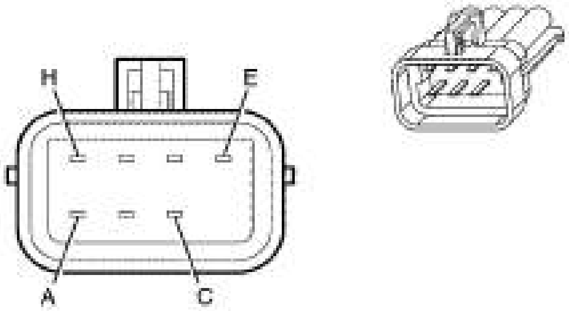
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X112 Engine Harness to the Ignition Coil Harness (L98)

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
A	0.75 BK	450	Ground	A	0.8 BK	151	Ground
B	0.5 OG/WH	2122	Ignition Control 2	B	0.5 OG/WH	2127	Ignition Control 2
C	0.5 D-GN/WH	2124	Ignition Control 4	C	0.5 D-GN/WH	2125	Ignition Control 4
E	0.5 BN/WH	2130	Low Reference	E	0.5 BN/WH	2129	Low Reference
F	0.5 L-BU/WH	2126	Ignition Control 6	F	0.5 L-BU/WH	2123	Ignition Control 6
G	0.5 PU/WH	2128	Ignition Control 8	G	0.5 PU/WH	2121	Ignition Control 8
H	0.75 PK	5292	Ignition 1 Voltage	H	0.8 PK/BK	39	Ignition 1 Voltage

X113 Engine Harness to the Ignition Coil Harness (L98)





Connector Part Information

- OEM: 7129-3170
- Service: 12102754
- Description: 7-Way F

Terminal Part Information

- Terminal/Tray: 12048074/2
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Connector Part Information

- OEM: 12047933
- Service: 12047933
- Description: 7-Way M Metri-Pack 150 Series (GY)

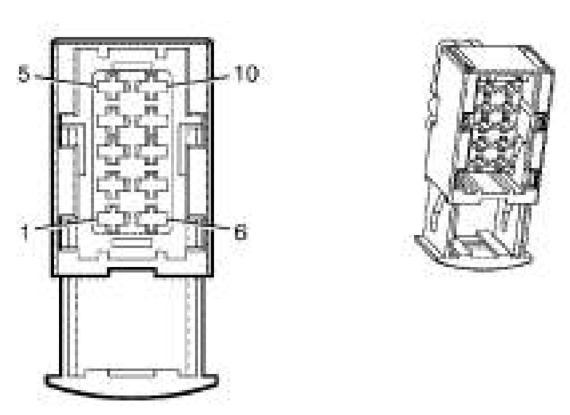
Terminal Part Information

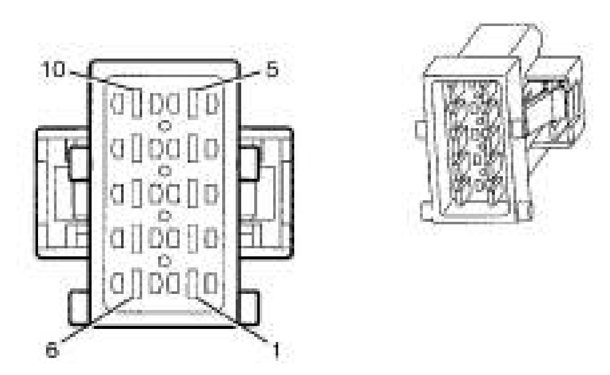
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X113 Engine Harness to the Ignition Coil Harness (L98)

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
A	0.75 BK	2450	Ground	A	0.8 BK	151	Ground
B	0.5 OG	2127	Ignition Control 7	B	0.5 OG	2127	Ignition Control 7
C	0.5 D-GN/RD	2125	Ignition Control 5	C	0.5 D-GN	2125	Ignition Control 5
E	0.5 BN	2129	Low Reference	E	0.5 BN	2129	Low Reference
F	0.5 L-BU	2123	Ignition Control 3	F	0.5 L-BU	2123	Ignition Control 3
G	0.5 PU	2121	Ignition Control 1	G	0.5 PU	2121	Ignition Control 1
H	0.75 PK/BK	5291	Ignition 1 Voltage	H	0.8 PK/BK	39	Ignition 1 Voltage

X114 Engine Harness to the Fuel Injector Harness (LY7)





Connector Part Information

- OEM: 7283-7109-30
- Service: See Catalog
- Description: 10-Way F (BK)

Terminal Part Information

- Pins: 3-8
- Terminal/Tray: 4-964286-1/16
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12093647/J-35616-4A (PU)

- Pins: 1, 2
- Terminal/Tray: 4-964273-1/15
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12093647/J-35616-4A (PU)

Connector Part Information

- OEM: 1-962352-1
- Service: See Catalog
- Description: 10-Way M Junior Power Timer Series, Sealed (BK)

Terminal Part Information

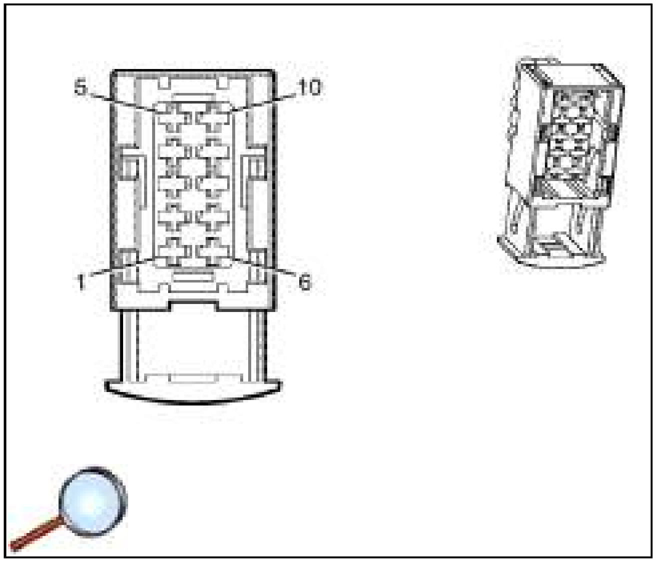
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

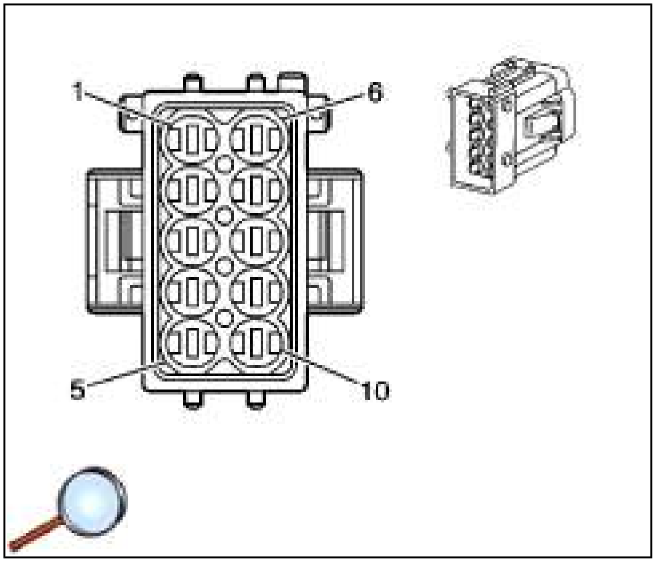
X114 Engine Harness to the Fuel Injector Harness (LY7)

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	1.25 PK/BU	5291	Ignition 1 Voltage	1	1.25 PK/BU	5291	Ignition 1 Voltage
2	1.25 PK	5292	Ignition 1 Voltage	2	1.25 PK	5292	Ignition 1 Voltage
3	0.75 BN/BK	1744	Fuel Injector 1 Control	3	0.8 BN/BK	1744	Fuel Injector 1 Control
4	0.75 PK/BK	1746	Fuel Injector 3 Control	4	0.8 PK/BK	1746	Fuel Injector 3 Control
5	0.75 BN/WH	845	Fuel Injector 5 Control	5	0.8 BN/WH	845	Fuel Injector 5 Control
	0.75 L-		Fuel Injector 2		0.8 L-		Fuel Injector 2

6	GN/BK	1745	Control	6	GN/BK	1745	Control
7	0.75 L-BU/BK	844	Fuel Injector 4 Control	7	0.8 L-BU/BK	844	Fuel Injector 4 Control
8	0.75 YE/BK	846	Fuel Injector 6 Control	8	0.8 YE/BK	846	Fuel Injector 6 Control
9-10	--	--	Not Used	9-10	--	--	Not Used

X115 Forward Lamp Harness to the Left Headlamp





Connector Part Information

- OEM: 7283-7109-30
- Service: See Catalog
- Description: 10-Way F (BK)

Terminal Part Information

- Terminal/Tray: 4-964286-1/16
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12093647/J-35616-4A (PU)

Connector Part Information

- OEM: 1-962352-1
- Service: Non Serviceable
- Description: 10-Way M (BK)

Terminal Part Information

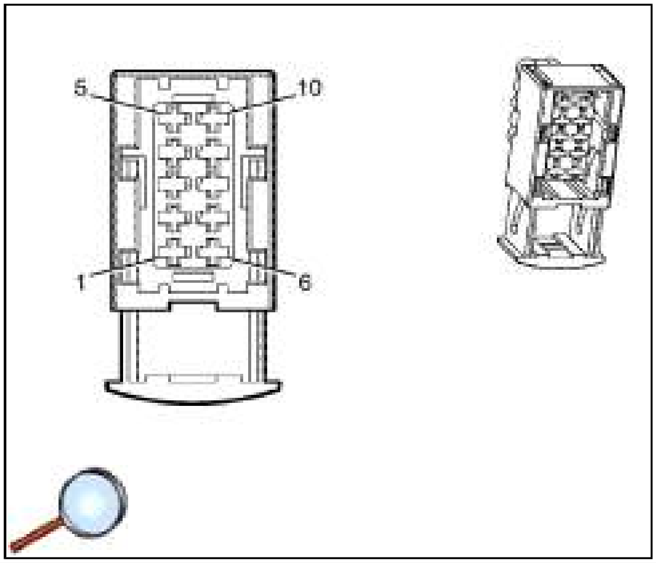
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

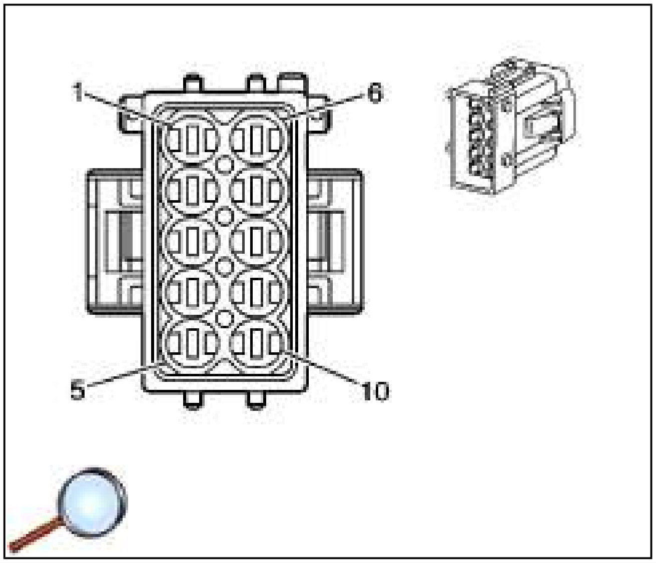
X115 Forward Lamp Harness to the Left Headlamp

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.5 BK	250	Ground	1	0.5 BK/WH	250	Ground
2	0.5 BK	350	Ground	2	0.5 TN	350	Ground
3	0.5 BK	250	Ground	3	0.5 BK	250	Ground
4-5	--	--	Not Used	4-5	--	--	Not Used

6	0.5 PU	709	Left Park Lamp Supply Voltage	6	0.5 L-GN	709	Left Park Lamp Supply Voltage
7	0.5 YE	712	Left Headlamp Low Beam Supply Voltage	7	0.5 TN	712	Left Headlamp Low Beam Supply Voltage
8	0.5 D-GN/WH	711	Left Headlamp High Beam Supply Voltage	8	0.5 BK	711	Left Headlamp High Beam Supply Voltage
9	0.5 L-BU/WH	1314	Left Front Turn Signal Lamp Supply Voltage	9	0.5 RD	1314	Left Front Turn Signal Lamp Supply Voltage
10	--	--	Not Used	10	--	--	Not Used

X116 Forward Lamp Harness to the Right Headlamp





Connector Part Information

- OEM: 7283-7109-30
- Service: See Catalog
- Description: 10-Way F (BK)

Terminal Part Information

- Terminal/Tray: 4-964286-1/16
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12093647/J-35616-4A (PU)

Connector Part Information

- OEM: 1-962352-1
- Service: Non Serviceable
- Description: 10-Way M (BK)

Terminal Part Information

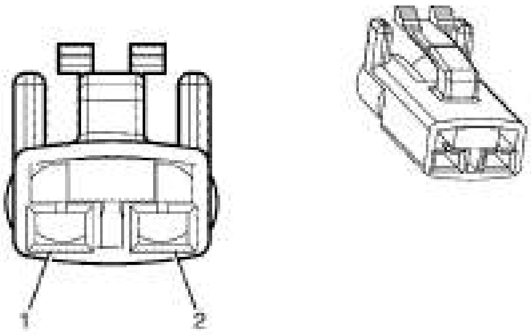
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

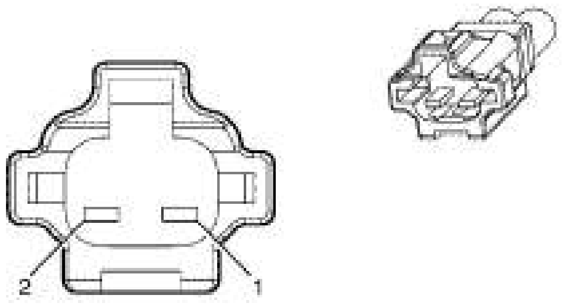
X116 Forward Lamp Harness to the Right Headlamp

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.5 BK	250	Ground	1	0.5 BK/WH	250	Ground
2	0.5 BK	350	Ground	2	0.5 TN	350	Ground

3	0.5 BK	250	Ground	3	0.5 BK	250	Ground
4-5	--	--	Not Used	4-5	--	--	Not Used
6	0.5 BN/WH	309	Right Park Lamp Supply Voltage	6	0.5 L-GN	309	Right Park Lamp Supply Voltage
7	0.5 BN/BK	312	Right Headlamp Low Beam Supply Voltage	7	0.5 TN	312	Right Headlamp Low Beam Supply Voltage
8	0.5 L-GN/BK	311	Right Headlamp High Beam Supply Voltage	8	0.5 BK	311	Right Headlamp High Beam Supply Voltage
9	0.5 D-BU/WH	1315	Right Front Turn Signal Lamp Supply Voltage	9	0.5 RD	1315	Right Front Turn Signal Lamp Supply Voltage
10	--	--	Not Used	10	--	--	Not Used

X160 Left Front Wheel Speed Sensor Harness to the Front Body Harness





Connector Part Information

- OEM: 7283-7420-40
- Service: See Catalog
- Description: 2-Way F (GY)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7282-7420-40
- Service: See Catalog
- Description: 2-Way M 090 II Series Sealed (GY)

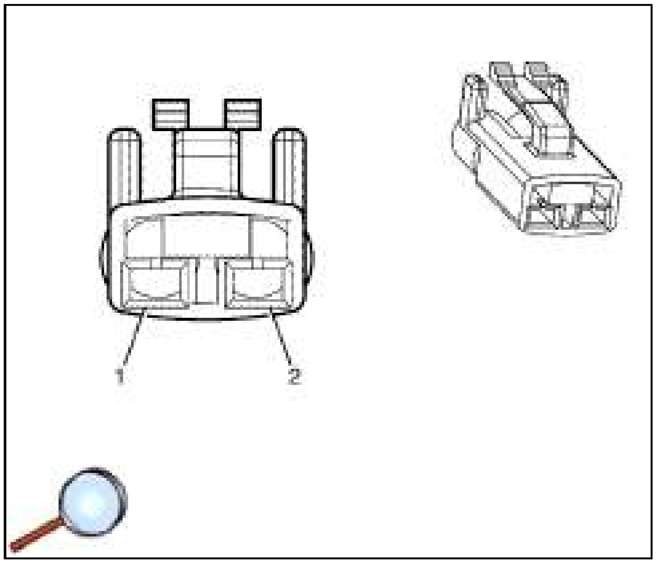
Terminal Part Information

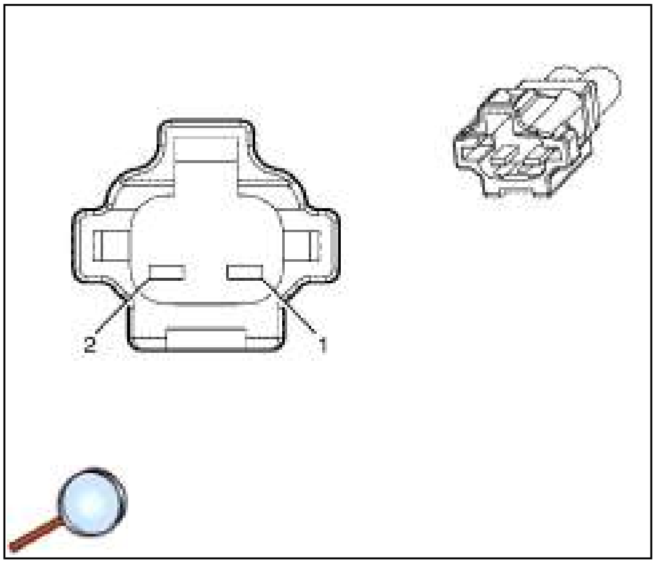
- Terminal/Tray: 7114-4025/11
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

X160 Left Front Wheel Speed Sensor Harness to the Front Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.75 BN	830	Left Front Wheel Speed Sensor Signal	1	0.5 L-BU	830	Left Front Wheel Speed Sensor Signal
2	0.75 BK	7064	Left Front Wheel Speed Sensor Supply Voltage	2	0.5 GY	7064	Left Front Wheel Speed Sensor Supply Voltage

X161 Right Front Wheel Speed Sensor Harness to the Front Body Harness





Connector Part Information

- OEM: 7283-7029-40
- Service: See Catalog
- Description: 2-Way F 090 II Series (GY)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7282-7420-40
- Service: See Catalog
- Description: 2-Way M 090 II Series Sealed (GY)

Terminal Part Information

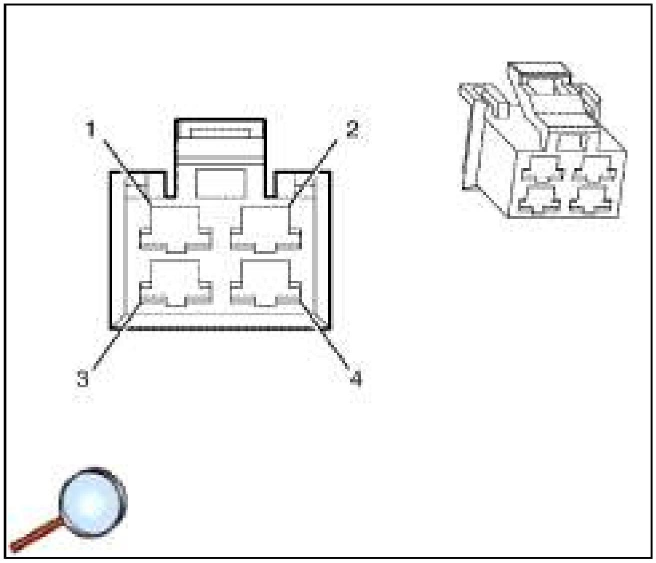
- Terminal/Tray: 7114-4025/11
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

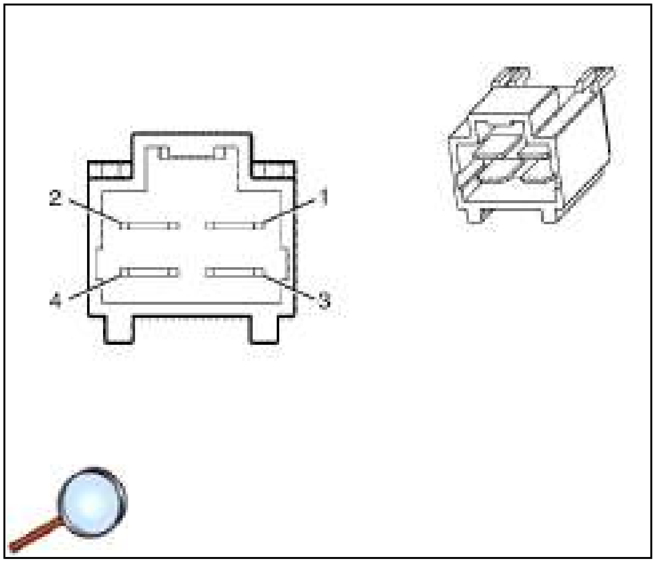
X161 Right Front Wheel Speed Sensor Harness to the Front Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.75 BN	872	Right Front Wheel Speed Sensor Signal	1	0.5 D-GN	872	Right Front Wheel Speed Sensor Signal
			Right Front Wheel				Right Front Wheel

2	0.75 BK	7065	Speed Sensor Supply Voltage	2	0.5 GY	7065	Speed Sensor Supply Voltage

X162 Forward Lamp Harness to the Cooling Fan Assembly





Connector Part Information

- OEM: 7123-6244-40
- Service: See Catalog
- Description: 4-Way F 58 X-Type Sealed (GY)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7222-6244-40
- Service: See Catalog
- Description: 4-Way M (GY)

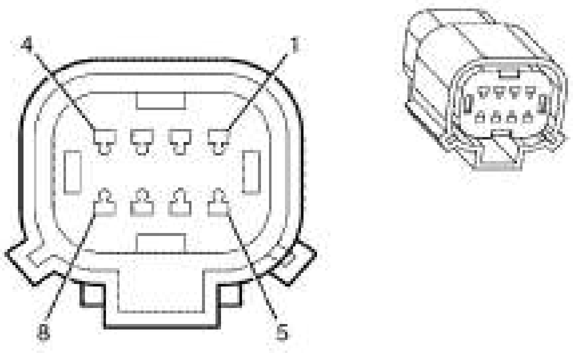
Terminal Part Information

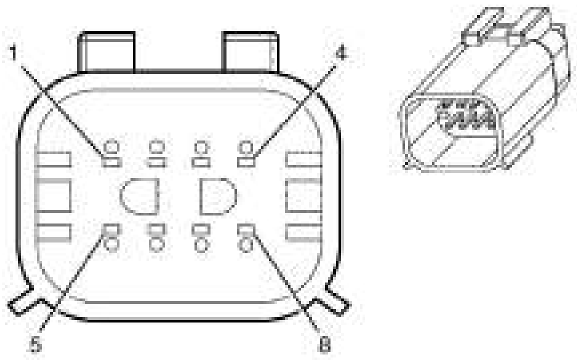
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X162 Forward Lamp Harness to the Cooling Fan Assembly

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	3 D-BU	409	Left Cooling Fan Motor Supply Voltage	1	3 L-BU	409	Left Cooling Fan Motor Supply Voltage
2	3 BK	250	Ground	2	3 BK	250	Ground
3	3 WH	504	Right Cooling Fan Motor Low Reference	3	3 WH	504	Right Cooling Fan Motor Low Reference
4	3 GY	532	Right Cooling Fan Motor Supply Voltage	4	3 GY	532	Right Cooling Fan Motor Supply Voltage

X165 Front Body Harness to the I / P Harness





Connector Part Information

- OEM: 7283-4258-30
- Service: See Catalog
- Description: 8-Way F (BK)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7282-4256-30
- Service: See Catalog
- Description: 8-Way M (BK)

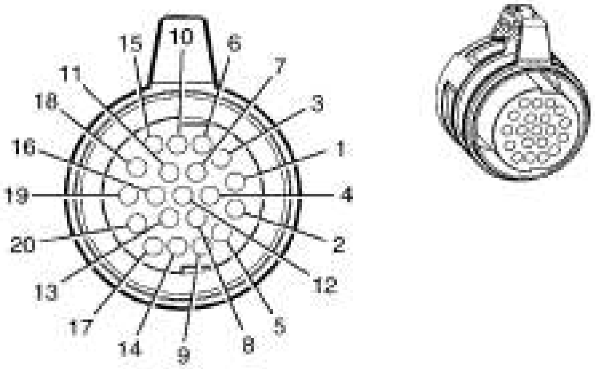
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X165 Front Body Harness to the I/P Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.5 L-BU	5986	Communication Enable Relay Supply Voltage	1	0.5 L-BU	5986	Communication Enable Relay Supply Voltage
2	0.5 BK/BU	2088	Low Reference	2	0.5 BK/BU	2088	Low Reference
3	--	--	Not Used	3	--	--	Not Used
4	0.5 BN	185	Low Washer Fluid Indicator Control	4	0.5 BN	185	Low Washer Fluid Indicator Control
5	--	--	Not Used	5	--	--	Not Used
6	0.5 WH	2282	Headlamp Washer Relay Control	6	0.5 WH	2282	Headlamp Washer Relay Control
7	0.3 BN	61	Low Reference	7	0.3 BN	61	Low Reference
8	0.3 L-GN/BK	735	Ambient Air Temperature Sensor Signal	8	0.3 L-GN/BK	735	Ambient Air Temperature Sensor Signal

X175 Engine Harness to the Automatic Transmission (M82)



Connector Part Information

- OEM: 7229-2575-30
- Service: See Catalog
- Description: 20-Way F (BK)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 9432001
- Service: See Catalog
- Description: 20-Way M (BK)

Terminal Part Information

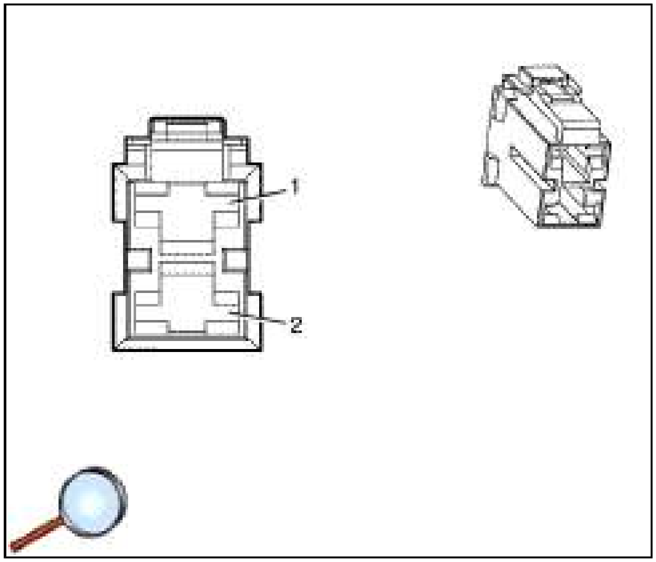
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

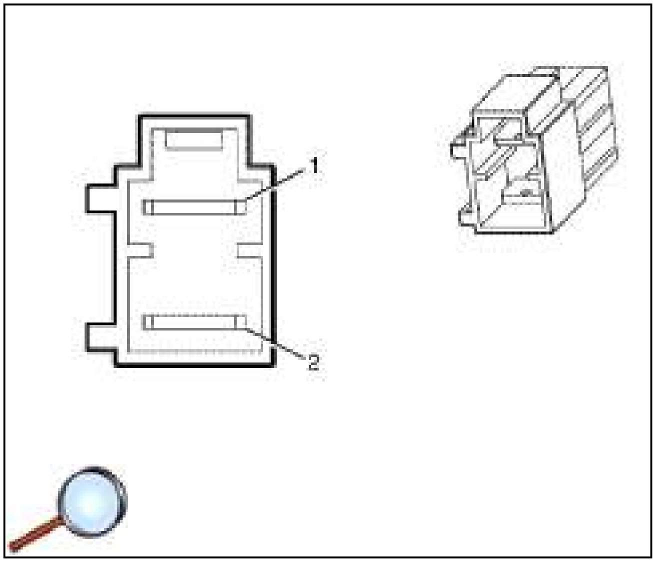
X175 Engine Harness to the Automatic Transmission (M82)

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.5 L-GN/BK	822	VSS Low Signal	1	0.5 OG	822	VSS Low Signal
2	0.5 OG/BK	1786	Park/Neutral Signal	2	0.5 BN	1786	Park/Neutral Signal
3	0.5 PU/WH	821	VSS High Signal	3	0.5 WH	821	VSS High Signal
4	0.5 BK	450	Ground	4	0.5 D-GN	450	Ground
5	0.5 WH	898	Shift Solenoid C Valve Control	5	0.5 GY	898	Shift Solenoid C Valve Control
6	0.5 BN/WH	2762	Low Reference	6	0.5 WH	2762	Low Reference
7	0.5 YE	772	Transmission Range Switch Signal B	7	0.5 BK	772	Transmission Range Switch Signal B
8	0.5 L-BU/WH	1229	PC Solenoid Valve Low Control	8	0.5 WH	1229	PC Solenoid Valve Low Control
	0.5		Shift Solenoid B Valve		0.5 D-		Shift Solenoid B Valve

9	YE/BK	1223	Control	9	BU	1223	Control
10	0.5 YE/BK	1227	TFT Sensor Signal	10	0.5 RD	1227	TFT Sensor Signal
11	0.5 WH	776	Transmission Range Switch Signal P	11	0.5 GY	776	Transmission Range Switch Signal P
12	--	--	Not Used	12	--	--	Not Used
13	0.5 OG/BK	1228	PC Solenoid Valve High Control	13	0.5 D-GN	1228	PC Solenoid Valve High Control
14	0.5 L-GN	1222	Shift Solenoid A Valve Control	14	0.5 BK	1222	Shift Solenoid A Valve Control
15	0.5 L-BU	1984	Transmission Turbine Speed Switch Low Reference	15	0.5 WH	1984	Transmission Turbine Speed Switch Low Reference
16	0.5 BN/YE	771	Transmission Range Switch Signal A	16	0.5 RD	771	Transmission Range Switch Signal A
17	0.5 OG	1525	Clutch Pressure Control Solenoid Valve 1 High Control	17	0.5 WH	1525	Clutch Pressure Control Solenoid Valve 1 High Control
18	0.5 OG	1983	Transmission Turbine Speed Switch Signal	18	0.5 YE	1983	Transmission Turbine Speed Switch Signal
19	0.5 GY	773	Transmission Range Switch Signal C	19	0.5 D-BU	773	Transmission Range Switch Signal C
20	0.5 BN	418	TCC PWM Solenoid Valve Control	20	0.5 YE	418	TCC PWM Solenoid Valve Control

X200 I/P Harness to the Front Body Harness





Connector Part Information

- OEM: 7123-4123-30
- Service: 88953301

Connector Part Information

- OEM: 7122-4123-30
- Service: See Catalog

- Description: 2-Way F L Type (BK)

Terminal Part Information

- Terminal/Tray: 7116-3250/10
- Core/Insulation Crimp: G/3
- Release Tool/Test Probe: 12094430/J-35616-22 (RD)

- Description: 2-Way M (BK)

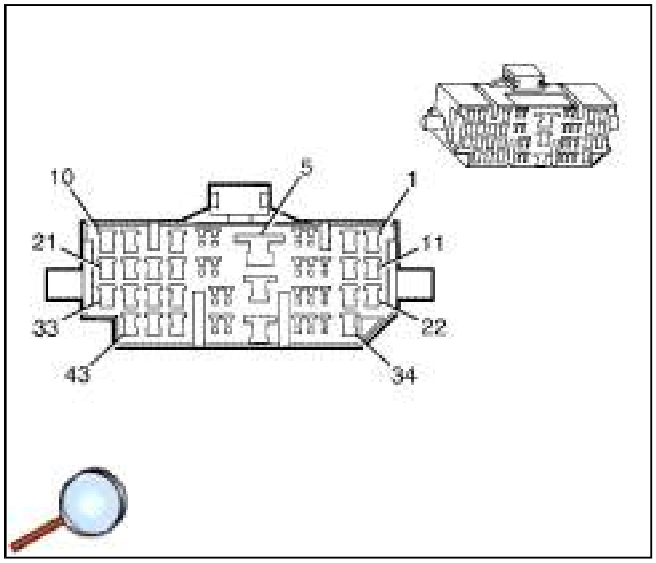
Terminal Part Information

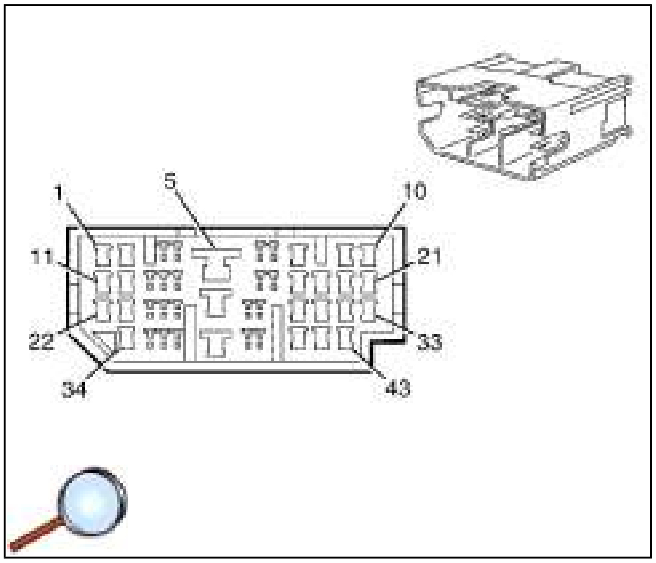
- Terminal/Tray: 7114-3250/14
- Core/Insulation Crimp: G/3
- Release Tool/Test Probe: 12094430/J-35616-21 (RD)

X200 I/P Harness to the Front Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	5 RD	9320	Battery Positive Voltage	1	5 RD	242	Battery Positive Voltage
2	5 RD/BK	9371	Battery Positive Voltage	2	5 RD/BK	642	Battery Positive Voltage

X201 I/P Harness to the Front Body Harness





Connector Part Information

- OEM: 7283-1734
- Service: See Catalog
- Description: 43-Way F (WH)

Terminal Part Information

- Pins: 3, 4, 6, 7, 13-15, 17, 18, 27, 29, 30, 36-40
- Terminal/Tray: 7116-4231-08/14
- Core/Insulation Crimp: K/K
- Release Tool/Test Probe: 15315247/J-35616-64B (L-BU)

- Pins: 8, 19-26, 31, 33, 34

Connector Part Information

- OEM: 7282-1734
- Service: See Catalog
- Description: 43-Way M (WH)

Terminal Part Information

- Pins: 3, 4, 6, 7, 13-15, 17, 18, 25-30, 36-40
- Terminal/Tray: 7114-4231-08/14
- Core/Insulation Crimp: K/K
- Release Tool/Test Probe: 15315247/J-35616-65B (L-BU)

- Pins: 8, 19-24, 31, 33, 34

- Terminal/Tray: 7116-4020/11
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

- Pin: 10
- Terminal/Tray: 7116-4021/11
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 12094430/J-35616-40 (BU)

- Pin: 16
- Terminal/Tray: 7116-4031/11
- Core/Insulation Crimp: C/A
- Release Tool/Test Probe: 12094430/J-35616-40 (BU)

- Pins: 32, 41-43
- Terminal/Tray: 7116-4021/11
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

- Terminal/Tray: 7114-4020/10
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pin: 10
- Terminal/Tray: 7114-4021/10
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pin: 16
- Terminal/Tray: 7114-4031/11
- Core/Insulation Crimp: C/A
- Release Tool/Test Probe: 12094430/J-35616-41 (BU)

- Pins: 32, 41-43
- Terminal/Tray: 7114-4021/10
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

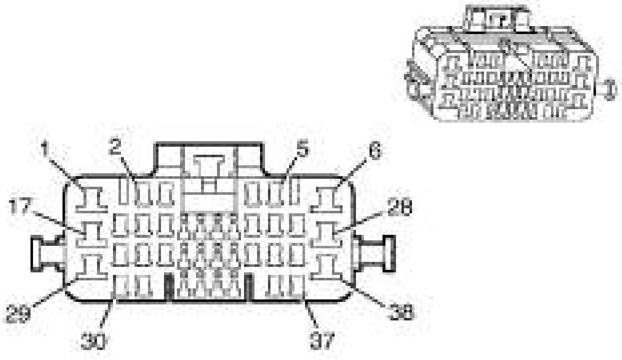
X201 I/P Harness to the Front Body Harness

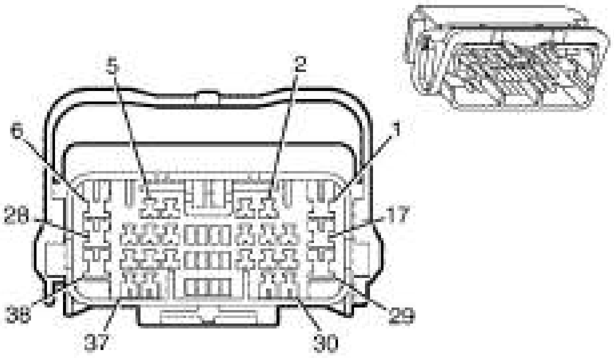
Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1-2	--	--	Not Used	1-2	--	--	Not Used
3	0.5 BN/BU	1946	Right Rear Speaker Output (-)	3	0.5 BN/BU	1946	Right Rear Speaker Output (-)
4	0.5 D-BU	658	Right Rear Speaker Output (+)	4	0.5 D-BU	658	Right Rear Speaker Output (+)
5	--	--	Not Used	5	--	--	Not Used
6	0.3 GY/BK	746	Right Front Door Ajar Switch Signal	6	0.3 GY/BK	746	Right Front Door Ajar Switch Signal
7	--	--	Not Used	7	--	--	Not Used
8	0.85 BN	5998	Puddle Lamp Supply Voltage	8	0.85 BN	5998	Puddle Lamp Supply Voltage
9	--	--	Not Used	9	--	--	Not Used
10	1.25 BN/RD	694	Driver Door Lock Actuator Unlock Control	10	1.25 BN/RD	694	Driver Door Lock Actuator Unlock Control
11	0.85 L-BU	1960	Front Center Speaker Output (-)	11	0.85 L-BU	1960	Front Center Speaker Output (-)
12	0.85 YE	1860	Front Center Speaker Output (+)	12	0.85 YE	1860	Front Center Speaker Output (+)
13	0.5 BN	1999	Left Rear Speaker Output (-)	13	0.5 BN	1999	Left Rear Speaker Output (-)
14	0.5 BN/WH	599	Left Rear Speaker Output (+)	14	0.5 BN/WH	599	Left Rear Speaker Output (+)

15	0.5 OG/BK	744	Rear Compartment Lid Ajar Switch Signal	15	0.5 OG/BK	744	Rear Compartment Lid Ajar Switch Signal
16	--	--	Not Used	16	--	--	Not Used
17	0.5 OG/BK	1134	Park Brake Switch Signal	17	0.5 OG/BK	1134	Park Brake Switch Signal
18	0.5 L-BU	223	Communication Enable Relay Supply Voltage	18	0.5 L-BU	223	Communication Enable Relay Supply Voltage
19	--	--	Not Used	19	--	--	Not Used
20	0.5 L-BU	115	Right Rear Speaker Output (-)	20	0.5 L-BU	115	Right Rear Speaker Output (-)
21	0.5 L-GN	115	Right Front Speaker Output (+)	21	0.5 L-GN	115	Right Front Speaker Output (+)
22	0.5 OG	200	Amplifier Mute Control	22	0.5 OG	200	Amplifier Mute Control
23	0.5 WH	6978	Amplifier Enable Signal	23	0.5 WH	6978	Amplifier Enable Signal
24	0.5 L-GN	1975	Right Front Speaker Output (-)	24	0.5 L-GN	1975	Right Front Speaker Output (-)
25	0.5 L-GN/WH	1875	Right Front Speaker Output (+)	25	0.5 L-GN/WH	1875	Right Front Speaker Output (+)
26	0.3 YE	391	Led Backlight Dimming Control	26	0.3 YE	391	Led Backlight Dimming Control
27	1.25 L-BU	17	Stop Lamp Supply Voltage	27	1.25 L-BU	17	Stop Lamp Supply Voltage
28	0.5 BK/BU	1540	Yaw Rate Low Reference	28	0.5 BK/BU	1540	Yaw Rate Low Reference
29	0.3 PK	2088	Driver Door Lock Switch Unlock Signal	29	0.3 PK	2088	Driver Door Lock Switch Unlock Signal
30	0.5 D-BU/WH	148	Courtesy Lamp Supply Voltage	30	0.5 D-BU/WH	148	Courtesy Lamp Supply Voltage
31	0.85 OG	149	Courtesy Lamps Supply Voltage	31	0.85 OG	149	Courtesy Lamps Supply Voltage
32	0.5 D-BU	1732	Right Rear Speaker Output (+)	32	0.5 D-BU	1732	Right Rear Speaker Output (+)
33	0.5 D-GN	46	Right Front Speaker Output (-)	33	0.5 D-GN	46	Right Front Speaker Output (-)
34	0.5 D-GN	117	Left Front Speaker Output (-)	34	0.5 D-GN	117	Left Front Speaker Output (-)
35	0.5 BN/OG	1947	Left Front Speaker Output (+)	35	0.5 BN/OG	1947	Left Front Speaker Output (+)
36	0.3 D-GN/WH	511	Fog Lamp Relay Control	36	0.3 D-GN/WH	511	Fog Lamp Relay Control
37	0.3 GY	8	Instrument Panel Lamp Supply Voltage	37	0.3 GY	8	Instrument Panel Lamp Supply Voltage
38	2 OG/BU	1317	Battery Positive Voltage	38	2 OG/BU	1317	Battery Positive Voltage

39	--	--	Not Used	39	--	--	Not Used
40	0.3 PK/BK	2514	Driver Door Lock Switch Lock Signal	40	0.3 PK/BK	2514	Driver Door Lock Switch Lock Signal
41	0.85 YE/BK	1334	Left Rear Turn Signal Lamp Supply Voltage	41	0.85 YE/BK	1334	Left Rear Turn Signal Lamp Supply Voltage
42	0.85 D-GN/WH	1335	Right Rear Turn Signal Lamp Supply Voltage	42	0.85 D-GN/WH	1335	Right Rear Turn Signal Lamp Supply Voltage
43	0.85 L-GN	24	Backup Lamp Supply Voltage	43	0.85 L-GN	24	Backup Lamp Supply Voltage

X202 I/P Harness to the Body Harness





Connector Part Information

- OEM: 7283-1684
- Service: See Catalog
- Description: 38-Way F 040 III Series (WH)

Terminal Part Information

- Pins: 1, 28
- Terminal/Tray: 7116-4032/11
- Core/Insulation Crimp: A/F
- Release Tool/Test Probe: 12094430/J-35616-40 (BU)

- Pins: 29, 38
- Terminal/Tray: 7116-4032/11
- Core/Insulation Crimp: 4/B
- Release Tool/Test Probe: 12094430/J-35616-40 (BU)

Connector Part Information

- OEM: 7282-1684
- Service: See Catalog
- Description: 38-Way M 040 III Series (WH)

Terminal Part Information

- Pins: 1, 28,
- Terminal/Tray: 7114-4032/11
- Core/Insulation Crimp: A/G
- Release Tool/Test Probe: 12094430/J-35616-41 (BU)

- Pins: 29, 38,
- Terminal/Tray: 7114-4032/11
- Core/Insulation Crimp: 4/B
- Release Tool/Test Probe: 12094430/J-35616-41 (BU)

- Pins: 2, 3, 8, 9, 14, 19, 30, 31, 36, 37
- Terminal/Tray: 7116-4020/11
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

- Pins: 4, 5, 7, 16, 18, 20, 26, 27
- Terminal/Tray: 7116-4021/11
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

- Pins: 6, 17
- Terminal/Tray: 7116-4031/11
- Core/Insulation Crimp: C/A
- Release Tool/Test Probe: 12094430/J-35616-40 (BU)

- Pins: 10-13, 21-24, 34, 35
- Terminal/Tray: 7116-4231-08/14
- Core/Insulation Crimp: K/K
- Release Tool/Test Probe: 15315247/J-35616-64B (L-BU)

- Pins: 2-5, 8, 9, 14, 19, 30, 31, 36, 37
- Terminal/Tray: 7114-4020/10
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pins: 6, 17
- Terminal/Tray: 7114-4031/11
- Core/Insulation Crimp: C/A
- Release Tool/Test Probe: 12094430/J-35616-41 (BU)

- Pins: 7, 16, 18, 20, 26, 27
- Terminal/Tray: 7114-4021/10
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pins: 10-13, 21-24, 34, 35
- Terminal/Tray: 7114-4231-08/14
- Core/Insulation Crimp: K/K
- Release Tool/Test Probe: 15315247/J-35616-65B (L-BU)

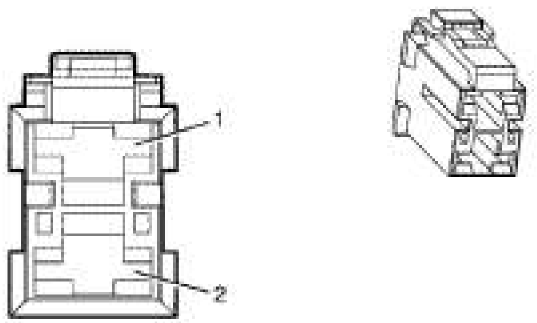
X202 I/P Harness to the Body Harness

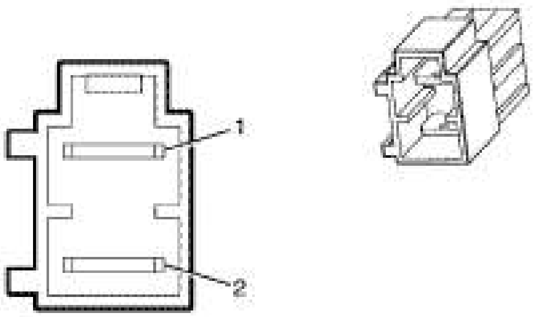
Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	3 OG/GN	2840	Battery Positive Voltage	1	3 OG/GN	2840	Battery Positive Voltage
2	0.5 BN	199	Left Rear Speaker Output (+)	2	0.5 BN	199	Left Rear Speaker Output (+)
3	0.5 YE/RD	116	Left Rear Speaker Output (-)	3	0.5 YE/RD	116	Left Rear Speaker Output (-)
4	0.5 BN	201	Left Front Speaker Output (+)	4	0.5 BN	201	Left Front Speaker Output (+)
5	0.5 GY	118	Left Front Speaker Output (-)	5	0.5 GY	118	Left Front Speaker Output (-)
	0.5 GY	118	Left Front Speaker Output (-)		0.5 GY	118	Left Front Speaker Output (-)
6	1.25 BN/WH	9301	Accessory Voltage	6	1.25 BN/WH	9301	Accessory Voltage
7	1.25 D-GN/WH	295	Door Lock Actuator Lock Control	7	1.25 D-GN/WH	295	Door Lock Actuator Lock Control
8	--	--	Not Used	8	--	--	Not Used
9	0.5 BN/BU	343	Accessory Voltage	9	0.5 BN/BU	343	Accessory Voltage
10	0.3 PK	5076	5-Volt Reference	10	0.3 PK	5076	5-Volt Reference
11	0.3 BN	5077	Low Reference	11	0.3 BN	5077	Low Reference
12	0.3	254	Power Door Unlock	12	0.3	254	Power Door Unlock

	BN/BK		Fuse Supply Voltage		BN/BK		Fuse Supply Voltage
13	0.5 BN/WH	746	Passenger Door Ajar Switch Control	13	0.5 BN/WH	746	Passenger Door Ajar Switch Control
14	0.3 OG/BU	2440	Battery Positive Voltage	14	0.3 OG/BU	2440	Battery Positive Voltage
15	0.5 OG/WH	2340	Battery Positive Voltage	15	0.5 OG/WH	2340	Battery Positive Voltage
16	1.25 BN/RD	294	Door Lock Actuator Unlock Control	16	1.25 BN/RD	294	Door Lock Actuator Unlock Control
17	1.25 BN/YE	143	Accessory Voltage	17	1.25 BN/YE	143	Accessory Voltage
18	1.25 OG/YE	4140	Battery Positive Voltage (KA1)	18	1.25 OG/YE	4140	Battery Positive Voltage (KA1)
19	--	--	Not Used	19	--	--	Not Used
20	0.85 BN/WH	56	Rear Compartment Lid Release Actuator	20	0.85 BN/WH	56	Rear Compartment Lid Release Actuator
21	0.3 WH/GN	5075	Battery Current Signal	21	0.3 WH/GN	5075	Battery Current Signal
22	--	--	Not Used	22	--	--	Not Used
23	0.5 OG/WH	1840	Battery Positive Voltage	23	0.5 OG/WH	1840	Battery Positive Voltage
24	0.3 BK	1850	Ground	24	0.3 BK	1850	Ground
25	0.85 OG/PU	2140	Battery Positive Voltage	25	0.85 OG/PU	2140	Battery Positive Voltage
26	0.85 OG/BU	4340	Battery Positive Voltage	26	0.85 OG/BU	4340	Battery Positive Voltage
27	--	--	Not Used	27	--	--	Not Used
28	3 GY	120	Fuel Pump Supply Voltage	28	3 GY	120	Fuel Pump Supply Voltage
29	2 OG	1140	Battery Positive Voltage	29	2 OG	1140	Battery Positive Voltage
30-31	--	--	Not Used	30-31	--	--	Not Used
32	0.3 BN	5852	Instrument Panel Lamp Supply Voltage	32	0.3 BN	5852	Instrument Panel Lamp Supply Voltage
33	0.3 GY	2555	Object Detection Disable Signal	33	0.3 GY	2555	Object Detection Disable Signal
34	0.35 D-GN	5060	Low Speed GMLAN Serial Data	34	0.35 D-GN	5060	Low Speed GMLAN Serial Data
35	0.3 GY/BK	255	Power Door Lock Fuse Supply Voltage	35	0.3 GY/BK	255	Power Door Lock Fuse Supply Voltage
36	0.5 D-GN	1301	Rap Fuse Supply Voltage	36	0.5 D-GN	1301	Rap Fuse Supply Voltage
37	0.5 OG/YE	1340	Battery Positive Voltage	37	0.5 OG/YE	1340	Battery Positive Voltage

38	2 D-GN	1001	Rap Fuse Supply Voltage	38	2 D-GN	1001	Rap Fuse Supply Voltage

X204 I/P Harness to the Front Body Harness





Connector Part Information

- OEM: 7123-4125-50
- Service: See Catalog
- Description: 2-Way F (RD)

Terminal Part Information

- Terminal/Tray: 7116-3250/10
- Core/Insulation Crimp: G/3
- Release Tool/Test Probe: 12094430/J-35616-22 (RD)

Connector Part Information

- OEM: 7122-4125-50
- Service: See Catalog
- Description: 2-Way M 58 L-Type (RD)

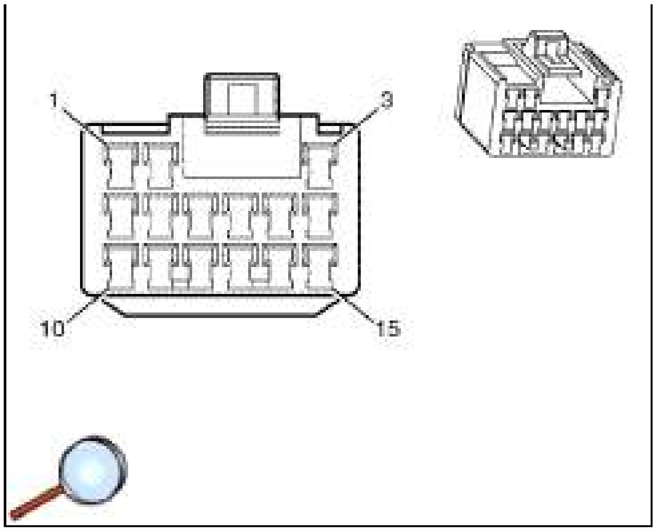
Terminal Part Information

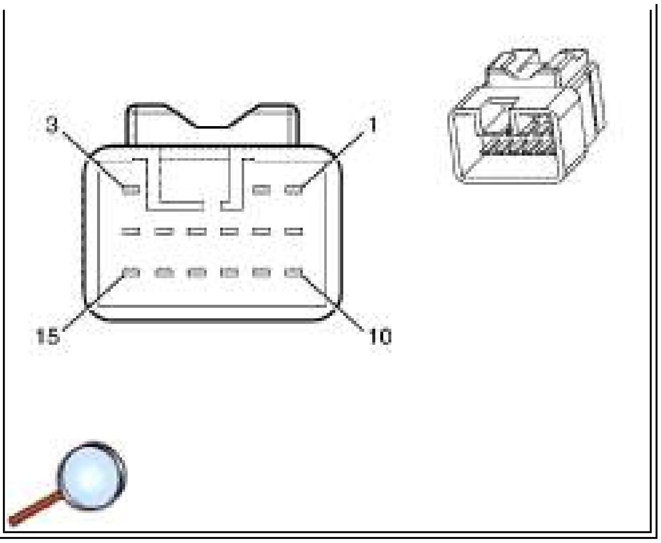
- Terminal/Tray: 7114-3250/14
- Core/Insulation Crimp: G/3
- Release Tool/Test Probe: 12094430/J-35616-21 (RD)

X204 I/P Harness to the Front Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	5 RD/WH	842	Battery Positive Voltage	1	5 RD/WH	842	Battery Positive Voltage
2	5 D-GN	442	Battery Positive Voltage	2	5 D-GN	442	Battery Positive Voltage

X205 Glove Box Assembly to the I/P Harness





Connector Part Information

- OEM: 7283-1150
- Service: See Catalog
- Description: 15-Way F 090 II Series (WH)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7282-1150
- Service: See Catalog
- Description: 15-way M (WH)

Terminal Part Information

- Pin: 3
- Terminal/Tray: 7114-4021/10
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

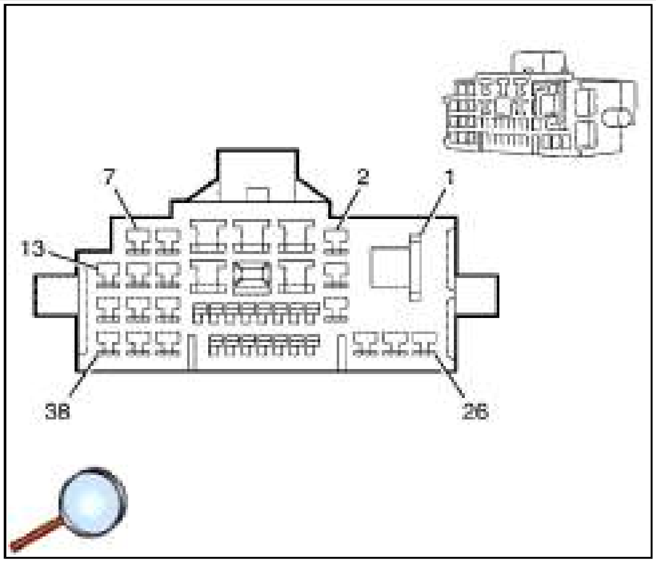
- Pin: 6
- Terminal/Tray: 7114-4020/10
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

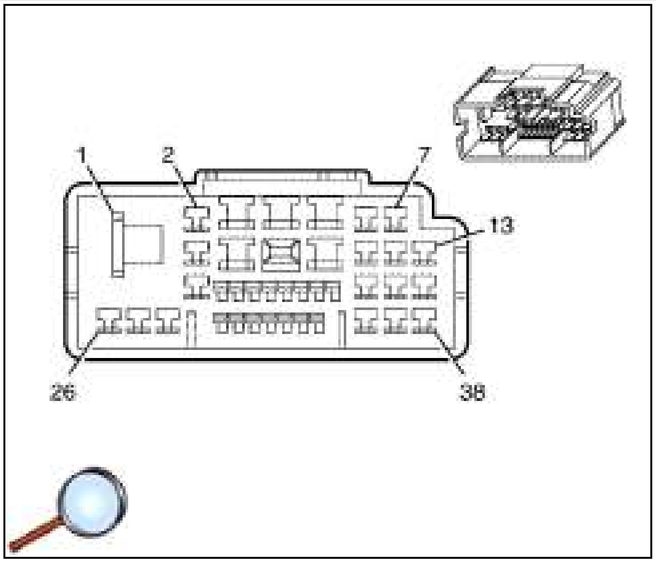
X205 Glove Box Assembly to the I/P Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.85 OG	9353	Courtesy Lamps Supply Voltage	1	0.85 OG	9353	Courtesy Lamps Supply Voltage
2	--	--	Not Used	2	--	--	Not Used
3	0.85 BK/WH	1450	Ground	3	0.85 BK	1450	Ground
4-5	--	--	Not Used	4-5	--	--	Not Used
6	0.3 D-BU	9345	Rear Compartment Lid Release Switch	6	0.3 D-BU	9345	Rear Compartment Lid Release Switch
7-9	--	--	Not Used	7-9	--	--	Not Used
10	0.5	2340	Battery Positive	10	0.5	2340	Battery Positive

	OG/WH		Voltage		OG/WH		Voltage
11	0.5 BK/WH	1050	Ground	11	0.5 BK	1050	Ground
12	0.5 L-GN	5060	Low Speed GMLAN Serial Data	12	0.5 D-GN	5060	Low Speed GMLAN Serial Data
13	0.3 PK/BK	2062	Navigation Mono Audio Signal (+)	13	0.3 PK/BK	2062	Navigation Mono Audio Signal (+)
14	0.3 OG/BK	2061	Navigation Mono Audio Signal (-)	14	0.3 OG/BK	2061	Navigation Mono Audio Signal (-)
15	--	--	Not Used	15	--	--	Not Used

X206 Front Body Harness to the Body Harness





Connector Part Information

- OEM: 7283-1683
- Service: See Catalog
- Description: 38-Way F (WH)

Terminal Part Information

- Pin: 1
- Terminal/Tray: 7116-3251/10
- Core/Insulation Crimp: F/3
- Release Tool/Test Probe: 12094430/J-35616-22 (RD)

- Pin: 3
- Terminal/Tray: 7116-4031/11
- Core/Insulation Crimp: C/A
- Release Tool/Test Probe: 12094430/J-35616-40 (BU)

Connector Part Information

- OEM: 7282-1683
- Service: See Catalog
- Description: 38-Way M (WH)

Terminal Part Information

- Pin: 1
- Terminal/Tray: 7114-3251/14
- Core/Insulation Crimp: F/3
- Release Tool/Test Probe: 12094430/J-35616-21 (RD)

- Pin: 3
- Terminal/Tray: 7114-4031/11
- Core/Insulation Crimp: C/A
- Release Tool/Test Probe: 12094430/J-35616-41 (BU)

- Pin: 5
- Terminal/Tray: 7116-4031/11
- Core/Insulation Crimp: C/E/A
- Release Tool/Test Probe: 12094430/J-35616-40 (BU)

- Pins: 6, 13, 23-25, 36-38
- Terminal/Tray: 7116-4020/11
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

- Pins: 7, 12, 28
- Terminal/Tray: 7116-4021/11
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

- Pins: 16-22, 31-35
- Terminal/Tray: 7116-4231-08/14
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-64B (L-BU)

- Pin: 5
- Terminal/Tray: 7114-4031/11
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 12094430/J-35616-41 (BU)

- Pins: 6, 13, 23-25, 36-38
- Terminal/Tray: 7114-4020/10
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pins: 7, 12, 28
- Terminal/Tray: 7114-4021/10
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pins: 16-18, 20-22, 31-35
- Terminal/Tray: 7114-4231-08/14
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-65B (L-BU)

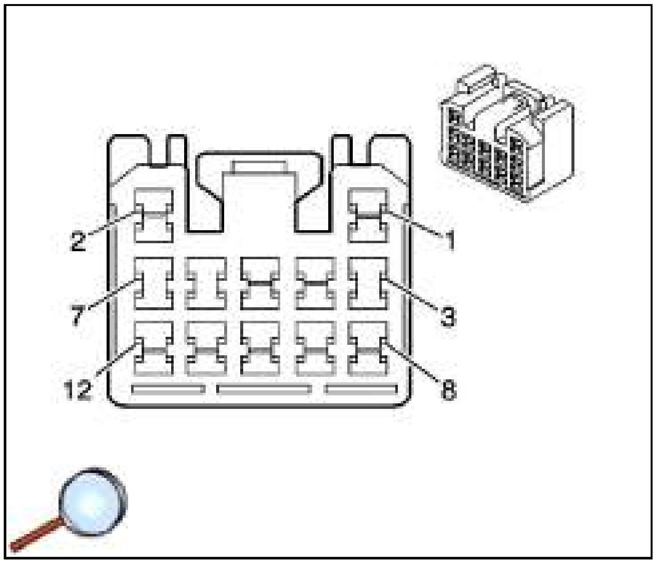
X206 Front Body Harness to the Body Harness

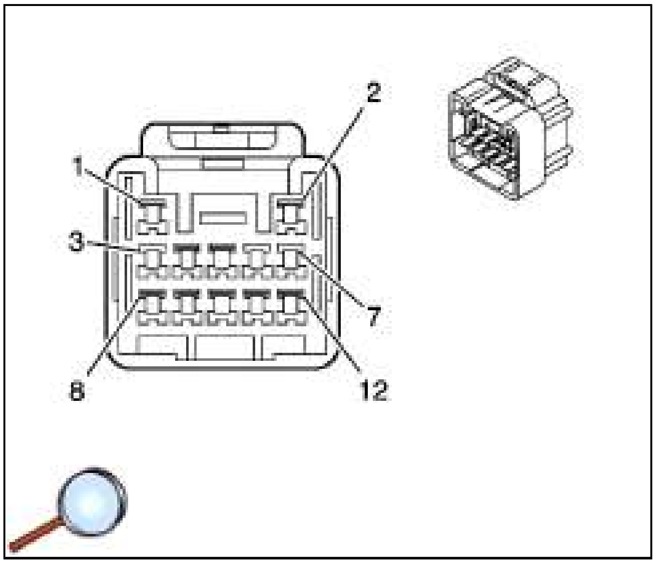
Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	3 PU	293	Rear Defog Element Supply Voltage	1	3 PU	293	Rear Defog Element Supply Voltage
2	0.3 BN	6581	Object Sensor Supply Voltage	2	0.3 BN	6581	Object Sensor Supply Voltage
3	0.85 L-GN	24	Backup Lamp Supply Voltage	3	0.85 L-GN	24	Backup Lamp Supply Voltage
4	--	--	Not Used	4-5	--	--	Not Used
6	0.3 L-BU	1937	Fuel Level Sensor	6	0.3 L-BU	1937	Fuel Level Sensor
7	0.85 BN/WH	309	Lamp Supply Voltage	7	0.85 BN/WH	309	Lamp Supply Voltage
8-11	0.3 OG/BK	5214	Object Sensor Low Reference	8	0.3 OG/BK	5214	Object Sensor Low Reference
8-11	--	--	Not Used	9-10	--	--	Not Used
8-11	0.3 OG/BK	5208	Headlamp Leveling Sensor Wire 2	11	0.3 OG/BK	5208	Headlamp Leveling Sensor Wire 2
12	0.85 PU	709	Left Park Lamp Supply Voltage	12	0.85 PU	709	Left Park Lamp Supply Voltage
13	0.5 PK/BU	339	Ignition 1 Voltage	13	0.5 PK/BU	339	Ignition 1 Voltage
14-15	0.3 PU/WH	5218	RF Middle Object Sensor Signal	14	0.3 PU/WH	5218	RF Middle Object Sensor Signal

14-15	0.3 BN/WH	5217	RF Corner Object Sensor Signal	15	0.3 BN/WH	5217	RF Corner Object Sensor Signal
16	--	--	Not Used	16	--	--	Not Used
17	0.5 BN/BK	884	Left Rear Wheel Speed Sensor Signal	17	0.5 BN/BK	884	Left Rear Wheel Speed Sensor Signal
18	0.5 GY	7128	Wheel Speed Sensor Supply Voltage Right Rear	18	0.5 GY	7128	Wheel Speed Sensor Supply Voltage Right Rear
19	0.3 BN/YE	452	Low Reference	19	0.3 BN/YE	452	Low Reference
20	0.3 GY	5600	Discriminating Sensor - Low Reference	20	0.3 GY	5600	Discriminating Sensor - Low Reference
21	0.3 YE	354	Discriminating Sensor - Signal	21	0.3 YE	354	Discriminating Sensor - Signal
22	0.3 D-GN/WH	1317	Fog Lamp Relay Control	22	0.3 D-GN/WH	1317	Fog Lamp Relay Control
23	0.5 BN/WH	2086	Yaw Rate Sensor Test Control	23	0.5 BN/WH	2086	Yaw Rate Sensor Test Control
24	--	--	Not Used	24-25	--	--	Not Used
26-27	0.3 L-GN/WH	5210	Headlamp Leveling Sensor Wire 3	26	0.3 L-GN/WH	5210	Headlamp Leveling Sensor Wire 3
26-27	0.3 L-GN/BK	5209	Headlamp Leveling Sensor Wire 1	27	0.3 L-GN/BK	5209	Headlamp Leveling Sensor Wire 1
28	0.85 OG/BK	540	Battery Positive Voltage	28	0.85 OG/BK	540	Battery Positive Voltage
29-30	0.3 WH	5216	LF Middle Object Sensor Signal	29	0.3 WH	5216	LF Middle Object Sensor Signal
29-30	0.3 PU/WH	5215	LF Corner Object Sensor Signal	30	0.3 PU/WH	5215	LF Corner Object Sensor Signal
31	0.5 GY	7127	Wheel Speed Sensor Supply Voltage Left Rear	31	0.5 GY	7127	Wheel Speed Sensor Supply Voltage Left Rear
32	0.5 BN	882	Right Rear Wheel Speed Sensor Signal	32	0.5 BN	882	Right Rear Wheel Speed Sensor Signal
33	0.3 PU	1589	Fuel Level Sensor Signal (Primary)	33	0.3 PU	1589	Fuel Level Sensor Signal (Primary)
34	0.3 D-GN	1409	Discriminating Sensor - Signal	34	0.3 D-GN	1409	Discriminating Sensor - Signal
35	0.3 BN/YE	5045	Discriminating Sensor - Low Reference	35	0.3 BN/YE	5045	Discriminating Sensor - Low Reference
36	0.5 D-GN	2087	Steering Wheel Position Sensor 5-V Reference	36	0.5 D-GN	2087	Steering Wheel Position Sensor 5-V Reference
37	0.5 L-GN/BK	5352	Yaw Rate Sensor Test Control	37	0.5 L-GN/BK	5352	Yaw Rate Sensor Test Control
38	0.5	1699	Combined Vehicle	38	0.5	1699	Combined Vehicle

	PU/WH		Inertial Sensor Signal		PU/WH		Inertial Sensor Signal

X207 I/P Harness to the Body Harness





Connector Part Information

- OEM: 7283-4325
- Service:See Catalog
- Description: 12-Way F (WH)

Terminal Part Information

- Terminal/Tray: 7116-4020/11
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

Connector Part Information

- OEM: 7282-4325
- Service: See Catalog
- Description: 12-Way M (WH)

Terminal Part Information

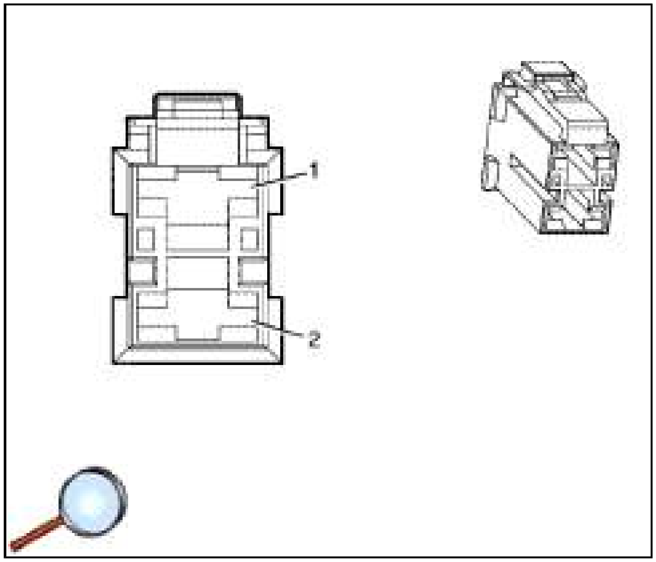
- Terminal/Tray: 7114-4020/10
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

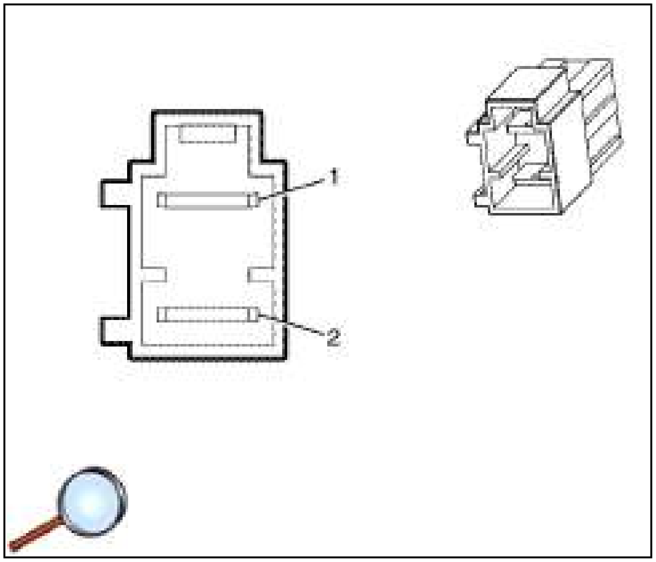
X207 I/P Harness to the Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.5 OG/WH	2340	Battery Positive Voltage	1	0.5 OG/WH	2340	Battery Positive Voltage
2	0.5 PK/BU	1339	Ignition 1 Voltage (KA1)	2	0.5 PK/BU	1339	Ignition 1 Voltage (KA1)
3	--	--	Not Used	3	--	--	Not Used
4	0.35 D-GN	5060	Low Speed GMLAN Serial Data	4	0.35 D-GN	5060	Low Speed GMLAN Serial Data
5	0.5 BK	1050	Ground	5	0.5 BK	1050	Ground
6-7	--	--	Not Used	6-7	--	--	Not Used
8	0.5 BN	372	Remote Radio Audio Output (-)	8	0.5 BN	372	Remote Radio Audio Output (-)
			Left Radio Audio				Left Radio Audio

9	0.5 D-GN	7007	Output	9	0.5 D-GN	7007	Output
10	0.35 BK	1573	Battery Positive Voltage	10	0.35 BK	1573	Battery Positive Voltage
11	0.5 GY	388	Remote Radio Right Audio Signal	11	0.5 GY	388	Remote Radio Right Audio Signal
12	0.5 GY	7008	Right Radio Audio Output	12	0.5 GY	7008	Right Radio Audio Output

X208





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 2-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe:See Terminal Repair Kit

Connector Part Information

- OEM:
- Service: See Catalog
- Description: 2-Way M

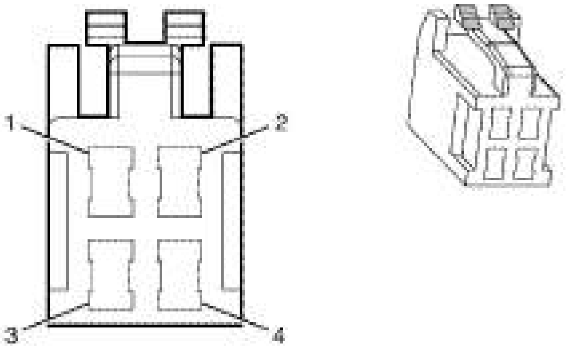
Terminal Part Information

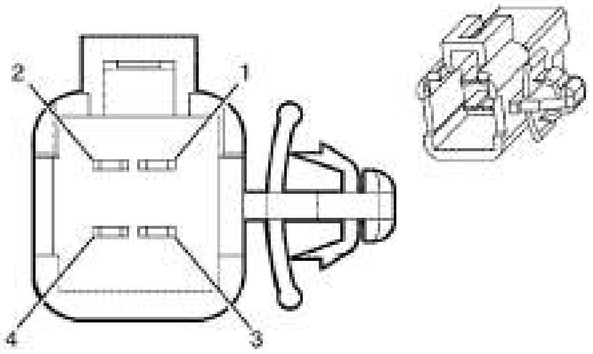
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe :See Terminal Repair Kit

X208

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	5 RD/YE		Battery Positive Voltage	1	5 RD/YE		Battery Positive Voltage
2	2 RD/BU		Battery Positive Voltage	2	2 RD/BU		Battery Positive Voltage

X210 Rear Body Harness to the Rear Latch Assembly Harness





Connector Part Information

- OEM: 7283-7040-10
- Service: See Catalog
- Description: 4-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7282-7040-10
- Service: See Catalog
- Description: 4-Way M

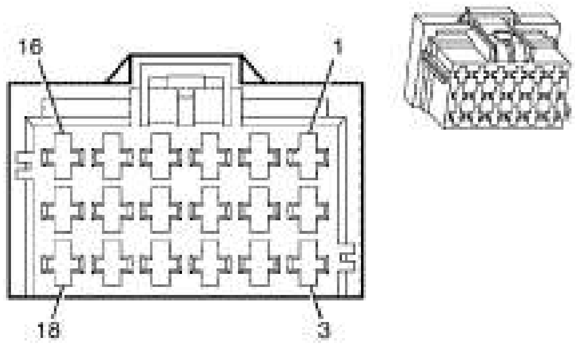
Terminal Part Information

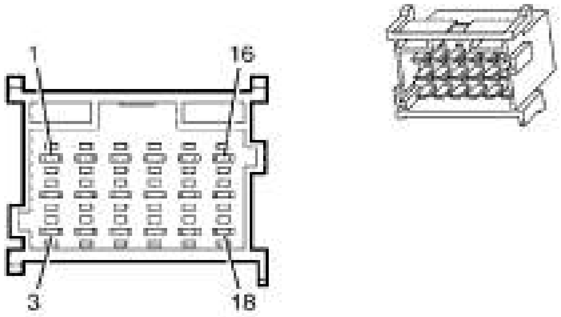
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X210 Rear Body Harness to the Rear Latch Assembly Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.5 OG/BK	744	Park/Neutral Signal	1	0.5 OG/BK	744	Park/Neutral Signal
2	0.5 BK	737	Ignition 1 Voltage	2	0.5 BK	737	Ignition 1 Voltage
3	0.5 BN/WH	56	Cruise Control Disable Clutch Switch Signal	3	0.5 BN/WH	56	Cruise Control Disable Clutch Switch Signal
4	0.5 PK/BU	1350	Ground	4	0.5 PK/BU	1350	Ground

X212 Headliner Harness to the I/P Harness





Connector Part Information

- OEM: 7183-9840-40
- Service: See Catalog
- Description: 18-Way F (GY)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7182-9840-40
- Service: See Catalog
- Description: 18-Way M (GY)

Terminal Part Information

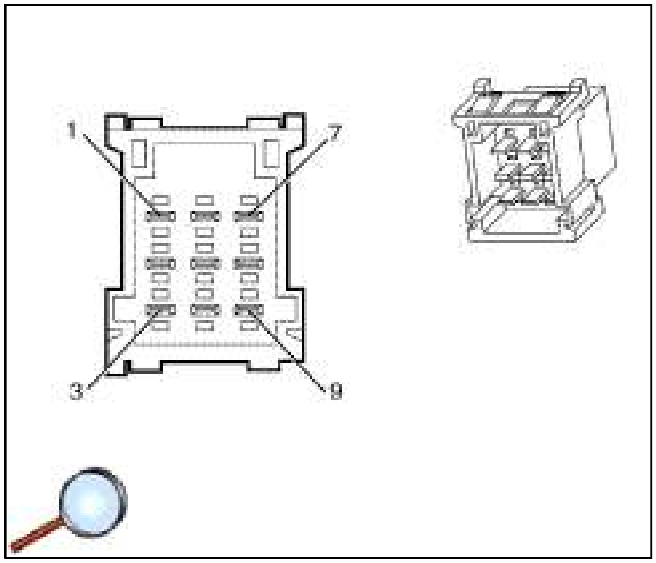
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

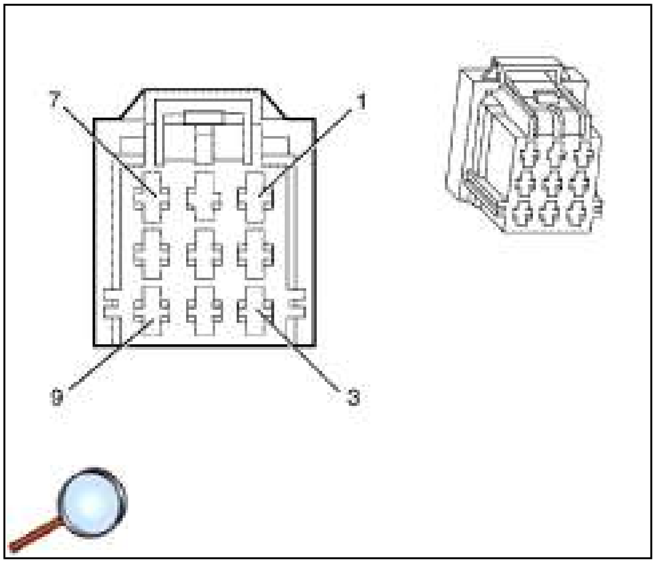
X212 Headliner Harness to the I/P Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.3 BN	481	Outside Moisture Sensor Signal 1	1	0.3 BN	481	Outside Moisture Sensor Signal 1
2	0.3 L-GN	482	Outside Moisture Sensor Signal 2	2	0.3 L-GN	482	Outside Moisture Sensor Signal 2
3	0.3 GY/BK	7043	Microphone Signal	3	0.3 D-BU	7043	Microphone Signal
4	0.5 L-BU	20	Stop Lamp Supply Voltage	4	0.5 L-BU	20	Stop Lamp Supply Voltage
5	0.3 WH/RD	6821	Surv SW	5	0.3 WH/RD	6821	Surv SW
6	0.3 PK/BK	7044	Microphone Return	6	0.3 PK/BK	7044	Microphone Return
7	0.3 PU	328	Interior Lamp Switch Signal	7	0.3 PU	328	Interior Lamp Switch Signal
8	0.3 PK/BK	1597	Courtesy Lamps Switch On Signal	8	0.3 PK/BK	1597	Courtesy Lamps Switch On Signal
			LED Backlight				LED Backlight

9	0.3 YE	6817	Dimming Control	9	0.3 YE	6817	Dimming Control
10	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage	10	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage
11	1.25 BK	850	Ground	11	1.25 BK	850	Ground
12	1.25 OG/BU	3040	Battery Positive Voltage	12	1.25 OG/BU	3040	Battery Positive Voltage
13	0.5 OG	1732	Courtesy Lamps Supply Voltage	13	0.5 OG	1732	Courtesy Lamps Supply Voltage
14	1.25 BK/WH	851	Ground	14	1.25 BK	851	Ground
15	0.5 BN	443	Accessory Voltage	15	0.5 BN	443	Accessory Voltage
16	0.5 OG/WH	1840	Battery Positive Voltage	16	0.5 OG/WH	1840	Battery Positive Voltage
17-18	--	--	Not Used	17-18	--	--	Not Used

X213 Headliner Harness to the Instrument Panel Harness





Connector Part Information

- OEM: 6-968971-1
- Service: See Catalog
- Description: 9-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 3-967626-1
- Service: See Catalog
- Description: 9-Way M

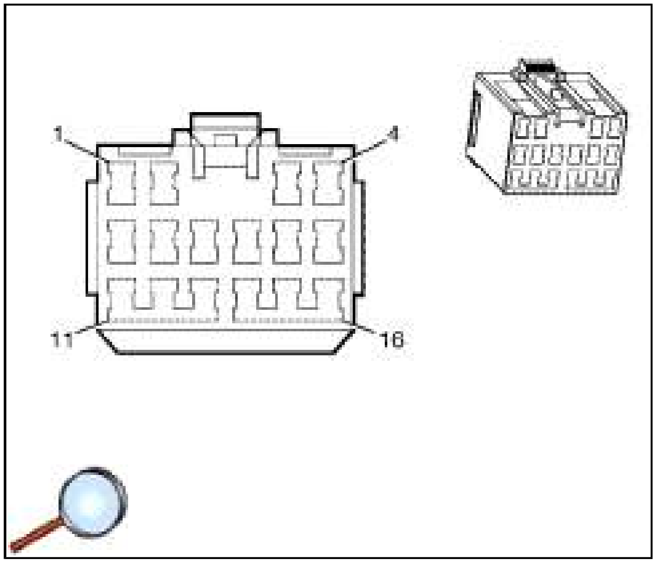
Terminal Part Information

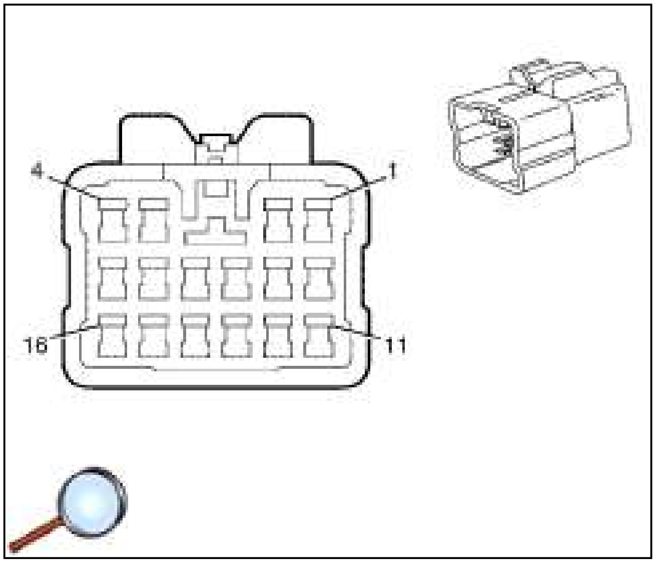
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X213 Headliner Harness to the Instrument Panel Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.3 PK	367	Left Audio Signal (+)	1	0.3 PK	367	Left Audio Signal (+)
2	0.3 D-GN/WH	1547	Common Audio Signal (-)	2	0.3 D-GN/WH	1547	Common Audio Signal (-)
3	0.3 D-GN	5060	Low Speed GMLAN Serial Data	3	0.3 D-GN	5060	Low Speed GMLAN Serial Data
4	0.3 D-BU	368	Right Audio Signal (+)	4	0.3 D-BU	368	Right Audio Signal (+)
5	--	--	Not Used	5	--	--	Not Used
6	0.5 OG/YE	4540	Battery Positive Voltage	6	0.5 OG/YE	4540	Battery Positive Voltage
7	2 BK	1050	Ground	7	2 BK	1050	Ground
8	0.3 RD	5334	DVD Video Signal (+)	8	0.3 RD	5334	DVD Video Signal (+)
9	0.3 WH/BK	5335	DVD Video Signal (-)	9	0.3 WH/BK	5335	DVD Video Signal (-)

X218 Body Harness to the Body Harness





Connector Part Information

- OEM: 7283-1160
- Service: See Catalog
- Description: 16-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal

Connector Part Information

- OEM: 7282-1160
- Service: See Catalog
- Description: 16-Way M

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal

Repair Kit

- Release Tool/Test Probe:See Terminal Repair Kit

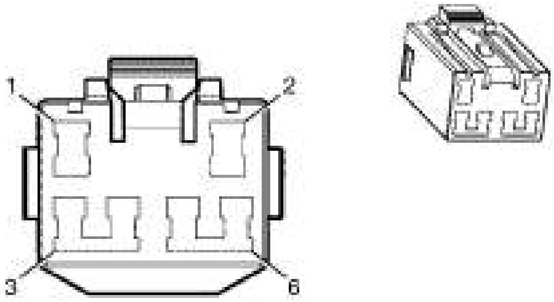
Repair Kit

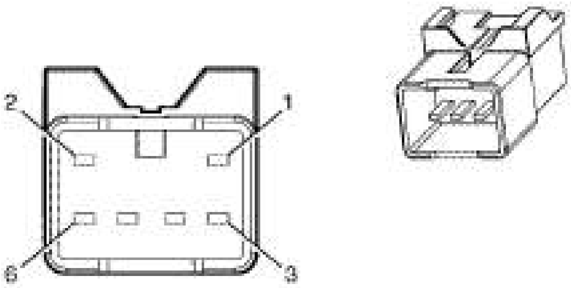
- Release Tool/Test Probe: See Terminal Repair Kit

X218 Body Harness to the Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.85 L-GN	200	Right Front Speaker Output (+)	1	0.85 L-GN	200	Right Front Speaker Output (+)
2	0.85 D-GN	117	Right Front Speaker Output (-)	2	0.85 D-GN	117	Right Front Speaker Output (-)
3	0.5 D-BU	546	Right Rear Speaker Output (+)	3	0.5 D-BU	546	Right Rear Speaker Output (+)
4	0.5 BN/BU	1946	Right Rear Speaker Output (-)	4	0.5 BN/BU	1946	Right Rear Speaker Output (-)
5	0.85 L-BU	1960	Front Centre Speaker Output (-)	5	0.85 L-BU	1960	Front Centre Speaker Output (-)
6	0.85 YE	1860	Front Centre Speaker Output (+)	6	0.85 YE	1860	Front Centre Speaker Output (+)
7	0.5 L-GN/WH	512	Right Front Speaker Output (+)	7	0.5 L-GN/WH	512	Right Front Speaker Output (+)
8	0.5 L-GN	1948	Right Front Speaker Output (-)	8	0.5 L-GN	1948	Right Front Speaker Output (-)
9	0.85 L-BU	115	Right Rear Speaker Output (-)	9	0.85 L-BU	115	Right Rear Speaker Output (-)
10	0.85 D-BU	46	Right Rear Speaker Output (+)	10	0.85 D-BU	46	Right Rear Speaker Output (+)
11	0.5 OG/BK		Roof Centre Speaker Output (-)	11	0.5 OG/BK		Roof Centre Speaker Output (-)
12	0.5 OG		Roof Centre Speaker Output (+)	12	0.5 OG		Roof Centre Speaker Output (+)
13	0.5 BN	1999	Left Rear Speaker Output (-)	13	0.5 BN	1999	Left Rear Speaker Output (-)
14	0.5 BN/WH	599	Left Rear Speaker Output (+)	14	0.5 BN/WH	599	Left Rear Speaker Output (+)
15	0.5 D-GN	1947	Left Front Speaker Output (-)	15	0.5 D-GN	1947	Left Front Speaker Output (-)
16	0.5 BN/OG	511	Left Front Speaker Output (+)	16	0.5 BN/OG	511	Left Front Speaker Output (+)

X220 I/P Harness to the Body Harness (LHD)





Connector Part Information

- OEM: 7283-7166
- Service: See Catalog
- Description: 6-Way F (WH)

Terminal Part Information

- Terminal/Tray: 7116-4020/11
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

Connector Part Information

- OEM: 7282-1060
- Service: See Catalog
- Description: 6-Way M 090 II Series (WH)

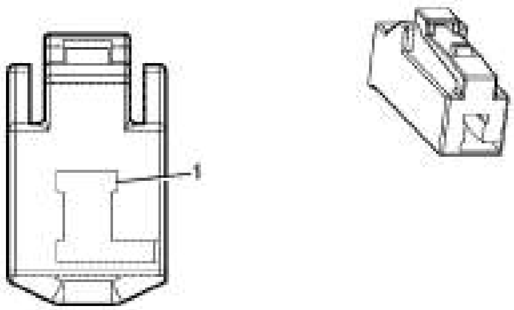
Terminal Part Information

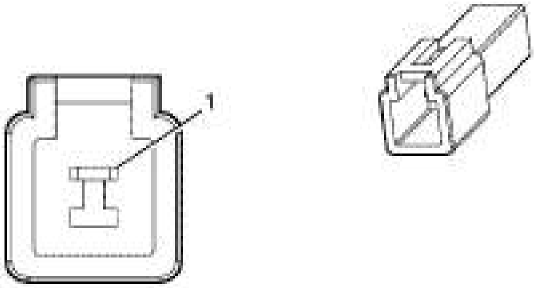
- Terminal/Tray: 7114-4020/10
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

X220 I/P Harness to the Body Harness (LHD)

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used	1	--	--	Not Used
2	0.5 OG/BK	233	Park Brake Switch Signal	2	0.5 OG/BK	233	Park Brake Switch Signal
3	0.5 PK/BK	780	Driver Door Lock Switch Lock Signal	3	0.5 PK/BK	780	Driver Door Lock Switch Lock Signal
4	0.3 PK	781	Driver Door Lock Switch Unlock Signal	4	0.3 PK	781	Driver Door Lock Switch Unlock Signal
5	--	--	Not Used	5	--	--	Not Used
6	0.3 GY/BK	745	Left Front Door Ajar Switch Signal	6	0.3 GY/BK	745	Left Front Door Ajar Switch Signal

X223 I/P Harness to the Console Ground





Connector Part Information

- OEM: 7283-7014
- Service: See Catalog
- Description: 1-Way F (BK)

Terminal Part Information

- Terminal/Tray: 7116-4022/11
- Core/Insulation Crimp: 4/A
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

Connector Part Information

- OEM: 7282-7014
- Service: See Catalog
- Description: 1-Way M (WH)

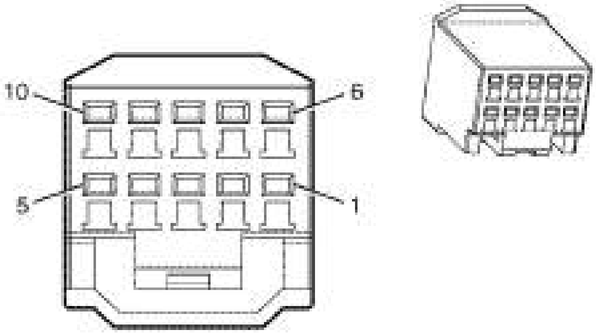
Terminal Part Information

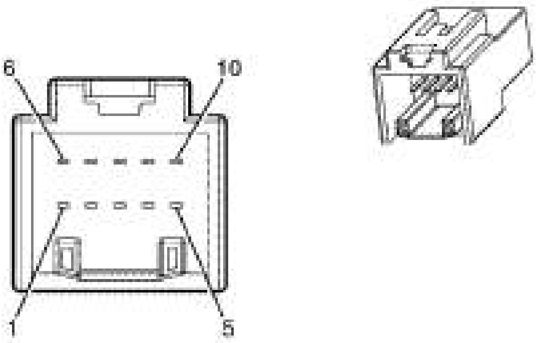
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X223 I/P Harness to the Console Ground

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	2 BK	1050	Ground	1	2 BK	1050	Ground

X225





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 10-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe:See Terminal Repair Kit

Connector Part Information

- OEM:
- Service: See Catalog
- Description: 10-Way M

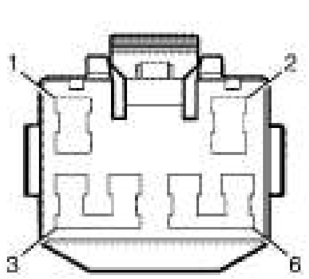
Terminal Part Information

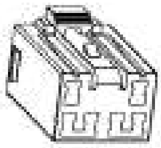
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

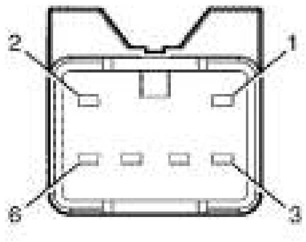
X225

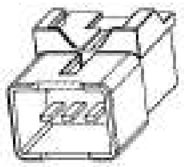
Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.3 RD		Video Connector - R	1	0.3 RD		Video Connector - R
2	0.3 D-GN		Video Connector - G	2	0.3 D-GN		Video Connector - G
3	0.3 WH		Video Connector - B	3	0.3 WH		Video Connector - B
4	0.3 BK		Ground	4	0.3 BK		Ground
5	0.3 YE		Video Connector - Sync	5	0.3 YE		Video Connector - Sync
6	0.3 BK		Drain Wire	6	0.3 BK		Drain Wire
7-10	--	--	Not Used	7-10	--	--	Not Used

X226 Gauge Assembly to the I/P Harness (HSV)









Connector Part Information

- OEM: 7283-1060
- Service: See Catalog
- Description: 6-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7282-1060
- Service: See Catalog
- Description: 6-Way M

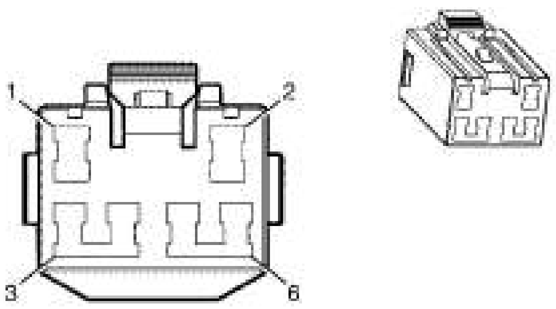
Terminal Part Information

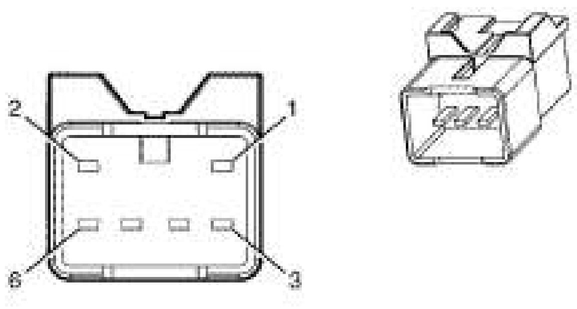
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X226 Gauge Assembly to the I/P Harness (HSV)

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.5 L-BU/WH	5986	Communication Enable Relay Supply Voltage	1	0.5 L-BU/WH	5986	Communication Enable Relay Supply Voltage
2	0.3 YE	1080	LED Backlight Dimming Control	2	0.3 YE	1080	LED Backlight Dimming Control
3	0.5 PK/BU	1339	Ignition 1 Voltage	3	0.5 PK/BU	1339	Ignition 1 Voltage
4	0.5 BK	1450	Ground	4	0.5 BK	1450	Ground
5	0.5 BN/BK	2500	High Speed GMLAN Serial Data Bus+	5	0.5 BN/BK	2500	High Speed GMLAN Serial Data Bus+
6	0.5 BN	2501	High Speed GMLAN Serial Data Bus-	6	0.5 BN	2501	High Speed GMLAN Serial Data Bus-

X227 Steering Angle Sensor Assembly to the I/P Harness





Connector Part Information

- OEM: 7283-1060
- Service: See Catalog
- Description: 6-Way F 090 II Series (WH)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7282-1060
- Service: See Catalog
- Description: 6-Way M (WH)

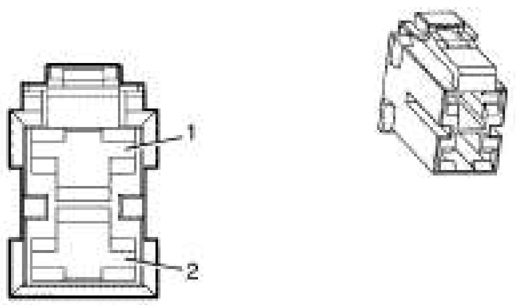
Terminal Part Information

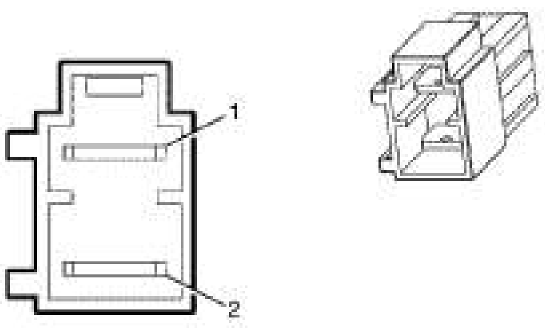
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X227 Steering Angle Sensor Assembly to the I/P Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.35 PU	2501	High Speed Gmlan Serial Data Bus -	1	0.35 BN	2501	High Speed Gmlan Serial Data Bus -
2	0.35 D-BU	2501	High Speed Gmlan Serial Data Bus -	2	0.35 BN	2501	High Speed Gmlan Serial Data Bus -
3	0.35 GY	2500	High Speed Gmlan Serial Data Bus +	3	0.35 BN/BK	2500	High Speed Gmlan Serial Data Bus +
4	0.35 BN/BK	2500	High Speed Gmlan Serial Data Bus +	4	0.35 BN/BK	2500	High Speed Gmlan Serial Data Bus +
5	0.5 L-GN	5986	Communication Enable Relay Supply Voltage	5	0.5 L-BU	5986	Communication Enable Relay Supply Voltage
6	0.5 OG	2088	Steering Wheel Position Sensor Low Reference	6	0.5 BK/BU	2088	Steering Wheel Position Sensor Low Reference

X228 I/P Harness to the I/P Harness





Connector Part Information

- OEM: 7123-4123-30
- Service: 88953301
- Description: 2-Way F L Type (BK)

Terminal Part Information

- Terminal/Tray: 7116-3250/10
- Core/Insulation Crimp: G/3
- Release Tool/Test Probe: 12094430/J-35616-22 (RD)

Connector Part Information

- OEM: 7122-4123-30
- Service: See Catalog
- Description: 2-Way M 58 L-Type (BK)

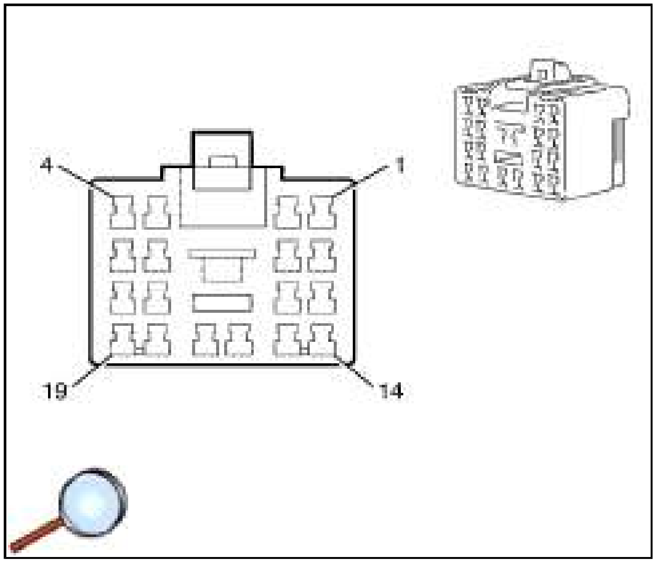
Terminal Part Information

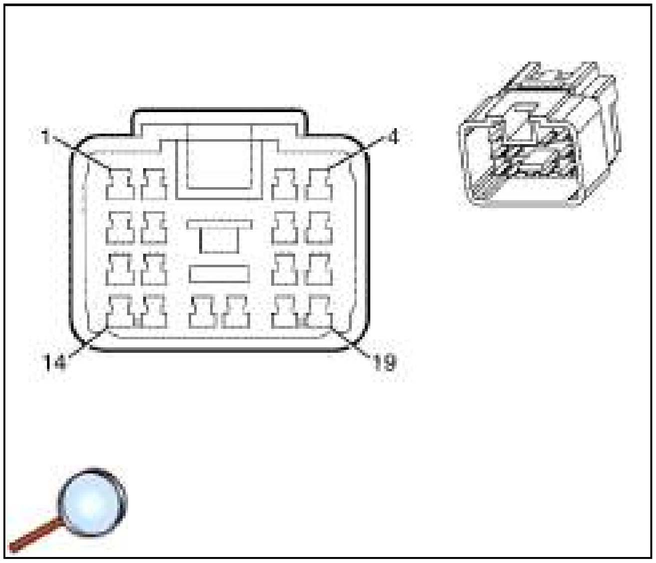
- Terminal/Tray: 7114-3250/14
- Core/Insulation Crimp: G/3
- Release Tool/Test Probe: 12094430/J-35616-21 (RD)

X228 I/P Harness to the I/P Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	5 RD	9370	Battery Positive Voltage	1	5 RD	242	Battery Positive Voltage
2	5 RD/BK	9371	Battery Positive Voltage	2	5 RD/BK	642	Battery Positive Voltage

X229 I/P Harness to the I/P Harness





Connector Part Information

- OEM: 7283-1194
- Service: See Catalog
- Description: 19-Way F 090 II Series (WH)

Connector Part Information

- OEM: 7282-1194
- Service: See Catalog
- Description: 19-Way M 090 II Series (WH)

Terminal Part Information

- Pins: 1, 3, 6, 8, 17-19
- Terminal/Tray: 7116-4020/11
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

- Pin: 4
- Terminal/Tray: 7116-4021/11
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

- Pin: 9
- Terminal/Tray: 7116-4021/11
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

Terminal Part Information

- Pins: 1, 3, 6, 8, 17-19
- Terminal/Tray: 7114-4020/10
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pin: 4
- Terminal/Tray: 7114-4021/10
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

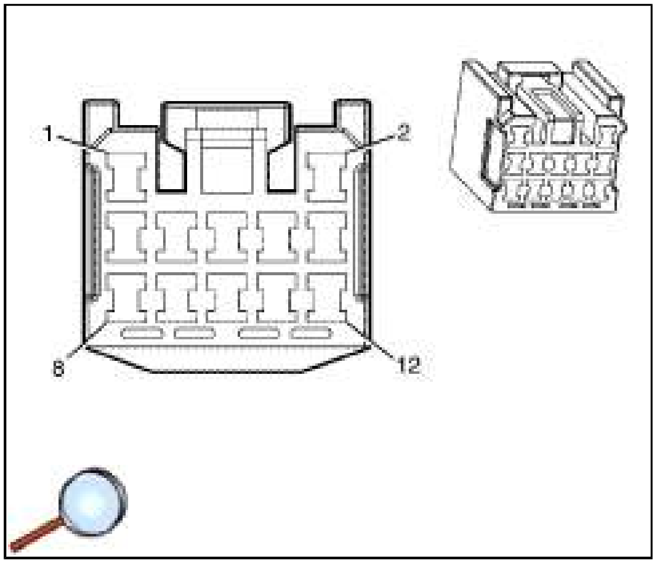
- Pin: 9
- Terminal/Tray: 7114-4021/10
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

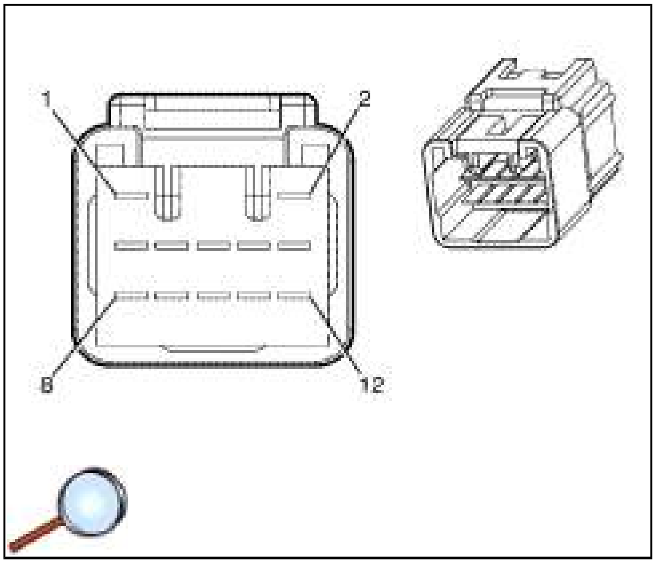
X229 I/P Harness to the I/P Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.85 OG	1732	Courtesy Lamps Supply Voltage	1	0.85 OG	1732	Courtesy Lamps Supply Voltage
2	0.5 D-GN	7392	A/C Compressor Supply Voltage	2	0.5 D-GN	7392	A/C Compressor Supply Voltage
3	0.75 OG/GN	2240	Battery Positive Voltage	3	0.75 OG/GN	2240	Battery Positive Voltage
4	0.3 D-BU	6189	Rear Compartment Relay Switch	4	0.3 D-BU	6189	Rear Compartment Relay Switch
5	1.25 BN/RD	694	Driver Door Lock Actuator Unlock Control	5	1.25 BN/RD	694	Driver Door Lock Actuator Unlock Control
6	0.5 D-BU	7393	AC Compressor Low Reference	6	0.5 D-BU	7393	AC Compressor Low Reference
7	2 OG/BU	1540	Battery Positive Voltage	7	2 OG/BU	1540	Battery Positive Voltage
8	0.3 WH/BU	193	Rear Defog Relay Control	8	0.3 WH/BU	193	Rear Defog Relay Control
9	0.3 L-BU	5921	Driver Door/Fuel Door Unlock Control	9	0.3 L-BU	5921	Driver Door/Fuel Door Unlock Control
10	0.3 D-BU/WH	195	Door Lock Relay Control	10	0.3 D-BU/WH	195	Door Lock Relay Control
11	--	--	Not Used	11	--	--	Not Used
12	0.3 WH	194	Door Unlock Control	12	0.3 WH	194	Door Unlock Control
13	--	--	Not Used	13	--	--	Not Used
14	0.85 OG/BU	1240	Battery Positive Voltage	14	0.85 OG/BU	1240	Battery Positive Voltage

15	0.3 L-GN/BK	735	Ambient Air Temperature Sensor Signal	15	0.3 L-GN/BK	735	Ambient Air Temperature Sensor Signal
16	0.85 OG/YE	1640	Battery Positive Voltage	16	0.85 OG/YE	1640	Battery Positive Voltage
17	1.25 OG	240	Battery Positive Voltage	17	1.25 OG	240	Battery Positive Voltage
18	0.85 D-BU/WH	149	Courtesy Lamp Supply Voltage	18	0.85 D-BU/WH	149	Courtesy Lamp Supply Voltage
19	--	--	Not Used	19	--	--	Not Used

X236 Electronic Suspension Assembly to the Body Harness (HSV)





Connector Part Information

- OEM: 7283-4325
- Service: See Cataolg
- Description: 12-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe:See Terminal Repair Kit

Connector Part Information

- OEM: 7282-4325
- Service: See Catalog
- Description: 12-Way M

Terminal Part Information

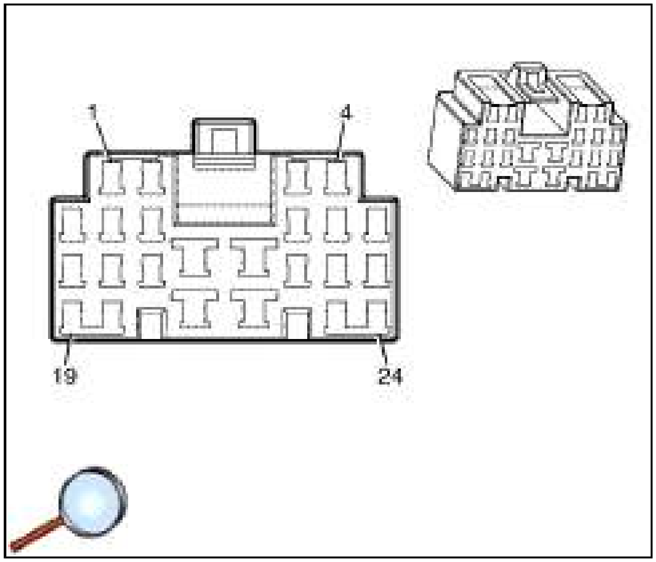
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

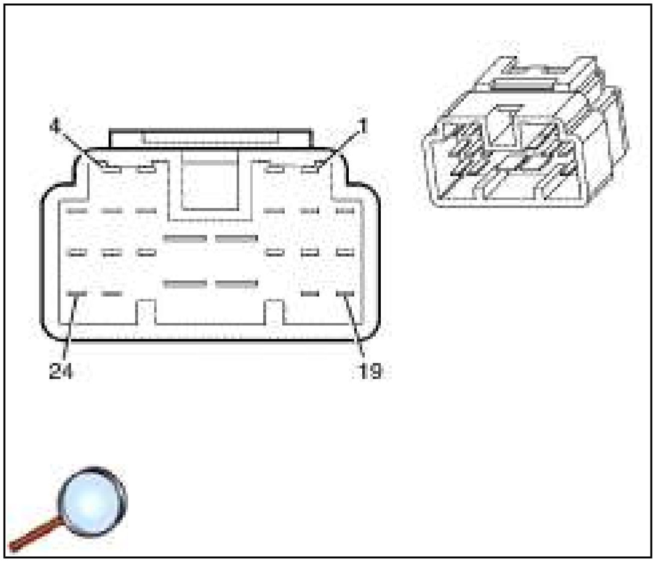
X236 Electronic Suspension Assembly to the Body Harness (HSV)

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.35 GY	1209	Left Rear Suspension Position Sensor Signal	1	0.35 GY	1209	Left Rear Suspension Position Sensor Signal
			Left Rear Suspension				Left Rear Suspension

2	0.35 GY/WH	1208	Position Sensor Voltage Reference	2	0.35 GY/WH	1208	Position Sensor Voltage Reference
3	0.35 BN	1216	Right Rear Suspension Position Sensor Signal	3	0.35 BN	1216	Right Rear Suspension Position Sensor Signal
4	0.35 BN/WH	1214	Right Rear Suspension Position Sensor Voltage Reference	4	0.35 BN/WH	1214	Right Rear Suspension Position Sensor Voltage Reference
5	0.75 WH/RD	1114	Left Rear Damper Control	5	0.75 WH/RD	1114	Left Rear Damper Control
6	0.75 WH/BK	1115	Left Rear Damper Low Reference	6	0.75 WH/BK	1115	Left Rear Damper Low Reference
7	0.35 GY/BK	1209	Left Rear Suspension Position Sensor Low Reference	7	0.35 GY/BK	1209	Left Rear Suspension Position Sensor Low Reference
8-9	--	--	Not Used	8-9	--	--	Not Used
10	0.75 L-GN/RD	1118	Right Rear Damper Control	10	0.75 L-GN/RD	1118	Right Rear Damper Control
11	0.75 L-GN/BK	1119	Right Rear Damper Low Reference	11	0.75 L-GN/BK	1119	Right Rear Damper Low Reference
12	0.35 BN/BK	1215	Right Rear Suspension Position Sensor Low Reference	12	0.35 BN/BK	1215	Right Rear Suspension Position Sensor Low Reference

X237 Electronic Suspension Assembly to the I/P Harness (HSV)





Connector Part Information

- OEM: 7283-1248
- Service: See Catalog
- Description: 24-Way F

Terminal Part Information

Connector Part Information

- OEM: 7282-1248
- Service: See Catalog
- Description: 24-Way M

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

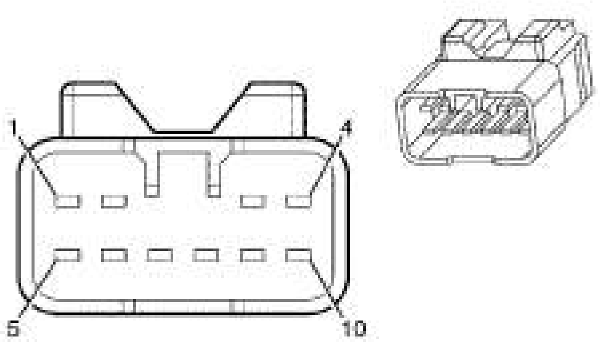
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X237 Electronic Suspension Assembly to the I/P Harness (HSV)

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.5 L-BU	5986	Communication Enable Relay Supply Voltage	1	0.5 L-BU	5986	Communication Enable Relay Supply Voltage
2	0.5 BN	2501	High Speed GMLAN Serial Data Bus-	2	0.5 BN	2501	High Speed GMLAN Serial Data Bus-
3	0.5 BN/BK	2500	High Speed GMLAN Serial Data Bus+	3	0.5 BN/BK	2500	High Speed GMLAN Serial Data Bus+
4	0.5 YE/RD	1384	Electronic Suspension Control Switch Signal	4	0.5 YE/RD	1384	Electronic Suspension Control Switch Signal
5-6	--	--	Not Used	5-6	--	--	Not Used
7	0.5 BN	2501	High Speed GMLAN Serial Data Bus-	7	0.5 BN	2501	High Speed GMLAN Serial Data Bus-
8	0.5 BN/BK	2500	High Speed GMLAN Serial Data Bus+	8	0.5 BN/BK	2500	High Speed GMLAN Serial Data Bus+
9	0.5 YE/BK	370	Module Signal Error	9	0.5 YE/BK	370	Module Signal Error
10	0.5 YE/GN	1437	Firm LED Supply Voltage	10	0.5 YE/GN	1437	Firm LED Supply Voltage
11	0.3 D-GN/BK	1212	Right Front Suspension Position Sensor Low Reference	11	0.3 D-GN/BK	1212	Right Front Suspension Position Sensor Low Reference
12	0.3 D-GN	1213	Right Front Suspension Position Sensor Signal	12	0.3 D-GN	1213	Right Front Suspension Position Sensor Signal
13	0.3 D-GN/WH	1211	Right Front Suspension Position Sensor Voltage Reference	13	0.3 D-GN/WH	1211	Right Front Suspension Position Sensor Voltage Reference
14	2 RD/BU	2640	Battery Positive Voltage	14	2 RD/BU	2640	Battery Positive Voltage
15	2 BK	850	Ground	15	2 BK	850	Ground
16	0.3 D-BU/BK	1206	Left Front Suspension Position Sensor Low Reference	16	0.3 D-BU/BK	1206	Left Front Suspension Position Sensor Low Reference
17	0.3 D-BU	1207	Left Front Suspension Position Sensor Signal	17	0.3 D-BU	1207	Left Front Suspension Position Sensor Signal
18	0.3 D-BU/WH	1205	Left Front Suspension Position Sensor Voltage Reference	18	0.3 D-BU/WH	1205	Left Front Suspension Position Sensor Voltage Reference
			Right Front Damper				Right Front Damper

19	0.75 PU	1116	Control	19	0.75 PU	1116	Control
20	0.75 PU/WH	1117	Right Front Damper Low Reference	20	0.75 PU/WH	1117	Right Front Damper Low Reference
21-22	--	--	Not Used	21-22	--	--	Not Used
23	0.75 PK	1107	Left Front Damper Control	23	0.75 PK	1107	Left Front Damper Control
24	0.75 PK/BK	1113	Left Front Damper Low Reference	24	0.75 PK/BK	1113	Left Front Damper Low Reference

X238 Indicator Assembly to the I/P Harness (HSV)



Connector Part Information

- OEM: 7283-1100
- Service: See Catalog
- Description: 10-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7282-1100
- Service: See Catalog
- Description: 10-Way M

Terminal Part Information

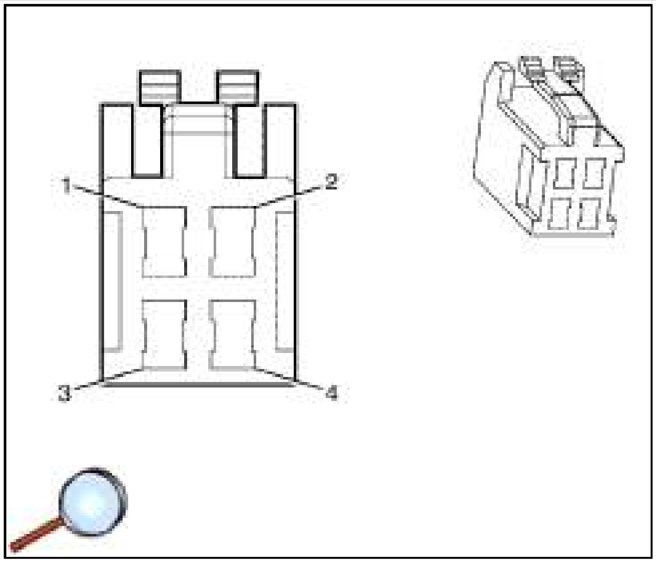
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

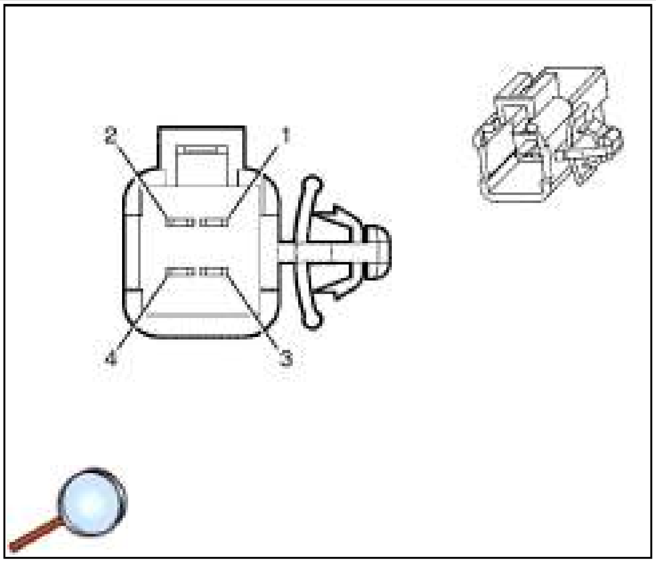
X238 Indicator Assembly to the I/P Harness (HSV)

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.3 YE	6817	Ground	1	0.3 YE	6817	Ground
2	0.5 L-BU	5986	Ground	2	0.5 L-BU	5986	Ground
3	0.5	1384	Electronic Suspension	3	0.5	1384	Electronic Suspension

	YE/RD		Control Switch Signal		YE/RD		Control Switch Signal
4	0.5 BK	850	Ground	4	0.5 BK	850	Ground
5-6	--	--	Not Used	5-6	--	--	Not Used
7	0.5 YE/BK	370	Module Signal Error	7	0.5 YE/BK	370	Module Signal Error
8	0.85 YE/GN	1437	Firm LED Supply Voltage	8	0.85 YE/GN	1437	Firm LED Supply Voltage
9	0.5 BK	850	Ground	9	0.5 BK	850	Ground
10	0.5 BK	850	Ground	10	0.5 BK	850	Ground

X241 I/P Harness to the Driver Information Center Harness





Connector Part Information

- OEM: 7283-1040
- Service: See Catalog
- Description: 4-Way F (WH)

Terminal Part Information

- Terminal/Tray: 7116-4020/11
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

Connector Part Information

- OEM: 7282-1641
- Service: See Catalog
- Description: 4-Way M 090 II Series (WH)

Terminal Part Information

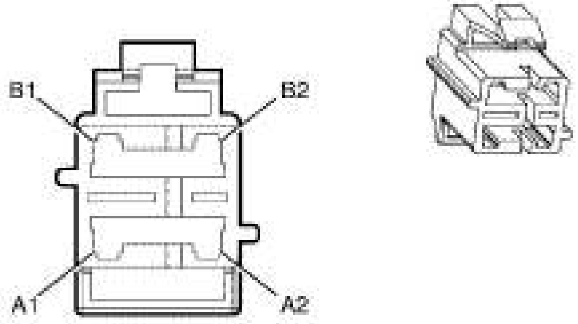
- Terminal/Tray: 7114-4020/10
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

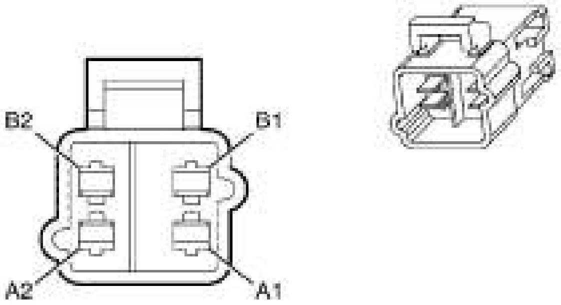
X241 I/P Harness to the Driver Information Center Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.35 D-GN	9205	Low Speed GMLAN Serial Data	1	0.35 D-GN	5060	Low Speed GMLAN Serial Data
	0.5		Battery Positive		0.5		Battery Positive

2	OG/WH	1840	Voltage	2	RD/WH	1840	Voltage
3	0.5 BK	1450	Ground	3	0.3 BK	1450	Ground
4	--	--	Not Used	4	--	--	Not Used

X253 I/P Harness to the Body Harness





Connector Part Information

- OEM: 7183-7297-70
- Service: 15306186
- Description: 4-Way F Metri-Pack 280 Series (YE)

Terminal Part Information

- Terminal/Tray: 12034046/2
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 12094430/J-35616-4A (PU)

Connector Part Information

- OEM: 7182-7297-70
- Service: See Catalog
- Description: 4-Way M (YE)

Terminal Part Information

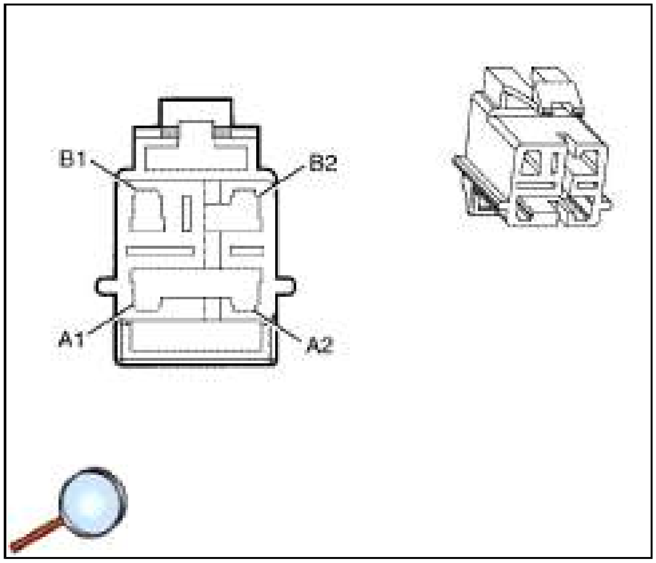
- Terminal/Tray: 12034047/2
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 12094430/J-35616-5 (PU)

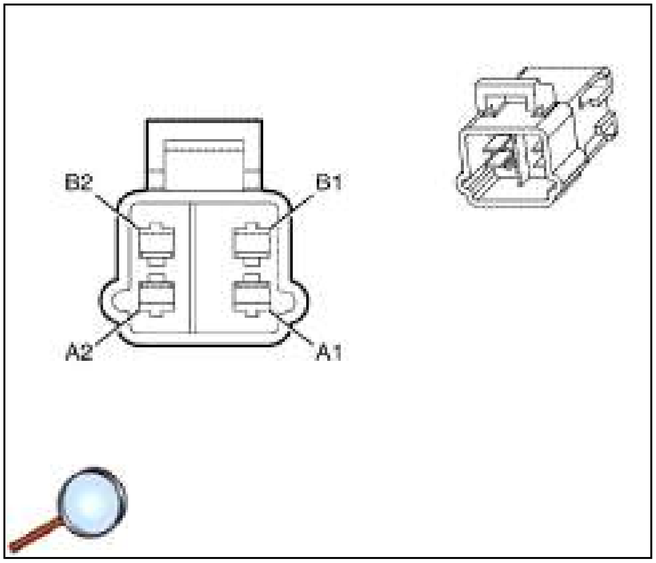
X253 I/P Harness to the Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
A1	0.3 PK	3022	Steering Wheel Module - Stage2 - Low Control	A1	0.3 PK	3022	Steering Wheel Module - Stage2 - Low Control
A2	0.3 WH	3023	Steering Wheel Module - Stage2 - High Control	A2	0.3 WH	3023	Steering Wheel Module - Stage2 - High Control
B1	0.3 BN	3020	Steering Wheel Module - Stage1 - Low Control	B1	0.3 BN	3020	Steering Wheel Module - Stage1 - Low Control
			Steering Wheel				Steering Wheel

B2	0.3 BN/RD	3021	Module - Stage1 - High Control	B2	0.3 BN/RD	3021	Module - Stage1 - High Control

X254 I/P Harness to the Body Harness





Connector Part Information

- OEM: 7287-0496-70
- Service: See Catalog
- Description: 4-Way F (YE)

Terminal Part Information

- Terminal/Tray: 12034046/2
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 12094430/J-35616-4A (PU)

Connector Part Information

- OEM: 7186-0493-70
- Service: See Catalog
- Description: 4-Way M (YE)

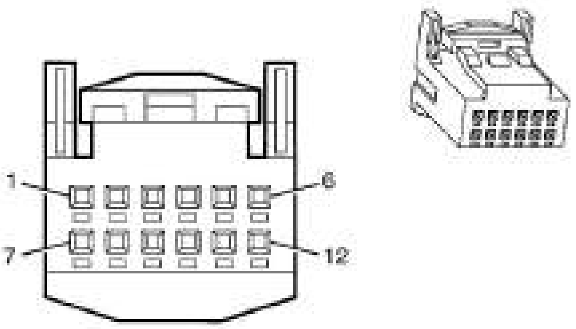
Terminal Part Information

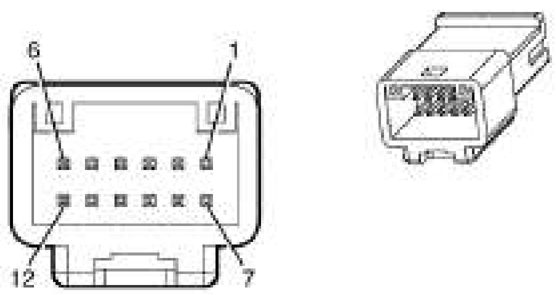
- Terminal/Tray: 12034047/2
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 12094430/J-35616-5 (PU)

X254 I/P Harness to the Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
A1	0.5 PU	3026	I/P Module - Stage 2 - Low Control	A1	0.3 PU	3026	I/P Module - Stage 2 - Low Control
A2	0.5 D-GN	3027	I/P Module - Stage 2 - High Control	A2	0.3 D-GN	3027	I/P Module - Stage 2 - High Control
B1	0.5 D-BU	3024	I/P Module - Stage 1 - Low Control	B1	0.3 D-BU	3024	I/P Module - Stage 1 - Low Control
B2	0.5 YE	3025	I/P Module - Stage 1 - High Control	B2	0.3 YE	3025	I/P Module - Stage 1 - High Control

X255 Digital Video Disc (DVD) Control Module to the Video Display





Connector Part Information

- OEM: 1376106
- Service: See Catalog
- Description: 12-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe:See Terminal Repair Kit

Connector Part Information

- OEM: 1376106
- Service: See Catalog
- Description: 12-way M

Terminal Part Information

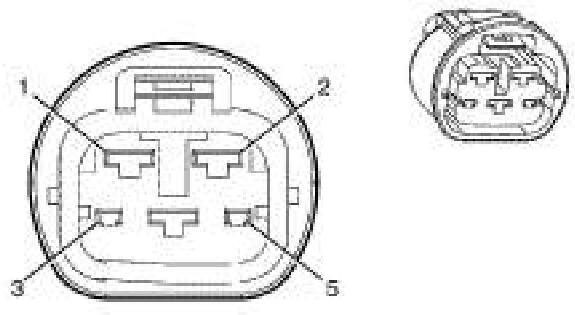
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe:See Terminal Repair Kit

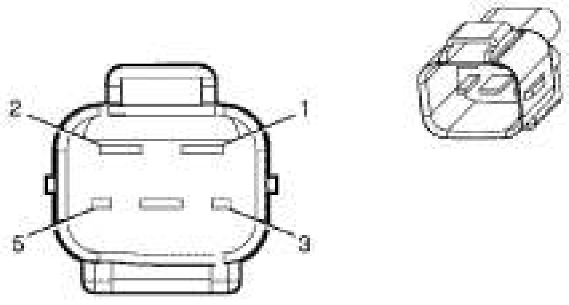
X255 Digital Video Disc (DVD) Control Module to the Video Display

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.18 L-GN	5826	DVD Audio Left Signal (+)	1	0.18 L-GN	5826	DVD Audio Left Signal (+)
2	0.18 D-GN/WH	5828	DVD Audio Right Signal (+)	2	0.18 D-GN/WH	5828	DVD Audio Right Signal (+)
3	0.18 WH	6976	DVD Video Signal (+)	3	0.18 WH	6976	DVD Video Signal (+)
4	0.18 YE	5485	RS485 TX	4	0.18 YE	5485	RS485 TX
5	0.18 BARE	5339	Shield	5	0.18 BARE	5339	Shield
6	0.18 OG	6849	Battery Positive	6	0.18 OG	6849	Battery Positive
7	0.18 L-GN	5825	DVD Audio Left Signal (-)	7	0.18 L-GN	5825	DVD Audio Left Signal (-)
8	0.18 D-GN/WH	5827	DVD Audio Right Signal (-)	8	0.18 D-GN/WH	5827	DVD Audio Right Signal (-)
9	0.18 WH	6975	DVD Video Signal (-)	9	0.18 WH	6975	DVD Video Signal (-)

10	0.18 D-GN	1098	RS485 RX	10	0.18 D-GN	1098	RS485 RX
11	--	--	Not Used	11	--	--	Not Used
12	0.18 L-BU	6873	Ground	12	0.18 L-BU	6873	Ground

X305 Body Harness to the Fuel Tank Harness





Connector Part Information

- OEM: 7283-7350-30
- Service: See Catalog
- Description: 5-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7282-7350-30
- Service: See Catalog
- Description: 5-Way M

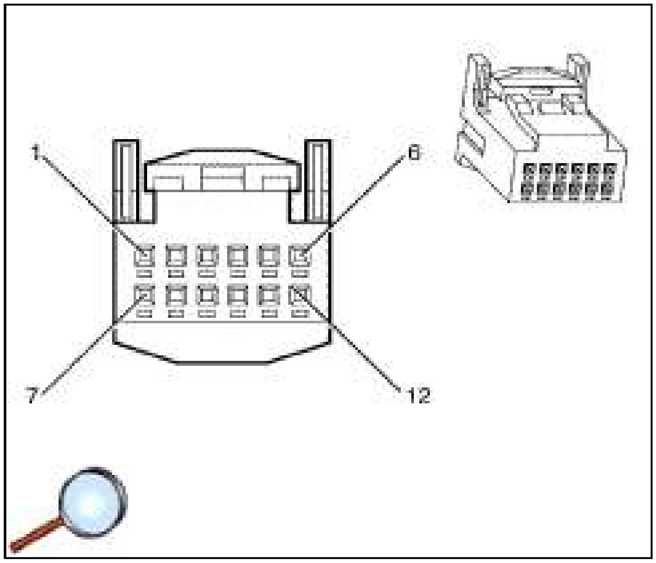
Terminal Part Information

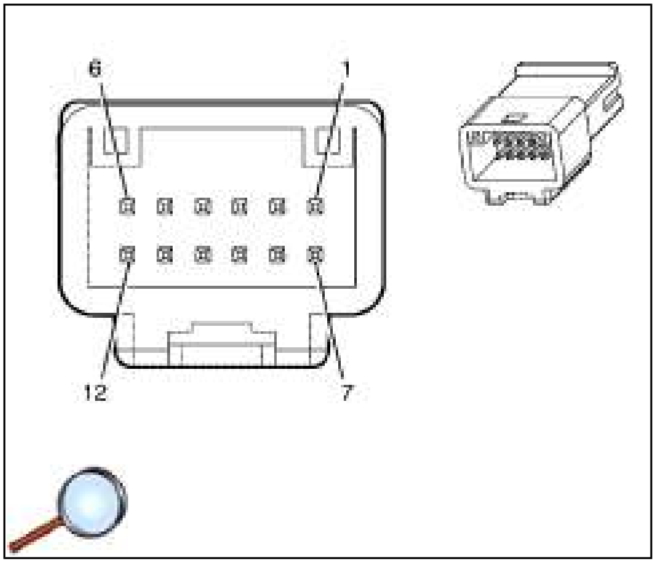
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X305 Body Harness to the Fuel Tank Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	2 BK	1350	Ground	1	2 BK	1350	Ground
2	2 GY	120	Fuel Pump Supply Voltage	2	2 GY	120	Fuel Pump Supply Voltage
3	0.5 L-BU	1937	Fuel Level Sensor Signal (Secondary)	3	0.5 L-BU	1937	Fuel Level Sensor Signal (Secondary)
4	0.5 BN/YE	452	Fuel Return	4	0.5 BN/YE	452	Fuel Return
5	0.5 PU	1589	Fuel Level Sensor Signal (Primary)	5	0.5 PU	1589	Fuel Level Sensor Signal (Primary)

X306 Driver Seat Harness to the Body Harness (A45)





Connector Part Information

- OEM: 1318774-1
- Service: See Catalog
- Description: 12-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 1565894-1
- Service: See Catalog
- Description: 12-Way M

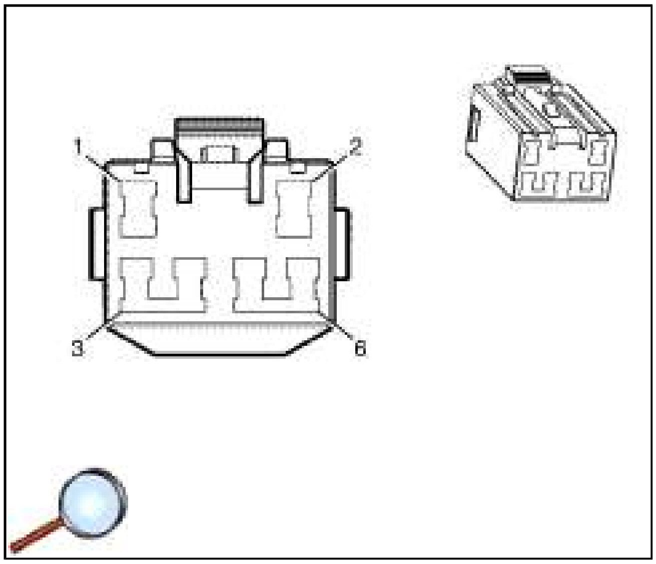
Terminal Part Information

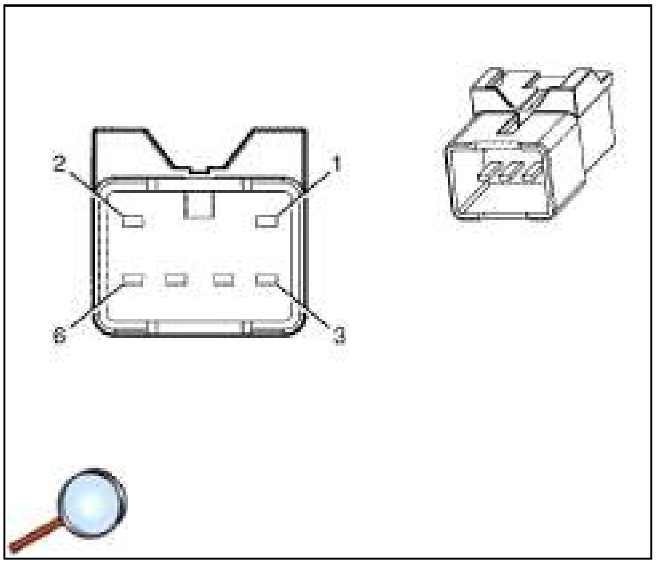
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X306 Driver Seat Harness to the Body Harness (A45)

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.5 PK/WH	6839	Memory Mirror Voltage	1	0.5 PK/WH	6839	Memory Mirror Voltage
2	0.5 BK/WH	2851	Memory Mirror Ground	2	0.5 BK/WH	2851	Memory Mirror Ground
3	0.3 D-GN/WH	7006	Mirror Control Signal	3	0.3 D-GN/WH	7006	Mirror Control Signal
4-10	--	--	Not Used	4-10	--	--	Not Used
11	0.5 BK	1350	Ground	11	0.5 BK	1350	Ground
12	0.35 D-GN	5060	Low Speed GMLAN Serial Data	12	0.35 D-GN	5060	Low Speed GMLAN Serial Data

X307 Body Harness to the Left Front Door Harness





Connector Part Information

- OEM: 7283-1060
- Service: See Catalog
- Description: 6-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe:See Terminal Repair Kit

Connector Part Information

- OEM: 7282-1060
- Service: See Catalog
- Description: 6-Way M

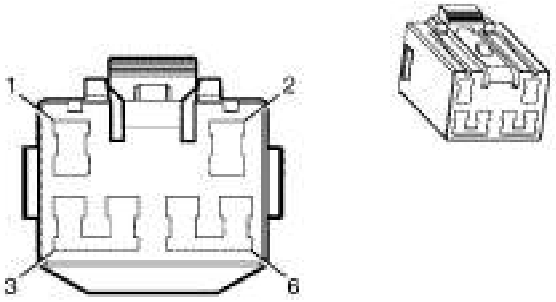
Terminal Part Information

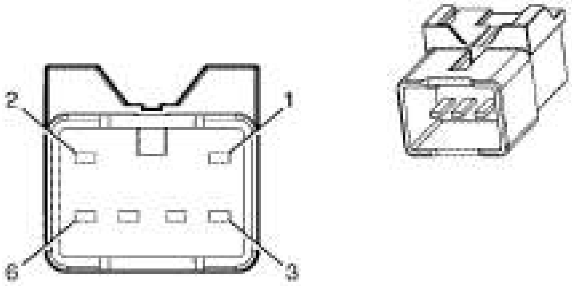
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe:See Terminal Repair Kit

X307 Body Harness to the Left Front Door Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used	1	--	--	Not Used
2	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage	2	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage
3	0.5 BK/WH	7391	Memory Mirror Ground	3	0.5 WH	7391	Memory Mirror Ground
4	0.5 D-GN/WH	81	Mirror Control Signal	4	0.5 WH/BK	81	Mirror Control Signal
5	0.5 PK/WH	89	Memory Mirror Voltage	5	0.5 PK/WH	89	Memory Mirror Voltage
6	0.5 BN	5998	Puddle Lamp Supply Voltage	6	0.5 BN	5998	Puddle Lamp Supply Voltage

X308 Body Harness to the Right Front Door Harness





Connector Part Information

- OEM: 7283-1060
- Service: See Catalog
- Description: 6-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe:See Terminal Repair Kit

Connector Part Information

- OEM: 7282-1060
- Service: See Catalog
- Description: 6-Way M

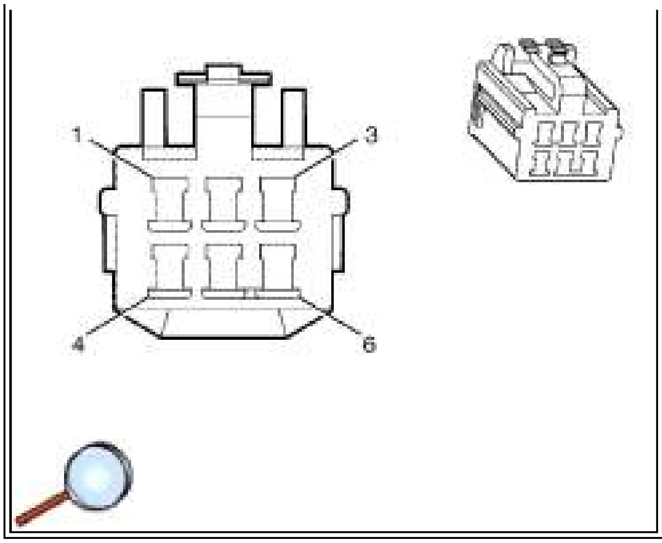
Terminal Part Information

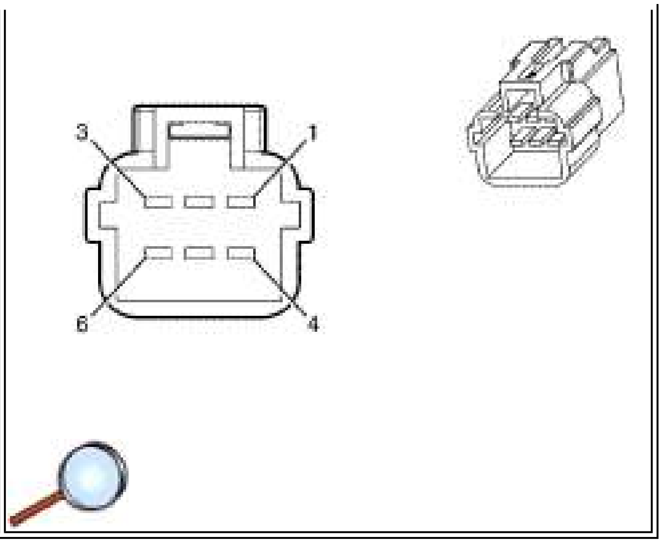
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe:See Terminal Repair Kit

X308 Body Harness to the Right Front Door Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used	1	--	--	Not Used
2	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage	2	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage
3	0.5 BK/WH	7391	Memory Mirror Ground	3	0.5 WH	7391	Memory Mirror Ground
4	0.5 D-GN/BK	881	Mirror Control Signal	4	0.5 OG/WH	881	Mirror Control Signal
5	0.5 PK/WH	889	Memory Mirror Voltage	5	0.5 PK/WH	889	Memory Mirror Voltage
6	0.5 BN	5998	Puddle Lamp Supply Voltage	6	0.5 BN	5998	Puddle Lamp Supply Voltage

X309 Body Harness to the I/P Harness





Connector Part Information

- OEM: 7283-1068
- Service: See Catalog
- Description: 6-Way F 090 II Series (WH)

Terminal Part Information

- Pins: 1, 4
- Terminal/Tray: 7116-4020/11
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

- Pins: 2, 5
- Terminal/Tray: 7116-4021/11
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

Connector Part Information

- OEM: 7282-1068
- Service: See Catalog
- Description: 6-Way M 090 II Series (WH)

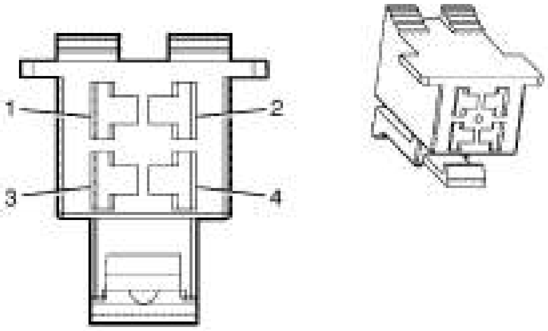
Terminal Part Information

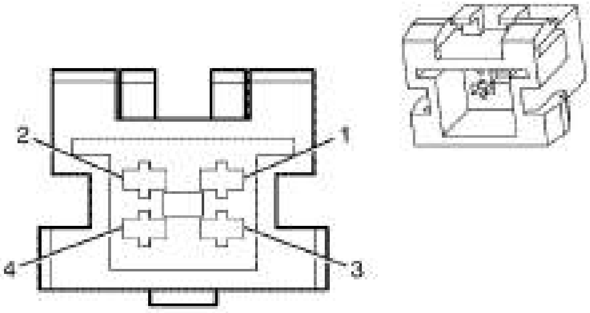
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X309 Body Harness to the I/P Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.5 OG/BK	233	Park Brake Switch Signal	1	0.5 OG/BK	233	Park Brake Switch Signal
2	1.25 BN/YE	9101	Accessory Voltage	2	1.25 BN/YE	9101	Accessory Voltage
3	0.85 OG	1732	Courtesy Lamps Supply Voltage	3	0.85 OG	1732	Courtesy Lamps Supply Voltage
4	0.3 GY	8	Instrument Panel Lamp Supply Voltage	4	0.3 GY	8	Instrument Panel Lamp Supply Voltage
5	1.25 BK	2050	Ground	5	1.25 BK	2050	Ground
6	--	--	Not Used	6	--	--	Not Used

X310 Passenger Seat Harness to the Body Harness





Connector Part Information

- OEM: 7183-8287-30
- Service: See Catalog
- Description: 4-Way F (BK)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7182-8287-30
- Service: See Catalog
- Description: 4-Way M (BK)

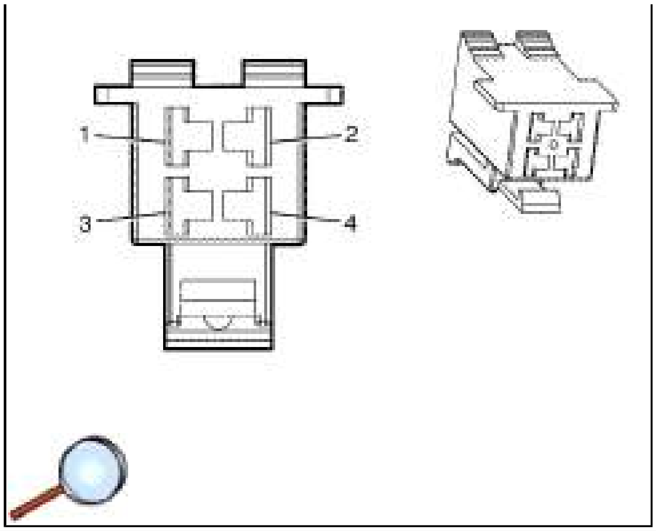
Terminal Part Information

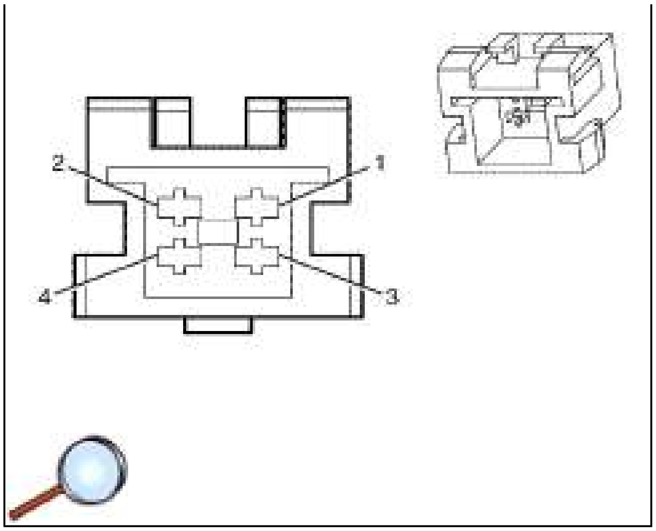
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X310 Passenger Seat Harness to the Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	2 OG	1140	Battery Positive Voltage	1	2 OG	1140	Battery Positive Voltage
2	2 BK	1350	Ground	2	2 BK	1350	Ground
3-4	--	--	Not Used	3-4	--	--	Not Used

X311 Driver Seat Harness to the Body Harness





Connector Part Information

- OEM: 7183-8287-30
- Service: See Catalog
- Description: 4-Way F (BK)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7182-8287-30
- Service: See Catalog
- Description: 4-Way M (BK)

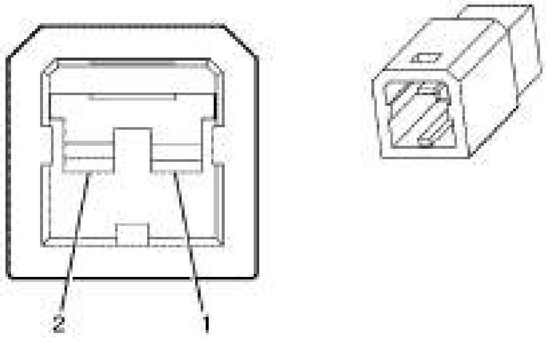
Terminal Part Information

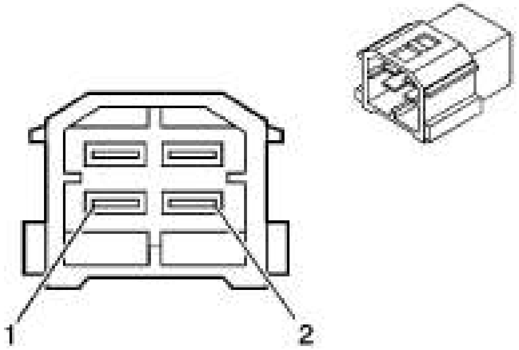
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X311 Driver Seat Harness to the Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	2 OG	1140	Battery Positive Voltage	1	2 OG	1140	Battery Positive Voltage (without A45)
					2 RD	1140	Battery Positive Voltage (A45)
2	2 BK	2050	Ground (without A45)	2	2 BK	2050	Ground (without A45)
	1.25 BK	2050	Ground (A45)		1.25 BK	2050	Ground (A45)
3	0.3 BK/WH	238	Seat Belt Switch - Left	3	0.3 BK/WH	238	Seat Belt Switch - Left
4	0.3 D-BU	1363	Seat Belt Switch - Left - Low Reference	4	0.3 D-BU	1363	Seat Belt Switch - Left - Low Reference

X312 Body Harness to the Passenger Seat Harness





Connector Part Information

- OEM: 7182-1724
- Service: See Catalog
- Description: 2-Way M (BK)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 174463-2
- Service: See Catalog
- Description: 2-Way F (WH)

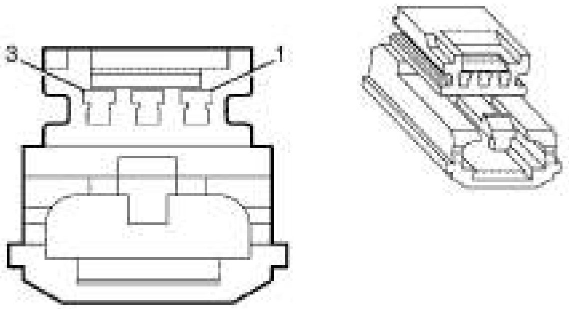
Terminal Part Information

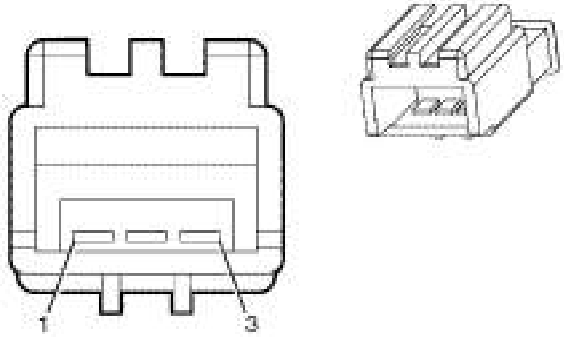
- Terminal/Tray: 173633-3/15
- Core/Insulation Crimp: E/4
- Release Tool/Test Probe: 15315247/J-35616-34 (YE)

X312 Body Harness to the Passenger Seat Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.3 PK/BU	5056	Seat Position Sensor-Right - Signal	1	0.3 L-BU	5056	Seat Position Sensor-Right - Signal
2	0.3 PU/WH	5057	Seat Position Sensor - Low Reference	2	0.3 PK	5057	Seat Position Sensor - Low Reference

X313 Body Harness to the Passenger Seat Harness





Connector Part Information

- OEM: 7283-9781-70
- Service: See Catalog
- Description: 3-Way F (YE)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 72829781
- Service: See Catalog
- Description: 3-Way M (YE)

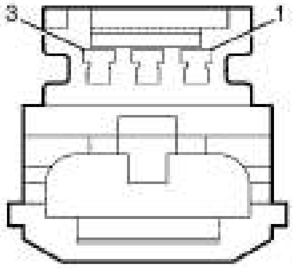
Terminal Part Information

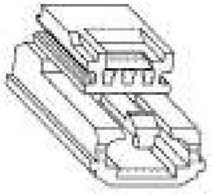
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

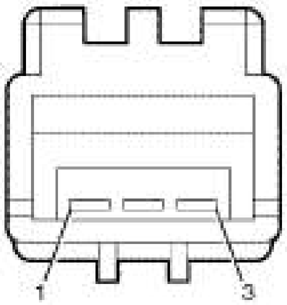
X313 Body Harness to the Passenger Seat Harness

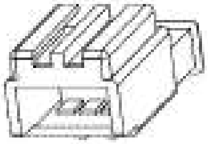
Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.3 BK/WH	2135	Side Impact Module - RF - High Control	1	0.3 BK/WH	2135	Side Impact Module - RF - High Control
2	0.3 L-GN	2136	Side Impact Module - RF - Low Control	2	0.3 L-GN	2136	Side Impact Module - RF - Low Control
3	0.3 BK/WH	1751	Ground	3	0.3 L-GN	1751	Ground

X314 Body Harness to the Driver Seat Harness









Connector Part Information

- OEM: 7283-9781-70
- Service: See Catalog
- Description: 3-Way F (YE)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 72829781
- Service: See Catalog
- Description: 3-Way M (YE)

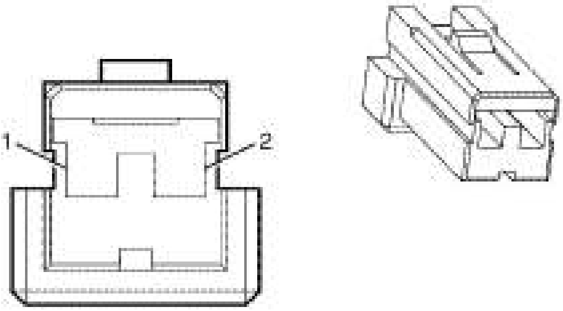
Terminal Part Information

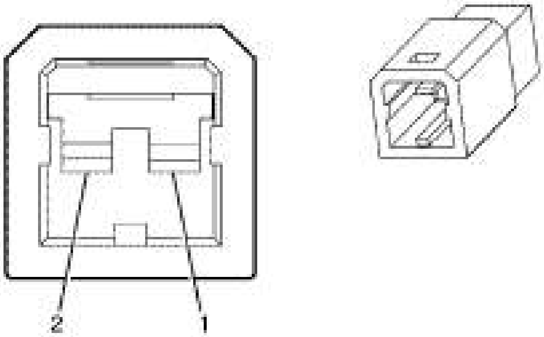
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X314 Body Harness to the Driver Seat Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.3 BN	2137	Side Impact Module - LF - High Control	1	0.3 BN	2137	Side Impact Module - LF - High Control
2	0.3 YE/BK	2138	Side Impact Module - LF - Low Control	2	0.3 YE/BK	2138	Side Impact Module - LF - Low Control
3	0.3 BK/WH	1751	Ground	3	0.3 BK/WH	1751	Ground

X315 Body Harness to the Driver Seat Harness





Connector Part Information

- OEM: 174463-2
- Service: See Catalog
- Description: 2-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7182-1724
- Service: See Catalog
- Description: 2-Way M

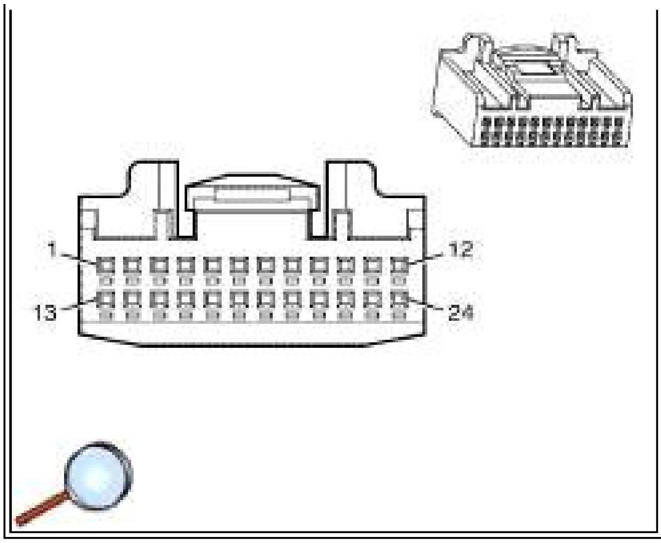
Terminal Part Information

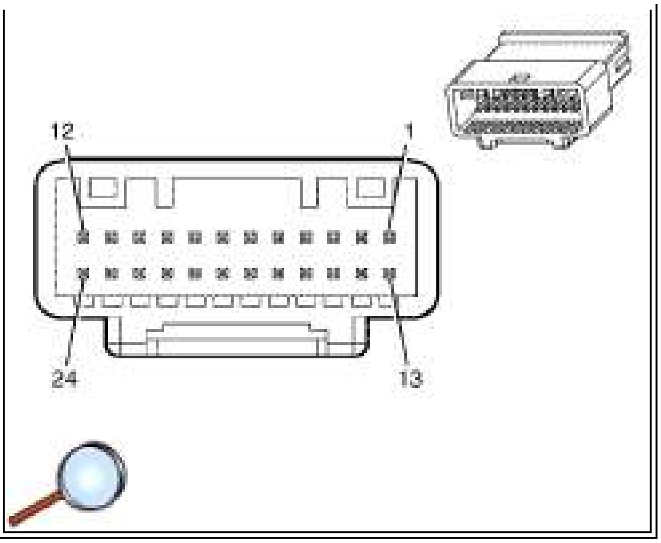
- Terminal/Tray: 173633-3/15
- Core/Insulation Crimp: E/4
- Release Tool/Test Probe: 15315247/J-35616-34 (YE)

X315 Body Harness to the Driver Seat Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.3 L-GN	5055	Seat Position Sensor-Left - Signal	1	0.3 PK/BU	5055	Seat Position Sensor-Left - Signal
2	0.3 D-BU	5057	Seat Position Sensor - Low Reference	2	0.3 PU/WH	5057	Seat Position Sensor - Low Reference

X316 Body Harness to the Digital Video Disc (DVD) Control Module





Connector Part Information

- OEM: 1318917
- Service: See Catalog
- Description: 24-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 1376103
- Service: See Catalog
- Description: 24-Way M

Terminal Part Information

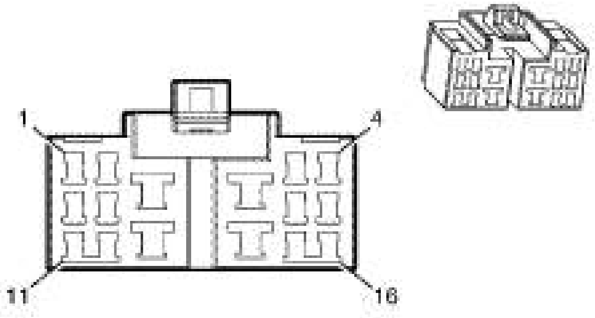
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

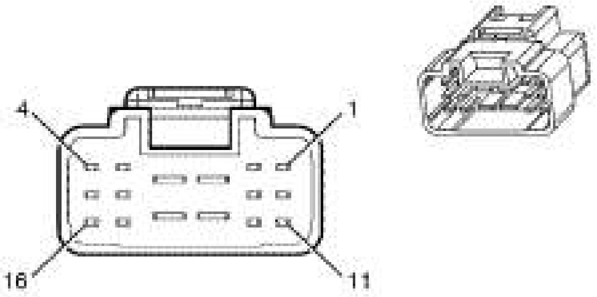
X316 Body Harness to the Digital Video Disc (DVD) Control Module

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.18 OG	6849	Battery Positive	1	0.18 OG	6849	Battery Positive
2	0.18 YE	5845	RS485 TX	2	0.18 YE	5845	RS485 TX
3	0.18 BARE	5339	Shield	3	0.18 BARE	5339	Shield
4	0.18 L-GN	5826	DVD Audio Left Signal (+)	4	0.18 L-GN	5826	DVD Audio Left Signal (+)
5	0.18 L-GN/WH	5828	DVD Audio Right Signal (+)	5	0.18 D-GN/WH	5828	DVD Audio Right Signal (+)
6	0.18 WH	6975	DVD Video Signal (+)	6	0.18 WH	6975	DVD Video Signal (+)
7	0.18 YE	2059	Auxiliary Audio Left Signal (+)	7	0.18 YE	2059	Auxiliary Audio Left Signal (+)
8	0.18 D-BU/WH	2058	Auxiliary Audio Right Signal (+)	8	0.18 WH/RD	2058	Auxiliary Audio Right Signal (+)
9	0.18 RD	2056	Auxiliary Video Signal (+)	9	0.18 PU	2056	Auxiliary Video Signal (+)

10	0.5 RD	5839	Auxiliary Audio Left Signal (+)	10	0.5 BN/WH	5839	Auxiliary Audio Left Signal (+)
11	0.5 D-GN	5841	Auxiliary Audio Right Signal (+)	11	0.5 D-BU	5841	Auxiliary Audio Right Signal (+)
12	0.5 OG	5756	Roof Centre Speaker Output (+)	12	0.5 OG	5756	Roof Centre Speaker Output (+)
13	0.18 L-BU	6873	Ground	13	0.18 L-BU	6873	Ground
14	0.18 D-BU	1098	RS485 RX	14	0.18 D-GN	1098	RS485 RX
15	--	--	Not Used	15	--	--	Not Used
16	0.18 BARE	5825	DVD Audio Left Signal (-)	16	0.18 L-GN	5825	DVD Audio Left Signal (-)
17	0.18 BARE	5827	DVD Audio Right Signal (-)	17	0.18 D-GN/WH	5827	DVD Audio Right Signal (-)
18	0.18 WH	6976	DVD Video Signal (-)	18	0.18 WH	6976	DVD Video Signal (-)
19	0.18 BARE	5843	Auxiliary Audio Left Signal (-)	19	0.18 YE	5843	Auxiliary Audio Left Signal (-)
20	0.18 WH/RD	5345	Auxiliary Audio Right Signal (-)	20	0.18 WH/RD	5345	Auxiliary Audio Right Signal (-)
21	0.18 BARE	2057	Auxiliary Video Signal (-)	21	0.18 PU	2057	Auxiliary Video Signal (-)
22	--	--	Not Used	22	--	--	Not Used
23	0.5 BARE	7001	Common Auxiliary Audio Signal (-)	23	0.5 D-BU	7001	Common Auxiliary Audio Signal (-)
24	0.5 OG/BK	5766	Roof Centre Speaker Output (-)	24	0.5 OG/BK	5766	Roof Centre Speaker Output (-)

X317 Body Harness to the Body Harness





Connector Part Information

- OEM: 7283-1168
- Service: See Catalog
- Description: 16-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7282-1168
- Service: See Catalog
- Description: 16-Way M

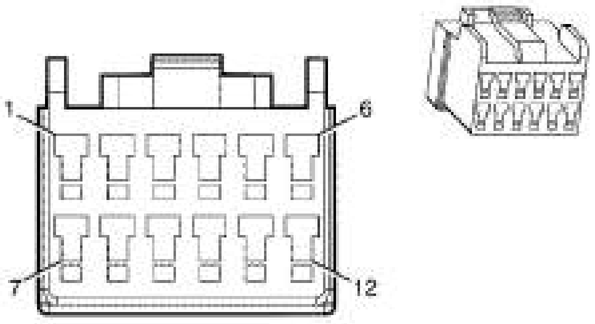
Terminal Part Information

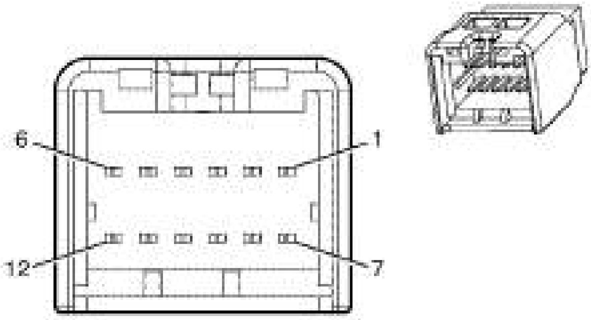
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X317 Body Harness to the Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1-2	--	--	Not Used	1-2	--	--	Not Used
3	0.5 BN	5998	Puddle Lamp Supply Voltage	3	0.5 BN	5998	Puddle Lamp Supply Voltage
4	0.3 OG	6978	Amplifier Mute Control	4	0.3 OG	6978	Amplifier Mute Control
5	0.3 BN/WH	5217	RF Corner Object Sensor Signal	5	0.3 BN/WH	5217	RF Corner Object Sensor Signal
6	--	--	Not Used	6	--	--	Not Used
7	2 OG/BU	1540	Battery Positive Voltage	7	2 OG/BU	1540	Battery Positive Voltage
8	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage	8	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage
9	0.3 OG/BK	5214	Object Sensor Low Reference	9	0.3 OG/BK	5214	Object Sensor Low Reference
10	0.3 WH	7066	Amplifier Enable Signal	10	0.3 WH	7066	Amplifier Enable Signal
11	0.3 BN	6581	Object Sensor Supply Voltage	11	0.3 BN	6581	Object Sensor Supply Voltage
12	0.3 PU/WH	5218	RF Middle Object Sensor Signal	12	0.3 PU/WH	5218	RF Middle Object Sensor Signal
13-14	--	--	Not Used	13-14	--	--	Not Used
15	0.3 WH	5216	LF Middle Object Sensor Signal	15	0.3 WH	5216	LF Middle Object Sensor Signal
16	0.3 PU/WH	5215	LF Corner Object Sensor Signal	16	0.3 PU/WH	5215	LF Corner Object Sensor Signal

X319 Headliner Harness to the Digital Video Disc (DVD) Control Module





Connector Part Information

- OEM: 174045-2
- Service: See Catalog
- Description: 12-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 174058-2
- Service: See Catalog
- Description: 12-Way M

Terminal Part Information

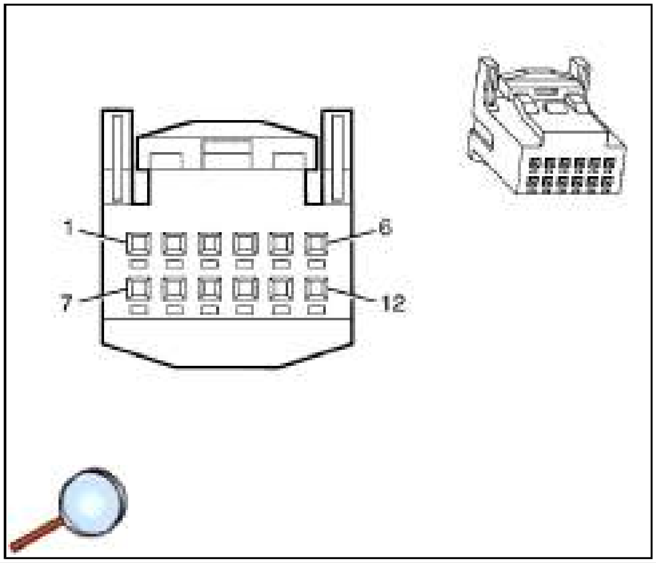
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

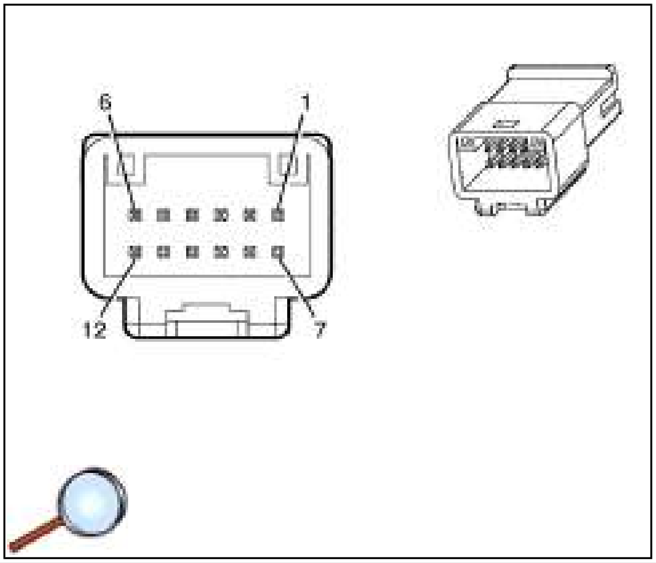
X319 Headliner Harness to the Digital Video Disc (DVD) Control Module

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.5 PK	367	Left Audio Signal (+) (U56)	1	0.5 BN/WH	367	Left Audio Signal (+) (U56)
	0.3 D-GN	5060	Low Speed Gmlan Serial Data (UWF)		0.3 D-GN	5060	Low Speed Gmlan Serial Data (UWF)
2	0.5WH/BK	5335	DVD Video Signal (-)	2	0.5 BK	5335	DVD Video Signal (-)
3	0.5 RD	5334	DVD Video Signal (+)	3	0.5 RD/WH	5334	DVD Video Signal (+)
4	--	--	Not Used	4	--	--	Not Used
5	0.5 OG/YE	4540	DVD Video Signal (+)	5	0.5 RD/WH	4540	DVD Video Signal (+)
6	0.3 D-GN	5060	Low Speed Gmlan Serial Data (U56)	6	0.3 D-GN	5060	Low Speed Gmlan Serial Data (U56)
	0.5 PK	367	Left Audio Signal (+) (UWF)		0.5 WH	367	Left Audio Signal (+) (UWF)
			Right Audio Signal		0.5 D-		Right Audio Signal

7	0.5 D-BU	368	(+) (U56)	7	BU	368	(+) (U56)
8	0.5 D-GN/WH	1547	Common Audio Signal (-) (U56)	8	0.5 D-GN	1547	Common Audio Signal (-) (U56)
9	0.5 BK	1050	Ground	9	0.5 BK	1050	Ground
10	0.5 BK	1050	Ground	10	0.5 BK	1050	Ground
11	0.5 D-GN/WH		Common Audio Signal (-) (UWF)	11	0.5 WH/RD		Common Audio Signal (-) (UWF)
12	0.5 OG/YE	4540	Battery Positive Voltage	12	0.5 RD/WH	4540	Battery Positive Voltage
	0.5 D-BU	368	Right Audio Signal (+) (UWF)		0.5 RD	368	Right Audio Signal (+) (UWF)

X322 Passenger Seat Harness to the Body Harness





Connector Part Information

- OEM: 1318774-1
- Service: See Catalog
- Description: 12-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 1565894-1
- Service: See Catalog
- Description: 12-Way M

Terminal Part Information

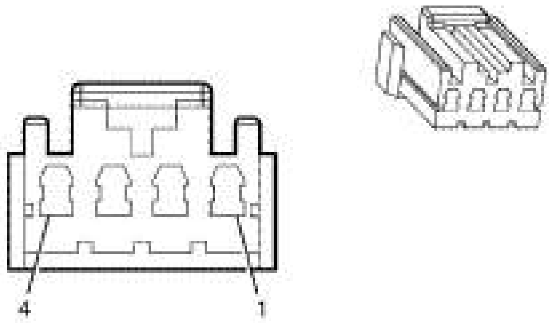
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

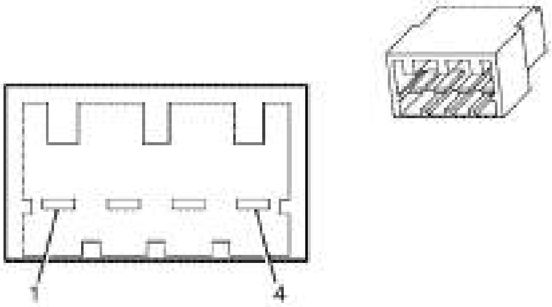
X322 Passenger Seat Harness to the Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.5	6839	Memory Mirror	1	0.5	6839	Memory Mirror

	RD/BU		Voltage		PK/WH		Voltage
2	0.5 BK/GN	2851	Memory Mirror Ground	2	0.5 BK/WH	2851	Memory Mirror Ground
3	0.5 YE/GN	7006	Mirror Control Signal	3	0.5 D-GN/WH	7006	Mirror Control Signal
4	0.5 OG	1512	Left Mirror Switch Right Signal	4	0.5 WH	1512	Left Mirror Switch Right Signal
5	0.5 D-BU	1513	Right Mirror Switch Right Signal	5	0.5 OG/WH	1513	Right Mirror Switch Right Signal
6	0.13 YE	5636	Left/Right Mirror Switch Signal	6	0.13 D-BU	5636	Left/Right Mirror Switch Signal
7	0.5 WH	1514	Left Mirror Motor Down Signal	7	0.5 L-GN	1514	Left Mirror Motor Down Signal
8	0.5 D-GN	1515	Right Mirror Motor Down Signal	8	0.5 PU/WH	1515	Right Mirror Motor Down Signal
9	0.5 BK	5478	Ground	9	0.5 BN	5478	Ground
10	0.5 RD	5477	Switch Voltage	10	0.5 YE	5477	Switch Voltage
11-12	--	--	Not Used	11-12	--	--	Not Used

X324 Driver Seat Back to the Driver Seat Harness (AH5)





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 4-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal

Connector Part Information

- OEM:
- Service: See Catalog
- Description: 4-Way M

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal

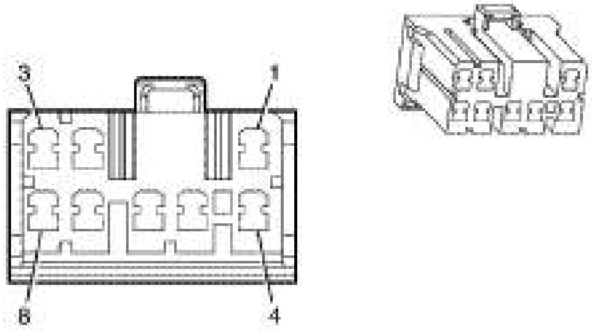
Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

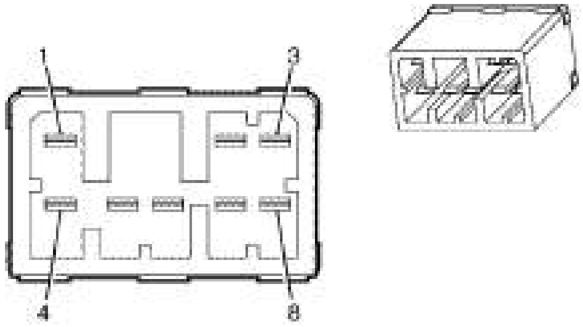
Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X324 Driver Seat Back to the Driver Seat Harness (AH5)

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.85 YE	276	Driver Seat Recline Motor Forward Control	1	0.85 YE	276	Driver Seat Recline Motor Forward Control
2	0.85 PU/GN	277	Driver Seat Recline Motor Rearward Control	2	0.85 PU/GN	277	Driver Seat Recline Motor Rearward Control
3	0.3 BK/OG	1350	Ground	3	0.3 BK/OG	1350	Ground
4	0.3 D-GN/BN	570	Driver Seat Recline Motor Position Sensor Signal	4	0.3 D-GN/BN	570	Driver Seat Recline Motor Position Sensor Signal

X324 Driver Seat Back to the Driver Seat Harness (AGB)





Connector Part Information

- OEM: 173850-2
- Service: See Catalog
- Description: 8-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe:See Terminal Repair Kit

Connector Part Information

- OEM: 174391-2
- Service: See Catalog
- Description: 8-Way M

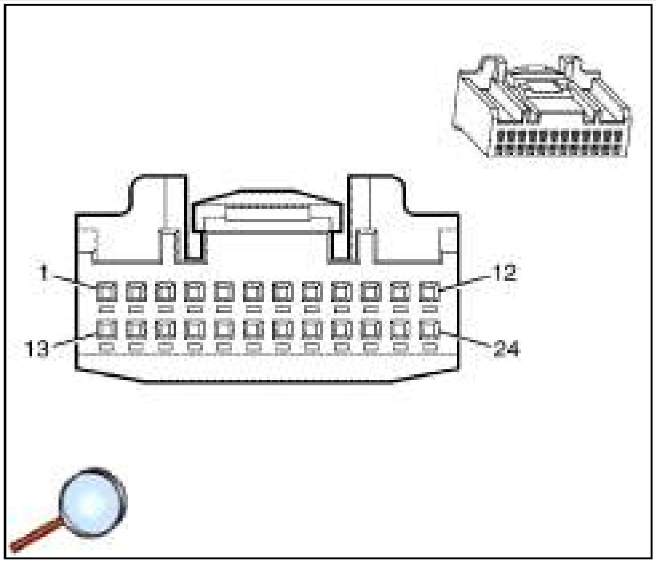
Terminal Part Information

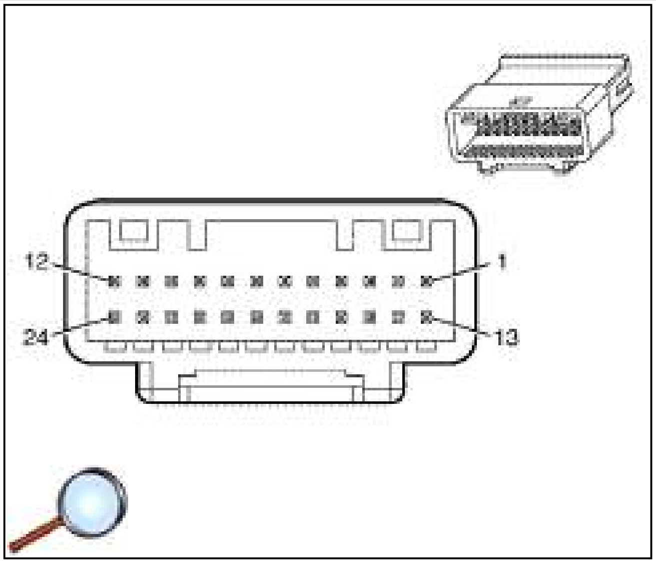
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X324 Driver Seat Back to the Driver Seat Harness (AGB)

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.85 RD/YE	768	Driver Seat Lumbar Motor Up Control	1	0.85 RD/YE	768	Driver Seat Lumbar Motor Up Control
2	0.85 YE	276	Driver Seat Recline Motor Forward Control	2	0.85 YE	276	Driver Seat Recline Motor Forward Control
3	0.85 PU/GN	277	Driver Seat Recline Motor Rearward Control	3	0.85 PU/GN	277	Driver Seat Recline Motor Rearward Control
4	0.85 D-GN/RD	767	Driver Seat Lumbar Motor Down Control	4	0.85 D-GN/RD	767	Driver Seat Lumbar Motor Down Control
5	0.3 PU/BU	1062	Driver Seat Lumbar Vertical Position Sensor Signal	5	0.3 PU/BU	1062	Driver Seat Lumbar Vertical Position Sensor Signal
6	0.3 D-BU/YE	1063	Driver Seat Lumbar Horizontal Position Sensor Signal	6	0.3 D-BU/YE	1063	Driver Seat Lumbar Horizontal Position Sensor Signal
7	0.3 BK/OG	1350	Ground	7	0.3 BK/OG	1350	Ground
8	0.3 D-GN/BN	570	Driver Seat Recline Motor Position Sensor Signal	8	0.3 D-GN/BN	570	Driver Seat Recline Motor Position Sensor Signal

X330 Left Seat Harness to the Body Harness





Connector Part Information

- OEM: 1318917
- Service: See Catalog
- Description: 24-Way F

Terminal Part Information

Connector Part Information

- OEM: 1375103
- Service: See Catalog
- Description: 24-Way M

Terminal Part Information

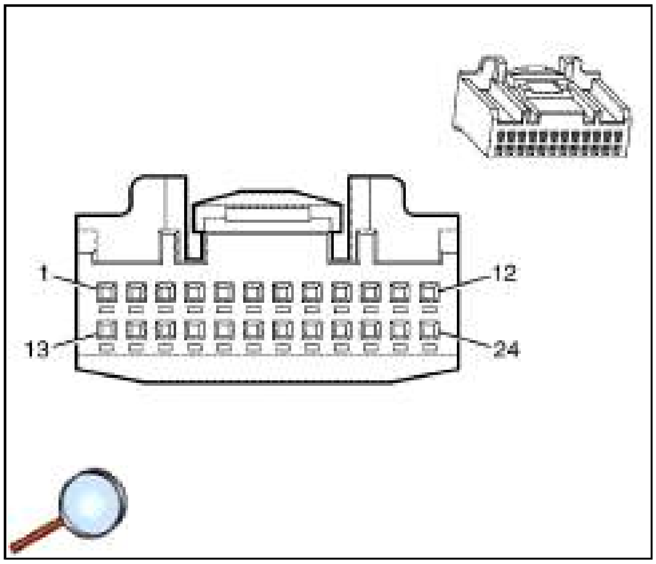
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

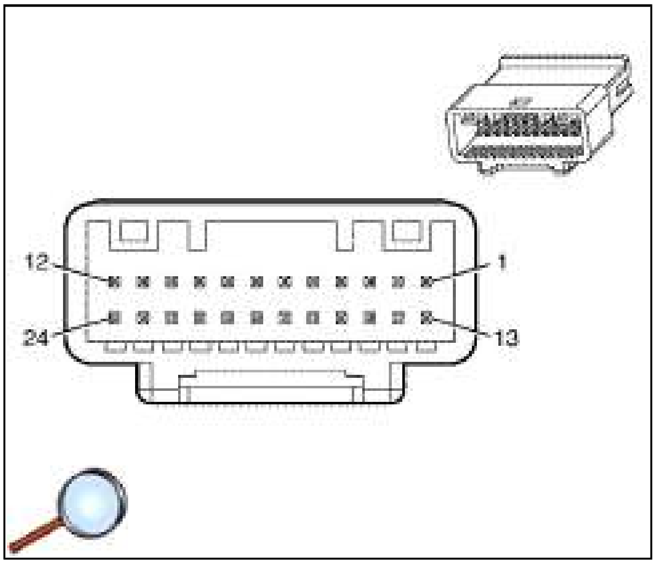
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X330 Left Seat Harness to the Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.5 OG	6849	Battery Positive	1	0.5 OG	6849	Battery Positive
2	0.5 YE	5845	RS485 TX	2	0.5 YE	5845	RS485 TX
3	0.5 BARE	5339	Shield	3	0.5 BARE	5339	Shield
4	0.5 L-GN	5826	DVD Audio Left Signal (+)	4	0.5 L-GN	5826	DVD Audio Left Signal (+)
5	0.5 D-GN/WH	5828	DVD Audio Right Signal (+)	5	0.5 L-GN/WH	5828	DVD Audio Right Signal (+)
6	0.5 WH	5975	DVD Video Signal (+)	6	0.5 WH	5975	DVD Video Signal (+)
7	0.5 YE	2059	Auxiliary Audio Left Signal (+)	7	0.5 YE	2059	Auxiliary Audio Left Signal (+)
8	0.5 WH/RD	2058	Auxiliary Audio Right Signal (+)	8	0.5 BN/WH	2058	Auxiliary Audio Right Signal (+)
9	0.5 PU	2056	Auxiliary Video Signal (+)	9	0.5 RD	2056	Auxiliary Video Signal (+)
10-12	--	--	Not Used	10-12	--	--	Not Used
13	0.5 L-BU	6873	Ground	13	0.5 L-BU	6873	Ground
14	0.5 D-GN	1098	RS485 RX	14	0.5 D-BU	1098	RS485 RX
15	--	--	Not Used	15	--	--	Not Used
16	0.5 L-GN	5825	DVD Audio Left Signal (-)	16	0.5 BARE	5825	DVD Audio Left Signal (-)
17	0.5 D-GN/WH	5827	DVD Audio Right Signal (-)	17	0.5 BARE	5827	DVD Audio Right Signal (-)
18	0.5 WH	6976	DVD Video Signal (-)	18	0.5 WH	6976	DVD Video Signal (-)
19	0.5 YE	5843	Auxiliary Audio Left Signal (-)	19	0.5 BARE	5843	Auxiliary Audio Left Signal (-)
20	0.5 WH/RD	5345	Auxiliary Audio Right Signal (-)	20	0.5 WH/RD	5345	Auxiliary Audio Right Signal (-)
21	0.5 PU	2057	Auxiliary Video Signal (-)	21	0.5 BARE	2057	Auxiliary Video Signal (-)
22-24	--	--	Not Used	22-24	--	--	Not Used

X331 Right Seat Harness to the Body Harness





Connector Part Information

- OEM: 1318917
- Service: See Catalog
- Description: 24-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 1376103
- Service: See Catalog
- Description: 24-Way M

Terminal Part Information

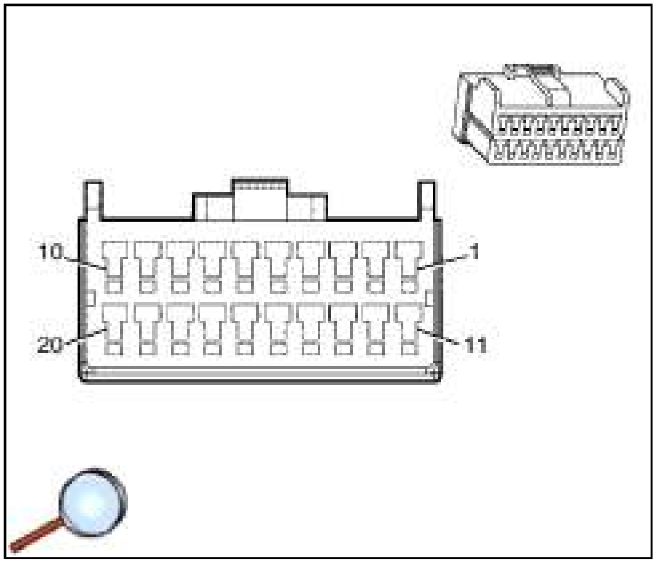
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

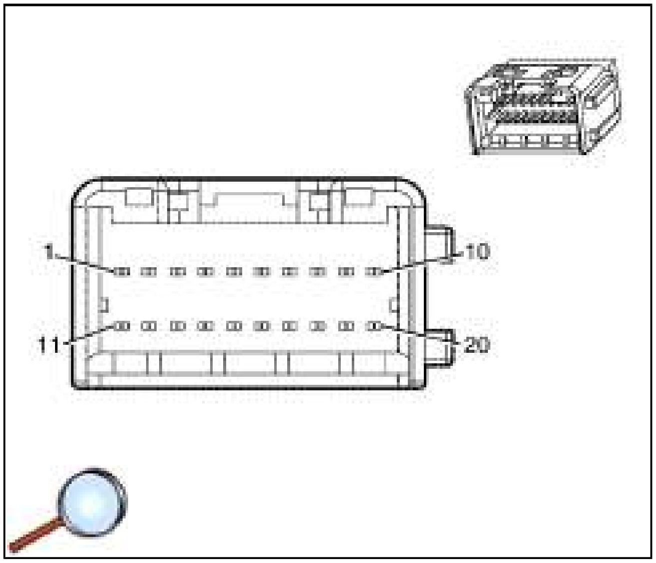
X331 Right Seat Harness to the Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.5 OG	6889	Battery Positive	1	0.5 OG	6889	Battery Positive
2	0.5 YE	6900	RS485 TX	2	0.5 YE	6900	RS485 TX
3	0.5 BARE	6904	Shield	3	0.5 BARE	6904	Shield
4	0.5 L-GN	6890	DVD Audio Left Signal (+)	4	0.5 L-GN	6890	DVD Audio Left Signal (+)
5	0.5 L-GN/WH	6891	DVD Audio Right Signal (+)	5	0.5 D-GN/WH	6891	DVD Audio Right Signal (+)
6	0.5 WH	7396	DVD Video Signal (+)	6	0.5 WH	7396	DVD Video Signal (+)
7-12	--	--	Not Used	7-12	--	--	Not Used
13	0.5 L-BU	6903	Ground	13	0.5 L-BU	6903	Ground
14	0.5 D-BU	6901	RS485 RX	14	0.5 D-GN	6901	RS485 RX
15	--	--	Not Used	15	--	--	Not Used
16	0.5 BARE	6892	DVD Audio Left Signal (-)	16	0.5 L-GN	6892	DVD Audio Left Signal (-)

17	0.5 BARE	6979	DVD Audio Right Signal (-)	17	0.5 D-GN/WH	6979	DVD Audio Right Signal (-)
18	0.5 BARE	7394	DVD Video Signal (-)	18	0.5 WH	7394	DVD Video Signal (-)
19-24	--	--	Not Used	19-24	--	--	Not Used

X332 Video Display to the Right Seat Harness





Connector Part Information

- OEM: 174047-2
- Service: See Catalog
- Description: 20-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 175652-2
- Service: See Catalog
- Description: 20-Way M

Terminal Part Information

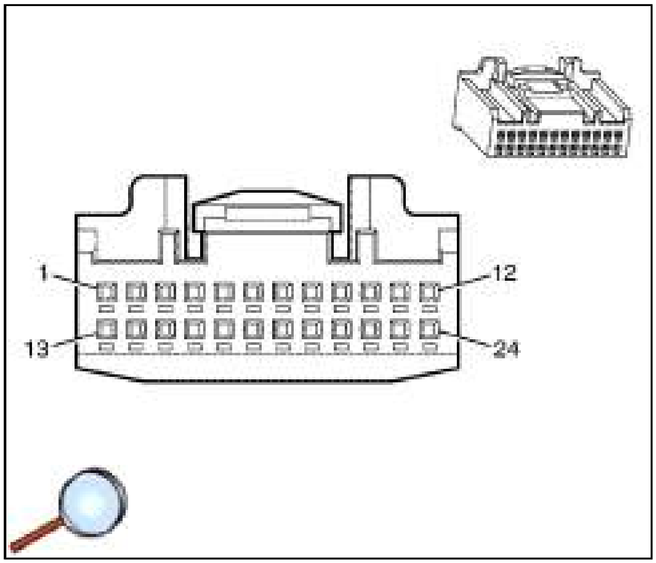
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

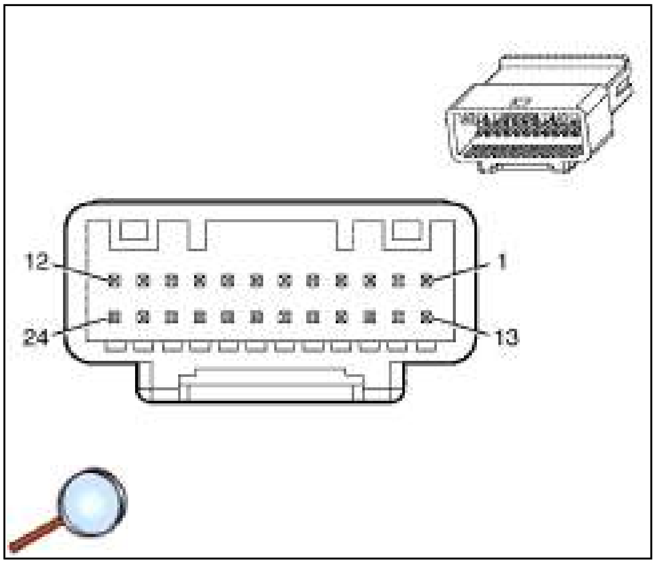
X332 Video Display to the Right Seat Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.18 L-GN	6890	DVD Audio Left Signal (+)	1	0.18 L-GN	6890	DVD Audio Left Signal (+)
2	0.18 D-GN/WH	6891	DVD Audio Right Signal (+)	2	0.18 D-GN/WH	6891	DVD Audio Right Signal (+)
3	0.18 BARE	6904	Shield	3	0.18 BARE	6904	Shield
4	0.18 WH	7396	DVD Video Signal (+)	4	0.18 WH	7396	DVD Video Signal (+)

5	0.18 WH	7394	DVD Video Signal (-)	5	0.18 WH	7394	DVD Video Signal (-)
6-7	--	--	Not Used	6-7	--	--	Not Used
8	0.18 OG	6889	Battery Positive	8	0.18 OG	6889	Battery Positive
9	0.18 L-BU	6890	Ground	9	0.18 L-BU	6890	Ground
10	0.18 PU	2057	Auxiliary Video Signal (-)	10	0.18 PU	2057	Auxiliary Video Signal (-)
11	0.18 L-GN	6892	DVD Audio Left Signal (-)	11	0.18 L-GN	6892	DVD Audio Left Signal (-)
12	0.18 D-GN/WH	6979	DVD Audio Right Signal (-)	12	0.18 D-GN/WH	6979	DVD Audio Right Signal (-)
13	--	--	Not Used	13	--	--	Not Used
14	0.18 D-GN	6901	RS485 RX	14	0.18 D-GN	6901	RS485 RX
15	0.18 YE	6900	RS485 TX	15	0.18 YE	6900	RS485 TX
16	--	--	Not Used	16	--	--	Not Used
17	0.18 YE	2059	Auxiliary Audio Left Signal (+)	17	0.18 YE	2059	Auxiliary Audio Left Signal (+)
18	0.18 YE	5843	Auxiliary Audio Left Signal (-)	18	0.18 YE/BK	5843	Auxiliary Audio Left Signal (-)
	0.18 WH/RD	5345	Auxiliary Audio Right Signal (-)		0.18 WH/RD	5345	Auxiliary Audio Right Signal (-)
19	0.18 WH/RD	2058	Auxiliary Audio Right Signal (+)	19	0.18 WH/RD	2058	Auxiliary Audio Right Signal (+)
20	0.18 PU	2056	Auxiliary Video Signal (+)	20	0.18 PU	2056	Auxiliary Video Signal (+)

X333 Left Seat Harness to the Body Harness





Connector Part Information

Connector Part Information

- OEM: 1318917
- Service: See Catalog
- Description: 24-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

- OEM: 1376103
- Service: See Catalog
- Description: 24-Way M

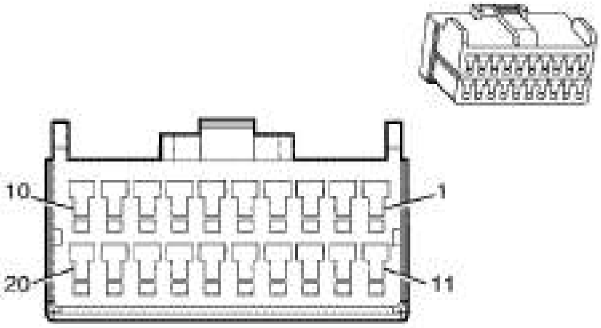
Terminal Part Information

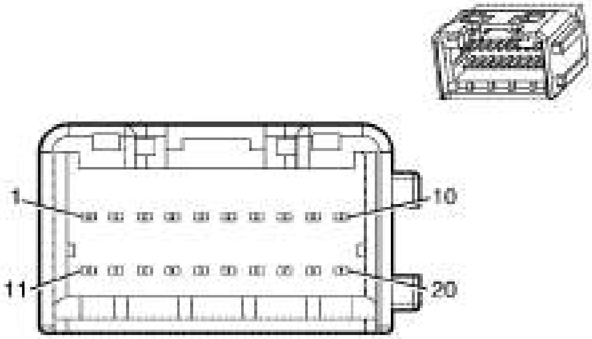
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X333 Left Seat Harness to the Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.18 OG	6849	Battery Positive	1	0.5 OG	6849	Battery Positive
2	0.18 YE	5845	RS485 TX	2	0.5 YE	5845	RS485 TX
3	0.18 BARE	5339	Shield	3	0.5 BARE	5339	Shield
4	0.18 L-GN	5826	DVD Audio Left Signal (+)	4	0.5 L-GN	5826	DVD Audio Left Signal (+)
5	0.18 D-GN/WH	5828	DVD Audio Right Signal (+)	5	0.5 L-GN/WH	5828	DVD Audio Right Signal (+)
6	0.18 WH	6975	DVD Video Signal (+)	6	0.5 WH	6975	DVD Video Signal (+)
7-12	--	--	Not Used	7-12	--	--	Not Used
13	0.18 L-BU	6873	Ground	13	0.5 L-BU	6873	Ground
14	0.18 D-GN	1098	RS485 RX	14	0.5 D-BU	1098	RS485 RX
15	--	--	Not Used	15	--	--	Not Used
16	0.18 L-GN	5825	DVD Audio Left Signal (-)	16	0.5 BARE	5825	DVD Audio Left Signal (-)
17	0.18 D-GN/WH	5827	DVD Audio Right Signal (-)	17	0.5 BARE	5827	DVD Audio Right Signal (-)
18	0.18 WH	6976	DVD Video Signal (-)	18	0.5 BARE	6976	DVD Video Signal (-)
19-24	--	--	Not Used	19-24	--	--	Not Used

X335 Video Display Assembly to the Body Harness





Connector Part Information

- OEM: 174047-2
- Service: See Catalog
- Description: 20-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 175652-2
- Service: See Catalog
- Description: 20-Way M

Terminal Part Information

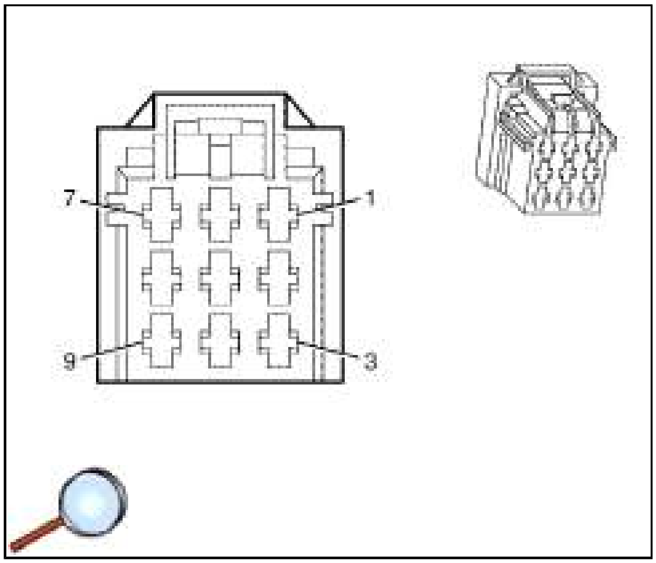
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

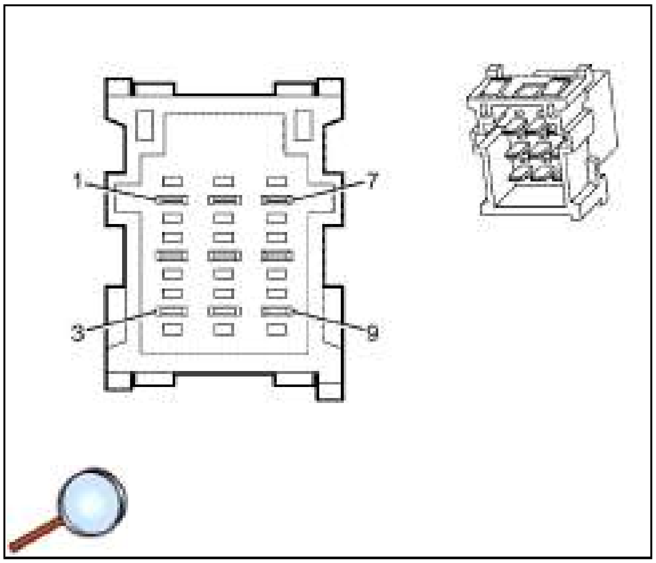
X335 Video Display Assembly to the Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.18 L-GN	5826	DVD Audio Left Signal (+)	1	0.18 L-GN	5826	DVD Audio Left Signal (+)
2	0.18 D-GN/WH	5828	DVD Audio Right Signal (+)	2	0.18 D-GN/WH	5828	DVD Audio Right Signal (+)
3	0.18 BARE	5339	Shield	3	0.18 BARE	5339	Shield
4	0.18 WH	6975	DVD Video Signal (+)	4	0.18 WH	6975	DVD Video Signal (+)
5	0.18 WH	6976	DVD Video Signal (-)	5	0.18 WH	6976	DVD Video Signal (-)
6-7	--	--	Not Used	6-7	--	--	Not Used
8	0.18 OG	6849	Battery Positive	8	0.18 OG	6849	Battery Positive
9-10	--	--	Not Used	9-10	--	--	Not Used
11	0.18 L-GN	5825	DVD Audio Left Signal (-)	11	0.18 L-GN	5825	DVD Audio Left Signal (-)
12	0.18 D-GN/WH	5827	DVD Audio Right Signal (-)	12	0.18 D-GN/WH	5827	DVD Audio Right Signal (-)

13	0.18 L-BU	6903	Ground	13	0.18 L-BU	6903	Ground
14	0.18 D-GN	6901	RS485 RX	14	0.18 D-GN	6901	RS485 RX
15	0.18 YE	6900	RS485 TX	15	0.18 YE	6900	RS485 TX
16-20	--	--	Not Used	16-20	--	--	Not Used

X344 Inside Rearview Mirror Harness to the I/P Harness





Connector Part Information

- OEM: 7283-3603
- Service: See Catalog
- Description: 9-Way F (WH)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7182-0220
- Service: See Catalog
- Description: 9-Way M (WH)

Terminal Part Information

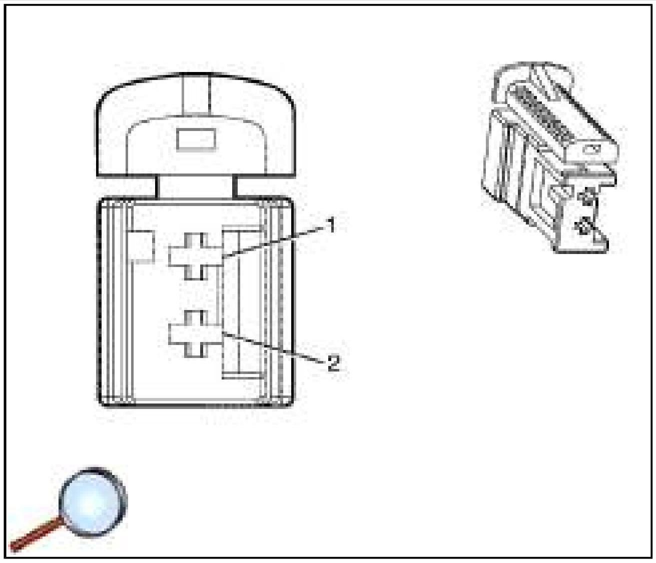
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

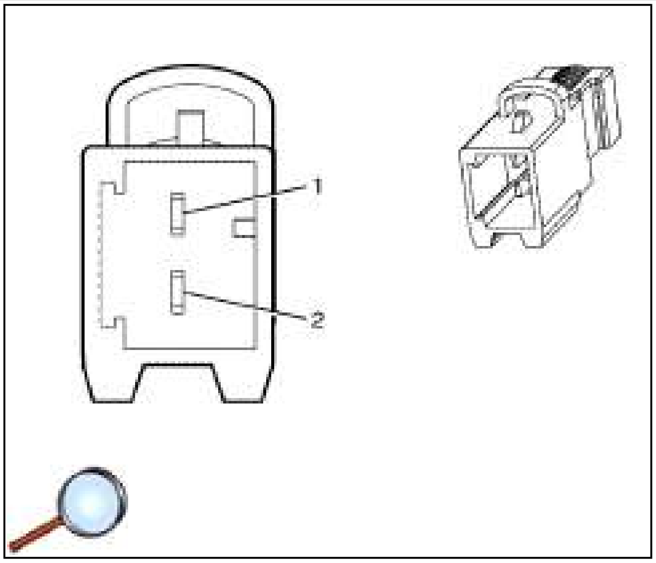
X344 Inside Rearview Mirror Harness to the I/P Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.3 PK	654	Cellular Telephone Microphone Low Reference	1	0.3 PK	654	Cellular Telephone Microphone Low Reference
2	0.3 BN/WH	2517	Keypad Red LED Signal	2	0.3 BN/WH	2517	Keypad Red LED Signal
3	0.3 L-GN/BK	2515	Keypad Supply Voltage	3	0.3 L-GN/BK	2515	Keypad Supply Voltage

4	0.3 D-GN	655	Cellular Microphone Signal	4	0.3 D-GN	655	Cellular Microphone Signal
5	0.3 YE/BK	2516	Keypad Green LED Signal	5	0.3 YE/BK	2516	Keypad Green LED Signal
6	0.3 D-GN/WH	2514	Keypad Signal	6	0.3 D-GN/WH	2514	Keypad Signal
7	0.3 L-GN	24	Backup Lamp Supply Voltage	7	0.3 L-GN	24	Backup Lamp Supply Voltage
8	0.5 BN	443	Accessory Voltage	8	0.5 BN	443	Accessory Voltage
9	0.5 BK	1450	Ground	9	0.5 BK	1450	Ground

X355 Body Harness to the Driver Seat Harness





Connector Part Information

- OEM: 174460-2
- Service: See Catalog
- Description: 2-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 174463-2
- Service: See Catalog
- Description: 2-Way M

Terminal Part Information

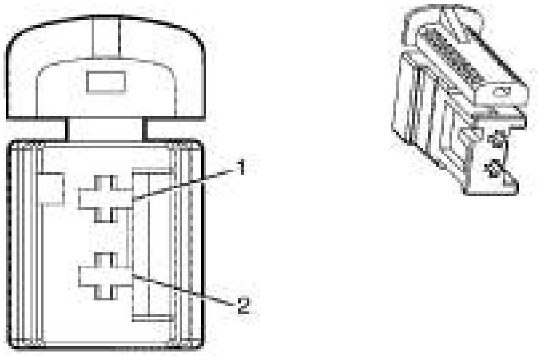
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

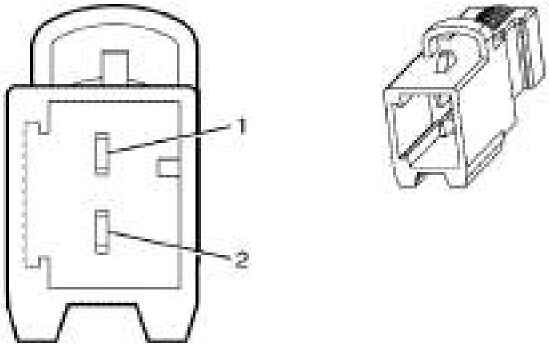
X355 Body Harness to the Driver Seat Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.3 L-GN	2118	Seat Belt Pretensioner - High Control	1	0.3 L-GN	2118	Seat Belt Pretensioner - High Control

2	0.3 OG	2119	Seat Belt Pretensioner - Low Control	2	0.3 OG	2119	Seat Belt Pretensioner - Low Control

X356 Body Harness to the Passenger Seat Harness





Connector Part Information

- OEM: 174460-2
- Service: See Catalog
- Description: 2-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 174463-2
- Service: See Catalog
- Description: 2-Way M

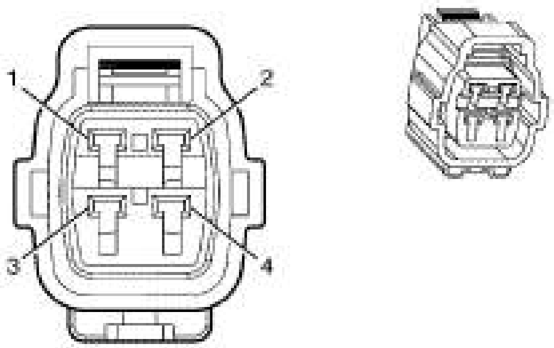
Terminal Part Information

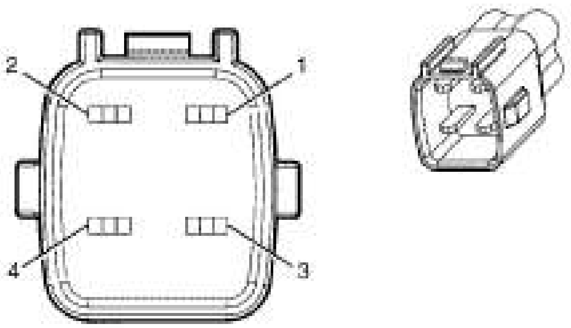
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X356 Body Harness to the Passenger Seat Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.3 BK/WH	2116	Seat Belt Pretensioner - High Control	1	0.3 BK/WH	2116	Seat Belt Pretensioner - High Control
2	0.3 OG/BK	2117	Seat Belt Pretensioner - Low Control	2	0.3 OG/BK	2117	Seat Belt Pretensioner - Low Control

X360 Body Harness to the Rear Wheel Speed Sensors





Connector Part Information

- OEM: 7283-7040-40
- Service: See Catalog
- Description: 4-Way F (BK)

Terminal Part Information

- Terminal/Tray: 7116-4025/11
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 15313892/J-35616-18 (BK)

Connector Part Information

- OEM: 7282-7040-40
- Service: See Catalog
- Description: 4-Way M 090 II Series Sealed (BK)

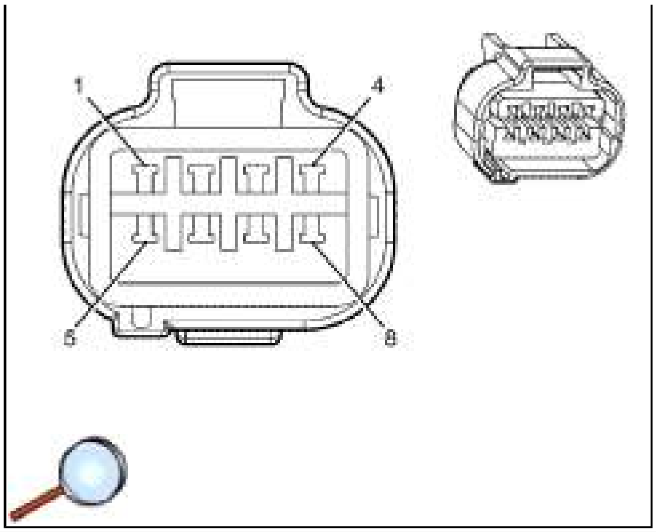
Terminal Part Information

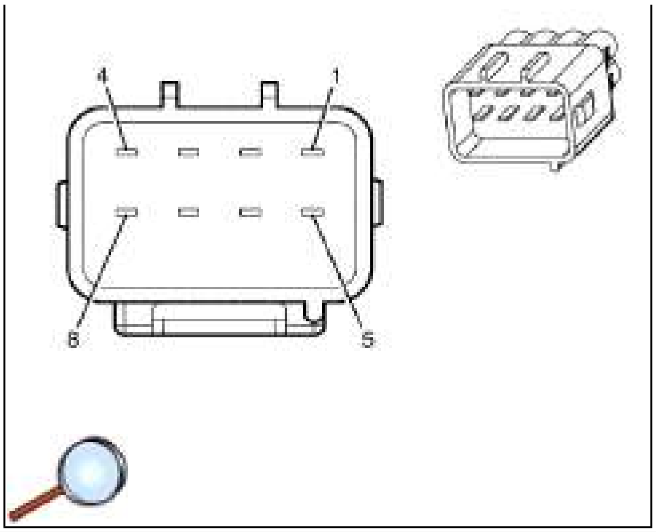
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X360 Body Harness to the Rear Wheel Speed Sensors

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.5 BN/BK	884	Left Rear Wheel Speed Sensor Signal	1	0.5 BN/BK	884	Left Rear Wheel Speed Sensor Signal
2	0.5 BN	882	Right Rear Wheel Speed Sensor Signal	2	0.5 BN	882	Right Rear Wheel Speed Sensor Signal
3	0.5 GY	7127	Left Rear Wheel Speed Sensor Supply Voltage	3	0.5 GY	7127	Left Rear Wheel Speed Sensor Supply Voltage
4	0.5 GY	7128	Right Rear Wheel Speed Sensor Supply Voltage	4	0.5 GY	7128	Right Rear Wheel Speed Sensor Supply Voltage

X361 Rear Axle Harness to the Body Harness





Connector Part Information

- OEM: 7283-7080-40
- Service: See Catalog
- Description: 8-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7282-7080-40
- Service: See Catalog
- Description: 8-Way M

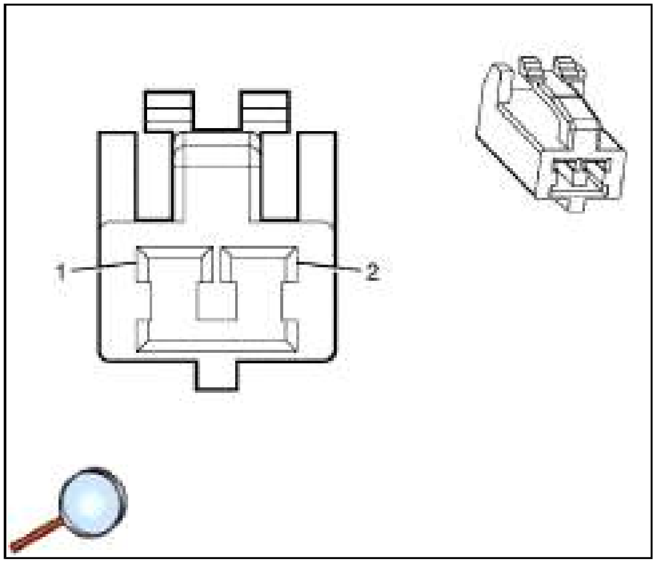
Terminal Part Information

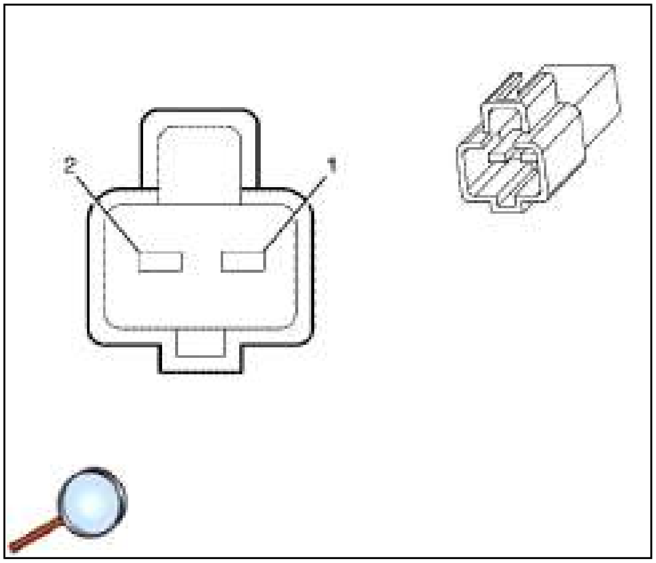
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X361 Rear Axle Harness to the Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.3 L-GN/BK	5209	Headlamp Leveling Sensor Wire 1	1	0.3 L-GN/BK	5209	Headlamp Leveling Sensor Wire 1
2	0.3 OG/BK	5208	Headlamp Leveling Sensor Wire 2	2	0.3 OG/BK	5208	Headlamp Leveling Sensor Wire 2
3	0.5 BN	882	Right Rear Wheel Speed Sensor Signal	3	0.5 BN	882	Right Rear Wheel Speed Sensor Signal
4	0.5 BN/BK	884	Left Rear Wheel Speed Sensor Signal	4	0.5 BN/BK	884	Left Rear Wheel Speed Sensor Signal
5	0.3 L-GN/WH	5210	Headlamp Leveling Sensor Wire 3	5	0.3 L-GN/WH	5210	Headlamp Leveling Sensor Wire 3
6	--	--	Not Used	6	--	--	Not Used
7	0.5 GY	7128	Right Rear Wheel Speed Sensor Supply Voltage	7	0.5 GY	7128	Right Rear Wheel Speed Sensor Supply Voltage
8	0.5 GY	7127	Left Rear Wheel Speed Sensor Supply Voltage	8	0.5 GY	7127	Left Rear Wheel Speed Sensor Supply Voltage

X402 Body Harness to the Decklid Harness





Connector Part Information

- OEM: 7283-1028-40
- Service: See Catalog
- Description: 2-Way F 090 II Series (GY)

Terminal Part Information

- Pin: 1
- Terminal/Tray: 7116-4021/11
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

- Pin: 2
- Terminal/Tray: 7116-4020/11
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

Connector Part Information

- OEM: 7282-1028-40
- Service: See Catalog
- Description: 2-Way M 090 II Series (GY)

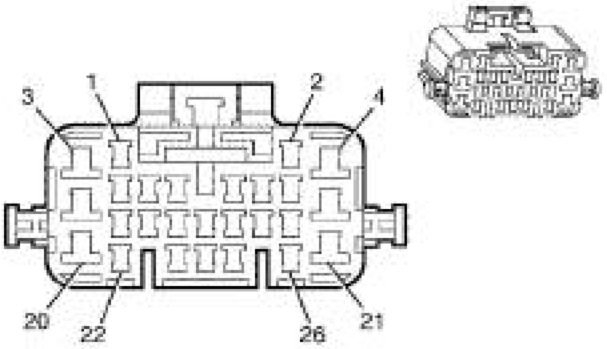
Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X402 Body Harness to the Decklid Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.85 BN/WH	309	Lamp Supply Voltage	1	0.5 BN/WH	309	Right Park Lamp Supply Voltage
2	0.5 BK	1350	Ground	2	0.5 BK	1350	Ground

X403 Rear Body Harness to the Body Harness



Connector Part Information

- OEM: 7283-1965
- Service: See Catalog
- Description: 26-Way F 090 II Series (WH)

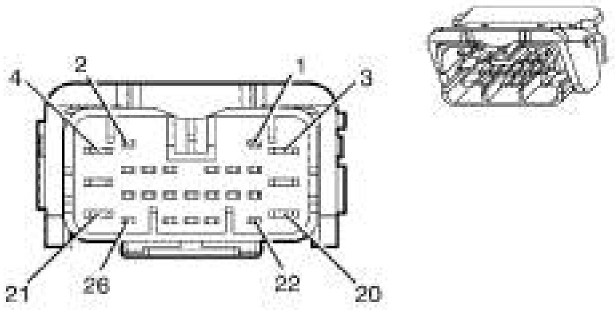
Terminal Part Information

- Pins: 1, 5, 7, 15, 16, 22-24
- Terminal/Tray: 7116-4020/11
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

- Pin: 25
- Terminal/Tray: 7116-4021/11
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

- Pins: 11, 20
- Terminal/Tray: 7116-4031/11
- Core/Insulation Crimp: C/A
- Release Tool/Test Probe: 12094430/J-35616-40 (BU)

- Pins: 12, 21
- Terminal/Tray: 7116-4032/11
- Core/Insulation Crimp: A/F
- Release Tool/Test Probe: 12094430/J-35616-40 (BU)



Connector Part Information

- OEM: 7282-1965
- Service: See Catalog
- Description: 26-Way M (WH)

Terminal Part Information

- Pins: 1, 5, 7, 15, 16, 22-24
- Terminal/Tray: 7114-4020/10
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pin: 25
- Terminal/Tray: 7114-4021/10
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pins: 11, 20
- Terminal/Tray: 7114-4031/11
- Core/Insulation Crimp: C/A
- Release Tool/Test Probe: 12094430/J-35616-41 (BU)

- Pins: 12, 21
- Terminal/Tray: 7114-4032/11
- Core/Insulation Crimp: A/G
- Release Tool/Test Probe: 12094430/J-35616-41 (BU)

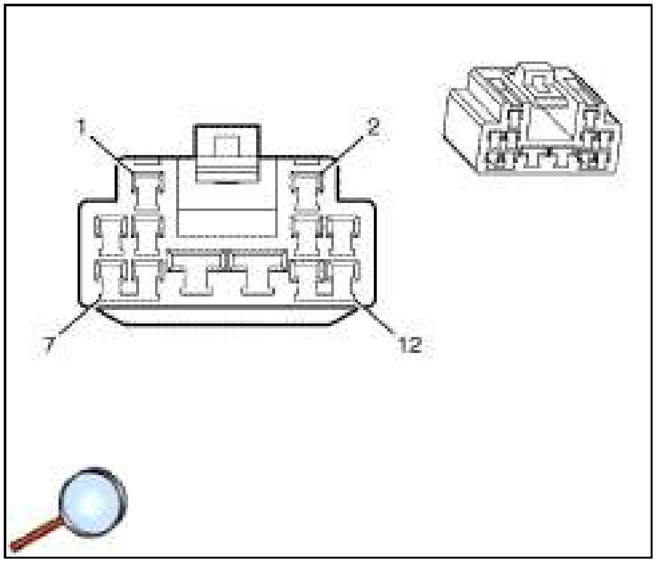
- Pin: 25
- Terminal/Tray: 7114-4021/10
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-

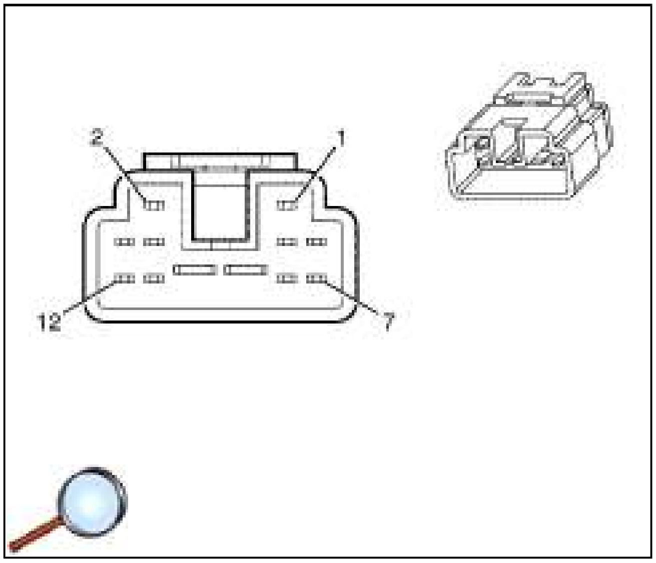
35616-19 (BK)

X403 Rear Body Harness to the Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used	1	--	--	Not Used
2	0.3 D-GN	2377	RR Middle Object Sensor Signal	2	0.3 D-GN	2377	RR Middle Object Sensor Signal
3-6	--	--	Not Used	3-6	--	--	Not Used
7	0.5 BN/WH	5077	Lamp Supply Voltage	7	0.5 BN/WH	5077	Lamp Supply Voltage
8	0.3 BN	309	Low Reference	8	0.3 BN	309	Low Reference
9	0.3 GY	2379	Object Sensor Low Reference	9	0.3 GY	2379	Object Sensor Low Reference
10	0.3 OG	2376	LR Middle Object Sensor Signal	10	0.3 OG	2376	LR Middle Object Sensor Signal
11	1.25 OG/BU	4340	Battery Positive Voltage	11	1.25 OG/BU	4340	Battery Positive Voltage
12	3 OG/WH	2040	Battery Positive Voltage	12	3 OG/WH	2040	Battery Positive Voltage
13	0.5 OG/YE	4540	Battery Positive Voltage	13	0.5 OG/YE	4540	Battery Positive Voltage
14-15	--	--	Not Used	14-15	--	--	Not Used
16	0.3 BK	1850	Ground	16	0.3 BK	1850	Ground
17	0.3 PK	5076	5-Volt Reference	17	0.3 PK	5076	5-Volt Reference
18	0.3 PU	2378	RR Corner Object Sensor Signal	18	0.3 PU	2378	RR Corner Object Sensor Signal
19	0.3 YE	2375	LR Corner Object Sensor Signal	19	0.3 YE	2375	LR Corner Object Sensor Signal
20	0.85 OG/BK	540	Battery Positive Voltage	20	0.85 OG/BK	540	Battery Positive Voltage
21	3 OG/GN	2840	Battery Positive Voltage	21	3 OG/GN	2840	Battery Positive Voltage
22	0.5 OG/WH	2340	Battery Positive Voltage	22	0.5 OG/WH	2340	Battery Positive Voltage
23	0.85 BN/WH	5075	Rear Compartment Lid Release Actuator	23	0.85 BN/WH	5075	Rear Compartment Lid Release Actuator
24	0.3 OG/BU	2440	Battery Positive Voltage	24	0.3 OG/BU	2440	Battery Positive Voltage
25	0.3 WH/GN	56	Battery Current Signal	25	0.3 WH/GN	56	Battery Current Signal
26	0.3 D-BU	2374	Object Sensor Supply Voltage	26	0.3 D-BU	2374	Object Sensor Supply Voltage

X404 Body Harness to the Rear Body Harness





Connector Part Information

- OEM: 7283-1128
- Service: See Catalog
- Description: 12-Way F (WH)

Terminal Part Information

- Pin: 1
- Terminal/Tray: 7116-4021/10
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pins: 2-8
- Terminal/Tray: 7116-4021/10
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pins: 11, 12
- Terminal/Tray: 7116-4020/10
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

Connector Part Information

- OEM: 7282-1128
- Service: See Catalog
- Description: 12-Way M 090 II Series (WH)

Terminal Part Information

- Pin: 1
- Terminal/Tray: 7114-4021/10
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pins: 2-3, 5, 6, 8
- Terminal/Tray: 7114-4021/10
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

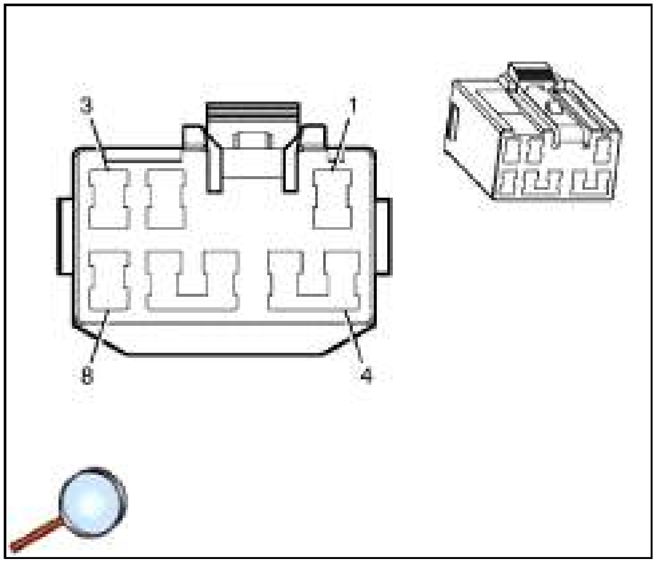
- Pins: 4, 7, 11, 12
- Terminal/Tray: 7114-4020/10
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

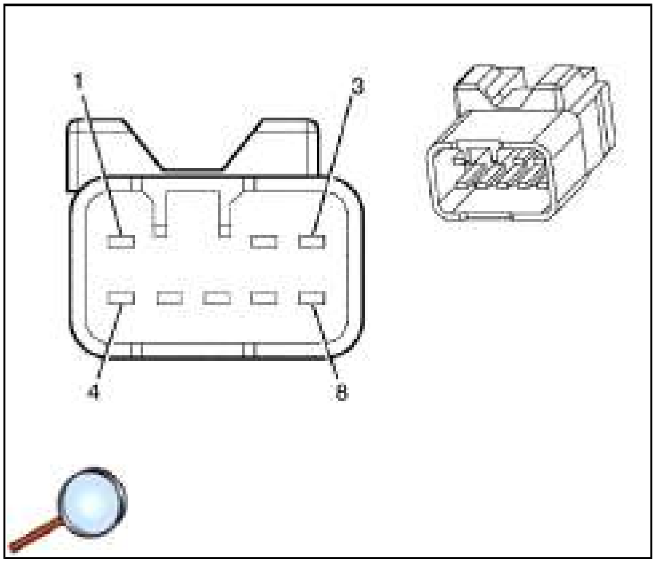
X404 Body Harness to the Rear Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	1.25 L-BU	20	Stop Lamp Supply Voltage	1	1.25 L-BU	20	Stop Lamp Supply Voltage
2	0.85 L-GN	24	Backup Lamp Supply Voltage	2	0.85 L-GN	24	Backup Lamp Supply Voltage
			Right Rear Turn				Right Rear Turn

3	0.85 D-GN/WH	1335	Signal Lamp Supply Voltage	3	0.85 D-GN/WH	1335	Signal Lamp Supply Voltage
4	0.85 BN/WH	309	Lamp Supply Voltage	4	0.5 BN/WH	309	Lamp Supply Voltage
5	0.85 PU	709	Left Park Lamp Supply Voltage	5	0.85 PU	709	Left Park Lamp Supply Voltage
6	0.85 YE/BK	1334	Left Rear Turn Signal Lamp Supply Voltage	6	0.85 YE/BK	1334	Left Rear Turn Signal Lamp Supply Voltage
7	0.85 BK/WH	1851	Ground	7	0.3 BK/WH	1851	Ground
8	0.85 BK	1851	Ground	8	0.85 BK/WH	1850	Ground
9-10	--	--	Not Used	9-10	--	--	Not Used
11	0.3 OG/BK	744	Rear Compartment Lid Ajar Switch Signal	11	0.3 OG/BK	744	Rear Compartment Lid Ajar Switch Signal
12	0.5 D-BU	737	Rear Compartment Lamp Control	12	0.5 D-BU	737	Rear Compartment Lamp Control

X405 X405 Body Harness to the Rear Compartment Harness (F19)





Connector Part Information

- OEM: 7283-1080
- Service: See Catalog
- Description: 8-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal

Connector Part Information

- OEM: 7282-1080
- Service: See Catalog
- Description: 8-Way M

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal

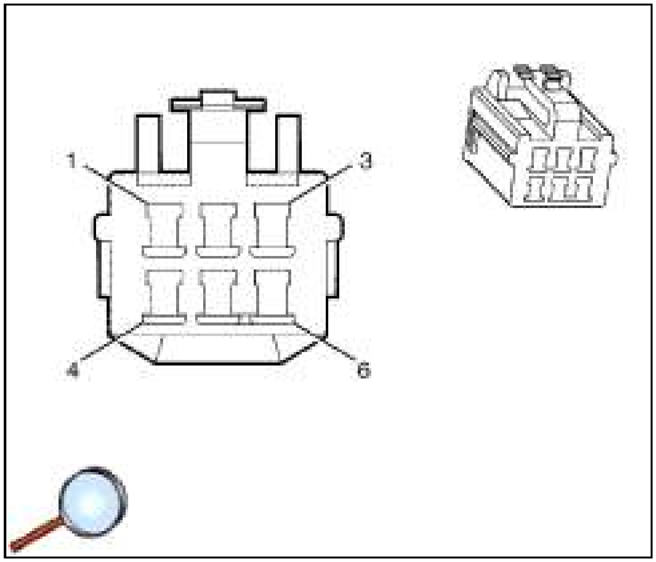
Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

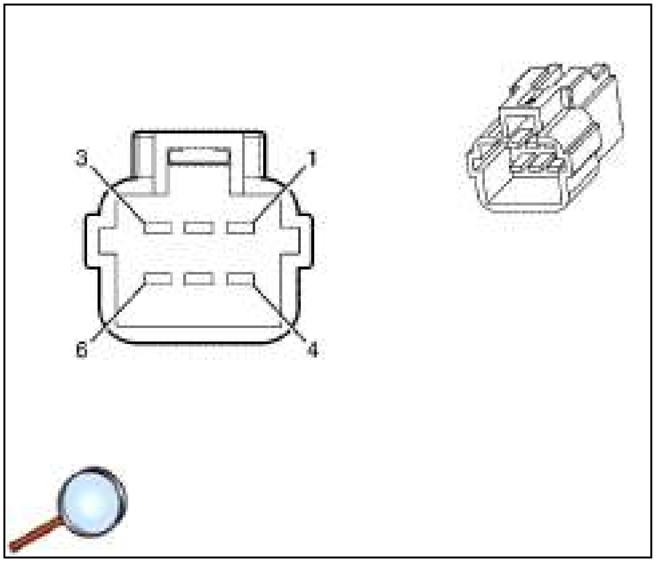
Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X405 X405 Body Harness to the Rear Compartment Harness (F19)

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.3 OG	2376	LR Middle Object Sensor Signal	1	0.3 OG	2376	LR Middle Object Sensor Signal
2	0.3 YE	2375	LR Corner Object Sensor Signal	2	0.3 YE	2375	LR Corner Object Sensor Signal
3	0.5 BN/WH	309	Lamp Supply Voltage	3	0.5 BN/WH	309	Lamp Supply Voltage
4	0.3 GY	2379	Object Sensor Low Reference	4	0.3 GY	2379	Object Sensor Low Reference
5	0.3 PU	2378	RR Corner Object Sensor Signal	5	0.3 PU	2378	RR Corner Object Sensor Signal
6	0.3 D-BU	2374	Object Sensor Supply Voltage	6	0.3 D-BU	2374	Object Sensor Supply Voltage
7	0.3 D-GN	2377	RR Middle Object Sensor Signal	7	0.3 D-GN	2377	RR Middle Object Sensor Signal
8	0.3 BK	1850	Ground	8	0.3 BK	1850	Ground

X405 Body Harness to the Rear Compartment Harness (F69 without T79)





Connector Part Information

- OEM: 7283-1068
- Service: See Catalog
- Description: 6-Way F

Connector Part Information

- OEM: 7282-1068
- Service: See Catalog
- Description: 6-Way M

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

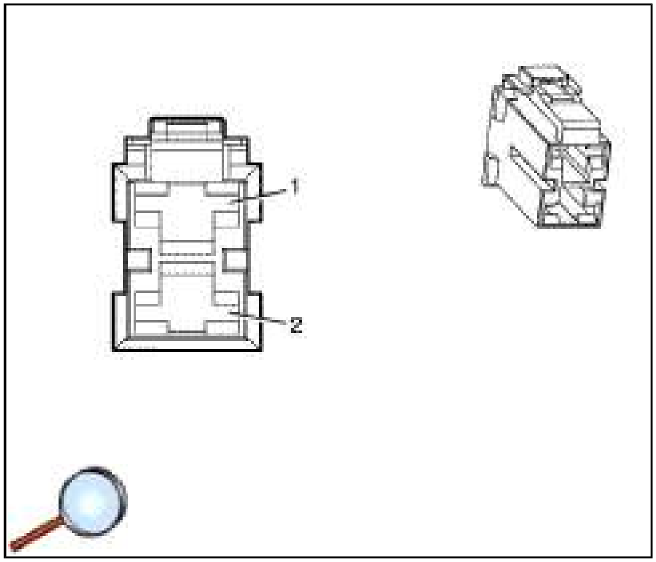
Terminal Part Information

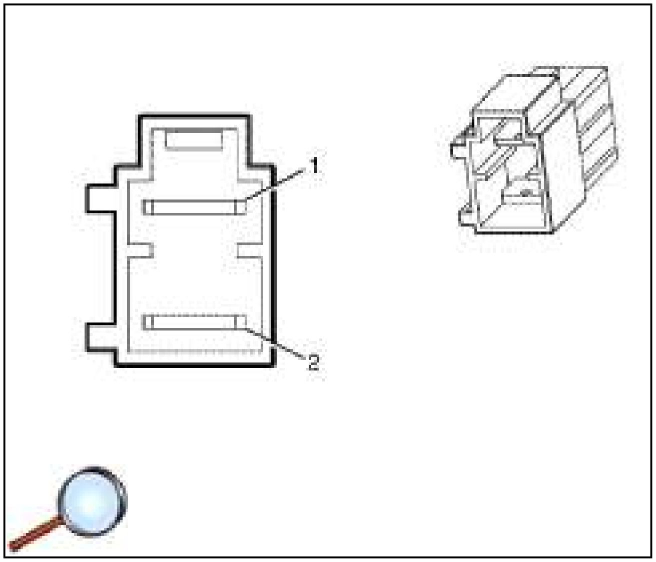
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X405 Body Harness to the Rear Compartment Harness (F69 without T79)

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.3 OG	2376	LR Middle Object Sensor Signal	1	0.3 OG	2376	LR Middle Object Sensor Signal
2	0.3 YE	2375	LR Corner Object Sensor Signal	2	0.3 YE	2375	LR Corner Object Sensor Signal
3	0.3 D-BU	2374	Object Sensor Supply Voltage	3	0.3 D-BU	2374	Object Sensor Supply Voltage
4	0.3 GY	2379	Object Sensor Low Reference	4	0.3 GY	2379	Object Sensor Low Reference
5	0.3 PU	2378	RR Corner Object Sensor Signal	5	0.3 PU	2378	RR Corner Object Sensor Signal
6	0.3 D-GN	2377	RR Middle Object Sensor Signal	6	0.3 D-GN	2377	RR Middle Object Sensor Signal

X408 Battery Cable to the Body Harness





Connector Part Information

- OEM: 7123-4123-30
- Service: 88953301
- Description: 2-Way F L Type (BK)

Connector Part Information

- OEM: 7122-4123-30
- Service: See Catalog
- Description: 2-Way M 58 L-Type (BK)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

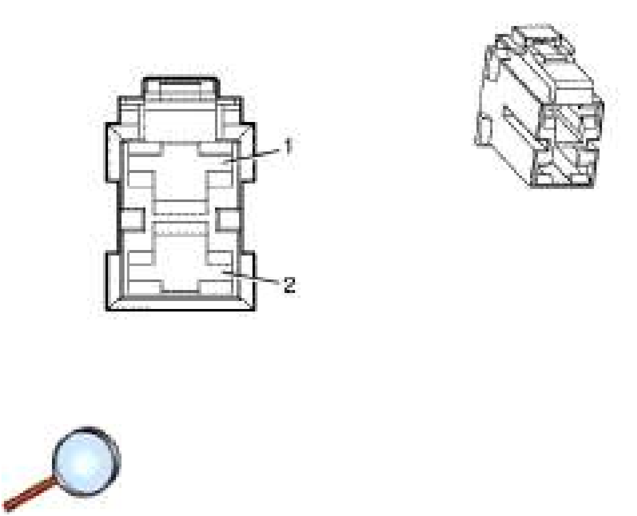
Terminal Part Information

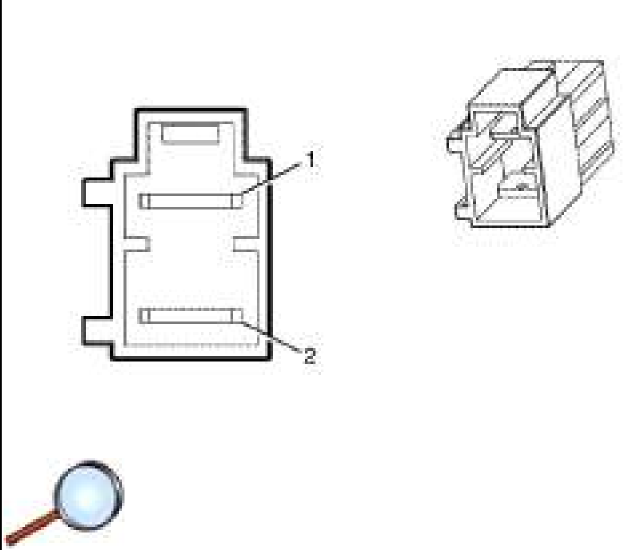
- Terminal/Tray: 7114-3250/14
- Core/Insulation Crimp: G/3
- Release Tool/Test Probe: 12094430/J-35616-21 (RD)

X408 Battery Cable to the Body Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	8 RD/BK	1042	Battery Positive Voltage	1	5 RD/BK	1042	Battery Positive Voltage
2	5 RD/BK	1242	Battery Positive Voltage	2	5 RD/BK	9242	Battery Positive Voltage

X412 Rear Body Harness to the Rear Body Harness





Connector Part Information

- OEM: 7123-4129-90
- Service:See Catalog
- Description: 2-Way F (BU)

Terminal Part Information

- Terminal/Tray: 7116-3250/10
- Core/Insulation Crimp: G/3
- Release Tool/Test Probe: 12094430/J-35616-22 (RD)

Connector Part Information

- OEM: 7122-4129-90
- Service: See Catalog
- Description: 2-Way M (BU)

Terminal Part Information

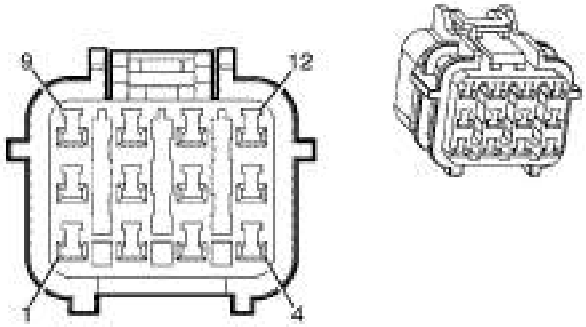
- Terminal/Tray: 7116-3250/10
- Core/Insulation Crimp: G/3
- Release Tool/Test Probe: 12094430/J-35616-22 (RD)

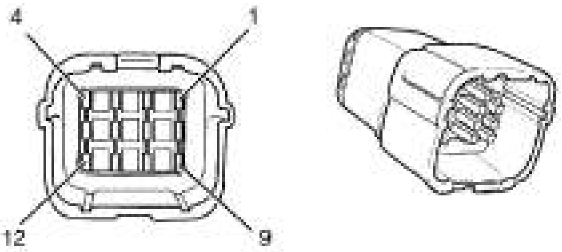
X412 Rear Body Harness to the Rear Body Harness

	Wire	Circuit			Wire	Circuit	

Pin	Color	No.	Function	Pin	Color	No.	Function
1	5 RD/BK	9242	Battery Positive Voltage	1	5 RD/BK	1242	Battery Positive Voltage
2	--	--	Not Used	2	--	--	Not Used

X413 Electronic Stability Control Harness to the Fuel Tank Harness (HSV)





Connector Part Information

- OEM: 7123-7923-30
- Service: See Catalog
- Description: 12-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7222-7933-30
- Service: See Catalog
- Description: 12-Way M

Terminal Part Information

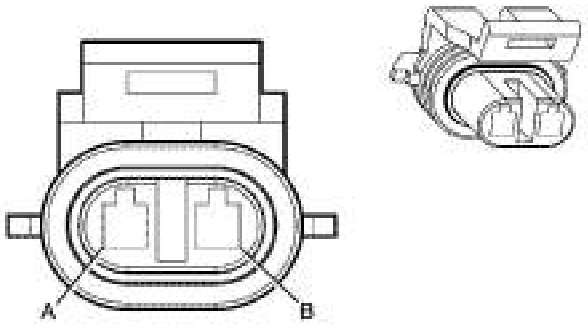
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

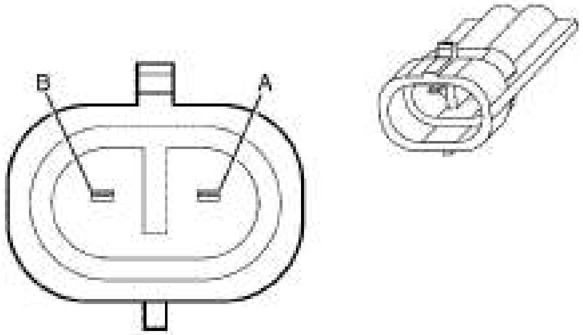
X413 Electronic Stability Control Harness to the Fuel Tank Harness (HSV)

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.35 GY/BU	1208	Left Rear Suspension Position Sensor Voltage Reference	1	0.35 GY/BU	1208	Left Rear Suspension Position Sensor Voltage Reference
2	0.35 GY	1210	Left Rear Suspension Position Sensor Signal	2	0.35 GY	1210	Left Rear Suspension Position Sensor Signal
	0.35		Left Rear Suspension		0.35		Left Rear Suspension

3	GY/BK	1209	Position Sensor Low Reference	3	GY/BK	1209	Position Sensor Low Reference
4	0.75 WH/BK	1115	Left Rear Damper Low Reference	4	0.75 WH/BK	1115	Left Rear Damper Low Reference
5	0.75 WH/RD	1114	Left Rear Damper Control	5	0.75 WH/RD	1114	Left Rear Damper Control
6	0.35 BN/WH	1214	Right Rear Suspension Position Sensor Voltage Reference	6	0.35 BN/WH	1214	Right Rear Suspension Position Sensor Voltage Reference
7	0.35 BN	1216	Right Rear Suspension Position Sensor Signal	7	0.35 BN	1216	Right Rear Suspension Position Sensor Signal
8	0.35 BN/BK	1215	Right Rear Suspension Position Sensor Low Reference	8	0.35 BN/BK	1215	Right Rear Suspension Position Sensor Low Reference
9	0.75 L-GN/BK	1119	Right Rear Damper Low Reference	9	0.75 L-GN/BK	1119	Right Rear Damper Low Reference
10	0.75 L-GN/RD	1118	Right Rear Damper Control	10	0.75 L-GN/RD	1118	Right Rear Damper Control
11-12	--	--	Not Used	11-12	--	--	Not Used

X415 (HSV) (Pigtail?)





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 2-Way F

Terminal Part Information

Connector Part Information

- OEM:
- Service: See Catalog
- Description: 2-Way M

Terminal Part Information

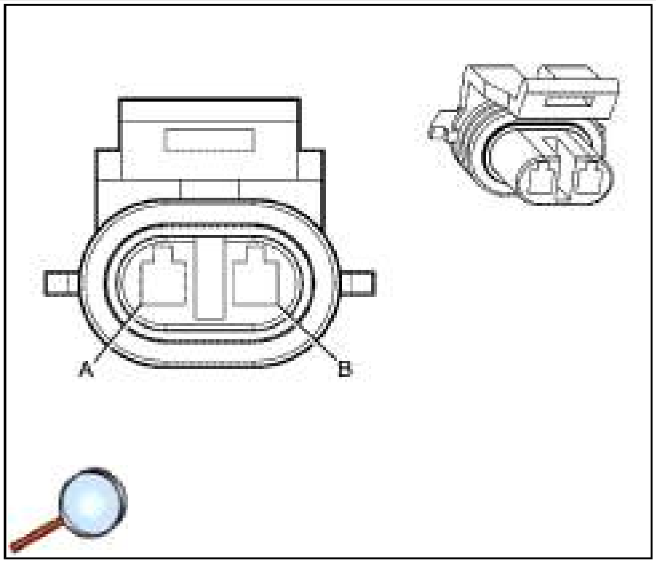
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

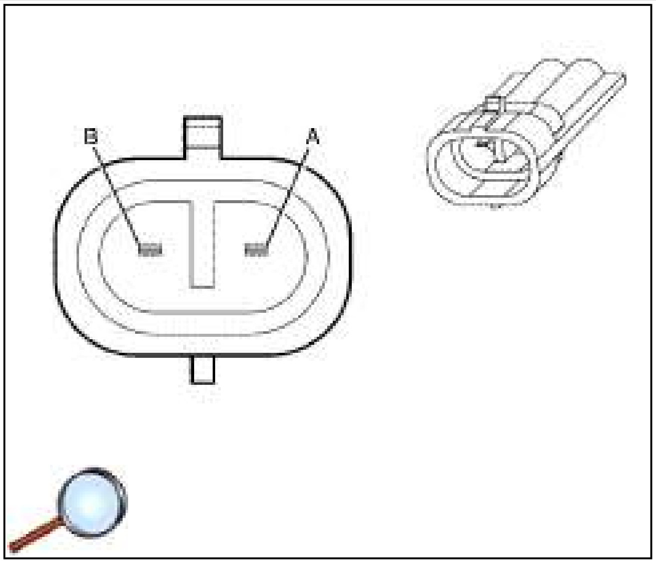
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X415 (HSV) (Pigtail?)

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
A	0.75 WH/RD	1118	Right Rear Damper Control	A	0.75 L-GN/RD	1118	Right Rear Damper Control
B	0.75 WH/BK	1119	Right Rear Damper Low Reference	B	0.75 L-GN/BK	1119	Right Rear Damper Low Reference

X416 (HSV) (Pigtail?)





Connector Part Information

- OEM:
- Service: See Catalog
- Description: 2-Way F

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM:
- Service: See Catalog
- Description: 2-Way M

Terminal Part Information

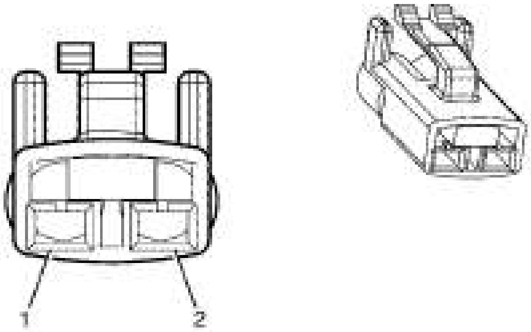
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

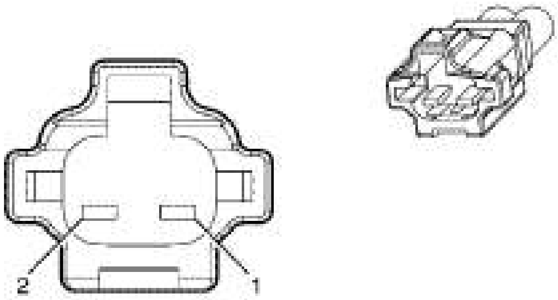
X416 (HSV) (Pigtail?)

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function

A	0.75 WH/RD	1114	Left Rear Damper Control	A	0.75 WH/RD	1114	Left Rear Damper Control
B	0.75 WH/BK	1115	Left Rear Damper Low Reference	B	0.75 WH/BK	1115	Left Rear Damper Low Reference

X433 Rear Fascia Harness to the License Lamp Harness (WM)





Connector Part Information

- OEM: 7283-7420-40
- Service: See Catalog
- Description: 2-Way F (GY)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 7282-7420-40
- Service: See Catalog
- Description: 2-Way M 090 II Series Sealed (GY)

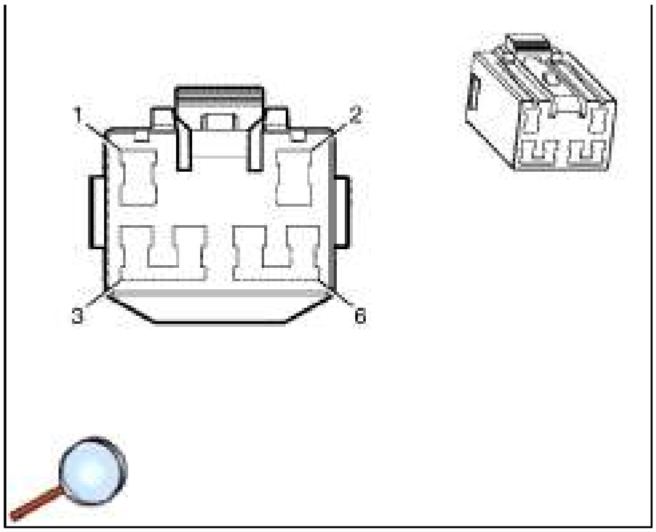
Terminal Part Information

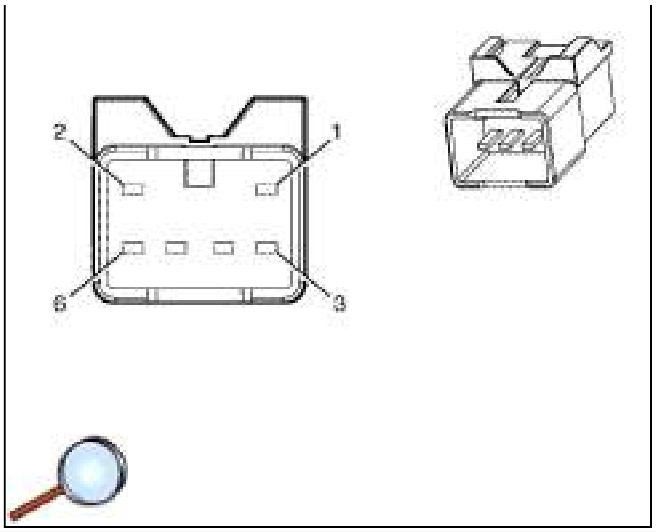
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X433 Rear Fascia Harness to the License Lamp Harness (WM)

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.5 BK	1850	Ground	1	0.5 BK	1850	Ground
2	0.5 BN/WH	309	Lamp Supply Voltage	2	0.5 BN/WH	309	Lamp Supply Voltage

X450 Rear Body Harness to the Right Rear Tail Lamp Assembly





Connector Part Information

- OEM: 7283-0637
- Service: See Catalog
- Description: 6-Way F 090 Series (WH)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 936268-1
- Service: See Catalog
- Description: 6-Way M (WH)

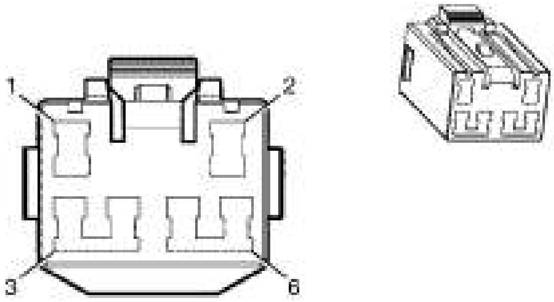
Terminal Part Information

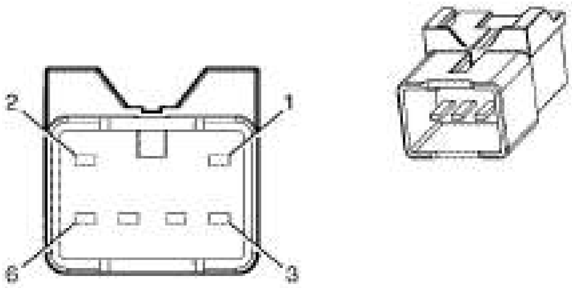
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X450 Rear Body Harness to the Right Rear Tail Lamp Assembly

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.85 BK/WH	1851	Ground	1	0.85 BK/WH	1851	Ground
2	0.85 BK	1850	Ground	2	0.85 BK	1850	Ground
3	0.85 BN/WH	709	Right Park Lamp Supply Voltage	3	0.85 BN/WH	709	Right Park Lamp Supply Voltage
4	0.85 L-BU	20	Stop Lamp Supply Voltage	4	0.85 L-BU	20	Stop Lamp Supply Voltage
5	0.85 L-GN	24	Backup Lamp Supply Voltage	5	0.85 L-GN	24	Backup Lamp Supply Voltage
6	0.85 D-GN/WH	1334	Right Rear Turn Signal Lamp Supply Voltage	6	0.85 D-GN/WH	1334	Right Rear Turn Signal Lamp Supply Voltage

X451 Rear Body Harness to the Left Rear Tail Lamp Assembly





Connector Part Information

- OEM: 7283-0637
- Service: See Catalog
- Description: 6-Way F 090 Series (WH)

Terminal Part Information

- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

Connector Part Information

- OEM: 936268-1
- Service: See Catalog
- Description: 6-Way M (WH)

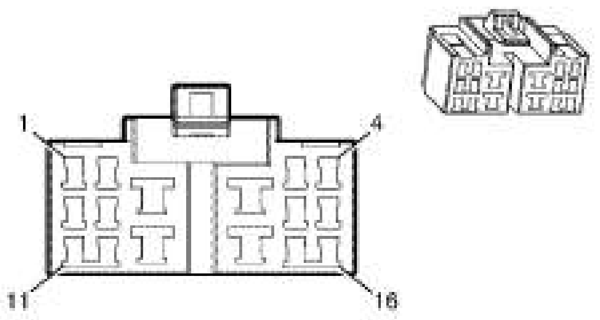
Terminal Part Information

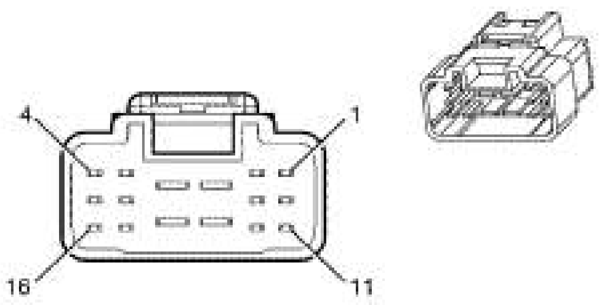
- Terminal/Tray: See Terminal Repair Kit
- Core/Insulation Crimp: See Terminal Repair Kit
- Release Tool/Test Probe: See Terminal Repair Kit

X451 Rear Body Harness to the Left Rear Tail Lamp Assembly

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	0.3 BK/WH	1851	Ground	1	0.3 BK/WH	1851	Ground
2	0.85 BK	1850	Ground	2	0.85 BK	1850	Ground
3	0.85 PU	309	Left Park Lamp Supply Voltage	3	0.85 PU	309	Left Park Lamp Supply Voltage
4	0.85 L-BU	20	Stop Lamp Supply Voltage	4	0.85 L-BU	20	Stop Lamp Supply Voltage
5	0.85 L-GN	24	Backup Lamp Supply Voltage	5	0.85 L-GN	24	Backup Lamp Supply Voltage
6	0.85 YE/BK	1335	Left Rear Turn Signal Lamp Supply Voltage	6	0.85 YE/BK	1335	Left Rear Turn Signal Lamp Supply Voltage

X500 Body Harness to the Left Front Door Harness





Connector Part Information

- OEM: 7283-1168
- Service: See Catalog
- Description: 16-Way F (WH)

Terminal Part Information

- Pins: 1, 2, 5, 6, 9, 11, 12, 15
- Terminal/Tray: 7116-4020/11
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pins: 4, 10
- Terminal/Tray: 7114-4021/10
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pin: 7
- Terminal/Tray: 7114-4030/11
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 12094430/J-35616-41 (BU)

- Pins: 8, 14
- Terminal/Tray: 7114-4032/11
- Core/Insulation Crimp: 4/B
- Release Tool/Test Probe: 12094430/J-35616-41 (BU)

Connector Part Information

- OEM: 7282-1168
- Service: See Catalog
- Description: 16-Way M 090 II Series (WH)

Terminal Part Information

- Pins: 1, 2, 5, 6, 9, 11, 12, 15
- Terminal/Tray: 7114-4020/10
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pins: 4, 10
- Terminal/Tray: 7114-4021/10
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pin: 7
- Terminal/Tray: 7114-4030/11
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 12094430/J-35616-41 (BU)

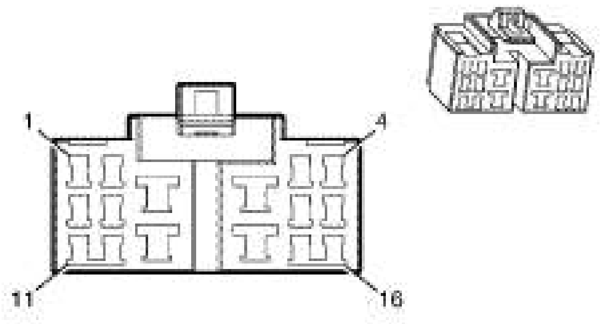
- Pins: 8, 14
- Terminal/Tray: 7114-4032/11
- Core/Insulation Crimp: 4/B
- Release Tool/Test Probe: 12094430/J-35616-41 (BU)

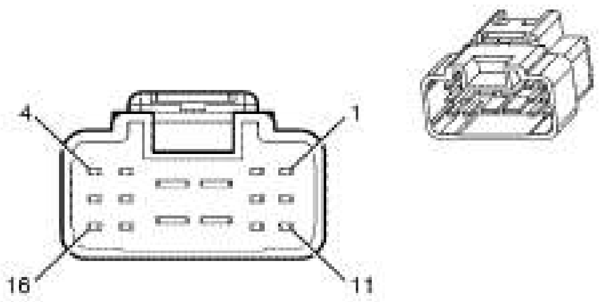
X500 Body Harness to the Left Front Door Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function

1	0.5 WH	7391	Power Window Switch Right and Up	1	0.5 WH	7391	Power Window Switch Right and Up
	0.5 D-GN	1301	Rap (X) Fuse Supply Voltage (WNB)		0.5 D-GN	1301	Rap (X) Fuse Supply Voltage (WNB)
2	0.3 BN/WH	746	Passenger Door Ajar Switch Signal	2	0.3 BN/WH	746	Passenger Door Ajar Switch Signal
3	--	--	Not Used	3	--	--	Not Used
4	0.75 BN/RD	294	Driver Door Lock Actuator Unlock Control	4	0.75 BN/RD	294	Driver Door Lock Actuator Unlock Control
5	0.5 WH/BK	81	Power Window Master Switch Left Front Up Signal	5	0.5 WH/BK	81	Power Window Master Switch Left Front Up Signal
	0.5 BN/RD	1300	Power Window Master Switch Left Front Up Signal (WNB)		0.5 BN/RD	1300	Power Window Master Switch Left Front Up Signal (WNB)
6	0.5 BN	201	Left Front Speaker Output (+) (UW5)	6	0.5 BN	201	Left Front Speaker Output (+) (UW5)
	0.5 TN	201	Left Front Speaker Output (+) (without UW5)		0.5 TN	201	Left Front Speaker Output (+) (without UW5)
7	0.5 BK	2050	Ground	7	0.5 BK	2050	Ground
8	2 D-BU	164	Power Window Motor Left Front Up Control	8	2 D-BU	164	Power Window Motor Left Front Up Control
9	--	--	Not Used	9	--	--	Not Used
10	0.75 D-GN/WH	295	Door Lock Actuator Lock Control	10	0.75 D-GN/WH	295	Door Lock Actuator Lock Control
11	0.5 L-GN/BK	89	Power Window Master Switch Left Front Down Signal (without A45)	11	0.5 L-GN/BK	89	Power Window Master Switch Left Front Down Signal (without A45)
	0.5 GY/BU	1136	Power Window Master Switch Left Front Down Signal (WNB)		0.5 GY/BU	1136	Power Window Master Switch Left Front Down Signal (WNB)
	0.5 PK/WH	889	Memory Mirror Voltage (A45)		0.5 PK/WH	889	Memory Mirror Voltage (A45)
12	0.5 GY	118	Left Front Speaker Output (-)	12	0.5 GY	118	Left Front Speaker Output (-)
13	0.5 RD/WH	1540	Battery Positive Voltage	13	0.5 RD/WH	1540	Battery Positive Voltage
14	2 BN/OG	165	Power Window Motor Left Front Down Control	14	2 BN/OG	165	Power Window Motor Left Front Down Control
15-16	--	--	Not Used	15-16	--	--	Not Used

X600 Body Harness to the Right Front Door Harness





Connector Part Information

- OEM: 7283-1168
- Service: See Catalog
- Description: 16-Way F 090 II Series (WH)

Terminal Part Information

- Pins: 1, 2, 5, 6, 11, 12
- Terminal/Tray: 7116-4020/11
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

- Pins: 4, 10
- Terminal/Tray: 7116-4021/11
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

- Pin: 7
- Terminal/Tray: 7116-4031/11
- Core/Insulation Crimp: C/E/A
- Release Tool/Test Probe: 12094430/J-35616-40 (BU)

- Pins: 8, 14
- Terminal/Tray: 7116-4032/11
- Core/Insulation Crimp: 4/B
- Release Tool/Test Probe: 12094430/J-35616-40 (BU)

Connector Part Information

- OEM: 7282-1168
- Service: See Catalog
- Description: 16-Way M (WH)

Terminal Part Information

- Pins: 1, 2, 5, 6, 11, 12
- Terminal/Tray: 7114-4020/10
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pins: 4, 10
- Terminal/Tray: 7114-4021/10
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pin: 7
- Terminal/Tray: 7114-4031/11
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 12094430/J-35616-41 (BU)

- Pins: 8, 14
- Terminal/Tray: 7114-4032/11
- Core/Insulation Crimp: 4/B
- Release Tool/Test Probe: 12094430/J-35616-41 (BU)

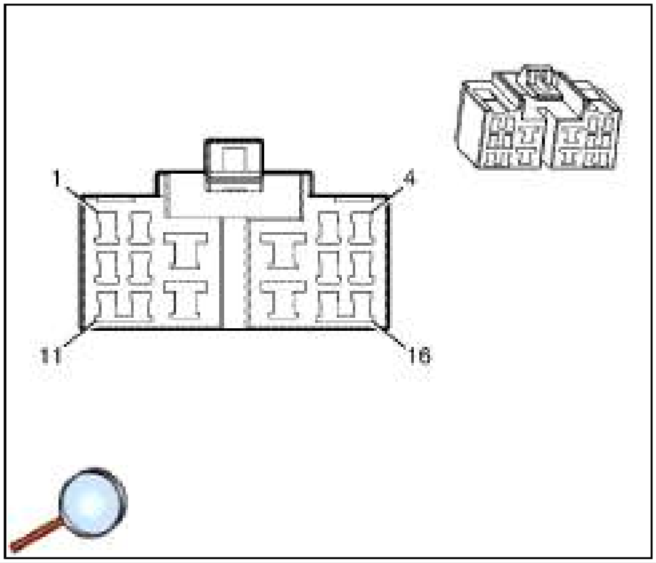
X600 Body Harness to the Right Front Door Harness

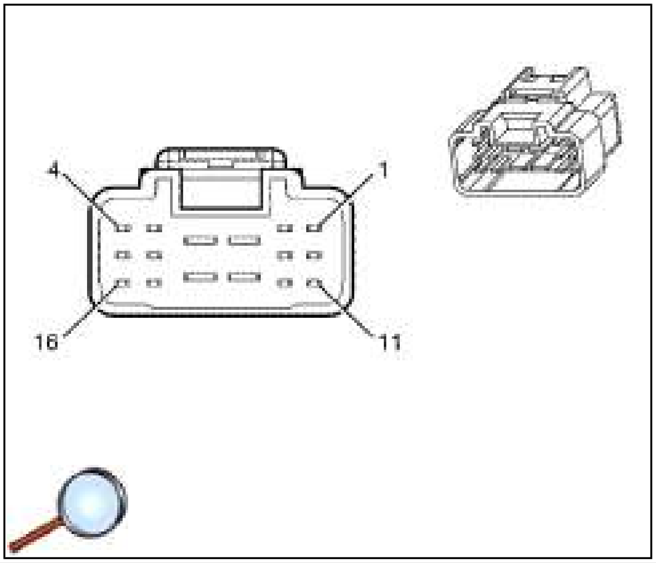
Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function

1		7391	Power Window Switch Right and Up (without A45)	1		7391	Power Window Switch Right and Up (without A45)
	0.5 WH	2851	Memory Mirror Ground (A45)		0.5 WH	2851	Memory Mirror Ground (A45)
	0.5 D-GN	1301	Rap (X) Fuse Supply Voltage		0.5 D-GN	1301	Rap (X) Fuse Supply Voltage
2	0.3 GY/BK	745	Right Front Door Ajar Switch Signal	2	0.3 GY/BK	745	Right Front Door Ajar Switch Signal
3	--	--	Not Used	3	--	--	Not Used
4	0.75 BN/RD	694	Driver Door Lock Actuator Unlock Control	4	0.75 BN/RD	694	Driver Door Lock Actuator Unlock Control
5	0.5 OG/WH	881	Power Window Master Switch Right Front Up Signal	5	0.5 OG/WH	881	Power Window Master Switch Right Front Up Signal
	0.5 L-BU	166	Power Window Master Switch Right Front Up Signal (WNB)		0.5 L-BU	166	Power Window Master Switch Right Front Up Signal (WNB)
6	0.5 L-GN/BK	200	Right Front Speaker Output (+) (UW5)	6	0.5 L-GN/BK	200	Right Front Speaker Output (+) (UW5)
	0.5 L-GN	200	Right Front Speaker Output (+) (without UW5)		0.5 L-GN	200	Right Front Speaker Output (+) (without UW5)
7	0.5 BK	1350	Ground	7	0.5 BK	1350	Ground
8	2 BU/WH	666	Power Window Motor Right Front Up Control	8	2 BU/WH	666	Power Window Motor Right Front Up Control
9	0.3 PK/BK	780	Driver Door Lock Switch Lock Signal	9	0.3 PK/BK	780	Driver Door Lock Switch Lock Signal
10	0.75 D-GN/WH	295	Door Lock Actuator Lock Control	10	0.75 D-GN/WH	295	Door Lock Actuator Lock Control
11	0.5 PU/WH	889	Power Window Master Switch Right Front Down Signal (without A45)	11	0.5 PU/WH	889	Power Window Master Switch Right Front Down Signal (without A45)
	0.5 PK/WH	6839	Memory Mirror Voltage (A45)		0.5 PK/WH	6839	Memory Mirror Voltage (A45)
	0.5 D-GN/WH	167	Power Window Master Switch Right Front Down Signal (WNB)		0.5 D-GN/WH	167	Power Window Master Switch Right Front Down Signal (WNB)
12	0.5 D-GN	117	Right Front Speaker Output (-)	12	0.5 D-GN	117	Right Front Speaker Output (-)
13	0.5 RD/WH	1540	Battery Positive Voltage	13	0.5 RD/WH	1540	Battery Positive Voltage
14	2 BN	667	Power Window Motor Right Front Down Control	14	2 BN	667	Power Window Motor Right Front Down Control
			Driver Door Lock				Driver Door Lock

15	0.3 PK	781	Switch Unlock Signal	15	0.3 PK	781	Switch Unlock Signal
16	--	--	Not Used	16	--	--	Not Used

X700 Body Harness to the Left Rear Door Harness





Connector Part Information

- OEM: 7283-1168
- Service: See Catalog
- Description: 16-Way F 090 II Series (WH)

Terminal Part Information

- Pins: 2, 6, 12
- Terminal/Tray: 7116-4020/11
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

- Pins: 4, 10
- Terminal/Tray: 7116-4021/11
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

- Pin: 7
- Terminal/Tray: 7116-4031/11
- Core/Insulation Crimp: C/E/A
- Release Tool/Test Probe: 12094430/J-35616-40 (BU)

- Pins: 8, 13, 14
- Terminal/Tray: 7116-4032/11
- Core/Insulation Crimp: 4/B

Connector Part Information

- OEM: 7282-1168
- Service: See Catalog
- Description: 16-Way M 090 II Series (WH)

Terminal Part Information

- Pins: 2, 6, 12
- Terminal/Tray: 7114-4020/10
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pins: 4, 10
- Terminal/Tray: 7114-4021/10
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-19 (BK)

- Pins: 7
- Terminal/Tray: 7114-4031/11
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 12094430/J-35616-41 (BU)

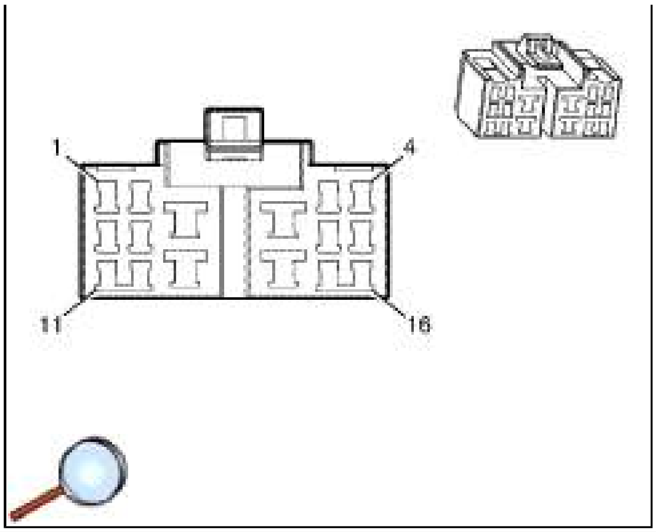
- Pins: 8, 13, 14
- Terminal/Tray: 7114-4032/11
- Core/Insulation Crimp: 4/B

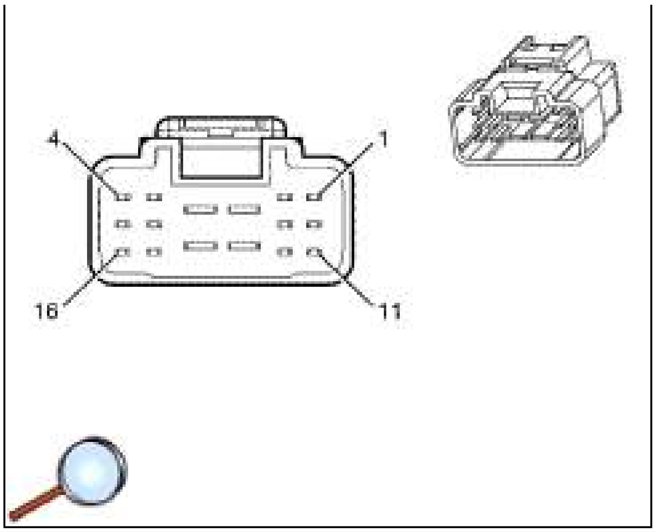
- Release Tool/Test Probe: 12094430/J-35616-40 (BU)
- Release Tool/Test Probe: 12094430/J-35616-41 (BU)

X700 Body Harness to the Left Rear Door Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used	1	--	--	Not Used
2	0.5 BN/WH	746	Right Front Door Ajar Switch Signal	2	0.5 BN/WH	746	Right Front Door Ajar Switch Signal
3	--	--	Not Used	3	--	--	Not Used
4	1.25 BN/RD	294	Driver Door Lock Actuator Unlock Control	4	0.75 BN/RD	294	Driver Door Lock Actuator Unlock Control
5	--	--	Not Used	5	--	--	Not Used
6	0.5 BN	199	Left Rear Speaker Output (+)	6	0.5 BN	199	Left Rear Speaker Output (+)
7	0.5 BK	2050	Ground	7	0.5 BK	2050	Ground
8	2 D-GN	168	Power Window Master Switch Left Rear Up Signal	8	2 D-GN	168	Power Window Master Switch Left Rear Up Signal
9	--	--	Not Used	9	--	--	Not Used
10	1.25 D-GN/WH	295	Door Lock Actuator Lock Control	10	0.75 D-GN/WH	295	Door Lock Actuator Lock Control
11	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage	11	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage
12	0.5 YE/RD	116	Left Rear Speaker Output (-)	12	0.5 YE/RD	116	Left Rear Speaker Output (-)
13	2 D-BU	1307	Power Window Master Switch Lockout Control	13	2 D-BU	1307	Power Window Master Switch Lockout Control
14	2 PU	169	Power Window Master Switch Left Rear Down Signal	14	2 PU	169	Power Window Master Switch Left Rear Down Signal
15-16	--	--	Not Used	15-16	--	--	Not Used

X800 Body Harness to the Right Rear Door Harness





Connector Part Information

- OEM: 7283-1168
- Service: See Catalog
- Description: 16-Way F (WH)

Terminal Part Information

- Pins: 2, 6, 12
- Terminal/Tray: 7116-4020/11
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

- Pins: 4, 10
- Terminal/Tray: 7116-4021/11
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

- Pin: 7
- Terminal/Tray: 7116-4031/11
- Core/Insulation Crimp: C/E/A
- Release Tool/Test Probe: 12094430/J-35616-40 (BU)

- Pins: 8, 13, 14
- Terminal/Tray: 7116-4032/11
- Core/Insulation Crimp: 4/B
- Release Tool/Test Probe: 12094430/J-35616-40 (BU)

Connector Part Information

- OEM: 7282-1168
- Service: See Catalog
- Description: 16-Way M (WH)

Terminal Part Information

- Pins: 4, 10
- Terminal/Tray: 7116-4021/11
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-18 (BK)

- Pin: 7
- Terminal/Tray: 7116-4031/11
- Core/Insulation Crimp: C/E/A
- Release Tool/Test Probe: 12094430/J-35616-40 (BU)

- Pins: 8, 13, 14
- Terminal/Tray: 7116-4032/11
- Core/Insulation Crimp: 4/B
- Release Tool/Test Probe: 12094430/J-35616-40 (BU)

X800 Body Harness to the Right Rear Door Harness

Pin	Wire Color	Circuit No.	Function	Pin	Wire Color	Circuit No.	Function
1	--	--	Not Used	1	--	--	Not Used

2	0.3 BN/WH	746	Passenger Door Ajar Switch Control	2	0.3 BN/WH	746	Right Front Door Ajar Switch Signal
3	--	--	Not Used	3	--	--	Not Used
4	1.25 BN/RD	294	Driver Door Lock Actuator Unlock Control	4	0.75 BN/RD	294	Driver Door Lock Actuator Unlock Control
5	--	--	Not Used	5	--	--	Not Used
6	0.5 D-BU	46	Right Rear Speaker Output (+)	6	0.5 D-BU	46	Base: Right Rear Speaker Output (+)
7	0.5 BK	1350	Ground	7	0.5 BK	1350	Ground
8	2 L-GN	170	Power Window Master Switch Right Rear Up Signal	8	2 L-GN	170	Power Window Master Switch Right Rear Up Signal
9	--	--	Not Used	9	--	--	Not Used
10	1.25 D-GN/WH	295	Door Lock Actuator Lock Control	10	0.75 D-GN/WH	295	Door Lock Actuator Lock Control
11	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage	11	0.5 D-BU/WH	149	Courtesy Lamp Supply Voltage
12	0.5 L-BU	115	Right Rear Speaker Output (-)	12	0.5 L-BU	115	Right Rear Speaker Output (-)
13	2 D-BU	1307	Power Window Master Switch Lockout Control	13	2 D-BU	1307	Power Window Master Switch Lockout Control
14	2 PU/WH	171	Power Window Master Switch Right Rear Down Signal	14	2 PU	171	Power Window Master Switch Right Rear Down Signal
15-16	--	--	Not Used	15-16	--	--	Not Used

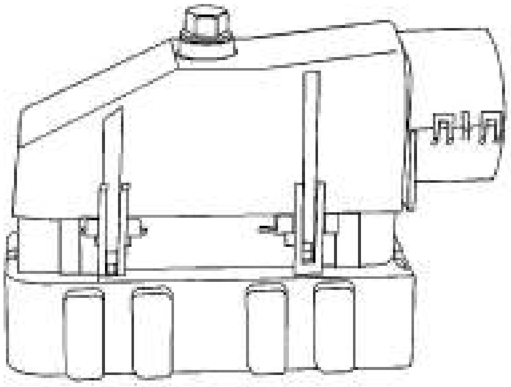
AFL / EPC Connectors

Special Tools

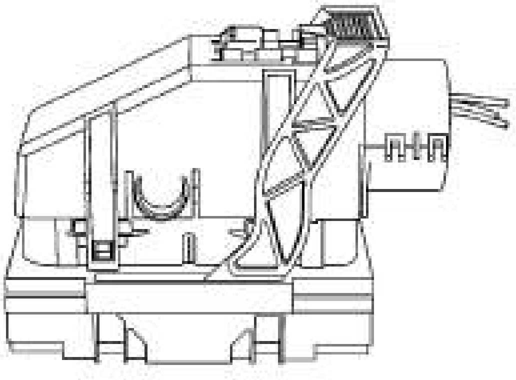
For equivalent regional tools, refer to Special Tools.

Removal Procedure

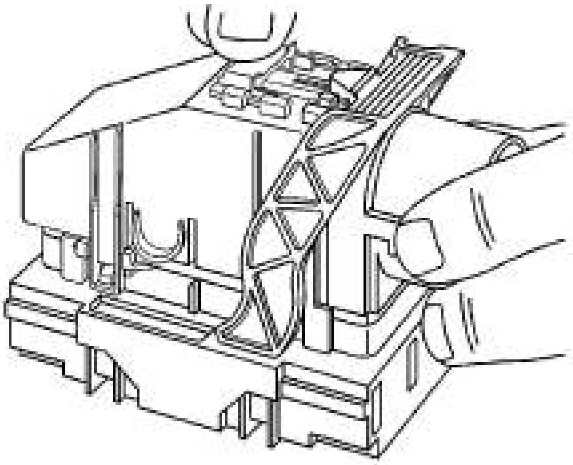
Follow the steps below in order to remove terminals from the connector.



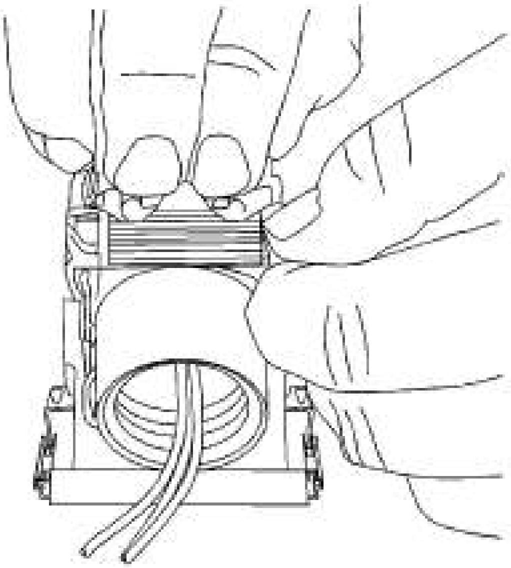
1. For connectors with a bolt in the dress cover, turn the bolt counterclockwise to remove the connector from the component.



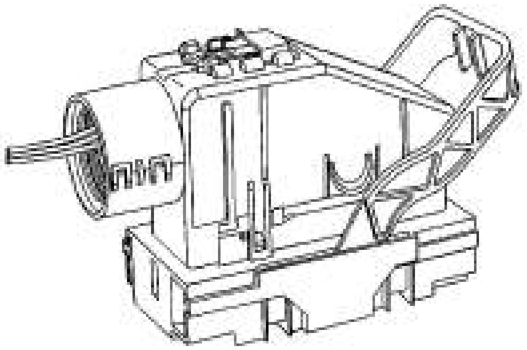
2. Locate the connector position assurance (CPA) on the top of the wire dress cover. Slide the CPA forward.



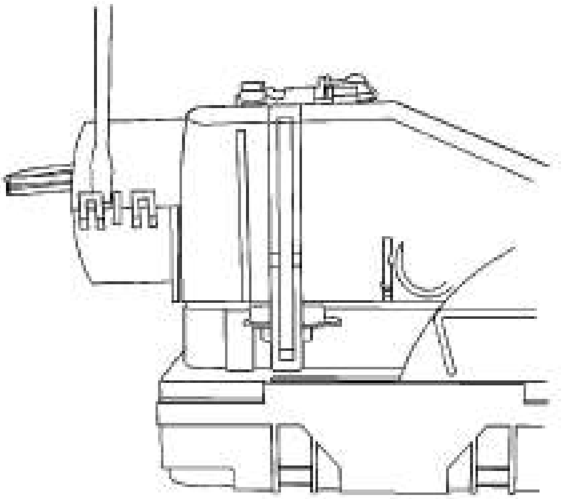
3. Slide the lever lock forward while pressing down on the lever lock release tab.



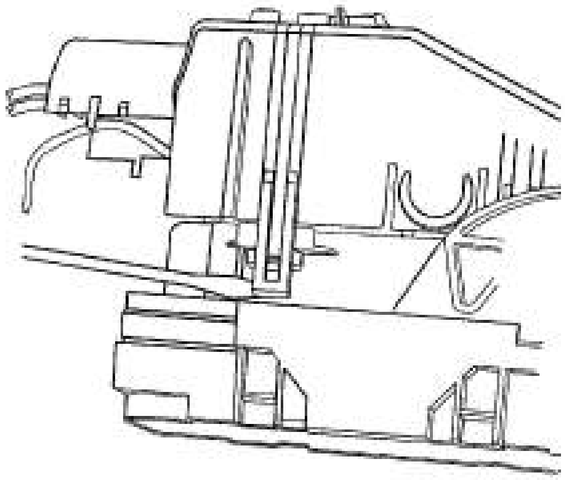
4. View showing depressing of the lever lock release tab.



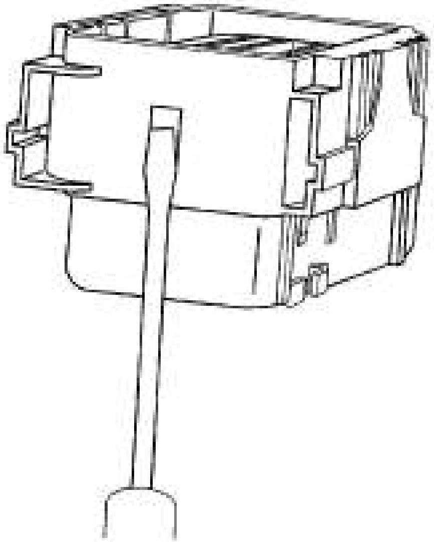
5. View of connector in released position.
6. Disconnect the connector from the component.
7. Locate the dress cover locking tabs at the corners of the dress cover. Use a small flat-blade tool to release the locking tabs and remove the dress cover.



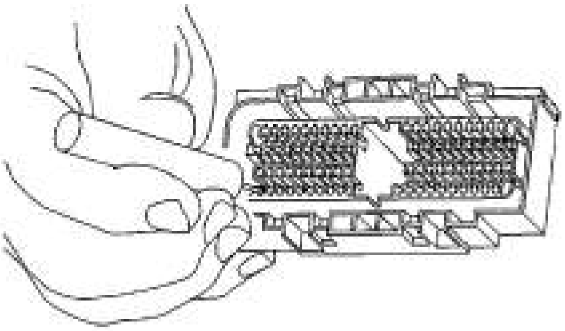
8. Release the rear lower half of the wiredress cover.



9. Release the tabs that are holding the wiredress cover to the connector body.
10. Remove the nose piece by inserting a small flat-blade tool into the slots on both ends of the connector body. Gently pry the nose piece out of the connector. EL-38125-216 can also be used to remove the nose piece.



11. Use the EL-38125-12A tool to release the terminals by lifting the terminal retaining tabs on the inside of the connector.



12. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.

Repair Procedure

Use the appropriate terminal / terminated lead.

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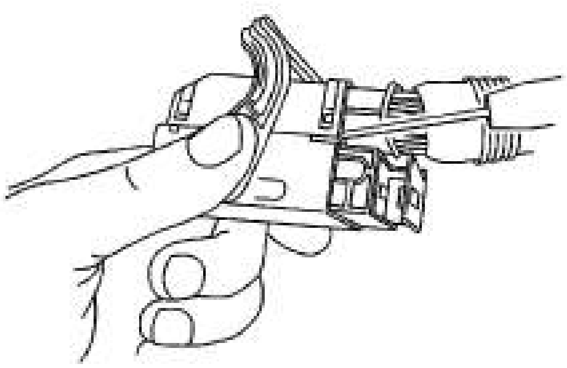
Bosch Connectors (0.64)

Special Tools

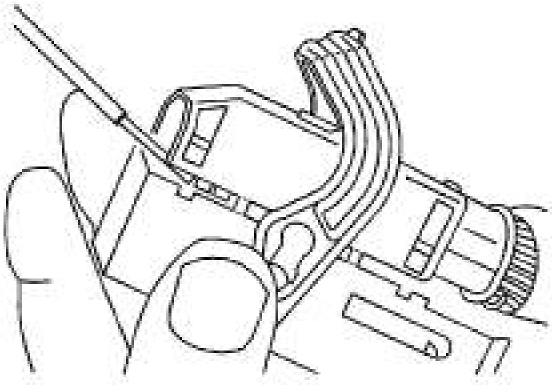
For equivalent regional tools, refer to Special Tools.

Terminal Removal Procedure

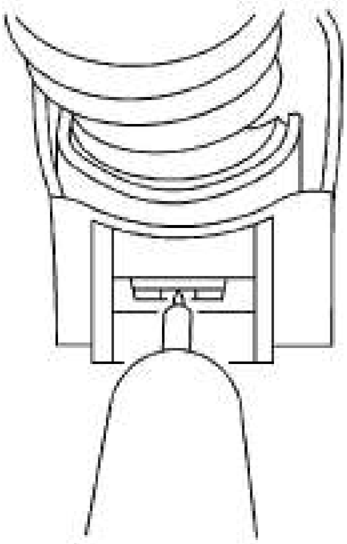
1. Locate the lever lock on the wire dress cover. While pressing the lock, pull the lever over and past the lock until the lever is at the end of its travel.
2. Disconnect the connector from the component.
3. Pull the rubber boot that covers the wires back to expose the end of the connector dress cover.
4. Place the connector locking lever in the center of the connector.



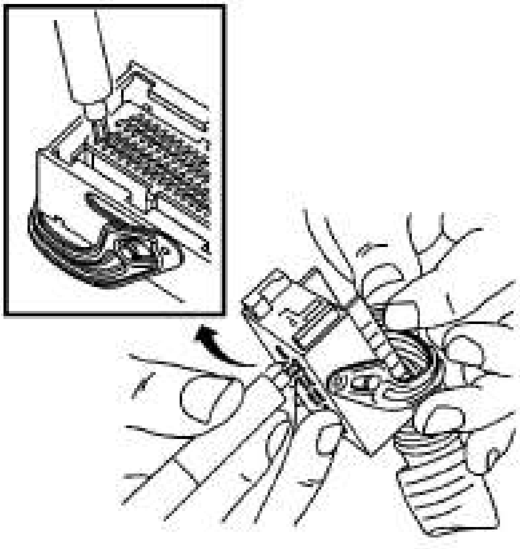
5. Locate the 2 dress cover locking tabs that are on the wire end of the connector. Insert a small flat-bladed tool between the cover and connector body and pry up.



6. Locate the 2 dress cover locking tabs located on the opposite side of the connector. Insert a small flat-bladed tool between the cover at the connector end and pry up.
7. Remove the dress cover.
8. Cut the tie wrap on the wire bundle.



9. Remove the terminal position assurance (TPA) by inserting a small flat-bladed tool into the small slot in the end of the slider and pushing on the TPA until it comes out of the connector. When the TPA exits the opposite side of the connector, gasp the TPA and pull it completely out of the connector.
10. Push the wire side of the terminal that is being removed toward the connector and hold it in position.

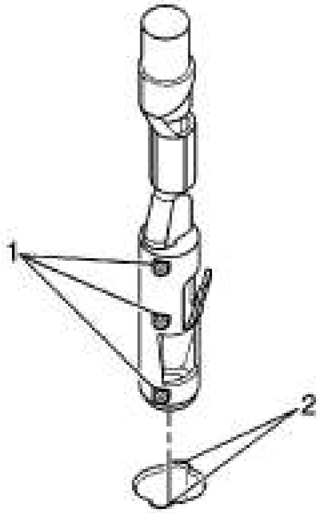


11. Insert the EL-38125-560 into the 2 triangular cavities on each side of the terminal at the front of the connector.
12. Carefully pull the terminal out of the connector. Always remember never use force when pulling a terminal out of a connector. If the terminal is difficult to remove, repeat the entire procedure.

Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

Terminal Replacement Procedure



1. Prior to installation the terminal must be aligned so the (1) coding lugs align with the (2) coding grooves on the connector.
2. Once the terminal is aligned, slide the terminal into the cavity until the retainer has engaged in the cavity of the connector.
3. Slide the TPA in the connector body and seat it using a small flat bladed tool. The TPA is seated when it is flush with the contact housing.
4. Secure the wires to the connector body using a tie wrap and replace the dress cover and grommet.

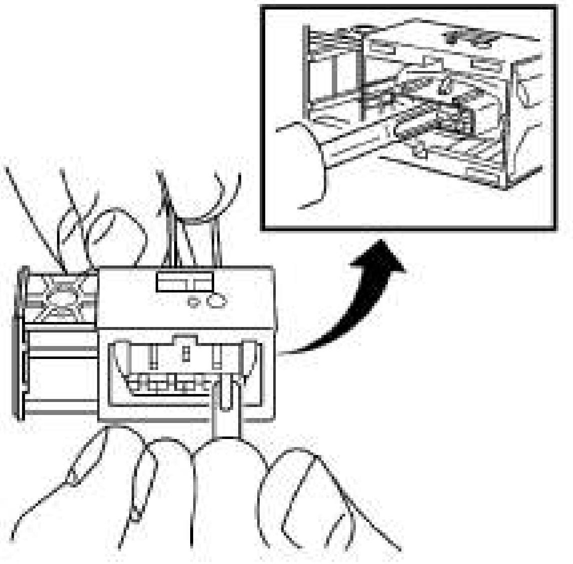
Bosch Connectors (2.8 JPT)

Special Tools

For equivalent regional tools, refer to Special Tools.

Terminal Removal Procedure

1. Pull out the slider on the connector position assurance (CPA) until it is at the end of its travel.
2. Disconnect the connector from the component.
3. Remove the wire dress cover, if necessary.
4. Push the wire side of the terminal that is being removed toward the connector and hold it in position.



5. Insert the EL-38125-557 into the 2 cavities on each side of the terminal at the front of the connector and push until you feel the tool disengage the terminal retainers.
6. Carefully pull the terminal out of the connector. Always remember never use force when pulling a terminal out of a connector. If the terminal is difficult to remove, repeat the entire procedure.

Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

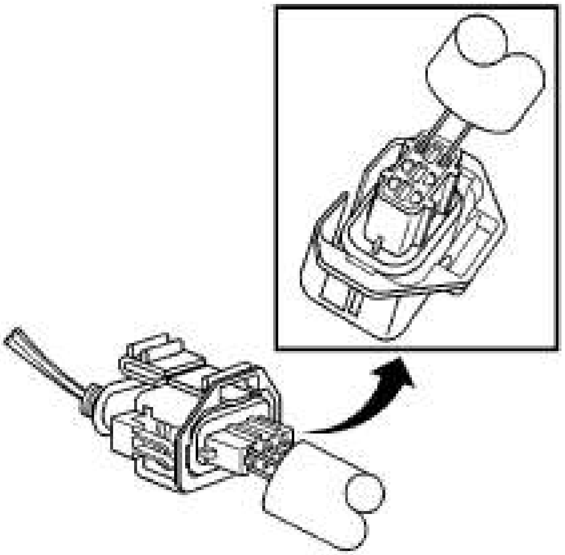
Bosch Connectors (BSK)

Special Tools

For equivalent regional tools, refer to Special Tools.

Terminal Removal Procedure

1. Disconnect the connector from the component.
2. Remove the wire dress cover, if necessary.
3. Push the wire side of the terminal that is being removed toward the connector and hold it in position.



4. Insert the EL-38125-561 tool into the 2 cavities on each side of the terminal at the front of the connector and push until you feel the tool disengage the terminal retainers.
5. Carefully pull the terminal out of the connector. Always remember never use force when pulling a terminal out of a connector. If the terminal is difficult to remove, repeat the entire procedure.

Terminated Lead Repair

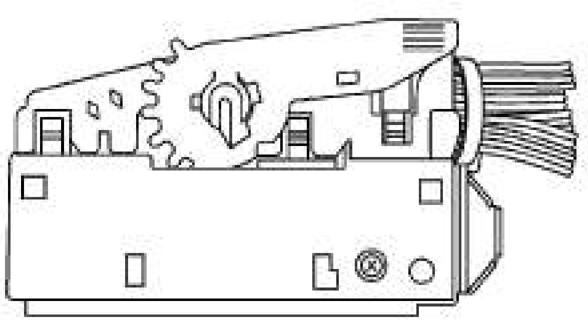
1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

Bosch Connectors (ECM)

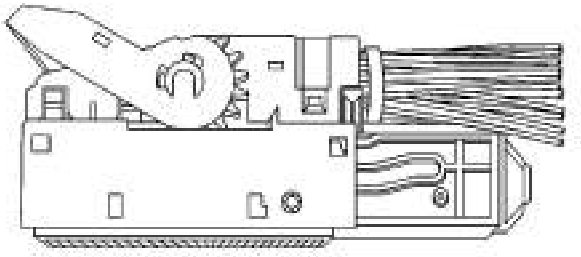
Special Tools

For equivalent regional tools, refer to Special Tools.

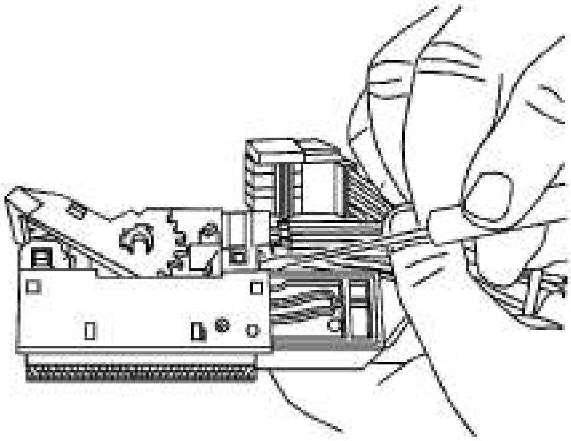
Removal Procedure



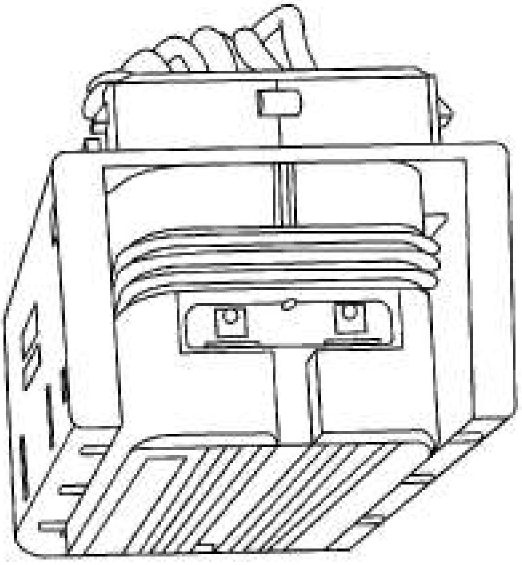
1. Locate the assist lever on the top of the connector. Move the assist lever to the forward position.



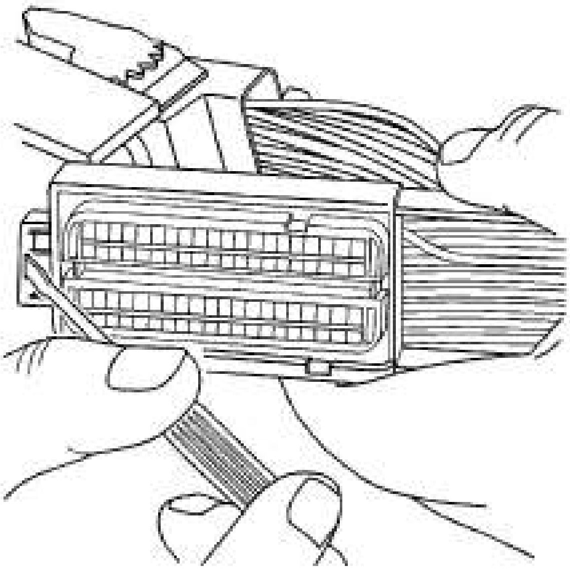
2. Disconnect the connector from the component.



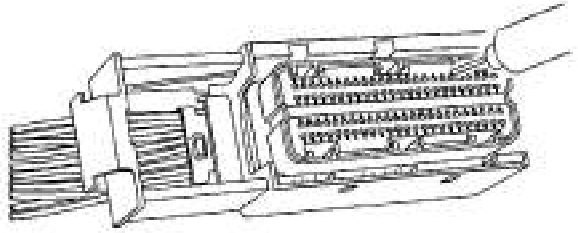
3. Locate the dress cover locking tabs at the corners of the connector. Use a small flat-blade tool to release the locking tabs and remove the dress cover.



4. The terminal positive assurance (TPA) is located in the front of the connector.

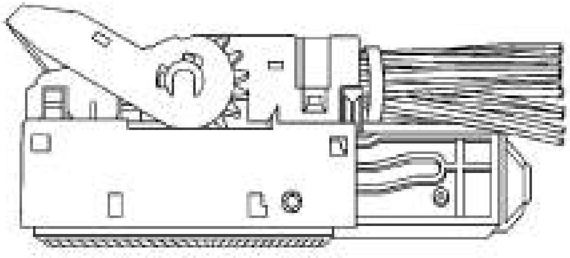


5. Use a small flat-blade tool to remove TPA from the connector.



6. Use the EL-38125-213 or the EL-38125-556 tool to release the terminals by inserting the tool into the terminal release cavity.
7. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.

Terminated Lead Repair



Note: Ensure that the dress cover and connector body are both in the released position before reassembling. Failure to do so may cause damage to the connector and component.

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

Checking Aftermarket Accessories

Caution: Refer to SIR Caution in the Preface section.

Notice: The OBD II symbol is used on the circuit diagrams in order to alert the technician that the circuit is essential for proper OBD II emission control circuit operation. Any circuit which fails and causes the malfunction indicator lamp (MIL) to turn ON, or causes emissions-related component damage, is identified as an OBD II circuit.

Do not connect aftermarket accessories into the following circuits:

- SIR circuits, all such circuits are indicated on circuit diagrams with the SIR symbol.
- OBD II circuits, all such circuits are indicated on circuit diagrams with the OBD II symbol.

Always check for aftermarket accessories (non-OEM) as the first step in diagnosing electrical problems. If the vehicle is so equipped, disconnect the system to verify that these add-on accessories are not the cause of the problems.

Possible causes of vehicle problems related to aftermarket accessories include:

- Power feeds connected to points other than the battery
- Antenna location
- Transceiver wiring located too close to vehicle electronic modules or wiring
- Poor shielding or poor connectors on antenna feed line
- Check for recent service bulletins detailing installation guidelines for aftermarket accessories.

Circuit Protection - Circuit Breakers

A circuit breaker is a protective device that is designed to open the circuit when a current load is in excess of the rated breaker capacity. If there is a short or other type of overload condition in the circuit, the excessive current will open the circuit between the circuit breaker terminals. Two types of circuit breakers are used.

Circuit Breaker: This type opens when excessive current passes through it for a period of time. It closes again after a few seconds, and if the cause of the high current is still present, it will open again. The circuit breaker will continue to cycle open and closed until the condition causing the high current is removed.

Positive Temperature Coefficient (PTC) Circuit Breaker: This type greatly increases its resistance when excessive current passes through it. The excessive current heats the PTC device, as the device heats its resistance increases. Eventually the resistance gets so high that the circuit is effectively open. Unlike the ordinary circuit breaker the PTC unit will not reset until the circuit is opened, by removing the voltage from its terminals. Once the voltage is removed the circuit breaker will re-close within a second or 2.

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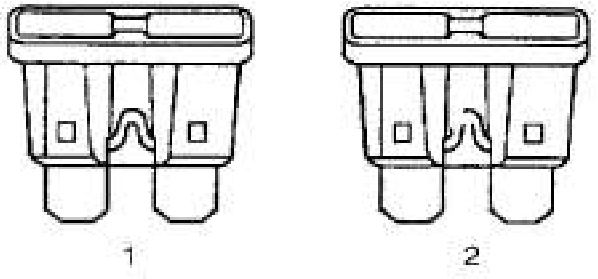
Document ID: 303635

Circuit Protection - Fuses



The fuse is the most common method of an automotive wiring circuit protection. Whenever there is an excessive amount of current flowing through a circuit the fusible element will melt and create an open or incomplete circuit. Fuses are an one time protection device and must be replaced each time the circuit is overloaded. To determine if a fuse is open, remove the suspected fuse and examine the element in the fuse for an open (2). If not broken (1), also check for continuity using a DMM or a continuity tester. If the element is open or continuity is suspect, replace the fuse with one of equal current rating.

Fuse Types

Current Rating Amperes	Color
Auto Fuses, Mini Fuses	
2	Gray
3	Violet
5	Tan
7.5	Brown
10	Red
15	Blue
20	Yellow
25	White or Natural
30	Green
Maxi Fuses	

20	Yellow
30	Light Green
40	Orange or Amber
60	Blue
50	Red
J-Case Fuses	
20	Blue
30	Pink
40	Green
50	Red
60	Yellow

Circuit Protection - Fusible Links

Fusible link is wire designed to melt and break continuity when excessive current is applied. It is often located between or near the battery and starter or electrical center. Use a continuity tester or a DMM at each end of the wire containing the fusible link in order to determine if it is broken. If broken, it must be replaced with fusible link of the same gage size.

Repairing a Fusible Link

Note: Fusible links cut longer than 225 mm (approximately 9 in) will not provide sufficient overload protection.

Circuit Testing

The Circuit Testing section contains the following diagnostic testing information. Using this information along with the diagnostic procedures will identify the cause of the electrical malfunction.

- Using Connector Test Adapters
- Probing Electrical Connectors
- Troubleshooting with a Digital Multimeter
- Troubleshooting with a Test Lamp
- Using Fused Jumper Wires
- Measuring Voltage
- Measuring Voltage Drop
- Measuring Frequency
- Testing for Continuity
- Testing for Short to Ground
- Testing for a Short to Voltage
- Testing for Intermittent Conditions and Poor Connections
- Inducing Intermittent Fault Conditions
- Testing for Electrical Intermittents
- Scan Tool Snapshot Procedure
- Circuit Protection - Fuses
- Circuit Protection - Circuit Breakers
- Circuit Protection - Fusible Links

Connector Position Assurance Locks

The connector position assurance (CPA) is a small plastic insert that fits through the locking tabs of the connector. CPAs are used in various connectors throughout the vehicle. CPAs are also used in all SIR system electrical connectors. The CPA ensures that the connector halves cannot vibrate apart. You must have the CPA in place in order to ensure good contact between the mating terminals, of the connector.

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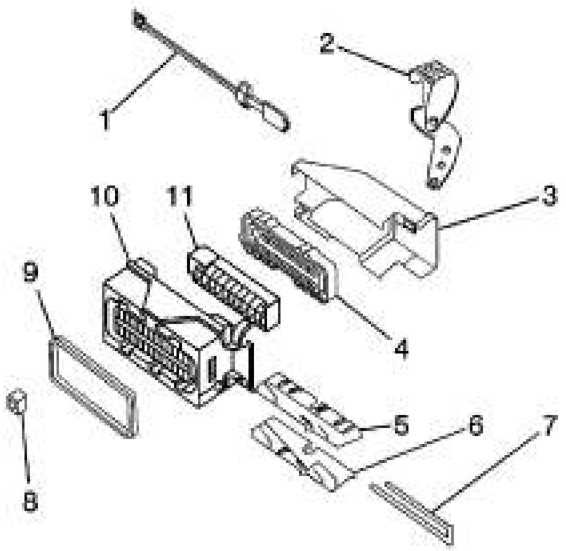
Document ID: 1465833

Connector Repairs

Connector Repairs contains a list of all connector repairs. The connector repairs are listed by the connector manufacturer and then by connector type. If the technician cannot identify the manufacturer of the connector, refer to Identifying Connectors below. Knowing the connector manufacturer will assist in finding the correct connector repair from the following list:

- Connector Position Assurance Locks
- Terminal Position Assurance Locks
- Bosch Connectors
- Delphi Connectors
- Tyco/AMP Connectors
- Yazaki Connectors
- Repairing Connector Terminals

Connector Anatomy



(1) Connector Positive Assurance (CPA)
(2) Assist Lever
(3) Wiredress Cover
(4) Seal Strain/Relief
(5) Slide Left Hand
(6) Slide Right Hand
(7) Terminal Positive Assurance (TPA)

(8) Terminal Positive Assurance (TPA)
(9) Connector Seal
(10) Connector Housing
(11) Inner Connector

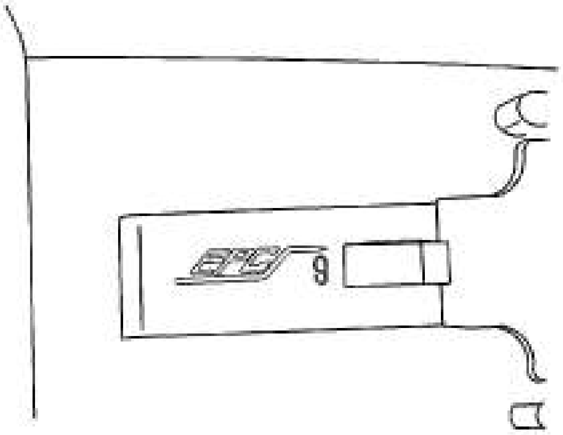
Identifying Connectors

Knowing the connector manufacturer is helpful when trying to locating the correct connector repair procedure. There are many different connector designs used on GM vehicles and it is sometimes difficult to identify the connector manufacturer. The information in this document should help with the identification of connector manufactures.

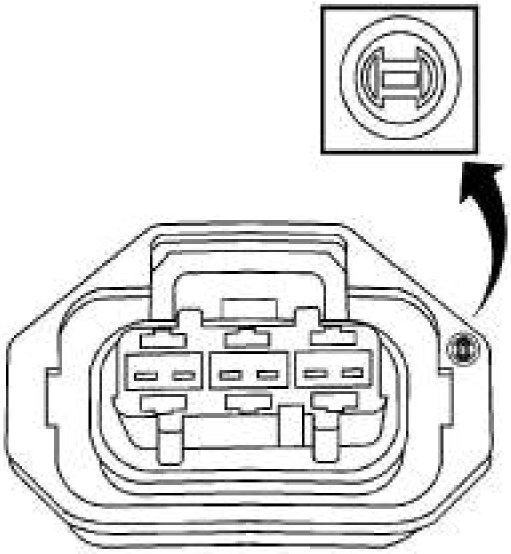
The following connector manufacturers make most of the connectors found in GM vehicles:

- AFL/EPC (Alcoa Fujikura Ltd./Engineered Plastics Components)
- Bosch
- Delphi
- FCI (Framatome Connectors International)
- JAE (Japan Aviation Electronics)
- JST (Japan Solderless Terminals)
- Kostel
- Molex
- Sumitomo
- Tyco/AMP
- Yazaki

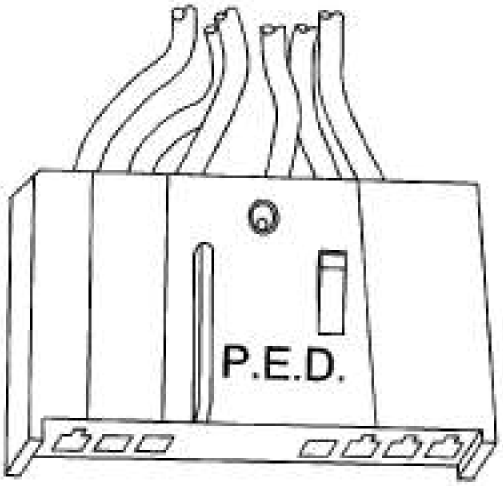
Identifying the manufacturer of a connector is often difficult. When trying to determine the manufacturer of a connector, look for specific identifying marks that are unique to that connector supplier. Most of these identify marks are hard to find or see. Check the connector carefully and refer to the information below for pictures and descriptions of connector identification markings.



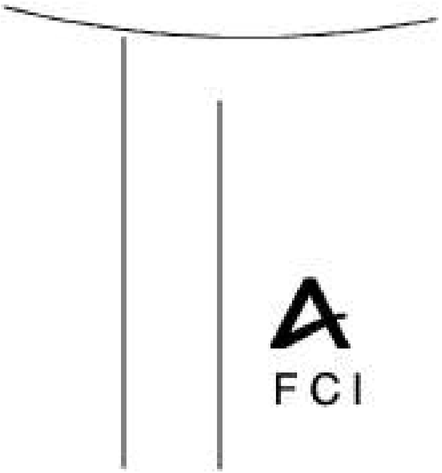
- Most of AFLs connectors have EPC on their connector body. Some of the smaller connectors will not have any markings on them.



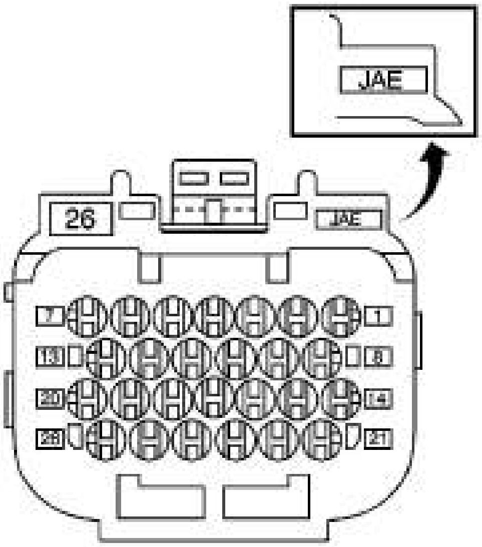
- In some cases Bosch will actually be printed on the connector. If Bosch does not appear on the connector, look for the Bosch logo. The Bosch logo is a circle with a blunted arrow inside. This logo can appear anywhere on the connector and is often very small.



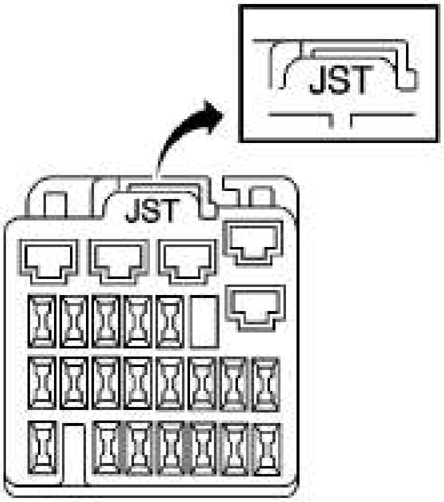
- In some cases Delphi will actually be printed on the connector. If Delphi is not printed on the connector, look for PED. In both cases there is no specific orientation for Delphi or PED and they can appear anywhere on the connector.



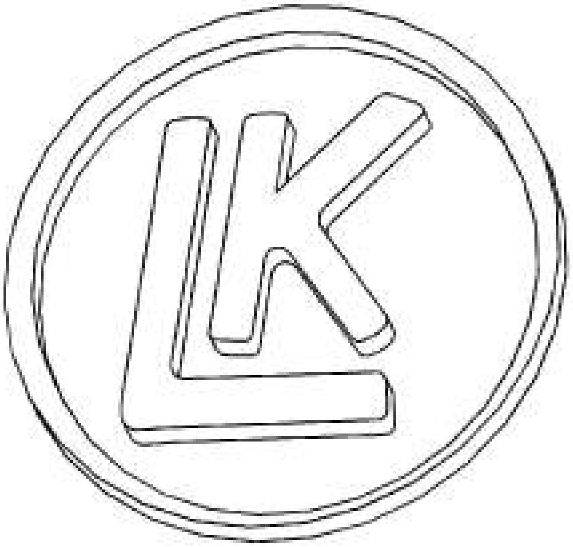
- FCI connectors may have the FCI logo on their connectors. The logo is the letters FCI with an "A" above it.



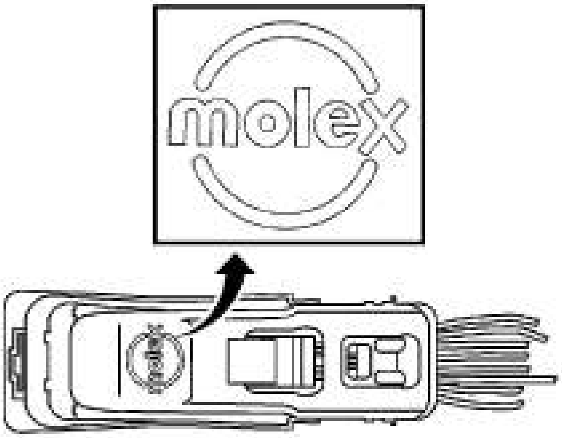
- JAE connector have JAE in small letters on their connectors.



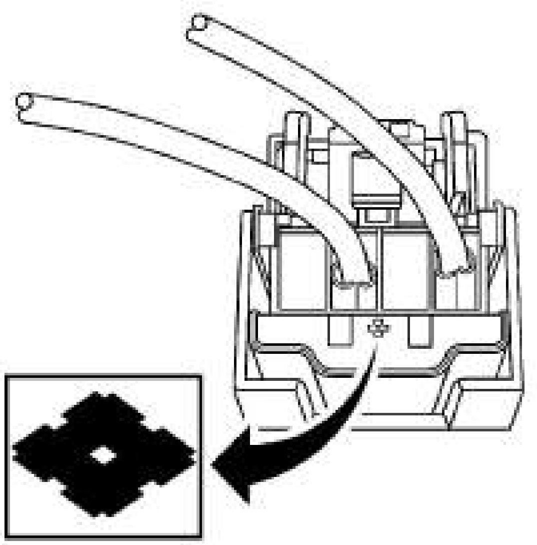
- JST connectors have JST in small letters on their connectors, similar to that above. The location of the logo will vary with the connector size and style.



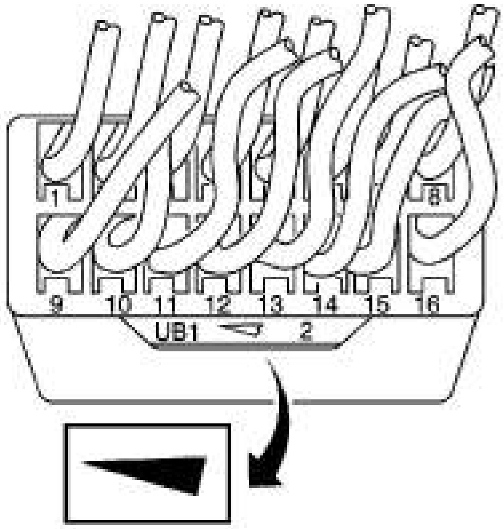
- Kostel has an "LK" with a circle around it. These connector are usually used as a transmissions connection.



- Most Molex connectors will have the Molex logo on the dresscover of the connector. In some cases the connectors may have MX followed by another letter. The third letter indicates where the connector was made. A connector with MXD is a Molex connector made in Detroit.



- Sumitomo has a unique symbol on their connector and possibly a part number. The symbol is similar to that of a diamond lying on its side, similar to that shown. The logo could appear anywhere but the most common place is at the wire side of the housing.
- Tyco/AMP has many different and unique connector designs. Some may or may not have identifiable marks on them.



- Yazaki has a wedge or arrow shape, similar to that shown.

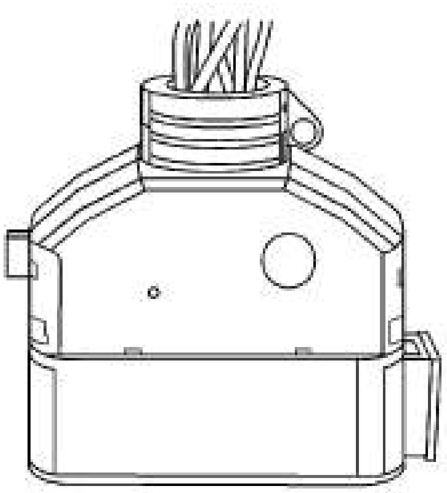
Delphi Connectors (12-Way)

Special Tools

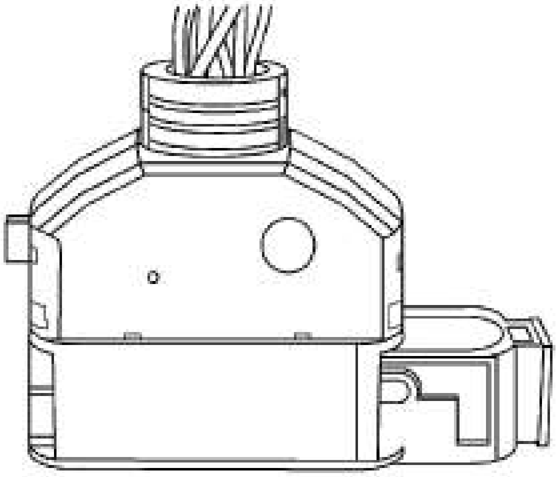
For equivalent regional tools, refer to Special Tools.

Removal Procedure

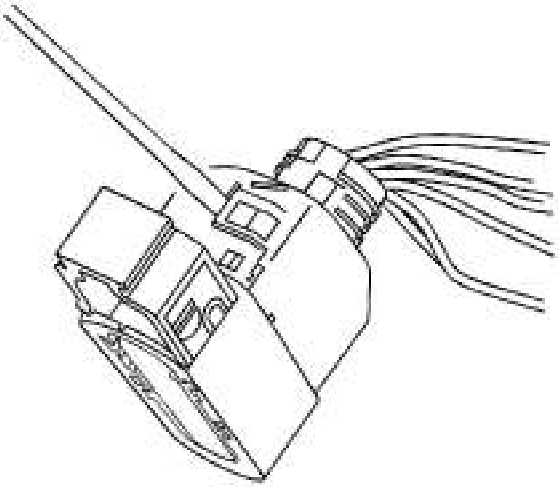
Follow the steps below in order to remove terminals from the connector.



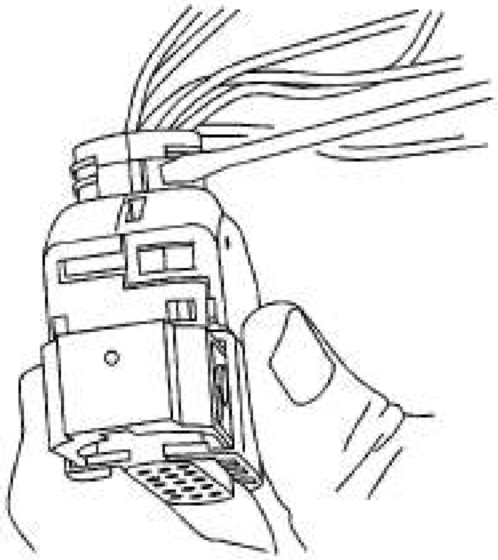
1. Locate the lever lock on the wire dress cover. Remove the connector position assurance (CPA) and slide the lever lock away from the connector body.
2. Disconnect the connector from the component.



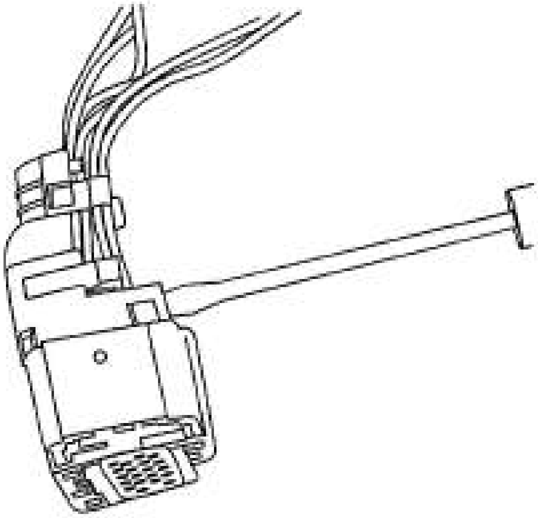
3. Locate the dress cover locking tabs on the dress cover of the connector. Using a small flat-blade tool release all of the locking tabs.



4. Release the lower wire dress cover locking tab.

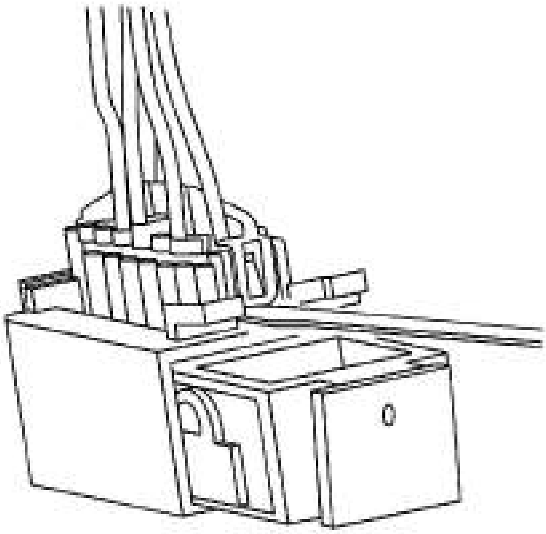


5. Release the upper wire dress cover locking tab.
6. Once the locks are unlocked, lift the dress cover off.

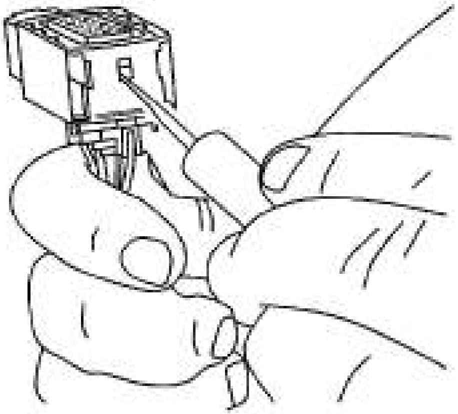


Note: Always use care when removing a terminal position assurance (TPA) in order to avoid damaging it.

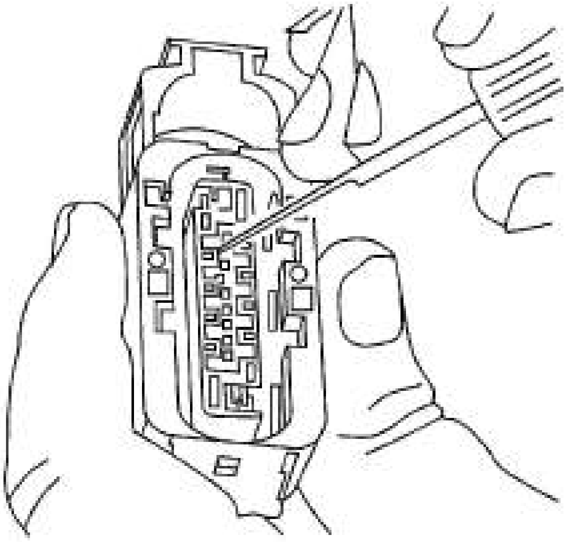
7. Remove the TPA by inserting a small flat-blade tool into the locking tabs on both sides of the TPA. Gently pry the TPA out of the connector.



8. Remove the nose piece by inserting a small flat-blade tool into the locking tabs on both sides of the nose piece. Gently pry the nose piece out of the connector.



9. Insert the EL-38125-12A tool to release the terminals by inserting the tool into the terminal release cavity.



10. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.

Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

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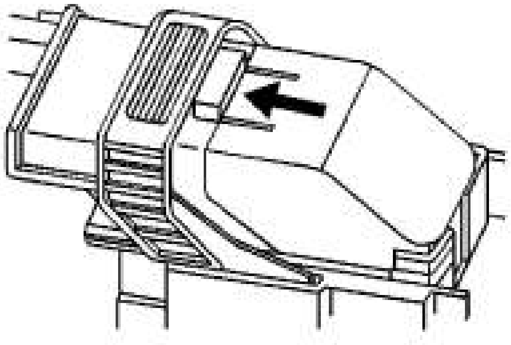
Delphi Connectors (Micro .64)

Special Tools

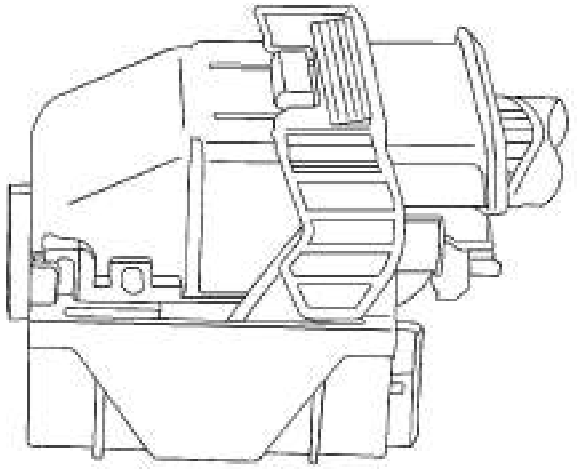
For equivalent regional tools, refer to Special Tools.

Removal Procedure

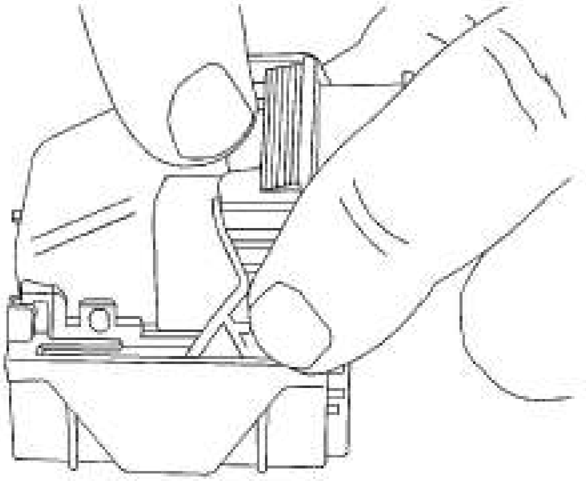
Follow the steps below in order to remove terminals from Micro .64 connectors.



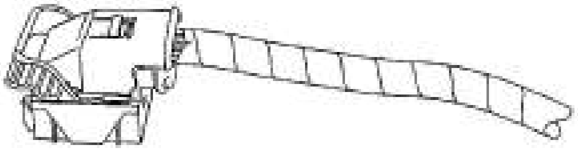
1. Locate the lever lock on the wire dress cover. While depressing the lock, pull the lever over and past the lock. The lever lock may be located on the top or sides of the wire dress cover.



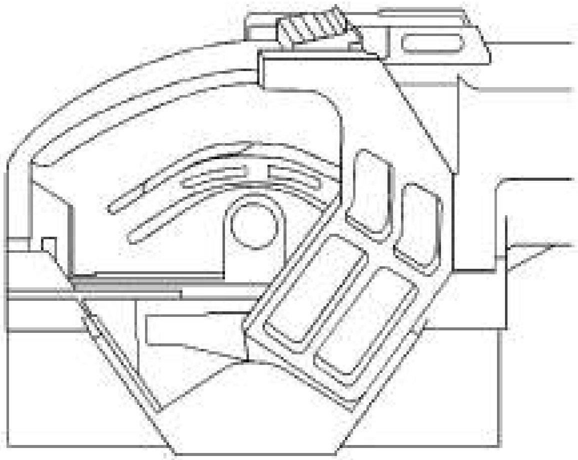
2. View of a typical Micro 64 connector.



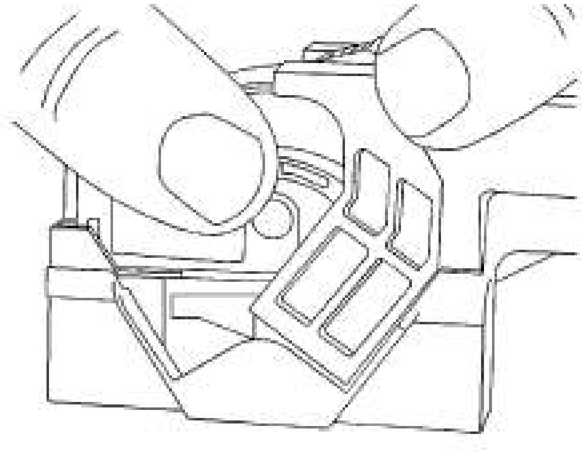
3. Depress the lock and pull the lever over and past the lock.



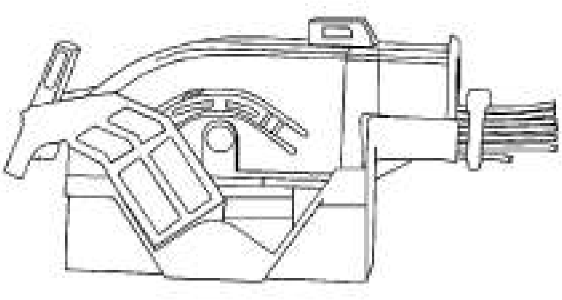
4. View of the connector when released from the component.



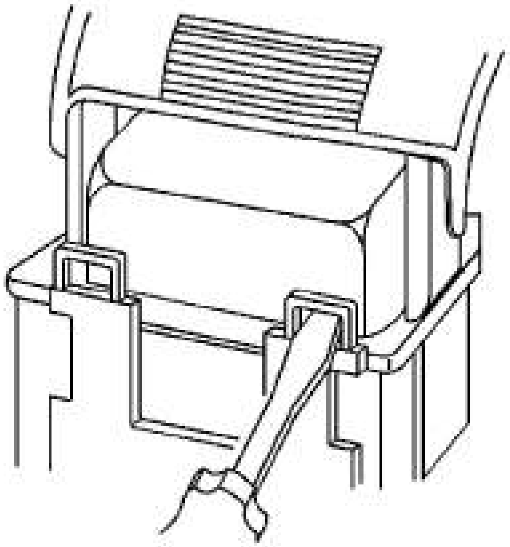
5. View of another type of Micro 64 connector.



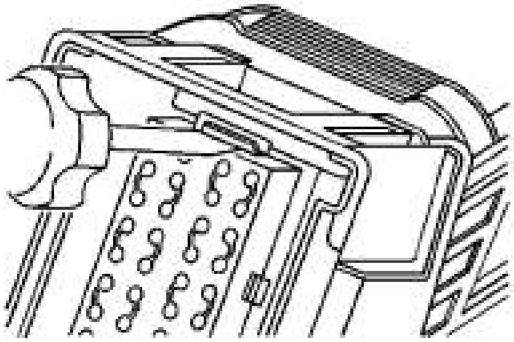
6. Depress the locks that are located on both sides of the wire dress cover and pull the lever over and past the locks.



7. View of the connector when released from the component.
8. Disconnect the connector from the component.

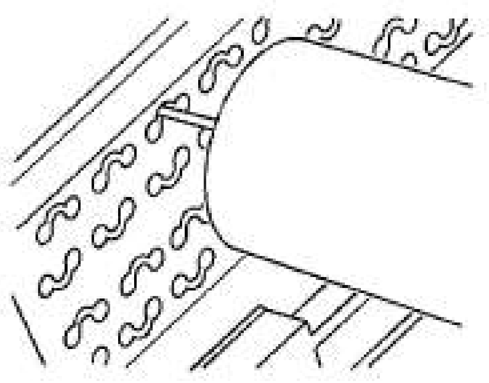


9. Locate the dress cover locking tabs at the front of the connector. Using a small flat-blade tool push down on one of the locking tabs and pull the cover up until the dress cover releases. Repeat this procedure for the other locking tab.
10. Once the front 2 locks are unlocked, lift the front of the dress cover and pull it forward.



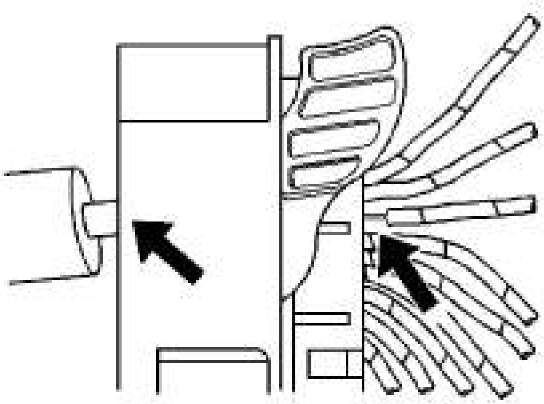
Note: Always use care when removing a terminal position assurance (TPA) in order to avoid damaging it.

11. Remove the TPA by inserting a small flat-blade tool into the small slot on the TPA and pushing down until the TPA releases. Gently pry the TPA out of the connector.



Note: Be careful not to angle or rock the EL-38125-21 tool when inserting it into the connector or the tool may break.

12. Insert the EL-38125-21 tool into the round canal between the terminals cavities at the front of the connector.



13. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.

Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.

3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

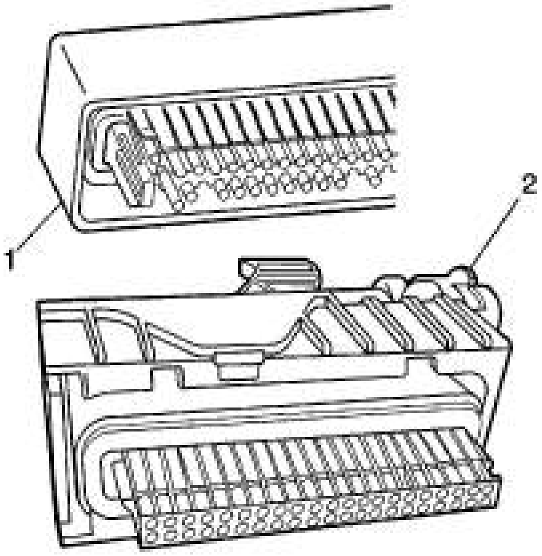
Delphi Connectors (Micro-Pack 100W)

Special Tools

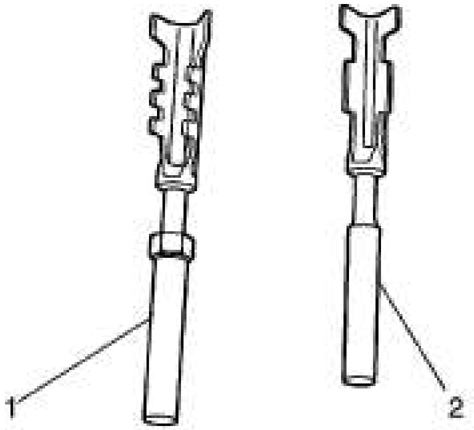
For equivalent regional tools, refer to Special Tools.

Terminal Removal Procedure

There are 2 styles of Micro-Pack 100W connectors. These connectors are very similar but use different terminals and have some minor physical differences also.



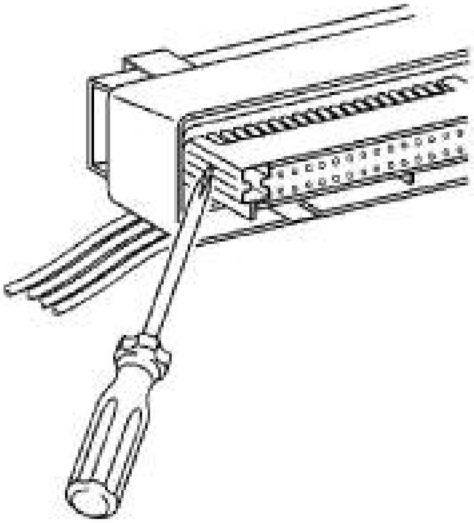
The first connector design of the Micro-Pack 100W (1) has a white connector interface that holds the terminals. The second design of the Micro-Pack 100W (2) has a gray interface to hold the terminals. Also, the first design has terminal cavities that are further apart (3 mm centerline) and offset from the other row of terminal cavities in the connector. The second design has terminals cavities that are closer together (2.54 mm centerline) and aligned vertically. One other way to identify the second design is the thin strip of material that runs along the outside of the cavities.



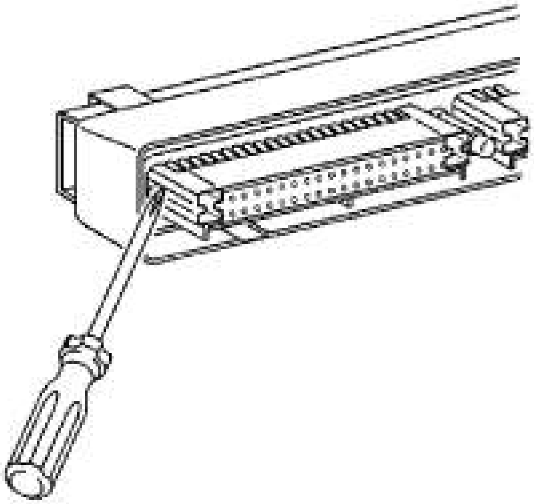
Note: There are 2 styles of Micro-Pack 100W terminals which are very similar. Ensure that you have the correct terminal before crimping the new terminal to the wire. The first design connector uses the longer terminal (1) that has a raised area in front of the recess in the terminal. The second design connector uses the shorter terminal without the raised area.

Follow the steps below in order to remove terminals from Micro-Pack 100W connectors. Some Micro-Pack 100W connector disassembly procedures will vary. Use this procedure as a guide.

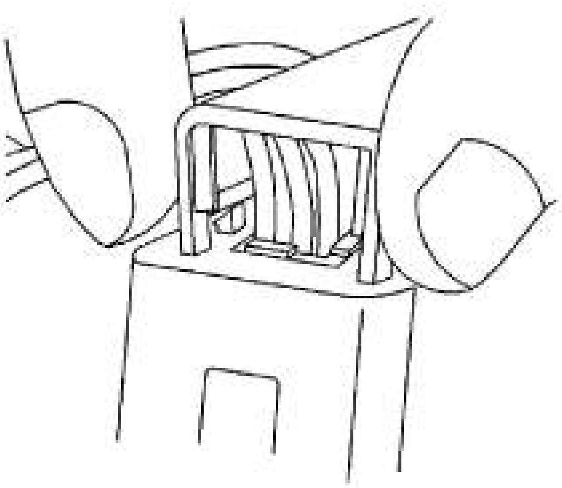
1. Disconnect the connector from the component.



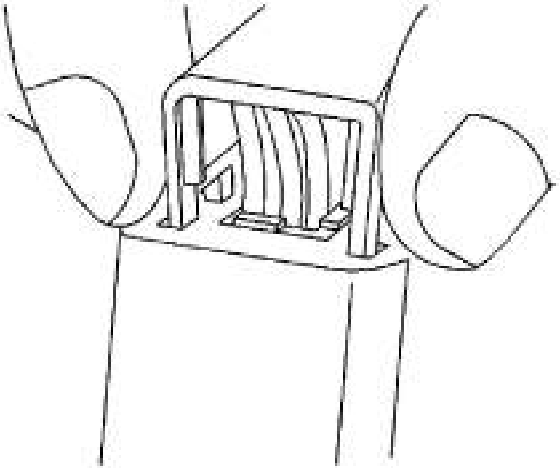
2. Locate the nose piece locking tabs that are positioned on the side of the connector nose piece. The connector nose piece acts as a terminal positive assurance (TPA) and may be referred to as such.



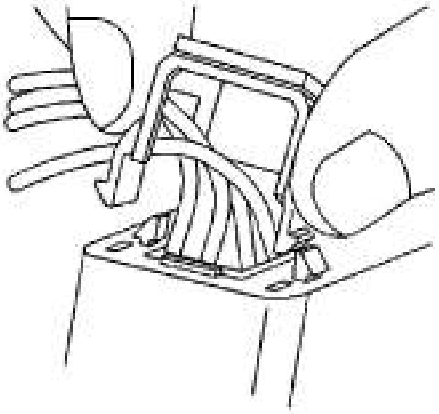
3. Use a small flat-blade tool to push in one of the locking tabs while gently pulling on the same side of the nose piece.
4. Repeat the procedure for the other locking tab and remove the nose piece.
5. Remove the wire dress cover. The following is a general procedure for wire dress cover removal. Use this procedure as a guide, some dress cover removal procedures may vary.



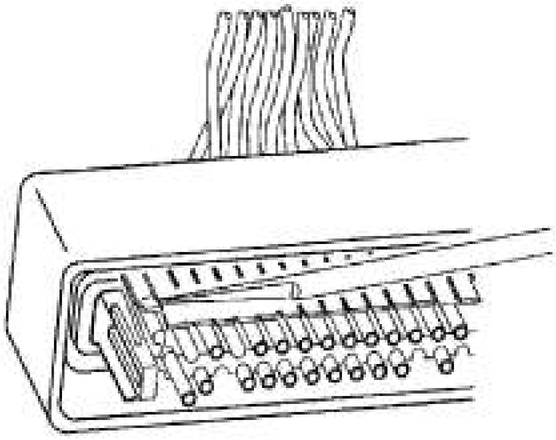
6. Use fingers to squeeze the 2 locking legs of the cover.



7. Apply pressure and gently rock the cover until one locking leg is unseated.



8. Continue to apply pressure and rock the cover until the second locking leg is unseated. Repeat procedure for the other side of the dress cover and remove the cover.



9. Use EL-38125-12A to gently lift the terminal retaining tab while gently pulling the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
10. If the terminal is severely bent or damaged, it may be possible on some connectors to push the wire out of the front of the connector instead of pulling it through. This will prevent damage to the internal seals of the connector. Once the terminal is pushed out of the connector, cut the wire as close to the terminal as possible and pull the wire through the connector.

Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

Terminal Replacement Procedure

After the terminal is crimped to the wire perform the following procedure in order to replace Micro-Pack 100 terminals.

1. Slide the new terminal into the correct cavity at the back of the connector.
2. Push the terminal into the connector until it locks into place. The new terminal should be even with the other terminals. Ensure that the terminal is locked in place by gently pulling on the wire.
3. To assemble the connector, reverse the Terminal Removal Procedure.

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Delphi Connectors (Pull To Seat)

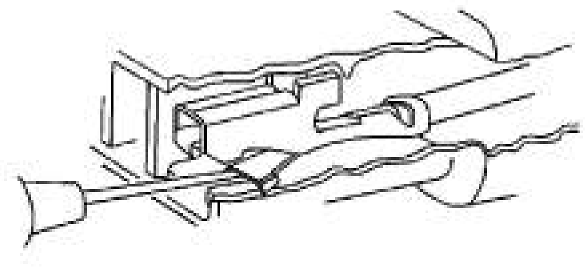
Special Tools

For equivalent regional tools, refer to Special Tools.

Terminal Removal

If the terminal is visibly damaged or is suspected of having a faulty connection, the terminal should be replaced.

Follow the steps below in order to repair pull-to-seat connectors:



1. Remove the connector position assurance (CPA) device and/or the secondary lock.
2. Disconnect the connector from the component or separate the connectors for in-line connectors.
3. Remove the terminal position assurance (TPA) device.
4. Insert the proper pick or removal tool into the front of the connector body.

   Note: On connectors with more than one terminal the service loop may not be large enough to remove the terminal and crimp on a new one. If the terminal wire does not have a large enough service loop for removal, cut the wire 5 cm (2 in) behind the connector before removal.

5. Grasp the wire at the back of the connector body and gently push the terminal out the front of the connector body.

Terminal Repair

1. If the wire needed to be cut in order to remove the terminal, gently push a small length of the same size wire through the back of the connector cavity until there is enough wire exposed in order to crimp on a new terminal. If the wire was not cut, cut the existing wire as close to the old terminal as possible.
2. Strip 5 mm (3/16 in) of insulation from the wire.
3. Crimp a new terminal to the wire.
4. Solder the crimp with rosin core solder.

Terminal Installation

1. Align the terminal and pull the wire from the back of the connector in order to seat the terminal.
2. If necessary, cut the new wire to proper length and splice with existing circuit. Refer to Splicing Copper Wire Using Splice Sleeves.
3. If the connector is outside of the passenger compartment, apply dielectric grease to the connector.
4. Install the TPA, CPA, and/or the secondary locks.

Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

Delphi Connectors (Push To Seat)

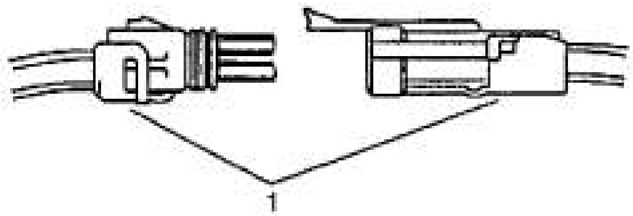
Special Tools

For equivalent regional tools, refer to Special Tools.

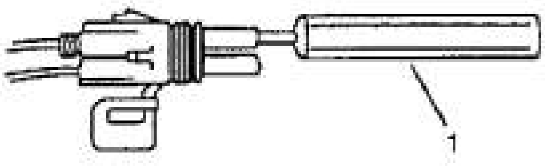
Terminal Removal

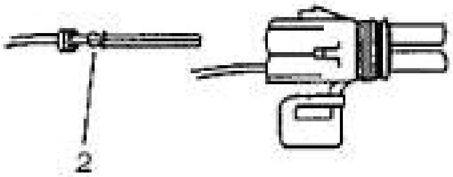
Follow the steps below in order to repair push to seat connectors.

1. Remove the terminal position assurance (TPA) device, the connector position assurance (CPA) device, and/or the secondary lock.

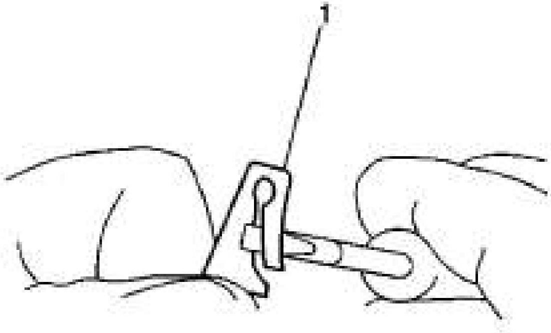


2. Separate the connector halves (1).





3. Use the proper pick or removal tool (1) in order to release the terminal.
4. Gently pull the cable and the terminal (2) out of the back of the connector.



5. Re-form the locking device if you are going to reuse the terminal (1).
6. To repair the terminal, refer to Terminal Repair.

Reinstalling Terminal

1. In order to reuse a terminal or lead assembly, refer to Wiring Repairs.
2. Ensure that the cable seal is kept on the terminal side of the splice.
3. Insert the lead from the back until it catches.
4. Install the TPA, CPA, and/or the secondary locks.

Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

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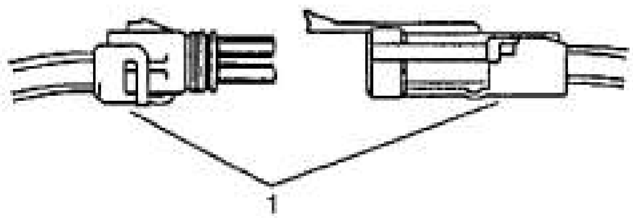
Delphi Connectors (Weather Pack)

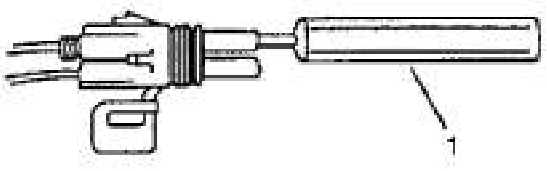
Special Tools

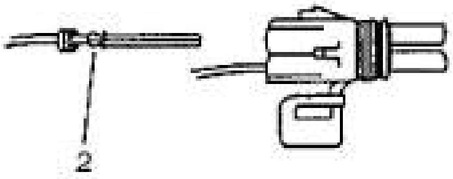
For equivalent regional tools, refer to Special Tools.

The following is the proper procedure for the repair of Weather Pack® Connectors.



1. Separate the connector halves (1).
2. Open the secondary lock. A secondary lock aids in terminal retention and is usually molded to the connector (1).
3. Grasp the wire and push the terminal to the forward most position. Hold the wire in this position.





4. Insert the Weather Pack® terminal removal tool EL-38125-10A into the front (mating end) of the connector cavity until it rests on the cavity shoulder (1).
5. Gently pull on the wire to remove the terminal through the back of the connector (2).

   Note: Never use force to remove a terminal from a connector.

6. Inspect the terminal and connector for damage. Repair as necessary. Refer to Repairing Connector Terminals.
7. Reform the lock tang (2) and reset terminal in connector body.
8. Close secondary locks and join connector halves.
9. Verify that circuit is complete and working satisfactorily.
10. Perform system check.

Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

Diagnostic Starting Point - Wiring Systems and Power Management

Begin the system diagnosis with Diagnostic System Check - Vehicle. The Diagnostic System Check - Vehicle will provide the following information:

- The identification of the control modules which are not communicating.
- The identification of any stored diagnostic trouble codes (DTCs) and their status.

The use of the Diagnostic System Check - Vehicle will identify the correct procedures to begin vehicle diagnosis. These must be performed before system DTC or symptom diagnosis.

DTC B1370-B1379, B1380-B1389, or B1440-B1443

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC B1370 01: Device Ignition 1 (ON and START) Circuit Short to Battery

DTC B1370 06: Device Ignition 1 (ON and START) Circuit Short to Ground or Open

DTC B1380 01: Device Ignition ACCESSORY Circuit Short to Battery

DTC B1380 06: Device Ignition ACCESSORY Circuit Short to Ground or Open

DTC B1440 00: Power Mode Master Input Circuits Mismatch

DTC B1441 01: Device Ignition OFF, RUN, and CRANK Circuit Short to Battery

DTC B1441 06: Device Ignition OFF, RUN, and CRANK Circuit Short to Ground or Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ - Terminal 2	B1370 06, B1380 06, B1440 00, U0100-U0299, 1, 2, 3, 4, 5	B1370 06, B1380 06, B1440 00, U0100-U0299, 1, 2, 3, 4, 5	--	--
Ignition - Terminal 3	B1370 06, B1380 06,U0100-U0299, 1, 2, 3, 4, 5	B1380 06, 1, 5	B1380 01, B3055 00, P0513 00, U0100-U0299, 1, 2, 4	--
Ignition - Terminal 4	B1370 06, B1380 006, B1423 03, B1440 00, B1441 06, P0513 00, U0100-U0299, 1, 2, 3, 4, 5	B1440 00, B1441 06, 1	B1441 01, P0513 00, U0100-U0299, 1, 2	--
Ignition - Terminal 1	B1370 06, B1380 06,U0100-U0299,	B1370 06, B1380 06,	B1370 01, B1440 00, P0575 00, P0856 00,	--

	1, 2, 3, 4, 5	U0100-U0299, 1	U0100-U0299, 1, 2, 4	
Ignition - Terminal 6	B1440 00, 1	B1440 00, 1	1, 2	--
Ignition Voltage - BCM Terminal 21 X4	B1380 06, B1428 00, U0100-U0299, 1, 2, 3, 4	P0628 00, 2, 4, 6	B1440 00, 7	--
Accessory Wakeup Serial Data, BCM Terminal 19 X4	U0100-U0299, U1814 00, B1380 06, 1, 2, 3, 4, 5	U0100-U0299, 4	B3055 00, B3935 57	--

1. Power Mode Mismatch. Different specific symptoms may occur depending on the vehicle operating conditions when the fault occurred.
2. Vehicle may not start.
3. The B+ circuit fuse to the ignition switch may be open.
4. May lose communication with other module(s).
5. The ignition switch may not return to the OFF position and the key may not come out of the ignition.
6. SIR system may retain DTC B1370 06 as current.
7. Vehicle will start and continue to run after the ignition key is removed.

Circuit/System Description

The vehicle power mode master (PMM) is the body control module (BCM). The ignition switch is a low current switch with multiple discrete circuits to the BCM. The BCM logic uses the ignition switch positions to identify the operator's desired power mode and activate specific discrete signals, and serial data messages for the operation of different subsystems as necessary. Other modules which have switched voltage inputs may operate in a default mode if the PMM serial data message does not match what the individual module can detect from its own connections.

The PMM will activate relays and other direct outputs of the PMM as needed according to the calculated power mode. Some relays controlled by the BCM are switched ignition voltage outputs that are pass through circuits within the BCM directly from the ignition switch. If these circuits short to ground, the B+ circuit fuse to the ignition switch will open.

Conditions for Running the DTC

B1370 01, B1380 01

Ignition switch is in the RUN or CRANK positions.

B1370 06, B1380 06

Ignition switch is in the RUN or ACCESSORY positions.

B1440 00

Ignition switch is in the RUN position.

B1441 01, B1441 06

Ignition switch is in the CRANK position.

Conditions for Setting the DTC

B1370 01

Ignition circuit is shorted to voltage.

B1370 06

- Ignition circuit is open.
- Ignition, accessory, or off/run/crank circuit shorted to ground.
- B+ circuit of the ignition switch is open or shorted to ground.
- Ignition relay control circuit open, including relay coil and ground.

B1380 01

Accessory circuit is shorted to voltage.

B1380 06

- Accessory circuit is open.
- Ignition, accessory, or off/run/crank circuit shorted to ground.
- B+ circuit of the ignition switch is open or shorted to ground.

B1440 00

BCM detects an open or short to voltage on the off/run/crank signal circuit when both ignition ACCESSORY/RUN and ignition RUN/CRANK parameters are active.

BCM detects an open on the B+ circuit to the ignition switch while the engine is running.

B1441 01

Off/run/crank signal circuit is shorted to voltage.

B1441 06

Off/run/crank signal circuit is open.

Actions Taken When the DTC Sets

- The BCM operates in a fail-safe power mode dependent on the last valid power mode detected and the state of the engine run flag data on the serial data communications circuits.
- The other modules on the vehicle operate in a fail-safe power mode dependent on the last

valid power mode transmitted by the BCM and the state of the engine run flag on the serial data communications circuits.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

- Body Control System Schematics
- Power Distribution Schematics
- Power Moding Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Mode Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC U1814 or B1428 is not set.
   If any of the DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. With a scan tool, access BCM, Power Mode data display list and compare all parameters listed with the corresponding ignition key position. The BCM Power Mode Parameters table below illustrates the correct state of these input parameters in correspondence to the ignition switch position. The circuits which the individual parameters are related to are in parentheses.
   If any parameters are incorrect in any key position, proceed to the Circuit/System Testing or Component Testing.

BCM Power Mode Parameters

Ignition Switch Position	Standard Power Mode	Ign. Off/Run/Crank (Ignition Switch, Terminal 4)	Ignition Accessory/Run (Ignition Switch, Terminal 3)	Ignition Run/Crank (Ignition Switch, Terminal 1)
Off Key Out	Off	Key Out/ACC	Inactive	Inactive
Off Key IN	Off	Key In/Off	Inactive	Inactive
Accessory	Accessory	Key Out/ACC	Active	Inactive
Run	Run	Run	Active	Active
Start	Crank	Cranking	Inactive	Active

Circuit/System Testing

1. Disconnect the harness connector at the ignition switch.
2. Verify that a test lamp illuminates between B+ circuit terminal 2 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse is open, test the ignition circuits listed below for a short to ground.

   Note: To help isolate a short to ground, it may be necessary to disconnect modules that are connected to the following circuits:

   - terminal 1
   - terminal 3
   - terminal 4
   - terminal 6
   - BCM terminal 19, X4
   - BCM terminal 21, X4
3. Connect the harness connector at the ignition switch.
4. Ignition OFF, key out, disconnect the X1 harness connector at the BCM. Verify that a test lamp does not illuminate between the ignition circuit terminals listed below and ground:
   - terminal 2
   - terminal 14
   - terminal 21

   If the test lamp illuminates, test the ignition circuits for a short to voltage. If the circuit tests normal, replace the ignition switch.
5. Ignition in the ACCESSORY position, verify that a test lamp illuminates between the terminal 21 and ground.

   If the test lamp does not illuminate, test the ignition circuit for an open/high resistance. If the circuit tests normal, replace the ignition switch.
6. Ignition in the CRANK position, verify that a test lamp illuminates between terminal 14 and ground.

   If the test lamp does not illuminate, test the ignition circuit for an open/high resistance. If the circuit tests normal, replace the ignition switch.
7. If all of the circuits test normal, replace the BCM.

Component Testing

Ignition Switch

1. Ignition OFF, disconnect the harness connector at the ignition switch.
2. Verify the resistance between the terminals listed below match for each ignition switch position.

   If not the specified value, replace the ignition switch.

Resistance Test

Ignition Switch Position	Terminals 1 and 2	Terminals 2 and 3	Terminals 2 and 4	Terminals 2 and 6	Terminals 4 and 6
Off Key Out	Infinite	Infinite	Infinite	Infinite	Infinite
Off Key IN	Infinite	Infinite	< 5.0 Ω	Infinite	Infinite
Accessory	Infinite	< 5.0 Ω	Infinite	Infinite	Infinite
Run	< 5.0 Ω	< 5.0 Ω	Infinite	Infinite	< 5.0 Ω
Start	< 5.0 Ω	Infinite	Infinite	Infinite	1275-1325 Ω

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Ignition and Start Switch Replacement
- Control Module References for BCM replacement, setup, and programming.

DTC B1428

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B1428 00: Ignition Switched Power Relay 1 Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Relay Coil B+	B1380 06, B1428 00, U0100-U0299, 1, 2	P0628 00, 1, 3, 4	B1440 00, 5	--
Ignition Relay Switch B+	1, 2, 3, 4	1, 2, 3, 4	--	--
Ignition Relay Control	1, 2, 3, 4	1, 2, 3, 4	--	--
Ignition Relay Ground	--	1, 2, 3, 4	--	--

1. Some modules may lose communication and/or be inoperable.
2. The B+ circuit fuse to the ignition switch may be open.
3. SIR system may retain DTC B1370 06 as current.
4. Vehicle may not start.
5. Vehicle will continue to run after the ignition key is removed.

Circuit/System Description

The body control module (BCM) controls the R14 IGN relay through the run/crank ignition circuit by applying voltage to the circuit. The R14 IGN relay is energized when the ignition switch is in the RUN or CRANK position, or when a remote start is requested.

Conditions for Running the DTC

- The system voltage is between 9-16 V.
- The ignition 1 relay control output is active.

Conditions for Setting the DTC

The BCM detects a short to ground on the ignition circuit.

Action Taken When the DTC Sets

The BCM disables the ignition output driver.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Power Moding Schematics

Power Distribution Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Mode Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the R14 IGN relay.
2. Test for less than 10 Ω between the ground circuit terminal 86 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Connect a test lamp between the B+ circuit terminal 85 and the ground circuit terminal 86.
4. Command the Run/Crank Relay ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the B+ circuit for a short to voltage. If the circuit tests normal, replace the BCM.

If the test lamp is always OFF, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.

5. If all circuits test normal, test or replace the R14 IGN relay.

Component Testing

1. Ignition OFF, disconnect the R14 IGN relay.
2. Test for 60 - 180 Ω between the B+ terminal 85 and the ground terminal 86 of the R14 IGN relay.

   If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If not the specified value, replace the relay.
4. Install a 3 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 Ω between terminals 30 and 87.

   If greater than specified range, replace the relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for BCM replacement, setup, and programming

DTC B1433

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B1433 00: Ignition Switched Power Relay 2 Circuit

Circuit/System Description

The body control module (BCM) supplies B+ to terminal 13, X5. For vehicles equipped with a Run relay, the BCM controls the Run relay through the coil control circuit by applying voltage to the coil side of the relay. The Run relay is energized when any of the following conditions are true:

- Ignition Switch is in ACCESSORY or RUN.
- The vehicle is remote started.
- The vehicle is in retained accessory power (RAP) mode.

Conditions for Running the DTC

- The system voltage is between 9-16 V.
- The DTC can only set when the output is actively being requested by the module.

Conditions for Setting the DTC

The DTC will set only when the module requests the output and there is a short to ground at BCM terminal 13, X5 or a short to ground in the Run relay coil control circuit.

Action Taken When the DTC Sets

The module output driver will be shut down and not supply voltage to the circuit.

Conditions for Clearing the DTC

- The current DTC will clear when the module request for the output is removed or the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- DTC B1433 00 will not cause any symptoms.
- Diagnose all other DTCs and symptoms first as this code may be set as a result of other concerns.
- BCM replacement is not necessary for this DTC.

Reference Information

Schematic Reference

- Body Control System Schematics
- Power Distribution Schematics
- Power Moding Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Mode Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Testing

1. Ignition OFF, disconnect the X5 harness connector at the BCM.
2. Verify there are not any aftermarket components wired into terminal 13.
3. If terminal 13 is empty, clear the code as there are not any further circuits to diagnose.

DTC B1475

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B1475 00: Retained Accessory Power Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
RAP Relay Switch B+	1	1	--	--
RAP Relay Coil B+	B1475 00, 1	1	--	--
RAP Relay Control	1	1	1	--
RAP Relay Ground	--	1	--	--
1. Retained Accessory Power (RAP) Malfunction				

Circuit/System Description

The body control module (BCM) controls the RAP relay through the RAP relay coil voltage circuit by applying voltage to the coil side of the relay. The RAP relay is energized when any of the following conditions are true:

- Ignition switch is in the ACCESSORY or RUN position.
- The vehicle was remote started.
- The vehicle is in RAP mode.

Conditions for Running the DTC

- The system voltage is between 9-16 V.
- The output is actively being requested by the module.

Conditions for Setting the DTC

The BCM detects a short to ground in the RAP relay coil voltage circuit.

Action Taken When the DTC Sets

The BCM will shut down voltage to the circuit.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Diagnostic Aids

The radio RAP mode is a separate function and will still operate properly. The radio RAP function is controlled by serial data and the specific module. These functions are not effected by the BCM RAP relay circuits.

Reference Information

Schematic Reference

- Power Distribution Schematics
- Power Moding Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Retained Accessory Power Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the RAP relay.
2. Test for less than 5 Ω between the ground circuit terminal 86 and ground.

If greater than the specified range, test the ground circuit for an open/high resistance.

3. Connect a test lamp between the relay control circuit terminal 85 and ground.
4. Cycle the ignition ON and OFF. The test lamp should turn ON and OFF when changing ignition switch positions.

   If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test the control circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the RAP relay.

Component Testing

1. Ignition OFF, disconnect the RAP relay.
2. Test for 70 - 150 Ω between the B+ terminal 85 and the ground terminal 86 of the relay.

   If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If not the specified value, replace the relay.
4. Install a 3 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 Ω between terminals 30 and 87.

   If greater than the specified range, replace the relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for BCM replacement, setup, and programming.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Power and Signal Distribution | Wiring Systems and Power Management | Diagnostic Information and Procedures |

Document ID: 1978481

Electrical Symbols

Table 1: Voltage Indicators
Table 2: General Icons
Table 3: Switch Position Icons
Table 4: Module Circuit Function Icons
Table 5: Harness Components
Table 6: Component Parts
Table 7: Switches and Relays
Table 8: Devices and Sensors

Voltage Indicators

Symbol	Description
B+	Battery Voltage
IGN 0	Ignition Switch - Off Position
	Ignition Switch - Accessory Position

IGN I	
IGN II	Ignition Switch - Run Position
IGN III	Ignition Switch - Start Position

General Icons

Symbol	Description
LOC	Master Component List Icon This icon is used on the schematic to link to the Master Electrical Component List.

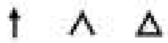
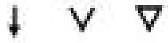
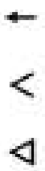
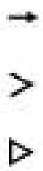
🔍	
DESC 🔍	Description and Operation Icon This icon is used on the schematic to link to the Description and Operation of that particular system.
⇄ 🔍	Computer Programming Icon This icon is used on the schematic to link to Control Module References, which identifies which components need programming upon replacement.
➔ 🔍	Next Schematic Page Icon This icon is used on the schematic to navigate to the next schematic in the subsystem.
	Previous Schematic Page Icon

← 🔍	This icon is used on the schematic to navigate to the previous schematic in the subsystem.
⚠ 🔍	Supplemental Inflatable Restraint (SIR) or Supplemental Restraint System (SRS) Icon This icon is used to alert the technician that the system contains SIR/SRS components that require certain precautions before servicing.
⚠ 🔍	Information Icon This icon is used to alert the technician that there is additional information that will aid in servicing a system.
⚠	Danger - High Voltage Icon This icon is used to alert the technician that a component/system contains 300 volt circuits.

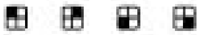
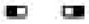
🔍	
⚡ 🔍	High Voltage Icon This icon is used to alert the technician that a component/system contains voltage greater than 42 volts but less than 300 volts.
⚠ 🔍	Caution Icon This icon is used to advise the technician to use caution when servicing this component.
⇅ 🔍	Functional Serial Data Communication This icon is used to show the technician that the serial data circuit detail is shown incomplete. It also provides an active link to the Data Communication Schematics were the circuit is shown complete.

Switch Position Icons

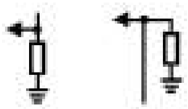
Symbol	Description

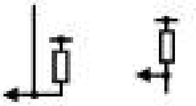
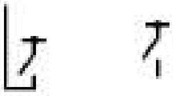
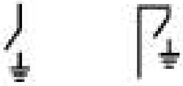
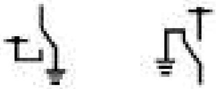
	Generic Up Arrows
	Generic Down Arrows
	Generic Left Arrows
	Generic Right Arrows

↓↓ 🔍	Generic Express Down Arrows
⏻ 🔍	On/Off Icon
🔒 🔍	Generic Lock Icon
🔓	Generic Unlock Icon

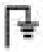
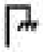
	Generic Window Switch Positions - 4 Door
	Generic Window Switch Positions - 2 Door

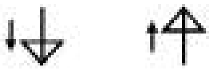
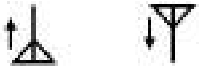
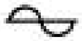
Module Circuit Function Icons

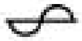
Symbol	Description
	I/O Pull-Down Resistors (-)
	I/O Pull-Up Resistors (+)

	
	I/O High-Side Drive Switch (+)
	I/O Low-Side Drive Switch (+)
	I/O Bidirectional Switch (+/-)

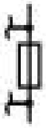
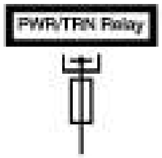
	Pulse-Width Modulation Symbol
B+	Battery Voltage
IGN	Ignition Voltage
5V	Voltage Reference

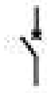
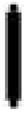
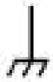
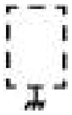
5V AC	A/C Voltage
	Low Reference
	Ground
	Serial Data

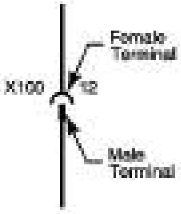
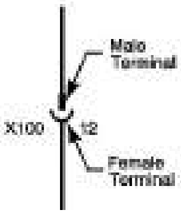
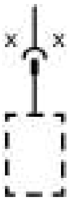
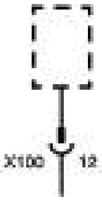
	Antenna Signal - In
	Antenna Signal - Out
	Speaker Control (+)

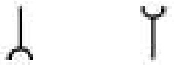
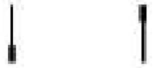
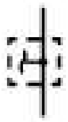
	Speaker Control (-)

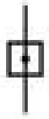
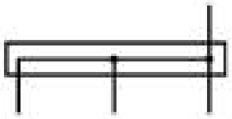
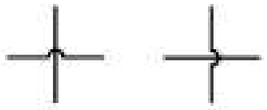
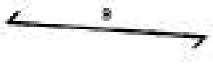
Harness Components

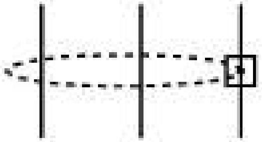
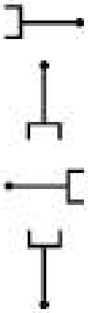
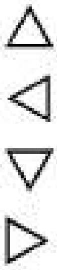
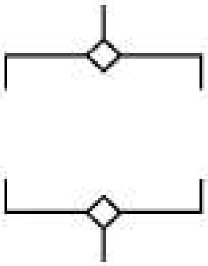
Symbol	Description
	Fuse
	Fuse Supplied by a Relay
	Circuit Breaker

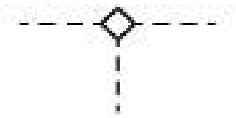
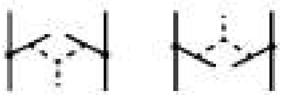
	
	Fusible Link
	Ground
	Case Ground

 Female Terminal X100 12 Male Terminal	Inline Harness Connector
 Male Terminal X100 12 Female Terminal	Inline Harness Connector
	Pigtail Connection
	Pigtail Connection

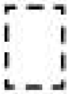
	Provisional or Diagnostic Connector
	Blunt Cut Wire
	Incomplete Physical Splice
	Complete Physical Splice - 2 Wires

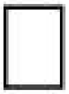
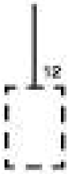
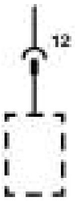
	
	Complete Physical Splice - 3 or more wires
	Wire Crosses
	Twisted Wires

	Shield
	Circuit References
	Circuit Continuation Arrowheads
	Option Breakpoint

	Ground Circuit Connection
	Connector Shorting Clip

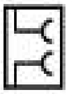
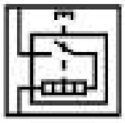
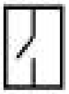
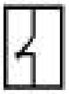
Component Parts

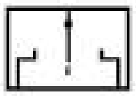
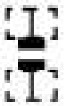
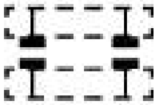
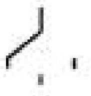
Symbol	Description
	Partial Component When a component is represented in a dashed box, the component or its wiring is not shown in its entirety.
	Entire Component

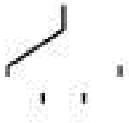
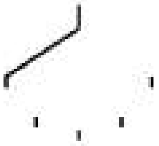
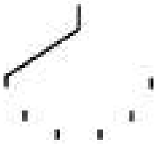
	When a component is represented in a solid box the component or its wiring is shown in its entirety.
	Connector Directly Attached to Component
	Pigtail Connector

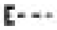
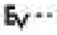
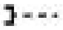
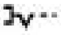
Switches and Relays

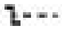
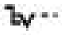
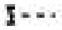
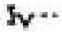
Symbol	Description
	Accessory Power Outlet

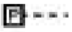
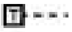
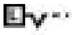
	
	Cigar Lighter
	Switch - 2 Position Normally Open
	Switch - 2 Position Normally Closed

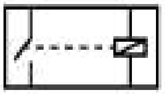
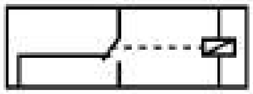
	Switch - Rocker
	Switch - Contact Plate (1 Wire)
	Switch - Contact Plate (2 Wire)
	Switch - 3 Position

	Switch - 4 Position
	Switch - 5 Position
	Switch - 6 Position
	Switch Actuator - Push (Momentary)

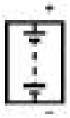
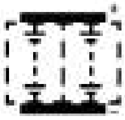
	
	Switch Actuator - Push (Latching)
	Switch Actuator - Pull (Momentary)
	Switch Actuator - Pull (Latching)

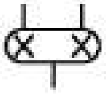
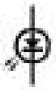
	Switch Actuator - Rotate (Momentary)
	Switch Actuator - Rotate (Latching)
	Switch Actuator - Slide (Momentary)
	Switch Actuator - Slide (Latching)

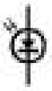
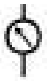
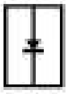
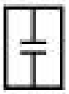
	Switch Actuator - Pressure (Momentary)
	Switch Actuator - Temperature (Momentary)
	Switch Actuator - Volume (Latching)
	4-Pin Single Pole/Throw Relay - Normally Open

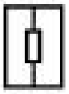
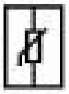
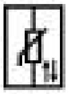
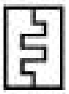
	
	5-Pin Relay - Normally Closed

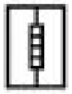
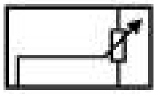
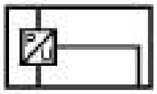
Devices and Sensors

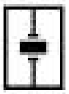
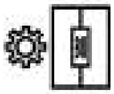
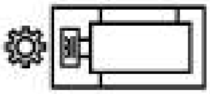
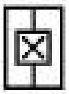
Symbol	Description
	Battery
	Battery Assembly - Hybrid

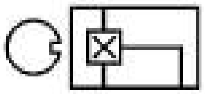
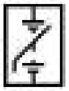
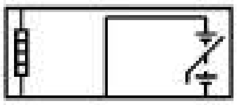
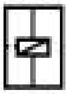
	Single Filament Light Bulb
	Double Filament Light Bulb
	Light Emitting Diode (LED)
	Photo Sensor

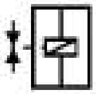
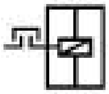
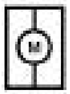
	
	Gage
	Diode
	Capacitor

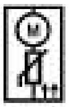
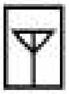
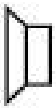
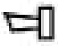
	Resistor
	Variable Resistor
	Variable Resistor - NTC
	Breakable Wire

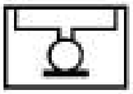
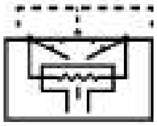
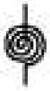
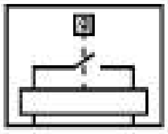
	Heating Element
	Position Sensor
	Pressure Sensor
	Knock Sensor

	
	Inductive Type Sensor - 2-Wire
	Inductive Type Sensor - 3-Wire
	Hall Effect Sensor - 2-Wire

	Hall Effect Sensor - 3-Wire
	Oxygen Sensor - 2-Wire
	Heated Oxygen Sensor - 4-Wire
	Solenoid - Actuator

	Solenoid - Valve
	Clutch
	Motor
	Motor with PTC

	
	Antenna
	Speaker
	Horn

	Microphone
	Airbag
	SIR Coil
	SIR Impact Sensor

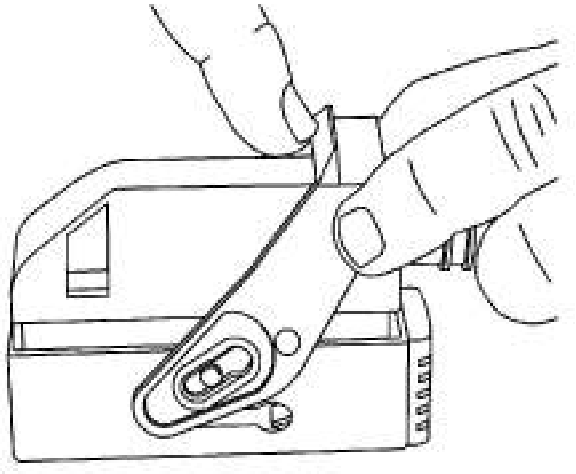
FCI Connectors

Special Tools

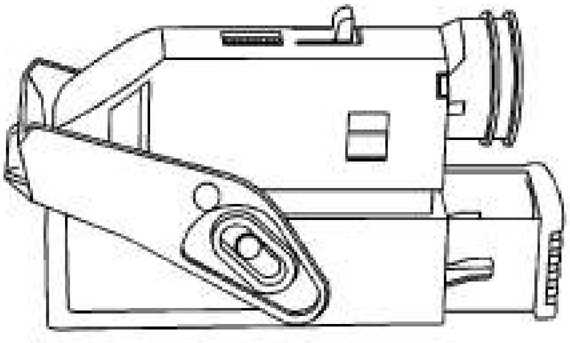
For equivalent regional tools, refer to Special Tools.

Removal Procedure

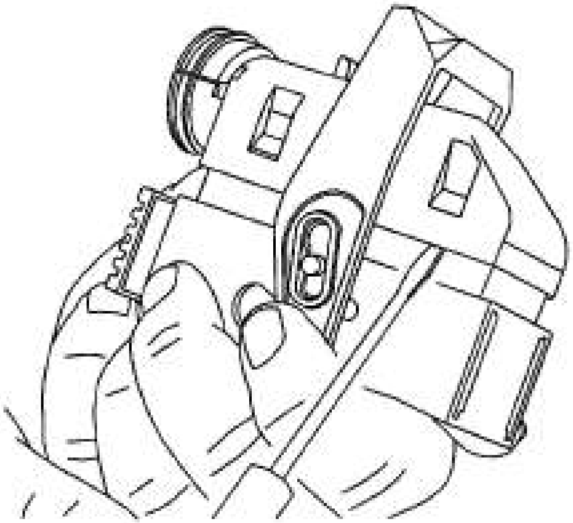
Follow the steps below in order to remove terminals from the connector.



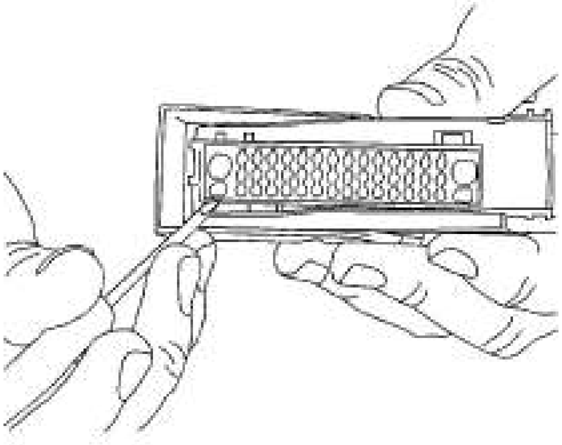
1. Slide the lever lock forward while pressing down on the lever lock release tab.
2. The release tab is located on the top of the wiredress cover.



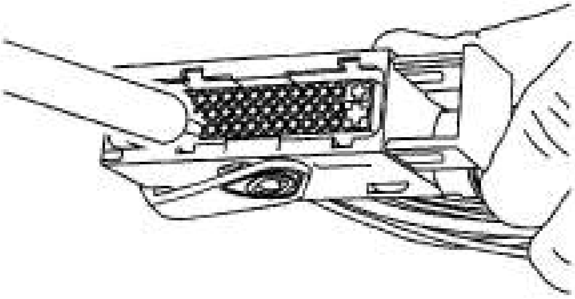
3. View of connector in released position.
4. Disconnect the connector from the component.
5. Locate the dress cover locking tabs at the corners of the dress cover. Use a small flat-blade tool to release the locking tabs and remove the dress cover.



6. Use a small flat-blade tool to slide the terminal position assurance (TPA) up one notch on both ends of the connector. The TPA is located underneath the wire dress cover.



7. For the larger terminals insert the EL-38125-556 tool to release the terminals by inserting the tool into the terminal release cavity. For the smaller terminals insert the EL-38125-560 tool to release the terminals by inserting the tool into the terminal release cavity.



8. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.

Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

Document ID: 2102021

Flat Wire Repairs

Caution: The flat wire within the flex wiring harness is not serviceable. If an open or short exists within the flex wiring harness the complete harness must be replaced.

General Electrical Diagnosis

Basic Knowledge Required

Without a basic knowledge of electricity, it will be difficult to use the diagnostic procedures contained in the service manual. You should understand the basic theory of electricity, and know the meaning of voltage (V), current (A), and resistance (Ω). You should also be able to read and understand a wiring diagram, as well as understand what happens in a circuit with an open or a shorted wire.

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GMLAN Wiring Repairs

Special Tools

- DuraSeal splice sleeves
- A wire stripping tool
- EL-38125-10 Splice Sleeve Crimp Tool
- EL-38125-5 Ultra Torch Special Tool

For equivalent regional tools, refer to Special Tools.

The DuraSeal splice sleeves have the following 2 critical features:

- A special heat shrink sleeve environmentally seals the splice. The heat shrink sleeve contains a sealing adhesive inside.
- A cross hatched (knurled) core crimp provides necessary contact integrity for the sensitive, low energy circuits.

The GM Local Area Network (GMLAN) System requires special wiring repair procedures due to the sensitive nature of the circuitry. Follow the specific procedures and instructions when working on GMLAN connectors and terminals.

GMLAN Repairs

Note: When making a repair to any GMLAN network, the original wire length after the repair must be the same length as before the repair. If the network is a twisted pair, the twist must be maintained after the repair is completed.

GMLAN has 2 types of networks, low speed and high speed. Low speed GMLAN has a single wire and works at slow speeds. High speed GMLAN has 2 wires in a twisted pair and works at higher speeds. For more information on GMLAN, refer to Data Link Communications Description and Operation.

GMLAN Connector Terminal Repair

Note: A terminated lead can be used to replace damaged connector terminals for both high speed and low speed GMLAN systems. When making a connector terminal repair on a GMLAN high speed system with twisted pair wires, do not untwist the wires more than necessary to make the repair.

If the individual terminals are damaged on any GMLAN connection, use the appropriate connector repair procedure in order to repair the terminal. Refer to Connector Repairs for the appropriate connector repair procedure.

GMLAN Wire Repair

Note: Refer to Wiring Repairs in order to determine the correct wire size for the circuit you are repairing. You must obtain this information in order to ensure circuit integrity.

If any wire except the pigtail is damaged, repair the wire by splicing in a new section of wire of the same gage size (0.5 mm, 0.8 mm, 1.0 mm etc.). Use the DuraSeal splice sleeves and EL-35125-10 splice sleeve crimping tool. Use the following wiring repair procedures in order to ensure the integrity of the DuraSeal splice sleeves.

Splice Sleeve Color	Crimp Tool Nest Color	Wire Gage mm² / (AWG)
Salmon (Yellow-Pink) 12089189	Red (1)	0.035-0.8/(18-20)
Blue 12089190	Blue (2)	1-2/(14-16)
Yellow 12089191	Yellow (3)	3-5/(10-12)
Green 88988379	Red (1)	0.22-0.35/(22-26)

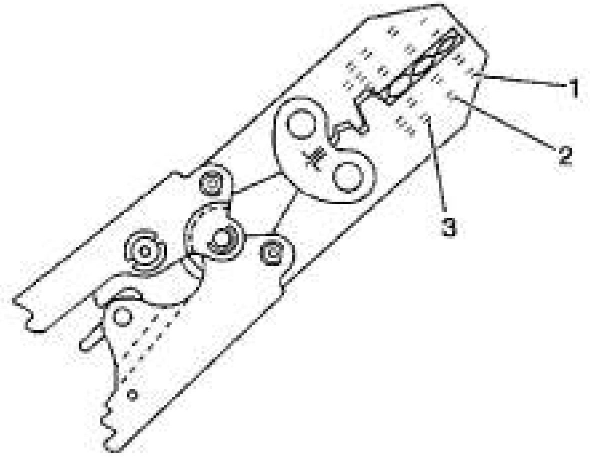
Note: You must perform the following procedures in the listed order. Repeat the procedure if any wire strands are damaged. You must obtain a clean strip with all of the wire strands intact.

1. Open the harness by removing any tape:
   - Use a sewing seam ripper, available from sewing supply stores, in order to cut open the harness in order to avoid wire insulation damage.
   - Use the DuraSeal splice sleeves on all types of insulation except tefzel and coaxial.
   - Do not use the crimp and DuraSeal splice sleeve to form a splice with more than 2 wires coming together.
2. Cut as little wire off the harness as possible. You may need the extra length of wire in order to change the location of a splice.

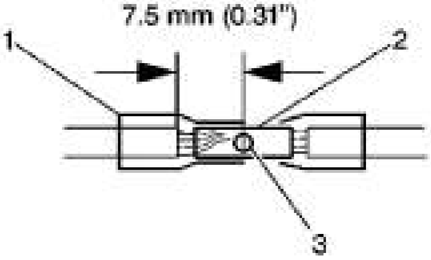
   Adjust splice locations so that each splice is at least 40 mm (1.5 in) away from the other splices, harness branches, or connectors.

3. Strip the insulation:
   - When adding a length of wire to the existing harness, use the same size wire as the original wire.
   - Perform one of the following items in order to find the correct wire size:
     - Find the wire on the schematic and convert to regional wiring gage size.
     - If you are unsure of the wire size, begin with the largest opening in the wire stripper and work down until achieving a clean strip of the insulation.
   - Strip approximately 7.5 mm (0.313 in) of insulation from each wire to be spliced.
   - Do not nick or cut any of the strands. Inspect the stripped wire for nicks or cut strands.
   - If the wire is damaged, repeat this procedure after removing the damaged section.
4. Select the proper DuraSeal splice sleeve according to the wire size. Refer to the above table

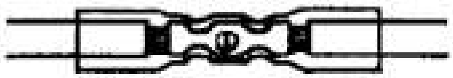
at the beginning of the repair procedure for the color coding of the DuraSeal splice sleeves and the crimp tool nests.



5. Use the EL-38125-10 splice sleeve crimp tool in order to position the DuraSeal splice sleeve in the proper color nest of the splice sleeve crimp tool. The crimp tool has four nests, one for each color.

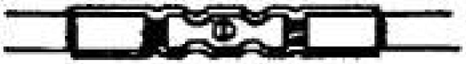


6. Place the DuraSeal splice sleeve in the nest. Ensure that the crimp falls midway between the end of the barrel and the stop. The sleeve has a stop (3) in the middle of the barrel (2) in order to prevent the wire (1) from going further. Close the hand crimper handles slightly in order to firmly hold the DuraSeal splice sleeve in the proper nest.



7. Insert the wire into the splice sleeve barrel until the wire hits the barrel stop.
8. Tightly close the handles of the crimp tool until the crimper handles open when released.

   The crimper handles will not open until you apply the proper amount of pressure to the DuraSeal splice sleeve. Repeat steps 4 and 5 for the opposite end of the splice.



9. Using the heat torch, apply heat to the crimped area of the barrel.
10. Start in the middle and gradually move the heat barrel to the open ends of the tubing:
    - The tubing will shrink completely as the heat is moved along the insulation.
    - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.

Heated Oxygen Sensor Wiring Repairs

Caution: Do not solder repairs under any circumstances as this could result in the air reference being obstructed.

If the heated oxygen sensor pigtail wiring, connector, or terminal is damaged the entire oxygen sensor assembly must be replaced. Do not attempt to repair the wiring, connector, or terminals. In order for the sensor to function properly it must have a clean air reference. This clean air reference is obtained by way of the oxygen sensor signal and heater wires. Any attempt to repair the wires, connectors or terminals could result in the obstruction of the air reference and degrade oxygen sensor performance.

The following guidelines should be used when servicing the heated oxygen sensor:

- Do not apply contact cleaner or other materials to the sensor or vehicle harness connectors. These materials may get into the sensor, causing poor performance. Also, the sensor pigtail and harness wires must not be damaged in such a way that the wires inside are exposed. This could provide a path for foreign materials to enter the sensor and cause performance problems.
- Neither the sensor nor vehicle lead wires should be bent sharply or kinked. Sharp bends, kinks, etc., could block the reference air path through the lead wire.
- Do not remove or defeat the oxygen sensor ground wire (where applicable). Vehicles that utilize the ground wire sensor may rely on this ground as the only ground contact to the sensor. Removal of the ground wire will also cause poor engine performance.
- To prevent damage due to water intrusion, be sure that the peripheral seal remains intact on the vehicle harness connector.

High Temperature Wiring Repairs

Special Tools

- DuraSeal splice sleeves, in order to repair the SIR/SRS wiring
- EL-38125-10 Splice Sleeve Crimping Tool
- EL-38125-5 Ultra Torch

For equivalent regional tools, refer to Special Tools.

High Temperature Wiring

Wiring that is exposed to high temperatures, 135°C (275°F) or higher, for prolonged periods of time may use materials i.e. wires, connectors, and shielding that has a higher heat rating than typical wiring. When making a repair in a high temperature area observe the following:

- Use high temperature bulk wire rated at 150°C (302°F) continuous temperature to replace any damaged wire.
- Replace any heat shielding that is removed.
- Cover any DuraSeal splice sleeves with SCT1 shrink tubing.
- After making a wiring repair, ensure that the location of the wiring is not moved closer to the heat source.

Identifying High Temperature Wiring

Wiring that is exposed to high temperature, 135°C (275°F) or higher, for prolonged periods of time need special considerations when making wiring repairs. Areas that may be exposed to higher temperatures can be identified by heat resistant materials that are being used in those areas. These materials may include heat reflective tape, moon tape, and high temperature shrink tubing. Also conduit and other protective coverings may be used. Because conduit or similar coverings are used throughout the vehicle regardless of the temperature, it may be necessary for the technician to determine if an area is exposed to excessive heat before making a wiring repair. Obvious areas of consideration would be any area located near the exhaust manifolds, catalytic converter, and exhaust pipes.

Items Required

- DuraSeal splice sleeves to crimp and seal connections
- High temperature SCT1 shrink tubing to protect the splice sleeves
- Terminated leads or pigtails
- The correct tools to remove the terminals from the connectors

Use high temperature bulk wire rated at 150°C (302°F) continuous temperature of the same or larger gage size as the original wire when repair damage wire. Also replace any reflective tape that you remove during the repair.

High Temperature Wire Repair

Note: Refer to Wiring Repairs in order to determine the correct wire size for the circuit you are repairing. You must obtain this information in order to ensure circuit integrity.

If any wire except the pigtail is damaged, repair the wire by splicing in a new section of wire rated at 150°C (302°F) continuous temperature rating of the same gage size (0.5 mm, 0.8 mm, 1.0 mm etc.). Use the DuraSeal splice sleeves and the EL-38125-10 splice sleeve crimping tool and then encapsulate the splice sleeve using the high temperature SCT1 shrink tubing. Use the following wiring repair procedures in order to ensure the integrity of the sealed splice.

Splice Sleeve Color	Crimp Tool Nest Color	Wire Gage mm² / (AWG)
Salmon (Yellow-Pink) 12089189	Red (1)	0.035-0.8/(18-20)
Blue 12089190	Blue (2)	1-2/(14-16)
Yellow 12089191	Yellow (3)	3-5/(10-12)
Green 88988379	Red (1)	0.22-0.35/(22-26)

Note: You must perform the following procedures in the listed order. Repeat the procedure if any wire strands are damaged. You must obtain a clean strip with all of the wire strands intact.

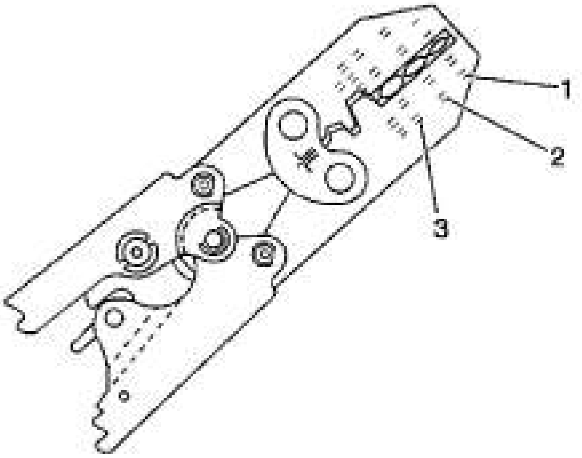
1. Open the harness by removing any tape:
   - Use a sewing seam ripper, available from sewing supply stores, in order to cut open the harness in order to avoid wire insulation damage.
   - Use the DuraSeal splice sleeves on all types of insulation except tefzel and coaxial.
   - Do not use the crimp and DuraSeal splice sleeve to form a splice with more than 2 wires coming together.
2. Cut as little wire off the harness as possible. You may need the extra length of wire in order to change the location of a splice.

   Adjust splice locations so that each splice is at least 40 mm (1.5 in) away from the other splices, harness branches, or connectors.

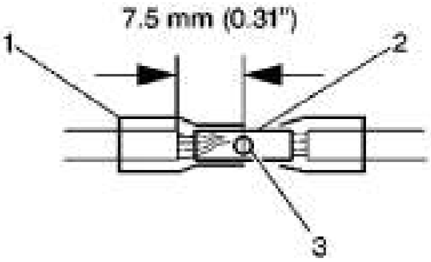
3. Strip the insulation:
   - When adding a length of wire to the existing harness, use the same size wire as the original wire.
   - Perform one of the following items in order to find the correct wire size:
     - Find the wire on the schematic and convert to regional wiring gage size.
     - If you are unsure of the wire size, begin with the largest opening in the wire stripper and work down until achieving a clean strip of the insulation.

- Strip approximately 7.5 mm (0.313 in) of insulation from each wire to be spliced.
- Do not nick or cut any of the strands. Inspect the stripped wire for nicks or cut strands.
- If the wire is damaged, repeat this procedure after removing the damaged section.

4. Slide a section of high temperature SCT1 shrink tubing down the length of wire to be spliced. Ensure that the shrink tubing will not interfere with the splice procedure.
5. Select the proper DuraSeal splice sleeve according to the wire size. Refer to the above table at the beginning of the repair procedure for the color coding of the DuraSeal splice sleeves and the crimp tool nests.

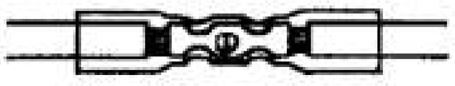


6. Use the EL-38125-10 splice sleeve crimp tool in order to position the DuraSeal splice sleeve in the proper color nest of the splice sleeve crimp tool. The crimp tool has four nests, one for each color.



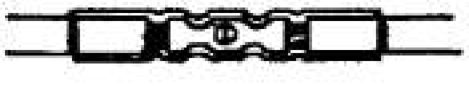
7. Place the DuraSeal splice sleeve in the nest. Ensure that the crimp falls midway between the end of the barrel and the stop. The sleeve has a stop (3) in the middle of the barrel (2) in

order to prevent the wire (1) from going further. Close the hand crimper handles slightly in order to firmly hold the DuraSeal splice sleeve in the proper nest.



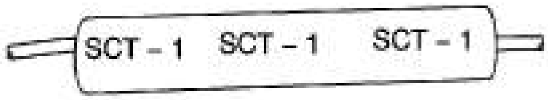
8. Insert the wire into the splice sleeve barrel until the wire hits the barrel stop.
9. Tightly close the handles of the crimp tool until the crimper handles open when released.

   The crimper handles will not open until you apply the proper amount of pressure to the DuraSeal splice sleeve. Repeat steps 4 and 5 for the opposite end of the splice.



10. Using the heat torch, apply heat to the crimped area of the barrel.
11. Start in the middle and gradually move the heat barrel to the open ends of the tubing:
    - The tubing will shrink completely as the heat is moved along the insulation.
    - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage

is achieved.



12. Center the high temperature SCT1 shrink tube over the DuraSeal splice sleeve.
13. Using the heat torch, apply heat to the high temperature heat shrink tubing.
14. Gradually move the heat from the center to the open end of the tubing:
    - The tubing will shrink completely as the heat is moved along the insulation.
    - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.
15. Replace any reflective tape and clips that may have been remove during the repair.

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Inducing Intermittent Fault Conditions

Special Tools

EL-25070 Heat Gun

For equivalent regional tools, refer to Special Tools.

Many intermittent open or shorted circuits are affected by harness/connector movement that is caused by vibration, engine torque, bumps/rough pavement, etc. In order to duplicate the customer's concern, it may be necessary to manipulate the wiring harness if the malfunction appears to be vibration related. Manipulation of a circuit can consist of a wide variety of actions, including:

- Wiggling the harness
- Disconnecting a connector and reconnecting
- Stressing the mechanical connection of a connector
- Pulling on the harness or wire in order to identify a separation/break inside the insulation
- Relocating a harness or wires

All these actions should be performed with some goal in mind. For instance, with a scan tool connected, wiggling the wires may uncover a faulty input to the control module. The snapshot option would be appropriate here. Refer to Scan Tool Snapshot Procedure. Another option is, with the component commanded ON and OFF by the scan tool, move related connectors and wiring and observe the component operation. With the engine running, move related connectors and wiring while monitoring engine operation. If harness or connector movement affects the data displayed, component/system operation, or engine operation, inspect and repair the harness/connections as necessary.

You may need to load the vehicle in order to duplicate the concern. This may require the use of weights, floor jacks, jackstands, frame machines, etc. In these cases you are attempting to duplicate the concern by manipulating the suspension or frame. This method is useful in finding harnesses that are too short and their connectors pull apart enough to cause a poor connection. A DMM set to Peak Min/Max mode and connected to the suspect circuit while testing can yield desirable results. Refer to Testing for Electrical Intermittents.

Certainly, using the senses of sight, smell, and hearing while manipulating the circuit can provide good results as well.

There may be instances where circuit manipulation alone will not meet the required criteria for the fault condition to appear. In such cases it may be necessary to expose the suspect circuit to other conditions while manipulating the harness. Such conditions would include high moisture conditions, along with exceptionally high or low temperatures. The following discusses how to expose the circuit to these kinds of conditions.

Salt Water Spray

Some compounds possess the ability to conduct electricity when dissolved in water such as ordinary salt. By mixing table salt with water in sufficient quantities, you can enhance the conductive properties of water so that any circuit which may be sensitive to moisture will more readily fail when liberally sprayed with this mixture.

Mixing 0.35L (12 oz) of water with approximately 1 tablespoon of salt will yield a salt solution of 5 percent. Fill a normal spray bottle with this mixture. This mixture is sufficient to enhance the water's own conductivity. This may cause the circuit to fail more easily when sprayed. Once the mixture is completed, spray the suspect area liberally with the solution. Then, while monitoring either a scan tool or DMM, manipulate the harness as discussed previously.

High Temperature Conditions

If the complaint tends to be heat related, you can simulate the condition using the EL-25070.

Using the heat gun, you can heat up the suspected area or component. Manipulate the harnesses under high temperature conditions while monitoring the scan tool or DMM to locate the fault condition.

The high temperature condition may be achieved simply by test driving the vehicle at normal operating temperature. If a heat gun is unavailable, consider this option to enhance your diagnosis. This option does not allow for the same control, however.

Low Temperature Conditions

Depending on the nature of the fault condition, placing a fan in front of the vehicle while the vehicle is in the shade can have the desired effect.

If this is unsuccessful, use local cooling treatments such as ice or a venturi type nozzle (one that provides hot or cold air). This type of tool is capable of producing air stream temperatures down to -18°C (0°F) from one end and +71°C (160°F) from the other. This is ideally suited for localized cooling needs.

Once the vehicle, component, or harness has been sufficiently cooled, manipulate the harness or components in an effort to duplicate the concern.

Duplicating Failure Conditions

- If none of the previous tests are successful, attempt to duplicate and/or capture the failure conditions.
- Freeze Frame/Failure Records data, where applicable, contains the conditions that were present when the DTC set.

1. Review and record Freeze Frame/Failure Records data.
2. Clear the DTCs using the scan tool.
3. Turn the key to OFF and wait 15 seconds.
4. Operate the vehicle under the same conditions that were noted in Freeze Frame/Failure Records data, as closely as possible. The vehicle must also be operating within the Conditions for Running the DTC. Refer to Conditions for Running the DTC in the supporting text if a DTC is being diagnosed.
5. Monitor DTC Status for the DTC being tested. The scan tool will indicate Ran, when the enabling conditions have been satisfied long enough for the DTC to run. The scan tool will

also indicate whether the DTC passed or failed.

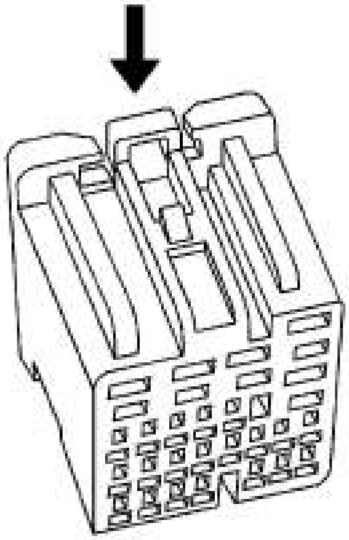
- An alternate method is to drive the vehicle with the DMM connected to a suspected circuit. An abnormal reading on the DMM when the concern occurs, may help you locate the concern.

JST Connectors

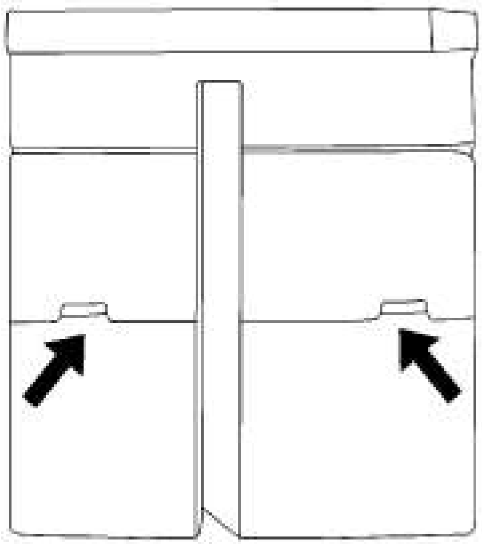
Special Tools

For equivalent regional tools, refer to Special Tools.

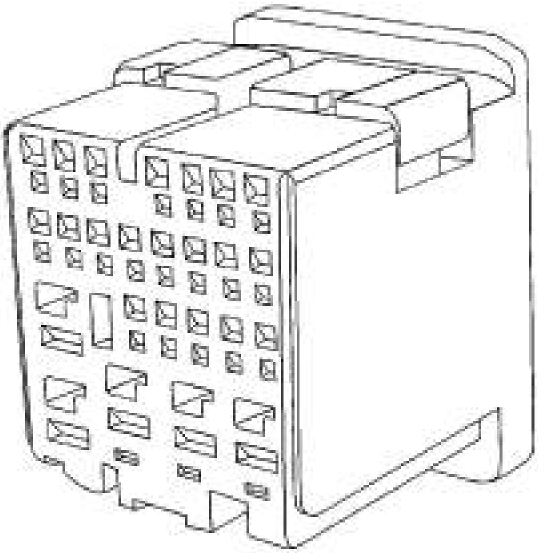
Removal Procedure



1. While depressing the lock, remove the connector from the component.

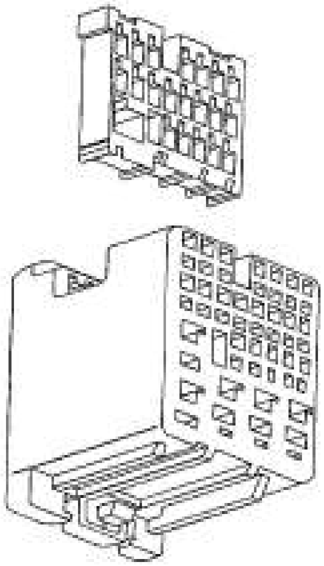


2. Locate the two indents of the terminal position assurance (TPA) located on the bottom of the connector body.

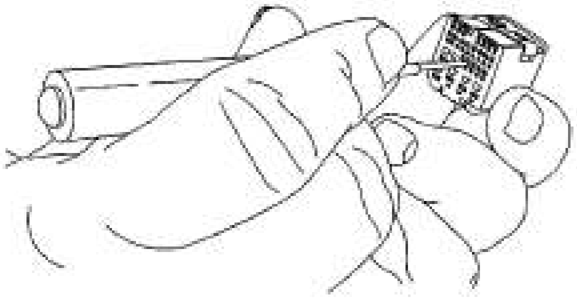


Note: The TPA cannot be removed from the connector while there are terminals present in the connector body.

3. Use a small flat-blade tool to very carefully raise the TPA on both sides of the connector.



4. View of the TPA when removed from the connector body.



5. Use the EL-38125-12A tool to release the terminals by inserting the tool into the left side of the terminal release cavity as shown in the graphic. Use the tool to move the terminal release to the right with a gentle prying motion.
6. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.

Terminated Lead Repair

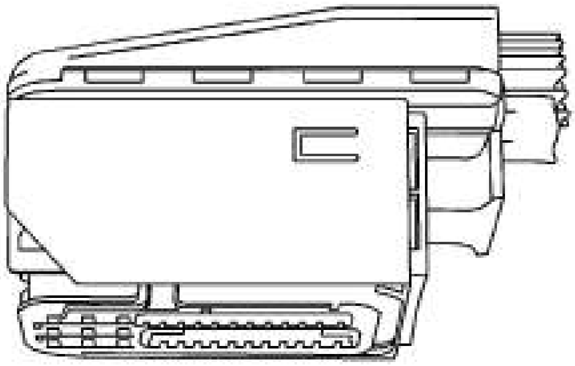
1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

Kostal Connectors (Glow Plug Control Module)

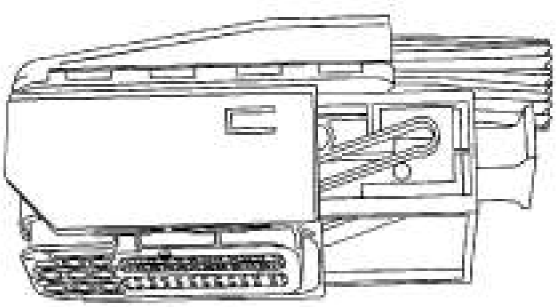
Special Tools

For equivalent regional tools, refer to Special Tools.

Removal Procedure

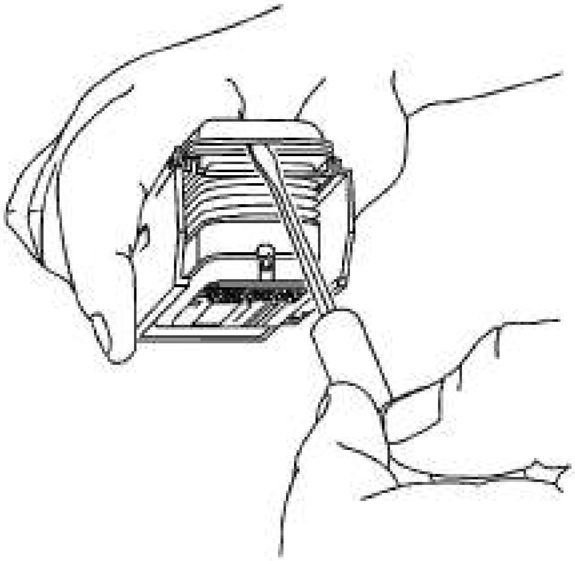


View of typical connector.

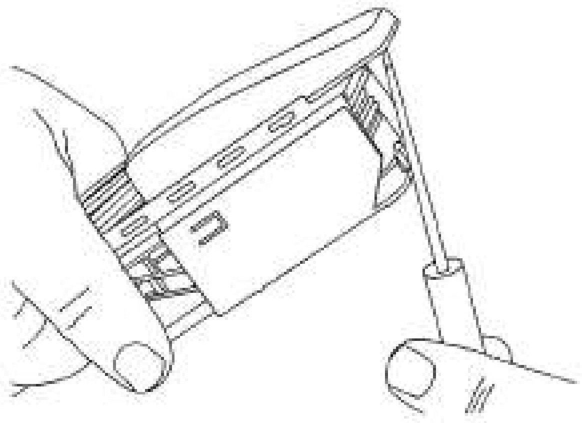


View of connector in released position.

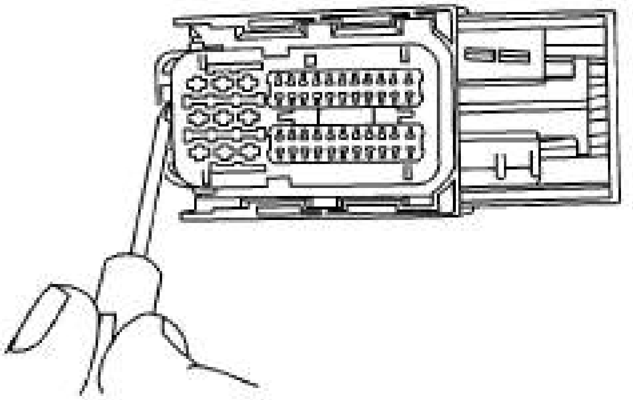
1. Locate the assist lever at the back of the connector. Move the assist lever to the rear position.
2. Disconnect the connector from the component.



3. Use a small flat-blade tool to remove the dress cover.



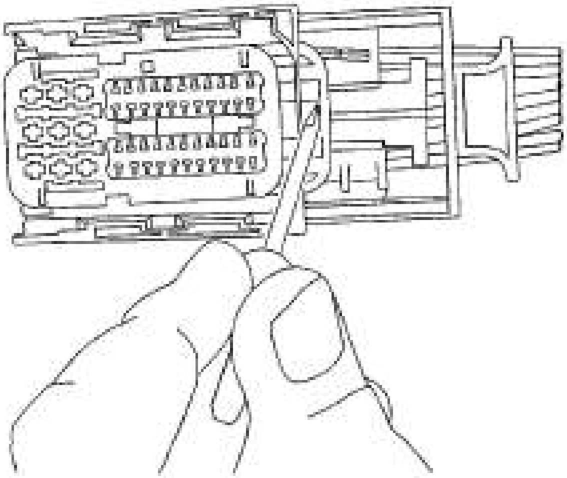
4. Slide the dress cover forward and off of the connector.



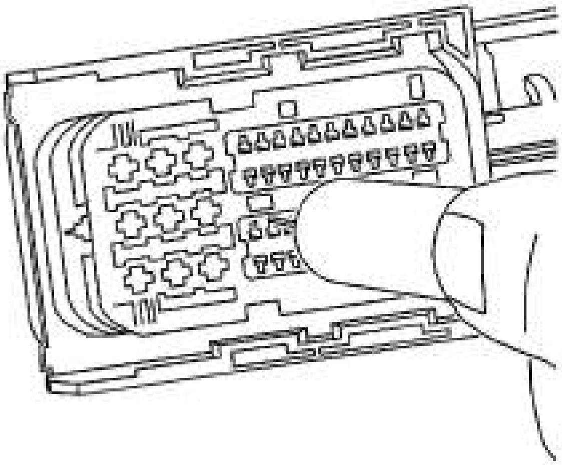
5. The terminal positive assurance (TPA) is located in the front and rear of the connector.

   Note: The front TPA cannot be removed from the connector. Only move it to the preset position.

6. Use a small flat-blade tool to move the front TPA to the preset position, outboard approximately 0.125 in. (3 mm).



7. Use a small flat-blade tool to completely remove the rear TPA from the connector.



8. Use the EL-38125-24 or the EL-38125-560 tool to release the terminals by inserting the tool into the terminal release cavity.
9. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.

Terminated Lead Repair

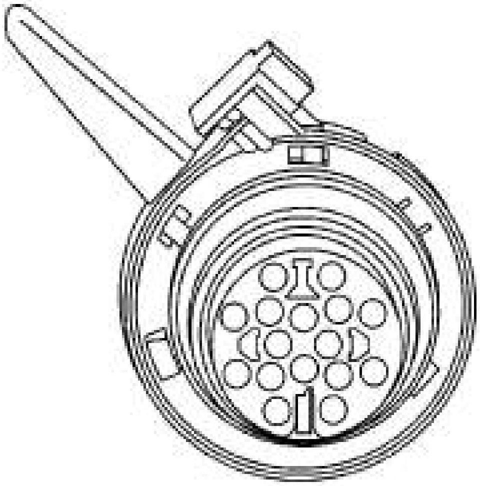
1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

Kostal Connectors (Transmission)

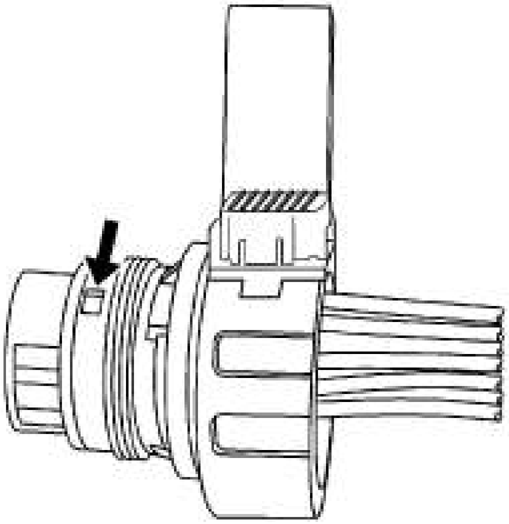
Special Tools

For equivalent regional tools, refer to Special Tools.

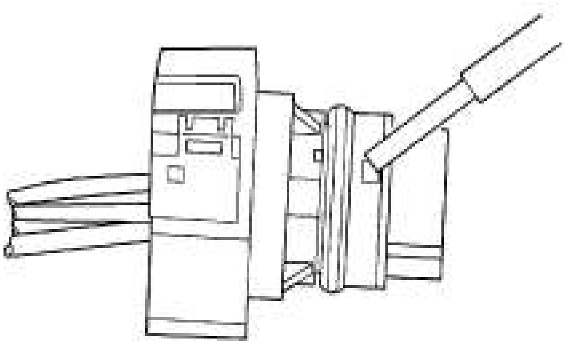
Removal Procedure



1. While depressing the lock, twist and remove the connector from the component.

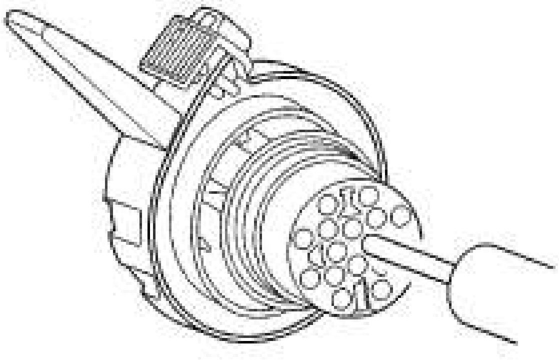


2. Locate the terminal position assurance (TPA).



Note: The TPA cannot be removed from the connector while there are terminals present in the connector body.

3. Use a small flat-blade tool to push the TPA until it bottoms out.



4. Use the EL-38125-28 tool to release the terminals by inserting the tool into the terminal cavity as shown in the graphic.
5. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.

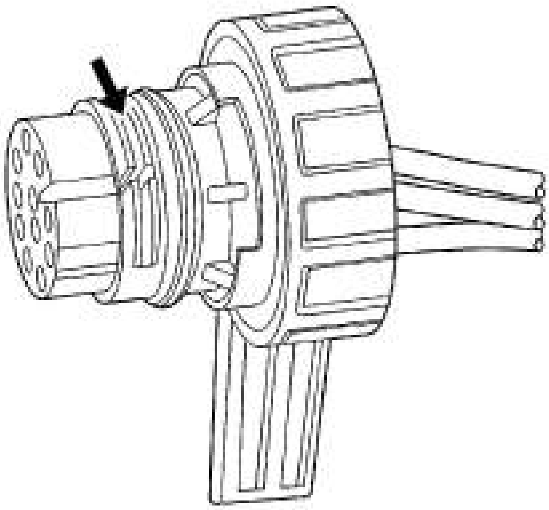
Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

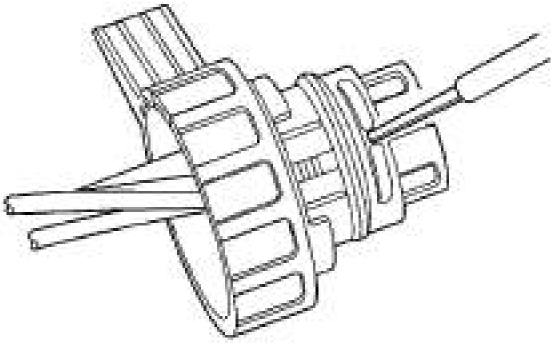
Terminal Replacement Procedure

After the terminal is crimped to the wire, perform the following procedure in order to replace the terminal.

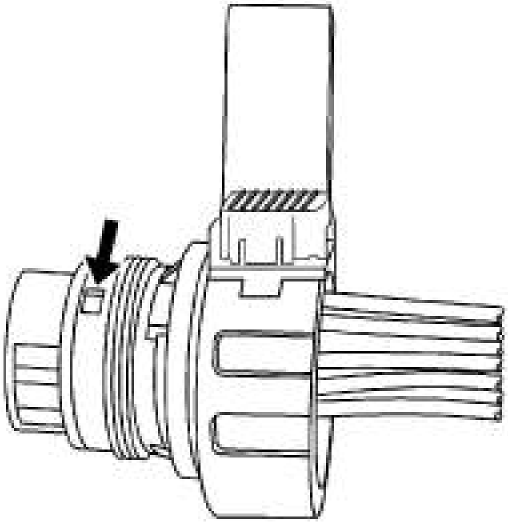
1. Slide the new terminal into the correct cavity at the back of the connector.
2. Push the terminal into the connector until it locks into place. The new terminal should be even with the other terminals. Ensure that the terminal is locked in place by gently pulling on the wire.



3. Locate the terminal position assurance (TPA).



4. Use a small flat-blade tool to push the TPA until it bottoms out.



5. Ensure the TPA is fully seated. The TPA should be centered and flush with the connector body when viewed.

Measuring Frequency

Notice: Refer to Test Probe Notice in the Preface section.

The following procedure determines the frequency of a signal.

Note: Connecting the DMM to the circuit before pressing the HZ button will allow the DMM to autorange to an appropriate range.

1. Apply power to the circuit.
2. Set the rotary dial of the DMM to the V (AC) position.
3. Connect the positive lead of the DMM to the circuit to be tested.
4. Connect the negative lead of the DMM to a good ground.
5. Press the HZ button on the DMM.
6. The DMM will display the frequency measured.

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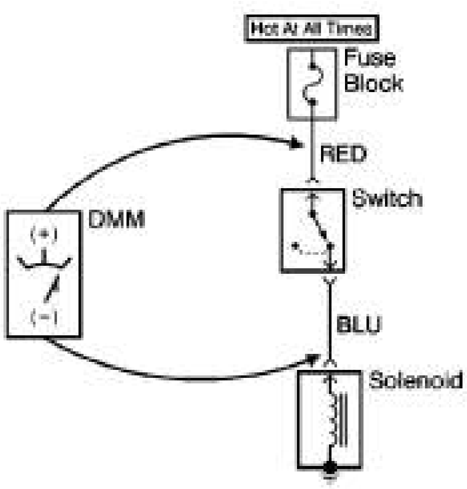
Measuring Voltage Drop

Notice: Refer to Test Probe Notice in the Preface section.

The following procedure determines the difference in voltage potential between 2 points.



1. Set the rotary dial of the DMM to the V (DC) position.
2. Connect the positive lead of the DMM to one point of the circuit to be tested.
3. Connect the negative lead of the DMM to the other point of the circuit.
4. Operate the circuit.
5. The DMM displays the difference in voltage between the 2 points.

Measuring Voltage

Notice: Refer to Test Probe Notice in the Preface section.

The following procedure measures the voltage at a selected point in a circuit.

1. Disconnect the electrical harness connector for the circuit being tested, if necessary.
2. Enable the circuit and/or system being tested. Use the following methods:
   - Turn ON the ignition, with the engine OFF.
   - Turn ON the engine.
   - Turn ON the circuit and/or system with a scan tool in Output Controls.
   - Turn ON the switch for the circuit and/or system being tested.
3. Select the V (AC) or V (DC) position on the DMM.
4. Connect the positive lead of the DMM to the point of the circuit to be tested.
5. Connect the negative lead of the DMM to a good ground.
6. The DMM displays the voltage measured at that point.

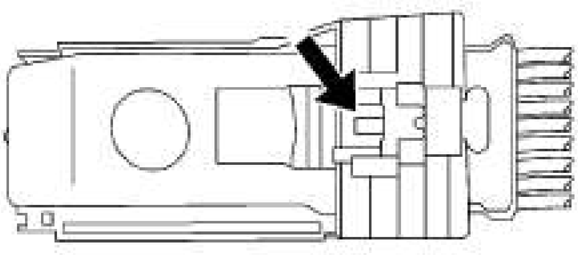
Molex Connectors

Special Tools

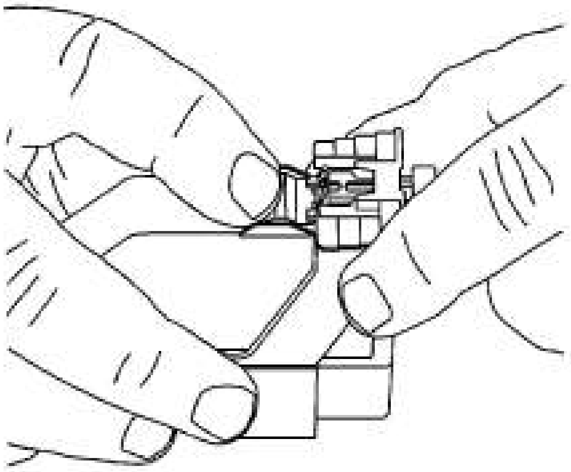
For equivalent regional tools, refer to Special Tools.

Terminal Removal Procedure

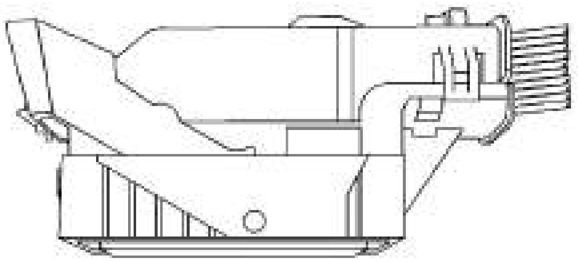
1. Locate the connector position assurance (CPA) on the top of the wire dress cover. Slide the CPA forward.



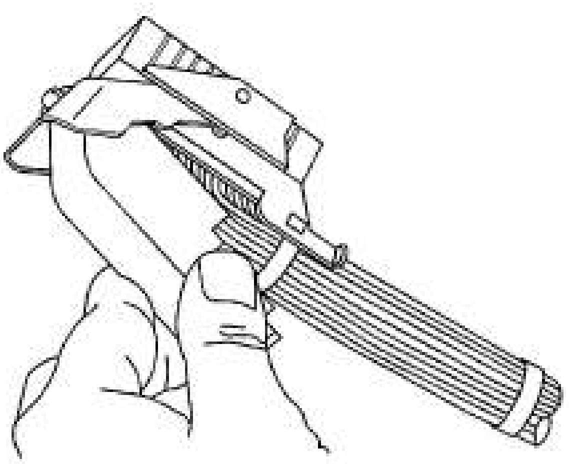
2. Slide the lever lock forward while pressing down on the lever lock release tab.



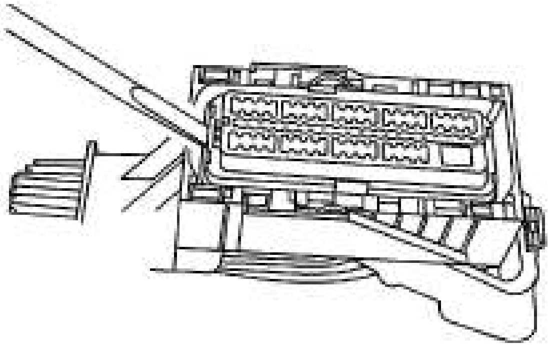
3. The lever should be in the full forward position.



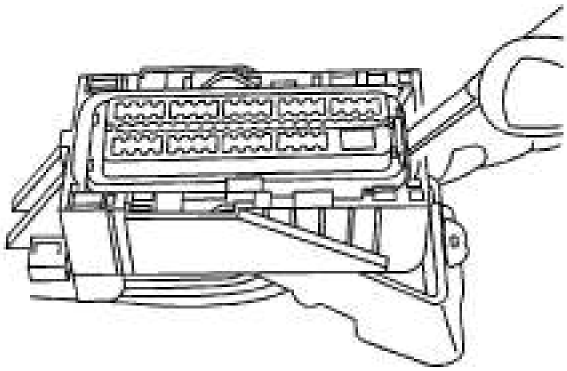
4. Disconnect the connector from the component.



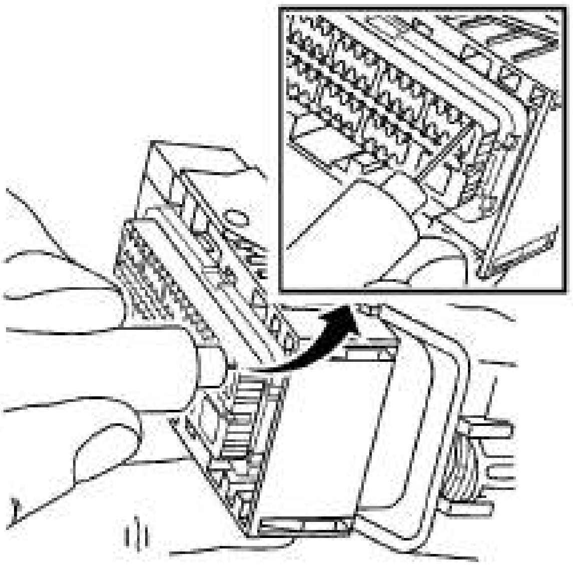
5. Remove the dress cover by using a flat bladed tool to release the dress cover locking tabs and lift up on the dress cover.
6. Cut the tie wrap that holds the wires to the connector body.



7. Use a small flat-blade tool to pry one side of the nose piece up to the pre-stage position. When the nose piece is in the pre-staged position, the nose piece will be raised above the connector body the length of the step in the nose piece.



8. Use a small flat-blade tool to pry the other side of the piece to the pre-stage position. If the nose piece is higher than the first step in the nose piece, gently push down on the nose piece until it meets with resistance from the connector body, you should feel the nose piece click into position.



9. Insert the EL-38125-213 into the small terminal release hole on the nose piece and gently pull on the back of the wire.

Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

Terminal Replacement Procedure

After the terminal is crimped to the wire, perform the following procedure in order to replace the terminal.

1. Slide the new terminal into the correct cavity at the back of the connector.
2. Push the terminal into the connector until it locks into place. The new terminal should be even with the other terminals. Insure that the terminal is locked in place by gently pulling on the wire.
3. To assemble the connector, reverse the connector disassembly procedure.

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Power Mode Mismatch

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC B1370 01: Device Ignition 1 (ON and START) Circuit Short to Battery

DTC B1370 06: Device Ignition 1 (ON and START) Circuit Short to Ground or Open

DTC B1380 01: Device Ignition ACCESSORY Circuit Short to Battery

DTC B1380 06: Device Ignition ACCESSORY Circuit Short to Ground or Open

DTC B1440 00: Power Mode Master Input Circuits Mismatch

DTC B1441 01: Device Ignition OFF, RUN, and CRANK Circuit Short to Battery

DTC B1441 06: Device Ignition OFF, RUN, and CRANK Circuit Short to Ground or Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ - Terminal 2	B1370 06, B1380 06, B1440 00, U0100-U0299, 1, 2, 3, 4, 5	B1370 06, B1380 06, B1440 00, U0100-U0299, 1, 2, 3, 4, 5	--	--
Ignition - Terminal 3	B1370 06, B1380 06,U0100-U0299, 1, 2, 3, 4, 5	B1380 06, 1, 5	B1380 01, B3055 00, P0513 00, U0100-U0299, 1, 2, 4	--
Ignition - Terminal 4	B1370 06, B1380 006, B1423 03, B1440 00, B1441 06, P0513 00, U0100-U0299, 1, 2, 3, 4, 5	B1440 00, B1441 06, 1	B1441 01, P0513 00, U0100-U0299, 1, 2	--
Ignition - Terminal 1	B1370 06, B1380 06,U0100-U0299,	B1370 06, B1380 06,	B1370 01, B1440 00, P0575 00, P0856 00,	--

	1, 2, 3, 4, 5	U0100-U0299, 1	U0100-U0299, 1, 2, 4	
Ignition - Terminal 6	B1440 00, 1	B1440 00, 1	1, 2	--
Ignition Voltage - BCM Terminal 21 X4	B1380 06, B1428 00, U0100-U0299, 1, 2, 3, 4	P0628 00, 2, 4, 6	B1440 00, 7	--
Accessory Wakeup Serial Data, BCM Terminal 19 X4	U0100-U0299, U1814 00, B1380 06, 1, 2, 3, 4, 5	U0100-U0299, 4	B3055 00, B3935 57	--

1. Power Mode Mismatch. Different specific symptoms may occur depending on the vehicle operating conditions when the fault occurred.
2. Vehicle may not start.
3. The B+ circuit fuse to the ignition switch may be open.
4. May lose communication with other module(s).
5. The ignition switch may not return to the OFF position and the key may not come out of the ignition.
6. SIR system may retain DTC B1370 06 as current.
7. Vehicle will continue to run after the ignition key is removed.

Circuit/System Description

The vehicle power mode master (PMM) is the body control module (BCM). The ignition switch is a low current switch with multiple discrete circuits to the BCM. The BCM logic uses the ignition switch positions to identify the operator's desired power mode and activate specific discrete signals, and serial data messages for the operation of different subsystems as necessary. Other modules which have switched voltage inputs may operate in a default mode if the PMM serial data message does not match what the individual module can detect from its own connections.

The PMM will activate relays and other direct outputs of the PMM as needed according to the calculated power mode. Some relays controlled by the BCM are switched ignition voltage outputs that are pass through circuits within the BCM directly from the ignition switch. If these circuits short to ground, the B+ circuit fuse to the ignition switch will open.

Conditions for Running the DTC

B1370 01, B1380 01

Ignition switch is in the RUN or CRANK positions.

B1370 06, B1380 06

Ignition switch is in the RUN or ACCESSORY positions.

B1440 00

Ignition switch is in the RUN position.

B1441 01, B1441 06

Ignition switch is in the CRANK position.

Conditions for Setting the DTC

B1370 01

Ignition circuit is shorted to voltage.

B1370 06

- Ignition circuit is open.
- Ignition, accessory, or off/run/crank circuit shorted to ground.
- B+ circuit of the ignition switch is open or shorted to ground.
- Ignition relay control circuit open, including relay coil and ground.

B1380 01

Accessory circuit is shorted to voltage.

B1380 06

- Accessory circuit is open.
- Ignition, accessory, or off/run/crank circuit shorted to ground.
- B+ circuit of the ignition switch is open or shorted to ground.

B1440 00

BCM detects an open or short to voltage on the off/run/crank signal circuit when both ignition ACCESSORY/RUN and ignition RUN/CRANK parameters are active.

BCM detects an open on the B+ circuit to the ignition switch while the engine is running.

B1441 01

Off/run/crank signal circuit is shorted to voltage.

B1441 06

Off/run/crank signal circuit is open.

Actions Taken When the DTC Sets

- The BCM operates in a fail-safe power mode dependent on the last valid power mode detected and the state of the engine run flag data on the serial data communications circuits.
- The other modules on the vehicle operate in a fail-safe power mode dependent on the last

valid power mode transmitted by the BCM and the state of the engine run flag on the serial data communications circuits.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

- Body Control System Schematics
- Power Distribution Schematics
- Power Moding Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Mode Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC U1814 or B1428 is not set.

   If any of the DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. With a scan tool, access BCM, Power Mode data display list and compare all parameters listed with the corresponding ignition key position. The BCM Power Mode Parameters table below illustrates the correct state of these input parameters in correspondence to the ignition switch position. The circuits which the individual parameters are related to are in parentheses.

   If any parameters are incorrect in any key position, proceed to the Circuit/System Testing or Component Testing.

BCM Power Mode Parameters

Ignition Switch Position	Standard Power Mode	Ign. Off/Run/Crank (Ignition Switch, Terminal 4)	Ignition Accessory/Run (Ignition Switch, Terminal 3)	Ignition Run/Crank (Ignition Switch, Terminal 1)
Off Key Out	Off	Key Out/ACC	Inactive	Inactive
Off Key IN	Off	Key In/Off	Inactive	Inactive
Accessory	Accessory	Key Out/ACC	Active	Inactive
Run	Run	Run	Active	Active
Start	Crank	Cranking	Inactive	Active

Circuit/System Testing

1. Disconnect the harness connector at the ignition switch.
2. Verify that a test lamp illuminates between B+ circuit terminal 2 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse is open, test the ignition circuits listed below for a short to ground.

   Note: To help isolate a short to ground, it may be necessary to disconnect modules that are connected to the following circuits:

   - terminal 1
   - terminal 3
   - terminal 4
   - terminal 6
   - BCM terminal 19, X4
   - BCM terminal 21, X4
3. Connect the harness connector at the ignition switch.
4. Ignition OFF, key out, disconnect the X1 harness connector at the BCM. Verify that a test lamp does not illuminate between the ignition circuit terminals listed below and ground:
   - terminal 2
   - terminal 14
   - terminal 21

   If the test lamp illuminates, test the ignition circuits for a short to voltage. If the circuit tests normal, replace the ignition switch.
5. Ignition in the ACCESSORY position, verify that a test lamp illuminates between the terminal 21 and ground.

   If the test lamp does not illuminate, test the ignition circuit for an open/high resistance. If the circuit tests normal, replace the ignition switch.
6. Ignition in the CRANK position, verify that a test lamp illuminates between terminal 14 and ground.

   If the test lamp does not illuminate, test the ignition circuit for an open/high resistance. If the circuit tests normal, replace the ignition switch.
7. If all of the circuits test normal, replace the BCM.

Component Testing

Ignition Switch

1. Ignition OFF, disconnect the harness connector at the ignition switch.
2. Verify the resistance between the terminals listed below match for each ignition switch position.

   If not the specified value, replace the ignition switch.

Resistance Test

Ignition Switch Position	Terminals 1 and 2	Terminals 2 and 3	Terminals 2 and 4	Terminals 2 and 6	Terminals 4 and 6
Off Key Out	Infinite	Infinite	Infinite	Infinite	Infinite
Off Key IN	Infinite	Infinite	< 5.0 Ω	Infinite	Infinite
Accessory	Infinite	< 5.0 Ω	Infinite	Infinite	Infinite
Run	< 5.0 Ω	< 5.0 Ω	Infinite	Infinite	< 5.0 Ω
Start	< 5.0 Ω	Infinite	Infinite	Infinite	1275-1325 Ω

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Ignition and Start Switch Replacement
- Control Module References for BCM replacement, setup, and programming.

Probing Electrical Connectors

Note: Always be sure to reinstall the connector position assurance (CPA) and terminal position assurance (TPA) when reconnecting connectors or replacing terminals.

Front probe

Disconnect the connector and probe the terminals from the mating side (front) of the connector.

Notice: Refer to Test Probe Notice in the Preface section.

Note: When probing female 0.64 terminals, it is important to use the correct adapter. There have been some revisions to the test adapter for 0.64 terminals. The proper adapter for 0.64 terminals is the EL-35616-64B which has a gold terminal and a black wire between the base and tip. Failure to use the proper test adapter may result in damage to the terminal being tested and improper diagnosis.

Note: The proper adapter for probing the terminals for fuses, relays, or diodes in an electrical center is EL-35616-35. Using any other tool or adapter may damage the terminal being tested.

Refer to the following table as a guide in selecting the correct test adapter for front probing connectors:

Test Adapter	Description
J-35616-2A	150 Male Probe Adapter (gray)
J-35616-3	150 Female Probe Adapter (gray)
J-35616-4A	280 Male Probe Adapter (purple)
J-35616-5	280 Female Probe Adapter (purple)
J-35616-6	100W Male (round) Probe Adapter (brown)
J-35616-7	100W Female (round) Probe Adapter (brown)
J-35616-8	Weather Pack Male Probe Adapter (orange)
J-35616-9	Weather Pack Female Probe Adapter (orange)
J-35616-10	100W Male (round) Probe Adapter (green)
J-35616-11	100W Female (round) Probe Adapter (green)
J-35616-12	130 Male Probe Adapter (blue)
J-35616-13	130 Female Probe Adapter (blue)
J-35616-14	150 Male Probe Adapter (green)
J-35616-16	100 Male Probe Adapter (lt green)
J-35616-17	100 Female Probe Adapter (lt green)
J-35616-18	220 Male Probe Adapter (black)
J-35616-19	220 Female Probe Adapter (black)
J-35616-21	950 Female Probe Adapter (red)

J-35616-22	950 Male Probe Adapter (red)
J-35616-31	500 Male Probe Adapter (orange)
J-35616-32	500 Female Probe Adapter (orange)
J-35616-33	160/180 Male Probe Adapter (yellow)
J-35616-34	160/180 Female Probe Adapter (yellow)
J-35616-35	280 Male Probe Adapter (violet)
J-35616-40	480 Male Probe Adapter (dk blue)
J-35616-41	480 Female Probe Adapter (dk blue)
J-35616-42	630 Male Probe Adapter (red)
J-35616-43	630 Female Probe Adapter (red)
J-35616-44	800 Male Probe Adapter (yellow)
J-35616-45	800 Female Probe Adapter (yellow)
J-35616-54	280 Male (round) Probe Adapter (tan)
J-35616-55	280 Female (round) Probe Adapter (tan)
J-35616-64B	0.64 Male Probe Adapter (lt blue)
J-35616-65B	0.64 Female Probe Adapter (lt blue)
J-35616-66	150 Male (round) Probe Adapter (yellow)
J-35616-67	150 Female (round) Probe Adapter (yellow)

Backprobe

Note:

- Backprobe connector terminals only when specifically required in diagnostic procedures.
- Do not backprobe a sealed (Weather Pack®) connector, less than a 280 series Metri-Pack connector, a Micro-Pack connector, or a flat wire (dock and lock) connector.
- Backprobing can be a source of damage to connector terminals. Use care in order to avoid deforming the terminal, either by forcing the test probe too far into the cavity or by using too large of a test probe.
- After backprobing any connector, inspect for terminal damage. If terminal damage is suspected, test for proper terminal contact.

Do not disconnect the connector and probe the terminals from the harness side (back) of the connector.

Repairing Connector Terminals

Special Tools

EL-38215-10 Splice Sleeve Crimp Tool

EL-35616-D Terminal Test Probe Kit

EL-38125-5 Ultra Torch

Terminal Release Tool Kit

For equivalent regional tools, refer to Special Tools

Making a Repair with a Terminated Lead or Connector Assembly

1. If using a terminated lead, remove the terminal to be replaced with the appropriate terminal release tool. Refer to the Terminal Release Tool Kit.
2. Cut and strip the wire insulation away from the terminal leaving enough wire length to reassemble the harness and connector without causing binding or a pinch condition.
3. Crimp the splice sleeve to the terminated lead or connector assembly to the harness wire using the Splice Sleeve Crimp Tool EL-38215-10. Refer to Splicing Copper Wire Using Splice Sleeves.
4. Use the Ultra Torch EL-38125-5 to seal the splice.
5. Repeat steps 2-4 if a connector assembly is being used to repair the vehicle.
6. Reassemble the connector and harness.
7. Verify the repair.

Repairing Damaged Wire Insulation

If the conductive portion of the wire is not damaged, locate the problem and apply tape around the wire. If the damage is more extensive, replace the faulty segment of the wire. Refer to Splicing Copper Wire Using Splice Sleeves and follow the instruction to repair the wire.

Wire Size Conversion

Metric Wire Sizes (mm 2)	AWG Sizes
0.13	26
0.21	24
0.32	22
0.52	20
0.83	18
1.31	16
2.09	14
3.31	12
5.27	10
8.37	8
13.3	6
21.2	4
33.6	2
53.5	1/0

Retained Accessory Power Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
RAP Relay Switch B+	1	1	2	--
RAP Relay Control	B1475 00, 1	1	2	--
RAP Relay Ignition	1	1	2	--
RAP Relay Ground	--	1	--	--

1. All or partial relay controlled RAP functions might be inoperative depending on the location that the fault occurred.
2. Relay RAP remains on past the timer limit after key out and will not turn off when a vehicle door is opened.

Circuit/System Description

The retained accessory power (RAP) system allows specific vehicle functions to operate after the ignition is turned OFF for a predetermined time. The RAP 1 relay is located in the I/P fuse block. The relay switched output feeds the WNDW CNTRL Fuse and the WNDW MTR circuit breaker within the fuse block. Relay RAP is controlled by the BCM using inputs from the door ajar switches to determine control of the relay when the ignition is turned OFF. Radio RAP is controlled by a serial data message from the BCM using inputs from the driver door open switch.

Diagnostic Aids

The radio RAP mode is a separate function and will still operate properly. The radio RAP function is controlled by serial data and the specific module. These functions are not effected by the BCM RAP relay circuits.

Reference Information

Schematic Reference

Power Distribution Schematics

Power Moding Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Retained Accessory Power Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Radio RAP

1. With all passenger doors closed, observe the courtesy lamps while opening and closing the driver door. The courtesy lamps should illuminate when the door is opened and turn off approximately 30 seconds after closing the door.

   If the courtesy lamp operation is incorrect from the drivers door, refer to Courtesy Lamps Malfunction.
2. If courtesy lamp operation is correct, and the radio is the only RAP concern, replace the radio.

Relay RAP

1. Ignition ON, observe the scan tool parameters in the modules listed below while opening and closing each vehicle door. The reading should change appropriately between Door Closed/Door Ajar for the door ajar switches, and between Open/Closed for the door open switches.

   #### Module/Parameter

   - Driver Door Ajar Sw.
   - Driver Door Open Sw.
   - Passenger Door Ajar Sw.
   - Passenger Door Open Sw.

If any parameter does not change as specified, refer to Door Ajar Indicator Malfunction.

2. Command the scan tool Accy/RAP Relay OFF. Attempt to operate any RAP relay controlled component within 5 seconds. The component should not operate.
3. Command the scan tool Accy/RAP Relay ON. Attempt to operate any RAP relay controlled component within 5 seconds. The component should operate.
4. Ignition ON, all doors closed. Observe the scan tool parameter Accy/RAP Relay Command. Ignition OFF, key removed, the reading should be ON for approximately 40 minutes then change to OFF.

   If the parameter does not respond as specified, replace the BCM.

Circuit/System Testing

1. Ignition OFF, disconnect the RAP relay.
2. Test for less than 5 Ω between the ground circuit terminal 86 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Connect a test lamp between the relay control circuit terminal 85 and ground.
4. With the driver and passenger doors open, cycle the ignition key ON and OFF. The test lamp should turn ON and OFF when cycling the ignition switch.

   If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
5. Verify that a test lamp illuminates between the B+ circuit terminal 30 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
6. If all circuits test normal, test or replace the RAP relay.

Component Testing

1. Ignition OFF, disconnect the RAP relay.
2. Test for 70 - 150 Ω between the control terminal 85 and the ground terminal 86 of the relay.

   If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If not the specified value, replace the relay.
4. Install a 3 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 Ω between terminals 30 and 87.

   If greater than specified, replace the relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Control Module References for BCM replacement, setup, and programming.

Scan Tool Snapshot Procedure

Snapshot is a recording of what a control module on the vehicle was receiving for information while the snapshot is being made. A snapshot may be used to analyze the data during the time a vehicle condition is current. This allows you to concentrate on making the condition occur, rather than trying to view all the data in anticipation of the fault. The snapshot contains information around a trigger point that you have determined. Only a single data list may be recorded in each snapshot. The Scan Tool has the ability to store 2 snapshots. The ability to record 2 snapshots allows comparing hot versus cold and good versus bad vehicle scenarios. The snapshots are stored on a first-in, first-out basis. If a third snapshot is taken, the first snapshot stored in the memory will be lost.

Snapshots can be 1 of 2 types:

- Snapshot - taken from the Snapshot menu choice
- Quick Snapshot - taken from the Data Display soft key choice, does not contain DTC information

When a snapshot is taken, it is recorded on the memory card and may contain as many as 1200 frames of information. Because the snapshot is recorded onto the memory card, snapshots are not lost if the Scan Tool is powered down.

The snapshot replay screen has a plot soft key that can be of great value for intermittent diagnosis. The snapshot plot feature can help you to quickly determine if a sensor is outside of its expected values by plotting 3 parameters at a time. The data will be displayed both graphically and numerically showing the minimum and maximum values for all frames captured. This is helpful, especially if the fault occurs only once and does not set a DTC.

SIR/SRS Wiring Repairs

Special Tools

- DuraSeal splice sleeves, in order to repair the SIR/SRS wiring
- EL-38125-10 Splice Sleeve Crimping Tool
- EL-38125-5 Ultra Torch

For equivalent regional tools, refer to Special Tools.

The DuraSeal splice sleeves have the following 2 critical features:

- A special heat shrink sleeve environmentally seals the splice. The heat shrink sleeve contains a sealing adhesive inside.
- A cross hatched (knurled) core crimp provides the necessary low resistance contact integrity for these sensitive, low energy circuits.

The Supplemental Inflatable Restraint (SIR) System/Supplemental Restraint System (SRS) requires special wiring repair procedures due to the sensitive nature of the circuitry. Follow the specific procedures and instructions when working with the SIR/SRS, and the wiring components, such as connectors and terminals.

Note: Do not use the terminals in the kit in order to replace damaged SIR/SRS system terminals. Use either an SIR/SRS pigtail or a terminated lead from the SIR Repair Kit Tray.

SIR/SRS Connector Repair (Plastic Body and Terminal Metal Pin)

The terminals in the SIR/SRS system are made with a special plating. This plating provides the necessary contact integrity for the sensitive, low energy circuits.

Pigtail repair packs are available for SIR/SRS connectors with eight or less terminals. Only the connector body is available for connectors with more than eight terminals. Terminated leads can be used to replace damaged terminals when replacing the connector body.

SIR/SRS Component Wire Pigtail Repair

Note: Do not make wire, connector, or terminal repairs on components with wire pigtails.

A wire pigtail is a wire or wires attached directly to the device, not by a connector. If a wiring pigtail is damaged, you must replace the entire component, with pigtail. The inflatable restraint steering wheel module coil is an example of a pigtail component.

SIR/SRS Wire Repair

Note: Refer to Wiring Repairs in order to determine the correct wire size for the circuit you are repairing. You must obtain this information in order to ensure circuit integrity.

If any wire except the pigtail is damaged, repair the wire by splicing in a new section of wire of the same gage size (0.5 mm, 0.8 mm, 1.0 mm etc.). Use the DuraSeal splice sleeves and EL-35125-10 splice sleeve crimping tool. Use the following wiring repair procedures in order to ensure the integrity of the DuraSeal splice sleeves.

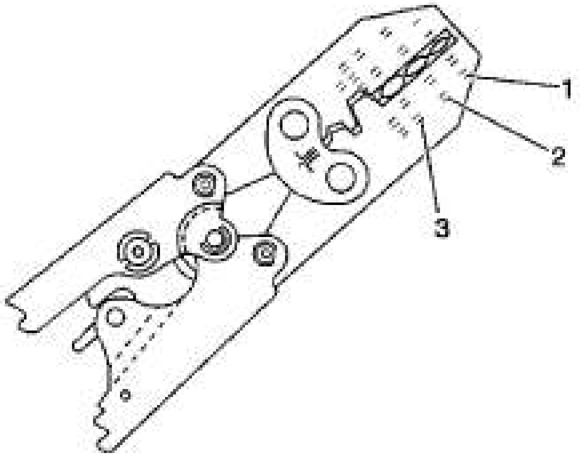
Splice Sleeve Color	Crimp Tool Nest Color	Wire Gage mm² / (AWG)
Salmon (Yellow-Pink) 12089189	Red (1)	0.035-0.8/(18-20)
Blue 12089190	Blue (2)	1-2/(14-16)
Yellow 12089191	Yellow (3)	3-5/(10-12)
Green 88988379	Red (1)	0.22-0.35/(22-26)

Note: You must perform the following procedures in the listed order. Repeat the procedure if any wire strands are damaged. You must obtain a clean strip with all of the wire strands intact.

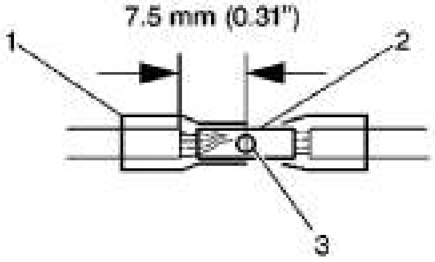
1. Open the harness by removing any tape:
   - Use a sewing seam ripper, available from sewing supply stores, in order to cut open the harness in order to avoid wire insulation damage.
   - Use the DuraSeal splice sleeves on all types of insulation except tefzel and coaxial.
   - Do not use the crimp and DuraSeal splice sleeve to form a splice with more than 2 wires coming together.
2. Cut as little wire off the harness as possible. You may need the extra length of wire in order to change the location of a splice.

   Adjust splice locations so that each splice is at least 40 mm (1.5 in) away from the other splices, harness branches, or connectors.

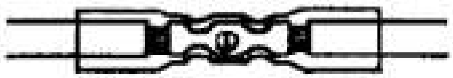
3. Strip the insulation:
   - When adding a length of wire to the existing harness, use the same size wire as the original wire.
   - Perform one of the following items in order to find the correct wire size:
     - Find the wire on the schematic and convert to regional wiring gage size.
     - If you are unsure of the wire size, begin with the largest opening in the wire stripper and work down until achieving a clean strip of the insulation.
   - Strip approximately 7.5 mm (0.313 in) of insulation from each wire to be spliced.
   - Do not nick or cut any of the strands. Inspect the stripped wire for nicks or cut strands.
   - If the wire is damaged, repeat this procedure after removing the damaged section.
4. Select the proper DuraSeal splice sleeve according to the wire size. Refer to the above table at the beginning of the repair procedure for the color coding of the DuraSeal splice sleeves and the crimp tool nests.



5. Use the EL-38125-10 splice sleeve crimp tool in order to position the DuraSeal splice sleeve in the proper color nest of the splice sleeve crimp tool. The crimp tool has four nests, one for each color.

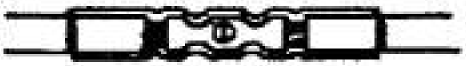


6. Place the DuraSeal splice sleeve in the nest. Ensure that the crimp falls midway between the end of the barrel and the stop. The sleeve has a stop (3) in the middle of the barrel (2) in order to prevent the wire (1) from going further. Close the hand crimper handles slightly in order to firmly hold the DuraSeal splice sleeve in the proper nest.



7. Insert the wire into the splice sleeve barrel until the wire hits the barrel stop.
8. Tightly close the handles of the crimp tool until the crimper handles open when released.

   The crimper handles will not open until you apply the proper amount of pressure to the DuraSeal splice sleeve. Repeat steps 4 and 5 for the opposite end of the splice.



9. Using the heat torch, apply heat to the crimped area of the barrel.
10. Start in the middle and gradually move the heat barrel to the open ends of the tubing:
    - The tubing will shrink completely as the heat is moved along the insulation.
    - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.

Connector Position Assurance (CPA)

The connector position assurance (CPA) is a small plastic insert that fits through the locking tabs of a connector. CPAs are used in all SIR System connectors and also in some connectors of other systems. The CPA ensures that the connector halves cannot vibrate apart. You must have the CPA in place in order to ensure good contact between the mating terminals of a connection.

Terminal Position Assurance (TPA)

The terminal position assurance (TPA) insert resembles the plastic combs used in the control module connectors. The TPA keeps the terminal securely seated in the connector body. Do not remove the TPA from the connector body unless you remove a terminal for replacement.

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Splicing Copper Wire Using Splice Sleeves

Special Tools

- DuraSeal splice sleeves, in order to repair the SIR/SRS wiring
- EL-38125-10 Splice Sleeve Crimping Tool
- EL-38125-5 Ultra Torch

For equivalent regional tools, refer to Special Tools.

Note: Use only DuraSeal splice sleeves. Other splice sleeves may not protect the splice from moisture or provide a good electrical connection.

Use DuraSeal splice sleeves to form a one-to-one splice on all types of insulation except tefzel and coaxial. Use DuraSeal splice sleeves where there is special requirements such as moisture sealing. Follow the instructions below in order to splice copper wire using DuraSeal splice sleeves.

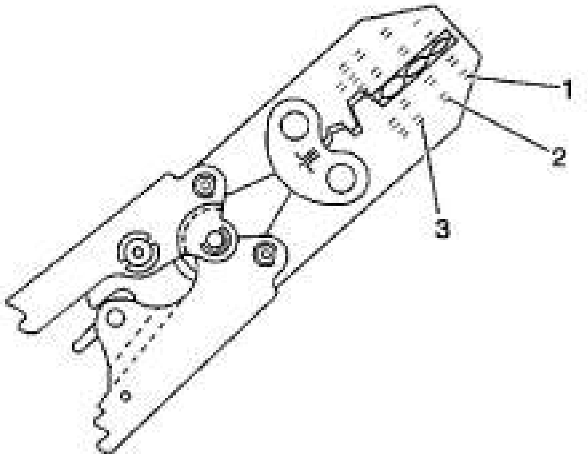
Splice Sleeve Color	Crimp Tool Nest Color	Wire Gage mm² / (AWG)
Salmon (Yellow-Pink) 12089189	Red (1)	0.035-0.8/(18-20)
Blue 12089190	Blue (2)	1-2/(14-16)
Yellow 12089191	Yellow (3)	3-5/(10-12)
Green 88988379	Red (1)	0.22-0.35/(22-26)

Note: You must perform the following procedures in the listed order. Repeat the procedure if any wire strands are damaged. You must obtain a clean strip with all of the wire strands intact.

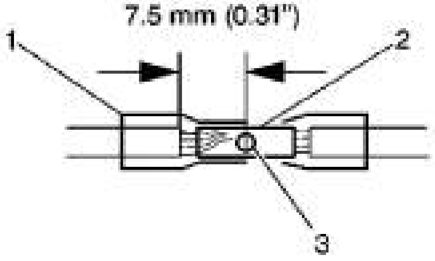
1. Open the harness by removing any tape:
   - Use a sewing seam ripper, available from sewing supply stores, in order to cut open the harness in order to avoid wire insulation damage.
   - Use the DuraSeal splice sleeves on all types of insulation except tefzel and coaxial.
   - Do not use the crimp and DuraSeal splice sleeve to form a splice with more than 2 wires coming together.
2. Cut as little wire off the harness as possible. You may need the extra length of wire in order to change the location of a splice.

   Adjust splice locations so that each splice is at least 40 mm (1.5 in) away from the other splices, harness branches, or connectors.

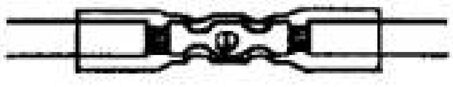
3. Strip the insulation:
   - When adding a length of wire to the existing harness, use the same size wire as the original wire.
   - Perform one of the following items in order to find the correct wire size:
     - Find the wire on the schematic and convert to regional wiring gage size.
     - If you are unsure of the wire size, begin with the largest opening in the wire stripper and work down until achieving a clean strip of the insulation.
   - Strip approximately 7.5 mm (0.313 in) of insulation from each wire to be spliced.
   - Do not nick or cut any of the strands. Inspect the stripped wire for nicks or cut strands.
   - If the wire is damaged, repeat this procedure after removing the damaged section.
4. Select the proper DuraSeal splice sleeve according to the wire size. Refer to the above table at the beginning of the repair procedure for the color coding of the DuraSeal splice sleeves and the crimp tool nests.



5. Use the EL-38125-10 splice sleeve crimp tool in order to position the DuraSeal splice sleeve in the proper color nest of the splice sleeve crimp tool. The crimp tool has four nests, one for each color.

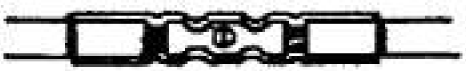


6. Place the DuraSeal splice sleeve in the nest. Ensure that the crimp falls midway between the end of the barrel and the stop. The sleeve has a stop (3) in the middle of the barrel (2) in order to prevent the wire (1) from going further. Close the hand crimper handles slightly in order to firmly hold the DuraSeal splice sleeve in the proper nest.



7. Insert the wire into the splice sleeve barrel until the wire hits the barrel stop.
8. Tightly close the handles of the crimp tool until the crimper handles open when released.

   The crimper handles will not open until you apply the proper amount of pressure to the DuraSeal splice sleeve. Repeat steps 4 and 5 for the opposite end of the splice.



9. Using the heat torch, apply heat to the crimped area of the barrel.
10. Start in the middle and gradually move the heat barrel to the open ends of the tubing:
    - The tubing will shrink completely as the heat is moved along the insulation.
    - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.

Splicing Inline Harness Diodes

Many vehicle electrical systems use a diode to isolate circuits and protect the components from voltage spikes. When installing a new diode use the following procedure.

1. Open the harness.
   - If the harness is taped, remove the tape.
   - To avoid wiring insulation damage, use a sewing ripper in order to cut open the harness.
   - If the harness has a black plastic conduit, pull out the diode.
2. If the diode is taped to the harness, remove all of the tape.
3. Check and record the current flow direction and orientation of diode.
4. Remove the inoperative diode from the harness with a suitable soldering tool.

   Note: If the diode is located next to a connector terminal remove the terminal(s) from the connector to prevent damage from the soldering tool.

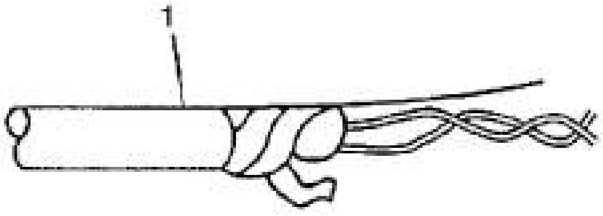
5. Carefully strip away a section of insulation next to the old soldered portion of the wire(s). Do not remove any more than is needed to attach the new diode.
6. Check current flow direction of the new diode, being sure to install the diode with correct bias. Reference the appropriate service manual wiring schematic to obtain the correct diode installation position.
7. Attach the new diode to the wire(s) using 60/40 rosin core solder. Before soldering attach some heat sinks (aluminum alligator clips) across the diode wire ends to protect the diode from excessive heat. Follow the manufacturer's instruction for the soldering equipment.
8. Reinstall terminal(s) into the connector body if previously removed.

   Note: To prevent shorts to ground and water intrusion, completely cover all exposed wire and diode attachment points with tape.

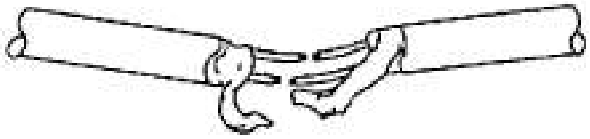
9. Tape the diode to the harness or connector using electrical tape.

Splicing Twisted or Shielded Cable

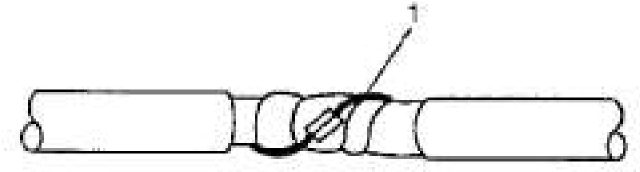
Twisted/shielded cable is used in order to protect wiring from electrical noise. Two-conductor cable of this construction is used between the radio and the Delco-Bose® speaker/amplifier units and other applications where low level, sensitive signals must be carried. Follow the instructions below in order to repair the twisted/shielded cable.



1. Remove the outer jacket (1). Use care not to cut into the drain wire of the mylar tape.
2. Unwrap the tape. Do not remove the tape. Use the tape in order to rewrap the twisted conductors after the splice is made.

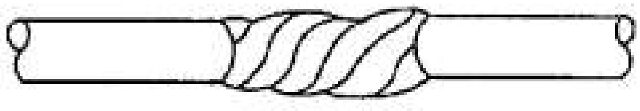


3. Prepare the splice. Untwist the conductors and follow the instructions for Splicing Copper Wire Using Splice Sleeves. Staggering the splices by 65 mm (2.5 in) is recommended.



Note: Apply the mylar tape with the aluminum side inward. This ensures good electrical contact with the drain wire.

4. Re-assemble the cable.
    - Rewrap the conductors with the mylar tape. If the mylar tape is damaged, use 3M product AL-36FR to replace the damaged mylar tape.
    - Use caution not to wrap the drain wire in the tape (1).
    - Follow the splicing instructions for copper wire and splice the drain wire.
    - Wrap the drain wire around the conductors and tape with electrical tape to replace the outer insulation.



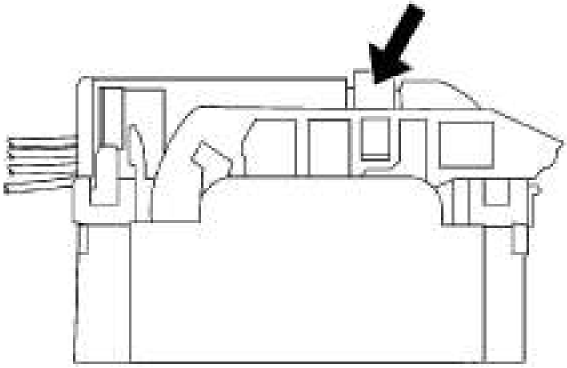
5. Tape over the entire cable. Use a winding motion when you apply the tape.

Sumitomo Connectors

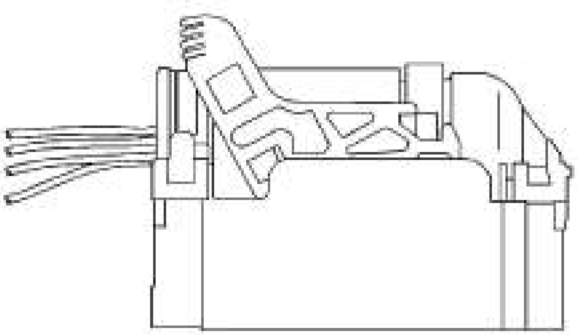
Special Tools

For equivalent regional tools, refer to Special Tools.

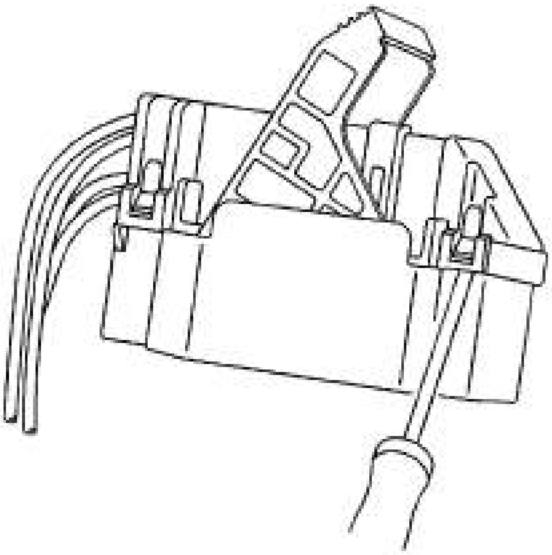
Terminal Removal Procedure



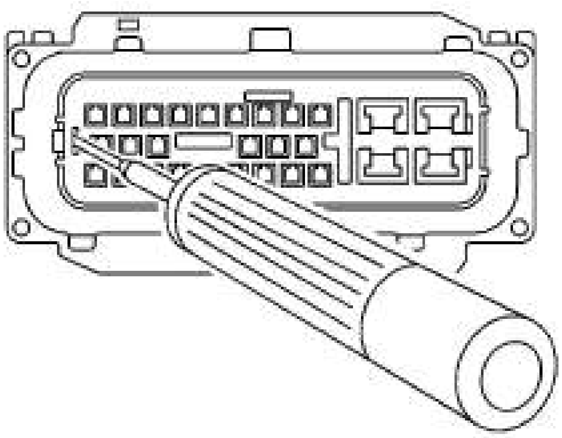
1. Slide the lever lock forward while pressing down on the lever lock release tab.



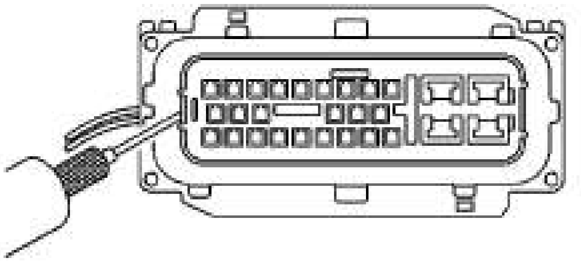
2. Disconnect the connector from the component.



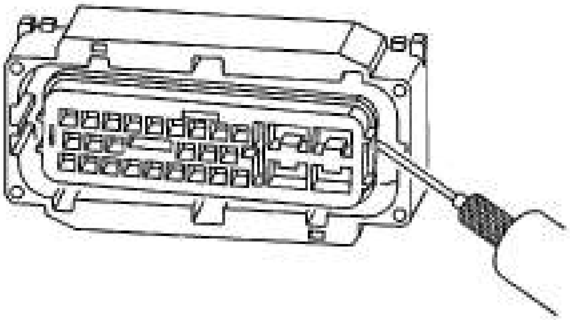
3. Remove the dress cover by using a flat-blade tool to release the connector locking tabs and pulling off the dress cover.



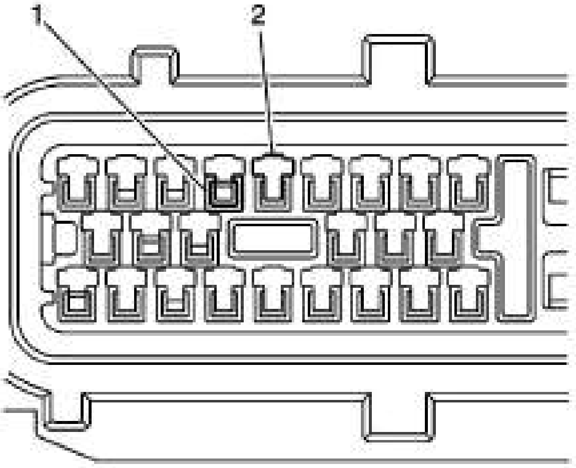
4. Relieve the tension on the nose piece retainers by inserting EL-38125-12A into the single retainer slot on the end of the nose piece and gently prying out the locking tab. Repeat the process for both of the nose piece locking tabs on the opposite side of the nose piece.



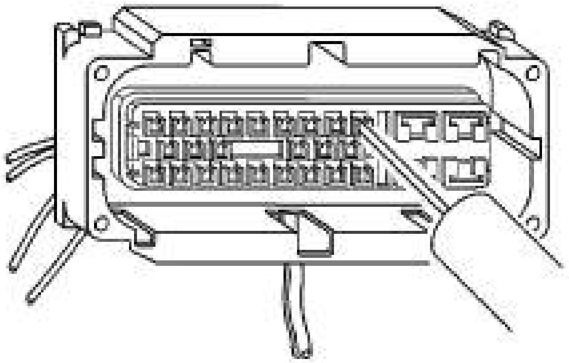
5. Once the nose piece retainers are relaxed, use the EL-38125-552 to pull up the nose piece by hooking the tool under the nose piece and pulling up. The nose piece should raise slightly.



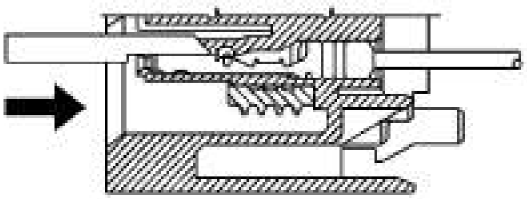
6. On the opposite side of the nose piece, use the EL-38125-552 pull up the nose piece by hooking the tool under the nose piece and pulling up. The nose piece should release completely. If the nose piece does not come off, repeat the procedure on the opposite side.

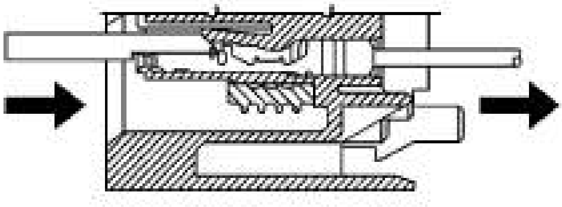


7. The illustration above identifies the entry canal where the terminal release tool will be inserted, and the terminal cavity.
   - Terminal (1)
   - Entry Canal (2)



8. Insert the EL-38125-553 tool into the entry canal and pry up on the terminal retainer. The terminal retainer is a small plastic piece on the top of the terminal. The terminal retainer must be held up while the terminal is pulled out of the connector.





9. The illustration shows a cutaway view of the connector to aid the technician in releasing the terminal retainer.

Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

Terminal Replacement Procedure

After the terminal is crimped to the wire, perform the following procedure in order to replace the terminal.

1. Slide the new terminal into the correct cavity at the back of the connector.
2. Push the terminal into the connector until it locks into place. The new terminal should be even with the other terminals. Ensure that the terminal is locked in place by gently pulling on the wire.
3. To assemble the connector, reverse the connector disassembly procedure.

Symptoms - Wiring Systems

Note: The following steps must be completed before using the symptom tables.

1. Perform the Diagnostic System Check - Vehicle before using the symptom tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data links.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to:
   - Power Mode Description and Operation
   - Retained Accessory Power Description and Operation

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the systems. Refer to Checking Aftermarket Accessories.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Power Mode Mismatch
- Retained Accessory Power Malfunction

Terminal Position Assurance Locks

The terminal position assurance (TPA) insert resembles the plastic combs used in the control module connectors. The TPA keeps the terminal securely seated in the connector body. Do not remove the TPA from the connector body unless you remove a terminal for replacement.

Testing for a Short to Voltage

Notice: Refer to Test Probe Notice in the Preface section.

The following procedure tests for a short to voltage in a circuit.

1. Set the rotary dial of the DMM to the V (DC) position.
2. Connect the positive lead of the DMM to one end of the circuit to be tested.
3. Connect the negative lead of the DMM to a good ground.
4. Turn ON the ignition and operate all accessories.
5. If the voltage measured is greater than 1 V, there is a short to voltage in the circuit.

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Testing for Continuity

Notice: Refer to Test Probe Notice in the Preface section.

The following procedures verify good continuity in a circuit.

With a DMM

1. Set the rotary dial of the DMM to the Ω position.
2. Disconnect the power feed (i.e. fuse, control module) from the suspect circuit.
3. Disconnect the load.
4. Press the MIN MAX button on the DMM.
5. Connect one lead of the DMM to one end of the circuit to be tested.
6. Connect the other lead of the DMM to the other end of the circuit.
7. If the DMM displays low or no resistance, the circuit has good continuity.

With a Test Lamp

Note: Only use the test lamp procedure on low impedance power and ground circuits.

1. Remove the power feed (i.e. fuse, control module) from the suspect circuit.
2. Disconnect the load.
3. Connect one lead of the test lamp to one end of the circuit to be tested.
4. Connect the other lead of the test lamp to battery positive voltage.
5. Connect the other end of the circuit to ground.
6. If the test lamp illuminates (full intensity), then the circuit has good continuity.

Testing for Electrical Intermittents

Special Tools

EL-39200 Digital Multimeter

For equivalent regional tools, refer to Special Tools.

Perform the following procedures while wiggling the harness from side to side. Continue this at convenient points (about 6 inches apart) while watching the test equipment.

- Testing for Short to Ground
- Testing for Continuity
- Testing for a Short to Voltage

If the fault is not identified, perform the procedure below using the MIN MAX feature on the EL-39200 DMM. This feature allows you to manipulate the circuit without having to watch the EL-39200. The EL-39200 will generate an audible tone when a change is detected.

Note: The EL-39200 must be used in order to perform the following procedure since the EL-39200 can monitor current, resistance or voltage while recording the minimum (MIN), and maximum (MAX) values measured.

1. Connect the EL-39200 to both sides of a suspected connector (still connected), or from one end of a suspected circuit to the other. Refer to Troubleshooting with a Digital Multimeter for information on connecting the EL-39200 to the circuit.
2. Set the rotary dial of the EL-39200 to the V (AC) or V (DC) position.
3. Press the range button of the EL-39200 in order to select the desired voltage range.
4. Press the MIN MAX button of the EL-39200. The EL-39200 displays 100 ms RECORD and emits an audible tone (beep).

   Note: The 100 ms RECORD mode is the length of time an input must stay at a new value in order to record the full change.

5. Simulate the condition that is potentially causing the intermittent connection, either by wiggling the connections or the wiring, test driving, or performing other operations. Refer to Inducing Intermittent Fault Conditions.
6. Listen for the audible Min Max Alert which indicates that a new minimum or maximum value has been recorded.
7. Press the MIN MAX button once in order to display the MAX value and note the value.
8. Press the MIN MAX button again in order to display the MIN value and note the value.
9. Determine the difference between the MIN and MAX values.
   - If the variation between the recorded MIN and MAX voltage values is 1 V or greater an intermittent open or high resistance condition exists. Repair the condition as necessary.
   - If the variation between the recorded MIN and MAX voltage values is less than 1 V, an intermittent open or high resistance condition does not exist.

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Testing for Intermittent Conditions and Poor Connections

Special Tools

EL-35616-D Terminal Test Probe Kit

For equivalent regional tools, refer to Special Tools.

When the condition is not currently present, but is indicated in DTC history, the cause may be intermittent. An intermittent may also be the cause when there is a customer complaint, but the symptom cannot be duplicated. Refer to the Symptom Table of the system that is suspect of causing the condition before trying to locate an intermittent condition.

Most intermittent conditions are caused by faulty electrical connections or wiring. Inspect for the following items:

- Wiring broken inside the insulation
- Poor connection between the male and female terminal at a connector
- Poor terminal to wire connection--Some conditions which fall under this description are poor crimps, poor solder joints, crimping over the wire insulation rather than the wire itself, and corrosion in the wire to terminal contact area, etc.
- Pierced or damaged insulation can allow moisture to enter the wiring causing corrosion. The conductor can corrode inside the insulation, with little visible evidence. Look for swollen and stiff sections of wire in the suspect circuits.
- Wiring which has been pinched, cut, or its insulation rubbed through may cause an intermittent open or short as the bare area touches other wiring or parts of the vehicle.
- Wiring that comes in contact with hot or exhaust components
- Refer to Inducing Intermittent Fault Conditions in order to duplicate the conditions required, in order to verify the customer concern.
- Refer to Testing for Electrical Intermittents for test procedures to detect intermittent open, high resistance, short to ground, and short to voltage conditions.
- Refer to Scan Tool Snapshot Procedure for advanced intermittent diagnosis and Vehicle Data Recorder operation.

Testing for Proper Terminal Contact

It is important to test terminal contact at the component and any inline connectors before replacing a suspect component. Mating terminals must be inspected to ensure good terminal contact. A poor connection between the male and female terminal at a connector may be the result of contamination or deformation.

Contamination may be caused by the connector halves being improperly connected. A missing or damaged connector seal, damage to the connector itself, or exposing the terminals to moisture and dirt can also cause contamination. Contamination, usually in the underhood or underbody connectors, leads to terminal corrosion, causing an open circuit or intermittently open circuit.

Deformation is caused by probing the mating side of a connector terminal without the proper adapter. Always use the EL-35616 when probing connectors. Other causes of terminal deformation are improperly joining the connector halves, or repeatedly separating and joining the connector halves. Deformation, usually to the female terminal contact tang, can result in poor terminal contact causing an open or intermittently open circuit.

Testing for Proper Terminal Contact in Bussed Electrical Centers

It is very important to use the correct test adapter when testing for proper terminal contact of fuses and relays in a bussed electrical center. Use EL-35616-35 to test for proper terminal contact. Failure to use EL-35616-35 can result in improper diagnosis of the bussed electrical center.

Follow the procedure below in order to test terminal contact:

1. Separate the connector halves.
2. Visually inspect the connector halves for contamination. Contamination may result in a white or green build-up within the connector body or between terminals. This causes high terminal resistance, intermittent contact, or an open circuit. An underhood or underbody connector that shows signs of contamination should be replaced in its entirety: terminals, seals, and connector body.
3. Using an equivalent male terminal / terminated lead, verify that the retention force is significantly different between a known good terminal and the suspect terminal. Replace the female terminal in question.

Flat Wire (Dock and Lock) Connectors

There are no serviceable parts for flat wire (dock and lock) connectors on the harness side or the component side.

Follow the procedure below in order to test terminal contact:

1. Remove the component in question.
2. Visually inspect each side of the connector for signs of contamination. Avoid touching either side of the connector as oil from your skin may be a source of contamination as well.
3. Visually inspect the terminal bearing surfaces of the flat wire circuits for splits, cracks, or other imperfections that could cause poor terminal contact. Visually inspect the component side connector to ensure that all of the terminals are uniform and free of damage or deformation.
4. Insert the appropriate adapter from the on the flat wire harness connector in order to test the circuit in question.

Control Module/Component Voltage and Grounds

Poor voltage or ground connections can cause widely varying symptoms.

- Test all control module voltage supply circuits. Many vehicles have multiple circuits supplying voltage to a control module. Other components in the system may have separate voltage supply circuits that may also need to be tested. Inspect connections at the module/component connectors, fuses, and any intermediate connections between the voltage source and the module/component. A test lamp or a DMM may indicate that voltage is present, but neither tests the ability of the circuit to carry sufficient current. Ensure that the circuit can carry the current necessary to operate the component. Refer to Circuit Testing and Power Distribution Schematics.

- Test all control module ground and system ground circuits. The control module may have multiple ground circuits. Other components in the system may have separate grounds that may also need to be tested. Inspect grounds for clean and tight connections at the grounding point. Inspect the connections at the component and in splice packs, where applicable. Ensure that the circuit can carry the current necessary to operate the component. Refer to Circuit Testing and Ground Distribution Schematics.

Temperature Sensitivity

- An intermittent condition may occur when a component/connection reaches normal operating temperature. The condition may occur only when the component/connection is cold, or only when the component/connection is hot.
- Freeze Frame, Failure Records, Snapshot, or Vehicle Data Recorder data may help with this type of intermittent condition, where applicable.
- If the intermittent is related to heat, review the data for a relationship with the following:
  - High ambient temperatures
  - Underhood/engine generated heat
  - Circuit generated heat due to a poor connection, or high electrical load
  - Higher than normal load conditions, towing, etc.
- If the intermittent is related to cold, review the data for the following:
  - Low ambient temperatures--In extremely low temperatures, ice may form in a connection or component. Inspect for water intrusion.
  - The condition only occurs on a cold start.
  - The condition goes away when the vehicle warms up.
- Information from the customer may help to determine if the trouble follows a pattern that is temperature related.
- If temperature is suspected of causing an intermittent fault condition, attempt to duplicate the condition. Refer to Inducing Intermittent Fault Conditions in order to duplicate the conditions required.

Electromagnetic Interference and Electrical Noise

Some electrical components/circuits are sensitive to electromagnetic interference or other types of electrical noise. Inspect for the following conditions:

- A misrouted harness that is too close to high voltage/high current devices such as secondary ignition components, motors, generator etc.--These components may induce electrical noise on a circuit that could interfere with normal circuit operation.
- Electrical system interference caused by a malfunctioning relay, or a control module driven solenoid or switch--These conditions can cause a sharp electrical surge. Normally, the condition will occur when the malfunctioning component is operating.
- Improper installation of non-factory or aftermarket add on accessories such as lights, 2-way radios, amplifiers, electric motors, remote starters, alarm systems, cell phones, etc.--These accessories may lead to interference while in use, but do not fail when the accessories are not in use. Refer to Checking Aftermarket Accessories.
- Test for an open diode across the A/C compressor clutch and for other open diodes. Some relays may contain a clamping diode.

- The generator may be allowing AC noise into the electrical system.

Incorrect Control Module

- There are only a few situations where reprogramming a control module is appropriate:
  - A new service control module is installed.
  - A control module from another vehicle is installed.
  - Revised software/calibration files have been released for this vehicle.

Note: DO NOT re-program the control module with the SAME software/calibration files that are already present in the control module. This is not an effective repair for any type of concern.

- Verify that the control module contains the correct software/calibration. If incorrect programming is found, reprogram the control module with the most current software/calibration. Refer to Control Module Referencesfor replacement, setup, and programming.

Testing for Short to Ground

Notice: Refer to Test Probe Notice in the Preface section.

The following procedures test for a short to ground in a circuit.

With a DMM

1. Remove the power feed (i.e. fuse, control module) from the suspect circuit.
2. Disconnect the load.
3. Set the rotary dial of the DMM to the Ω position.
4. Connect one lead of the DMM to one end of the circuit to be tested.
5. Connect the other lead of the DMM to a good ground.
6. If the DMM does NOT display infinite resistance (OL), there is a short to ground in the circuit.

With a Test Lamp

1. Remove the power feed (i.e. fuse, control module) from the suspect circuit.
2. Disconnect the load.
3. Connect one lead of the test lamp to battery positive voltage.
4. Connect the other lead of the test lamp to one end of the circuit to be tested.
5. If the test lamp illuminates, there is a short to ground in the circuit.

Fuse Powering Several Loads

1. Review the system schematic and locate the fuse that is open.
2. Open the first connector or switch leading from the fuse to each load.
3. Connect a DMM across the fuse terminals (be sure that the fuse is powered).
   - When the DMM displays voltage the short is in the wiring leading to the first connector or switch.
   - If the DMM does not display voltage refer to the next step.
4. Close each connector or switch until the DMM displays voltage in order to find which circuit is shorted.

Troubleshooting with a Digital Multimeter

Special Tools

EL-39200 Digital Multimeter

For equivalent regional tools, refer to Special Tools.

Notice: Refer to Test Probe Notice in the Preface section.

Note: Circuits which include any solid state control modules, such as the powertrain control module (PCM), should only be tested with a 10 MΩ or higher impedance digital multimeter such as the EL-39200 Digital Multimeter (DMM).

The EL-39200 instruction manual is a good source of information and should be read thoroughly upon receipt of the DMM as well as kept on hand for future reference.

A DMM should be used instead of a test lamp in order to test for voltage in high impedance circuits. While a test lamp shows whether voltage is present if the impedance is low enough, a DMM indicates how much voltage is present. In other words, if there is not enough current, the test lamp will not illuminate even though voltage is present.

The ohmmeter function on a DMM shows how much resistance exists between 2 points along a circuit. Low resistance in a circuit means good continuity.

Note: Disconnect the power feed from the suspect circuit when measuring resistance with a DMM. This prevents incorrect readings. DMMs apply such a small voltage to measure resistance that the presence of voltages can upset a resistance reading.

Diodes and solid state components in a circuit can cause a DMM to display a false reading. To find out if a component is affecting a measurement take a reading once, then reverse the leads and take a second reading. If the readings differ the solid state component is affecting the measurement.

Following are examples of the various methods of connecting the DMM to the circuit to be tested:

- Backprobe both ends of the connector and either hold the leads in place while manipulating the connector or tape the leads to the harness for continuous monitoring while you perform other operations or test driving. Refer to Probing Electrical Connectors.
- Disconnect the harness at both ends of the suspected circuit where it connects either to a component or to other harnesses.
- If the system that is being diagnosed has a specified pinout or breakout box, it may be used in order to simplify connecting the DMM to the circuit or for testing multiple circuits quickly.

Troubleshooting with a Test Lamp

Special Tools

EL-35616-200 Test Light - Probe Kit

Notice: Refer to Test Probe Notice in the Preface section.

A test lamp can simply and quickly test a low impedance circuit for voltage. A DMM should be used instead of a test lamp in order to test for voltage in high impedance circuits. While a test lamp shows whether voltage is present if the impedance is low enough, a DMM indicates how much voltage is present. In other words, if there is not enough current, the test lamp will not illuminate even though voltage is present.

The EL-35616-200 is Micro-Pack compatible and comprised of a 12 V light bulb with an attached pair of leads.

To properly operate this tool use the following procedures.

When testing for voltage:

1. Attach one lead to ground.
2. Touch the other lead to various points along the circuit where voltage should be present.
3. When the bulb illuminates, there is voltage at the point being tested.

When testing for ground:

1. Attach one lead to battery positive voltage.
2. Touch the other lead to various points along the circuit where ground should be present.
3. When the bulb illuminates, there is ground at the point being tested.

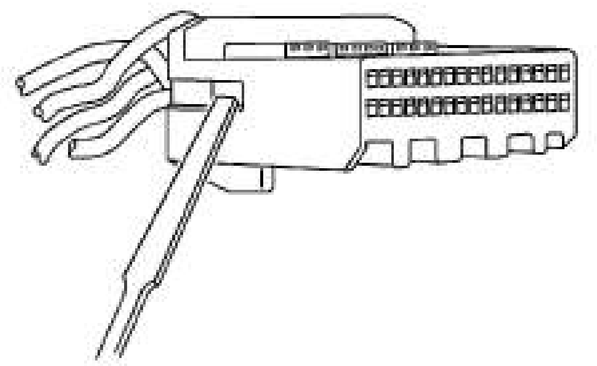
Tyco / AMP Connectors (0.25 Cap)

Special Tools

For equivalent regional tools, refer to Special Tools.

Terminal Removal Procedure

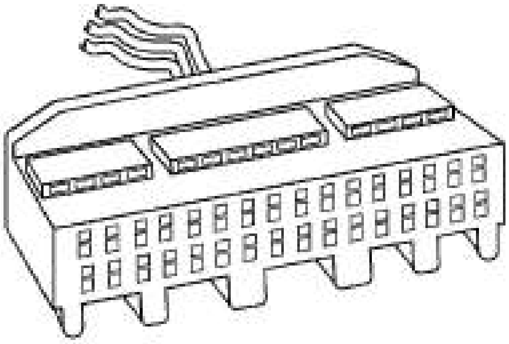
1. Disconnect the connector from the component by pressing down on the connector position assurance (CPA).



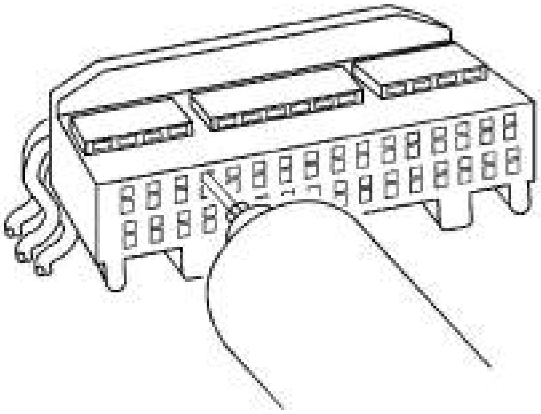
2. Use a small flat-bladed tool to release the terminal position assurance (TPA) by inserting the tool in the small recess on the side of the connector and pushing up until the TPA releases from the connector body. The TPA should raise just slightly. Do not try to remove the TPA.

   Note: The TPA on this connector cannot be removed unless the terminals are removed first. The TPA will come out of the connector body, but only slightly. When the TPA is slightly raised the terminals can be removed. Using excessive force to remove the TPA with the terminals still in the connector will damage the connector.

3. Repeat the process for the other side of the connector.



4. Ensure that the TPA is in the proper position to remove the terminals.



5. While pushing the terminal forward, insert the EL-38125-24 in the release cavity above the terminal you are removing, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.

Terminated Lead Repair

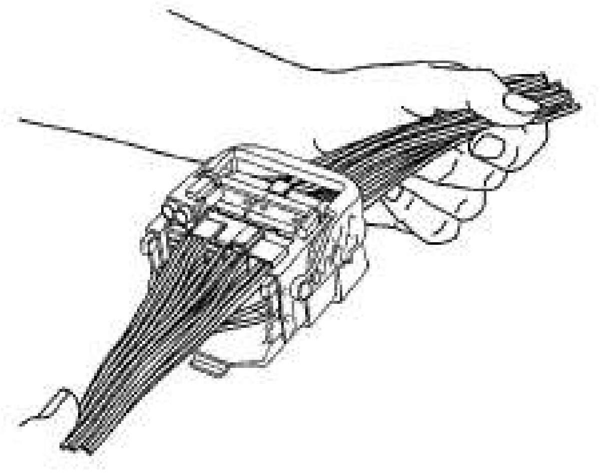
1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

Tyco / AMP Connectors (102-Way Inline)

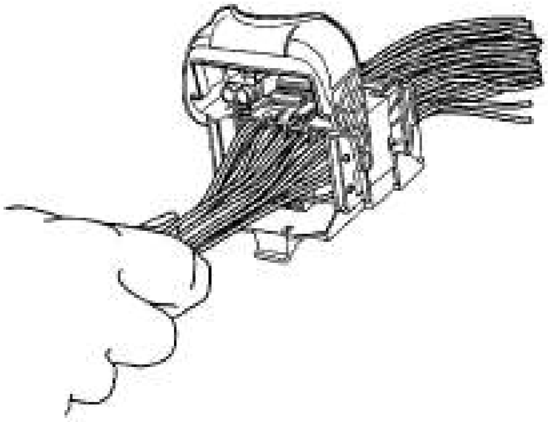
Special Tools

For equivalent regional tools, refer to Special Tools Special Tools.

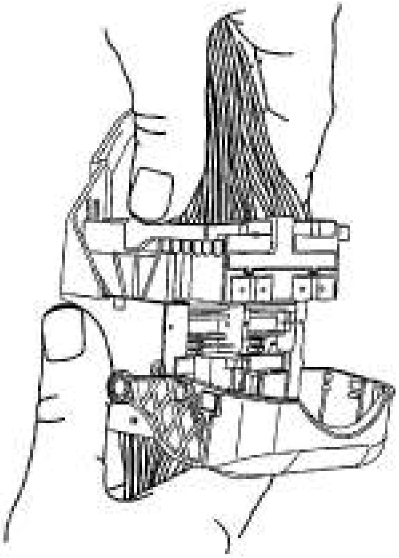
Removal Procedure



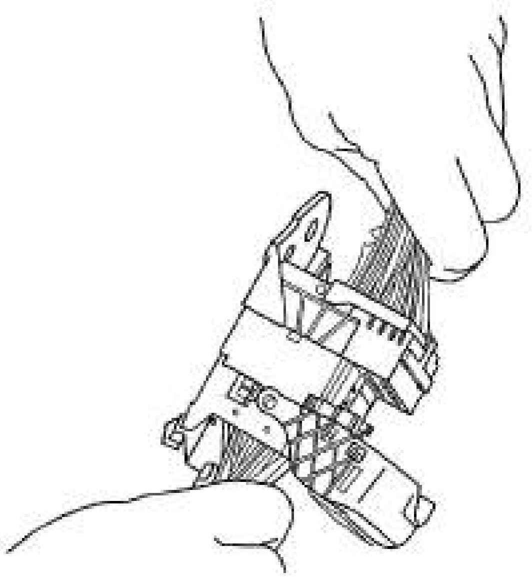
View of a typical connector in the assembled position.



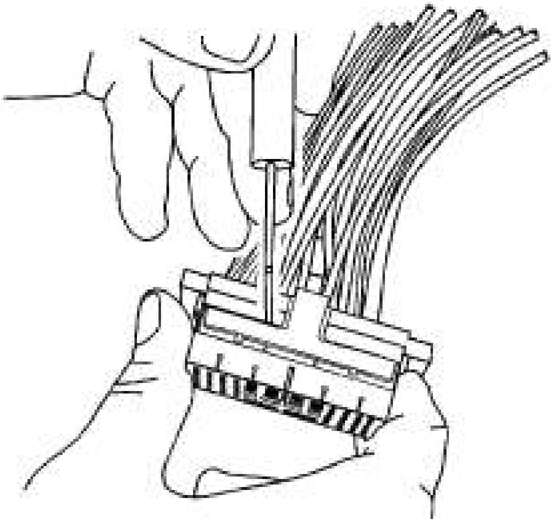
1. Pull the locking lever to the 90 degree position from the connector body.



2. With the locking lever in the 90 degree position and the male connector body separated, it can be slid outward for removal.

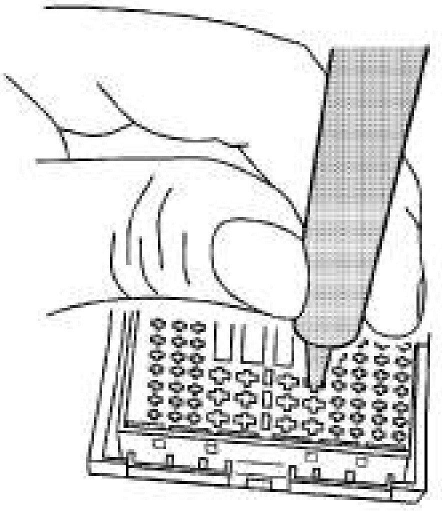


3. Slide the male connector body out away from the guide plates.

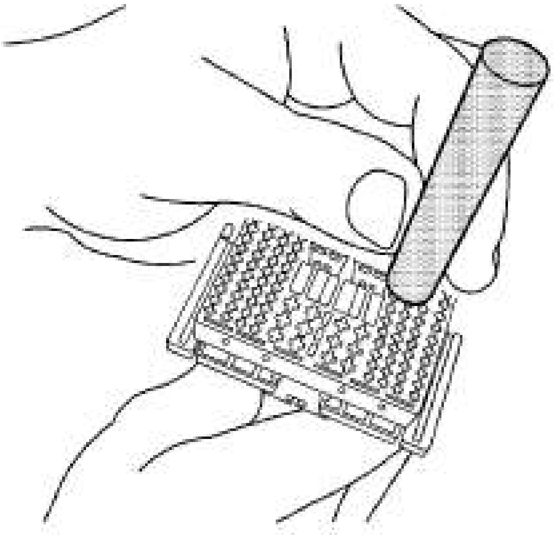


Note: During assembly the TPA will not fully seat if any terminal is not fully seated.

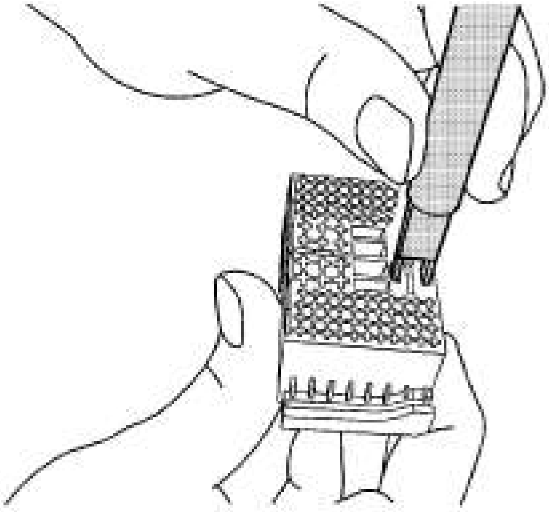
4. Using terminal release tool J-38125-11A or equivalent, remove the TPA from the connector body.



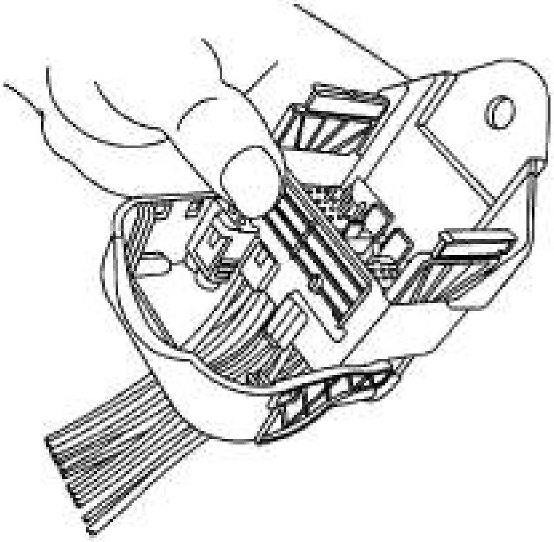
5. Using terminal release tool J 38125-566, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.



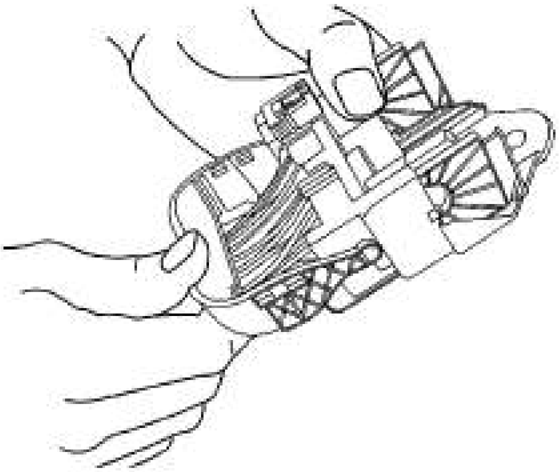
6. Using terminal release tool J 38125-560, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.



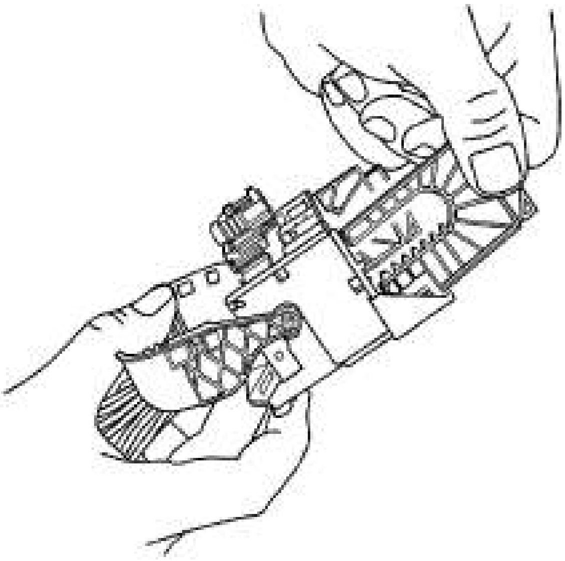
7. Using terminal release tool J 38125-221, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.



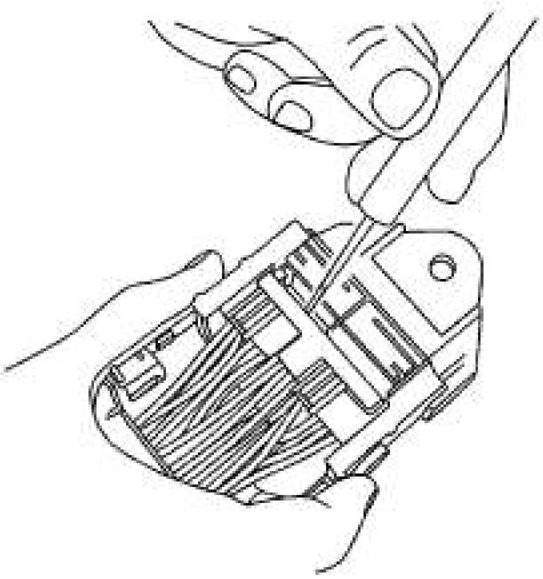
8. The female connector body may have an additional connector hooked to the edge of the body. Use terminal release tool J-38125-11A or equivalent to release the locking tab and slide the connector off the female body.



9. Move the locking lever 180 degrees from the connected position.

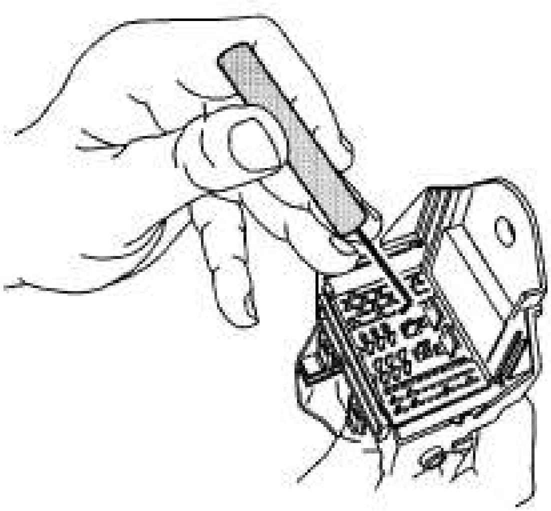


10. With the locking lever in the 180 degree position the guide plates can be removed from the connector body.

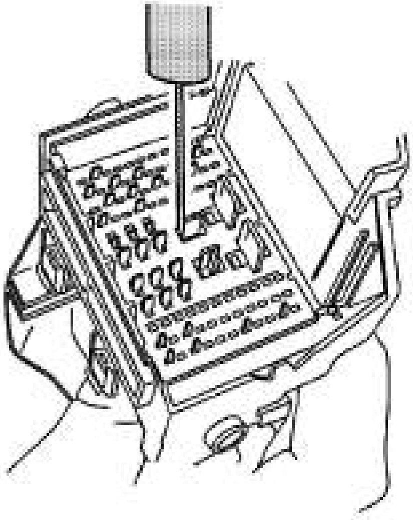


Note: During assembly the TPA will not fully seat if any terminal is not fully seated.

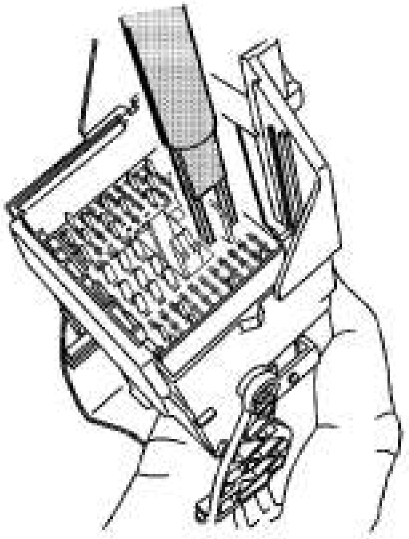
11. Using terminal release tool J 38125-11A or equivalent, remove the TPA from the connector body.



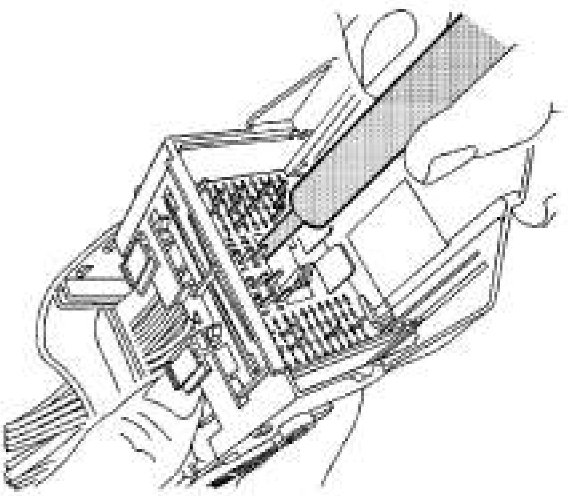
12. Using terminal release tool J 38125-216, lift the terminal plate past the terminals and out of the connector body cavity.



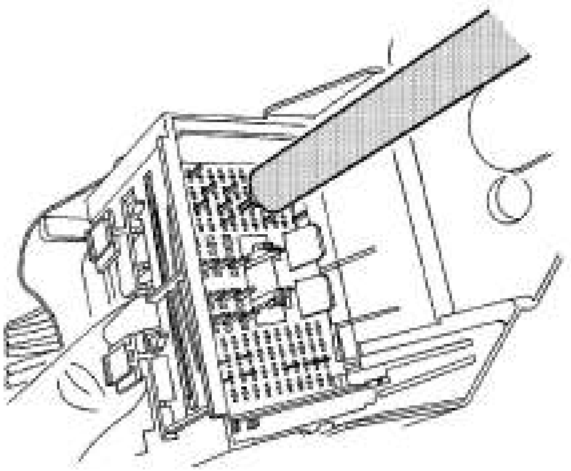
13. Terminal plate will bind slightly on each corner.



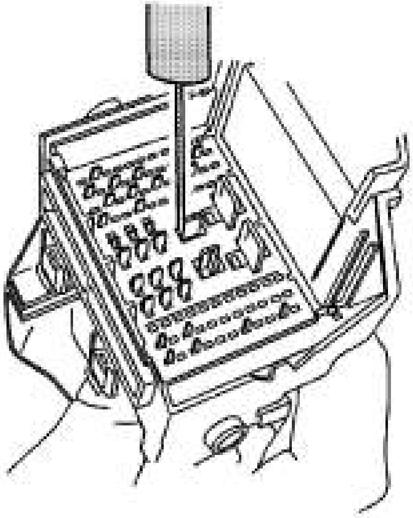
14. Using terminal release tool J 38125-221, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.



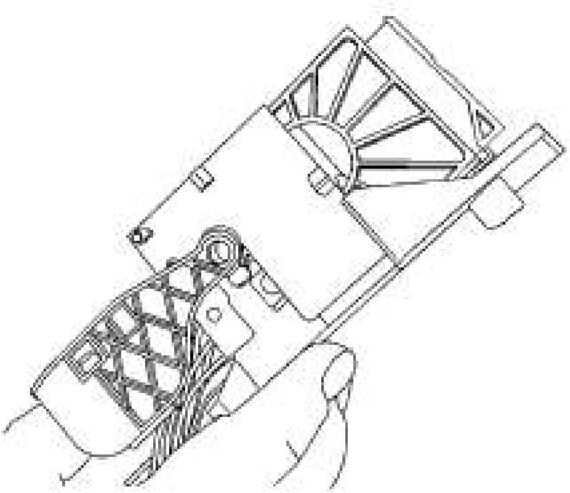
15. Using terminal release tool J 38125-212, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.



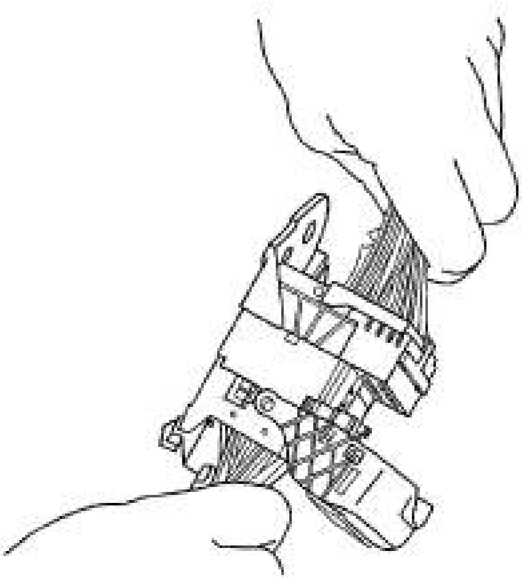
16. Using terminal release tool J 38125-560, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.



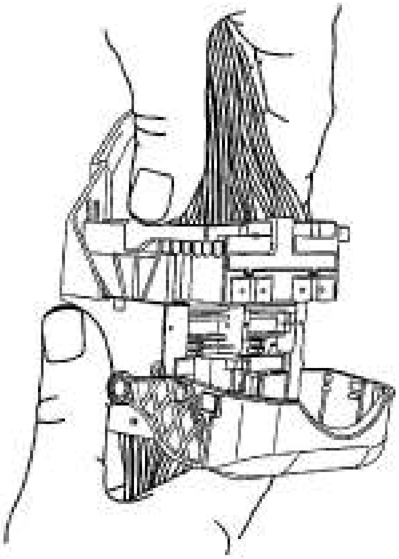
17. Press the terminal plate back into the female connector to the preset position. The plate will bind slightly on each corner.



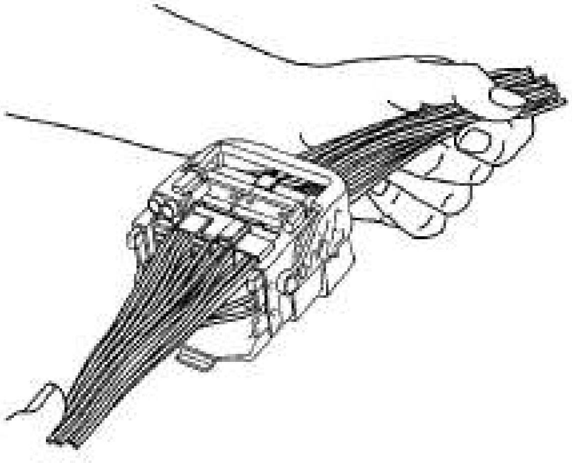
18. With the locking lever in the 180 degree position, align the guide plates to mesh with the gears on the locking lever.



19. Slide the male connector body back inward toward the guide plates.



20. With the locking lever in the 90 degree position and the male connector body connected, it can be slid inward for assembly.



21. Move the lever into the locked position or in the assembled position. This will pull the male connector down into the female connector.

Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

Tyco/AMP Connectors (43-Way)

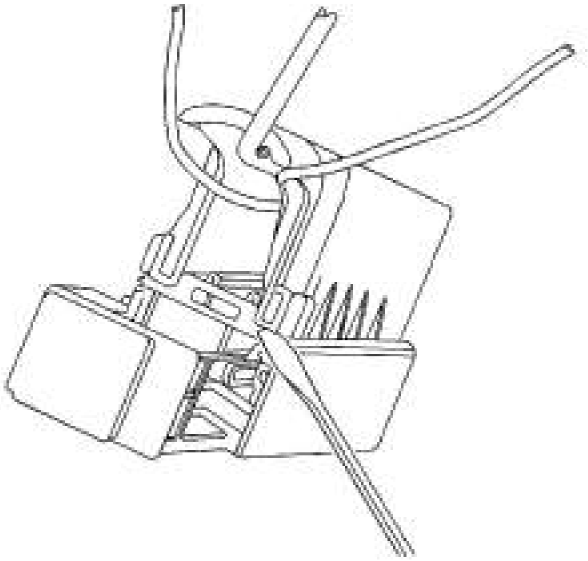
Special Tools

For equivalent regional tools, refer to Special Tools.

Removal Procedure

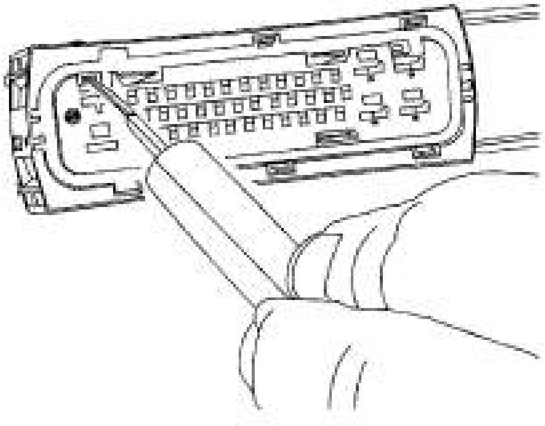
Follow the steps below in order to remove terminals from the connector.

1. Locate the lever lock on the wire dress cover. Slide the lever lock away from the connector body.
2. Disconnect the connector from the component.
3. Locate the dress cover locking tabs on the dress cover of the connector. Using a small flat-blade tool release all of the locking tabs.
4. Once the locks are unlocked, lift the dress cover off.

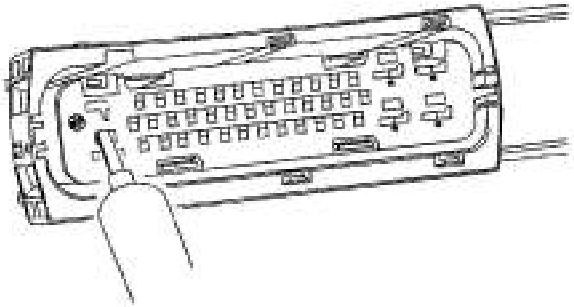


Note: Always use care when removing a terminal position assurance (TPA) in order to avoid damaging it.

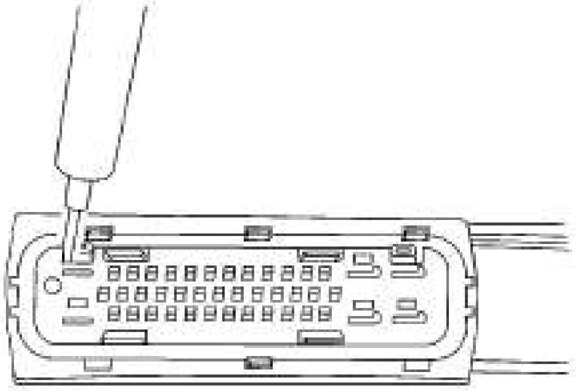
5. Release the TPA by inserting a small flat-blade tool into the blue locking tabs on both ends of the connector. Gently slide the TPA up to the released position on both ends.



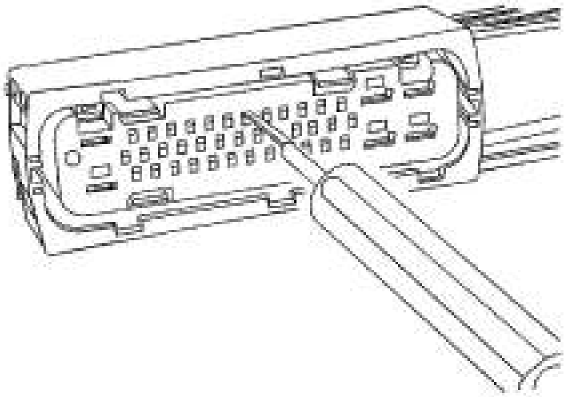
6. For the larger terminals insert the EL-38125-13A tool to release the terminals by inserting the tool into the terminal release cavity. For the smaller terminals insert the EL-38125-12A tool to release the terminals by inserting the tool into the terminal release cavity.



7. View of the release tool being used for the larger terminals.



8. View of the release tool being used for the larger terminals.



9. View of the release tool being used for the smaller terminals.
10. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.

Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

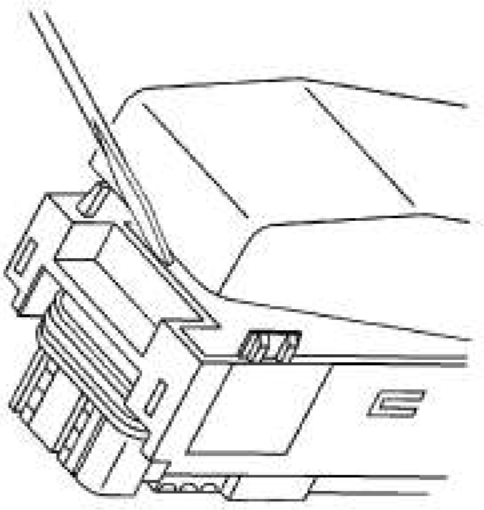
Tyco / AMP Connectors (CM 42-Way)

Special Tools

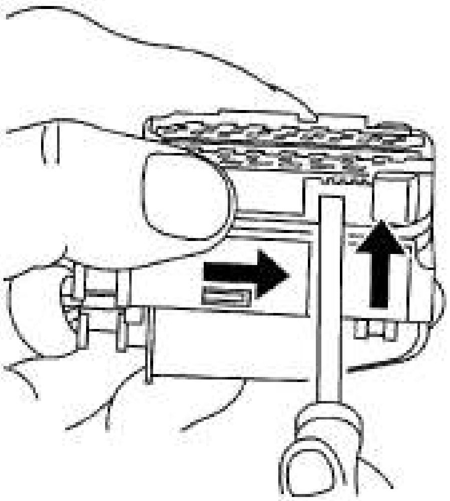
For equivalent regional tools, refer to Special Tools.

Removal Procedure

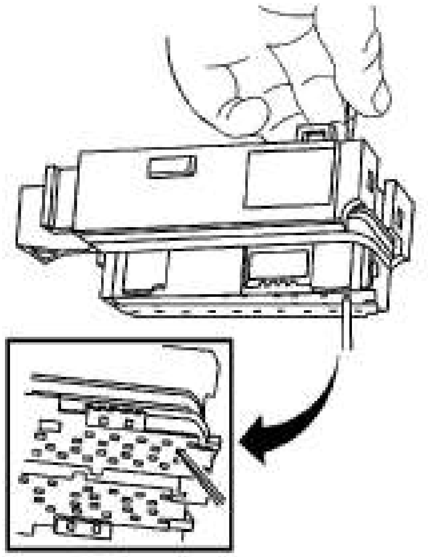
1. Locate the connector position assurance (CPA) on the connector body and pull the CPA out. The CPA is on the wire harness side of connector.
2. Disconnect the connector from the component.



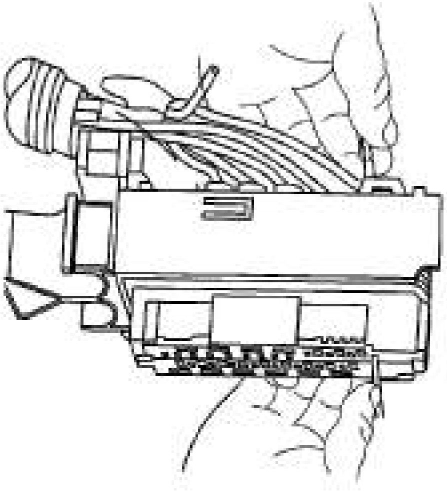
3. Use a small flat-bladed tool to gently pry off the dress cover by inserting the tool under the cover opposite the harness side and prying up.
4. Remove the cover.



5. Using a small flat-bladed tool, push on the side of the nose piece retainer while pushing the nose piece forward with your thumb. This will release the terminal position assurance (TPA).



6. Insert the EL-38125-12A into the corresponding terminal release cavity. The release cavities are the 2 center rows of cavities on one half of the connector.



7. Pressing the EL-38125-12A tool in the release cavity of the terminal you are removing, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.

Terminated Lead Repair

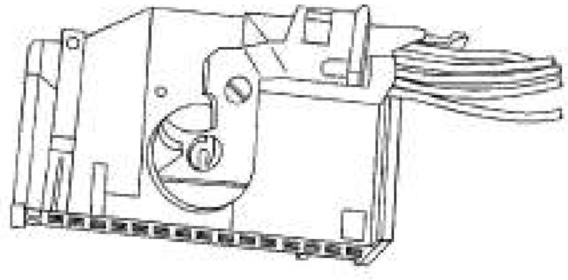
1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

Tyco / AMP Connectors (Door Module)

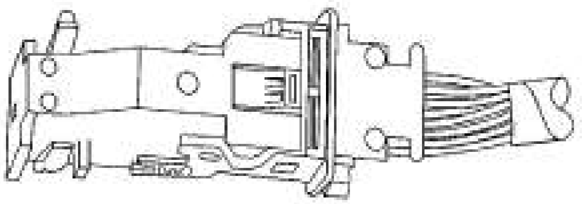
Special Tools

For equivalent regional tools, refer to Special Tools.

Removal Procedure

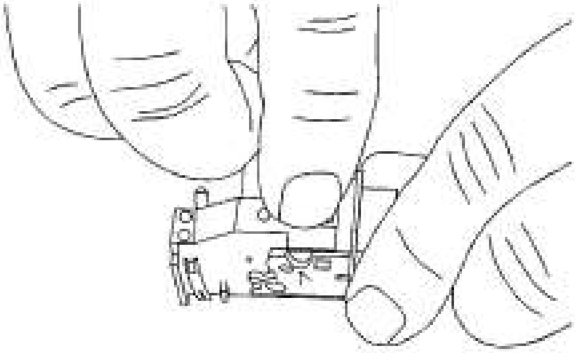


Side view of connector.

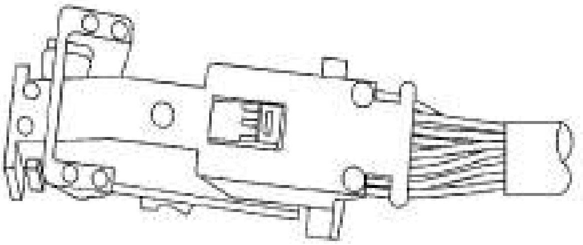


View of top of connector.

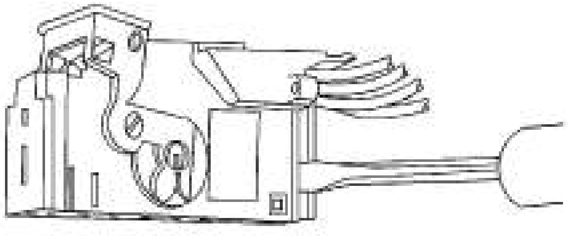
1. Locate the assist lever and lock on the top of the connector.



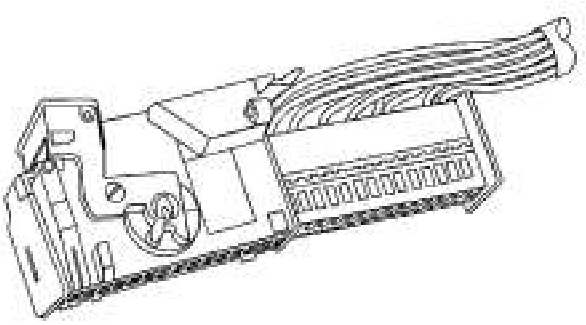
2. While depressing the lock, pull the lever over and past the lock.



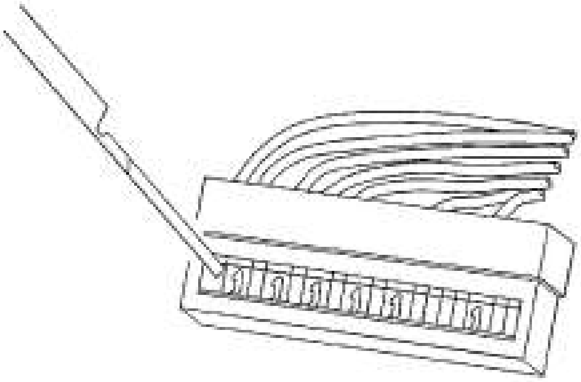
3. Disconnect the connector from the component.



4. Locate the dress cover locking tabs at the rear of the connector. Use a small flat-blade tool to release the locking tabs. Repeat this procedure for the other locking tab.



5. Once the locking tabs are unlocked, slide the inner connector out of the rear of the connector housing.



6. Use the EL-38125-12A tool to release the terminals by pressing on the tang.
7. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.

Terminated Lead Repair

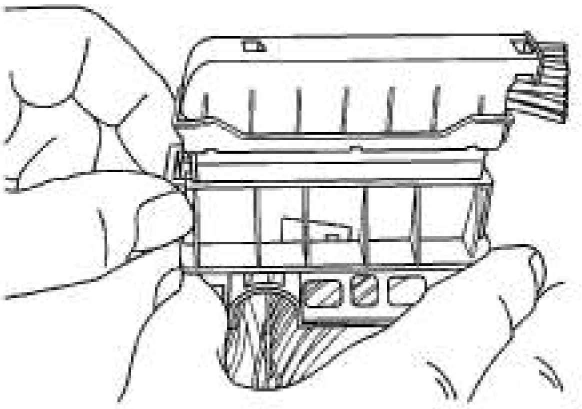
1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

Tyco / AMP Connectors (Seat)

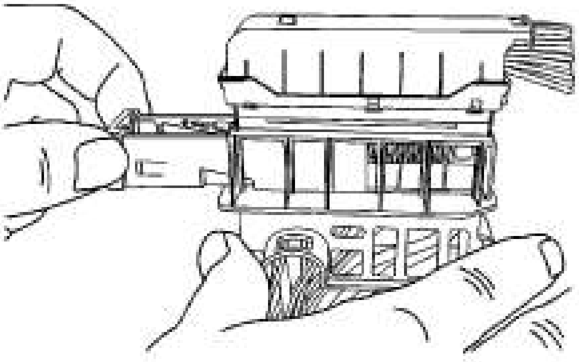
Special Tools

For equivalent regional tools, refer to Special Tools.

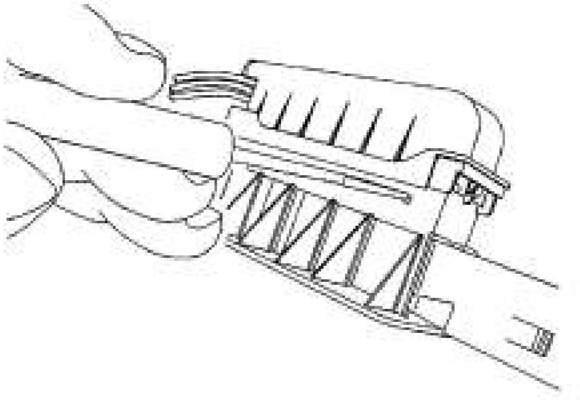
Removal Procedure



1. Grasp the locking slide lever and pull outward from the end of the connector.

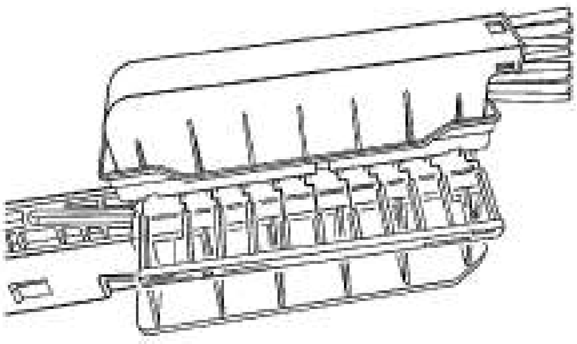


2. As the slide lever is pulled out the mating connector is lifted from the seated position.

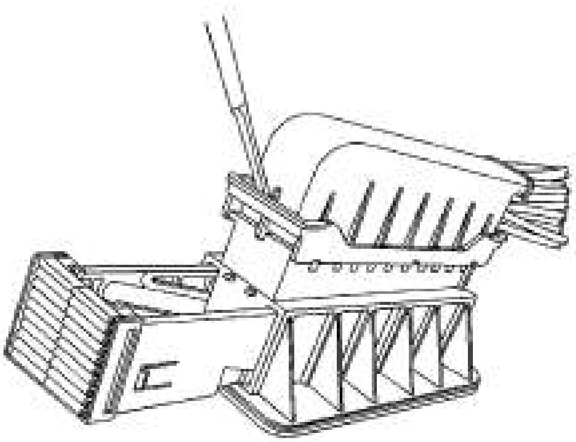


Note: TPA is keyed and can only be inserted in one direction.

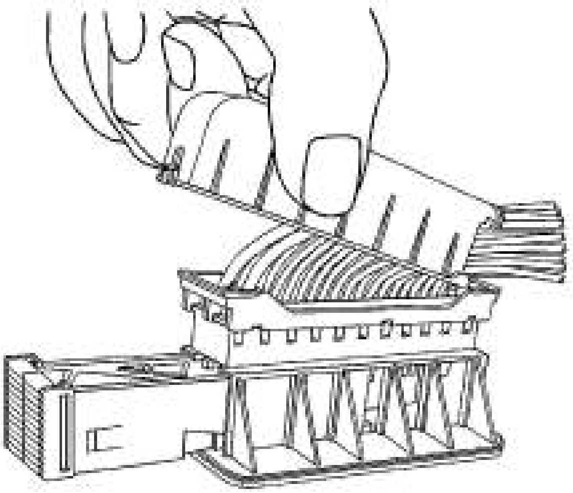
3. Using terminal release tool J-38125-11A or equivalent, push the TPA tabs into the connector body.



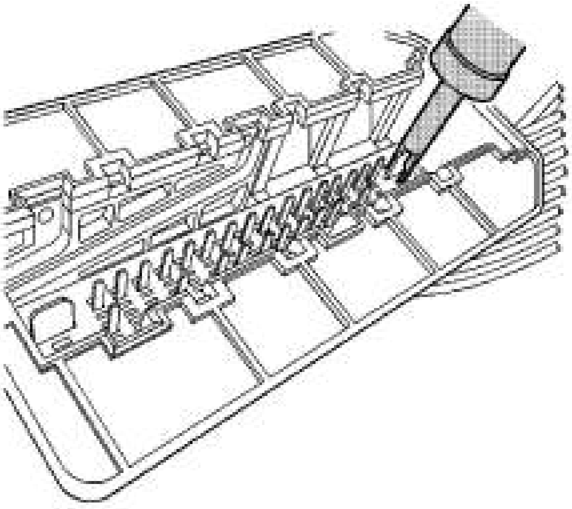
4. Pull the TPA from the connector body.



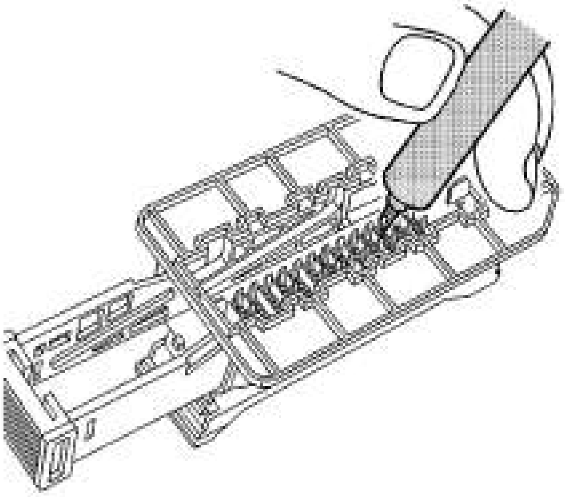
5. Using terminal release tool J-38125-11A or equivalent, release the connector wire dress cover locking tab.



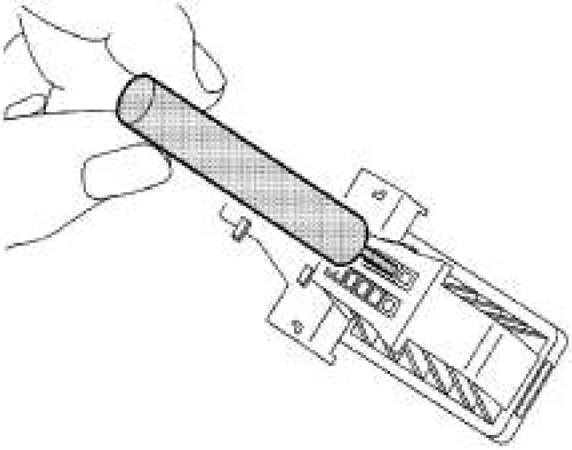
6. With the lock tab released, lift the connector wire dress cover from the connector body.



7. Using terminal release tool EL-38125-212, press the prongs into the holes each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.



8. Using terminal release tool EL-38125-560, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.



9. Using terminal release tool EL-38125-556, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.

Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

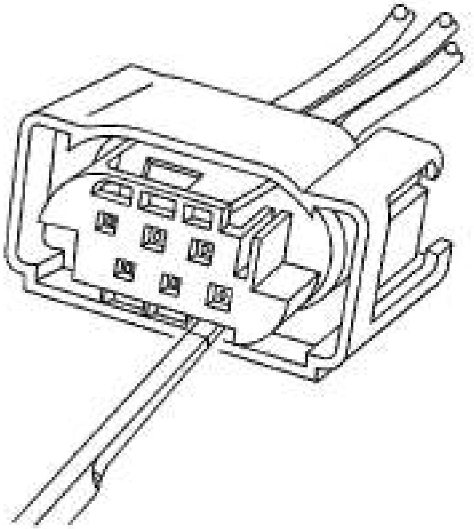
Tyco / AMP Connectors (Sensor)

Special Tools

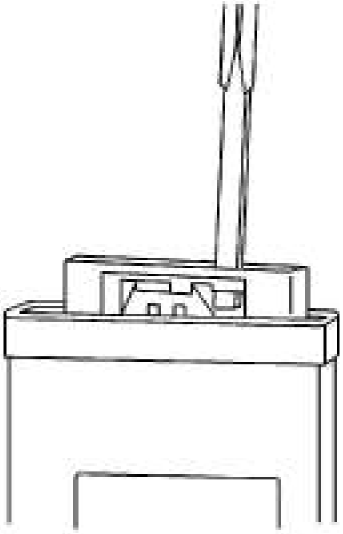
J-38125 Terminal Repair Kit

Terminal Removal Procedure

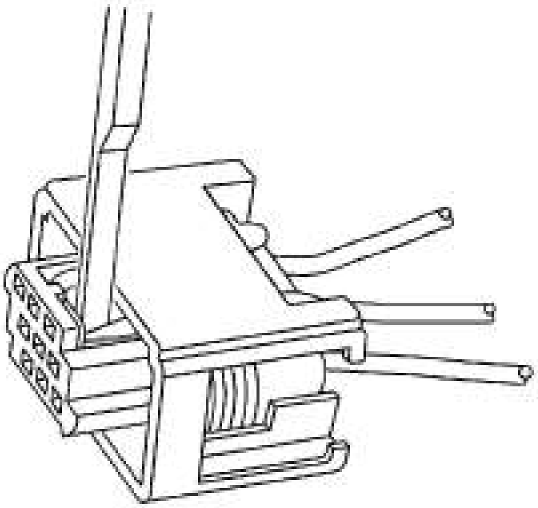
1. Disconnect the connector from the component.



2. Insert the EL-38125-11A tool into the cavity on the lower right hand face of the connector until the terminal release tang access panel slides over.



3. Ensure that the terminal release tang access panel is in the correct location to access the terminals.
4. Push the wire side of the terminal that is being removed toward the connector and hold it in position.



5. Insert the EL-38125-11A into the terminal release tang access slot located behind the access panel of the connector and press down on the terminal while carefully pulling the terminal out of the connector. Always remember never use force when pulling a terminal out of a connector. If the terminal is difficult to remove, repeat the entire procedure.

Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

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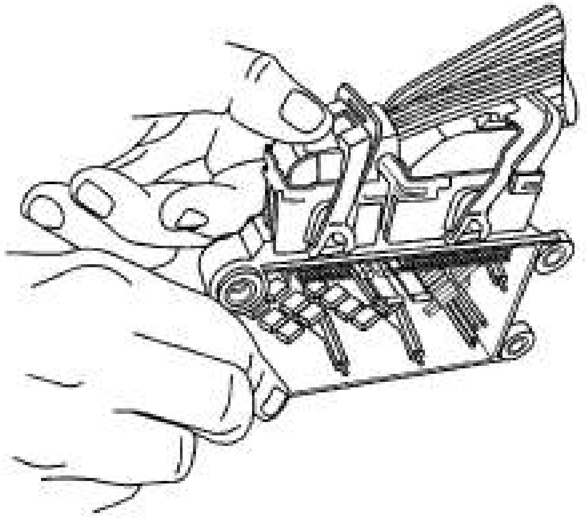
Tyco / AMP Connectors (SIR)

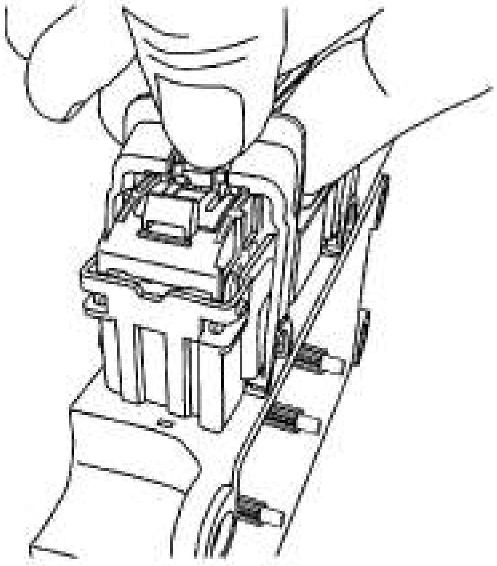
Special Tools

For equivalent regional tools, refer to Special Tools.

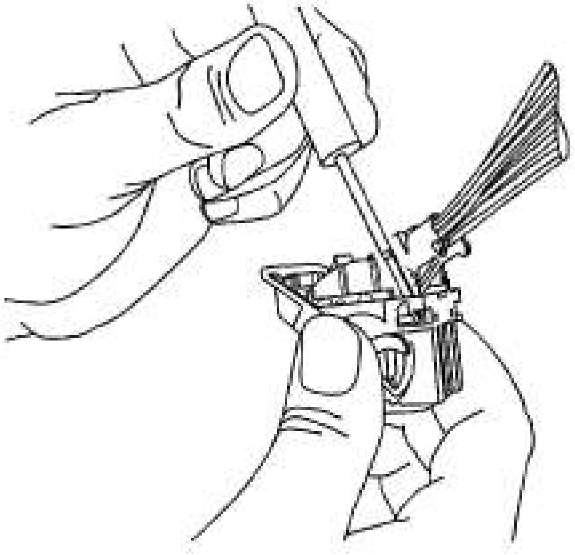
Removal Procedure



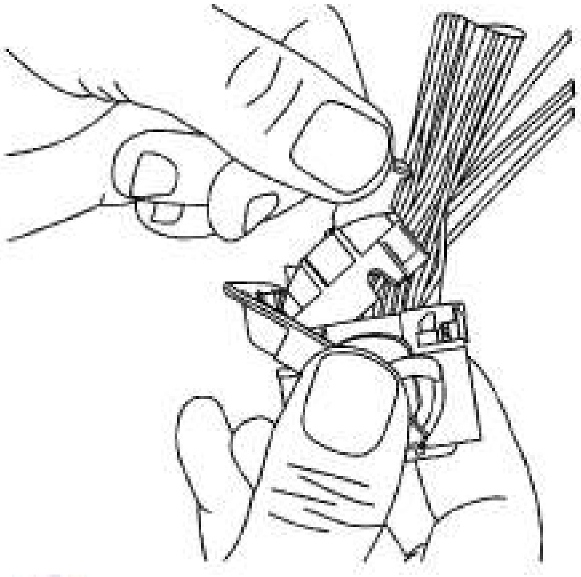
1. Using your thumbs press down and slide the red CPA away from the connector lever.



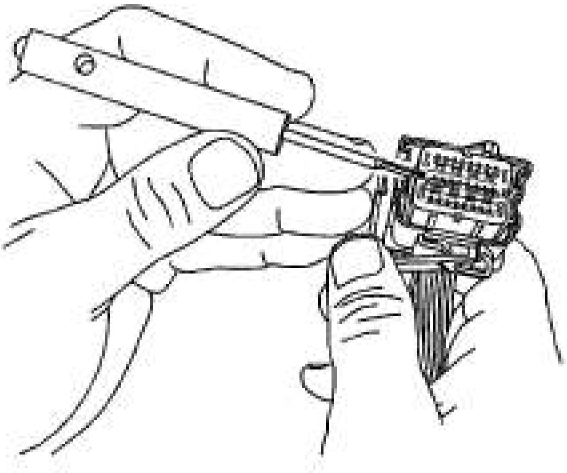
2. Using your thumb press down on the locking tab and move the lever to the released position.



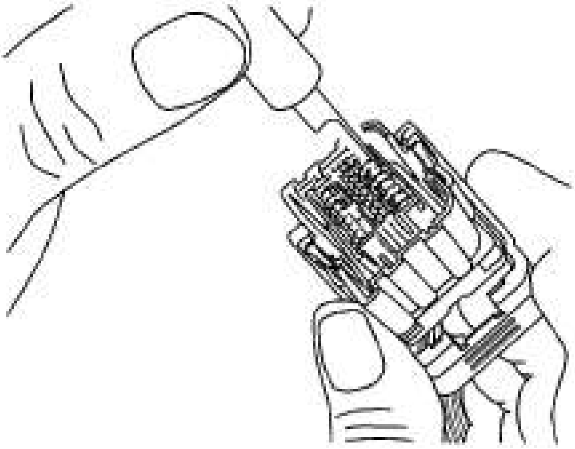
3. Using terminal tool J-38125-11A or equivalent, release the wire dress cover locking tabs.



4. Pivot connector wire dress cover while removing from the connector body.



5. Using terminal tool J-38125-11A or equivalent, remove the TPA by lifting straight off the connector body.



6. Using terminal release tool EL-38125-215A, place the tip of the tool on the outside edge next to the terminal and depress the lock tab and remove the rear of the connector body.

Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

Using Connector Test Adapters

Notice: Do not insert test equipment probes (DVOM etc.) into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal will cause a poor connection, which will result in a system failure. Always use the J-35616-C Holden-Approved Terminal Test Kit or the J 42675 Flat-Wire Probe Adapter in order to front probe terminals. Do not use paper clips or other substitutes to probe terminals.

When using the J-35616-C Holden-Approved Terminal Test Kit, ensure the terminal test adapter choice is the correct size for the connector terminal. Do not visually choose the terminal test adapter because some connector terminal cavities may appear larger than the actual terminal in the cavity. Using a larger terminal test adapter will damage the terminal. Refer to the J-35616-C Holden-Approved Terminal Test Kit label on the inside of the J-35616-C Holden-Approved Terminal Test Kit for the correct adapter along with the connector end view for terminal size.

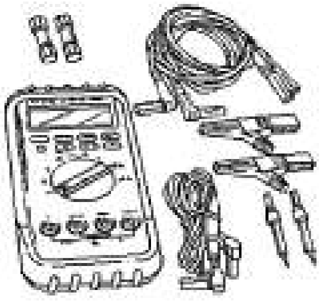
Using Fused Jumper Wires

Special Tools

EL-35616-D Fused Jumper Wire

For equivalent regional tools, refer to Special Tools.

Note: A fused jumper may not protect solid state components from being damaged.



The EL-35616-20F includes small clamp connectors that provide adaptation to most connectors without damage. This fused jumper wire is supplied with a 20-A fuse which may not be suitable for some circuits. Do not use a fuse with a higher rating than the fuse that protects the circuit being tested.

Wiring Repairs

The Wiring Repairs section contains the following types of wiring repair information. Using these elements together will make wiring repair faster and easier:

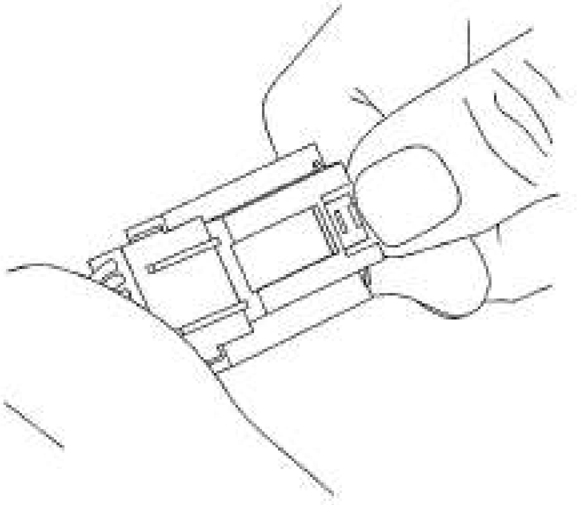
- Testing for Intermittent Conditions and Poor Connections
- Flat Wire Repairs
- GMLAN Wiring Repairs
- High Temperature Wiring Repairs
- Heated Oxygen Sensor Wiring Repairs
- Splicing Copper Wire Using Splice Sleeves
- Splicing Twisted or Shielded Cable
- Splicing Inline Harness Diodes
- SIR/SRS Wiring Repairs

Yazaki Connectors (16-Way)

Special Tools

For equivalent regional tools, refer to Special Tools.

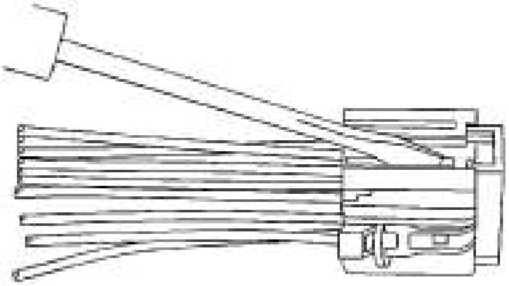
Removal Procedure



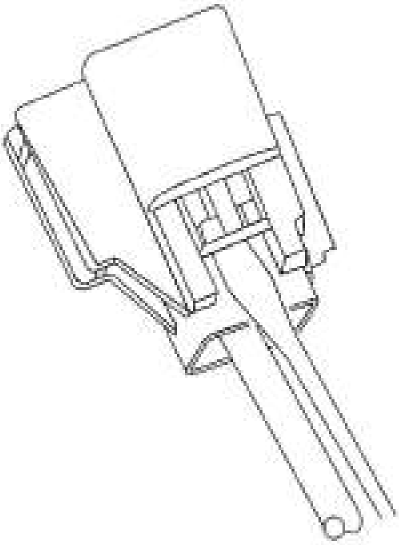
1. While depressing the lock, pull the two connector halves apart.

   Note: The TPA is fragile and may break if not done carefully.

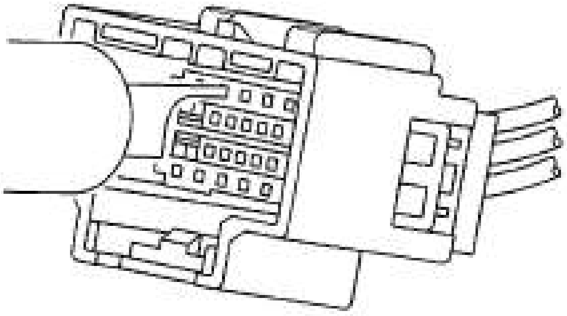
2. Use a small flat-blade tool to very carefully push the terminal position assurance (TPA) towards the face of the connector on both sides of the connector.



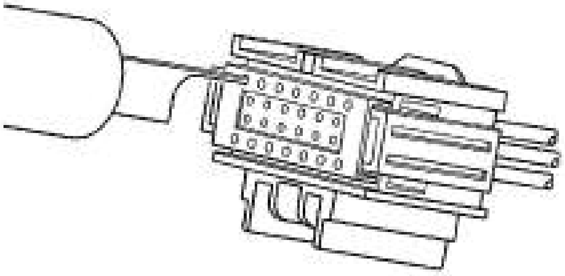
3. View of the male half of the connector with female terminals.



4. View of the female half of the connector with male terminals.
5. Use the EL 38125-215 tool to release the terminals by inserting the tool into the terminal release cavity.



6. View of the female half of the connector with male terminals.



7. View of the male half of the connector with female terminals.
8. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.

Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

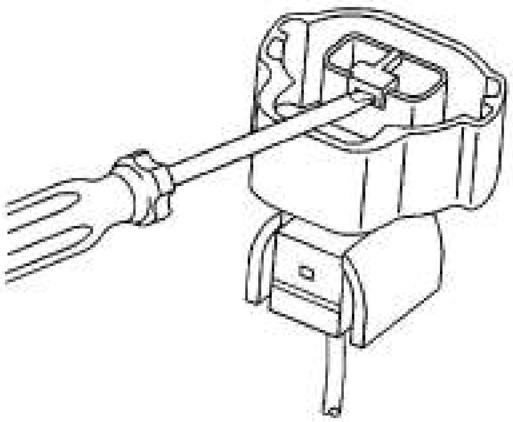
Yazaki Connectors (2-Way)

Special Tools

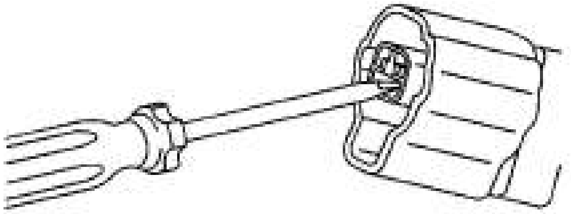
For equivalent regional tools, refer to Special Tools.

Terminal Removal Procedure

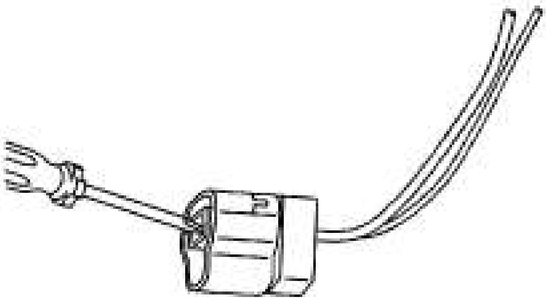
1. Disconnect the connector from the component.



2. Insert a small flat-blade tool in the slot below the front loaded terminal position assurance (TPA) and pry up.
3. Remove the TPA by pulling it out of the connector.
4. Push the wire side of the terminal that is being removed toward the connector and hold it in position.



5. Insert the EL 38125-553 on a slight upward angle into the cavity below the terminal to be removed. Ensure that the pointed on the end of the tool is facing the bottom of the terminal and it stays in contact with the terminal until it stops on the plastic terminal retainer.



6. Gently pry the plastic terminal retainer down and carefully pull the terminal out of the connector. Always remember never use force when pulling a terminal out of a connector. If the terminal is difficult to remove, repeat the entire procedure.

Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gage size.
4. Refer to Splicing Copper Wire Using Splice Sleeves.

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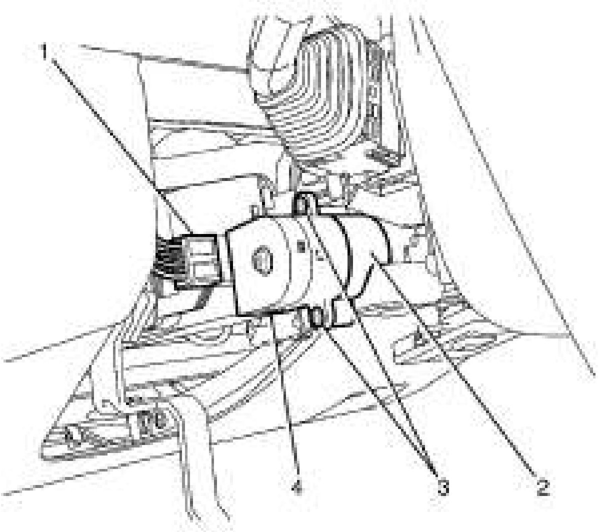
Ignition and Start Switch Replacement

Removal Procedure

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .

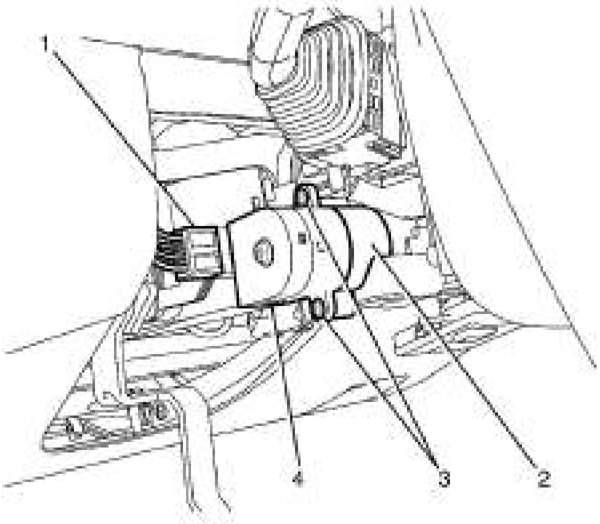
   Caution: Refer to SIR Caution in the Preface section.

2. Disable the SIR system. Refer to SIR Disabling and Enabling Disabling the SIR in SIR.
3. Remove the Steering Column Trim Covers. Refer to Steering Column Trim Covers Replacement .



4. Disconnect the ignition switch electrical connector (1).
5. Remove the ignition switch to steering column assembly retaining screws (3).
6. Remove the ignition switch (4) from the steering column assembly (2).

Installation Procedure



Important: The ignition switch groove must be correctly aligned with the ignition lock cylinder tongue.

1. Install the ignition switch (4) to the steering column assembly (2).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the ignition switch to steering column assembly retaining screws (3).

   Tighten
   Tighten the screws to 3 N·m (27 lb in).

3. Connect the ignition switch electrical connector (1).
4. Install the Steering Column Trim Covers. Refer to Steering Column Trim Covers Replacement .
5. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
6. Enable the SIR system. Refer to SIR Disabling and Enabling Disabling the SIR in SIR.

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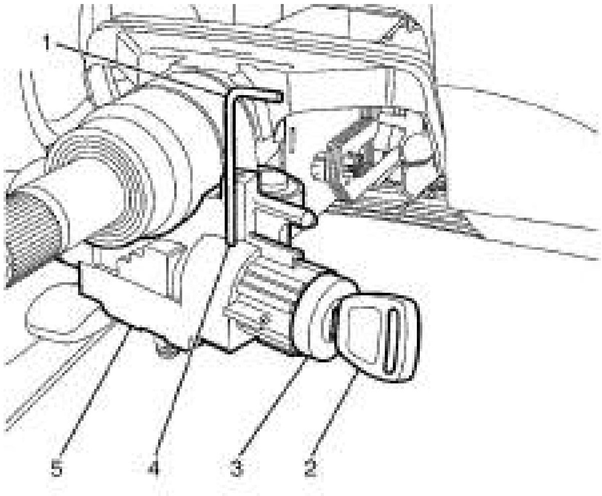
Ignition Lock Cylinder Replacement

Removal Procedure

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .

   Caution: Refer to SIR Caution in the Preface section.

2. Disable the SIR system. Refer to SIR Disabling and Enabling .
3. Remove the inflatable restraint steering wheel module. Refer to Inflatable Restraint Steering Wheel Module Replacement .
4. Remove the steering wheel. Refer to Steering Wheel Replacement .
5. Remove the steering column trim covers. Refer to Steering Column Trim Covers Replacement .
6. Remove the inflatable restraint steering wheel module coil. Refer to Inflatable Restraint Steering Wheel Module Coil Replacement .
7. Remove the theft deterrent exciter module. Refer to Theft Deterrent Module Replacement .

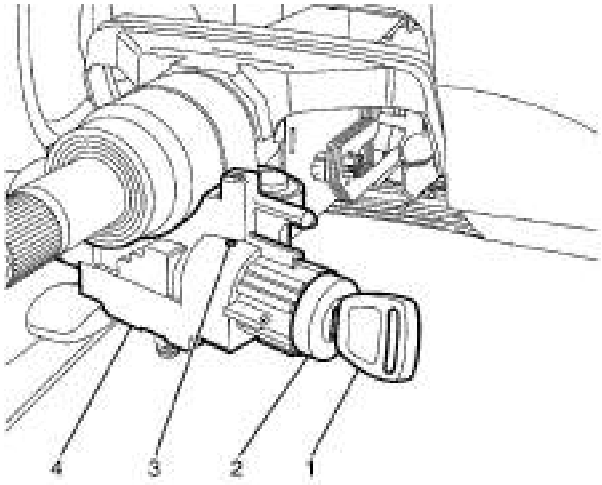


8. Insert the ignition key (2) into the ignition lock cylinder (3), and turn to the ON position.

   Important: Insert a 2.5 mm pin (1) into the locking pin hole (4) to depress the spring loaded ignition lock cylinder locking latch in order to release the ignition lock cylinder from the ignition lock cylinder housing (5).

9. Release the ignition lock cylinder locking latch.
10. Remove the pin (1) from the locking pin hole (4).
11. Remove the ignition lock cylinder (3) and ignition key (2) assembly from the ignition lock cylinder housing (5).
12. Remove the ignition key (2) from the ignition lock cylinder (3).

Installation Procedure



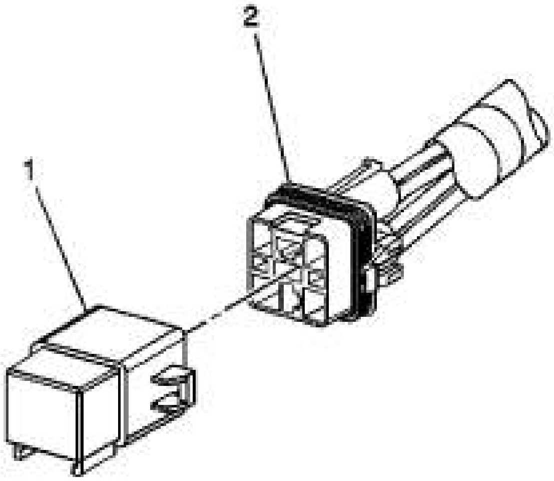
1. Insert the ignition key (1) into the ignition lock cylinder (2) and turn to the ON position.

   Important: The ignition lock cylinder latch must fully engage and lock into the ignition lock cylinder housing (3).

2. Install the ignition lock cylinder (2) and ignition key (1) assembly into the ignition lock cylinder housing (3).
3. Turn the key to the OFF lock position.
4. Remove the ignition key (1) from the ignition lock cylinder (2).
5. Install the inflatable restraint steering wheel module coil. Refer to Inflatable Restraint Steering Wheel Module Coil Replacement .
6. Install the theft deterrent exciter module. Refer to Theft Deterrent Module Replacement .
7. Install the steering column trim covers. Refer to Steering Column Trim Covers Replacement .
8. Install the steering wheel. Refer to Steering Wheel Replacement .
9. Install the inflatable restraint steering wheel module. Refer to Inflatable Restraint Steering Wheel Module Replacement .
10. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
11. Enable the SIR system. Refer to SIR Disabling and Enabling .

Relay Replacement (Attachedto Wire Harness)

Removal Procedure

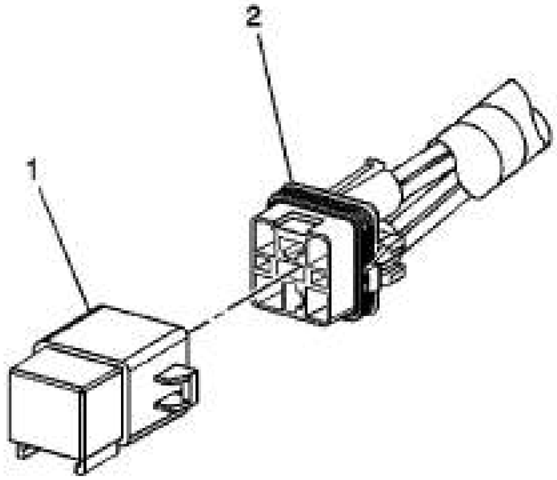


1. Locate the relay. Refer to the Master Electrical Component List to locate the relay in the vehicle.
2. Remove any fasteners which hold the relay in place.
3. Remove any connector position assurance (CPA) devices or secondary locks.

   Note: Use care when removing a relay in a wiring harness when the relay is secured by fasteners or tape.

4. Separate the relay (1) from the wire harness connector (2).

Installation Procedure



1. Connect the relay (1) to the wire harness connector (2).
2. Install any connector position assurance (CPA) devices or secondary locks.
3. Install the relay using any fasteners or tape that originally held the relay in place.

Relay Replacement (Within an Electrical Center)

Special Tools

EL 43244 Relay Puller Pliers

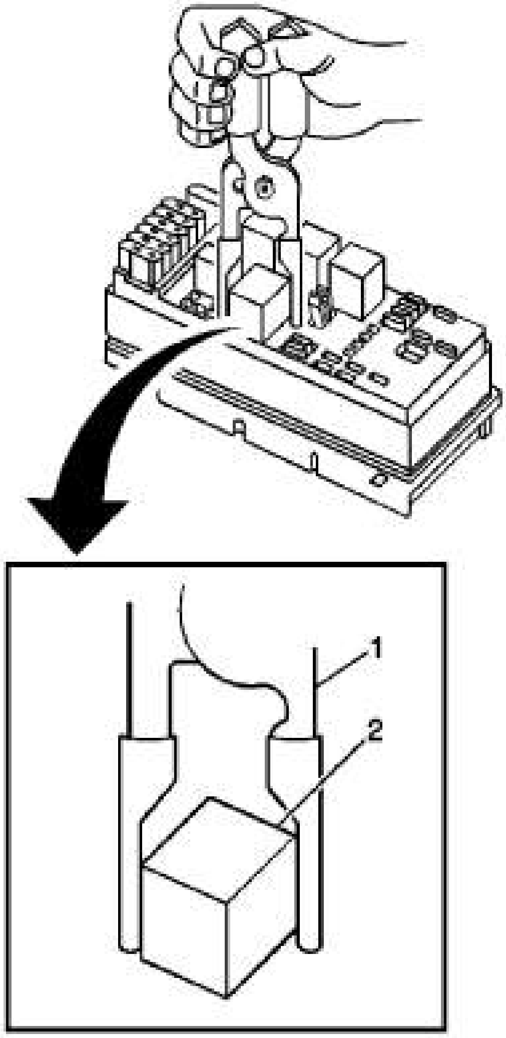
For equivalent regional tools, refer to Special Tools.

Removal Procedure

1. Remove the electrical center cover.
2. Locate the relay. Refer to Electrical Center Identification Views to locate the electrical center where the relay exists.

Note:

- Always note the orientation of the relay.
- If equipped with a notch style relay; observe the location of the notch on the old relay to verify the new relay is installed with the notch in the same location.
- Ensure that the electrical center is secure, as not to put added stress on the wires or terminals.

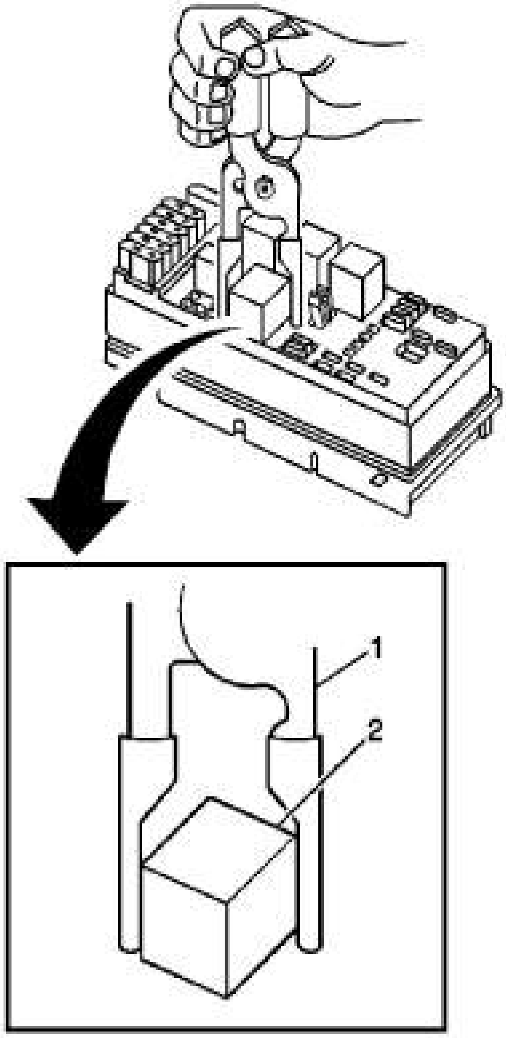


3. Using the EL 43244 (1) position the tool on opposing corners of the relay (2).

   Caution: Use EL-43244 to pull the relay straight out from the electrical center terminals. The use of pliers or a flat bladed tool could damage the electrical center.

4. Remove the relay (2) from the electrical center.

Installation Procedure



1. Install the relay (2) in the same position as removed.
2. Install the electrical center cover.

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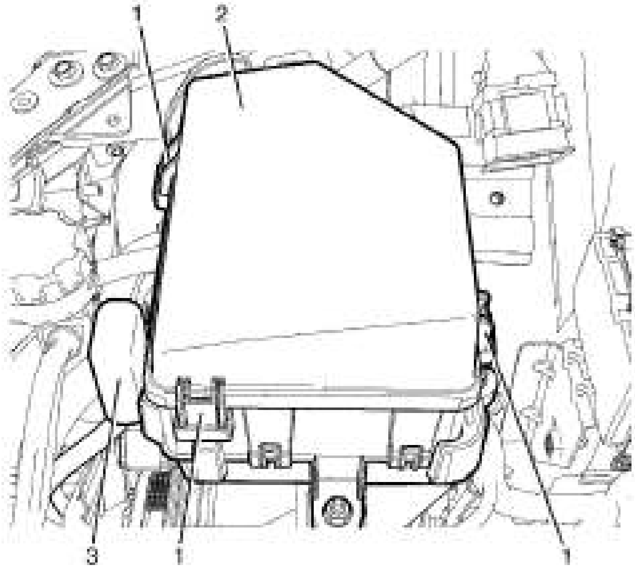
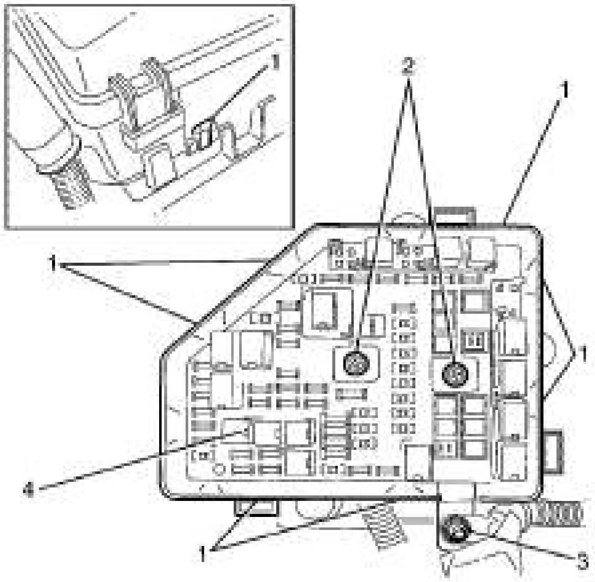
Underhood Electrical Center or Junction Block Replacement

Removal Procedure

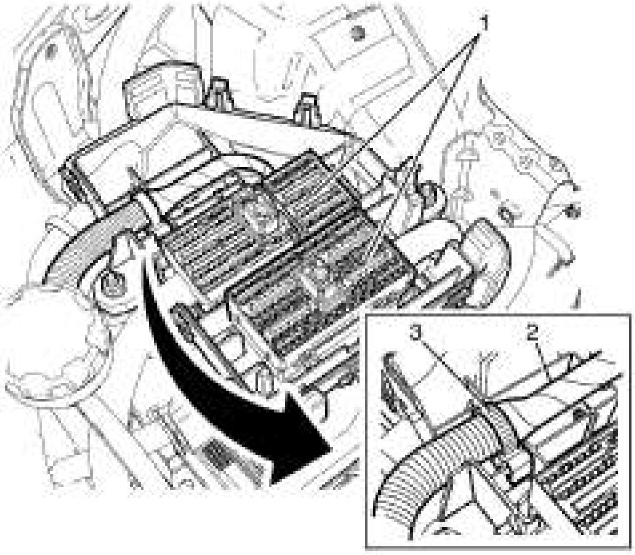
1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.



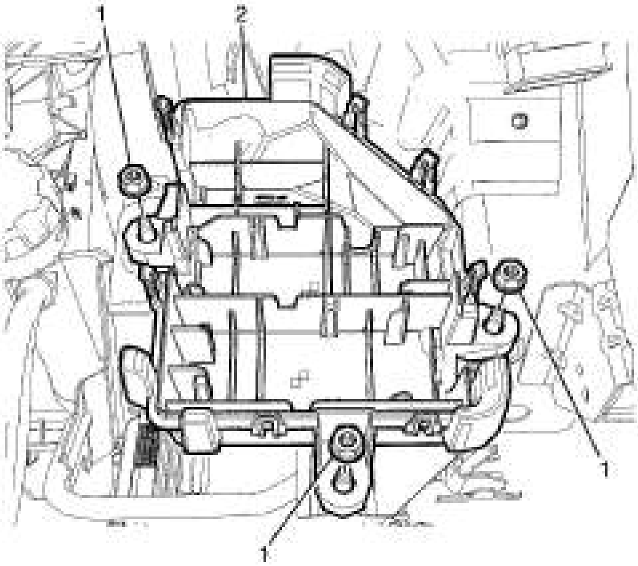
2. Release the underhood body electrical centre cover retaining clips (1).
3. Remove the underhood body electrical centre cover (2).
4. Detach the battery positive cable cover (3).



5. Remove the battery positive cable to upper underhood body electrical centre retaining nut (3).
6. Loosen the upper underhood body electrical centre to lower underhood body electrical centre retaining bolts (2).
7. Release the upper underhood body electrical centre retaining clips (1).
8. Remove the upper underhood body electrical centre (4).

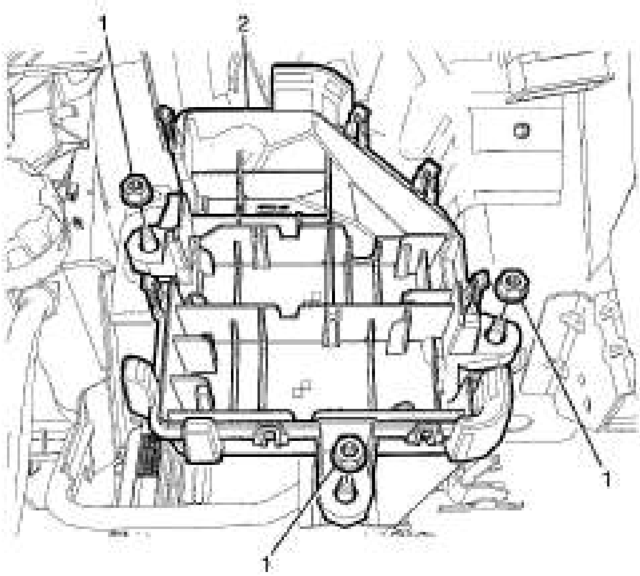


9. Release the wiring harness retaining clip (3) to allow movement of the wiring harness (2).
10. Reposition the underhood body electrical centre electrical connectors (1) to gain access to the lower underhood body electrical centre.

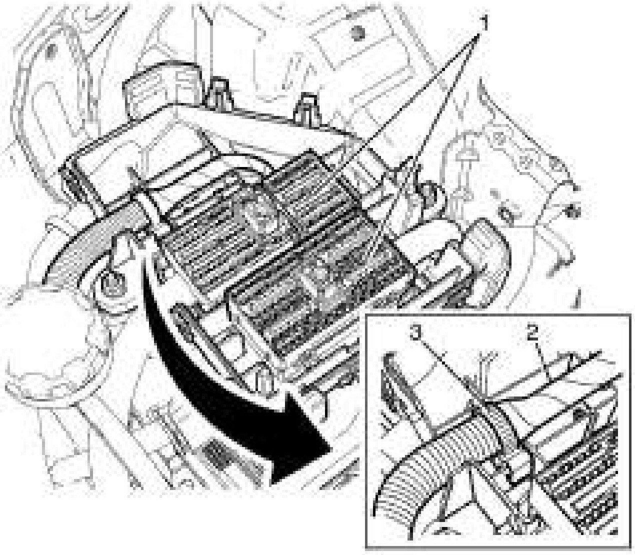


11. Remove the lower underhood body electrical centre to body retaining nuts (1).
12. Remove the lower underhood body electrical centre (2).

Installation Procedure



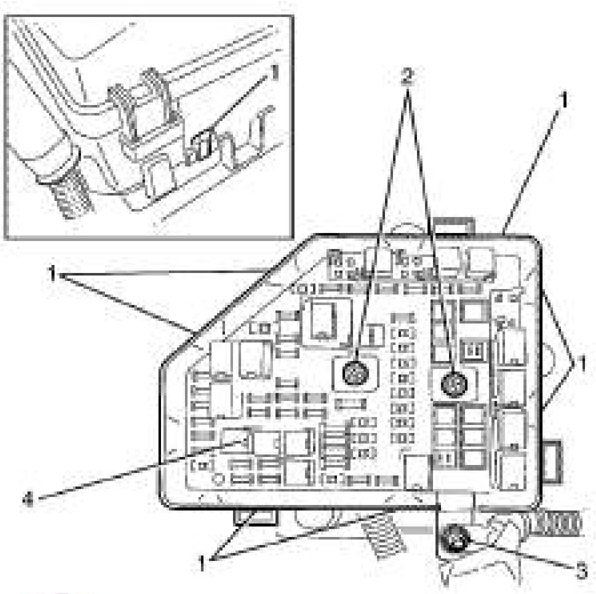
1. Install the lower underhood body electrical centre (2).
2. Install the lower underhood body electrical centre to body retaining nuts (1).



3. Reposition the underhood body electrical centre electrical connectors (1) into the lower underhood body electrical centre.

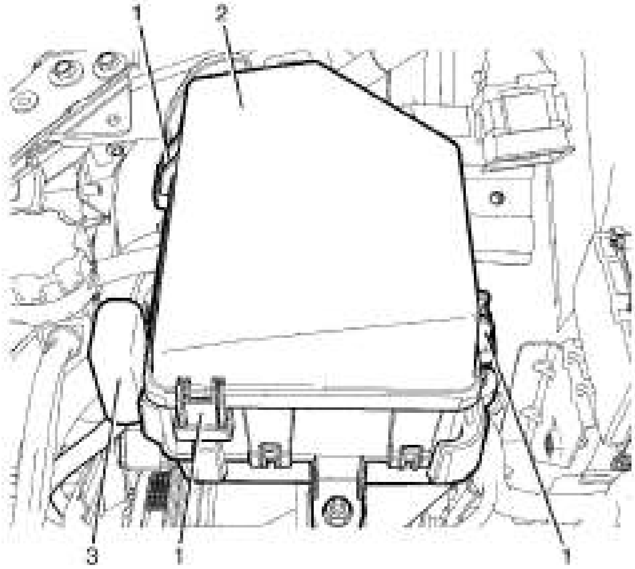
   Important: Ensure that the wiring harness (2) is routed correctly.

4. Attach the wiring harness retaining clip (3).



Important: Ensure that the upper underhood body electrical centre retaining clips (1) are located correctly.

5. Install the upper underhood body electrical centre (4).
6. Tighten the upper underhood body electrical centre to lower underhood body electrical centre retaining bolts (2).
7. Tighten the battery positive cable to upper underhood body electrical centre retaining nut (3).



Important: Ensure the underhood body electrical centre cover retaining clips (1) are located correctly.

8. Install the underhood body electrical centre cover (2).
9. Reposition the battery positive cable cover (3).
10. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

Power Mode Description and Operation

Serial Data Power Mode Master

Power to many of this vehicles circuits is controlled by the module that is designated the power mode master (PMM). This vehicles PMM is the body control module (BCM). The ignition switch is a low current switch with multiple discrete ignition switch signals to the PMM for determination of the power mode that will be sent over the serial data circuits to the other modules that need this information. The PMM will also activate relays and other direct outputs of the PMM as needed. The PMM determines which power mode (Off, Accessory, Run, Crank Request) is required, and reports this information to other modules via serial data. Modules which have switched voltage inputs may operate in a default mode if the PMM serial data message does not match what the individual module can see from its own connections.

The PMM receives ignition switch signals to identify the operators desired power mode. The PMM Power Mode Parameters table below illustrates the correct state of these input parameters (circuits) in correspondence to the ignition switch position:

PMM Power Mode Parameters

Ignition Switch Position	Power Mode Transmitted	Ign. Off/Run/Crank (Run Crank Ignition 1 Voltage circuit)	Ignition Accessory/Run (Accessory voltage circuit)	Ignition Run/Crank (Ignition 1 Voltage circuit)
Off Key Out	Off	Key Out/ACC	Inactive	Inactive
Off Key IN	Off	Key In/Off	Inactive	Inactive
Accessory	Accessory	Key In/ACC	Active	Inactive
Run	Run	Run	Active	Active
Start	Crank Request	Crank	Inactive	Active

Relay Controlled Power Mode

The BCM uses the discrete ignition switch inputs Run/Crank Ignition 1 Voltage, Accessory Voltage, and Ignition 1 Voltage, to distinguish the correct power mode. The BCM, after determining the desired power mode, will activate the appropriate relays for that power mode.

The RAP relay remains on for a timed period after the Ignition key is removed. Refer to Retained Accessory Power Description and Operation for more information on the retained accessory power (RAP) function.

BCM Awake/Sleep States

The BCM is able to control or perform all of the BCM functions in the awake state. The BCM enters the sleep state when active control or normal monitoring of system functions has stopped and a time limit has passed. The BCM must detect certain wake-up inputs before entering the awake state. The BCM monitors for these inputs during the sleep state.

The BCM will enter the awake state if any of the following wake-up inputs are detected:

- Activity on the serial data line
- Detection of a battery reconnect
- Any door open signal
- Headlamps ON
- Key-in-ignition
- Ignition ON
- Park lamps ON
- Keyless entry or remote start message

The BCM will enter a sleep state when all of the following conditions exist:

- The ignition switch is OFF, key out.
- No activity exists on the serial data line.
- No outputs are commanded.
- No delay timers are actively counting.
- No wake-up inputs are present.

If all these conditions are met, the BCM will enter a low power or sleep condition.

Retained Accessory Power Description and Operation

Serial Data Control of Retained Accessory Power (RAP)

The modules receive the power mode message from the body control module (BCM) over the serial data circuits, indicating when the retained accessory power (RAP) power mode is current. The BCM monitors the ignition switch position, battery condition and passenger compartment doors status to determine whether RAP should be initiated. The modules then support the operation of the systems under their control as required by their RAP power mode operation. Components and systems that are active in RAP are also activated anytime the ignition is any position other than OFF.

The BCM sends a serial data power mode message ending the RAP function when one of the following conditions is met:

- The BCM receives an input indicating the opening of any passenger compartment door after the ignition key is out of the ignition.

  Note: The only door that will turn off the radio during RAP is the driver door. This is a function of the radio and will still turn off after the time limit.

- The BCM internal timer for the RAP expires after approximately 40 minutes.
- The BCM detects a decrease in battery capacity below a prescribed limit.

Relay Control of Retained Accessory Power (RAP)

The BCM keeps the RAP relay energized during all power modes, except Off-Awake and Crank. The relay is also energized for approximately 40 minutes after shutting the ignition OFF and removing the key, providing no door is opened. The BCM will de-energize the RAP relay a the same time as the serial data message is sent to end RAP.

The devices powered by the accessory relay during the RAP power mode are the sunroof, power window switches and BTSI/Park Lock.

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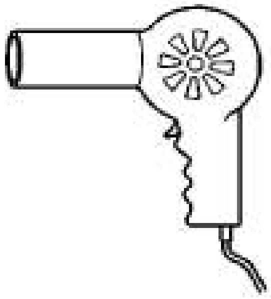
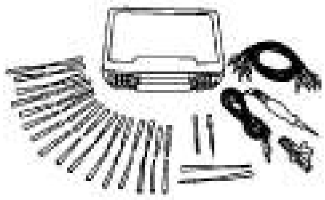
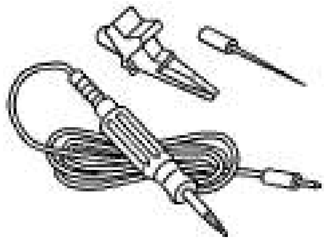
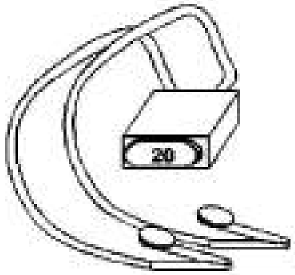
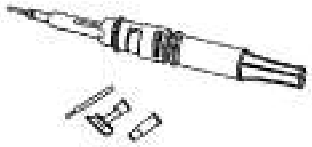
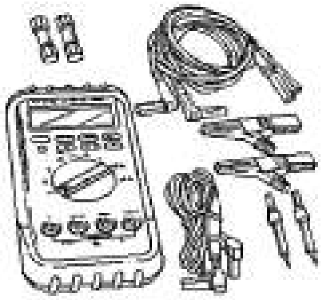
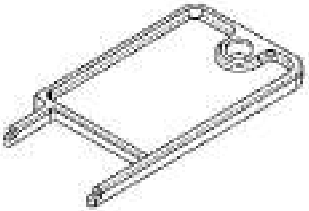
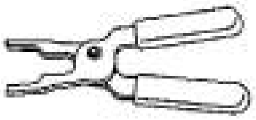
Document ID: 2193123

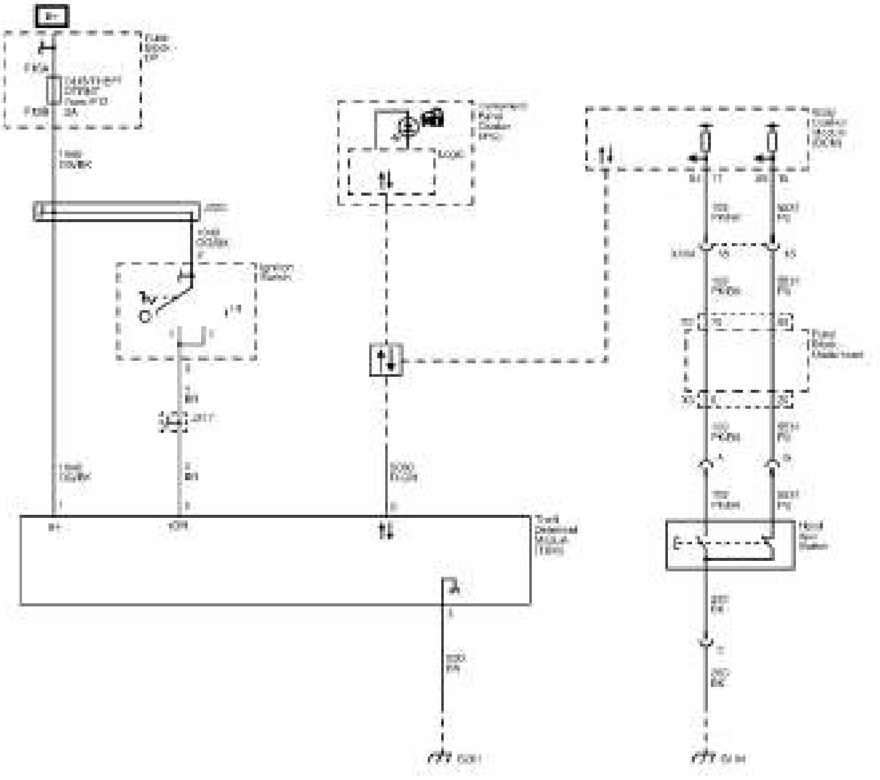
Special Tools

Illustration	Tool Number / Description
	EL-25070 Heat Gun 500-700 F
	EL-35616-D Terminal Test Probe Kit
	EL-35616-200 Test Light - Probe Kit

	EL-35616-20F Fused Jumper Wire
	EL-38125-5 Ultra Torch
	EL-39200 Digital Multimeter
	EL-42759 Ignition Switch Connector Release Tool

	EL-43244 Relay Puller Pliers

Immobilizer Schematics



DTC B3006

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B3006 5A: Hood Ajar Circuit Plausibility Failure

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Hood Ajar Switch Signal	B3006 5A	B3006 5A	B3006 5A	--
Hood Closed Switch Signal	B3006 5A	B3006 5A	B3006 5A	--
Ground	B3006 5A	B3006 5A	--	--

Circuit/System Description

The body control module (BCM) monitors the voltage input of the hood open switch signal circuit and the hood open closed switch signal circuit. With the hood open, the hood ajar portion of the switch is closed, grounding the hood ajar switch signal circuit from the BCM, and the hood closed portion of the switch is open. With the hood closed, the hood closed portion of the switch is closed, grounding the hood closed switch signal circuit from the BCM, and the hood ajar portion of the switch is open. During proper operation, the two separate voltage signals at the BCM should never be at the same voltage.

Conditions for Running the DTC

The BCM continuously monitors for this DTC

Conditions for Setting the DTC

Both the hood open switch signal circuit and the hood closed switch signal circuit are simultaneously in an active or inactive state.

Action Taken When the DTC Sets

- Remote start functions will be disabled.

- The hood ajar switch inputs will be ignored by content theft deterrent (CTD).

Conditions for Clearing the DTC

- A current DTC will clear when the conditions for setting are no longer present.
- A history DTC will clear after 40 malfunction free ignition cycles.

Reference Information

Schematic Reference

- Immobilizer Schematics
- Remote Function Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Keyless Entry System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool BCM Hood Open Switch and Hood Closed Switch parameters. With the hood open, the Hood Open Switch parameter should read Active and the Hood Closed Switch parameter should read Inactive. With the hood closed, the Hood Open Switch parameter should read Inactive and the Hood Closed Switch parameter should read Active.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the hood ajar switch.
2. Ignition OFF, test for less than 5 ohms between the ground circuit terminal C and ground.
   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, test for 11.5-12.0 volts between the signal circuit terminal A and ground.

If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the BCM.

If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.

4. Ignition ON, test for 11.5-12.0 volts between the signal circuit terminal B and ground.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the BCM.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.

5. If all circuits test normal, test or replace the hood ajar switch.

Component Testing

Hood Ajar Switch

1. Ignition OFF, disconnect the harness connector at the hood ajar switch.
2. With the switch in the hood closed position, test for infinite resistance between the ground terminal C and the signal terminal A.

   If not infinite, replace the hood ajar switch.

3. Test for less than 2.0 ohms between the ground terminal C and the signal terminal B.

   If greater than the specified range, replace the hood ajar switch.

4. With the switch in the hood open position, test for infinite resistance between the ground terminal C and the signal terminal B.

   If not infinite, replace the hood ajar switch.

5. Test for less than 2.0 ohms between the ground terminal C and the signal terminal A.

   If greater than the specified range, replace the hood ajar switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Hood Primary and Secondary Latch Replacement
- Control Module References for BCM replacement, programming and setup

DTC B302A

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B302A 00: Telematic Requested Immobilization

Circuit/System Description

As part of the vehicle telematics enhanced services, a request may be sent to the theft deterrent module (TDM) to disable vehicle starting. If a valid message is received by the TDM requesting that starting be disabled, the start enable message will not be sent to the engine control module (ECM).

Conditions for Setting the DTC

A valid start disable from telematics will set DTC B302A only as a history DTC.

Action Taken When the DTC Sets

Vehicle starting will be suspended and the security indicator will be illuminated.

Conditions for Clearing the DTC

- A current DTC will clear when the telematic start disable request is no longer seen.
- A history DTC will clear after 100 ignition cycles in which the telematic start disable request is not seen.

Diagnostic Aids

DTC B302A is only an indicator that a start disable request has been received from the vehicle telematics system and does not indicate a fault in the immobilizer system. B302A will only set as a history DTC. The only procedure required is to clear the DTC with a scan tool.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. With a master vehicle key, turn the ignition ON.
2. Observe the security indicator. After approximately 10 minutes, the indicator will turn off.
3. Turn the ignition OFF and wait 5 seconds.
4. Repeat steps 2-4 two more times for a total of 3 cycles or 30 minutes.
5. With a master vehicle key, turn the ignition ON. The start disable will now be cleared.
6. With a scan tool, clear any DTCs.

DTC B3031

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B3031 00: Security System Controller In Learn Mode

Circuit/System Description

When learning a coded key, the theft deterrent module (TDM) is placed in learn mode. DTC B3031 will set automatically as an indicator that the system is in learn mode and not as a fault indicator. Once the coded key is learned, learn mode will be exited and the DTC cleared. If the TDM does not exit learn mode, B3031 will remain current and indicate a fault.

Conditions for Running the DTC

The immobilizer system is the learn coded keys state.

Conditions for Setting the DTC

DTC B3031 will set any time the TDM enters the learn coded keys state.

Action Taken When the DTC Sets

The security indicator will illuminate.

Conditions for Clearing the DTC

- A current DTC B3031 will be cleared upon the successful exit of learn mode.
- A history DTC will be cleared after 100 malfunction-free ignition cycles or when a scan tool is used to clear DTCs.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Important: When performing the 10-Minute Vehicle Key Relearn Procedure, all keys not learned at that time will be erased and not be recognized. Perform the Adding Keys procedure on all keys or instruct the customer how to perform the Adding Keys procedure should all keys not be present at the time of repair.

1. Verify DTC B3055 is not set.
   If the DTC is set, refer to DTC B3055.
2. Verify the scan tool TDM Learn Coded Key parameter displays Yes.
   If not the specified value, perform the 10 Minute Vehicle Key Relearn procedure. Refer to Replacing Keys.
3. Perform the 10 Minute Vehicle Key Relearn procedure. Refer to Replacing Keys. The TDM should exit the learn coded key state and DTC B3031 should clear.
   If the TDM does not exit the learn coded key state after the programming attempt, replace the TDM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for TDM replacement, setup and programming

DTC B3055

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B3055 00: No Transponder Modulation or No Transponder

Circuit/System Description

When an ignition key is inserted into the ignition lock cylinder and the ignition is switched ON, the transponder embedded in the head of the key is energized by the exciter coils surrounding the ignition lock cylinder. The energized transponder transmits a signal that contains its unique value, which is received by the theft deterrent module (TDM). The TDM then compares this value to a value stored in memory. This stored value is the learned key code. If the value is correct, the TDM will send the prerelease password via the serial data circuit to the engine control module (ECM). If the learned key code does not match or a transponder value is not received, the TDM will send the start disable password to the ECM.

Conditions for Running the DTC

Ignition is in the Accessory or Run position.

Conditions for Setting the DTC

The TDM is unable to measure the ignition key transponder value.

Action Taken When the DTC Sets

- Vehicle starting will be disabled.
- The security indicator will be illuminated.

Conditions for Clearing the DTC

- A current DTC will be cleared when the TDM detects a valid transponder value from the ignition key.
- A history DTC will be cleared after 100 malfunction-free ignition cycles or when a scan tool is used to clear DTCs.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Important: When using this diagnostic, more than one vehicle key is required to ensure proper diagnosis. If more than one key is not available at the time of service, contact the customer and ask if any other keys can be provided for service. If unavailable, a new second key can be created.

1. Inspect all available vehicle keys that they are correct vehicle keys .
   If not a correct vehicle key, replace the key.
2. While viewing the scan tool TDM Transponder Key parameter, turn ON the ignition with each of the available vehicle keys. The parameter should read Present with all available keys.
   If only one key results in the parameter reading Not Present, replace the appropriate key.
   If all available keys result in the parameter reading Not Present, replace the TDM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Replacing Keys
- Control Module References for TDM replacement, setup, and programming

DTC B3060

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B3060 00 : Unprogrammed Transponder Identification Code Received

Circuit / System Description

When an ignition key is inserted into the ignition lock cylinder and the ignition is switched ON, the transponder embedded in the head of the key is energized by the exciter coils surrounding the ignition lock cylinder. The energized transponder transmits a signal that contains its unique value, which is received by the theft deterrent module (TDM). The TDM then compares this value to a value stored in memory. This stored value is the learned key code. If the value is correct, the TDM will send the prerelease password via the serial data circuit to the engine control module (ECM). If the transponder value does not match the learned key code or a transponder value is not received, the TDM will send the start disable password to the ECM.

Conditions for Running the DTC

Ignition is in the Accessory or Run position.

Conditions for Setting the DTC

The transponder value measured by the TDM is incorrect or not learned to the vehicle.

Action Taken When the DTC Sets

- Vehicle starting will be disabled.
- The security indicator will be illuminated.
- The security indicator will flash (Canada only).

Conditions for Clearing the DTC

- A current DTC will be cleared when the TDM detects a valid transponder value from the ignition key.
- A history DTC will be cleared after 100 malfunction-free ignition cycles or when a scan tool is used to clear DTCs.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Important: When using this diagnostic, more than one vehicle key is required to ensure proper diagnosis. If more than one key is not available at the time of service, contact the customer and ask if any other keys can be provided for service. If unavailable, a new second key can be created.

1. Perform the 10-Minute Vehicle Key Relearn procedure. Refer to Replacing Keys .
2. While viewing the scan tool TDM Valid Key parameter, turn ON the ignition with each of the available vehicle keys. The parameter should read Yes with all available keys.

   If not the specified value, replace the appropriate key.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Replacing Keys
- Control Module References for TDM replacement, setup, and programming

DTC B3935

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B3935 57: Transponder Authentication Error

Circuit/System Description

When an ignition key is inserted into the ignition lock cylinder and the ignition is switched ON, the transponder embedded in the head of the key is energized by the exciter coils surrounding the ignition lock cylinder. The energized transponder transmits a signal that contains its unique value, which is received by the theft deterrent module (TDM). The TDM then compares this value to a value stored in memory. This stored value is the learned key code. If the value is correct, the TDM will send the prerelease password via the serial data circuit to the engine control module (ECM). If the transponder value does not match the learned key code or a transponder value is not received, the TDM will send the start disable password to the ECM.

Conditions for Running the DTC

- Ignition is in the Accessory or Run position.
- A valid transponder value has been read.

Conditions for Setting the DTC

- The transponder value is valid and matches the value stored in the TDM memory.
- The transponder calculation to the challenge from the TDM does not match the TDM calculation.

Action Taken When the DTC Sets

- Vehicle starting will be disabled.
- The security indicator will be illuminated.

Conditions for Clearing the DTC

- A current DTC will be cleared when a valid transponder value has been read and authenticated.
- A history DTC will be cleared after 100 malfunction-free ignition cycles or when a scan tool is

used to clear DTCs.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Replace the suspected inoperative or malfunctioning key. DTC B3935 should not reset and the vehicle should start.

If the replacement key results in the resetting of DTC B3935, replace the TDM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Replacing Keys
- Control Module References for theft deterrent module replacement, setup, and programming

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DTC B3976

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B3976 46 : Unconfigured Transponder/Vehicle Configuration Not Programmed

Circuit/System Description

When the theft deterrent module (TDM) is in the learn coded key state, the TDM checks the current key to ensure it has been configured as a proper vehicle key.

Conditions for Running the DTC

- Ignition is in the Accessory or Run position.
- The TDM is in the learn coded key state.

Conditions for Setting the DTC

The TDM has determined the current key is not configured as a proper vehicle key.

Action Taken When the DTC Sets

- The security indicator will be illuminated.
- Vehicle starting will be disabled.

Conditions for Clearing the DTC

- A current DTC will be cleared when the TDM detects a properly configured vehicle key.
- A history DTC will be cleared after 100 malfunction-free ignition cycles or when a scan tool is used to clear DTCs.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Important: When using this diagnostic, more than one vehicle key is required to ensure proper diagnosis. If more than one key is not available at the time of service, contact the customer and ask if any other keys can be provided for service. If unavailable, a new second key can be created.

While viewing DTCs with a scan tool, attempt to start the vehicle using all of the available keys. The vehicle should start with all available keys.

If any key results in inoperative starting and DTC B3976 is set, replace the appropriate key.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Replacing Keys

DTC P0513

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0513: Theft Deterrent Key Incorrect

Circuit/System Description

The theft deterrent module (TDM) sends the prerelease password to the engine control module (ECM) via the serial data circuit. The ECM then sends a challenge to the TDM. Both the ECM and TDM perform a calculation on this challenge. If the calculated response from the TDM equals the calculation performed by the ECM, the ECM will allow vehicle starting.

Conditions for Running the DTC

Ignition is in the ACCESSORY or RUN position.

Conditions for Setting the DTC

The calculated response from the TDM does not equal the calculation performed by the ECM.

Action Taken When the DTC Sets

- The security indicator will illuminate.
- Vehicle starting will be disabled.

Conditions for Clearing the DTC

- A current DTC P0513 will be cleared when a valid calculation is received.
- A history DTC will be cleared after 40 malfunction-free ignition cycles or when a scan tool is used to clear DTCs.

Diagnostic Aids

The "key" referenced in the DTC descriptor does not refer to the vehicle key. In this case, "key" is referring to the challenge response.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the following BCM DTCs are not present:
   - U1814
   - U2099
   - B1428
   - B1370
   - B1380
   - B1440
   - B1441

   If any listed DTC is present, refer to Diagnostic Trouble Code (DTC) List - Vehicle to diagnose that DTC prior to this diagnostic.

   Important: Because of normal system communications between the TDM and ECM, any theft deterrent B-codes must be diagnosed prior to the diagnosis of P-codes.

2. Perform the 10-Minute Immobilizer Relearn procedure. Refer to Immobilizer System Component Programming. The ECM should successfully complete the password learn and the vehicle should start.

   If the ECM does not complete the learn or vehicle starting remains disabled, replace the ECM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for ECM replacement, setup, and programming

DTC P0633

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0633: Theft Deterrent Key Not Programmed

Circuit/System Description

When learning the prerelease password, as well as the challenge and response sequence, the engine control module (ECM) is placed in learn mode. DTC P0633 will set automatically as an indicator that the system is in learn mode and not as a fault indicator. Once the password and challenge/response are learned, learn mode will be exited when the engine is successfully started. If the ECM does not exit learn mode, P0633 will remain current and indicate a fault.

Conditions for Running the DTC

The ECM is in learn mode.

Conditions for Setting the DTC

DTC P0633 will set any time the ECM enters learn mode.

Action Taken When the DTC Sets

The security indicator will illuminate.

Conditions for Clearing the DTC

- A current DTC P0633 will be cleared upon a successful engine start after exit of learn mode.
- A history DTC will be cleared after 100 malfunction-free ignition cycles or when a scan tool is used to clear DTCs.

Diagnostic Aids

The "key" referenced in the DTC descriptor does not refer to the vehicle key. In this case, "key" is referring to the challenge response.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Important: Because of normal system communications between the TDM and ECM, any theft deterrent B-codes must be diagnosed prior to the diagnosis of P-codes.

DTC P0633 will clear upon a successful engine start. Any malfunction that will cause a no-start condition will prevent DTC P0633 from clearing. Prior to diagnosing DTC P0633, ensure that all power moding and engine control systems are operating properly and all conditions that may cause a no-start have been corrected.

1. Ignition in the CRANK position, verify the scan tool Ignition Run/Crank parameter is Active.
   If not the specified value, refer to Power Mode Mismatch .
2. Perform the 10-Minute Immobilizer Relearn procedure. Refer to Immobilizer System Component Programming . The ECM should successfully complete the password learn and the vehicle should start.
   If the ECM does not complete the learn or vehicle starting remains disabled, replace the ECM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for ECM replacement, setup, and programming

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DTC P1629

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P1629: Theft Deterrent Fuel Enable Signal Not Received

Circuit/System Description

The theft deterrent module (TDM) sends the prerelease password to the engine control module (ECM) via the serial data circuit. The ECM then sends a challenge to the TDM. Both the ECM and TDM perform a calculation on this challenge. If the calculated response from the TDM equals the calculation performed by the ECM, the ECM will allow vehicle starting.

Conditions for Running the DTC

- Ignition is in the ACCESSORY or RUN position.
- The ECM is not in learn mode.

Conditions for Setting the DTC

The ECM receives does not receive the challenge response from the TDM within the required amount of time.

Action Taken When the DTC Sets

The security indicator will illuminate.

Conditions for Clearing the DTC

- A current DTC P1629 will be cleared when a challenge response is received.
- A history DTC will be cleared after 40 malfunction-free ignition cycles or when a scan tool is used to clear DTCs.

Diagnostic Aids

DTC P1629 is an indicator that the challenge/response was not received within the required time. This does not necessarily indicate a fault is present with the TDM or ECM. Factors such as a long engine crank, a delay in the serial data communication, or B-codes set in the TDM will cause DTC P1629 to set. This DTC should not be used as a fault indicator, but rather as a symptom to assist in the diagnosis of these other systems.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

DTC P1631

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P1631: Theft Deterrent Fuel Enable Signal Not Correct

Circuit/System Description

The theft deterrent module (TDM) sends the prerelease password to the engine control module (ECM) via the serial data circuit. The ECM then sends a challenge to the TDM. Both the ECM and TDM perform a calculation on this challenge. If the calculated response from the TDM equals the calculation performed by the ECM, the ECM will allow vehicle starting.

Conditions for Running the DTC

Ignition is in the ACCESSORY or RUN position.

Conditions for Setting the DTC

The ECM receives an incorrect prerelease password from the TDM.

Action Taken When the DTC Sets

- The security indicator will illuminate.
- Vehicle starting will be disabled.

Conditions for Clearing the DTC

- A current DTC P1631 will be when a correct fuel enable password is received.
- A history DTC will be cleared after 40 malfunction-free ignition cycles or when a scan tool is used to clear DTCs.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Important: Because of normal system communications between the TDM and ECM, any theft deterrent B-codes must be diagnosed prior to the diagnosis of P-codes.

Perform the 10-Minute Immobilizer Relearn procedure. Refer to Immobilizer System Component Programming . The ECM should successfully complete the password learn and the vehicle should start.

If the ECM does not complete the learn or vehicle starting remains disabled, replace the ECM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for ECM replacement, setup and programming

DTC P1632

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P1632: Theft Deterrent Fuel Disable Signal Received

Circuit/System Description

The theft deterrent module (TDM) sends the prerelease password to the engine control module (ECM) via the serial data circuit. The ECM then sends a challenge to the TDM. Both the ECM and TDM perform a calculation on this challenge. If the calculated response from the TDM equals the calculation performed by the ECM, the ECM will allow vehicle starting.

Conditions for Running the DTC

Ignition is in the RUN position.

Conditions for Setting the DTC

A fuel disable signal from the TDM is received by the ECM.

Action Taken When the DTC Sets

- The security indicator will illuminate.
- Vehicle starting will be disabled.

Conditions for Clearing the DTC

- A current DTC P1632 will be when a valid calculation is received.
- A history DTC will be cleared after 40 malfunction-free ignition cycles or when a scan tool is used to clear DTCs.

Diagnostic Aids

The prerelease password sent to the ECM by the TDM is reliant on the communications between the transponder located in the vehicle key and the TDM. Failure to establish communications or an interruption in the communications between the vehicle key and the TDM will cause the fuel disable message to be sent and the setting of DTC B1632. DTC B3055 or B3060 will be set in the TDM. To properly diagnose DTC P1632, DTC B3055 or B3060 must be diagnosed and corrected first.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Important: Because of normal system communications between the TDM and ECM, any theft deterrent B-codes must be diagnosed prior to the diagnosis of P-codes.

Perform the 10-Minute Immobilizer Relearn procedure. Refer to Immobilizer System Component Programming . The ECM should successfully complete the password learn and the vehicle should start.

If the ECM does not complete the learn or vehicle starting remains disabled, replace the ECM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for ECM replacement, setup and programming

Immobilizer System Component Programming

10-Minute Immobilizer Relearn

This 10-minute relearn procedure will relearn the prerelease password and the challenge/response data between the theft deterrent module (TDM) and the engine control module (ECM).

1. Connect a scan tool to the vehicle in the pass-thru arrangement.
2. Turn ON the ignition, with the engine OFF.
3. Ensure that all power consuming devices are turned OFF on the vehicle.
4. On the Techline Terminal, select Service Programming System and follow the Techline Terminal on-screen instructions, using the Pass-Thru method. Ensure the correct programming selection is chosen based on component being replaced or programmed. For this procedure, go to the V.T.D. Vehicle Theft Deterrent Learn menu and choose the Vehicle Theft Deterrent Learn, ECM, or PK3 Replaced selection.
5. At this point the scan tool must remain connected for the duration of the 10-minute relearn procedure.

   Important:
   - The scan tool will initially display 12 Minutes. The first 2 minutes allow the scan tool to initialize the appropriate control module. The remaining 10 minutes is the relearn timer.
   - On some vehicles the security indicator may be illuminated for the duration of the 10-minute relearn procedure.

6. Observe the scan tool, after approximately 10 minutes the scan tool will display "Programming Successful, Turn OFF Ignition". The vehicle is now ready to relearn the key information and/or the passwords on the next ignition switch transition from OFF to CRANK.
7. Turn OFF the ignition and wait 2 minutes.
8. With a master vehicle key, turn the ignition to the RUN position for 15 seconds, then start the vehicle. The TDM and ECM have now relearned the pre-release password and the challenge/response data.
9. With a scan tool, clear any DTCs.

Adding Keys

Important:

- To initiate, this procedures requires that a learned master key be available.
- A total of 10 keys may be programmed to a single vehicle.
- This procedure adds keys only. The procedure does not erase previously learned keys.
- The keys to be learned must duplicate the mechanical cut of the current key.
- If more than one valet key is to be learned, immediately precede each valet key with a learned master key.

1. With a previously learned master key, turn ON the ignition, with the engine OFF.
2. Turn OFF the ignition and remove the key.
3. Within 10 seconds of turning OFF the ignition, insert the key to be learned and turn ON the ignition. The vehicle has now learned the new key.

Replacing Keys

When replacing keys, the 10-minute re-learn procedure must be performed. Lost keys can also be delisted. Refer to Theft Deterrent Control Module Programming and Setup.

Immobilizer Description and Operation

The immobilizer system functions are provided by the theft deterrent module (TDM) and the engine control module (ECM). When an ignition key is inserted into the ignition lock cylinder and the ignition is switched ON, the transponder embedded in the head of the key is energized by the exciter coil surrounding the ignition lock cylinder. This exciter coil is part of the TDM. The energized transponder transmits a signal that contains its unique value, which is received by the TDM. The TDM then compares this value to a value stored in memory. If the values match, the TDM will send the prerelease password via the serial data circuit to the ECM. If the transponders unique value is incorrect, the TDM will send the fuel disable password to the ECM.

When the ECM receives the TDM prerelease password, the ECM will challenge the password. The ECM sends this challenge back to the TDM via the serial data circuit. Both the ECM and TDM perform a calculation on this challenge. If the calculated response from the TDM equals the calculation performed by the ECM, the ECM will allow vehicle starting.

The components of the theft system are as follows:

- TDM
- ECM
- Ignition key (Transponder)
- Security indicator

Theft Deterrent Module (TDM)

Vehicles with steering column mounted ignition switches have the exciter integral with the theft deterrent module (TDM), which is located within the steering column. The TDM can learn up to 10 keys (transponder values).

The TDM uses the following inputs:

- Battery voltage
- Ignition switched voltage
- Ground circuit

The theft deterrent control module uses the following outputs:

- Password exchange
- Challenge/response with the engine control module (ECM)

When an ignition key is inserted into the ignition lock cylinder and the ignition is switched ON, the transponder embedded in the head of the key is energized by the exciter coils surrounding the ignition lock cylinder. The energized transponder transmits a signal that contains its unique value, which is received by the TDM. The TDM then compares this value to the learned key code stored in memory. The TDM then performs one of the following functions:

- If the transponder value matches the values stored in the TDM memory, the TDM will send the prerelease password to the ECM via the serial data circuit.

- If the transponders unique value does not match the value stored in the TDM, the TDM will send the fuel disable message to the ECM via the serial data circuit.
- If the TDM is unable to measure the ignition key transponder value, the TDM will not send any messages to the ECM.

Engine Control Module (ECM)

When the engine control module (ECM) receives the theft deterrent module (TDM) prerelease password, the ECM will challenge the password. The ECM sends this challenge back to the TDM via the serial data circuit. Both the ECM and TDM perform a calculation on this challenge. If the calculated response from the TDM equals the calculation performed by the ECM, the ECM will allow vehicle starting.

The ECM will disable vehicle starting if any of the following conditions occur:

- The prerelease password is invalid.
- The fuel disable password is sent by the TDM.
- No passwords are received. There is no communication with the TDM.
- The TDM calculated response to the challenge does not equal the calculation performed by the ECM.

The Ignition Key (Transponder)

The ignition key for PassKey III+ (PK3+) equipped vehicles is a standard ignition key with a transponder located in the plastic head of the key. The transponder value is fixed and unable to be changed. The immobilizer system uses the ignition key transponder value to determine if a valid ignition key is being used to start the vehicle. There are approximately 3 trillion possible transponder values. There are no visible electrical contacts. The keys are identified by + symbol in a circle stamped into the steel shank of the key. The immobilizer system use the following types of ignition keys:

Master Keys

Master keys have a black plastic head for full access operation of the vehicle. Master keys may perform the following functions:

- Start the vehicle.
- Lock/unlock all of the door locks and rear compartment.
- Lock/unlock all of the storage compartments.

Valet Keys

Important: Valet keys are NOT standard equipment on all GM vehicle lines.

Valet keys have a gray plastic head and are for restricted operation of the vehicle. Valet keys may perform the following functions:

- Start the vehicle.
- Lock/unlock all of the door locks.

Fleet Keys

Important: Fleet keys are NOT standard equipment on all GM vehicle lines.

Fleets keys allow full access to the vehicle just as a master key would. However, unlike a master key which may only learn 10 keys to a particular vehicle, an unlimited number of fleet keys may be learned to the vehicle. Fleet keys are only used in vehicles configured for fleet use with RPO 6E2 or 6E8.

- Start the vehicle.
- Lock/unlock all of the door locks and rear compartment.
- Lock/unlock all of the storage compartments.

Security Indicator

The theft deterrent module (TDM) can command the instrument panel cluster (IPC) to illuminate the security indicator only when the ignition key is in the ON position. The TDM will command the security indicator be illuminated any time a fault is noted in the immobilizer system and when the engine starting is disabled.

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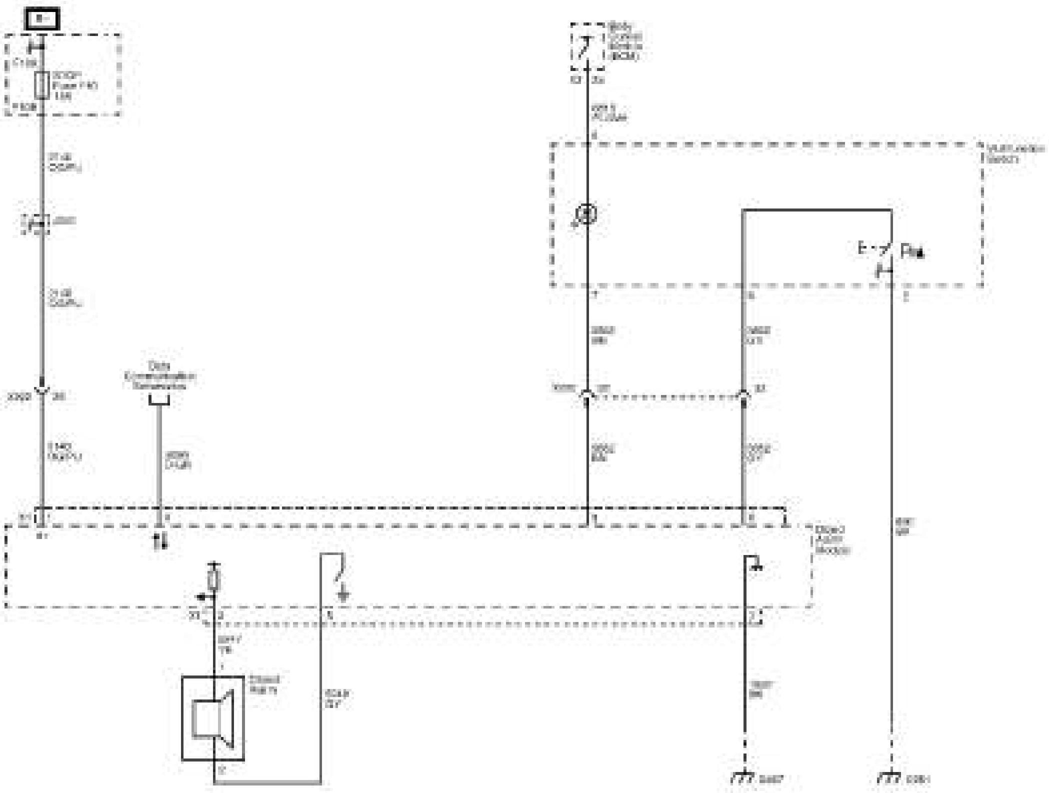
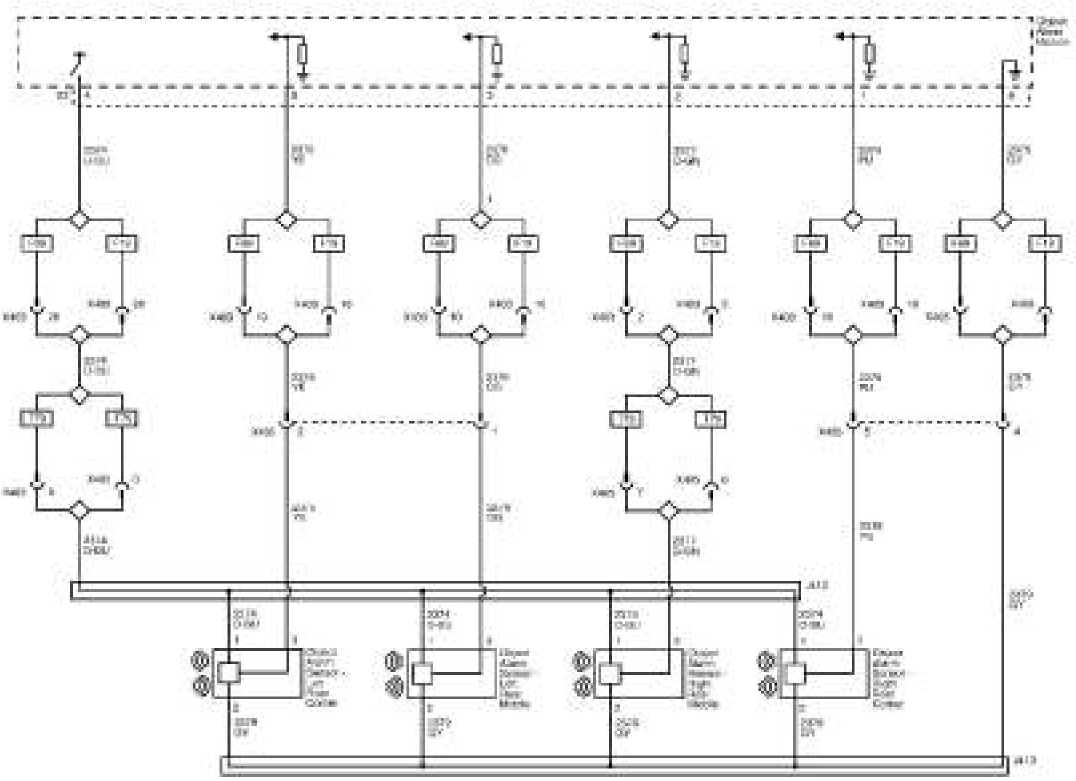
Power, Ground, Serial Data, Alarm, and Controls

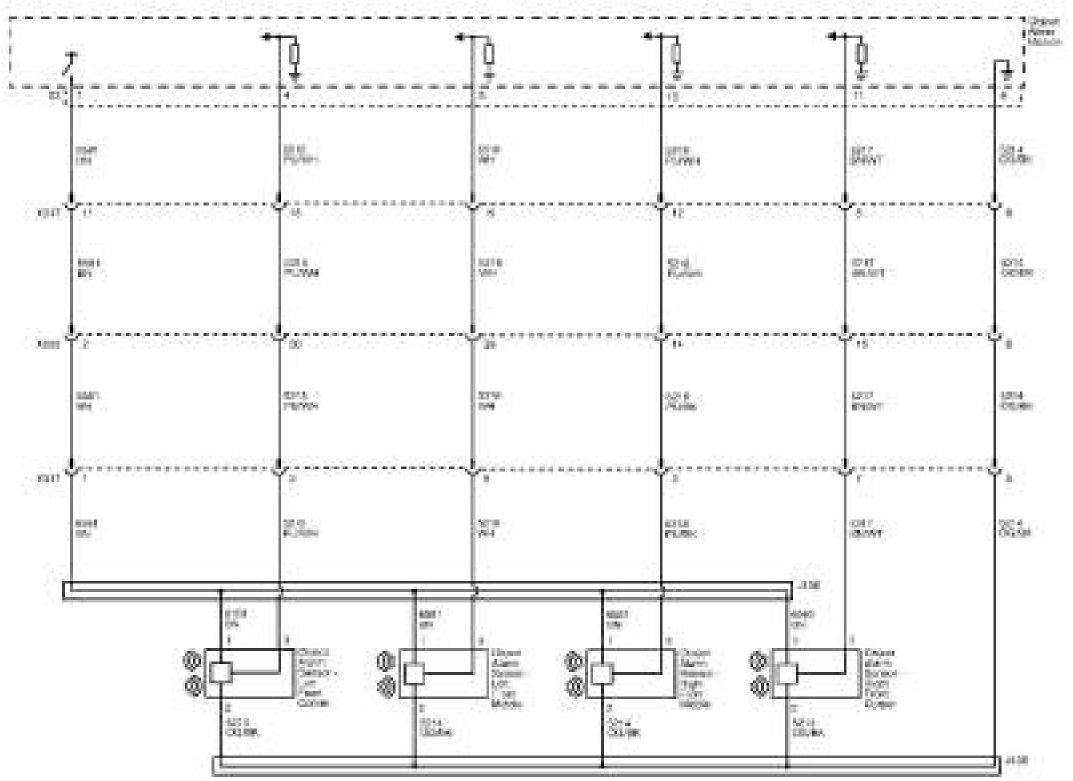


Sensors (UFR with UD7)



2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Safety and Security | Object Detection | Schematic and Routing Diagrams | **Document ID: 2154651**

Sensors (UFR Except UD7)



Diagnostic Starting Point - Object Detection

Begin the system diagnosis with the Diagnostic System Check - Vehicle.

- The identification of the control module which commands the system.
- The ability of the control module to communicate through the serial data circuit.
- The identification of any stored diagnostic trouble codes (DTC's) and their status.

The use of Diagnostic System Check - Vehicle, will identify the correct procedure for diagnosing the system and where the procedure is located.

DTC B0953

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B0953 00: Park Assist Audio Output Circuit

Circuit/System Description

The dual object detection system consists of an object alarm module, eight object alarm sensors, an object alarm speaker, and a switch. The object alarm speaker will sound as the vehicle approaches an object.

Conditions for Running the DTC

Ignition RUN

Conditions for Setting the DTC

The object alarm module has detected a malfunction.

Action Taken When the DTC Sets

- Park assist system is disabled.
- The multifunction switch light will flash rapidly when the switch is pressed.
- A chime will sound.

Conditions for Clearing

The object alarm module clears the history DTC when a current DTC is not detected in 100 ignition cycles.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Object Detection Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Circuit/System Testing

1. Ignition OFF, disconnect the harness at the object alarm speaker.
2. Connect a test lamp between the voltage circuit terminal 1 and ground.
3. Ignition ON, engine OFF, transmission in REVERSE, the test lamp should illuminate.

   If the test lamp does not illuminate, test the voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the object alarm module.
4. Connect a test lamp between the low reference circuit terminal 2 and ground. The test lamp should not illuminate.

   If the test lamp illuminates, test the low reference circuit for a short to voltage. If the circuit tests normal, replace the object alarm module.
5. Test for infinite resistance between the low reference circuit terminal 2 and ground.

   If less than the specified value test the low reference circuit for a short to ground. If the circuit tests normal, replace the object alarm module.
6. Ignition OFF, place an object behind the vehicle.
7. Connect a test lamp between the voltage circuit terminal 1 and low reference circuit terminal 2.
8. Ignition ON, engine OFF, transmission in REVERSE, the test lamp should illuminate.

   If the test lamp does not illuminate, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the object alarm module.
9. If all circuits test normal, test or replace the object alarm speaker.

Component Testing

1. Ignition OFF, disconnect the harness at the object alarm speaker.
2. Apply 2.5 V to the voltage circuit terminal 1.
3. Apply ground to the ground circuit terminal 2, the object alarm speaker should sound.

   If the speaker does not sound replace the object alarm speaker.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for object alarm speaker replacement.

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DTC B0954, B0955, B0956, or B0957

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B0954 01: Park Assist Sensor Front Left Outer Circuit Malfunction

DTC B0954 06: Park Assist Sensor Front Left Outer Circuit Open or Low Voltage

DTC B0954 08: Park Assist Sensor Front Left Outer Invalid Signal

DTC B0954 21: Park Assist Sensor Front Left Outer Circuit Incorrect Period

DTC B0955 01: Park Assist Sensor Front Left Middle Circuit Malfunction

DTC B0955 06: Park Assist Sensor Front Left Middle Circuit Open or Low Voltage

DTC B0955 08: Park Assist Sensor Front Left Middle Invalid Signal

DTC B0955 21: Park Assist Sensor Front Left Middle Circuit Incorrect Period

DTC B0956 01: Park Assist Sensor Front Right Middle Circuit Malfunction

DTC B0956 06: Park Assist Sensor Front Right Middle Circuit Open or Low Voltage

DTC B0956 08: Park Assist Sensor Front Right Middle Invalid Signal

DTC B0956 21: Park Assist Sensor Front Right Middle Circuit Incorrect Period

DTC B0957 01: Park Assist Sensor Front Right Outer Circuit Malfunction

DTC B0957 06: Park Assist Sensor Front Right Outer Circuit Open or Low Voltage

DTC B0957 08: Park Assist Sensor Front Right Outer Invalid Signal

DTC B0957 21: Park Assist Sensor Front Right Outer Circuit Incorrect Period

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
8-Volt Reference	B0954 06, B0955 06, B0956 06, B0957 06, B138A 03	B0954 06, B0955 06, B0956 06, B0957 06, B138A 03	B138A 07	--

Left Front Corner Object Sensor Signal	B0954 06	B0954 06	B0954 01	B0954 08, B0954 21
Left Front Middle Object Sensor Signal	B0955 06	B0955 06	B0955 01	B0955 08, B0955 21
Right Front Middle Object Sensor Signal	B0956 06	B0956 06	B0956 01	B0956 08, B0956 21
Right Front Corner Object Sensor Signal	B0957 06	B0957 06	B0957 01	B0957 08, B0957 21
Low Reference	--	B0954 06, B0955 06, B0956 06, B0957 06	--	--

Circuit/System Description

The object sensors are 3-wire sensors that are used to determine the distance between the vehicle and an object of interest. The object alarm module supplies an 8 V reference and ground reference to each of the object sensors. The object alarm module triggers the sensors in a sequential loop. After each sensor transmits, the object alarm module uses the sensor ring received through the signal circuit to calculate the distance and position of an object.

Conditions for Running the DTC

- DTC B1325 is not set
- The ignition voltage is at least 9.0 V and no more than 16.0 V
- Transmission is in DRIVE or REVERSE

Conditions for Setting the DTC

B0954 01, B0955 01, B0956 01 or B0957 01

The front object sensor signal circuit detects a voltage greater than 11.5 V.

B0954 06, B0955 06, B0956 06 or B0957 06

The front object sensor signal circuit detects a voltage less than 0.5 V.

B0954 08, B0955 08, B0956 08 or B0957 08

The object alarm module detects an invalid signal.

B0954 21, B0955 21, B0956 21 or B0957 21

The front object sensor determines no change in the position of an object while the vehicle is in motion.

Action Taken When the DTC Sets

- Park assist system is disabled.
- SERVICE PARK ASSIST message is displayed on the driver information center and a chime will sound.

Conditions for Clearing the DTC

- The object alarm module clears the history DTC when a current DTC is not detected in 100 ignition cycles.
- The condition for the DTC is no longer present.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Object Detection Description and Operation

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs
- Connector Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC B138A is not set.
   If DTC is set, refer to DTC B138A.
2. Park brake OFF, transmission in DRIVE, individually place a suitable object in front of each object sensor. Verify the appropriate scan tool Front Region parameter is between Zone 1 and Zone 4.

Circuit/System Testing

Single Object Sensor DTC Set

1. Ignition OFF, disconnect the harness connector at the appropriate front object sensor.
2. Ignition OFF for 30 seconds, test for less than 5 Ω between the low reference circuit terminal 2 and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the object alarm module.
3. Ignition ON, transmission in DRIVE, test for 7.2 - 9.2 V between the voltage reference terminal 1 and ground.

   If greater than the specified range, test the voltage reference circuit for a short to voltage. If the circuit tests normal, replace the object alarm module.

   If less than the specified range, test the voltage reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the object alarm module.
4. Ignition OFF, remove the malfunctioning object sensor and swap locations with another properly functioning object sensor. Connect the harness connector at both sensors.
5. Ignition ON, verify the DTC is set for the new location in which the malfunctioning sensor is installed.

   If the DTC does not set for the new location, test the signal circuit terminal 3 for a short to voltage, short to ground, or an open/high resistance. If the circuit tests normal, replace the object alarm module.
6. If the DTC sets for the new location in which the malfunctioning sensor is installed, replace the appropriate front object sensor.

Multiple Object Sensor DTCs Set

1. Ignition OFF, disconnect the harness connector at each of the object sensors.
2. Ignition OFF for 30 seconds, test for less than 5 Ω between the low reference circuit terminal 2 and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the object alarm module.
3. Ignition ON, transmission in DRIVE, test for 8.0 - 9.0 V between the voltage reference circuit terminal 1 and ground.

   If greater than the specified range, test the voltage reference circuit for a short to voltage. If the circuit tests normal, replace the object alarm module.

   If less than the specified range, test the voltage reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the object alarm module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Front Object Alarm Sensor Replacement
- Control Module References for park assist module replacement, setup, and programming

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DTC B0958, B0959, B0960, or B0961

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B0958 01: Park Assist Sensor Rear Left Outer Circuit Malfunction

DTC B0958 06: Park Assist Sensor Rear Left Outer Circuit Open or Low Voltage

DTC B0958 08: Park Assist Sensor Rear Left Outer Invalid Signal

DTC B0958 21: Park Assist Sensor Rear Left Outer Circuit Incorrect Period

DTC B0959 01: Park Assist Sensor Rear Left Middle Circuit Malfunction

DTC B0959 06: Park Assist Sensor Rear Left Middle Circuit Open or Low Voltage

DTC B0959 08: Park Assist Sensor Rear Left Outer Invalid Signal

DTC B0959 21: Park Assist Sensor Rear Left Outer Circuit Incorrect Period

DTC B0960 01: Park Assist Sensor Rear Right Middle Circuit Malfunction

DTC B0960 06: Park Assist Sensor Rear Right Middle Circuit Open or Low Voltage

DTC B0960 08: Park Assist Sensor Rear Right Middle Invalid Signal

DTC B0960 21: Park Assist Sensor Rear Right Middle Circuit Incorrect Period

DTC B0961 01: Park Assist Sensor Rear Right Outer Circuit Malfunction

DTC B0961 06: Park Assist Sensor Rear Right Outer Circuit Open or Low Voltage

DTC B0961 08: Park Assist Sensor Rear Right Middle Invalid Signal

DTC B0961 21: Park Assist Sensor Rear Right Middle Circuit Incorrect Period

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
8-Volt Reference	B0958 06, B0959 06, B0960 06, B0961 06, B138A 03	B0958 06, B0959 06, B0960 06, B0961 06, B138A 03	B138A 07	--

Left Rear Corner Object Sensor Signal	B0958 06	B0958 06	B0958 01	B0958 08, B0958 21
Left Rear Middle Object Sensor Signal	B0959 06	B0959 06	B0959 01	B0959 08, B0959 21
Right Rear Middle Object Sensor Signal	B0960 06	B0960 06	B0960 01	B0960 08, B0960 21
Right Rear Corner Object Sensor Signal	B0961 06	B0961 06	B0961 01	B0961 08, B0961 21
Low Reference	--	B0958 06, B0959 06, B0960 06, B0961 06	--	--

Circuit/System Description

The object sensors are 3-wire sensors that are used to determine the distance between the vehicle and an object of interest. The object alarm module supplies an 8 V reference and ground reference to each of the object sensors. The object alarm module triggers the sensors in a sequential loop. After each sensor transmits, the object alarm module uses the sensor ring received through the signal circuit to calculate the distance and position of an object.

Conditions for Running the DTC

- DTC B1325 is not set
- The ignition voltage is at least 9.0 V and no more than 16.0 V
- Transmission is in DRIVE or REVERSE

Conditions for Setting the DTC

B0958 01, B0959 01, B0960 01 or B0961 01

The rear object sensor signal circuit detects a voltage greater than 11.5 V.

B0958 06, B0959 06, B0960 06 or B0961 06

The rear object sensor signal circuit detects a voltage less than 0.5 V.

B0958 08, B0959 08, B0960 08 or B0961 08

The object alarm module detects an invalid signal.

B0958 21, B0959 21, B0960 21 or B0961 21

The rear object sensor determines no change in the position of an object while the vehicle is in motion.

Action Taken When the DTC Sets

- Parking assist is disabled.
- SERVICE PARK ASSIST message is displayed in the driver information center and a chime will sound.

Conditions for Clearing the DTC

- The object alarm module clears the history DTC when a current DTC is not detected in 100 ignition cycles.
- The condition for the DTC is no longer present.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Object Detection Description and Operation

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs
- Connector Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC B138A is not set.
   If DTC is set, refer to DTC B138A.
2. Park brake OFF, transmission in REVERSE, individually place a suitable object behind each sensor. Verify the appropriate scan tool Rear Region parameter is between Zone 1 and Zone 4.

Circuit/System Testing

Single Object Sensor DTC Set

1. Ignition OFF, disconnect the harness connector at the appropriate object sensor.
2. Ignition OFF for 30 seconds, test for less than 5 Ω between the low reference circuit terminal 2 and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the object alarm module.
3. Ignition ON, transmission in REVERSE, test for 7.2 - 9.2 V between the voltage reference circuit terminal 1 and ground.

   If greater than the specified range, test the voltage reference circuit for a short to voltage. If the circuit tests normal, replace the object alarm module.

   If less than the specified range, test the voltage reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the object alarm module.
4. Ignition OFF, remove the malfunctioning object sensor and swap locations with another properly functioning rear object sensor. Connect the harness connector at both sensors.
5. Ignition ON, verify the DTC is set for the new location in which the malfunctioning sensor is installed.

   If the DTC does not set for the new location, test the signal circuit terminal 3 for a short to voltage, short to ground, or an open/high resistance. If the circuit tests normal, replace the object alarm module.
6. If the DTC sets for the new location in which the malfunctioning sensor is installed, replace the appropriate rear object sensor.

Multiple Object Sensor DTCs Set

1. Ignition OFF, disconnect the harness connector at each of the object sensors.
2. Ignition OFF for 30 seconds, test for less than 5 Ω between the low reference circuit terminal 2 and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the object alarm module.
3. Ignition ON, transmission in REVERSE, test for 8.0 - 9.0 V between the voltage reference circuit terminal 1 and ground.

   If greater than the specified range, test the voltage reference circuit for a short to voltage. If the circuit tests normal, replace the object alarm module.

   If less than the specified range, test the voltage reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the object alarm module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Rear Object Sensor Replacement
- Control Module References for object alarm module replacement, setup, and programming

DTC B0967

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B0967 02: Park Assist Switch Circuit Short to Ground

Circuit/System Description

The object detection park assist switch allows the driver to enable or disable the park assist system. The park assist switch is supplied voltage from the object alarm module. When the park assist system is enabled low reference is provided to the switch activating the park assist system.

Conditions for Running the DTC

- DTC B1325 is not set
- Ignition is in RUN mode

Conditions for Setting the DTC

The object alarm module detects a malfunction with the park assist switch.

Action Taken When the DTC Sets

- The park assist system is enabled when transmission is in DRIVE or REVERSE.
- The park assist switch will not disable the park assist system when commanded by the switch.

Conditions for Clearing

- The object alarm module clears the history DTC when a current DTC is not detected in 100 ignition cycles.
- The condition for the DTC is no longer present.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Object Detection Description and Operation

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs
- Connector Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Park brake OFF, transmission in REVERSE, using the park assist switch enable and disable the park assist system. Verify the park assist system enables and disables respectively.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the park assist switch.
2. Test for less than 5 Ω between the ground circuit terminal 2 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance. If the circuit tests normal, replace the park assist switch.
3. Ignition ON, transmission in REVERSE, test for 4.0 - 6.0 V between the voltage reference circuit terminal 5 and ground.

   If greater than the specified range, test the voltage reference circuit for a short to voltage. If the circuit tests normal, replace the object alarm module.

   If less than the specified range, test the voltage reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the object alarm module.
4. If the circuit tests normal, replace the park assist switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for park assist module replacement, setup, and programming

DTC B0968

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B0968 00: Park Assist Indicator Circuit Malfunction

Circuit/System Description

The park assist switch is equipped with a light that indicates when the park assist system is enabled or disabled. When the park assist system is enabled the light is turned on.

Conditions for Running the DTC

- DTC B1325 is not set
- Ignition is in RUN mode

Conditions for Setting the DTC

The object alarm module detects a malfunction with the park assist switch light.

Action Taken When the DTC Sets

- The park assist system is disabled.
- The park assist switch light will not turn on.

Conditions for Clearing

- The object alarm module clears the history DTC when a current DTC is not detected in 100 ignition cycles.
- The condition for the DTC is no longer present.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Object Detection Description and Operation

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs
- Connector Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Park brake OFF, transmission in REVERSE, the park assist switch light should turn on.

Circuit/System Testing

1. Ignition OFF, disconnect the park assist switch.
2. Test for less than 5 Ω between the low reference circuit terminal 8 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance. If the circuit tests normal, replace the object alarm module.
3. Ignition ON, transmission in REVERSE, test for 1.7 - 3.3 V between the voltage reference circuit terminal 7 and ground.

   If greater than the specified range, test the voltage reference circuit for a short to voltage. If the circuit tests normal, replace the body control module.

   If less than the specified range, test the voltage reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the body control module.
4. If the circuit tests normal, replace the park assist switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for body control module replacement, setup, and programming

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DTC B1008

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B1008 42: Calibration Data Not Programmed

Circuit/System Description

When the ignition is turned ON, the object alarm module performs a self-test to verify if any critical malfunction exists within the system. During the power-up mode, the object alarm module checks for a valid calibration data set.

Conditions for Running the DTC

- DTC B1325 is not set
- The ignition voltage is at least 9.0 V and no more than 16.0 V

Conditions for Setting the DTC

The object alarm module does not detect a valid calibration data set.

Action Taken When the DTC Sets

- Parking assist is disabled.
- SERVICE PARK ASSIST message is displayed in the driver information center and a chime will sound.

Conditions for Clearing

- The object alarm module clears the history DTC when a current DTC is not detected in 100 ignition cycles.
- The condition for the DTC is no longer present.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Object Detection Description and Operation

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs
- Connector Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Verify that DTC B1008 is not set.

> If the DTC is set, program the object alarm module. Refer to Object Alarm Module Programming and Setup. If the DTC resets, replace the object alarm module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for park assist module replacement, setup, and programming

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Safety and Security | Object Detection | Diagnostic Information and Procedures | **Document ID: 1978112**

DTC B138A

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC B138A 03: Device Voltage Reference Group 1 Outputs Voltage Below Threshold

DTC B138A 07: Device Voltage Reference Group 1 Outputs Voltage Above Threshold

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
8-Volt Reference	B0954 06, B0955 06, B0956 06, B0957 06, B0958 06, B0959 06, B0960 06, B0961 06, B138A 03	B0954 06, B0955 06, B0956 06, B0957 06, B0958 06, B0959 06, B0960 06, B0961 06, B138A 03	B138A 07	--
Left Front Corner Object Sensor Signal	B0954 06	B0954 06	B0954 01	B0954 08, B0954 21
Left Front Middle Object Sensor Signal	B0955 06	B0955 06	B0955 01	B0955 08, B0955 21
Right Front Middle Object Sensor Signal	B0956 06	B0956 06	B0956 01	B0956 08, B0956 21
Right Front Corner Object Sensor Signal	B0957 06	B0957 06	B0957 01	B0957 08, B0957 21
Left Front Corner Object Sensor Signal	B0954 06	B0954 06	B0954 01	B0954 08, B0954 21
Left Front Middle Object Sensor Signal	B0955 06	B0955 06	B0955 01	B0955 08, B0955 21
Right Front Middle Object Sensor Signal	B0956 06	B0956 06	B0956 01	B0956 08, B0956 21
Right Front Corner Object	B0957 06	B0957 06	B0957 01	B0957 08,

Sensor Signal				B0957 21
Left Rear Corner Object Sensor Signal	B0958 06	B0958 06	B0958 01	B0958 08, B0958 21
Left Rear Middle Object Sensor Signal	B0959 06	B0959 06	B0959 01	B0959 08, B0959 21
Right Rear Middle Object Sensor Signal	B0960 06	B0960 06	B0960 01	B0960 08, B0960 21
Right Rear Corner Object Sensor Signal	B0961 06	B0961 06	B0961 01	B0960 08, B0960 21
Low Reference	--	B0954 06, B0955 06, B0956 06, B0957 06, B0958 06, B0959 06, B0960 06, B0961 06	--	--

Circuit/System Description

The object sensors are 3-wire sensors that are used to determine the distance between the vehicle and an object of interest. The object alarm module supplies an 8 V reference and ground reference to each of the object sensors. The object alarm module triggers the sensors in a sequential loop. After each sensor transmits, the object alarm module uses the sensor ring received through the signal circuit to calculate the distance and position of an object.

Conditions for Running the DTC

- DTC B1325 is not set
- The vehicle is in REVERSE or DRIVE

Conditions for Setting the DTC

B138A 03

The object alarm module detects the sensor 8 V reference circuit is less than 7.2 V.

B138A 07

The object alarm module detects the sensor 8 V reference circuit is greater than 9.2 V.

Action Taken When the DTC Sets

- Parking assist system is disabled.
- SERVICE PARK ASSIST message is displayed in the driver information center and a chime will sound.

Conditions for Clearing

- The object alarm module clears the history DTC when a current DTC is not detected in 100 ignition cycles.
- The condition for the DTC is no longer present.

Reference Information

Schematic Reference

Object Detection Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Object Detection Description and Operation

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs
- Connector Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, transmission in REVERSE, verify that the scan tool Sensor Supply Voltage parameter is between 7.2 - 9.2 V.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at each of the object sensors.
2. Ignition ON, verify DTC B138A is not set as current.

   If the DTC is set, test the 8 V reference circuit terminal 1 for a short to voltage, short to ground, or an open/high resistance. If circuit tests normal, replace the object alarm module.
3. Install each sensor harness connector one at a time, checking DTCs after each sensor is connected. Verify DTC B138A is not set as current.

   If the DTC is set, replace the object sensor that was connected immediately before the DTC set.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Front Object Alarm Sensor Replacement
- Rear Object Sensor Replacement
- Control Module References for object alarm module replacement, setup, and programming.

Symptoms - Object Detection

Note: Review the system operation in order to familiarize yourself with the system functions. Refer to Object Detection Description and Operation.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the system. Refer to Checking Aftermarket Accessories
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Make sure the front object alarm sensors located on the vehicles front bumper are clear. Remove any snow, mud or ice that is blocking the sensors.
- Make sure the rear object alarm sensors located on the vehicles rear bumper are clear. Remove any snow, mud or ice that is blocking the sensors.
- If the vehicle is fitted with a trailer hitch, enter the customization menu in the infotainment unit and select *Tow Bar Att* . Select *Yes* if a tow ball tongue/neck is attached or *No* if a tow ball tongue/neck is removed.
- Drive the vehicle for longer than 20 seconds and at a speed greater than 17 km/h.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

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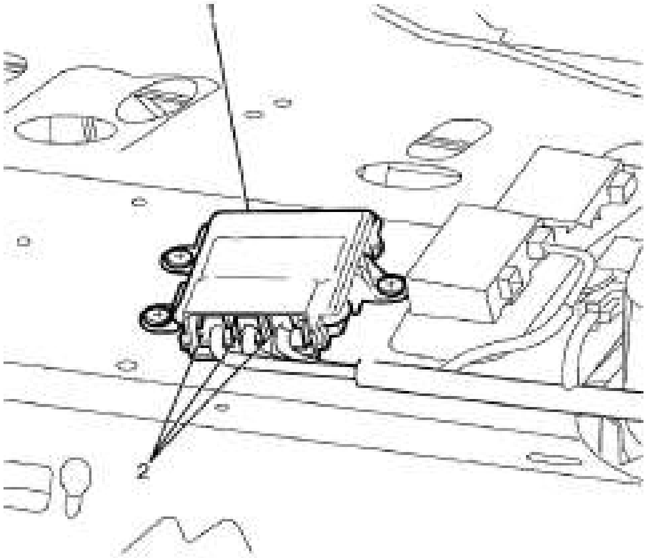
Front and Rear Object Alarm Module Replacement (LWB SWB)

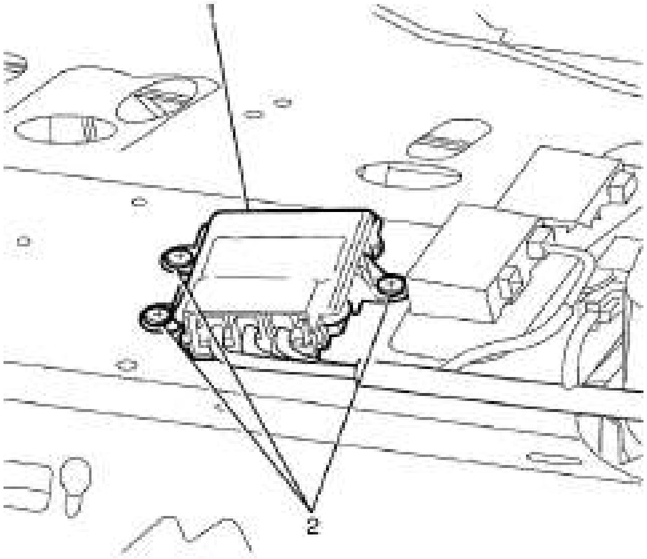
Removal Procedure

1. Remove the rear window shelf trim panel assembly. Refer to Rear Window Shelf Trim Panel Replacement.



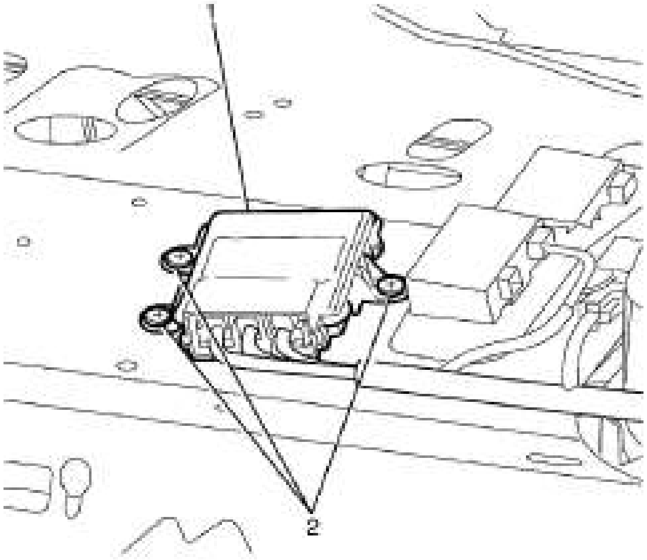
Important: Release the retaining lever before disconnecting the front and rear object sensor alarm module electrical connectors.

2. Disconnect the front and rear object alarm module electrical connectors (2) from the front and rear object alarm module (1).

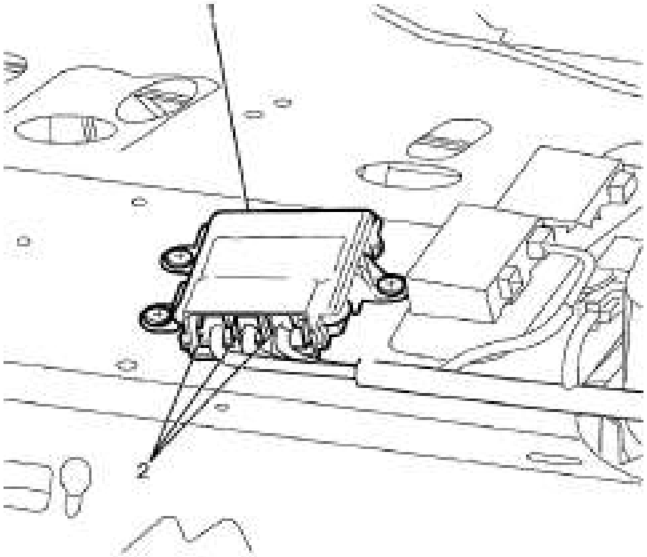


3. Remove the front and rear object alarm module retaining clips (2).
4. Remove the front and rear object alarm module (1) from the vehicle.

Installation Procedure



1. Install the front and rear object alarm module (1) to the vehicle.
2. Install the front and rear object alarm module retaining clips (2).

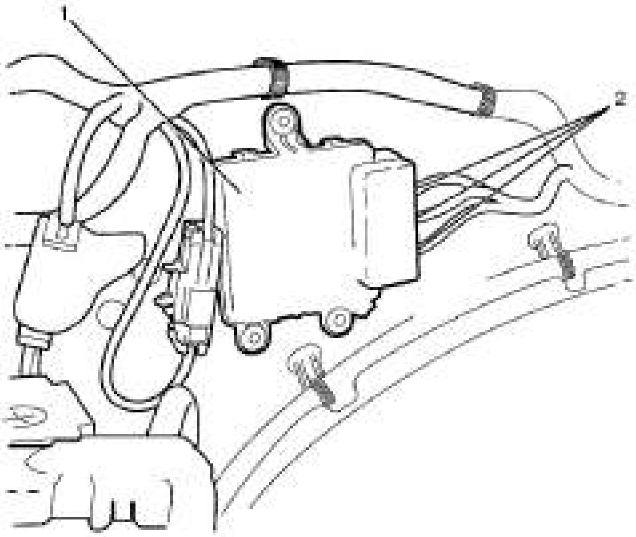


3. Connect the front and rear object alarm module electrical connectors (2) to the front and rear object alarm module (1).
4. Install the rear window shelf trim panel assembly. Refer to Rear Window Shelf Trim Panel Replacement.
5. If re-programming is required. Refer to Control Module References.

Front and Rear Object Alarm Module Replacement (Sportwagon)

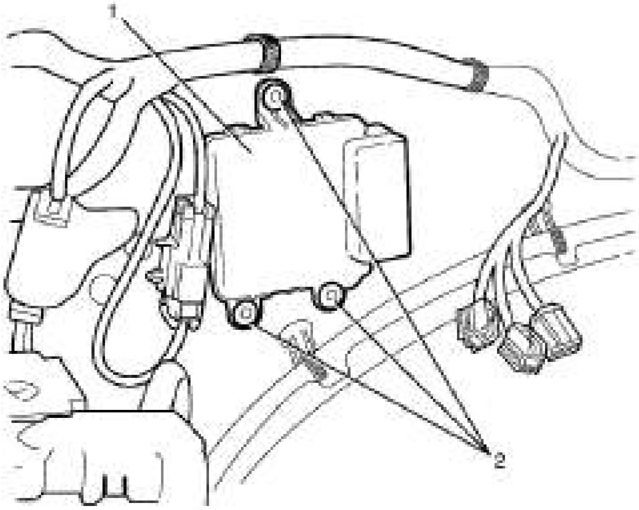
Removal Procedure

1. Remove the rear window shelf panel assembly. Refer to Rear Window Shelf Trim Panel Replacement.



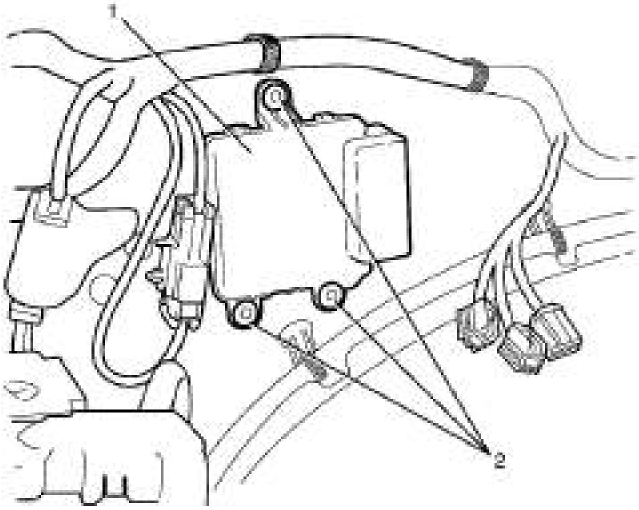
Important: Release the retaining lever before disconnecting the front and rear object sensor alarm module electrical connectors.

2. Disconnect the front and rear object alarm module electrical connectors (2) from the front and rear object alarm module (1).

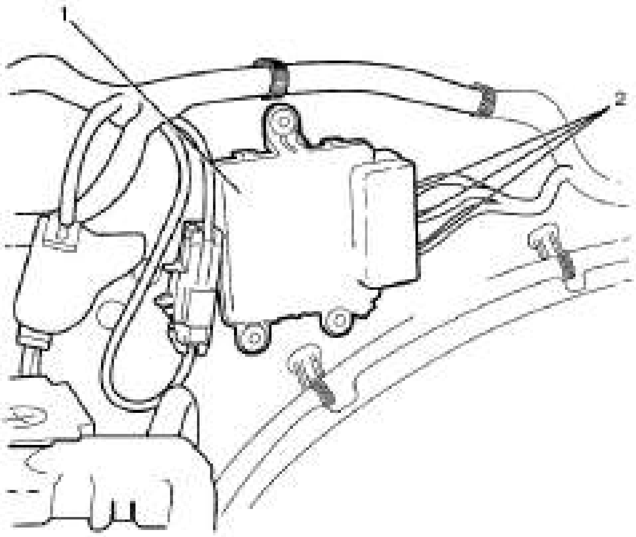


3. Using a suitable tool depress the centres of the retaining clips (2) to disengage them form the front and rear object alarm module (1).
4. Remove the front and rear object alarm module (1) from the vehicle.

Installation Procedure



1. Install the front and rear object alarm module (1) to the vehicle.
2. Install the front and rear object alarm module retaining clips (2).

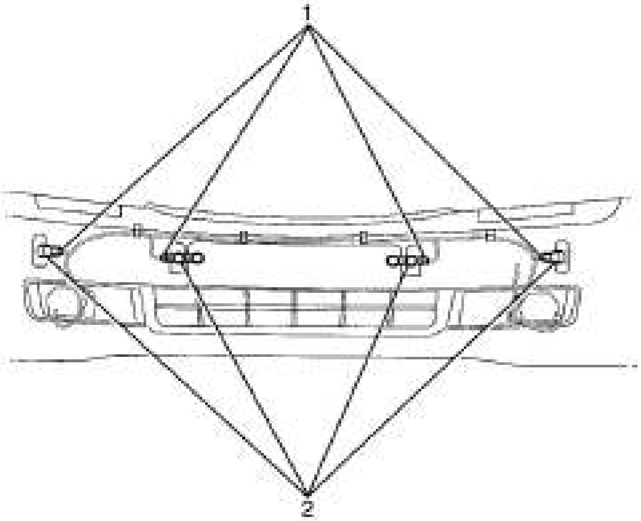


3. Connect the front and rear object alarm module electrical connectors (2) to the front and rear object alarm module (1).
4. Install the rear window shelf panel assembly. Refer to Rear Window Shelf Trim Panel Replacement.
5. If re-programming is required. Refer to Control Module References in Computer/Integrating Systems.

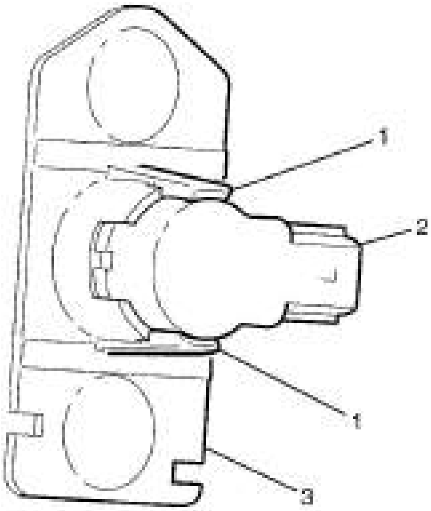
Front Object Alarm Sensor Replacement (LWB SWBRHD)

Removal Procedure - Sensor Front

1. Remove the front bumper fascia assembly. Refer to Front Bumper Fascia Replacement.



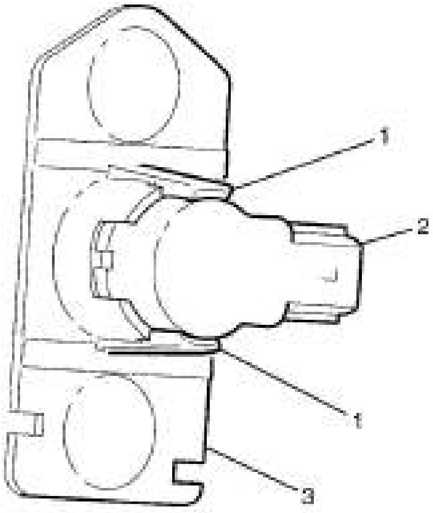
2. Disconnect the front object alarm sensor electrical connector (1) from the front object alarm sensor (2).



Important: Lift the top and bottom housing tabs (1) to release the front object alarm sensor (2) from the front object alarm sensor housing (3).

3. Remove the front object alarm sensor (2) from the front object alarm sensor housing (3).

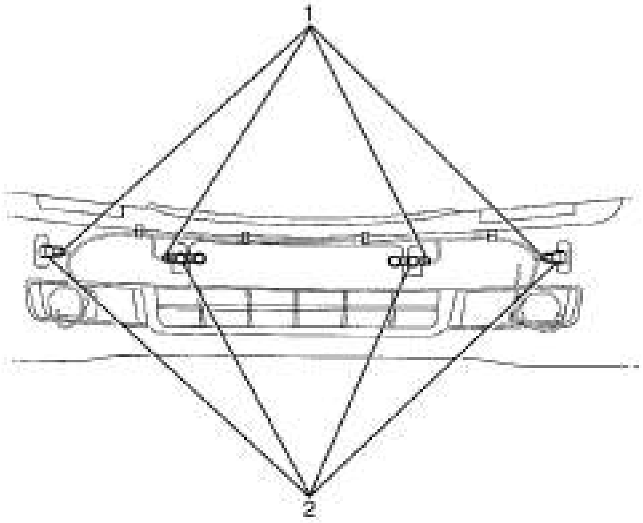
Installation Procedure - Sensor Front



Important: Replacement front object alarm sensors (2) are not pre-painted, they will require painting before installation is carried out.

Important: Ensure that the front object alarm sensor (2) is installed correctly.

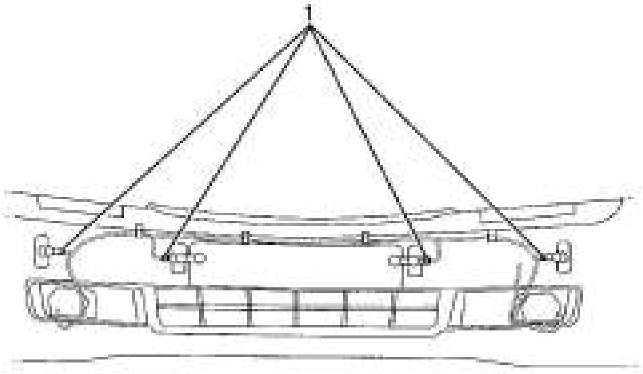
1. Locate the top and bottom housing tabs (1) to install the front object alarm sensor (2) to the front object alarm sensor housing (3).
2. Press the front object alarm sensor bezel flush to the fascia.



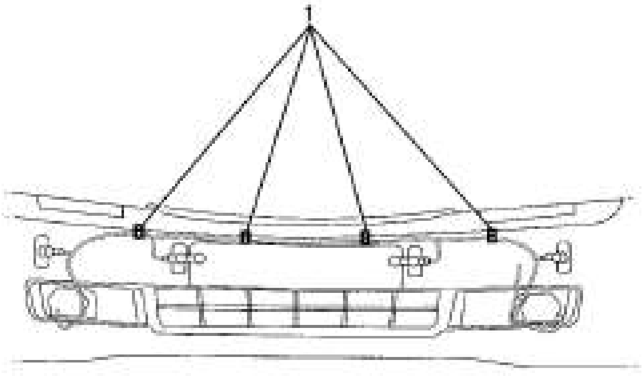
3. Connect the front object alarm sensor electrical connector (1) to the front object alarm sensor (2).
4. Install the bumper fascia assembly. Refer to Front Bumper Fascia Replacement.

Removal Procedure - Wiring Harness Front

1. Remove bumper fascia assembly. Refer to Front Bumper Fascia Replacement.



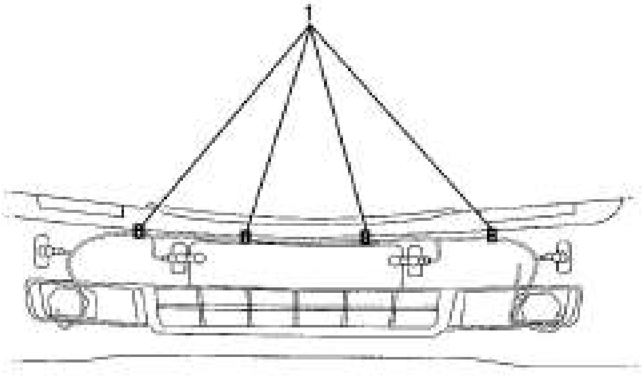
2. Disconnect the front object alarm sensor electrical connectors (1) from the front object alarm sensors.



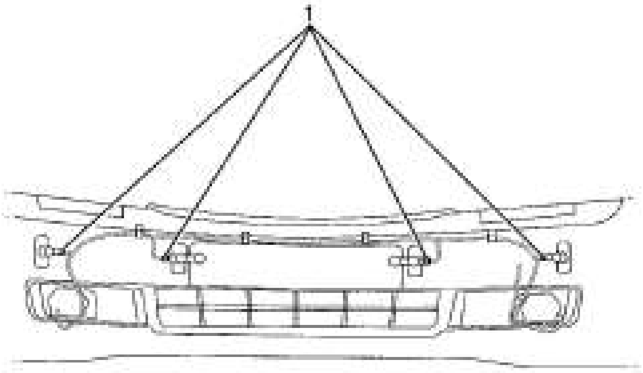
Important: If required use a suitable tool to pry the wiring harness away from bumper fascia connectors (1).

3. Remove the front object alarm sensor wiring harness from the bumper fascia connectors (1).

Installation Procedure - Wiring Harness Front



1. Install the front object alarm sensor wiring harness to the bumper fascia connectors (1).



2. Connect the front object alarm sensor electrical connectors (1) to the front object alarm sensors.
3. Install the front bumper. Refer to Front Bumper Fascia Replacement.

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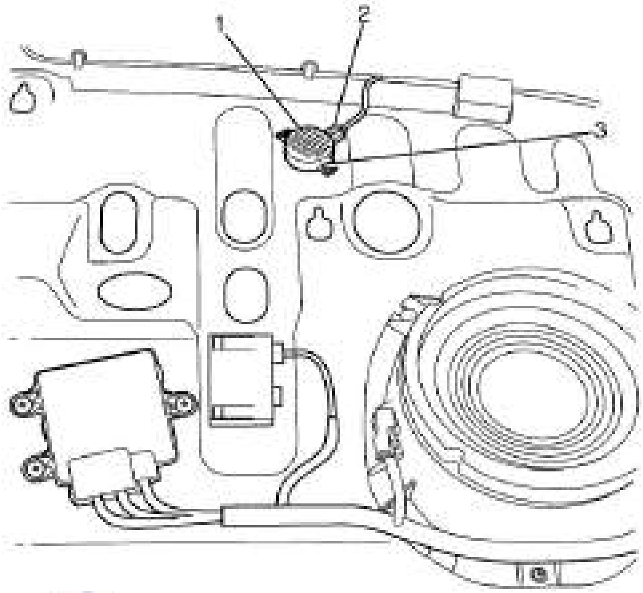
Rear Object Alarm Replacement (SWB)

Removal Procedure

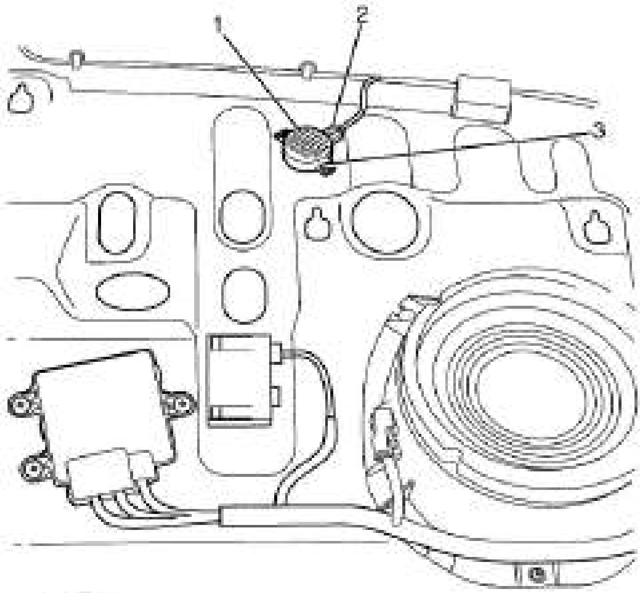
1. Remove the rear window shelf trim panel assembly. Refer to Rear Window Shelf Trim Panel Replacement.



Important: Before removing the rear object alarm (1), make note of its orientation on the rear window shelf.

2. Disconnect the rear object alarm electrical connector (2) from the rear object alarm (1).
3. Remove the rear object alarm retaining clips (3).
4. Remove the rear object alarm (1) from the vehicle.

Installation Procedure



Important: Orientate the rear object alarm (1) in the same position as it was removed.

1. Install the rear object alarm (1) to the vehicle.
2. Install the rear object alarm retaining clips (3).
3. Install the rear object alarm electrical connector (2) to the rear object alarm (1).
4. Install the rear window shelf trim panel assembly. Refer to Rear Window Shelf Trim Panel Replacement.

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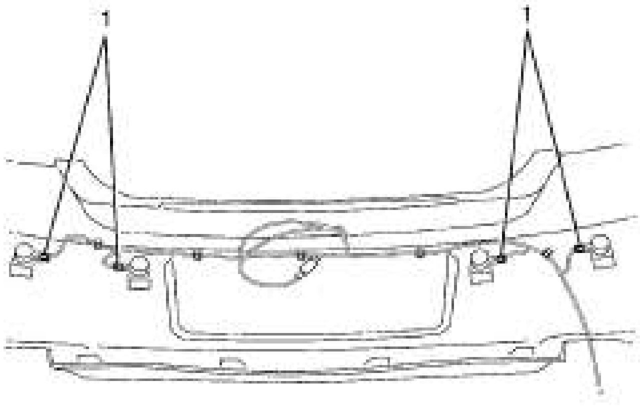
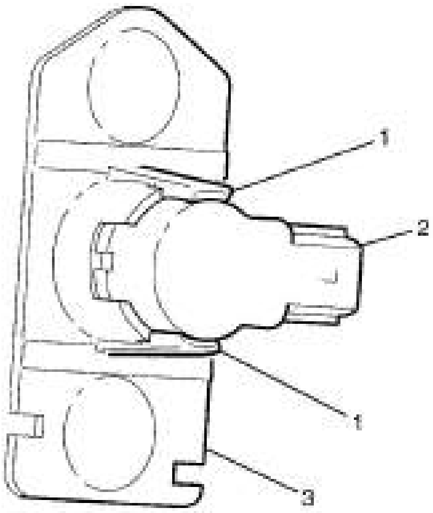
Rear Object Sensor Replacement

Removal Procedure - Sensor Rear

1. Remove the rear bumper fascia assembly. Refer to Rear Bumper Fascia Replacement.



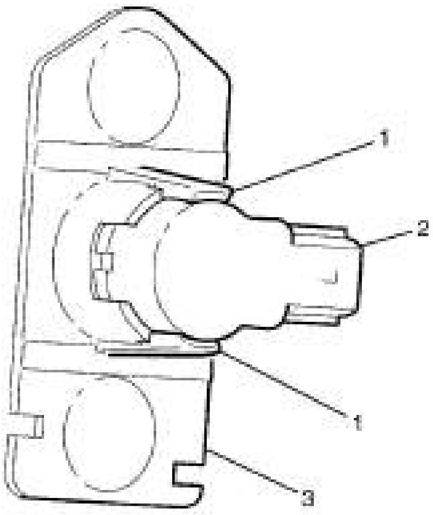
2. Disconnect the rear object alarm sensor electrical connectors (1) from the rear object alarm sensors.



Important: Lift the top and bottom housing tabs (1) to release the rear object alarm sensor (2) from the rear object alarm sensor housing (3).

3. Remove the rear object alarm sensor (2) from the rear object alarm sensor housing (3).

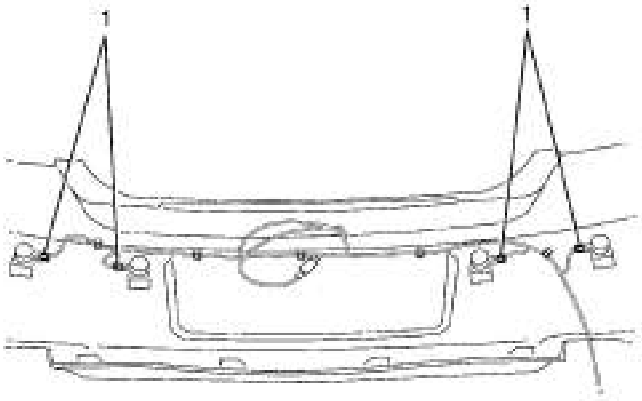
Installation Procedure - Sensor Rear



Important: Replacement rear object alarm sensors (2) are pre-painted in the vehicles body colour. Do not apply any further paint to the rear object alarm sensor (2) as this may affect system operation.

Important: Ensure that the rear object alarm sensor (2) is installed correctly.

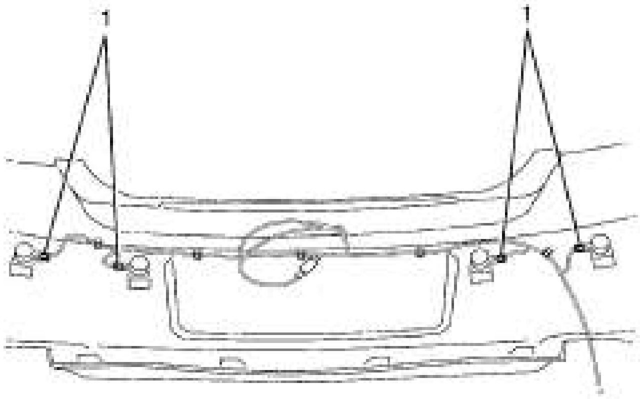
1. Locate the top and bottom housing tabs (1) to install the rear object sensor alarm sensor (2) to the rear object sensor alarm sensor housing (3)
2. Press the rear object alarm sensor bezel flush to the fascia.



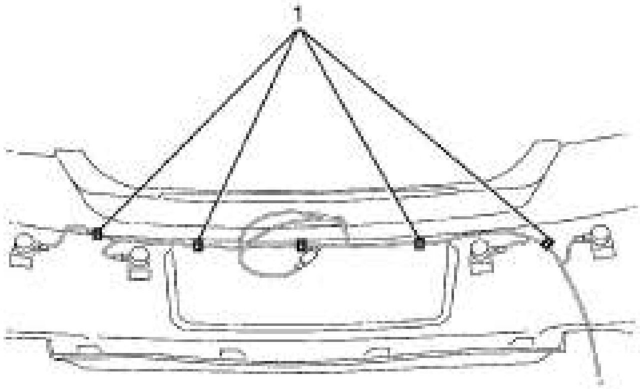
3. Connect the rear object alarm sensor electrical connectors (1) to the rear object alarm sensors.
4. Install the rear bumper fascia assembly. Refer to Rear Bumper Fascia Replacement .

Removal Procedure - Wiring Harness Rear

1. Remove rear bumper fascia assembly. Refer to Rear Bumper Fascia Replacement.



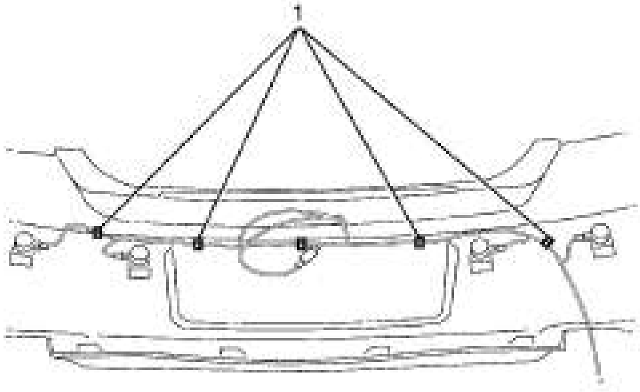
2. Disconnect the rear object alarm sensor electrical connectors (1) from the rear object alarm sensors.



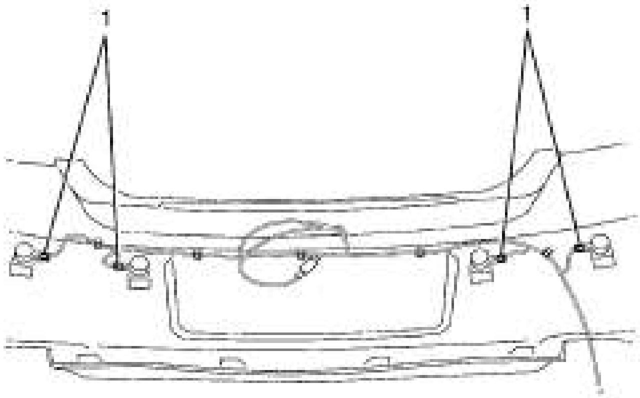
Important: If required use a suitable tool to pry the wiring harness away from bumper fascia connectors (1).

3. Remove the rear object alarm sensor wiring harness from bumper fascia connectors (1).

Installation Procedure - Wiring Harness Rear



1. Install the rear object alarm sensor wiring harness to bumper fascia connectors (1).



2. Connect the rear object alarm sensor electrical connectors (1) to the rear object alarm sensors.
3. Install the rear bumper. Refer to Rear Bumper Fascia Replacement.

Object Detection Description and Operation (UD7)

The rear object detection system consists of four object alarm sensors located in the rear bumper, a object alarm module, an object alarm speaker, and a switch. The object detection system is designed to identify and notify the driver of an object in the path of the vehicle. The distance and location of the object is determined by the alarm sensors.

Object Alarm Module

The object alarm module provides an 8 V reference and a low reference to each of the object alarm sensors. The object alarm module contains the logic needed to receive the individual signals from each of the sensors and determine the location and distance of an object. As the vehicle gets closer to an object the object alarm speaker will sound.

Object Alarm Sensors

The ultrasonic sensors are located in the rear bumper of the vehicle. The sensors are used to determine the distance between an object and the bumper. When the transmission is in reverse the rear sensors are activated. Each sensor emits an ultrasonic frequency which is reflected off an object located behind the vehicle, the reflections are received by the sensors. The time difference between when the frequency was emitted and when the reflection is received is used to determine the distance to the object. This information is sent to the object alarm module.

Object Alarm Speaker

The object alarm speaker will sound when the ultrasonic sensors detect an object in the vehicles path. The following table shows the object distance from the vehicle and the tone duration of the object alarm speaker.

Rear Object Detection System Tone Activation

Object Distance (MM)	Tone Duration ON (MS)	Tone Duration OFF (MS)
Less than 300	Continuous	
300-600	75	75
600-900	75	150
900-1200	75	225
1200-1500	75	300
1500-1800	75	375
1800-2100	75	450
2100-2500	75	525

Object Detection Switch

The object detection switch is equipped with a light that will illuminate when the system is activated. The switch allows the driver to manually enable or disable the object detection system. The switch light will flash rapidly when it is pressed if there is a malfunction present with the object detection system.

Object Detection Operation

The rear object detection system is automatically activated when the vehicle ignition is on, the park brake is released and the transmission is in reverse. When the transmission is in reverse the rear sensors will activate and the object alarm speaker will sound. If the object alarm speaker does not sound there is a malfunction with the object detection system. The object detection system will automatically deactive when the vehicle speed exceeds 25 km/h (15 mph).

Objects attached to the vehicle

If an object is attached to the vehicle, the object detection system will automatically deactivate approximately 10 seconds after the vehicle speed exceeds 15 km/h (9 mph). The object detection will be reactivated automatically when the object is removed or the ignition is switched OFF and then ON again.

Object Detection Description and Operation (UFR)

Table 1: Rear Object Detection System Tone Activation

Table 2: Front Object Detection System Tone Activation

The dual object detection system is designed to identify and notify the driver of an object in front and at the rear of the vehicle. The dual object detection system consists of an object alarm module, eight object alarm sensors, an object alarm speaker, and a switch. The distance and location of the object is determined by the eight object alarm sensors. Four object alarm sensors are located in the rear bumper and four are located in the front bumper.

Object Alarm Module

The object alarm module provides an 8 V reference and a low reference to each of the object alarm sensors. The object alarm module contains the logic needed to receive the individual signals from each of the sensors and determine the location and distance of an object. As the vehicle gets closer to an object the object alarm speaker will sound.

Object Alarm Sensors

The ultrasonic sensors are located in the front and rear bumpers of the vehicle. The sensors are used to determine the distance between an object and the bumper. When the transmission is in reverse the front and rear sensors are activated. If the front and rear sensors simultaneously detect an object at equal distances the rear sensors will be given priority. When the objects are not at equal distances the object closest to the vehicle will be given priority. Each sensor emits an ultrasonic frequency which is reflected off an object located behind or in front of the vehicle. The reflections are received by the sensors. The time difference between when the frequency was emitted and when the reflection is received is used to determine the distance to the object. This information is sent to the object alarm module.

Object Alarm Speaker

The object alarm speaker will sound when the ultrasonic sensors detect an object in the vehicles path. The following tables shows the object distance from the vehicle and the tone duration of the object alarm speaker.

Rear Object Detection System Tone Activation

Object Distance (MM)	Tone Duration ON (MS)	Tone Duration OFF (MS)
Less than 300	Continuous	
300-600	75	75
600-900	75	150
900-1200	75	225
1200-1500	75	300
1500-1800	75	375
1800-2100	75	450
2100-2500	75	525

Front Object Detection System Tone Activation

Object Distance MM	Tone Duration ON (MS)	Tone Duration OFF (MS)
Less than 300	Continuous	0
300-600	75	75
600-900	75	225
900-1200	75	450

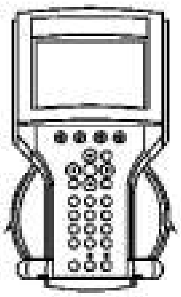
Object Detection Switch

The object detection switch is equipped with a light that will illuminate when the system is activated. The switch allows the driver to enable or disable the object detection system. The switch light will flash rapidly when it is pressed if there is a malfunction present with the object detection system.

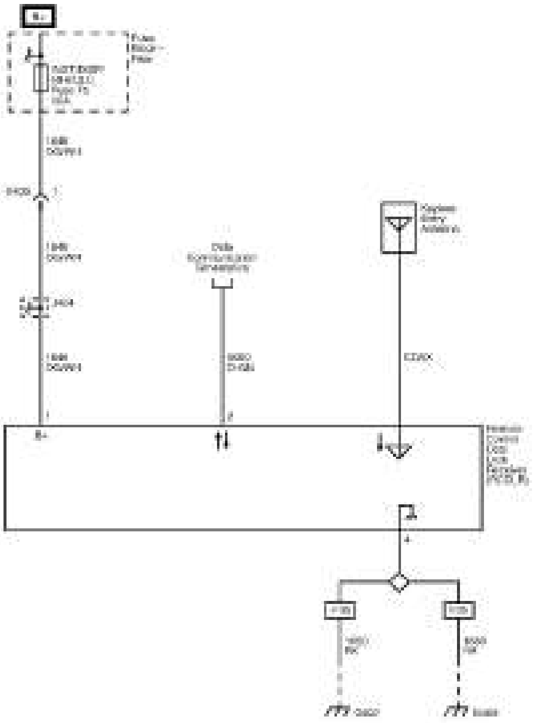
Object Detection Operation

The object detection system is automatically activated when the vehicle ignition is on, the park brake is released and the transmission is in reverse or drive. When the transmission is in drive the front sensors will activate and the object alarm speaker will sound. If the transmission is in reverse the front and rear sensors will activate and the object alarm speaker will sound. If the object alarm speaker does not sound there is a malfunction with the object detection system. The object detection system will automatically deactive when the vehicle speed exceeds 25 km/h (15 mph).

Special Tools

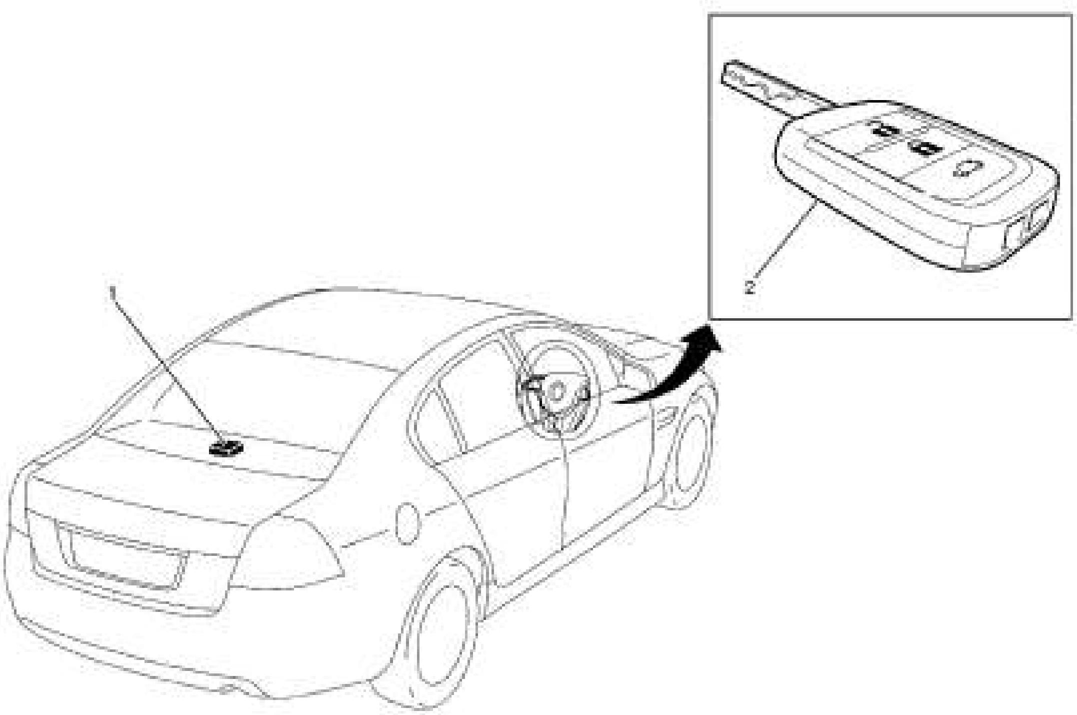
Illustration	Tool Number / Description
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

Remote Function Schematics



Remote Function Component Views (SWBRHD)

Rear of the Vehicle



(1) Remote Function Actuator

(2) Transmitter Key

Diagnostic Starting Point - Keyless Entry

Begin the system diagnosis with Diagnostic System Check - Vehicle. The Diagnostic System Check will provide the following information:

- The identification of the control module(s) which command the system
- The ability of the control module(s) to communicate through the serial data circuit
- The identification of any stored diagnostic trouble codes (DTCs) and their status

The use of the Diagnostic System Check will identify the correct procedure for diagnosing the system and where the procedure is located.

DTC B3105

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B3105: Keyless Entry System Key Not Programmed

Circuit / System Description

DTC B3105 sets if the remote function actuator (RFA) has not learned any key.

Conditions for Running the DTC

The RFA system must be enabled and a test is ran every time the key is cycled.

Conditions for Setting the DTC

This code is set if there are no learned key in the RFA.

Action Taken When the DTC Sets

The RFA system is inoperative.

Conditions for Clearing the DTC

The code is cleared as current when at least one key is programmed to the RFA.

Reference Information

Schematic Reference

Remote Function Schematics .

Connector End View Reference

Component Connector End Views .

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Testing

1. Verify that the transmitter is the correct type for the vehicle.
   If it is not the correct transmitter, replace the transmitter.
2. Verify the scan tool KEY Programmed parameter is Yes.
   If not Yes, program the transmitter.
3. Using scan tool, verify transmitter is transmitting signal when each button is pressed.
   If scan tool fails to indicate signal from transmitter, replace transmitter battery.

   If scan tool indicates a signal from one or more button presses, replace the transmitter.
4. Replace the RFA module.

Repair Instructions

Perform the Diagnostic Repair Verification .

Refer to Control Module References .

DTC B3109

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B3109: Keyless Entry Transmitter 1 or Generic Low Battery

Circuit / System Description

This fault sets if the key programmed to slot 1 has a low battery.

Conditions for Running the DTC

The remote function actuation (RFA) system must be enabled.

Conditions for Setting the DTC

The code sets after 3 consecutive low battery signals from the same programmed transmitter.

Action Taken When the DTC Sets

The RFA system is inoperative.

Conditions for Clearing the DTC

The code is cleared as current when a normal transmitter voltage signal is received from any programmed transmitter.

Reference Information

Schematic Reference

Remote Function Schematics .

Connector End View Reference

Component Connector End Views .

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Testing

1. Replace the batteries in the transmitter and with the scan tool clear the DTC.
2. Operate the transmitter three consecutive times.
   If the DTC sets again, test the battery connections for an open/high resistance.
3. If all circuits test normal, test or replace the transmitter.

Repair Instructions

Perform the Diagnostic Repair Verification .

DTC B3110

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B3110: Keyless Entry Transmitter 2 or Generic Low Battery

Circuit / System Description

This fault sets if the key programmed to slot 2 has a low battery.

Conditions for Running the DTC

The remote function actuation (RFA) system must be enabled.

Conditions for Setting the DTC

The code sets after 3 consecutive low battery signals from the same programmed transmitter.

Action Taken When the DTC Sets

The RFA system is inoperative.

Conditions for Clearing the DTC

The code is cleared as current when a normal transmitter voltage signal is received from any programmed transmitter.

Reference Information

Schematic Reference

Remote Function Schematics .

Connector End View Reference

Component Connector End Views .

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Testing

1. Replace the batteries in the transmitter and with the scan tool clear the DTC.
2. Operate the transmitter three consecutive times.
   If the DTC sets again, test the battery connections for an open/high resistance.
3. If all circuits test normal, test or replace the transmitter.

Repair Instructions

Perform the Diagnostic Repair Verification .

DTC B3111

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B3111: Keyless Entry Transmitter 3 or Generic Low Battery

Circuit / System Description

This fault sets if the key programmed to slot 3 has a low battery.

Conditions for Running the DTC

The remote function actuation (RFA) system must be enabled.

Conditions for Setting the DTC

The code sets after 3 consecutive low battery signals from the same programmed transmitter.

Action Taken When the DTC Sets

The RFA system is inoperative.

Conditions for Clearing the DTC

The code is cleared as current when a normal transmitter voltage signal is received from any programmed transmitter.

Reference Information

Schematic Reference

Remote Function Schematics .

Connector End View Reference

Component Connector End Views .

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Testing

1. Replace the batteries in the transmitter and with the scan tool clear the DTC.
2. Operate the transmitter three consecutive times.

   If the DTC sets again, test the battery connections for an open/high resistance.
3. If all circuits test normal, test or replace the transmitter.

Repair Instructions

Perform the Diagnostic Repair Verification .

DTC B3112

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B3112: Keyless Entry Transmitter 4 or Generic Low Battery

Circuit/System Description

This fault sets if the key programmed to slot 4 has a low battery.

Conditions for Running the DTC

The remote function actuation (RFA) system must be enabled.

Conditions for Setting the DTC

The code sets after 3 consecutive low battery signals from the same programmed transmitter.

Action Taken When the DTC Sets

The RFA system is inoperative.

Conditions for Clearing the DTC

The code is cleared as current when a normal transmitter voltage signal is received from any programmed transmitter.

Reference Information

Schematic Reference

Remote Function Schematics .

Connector End View Reference

Component Connector End Views .

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Testing

1. Replace the batteries in the transmitter and with the scan tool clear the DTC.
2. Operate the transmitter three consecutive times.
   If the DTC sets again, test the battery connections for an open/high resistance.
3. If all circuits test normal, test or replace the transmitter.

Repair Instructions

Perform the Diagnostic Repair Verification .

Keyless Entry System Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit/System Description

The keyless entry system is a vehicle entry device. The keyless entry will unlock the vehicle doors or open the rear compartment when a corresponding button on the keyless entry transmitter is pressed. This is accomplished by the keyless entry transmitter sending a radio frequency to the remote control door lock receiver (RCDLR). The RCDLR interprets the signal and activates the requested function via a message over the GMLAN serial data line. A low transmitter battery or radio frequency (RF) interference from aftermarket devices such as 2-way radios, power inverters, cellular phone chargers, computers, etc. may cause a system malfunction. High RF traffic areas, such as gas stations which use pay-at-the-pump RF transponders, may also cause interference that could lead to a malfunction.

Diagnostic Aids

For the J 43241 Keyless Entry Tester, inspect the keyless entry transmitter part number to determine that it is the correct model for the vehicle. A wrong model transmitter may pass the test, but it will not activate the vehicle remote system.

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Keyless Entry System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections

- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 43241 Keyless Entry Tester

Circuit/System Verification

Attempt to program the keyless entry transmitter, refer to Transmitter Programming. The transmitter should program.

Circuit/System Testing

1. Verify that the transmitter is the correct transmitter for the vehicle.
   If not the correct transmitter, replace the transmitter.
2. Verify the scan tool Remote Key parameter for the appropriate transmitter is Programmed.
   If not the specified value, program the transmitter. Refer to Transmitter Programming.
3. Place the transmitter on the test pad of the J 43241 and press each transmitter button one at a time. The tester should sound a tone and illuminate a green light with each button press.
   If one or more buttons does not sound the tone and illuminate the green light, replace the transmitter battery and retest with the J 43241 . If the condition continues after battery replacement, replace the transmitter.
4. Operate the transmitter while observing the scan tool Remote Key Function parameter for the appropriate transmitter. The parameter should correspond with the function selected on the transmitter.
   If the parameter does not match the function selected on the transmitter, replace the transmitter.
5. Attempt to program the transmitter, refer to Transmitter Programming. The transmitter should program.
   If the transmitter does not program, test the keyless entry coax and/or antenna (if equipped) for a short to ground or an open/high resistance. If the circuit tests normal, replace the RCDLR.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Transmitter Programming
- Control Module References for RCDLR replacement, setup, and programming

Remote Vehicle Start Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of each diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit/System Description

Remote vehicle start (RVS) begins as an RF message received by the remote control door lock receiver (RCDLR) from a keyless entry transmitter. The RVS request is sent by the RCDLR to the body control module (BCM) via serial data. The BCM monitors system conditions such as content theft deterrent (CTD), hood ajar status, and body DTCs to determine if an RVS event will occur. If conditions are determined to be acceptable, the RVS message is sent to the engine control module (ECM). The ECM monitors system conditions such as engine control parameters and vehicle theft deterrent (VTD) to determine if engine starting will be allowed. If conditions are acceptable, the ECM will initiate engine starting. During the engine run time in a RVS attempt, before the operator enters the vehicle, the ECM may discontinue engine operation if system conditions require it or a message is received from the BCM requesting the engine be turned OFF.

Diagnostic Aids

Important: If the vehicle has a current vehicle DTC that illuminates the malfunction indicator lamp (MIL), the cause of the DTC must be diagnosed before proceeding with the Remote Vehicle Start Inoperative diagnostic.

The RVS system will not operate if any of the following conditions are present:

- A current vehicle DTC that illuminates the malfunction indicator lamp (MIL)
- The vehicle is in valet mode.
- More than 2 remote starts have been attempted.
- The hazard switch is in the ON position.
- A current hazard switch DTC is set.
- The vehicle hood is ajar.
- A current hood ajar DTC is set.
- The CTD system detects an alarm trigger.
- Excessive engine RPM
- Excessive coolant temperature
- Accelerator pedal position greater than 0 percent
- Vehicle not in park
- Vehicle theft deterrent malfunction
- A current automatic transmission shift lock control system DTC is set.
- A vehicle speed sensor signal is detected by the ECM.

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Keyless Entry System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Verify that RVS is enabled through vehicle personalization.

   If RVS is not enabled, use vehicle personalization to turn on RVS functionality. Refer to the vehicle owners manual.
2. Verify that the keyless entry functions operate with all available keyless entry transmitters.

   If the keyless entry system does not function properly, refer to Keyless Entry System Malfunction.
3. Observe the scan tool ECM and BCM RVS Disable History parameters, Verify that no RVS Disable History items are present.

   If RVS Disable History items are present, refer to the appropriate subsection in which the failure occurred.
4. Verify the scan tool BCM Current CTD Trigger parameter displays None.

   If not specified value, refer to Content Theft Deterrent Malfunction.

Symptoms - Keyless Entry

Important: The following steps must be completed before using the symptom tables.

1. Perform Diagnostic System Check - Vehicle before using the Symptom Tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to Keyless Entry System Description and Operation.

Visual / Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the Keyless Entry System. Refer to Checking Aftermarket Accessories.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

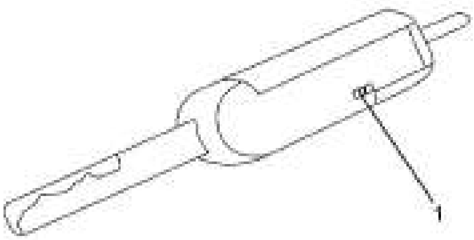
- Keyless Entry System Malfunction
- Remote Vehicle Start Malfunction

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Safety and Security | Remote Functions | Repair Instructions | **Document ID: 1995572**

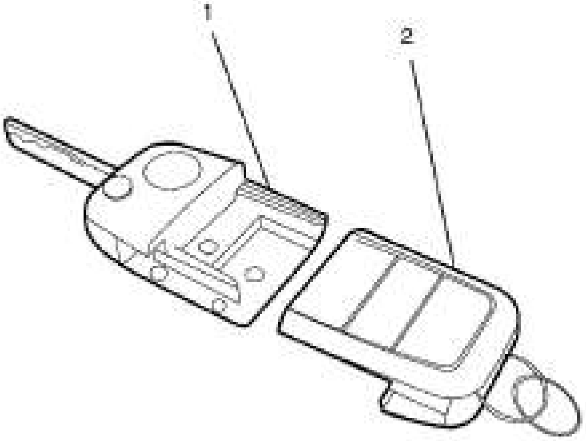
Transmitter Battery Replacement

Removal Procedure

Important: Replacement of the transmitter battery should only be carried out by your authorised Holden dealer.



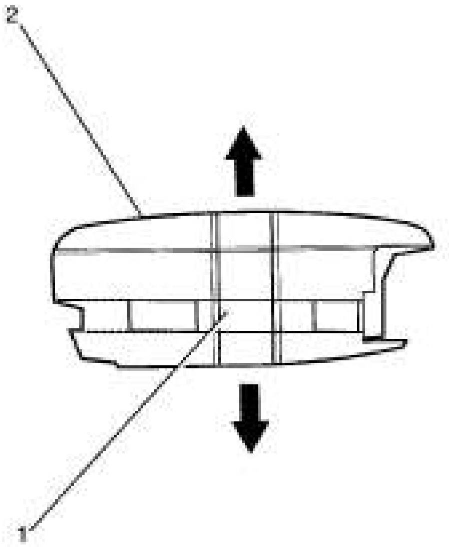
1. Insert a suitable tool between the two key halves (1).



Important: Do NOT twist the tool as damage to the key retaining tang will occur.

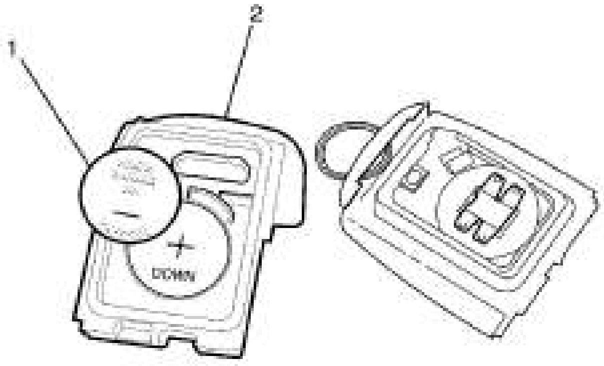
Important: While inserting the tool, push the remote half (2) away from the key half (1).

2. Separate the two key halves (1, 2).



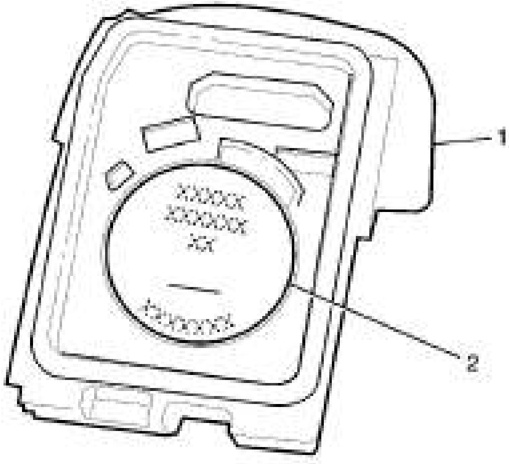
Important: Replace the battery when the range of the transmitter decreases to less than 7 m (23 ft).

3. Insert a suitable tool between the two halves (1) of the transmitter case (2), as shown in illustration.
4. Separate the two halves of the transmitter case (2).



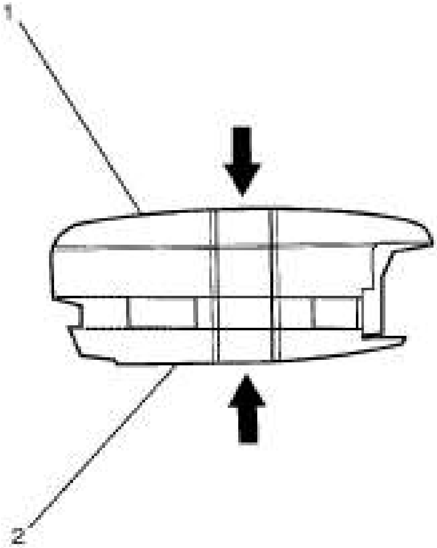
5. Remove the battery (1) from the transmitter case (2).

Installation Procedure

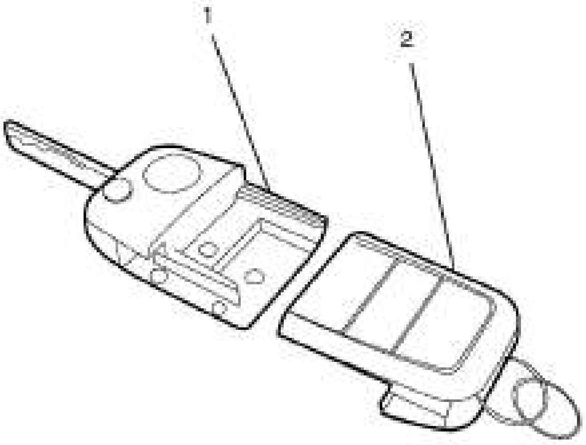


Important: Transfer the battery directly from the blister pack to the fob. Avoid finger contact with battery.

1. Install the transmitter battery (2) inside of the transmitter case (1) with the positive (+) side down.



2. Marry both halves of the transmitter case (1, 2).
3. Close the transmitter case, listen for an audible click to confirm fitting.



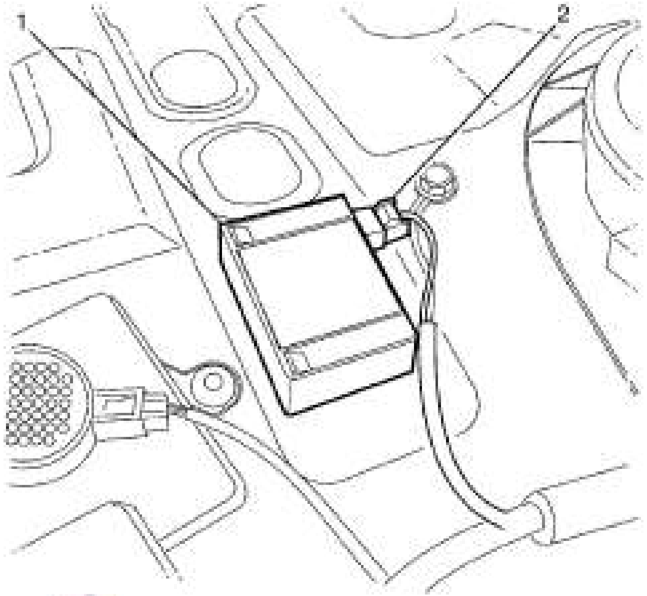
4. Marry the two halves (1 and 2) of the key by firmly pushing the two together, listen for an audible click to confirm fitting
5. Synchronize the transmitter. Refer to Transmitter Programming.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Safety and Security | Remote Functions | Repair Instructions | Document ID: 2126725

Remote Control Door Lock Receiver and Theft Deterrent Module Replacement (Sedan)

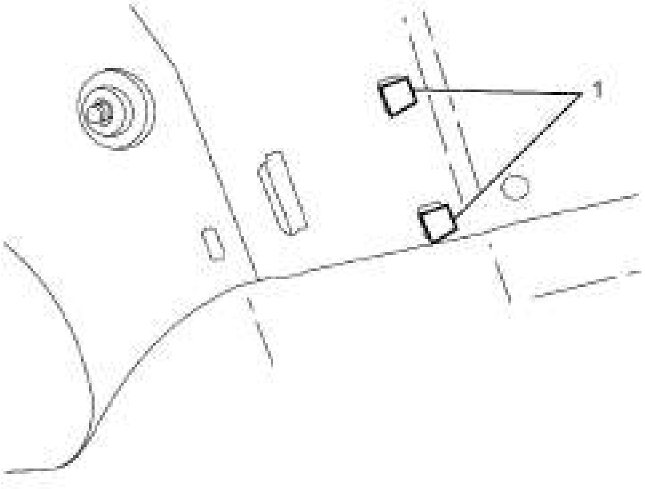
Removal Procedure

1. Remove the rear window shelf. Refer to Rear Window Shelf Trim Panel Replacement in Interior Trim.



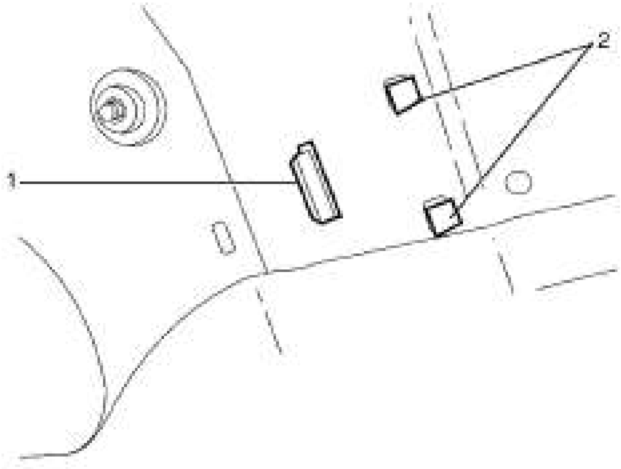
2. Disconnect the remote function actuator (RFA) (1) electrical connector (2).

Notice: Refer to General Repair Instructions in the Preface section.

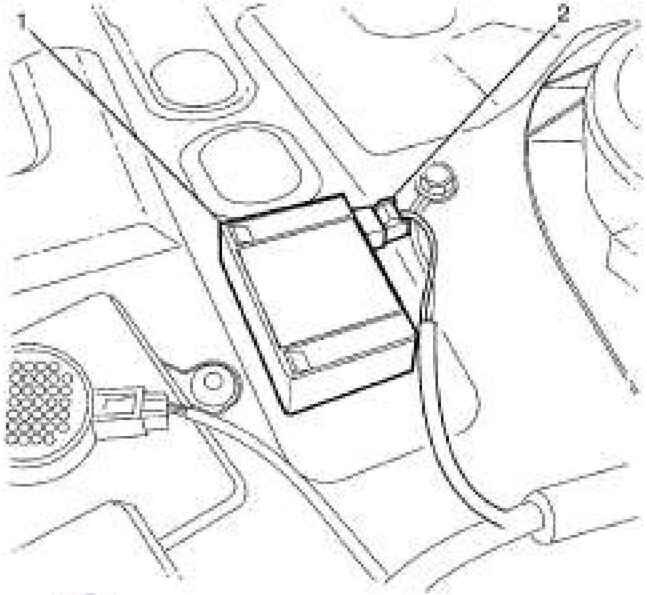


3. Remove the RFA by releasing the two retaining tangs (1) and removing it from the rear window shelf.

Installation Procedure



1. Install the RFA by inserting the retaining tang (1) first and snap fitting the other two retaining tangs (2) listen for an audible click to confirm fitting.



2. Connect the RFA (1) electrical connector (2).
3. Install the rear window shelf. Refer to Rear Window Shelf Trim Panel Replacement in Interior

Trim.

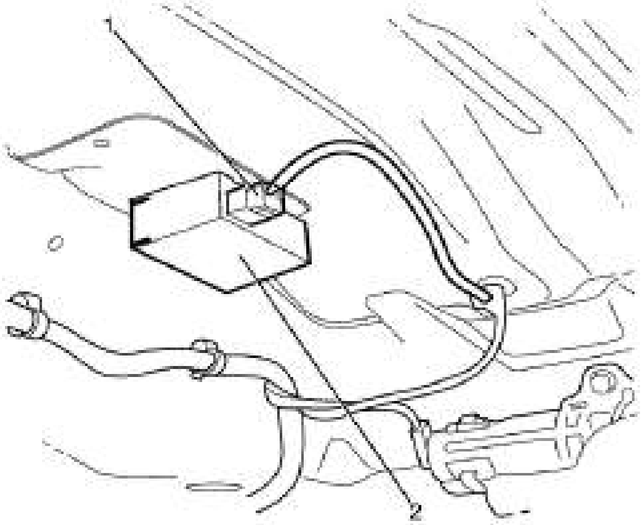
4. Program the RFA. Refer to Remote Control Door Lock Receiver and Theft Deterrent Module Programming and Setup.
5. Operate the keyless entry for correct operation.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Safety and Security | Remote Functions | Repair Instructions | **Document ID: 2126727**

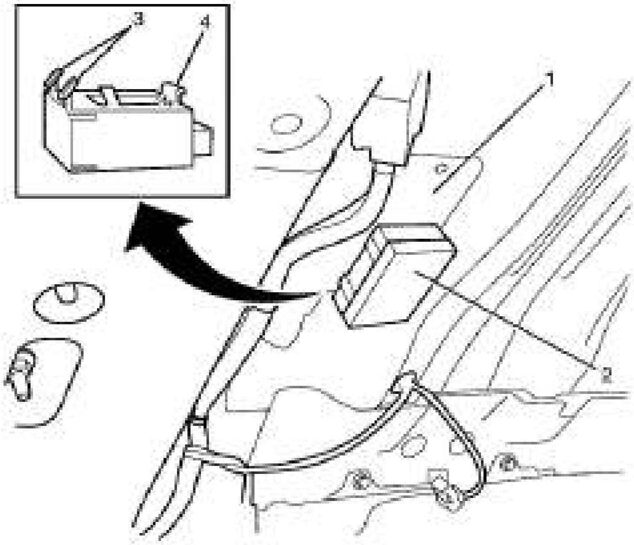
Remote Control Door Lock Receiver and Theft Deterrent Module Replacement (Sportwagon)

Removal Procedure

1. Remove the headliner. Refer to Headlining Trim Panel Replacement.



2. Disconnect the remote function actuator (RFA) electrical connector (1) from the RFA module (2).

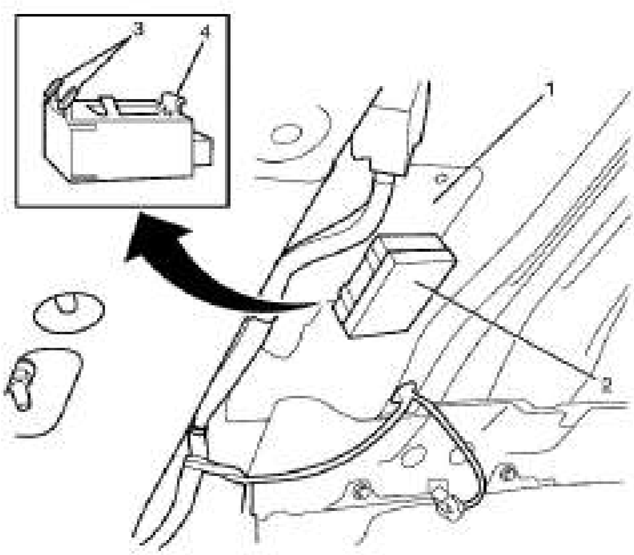


3. Apply suitable pressure to the RFA module retainers (3) and disengage the RFA module (2)

from the roof mounting (1).

4. Pivot the RFA module (2) down to disengage the RFA module retainer (4) from the roof mounting (1).
5. Remove the RFA module (2) from the vehicle.

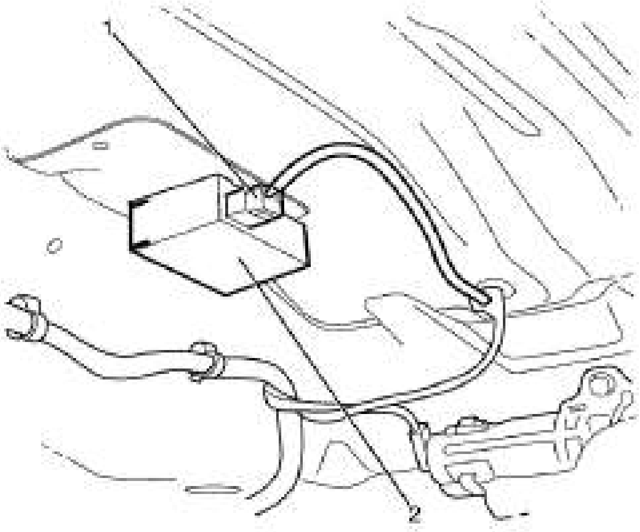
Installation Procedure



1. Install the RFA module retainer (4) to the roof mounting (1).

   Important: Listen for an audible click to confirm correct installation of the RFA module (2).

2. Pivot the RFA module (2) upward and apply suitable upward pressure. Make sure that the RFA module retainers (3) engage into the roof mounting (1).



3. Connect the RFA electrical connector (1) to the RFA module (2).
4. Program the RFA module (2). Refer to Remote Control Door Lock Receiver and Theft Deterrent Module Programming and Setup.
5. Operate the keyless entry to confirm correct operation.
6. Install the headliner. Refer to Headlining Trim Panel Replacement.

Transmitter Programming

Important: All transmitters which are to be recognized by the remote function actuator (RFA) must be programmed in a single programming sequence. If the system is placed in program mode it will erase all previously programmed transmitters upon the receipt of the programming signal from the first transmitter. Up to 4 transmitters can be programmed. Do not operate or program the transmitters in the vicinity of other vehicles that are in the keyless entry program mode. This prevents the programming of the transmitters to the incorrect vehicle.

1. Install a scan tool.

   Important: When the RFA is programmed the remote key and TPMS sensor data will be erased.

2. Use the scan tool in order to access programming: Body/RFA (Remote Function Actuator)/Programming and select either of the following options:
   - Erase all and program remotes.
   - Add additional remotes.
3. Follow the scan tool on screen instructions.

   Important: The scan tool must stay connected until all of the transmitters are programmed.

4. Press and hold the LOCK button and the UNLOCK button simultaneously on one transmitter. After a delay of 5-10 seconds, the scan tool will indicate that the transmitter is programmed.
5. Repeat the previous step in order to program up to 4 transmitters.
6. Remove the scan tool.
7. Operate the transmitter functions in within the specified range in order to verify correct system operation.
8. Do not cycle ignition. Final key fob may need to be programmed.

Keyless Entry System Description and Operation (Sedan)

The keyless entry system is a supplementary vehicle entry device. Radio frequency interference or discharged batteries may disable the system.

Keyless entry allows you to operate the following features:

- The door locks
- The Remote trunk release - Press and hold the trunk release button to release deck lid. The transmission must be in park for this feature to operate.
- The illuminated entry lamps
- The panic alarm
- Remote start (when installed)

The keyless entry system has the following main components:

- The transmitters
- The Remote Function Actuator (RFA) - When you press a button on the transmitter, the transmitter sends a signal to the RFA. The RFA receives the signal and sends a GMLAN serial data message requesting the appropriate function to the BCM.

Unlock Driver Door Only

Momentarily press the UNLOCK button in order to perform the following functions:

- Unlock the driver door only.
- Illuminate the interior lamps for approximately 20 seconds or until the ignition is turned ON.
- Flash all the direction indicators if the ignition is turned OFF and the doors are closed.
- Identify the driver to the Driver Information Center (DIC). The DIC will then revert to the station presets, the last station, the last volume settings, and the last playback mode used by that driver.

Unlock All Doors - Second Operation

Momentarily press the UNLOCK button a second time, within 5 seconds of the first press, in order to perform the following functions:

- Unlock all of the doors.
- Illuminate the interior lamps for approximately 20 seconds or until the ignition is turned ON.

Lock All Doors

Press the LOCK button in order to perform the following functions:

- Lock all of the doors.
- Immediately turn OFF the interior lamps.
- Flash the indicators if the ignition is OFF and the doors are closed.
- Chirp the horn if the ignition is OFF and the doors are closed.

Panic Alarm Function

A single press of the panic button performs the following functions:

- Illuminates the interior lamps
- Pulses the horn
- Powers up the daytime running lamps for 2 minutes or until the following conditions occur:
  - The panic button is pressed again.
  - The ignition switch is turned to the RUN position with a valid key.

Press and hold the panic button performs the following functions:

- The horn will sound continuously
- The turn signals will flash

This will continue until the button is pressed again or until the key is placed in the ignition.

Keyless Entry System Description and Operation (Sportwagon)

The keyless entry system is a supplementary vehicle access device. Radio frequency interference or discharged batteries may disable the system.

Keyless entry allows you to operate the following features:

- Door locks.
- Liftgate lock.
- Fuel tank filler door.
- Illuminated entry lamps.
- Panic alarm.

The keyless entry system has the following main components:

- Transmitters -- When a button on the transmitter is pressed, the transmitter sends a signal to the remote function actuator.
- Remote function actuator (RFA) - The RFA receives a signal from the transmitter and sends a GMLAN serial data message requesting the BCM to perform the appropriate functions.

Unlock All Doors (second stage unlocking disabled)

Momentarily press the UNLOCK button in order to perform the following functions:

- Unlock all the doors.
- Unlock the liftgate.
- Unlock the fuel tank filler door.
- Illuminate the dome lamp/lamps for approximately 20 seconds, or until the ignition is turned ON.
- Chirps the horn if the ignition is OFF and the doors are closed (when enabled via customisation menu).
- Flash the turn signal lamps, if the ignition is turned OFF and the doors are closed (if enabled via customisation menu).
- Identify the personalization setting to the Driver Information Centre (DIC). The DIC will then revert to the last IRC, IPC, HVAC setting used previously.

Unlock Driver Door Only (second stage unlocking enabled)

Momentarily press the UNLOCK button in order to perform the following functions:

- Unlock the driver door only.
- Unlock the fuel tank filler door.

- Illuminate the dome lamp/lamps for approximately 20 seconds, or until the ignition is turned ON.
- Flash the turn signal lamps, if the ignition is turned OFF and the doors are closed (when enabled via customisation menu).
- Identify the personalization setting to the Driver Information Centre (DIC). The DIC will then revert to the last IRC, IPC, HVAC setting used previously.

Unlock Passenger Doors - Second Operation (second stage unlocking enabled)

Momentarily press the UNLOCK button a second time, within 10 seconds of the first press, in order to perform the following functions:

- Unlock all the passenger doors.
- Unlock the liftgate.
- Illuminate the dome lamp/lamps for approximately 20 seconds or until the ignition is turned ON.

Lock All Doors

Momentarily press the LOCK button in order to perform the following functions:

- Lock all the doors.
- Lock the liftgate.
- Lock fuel tank filler door.
- Immediately turns OFF the dome lamp/lamps.
- Flashes the turn signal lamps if the ignition is OFF and the doors are closed (when enabled via customisation menu).
- Chirps the horn if the ignition is OFF and the doors are open (when enabled via customisation menu).

Panic Alarm Function

A single press of the panic button will perform the following functions:

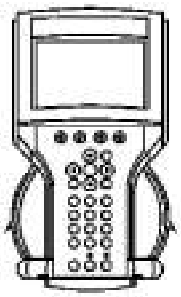
- Pulses the horn.
- Flash the turn signal lamps.

Pressing and holding the panic button will perform the following functions:

- Continuously sound the horn for 30 seconds.
- Flash the turn signal lamps.
- Illuminate the dome lamp/lamps.
- Illuminate the outside rearview mirror courtesy lamps (where fitted).
- Illuminate the approach lighting (when enabled via customisation menu).

This will continue until the panic button is pressed again or the key is placed in the ignition lock and turned to the ignition position.

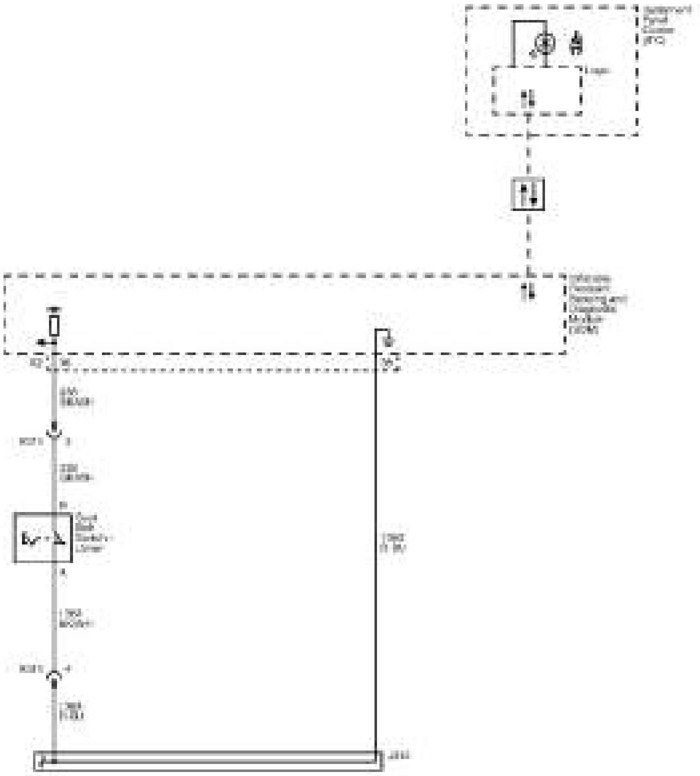
Special Tools

Illustration	Tool Number / Description
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

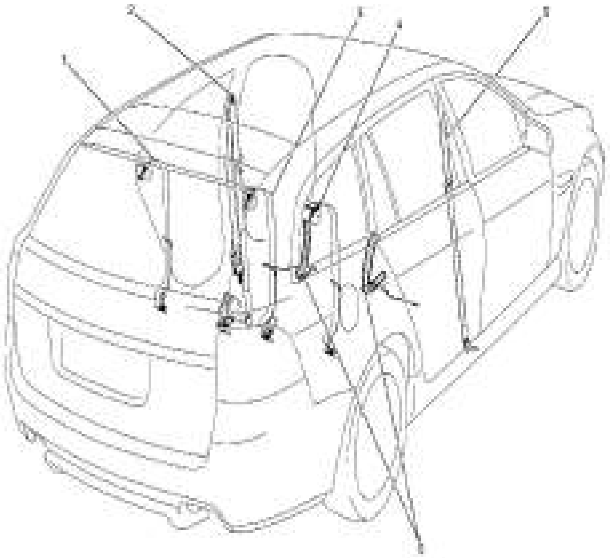
Fastener Tightening Specifications

Application	Specification	
	Metric	English
Centre Seat Belt Retractor Fastener	43 N·m	32 lb ft
Centre/Left Rear Seat Belt Buckle Nut (Sportwagon)	43 N·m	32 lb ft
Child Restraint Anchor to Parcel Shelf Retaining Bolt	20 N·m	15 lb ft
Front Seat Belt Height Adjuster to Pillar Retaining Bolts	30 N·m	22 lb ft
Front Seat Belt Lower Anchor to Body Retaining Bolt	43 N·m	32 lb ft
Front Seat Belt Retractor to Pillar Retaining Bolts	43 N·m	32 lb ft
Front Seat Intermediate Guide to Pillar Retaining Screws	3 N·m	27 lb in
Front Seat Upper Guide to Body Retaining Bolt (Adjustable D-ring)	43 N·m	32 lb ft
Intermediate Seat Belt Guide to Vehicle (LHD)	2 N·m	18 lb in
Rear Seat Belt Buckle to Body Retaining Nuts	43 N·m	32 lb ft
Rear Seat Belt Lower Anchor to Body Retaining Bolt	43 N·m	32 lb ft
Rear Seat Belt Retractor to Body Retaining Bolts	43 N·m	32 lb ft
Rear Seat Upper Guide to Body Retaining Bolt	43 N·m	32 lb ft
Seat Belt Retractor to Seat Frame Retaining Nut (Sportwagon)	43 N·m	32 lb ft

Seat Belt Schematics


Instrument Panel Cluster (IPC)
Logic
Inflatable Restraint Sensing and Diagnostic Module (SDM)
Seat Belt Switch - Driver

Seat Belt Component Views (Sportwagon)



(1) Rear Seat Belt (Left Side)

(2) Front Seat Belt (Left Side)

(3) Rear Seat Belt (Centre)

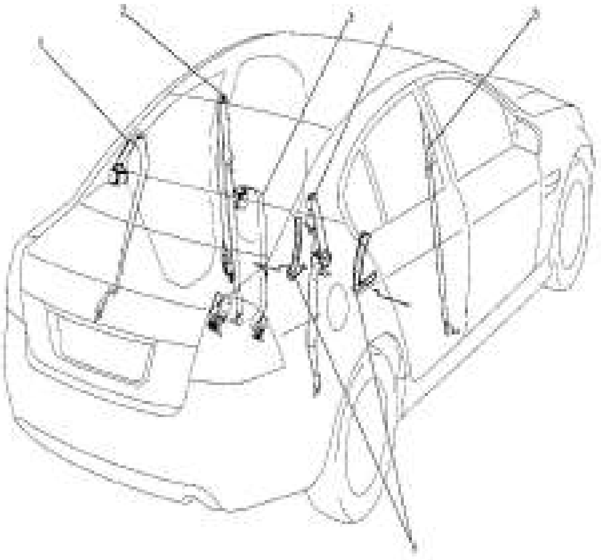
(4) Rear Seat Belt (Right Side)

(5) Front Seat Belt (Right Side)

(6) Front Seat Belt Buckles

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Safety and Security | Seat Belts | Component Locator | **Document ID: 1997467**

Seat Belt Component Views (SWB)



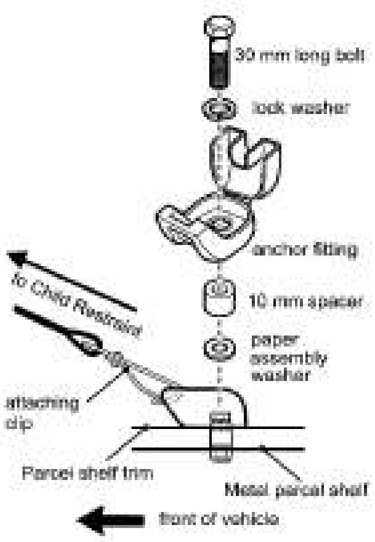
(1) Rear Seat Belt (Left Side)
(2) Front Seat Belt (Left Side)
(3) Rear Seat Belt (Centre)
(4) Rear Seat Belt (Right Side)
(5) Front Seat Belt (Right Side)
(6) Front Seat Belt Buckles

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Safety and Security | Seat Belts | Repair Instructions | **Document ID: 1974931**

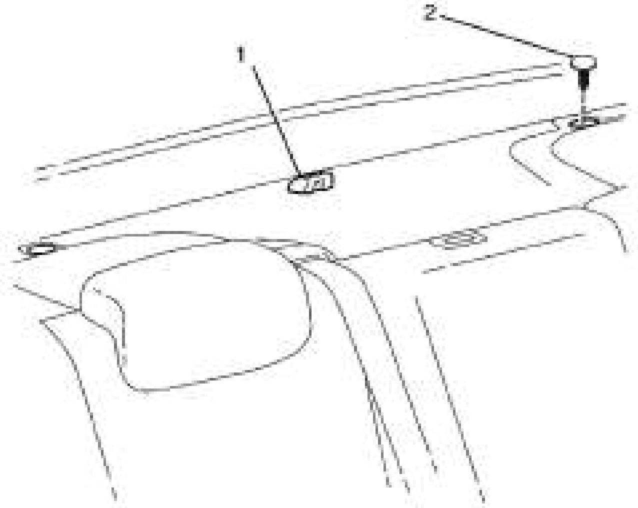
Child Restraint Tether Anchor Replacement (RHD)

Removal Procedure

Important: Do NOT attempt to repair or alter the bracket on the child seat restraint system. If the bracket is damaged, replace the entire bracket. Altering the bracket could result in personal injury.

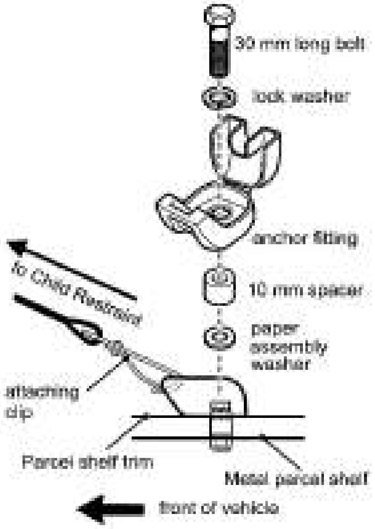

30 mm long bolt
lock washer
anchor fitting
to Child Restraint
10 mm spacer
paper assembly washer
attaching clip
Parcel shelf trim
Metal parcel shelf
front of vehicle

1. Using a suitable tool to open the cap, remove the bolt that retains the child restraint anchor fitting that is being serviced.



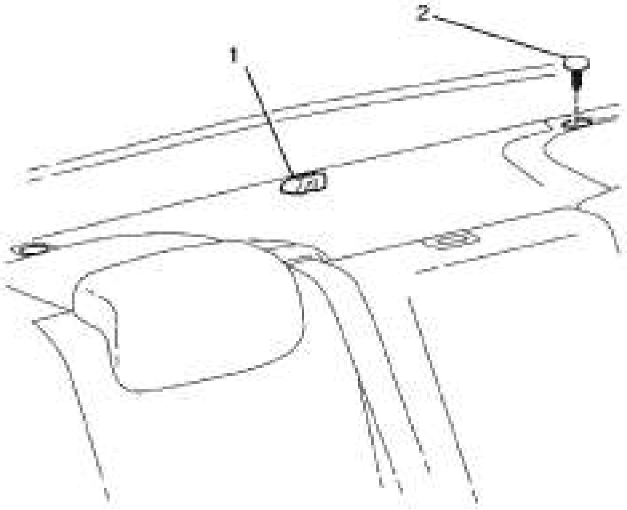
2. Remove the child restraint anchor fitting (1) from the vehicle.

Installation Procedure


30 mm long bolt
lock washer
anchor fitting
10 mm spacer
paper assembly washer
to Child Restraint
attaching clip
Parcel shelf trim
Metal parcel shelf
front of vehicle

1. Install the child restraint anchor fitting to the rear windshield shelf.

Notice: Refer to Component Fastener Tightening Notice in the Preface section.



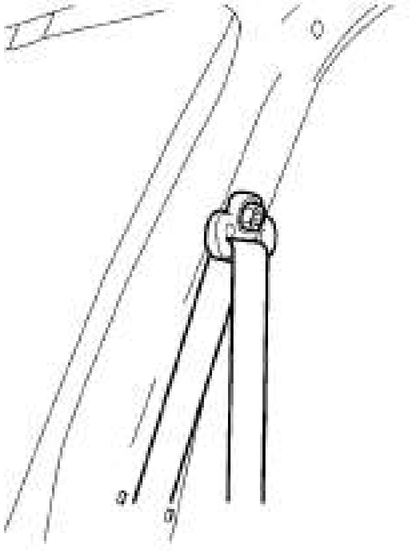
2. Install the child restraint anchor fitting bolt (1).

   Tighten
   Tighten the bolt to 20 N·m (22 lb ft).

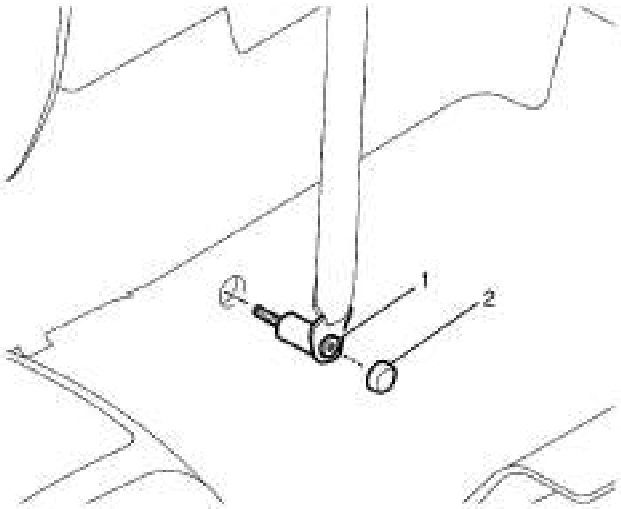
3. Using a suitable tool remove the retaining clip (2) to gain access for installing a secondary child restraint anchor (if required).

Front Seat Belt Replacement

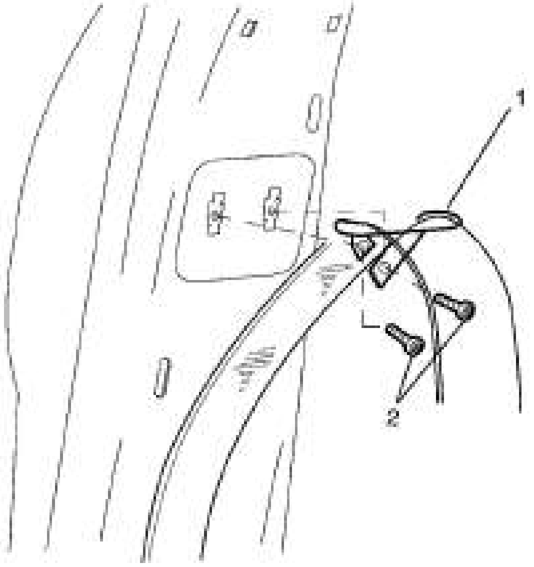
Removal Procedure - Type A (Fixed D-Ring) - Up to 8 Jun 2007



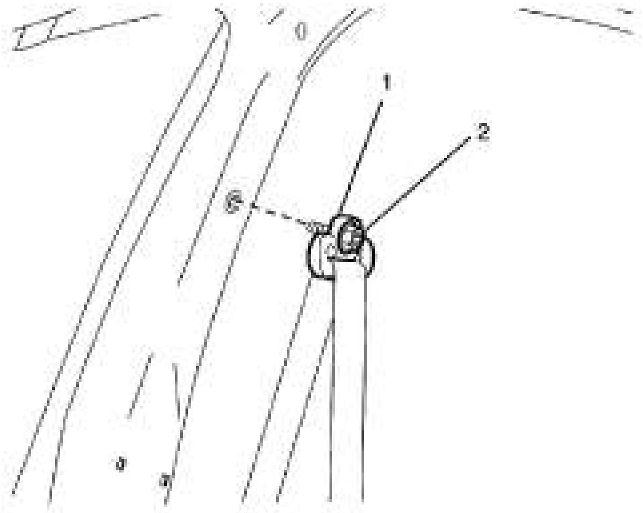
1. Move the seat all the way forward towards the front of the vehicle, to gain access to the seat belt.
2. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement .
3. Remove the front seat rail trim cover. Refer to Front Seat Replacement - Bucket .
4. Remove the front and rear door sill trim plates. Refer to Door Sill Plate Replacement .
5. Remove the lower centre pillar trim plate. Refer to Center Pillar Lower Trim Panel Replacement .
6. Remove the upper centre pillar trim panel. Refer to Center Pillar Upper Trim Panel Replacement .



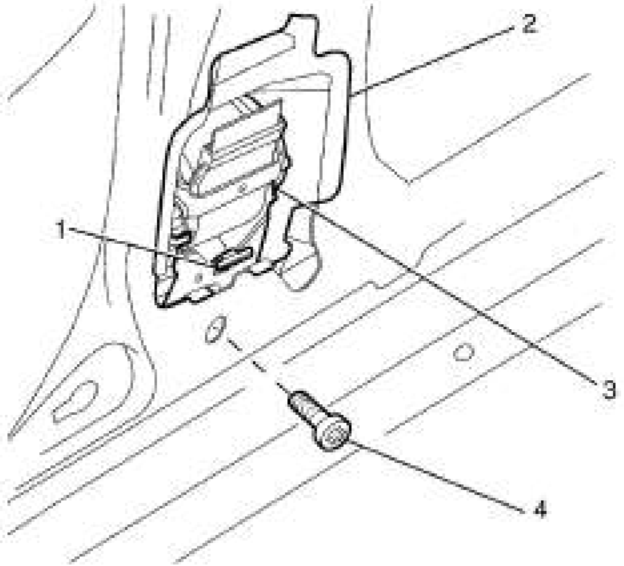
7. Remove the front seat belt lower anchor bolt cover (2).
8. Remove the front seat belt lower anchor assembly (1).



9. Remove the intermediate seat belt guide screws (2).
10. Remove the intermediate seat belt guide (1).

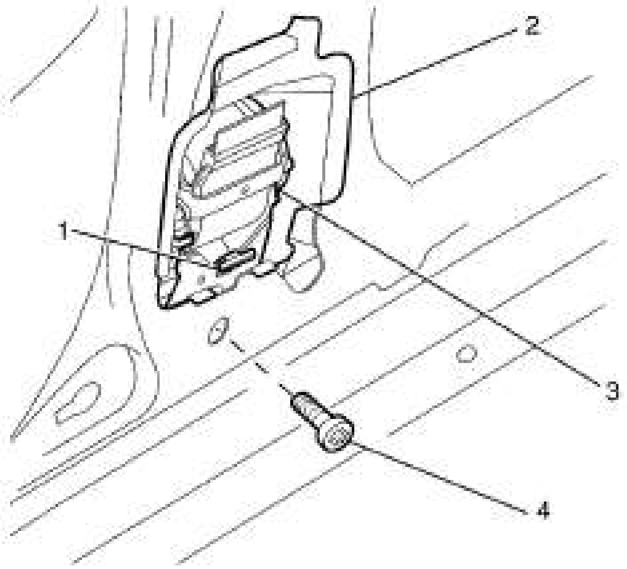


11. Remove the front seat belt upper guide bolt assembly (1).



12. Remove the front seat belt retractor bolt (4).
13. Lift the retractor (3) in a upwards direction.
14. Tilt the retractor on a 30 degree angle making sure that the locking tab (1) is clear.
15. Remove the dust cover (2) from the centre pillar (if required).

Installation Procedure - Type A (Fixed D-Ring) - Up to 8 Jun 2007

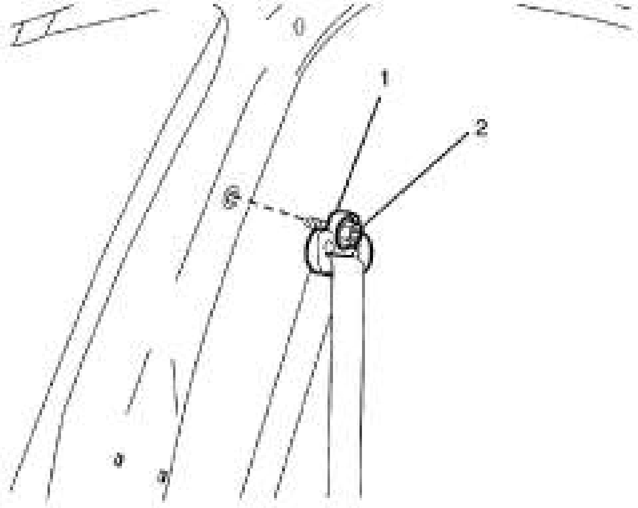


1. Install the front seat belt dust cover (2) to the vehicle (if removed).

   Notice: Refer to Fastener Notice in the Preface section.

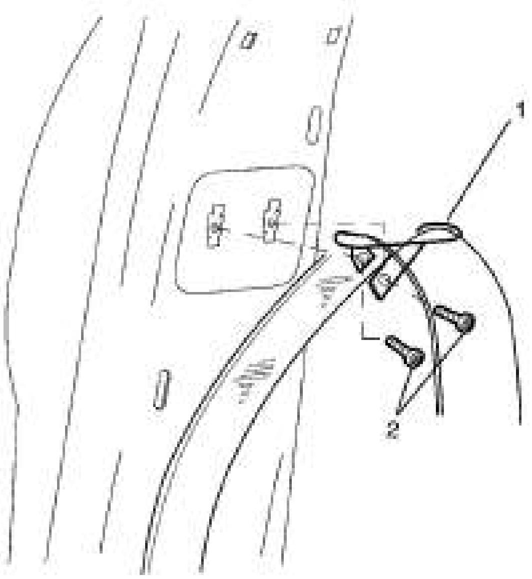
2. Install the front seat belt retractor (3) to the vehicle.
3. Make sure that the locking tab (1) is seated correctly.
4. Secure the retractor (3) with the bolt (4).

   Tighten
   Tighten the bolt (4) to 43 N·m (32 lb ft).



5. Install the front seat belt upper guide assembly (1).

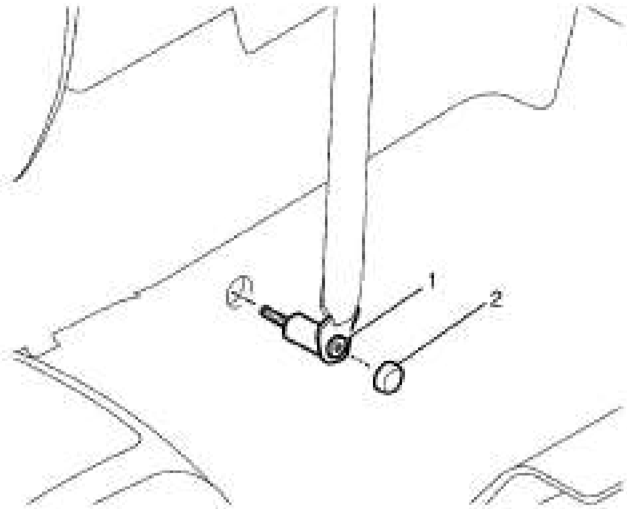
Tighten
Tighten the front seat belt upper guide bolt (2) to 43 N·m (32 lb ft).



6. Install the intermediate seat belt guide (1) to the vehicle. Secure the guide with the screws (2).

   Tighten
   Tighten the intermediate seat belt guide screws (2) to 3 N·m (27 lb in).

7. Install the upper centre pillar trim panel. Refer to Center Pillar Upper Trim Panel Replacement .
8. Install the lower centre panel trim panel. Refer to Center Pillar Lower Trim Panel Replacement .
9. Install the front and rear door sill trim plates. Refer to Door Sill Plate Replacement .
10. Install the front seat rail trim cover. Refer to Front Seat Replacement - Bucket .
11. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement .

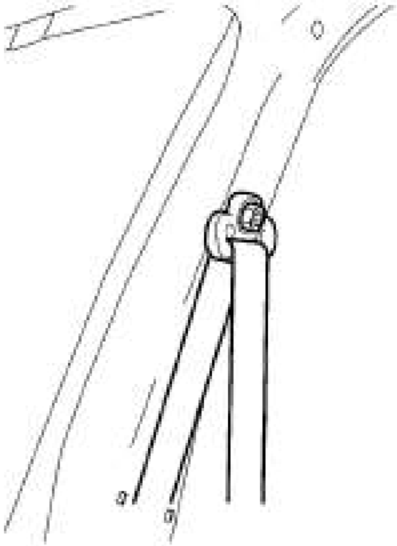


12. Install the front seat belt lower anchor bolt assembly (1).

    Tighten
    Tighten the front seat belt lower anchor bolt (1) to 43 N·m (32 lb ft).

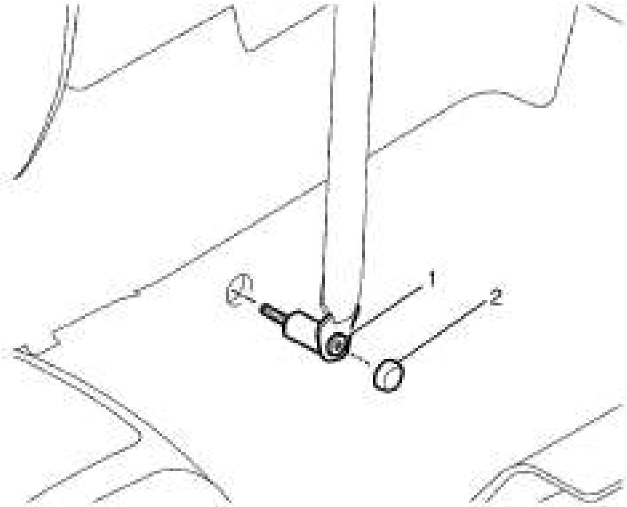
13. Install the front seat belt lower anchor bolt trim cover (2).
14. Move the front seat back to original position.

Removal Procedure - Type A (Fixed D-Ring) - From 8 Jun 2007

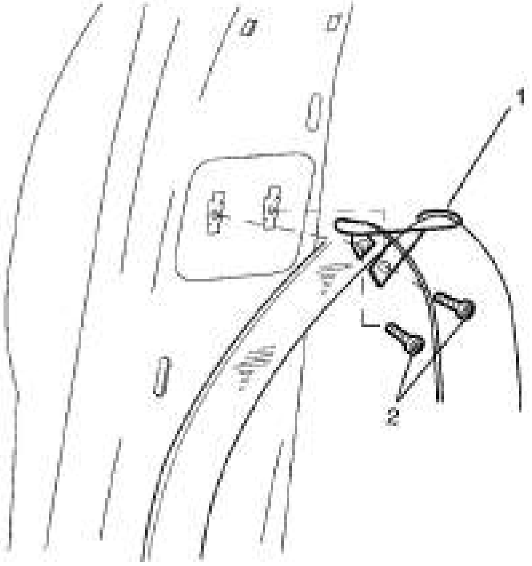


1. Move the seat all the way forward towards the front of the vehicle, to gain access to the seat belt.

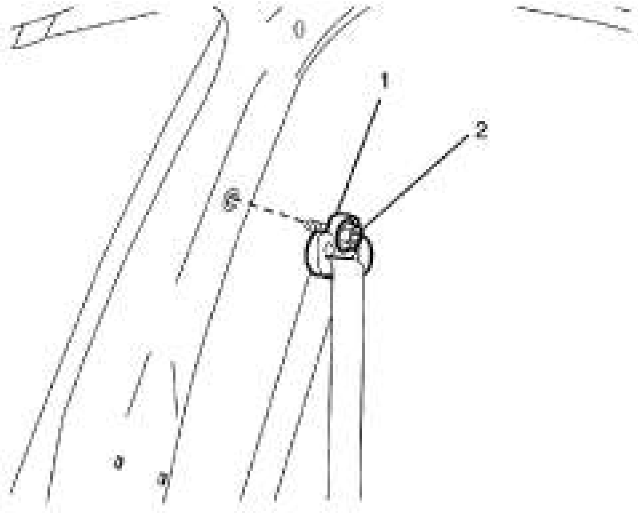
2. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement .
3. Remove the front seat rail trim cover. Refer to Front Seat Replacement - Bucket .
4. Remove the front and rear door sill trim plates. Refer to Door Sill Plate Replacement .
5. Remove the lower centre pillar trim plate. Refer to Center Pillar Lower Trim Panel Replacement .
6. Remove the upper centre pillar trim panel. Refer to Center Pillar Upper Trim Panel Replacement .



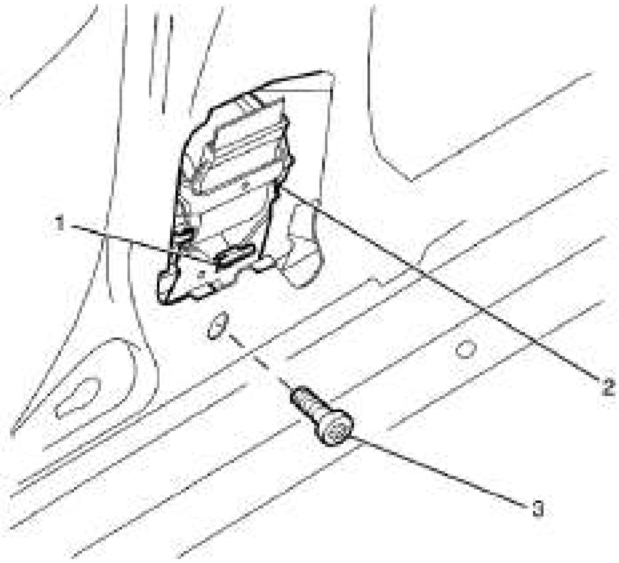
7. Remove the front seat belt lower anchor bolt cover (2).
8. Remove the front seat belt lower anchor assembly (1).



9. Remove the intermediate seat belt guide screws (2).
10. Remove the intermediate seat belt guide (1).

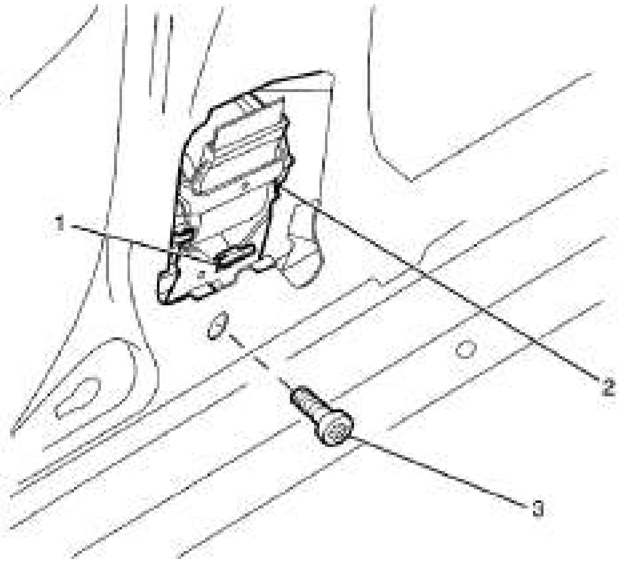


11. Remove the front seat belt upper guide bolt assembly (1).



12. Remove the front seat belt retractor bolt (4).
13. Lift the retractor (3) in a upwards direction.
14. Tilt the retractor on a 30 degree angle making sure that the locking tab (1) is clear.
15. Remove the dust cover (2) from the centre pillar (if required).

Installation Procedure - Type A (Fixed D-Ring) - From 8 Jun 2007

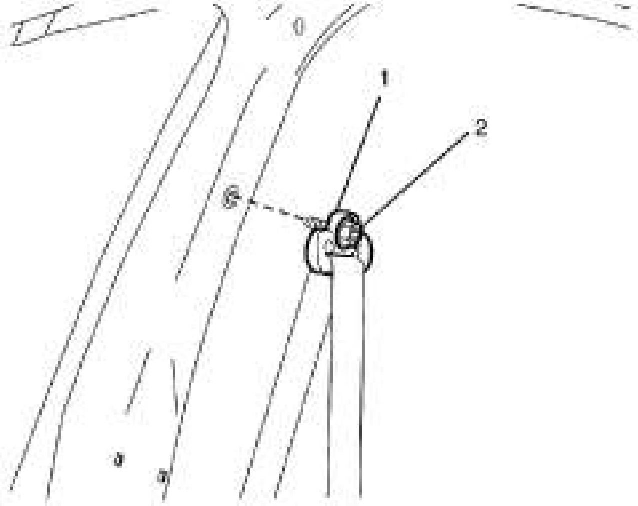


1. Install the front seat belt dust cover (2) to the vehicle (if removed).

   Notice: Refer to Fastener Notice in the Preface section.

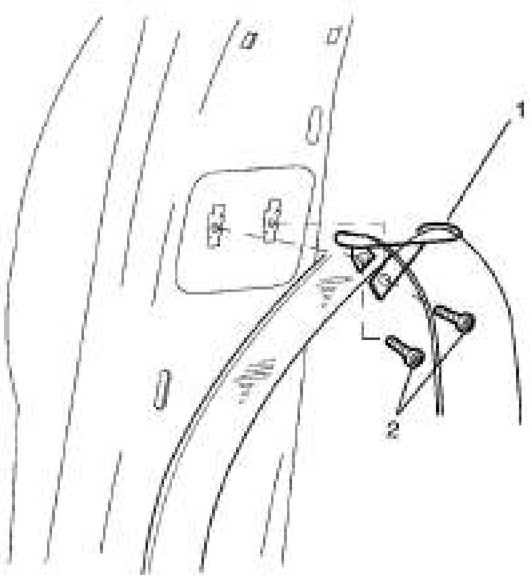
2. Install the front seat belt retractor (3) to the vehicle.
3. Make sure that the locking tab (1) is seated correctly.
4. Secure the retractor (3) with the bolt (4).

   Tighten
   Tighten the bolt (4) to 43 N·m (32 lb ft).



5. Install the front seat belt upper guide assembly (1).

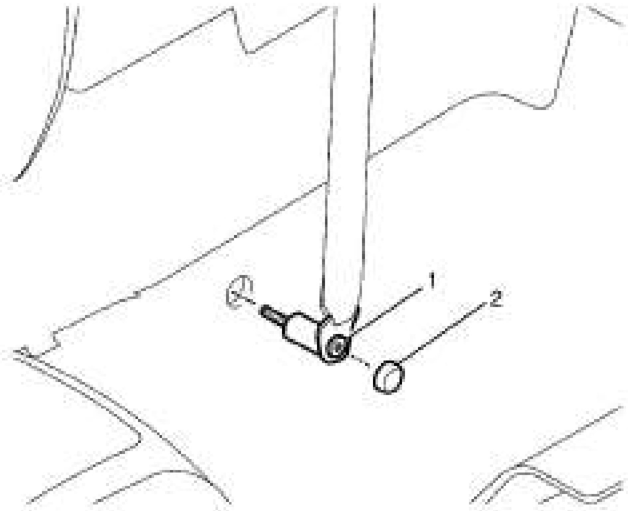
Tighten
Tighten the front seat belt upper guide bolt (2) to 43 N·m (32 lb ft).



6. Install the intermediate seat belt guide (1) to the vehicle. Secure the guide with the screws (2).

   Tighten
   Tighten the intermediate seat belt guide screws (2) to 3 N·m (27 lb in).

7. Install the upper centre pillar trim panel. Refer to Center Pillar Upper Trim Panel Replacement .
8. Install the lower centre panel trim panel. Refer to Center Pillar Lower Trim Panel Replacement .
9. Install the front and rear door sill trim plates. Refer to Door Sill Plate Replacement .
10. Install the front seat rail trim cover. Refer to Front Seat Replacement - Bucket .
11. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement .

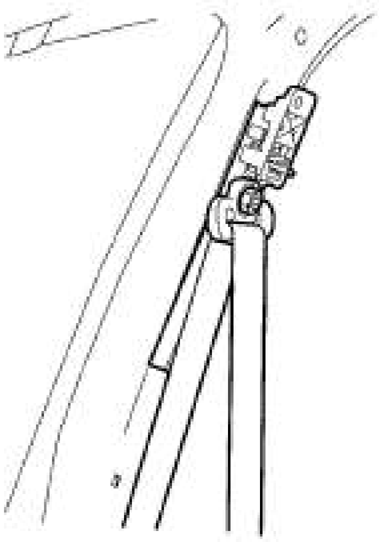


12. Install the front seat belt lower anchor bolt assembly (1).

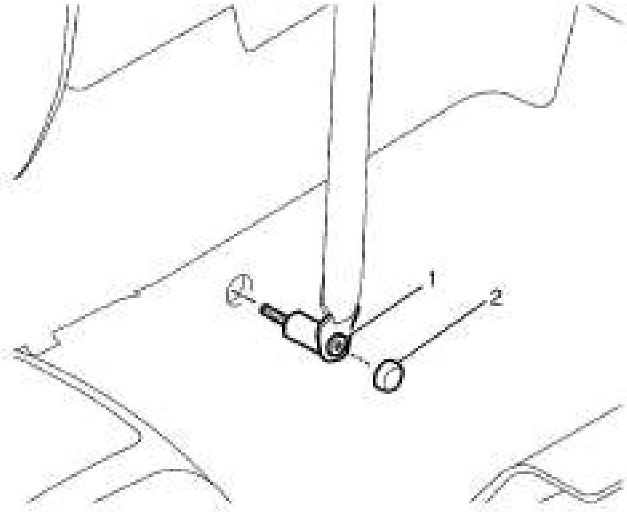
    Tighten
    Tighten the front seat belt lower anchor bolt (1) to 43 N·m (32 lb ft).

13. Install the front seat belt lower anchor bolt trim cover (2).
14. Move the front seat back to original position.

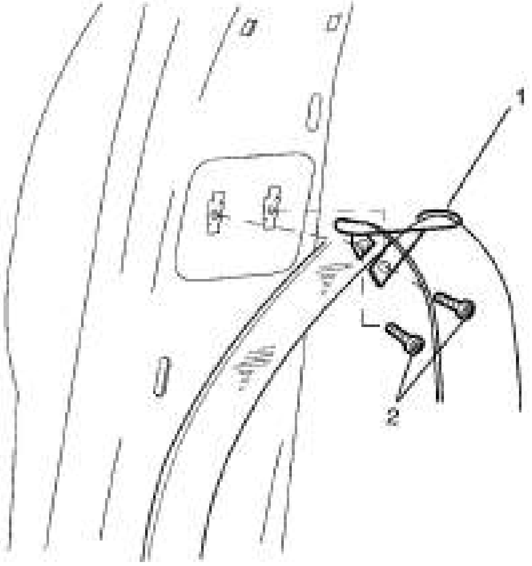
Removal Procedure - Type B (Adjustable D-Ring) - Up to 8 Jun 2007



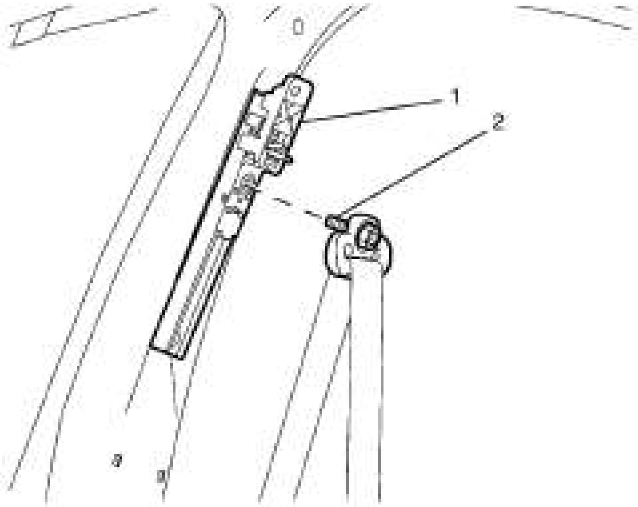
1. Move the seat all the way forward towards the front of the vehicle, to gain access to the seat belt.
2. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement .
3. Remove the front seat rail trim cover. Refer to Front Seat Replacement - Bucket .
4. Remove the front and rear door sill trim plates. Refer to Door Sill Plate Replacement .
5. Remove the lower centre pillar trim plate. Refer to Center Pillar Lower Trim Panel Replacement .
6. Remove the upper centre pillar trim panel. Refer to Center Pillar Upper Trim Panel Replacement .



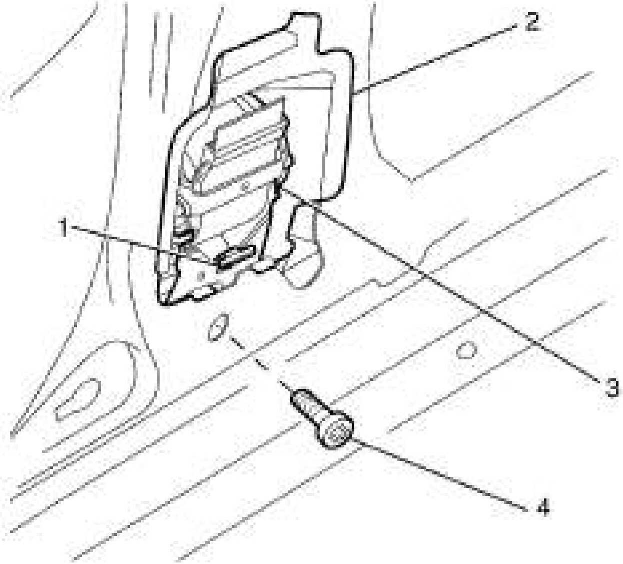
7. Remove the front seat belt lower anchor bolt cover (2).
8. Remove the front seat belt lower anchor assembly (1).



9. Remove the intermediate seat belt guide screws (2) and the intermediate seat belt guide (1).

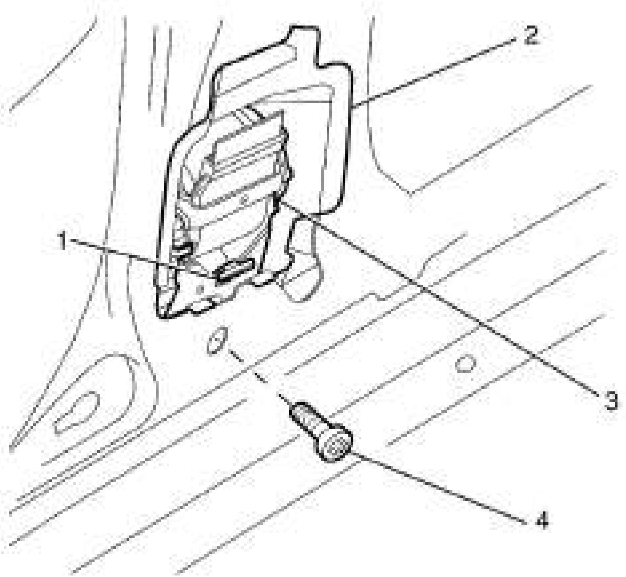


10. Remove the front seat belt upper guide bolt assembly (2) holding the D-ring belt guide to the height adjuster assembly (1).



11. Remove the front seat belt retractor bolt (4).
12. Lift the retractor (3) in a upwards direction.
13. Tilt on a 30 degree angle making sure that the locking tab (1) is clear.
14. Remove the dust cover (2) from the centre pillar (if required).

Installation Procedure - Type B (Adjustable D-Ring) - Up to 8 Jun 2007

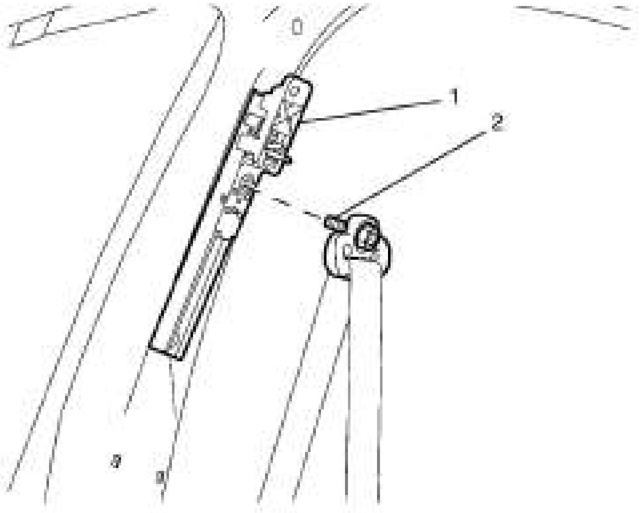


1. Install the front seat belt dust cover (2) to the vehicle (if removed).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the front seat belt retractor (3) to the vehicle.
3. Make sure that the locking tab (1) is seated correctly.
4. Secure the retractor (3) with the bolt (4).

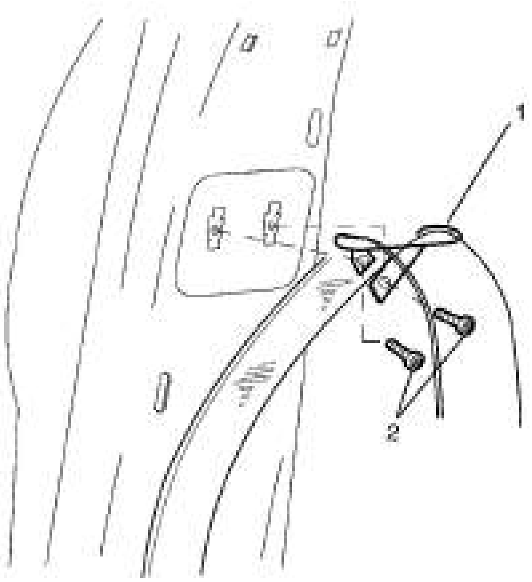
   Tighten
   Tighten the bolt (4) to 43 N·m (32 lb ft).



5. Install the front seat belt upper guide bolt assembly (2) holding the D-ring belt guide to the

height adjuster assembly (1).

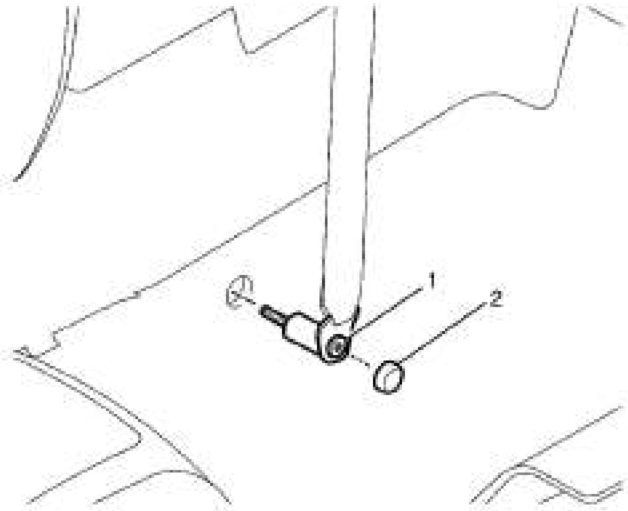
Tighten
Tighten the front seat belt upper guide bolt assembly (2) to 43 N·m (32 lb ft).



6. Install the intermediate seat belt guide (1) to the vehicle. Secure the guide with the screws (2).

   Tighten
   Tighten the intermediate seat belt guide screws (2) to 3 N·m (27 lb in).

7. Install the upper centre pillar trim panel. Refer to Center Pillar Upper Trim Panel Replacement .
8. Install the lower centre panel trim panel. Refer to Center Pillar Lower Trim Panel Replacement .
9. Install the front and rear door sill trim plates. Refer to Door Sill Plate Replacement .
10. Install the front seat rail trim cover. Refer to Front Seat Replacement - Bucket .
11. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement .

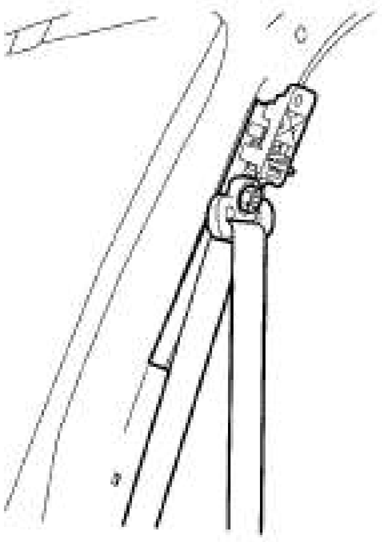


12. Install the front seat belt lower anchor bolt assembly (1).

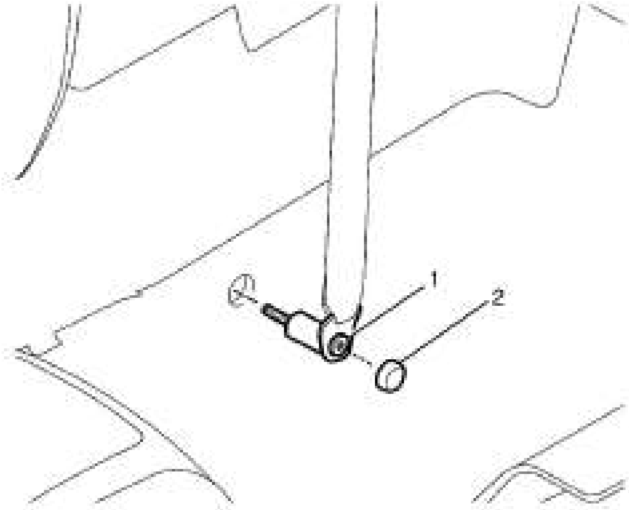
    Tighten
    Tighten the front seat belt lower anchor bolt to 43 N·m (32 lb ft).

13. Install the front seat belt lower anchor bolt trim cover (2).
14. Move the front seat back to original position.

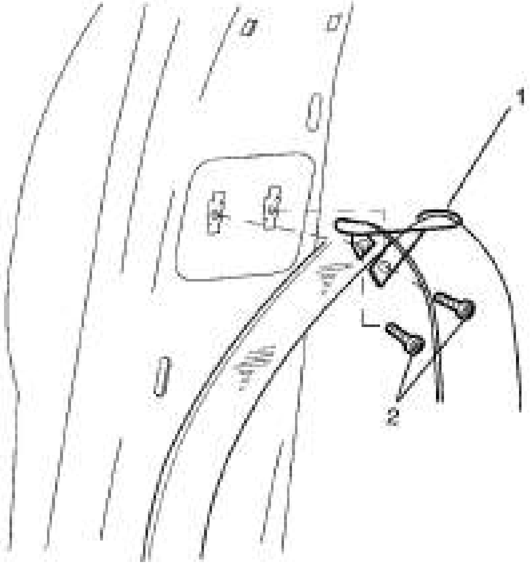
Removal Procedure - Type B (Adjustable D-Ring) - From 8 Jun 2007



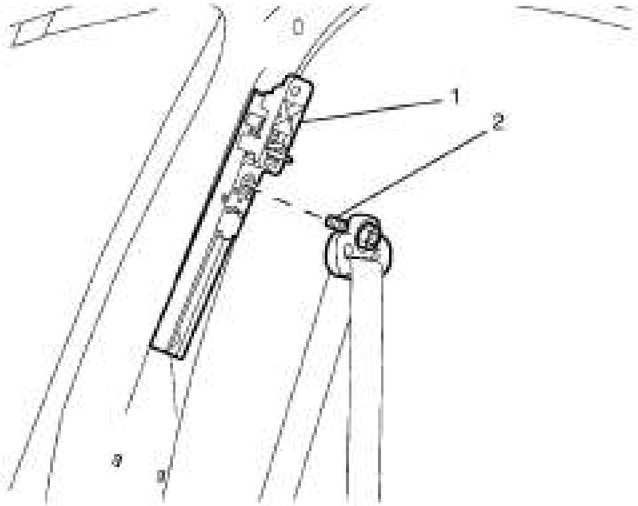
1. Move the seat all the way forward towards the front of the vehicle, to gain access to the seat belt.
2. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement .
3. Remove the front seat rail trim cover. Refer to Front Seat Replacement - Bucket .
4. Remove the front and rear door sill trim plates. Refer to Door Sill Plate Replacement .
5. Remove the lower centre pillar trim plate. Refer to Center Pillar Lower Trim Panel Replacement .
6. Remove the upper centre pillar trim panel. Refer to Center Pillar Upper Trim Panel Replacement .



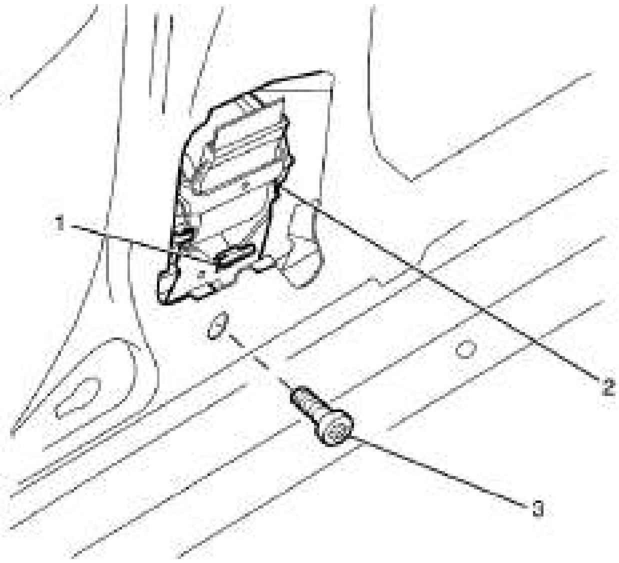
7. Remove the front seat belt lower anchor bolt cover (2).
8. Remove the front seat belt lower anchor assembly (1).



9. Remove the intermediate seat belt guide screws (2) and the intermediate seat belt guide (1).

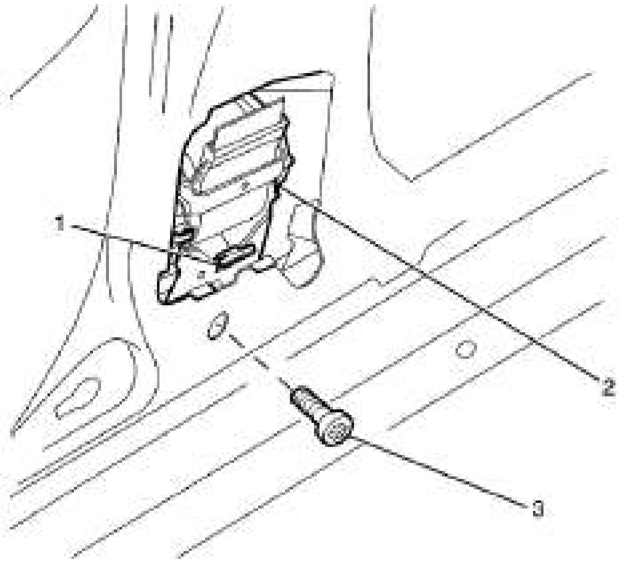


10. Remove the front seat belt upper guide bolt assembly (2) holding the D-ring belt guide to the height adjuster assembly (1).



11. Remove the front seat belt retractor bolt (4).
12. Lift the retractor (3) in a upwards direction.
13. Tilt on a 30 degree angle making sure that the locking tab (1) is clear.
14. Remove the dust cover (2) from the centre pillar (if required).

Installation Procedure - Type B (Adjustable D-Ring) - From 8 Jun 2007

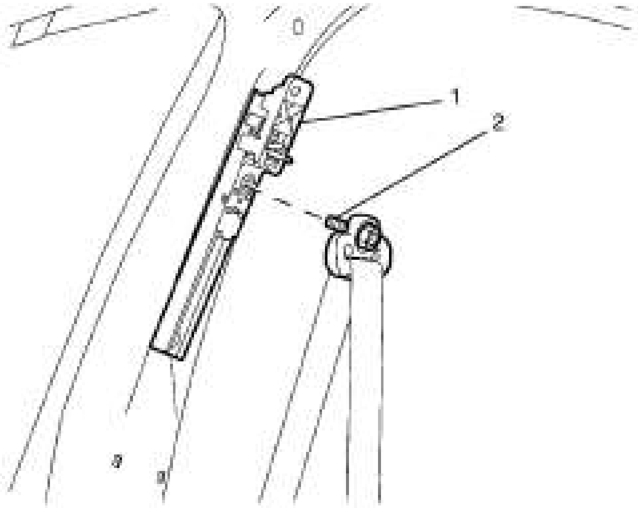


1. Install the front seat belt dust cover (2) to the vehicle (if removed).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the front seat belt retractor (3) to the vehicle.
3. Make sure that the locking tab (1) is seated correctly.
4. Secure the retractor (3) with the bolt (4).

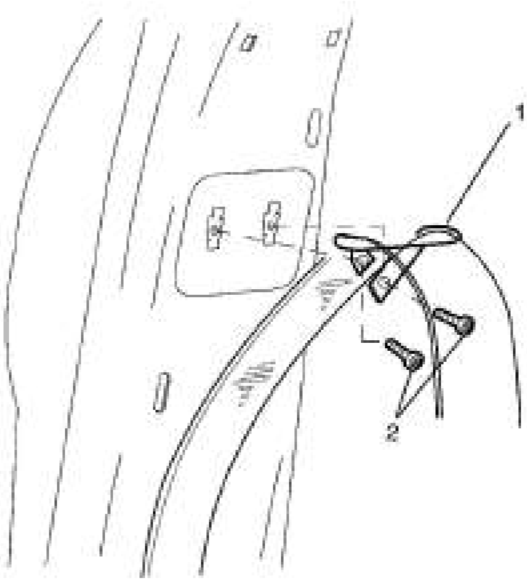
   Tighten
   Tighten the bolt (4) to 43 N·m (32 lb ft).



5. Install the front seat belt upper guide bolt assembly (2) holding the D-ring belt guide to the

height adjuster assembly (1).

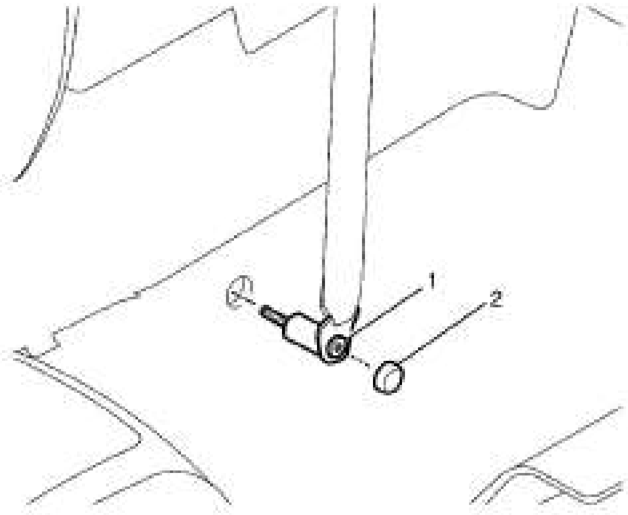
Tighten
Tighten the front seat belt upper guide bolt assembly (2) to 43 N·m (32 lb ft).



6. Install the intermediate seat belt guide (1) to the vehicle. Secure the guide with the screws (2).

   Tighten
   Tighten the intermediate seat belt guide screws (2) to 3 N·m (27 lb in).

7. Install the upper centre pillar trim panel. Refer to Center Pillar Upper Trim Panel Replacement .
8. Install the lower centre panel trim panel. Refer to Center Pillar Lower Trim Panel Replacement .
9. Install the front and rear door sill trim plates. Refer to Door Sill Plate Replacement .
10. Install the front seat rail trim cover. Refer to Front Seat Replacement - Bucket .
11. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement .



12. Install the front seat belt lower anchor bolt assembly (1).

    Tighten
    Tighten the front seat belt lower anchor bolt to 43 N·m (32 lb ft).

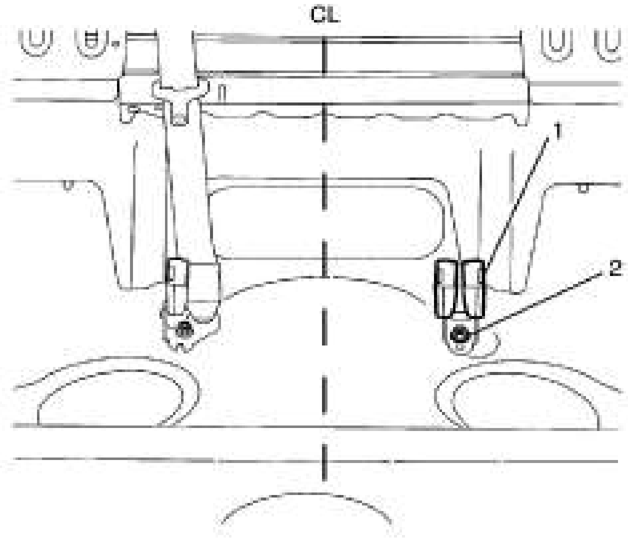
13. Install the front seat belt lower anchor bolt trim cover (2).
14. Move the front seat back to original position.

Rear Seat Belt Buckle Replacement (RHD)

Removal Procedure

Caution: Refer to SIR Caution in the Preface section.

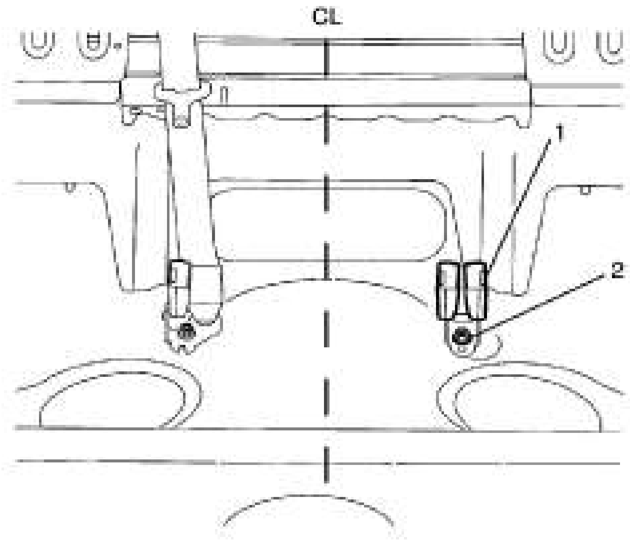
1. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement .



2. Remove the seat belt buckle nut (2).
3. Remove the rear seat belt twin buckle (1) from the floor pan.

Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



Important: Make sure buckle is parallel to vehicle centreline.

1. Install the rear seat belt buckles (1) to the floor pan.

   Tighten
   Tighten the seat belt buckle nut (2) to 43 N·m (31 lb ft).

2. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement .

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Rear Seat Belt Buckle Replacement (Wagon)

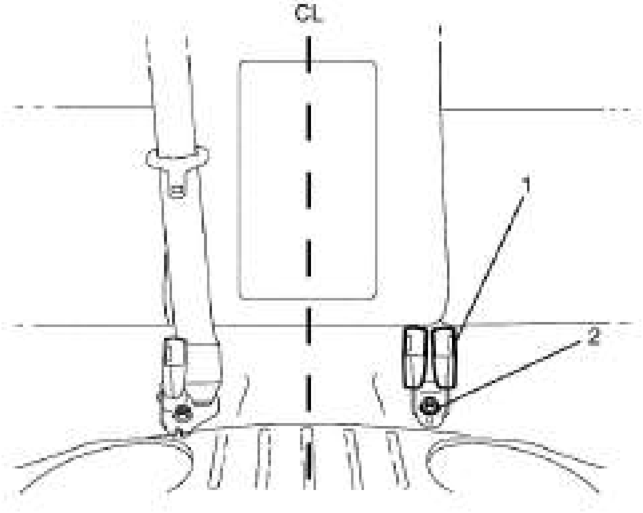
Removal / Installation Procedure - Right Rear

Important: The right rear seat belt buckle is an integral part of the centre rear seat belt retractor assembly and must be replaced as an assembly.

For replacement of the right rear seat belt buckle. Refer to Seat Belt Replacement - Center Rear.

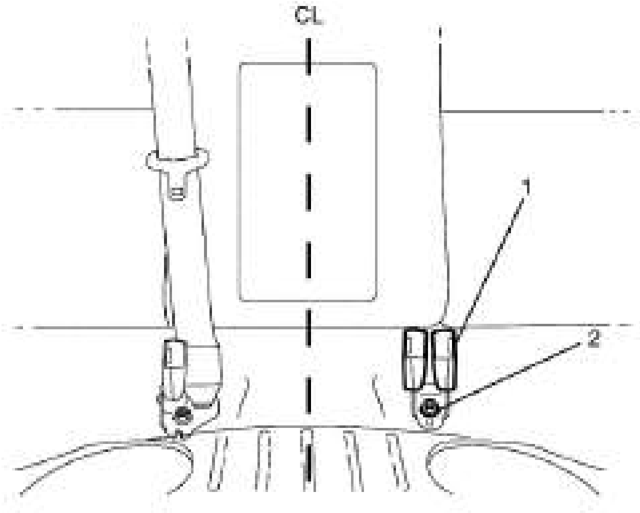
Removal Procedure - Centre / Left Rear

1. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement.



2. Remove the centre/left rear seat belt buckle nut (2).
3. Remove the centre/left rear seat belt buckle (1) from the vehicle.

Installation Procedure



Important: Make sure the centre/left rear seat belt buckle is parallel to vehicle centreline as shown.

1. Install the centre/left rear seat belt buckle (1) to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the centre/left rear seat belt buckle nut (2).

   Tighten
   Tighten the nut to 43 N·m (31 lb ft).

3. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.

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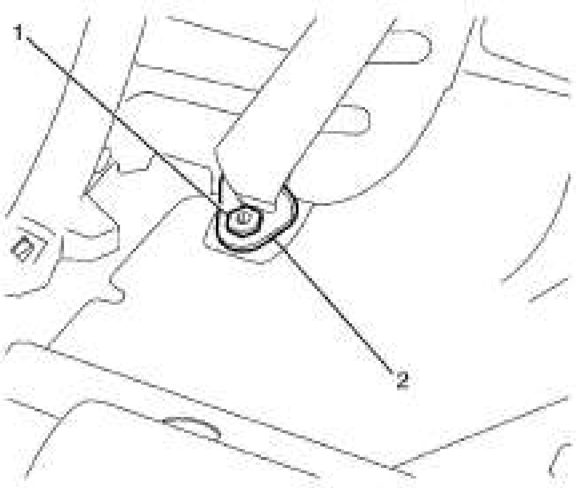
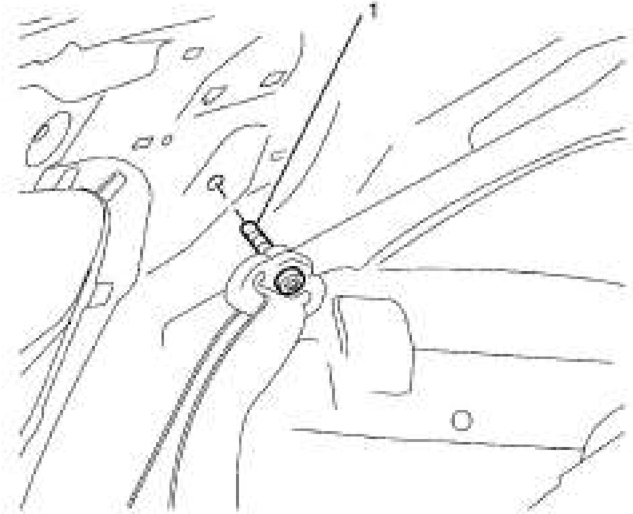
Rear Seat Belt Replacement (RHD)

Removal Procedure

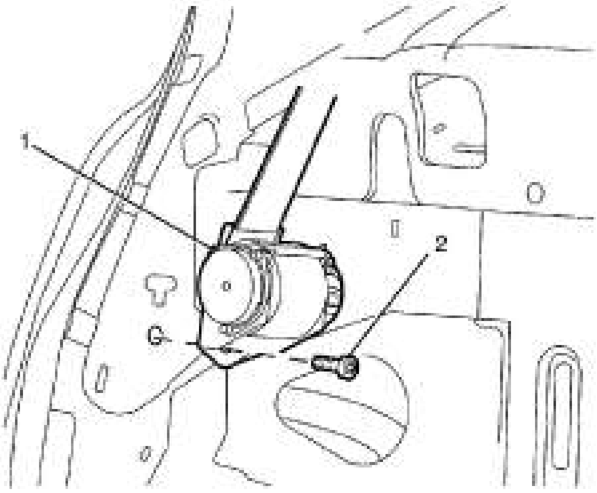
1. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement.
2. Remove the rear seat back. Refer to Rear Seat Back Replacement.
3. Remove the upper rear quarter trim panel. Refer to Quarter Upper Trim Panel Replacement.



4. Remove the bolt (1) attaching the seat belt lower anchor (2) to the vehicle

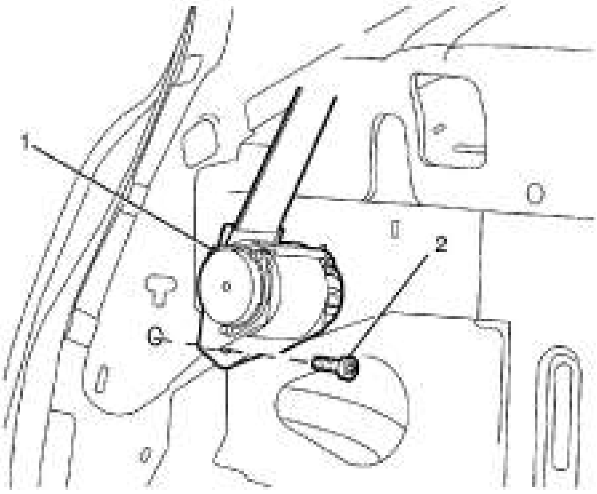


5. Remove the rear seat belt guide bolt assembly (1).



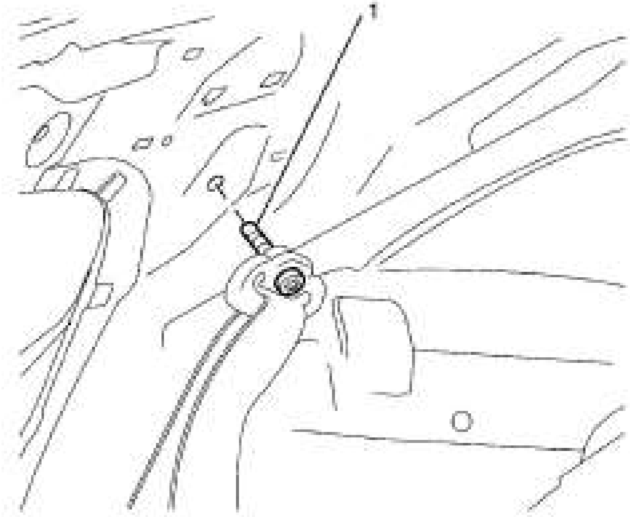
6. Remove the rear seat belt retractor bolt (2).
7. Lift the retractor (1) in a upwards direction and tilt on a 30 degree angle making sure that the locking tab is clear.

Installation Procedure



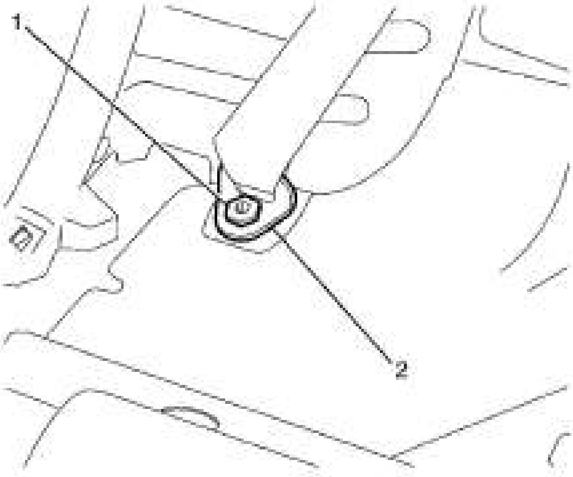
1. Replace the rear seat belt retractor assembly (1).
2. Remove the rear seat belt retractor bolt (2) .

Tighten
Tighten the intermediate rear seat belt retractor mounting bolt (2) to 43 N·m (31 lb ft).



3. Replace the rear seat belt guide bolt assembly (1).

Tighten
Tighten the rear seat belt guide mounting bolt (4) to 43 N·m (32 lb ft).



4. Replace the bolt (1) attaching the seat belt lower anchor (2) to the vehicle

Important: Make Sure the seat belt lower anchor is parallel to vehicle centreline as shown.

Tighten
Tighten the bolt (1) to 43 N·m (31 lb ft).

5. Replace the upper rear quarter trim panel. Refer to Quarter Upper Trim Panel Replacement.
6. Replace the rear seat cushion. Refer to Rear Seat Cushion Replacement.
7. Replace the rear seat back. Refer to Rear Seat Back Replacement.

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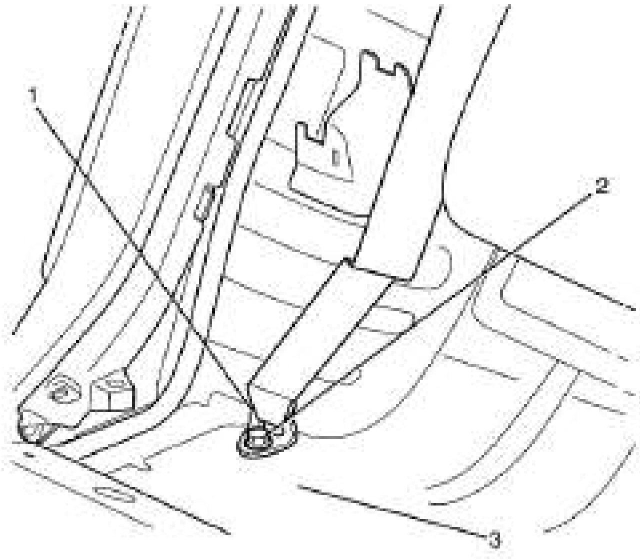
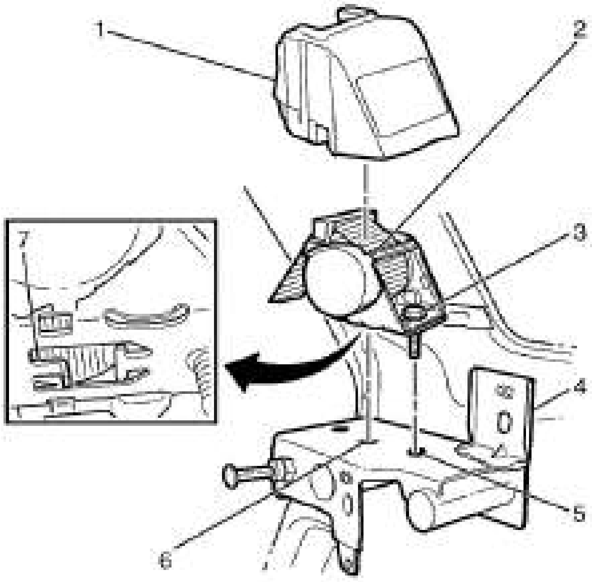
Rear Seat Belt Replacement (Sportwagon)

Removal Procedure

1. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement.
2. Remove the rear seat back bolster. Refer to Rear Split Folding Seat Back Bolster Replacement.
3. Remove the body lock pillar lower trim. Refer to Body Lock Pillar Trim Panel Replacement.

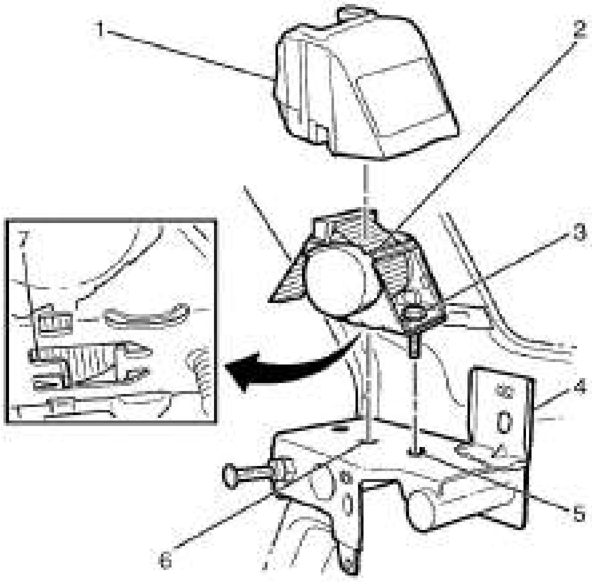


4. Remove the rear seat belt lower anchor bolt (2) from the vehicle body (3).
5. Remove the rear seat belt lower anchor (1) to the vehicle body (3).
6. Fold the seat back into the lowered position.
7. Remove the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
8. Remove the body lock pillar trim. Refer to Body Lock Pillar Trim Panel Replacement.
9. Thread the rear seat belt lower anchor through the body lock pillar trim.



10. Remove the rear seat belt retractor noise block (1) from the rear seat belt retractor (2).
11. Thread the rear seat belt lower anchor through the retractor noise block (1).
12. Remove the rear seat belt retractor bolt (3).
13. Remove the rear seat belt retractor (2) from the rear seat belt retractor mounting bracket (4).

Installation Procedure



Important: Make sure that the rear seat belt retractor bolt (3) is aligned and threads easily into the rear seat belt retractor mounting bracket captive nut before tightening with a hand tool.

Important: Make sure that the rear seat belt retractor dowel (7) locates into the rear seat belt retractor mounting bracket datum hole (6).

1. Install the rear seat belt retractor assembly (2) to the rear seat belt retractor mounting bracket (4).

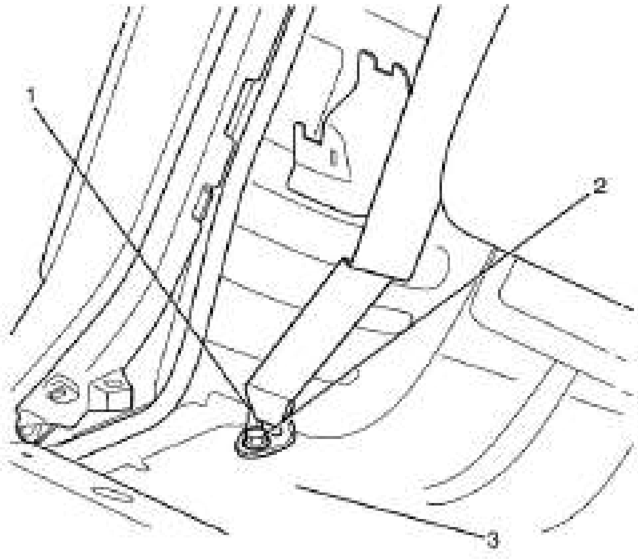
   Notice: Refer to Fastener Notice in the Preface section.

2. Install the rear seat belt retractor bolt (3).

   Tighten
   Tighten the bolt to 43 N·m (32 lb ft).

3. Thread the rear seat belt lower anchor through the retractor noise block (1).
4. Install the rear seat belt retractor noise block (1) to the rear seat belt retractor (2).
5. Thread the rear seat belt lower anchor through the body lock pillar trim.
6. Install the body lock pillar trim. Refer to Body Lock Pillar Trim Panel Replacement.
7. Install the quarter inner trim finish panel. Refer to Quarter Inner Trim Finish Panel Replacement.
8. Fold the seat back into the upright position.

   Notice: Refer to Fastener Notice in the Preface section.



9. Install the rear seat belt lower anchor (1) to the vehicle body (3).
10. Install the rear seat belt lower anchor bolt (2) to the vehicle body (3).

    Tighten
    Tighten the bolt to 43 N·m (32 lb ft).

11. Install the body lock pillar lower trim. Refer to Body Lock Pillar Lower Trim Panel Replacement.
12. Install the seat back bolster. Refer to Rear Split Folding Seat Back Bolster Replacement.

13. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.
14. Check rear seat belt operation.

Repairs and Inspections Required After a Collision

Important: After a minor collision where no automatic restraint device was deployed, seat belt system replacement may not be necessary, unless some of the parts are torn, worn, or damaged. Restraint systems can be damaged in a collision. To help avoid injury and ensure that all parts in need of replacement are replaced:

- Replace any seat belt system that was in use during the collision serious enough to deploy any automatic restraint device such as air bags and seat belt pretensioners. This not only includes seat belt systems in use by people of adult size, but seat belt systems used to secure child restraints, infant carriers and booster seats, including child restraint anchor fittings and top tether anchorages.
- Replace any seat belt system that has torn, worn, or damaged components. This not only includes adult seat belt systems, but built-in child restraints and child restraint anchor fittings components, if any.
- Replace any seat belt system if you are doubtful about its condition. This not only includes adult seat belt systems, but built-in child restraints, child restraint anchor fittings components, and any restraint system used to secure infant carriers, child restraints, and booster seats.
- Do NOT replace single seat belt system components in vehicles that have been in a collision as described above. Always replace the entire seat belt system with the buckle, guide and retractor assembly, which includes the latch and webbing material.

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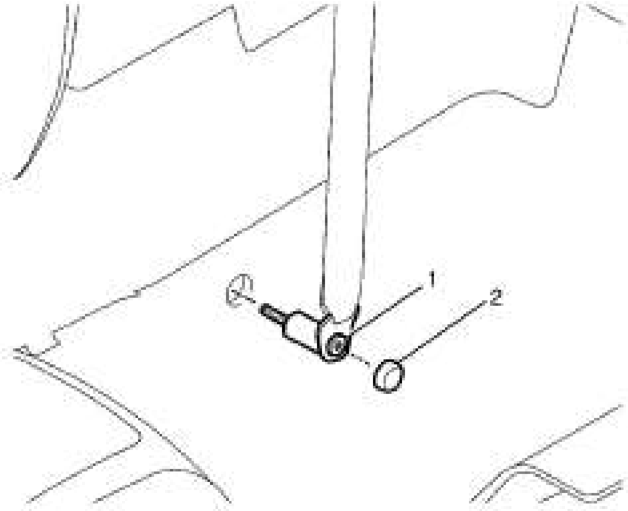
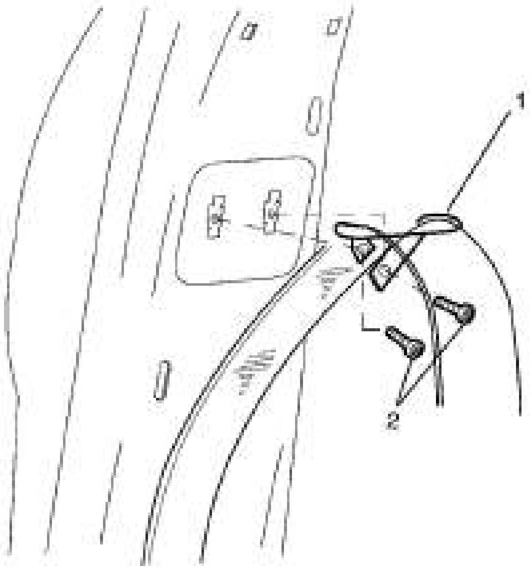
Seat Belt Height Adjuster Replacement - Front (RHD)

Removal Procedure

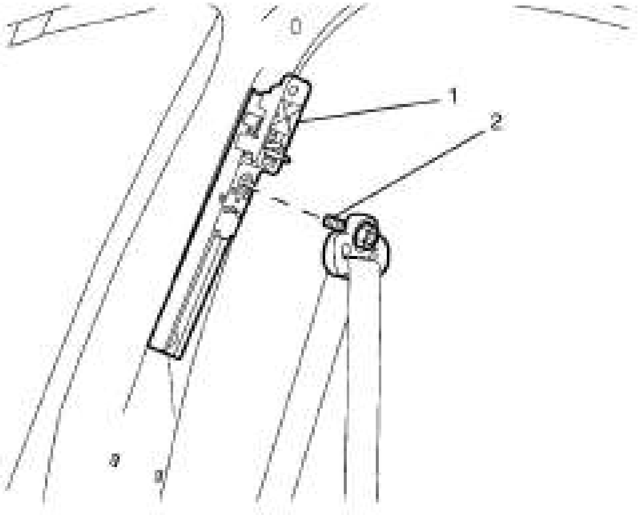
1. Remove the door sill trim plate. Refer to Door Sill Plate Replacement.
2. Remove the lower centre pillar trim plate. Refer to Center Pillar Lower Trim Panel Replacement .
3. Remove the upper centre pillar trim panel. Refer to Center Pillar Upper Trim Panel Replacement.
4. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement.



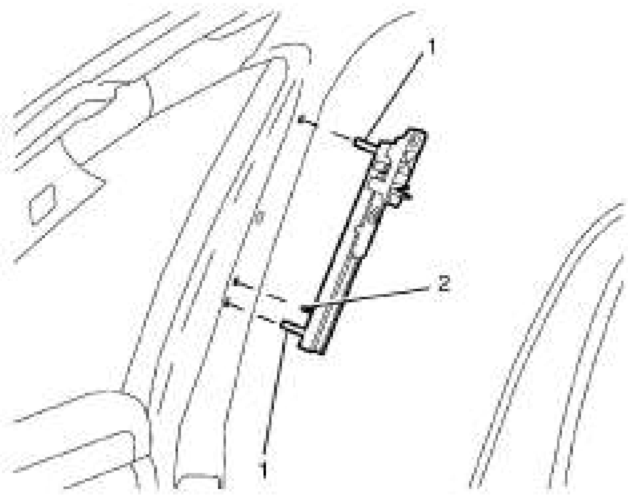
5. Remove the front seat belt lower anchor bolt cover (2).
6. Remove the front seat belt lower anchor bolt assembly (1).
7. Move the seat all the way forward towards the front of the vehicle, to gain access to the seat belt.



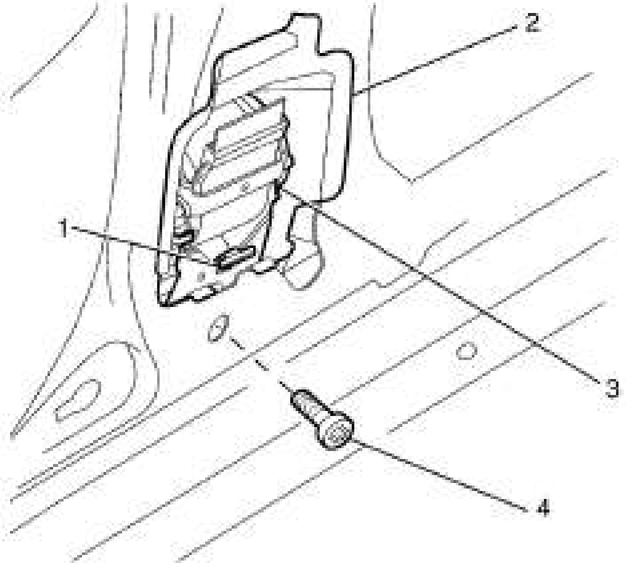
8. Remove the intermediate seat belt guide screws (2).
9. Remove the intermediate seat belt guide (1).



10. Remove the front seat belt D-Ring seat belt guide (2) to the height adjuster assembly (1).



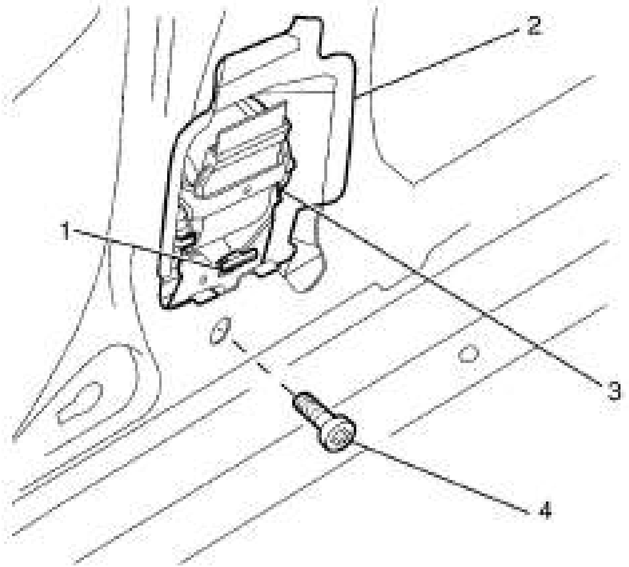
11. Move the height adjuster to gain access to the bolts (1). Remove the height adjuster from the vehicle. Remove the seat belt height adjuster (if required).



12. Remove the front seat belt retractor bolt (4).
13. Lift the retractor (3) in a upwards direction and tilt on a 30 degree angle making sure that the locking tab (1) is clear.
14. Remove the dust cover (2) from the centre pillar (if required).

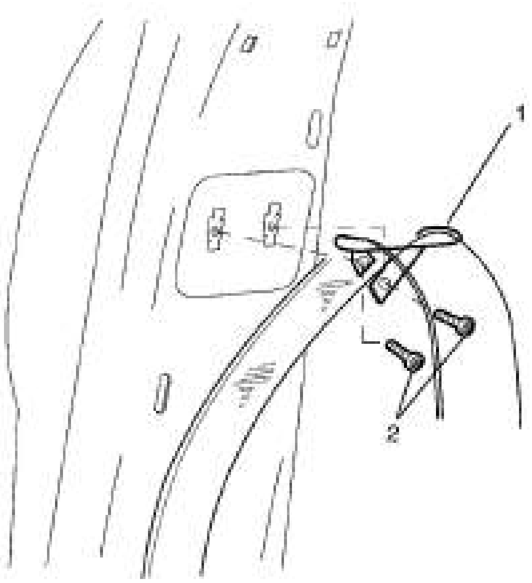
Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



1. Install the front seat belt dust cover (2) to the vehicle (if removed).
2. Install the front seat belt retractor (3) to the vehicle.
3. Making sure that the locking tab (1) is seated correctly.
4. Secure the retractor (3) with the bolt (4).

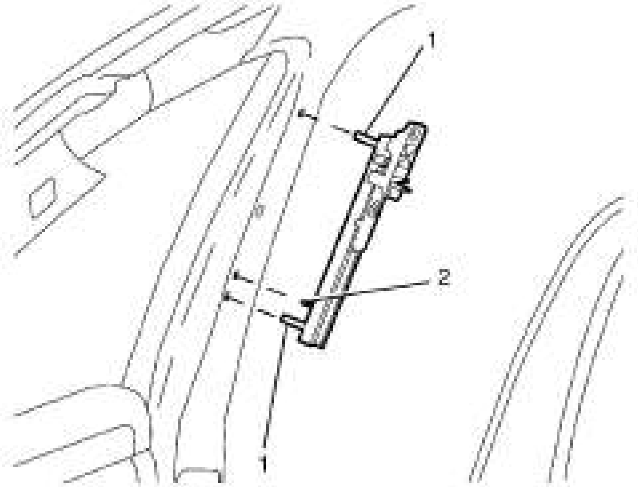
   Tighten
   Tighten the bolt (4) to 43 N·m (31 lb ft).



5. Install the intermediate seat belt guide (1) to the vehicle. Secure the guide with the screws (2).

   Tighten

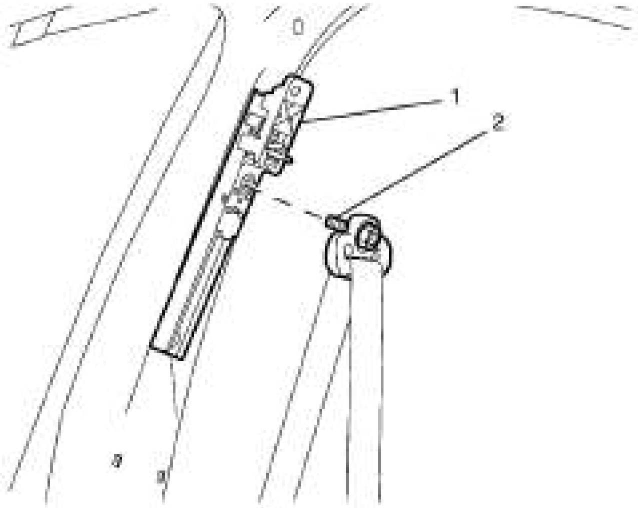
Tighten the intermediate seat belt guide screws to 2 N·m (18 lb in).



Important: Install a new height adjuster assembly (if required) and tighten.

6. Install the seat belt height adjuster bolts (1) to the vehicle. Make sure the seat belt height locating pin (2) is seated correctly before tightening.

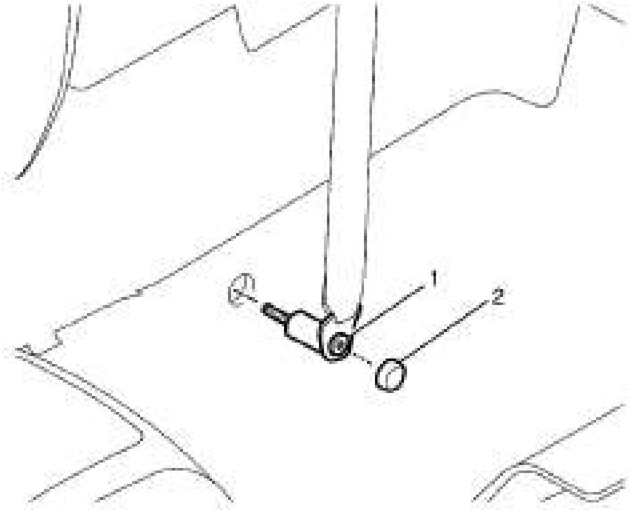
   Tighten
   Tighten the bolts (1) to 30 N·m (24 lb ft).



7. Install the front seat belt upper guide assembly (2) to the height adjuster assembly (1).

   Tighten
   Tighten the front seat belt upper guide bolt assembly to 43 N·m (32 lb ft).

8. Install the upper centre pillar trim panel. Refer to Center Pillar Upper Trim Panel Replacement.
9. Install the lower centre panel trim panel. Refer to Center Pillar Lower Trim Panel Replacement.
10. Install the door sill trim plate. Refer to Door Sill Plate Replacement.
11. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.



12. Install the front seat belt lower anchor assembly (1).

    Tighten
    Tighten the bolt to 42.5 N·m (31 lb ft).

13. Install the front seat belt lower anchor bolt trim cover (2).
14. Move the front seat back to original position.

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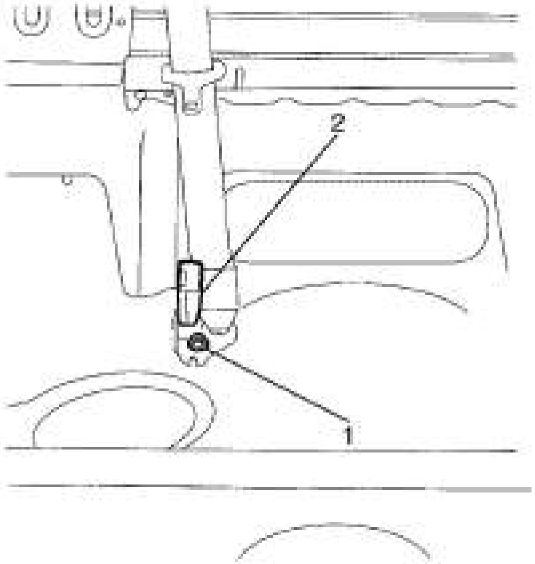
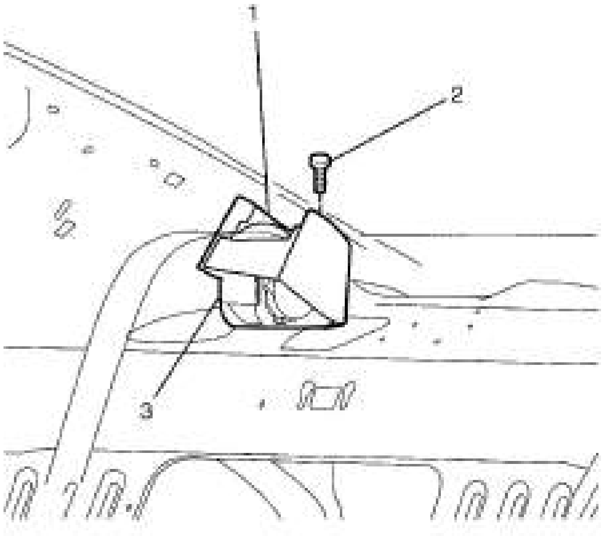
Seat Belt Replacement - Center Rear (RHD)

Removal Procedure

1. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement.
2. Remove the rear seat back. Refer to Rear Seat Back Replacement.
3. Remove the rear shelf trim panel. Refer to Rear Window Shelf Trim Panel Replacement.



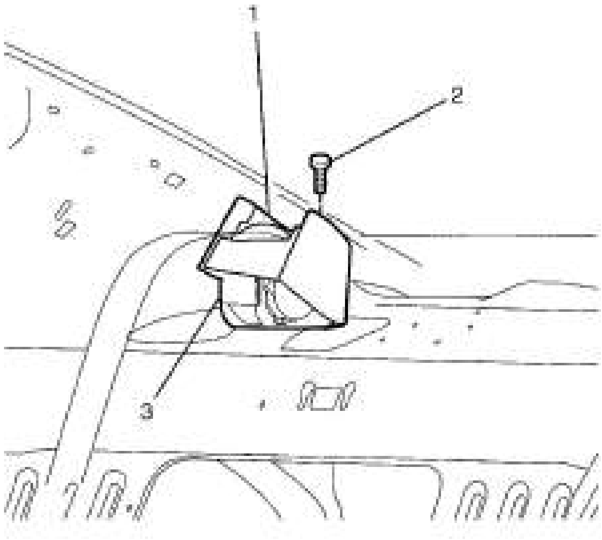
4. Remove the rear seat centre belt anchor nut (1).
5. Remove the anchor mounting bracket (2) from the vehicle.



6. Remove the rear seat centre belt noise block (1).

7. Remove the retractor bolt (2).
8. Remove the seat belt retractor (3).

Installation Procedure



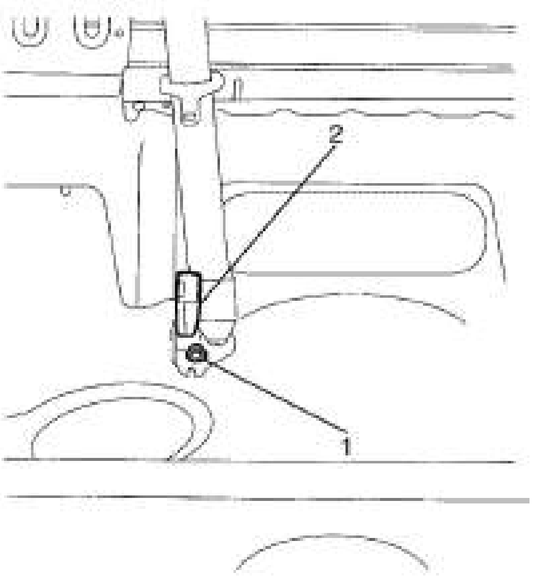
Important: Make Sure the retractor is parallel to vehicle centre line.

1. Install the centre seat belt retractor (3) to the rear window shelf. Make sure the retainer tab engages the notch in the shelf.
2. Install the retractor bolt (2) and seat belt retractor noise block (1).

   Notice: Refer to Component Fastener Tightening Notice in the Preface section.

3. Install the centre seat belt retractor fastener (2).

   Tighten
   Tighten the fastener to 43 N·m (32 lb ft).



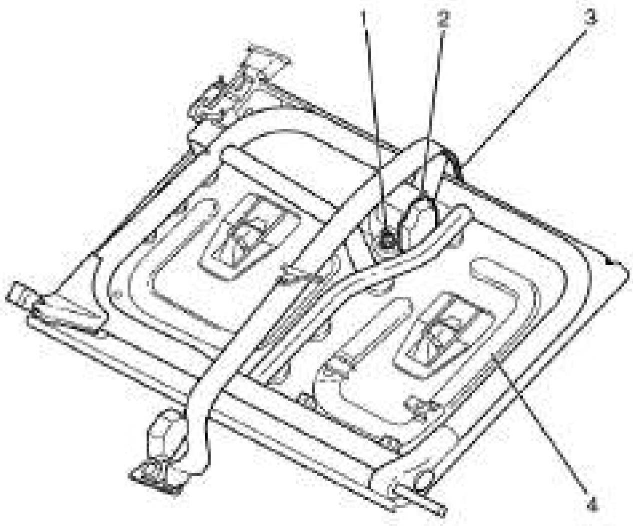
Important: Make Sure the centre belt anchor is parallel to vehicle centreline.

4. Install the rear seat centre belt anchor nut (1).
5. Remove the anchor mounting bracket (2) from the vehicle.
6. Install the rear shelf trim panel. Refer to Rear Window Shelf Trim Panel Replacement.
7. Install the rear seat back. Refer to Rear Seat Back Replacement.
8. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.

Seat Belt Replacement - Center Rear (Sportwagon)

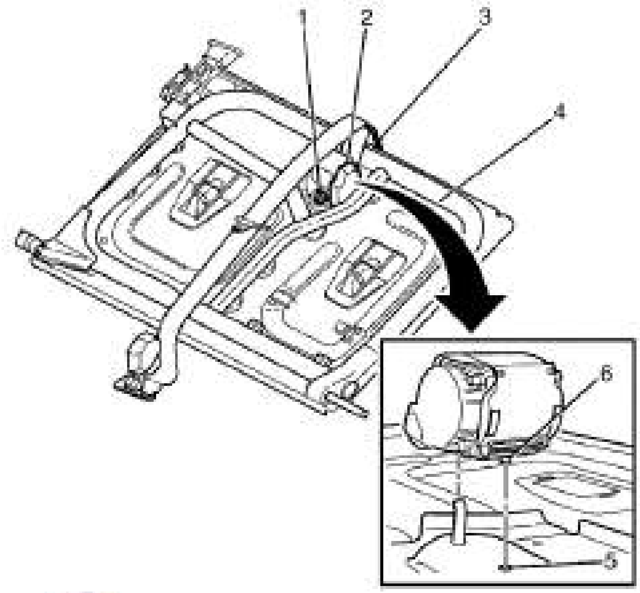
Removal Procedure

1. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement.
2. Remove the right rear seat back assembly. Refer to Rear Split Folding Seat Back Replacement.
3. Remove the right rear seat cover and pad. Refer to Rear Split Folding Seat Back Cushion Cover and Pad Replacement.



4. Remove the seat belt retractor to seat frame retaining nut (1).
5. Detach the seat belt retractor (2) from the seat frame assembly (4).
6. Thread the belt and buckle through the guide bracket (3) and remove the seat belt retractor (2).

Installation Procedure



1. Thread the belt and buckle through the guide bracket (3) and locate the seat belt retractor (2) to the seat frame assembly (4).

   Important: Make sure that the seat belt retractor dowel (6) locates into the seat frame assembly datum hole (5).

2. Install the seat belt retractor (1) to the seat frame assembly (4).

   Notice: Refer to Fastener Notice in the Preface section.

   Important: A NEW nut must be used when installing the rear seat belt retractor (2).

3. Tighten the seat belt retractor to seat frame retaining nut (1).

   Tighten
   Tighten the nut to 43 N·m (32 lb ft).

4. Install the right rear seat cover and pad. Refer to Rear Split Folding Seat Back Cushion Cover and Pad Replacement.
5. Install the right rear seat back assembly. Refer to Rear Split Folding Seat Back Replacement.
6. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.

Diagnostic Starting Point - Seat Belts

Begin the system diagnosis by reviewing the Seat Belt System Description and Operation. Reviewing the description and operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists and will also help you determine if the condition described by the customer is normal operation.

Refer to Symptoms - Seat Belts. In order to identify the correct procedure for diagnosing the system and where the procedure is located.

Operational and Functional Checks

Important: If the vehicle has been in a collision, refer to Repairs and Inspections Required After a Collision in Seat Belts. For additional information.

Perform the following inspection of the driver and passenger seat:

1. Ignition ON. Verify proper operation of the seat belt reminder lamp with the belt buckled and with the belt unbuckled. Refer to Seat Belt System Description and Operation in Seat Belts.
2. Inspect the shoulder belt guide in order to make sure that the following conditions are met:
   - The seat belt webbing is seated flat in the guide slot.
   - The seat belt webbing does not bind.
3. Verify that the seat belt buckle faces inboard and is accessible.
4. Verify that the seat belt retractor units are securely attached.
5. Verify that the seat belt anchor bolts are secure.
6. Fully extend the seat belt webbing. Verify that the seat belt webbing does not have any twists or tears.
7. Allow the seat belt webbing to retract. Verify that the seat belt webbing returns freely and completely back into the retractor.
8. Snap the seat belt latch plate into the buckle.
9. Sharply tug on the seat belt latch plate and the buckle. Verify that the seat belt latch plate and the buckle remain locked when tugged.
10. Push the button on the buckle.
    - Verify that the seat belt latch plate releases easily from the buckle.
    - Verify that the button returns to its original position.

Perform the following steps to inspect the left and right seat belts:

1. Inspect the shoulder belt guide in order to make sure that the following conditions are met:
   - The seat belt webbing is seated flat in the guide slot.
   - The seat belt webbing does not bind.
2. Verify that the seat buckle is accessible.
3. Verify that the seat belt retractor units are securely attached.
4. Verify that the seat belt anchor bolts are secure.
5. Fully extend the seat belt webbing. Verify that the seat belt webbing does not have any twists or tears.
6. Allow the seat belt webbing to retract. Verify that the seat belt webbing returns freely and completely back into the retractor.
7. Snap the seat belt latch plate into the buckle.
8. Sharply tug on the seat belt latch plate and the buckle. Verify that the seat belt latch plate and the buckle remain locked when tugged.
9. Push the button on the buckle.
   - Verify that the seat belt latch plate releases easily from the buckle.
   - Verify that the button returns to its original position.

Perform the following steps to inspect the centre rear seat belts:

1. Verify that the centre seat belts are accessible.
2. Verify that the centre seat belt retractor unit is securely attached.

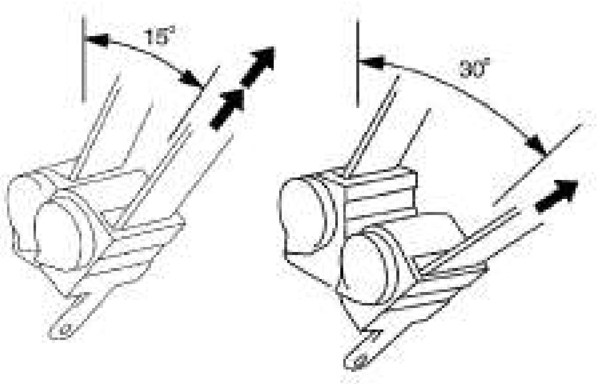
3. Verify that the seat belt anchor bolts are secure.
4. Verify that the seat belt buckle anchor bolts are secure.
5. Fully extend the centre seat belt webbing. Verify that the seat belt webbing does not have any twists or tears.
6. Allow the centre seat belt webbing to retract. Verify that the seat belt webbing returns freely and completely back into the retractor.
7. Snap the seat belt latch plate into the buckle.
8. Sharply tug on the seat belt latch plate and the buckle. Verify that the seat belt latch plate and the buckle remain locked when tugged.
    - Verify that the seat belt latch plate releases easily from both buckles.
    - Verify that the buttons return to their original positions.

For information on removal of the rear seats cushions refer to Rear Seat Cushion Replacement in Seats.

Emergency Locking Retractors

1. Fasten the seat belts, an assistant is needed when the retractor under test is not part of the driver seat belt.
2. Accelerate the vehicle slowly to 16 km/h and apply the brakes firmly.
3. Verify that the seat belt locks when braking firmly.
4. If the belt does not lock, proceed with the following steps.

Important: When performing this check , note the position the retractor is mounted.



4.1. Remove the seat belt retractor assembly.

4.2. Tilt the seat belt retractor slowly.

4.3. Make sure that the seat belt webbing can be pulled from the retractor at an inclination from the vehicle position of 15 degrees or less and cannot be pulled from the retractor at an inclination of 30 degrees or more.

4.4. If the seat belt retractor does not operate as described, replace the retractor assembly. Refer to the following procedures:

- Front Seat Belt Replacement in Seat Belts
- Rear Seat Belt Replacement in Seat Belts
- Seat Belt Replacement - Center Rearin Seat Belts

Seat Belt Indicator Circuit Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Driver Seat Belt Sensor Signal	1, B0072 02	2, B0072 05	2, B0072 05	2, B0072 01	B0072 08
Driver Seat Belt Sensor Low Reference	--	2, B0072 05	2, B0072 05	2	B0072 08

1. Indicator will remain ON with seat belt buckled.

2. Indicator will illuminate only for the bulb test.

Circuit/System Description

The driver seat belt switch is a 2-wire switch wired to the inflatable restraint sensing and diagnostic module (SDM) using a signal circuit and a low reference circuit. When the seat belt is unbuckled the switch is closed, and when the seat belt is buckled the switch is open. The SDM sends the status of the driver seat belt via serial data to the instrument panel cluster (IPC). After receiving the message, the IPC controls the illumination of the driver seat belt indicator.

Reference Information

Schematic Reference

- Seat Belt Schematics
- SIR Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Seat Belt System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Ignition ON, with a scan tool perform the IPC Display Test and verify the driver seat belt indicator is illuminated for 5 seconds.

   If the indicator does not illuminate, replace the IPC.
2. Monitor the scan tool Driver Seat Belt Switch parameter while connecting and disconnecting the seat belt. The parameter should display Buckled and Not Buckled when changing seat belt states.

Circuit / System Testing

> **Important:** When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected component/connector.
>
> - Seat belt switch
> - Seat belt switch harness connector
> - SDM
> - SDM wiring harness connector

1. Ignition OFF, disconnect the harness connector at the seat belt switch.
2. Ignition OFF, test for less than 1 ohm between the low reference circuit terminal A and ground.

   If greater than the specified range, test the low reference circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the SDM.
3. Ignition ON, verify the scan tool Driver Seat Belt Switch parameter displays Buckled.

   If not the specified value, test the signal circuit for a short to ground. If the circuit tests normal replace the SDM.
4. Install a 3A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the scan tool Driver Seat Belt Switch parameter displays Not Buckled.

   If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the SDM.
5. If all circuits test normal, test or replace the seat belt switch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the seat belt switch.

2. With the seat belt buckled, test for infinite resistance between the signal circuit terminal B and the low reference terminal A.

   If less than the specified value, replace the seat belt switch.
3. With the seat belt unbuckled, test for less than 1 ohm between the signal circuit terminal B and the low reference terminal A.

   If greater than the specified range, replace the seat belt switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Front Seat Belt Replacement
- Control Module References for SDM and IPC replacement, setup, and programming

Seat Belt Service Precautions

Important: If the vehicle has been in a collision, refer to Repairs and Inspections Required After a Collision in Seat Belts. For additional information.

- Do not bleach or dye the seat belt webbing. Use only the following items in order to clean the seat belt webbing:
  - A mild soap and water solution.
  - A soft brush or cloth.
  - Rinse with fresh water.
- Keep sharp edges and damaging objects away from the seat belts. Avoid bending or damaging any part of the seat belt buckle or the latch plate. Replace any seat belts which are cut or damaged in any way.
- Use only the correct seat belt anchor bolts/screws and tighten the anchor bolts/screws to the correct torque value. Refer to Fastener Tightening Specifications. When installing seat belt anchor bolts, start the bolt by hand to ensure that the bolt is threaded straight.
- Some seat belts and retractors require service as a set, with service replacement parts only. Do not attempt to repair to individual components that require service as a set.
- Verify that the replacement part number is correct for the vehicle at that seating position. Do not substitute a seat belt from a different seating position.

Symptoms - Seat Belts

Important: Review the seat belt system description and operation in order to familiarise yourself with the system and how it functions. Refer to Seat Belt System Description and Operation.

Visual / Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the seat belt system. Refer to Checking Aftermarket Accessories .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to the following symptom diagnostic procedure in order to diagnose the symptom:

Seat Belt System Description and Operation (Sedan)

Description

The Occupant Protection System (OPS) is designed to restrain and protect occupants of the vehicle during a collision. This is achieved by the use of:

- Lap-sash inertia reel seat belt assemblies fitted in all seating positions.
- Seat belt pretensioners which are incorporated in the front drivers and passenger seat belt buckles.
- A dual stage drivers airbag which is incorporated in the steering wheel.
- A dual stage passenger airbag which is incorporated in the instrument panel.
- Side impact inflatable restraints which are incorporated in the front driver and passenger seats, where fitted.
- Side impact inflatable restraints (curtain airbags) which are incorporated in the roof, where fitted.
- Active head restraints which are incorporated in the front seat assemblies, where fitted.

Locking of the inertia reel seat belt is automatic. Deployment of the seat belt pretensioners and inflatable restraints is controlled by a sensing diagnostic module (SDM), which is mounted on the floor panel beneath the centre console. The SDM has an internal velocity sensor and two external impact sensors mounted to the front of the vehicle to detect frontal collisions, while side impact sensor assemblies fitted to each side of the vehicle detect side impacts.

Front Seat Belt System

The front seat belt system includes the following components:

- Driver and passenger seat belt retractors which are located behind the centre pillar lower trim panel and are attached to the vehicle body.
- Driver and passenger seat belt buckles which are located near the centre console side of the seats and are attached to the seat frame.
- The system also includes a seat belt switch in the drivers seat buckle which controls a warning indicator lamp and a tone alarm.

Rear Seat Belt System

The rear seat belt system includes the following components:

- The rear seat belt retractors are located behind the body lock pillar trims and are attached to the vehicle body.
- The centre rear seat belt retractor is located in the rear seat and is attached to the rear seat frame assembly.
- The centre rear seat belt buckle and the outer rear seat belt buckles are located in the seat cushion and are attached to the vehicle body.

Child Seat Restraint System

Important: : A child in a rear-facing child restraint can be seriously injured if the front passengers air bag inflates. This is because the back of a rear-facing child restraint would be very close to the inflating air bag. NEVER use a rear-facing child restraint in the front seat of this vehicle. If a forward-facing child restraint is suitable for your child, ALWAYS move the front passenger seat as far back as it will go and then install the child restraint. Be sure the child restraint position does not conflict with any additional requirements provided by the manufacturer. For more information, refer to the vehicle owners manual and the instruction that came with the child restraint.

The child seat may only be used in a forward facing seating location. The child seat should be installed and secured according to the manufacturer's directions. If the child seat has a top strap, the seat will need to be anchored. Passengers should not be allowed to sit at locations where the seat belts are being used to secure the child seat.

Fasten Safety Belt Indicator (ISO Symbol) (Red)

The fasten safety belt indicator may only be ON when the vehicle is in RUN mode. The instrument panel cluster (IPC) illuminates the fasten safety belt indicator under the following conditions:

- During the bulb check.
- The inflatable restraint sensing and diagnostic module (SDM) sends the status of the driver seat belt switch to the IPC. If the seat belt is unfastened, the IPC will illuminate the fasten safety belt indicator for approx. 20 seconds or until the seat belt is fastened. If the seat belt is unfastened within 8 seconds following the bulb check, the SDM sends a request to the IPC for 5 chimes to sound.

Seat Belt System Description and Operation (Sportwagon)

Description

Important: If the vehicle has been in a collision, refer to Repairs and Inspections Required After a Collision for additional information.

The vehicle has front and rear seat belts that are the primary means of occupant restraint. The seat belts help to keep the occupants inside the passenger compartment and to gradually reduce the impact forces during the following events:

- Frontal impact type collisions
- Rear impact type collisions
- Side impact type collisions
- Roll-over type collisions

All seat belt retractors have emergency locks. The seat belt retractors remain unlocked during normal operation and under normal driving conditions in order to allow free movement to the upper body of each occupant. The seat belt retractor mechanism emergency lock engages preventing any movement of the seat belt when the following conditions occur:

- A rapid extraction of the seat belt webbing from the retractor
- An abrupt change in vehicle speed
- An abrupt change in vehicle direction
- Operation of the vehicle on a steep upgrade
- Operation of the vehicle on a downgrade

Front Seat Belt System

The front seat belt system includes the following components:

- The driver and passenger seat belt retractors which are located behind the centre pillar lower trim panels and are attached to the vehicle body.
- The driver and passenger seat belt pretensioner buckles which are attached to the console side of the seat frame.
- The seat belt reminder switch in the drivers seat belt buckle.

The driver and passenger seat belt pretensioner buckles are controlled by the sensing and diagnostic module (SDM). In the event of a front, rear or angled impact the SDM deploys the driver and passenger seat belt pretensioners. When deployed the pretensioner decreases in length tightening the seat belt and securing the occupant into the seat, reducing the severity and extent of injuries. The driver's seat belt switch in the driver seat buckle controls a seat belt reminder warning lamp and an audible chime.

Rear Seat Belt System

The rear seat belt system includes the following components:

- The left and right rear seat belt retractors which are located behind the body lock pillar trims and are attached to the vehicle body.
- The centre rear seat belt retractor which is located under the rear parcel shelf and is attached to the vehicle body (Sedan).
- The centre rear seat belt retractor is located in the rear seat and is attached to the rear seat frame assembly (Sportwagon).
- The centre rear seat belt buckle and the outer rear seat belt buckles are located under the seat cushion and are attached to the vehicle body.

Child Seat Restraint System

Important: : A child in a rear-facing child restraint can be seriously injured if the front passengers air bag inflates. This is because the back of a rear-facing child restraint would be very close to the inflating air bag. NEVER use a rear-facing child restraint in the front seat of this vehicle. If a forward-facing child restraint is suitable for your child, ALWAYS move the front passenger seat as far back as it will go and then install the child restraint. Be sure the child restraint position does not conflict with any additional requirements provided by the manufacturer. For more information, refer to the vehicle owners manual and the instruction that came with the child restraint.

The child seat may only be used in a forward facing seating location. The child seat should be installed and secured according to the manufacturer's directions. If the child seat has a top strap, the seat will need to be anchored.

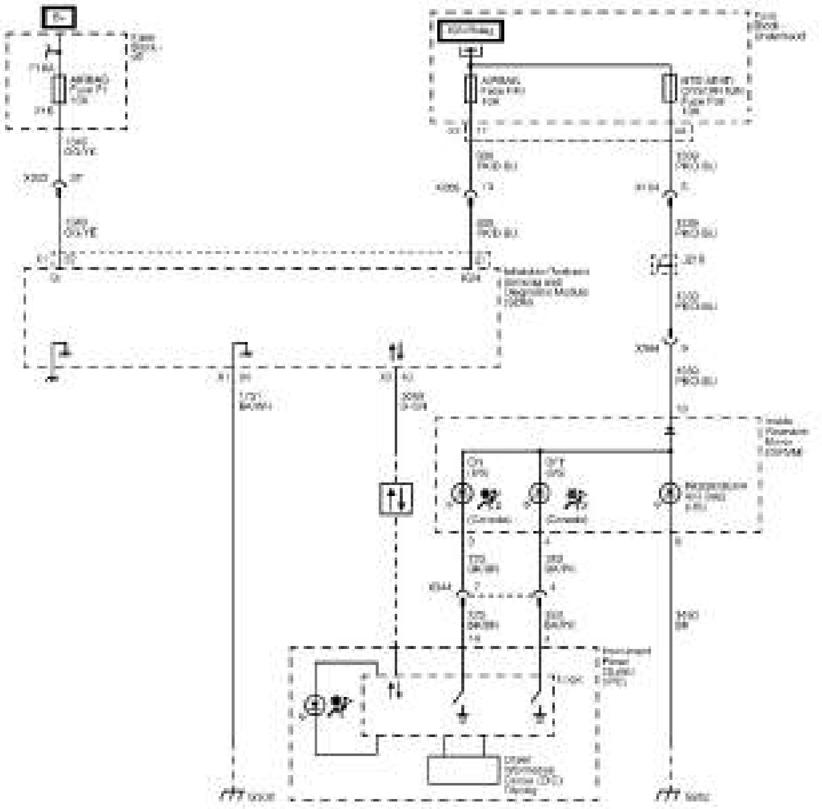
Fasten Safety Belt Indicator (ISO Symbol) (Red)

The seat belt reminder switch is wired to the SDM, which sends a message via GMLAN to the instrument panel cluster (IPC) on the status of the seat belt buckle. The IPC activates the seat belt warning lamp and an audible chime. If the seat belt is not fastened when the ignition is ON, the seat belt warning lamp will illuminate and a chime will sound for approximately 20 seconds. If the seat belt is not fastened and the vehicle speed reaches 25 Km/h, the seat belt warning lamp will flash, the chime will sound and the Fasten Seat Belt message is displayed in the drivers multi function display until the seat belt is fastened.

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Inflatable Restraint Front End Module Sensor Retaining Bolts	8 N·m	71 lb in
Inflatable Restraint Front Impact Sensor to Front End Module Retaining Bolt	9 N·m	80 lb in
Inflatable Restraint Instrument Panel Module Retaining Bolts	16 N·m	12 lb ft
Inflatable Restraint Roof Rail Module Retaining Bolts	7 N·m	62 lb in
Inflatable Restraint Sensing and Diagnostic Module to Body Retaining Nuts	10 N·m	89 lb in
Inflatable Restraint Side Impact Module Bracket to Seat Frame Retaining Bolts	6 N·m	53 lb in
Inflatable Restraint Side Impact Sensor Securing Bolt	9 N·m	80 lb in
Seat Belt Buckle Pretensioner to Seat Retaining Bolts	43 N·m	32 lb ft

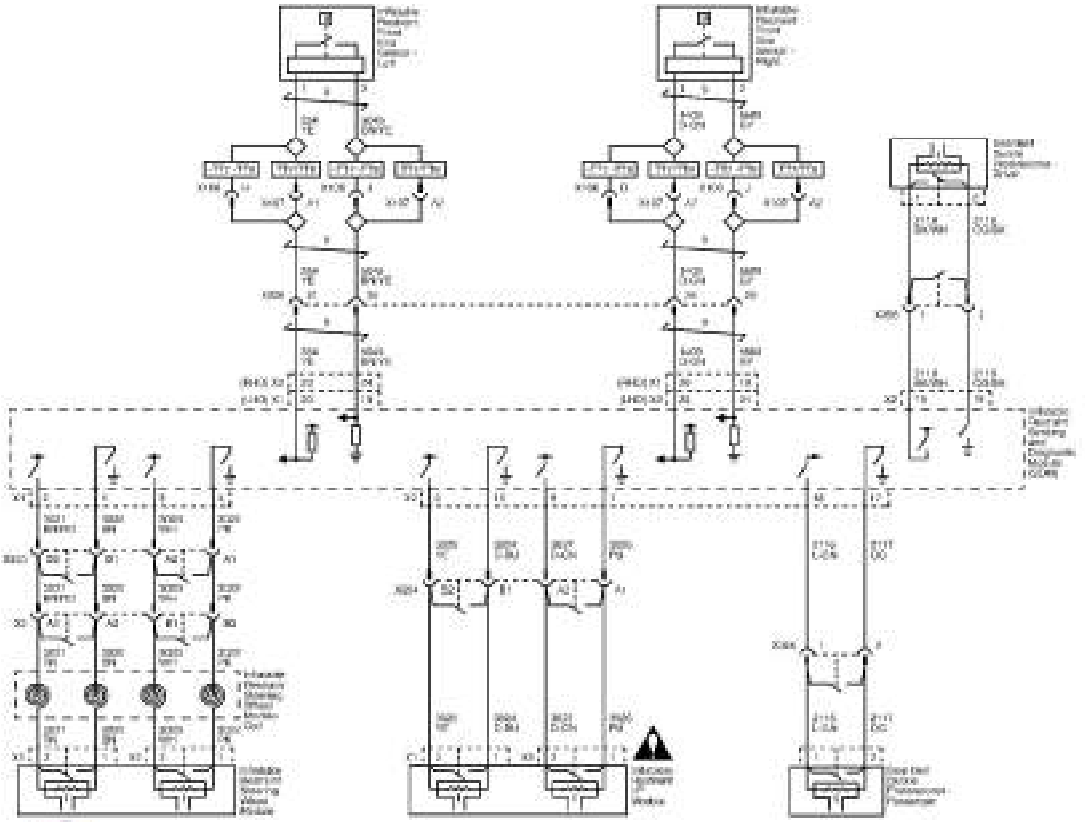
Module Power, Ground, and Indicators


AIRBAG
Fuse F1
X302
AIRBAG
Fuse Block Underhood
Inflatable Restraint Sensing and Diagnostic Module (SDM)
Inside Rearview Mirror (ISRVM)
(Canada)
(Canada)
Instrument Panel Cluster (IPC)
Logic
Driver Information Center (DIC) Display

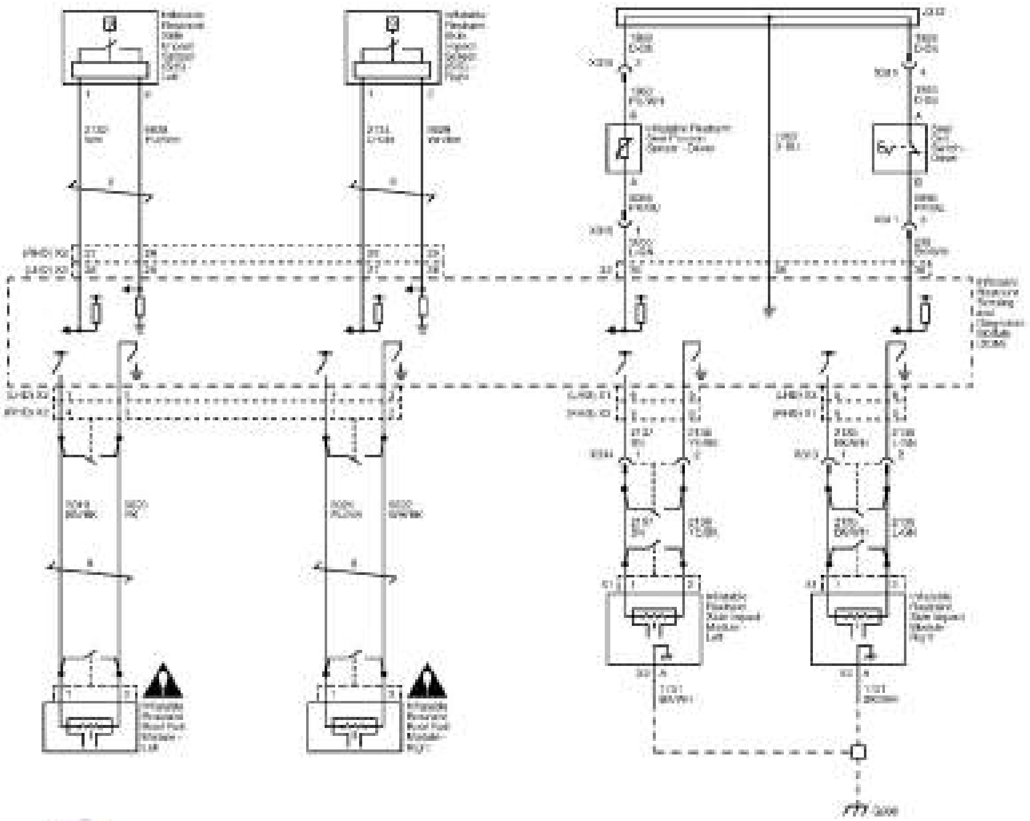
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Safety and Security | Supplemental Inflatable Restraints | Schematic and Routing Diagrams |

Document ID: 2155439

Front End Sensors, Seat Belt Pretensioner, and Front Air Bags



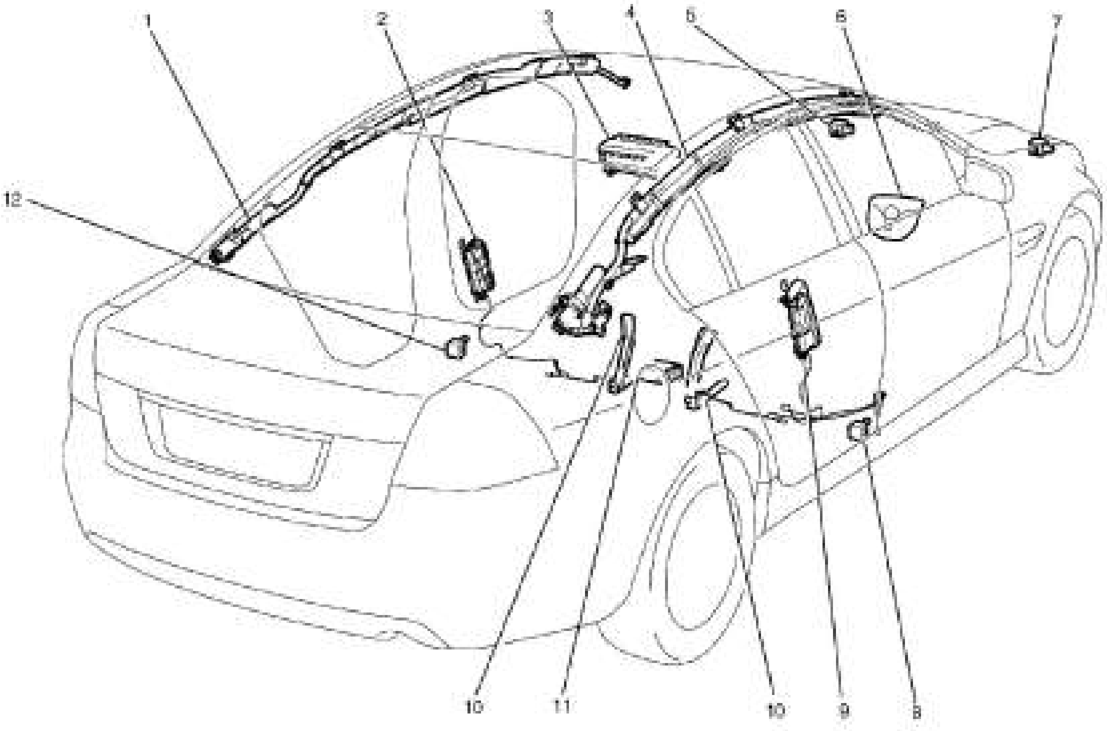
Seat Position / Side Impact Sensors and Roof Rail / Side Impact Air Bags



2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Safety and Security | Supplemental Inflatable Restraints | Component Locator | **Document ID: 1979937**

SIR Component Views (SWBRHD)

SRS Component Location



(1) Inflatable Restraint Roof Rail Module (Left Side)
(2) Inflatable Restraint Side Impact Module (Left Side)
(3) Inflatable Restraint Instrument Panel Module
(4) Inflatable Restraint Roof Rail Module (Right Side)
(5) Inflatable Restraint Front End Sensor (Left Side)
(6) Inflatable Restraint Steering Wheel Module
(7) Inflatable Restraint Front End Sensor (Right Side)
(8) Inflatable Restraint Side Impact Sensor (Right Side)
(9) Inflatable Restraint Side Impact Module (Right Side)
(10) Seat Belt Buckle Pretensioners
(11) Sensing and Diagnostic Module (SDM)
(12) Inflatable Restraint Side Impact Sensor (Left Side)

Diagnostic Starting Point - SIR

Begin the system diagnosis by reviewing the SIR System Description and Operation. Reviewing the description and operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists and will also help you determine if the condition described by the customer is normal operation.

DTC B0012 or B0013

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B0012 01: Driver Frontal Deployment Loop Stage 1 Short to Battery

DTC B0012 02: Driver Frontal Deployment Loop Stage 1 Short to Ground

DTC B0012 08: Driver Frontal Deployment Loop Stage 1 Signal Invalid

DTC B0012 0D: Driver Frontal Deployment Loop Stage 1 Resistance Above Threshold

DTC B0012 0E: Driver Frontal Deployment Loop Stage 1 Resistance Below Threshold

DTC B0013 01: Driver Frontal Deployment Loop Stage 2 Short to Battery

DTC B0013 02: Driver Frontal Deployment Loop Stage 2 Short to Ground

DTC B0013 08: Driver Frontal Deployment Loop Stage 2 Signal Invalid

DTC B0013 0D: Driver Frontal Deployment Loop Stage 2 Resistance Above Threshold

DTC B0013 0E: Driver Frontal Deployment Loop Stage 2 Resistance Below Threshold

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Steering Wheel Module Stage 1 High Control	B0012 02	B0012 0D	B0012 08	B0012 01	B0012 0E
Steering Wheel Module Stage 1 Low Control	B0012 02	B0012 0D	B0012 08	B0012 01	B0012 0E
Steering Wheel Module Stage 2 High Control	B0013 02	B0013 0D	B0013 08	B0013 01	B0013 0E
Steering Wheel Module Stage 2 Low Control	B0013 02	B0013 0D	B0013 08	B0013 01	B0013 0E

Circuit/System Description

During a frontal crash of sufficient force the inflatable restraint sensing and diagnostic module (SDM) will allow current to flow through the deployment loop in order to deploy the steering wheel module. The SDM performs continuous diagnostic tests on the deployment loops to check for proper circuit continuity and for shorts to ground or voltage. There are 2 shorting bars used within the steering wheel module coil connector which will short together both steering wheel module stage 1 high circuit and steering wheel module stage 1 low circuit and both steering wheel module stage 2 high circuit and steering wheel module stage 2 low circuit when the connector is disconnected. This will help to prevent unwanted deployment of the inflator module during servicing.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

B0012 01 Stage 1 or B0013 01 Stage 2

The steering wheel module high and/or low control circuit is shorted to voltage for 2 seconds.

B0012 02 Stage 1 or B0013 02 Stage 2

The steering wheel module high and/or low control circuit is shorted to ground for 2 seconds.

B0012 08 Stage 1 or B0013 08 Stage 2

The steering wheel module high and/or low control circuit is invalid during SDM initialization.

B0012 0D Stage 1 or B0013 0D Stage 2

The steering wheel module deployment loop resistance is more than 5.5 ohms for 2 seconds.

B0012 0E Stage 1 or B0013 0E Stage 2

The steering wheel module deployment loop resistance is less than 1.7 ohms for 2 seconds.

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.
- The SDM will store a DTC, however if an event occurs the system will still attempt deployment.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present
- A history DTC will clear after 100 fault-free ignition cycles

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

Important: Refer to SIR Service Precautions.

When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected component/connector.

- Steering wheel coil module
- SDM module
- Steering wheel coil module wiring harness connector
- SDM wiring harness connector

Important: The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shorting-bars within the connector allowing the deployment circuit to operate properly.

1. Ignition OFF, disconnect the appropriate harness connector at the inflatable restraint steering wheel module.
2. Ignition ON, verify that the appropriate scan tool Driver Airbag Stage 1 or Stage 2 Squib Circuit Resistance parameter is greater than 5.4 ohms at the control circuits.

   If less than the specified range, test the control circuits for a short to ground. If the circuits test normal, replace the SDM.
3. Connect a fused jumper wire between the appropriate control circuit terminals listed below:
   - Steering wheel module stage 1 terminal 1 X1 and terminal 2 X1
   - Steering wheel module stage 2 terminal 1 X2 and terminal 2 X2
4. Ignition ON, verify that the appropriate scan tool Driver Airbag Stage 1 or Stage 2 Squib Circuit Resistance parameter is less than 1.2 ohms at the control circuits.

If greater than the specified range, test the control circuits for a short to voltage or an open/high resistance. If the circuits test normal, replace the SDM.

5. If all circuits test normal, replace the inflatable restraint steering wheel module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Steering Wheel Inflatable Restraint Module Coil Replacement
- Steering Wheel Inflatable Restraint Module Replacement
- SIR/SRS Wiring Repairs
- Control Module References for SDM replacement, setup, and programming

DTC B0014

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B0014 01: Driver Side Deployment Loop Short to battery

DTC B0014 02: Driver Side Deployment Loop Short to Ground

DTC B0014 08: Driver Side Deployment Loop Signal Invalid

DTC B0014 0D: Driver Side Deployment Loop Resistance Above Threshold

DTC B0014 0E: Driver Side Deployment Loop Resistance Below Threshold

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Low Resistance	Short to Voltage	Open
Driver Side Module High Control	B0014 02	B0014 0D	B0014 0E	B0014 01	B0014 08
Driver Side Module Low Control	B0014 02	B0014 0D	B0014 0E	B0014 01	B0014 08
Passenger Side Module High Control	B0021 02	B0021 0D	B0021 0E	B0021 01	B0021 08
Passenger Side Module Low Control	B0021 02	B0021 0D	B0021 0E	B0021 01	B0021 08

Circuit/System Description

During a side impact event of sufficient force the inflatable restraint sensing and diagnostic module (SDM) will allow current to flow through the deployment loop in order to deploy the side impact modules. The SDM performs continuous diagnostic tests on the deployment loops to check for correct circuit continuity and for shorts to ground or voltage. There is a shorting bar used within the side impact modules coil connector which will short together the side impact module high circuit and side impact module low circuit when the connector is disconnected. This will help to prevent unwanted deployment of the inflator module during servicing.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

B0014 01

The side impact module high and/or low control circuit is shorted to voltage for 2 seconds.

B0014 02

The side impact module high and/or low control circuit is shorted to ground for 2 seconds.

B0014 08

The side impact module high and/or low signal control circuit is invalid during SDM initialization.

B0014 0D

The side impact module deployment loop resistance is more than 5.5 ohms for 2 seconds.

B0014 0E

The side impact module deployment loop resistance is less than 1.1 ohms for 2 seconds.

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.
- The SDM will store a DTC, however if an event occurs the system will still attempt deployments.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present
- A history DTC will clear after 100 fault-free ignition cycles

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

Important: Refer to SIR Service Precautions.

When removing the connectors, inspect for damage or corrosion. Damage or corrosion to the following requires repair or replacement of the affected component/connector:

- Side impact module- driver
- SDM module
- Side impact module wiring harness connector
- SDM wiring harness connector

Important: The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shoring-bars within the connector allowing the deployment circuit to operate properly.

1. Ignition OFF, disconnect the harness connector at the driver inflatable restraint side impact module.
2. Ignition ON, verify that the scan tool Driver Side Airbag Squib Circuit Resistance parameter is greater than 5.4 ohms at the control circuits.

   If less than the specified range, test the control circuits for a short to ground. If the circuits test normal, replace the SDM.
3. Connect a fused jumper wire in between the side impact module terminal 1 X1 and terminal 2 X1.
4. Ignition ON, verify that the scan tool Driver Side Airbag Squib Circuit Resistance parameter is less than 1.2 ohms at the control circuits.

   If greater than the specified range, test the control circuits for a short to voltage or an open/high resistance. If the circuits test normal, replace the SDM.
5. If all circuits test normal, replace the driver inflatable restraint side impact module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Driver or Passenger Seat Side Inflatable Restraint Module Replacement
- Control Module References for SDM replacement, setup, and programming

DTC B0015

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B0015 01: Driver Pretensioner Deployment State 1 Loop Short to Battery

DTC B0015 02: Driver Pretensioner Deployment State 1 Loop Short to Ground

DTC B0015 08: Driver Pretensioner Deployment State 1 Loop Single Invalid

DTC B0015 0D: Driver Pretensioner Deployment State 1 Loop Resistance Above Threshold

DTC B0015 0E: Driver Pretensioner Deployment State 1 Loop Resistance Below Threshold

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Low Resistance	Short to Voltage	Signal Performance
Seat Belt Pretensioner Driver High Control	B0015 02	B0015 0D	B0015 0E	B0015 01	B0015 08
Seat Belt Pretensioner Driver Low Control	B0015 02	B0015 0D	B0015 0E	B0015 01	B0015 08
Seat Belt Pretensioner - Passenger High Control	B0022 02	B0022 0D	B0022 0E	B0022 01	B0022 08
Seat Belt Pretensioner - Passenger Low Control	B0022 02	B0022 0D	B0022 0E	B0022 01	B0022 08

Circuit/System Description

During a side or frontal crash of sufficient force the inflatable restraint sensing and diagnostic module (SDM) will allow current to flow through the deployment loop in order to deploy the seat belt pretensioner - driver. The SDM performs continuous diagnostic tests on the deployment loops to check for proper circuit continuity and for shorts to ground or voltage. A shorting bar used within the seat belt pretensioner - driver connector which will short together both seat belt pretensioner -

driver high and low circuits when the connector is disconnected, this will help to prevent unwanted deployment of the inflator module during servicing.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

B0015 01

The seat belt pretensioner - driver high and/or low control circuit is shorted to voltage for 2 seconds.

B0015 02

The seat belt pretensioner - driver high and/or low control circuit is shorted to ground for 2 seconds.

B0015 08

The seat belt pretensioner - driver high and/or low control circuit is invalid during SDM initialization.

B0015 0D

The seat belt pretensioner - driver deployment loop resistance is more than 5.5 ohms for 2 seconds.

B0015 0E

The seat belt pretensioner - driver deployment loop resistance is less than 1.1 ohms for 2 seconds.

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.
- The SDM will store a DTC, however if an event occurs the system will still attempt deployments.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC will clear after 100 fault-free ignition cycles.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

Important: When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected component/connector.

- Seat belt buckle pretensioner - driver
- SDM module
- Seat belt buckle pretensioner - driver wiring harness connector
- SDM wiring harness connector

Important: The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shoring-bars within the connector allowing the deployment circuit to operate properly.

1. Ignition OFF, disconnect the harness connector at the driver seat belt buckle pretensioner.
2. Ignition ON, verify that the scan tool Driver Pretensioner Circuit Resistance parameter is greater than 5.4 ohms at the control circuits.

   If less than the specified range, test the control circuits for a short to ground. If the circuits test normal, replace the SDM.
3. Connect a fused jumper wire in between the seat belt buckle pretensioner terminal 1 and terminal 2.
4. Ignition ON, verify that the scan tool Driver Pretensioner Circuit Resistance parameter is less than 1.2 ohms at the control circuits.

   If greater than the specified range, test the control circuits for a short to voltage or an open/high resistance. If the circuits test normal, replace the SDM.
5. If all circuits test normal, replace the driver seat belt buckle pretensioner.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Seat Belt Buckle Pretensioner Replacement.

- Control Module References for SDM replacement, setup, and programming

DTC B0016

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B0016 01: Driver Curtain Deployment Loop Initiator Short to Battery

DTC B0016 02: Driver Curtain Deployment Loop Initiator Short to Ground

DTC B0016 08: Driver Curtain Deployment Loop Initiator Signal Invalid

DTC B0016 0D: Driver Curtain Deployment Loop Initiator Resistance Above Threshold

DTC B0016 0E: Driver Curtain Deployment Loop Initiator Resistance Below Threshold

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Low Resistance	Short to Voltage	Open
Roof Rail Module - Driver High	B0016 02	B0016 0D	B0016 0E	B0016 01	B0016 08
Roof Rail Module - Driver Low	B0016 02	B0016 0D	B0016 0E	B0016 01	B0016 08
Roof Rail Module - Passenger High Control	B0023 02	B0023 0D	B0023 0E	B0023 01	B0023 08
Roof Rail Module - Passenger Low Control	B0023 02	B0023 0D	B0023 0E	B0023 01	B0023 08

Circuit/System Description

During a side or frontal crash of sufficient force the inflatable restraint sensing and diagnostic module (SDM) will allow current to flow through the deployment loop in order to deploy the roof rail module. The SDM performs continuous diagnostic tests on the deployment loops to check for proper circuit continuity and for shorts to ground or voltage.

A shorting bar used within the roof rail module connector which will short together both roof rail module - driver high and low circuits when the connector is disconnected, this will help to prevent unwanted deployment of the inflator module during servicing.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

B0016 01

The roof rail module - driver high and/or low control circuit is shorted to voltage for 2 seconds.

B0016 02

The roof rail module - driver high and/or low control circuit is shorted to ground for 2 seconds.

B0016 08

The roof rail module - driver high and/or low control circuit is invalid during SDM initialization.

B0016 0D

The roof rail module - driver deployment loop resistance is more than 5.5 ohms for 2 seconds.

B0016 0E

The roof rail module - driver deployment loop resistance is less than 1.1 ohms for 2 seconds.

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.
- The SDM will store a DTC, however if an event occurs the system will still attempt deployments.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present
- A history DTC will clear after 100 fault-free ignition cycles

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

Important: Refer to SIR Service Precautions.

When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected component/connector.

- Roof rail module - driver
- SDM module
- Roof rail module - driver wiring harness connector
- SDM wiring harness connector

Important: The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shoring-bars within the connector allowing the deployment circuit to operate properly.

1. Ignition OFF, disconnect the harness connector at the driver inflatable roof rail restraint module.
2. Ignition ON, verify that the scan tool Driver Curtain Airbag Squib Circuit Resistance parameter is greater than 5.4 ohms at the control circuits.

   If less than the specified range, test the control circuits for a short to ground. If the circuits test normal, replace the SDM.
3. Connect a fused jumper wire in between the roof rail module terminal 1 and terminal 2.
4. Ignition ON, verify that the scan tool Driver Curtain Airbag Squib Circuit Resistance parameter is less than 1.2 ohms at the control circuits.

   If greater than the specified range, test the control circuits for a short to voltage or an open/high resistance. If the circuits test normal, replace the SDM.
5. If all circuits test normal, replace the driver inflatable roof rail restraint module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Inflatable Restraint Roof Side Rail Module Replacement - Front
- Control Module References for SDM replacement, setup, and programming

DTC B0019 or B0020

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B0019 01: Passenger Frontal Deployment Loop Stage 1 Short to Battery

DTC B0019 02: Passenger Frontal Deployment Loop Stage 1 Short to Ground

DTC B0019 08: Passenger Frontal Deployment Loop Stage 1 Signal Invalid

DTC B0019 0D: Passenger Frontal Deployment Loop Stage 1 Resistance Above Threshold

DTC B0019 0E: Passenger Frontal Deployment Loop Stage 1 Resistance Below Threshold

DTC B0020 01: Passenger Frontal Deployment Loop Stage 2 Short to Battery

DTC B0020 02: Passenger Frontal Deployment Loop Stage 2 Short to Ground

DTC B0020 08: Passenger Frontal Deployment Loop Stage 2 Signal Invalid

DTC B0020 0D: Passenger Frontal Deployment Loop Stage 2 Resistance Above Threshold

DTC B0020 0E: Passenger Frontal Deployment Loop Stage 2 Resistance Below Threshold

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Low Resistance	Short to Voltage	Signal Performance
I/P Module Stage 1 High Control	B0019 02	B0019 0D	B0019 0E	B0019 01	B0019 08
I/P Module Stage 1 Low Control	B0019 02	B0019 0D	B0019 0E	B0019 01	B0019 08
I/P Module Stage 2 High Control	B0020 02	B0020 0D	B0020 0E	B0020 01	B0020 08
I/P Module Stage 2 Low Control	B0020 02	B0020 0D	B0020 0E	B0020 01	B0020 08

Circuit/System Description

If a malfunction is detected, a DTC will be stored in non-volatile memory. During a side or frontal crash of sufficient force the inflatable restraint sensing and diagnostic module (SDM) will allow current to flow through the deployment loop in order to deploy the instrument panel (I/P) module. The SDM performs continuous diagnostic tests on the deployment loops to check for proper circuit continuity and for shorts to ground or voltage. There are 2 shorting bars used within the I/P module connector which will short together both I/P module stage 1 high and low circuits, and both I/P module stage 2 high and low circuits, when the connector is disconnected. This will help to prevent unwanted deployment of the inflator module during servicing.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

B0019 01 Stage 1 or B0020 01 Stage 2

The I/P module high and/or low control circuit is shorted to voltage for 2 seconds.

B0019 02 Stage 1 or B0020 02 Stage 2

The I/P module high and/or low control circuit is shorted to ground for 2 seconds.

B0019 08 Stage 1 or B0020 04 Stage 2

The I/P module high and/or low control circuit is invalid during SDM initialization.

B0019 0D Stage 1 or B0020 0D Stage 2

The I/P module deployment loop resistance is more than 5.5 ohms for 2 seconds.

B0019 0E Stage 1 or B0020 0E Stage 2

The I/P module deployment loop resistance is less than 1.1 ohms for 2 seconds.

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.
- The SDM will store a DTC, however if an event occurs the system will still attempt deployments.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC will clear after 100 fault-free ignition cycles.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

Important: Refer to SIR Service Precautions.

When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected component/connector.

- I/P module
- SDM module
- I/P module wiring harness connector
- SDM wiring harness connector

Important: The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shorting-bars within the connector allowing the deployment circuit to operate properly.

1. Ignition OFF, disconnect the appropriate harness connector at the inflatable restraint I/P module.
2. Ignition ON, verify that the appropriate scan tool Passenger Airbag Stage 1 or Stage 2 Squib Circuit Resistance parameter is greater than 5.4 ohms at the control circuits.

   If less than the specified range, test the control circuits for a short to ground. If the circuits test normal, replace the SDM.
3. Connect a fused jumper wire between the appropriate control circuit terminals listed below:
   - I/P module stage 1 terminal 1 X1 and terminal 2 X1
   - I/P module stage 2 terminal 1 X2 and terminal 2 X2
4. Ignition ON, verify that the appropriate scan tool Passenger Airbag Stage 1 or Stage 2 Squib Circuit Resistance parameter is less than 1.2 ohms at the control circuits.

If greater than the specified range, test the control circuits for a short to voltage or an open/high resistance. If the circuits test normal, replace the SDM.

5. If all circuits test normal, replace the inflatable restraint I/P module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Instrument Panel Inflatable Restraint Module Replacement
- SIR/SRS Wiring Repairs
- Control Module References for SDM replacement, setup, and programming

DTC B0021

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B0021 01: Passenger Side Deployment Loop Stage 1 Short to Battery

DTC B0021 02: Passenger Side Deployment Loop Stage 1 Short to Ground

DTC B0021 08: Passenger Side Deployment Loop Stage 1 Signal Invalid

DTC B0021 0D: Passenger Side Deployment Loop Stage 1 Resistance Above Threshold

DTC B0021 0E: Passenger Side Deployment Loop Stage 1 Resistance Below Threshold

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Low Resistance	Short to Voltage	Open
Driver Side Module High Control	B0014 02	B0014 0D	B0014 0E	B0014 01	B0014 08
Driver Side Module Low Control	B0014 02	B0014 0D	B0014 0E	B0014 01	B0014 08
Passenger Side Module High Control	B0021 02	B0021 0D	B0021 0E	B0021 01	B0021 08
Passenger Side Module Low Control	B0021 02	B0021 0D	B0021 0E	B0021 01	B0021 08

Circuit/System Description

During a side impact event of sufficient force the inflatable restraint sensing and diagnostic module (SDM) will allow current to flow through the deployment loop in order to deploy the side impact modules. The SDM performs continuous diagnostic tests on the deployment loops to check for correct circuit continuity and for shorts to ground or voltage. There is a shorting bar used within the side impact modules coil connector which will short together the side impact module high circuit and side impact module low circuit when the connector is disconnected. This will help to prevent unwanted deployment of the inflator module during servicing.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

B0021 01

The side impact module high and/or low control circuit is shorted to voltage for 2 seconds.

B0021 02

The side impact module high and/or low control circuit is shorted to ground for 2 seconds.

B0021 08

The side impact module high and/or low control circuit is invalid during SDM initialization.

B0021 0D

The side impact module deployment loop resistance is more than 5.5 ohms for 2 seconds.

B0021 0E

The side impact module deployment loop resistance is less than 1.1 ohms for 2 seconds.

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.
- The SDM will store a DTC, however if an event occurs the system will still attempt deployments.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC will clear after 100 fault-free ignition cycles.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

Important: Refer to SIR Service Precautions.

When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected component/connector.

- Side impact module- passenger
- SDM module
- Side impact module wiring harness connector
- SDM wiring harness connector

Important: The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shoring-bars within the connector allowing the deployment circuit to operate properly.

1. Ignition OFF, disconnect the harness connector at the passenger inflatable restraint side impact module.
2. Ignition ON, verify that the scan tool Passenger Side Airbag Squib Circuit Resistance parameter is greater than 5.4 ohms at the control circuits.

   If less than the specified range, test the control circuits for a short to ground. If the circuits test normal, replace the SDM.
3. Connect a fused jumper wire in between the side impact module terminal 1 X1 and terminal 2 X1.
4. Ignition ON, verify that the scan tool Passenger Side Airbag Squib Circuit Resistance parameter is less than 1.2 ohms at the control circuits.

   If greater than the specified range, test the control circuits for a short to voltage or an open/high resistance. If the circuits test normal, replace the SDM.
5. If all circuits test normal, replace the passenger inflatable restraint side impact module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Driver or Passenger Seat Side Inflatable Restraint Module Replacement
- Control Module References for SDM replacement, setup, and programming

DTC B0022

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B0022 01: Passenger Pretensioner Deployment Stage 1 Loop Short to Battery

DTC B0022 02: Passenger Pretensioner Deployment Stage 1 Loop Short to Ground

DTC B0022 08: Passenger Pretensioner Deployment Stage 1 Loop Signal Invalid

DTC B0022 0D: Passenger Pretensioner Deployment Stage 1 Loop Resistance Above Threshold

DTC B0022 0E: Passenger Pretensioner Deployment Stage 1 Loop Resistance Below Threshold

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Low Resistance	Short to Voltage	Signal Performance
Seat Belt Pretensioner Driver High Control	B0015 02	B0015 0D	B0015 0E	B0015 01	B0015 08
Seat Belt Pretensioner Driver Low Control	B0015 02	B0015 0D	B0015 0E	B0015 01	B0015 08
Seat Belt Pretensioner - Passenger High Control	B0022 02	B0022 0D	B0022 0E	B0022 01	B0022 08
Seat Belt Pretensioner - Passenger Low Control	B0022 02	B0022 0D	B0022 0E	B0022 01	B0022 08

Circuit/System Description

During a side or frontal crash of sufficient force the inflatable restraint sensing and diagnostic module (SDM) will allow current to flow through the deployment loop in order to deploy the seat belt pretensioner - passenger. The SDM performs continuous diagnostic tests on the deployment loops to check for proper circuit continuity and for shorts to ground or voltage. A shorting bar used within the seat belt pretensioner - passenger connector which will short together both seat belt pretensioner - passenger high and low circuits when the connector is disconnected, this will help to prevent unwanted deployment of the inflator module during servicing.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

B0022 01

The seat belt pretensioner - passenger high and/or low control circuit is shorted to voltage for 2 seconds.

B0022 02

The seat belt pretensioner - passenger high and/or low control circuit is shorted to ground for 2 seconds.

B0022 08

The seat belt pretensioner - passenger high and/or low control circuit is invalid during SDM initialization.

B0022 0D

The seat belt pretensioner - passenger deployment loop resistance is more than 5.5 ohms for 2 seconds.

B0022 0E

The seat belt pretensioner - passenger deployment loop resistance is less than 1.1 ohms for 2 seconds.

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.
- The SDM will store a DTC, however if an event occurs the system will still attempt deployments.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC will clear after 100 fault-free ignition cycles.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

Important: Refer to SIR Service Precautions.

When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected component/connector.

- Seat belt buckle pretensioner - passenger
- SDM module
- Seat belt buckle pretensioner - passenger wiring harness connector
- SDM wiring harness connector

Important: The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shoring-bars within the connector allowing the deployment circuit to operate properly.

1. Ignition OFF, disconnect the harness connector at the passenger seat belt buckle pretensioner.
2. Ignition ON, verify that the scan tool Passenger Pretensioner Circuit Resistance parameter is greater than 5.4 ohms at the control circuits.

   If less than the specified range, test the control circuits for a short to ground. If the circuits test normal, replace the SDM.
3. Connect a fused jumper wire in between the seat belt buckle pretensioner terminal 1 and terminal 2.
4. Ignition ON, verify that the scan tool Passenger Pretensioner Circuit Resistance parameter is less than 1.2 ohms at the control circuits.

   If greater than the specified range, test the control circuits for a short to voltage or an open/high resistance. If the circuits test normal, replace the SDM.
5. If all circuits test normal, replace the passenger seat belt buckle pretensioner.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Seat Belt Buckle Pretensioner Replacement
- Control Module References for SDM replacement, setup, and programming

DTC B0023

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B0023 01: Passenger Curtain Deployment Loop Initiator Short to Battery

DTC B0023 02: Passenger Curtain Deployment Loop Initiator Short to Ground

DTC B0023 08: Passenger Curtain Deployment Loop Initiator Signal Invalid

DTC B0023 0D: Passenger Curtain Deployment Loop Initiator Resistance Above Threshold

DTC B0023 0E: Passenger Curtain Deployment Loop Initiator Resistance Below Threshold

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Low Resistance	Short to Voltage	Open
Roof Rail Module - Driver High	B0016 02	B0016 0D	B0016 0E	B0016 01	B0016 08
Roof Rail Module - Driver Low	B0016 02	B0016 0D	B0016 0E	B0016 01	B0016 08
Roof Rail Module - Passenger High Control	B0023 02	B0023 0D	B0023 0E	B0023 01	B0023 08
Roof Rail Module - Passenger Low Control	B0023 02	B0023 0D	B0023 0E	B0023 01	B0023 08

Circuit/System Description

During a side or frontal crash of sufficient force, the inflatable restraint sensing and diagnostic module (SDM) will allow current to flow through the deployment loop in order to deploy the roof side rail module. The SDM performs continuous diagnostic tests on the deployment loops to check for proper circuit continuity and for shorts to ground or voltage. A shorting bar used within the roof rail module connector will short together both roof rail module - passenger high and low circuits when the connector is disconnected; this will help to prevent unwanted deployment of the inflator module during servicing.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

B0023 01

The roof rail module - passenger high and/or low control circuit is shorted to voltage for 2 seconds.

B0023 02

The roof rail module - passenger high and/or low control circuit is shorted to ground for 2 seconds.

B0023 08

The roof rail module - passenger high and/or low control circuit is invalid during SDM initialization.

B0023 0D

The roof rail module - passenger deployment loop resistance is more than 5.5 ohms for 2 seconds.

B0023 0E

The roof rail module - passenger deployment loop resistance is less than 1.1 ohms for 2 seconds.

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.
- The SDM will store a DTC, however if an event occurs the system will still attempt deployments.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC will clear after 100 fault-free ignition cycles.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

Important: Refer to SIR Service Precautions.

When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected component/connector.

- Roof rail module - passenger
- SDM module
- Roof rail module - passenger wiring harness connector
- SDM wiring harness connector

Important: The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shoring-bars within the connector allowing the deployment circuit to operate properly.

1. Ignition OFF, disconnect the harness connector at the passenger inflatable roof rail restraint module.
2. Ignition ON, verify that the scan tool Passenger Curtain Airbag Squib Circuit Resistance parameter is greater than 5.4 ohms at the control circuits.

   If less than the specified range, test the control circuits for a short to ground. If the circuits test normal, replace the SDM.
3. Connect a fused jumper wire in between the roof rail module terminal 1 and terminal 2.
4. Ignition ON, verify that the scan tool Passenger Curtain Airbag Squib Circuit Resistance parameter is less than 1.2 ohms at the control circuits.

   If greater than the specified range, test the control circuits for a short to voltage or an open/high resistance. If the circuits test normal, replace the SDM.
5. If all circuits test normal, replace the passenger inflatable roof rail restraint module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Inflatable Restraint Roof Side Rail Module Replacement - Front
- Control Module References for SDM replacement, setup, and programming

DTC B0052 or B0053

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B0052: Deployment Commanded

DTC B0053: Deployment Commanded with Loop DTCs Present

Circuit/System Description

The inflatable restraint sensing and diagnostic module (SDM) contains a sensing device that converts vehicle velocity changes into an electrical signal. The SDM compares this electrical signal to a value stored in memory. When the generated signal exceeds the stored value, the SDM performs additional signal processing and compares the generated signals to values stored in memory. When 2 of the generated signals exceed the stored values, the SDM will cause current to flow through the deployment loops, deploying the air bags and/or pretensioners causing DTC B0052 or B0053 to set.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

B0052

- The SDM detects a frontal impact of sufficient force to warrant deployment of the frontal modules.
- The SDM detects a side impact of sufficient force to warrant deployment of a side impact module and/or roof rail module.
- The SDM has deployed the seat belt pretensioner for 3 separate deployments.

B0053

SDM commands inflators deployment with loop faults present.

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.
- The SDM records crash data.

Conditions for Clearing the DTC

After an air bag deployment or 3 separate pretensioner deployments the DTC becomes latched and cannot be cleared.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Important:

- The seat belt pretensioners may deploy for impacts that are not severe enough to warrant frontal or side air bag deployment. The SDM is capable of sustaining 3 pretensioner deployment events, or one frontal or side deployment event. After the maximum number of deployments has occurred, DTC B0052 sets and becomes a latched code, which cannot be cleared.
- When DTC B0053 is accompanied by additional DTCs, other than B0052, repair the malfunction causing the other DTCs before replacing the SDM.

1. Ignition OFF, verify no signs of inflator module or pretensioner deployment exist.
   If any signs of deployment exist, refer to Repairs and Inspections Required After a Collision.
2. Verify DTC B0053 is not set.
   If DTC B0053 is set along with additional DTCs, other than B0052, repair the malfunction causing the DTCs before replacing the SDM.
3. Verify DTC B0052 is not set.

If the DTC resets, replace the SDM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for SDM replacement, setup, and programming

DTC B0055

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B0055 00: Side Airbag Deployment Commanded

Circuit/System Description

The inflatable restraint sensing and diagnostic module (SDM) contains a sensing device that converts vehicle velocity changes into an electrical signal. The SDM compares this electrical signal to a value stored in memory. When the generated signal exceeds the stored value, the SDM performs additional signal processing and compares the generated signals to values stored in memory. When 2 of the generated signals exceed the stored values, the SDM will cause current to flow through the inflator modules, deploying the side air bags and causing DTC B0055 to set.

This DTC is set when the SDM has commanded an air bag deployment with no faults present.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

- The SDM detects a frontal impact of sufficient force to warrant deployment of the frontal inflator modules.
- The SDM detects a side impact of sufficient force to warrant deployment of a side inflator module and/or roof rail module.

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.
- The SDM records crash data.

Conditions for Clearing the DTC

DTC B0055 is a latched code and cannot be cleared.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition OFF, Verify that the vehicle does not show any signs of side impact or frontal inflator module deployment.

   If the vehicle displays any signs of inflator deployment, refer to Repairs and Inspections Required After a Collision.
2. Verify DTC B0055 is not set.

   If DTC B0055 is set, replace the SDM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for SDM replacement, setup, and programming

DTC B0072

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B0072 01: Driver Seat Belt Sensor Circuit Short to Voltage

DTC B0072 02: Driver Seat Belt Sensor Circuit Short to Ground

DTC B0072 05: Driver Seat Belt Sensor Circuit Short to Battery or Open

DTC B0072 08: Driver Seat Belt Sensor Circuit Signal Invalid

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Seat Belt Sensor Driver Low Reference	--	B0072 05, 2	B0072 05, 2	2	B0072 08
Seat Belt Sensor Driver Signal	B0072 02, 1	--	B0072 05, 2	B0072 01, 2	B0072 08
1. Indicator will remain ON with seat belt buckled 2. Indicator will illuminate only for the bulb test					

Circuit/System Description

The inflatable restraint seat belt buckle switch is within the seat belt buckle and provides an input to the inflatable restraint sensing and diagnostic module (SDM). The SDM supplies a low reference circuit and a seat belt switch signal circuit to determine a buckled or unbuckled condition. The SDM monitors the seat belt switch circuits and if a fault is detected a DTC will be set.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

B0072 01

The SDM detects the seat belt sensor circuit is shorted to voltage for 2 seconds.

B0072 02

The SDM detects the seat belt sensor circuit is shorted to ground for 2 seconds.

B0072 05

The SDM detects the seat belt sensor circuit is open for 2 seconds.

B0072 08

The SDM detects the seat belt sensor signal circuit is invalid for 2 seconds.

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.
- The SDM will store the DTC.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC will clear after 250 fault-free ignition cycles.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

Ignition ON, observe the scan tool Driver Seat Belt Switch parameter while buckling and unbuckling the seat belt. The reading should be Not Buckled when the seat belt is unbuckled and the seat belt switch is closed. The reading should be Buckled when the seat belt is buckled and the seat belt switch is open.

Circuit / System Testing

Important: When removing connectors, inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected component/connector:

- Seat belt sensor.
- SDM.
- Seat belt sensor wiring harness connector.
- SDM wiring harness connector.

1. Ignition OFF, disconnect the harness connector of the seat belt switch.
2. Test for less than 1 ohm between low reference circuit terminal A and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the SDM.
3. Ignition ON, verify the scan tool Driver Seat Belt switch parameter is Buckled.

   If not the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the SDM.
4. Connect a 3A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the scan tool Driver Seat Belt Switch parameter is Not Buckled.

   If not the specified value, test the signal circuit for short to voltage or an open/high resistance. If the circuit tests normal, replace the SDM.
5. If the circuits test normal, replace the seat belt buckle switch.

Repair Instructions

perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Seat Belt Buckle Pretensioner Replacement.
- Control Module References for SDM replacement, setup, and programming

DTC B0079

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC B0079 01: Driver Seat Position Sensor Circuit Short to Battery

DTC B0079 02: Driver Seat Position Sensor Circuit Short to Ground

DTC B0079 05: Driver Seat Position Sensor Circuit Short to Battery or Open

DTC B0079 08: Driver Seat Position Sensor Circuit Signal Invalid

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Seat Position Sensor Driver Low Reference	B0079 02	B0079 05	B0079 05	B0079 01	B0079 08
Seat Position Sensor Driver Signal	B0079 02	B0079 05	B0079 05	B0079 01	B0079 08

Circuit/System Description

The inflatable restraint seat position sensor (SPS) is used to determine the proximity of a front driver or passenger seat position with respect to the frontal air bag. The SPS interfaces with the sensing and diagnostic module (SDM). The state of the SPS allows the SDM to disable stage 2 of the frontal air bag for a front seat that is forward of a forward/rearward point in seat track travel. The SPS is a hall effect sensor that is mounted on the outboard seat track of the driver and passenger seats. The seat track includes a metal bracket that shunts the SPS magnetic circuit creating 2 states of seat position. The shunted state represents a rearward seat position. The non-shunted state represents a forward position. The SPS provides 2 current ranges, one range for the shunted state and a second range for a non-shunted state. These 2 states are inputs to the SDM, state 1 (shunted) being the rearward threshold and state 2 (non-shunted) being the forward threshold. When the SDM receives input from a SPS that state 1 threshold is reached (seat is rearward), the SDM will not disable stage 2 deployment, if required by the deployment sensors. When state 2 threshold is reached (seat is forward), the SDM will disable stage 2 deployment on the side the seat is forward. The SDM monitors the SPS circuit and if a fault is detected, the SDM will set codes B0079 and defaults to disabling stage 2 frontal deployment.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

B0079 01

The SDM detects the SPS signal circuit is shorted to voltage for 2 seconds.

B0079 02

The SDM detects the SPS signal circuit is shorted to ground for 2 seconds.

B0079 05

The SDM detects the SPS signal circuit is shorted to voltage or open for 2 seconds.

B0079 08

The SDM detects the SPS signal circuit is invalid for 500 milliseconds.

Action Taken When the DTC Sets

- The SDM defaults the SPS to seat forward threshold.
- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC will clear after 250 fault-free ignition cycles.
- The DTC can be cleared using a scan tool.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

> **Important:** When removing connectors, inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected component/connector:
>
> - Seat position sensor
> - SDM module
> - Seat position sensor wiring harness connector
> - SDM wiring harness connector

1. Ignition OFF, disconnect the harness connector at the SPS.
2. Test for less than 1 ohm between the low reference circuit terminal B and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the SDM.
3. Ignition ON, test for 1.2-2.0 volts between the signal circuit terminal A and ground.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the SDM.

   If less than the specified range, test the voltage reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the SDM.
4. If the circuits test normal, replace the SPS.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Front Seat Horizontal Adjuster Position Sensor Replacement.
- Control Module References for SDM replacement, setup, and programming

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DTC B0083 or B0084

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B0083 01: Front End Sensor 1 Short to Battery (Driver)

DTC B0083 02: Front End Sensor 1 Short to Ground (Driver)

DTC B0083 04: Front End Sensor 2 Open Circuit (Driver)

DTC B0083 39: Front End Sensor 1 Internal Electronic Failure (Driver)

DTC B0083 3A: Front End Sensor 1 Incorrect Component Installed (Driver)

DTC B0083 71: Front End Sensor 1 Invalid Serial Data Received (Driver)

DTC B0084 01: Front End Sensor 2 Short to Battery (Passenger)

DTC B0084 02: Front End Sensor 2 Short to Ground (Passenger)

DTC B0084 04: Front End Sensor 2 Open Circuit (Passenger)

DTC B0084 39: Front End Sensor 2 Internal Electronic Failure (Passenger)

DTC B0084 3A: Front End Sensor 2 Incorrect Component Installed (Passenger)

DTC B0084 71: Front End Sensor 2 Invalid Serial Data Received (Passenger)

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Front End Sensor 1 High Signal	B0083 02	B0083 04	B0083 04	B0083 01	B0083 3A
Front End Sensor 1 Low Reference	B0083 02	B0083 04	B0083 04	B0083 01	B0083 3A
Front End Sensor 2 High Signal	B0084 02	B0084 04	B0084 04	B0084 01	B0084 3A
Front End Sensor 2 Low Reference	B0084 02	B0084 04	B0084 04	B0084 01	B0084 3A

Left Front Side Impact Sensor High Signal	B0085 02	B0085 04	B0085 04	B0085 01	B0085 3A
Left Front Side Impact Low Reference	B0085 02	B0085 04	B0085 04	B0085 01	B0085 3A
Right Front Side Impact Sensor High Signal	B0086 02	B0086 04	B0086 04	B0086 01	B0086 3A
Right Front Side Impact Low Reference	B0086 02	B0086 04	B0086 04	B0086 01	B0086 3A

Circuit/System Description

The inflatable restraint front end sensor utilizes a unidirectional 2-wire circuit. The front end sensor modulates current on the interface to send ID, state of health, and deployment commands to the inflatable restraint sensing and diagnostic module (SDM). The SDM serves as a power source and a ground for the front end sensor. When the ignition is turned ON and input power from the SDM is first detected, the front end sensor responds by performing internal diagnostics and sending an ID to the SDM. The SDM considers the ID to be valid if the response time is less than 5 seconds. The front end sensor continually communicates status messages to the SDM, which determines if a fault is present in the front end sensor circuit. When a fault is detected, the SDM may reset the front end sensor up to 2 times by removing and reapplying power to it. If the fault is still present, the SDM will set a DTC.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

All of the following conditions exist for 2 seconds:

B0083 01 or B0084 01

- The front end sensor has been shorted to voltage.
- The SDM has not received a message from the front end sensor for more than 5 milliseconds.

B0083 02 or B0084 02

- The front end sensor has been shorted to ground.
- The front end sensor current has been above 23 mA for longer than 5 milliseconds.

B0083 04 or B0084 04

The front end sensor circuit is open.

B0083 39 or B0084 39

- The SDM has received a NOK message from the front end sensor.

- The SDM has not received a message.

B0083 3A or B0084 3A

- The SDM has received an ID message from the front end sensor, which does not match the ID stored in the SDM memory.
- The SDM has reset the front end sensor twice without detecting the correct ID message.

B0083 71 or B0084 71

The SDM has received invalid serial data from the front end sensor.

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.
- The SIR System is disabled and no deployments are allowed.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC will clear after 250 fault-free ignition cycles.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

Important: Refer to SIR Service Precautions.

When removing connectors, inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected component/connector:

- Front end sensor
- SDM module
- Front end sensor wiring harness connector
- SDM wiring harness connector

1. Ignition OFF, disconnect the X1 and X2 harness connectors at the SDM and the appropriate front end sensor.
2. Ignition ON, test for less than 1 volt between the appropriate front end sensor low reference circuit terminal 2 and ground.

   If greater than the specified range, test the circuit for a short to voltage.
3. Ignition ON, test for less than 1 volt between the appropriate front end sensor signal circuit terminal 1 and ground.

   If greater than the specified range, test the circuit for a short to voltage.
4. Test for infinite resistance between the appropriate front end sensor signal circuit terminal 1 and ground.

   If less than the specified value, test the circuit for a short to ground.
5. Test for less than 1 ohm between the appropriate front end low reference circuit terminals listed below:
   - With LHD left front end sensor terminal 2 and SDM terminal 19 X1.
   - With RHD left front end sensor terminal 2 and SDM terminal 24 X2.
   - With LHD right front end sensor terminal 2 and SDM terminal 24 X2.
   - With RHD right front end sensor terminal 2 and SDM terminal 19 X1.

   If greater than the specified range, test the circuit for an open/high resistance.
6. Test for less than 1 ohm between the appropriate front end sensor signal circuit terminals listed below:
   - With LHD left front end sensor terminal 1 and SDM terminal 20 X1.
   - With RHD left front end sensor terminal 1 and SDM terminal 23 X2.
   - With LHD right front end sensor terminal 1 and SDM terminal 23 X2.
   - With RHD right front end sensor terminal 1 and SDM terminal 20 X1.

   If greater than the specified range, test the circuit for an open/high resistance.
7. If all circuits test normal, replace the appropriate front end sensor.

   If the DTC resets, replace the SDM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Inflatable Restraint Front End Sensor Replacement
- Control Module References for SDM replacement, setup, and programming

DTC B0085 or B0086

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Front End Sensor 1 High Signal	B0083 02	B0083 04	B0083 04	B0083 01	B0083 3A
Front End Sensor 1 Low Reference	B0083 02	B0083 04	B0083 04	B0083 01	B0083 3A
Front End Sensor 2 High Signal	B0084 02	B0084 04	B0084 04	B0084 01	B0084 3A
Front End Sensor 2 Low Reference	B0084 02	B0084 04	B0084 04	B0084 01	B0084 3A
Left Front Side Impact Sensor High Signal	B0085 02	B0085 04	B0085 04	B0085 01	B0085 3A
Left Front Side Impact Low Reference	B0085 02	B0085 04	B0085 04	B0085 01	B0085 3A
Right Front Side Impact Sensor High Signal	B0086 02	B0086 04	B0086 04	B0086 01	B0086 3A
Right Front Side Impact Low Reference	B0086 02	B0086 04	B0086 04	B0086 01	B0086 3A

Circuit/System Description

The inflatable restraint side impact sensor utilizes a unidirectional 2-wire circuit. The side impact sensor modulates current on the interface to send ID, state of health, and deployment commands to the inflatable restraint sensing and diagnostic module (SDM). The SDM serves as a power source and a ground for the side impact sensor. When the ignition is turned ON and input power from the SDM is first detected, the side impact sensor responds by performing internal diagnostics and sending an ID to the SDM. The SDM considers the ID to be valid if the response time is less than 5 seconds. The side impact sensor continually communicates status messages to the SDM, which determines if a fault is present in the side impact sensor circuit. When a fault is detected, the SDM may reset the side impact sensor up to 2 times by removing and reapplying power to it. If the fault is still present, the SDM will set a DTC.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

All of the following conditions exist for 2.5 seconds:

B0085 01 or B0086 01

- The side impact sensor (SIS) has been shorted to voltage.
- The SDM has not received a message from the SIS for more than 2.5 milliseconds

B0085 02 or B0086 02

- The side impact sensor has been shorted to ground.
- The side impact sensor current has been above 23 mA for longer than 5 milliseconds.

B0085 04 or B0086 04

The SIS circuit is open

B0085 39 or B0086 39

- The SDM has received a NOK message from the side impact sensor.
- The SDM has not received a message.

B0085 71 or B0086 71

The SDM has received invalid serial data from the side impact sensor.

B0085 3A or B0086 3A

- The SDM has received an ID message from the side impact sensor, which does not match the ID stored in the SDM memory.
- The SDM has reset the side impact sensor twice without detecting the correct ID message.

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.
- The SIR System is disabled and no deployments are allowed.

Conditions for Clearing the DTC

- The condition for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Testing

Important: Refer to SIR Service Precautions.

When removing connectors, inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected component/connector:

- Side Impact sensor
- SDM module
- Side Impact sensor wiring harness connector
- SDM wiring harness connector

1. Ignition OFF, disconnect the X2 harness connector at the SDM and the harness connector at the appropriate side impact sensor.
2. Ignition ON, test for less than 1 volt between the appropriate side impact sensor low reference circuit terminal 2 and ground.

   If greater than the specified range, test the circuit for a short to voltage
3. Ignition ON, test for less than 1 volt between the appropriate side impact sensor signal circuit terminal 1 and ground.

   If greater than the specified range, test the circuit for a short to voltage.
4. Test for infinite resistance between the appropriate side impact sensor signal circuit terminal 2 and ground.

   If less than the specified value, test the circuit for a short to ground.
5. Test for less than 1 ohm between the appropriate side impact sensor low reference circuit terminals listed below:
   - With LHD left side impact sensor terminal 2 and SDM terminal 25 X2.

- With RHD left side impact sensor terminal 2 and SDM terminal 28 X2.
- With LHD right side impact sensor terminal 2 and SDM terminal 28 X2.
- With RHD right side impact sensor terminal 2 and SDM terminal 25 X2.

  If greater than the specified range, test the circuit for an open/voltage resistance.

6. Test for less than 1 ohm between the appropriate side impact sensor signal circuit terminals listed below:
   - With LHD left side impact sensor terminal 1 and SDM terminal 26 X2.
   - With RHD left side impact sensor terminal 1 and SDM terminal 27 X2.
   - With LHD right side impact sensor terminal 1 and SDM terminal 27 X2
   - With RHD right side impact sensor terminal 1 and SDM terminal 26 X2

   If greater than the specified range, test the circuit for an open/high resistance.
7. If all circuits test normal, replace the appropriate side impact sensor.
8. Reconnect all SIR components. Ignition ON, verify the DTC does not set as current.

   If the DTC resets as current, replace the SDM.

Repair Instructions

- Inflatable Restraint Side Impact Sensor Replacement.
- Control Module References for SDM replacement, setup, and programming

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DTC B1001

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B1001 3A: SDM Option Configuration Error

Circuit/System Description

The inflatable restraint sensing and diagnostic module (SDM) stores a primary data key, which is a 4-digit number, and a secondary data key, which is a portion of the vehicle identification number (VIN). When the ignition is turned ON, the SDM compares this information to the information stored in the body control module (BCM) over the serial data communication circuit. If there is a mismatch between the information stored in the SDM and BCM, DTC B1001 will set.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

- The 4-digit primary data key stored in the SDM does not match the 4 digits stored in the BCM.
- The VIN stored in the BCM does not match that of the vehicle.

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.
- The SDM disables all deployments.

Conditions for Clearing the DTC

- The last 4-digit Primary Data Key in the SDM match the last 4 digits stored in the BCM.
- The VIN that is stored in the SDM matches the VIN stored in the BCM.

Diagnostic Aids

This DTC is an indication that an incorrect SDM is installed in the vehicle, or that the SDM and/or the BCM was replaced without reprogramming the BCM with the new information.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Important: When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected.

- SDM
- SDM wiring harness

1. Ignition ON, verify the scan tool Secondary Key Status displays Valid.
   If not the specified value, verify the scan tool Received VIN Digits 2-7 match the vehicle VIN , if the VIN does not match, reprogram the BCM. If the VIN matches, reprogram the SDM.
2. Ignition ON, verify the scan tool Primary Key Status displays Valid.
   If not the specified value, verify the scan tool SDM Primary Key matches the Received Primary Key, if the key does not match, perform the Setup SDM Primary Key in BCM procedure.
3. With a scan tool, verify DTC B1001 is not set.
   If the DTC is set, replace the SDM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for SDM and BCM replacement, setup, and programming

DTC B1016

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B1016 00: Vehicle Identification Number (VIN) Not Programmed

Circuit/System Description

This code indicates that the inflatable restraint sensing and diagnostic module (SDM) has received an invalid vehicle identification number (VIN) from the body control module (BCM).

Conditions for Running DTC

- System voltage is between 9-16 volts.
- Ignition switch is in the ON position.

Conditions for Setting the DTC

- VIN is not programmed in the SDM.
- Communication is lost between the SDM and BCM.

Conditions for Clearing the DTC

- VIN number is reprogrammed.
- A valid VIN is received from the BCM.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Important: When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected.

- SDM
- SDM wiring harness

1. Ignition ON, verify the correct VIN is programmed in the SDM.
   If the VIN is incorrect, reprogram the VIN to the SDM.
2. If the DTC resets, replace the SDM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for SDM replacement, setup, and programming

DTC B1325

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC B1325 03: System Voltage Low Voltage

DTC B1325 07: System Voltage High Voltage

Circuit / System Description

With the ignition in either the ACC or ON positions, the inflatable restraint sensing and diagnostic module (SDM) should receive a 12V power supply. DTC B1325 will set to indicate the B+ positive supplied to the SDM is below the threshold.

Conditions for Setting the DTCs

This DTC runs continuously once the following condition is met:

The supplied power to the SDM is between 9 - 16V.

Action Taken When the DTC Sets

A warning lamp will illuminate.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The DTC can be cleared using a scan tool.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

Component Connector End Views

Scan Tool Reference

Control Module References

Circuit / System Testing

1. Ignition OFF, wait for 30 seconds, and then disconnect the X1 harness connector at the SDM
2. Ignition ON, verify a test lamp illuminates between the B+ circuit terminal 22 X1 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open high resistance.
3. If all circuits test normal, replace the SDM

Repair Instructions

Important: Always perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for SDM replacement, setup, and programming

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Safety and Security | Supplemental Inflatable Restraints | Diagnostic Information and Procedures |

Document ID: 1995473

DTC B1370

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B1370 01: Device Ignition 1 Circuit Short to Battery

DTC B1370 06: Device Ignition 1 Circuit Short to Ground or Open

DTC Descriptor

DTC B1370 06: Device Ignition 1 Circuit Short to Ground or Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition 1 Voltage	B1370 06	B1370 06	--	--

Circuit/System Description

The inflatable restraint sensing and diagnostic module (SDM) monitors the ignition 1 signal from the ignition switch. When the vehicle ignition switch is placed in the RUN or CRANK position, the switch supplies voltage to the SDM ignition 1 input terminal. If an open or short to ground in this SDM ignition 1 circuit is detected, then DTC B1370 will set.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

The SDM detects a short to ground or an open in the ignition 1 voltage circuit for at least 2 seconds when the ignition switch is in RUN or CRANK.

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.

- The SDM determines its power mode only from the GMLAN power mode messages and discards the ignition 1 input for the remainder of the ignition cycle.

Conditions for Clearing the DTC

- The condition for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

Important: When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected.

- SDM
- SDM wiring harness

1. Ignition OFF, disconnect the X1 harness connector at the SDM and the X2 harness connector at the underhood fuse block.
2. Ignition OFF, test for greater than 1 ohm between the ignition 1 voltage circuit terminal 21 X1 and ground.

   If less then the specified value, test the circuit for a short to ground.
3. Ignition OFF, test for less than 1 ohm between the ignition 1 voltage circuit terminal 21 X1 and the underhood fuse block terminal 17 X2.

   If greater then the specified range, test the circuit for an open/high resistance.
4. If all circuits test normal, replace the SDM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for SDM replacement, setup, and programming

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Air Bag Indicator Circuit Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit / System Description

When the ignition is turned ON, the instrument panel cluster (IPC) flashes the air bag indicator 7 times for a bulb check. The inflatable restraint sensing and diagnostic module (SDM) performs diagnostic tests on the SIR system during the bulb check. If any malfunction exists the SDM will request the IPC to illuminate the air bag indicator steady, via serial data. If a preexisting malfunction exists, the air bag indicator will illuminate steady immediately after the ignition is turned ON. If the ignition 1 voltage is outside of the normal operating voltage range 9-16 volts, the SDM will command the IPC to turn the air bag indicator ON with no DTCs present, then disables all deployment loops.

Diagnostic Aids

A DTC B1370 may set if the ignition 1 circuit is outside the 9-16 volts range.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

SIR System Description and Operation

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Connector Repairs
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Verify SDM DTCs are not set.
   If any DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. Ignition OFF, monitor the IPC, ignition ON. The SIR warning indicator should flash then turn OFF.
   If the SIR warning indicator continually flashes, program the SDM.
3. Perform the Display Test in Instrument Panel Cluster/Special Functions. The Air Bag indicator should turn ON and OFF as commanded.
   If the air bag indicator does not illuminate as expected, replace the IPC.
4. If all circuits test normal, replace the SDM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- SIR/SRS Wiring Repairs
- Control Module References for IPC and SDM replacement, setup, and programming

SIR Disabling and Enabling

- SIR component location affects how a vehicle should be serviced. There are parts of the SIR system installed in various locations around a vehicle. To find the location of the SIR components refer to SIR Component Views.
- There are several reasons for disabling the SIR system, such as repairs to the SIR system or servicing a component near or attached to an SIR component. There are several ways to disable the SIR system depending on what type of service is being performed. The following information covers the proper procedures for disabling/enabling the SIR system.

Condition	Action
If the vehicle was involved in an accident with an air bag deployment.	Disconnect the negative battery cable(s) *. Refer to Battery Negative Cable Disconnection and Connection.
When performing SIR diagnostics.	Follow the appropriate SIR service manual diagnostic procedure(s) *
When removing or replacing an SIR component or a component attached to an SIR component.	Disconnect the negative battery cable(s) *
If the vehicle is suspected of having shorted electrical wires.	Disconnect the negative battery cable(s) *
When performing electrical diagnosis on components other than the SIR system.	Remove the SIR/Air bag fuse(s) when indicated by the diagnostic procedure to disable the SIR system
* DTCs will be lost when the negative battery cable is disconnected.	

Disabling Procedure - Negative Battery Cable

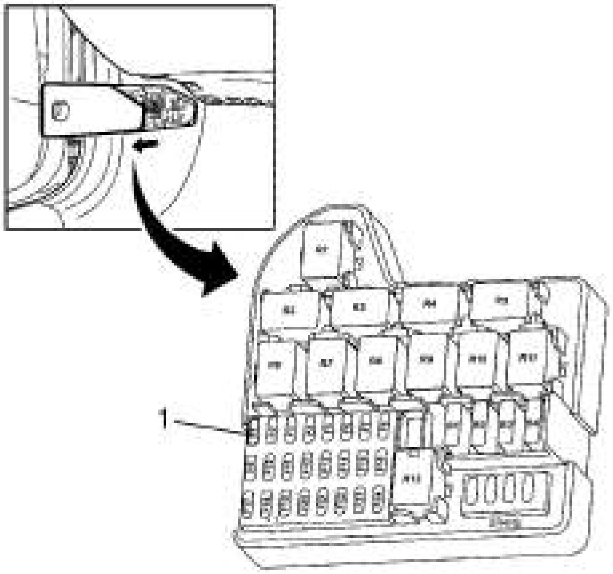
1. Turn the steering wheel so that the vehicles wheels are pointing straight ahead.
2. Ignition OFF.
3. Disconnect the negative battery cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
4. Wait 2 minutes before removing the fuse.

Enabling Procedure - Negative Battery Cable

1. Ignition OFF.
2. Connect the negative battery cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.
3. Ignition ON. The AIR BAG indicator will flash then turn OFF.
4. Perform the Diagnostic System Check - Vehicle if the AIR BAG warning indicator does not operate as described. Refer to Diagnostic System Check - Vehicle.

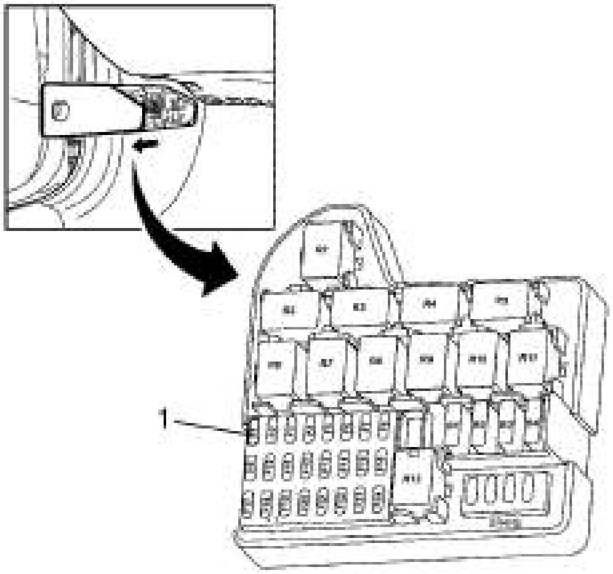
Disabling Procedure - Air Bag Fuse

Important: The SDM may have more than one fused power input. To ensure there is no unwanted SIR deployment, personal injury, or unnecessary SIR system repairs, remove all fuses supplying power to the SDM. With all SDM fuses removed and the ignition switch in the ON position, the AIR BAG warning indicator illuminates. This is normal operation, and does not indicate a SIR system malfunction.



1. Locate and remove the 10 amp fuse (1) supplying power to the SDM. Refer to SIR Schematics.
2. Wait 2 minutes before working on the system.

Enabling Procedure - Air Bag Fuse



1. Ignition OFF.

2. Install the 10 amp fuse (1) supplying power to the SDM. Refer to SIR Schematics.
3. Ignition ON. The AIR BAG indicator will flash then turn OFF.
4. Perform the Diagnostic System Check - Vehicle, if the AIR BAG warning indicator does not operate as described. Refer to Diagnostic System Check - Vehicle.

Symptoms - SIR

Important: Complete the following steps before using the symptom tables:

1. Perform the Diagnostic System Check - Vehicle , before using the symptom tables in order to verify that all of the following are true:
   - There are no diagnostic trouble codes (DTCs) set.
   - The inflatable restraint sensing and diagnostic module (SDM) can communicate via the serial data link.
2. Review the SIR system description and operation in order to familiarize yourself with the system functions. Refer to SIR System Description and Operation .

Visual / Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the SIR system. Refer to Checking Aftermarket Accessories .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Poor electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections .

Symptom List

Refer to Air Bag Indicator Circuit Malfunction in order to diagnose the symptom.

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Driver or Passenger Seat Side Inflatable Restraint Module Replacement (RHD)

Removal Procedure

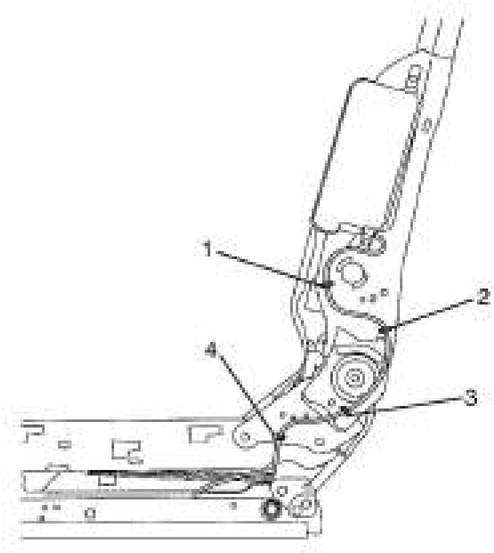
Caution: This vehicle is equipped with a Supplemental Inflatable Restraint (SIR) System. Failure to follow the correct procedure could cause the following conditions:

- Air bag deployment
- Personal injury
- Unnecessary SIR system repairs

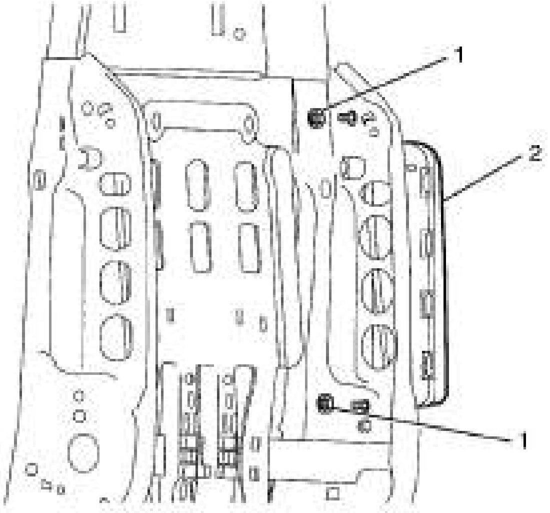
In order to avoid the above conditions, observe the following guidelines:

- Refer to SIR Component Views in order to determine if you are performing service on or near the SIR components or the SIR wiring.
- If you are performing service on or near the SIR components or the SIR wiring, disable the SIR system. Refer to Disabling the SIR System.

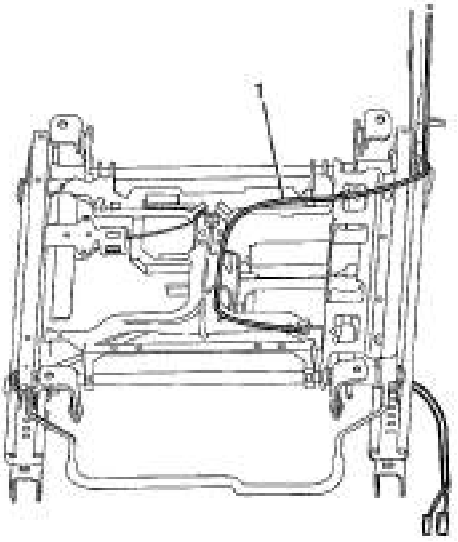
1. Disable the SIR system. Refer to SIR Disabling and Enabling.
2. Remove the front seat. Refer to Front Seat Replacement - Bucket.
3. Remove the front seat back trim cover. Refer to Front Seat Back Cushion Cover and Cushion Pad Replacement.



4. Remove the module wiring harness (1), (2), (3) and (4) from the side of seat frame.



5. Remove the 2 bracket retaining nuts (1) holding the module (2) to the seat frame.

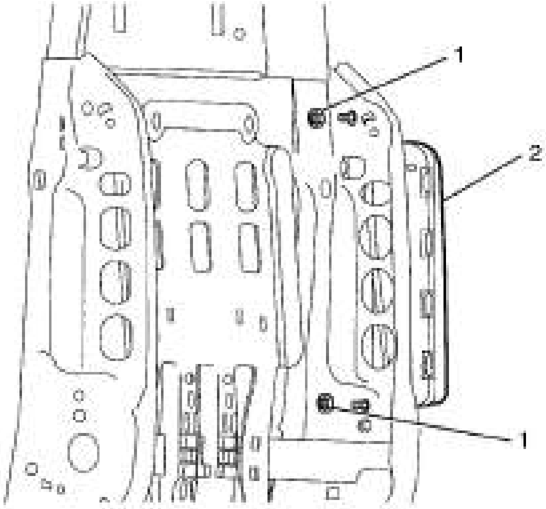


6. Remove the module wiring harness (1) from under the seat frame.
7. Fully deploy the module before disposal. If the module was replaced under warranty, fully deploy and dispose of the module after the required retention period. Refer to Inflator Module Handling and Scrapping.

Installation Procedure

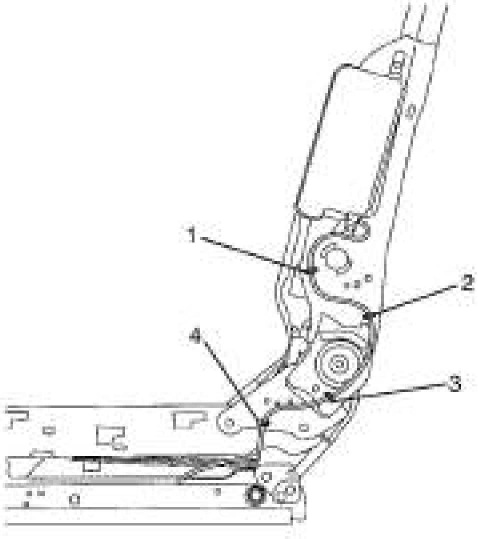
1. Install a new inflatable restraint side impact module to the seat frame.

   Notice: Refer to Fastener Notice in the Preface section.

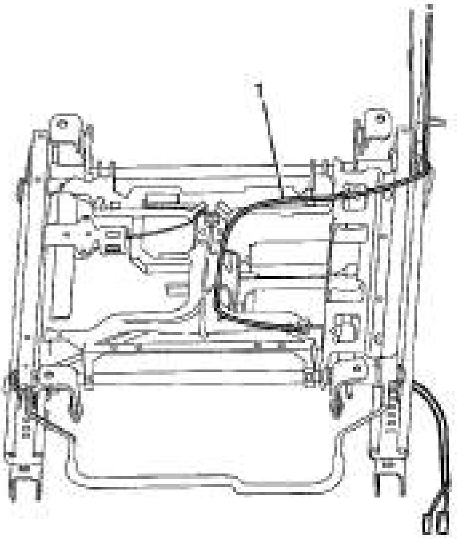


2. Install the module (2) to the seat frame and install the 2 retaining nuts (1).

   Tighten
   Tighten the nuts to 6 N·m (53 lb in).



3. Install the module wiring harness (1), (2), (3) and (4) to the seat.



4. Install the module wiring harness (1) through the underside of the seat frame.
5. Install the front seat back trim cover. Refer to Front Seat Back Cushion Cover and Cushion Pad Replacement.
6. Install the front seat. Refer to Front Seat Replacement - Bucket.
7. Enable the SIR system. Refer to SIR Disabling and Enabling.
8. If re-programming is required. Refer to Control Module References.

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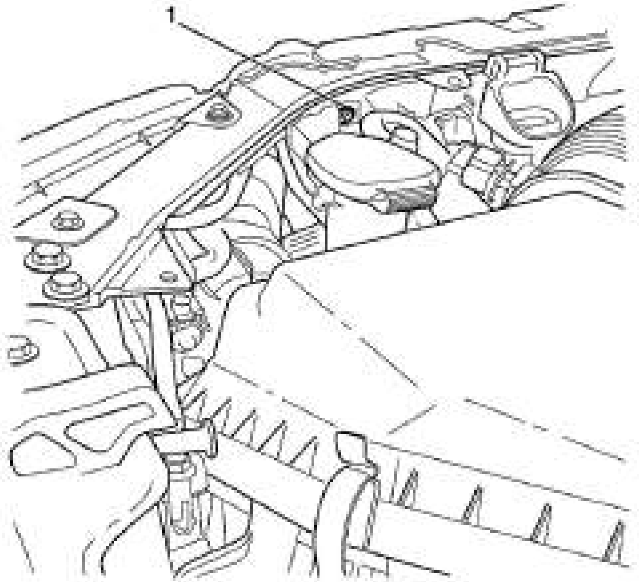
Inflatable Restraint Front End Sensor Replacement

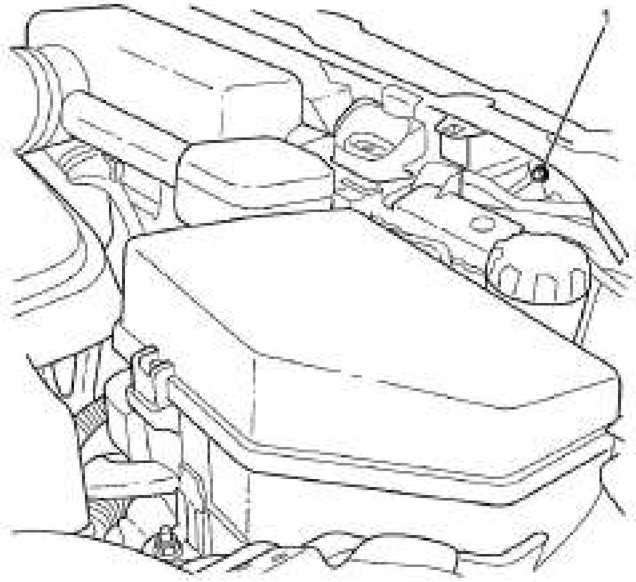
Removal Procedure

1. Disable the SIR. Refer to SIR Disabling and Enabling .
2. Remove the Radiator Air Upper Baffle and Deflector (if fitted). Refer to Radiator Air Upper Baffle and Deflector Replacement

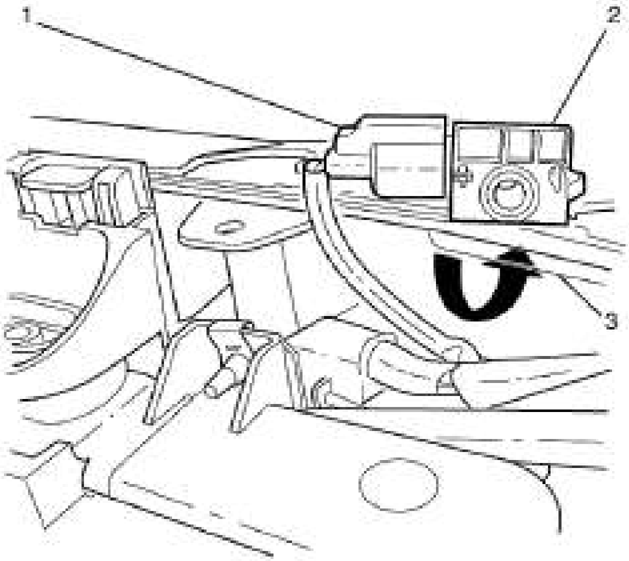


Important: The radiator top mounts can be taken off and the radiator lent back to aid in removal.

3. Remove the left front impact sensor to front end module retaining bolt (1).

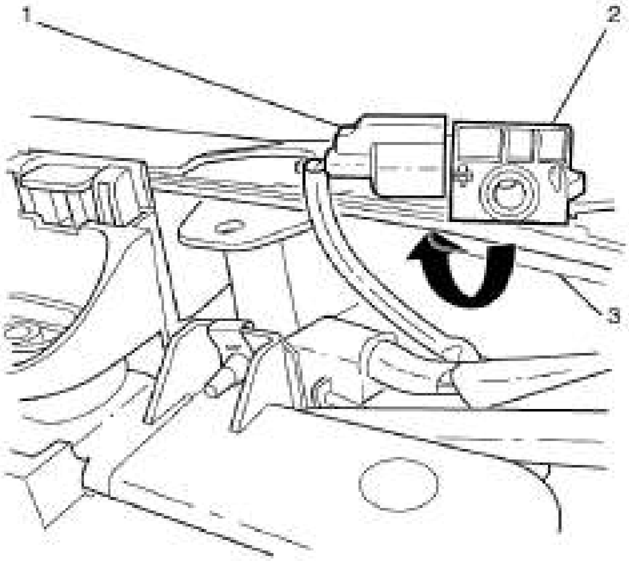


4. Remove the right front impact sensor to front end module retaining bolt (1).



5. Remove the front impact sensors (2) from the front end module (3).
6. Remove the front impact sensor electrical connections (1).

Installation Procedure

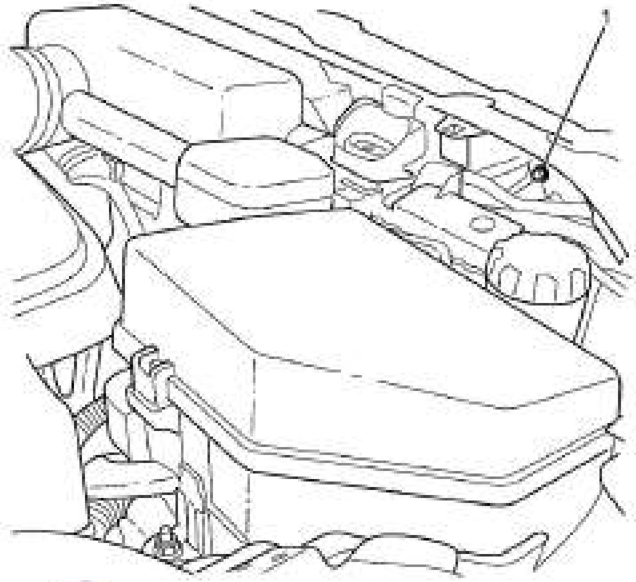


1. Install the front impact sensor electrical connections (1).

Important: Locating lugs will hold the NEW sensors in place.

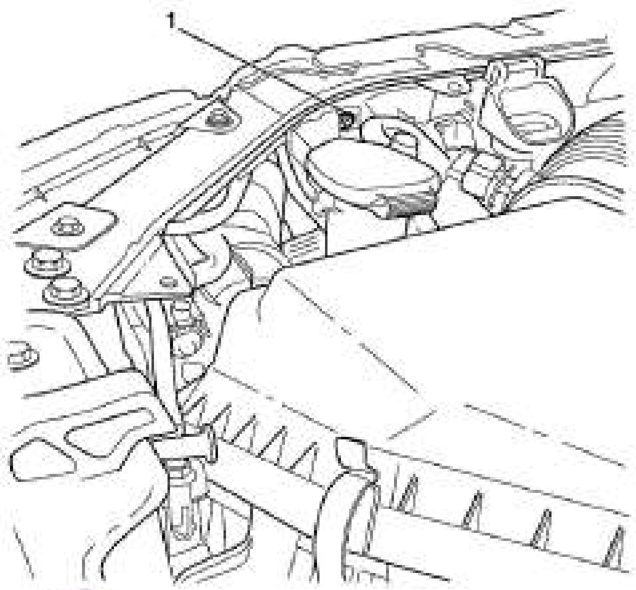
2. Install the NEW front impact sensors (2) to the front end module (3).

   Notice: Refer to Fastener Notice in the Preface section.



3. Install the right front impact sensor to front end module retaining bolt (1).

   Tighten
   Tighten the retaining bolt to 9 N·m (80 lb in).



Important: The radiator top mounts can be taken off and the radiator lent back to aid in installation.

4. Install the left front impact sensor to front end module retaining bolt (1).

   Tighten
   Tighten the retaining bolt to 9 N·m (80 lb in).

5. Install the Radiator Air Upper Baffle and Deflector (if fitted). Refer to Radiator Air Upper Baffle and Deflector Replacement
6. Enable the SIR. Refer to SIR Disabling and Enabling .

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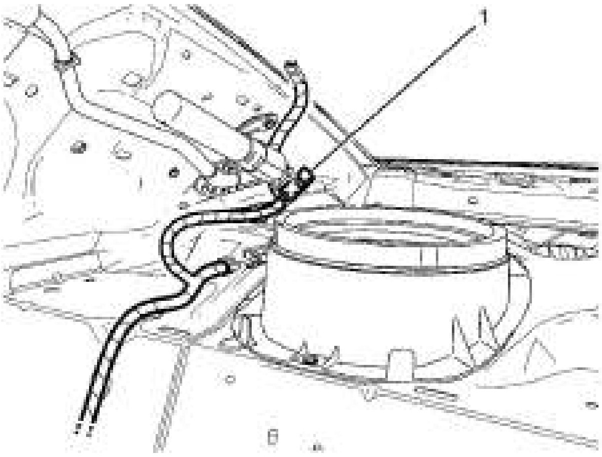
Inflatable Restraint Roof Side Rail Module Replacement - Front (RHD)

Removal Procedure

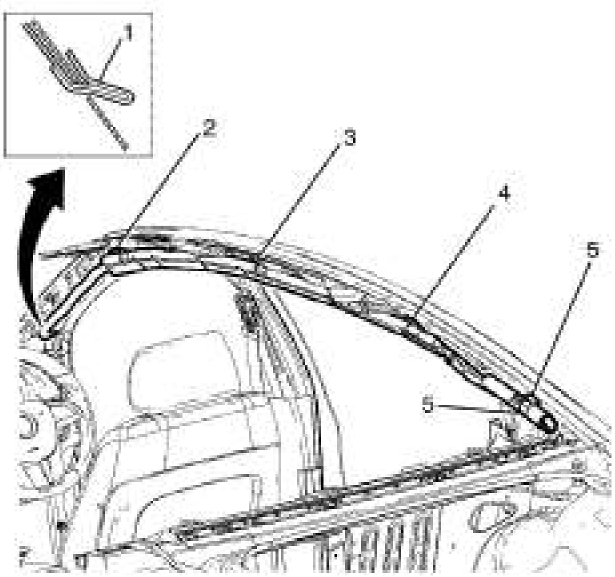
Caution: Refer to SIR Caution in the Preface section.

Caution: Refer to SIR Inflator Module Handling and Storage Caution in the Preface section.

1. Disable the SIR system. Refer to SIR Disabling and Enabling .
2. Remove the windshield garnish moulding. Refer to Windshield Garnish Molding Replacement .
3. Remove the sunshade from the headliner. Refer to Sunshade Replacement .
4. Remove the assist handles from the headliner. Refer to Assist Handle Replacement .
5. Remove the lower centre pillar trim panel. Refer to Center Pillar Lower Trim Panel Replacement .
6. Remove the upper centre pillar trim panel. Refer to Center Pillar Upper Trim Panel Replacement .
7. Remove the rear window shelf trim panel. Refer to Rear Window Shelf Trim Panel Replacement .
8. Remove the rear quarter pillar trim panel. Refer to Quarter Lower Rear Trim Panel Replacement .
9. Remove the rear quarter pillar trim panel. Refer to Quarter Upper Trim Panel Replacement .
10. Lower the headliner in order to gain access to the roof rail module. Refer to Headlining Trim Panel Replacement .



11. Disconnect the harness connector (1) from the roof rail module.



12. Remove the following roof rail bolts in sequence (5), (4), (3), and (2), then unhook the tether (1).
13. With the aid of an assistant lift the roof rail upwards towards the roof making sure to unhook the mounting points on the roof.
14. For deployment procedure. Refer to Inflator Module Handling and Scrapping .

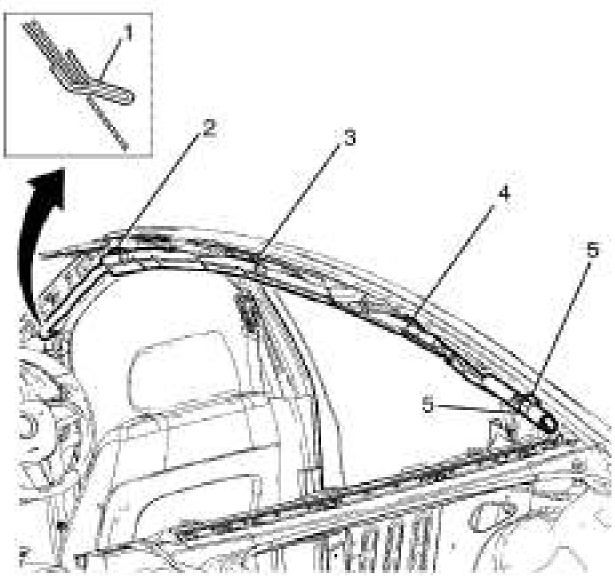
Installation Procedure

Caution: Refer to SIR Caution in the Preface section.

Caution: Refer to SIR Inflator Module Handling and Storage Caution in the Preface section.

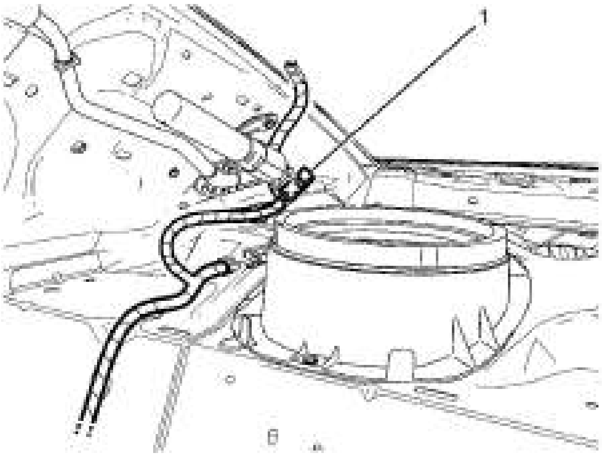
Caution: In order to prevent accidental deployment of the air bag which could cause personal injury, do not dispose of an undeployed inflator module as normal shop waste. The undeployed inflator module contains substances that could cause severe illness or personal injury if the sealed container is damaged during disposal. Use the following deployment procedures to safely dispose of an undeployed inflator module. Failure to dispose of an inflator module as instructed may be a violation of federal, state, province, or local laws.

1. Remove any dirt, grease, or other impurities from the mounting surface.
2. With the aid of an assistant carefully replace the roof rail upwards towards the roof making sure the hooks are seated correctly in place on the roof.



3. Install the mounting fasteners to the inflatable restraint roof rail module in the following order (2), (3), (4), (5) and then the tether hook (1).

   Tighten
   Tighten the fasteners to 6 N·m (53 lb in).



4. Re-connect the harness connector (1) to the roof rail module.
5. Raise the headliner. Refer to Headlining Trim Panel Replacement .
6. Install the rear quarter pillar trim panel. Refer to Quarter Upper Trim Panel Replacement .
7. Install the rear quarter pillar trim panel. Refer to Quarter Lower Rear Trim Panel Replacement .
8. Install the rear window shelf trim panel. Refer to Rear Window Shelf Trim Panel

Replacement .

9. Install the upper centre pillar trim panel. Refer to Center Pillar Upper Trim Panel Replacement .
10. Install the lower centre pillar trim panel. Refer to Center Pillar Lower Trim Panel Replacement .
11. Install the windshield garnish moulding. Refer to Windshield Garnish Molding Replacement .
12. Install the sunshade from the headliner. Refer to Sunshade Replacement .
13. Install the assist handles from the headliner. Refer to Assist Handle Replacement .
14. Enable the SIR system. Refer to SIR Disabling and Enabling .
15. If re-programming is required. Refer to Control Module References .

Inflatable Restraint Sensing and Diagnostic Module Replacement (RHD)

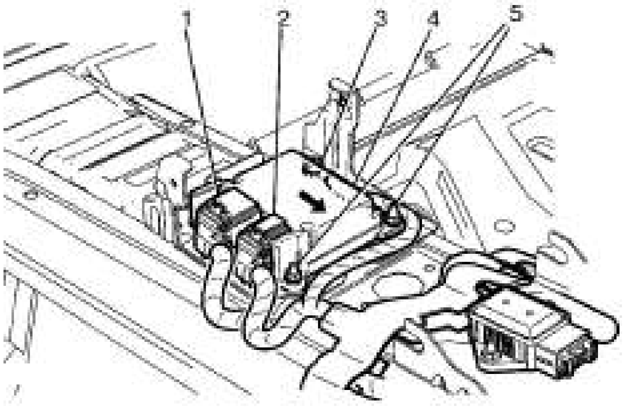
Removal Procedure

Caution: Refer to SIR Caution in the Preface section.

Caution: Do not strike or jolt the inflatable restraint side impact sensor (SIS). Before applying power to the SIS make sure that it is securely fastened. Failure to observe the correct installation procedures could cause SIR deployment, personal injury, or unnecessary SIR system repairs.

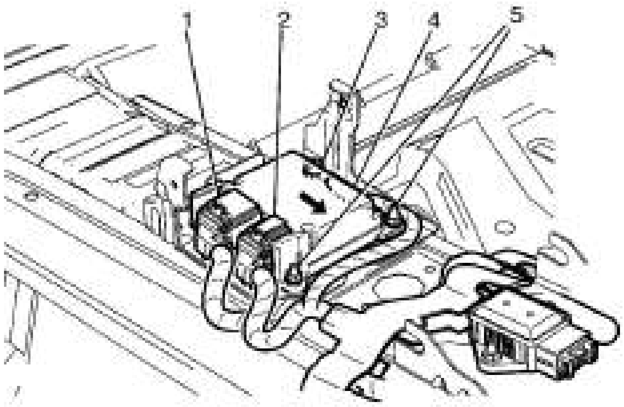
1. Disable the SIR system. Refer to SIR Disabling and Enabling .
2. Remove the centre console. Refer to Front Floor Console Replacement .

Important: The sensing and diagnostic module (SDM) (4) is shown with the carpet removed for illustration purposes only. Removal of the front carpet or the front seats is not necessary to service the SDM (4).



3. Disconnect the SDM electrical connectors (1) and (2) from the SDM (4).
4. Remove the SDM to transmission tunnel retaining nuts (5).
5. Disconnect the SDM earth strap bolt (3).
6. Remove the SDM (4).

Installation Procedure



1. Install the SDM (4) horizontally to the transmission tunnel, making sure the arrow on the SDM toward the front of the vehicle.
2. Connect the SDM earth strap bolt (3).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the SDM to transmission tunnel retaining nuts (5).

   Tighten
   Tighten the nuts to 10 N·m (89 lb in).

4. Connect the SDM electrical connectors (1) and (2) from the SDM (4).
5. Install the centre console. Refer to Front Floor Console Replacement .
6. Return the driver and the passenger seats to the original position.
7. Enable the SIR system. Refer to SIR Disabling and Enabling .

   Important: After programming the SDM, the SDM is then locked to the vehicle and it will not be possible to swap between other vehicles.

8. Refer to Inflatable Restraint Sensing and Diagnostic Module Programming and Setup .
9. Program the new SDM primary key into the BCM.

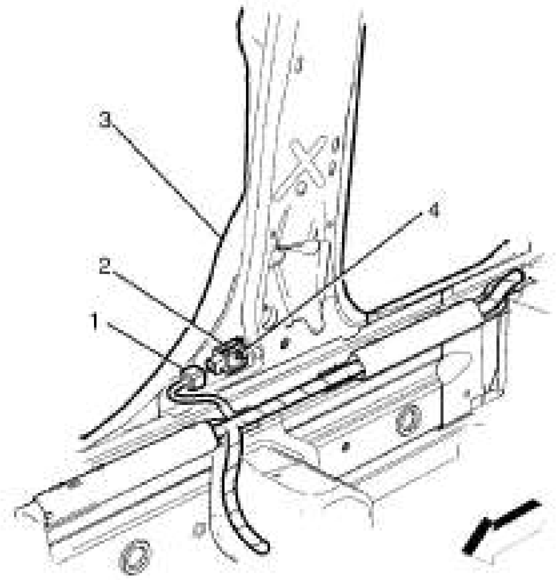
   Important: The AIR BAG indicator may remain ON after the SDM has been replaced. If the indicator remains ON after enabling the SIR system, perform the diagnostic system check and follow the steps thoroughly to ensure that the SDM is set properly.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Safety and Security | Supplemental Inflatable Restraints | Repair Instructions | Document ID: 1995259

Inflatable Restraint Side Impact Sensor Replacement (RHD)

Removal Procedure

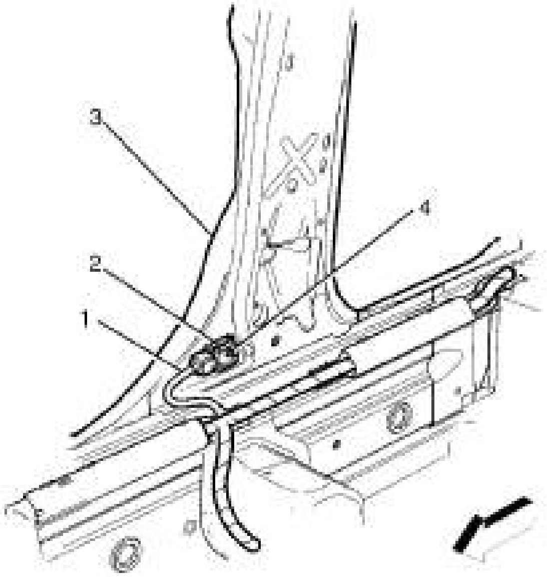
1. Disable the SIR. Refer to SIR Disabling and Enabling .
2. Remove the lower centre pillar trim panel. Refer to Center Pillar Lower Trim Panel Replacement .
3. Remove the door sill plate. Refer to Door Sill Plate Replacement .



4. Disconnect the side impact sensor electrical connector (1) from the side impact sensor (2).
5. Remove the side impact sensor (2) securing bolt (4)
6. Remove the side impact sensor (2) from the centre pillar (3).

Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



1. Install the side impact sensor (2) to the centre pillar (3).
2. Install the side impact sensor (2) securing bolt (4)

   Tighten
   Tighten the retaining bolt (4) to 9 N·m (80 lb in).

3. Connect the side impact sensor electrical connector to the side impact sensor (1).
4. Install the door sill plate. Refer to Door Sill Plate Replacement .
5. Install the lower centre pillar trim panel. Refer to Center Pillar Lower Trim Panel Replacement .
6. Enable the SDM. Refer to SIR Disabling and Enabling .
7. Ignition ON, observe the air bag warning indicator in the instrument panel cluster. The warning indicator should be illuminated for approximately five seconds. During this period the SDM performs a wiring and self-check. If no system faults are detected, the air bag warning indicator will be switched off.

   Important: If the warning indicator remains illuminated, a warning is shown in the instrument panel cluster multi-function display and an audible alarm chimes, or the warning indicator illuminates two seconds after it was originally switched off, a fault is present.

Inflator Module Handling and Scrapping (LWBRHD)

Handling Procedure

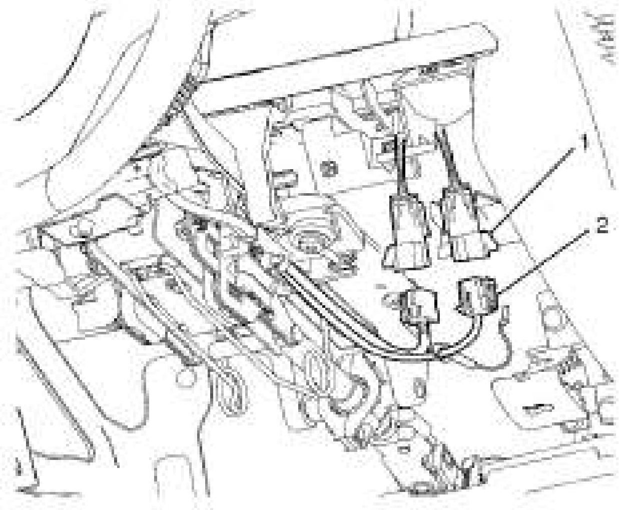
1. Do not apply power to a inflatable restraint except as specified.
2. Do not attempt to make any repairs to the inflatable restraint assembly or front/side-impact sensors. A damaged or defective component must be replaced.
3. Do not weld, solder, braze, hammer, machine drill, or otherwise heat any SIR component.
4. When handling a deployed inflatable restraint assembly or pretensioner:
   - Always wear gloves and safety glasses
   - Wash hands with mild soap and water afterwards. The surface of these components may contain chemicals as a result of the gas generated during combustion which can irritate your skin
5. When handling a steering column:
   - During any service operation that requires removal and reinstallation of a steering column fitted with an inflatable restraint assembly, always carry the steering column with two hands and with the steering wheel away from your body
   - Do not set a steering column on the floor with the steering wheel facing towards the floor
6. When carrying out steering gear removal and installation procedures, remove the ignition key from the lock and ensure the steering column is locked. If this operation is not carried out and the steering wheel is spun while the steering gear is removed, the clock spring coil will be destroyed. This will result in the SDM setting a DTC, and non-deployment of the steering wheel inflatable restraint assembly.

Deployment Inside Vehicle (Vehicle Scrapping Procedure)

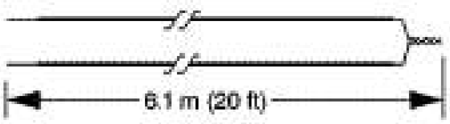
Important: Deploy the inflator modules inside of the vehicle when destroying the vehicle or when salvaging the vehicle for parts. This includes but is not limited to the following situations:

- The vehicle has completed its useful life
- Irreparable damage occurs to the vehicle in a non-deployment type accident
- Irreparable damage occurs to the vehicle during a theft
- The vehicle is being salvaged for parts to be used on a vehicle with a different VIN as opposed to rebuilding as the same VIN

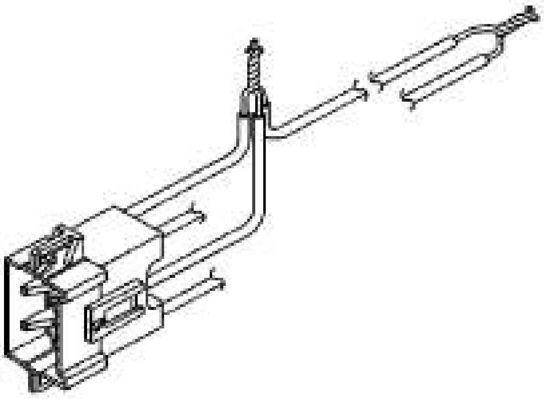
1. Turn the ignition switch to the OFF position.
2. Remove the ignition key.
3. Put on safety glasses.
4. Remove all loose objects from the front seats.
5. Disable the SIR system. Refer to SIR Disabling and Enabling .



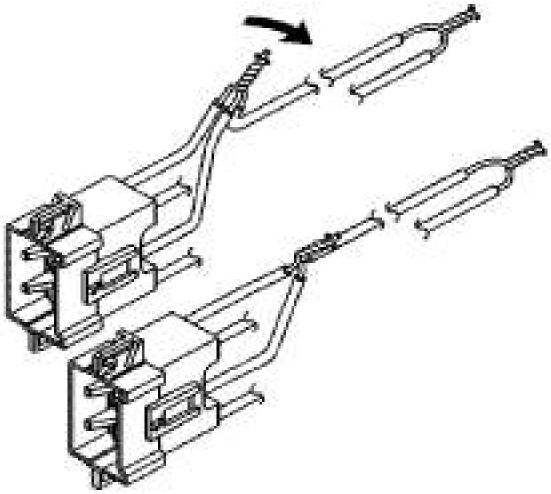
6. Disconnect the steering wheel module yellow connector (2) from vehicle harness yellow connector (1).
7. If vehicle is equipped with dual stage air bag the steering wheel module and I/P module will each have 4 wires. Refer to Component Connector End Views , for determining high and low circuits.
8. Cut the yellow harness connector out of the vehicle, leaving at least 16 cm (6 in) of wire at the connector.
9. Strip 13 mm (0.5 in) of insulation from each of the connector wire leads.



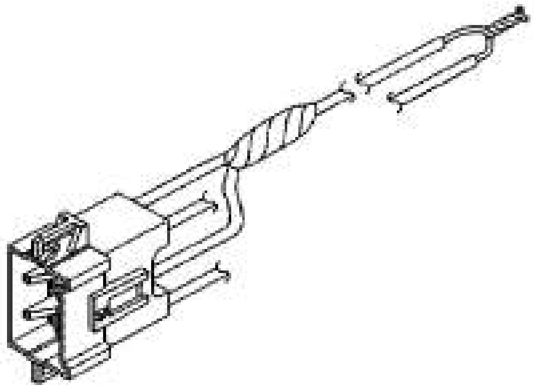
10. Cut two 6.1 m (20 ft) deployment wires from a 0.8 mm (18 gage) or thicker multi-strand wire. Use these wires to fabricate the driver deployment harness.
11. Strip 13 mm (0.5 in) of insulation from both ends of the wires cut in the previous step.
12. Twist together one end from each of the wires in order to short the wires. Deployment wires shall remain shorted, and not connected to a power source until you are ready to deploy the inflator module.



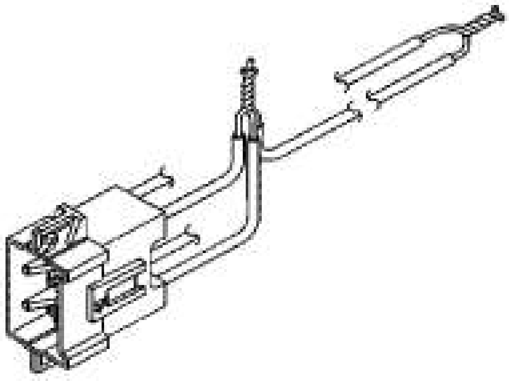
13. Twist together 2 connector wire leads (the high circuits from both stages of the steering wheel module) to one sets of deployment wires. Refer to Component Connector End Views , in order to determine the correct circuits.
14. Inspect that the 3-wire connection is secure.



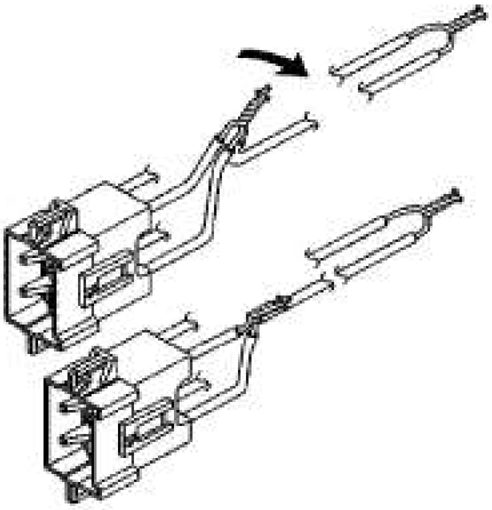
15. Bend flat the twisted connection.



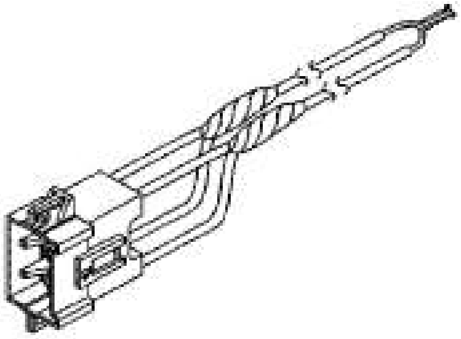
16. Secure and insulate the 3-wire connection to deployment harness using electrical tape.



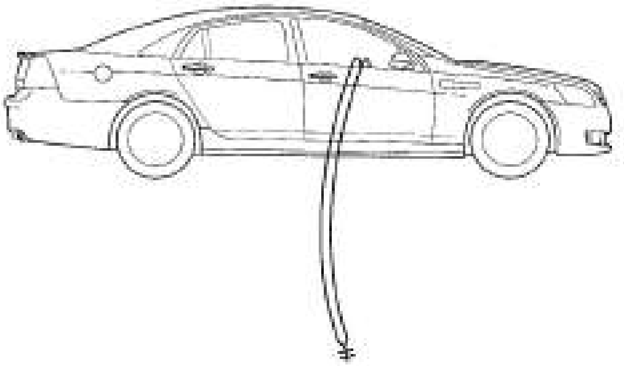
17. Twist together 2 connector wire leads (the low circuits from both stages of the steering wheel module) to one sets of deployment wires. Refer to Component Connector End Views , in order to determine the correct circuits.
18. Inspect that the 3-wire connection is secure.



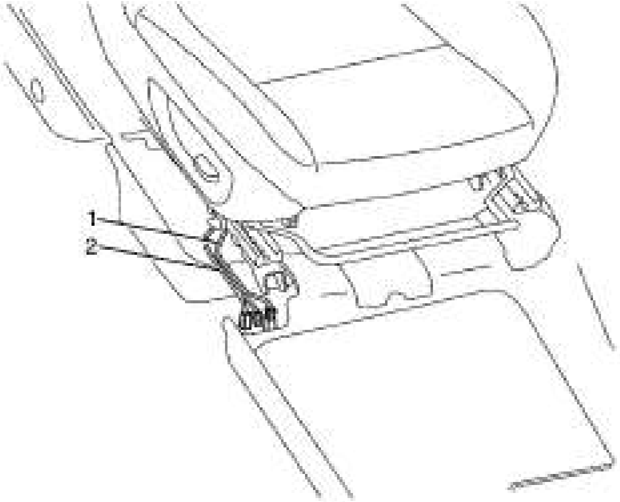
19. Bend flat the twisted connection.



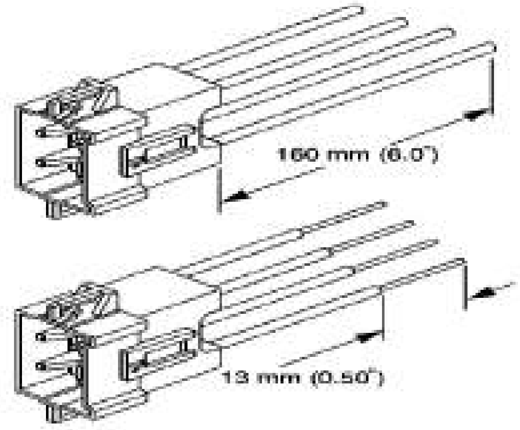
20. Secure and insulate the 3-wire connection to deployment harness using electrical tape.
21. Connect the deployment harness to the steering wheel module in-line connector.



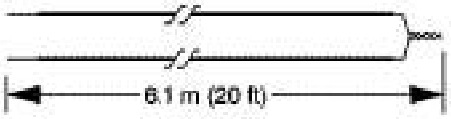
22. Route the deployment harness out of the driver side of the vehicle.



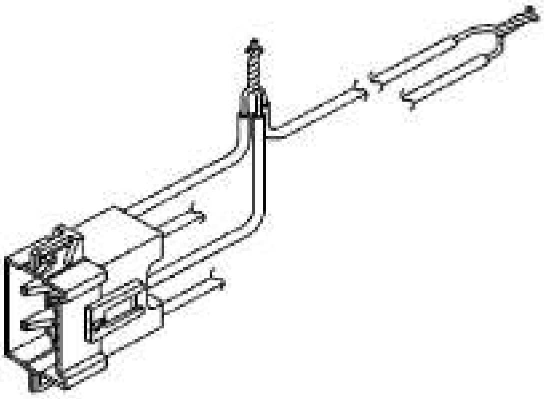
23. Disconnect the driver side air bag/pretensioner yellow connector (1) from the vehicle wiring harness located under the front of driver seat.



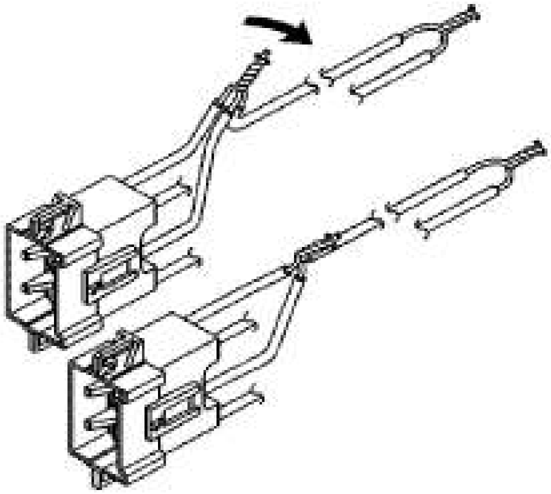
24. Cut the 4 SIR wires (2 for side air bag and 2 for pretensioner) leading to the yellow harness connector from the vehicle, leaving at least 16 cm (6 in) of wire at the connector.
25. Strip 13 mm (0.5 in) of insulation from all 4 SIR wires connector leads (2 for side air bag and 2 for pretensioner).



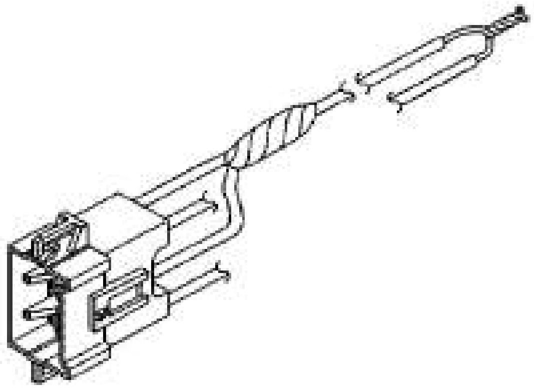
26. Cut two 6.1 m (20 ft) deployment wires from a 0.8 mm (18 gage) or thicker multi-strand wire. Use these wires to fabricate the deployment harness.
27. Strip 13 mm (0.5 in) of insulation from both ends of the wires cut in the previous step.
28. Twist together one end from each of the wires in order to short the wires. Deployment wires shall remain shorted, and not connected to a power source until you are ready to deploy the side air bag module and pretensioner.



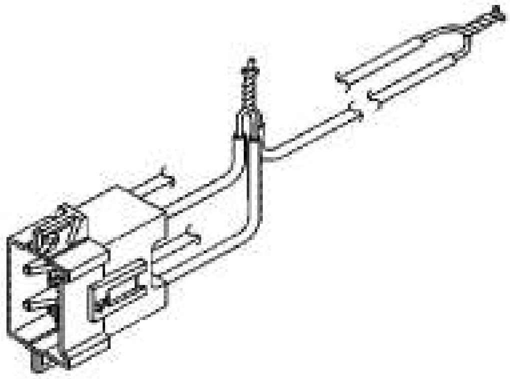
29. Twist together 2 connector wire leads (the high circuits from side air bag and pretensioner) to one sets of deployment wires. Refer to Component Connector End Views , in order to determine the correct circuits.
30. Inspect that the 3-wire connection is secure.



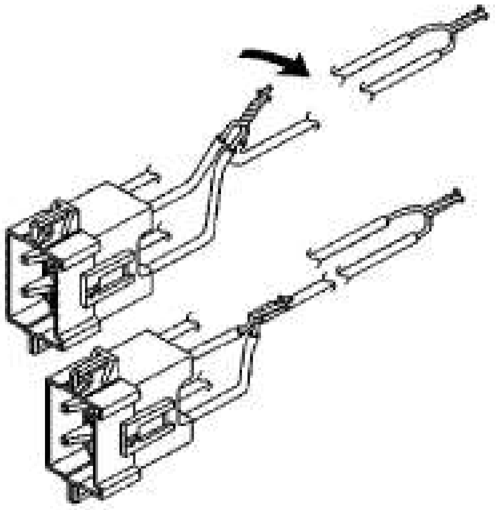
31. Bend flat the twisted connection.



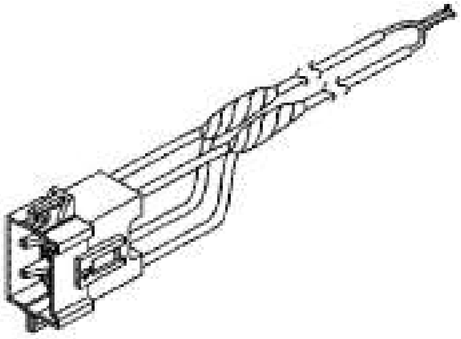
32. Secure and insulate the 3-wire connection to deployment harness using electrical tape.



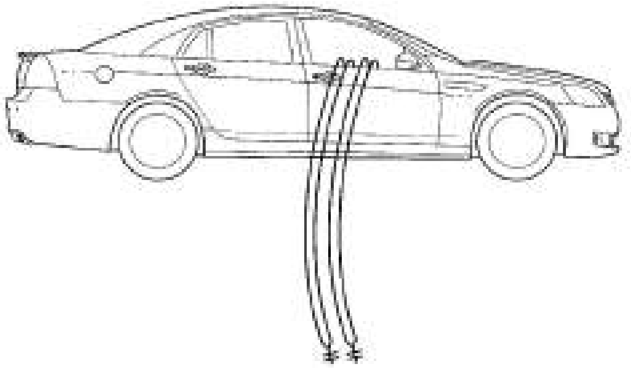
33. Twist together 2 connector wire leads (the low circuits from side air bag and pretensioner) to one sets of deployment wires. Refer to Component Connector End Views , in order to determine the correct circuits.
34. Inspect that the 3-wire connection is secure.



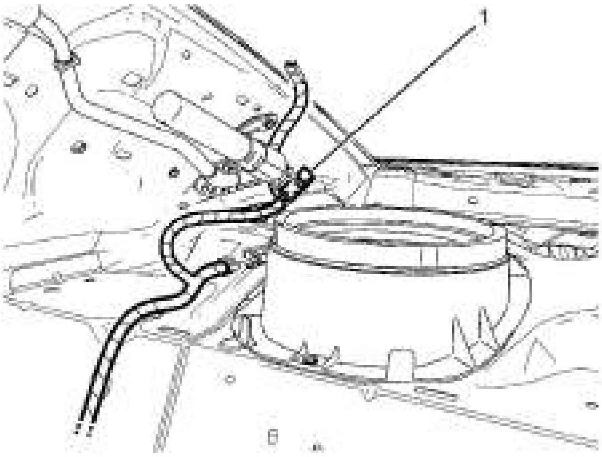
35. Bend flat the twisted connection.



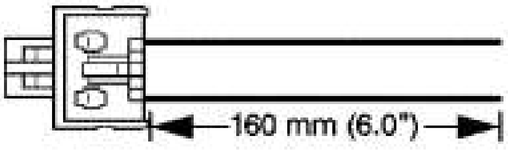
36. Secure and insulate the 3-wire connection to deployment harness using electrical tape.
37. Connect the deployment harness to the driver side air bag/pretensioner yellow connector.

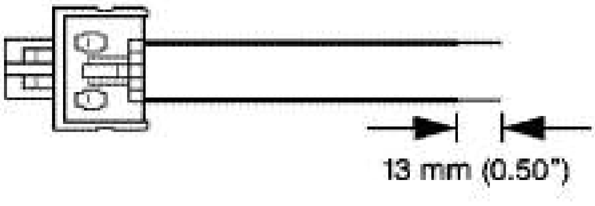


38. Route the deployment harness out of the driver side of the vehicle.

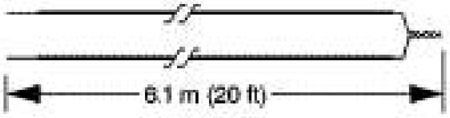


39. Disconnect the left/driver roof rail yellow harness connector (1) from the left roof rail air bag.

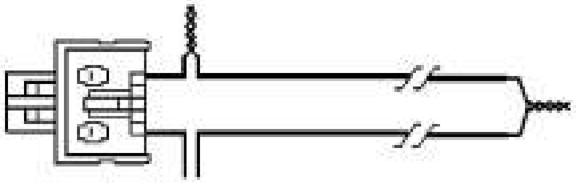




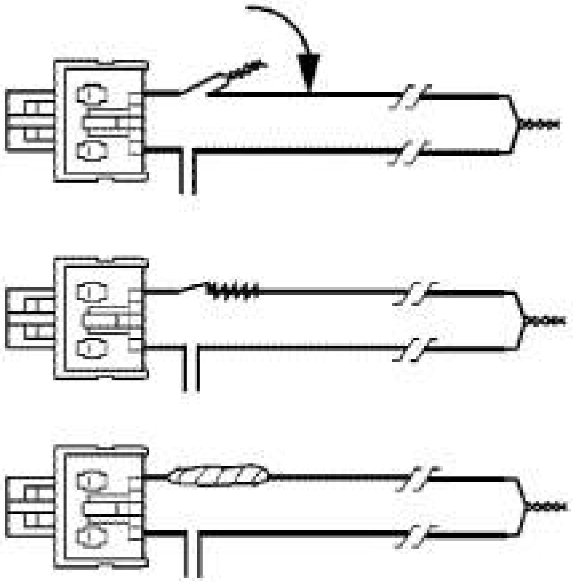
40. Cut the harness connector out of the vehicle, leaving at least 16 cm (6 in) of wire at the connector.
41. Strip 13 mm (0.5 in) of insulation from each of the connector wire leads.



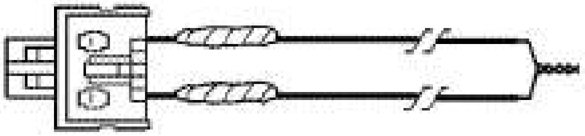
42. Cut two 6.1 m (20 ft) deployment wires from a 0.8 mm (18 gage) or thicker multi-strand wire. These wires will be used to fabricate the roof rail air bag deployment harness.
43. Strip 13 mm (0.5 in) of insulation from both ends of the wires cut in the previous step.
44. Twist together one end from each of the wires in order to short the wires.



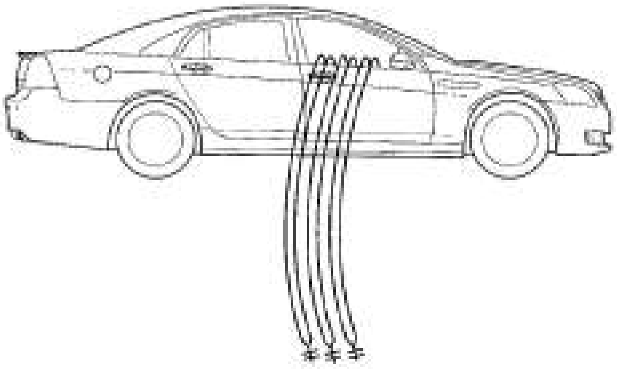
45. Twist together one connector wire lead to one deployment wire.



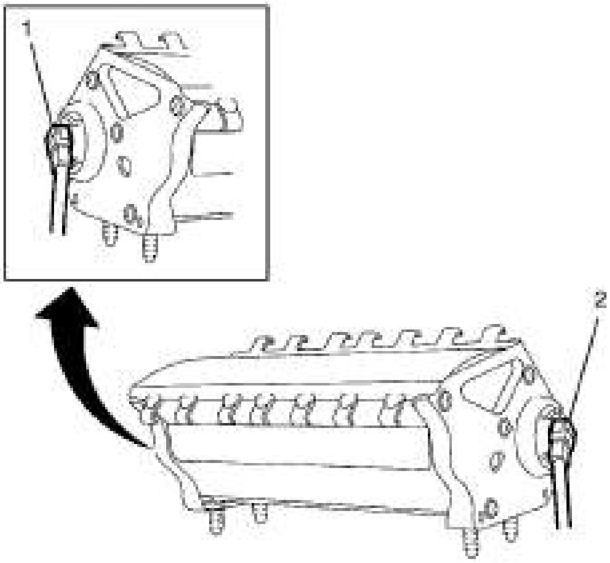
46. Bend flat the twisted connection.
47. Secure and insulate the connection using electrical tape.



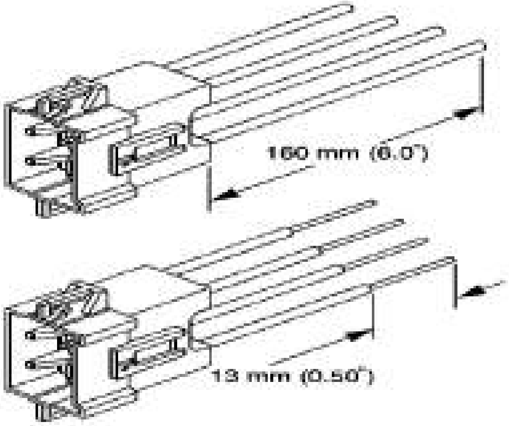
48. Twist together, bend, and tape the remaining connector wire lead to the remaining deployment wire.
49. Connect the deployment harness to the roof rail module yellow connector.



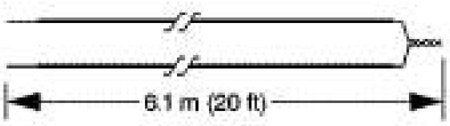
50. Route the deployment harness out of the driver side of the vehicle.



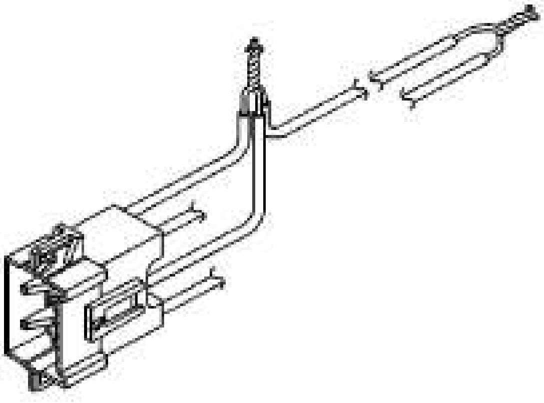
51. Disconnect the I/P module yellow harness connector (1) from the vehicle harness connector (2).



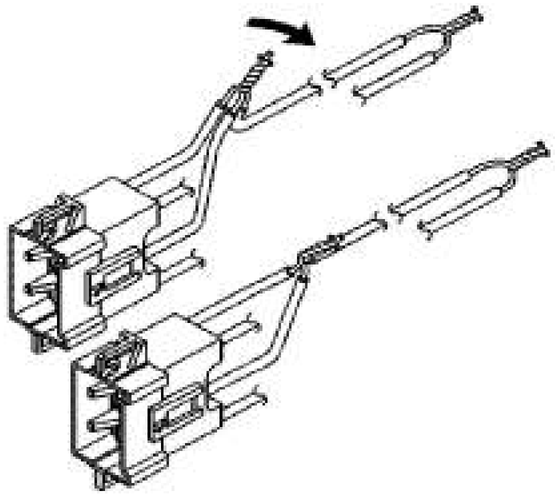
52. If vehicle is equipped with dual stage air bags the I/P module will each have 4 wires. Refer to Component Connector End Views , for determining high and low circuits.
53. Cut the yellow harness connector out of the vehicle, leaving at least 16 cm (6 in) of wire at the connector.
54. Strip 13 mm (0.5 in) of insulation from each of the connector wire leads.



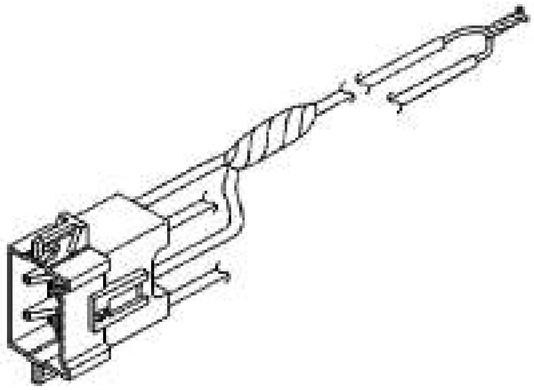
55. Cut two 6.1 m (20 ft) deployment wires from a 0.8 mm (18 gage) or thicker multi-strand wire. These wires will be used to fabricate the passenger deployment harness.
56. Strip 13 mm (0.5 in) of insulation from both ends of the wires cut in the previous step.
57. Twist together one end from each of the wires in order to short the wires.



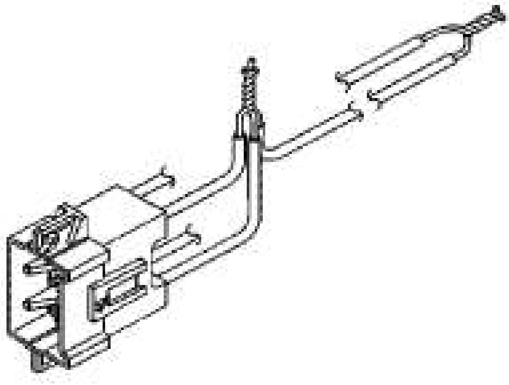
58. Twist together 2 connector wire leads (the high circuits from both stages of the steering wheel module) to one sets of deployment wires. Refer to Component Connector End Views , in order to determine the correct circuits.
59. Inspect that the 3-wire connection is secure.



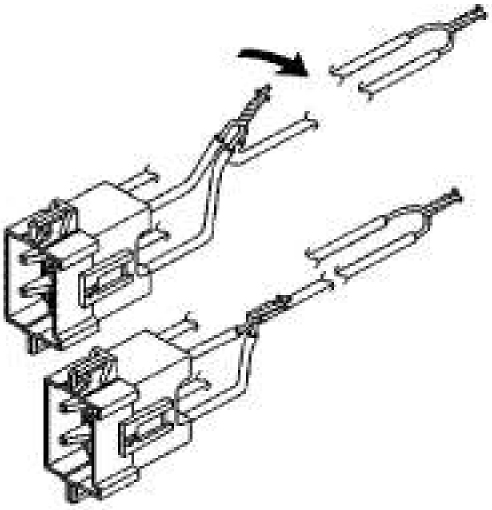
60. Bend flat the twisted connection.



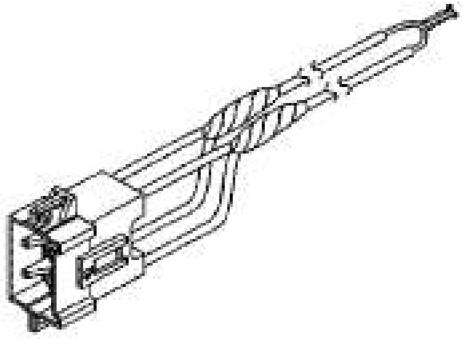
61. Secure and insulate the 3-wire connection to deployment harness using electrical tape.



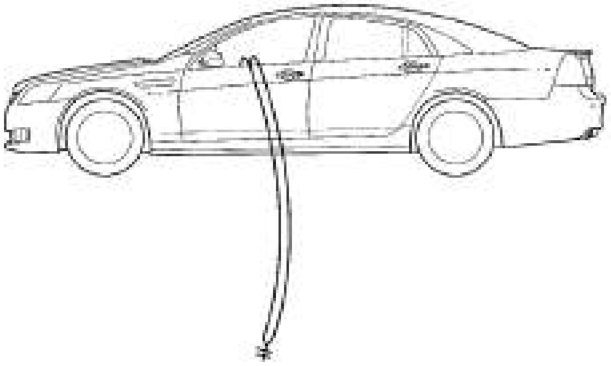
62. Twist together 2 connector wire leads (the low circuits from both stages of the I/P module) to one sets of deployment wires. Refer to Component Connector End Views , in order to determine the correct circuits.
63. Inspect that the 3-wire connection is secure.



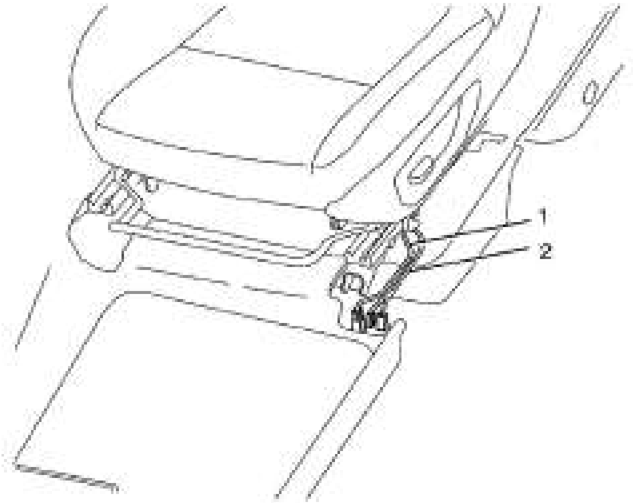
64. Bend flat the twisted connection.



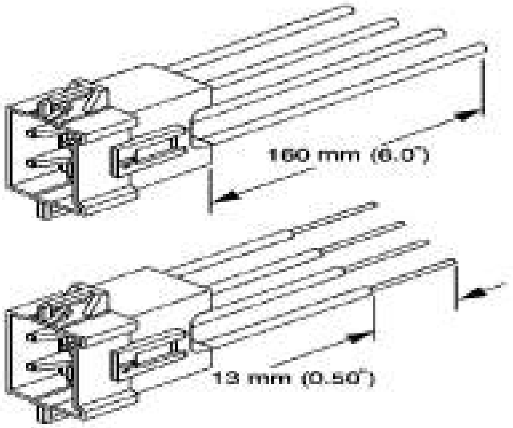
65. Secure and insulate the 3-wire connection to deployment harness using electrical tape.
66. Connect the deployment harness to the I/P module in-line connector.



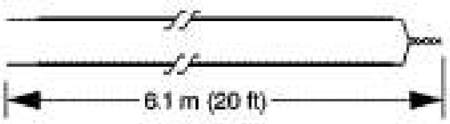
67. Route the deployment harness out of the passenger side of the vehicle.



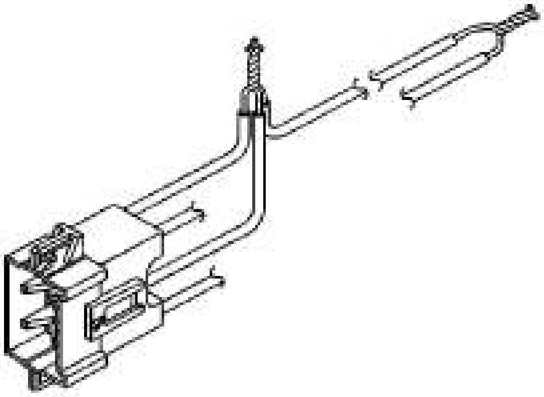
68. Disconnect the passenger side air bag/pretensioner yellow connector (1) from the vehicle wiring harness located under the front of driver seat.



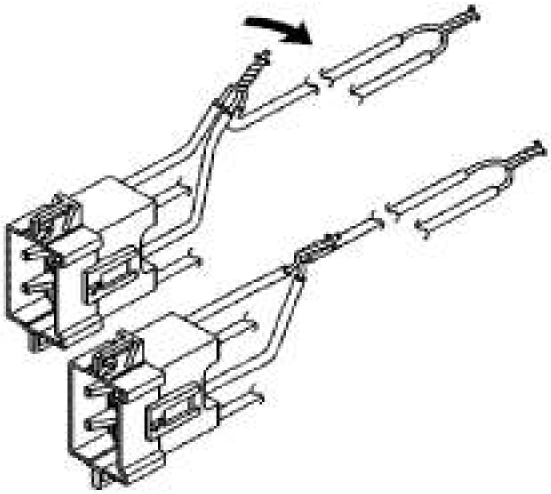
69. Cut the 4 SIR wires (2 for side air bag and 2 for pretensioner) leading to the yellow harness connector from the vehicle, leaving at least 16 cm (6 in) of wire at the connector.
70. Strip 13 mm (0.5 in) of insulation from all 4 SIR wires connector leads (2 for side air bag and 2 for pretensioner).



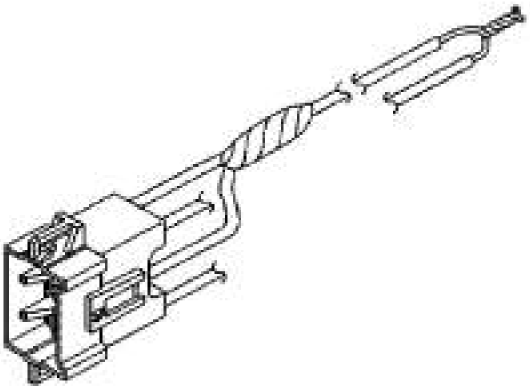
71. Cut two 6.1 m (20 ft) deployment wires from a 0.8 mm (18 gage) or thicker multi-strand wire. Use these wires to fabricate the deployment harness.
72. Strip 13 mm (0.5 in) of insulation from both ends of the wires cut in the previous step.
73. Twist together one end from each of the wires in order to short the wires. Deployment wires shall remain shorted, and not connected to a power source until you are ready to deploy the side air bag module and pretensioner.



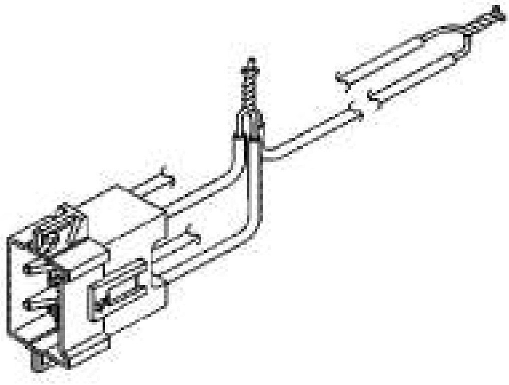
74. Twist together 2 connector wire leads (the high circuits from side air bag and pretensioner) to one sets of deployment wires. Refer to Component Connector End Views , in order to determine the correct circuits.
75. Inspect that the 3-wire connection is secure.



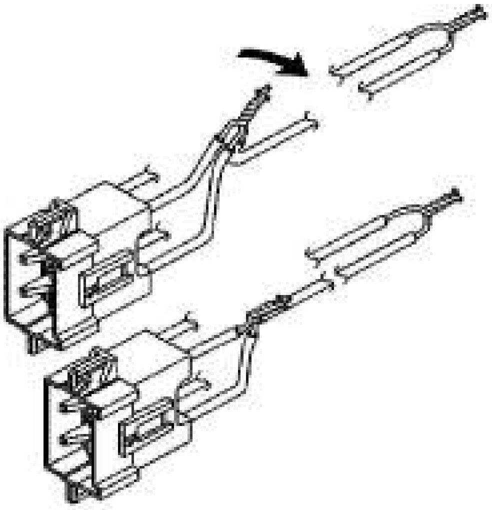
76. Bend flat the twisted connection.



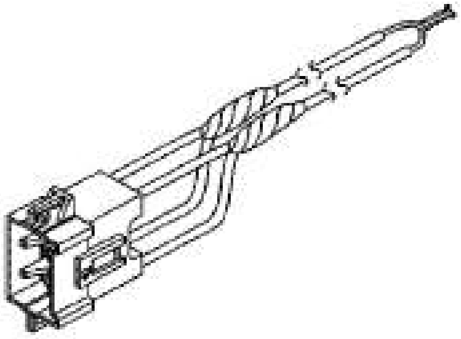
77. Secure and insulate the 3-wire connection to deployment harness using electrical tape.



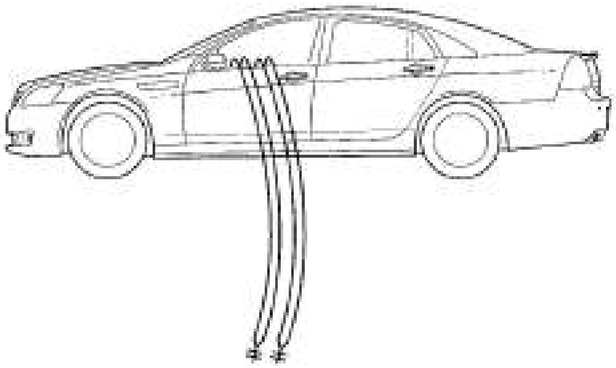
78. Twist together 2 connector wire leads (the low circuits from side air bag and pretensioner) to one sets of deployment wires. Refer to Component Connector End Views , in order to determine the correct circuits.
79. Inspect that the 3-wire connection is secure.



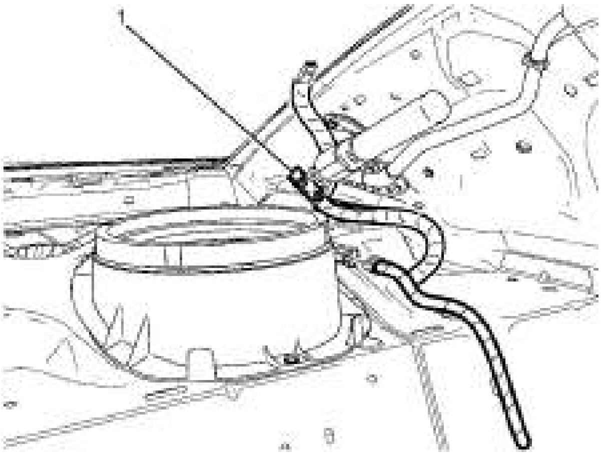
80. Bend flat the twisted connection.



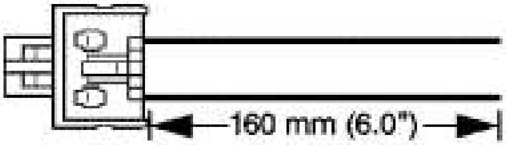
81. Secure and insulate the 3-wire connection to deployment harness using electrical tape.
82. Connect the deployment harness to the passenger side air bag/pretensioner yellow connector.

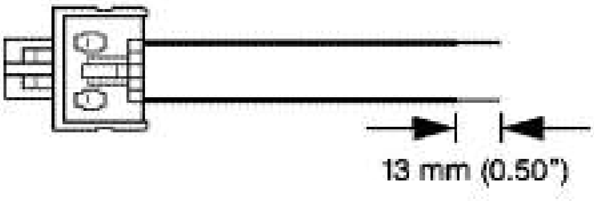


83. Route the deployment harness out of the passenger side of the vehicle.

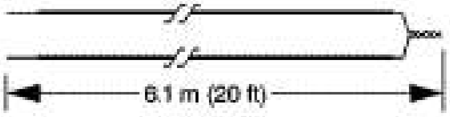


84. Disconnect the right/passenger roof rail air bag yellow harness connector (1) from the right roof rail air bag.

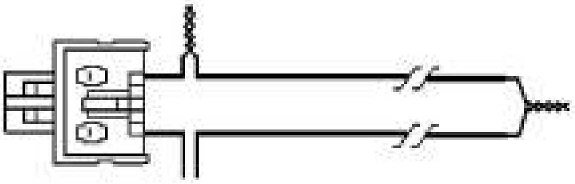




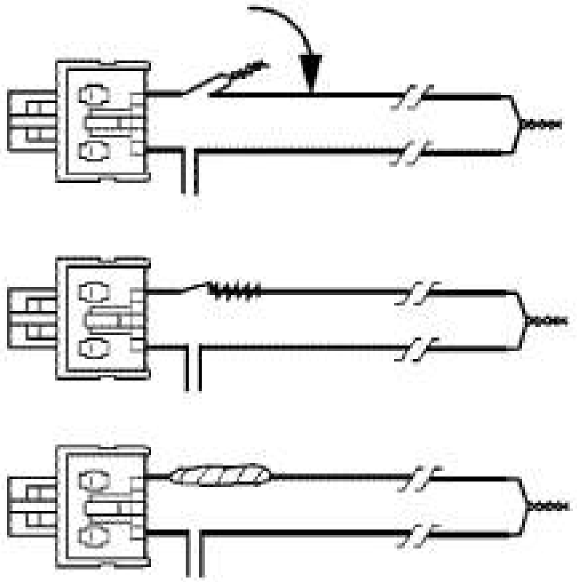
85. Cut the harness connector out of the vehicle, leaving at least 16 cm (6 in) of wire at the connector.
86. Strip 13 mm (0.5 in) of insulation from each of the connector wire leads.



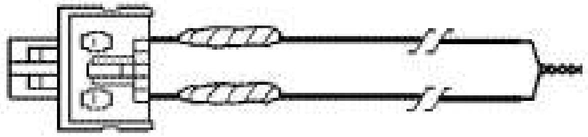
87. Cut two 6.1 m (20 ft) deployment wires from a 0.8 mm (18 gage) or thicker multi-strand wire. These wires will be used to fabricate the roof rail air bag deployment harness.
88. Strip 13 mm (0.5 in) of insulation from both ends of the wires cut in the previous step.
89. Twist together one end from each of the wires in order to short the wires.



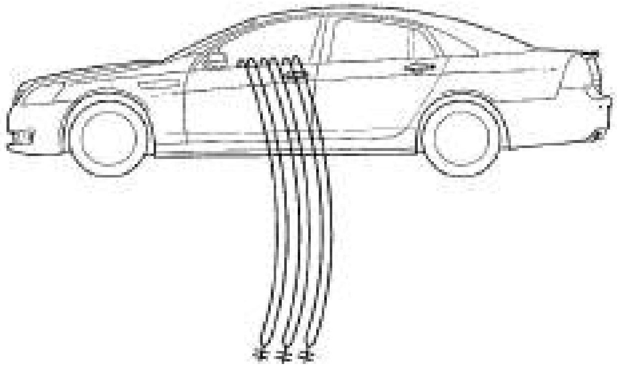
90. Twist together one connector wire lead to one deployment wire.



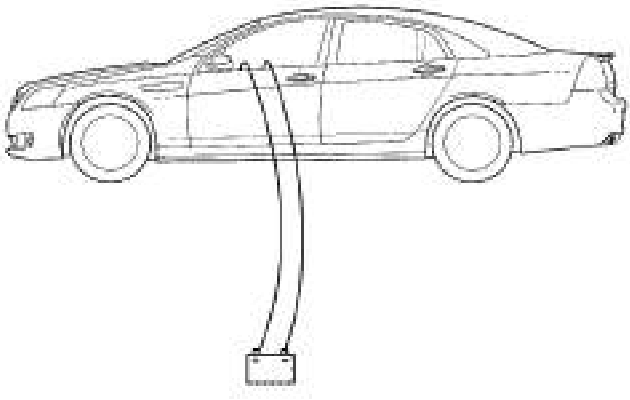
91. Bend flat the twisted connection.
92. Secure and insulate the connection using electrical tape.



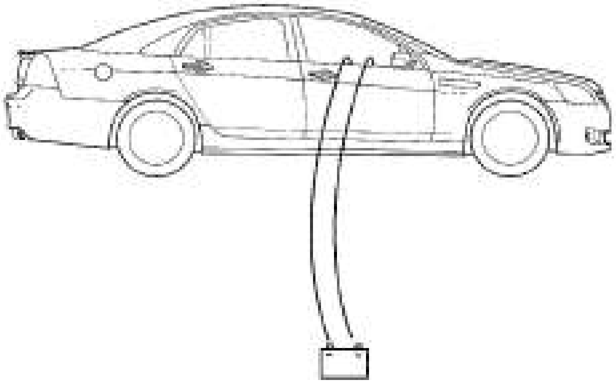
93. Twist together, bend, and tape the remaining connector wire lead to the remaining deployment wire.
94. Connect the deployment harness to the roof rail module yellow connector.



95. Route the deployment harness out of the passenger side of the vehicle.



96. Completely cover the windshield and front door window openings with a drop cloth.
97. Stretch out all of the deployment harness wires on the right side of the vehicle to their full length.
98. Deploy each deployment loop one at a time.
99. Place a power source, 12 V minimum/2 A minimum (i.e., a vehicle battery) near the shorted end of the harnesses.
100. Separate the one set of wires and touch the wires ends to the power source in order to deploy the inflator modules, doing one module at a time.
101. Disconnect the deployment harness from the power source and twist the wire ends together.
102. Continue the same process with the remaining deployment harnesses that are available.



103. Stretch out all of the deployment harness wires on the left side of the vehicle to their full length.
104. Deploy each deployment loop one at a time.
105. Place a power source, 12 V minimum/2 A minimum (i.e., a vehicle battery) near the shorted end of the harnesses.
106. Separate the one set of wires and touch the wires ends to the power source in order to deploy the inflator modules, doing one module at a time.
107. Disconnect the deployment harness from the power source and twist the wire ends together.
108. Continue the same process with the remaining deployment harnesses that are available.
109. Remove the drop cloth from the vehicle.
110. Disconnect all harnesses from the vehicle.
111. Discard the harnesses.
112. Scrap the vehicle in the same manner as a non-SIR equipped vehicle.
113. If one or all of the inflator modules did not deploy, perform the following steps to remove the undeployed module(s) from the vehicle:
    - Inflatable Restraint Steering Wheel Module Replacement .
    - Inflatable Restraint Instrument Panel Module Replacement .
    - Driver or Passenger Seat Side Inflatable Restraint Module Replacement .
    - Inflatable Restraint Roof Side Rail Module Replacement - Front .

Deployment Procedure - (Out Of Vehicle)

Refer to TAS (Technical Assistant Service) for further instructions.

Inflator Module Handling and Scrapping (SWBRHD)

Handling Procedure

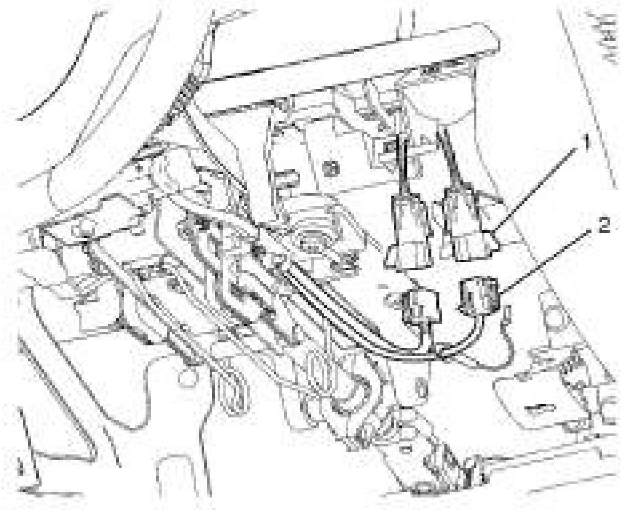
1. Do not apply power to a inflatable restraint except as specified.
2. Do not attempt to make any repairs to the inflatable restraint assembly or front/side-impact sensors. A damaged or defective component must be replaced.
3. Do not weld, solder, braze, hammer, machine drill, or otherwise heat any SIR component.
4. When handling a deployed inflatable restraint assembly or pretensioner:
   - Always wear gloves and safety glasses
   - Wash hands with mild soap and water afterwards. The surface of these components may contain chemicals as a result of the gas generated during combustion which can irritate your skin
5. When handling a steering column:
   - During any service operation that requires removal and reinstallation of a steering column fitted with an inflatable restraint assembly, always carry the steering column with two hands and with the steering wheel away from your body
   - Do not set a steering column on the floor with the steering wheel facing towards the floor
6. When carrying out steering gear removal and installation procedures, remove the ignition key from the lock and ensure the steering column is locked. If this operation is not carried out and the steering wheel is spun while the steering gear is removed, the clock spring coil will be destroyed. This will result in the SDM setting a DTC, and non-deployment of the steering wheel inflatable restraint assembly.

Deployment Inside Vehicle (Vehicle Scrapping Procedure)

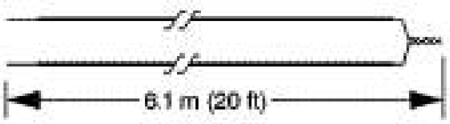
Important: Deploy the inflator modules inside of the vehicle when destroying the vehicle or when salvaging the vehicle for parts. This includes but is not limited to the following situations:

- The vehicle has completed its useful life
- Irreparable damage occurs to the vehicle in a non-deployment type accident
- Irreparable damage occurs to the vehicle during a theft
- The vehicle is being salvaged for parts to be used on a vehicle with a different VIN as opposed to rebuilding as the same VIN

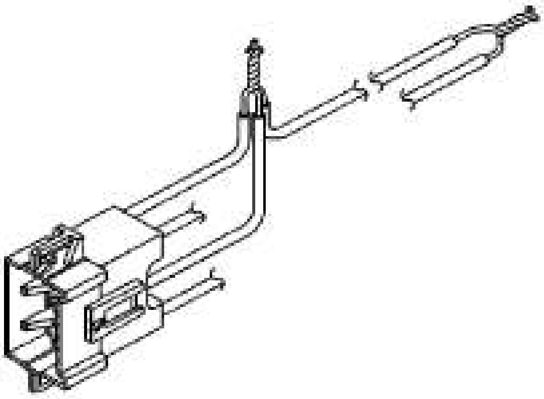
1. Turn the ignition switch to the OFF position.
2. Remove the ignition key.
3. Put on safety glasses.
4. Remove all loose objects from the front seats.
5. Disable the SIR system. Refer to SIR Disabling and Enabling.



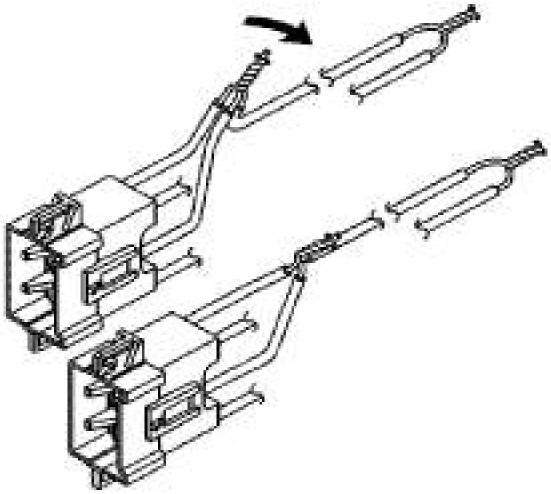
6. Disconnect the steering wheel module yellow connector (2) from vehicle harness yellow connector (1).
7. If vehicle is equipped with dual stage air bag the steering wheel module and I/P module will each have 4 wires. Refer to Component Connector End Views , for determining high and low circuits.
8. Cut the yellow harness connector out of the vehicle, leaving at least 16 cm (6 in) of wire at the connector.
9. Strip 13 mm (0.5 in) of insulation from each of the connector wire leads.



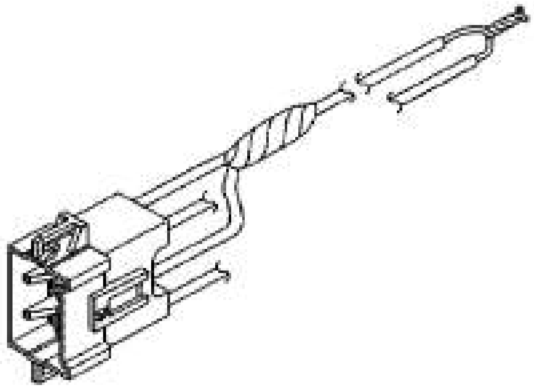
10. Cut two 6.1 m (20 ft) deployment wires from a 0.8 mm (18 gage) or thicker multi-strand wire. Use these wires to fabricate the right deployment harness.
11. Strip 13 mm (0.5 in) of insulation from both ends of the wires cut in the previous step.
12. Twist together one end from each of the wires in order to short the wires. Deployment wires shall remain shorted, and not connected to a power source until you are ready to deploy the inflator module.



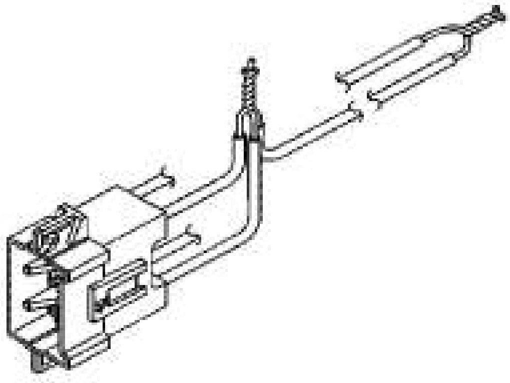
13. Twist together 2 connector wire leads (the high circuits from both stages of the steering wheel module) to one sets of deployment wires. Refer to Component Connector End Views , in order to determine the correct circuits.
14. Inspect that the 3-wire connection is secure.



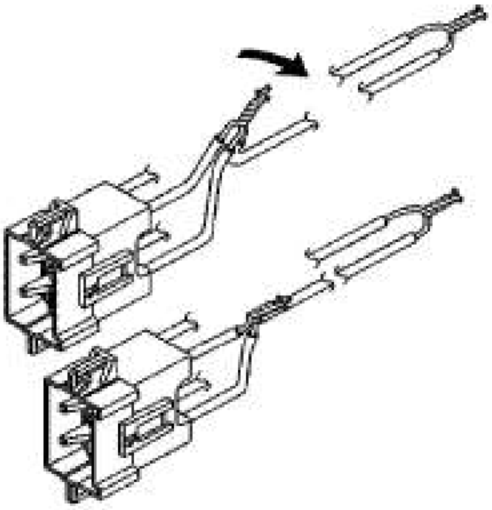
15. Bend flat the twisted connection.



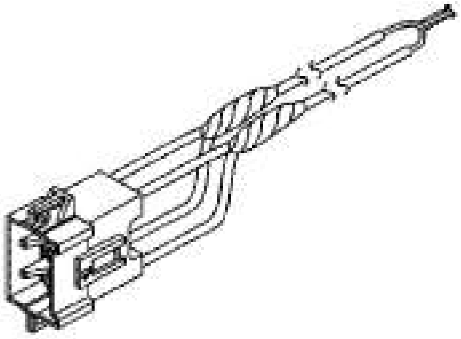
16. Secure and insulate the 3-wire connection to deployment harness using electrical tape.



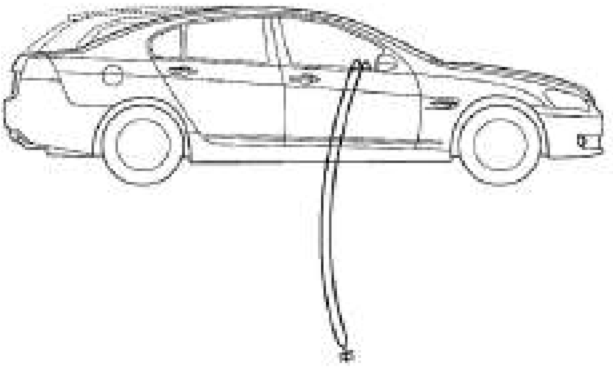
17. Twist together 2 connector wire leads (the low circuits from both stages of the steering wheel module) to one sets of deployment wires. Refer to Component Connector End Views , in order to determine the correct circuits.
18. Inspect that the 3-wire connection is secure.



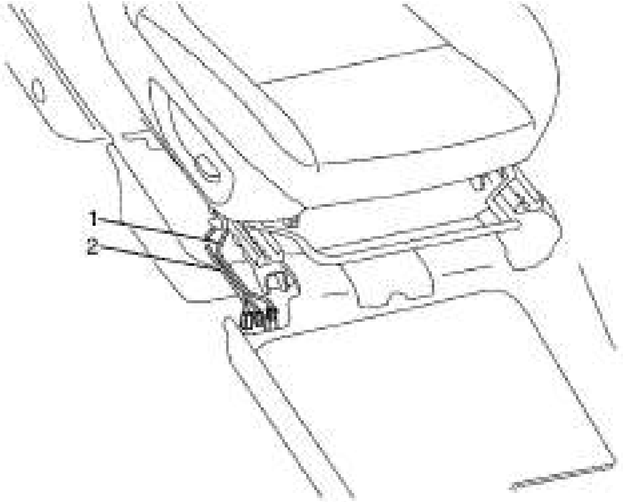
19. Bend flat the twisted connection.



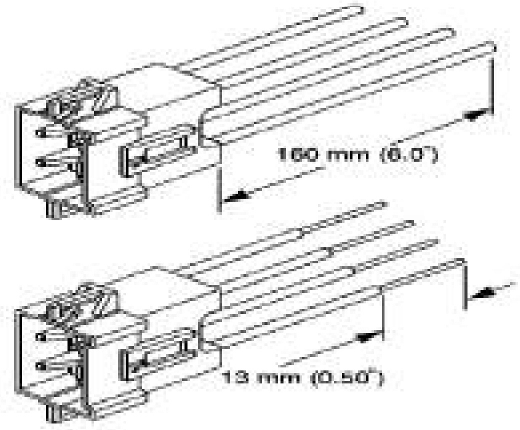
20. Secure and insulate the 3-wire connection to deployment harness using electrical tape.
21. Connect the deployment harness to the steering wheel module in-line connector.



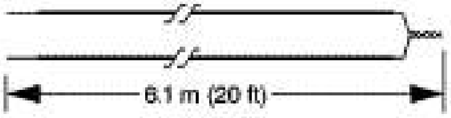
22. Route the deployment harness out of the right side of the vehicle.



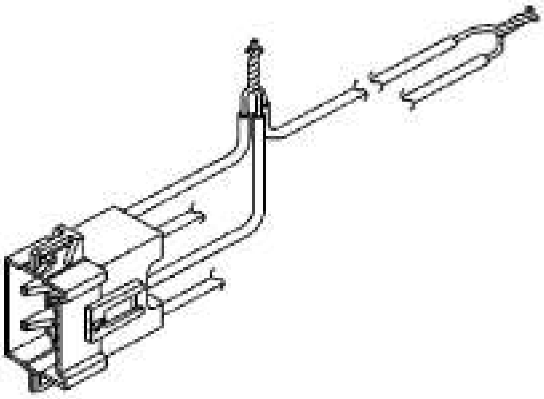
23. Disconnect the right side air bag/pretensioner yellow connector (1) from the vehicle wiring harness located under the front right seat.



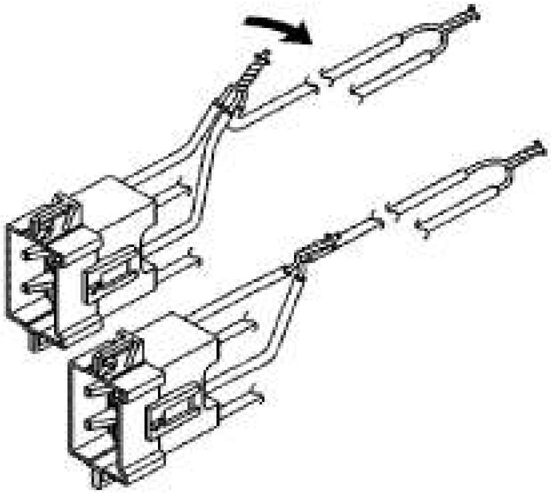
24. Cut the 4 SIR wires (2 for side air bag and 2 for pretensioner) leading to the yellow harness connector from the vehicle, leaving at least 16 cm (6 in) of wire at the connector.
25. Strip 13 mm (0.5 in) of insulation from all 4 SIR wires connector leads (2 for side air bag and 2 for pretensioner).



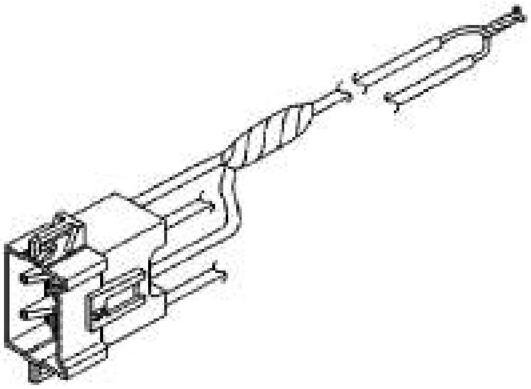
26. Cut two 6.1 m (20 ft) deployment wires from a 0.8 mm (18 gage) or thicker multi-strand wire. Use these wires to fabricate the deployment harness.
27. Strip 13 mm (0.5 in) of insulation from both ends of the wires cut in the previous step.
28. Twist together one end from each of the wires in order to short the wires. Deployment wires shall remain shorted, and not connected to a power source until you are ready to deploy the side air bag module and pretensioner.



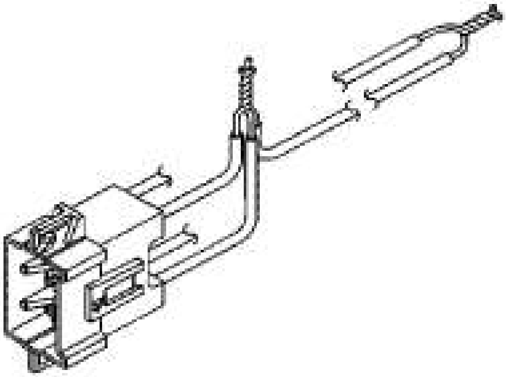
29. Twist together 2 connector wire leads (the high circuits from side air bag and pretensioner) to one sets of deployment wires. Refer to Component Connector End Views , in order to determine the correct circuits.
30. Inspect that the 3-wire connection is secure.



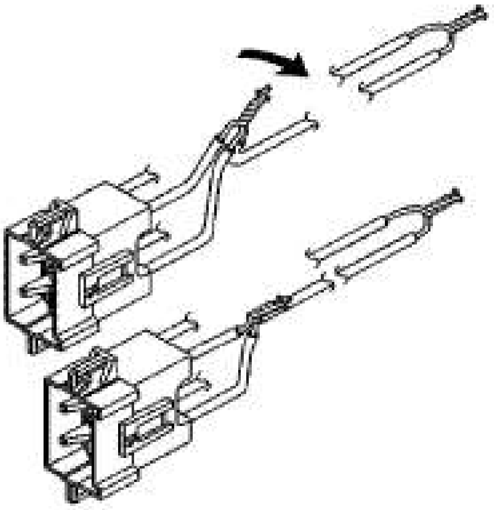
31. Bend flat the twisted connection.



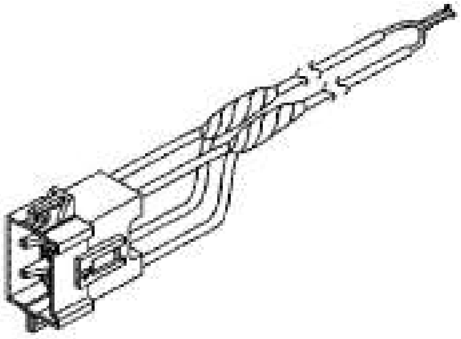
32. Secure and insulate the 3-wire connection to deployment harness using electrical tape.



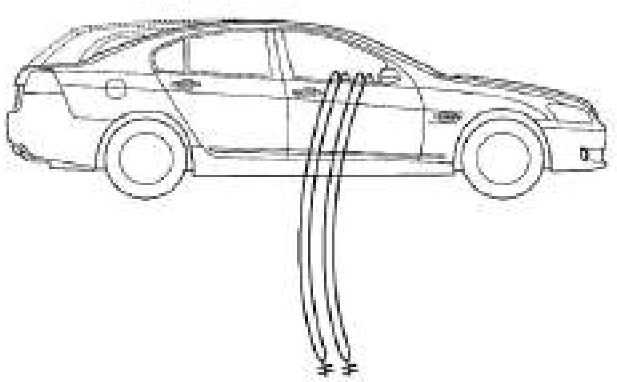
33. Twist together 2 connector wire leads (the low circuits from side air bag and pretensioner) to one sets of deployment wires. Refer to Component Connector End Views , in order to determine the correct circuits.
34. Inspect that the 3-wire connection is secure.



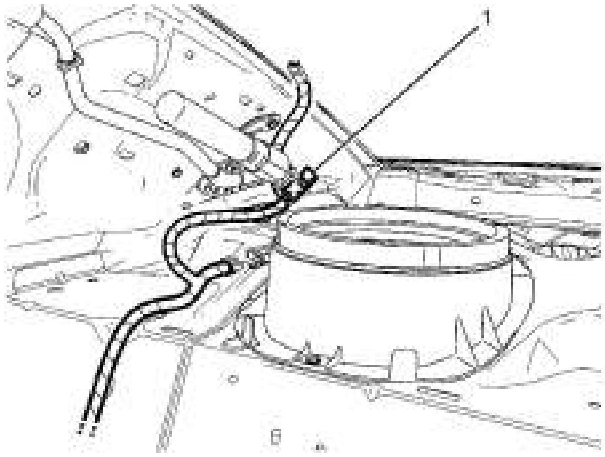
35. Bend flat the twisted connection.



36. Secure and insulate the 3-wire connection to deployment harness using electrical tape.
37. Connect the deployment harness to the right side air bag/pretensioner yellow connector.

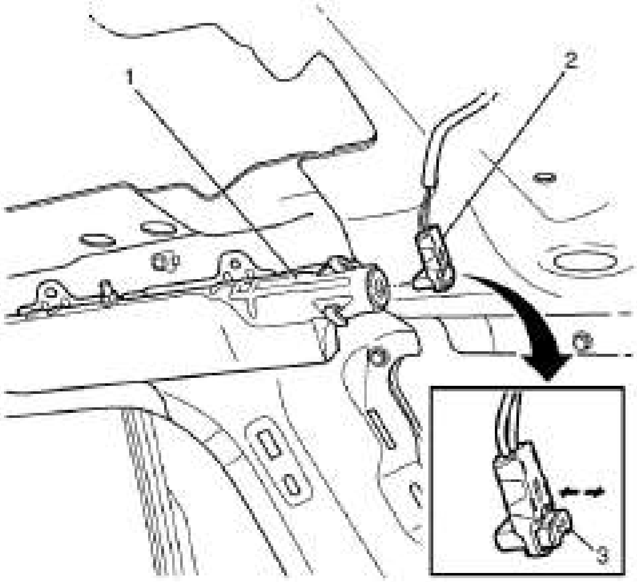


38. Route the deployment harness out of the right side of the vehicle.



Important: This step applies to sedan vehicles only.

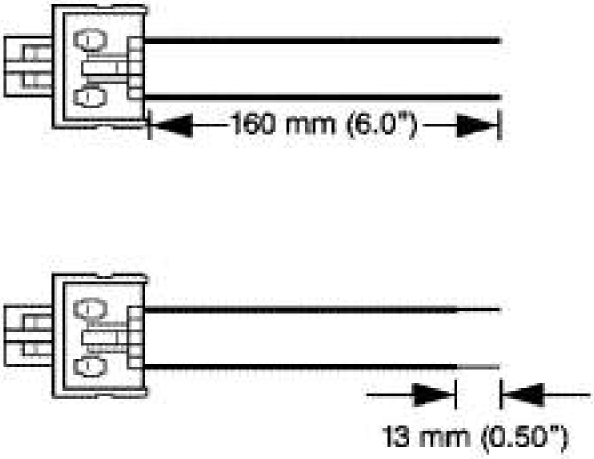
39. Disconnect the right roof rail yellow harness connector (1) from the right roof rail module.



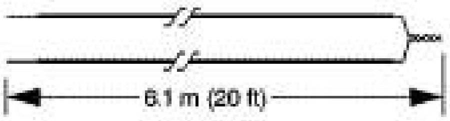
Important: This step applies to sportwagon vehicles only.

Important: The right roof rail module electrical connector retaining clip (3) must be released prior to removing the right roof rail module electrical connector (2).

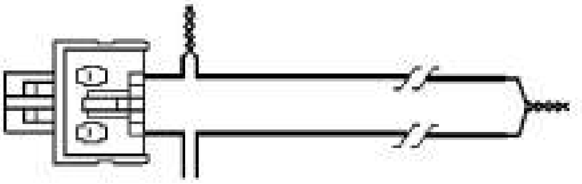
40. Disengage the right roof rail module electrical connector retaining clip (3) from the right roof rail module electrical connector (2).
41. Disconnect the right roof rail module electrical connector (2) from the right roof rail module (1).



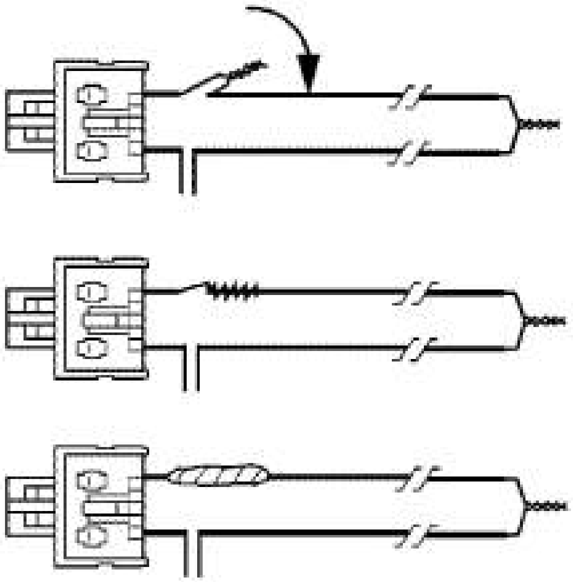
42. Cut the harness connector out of the vehicle, leaving at least 16 cm (6 in) of wire at the connector.
43. Strip 13 mm (0.5 in) of insulation from each of the connector wire leads.



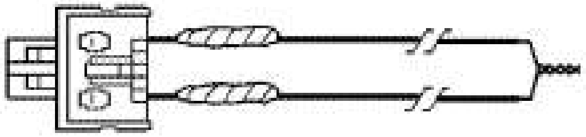
44. Cut two 6.1 m (20 ft) deployment wires from a 0.8 mm (18 gage) or thicker multi-strand wire. These wires will be used to fabricate the roof rail air bag deployment harness.
45. Strip 13 mm (0.5 in) of insulation from both ends of the wires cut in the previous step.
46. Twist together one end from each of the wires in order to short the wires.



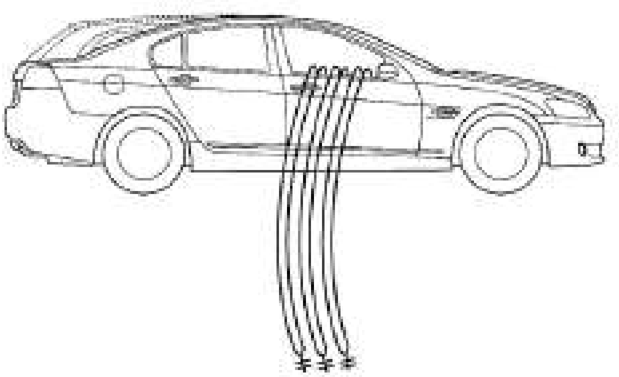
47. Twist together one connector wire lead to one deployment wire.



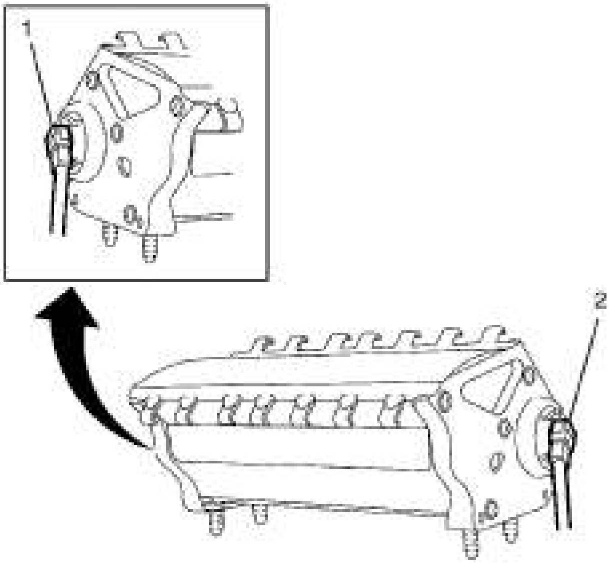
48. Bend flat the twisted connection.
49. Secure and insulate the connection using electrical tape.



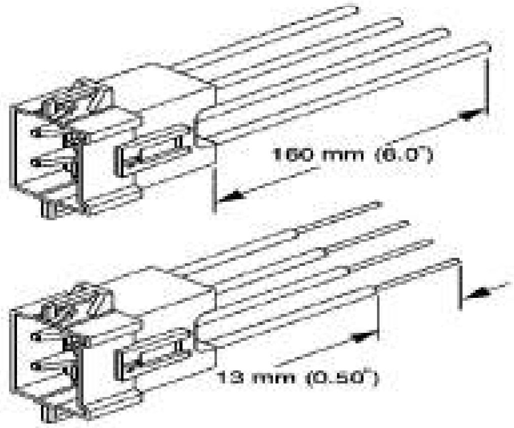
50. Twist together, bend, and tape the remaining connector wire lead to the remaining deployment wire.
51. Connect the deployment harness to the roof rail module yellow connector.



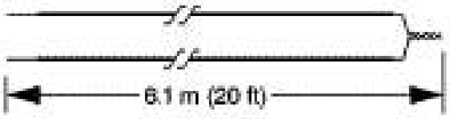
52. Route the deployment harness out of the right side of the vehicle.



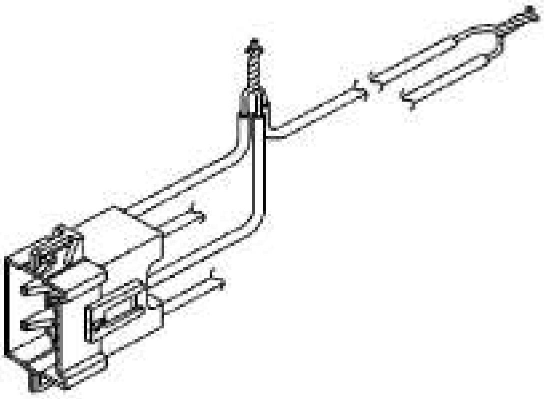
53. Disconnect the I/P module yellow harness connector (1) from the vehicle harness connector (2).



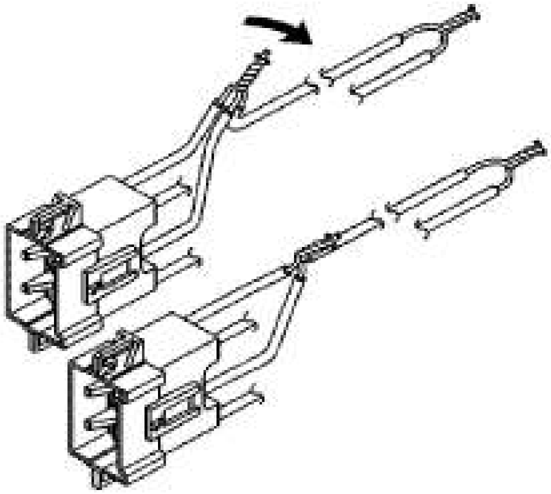
54. If vehicle is equipped with dual stage air bags the I/P module will each have 4 wires. Refer to Component Connector End Views , for determining high and low circuits.
55. Cut the yellow harness connector out of the vehicle, leaving at least 16 cm (6 in) of wire at the connector.
56. Strip 13 mm (0.5 in) of insulation from each of the connector wire leads.



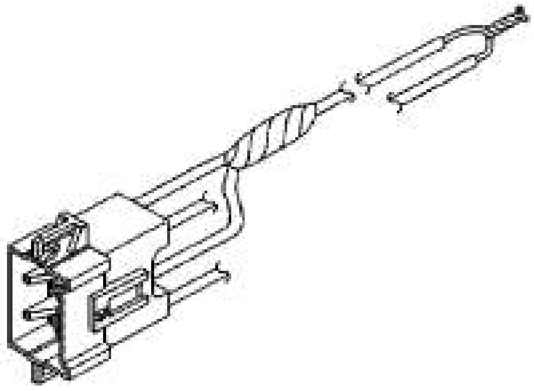
57. Cut two 6.1 m (20 ft) deployment wires from a 0.8 mm (18 gage) or thicker multi-strand wire. These wires will be used to fabricate the left deployment harness.
58. Strip 13 mm (0.5 in) of insulation from both ends of the wires cut in the previous step.
59. Twist together one end from each of the wires in order to short the wires.



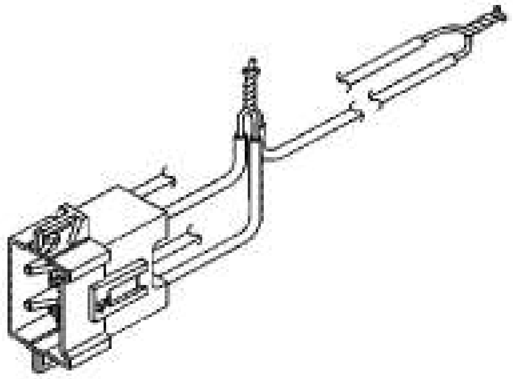
60. Twist together 2 connector wire leads (the high circuits from both stages of the steering wheel module) to one sets of deployment wires. Refer to Component Connector End Views , in order to determine the correct circuits.
61. Inspect that the 3-wire connection is secure.



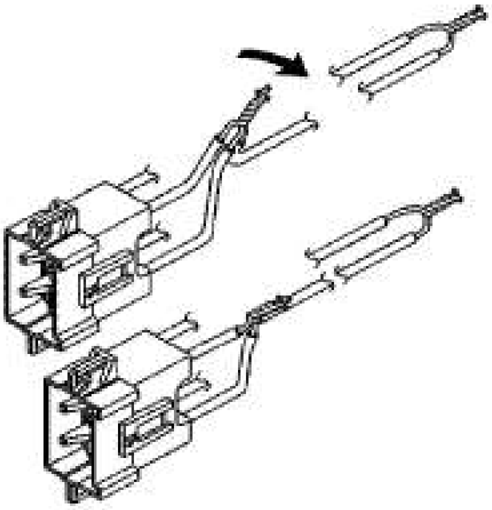
62. Bend flat the twisted connection.



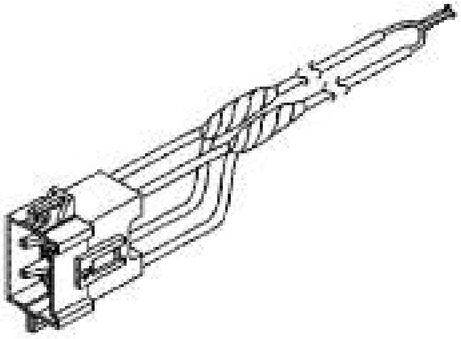
63. Secure and insulate the 3-wire connection to deployment harness using electrical tape.



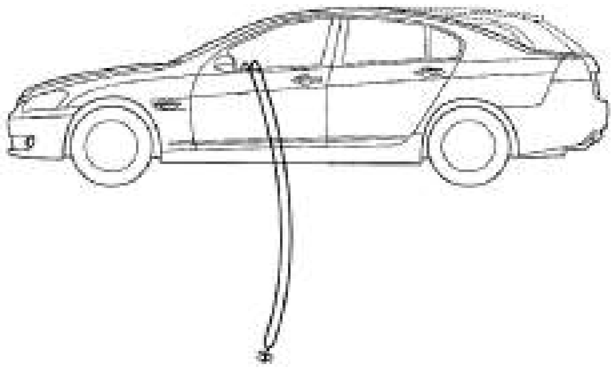
64. Twist together 2 connector wire leads (the low circuits from both stages of the I/P module) to one sets of deployment wires. Refer to Component Connector End Views , in order to determine the correct circuits.
65. Inspect that the 3-wire connection is secure.



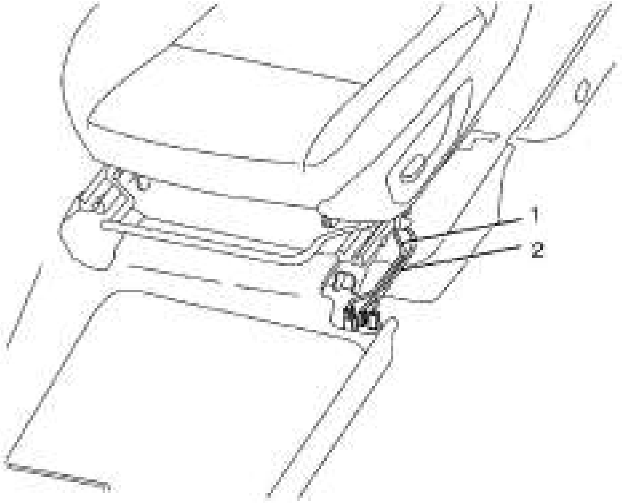
66. Bend flat the twisted connection.



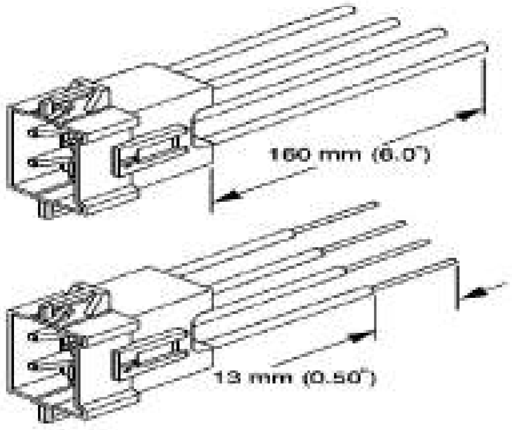
67. Secure and insulate the 3-wire connection to deployment harness using electrical tape.
68. Connect the deployment harness to the I/P module in-line connector.



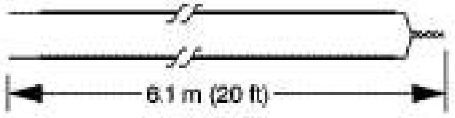
69. Route the deployment harness out of the left side of the vehicle.



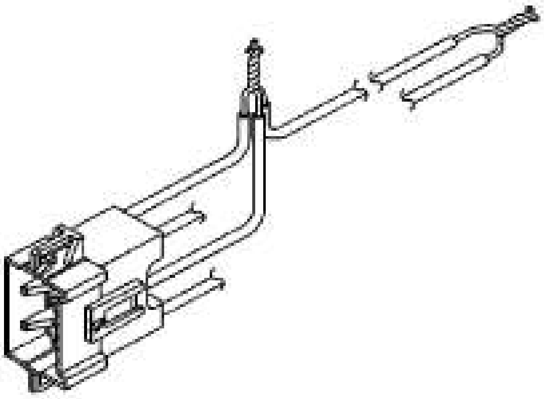
70. Disconnect the left side air bag/pretensioner yellow connector (1) from the vehicle wiring harness located under the front left seat.



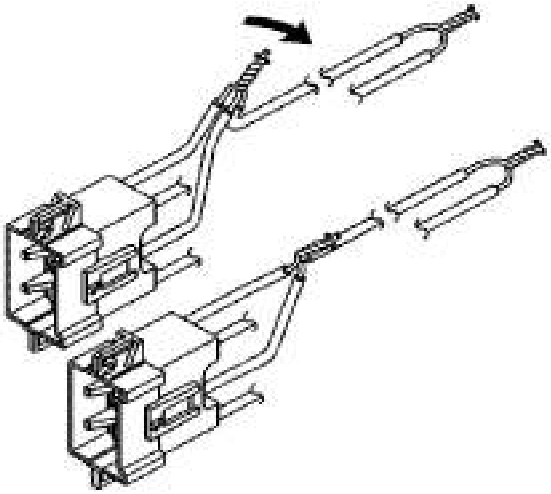
71. Cut the 4 SIR wires (2 for side air bag and 2 for pretensioner) leading to the yellow harness connector from the vehicle, leaving at least 16 cm (6 in) of wire at the connector.
72. Strip 13 mm (0.5 in) of insulation from all 4 SIR wires connector leads (2 for side air bag and 2 for pretensioner).



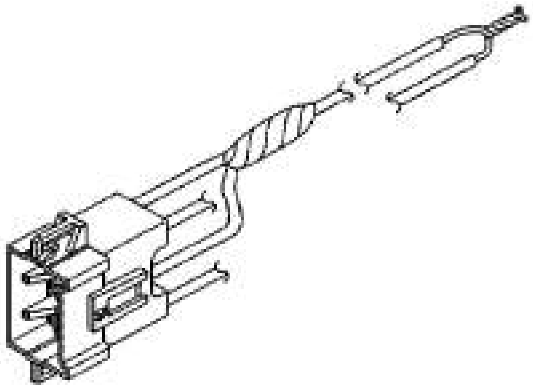
73. Cut two 6.1 m (20 ft) deployment wires from a 0.8 mm (18 gage) or thicker multi-strand wire. Use these wires to fabricate the deployment harness.
74. Strip 13 mm (0.5 in) of insulation from both ends of the wires cut in the previous step.
75. Twist together one end from each of the wires in order to short the wires. Deployment wires shall remain shorted, and not connected to a power source until you are ready to deploy the side air bag module and pretensioner.



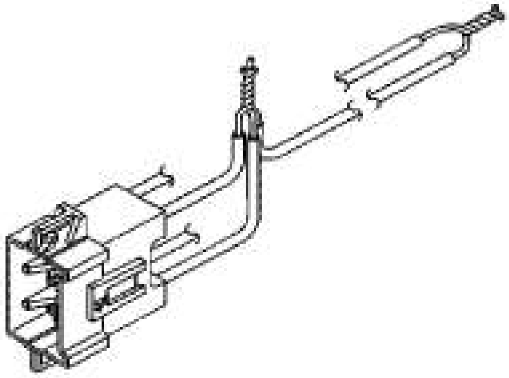
76. Twist together 2 connector wire leads (the high circuits from side air bag and pretensioner) to one sets of deployment wires. Refer to Component Connector End Views , in order to determine the correct circuits.
77. Inspect that the 3-wire connection is secure.



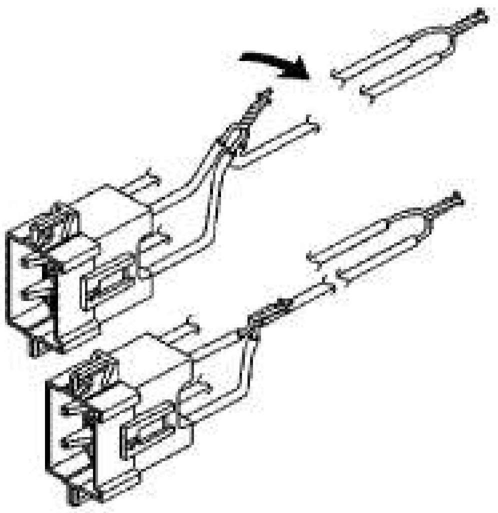
78. Bend flat the twisted connection.



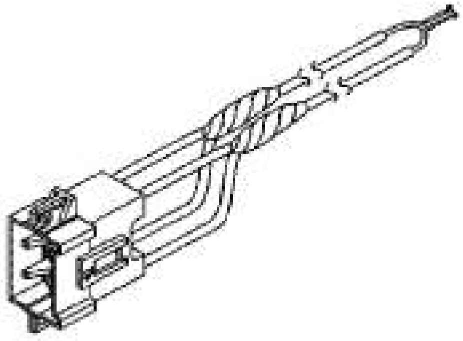
79. Secure and insulate the 3-wire connection to deployment harness using electrical tape.



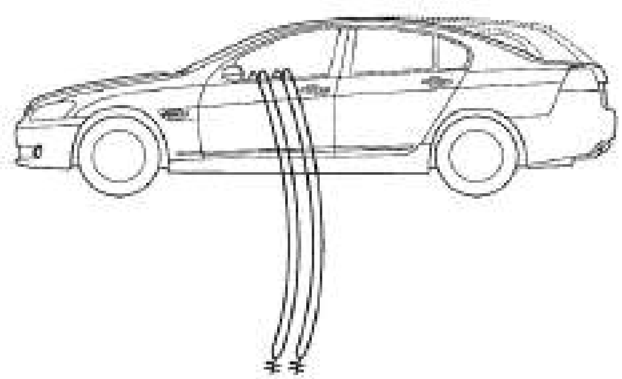
80. Twist together 2 connector wire leads (the low circuits from side air bag and pretensioner) to one sets of deployment wires. Refer to Component Connector End Views in order to determine the correct circuits.
81. Inspect that the 3-wire connection is secure.



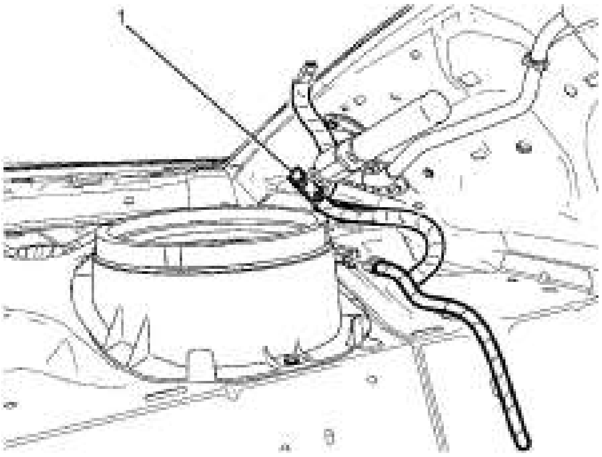
82. Bend flat the twisted connection.



83. Secure and insulate the 3-wire connection to deployment harness using electrical tape.
84. Connect the deployment harness to the left side air bag/pretensioner yellow connector.

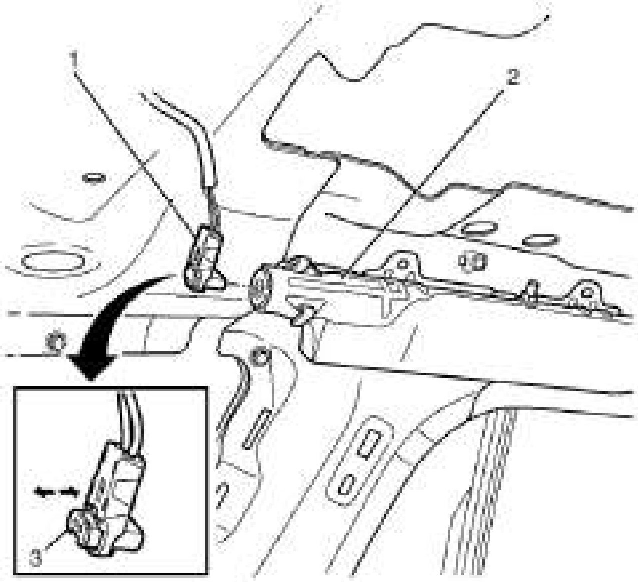


85. Route the deployment harness out of the left side of the vehicle.



Important: This step applies to sedan vehicles only.

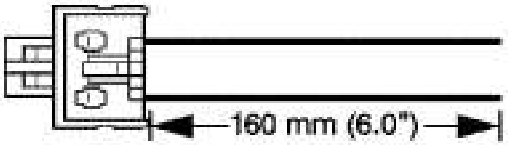
86. Disconnect the left roof rail air bag yellow harness connector (1) from the left roof rail module.

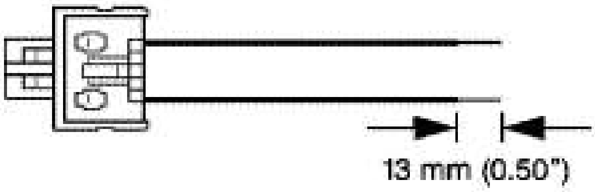


Important: This step applies to sportwagon vehicles only.

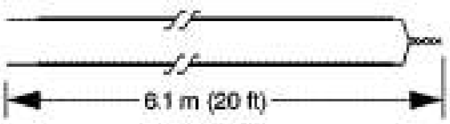
Important:: The left roof rail module electrical connector retaining clip (3) must be released prior to removing the left roof rail module electrical connector (1).

87. Disengage the left roof rail module electrical connector retaining clip (3) from the left roof rail module electrical connector (1).
88. Disconnect the left roof rail module electrical connector (1) from the left roof rail module (2).

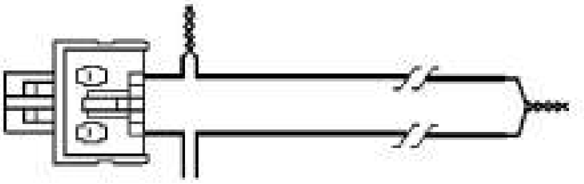




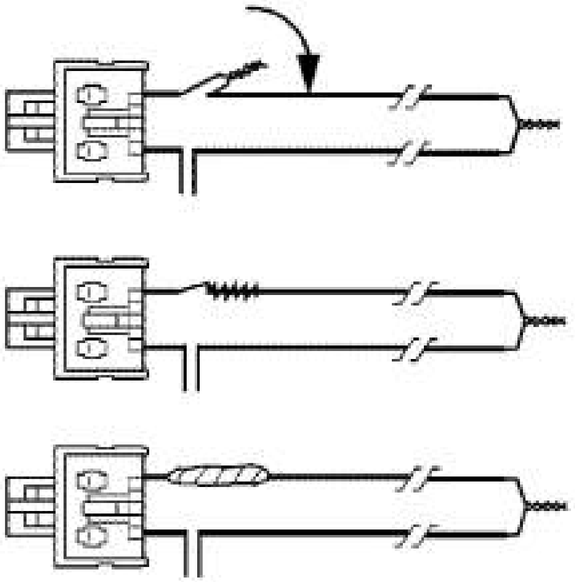
89. Cut the harness connector out of the vehicle, leaving at least 16 cm (6 in) of wire at the connector.
90. Strip 13 mm (0.5 in) of insulation from each of the connector wire leads.



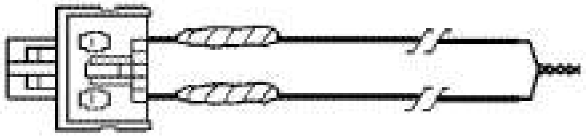
91. Cut two 6.1 m (20 ft) deployment wires from a 0.8 mm (18 gage) or thicker multi-strand wire. These wires will be used to fabricate the roof rail air bag deployment harness.
92. Strip 13 mm (0.5 in) of insulation from both ends of the wires cut in the previous step.
93. Twist together one end from each of the wires in order to short the wires.



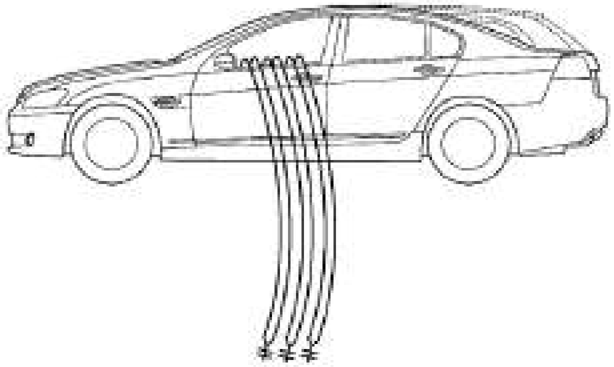
94. Twist together one connector wire lead to one deployment wire.



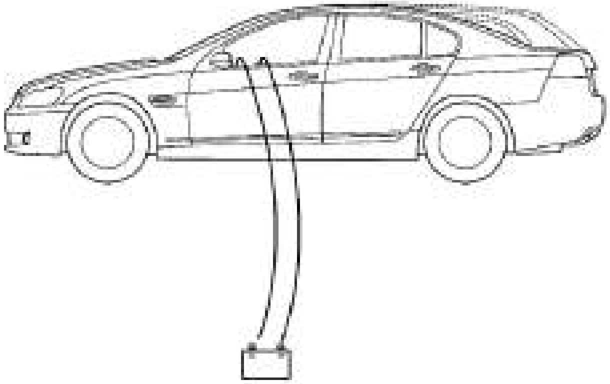
95. Bend flat the twisted connection.
96. Secure and insulate the connection using electrical tape.



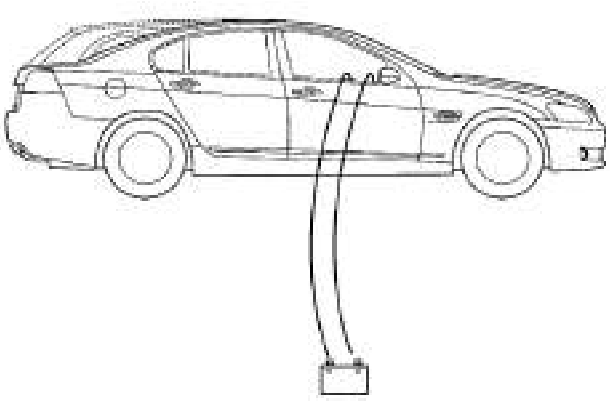
97. Twist together, bend, and tape the remaining connector wire lead to the remaining deployment wire.
98. Connect the deployment harness to the roof rail module yellow connector.



99. Route the deployment harness out of the left side of the vehicle.



100. Completely cover the windshield and front door window openings with a drop cloth.
101. Stretch out all of the deployment harness wires on the left side of the vehicle to their full length.
102. Deploy each deployment loop one at a time.
103. Place a power source, 12 V minimum/2 A minimum (i.e., a vehicle battery) near the shorted end of the harnesses.
104. Separate the one set of wires and touch the wires ends to the power source in order to deploy the inflator modules, doing one module at a time.
105. Disconnect the deployment harness from the power source and twist the wire ends together.
106. Continue the same process with the remaining deployment harnesses that are available.



107. Stretch out all of the deployment harness wires on the right side of the vehicle to their full length.
108. Deploy each deployment loop one at a time.
109. Place a power source, 12 V minimum/2 A minimum (i.e., a vehicle battery) near the shorted end of the harnesses.
110. Separate the one set of wires and touch the wires ends to the power source in order to deploy the inflator modules, doing one module at a time.
111. Disconnect the deployment harness from the power source and twist the wire ends together.
112. Continue the same process with the remaining deployment harnesses that are available.
113. Remove the drop cloth from the vehicle.
114. Disconnect all harnesses from the vehicle.
115. Discard the harnesses.
116. Scrap the vehicle in the same manner as a non-SIR equipped vehicle.
117. If one or all of the inflator modules did not deploy, perform the following steps to remove the undeployed module(s) from the vehicle:
    - Steering Wheel Inflatable Restraint Module Replacement.
    - Instrument Panel Inflatable Restraint Module Replacement.
    - Driver or Passenger Seat Side Inflatable Restraint Module Replacement.
    - Inflatable Restraint Roof Side Rail Module Replacement - Front.

Deployment Procedure - (Out Of Vehicle)

Refer to TAS (Technical Assistant Service) for further instructions.

Instrument Panel Inflatable Restraint Module Replacement

Important: Due to the clipping design of the passenger air bag (PAB) module it is extremely difficult to remove from the plastic cradle which is vibration welded to the underside of the Instrument Panel (IP) pad and the metal clips of the PAB would most likely be bent in removing from a pad assembly. This may result in the air bag being deployed incorrectly in an accident should it be re-used with the new IP pad assembly. If replacing the PAB for any reason you *must* also replace the IP pad assembly.

Refer to Instrument Panel Upper Trim Pad Replacement.

Pretensioner Handling and Scrapping

Handling Procedure

1. Do not carry a seat belt pretensioner by it's wiring harness lead.
2. Do not apply power to a pretensioner except as specified.
3. Do not attempt to make any repairs to the pretensioner assembly. A damaged or defective component must be replaced.
4. Do not weld, solder, braze, hammer, machine drill, or otherwise heat any SIR component.

Deployment Procedure - (In Vehicle)

Refer to Inflator Module Handling and Scrapping .

Deployment Procedure - (Out Of Vehicle)

Refer to TAS (Technical Assistant Service) for further instructions.

Repairs and Inspections Required After a Collision

Accident With or Without Air Bag Deployment - Component Inspections

Important: After any collision, inspect the following components as indicated. If you detect any damage, replace the component. If you detect any damage to the mounting points or mounting hardware, repair the component or replace the hardware as needed.

- The instrument panel (IP) area - inspect for bending, twisting, buckling, or any other type of damage
- The steering column, inspect for excessive movement (check for shear capsule separation)
- The seat belts - perform the seat belt operational and functional checks Repairs and Inspections Required After a Collision .
- The IP mounting points and brackets - inspect for bending, twisting, buckling, or any other type of damage
- The seats and seat mounting points - inspect for bending, twisting, buckling, or any other type of damage
- The door and garnish trim
- The roof and headliner mounting points
- Front end sensors

Accident With Frontal Air Bag Deployment - Component Replacement and Inspections

Important: The following must be replaced after a accident:

- Inflatable restraint SDM, refer to Inflatable Restraint Sensing and Diagnostic Module Replacement .
- Front end sensors, refer to Inflatable Restraint Front End Sensor Replacement .
- Seat belt pretensioners, refer to Seat Belt Buckle Pretensioner Replacement .
- Driver air bag, refer to Inflatable Restraint Steering Wheel Module Replacement . Inflatable Restraint Instrument Panel Module Replacement .
- Steering column, refer to Steering Column Replacement .
- Steering wheel, refer to Steering Wheel Replacement .
- Coil and the coil electrical harness, refer to Inflatable Restraint Steering Wheel Module Coil Replacement .
- All occupied seat belts. Refer to Seat Belts.
- All occupied seats. Refer to Seats.

Important: Inspect all mounting points and mounting hardware for after a accident

- Mounting points or mounting hardware for the I/P module, steering wheel module, SDM, and pretensioner - inspect for any damage and repair or replace each component as needed

Accident With Side Air Bag Deployment - Component Replacement and Inspections

Important: The following must be replaced after a accident:

- Inflatable restraint side impact sensors (SIS), on the side of the impact, refer to Driver or Passenger Seat Side Inflatable Restraint Module Replacement .
- Inflatable restraint roof rail module, on the side of the impact (if fitted), refer to Inflatable Restraint Roof Side Rail Module Replacement - Front .
- The steering column, inspect for excessive movement (check for shear capsule separation).
- Inflatable restraint sensing and diagnostic module (SDM), refer to Inflatable Restraint Sensing and Diagnostic Module Replacement .
- Side impact air bags, on the side of impact (Replace the seat assembly), refer to Driver or Passenger Seat Side Inflatable Restraint Module Replacement .
- All occupied seat belts including seat belt on impacted side. Refer to Seat Belts.
- Seat belt pretensioner. Refer to Seat Belt Buckle Pretensioner Replacement .
- A, B and C pillars and headliner when roof rail module has deployed. refer to Collision Repair.
- Mounting points or mounting hardware for the Side Impact Sensor (SIS), on the side of impact - inspect for any damage and repair or replace each component as needed
- Mounting points or mounting hardware for the roof rail module on the side of impact - inspect for any damage and repair or replace each component as needed
- Mounting points or mounting hardware for the SDM - inspect for any damage and repair or replace each component as needed

Sensor Replacement Guidelines

Important: The SIR front/side air bag sensor replacement policy requires replacing sensors in the area of accident damage. The area of accident damage is defined as the portion of the vehicle which is crushed, bent, or damaged due to a collision. An example of this would be a moderate collision where the front of the vehicle impacts a tree. The SIR front sensor must be replaced.

- Replace the sensor whether or not the air bags have deployed.
- Replace the sensor even if it appears to be undamaged.

> **Important:** Sensor damage which is not visible, such as slight bending of the mounting bracket or cuts in the wire insulation, can cause improper operation of the SIR/side air bag sensing system. Do not try to determine whether the sensor is undamaged. Replace the sensor. Also, if you follow a diagnostic trouble code (DTC) table and a malfunctioning sensor is indicated, replace the sensor.

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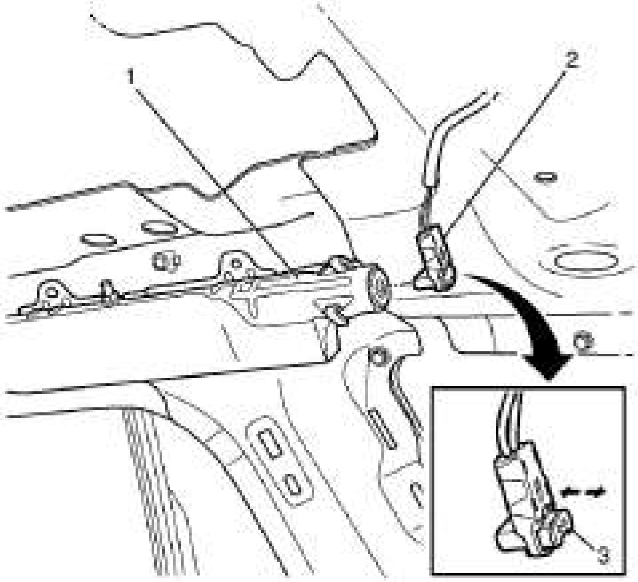
Roof Side Rail Inflatable Restraint Module Replacement (Sportwagon)

Removal Procedure

Caution: Refer to SIR Caution in the Preface section.

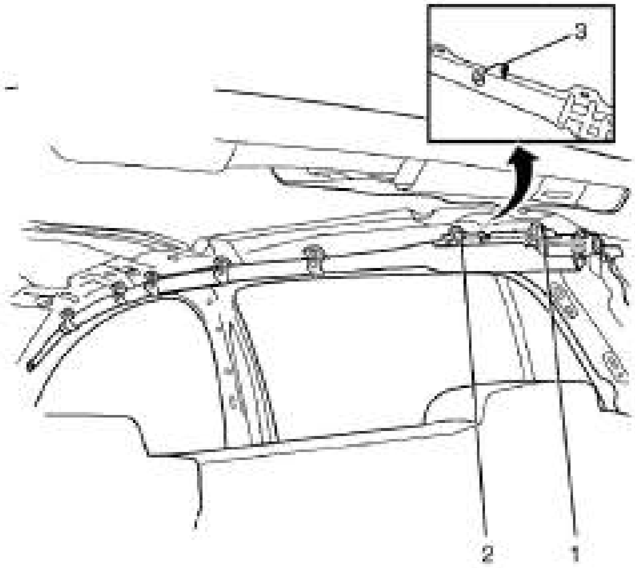
Caution: Refer to SIR Inflator Module Handling and Storage Caution in the Preface section.

1. Disable the SIR system. Refer to SIR Disabling and Enabling.
2. Remove the headlining. Refer to Headlining Trim Panel Replacement.

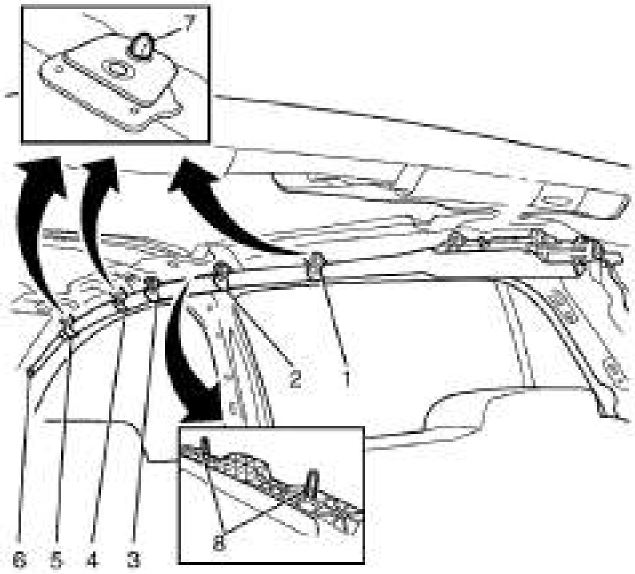


Important: The roof rail module electrical connector retaining clip (3) must be released prior to removing the roof rail module electrical connector (2).

3. Disengage the roof rail module electrical connector retaining clip (3) from the roof rail module electrical connector (2).
4. Disconnect the roof rail module electrical connector (2) from the roof rail module (1).



5. Remove the roof rail module bolts (1), (2).
6. With the aid of an assistant carefully lift the roof rail module up towards the roof to unhook the mounting point (3).



7. Remove the following roof rail module bolts in sequence (1), (2), (3), (4), (5), (6).
8. Release the datum pins (7), (8) from the vehicle.
9. Remove the roof rail module from the vehicle.
10. For deployment procedure. Refer to Inflator Module Handling and Scrapping.

Installation Procedure

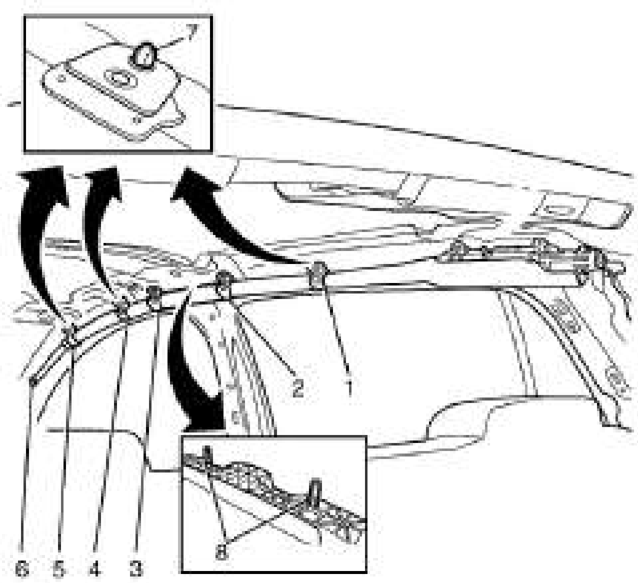
Caution: Refer to SIR Caution in the Preface section.

Caution: Refer to SIR Inflator Module Handling and Storage Caution in the Preface section.

Caution: In order to prevent accidental deployment of the air bag which could cause personal injury, do not dispose of an undeployed inflator module as normal shop waste. The undeployed inflator module contains substances that could cause severe illness or personal injury if the sealed container is damaged during disposal. Use the following deployment procedures to safely dispose of an undeployed inflator module. Failure to dispose of an inflator module as instructed may be a violation of federal, state, province, or local laws.

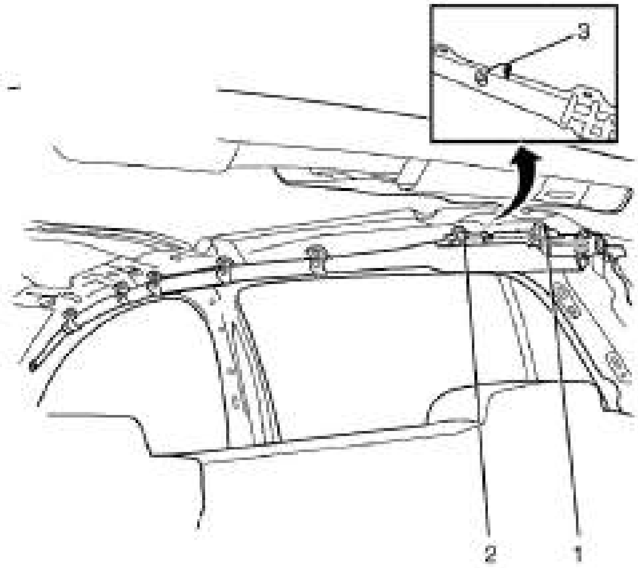
1. Remove any dirt, grease, or other impurities from the mounting surface.

   Notice: Refer to Fastener Notice in the Preface section.



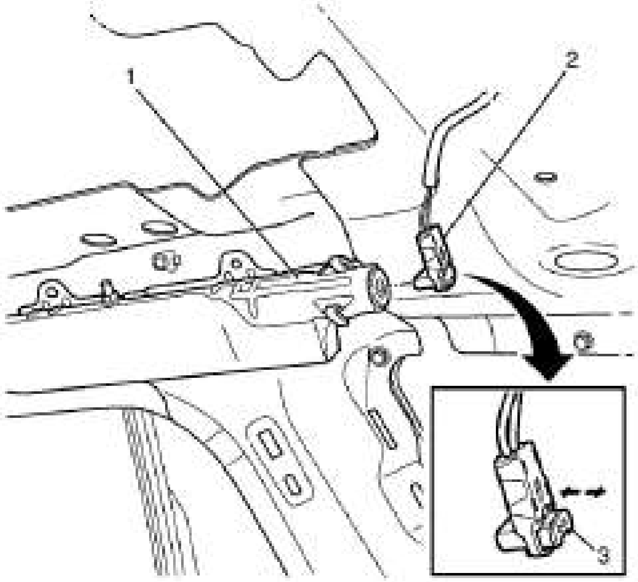
2. With the aid of an assistant carefully position the roof rail module up towards the roof making sure the datum pins (7) and (8) are correctly seated in place on the roof.
3. Install the roof rail module bolts to the roof in the following sequence (6), (5), (4), (3), (2), (1).
4. Tighten the roof rail module bolts to the roof in the following sequence (6), (5), (4), (3), (2), (1).

   Tighten
   Tighten the bolts to 7 N·m (62 lb in).



5. With the aid of an assistant carefully hook the mounting point (3) to the roof.
6. Install the roof rail module bolts to the roof in the following sequence (2), (1).
7. Tighten the roof rail module bolts to the roof in the following sequence (2), (1).

   Tighten
   Tighten the bolts to 7 N·m (62 lb in).



Important : Make sure the roof rail module electrical connector retaining clip (3) seats into the roof rail module electrical connector (2).

8. Install the roof rail module electrical connector (2) to the roof rail module (1).

9. Engage the roof rail module electrical connector retaining clip (3) into the roof rail module electrical connector (2).
10. Install the headliner. Refer to Headlining Trim Panel Replacement.
11. Enable the SIR system. Refer to SIR Disabling and Enabling.
12. If re-programming is required. Refer to Control Module References.

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Seat Belt Buckle Pretensioner Replacement (RHD)

Removal Procedure

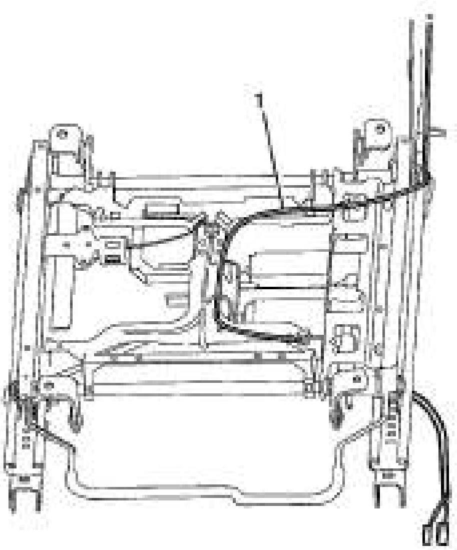
Caution: Refer to SIR Caution in the Preface section.

Caution: Refer to SIR Inflator Module Handling and Storage Caution in the Preface section.

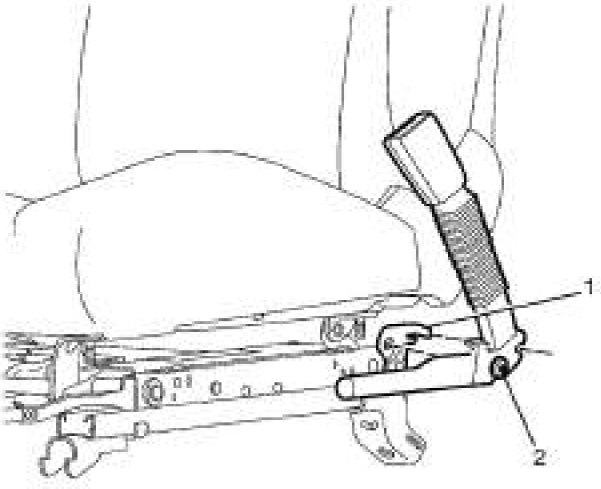
1. Disable the SIR system. Refer to SIR Disabling and Enabling .
2. Remove the front seat. Refer to Front Seat Replacement - Bucket .

Important: Note the wiring and connector routing during the removal, in order to route the wiring properly during assembly.

3. Remove the seat.

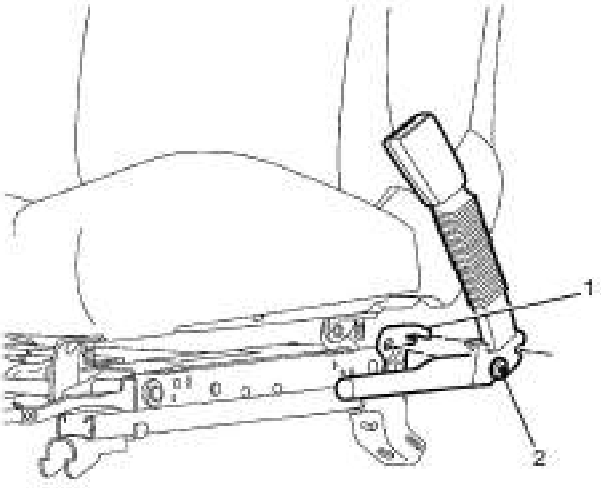


4. With the seat on the work bench, lay the seat on it side and remove the wiring harness (1) from the underside of the seat rail.



5. Remove the pretensioner bolt (2) and the pretensioner (1) from the seat.
6. Fully deploy the buckle pretensioner before disposal. If the buckle pretensioner was replaced under warranty, fully deploy and dispose of the module after the required retention period. Refer to Pretensioner Handling and Scrapping .

Installation Procedure



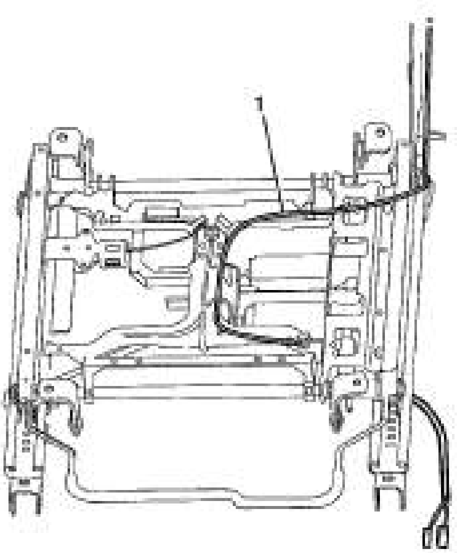
Important: The pretensioner has a locating tab that ensures the pretensioner is in the proper position.

1. Align the locating tab to the slot and install the pretensioner (1) to the seat.

Notice: Refer to Fastener Notice in the Preface section.

2. Install the bolt (2) while holding the pretensioner in place.

Tighten
Tighten the bolt to 43 N·m (32 lb ft).



3. With the seat on the work bench, lay the seat on it side and install the wiring harness (1) to the underside of the seat rail.
4. Install the seat. Refer to Front Seat Replacement - Bucket .
5. Enable the SIR system. Refer to SIR Disabling and Enabling .

SIR Service Precautions (RHD)

General Service Instructions

Caution: When performing service on or near the SIR components or the SIR wiring, the SIR system must be disabled. Refer to SIR Disabling and Enabling . Failure to observe the correct procedure could cause deployment of the SIR components, personal injury, or unnecessary SIR system repairs.

Important: The sensing and diagnostic module (SDM) maintains a reserved energy supply. The reserved energy supply provides deployment power for the SIR modules. Deployment power may be available for up to 2 minutes after disconnecting the vehicle power. Disabling the SIR system prevents deployment of the SIR modules from the reserved energy supply.

Important: The following are general service instructions which must be followed in order to properly repair the vehicle and return it to its original integrity:

- Do not expose inflator modules to temperatures above 65 °C (147 °F)
- Verify the correct replacement part number. Do not substitute a component from a different vehicle
- Use only original Holden replacement parts available from your authorized Holden dealer. Do not use salvaged parts for repairs to the SIR system

Important: Discard any of the following components if it has been dropped from a height of 96 cm (3 ft) or greater:

- Inflatable restraint SDM
- Inflatable restraint instrument panel (I/P) module
- Inflatable restraint steering wheel module
- Inflatable restraint steering wheel module clock-spring coil
- Inflatable restraint roof side rail modules
- Inflatable restraint side impact sensors (SIS)
- Inflatable restraint seat belt pretensioners
- Electronic front sensors
- Front seat (with side impact module)

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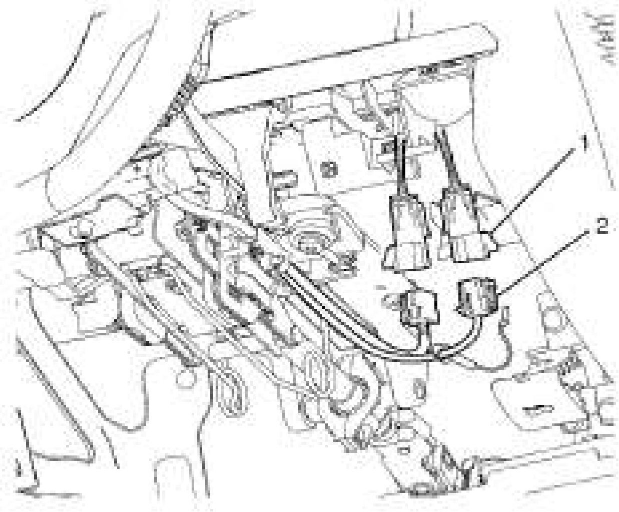
Steering Wheel Inflatable Restraint Module Coil Replacement (RHD)

Removal Procedure

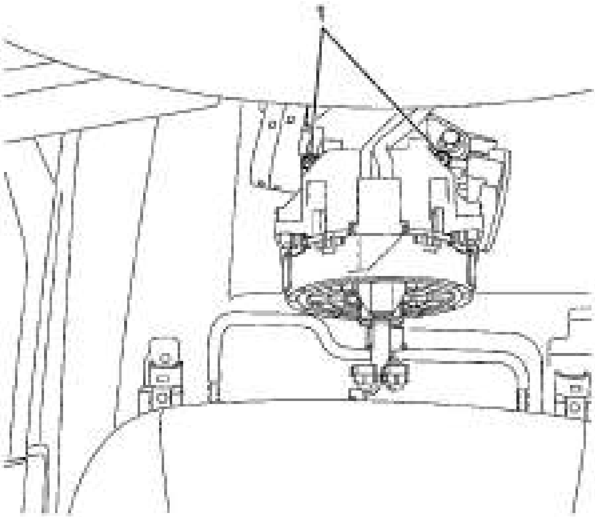
1. Disable the SIR. Refer to SIR Disabling and Enabling.
2. Remove inflatable restraint steering wheel module. Refer to Inflatable Restraint Steering Wheel Module Replacement.
3. Remove the steering wheel. Refer to Steering Wheel Replacement.
4. Remove the steering column trim covers. Refer to Steering Column Trim Covers Replacement.
5. Remove the turn signal switch from the SIR steering wheel module coil assembly. Refer to Turn Signal Switch Replacement.
6. Remove the windshield wiper and washer switch from the SIR steering wheel module coil assembly. Refer to Windshield Wiper and Washer Switch Replacement.



7. Disconnect the SIR steering wheel module coil connector (2) from the I/P harness (1)

   Important: If the SIR coil module is to be reused, it must be re-fitted in the same position as when removed.

8. Place some tape around the SIR steering wheel module coil assembly before removing from the steering column.



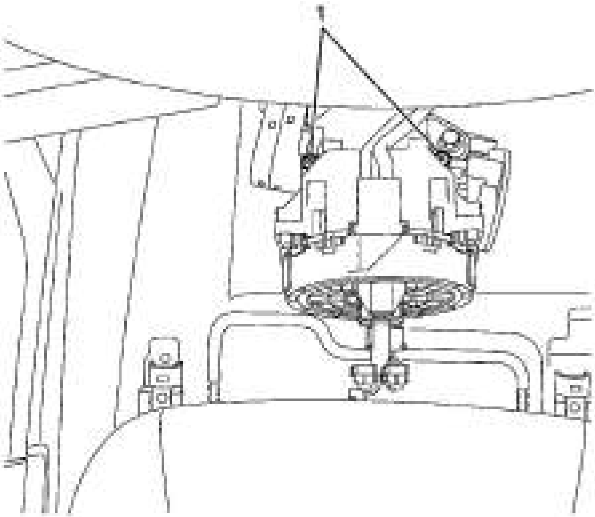
9. Remove the SIR steering wheel module coil assembly to steering column retaining screws (1).
10. Remove the SIR steering wheel module coil assembly.

Installation Procedure

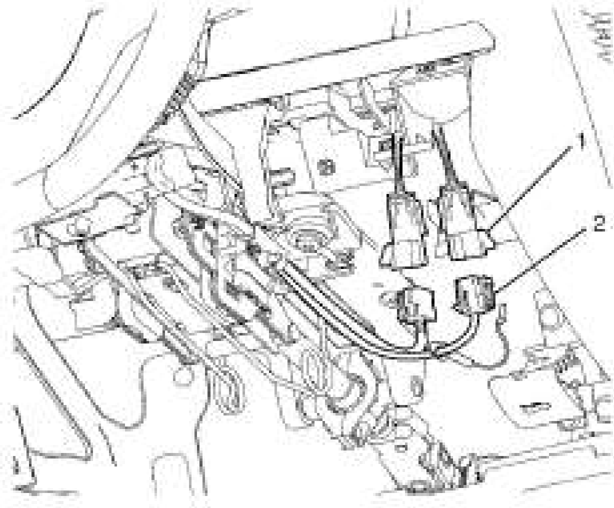
Notice: The new SIR coil assembly will be centered. Improper alignment of the SIR coil assembly may damage the unit, causing an inflatable restraint malfunction.

Important: If the existing SIR steering wheel module coil assembly is to be reinstalled, the SIR steering wheel module coil assembly must be fitted in the same position as when removed.

1. Install the SIR steering wheel module coil assembly. (If the original SIR steering wheel module coil assembly is being reused, remove the tape after installing the SIR coil module assembly.)



2. Install the SIR steering wheel module coil assembly to steering column retaining screws (1).

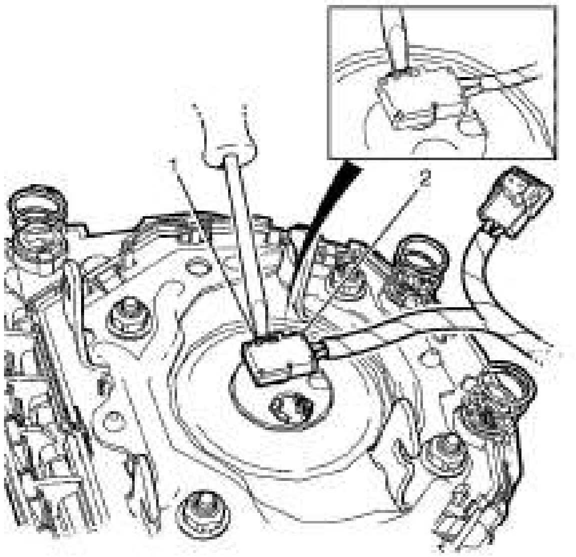


3. Connect the SIR steering wheel module coil assembly connector (2) to the I/P harness (1).
4. Install the windshield wiper and washer switch to the SIR steering wheel module coil assembly. Refer to Windshield Wiper and Washer Switch Replacement.
5. Install the turn signal switch to the SIR steering wheel module coil assembly. Refer to Turn Signal Switch Replacement.
6. Install steering column trim covers. Refer to Steering Column Trim Covers Replacement.
7. Install the steering wheel. Refer to Steering Wheel Replacement.
8. Install the inflatable restraint steering wheel module to the steering wheel. Refer to Inflatable Restraint Steering Wheel Module Replacement.
9. Enable the SIR system. Refer to SIR Disabling and Enabling.
10. Calibrate the steering angle sensor. Refer to Steering Angle Sensor Centering.
11. If re-programming is required. Refer to Control Module References.

Steering Wheel Inflatable Restraint Module Replacement

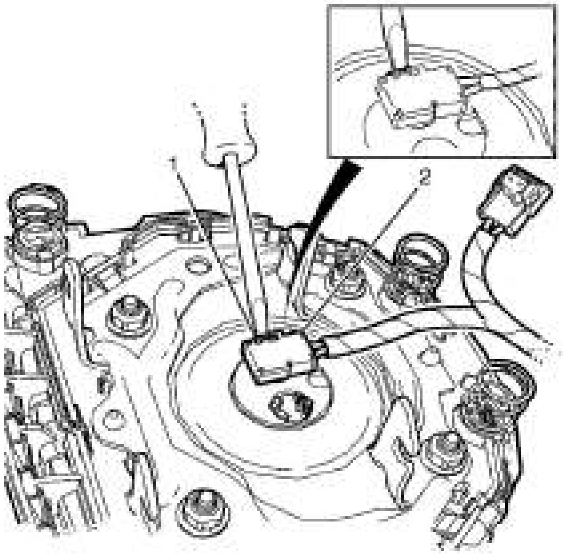
Removal Procedure

1. Disable the SDM, refer to SIR Disabling and Enabling .
2. Rotate the steering wheel 90 degrees from the straight-ahead position to expose the access aperture hole in the rear of the steering wheel hub.
3. Using tool no. EL-48508 , insert into the aperture and pivot towards the instrument panel moving the tool in an outward direction. This will relieve the tension on the spring-loaded retaining clips. The inflatable restraint assembly will move slightly away from the steering wheel. Rotate the steering wheel 180 degrees to expose the remaining access aperture hole. Repeat for other side.
4. Carefully lift the steering wheel inflatable restraint assembly away from the steering wheel and disconnect the wiring harness connectors (Orange and Blue) from the rear assembly.



5. Using a suitable tool, press in on the locking tab (1) while lifting the connector (2) away from the module.
6. Remove the black earth connector from the bottom of the steering wheel inflatable restraint assembly.
7. Refer to Inflator Module Handling and Scrapping .

Installation Procedure



1. Connect the wiring harness connectors (2) to the corresponding colours on the inflatable restraint steering wheel module.
2. Connect the black earth connector on the bottom of the steering wheel inflatable restraint assembly.
3. Align the steering wheel module firmly into the steering wheel assembly applying even pressure to the module until you hear a click.
4. Enable the SIR system. Refer to SIR Disabling and Enabling .
5. After replacing the module, deploy the old module before disposal. If the module replaced under warranty, fully deploy and dispose of the module after the required retention period. Refer to Inflator Module Handling and Scrapping .
6. If re-programming is required. Refer to Control Module References .

SIR System Description and Operation

SIR System Overview

Supplemental Restraint System (SIR) is a generic term for all air bag inflators/modules including driver, passenger, side impact, curtain bag and also includes pyrotechnic seat belt buckle and all associated hardware and wiring.

Air bags are supplemental restraint systems that are designed to work in conjunction with seat belts to reduce the severity and extent of injuries to the occupants of a vehicle in the event of an accident. When a condition or impact of sufficient force occurs, a sensor or sensors send an electrical signal to the diagnostic unit. The diagnostic unit (SDM) determines the type and severity of the collision and which of the SIR components are to be deployed. An electrical signal is then sent to the SIR's, which ignites the energetic materials and deploys the SIR.

Each inflator module has a deployment loop that is controlled by the inflatable restraint Sensing and Diagnostic Module (SDM), which is mounted inside of the vehicle. The SDM determines the severity of a collision and commands deployment of each inflator module. The SDM performs continuous diagnostic monitoring of the SIR system electrical components. Upon detection of a circuit malfunction, the SDM will set a diagnostic trouble code (DTC) and inform the driver by commanding the instrument panel cluster (IPC) to turn the AIR BAG indicator ON. The steering column is designed to absorb energy and compress during frontal collisions in order to decrease the chance of injury to the driver.

Dual Stage Inflator Module

Dual stage inflator modules contain a housing, inflatable air bag, 2 initiating devices, canister of gas generating material and, in some cases, stored compressed gas. The 2 initiators are part of the frontal deployment loop. The function of the frontal deployment loops are to supply current through the steering wheel and instrument panel (I/P) inflator modules to deploy the air bags. The inflator modules have 2 stages of deployment, which varies the amount of restraint to the occupant according to the collision severity. For moderate frontal collisions, the inflator modules deploy at less than full deployment (low deployment) which consists of stage 1 of the inflator module. For more severe frontal collisions, a full deployment is initiated which consists of stage 1 and stage 2 of the inflator module. The current passing through the initiators ignites the material in the canister producing a rapid generation of gas and is some cases, the release of compressed gas. The gas produced from this reaction rapidly inflates the air bag. Once the air bag is inflated, it quickly deflates through the air bag vent holes and/or the bag fabric.

Each dual stage inflator module is equipped with a shorting bar located in the connectors of the module. The shorting bar shorts the inflator module deployment loop circuitry to prevent unwanted deployment of the air bag when it is disconnected.

Frontal SIR System Description

The frontal supplemental restraint system (SIR) consists of the following components:

- SIR warning indicator located in the instrument panel cluster (IPC).
- Inflatable restraint dual stage instrument panel module. (Passenger's Airbag).

- Inflatable restraint sensing and diagnostic module (SDM).
- Inflatable restraint dual stage steering wheel module. (Driver's Airbag).
- Inflatable restraint steering wheel module clock-spring.
- Inflatable restraint wiring harnesses.
- Driver and passenger buckle pretensioners.
- Driver seat position switch.

A frontal collision of sufficient force will deploy the frontal air bags. The SDM contains a sensing device that converts vehicle velocity changes to an electrical signal. In the event of a frontal collision, the SDM receives a signal from the electronic frontal sensor which assists the SDM in determining the severity of the collision. The SDM compares these signals to a value stored in memory. When the generated signals exceed the stored value, the SDM will cause current to flow through the frontal deployment loops simultaneously deploying the frontal air bags. The SDM, I/P module, steering wheel module, steering wheel module coil, seat belt pretensioner and the connecting wires make up the frontal deployment loops. The SDM continuously monitors the deployment loops for malfunctions and turns the AIR BAG indicator ON if a fault is detected.

Inflatable Restraint Sensing and Diagnostic Module (SDM)

The sensing and diagnostic module (SDM) is a microprocessor and the control centre for the supplemental restraint system (SIR) . This SDM has 2 fused power inputs; one fuse is for the battery voltage and the other fuse is for the ignition voltage.

The SDM uses vehicle battery voltage as its main power input. The SDM then uses the vehicles GMLAN Serial Data Communication line and the ignition voltage logic input for enabling or disabling the SIR deployment loops. The SDM communicates with internal sensors and several external sensors. In the event of a collision, the SDM compares the signals from the internal and external sensors to values stored in memory. When the generated signals exceed the stored value, the SDM will cause current to flow through the appropriate deployment loops to deploy the seat belt pretensioner's and air bag(s) if required.

If the force of the impact is not sufficient to warrant inflator module deployment, the SDM may still deploy the seat belt pretensioners. The SDM records the SIR system status when a deployment occurs and turns the SIR warning lamp indicator located in the instrument panel cluster (IPC) ON. As soon as 3 distinct deployment commands (representing different events) have been issued to all belt pretensioner, or the SDM commands any front and/or side air bag to deploy once, the SDM shall be considered to not be reusable. The SDM performs continuous diagnostic monitoring of the SIR system electrical components and circuitry when the ignition is turned ON. If the SDM detects a malfunction, a DTC will be stored and the SDM will command the SIR warning lamp indicator ON, notifying the driver that a malfunction exist.

Inflatable Restraint Steering Wheel Module Coil

The steering wheel module coil is attached to the steering column and is located under the steering wheel. The steering wheel module coil consists of 2 or more current-carrying coils. The coils allow the rotation of the steering wheel while maintaining continuous electrical contact between the steering wheel module deployment loop and the steering wheel module. Four coil wires are used for the steering wheel module deployment loops. Additional coil wires are used for accessories that are attached to the steering wheel, depending on the vehicle model. The steering wheel module coil connector is located near the base of the steering column. The connector contains a shorting bar that shorts the steering wheel module coil deployment loop circuitry to prevent unwanted deployment of the steering wheel module when the connector is disconnected.

Inflatable Restraint Front End Sensor's

The front end sensor's, also known as the electronic frontal sensor's (EFS), are equipped on vehicles to supplement the Supplemental Restraint System (SIR) performance. The front end sensor's are an electronic sensor and is not part of the deployment loops, but instead provides an input to the sensing and diagnostic module (SDM). The front end sensor can assist in determining the severity of some frontal collisions. The SDM contains a microprocessor which performs calculations using the measured acceleration and compares these calculations to a value stored in memory. When the generated calculations exceed the stored value, the SDM will cause current to flow through the frontal deployment loops deploying the frontal air bags.

Inflatable Restraint Side Impact Sensors

The side impact sensor (SIS) contains a sensing device which monitors vehicle acceleration and velocity changes to detect side collisions that are severe enough to warrant air bag deployment. The SIS is not part of the deployment loop, but instead provides an input to the sensing and diagnostic module (SDM). The SDM contains a microprocessor that performs calculations using the measured acceleration and compares these calculations to a value stored in memory. When the generated calculations exceed the stored value, the SDM will cause current to flow through the deployment loops deploying the side air bags and curtain airbag's (if fitted).

Seat Belt Buckle Pretensioner

The seat belt pretensioner is a device that tightens a seat belt in the event of an accident. When a frontal, side (if side airbag's are fitted) or rear impact of sufficient force occurs, sensors send an activation signal to the pretensioning device. Upon deployment the pretensioning device tightens the seat belt webbing by reducing the length of the anchor line of the buckle. The intended purpose is to couple the occupant to the vehicle at an early stage, thereby reducing the load on the occupant and the severity and extent of injuries to the occupant.

During deployment the energetic materials pyrotechnic pretensioners are consumed in the reaction, therefore these devices can not be reused or repaired and must be replaced after a deployment.

Inflatable Restraint Steering Wheel Module

The "Driver air bag" or "Driver SIR" is an inflatable crash protection device deployed from the steering wheel. This system is activated when a frontal impact, up to 30 degrees off the centerline of the vehicle, of sufficient force occurs. The bag itself is shaped like a round pillow and inflates to the size of a large donut.

Inflatable Restraint Instrument Panel Module

The "Passenger air bag" or "Passenger SIR" is an inflatable crash protection device deployed from the passenger side instrument panel. This system is activated when a frontal impact, up to 30 degrees off the centerline of the vehicle, of sufficient force occurs. The bag itself is shaped like a rectangular pillow.

Inflatable Restraint Side Impact Module

The side impact air bag is located in the sides of the front seats. It deploys in a side impact collision to protect the occupant. Side impact air bags offer protection to the occupant, with bag fill timed to provide protection during an impact event.

Important: A side impact airbag only deploys on the side of the vehicle that is struck.

Inflatable Restraint Roof Rail Module

The "roof rail air bag" or "Curtain air bag stows unseen along the vehicle's interior roof rail. During a side impact the air bag deploys downwards from the vehicle's roof rail, providing protection for the front and rear occupants head.

Important: A curtain air bag only deploys on the side of the vehicle that is struck.

Inflatable Restraint Wiring Harness

The inflatable restraint wiring harness connects the inflator modules, the sensing and diagnostic module (SDM), the deployment loops, and the serial data circuit together using weather-packed connectors (where required). Supplemental restraint system (SIR) connectors are yellow for easy identification. When repairing SIR wiring harnesses, follow the proper SIR/SRS Wiring Repairs.

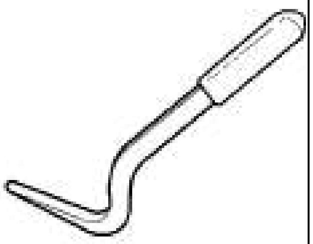
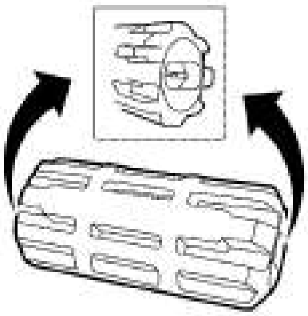
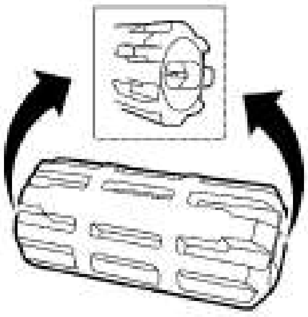
SIR Warning Indicator

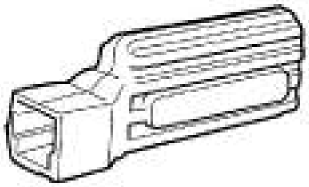
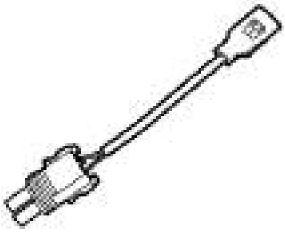
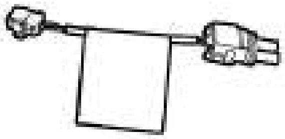
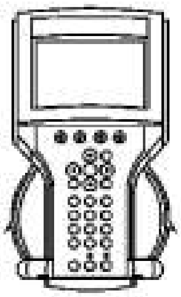
The SIR warning lamp indicator, located in the instrument panel cluster (IPC), is used to notify the driver of supplemental inflatable restraint (SIR) system malfunctions and to verify that the sensing and diagnostic module (SDM) is communicating with the IPC. When the ignition is turned ON, the SDM is supplied with ignition positive voltage. The SDM requests the IPC to flash the SIR warning lamp indicator seven times. While flashing the indicator, the SDM conducts tests on all SIR system components and circuits. If no malfunctions are detected, the SDM will communicate with the IPC through the GMLAN serial data circuit and command the SIR warning lamp indicator OFF. The SDM provides continuous monitoring of the air bag circuits by conducting a sequence of checks. If a malfunction is detected the SDM will store a diagnostic trouble code (DTC) and command the IPC to turn the SIR warning lamp indicator ON via GMLAN serial data. The presence of a SIR system malfunction could result in non-deployment of the air bags or deployment in conditions less severe than intended. The SIR warning lamp indicator will remain ON until the malfunction has been repaired.

Steering Wheel and Column

The steering wheel and column are designed to absorb energy when driver contact is made with steering wheel or inflated module. When the driver applies load to the inflator module or the steering wheel, the column will compress downward, absorbing some of the impact and helping to reduce bodily injuries to the driver. The steering wheel and column must be inspected for damages after a collision.

Special Tools

Illustration	Descripton
	EL 48508 Drivers Steering Wheel Module Removal Tool.
	EL 48522 Dummy Load for Drivers Steering Wheel Module.
	EL 48523 Dummy Load for Passenger Air Bag Module.

	EL 48526 Dummy Load for Pretensioner.
	EL 48517 SIR Deployment Harness Adapter for Passenger Air Bag Module.
	EL 48515 SIR Deployment Harness Adapter for Drivers Steering Wheel Module.
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

Fastener Tightening Specifications

Application	Specification	
	Metric	English
TDM to steering column assembly retaining screw	1 N·m	9 lb in
Theft Deterrent Horn to Body	8 N-m	71 lb in

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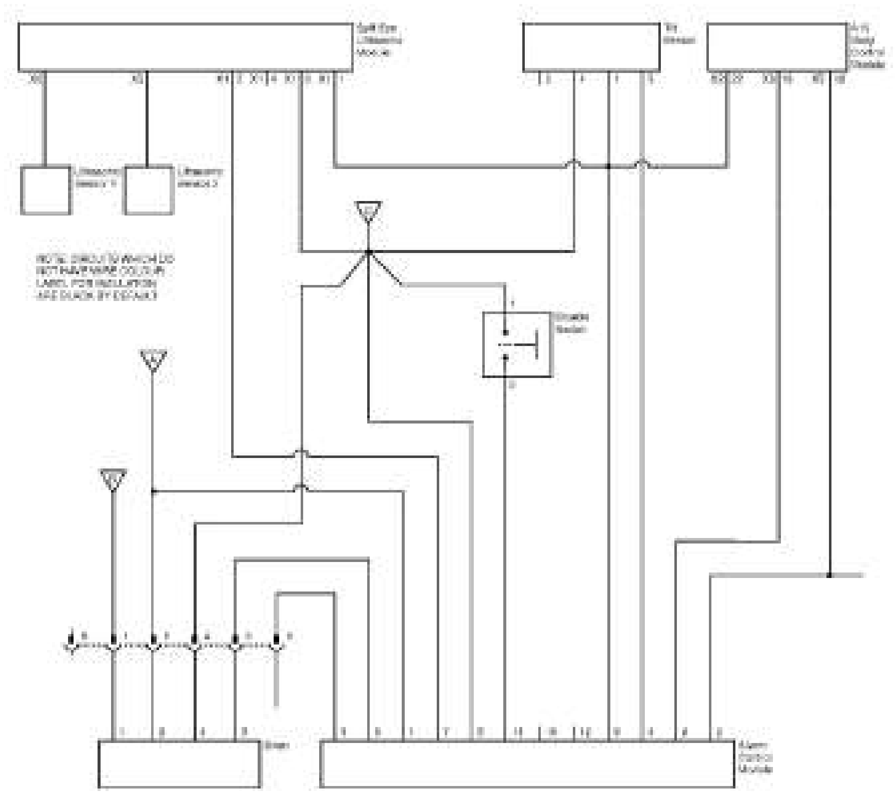
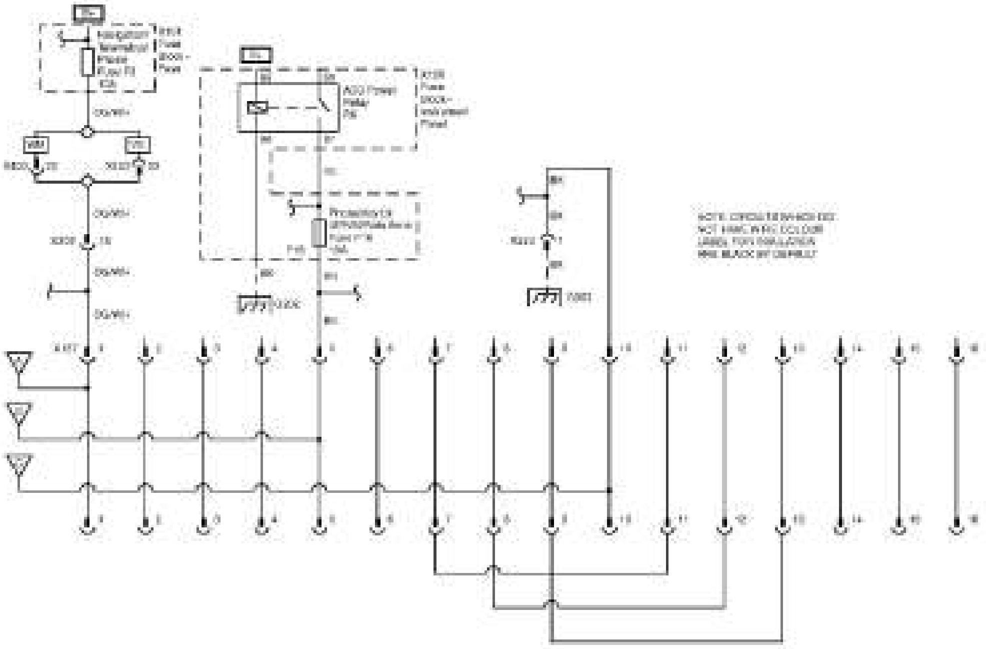
Genuine Accessory Security System - Power/Ground Supply, Alarm Control Module, Disable Switch, Siren, Split Eye Ultrasonic Module, Tilt Sensor

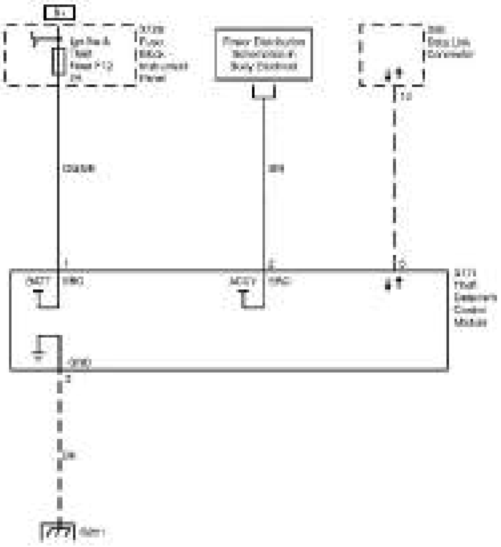

Split Eye Ultrasonic Module
Ultrasonic Sensor 1
Ultrasonic Sensor 2
Tilt Sensor
Body Control Module
Disable Switch
Siren
Alarm Control Module

NOTE: CIRCUITS WHICH DO NOT HAVE WIRE COLOUR LABEL FOR INSULATION ARE BLACK BY DEFAULT

Genuine Accessory Security System - Power/Ground Supply, Dealer Option Connector



Theft Deterrent Module, Power, Ground, Serial Data -- BRL


B+
Fuse Block - Instrument Panel
Power Distribution Schematics in Body Electrical
Data Link Connector
12
1
2
BATT
ACCY
Theft Deterrent Control Module
2

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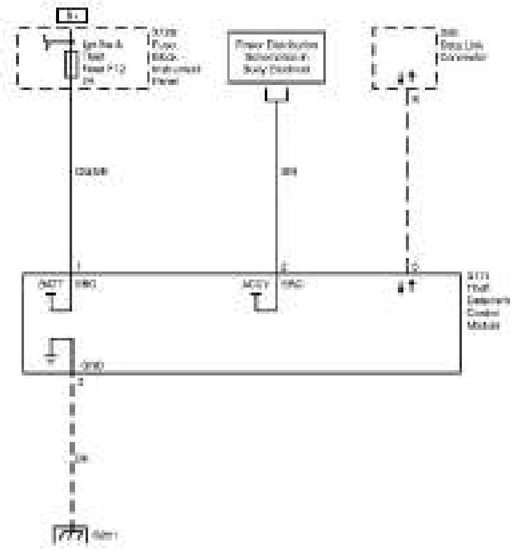
Theft Deterrent Module, Power, Ground, Serial Data - Except BRL


B+
Fuse Block - Instrument Panel
Fuse F12
Power Distribution Schematics in Body Electrical
Data Link Connector
BATT
ACCY
Theft Deterrent Control Module
GND

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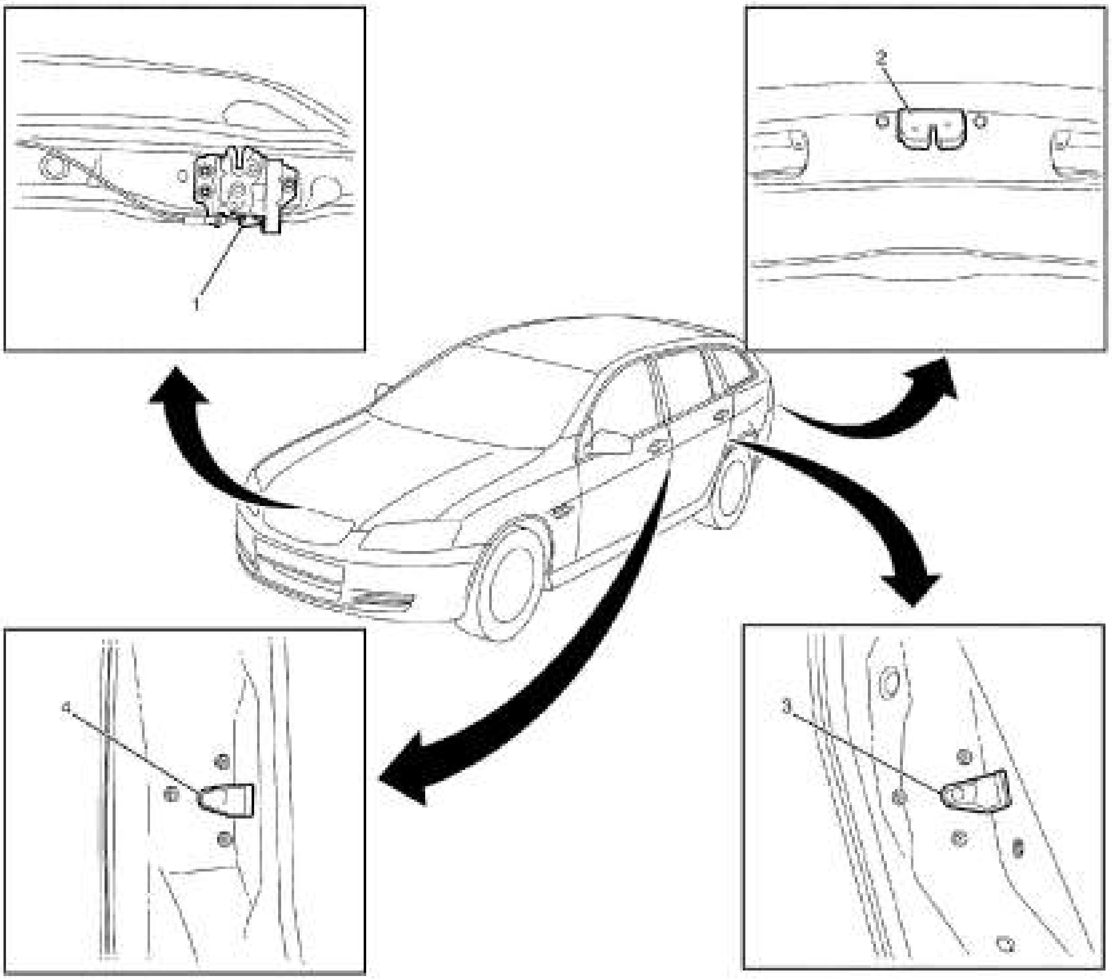
Hood Latch Assembly, Liftgate Latch Assembly, Front Door Latch Assembly and Rear Door Latch Assembly



(1) Hood Latch Assembly
(2) Liftgate Latch Assembly
(3) Rear Door Latch Assembly
(4) Front Door Latch Assembly

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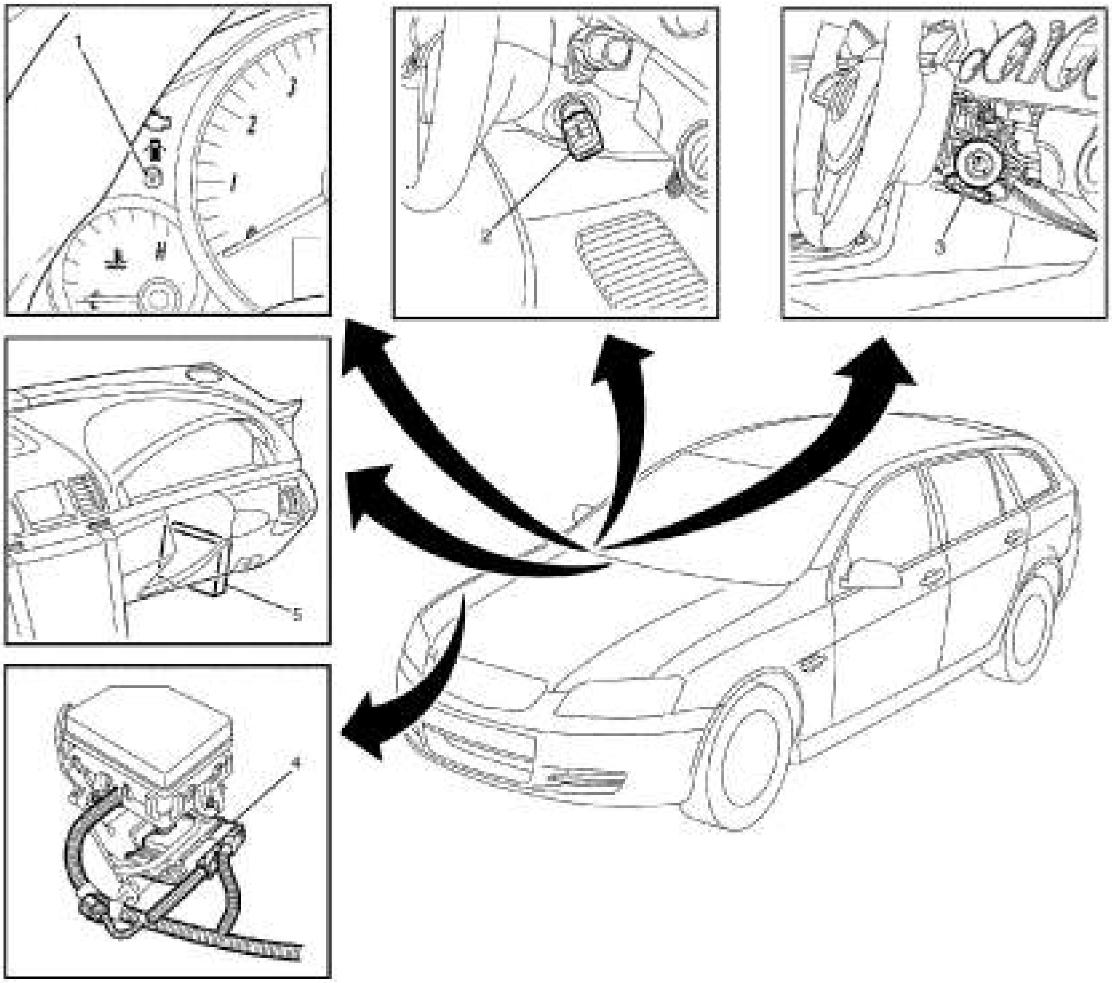
Security Warning Lamp, Ignition key (Transponder), Theft Deterrent Module (TDM), Engine Control Module (ECM) and Body Control Module (BCM).



(1) Security Warning Lamp
(2) Ignition Key (Transponder)
(3) Theft Deterrent Module (TDM)
(4) Engine Control Module (ECM)
(5) Body Control Module (BCM)

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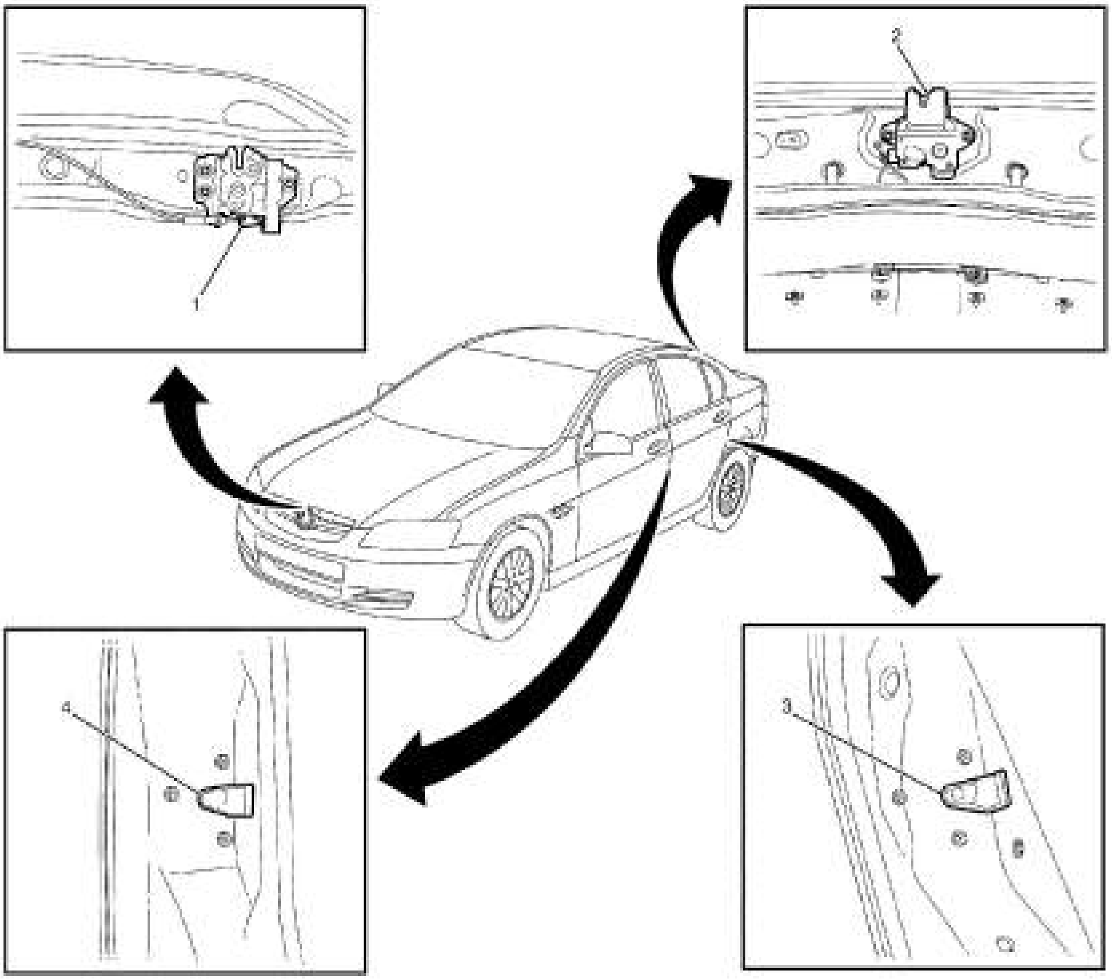
Hood Latch Assembly, Trunk Latch Assembly, Front Door Latch Assembly and Rear Door Latch Assembly



(1) Hood Latch Assembly

(2) Trunk Latch Assembly

(3) Front Door Latch Assembly

(4) Rear Door Latch Assembly

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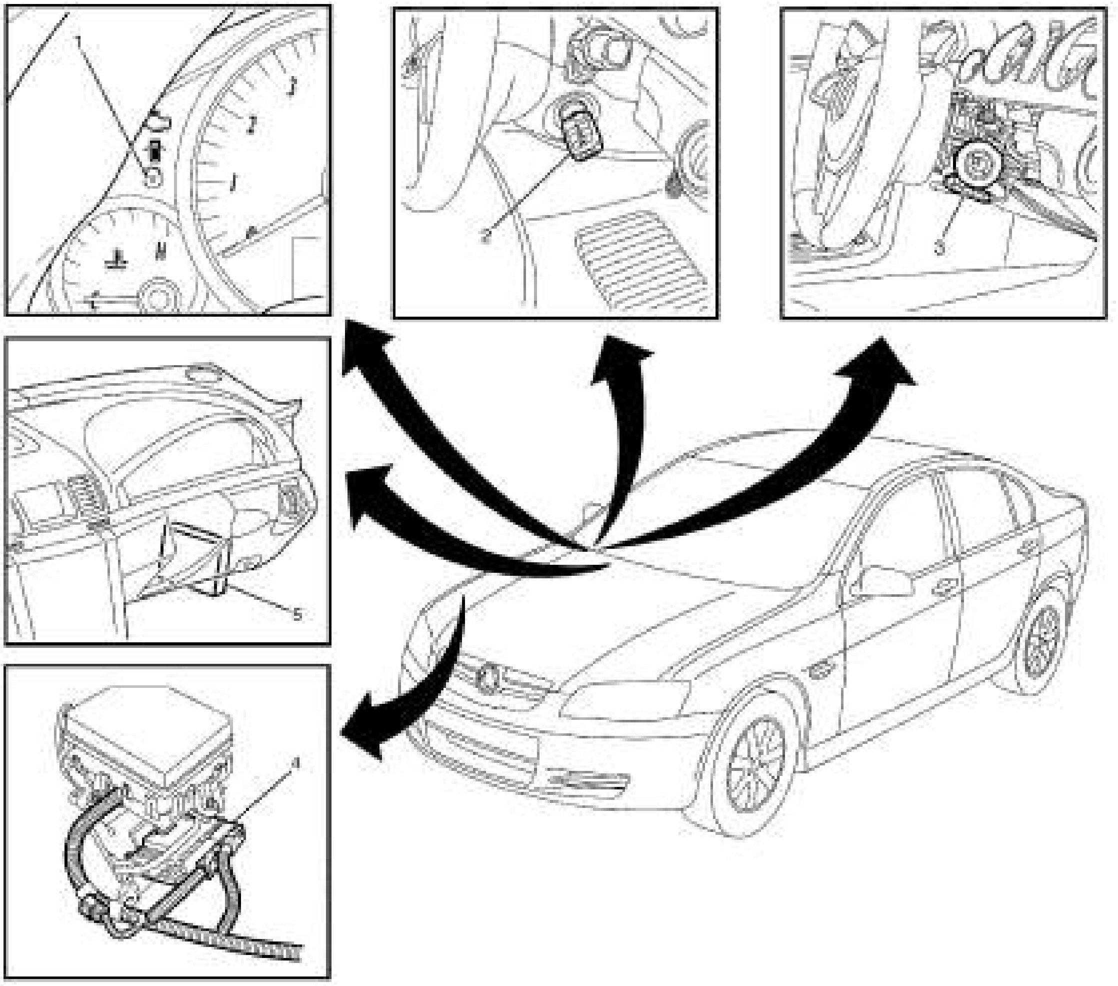
Security Warning Lamp, Ignition key (Transponder), Theft Deterrent Module (TDM), Engine Control Module (ECM) and Body Control Module (BCM)



(1) Security Warning Lamp

(2) Ignition Key (Transponder)

(3) Theft Deterrent Module (TDM)

(4) Engine Control Module (ECM)

(5) Body Control Module (BCM)

Diagnostic Starting Point - Theft Deterrent

Begin the system diagnosis with the Diagnostic System Check - Vehicle . The Diagnostic System Check will provide the following information:

- The identification of the control modules which command the system
- The ability of the control modules to communicate through the serial data circuit
- The identification of any stored diagnostic trouble codes (DTCs) and their status

The use of the Diagnostic System Check will identify the correct procedure for diagnosing the system and where the procedure is located.

DTC B0983

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B0983 00: Security System Indicator 2 Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Security Indicator Control	B0983	B0983	B0983	--

Circuit/System Description

The security indicator is controlled by the body control module (BCM) based on commands from the immobilizer system or the content theft deterrent (CTD) system. With the ignition OFF, the security indicator is commanded by the CTD system. With the ignition ON, the security indicator is commanded by the immobilizer system.

The security indicator is located in the instrument panel cluster (IPC) and is supplied B+ at all times. When the immobilizer or CTD system requests the indicator be commanded ON, the BCM grounds the security indicator control circuit, illuminating the indicator.

Conditions for Running the DTC

The security indicator is commanded ON.

Conditions for Setting the DTC

The BCM detects a short to voltage, short to ground, or an open/high resistance on the security indicator control circuit.

Action Taken When the DTC Sets

The security indicator is disabled.

Conditions for Clearing the DTC

- A current DTC will clear when the condition for setting the DTC is no longer present.
- A history DTC will be cleared after 100 malfunction-free ignition cycles.

Reference Information

Schematic Reference

Theft Deterrent System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Content Theft Deterrent (CTD) Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Arm the CTD system. The security indicator should illuminate and/or flash during the arming sequence.

Circuit/System Testing

1. Ignition OFF, disconnect the X3 harness connector at the BCM.
2. Ignition ON, verify the security indicator is not illuminated.
   If the security indicator is illuminated, test the control circuit terminal 7 for a short to ground. If the circuit tests normal, replace the IPC.
3. Install a 10A fused jumper wire between the control circuit terminal 7 and ground. Verify the security indicator is illuminated.
   If the security indicator is not illuminated, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the IPC.
4. If all circuits test normal, replace the BCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for BCM or IPC replacement, setup, and programming

Symptoms - Theft Deterrent

Important: The following steps must be completed before using the symptom tables.

1. Perform the Diagnostic System Check - Vehicle before using the symptom tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to Content Theft Deterrent (CTD) Description and Operation.

Visual / Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the Keyless Entry System. Refer to Checking Aftermarket Accessories.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Content Theft Deterrent Malfunction
- Security Indicator Malfunction
- Theft Deterrent Alarm Malfunction

Content Theft Deterrent Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit/System Description

The content theft deterrent (CTD) system is a software based system in which the body control module (BCM) actively monitors certain inputs to determine if unauthorized vehicle access is being attempted. Based on inputs such as the door ajar switches, the rear compartment ajar switch, and the hood ajar switch, the BCM determines whether a CTD alarm is warranted. If unauthorized access is being detected, the BCM will pulse the vehicle horn and flash the turn signals as a means of theft deterrence.

Reference Information

Schematic Reference

Theft Deterrent System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Content Theft Deterrent (CTD) Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Individually open and close each vehicle door while observing the door ajar

indicator/message. The indicator/message should accurately transition between the door ajar and door closed state when each door is opened and closed.

If the door ajar indicator/message does not properly transition when each door is opened and closed, refer to Door Ajar Indicator Malfunction.

2. Completely lower the driver door window and close all vehicle doors.
3. Ignition OFF, arm the CTD system using the keyless entry system by pressing the transmitter LOCK button twice. Verify the scan tool CTD Status parameter displays Armed.

   If not the specified value, refer to Keyless Entry System Malfunction.
4. Without disarming the system, reach in through the open driver window, unlock and open the driver door. Verify the scan tool Content Theft Mode parameter displays False.

   If not the specified value, replace the BCM.
5. With the door open, verify the vehicle horn is pulsing and the exterior lamps are flashing.

   If the horn is not pulsing, refer to Horns Malfunction.

   If the exterior lights are not flashing, refer to Turn Signal Lamps and/or Indicators Malfunction.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for BCM replacement, setup and programming

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Safety and Security | Theft Deterrent | Diagnostic Information and Procedures | **Document ID: 2014545**

Tilt Sensor Function Inoperative (Genuine Accessory)

Diagnostic Fault Information

Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.

Circuit/System Description

This diagnostic procedure should be used in the case of the following: The alarm has been armed, a 30 second period has elapsed to enable the alarm system to complete the full arming cycle and the alarm siren does not sound when the vehicle inclination angle is changed. The alarm module registers the current vehicle inclination when the alarm system is armed. If the inclination angle of the vehicle is changed while the alarm system is in an armed state, then the alarm siren should sound. The tilt feature inoperative may be caused by the following:

- Tilt sensor not mounted securely.
- Tilt sensor incorrectly connected.
- Short circuit to ground or incorrect function of the disable switch.

Reference Information

Schematic Reference

Theft Deterrent System Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Circuit/System Testing

Tilt Sensor not Securely Mounted

1. Locate the tilt sensor mounting bolts.
2. Ensure that the bolt holding the mounting bracket is tightened to 6 Nm.
3. Ensure that the plastic case of the tilt sensor is firmly attached to the mounting bracket.
4. Ensure that the harness connector is firmly connected to the tilt sensor.

Tilt Sensor Incorrectly Connected

1. Ensure that the harness connecter terminal 2 is vacant.
2. Test for less than 1.0 ohm of resistance between the tilt sensor harness connector terminal 4 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Connect the alarm module harness connector and from inside the vehicle, enable the alarm system with the remote transmitter key. Test for 4.8-5.2 volts between the tilt sensor 5-volt reference circuit terminal 1 and ground.

   If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance.

   If greater than the specified range, test the 5-volt reference circuit for a short to voltage.
4. Disconnect the alarm module harness connector and test for less than 1.0 ohm of resistance between the alarm module harness connector terminal 4 and the tilt sensor harness connector terminal 3

   If greater than the specified range, test the circuit for an open/high resistance.
5. Test for infinite resistance between the alarm module harness connector terminal 4 and ground.

   If not the specified value, replace the alarm module harness.
6. Replace the tilt sensor and test the alarm operation.

   If alarm system is still inoperative, replace the alarm module.

Short Circuit to Ground or Incorrect Function of the Disable Switch

1. Ignition OFF, alarm module connector and disable switch disconnected.
2. Test for infinite resistance between the alarm module harness connector terminal 11 and ground.

   If not the specified value, replace the alarm module harness.
3. Connect the disable switch.
4. While pressing the disable switch button, test for less than 1.0 ohm resistance between the alarm module harness connector terminal 11 and ground.

   If not the specified value, replace the disable switch.
5. Release the disable button and test for infinite resistance between the alarm module harness connector terminal 11 and ground.

   If not the specified value, replace the disable switch.

Repair Instructions

For component removal and installation refer to the accessory fitting instructions.

Ultrasonic Sensor Function Inoperative (Genuine Accessory)

Diagnostic Fault Information

Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.

Circuit/System Description

After the alarm system has been armed, causing movement inside the cabin of the vehicle, will cause the alarm siren to be activated. The alarm movement detection feature consists of two ultrasonic sensors and an ultrasonic module. The one sensor transmits an ultrasonic signal and the other sensor receives the ultrasonic signal. When there is a distortion of the ultrasonic sound waves, the ultrasonic module will interpret this as movement. The ultrasonic module will relay this information to the alarm module which in turn will activate the siren. Inoperative ultrasonic function can be caused by the following:

- Ultrasonic sensor sensitivity set too low.
- Ultrasonic sensor wiring damaged.
- The ultrasonic sensors incorrectly connected to the ultrasonic module.
- Short circuit to ground or incorrect function of the disable switch.
- Incorrect or poor wiring connections between the alarm module and the body control module.
- Tilt sensor incorrectly connected to the alarm module

Reference Information

Schematic Reference

Theft Deterrent System Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Circuit/System Testing

Ultrasonic Sensor Sensitivity Set Too Low

1. Ignition OFF, locate the ultrasonic module sensitivity adjustment screw.
2. Using a suitable flat blade screwdriver, turn the ultrasonic sensitivity adjustment screw until the marker indicates a higher value. A setting of between 2 and 3 is recommended (do not set to a value of 1).

   Function test the alarm ultrasonics before reassembling the vehicle. Adjust the ultrasonic sensitivity if further adjustment is necessary.

Ultrasonic Sensor Wiring Damaged

1. Locate the ultrasonic sensor wiring.
2. Inspect the ultrasonic sensors harness routing, ensuring that the cables are not pinched or damaged.
3. Inspect the ultrasonic sensor connectors at the ultrasonic module for damage.

Ultrasonic Sensors Incorrectly Connected to the Ultrasonic Module

1. Locate the 2-terminal connector socket on the ultrasonics module marked 'RED'. Ensure that one of the wires that is on the plug connector that connects to the socket marked 'RED' is in fact RED.
2. Locate the 2-terminal connector socket on the ultrasonics module marked 'BLACK'. Ensure that one of the wires that is on the plug connector that connects to the socket marked 'BLACK' is either BLACK or WHITE.
3. Ensure that the 4-terminal connector is firmly connected to the centre location on the ultrasonics module.

Short Circuit to Ground or Incorrect Function of the Disable Switch

1. Ignition OFF, alarm module connector and disable switch disconnected.
2. Test for infinite resistance between the alarm module harness connector terminal 11 and ground.

   If not the specified value, replace the alarm module harness.
3. Connect the disable switch.
4. While pressing the disable button, test for less than 1.0 ohm resistance between the alarm module harness connector terminal 11 and ground.

   If not the specified value, replace the disable switch.
5. Release the disable button and test for infinite resistance between the alarm module harness connector terminal 11 and ground.

   If not the specified value, replace the disable switch.

Incorrect or Poor Wiring Connections Between the Alarm Module and the Body Control Module

1. Ignition OFF, alarm module connector disconnected.
2. Locate the body control module (BCM) connectors X5 and X6
3. Test for less than 1 ohm resistance between the BCM harness connector terminal X6-16 and the alarm module harness connector terminal 8.

   If not the specified value, replace the harness.
4. Test for less than 1 ohm resistance between the BCM harness connector terminal X5-18 and the alarm module harness connector terminal 2.

   If not the specified value, replace the harness.

Tilt Sensor Incorrectly Connected to the Alarm Module

If the tilt sensor is incorrectly connected to the alarm module the alarm module may not initialize. Refer to the diagnostic procedure for the tilt sensor wiring.

Repair Instructions

For component removal and installation refer to the accessory fitting instructions.

Security Indicator Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Security Indicator Control	2	1	1	--
1. Security Indicator Inoperative 2. Security Indicator ON At All Times				

Circuit/System Description

The security indicator is controlled by the body control module (BCM) based on commands from the immobilizer system or the content theft deterrent (CTD) system. With the ignition OFF, the security indicator is commanded by the CTD system. With the ignition ON, the security indicator is commanded by the immobilizer system.

The security indicator is located in the instrument panel cluster (IPC) and is supplied B+ at all times. When the immobilizer or CTD system requests the indicator be commanded ON, the BCM grounds the security indicator control circuit, illuminating the indicator.

Reference Information

Schematic Reference

Theft Deterrent System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Content Theft Deterrent (CTD) Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Arm the CTD system. The security indicator should illuminate and/or flash during the arming sequence.

Circuit/System Testing

1. Ignition OFF, disconnect the X3 harness connector at the BCM.
2. Ignition ON, verify the security indicator is not illuminated.
   If the security indicator is illuminated, test the control circuit terminal 7 for a short to ground. If the circuit tests normal, replace the IPC.
3. Install a 10A fused jumper wire between the control circuit terminal 7 and ground. Verify the security indicator is illuminated.
   If the security indicator is not illuminated, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the IPC.
4. If all circuits test normal, replace the BCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for BCM or IPC replacement, setup, and programming

Theft Deterrent Alarm Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil B+	1	1	--	--
Relay Switch B+	1	1	--	--
Relay Coil Control	1	1	1	--
Relay Switch Control	1	1	2	--
1. Theft Deterrent Alarm Siren always OFF 2. Theft Deterrent Alarm Siren always ON				

Circuit/System Description

The alarm siren monitors the alarm enable signal circuit and will sound an audible alarm when the body control module indicates a event has occurred that requires an alarm. The alarm siren also monitors its own voltage circuits independent of the body control module. In the event of the interruption of voltage to the alarm siren, the alarm will sound.

Reference Information

Schematic Reference

Theft Deterrent System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Content Theft Deterrent (CTD) Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, command the Alarm Siren ON and OFF with a scan tool. Listen and feel for the relay to turn ON and OFF.

Circuit/System Testing

1. Ignition OFF, disconnect the horn relay.
2. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 87 and ground.

   If the test lamp illuminates, test the control circuit for a short to voltage.
3. Verify that a test lamp illuminates between the B+ circuit terminal 30 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the horn relay.
4. Verify that a test lamp illuminates between the B+ circuit terminal 85 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the horn relay.
5. Disconnect the harness connector at the alarm siren.
6. Test for less than 5 Ω between the ground circuit terminal A X2 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
7. Connect the harness connector at the alarm siren.
8. Connect a 15 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87. Verify the alarm siren is activated.

   If the alarm siren does not activate, test the control circuit for an open/high resistance.If the circuit tests normal and the control circuit fuse is open, test the control circuit for a short to ground. If the circuit tests normal, test or replace the alarm siren.
9. Connect a test lamp between the B+ circuit terminal 86 and the control circuit terminal 85.
10. Command the Alarm Siren ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

    If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the body control module.

    If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the body control module.
11. If all circuits test normal, test or replace the horn relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the content theft relay.

2. Test for 60 - 120 ohms between terminals 85 and 86.

   If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87

   If not the specified value, replace the relay.
4. Install a 15A fused jumper wire between relay terminal 85 and 12V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.

   If greater than the specified range, replace the relay.

Repair Instructions

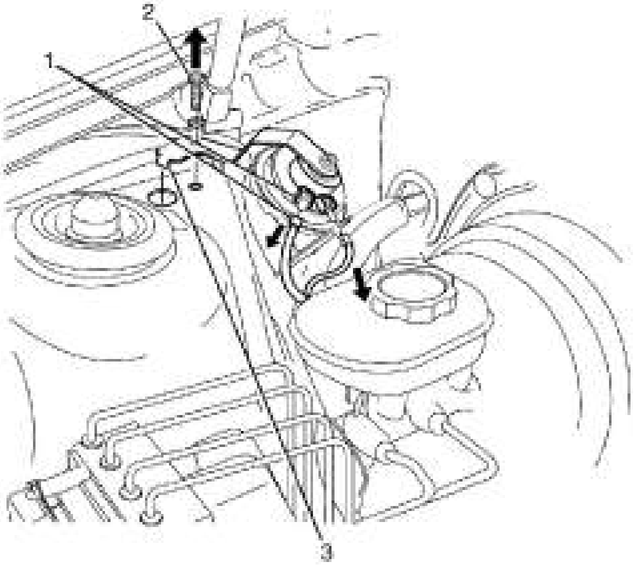
Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Theft Deterrent Alarm Replacement
- for BCM replacement, setup, and programming

Theft Deterrent Alarm Replacement (RHD)

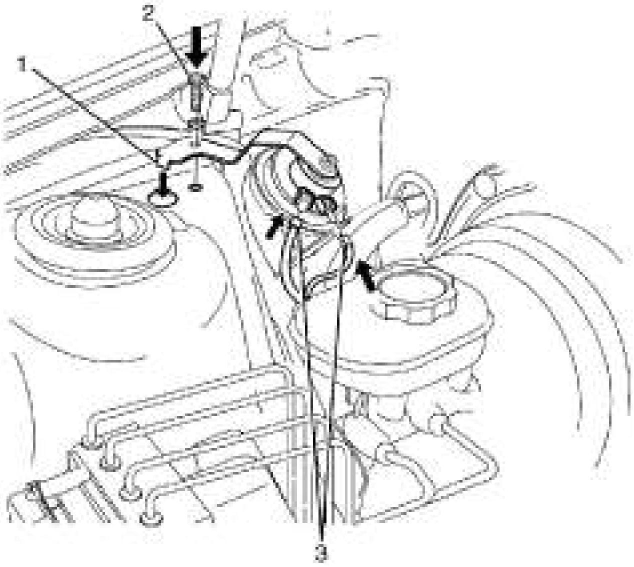
Removal Procedure

1. Open the Hood.



2. Disconnect the electrical connectors (1) from the theft deterrent horn assembly.
3. Remove the theft deterrent horn assembly to vehicle body retaining bolt (2).
4. Pull the theft deterrent horn assembly (3) upward in order to remove it from the vehicle.

Installation Procedure



1. Align the theft deterrent horn assembly in original position. Be sure to align "tang" (1) in the correct position.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the theft deterrent horn to vehicle body retaining bolt (2).

   Tighten
   Tighten the bolt to 8 N·m (6 lb ft).

3. Connect the electrical connectors (3) to the theft deterrent horn assembly.
4. Close the hood.

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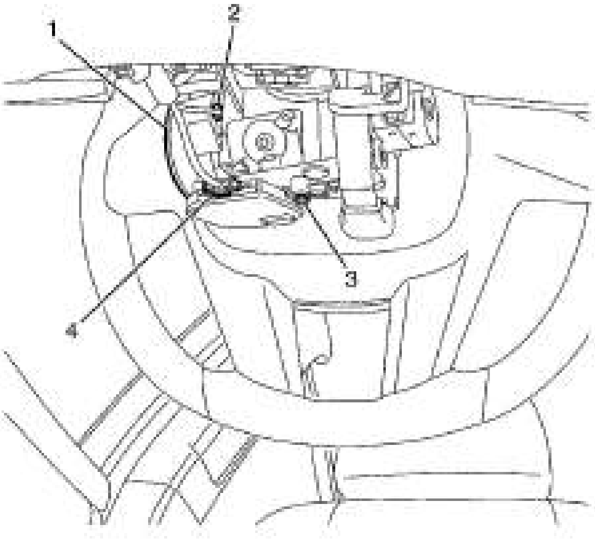
Theft Deterrent Module Replacement (RHD)

Removal Procedure

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .

   Caution: Refer to SIR Caution in the Preface section.

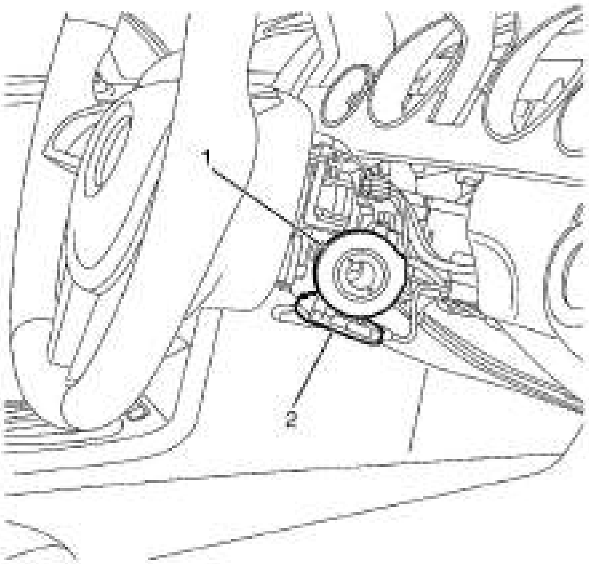
2. Disable the SIR system. Refer to SIR Disabling and Enabling .
3. Remove the steering column trim covers. Refer to Steering Column Trim Covers Replacement .



4. Disconnect the theft deterrent module (TDM) electrical connector (4).

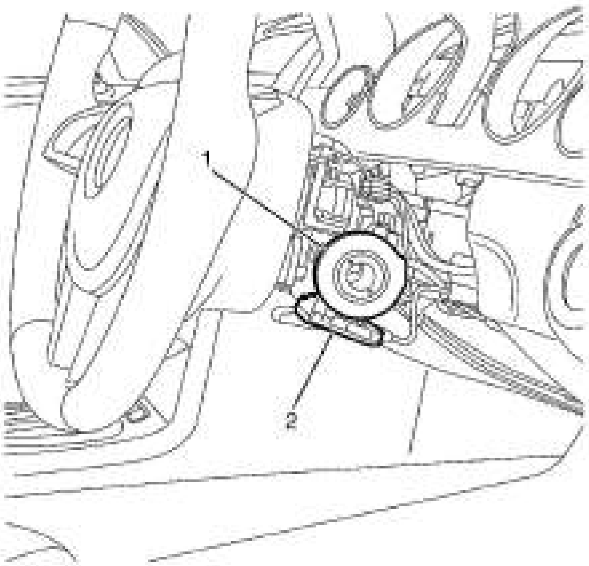
   Important: Rotate the ignition lock cylinder lamp socket counter-clockwise to disengage the locking tangs and pull to detach the ignition lock cylinder lamp socket (2) from the TDM.

5. Detach the ignition lock cylinder lamp socket (2) from the TDM (1).
6. Remove the TDM to steering column assembly retaining screw (3).



7. Remove the TDM (1) from the steering column assembly (2).

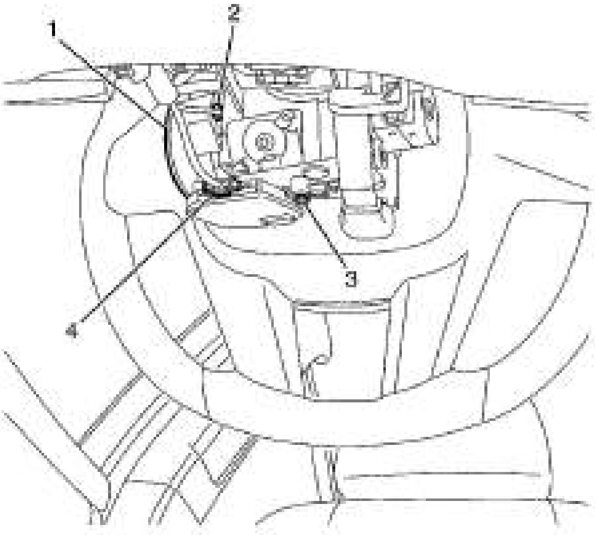
Installation Procedure



Important: Make sure the locating pin on the steering column assembly (2) is aligned with the TDM (1).

1. Install the TDM (1) to the steering column assembly (2).

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the TDM to steering column assembly retaining screw (3).

   Tighten
   Tighten the screw to 3 N·m (27 lb in).

   Important: Rotate the ignition lock cylinder lamp socket clockwise to engage the locking tangs and attach the ignition lock cylinder lamp socket (2) to the TDM.

3. Attach the ignition lock cylinder lamp socket (2) to the TDM (1).
4. Connect the theft deterrent module (TDM) electrical connector (4).
5. Install the steering column trim covers. Refer to Steering Column Trim Covers Replacement .
6. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
7. Enable the SIR system. Refer to SIR Disabling and Enabling .
8. Program the TDM. Refer to Theft Deterrent Control Module Programming and Setup .

Content Theft Deterrent (CTD) Description and Operation

The content theft deterrent (CTD) system, when armed, is designed to deter vehicle content theft by pulsing the horns and exterior lamps for approximately 30 seconds when an unauthorized vehicle entry is detected. However, the CTD System does not affect engine starting.

An unauthorized entry can be any of the following with the CTD System armed:

- When the rear compartment has been opened without the use of the keyless entry system.
- When the hood has been opened without disarming the CTD system.
- When any door is opened without being unlocked using the keyless entry transmitter.

The components of the system are:

- The body control module
- The door ajar switches
- The hood ajar switch
- The rear compartment lid ajar switch

Arming the CTD System

Important: The content theft deterrent (CTD) system can be armed with the windows open.

Use the following procedure in order to arm the system:

1. Turn OFF the ignition.
2. Exit the vehicle.
3. Lock the doors with either the LOCK button on the transmitter or by the driver door external key cylinder lock.
4. If the doors are open when locking is requested, a warning of 5 horn chirps will occur.
5. The system will arm approximately 30 seconds from the time that the system has entered the locked state. When the indicator transitions to flashing slowly, the system is armed.

Disarming an Armed System / Silencing an Alarm

If system arming has been requested by the keyless entry transmitter, it must be disarmed.

Important: Manually unlocking the doors does not disable the CTD armed mode. Also, disconnecting the battery or pulling fuses does not disable the armed mode, as the body control module (BCM) stores the CTD status in memory.

To disarm the CTD system perform one of the following:

1. Press the UNLOCK button on the keyless entry transmitter.
2. Insert a valid key into the ignition and start the vehicle.

Simulated Armed Mode

If a vehicle remains disarmed with all doors and rear compartment lid closed for an extended time period (60 seconds), the CTD system will enter Simulated Armed Mode. In Simulated Armed Mode, the system activates the alarm indicator to replicate the armed mode by flashing slowly. However if the power mode changes or if any doors or the rear compartment lid are opened, the CTD system will turn off the lamp and not activate the alarm.

CTD Circuit Description

The following is a description of each component used in the content theft deterrent (CTD) system:

Body Control Module (BCM)

The CTD system is an internal function of the body control module (BCM) which utilizes serial data and various switch inputs to perform CTD functions. When the BCM detects an unauthorized entry, it activates the horns and exterior lamps.

When the BCM detects an unauthorized entry from the drivers door, the BCM will first enter the pre-alarm mode. The pre-alarm mode will command short chirps from the horn. If after 10 seconds the unauthorized entry still exists, the BCM will transition to the alarm mode. The horn and lamps will pulse for 30 seconds. Following the 30 second alarm period is a 5 second time-out. The CTD system will then re-arm.

Door Ajar Switches

The CTD system uses the integrated door ajar switches in the door latches as one method to activate the alarm. The BCM monitors all door ajar switches via a discrete input from each door ajar switch. If the BCM receives a ground signal from a door ajar switch when the CTD system is armed, the BCM activates the alarm.

Inputs

The BCM monitors the following inputs:

- The driver and passenger door ajar switches
- The hood ajar switch
- The rear compartment lid ajar switch
- The transmitter LOCK/UNLOCK buttons; an internal function of the BCM
- The Passkey status--The BCM uses the Passkey status for disarming the system or silencing and alarm when the correct vehicle key is used to start the vehicle.

Outputs

The BCM controls the following:

- The horn relay
- The exterior lights

Theft Systems Description and Operation

The vehicle theft deterrent (VTD) system functions are provided by the theft deterrent module (TDM) and the engine control module (ECM). When an ignition key is inserted into the ignition lock cylinder and the ignition is switched ON, the transponder embedded in the head of the key is energized by the exciter coil surrounding the ignition lock cylinder. This exciter coil is part of the TDM. The energized transponder transmits a signal that contains its unique value, which is received by the TDM. The TDM then compares this value to a value stored in memory. If the ignition key is recognised as valid, the TDM performs a module substitution check where the identities of the instrument panel cluster (IPC), body control module (BCM), infotainment unit (IRC), rear seat entertainment (RSE) and sensing diagnostic module (SDM) control units are checked. If they are recognised as valid components, the TDM will send the fuel enable password to the ECM via the BCM using the GMLAN. If the transponders unique value is incorrect or module substitution has been detected, the TDM will send the fuel disable password to the ECM. It is important to note that while it is referred to as the fuel enable/disable password, the vehicles starter may also be disabled, preventing engine cranking.

When the ECM receives the TDM fuel enable password, the ECM will challenge the password. The ECM sends this challenge back to the TDM via the BCM using the GMLAN. Both the ECM and TDM perform a calculation on this challenge. If the calculated response from the TDM equals the calculation performed by the ECM, the ECM will allow vehicle starting.

The components of the VTD system are as follows:

- Body Control Module (BCM)
- Theft Deterrent Module (TDM)
- Engine Control Module (ECM)
- Ignition key (Transponder)
- Security warning lamp

Theft Deterrent Module (TDM)

Vehicles with steering column mounted ignition switches have the exciter integral with the theft deterrent module (TDM), which is located within the steering column. The TDM can learn up to 10 keys (transponder values).

The TDM uses the following inputs: battery voltage, ignition switched voltage and ground circuit. The theft deterrent control module uses the following outputs: password exchange and challenge/response with the engine control module (ECM).

When an ignition key is inserted into the ignition lock cylinder and the ignition is switched to accessories (ACC), the transponder embedded in the head of the key is energized by the exciter coils surrounding the ignition lock cylinder. The energized transponder transmits a signal that contains its unique value, which is received by the theft deterrent control module. The theft deterrent control module then compares this value to the learned key code stored in memory. If the ignition key is recognised as valid, the TDM performs a module substitution check where the identities of the instrument panel cluster (IPC), body control module (BCM), infotainment unit (IRC), rear seat entertainment (RSE) and sensing diagnostic module (SDM) control units are checked. The theft deterrent control module then performs one of the following functions:

- If the transponder value and control units match the values and identification stored in the TDM memory, the TDM will send the fuel enable message to the ECM via the BCM using the GMLAN.
- If the transponders unique value does not match either or both the values and/or identification stored in the TDM memory, the TDM will send the fuel disable message to the ECM via the BCM using the GMLAN.
- If the TDM is unable to measure the ignition key transponder value, the TDM will not send any messages to the ECM.

Engine Control Module (ECM)

When the engine control module (ECM) receives the theft deterrent module (TDM) fuel enable password, the ECM will challenge the password. The ECM sends this challenge back to the TDM via the serial data circuit. Both the ECM and TDM perform a calculation on this challenge. If the calculated response from the TDM equals the calculation performed by the ECM, the ECM will allow vehicle starting.

The ECM will disable vehicle starting if any of the following conditions occur:

- The fuel enable password is invalid.
- The fuel disable password is sent by the TDM.
- No passwords are received--There is no communication with the TDM.
- The TDM calculated response to the challenge does not equal the calculation performed by the ECM.
- Module substitution has occurred.

The Ignition Key (Transponder)

The ignition key for Passkey III+ (PK3+) equipped vehicles is a standard ignition key with a transponder located in the plastic head of the key. The transponder value is fixed and unable to be changed. The vehicle theft deterrent (VTD) system uses the ignition key transponder value to determine if a valid ignition key is being used to start the vehicle. There are approximately 3 trillion possible transponder values. There are no visible electrical contacts.

Ignition keys have a black plastic head for full access operation of the vehicle. Ignition keys perform the following functions:

- Start the vehicle.
- Lock/unlock all of the door locks and rear compartment.
- Lock/unlock all of the storage compartments.

Module Substitution Detection

Module substitution detection is achieved by building an immobiliser chain made out of five control units which contain the VIN. When the ignition is switched to the ACC position, the TDM will request and compare the identities of each control unit to the identity stored in the TDM memory. This is called a module substitution check.

The following control units are in the immobiliser chain:

- Instrument panel cluster (IPC)
- Body control module (BCM)
- Infotainment unit (IRC)
- Rear seat entertainment (RSE)
- Sensing diagnostic module (SDM)

Two out of the five control units (IPC, BCM, IRC, RSE or SDM), are required to respond with the correct VIN to allow vehicle starting. Therefore, if only one unit is missing or reports with an incorrect VIN, vehicle starting is still enabled.

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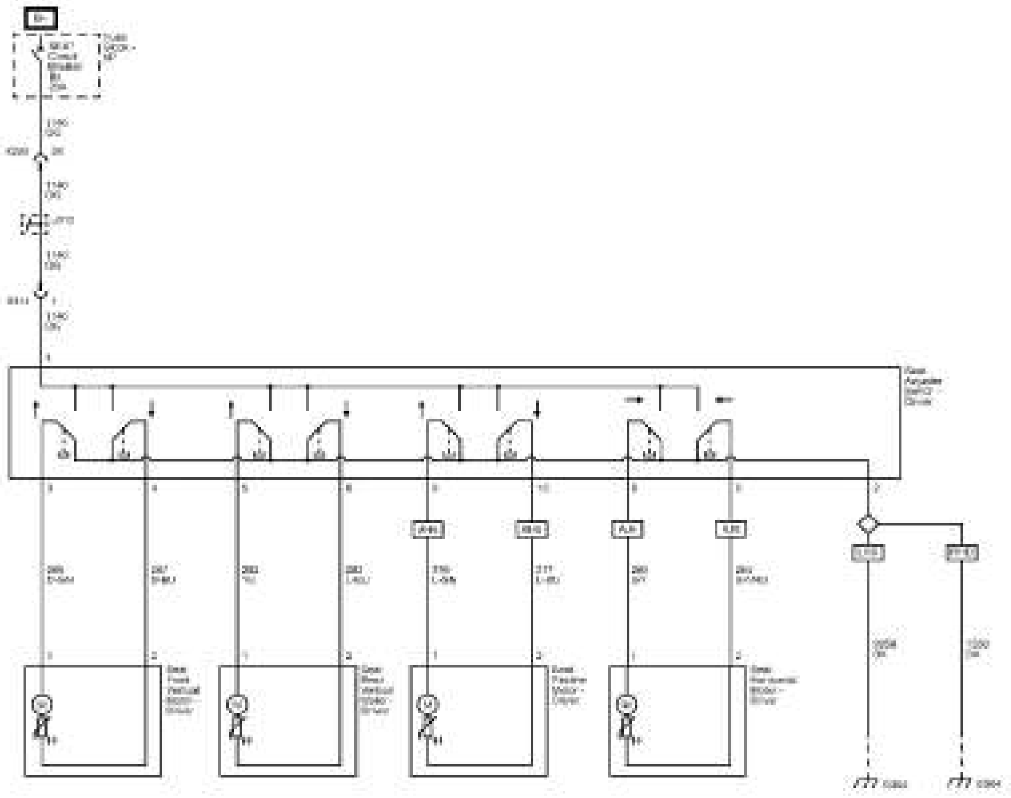
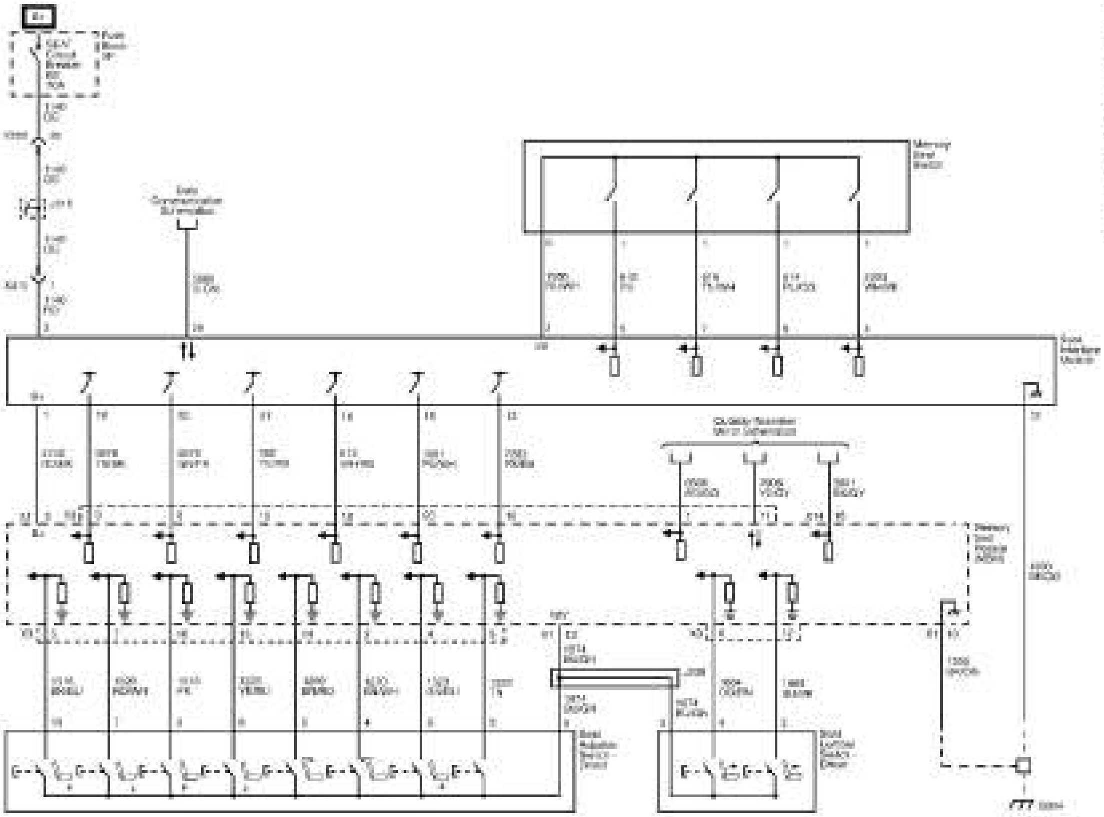
AH5 / AH6 / AJ6

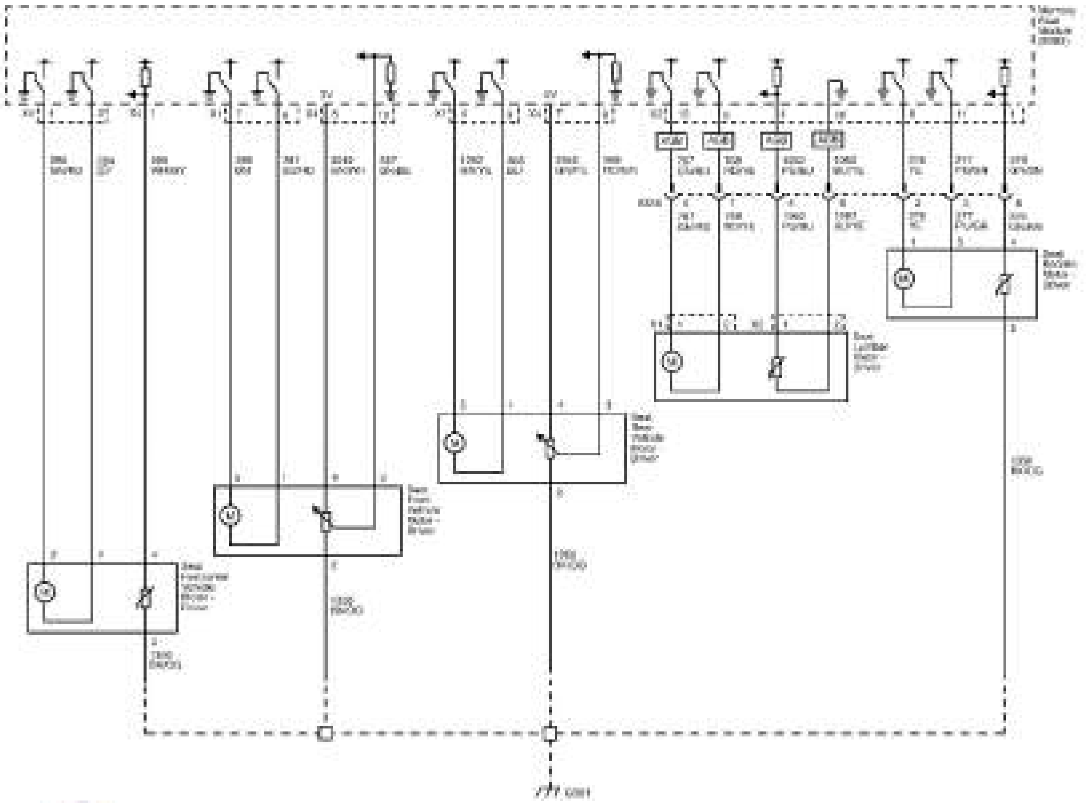

B+
Seat Adjuster Switch - Driver
Seat Front Vertical Motor - Driver
Seat Rear Vertical Motor - Driver
Seat Recline Motor - Driver
Seat Horizontal Motor - Driver
M
M
M
M

Memory Seat Controls (AG3 / AGB)


B+
Fuse Block - IP
SEAT Circuit Breaker
Data Communication Schematics
Memory Seat Switch
Seat Interface Module

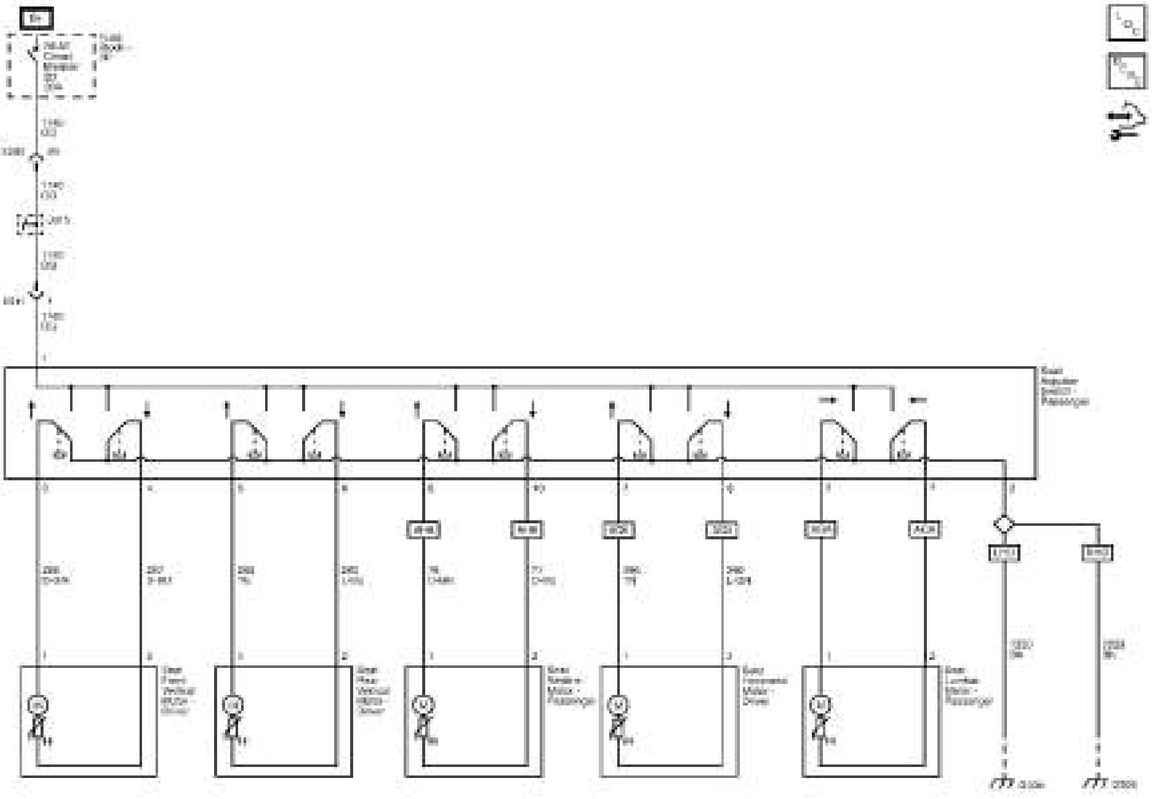
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Seats | Power Seats | Schematic and Routing Diagrams | **Document ID: 2154628**

Seat Motors and Position Sensors (AG3 / AGB)



2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Seats | Power Seats | Schematic and Routing Diagrams | **Document ID: 2154702**

Passenger Seat Schematics



Diagnostic Starting Point - Seats

Begin the system diagnosis with the Diagnostic System Check - Vehicle. The Diagnostic System Check will provide the following information:

- The identification of the control modules which command the system.
- The ability of the control modules to communicate through the serial data circuit.
- The identification of any stored diagnostic trouble codes (DTCs) and their status.

The use of the Diagnostic System Check will identify the correct procedure for diagnosing the system and where the procedure is located.

DTC B0997

DTC Descriptor

DTC B0997 31: Memory Seat and Mirror Module Checksum Error

Diagnostic Fault Information

Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.

Circuit / System Description

The EEPROM (Electrically Erasable Programmable Read Only Memory) is part of the printed circuit board housed within the memory seat module (MSM). It stores variables required for the operation of the power seat system.

DTC B0997 will set if the EEPROM checksum is incorrect. The testing of the EEPROM checksum occurs every time the ignition is turned on. The DTC is reset when the EEPROM checksum is tested as being correct. The DTC is logged as a History DTC.

Conditions for Running the DTC

The MSM runs the program to detect an internal fault or compatibility concern when power up is commanded. The only requirements are voltage and ground. This program runs even if the voltage is out of the valid operating range.

Conditions for Setting the DTC

The MSM internal EEPROM has failed or is corrupt.

Action Taken When the DTC Sets

The system will set the DTC and disable itself.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- The DTC can be cleared using a scan tool.

Reference Information

Electrical Information Reference

- Circuit Testing .
- Connector Repairs .

- Testing for Intermittent Conditions and Poor Connections .
- Wiring Repairs .

Scan Tool Reference

Control Module References

Circuit / System Testing

1. Verify that no other DTCs are not set.
   If any other DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle Diagnostic Trouble Code (DTC) List.
2. Using a scan tool, select the DTC display function.
   If DTC B0997 31 is set to current, replace the MSM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Memory Seat Control Module Replacement .

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DTC B1370

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B1370 03: MSM Wake Up Circuit Short to Ground

DTC B1370 07: MSM Wake Up Circuit Short to Battery

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
MSM Wake-Up Signal	B1370 03	1	B1370 07	--

1. Power seats and memory recall functions are inoperative

Circuit/System Description

Whenever the memory seat module (MSM) is in the sleep mode, the seat interface module (SIM) must apply a voltage signal through the wake-up signal circuit to the MSM before power seat or memory functions are allowed.

Conditions for Running the DTC

The MSM is active.

Conditions for Setting the DTC

BB1370 03

The SIM senses that the MSM wake-up control circuit is shorted to ground.

BB1370 07

The SIM senses that the MSM wake-up control circuit is shorted to B+.

Action Taken When the DTC Sets

Power seats and memory recall functions are disabled.

Conditions for Clearing the DTC

- The current DTC clears when the fault is no longer present.
- The history DTC will clear after 50 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Driver Seat Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Memory Seats Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X3 harness connector at the MSM.
2. Ignition ON, test for 8.5 - 10.5 V between the signal circuit terminal 10 and ground.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the SIM.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the SIM.
3. If all circuits test normal, replace the MSM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for SIM and MSM replacement, setup, and programming

DTC B1390, B1400, B1410, or B2765

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B1390 01: Button 1 Circuit Short to Battery

DTC B1400 01: Button 2 Circuit Short to Battery

DTC B1410 01: Button 3 Circuit Short to Battery

DTC B2765 01: Button M Circuit Short to Battery

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Seat Adjuster Memory Switch 12 Volt Reference	B3907 02, 1	1	--	--
Memory Seat Switch Signal 1	1	1	B1390 01	--
Memory Seat Switch Signal 2	1	1	B1400 01	--
Memory Seat Switch Signal 3	1	1	B1410 01	--
Memory Mirror Switch Signal M	1	1	B2765 01	1
1. Memory recall is inoperative				

Circuit/System Description

Reference voltage from the seat interface module (SIM) is supplied at all times to the memory seat switch. When a memory recall switch is pressed, reference voltage is applied through the switch contacts and the signal circuit to the SIM indicating the memory recall request. The SIM serves as a interface and applies a reference voltage through the appropriate memory signal circuit to the memory seat module (MSM) indicating the memory seat request. The MSM then commands the driver seat motors and the exterior mirrors to move to the appropriate seat and mirror positions stored in memory.

Conditions for Running the DTC

The MSM is active.

Conditions for Setting the DTC

B1390 01

The SIM will set this DTC if it senses that the memory 1 switch signal is active for more than 50 seconds.

B1400 01

The SIM will set this DTC if it senses that the memory 2 switch signal is active for more than 50 seconds.

B1410 01

The SIM will set this DTC if it senses that the memory 3 switch signal is active for more than 50 seconds.

B2765 10

The SIM will set this DTC if it senses that the memory M switch signal is active for more than 50 seconds.

Action Taken When the DTC Sets

The memory recall function for the particular memory button is disabled.

Conditions for Clearing the DTC

- The current DTC will clear when the switch circuit setting the DTC is no longer active.
- The history DTC will clear after 50 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Driver Seat Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Memory Seats Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool SIM Input parameters listed below while pressing the appropriate memory 1, 2, 3, and M switches. The readings should change between Inactive and Active.

- Button 1 Input Status
- Button 2 Input Status
- Button 3 Input Status
- Button M Input Status

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the memory seat switch.
2. Ignition ON, verify the scan tool SIM Input parameters listed below are Inactive:
    - Button 1 Input Status
    - Button 2 Input Status
    - Button 3 Input Status
    - Button M Input Status

   If not the specified value, test the appropriate signal circuit for a short to voltage. If the circuit tests normal, replace the SIM.
3. If all circuits test normal, test or replace the memory seat switch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the memory seat switch.
2. Test for infinite resistance between the 12 V reference terminal 6 and each signal terminal listed below with the switch in the open position:
    - Memory 1 terminal 1
    - Memory 2 terminal 2
    - Memory 3 terminal 3
    - Memory M terminal 4

   If not the specified value, replace the memory seat switch.
3. Test for less than 2 Ω between the 12 V reference terminal 6 and each signal terminal listed below with the appropriate switch in the closed position:
    - Memory 1 terminal 1
    - Memory 2 terminal 2

- Memory 3 terminal 3

  If greater than the specified range, replace the memory seat switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Driver Seat Adjuster Memory Switch Replacement
- Control Module References for SIM replacement, setup, and programming

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DTC B1565, B2755, B2760, or B3599

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B1565 00: Mirror DIP Button Stuck

DTC B2755 00: Memory Button 1 Stuck

DTC B2760 00: Memory Button 2 Stuck

DTC B3599 00: Memory Button 3 Stuck

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Memory Seat Switch 12 Volt Reference	1, 2	1, 2	--	--
Memory Mirror Dip Signal	1, 2	2	B1565 00	--
Memory Seat Signal 1	1, 2	1	B2755 00	--
Memory Seat Signal 2	1, 2	1	B2760 00	--
Memory Seat Signal 3	1, 2	1	B3599 00	--
Memory Mirror Switch Signal M	1, 2	2	B2765 01	--
Memory Seat Switch Signal 1	1, 2	1	B1390 01	--
Memory Seat Switch Signal 2	1, 2	1	B1400 01	--
Memory Seat Switch Signal 3	1, 2	1	B1410 01	--
1. Memory recall is inoperative 2. Memory mirror recall inoperative				

Circuit/System Description

Reference voltage from the seat interface module (SIM) is supplied at all times to the memory seat switch. When a memory recall switch is pressed, reference voltage is applied through the switch contacts and the signal circuit to the SIM indicating the memory recall request. The SIM serves as a interface and applies a reference voltage through the appropriate memory signal circuit to the memory seat module (MSM) indicating the memory seat request. The MSM then commands the driver seat motors and the exterior mirrors to move to the appropriate seat and mirror positions stored in memory.

Conditions for Running the DTC

The MSM is active.

Conditions for Setting the DTC

B1565 00

If the memory button M switch signal is active for greater than 60 seconds this DTC will set.

B2755 00

If the memory 1 switch signal is active for greater than 60 seconds this DTC will set.

B2760 00

If the memory 2 switch signal is active for greater than 60 seconds this DTC will set.

B3599 00

If the memory 3 switch signal is active for greater than 60 seconds this DTC will set.

Action Taken When the DTC Sets

The memory recall function for the particular memory button is disabled this DTC will set.

Conditions for Clearing the DTC

- The current DTC will clear when the switch circuit setting the DTC is no longer active.
- The history DTC will clear after 50 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Driver Seat Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Memory Seats Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool MSM Input parameters listed below while pressing the appropriate memory 1, 2, 3, and M switches. The readings should change between Not Pressed and Pressed.

- Memory 1 Button
- Memory 2 Button
- Memory 3 Button
- Memory M Button

Circuit/System Testing

1. Ignition OFF, disconnect the X3 harness connector at the MSM.
2. Connect a test lamp between the appropriate signal circuit listed below and ground:
   - Memory 1 terminal 9
   - Memory 2 terminal 8
   - Memory 3 terminal 19
   - Memory M terminal 19
3. Ignition ON, command the appropriate memory position listed below ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
   - Button 1 Input
   - Button 2 Input
   - Button 3 Input
   - Button M Input

   If the test lamp is always ON, test the signal circuit for a short to voltage. If the circuit tests normal replace the SIM.

   If the test lamp is always OFF, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal replace the SIM.
4. If all circuits test normal, replace the MSM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for SIM and MSM replacement, setup, and programming

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DTC B1735, B1740, B1745, B1750, B1755, B1760, B1815, or B1820

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

This diagnostic procedure supports the following DTCs:

DTC B1735 00: Front Vertical Up Switch Stuck

DTC B1740 00: Front Vertical Down Switch Stuck

DTC B1745 00: Rear Vertical Up Switch Stuck

DTC B1750 00: Rear Vertical Down Switch Stuck

DTC B1755 00: Horizontal Forward Switch Stuck

DTC B1760 00: Horizontal Back Switch Stuck

DTC B1815 00: Recline Up Switch Stuck

DTC B1820 00: Recline Down Switch Stuck

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Front Vertical Up Switch Signal	2	1	B1735 00, B1740 00, B1745 00, B1750 00, B1755 00, B1760 00, B1815 00, B1820 00	--
Front Vertical Down Switch Signal	2	1	B1735 00, B1740 00, B1745 00, B1750 00, B1755 00, B1760 00, B1815 00, B1820 00	--
Rear Vertical Up Switch Signal	2	1	B1735 00, B1740 00, B1745 00, B1750 00, B1755 00, B1760 00, B1815 00, B1820 00	--
Rear Vertical			B1735 00, B1740 00, B1745 00, B1750 00	

Down Switch Signal	2	1	B1755 00, B1760 00, B1815 00, B1820 00	--
Horizontal Forward Switch Signal	2	1	B1735 00, B1740 00, B1745 00, B1750 00, B1755 00, B1760 00, B1815 00, B1820 00	--
Horizontal Rearward Switch Signal	2	1	B1735 00, B1740 00, B1745 00, B1750 00, B1755 00, B1760 00, B1815 00, B1820 00	--
Recline Forward Switch Signal	2	1	B1735 00, B1740 00, B1745 00, B1750 00, B1755 00, B1760 00, B1815 00, B1820 00	--
Recline Rearward Switch Signal	2	1	B1735 00, B1740 00, B1745 00, B1750 00, B1755 00, B1760 00, B1815 00, B1820 00	--
1. Power seat inoperative 2. Scan Tool Does Not Communicate with Low Speed GMLAN Device				

Circuit Description

When the power seat switches are pressed, they send a 12 volt signal through the switch signal circuits to the memory seat module (MSM). The MSM then commands the driver seat motors to move in response to the switch signals.

Conditions for Running the DTC

The MSM must be powered and cannot have DTC B1327 Battery Positive Low as an active DTC for this DTC to set.

Conditions for Setting the DTC

- If a seat switch circuit continues to be active for 30 seconds after a motor controlled by that switch reaches the end of its travel, the switch will be considered shorted and the MSM will set the DTC.
- A short to voltage on a switch signal circuit.

Action Taken When the DTC Sets

- A motor output driven in response to a switch considered failed, is deactivated for both directions.
- All memory recall commands are ignored.
- The MSM will respond to any other switch signal that has not set a DTC.

Conditions for Clearing the DTC

- The current DTC will clear when the switch circuit setting the DTC is no longer active.
- The history DTC will clear after 50 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Driver Seat Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

- Power Seats System Description and Operation
- Memory Seats Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Memory Seat Module seat switch parameters while pressing the appropriate seat directional switches. The reading should change between Inactive and Active.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the seat adjuster switch.
2. Ignition ON, verify the scan tool seat switch parameters listed below are Inactive.
   - Front Vertical Switch
   - Rear Vertical Switch
   - Horizontal Switch
   - Recline Switch

   If not the specified value, test the appropriate signal circuit listed below for a short to voltage. If the circuit tests normal, replace the MSM.
   - Front vertical upward switch terminal 10
   - Front vertical downward switch terminal 7

- Rear vertical upward switch terminal 9
- Rear vertical downward switch terminal 8
- Horizontal forward switch terminal 3
- Horizontal rearward switch terminal 6
- Recline forward switch terminal 2
- Recline rearward switch terminal 4

3. If all circuits test normal, test or replace the seat adjuster switch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the seat adjuster switch.
2. Test for infinite resistance between the B+ terminal 5 and each signal terminal listed below with the switch in the open position.
   - Front vertical upward switch terminal 10
   - Front vertical downward switch terminal 7
   - Rear vertical upward switch terminal 9
   - Rear vertical downward switch terminal 8
   - Horizontal forward switch terminal 3
   - Horizontal rearward switch terminal 6
   - Recline forward switch terminal 2
   - Recline rearward switch terminal 4

   If not the specified value, replace the seat adjuster switch.
3. Test for less than 1 Ω between the B+ terminal 5 and each signal terminal listed below with the appropriate switch in the closed position.
   - Front vertical upward switch terminal 10
   - Front vertical downward switch terminal 7
   - Rear vertical upward switch terminal 9
   - Rear vertical downward switch terminal 8
   - Horizontal forward switch terminal 3
   - Horizontal rearward switch terminal 6
   - Recline forward switch terminal 2
   - Recline rearward switch terminal 4

   If greater than the specified range, replace the seat adjuster switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Power Seat Switch Replacement
- Control Module References for MSM replacement, setup, and programming

DTC B1825, B2355, B2365, or B2375

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

This diagnostic procedure supports the following DTCs:

DTC B1825 00: Recline Position Sensor Fault

DTC B2355 00: Front Vertical Position Sensor Fault

DTC B2365 00: Rear Vertical Position Sensor Fault

DTC B2375 00: Horizontal Position Sensor Fault

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Front Vertical Motor Position Sensor 5 V Reference	B2355 00	B2355 00	B2355 00	--
Front Vertical Motor Position Sensor Signal	B2355 00	B2355 00	B2355 00	--
Front Vertical Motor Position Sensor Ground	--	B2355 00	--	--
Horizontal Motor Position Sensor Signal	B2375 00	B2375 00	B2375 00	--
Horizontal Motor Position Sensor Ground	--	B2375 00	--	--
Rear Vertical Motor Position Sensor 5 V Reference	B2365 00	B2365 00	B2365 00	--
Rear Vertical Motor Position Sensor Signal	B2365 00	B2365 00	B2365 00	--
Rear Vertical Motor Position Sensor Ground	--	B2365 00	--	--
Recline Motor Position Sensor Signal	B1825 00	B1825 00	B1825 00	--
Recline Motor Position Sensor Ground	--	B1825 00	--	--

Circuit Description

The seat and lumbar motors are equipped with position sensors internal to the motor. The sensors are monitored by the memory seat module (MSM) and are used to determine seat positions when storing or recalling memory settings. The seat front vertical and rear vertical motors use 3 wire hall effect type position sensors while the seat horizontal and recline motors use 2 wire hall effect type position sensors. The MSM supplies the 3 wire hall effect position sensors with a separate 5 V reference circuit and signal circuit while ground is provided at G304. The MSM supplies the 2 wire hall effect position sensors with a signal circuit while ground is also provided at G304. During seat motor operation, the hall effect position sensor provides a determined number of pulse signals for every revolution of the motor shaft. These pulse signals (Steps) range from 0 - 65,535. High scan tool step values indicate forward or upward seat positions while low step values indicate rearward or downward seat positions.

Conditions for Running the DTC

The MSM must be powered and can not have B1327 as an active DTC for this DTC to set.

Conditions for Setting the DTC

The MSM does not detect position sensor movement while the adjuster motor is active.

Action Taken When the DTC Sets

The MSM disables the memory recall commands of the motor monitored by the sensor. The motor will respond to manual positioning commands.

Conditions for Clearing the DTC

- The DTC will clear when the fault is no longer present.
- The history DTC will clear after 50 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Driver Seat Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

- Power Seats System Description and Operation
- Memory Seats Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool seat position sensor parameters listed below while commanding the appropriate seat motor Up and Down or Forward and Rearward using the seat adjuster switch. Each parameter should change between 0 and 65,535 Steps.

- Front Vertical Position Sensor
- Horizontal Position Sensor
- Rear Vertical Position Sensor
- Recline Position Sensor

Circuit/System Testing

B1825 00 or B2375 00

1. Ignition OFF, disconnect the harness connector at the appropriate seat motor.
2. Test for less than 5.0 Ω between the appropriate ground circuit terminal listed below and ground.
   - Seat horizontal sensor terminal 3
   - Seat recline sensor terminal 2

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, test for 4.8 - 5.2 V between the 5 V reference circuit terminal 4 and ground while commanding the seat motor ON with a scan tool.

   If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the MSM.

   If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the MSM.
4. If all circuits test normal, test or replace the appropriate motor.

B2355 00 or B2365 00

1. Ignition OFF, disconnect the harness connector at the appropriate seat motor.
2. Test for less than 5.0 Ω between the ground circuit terminal 2 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, test for 4.8 - 5.2 V between the 5 V reference circuit terminal 4 and ground while commanding the seat motor ON with a scan tool.

   If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the MSM.

If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the MSM.

4. Test for 4.8 - 5.2 V between the signal circuit terminal 3 and ground while commanding the seat motor ON with a scan tool.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the MSM.

   If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the MSM.
5. If all circuits test normal, test or replace the appropriate seat motor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Seat Adjuster Motor Replacement - Horizontal
- Seat Adjuster Motor Replacement - Vertical
- Front Seat Horizontal Adjuster Position Sensor Replacement
- Control Module References for MSM replacement, setup, and programming

DTC B1831 or B1836

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC B1831 00: Lumbar Forward Switch Stuck

DTC B1836 00: Lumbar Rearward Switch Stuck

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Lumbar Forward Switch Signal	1	1	B1831 00	--
Lumbar Rearward Switch Signal	1	1	B1836 00	--
1. Lumbar Support Inoperative				

Circuit/System Description

When the lumbar switches are pressed, they send 12 V signal through the switch signal circuit to the memory seat module (MSM). The MSM interprets the signal and commands the lumbar motor to move in response to the switch signals.

Conditions for Running the DTC

The MSM must be powered.

Conditions for Setting the DTC

- If a lumbar switch circuit is active in one direction and the switch for the opposite direction is pressed, this DTC will set.
- A short to voltage on a switch signal circuit.

Action Taken When the DTC Sets

- A motor output driven in response to a switch considered failed, is deactivated for both directions.

- All memory recall commands are ignored.
- The MSM will respond to any other switch signal that has not set a DTC.

Conditions for Clearing the DTC

- The current DTC will clear and set the code to history, 3 seconds after the fault is no longer present and the ignition is cycled OFF then back to ACC or RUN.
- The history DTC will clear after 50 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Driver Seat Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Memory Seats Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool MSM Lumbar Switch parameter while pressing and releasing the lumbar switch in both directions. The reading should change between Inactive and Active

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the lumbar switch.
2. Ignition ON, verify the scan tool Lumbar Switch parameter is Inactive.

   If not the specified value, test the appropriate signal circuit terminal listed below for a short to voltage. If the circuit tests normal, replace the MSM.

   - Lumbar forward switch signal terminal 2

  - Lumbar rearward switch signal terminal 4
3. If all circuits test normal, test or replace the lumbar switch.

Component Testing

Lumbar Switch

1. Ignition OFF, disconnect the harness connector at the lumbar switch.
2. Test for infinite resistance between the 12 V reference terminal 3 and each signal terminal listed below and with the switch in the open position.
   - Lumbar forward switch signal terminal 2
   - Lumbar rearward switch signal terminal 4

   If not the specified value, replace the lumbar switch.
3. Test for less than 1 Ω between the 12 V reference terminal 3 and each signal terminal listed below and with the appropriate switch in the closed position.
   - Lumbar forward switch signal terminal 2
   - Lumbar rearward switch signal terminal 4

   If greater than the specified range, replace the lumbar switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Front Seat Lumbar Control Switch Replacement
- Control Module References for MSM replacement, setup, and programming

DTC B1851

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC B1851 00: Lumbar Position Sensor Fault

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Lumbar Horizontal Position Sensor Signal	B1851 00	B1851 00	B1851 00	--
Memory Seat/Mirror Sensor Low Reference	--	B1851 00	--	--

Circuit/System Description

The lumbar position sensor that set this diagnostic trouble code (DTC) is directly attached to the motor it monitors. It receives a signal circuit and ground from the memory seat module (MSM). The sensor sends a voltage signal that varies with the movement of the lumbar support through the signal circuit to the MSM. Then based on this voltage signal, the MSM determines the position of the lumbar.

Conditions for Running the DTC

The MSM must be powered.

Conditions for Setting the DTC

If the MSM sees the voltage signal from this sensor as either lower than 0.25 V or higher than 4.75 V, the sensor will be considered out of range and the MSM will set this DTC.

Action Taken When the DTC Sets

All memory recall functions will be disabled.

Conditions for Clearing the DTC

- The current DTC will clear and set to history, when the MSM sees the analog input from the sensor as between 0.25 V and 4.75 V and the ignition is cycled OFF then back to ACC or RUN.
- The history DTC will clear after 50 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Driver Seat Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Memory Seats Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool MSM Lumbar Position Sensor parameter. The reading should be between 0.25 V and 4.75 V and change while adjusting the lumbar position.

Circuit/System Testing

1. Ignition OFF, disconnect the X2 harness connector at the seat lumbar motor.
2. Test for less than 2 Ω between the low reference circuit terminal 2 and ground.

   If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the MSM.
3. Ignition ON, verify the scan tool Lumbar Position Sensor parameter is greater than 4.75 V.

   If less than the specified range, test the signal circuit for a short to ground. If the circuit tests normal, replace the MSM.
4. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2. Verify the scan tool Lumbar Horizontal Sensor parameter is less than 0.25 V.

   If greater than the specified range, test the signal circuit for short to voltage or an open/high resistance. If the circuit tests normal, replace the MSM.

5. If all circuits test normal, test or replace the lumbar position sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Seat Lumbar Sub System Replacement
- Control Module References for MSM replacement, setup, and programming

DTC B3907

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptors

DTC B3907 02: Button PCB Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Seat Adjuster Memory Switch 12 Volt Reference	B3907 02, 1	1	--	--
Memory Seat Switch Signal 1	1	1	B1390 01	--
Memory Seat Switch Signal 2	1	1	B1400 01	--
Memory Seat Switch Signal 3	1	1	B1410 01	--
Memory Mirror Switch Signal	1	1	B2765 01	1
1. Memory recall is inoperative				

Circuit/System Description

Reference voltage from the seat interface module (SIM) is supplied at all times to the memory seat switch. When a memory recall switch is pressed, reference voltage is applied through the switch contacts and the signal circuit to the SIM indicating the memory recall request. The SIM serves as a interface and applies a reference voltage through the appropriate memory signal circuit to the memory seat module (MSM) indicating the memory seat request. The MSM then commands the driver seat motors and the exterior mirrors to move to the appropriate seat and mirror positions stored in memory.

Conditions for Running the DTC

The SIM is powered.

Conditions for Setting the DTC

The button PCB assembly is shorted to ground.

Action Taken When the DTC Sets

The memory recall function is disabled.

Conditions for Clearing the DTC

- The current DTC clears when the fault is no longer present.
- The history DTC will clear after 50 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Driver Seat Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Memory Seats Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool SIM Input parameters listed below while pressing the appropriate memory 1, 2, 3, and M switches. The readings should change between Inactive and Active.

- Button 1 Input Status
- Button 2 Input Status
- Button 3 Input Status
- Button M Input Status

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the memory seat switch.
2. Ignition ON, verify that a test lamp illuminates between the 12 V reference circuit terminal 6 and ground.

   If the test lamp does not illuminate, test the 12 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the SIM.
3. Ignition ON, verify the scan tool SIM Input parameters listed below are Inactive:
   - Button 1 Input Status
   - Button 2 Input Status
   - Button 3 Input Status
   - Button M Input Status

   If not the specified value, test the appropriate signal circuit for a short to voltage. If the circuit tests normal, replace the SIM.
4. Install a 3 A fused jumper wire between the 12 V reference circuit terminal 6 and the signal circuit terminals listed below. Verify the appropriate scan tool SIM Memory Button Input Status parameter is Active between each test.
   - Button 1 Input Status
   - Button 2 Input Status
   - Button 3 Input Status
   - Button M Input Status

   If not the specified value, test the appropriate signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the SIM.
5. If all circuits test normal, test or replace the memory seat switch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the memory seat switch.
2. Test for infinite resistance between the 12 V reference terminal 6 and each signal terminal listed below with the switch in the open position:
   - Memory 1 terminal 1
   - Memory 2 terminal 2
   - Memory 3 terminal 3
   - Memory M terminal 4

   If not the specified value, replace the memory seat switch.
3. Test for less than 2 Ω between the 12 V reference terminal 6 and each signal terminal listed below with the appropriate switch in the closed position:
   - Memory 1 terminal 1
   - Memory 2 terminal 2
   - Memory 3 terminal 3
   - Memory M terminal 4

   If greater than the specified range, replace the memory seat switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Driver Seat Adjuster Memory Switch Replacement

- Control Module References for SIM and MSM replacement, setup, and programming

DTC U1401

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC U1401: No Communication with MSM (Memory Seat and Mirror Module)

Circuit/System Description

The SIM continuously sends a communication signal to the MSM. Upon receiving the signal, the MSM sends a reply signal, confirming that it can communicate.

Conditions for Running the DTC

The SIM is active.

Conditions for Setting the DTC

The SIM does not receive a response from the MSM for 10 or more consecutive seconds.

Action Taken When the DTC Sets

The memory recall function is disabled.

Conditions for Clearing the DTC

- The current DTC will clear when the SIM receives a communication reply from the MSM.
- The history DTC will clear after 50 fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Driver Seat Schematics .

Connector End View Reference

Component Connector End Views .

Electrical Information Reference

- Circuit Testing .
- Connector Repairs .
- Testing for Intermittent Conditions and Poor Connections .
- Wiring Repairs .

Scan Tool Reference

Control Module References

Circuit/System Testing

1. Disconnect the A154 SIM connector, and the A21-X3 MSM connector.
2. Using a DMM test the SIM; position 1, position 2, position 3, mirror dip, UART, module wake-up, power and ground circuits for short to ground or an open/high resistance.
   If the circuits do not test normal, repair or replace the effected circuit(s).

   If the circuits test normal, replace the MSM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Memory Seat Control Module Replacement .

DTC U2136

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC U2136: No Exterior Mirror Communication

Circuit/System Description

The memory seat module (MSM) continuously sends a communication signal to the MCM. Upon receiving the signal, the MCM sends a reply signal, confirming that it can communicate.

Conditions for Running the DTC

The MSM is active.

Conditions for Setting the DTC

The MSM does not receive a response from the MCM for 10 or more consecutive seconds.

Action Taken When the DTC Sets

The memory recall function is disabled.

Conditions for Clearing the DTC

- The current DTC will clear when the MSM receives a communication reply from the MCM.
- The history DTC will clear after 50 fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

- Driver Seat Schematics .
- Outside Rearview Mirror Schematics .

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing .
- Connector Repairs .
- Testing for Intermittent Conditions and Poor Connections .
- Wiring Repairs .

Scan Tool Reference

Control Module References

Circuit/System Testing

1. Disconnect the A154 SIM connector, and the A21-X3 MSM connector.
2. Using a DMM test the SIM; position 1, position 2, position 3, mirror dip, UART, module wake-up and power circuits for resistance.
   If greater than 5 ohms, repair or replace the effected circuit(s).
   If less than 5 ohms, replace the MSM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Memory Seat Control Module Replacement .

Lumbar Support Inoperative (With Memory A45)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Seat Lumbar Switch B+	1, 2	1, 2	--	--
Driver Seat Lumbar Forward Switch Signal	1, 2	1	B1831 00	--
Driver Seat Lumbar Rearward Switch Signal	1, 2	1	B1836 00	--
Lumbar Motor Rearward Control	1	1	--	--
Lumbar Motor Forward Control	1	1	--	--
1. Lumbar support inoperative 2. Power seats inoperative				

Circuit/System Description

Battery voltage is supplied at all times to the memory seat module (MSM) from the seat interface module (SIM) and the Power Seats circuit breaker located in the I/P fuse block. This voltage is used by the MSM for logic power and to drive the driver seat adjuster motors, recline motor and the lumbar motor.

The lumbar motor is reversible. For example, when the lumbar switch is operated to move the lumbar support forward, battery voltage is applied through the switch contacts and the lumbar horizontal forward switch signal circuit to the MSM. In response to this signal, the MSM applies battery voltage through the lumbar horizontal motor forward control circuit and ground through the lumbar horizontal motor rearward control circuit to the motor. The motor runs to drive the lumbar support forward toward the occupant's back until the switch is released. Moving the lumbar support rearward works similarly to moving the lumbar support forward, except that battery positive voltage and ground are applied on the opposite circuits causing the motor to run in the opposite direction. The MSM also controls the lumbar motor during memory recall functions.

Reference Information

Schematic Reference

Driver Seat Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Seats System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool MSM Lumbar Switch parameter while pressing the lumbar switch in both directions. The reading should change between Inactive and Forward or Backward.

> If the reading does not change between the specified values, refer to the Lumbar Switch Circuit Test.
>
> If the lumbar switch inputs to the MSM function normal, refer to the Lumbar Motor Control Circuit Test.

Circuit/System Testing

Lumbar Switch Circuit Test

1. Ignition OFF, disconnect the harness connector at the lumbar switch.
2. Ignition ON, verify that a test lamp illuminates between the 12 V reference circuit terminal 3 and ground.

   If the test lamp does not illuminate, test the 12 V reference circuit for an open/high resistance.
3. Verify the scan tool MSM Lumbar Switch parameter is Inactive.

   If not the specified value, test the appropriate signal circuit listed below for a short to voltage. If the circuit tests normal, replace the MSM.

   - Lumbar forward terminal 2
   - Lumbar rearward terminal 4
4. Install a 3 A fused jumper wire between the B+ circuit terminal 3 and the appropriate signal circuit terminal listed below. Verify the scan tool Lumbar Switch parameter is Forward or Backward.

- Lumbar forward terminal 2
- Lumbar rearward terminal 4

  If not the specified value, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the MSM.

5. If all circuits test normal, test or replace the lumbar switch.

Lumbar Motor Control Circuit Test

1. Ignition OFF, disconnect the X1 harness connector at the lumbar motor.
2. Connect a test lamp between control circuit terminal 1 and control circuit terminal 2.
3. Ignition ON, command the Lumbar Motor in the Forward and Rearward directions with a scan tool. The test lamp should turn ON when commanding the forward and rearward states.

   If the test lamp is always OFF during either of the commands, test the control circuits for an open/high resistance. If the circuits test normal replace the MSM.
4. If all circuits test normal, test or replace the lumbar motor.

Component Testing

Lumbar Switch

1. Ignition OFF, disconnect the harness connector at the lumbar switch.
2. Test for infinite resistance between the 12 V reference terminal 3 and the signal terminals listed below with the switch in the open position.
   - Lumbar forward switch terminal 2
   - Lumbar rearward switch terminal 4

   If not the specified value, replace the lumbar switch.
3. Test for less than 1 Ω between the 12 V reference terminal 3 and the signal terminals listed below with the appropriate switch in the closed position.
   - Lumbar forward switch terminal 2
   - Lumbar rearward switch terminal 4

   If greater than the specified range, replace the lumbar switch.

Lumbar Motor

1. Ignition OFF, disconnect the harness connector at the lumbar motor.

   Note: When performing the following tests, make sure that the lumbar is not already in the position the test is attempting to produce.

2. Install a 30 A fused jumper wire between control terminal 1 and 12 V. Momentarily install a jumper wire between control terminal 2 and ground. The lumbar motor should operate in the FORWARD direction.

   If the motor does not perform as specified, replace the lumbar motor.
3. Reverse the jumper wires. The lumbar motor should operate in the REARWARD direction.

   If the motor does not perform as specified, replace the lumbar motor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Front Seat Lumbar Control Switch Replacement
- Seat Lumbar Sub System Replacement
- Control Module References for MSM replacement, programming, and setup.

Lumbar Support Inoperative (Without Memory A45)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Seat Adjuster Switch B+	1, 2	1, 2	--	--
Lumbar Motor Rearward Control	1, 2	1	--	--
Lumbar Motor Forward Control	1, 2	1	--	--
Seat Adjuster Switch Ground	--	1, 2	--	--
1. Lumbar support inoperative 2. Power seats inoperative				

Circuit/System Description

Power seat lumbar support without memory is completely controlled through the seat adjuster switch. Battery voltage is supplied at all times to the seat switch through the SEAT 25A circuit breaker located in the I/P fuse block. When the lumbar switches are in an inactive state, the switch contacts are closed to the switch ground circuit.

The lumbar motor is reversible. For example, when the lumbar horizontal forward switch is pressed to move the lumbar support forward, battery voltage is applied through the switch contacts and the lumbar motor forward control circuit to the motor. The motor is grounded through the lumbar motor rearward switch contacts and the lumbar motor rearward control circuit to the motor. The motor runs in order to drive the lumbar support forward toward the occupants back until the switch is released. Moving the lumbar support rearward works similarly to moving the lumbar support forward, except that battery positive voltage and ground are applied on opposite circuits causing the motor to run in the opposite direction.

Reference Information

Schematic Reference

Passenger Seat Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Seats System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Circuit/System Verification

Ignition ON, verify that all manual power seat functions operate when being controlled by the seat adjuster switches.

If all seat functions do not operate, refer to Power Seat Inoperative.

If all power seat functions operate normal, refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the lumbar motor.
2. Connect a test lamp between control circuit terminal 1 and control circuit terminal 2.
3. Ignition ON, command the lumbar support FORWARD and REARWARD using the lumbar switch. The test lamp should turn ON when commanding the FORWARD and REARWARD states.

   If the test lamp is always OFF during either of the commands, test for a short to ground or an open high resistance on either control circuit. If the circuits test normal, test or replace the seat adjuster switch.
4. If all circuits test normal, test or replace the lumbar motor.

Component Testing

Lumbar Switch

1. Ignition OFF, disconnect the harness connector at the seat adjuster switch.
2. Test for infinite resistance the between B+ terminal 1 and each control terminal the with the switch in the open position.

   If not the specified value, replace the seat adjuster switch.
3. Test for less than 1 Ω between the B+ terminal 1 and each control terminal with the appropriate switch in the closed position.

   If greater than the specified range, replace the seat adjuster switch.
4. Test for less than 1 Ω between the ground terminal 2 and each control terminal with the switch in the open position.

If greater than the specified range, replace the seat adjuster switch.

Lumbar Motor

1. Ignition OFF, disconnect the harness connector at the lumbar motor.

   Note: When performing the following tests, make sure that the lumbar is not already in the position the test is attempting to produce.

2. Install a 30 A fused jumper wire between control terminal 1 and 12 V. Momentarily install a jumper wire between control terminal 2 and ground. The lumbar motor should operate in the FORWARD direction.

   If the motor does not perform as specified, replace the lumbar motor.
3. Reverse the jumper wires. The lumbar motor should operate in the REARWARD direction.

   If the motor does not perform as specified, replace the lumbar motor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Power Seat Switch Replacement
- Seat Lumbar Sub System Replacement

Memory Seat Feature Inoperative

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Memory Seat Switch 12 Volt Reference	B3907 02, 1	1	--	--
Memory Seat Signal 1	1	1	B2755 00	--
Memory Seat Signal 2	1	1	B2760 00	--
Memory Seat Signal 3	1	1	B3599 00	--
Memory Seat Switch Signal 1	1	1	B1390 01	--
Memory Seat Switch Signal 2	1	1	B1400 01	--
Memory Seat Switch Signal 3	1	1	B1410 01	--
1. Memory recall is inoperative				

Circuit/System Description

Reference voltage from the seat interface module (SIM) is supplied at all times to the memory seat switch. When a memory recall switch is pressed, reference voltage is applied through the switch contacts and the signal circuit to the SIM indicating the memory recall request. The SIM serves as a interface and applies a reference voltage through the appropriate memory signal circuit to the memory seat module (MSM) indicating the memory seat request. The MSM then commands the driver seat motors and the exterior mirrors to move to the appropriate seat and mirror positions stored in memory.

Reference Information

Schematic Reference

Driver Seat Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Memory Seats Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that all manual power seat and lumbar functions operate when being controlled by the seat adjuster and lumbar switches.

   If any seat or lumbar function does not operate, refer to Power Seat Inoperative or Lumbar Support Inoperative.
2. Ignition ON, observe the scan tool SIM Input parameters listed below while pressing the appropriate memory 1, 2, and 3 switches. The readings should change between Inactive and Active.
   - Button 1 Input Status
   - Button 2 Input Status
   - Button 3 Input Status

   If not the specified value for all memory buttons, refer to the Memory Seat Switch Circuit Test.
3. Ignition ON, observe the scan tool MSM Input parameters listed below while pressing the appropriate memory 1, 2, and 3 switches. The readings should change between Not Pressed and Pressed.
   - Memory 1 Button
   - Memory 2 Button
   - Memory 3 Button

   If not the specified value for all memory buttons, refer to the SIM to MSM Circuit Test.
4. If all scan tool readings are normal, replace the MSM.

Circuit/System Testing

Memory Seat Switch Circuit Test

1. Ignition OFF, disconnect the harness connector at the memory seat switch.
2. Ignition ON, verify that a test lamp illuminates between the 12 V reference circuit terminal 6 and ground.

   If the test lamp does not illuminate, test the 12 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the SIM.

3. Ignition ON, verify the scan tool SIM Input parameters listed below are Inactive:
    - Button 1 Input Status
    - Button 2 Input Status
    - Button 3 Input Status
    - Button M Input Status

    If not the specified value, test the appropriate signal circuit for a short to voltage. If the circuit tests normal, replace the SIM.
4. Install a 3 A fused jumper wire between the 12 V reference circuit terminal 6 and the signal circuit terminals listed below. Verify the appropriate scan tool SIM Memory Button Input Status parameter is Active between each test.
    - Button 1 Input Status
    - Button 2 Input Status
    - Button 3 Input Status
    - Button M Input Status

    If not the specified value, test the appropriate signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the SIM.
5. If all circuits test normal, test or replace the memory seat switch.

SIM to MSM Circuit Test

1. Ignition OFF, disconnect the X3 harness connector at the MSM.
2. Connect a test lamp between the appropriate signal circuit listed below and ground:
    - Memory 1 terminal 9
    - Memory 2 terminal 8
    - Memory 3 terminal 19
    - Memory M terminal 18
3. Ignition ON, command the appropriate memory position listed below ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - Button 1 Input
    - Button 2 Input
    - Button 3 Input
    - Button M Input

    If the test lamp is always ON, test the signal circuit for a short to voltage. If the circuit tests normal replace the SIM.

    If the test lamp is always OFF, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal replace the SIM.
4. If all circuits test normal, replace the MSM.

Component Testing

1. Ignition OFF, disconnect the harness connector at the memory seat switch.
2. Test for infinite resistance between the 12 V reference terminal 6 and each signal terminal listed below with the switch in the open position:
    - Memory 1 terminal 1
    - Memory 2 terminal 2
    - Memory 3 terminal 3

- Memory M terminal 4

  If not the specified value, replace the memory seat switch.

3. Test for less than 2 Ω between the 12 V reference terminal 6 and each signal terminal listed below with the appropriate switch in the closed position:
   - Memory 1 terminal 1
   - Memory 2 terminal 2
   - Memory 3 terminal 3
   - Memory M terminal 4

   If greater than the specified range, replace the memory seat switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Driver Seat Adjuster Memory Switch Replacement
- Control Module References for SIM and MSM replacement, setup, and programming

Power Seat Inoperative (With Memory A45)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Memory Seat Module B+	1	1	--	--
Seat Adjuster Switch B+	2	1	--	--
Front Vertical Up Switch Signal	2	1	B1735 00, B1740 00, B1745 00, B1750 00, B1755 00, B1760 00, B1815 00, B1820 00	--
Front Vertical Down Switch Signal	2	1	B1735 00, B1740 00, B1745 00, B1750 00, B1755 00, B1760 00, B1815 00, B1820 00	--
Horizontal Forward Switch Signal	2	1	B1735 00, B1740 00, B1745 00, B1750 00, B1755 00, B1760 00, B1815 00, B1820 00	--
Horizontal Rearward Switch Signal	2	1	B1735 00, B1740 00, B1745 00, B1750 00, B1755 00, B1760 00, B1815 00, B1820 00	--
Rear Vertical Down Switch Signal	2	1	B1735 00, B1740 00, B1745 00, B1750 00, B1755 00, B1760 00, B1815 00, B1820 00	--
Rear Vertical Up Switch Signal	2	1	B1735 00, B1740 00, B1745 00, B1750 00, B1755 00, B1760 00, B1815 00, B1820 00	--
Recline Forward Switch Signal	2	1	B1735 00, B1740 00, B1745 00, B1750 00, B1755 00, B1760 00, B1815 00, B1820 00	--

Recline Rearward Switch Signal	2	1	B1735 00, B1740 00, B1745 00, B1750 00, B1755 00, B1760 00, B1815 00, B1820 00	--
Driver Seat Front Vertical Motor Down Control	1	1	--	--
Driver Seat Front Vertical Motor Up Control	1	1	--	--
Driver Seat Horizontal Motor Forward Control	1	1	--	--
Driver Seat Horizontal Motor Rearward Control	1	1	--	--
Driver Seat Rear Vertical Motor Down Control	1	1	--	--
Driver Seat Rear Vertical Motor Up Control	1	1	--	--
Driver Seat Recline Motor Forward Control	1	1	--	--
Driver Seat Recline Motor Rearward Control	1	1	--	--
Memory Seat Module Ground	--	2	--	--

1. Power seat inoperative

2. Scan Tool Does Not Communicate with Low Speed GMLAN Device

Circuit/System Description

Battery voltage is supplied at all times to the memory seat module (MSM) from the seat interface module (SIM) and the Power Seats circuit breaker located in the I/P fuse block. This voltage is used by the MSM for logic power and to drive the driver seat adjuster motors, recline motor and the lumbar motor.

All motors are reversible. For example, when the seat switch is pressed to move the seat forward, battery voltage is applied through the switch contacts and the seat horizontal forward switch signal circuit to the MSM. In response to this signal, the MSM applies battery voltage through the seat horizontal motor forward control circuit and ground through the seat horizontal motor rearward control circuit to the motor. The motor runs to drive the seat forward until the switch is released. Moving the seat rearward works similarly to moving the seat forward, except that battery positive voltage and ground are applied on the opposite circuits causing the motor to run in the opposite direction.

Reference Information

Schematic Reference

Driver Seat Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Memory Seats Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool MSM seat adjuster switch parameters listed below while operating each adjuster switch in both directions. The reading should change between Inactive and the desired direction.
   - Front Vertical Switch
   - Horizontal Switch
   - Rear Vertical Switch
   - Recline Switch

   If any of the readings are Inactive or Invalid while the switch is pressed, refer to the Seat Adjuster Switch Circuit Test
2. If all scan tool readings are normal, refer to the Seat Motor Control Circuit Test.

Circuit/System Testing

Seat Adjuster Switch Circuit Test

1. Ignition OFF, disconnect the harness connector at the seat adjuster switch.
2. Ignition ON, verify that a test lamp illuminates between the 12 V reference circuit terminal 5 and ground.

   If the test lamp does not illuminate, test the 12 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the MSM.

3. Install a 3 A fused jumper wire between the appropriate signal circuit terminal listed below and the 12 V reference circuit terminal 5. Verify the appropriate scan tool MSM seat adjuster switch parameter is Forward/Rearward or Up/Down.
   - Front vertical up switch terminal 10
   - Front vertical down switch terminal 7
   - Rear vertical up switch terminal 9
   - Rear vertical down switch terminal 8
   - Horizontal forward switch terminal 3
   - Horizontal rearward switch terminal 6
   - Recline forward switch terminal 2
   - Recline rearward switch terminal 4

   If not the specified value, test the signal circuit for short to ground or an open/high resistance. If the circuit tests normal, replace the MSM.
4. If all circuits test normal, test or replace the seat adjuster switch.

Seat Motor Control Circuit Test

1. Ignition OFF, disconnect the harness connector at the appropriate seat motor.
2. Connect a test lamp between the appropriate control circuit terminals listed below:
   - Front vertical motor terminal 1 and terminal 5
   - Rear vertical motor terminal 1 and terminal 5
   - Horizontal motor terminal 1 and terminal 2
   - Recline motor terminal 1 and terminal 5
3. Ignition ON, command the appropriate seat motor in the Up/Down or Forward/Rearward directions with a scan tool. The test lamp should turn ON when commanding the up and down or forward and rearward states.

   If the test lamp remains OFF during either of the commands, test the control circuits for a short to ground or an open/high resistance. If the circuits test normal replace the MSM.
4. If all circuits test normal, test or replace the seat motor.

Component Testing

Seat Adjuster Switch Test

1. Ignition OFF, disconnect the harness connector at the seat adjuster switch.
2. Test for infinite resistance between the 12 V reference terminal 5 and each signal terminal listed below with the switch in the open position:
   - Front vertical up switch terminal 10
   - Front vertical down switch terminal 7
   - Rear vertical up switch terminal 9
   - Rear vertical down switch terminal 8
   - Horizontal forward switch terminal 3
   - Horizontal rearward switch terminal 6
   - Recline forward switch terminal 2
   - Recline rearward switch terminal 4

   If not the specified value, replace the seat adjuster switch.

3. Test for less than 2 Ω between the 12 V reference terminal 5 and each signal terminal listed below with the appropriate switch in the closed position:
    - Front vertical up switch terminal 10
    - Front vertical down switch terminal 7
    - Rear vertical up switch terminal 9
    - Rear vertical down switch terminal 8
    - Horizontal forward switch terminal 3
    - Horizontal rearward switch terminal 6
    - Recline forward switch terminal 2
    - Recline rearward switch terminal 4

    If greater than the specified range, replace the seat adjuster switch.

Seat Motors

1. Ignition OFF, disconnect the harness connector at the appropriate seat motor.

    Note: When performing the following tests, make sure that the seat is not already in the position the test is attempting to produce.

2. Install a 30 A fused jumper wire between control terminal 1 and 12 V. Momentarily install a jumper wire between control terminal 2 and ground. The seat motor should operate in the appropriate UP or FORWARD direction.
    If the motor does not perform as specified, replace the seat motor.
3. Reverse the jumper wires. The seat motor should operate in the appropriate DOWN or REARWARD direction.
    If the motor does not perform as specified, replace the seat motor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Power Seat Switch Replacement
- Seat Adjuster Motor Replacement - Horizontal
- Seat Adjuster Motor Replacement - Vertical
- Control Module References for MSM replacement, programming, and setup.

Power Seat Inoperative (Without Memory A45)

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Seat Adjuster Switch B+	1	1	--	--
Front Vertical Motor Down Control	1	1	--	--
Front Vertical Motor Up Control	1	1	--	--
Horizontal Motor Forward Control	1	1	--	--
Horizontal Motor Rearward Control	1	1	--	--
Rear Vertical Motor Down Control	1	1	--	--
Rear Vertical Motor Up Control	1	1	--	--
Recline Motor Forward Control	1	1	--	--
Recline Motor Rearward Control	1	1	--	--
Seat Adjuster Switch Ground	--	1	--	--
1. Power seat inoperative				

Circuit/System Description

The power seat is controlled through the seat adjuster switch. Battery voltage is supplied at all times to the seat adjuster switch through the Power Seats 20 A Circuit Breaker located in the instrument panel fuse block. When the seat adjuster switches are in an inactive state, the switch contacts are closed to the switch ground circuit.

All seat motors are reversible. For example, when the seat horizontal forward switch is pressed to move the entire seat forward, battery voltage is applied through the switch contacts and the seat horizontal motor forward control circuit to the motor. The motor is grounded through the horizontal motor rearward switch contacts and the horizontal motor rearward control circuit to the motor. The motor runs in order to drive the entire seat forward until the switch is released. Moving the entire seat rearward works similarly to moving the entire seat forward, except that battery positive voltage and ground are applied on opposite circuits causing the motor to run in the opposite direction. All seat motors are powered this way.

Reference Information

Schematic Reference

- Driver Seat Schematics
- Passenger Seat Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Power Seats System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Circuit/System Verification

Operate the seat switches for the appropriate seat directional motors listed below in both directions. The seat should move in the commanded directions.

- Horizontal motor (AGB, AH5, AH8, AJ6, or AQ5)
- Front vertical motor (AGB, AH5, AH6, AH7, AH8, AJ6, or AQ5)
- Rear vertical motor (AGB, AH5, AH6, AH7, AH8, AJ6, or AQ5)
- Recline motor (AGB, AH5, or AH8)

If the power seat is inoperative in all directions, refer to the Seat Adjuster Switch Circuit Test.

If 1 or more of the seat adjuster motors operate, refer to the Seat Adjuster Motor Circuit Test.

Circuit/System Testing

Seat Adjuster Switch Circuit Test

1. Disconnect the harness connector at the seat adjuster switch.
2. Test for less than 5 Ω between the ground circuit terminal 2 and ground.
   If greater than the specified range, test the ground circuit for an open/high resistance.

3. Verify that a test lamp illuminates between the appropriate B+ circuit terminal 1 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
4. If all circuits test normal, test or replace the seat adjuster switch.

Seat Adjuster Motor Circuit Test

1. Ignition OFF, disconnect the harness connector at the appropriate seat motor.
2. Connect a test lamp between control circuit terminal 1 and control circuit terminal 2.
3. Ignition ON, command the appropriate seat motor Up and Down or Forward and Rearward using the seat adjuster switch. The test lamp should turn ON when commanding the up and down or forward and rearward states.

   If the test lamp remains OFF for either of the commands, test the control circuits for a short to ground or an open/high resistance. If the circuits test normal, test or replace the seat adjuster switch.
4. If all circuits tests normal, test or replace the seat motor.

Component Testing

Seat Adjuster Switch Test

1. Ignition OFF, disconnect the harness connector at the seat adjuster switch.
2. Test for infinite resistance between the B+ terminal 1 and each control terminal listed below with the switch in the open position.
   - Seat front up terminal 3
   - Seat front down terminal 4
   - Seat rear up terminal 5
   - Seat rear down terminal 6
   - Horizontal forward terminal 7
   - Horizontal rearward terminal 8

   If not the specified value, replace the seat adjuster switch.
3. Test for less than 1 Ω between the B+ terminal 1 and each control terminal listed below with the appropriate switch in the closed position.
   - Seat front up terminal 3
   - Seat front down terminal 4
   - Seat rear up terminal 5
   - Seat rear down terminal 6
   - Horizontal forward terminal 7
   - Horizontal rearward terminal 8

   If greater than the specified range, replace the seat adjuster switch.
4. Test for less than 1 Ω between the ground terminal 2 and each control terminal listed below with the switch in the open position.
   - Seat front up terminal 3
   - Seat front down terminal 4
   - Seat rear up terminal 5
   - Seat rear down terminal 6

- Horizontal forward terminal 7
- Horizontal rearward terminal 8

  If greater than the specified range, replace the seat adjuster switch.

Seat Motors

1. Ignition OFF, disconnect the harness connector at the appropriate seat motor.

   Note: When performing the following tests, make sure that the seat is not already in the position the test is attempting to produce.

2. Install a 30 A fused jumper wire between control terminal 1 and 12 V. Momentarily install a jumper wire between control terminal 2 and ground. The seat motor should operate in the appropriate UP or FORWARD direction.

   If the motor does not perform as specified, replace the seat motor.
3. Reverse the jumper wires. The seat motor should operate in the appropriate DOWN or REARWARD direction.

   If the motor does not perform as specified, replace the seat motor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Power Seat Switch Replacement
- Seat Adjuster Motor Replacement - Horizontal
- Seat Adjuster Motor Replacement - Vertical

Symptoms - Seats

Important: The following steps must be completed before using the symptom tables.

1. Perform the Diagnostic System Check - Vehicle before using the Symptom Tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to the following system descriptions:
   - Memory Seats Description and Operation.
   - Power Seats System Description and Operation.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the system. Refer to Checking Aftermarket Accessories.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

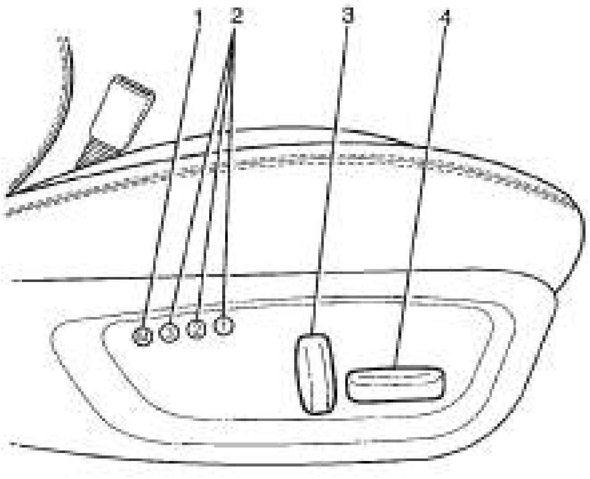
Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Lumbar Support Inoperative
- Memory Seat Feature Inoperative
- Power Seat Inoperative

Driver Seat Adjuster Memory Switch Replacement (RHD)

Seat Switch Identification

Type A Switch (8 Way)



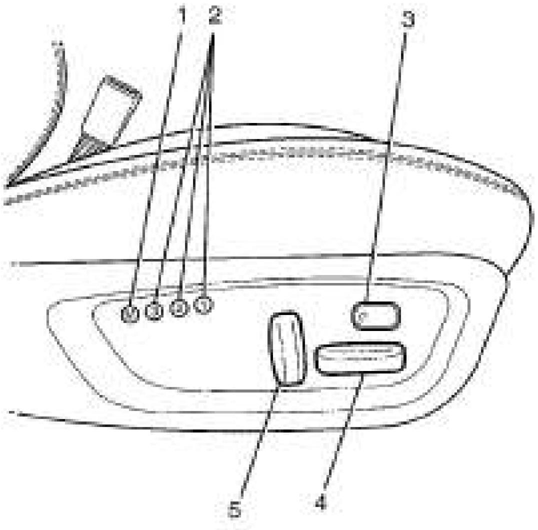
(1) Mirror Dip/Memory Store

(2) Seat Memory

(3) Recliner

(4) Fore/Up/Down/Tilt

Type B Switch (10 Way)



(1) Memory Dip/Memory Store
(2) Seat Memory
(3) Lumbar Switch
(4) Fore/Up/Down/Tilt
(5) Recliner

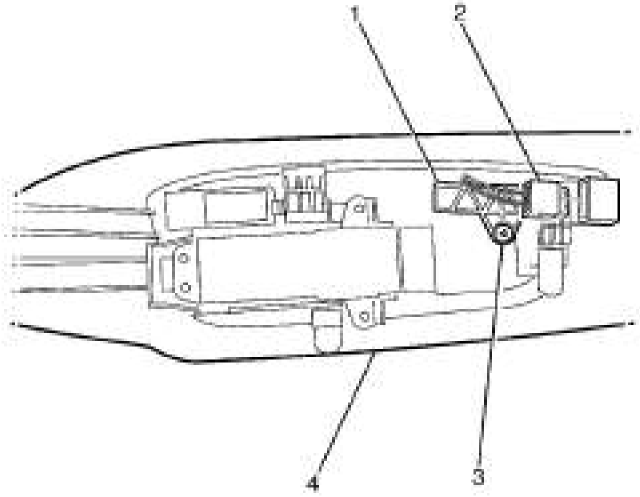
Removal Procedure - (Type A and B)

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.

Caution: Refer to SRS Caution in the Preface section.

2. Disable the SIR system. Refer to SIR Disabling and Enabling.
3. Remove the front seat. Refer to Front Seat Replacement - Bucket.
4. Remove the outer trim panel. Refer to Seat Cushion Outer Trim Panel Replacement.

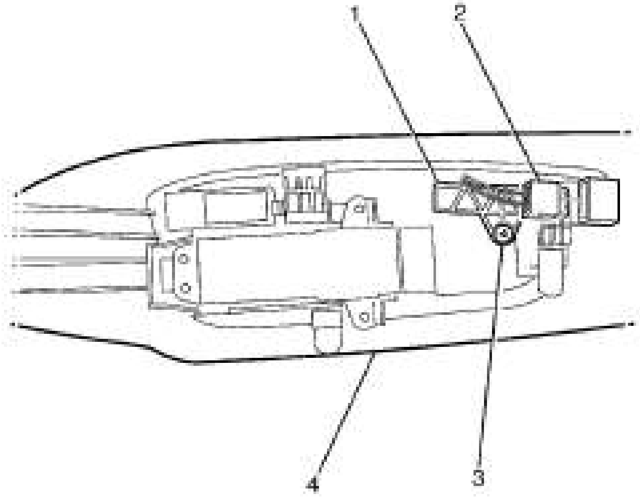


5. Disconnect the memory switch electrical connector (2).
6. Remove screw (3) attaching the memory position switch (1) to the front seat outer side cover (4).
7. Lift out the memory position switch assembly (1) from its recess in the side cover (4).
8. As required, each position switch button can be removed from the switch.

Installation Procedure

Important: Ensure buttons are installed as per removal.

1. As required, install the position button by pushing it into the memory position switch, listen for an audible click to confirm fitting



2. Install the seat memory position switch (1), into the its recess in the outer seat trim (4).

Notice: Refer to Fastener Notice in the Preface section.

3. Install the memory position switch retaining screw (3).

   Tighten
   Tighten the retaining screw to 2.0 N·m (18 lb in).

4. Connect the memory switch electrical connector (2).
5. Install the outer trim panel. Refer to Seat Cushion Outer Trim Panel Replacement.
6. Install the front seat. Refer to Front Seat Replacement - Bucket.

   Caution: Refer to SRS Caution in the Preface section.

7. Enable the SIR system. Refer to SIR Disabling and Enabling.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

8. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.
9. Test the seat for correct mechanical and electrical operation.

Front Seat Lumbar Control Switch Replacement

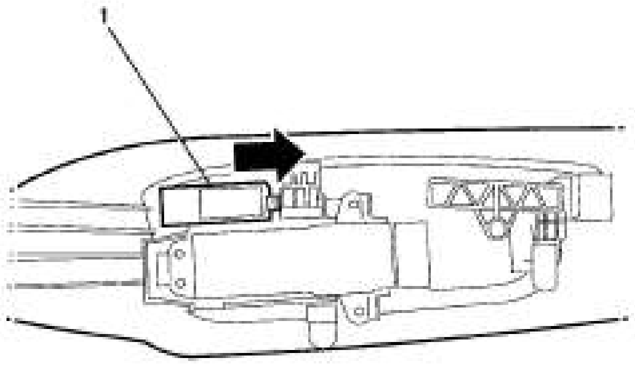
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .

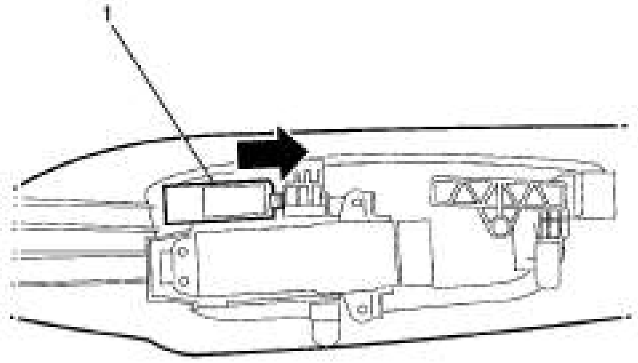
Caution: Refer to SIR Caution in the Preface section.

2. Disable the SIR system. Refer to SIR Disabling and Enabling in SIR.
3. Remove the front seat. Refer to Front Seat Replacement - Bucket .
4. Remove the outer trim panel. Refer to Seat Cushion Outer Trim Panel Replacement .



5. Disconnect the electrical connectors (1).
6. Remove the lumbar support switch, by releasing the retaining tab as shown.

Installation Procedure



1. Install the lumbar support switch.
2. Connect the electrical connectors.
3. Install the outer trim panel. Refer to Seat Cushion Outer Trim Panel Replacement .

Memory Seat Calibration

Calibration Procedure

The memory seat module uses position sensor inputs to establish soft stop locations for the adjuster motors several millimetres ahead of the physical limits of the adjuster assembly. After replacing a memory seat module or adjuster components, it may be necessary to reset the adjuster motor soft stop locations. When the repair procedure has been completed, operate the seat adjuster switch in every direction until the seat adjuster reaches its mechanical hard stop by repeatedly pressing and releasing the switch as necessary.

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Memory Seat Control Module Replacement

Removal Procedure

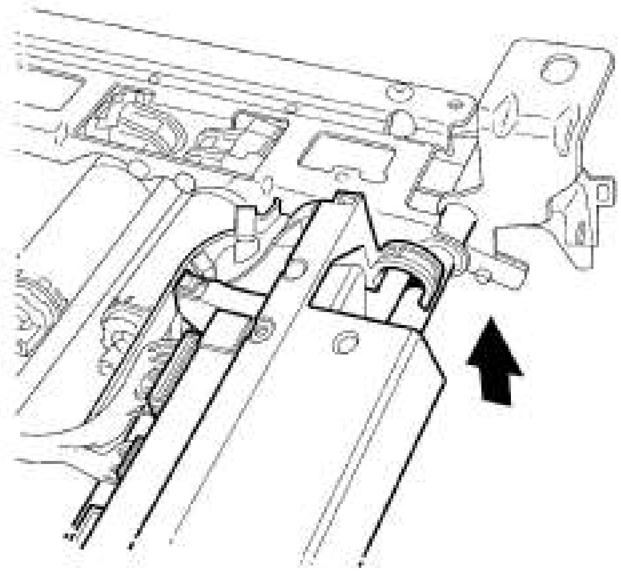
Caution: Refer to Battery Disconnect Caution in the Preface section.

Important: The seat memory seat module and seat interface module (MSM and SIM) are an integral part of the seat system and should only be replaced as a complete assembly.

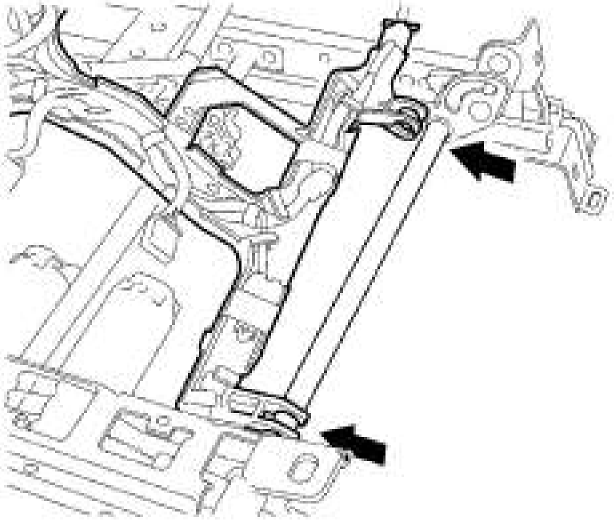
1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .

Caution: Refer to SIR Caution in the Preface section.

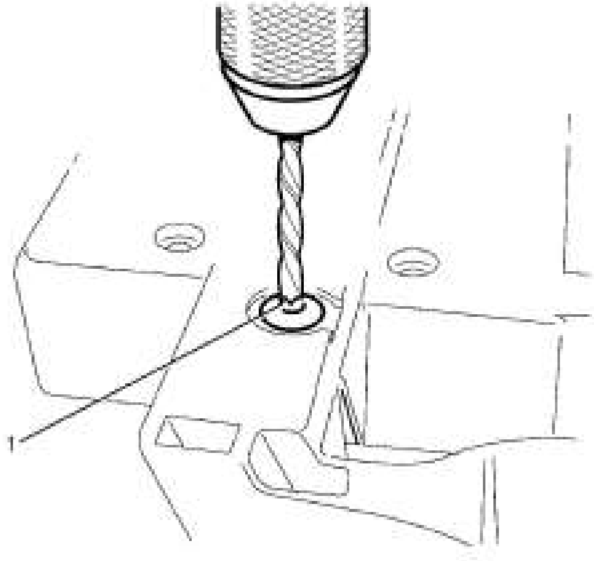
2. Disable the SIR system. Refer to SIR Disabling and Enabling in SIR.
3. Remove the front seat. Refer to Front Seat Replacement - Bucket .
4. Remove the front seat adjuster. Refer to Front Seat Adjuster Replacement .
5. Disconnect the wiring harness connectors as required.



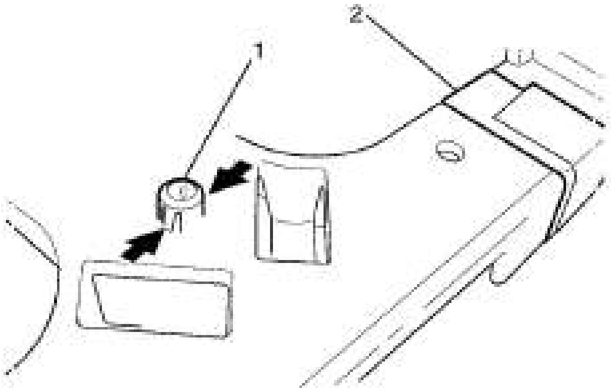
6. Unclip the cable tray from the seat adjuster.



7. Pull the cable tray forward to release it from the seat adjuster.

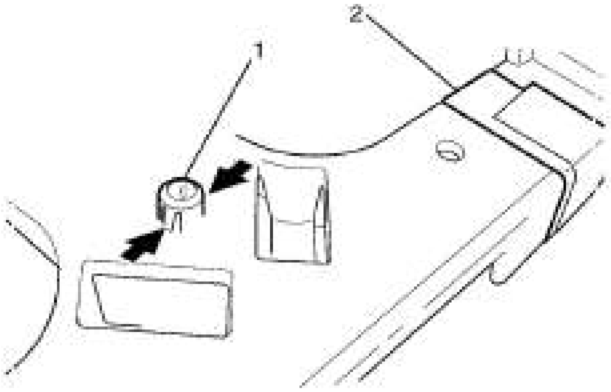


8. Using a 5mm drill bit drill out the pop rivet, (1) in two places, securing the memory seat module to the cable tray.
9. Carry out the above procedure for the seat interface module, (SIM), which is located on the memory seat module.



10. Remove the wiring harness from the cable tray by squeezing the tabs on the harness clips (1) and by removing the tape (2).

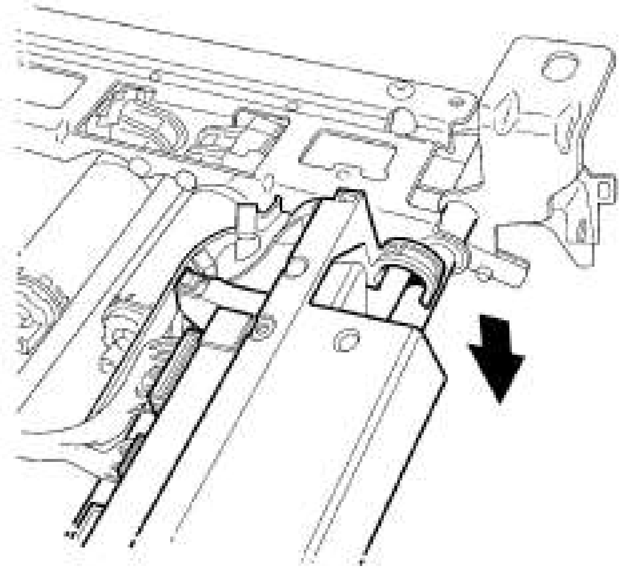
Installation Procedure



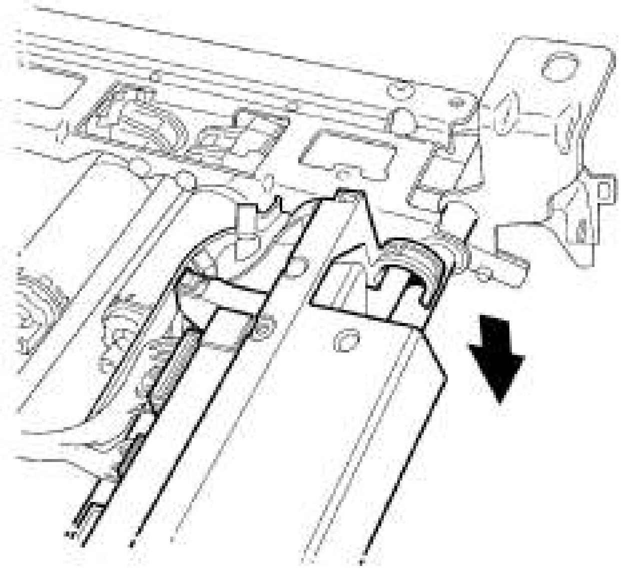
Important: Ensure the wiring harness is install as per removal.

1. Install the wiring harness to the cable tray and secure installing the wiring harness clip (1) listen fir an audible click to confirm fitting.
2. Install tape around the wiring harness.
3. Align the memory seat module with the cable tray.

4. Using a universal pop rivet gun and pop rivets secure the memory seat module to the cable tray.
5. Carry out the above procedure for the seat interface module, (SIM).
6. Align the memory seat module with the cable tray.
7. Using a universal pop rivet gun and pop rivets secure the memory seat module to the cable tray.
8. Carry out the above procedure for the seat interface module, (SIM).



9. Push the cable tray onto the seat adjuster backwards to secure it to the seat adjuster.



10. Clip the cable tray to the seat adjuster.
11. Connect the wiring harness connectors as required.
12. Install the front seat adjuster. Refer to Front Seat Adjuster Replacement .
13. Install the front seat. Refer to Front Seat Replacement - Bucket .

Caution: Refer to SIR Caution in the Preface section.

14. Enable the SIR system. Refer to SIR Disabling and Enabling in SIR.

    Caution: Refer to Battery Disconnect Caution in the Preface section.

15. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
16. If re-programming is required. Refer to Control Module References .
17. Test the seat for correct mechanical and electrical operation.

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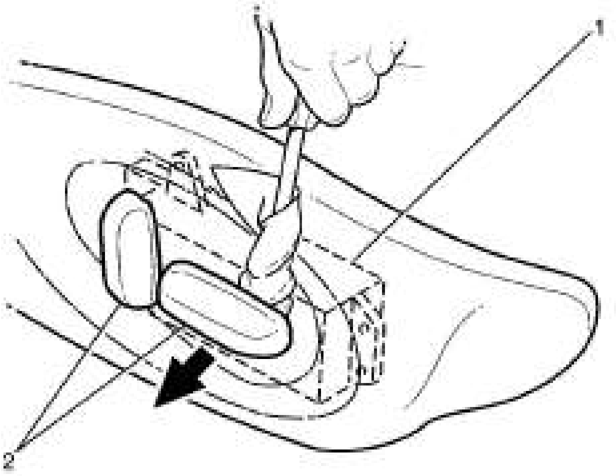
Power Seat Switch Replacement (RHD)

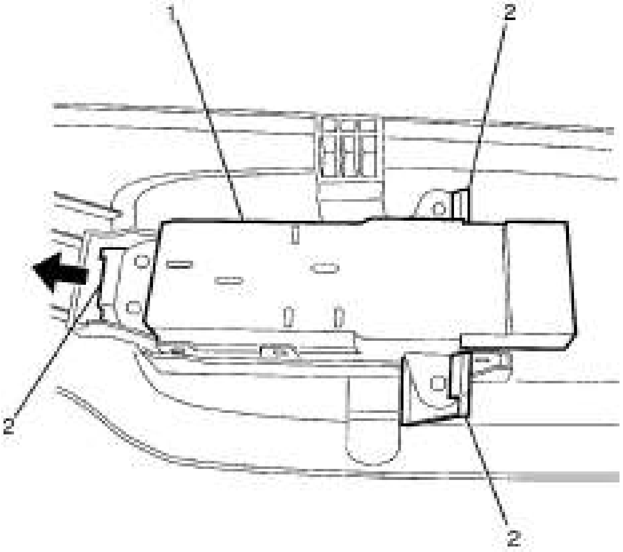
Removal Procedure

1. Remove the outer trim panel. Refer to Seat Cushion Outer Trim Panel Replacement.



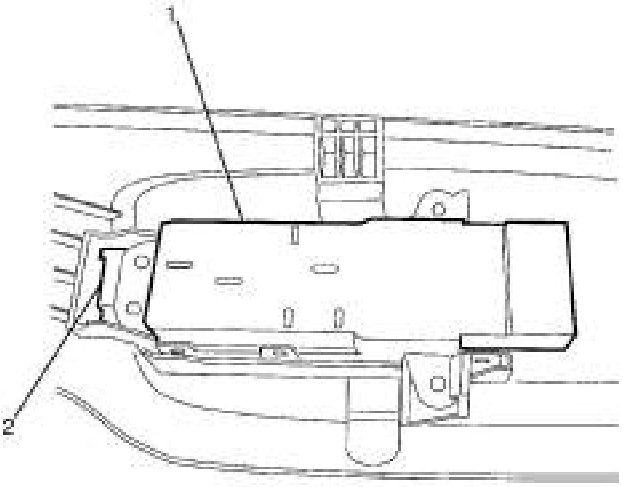
Important: Use an appropriate flat blade tool wrapped in a soft cloth.

2. Remove the power seat switch knobs (2) by gently prying the buttons off from the switch (1).

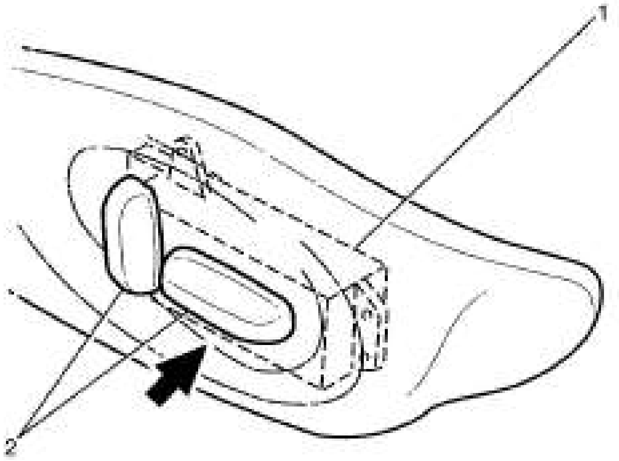


3. Remove the power seat switch (1) by releasing the retaining clips (2) and removing it out of its recess, located in the front seat trim panel.

Installation procedure



1. Install the power seat switch (1) into the its recess located in the outer trim panel, listen for an audible click from the retaining clip (2) to confirm fitting,



2. Install the power seat switch buttons (2) to the power seat switch, listen for an audible click to confirm fitting.
3. Install the outer trim panel. Refer to Seat Cushion Outer Trim Panel Replacement.
4. Test the power seat switch for the correct operation.

Seat Adjuster Motor Replacement - Horizontal

The horizontal seat motor is not a serviceable item, if the horizontal seat motor requires replacing it must be replaced as an assembly. Refer to Front Seat Adjuster Replacement.

Seat Adjuster Motor Replacement - Vertical

The vertical seat motor is not a serviceable item, if the vertical seat motor requires replacing it must be replaced as an assembly. Refer to Front Seat Back Frame Replacement.

Memory Seats Description and Operation

The memory seat system consists of the following components:

- Memory Seat Switch
- Seat Adjuster Switch
- Seat Lumbar Switch
- Memory Seat Module (MSM)
- Seat Interface Module (SIM)
- Seat Horizontal Motor/Sensor
- Seat Front Vertical Motor/Sensor
- Seat Rear Vertical Motor/Sensor
- Seat Recline Motor/Sensor
- Seat Lumbar Motor/Sensor
- SEAT Circuit Breaker 20 A

Seat Interface Module and Memory Seat Module

The seat interface module (SIM) serves as an interface to the memory seat module (MSM) for serial data communications. It communicates with the MSM through a UART serial data line while it communicates with the vehicle through the low speed GMLAN serial data line. When the scan tool is used to observe MSM DTC information or scan tool data parameters, the SIM retrieves the information from the MSM via the UART serial data line, then gateways the information via the GMLAN serial data line that is displayed on the scan tool.

The SIM also serves as an interface to the MSM for memory recall operations. For memory recall operation refer to Memory Functions below.

SIM and MSM Power and Ground

Battery positive voltage is supplied at all times through the SEAT circuit breaker located in the I/P fuse block to the seat interface module (SIM). This voltage is used to power up SIM and the memory seat module (MSM). The MSM uses this voltage to apply power to the seat and lumbar motors. Ground for the SIM and MSM is provided at G304.

Seat Adjuster Switch and Lumbar Switch

Battery positive voltage is supplied at all times to the seat adjuster switch and lumbar switch from the SEAT circuit breaker located in the I/P fuse block. When the seat or lumbar switches are pressed they send a 12 V signal to the MSM. The MSM then commands the selected seat or lumbar motor to move in response to the switch signal.

Seat Motors

There are four seat motors and one lumbar that move the position of the seat. These are the seat horizontal motor, front vertical motor, rear vertical motor, recline motor and the lumbar motor. The horizontal motor moves the entire seat forward and rearward. The seat front and rear vertical motors may operate independently to tilt the front or rear of the seat cushion up and down. Or, both vertical motors can run simultaneously to move the entire seat up or down. The recline motor moves the angle of the seat back forward or rearward while the lumbar motor moves the lumbar support forward and rearward. Each motor contains a electronic circuit breaker (PTC), that opens in the event of a circuit overload and will reset only after voltage has been removed from the circuit.

All motors are reversible. For example, when the seat switch is operated to moved the entire seat forward, battery positive voltage is applied through the horizontal forward switch contacts and the power seat horizontal forward switch signal circuit to the MSM. In response to this signal, the MSM applies battery positive voltage through the driver seat horizontal motor forward control circuit to the horizontal motor. The MSM supplies ground to the motor through the driver seat horizontal motor rearward control circuit. The motor runs to drive the entire seat forward until the switch is released. Moving the entire seat rearward works similarly to moving the entire seat forward, except that battery positive voltage and ground are applied on the opposite circuits causing the motor to run in the opposite direction. All of the seat motors and the lumbar motor are powered this way.

Position Sensors

The seat and lumbar motors are equipped with position sensors internal to the motor. The sensors are monitored by the MSM and are used to determine seat and lumbar positions when storing or recalling memory settings. The seat front vertical and rear vertical motors use 3 wire hall effect type position sensors while the seat horizontal and recline motors use 2 wire hall effect type position sensors. The lumbar motor is equipped with a 2 wire potentiometer type position sensor. The MSM supplies the 3 wire hall effect position sensors with a separate 5 V reference circuit and signal circuit while ground is provided at G304. The MSM supplies the 2 wire hall effect position sensors with a signal circuit while ground is also provided at G304. During seat motor operation, the hall effect position sensor provides a determined number of pulse signals for every revolution of the motor shaft. These pulse signals (Steps) range from 0 - 65,535. The MSM monitors the step values from the signal circuits to determine seat motor positions. The MSM supplies the lumbar sensor with a signal and low reference circuits. The signal circuit voltage ranges from 0.25 - 4.75 V which is determined by the wiper location within the sensor. The MSM monitors this voltage signal to determine the lumbar position. High scan tool step or voltage readings indicate forward or upward seat/lumbar positions while low voltage or step readings indicate rearward or downward seat/lumbar positions.

Memory Functions

The current seat position may be recorded for 3 different drivers. To record a position, adjust the drivers seat to a comfortable position, then press and hold the appropriate button for 5 seconds, a double beep will sound each time a memory position is set. Once the MSM receives the memory set message, it records the steps/voltage from all seat/lumbar position sensors for the appropriate driver.

When a memory switch is pressed, battery voltage is applied through the switch contacts and the signal circuit to the SIM. The SIM interprets this signal then applies battery voltage through the appropriate signal circuit to the MSM indicating the memory request. In response to this signal, the MSM applies battery voltage to run the seat motors until the position sensor steps/feedback voltages equal the steps/feedback voltages stored in memory for the appropriate driver.

Memory recall will not work if the shift lever is out of NEUTRAL (N) or PARK (P).

Memory Inhibit/Enable

The memory seat module receives the ignition switch signal and the gear selector position via serial data messages. When the gear selector is in the PARK position and ignition switch is in the ON or OFF position, memory record and memory recall functions are all allowed. When the ignition switch is in the ON position and the gear selector is out of the PARK position, only memory record is allowed, all other memory seat functions are not allowed.

Power Seats System Description and Operation

The driver and passenger power seat systems each consist of the following components:

- Seat Adjuster Switch
- Seat Horizontal Motor
- Seat Front Vertical Motor
- Seat Rear Vertical Motor
- Seat Recline Motor
- Lumbar Motor (Passenger Seat only)
- SEAT Circuit Breaker 20 A

Seat Adjuster Switch

Battery positive voltage is supplied at all times to the driver and front passenger seat adjuster switches through a 20 A circuit breaker located in the I/P fuse block. Ground is provided to both switches from the ground stakes. When active the seat adjuster switches provide both power and ground to the selected seat motors.

Seat Motors

All seat and lumbar motors operate independently of each other. Each motor contains an electronic circuit breaker (PTC) that opens in the event of a circuit overload and will reset only after voltage has been removed from the circuit. There are four seat position motors and one lumbar motor. These are the horizontal motor, front vertical motor, rear vertical motor, seat back recline motor and the lumbar motor. The horizontal motor moves the entire seat forward and rearward. The seat vertical motors may operate independently to tilt the front or rear of the seat cushion up or down. Both motors can also run simultaneously to move the entire seat up or down. The recline motor moves the angle of the seat back forward or rearward while the lumbar motor moves the lumbar support forward and rearward.

All seat motors are reversible. For example, when the seat switch is operated to move the entire seat forward, battery positive voltage is applied through the switch contacts and the horizontal motor forward control circuit to the motor. The motor is grounded through the horizontal motor rearward switch contacts and the horizontal motor rearward control circuit to the motor. The motor runs in order to drive the entire seat forward until the switch is released. Moving the entire seat rearward works similarly to moving the entire seat forward, except that battery positive voltage and ground are applied on opposite circuits causing the motor to run in the opposite direction. All of the other seat and lumbar motors are powered this way.

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Centre Rear Seat Belt Anchor to Body Retaining Nut (Sportwagon)	43 N·m	32 lb ft
Fire Extinguisher Assembly Retaining Bolts	18 N·m	13 lb ft
Front Seat to Body Retaining Bolts	42 N·m	31 lb ft
Lock Actuator to Seat Back Tray	2 N·m	18 lb in
Rear Armrest Assembly to Seat Back Tray Retaining Screws	4 N·m	35 lb in
Rear Seat Back Armrest to Rear Seat Back Frame Retaining Bolts (Sportwagon)	8 N·m	71 lb in
Rear Seat Back Latch to Seat Back Tray Retaining Screws	2 N·m	18 lb in
Rear Seat Back to Body Retaining Nuts	27 N·m	20 lb ft
Rear Split Folding Armrest to Rear Split Folding Back Frame Retaining Bolts (Sportwagon)	8 N·m	71 lb in
Rear Split Folding Seat Back to Body Retaining Nuts	23 N·m	17 lb ft
Seat Adjuster to Seat Cushion Frame Retaining Nuts	42 N·m	31 lb ft
Seat Back Assembly to Seat Base Retaining Bolts	32 N·m	24 lb ft
Seat Lock to Seat Frame Retaining Bolts (Sportwagon)	43 N·m	32 lb ft
Seat Memory Position Switch to Seat Outer Trim Retaining Screw	2 N·m	18 lb in

Driver or Passenger Seat Back Cushion Cover and Pad Replacement

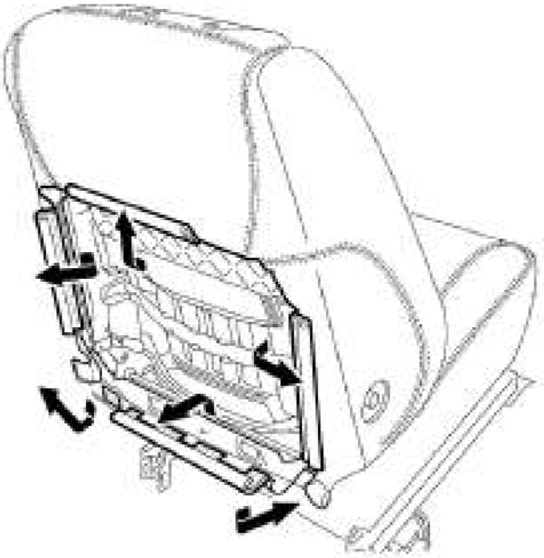
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

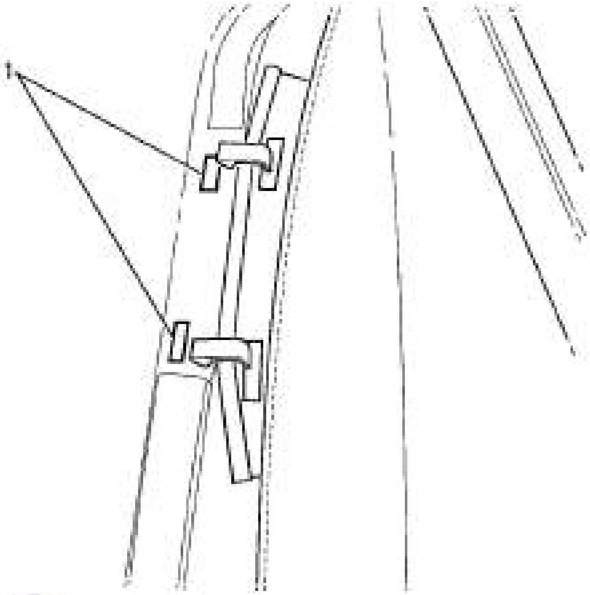
1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .

Caution: Refer to SIR Caution in the Preface section.

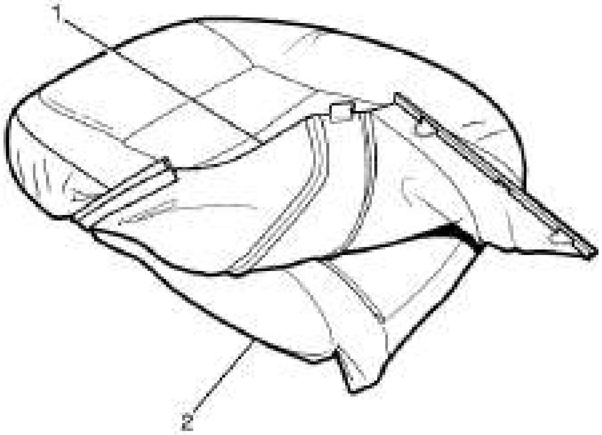
2. Disable the SIR system. Refer to SIR Disabling and Enabling in SIR.
3. Remove the front seat. Refer to Front Seat Replacement - Bucket .
4. Remove the lumbar support knob assembly. Refer to Lumbar Support Knob Replacement .
5. Remove the seat-back assembly. Refer to Front Seat Back Replacement .
6. Remove the head restraints. Refer to Front Seat Head Restraint Replacement .
7. Remove the seat back trim. Refer to Front Seat Back Trim Replacement .
8. Remove the head restraint guides. Refer to Front Seat Head Restraint Guide Replacement .



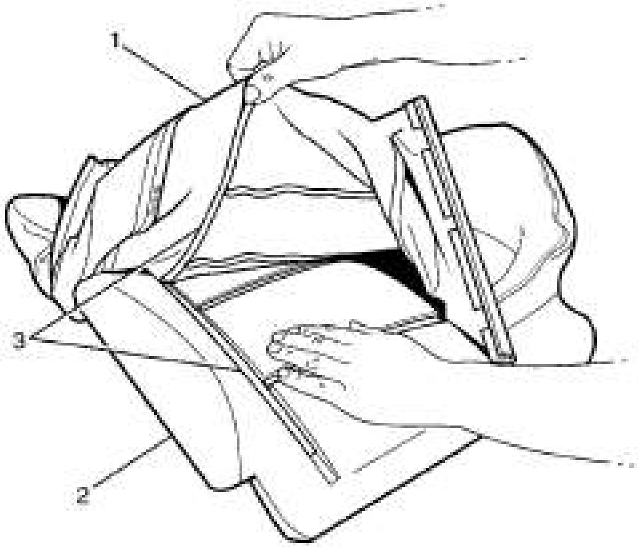
9. Disengage the J-strips away from the seat frame and the velcro tab at each lower corner.
10. Lift the cover and pad assembly up and away from the seat-back frame, manoeuvring it over the front seat dummy block insert assemblies.
11. Place pad and cover assembly on a clean and suitable work surface.



12. Detach the two securing hooks (1) located on the right hand side of the back.

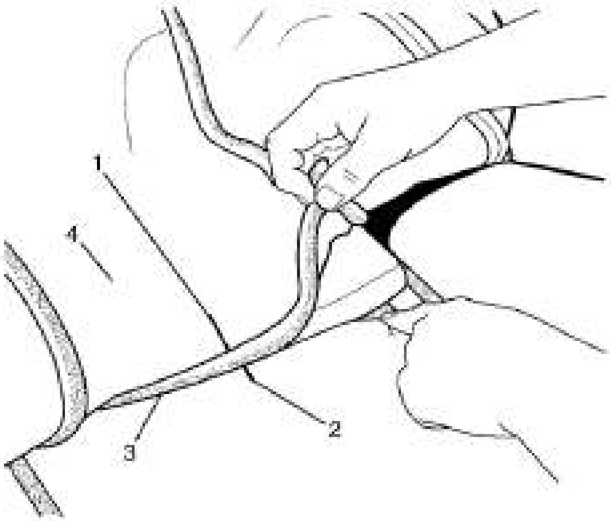


13. Fold the lower corners of the seat cushion cover (1) over the seat cushion pad (2).

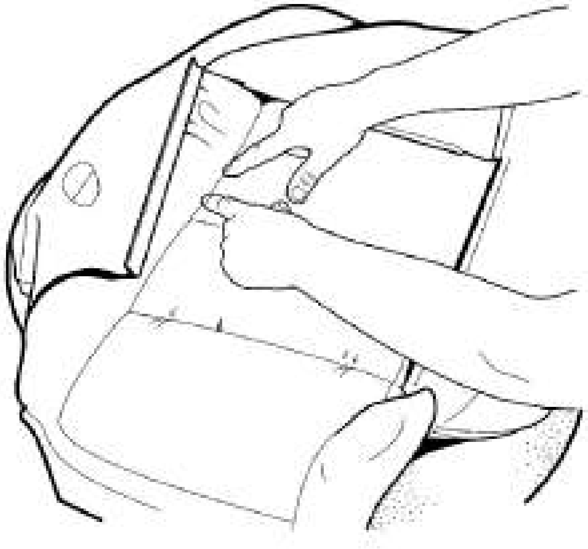


14. While holding the front seat cushion pad (1) pull the rear corners of the front seat cushion cover (2) forward and away from the pad to disengage the hook and loop strips (3).
15. Pull the cover up and over the forward edge of the pad.
16. Remove the seat cushion cover.

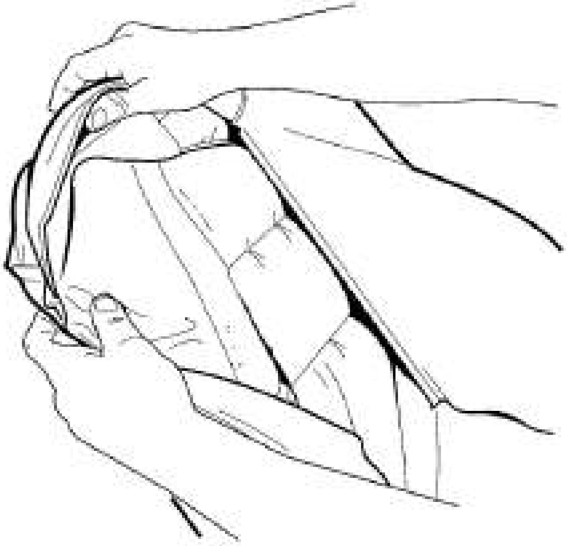
Installation Procedure



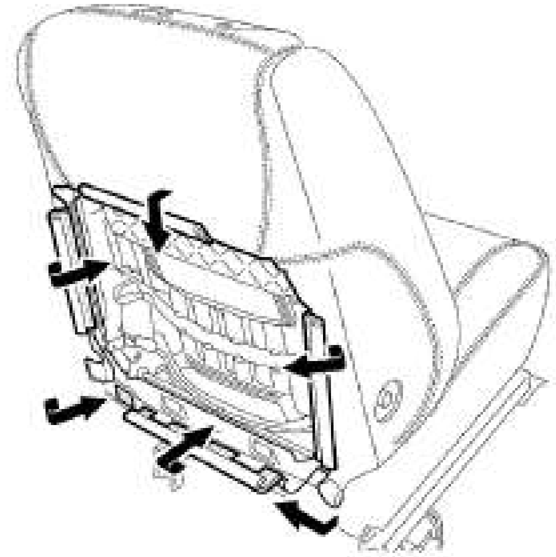
1. With the front seat-back cover (1) folded at the central horizontal strip of the hook and loop (2), align the centre mark (4) on the front seat-back pad.
2. Press the cover in the corresponding groove in the pad to engage the hook and loop.



3. With the cover folded at the two vertical strips of the hook and loop, press the cover firmly into the corresponding grooves in the pad.



4. Roll the upper corners of the seat cover over the pad.
5. Roll the sides of the seat cover over the pad.
6. Roll the lower corners of the seat cover over the pad.
7. Firmly run your finger in the seat cushion channels, to ensure a correct fitting.
8. Install the cover and pad assembly over from the seat-back frame, manoeuvring it over the front seat dummy block insert assemblies.



9. Engage the J-strips onto the seat frame and the velcro tab at each lower corner.
10. Install the head restraint guides. Refer to Front Seat Head Restraint Guide Replacement .
11. Install the seat back trim. Refer to Front Seat Back Trim Replacement .
12. Install the head restraints. Refer to Front Seat Head Restraint Replacement .
13. Install the seat-back assembly. Refer to Front Seat Back Replacement .
14. Install the lumbar support knob assembly. Refer to Lumbar Support Knob Replacement .
15. Install the front seat. Refer to Front Seat Replacement - Bucket .

    Caution: Refer to SIR Caution in the Preface section.

16. Enable the SIR system. Refer to SIR Disabling and Enabling in SIR.
17. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
18. Test the seat for correct mechanical and electrical operation.

Driver or Passenger Seat Back Cushion Frame Replacement

Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .

Caution: Refer to SIR Caution in the Preface section.

2. Disable the SIR system. Refer to SIR Disabling and Enabling in SIR.
3. Remove the front seat. Refer to Front Seat Replacement - Bucket .
4. Remove the outer trim panel. Refer to Seat Cushion Outer Trim Panel Replacement .
5. Remove the front seat-back. Refer to Front Seat Back Replacement .
6. Remove the front seat-back cover. Refer to Front Seat Back Cushion Cover and Cushion Pad Replacement .
7. Discard the seat-back frame.

Installation Procedure

1. Install the front seat-back cover. Refer to Front Seat Back Cushion Cover and Cushion Pad Replacement .
2. Install the seat-back. Refer to Front Seat Back Replacement .
3. Install the outer trim panel. Refer to Seat Cushion Outer Trim Panel Replacement .
4. Install the front seat. Refer to Front Seat Replacement - Bucket .

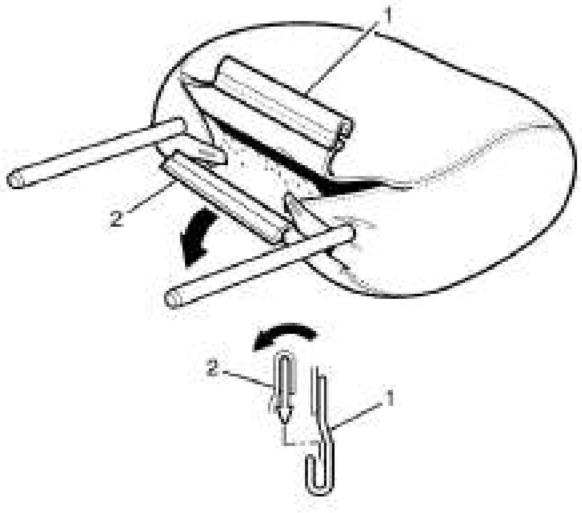
Caution: Refer to SIR Caution in the Preface section.

5. Enable the SIR system. Refer to SIR Disabling and Enabling in SIR.
6. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
7. Test the seat for correct mechanical and electrical operation.

Driver or Passenger Seat Head Restraint Replacement (SWB)

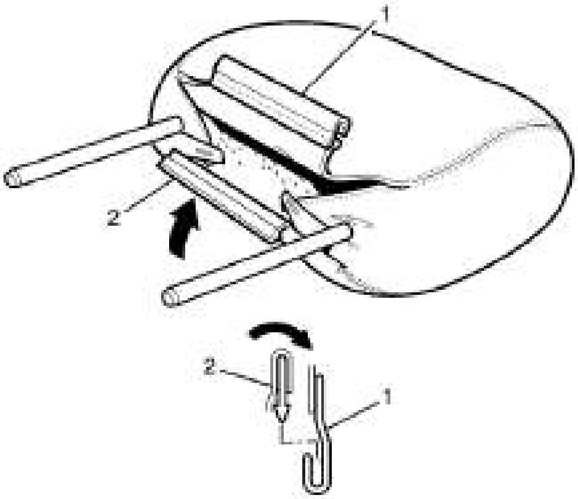
Removal Procedure

1. Remove the front seat head restraint. Refer to Front Seat Head Restraint Replacement.



2. Disengage the front head restraint cover J-strip by pulling the flap (1) back and out of flap (2) in the direction shown.
3. Pull out staples attaching cover side tabs.
4. Remove the front head restraint cover.

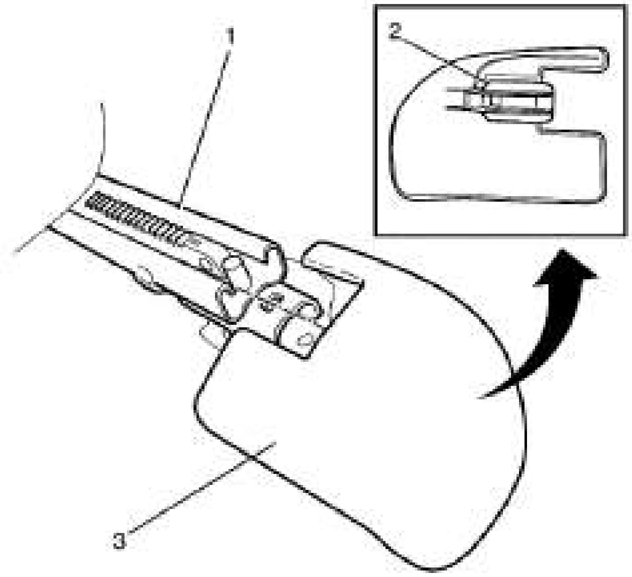
Installation Procedure



1. Install the head restraint cover.
2. Use staples to secure cover side tabs.
3. Engage the front head restraint cover J-strip by inter locking the flap (1) with flap (2) in the direction shown.
4. Install the front seat head restraint. Refer to Front Seat Head Restraint Replacement.

Driver or Passenger Seat Inner Adjuster Front Finish Cover Replacement

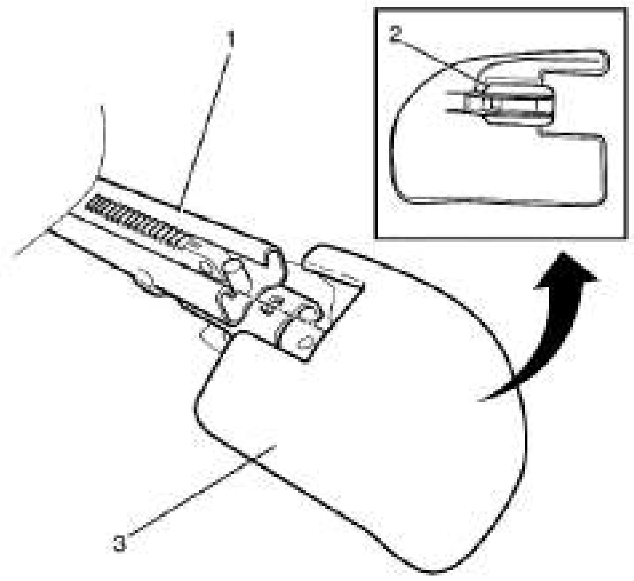
Removal Procedure



Important: Grasp the base of the front seat inner front track cover and disengage the retaining clip from the seat track (2).

Remove the front seat inner front track cover (3) from the seat track (1).

Installation Procedure



Important: Make sure to align the front seat inner front track cover (2) to the seat track (1). Listen for an audible click to indicate correct fitment of the retaining clip (2).

Install the front seat inner front track cover (3) to the seat track (1).

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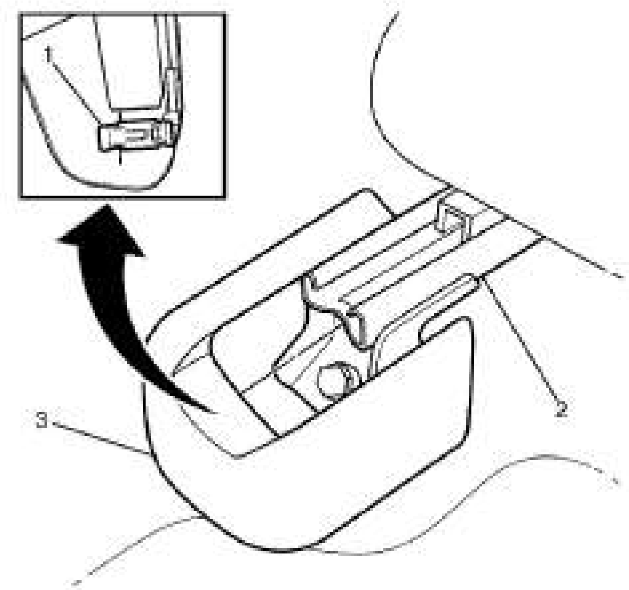
Driver or Passenger Seat Inner Adjuster Rear Finish Cover Replacement

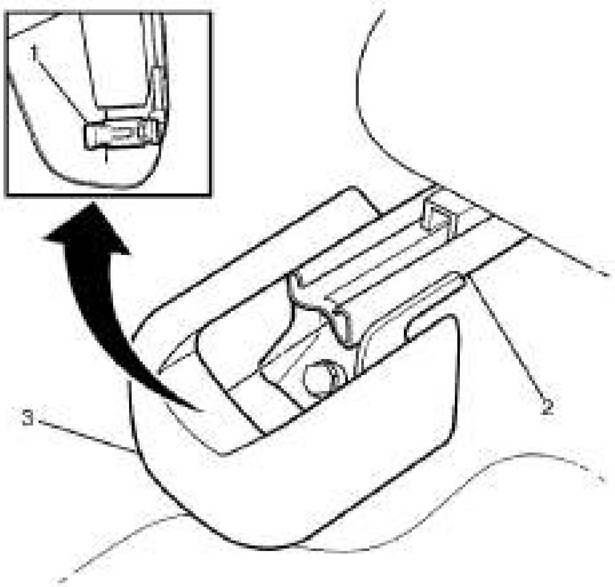
Removal Procedure



Important: Slide your hand under the outboard side of the front seat inner rear track cover (3) until you get to the rear edge, then lift upwards and rearwards to disengage the retaining clip (1) from the seat track.

Remove the front seat inner rear track cover from the seat track (2).

Installation Procedure



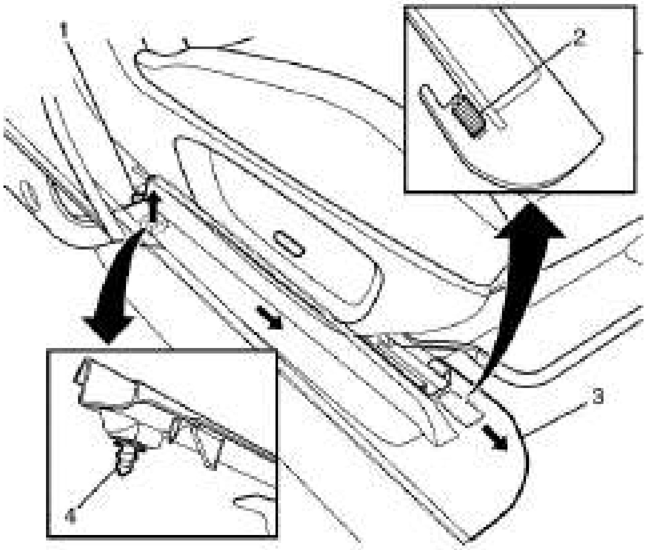
Important: Align the front seat inner rear track cover (3) with the seat track and engage the retaining clip (1).

Install the front seat rear inner rear track cover (1) to the seat track (2).

Driver or Passenger Seat Outer Adjuster Front Finish Cover Replacement

Removal Procedure

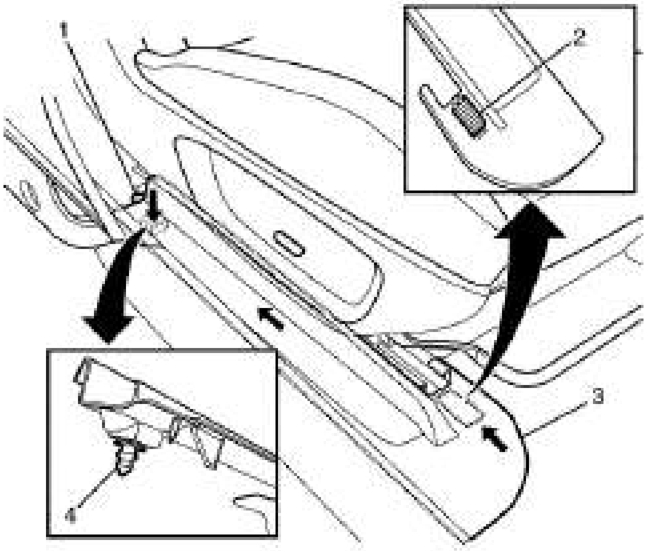
1. Remove the front seat outer rear track cover. Refer to Driver or Passenger Seat Outer Adjuster Rear Finish Cover Replacement.



Important: Grasp the rear edge of the front seat outer front track cover (1) and prise upwards to disengage the rear retainer (4).

2. Disengage the rear retainer (4) on the front seat outer front track cover (3).
3. Slide the front seat outer front track cover (3) forward to remove, making sure to disengage the front retainer (2).

Installation Procedure



1. Slide the front seat outer front track cover (3) towards to the rear of the seat, making sure to engage the front retainer (2).

   Important: Grasp the rear edge of the front seat outer front track cover (1) and push downwards to engage the rear retainer (4).

2. Engage the rear retainer (4) on the front seat outer front track cover (3).
3. Install the front seat outer rear track cover. Refer to Driver or Passenger Seat Outer Adjuster Rear Finish Cover Replacement.

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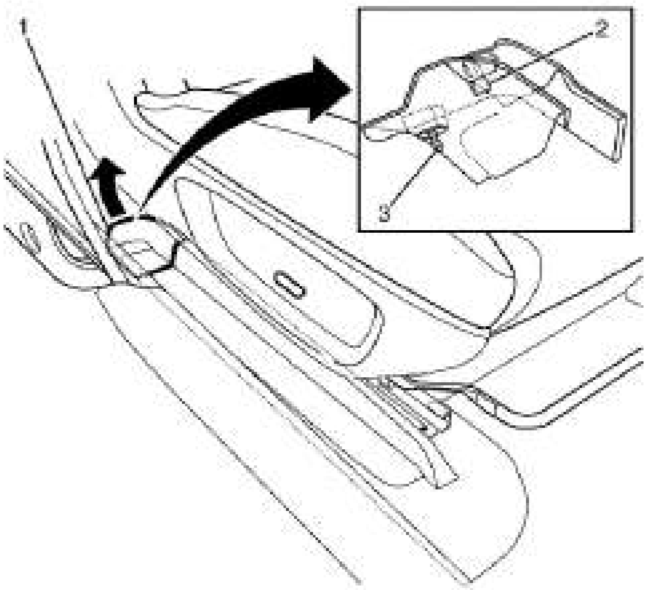
Driver or Passenger Seat Outer Adjuster Rear Finish Cover Replacement

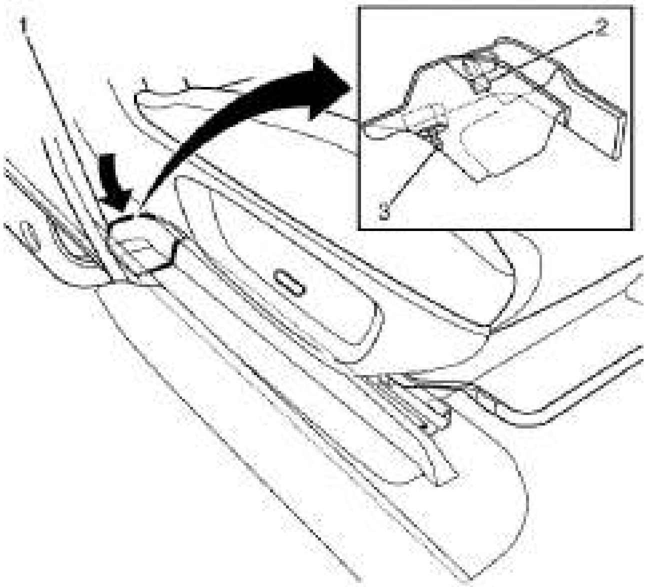
Removal Procedure



Important: Move the seat forward and grasp the rear edge of the front seat outer rear track cover (1), lift upwards to disengage the retaining clips (2 and 3).

Remove the front seat outer rear track cover (1) from the seat rail.

Installation Procedure



Important: Move the seat forward and grasp the rear edge of the front seat outer rear track cover (1), push downwards to engage the retaining clips (2 and 3).

Install the front seat outer rear track cover (1) to the seat rail.

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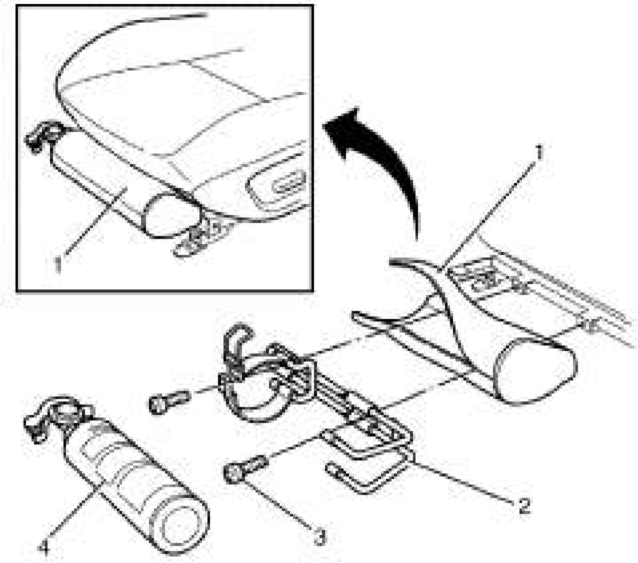
Fire Extinguisher Bracket and Cover Replacement

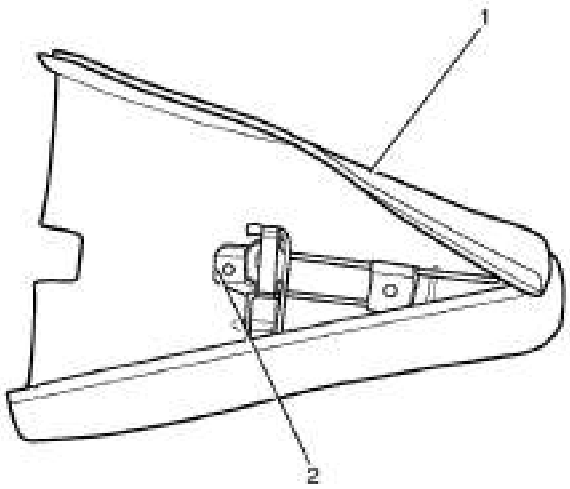
Removal Procedure

1. Adjust the passenger seat in order to obtain access to the fire extinguisher.



2. Raise the fire extinguisher cover (1) to reveal the fire extinguisher (4).
3. Unclip the fire extinguisher bracket (2) and remove the fire extinguisher (4).
4. Remove the fire extinguisher bracket to seat adjuster retaining bolts (3).
5. Remove the fire extinguisher bracket and cover.

Installation Procedure



1. Assembly the fire extinguisher cover and bracket out of the vehicle on a clean suitable work surface. As illustrated.
2. Install the fire extinguisher assembly to the seat adjuster.

   Tighten
   Tighten the retaining bolts to 18 N·m (13 lb ft).

3. Install and secure the fire extinguisher into the fire extinguisher bracket. Listen for an audible click to confirm fitting.
4. Lower the fire extinguisher cover.
5. Adjust the passenger seat back to it's original position.

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Front Seat Adjuster Replacement

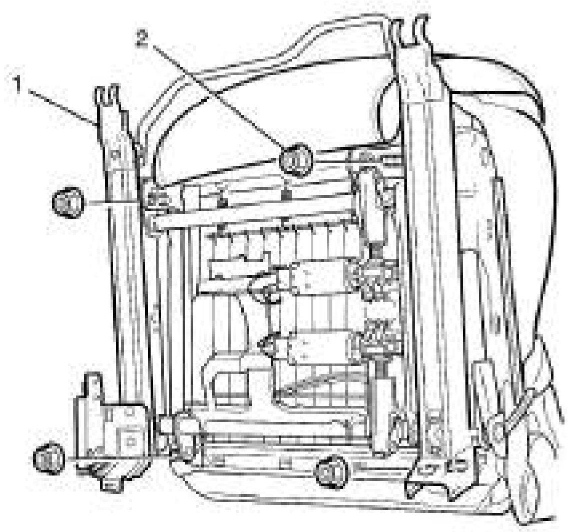
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

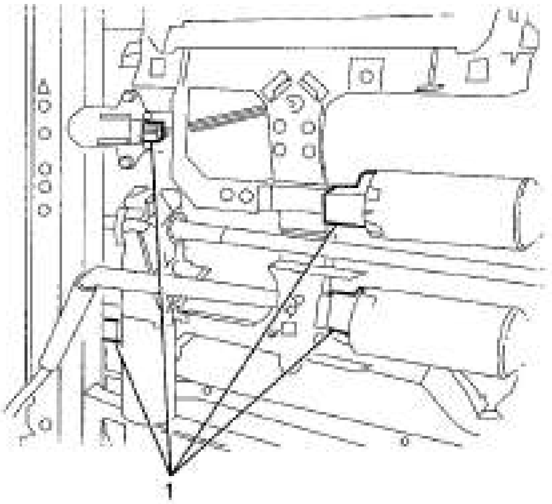
1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .

Caution: Refer to SIR Caution in the Preface section.

2. Disable the SIR system. Refer to SIR Disabling and Enabling in SIR.
3. Remove the front seat. Refer to Front Seat Replacement - Bucket .
4. Remove the outer trim panel. Refer to Seat Cushion Outer Trim Panel Replacement .
5. If required, remove the seat-belt buckle. Refer to Front Seat Belt Replacement .
6. As required, detach the seat-belt pretensioner wiring harness connector.



7. Remove the four seat adjuster retaining nuts (2) attaching the seat adjuster assembly (1) to the seat cushion frame.
8. Remove the seat adjuster assembly (1).

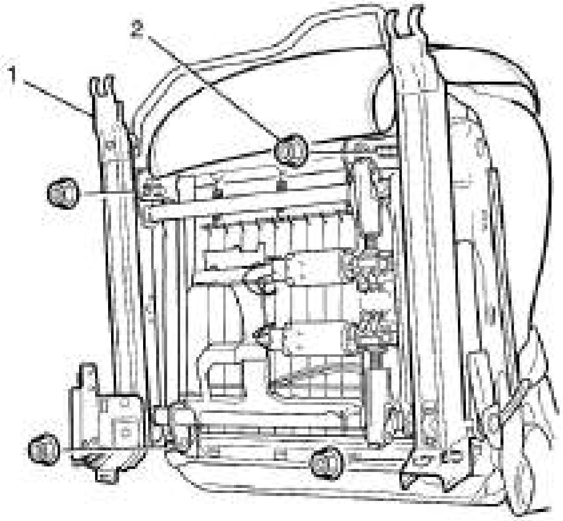


9. As required, detach the electrical wiring harness connectors (1).

Installation Procedure

1. Install the seat adjuster assembly onto the seat cushion frame.

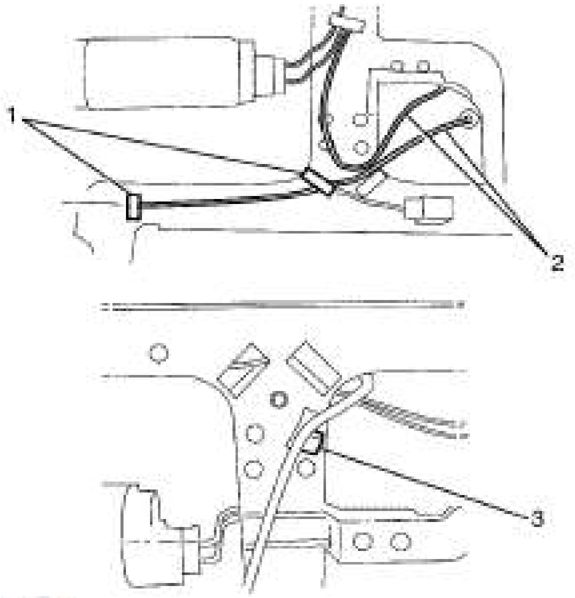
   Notice: Refer to Fastener Notice in the Preface section.



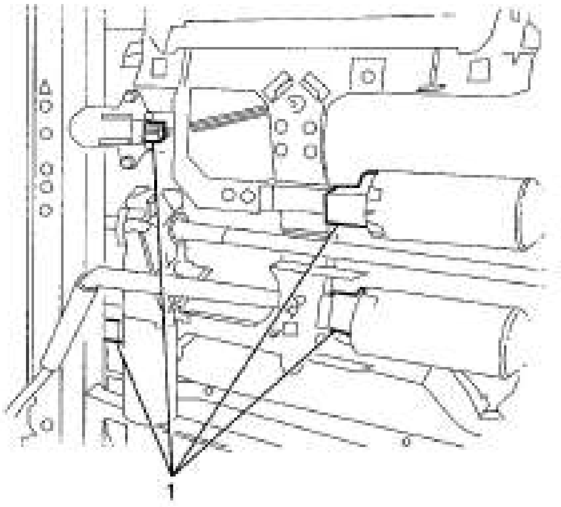
2. Install the four seat adjuster retaining nuts (2) attaching the seat adjuster assembly (1) to the seat cushion frame.

Tighten

Tighten the retaining nuts to 42 N·m (31 lb ft).



3. Ensure seat-belt pretensioner wiring harness is routed as follows:
   - Route pretensioner cable under cable tray tabs (1)
   - Direct pretensioner cable through cable tray gap (2)
   - Clip to under side of cable tray in the top hole (3)
4. As required, attach the seat-belt pretensioner wiring harness connector.



5. As required, attach the electrical wiring harness connectors (1).
6. If required, install the seat-belt buckle. Refer to Front Seat Belt Replacement .
7. Install the outer trim panel. Refer to Seat Cushion Outer Trim Panel Replacement .

8. Install the front seat. Refer to Front Seat Replacement - Bucket .

   Caution: Refer to SIR Caution in the Preface section.

9. Enable the SIR system. Refer to SIR Disabling and Enabling in SIR.
10. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
11. Test the seat for correct mechanical and electrical operation.

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Front Seat Back Replacement

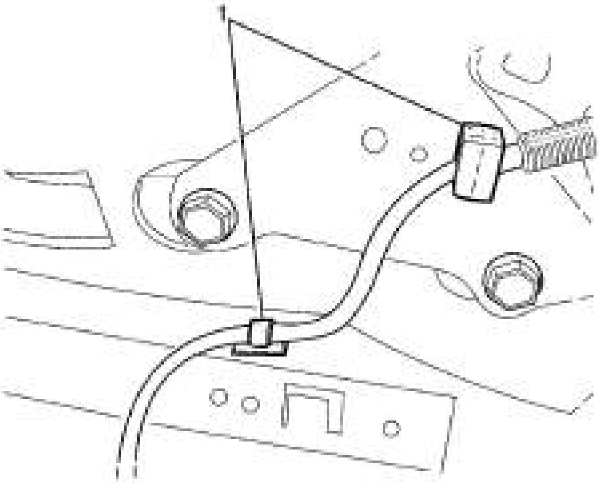
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

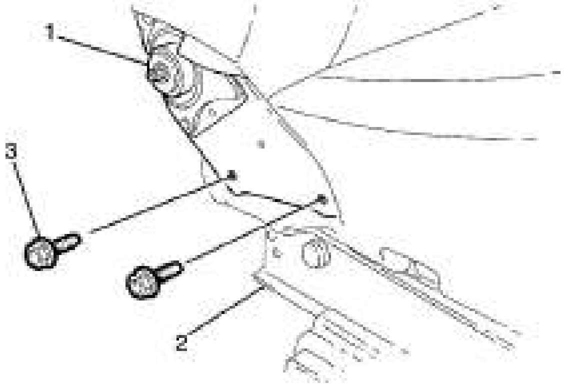
1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.

Caution: Refer to SIR Caution in the Preface section.

2. Disable the SIR system. Refer to SIR Disabling and Enabling in SIR.
3. Remove the front seat. Refer to Front Seat Replacement - Bucket.
4. Remove the outer trim panel. Refer to Seat Cushion Outer Trim Panel Replacement.
5. Remove the inner trim panel. Refer to Seat Cushion Inner Trim Panel Replacement.

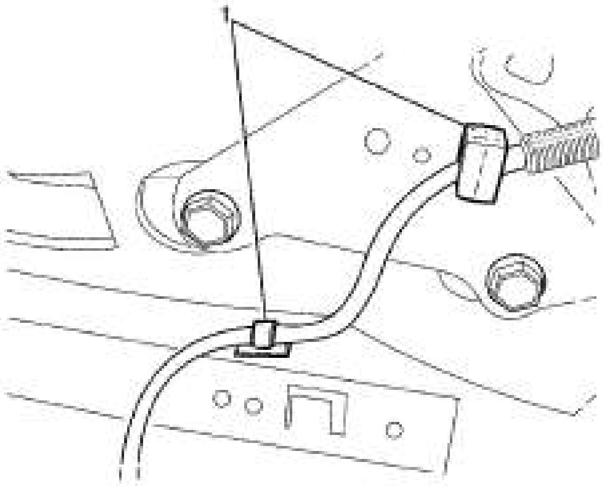


6. If required, disconnect and detach the front seat-back recline motor and side impact airbag wiring harness (1).



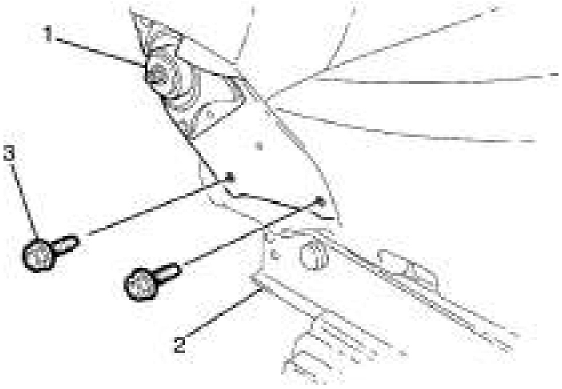
7. Remove the two seat back to seat base retaining bolts (3), each side, attaching the seat back assembly (1) to the front seat cushion frame assembly (2).
8. Remove the seat back assembly (1).

Installation Procedure



1. If removed, connect and attach the seat-back recline motor and airbag wiring harness (1).

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the two retaining bolts (3) each side, attaching the seat back assembly (1) to the front seat cushion frame assembly (2).

   Tighten
   Tighten the retaining bolts to 32 N·m (24 lb ft).

3. Install the inner trim panel. Refer to Seat Cushion Inner Trim Panel Replacement.
4. Install the outer trim panel. Refer to Seat Cushion Outer Trim Panel Replacement.
5. Install the front seat. Refer to Front Seat Replacement - Bucket.

   Caution: Refer to SIR Caution in the Preface section.

6. Enable the SIR system. Refer to SIR Disabling and Enabling in SIR.
7. Connect the battery ground cable to battery. Refer to Battery Negative Cable Disconnection and Connectionl.
8. Test seat for correct mechanical and electrical operation.

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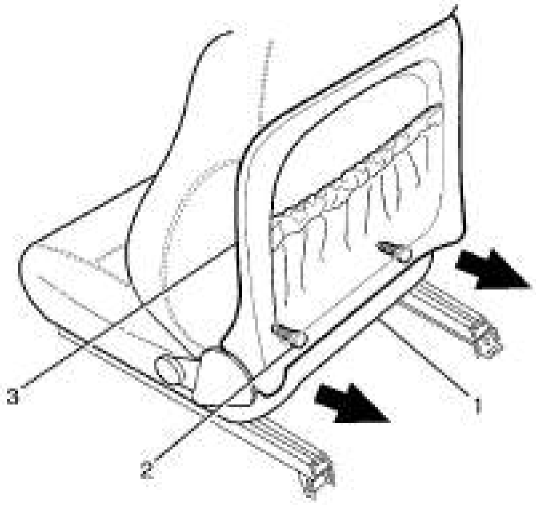
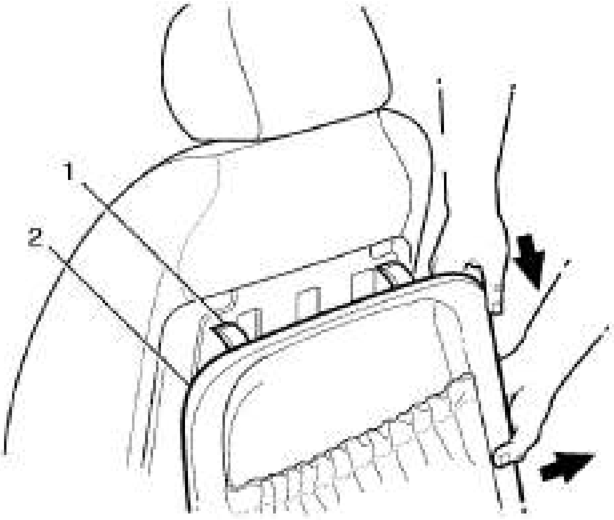
Front Seat Back Trim Replacement

Removal Procedure



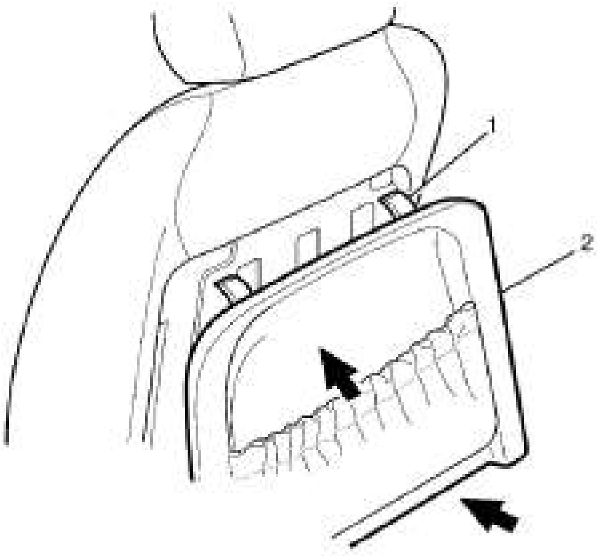
1. Pull the lower corners of the front seat-back trim (3) away from the seat (1) disengaging the two retaining clips (2).



2. While holding the lower section of the rear trim cover (2) out, pull the cover down to release the two upper retaining lugs (1).
3. Remove the rear trim cover (2).

Installation Procedure

Notice: Refer to General Repair Instructions in the Preface section.



1. Align the two upper retaining lugs (1) with the seat-back.
2. Push the front seat-back rear trim cover (2) up and in at the lower edge to engage the two lower retaining clips.

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Front Seat Cushion Cover and Pad Replacement

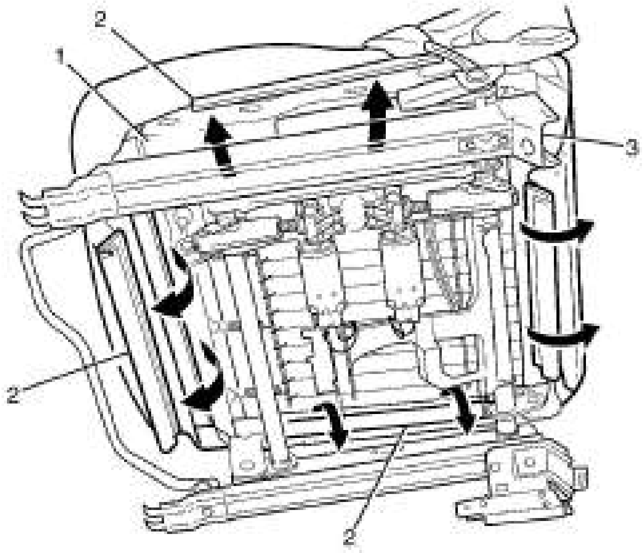
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

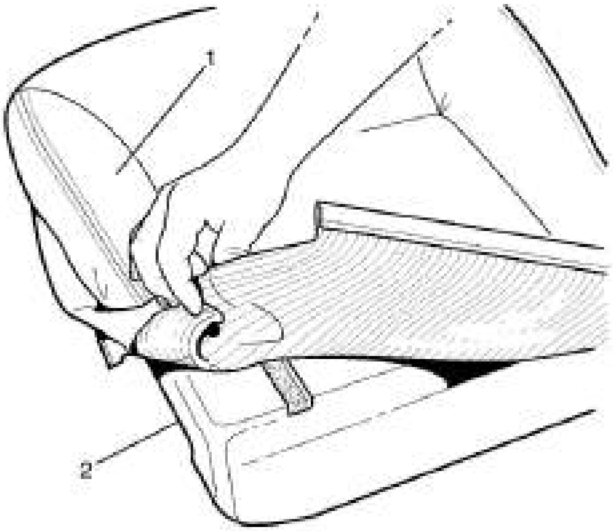
1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .

Caution: Refer to SIR Caution in the Preface section.

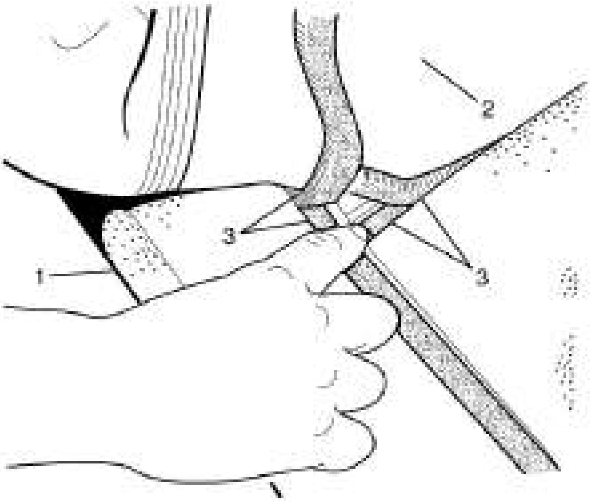
2. Disable the SIR system. Refer to SIR Disabling and Enabling in SIR.
3. Remove the front seat. Refer to Front Seat Replacement - Bucket .
4. Remove seat-back frame assembly. Refer to Front Seat Back Frame Replacement .



5. Disengage the front and side J-strips (2) away from the seat adjuster (3).
6. Lift the cover and pad assembly away from the seat frame and then release the J-strip (2).
7. Remove the pad and cover assembly (1).
8. Place pad and cover assembly on a clean and suitable work surface.

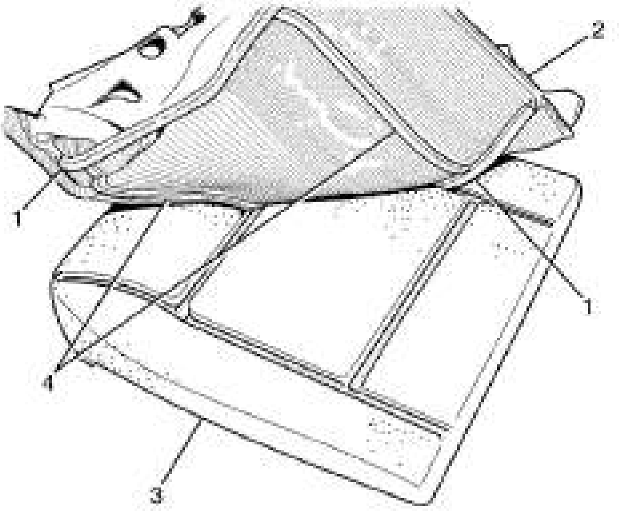


9. Fold the rear corners of the seat cushion cover (1) over the seat cushion pad (2).

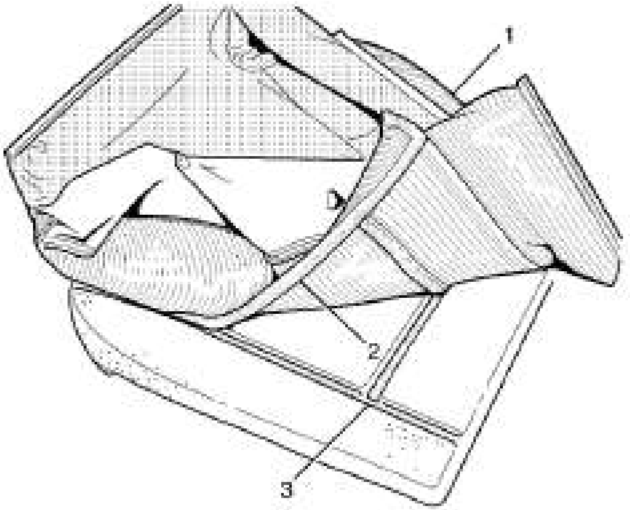


10. While holding the front seat cushion pad (1) pull the rear corners of the front seat cushion cover (2) forward and away from the pad to disengage the hook and loop strips (3).
11. Pull the cover up and over the forward edge of the pad.
12. Remove the seat cushion cover.

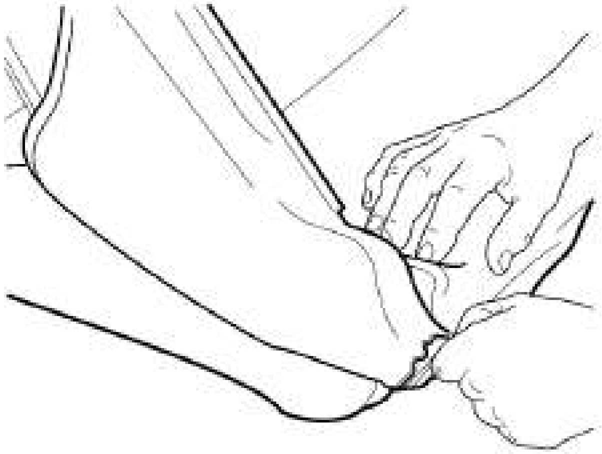
Installation Procedure



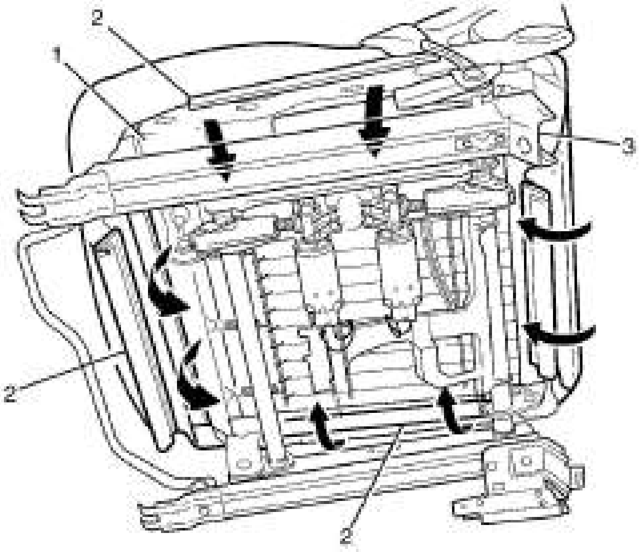
1. Align either the outer hook and loop strips (1) and the one or two cross hook and loop strips (2) on the front seat cushion cover (3) with the front seat cushion cover pad (4).
2. Press the folded edge of the seat cushion cover firmly into the corresponding groove in the pad to engage the hook and loop strip.



3. Align and press the outer hook and loop strip (1) on the cover (2) with the corresponding groove on the pad (3).



4. Roll the front corners of the seat cover over the pad.
5. Roll the sides of the seat cover over the pad.
6. Roll the rear corners of the seat cover over the pad.
7. Firmly run your finger in the seat cushion channels, to ensure a correct fitting.
8. Place seat the seat cover and pad onto the seat cushion frame.



9. Install the seat cushion (1) onto the seat adjuster assembly (3).
10. Engage the J-strips (2) onto the seat adjuster assembly (3)
11. Install the seat-back frame assembly. Refer to Front Seat Back Frame Replacement .
12. Install the front seat. Refer to Front Seat Replacement - Bucket .

Caution: Refer to SIR Caution in the Preface section.

13. Enable the SIR system. Refer to SIR Disabling and Enabling in SIR.

14. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
15. Test seat for correct mechanical and electrical operation.

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Front Seat Cushion Replacement

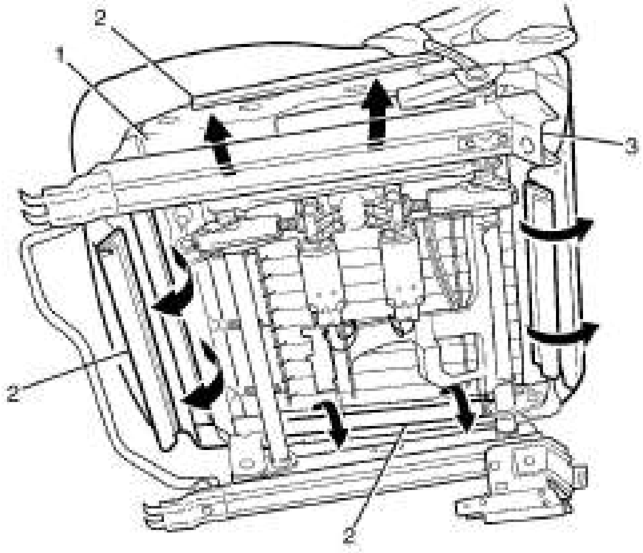
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .

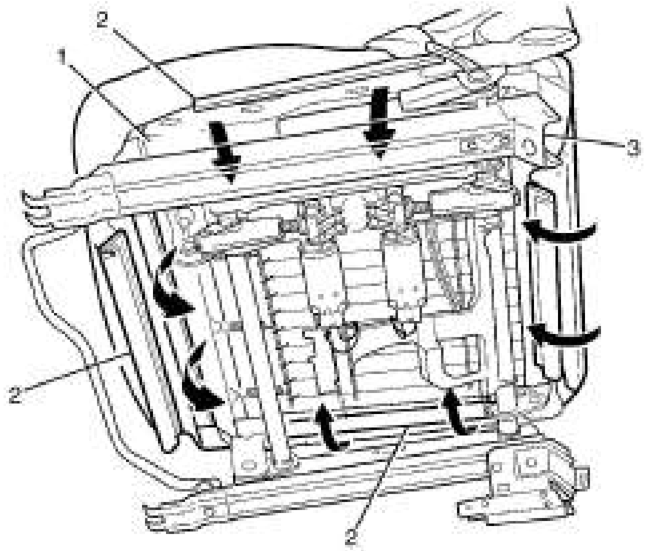
   Caution: Refer to SIR Caution in the Preface section.

2. Disable the SIR system. Refer to SIR Disabling and Enabling in SIR.
3. Remove the front seat. Refer to Front Seat Replacement - Bucket .
4. Remove the front seat adjuster. Refer to Front Seat Adjuster Replacement .
5. Remove seat-back frame assembly. Refer to Front Seat Back Frame Replacement .



6. Disengage the front and side J-strips (2) away from the seat adjuster (3).
7. Remove the front seat cushion (1).

Installation Procedure



1. Install the front seat cushion (1) onto the front seat adjuster (3).
2. Engage the front and side J-strips (2) onto the seat adjuster (3).
3. Install seat-back frame assembly. Refer to Front Seat Back Frame Replacement .
4. Install the front seat. Refer to Front Seat Replacement - Bucket .

Caution: Refer to SIR Caution in the Preface section.

5. Enable the SIR system. Refer to SIR Disabling and Enabling in SIR.
6. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
7. Test the seat for correct mechanical and electrical operation.

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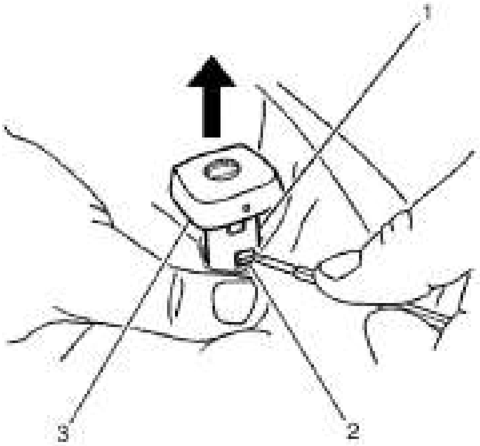
Front Seat Head Restraint Guide Replacement

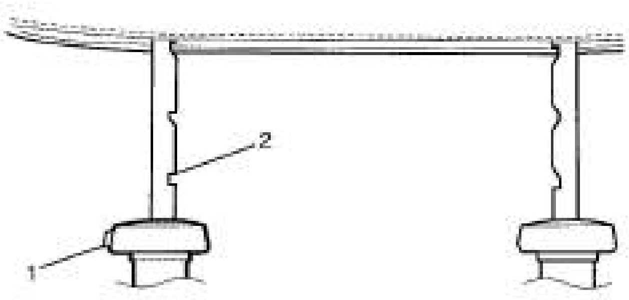
Removal Procedure

1. Remove the front seat head restraint. Refer to Front Seat Head Restraint Replacement .

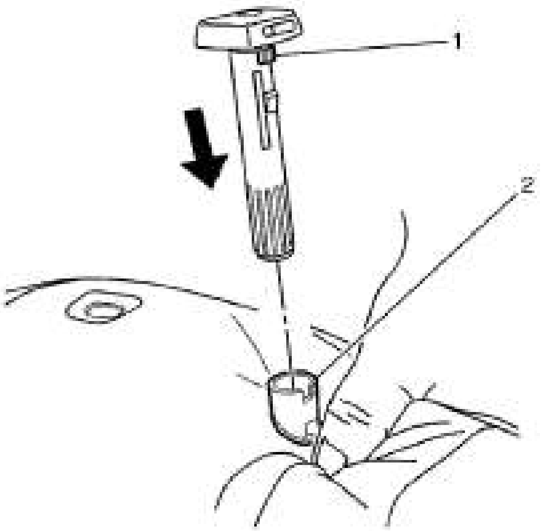


2. Push down on the seat cover to reveal the upper part of the head restraint guide (1).
3. Press the head restraint guide retaining lug (2), then remove the guide (3) from the frame.

Installation Procedure



1. Ensure the guide with the height adjuster lock (1), is installed on the left hand side of the seat and the side that corresponds the lower square notch (2) in the head restraint shaft.



2. Align the head restraint guide locating ribs (1) with the notch (2) in the seat back frame.
3. Insert the sleeve, listen for an audible click to confirm fitting.
4. Install the front seat head restraint. Refer to Front Seat Head Restraint Replacement .

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Front Seat Horizontal Adjuster Position Sensor Replacement

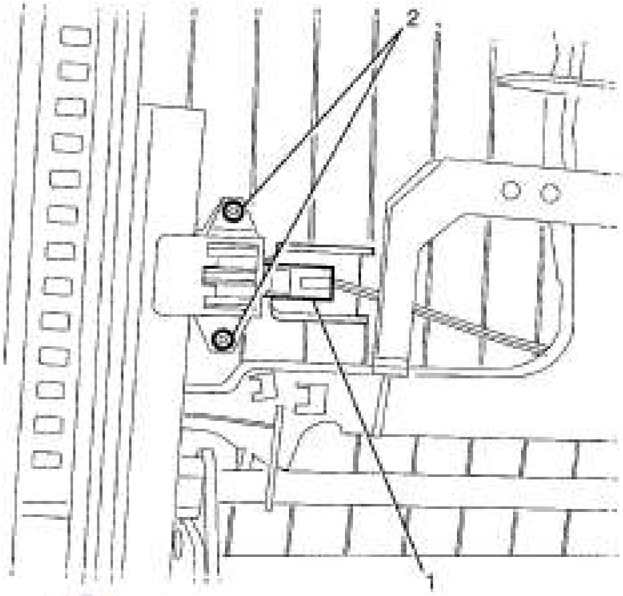
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .

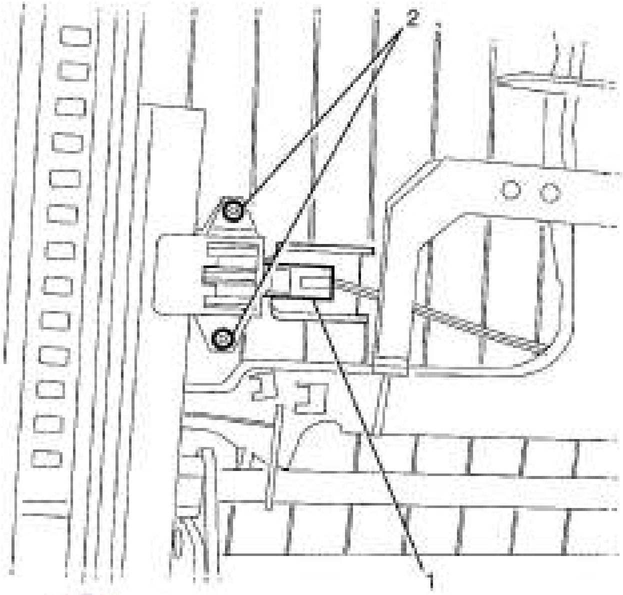
Caution: Refer to SIR Caution in the Preface section.

2. Disable the SIR system. Refer to SIR Disabling and Enabling .
3. Remove the front seat. Refer to Front Seat Replacement - Bucket .
4. Place the front seat on a clean and suitable work surface.



5. Disconnect the track position sensor electrical connector (1).
6. Using a suitable drill bit and drill, remove the pop rivets (2) that secure the track position sensor to the track position sensor bracket.
7. Remove the track position sensor.

Installation Procedure



1. Align the track position sensor with the track position sensor bracket.
2. Using a universal pop rivet gun and pop rivets (2) secure the track position sensor to the track position bracket.
3. Connect the track position sensor electrical connector (1).
4. Install the front seat. Refer to Front Seat Replacement - Bucket .

Caution: Refer to SIR Caution in the Preface section.

5. Enable the SIR system. Refer to SIR Disabling and Enabling .
6. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
7. Test the front seat for correct mechanical and electrical operation.

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Front Seat Replacement - Bucket

Removal Procedure

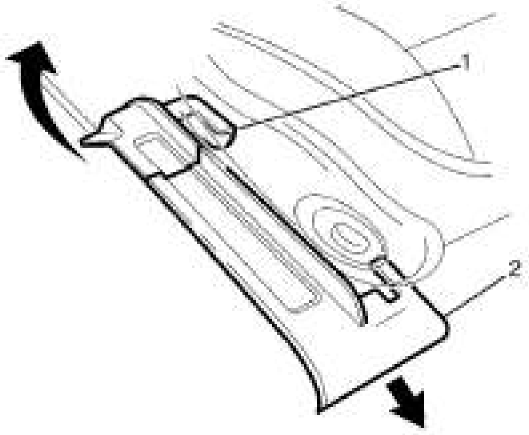
Caution: Refer to Battery Disconnect Caution in the Preface section.

Notice: Refer to General Repair Instructions in the Preface section.

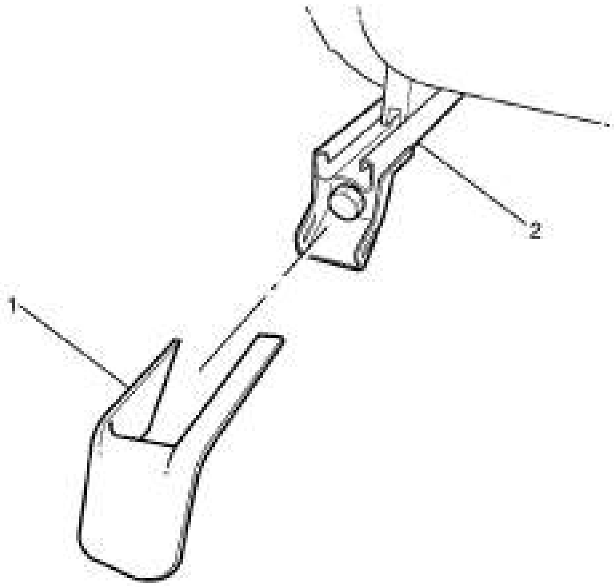
1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection in Engine Electrical.

Caution: Refer to SIR Caution in the Preface section.

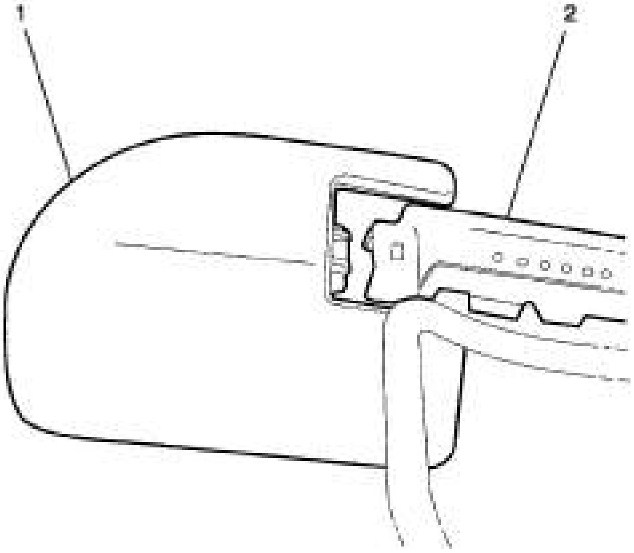
2. Disable the SIR system. Refer to SIR Disabling and Enabling in SIR.



3. Slide your hand around and under the inboard side of the rear outer cover (1) until you get to the rear edge, then lift upwards to disengage the retaining clip and remove cover.
4. Using a long flat head screwdriver, prise the rear edge of the front outboard cover (2) upwards, to disengage the clip.
5. Slide the front outboard cover (2) forward to remove.



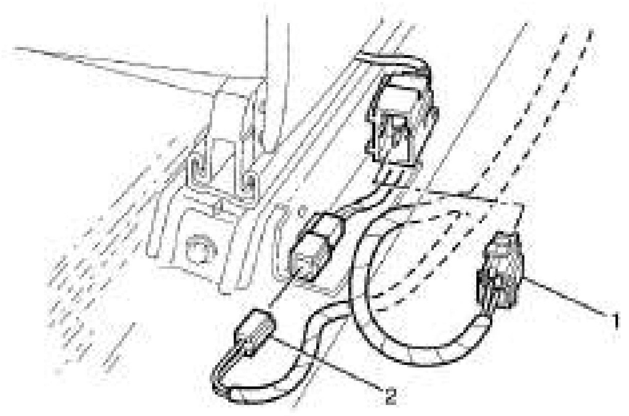
6. Remove the rear inner cover, by sliding your hand under the outboard side of the cover until you get to the rear edge, then lift upwards and rearwards to disengage the retaining clip.



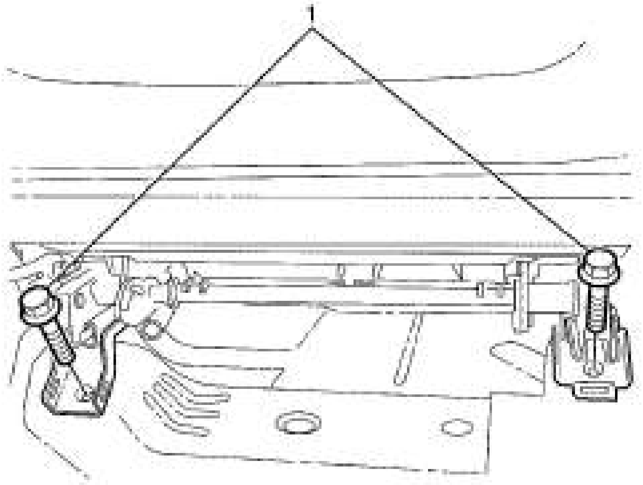
7. Remove the front seat track cover (1) by grasping the base of the cover and disengaging the retaining clip from the seat track (2).

Notice: Refer to General Repair Instructions in the Preface section.

Notice: Refer to Battery Negative Cable Disconnection and Connection in the Preface section.



8. Disconnect the front seat electrical connector (1), if fitted, and the seatbelt pretensioner electrical connector (2).



9. Remove the front seat rear retaining bolts (1).

Notice: Refer to General Repair Instructions in the Preface section.

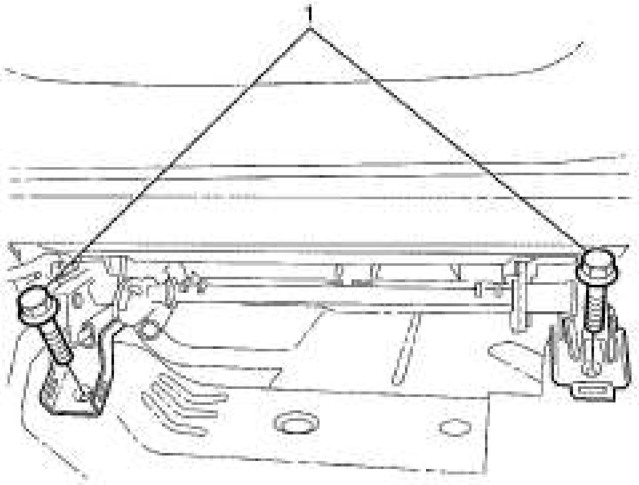
10. With the aid of an assistant remove the front seat, by lifting and tilting the seat forward, and then lifting and pulling the seat rearwards to disengage the front hooks.

Installation Procedure

Important: Physically inspect each hook to ensure it is correctly engage.

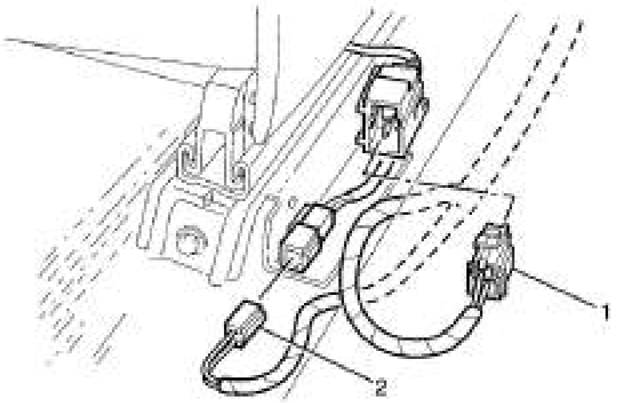
1. Engage the front seat retaining hooks into the slots in the body and slide the seat forward and down.

   Notice: Refer to Fastener Notice in the Preface section.



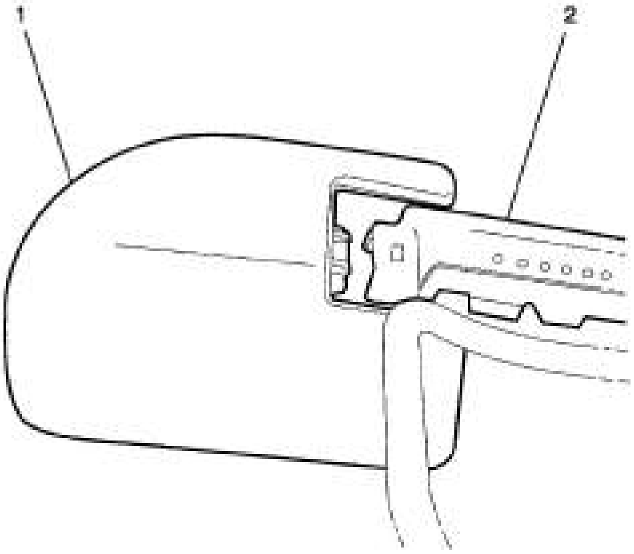
2. Install the front seat retaining bolts (1).

   Tighten
   Tighten the retaining bolts to 42 N·m (31 lb ft).

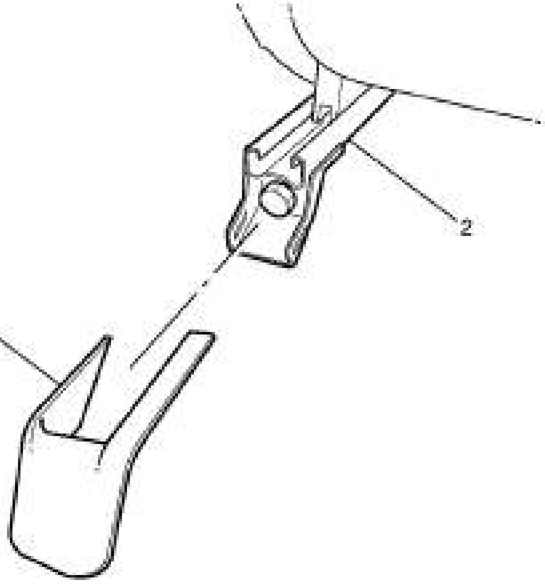


3. Connect the front seat electrical connector (1), if fitted, and the seatbelt pretensioner

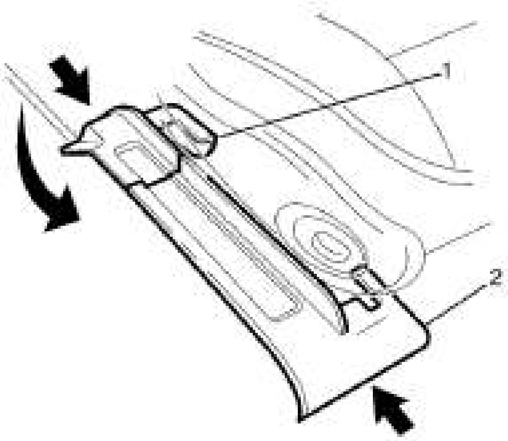
electrical connector (2) and the side air bag electrical connector, if fitted.



4. Install the front seat rail cover (1) by alining the cover with the seat track (2) and engaging the retaining clip.



5. Install the front seat rear inner retaining bolt cover (1) to the seat track (2).



6. Slide the lug on the front outer cover (2) into the outboard (1) seat rail.
7. Ensure the barb on the front outer cover (located 10cm rear of the front edge) engages with the carpet retainer trim.
8. Slide the cover fully rearwards, then push the cover down to engage the middle and rear most clip.
9. Line up the alignment tab on the rear outer cover with the slot on the front over cover.
10. Push downwards on the rear outer cover (1) to secure it to the seat rail and front outer cover. Listen for an audible click to confirm fitting.

    Caution: Refer to SIR Caution in the Preface section.

11. Enable the SIR system. Refer to SIR Disabling and Enabling in SIR.
12. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
13. Test the front seat for correct mechanical and electrical operation.

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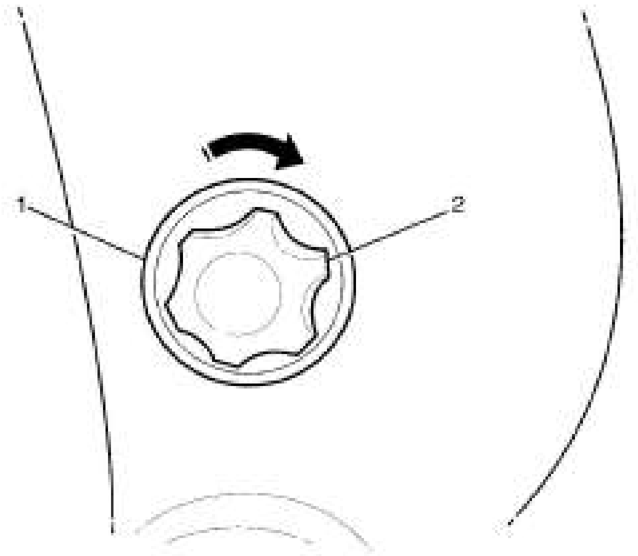
Lumbar Support Knob Replacement

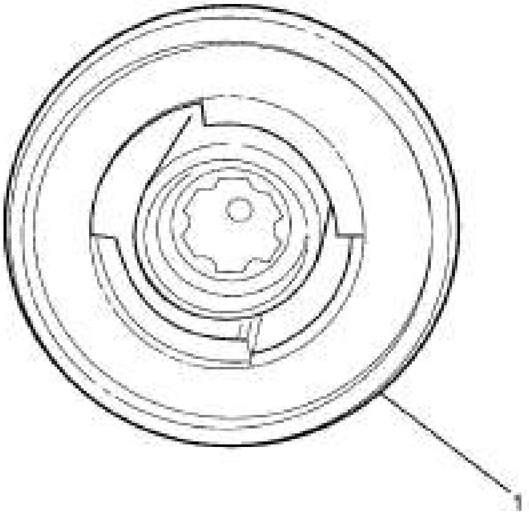
Removal Procedure



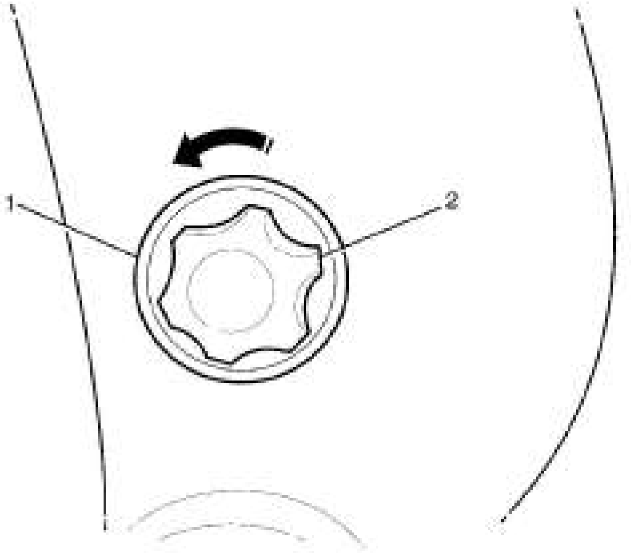
1. Turn the lumbar support adjuster deflector ring (1) clockwise until it is released from the adjuster shaft.
2. Remove the deflector ring (1) and knob assembly (2) by firmly pulling forward.

Installation Procedure

Notice: Refer to General Repair Instructions in the Preface section.



1. Install the deflector ring (1) onto the adjustment shaft.

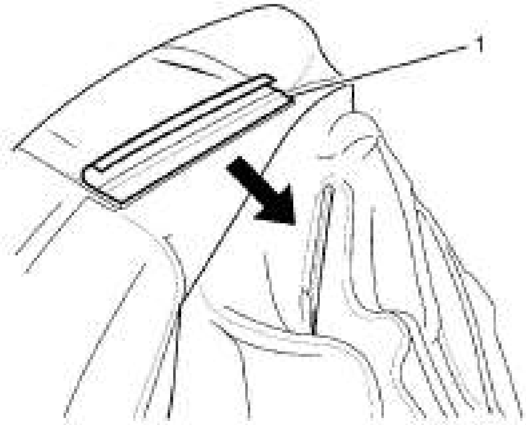


2. Twist the lumbar support deflector ring (1) anti-clockwise until it locks into place on the adjustment shaft, listen for an audible click to confirm fitting.
3. Install the lumbar support knob assembly (2) by firmly pushing it onto the adjuster shaft.
4. Test lumbar support assembly for correct operation.

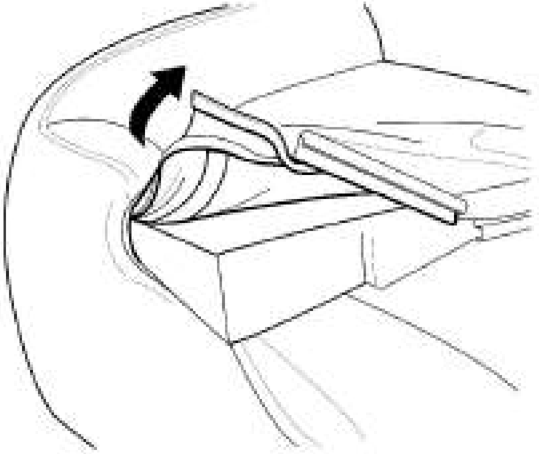
Rear Folding Seat Back Cover Replacement (Sedan)

Removal Procedure

1. Remove seat cushion. Refer to Rear Seat Cushion Replacement.
2. Remove the rear seat back. Refer to Rear Seat Back Replacement in Seats.
3. If fitted, remove head restraints. Refer to Rear Seat Head Restraint Replacement.
4. Place seat on suitable work surface.
5. Turn seat over on its front.

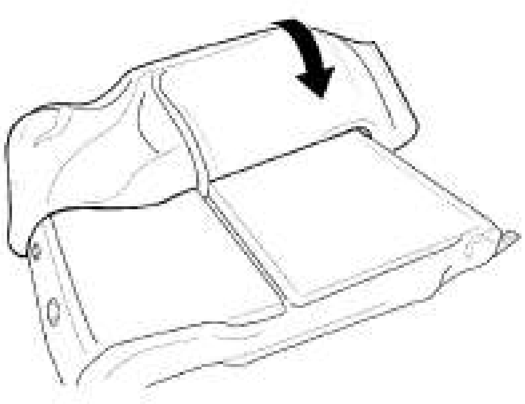


6. Detach the J-strips (1) retaining the back of the cover to the seat pad and frame.

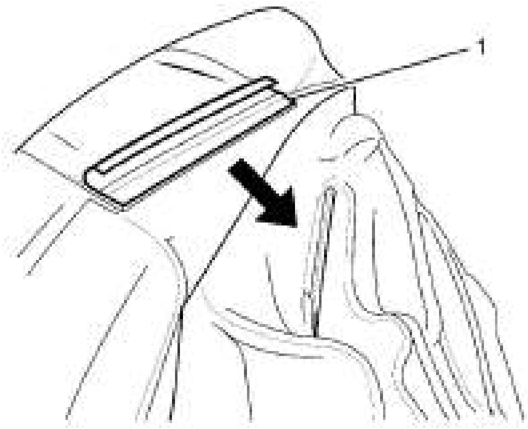


7. While holding the seat back pad, remove the seat back cover.

Installation Procedure



1. Align the aplix with the seat cover.
2. Install the seat cover.
3. Turn the seat back over on its front.



Important: When installing the seat cover, pull the cover tight in all corners to ensure no lumps will occur.

4. Attach the seat back cover J-strips to the seat back pad and frame.

5. If fitted, install head restraints. Refer to Rear Seat Head Restraint Replacement.
6. Install the rear seat back. Refer to Rear Seat Back Replacement in Seats.
7. Install seat cushion. Refer to Rear Seat Cushion Cover and Pad Replacement.

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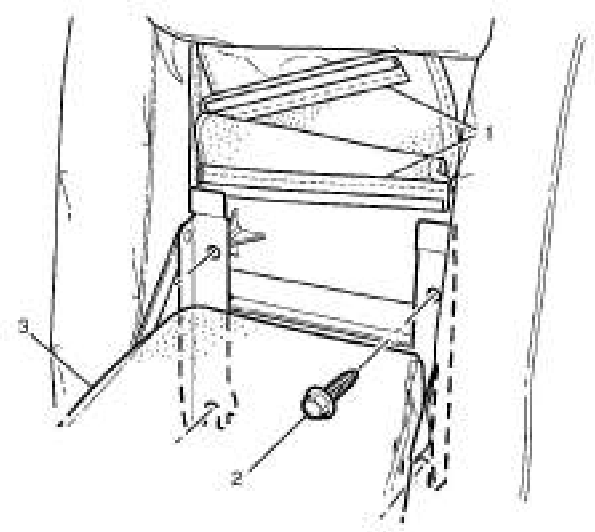
Rear Seat Armrest Replacement (Sedan)

Removal Procedure

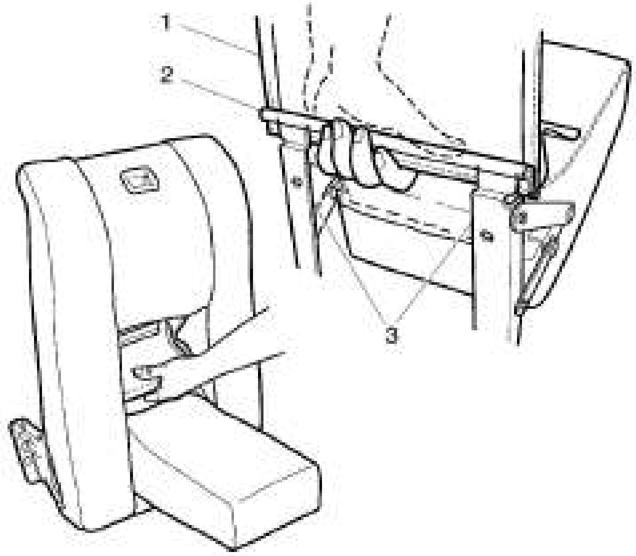
1. Remove the rear seat back. Refer to Rear Seat Back Replacement in Seats.
2. Remove the rear seat back folding. Refer to Rear Split Folding Seat Back Cushion Cover and Pad Replacement in Seats.
3. Place the centre seat on a suitable work surface.



4. Lower the arm rest assembly (3) and disengage the trim flap (1) from the armrest hinge to obtain access to the retaining bolts (2).
5. Remove the top two retaining bolts from the armrest hinge then loosen the two lower retaining bolts.
6. Remove the armrest assembly (3) by sliding it up and out.

Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



1. Install the armrest assembly, to the seat back tray.
2. Install the four attaching screws.

   Tighten
   Tighten the bolts to 4 N·m (35 lb in).

3. Install the armrest trim flap (1) upper J-strip (2), to the upper part of the hinge bracket (3).
4. Install the armrest trim flap (1) J-strip to the lower part of the hinge bracket (3).
5. Install the rear centre seat back. Refer to Rear Split Folding Seat Back Cushion Cover and Pad Replacement in Seats.
6. Install the rear seat back. Refer to Rear Seat Back Replacement in Seats.

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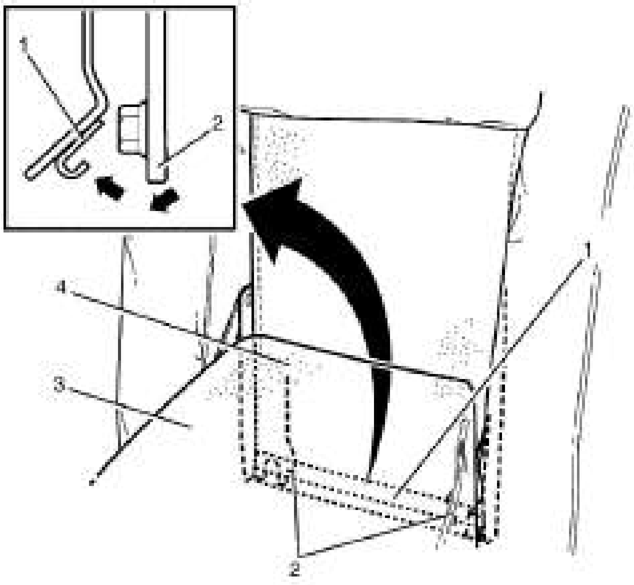
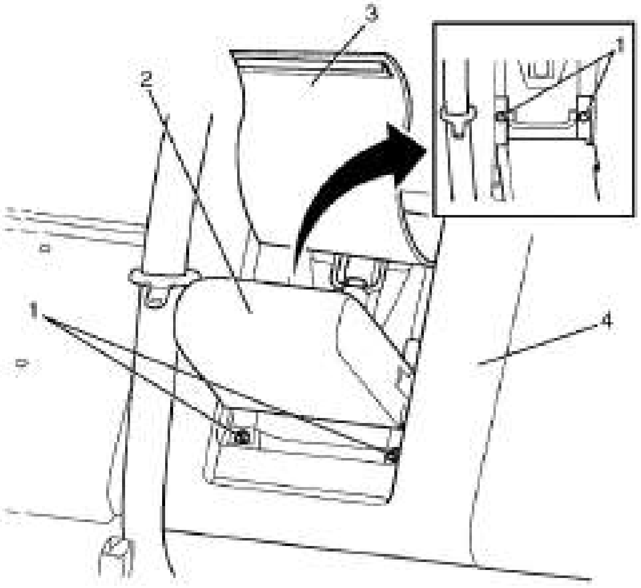
Rear Seat Armrest Replacement (Sportwagon)

Removal Procedure



Important: Adjust the armrest (3) to a suitable position to access the right rear seat back cover retainer (1).

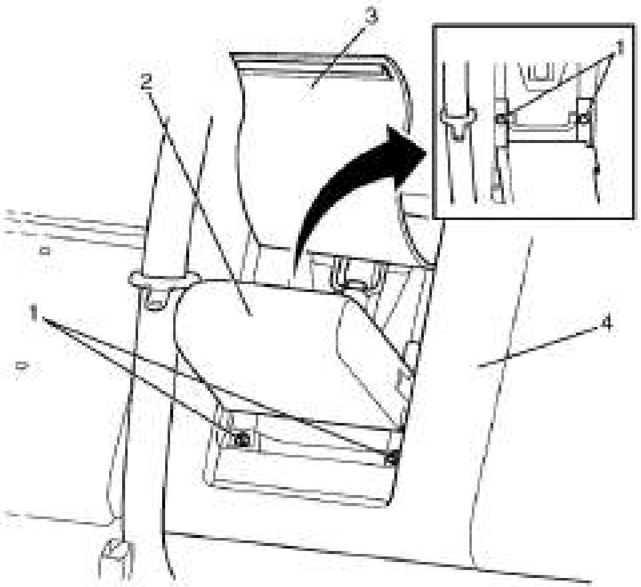
1. Carefully pull down on the right rear seat back cover retainer (1) and detach the trim flap (4) from the trim flap retainer (2).



Important: Lift the right rear seat back cover trim flap (3) to expose the armrest to right rear seat back frame retaining bolts (1).

2. Remove the right rear seat back armrest to the right rear seat back frame retaining bolts (1).
3. Remove the right rear seat back armrest assembly (2) from the right rear seat back assembly (4).

Installation Procedure

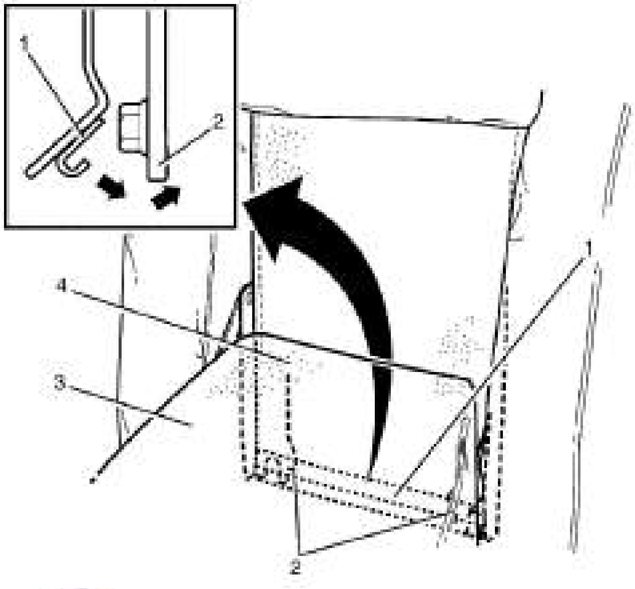


1. Install the right rear seat back armrest assembly (2) to the right rear seat back assembly (4).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the right rear seat back armrest to right rear seat back frame retaining bolts (1).

   Tighten
   Tighten the bolts to 8 N·m (31 lb in).



Important: Adjust the armrest (3) to a suitable position to access the right rear seat back cover retainer (1).

3. Carefully pull down on the right rear seat back cover retainer (1) and attach the trim flap (4) to the trim flap retainer (2).

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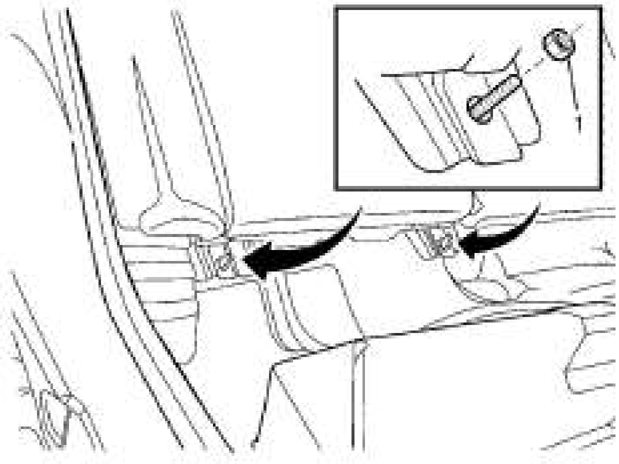
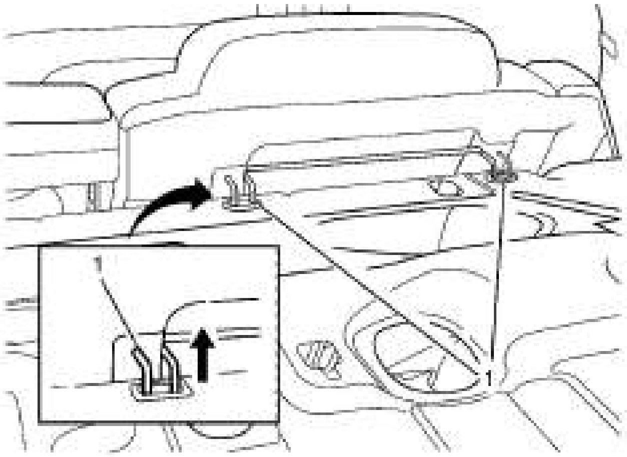
Rear Seat Back Cushion Replacement

Removal Procedure

1. Remove the seat cushion. Refer to Rear Seat Cushion Replacement.



2. Remove the two retaining bolts (1) attaching the seat back to body panel.

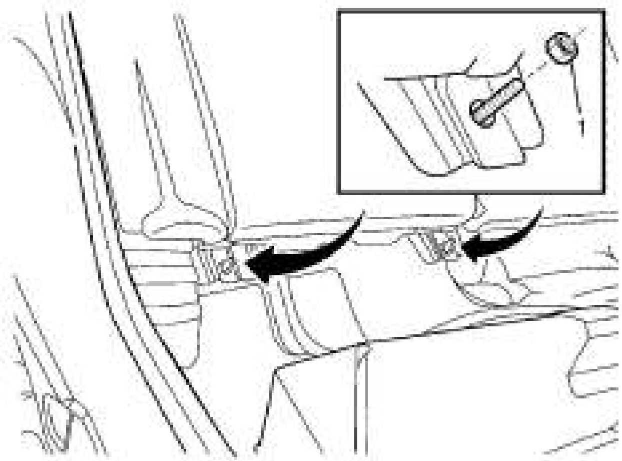


3. Remove the seat back out of the retaining slots (1).
4. Remove the seat back.

Installation Procedure

1. Install the seat back into the retaining slots.

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the two seat back retaining nuts (1).

   Tighten
   Tighten the nuts to 27 N·m (20 lb ft).

3. Install the seat cushion. Refer to Rear Seat Cushion Replacement.

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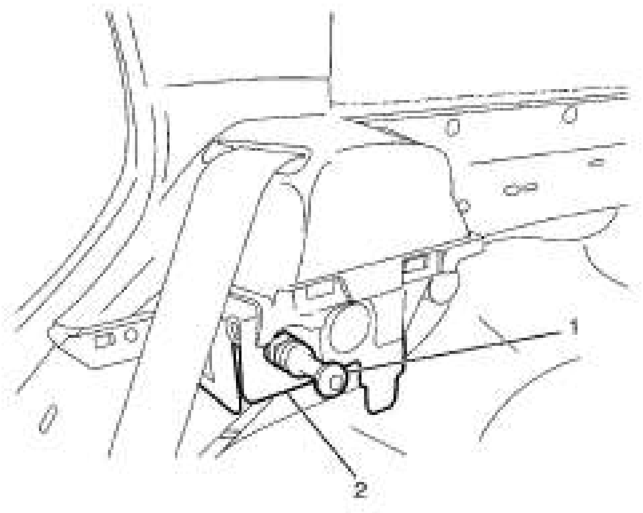
Rear Seat Back Cushion Stop Striker Replacement

Removal Procedure

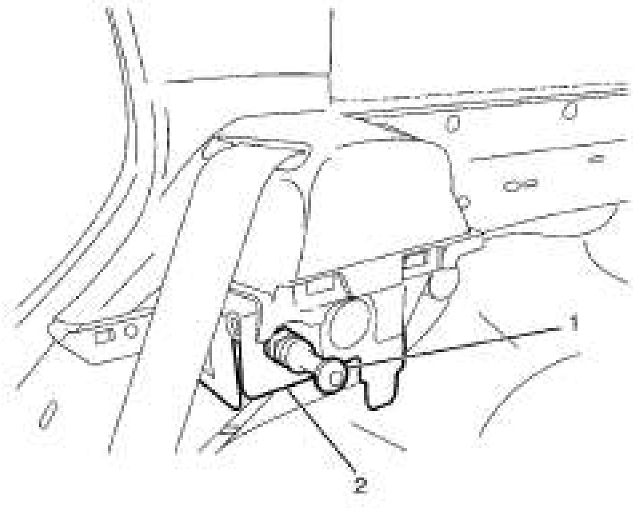
1. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement.
2. Remove the rear seat back bolster. Refer to Rear Split Folding Seat Back Bolster Replacement.
3. Remove the luggage shade. Refer to Luggage Shade Replacement.
4. Remove the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
5. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
6. Remove the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
7. Remove the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
8. Remove the quarter inner finish trim panel. Refer to Quarter Inner Trim Finish Panel Replacement.



9. Remove the rear seat back cushion stop striker (1) from the body lock pillar inner panel bracket (2).

Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



1. Install the rear seat back cushion stop striker (1) to the body lock pillar inner panel bracket (2).

   Tighten
   Tighten the striker to 70 N·m (52 lb ft).

2. Install the quarter inner finish trim panel. Refer to Quarter Inner Trim Finish Panel Replacement.
3. Install the load floor front panel carpet. Refer to Load Floor Front Panel Carpet Replacement.
4. Install the load floor stationary panel carpet. Refer to Load Floor Stationary Panel Carpet Replacement.
5. Install the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement.
6. Install the rear end trim finish panel. Refer to Rear End Trim Finish Panel Replacement.
7. Install the luggage shade. Refer to Luggage Shade Replacement.
8. Install the seat back bolster. Refer to Rear Split Folding Seat Back Bolster Replacement.
9. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.
10. Check rear seat back latch operation.

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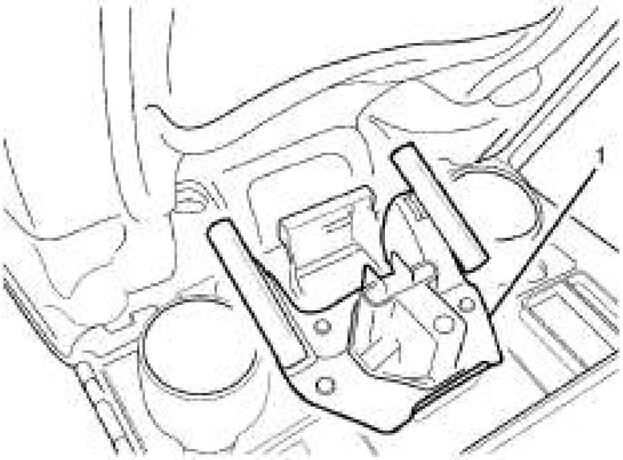
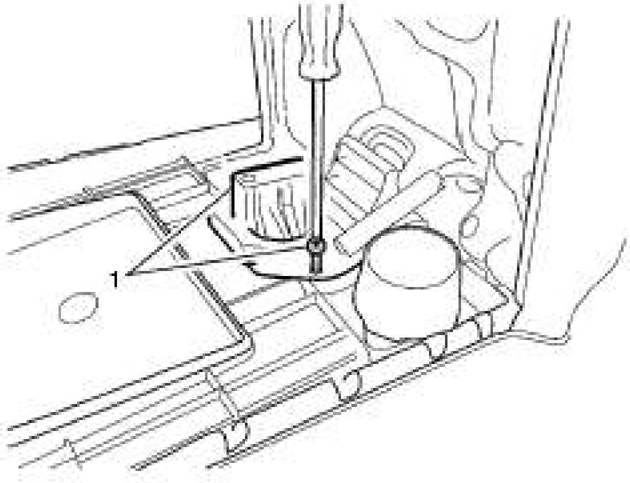
Rear Seat Back Latch Replacement (Sedan)

Removal Procedure

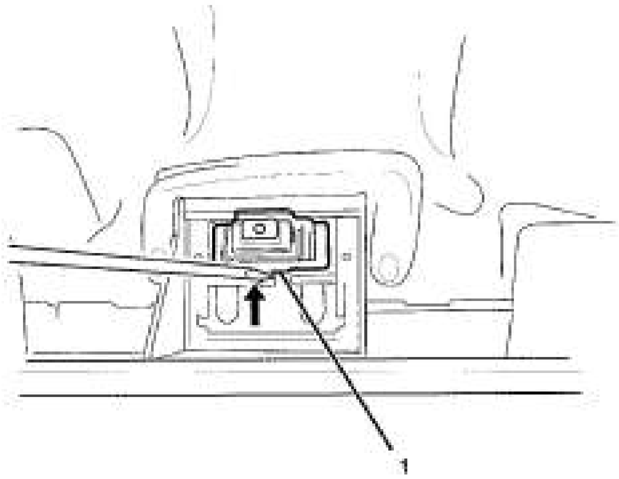
1. Remove the rear seat back. Refer to Rear Seat Back Replacement.
2. Remove the rear set back folding. Refer to Rear Split Folding Seat Back Replacement.



3. Detach seat back cover and lift to expose latch assembly (1).



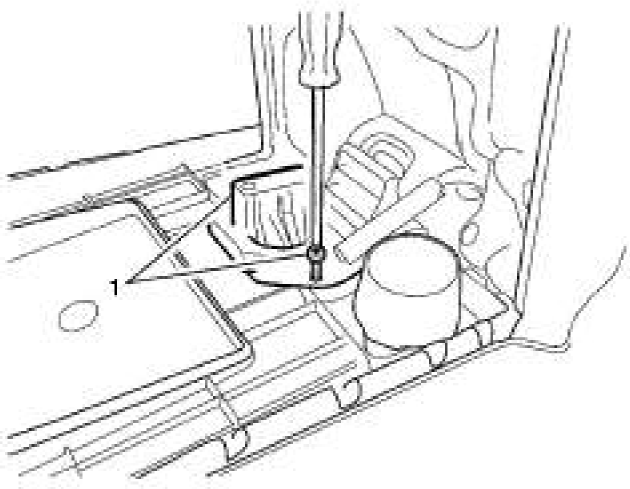
4. Remove the retaining screws (1) attaching the lock actuator to the seat back tray.
5. Remove the lock actuator from the seat back tray.



6. Using a suitable screwdriver, depress the tang (1) on the front of the release button.
7. Remove the release button from the rear centre seat back.

Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



1. Install the lock actuator onto the seat back tray.

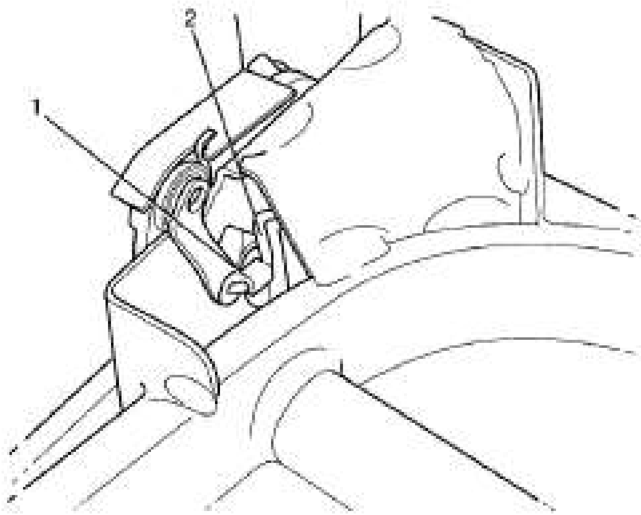
Tighten
Tighten the screws (1) to 2 N·m (18 lb in).

2. Install the rear centre seat back cover. Refer to Rear Split Folding Seat Back Cushion Cover and Pad Replacement in Seats.
3. Install the centre seat back release button, listen for an audible click to confirm fitting.
4. Remove the rear set back folding. Refer to Rear Split Folding Seat Back Replacement in Seats.
5. Install the rear seat back. Refer to Rear Seat Back Replacement in Seats.
6. Operate release button, to ensure correct operation.

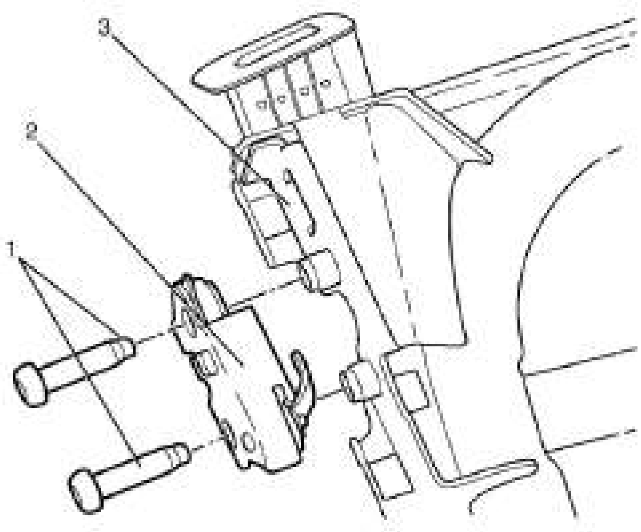
Rear Seat Back Latch Replacement (Sportwagon)

Removal Procedure

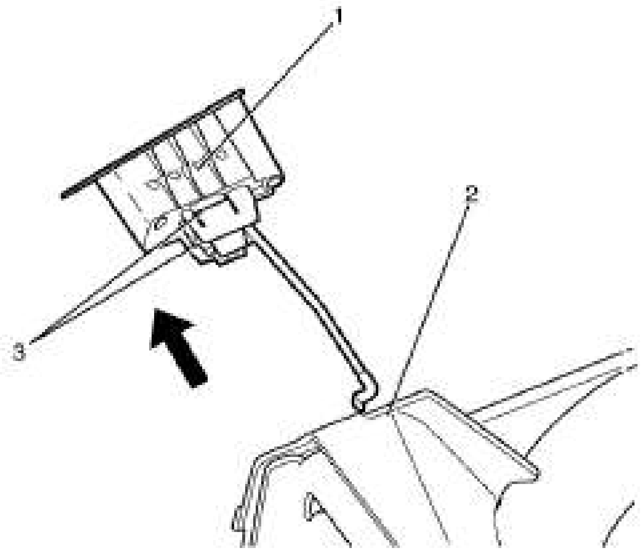
1. Remove the rear seat cushion assembly. Refer to Rear Seat Cushion Replacement.
2. Remove the appropriate rear seat back assembly. Refer to Rear Seat Back Cushion Replacement.
3. Remove the appropriate rear seat cover and pad. Refer to Rear Seat Cushion Cover and Pad Replacement.



4. Remove the seat lock linkage (2) from the linkage retainer clip (1).



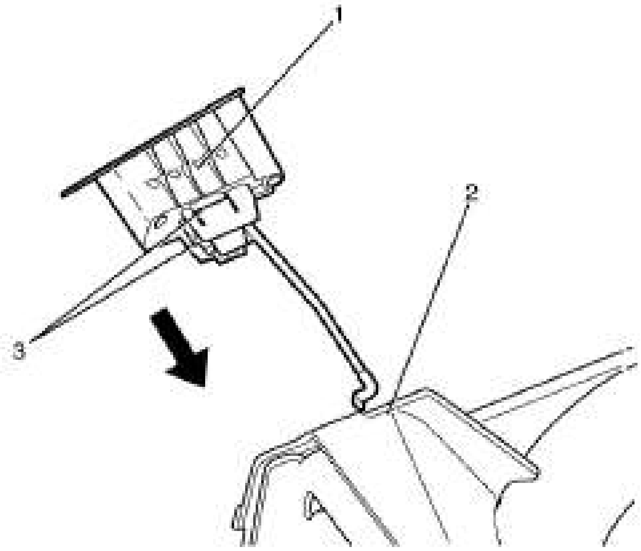
5. Remove the seat lock to seat frame retaining bolts (1).
6. Remove the seat lock (2) from the seat frame (3).



Important: Care must be taken not to damage the seat release handle assembly retainers (3).

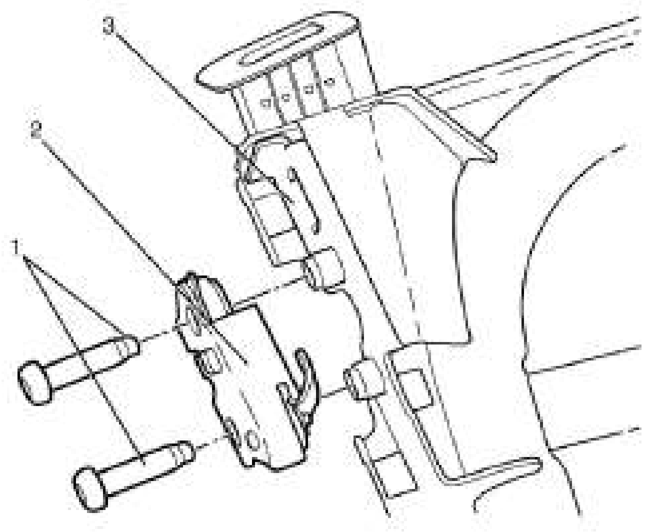
7. Using a suitable tool detach the seat release handle assembly retainers (3).
8. Remove the seat release handle assembly (1) from the seat frame (2).

Installation Procedure



Important: Listen for an audible click to confirm correct installation of the seat release handle assembly retainers (3).

1. Install the seat release handle assembly (1) to the seat frame (2).

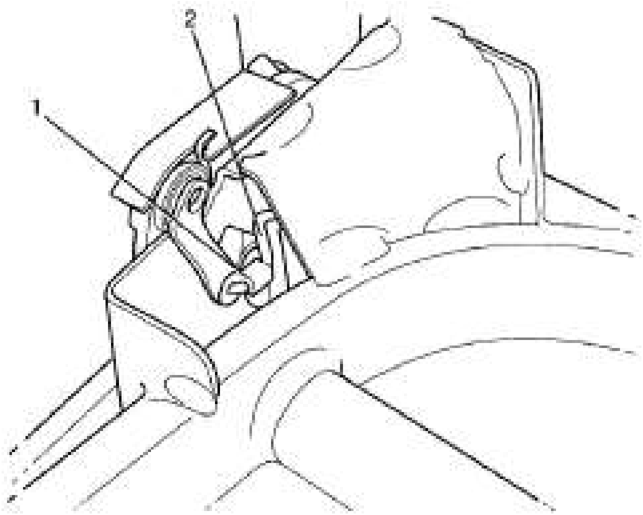


2. Install the seat lock (2) to the seat frame (3).

Notice: Refer to Fastener Notice in the Preface section.

3. Install the seat lock to seat frame retaining bolts (1).

Tighten
Tighten the bolts to 43 N·m (31 lb ft).

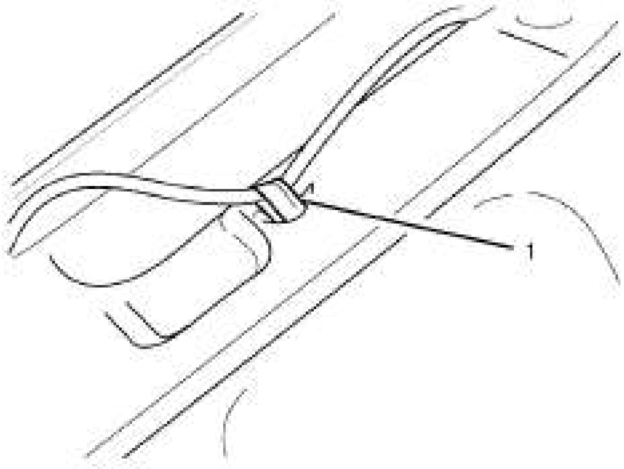


4. Install the seat lock linkage (2) to the retainer clip (1).
5. Attach the linkage retainer clip (1) to the seat lock linkage (2).
6. Install the appropriate rear seat cover and pad. Refer to Rear Seat Cushion Cover and Pad Replacement.
7. Install the appropriate rear seat back assembly. Refer to Rear Seat Back Cushion Replacement.
8. Install the rear seat cushion assembly. Refer to Rear Seat Cushion Replacement.

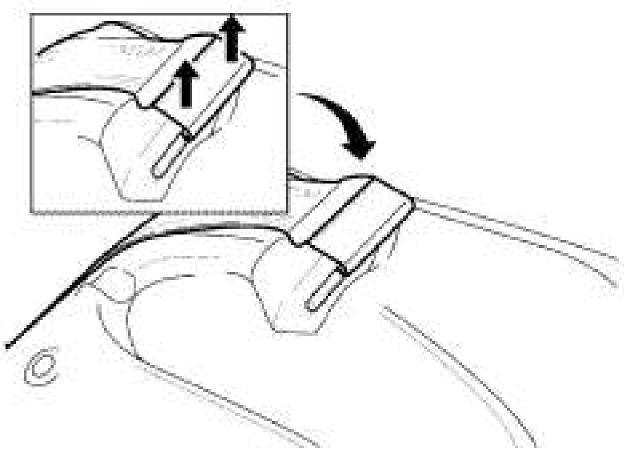
Rear Seat Cushion Cover and Pad Replacement

Removal Procedure

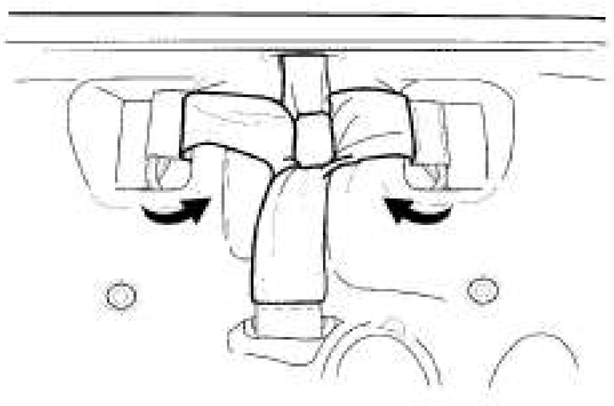
1. Remove the seat cushion. Refer to Rear Seat Cushion Replacement.
2. Place seat cushion on a suitable work surface.



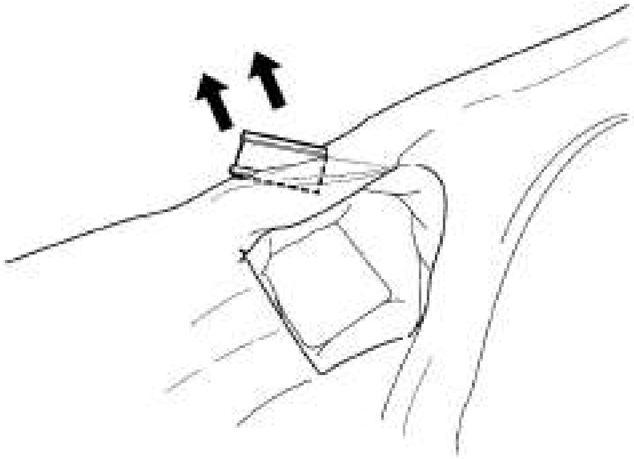
3. Detach the cushion cover from the base pad by uncliping the cushion cover retaining clip (1), carry this procedure until all the retaining clips are detach.



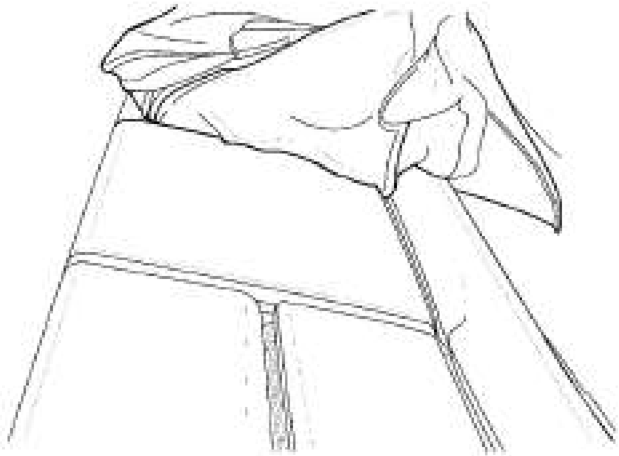
4. Detach the back of the seat cushion cover, by unhooking the J-strips from the base pad.



5. Detach the seat belt cross strap, by unhooking the J-strips from the base pad.

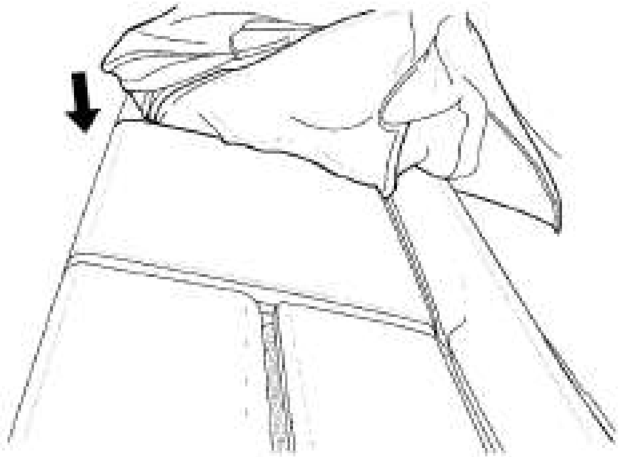


6. Detach the front of the seat cushion cover.
7. Turn seat cushion over.



8. Remove the seat cushion cover.

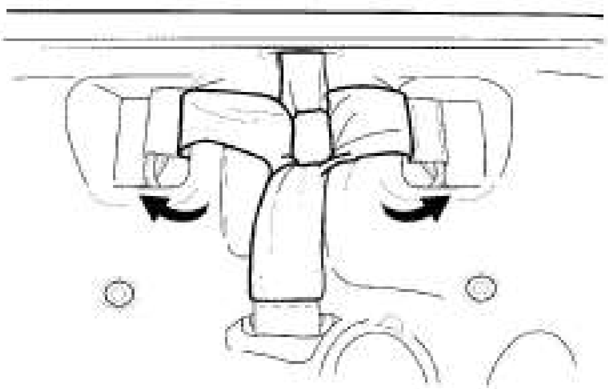
Installation Procedure



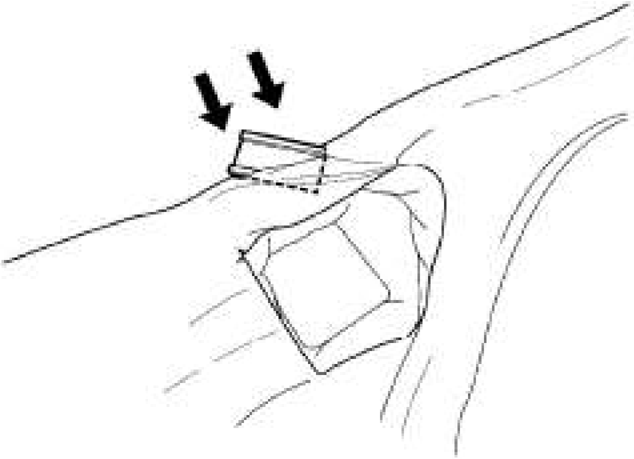
1. Install the seat cushion cover.
2. Turn the seat cushion over.

Important: When installing the front of the cover, ensure the corners are pulled tight.

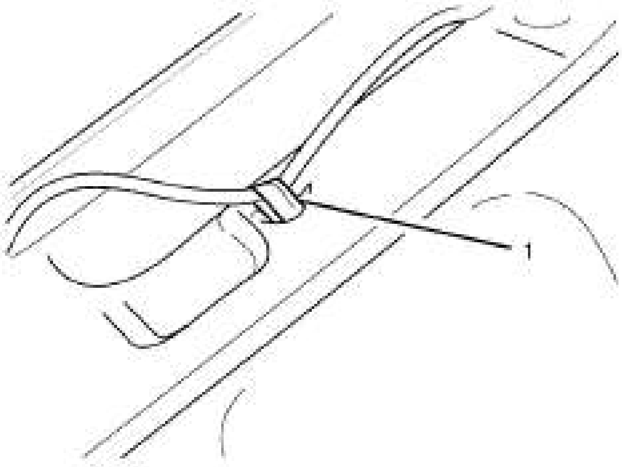
3. Install the front of the seat cushion cover.



4. Install the seat belt cross strap, by hooking the J-strips onto the base pad.



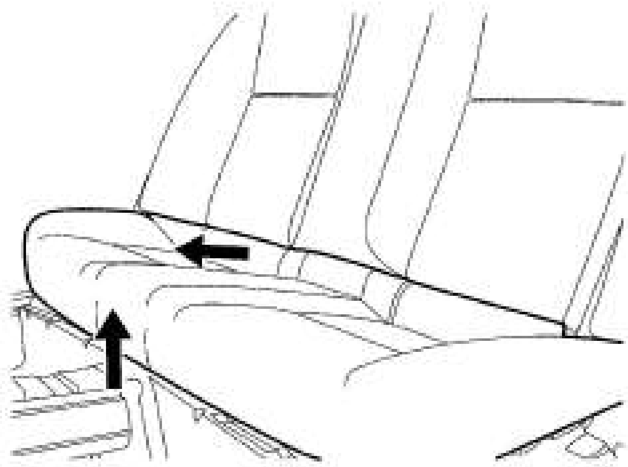
5. Install the back of the seat cushion cover.



6. Attach the cushion cover to the base pad by attaching the cushion cover retaining clip (1), listen for an audible click to confirm fitting.
7. Firmly run your finger in the seat cushion channels, to ensure a correct fitting.
8. Install the seat cushion. Refer to Rear Seat Cushion Replacement.

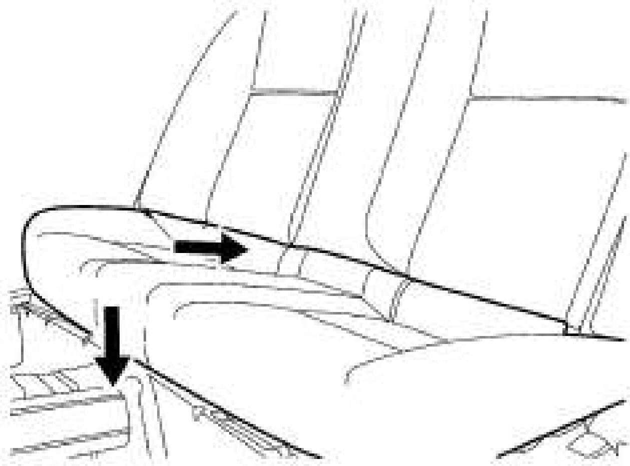
Rear Seat Cushion Replacement

Removal Procedure



1. Grasp base of seat and pull vertically upwards to avoid damage to clips, and pull outwards as shown.
2. Remove the seat cushion.

Installation Procedure



1. Install the seat back.
2. With downward pressure, install the seat cushion into the retaining grommets.

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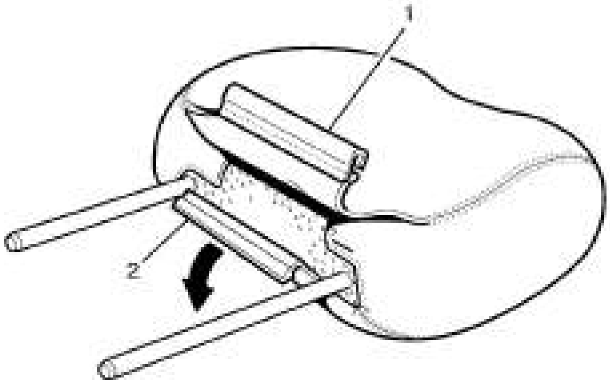
Rear Seat Head Restraint Cover Replacement

Removal Procedure

1. Remove the head restraint. Refer to Rear Seat Head Restraint Replacement.



2. Disengage the rear seat head restraint cover J-strip by pulling the flap (1) back out of the flap (2) in the direction shown.
3. Carefully remove the head restraint cover.

Installation Procedure

1. Carefully install the head restraint cover.
2. Engage the two J-strips, ensure the J-strips are fully engaged.
3. Install the head restraint. Refer to Rear Seat Head Restraint Replacement.

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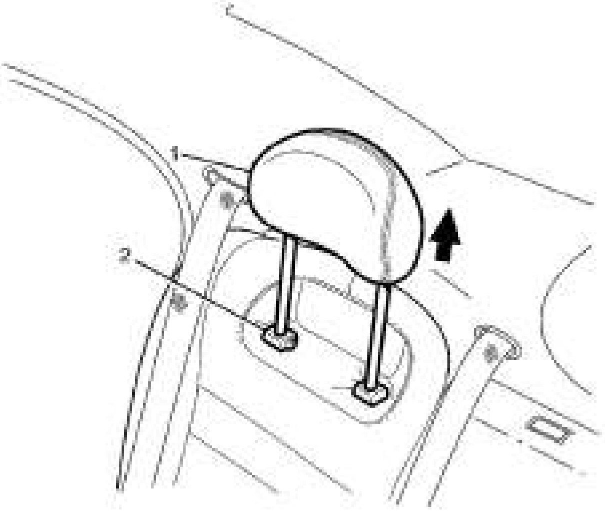
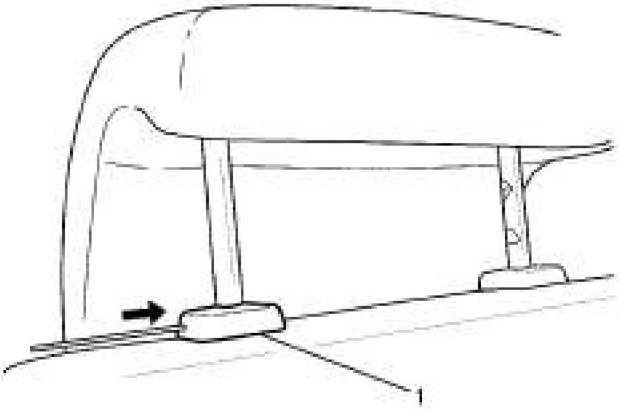
Rear Seat Head Restraint Replacement

Removal Procedure



Important: This procedure will require the aid of an assistant.

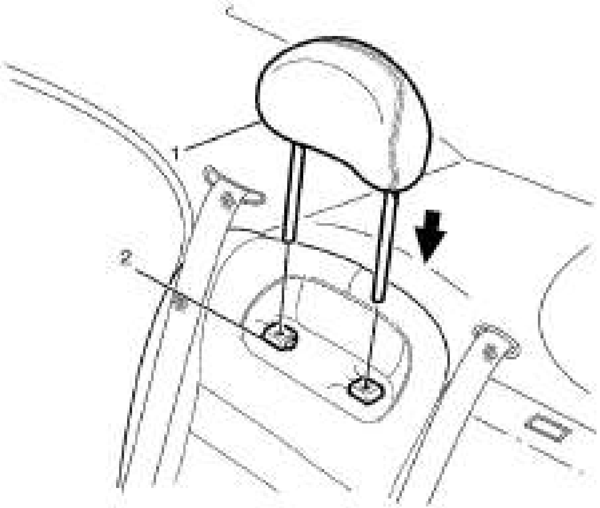
1. Fully extend the head restraint (1), out of the head restraint guides (2).



2. Insert a suitable size probe into the hole in the left hand restraint guide (1).

3. Depress the right-hand head restraint sleeve height adjuster lock and remove the head restraint
4. With the aid of the assistant remove the head restraint out of the guide.

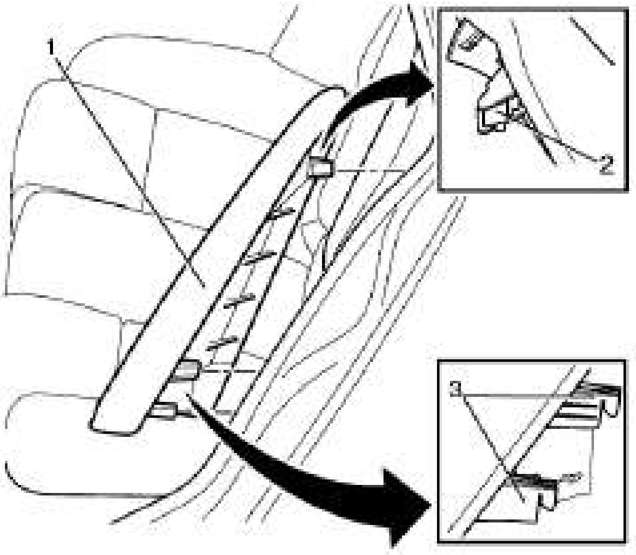
Installation Procedure



1. Locate the head restraint (1) in the head restraint guides (2).
2. Install the head restraint by pushing it into the head restraint guides, listen for an audible click to confirm fitting.

Rear Split Folding Seat Back Bolster Replacement (Sportwagon)

Removal Procedure

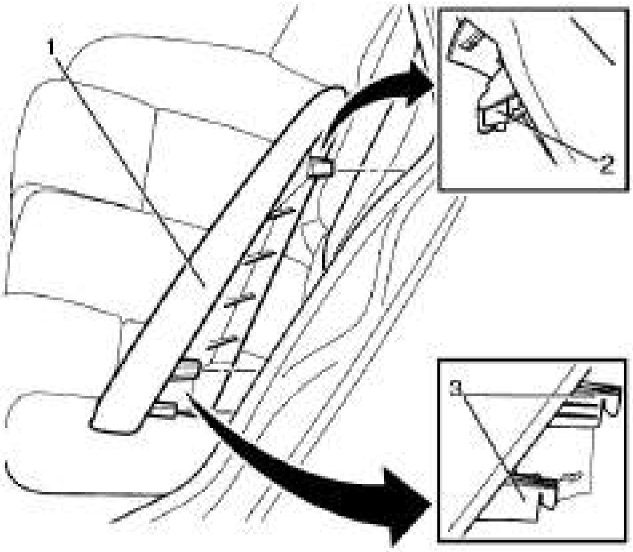


Important: The left hand side and right hand side seat back bolster are identical in removal and installation.

Important: Use a suitable tool to disengage the seat back bolster to body retainer (2).

1. Disengage the seat back bolster to body retainer (2).
2. Apply suitable upward pressure to the seat back bolster (1) to disengage the seat back bolster to body retaining hooks (3).
3. Remove the seat back bolster (1) from the vehicle.

Installation Procedure



1. Align the seat back bolster (1) to the vehicle and engage the seat back bolster to body retaining hooks (3).
2. Align the seat back bolster to body retainer (2) to the vehicle.

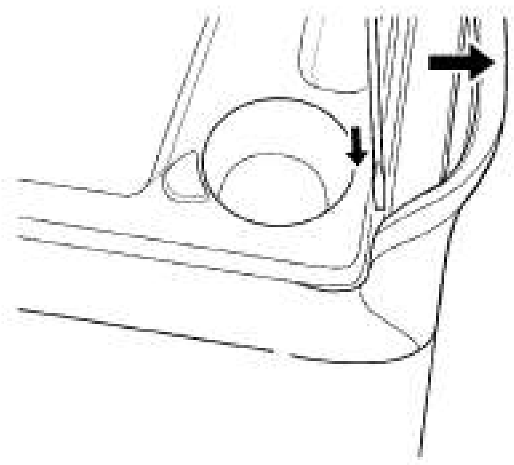
Important: Listen for an audible click to confirm correct installation of the seat back bolster to body retainer (2).

3. Apply suitable pressure to the seat back bolster (1) to engage the seat back bolster to body retainer (2).

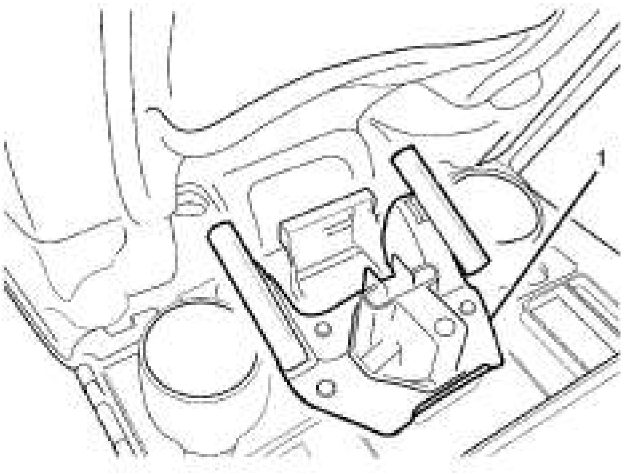
Rear Split Folding Seat Back Cushion Cover and Pad Replacement (Sedan)

Removal Procedure

1. Remove the seat cushion. Refer to Rear Seat Cushion Replacement.
2. Remove the rear seat back. Refer to Rear Seat Back Replacement in Seats.
3. Remove the rear set back folding. Refer to Rear Split Folding Seat Back Replacement.
4. Place seat back face down on a suitable work surface.



5. Detach the seat back cover from the seat back base as shown in illustration.
6. Turn the seat back over on the base.



7. lift the seat cover and pad to expose the seat back latch assembly (1).
8. Remove the rear centre seat latch assembly. Refer to Rear Seat Back Latch Replacement.
9. Remove the seat back cover.

Installation Procedure

Important: Do not install the release button until the seat cover is fully installed.

1. Install the centre seat back latch assembly. Refer to Rear Seat Back Latch Replacement.
2. Turn the centre seat over.

Important: When installing the seat cover, pull the cover tight in all corners to ensure no lumps will occur.

3. Install the centre seat cover to the seat pad and frame, listen for audible clicks to confirm fitting.
4. Turn the centre seat over.
5. Press down firmly on the seat pad channels to ensure a smooth finish to the cover.
6. Install the rear set back folding. Refer to Rear Split Folding Seat Back Replacement.
7. Install the rear seat back. Refer to Rear Seat Back Replacement in Seats.
8. Install the seat cushion. Refer to Rear Seat Cushion Replacement.

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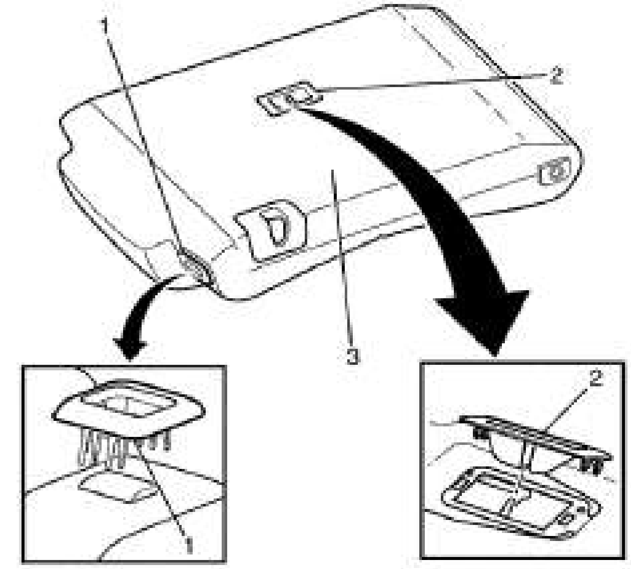
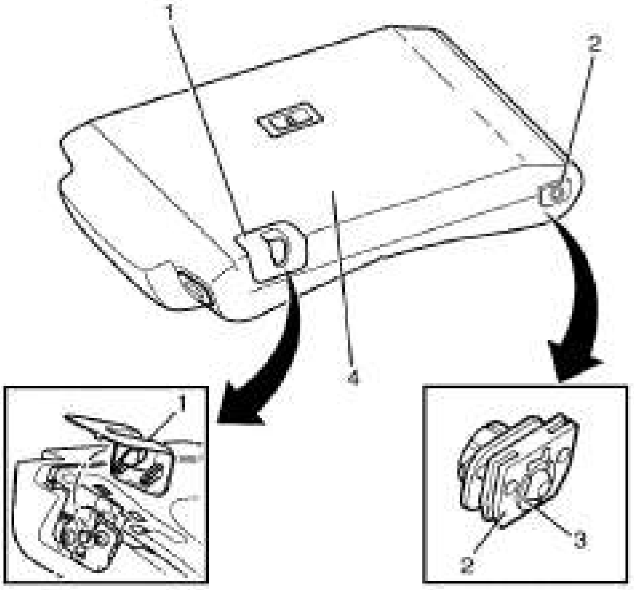
Rear Split Folding Seat Back Cushion Cover and Pad Replacement (Sportwagon)

Removal Procedure - Left Rear Seat Back Cover

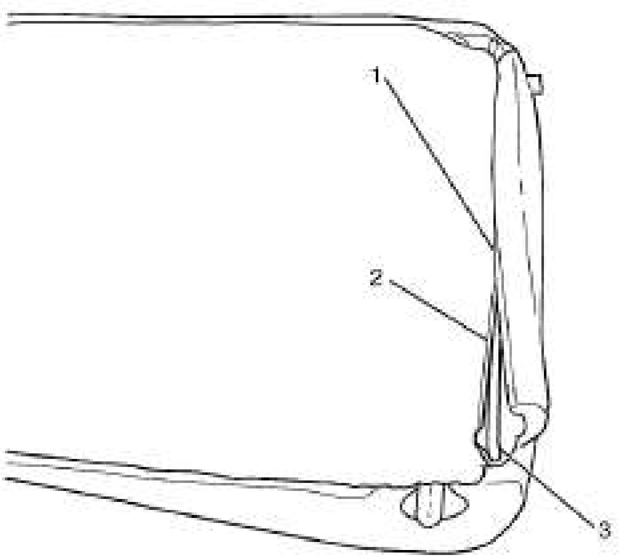
1. Remove the rear seat cushion assembly. Refer to Rear Seat Cushion Replacement.
2. Remove the left rear seat back assembly. Refer to Rear Seat Back Replacement.
3. Place the left rear seat back assembly on a suitable surface.



4. Remove the left rear seat back latch release button cover (1) from the left rear seat back assembly (3).
5. Remove the left rear seat back child restraint tether anchor cover (2) from the left rear seat back assembly (3).

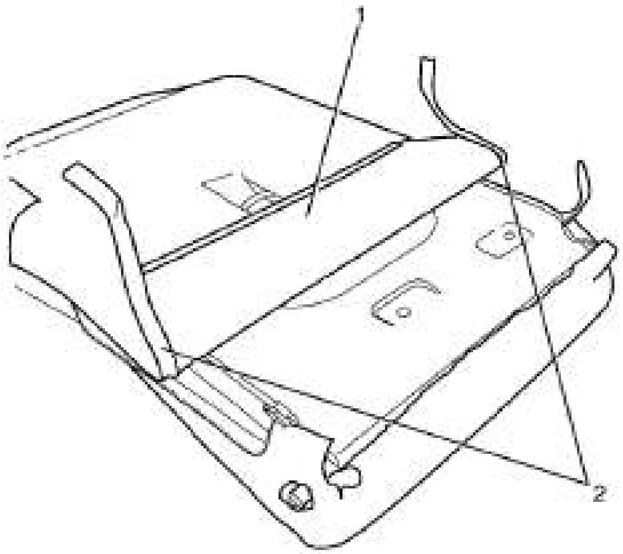


6. Remove the circlip (3) from the left rear seat back pivot retainer assembly (2).
7. Remove the left rear seat back pivot retainer assembly (2) from the left rear seat back assembly (4).
8. Remove the left rear seat back latch trim cover (1) from the left rear seat back assembly (4).

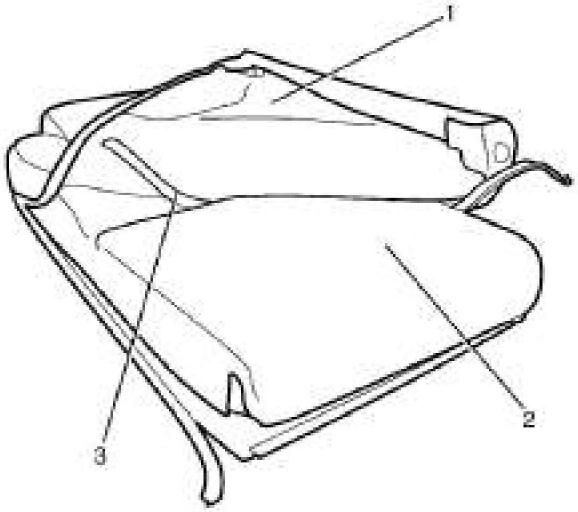


Important: Care must be taken not to damage the left rear seat back cover front retaining strip (1) and the left rear seat back cover rear retaining strip (2) when disengaging them from the left rear seat back cover retaining strip channel (3).

9. Using a suitable tool disengage the left rear seat back cover front retaining strip (1) from the left rear seat back retaining strip channel (3).
10. Using a suitable tool disengage the left rear seat back cover rear retaining strip (2) from the left rear seat back retaining strip channel (3).



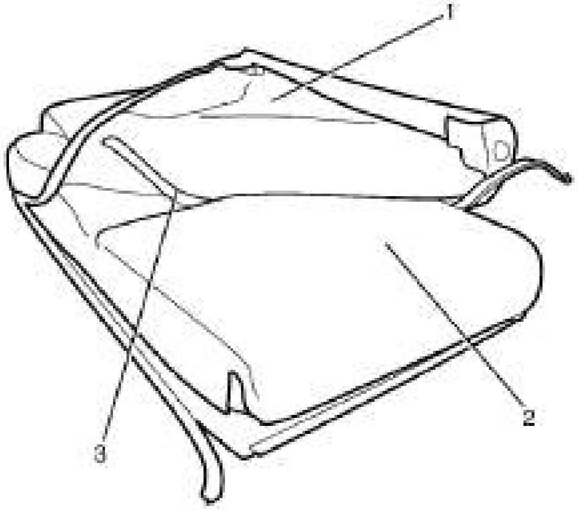
11. Unzip the left rear seat back cover zippers (2).
12. Fold back the left rear seat back cover (1).



Important: Take care not to tear the left rear seat back cover (1) when removing it from the left rear seat back assembly (2).

13. Detach the velcro strips (3) from the left rear seat back assembly (2) and remove the left rear seat back cover (1) from the left rear seat back assembly (2).

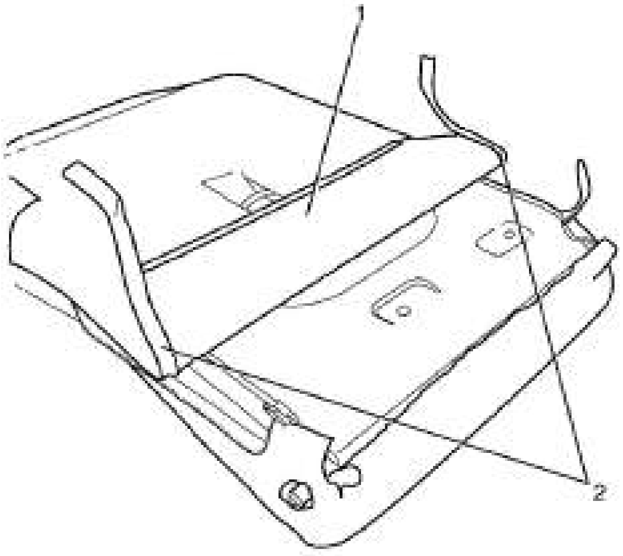
Installation Procedure - Left Rear Seat Back Cover



Important: Make sure that the velcro strips (3) are located correctly. Failure to comply may result in the incorrect installation of the left rear seat back cover (1).

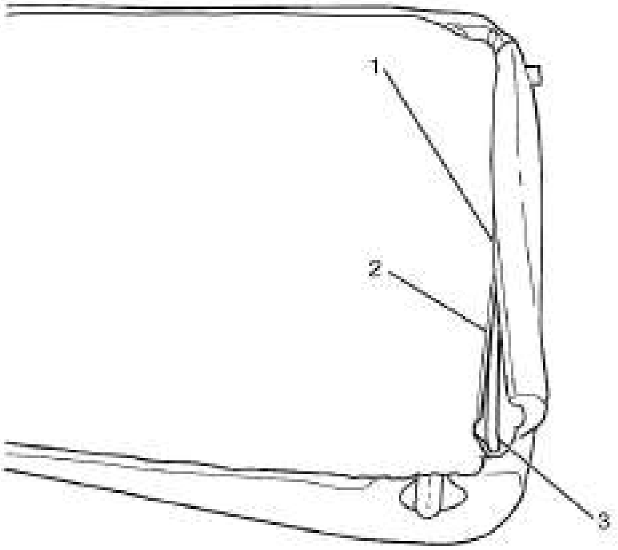
Important: Make sure that the left rear seat back cover (1) fits tightly without creasing, over the left rear seat back assembly (2).

1. Install the left rear seat back cover (1) to the left rear seat back assembly (2).
2. Attach the velcro strips (3) to the left rear seat back assembly (2).



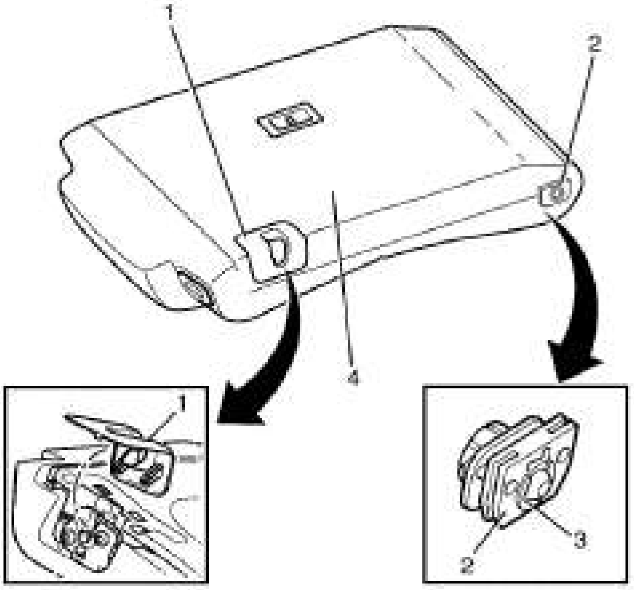
Important: Conceal the zipper ends behind the left rear seat back cover (1). Failure to comply may result in damage to the left rear seat back cover zippers (2).

3. Zip up the left rear seat back cover zippers (2).



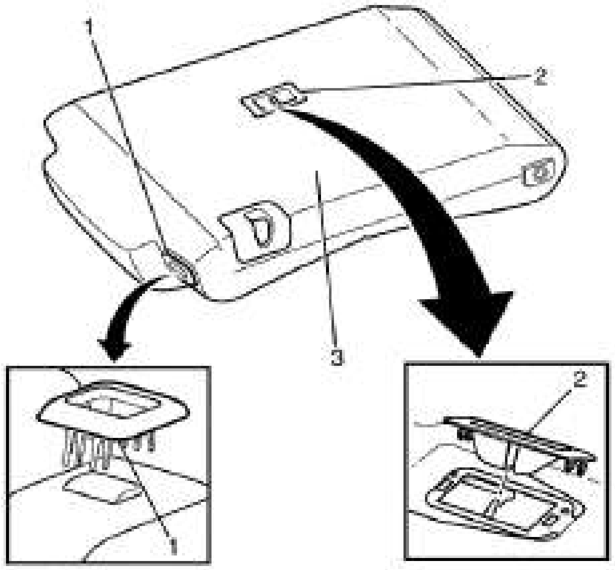
Important: Care must be taken not to damage the left rear seat back cover front retaining strip (1) and the left rear seat back cover rear retaining strip (2) when engaging them into the left rear seat back cover retaining strip channel (3).

4. Using a suitable tool engage the left rear seat back cover front retaining strip (1) into the left rear seat back retaining strip channel (3).
5. Using a suitable tool engage the left rear seat back cover rear retaining strip (2) into the left rear seat back retaining strip channel (3).



6. Install the left rear seat back latch trim cover (1) to the left rear seat back assembly (4)
7. Install the left rear seat back pivot retainer assembly (2) to the left rear seat back assembly (4).

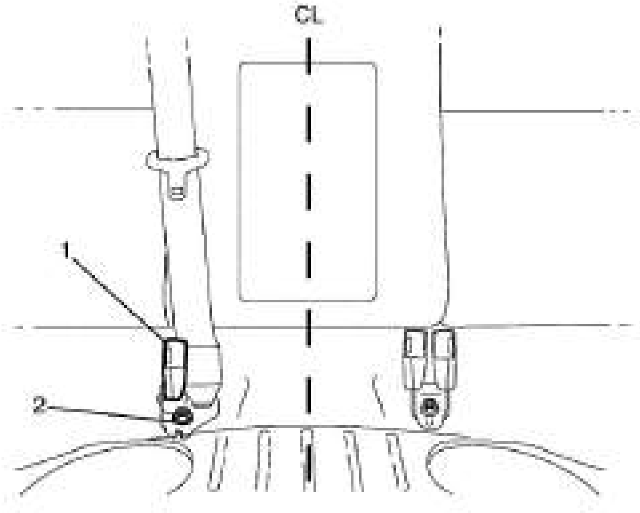
8. Install the circlip (3) to the left rear seat back pivot retainer assembly (2).



9. Install the left rear seat back child restraint tether anchor cover (2) to the left rear seat back assembly (3).
10. Install the left rear seat back latch release button cover (1) to the left rear seat back assembly (3).
11. Install the left rear seat back assembly. Refer to Rear Seat Back Replacement.
12. Install the rear seat cushion assembly. Refer to Rear Seat Cushion Replacement.

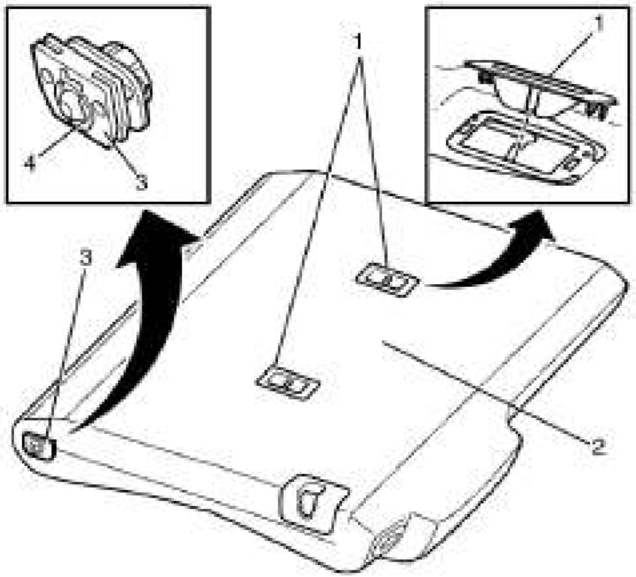
Removal Procedure - Right Rear Seat Back Cover

1. Remove the rear seat cushion assembly. Refer to Rear Seat Cushion Replacement.

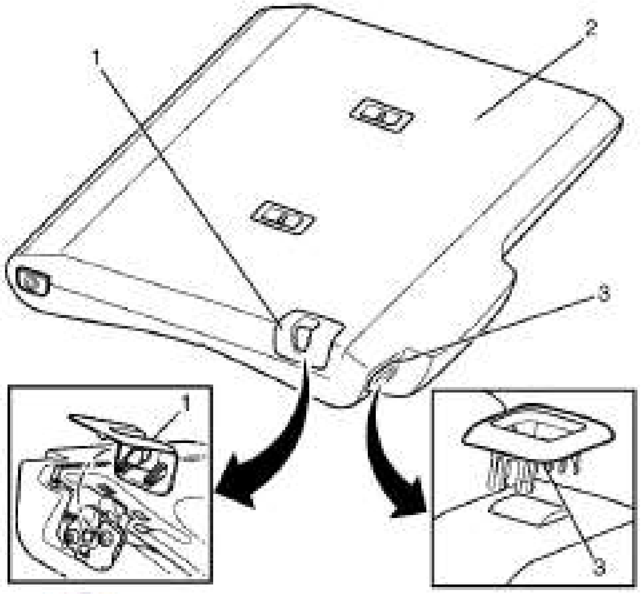


2. Remove the right rear seat belt buckle nut (2).
3. Remove the right rear seat belt buckle (1).

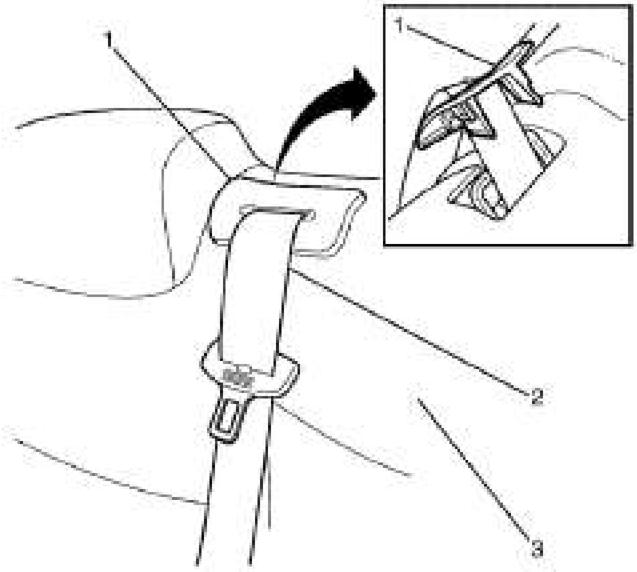
4. Remove the right rear seat back assembly. Refer to Rear Seat Back Replacement.
5. Place the right rear seat back assembly on a suitable surface.



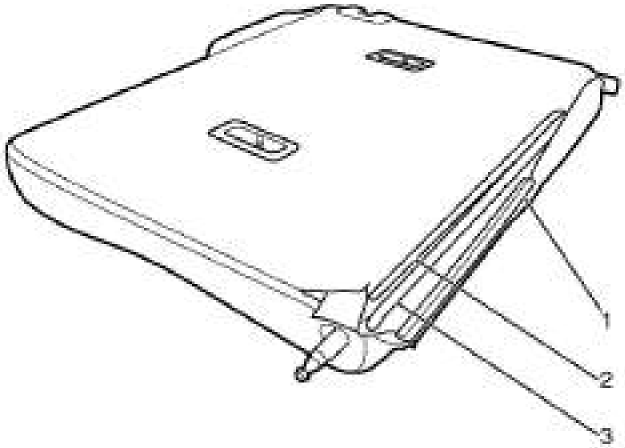
6. Remove the right rear seat back child restraint tether anchor covers (1) from the right rear seat back assembly (2).
7. Remove the circlip (4) from the pivot retainer assembly (3).
8. Remove the pivot retainer assembly (3) from the right rear seat back assembly (2).



9. Remove the right rear seat back latch trim cover (1) from the right rear seat back assembly (2).
10. Remove the right rear seat back latch release button cover (3) from the right rear seat back assembly (2).

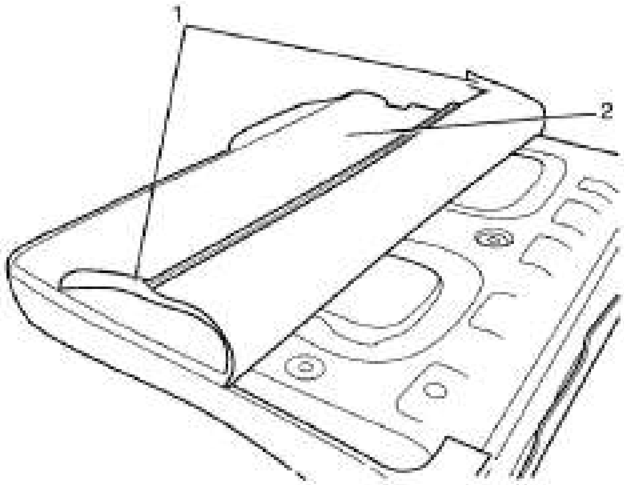


11. Remove the centre rear seatbelt guide trim (1) from the right rear seat back assembly (3).
12. Remove the centre rear seatbelt guide trim (1) from the centre rear seatbelt (2).

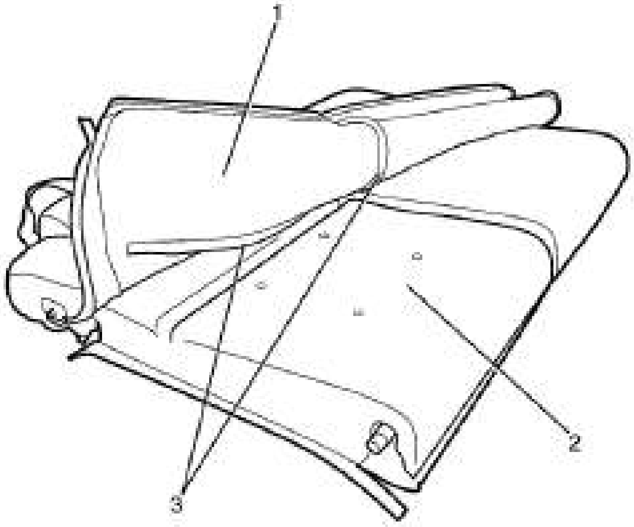


Important: Care must be taken not to damage the right rear seat back cover front retaining strip (1) and the right rear seat back cover rear retaining strip (2) when disengaging them from the right rear seat back cover retaining strip channel (3).

13. Using a suitable tool disengage the right rear seat back cover front retaining strip (1) from the right rear seat back retaining strip channel (3).
14. Using a suitable tool disengage the right rear seat back cover rear retaining strip (2) from the right rear seat back retaining strip channel (3).



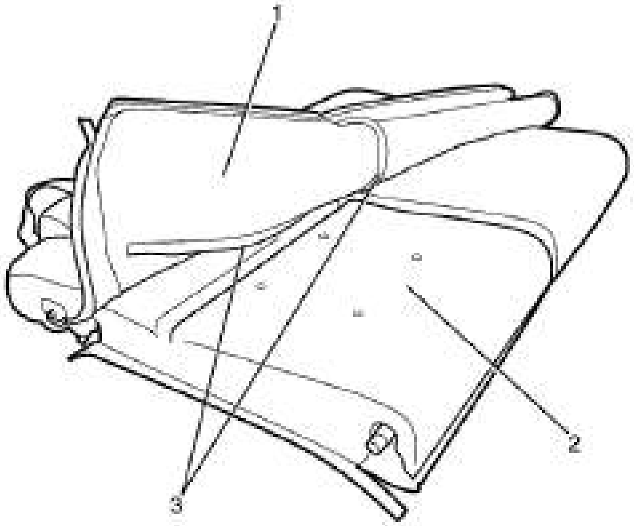
15. Unzip the right rear seat back cover zippers (1).
16. Fold back the right rear seat back cover (2).



Important: Take care not to tear the right rear seat back cover (1) when removing it from the right rear seat back assembly (2).

17. Detach the velcro strips (3) from the right rear seat back assembly (2) and remove the right rear seat back cover (1) from the right rear seat back assembly (2).

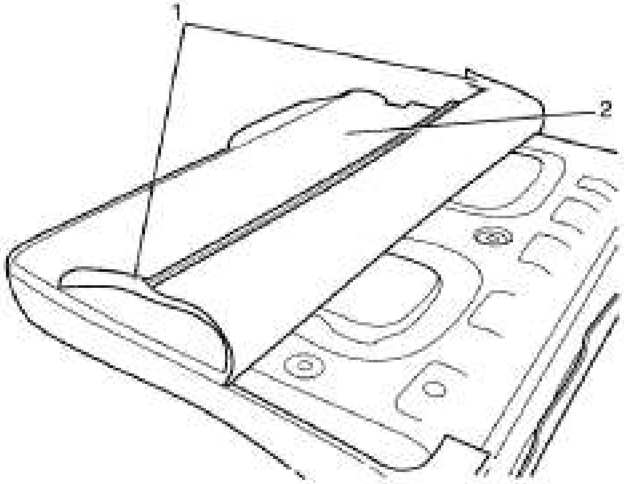
Installation Procedure - Right Rear Seat Back Cover



Important: Make sure that the velcro strips (3) are located correctly. Failure to comply may result in the incorrect installation of the right rear seat back cover (1).

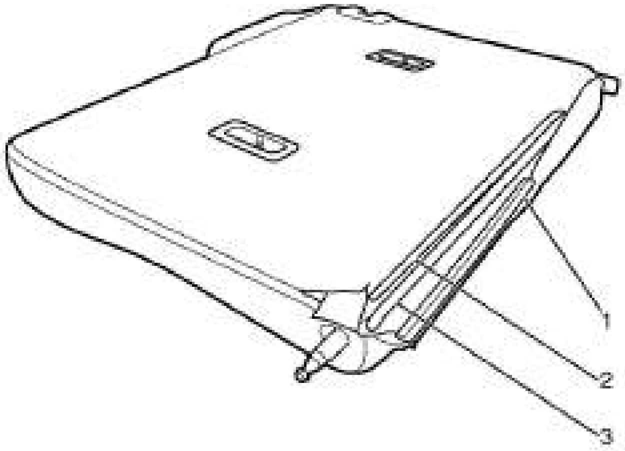
Important: Make sure that the right rear seat back cover (1) fits tightly without creasing, over the right rear seat back assembly (2).

1. Install the right rear seat back cover (1) to the right rear seat back assembly (2). Attach the velcro strips (3) to the right rear seat back assembly (2).



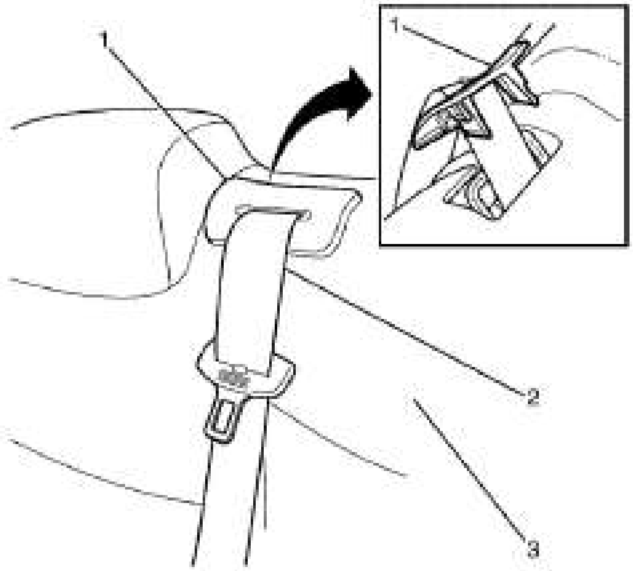
Important: Conceal the zipper ends behind the right rear seat back cover (1). Failure to comply may result in damage to the right rear seat back cover zippers (2).

2. Zip up the right rear seat back cover zippers (1).

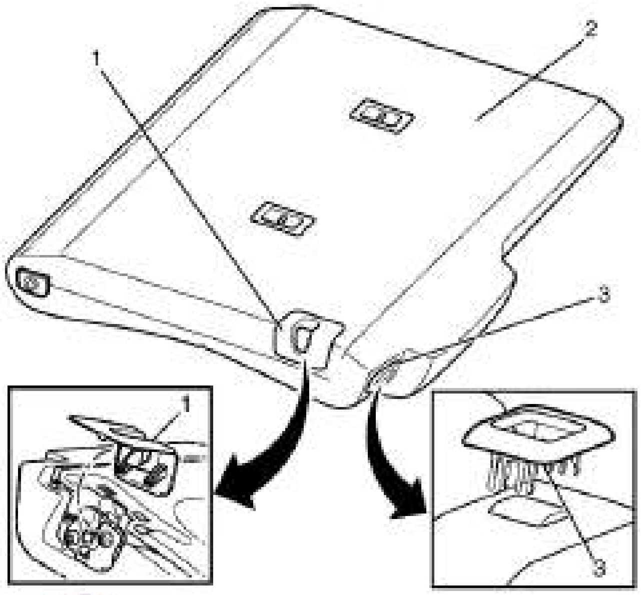


Important: Care must be taken not to damage the right rear seat back cover front retaining strip (1) and the right rear seat back cover rear retaining strip (2) when engaging them into the right rear seat back cover retaining strip channel (3).

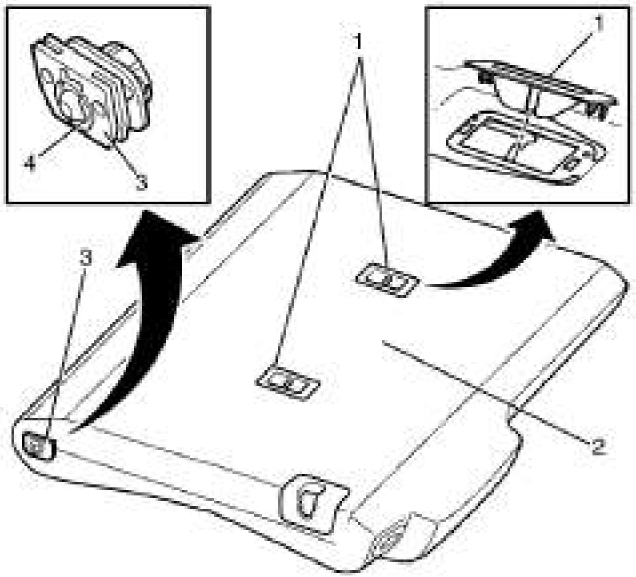
3. Using a suitable tool engage the right rear seat back cover front retaining strip (1) into the right rear seat back retaining strip channel (3).
4. Using a suitable tool engage the right rear seat back cover rear retaining strip (2) into the right rear seat back retaining strip channel (3).



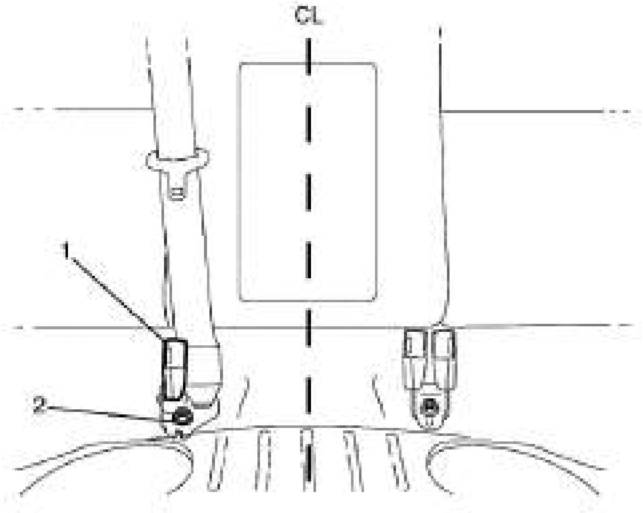
5. Install the centre rear seatbelt (2) to the centre rear seatbelt guide trim (1).
6. Install the centre rear seatbelt guide trim (1) to the rear seat back assembly (3).



7. Attach the right rear seat back latch release button cover (3) to the right rear seat back assembly (2).
8. Attach the right rear seat back latch trim cover (1) to the right rear seat back assembly (2).



9. Attach the pivot retainer assembly (3) to the right rear seat back assembly (2).
10. Attach the circlip (4) to the pivot retainer assembly (3).
11. Attach the right rear seat back child restraint tether anchor covers (1) to the right rear seat back assembly (2).
12. Install the right rear seat back assembly. Refer to Rear Split Folding Seat Back Replacement.



Important: Make sure the right rear seat belt buckle is parallel to vehicle centreline as shown.

13. Install the right rear seat belt buckle (1).

    Notice: Refer to Fastener Notice in the Preface section.

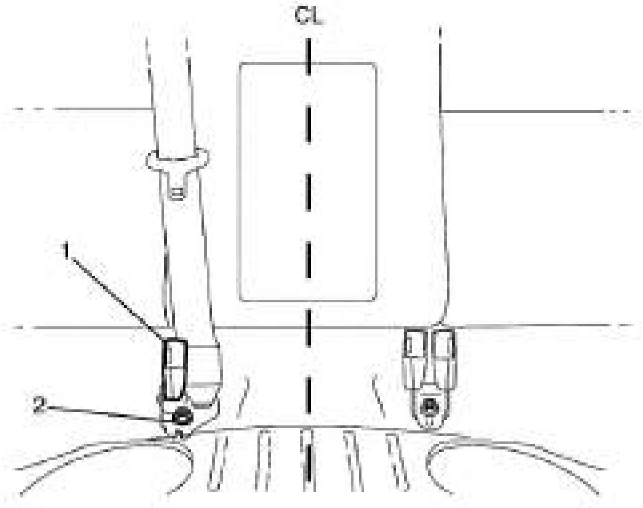
14. Install the right rear seat belt buckle nut (2).

    Tighten
    Tighten the nut to 43 N·m (31 lb ft).

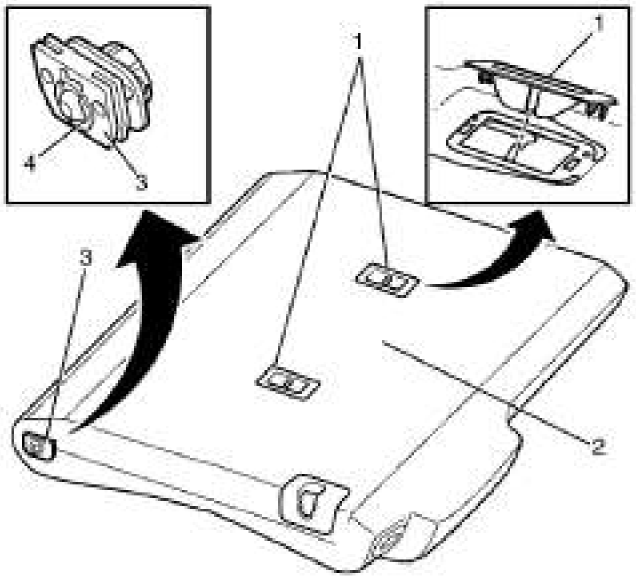
15. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.

Removal Procedure - Right Rear Seat Back Cover with Centre Armrest

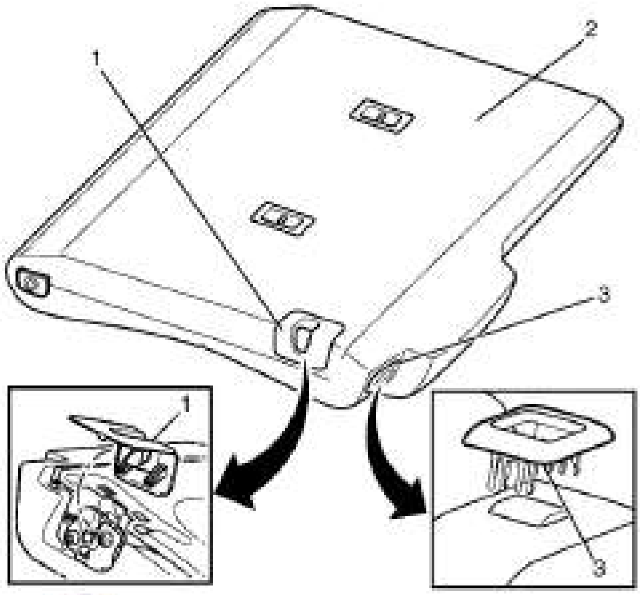
1. Remove the rear seat cushion assembly. Refer to Rear Seat Cushion Replacement.



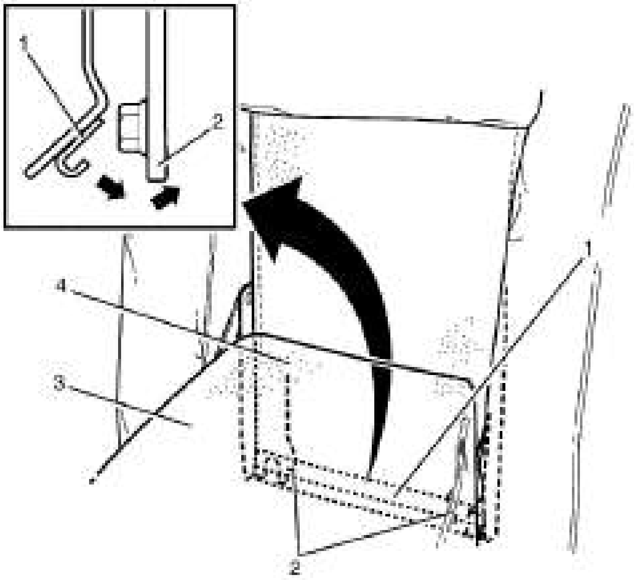
2. Remove the right rear seat belt buckle nut (2).
3. Remove the right rear seat belt buckle (1).
4. Remove the right rear seat back assembly. Refer to Rear Seat Back Replacement.
5. Place the right rear seat back assembly on a suitable surface.



6. Remove the right rear seat back child restraint tether anchor covers (1) from the right rear seat back assembly (2).
7. Remove the circlip (4) from the pivot retainer assembly (3).
8. Remove the pivot retainer assembly (3) from the right rear seat back assembly (2).

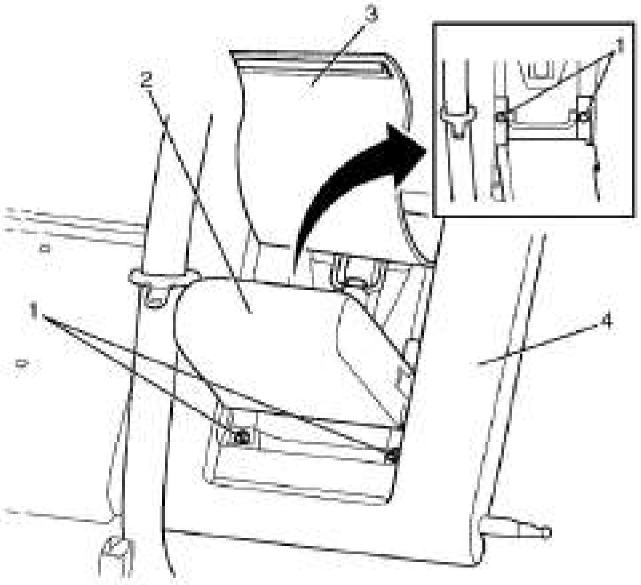


9. Remove the right rear seat back latch trim cover (1) from the right rear seat back assembly (2).
10. Remove the right rear seat back latch release button cover (3) from the right rear seat back assembly (2).



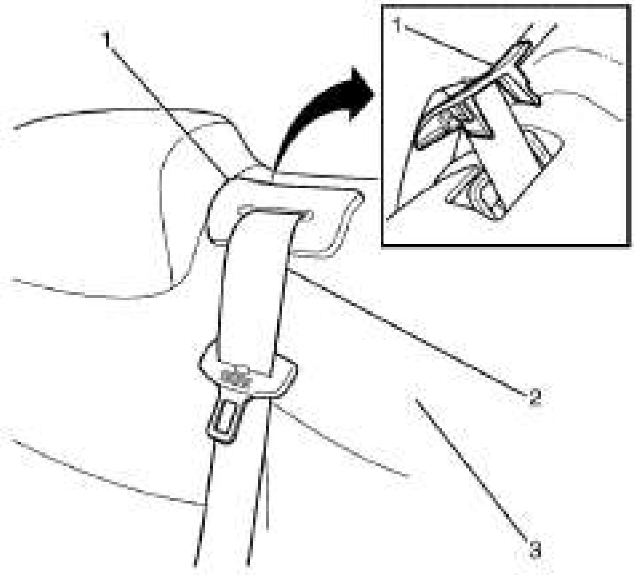
Important: Adjust the armrest (3) to a suitable position to access the right rear seat back cover retainer (1).

11. Carefully pull down on the right rear seat back cover retainer (1) and detach the trim flap (4) from the trim flap retainer (2).

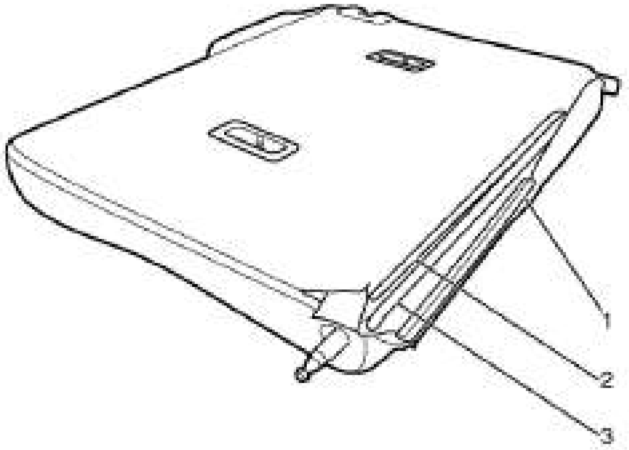


Important: Lift the right rear seat back cover trim flap (3) to expose the armrest to right rear seat back frame retaining bolts (1).

12. Remove the right rear seat back armrest to the right rear seat back frame retaining bolts (1).
13. Remove the right rear seat back armrest assembly (2) from the right rear seat back assembly (4).

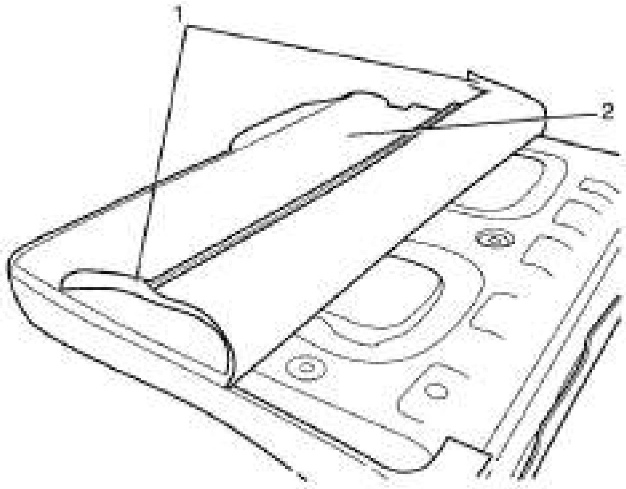


14. Remove the centre rear seatbelt guide trim (1) from the rear seat back assembly (3).
15. Remove the centre rear seatbelt guide trim (1) from the centre rear seatbelt (2).

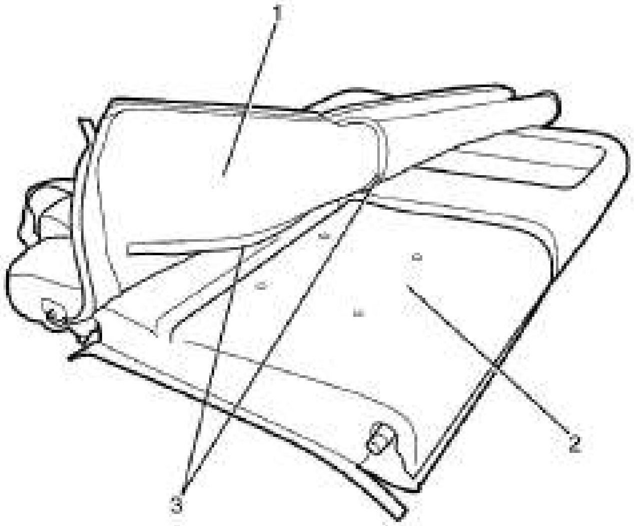


Important: Care must be taken not to damage the right rear seat back cover front retaining strip (1) and the right rear seat back cover rear retaining strip (2) when disengaging them from the right rear seat back cover retaining strip channel (3).

16. Using a suitable tool disengage the right rear seat back cover front retaining strip (1) from the right rear seat back retaining strip channel (3).
17. Using a suitable tool disengage the right rear seat back cover rear retaining strip (2) from the right rear seat back retaining strip channel (3).



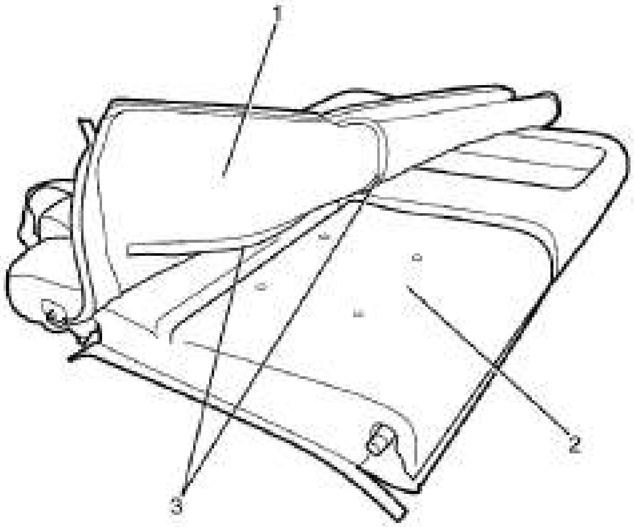
18. Unzip the right rear seat back cover zipper (1).
19. Fold back the right rear seat back cover (2).



Important: Take care not to tear the right rear seat back cover (1) when removing it from the right rear seat back assembly (2).

20. Detach the velcro strips (3) from the right rear seat back assembly (2) and remove the right rear seat back cover (1) from the right rear seat back assembly (2).

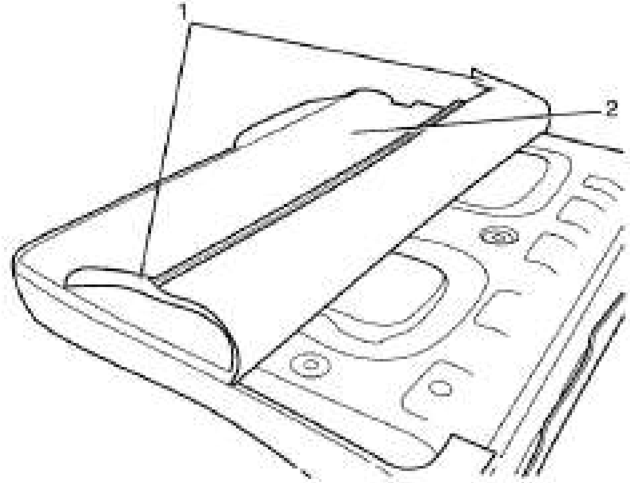
Installation Procedure - Right Rear Seat Back Cover with Centre Armrest



Important: Make sure that the velcro strips (3) are located correctly. Failure to comply may result in the incorrect installation of the right rear seat back cover (1).

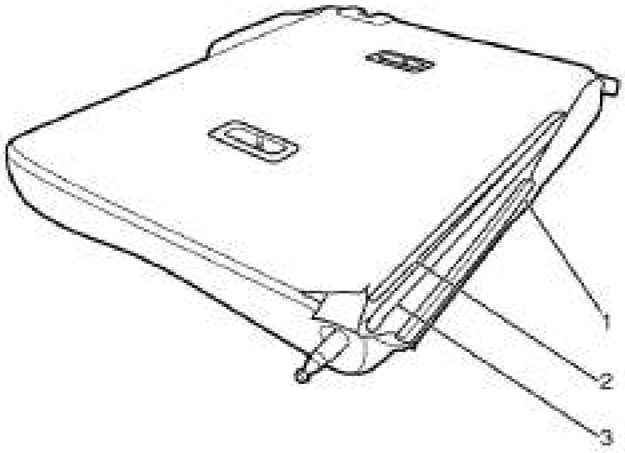
Important: Make sure that the right rear seat back cover (1) fits tightly without creasing, over the right rear seat back assembly (2).

1. Install the right rear seat back cover (1) to the right rear seat back assembly (2). Attach the velcro strips (3) to the right rear seat back assembly (2).



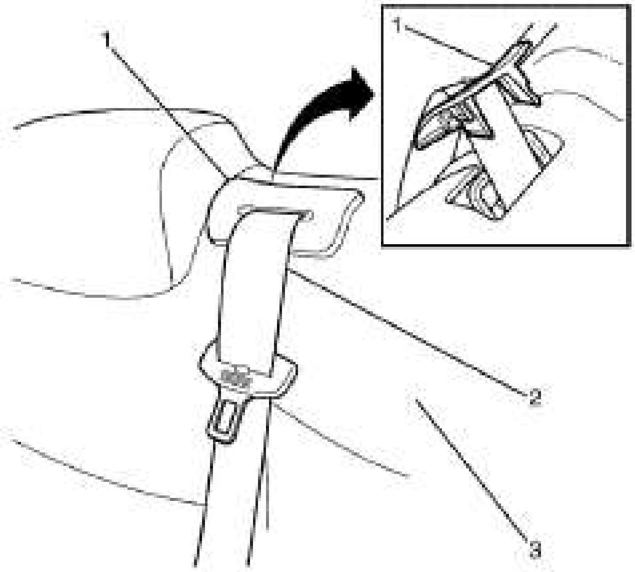
Important: Conceal the zipper ends behind the right rear seat back cover (1). Failure to comply may result in damage to the right rear seat back cover zippers (2).

2. Zip up the right rear seat back cover zipper (1).

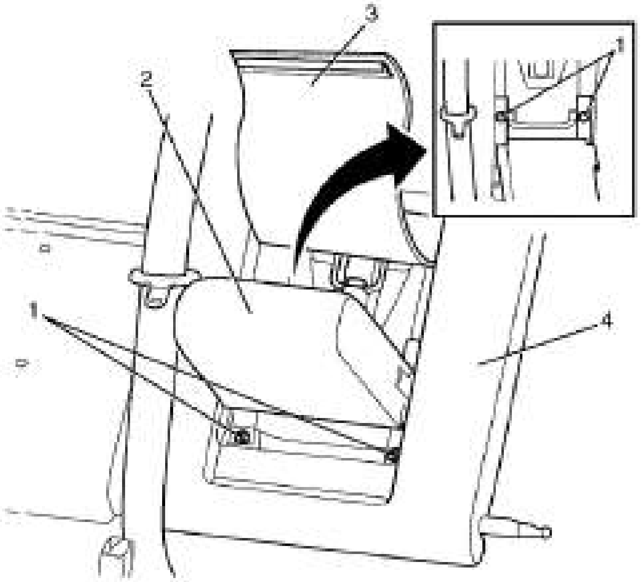


Important: Care must be taken not to damage the right rear seat back cover front retaining strip (1) and the right rear seat back cover rear retaining strip (2) when engaging them into the right rear seat back cover retaining strip channel (3).

3. Using a suitable tool engage the right rear seat back cover front retaining strip (1) into the right rear seat back retaining strip channel (3).
4. Using a suitable tool engage the right rear seat back cover rear retaining strip (2) into the right rear seat back retaining strip channel (3).



5. Install the centre rear seatbelt (2) to the centre rear seatbelt guide trim (1).
6. Install the centre rear seatbelt guide trim (1) to the rear seat back assembly (3).

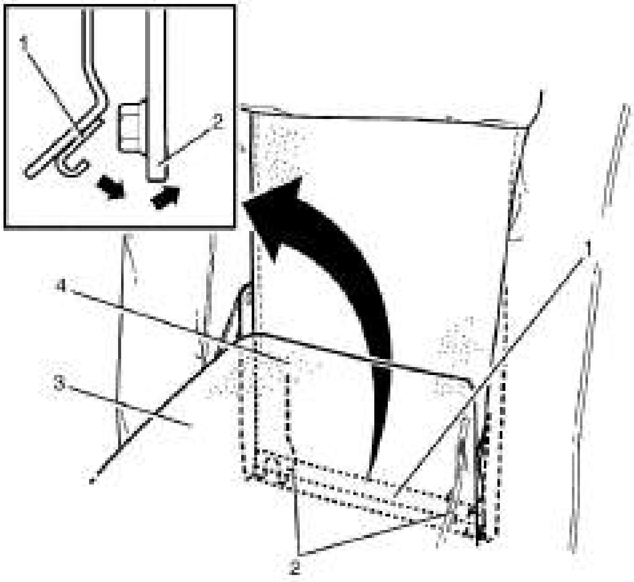


7. Install the right rear seat back armrest assembly (2) to the right rear seat back assembly (4).

Notice: Refer to Fastener Notice in the Preface section.

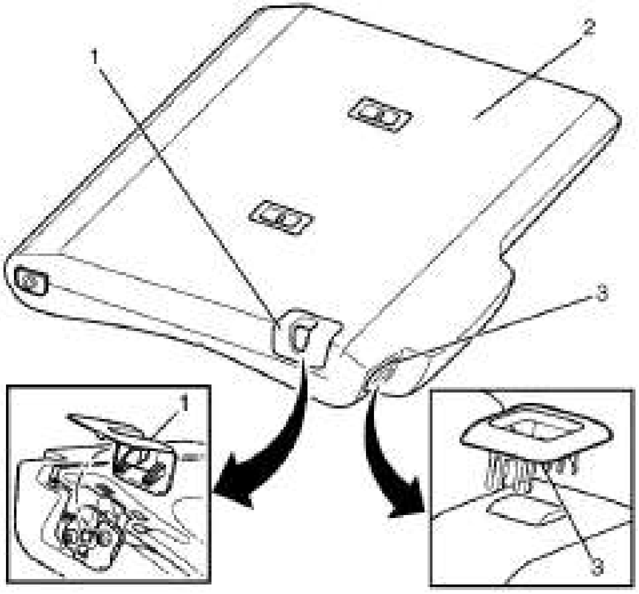
8. Install the right rear seat back armrest to right rear seat back frame retaining bolts (1).

Tighten
Tighten the bolts to 8 N·m (31 lb in).

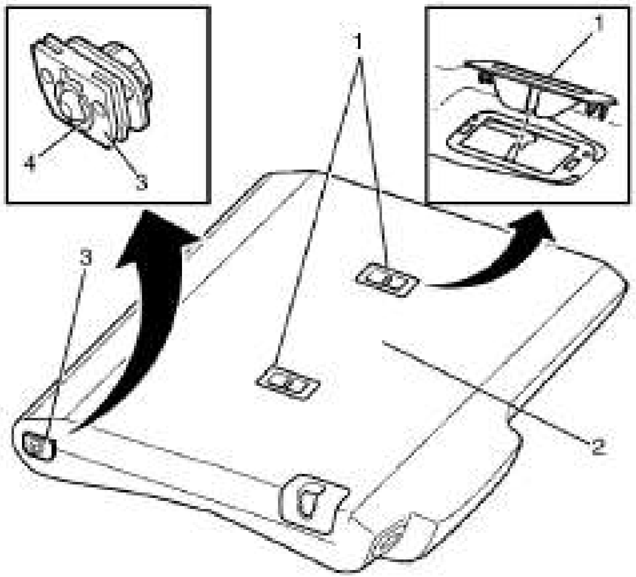


Important: Adjust the armrest (3) to a suitable position to access the right rear seat back cover retainer (1).

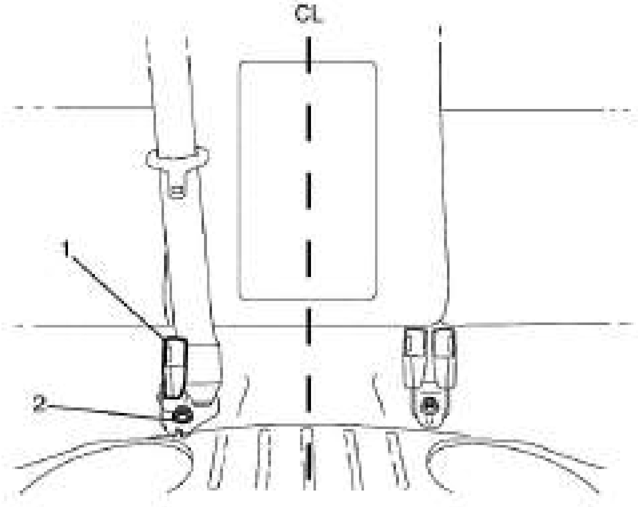
9. Carefully pull down on the right rear seat back cover retainer (1) and attach the trim flap (4) to the trim flap retainer (2).



10. Attach the right rear seat back latch release button cover (3) to the right rear seat back assembly (2).
11. Attach the right rear seat back latch trim cover (1) to the right rear seat back assembly (2).



12. Attach the pivot retainer assembly (3) to the right rear seat back assembly (2).
13. Attach the circlip (4) to the pivot retainer assembly (3).
14. Attach the right rear seat back child restraint tether anchor covers (1) to the right rear seat back assembly (2).
15. Install the right rear seat back assembly. Refer to Rear Split Folding Seat Back Replacement.



Important: Make sure the right rear seat belt buckle is parallel to vehicle centreline as shown.

16. Install the right rear seat belt buckle (1).

    Notice: Refer to Fastener Notice in the Preface section.

17. Install the right rear seat belt buckle nut (2).

    Tighten
    Tighten the nut to 43 N·m (31 lb ft).

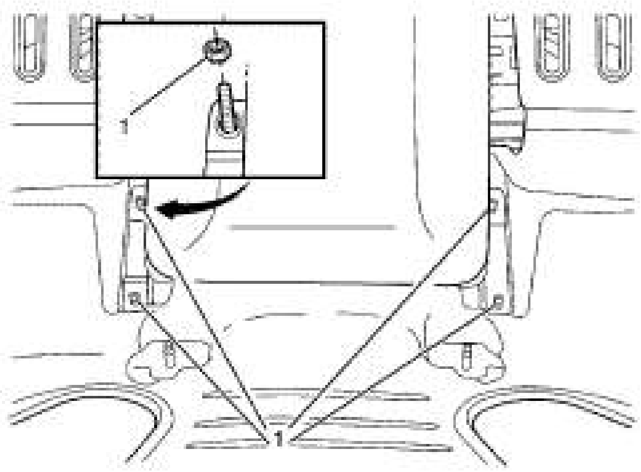
18. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Seats | Seat Hardware, Trim, and Upholstery | Repair Instructions | **Document ID: 2100387**

Rear Split Folding Seat Back Replacement (Sedan)

Removal Procedure

1. Remove the seat cushion. Refer to Rear Seat Cushion Replacement.
2. Remove the rear seat back. Refer to Rear Seat Back Replacement.

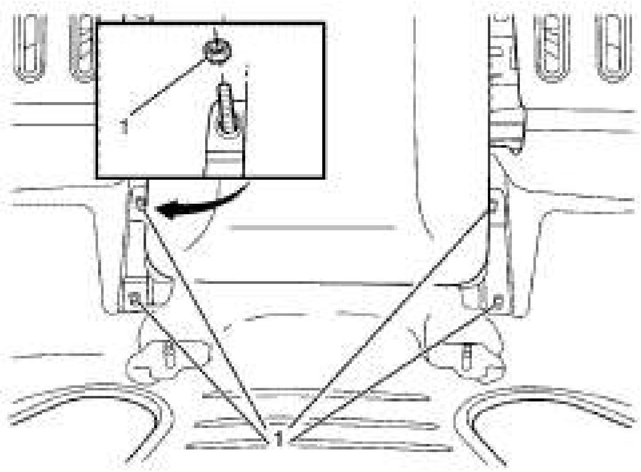


3. Remove the four seat back retaining nuts (1) attaching the seat back to the body panel.
4. Operate the seat back release button and remove the seat back.

Installation Procedure

1. Install the seat back onto the lock striker, listen for an audible click to confirm fitting.

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the four seat back retaining nuts (1).

   Tighten
   Tighten the nuts (1) to 23 N·m (17 lb ft).

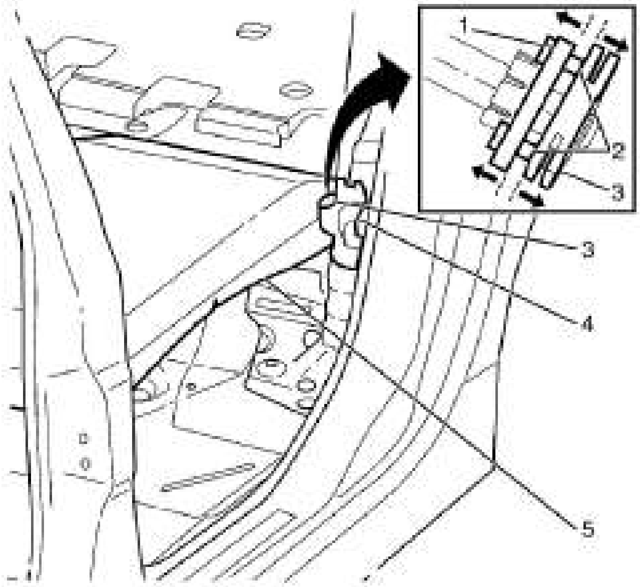
3. Install the rear seat back. Refer to Rear Seat Back Replacement in Seats.
4. Install the seat cushion. Refer to Rear Seat Cushion Replacement.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Seats | Seat Hardware, Trim, and Upholstery | Repair Instructions | **Document ID: 2100388**

Rear Split Folding Seat Back Replacement (Sportwagon)

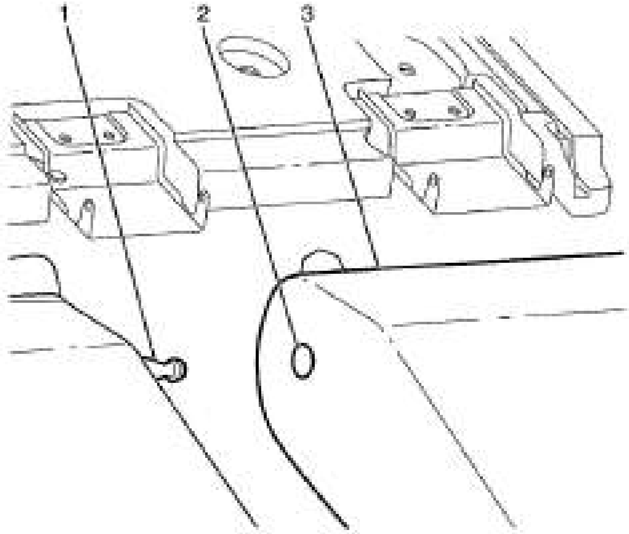
Removal Procedure - Left Rear Seat Back Assembly

1. Remove the rear seat cushion assembly. Refer to Rear Seat Cushion Replacement.
2. Remove the rear split folding seat back bolster. Refer to Rear Split Folding Seat Back Bolster Replacement.
3. Remove the rear compartment floor panel carpet. Refer to Rear Compartment Floor Panel Carpet Replacement
4. Adjust both front seats to the completely forward position.
5. Fold both rear seat backs down.

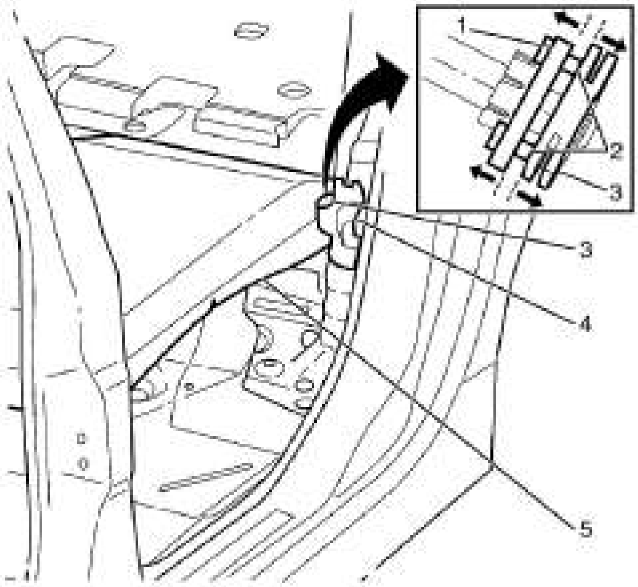


6. Using a suitable tool detach the pivot retainer plate (1) from the pivot retainer (3) in order to disengage the pivot retainer pins (2) from the pivot retainer mounting (4).
7. Lift the left rear seat back (5) to disengage the pivot retainer (3) from the pivot retainer mounting (4).
8. With the aid of an assistant pull the left rear seat back (5) towards the left rear door opening and remove from the vehicle.

Installation Procedure - Left Rear Seat Back Assembly



1. With the aid of an assistant install the left rear seat back (3) to the vehicle.
2. Align the left rear seat spindle cavity (2) with the right rear seat spindle (1).



Important: In order to engage the pivot retainer pins (2) to the pivot retainer mounting (4) the left rear seat back (5) must be folded into the upright position.

3. Attach the pivot retainer (3) to the pivot retainer mounting (4).

Important: Listen for an audible click to confirm correct installation of the pivot retainer (3) to the pivot retainer mounting (4).

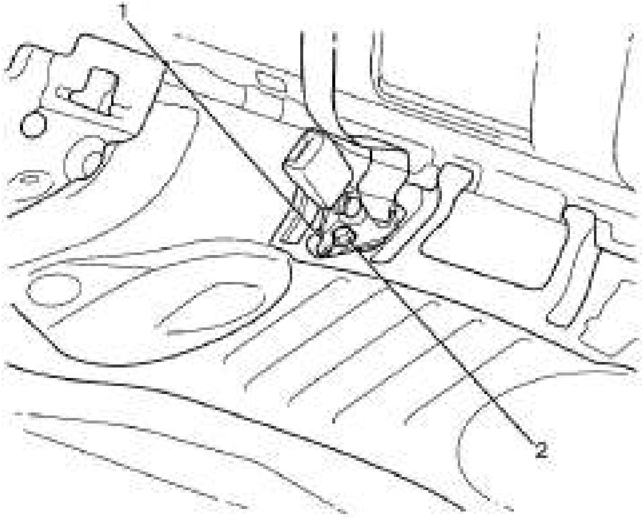
4. Fold the left rear seat back (5) into the upright position.
5. Install the rear split folding seat back bolster. Refer to Rear Split Folding Seat Back Bolster

Replacement.

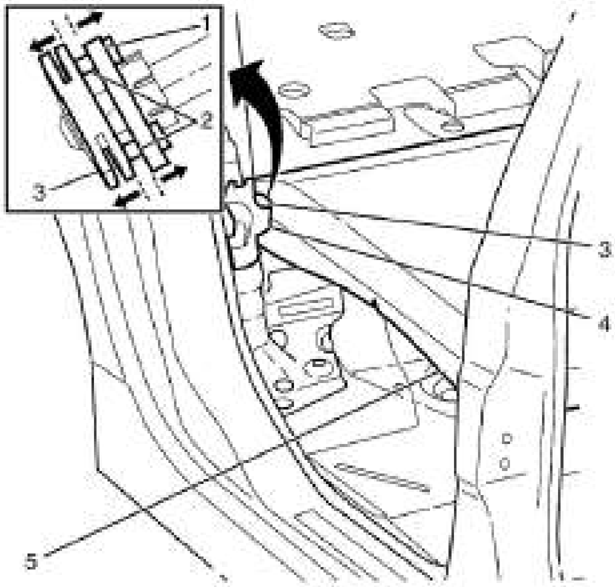
6. Install the rear seat cushion assembly. Refer to Rear Seat Cushion Replacement.

Removal Procedure - Right Rear Seat Back Assembly

1. Remove the left rear seat back.



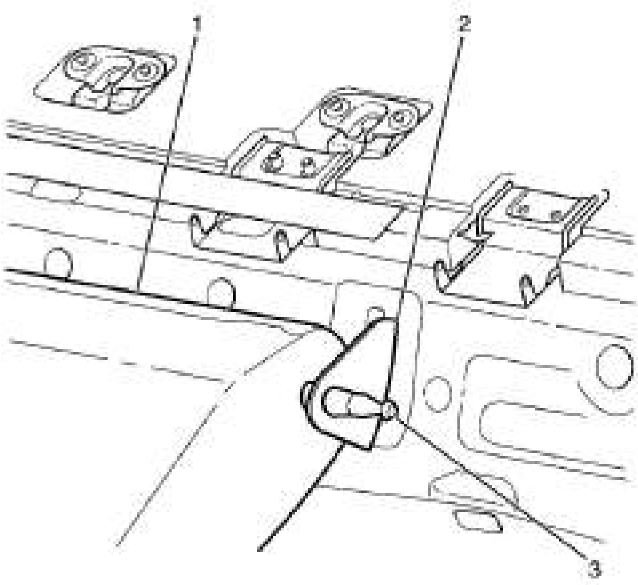
2. Remove the centre rear seatbelt anchor to body retaining nut (2) from the centre rear seatbelt anchor (1).



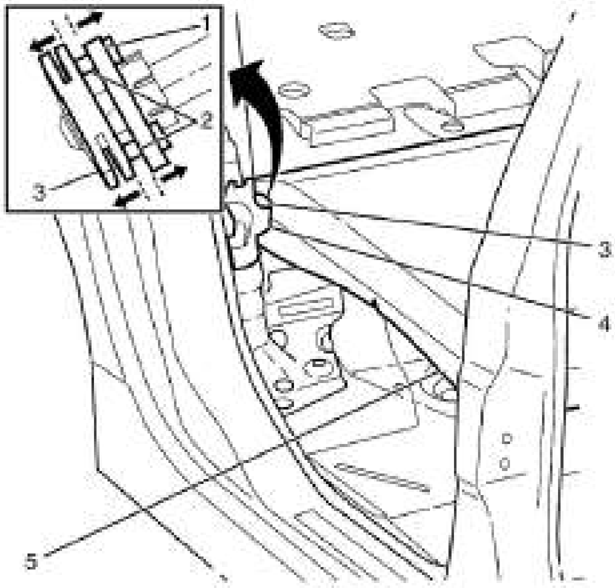
3. Using a suitable tool detach the pivot retainer plate (1) from the pivot retainer (3) in order to disengage the pivot retainer pins (2) from the pivot retainer mounting (4).
4. Lift the right rear seat back (5) to disengage the pivot retainer (3) from the pivot retainer mounting (4).
5. With the aid of an assistant pull the right rear seat back (5) towards the right rear door

opening and remove from the vehicle.

Installation Procedure - Right Rear Seat Back Assembly



1. With the aid of an assistant install the right rear seat back (1) to the vehicle.
2. Align the right rear seat spindle shaft (3) with the spindle shaft mounting (2).

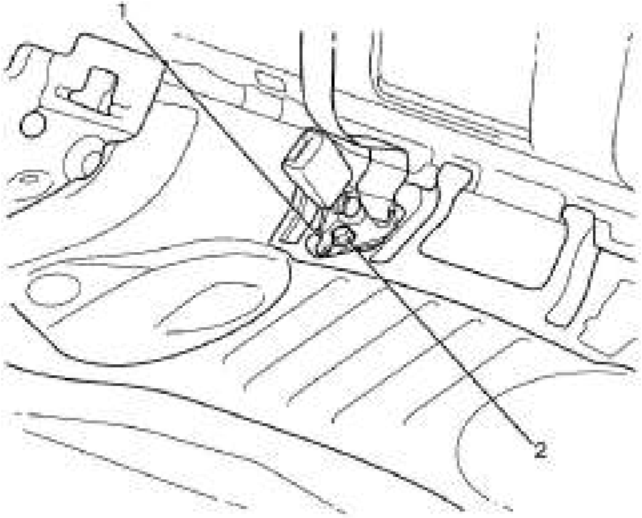


Important: In order to engage the pivot retainer pins (2) to the pivot retainer mounting (4) the right rear seat back (5) must be folded to the upright position.

3. Attach the pivot retainer (3) to the pivot retainer mounting (4).

Important: Listen for an audible click to confirm correct installation of the right rear seat.

4. Fold the right rear seat back (5) into the upright position.



5. Install the centre rear seatbelt anchor (1) to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.

6. Install the centre rear seatbelt anchor to body retaining nut (2) to the centre rear seatbelt anchor (1).

   Tighten
   Tighten the bolts to 43 N·m (31 lb ft).

7. Install the left rear seat back.

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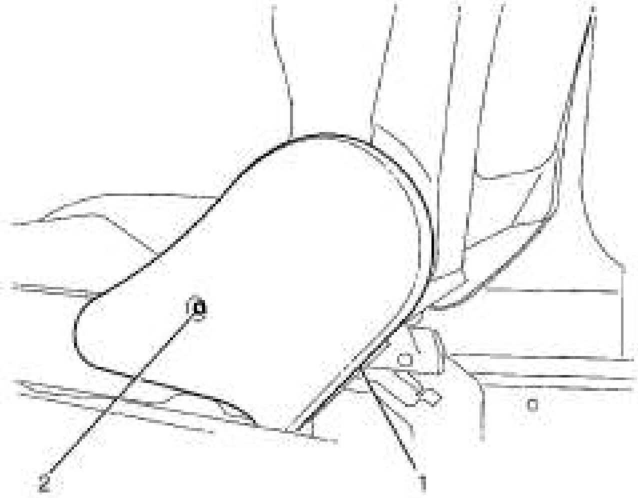
Seat Cushion Inner Trim Panel Replacement

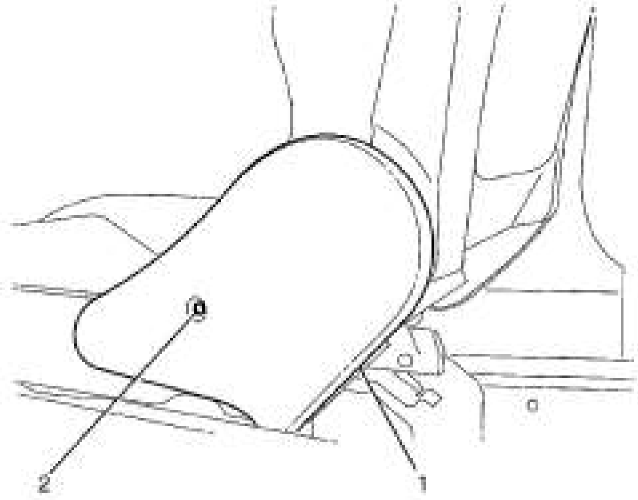
Removal Procedure

1. Remove the seat belt buckle. Refer to Seat Belt Buckle Pretensioner Replacement .



2. Remove the front seat inner trim (1) to hinge assembly retaining screw (2).
3. Firmly grasped the top of the front seat inner trim (1) and disengage the retaining clip.
4. Remove the front seat cushion inner trim (1).

Installation Procedure



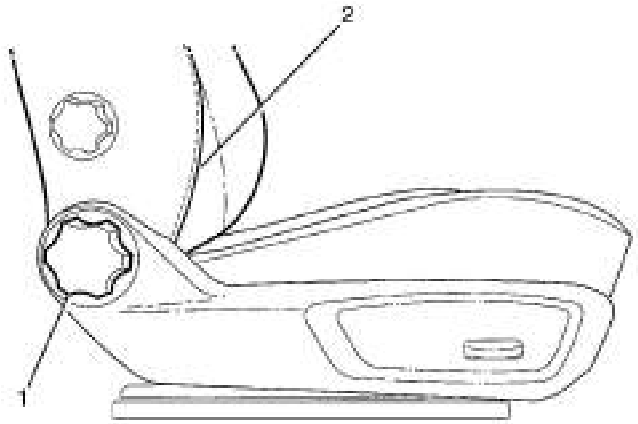
1. Install the front seat inner trim (1) to the hinge assembly.
2. Install the front seat inner trim (1) retaining screw (2).
3. Install the seat belt Buckle. Refer to Seat Belt Buckle Pretensioner Replacement .

Seat Cushion Outer Trim Panel Replacement (RHD)

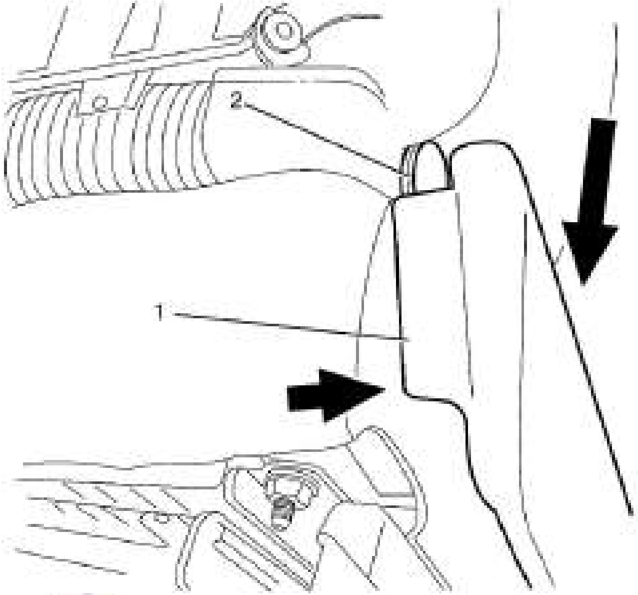
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

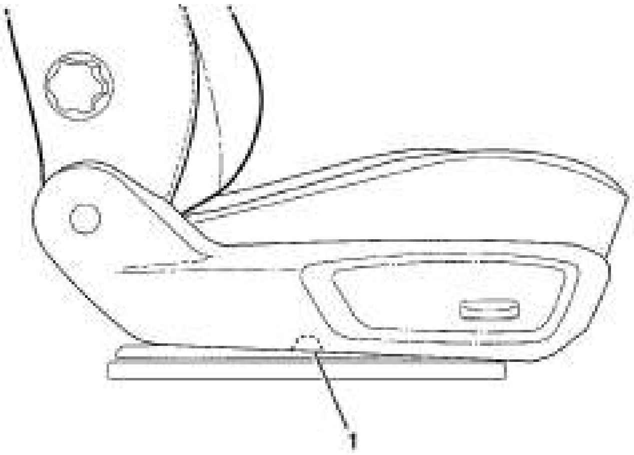
1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
2. Remove the front seat. Refer to Front Seat Replacement - Bucket .



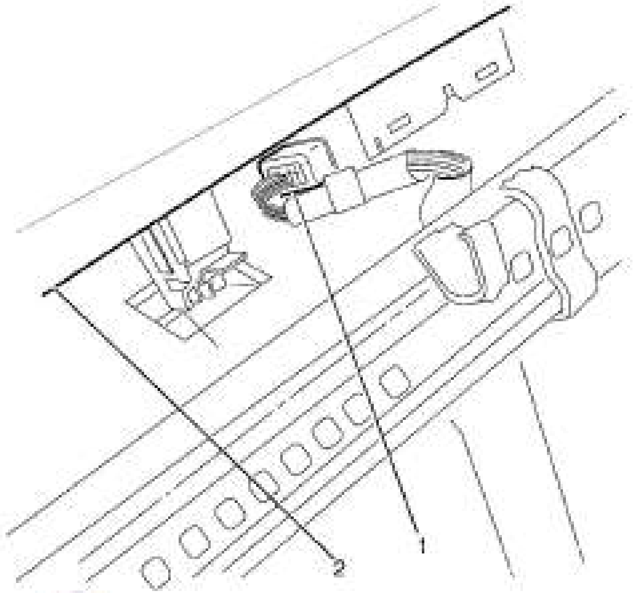
3. Using a suitable flat blade tool, gently pry off the adjusting knob (1) from the seat back (2).



4. Detach the rear of the outer trim panel (1) from the hinge assembly (2), by pushing the side cover down, and prying the bottom of the cover away from the hinge assembly.

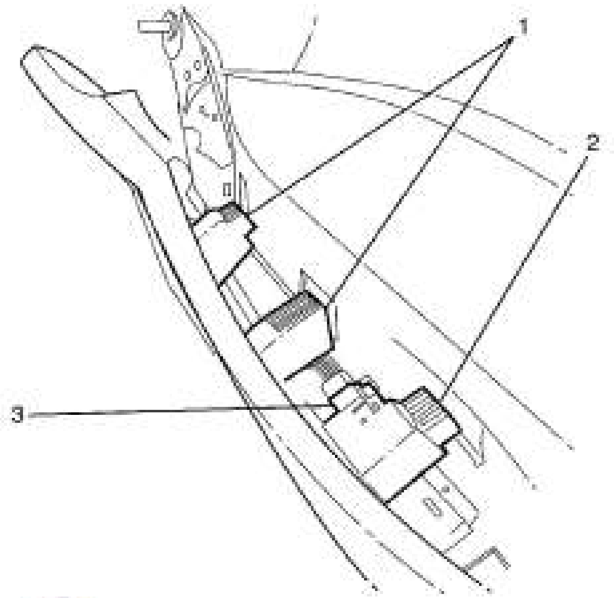


5. Using your finger press the trim panel retaining tang (1) down and slide the trim towards the front of the seat.

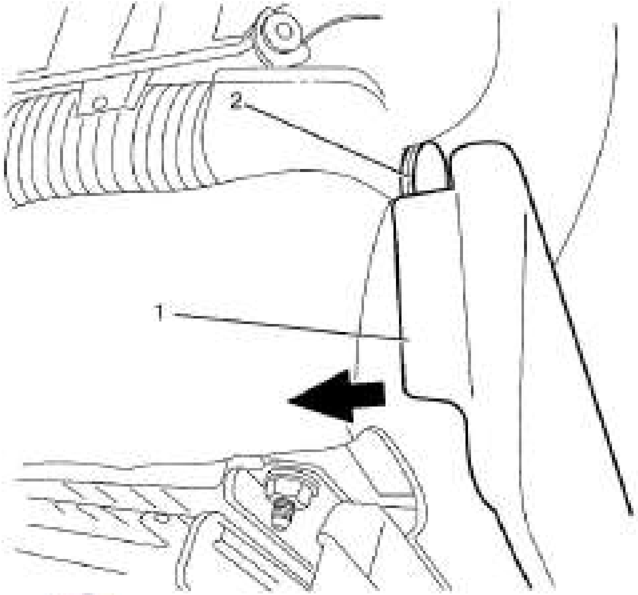


6. Disconnect the electrical connector (1).
7. Remove the outer trim panel (2).

Installation Procedure



1. Connect the electrical connector (3).
2. Locate front tab (2), then middle and rear (1).
3. Push outer trim panel towards cushion and slide towards rear of seat.



4. Attach the rear or the outer trim panel (1) to the hinge assembly (2).
5. Firmly push the adjusting knob on to the adjusting shaft.
6. Install the front seat. Refer to Front Seat Replacement - Bucket .
7. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
8. Test the seat for correct mechanical and electrical operation.

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Seat Lumbar Sub System Replacement

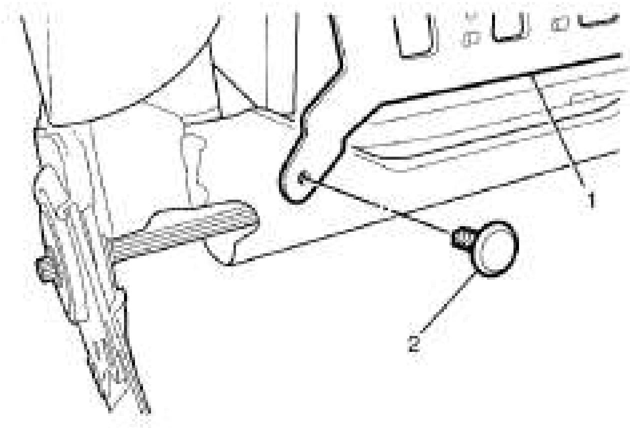
Removal Procedure

Caution: Refer to Battery Disconnect Caution in the Preface section.

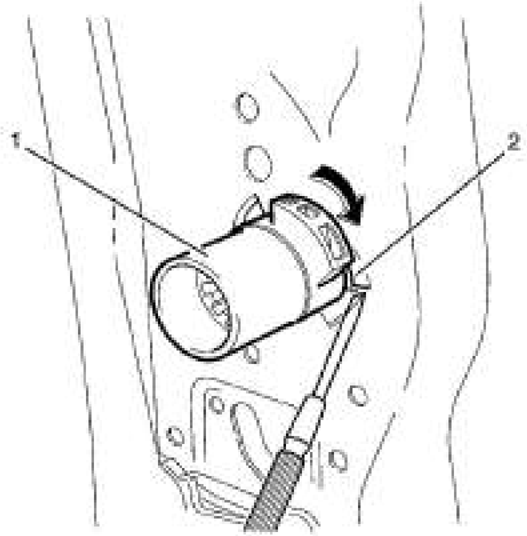
1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .

Caution: Refer to SIR Caution in the Preface section.

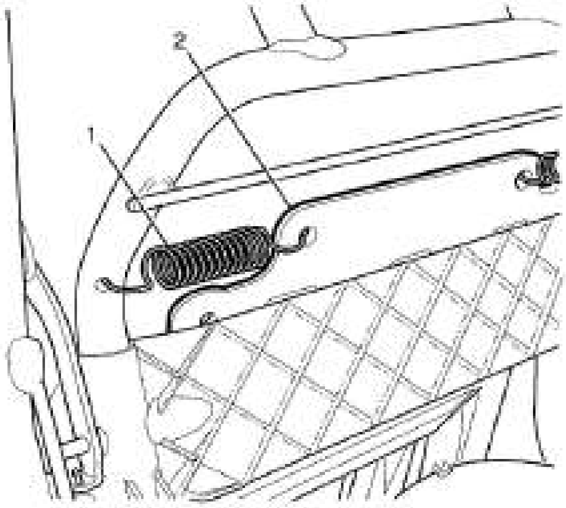
2. Disable the SIR system. Refer to SIR Disabling and Enabling .
3. Remove the front seat. Refer to Front Seat Replacement - Bucket .
4. Remove the front seat-back. Refer to Front Seat Back Replacement .
5. Remove the front seat cover and pad. Refer to Front Seat Back Cushion Cover and Cushion Pad Replacement .
6. Remove the front head restraints. Refer to Front Seat Head Restraint Replacement .
7. Remove the front head restraints guides. Refer to Front Seat Head Restraint Guide Replacement .



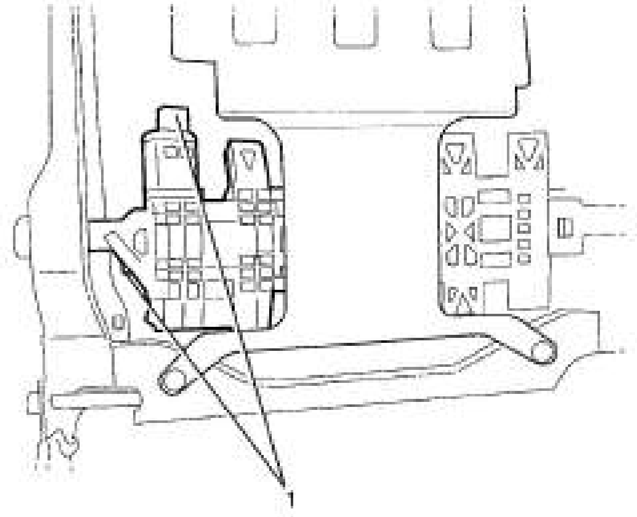
8. Remove the retainer (2) two places, attaching the lumbar support assembly (1) to the seat-back frame.



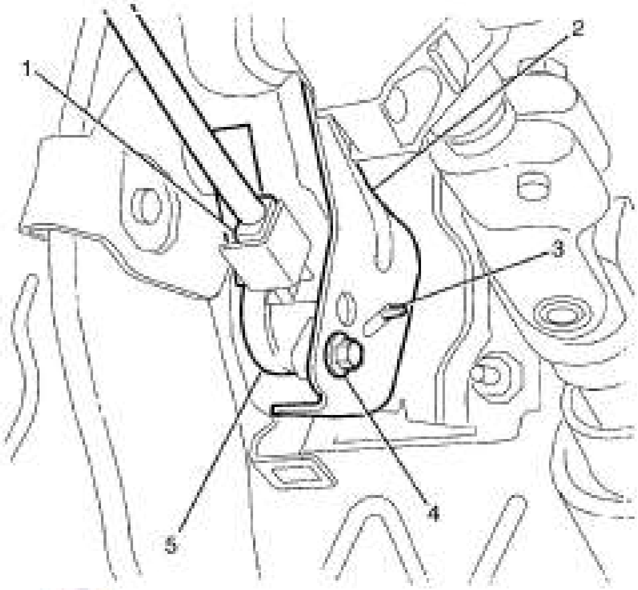
9. Depress the retaining tab (2) and from the inner side of the seat-back frame, rotate the lumbar support shaft (1) and withdraw from the seat-back frame.
10. Repeat this procedure for the opposite side.



11. Disconnect the spring (1), two places, attaching the lumbar support assembly (2) to the head restraint frame.

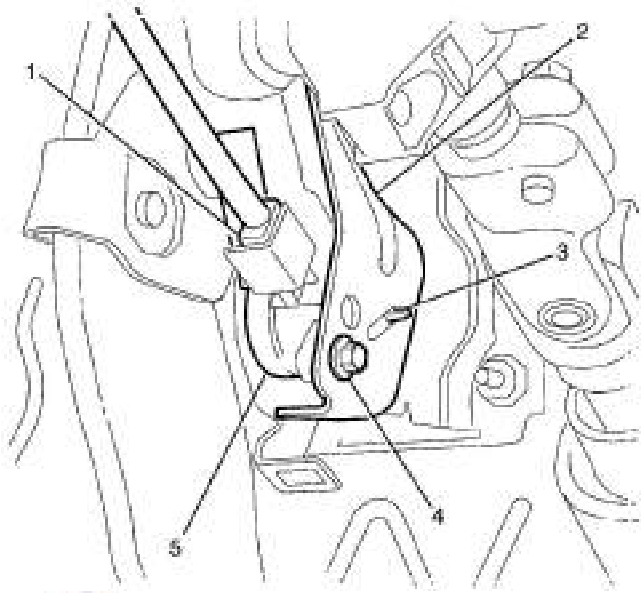


12. Disconnect the electrical connectors (1) attached to seat back harness for power & memory.

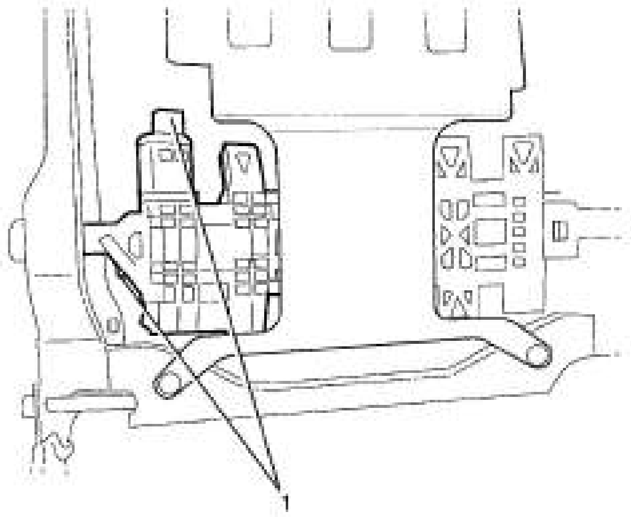


13. Remove the lumbar support assembly (1).

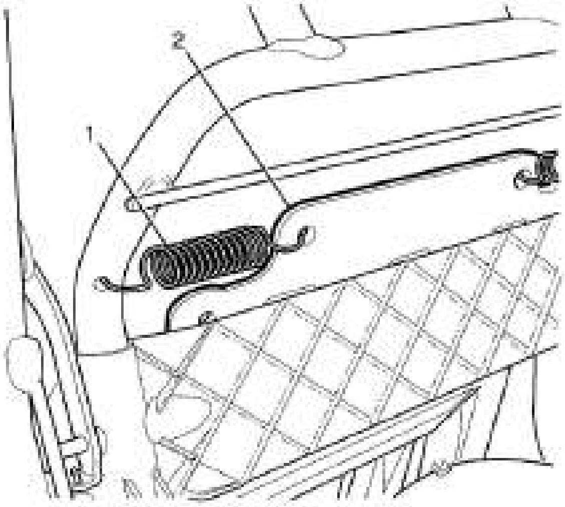
Installation Procedure



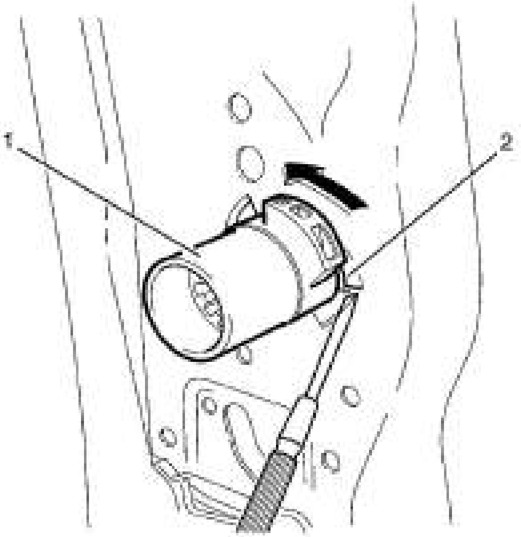
1. Install the lumbar support assembly (1) to the seat-back frame.



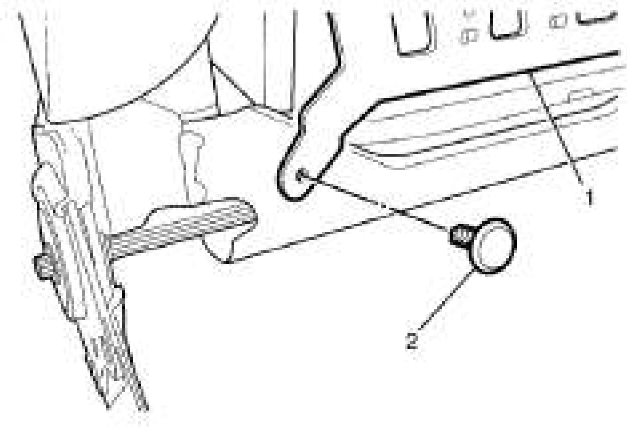
2. Connect the electrical connectors (1) attached to seat back harness for power & memory.



3. Connect the spring (1) two places, attaching the lumbar support assembly (2) to the head restraint frame.



4. Insert the lumbar support shaft (1) to the seat-back frame and rotate anti-clockwise until it locks in front of the retaining tab (2).



5. Install the lumbar support assembly (1) to seat-back frame retainers (2).
6. Install the front seat cover and pad. Refer to Front Seat Back Cushion Cover and Cushion Pad Replacement .
7. Install the front head restraints guides. Refer to Front Seat Head Restraint Guide Replacement .
8. Install the front head restraints. Refer to Front Seat Head Restraint Replacement .
9. Install the front seat. Refer to Front Seat Replacement - Bucket .

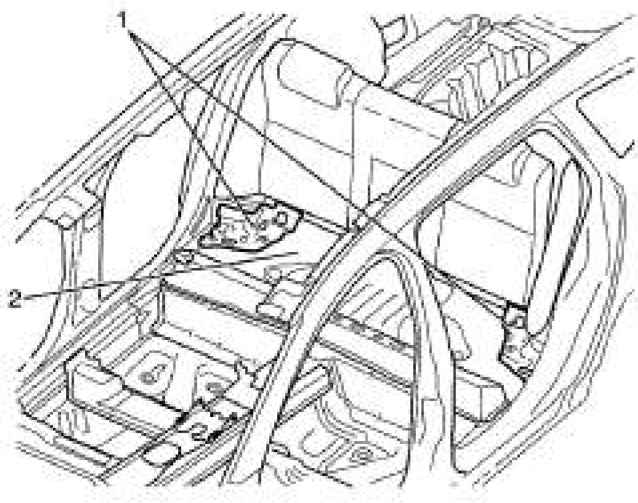
   Caution: Refer to SIR Caution in the Preface section.

10. Enable the SIR system. Refer to SIR Disabling and Enabling .
11. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
12. Test the seat for correct mechanical and electrical operation.

Sound Barrier Replacement - Rear Seat Cushion to Floorpan (Sportwagon)

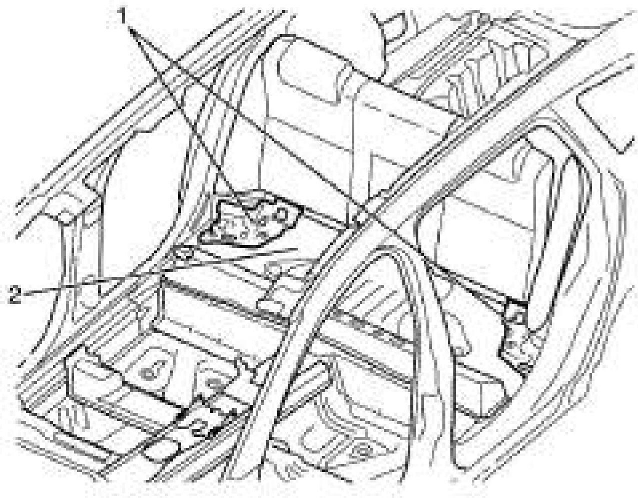
Removal Procedure

1. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement.



2. Remove the rear floorpan sound barriers (1) from the floorpan (2).

Installation Procedure



Caution: All floor pan insulator material must meet Federal Vehicle Safety Standards for flammability. Failure to do so could result in personal injury and/or vehicle damage.

Important: When installing the floorpan sound barriers, aligned with the floorpan sound barriers with the respective contours on the floorpan (2).

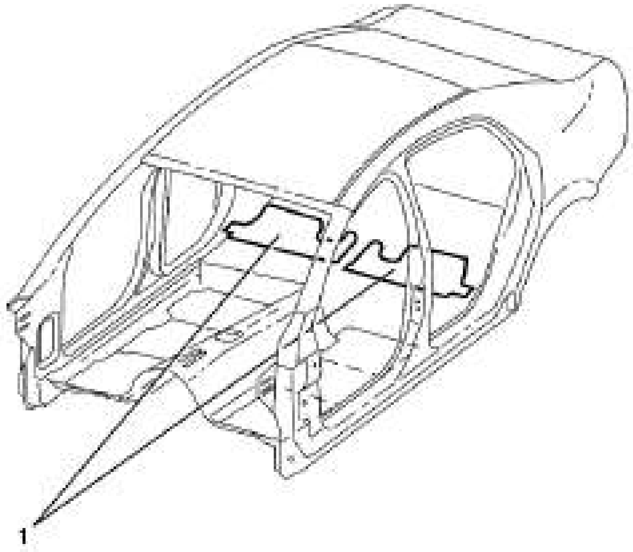
Important: Make sure that the floorpan sound barriers (1) bonds to the floorpan (2) adequately.

1. Clean the contact surface area with a suitable cleaning solution and a lint free cloth to remove any adhesive or grease.
2. Peel the backing from the floorpan sound barriers (1).
3. Install the floorpan sound barriers (1) to the floorpan (2).
4. Press the floorpan sound barriers (1) firmly in all areas in order to secure the sound barriers to the floorpan (2).
5. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement.

Sound Barrier Replacement - Rear Seat Cushion to Floorpan (SWB)

Removal Procedure - Up to 24 Oct 06

1. Remove the rear seat back. Refer to Rear Seat Back Replacement .
2. Remove the rear seat cushion. Refer to Rear Seat Cushion Replacement .



3. Lift the rear floor pan sound barriers (1) upward and pull outward in order to remove.

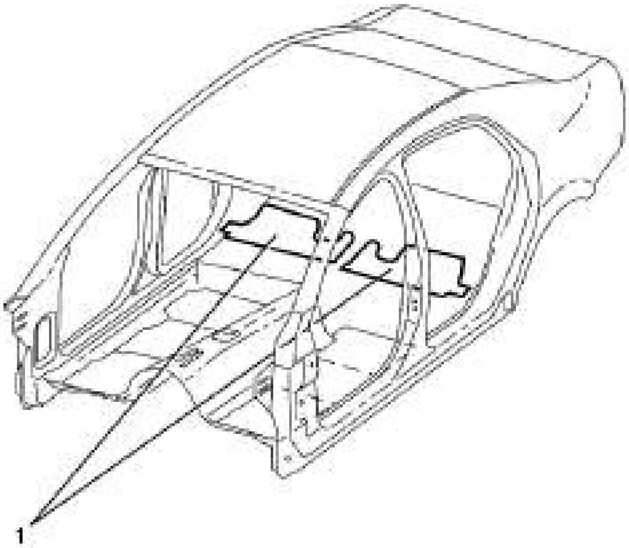
Installation Procedure - Up to 24 Oct 06

Caution: All floor pan insulator material must meet Federal Vehicle Safety Standards for flammability. Failure to do so could result in personal injury and/or vehicle damage.

Important: Align the sound barriers in order to keep the seat belt and seat attachment areas are clear.

Important: When installing the barriers, ensure they are aligned with the respective holes in the sheet metal.

1. Ensure the attachment areas are clear.
2. Remove the backing of the sound barriers.
3. Route the sound barriers around the electrical harness.



4. Press firmly in all areas in order to secure the sound barriers (1) to the floor pan.
5. Install the rear seat cushion. Refer to Rear Seat Cushion Replacement .
6. Install the rear seat back. Refer to Rear Seat Back Replacement .

Lumbar Support Description and Operation

Lumbar Support Components

The driver seat lumbar support system with memory consists of the following components:

- Lumbar Switch
- Memory Seat Module (MSM)
- Lumbar Horizontal Motor
- Lumbar Horizontal Position Sensor
- SEATS Fuse 10 A

Lumbar Switch

Battery positive voltage is supplied at all times to the driver seat lumbar switch from the SEATS Fuse located in the left rear fuse block. When the lumbar switches are pressed they send a 12 volt signal to the MSM. The MSM then commands the lumbar motor to move in response to the switch signals.

Lumbar Motor

The lumbar support system consists of one motor that moves the lumbar support horizontally forward or rearward. The motor contains a electronic circuit breaker (PTC) that opens in the event of a circuit overload and will reset only after voltage has been removed from the circuit. The memory seat module provides the motor with a soft stop that will actually stop the motor just before its physical end-of-travel. This decreases the stress on the motor. If the motor reaches it's end-of-travel due a soft stop and the switch is released and pressed again, the lumbar support will move short distance farther to it's physical travel limit.

Lumbar Operation

When the lumbar switch is operated to move the lumbar support forward, battery positive voltage is applied through the switch contacts and the driver seat lumbar forward switch signal circuit to the MSM. In response to this signal, the MSM applies battery positive voltage through the lumbar motor forward control circuit and ground through the lumbar motor rearward control circuit to the motor. The motor runs to drive the lumbar support forward toward the occupant's back until the switch is released. Moving the lumbar support rearward works similarly to moving the lumbar support forward, except that battery positive voltage and ground are applied on the opposite circuits causing the motor to run in the opposite direction. The MSM also controls the lumbar horizontal motor during memory recall functions.

Position Sensors

The lumbar position sensor is a potentiometer which is attached directly to the lumbar motor. The MSM supplies a 5 volt reference voltage through the 5 volt reference circuit and ground through the low reference circuit to the lumbar position sensor. When the lumbar motor rotates, the resistance of the potentiometer varies changing the feedback voltage of the position sensor signal circuit. This voltage varies from 0.25-4.75 volts. The MSM monitors this voltage signal to determine the lumbar position.

When a memory set command is received, the MSM records the lumbar position by storing the feedback voltage from the position sensor. Then, when a memory recall command is received, the MSM moves the motor until the position sensor feedback voltage equals the feedback voltage stored in memory. The lumbar support is not involved in the easy exit function.

Memory Functions

Refer to Memory Seats Description and Operation.

Manual Seats Description (Rear - Sportwagon)

Manual Rear Seat Description and Operation

All vehicles have rear seat backs that folds forward. The vehicle is equipped with a 3 passenger bench seat with a split 60/40 seat back.

The seat back and seat cushions have formed foam pads, which fit the contours of the full panel seat back frame assembly and the designed contours of the seat cushion frame.

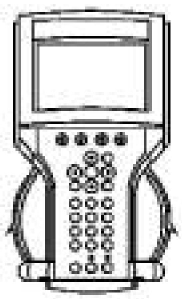
All vehicles have built in child seat tether anchors on the rear seat backs for securing child seats to the rear seat backs.

Some models are equipped with a rear seat armrest. Pull the rear seat armrest at the top to fold the rear seat armrest down. To fold the rear seat armrest away, lift the rear seat armrest and push into the rear seat armrest compartment in the rear seat back. Models with an armrest fitted also include a cupholder in the rear seat cushion. Pressing the front face of the cupholder releases it forward, it can then be retracted back into cushion by pushing it rearward until its latch engages.

The seat backs can operate independently from one another. Each seat back has a seat back release latch located at the top outer ends of the seat backs. The seat backs can only be operated in two positions, completely down or upright. Pressing the seat back release button enables the seat back to fold down. When the seat back is lifted to the upright position, the seat back is locked into place by the seat back locks.

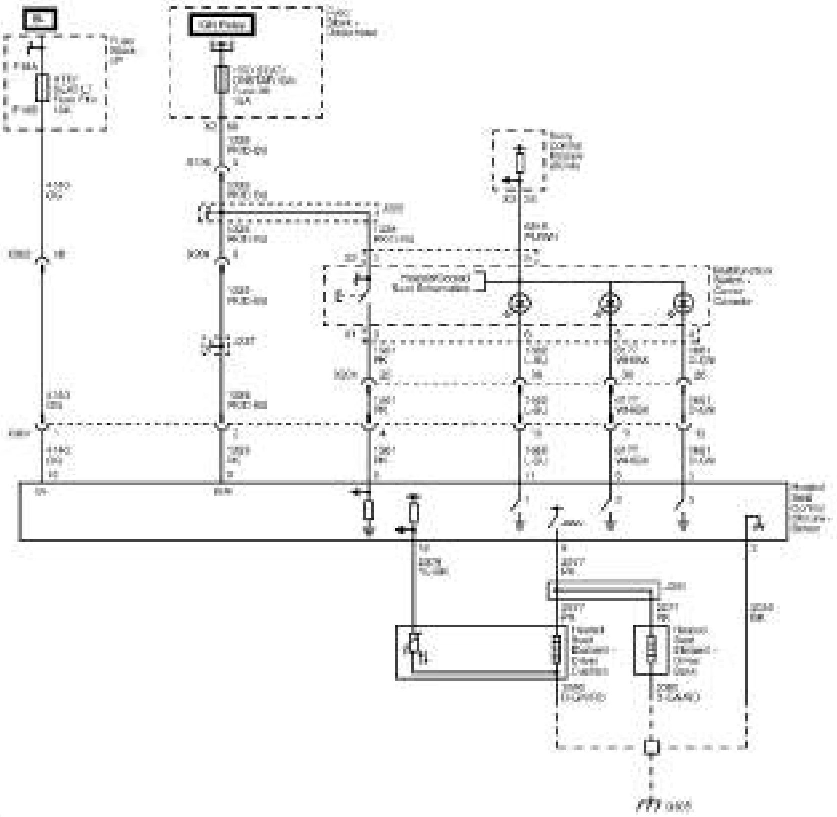
The right rear seat back is equipped with a three point safety belt for the centre occupant. The retractor is located on the seat frame below the foam pad.

Special Tools

Illustration	Tool Number / Description
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

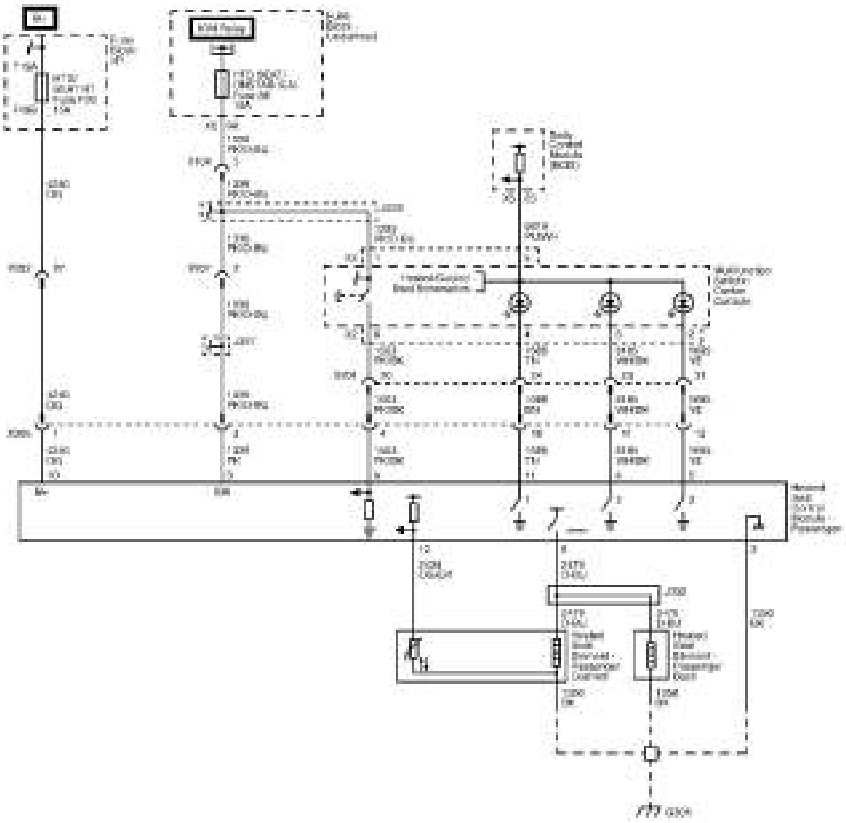
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Seats | Seat Heating and Cooling | Schematic and Routing Diagrams | **Document ID: 2154639**

Driver Seat



2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Seats | Seat Heating and Cooling | Schematic and Routing Diagrams | Document ID: 2154646

Passenger Seat


B+
IGN Relay
Fuse Block - Underhood
Body Control Module (BCM)
Multifunction Switch - Center Console
Heated Seat Control Module - Passenger

Fastener Tightening Specifications

Application	Specification	
	Metric	English
End Plate to Power Steering Pump Housing Retaining Bolts	22 N·m	16 lb ft
Front Castor Arm Ball Joint to Steering Knuckle Retaining Nut		
• First Pass	40 N·m	30 lb
• Final Pass	60 degrees	
High Pressure Outlet Fitting to Power Steering Pump Housing	59 N·m	44 lb ft
Intermediate Steering Shaft to Pinion Shaft Retaining Bolt	25 N·m	18 lb ft
Power Steering Fluid Reservoir Outlet Hose Worm Drive Clamp	2 N·m	18 lb in
Power Steering Fluid Reservoir Inlet Pipe/Hose Bracket to Subframe Retaining Bolt	9 N·m	80 lb in
Power Steering Gear Outlet Pipe/Hose Bracket to Subframe Retaining Bolt	9 N·m	80 lb in
Power Steering Gear Inlet Pipe/Hose to Power Steering Gear Retaining Banjo Bolt	58 N·m	43 lb ft
Power Steering Gear Inlet Pipe to Power Steering Pump Retaining Banjo Bolt	58 N·m	43 lb ft
Power Steering Gear Inlet Pipe/Hose Bracket to Subframe Retaining Bolt	9 N·m	80 lb in
Power Steering Gear Outlet Pipe/Hose to Power Steering Gear Retaining Banjo Bolt	58 N·m	43 lb ft
Power Steering Pump Inlet Pipe to Power Steering Pump Housing Retaining Bolt	10 N·m	89 lb in
Power Steering Pump to Power Steering Pump Bracket Retaining Bolts	27 N·m	20 lb ft
Steering Gear to Subframe Retaining Bolts	65 N·m	48 lb ft
Tie Rod End Retaining Lock Nut	170 N·m	125 lb ft
Tie Rod End to Steering Knuckle Retaining Nut		
First Pass	25 N·m	18 lb ft
Final Pass	120 degrees	

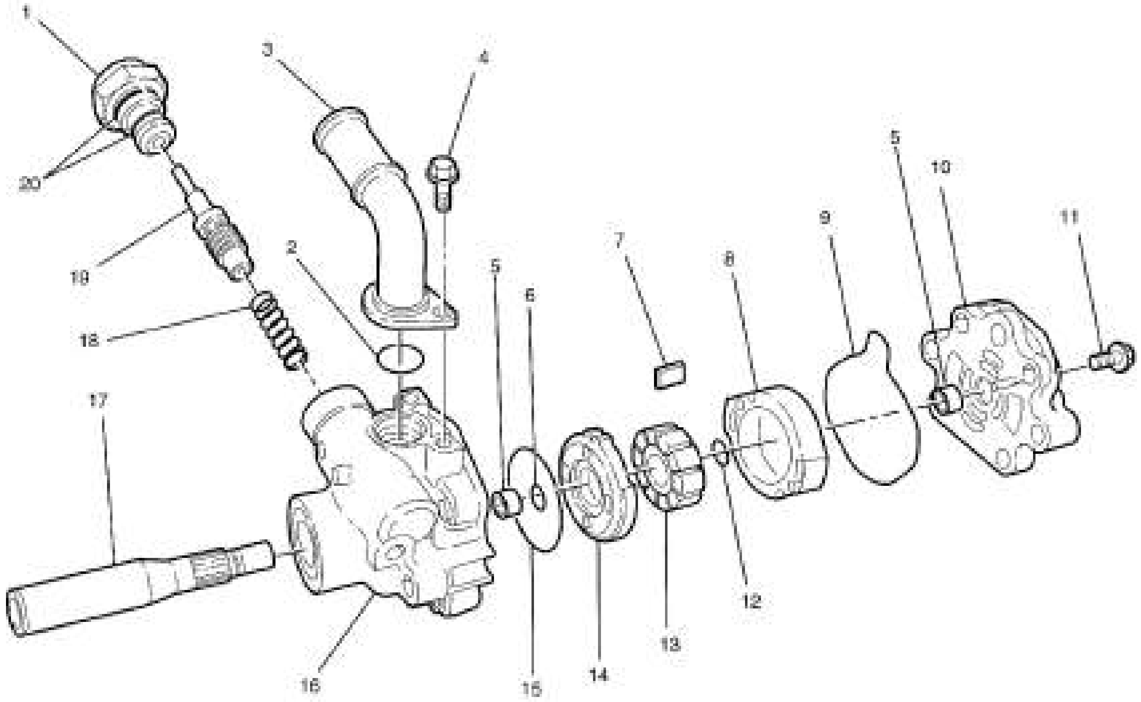
Power Steering Pump Specifications

Application	Specification
Make	Kayaba
Type	Vane type constant flow
Pressure @ 1,000 engine rpm	
- V6 Engine	7,580-8,270 kPa
- V8 Engine	8,270-8,960 kPa
Flow	8 L/pm
Drive	Pulley driven by the crankshaft via a drive belt
Drive Belt Tension	Self Adjusting
Lubrication	
- Hydraulic Fluid	Dexron® VI Automatic Transmission Fluid
- Grease	EP Semi Fluid Lithium Base O Grease
Power Steering Fluid Capacity	
- Dry Fill	700 ml **Important:** Use the power steering fluid level indicator as a final check to make sure the correct refill quantity.
- Wet Fill	Approx. 650 ml **Important:** Use the power steering fluid level indicator as a final check to make sure the correct refill quantity.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Steering | Power Steering | Component Locator | **Document ID: 1982178**

Power Steering Pump Disassembled View

Power Steering Pump



(1) High Pressure Outlet Fitting
(2) Low Pressure Inlet Pipe O-ring
(3) Low Pressure Inlet Pipe
(4) Low Pressure Inlet Pipe to Power Steering Pump Housing Retaining Bolt
(5) Pump Housing Bushes
(6) Thrust Plate O-Ring - Small
(7) Vane, Ten places
(8) Power Steering Pump Ring
(9) Rear End Plate Seal
(10) Rear End Plate
(11) Rear End Plate Attaching Bolt, 4 Places
(12) Full Circumference Retainer Ring
(13) Rotor
(14) Thrust Plate
(15) Thrust Plate O-Ring - Large
(16) Pump Housing
(17) Power Steering Pump Drive Shaft

(18) Droop Flow Control Valve Spring
(19) Droop Flow Control Valve Assembly
(20) High Pressure Outlet Fitting O-Rings

Diagnostic Starting Point - Power Steering System

Begin the system diagnosis by reviewing the system description and operation. Refer to Power Steering System Description and Operation. Reviewing the description and operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the description and operation information will also help you determine if the condition described by the customer is normal operation. To identify the correct procedure for diagnosing the system and where the procedure is located. Refer to Symptoms - Power Steering System.

Symptoms - Power Steering System

Important: Review the system description and operation in order to familiarise yourself with the system functions. Refer to Power Steering System Description and Operation.

Visual / Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the power steering system.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect the power steering fluid reservoir for the correct power steering fluid level and condition.

Symptoms List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Power Steering Fluid Leaks.
- Rattle, Clunk, or Shudder Noise from the Power Steering System.
- Whine or Growl Noise from the Power Steering System.
- Steering Effort Hard in One or Both Directions.

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Power Steering System Test

Test Description

DEFINITION: The Power Steering System Testing Procedure will perform the following functions:

- Test the operation of the hydraulic power steering system.
- Test the operation of the power steering pump and power steering gear.
- Identify restrictions in the system.

The numbers below refer to the step numbers on the diagnostic table.

5. This step tests the system for restrictions.

7. This step tests the following components for the following conditions:

   - The pump for internal leakage
   - The power steering pipes for restrictions

8. This step tests the ability of the pump to regulate flow at minimum pressure.

10. This step tests the ability of the pump to regulate flow under normal operating conditions.

12. This step tests the internal components of the pump and the gear.

Test Procedure

Step	Action	Value (s)	Yes	No
1	Inspect the power steering fluid for the following indications of contamination: • Milky fluid - water • Brown fluid - burnt • Debris in fluid - plastic or dirt Is the fluid contaminated?	--	Go to Step 2	Go to Step 3
2	Flush the power steering system. Refer to Power Steering System Flushing. Did you complete the procedure?	--	Go to Step 3	--
3	**Important:** In order to accurately diagnose the system, the condition must be present during the test procedure. Attempt to duplicate the condition.	--	Go to	System

	Is the condition present?		Step 4	OK
4	1. Turn the ignition switch to the OFF position. 2. Place a drain pan under the vehicle in order to catch any power steering fluid. 3. Disconnect the power steering gear inlet pipe/hose from the power steering pump. 4. Install the J 44721 Power Steering System Analyser 5. Fill the power steering system to the correct level. Refer to Checking and Adding Power Steering Fluid. 6. Fully open the J 44721 valve. 7. Start the engine. **Notice:** Refer to Steering Wheel in the Full Turn Position Notice in the Preface section. 8. Turn the steering wheel from lock to lock three times, BRIEFLY holding the steering wheel against the steering stop each time in order to release any trapped air from the system. 9. Inspect and make sure that all of the power steering pipe/hose connections are not leaking. Did you complete the installation?	--	Go to Step 5	--
5	1. Start the engine. **Important:** The steering must not be against the steering stop. 2. Observe the pressure reading. Is the pressure reading greater than the specified value?	1379 kPa (200 psi)	Go to Step 6	Go to Step 7
6	**Important:** A restriction may be present in the power steering system. Turn off the engine immediately. Locate and repair the restriction. Did you complete the repair?	--	Go to Step 15	--
7	1. Allow the engine to run until the engine reaches normal operating temperature. 2. Record the pressure and flow readings. 3. Partially close the J 44721 valve to adjust the system pressure to the specified value. Record the flow reading. 4. Subtract second flow reading from the first flow reading. Is the decrease in flow greater than 3.8 L (1 gal) per minute?	4827 kPa (700 psi)	Go to Step 11	Go to Step 8
	Important: Do not leave the valve closed for more than 5 seconds, or internal pump damage could occur. Fully close then open the J 44721 valve 3 times. Record all			

8	of the high pressure readings. Refer to Power Steering Pump Specifications, for power steering system pressure relief specifications. Are the three high pressure readings within specifications?	--	Go to Step 9	Go to Step 13
9	Are the three high pressure readings within 245 kPa (50 psi) of each other?	--	Go to Step 10	Go to Step 13
10	1. Increase the engine speed to approximately 1500 RPM. 2. Record the flow reading. Refer to Power Steering Pump Specifications, for power steering system pressure specifications. Is the flow reading within specifications?	--	Go to Step 11	Go to Step 13
11	Is the difference between the flow reading recorded in step 7.2 and the minimum flow specification more than 3.8 L (1 gal) per minute?	--	Go to Step 13	Go to Step 12
12	**Notice:** Refer to Steering Wheel in the Full Turn Position Notice in the Preface section. Turn the steering wheel from steering stop to steering stop and record the flow readings at each stop. Is the flow lower than 3.8 L (1 gal) per minute?	--	Go to Step 15	Go to Step 14
13	Replace the power steering pump. Refer to Power Steering Pump Replacement. Did you complete the replacement?	--	Go to Step 15	--
14	The power steering gear is leaking across the piston or bypassing the valve circuit. Replace the power steering gear. Refer to Steering Gear Replacement in Power Steering System. Refer to Steering Gear Replacement in Power Steering System. Did you complete the replacement?	--	Go to Step 15	--
15	Test the power steering system for the original condition. Does the original condition still exist?	--	Go to Step 5	Go to Step 16
16	1. Disconnect and remove the J 44721 from the vehicle. 2. Connect the power steering gear inlet pipe/hose to the power steering pump. 3. Fill the power steering system to the correct level. Refer to Checking and Adding Power Steering Fluid. Did you complete the procedure?	--	System OK	--

Power Steering Fluid Leaks

Step	Action	Yes	No
1	Did you review the Power Steering System General Description and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Power Steering System .
2	Verify that power steering fluid leaks are present. Is the power steering system leaking?	Go to Step 3	System OK
3	Inspect the power steering system fittings. Are the fittings leaking?	Go to Step 8	Go to Step 4
4	Inspect the power steering hoses. Are the hoses leaking?	Go to Step 9	Go to Step 5
5	Inspect the power steering pump and the fluid reservoir for leaks. Is the power steering pump or fluid reservoir leaking?	Go to Step 10	Go to Step 6
6	Inspect the power steering gear for leaks. Is the power steering gear leaking?	Go to Step 11	Go to Step 7
7	Inspect the power steering cooler for leaks. Is the power steering cooler leaking?	Go to Step 12	Go to Step 2
8	**Notice:** Refer to Fastener Notice in the Preface section. Tighten the fittings. Refer to Fastener Tightening Specifications . Did you complete the repair?	Go to Step 13	--
9	Replace the power steering hoses. Refer to the appropriate procedures: • Power Steering Fluid Reservoir Outlet Hose Replacement . • Power Steering Gear Inlet Pipe/Hose Replacement . • Power Steering Gear Outlet Pipe/Hose Replacement . • Power Steering Fluid Reservoir Inlet Hose Replacement . Did you complete the repair?	Go to Step 13	--
	Replace the power steering pump or reservoir. Refer to		

10	Power Steering Pump Replacement . Refer to Power Steering Fluid Reservoir Replacement . Did you complete the repair?	Go to Step 13	--
11	Replace the power steering gear. Refer to Power Steering Fluid Reservoir Outlet Hose Replacement . Did you complete the repair?	Go to Step 13	--
12	Replace the power steering cooler. Refer to Power Steering Fluid Cooler Replacement . Did you complete the repair?	Go to Step 13	--
13	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

Whine or Growl Noise from the Power Steering System

Step	Action	Yes	No
1	Did you review the Power Steering System Description and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Power Steering System .
2	Verify that a whine or growl noise is present. Is a whine or growl noise present?	Go to Step 3	System OK
3	Perform the power steering test procedure in order to diagnose a hydraulic condition and repair or replace a component. Refer to Power Steering System Test . Did you repair or replace a power steering system component?	Go to Step 10	Go to Step 4
4	Using the J 39570 Chassis Ear, inspect the power steering gear for a whine or growl noise. Is the noise present at the power steering gear?	Go to Step 7	Go to Step 5
5	Using the J 39570 , inspect the power steering pump for a whine or growl noise. Is the noise present at the power steering pump?	Go to Step 8	Go to Step 6
6	Using the J 39570 , inspect the power steering hoses for a whine or growl noise. Is the noise present at the power steering hoses?	Go to Step 9	Go to Step 2
7	Replace the power steering gear. Refer to Steering Gear Replacement . Did you complete the repair?	Go to Step 10	--
8	Replace the power steering pump. Refer to Power Steering Pump Replacement . Did you complete the repair?	Go to Step 10	--
9	Adjust the routing of the power steering hoses. Did you complete the repair?	Go to Step 10	--
10	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

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Steering Effort Hard in One or Both Directions

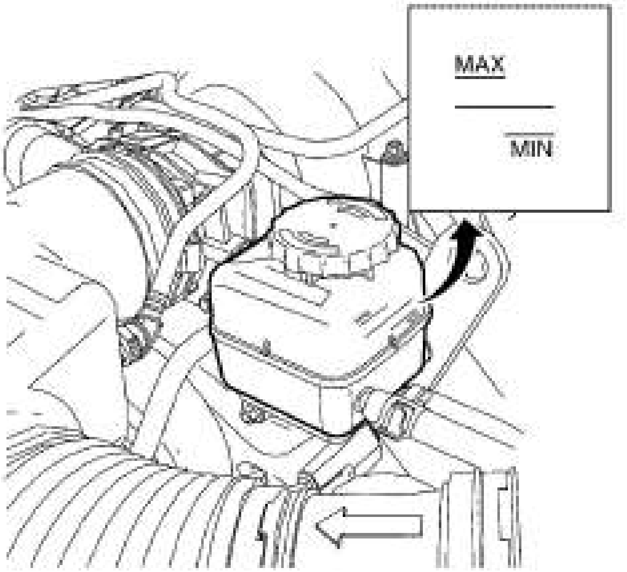
Step	Action	Yes	No
1	Did you review the Power Steering System General Description and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Power Steering System.
2	Verify that the steering effort is hard in one or both directions. Does the system operate normally?	System OK	Go to Step 3
3	Perform the power steering test procedure. Refer to Power Steering System Test. Did you complete the procedure?	Go to Step 4	--
4	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

Checking and Adding Power Steering Fluid

Notice: When adding fluid or making a complete fluid change, always use the proper power steering fluid. Failure to use the proper fluid will cause hose and seal damage and fluid leaks.

Important: When checking the fluid level after servicing the steering system, bleed the air from the system. Refer to Power Steering System Bleeding .

1. Remove the engine dress cover. Refer to Engine Cover Replacement for 3.6L engine, or Engine Cover Replacement for 6.0L engine.
2. Clean the area surrounding the power steering fluid reservoir cap and level indicators.



3. Make sure that the fluid level is at the correct level mark on the power steering fluid reservoir.
   - If fluid is hot, the fluid level should be at the MAX level mark on the reservoir.
   - If fluid is cold, the fluid level should be at the MIN level mark on the reservoir.
4. Remove the power steering fluid reservoir cap.

Important: Use approved new power steering fluid from a sealed container. For fluid specifications refer to Fluid and Lubricant Recommendations .

5. Add power steering fluid as required, until the correct fluid level is obtained.
6. Install the power steering fluid reservoir cap.

Power Steering Fluid Cooler Replacement

The power steering cooler is an integral part of the air conditioning condenser and must be replaced as an assembly. Refer to Air Conditioning Condenser Replacement.

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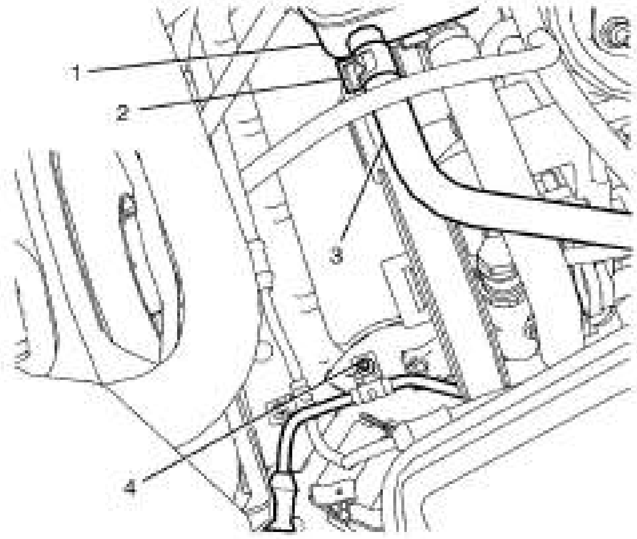
Power Steering Fluid Reservoir Inlet Hose Replacement (3.6L Engine)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

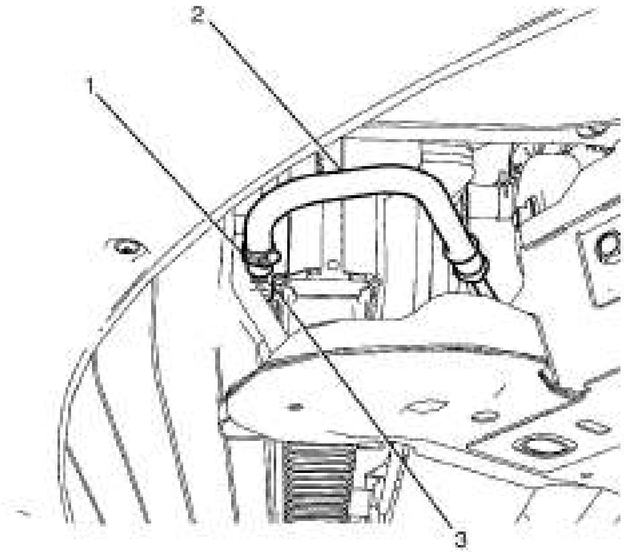
1. Remove the engine dress cover. Refer to Engine Cover Replacement.
2. Remove the upper section of the air box. Refer to Air Cleaner Assembly Replacement.
3. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.
4. Place a large suitable container under the vehicle in order to collect draining power steering fluid.



5. Remove the power steering fluid reservoir inlet pipe/hose bracket to subframe retaining bolt (4).

Important: The power steering fluid reservoir (1) must be plugged to prevent the entry of foreign particles into the power steering system.

6. Release the power steering fluid reservoir inlet pipe/hose spring clamp (2) and disconnect the power steering fluid reservoir inlet pipe/hose (3) from the power steering fluid reservoir (1).
7. Plug the power steering fluid reservoir (1).
8. Remove the front air deflector. Refer to Front Air Deflector Replacement.

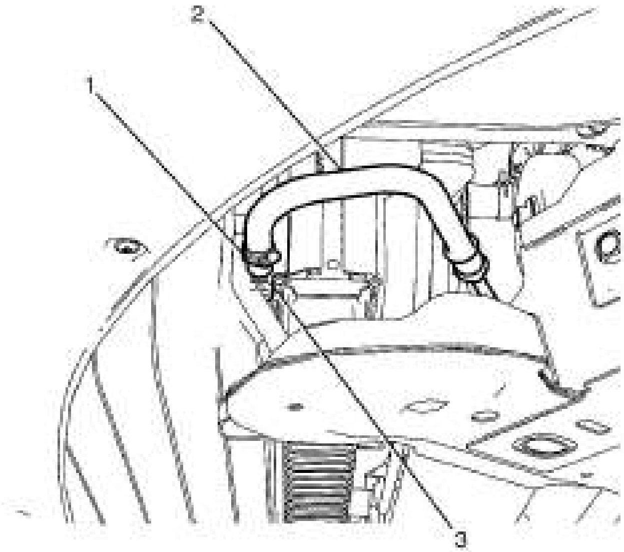


Important: The power steering cooler (3) must be plugged to prevent the entry of foreign particles into the power steering system.

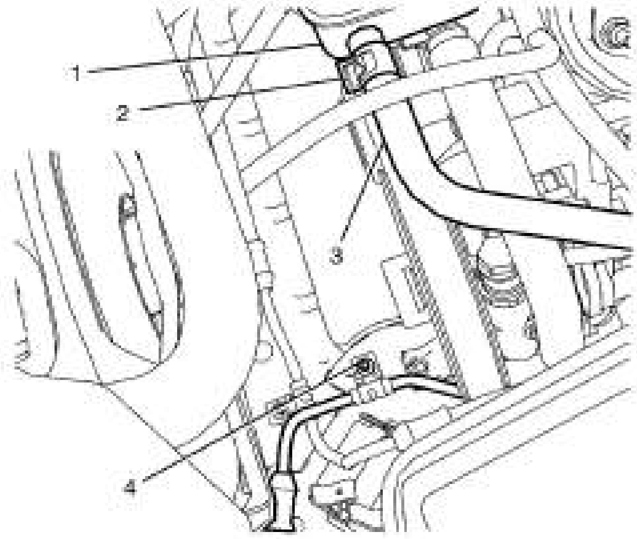
9. Release the power steering fluid reservoir inlet pipe/hose spring clamp (1) and disconnect the power steering fluid reservoir inlet hose (2) from the power steering cooler (3).
10. Plug the power steering cooler (3).
11. Plug the power steering fluid reservoir (1).
12. Remove the fluid reservoir inlet pipe/hose (2).

Installation Procedure

1. Install the power steering fluid reservoir inlet pipe/hose spring clamps to the power steering fluid reservoir inlet pipe/hose.



2. Position the power steering fluid reservoir inlet pipe/hose (2).
3. Remove the plug from the power steering cooler (3).
4. Release the power steering fluid reservoir inlet pipe/hose spring clamp (1) and connect the power steering fluid reservoir inlet pipe/hose (2) to the power steering cooler (3).
5. Install the front air deflector. Refer to Front Air Deflector Replacement.
6. Remove the safety stands.
7. Lower the vehicle to the ground.



8. Remove the plug from the power steering fluid reservoir (1).
9. Release the power steering fluid reservoir inlet pipe/hose spring clamp (2) and connect the power steering fluid reservoir inlet hose (3) to the power steering fluid reservoir (1).

   Notice: Refer to Fastener Notice in the Preface section.

10. Install the power steering fluid reservoir inlet pipe/hose bracket to subframe retaining bolt (4).

    Tighten
    Tighten the bolt to 9 N·m (80 lb in).

11. Install the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.
12. Install the upper section of the air box. Refer to Air Cleaner Assembly Replacement.

    Notice: When adding fluid or making a complete fluid change, always use the proper power steering fluid. Failure to use the proper fluid will cause hose and seal damage and fluid leaks.

13. Fill power steering fluid reservoir with fluid to FULL level mark on the fluid reservoir.
14. Bleed the power steering system. Refer to Power Steering System Bleeding.
15. Check for power steering fluid leaks.
16. Remove the container from under the vehicle.
17. Install the engine dress cover. Refer to Engine Cover Replacement.

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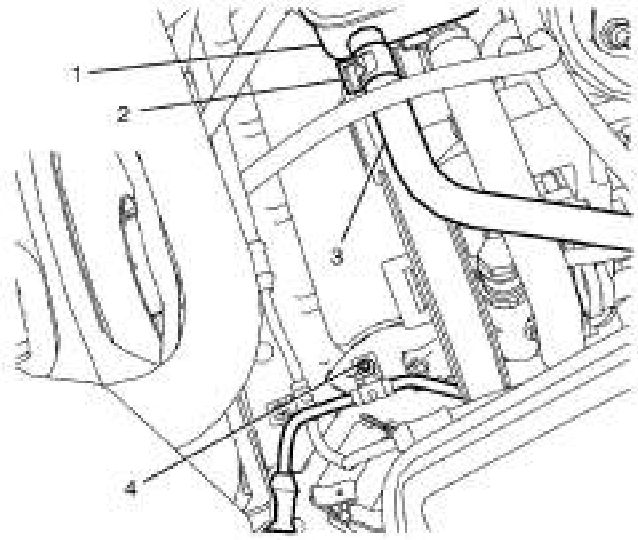
Power Steering Fluid Reservoir Inlet Hose Replacement (6.0L Engine)

Removal Procedure

1. Remove the engine dress cover. Refer to Engine Cover Replacement.
2. Remove the mass air flow (MAF) sensor. Refer to Mass Airflow Sensor/Intake Air Temperature Sensor Replacement.
3. Remove the upper section of the air box. Refer to Air Cleaner Assembly Replacement.
4. Place a large suitable container under the vehicle in order to collect draining fluid.



5. Remove the power steering fluid reservoir inlet pipe/hose bracket to subframe retaining bolt (4).

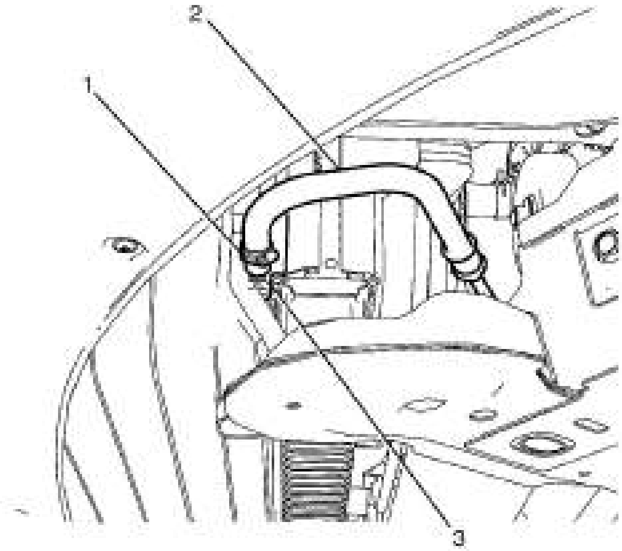
   Important: The power steering fluid reservoir (1) must be plugged to prevent the entry of foreign particles into the power steering system.

6. Release the power steering fluid reservoir inlet pipe/hose spring clamp (2) and disconnect the power steering fluid reservoir inlet pipe/hose (3) from the power steering fluid reservoir (1).
7. Plug the power steering fluid reservoir (1).

   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

8. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
9. Remove the front air deflector. Refer to Front Air Deflector Replacement.

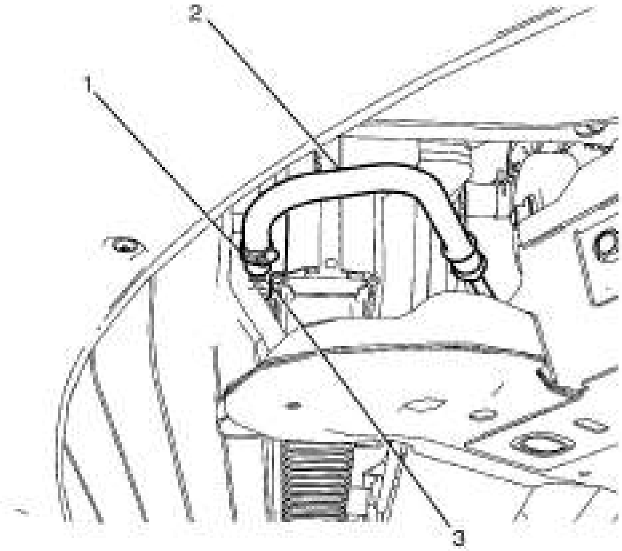


Important: The power steering cooler (3) must be plugged to prevent the entry of foreign particles into the power steering system.

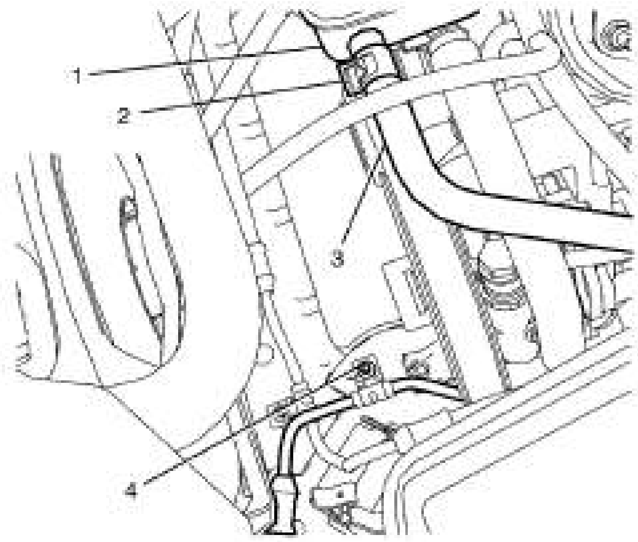
10. Release the power steering fluid reservoir inlet pipe/hose spring clamp (1) and disconnect the power steering fluid reservoir inlet pipe/hose (2) from the power steering cooler (3).
11. Plug the power steering cooler (3).
12. Remove the fluid reservoir inlet pipe/hose (2).

Installation Procedure

1. Install the power steering fluid reservoir inlet pipe/hose spring clamps to the power steering fluid reservoir inlet pipe/hose.



2. Install the power steering fluid reservoir inlet pipe/hose (2).
3. Remove the plug from the power steering cooler (3).
4. Release the power steering fluid reservoir inlet pipe/hose spring clamp (1) and connect the power steering fluid reservoir inlet pipe/hose (2) to the power steering cooler (3).
5. Install the front air deflector. Refer to Front Air Deflector Replacement.
6. Remove the safety stands.
7. Lower the vehicle to the ground.



8. Remove the plug from the power steering fluid reservoir (1).
9. Release the power steering fluid reservoir inlet pipe/hose spring clamp (2) and connect the power steering fluid reservoir inlet pipe/hose (3) to the power steering fluid reservoir (1).

   Notice: Refer to Fastener Notice in the Preface section.

10. Install the power steering fluid reservoir inlet pipe/hose bracket to subframe retaining bolt (4).

    Tighten
    Tighten the bolt to 9 N·m (80 lb in).

11. Install the mass air flow (MAF) sensor. Refer to Mass Airflow Sensor/Intake Air Temperature Sensor Replacement.
12. Install the upper section of the air box. Refer to Air Cleaner Assembly Replacement.

    Notice: When adding fluid or making a complete fluid change, always use the proper power steering fluid. Failure to use the proper fluid will cause hose and seal damage and fluid leaks.

13. Fill power steering fluid reservoir with fluid to the MAX level mark on the reservoir.
14. Bleed the power steering system. Refer to Power Steering System Bleeding.
15. Check for power steering fluid leaks.
16. Remove the container from under the vehicle.
17. Install the engine dress cover. Refer to Engine Cover Replacement.

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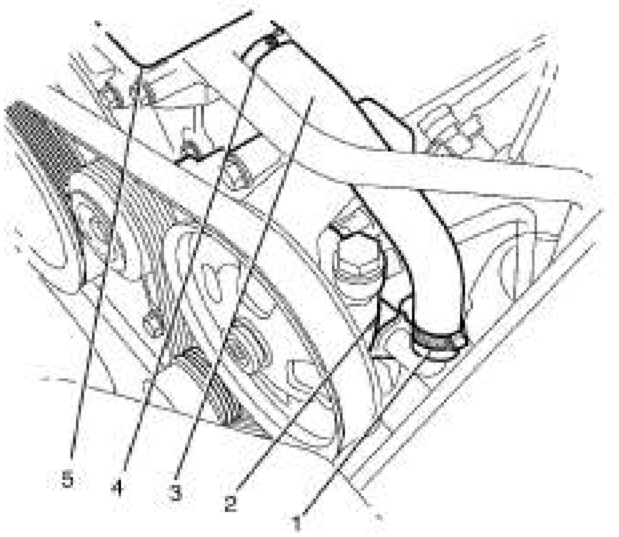
Power Steering Fluid Reservoir Outlet Hose Replacement (3.6L Engine)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Remove the engine dress cover. Refer to Engine Cover Replacement.
2. Place a large suitable container under the vehicle in order to collect draining fluid.



3. Release the power steering fluid reservoir outlet hose worm drive clamp (4).

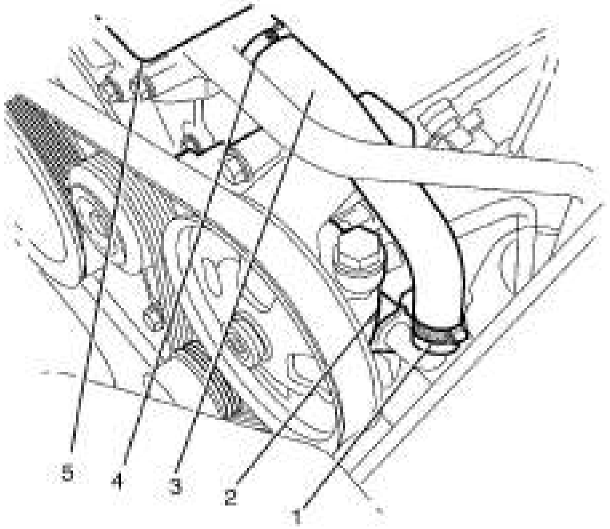
Important: The power steering fluid reservoir (5) must be plugged to prevent the entry of foreign particles into the power steering system.

4. Disconnect the power steering fluid reservoir outlet hose (3) from the power steering fluid reservoir (5).
5. Plug the power steering fluid reservoir (5).
6. Release the power steering fluid reservoir outlet hose worm drive clamp (1).

Important: The power steering pump (2) must be plugged to prevent the entry of foreign particles into the power steering system.

7. Remove the power steering fluid reservoir outlet hose (3) from the power steering pump (2).
8. Plug the power steering pump (2).
9. Inspect all parts for wear and damage.

Installation Procedure



1. Install the power steering fluid reservoir outlet hose worm drive clamps (1) and (4) to power steering fluid reservoir outlet pipe/hose (3).
2. Remove the plug from the power steering pump (2).
3. Install the fluid reservoir outlet hose (3) to the power steering pump (2).

Notice: Refer to Fastener Notice in the Preface section.

4. Tighten the power steering fluid reservoir outlet hose worm drive clamp (1).

Tighten
Tighten the worm drive clamp.

5. Remove the plug from the power steering fluid reservoir (5).
6. Connect the fluid reservoir outlet hose (3) to the power steering fluid reservoir (5).
7. Tighten the power steering fluid reservoir outlet hose worm drive clamp (4).

Tighten
Tighten the worm drive clamp.

Notice: When adding fluid or making a complete fluid change, always use the proper power steering fluid. Failure to use the proper fluid will cause hose and seal damage and fluid leaks.

8. Fill power steering fluid reservoir with fluid to the MAX level mark on the reservoir.
9. Bleed the power steering system. Refer to Power Steering System Bleeding.
10. Check for power steering fluid leaks.
11. Remove the container from under the vehicle.
12. Install the engine dress cover. Refer to Engine Cover Replacement.

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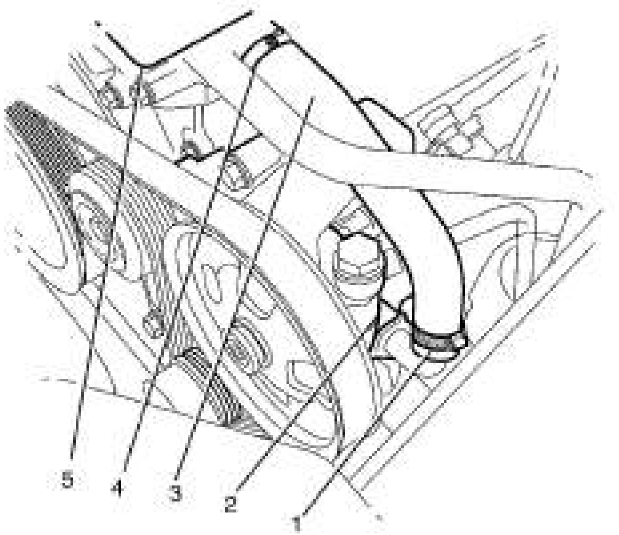
Power Steering Fluid Reservoir Outlet Hose Replacement (6.0L Engine)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Remove the engine dress cover. Refer to Engine Cover Replacement.
2. Place a large suitable container under the vehicle in order to collect draining fluid.



3. Release the power steering fluid reservoir outlet hose worm drive clamp (4).

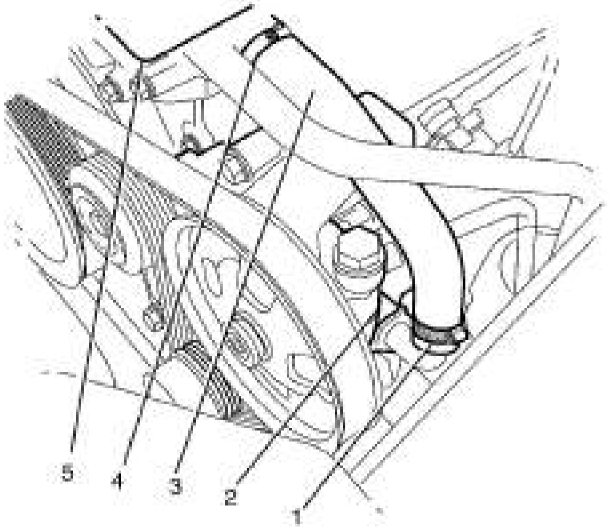
Important: The power steering fluid reservoir (5) must be plugged to prevent the entry of foreign particles into the power steering system.

4. Disconnect the power steering fluid reservoir outlet hose (3) from the power steering fluid reservoir (5).
5. Plug the power steering fluid reservoir (5).
6. Release the power steering fluid reservoir outlet hose worm drive clamp (1).

Important: The power steering pump (2) must be plugged to prevent the entry of foreign particles into the power steering system.

7. Remove the power steering fluid reservoir outlet hose (3) from the power steering pump (2).
8. Plug the power steering pump (2).
9. Inspect all parts for wear and damage.

Installation Procedure



1. Install the power steering fluid reservoir outlet hose worm drive clamps (1) and (4) to power steering fluid reservoir outlet pipe/hose (3).
2. Remove the plug from the power steering pump (2).
3. Install the fluid reservoir outlet hose (3) to the power steering pump (2).

   Notice: Refer to Fastener Notice in the Preface section.

4. Tighten the power steering fluid reservoir outlet hose worm drive clamp (1).

   Tighten
   Tighten the worm drive clamp.

5. Remove the plug from the power steering fluid reservoir (5).
6. Connect the fluid reservoir outlet hose (3) to the power steering fluid reservoir (5).
7. Tighten the power steering fluid reservoir outlet hose worm drive clamp (4).

   Tighten
   Tighten the worm drive clamp.

   Notice: When adding fluid or making a complete fluid change, always use the proper power steering fluid. Failure to use the proper fluid will cause hose and seal damage and fluid leaks.

8. Fill power steering fluid reservoir with fluid to the MAX level mark on the reservoir.
9. Bleed the power steering system. Refer to Power Steering System Bleeding.
10. Check for power steering fluid leaks.
11. Remove the container from under the vehicle.
12. Install the engine dress cover. Refer to Engine Cover Replacement.

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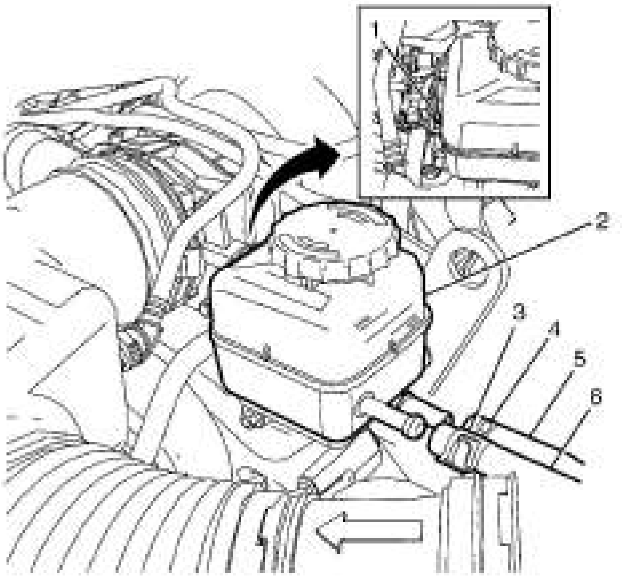
Power Steering Fluid Reservoir Replacement (3.6L Engine)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Remove the engine dress cover. Refer to Engine Cover Replacement .
2. Place a large suitable container under the power steering fluid reservoir Inlet and outlet in order to collect draining fluid.



Important: The power steering fluid reservoir inlet pipe/hose (5) must be plugged to prevent the entry of foreign particles into the power steering system.

3. Release the power steering fluid reservoir inlet pipe/hose worm drive clamp (4) and disconnect the power steering fluid reservoir inlet pipe/hose (5) from the power steering fluid reservoir (2).
4. Plug the power steering fluid reservoir inlet pipe/hose (5).
5. Release the power steering fluid reservoir outlet pipe/hose spring clamp (3).

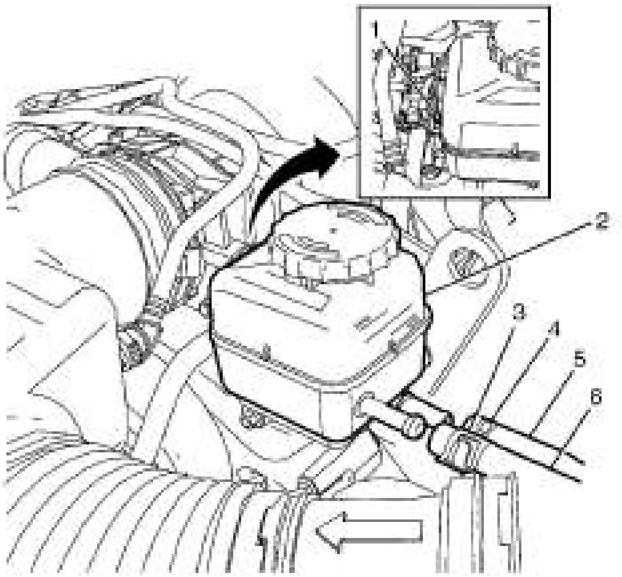
Important: The power steering fluid reservoir outlet pipe/hose (6) must be plugged to prevent the entry of foreign particles into the power steering system.

6. Disconnect the power steering fluid reservoir outlet pipe/hose (6) from the power steering fluid reservoir (2).
7. Plug the power steering fluid reservoir outlet pipe/hose (6).

Important: The power steering fluid reservoir bracket locking tang (1) must be released before removing the power steering fluid reservoir (2).

8. Remove the power steering fluid reservoir (2).

Installation Procedure



Important: The power steering fluid reservoir bracket locking tang (1) must be located correctly.

1. Install the power steering fluid reservoir (2).
2. Remove the plug from the power steering fluid reservoir outlet pipe/hose (6).
3. Connect the power steering fluid reservoir outlet pipe/hose (6) to the power steering fluid reservoir (2).
4. Tighten the power steering fluid reservoir outlet pipe/hose spring clamp (3).
5. Remove the plug from the power steering fluid reservoir inlet pipe/hose (5).
6. Release the power steering fluid reservoir inlet pipe/hose worm drive clamp (4) and connect the power steering fluid reservoir inlet pipe/hose (5) to the power steering fluid reservoir (2).

Notice: When adding fluid or making a complete fluid change, always use the proper power steering fluid. Failure to use the proper fluid will cause hose and seal damage and fluid leaks.

7. Fill power steering fluid reservoir with fluid to the MAX level mark on the reservoir.
8. Bleed the power steering system. Refer to Power Steering System Bleeding .
9. Check for power steering fluid leaks.
10. Install the engine dress cover. Refer to Engine Cover Replacement .

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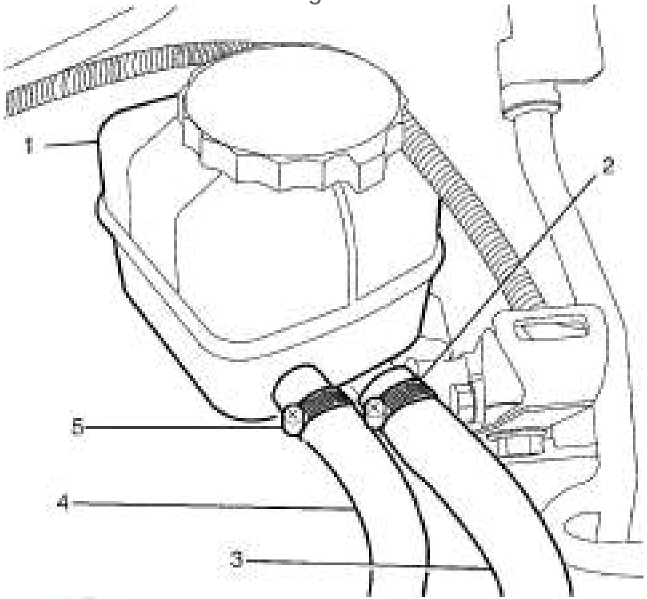
Power Steering Fluid Reservoir Replacement (6.0L Engine)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Remove the engine dress cover. Refer to Engine Cover Replacement
2. Place a large suitable container under the power steering fluid reservoir Inlet and outlet in order to collect draining fluid.



Important: The hose must be plugged to prevent the entry of foreign particles into the power steering system.

3. Release the power steering fluid reservoir inlet pipe/hose spring clamp (5) and disconnect the power steering fluid reservoir inlet pipe/hose (4) from the power steering reservoir (1). Plug the hose.
4. Release the power steering fluid reservoir outlet pipe/hose worm drive clamp (2).

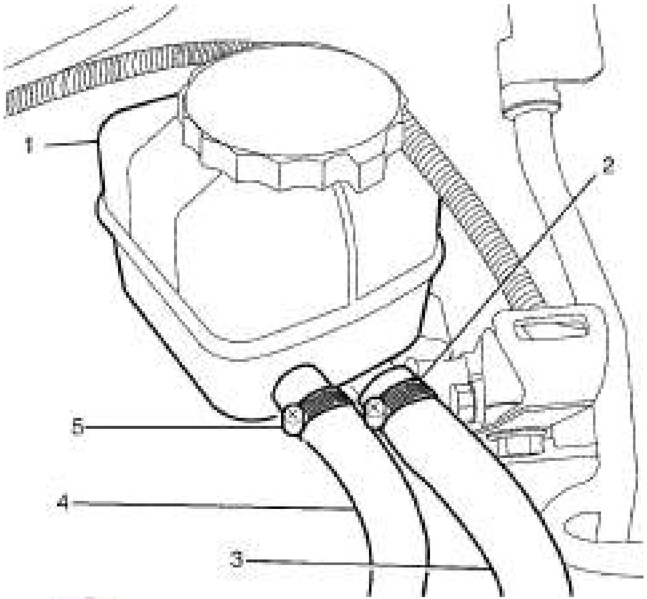
Important: The hose must be plugged to prevent the entry of foreign particles into the power steering system.

5. Disconnect the power steering fluid reservoir outlet pipe/hose (3) from the power steering reservoir.
6. Plug the hose.

Important: The power steering fluid reservoir bracket locking tang must be released before removing the power steering reservoir.

7. Remove the power steering fluid reservoir (1) from the engine bracket.

Installation Procedure



1. Install the power steering fluid reservoir (1) to the engine bracket.
2. Remove the plug from the power steering fluid reservoir outlet pipe/hose (4).
3. Connect the power steering fluid reservoir outlet pipe/hose (4) to the power steering reservoir (1).

   Notice: Refer to Fastener Notice in the Preface section.

4. Tighten the power steering fluid reservoir outlet pipe/hose worm drive clamp (2).
5. Remove the plug from the power steering fluid reservoir inlet pipe/hose (3).
6. Release the power steering fluid reservoir inlet pipe/hose spring clamp (5) and connect the power steering fluid reservoir inlet pipe/hose (3) to the power steering reservoir (1).

   Notice: When adding fluid or making a complete fluid change, always use the proper power steering fluid. Failure to use the proper fluid will cause hose and seal damage and fluid leaks.

7. Fill power steering fluid reservoir with fluid to the MAX level mark on the reservoir.
8. Bleed the power steering system. Refer to Power Steering System Bleeding .
9. Check for power steering fluid leaks.
10. Install the engine dress cover. Refer to Engine Cover Replacement .

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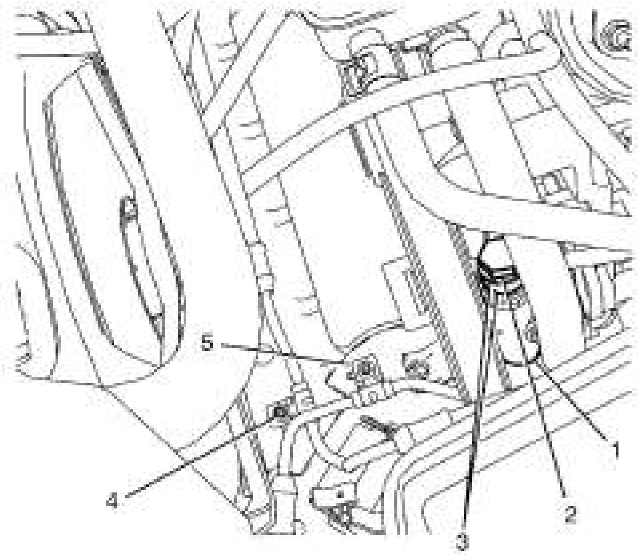
Power Steering Gear Inlet Pipe/Hose Replacement (3.6L Engine)

Removal Procedure

1. Remove the engine dress cover. Refer to Engine Cover ReplacementEngine Cover Replacement.
2. Remove the upper section of the air box. Refer to Air Cleaner Assembly ReplacementAir Cleaner Assembly Replacement.
3. Remove the air inlet duct. Refer to Air Cleaner Inlet Duct ReplacementAir Cleaner Inlet Duct Replacement.
4. Place a large suitable container under the vehicle in order to collect draining fluid.



5. Remove the power steering gear inlet pipe/hose bracket to subframe retaining bolt (4).

   Important: Remove the power steering fluid reservoir inlet hose to subframe retaining bolt (5) to aid in removing the power steering gear inlet pipe/hose.

6. Remove the power steering fluid reservoir inlet hose to subframe retaining bolt (5).

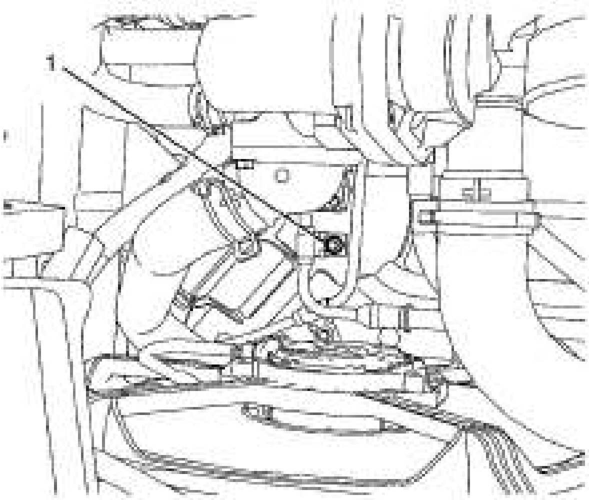
   Important: The power steering pump (1) must be plugged to prevent the entry of foreign particles into the power steering system.

   Important: The copper sealing washers (3) must be discarded after removal.

7. Remove the power steering gear inlet pipe/hose to power steering pump retaining banjo bolt (2) and copper sealing washers (3).

   Discard the washers.

8. Plug the power steering pump (1).

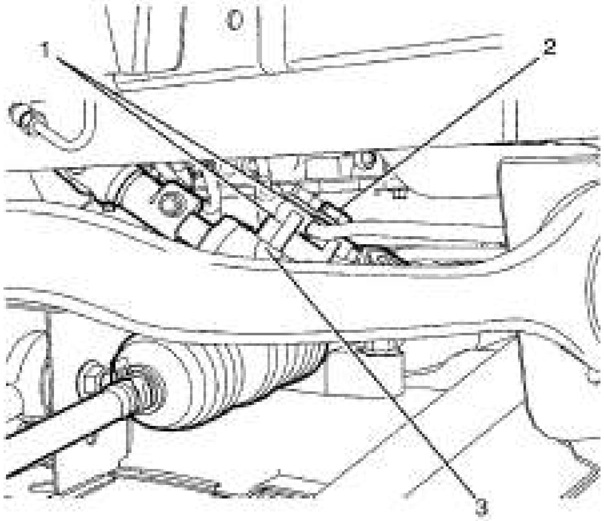


9. Remove the power steering gear inlet pipe/hose bracket to subframe retaining bolt (1).

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

10. Raise and support the vehicle. Refer to Lifting and Jacking the VehicleLifting and Jacking the Vehicle.
11. Remove the front air deflector. Refer to Front Air Deflector ReplacementFront Air Deflector Replacement.



Important: The power steering gear (3) must be plugged to prevent the entry of foreign particles into the power steering system.

Important: The copper sealing washers (1) must be discarded after removal.

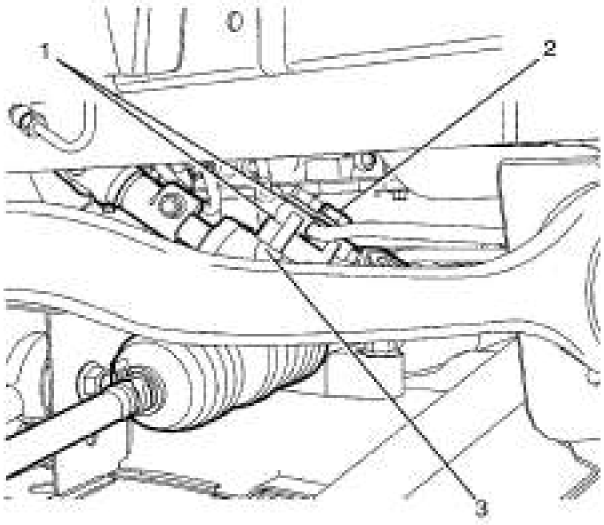
12. Remove the power steering gear inlet pipe/hose to power steering gear retaining banjo bolt (2) and copper sealing washers (1).

    Discard the washers.

13. Plug the power steering gear (3).
14. Remove the power steering gear inlet pipe/hose.

Installation Procedure

1. Position the power steering gear inlet pipe/hose.



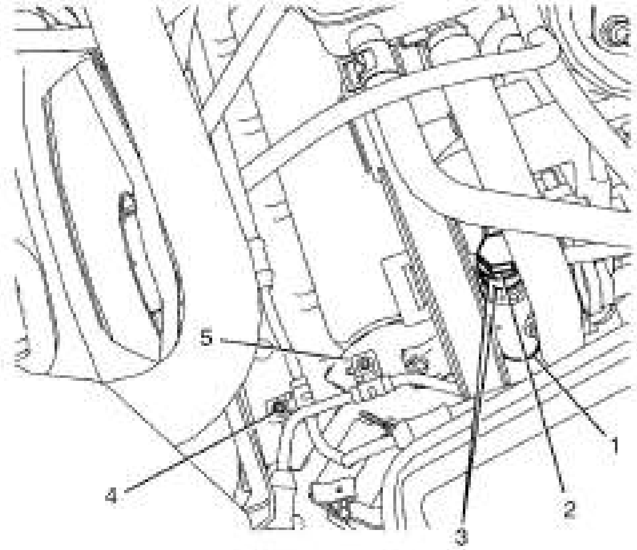
2. Remove the plug from the power steering gear (3).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the power steering gear inlet pipe/hose to power steering gear retaining banjo bolt (2) and NEW copper sealing washers (1).

   Tighten
   Tighten the banjo bolt to 58 N·m (43 lb ft).

4. Install the front air deflector. Refer to Front Air Deflector ReplacementFront Air Deflector Replacement.
5. Remove the safety stands.
6. Lower the vehicle to the ground.



7. Remove the plug from the power steering pump (1).
8. Install the power steering gear inlet pipe/hose to power steering pump retaining banjo bolt (2) and NEW copper sealing washers (3).

   Tighten
   Tighten the banjo bolt to 58 N·m (43 lb ft).

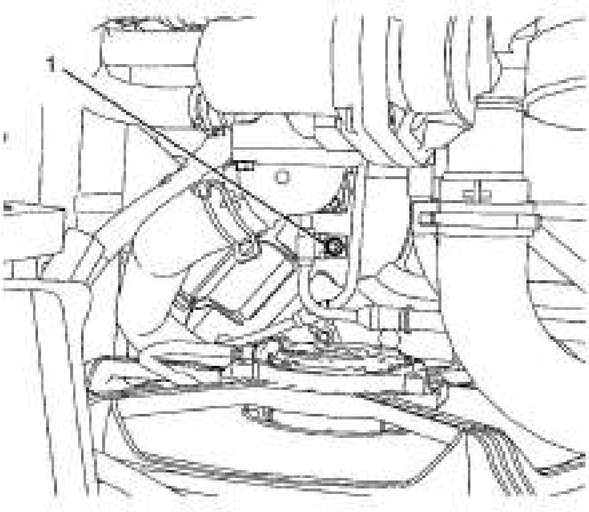
9. Install the power steering gear inlet pipe/hose bracket to subframe retaining bolt (4).

   Tighten
   Tighten the bolt to 9 N·m (80 lb in).

10. Install the power steering fluid reservoir inlet pipe/hose bracket to subframe retaining bolt (5).

    Tighten
    Tighten the bolt to 9 N·m (80 lb in).

11. Remove the container from under the vehicle.



12. Install the power steering gear inlet pipe/hose bracket to subframe retaining bolt (1).

    Tighten
    Tighten the bolt to 9 N·m (80 lb in).

13. Fill power steering fluid reservoir with fluid to the MAX level mark on the reservoir.
14. Bleed the power steering system. Refer to Power Steering System BleedingPower Steering System Bleeding.
15. Check for power steering fluid leaks.
16. Install the engine dress cover. Refer to Engine Cover ReplacementEngine Cover Replacement.
17. Install the air inlet duct. Refer to Air Cleaner Inlet Duct ReplacementAir Cleaner Inlet Duct Replacement.
18. Install the upper section of the air box. Refer to Air Cleaner Assembly ReplacementAir Cleaner Assembly Replacement.

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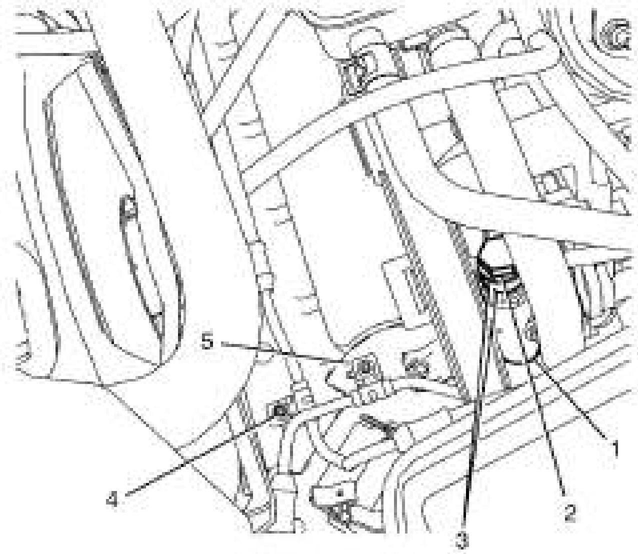
Power Steering Gear Inlet Pipe / Hose Replacement (6.0L Engine)

Removal Procedure

1. Remove the engine dress cover. Refer to Engine Cover ReplacementEngine Cover Replacement.
2. Remove the air intake duct. Refer to Air Cleaner Inlet Duct ReplacementAir Cleaner Inlet Duct Replacement.
3. Remove the mass air flow (MAF) sensor. Refer to Mass Airflow Sensor with Intake Air Temperature Sensor ReplacementMass Airflow Sensor with Intake Air Temperature Sensor Replacement.
4. Remove the upper section of the air box. Refer to Air Cleaner Assembly ReplacementAir Cleaner Assembly Replacement.
5. Place a large suitable container under the vehicle in order to collect draining fluid.



6. Remove the power steering gear inlet pipe/hose bracket to subframe retaining bolt (4).

   Important: Remove the power steering fluid reservoir inlet hose to subframe retaining bolt (5) to aid in removing the power steering gear inlet pipe/hose.

7. Remove the power steering fluid reservoir inlet hose to subframe retaining bolt (5).

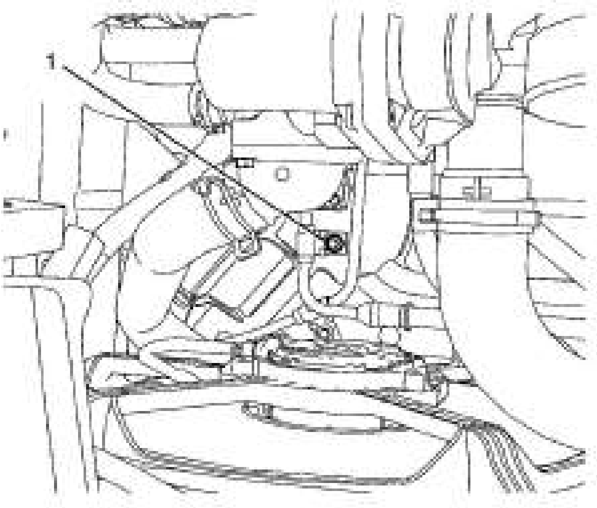
   Important: The power steering pump (1) must be plugged to prevent the entry of foreign particles into the power steering system.

   Important: The copper sealing washers (3) must be discarded after removal.

8. Remove the power steering gear inlet pipe/hose to power steering pump retaining banjo bolt (2) and copper sealing washers (3).

Plug the power steering pump (1).

Discard the washers.

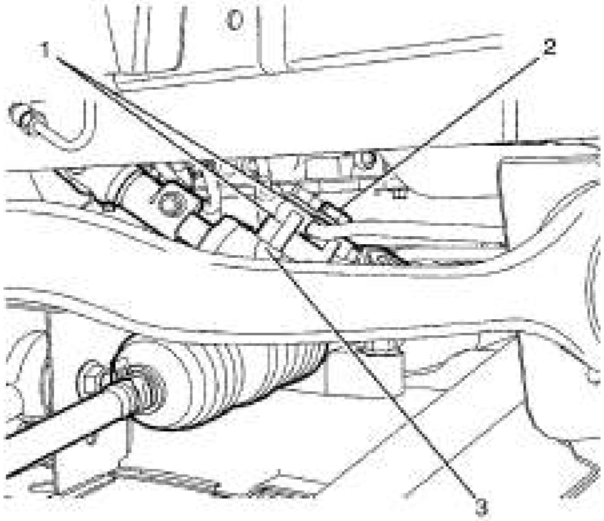


9. Remove the power steering gear inlet pipe/hose bracket to subframe retaining bolt (1).

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

10. Raise and support the vehicle. Refer to Lifting and Jacking the VehicleLifting and Jacking the Vehicle.
11. Remove the splash shield. Refer to Engine Splash Shield ReplacementEngine Splash Shield Replacement.



Important: The power steering gear (3) must be plugged to prevent the entry of foreign particles into the power steering system.

Important: The copper sealing washers (1) must be discarded after removal.

12. Remove the power steering gear inlet pipe/hose to power steering gear retaining banjo bolt (2) and copper sealing washers (1).

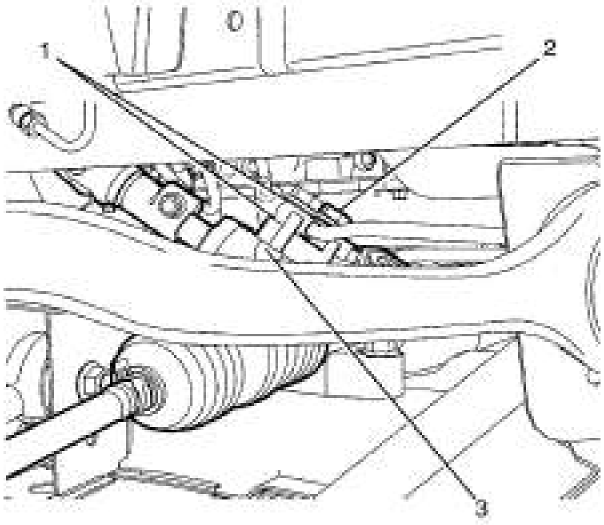
    Plug the power steering gear (3).

    Discard the washers.

13. Remove the power steering gear inlet pipe/hose.

Installation Procedure

1. Install the power steering gear inlet pipe/hose.



2. Remove the plug from the power steering gear (3).

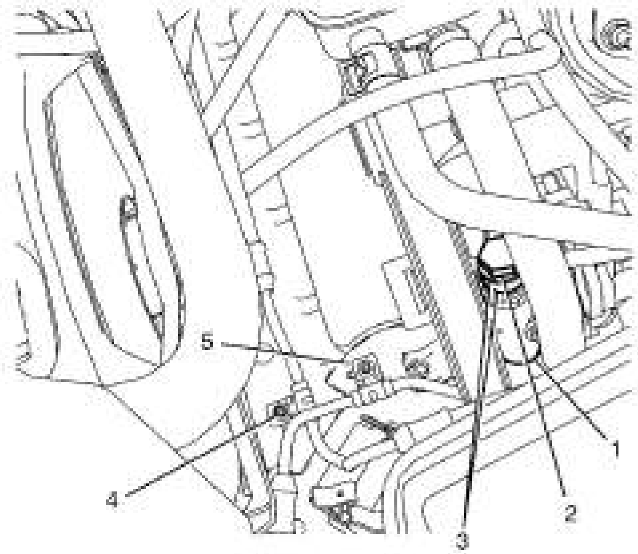
   Notice: Refer to Fastener Notice in the Preface section.

3. Install the power steering gear inlet pipe/hose to power steering gear retaining banjo bolt (2) and NEW copper sealing washers (1).

   Tighten
   Tighten the banjo bolt to 58 N·m (43 lb ft).

4. Install the splash shield. Refer to Engine Splash Shield ReplacementEngine Splash Shield Replacement.

5. Remove the safety stands.
6. Lower the vehicle to the ground.



7. Remove the plug from the power steering pump (1).
8. Install the power steering gear inlet pipe/hose to power steering pump retaining banjo bolt (2) and NEW copper sealing washers (3).

   Tighten
   Tighten the banjo bolt to 58 N·m (43 lb ft).

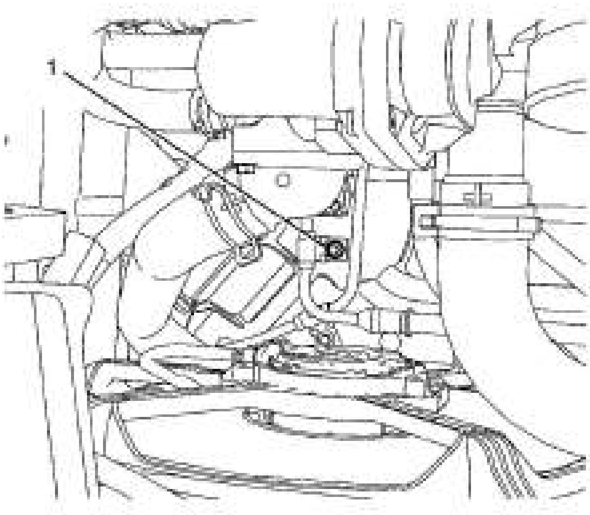
9. Install the power steering gear inlet pipe/hose bracket to subframe retaining bolt (4).

   Tighten
   Tighten the bolt to 9 N·m (80 lb in).

10. Install the power steering fluid reservoir inlet pipe/hose to subframe retaining bolt (5).

    Tighten
    Tighten the bolt to 9 N·m (80 lb in).

11. Remove the container from under the vehicle.



12. Install the power steering gear inlet pipe/hose bracket to subframe retaining bolt (1).

    Tighten
    Tighten the bolt to 9 N·m (80 lb in).

13. Fill power steering fluid reservoir with fluid to the MAX level mark on the reservoir.
14. Bleed the power steering system. Refer to Power Steering System BleedingPower Steering System Bleeding.
15. Check for power steering fluid leaks.
16. Install the upper section of the air box. Refer to Air Cleaner Assembly ReplacementAir Cleaner Assembly Replacement.
17. Install the mass air flow (MAF) sensor. Refer to Mass Airflow Sensor with Intake Air Temperature Sensor ReplacementMass Airflow Sensor with Intake Air Temperature Sensor Replacement.
18. Install the air intake duct. Refer to Air Cleaner Inlet Duct ReplacementAir Cleaner Inlet Duct Replacement.
19. Install the engine dress cover. Refer to Engine Cover ReplacementEngine Cover Replacement.

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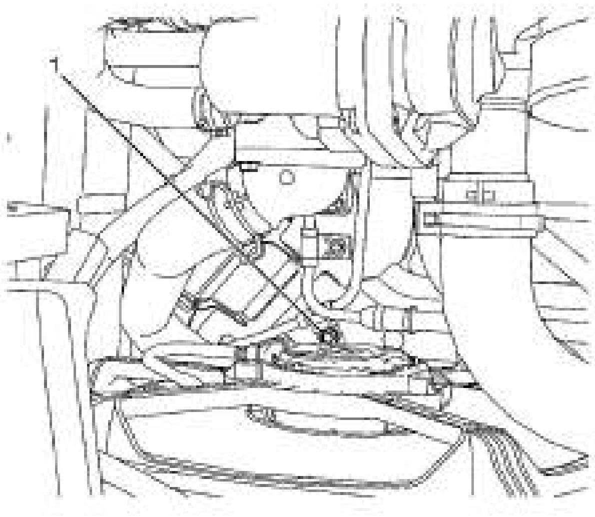
Power Steering Gear Outlet Pipe / Hose Replacement (3.6L Engine)

Removal Procedure -- Up to 12 Sep 07

1. Remove the engine dress cover. Refer to Engine Cover Replacement.
2. Remove the air inlet duct. Refer to Air Cleaner Inlet Duct Replacement.

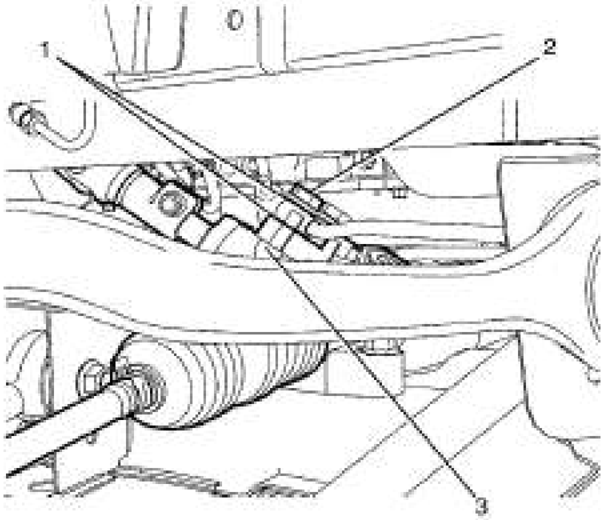


3. Remove the power steering gear outlet pipe/hose bracket to subframe retaining bolt (1).

   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
5. Remove the front air deflector. Refer to Front Air Deflector Replacement.
6. Remove the engine splash shield. Refer to Engine Splash Shield Replacement.
7. Place a large suitable container under the vehicle.



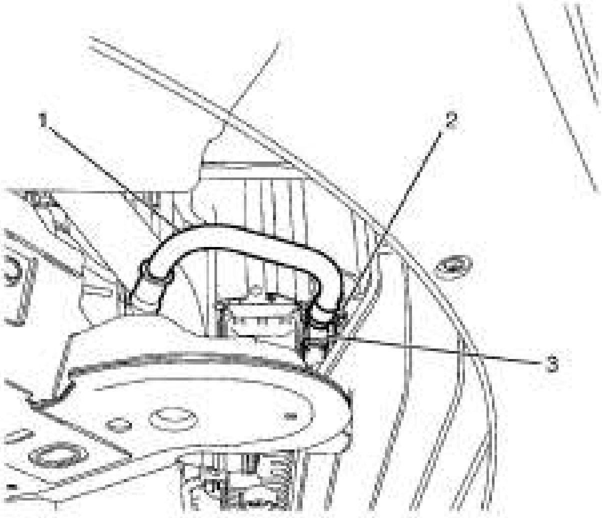
Important: The power steering gear (3) must be plugged to prevent the entry of foreign particles into the power steering system.

Important: Copper sealing washers (1) must be discarded after removal.

8. Remove the power steering gear outlet pipe/hose to power steering gear retaining banjo bolt (2) and copper sealing washers (1).

   Discard the washers.

9. Plug the power steering gear (3).



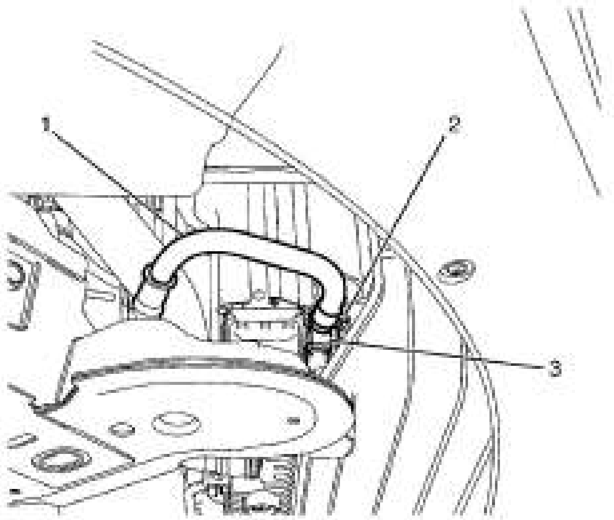
Important: The power steering cooler (3) must be plugged to prevent the entry of foreign particles into the power steering system.

10. Release the power steering gear outlet pipe/hose spring clamp (2) and disconnect the power steering gear outlet pipe/hose (1) from the power steering cooler (3).
11. Plug the power steering cooler (3).

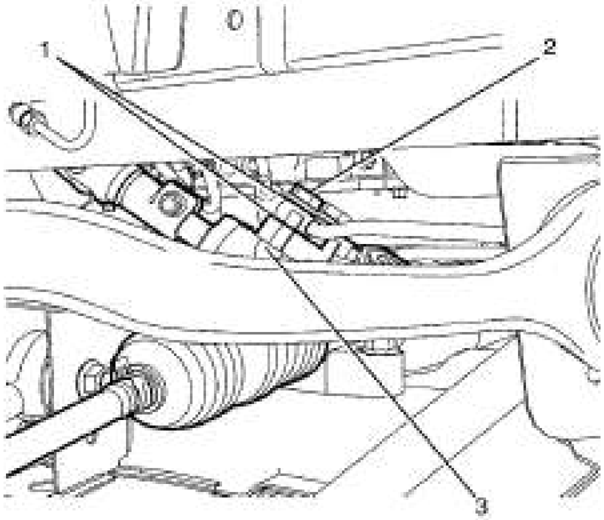
Important: If fitting the later type steering high pressure hose and secondary hose to a pre 12th September 2007 vehicle, they must be replaced as a pair.

12. Remove the power steering gear outlet pipe/hose (1).

Installation Procedure -- Up to 12 Sep 07



1. Install the power steering gear outlet pipe/hose (1).
2. Remove the plug from the power steering cooler (3).
3. Release the power steering gear outlet pipe/hose spring clamp (2) and connect the power steering gear outlet pipe/hose (1) to the power steering cooler (3).



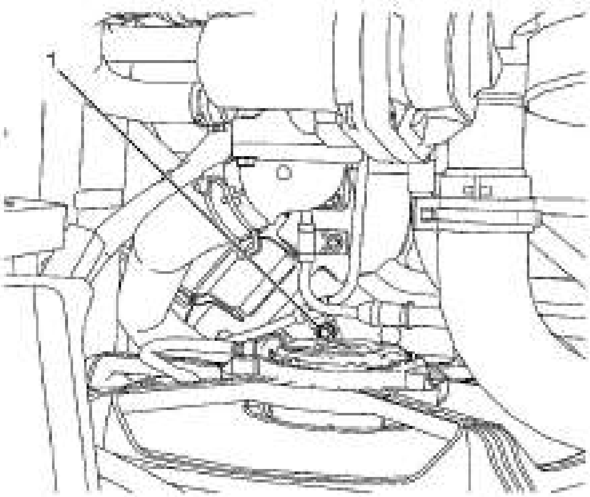
4. Remove the plug from the power steering gear (3).

   Notice: Refer to Fastener Notice in the Preface section.

5. Install the power steering gear outlet pipe/hose to power steering gear retaining banjo bolt (1) and NEW copper sealing washers (2).

   Tighten
   Tighten the banjo bolt to 58 N·m (43 lb ft).

6. Remove the container from under the vehicle.
7. Install the engine splash shield. Refer to Engine Splash Shield Replacement.
8. Install the front air deflector. Refer to Front Air Deflector Replacement.
9. Remove the safety stands.
10. Lower the vehicle to the ground.



11. Install the power steering gear outlet pipe/hose bracket to subframe retaining bolt (1).

Tighten
Tighten the bolt to 9 N·m (80 lb in).

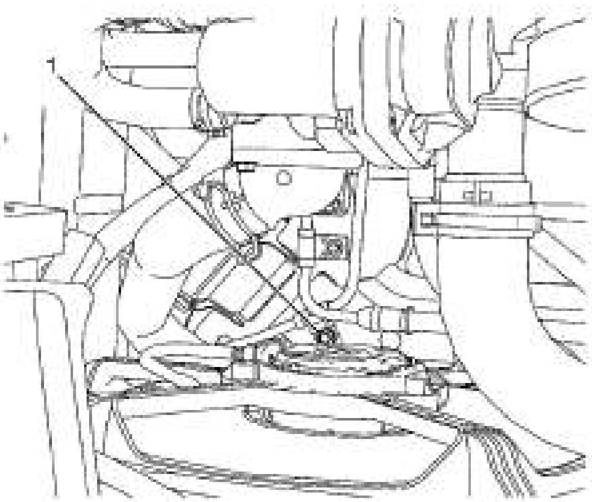
12. Install the engine dress cover. Refer to Engine Cover Replacement.
13. Remove the air inlet duct. Refer to Air Cleaner Inlet Duct Replacement.

Notice: When adding fluid or making a complete fluid change, always use the proper power steering fluid. Failure to use the proper fluid will cause hose and seal damage and fluid leaks.

14. Fill power steering fluid reservoir with fluid to the MAX level mark on the reservoir.
15. Bleed the power steering system. Refer to Power Steering System Bleeding.
16. Check for power steering fluid leaks.

Removal Procedure -- As of 12 Sep 07

1. Remove the engine dress cover. Refer to Engine Cover Replacement.
2. Remove the air inlet duct. Refer to Air Cleaner Inlet Duct Replacement.

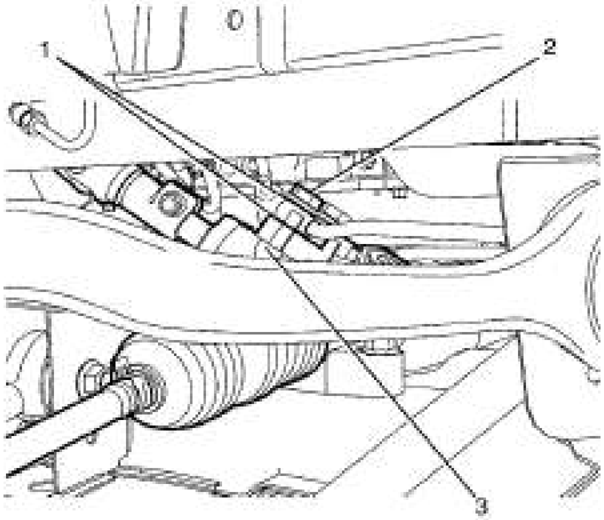


3. Remove the power steering gear outlet pipe/hose bracket to subframe retaining bolt (1).

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
5. Remove the front air deflector. Refer to Front Air Deflector Replacement.
6. Remove the engine splash shield. Refer to Engine Splash Shield Replacement.
7. Place a large suitable container under the vehicle.



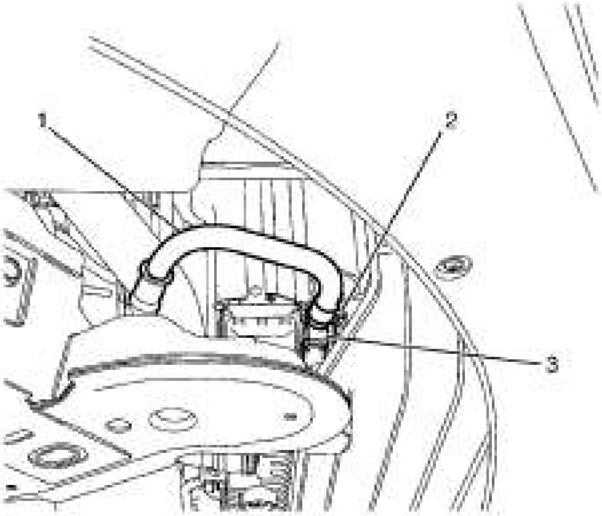
Important: The power steering gear (3) must be plugged to prevent the entry of foreign particles into the power steering system.

Important: Copper sealing washers (1) must be discarded after removal.

8. Remove the power steering gear outlet pipe/hose to power steering gear retaining banjo bolt (2) and copper sealing washers (1).

   Discard the washers.

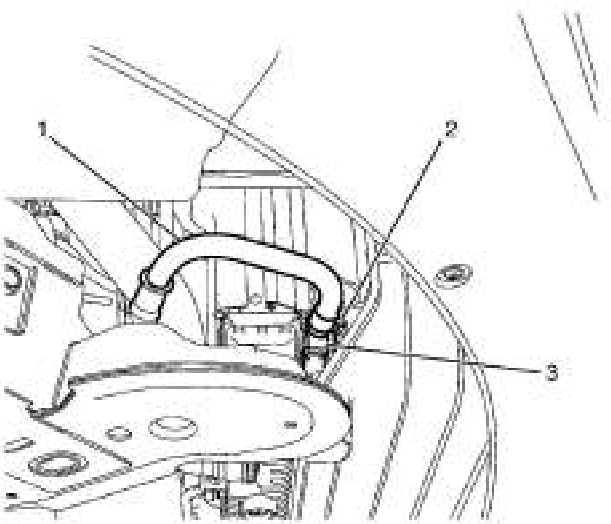
9. Plug the power steering gear (3).



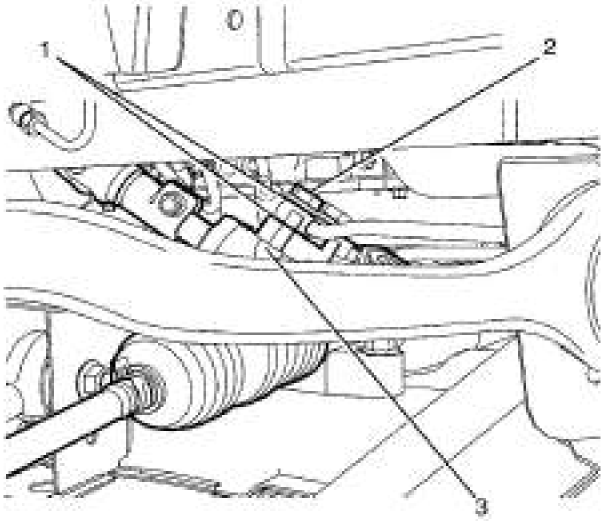
Important: The power steering cooler (3) must be plugged to prevent the entry of foreign particles into the power steering system.

10. Release the power steering gear outlet pipe/hose spring clamp (2) and disconnect the power steering gear outlet pipe/hose (1) from the power steering cooler (3).
11. Plug the power steering cooler (3).
12. Remove the power steering gear outlet pipe/hose (1).

Installation Procedure -- As of 12 Sep 07



1. Install the power steering gear outlet pipe/hose (1).
2. Remove the plug from the power steering cooler (3).
3. Release the power steering gear outlet pipe/hose spring clamp (2) and connect the power steering gear outlet pipe/hose (1) to the power steering cooler (3).



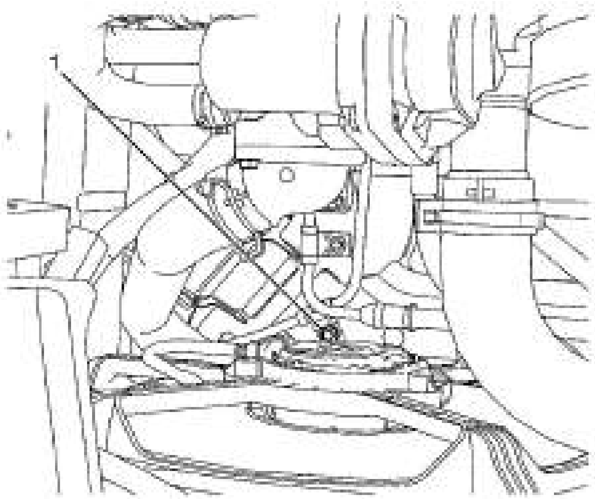
4. Remove the plug from the power steering gear (3).

   Notice: Refer to Fastener Notice in the Preface section.

5. Install the power steering gear outlet pipe/hose to power steering gear retaining banjo bolt (1) and NEW copper sealing washers (2).

   Tighten
   Tighten the banjo bolt to 58 N·m (43 lb ft).

6. Remove the container from under the vehicle.
7. Install the engine splash shield. Refer to Engine Splash Shield Replacement.
8. Install the front air deflector. Refer to Front Air Deflector Replacement.
9. Remove the safety stands.
10. Lower the vehicle to the ground.



11. Install the power steering gear outlet pipe/hose bracket to subframe retaining bolt (1).

    Tighten
    Tighten the bolt to 9 N·m (80 lb in).

12. Install the engine dress cover. Refer to Engine Cover Replacement.
13. Remove the air inlet duct. Refer to Air Cleaner Inlet Duct Replacement.

    Notice: When adding fluid or making a complete fluid change, always use the proper power steering fluid. Failure to use the proper fluid will cause hose and seal damage and fluid leaks.

14. Fill power steering fluid reservoir with fluid to the MAX level mark on the reservoir.
15. Bleed the power steering system. Refer to Power Steering System Bleeding.
16. Check for power steering fluid leaks.

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Power Steering Pump Pulley Replacement

Tools Required

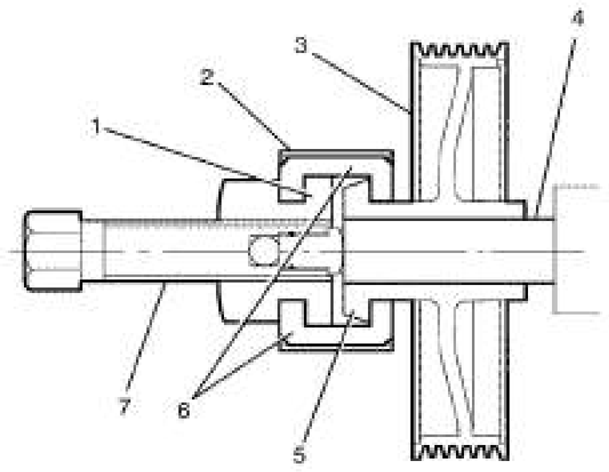
- 7185 Power Steering Pump Pulley Remover
- 7005 Power Steering Pump Pulley Installer

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Remove the power steering pump. Refer to Power Steering Pump Replacement .
2. Suitably support the power steering pump in a vice.



3. Lubricate the forcing screw (7) of 7185 .
4. Position the forcing screw (7) against the pulley shaft (4).

Important: The half jaws (6) must be fully engaged with the pulley flange (5) and the 7185 flange (1), the larger open end diameter (has chamfer and relief profile) engages with the pulley flange (5).

5. Install the half jaws (6) over the pulley flange (5) and the 7185 flange (1).

Important: The forcing screw (7) must be aligned with the pump axis.

6. Slide the retainer sleeve (2) over the half jaws, and hand tighten the forcing screw (7).

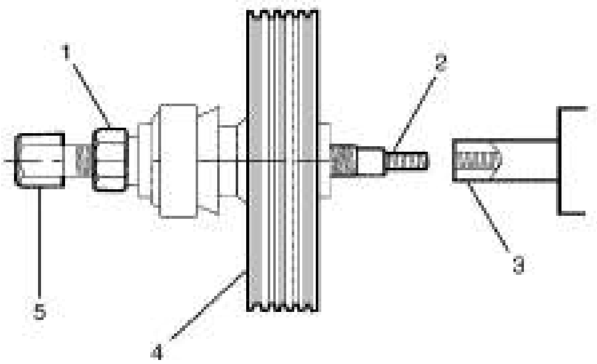
Important: Observe the orientation and the depth of the pulley (3) with reference to the original position, this will minimise the potential of incorrect pulley installation.

Important: Do not use power tools or exceed a torque of 90.0 N·m. If the pulley cannot be removed within this torque, remove the pulley using 7185 . If still unsuccessful, replace the complete power steering pump assembly.

7. Remove the pulley (3) from the pulley shaft (4) by progressively tightening the forcing screw (7).

Installation Procedure

1. Lubricate the thread of the 7005 forcing nut (1).



Important: Before installing the pulley (4) it must be properly aligned and orientated in relation to the pump shaft (3).

2. Slide the power steering pump pulley (4) over the 7005 forcing screw (2).
3. Install the 7005 forcing screw (2) into the pump shaft (3).

Important: The depth to which the pulley (4) is going to travel must be observed and maintained.

Important: Hold the forcing screw hex (5) while tightening the forcing nut (1).

4. Install the pulley (4) to the pump shaft (3) by progressively tightening the forcing nut (1).
5. Remove the 7005 from the pump shaft (3).
6. Remove the power steering pump from the vice.
7. Install the power steering pump. Refer to Power Steering Pump Replacement .

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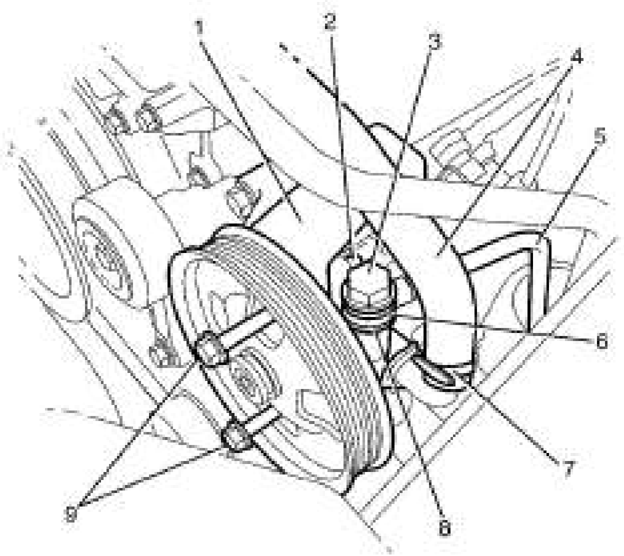
Power Steering Pump Replacement (3.6L Engine)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Remove the engine dress cover. Refer to Engine Cover ReplacementEngine Cover Replacement.
2. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct ReplacementAir Cleaner Outlet Duct Replacement.
3. Remove the upper section of the air box. Refer to Air Cleaner Outlet Duct ReplacementAir Cleaner Outlet Duct Replacement.
4. Remove the power steering drive belt. Refer to Drive Belt ReplacementDrive Belt Replacement.
5. Place a large suitable container under the vehicle in order to collect draining power steering fluid.



Important: The copper sealing washers (6 and 8) must be discarded after removal.

6. Remove the power steering gear inlet pipe to power steering pump retaining banjo bolt (3) and copper sealing washers (6 and 8).

   Discard the washers.

7. Disconnect the power steering gear inlet pipe (5) from the power steering pump (2).

Important: The power steering gear inlet pipe/hose (5) must be plugged to prevent the entry of foreign particles into the power steering system.

8. Plug the power steering gear inlet pipe/hose (5).
9. Release the power steering fluid reservoir outlet pipe/hose spring clamp (7).

   Important: The power steering power steering fluid reservoir outlet pipe/hose (4) must be plugged to prevent the entry of foreign particles into the power steering system.

10. Disconnect the power steering fluid reservoir outlet pipe/hose (4) from the power steering pump (2).
11. Plug the power steering fluid reservoir outlet pipe/hose (4).

    Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

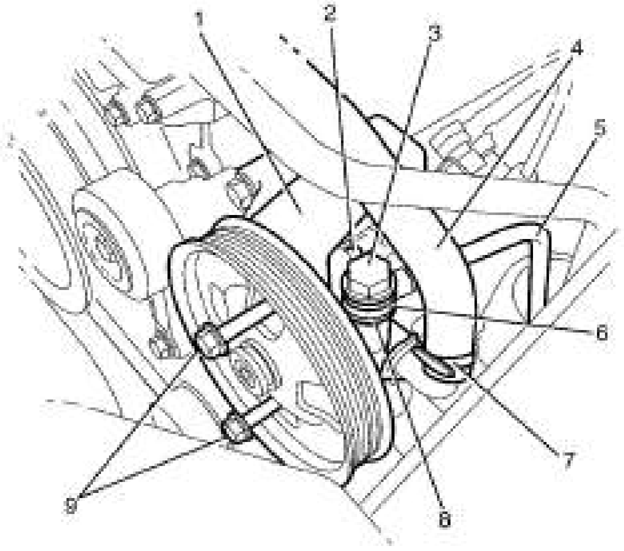
12. Remove the power steering pump to power steering pump bracket retaining bolts (9).

    Discard the bolts.

13. Remove the power steering pump (2) from the power steering pump bracket (1).
14. Remove the power steering pulley from the power steering pump. Refer to Power Steering Pump Pulley ReplacementPower Steering Pump Pulley Replacement.

Installation Procedure

1. Install the power steering pulley to the power steering pump. Refer to Power Steering Pump Pulley ReplacementPower Steering Pump Pulley Replacement.



2. Position the power steering pump (2) to the power steering pump bracket (1).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the NEW power steering pump to power steering pump bracket retaining bolts (9).

   Tighten
   Tighten the bolts to 27 N·m (20 lb ft).

4. Remove the plug from the power steering gear inlet pipe/hose (5).
5. Connect the power steering gear inlet pipe/hose (5) to the power steering pump (2).
6. Install the power steering gear inlet pipe to power steering pump retaining banjo bolt (3) and NEW copper sealing washers (6 and 8).

   Tighten
   Tighten the banjo bolt to 58 N·m (43 lb ft).

7. Remove the plug from the power steering fluid reservoir outlet pipe/hose (4).
8. Connect the power steering fluid reservoir outlet pipe/hose (4) to the power steering pump (2).
9. Tighten the power steering fluid reservoir outlet hose spring clamp (7).
10. Install the power steering drive belt. Refer to Drive Belt ReplacementDrive Belt Replacement.
11. Install the upper section of the air box. Refer to Air Cleaner Assembly ReplacementAir Cleaner Assembly Replacement.
12. Install the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct ReplacementAir Cleaner Outlet Duct Replacement.
13. Fill power steering fluid reservoir with fluid to FULL level mark on the fluid reservoir.
14. Bleed the power steering system. Refer to Power Steering System BleedingPower Steering System Bleeding.
15. Check for power steering fluid leaks.
16. Remove the container from under the vehicle.
17. Install the engine dress cover. Refer to Engine Cover ReplacementEngine Cover Replacement.

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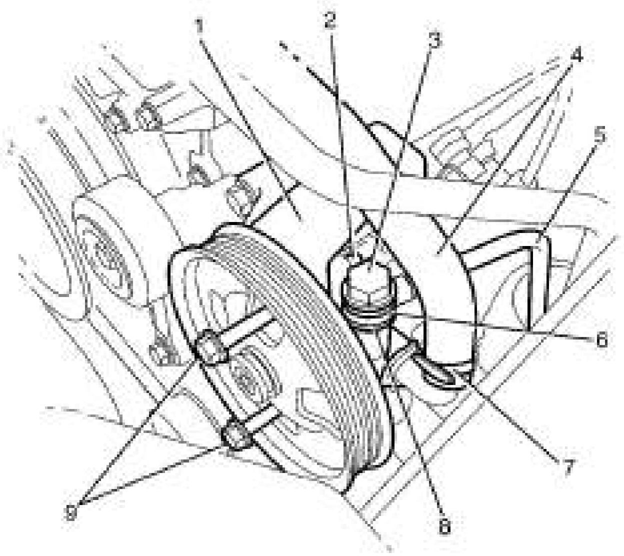
Power Steering Pump Replacement (6.0L Engine)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Remove the engine dress cover. Refer to Engine Cover ReplacementEngine Cover Replacement.
2. Remove the mass air flow (MAF) sensor. Refer to Mass Airflow Sensor with Intake Air Temperature Sensor ReplacementMass Airflow Sensor with Intake Air Temperature Sensor Replacement.
3. Remove the upper section of the air box. Refer to Air Cleaner Assembly ReplacementAir Cleaner Assembly Replacement.
4. Remove the power steering drive belt. Refer to Drive Belt Replacement - AccessoryDrive Belt Replacement - Accessory.
5. Place a large suitable container under the vehicle in order to collect draining power steering fluid.



Important: The power steering gear inlet pipe (5) must be plugged to prevent the entry of foreign particles into the power steering system.

Important: The copper sealing washers (6 and 8) must be discarded after removal.

6. Remove the power steering gear inlet pipe to power steering pump retaining banjo bolt (3) and copper sealing washers (6 and 8).

Plug the power steering gear inlet pipe (5).

Discard the washers.

7. Disconnect the power steering gear inlet pipe (5) from the power steering pump (2).
8. Release the power steering fluid reservoir outlet hose spring clamp (7).

Important: The power steering power steering fluid reservoir outlet hose (4) must be plugged to prevent the entry of foreign particles into the power steering system.

9. Disconnect the power steering fluid reservoir outlet hose (4) from the power steering pump (2).

Plug the power steering fluid reservoir outlet hose (4).

Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

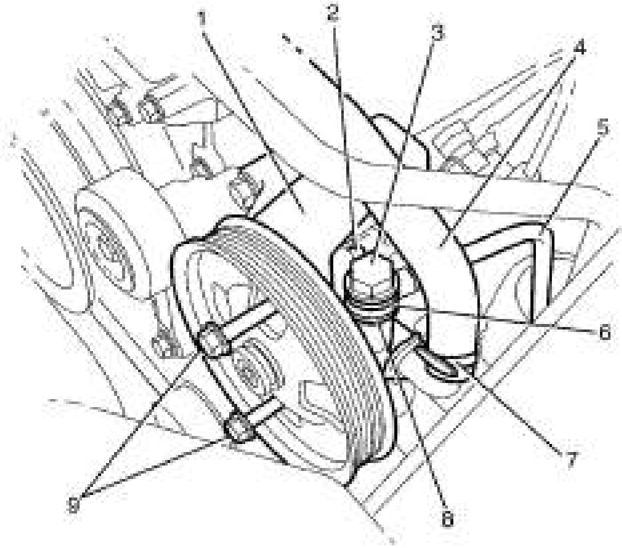
10. Remove the power steering pump to power steering pump bracket retaining bolts (9).

Discard the bolts.

11. Remove the power steering pump (2) from the power steering pump bracket (1).
12. Remove the power steering pulley from the power steering pump. Refer to Power Steering Pump Pulley ReplacementPower Steering Pump Pulley Replacement.

Installation Procedure

1. Install the power steering pulley to the power steering pump. Refer to Power Steering Pump Pulley ReplacementPower Steering Pump Pulley Replacement.



2. Install the power steering pump (2) to the power steering pump bracket (1).

Notice: Refer to Fastener Notice in the Preface section.

3. Install the NEW power steering pump to power steering pump bracket retaining bolts (9).

Tighten
Tighten the bolts to 27 N·m (22 lb ft).

4. Remove the plug from the power steering gear inlet pipe (5).
5. Connect the power steering gear inlet pipe/hose (5) to the power steering pump (2).
6. Install the power steering gear inlet pipe to power steering pump retaining banjo bolt (3) and NEW copper sealing washers (6 and 8).

Tighten
Tighten the banjo bolt to 58 N·m (43 lb ft).

7. Remove the plug from the power steering fluid reservoir outlet hose (4).
8. Connect the power steering fluid reservoir outlet hose (4) to the power steering pump (2).
9. Tighten the power steering fluid reservoir outlet hose spring clamp (7).
10. Install the power steering drive belt. Refer to Drive Belt Replacement - AccessoryDrive Belt Replacement - Accessory.
11. Install the mass air flow (MAF) sensor. Refer to Mass Airflow Sensor with Intake Air Temperature Sensor ReplacementMass Airflow Sensor with Intake Air Temperature Sensor Replacement.
12. Install the upper section of the air box. Refer to Air Cleaner Assembly ReplacementAir Cleaner Assembly Replacement.
13. Fill power steering fluid reservoir with fluid to FULL level mark on the fluid reservoir.
14. Bleed the power steering system. Refer to Power Steering System BleedingPower Steering System Bleeding.
15. Check for power steering fluid leaks.
16. Remove the container from under the vehicle.
17. Install the engine dress cover. Refer to Engine Cover ReplacementEngine Cover Replacement.

Power Steering System Bleeding

Important:

- Use approved new power steering fluid from a sealed container. For fluid specifications refer to Fluid and Lubricant Recommendations.
- Hoses touching the frame, body or engine may cause power steering system noise. Verify that the hoses do not touch any other part of the vehicle.
- Loose connections may not leak, but may allow air into the steering system. Verify that all hose connections are tight. Refer to Fastener Tightening Specifications.

Notice: When adding fluid or making a complete fluid change, always use the proper power steering fluid. Failure to use the proper fluid will cause hose and seal damage and fluid leaks.

Important: Power steering fluid level must be maintained throughout bleed procedure.

1. Fill power steering fluid reservoir with fluid to the COLD MAX level mark on the reservoir.
2. Raise the vehicle until the front wheels are off the ground. Refer to Lifting and Jacking the Vehicle.
3. With the engine OFF, turn the steering wheel from stop to stop 12 times.
4. Verify power steering fluid level per operating specification. Refer to Checking and Adding Power Steering Fluid.
5. Start the engine and allow to run at idle for three seconds, turn the engine OFF.
6. Repeat steps 4 and 5 until the power steering level remains constant.
7. Start the engine and allow to run at idle.
8. Rotate steering wheel from left to right 8 times. Check for sign of cavitation or fluid aeration (pump noise/whining).
9. Turn the engine OFF. Verify the fluid level. Refer to Checking and Adding Power Steering Fluid.

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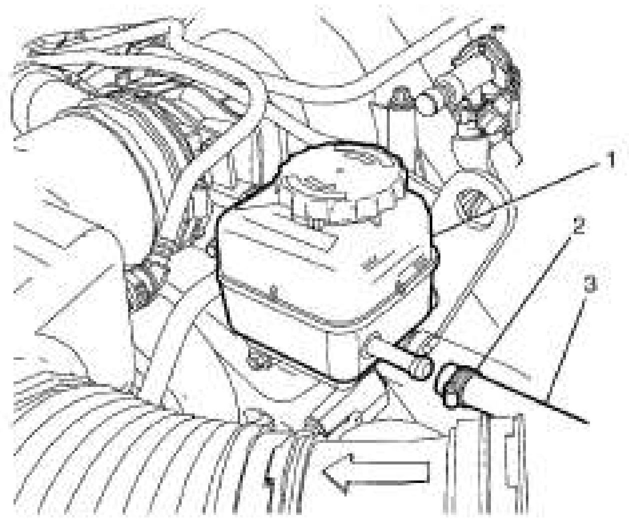
Power Steering System Flushing

Important: Do not reuse drained power steering fluid regardless of appearance or condition.

1. Raise and support the front of the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Place a large suitable container under the power steering fluid reservoir inlet connection in order to collect draining fluid.
3. Clean the area surrounding the fluid reservoir cap.

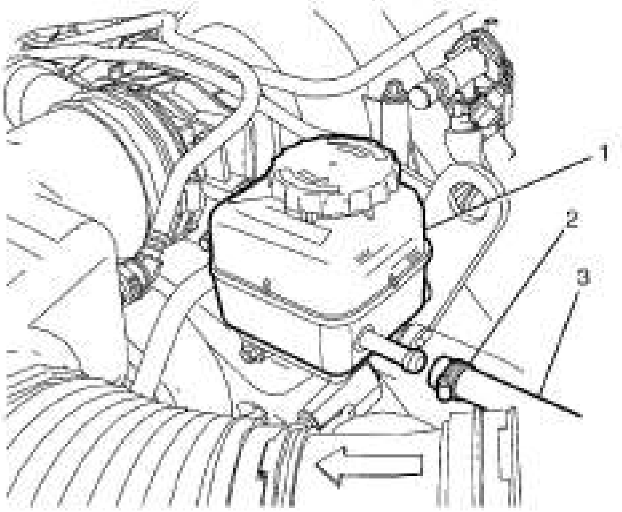


4. Release the power steering fluid reservoir inlet pipe/hose spring clamp (2) and disconnect the power steering fluid reservoir inlet pipe/hose (3) from the power steering fluid reservoir (1).
5. Plug the power steering fluid reservoir (1).

Important:

- This step may require 4 L (3.5 qt) of power steering fluid until the draining fluid appears clear.
- Do not allow the power steering fluid level in the fluid reservoir to drop below MAX while the engine is running.
- Use approved new power steering fluid from a sealed container. For fluid specifications refer to Fluid and Lubricant Recommendations.

6. Run the engine at idle while maintaining the fluid level at MAX in the reservoir, until the fluid draining from the power steering fluid reservoir Inlet hose is clean and free from debris.
7. Turn the engine OFF.



8. Remove the plug from power steering fluid reservoir.
9. Release the power steering fluid reservoir inlet pipe/hose spring clamp (2) and connect the power steering fluid reservoir inlet pipe/hose (3) to the power steering fluid reservoir (1).
10. Remove the container.
11. Check the power steering fluid. Refer to Checking and Adding Power Steering Fluid.
12. Run the engine at idle for approximately 15 minutes.
13. Inspect the power steering fluid for the following indications of contamination:
    - Milky fluid - water
    - Brown fluid - burnt
    - Plastic debris or dirt chunks
14. If the fluid is contaminated, repeat steps 3 - 12.
15. Clean any spilt fluid.
16. Bleed the power steering system. Refer to Power Steering System Bleeding.

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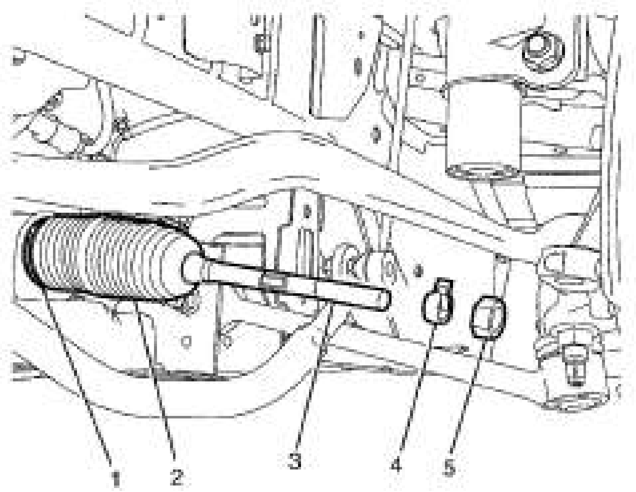
Steering Gear Boot Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the VehicleLifting and Jacking the Vehicle.
2. Remove the front wheel. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation.
3. Remove the tie rod end. Refer to Steering Linkage Outer Tie Rod ReplacementSteering Linkage Outer Tie Rod Replacement.



Important: Note the number of turns required to remove the tie rod end lock nut (5).

4. Remove the tie rod end lock nut (5) from the tie rod (3).

Important: The tie rod boot to tie rod retaining clamp (4) is a single use part and must be discarded after removal.

5. Remove the tie rod boot to tie rod retaining clamp (4).

Discard the clamp.

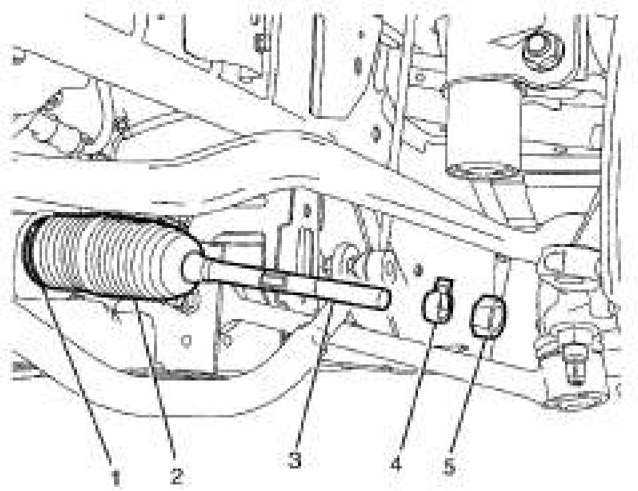
Important: The tie rod boot to steering gear housing clamp (1) is a single use part and must be discarded after removal.

6. Remove the tie rod boot to steering gear housing clamp (1).

Discard the clamp.

7. Remove the tie rod boot (2) from the tie rod (3).

Installation Procedure



1. Install the tie rod boot (2) to the tie rod (3).
2. Install the NEW tie rod boot to steering gear housing clamp (1).
3. Install the NEW tie rod boot to tie rod retaining clamp (4).

Important: The tie rod end lock nut (5) must be installed rotating the same number of turns as recorded during removal and aligned with the mark previously made on the tie rod (3).

4. Install the tie rod end lock nut (5) to the tie rod (3).
5. Install the tie rod end. Refer to Steering Linkage Outer Tie Rod ReplacementSteering Linkage Outer Tie Rod Replacement.
6. Install the front wheel. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation.
7. Remove the safety stands.
8. Lower the vehicle to the ground.
9. Bounce the vehicle several times to settle the suspension.
10. Check and adjust the wheel alignment. Refer to Wheel Alignment MeasurementWheel Alignment Measurement.

Notice: Refer to Fastener Notice in the Preface section.

11. Tighten the tie rod end lock nut (5).

Tighten
Tighten the nut to 170 N·m (125 lb ft).

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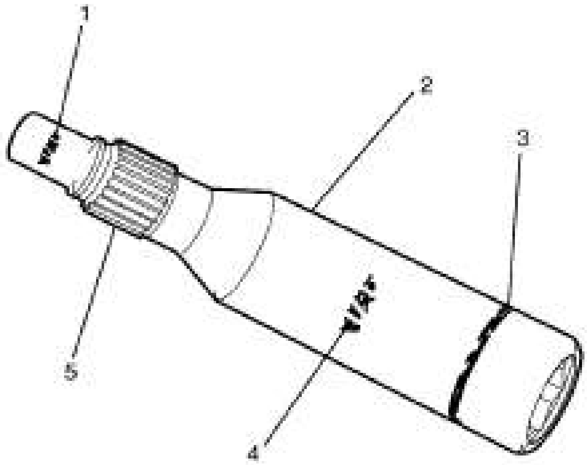
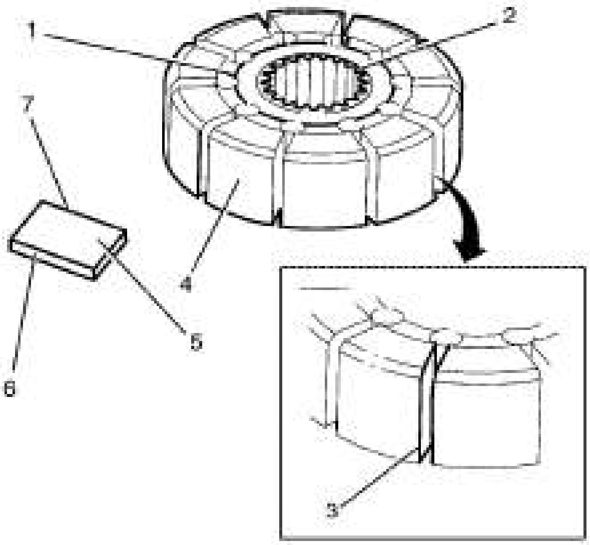
Steering Gear Component Inspection

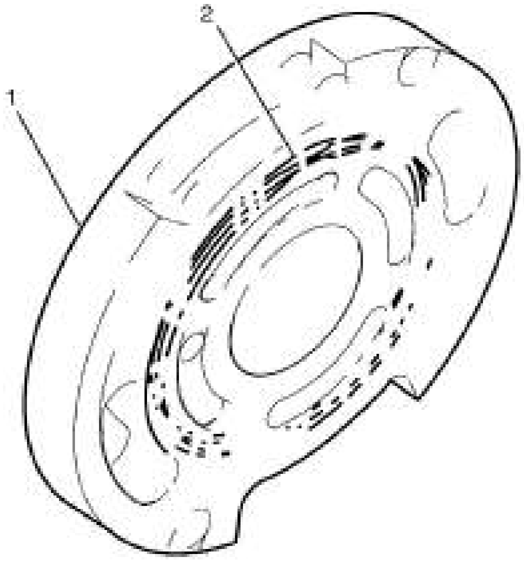
Caution: Refer to General Repair Instructions in the Preface section.



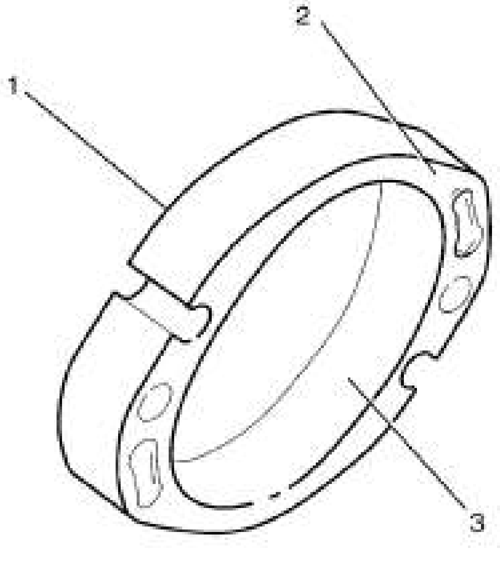
1. Clean all parts in a suitable cleaning fluid and dry.
2. Inspect the power steering pump drive shaft (2) for:
   - Scoring, pitting or bush pick-up on the pump housing bush surface (1).
   - Worn or damaged splines (5).
   - Scoring, pitting or bush pick-up on the rear end plate bush surface (4).
   - Excessive wear on the seal track (3).



3. Inspect the pump rotor (4) for:
    - Scoring on the thrust surfaces (1).
    - Worn or damaged splines (2).
    - Damage to the vane channels (3) that may cause the vanes to stick.
4. Inspect the vanes (5) for:
    - Excessive wear on the contact surface (7).
    - Wear on the thrust faces of the vane (6).
    - Make sure the vanes move freely in the vane channels (3).

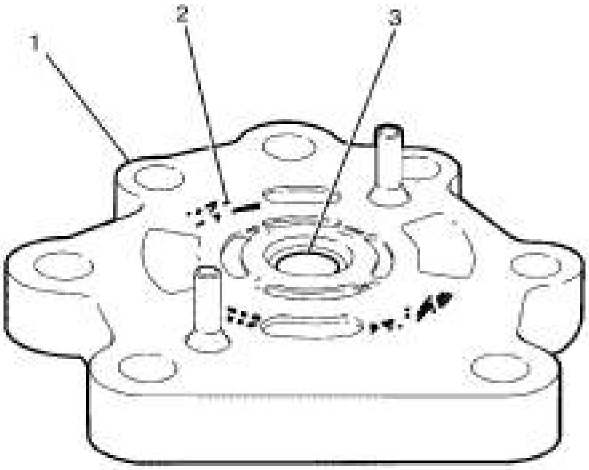


5. Inspect the thrust plate (1) for wear and any scoring marks (2).

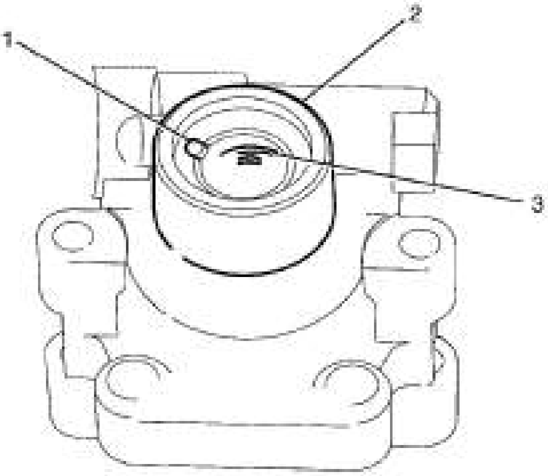


Important: A high polish is always present on the surface of the power steering pump ring as a result of normal wear. Do not confuse this with abnormal wear.

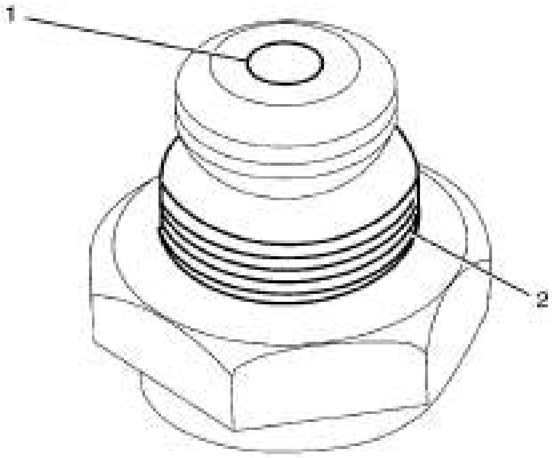
6. Inspect the power steering pump ring (1) for excessive wear and scouring on the inner surface (3) and the side faces (3).



7. Inspect the rear end plate (1) for:
   - Excessive wear, signs of bush material pick-up or pitting of the rear end plate bush (3).
   - Scouring and excessive wear on the thrust face (2).



8. Inspect the power steering pump housing (3) for:
   - Excessive wear, signs of bush material pick-up or pitting of the power steering pump housing bush (1).
   - Blockages in the power steering pump housing bush lubrication passage (2).



9. Inspect the high pressure outlet fitting for:
   - Damage to the threads (2).
   - Restrictions in the outlet orifice (1).
10. Inspect the droop flow control valve for:
    - Burrs and foreign material on the shaft and piston plunger.
    - Blocked filer screen, which is located in the base of the valve assembly.
    - Insert the valve assembly into the pump housing and make sure the valve is free to move in the housing bore. If sticking is observed, check for foreign material and burrs on the inside the housing.

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Steering Gear Replacement (3.6L Engine RHD)

Tools Required

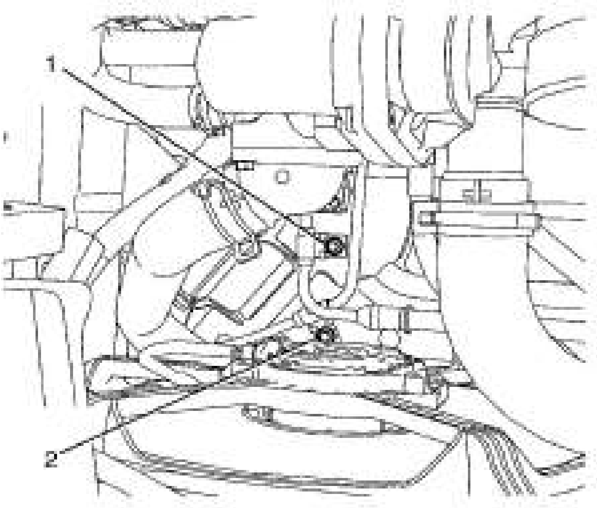
CH-49405 CH-49405 Ball Joint Release Too.l

Removal Procedure

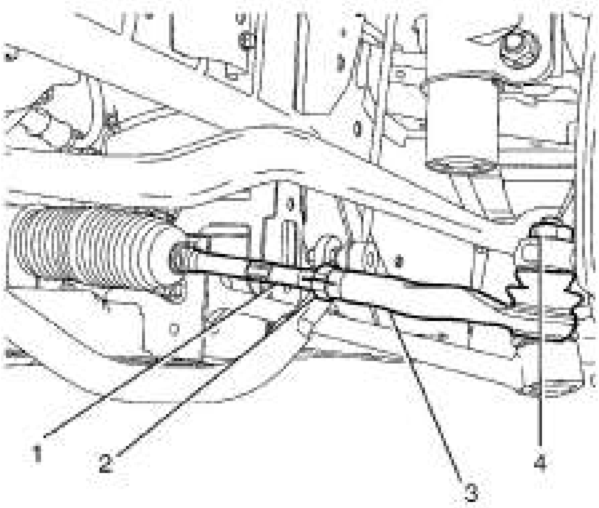
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Remove the engine dress cover. Refer to Engine Cover ReplacementEngine Cover Replacement.
2. Remove the air inlet duct. Refer to Air Cleaner Inlet Duct ReplacementAir Cleaner Inlet Duct Replacement.



3. Remove the power steering gear inlet pipe/hose bracket to subframe retaining bolt (1).
4. Remove the power steering gear outlet pipe/hose bracket to subframe retaining bolt (2).
5. Raise and support the vehicle. Refer to Lifting and Jacking the VehicleLifting and Jacking the Vehicle.
6. Remove the front wheels. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation.



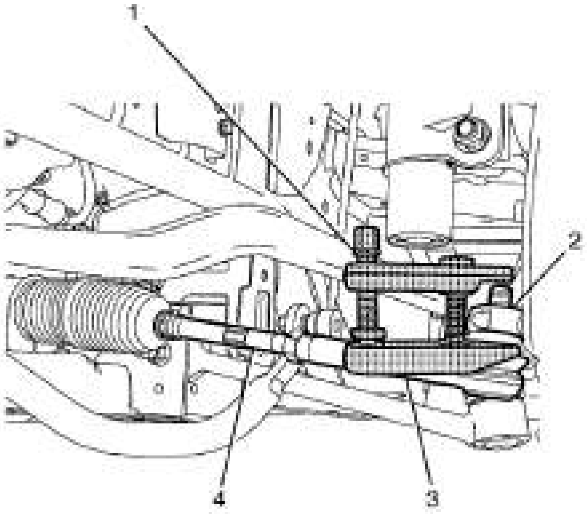
Important: Mark the tie rod end (3) and tie rod end lock nut (2) in relation to the tie rod (1).

7. Loosen the tie rod end lock nut (2) half a turn.

   Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

8. Remove the tie rod end to steering knuckle retaining nut (4).

   Discard the nut.

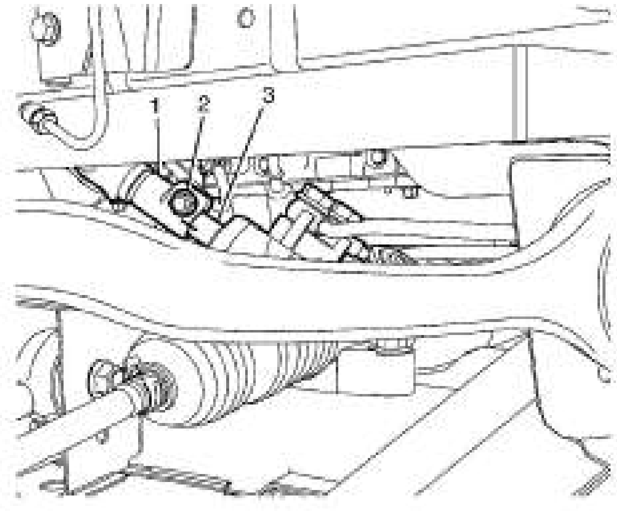


Important: Once a load is applied by the ball joint release tool loading bolt, a quick tap on the nut end of the tool will reduce the separating force required.

9. Separate the tie rod end (3) from the steering knuckle (2) using the CH-49405 CH-49405 (1).
10. Remove the CH-49405 CH-49405 (1).
11. Disconnect the tie rod end (3) from the steering knuckle (1).

Important: Note the number of turns required to remove.

12. Remove the tie rod end (3) from the tie rod (4).
13. Repeat steps 6 to 11 on the other side of the vehicle.
14. Remove the engine undertray. Refer to.



Important: Observing the orientation of the intermediate steering shaft (1) with reference to the pinion shaft (3) will minimise the potential of incorrect steering column assembly alignment.

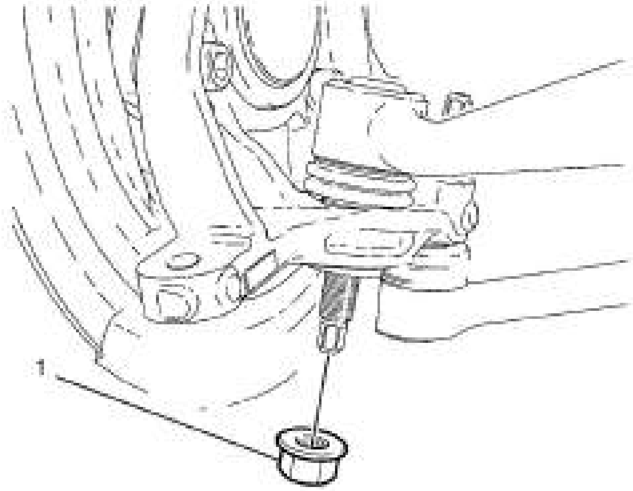
15. Mark the intermediate steering shaft (1) in relation to the pinion shaft (3).
16. Remove the intermediate steering shaft to pinion shaft retaining bolt (2).

Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

17. Disconnect the intermediate shaft (2) from the pinion shaft (3).

    Discard the bolt.

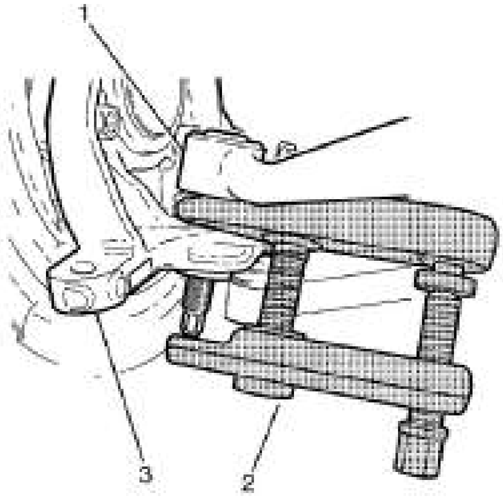
18. Lower the vehicle.



Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

19. Remove the driver side front castor arm to steering knuckle retaining nut (1).

    Discard the nut.

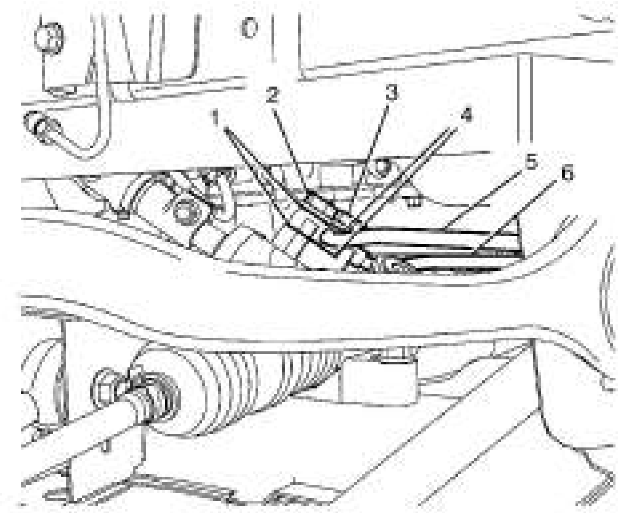


Important: Once a load is applied by the release tool loading bolt, a quick tap on the nut end of the tool will reduce the separating force required.

20. Separate the driver side front castor arm (3) from the steering knuckle (1) using the CH-

49405 CH-49405 (2).

21. Disconnect the driver side front castor arm (3) from the steering knuckle (1).
22. Place a large suitable container under the vehicle in order to collect draining fluid.



Important: The power steering inlet pipe/hose (5) must be plugged to prevent the entry of foreign particles into the power steering system.

Important: The copper sealing washers (1) must be discarded after removal.

23. Remove the power steering gear inlet pipe/hose to power steering gear retaining banjo bolt (2) and copper sealing washers (1).

    Plug the steering gear inlet pipe/hose (5).

    Discard the washers.

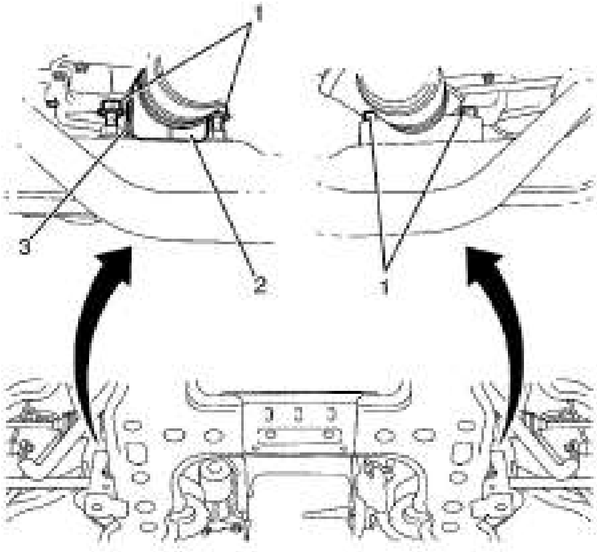
    Important: The power steering outlet pipe/hose (6) must be plugged to prevent the entry of foreign particles into the power steering system.

    Important: The copper sealing washers (4) must be discarded after removal.

24. Remove the power steering gear outlet pipe/hose to power steering gear retaining banjo bolt (3) and copper sealing washers (4).

    Plug the steering gear outlet pipe/hose (6).

    Discard the washers.

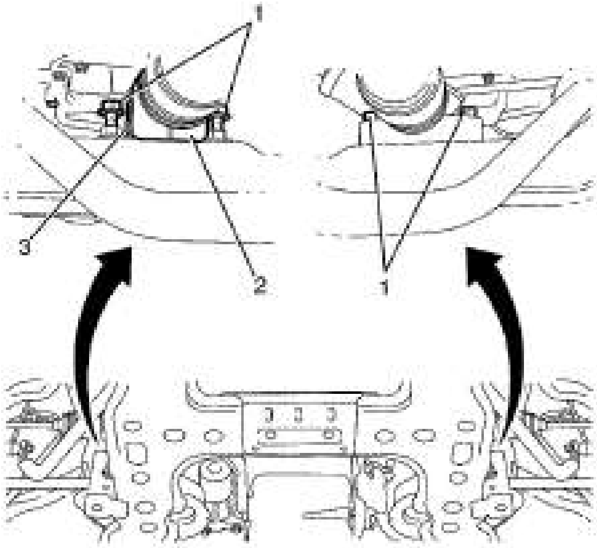


25. Remove the steering gear to subframe retaining bolts (1).
26. Remove the steering gear insulator retaining bracket (2) from the steering gear insulator (3).
27. Remove the steering gear insulator (3) from the steering gear.

Important: The steering gear must be removed from the driver side of the vehicle.

28. Remove the steering gear from the vehicle.

Installation Procedure



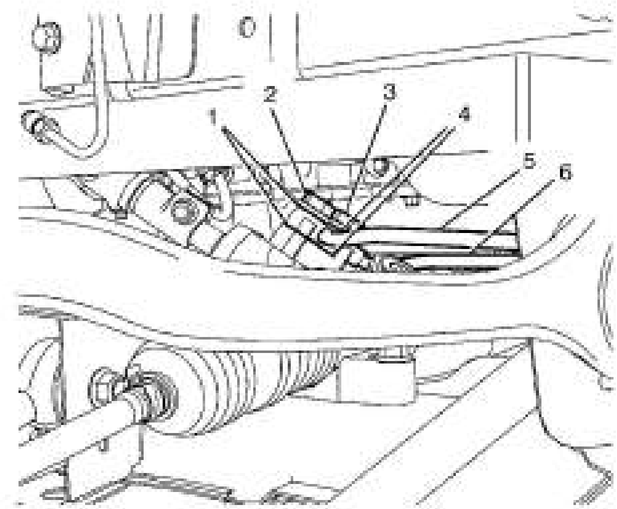
Important: The steering gear must be installed from the driver side of the vehicle.

1. Install the steering gear to the vehicle.
2. Install the steering gear insulator (3) to the steering gear.
3. Install the steering gear insulator retaining bracket (2) to the steering gear insulator (3).

Notice: Refer to Fastener Notice in the Preface section.

4. Install the steering gear to subframe retaining bolts (1).

Tighten
Tighten the Bolts to 65 N·m (48 lb ft).



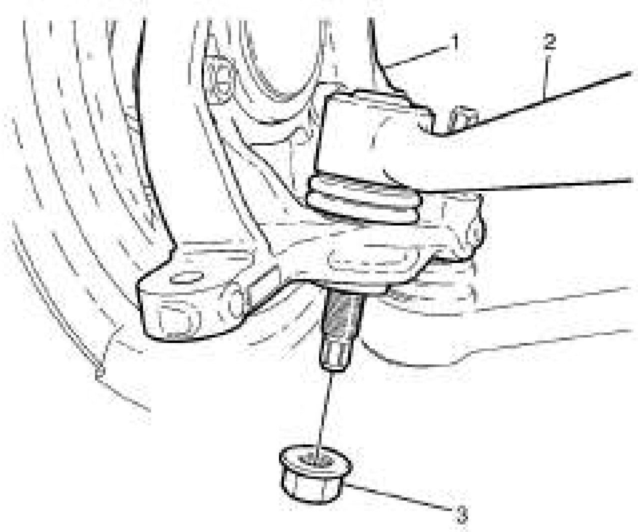
5. Remove the plug from the steering gear inlet pipe/hose (5).
6. Install the power steering gear inlet pipe/hose to power steering gear retaining banjo bolt (1) and NEW copper sealing washers (2).

Tighten
Tighten the banjo bolt to 58 N·m (43 lb ft).

7. Remove the plug from the steering gear outlet pipe/hose (6).
8. Install the power steering gear outlet pipe/hose to power steering gear retaining banjo bolt (3) and NEW copper sealing washers (4).

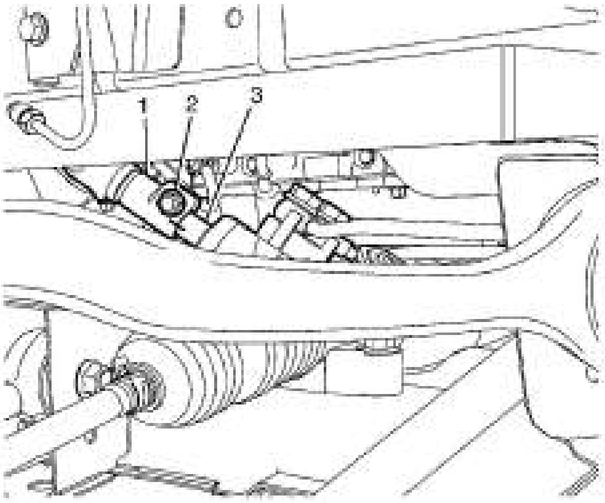
Tighten
Tighten the banjo bolt to 58 N·m (43 lb ft).

9. Remove the container from under the vehicle.



10. Connect the driver side front castor arm (2) to the steering knuckle (1).
11. Install the driver side front castor arm ball joint to steering knuckle NEW retaining nut (3).

Tighten
Tighten nut to 70 N·m (52 lb ft).

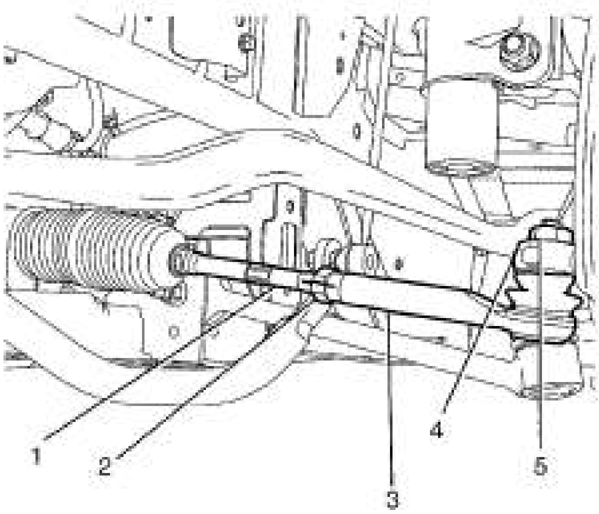


Important: The intermediate steering shaft and pinion shaft splines must be installed in the position recorded during removal and aligned with the marks previously made.

12. Connect the intermediate steering shaft (1) to the pinion shaft (3).
13. Install the intermediate steering shaft to pinion shaft NEW retaining bolt (2).

Tighten

Tighten the bolt to 25 N·m (18 lb ft).



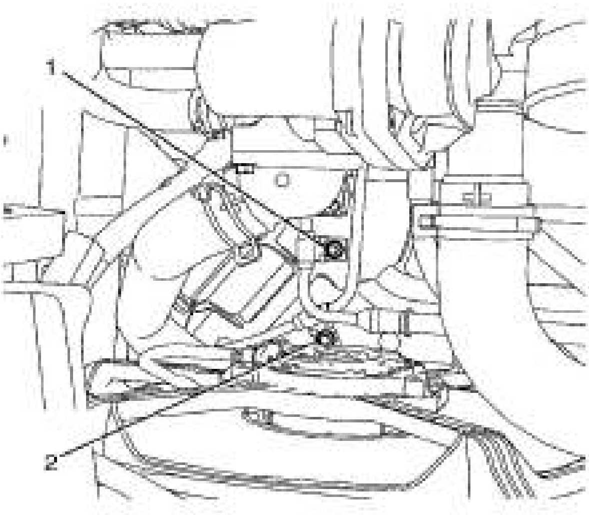
Important: The tie rod end (3) must be installed rotating the same number of turns as recorded during removal and aligned with the mark previously made on the tie rod (1) and tie rod end lock nut (2).

14. Install the tie rod end (3) to the tie rod (1).
15. Connect the tie rod end (3) to the steering knuckle (4).
16. Install the tie rod end to steering knuckle retaining NEW nut (5).

Tighten

Tighten the nut to 25 N·m+ 120 degrees (18 lb ft + 120 degrees).

17. Repeat steps 14 to 16 on the other side of the vehicle.
18. Install the engine undertray. Refer to Engine Splash Shield ReplacementEngine Splash Shield Replacement.
19. Install the front wheels. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation.
20. Remove the safety stands.
21. Lower the vehicle to the ground.



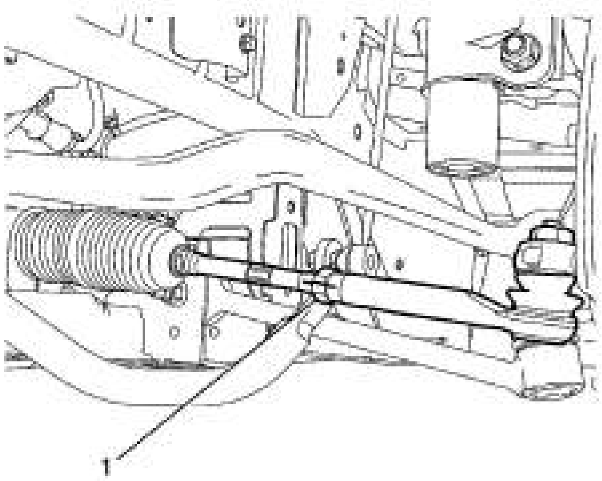
22. Install the power steering gear inlet pipe/hose bracket to subframe retaining bolt (1).

    Tighten
    Tighten the bolt to 9 N·m (80 lb in).

23. Install the power steering gear outlet pipe/hose bracket to subframe retaining bolt (2).

    Tighten
    Tighten the bolt to 9 N·m (80 lb in).

24. Fill power steering fluid reservoir with fluid to the MAX level mark on the reservoir.
25. Bleed the power steering system. Refer to Power Steering System BleedingPower Steering System Bleeding.
26. Check for power steering fluid leaks.
27. Install the engine dress cover. Refer to Engine Cover ReplacementEngine Cover Replacement.
28. Install the air inlet duct. Refer to Air Cleaner Inlet Duct ReplacementAir Cleaner Inlet Duct Replacement.
29. Bounce the vehicle several times to settle the suspension.
30. Check and adjust the wheel alignment. Refer to Wheel Alignment MeasurementWheel Alignment Measurement.



31. Tighten the tie rod end lock nut (1).

    Tighten
    Tighten the nut to 170 N·m (125 lb ft).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Steering | Power Steering | Repair Instructions | **Document ID: 2194798**

Steering Gear Replacement (6.0L Engine RHD)

Tools Required

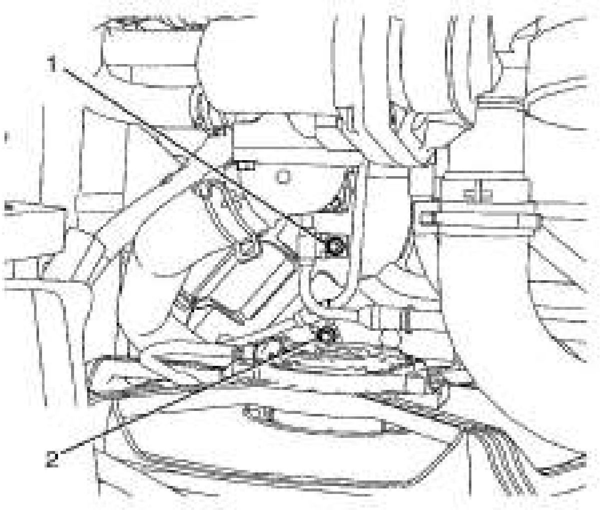
6297 6297 Ball Joint Release Too.l

Removal Procedure

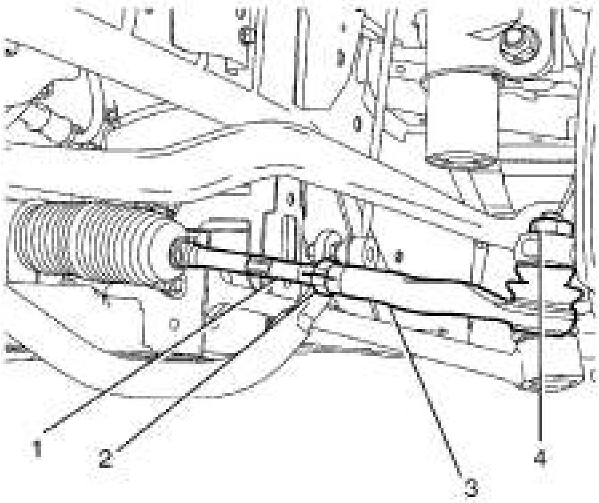
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Remove the engine dress cover. Refer to Engine Cover ReplacementEngine Cover Replacement.
2. Remove the air inlet duct. Refer to Air Cleaner Assembly ReplacementAir Cleaner Assembly Replacement.



3. Remove the power steering gear inlet pipe/hose bracket to subframe retaining bolt (1).
4. Remove the power steering gear outlet pipe/hose bracket to subframe retaining bolt (2).
5. Raise and support the vehicle. Refer to Lifting and Jacking the VehicleLifting and Jacking the Vehicle.
6. Remove the front wheels. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation.



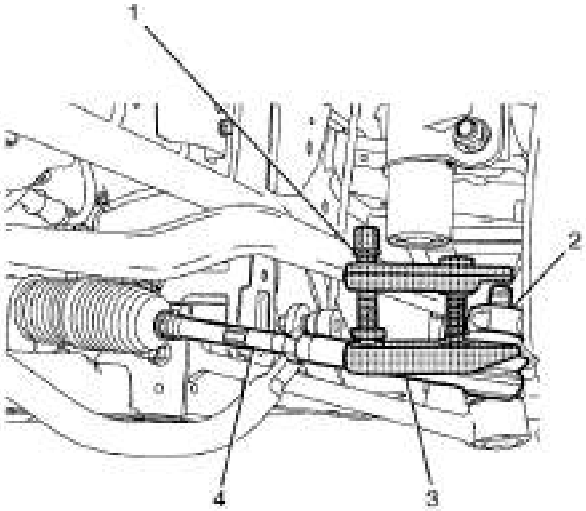
Important: Mark the tie rod end (3) and tie rod end lock nut (2) in relation to the tie rod (1).

7. Loosen the tie rod end lock nut (2) half a turn.

   Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

8. Remove the tie rod end to steering knuckle retaining nut (4).

   Discard the nut.

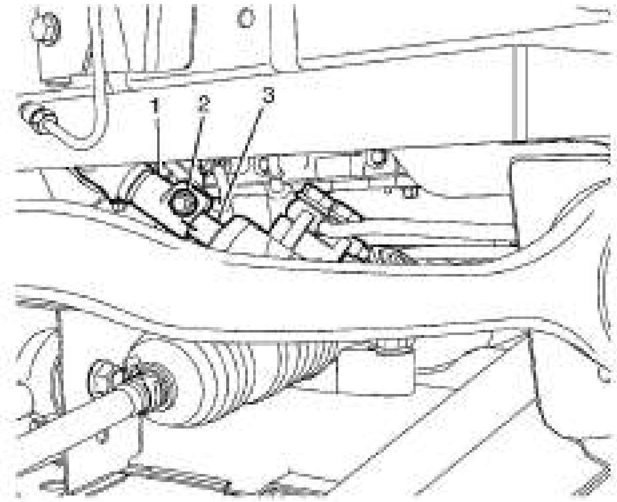


Important: Once a load is applied by the ball joint release tool loading bolt, a quick tap on the nut end of the tool will reduce the separating force required.

9. Separate the tie rod end (3) from the steering knuckle (2) using the 6297 6297 (1).
10. Remove the 6297 6297 (1).
11. Disconnect the tie rod end (3) from the steering knuckle (1).

Important: Note the number of turns required to remove.

12. Remove the tie rod end (3) from the tie rod (4).
13. Repeat steps 6 to 11 on the other side of the vehicle.
14. Remove the engine undertray. Refer to Engine Splash Shield ReplacementEngine Splash Shield Replacement.



Important: Observing the orientation of the intermediate steering shaft (1) with reference to the pinion shaft (3) will minimise the potential of incorrect steering column assembly alignment.

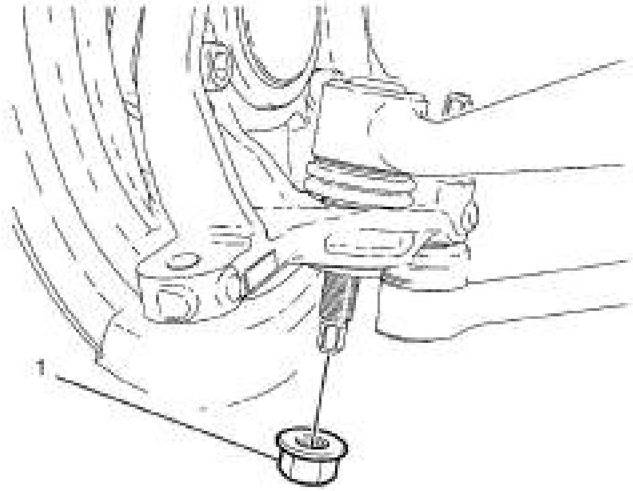
15. Mark the intermediate steering shaft (1) in relation to the pinion shaft (3).
16. Remove the intermediate steering shaft to pinion shaft retaining bolt (2).

Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

17. Disconnect the intermediate shaft (2) from the pinion shaft (3).

    Discard the bolt.

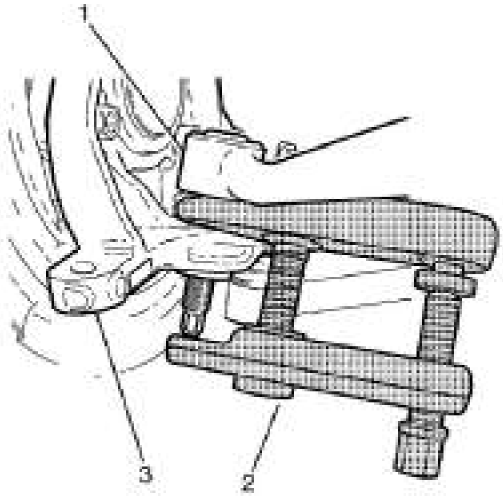
18. Lower the vehicle.



Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

19. Remove the driver side front castor arm to steering knuckle retaining nut (1).

    Discard the nut.

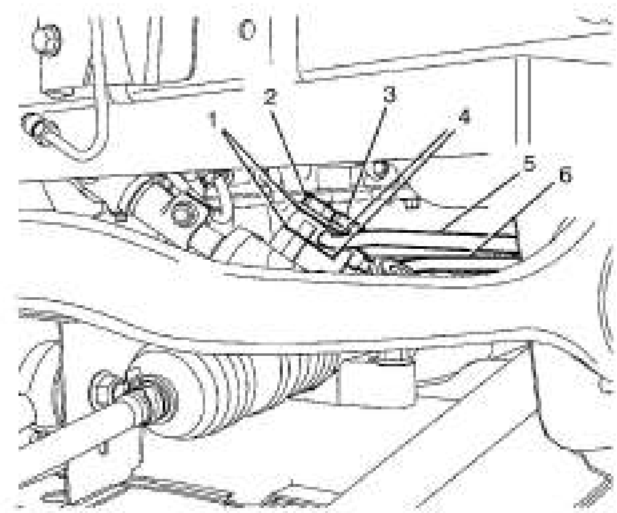


Important: Once a load is applied by the release tool loading bolt, a quick tap on the nut end of the tool will reduce the separating force required.

20. Separate the driver side front castor arm (3) from the steering knuckle (1) using the 6297

6297 (2).

21. Disconnect the driver side front castor arm (3) from the steering knuckle (1).
22. Place a large suitable container under the vehicle in order to collect draining fluid.



Important: The power steering inlet pipe/hose (5) must be plugged to prevent the entry of foreign particles into the power steering system.

Important: The copper sealing washers (1) must be discarded after removal.

23. Remove the power steering gear inlet pipe/hose to power steering gear retaining banjo bolt (2) and copper sealing washers (1).

    Plug the steering gear inlet pipe/hose (5).

    Discard the washers.

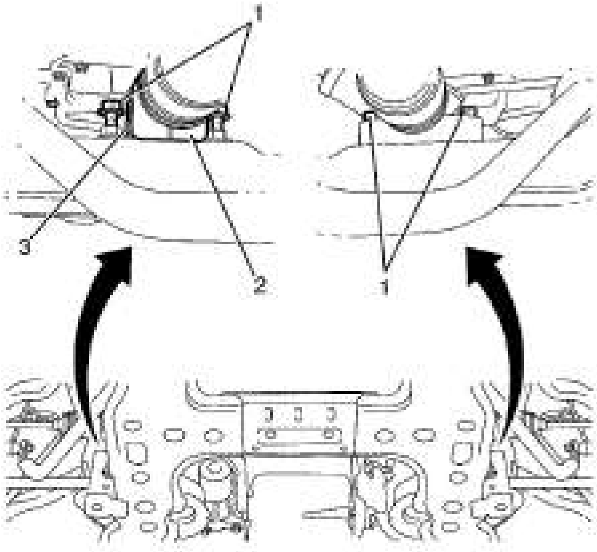
    Important: The power steering outlet pipe/hose (6) must be plugged to prevent the entry of foreign particles into the power steering system.

    Important: The copper sealing washers (4) must be discarded after removal.

24. Remove the power steering gear outlet pipe/hose to power steering gear retaining banjo bolt (3) and copper sealing washers (4).

    Plug the steering gear outlet pipe/hose (6).

    Discard the washers.

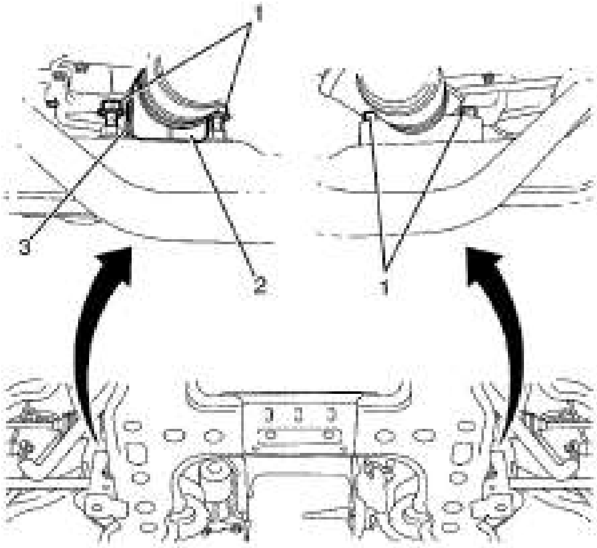


25. Remove the steering gear to subframe retaining bolts (1).
26. Remove the steering gear insulator retaining bracket (2) from the steering gear insulator (3).
27. Remove the steering gear insulator (3) from the steering gear.

Important: The steering gear must be removed from the driver side of the vehicle.

28. Remove the steering gear from the vehicle.

Installation Procedure



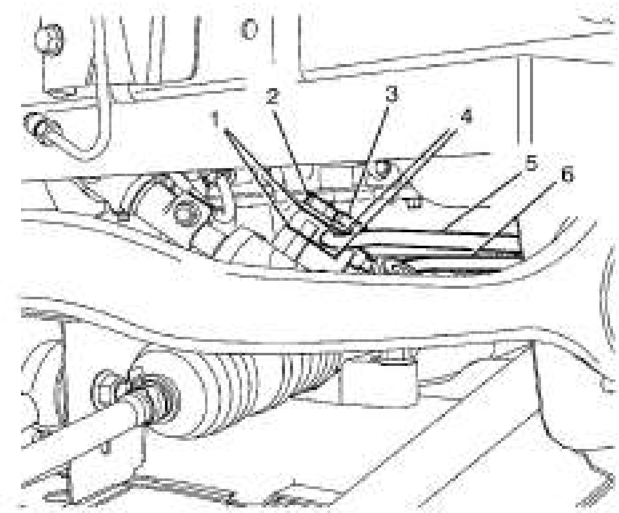
Important: The steering gear must be installed from the driver side of the vehicle.

1. Install the steering gear to the vehicle.
2. Install the steering gear insulator (3) to the steering gear.
3. Install the steering gear insulator retaining bracket (2) to the steering gear insulator (3).

Notice: Refer to Fastener Notice in the Preface section.

4. Install the steering gear to subframe retaining bolts (1).

Tighten
Tighten the Bolts to 65 N·m (48 lb ft).



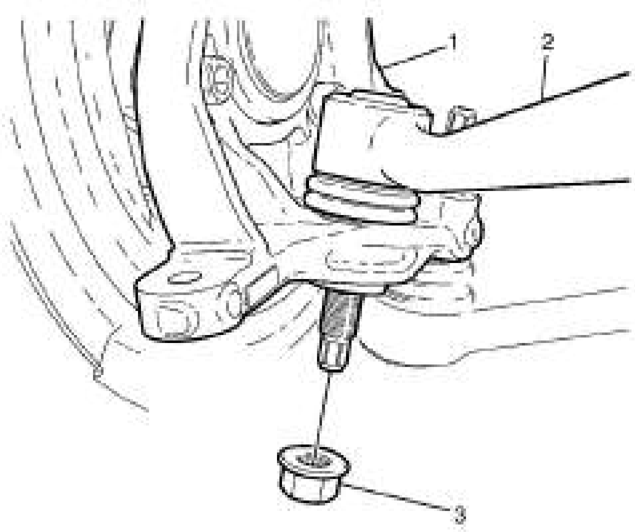
5. Remove the plug from the steering gear inlet pipe/hose (5).
6. Install the power steering gear inlet pipe/hose to power steering gear retaining banjo bolt (1) and NEW copper sealing washers (2).

Tighten
Tighten the banjo bolt to 58 N·m (43 lb ft).

7. Remove the plug from the steering gear outlet pipe/hose (6).
8. Install the power steering gear outlet pipe/hose to power steering gear retaining banjo bolt (3) and NEW copper sealing washers (4).

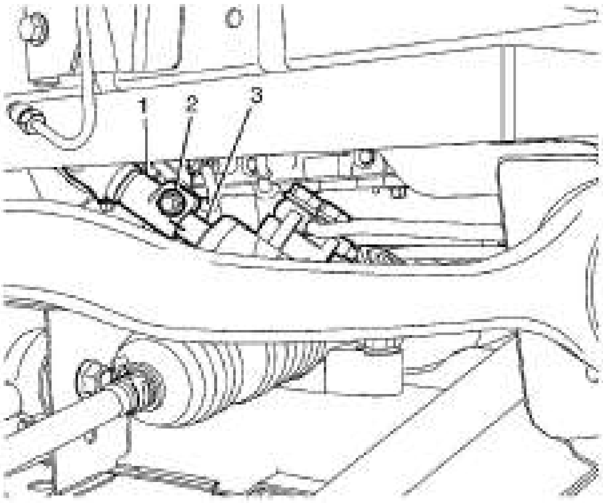
Tighten
Tighten the banjo bolt to 58 N·m (43 lb ft).

9. Remove the container from under the vehicle.



10. Install the driver side front control arm (2) to the steering knuckle (1).
11. Install the driver side front castor arm ball joint to steering knuckle NEW retaining nut (3).

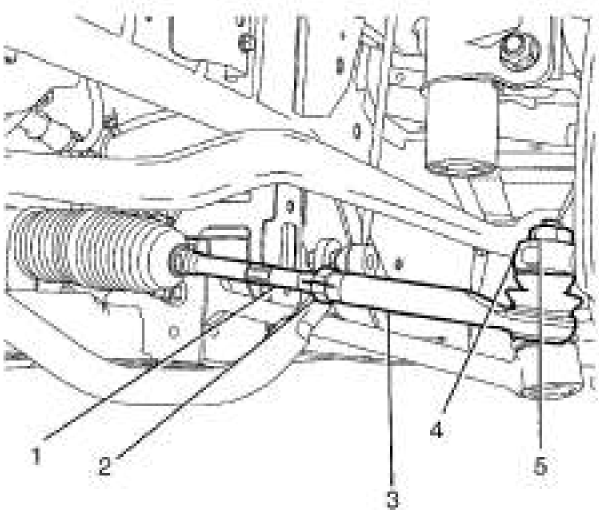
    Tighten
    Tighten nut to 70 N·m (52 lb ft).



Important: The intermediate steering shaft and pinion shaft splines must be installed in the position recorded during removal and aligned with the marks previously made.

12. Connect the intermediate steering shaft (1) to the pinion shaft (3).
13. Install the intermediate steering shaft to pinion shaft NEW retaining bolt (2).

Tighten
Tighten the bolt to 25 N·m (18 lb ft).

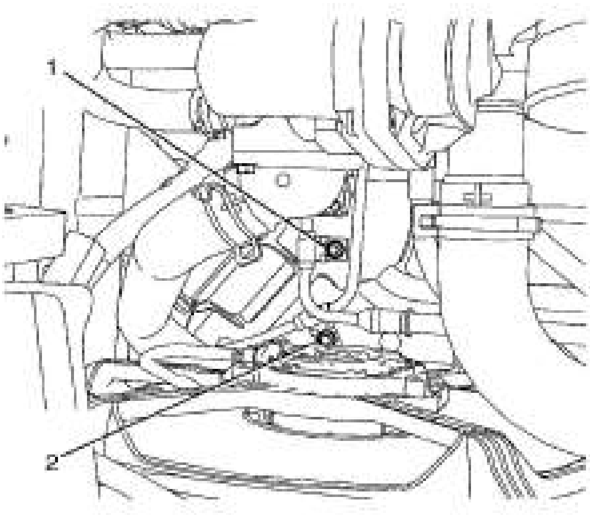


Important: The tie rod end (3) must be installed rotating the same number of turns as recorded during removal and aligned with the mark previously made on the tie rod (1) and tie rod end lock nut (2).

14. Install the tie rod end (3) to the tie rod (1).
15. Connect the tie rod end (3) to the steering knuckle (4).
16. Install the tie rod end to steering knuckle retaining NEW nut (5).

Tighten
Tighten the nut to 25 N·m+ 120 degrees (18 lb ft + 120 degrees).

17. Repeat steps 14 to 16 on the other side of the vehicle.
18. Install the engine undertray. Refer to Engine Splash Shield ReplacementEngine Splash Shield Replacement.
19. Install the front wheels. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation.
20. Remove the safety stands.
21. Lower the vehicle to the ground.



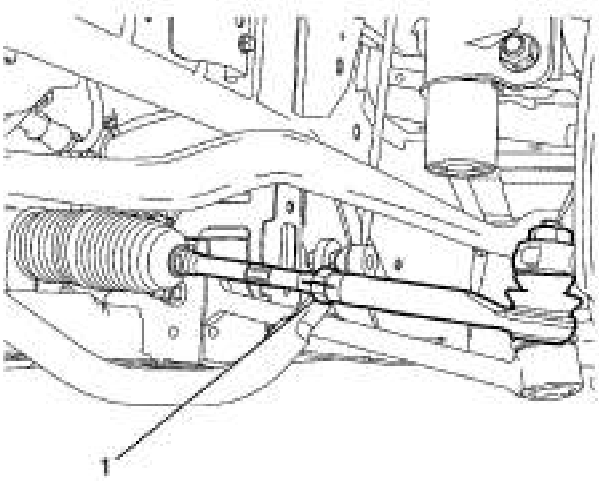
22. Install the power steering gear inlet pipe/hose bracket to subframe retaining bolt (1).

    Tighten
    Tighten the bolt to 9 N·m (80 lb in).

23. Install the power steering gear outlet pipe/hose bracket to subframe retaining bolt (2).

    Tighten
    Tighten the bolt to 9 N·m (80 lb in).

24. Fill power steering fluid reservoir with fluid to the MAX level mark on the reservoir.
25. Bleed the power steering system. Refer to Power Steering System BleedingPower Steering System Bleeding.
26. Check for power steering fluid leaks.
27. Install the engine dress cover. Refer to Engine Cover ReplacementEngine Cover Replacement.
28. Install the air inlet duct. Refer to Air Cleaner Assembly ReplacementAir Cleaner Assembly Replacement 3.
29. Bounce the vehicle several times to settle the suspension.
30. Check and adjust the wheel alignment. Refer to Wheel Alignment MeasurementWheel Alignment Measurement.



31. Tighten the tie rod end lock nut (1).

Tighten
Tighten the nut to 170 N·m (125 lb ft).

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Steering Linkage Outer Tie Rod Replacement

Tools Required

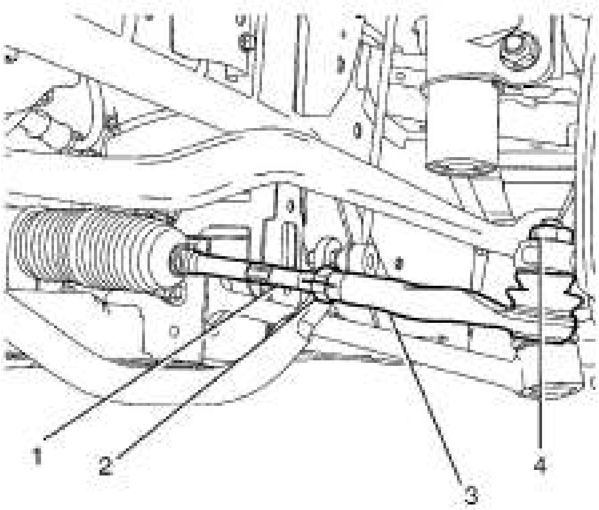
6297 6297 Ball Joint Release Tool.

Removal Procedure After

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the VehicleLifting and Jacking the Vehicle.
2. Remove the front wheel. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation.



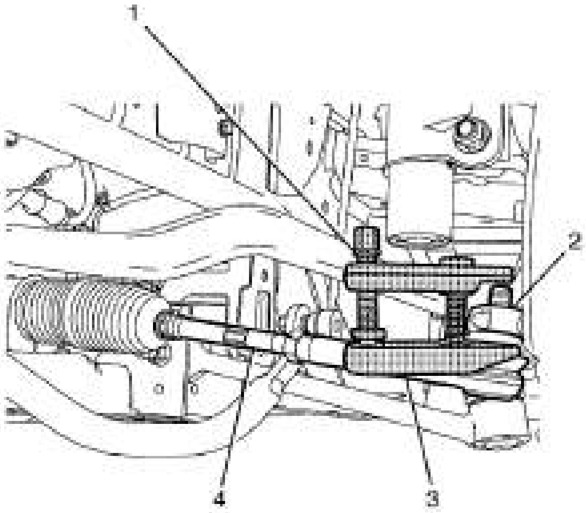
Important: Mark the tie rod end (3) and tie rod end lock nut (2) in relation to the tie rod (1).

3. Loosen the tie rod end lock nut (2) half a turn.

Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

4. Remove the tie rod end to steering knuckle retaining nut (4).

Discard the nut.



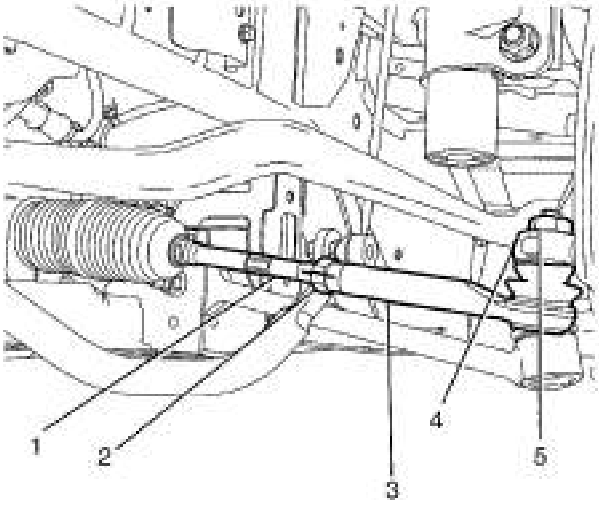
Important: Once a load is applied by the ball joint release tool loading bolt, a quick tap on the nut end of the tool will reduce the separating force required.

5. Separate the tie rod end (3) from the steering knuckle (2) using the 6297 6297 (1).
6. Remove the 6297 6297 (1).
7. Disconnect the tie rod end (3) from the steering knuckle (2).

Important: Note the number of turns required to remove.

8. Remove the tie rod end (3) from the tie rod (4).

Installation Procedure



Important: The tie rod end (3) must be installed rotating the same number of turns as recorded during removal and aligned with the mark previously made on the tie rod (1).

1. Install the tie rod end (3) to the tie rod (1).
2. Connect the tie rod end (3) to the steering knuckle (4).

Notice: Refer to Fastener Notice in the Preface section.

3. Install the tie rod end to steering knuckle retaining NEW nut (5).

Tighten
Tighten the nut to 25 N·m+ 120 degrees (18 lb ft + 120 degrees).

4. Install the front wheel. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation.
5. Remove the safety stands.
6. Lower the vehicle to the ground.
7. Bounce the vehicle several times to settle the suspension.
8. Check and adjust the wheel alignment. Refer to Wheel Alignment MeasurementWheel Alignment Measurement.
9. Tighten the tie rod end lock nut (2).

Tighten
Tighten the nut to 170 N·m (125 lb ft).

Power Steering System Description and Operation

Power Steering System Description

The power steering fluid reservoir holds the power steering fluid. It is mounted to a bracket on the engine remotely located from the power steering pump. The power steering fluid reservoir outlet hose allows low pressure fluid to flow from the power steering fluid reservoir to the power steering pump. The power steering pump is a constant displacement vane-type pump that provides hydraulic pressure and flow for the power steering gear. The power steering pump is belt-driven. The power steering gear inlet pipe/hose connects the power steering pump to the power steering gear allowing pressurised power steering fluid to flow from the power steering pump to the power steering gear. The power steering gear is a rack and pinion type assembly. The power steering gear converts steering wheel rotation to lateral movement. The power steering gear outlet pipe/hose allows fluid to flow from the power steering gear to the power steering fluid cooler. The power steering fluid cooler transfers the heat generated by power steering pump and power steering gear from the fluid to the atmosphere. The power steering fluid reservoir inlet hose allows fluid to flow from the power steering fluid cooler back to the power steering fluid reservoir.

Power Steering Pump Description

Hydraulic pressure for the power steering system is provided by a Kayaba vane type constant flow pump.

Fluid from the power steering fluid reservoir outlet pipe/hose flows through a passage in the power steering pump housing to the rear end plate which will then supply the vanes with under-vane pressure and to fill the cavity between the rotor and the pump ring as well as filling the high pressure chamber.

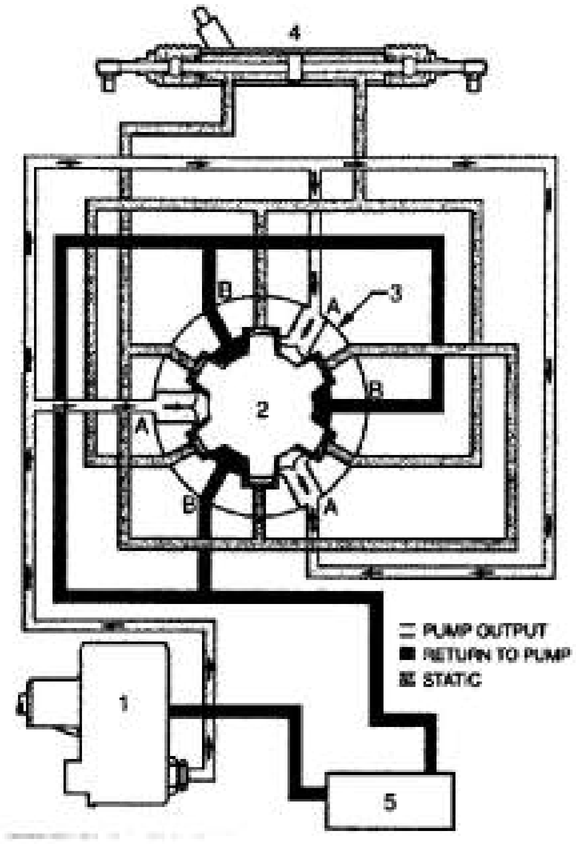
The power steering pump drive shaft is fitted with a pulley, which is driven by the serpentine belt from the engine crankshaft. The power steering pump drive shaft turns the rotor and vane assembly. The vane tips follow the inner cam surface of the power steering pump ring, moving outward and inward twice during each revolution. This results in a complete pumping cycle every 180% of rotation. Power steering fluid is moved in the spaces between the vanes. As the vane tips move inwards, the pressure of the power steering fluid is raised and the power steering fluid is discharged from the power steering pump ring through the thrust plate to the cavity in the front of the power steering pump housing. A portion of this pressurised power steering fluid is circulated through the central port system in the rear plate forcing the vanes against the cam surface of the power steering pump ring.

Power Steering Gear Description

The power steering gear is a rack and pinion type system, the rack and the pinion are the two components that convert steering wheel rotation to lateral movement. The steering shaft is attached to the pinion in the steering gear. The pinion rotates with the steering wheel. Gear teeth on the pinion mesh with gear teeth on the rack. The rotating pinion moves the rack from side to side. The steering gear contains a valve assembly that regulates the incoming fluid to the right and left chambers in order to assist in right and left turns. Turning the steering wheel partially rotates the valve assembly, which applies greater fluid pressure and flow to one side of the rack piston, and lower pressure and flow to the other side of the rack piston. The pressure assists the lateral movement of the rack. The lateral action of the rack pushes and pulls the tie rods in order to change the direction of the vehicle's front wheels.

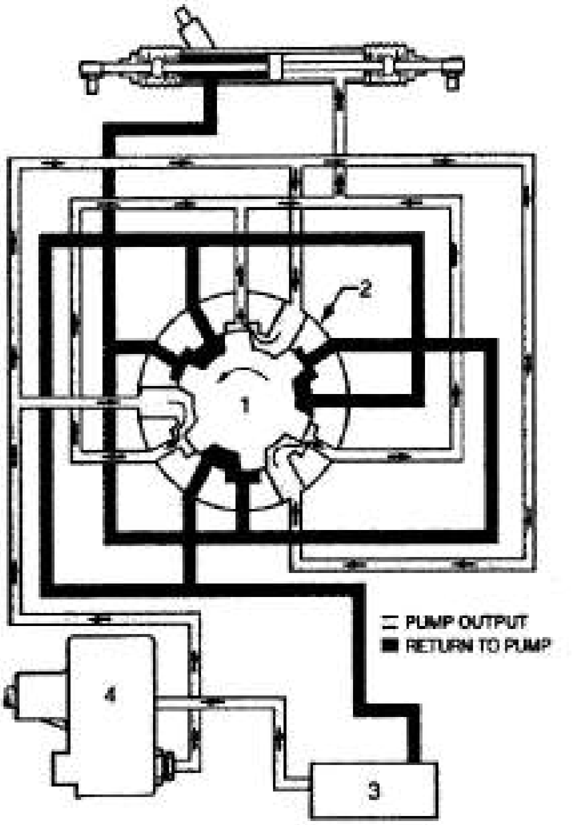
Power Steering Fluid Flow

Neutral Position -- Straight Ahead



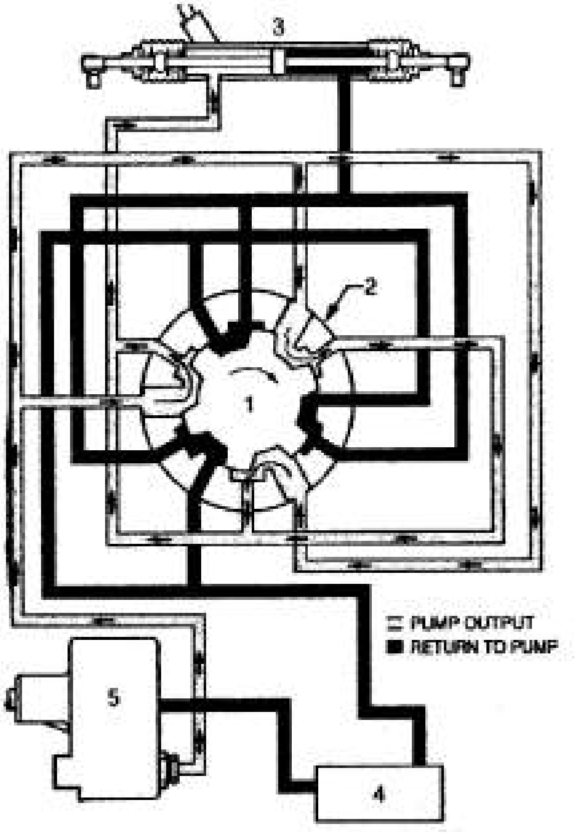
In the straight ahead position, power steering fluid flow from the pump (1) is directed into the cavity (A) of the inner valve assembly (2) and out through a number of drilled holes (B) in the outer sleeve (3). In this steering position, the inner valve allows power steering fluid to pass equally to both sides of the rack (4) piston (shown as static because no power steering fluid actually flows to and from the steering gear). The bypassed power steering fluid returns to the power steering fluid reservoir (5) through holes drilled in the longitudinal grooves of the inner valve. With an equal pressure applied to both sides of the rack piston, no power assistance is provided.

Turning Left



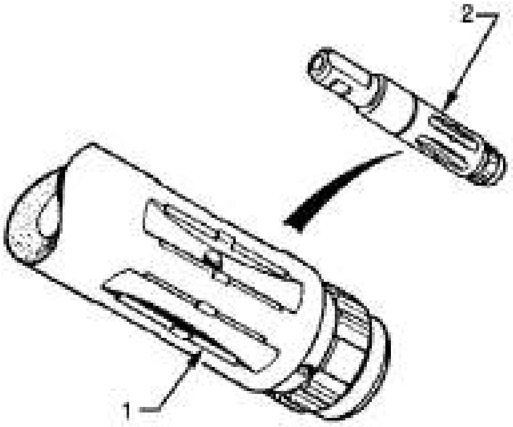
When turning to the left, relative motion between the inner rotating valve (1) and the outer sleeve (2) occurs, this blocks the fluid return cricuit and redirects the fliud to the right-hand side of the rack piston (3), at the same time the power steering fluid on the opposite side of the piston is directed to the return circuit, leading to the reservoir (3) and the pump (4). This action is slight at first, providing only a small amount of driver assistance, but becomes progressively greater with higher steering loads as the torsion bar in the rotary valve assembly allows the valve to rotate further.

Turning Right



When turning to the right, relative motion between the inner rotating valve (1) and the outer sleeve (2) occurs, this blocks the fluid return cricuit and redirects the fliud to the left-hand side of the rack piston (3), at the same time the power steering fluid on the opposite side of the piston is directed to the return circuit, leading to the reservoir (3) and the pump (4). This action is slight at first, providing only a small amount of driver assistance, but becomes progressively greater with higher steering loads as the torsion bar in the rotary valve assembly allows the valve to rotate further.

Inner Rotating Valve



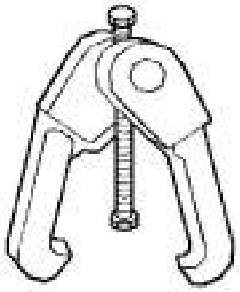
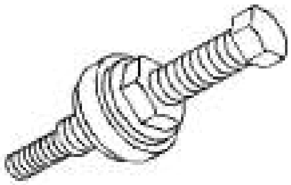
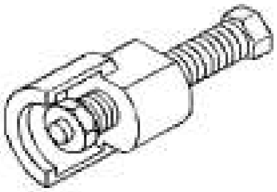
When parking the vehicle more than 90% of the work is done by the power steering fluid. In order to achieve a balance between this graduated increase of assistance and maintain a realistic feel with good response as the road speed increases, the grooves (1) of the inner rotating valve (2) are precisely shaped to meter the flow of power steering fluid.

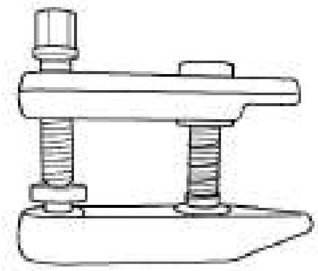
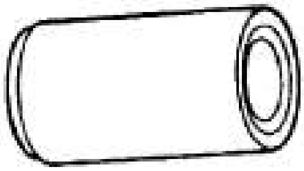
Under extreme load conditions or for any reason the hydraulic system becomes inoperative, the torsion bar will deflect to a pre-determined point, then allow the input shaft to drive the steering pinion directly. This is achieved by having a loose fitting spline between the lower end of the input shaft and the surrounding upper end of the pinion.

Under these operating conditions, steering loads will be high and a noticeable amount of slack will develop because of the torsion bar flexing. Therefore while the steering gear remains entirely operable, the vehicle should only be operated in this manner for the minimum distance needed to reach a point where the system can be serviced.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Steering | Power Steering | Special Tools and Equipment | Document ID: 1989971

Special Tools

Illustration	Tool Number / Description
	9A10 Steering Linkage and Tie Rod Puller
	7005 Pulley Installer
	7185 Pulley Remover
	CH-49405

	Steering Linkage and Tie Rod Puller
	E-1460-1 Power Steering Pump Seal Installer

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Steering Column Lower Trim Cover to Steering Column Assembly Retaining Screw	2 N·m	18 lb in
Steering Wheel to Steering Column Shaft Retaining Bolt	45 N·m	33 lb ft
Ignition Switch to Steering Column Assembly Retaining Screws	3 N·m	27 lb in
Steering Column Assembly to Body Retaining Bolts	22 N·m	16 lb ft
Steering Column Shaft to Intermediate Steering Shaft Retaining Bolt	28 N·m	21 lb ft
Intermediate Steering Shaft to Pinion Shaft Retaining Bolt	28 N·m	21 lb ft

Diagnostic Starting Point - Steering Column

Begin the system diagnosis by reviewing the system Description and Operation. Refer to Steering Wheel and Column Description and Operation . Reviewing the Description and Operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the Description and Operation information will also help you determine if the condition described by the customer is normal operation. Refer to Symptoms - Steering Wheel and Column in order to identify the correct procedure for diagnosing the system and where the procedure is located.

Symptoms - Steering Wheel and Column

Review the system description and operation in order to familiarize yourself with the system functions. Refer to Steering Wheel and Column Description and Operation in Steering Wheel and Column.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the steering wheel and column.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Symptoms List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Lock System Does Not Unlock.
- Lock System Does Not Lock.
- Steering Column Tilt Function Inoperative.
- Lock System Sticks in Start.
- Ignition Key Cannot Be Removed from the Ignition Lock Cylinder.
- Noise in Steering Column.
- Looseness in Steering Column.

Lock System Does Not Lock

Step	Action	Yes	No
DEFINITION: The lock system does not allow the key to rotate out of the OFF position.			
1	Did you review the Steering Wheel and Column Description and Operation?	Go to Step 2	Go to Steering Wheel and Column Description and Operation in Steering Wheel and Column.
2	Verify that the ignition lock system does not unlock. Does the ignition lock system operate normally?	System OK	Go to Step 3
3	Inspect for an incorrect, worn, or damaged key. Is the key incorrect, worn, or damaged?	Go to Step 7	Go to Step 4
4	Inspect for a faulty ignition lock cylinder. Is the ignition lock cylinder damaged?	Go to Step 8	Go to Step 5
5	Inspect the ignition lock cylinder housing for damage. Is the ignition lock cylinder housing damaged?	Go to Step 9	Go to Step 6
6	Inspect the ignition switch assembly for damage. Is the ignition switch assembly damaged?	Go to Step 10	Verify customer concern, go to Strategy Based Diagnosis in General information.
7	Replace the key. Refer to Replacing Keys in Theft Deterrent. Did you complete the repair?	Go to Step 11	--
8	Replace the ignition lock cylinder. Refer to Ignition Lock Cylinder Replacement in Steering Wheel and Column. Did you complete the repair?	Go to Step 11	--
9	Replace the steering column assembly. Refer to Steering Column Replacement in Steering Wheel and Column. Did you complete the repair?	Go to Step 11	--
10	Replace the ignition switch. Refer to Ignition and Start Switch Replacement in Steering Wheel and Column.		

	Did you complete the repair?	Go to Step 11	--
11	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

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Lock System Does Not Unlock

Step	Action	Yes	No
DEFINITION: The lock system does not allow the key to rotate out of the OFF position.			
1	Did you review the Steering Wheel and Column Description and Operation and perform the necessary inspections?	Go to Step 2	Go to Steering Wheel and Column Description and Operation in Steering Wheel and Column.
2	Verify that the lock system does not unlock. Does the lock system operate normally?	System OK	Go to Step 3
3	Inspect for an incorrect, worn, or damaged key. Is the key incorrect, worn, or damaged?	Go to Step 7	Go to Step 4
4	Inspect for a faulty lock cylinder. Is the lock cylinder damaged?	Go to Step 8	Go to Step 5
5	Inspect the ignition switch assembly for damage. Is the ignition switch assembly damaged?	Go to Step 10	Go to Step 6
6	Inspect the lock module assembly for looseness or binding. Is the lock module assembly loose or binding?	Go to Step 9	Go to Step 11
7	Replace the key. Refer to Replacing Keys in Theft Deterrent. Did you complete the repair?	Go to Step 11	--
8	Replace the lock cylinder. Refer to Ignition Lock Cylinder Replacement in Steering Wheel and Column. Did you complete the repair?	Go to Step 11	--
9	Tighten or replace the ignition switch to steering column assembly retaining screws. Refer to Fastener Tightening Specifications . Did you complete the repair?	Go to Step 11	--
10	Replace the ignition switch. Refer to Ignition and Start Switch Replacement in Steering Wheel and Column. Did you complete the repair?	Go to Step 11	--

11	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

Lock System Sticks in Start

Step	Action	Yes	No
1	Did you review the Steering Wheel and Column Description and Operation?	Go to Step 2	Go to Steering Wheel and Column Description and Operation in Steering Wheel and Column.
2	Verify that the lock system sticks in the START position. Does the lock system operate normally?	System OK	Go to Step 3
3	Inspect the ignition lock cylinder housing for damage. Is the ignition lock cylinder case assembly damaged?	Go to Step 6	Go to Step 4
4	Inspect the ignition lock cylinder for damage. Is the ignition lock cylinder damaged?	Go to Step 7	Go to Step 5
5	Inspect the ignition switch for damage. Is the ignition switch damaged?	Go to Step 8	Verify customer concern, go to Strategy Based Diagnosis in General information.
6	Replace the steering column assembly. Refer to Steering Column Replacement in Steering Wheel and Column. Did you complete the repair?	Go to Step 9	--
7	Replace the ignition lock cylinder. Refer to Ignition Lock Cylinder Replacement in Steering Wheel and Column. Did you complete the repair?	Go to Step 9	--
8	Replace the ignition switch. Refer to Ignition and Start Switch Replacement in Steering Wheel and Column. Did you complete the repair?	Go to Step 9	--
9	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

Looseness in Steering Column

Step	Action	Yes	No
1	Did you review the Steering Wheel and Column Description and Operation and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Steering Wheel and Column in Steering Wheel and Column.
2	Verify that the steering column is loose. Is the steering column loose?	Go to Step 3	System OK
3	Inspect the steering column mounting bolts for looseness. Are the steering column mounting bolts loose?	Go to Step 8	Go to Step 4
4	Verify that the steering column mounting bracket capsule is not sheared. Is the steering column bracket mounting capsule sheared?	Go to Step 9	Go to Step 5
5	Inspect the upper and lower tilt head pivots for wear or damage. Are the upper or lower tilt head pivots worn or damaged?	Go to Step 9	Go to Step 6
6	Inspect the intermediate shaft universal joints for wear or damage Are the intermediate joints worn or damaged?	Go to Step 10	Go to Step 7
7	Inspect the steering shaft bearings for wear or damage. Are the steering shaft bearings worn or damaged?	Go to Step 9	Verify customer concern, go to Strategy Based Diagnosis in General information.
8	Tighten the brackets to specifications. Refer to Fastener Tightening Specifications in Steering Wheel and Column. Did you complete the repair?	Go to Step 11	--
9	Replace the steering column assembly. Refer to Steering Column Replacement in Steering Wheel and Column. Did you complete the replacement?	Go to Step 11	--
10	Replace the intermediate steering shaft. Refer to Intermediate Steering Shaft Replacement.		

	Did you complete the repair?	Go to Step 11	--
11	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

Noise in Steering Column

Step	Action	Yes	No
1	Did you review the Steering Wheel and Column Description and Operation and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Steering Wheel and Column in Steering Wheel and Column.
2	Verify that noise is present in the steering column during operation. Is noise present in the steering column during operation?	Go to Step 3	System OK
3	Inspect the steering column components for looseness. Are any of the steering column components loose?	Go to Step 9	Go to Step 4
4	Inspect the SIR coil for noise. Is the SIR coil noisy?	Go to Step 10	Go to Step 5
5	Inspect the steering column tilt mechanism assembly for wear or damage. Is the tilt mechanism assembly worn or damaged?	Go to Step 11	Go to Step 6
6	Inspect the steering shaft bearings for wear or damage. Are the steering shaft bearings worn or damaged?	Go to Step 11	Go to Step 7
7	Inspect the intermediate shaft upper universal joint for wear or damage. Is the intermediate shaft upper universal joint worn or damaged?	Go to Step 12	Go to Step 8
8	Inspect the intermediate shaft lower universal joint for wear or damage. Is the intermediate shaft lower universal joint worn or damaged?	Go to Step 12	Verify customer concern, go to Strategy Based Diagnosis in General information.
9	**Notice:** Refer to Fastener Notice in the Preface section. Tighten the steering column components to the required specifications. Refer to Fastener Tightening Specifications. Did you complete the repair?	Go to Step 13	--

10	Replace the SIR coil. Refer to Inflatable Restraint Steering Wheel Module Coil Replacement in SIR. Did you complete the repair?	Go to Step 13	--
11	Replace the steering column assembly. Refer to Steering Column Replacement in Steering Wheel and Column. Did you complete the repair?	Go to Step 13	--
12	Replace the intermediate steering shaft. Refer to Intermediate Steering Shaft Replacement Did you complete the repair?	Go to Step 13	--
13	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

Steering Column Tilt Function Inoperative

Step	Action	Yes	No
1	Did you review the Steering Wheel and Column Description and Operation and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Steering Wheel and Column.
2	Verify that the steering column tilt function is inoperative. Does the steering column tilt function operate normally?	System OK	Go to Step 3
3	Verify that the shoe is not seized on the pivot pin. Is the shoe seized on the pivot pin?	Go to Step 9	Go to Step 4
4	Inspect the shoe grooves for dirt, burrs, or rust. Are the shoe grooves free of dirt, burrs, and rust?	Go to Step 9	Go to Step 5
5	Inspect weak or broken shoe lock spring. Is the shoe lock spring weak or broken?	Go to Step 9	Go to Step 6
6	Inspect the pivot pins for binding. Are the pivot pins binding?	Go to Step 9	Go to Step 7
7	Inspect for a weak or broken wheel tilt spring. Is the wheel tilt spring weak or broken?	Go to Step 9	Go to Step 8
8	Inspect the steering column wiring harness for tightness. Is the steering column wiring harness too tight?	Go to Step 10	Verify customer concern, go to Strategy Based Diagnosis.
9	Replace the steering column. Refer to Steering Column Replacement. Is the repair complete?	Go to Step 13	--
10	Reposition the steering column wiring harness to the correct location. Is the steering column wiring harness routed correctly?	Go to Step 13	--
11	Operate the steering column tilt function in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

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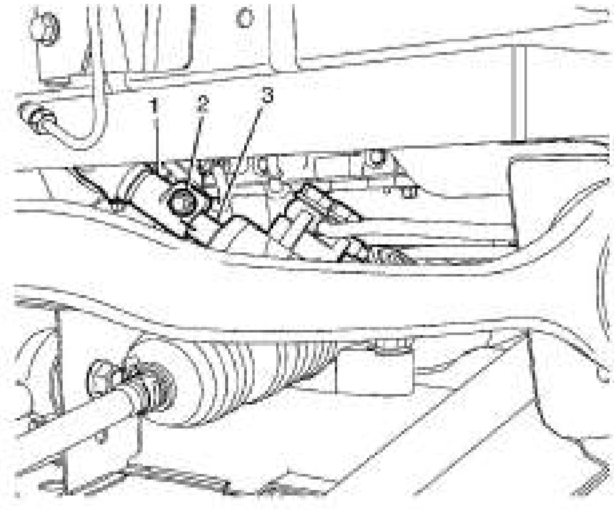
Intermediate Steering Shaft Replacement (RHD)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



Important: Observing the orientation of the intermediate steering shaft (1) with reference to the pinion shaft (3) will minimise the potential of incorrect steering column assembly alignment.

2. Mark the intermediate steering shaft (1) in relation to the pinion shaft (3).
3. Remove the intermediate steering shaft to pinion shaft retaining bolt (2).

Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

4. Disconnect the intermediate shaft (2) from the pinion shaft (3).

   Discard the bolt.

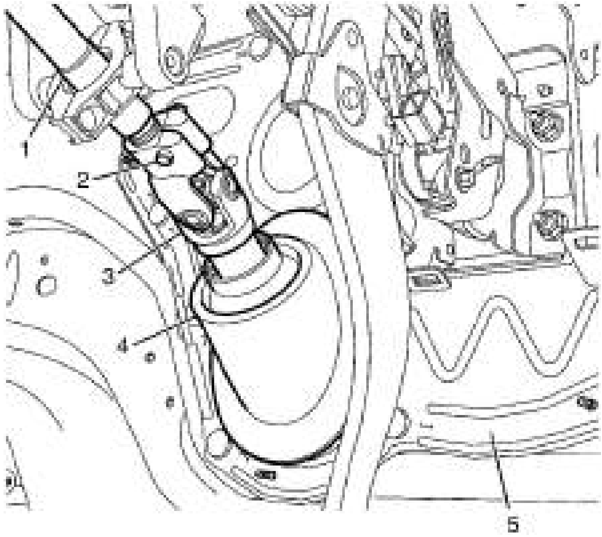
5. Lower the vehicle.

Caution: Refer to SIR Caution in the Preface section.

6. Disable the SIR system. Refer to SIR Disabling and Enabling .
7. Remove the driver side instrument panel lower trim panel assembly. Refer to Knee Bolster

Replacement .

8. Remove the driver side instrument panel lower right trim plate assembly. Refer to Instrument Panel Outer Trim Cover Replacement .
9. Remove the driver side instrument panel lower trim panel retainer. Refer to Instrument Panel Retainer Replacement .
10. Remove the driver side air outlet duct - floor, RH Instrument Panel Outer Air Outlet Deflector Replacement - Right Side .



Important: Observing the orientation of the steering column shaft (1) with reference to the intermediate steering shaft (3) will minimise the potential of incorrect steering column assembly alignment.

11. Mark the steering column shaft (1) in relation to the intermediate shaft (3).

Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

12. Remove the steering column shaft to intermediate steering shaft retaining bolt (2).

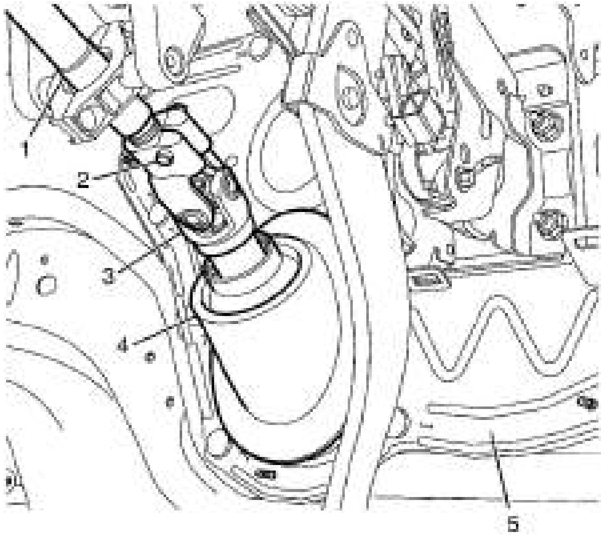
Discard the bolt.

13. Disconnect the steering column shaft (1) from the intermediate steering shaft (3).

Important: Pull the intermediate steering shaft grommet (1) from the cabin side of the mod plate (5) to detach.

14. Detach the intermediate steering shaft grommet (1).
15. Remove the intermediate shaft (2).

Installation procedure



1. Install the intermediate steering shaft (3).

   Important: Push the intermediate shaft grommet (4) from the cabin side of the mod plate (5).

2. Mount the intermediate shaft grommet (4).

   Important: The steering column shaft and intermediate steering shaft splines must be installed in the position recorded during removal and aligned with the marks previously made.

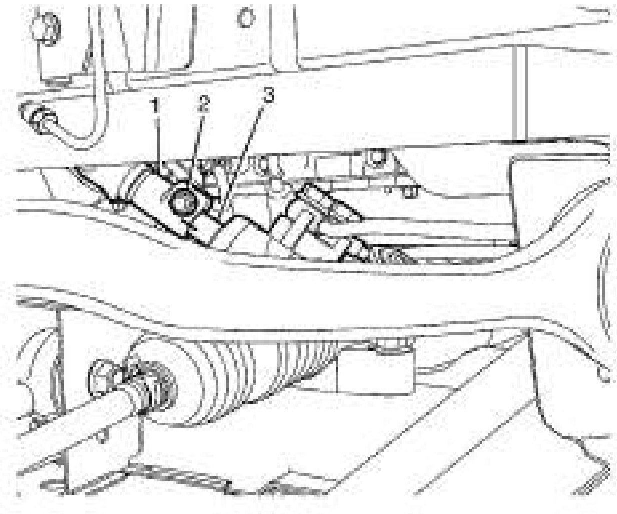
3. Connect the steering column shaft (1) to the intermediate steering shaft (3).

   Notice: Refer to Fastener Notice in the Preface section.

4. Install the NEW steering column shaft to intermediate steering shaft retaining bolt (2).

   Tighten
   Tighten the bolt to 28 N·m (21 lb ft).

5. Install the driver side air outlet duct - floor, RH Instrument Panel Outer Air Outlet Deflector Replacement - Right Side .
6. Install the driver side instrument panel lower trim panel retainer. Refer to Instrument Panel Retainer Replacement .
7. Install the driver side instrument panel lower right trim plate assembly. Refer to Instrument Panel Outer Trim Cover Replacement .
8. Install the driver side instrument panel lower trim panel assembly. Refer to Knee Bolster Replacement .
9. Enable the SIR system. Refer to SIR Disabling and Enabling .
10. Raise vehicle.



Important: The intermediate steering shaft and pinion shaft splines must be installed in the position recorded during removal and aligned with the marks previously made.

11. Connect the intermediate steering shaft (1) to the pinion shaft (3).
12. Install NEW the intermediate steering shaft to pinion shaft retaining bolt (2).

    Tighten
    Tighten the bolt to 28 N·m (21 lb ft).

13. Lower the vehicle to the ground.

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Steering Angle Sensor Replacement (RHD)

Removal Procedure

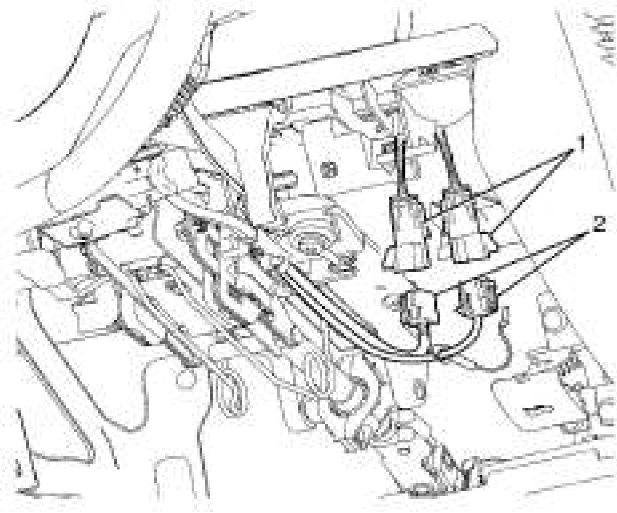
1. Turn the key to the ignition OFF position.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .

   Caution: Refer to SIR Caution in the Preface section.

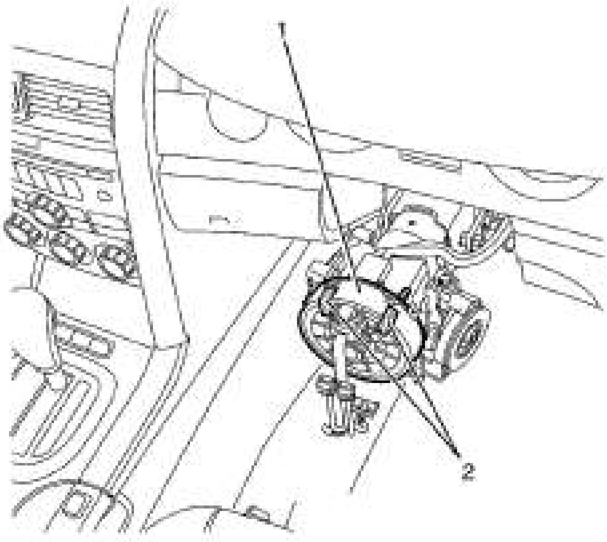
3. Disable the SIR system. Refer to SIR Disabling and Enabling .
4. Remove the inflatable restraint steering wheel module. Refer to Inflatable Restraint Steering Wheel Module Replacement .
5. Remove the steering wheel. Refer to Steering Wheel Replacement .
6. Remove the steering column trim covers. Refer to Steering Column Trim Covers Replacement .
7. Remove the cruise control switch. Refer to Turn Signal Switch Replacement .
8. Remove the wipers/washer switch. Refer to Windshield Wiper and Washer Switch Replacement .



Important: The clock spring is referred to as the SIR coil.

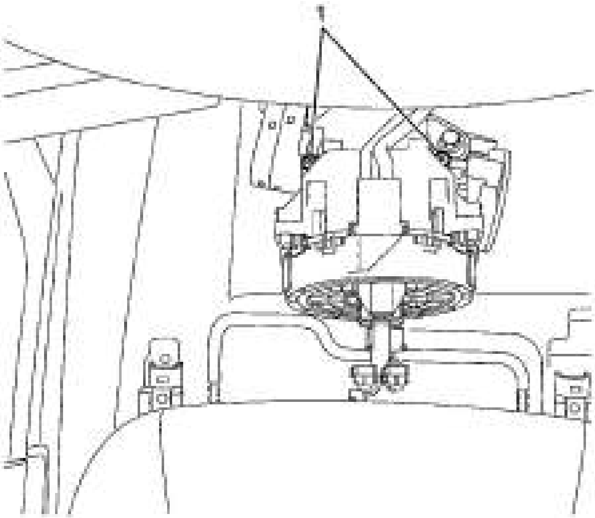
Important: The steering angle sensor, SIR coil and turn signal cancel cam assembly is referred to as the SIR coil assembly.

9. Disconnect the SIR coil assembly connectors, (1) from (2).



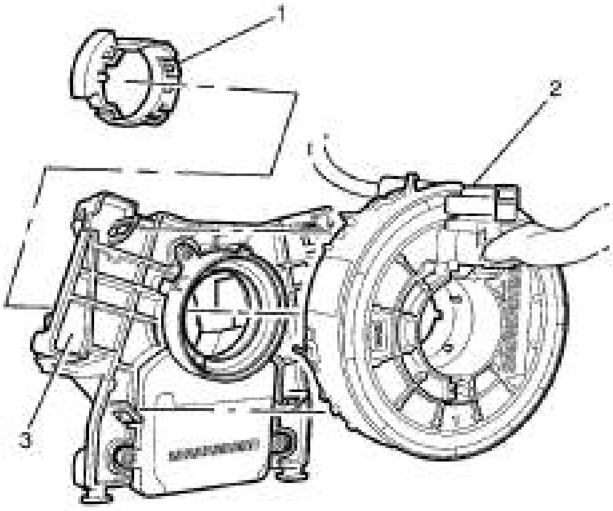
Important: Secure the SIR coil assembly so it does not rotate whilst disassembling.

10. Secure the SIR coil assembly (1) using suitable tape (2) to prevent rotation during disassembly.



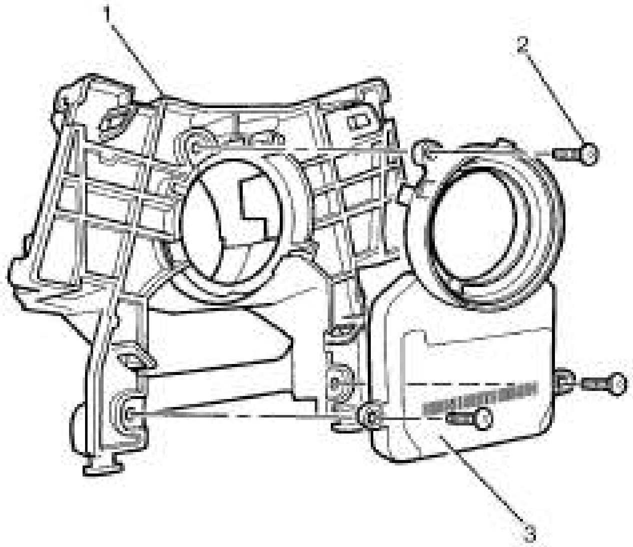
11. Remove the SIR coil assembly to steering column retaining screws (1).

Disassembly Procedure



Important: Discard the turn signal cancel cam after removal.

1. Remove turn signal cancel cam (1) from back of the SIR coil assembly using a suitable tool and discard the turn signal cancel cam .

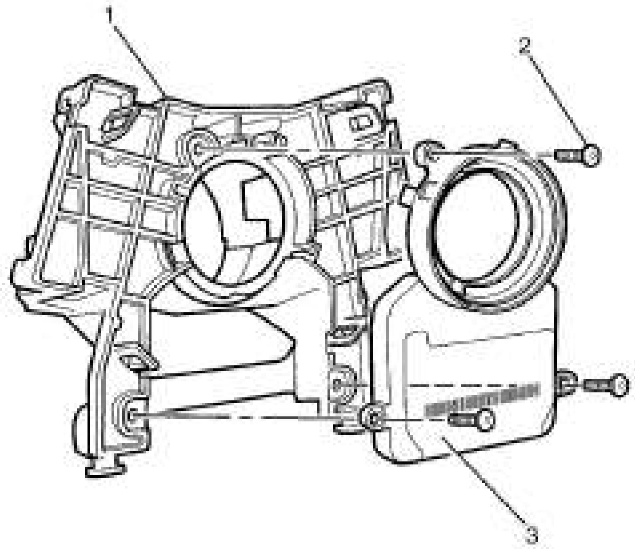


2. Remove the steering angle sensor to multifunction switch (MFS) holder retaining screws (2).

   Important: The MFS must be discarded if steering angle sensor is replaced

3. Remove the steering angle sensor (3) from the MFS holder (1) and discard the holder.

Assembly Procedure



1. Install the steering angle sensor (3) to the NEW MFS holder (1).

   Important: Install the steering angle sensor to MFS holder retaining screws (2) until there is no movement of the sensor to MFS holder, DO NOT overtighten the screws as damage to the steering angle sensor may occur.

2. Install the steering angle sensor to MFS holder retaining screws (2).

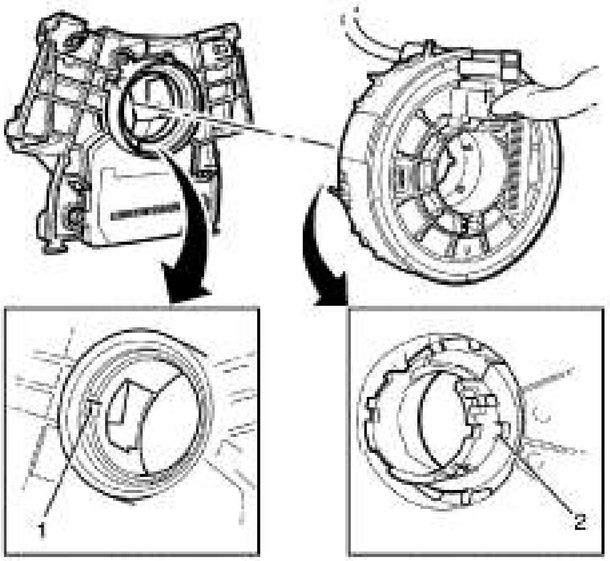
   Tighten
   Tighten the screws to 0.3 Nm (0.22 lb in).

   Notice: The new SIR coil assembly will be centered. Improper alignment of the SIR coil assembly may damage the unit, causing an inflatable restraint malfunction.

   Important: If an existing SIR coil assembly is to being installed, the SIR coil assembly must be centred.

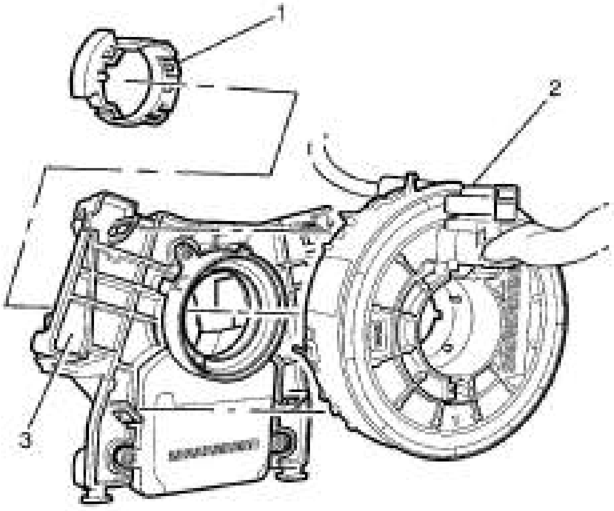
   Important: To centre the SIR coil rotate the coil in one direction until resistance can be felt, then rotate the coil in the opposite direction counting the amount of rotations (there should be approximately 6 complete rotations). Position the wiring harness on the front of the SIR coil to the 12 O'clock position (if not already there) then rotate the coil 3 full turns in the opposite direction and lock the coil in this position, this is the centre position.

3. Centre the SIR coil assembly if required.

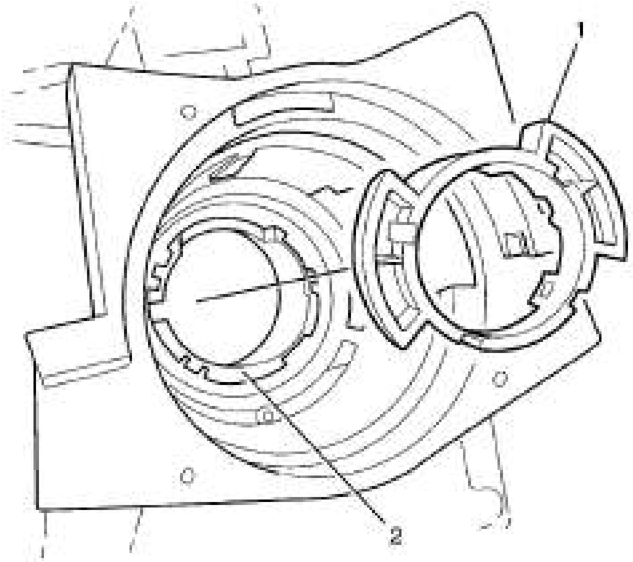


Important: Make sure that the locating cutout on the steering angle sensor (1) aligns with the SIR coil (2), mark the cutout on the steering angle sensor (1) to assist in correct locating of the SIR coil (2).

4. Align SIR coil assembly locating block (2) to the steering angle sensor (1) cutout

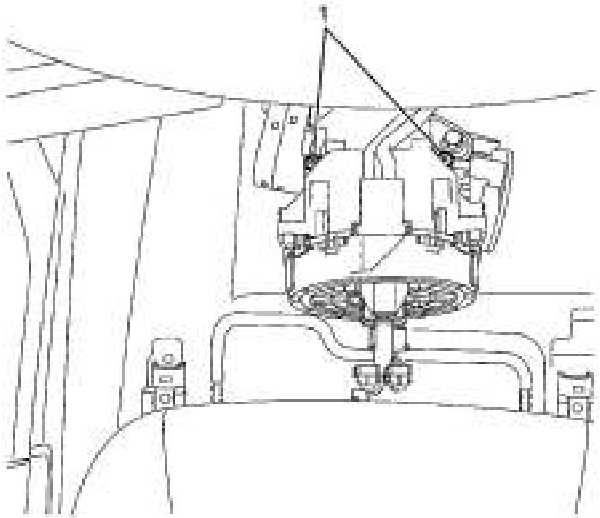


5. Install the SIR coil assembly (2) to the MFS holder (3).



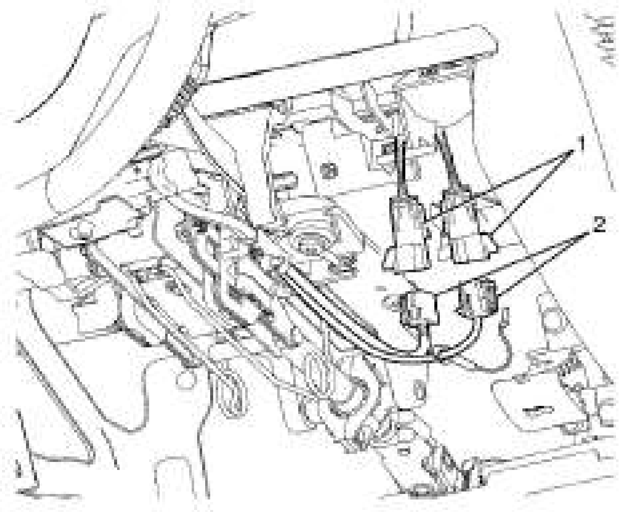
6. Install the NEW turn signal cancel cam (1) to the back of the SIR coil assembly (2).

Installation Procedure



1. Install the SIR coil assembly to steering column retaining screws (1).

   Tighten
   Tighten the screws to 1 Nm (9 lb in).



2. Connect the SIR coil assembly connectors, (1) to (2).
3. Install the wipers/washer switch. Refer to Windshield Wiper and Washer Switch Replacement .
4. Install the cruise control switch. Refer to Turn Signal Switch Replacement .
5. Remove the SIR coil assembly securing tape.
6. Install the steering column trim covers. Refer to Steering Column Trim Covers Replacement .
7. Install the steering wheel. Refer to Steering Wheel Replacement .
8. Install the inflatable restraint steering wheel module to the steering wheel. Refer to Inflatable Restraint Steering Wheel Module Replacement .
9. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .
10. Enable the SIR system. Refer to SIR Disabling and Enabling .
11. Calibrate the steering angle sensor. Refer to Steering Angle Sensor Centering .

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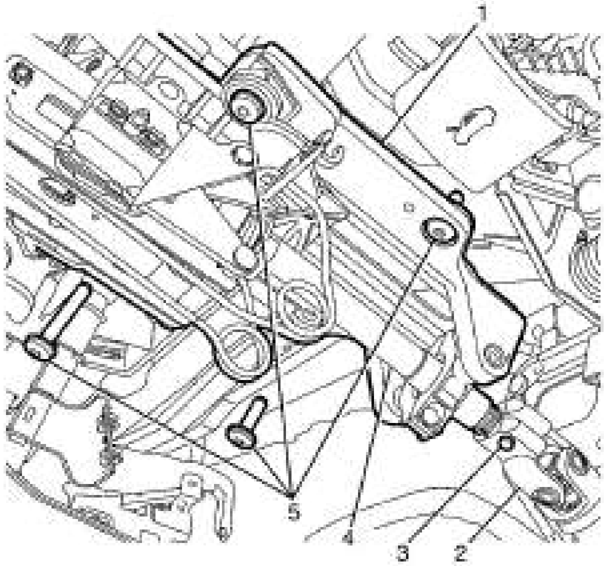
Steering Column Replacement (RHD)

Removal Procedure

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection .

   Caution: Refer to SIR Caution in the Preface section.

2. Disable the SIR system. Refer to SIR Disabling and Enabling .
3. Remove the inflatable restraint steering wheel module. Refer to Inflatable Restraint Steering Wheel Module Replacement .
4. Remove the steering wheel. Refer to Steering Wheel Replacement .
5. Remove the steering column trim covers. Refer to Steering Column Trim Covers Replacement .
6. Remove the theft deterrent exciter module. Refer to Theft Deterrent Module Replacement .
7. Remove the turn signal switch. Refer to Turn Signal Switch Replacement .
8. Remove the wipers/washer switch. Refer to Windshield Wiper and Washer Switch Replacement .
9. Remove the inflatable restraint steering wheel module coil. Refer to Inflatable Restraint Steering Wheel Module Coil Replacement .
10. Remove the ignition switch. Refer to Ignition and Start Switch Replacement .
11. Remove the driver side instrument panel lower trim panel assembly. Refer to Knee Bolster Replacement .
12. Remove the driver side instrument panel lower right trim plate assembly. Refer to Instrument Panel Outer Trim Cover Replacement .
13. Remove the driver side instrument panel lower trim panel retainer. Refer to Instrument Panel Retainer Replacement .
14. Remove the driver side floor air outlet duct. Refer to Instrument Panel Outer Air Outlet Deflector Replacement - Right Side .



Important: Observing the orientation of the steering column shaft (4) with reference to the intermediate steering shaft (2) will minimise the potential of incorrect steering column assembly alignment.

15. Mark the steering column shaft (4) in relation to the intermediate steering shaft (2).

    Important: Secure the steering wheel to prevent rotation otherwise damage to the SIR coil will occur.

    Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

16. Remove the steering column shaft to intermediate steering shaft retaining bolt (3).

    Discard the bolt.

17. Disconnect the steering column shaft (4) from the intermediate steering shaft (2).

    Important: The steering column assembly (1) must be supported before removing the steering column assembly to body retaining bolts (5).

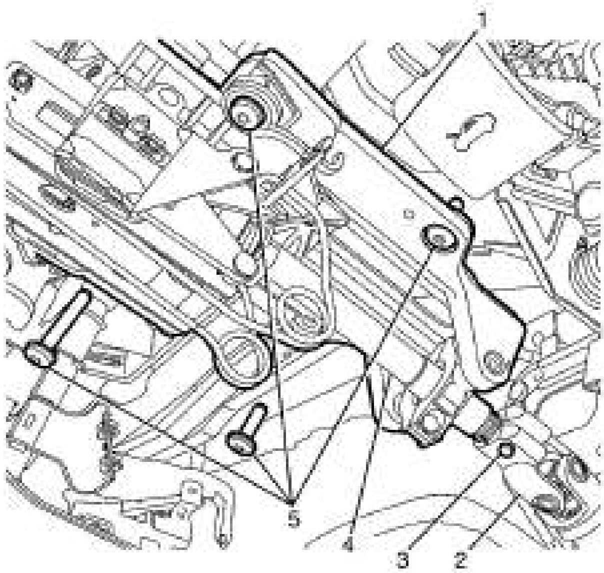
    Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

18. Remove the steering column assembly to body retaining bolts (5).

    Discard the bolts.

19. Remove the steering column assembly (1).

Installation Procedure



Important: The steering column shaft (4) and intermediate shaft (2) splines must be installed in the position recorded during removal and aligned with the marks previously made.

1. Connect the steering column shaft (4) to the intermediate shaft (2).
2. Install the steering column assembly (1) to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the NEW steering column assembly to body retaining bolts (5).

   Tighten
   Tighten the bolts to 22 N·m (16 lb ft).

4. Install the NEW steering column shaft to intermediate steering shaft retaining bolt (3).

   Tighten
   Tighten the bolt to 28 N·m (21 lb ft).

5. Install the driver side floor air outlet duct Instrument Panel Outer Air Outlet Deflector Replacement - Right Side .
6. Install the driver side instrument panel lower trim panel retainer. Refer to Instrument Panel Retainer Replacement .
7. Install the driver side instrument panel lower right trim plate assembly. Refer to Instrument Panel Outer Trim Cover Replacement .
8. Install the driver side instrument panel lower trim panel assembly. Refer to Knee Bolster Replacement .
9. Install the ignition switch. Refer to Ignition and Start Switch Replacement .
10. Install the inflatable restraint steering wheel module coil. Refer to Inflatable Restraint Steering Wheel Module Coil Replacement .
11. Install the wipers/washer switch. Refer to Windshield Wiper and Washer Switch Replacement .
12. Install the turn signal switch replacement. Refer to Turn Signal Switch Replacement .
13. Install the theft deterrent exciter module. Refer to Theft Deterrent Module Replacement .
14. Install the steering column trim covers. Refer to Steering Column Trim Covers Replacement .
15. Install the steering wheel. Refer to Steering Wheel Replacement .
16. Install the inflatable restraint steering wheel module. Refer to Inflatable Restraint Steering Wheel Module Replacement .
17. Enable the SIR system. Refer to SIR Disabling and Enabling .

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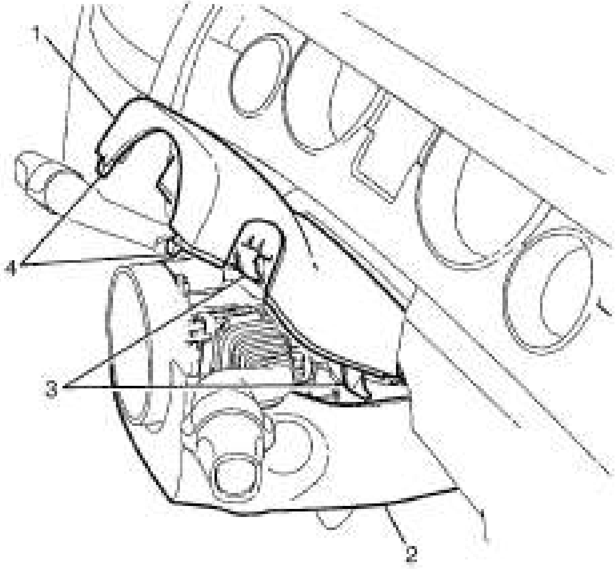
Steering Column Trim Cover Replacement (RHD)

Removal Procedure

Caution: Refer to SIR Caution in the Preface section.

1. Disable the SIR system. Refer to SIR Disabling and Enabling .
2. Remove the steering wheel. Refer to Steering Wheel Replacement .



Important: Note original position of the steering wheel and column assembly with regards to steering wheel height and reach.

3. Release the steering column tilt lever.

   Fully lower the steering wheel and column assembly.

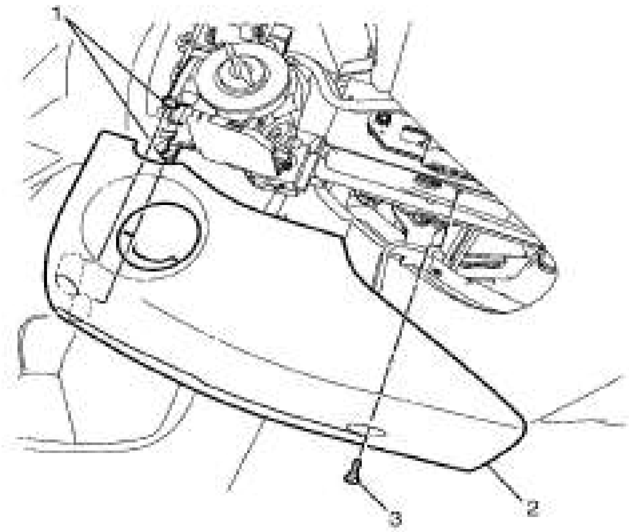
   Important: Do not use excessive force to separate the steering column trim covers.

   Important: Press the steering column upper trim cover lower edge towards the front of the vehicle and lift in order to disengage the front locking tabs (4).

4. Unclip the face of the steering column upper trim cover (1) from the steering column lower trim cover (2).

   Important: Lift the steering column upper trim cover face and pull towards the rear of the vehicle in order to disengage the rear locking tabs (3).

5. Remove the steering column upper trim cover (1).



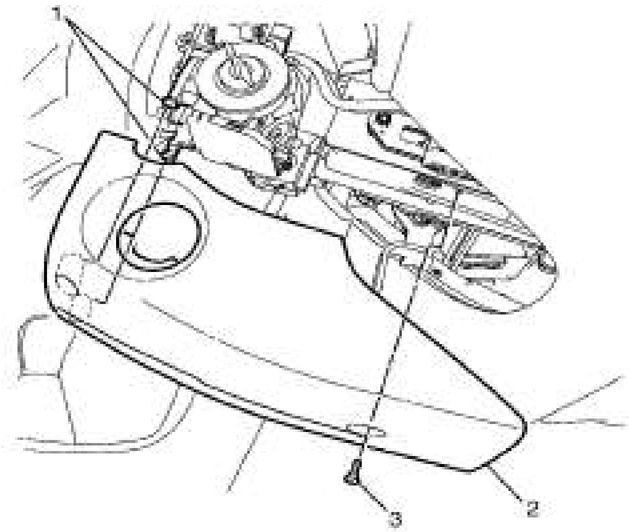
6. Remove the steering column lower trim cover to steering column assembly retaining screw (3).

   Important: Do not use excessive force to separate the steering column lower trim cover from the mounting tabs (1).

   Important: Pull the steering column lower trim cover (2) towards the rear of the vehicle in order to disengage the mounting tabs (1).

7. Remove the steering column lower trim cover (2).

Installation Procedure



Important: Do not use excessive force to mount the steering column lower trim cover (2) to the mounting tabs (1).

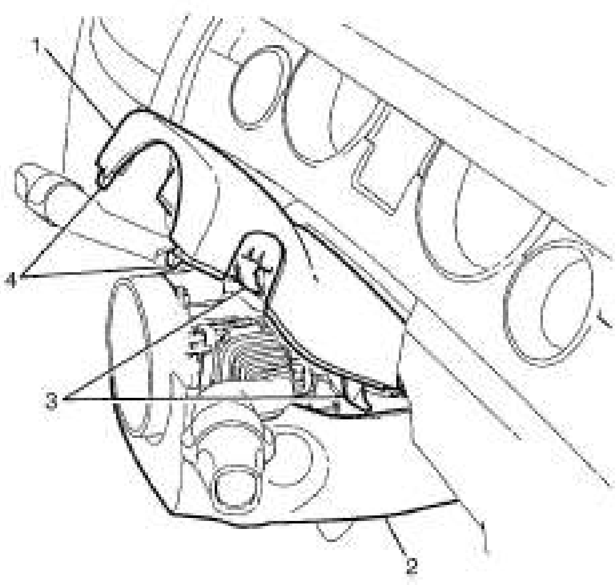
Important: Lift the column lower trim cover and press towards the front of the vehicle in order to engage the mounting tabs (1).

1. Install the steering column lower trim cover (2).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the steering column lower trim cover to steering column assembly retaining screw (3).

   Tighten
   Tighten the screw to 2 N·m (18 lb in).



Important: Do not use excessive force to secure the steering column upper trim cover (1).

Important: Lower the steering column upper trim cover (1) and push towards the front of the vehicle in order to engage the rear locking tabs (3).

3. Install the steering column upper trim cover (1).

   Important: Press down on the steering column upper trim cover front face in order to clip the front locking tabs (4) to the steering column lower trim cover (2).

4. Clip the face of the steering column upper trim cover (1) to the steering column lower trim cover (2).

5. Install the steering wheel. Refer to Steering Wheel Replacement .
6. Set the steering wheel and column assembly to the original position and lock the steering column tilt lever.
7. Enable the SIR system. Refer to SIR Disabling and Enabling .

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Steering Wheel Replacement (RHD)

Tools Required

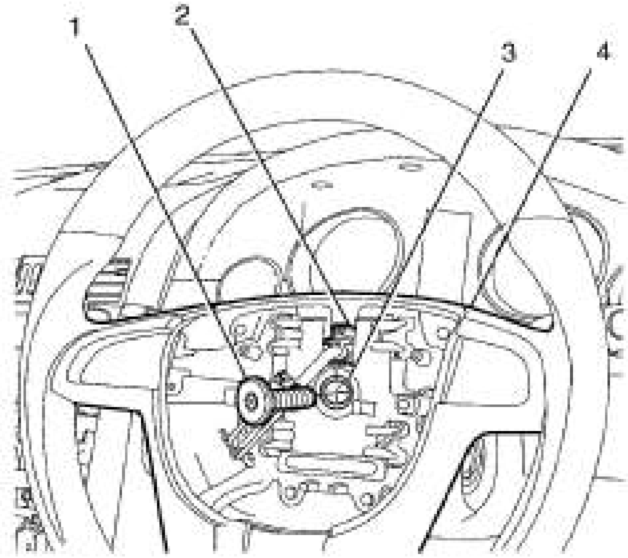
7245 Steering Wheel Puller.

Removal procedure

1. Disconnect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.

   Caution: Refer to SIR Caution in the Preface section.

2. Disable the SIR system. Refer to SIR Disabling and Enabling.
3. Remove the inflatable restraint steering wheel module. Refer to Steering Wheel Inflatable Restraint Module Replacement.



4. Disconnect the steering wheel electrical connector (2).

   Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

5. Remove the steering wheel to steering column retaining bolt (1).
6. Discard the bolt.

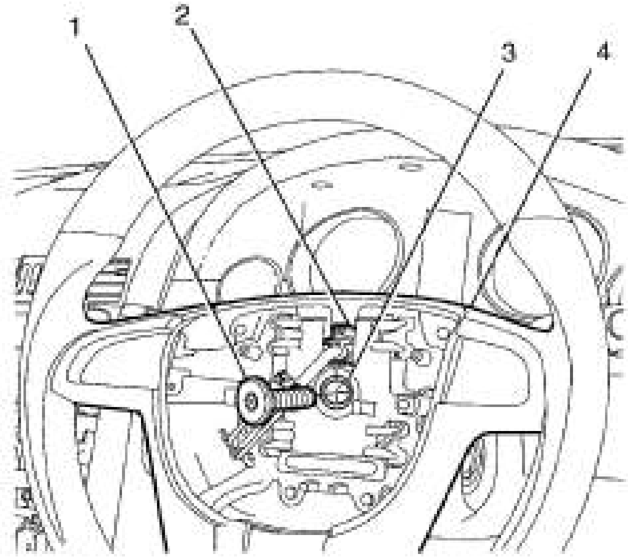
   Important: Observing the orientation of the steering wheel with reference to the steering column will minimise the potential of incorrect steering wheel alignment.

7. Mark the steering wheel (4) in relation to the steering column shaft (3).

   Important: The front wheels and steering wheel (4) must be in the straight ahead position before removing the steering wheel (4) from the steering column shaft (3).

8. Remove the steering wheel (4) from the steering column shaft (3). If necessary use the 7245 Steering Wheel Puller.

Installation Procedure



Important: The steering wheel and steering column shaft splines must be installed in the position recorded during removal and aligned with the marks previously made.

1. Install the steering wheel (4) to the steering column shaft (3).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the NEW steering wheel to steering column shaft retaining bolt (1).

   Tighten
   Tighten the bolt to 45 N·m (33 lb ft).

3. Connect the steering wheel electrical connector (2).
4. Install the inflatable restraint steering wheel module to the steering wheel. Refer to Steering Wheel Inflatable Restraint Module Replacement.
5. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection.
6. Enable the SIR system. Refer to SIR Disabling and Enabling.

Tilt Lever Replacement

The tilt lever is an integral part of the steering column and must only be replaced as a complete assembly. Refer to Steering Column Replacement.

Steering Wheel and Column Description and Operation

The steering wheel and column has 4 primary functions:

- Vehicle steering
- Vehicle security
- Driver convenience
- Driver safety

Vehicle Steering

The steering wheel is the first link between the driver and the vehicle. The steering wheel is fastened to a steering shaft within the column. At the lower end of the column, the intermediate shaft connects the column to the steering gear.

Vehicle Security (If Equipped)

Theft deterrent components are mounted and designed into the steering column. The following components allow the column to be locked in order to minimize theft:

- The ignition switch--location varies
- The steering column lock--content varies
- The ignition cylinder--location varies
- The theft deterrent module--location varies

Driver Convenience

The steering wheel and column also features driver controls attached for convenience and comfort. The following controls are mounted on or near the steering wheel or column.

- The turn signal switch
- The wiper/washer switch
- The horn pad/cruise control switch
- The redundant radio/entertainment system controls
- The manual/power tilt or tilt/telescoping functions
- The navigation

Driver Safety

The steering wheel and column has safety features to protect the driver. The following components may be mounted on or near the steering column:

Energy-Absorbing Steering Column: The energy-absorbing steering column compresses in the event of a front-end collision, which reduces the chance of injury to the driver. The energy-absorbing feature, collapsible steering shaft, and break away mounting features help reduce the injury in the event of an accident. In addition to these features, the following driver safety features may be on the steering column.

Electronic Park Lock (EPL) / Ignition Lock Cylinder Control Actuator (If Equipped): If the vehicle is equipped with automatic transmission and a floor mounted console gear shift, it has an ignition lock cylinder control actuator system in the steering column. The ignition lock cylinder control actuator purpose is to prevent the ignition key from being turned to the OFF position when the transmission is in any position other than PARK and the vehicle may still be moving. The column ignition lock system consists of an ignition lock cylinder control actuator, and a park position switch that is located in the automatic transmission shift lock control switch. The ignition lock cylinder control actuator contains a pin that is spring loaded to mechanically prevent the ignition key cylinder from being turned to the lock position when the vehicle transmission is not in the PARK position. If vehicle power is lost, and/or the transmission is not in the PARK position the operator will not be able to turn the ignition key to the lock position and will not be able to remove the ignition key from the column.

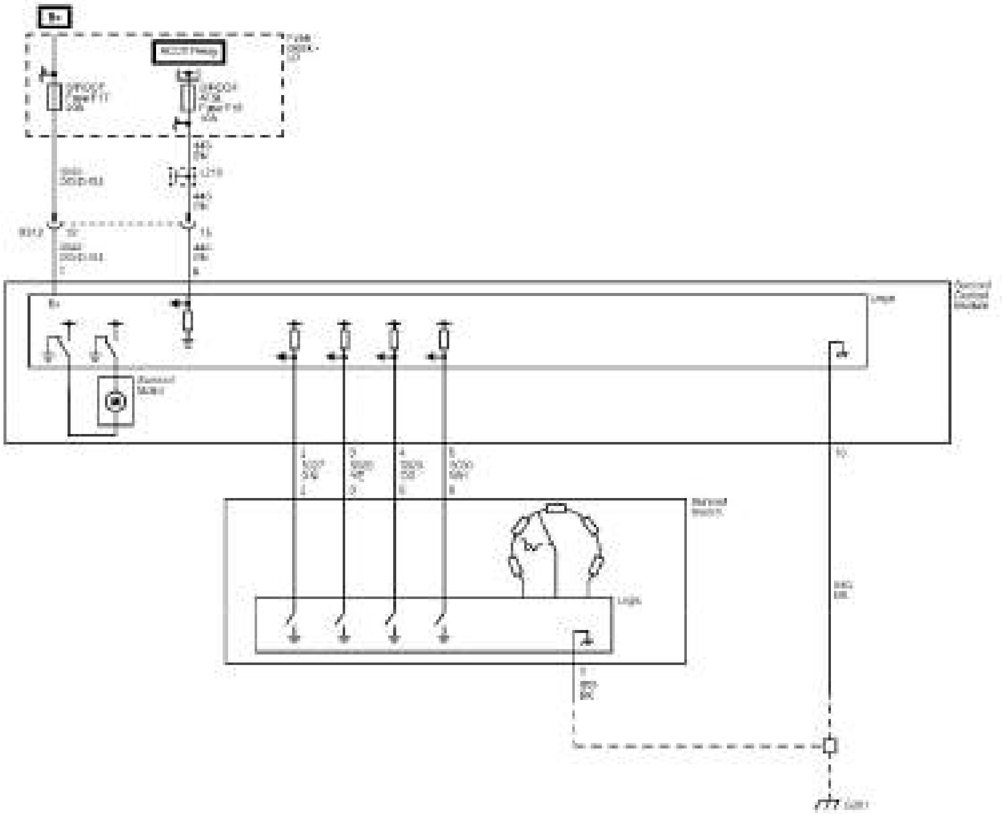
SIR Coil and Module: For additional information on the operation of the SIR coil and module, refer to SIR System Description and Operation.

Steering Wheel Angle Sensor or Steering Wheel Position Sensor : The steering wheel position sensor is located somewhere along the steering shaft assembly. The sensor measures the position of the steering wheel and the speed at which it is rotated. A signal representing this measurement is provided to the vehicle stability enhancement system (VSES) module. The VSES module uses this signal, along with several others representing different vehicle conditions, to monitor the driving behavior of the vehicle and ensure that it stays in control. If the VSES module determines that the vehicle is out of control it provides signals to the powertrain control module (PCM) and the ABS module. These output signals are used to modulate the transmission torque and brake pressure of each of the vehicles wheels in order to regain control of the vehicle.

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Sunroof Actuator Retaining Bolts	2 N·m	18 lb in
Sunroof Module to Roof Retaining Bolts	2 N·m	18 lb in
Sunroof Sunshade Stop Rubber Retaining Screws	1 N·m	9 lb in
Sunroof Window Retaining Screws	3 N·m	27 lb in

Sunroof Schematics


B+
Logic
Sunroof Motor
Sunroof Switch
Logic

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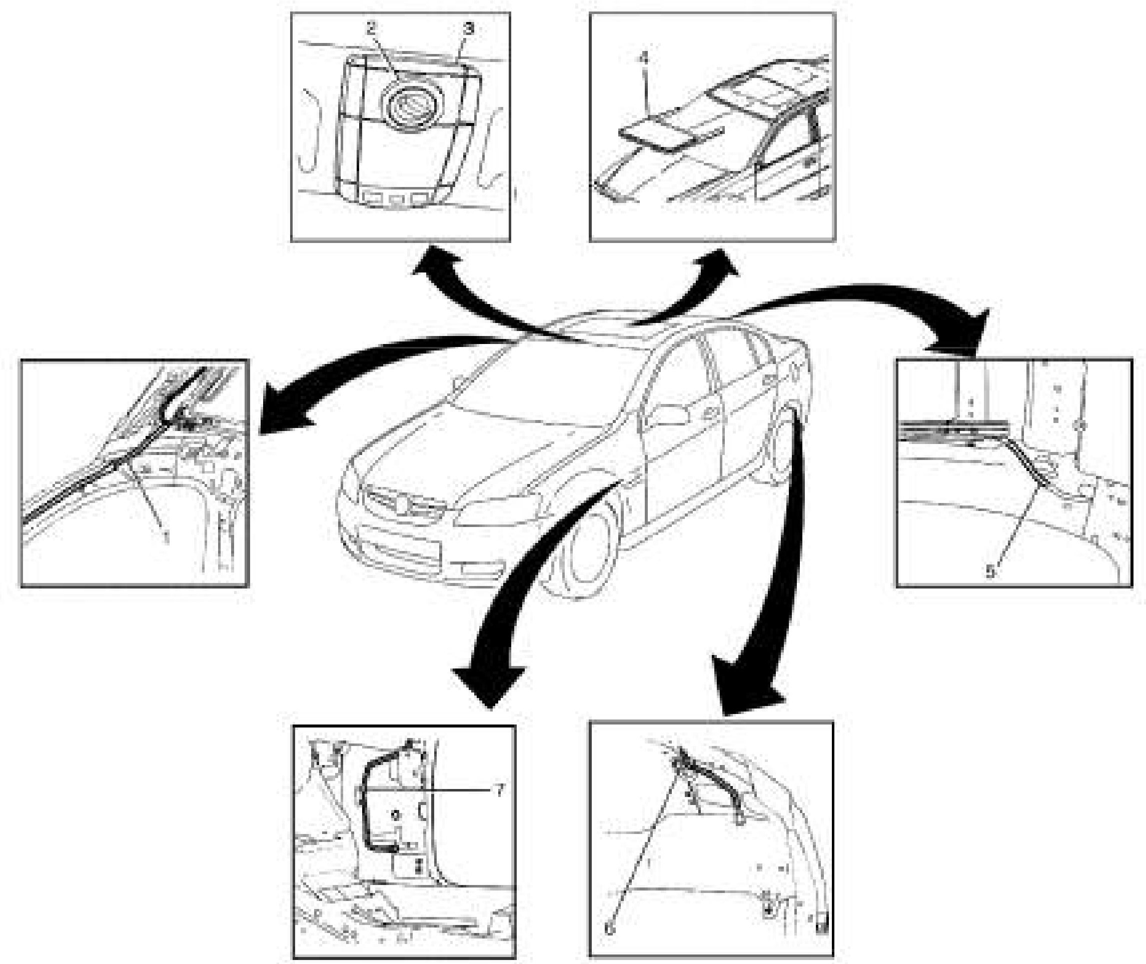
Sunroof Component Views (SWB)

Roof Subsystem Components



(1) Sunroof Housing Front Drain Hose (Upper)
(2) Sunroof Control Switch
(3) Overhead Console
(4) Sunroof Module
(5) Sunroof Housing Rear Drain Hose (Upper)
(6) Sunroof Housing Rear Drain Hose (Lower)
(7) Sunroof Housing Front Drain Hose (Lower)

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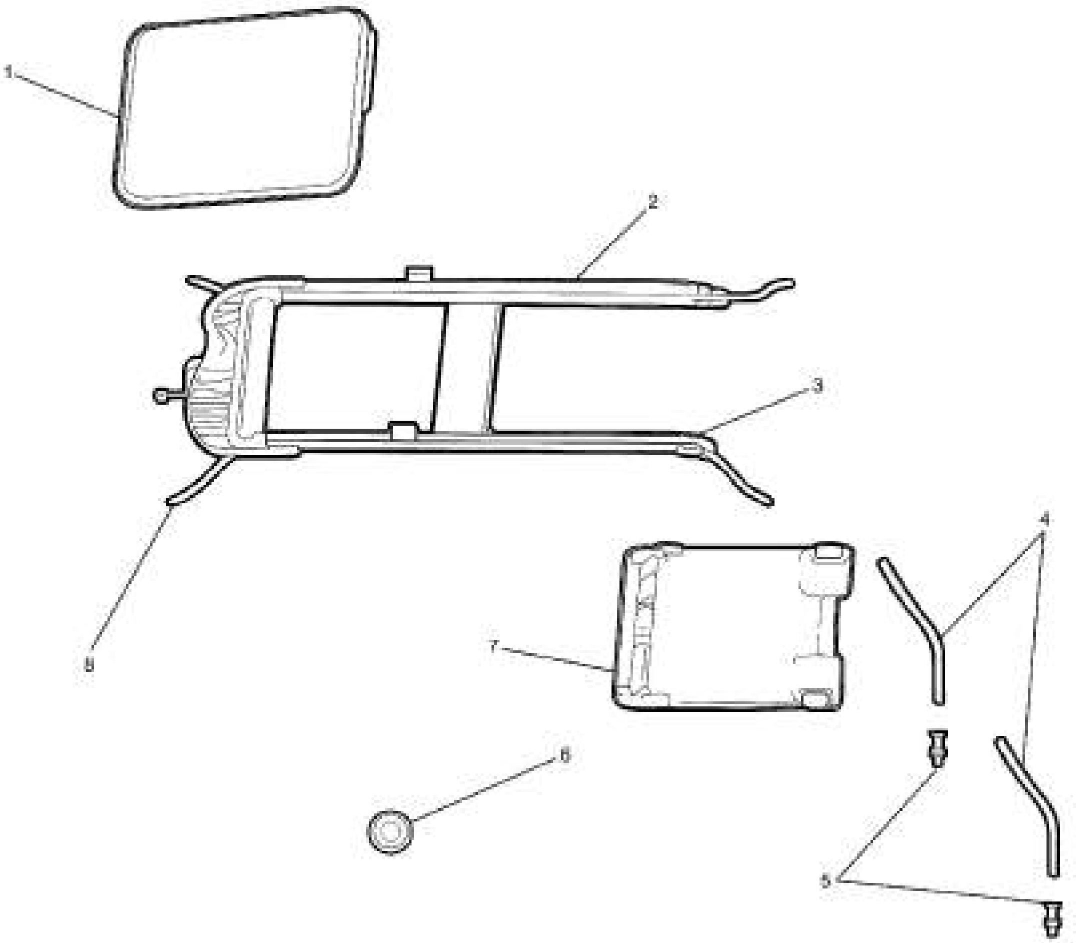
Power Sunroof Disassembled View

Sunroof Disassembled View



(1) Sunroof Window
(2) Sunroof Assembly
(3) Sunroof Housing Rear Drain Hose (Upper)
(4) Sunroof Housing Rear Drain Hose (Lower)
(5) Sunroof Drain Hose Grommet-Rear
(6) Sunroof Drain Hose Grommet-Front
(7) Sunroof Sunshade Panel
(8) Sunroof Housing Front Drain Hose (Upper)

Diagnostic Starting Point - Roof

Begin the system diagnosis with the Diagnostic System Check - Vehicle. The Diagnostic System Check will provide the following information:

- The identification of the control module(s) which command the system.
- The ability of the control module(s) to communicate through the serial data circuit.
- The identification of any stored diagnostic trouble codes (DTCs) and their status.

The use of the Diagnostic System Check will identify the correct procedure for diagnosing the system and where the procedure is located.

Symptoms - Roof

Important: Review the system operation in order to familiarize yourself with the system functions. Refer to Sunroof Description and Operation.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the Power Sunroof system. Refer to Checking Aftermarket Accessories.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect for mechanical binding.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

Power Sunroof Malfunction

Power Sunroof Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	1	1	--	--
Ignition	1	1	2	--
Signal Terminal 5	1	1	1*	--
Signal Terminal 4	1	1	1*	--
Signal Terminal 3	1	1	1*	--
Signal Terminal 2	1	1	1*	--
Sunroof Switch Ground	--	1	--	--
Sunroof Control Module Ground	--	1	--	--
* Internal damage to the sunroof switch may occur if shorted to B+ 1. Power sunroof malfunction 2. Power sunroof operates with ignition OFF				

Circuit/System Description

The sunroof control module determines the sunroof motor direction based on the inputs received from the sunroof switch. The sunroof switch is a rotary dial type switch with four outputs, the sunroof switch data 1 through 4 signal circuits. The coded inputs to the sunroof control module will initiate a request to slide the sunroof window to a specific position. The sunroof control module supplies the corresponding switch data signal circuits with a 12-volt reference. When the ignition switch is in the ON position, voltage is applied to the sunroof control module via the electronic control unit and the S/ROOF 20A fuse located in the instrument panel fuse block.

Diagnostic Aids

If the sunroof is experiencing an intermittent inoperative condition, check the sunroof switch ground circuit for an open. If the sunroof switch ground circuit is open, the switch may take a redundant path to ground through the switch illumination circuit. When the lights are turned ON, the redundant path to ground is removed, and the sunroof will become inoperative.

Reference Information

Schematic Reference

Sunroof Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Sunroof Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Circuit/System Verification

1. With the sunroof in the closed position, turn the rotary dial switch clockwise through each of the open slide positions. It should open in increments to the fully open position. When the rotary dial switch is brought back to the close position the sunroof should express close.
2. With the sunroof in the closed position, turn the rotary dial switch counter clockwise through each of the vent positions. It should vent open in increments to the fully vent open position. When the rotary dial switch is brought back to the close position the sunroof should express close.

Circuit/System Testing

Note: Portions of the circuit/system testing require removal of the headliner. It is suggested that the sunroof switch component test is performed prior to removing the headliner.

1. Ignition OFF, disconnect the harness connector at the sunroof control module.
2. Ignition OFF, test for less than 5 Ω between the ground circuit terminal 10 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.
3. Verify that a test lamp illuminates between the B+ circuit terminal 6 and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse is open, replace the sunroof control module.
4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 9 and ground.

   If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, replace the sunroof control module.
5. Ignition OFF, connect the harness connector at the sunroof control module.

6. Disconnect the harness connector at the sunroof switch.
7. Test for less than 5 Ω between the ground circuit terminal 1 and ground.
   If greater than the specified range, test the ground circuit for an open/high resistance.
8. Ignition ON, test for B+ between the signal circuit terminal 2 and ground.
   If less than the specified value, test for a short to ground or an open/high resistance. If the circuit tests normal, replace the sunroof control module.
9. Ignition ON, test for B+ between the signal circuit terminal 3 and ground.
   If less than the specified value, test for a short to ground or an open/high resistance. If the circuit tests normal, replace the sunroof control module.
10. Ignition ON, test for B+ between the signal circuit terminal 5 and ground.
   If less than the specified value, test for a short to ground or an open/high resistance. If the circuit tests normal, replace the sunroof control module.
11. Ignition ON, test for B+ between the signal circuit terminal 6 and ground.
   If less than the specified value, test for a short to ground or an open/high resistance. If the circuit tests normal, replace the sunroof control module.
12. If all circuits test normal, test or replace the sunroof switch.

Component Testing

Sunroof Switch

1. Ignition OFF, disconnect the harness connector at the sunroof switch.
2. Test for continuity between the terminals indicated for each position of the switch. The continuity should display as indicated in the test table.
   If not the specified value for all switch positions, test the appropriate signal circuit for a short to battery voltage. If all circuits test normal, replace the sunroof switch.

Switch Position	Terminal 1 & Terminal 2	Terminal 1 & Terminal 3	terminal 1 & Terminal 5	Terminal 1 & Terminal 6
Vent Position 3	0-200 Ω	Infinite	Infinite	Infinite
Vent Position 2	Infinite	0-200 Ω	Infinite	Infinite
Vent Position 1	0-200 Ω	0-200 Ω	Infinite	Infinite
Close	0-200 Ω	0-200 Ω	Infinite	0-200 Ω
Roof Position 1	Infinite	0-200 Ω	Infinite	0-200 Ω
Roof Position 2	Infinite	Infinite	Infinite	0-200 Ω
Roof Position 3	0-200 Ω	Infinite	Infinite	0-200 Ω
Roof Position 4	0-200 Ω	Infinite	0-200 Ω	0-200 Ω
Roof Position 5	Infinite	Infinite	0-200 Ω	0-200 Ω
Roof Position 6	Infinite	0-200 Ω	0-200 Ω	0-200 Ω

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Sunroof Switch Replacement
- Control Module References for sunroof motor/actuator replacement, setup, and programming

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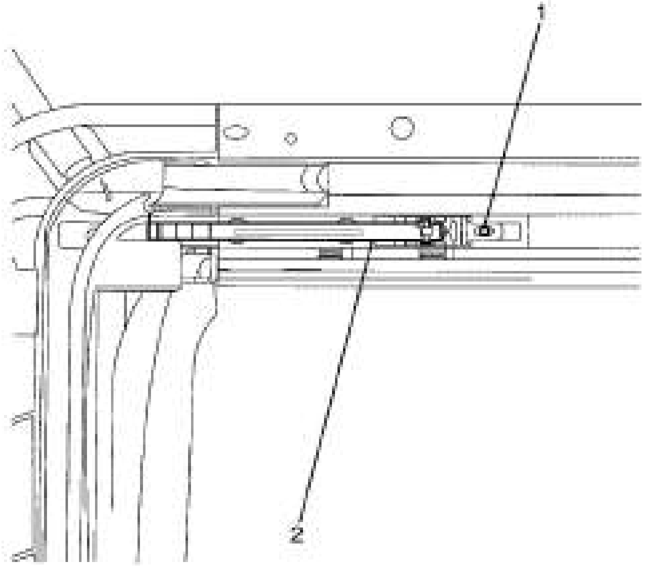
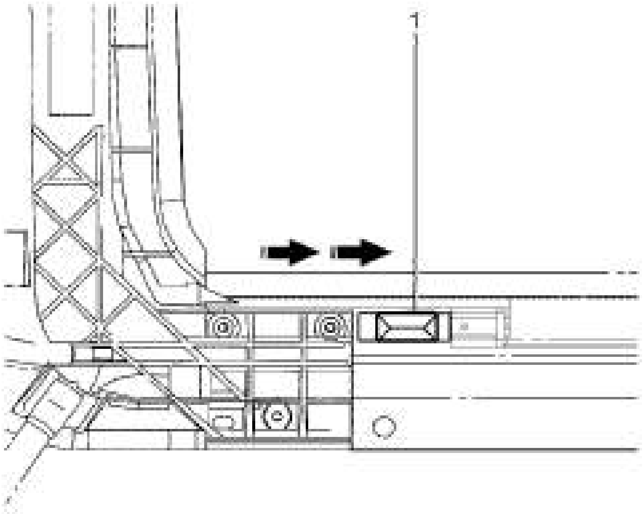
Sunroof Air Deflector Replacement

Removal Procedure

1. Cycle the sunroof window to the rear.



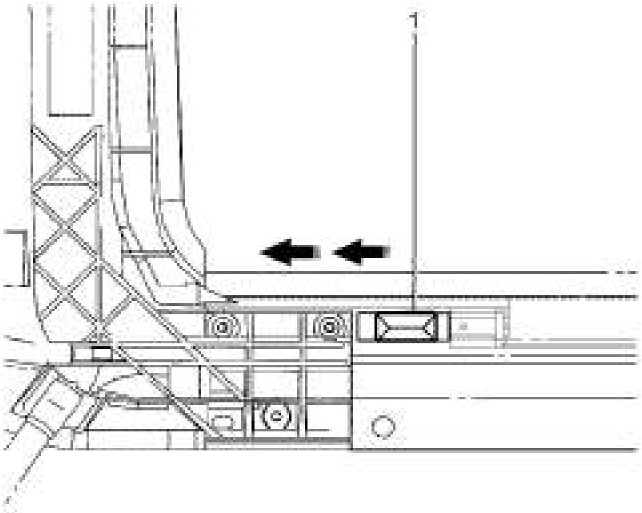
2. Remove the air deflector to sunroof module retaining bolt (1). Repeat for the opposite side.
3. Disconnect deflector spring (2) from the sunroof module. Repeat for opposite side.



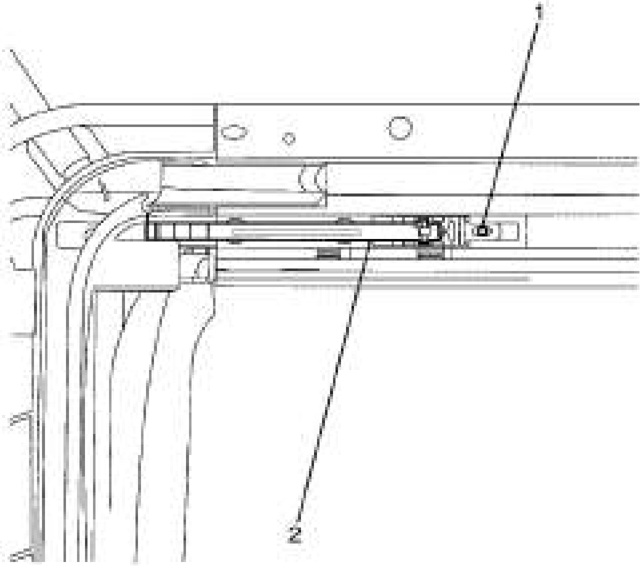
4. With the aid of an assistant, slide the air deflector towards the rear of the vehicle to disengage the retaining clips (1) of the sunroof module.
5. Remove the air deflector from the vehicle.

Installation Procedure

1. Install the air deflector to the sunroof module.



2. With the aid of an assistant, slide the air deflector towards the front of the vehicle to engage the retaining clips (1) of the sunroof module.
3. While holding the right side down push the left front side of the air deflector towards the right side.
4. Pull up on the left side until the lower tab (1) clears the roof opening.



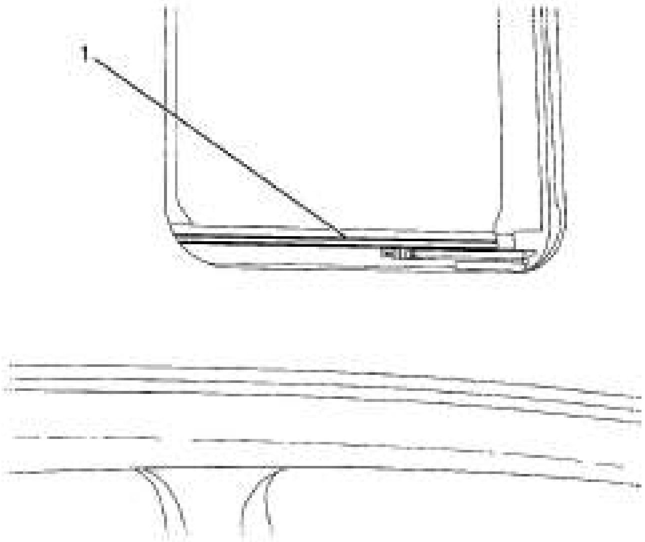
5. Connect the deflector spring (2) to the sunroof module. Repeat for opposite side.
6. Install the air deflector to sunroof module retaining bolt (1). Repeat for opposite side.

   Tighten
   Tighten the bolts to 1 N·m (9 lb in).

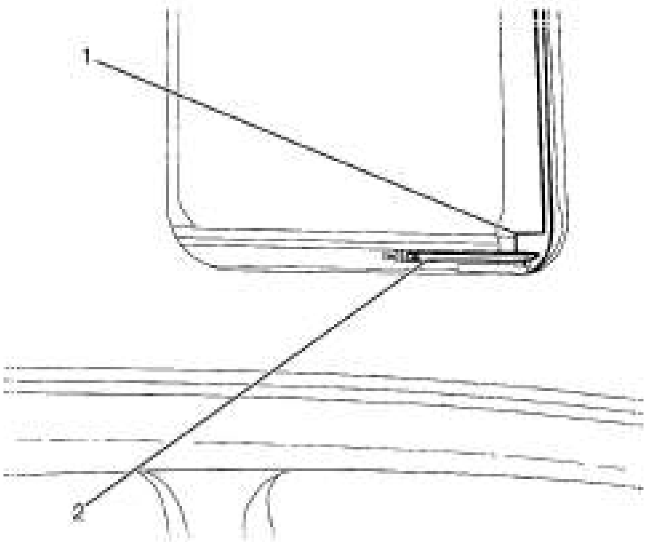
7. Push the left front side of the air deflector inwards and down so the tab clears the roof opening.
8. Close the sunroof window.

Sunroof Cleaning and Inspection

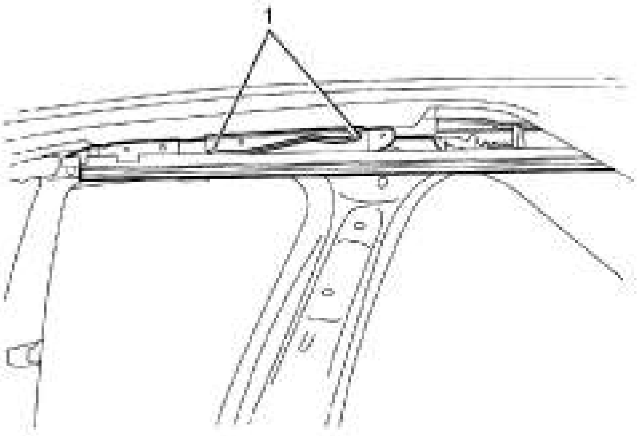
1. Open the sunshade to the full rearward position.
2. Cycle the sunroof window from the full closed to the full open position.
3. Remove the sunroof side panel cover. Refer to Sunroof Panel Side Opening Closeout Cover Replacement.



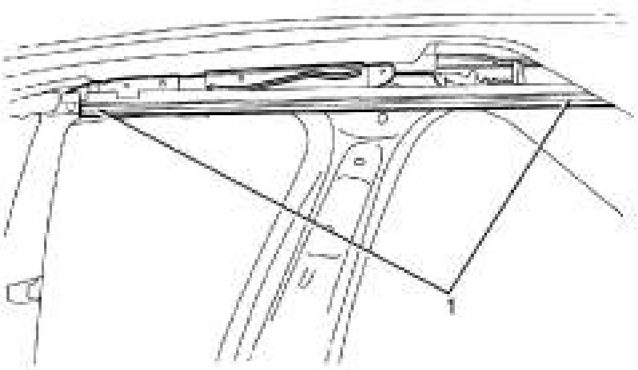
4. Remove the excess dirt from the sunroof runner guide (1).
5. Clean the sunroof drains. Refer to Sunroof Drain Inspection and Cleaning.



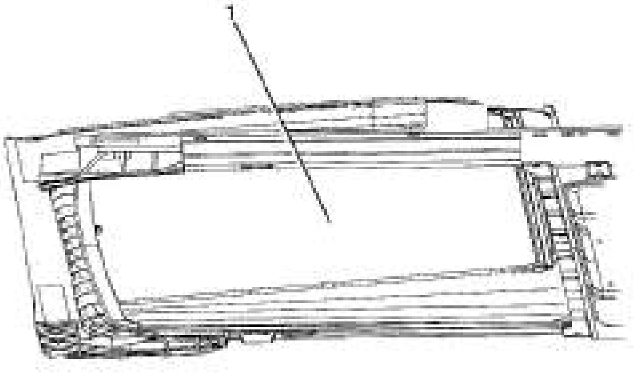
6. Remove the excess dirt around the sunroof air deflector (1) and sunroof air deflector spring (2).



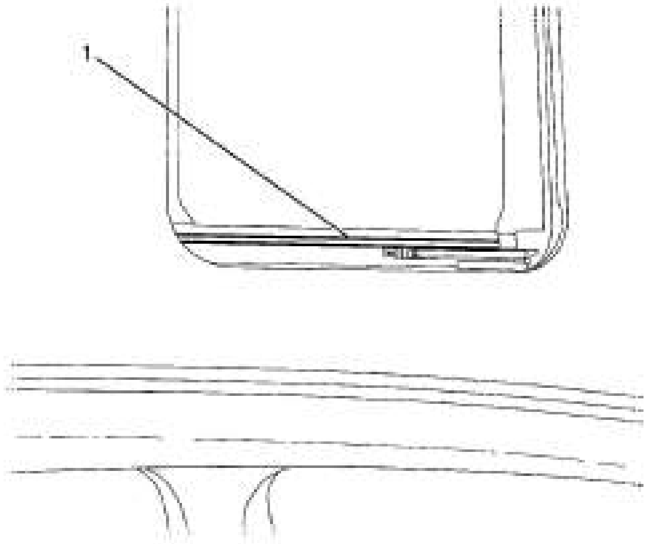
7. Remove the excess dirt around the sunroof glass guide (1).
8. Inspect the sunroof glass guide (1) for wear or deterioration of the sunroof mechanism.



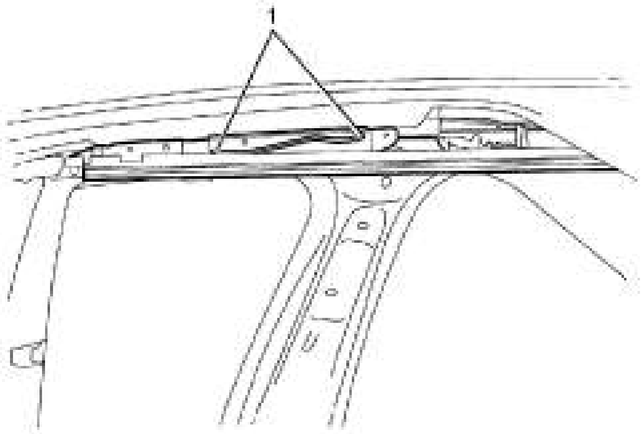
9. Remove the excess dirt from the sunroof shade panel runner (1).



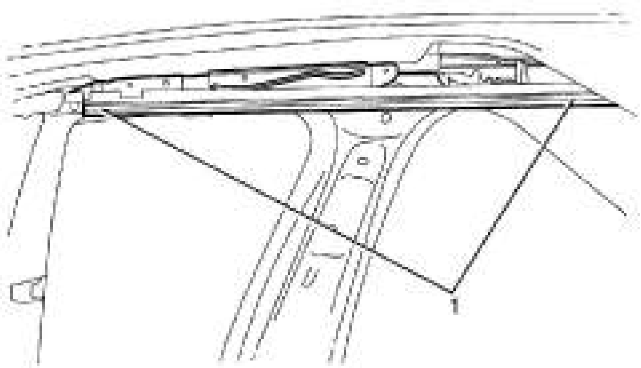
10. Clean the excess dirt around the sunroof glass (1).



11. Lubricate the sunroof runner guide (1) with an approved grease or equivalent.



12. Lubricate the sunroof glass guide (1) with an approved grease or equivalent.



13. Lubricate the sunroof shade panel runner (1) with an approved grease or equivalent.

Important: Before fitment of the sunroof side opening cover make sure that the cover is clean.

14. Install the sunroof side panel cover. Refer to Sunroof Panel Side Opening Closeout Cover Replacement.

Sunroof Control Module Replacement

Important: The sunroof control module is an integral part of the sunroof motor/actuator and must be replaced as an assembly. For replacement refer to Sunroof Motor/Actuator Replacement.

Sunroof Drain Inspection and Cleaning

Important: The drain hoses are pushed on as an interference fit and are not clamped or cemented. Do NOT disconnect the hose from the drain channel spouts while cleaning.

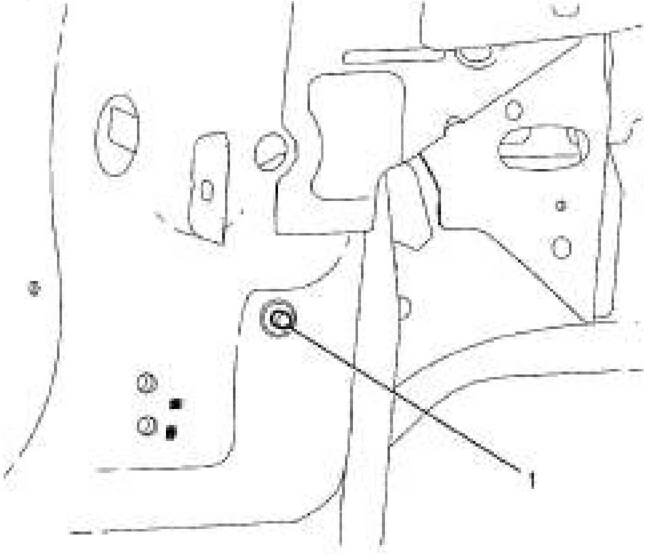
A drain trough encircles the sliding panel which leads to the drain spouts and into the hoses. The drain hoses are located at each corner of the housing. The two front drain hoses route down the windshield pillars and exit out the hinge pillars between the door hinges. The two rear drain hoses route down the quarter panels and exit the inner wheelhouse panels.

If you encounter a wet headliner or other water leak, inspect the following areas for the source of the leak:

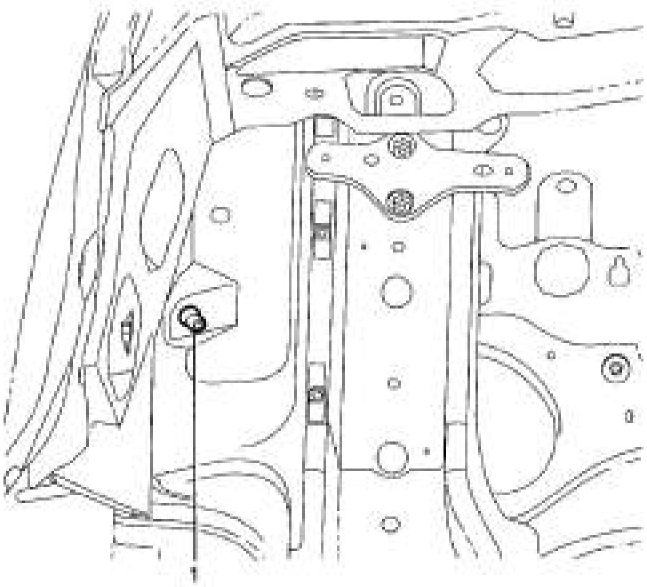
- The windshield
- The rear window

Verify the drainage system is not plugged or restricted. Use the following procedure:

1. With the sunroof open, using a one litre container, pour water into the drain trough.
2. Open the front doors.



3. Inspect for water drainage exiting through the grommets (1) at the hinge pillar.

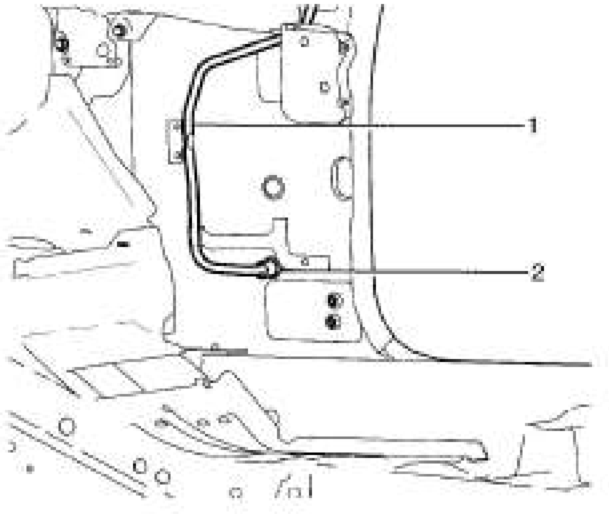


4. Look at the rear of the inner wheelhouse panels for water exiting the rear drain grommet (1).
5. If the water flow is restricted, use a low volume of compressed air in order to clear the drainage system.
6. Retest the system.
7. If water drips from the headliner above the doors, lower the headliner. Refer to Headlining Trim Panel Replacement. Inspect for proper drain tube connections at the housing drain spouts.
8. If necessary, secure the tubes onto the housing drain spouts.
9. If blockage is still present, replace the restricted drain hose. Refer to Sunroof Housing Front Drain Hose Replacement or Sunroof Housing Rear Drain Hose Replacement.

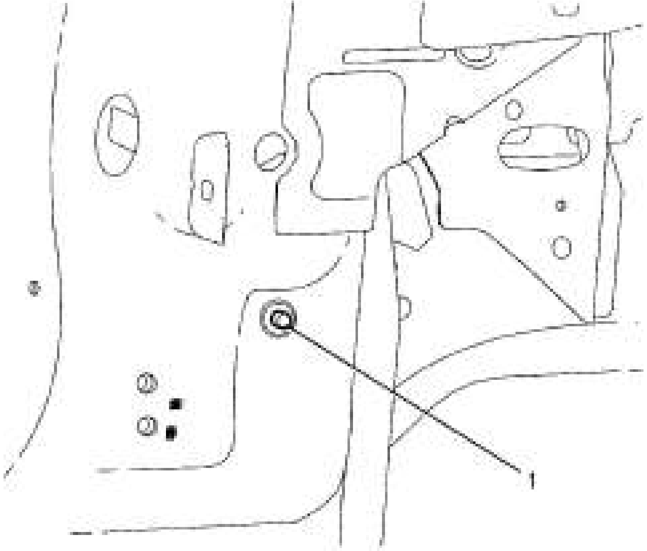
Sunroof Housing Front Drain Hose Replacement (Lower)

Removal Procedure

1. Remove the front fender. Refer to Front Fender Replacement.
2. Remove the hinge pillar trim panel. Refer to Body Hinge Pillar Trim Panel Replacement.



3. Disengage the drain tube (1) from the front sunroof grommet.



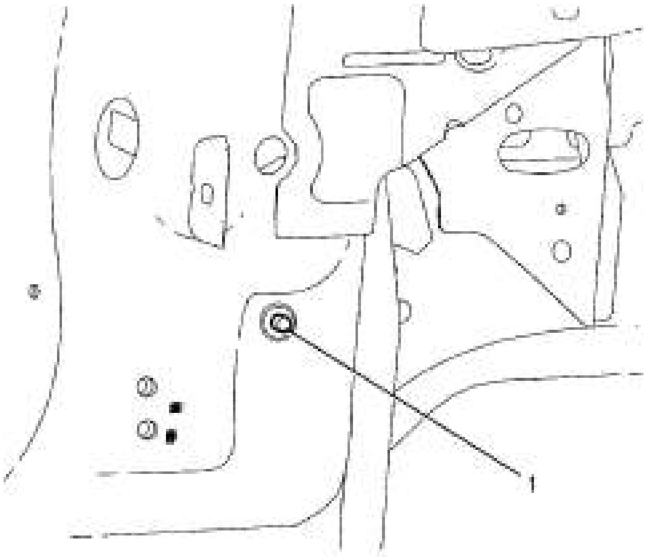
Important: Heat the front sunroof grommet to aid in removal.

4. Remove the front sunroof grommet (1) from the front hinge pillar.

   Discard the front sunroof drain grommet.

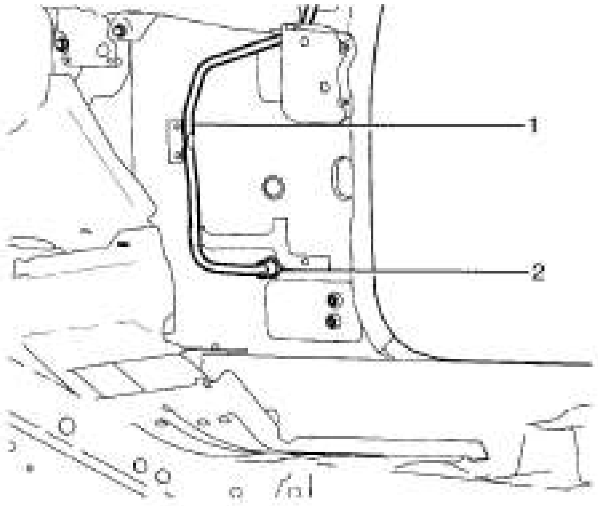
5. Scrape the remaining adhesive of the front sunroof grommet from the front hinge pillar.

Installation Procedure



1. Install the NEW front sunroof grommet (1) to the front hinge pillar.
2. Heat the front sunroof grommet to allow adhesion of the front sunroof grommet to the front hinge pillar.

   Important: The only suitable lubricant is clean water for the drain hose installation.



3. Connect the front lower drain tube (1) to the front sunroof grommet (2).
4. Inspect for proper drainage.
5. Install the hinge pillar trim panel. Refer to Body Hinge Pillar Trim Panel Replacement.
6. Install the front fender. Refer to Front Fender Replacement.

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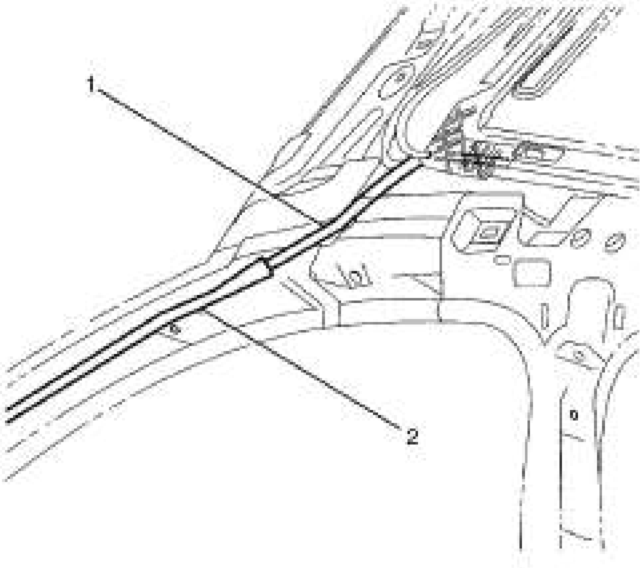
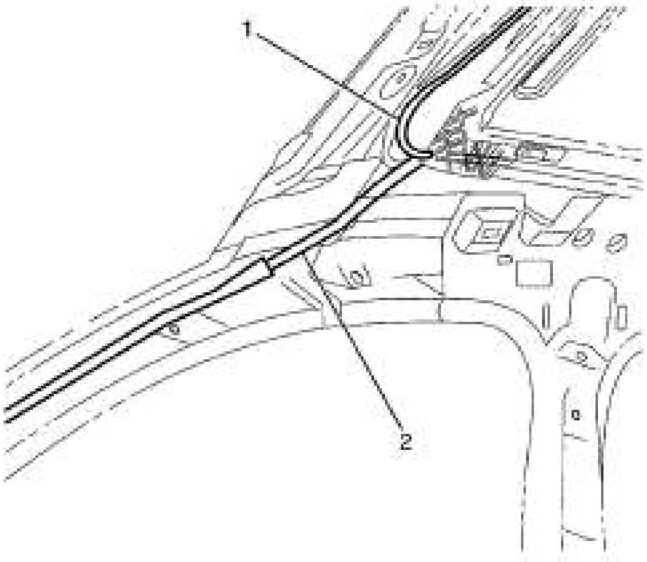
Sunroof Housing Front Drain Hose Replacement (Upper)

Removal Procedure

1. Remove the headliner. Refer to Headlining Trim Panel Replacement.



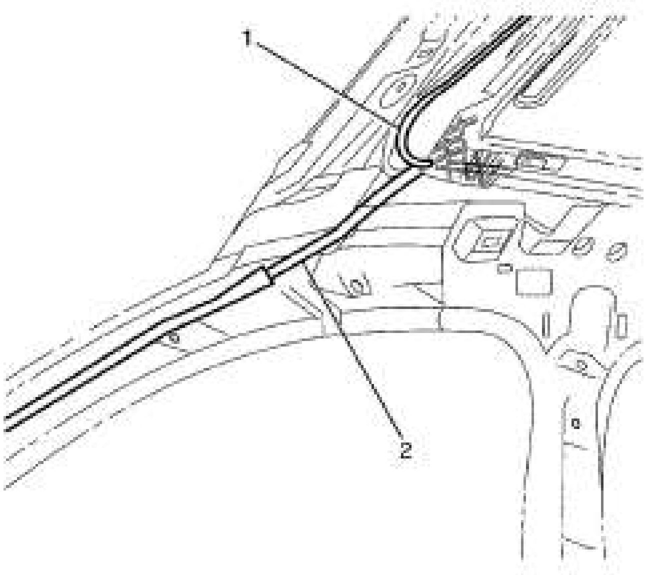
2. Disengage the front drain hose from the front drain tube (2).



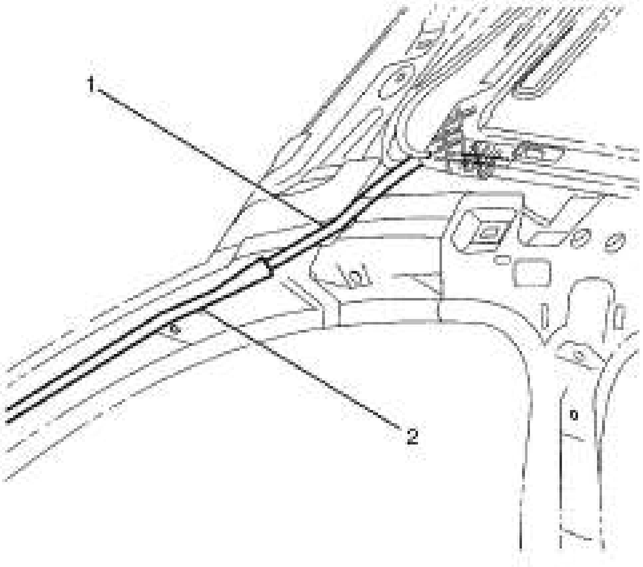
3. Disengage the front drain hose from the sunroof front drain spout (1).
4. Remove the front drain hose (2) from the vehicle.

Installation Procedure

Important: The only suitable lubricant is clean water for the drain hose installation.



1. Install the front drain hose (2) to the vehicle.
2. Connect the front drain hose to the sunroof front drain spout (1).

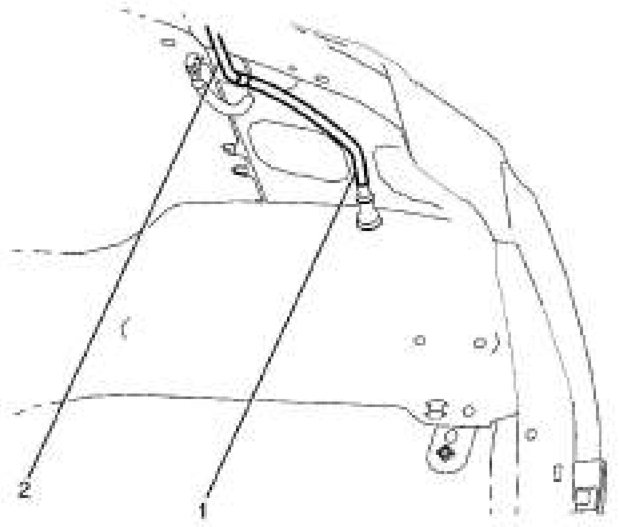


3. Connect the front drain hose to the front drain tube (1).
4. Inspect for proper drainage.
5. Install the headliner. Refer to Headlining Trim Panel Replacement.

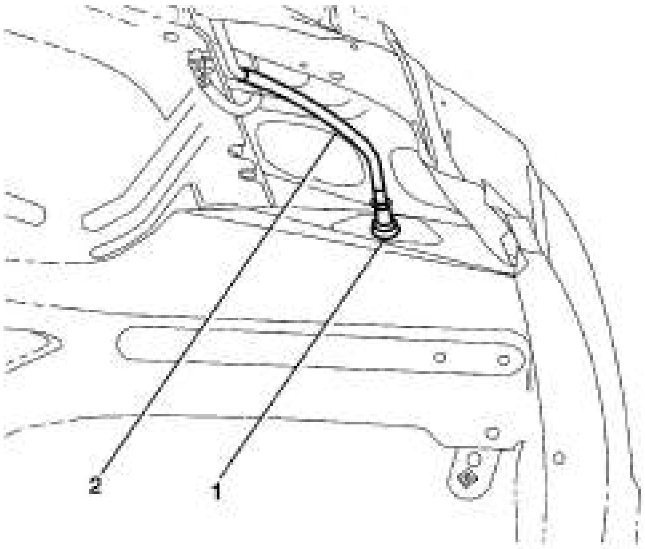
Sunroof Housing Rear Drain Hose Replacement (Lower)

Removal Procedure

1. Remove the rear compartment side trim panel. Refer to Rear Corner Trim Panel Carpet Replacement.



2. Disconnect the rear lower drain hose (1) from the rear drain tube (2).



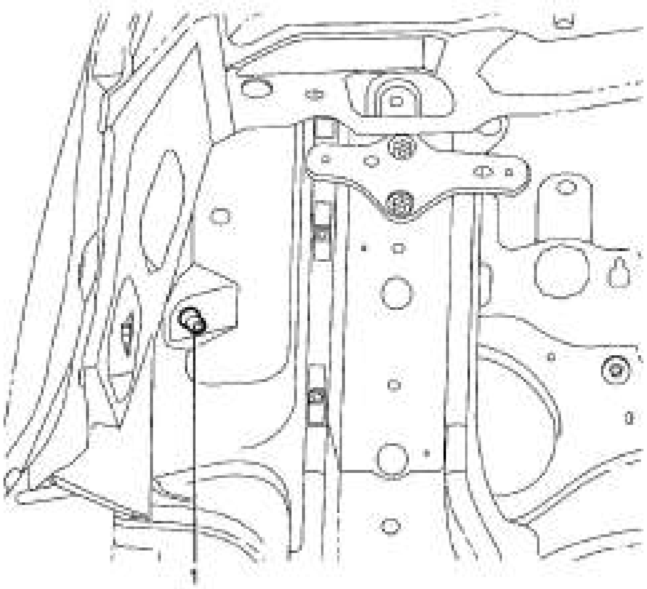
3. Disconnect the rear lower drain hose (2) from the rear drain hose grommet (1).
4. Remove the rear lower drain hose (2) from the vehicle.

Important: Heat the rear lower drain hose grommet to aid in removal.

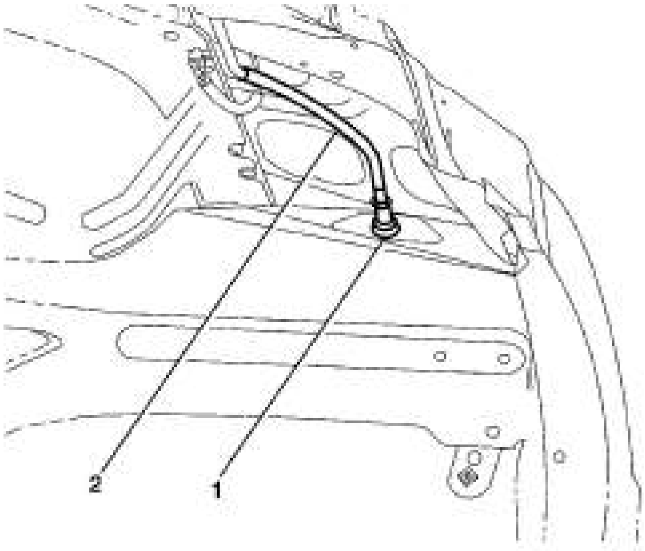
5. Remove the rear lower drain hose grommet (1) from the vehicle.
6. Scrape the remaining adhesive of the rear lower drain hose grommet from the rear inner wheelhouse.

Installation Procedure

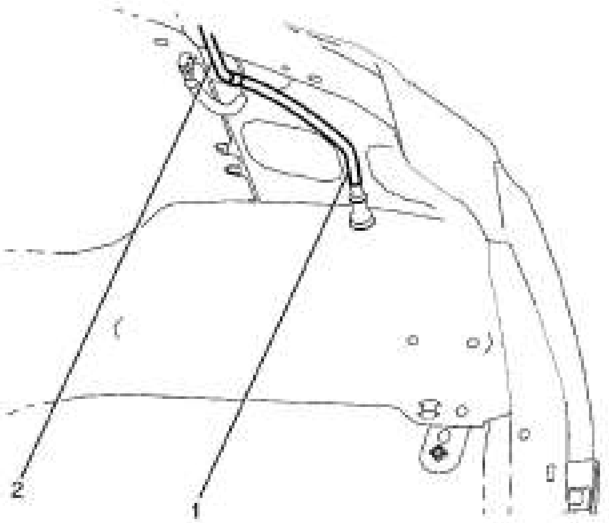
Important: The only suitable lubricant is clean water for the drain hose installation.



1. Install the rear lower drain hose grommet (1) to the rear inner wheelhouse.
2. Heat the rear lower drain hose grommet (1) to allow adhesion of the sunroof grommet to the rear inner wheelhouse.



3. Install the rear lower drain hose to the vehicle.
4. Connect the rear lower drain hose (2) to the rear lower drain hose grommet (1).



5. Connect the rear drain hose (1) to the rear drain tube (2).
6. Inspect for proper drainage.
7. Install the rear compartment side trim panel. Refer to Rear Corner Trim Panel Carpet Replacement.

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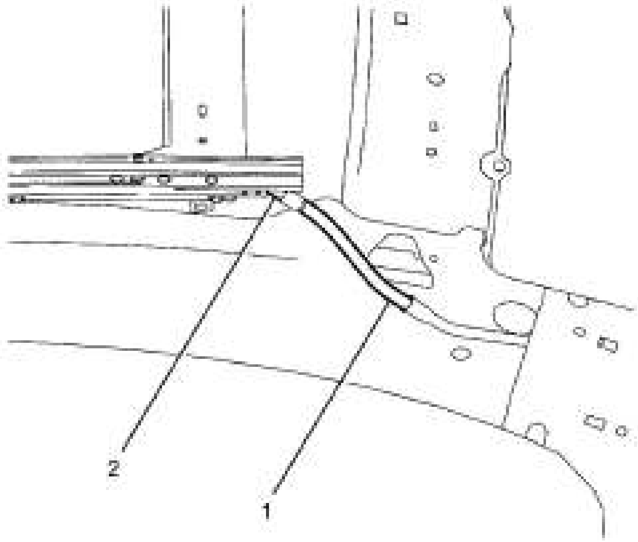
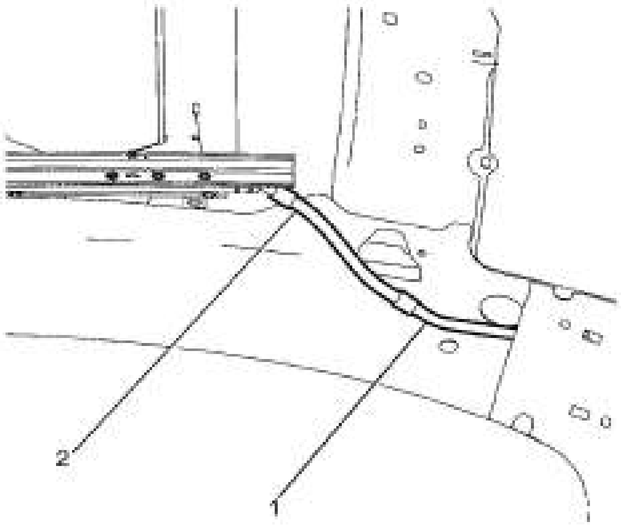
Sunroof Housing Rear Drain Hose Replacement (Upper)

Removal Procedure

1. Remove the rear quarter trim panel. Refer to Quarter Upper Trim Panel Replacement.
2. Remove the headliner in order to access the upper rear drain hose connections. Refer to Headlining Trim Panel Replacement.



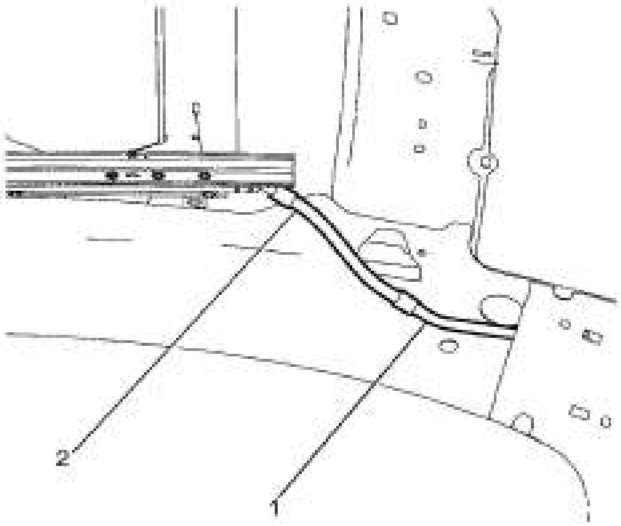
3. Disconnect the rear upper drain hose (1) from the sunroof spout (2).



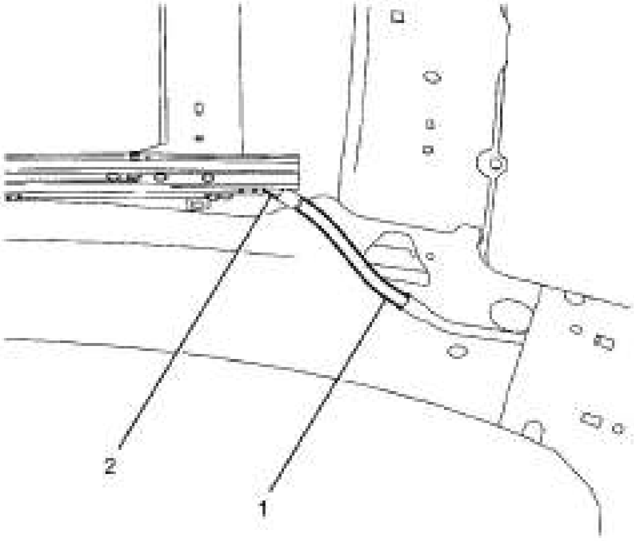
4. Disconnect the rear upper drain hose (2) from the rear drain tube (1).
5. Remove the rear upper drain hose (2) from the rear of the sunroof module.

Installation Procedure

Important: The only suitable lubricant is clean water for the drain hose installation.



1. Connect the rear upper drain hose (2) to the rear drain tube (1).



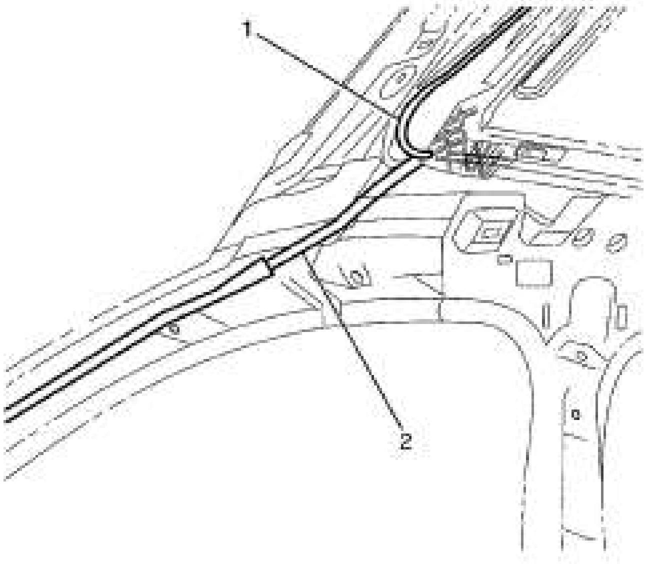
2. Connect the rear upper drain hose (1) to the sunroof spout (2).
3. Inspect for proper drainage.
4. Install the headliner with the aid of an assistant. Refer to Headlining Trim Panel Replacement.
5. Install the rear quarter trim panel. Refer to Quarter Upper Trim Panel Replacement.

Sunroof Module Assembly Replacement

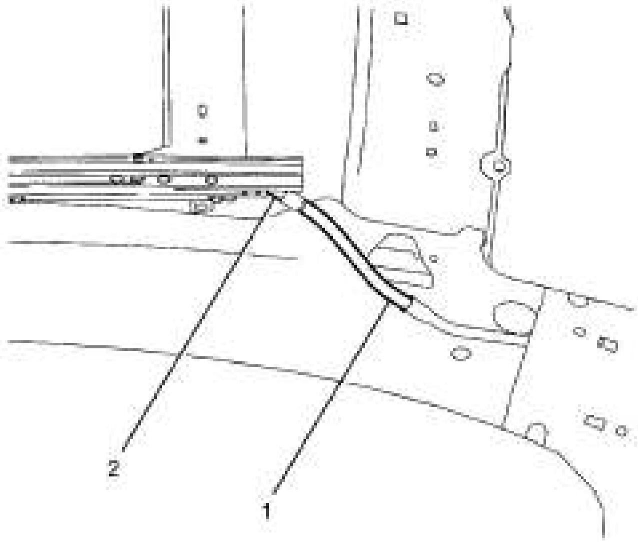
Removal Procedure

Important: A new sunroof module will not have the sunroof window or the sunshade as components of the new service part.

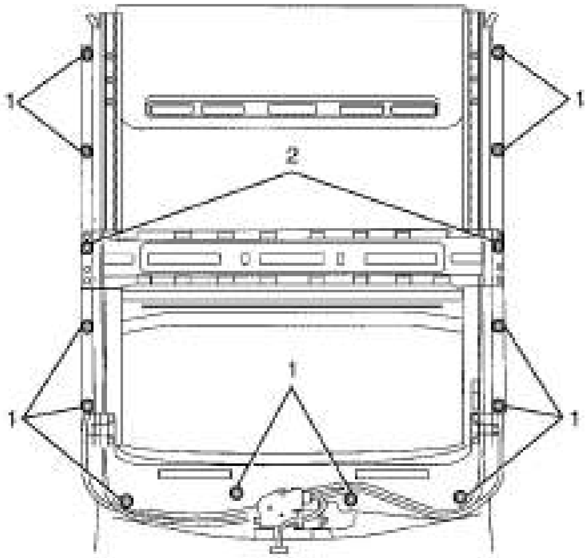
1. The old sunroof window and sunshade will need to be installed to the new sunroof module.
2. Remove the headliner. Refer to Headlining Trim Panel Replacement .



3. Disconnect the front drain hoses from the sunroof front drain spouts (1).



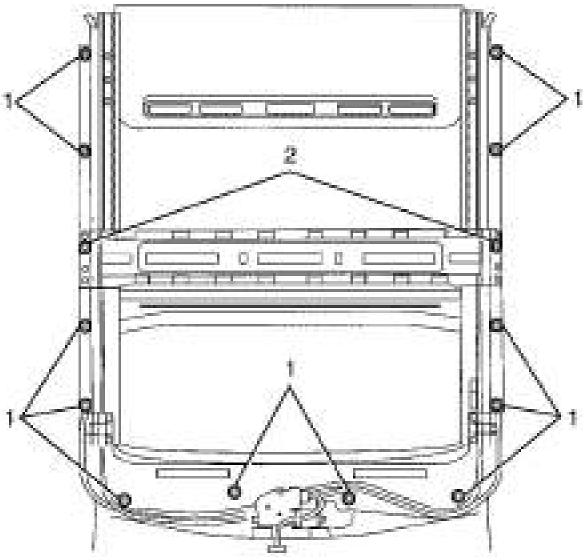
4. Disconnect the rear upper drain hoses (1) from the sunroof rear drain spouts (2).



5. Remove the sunroof module to roof ring retaining bolts (1).
6. Remove the two centre, side to side, bolts last in order to help support the sunroof module to the roof ring.
7. With the aid of an assistant, remove the last two sunroof module to roof ring retaining bolts.
8. With the aid of an assistant, lower and remove the sunroof module out the front passenger side door.
9. Remove the sunroof window. Refer to Sunroof Window Replacement .
10. Remove the sunshade panel. Refer to Sunroof Sunshade Replacement .
11. Remove the air deflector. Refer to Sunroof Air Deflector Replacement .

Installation Procedure

1. Install the air deflector. Refer to Sunroof Air Deflector Replacement .
2. Install the sunshade panel. Refer to Sunroof Sunshade Replacement .
3. Install the sunroof window and loosely install the retaining screws. Refer to Sunroof Window Replacement .

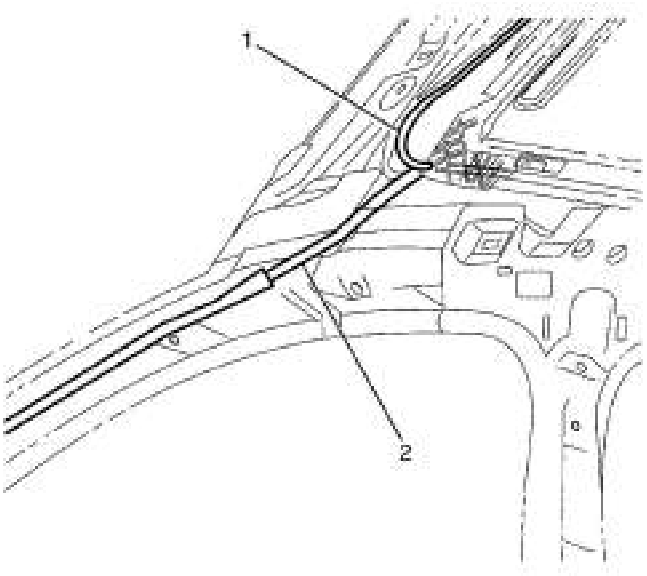


4. With the aid of an assistant, position the new sunroof module into the alignment pins (2) located on the roof ring.
5. Hand start the two centre, side to side, sunroof module to roof ring retaining bolts (1) in order to hold the sunroof module in place.
6. Finger tighten the two centre retaining bolts.

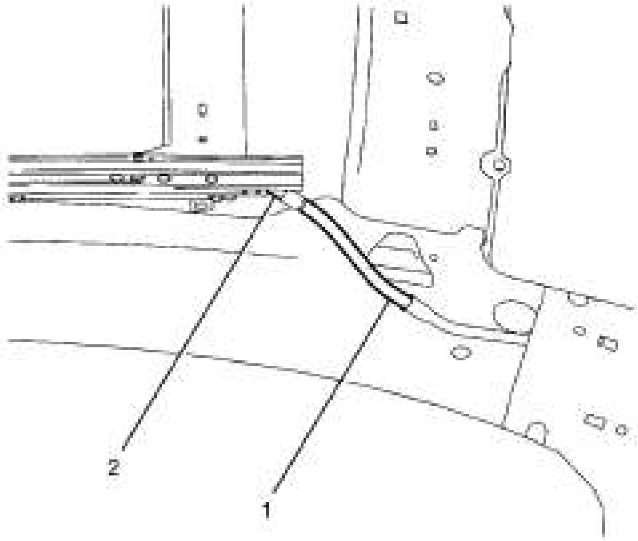
Notice: Refer to Fastener Notice in the Preface section.

7. Install the remaining sunroof module to roof ring retaining bolts (1).

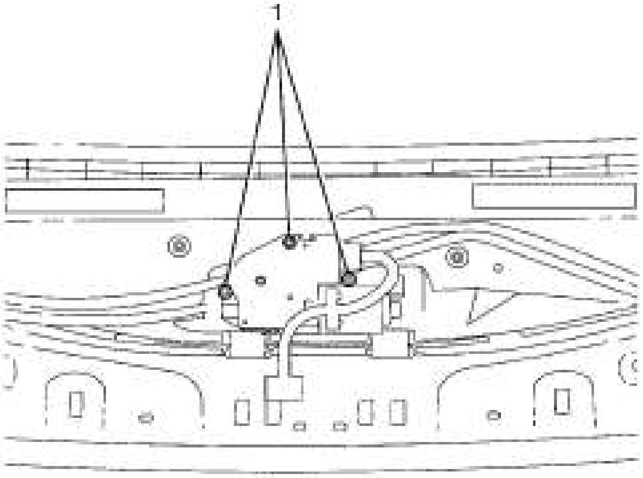
Tighten
Tighten the bolts to 2 N·m (18 lb in).



8. Connect the front drain hoses to the drain spouts (1).



9. Connect the rear drain hoses to the drain spouts (1).



10. Install sunroof motor/actuator to the module.
11. Install the motor/actuator to sunroof module retaining screws (1).

Tighten
Tighten all of the bolts to 2 N·m (18 lb in).

12. Connect the electrical connector to the sunroof motor/actuator.
13. Secure the harness with suitable straps.
14. Adjust the sunroof window. Refer to Sunroof Window Height and Opening Fit Adjustment .

15. If re-programming is required. Refer to Control Module References .
16. Verify the proper operation of the sunroof before securing the headliner.
17. Initilization /Teach the sunroof motor. Refer to Sunroof Motor/Actuator Synchronization .
18. Install the headliner, with an assistant. Refer to Headlining Trim Panel Replacement .

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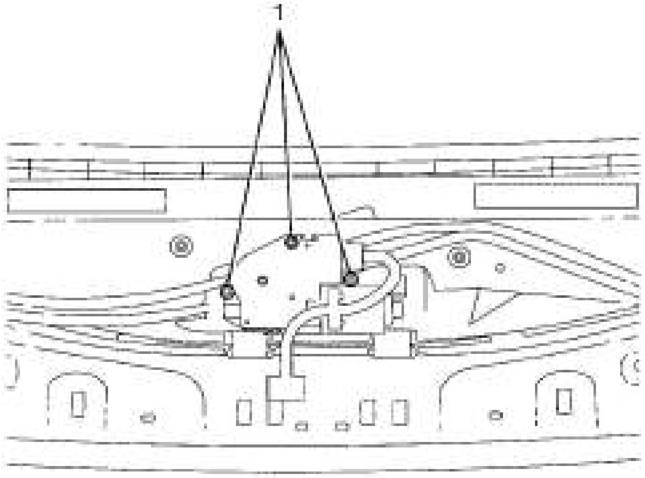
Sunroof Motor / Actuator Replacement

Removal Procedure

1. Lower the headliner to access the sunroof actuator. Refer to Headlining Trim Panel ReplacementHeadliner Replacement in Interior Trim.



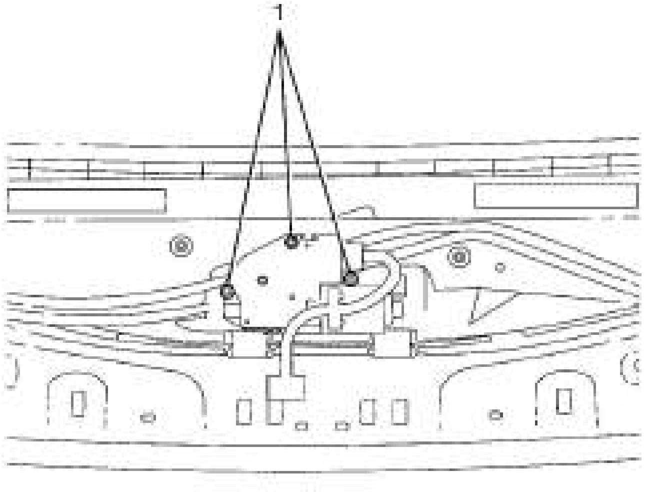
Important: If the sunroof window is partially closed, remove the actuator first, before moving the sunroof window forward.

2. Remove the sunroof actuator to sunroof module retaining bolts (1).
3. Disconnect the sunroof actuator wiring connector.
4. Remove the sunroof actuator from the sunroof module.

Installation Procedure

1. Manually move the sunroof window to the fully closed position.
2. Install the sunroof actuator to the sunroof module.

Notice: Refer to Fastener Notice in the Preface section.



3. Install the sunroof actuator to sunroof module retaining screws (1).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).

4. Connect the sunroof actuator wiring connector to the sunroof actuator.
5. Initilization /Teach the sunroof motor. Refer to Sunroof Motor/Actuator Synchronization.
6. Verify the sunroof operation.
7. Install the headliner. Refer to Headlining Trim Panel ReplacementHeadliner Replacement in Interior Trim.

Sunroof Motor / Actuator Synchronization

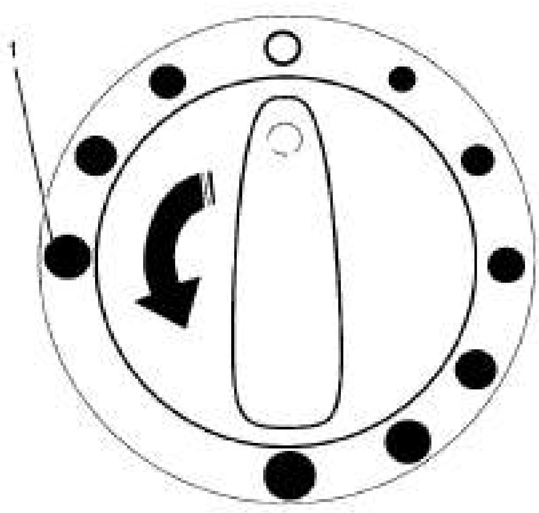
Important: The sunroof actuator is timed at the factory. If there is battery voltage applied to a new sunroof actuator, the pre-timed settings within the sunroof actuator are lost and cannot be reset or used to accommodate proper installation.

There should be no battery voltage applied to a new sunroof actuator until the following conditions are satisfied:

The power sunroof actuator is installed to the sunroof control module.

Initialization Procedure

1. Install the power sunroof actuator. Refer to Sunroof Motor/Actuator Replacement.
2. Ensure that all electrical harness connectors are connected.
3. Turn ignition ON.



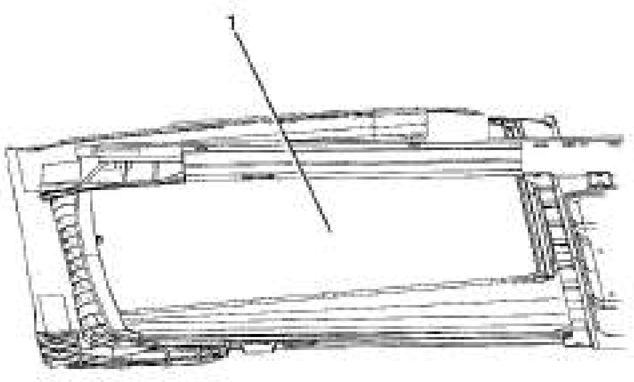
4. Turn the sunroof dial to the full vent position (1).
5. Press and hold the sunroof dial switch in for a minimum of five seconds to activate the sunroof initialization process. The sunroof will move to the hard stop position and will stop in the soft stop position.
6. Release the switch.

Teach Mode Procedure

1. Press and hold the sunroof switch in within 2 seconds of the initialization procedure.
2. Hold the switch in until the sunroof moves to the full open position then moves to the closed position and stops.
3. Release the switch.
4. Verify the operation of the sunroof in all positions.

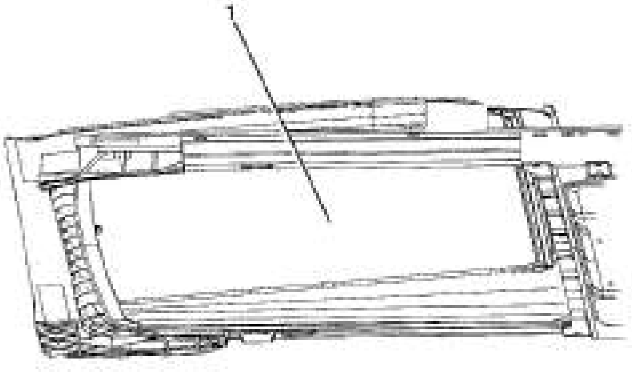
Sunroof Panel Side Opening Closeout Cover Replacement

Removal Procedure



1. Open the sunshade to the full rearward position.
2. Open the sunroof window to the vent position.
3. Detach both sides of the sunroof panel side opening covers (2) from the sunroof window (1).
4. Open the sunroof to the full open position.
5. Using a suitable tool, press the locking tab (4) outward, from inside the roof opening, in order to detach the sunroof panel side opening cover from the sunroof track channel (3).
6. With the lock tab (4) depressed, lift the front edge of the sunroof panel side opening cover from the track, working towards the rear of the sunroof opening.
7. Repeat the steps for the entire length of the sunroof panel side opening cover (6).
8. Remove the sunroof panel side opening cover from the sunroof module track assembly.

Installation Procedure

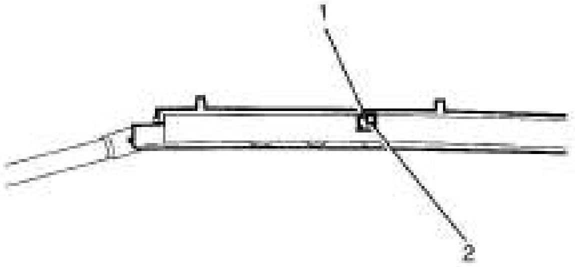


1. Place in position, the new sunroof panel side opening cover to the sunroof module track assembly.
2. Hold the lower part of the sunroof panel side opening cover firmly and press the locking tab (2) into the track assembly.
3. Make sure the entire length of the sunroof panel side opening cover is secure to the sunroof assembly track.
4. Close the sunroof window (1).
5. Open the sunroof window to the vent position.
6. Secure the sunroof panel side opening cover to the three clips (1) located on the inside edge of the sunroof window.
7. Close the sunroof window.
8. Cycle the sunroof window to the vent position and full open positions in order to make sure the sunroof panel side opening covers are secure to the attachment clips.
9. Close the sunroof window.
10. Close the sunshade.

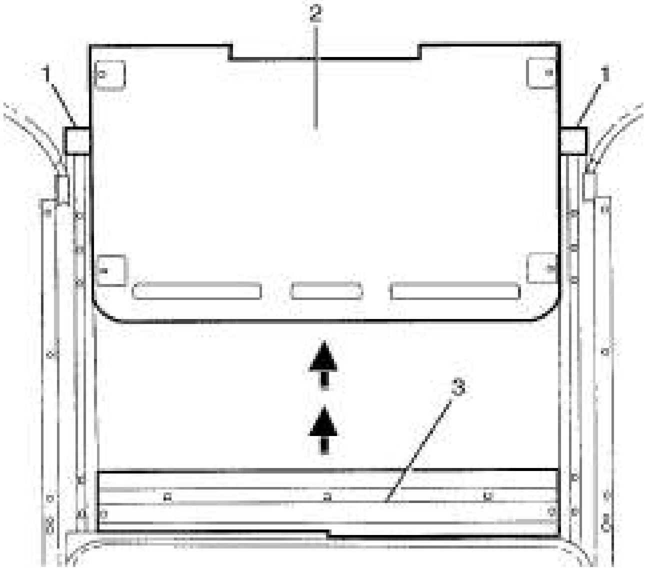
Sunroof Sunshade Replacement

Removal Procedure

1. Cycle the sunroof window to the vent position in order to ease in the removal of the sunshade panel.
2. Remove the headliner. Refer to Headlining Trim Panel Replacement.
3. Remove the sunroof module. Refer to Sunroof Module Assembly Replacement.



4. Remove the sunshade stop rubber to sunroof module retaining screw (2). Repeat for the opposite side.
5. Remove the sunshade stop rubber (1) from the sunroof module by sliding the sunshade stop rubber to the rear of the sunroof module. Repeat for the opposite side.

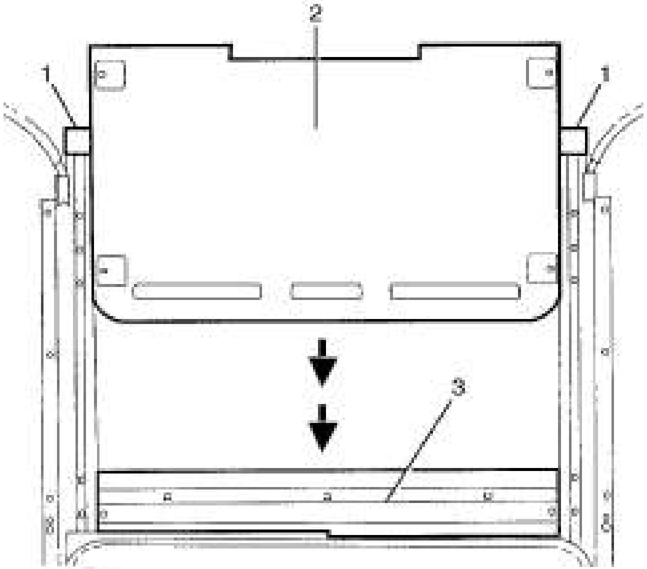


6. Remove the end caps (1) from the sunroof rail.
7. Carefully remove the sunshade panel (2) by sliding the sunshade panel towards the rear of the sunroof.

   Important: Do not apply excessive pressure when arching the sunshade panel, failure to comply may result in damage to the sunshade panel.

8. Remove the sunshade panel (1) from the sunroof module (3).

Installation Procedure



1. Position front edge of the sunshade panel (2) to the track.

   Important: Do not apply excessive pressure to the sunshade panel, failure to comply may result in damage to the sunshade panel.

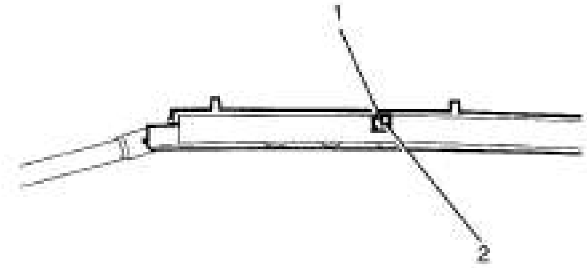
2. Carefully install the sunshade panel (2) by sliding the sunshade panel toward to the front of the sunroof module (3).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the sunroof end caps (1) to the sunroof rail.

   Tighten
   Tighten the screw to 1 N·m (9 lb in).

4. Slide the sunshade panel forward and rearward to make sure free operation is present.



5. Install the sunshade stop rubber (1) to the sunroof module. Repeat for the opposite side.
6. Install the sunshade stop rubber to sunroof module retaining screw (2). Repeat for the opposite side.

   Tighten
   Tighten the screws to 1 N·m (9 lb in).

7. Install the sunroof module. Refer to Sunroof Module Assembly Replacement.
8. Install the headliner. Refer to Headlining Trim Panel Replacement.

Sunroof Switch Replacement

Removal Procedure

1. Disconnect the electrical connector to the sunroof switch.
2. Disengage the retaining clips (1) securing the sunroof switch to the sunroof overhead console.
3. Remove the sunroof switch from the sunroof overhead console.

Installation Procedure

1. Install the sunroof switch to the sunroof overhead console.
2. Engage the retaining clips (1) to secure the sunroof switch to the sunroof overhead console.
3. Connect the electrical connector to the sunroof switch.

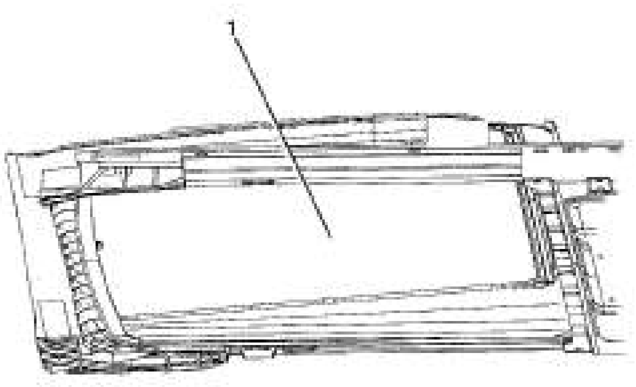
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Roof | Sunroof | Repair Instructions | **Document ID: 1976202**

Sunroof Window Height and Opening Fit Adjustment

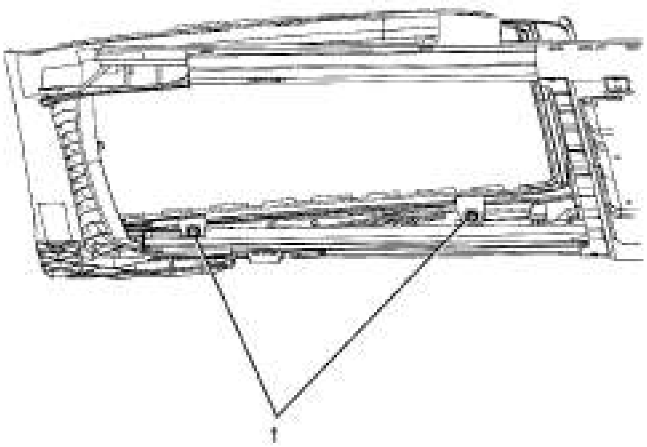
Adjustment Procedure

1. Cycle the sunroof window from the full open to the full closed position.

   Important: Correct adjustment cannot be achieved if the sunroof window is closed from the vent position.



2. Remove the top side of the sunroof panel side opening closeout panel covers (1) from the 3 clips located on the inner edge of the sunroof window (2) in order to access the window adjustment screws.
3. Cycle the sunroof to the closed position.



4. Loosen the adjusting screws (1) on each side of the sunroof window.
5. Centre the window front to rear in the opening.

Important: Do not fully tighten the sunroof retaining screws at this stage.

6. Adjust the front of the sunroof window (2) from flush to 1 mm (0.04 in) (1) below the top surface of the roof panel (3).

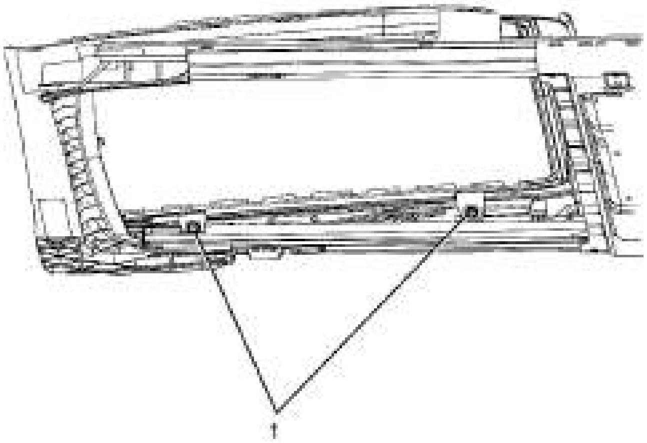
   Do not fully tighten at this stage.

   Important: Do not fully tighten the sunroof retaining screws at this stage.

7. Adjust the rear of the sunroof window (2) from flush to 1 mm (0.04 in) above the top surface of the roof panel (1).

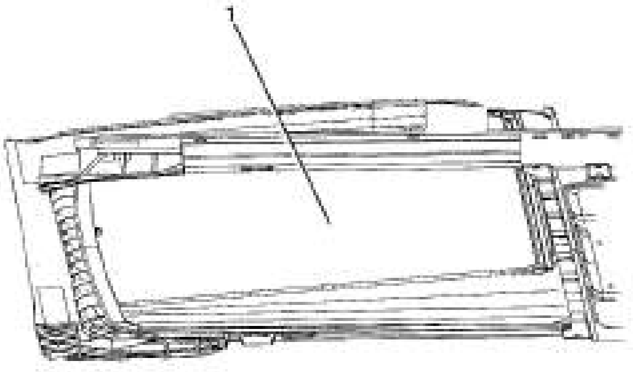
   Do not fully tighten at this stage.

   Notice: Refer to Fastener Notice in the Preface section.



8. Tighten the sunroof glass to the sunroof frame retaining screws (1).

   Tighten
   Tighten the screws to 3 N·m (27 lb in).



9. Install the sunroof panel side opening closeout covers (2).
10. Cycle the sunroof window through all of the positions.
11. Verify the sunroof window fore/aft adjustment.
12. Verify the front and rear height adjustment.
13. Readjust the sunroof window, if necessary.

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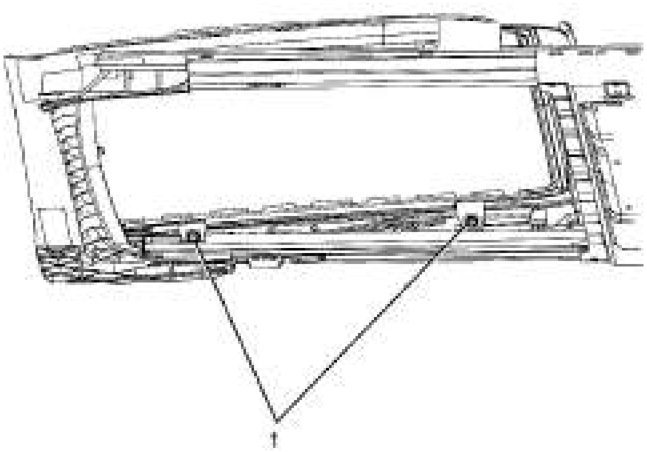
Sunroof Window Replacement

Removal Procedure

Notice: Refer to General Repair Instructions in the Preface section.

Notice: In order to prevent damage to the paint, mask the roof panel in front of the sunroof opening using masking tape and paper.

1. Cycle the sunroof window to the vent position.
2. Slide the sunshade rearward.
3. Remove the sunroof panel side opening covers. Refer to Sunroof Panel Side Opening Closeout Cover Replacement.

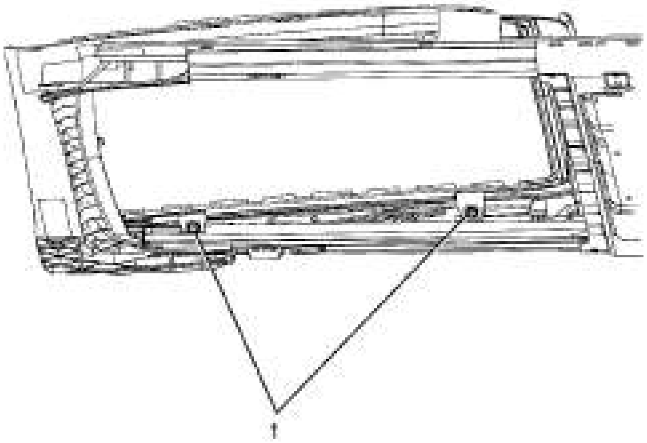


4. Remove the sunroof window to sunroof module retaining screws (1). Repeat for the opposite side.

Important: Be careful not to scratch the roof surface or the sunroof window.

5. Lift the sunroof window (3) from the sunroof module.

Installation Procedure



1. Position the sunroof window (3) into the opening, with the window trade mark pointing rearward.

   Important: Do not fully tighten the sunroof window to sunroof module retaining screws (1) at this stage.

2. Install the sunroof window to sunroof module retaining screws (1).

   Do not fully tighten at this stage.

3. Carefully close the sunroof window from the vent position to the fully closed position.
4. Adjust the sunroof window. Refer to Sunroof Window Height and Opening Fit Adjustment.
5. Install the sunroof panel side opening covers. Refer to Sunroof Panel Side Opening Closeout Cover Replacement.
6. Close the sunshade.
7. Cycle the sunroof window to make sure proper operation and fit.

Sunroof Description and Operation

Power Sunroof System Components

The Power Sunroof System consists of the following components:

- Sunroof control module
- Sunroof switch
- Sunroof glass, tilt-slide-vent style with glass sliding between the headliner and the roof panel
- Rail and track assembly upon which the sunroof glass rides
- Sunroof sunshade panel
- SUNROOF Fuse 20 A
- Ground G201

Power and Grounds

Battery positive voltage is supplied at all times to the sunroof control module from the 20 A SUNROOF fuse located in the instrument panel fuse block. Ground is supplied to the sunroof control module through the module ground circuit and G201.

Ground is supplied to the sunroof switch through the switch ground circuit and G201.

Power Sunroof Operation

The Power Sunroof System will operate only with the ignition turned to the RUN or Accessory positions. Once the ignition is turned OFF and the sunroof is open, the sunroof might automatically close.

The power sunroof is operated from the sunroof switch. The sunroof switch, when rotated to a selection, will send coded information to the sunroof control module as to what position the sunroof window is to move to. The sunroof control module will then command the motor to slide the sunroof glass to the requested position.

Sunroof Switch

The sunroof switch is a rotary dial type switch with four output signals to the sunroof control module. The coded inputs to the sunroof control module will initiate a request to open the sunroof window to a specific position. The sunroof switch is located in the dome light assembly. The sunroof switch positions are:

- 6 sliding open positions
- 3 vent positions
- Flush close position
- Emergency stop/resume position

Express Open

To express open the sunroof select any of the 6 express sliding open positions by rotating the sunroof switch clockwise. The sunroof switch will send a sunroof position request signal through the switch output signals to the sunroof control module. The sunroof control module will interpret the inputs and command the motor to slide the window to the specified requested position. The sunshade will slide open along with the window.

Express Fully Close

To express close the sunroof rotate the sunroof switch to the flush close position. The sunroof switch will send a sunroof position request signal through the sunroof switch output signals to the sunroof control module. The sunroof control module will interpret the inputs and command the motor to slide the window to the close position. The sunroof control module will continue to control the sunroof motor until the sunroof window reaches the flush close position. The sunshade panel will have to be manually slid closed.

Express Vent Open

To express open the sunroof to a vent position rotate the sunroof switch counterclockwise to any of the three vent selections. The sunroof switch will send a coded input through the sunroof switch output signals to the sunroof control module. The sunroof control module will interpret the inputs and command the motor to slide the window to the specified requested position. The sunshade panel will have to be manually slid open.

Emergency Stop

When the sunroof is performing an automatic open or automatic close operation, the automatic sliding action of the sunroof can be interrupted by pressing the sunroof switch upward. When the sunroof switch is pressed again, the sunroof will resume and complete the previous requested action.

Anti-Pinch Guard

If the sunroof encounters an obstruction when closing from a sliding position, it immediately returns to the fully open position. If the sunroof encounters an obstruction when closing from the vent position, it immediately returns to the fully open vent position. The sunroof will not operate again until the sunroof switch is pressed upwards or a different position is selected.

Power Sunroof Motor

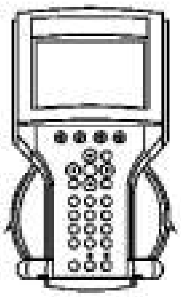
The sunroof motor is a reversible drive permanent magnet DC motor. The sunroof control module manipulates the voltage polarity at the motor to achieve the different opening and closing positions.

Limit Switch

When closing the sunroof window from any vent position, the sunroof window drops slightly below the flush close position and returns, swiping the seal and coming to rest in the flush close position. When closing the sunroof window from any of the 6 sliding open positions, the sunroof module considers the position of the sunroof window and stops the sunroof window in the flush close position.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Roof | Sunroof | Special Tools and Equipment | **Document ID: 1996338**

Special Tools

Illustration	Tool Number / Description
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

#PIT4636: GM Accessories Wheel Appearance Standards - keywords accessory aesthetics blister chrome ding dent dust peel rim wheel - (May 1, 2008)

Subject: GM Accessories Wheel Appearance Standards

Models: 1996-2009 GM Passenger Cars and Light Duty Trucks (including Saturn)

2009 and Prior HUMMER H2, H3

2005-2009 Saab 9-7X

The following diagnosis might be helpful if the vehicle exhibits the symptom(s) described in this PI.

Condition / Concern:

GM Dealers and ADIs may occasionally question the initial quality of a GM Accessories Wheel Assembly from an aesthetics perspective.

Recommendation / Instructions:

When in doubt, the general rule that should be followed (as approved by GM Tire & Wheel Systems) is:

"No visible defects with the wheel in car position in daylight at a distance of 3 feet."

Otherwise, GM Dealers should reference TSB 07-03-10-015A to determine which issues are covered under warranty and which are not for plant-installed (OE) wheels as well as GM Accessories Wheels that have already been installed on a customer's vehicle.

Please follow this diagnostic or repair process thoroughly and complete each step. If the condition exhibited is resolved without completing every step, the remaining steps do not need to be performed.

GM bulletins are intended for use by professional technicians, NOT a ""do-it-yourselfer"". They are written to inform these technicians of conditions that may occur on some vehicles, or to provide information that could assist in the proper service of a vehicle. Properly trained technicians have the equipment, tools, safety instructions, and know-how to do a job properly and safely. If a condition is described, DO NOT assume that the bulletin applies to your vehicle, or that your vehicle will have that condition. See your GM dealer for information on whether your vehicle may benefit from

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the information.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Suspension | Front Suspension | Specifications | Document ID: 2193597

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Control Arm to Steering Knuckle Retaining Nut		
• First Pass	40 N·m	30 lb ft
• Final Pass	60 Degrees	
Front Brake Disc Splash Shield to Steering Knuckle Retaining Bolts	9 N·m	80 lb in
Front Caster Arm to Steering Knuckle Retaining Nut		
• First Pass	40 N·m	30 lb ft
• Final Pass	60 Degrees	
Front Caster Arm to Subframe Retaining Nut		
• First Pass	50 N·m	37 lb ft
• Final Pass	120 Degrees	
Front Control Arm to Subframe Retaining Bolt		
• First Pass	50 N·m	37 lb ft
• Final Pass	120 Degrees	
Front Wheel Hub Assembly to Steering Knuckle Retaining Bolts	107 N·m	79 lb ft
Power Steering Gear Inlet Pipe/Hose Bracket to Sub Frame Retaining Bolt	9 N·m	80 lb in
Power Steering Gear Outlet Pipe/Hose Bracket to Sub Frame Retaining Bolt	9 N·m	80 lb in
Stabiliser Bar Insulator Bracket to Subframe Retaining Nuts	22 N·m	16 lb ft
Stabiliser Bar Link to Stabiliser Bar Retaining Nuts	50 N·m	37 lb ft
Stabiliser Bar Link to Strut Assembly (Bracket) Retaining Nuts	50 N·m	37 lb ft
Strut Assembly Retaining Nut	75 N·m	55 lb ft
Strut Assembly to Body Retaining Nut	55 N·m	40 lb ft
Strut Assembly to Steering Knuckle Retaining Bolts and Nuts		
• First Pass	100 N·m	74 lb ft
• Final Pass	90 Degrees	
Tie Rod to Steering Knuckle Retaining Nut		
First Pass	25 N·m	18 lb ft
Final Pass	120 Degrees	

Front Spring Specifications

Suspension Configuration	Number of Coils	Free Length		Main Body Inside Diameter		Spring Rate		Production I.D Code
FE1	5.5	391 mm	15.39 in	146 mm	5.75 in	21 - 23 N/mm	117 - 129 lb/in	AVA

FE2	5.1	358 mm	14.09 in	146 mm	5.75 in	23 - 26 N/mm	129 - 145 lb/in	AVB
FR1	5.1	348 mm	13.70 in	146 mm	5.75 in	31 - 33 N/mm	173 - 185 lb/in	AVC
FE1 Long Wheelbase	5.7	404 mm	15.90 in	146 mm	5.75 in	21 - 23 N/mm	117 - 129 lb/in	AVD
Grange	5.5	360 mm	14.17 in	147 mm	5.79 in	19 - 26 N/mm	106 - 145 lb/in	03C-060601
Clubsport	5.1	358 mm	14.09 in	146 mm	5.75 in	23 - 26 N/mm	129 - 145 lb/in	AVB
GTS/Senator	5.5	360 mm	14.17 in	147 mm	5.79 in	19 - 26 N/mm	106 - 145 lb/in	03C-060601

Front Stabiliser Bar Specifications

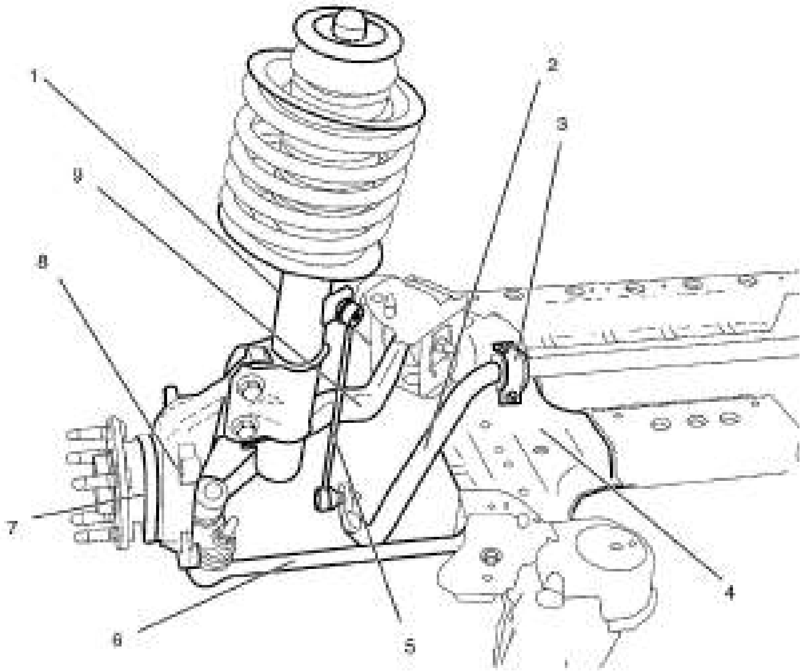
Suspension Configuration	Diameter mm (in)	Production I.D Code
All	23 mm (9.05 in)	XJ
Statesman	23 mm (9.05 in)	XJ
Caprice	23 mm (9.05 in)	AE
Grange	23 mm (9.05 in)	XJ
Clubsport	23 mm (9.05 in)	XJ
GTS/Senator	23 mm (9.05 in)	XJ

Front Strut Unit Specifications

Suspension Configuration	Left Side I.D Code	Right Side I.D Code
FE1	AM	AL
FE2	AB	AA
FR1	BSY	BSZ
Statesman	BSK	BDK
Caprice	BST	BSU
Grange	MFL	MFL
Clubsport	TUE	TUE
GTS/Senator	MFL	MFL

Front Suspension Components (LWB SWB Clubsport CSV VXR8)

Front Suspension



(1) Front Strut Assembly

(2) Stabiliser Bar

(3) Stabiliser Bar Insulator Bracket

(4) Subframe

(5) Stabiliser Bar Link

(6) Lower Control Arm

(7) Wheel Hub Assembly

(8) Steering Knuckle

(9) Front Caster Arm

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Suspension | Front Suspension | Repair Instructions | Document ID: 2193595

Control Arm Replacement

Tools Required

CH-49405 Ball Joint Release Tool.

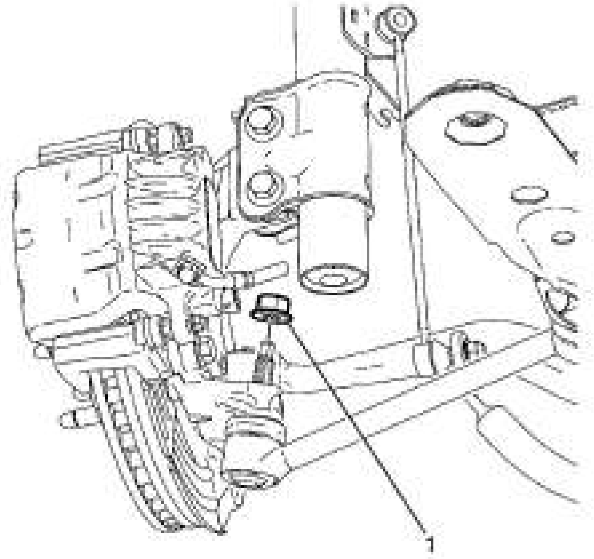
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Important: The front control arm ball joint is non-serviceable, if found faulty, the complete front control arm assembly must be replaced..

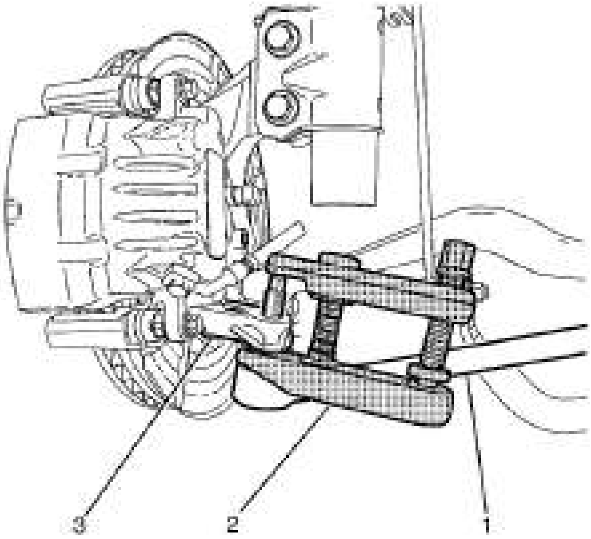
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the front wheel. Refer to Tire and Wheel Removal and Installation.



Important: Bolts and nuts with micro-encapsulated thread sealant must be discarded after removal.

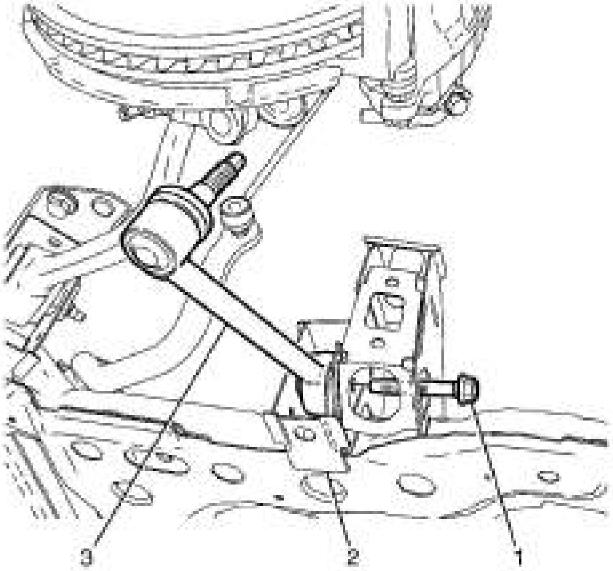
3. Remove the control arm to steering knuckle retaining nut (1).

   Discard the nut.



Important: Once a load is applied by the ball joint release tool loading bolt, a quick tap on the nut end of the tool will reduce the separating force required.

4. Separate the front control arm (1) from the steering knuckle (3) using the CH-49405 (2).
5. Disconnect the front control arm (1) from the steering knuckle (3).



6. Remove the front control arm to subframe retaining bolt (1).

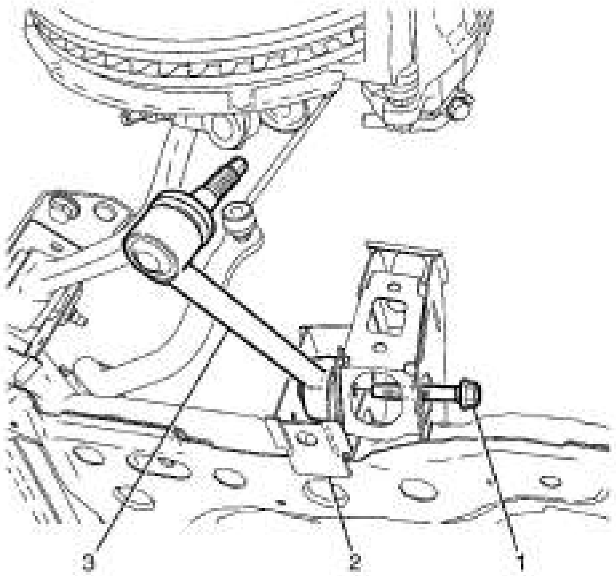
   Discard the bolt.

7. Remove the front control arm (3) from the subframe (2).

Important: Clean the captive nut thread free of loctite with a suitable tap. This enables the correct torque value to be achieved on fitment.

8. Clean the captive nut thread.
9. Inspect all parts for wear and damage.

Installation Procedure

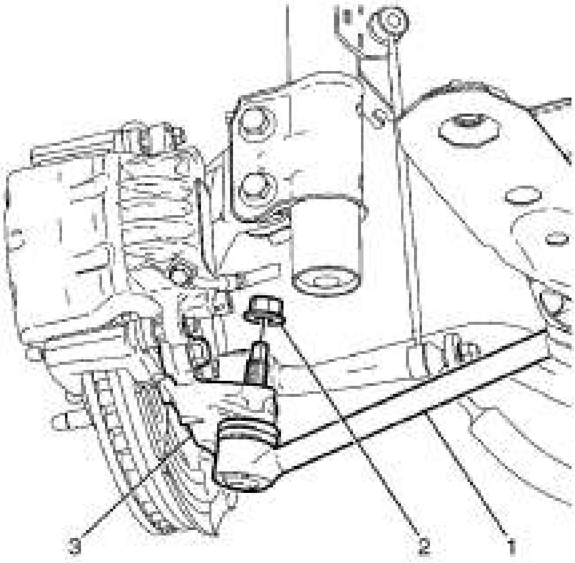


1. Install the front control arm (3) to the subframe (2).

   Important: The NEW front control arm to subframe retaining bolt (1) must not be fully tightened at this stage.

2. Install the NEW front control arm to subframe retaining bolt (1).

   Do not fully tighten at this stage.



3. Install the front control arm (1) to the steering knuckle (3).

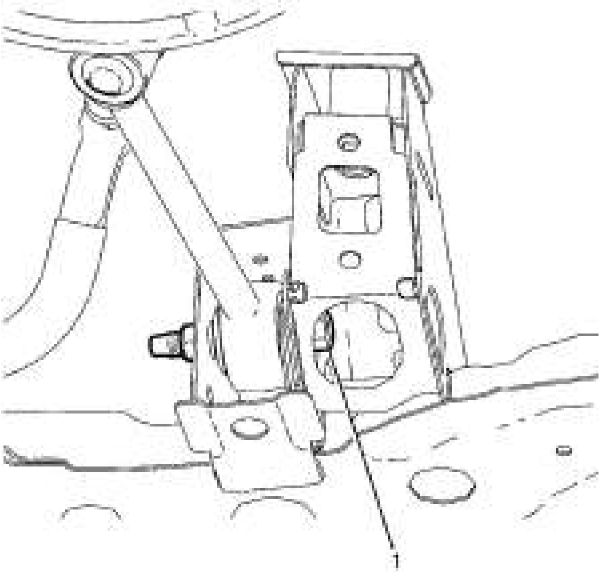
   Notice: Refer to Fastener Notice in the Preface section.

4. Install the NEW control arm to steering knuckle retaining nut (2).

   Tighten
   Tighten the bolts a first pass to 40 N·m (30 lb ft).

   Tighten the bolts an additional 60 degrees.

5. Install the front wheel. Refer to Tire and Wheel Removal and Installation.
6. Remove the safety stands.
7. Lower the vehicle to the ground.



8. Bounce the vehicle several times to settle the suspension.
9. Tighten the front control arm to subframe retaining bolt (1).

    Tighten
    Tighten the bolts a first pass to 50 N·m (37 lb ft).

    Tighten the bolts an additional 120 degrees.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Suspension | Front Suspension | Repair Instructions | **Document ID: 1993274**

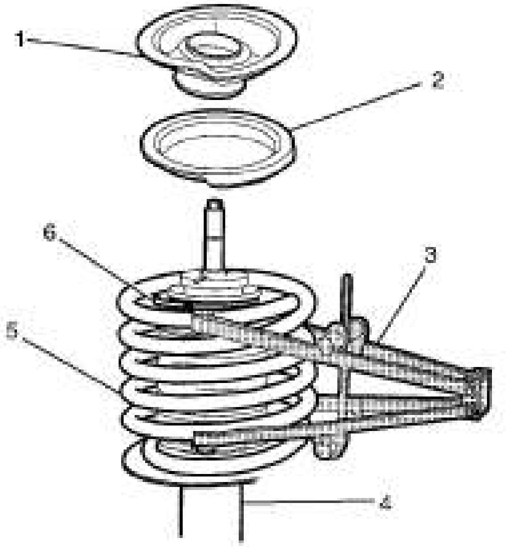
Front Coil Springs Replacement (LWB SWB Clubsport CSV VXR8)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the front wheel. Refer to Tire and Wheel Removal and Installation .
3. Remove the front strut assembly. Refer to Strut Assembly Replacement
4. Remove the strut assembly support bearing and mount. Refer to Front Suspension Strut Mount and Bearing Replacement .



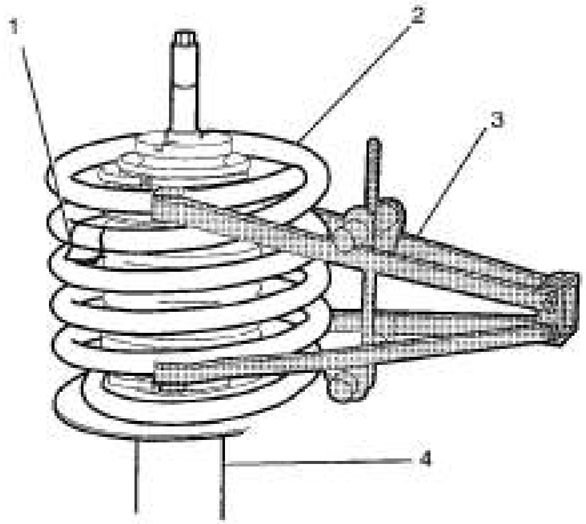
5. Remove the dust boot upper retaining clamp (6).

   Discard the clamp.

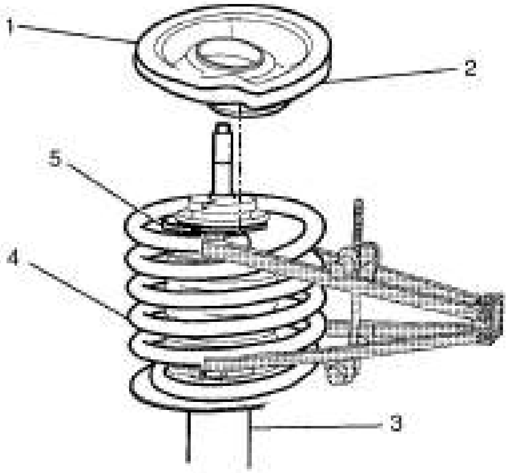
6. Remove the coil spring seat (1) and coil spring insulator (2).
7. Remove the coil spring (5) from the strut unit (4) and release the spring compressor (3).
8. Inspect all parts for wear and damage.

Installation Procedure

Notice: Refer to Fastener Tightening Specifications in the Preface section.



1. Make sure that all components have been cleaned and inspected.
2. Install the spring compressor (3) to the coil spring (2) and compress coil spring.
3. Install the coil spring (2) to the strut unit (4).



Important: The coil spring insulator (2) and seat (1) have a step which locates on to the straight projecting end of the spring. The step must be correctly orientated in relation to the spring.

4. Install the coil spring insulator (2) and coil spring seat (1).

Important: Align the mark on the spring seat with the mark on the strut unit when installing, with straight projecting end of the spring correctly located in the coil spring insulator (2) and seat (1).

5. Position the coil spring (5) and spring seat on the strut unit (4).
6. Install the NEW dust boot upper retaining clamp (6) securing the dust boot to the coil spring seat (1).
7. Install the strut assembly support bearing and mount. Refer to Front Suspension Strut Mount and Bearing Replacement
8. Install the front strut assembly. Refer to Strut Assembly Replacement .
9. Install the front wheel. Refer to Tire and Wheel Removal and Installation .
10. Remove the safety stands.
11. Lower the vehicle to the ground.

Front Lower Control Front Arm Replacement

Tools Required

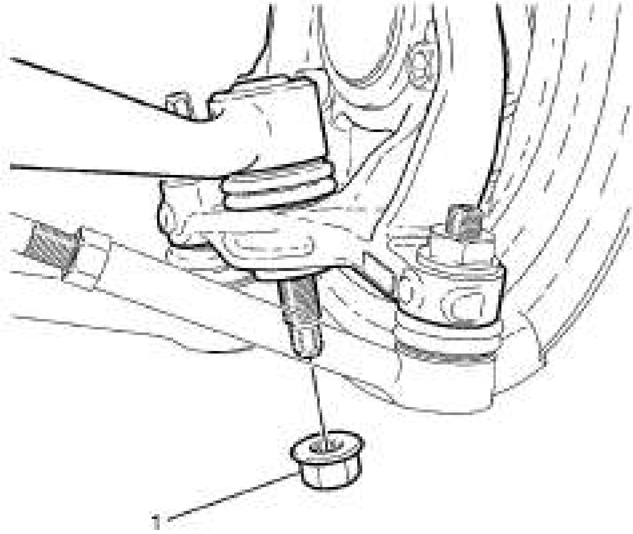
CH-49405 Ball Joint Release Tool.

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

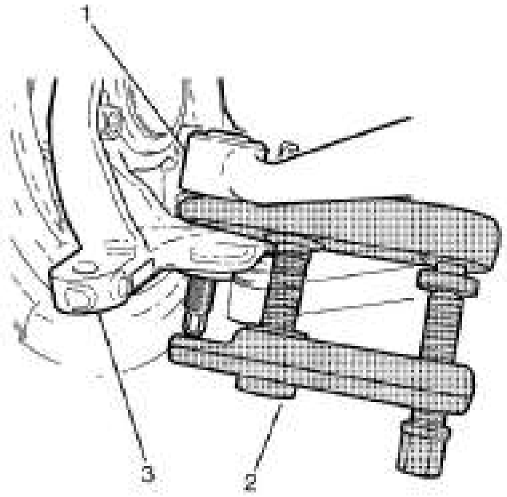
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the front wheel. Refer to Tire and Wheel Removal and Installation.



Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

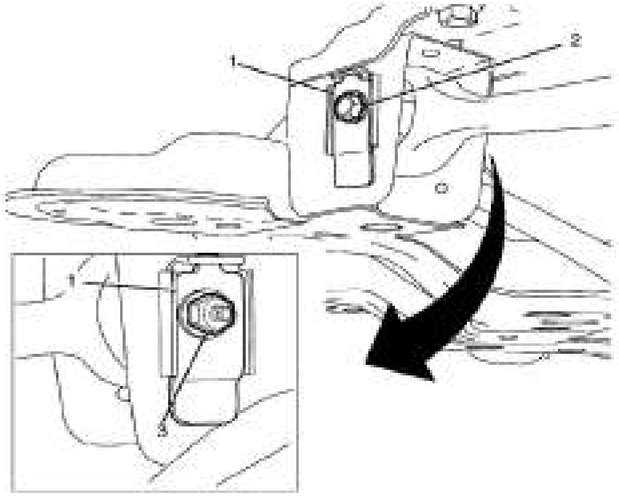
3. Remove the front caster arm to steering knuckle retaining nut (1).

   Discard the nut.



Important: Once a load is applied by the release tool loading bolt, a quick tap on the nut end of the tool will reduce the separating force required.

4. Separate the front caster arm (1) from the steering knuckle (3) using the CH-49405 (2).
5. Disconnect the front caster arm (1) from the steering knuckle (3).

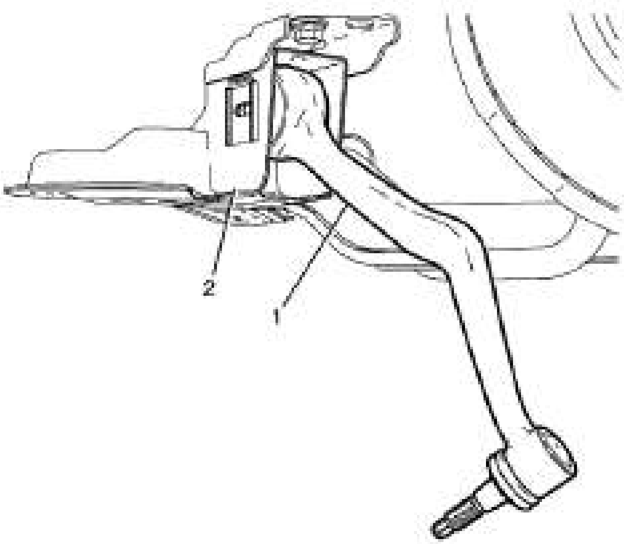


6. Remove the front caster arm to subframe retaining nut (3).

   Discard the nut.

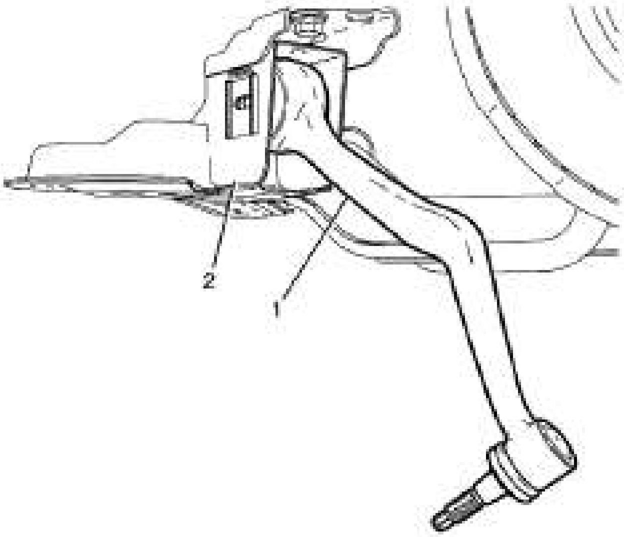
7. Remove the front caster arm to subframe retaining bolt (2).

   Discard the bolt.

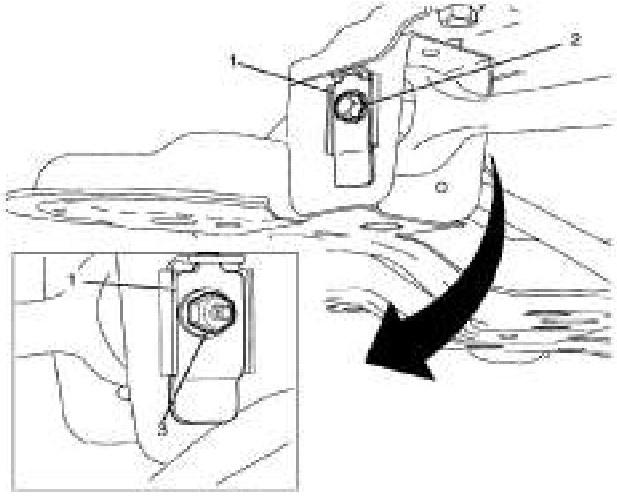


8. Remove the front caster arm (1) from the subframe (2).
9. Inspect all parts for wear and damage.

Installation Procedure

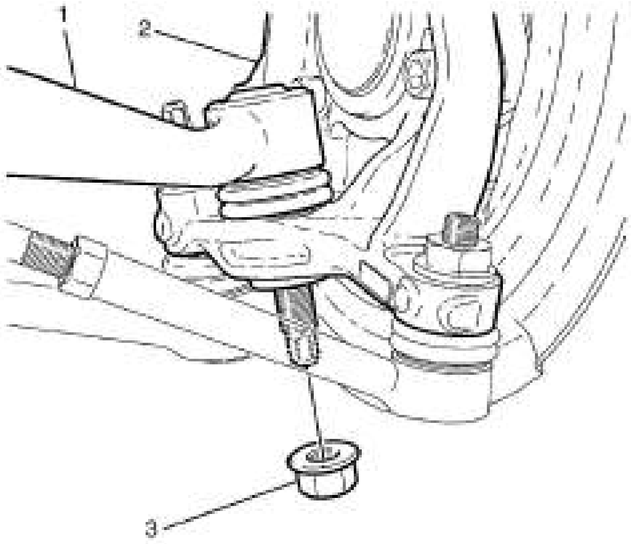


1. Install the front caster arm (1) from the subframe (2).



2. Install the NEW lower caster arm to the subframe retaining bolt (2).
3. Install the NEW lower caster arm to the subframe retaining nut (3).

   Do not fully tighten at this stage.



4. Install the front caster arm ball joint (1) to the steering knuckle (2).

   Notice: Refer to Fastener Notice in the Preface section.

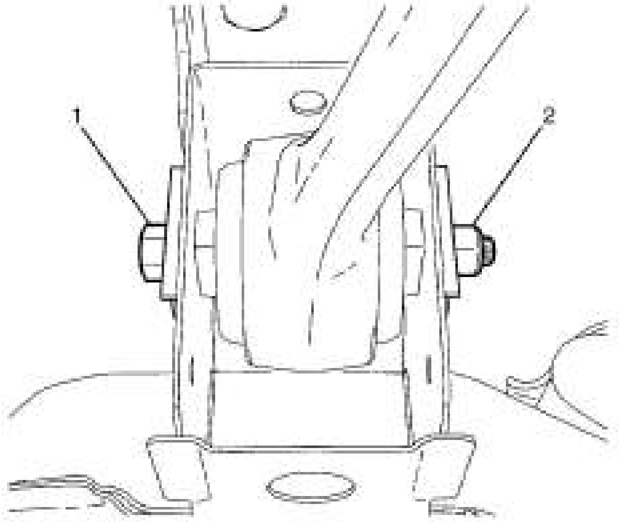
5. Install the NEW front caster arm to steering knuckle retaining nut (3).

   Tighten

Tighten the bolts a first pass to 40 N·m (30 lb ft).

Tighten
Tighten the bolts an additional 60 degrees.

6. Install the front wheel. Refer to Tire and Wheel Removal and Installation.
7. Remove the safety stands.
8. Lower the vehicle to the ground.



9. Bounce the vehicle several times to settle the suspension.
10. Check and adjust the wheel alignment. Refer to Wheel Alignment Measurement in Wheel Alignment.

Important: The weight of the vehicle must be on a level surface and on all four wheels before fully tightening the bolts and nuts that have been partially tightened. Failure to comply with to this requirement may adversely affect the ride and handling characteristics of the vehicle and reduce bushing life.

11. Tighten the front caster arm to subframe retaining bolt (1).

Tighten
Tighten the bolts a first pass to 50 N·m (37 lb ft).

Tighten
Tighten the bolts an additional 120 degrees.

Front Suspension Strut Mount and Bearing Replacement

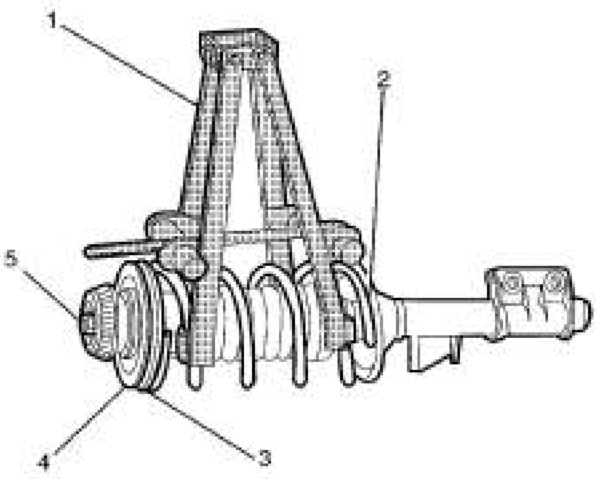
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

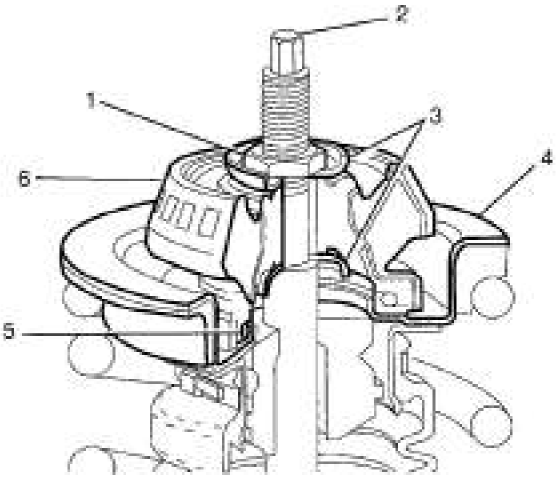
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the front wheel. Refer to Tire and Wheel Removal and Installation.
3. Remove the front strut assembly. Refer to Strut Assembly Replacement.

Caution: Refer to General Repair Instructions in the Preface section.



4. Install the spring compressor (1) on to the front coil spring (2), make sure the hooks are seated on the coil spring (2) correctly.
5. Mark the coil spring seat in relation to the strut unit.
6. Compress the coil spring (2) until the coil spring insulator (4) has clearance at the coil spring seat (3).



Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

Important: Use the hex on the strut unit piston shaft to hold the strut unit piston shaft (2) while loosening the strut assembly retaining nut (1).

7. Remove the strut assembly retaining nut (1).

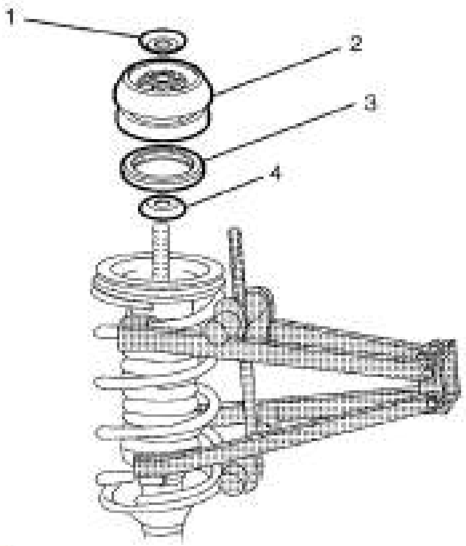
Important: Special attention must be paid to the orientation of the cup washers (3) in relation to strut assembly support mount (6).

Important: Special attention must be paid to the orientation of the strut assembly support bearing (5) in relation to the coil spring seat (4).

Important: The strut assembly support bearing (5) is sealed for life. If considered to be faulty, the bearing must be replaced as an assembly.

8. Remove the strut assembly support mount (6), bearing (5) and the two washers (3) on both sides of the bearing.
9. Inspect all parts for wear and damage.

Installation Procedure

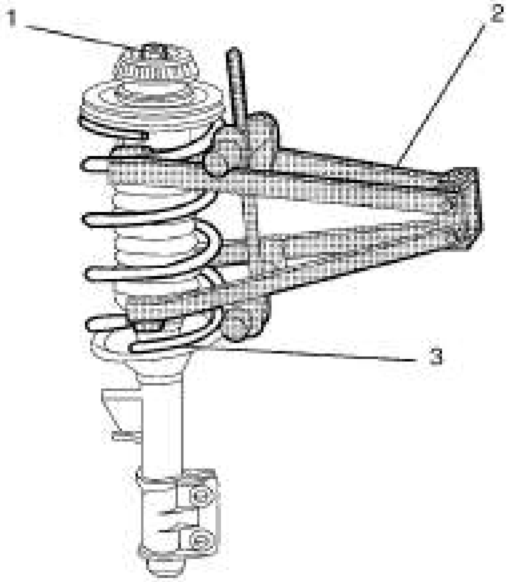


1. Install the lower cup washer (4) with the dished side facing downward.

   Important: Before installing the bearing, the bearing must be properly aligned and orientated.

2. Install the strut assembly support bearing (3) with the same orientation as noted on removal.
3. Install the strut assembly support mount (2).
4. Install the upper cup washer (1) with the dished side facing upward.

   Notice: Refer to Fastener Notice in the Preface section.



Important: Align the mark on the coil spring seat with the strut unit before tightening the strut assembly retaining nut (1).

5. Install the strut assembly retaining nut (1).

   Tighten
   Tighten the nut to 75 N·m (55 lb ft).

6. Remove the spring compressor (2) from the front coil spring (3).
7. Install the front strut assembly. Refer to Strut Assembly Replacement.
8. Install the front wheel. Refer to Tire and Wheel Removal and Installation.
9. Remove the safety stands.
10. Lower the vehicle to the ground.

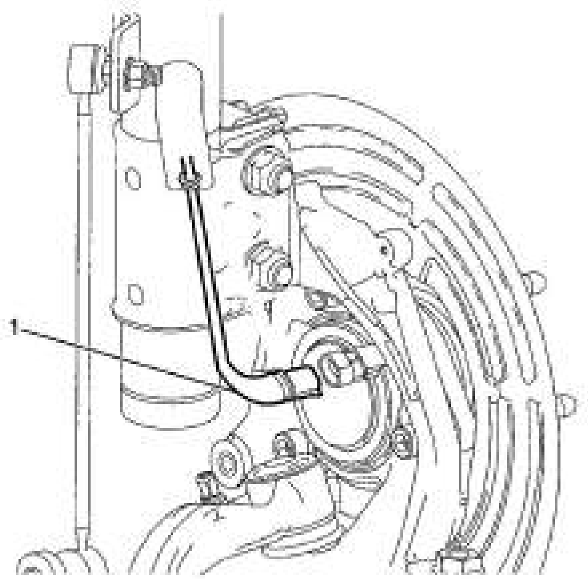
Front Wheel Bearing and Hub Replacement

Removal Procedure

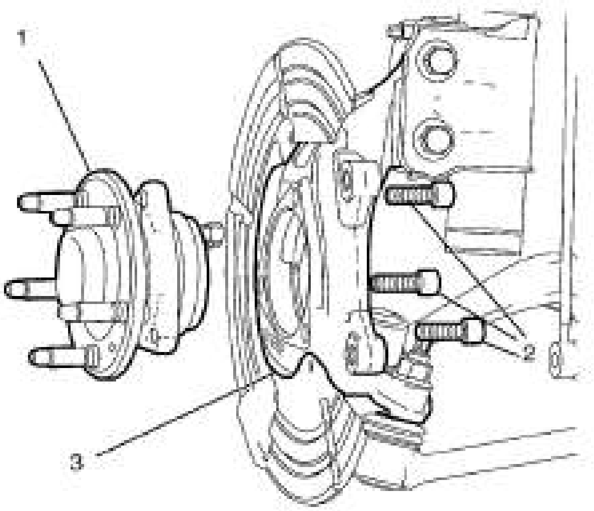
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the VehicleLifting and Jacking the Vehicle.
2. Remove the front wheel. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation.
3. Remove the brake disc. Refer to Front Brake Rotor ReplacementFront Brake Rotor Replacement.



4. Disconnect the wheel speed sensor electrical connector (1).



Important: Before a hub assembly is replaced, the end-float measurement must be checked. Refer to Front Wheel Hub Assembly InspectionFront Wheel Hub Assembly Inspection

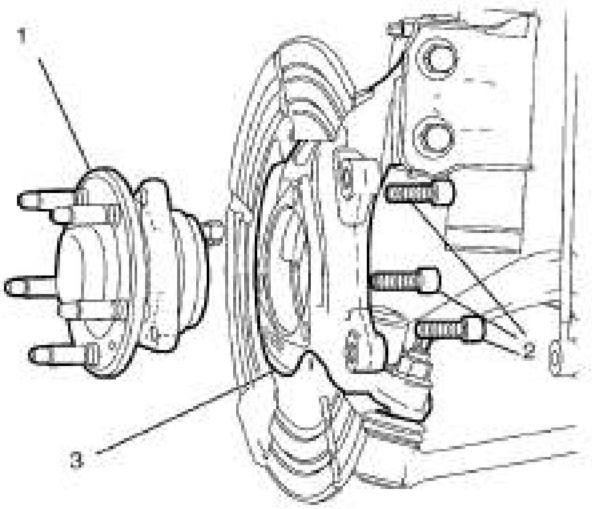
Important: Bolts with micro-encapsulated thread sealant must be discarded after removal.

5. Remove the hub assembly to steering knuckle retaining bolts (2).

   Discard the bolts.

6. Remove the hub assembly (1) from the steering knuckle (3).

Installation Procedure



Important: Wheel studs are the only serviceable item of the front wheel hub assembly.

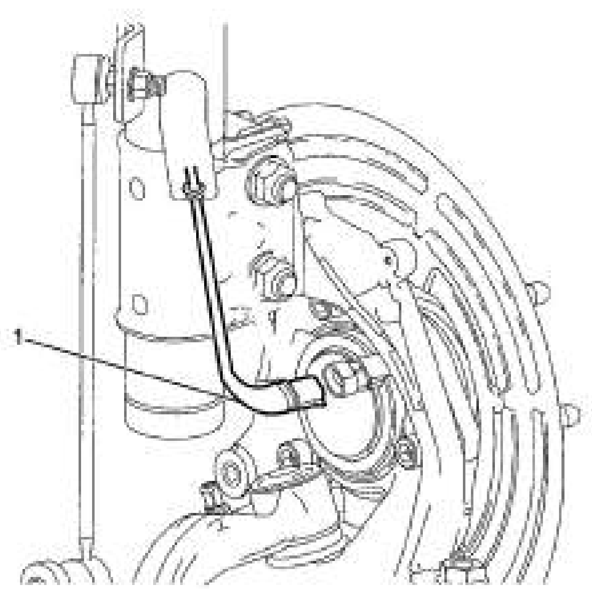
1. Install the hub assembly (1) to the steering knuckle (3).

   Notice: Refer to Fastener Notice in the Preface section.

   Important: After a hub assembly is replaced, the end-float measurement must be checked. Refer to Front Wheel Hub Assembly InspectionFront Wheel Hub Assembly Inspection

2. Install the NEW hub assembly to steering knuckle retaining bolts (2).

   Tighten
   Tighten the bolts to 107 N·m (79 lb ft).



3. Connect the wheel speed sensor electrical connector (1).
4. Install the brake disc. Refer to Front Brake Rotor ReplacementFront Brake Rotor Replacement.
5. Install the front wheel. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation.
6. Remove the safety stands.
7. Lower the vehicle to the ground.

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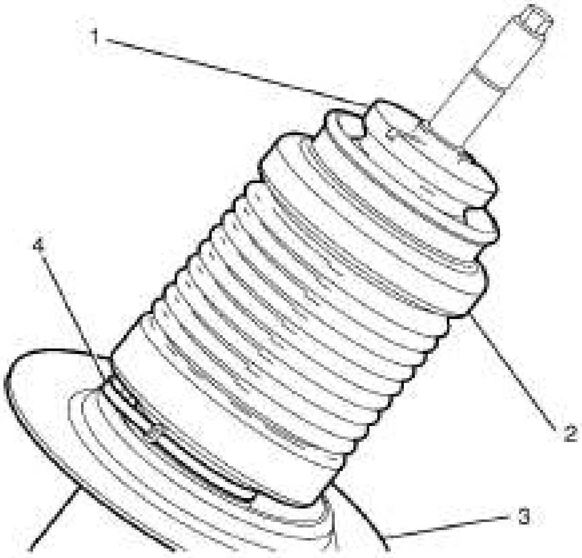
Shock Absorber Replacement (LWB SWB Clubsport CSV VXR8)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the front wheel. Refer to Tire and Wheel Removal and Installation .
3. Remove the front strut assembly. Refer to Strut Assembly Replacement .
4. Remove the front strut assembly support bearing and mount. Refer to Front Suspension Strut Mount and Bearing Replacement
5. Remove the front coil spring. Refer to Coil Spring Replacement in Front Suspension.



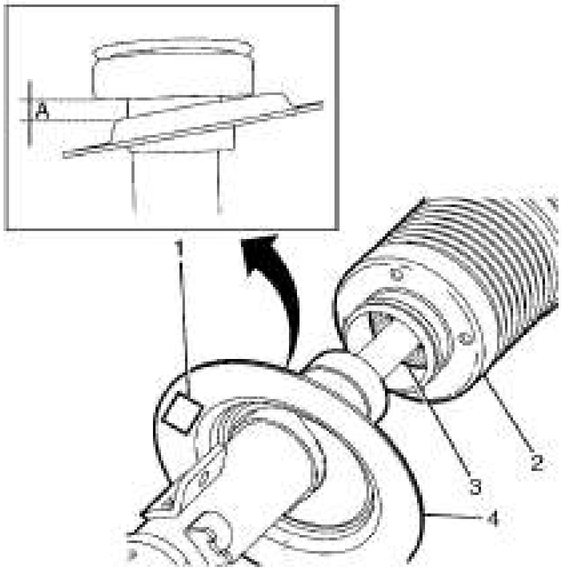
6. Remove the compression bumper (1).
7. Remove the dust boot lower retaining clamp (4).

   Discard the clamp.

8. Remove the dust boot and filter assembly (2) from the strut unit (3).
9. Inspect all parts for wear and damage.

Installation Procedure

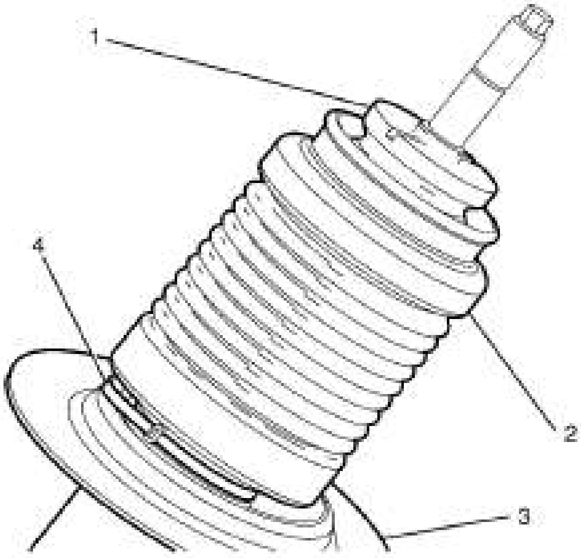
Notice: Refer to Fastener Tightening Specifications in the Preface section.



Important: The filter (3) must remain correctly seated inside the dust boot (2).

Important: The bottom of the dust boot and filter assembly (2) must be positioned so that the lower lip of the dust boot completely passes over the strut body retaining ring.

1. Install the dust boot and filter assembly (2) over the strut unit (3).



2. Install the NEW dust boot lower retaining clamp (4) securing the dust boot (2) to the strut unit (3).
3. Install the compression bumper (1).
4. Install the coil spring. Refer to Coil Spring Replacement in Front Suspension.
5. Install the front strut assembly support bearing and mount. Refer to Front Suspension Strut Mount and Bearing Replacement

6. Install the front strut assembly. Refer to Strut Assembly Replacement .
7. Install the front wheel. Refer to Tire and Wheel Removal and Installation .
8. Remove the safety stands.
9. Lower the vehicle to the ground.

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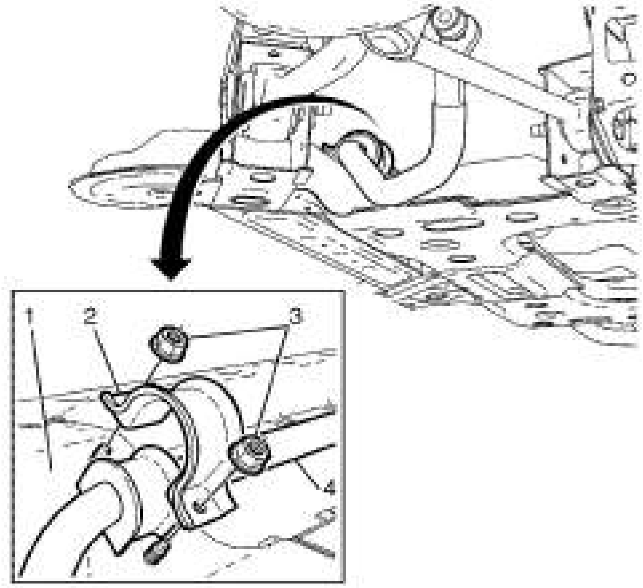
Stabilizer Shaft Insulator Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

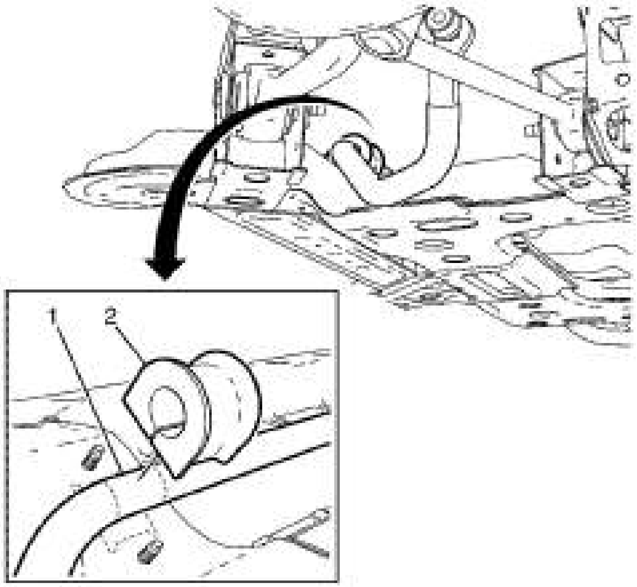


Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

2. Remove the stabliser bar insulator bracket to subframe retaining nuts (3) on both sides of the stabiliser bar (4).

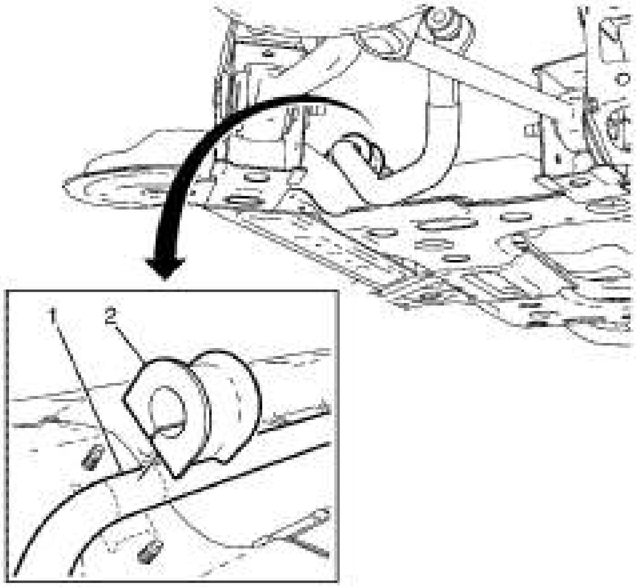
   Discard the nuts.

3. Remove the stabliser bar insulator bracket (2) from the subframe (1) on both sides of the stabiliser bar.

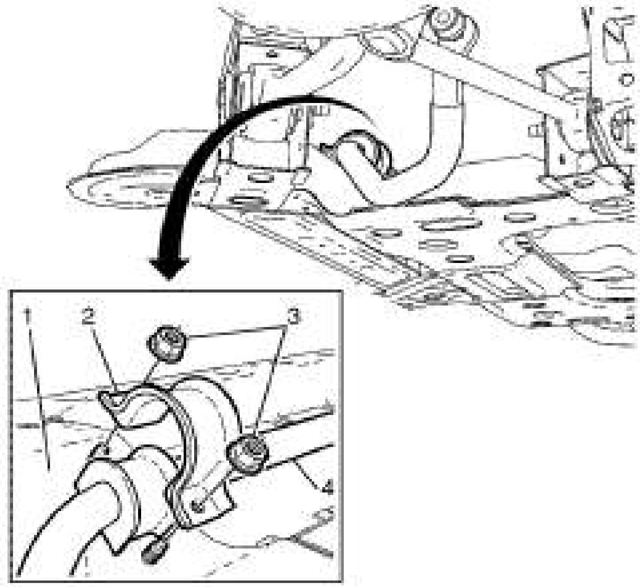


4. Remove the stabliser bar insulator (2) from both sides of the stabiliser bar (1).
5. Inspect all parts for wear and damage.

Installation Procedure



1. Install the stabliser bar insulator (2) to both sides of the stabiliser bar (1).



2. Install the stabliser bar insulator bracket (2) to the subframe (1) on both sides of the stabiliser bar.

   Notice: Refer to Fastener Notice in the Preface section.

3. Install stabliser bar insulator bracket to subframe retaining nuts (3) on both sides of the stabiliser bar.

   Tighten
   Tighten the nuts to 22 N·m (16 lb ft).

4. Remove the safety stands.
5. Lower the vehicle to the ground.

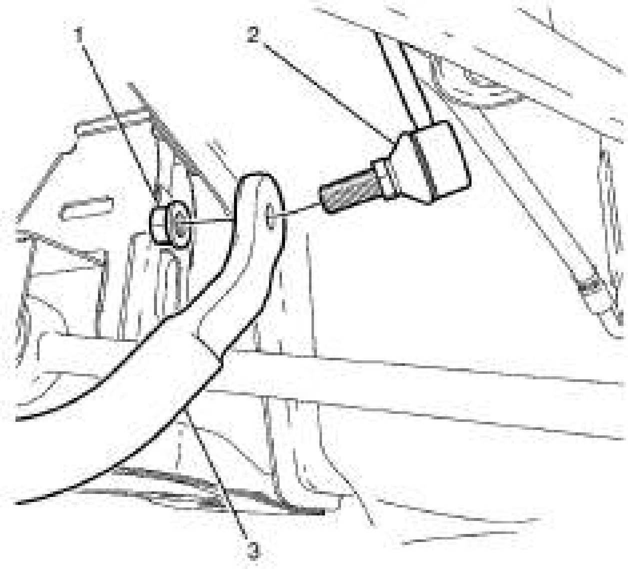
Stabilizer Shaft Link Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the front wheel. Refer to Tire and Wheel Removal and Installation.

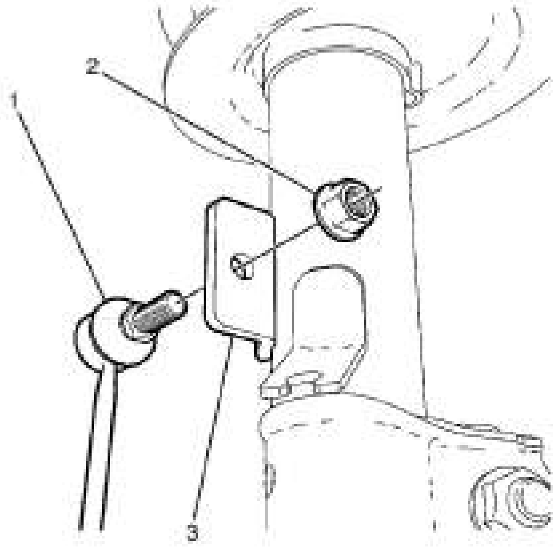


Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

3. Remove the stabiliser bar link to stabiliser bar retaining nut (1).

   Discard the nut.

4. Disconnect the stabiliser bar link (2) from the stabiliser bar (3).

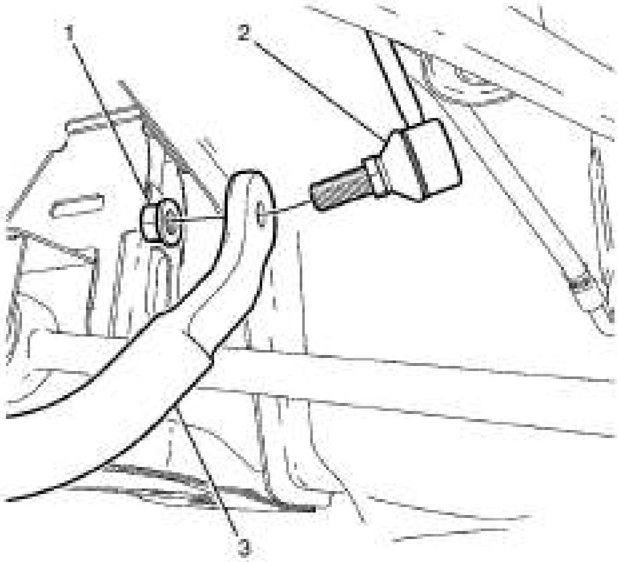


5. Remove the stabiliser bar link to strut assembly retaining nut (2).

   Discard the nut.

6. Remove the stabiliser link bar (1) from the strut assembly bracket (3).
7. Inspect all parts for wear and damage.

Installation Procedure



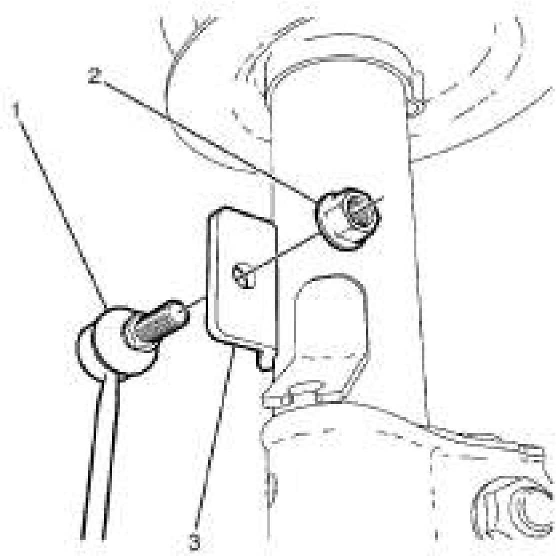
Important: Install the shorter link end to the stabilizer bar.

1. Install the stabiliser bar link (2) to the stabiliser bar (3).

   Caution: Refer to Fastener Notice in the Preface section.

2. Install the NEW stabiliser bar link to stabiliser bar retaining nut (1).

   Tighten
   Tighten the nut to 50 N·m (37 lb ft).



Important: Install the longer link end to the strut.

3. Install the stabiliser bar link (1) to the strut assembly bracket (3).
4. Install the NEW stabiliser bar link to strut assembly retaining nut (2).

   Tighten
   Tighten the nut to 50 N·m (37 lb ft).

5. Install the front wheel. Refer to Tire and Wheel Removal and Installation.
6. Remove the safety stands.
7. Lower the vehicle to the ground.

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Stabilizer Shaft Replacement

Tools Required

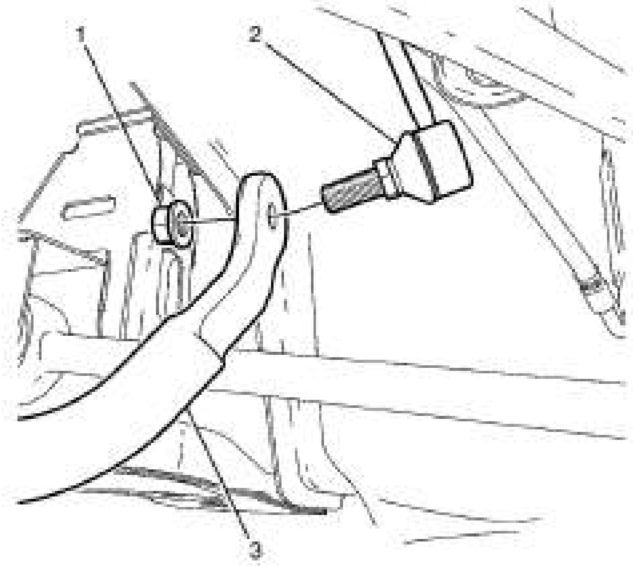
6297 Ball Joint Release Tool.

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the front wheel. Refer to Tire and Wheel Removal and Installation.

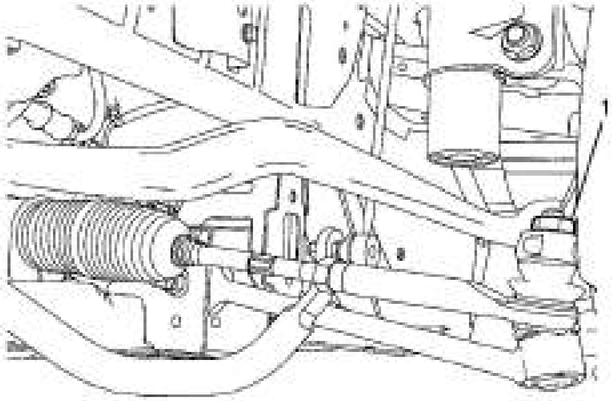


Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

3. Remove the stabiliser bar link to stabiliser bar retaining nut (1) from both sides of the stabiliser bar.

   Discard the nuts.

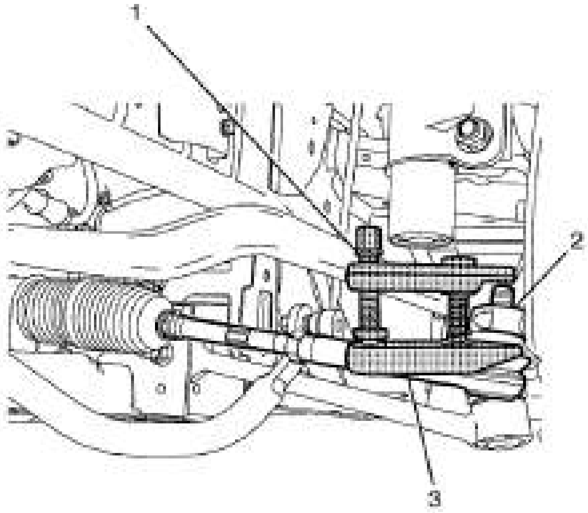
4. Disconnect the stabiliser bar link (2) from the stabiliser bar (3) from both sides of the stabiliser bar.



Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

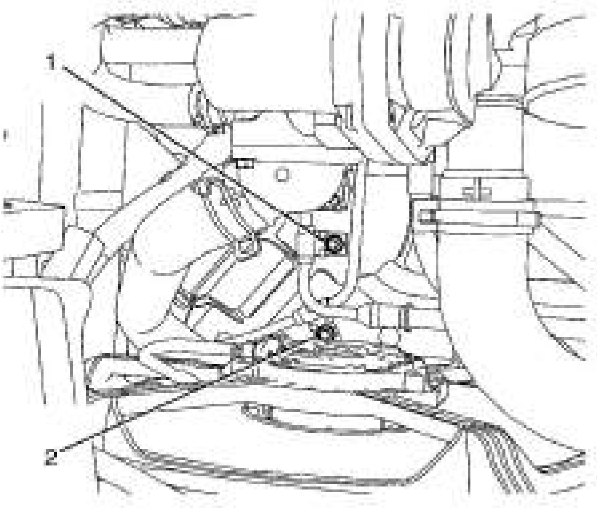
5. Remove the tie rod end ball joint to steering knuckle retaining nut (1) on both sides of the vehicle.

   Discard the nuts.



Important: Once a load is applied by the ball joint release tool loading bolt, a quick tap on the nut end of the tool will reduce the separating force required.

6. Disconnect the tie rod (3) from the steering knuckle (2) using the 6297 (1) on both sides of the vehicle.
7. Remove the mass air flow (MAF) sensor. Refer to Mass Airflow Sensor/Intake Air Temperature Sensor Replacement for 3.6L engine or Mass Airflow Sensor/Intake Air Temperature Sensor Replacement for 6.0L engine.
8. Remove the upper section of the air box. Refer to Air Cleaner Assembly Replacement for 3.6L engine or Air Cleaner Assembly Replacement for 6.0L engine.



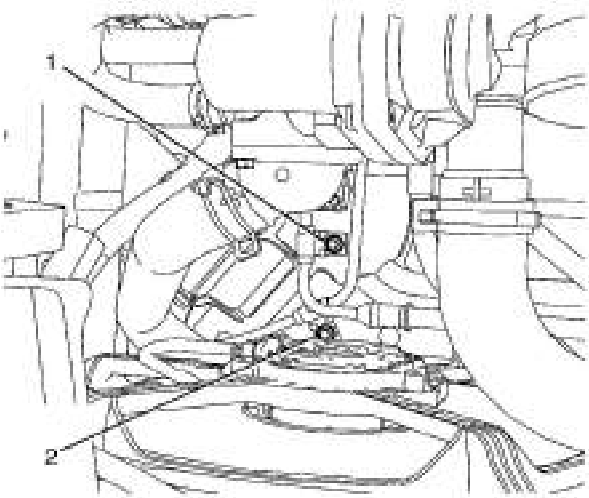
9. Remove the power steering gear inlet pipe/hose bracket to subframe retaining bolt (2).
10. Remove the power steering gear outlet pipe/hose bracket to subframe retaining bolt (1).
11. Remove the stabiliser bar insulators from the stabiliser bar. Refer to Stabilizer Shaft Insulator Replacement .
12. Remove the stabiliser bar from the vehicle.

Installation Procedure

Notice: Refer to Fastener Tightening Specifications in the Preface section.

1. Install the stabiliser bar to the vehicle.
2. Install the stabiliser bar insulators. Refer to Stabilizer Shaft Insulator Replacement .
3. Install the mass air flow (MAF) sensor. Refer to Mass Airflow Sensor/Intake Air Temperature Sensor Replacement for 3.6L engine or Mass Airflow Sensor/Intake Air Temperature Sensor Replacement for 6.0L engine.
4. Install the upper section of the air box. Refer to Air Cleaner Assembly Replacement for 3.6L engine or Air Cleaner Assembly Replacement for 6.0L engine.

Notice: Refer to Fastener Notice in the Preface section.

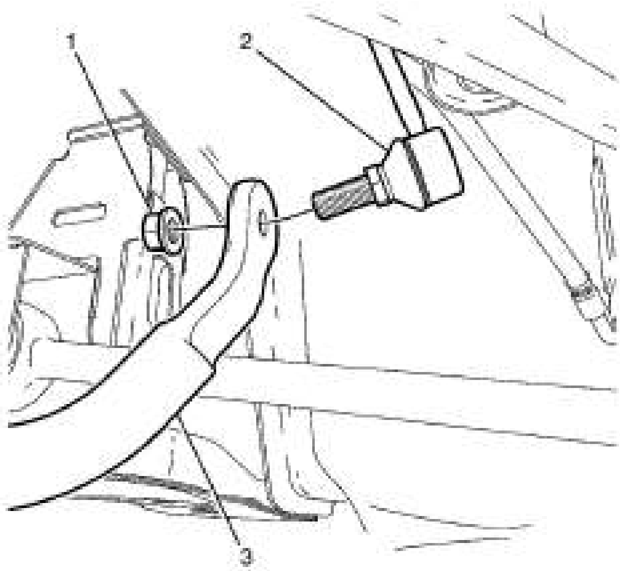


5. Remove the power steering gear inlet pipe/hose bracket to subframe retaining bolt (2).

   Tighten
   Tighten the bolt to 9 N·m (80 lb in).

6. Remove the power steering gear outlet pipe/hose bracket to subframe retaining bolt (1).

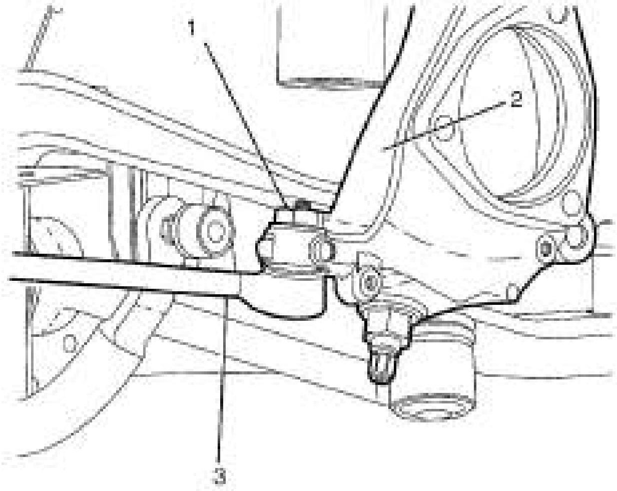
   Tighten
   Tighten the bolt to 9 N·m (80 lb ft).



7. Install the stabiliser bar link (2) to the stabiliser bar (3) to both sides of the vehicle.
8. Install the NEW stabiliser bar link to stabiliser bar retaining nut (1) to both sides of the

vehicle.

Tighten
Tighten the nut to 50 N·m (37 lb ft).



9. Install the tie rod (3) to the steering knuckle (2) on both sides of the vehicle.
10. Install the NEW tie rod to steering knuckle retaining nut (1) on both sides of the vehicle.

Tighten
Tighten the nut to 70 N·m (52 lb ft).

11. Install the front wheel. Refer to Tire and Wheel Removal and Installation .
12. Remove the safety stands.
13. Lower the vehicle to the ground.

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Steering Knuckle Replacement

Tools Required

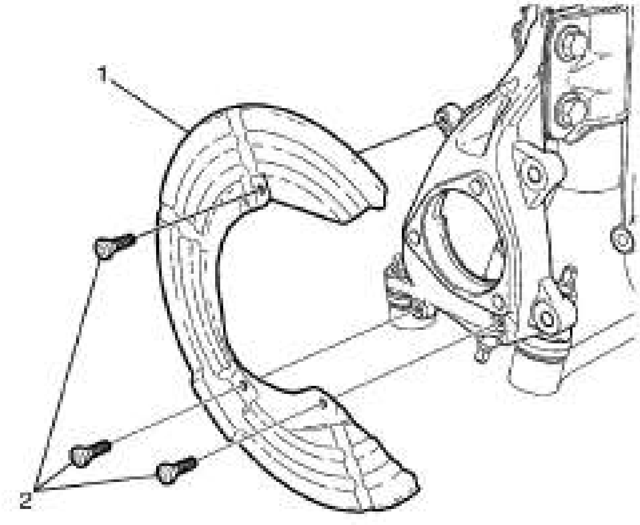
- 6297 6297 Ball Joint Release Tool.
- E7115 E7115 Angle Wrench.

Removal Procedure

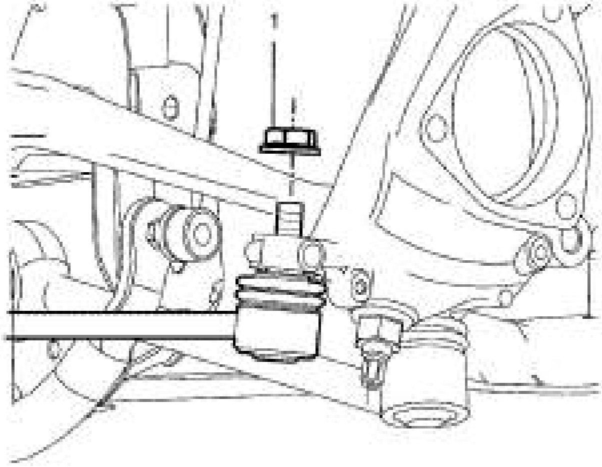
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the VehicleLifting and Jacking the Vehicle.
2. Remove the front wheel. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation.
3. Remove the front wheel hub assembly. Refer to Front Wheel Bearing and Hub ReplacementFront Wheel Bearing and Hub Replacement.



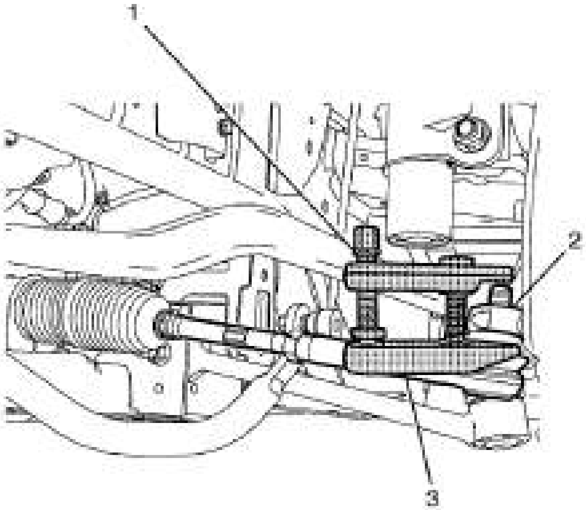
4. Remove the brake disc splash shield to steering knuckle retaining bolts (2).
5. Remove the brake disc splash shield (1) from the steering knuckle.



Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

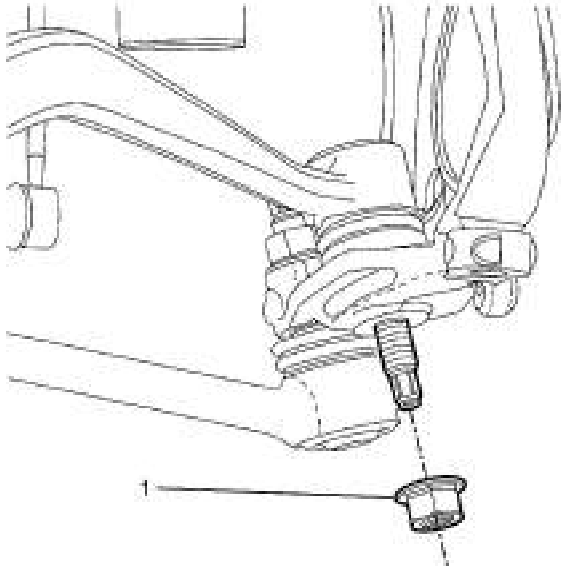
6. Remove the tie rod end to steering knuckle retaining nut (1).

   Discard the nut.



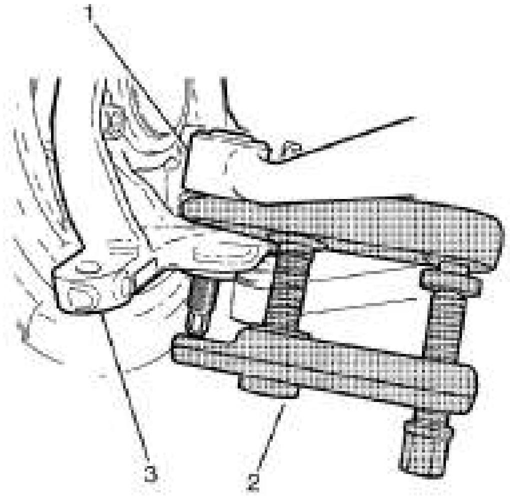
Important: Once a load is applied by the ball joint release tool loading bolt, a quick tap on the nut end of the tool will reduce the separating force required.

7. Disconnect the tie rod (3) from the steering knuckle (2) using the 6297 6297 (1).



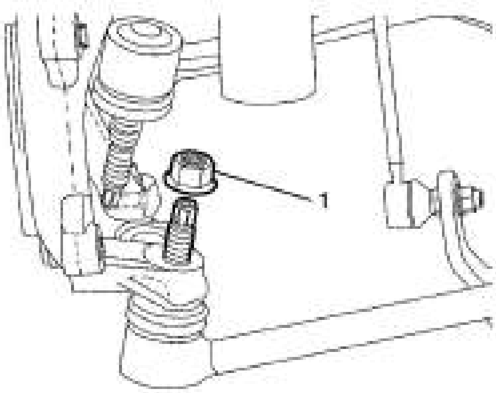
8. Remove the caster arm to steering knuckle retaining nut (1).

   Discard the nut.



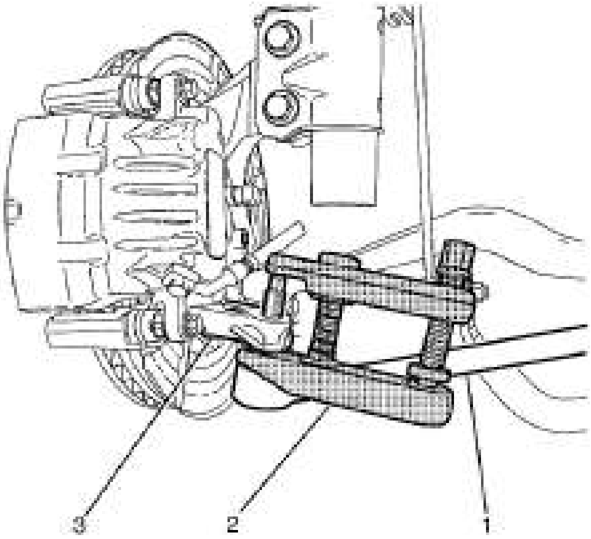
Important: Once a load is applied by the ball joint release tool loading bolt, a quick tap on the nut end of the tool will reduce the separating force required.

9. Separate the caster arm (1) from the steering knuckle (3) using the 6297 6297 (2).
10. Remove the 6297 6297 (2).
11. Disconnect the caster arm (1) from the steering knuckle (3).



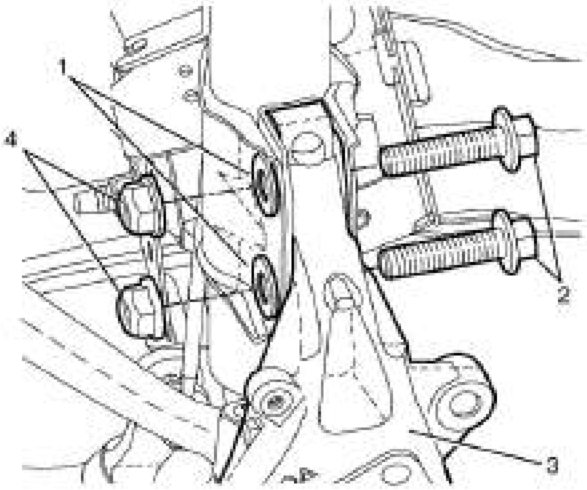
12. Remove the control arm to steering knuckle retaining nut (1).

    Discard the nut.



Important: Once a load is applied by the ball joint release tool loading bolt, a quick tap on the nut end of the tool will reduce the separating force required.

13. Separate the control arm (1) from the steering knuckle (3) using the 6297 6297 (2).
14. Remove the 6297 6297 (2).
15. Disconnect the control arm (1) from the steering knuckle (3).

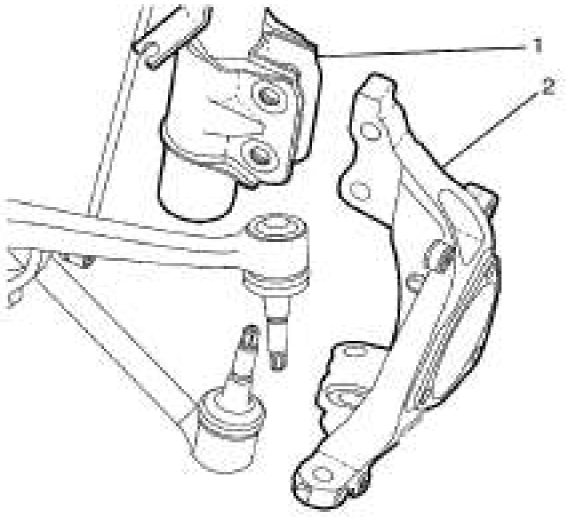


Important: The strut assembly to steering knuckle retaining bolts (2) nuts (4) and washers (1) are single use parts. They must be discarded after removal.

Important: Suitably support the steering knuckle (3) before removing strut assembly to steering knuckle retaining bolts (2)

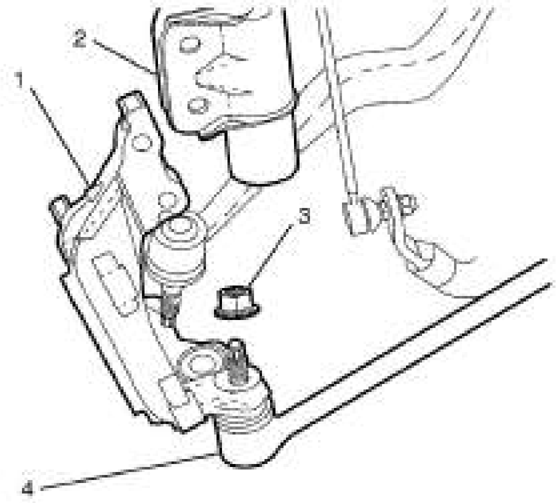
16. Remove the strut assembly to steering knuckle retaining bolts (2) nuts (4) and washers (1).

    Discard the bolts, nuts and washers.



17. Remove the steering knuckle (2) from the strut assembly (1).

Installation Procedure



1. Install the steering knuckle (1) to the control arm (4).

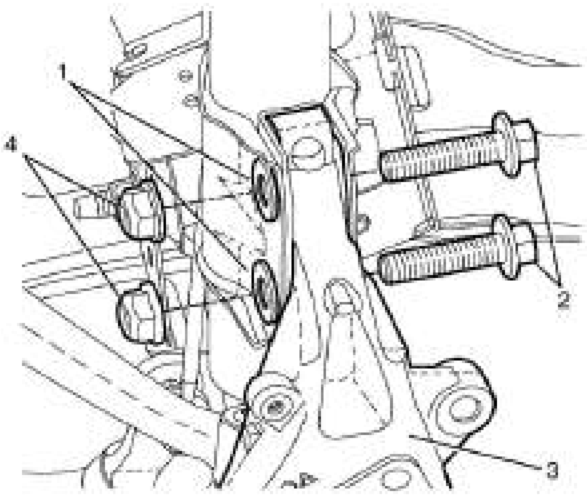
   Notice: Refer to Fastener Notice in the Preface section.

2. Install the NEW control arm to steering knuckle retaining nut (3).

   Tighten
   Tighten the nuts a first pass to 40 N·m (30 lb ft).

   Tighten
   Tighten the nuts an additional 60 degrees.

3. Install the steering knuckle (1) to the strut assembly (2).

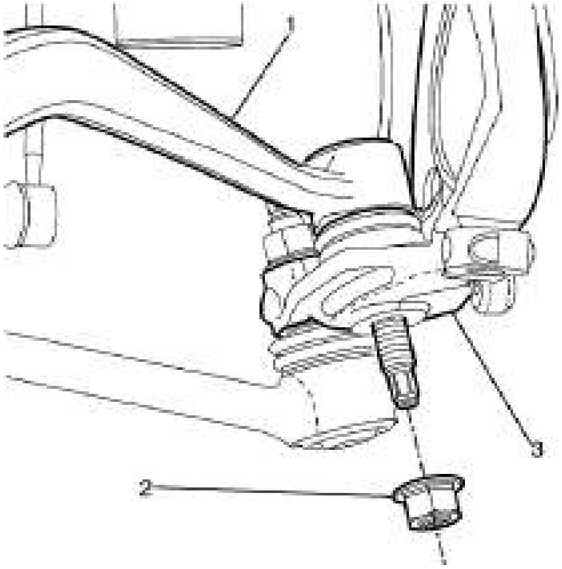


Important: The steering knuckle (3) to strut assembly retaining bolts (2), nuts (4) and washers (1) are not to be fully tightened at this stage.

4. Install the NEW steering knuckle to strut assembly retaining bolts (2), nuts (4) and washers (1).

   Do not fully tighten at this stage.

5. Install the caster arm to the steering knuckle.

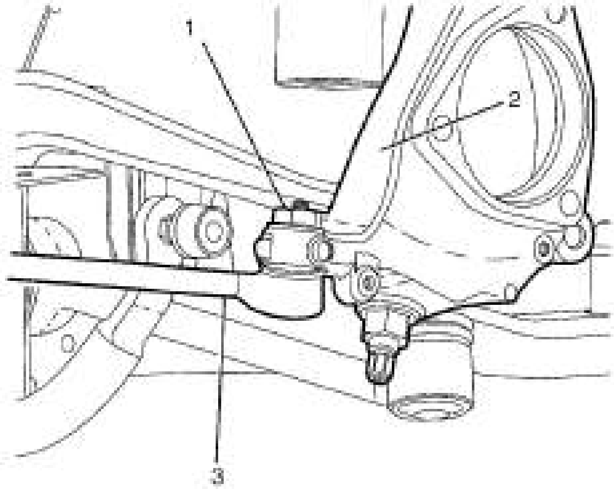


6. Install the NEW caster arm (1) to steering knuckle (3) retaining nut (2).

   Tighten

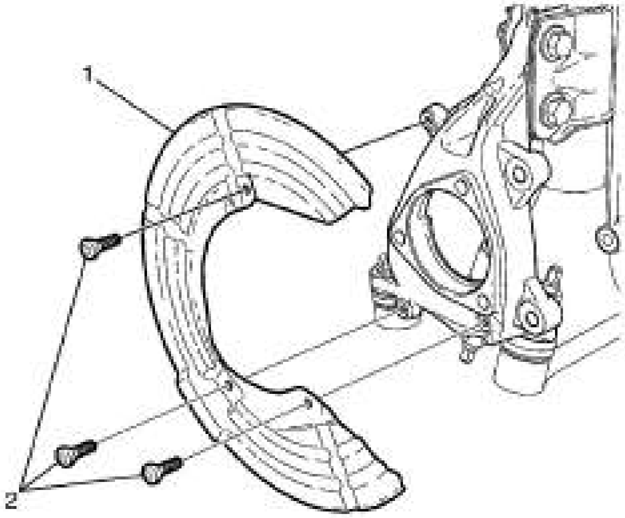
Tighten the nuts a first pass to 40 N·m (30 lb ft).

Tighten
Tighten the nuts an additional 60 degrees.



7. Install the tie rod (3) to the steering knuckle (2).
8. Install the NEW tie rod to steering knuckle retaining nut (1).

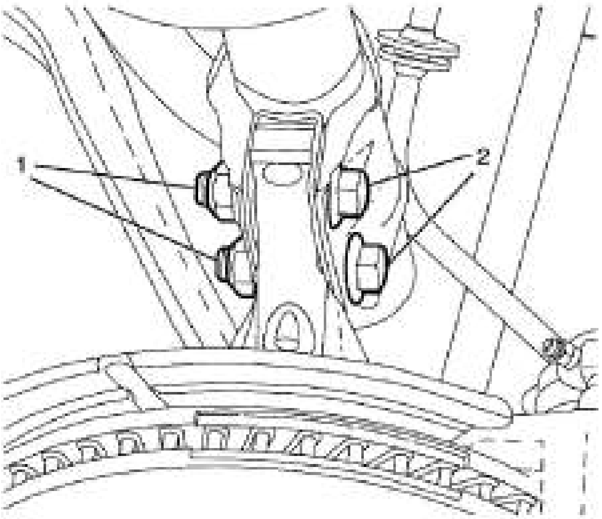
Tighten
Tighten the nut to 25 N·m+ 120 degrees (18 lb ft + 120 degrees).



9. Install the brake disc splash shield (1).
10. Install the brake disc splash shield to steering knuckle retaining bolts (2).

    Tighten
    Tighten the bolts to 9 N·m (80 lb in).

11. Install the front wheel hub assembly. Refer to Front Wheel Bearing and Hub ReplacementFront Wheel Bearing and Hub Replacement.



Important: If the steering knuckle has been replaced, the end-float measurement must be checked. Refer to Front Wheel Hub Assembly InspectionFront Wheel Hub Assembly Inspection.

12. Install the front wheel. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation.
13. Remove the safety stands.
14. Lower the vehicle to the ground.
15. Bounce the vehicle several times to settle the suspension.
16. Check and adjust the wheel alignment. Refer to Wheel Alignment MeasurementWheel Alignment Measurement.
17. Tighten the strut assembly to steering knuckle retaining bolts (2) and nuts (1).

    Tighten
    Tighten the bolts a first pass to 100 N·m (74 lb ft).

    Tighten
    Tighten the bolts an additional 90 degrees.

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Strut Assembly Replacement (LWB SWB Clubsport CSV VXR8)

Tools Required

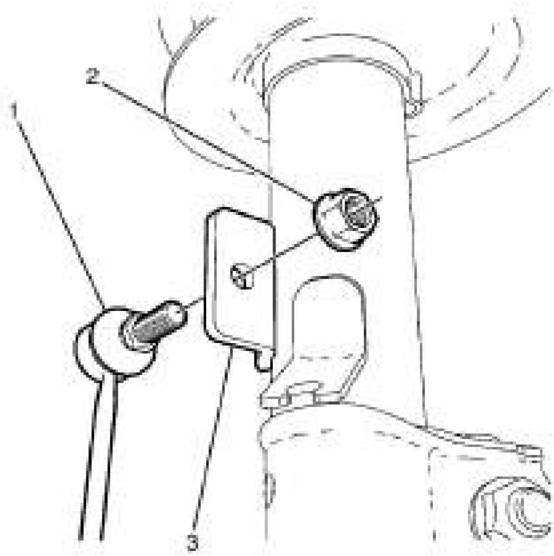
E7115 E7115 Angle Wrench.

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the VehicleLifting and Jacking the Vehicle.
2. Remove the front wheel. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation.

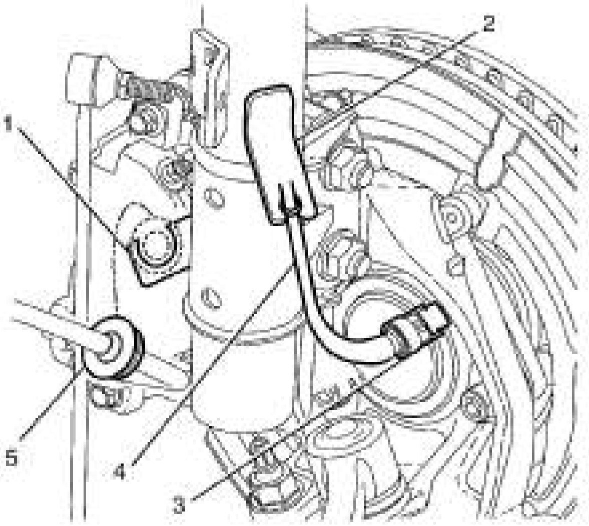


Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

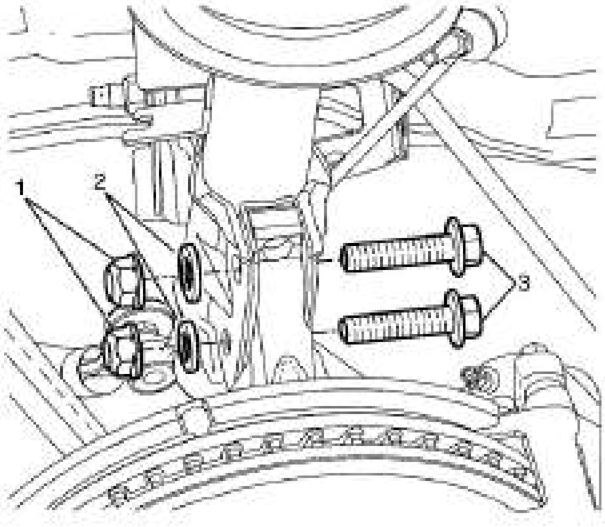
3. Remove the stabiliser bar link to strut assembly retaining nut (2).

   Discard the nut.

4. Disconnect the stabiliser bar link (1) from the strut assembly bracket (3).



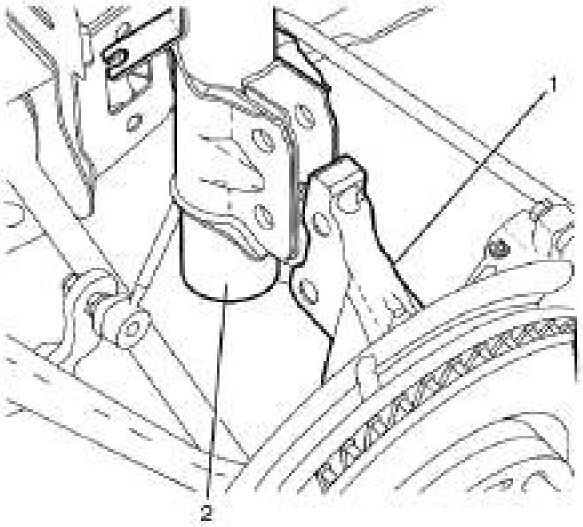
5. Disconnect the wheel speed sensor electrical connector (3).
6. Disconnect the wheel speed sensor wiring harness (4) from the strut assembly bracket (2).
7. Disconnect the brake hose (5) from the strut bracket (1).



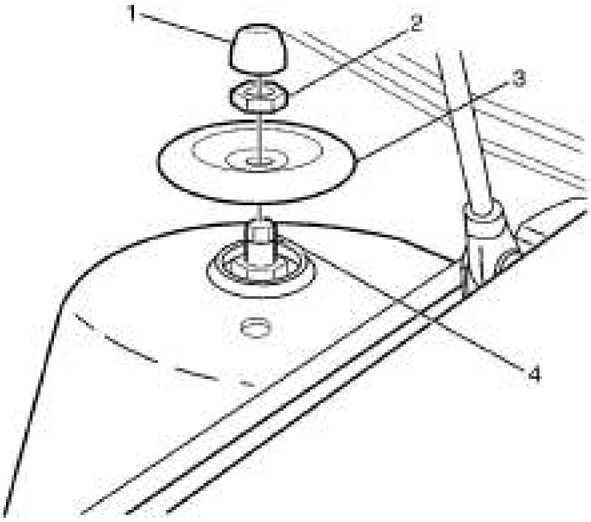
Important: The strut assembly to steering knuckle retaining bolts (3) nuts (1) and washers (2) are single use parts. They must be discarded after removal.

8. Remove the strut assembly to steering knuckle retaining bolts (3), nuts (1) and washers (2).

   Discard the bolts, nuts and washers.



9. Disconnect the steering knuckle (1) from the strut assembly (2).
10. Lower the vehicle.



11. Remove the stud dust cover (1) from the strut assembly to body retaining nut (2).

    Important: The strut assembly (4) must be supported from underneath before the strut assembly to body retaining nut (2) is removed.

12. Remove the strut assembly to body retaining nut (2) while holding the strut piston shaft (4).

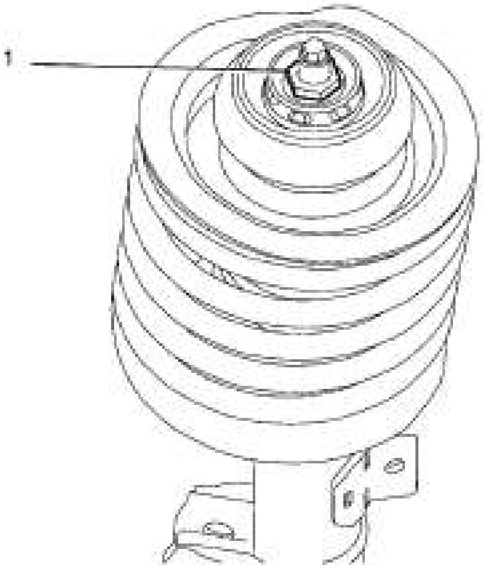
    Discard the nut.

13. Remove the strut assembly to body retaining plate (3).
14. Remove the strut assembly from the vehicle.

15. Inspect all parts for wear and damage.

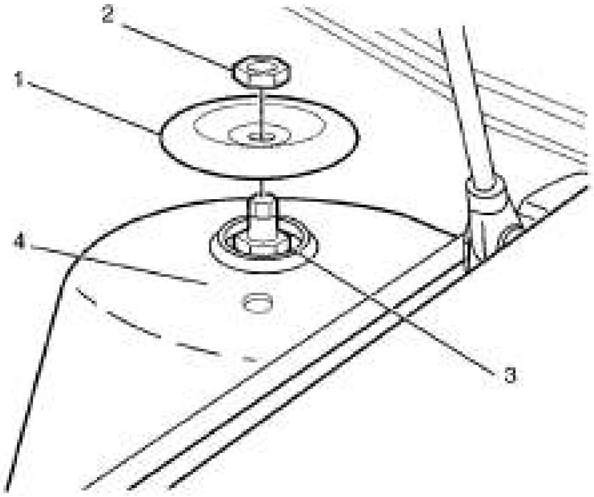
Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



Important: The strut assembly retaining nut (1) must be checked for correct torque before installing the strut assembly into the vehicle. The strut assembly retaining nut torque must be 75 N·m (55 lb ft).

1. Check the torque of the strut assembly retaining nut (1), correct if necessary.



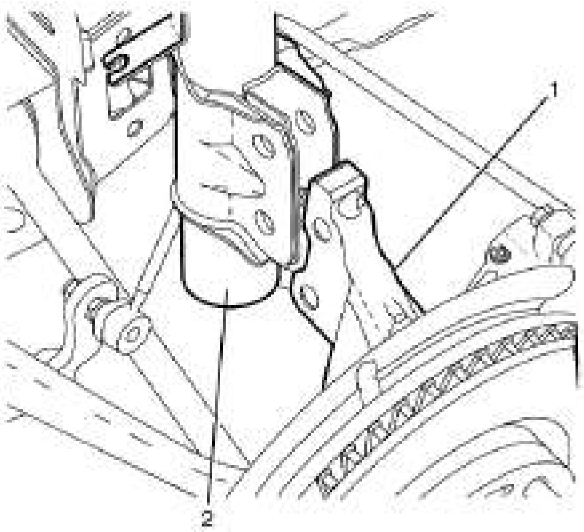
2. Install the strut assembly (3) to the vehicle (4).
3. Install strut assembly to body retaining plate (1).

Important: The strut assembly to body retaining nut (2) must not be fully tightened at this stage.

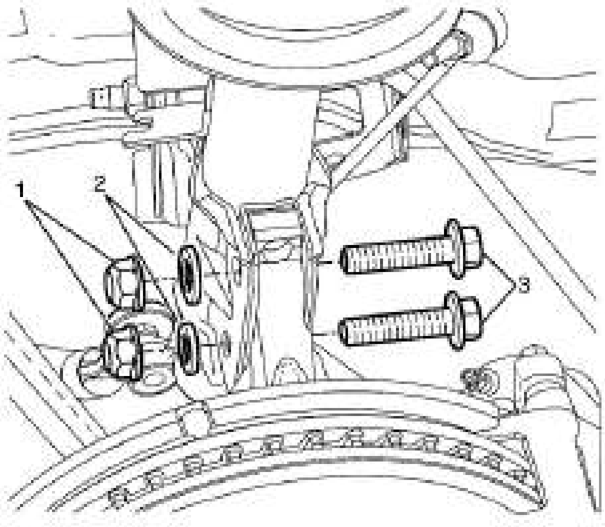
4. Install the NEW strut assembly to body retaining nut (2) to the strut assembly (3).

   Do not fully tighten at this stage.

5. Raise the vehicle.



6. Install the steering knuckle (1) to the strut assembly (2).



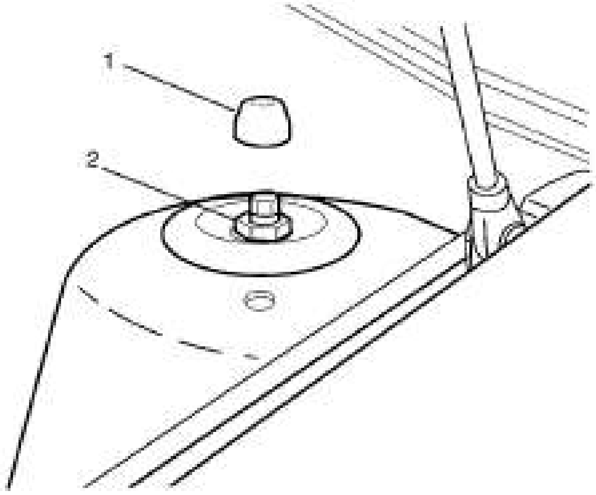
Important: Pivot the hub and steering knuckle assembly sufficiently to line up the bolt holes in the steering knuckle and strut assembly.

Important: The strut assembly to steering knuckle retaining bolts (3) and nuts (1) must not be fully tightened at this stage.

7. Install the NEW Strut assembly to steering knuckle retaining bolts (3), nuts (1) and washers (2).

   Do not fully tighten at this stage.

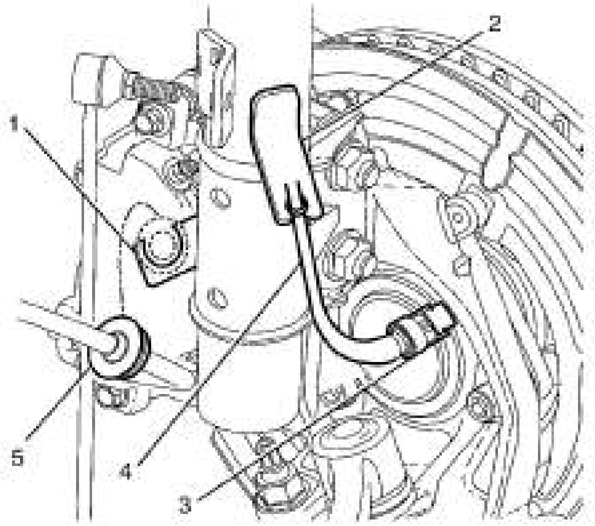
8. Lower the vehicle.



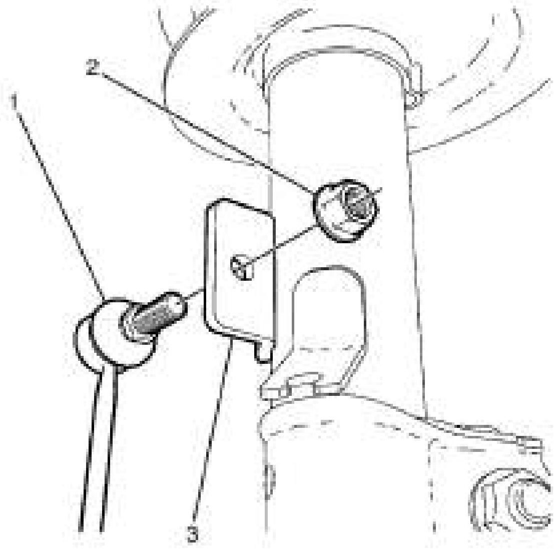
9. Tighten the NEW strut assembly to body retaining nut (2).

   Tighten
   Tighten the nut to 55 N·m (40 lb ft).

10. Install the dust cover (1) to the strut assembly to body retaining nut (2).
11. Raise the vehicle.



12. Install the brake hose (5) to the strut assembly bracket (1).
13. Connect the wheel speed sensor electrical connector (3).
14. Install the wheel speed sensor wiring harness (4) to the strut assembly bracket (2).

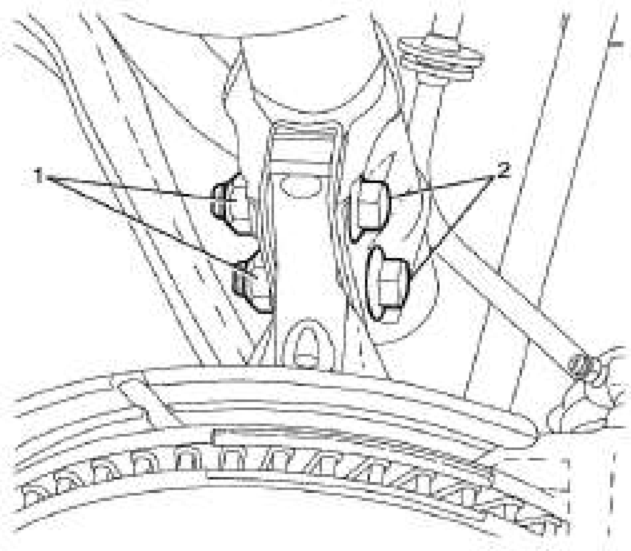


15. Connect the stabiliser bar link (1) to the strut assembly bracket (3).
16. Install the stabiliser bar link to strut assembly bracket retaining nut (2).

    Tighten
    Tighten the nut to 50 N·m (37 lb ft).

17. Install the front wheel. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation.
18. Remove the safety stands.
19. Lower the vehicle to the ground.

20. Bounce the vehicle several times to settle the suspension.
21. Check and adjust the wheel alignment. Refer to Wheel Alignment MeasurementWheel Alignment Measurement in Wheel Alignment.



22. Tighten the strut assembly to steering knuckle retaining bolts (2) and nuts (1).

Tighten
Tighten the nuts a first pass to 100 N·m (74 lb ft).

Tighten
Tighten the nuts an additional 90 degrees.

Wheel Stud Replacement

Tools Required

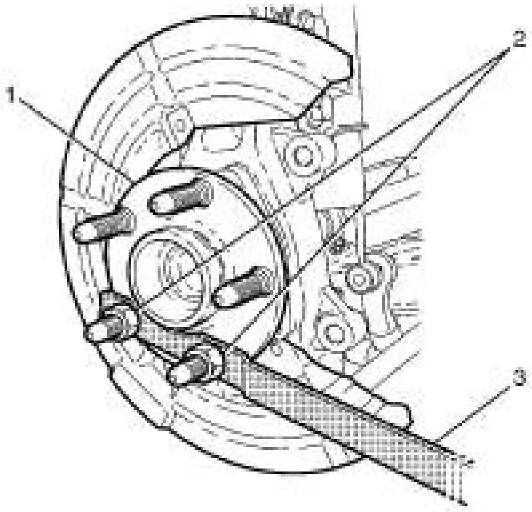
- C-4150-C Press Tool.
- KM-468 Holding Bar.

Removal Procedure

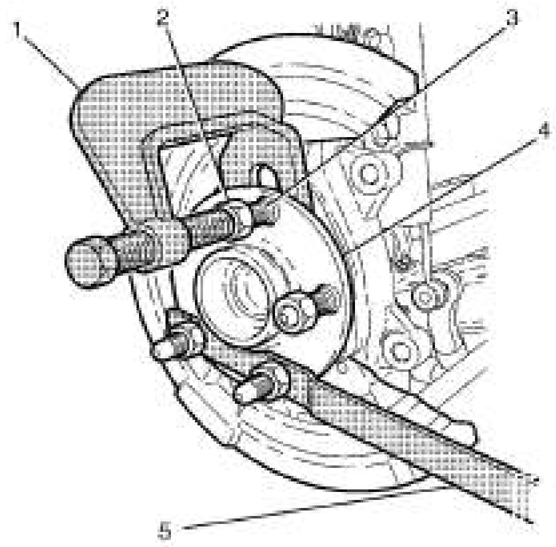
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the front wheel. Refer to Tire and Wheel Removal and Installation .
3. Remove the brake disc. Refer to Front Brake Rotor Replacement .

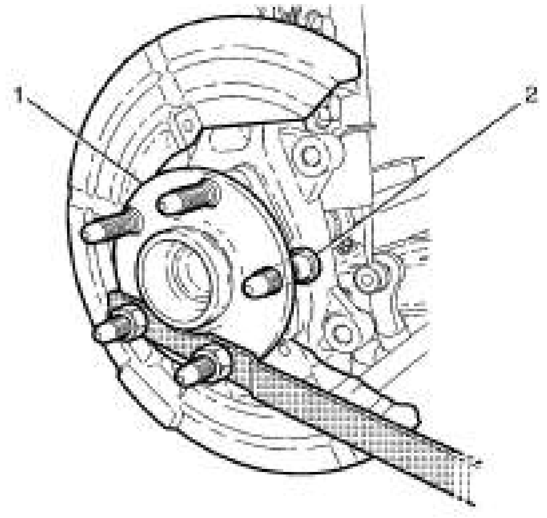


4. Attach the KM-468 (3), to the wheel hub (1) using two inverted wheel nuts (2).

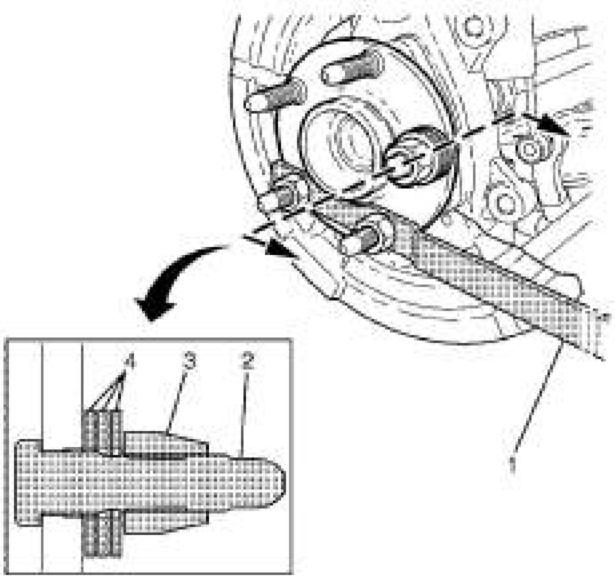


5. Install a wheel nut (2) flush with the end of the wheel stud (3).
6. Secure the KM-468 (5) and remove the wheel stud (3) from the wheel hub (4) using the C-4150-C (1).
7. Repeat steps 5 and 6 for any additional wheel studs that require replacement.

Installation Procedure



1. Install the replacement wheel stud (2) to the wheel hub flange (1).



Important: Suitable sized spacing washers (4) must be used to seat the wheel stud (2) fully.

2. Install spacing washers (4) and a inverted wheel nut (3) onto the replacement wheel stud (2).
3. Secure the KM-468 (1) and tighten the wheel nut (3) to pull the wheel stud (2) into place.
4. Remove the wheel nut (3) and spacing washers (4).
5. Repeat steps 1 to 4 for any additional studs that require replacement.
6. Remove the KM-468 (1).
7. Install the brake disc. Refer to Front Brake Rotor Replacement .
8. Install the front wheel. Refer to Tire and Wheel Removal and Installation .
9. Remove the safety stands.
10. Lower the vehicle to the ground.

General Description

The front suspension has 2 primary purposes:

- Isolate the driver from irregularities in the road surface.
- Define the ride and handling characteristics of the vehicle.

The front suspension absorbs the impact of the tyres travelling over irregular road surfaces and dissipates this energy throughout the suspension system. This process isolates the vehicle occupants from the road surface. The rate at which the suspension dissipates the energy and the amount of energy that is absorbed is how the suspension defines the vehicles ride characteristics. Ride characteristics are designed into the suspension system and are not adjustable. The ride characteristics are mentioned in this description in order to aid in the understanding of the functions of the suspension system. The suspension system must allow for the vertical movement of the tyre and wheel assembly as the vehicle travels over irregular road surfaces while maintaining the tyre's horizontal relationship to the road.

This requires that the steering knuckle be suspended between a lower control arm and a strut assembly. The lower control arm attaches from the steering knuckle at the outermost point of the control arm. The attachment is through a ball and socket type joint. The innermost end of the control arm is attached to the vehicle frame through a bushing. The upper portion of the steering knuckle is attached to a strut assembly by two bolts and nuts. The strut assembly then connects to the vehicle's body by way of a support bearing and mount. The steering knuckle is allowed to travel up and down independent of the vehicle body structure and frame. A shock absorber is used in conjunction with this system in order to dampen out the oscillations of the coil spring. A shock absorber is a basic hydraulic cylinder.

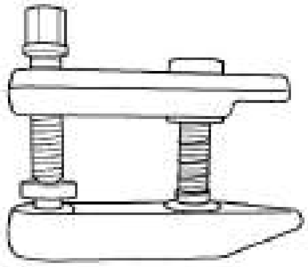
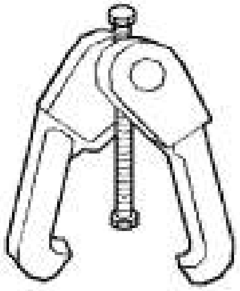
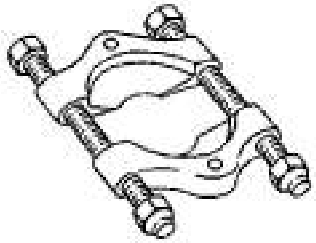
The shock absorber is filled with oil and has a moveable shaft that connects to a piston inside the strut unit. Valves inside the shock absorber offer resistance to oil flow and consequently inhibit rapid movement of the piston and shaft. Each end of the shock absorber is connected in such a fashion to utilise this recoil action of a spring alone. Each end of the strut unit is designed as the connection point of the suspension system to the vehicle and acts as the coil spring seat. This allows the strut assembly to utilise the dampening action to reduce the recoil of a spring alone.

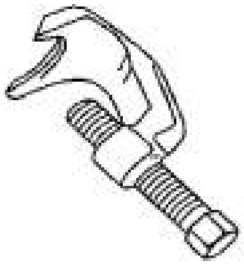
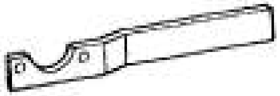
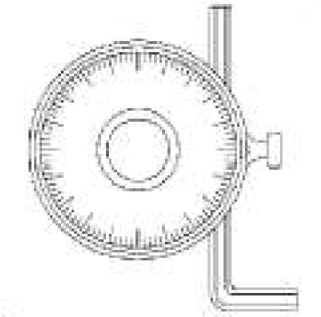
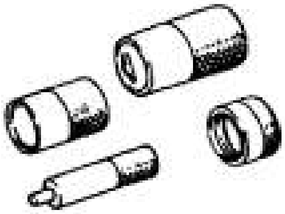
The lower control arm is allowed to pivot at the vehicle frame in a vertical fashion. The ball joint allows the steering knuckle to maintain the perpendicular relationship to the road surface. The subframe is bolted to both longitudinal frame side members. The front subframe to side member attaching bolts incorporate a tapered boss near the head of the bolt on the front bolts, to assist in front subframe to body alignment during assembly while the pivots of the front control arms are rubber bushed and are attached to the subframe by bolts and nuts.

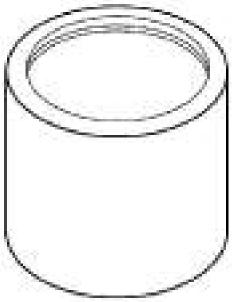
A stabiliser bar is mounted to the subframe by two brackets and insulating rubbers. The link connecting the stabiliser bar to each front suspension strut assembly has a ball joint and nut at each end. There are numerous configurations for each suspension option, depending on body type and powertrain combination. For further information regarding the identification of which suspension option is fitted to a particular vehicle, refer to Vehicle, Engine and Transmission ID and VIN Location, Derivative and Usage. For all other information regarding the suspension specification fitted to a particular vehicle, refer to Fastener Tightening Specifications.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Suspension | Front Suspension | Special Tools and Equipment | **Document ID: 1989979**

Special Tools

Illustration	Tool Number / Description
	CH-49405 Steering Linkage and Tie Rod Puller
	7311 Universal Puller
	7A42 Press Plates
	C4150

	Press Tool
	KM 468 Holding Bar
	E7115 Angle Wrench
	KM619 Front Control Link Bushing Remover and Installer

	CH-48510 Front Control Link Bushing Installaing Support Sleeve

Fastener Tightening Specifications (SWB)

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Disc Brake Backing Plate to Knuckle Retaining Bolt - Upper	60 N·m	44 lb ft
Disc Brake Backing Plate to Knuckle Retaining Bolts - Lower	130 N·m	96 lb ft
I-Link to Knuckle Retaining Bolt	140 N·m	103 lb ft
I-Link to Subframe Retaining Bolt and Nut	175 N·m	129 lb ft
Lower Control Arm to Knuckle Retaining Bolt and Nut		
• First Pass	40 N·m	30 lb ft
• Final Pass	120 Degrees	
Lower Control Arm to Subframe Retaining Bolt	175 N·m	129 lb ft
Lower Control Arm to Strut Assembly Retaining Bolt and Nut		
• First Pass	40 N·m	30 lb ft
• Final Pass	120 Degrees	
Rear Drive Shaft to Rear Hub Retaining Nut There are two alternate methods of achieving the required Rear Hub Retaining Nut torque. **Important:** DO NOT EXCEED THE SPECIFIED TIGHTENING VALUES, otherwise premature bearing failure may result.		
Preferred Method		
• First Pass	150 N·m	110 lb ft
• Loosen	-180 Degrees	
• Final Pass	425 N·m	313 lb ft
Alternate Method		
• First Pass	150 N·m	110 lb ft
• Loosen	-180 Degrees	
• Second Pass	50 N·m	37 lb ft
• Final Pass	45 Degrees	
Stabiliser Bar Insulator Bracket to Subframe Retaining Bolts	22 N·m	16 lb ft
Stabiliser Bar Link to Lower Control Arm Retaining Nut	50 N·m	37 lb ft
Stabiliser Bar Link to Stabiliser Bar Retaining Nut	50 N·m	37 lb ft
Strut Assembly Retaining Nut	45 N·m	33 lb ft
Strut Assembly to Body Retaining Bolts	58 N·m	43 lb ft
Upper Control Arm Ball Joint to Subframe Retaining Bolt and Nut		
• First Pass	80 N·m	59 lb ft
• Final Pass	120 Degrees	

Upper Control Arm Pivot Bushing Bracket to Subframe Retaining Bolts		
● First Pass	40 N·m	29 lb ft
● Final Pass	90 Degrees	
Upper Control Arm Pivot Bushing to Upper Control Arm Retaining Bolt	170 N·m	125 lb ft
Upper Control Arm to Knuckle Retaining Bolt and Nut		
● First Pass	60 N·m	44 lb ft
● Final Pass	90 Degrees	
Wheel Speed Sensor to Knuckle Retaining Bolt	7 N·m	62 lb In
Y-Link to Knuckle Retaining Bolt and Nut		
● First Pass	40 N·m	30 lb ft
● Final Pass	120 Degrees	
Y-Link to Subframe Retaining Bolt and Nut	100 N·m	74 lb ft

Rear Coil Spring Specifications

Suspension Configuration	Number of Coils	Free Length mm (in)	Main Body Inside Diameter mm (in)	Spring Rate and Type N/mm (lb/in)	Production I.D Code
FE1 Sedan	8.6	365 mm (14.37 in)	98 mm (3.85 in)	43 - 53 N/mm (240 - 297 lb/in)	DK
FE2 Sedan	8.0	354 mm (13.93 in)	98 mm (3.85 in)	47 - 55 N/mm (263 - 308 lb/in)	CL
FR1	9.1	379 mm (14.92 in)	98 mm (3.85 in)	43 - 53 N/mm (240 - 297 lb/in)	CM

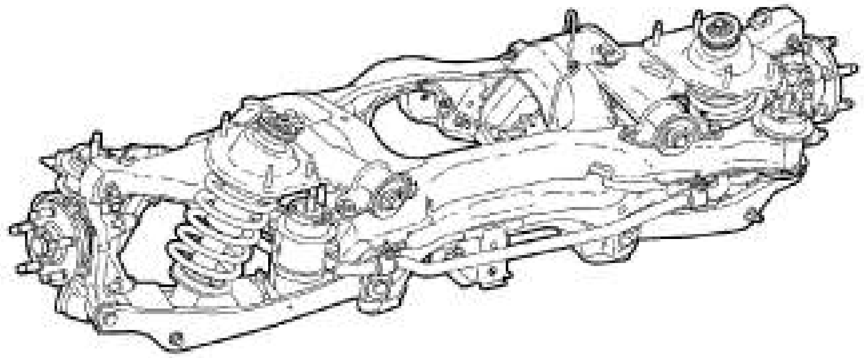
Rear Stabiliser Bar Specifications

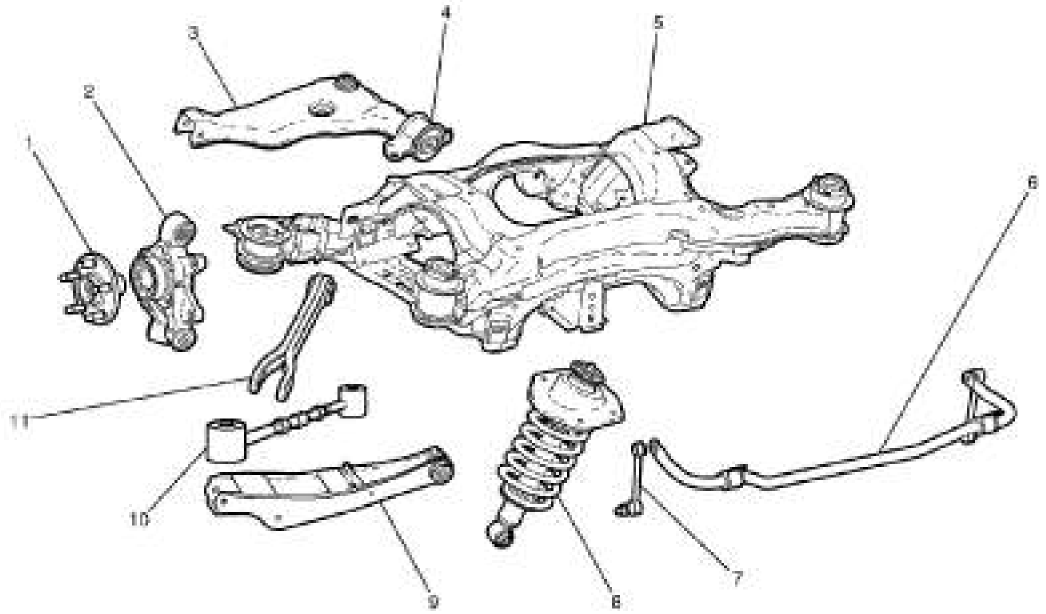
Suspension Configuration	Diameter mm (in)	Production I.D Code
FE1 Sedan	16 mm (.62 in)	AK
FE2 Sedan	18 mm (.70 in)	AJ

Rear Strut Unit Specifications

Suspension Configuration	I.D Code
FE1 Sedan	CR
FE2 Sedan	CS
FR1	CT

Rear Suspension

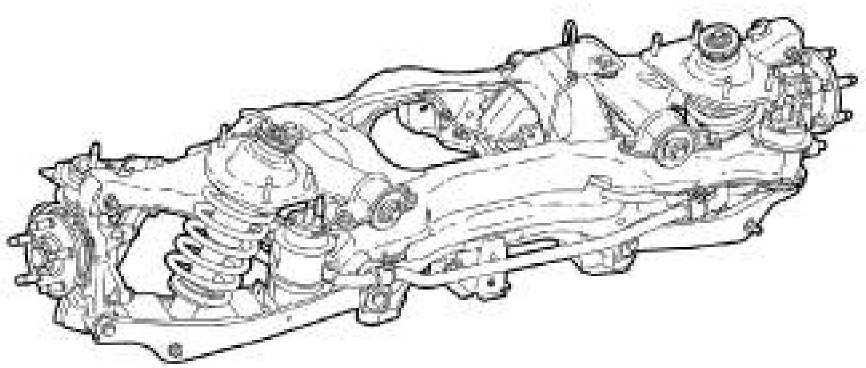


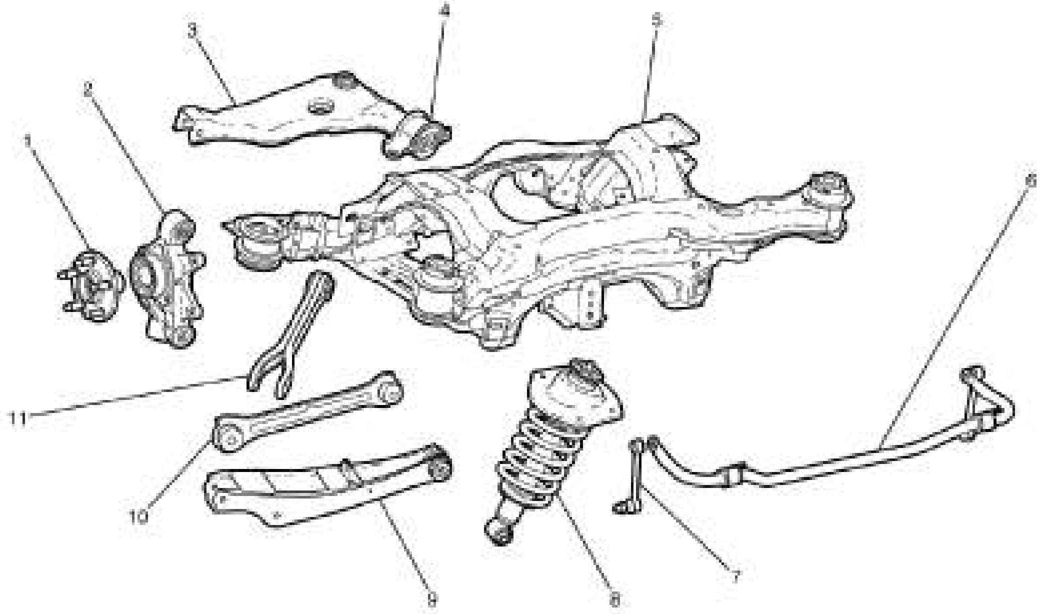


(1) Wheel Hub Assembly
(2) Wheel Hub Knuckle
(3) Upper Control Arm
(4) Upper Control Arm Pivot Bushing and Bracket Assembly
(5) Subframe
(6) Stabiliser Bar
(7) Stabiliser Bar Link
(8) Strut Assembly
(9) Lower Control Arm
(10) I-Link
(11) Y-Link

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Suspension | Rear Suspension | Component Locator | Document ID: 2034217

Rear Suspension Component Locator





(1) Wheel Hub Assembly
(2) Wheel Hub Knuckle
(3) Upper Control Arm
(4) Upper Control Arm Pivot Bushing and Bracket Assembly
(5) Subframe
(6) Stabiliser Bar
(7) Stabiliser Bar Link
(8) Strut Assembly
(9) Lower Control Arm
(10) I-Link
(11) Y-Link

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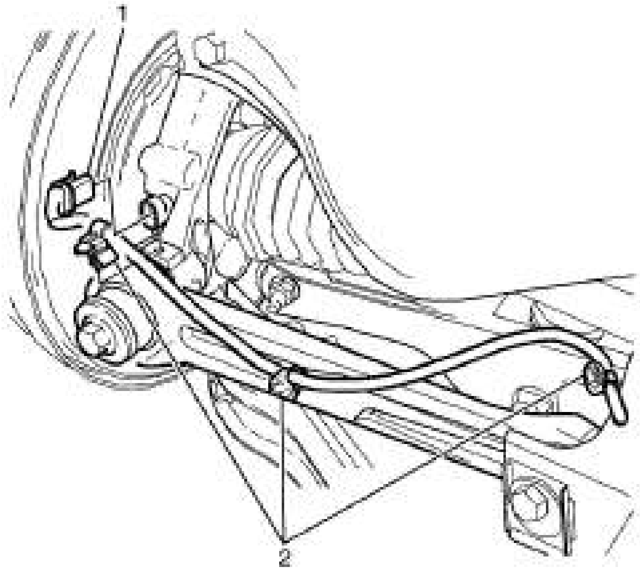
Adjust Link Replacement (LWB SWB)

Removal Procedure

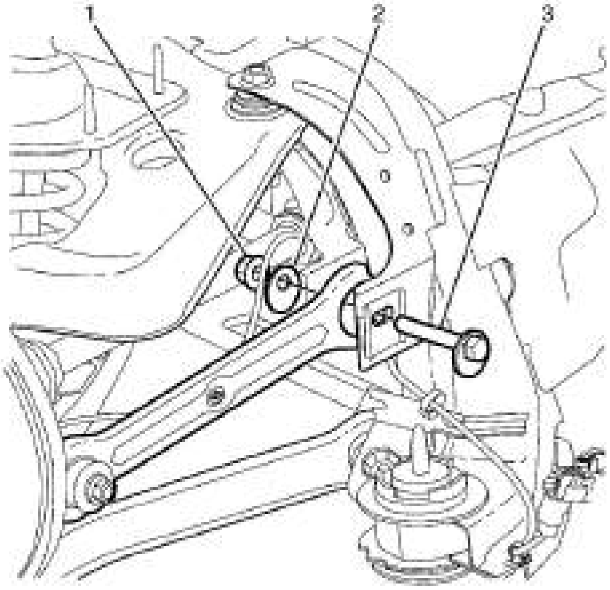
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear wheel. Refer to Tire and Wheel Removal and Installation.

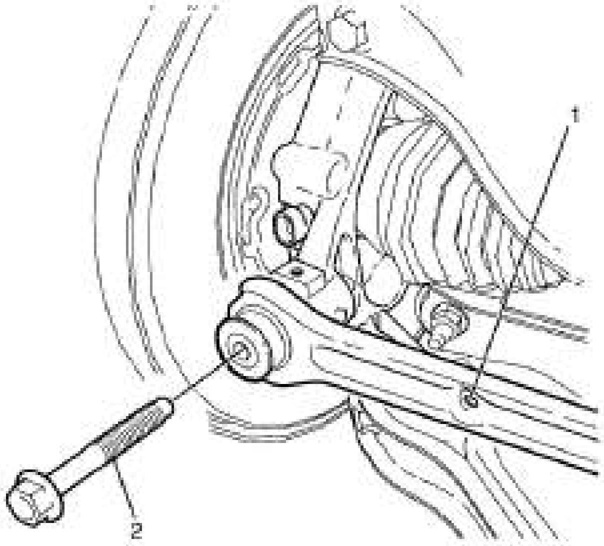


3. Disconnect the wheel speed sensor electrical connector (1).
4. Detach the wheel speed sensor wiring harness retainers (2).



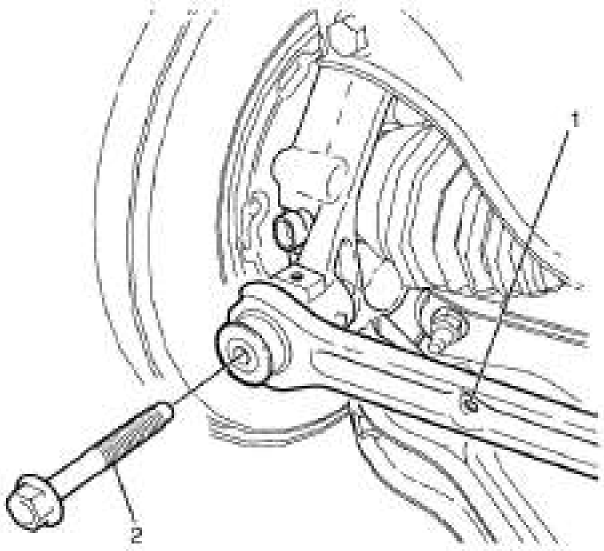
Important: Mark the I-Link to subframe retaining bolt (3) in relation to the subframe before removing the I-Link to subframe retaining nut (1).

5. Remove the I-Link to subframe retaining nut (1), eccentric washer (2) and retaining bolt (3).
6. Discard the I-Link to subframe retaining nut (1).



7. Remove the I-Link to knuckle retaining bolt (2).
8. Remove the I-Link from the subframe (1).

Installation Procedure

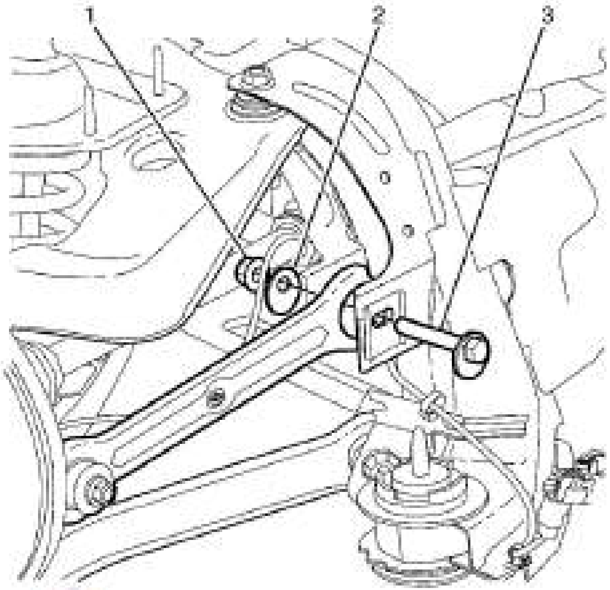


Important: The I-Link to knuckle retaining bolt (1) is not to be fully tightened at this stage.

1. Install the NEW I-Link (1)
2. Install the I-Link to knuckle retaining bolt (2).

   Tighten
   Tighten the bolt to 20 N·m (15 lb ft).

3. Loosen the bolt by 90 degrees



Important: The I-Link to subframe retaining bolt and nut must not to be fully tightened at this stage.

4. Install the I-Link to subframe retaining bolt (3), washer (2) and NEW nut (1).
5. Using a suitable tool, align the previously made aligning mark on the I-Link to subframe retaining bolt (3) to the corresponding rear subframe mark.
6. Using a suitable tool, hold the I-Link to subframe retaining bolt (3) in the correct position and tighten the NEW nut (1).

   Tighten
   Tighten the nut to 20 N·m (15 lb ft).

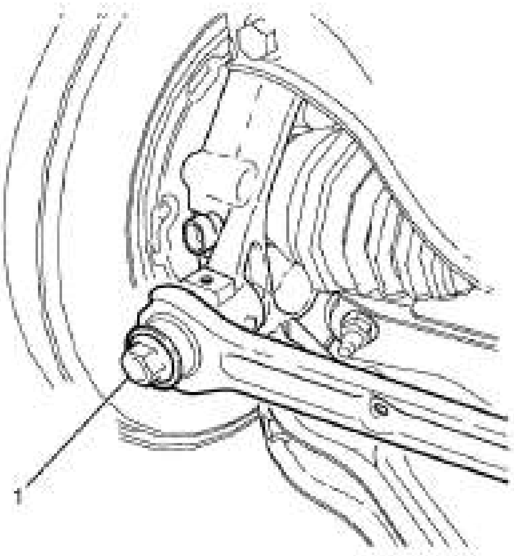
7. Loosen the nut by 90 degrees.
8. Install the rear wheel. Refer to Tire and Wheel Removal and Installation.

   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

9. Lower the vehicle. Refer to Lifting and Jacking the Vehicle.

   Notice: Refer to Fastener Notice in the Preface section.

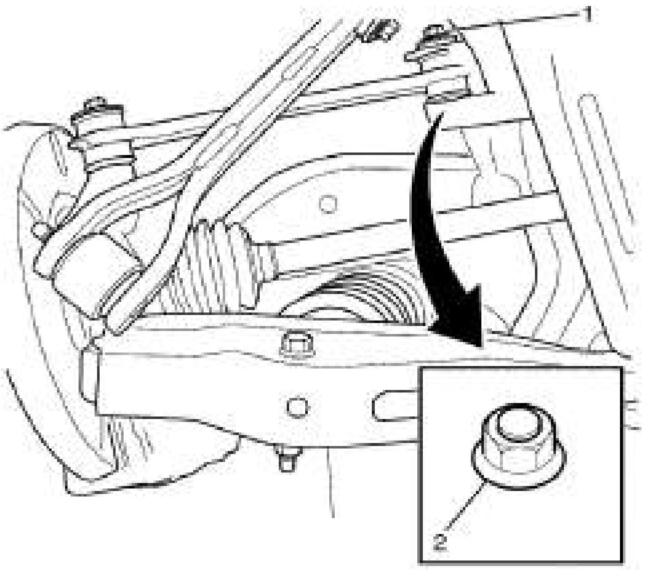


Important: The weight of the vehicle must be on a level surface and on all four wheels before fully tightening the nut.

Important: The suggested method to settle the rear suspension is with the wheels on the ground, open rear compartment lid and support the lid with a suitable brace. Using your hands press down hard on the rear compartment floor and release a number of times.

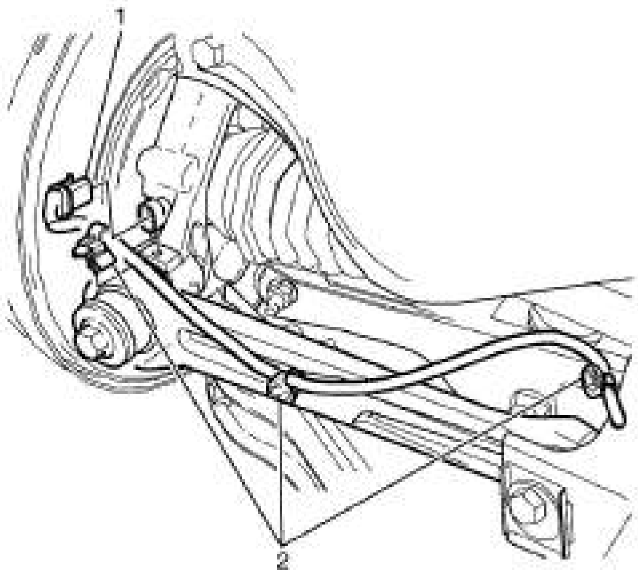
10. Settle the suspension.
11. Tighten the I-Link to knuckle retaining bolt (1).

Tighten
Tighten the bolt to 140 N·m (103 lb ft).



12. Using a suitable tool, align the previously made aligning marks on the I-Link to subframe retaining bolt (1) and hold in position.
13. Tighten the I-Link to subframe retaining nut (2).

Tighten
Tighten the nut to 175 N·m (129 lb ft).



14. Connect the wheel speed sensor electrical connector (1).
15. Attach the wheel speed sensor wiring harness retainers (2).
16. Check the vehicle rear wheel alignment and adjust if necessary. Refer to Wheel Alignment Specifications.
17. Correct the wheel alignment of the vehicle, if necessary. Refer to Rear Camber Adjustment

and Rear Toe Adjustment

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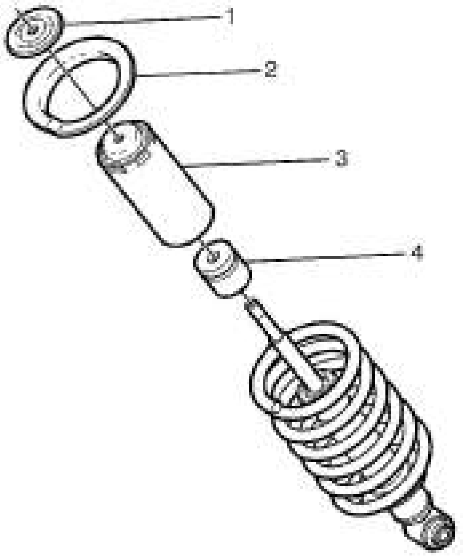
Coil Spring Replacement (LWB SWB Clubsport CSV VXR8)

Removal Procedure

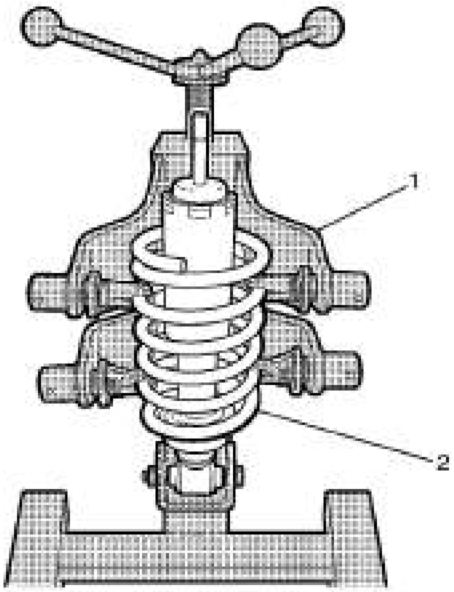
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

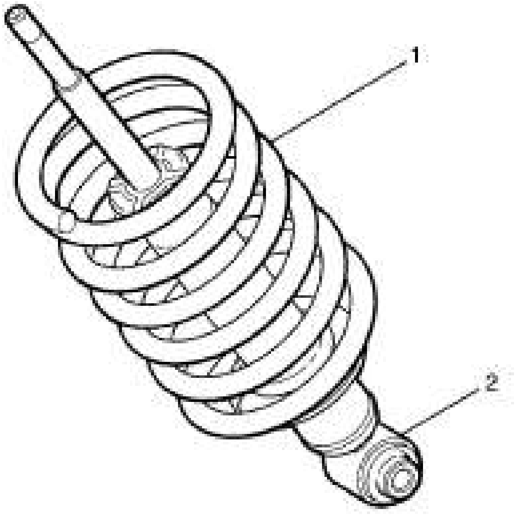
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the rear wheels. Refer to Tire and Wheel Removal and Installation .
3. Remove the ESC strut assembly. Refer to Strut Assembly Replacement .
4. Remove the strut assembly support mount. Refer to Rear Suspension Strut Mount Replacement .



5. Remove the spring insulator (2).
6. Note the orientation and remove the lower washer (1).
7. Remove the dust shield (3).
8. Remove the compression bumper (4).



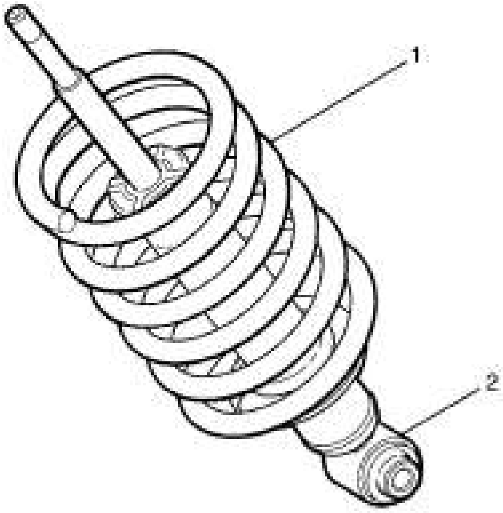
9. Release and remove the spring compressor (1) from the coil spring (2).



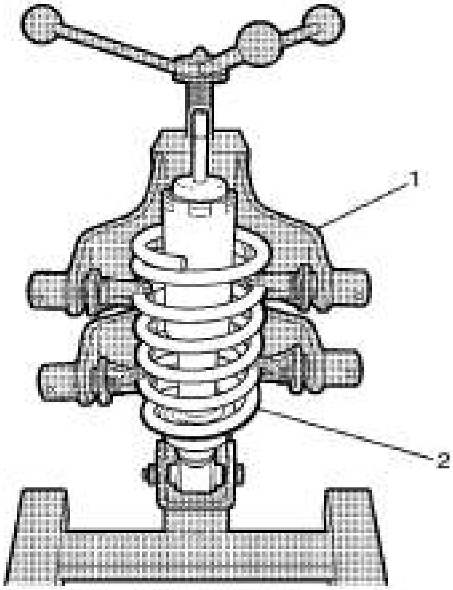
10. Remove the coil spring (1) from the shock absorber (2).
11. Inspect parts for wear and damage.

Installation Procedure

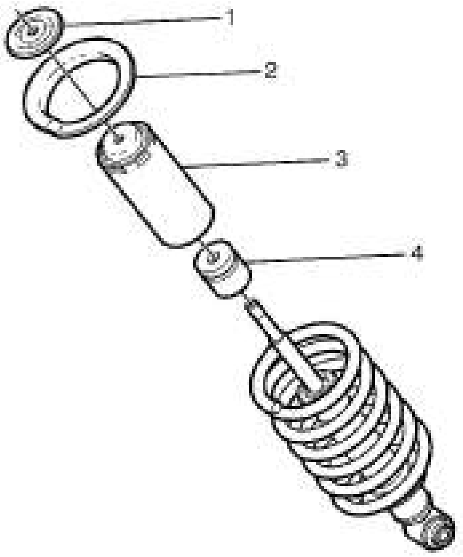
Notice: Refer to General Repair Instructions in the Preface section.



1. Install the coil spring (1) to the shock absorber (2).



2. Compress the coil spring (2) using the spring compressor (1).



3. Install the compression bumper (4).
4. Install the dust shield (3).
5. Note the orientation and install the lower washer (1).
6. Install the spring insulator (2).
7. Install the rear strut assembly support mount. Refer to Rear Suspension Strut Mount Replacement .
8. Install the rear strut assembly. Refer to Strut Assembly Replacement .
9. Install the rear wheel. Refer to Tire and Wheel Removal and Installation .
10. Remove the safety stands.
11. Lower the vehicle to the ground.

Control Arm Bushing Replacement

Tools Required

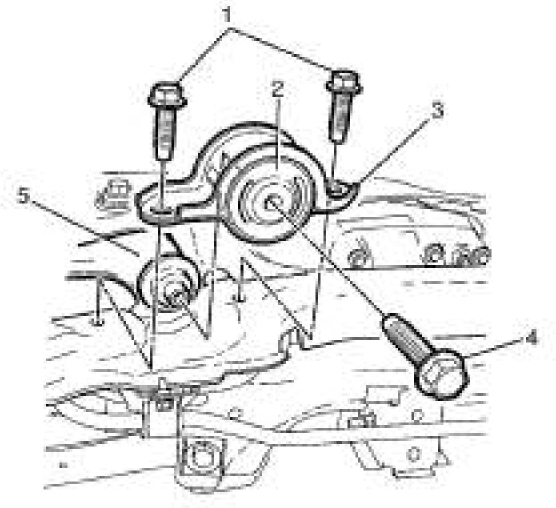
KM-619 Bushing Remover/Installer.

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear frame. Refer to Rear Frame Replacement.

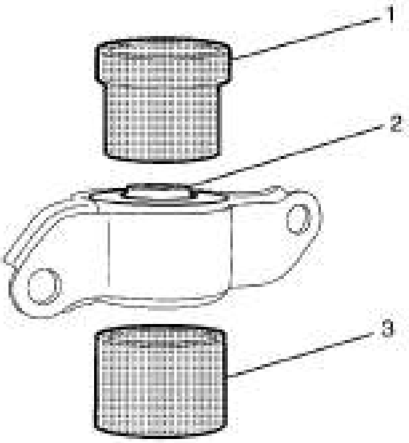


Important: Mark the location of the pivot bushing bracket relative to the rear frame for correct re-assembly.

3. Remove the upper control arm pivot bushing to upper control arm retaining bolt (4).

Important: If both upper control arm pivot bushings are to be replaced at the same time, the upper control arm pivot bushing brackets must be marked as left or right. In all cases, the upper control arm pivot bushing bracket must be marked with an arrow facing towards the front of the vehicle.

4. Remove the upper control arm pivot bushing bracket to subframe retaining bolts (1).
5. Remove the upper control arm pivot bushing (2) and bracket (3) assembly from the upper control arm (5).

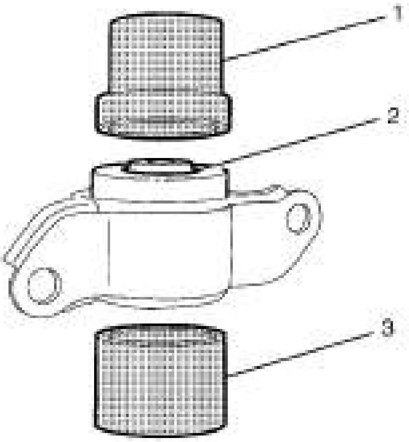


Important: The orientation of the asymmetrical bush is critical to its function. Observe the orientation and depth of the upper control arm pivot bushing (2) with reference to the original position. Adhering to this recommendation will minimize the poential of incorrect upper control arm pivot bushing (2) installation.

Important: The upper control arm pivot bushing (2) must be lubricated with soapy water solution to ease the removal process.

6. Remove the upper control arm pivot bushing (2) using the KM-619 (1, 3).
7. Inspect all parts for wear and damage.

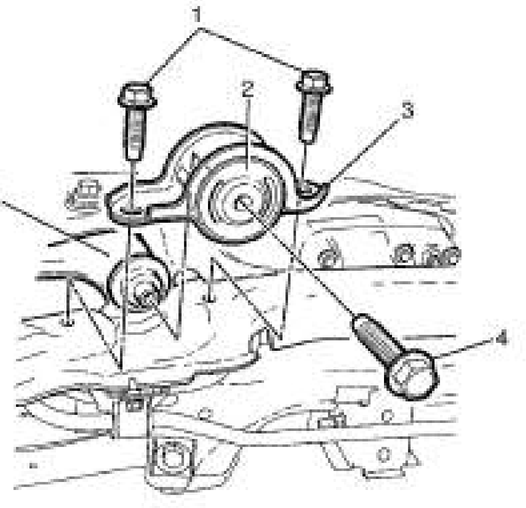
Installation Procedure



Important: The upper control arm pivot bushing (2) must be lubricated with soapy water solution to ease the installation process.

Important: Before installing, the upper control arm pivot bushing (2) must be correctly aligned and orientated. The depth to which the upper control arm pivot bushing (2) is going to travel must also be observed and maintained.

1. Install the upper control arm pivot bushing (2) to the upper control arm (3) using the KM-619 (1, 3).



Important: Align the pivot bushing bracket to the mark made prior to removal.

Important: The upper control arm pivot bushing bracket directional marks must be observed before installation.

2. Install the upper control arm pivot bushing (2) and bracket (3) assembly to the upper control arm (5).

Notice: Refer to Fastener Notice in the Preface section.

3. Install the upper control arm pivot bushing bracket to subframe retaining bolts (1).

Tighten
Tighten the bolts a first pass to 40 N·m (29 lb ft).

Tighten the bolts a final pass 90 Degrees.

4. Install the upper control arm pivot bushing to upper control arm retaining bolt (4).

Tighten
Tighten the bolt to 170 N·m (125 lb ft).

5. Install the rear frame. Refer to Rear Frame Replacement.
6. Remove the safety stands.
7. Lower the vehicle to the ground.
8. Check the vehicle rear wheel alignment and adjust if necessary. Refer to Wheel Alignment Specifications.

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Knuckle Bushing Replacement- Lower

Tools Required

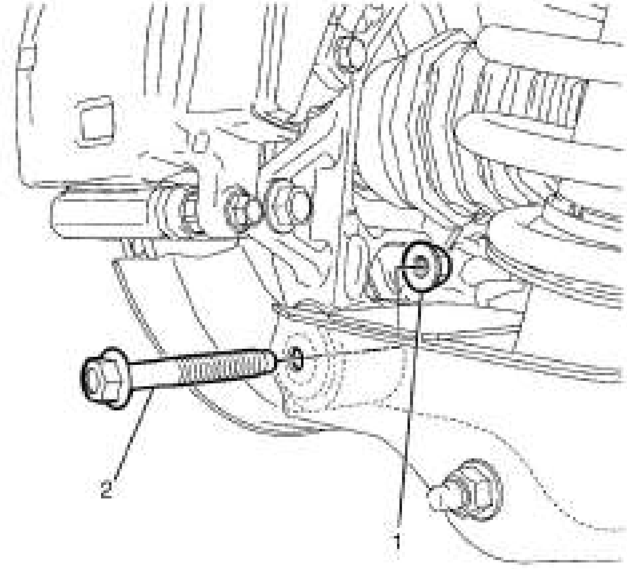
KM-619 Bushing Remover/Installer.

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

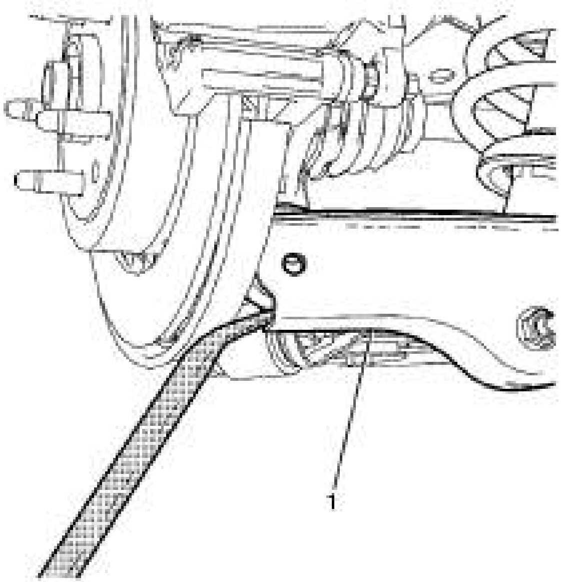
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear wheel. Refer to Tire and Wheel Removal and Installation.
3. Support the lower control arm with a suitable jack.



Important: Prevailing torque nuts must be discarded after removal.

4. Remove the lower control arm to knuckle retaining bolt (2) and nut (1).

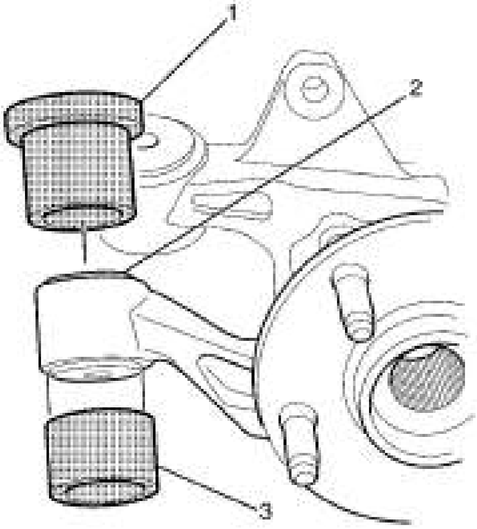
   Discard the nut.



Important: Do not apply pressure to the rear brake disc backing plate while levering.

5. Detach the lower control arm (1) using a suitable pry bar.

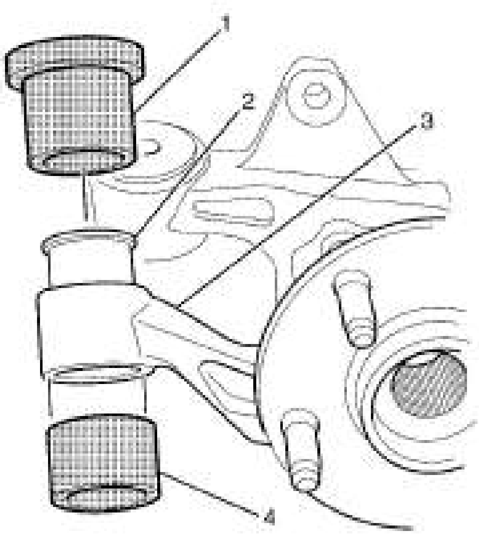
   Reposition the jack as necessary.



Important: It is recommended to observe the orientation and depth of the lower control arm to knuckle bushing (2) with reference to the original position. Adhering to this recommendation will minimize the potential of incorrect lower control arm to knuckle bushing (2) installation.

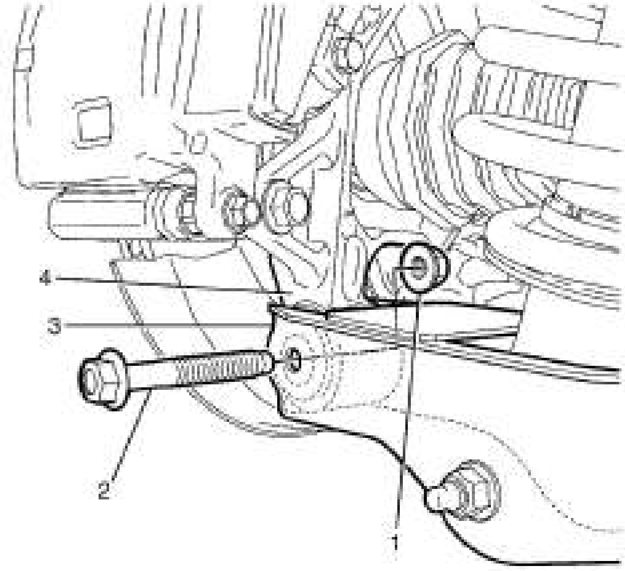
6. Remove the lower control arm to knuckle arm bushing (2) using the KM-619 (1, 3).
7. Inspect all parts for wear and damage.

Installation Procedure



Important: Before installing, the lower control arm to knuckle arm bushing (2) must be correctly aligned and orientated.

1. Install the lower control arm to knuckle arm bushing (2) to the knuckle (3) using the KM-619 (1, 4).



2. Connect the lower control arm (3) to the knuckle (4).

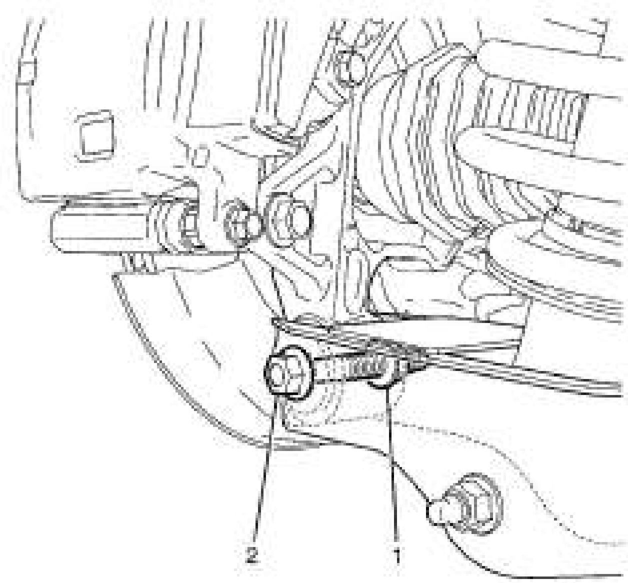
Important: The lower control arm to knuckle arm retaining bolt (2) and nut (1) must not to be fully tightened at this stage.

3. Install the lower control arm to knuckle retaining bolt (2) and NEW nut (1).

   Do not fully tighten at this stage.

4. Install the rear wheel. Refer to Tire and Wheel Removal and Installation.
5. Remove the safety stands.
6. Lower the vehicle to the ground.
7. Bounce the vehicle several times to settle the suspension.

   Notice: Refer to Fastener Notice in the Preface section.



Important: The weight of the vehicle must be on a level surface and on all four wheels before fully tightening the nuts and bolts.

8. Tighten the lower control arm to knuckle retaining bolt (2) and NEW nut (1).

   Tighten
   Tighten the bolt and nut a first pass to 40 N·m (30 lb ft).

   Tighten the bolt and nut a final pass 120 Degrees.

Knuckle Replacement

Tools Required

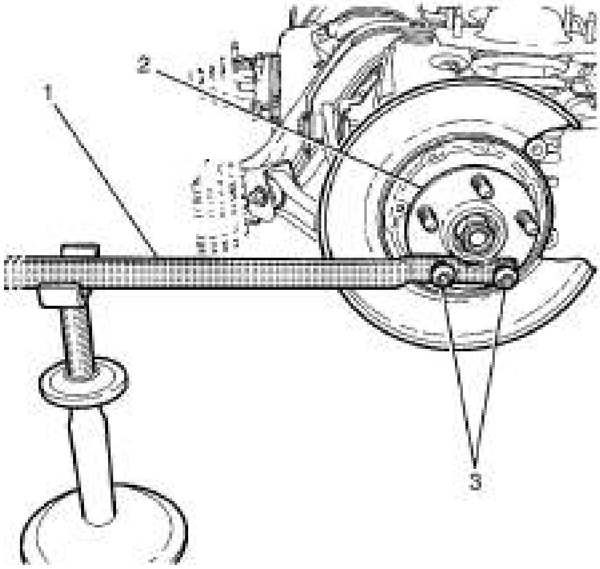
- 7208 Drive Shaft Remover.
- KM-468 Hub Holding Tool.

Removal Procedure - Up to 13 Aug 2007

Caution: Refer to Safety Glasses Caution in the Preface section.

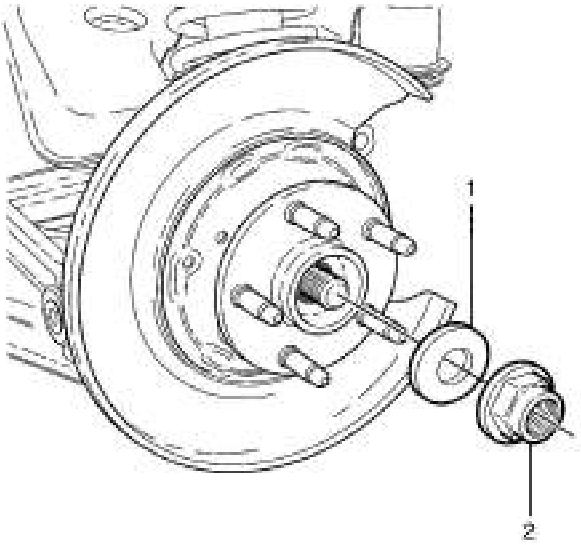
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear wheel. Refer to Tire and Wheel Removal and Installation.
3. Remove the rear brake disc. Refer to Rear Brake Rotor Replacement.



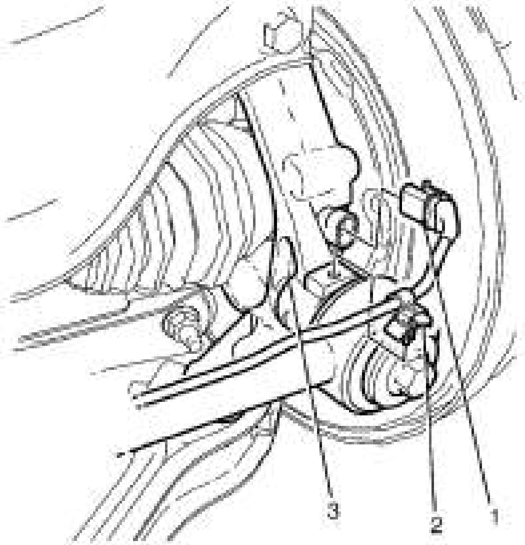
4. Install the KM-468 (1) to the wheel hub (2) with two inverted wheel nuts (3).

   Support the KM-468 outer end on a safety stand.



Important: The wheel drive shaft retaining nut (2) and washer (1) must be discarded after removal.

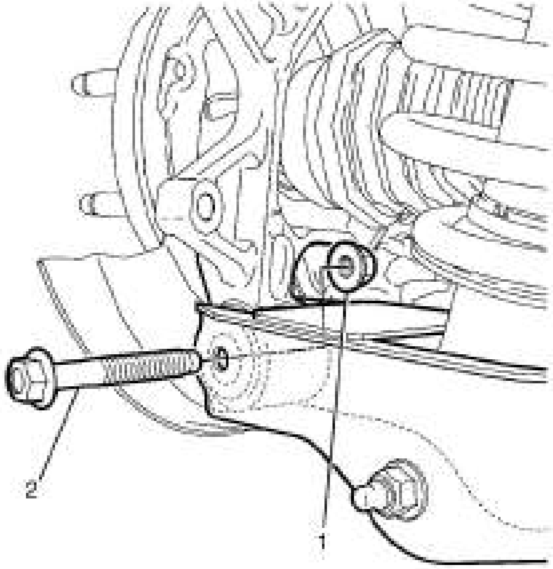
5. Remove the wheel drive shaft retaining nut (2) and washer (1).
   - Discard the nut.
   - Discard the washer.
6. Remove the 7208 from the wheel hub.



Important: The wheel speed sensor cable must be secured to protect it from damage.

7. Disconnect the wheel speed sensor electrical connector (1).

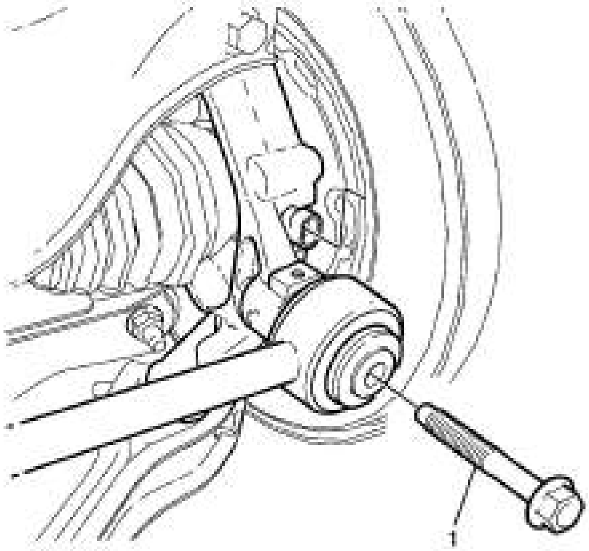
8. Detach the wheel speed sensor wiring harness mounting clip (2) from the knuckle (3).



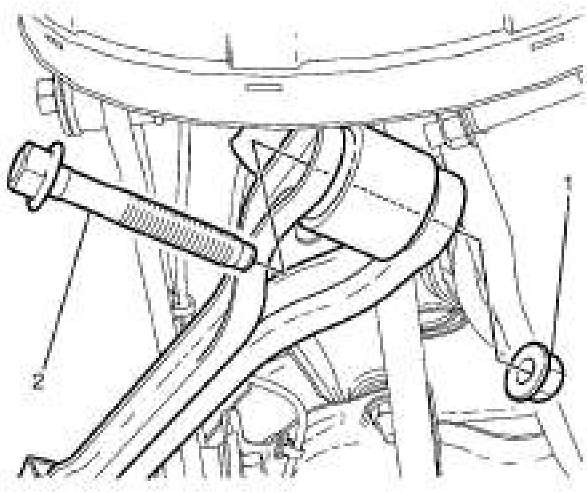
Important: Prevailing torque nuts must be discarded after removal.

9. Remove the lower control arm to knuckle retaining bolt (2) and nut (1).

   Discard the nut.



10. Remove the I-Link to knuckle retaining bolt (1).

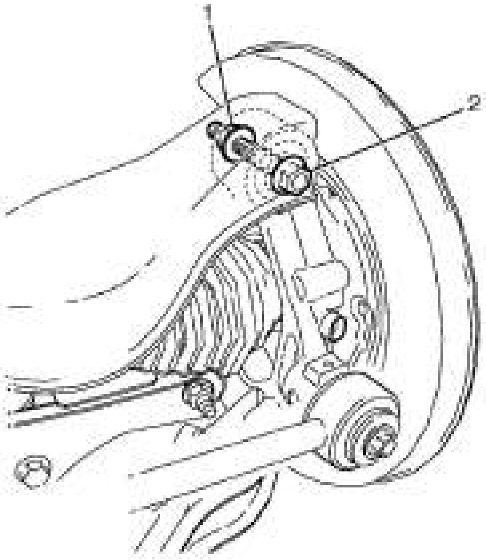


Important: Mark the location of the bolt and nut relative to the Y-Link for correct re-assembly.

Important: Prevailing torque nuts must be discarded after removal.

11. Remove the Y-Link to knuckle retaining bolt (2) and nut (1).

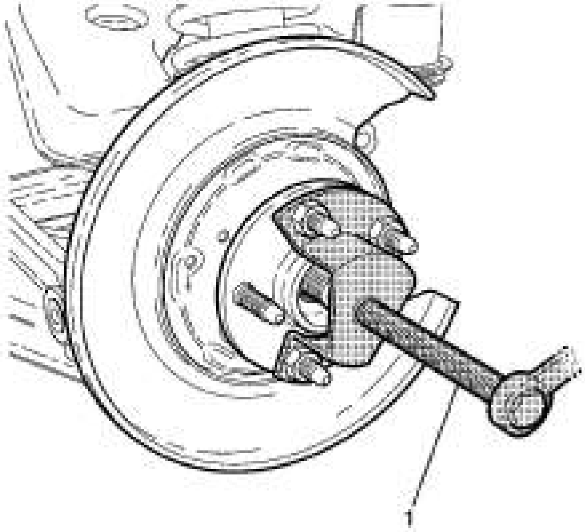
    Discard the nut.



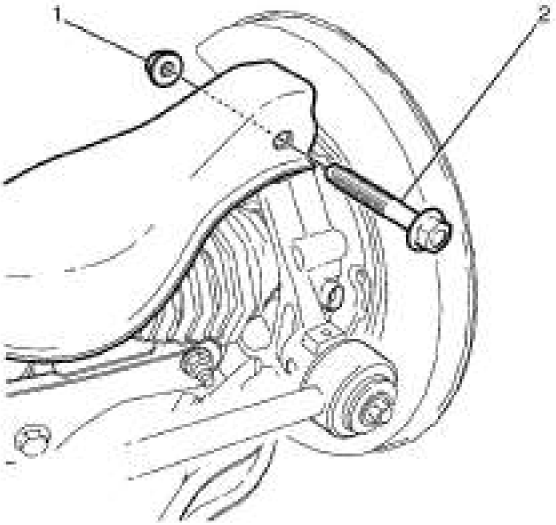
Important: Mark the location of the bolt and nut relative to the upper control arm for correct re-assembly.

12. Loosen the upper control arm to knuckle retaining bolt (2) and nut (1).

    Do not remove the bolt and nut.



13. Secure the rear driveshaft with wire to protect it from damage.
14. Install the 7208 to the wheel hub.
15. Press the wheel drive shaft from the wheel hub using the 7208 (1).
16. Remove the 7208 from the wheel hub.

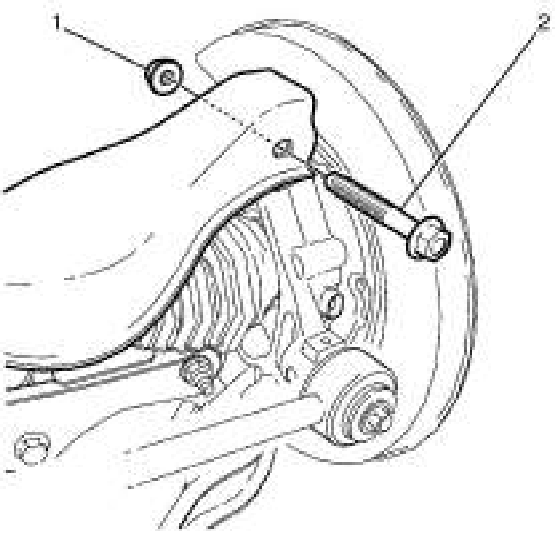


Important: Prevailing torque nuts must be discarded after removal.

17. Remove the upper control arm to knuckle bolt (2) and nut (1).
18. Remove the wheel hub and knuckle assembly.
19. Disassemble the wheel hub and knuckle assembly. Refer to Rear Wheel Bearing and Hub Replacement.

Installation Procedure - Up to 13 Aug 2007

1. Assemble the wheel hub and knuckle assembly. Refer to Rear Wheel Bearing and Hub Replacement.

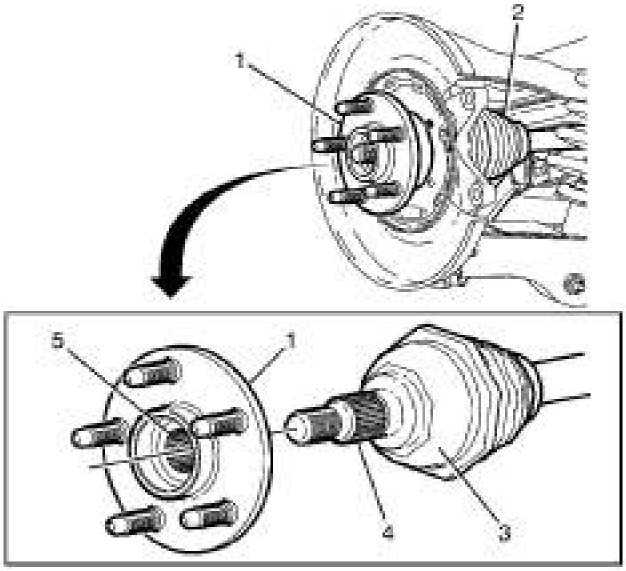


2. Install the wheel hub and knuckle assembly to the upper control arm.

   Important: The upper control arm to knuckle retaining bolt (2) and nut (1) must not to be fully tightened at this stage.

3. Install the upper control arm to knuckle retaining bolt (2) and nut (1).

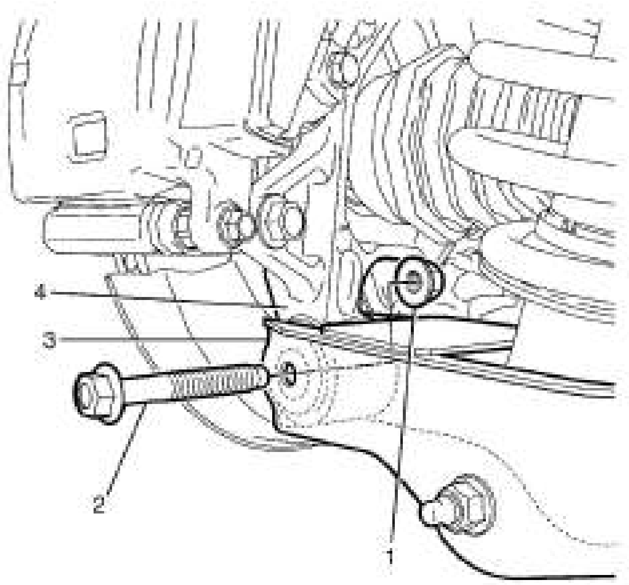
   Do not fully tighten at this stage.



Important: Lightly lubricate the wheel drive shaft outer splined end (4) with the recommended differential lubricant.

Important: Do not excessively push the wheel drive shaft (3) through the wheel hub (1).

4. Push the wheel drive shaft outer splined end (4) into the splined cavity (5) of the wheel hub (1).
5. Remove the wheel drive shaft securing wire, used in the removal process to prevent damage.

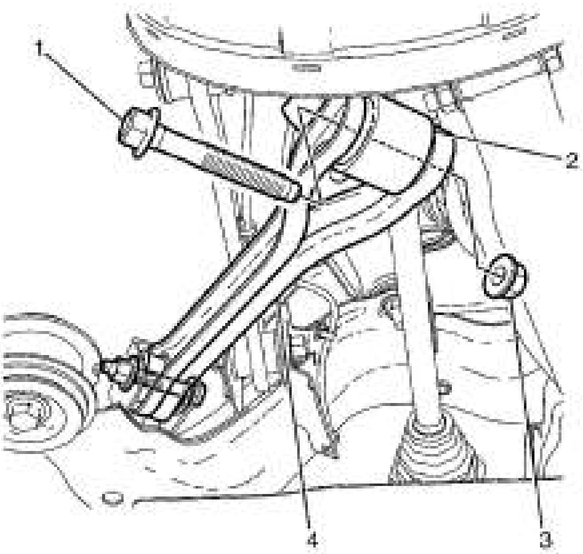


6. Install the lower control arm (3) to the knuckle (4).

Important: The lower control arm to knuckle retaining bolt (2) and nut (1) must not to be fully tightened at this stage.

7. Install the lower control arm to knuckle retaining bolt (2) and NEW nut (1).

   Do not fully tighten at this stage.

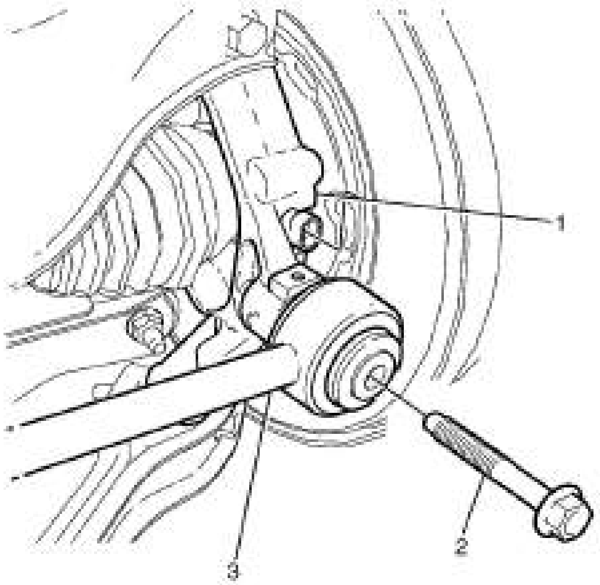


8. Install the Y-Link (4) to the knuckle (2).

   Important: The Y-Link to knuckle retaining bolt (1) and nut (3) must not to be fully tightened at this stage.

9. Install the Y-Link to knuckle retaining bolt (1) and NEW nut (3).

   Do not fully tighten at this stage.

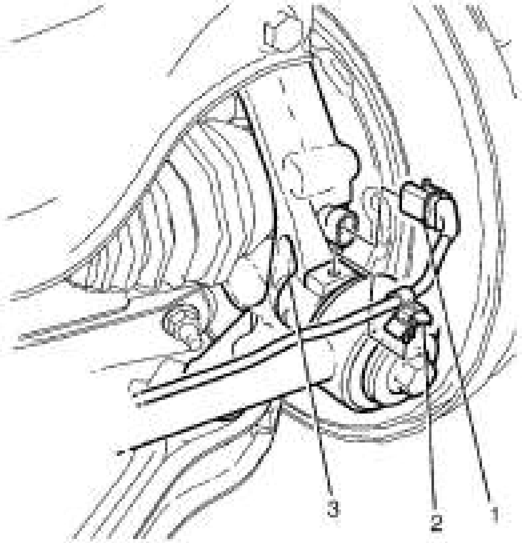


10. Install the I-Link (4) to the knuckle (1).

    Important: The I-Link to knuckle retaining bolt (2) and nut (3) must not to be fully tightened at this stage.

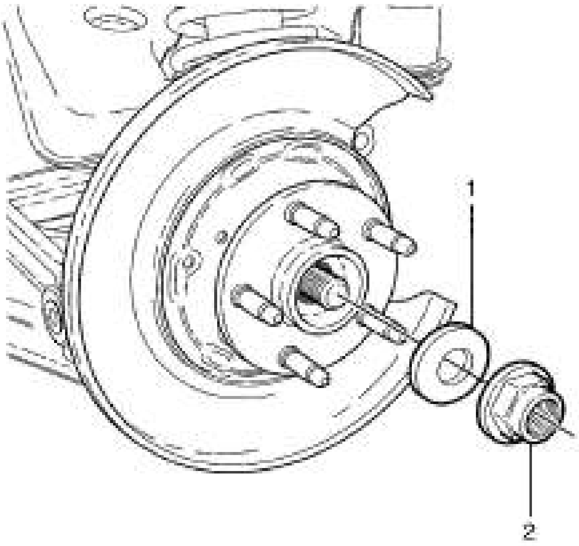
11. Install the I-Link to knuckle retaining bolt (2) and washer (3).

    Do not fully tighten at this stage.



12. Connect the wheel speed sensor electrical connector (1).
13. Attach the wheel speed sensor wiring harness mounting clip (2) to the knuckle (3).

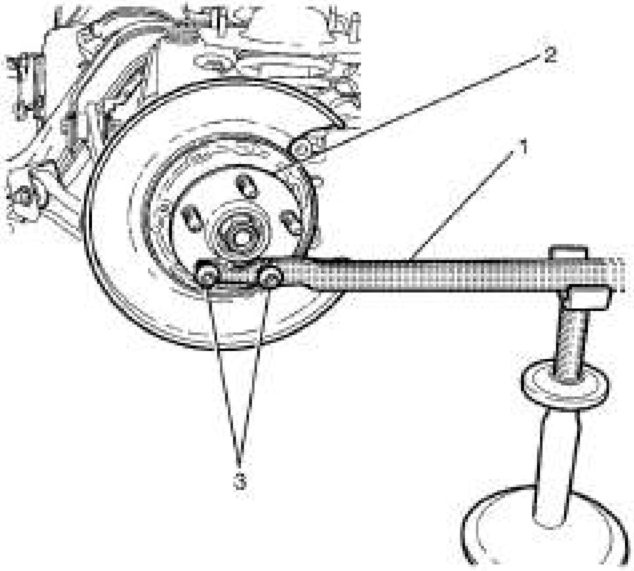
Notice: Refer to Fastener Notice in the Preface section.



Important: A NEW nut and NEW washer must be used when installing the wheel drive shaft.

14. Install NEW retaining washer (1) and NEW nut (2) to the wheel drive shaft.

Notice: Refer to Fastener Notice in the Preface section.



15. Install the KM-468

Support the KM-468

Notice: Refer to Fastener Notice in the Preface section.

Important: There are two suitable methods of tightening the wheel drive shaft retaining nut. DO NOT EXCEED THE SPECIFIED TIGHTENING VALUES, otherwise premature bearing failure may result.

16. Preferred Method

    Tighten
    Tighten the nut on first pass to 150 N·m (111 lb ft).

    Loosen
    Loosen the nut on second pass by 180 Degrees.

    Tighten
    Tighten the nut on third pass to 425 N·m (313 lb ft)

    Crimp nut.

    Alternate Method

    Tighten
    Tighten the nut on first pass to 150 N·m (111 lb ft).

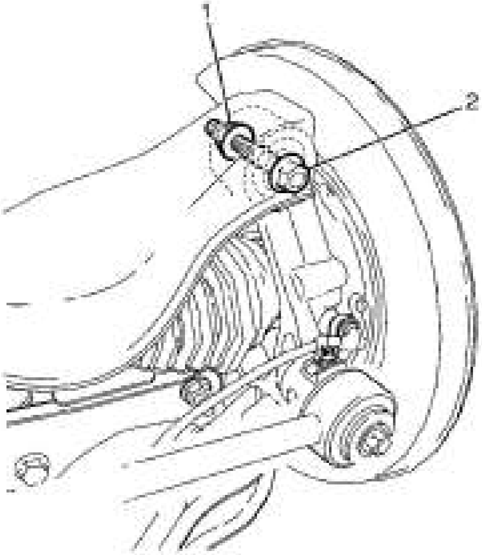
    Loosen
    Loosen the nut on second pass by 180 Degrees.

    Tighten
    Tighten the nut on the third pass to 50 N·m (37 lb ft)

    Tighten
    Tighten the nut on the forth pass by 45 Degrees

    Crimp nut.

17. Remove the KM-468 (1).
18. Install the rear brake disc. Refer to Rear Brake Rotor Replacement
19. Install the rear wheel. Refer to Tire and Wheel Removal and Installation
20. Remove the safety stands.
21. Lower the vehicle to the ground.
22. Bounce the vehicle several times to settle the suspension.



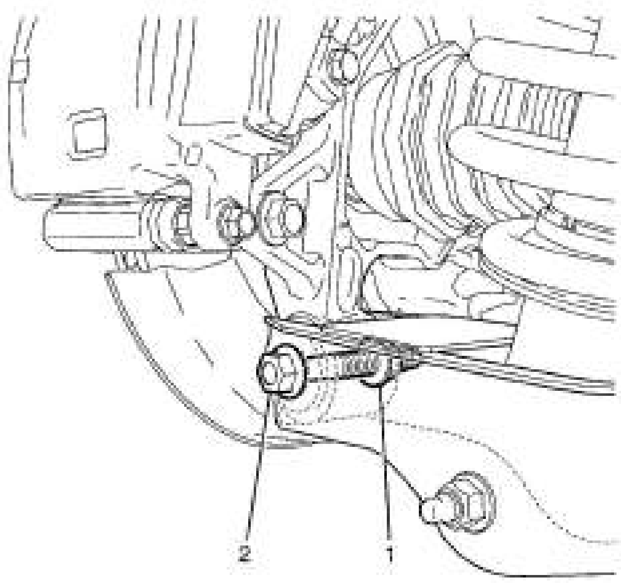
Important: The weight of the vehicle must be on a level surface and on all four wheels before fully tightening the nuts and bolts.

Important: Align the bolt to the mark made prior to removal.

23. Tighten the upper control arm to knuckle retaining bolt (2) and NEW nut (1).

Tighten
Tighten the bolt and nut first pass to 60 N·m(44 lb ft).

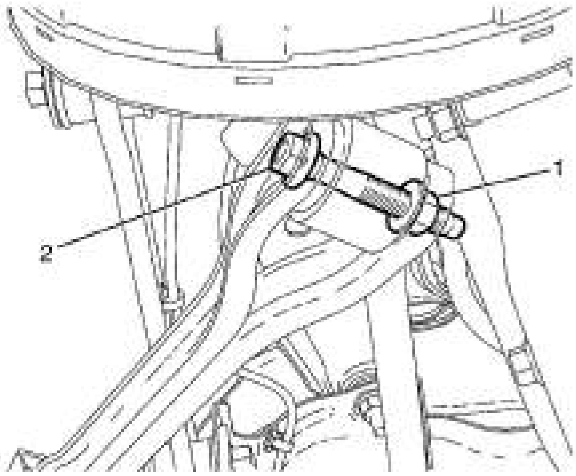
Tighten the bolt and nut final pass to 90 Degrees.



24. Tighten the lower control arm to knuckle retaining bolt (2) and NEW nut (1).

    Tighten
    Tighten the nut a first pass to 40 N·m (30 lb ft).

    Tighten the nut in a final pass 120 Degrees.

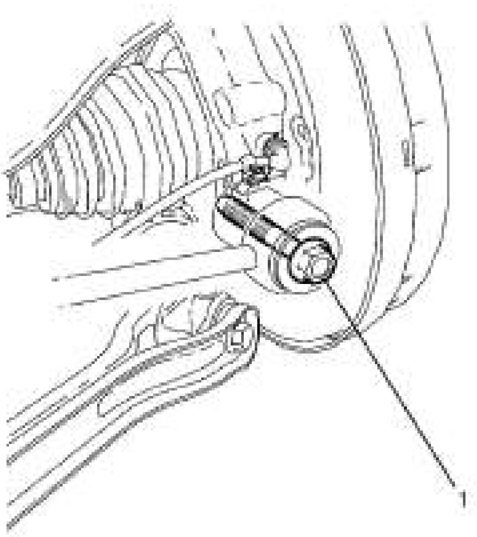


Important: Align the mark from bolt to Y-Link made prior to removal.

25. Tighten the Y-Link to knuckle retaining bolt (2) and NEW nut (1).

    Tighten
    Tighten the bolt and nut a first pass to 40 N·m (30 lb ft).

    Tighten the bolt and nut in a second pass 120 Degrees.



26. Tighten the I-Link to knuckle retaining bolt (1).

    Tighten
    Tighten the bolt to 140 N·m (103 lb ft).

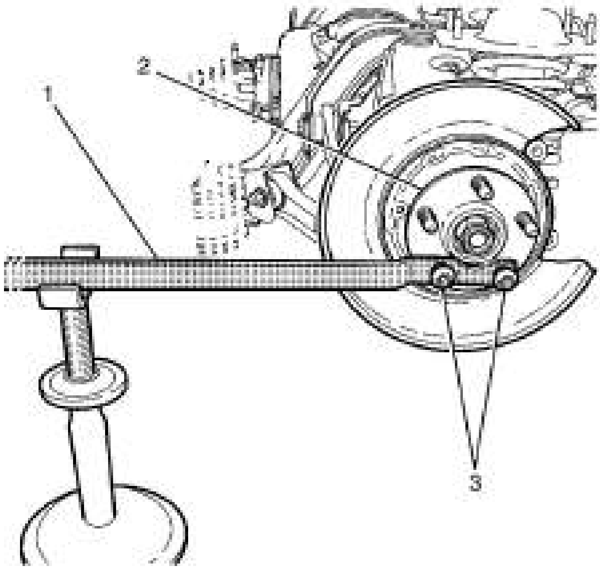
27. Check the vehicle rear wheel alignment and adjust if necessary. Refer to Wheel Alignment Specifications.

Removal Procedure - After 13 Aug 2007

Caution: Refer to Safety Glasses Caution in the Preface section.

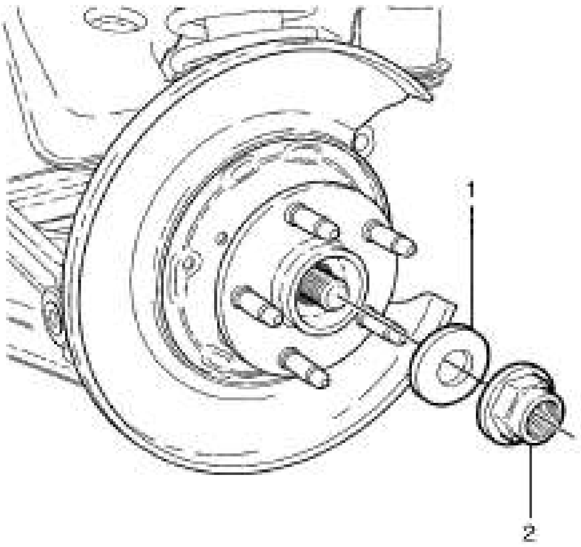
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear wheel. Refer to Tire and Wheel Removal and Installation.
3. Remove the rear brake disc. Refer to Rear Brake Rotor Replacement.



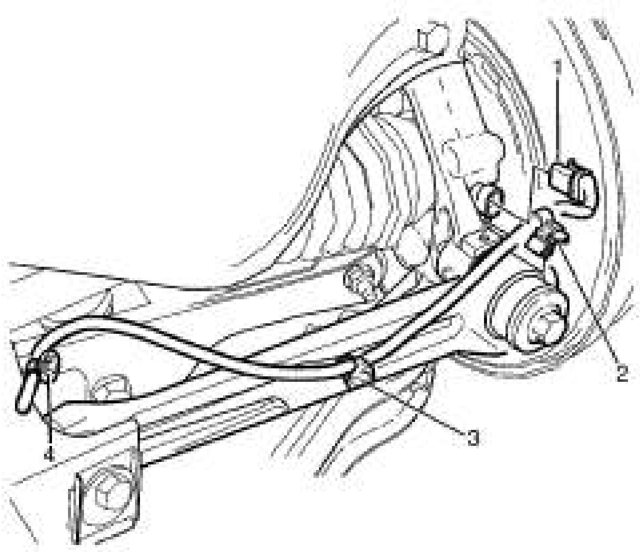
4. Install the KM-468 (1) to the wheel hub (2) with two inverted wheel nuts (3).

   Support the KM-468 (1) outer end on a safety stand.



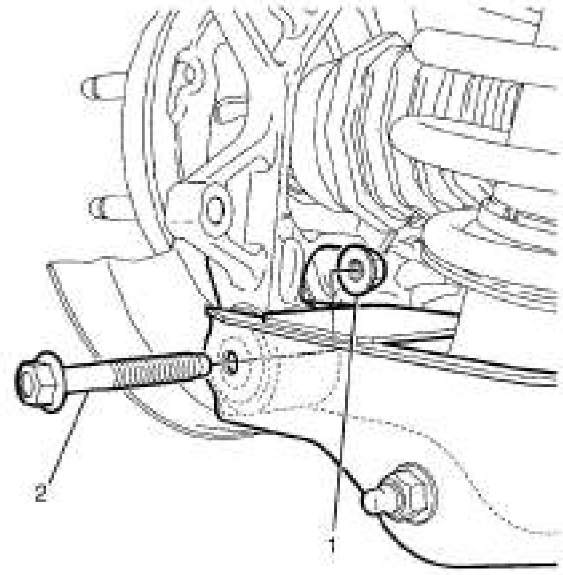
Important: The wheel drive shaft retaining nut (2) and washer (1) must be discarded after removal.

5. Remove the wheel drive shaft retaining nut (2) and washer (1).
   - Discard the nut.
   - Discard the washer.



Important: The wheel speed sensor cable must be secured to protect it from damage.

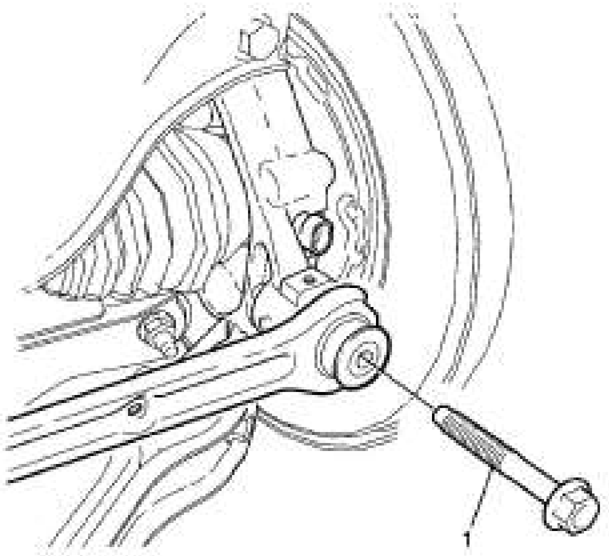
6. Disconnect the wheel speed sensor electrical connector (1).
7. Detach the wheel speed sensor wiring harness mounting clips (2, 3 and 4).



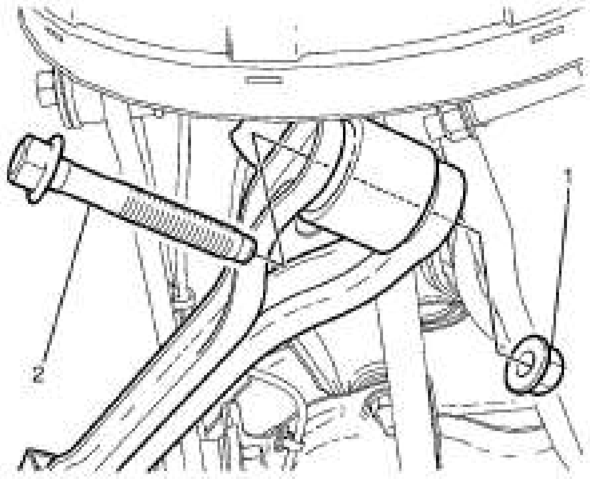
Important: Prevailing torque nuts must be discarded after removal.

8. Remove the lower control arm to knuckle retaining bolt (2) and nut (1).

   Discard the nut.



9. Remove the I-Link to knuckle retaining bolt (1).

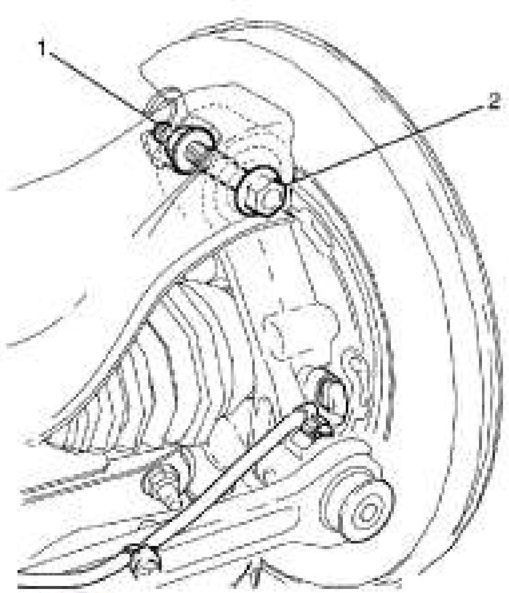


Important: Mark the location of the Y-Link to knuckle retaining bolt and nut relative to the Y-Link for correct re-assembly.

Important: Prevailing torque nuts must be discarded after removal.

10. Remove the Y-Link to knuckle retaining bolt (2) and nut (1).

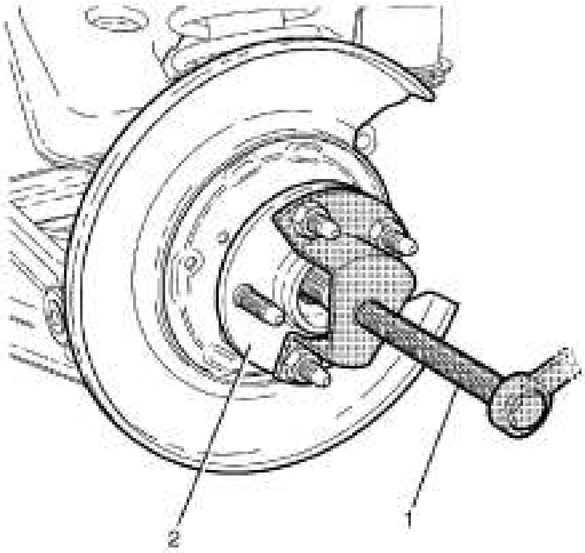
    Discard the nut.



Important: Mark the location of the bolt and nut relative to the upper control arm for correct assembly.

11. Loosen the upper control arm to knuckle retaining bolt (2) and nut (1).

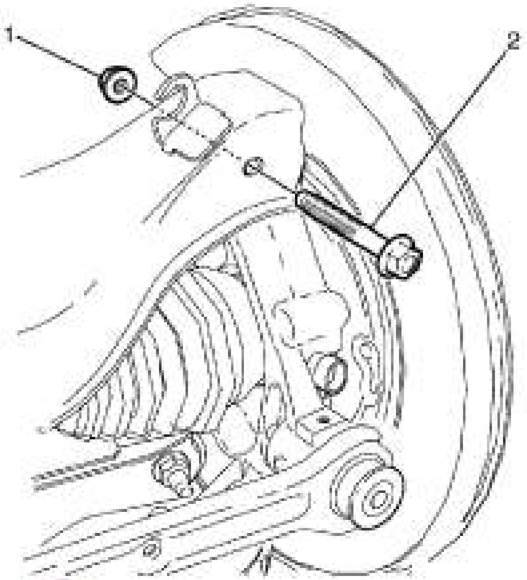
    Do not remove the bolt and nut.



Important: Secure the wheel drive shaft with wire to protect it from damage.

12. Install the 7208 (1) to the wheel hub (2).

13. Press the wheel drive shaft from the wheel hub using the 7208 (1).
14. Remove the 7208 (1) from the wheel hub (2).



Important: Prevailing torque nuts must be discarded after removal.

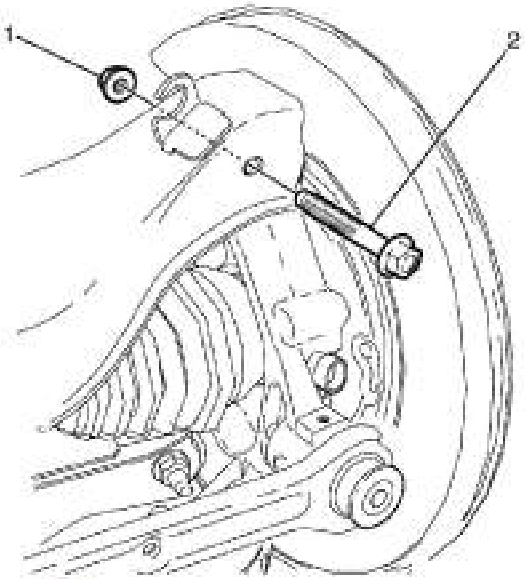
15. Remove the upper control arm to knuckle bolt (2) and nut (1).

    Discard the nut.

16. Remove the wheel hub and knuckle assembly.
17. Disassemble the wheel hub and knuckle assembly. Refer to Rear Wheel Bearing and Hub Replacement.

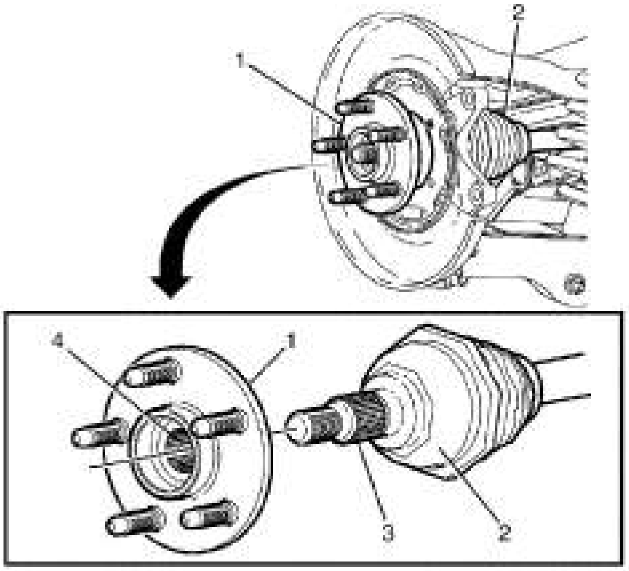
Installation Procedure - After 13 Aug 2007

1. Assemble the wheel hub and knuckle assembly. Refer to Rear Wheel Bearing and Hub Replacement.
2. Install the wheel hub and knuckle assembly to the upper control arm.



Important: The upper control arm to knuckle retaining bolt (2) and NEW nut (1) must not to be fully tightened at this stage.

3. Install the upper control arm to knuckle retaining bolt (2) and NEW nut (1).

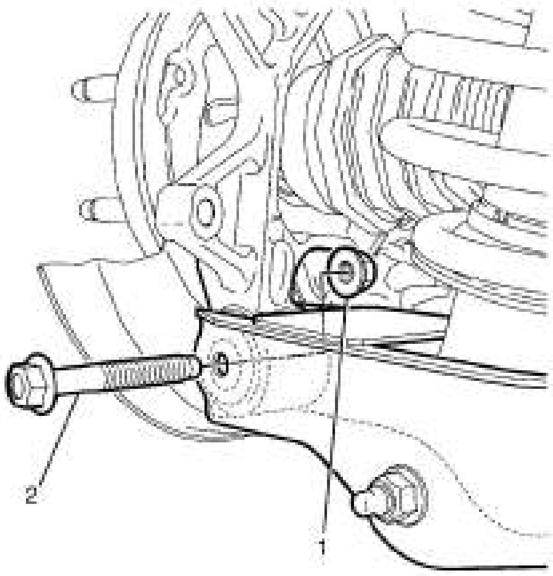


Important: Lightly lubricate the wheel drive shaft outer splined end (3) with the recommended differential lubricant.

Important: Do not excessively push the wheel drive shaft (2) through the wheel hub (1).

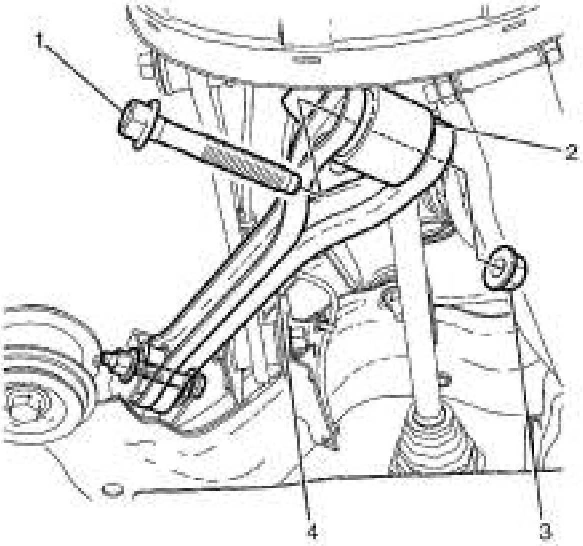
4. Push the wheel drive shaft outer splined end (3) into the splined cavity (4) of the wheel hub (1).

5. Remove the wheel drive shaft securing wire, used in the removal process to prevent damage.



Important: The lower control arm to knuckle retaining bolt (2) and NEW nut (1) must not to be fully tightened at this stage.

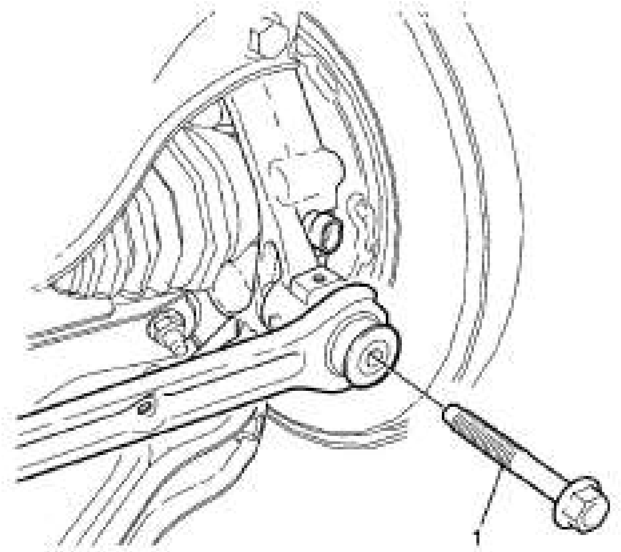
6. Install the lower control arm to knuckle retaining bolt (2) and NEW nut (1).



7. Install the Y-Link (4) to the knuckle (2).

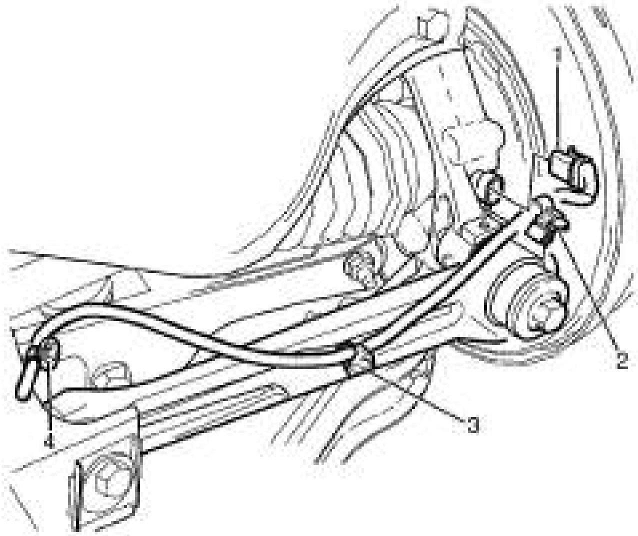
Important: The Y-Link to knuckle retaining bolt (1) and NEW nut (3) must not to be fully tightened at this stage.

8. Install the Y-Link to knuckle retaining bolt (1) and NEW nut (3).

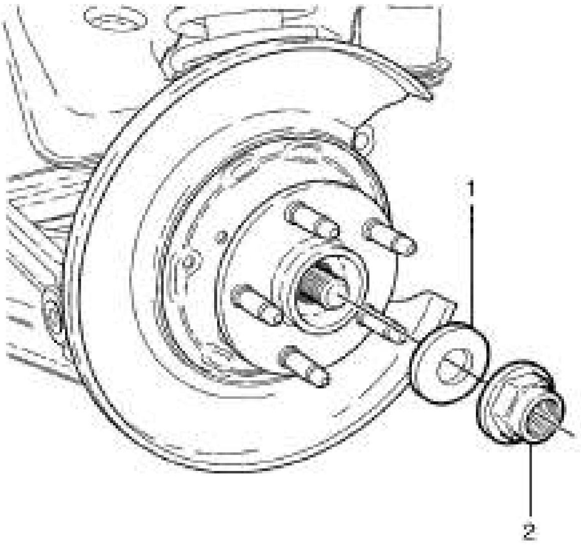


Important: The I-Link to knuckle retaining bolt (1) must not to be fully tightened at this stage.

9. Install the I-Link to knuckle retaining bolt (1).



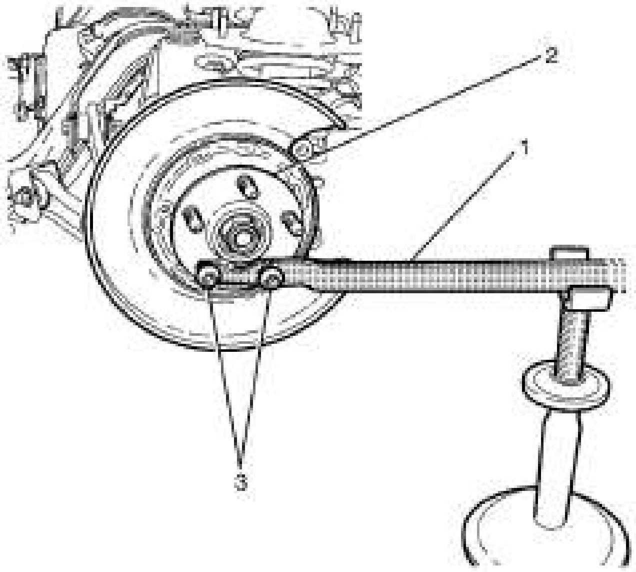
10. Connect the wheel speed sensor electrical connector (1).
11. Attach the wheel speed sensor wiring harness mounting clips (2, 3 and 4).



Important: A NEW wheel drive shaft retaining nut and NEW washer must be used when installing the wheel drive shaft.

12. Install the NEW wheel drive shaft retaining nut (2) and NEW washer (1).

    Notice: Refer to Fastener Notice in the Preface section.



13. Install the KM-468 (1) to the wheel hub (2) with two inverted wheel nuts (3).

    Support the KM-468 (1) outer end on a safety stand.

Notice: Refer to Fastener Notice in the Preface section.

Important: There are two suitable methods of tightening the wheel drive shaft retaining nut. DO NOT EXCEED THE SPECIFIED TIGHTENING VALUES, otherwise premature bearing failure may result.

14. Preferred Method

    Tighten
    Tighten the nut on first pass to 150 N·m (111 lb ft).

    Loosen
    Loosen the nut on second pass by 180 Degrees.

    Tighten
    Tighten the nut on third pass to 425 N·m (313 lb ft)

    Crimp nut.

    Alternate Method

    Tighten
    Tighten the nut on first pass to 150 N·m (111 lb ft).

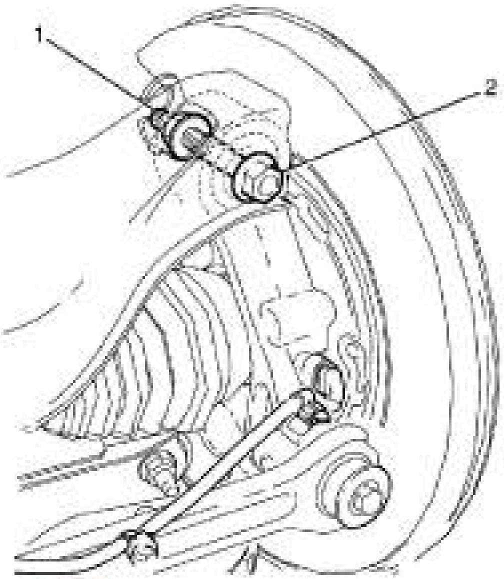
    Loosen
    Loosen the nut on second pass by 180 Degrees.

    Tighten
    Tighten the nut on the third pass to 50 N·m (37 lb ft)

    Tighten
    Tighten the nut on the forth pass by 45 Degrees

    Crimp nut.

15. Remove the KM-468 (1).
16. Install the rear brake disc. Refer to Rear Brake Rotor Replacement.
17. Install the rear wheel. Refer to Tire and Wheel Removal and Installation.
18. Remove the safety stands.
19. Lower the vehicle to the ground.
20. Bounce the vehicle several times to settle the suspension.



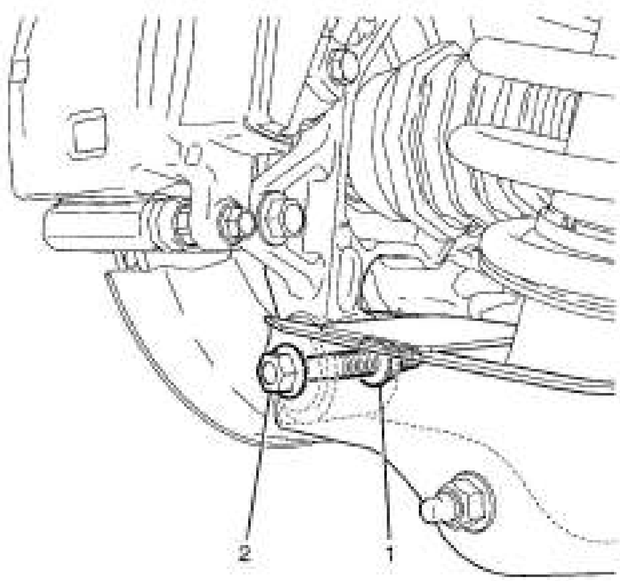
Important: The weight of the vehicle must be on a level surface and on all four wheels before fully tightening the nuts and bolts.

Important: Align the bolt to the mark made prior to removal.

21. Tighten the upper control arm to knuckle retaining bolt (2) and NEW nut (1).

Tighten
Tighten the bolt and nut first pass to 60 N·m(44 lb ft).

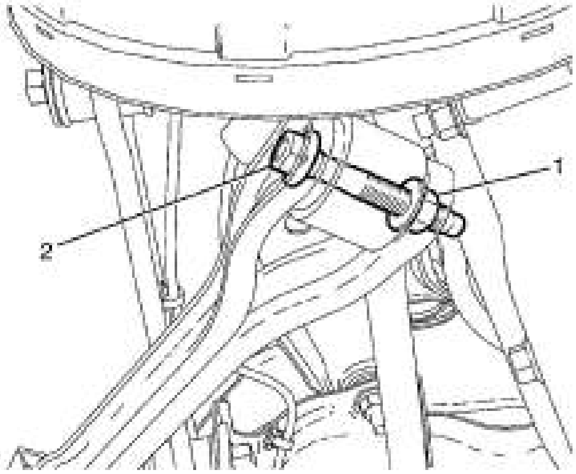
Tighten the bolt and nut final pass to 90 Degrees.



22. Tighten the lower control arm to knuckle retaining bolt (2) and NEW nut (1).

Tighten
Tighten the nut a first pass to 40 N·m (30 lb ft).

Tighten the nut in a final pass 120 Degrees.

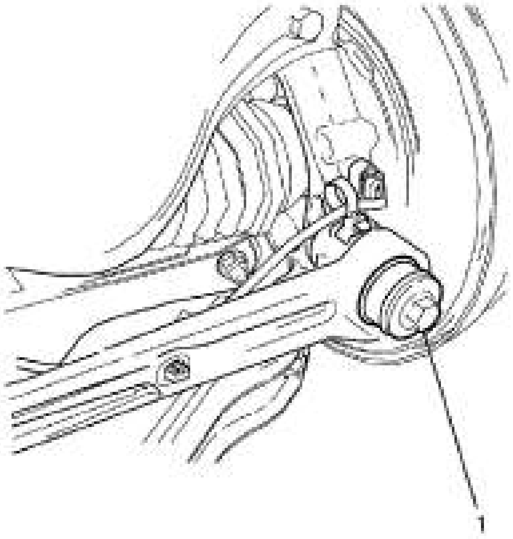


Important: Align the mark from bolt to Y-Link made prior to removal.

23. Tighten the Y-Link to knuckle retaining bolt (2) and NEW nut (1).

Tighten
Tighten the bolt and nut a first pass to 40 N·m (30 lb ft).

Tighten the bolt and nut in a second pass 120 Degrees.



24. Tighten the I-Link to knuckle retaining bolt (1).

    Tighten
    Tighten the bolt to 140 N·m (103 lb ft).

25. Check the vehicle rear wheel alignment and adjust if necessary. Refer to Wheel Alignment Specifications.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Suspension | Rear Suspension | Repair Instructions | Document ID: 1975625

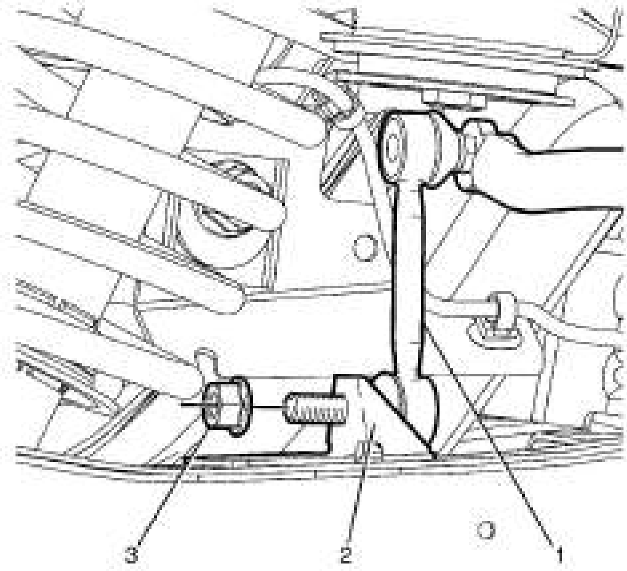
Lower Control Arm Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear wheel. Refer to Tire and Wheel Removal and Installation.
3. Support the lower control arm using a suitable jack.

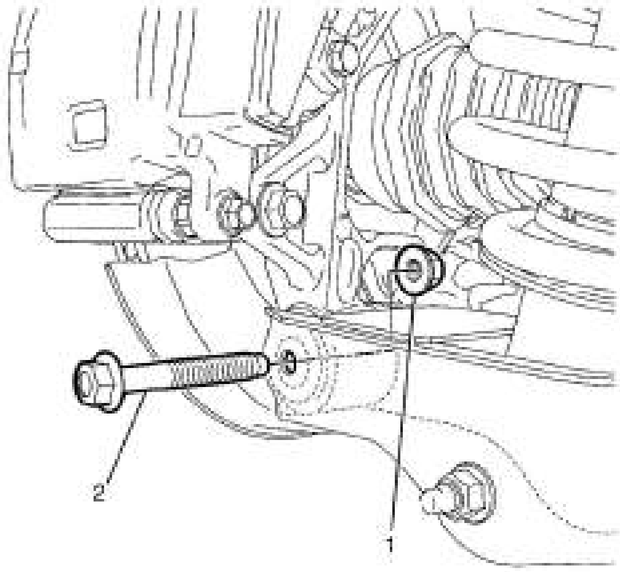


Important: Prevailing torque nuts must be discarded after removal.

4. Remove the stabiliser bar link to lower control arm retaining nut (3).

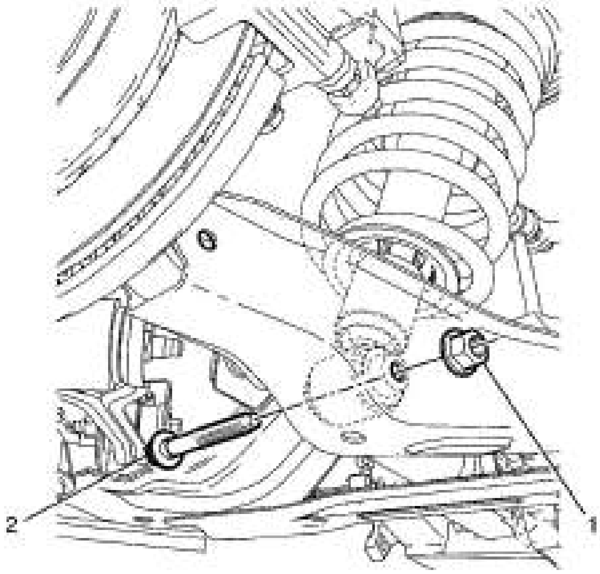
   Discard the nut.

5. Disconnect the stabiliser bar link (1) from the lower control arm (2).



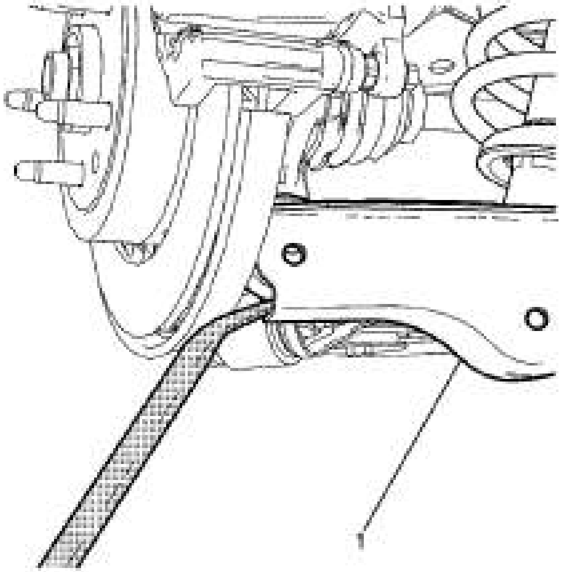
6. Remove the lower control arm to knuckle retaining bolt (2) and nut (1).

   Discard the nut.



7. Remove the lower control arm to strut assembly retaining bolt (2) and nut (1).

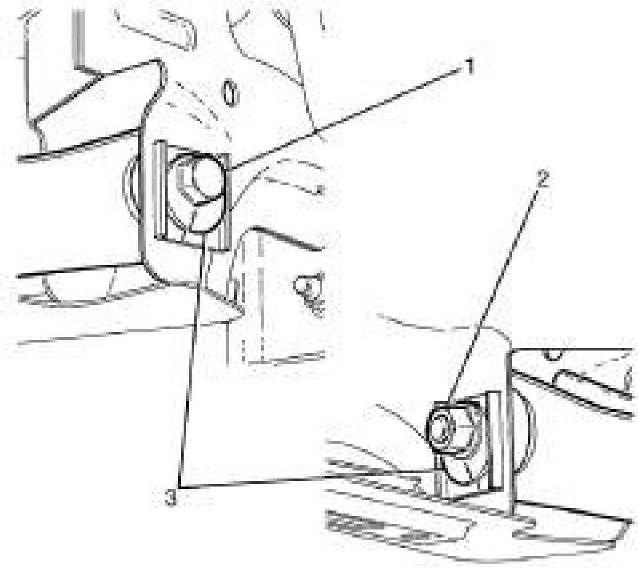
   Discard the nut.



Important: Do not apply pressure to the rear brake disc backing plate while levering.

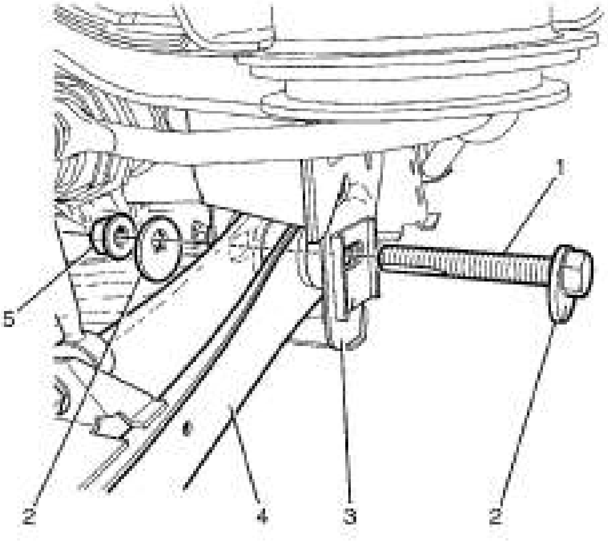
8. Detach the lower control arm (1) using a suitable pry bar.

   Reposition the jack as necessary.



Important: The lower control arm to subframe retaining bolt (1) and nut (2) eccentric washers (3) are used to adjust the rear suspension camber. One eccentric washer (3) is mounted directly to the head of the lower control arm to subframe retaining bolt (1).

9. Scribe the eccentric washers (3) with reference to their seating position relative to the subframe.

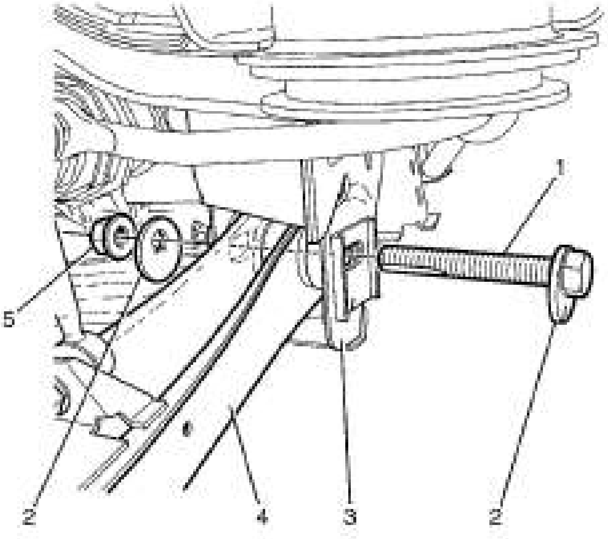


10. Remove the lower control arm to subframe retaining bolt (1) and nut (5).

    Discard the nut.

11. Remove the lower control arm (4) from the subframe (3).

Installation Procedure



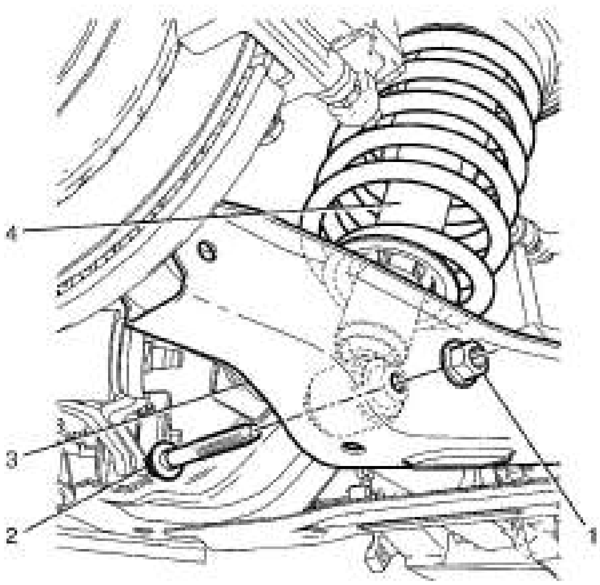
1. Install the lower control arm (4) into the subframe (3).

Important: The eccentric washers (2) must be fitted correctly in terms of their orientation and alignment marks.

Important: Do not fully tighten the lower control arm to subframe retaining bolt (1) and nut (5) at this stage.

2. Install the lower control arm to subframe retaining bolt (1).
3. Install the eccentric washer (2) and the NEW nut (5).

   Do not fully tighten at this stage.

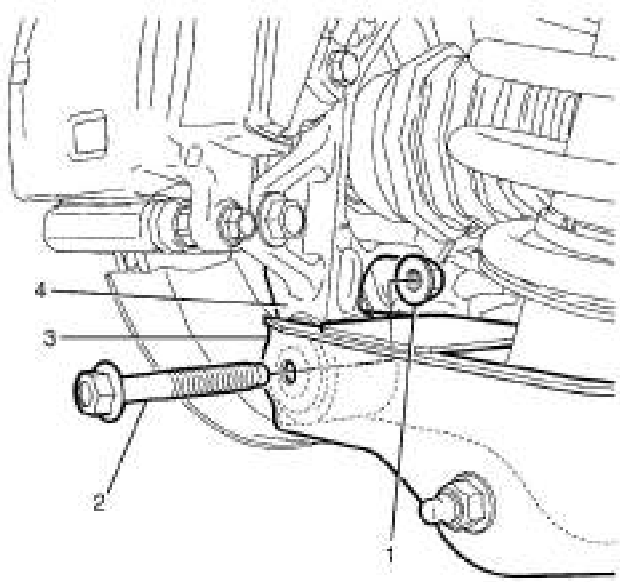


4. Connect the rear strut assembly (4) to the lower control arm (3).

   Important: Do not fully tighten the lower control arm to strut assembly retaining bolt (2) and nut (1) at this stage.

5. Install the lower control arm to strut assembly retaining bolt (2) and NEW nut (1).

   Do not fully tighten at this stage.

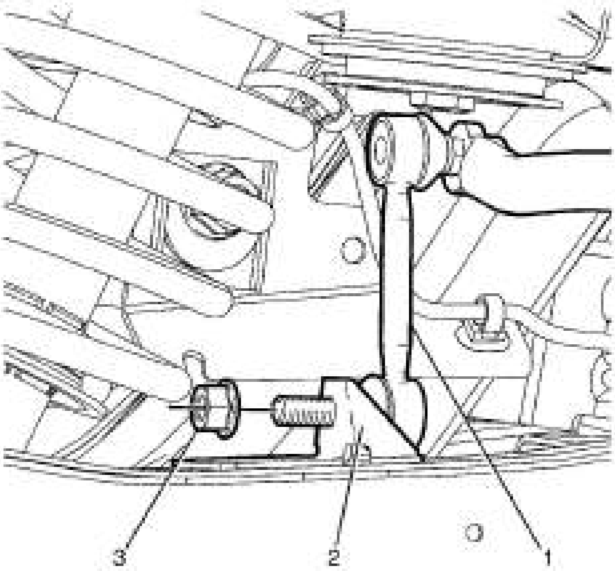


6. Connect the lower control arm (3) to the knuckle (4) using a suitable jack.

   Important: Do not fully tighten the lower control arm to knuckle retaining bolt (2) and nut (1) at this stage.

7. Install the lower control arm to the knuckle retaining bolt (2) and NEW nut (1).

   Do not fully tighten at this stage.



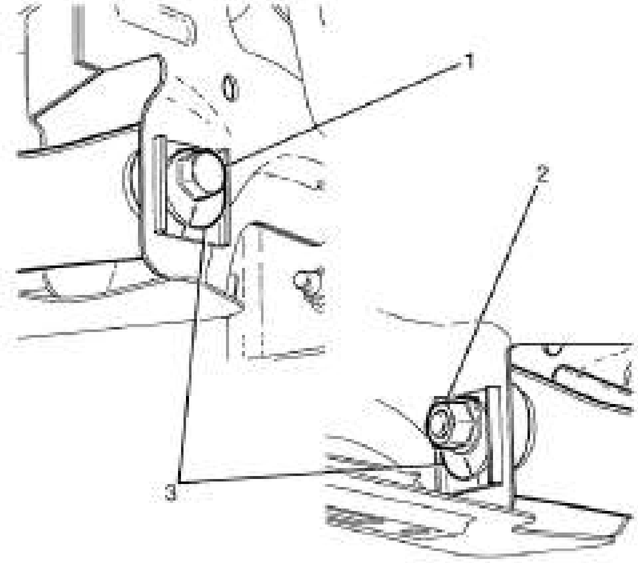
8. Connect the stabiliser bar link (1) to the lower control arm (2).

   Notice: Refer to Fastener Notice in the Preface section.

9. Install the stabiliser bar link to lower control arm retaining NEW nut (3).

   Tighten
   Tighten the nut to 50 N·m (37 lb ft).

10. Install the rear wheel. Refer to Tire and Wheel Removal and Installation.
11. Remove the safety stands.
12. Lower the vehicle to the ground.
13. Bounce the vehicle several times to settle the suspension.



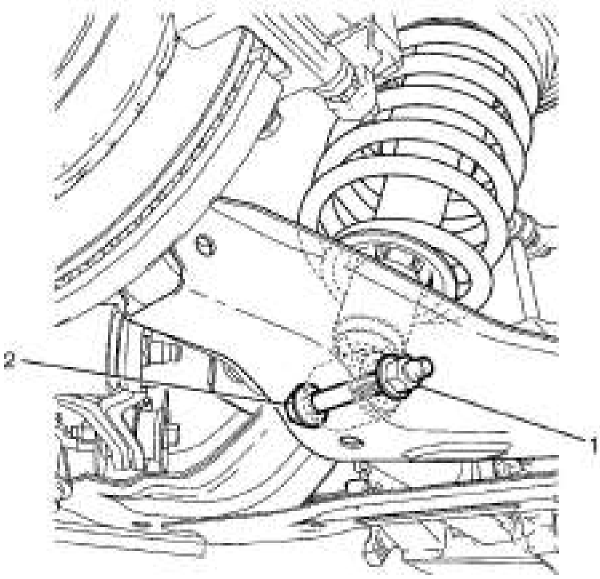
Important: The lower control arm to the subframe retaining bolt (1) and nut (2) eccentric washers (3) are used to adjust rear suspension camber.

14. Align the marks on the eccentric washers (3) with the marks on the subframe.

    Important: The weight of the vehicle must be on a level surface and on all four wheels before fully tightening the nuts and bolts.

15. Tighten the lower control arm to subframe retaining bolt (1) and nut (2).

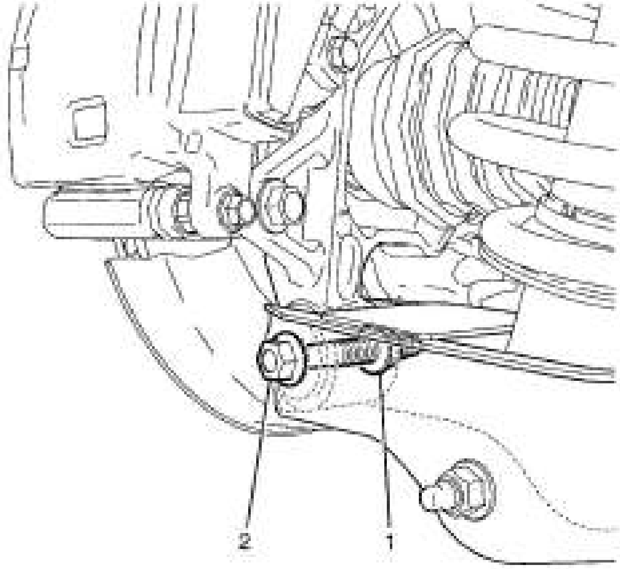
    Tighten
    Tighten the bolt and nut to 175 N·m (129 lb ft).



16. Tighten the lower control arm to strut assembly retaining bolt (2) and nut (1).

    Tighten
    Tighten the bolt and nut a first pass to 40 N·m (30 lb ft).

    Tighten the bolt and nut a final pass 120 Degrees.



17. Tighten the lower control arm to knuckle retaining bolt (2) and nut (1).

    Tighten
    Tighten the bolt and nut a first pass to 40 N·m (30 lb ft).

Tighten the bolt and nut a final pass 120 Degrees.

18. Check the wheel alignment of the vehicle. Refer to Wheel Alignment Measurement.
19. Correct the wheel alignment of the vehicle, if necessary. Refer to Rear Camber Adjustment and Rear Toe Adjustment.

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Rear Axle Lower Control Arm Bushing Replacement

Tools Required

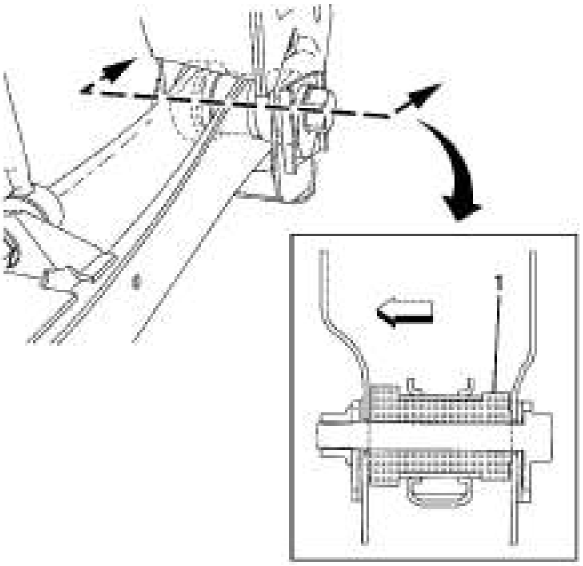
KM-619 Control Arm Bushing Remover/Installer.

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

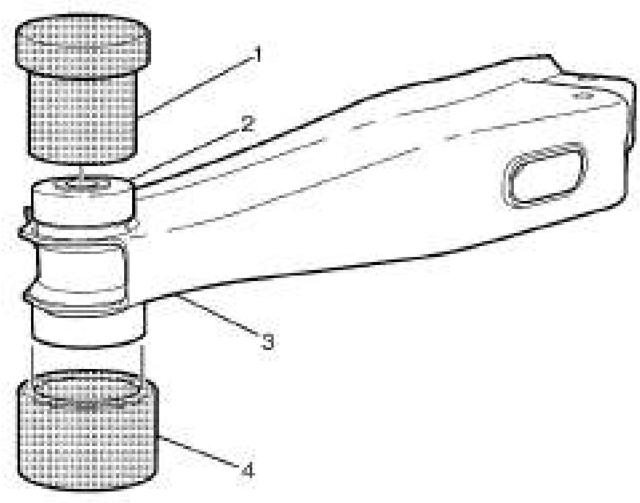
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the lower control arm. Refer to Lower Control Arm Replacement.



Important: The lower control arm bushing (1) has a conical shape with a mid-section recess that fits inside the lower control arm bushing cavity. The wider end of the lower control arm bushing (1) faces towards the front of the vehicle.

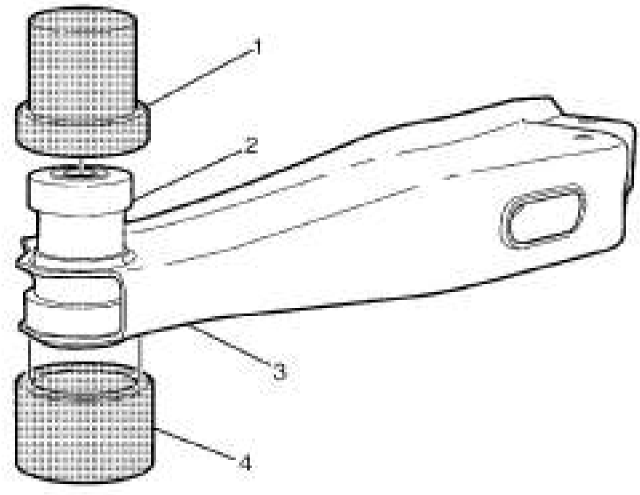
3. Check the orientation of the lower control arm bushing.



Important: The lower control arm bushing (2) must be lubricated with soapy water solution to ease the removal process.

4. Remove the lower control arm bushing (2) from the lower control arm (3) using the KM-619 (1, 4).

Installation Procedure



Important: The wider end of the lower control arm bushing (2) must be installed facing towards the front of the vehicle.

Important: The lower control arm bushing (2) must be lubricated with soapy water solution to ease the installation process.

1. Install the lower control arm bushing (2) using the KM-619 (1, 4).
2. Install the lower control arm (3). Refer to Lower Control Arm Replacement.
3. Remove the safety stands.
4. Lower the vehicle to the ground.

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Rear Axle Upper Control Arm Replacement

Tools Required

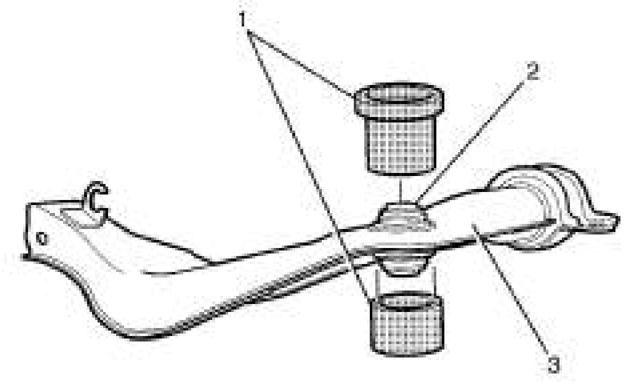
KM-619 Bushing Remover/Installer.

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

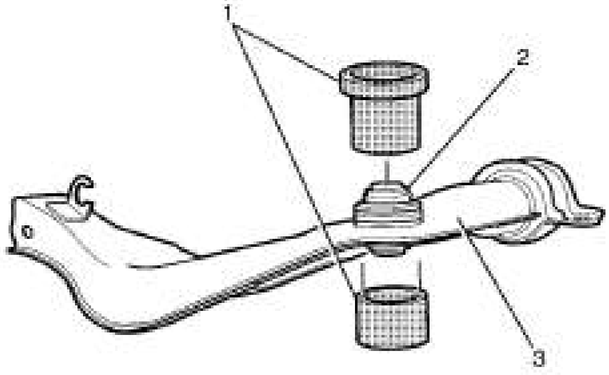
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the subframe. Refer to Rear Frame Replacement .
3. Remove the upper control arm pivot bushing. Refer to Control Arm Bushing Replacement
4. Remove the upper control arm. Refer to Upper Control Arm Replacement .



Important: It is recommended to observe the orientation and depth of the upper control arm ball joint bushing (2) with reference to the original position. Adhering to this recommendation will minimize the potential of incorrect upper control arm ball joint bushing (2) installation.

5. Remove the upper control arm ball joint bushing (2) from the upper control arm (3) using the KM-619 (1).
6. Inspect all parts for wear and damage.

Installation Procedure



Important: Before installing, the upper control arm ball joint bushing (2) must be correctly aligned and orientated. The depth to which the bushing is going to travel must also be observed and maintained.

1. Install the upper control arm ball joint bushing (2) using the KM-619 (1).
2. Install the upper control arm (3). Refer to Upper Control Arm Replacement .
3. Install the upper control arm pivot bushing. Refer to Control Arm Bushing Replacement .
4. Install the subframe. Refer to Rear Frame Replacement .
5. Remove the safety stands.
6. Lower the vehicle to the ground.
7. Check the vehicle rear wheel alignment and adjust if necessary. Refer to Wheel Alignment Measurement .

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Rear Suspension Knuckle Upper Bushing Replacement

Tools Required

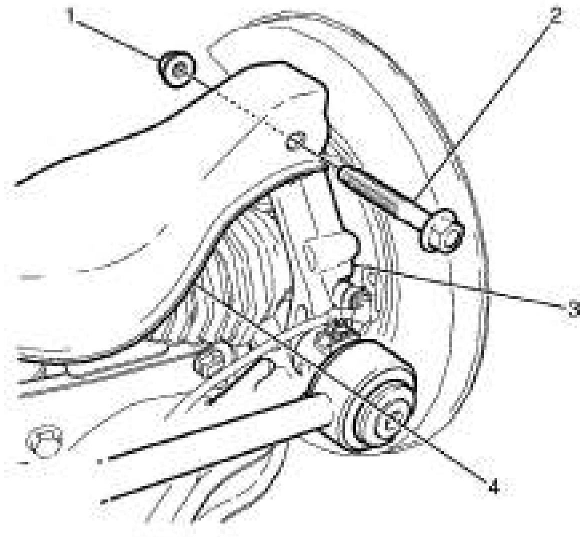
KM-619 Bushing Remover/Installer.

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear wheel. Refer to Tire and Wheel Removal and Installation.



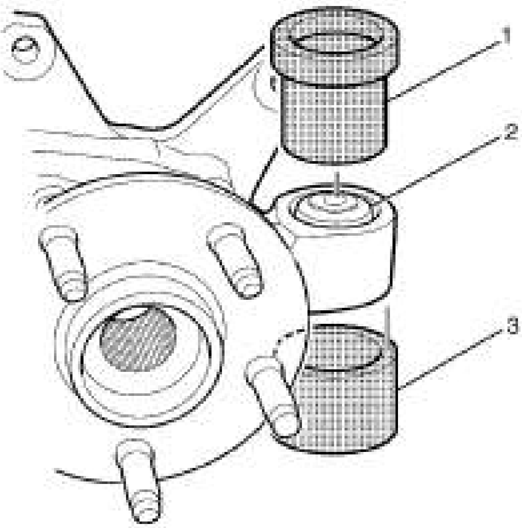
Important: Mark the location of the bolt and nut relative to the upper control arm for correct re-assembly.

Important: Nuts with micro-encapsulated thread sealant must be replaced after removal.

3. Remove the upper control arm to knuckle retaining bolt (2) and nut (1).

   Discard the nut.

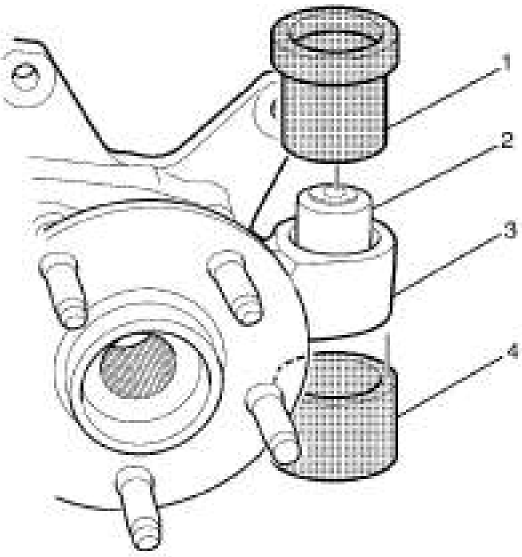
4. Disconnect the upper control arm (4) from the knuckle (3).



Important: It is recommended to observe the orientation and depth of the knuckle to upper control arm bushing (2) with reference to the original position. Adhering to this recommendation will minimize the potential of incorrect knuckle to upper control arm bushing (2) installation.

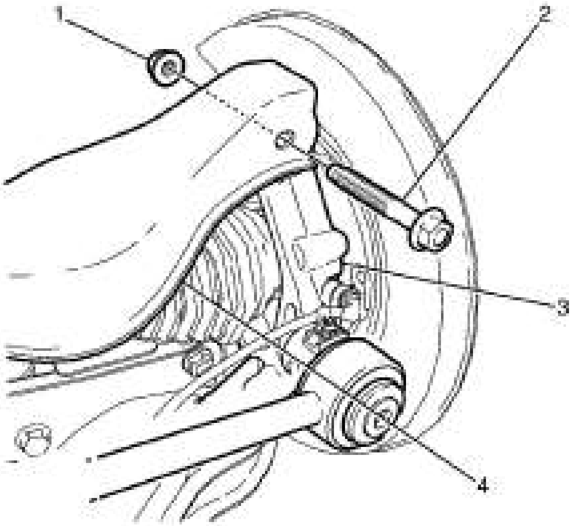
5. Remove the upper control arm to knuckle bushing (2) using the KM-619 (1, 3).
6. Inspect all parts for wear and damage.

Installation Procedure



Important: Before installing, the upper control arm to knuckle bushing (2) must be correctly aligned and orientated.

1. Install the upper control arm to knuckle bushing (2) to the knuckle (3) using the KM-619 (1, 4).



2. Connect the upper control arm (4) to the knuckle (3).

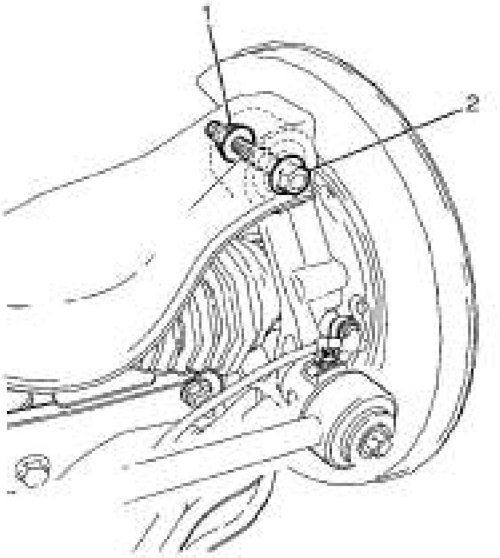
Important: The upper control arm to knuckle retaining bolt and nut must not to be fully tightened at this stage.

3. Install the upper control arm to knuckle retaining bolt (2) and NEW nut (1).

   Do not fully tighten at this stage.

4. Remove the safety stands.
5. Lower the vehicle to the ground.
6. Bounce the vehicle several times to settle the suspension.

Notice: Refer to Fastener Notice in the Preface section.



Important: Align the mark from bolt to upper control arm made prior to removal.

Important: The weight of the vehicle must be on a level surface and on all four wheels before fully tightening the nuts and bolts.

7. Tighten the upper control arm to knuckle retaining bolt (2) and NEW nut (1).

   Tighten
   Tighten the bolt and nut to 60 N·m(44 lb ft).

   Tighten the bolt and nut to 90 Degrees.

8. Check the vehicle rear wheel alignment and adjust if necessary. Refer to Wheel Alignment Specifications.

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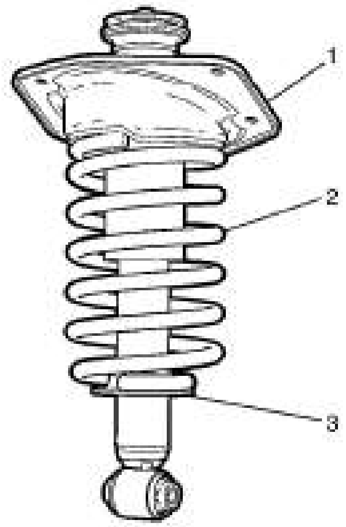
Rear Suspension Strut Mount Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the rear wheels. Refer to Tire and Wheel Removal and Installation .
3. Remove the rear strut assembly. Refer to Strut Assembly Replacement .

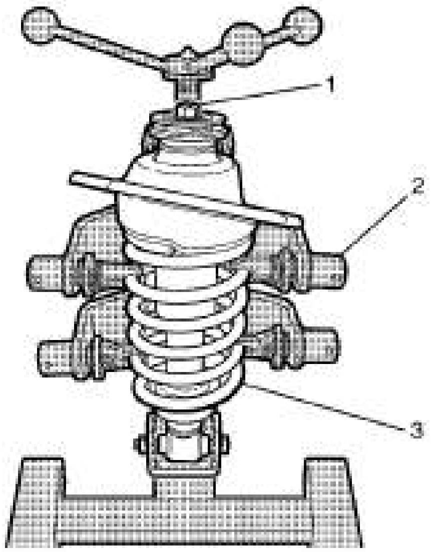


Important: Before disassembling the rear strut assembly observe the seating position of the coil spring (2) relative to the rear strut carrier plate (3) and rear strut assembly support mount (1).

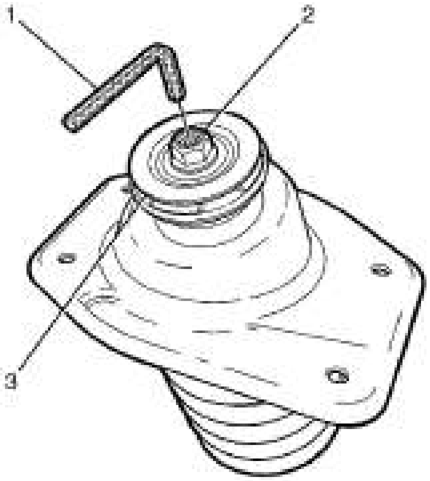
4. Inspect the rear strut.

Caution: Refer to General Repair Instructions in the Preface section.

Caution: Refer to General Repair Instructions in the Preface section.



5. Mount the rear strut assembly on a mounting trestle, or a vice.
6. Fasten the spring compressor (2) to the rear strut assembly. Make sure the hooks are seated on the coil spring (3) correctly.
7. Compress the coil spring (3) using the spring compressor (2).



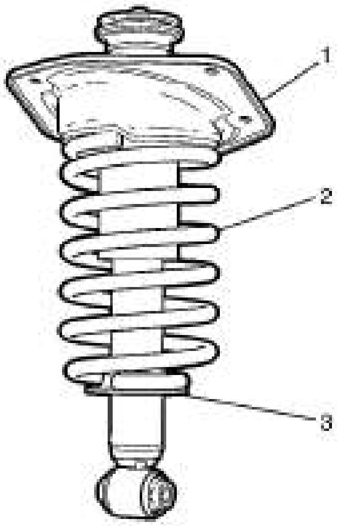
Important: Use a hex key (1) to prevent the rear strut assembly piston shaft from rotating while removing the strut assembly retaining nut (2).

Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

8. Remove the rear strut assembly retaining nut (2).

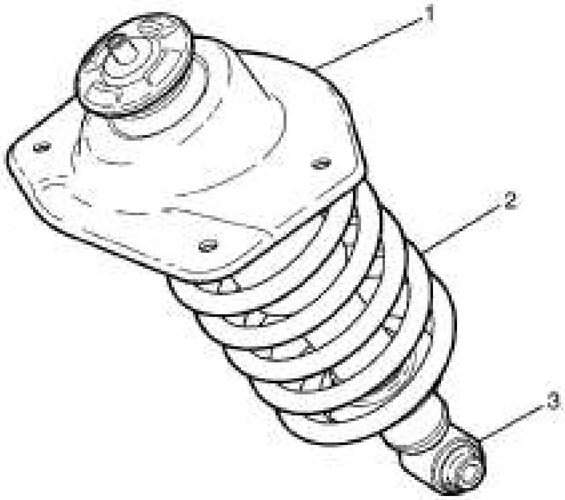
   Discard the nut.

9. Note the orientation and remove the upper washer (3).



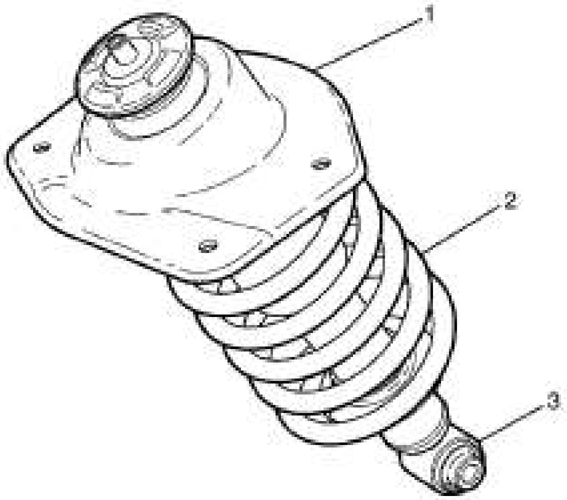
Important: The correct seating position of the coil spring (2) relative to the rear strut carrier plate (3) and rear strut assembly support mount (1) must be observed before removing the rear strut assembly support mount (1).

10. Inspect the rear strut.

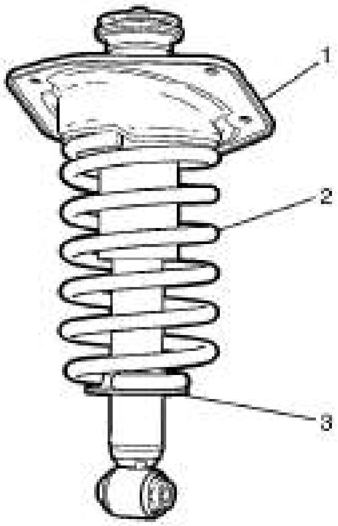


11. Remove the rear strut assembly support mount (1) from the coil spring (2) and rear strut unit (3).
12. Inspect all parts for wear and damage.

Installation Procedure



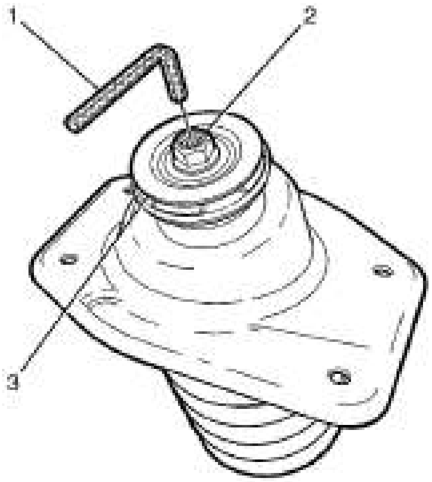
1. Install the rear strut assembly support mount (1) to the coil spring (2) and rear strut unit (3).



Important: The correct seating position of the coil spring (2) relative to the rear strut carrier plate (3) and rear strut assembly support mount (1) must be maintained.

2. Inspect the rear strut.

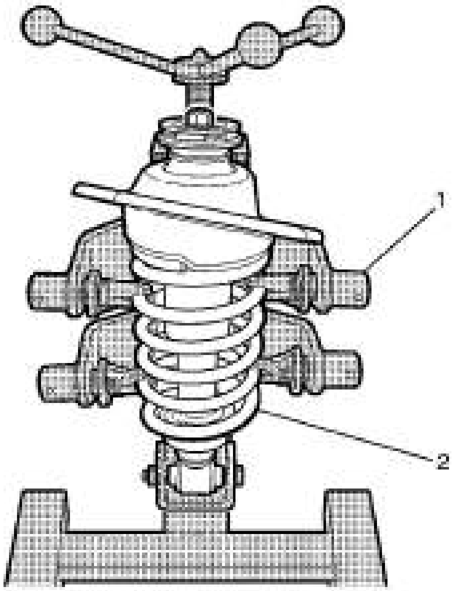
Notice: Refer to Fastener Notice in the Preface section.



Important: Use a hex key (1) to prevent the rear strut unit piston shaft from rotating while tightening the rear strut assembly retaining nut (2).

3. Note the orientation and install the upper washer (3).
4. Install a NEW rear strut assembly retaining nut (2).

Tighten
Tighten the nut to 45 N·m (33 lb ft).



5. Release and remove the spring compressor (1) from the coil spring (2).
6. Remove the rear strut unit from the mounting trestle, or the vice.

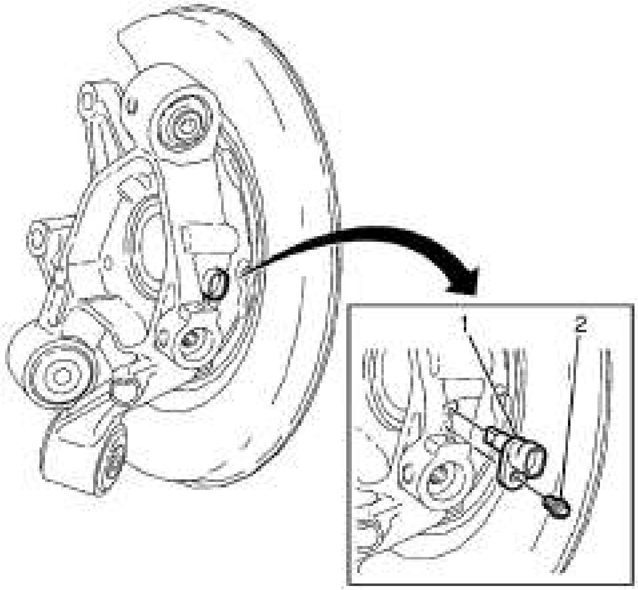
7. Install the rear strut assembly into the vehicle. Refer to Strut Assembly Replacement .
8. Remove the safety stands.
9. Lower the vehicle to the ground.

Rear Wheel Bearing and Hub Replacement (Original)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

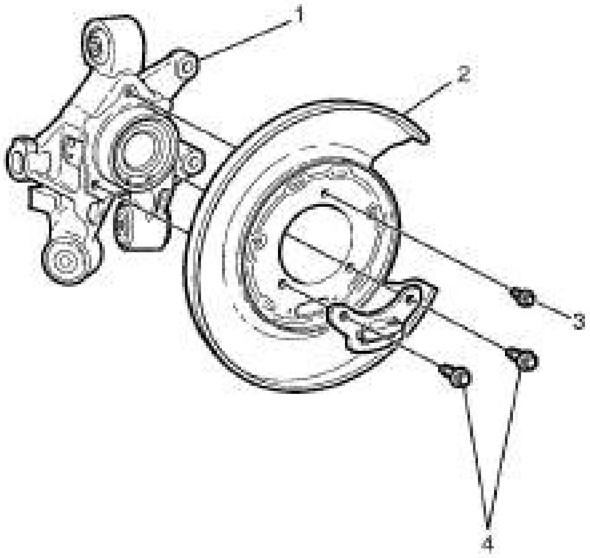
1. Remove the wheel hub and knuckle assembly. Refer to Knuckle Replacement.
2. Secure the wheel hub and knuckle assembly using a suitable vice.



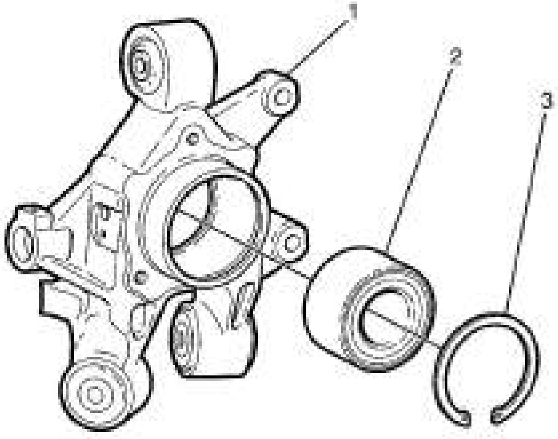
3. Remove the wheel speed sensor to knuckle retaining bolt (2).
4. Remove the wheel speed sensor (1).

Important: The wheel bearing will be damaged when pressing out the wheel hub flange. The wheel bearing must be replaced every time the wheel hub is removed.

5. Remove the wheel hub flange using a suitable workshop press.
6. Remove the park brake shoes. Refer to Parking Brake Shoe Replacement.



7. Remove the disc brake backing plate to knuckle retaining bolts (3 and 4).
8. Remove the disc brake backing plate (2) from the knuckle (1).



9. Remove the wheel bearing retaining circlip (3) using suitable circlip pliers.

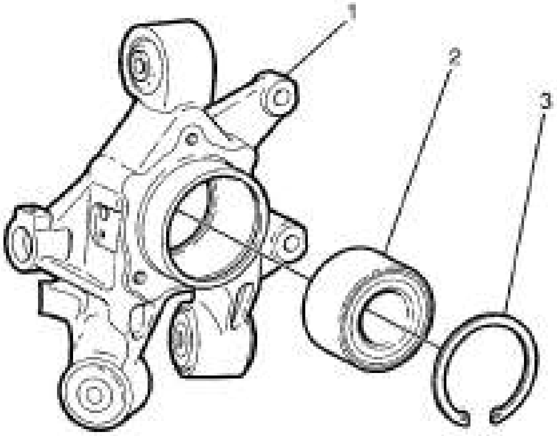
   Important: The wheel bearing will be damaged when pressing out the wheel hub flange. The wheel bearing must be replaced every time the wheel hub is removed.

10. Press the wheel bearing (2) from the knuckle (1) using a suitable workshop press.

    Discard the wheel bearing.

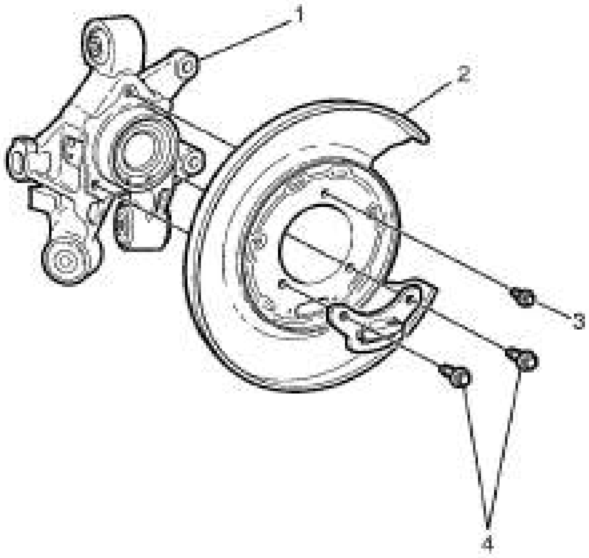
Installation Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.



Important: Prior to installing the NEW wheel bearing it is essential that the correct orientation is attained, the wheel speed sensor decoder ring MUST face inboard, towards the wheel speed sensor. Failure to install in the correct orientation will result in ABS/ESP faults.

1. Install the NEW wheel bearing (2) to the knuckle (1) using a workshop press.
2. Install the wheel bearing retaining circlip (3) using suitable circlip pliers.



3. Install the disc brake backing plate (2) to the knuckle (1).

Notice: Refer to Fastener Notice in the Preface section.

4. Install the upper disc brake backing plate to knuckle retaining bolt (3).

   Tighten
   Tighten the bolts to 60 Nm (44 lb ft).

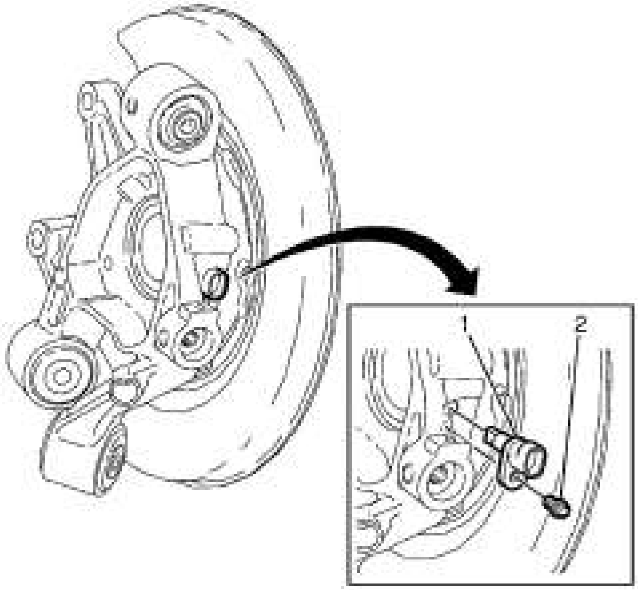
5. Install the lower disc brake backing plate to knuckle retaining bolts (4).

   Tighten
   Tighten the bolts to 130 Nm (96 lb ft).

6. Install the park brake shoes. Refer to Parking Brake Shoe Replacement.

   Important: The wheel hub flange (1) must be fully seated against the wheel bearing.

7. Install the wheel hub flange (1) using a suitable press.



8. Install the wheel speed sensor (1).

   Notice: Refer to Fastener Notice in the Preface section.

9. Install the wheel speed sensor to knuckle retaining bolt (2).

   Tighten
   Tighten the bolt to 7 N·m (62 lb in).

10. Remove the hub and knuckle assembly from the vice.
11. Install the wheel hub and knuckle assembly. Refer to Knuckle Replacement.

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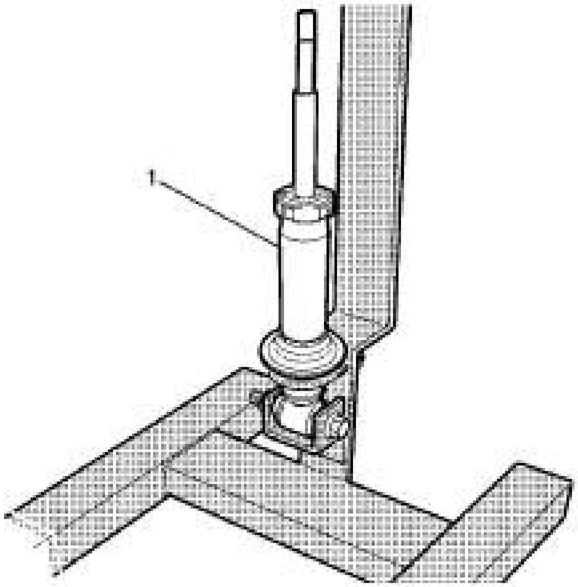
Shock Absorber Replacement (LWB SWB Clubsport CSV VXR8)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

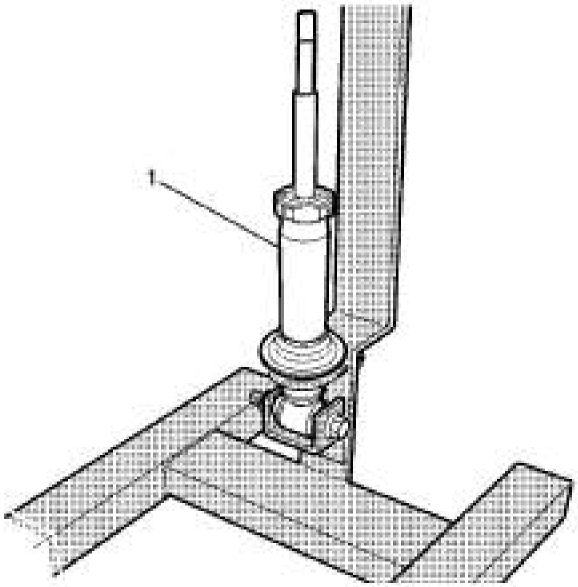
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear wheels. Refer to Tire and Wheel Removal and Installation.
3. Remove the rear strut assembly. Refer to Strut Assembly Replacement.
4. Remove the rear strut assembly support mount. Refer to Rear Suspension Strut Mount Replacement.
5. Remove the rear coil spring. Refer to Coil Spring Replacement.



6. Remove the shock absorber (1) from the mounting trestle, or vice.
7. Inspect all parts for wear and damage.

Installation Procedure

Notice: Refer to General Repair Instructions in the Preface section.



1. Mount the shock absorber (1) on a mounting trestle, or a vice.
2. Install the rear coil spring. Refer to Coil Spring Replacement.
3. Install the rear strut assembly support mount. Refer to Rear Suspension Strut Mount Replacement.
4. Install the rear strut assembly. Refer to Strut Assembly Replacement.
5. Install the rear wheel. Refer to Tire and Wheel Removal and Installation.
6. Remove the safety stands.
7. Lower the vehicle to the ground.

Stabilizer Shaft Insulator Replacement

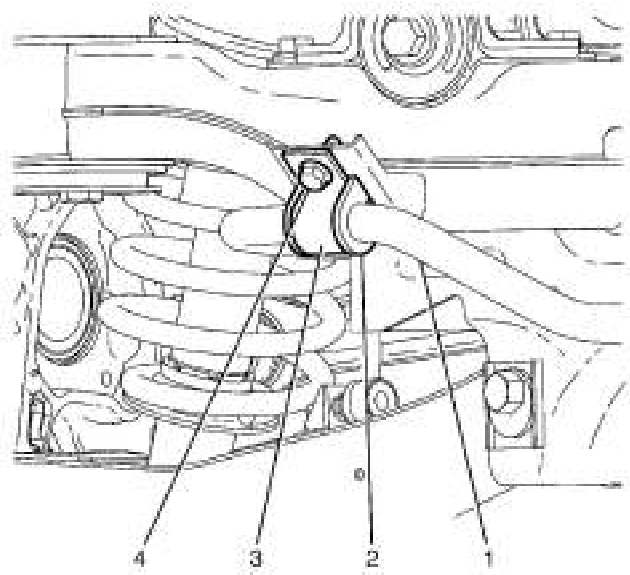
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

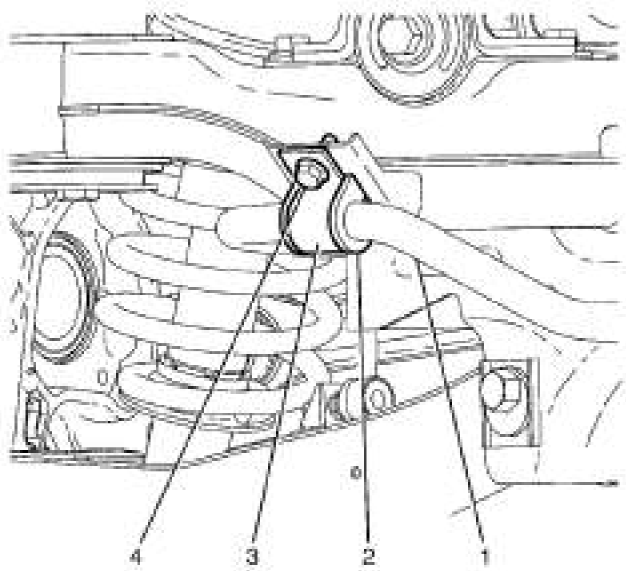
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

Caution: Refer to General Repair Instructions in the Preface section.



2. Remove the stabiliser bar insulator bracket to subframe retaining bolts (4) on both sides of the stabiliser bar (1).
3. Remove the stabiliser bar insulator bracket (3) from the subframe on both sides of the stabiliser bar (1).
4. Remove the stabiliser bar insulator (2) from both sides of the stabiliser bar (1).
5. Inspect all parts for wear and damage.

Installation Procedure



1. Install the stabiliser bar insulator (2) to both sides of the stabiliser bar (1).
2. Install the stabiliser bar insulator bracket (3) to the subframe on both sides of the stabiliser bar (1).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the stabiliser bar insulator bracket to subframe retaining bolts (4) on both sides of the stabiliser bar (1).

   Tighten
   Tighten the bolts to 22 N·m (16 lb ft).

4. Remove the safety stands.
5. Lower the vehicle to the ground.

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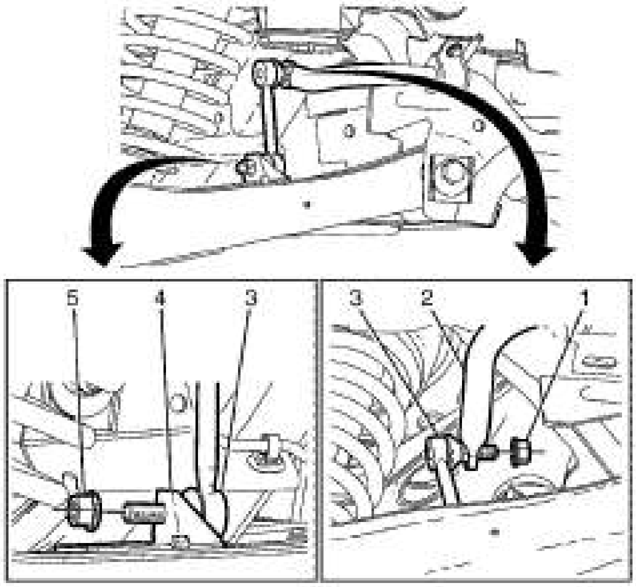
Stabilizer Shaft Link Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

2. Remove the stabiliser bar link to stabiliser bar retaining nut (1).

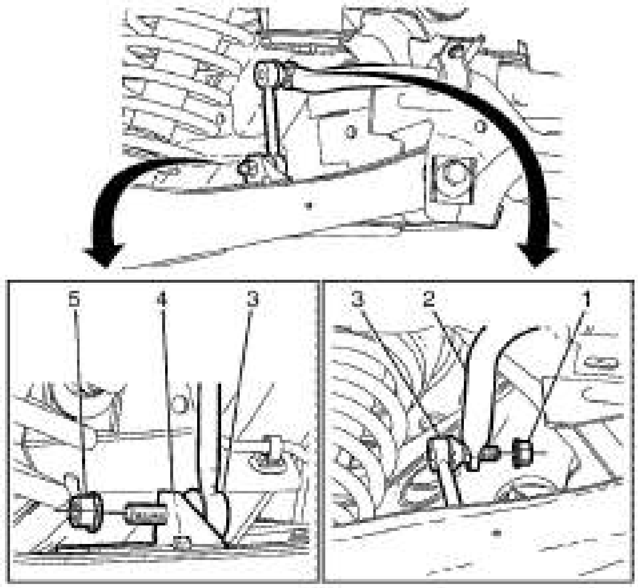
   Discard the nut.

3. Disconnect the stabiliser bar link (3) from the stabiliser bar (2).
4. Remove and the stabiliser bar link to lower control arm retaining nut (5).

   Discard the nut.

5. Remove the stabiliser bar link (3) from the lower control arm (4).
6. Remove the stabiliser bar link (3).
7. Inspect all parts for wear and damage.

Installation Procedure



1. Connect the stabiliser bar link (3) to the stabiliser bar (2).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the stabiliser bar link to stabiliser bar NEW retaining nut (1).

   Tighten
   Tighten the nut to 50 N·m (37 lb ft).

3. Install the stabiliser bar link (3) to the lower control arm (4).
4. Install the stabiliser bar link to lower control arm retaining NEW nut (5).

   Tighten
   Tighten the nut to 50 N·m (37 lb ft).

5. Remove the safety stands.
6. Lower the vehicle to the ground.

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Stabilizer Shaft Replacement

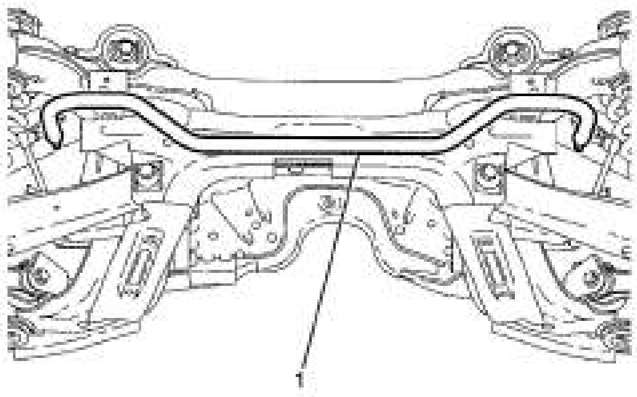
Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Disconnect the stabiliser bar links from the stabiliser bar. Refer to Stabilizer Shaft Link Replacement .
3. Remove the stabiliser bar insulators. Refer to Stabilizer Shaft Insulator Replacement .

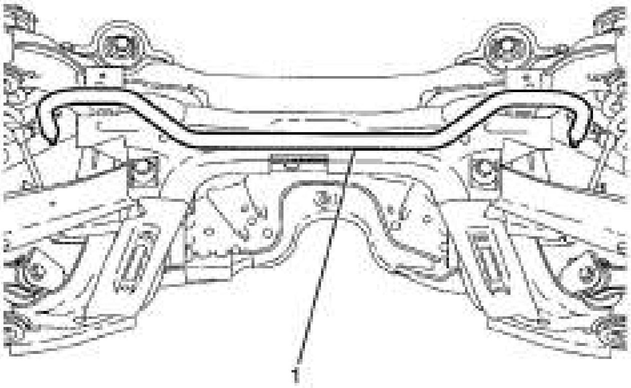
Caution: Refer to General Repair Instructions in the Preface section.



4. Remove the stabiliser bar (1) from the vehicle.
5. Inspect all parts for wear and damage.

Installation Procedure

Notice: Refer to General Repair Instructions in the Preface section.



1. Install the stabiliser bar (1) to the vehicle.
2. Install the stabiliser bar insulators and brackets. Refer to Stabilizer Shaft Insulator Replacement .
3. Install the stabiliser bar links to the stabiliser bar. Refer to Stabilizer Shaft Link Replacement .
4. Remove the safety stands.
5. Lower the vehicle to the ground.

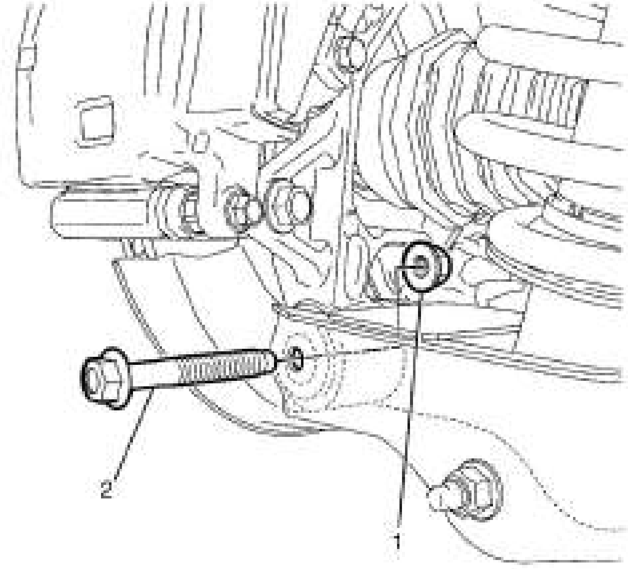
Strut Assembly Replacement (LWB SWB Clubsport CSV VXR8)

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

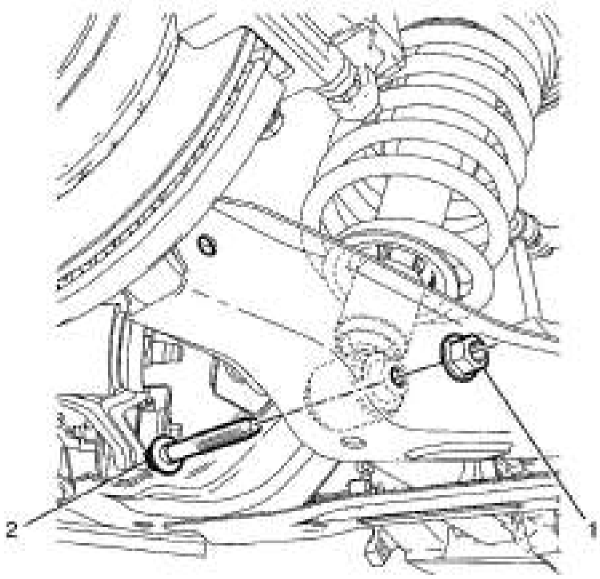
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear wheel. Refer to Tire and Wheel Removal and Installation.
3. Support the lower control arm with a suitable jack.



Important: Prevailing torque nuts must be discarded after removal.

4. Remove the lower control arm to knuckle retaining bolt (2) and nut (1).

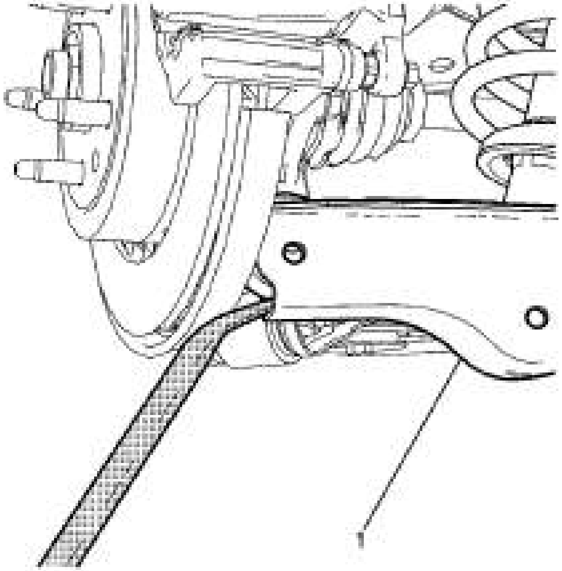
   Discard the nut.



Important: Prevailing torque nuts must be discarded after removal.

5. Remove the lower control arm to rear strut assembly retaining bolt (2) and nut (1).

   Discard the nut.

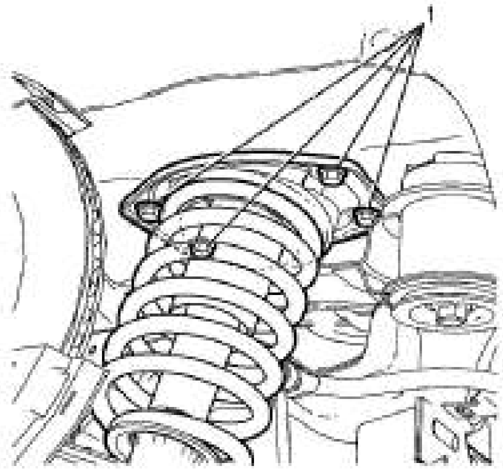


Important: Do not apply pressure to the rear brake disc backing plate while levering.

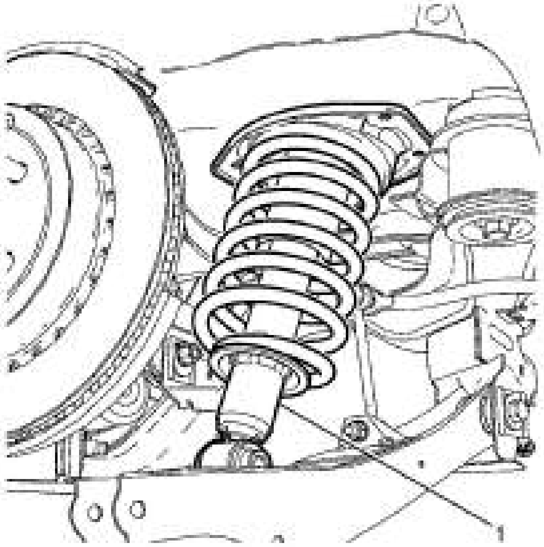
6. Detach the lower control arm (1) using a suitable pry bar.

Reposition the jack as necessary.

Caution: Refer to General Repair Instructions in the Preface section.

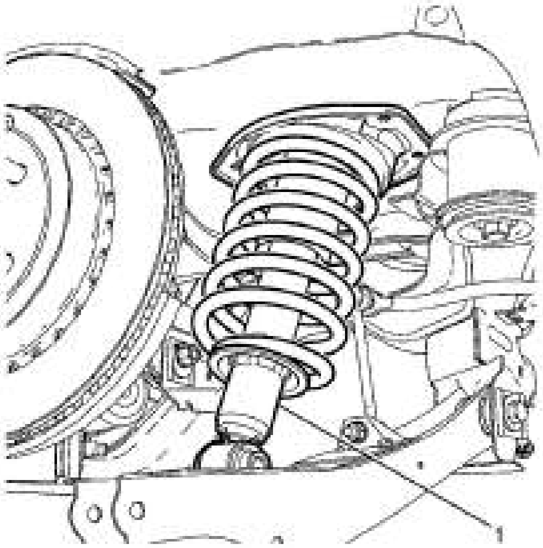


7. Remove the rear strut assembly to body retaining bolts (1).



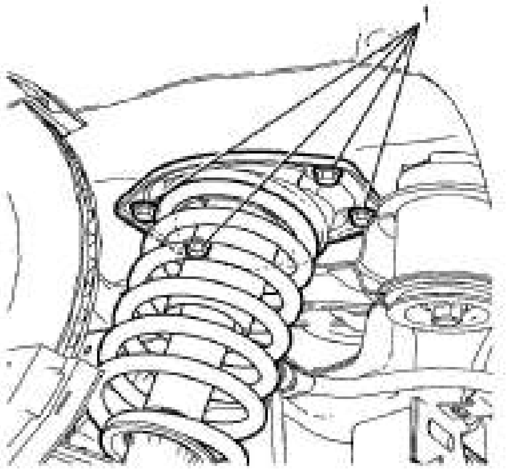
8. Remove the rear strut assembly (1) from the vehicle.
9. Inspect all parts for wear and damage.

Installation Procedure



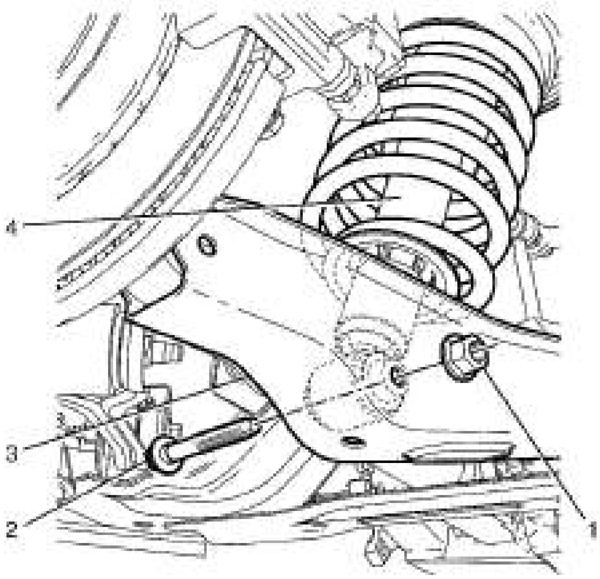
1. Install the rear strut assembly (1) into the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the rear strut assembly to body retaining bolts (1).

   Tighten
   Tighten the bolts to 58 N·m (43 lb ft).

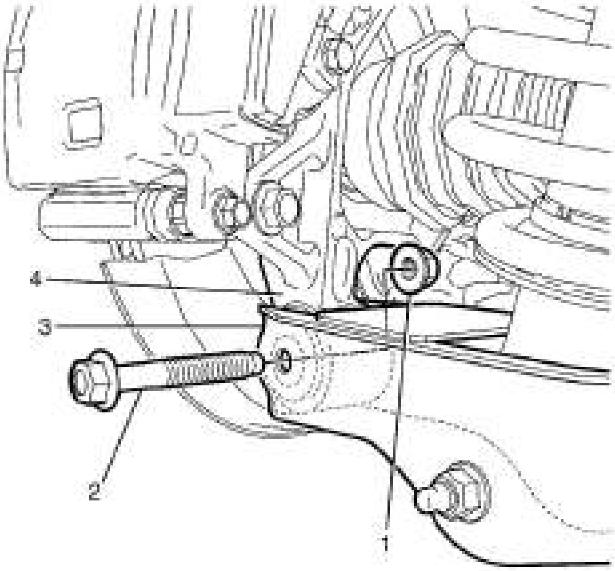


3. Connect the rear strut assembly (4) to the lower control arm (3).

   Important: Do not fully tighten the lower control arm to strut assembly retaining bolt (2) and nut (1) at this stage.

4. Install the lower control arm to strut assembly retaining bolt (2) and NEW nut (1).

   Do not fully tighten at this stage.



5. Connect the lower control arm (3) to the knuckle (4) using a suitable jack.

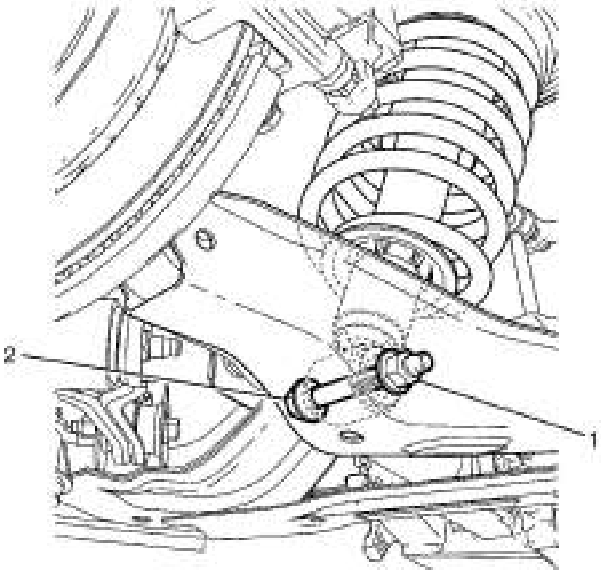
   Important: Do not fully tighten the lower control arm to knuckle retaining bolt (2) and nut

(1) at this stage.

6. Install the lower control arm to the knuckle retaining bolt (2) and NEW nut (1).

   Do not fully tighten at this stage.

7. Install the rear wheel. Refer to Tire and Wheel Removal and Installation.
8. Remove the safety stands.
9. Lower the vehicle to the ground.
10. Bounce the vehicle several times to settle the suspension.

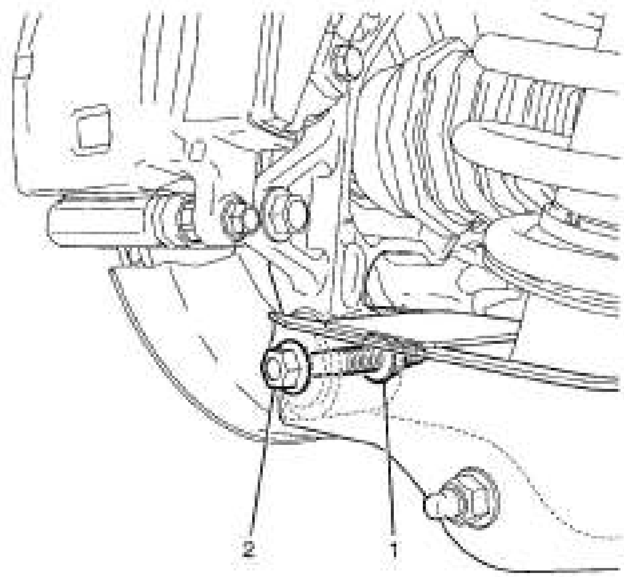


Important: The weight of the vehicle must be on a level surface and on all four wheels before fully tightening the nuts and bolts.

11. Tighten the lower control arm to strut assembly retaining bolt (2) and NEW nut (1).

    Tighten
    Tighten the bolt and nut a first pass to 40 N·m (30 lb ft).

    Tighten the bolt and nut a final pass 120 Degrees.



12. Tighten the lower control arm to knuckle retaining bolt (2) and NEW nut (1).

    Tighten
    Tighten the bolt and nut a first pass to 40 N·m (30 lb ft).

    Tighten the bolt and nut a final pass 120 Degrees.

13. Check the wheel alignment of the vehicle. Refer to Wheel Alignment Measurement.
14. Correct the wheel alignment of the vehicle, if necessary. Refer to Rear Camber Adjustment and Rear Toe Adjustment.

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Trailing Arm Bushing Replacement

Tools Required

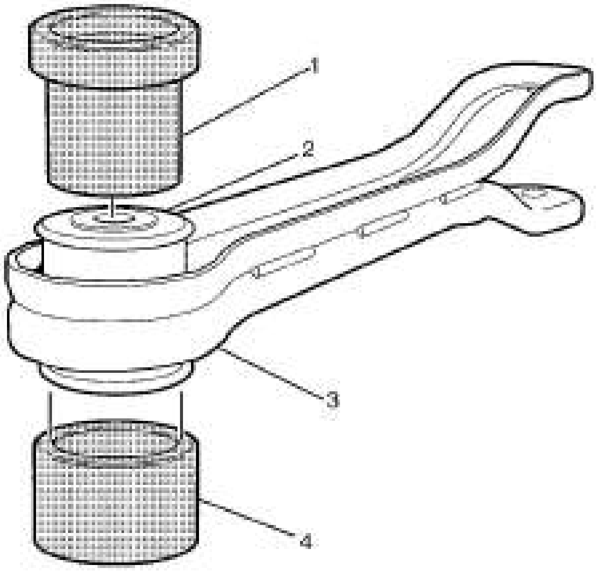
KM-906-B Control Arm Bushing Remover/Installer.

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

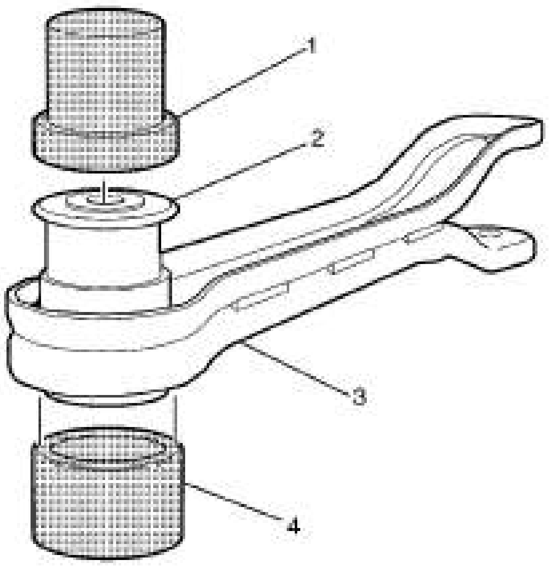
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the Y-Link. Refer to Trailing Arm Replacement.



Important: It is recommended to observe the orientation and depth of the Y-Link bushing (2) with reference to the original position. Adhering to this recommendation will minimize the potential of incorrect Y-Link bushing (2) installation.

3. Remove the Y-Link bushing (2) from the Y-Link (3) using the KM-906-B (1, 4).
4. Inspect all parts for wear and damage.

Installation Procedure



Important: Before installing, the Y-Link bushing (2) must be correctly aligned and orientated.

1. Install the Y-Link (2) bushing to the Y-Link (3) using the KM-906-B 9 (1, 4).
2. Install the Y-Link (3). Refer to Trailing Arm Replacement.
3. Remove the safety stands.
4. Lower the vehicle to the ground.

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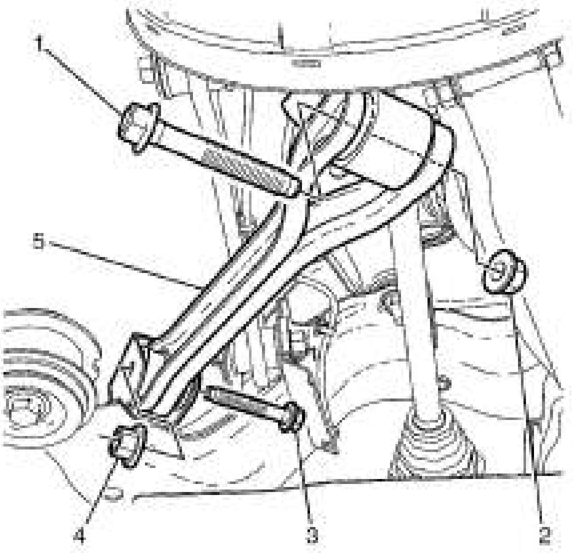
Trailing Arm Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear wheel. Refer to Tire and Wheel Removal and Installation.



Important: Mark the location of the bolt and nut relative to the Y-Link for correct re-assembly.

Important: Prevailing torque nuts must be discarded after removal.

3. Remove the Y-Link to knuckle retaining bolt (1) and nut (2).

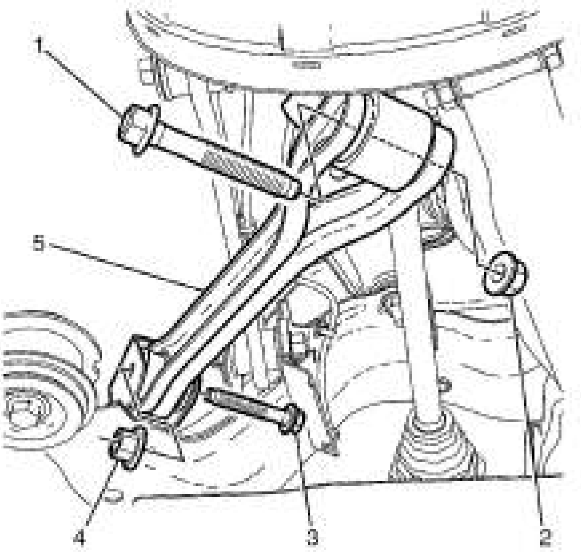
   Discard the nut.

4. Remove the Y-Link to subframe retaining bolt (3) and nut (4).

   Discard the nut.

5. Remove the Y-Link (5).
6. Inspect all parts for wear and damage.

Installation Procedure



1. Install the Y-Link (5) into the subframe.

   Important: The Y-Link to subframe retaining bolt (3) and nut (4) must not to be fully tightened at this stage.

2. Install the Y-Link to subframe retaining bolt (3) and NEW nut (4).

   Do not fully tighten at this stage.

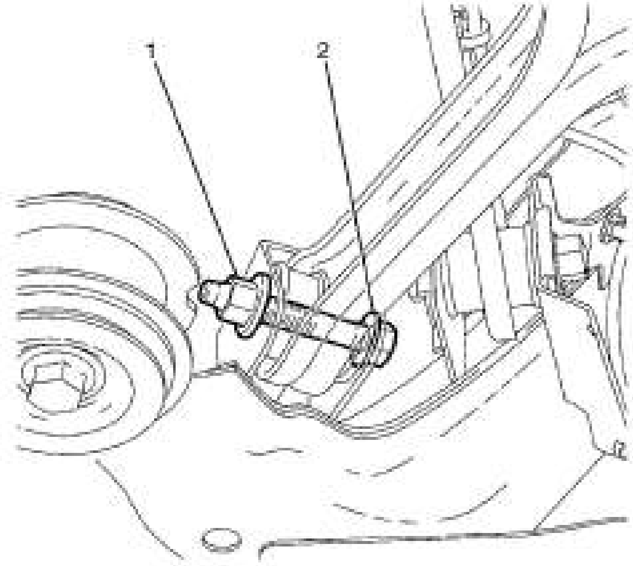
   Important: The Y-Link to knuckle retaining bolt (1) and nut (2) must not to be fully tightened at this stage.

3. Install the Y-Link to knuckle retaining bolt (1) and NEW nut (2).

   Do not fully tighten at this stage.

4. Lower the vehicle to the ground.
5. Bounce the vehicle several times to settle the suspension.
6. Check the vehicle rear wheel alignment and adjust if necessary. Refer to Wheel Alignment Specifications.

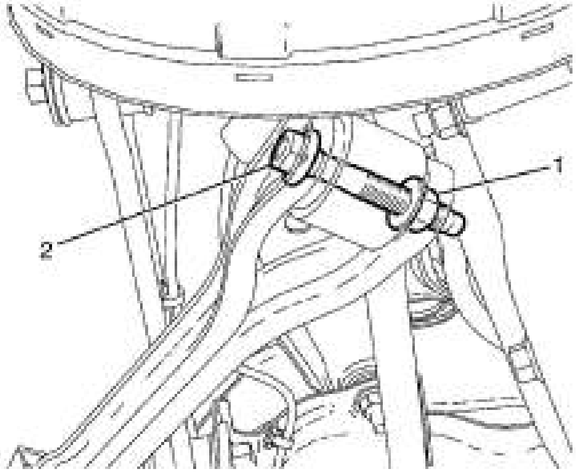
   Notice: Refer to Fastener Notice in the Preface section.



Important: The weight of the vehicle must be on a level surface and on all four wheels before fully tightening the nuts and bolts.

7. Tighten the Y-Link to subframe retaining bolt (2) and NEW nut (1).

Tighten
Tighten the bolt and nut to 100 N·m (74 lb ft).



8. Tighten the Y-Link to knuckle retaining bolt (2) and NEW nut (1).

Tighten

Tighten the bolt and nut a first pass to 40 N·m (30 lb ft).

Tighten the bolt and nut a final pass 120 Degrees.

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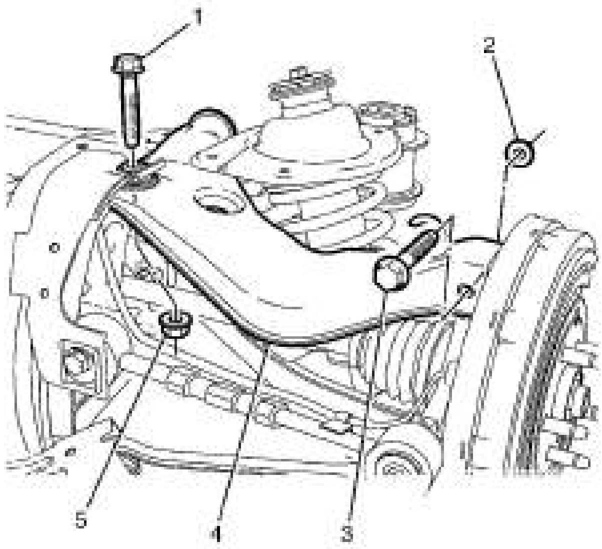
Upper Control Arm Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the subframe. Refer to Rear Frame Replacement.
3. Remove the upper control arm pivot bushing. Refer to Control Arm Bushing Replacement.



Important: Mark the location of the bolt and nut relative to the Y-Link for correct re-assembly.

Important: Prevailing torque nuts must be replaced after removal.

4. Remove the upper control arm ball joint bushing to subframe retaining bolt (1) and nut (5).

   Discard the nut.

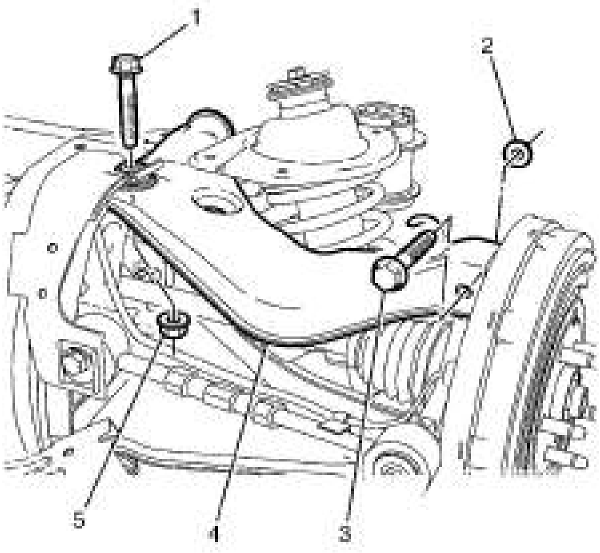
5. Remove the upper control arm to knuckle retaining bolt (3) and nut (2).

   Discard the nut.

6. Remove the upper control arm (4).
7. Inspect all parts for wear and damage.

Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



1. Install the upper control arm (4) into the subframe.
2. Install the upper control arm ball joint bushing to subframe retaining bolt (1) and NEW nut (5).

   Tighten
   Tighten the bolt and nut a first pass to 80 N·m (59 lb ft).

   Tighten
   Tighten the bolt and nut a final pass 120 Degrees.

3. Install the upper control arm to knuckle retaining bolt (3) and NEW nut (2).

   Tighten
   Tighten the bolt and nut a first pass to 60 N·m (44 lb ft).

   Tighten
   Tighten the bolt and nut a final pass 90Degrees.

4. Install the upper control arm pivot bushing. Refer Control Arm Bushing Replacement.
5. Install the subframe. Refer to Rear Frame Replacement.
6. Remove the safety stands.
7. Lower the vehicle to the ground.
8. Check the vehicle rear wheel alignment and adjust if necessary. Refer to Wheel Alignment Specifications.

Wheel Stud Replacement

Tools Required

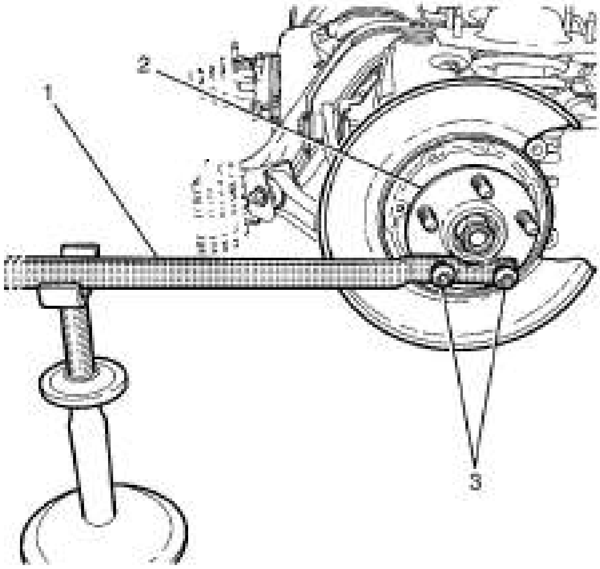
- C-4150-C Press Tool.
- 7208 Drive Shaft Remover.
- KM-468 Hub Holding Tool.

Removal Procedure

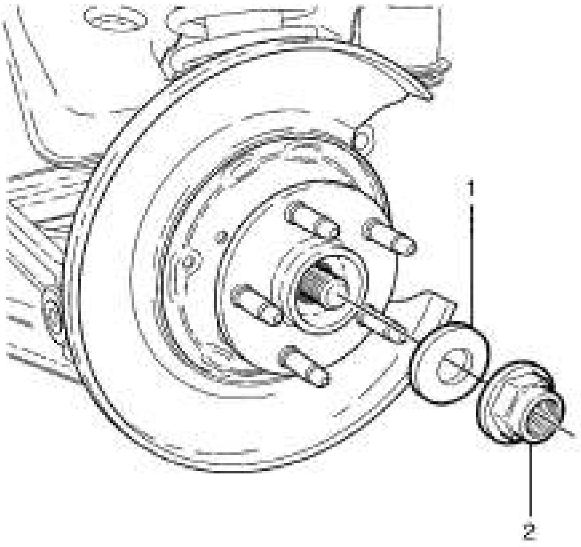
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear wheels. Refer to Tire and Wheel Removal and Installation.
3. Remove the rear brake disc. Refer to Rear Brake Rotor Replacement.



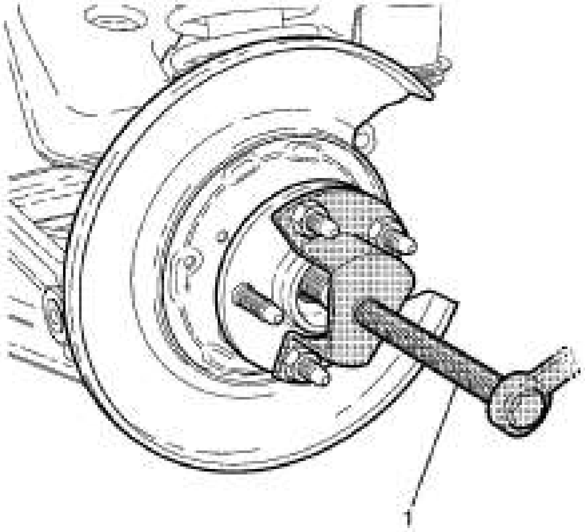
4. Install the KM-468 (1) to the wheel hub (2) with two inverted wheel nuts (3).
5. Support the KM-468 (1) outer end on a safety stand.



Important: The rear driveshaft retaining nut (2) and washer (1) must be discarded after removal.

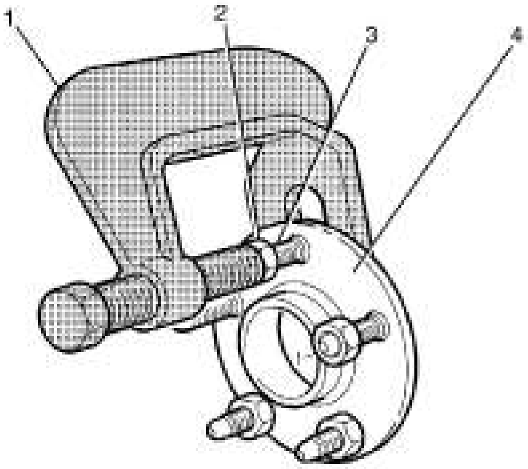
6. Remove the rear driveshaft retaining nut (2) and washer (1).
   - Discard the nut.
   - Discard the washer.

Notice: Refer to General Repair Instructions in the Preface section.



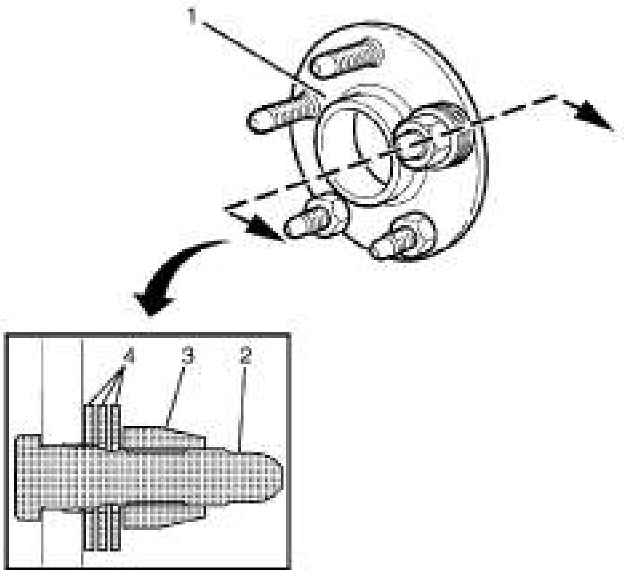
7. Secure the rear driveshaft with wire to protect it from damage.

8. Install the 7208 (1) to the wheel hub (2).
9. Press the rear driveshaft from the wheel hub using the 7208 (1).
10. Remove the 7208 (1) from the wheel hub (2).



11. Install a wheel nut (2) flush with the end of the wheel stud (3).
12. Remove the wheel stud (3) from the wheel hub (4) using the C-4150-C (1).
13. Repeat steps 11 and 12 for any additional wheel studs that require replacement.

Installation Procedure



1. Install the wheel stud (2) to the wheel hub (1).

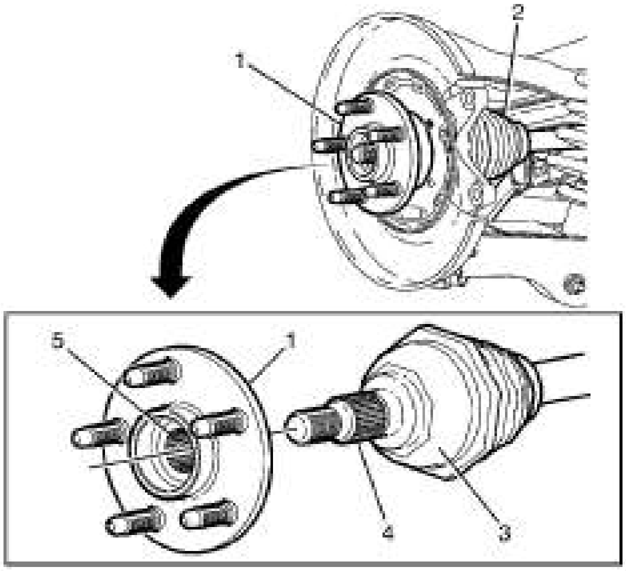
Notice: Refer to Fastener Notice in the Preface section.

Important: Suitable sized spacing washers (4) must be used to fully seat the wheel stud (2).

2. Install spacing washers (4) and an inverted wheel nut (3) onto the replacement wheel stud (2).

   Tighten
   Tighten the nut to 170 N·m (125 lb ft).

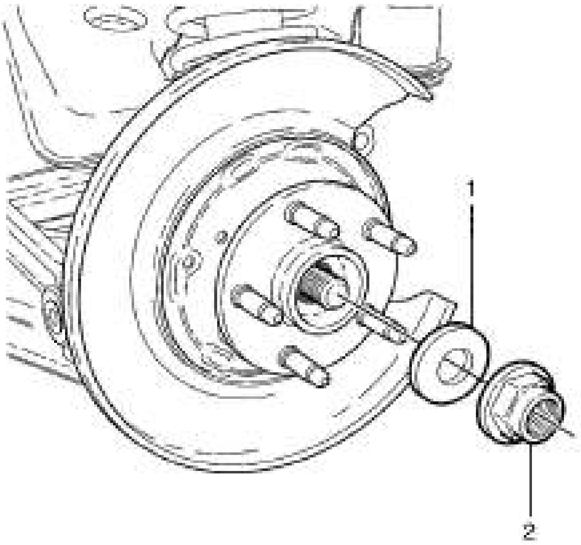
3. Remove the wheel nut (3) and spacing washers (4).
4. Repeat steps 1 to 3 for any additional studs that require replacement.



Important: Lightly lubricate the rear driveshaft outer splined end (4) with the recommended differential lubricant.

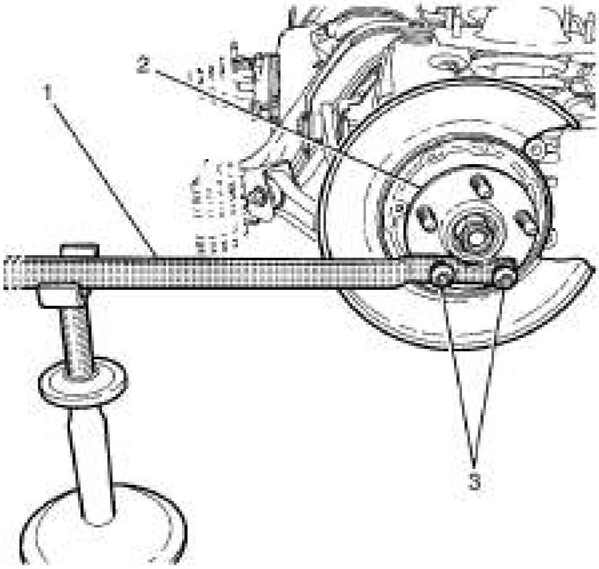
Important: DO NOT excessively push the rear driveshaft (3) through the wheel hub (1).

5. Remove the rear driveshaft securing wire, used in the removal process to prevent damage.
6. Push the rear driveshaft outer splined end (4) into the splined cavity (5) of the wheel hub (1).



Important: A NEW nut and NEW washer must be used when installing the rear drive shaft.

7. Install the rear driveshaft NEW retaining nut (2) and NEW washer (1).



8. Install the KM-468 (1) to the wheel hub (2) with two inverted wheel nuts (3).

   Support the KM-468 (1) outer end on a safety stand.

   Notice: Refer to Fastener Notice in the Preface section.

   Important: There are two suitable methods of tightening the wheel drive shaft retaining nut. DO NOT EXCEED THE SPECIFIED TIGHTENING VALUES, otherwise premature bearing failure may result.

9. Preferred Method

   Tighten
   Tighten the nut on first pass to 150 N·m (111 lb ft).

   Loosen
   Loosen the nut on second pass by 180 Degrees.

   Tighten
   Tighten the nut on third pass to 425 N·m (313 lb ft)

   Crimp nut.

   Alternate Method

   Tighten
   Tighten the nut on first pass to 150 N·m (111 lb ft).

   Loosen
   Loosen the nut on second pass by 180 Degrees.

   Tighten
   Tighten the nut on the third pass to 50 N·m (37 lb ft)

   Tighten
   Tighten the nut on the forth pass by 45 Degrees

   Crimp nut.

10. Remove the KM-468 (1).
11. Install the rear brake disc. Refer to Rear Brake Rotor Replacement.
12. Install the rear wheel. Refer to Tire and Wheel Removal and Installation.
13. Remove the safety stands.
14. Lower the vehicle to the ground.

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Rear Suspension Description and Operation

After - 13 Aug 2007

The rear suspension has been designed to maximize the ride and road handling characteristics, as well as, the road isolation of the vehicle.

The rear suspension absorbs the impact of the tyres travelling over irregular road surfaces and dissipates this energy throughout the suspension system.

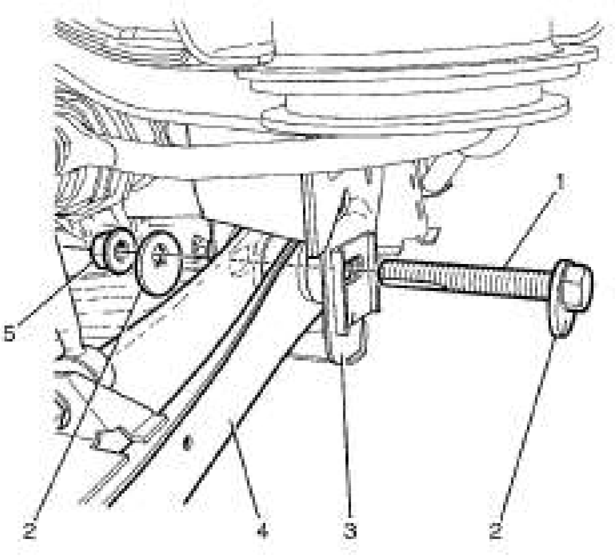
This process isolates the vehicle occupants from the road surface.

The rate at which the suspension dissipates the energy and the amount of energy that is absorbed is how the suspension defines the vehicles ride characteristics. Ride characteristics are designed into the suspension system and are not adjustable. The ride characteristics are mentioned in this description in order to aid in the understanding of the functions of the suspension system.

The suspension system must allow for the vertical movement of the tyre and wheel assembly as the vehicle travels over irregular road surfaces while maintaining the tyre's contact and horizontal relationship to the road.

The knuckle is suspended between a lower and an upper control arm.

The lower control arm attaches to the knuckle at the outermost point of the control arm. The innermost point of the lower control arm is attached to the subframe through bushings.

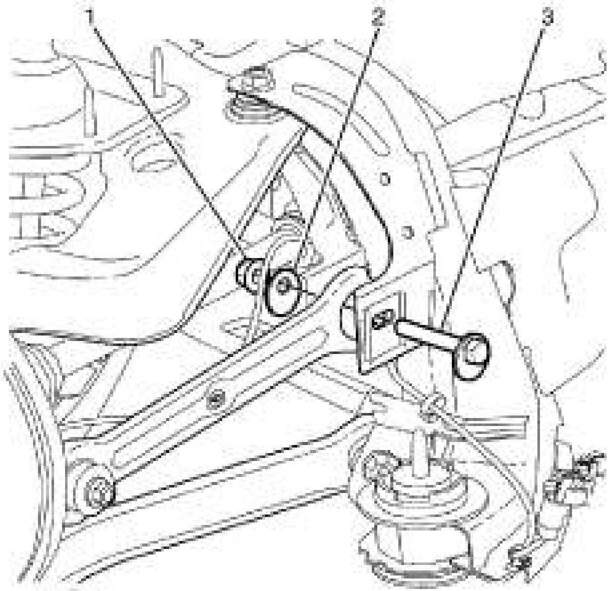


A nut (5) and bolt (1) with eccentric washers (2) connect the lower control arm (4) to the subframe (3), this arrangement provides camber adjustment of the rear suspension.

The supporting function of the lower control arm is further enhanced by the Y-Link, which extends between the knuckle and the subframe.

The upper control arm attaches from the knuckle at the outermost point of the control arm. The innermost end of the upper control arm attaches to the subframe through pivot and ball joint bushings.

The I-Link provides a side attachment between the knuckle and the subframe.



Loosen the I-Link retaining lock nut (1) from the I-Link retaining bolt (3). Rotate the I-Link retaining bolt (3) which also rotates the eccentric washer (2) to adjust the rear toe.

The rear strut assembly attaches the lower control arm to the body of the vehicle.

The knuckle is allowed to travel up and down independent of the vehicle body structure and frame.

This up and down motion of the knuckle as the vehicle travels over bumps is absorbed predominantly by the coil spring. This spring is retained under tension within the strut assembly. A shock absorber is used in conjunction with this system in order to dampen the oscillations of the coil spring. The shock absorber is filled with oil and has a moveable shaft that connects to a piston inside. Valves inside the shock absorber offer resistance to oil flow and consequently inhibit rapid movement of the piston and shaft. Each end of the shock absorber is connected in such a fashion to utilize this recoil action of the spring alone. Each end of the strut is designed as the connection point of the suspension system to the vehicle and acts as the coil spring seat. This allows the strut to utilize the dampening action to reduce the recoil of a spring alone.

The subframe is bolted to the body of the vehicle. The subframe to body attaching bolts incorporate a tapered boss near the head of the bolt on the front bolts, to assist in the alignment during assembly. The front and rear mount bushings enhance the road isolation characteristics of the rear suspension structure.

A stabiliser bar is mounted to the subframe by two brackets and insulating rubbers. The link connecting the stabiliser bar to each lower control arm has a ball joint socket stud and nut, at each end of it.

There are numerous configurations for each suspension option, depending on body type and powertrain combination. For further information regarding the identification of which suspension option is fitted to a particular vehicle. Refer to Vehicle, Engine and Transmission ID and VIN Location, Derivative and Usage in General Information.

For all other information regarding the suspension specification fitted to a particular vehicle, refer to Fastener Tightening Specifications in Rear Suspension. Although the rear suspension components are lubricated for life and require no routine lubrication, they should be inspected periodically for damage and wear.

Up to - 13 Aug 2007

The rear suspension has been designed to maximize the ride and road handling characteristics, as well as, the road isolation of the vehicle.

The rear suspension absorbs the impact of the tyres travelling over irregular road surfaces and dissipates this energy throughout the suspension system.

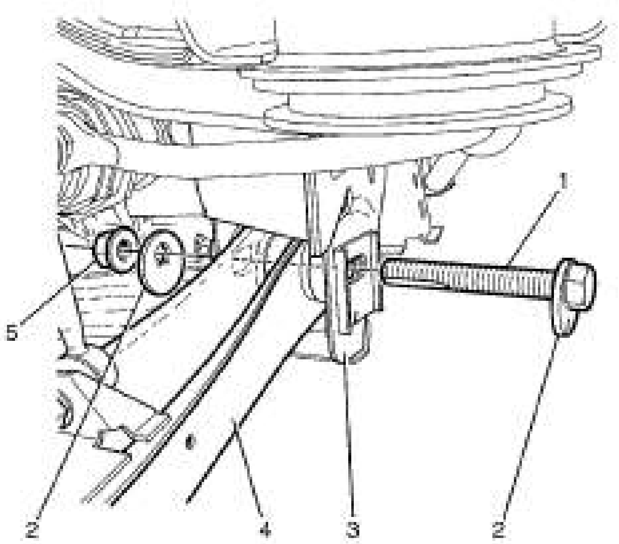
This process isolates the vehicle occupants from the road surface.

The rate at which the suspension dissipates the energy and the amount of energy that is absorbed is how the suspension defines the vehicles ride characteristics. Ride characteristics are designed into the suspension system and are not adjustable. The ride characteristics are mentioned in this description in order to aid in the understanding of the functions of the suspension system.

The suspension system must allow for the vertical movement of the tyre and wheel assembly as the vehicle travels over irregular road surfaces while maintaining the tyre's horizontal relationship to the road.

The knuckle is suspended between a lower and an upper control arm.

The lower control arm attaches to the knuckle at the outermost point of the control arm. The innermost point of the lower control arm is attached to the subframe through bushings.

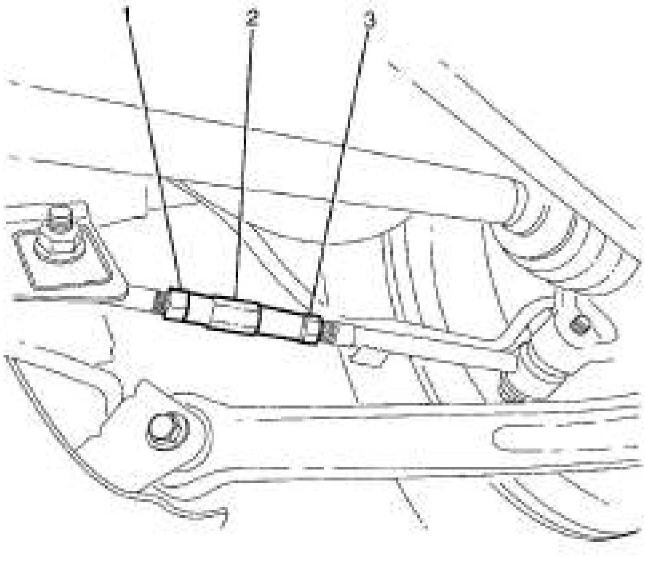


The two eccentric washers (2) of the bolt (1) and under the nut (2) connecting the lower control arm (4) to the subframe (5) are used to adjust the camber of the rear suspension.

The supporting function of the lower control arm is further enhanced by the Y-Link, which extends between the knuckle and the subframe.

The upper control arm attaches from the knuckle at the outermost point of the control arm. The innermost end of the upper control arm attaches to the subframe through pivot and ball joint bushings.

The I-Link provides a side attachment between the knuckle and the subframe.



Loosen the I-Link adjuster lock nuts (1, 3) from the I-Link adjuster (2). Rotate the I-Link adjuster (2) to adjust the camber.

The rear strut assembly attaches the lower control arm to the body of the vehicle.

The knuckle is allowed to travel up and down independent of the vehicle body structure and frame.

This up and down motion of the knuckle as the vehicle travels over bumps is absorbed predominantly by the coil spring. This spring is retained under tension within the strut assembly. A shock absorber is used in conjunction with this system in order to dampen the oscillations of the coil spring. A shock absorber is a basic hydraulic cylinder, it is filled with oil and has a moveable shaft that connects to a piston inside. Valves inside the shock absorber offer resistance to oil flow and consequently inhibit rapid movement of the piston and shaft. Each end of the shock absorber is connected in such a fashion to utilize this recoil action of a spring alone. Each end of the strut is designed as the connection point of the suspension system to the vehicle and acts as the coil spring seat. This allows the strut to utilize the dampening action to reduce the recoil of a spring alone.

The subframe is bolted to the body of the vehicle. The subframe to body retaining bolts incorporate a tapered boss near the head of the bolt on the front bolts, to assist in the alignment during assembly. The front and rear mount bushings enhance the road isolation characteristics of the rear suspension structure.

A stabiliser bar is mounted to the subframe by two brackets and insulating rubbers. The link connecting the stabiliser bar to each lower control arm has a ball joint socket stud and nut, at each end of it.

There are numerous configurations for each suspension option, depending on body type and powertrain combination. For further information regarding the identification of which suspension option is fitted to a particular vehicle, refer to Vehicle, Engine and Transmission ID and VIN Location, Derivative and Usage .

For all other information regarding the suspension specification fitted to a particular vehicle, refer to Fastener Tightening Specifications .

Although the rear suspension components are lubricated for life and require no routine lubrication, they should be inspected periodically for damage and wear.

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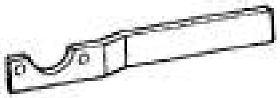
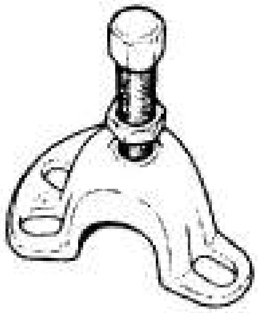
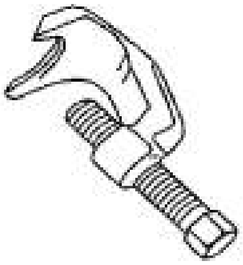
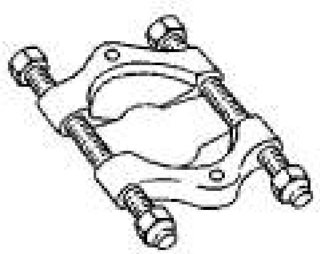
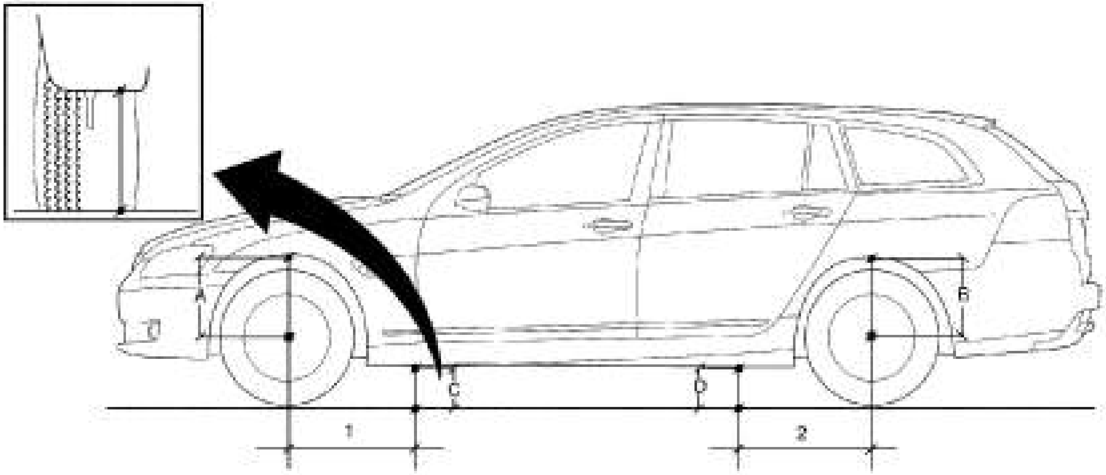
Special Tools

Illustration	Descripton	Tool Classification
	KM 468 Holding Bar	Desirable
	7208 Rear Axle Removal	Unique
	C4150-C Press Tool	Desirable
	J 22912-01	

	Press Plates	Desirable

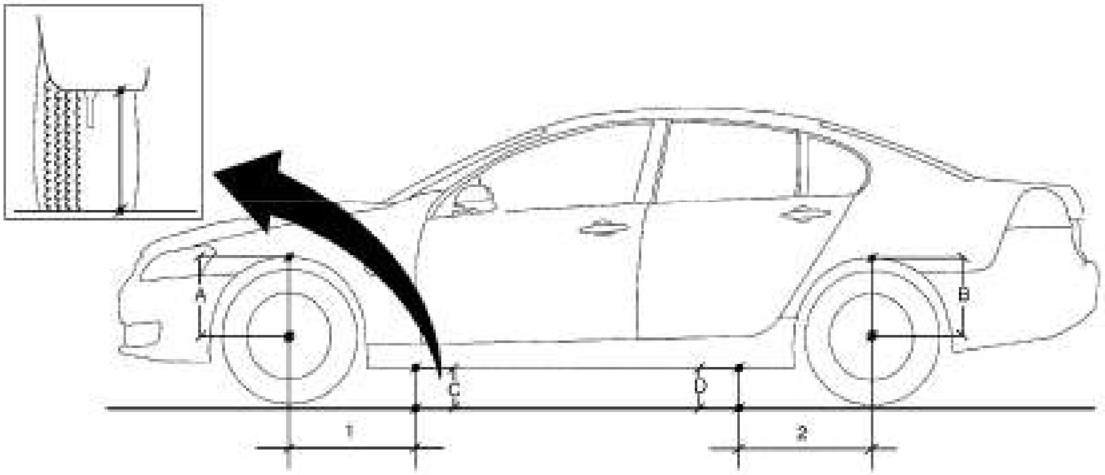
Trim Height Specifications (Sportwagon)



			Suspension Height mm (in)		Trim Height mm (in)	
***Model**	**Model Name**	***Suspension**	**Front Suspension Height 'A'**	**Rear Suspension Height 'B'**	**Front Trim Height 'C'**	**Rear Trim Height 'D'**
8EK35, 8EL35	Omega, Berlina	FE1	403 mm (15.9 in)	388 mm (15.3 in)	200 mm (7.87 in)	195 mm (7.68 in)
8EK35 &A9D&LY7	SV6	FE2	403 mm (15.9 in)	390 mm (15.4 in)	200 mm (7.87 in)	198 mm (7.80 in)
8EK35 &A9D&L98; 8EP35; 8EX35	SS, SS-V, Calais, Calais-V	FE2	398 mm (15.7 in)	388 mm (15.3 in)	198 mm (7.80 in)	195 mm (7.68 in)
8EK35 &FR1	Omega	FR1	423 mm (16.7 in)	418 mm (16.5 in)	211 mm (8.31 in)	217 mm (8.54 in)

All measurements are for reference only and intended to be a guide. *For model and option identification refer to Body & Option Plate section in Vehicle, Engine and Transmission ID and VIN Location, Derivative and Usage.

Trim Height Specifications (SWB)



			Suspension Height mm (in)		Trim Height mm (in)	
Vehicle Description	**Transmission**	**Suspension**	**Front Suspension Height 'A'**	**Rear Suspension Height 'B'**	**Front Trim Height 'C'**	**Rear Trim Height 'D'**
Level 1 and 2 Sedan	Manual / Automatic	FE1	404 mm (15.90 in)	405 mm (15.90 in)	198 mm (7.79 in)	205 mm (8.07 in)
Level 1 and 2 Sedan	Manual / Automatic	FR1	424 mm (16.69 in)	425 mm (16.73 in)	118 mm (4.65 in)	225 mm (8.86 in)
Level 1 and 2 Sedan	Manual / Automatic	FE2	393 mm (15.47 in)	391 mm (15.39 in)	188 mm (7.40 in)	194 mm (7.64 in)
Level 3 Sedan	Automatic	FE2	393 mm (15.47 in)	391 mm (15.39 in)	188 mm (7.40 in)	194 mm (7.64 in)
All measurements are for reference only and intended to be a guide.						

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Ball Joint Inspection

Ball Joint Inspection

Step	Action	Values	Yes	No
1	Did you review the General Description and perform the necessary inspections?	--	Go to Step 2	Go to Symptoms - Suspension General Diagnosis in Suspension General Diagnosis.
2	Clean the ball joint and inspect the seal for damage. Is the ball joint seal damaged?	--	Go to Step 5	Go to Step 3
3	**Important:** Remove tension from the ball joints. Check the ball joint for horizontal looseness using the following procedure: 1. Mount the J 8001 dial indicator to the arm housing the ball joint to be inspected. 2. Position the J 8001 dial indicator mounted against the side of the ball joint stud. 3. Move the wheel in and out in the direction of the arm while reading the dial indicator. Does the dial indicator measure greater than the specified value?	3.18 mm (0.125 in)	Go to Step 5	Go to Step 4
4	**Important:** Remove tension from the ball joints. Check the ball joint for vertical looseness using the following procedure: 1. Mount the J 8001 dial indicator to the arm housing the ball joint to be inspected. 2. Position the J 8001 dial indicator against the top of the ball joint stud. 3. Move wheel up and down while reading the dial indicator. Does the dial indicator measure greater than the specified value?	3.18 mm (0.125 in)	Go to Step 5	Go to Step 6

5	Repair as required or replace the affected component. Refer to the affected components repair procedure for service. Did you complete the repair?	--	Go to Step 6	--
6	Operate the system in order to verify the repair. Did you correct the condition?	--	System OK	Go to Step 2

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Body Leans or Sways in Corners

Step	Action	Yes	No
1	Did you review the General Description and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Suspension General Diagnosis.
2	Verify the vehicle leans or sways in corners. Does the vehicle operate normally?	System OK	Go to Step 3
3	Inspect the following components for wear or damage: • The front coil springs • The rear coil springs Are the components worn or damaged?	Go to Step 7	Go to Step 4
4	Inspect the stabiliser bar links for wear or damage. Are the stabiliser bar links worn or damaged?	Go to Step 8	Go to Step 5
5	Inspect the stabiliser bar insulators for wear or damage. Are the stabiliser bar insulators worn or damaged?	Go to Step 9	Go to Step 6
6	Inspect the stabiliser bars for wear or damage. Are the stabiliser bars worn or damaged?	Go to Step 10	Go to Strategy Based Diagnosis.
7	Replace the springs. Refer to the appropriate procedure: • Front Coil Springs Replacement for Front. • Coil Spring Replacement for Rear. Did you complete the repair?	Go to Step 11	--
8	Replace the stabiliser bar link(s). Refer to Stabilizer Shaft Link Replacement for Front or Stabilizer Shaft Link Replacement for Rear. Did you complete the repair?	Go to Step 11	--
9	Replace the stabiliser bar Insulators. Refer to Stabilizer Shaft Insulator Replacement for Front or Stabilizer Shaft Insulator Replacement for Rear. Did you complete the repair?	Go to Step 11	--
	Replace the stabiliser bar. Refer to Stabilizer Shaft Replacement for Front or Stabilizer Shaft		

10	Replacement for Rear. Did you complete the repair?	Go to Step 11	--
11	Operate the vehicle in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

Diagnostic Starting Point - Suspension General Diagnosis

Begin the system diagnosis by reviewing the Description and Operation information, and the vehicle RPO, this will help you determine if the condition described by the customer is normal operation. Refer to Symptoms - Suspension General Diagnosis, in order to identify the correct procedure for diagnosing the system and where the procedure is located.

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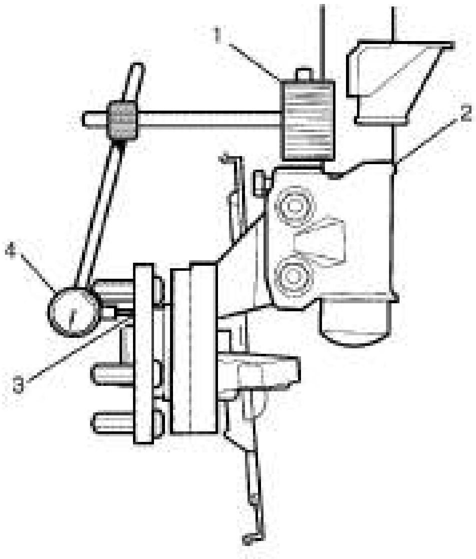
Front Wheel Hub Assembly Inspection

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

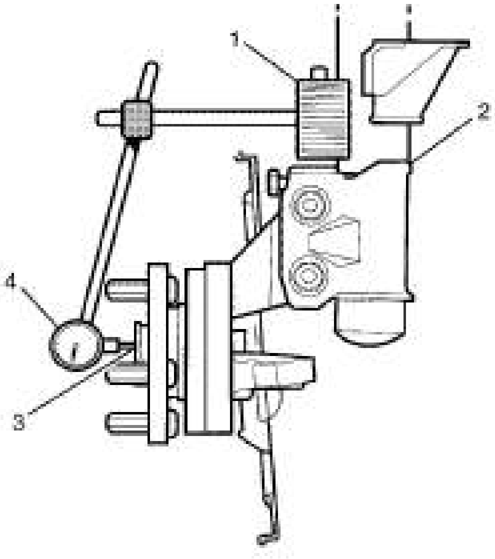
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the front wheel. Refer to Tire and Wheel Removal and Installation.
3. Remove the brake disc. Refer to Front Brake Rotor Replacement.
4. Clean the wheel mounting surface of the front wheel hub assembly of any loose debris, rust, and/or corrosion.



Important: The dial gauge mounting base (1) must be securely mounted to the front strut unit (2).

5. Position a dial indicator (4), on the wheel mounting surface of the front wheel hub assembly (3) perpendicular to the surface.
6. Slowly rotate the front wheel hub assembly one complete revolution in order to find the low spot.
7. Set the dial indicator to zero at the low spot.
8. Slowly rotate the front wheel hub assembly one more complete revolution and measure the total amount of radial runout.

Specification
Maximum front wheel hub assembly runout 0.025 mm (0.001 in)



Important: The dial gauge mounting base (1) must be securely mounted to the front strut unit (2).

9. Position the dial indicator (4) on the centre of the wheel mounting flange (3) of the front wheel hub assembly perpendicular to the surface.
10. Push the wheel mounting flange towards the centre of the car, set the dial indicator to zero.
11. Pull the wheel mounting flange towards the outside of the car and measure the total amount of axial end float.

Specification
The front wheel hub assembly has zero axial end float (preload).

12. If the measurements are not within the specified range replace the front wheel hub assembly. Refer to Front Wheel Bearing and Hub Replacement.
13. Install the brake disc. Refer to Front Brake Rotor Replacement.
14. Install the rear wheel. Refer to Tire and Wheel Removal and Installation.
15. Remove the safety stands.
16. Lower the vehicle to the ground.

Noise Diagnosis - Front Suspension

Step	Action	Yes	No
DEFINITION: Any noise emitted from the front of the vehicle that is induced by VEHICLE SPEED or DRIVING TERRAIN as related to the front suspension.			
1	Did you review the General Description and perform the necessary Inspections?	Go to Step 2	Go to Symptoms - Suspension General Diagnosis.
2	Attempt to duplicate the condition. Road test the vehicle. Did you duplicate the condition?	Go to Step 3	System OK
3	Is the noise reactive to vehicle load or speed?	Go to Step 4	Go to Step 5
4	1. Inspect the tyres and wheels for the following condition: • Correct tyre Inflation. Refer to Tire Inflation Pressure Specifications. • Abnormal tyre wear or damage. Refer to Tire Diagnosis - Irregular or Premature Wear. • Inspect the wheel nuts for looseness. Refer to Fastener Tightening Specifications. 2. Repair as necessary. Did you find and correct the condition?	Go to Step 11	Go to Step 5
5	Bounce the front of the vehicle in order to duplicate the noise. Did you duplicate the noise?	Go to Step 6	Go to Step 7
6	1. Inspect the front suspension and steering components for looseness. 2. Tighten as necessary. Refer to Fastener Tightening Specifications or Fastener Tightening Specifications. Did you find and correct the condition?	Go to Step 11	Go to Step 7
7	Inspect the front suspension and steering ball joints for wear and damage. Refer to Ball Joint Inspection. Did you find and correct the condition?	Go to Step 11	Go to Step 8
8	Inspect the front struts. Refer to Suspension Strut and Shock Absorber Testing - On Vehicle. Did you find and correct the condition?	Go to Step 11	Go to Step 9

9	1. Inspect the front stabiliser bar, links, and insulators for wear or damage. 2. Replace as necessary. • Refer to Stabilizer Shaft Replacement. • Refer to Stabilizer Shaft Insulator Replacement. • Refer to Stabilizer Shaft Link Replacement. Did you find and correct the condition?	Go to Step 11	Go to Step 10
10	1. Inspect the front suspension control arms, caster arms for wear or damage. 2. Repair as necessary. • Refer to Control Arm Replacement. • Refer to Front Lower Control Front Arm Replacement . Did you find and correct the condition?	Go to Step 11	Go to Strategy Based Diagnosis in General Information.
11	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

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Noise Diagnosis - Rear Suspension

Step	Action	Yes	No
DEFINITION: Any noise emitted from the rear of the vehicle that is induced by VEHICLE SPEED or DRIVING TERRAIN as related to the rear suspension.			
1	Did you review the General Description and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Suspension General Diagnosis.
2	Attempt to duplicate the condition. Road test the vehicle. Did you duplicate the condition?	Go to Step 3	System OK
3	Is the noise reactive to vehicle load or speed?	Go to Step 4	Go to Step 7
4	1. Inspect the tyres and wheels for the following condition: • Correct tyre inflation. Refer to Tire Inflation Pressure Specifications. • Abnormal tyre wear or damage. Refer to Tire Diagnosis - Irregular or Premature Wear. • Inspect the wheel nuts for looseness. Refer to Fastener Tightening Specifications. 2. Repair as necessary. Did you find and correct the condition?	Go to Step 11	Go to Step 5
5	Inspect the differential for noise. Refer to Diagnostic Starting Point - Rear Drive Axle. Did you find and correct the condition?	Go to Step 11	Go to Step 6
6	Bounce the rear of the vehicle in order to duplicate the noise. Did you duplicate the noise?	Go to Step 8	Go to Step 9
7	1. Inspect the rear suspension components for looseness. Refer to Fastener Tightening Specifications. 2. Tighten as necessary. Refer to Fastener Tightening Specifications. Did you find and correct the condition?	Go to Step 11	Go to Step 9
8	Inspect the rear struts. Refer to Suspension Strut and Shock Absorber Testing - On Vehicle. Did you find and correct the condition?	Go to Step 11	Go to Step 10

9	1. Inspect the rear stabiliser bar, links, and insulators for wear or damage. 2. Replace as necessary. • Refer to Stabilizer Shaft Replacement. • Refer to Stabilizer Shaft Insulator Replacement. • Refer to Stabilizer Shaft Link Replacement. Did you find and correct the condition?	Go to Step 11	Go to Step 10
10	1. Inspect the rear suspension control arms, caster arms for wear or damage. 2. Repair as necessary. • Refer to Lower Control Arm Replacement. • Refer to Upper Control Arm Replacement. • Refer to Adjust Link Replacement . • Refer to Trailing Arm Replacement . Did you find and correct the condition?	Go to Step 11	Go to Strategy Based Diagnosis in General Information.
11	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

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Poor Directional Stability

Step	Action	Yes	No
DEFINITION: Driver is unable to maintain consistent, predictable vehicle driving control in any direction.			
1	Did you review the General Description and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Suspension General Diagnosis.
2	Verify that the directional stability is poor. Does the system operate normally?	System OK	Go to Step 3
3	1. Inspect the stabiliser bar, links, and insulators for wear or damage. 2. Replace as necessary. • Refer to Stabilizer Shaft Replacement for Front Suspension and Stabilizer Shaft Replacement for Rear Suspension. • Refer to Stabilizer Shaft Insulator Replacement for Front Suspension and Stabilizer Shaft Insulator Replacement for Rear Suspension • Refer to Stabilizer Shaft Link Replacement for Front Suspension and Stabilizer Shaft Link Replacement for Rear Suspension. Did you find and correct the condition?	Go to Step 10	Go to Step 4
4	1. Inspect the front suspension control arms, caster arms, tie rods and ball joints for wear or damage. For ball joint inspection refer to Ball Joint Inspection . 2. Repair as necessary. • Refer to Control Arm Replacement. • Refer to Front Lower Control Front Arm Replacement . • Refer to Steering Linkage Outer Tie Rod Replacement. Did you find and correct the condition?	Go to Step 10	Go to Step 5
5	Inspect the wheel bearing for wear or damage. Refer to Front Wheel Hub Assembly Inspection and Rear Wheel Hub Assembly Inspection. Did you find and correct the condition?	Go to Step 10	Go to Step 6
6	1. Inspect the vehicle trim height. Refer to Trim Height Inspection in Suspension General Diagnosis. 2. Repair as necessary.		

	Did you find and correct the condition?	Go to Step 10	Go to Step 7
7	Inspect the steering column for looseness. Refer to Looseness in Steering Column . Did you find and correct the condition?	Go to Step 10	Go to Step 8
8	Inspect the steering gear mounting bolts for looseness. Refer to Fastener Tightening Specifications. Did you find and correct the condition?	Go to Step 10	Go to Step 9
9	Inspect and adjust the wheel alignment as necessary. Refer to Wheel Alignment Measurement . Did you complete the alignment?	Go to Step 10	Go to Strategy Based Diagnosis in General Information. --
10	Operate the vehicle in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

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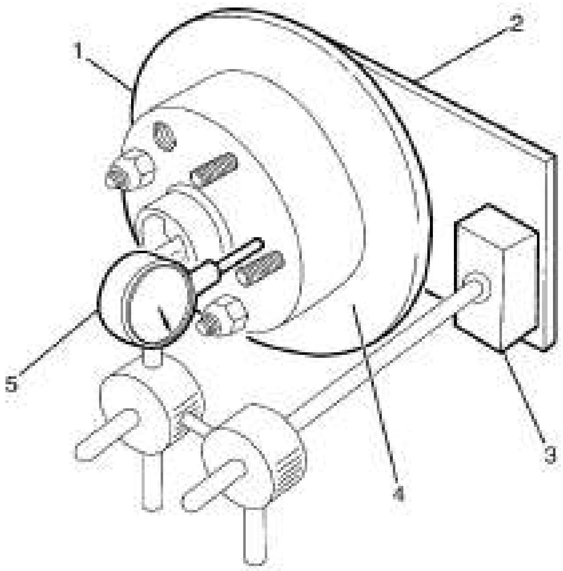
Rear Wheel Hub Assembly Inspection

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the rear wheel. Refer to Tire and Wheel Removal and Installation.
3. Remove the brake disc. Refer to Rear Brake Rotor Replacement.
4. Clean the wheel mounting surface of the rear wheel hub assembly of any loose debris, rust, and/or corrosion.



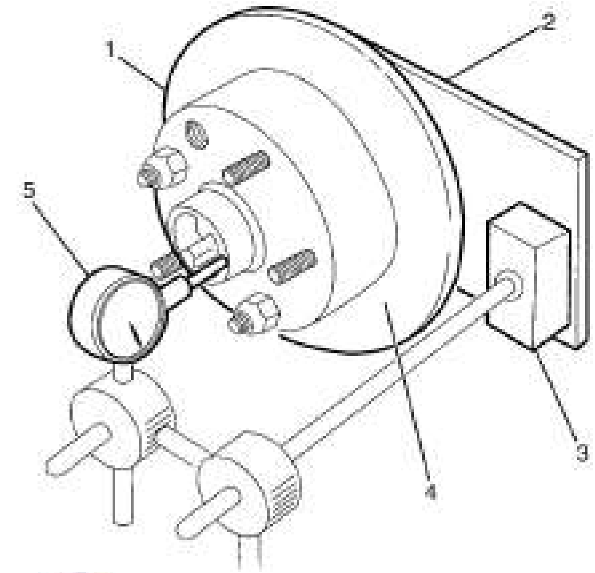
5. Install the dial indicator plate (2) to the rear knuckle assembly (1).

Important: The dial gauge mounting base (3) must be securely mounted to the dial indicator plate (2).

Important: The hub runout should not be measured on the top of the rotor.

6. Position a dial indicator (5) fitted with a roller, on the wheel mounting surface of the rear wheel hub assembly perpendicular to the surface (4).
7. Slowly rotate the rear wheel hub assembly (1) one complete revolution in order to find the low spot.
8. Set the dial indicator to zero at the low spot.
9. Slowly rotate the rear wheel hub assembly one more complete revolution and measure the total amount of runout.

Specification
Maximum rear wheel hub assembly radial runout 0.025 mm (0.001 in)



Important: The dial gauge mounting base (3) must be securely mounted to the dial indicator plate (2).

10. Position a dial indicator (5) on the centre of the wheel mounting flange of the rear wheel hub assembly (4) perpendicular to the surface.
11. Push the wheel mounting flange towards the centre of the car, set the dial indicator to zero.
12. Pull the wheel mounting flange towards the outside of the car and measure the total amount of axial end float.

Specification
The rear wheel hub assembly has zero axial end float (preload).

13. If the measurements are not within the specified range replace the rear wheel bearing. Refer to Rear Wheel Bearing and Hub Replacement.
14. Remove the dial indicator plate (1) to the rear knuckle assembly (2).
15. Install the brake disc. Refer to Rear Brake Rotor Replacement.
16. Install the rear wheel. Refer to Tire and Wheel Removal and Installation.
17. Remove the safety stands.
18. Lower the vehicle to the ground.

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Ride Diagnosis

Step	Action	Yes	No
1	Did you review the General Description and perform the necessary inspections?	Go to Step 2	Go to Trim Height Specifications.
2	**Important:** Verify the vehicle suspension package RPO. Verify that the ride is too soft or too hard. Does the vehicle ride normally?	System OK	Go to Step 3
3	Inspect the tyres for the correct inflation pressure. Refer to Tire Inflation Pressure Specifications. Is the tyre inflation pressure correct?	Go to Step 4	Go to Step 6
4	Inspect the vehicle trim height. Refer to Trim Height Inspection. Is the vehicle trim height correct?	Go to Step 5	Go to Step 7
5	Inspect the following suspension components for wear or damage: • Coil Springs. • Strut Units. Refer to Suspension Strut and Shock Absorber Testing - On Vehicle. Are any of the components the worn or damaged?	Go to Step 8	Go to Strategy Based Diagnosis in General Information.
6	Inflate the tyres to the correct pressure. Did you complete the repair?	Go to Step 9	--
7	Replace the suspension components as necessary. Did you complete the repair?	Go to Step 9	--
8	Replace all of the worn or damaged components. • For shock absorber replacement, refer to Strut Assembly Replacement or Strut Assembly Replacement. • For coil spring replacement, refer to Front Coil Springs Replacement or Coil Spring Replacement.	Go to	

	Did you complete the repair?	Step 9	--
9	Drive the vehicle in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

Suspension Bottoms

Step	Action	Yes	No
DEFINITION: A loud bang or thump that can usually be felt and/or heard when the vehicle is driven over bumps. This condition is commonly noticed when the vehicle trim height is too low.			
1	Did you review the General Description and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Suspension General Diagnosis.
2	Verify that the suspension bottoms. Does the vehicle operate normally?	System OK	Go to Step 3
3	Check for vehicle overloading and correct the overloading condition as necessary. Did you find and correct the condition?	Go to Step 7	Go to Step 4
4	Inspect the suspension struts. Refer to Suspension Strut and Shock Absorber Testing - On Vehicle. Did you find and correct the condition?	Go to Step 7	Go to Step 5
5	Inspect the suspension coil springs for wear or damage: Are the suspension coil springs worn or damaged?	Go to Step 7	Go to Step 6
6	Inspect the vehicle trim height. Refer to Trim Height Inspection. Did you find and correct the condition?	Go to Step 7	Go to Strategy Based Diagnosis in General Information.
7	Operate the vehicle in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

Suspension Strut and Shock Absorber Testing - On Vehicle

Step	Action	Yes	No
1	Did you review the General Description and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Suspension General Diagnosis.
2	Verify that the customer's concern is present. Does the vehicle operate normally?	System OK	Go to Step 3
3	1. Use your hands in order to lift up and push down each corner of the vehicle 3 times. 2. Remove your hands from the vehicle. 3. Locate a shock or strut that exceeds 2 undulations. Did you locate a shock or strut that exceeds 2 undulations?	Go to Step 5	Go to Step 4
4	**Important:** A strut does not require replacement if any or a combination of the following are present: • A build up of oil up to 11 mm wide at the end of the piston rod. • Oily sludge accumulated from normal operating conditions to 4 cm from the top of the strut body. • Road grease, oil, sand and dust discoloration on the body. Inspect each strut for external fluid leakage. Is a strut leaking?	Go to Step 5	Go to Strategy Based Diagnosis.
5	Replace the strut unit or shock absorber. Refer to the appropriate procedure: • Shock Absorber Replacement for Front. • Shock Absorber Replacement for Rear. Did you complete the repair?	Go to Step 6	--
6	Operate the vehicle in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

Symptoms - Suspension General Diagnosis

Important: The following step must be completed before using the symptom tables.

Review the system description and operation in order to familiarise yourself with the system functions. Refer to the appropriate description and operation:

- General Description.
- Rear Suspension Description and Operation.
- General Description.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of any of the suspension sub-systems.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect for correct tyre size and inflation pressure. Refer to Tire Placard.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Ride Diagnosis.
- Vehicle Leads/Pulls.
- Body Leans or Sways in Corners.
- Suspension Bottoms.
- Poor Directional Stability.
- Noise Diagnosis - Front Suspension.
- Noise Diagnosis - Rear Suspension.
- Suspension Strut and Shock Absorber Testing - On Vehicle.
- Wheel Bearings Diagnosis.

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Trim Height Inspection (Sportwagon)

Trim Height Measurement

Trim height is a predetermined measurement relating to vehicle ride height. Incorrect trim heights can cause the vehicle to bottom out over bumps causing damage to the suspension components and symptoms similar to wheel alignment concerns. Check the trim heights when diagnosing suspension concerns and before checking the wheel alignment.

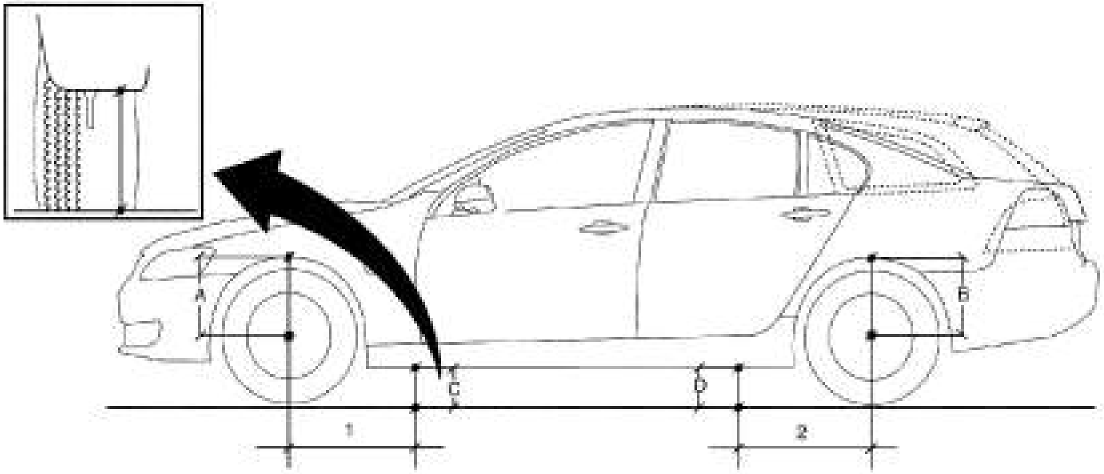
The vehicle must be on a flat level surface and all dimensions must be measured vertical from the ground. Trim heights should be within 13 mm (0.51 in) to be considered correct.

The suspension and trim height dimensions are for standard vehicles with base equipment only. The dimensions are for a new vehicle built to standard specification and are intended as a guide when checking trim height dimensions at normal kerb weight.

Perform the following before measuring the trim heights:

- Check the tyre pressures. Refer to Tire Inflation Pressure Specifications.
- Check the fuel level. Add additional weight if necessary to simulate a full tank.
- Make sure the passenger and rear compartments are empty, except for the spare tyre.
- Make sure the vehicle is on a flat and level surface, such as an alignment rack.
- Check that all the vehicle doors are securely closed.
- Check that the vehicle hood and trunk are securely closed.
- Check for installed after market accessories or modifications that could affect trim height measurement.

Measuring the trim height



Important: The vehicle must be on a flat level surface

1. Using your hands, lift the front bumper approximately 38 mm (1.49 in).
2. Gently remove your hands and allow the vehicle to lower.
3. Using your hands, bounce the front of the vehicle downward approximately 38 mm (1.49 in).
4. Gently remove your hands and allow the vehicle to rise.
5. Measure and note the C dimension for the left and right side of the vehicle, inboard of the pinch-weld flange at 544 mm (21.42 in) (1) from the centreline of the front wheel.
6. Measure and note the A dimension for the left and right side of the vehicle from the bottom of the front wheel rim to the wheel arc along the centreline of the front wheel.
7. Using your hands, lift the front bumper approximately 38 mm (1.49 in).
8. Gently remove your hands and allow the vehicle to lower.
9. Using your hands, bounce the front of the vehicle downward approximately 38 mm (1.49 in).
10. Gently remove your hands and allow the vehicle to rise.
11. Measure and note the D dimension for the left and right side of the vehicle, inboard of the pinch-weld flange at 544 mm (21.42 in) (1) from the centreline of the rear wheel.
12. Measure and note the B dimension for the left and right side of the vehicle from the bottom of the rear wheel rim to the wheel arc along the centreline of the rear wheel.
13. Compare the A, B, C and D dimension measurements to the trim height specifications. Refer to Trim Height Specifications.
14. Compare the right and left and front and rear dimension measurements to the trim height variation specifications. Refer to Trim Height Specifications.
15. If the measurements are not within the specified range, replace the coil springs as required. Refer to Coil Spring Replacement or Coil Spring Replacement.

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Trim Height Inspection (SWB)

Trim Height Measurement

Trim height is a predetermined measurement relating to vehicle ride height. Incorrect trim heights can cause the vehicle to bottom out over bumps causing damage to the suspension components and symptoms similar to wheel alignment concerns. Check the trim heights when diagnosing suspension concerns and before checking the wheel alignment.

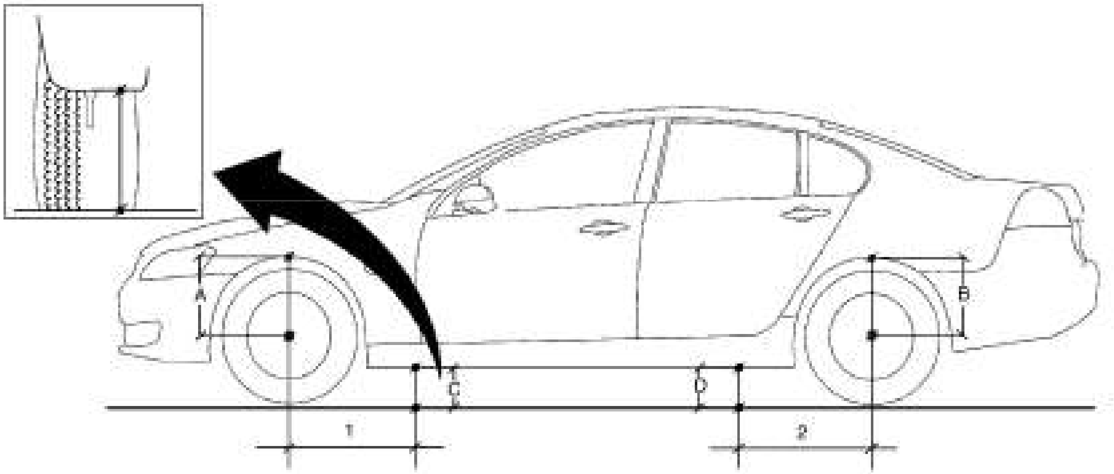
The vehicle must be on a flat level surface and all dimensions must be measured vertical from the ground. Trim heights should be within 13 mm (0.51 in) to be considered correct.

The suspension and trim height dimensions are for standard vehicles with base equipment only. The dimensions are for a new vehicle built to standard specification and are intended as a guide when checking trim height dimensions at normal kerb weight.

Perform the following before measuring the trim heights:

- Check the tyre pressures. Refer to Tire Inflation Pressure Specifications .
- Check the fuel level. Add additional weight if necessary to simulate a full tank.
- Make sure the passenger and rear compartments are empty, except for the spare tyre.
- Make sure the vehicle is on a flat and level surface, such as an alignment rack.
- Check that all the vehicle doors are securely closed.
- Check that the vehicle hood and trunk are securely closed.
- Check for installed after market accessories or modifications that could affect trim height measurement.

Measuring the trim height



Important: The vehicle must be on a flat level surface

1. Using your hands, lift the front bumper approximately 38 mm (1.49 in).
2. Gently remove your hands and allow the vehicle to lower.
3. Using your hands, bounce the front of the vehicle downward approximately 38 mm (1.49 in).
4. Gently remove your hands and allow the vehicle to rise.
5. Measure and note the C dimension for the left and right side of the vehicle, inboard of the pinch-weld flange at 544 mm (21.42 in) (1) from the centreline of the front wheel.
6. Measure and note the A dimension for the left and right side of the vehicle from the bottom of the front wheel rim to the wheel arc along the centreline of the front wheel.
7. Using your hands, lift the front bumper approximately 38 mm (1.49 in).
8. Gently remove your hands and allow the vehicle to lower.
9. Using your hands, bounce the front of the vehicle downward approximately 38 mm (1.49 in).
10. Gently remove your hands and allow the vehicle to rise.
11. Measure and note the D dimension for the left and right side of the vehicle, inboard of the pinch-weld flange at 544 mm (21.42 in) (1) from the centreline of the rear wheel.
12. Measure and note the B dimension for the left and right side of the vehicle from the bottom of the rear wheel rim to the wheel arc along the centreline of the rear wheel.
13. Compare the A, B, C and D dimension measurements to the trim height specifications. Refer to Trim Height Specifications .
14. Compare the right and left and front and rear dimension measurements to the trim height variation specifications. Refer to Trim Height Specifications .
15. If the measurements are not within the specified range, replace the coil springs as required. Refer to Coil Spring Replacement or Coil Spring Replacement .

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Vehicle Leads/Pulls

Step	Action	Yes	No
DEFINITION: At a constant highway speed on a typical straight road, lead/pull is the amount of effort required at the steering wheel to maintain the vehicle straight path.			
1	Did you review the General Description and perform the visual/physical inspections?	Go to Step 2	Go to Symptoms - Suspension General Diagnosis.
2	Road test the vehicle in order to verify the complaint. Does the vehicle operate normally?	System OK	Go to Step 3
3	Inspect the tyre/wheel assemblies for: • Correct tyre pressure. Refer to Tire Placard. • Correct tyre size. Refer to Tire Placard. • Abnormal tyre wear or damage. Refer to Tire Diagnosis - Irregular or Premature Wear. Did you find and correct the condition?	Go to Step 8	Go to Step 4
4	Perform the Radial Tire Lead/Pull Correction. Did you find and correct the condition?	Go to Step 8	Go to Step 5
5	Inspect and correct/adjust the suspension and steering systems for: • Vehicle trim height. Refer to Trim Height Inspection. • Excessively worn, loose, or damaged components. Did you find and correct the condition?	Go to Step 8	Go to Step 6
6	Inspect/correct the brake system for brake drag. Refer to Brakes Drag. Did you find and correct the condition?	Go to Step 8	Go to Step 7
7	Inspect the wheel alignment and adjust as necessary. Refer to Wheel Alignment Measurement. Did you find and correct the condition?	Go to Step 8	Go to Strategy Based Diagnosis.
8	Operate the vehicle in order to verify the repair.	System	

	Did you correct the condition?	OK	Go to Step 3

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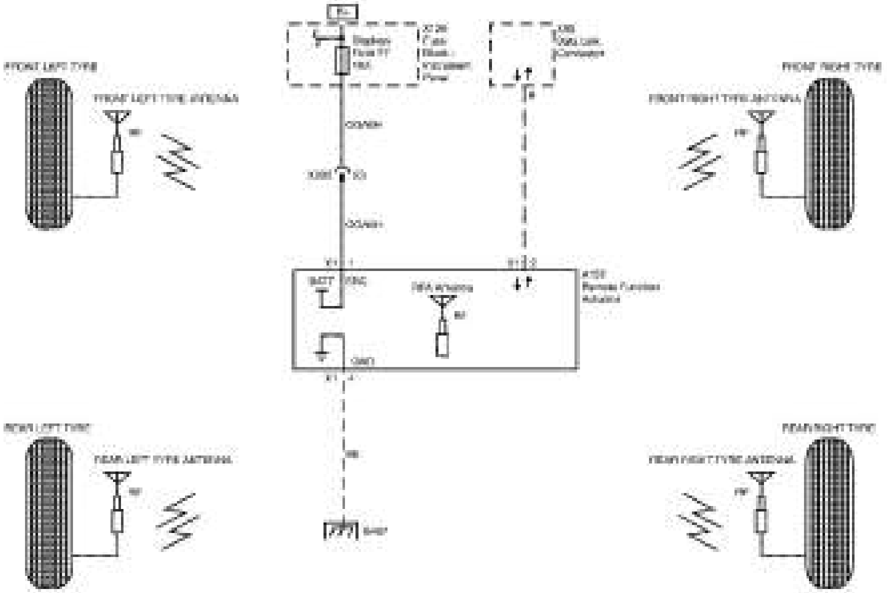
Wheel Bearings Diagnosis

Step	Action	Yes	No
1	Did you review the General Description and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Suspension General Diagnosis.
2	1. Inspect the tyres and wheels for the following condition: - Correct tyre inflation. Refer to Tire Inflation Pressure Specifications. - Abnormal tyre wear or damage. Refer to Tire Diagnosis - Irregular or Premature Wear. - Inspect the wheel nuts for looseness. Refer to Fastener Tightening Specifications. 2. Repair as necessary. Did you find and correct the condition?	Go to Step 8	Go to Step 3
3	**Important:** A noise heard during left turns is a good indicator of a noisy right wheel bearing. A noise heard during right turns is a good indicator of a noisy left wheel bearing. A noise heard during acceleration is a good indicator of noisy rear wheel bearings. Road test the vehicle to identify the noisy bearing. Drive the vehicle on a smooth road at a moderate speed range. While driving, turn the wheel to the left and the right to apply loads to each wheel. Did you identify the noisy bearing.	Go to Step 7	Go to Step 4
4	Inspect the front and rear wheel bearings for wear and damage.. - Front Wheel Hub Assembly Inspection - Rear Wheel Hub Assembly Inspection Did you identify the noisy bearing.	Go to Step 8	Go to Step 5
5	Inspect for tyre and wheel assemblies for run out. Refer to Tire and Wheel Assembly Runout Measurement - On-Vehicle. Did you find and correct the condition?	Go to Step 8	Go to Step 6
6	Inspect the front and/or rear suspension. Refer to Noise Diagnosis - Front Suspension or Noise Diagnosis - Rear Suspension. Did you find and correct the condition?	Go to Step 8	Go to Strategy Based Diagnosis.

7	Replace the wheel bearing. Refer to Front Wheel Bearing and Hub Replacement or Rear Wheel Bearing and Hub Replacement. Did you complete the repair?	Go to Step 8	--
8	Road test the vehicle to verify the repair. Does the vehicle operate normally?	System OK	Go to Step 3

Tire Pressure Monitoring System Schematics

Module Power, Ground and Serial Data


FRONT LEFT TYRE
FRONT LEFT TYRE ANTENNA
RF
Fuse 77
Fuse Block - Instrument Panel
X50
Data Link Connector
FRONT RIGHT TYRE
FRONT RIGHT TYRE ANTENNA
RF
BATT
IGN
RFA Antenna
RF
Remote Function Actuator
GND
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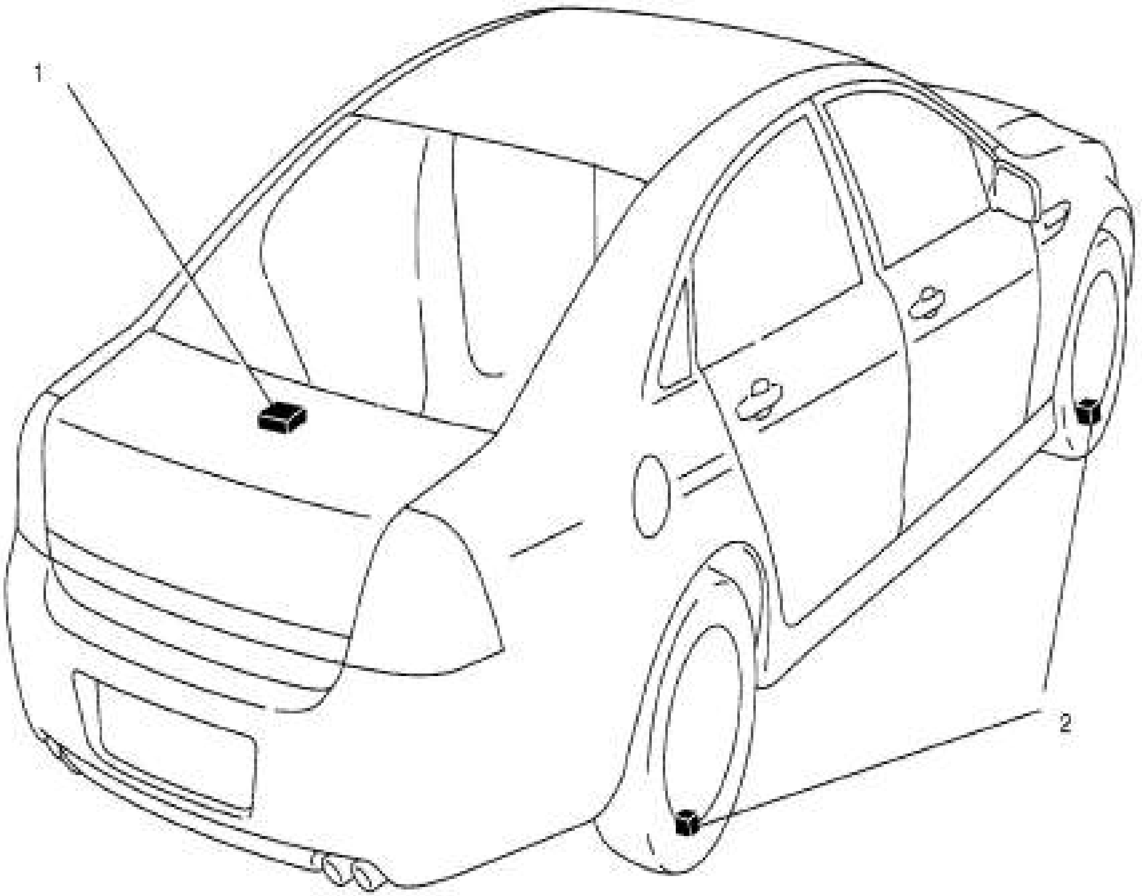
Tire Pressure Monitoring System Component Views (LWB)

Component Locator TPMS



(1) Remote Control Door Lock Receiver (RCDLR)/Tyre Pressure Monitor (TPM) Module
(2) Tyre Pressure Monitoring System (TPMS) Sensors

Diagnostic Starting Point - Tire Pressure Monitoring

Visual / Physical Inspection

- Inspect for after-market devices, such as tyres, wheels or radio frequency transmitting devices which could affect the operation of the tyre pressure monitor systems. Refer to Checking Aftermarket Accessories in Wiring Systems.
- Inspect the easily accessible or visible system components for obvious physical damage or missing components such as the valve stems which could also effect the operation of the system.
- Inspect the tyres for the correct inflation pressures.
- Inspect the tyres for any use of sealants. The use of tyre sealants can obstruct the sensor's pressure sensing port and cause inaccurate tyre pressure readings. If this condition is verified, replace the sensor. Refer to Tire Pressure Indicator Sensor Replacement .

System Diagnosis

After incorrect system operation has been verified and that aftermarket devices or tyre sealants are not the cause, begin the system diagnosis with the diagnostic system check. The diagnostic system check will provide the following information:

1. The identification of the control modules that control the tyre pressure monitoring system.
2. The ability of those control modules to communicate via the serial data circuit.
3. The presence of any stored diagnostic trouble codes (DTCs) in those control modules and there status.

The use of the diagnostic system check will identify the correct procedure for diagnosing the system and where the procedure is located. Refer to Diagnostic System Check - Vehicle .

Diagnostic System Check - Tire Pressure Monitoring

Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.

Review the systems description and operation in order to familiarise yourself with the system functions. Refer to Tire Pressure Monitor Description and Operation .

The Remote Function Actuator supports two systems, keyless entry and tyre pressure monitoring, DTCs specific to these systems can be found within their relevant sections. For keyless entry diagnostic procedures, refer to Diagnostic Starting Point - Keyless Entry in Keyless Entry.

1. Inspect for aftermarket devices which could affect the operation of the tyre pressure monitoring system (TPMS) system to verify that none are installed. Refer to Checking Aftermarket Accessories .

   If such devices are installed, remove/disable them and re-test.
2. Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

   If damage or such conditions are found, repair as required.
3. Compare the scan tool tyre pressure parameters to the actual tyre pressures.

   If tyre pressure parameters are not correct, use scan tool special functions to adjust setting.
4. Using J-46079 Tyre Pressure Monitor Diagnostic Tool, verify that the scan tool pressure sensor ID parameters match the actual on-vehicle locations.

   If actual pressure sensor locations do not match scan tool readings, refer to Tire Pressure Indicator Sensor Programming .
5. Verify the scan tool TPM system enabled parameter is YES.

   If the TPM system enabled parameter is NO, use scan tool special functions to adjust setting.
6. Verify the tyres are inflated to the correct pressure.

DTC C0569

DTC Descriptor

DTC C0569 00: System Configuration Error

Diagnostic Fault Information

Perform the Diagnostic System Check - Tire Pressure Monitoring prior to using this diagnostic procedure.

Circuit/System Description

The remote function actuator (RFA) receives a radio frequency (RF) transmission from each tire pressure sensor. Each sensors RF transmission contains its own unique identification (ID) code that must be learned into the RFA memory. Once all four IDs have been learned and vehicle speed is 40 kph (25 mph) or greater the RFA continuously compares IDs in received transmission to its learned IDs to determine if all four sensors are present.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The RFA has not undergone the tire type and tire pressure selection setup procedure.

Action Taken When the DTC Sets

The instrument panel cluster (IPC) displays the SERVICE TIRE MONITOR warning message.

Conditions for Clearing the DTC

A current DTC will clear when the RFA has undergone the setup procedure.

Diagnostic Aids

A newly replaced RFA will set DTC C0569 on its initial ignition ON cycle. tire type and tire pressure selection setup must be performed. Refer to Tire Pressure Indicator Sensor Programming .

Reference Information

Schematic Reference

Tire Pressure Monitoring System Schematics .

Description and Operation

Tire Pressure Monitor Description and Operation

Scan Tool Reference

Control Module References

Special Tools Required

J-46079 Tire Pressure Monitor Diagnostic Tool

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure and Control Module References for RFA replacement, setup and programming.

DTC C0750, C0755, C0760, or C0765

DTC Descriptor

DTC C0750: Left Front Tire Pressure Sensor/Transmitter Fault

DTC C0755: Right Front Tire Pressure Sensor/Transmitter Fault

DTC C0760: Left Rear Tire Pressure Sensor/Transmitter Fault

DTC C0765: Right Rear Tire Pressure Sensor/Transmitter Fault

Diagnostic Fault Information

Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.

Circuit/System Description

The tire pressure monitoring system (TPMS) has four radio frequency transmitting pressure sensors inside the wheel/tire assemblies. As vehicle speed increases to above 40 km/h (25 mph) the sensors internal roll switch closes, which puts the sensors into drive mode. The sensors begin to transmit once every 60 seconds to the driver side antenna module. The data within this radio frequency transmission contains sensor identification, sensor mode, sensor status and tire pressure. Once vehicle speed is greater than 40 km/h (25 mph) the antenna module waits for all sensors to go into drive mode. If one or more sensors do not go into drive mode or do not transmit at all the driver side antenna module will set DTC C0750, C0755, C0760, or C0765.

Conditions for Running the DTC

- The engine is running
- Vehicle speed is at least 40 km/h (25 mph).

Conditions for Setting the DTC

Any given sensor stops transmitting for ten minutes.

Action Taken When the DTC Sets

- A DTC is stored in memory
- The fault is displayed on the instrument panel cluster (IPC)
- A warning tone is activated.

Conditions for Clearing the DTC

- A history DTC will clear after 100 consecutive ignition cycles

- Use a scan tool to clear DTC.

Reference Information

- Instrument Cluster Schematics .
- Driver Information System Schematics .
- Remote Function Schematics .
- Tire Pressure Monitoring System Schematics .

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing .
- Testing for Intermittent Conditions and Poor Connections .
- Wiring Repairs .

Scan Tool Reference

Control Module References .

Circuit/System Verification

1. DTC C0750, C0755, C0760 or C0765 if more than one of these DTCs are set. Refer to Remote Control Door Lock Receiver and Theft Deterrent Module Programming and Setup .
2. If the vehicle passes the Circuit/System Verification test, then operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that are captured in the Freeze Frame/Failure Records Data List.

Circuit/System Testing

1. If any other DTCs are set diagnosis these first, refer to Diagnostic Trouble Code (DTC) List - Vehicle .
2. Ignition ON, observing the tire pressure monitor parameter on the scan tool, activate the transponder at appropriate wheel. The parameter status should change on the scan tool.

   If the scan tool parameter does not change replace the appropriate tire pressure monitor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Remote Control Door Lock Receiver and Theft Deterrent Module Replacement .
- Control Module References for TPM module replacement, setup and programming.

Tire Pressure Indicator Sensor Programming

When replacing the Tire Pressure Monitor (TPM) the module will have to be programmed. Refer to Remote Control Door Lock Receiver and Theft Deterrent Module Programming and Setup .

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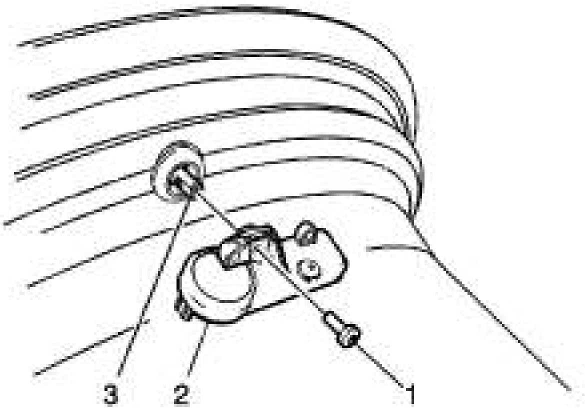
Tire Pressure Indicator Sensor Replacement

Removal Procedure

1. Raise the vehicle on a suitable support. Refer to Lifting and Jacking the Vehicle .
2. Remove the tire/wheel assembly from the vehicle. Refer to Tire and Wheel Removal and Installation .
3. Remove the tire from the rim. Refer to Tire Dismounting and Mounting .

Important: When servicing the tire pressure sensor always use a new Schrader® tire pressure monitor (TPM) and a new TORX screw during installation.



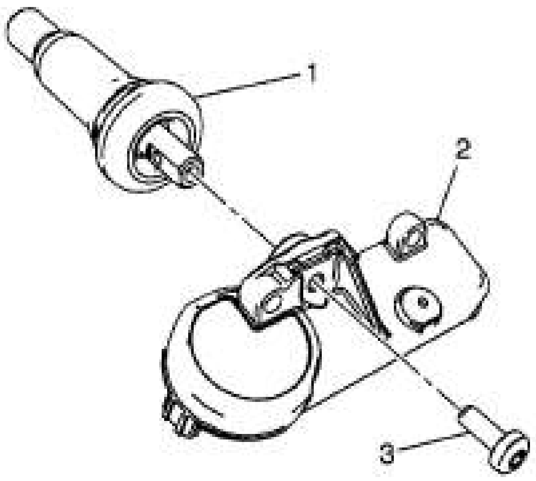
4. Remove the TORX screw (1) from the tire pressure sensor (2) and pull it straight off the tire pressure valve stem (3).

Notice: Do not scratch or damage the clear coating on aluminum wheels with the tire changing equipment. Scratching the clear coating could cause the aluminum wheel to corrode and the clear coating to peel from the wheel.

5. Remove the tire pressure valve stem by pulling it through the rim.

Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



Important:

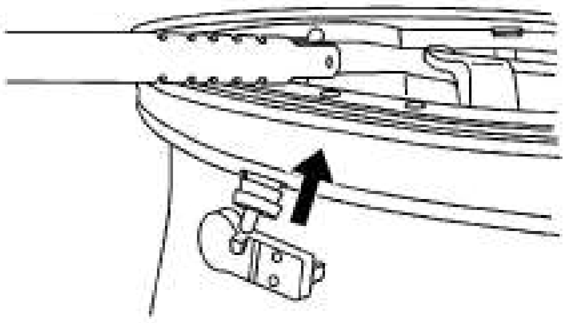
- Ensure the flat of the valve, lines up with the flats of the snap in the enclosure.
- TPM valves and TORX screws are one-time use only.

1. Assemble the tire pressure sensor (2) to the valve stem and install the new TORX screw (3).

   Tighten
   Tighten the TORX screw to 1.3 N·m (11.5 lb in).

   Important: Use and approved tire mounting lubricant. DO NOT use silicon or corrosive base compounds to lubricate the tire bead and the wheel rim. A corrosive type compound can cause tire or rim deterioration.

2. Apply tire soap to the rubber portion of the valve stem (1).



3. Using a tire valve stem mounting tool, pull the valve stem through in a direction parallel to the valve hole on the rim.

   Important: Snap Fit TPM sensors are still shipped in the OFF mode. However, the TPM no longer needs to be spun to remove it from the OFF mode. The sensor will exit its OFF state when the tire is inflated. The technician can then program the vehicle as normal.

4. Fit the tire to the rim. Refer to Tire Dismounting and Mounting .
5. Install the tire/wheel assembly on the vehicle. Refer to Tire and Wheel Removal and Installation .
6. Lower the vehicle.
7. Learn the tire pressure sensors. Refer to Tire Pressure Indicator Sensor Programming .

Tire Pressure Monitor Description and Operation (LWB)

Tyre Pressure Monitoring System (TPMS) Description and Operation Overview

The tyre pressure monitor system (TPMS) warns the driver when a significant loss of tyre pressure occurs in any of the four tyres and allows the driver to display the individual tyre pressures on the instrument panel cluster (IPC) while the vehicle is being driven. The system uses the remote control door lock receiver (RCDLR)/tyre pressure monitor (TPM) module, instrument panel cluster (IPC) and four radio frequency transmitting pressure sensors inside each wheel/tyre assembly (spare wheel is equipped but inactive) to perform the system functions. When vehicle speed is less than 32 km/h (20 mph), the sensors go into stationary mode. In this mode the sensors transmit to the RCDLR once every 60 minutes to minimize sensor battery consumption. As vehicle speed increases to 32 km/h (20 mph), centrifugal force closes the sensor's internal roll switch causing the sensors to go into drive mode. In this mode the sensor transmits once every 60 seconds to the RCDLR. The RCDLR translates the information within the sensors radio frequency transmission into sensor presence, sensor mode and tyre pressure. The RCDLR then sends this information to the IPC unit via the TPM module where the tyre pressures and there locations are displayed on the IPC. If the TPM module detects a significant loss of tyre pressure or if a tyre is over inflated the tyre pressure of the affected tyre is displayed on the IPC. The IPC will flash and the affected tyre pressure warning indicator is displayed on the IPC. The IPC indicator can be cleared by adjusting tyre pressures to the recommended kPa/psi.(refer to the tyre placard). The sensors pressure accuracy range is from -10°C to +70°C (+14°F to +158°F) is plus or minus seven kPa (one psi). The RCDLR has the ability to detect malfunctions within the TPMS. Any malfunctions detected will cause the IPC to display the relevant fault message.

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Tire and Wheel Specifications (LWB SWB)

Description	Specifications
Steel Wheels	
Rim Width Code	7J
Diameter Code	16
Maximum Permissible Radial runout All Steel Wheels	0.7 mm
Offset	43 mm (positive)

Alloy Wheel Specifications

Description	Specifications	
Alloy Wheels		
Rim Width Code	7J	8J
Diameter Code	16, 17	18, 19
Maximum Permissible Radial runout All Models	0.4 mm	
Offset		
16" x 7", 17" x 7"	43 mm (positive)	
18" x 8", 19" x 8"	48 mm (positive)	

Inflation Pressure Specifications

Model	Engine	Wheel	Tire Designation	Recommended Cold Inflation kPa			
				Up to 3 Passengers		Up to Max. Load	
				Front	Rear	Front	Rear
Sedan	V6	7J x 16 steel	225/60 R16 98V	250	250	250	270
Sedan	V6	7J x 16 alloy	225/60 R16 98V	250	250	250	270
Sedan	V6	7J x 17 alloy	225/55 R17 97V	250	250	250	270
SV6 Sedan	V6	8J x 18 alloy	245/45 R18 96V	250	250	250	270
Temporary use spare		17 x 4	T155/80 R17 111M	420			
SS-V	--	8J x 19 alloy	245/40 R19 94W	250	250	250	270
SS	V8	8J x 18 alloy	245/45 R18 96V	250	250	250	270
Sedan	V6/V8	7J x 17	225/55 R17 97V	250	250	250	270

		alloy					
Sedan	V6 / V8	8J x 18 alloy	245/45 R18 96V	250	250	250	270
For speeds above 160 km/h				250	250	270	300

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Tire and Wheel Specifications (Sportwagon)

Steel Wheel Specifications

Description	Specifications
Steel Wheels	
Rim Width Code	7J
Diameter Code	16
Maximum Permissible Radial runout All Steel Wheels	0.7 mm
Offset	43 mm (positive)

Alloy Wheel Specifications

Description	Specifications	
Alloy Wheels		
Rim Width Code	7J	8J
Diameter Code	16, 17	18, 19
Maximum Permissible Radial runout All Models	0.4 mm	
Offset		
16" x 7", 17" x 7"	43 mm (positive)	
18" x 8", 19" x 8"	48 mm (positive)	

Inflation Pressure Specifications

Model	Engine	Wheel	Tire Designation	Recommended Cold Inflation kPa			
				Up to 3 Passengers		Up to Max. Load	
				Front	Rear	Front	Rear
Sportwagon	V6	7J x 16 steel	225/60 R16 98V	250	280	250	280
Sportwagon	V6	7J x 16 alloy	225/60 R16 98V	250	280	250	280
SV6 Sportwagon	V6	8J x 18 alloy	245/45 R18 96V	250	250	250	280
Temporary use spare		17 x 4	T155/80 R17 111M	420			
SS-V Sportwagon	V8	8J x 19 alloy	245/40 R19 98W	250	250	250	280
SS Sportwagon	V8	8J x 18 alloy	245/45 R18 96V	250	250	250	280

Sportwagon	V6/V8	7J x 17 alloy	225/55 R17 97V	250	250	250	280
Calais-V Sportwagon	V6 / V8	8J x 18 alloy	245/45 R18 100V	250	250	250	280
For speeds above 160 km/h				270	300	270	300

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Wheel Nuts	170 N·m	125 lb ft

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Diagnostic Starting Point - Tires and Wheels

Tyre Wear

Analysis of tyre wear conditions varies according to the type, size and brand of the tyre fitted to the vehicle. Refer to the tyre manufacturer's literature relating to tyre wear when evaluating tyre wear conditions.

Tyre and Wheel Inspection

This visual inspection should be conducted for all vibration concerns unless the disturbance only occurs with the vehicle at a standstill.

- The tyres should be inspected for unusual wear. Unusual wear conditions can cause tyre growl, howl, slapping noises, and vibrations throughout the vehicle. Refer to Tire Diagnosis - Irregular or Premature Wear .
- Check for debris build-up, such as packed mud, undercoating, ice/snow buildup, road tar, etc. If debris build up is found it must be removed.
- Check for bulging in the tyre sidewalls. If bulging is found tyre must be replaced. Refer to Tire Dismounting and Mounting .
- Check the condition of all wheels. Refer to Replacement Wheels Description .
- Check that all tyres are inflated to the correct pressures prior to any road test. Refer to Tire Inflation Pressure Specifications .

Road Testing

Caution: Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.

There are many potential causes for a vibration condition to be present in a vehicle. It is vital that a thorough road test be conducted to identify the causes for a vibration condition.

Slow Acceleration Test

This test is to identify engine or vehicle speed related conditions. It will be necessary to perform additional tests in order to determine in which category the vibration belongs.

1. Slowly accelerate on a smooth level road up to allowable speed.
2. Identify a vibration condition that matches the customer's description.
3. Note the vehicle speed (km/h) and engine speed (RPM) where the vibration condition occurs.

Follow this test with the neutral coast down test, and the downshift test.

Neutral Coast Down Test

1. Accelerate on a smooth level road, to a speed slightly higher than the speed at which the

vibration occurs.

2. Shift the vehicle into NEUTRAL and coast down through the vibration range. Note if the vibration occurs in NEUTRAL.

If the vibration occurs in NEUTRAL, the vibration is vehicle-speed sensitive eliminating the engine and torque converter as a cause. Depending on the symptoms or frequency, the repair will concentrate on either the tyres and wheels, the propeller shaft or the rear axle.

Downshift Test

1. Accelerate on a smooth level road, to the speed at which the vibration condition occurs. Note the engine RPM.
2. Decelerate and safely downshift to the next lower gear.
3. Operate the vehicle at the previously noted engine RPM.

If the vibration returns at the noted engine RPM, the engine or torque converter is the most probable cause. To confirm these results, repeat this test in lower gears and NEUTRAL.

Steering Input Test

This test is intended to determine how much wheel bearings and other suspension components contribute to a vibration, especially those relating to noises, howl, growl, grinding and roaring.

With the vehicle at the vibration speed drive through slow sweeping turns in both directions.

If the vibration gets worse or goes away, the wheel hubs and tyre tread wear are possible causes.

Standing Start Acceleration

The purpose of this test is to duplicate a vibration known as Take-off-Shudder. A powertrain mount or the exhaust contacting the body may also be a potential cause depending on the symptoms.

1. With the vehicle at a complete stop and in gear, remove your foot from the brake.
2. Accelerate while checking for vibrations that match the customer's description.

Shudder in the seat or steering wheel under these conditions usually results from incorrect driveline angles. Worn, tight or failed universal joint may also be a cause, and should be inspected first.

Grunting or groaning noises along with a buzzing or roughness in the floor usually points to the vibration being conducted through the engine or transmission mounts, or through exhaust mounts and hangers that have grounded.

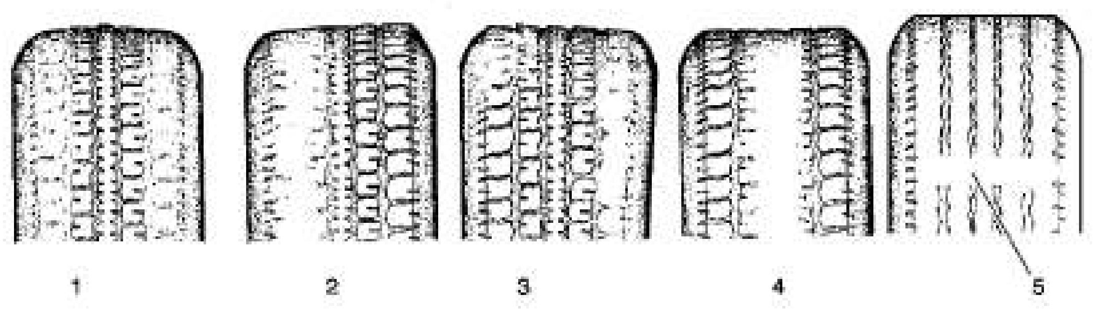
Radial Tire Lead / Pull Correction

Step	Action	Yes	No
DEFINITION: Lead/pull is the deviation of the vehicle from a straight path on a level road with no pressure on the steering wheel.			
1	Road test the vehicle to verify the complaint. Select a smooth level surface to perform the test. Does the condition exist?	Go to Step 2	System OK
2	1. Switch the front tyre and wheel assemblies from side to side. Refer to Tire and Wheel Removal and Installation in Tires and Wheels. 2. Road test the vehicle on a smooth level surface. Does the vehicle still lead/pull?	Go to Step 3	System OK
3	Does the vehicle lead/pull in the opposite direction?	Go to Step 4	Go to Wheel Alignment Measurement in Wheel Alignment
4	1. Switch the left front tyre and wheel assembly with the left rear tyre and wheel assembly. Refer to Tire and Wheel Removal and Installation in Tires and Wheels. 2. Road test the vehicle on a smooth level surface. Does the vehicle still lead/pull?	Go to Step 5	Go to Step 6
5	1. Switch the right front tyre and wheel assembly with the right rear tyre and wheel assembly. Refer to Tire and Wheel Removal and Installation in Tires and Wheels. 2. Road test the vehicle on a smooth level surface. Does the vehicle still lead/pull?	Go to Wheel Alignment Measurement in Wheel Alignment	Go to Step 7
6	Replace the left rear tyre. Refer to Tire Dismounting and Mounting in Tires and Wheels. Is the repair complete?	Go to Step 8	--
7	Replace the right rear tyre. Refer to Tire Dismounting and Mounting in Tires and Wheels.		

	Is the repair complete?	Go to Step 8	--
8	Verify correct vehicle operation. Does the condition still exist?	Go to Step 1	System OK

Tire Diagnosis - Irregular or Premature Wear

Tyre Wear



(1) Under-Inflation, Hard Cornering, Lack of Regular Rotation

(2) Incorrect Wheel Alignment, Hard Cornering, Lack of Regular Rotation

(3) Incorrect Wheel Alignment, Shock Absorber Failure

(4) Over-Inflation, Heavy Acceleration, Lack of Regular Rotation

(5) Normal Wear to wear indicator

Inspection Procedure

1. Inspect front tyres for wear and damage.
2. Inspect rear tyres for wear and damage.
3. Rotate the tyre and wheel assembly if any of the following conditions exist:
   - The amount of time or distance since the last tyre rotation matches the maintenance schedule.
   - The outer tread blocks are worn more than the middle tread blocks (1).
   - The outer tread blocks are worn more than the inner tread blocks (2).
   - The middle tread blocks are worn more than the outer tread blocks (4).
4. Measure the wheel alignment. Refer to Wheel Alignment Measurement . If any of the following conditions exist:
   - The tread blocks have feather edges (3).
   - The outer tread blocks are worn more than the inner tread blocks (2).
   - The inner tread blocks are worn more than the outer tread blocks (4).
5. Inspect the struts or the shock absorbers if the tyre tread exhibits a cupped appearance (3).

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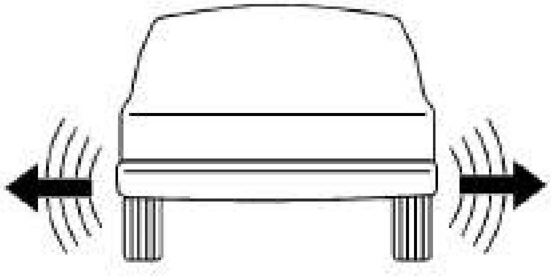
Tire Diagnosis - Waddle Complaint



Tyre waddle is a side to side movement at the front of the vehicle and/or the rear of the vehicle. Tyre waddle can be caused by the following conditions:

- A steel belt not being straight within the tyre.
- Excessive lateral runout of the tyre.
- Excessive lateral runout of the wheel.

Tyre waddle is most noticeable at an approximate speed of about 8-48 km/h (5-30 mph). Tyre waddle may appear as ride roughness at 80-113 km/h (50-70 mph). Tyre waddle may appear as a vibration at 80-113 km/h (50-70 mph).

Inspection Procedure

Step	Action	Yes	No
1	Has a vehicle road test been completed?	Go to Step 2	Go to Diagnostic Starting Point - Tires and Wheels
	Caution: Wear gloves when inspecting the tires in order to prevent personal injury from steel belts sticking through the tire. 1. Raise and support the vehicle with safety stands. Refer to Lifting and Jacking the Vehicle. 2. Mark the tyre in order to note the start and the		

2	stop position. 3. Rotate each tyre and wheel assembly by hand. 4. Visually inspect the tyre and wheel assemblies for the following: - Debris build-up, such as packed mud, undercoating, ice/snow buildup, road tar, etc. - Damage, abnormal or excessive wear Do any of the tyre and wheel assemblies exhibit any of the conditions listed?	Go to Step 3	Go to Step 4
3	1. Remove the debris from the tyre and wheel assemblies. 2. Replace the damaged, abnormally or excessively worn wheels or tyres as necessary. Refer to Tire Dismounting and Mounting. Did you complete the repair or replacement?	Go to Step 8	--
4	Measure the on-vehicle runout of the tyre and wheel assemblies. Refer to Tire and Wheel Assembly Runout Measurement - On-Vehicle. Does the runout measurement indicate a runout concern?	Go to Step 5	Go to Step 9
5	Measure the off-vehicle runout of the tyre and wheel assemblies. Refer to Tire and Wheel Assembly Runout Measurement - Off Vehicle. Does the runout measurement indicate a runout concern?	Go to Step 15	Go to Step 6
6	Are any of the tyre and wheel assembly runout measurements marginal; within acceptable limits, but close to the maximum?	Go to Step 7	Go to Step 12
7	**Important:** Ensure that each tyre and wheel assembly is match-mounted and balanced before reinstalling to the vehicle. 1. Match-mount the tyre to the wheel for each tyre and wheel assembly with marginal runout. Refer to Tire-to-Wheel Match-Mounting (Vectoring). 2. Measure the runout of each match-mounted tyre and wheel assembly. Refer to Tire and Wheel Assembly Runout Measurement - Off Vehicle. Were you able to significantly reduce the amount of tyre and wheel assembly runout?	Go to Step 8	Go to Step 15
8	Remeasure the on-vehicle runout of the tyre and wheel assemblies. Refer to Tire and Wheel Assembly Runout Measurement - On-Vehicle. Does the measurement indicate a runout concern?	Go to Step 12	Go to Step 17
	Inspect the balance of the tyre and wheel assemblies.		

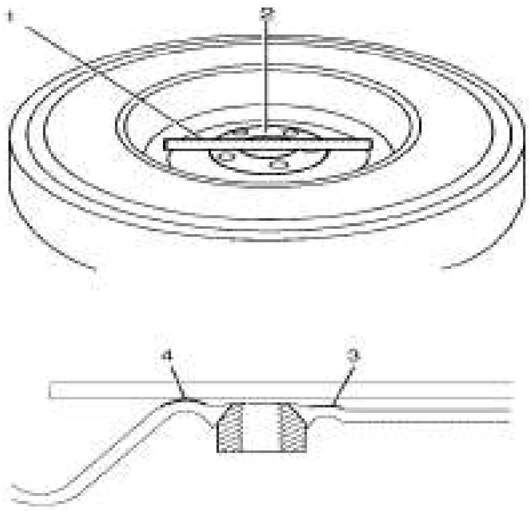
9	Refer to Tire and Wheel Balancing . Are any or the tyre and wheel assemblies out of balance?	Go to Step 10	Go to Step 11
10	Balance the tyre and wheel assemblies as necessary. Refer to Tire and Wheel Balancing . Did you complete the repair or replacement?	Go to Step 17	--
11	1. Inspect the brake discs for damage. 2. Inspect the brake disc assembled lateral runout. Refer to Brake Rotor Assembled Lateral Runout Correction. Are any of the brake discs damaged and/or indicate a runout concern?	Go to Step 14	Go to Step 16
12	Measure the runout of the hub/axle flanges. Refer to Front Wheel Hub Assembly Inspection Does the runout measurement indicate a runout concern?	Go to Step 13	Verify customer concern, go to Strategy Based Diagnosis.
13	Replace components as required. Refer to the following procedures as necessary: • Front Wheel Bearing and Hub Replacement. • Rear Wheel Bearing and Hub Replacement. Did you complete the replacement?	Go to Step 17	--
14	Replace the brake discs as necessary. Refer to the appropriate procedure: • Front Brake Rotor Replacement • Rear Brake Rotor Replacement Did you complete the replacement?	Go to Step 17	--
15	Replace any tyres and/or wheels that were isolated as the cause of the disturbance, as necessary. Refer to Tire Dismounting and Mounting in Tires and Wheels. Did you complete the replacement?	Go to Step 17	--
16	Finish-balance the tyre and wheel assemblies on-vehicle. Refer to Tire and Wheel Balancing in Tires and Wheels. Did you complete the on-vehicle finish balancing?	Go to Step 17	--
17	1. Install or connect any components that were removed or disconnected during diagnosis. 2. Operate the vehicle in order to verify the repair. Did you correct the condition?	System OK	Go to Step 4

Wheel Mounting Surface Check

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the wheels. Refer to Tire and Wheel Removal and Installation .
3. Inspect the wheel stud holes for damage. If damage is found the wheel must be replaced. Refer to Replacement Wheels Description .
4. Thoroughly clean the wheel mounting surface.



Important: Use a straight edge (1) 150 to 165 mm (6 to 6.5 in) long.

Important: If you can rock the straight edge (1) the mounting surface (2) is bent and the wheel must be replaced.

Important: For steel wheels the outer mounting ring (4) is designed to be raised slightly above the inner mounting ring (3).

5. Place a straight edge (1) across the wheel inboard mounting surface (2) over a wheel stud hole. Attempt to rock the straight edge up and down on the mounting surface.
6. Repeat Step 5 over every wheel stud hole.
7. Replace wheels as required. Refer to Replacement Wheels Description and Tire Dismounting and Mounting .
8. Remove the safety stands.
9. Lower the vehicle to the ground.

Tire and Wheel Balancing (Off Vehicle LWB SWB)

Important: The tyre and wheel assembly must be balanced off vehicle before attempting to balance the tyre and wheel assembly on vehicle. Refer to Tire and Wheel Balancing .

If after following the tyre and wheel vibration diagnostic process, some amount of tyre and wheel vibration is still evident, an on-vehicle high-speed spin balancer may be used to perform an on-vehicle balance in an attempt to finish balance the tyre and wheel assemblies, wheel hubs, brake rotors and wheel trim, if equipped, simultaneously. On-vehicle balancing can also compensate for minor amounts of residual runout encountered as a result of mounting the tyre and wheel assembly on the vehicle, as opposed to the balance which was achieved with the off-vehicle balancing procedure.

Important: Note the following information before performing the on-vehicle tyre and wheel balance:

- Vehicles equipped with low profile, wide tread path, high performance tyres and wheels are susceptible to small amounts of dynamic imbalance.
- When performing an on-vehicle balance, care must be taken when placing the wheel balance weights on the wheels. If the wheel balance weights are not placed accurately, they can induce dynamic imbalance and increase the severity of the vibration.
- Inspect the wheel bearings to ensure that they are in good condition. Refer to Front Wheel Bearing and Hub Replacement or Rear Wheel Bearing and Hub Replacement .
- Thoroughly inspect all on-vehicle balancing equipment and make sure that it is within the manufacturer's recommended specifications.
- Do not remove the off-vehicle balance weights. The purpose of on-vehicle balance is to fine tune the assembly balance already achieved off-vehicle, not to start over.
- Leave all wheel trims installed whenever possible.
- If the on-vehicle balancer calls for more than 56 g (2 oz) of additional weight, split the weight between the inboard and outboard flanges of the wheel, so as not to upset the dynamic balance of the assembly achieved in the off-vehicle balance.

  Perform the on-vehicle balancing procedure in accordance with the on-vehicle balancer manufacturer's instructions.

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Tire and Wheel Removal and Installation

Tools Required

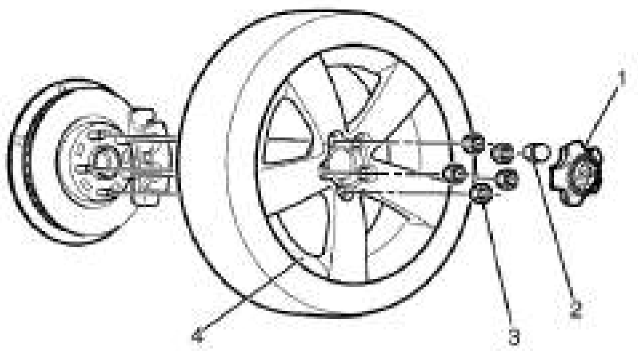
J-39544-18A Torque Limiting Bar

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



2. Remove the wheel centre cap (1) (alloy wheels).
3. Remove the wheel nut caps (2), if equipped.
4. Mark the wheel in relation to the wheel hub flange.
5. Remove the wheel nuts (3).

Caution: If penetrating oil gets on the vertical surfaces between the wheel and the rotor or drum it could cause the wheel to work loose as the vehicle is driven, resulting in loss of control and an injury accident.

Notice: Never use heat to loosen a tight wheel. It can shorten the life of the wheel, studs, or hub and bearing assemblies. Wheel nuts must be tightened in sequence and to the specified torque to avoid bending the wheel or rotor.

6. Remove the tire and wheel assembly (4).

If the tire and wheel assembly is difficult to remove, perform the following steps:

6.1. Install and tighten all wheel nuts on the affected wheel.
6.2. Loosen each wheel nut 2 turns.
6.3. Lower the vehicle to the ground.
6.4. Rock the vehicle from side to side.
6.5. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
6.6. Remove the wheel nuts.
6.7. Remove the tire and wheel assembly.

Installation Procedure

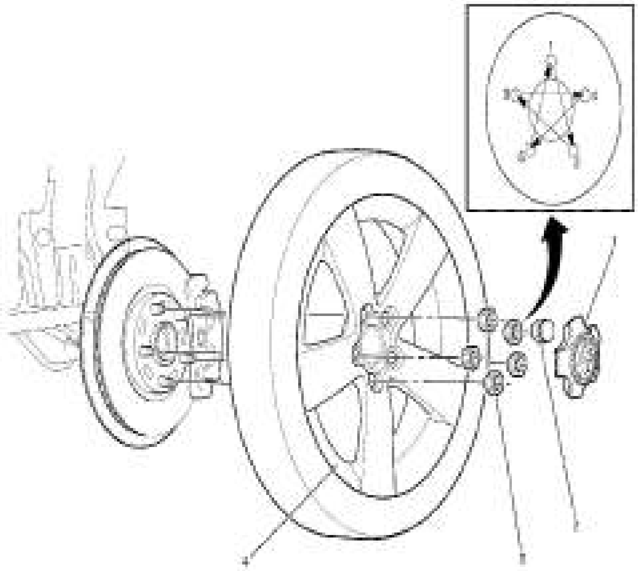
Caution: Before installing the wheels, remove any buildup of corrosion on the wheel mounting surface and brake drum or disc mounting surface by scraping and wire brushing. Installing wheels with poor metal-to-metal contact at the mounting surfaces can cause wheel nuts to loosen. This can cause a wheel to come off when the vehicle is moving, causing loss of control and possibly personal injury.

1. Remove any corrosion or foreign material from the wheel and the hub mounting surfaces.

Important: Do not apply any lubricant to the wheel stud or wheel nut threads.

2. Clean the threads on the wheel studs and wheel nuts.

Notice: Refer to Fastener Notice in the Preface section.



Notice: A torque wrench or J 39544 must be used to ensure that wheel nuts are tightened to specification. Never use lubricants or penetrating fluids on wheel stud, nuts, or mounting surfaces, as this can raise the actual torque on the nut without a corresponding torque reading on the torque wrench. Wheel nuts, studs, and mounting surfaces must be clean and dry. Failure to follow these instructions could result in wheel, nut, and/or stud damage.

Important: Tighten the nuts evenly and alternately in the sequence shown.

Important: An pneumatic/electric impact tool can only be used to tighten wheels nuts if used in conjunction with the correct specification torque limiting bar. Use special tool J-39544-18A.

3. Install the tire and wheel assembly (4).

   Install the wheel nuts (3).

   Tighten
   Tighten the wheel nuts in sequence to 170 N·m (125 lb ft)

4. Install the wheel nut caps (2), if equipped.
5. Install the wheel centre cap (1) (alloy wheels).
6. Lower the vehicle to the ground.

Tire Dismounting and Mounting (LWB SWB)

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the tyre and wheel assemblies from the vehicle. Refer to Tire and Wheel Removal and Installation .

Notice: Damage to either the tire bead or the wheel mounting holes can result from the use of improper wheel attachment or tire mounting procedures. It takes up to 70 seconds for all of the air to completely exhaust from a large tire. Failure to follow the proper procedures could cause the tire changer to put enough force on the tire to bend the wheel at the mounting surface. Such damage may result in vibration and/or shimmy, and under severe usage lead to wheel cracking.

3. Deflate the tyre completely.

Notice: Use a tire changing machine in order to dismount tires. Do not use hand tools or tire irons alone in order to remove the tire from the wheel. Damage to the tire beads or the wheel rim could result.

Notice: Do not scratch or damage the clear coating on aluminum wheels with the tire changing equipment. Scratching the clear coating could cause the aluminum wheel to corrode and the clear coating to peel from the wheel.

Important: If the tyre is to be refitted note and record the relationship and orientation of the tyre to the wheel.

4. Remove the tyre from the wheel, using a tyre changing machine.
5. Remove any rubber, light rust or corrosion from the wheel bead seats.

Notice: When mounting the tires, use an approved tire mounting lubricant. DO NOT use silicon or corrosive base compounds to lubricate the tire bead and the wheel rim. A silicon base compound can cause the tire to slip on the rim. A corrosive type compound can cause tire or rim deterioration.

6. Apply an approved Lubricant to the tyre bead and the wheel rim.

Important: Rim-clamp tyre changes are recommended.

Important: If fitting the original tyre maintain the original relationship and orientation of the tyre to the wheel.

Important: If fitting an Australian manufactured tyre align the RED dot on tyre to the mark on outer flange of wheel, or if there is no mark on the wheel, align RED dot to low point of wheel as measured with dial indicator.

Important: If fitting an European manufactured tyre align the WHITE dot on the tyre

180 degrees from the mark on outer flange of wheel, or if there is no mark on the wheel, align WHITE dot 180 degrees from the low point of the wheel as measured with the dial indicator.

Important: If fitting a Japanese manufactured tyre and there is a YELLOW dot but not a RED dot use the rule for Australian tyres. If there is a YELLOW and a RED dot, ignore the YELLOW dot and use the RED dot as per the rule for Australian tyres.

7. Install the tyre to the wheel using a tyre changer.

Caution: To avoid serious personal injury, do not stand over tire when inflating. The bead may break when the bead snaps over the safety hump. Do not exceed 275 kPa (40 psi) pressure when inflating any tire if beads are not seated. If 275 kPa (40 psi) pressure will not seat the beads, deflate, relubricate the beads and reinflate. Overinflation may cause the bead to break and cause serious personal injury.

8. Inflate the tyre to the specified pressure. Refer to Tire Inflation Pressure Specifications .
9. Make sure that the locating rings are visible on both sides of the tyre in order to verify that the tyre bead is fully seated on the wheel.
10. Balance the tyre and wheel. Refer to Tire and Wheel Balancing off vehicle.
11. Install the tyre and wheel. Refer to Tire and Wheel Removal and Installation .
12. Remove the safety stands.
13. Lower the vehicle.

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Tire Dismounting and Mounting (LWB)

Removal Procedure

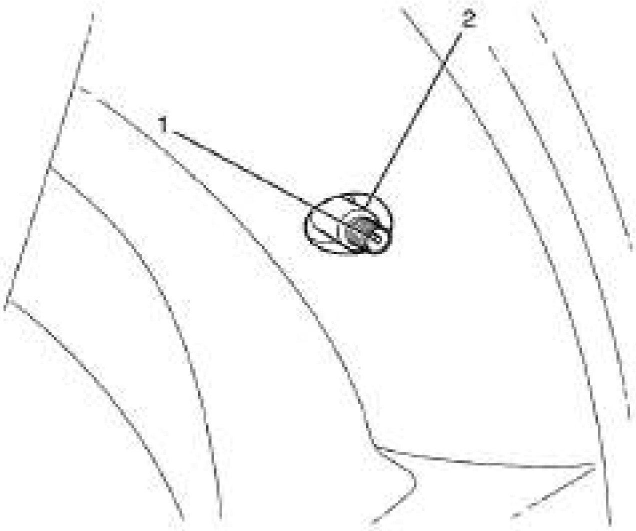
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the VehicleLifting and Jacking the Vehicle.
2. Remove the tyre and wheel assemblies from the vehicle. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation.

Notice: Refer to General Repair Instructions in the Preface section.

3. Remove the valve cap.



Important: The valve core (1) is a single use part. It must be discarded after removal.

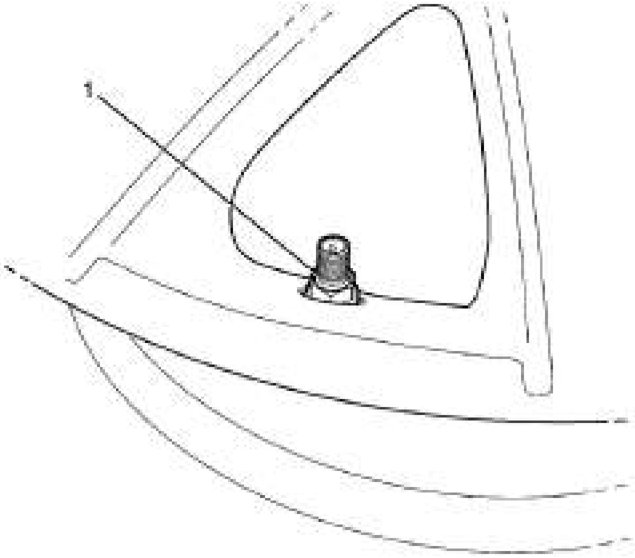
Important: If the tyre is to be refitted note and record the relationship and orientation of the tyre to the wheel.

4. Using a suitable tool remove the valve core (1) from the valve stem (2).

   Discard the valve core.

5. Deflate the tyre completely.
6. Remove the tyre from the wheel, using a tyre changing machine.
7. Remove any rubber, light rust or corrosion from the wheel bead seats.

Disassembly Procedure

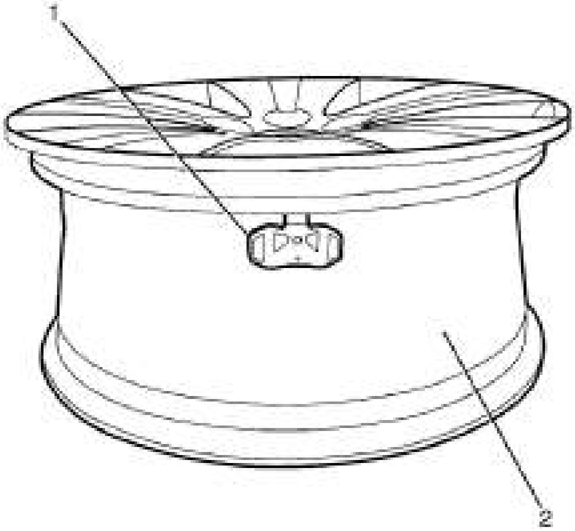


Important: The tyre pressure transmitter to wheel retaining nut (1) is a single use part. It must be discarded after removal.

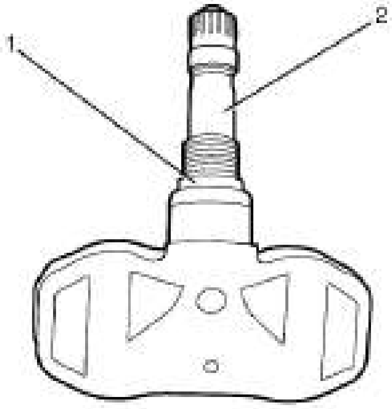
1. Remove the tyre pressure transmitter to wheel retaining nut (1).

   Discard the nut.

2. Remove the tyre pressure transmitter from the wheel.



3. Remove the tyre pressure transmitter (1) from the wheel (2).

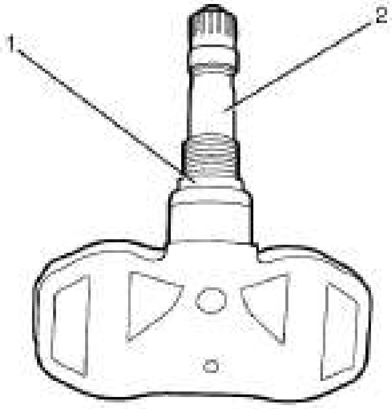


Important: The tyre pressure transmitter seal (1) is a single use part. It must be discarded after removal.

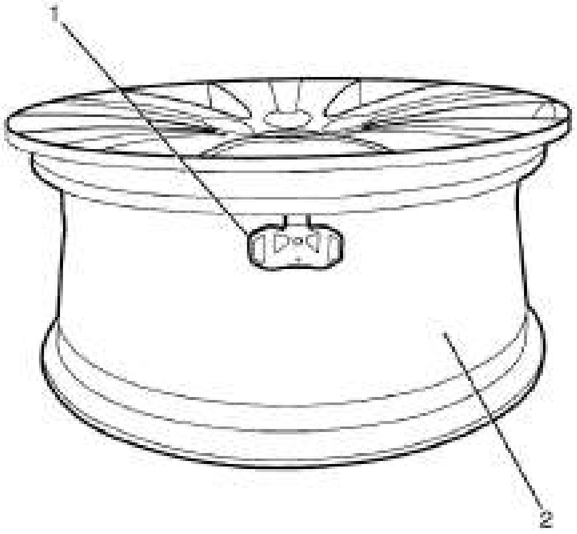
4. Remove the tyre pressure transmitter seal (1) from the tyre pressure transmitter (2).

   Discard the seal.

Assembly Procedure

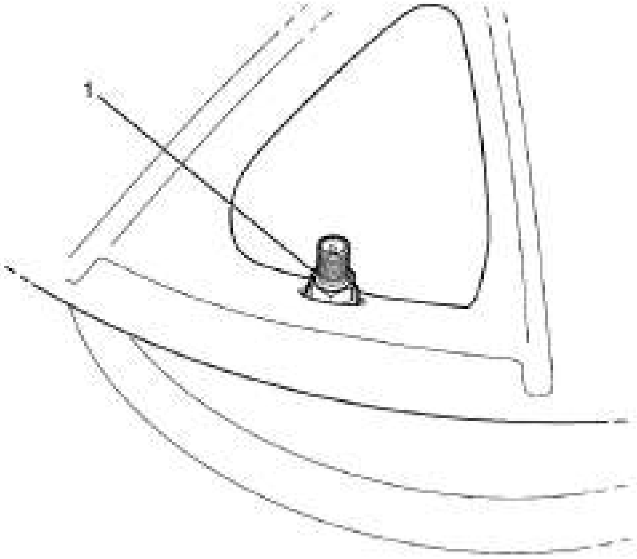


1. Install a NEW tyre pressure transmitter seal (1) to the tyre pressure transmitter (2).



2. Position tyre pressure transmitter (1) to the wheel (2).

   Notice: Refer to Fastener Notice in the Preface section.



Important: Secure the tyre pressure transmitter in the valve hole while tightening.

3. Install a NEW tyre pressure transmitter to wheel retaining nut (1).

   Tighten
   Tighten the nut to 2 N·m (18 lb in).

Installation Procedure

Notice: Refer to General Repair Instructions in the Preface section.

Important: Rim-clamp tyre changers are recommended.

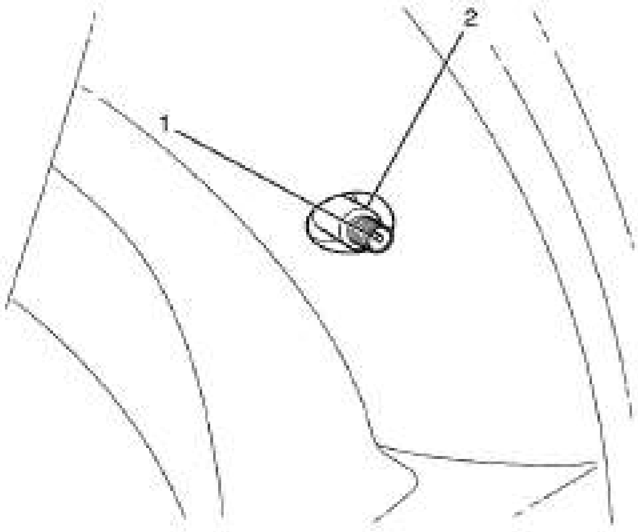
Important: If fitting the original tyre maintain the original relationship and orientation of the tyre to the wheel.

Important: If fitting an Australian manufactured tyre align the RED dot on tyre to the mark on outer flange of wheel, or if there is no mark on the wheel, align RED dot to low point of wheel as measured with dial indicator.

Important: If fitting an European manufactured tyre align the WHITE dot on the tyre 180 degrees from the mark on outer flange of wheel, or if there is no mark on the wheel, align WHITE dot 180 degrees from the low point of the wheel as measured with the dial indicator.

Important: If fitting a Japanese manufactured tyre and there is a YELLOW dot but not a RED dot use the rule for Australian tyres. If there is a YELLOW and a RED dot, ignore the YELLOW dot and use the RED dot as per the rule for Australian tyres.

1. Apply an approved lubricant to the tyre bead and the wheel rim.
2. Install the tyre using a tyre changing machine.



3. Install a NEW valve core (1) to the valve stem (2).

Caution: Refer to General Repair Instructions in the Preface section.

4. Inflate the tyre until the bead snaps over the safety hump then inflate to the specified pressure. Refer to Tire Inflation Pressure SpecificationsTire Inflation Pressure Specifications.
5. Install a valve cap to the valve stem.
6. Make sure that the locating rings are visible on both sides of the tyre in order to verify that the tyre bead is fully seated on the wheel.

7. Balance the tyre and wheel assemblies. Refer to Tire and Wheel BalancingTire and Wheel Balancing (Off Vehicle).
8. Install the tyre and wheel assemblies. Refer to Tire and Wheel Removal and InstallationTire and Wheel Removal and Installation.
9. Lower the vehicle.

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Tire Rotation (LWB SWB)

Important: If uneven tyre wear is evident, the reason for the wear should be corrected.

Important: If the tyres are rotated, it is recommended that the tyre and wheel assembly balance be checked at the same time.

1. It is recommended that tyre rotation be carried out when brake inspections are performed, as per the service schedule outlined in the Owner's Handbook, or when:

   Difference in tread depth between front and rear tires exceed 1.55 mm.

   When any unusual tyre wear pattern develops.

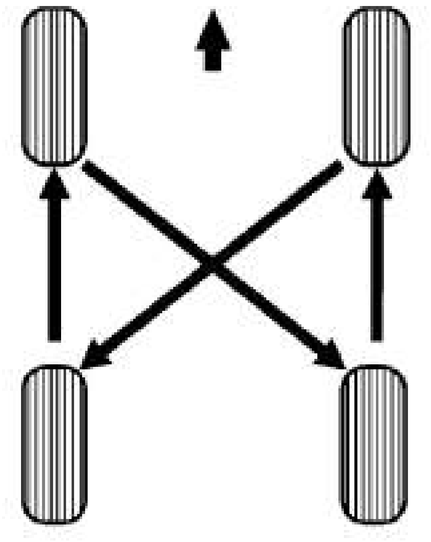
   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

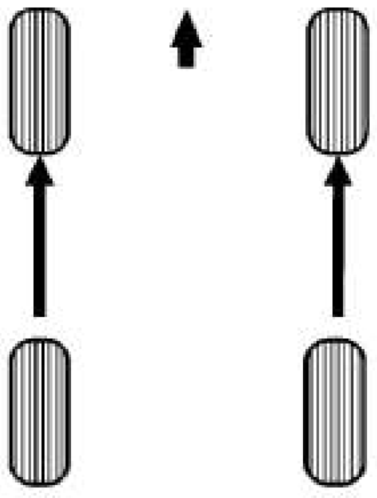
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

   Important: Note the location of each tyre and wheel assembly in relation to the original position on the vehicle.

3. Remove the tyre and wheel assembly. Refer to Tire and Wheel Removal and Installation.
4. Rotate the tyre and wheel assemblies as shown in the following diagrams.



Important: For 'Non Directional' tyres carry out rotation as shown Above.



Important: For 'Directional' tyres carry out rotation as shown Above.

5. Install the tyre and wheel assemblies. Refer to Tire and Wheel Removal and Installation.
6. Remove the safety stands.
7. Lower the vehicle.
8. Check and adjust the tyre inflation pressure. Refer to Tire Inflation Pressure Specifications.

Tire Repair

Many different materials and techniques are available on the market in order to repair tyres. Not all of the materials and techniques work on some types of tyres. Tyre manufacturers have published detailed instructions on how and when to repair tyres. Obtain the instructions from the manufacturer. If the vehicle is equipped with a compact spare tyre, do not repair the compact spare tyre.

General Description

The factory installed tires are designed to operate satisfactorily with loads up to and including the full rated load capacity when these tires are inflated to the recommended pressures.

The following factors have an important influence on tire life:

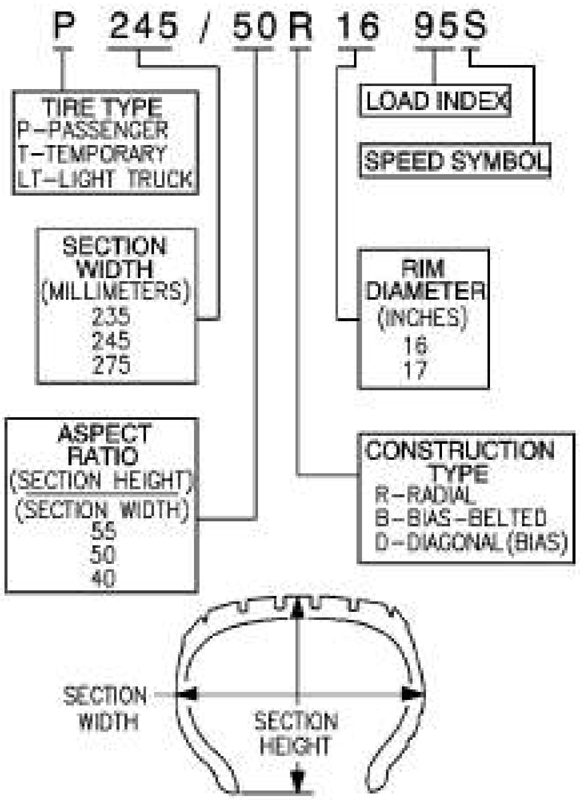
- Correct tire pressures
- Correct wheel alignment
- Proper driving techniques
- Tire rotation

The following factors increase tire wear:

- Heavy cornering
- Excessively rapid acceleration
- Heavy braking

P-Metric Sized Tires Description

The tyre sidewall has a coded marking system, which provides information about the tyre.


P 245 / 50 R 16 95S
TIRE TYPE
P–PASSENGER
T–TEMPORARY
LT–LIGHT TRUCK
SECTION WIDTH (MILLIMETERS)
235
245
275
ASPECT RATIO
(SECTION HEIGHT)
(SECTION WIDTH)
55
50
40
LOAD INDEX
SPEED SYMBOL
RIM DIAMETER (INCHES)
16
17
CONSTRUCTION TYPE
R–RADIAL
B–BIAS–BELTED
D–DIAGONAL (BIAS)
SECTION WIDTH
SECTION HEIGHT

Tyre Marking Example:	
P 245 50 R 16 95 S	
P	Passenger Vehicle Designation
245	Section Width in mm (245 mm)
50	Aspect Ratio % (Section Height to Section Width) (50 = 50%)
R	Tyre Construction

	(R = Radial)	
16	Rim Diameter in inches (16 = 16")	
C	Service Application Code (C or LT = Light Truck or Multi-purpose Passenger Vehicle) **NOTE:** Some European and Japanese light truck tyres use C instead of LT for the same purpose.	
95	Max Load Index	91 = 615 kg
		92 = 630 kg
		93 = 650 kg
		94 = 670 kg
		95 = 690 kg
		96 = 710 kg
		97 = 730 kg
		99 = 775 kg
		104 = 900 kg
		106 = 950 kg
S	Speed Rating	R = 170 km/h
		S = 180 km/h
		H = 210 km/h
		V = 240 km/h
		W = 270 km/h

Metric Wheel Nuts and Bolts Description

All models use metric (M14 x 1.5) wheel attaching studs and nuts. There is only 1 type of wheel nut that is used to attach both alloy and steel wheels. Each wheel is attached to the wheel hub by 5 wheel hub studs and 5 wheel nuts.

For removal and installation instructions for the wheel attaching studs, refer to Wheel Stud Replacement for Front, or Wheel Stud Replacement for Rear.

Metric wheel/nuts and bolts are identified in the following way:

The wheel/nut has the word Metric stamped on the face.

The thread sizes of metric wheel/nuts and the bolts are indicated by the following example: M14 x 1.5.

- M = Metric
- 14 = Diameter in millimeters
- 1.5 = Thread pitch in Millimeters

Replacement Wheels Description

Replace the wheel if any of the following conditions exist:

- The wheel exhibits excessive runout.
- The wheel is bent.
- The wheel mounting surface is bent.
- The wheel is cracked.
- The wheel is severely rusted.
- The wheel is severely corroded.

Replace the wheel, the wheel hub studs and the wheel nuts, if any of the following conditions exist:

- The wheel has elongated wheel stud holes.
- The wheel nuts loosen repeatedly.

Caution: Refer to General Repair Instructions in the Preface section.

Notice: Refer to General Repair Instructions in the Preface section.

Important:

- Replacement wheels must be equivalent to the original equipment wheels in the following ways:
  - The load capacity.
  - The wheel diameter.
  - The rim width.
  - The wheel offset.
  - The mounting configuration.
- A wheel of the incorrect size or type may affect the following conditions:
  - Wheel and hub-bearing life.
  - Brake cooling.
  - Speedometer/odometer calibration.
  - Vehicle ground clearance.
  - Tire clearance to the body and the chassis.

Steel wheel identification is stamped into the wheel rim.

Aluminium wheel identification is cast into the inboard side of the wheel.

Tire Inflation Description

This vehicle has been engineered to operate up to the stated load capacity with wheel and tyre assemblies of the type, size, construction, and configuration as originally installed. Maintenance of the tyre inflation pressures is critical to the continued satisfactory performance, handling, and operating economy of the vehicle.

Operating the vehicle with incorrectly inflated tyres can adversely affect vehicle performance and may contribute to the following:

- Reduced fuel economy
- Tyre overloading
- Reduced tyre life
- Excessive tyre wear
- Uneven tyre wear
- Vehicle handling concerns

Inspect the tyre pressures when the vehicle has not been driven for at least 3 hours or not more than 1.6 km (1 mi) and when the tyres are cool to the touch.

Replace any missing or damaged tyre valve stem extensions and/or caps to prevent the intrusion of water and contaminates.

One pound per square inch (psi) equals 6.9 kilopascals (kPa). The following table illustrates the conversion of kilopascals to pounds per square inch:

Inflation Pressure Conversion (Kilopascals to PSI)

kPa	psi	kPa	psi
140	20	215	31
145	21	220	32
155	22	230	33
160	23	235	34
165	24	240	35
170	25	250	36
180	26	275	40
185	27	310	45
190	28	345	50
200	29	380	55
205	30	415	60
Conversion: 6.9 kPa = 1 psi			

For the correct inflation pressures refer to the vehicle's tyre placard.

Tyres inflated to a higher than recommended pressure can contribute to the following conditions:

- A hard ride
- Tyre bruising
- Rapid tread wear at the center of the tyre

Tyres inflated to a lower than recommended pressure can contribute to the following conditions:

- Tyre squeal on turns
- Hard steering
- Rapid and/or uneven wear on the outer edges of the tread
- Tyre rim bruises and tyre rim rupture
- Tyre cord breakage
- High tyre temperatures
- Sluggish vehicle handling
- Higher fuel consumption

Unequal pressure on the same axle can cause the following conditions:

- Uneven braking action
- Steering lead
- Imprecise vehicle handling

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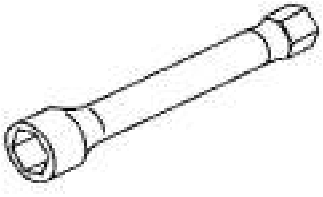
Special Tools

Illustration	Tool Number / Description
	J 39544-18A Torque Socket - 7/8 in 120 lbft

Wheel Alignment Specifications (LWB SWB)

Suspension Option	FE1	FE2	FR1
Front wheel alignment at kerb height			
Caster	6° ± 1.25°		
Toe in (per wheel)	+0.08° ± 0.08°		
Toe in (total)	+0.17° ± 0.17°		
Camber	-0.20° ± 0.33°	-0.34° ± 0.33°	+0.18° ± 0.33°
Cross caster tolerance	± 0.6°		
Steering wheel angle	0.0° ± 3.5°		
Rear wheel alignment at kerb height			
Camber	-0.5° + 0.35°/-0.55°	-0.8° + 0.35°/-0.55°	-0.16° + 0.35°/-0.55°
Toe in (per wheel)	+0.17° ± 0.1°		
Toe in (total)	+0.33° ± 0.2°		
Thrust angle	0.0° ± 0.2°		

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Wheel Alignment Specifications (Sportwagon)

Suspension Option	FE1	FE2	FR1
Front wheel alignment at kerb height			
Caster	6° ± 1.25°		
Toe in (per wheel)	+0.08° ± 0.08°		
Toe in (total)	+0.17° ± 0.17°		
Camber	-0.20° ± 0.33°	-0.34° ± 0.33°	+0.18° ± 0.33°
Cross caster tolerance	± 0.6°		
Steering wheel angle	0.0° ± 3.5°		
Rear wheel alignment at kerb height			
Camber	-0.39° + 0.35°/-0.55°	-0.5° + 0.35°/-0.55°	+0.07° + 0.35°/-0.55°
Toe in (per wheel)	+0.10° ± 0.1°		
Toe in (total)	+0.20° ± 0.2°		
Thrust angle	0.0° ± 0.2°		

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Tie Rod End to Tie Rod Locking Nut	50Nm	37 lb ft
Rear Adjustment Link Lock Nuts (Up to 9 October 2007)	50Nm	37 lb ft
I-Link to Subframe Retaining Bolt and Nut (After 9 October 2007)	175Nm	129 lb ft
Strut to Knuckle Retaining Nuts and Bolts		
- First Pass	85Nm	63 lb ft
- Second Pass	100Nm	74 lb ft
- Third Pass	+ 90 Degrees	

Wheel Alignment Measurement

Important: Steering and vibration concerns are not always the result of incorrect alignment. Other causes could include:

- Wheel and Tyre imbalance. Refer to Tire and Wheel Assembly Balancing - Off Vehicle or Tire and Wheel Assembly Balancing - On-Vehicle
- Tyre lead due to wear, incorrectly manufactured or incorrectly mounted tyres. Refer to Radial Tire Lead/Pull Correction .
- Before performing any adjustments affecting wheel alignment, perform the following inspections and adjustments in order to ensure correct alignment readings.
- Inspect tyres for correct inflation. Refer to Tire Inflation Pressure Specifications .
- Inspect tyres for irregular wear. Refer to Tire Diagnosis - Irregular or Premature Wear .
- Inspect the run out of the wheels and tyres. Refer to Tire and Wheel Assembly Runout Measurement - On-Vehicle .
- Inspect the wheel hub end float.
  - For front wheel hub Refer to Front Wheel Hub Assembly Inspection
  - For rear wheel hub Refer to Rear Wheel Hub Assembly Inspection
- Inspect the front suspension and steering ball joints for wear and damage. Refer to Ball Joint Inspection .
- Inspect the suspension control arms and stabiliser bar for wear and damage.
- Inspect the steering gear for looseness.
- Inspect the struts/shock absorbers for wear and damage. Refer to Suspension Strut and Shock Absorber Testing - On Vehicle .
- Inspect the vehicle trim height. Refer to Trim Height Inspection .
- Inspect the steering wheel for excessive drag or poor return due to stiff or binding suspension components.
- Inspect the fuel level. The fuel tank should be full or the vehicle should have compensating load added.

Important: Give consideration to excess loads such as tool boxes, sample cases, etc. If normally carried in the vehicle, these items should remain in the vehicle during the alignment adjustments. Give consideration also to the condition of the equipment being used for the alignment. Follow the equipment manufacturer's instructions.

Perform the following steps to measure the front and rear alignment angles:

Important: Satisfactory vehicle operation may occur over a wide range of alignment settings. However, if the settings are not within the allowable specifications, correct the alignment to the correct specifications. Refer to Wheel Alignment Specifications .

1. Install the alignment equipment according to the manufacturer's instructions.
2. Bounce the front and rear bumpers 3 times prior to checking the wheel alignment.
3. Measure the alignment angles and record the readings.

Important: When performing adjustments to vehicles requiring a four wheel alignment, set the rear wheel alignment angles first in order to obtain the correct front alignment angles.

4. Adjust alignment angles to vehicle specifications, if necessary. Refer to Wheel Alignment Specifications .

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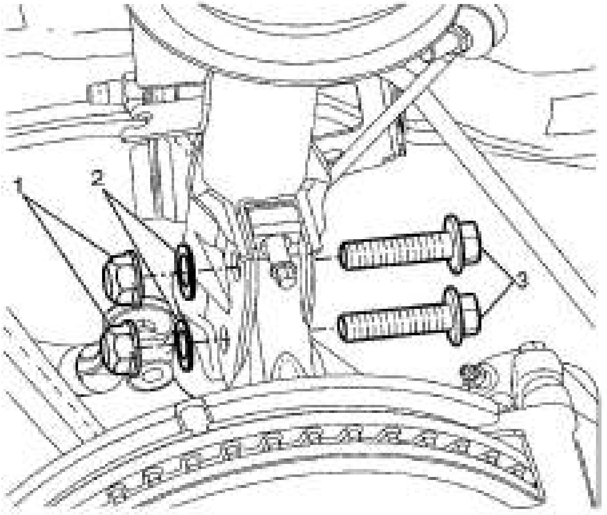
Front Caster and Camber Adjustment

Front Caster and Camber Adjustment - Up to xx/xx

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the front wheel. Refer to Tire and Wheel Removal and Installation .



Important: The strut assembly to steering knuckle retaining bolts (3), nuts (1) and washers (2) are single use parts. They must be discarded after removal.

3. Remove the strut assembly to steering knuckle retaining bolts (3), nuts (1) and washers (2).

   Discard the bolts, nuts and washers.

   Important: The strut assembly to steering knuckle retaining bolts (2) and nuts (1) are not to be fully tightened until after the front camber has been adjusted.

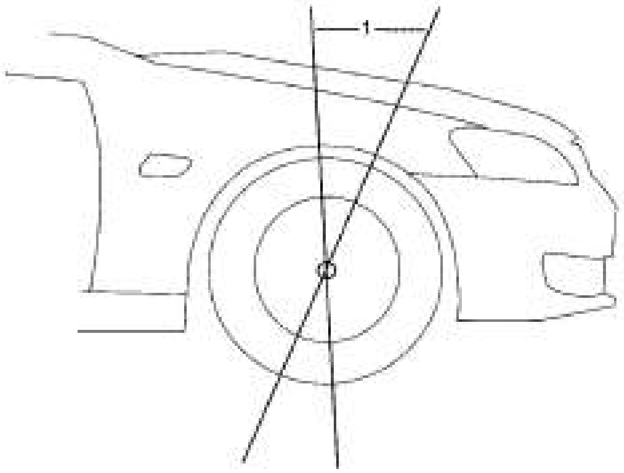
4. Install NEW strut assembly to steering knuckle retaining bolts (3), washers (2) and nuts (1).

   Do not fully tighten at this stage.

5. Install the front wheel. Refer to Tire and Wheel Removal and Installation .
6. Remove the safety stands.
7. Lower the vehicle to the ground.

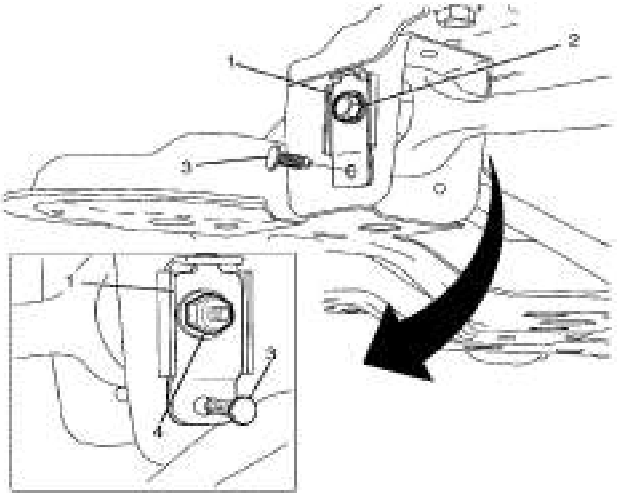
Important: Before checking and adjusting any wheel alignment angles bounce the vehicle to settle the suspension to normal ride height.

8. Bounce the vehicle several times to settle the suspension.



Important: For accurate readings do not push or pull on the tyre and wheel assembly during the alignment process.

9. Determine the actual caster angle (1).



10. Remove the front caster arm to subframe retaining nut (4) and bolt (2).

Discard the bolts and nuts.

Important: The front caster arm to subframe offset washers (1) are used to adjust the caster of the front suspension.

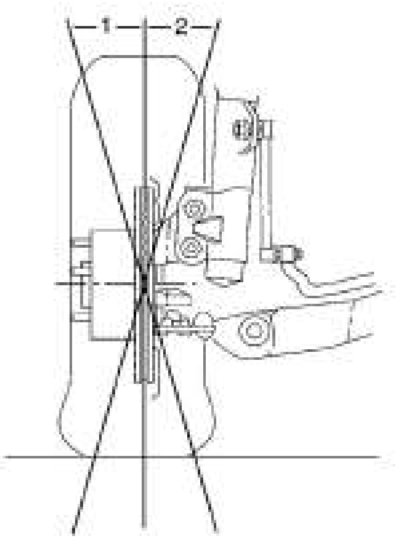
11. Adjust the caster to specification by selecting and installing the correct front caster arm to subframe offset washer (1). For caster specifications, Refer to Wheel Alignment Specifications .
12. Install the subframe offset washer to subframe retaining clips (3).
13. Install the NEW lower caster arm to the subframe retaining bolt (2).
14. Install the NEW lower caster arm to the subframe retaining nut (4).

    Do not fully tighten at this stage.

    Notice: Refer to Fastener Notice in the Preface section.

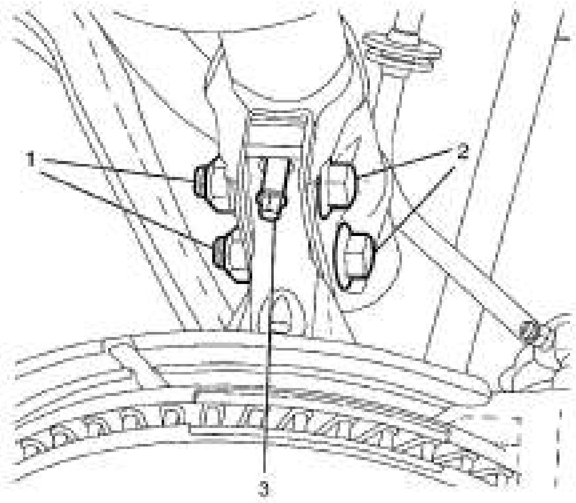
15. Tighten the front caster arm to subframe retaining nut (4).

    Tighten
    Tighten the nut to 50 N·m+ 120° (30 lb ft + 120°).



Important: For accurate readings do not push or pull on the tyre and wheel assembly during the alignment process.

16. Determine the actual camber, Positive (1) or Negative (2).



17. Adjust the camber to specification using the camber adjusting bolt (3). Turning clockwise will reduce negative camber. For camber specifications, Refer to Wheel Alignment Specifications .
18. Tighten the strut assembly to steering knuckle retaining bolts (2) and nuts (1).

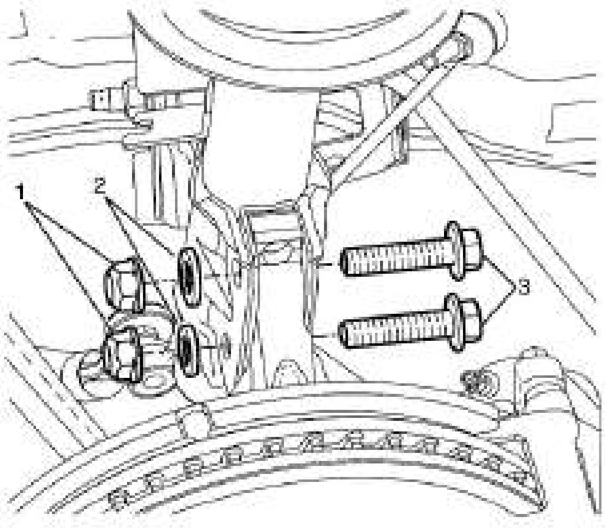
    Tighten

    - Tighten the bolts a first pass to 85 N·m (63 lb ft).
    - Tighten the bolts a second pass to 100 N·m (74 lb ft).
    - Tighten the bolts an additional 90 degrees.
19. Verify that the caster and camber are still within specifications. Refer to Wheel Alignment Specifications .
20. If further adjustment is required, adjust as necessary.

Front Caster and Camber Adjustment - From xx/xx

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the front wheel. Refer to Tire and Wheel Removal and Installation .



Important: The strut assembly to steering knuckle retaining bolts (3), nuts (1) and washers (2) are single use parts. They must be discarded after removal.

3. Remove the strut assembly to steering knuckle retaining bolts (3), nuts (1) and washers (2).

   Discard the bolts, nuts and washers.

   Important: The strut assembly to steering knuckle retaining bolts (2) and nuts (1) are not to be fully tightened until after the front camber has been adjusted.

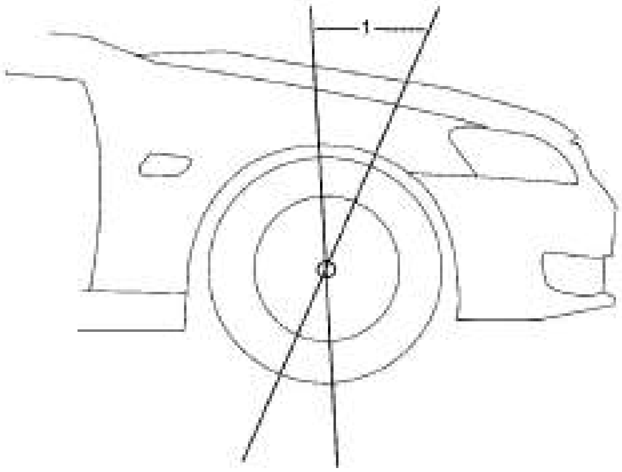
4. Install NEW strut assembly to steering knuckle retaining bolts (3), washers (2) and nuts (1).

   Do not fully tighten at this stage.

5. Install the front wheel. Refer to Tire and Wheel Removal and Installation .
6. Remove the safety stands.
7. Lower the vehicle to the ground.

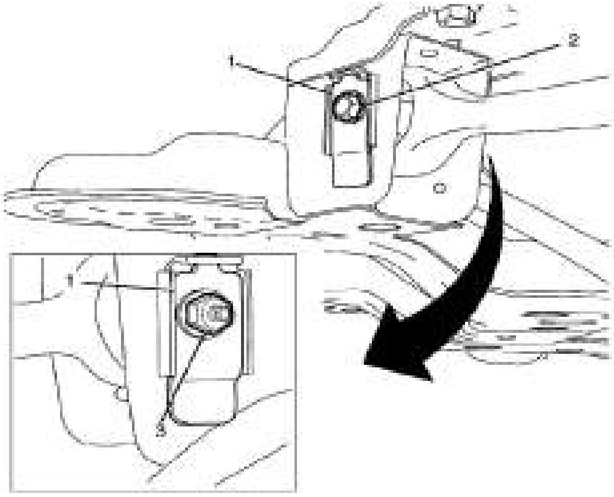
   Important: Before checking and adjusting any wheel alignment angles bounce the vehicle to settle the suspension to normal ride height.

8. Bounce the vehicle several times to settle the suspension.



Important: For accurate readings do not push or pull on the tyre and wheel assembly during the alignment process.

9. Determine the actual caster angle (1).



10. Remove the front caster arm to subframe retaining nut (3) and bolt (2).

    Discard the bolts and nuts.

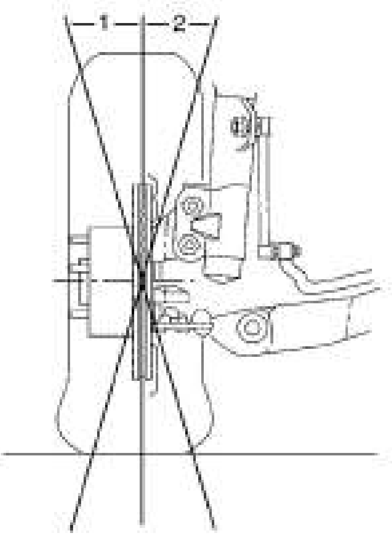
11. For caster specifications, Refer to Wheel Alignment Specifications .
12. Install the NEW lower caster arm to the subframe retaining bolt (2).
13. Install the NEW lower caster arm to the subframe retaining nut (4).

Do not fully tighten at this stage.

Notice: Refer to Fastener Notice in the Preface section.

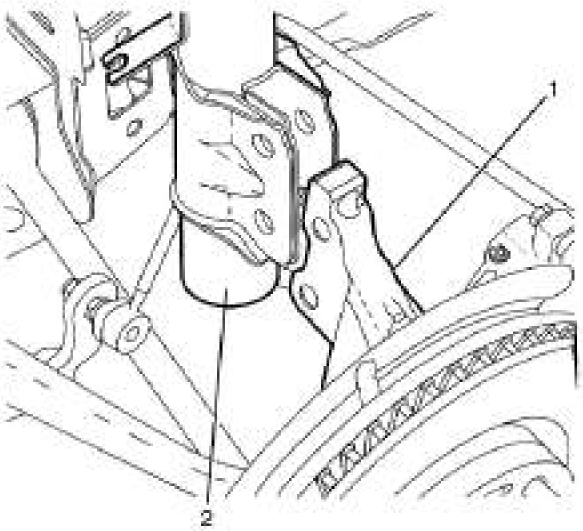
14. Tighten the front caster arm to subframe retaining nut (4).

    Tighten
    Tighten the nut to 50 N·m+ 120° (30 lb ft + 120°).



Important: For accurate readings do not push or pull on the tyre and wheel assembly during the alignment process.

15. Determine the actual camber, Positive (1) or Negative (2).



16. For camber specifications, Refer to Wheel Alignment Specifications .
17. Tighten the strut assembly to steering knuckle retaining bolts (2) and nuts (1).

    Tighten

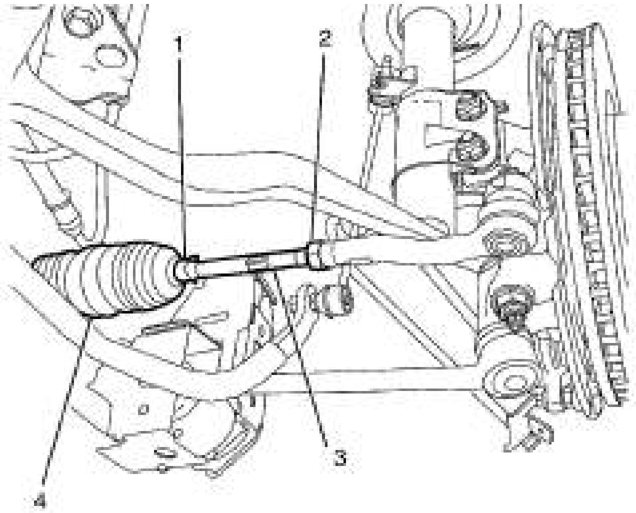
    - Tighten the bolts a first pass to 85 N·m (63 lb ft).
    - Tighten the bolts a second pass to 100 N·m (74 lb ft).
    - Tighten the bolts an additional 90 degrees.
18. Verify that the caster and camber are still within specifications. Refer to Wheel Alignment Specifications .
19. If further adjustment is required, adjust as necessary.

Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment

1. Bounce the vehicle several times to settle the suspension.

   Important: The toe of the front wheels must be checked with the wheels in the straight ahead position.

2. Set the wheels and steering gear to the straight ahead position.



3. Disconnect the outer steering gear boot to tie rod retaining clip (1).
4. Loosen the tie rod end to tie rod locking nut (2).
5. Determine the actual front wheel toe setting.
6. Adjust the front wheel toe to specification by turning the tie rod (3). For front wheel toe specifications, Refer to Wheel Alignment Specifications .

   Notice: Refer to Fastener Notice in the Preface section.

   Important: Do not allow the tie rod (3) to turn while tightening the tie rod end to tie rod locking nut (2).

7. Tighten the tie rod end to tie rod lock nut (2)

   Tighten
   Tighten the nut to 50 N·m (37 lb ft).

8. Verify that the toe is still within specifications. Refer to Wheel Alignment Specifications .
9. If further adjustment is required, adjust as necessary.

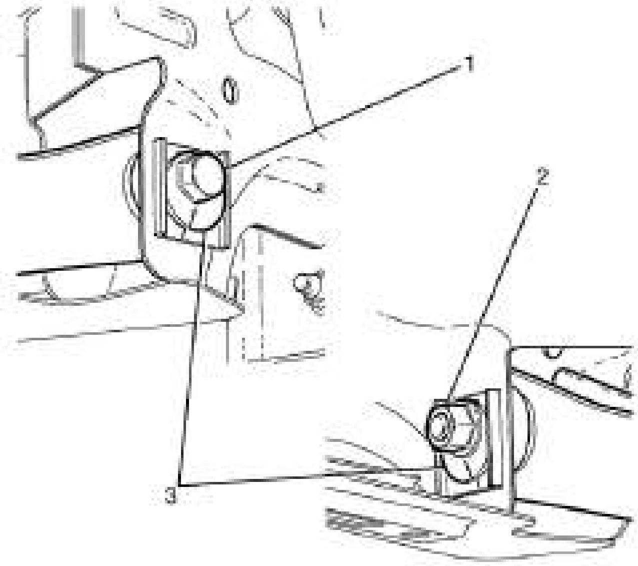
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Suspension | Wheel Alignment | Repair Instructions | **Document ID: 1992522**

Rear Camber Adjustment

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



Important: The lower control arm to the subframe retaining bolt (1) and nut (2) eccentric washers (3) are used to adjust rear suspension camber.

Important: Nuts with micro-encapsulated thread sealant must be discarded after removal.

2. Remove the lower control arm to the subframe retaining nut (2).

   Discard the nut.

   Important: The lower control arm to the subframe retaining nut (2) is not to be fully tightened until after the rear suspension camber has been adjusted.

3. Install NEW lower control arm to the subframe retaining nut (2).

   Do not fully tighten at this stage.

4. Remove the safety stands.
5. Lower the vehicle to the ground.

Important: Before checking and adjusting any wheel alignment angles bounce the vehicle to settle the suspension at normal ride height.

6. Bounce the vehicle several times to settle the suspension.
7. Determine the actual rear suspension camber angle.
8. Adjust the rear suspension camber to specification by turning the lower control arm to subframe retaining bolt (1). For rear suspension camber specifications, refer to Wheel Alignment Specifications .

   Notice: Refer to Fastener Notice in the Preface section.

   Important: The weight of the vehicle must be on a level surface such as an alignment rack and on all four wheels before fully tightening the bolts and nuts that have been partially tightened. Failure to comply with this requirement may adversely affect the ride and handling characteristics of the vehicle.

   Important: Do not allow the lower control arm to subframe retaining bolt (1) to turn while tightening.

9. Tighten the lower control arm to subframe retaining bolt (1) and nut (2).

   Tighten
   Tighten the bolt and nut to 175 N·m (129 lb ft).

10. Verify that camber is still within specifications. Refer to Wheel Alignment Specifications .
11. If further adjustment is required, adjust as necessary.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Suspension | Wheel Alignment | Repair Instructions | Document ID: 1992529

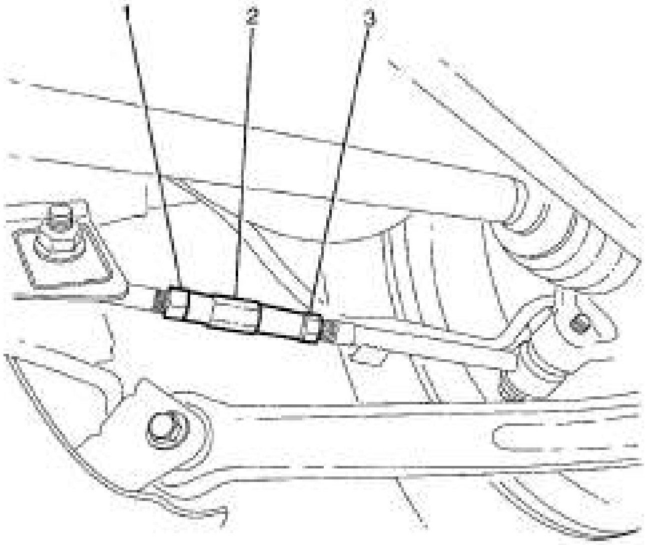
Rear Toe Adjustment

Adjustment Procedure -- Up to 09 Oct 2007

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



2. Loosen the I-Link adjuster lock nuts (1 and 3) from the I-Link adjuster (2).
3. Remove the safety stands.
4. Lower the vehicle to the ground.

Important: Before checking and adjusting any wheel alignment angles bounce the vehicle to settle the suspension to normal ride height.

5. Bounce the vehicle several times to settle the suspension.
6. Determine the actual rear suspension toe setting.
7. Adjust the rear suspension toe to specification by turning the I-Link adjuster (2). For rear suspension toe specifications, Refer to Wheel Alignment Specifications.

Notice: Refer to Fastener Notice in the Preface section.

Important: The weight of the vehicle must be on a level surface such as an alignment rack and on all four wheels before fully tightening the bolts and nuts that have been partially tightened. Failure to comply with this requirement may adversely affect the ride and handling characteristics of the vehicle.

Important: Do not allow the I-Link adjuster (2) to turn while tightening the I-Link adjuster lock nuts (1 and 3).

8. Tighten the I-Link lock nuts (1 and 3).

   Tighten
   Tighten the nut to 50 N·m (37 lb ft).

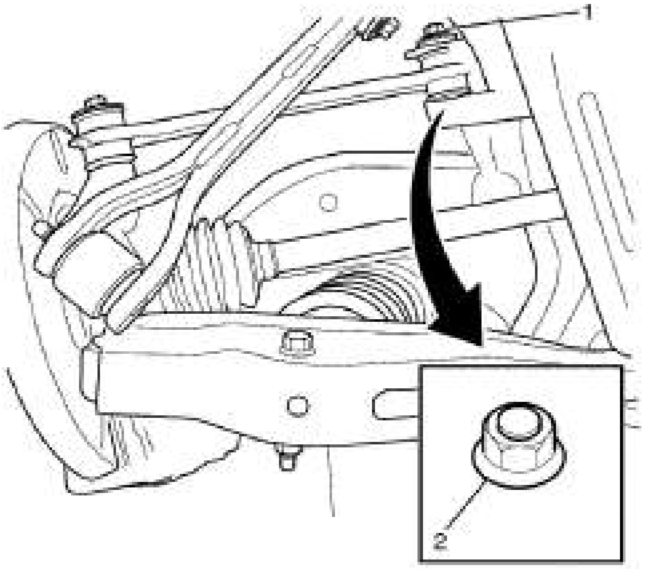
9. Verify that the toe is still within specifications. Refer to Wheel Alignment Specifications.
10. Readjust if necessary.

Adjustment Procedure -- After 09 Oct 2007

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



2. Remove and discard the lock nut (2).

   Important: Do not fully tighten the NEW lock nut (2) at this time.

3. Fit a NEW lock nut (2).
4. Lower the vehicle to the ground.

   Important: The weight of the vehicle must be on a level surface and on all four wheels before fully tightening the nut.

   Important: The suggested method to settle the rear suspension is with the wheels on the ground, open rear compartment lid and support the lid with a suitable brace. Using your hands press down hard on the rear compartment floor and release a number of times.

5. Settle the suspension.
6. Determine the actual rear suspension toe setting.
7. Adjust the rear suspension toe to specification by turning the bolt adjuster (1). For rear

suspension toe specifications, Refer to Wheel Alignment Specifications.

Notice: Refer to Fastener Notice in the Preface section.

Important: The weight of the vehicle must be on a level surface such as an alignment rack and on all four wheels before fully tightening the bolts and nuts that have been partially tightened. Failure to comply with this requirement may adversely affect the ride and handling characteristics of the vehicle.

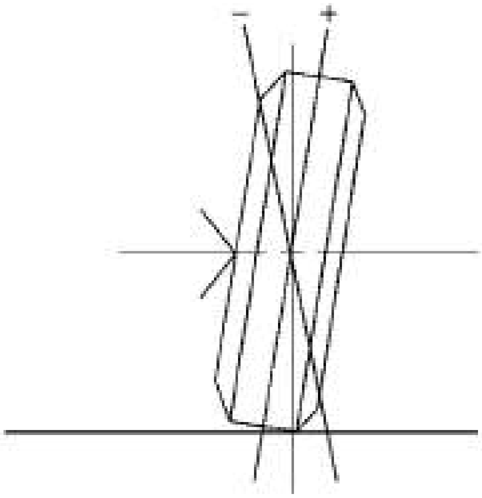
Important: Do not allow the bolt adjuster (1) to turn while tightening the lock nut (2).

8. Tighten the lock nut (2).

   Tighten
   Tighten the nut to 175 N·m (129 lb ft).

9. Verify that the toe is still within specifications. Refer to Wheel Alignment Specifications.
10. Readjust if necessary.

Camber Description



Camber is the tilting of the wheels from the vertical when viewed from the front of the vehicle. When The wheel tilts outward at the top, The camber is positive (+). When the wheel tilts inward at the top the camber is negative (-). The amount of tilt is measured in degrees from the vertical. The camber setting influences the directional control of the vehicle and tyre wear.

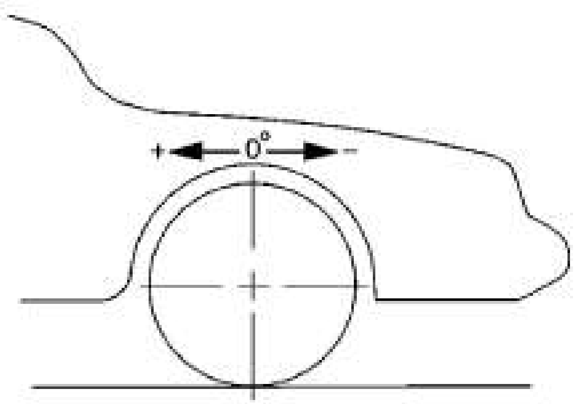
Too much positive camber will result in premature wear on the outside of the tyre and cause excessive wear on the suspension parts.

Too much negative camber will result in premature wear on the inside of the tyre and cause excessive wear on the suspension parts.

Unequal side-to-side camber of 1 degree or more will cause the vehicle to pull or lead to the side with the most positive camber.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Suspension | Wheel Alignment | Description and Operation | **Document ID: 1987828**

Caster Description



Caster is the tilting of the upper most point of the steering axis either forward (-) or backward (+) from vertical when viewed from the side of the vehicle. A backward tilt at the top steering axis point is positive (+) and a forward tilt is negative (-). Measurement is usually expressed as an angle in degrees and minutes. Caster influences directional control of the steering but does not affect tyre wear. Caster is affected by the vehicle ride height, therefore it is important to keep the body at its designed height. Overloading the vehicle or weak or sagging springs will affect caster. When the rear of the vehicle is lower than its designated trim height, the front suspension moves to a more positive caster. If the rear suspension is higher than its designated trim height, the front suspension moves to a less positive caster.

With too little positive caster, steering may be unstable at high speed and wheel returnability may be diminished when coming out of a turn. Too much positive caster can result in excessive steering effort and associated 'wheel fight' and 'kickback'. If one wheel has more positive caster than the other, that wheel will pull toward the center of the vehicle. This condition will cause the vehicle to pull or lead towards the side with the least amount of positive caster.

Lead/Pull Description

At a constant speed on a typical straight road, lead/pull is the amount of effort required at the steering wheel to maintain the vehicles straight path.

Lead/pull is usually caused by the following factors.

- Tyre Construction
- Wheel Alignment
- Unbalanced Steering Gear

The way in which a tyre is built may produce lead/pull.

The rear tyres will not cause lead.

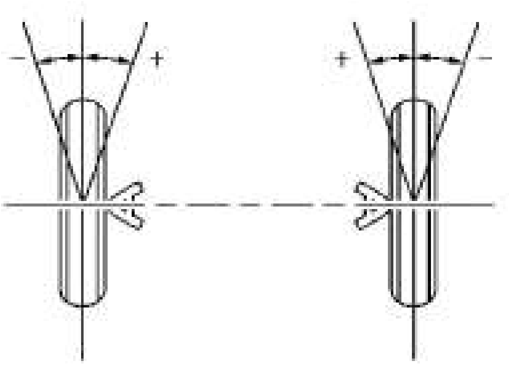
Scrub Radius Description

Ideally the scrub radius is as small as possible normally, the steering axis inclination (SAI) angle and the centerline of the tyre and wheel intersect below the road surface, causing a positive scrub radius. With struts, the SAI angle is much larger than the long arm/short arm type of suspension. This allows the SAI angle to intersect the camber angle above the road surface, forming a negative scrub radius. The smaller the scrub radius, the better the directional stability. Installing aftermarket wheels that have additional offset will dramatically increase scrub radius. The newly installed wheels may cause the centerline of the tyres to move further away from the spindle. This will increase the scrub radius.

A large amount of scrub radius can cause severe shimmy after hitting a bump. Four-Wheel drive vehicles with large tyres use a steering damper to compensate for an increased scrub radius. Scrub radius is not directly measurable by conventional methods. Scrub radius is projected geometrically by engineers during the design phase of the suspension.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Suspension | Wheel Alignment | Description and Operation | **Document ID: 1987832**

Toe Description



Toe is a measurement of how much the front and or rear wheels are turned in or out from a straight ahead position. When the wheels are turned in, toe is positive (+). When the wheels are turned out, toe is negative (-). The actual amount of toe is normally only a fraction of a degree. Toe offsets the small deflections of the wheel support system that occur when the vehicle is rolling forward. In other words, with the vehicle standing still and the wheels set with toe-in, the wheels tend to roll parallel on the road when the vehicle is moving.

Incorrect toe adjustment will cause premature tyre wear and cause steering instability.

Wander Description

Wander is the undesired drifting or deviation of a vehicle to either side from a straight path with hand pressure on the steering wheel. Wander is a symptom of the vehicles sensitivity to external disturbances, such as road camber and cross wind, and accentuated by poor on-centre steering feel.

Transmission Fluid Temperature Sensor Specifications

Temperature	Temperature	Minimum Resistance	Nominal Resistance	Maximum Resistance	Signal
°F	°C	Ω	Ω	Ω	Volts
-40	-40	90636	100707	110778	5.00
-22	-30	47416	52684	57952	4.78
-4	-20	25809	28677	31545	4.34
14	-10	14558	16176	17794	3.89
32	0	8481	9423	10365	3.45
50	10	5104	5671	6238	3.01
68	20	3164	3515	3867	2.56
86	30	2013	2237	2461	1.80
104	40	1313	1459	1605	1.10
122	50	876	973	1070	3.25
140	60	600	667	734	2.88
158	70	420	467	514	2.56
176	80	299	332	365	2.24
194	90	217	241	265	1.70
212	100	159	177	195	1.42
230	110	119	132	145	1.15
248	120	89.9	99.9	109.9	0.87
266	130	69.1	76.8	84.5	0.60
284	140	53.8	59.8	65.8	0.32
302	150	42.5	47.2	51.9	0.00

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 4L60-E/4L65-E/4L70-E | Specifications | Document ID: 2036127

Fastener Tightening Specifications

Description of Usage	Ref No.*	Qty	Size	Specification	
				Metric	English
Accumulator Cover to Case	58	1	M6x1.0x65	8-14 N·m	71-124 lb in
Accumulator Cover to Case	117	1	M6x1.0x65	8-14 N·m	71-124 lb in
Accumulator Cover to Case	118	2	M6x1.0x28.0	8-14 N·m	71-124 lb in
Accumulator Cover to Case	59	2	M6x1.0x35	8-14 N·m	71-124 lb in
Converter Cover Bolt	--	--	--	10 N·m	89 lb in
Converter Housing to Case	94	8	M10x1.5gx45	65-75 N·m	48-55 lb ft
Cooler Pipe Connector	95	2	1/4-18NSPS (SPL)	35-41 N·m	26-30 lb ft
Detent Spring to Valve Body	64	1	M8x1.25x20	20-27 N·m	15-20 lb ft
Extension Housing to Case	32	6	M10x1.5x33.4	42-48 N·m	31-35 lb ft
Extension Housing to Case (4WD Shipping)	N/A	4	M10x1.5x33.4	11-23 N·m	8-17 lb in
Floorshift Control Bolt	--	--	--	10 N·m	89 lb in
Flywheel to Torque Converter Bolt	--	--	--	60 N·m	44 lb ft
Forward Accumulator Cover to Valve Body	364	3	M6x1.0x17.7	8-14 N·m	71-124 lb in
Heat Shield to Transmission Bolt	--	--	--	17 N·m	13 lb ft
Input Speed Sensor Hole Plug to Pump Cover	248	1	M6x1.0x17.7	9-11 N·m	80-97 lb in
Input Speed Sensor to Pump Cover	247	1	M6x1.0x17.7	9-11 N·m	80-97 lb in
Line Pressure Test Hole Plug	39	1	1/8-27NPTF	8-14 N·m	71-124 lb in
Negative Battery Cable Bolt	--	--	--	15 N·m	11 lb ft
Oil Cooler Pipe Fitting	10	2	9/16-18UNF	20 +/- 2 N·m	15 lb ft
Oil Level Indicator Nut	--	--	--	18 N·m	13 lb ft
Oil Passage Cover (Spacer Plate Support) to Case	77	3	M6x1.0x17.7	8-14 N·m	71-124 lb in
Oil Passage Cover (Spacer Plate Support) to Case	115	1	M6x1.0x19.0	8-14 N·m	71-124 lb in
Park Brake Bracket to Case Bolt	--	--	--	27-34 N·m	20-25 lb ft
Park Lock Bracket to Case	87	1	M8x1.25x20	27-34 N·m	20-25 lb ft
Park/Neutral Position Switch Bolts	--	--	--	25 N·m	18 lb ft

Plate to Case (Shipping)	N/A	2	M10x1.5x35	27-34 N·m	20-25 lb ft
Plate to Converter (Shipping)	N/A	1	M10x1.5x25	27-34 N·m	20-25 lb ft
Plate to Converter (Shipping)	N/A	1	M10x1.5x15	27-34 N·m	20-25 lb ft
Pressure Control Solenoid Bracket to Valve Body Bolt	364	1	M6x1.0x17.7	8-14 N·m	71-124 lb in
Pump Assembly to Case	2	7	M8x1.25x60	26-32 N·m	19-24 lb ft
Pump Cover to Pump Body	233	5	M8x1.25x40	20-27 N·m	15-20 lb ft
Range Selector Cable Bolts	--	--	--	25 N·m	18 lb ft
Shift Cable Grommet Screw	--	--	--	1.7 N·m	15 lb in
Shift Control Cable Attachment	--	--	--	20 N·m	15 lb ft
Shift Control Knob Set Screw	--	--	--	2 N·m	18 lb in
Speed Sensor Retainer Bolt	35	1	M6x1.0x15	10.5-13.5 N·m	93-119 lb in
TCC Solenoid Assembly to Case	68	2	M6x1.0x12	8-14 N·m	71-124 lb in
TCM Bracket Nut	--	--	--	6 N·m	53 lb in
Transmission Control Bolts	--	--	--	25 N·m	18 lb ft
Transmission Control Lever Nut	--	--	--	25 N·m	18 lb ft
Transmission Mount to Exhaust Hanger Bracket Bolt	--	--	--	30 N·m	22 lb ft
Transmission Mount Spacer Bolts	--	--	--	65 N·m	48 lb ft
Transmission Mount to Transmission Bolt	--	--	--	65 N·m	48 lb ft
Transmission Mount to Transmission Support Nut	--	--	--	46 N·m	35 lb ft
Transmission Oil Pan to Case Screw	76	16	M8x1.25x19.3	9.5-13.6 N·m	84-120 lb in
Transmission to Engine Bolt	--	--	--	50 N·m	37 lb ft
Valve Body to Case	120	3	M6x1.0x54.4	8-14 N·m	71-124 lb in
Valve Body to Case	62	12	M6x1.0x47.5	8-14 N·m	71-124 lb in
Valve Body to Case	59	2	M6x1.0x35	8-14 N·m	71-124 lb in

* Reference Number refers to the callout number on the disassembled view.

Transmission General Specifications

Transmission General Specifications

Description	Hydra-Matic 4L60-E	Hydra-Matic 4L65-E
RPO Codes	M30	M32
Vehicle Platform (Engine/Transmission) Usage	LE0, LW2/M30	L98/M32
Transmission Drive	Longitudinally-Mounted Rear Wheel Drive	
1st Gear Ratio	3.059:1	
2nd Gear Ratio	1.625:1	
3rd Gear Ratio	1.000:1	
4th Gear Ratio	0.696:1	
Reverse	2.294:1	
Torque Converter Size (Diameter of Torque Converter Turbine)	258 mm (10.6 inch)	300 mm (11.81 inch)
Pressure Taps	Line Pressure	
Transmission Fluid Type	DEXRON® VI	
Transmission Type: 4	Four Forward Gears	
Transmission Type: L	Longitudinal Mount	
Transmission Type: 60/ 65	Product Series	
Transmission Type: E	Electronic Controls	
Position Quadrant	P, R, N, D ,3, 2, 1	
Case Material	Die Cast Aluminum	
Transmission Weight Dry (Approximate)	258 mm Converter 71.6 kg (157.9 lb)	300 mm Converter 79.0 kg (174.2 lb)
Transmission Weight Wet (Approximate)	258 mm Converter 78.8 kg (173.7 lb)	300 mm Converter 88.3 kg (194.7 lb)

Fluid Capacity Specifications

Fluid Capacity

Application	Specification	
	4L60-E	4L65-E
Overhaul	8.4 litres (1.8 Gallons)	10.8 litres(2.4 Gallons)
Pan Removal	4.8 litres (1.05 Gallons)	5.0 litres (1.09 Gallons)

Fluid Pump Rotor and Slide Measurement

Oil Pump Rotor and Slide Measurement

Thickness (mm)	Thickness (in)
Oil Pump Rotor	
17.948-17.961	0.7066-0.7071
17.961-17.974	0.7071-0.7076
17.974-17.987	0.7076-0.7081
17.987-18.000	0.7081-0.7086
18.000-18.013	0.7086-0.7091
Oil Pump Slide	
17.948-17.961	0.7066-0.7071
17.961-17.974	0.7071-0.7076
17.974-17.987	0.7076-0.7081
17.987-18.000	0.7081-0.7086
18.000-18.013	0.7086-0.7091

Line Pressure

Line Pressure

Pressure Control Solenoid Current (Amp)	Approximate Line Pressure (kPa)	Approximate Line Pressure (PSI)
0.00	1,365-1,565	198-227
0.10	1,358-1,558	197-226
0.20	1,303-1,489	189-221
0.30	1,247-1,489	181-216
0.40	1,158-1,413	168-205
0.50	1,061-1,331	154-193
0.60	945-1207	137-175
0.70	786-1076	114-156
0.80	621-910	90-132
0.90	441-724	64-105
1.00	365-586	53-85
1.10	365-469	53-68

Range Reference

Range Reference Table

Range	Park	Reverse	Neutral	OD				D			2		1	
Gear				1st	2nd	3rd	4th	1st	2nd	3rd	1st**	2nd	1st	2nd***
1-2 Shift Solenoid	ON*	ON*	ON*	ON	OFF	OFF	ON	ON	OFF	OFF	ON	OFF	ON	OFF
2-3 Shift Solenoid	ON*	ON*	ON*	ON	ON	OFF	OFF	ON	ON	OFF	ON	ON	ON	ON
2-4 Band	--	--	--	--	A	--	A	--	A	--	--	A	--	A
Reverse Input Clutch	--	A	--	--	--	--	--	--	--	--	--	--	--	--
Overrun Clutch	--	--	--	--	--	--	--	--	--	A	A	A	A	A
Forward Clutch	--	--	--	A	A	A	A	A	A	A	A	A	A	A
Forward Sprag Clutch Assembly	--	--	--	H	H	H	--	H	H	H	H	H	H	H
3-4 Clutch	--	--	--	--	--	A	A	--	--	A	--	--	--	--
Lo/Roller Clutch	--	--	--	H	--	--	--	H	--	--	H	--	H	--
Lo/Rev Clutch	A	A	--	--	--	--	--	--	--	--	--	--	A	--

- A = Applied
- H = Holding
- ON = The solenoid is energised.
- OFF = The solenoid is de-energised.
- *Shift Solenoid state is a function of vehicle speed and may change if the vehicle speed increases sufficiently in Park, Reverse or Neutral. However, this does not affect the operation of the transmission.
- **Manual Second-First gear is electronically prevented under normal operating conditions.
- ***Manual First-Second gear is only available above approximately 48-56 km/h (30-35 mph).

Shift Solenoid Valve State and Gear Ratio

Shift Solenoid Valve State and Gear Ratio 4L60-E

Gear	1-2 Shift Solenoid	2-3 Shift Solenoid	Gear Ratio
1	ON	ON	3.059:1
2	OFF	ON	1.625:1
3	OFF	OFF	1.000:1
4	ON	OFF	0.696:1

Shift Speed

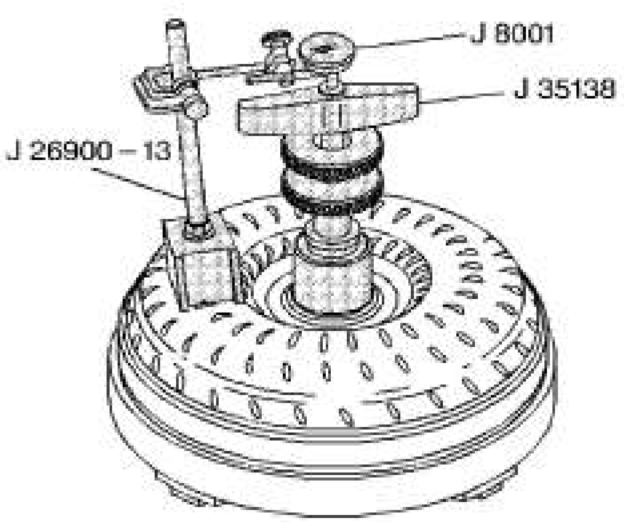
Shift Speed

			1-2 Upshift @ +/- 250 RPM Output Shaft Speed			2-3 Upshift @ +/-250 RPM Output Shaft Speed			3-4 Upshift @ +/- 250 RPM Output Shaft Speed			1-2 Upshift @ WOT +/- 250 RPM, Output Shaft Speed	2-3 Upshift @ WOT +/- 250 RPM, Output Shaft Speed	WOT 3 Downs +/- 1 RPM Outp Shaf Spee
% of TPS			12	25	50	12	25	50	12	25	50			
Trans Cal	Body	Axle	--			--			--			--	--	--
3.6L (LE0,LW2)														
A	S/T	3.42	485	670	1340	800	1250	2500	1200	1910	3625	2000	3750	155
B	S/T	3.73	485	670	1340	800	1250	2500	1200	1910	3625	2000	3750	155
C	S/T	4.10	485	670	1340	800	1250	2500	1200	1910	3625	2000	3750	155
6.0L (L98)														
D	S/T	3.42/3.73	430	650	1100	815	1080	1800	1200	1640	2700	1830	3190	136

Torque Converter End Play Inspection

Tools Required

- J 8001 Dial Indicator Set
- J 26900-13 Magnetic Indicator Base
- J 35138 Converter End Play Checker
- J 39195 Converter End Play Check Tool



1. Inspect the torque converter and replace if any of the following conditions exist:
   - Evidence of damage to the pump assembly.
   - Metal particles are found after flushing the cooler and cooler lines.
   - External leaks in the hub area.
   - Converter pilot is broken, damaged or poor fit into the crankshaft.
   - Converter hub is scored or damaged.
   - Internal damage to the stator.
   - Contamination from engine coolant.
   - Excessive end play.

   Important: The torque converter should not be replaced if the fluid has an odour, discoloration or no evidence of metal or clutch plate material.

   Flushing the torque converter is not recommended.

2. Install the J 35138 , the J 26900-13 and the J 8001 or J 39195 to be used with the 300 mm

torque converter.

Specification

- The end play for a 245 mm torque converter should be 0-0.38 mm (0-0.015 in).
- The end play for a 298 mm torque converter should be 0.1-0.48 mm (0.004-0.019 in).
- The end play for a 258 mm and 300 mm torque converter should be 0.1-0.5 mm (0.004-0.020 in).

3. Remove the tools.

Torque Converter End Play Specifications

Torque Converter End Play Check

Torque Converter Size	Specification
258 mm (10.16 in)	0.1-0.5 mm (0.004-0.020 in)
300 mm (11.81 in)	0.1-0.5 mm (0.004-0.020 in)

Transmission Fluid Pressure Manual Valve Position Switch Logic

TFP Manual Valve Position Switch Logic

Gear Selector Position	Signal A	Signal B	Signal C
Park/Neutral (P or N)	HI	LOW	HI
Reverse (R)	LOW	LOW	HI
Drive 4 (D)	HI	LOW	LOW
Drive 3 (3)	HI	HI	LOW
Drive 2 (2)	HI	HI	HI
Drive 1 (1)	LOW	HI	HI
Invalid	LOW	HI	LOW
	LOW	LOW	LOW

- HI = Ignition voltage
- LOW = 0 voltage

Transmission Range Switch Logic

Transmission Range Switch Logic

Gear Selector Position	Signal A	Signal B	Signal C	Signal P
Park (P)	LOW	HI	HI	LOW
Reverse (R)	LOW	LOW	HI	HI
Neutral (N)	HI	LOW	HI	LOW
Drive 4 (OD)	HI	LOW	LOW	HI
Drive 3 (3)	LOW	LOW	LOW	LOW
Drive 2 (2)	LOW	HI	LOW	HI
Drive 1 (1)	HI	HI	LOW	LOW
HI = Ignition voltage LOW = 0 volts				

Transmission Internal Mode Switch Logic

Gear Selector Position	Signal A	Signal B	Signal C	Signal P
Park (P)	LOW	HI	HI	LOW
Reverse (R)	LOW	LOW	HI	HI
Neutral (N)	HI	LOW	HI	LOW
Drive 4 (D)	HI	LOW	LOW	HI
Drive 3 (3)	LOW	LOW	LOW	LOW
Drive 2 (2)	LOW	HI	LOW	HI
Drive 1 (1)	HI	HI	LOW	LOW
HI = Ignition voltage LOW = 0 volts				

Component Resistance

Component Resistance

Component	Pass/Thru Pins	Resistance at 20°C (68°F)	Resistance at 100°C (212°F)	Resistance to Ground (Case)
1-2 Shift Solenoid Valve	A, E	19-24 Ω	24-31 Ω	Greater than 250 K Ω
2-3 Shift Solenoid Valve	B, E	19-24 Ω	24-31 Ω	Greater than 250 K Ω
TCC Solenoid Valve	T, E	21-26 Ω	26-33 Ω	Greater than 250 K Ω
TCC PWM Solenoid Valve	U, E	10-11 Ω	13-15 Ω	Greater than 250 K Ω
3-2 Shift Solenoid Valve	S, E	20-24 Ω	29-32 Ω	Greater than 250 K Ω
Pressure Control Solenoid Valve	C, D	3-5 Ω	4-7 Ω	Greater than 250 K Ω
*Transmission Fluid Temperature (TFT) Sensor	M, L	3088-3942 Ω	159.3-198.0 Ω	Greater than 10 M Ω
Output Speed Sensor	A, B OSS CONN	1420 Ω @ 25°C	2140 Ω @ 150°C	Greater than 10 M Ω
***Important:** The resistance of this device is necessarily temperature dependent and will therefore vary far more than any other device. Refer to Transmission Fluid Temperature Sensor Specifications.				

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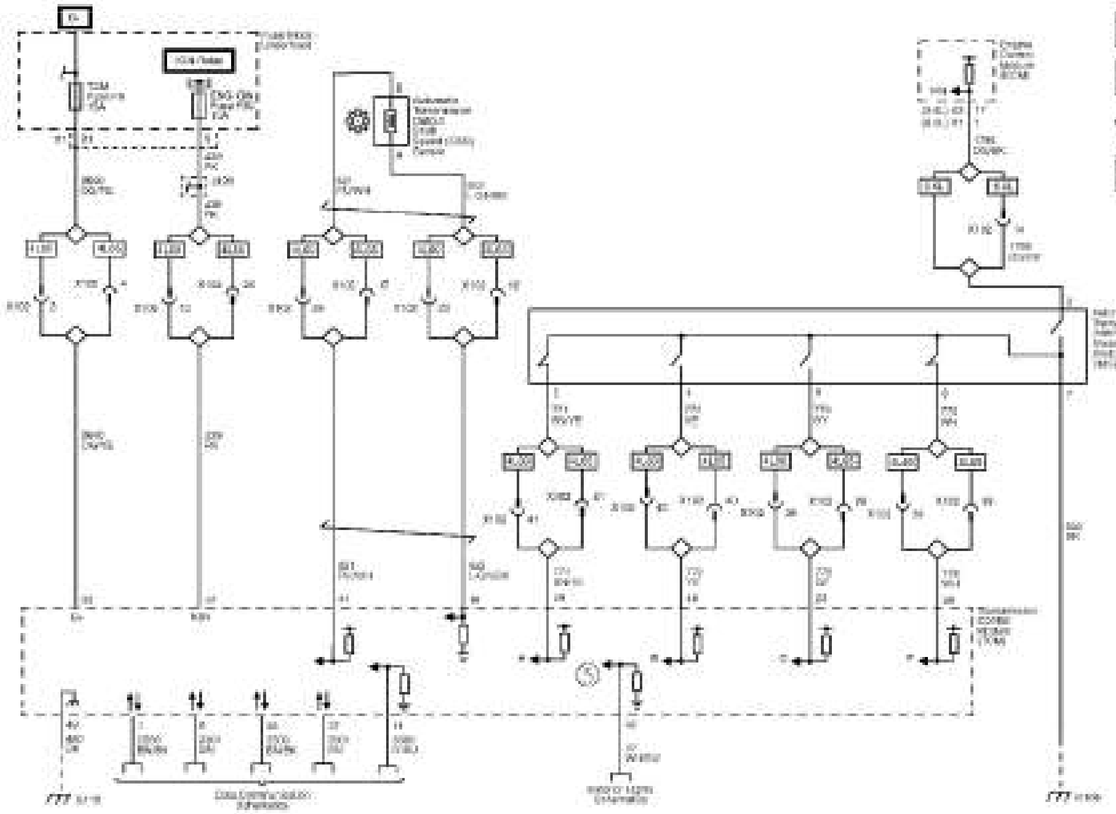
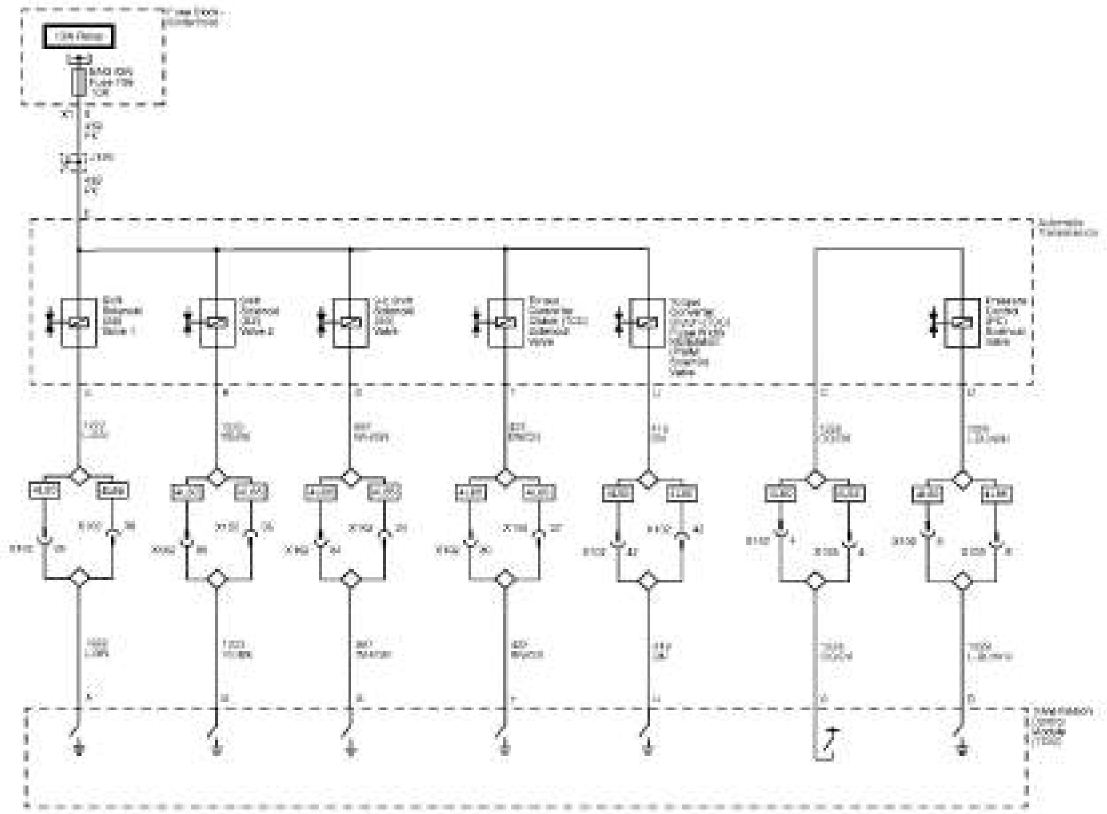
TCM and Transmission, Power, Ground, Serial Data, Inputs and Outputs



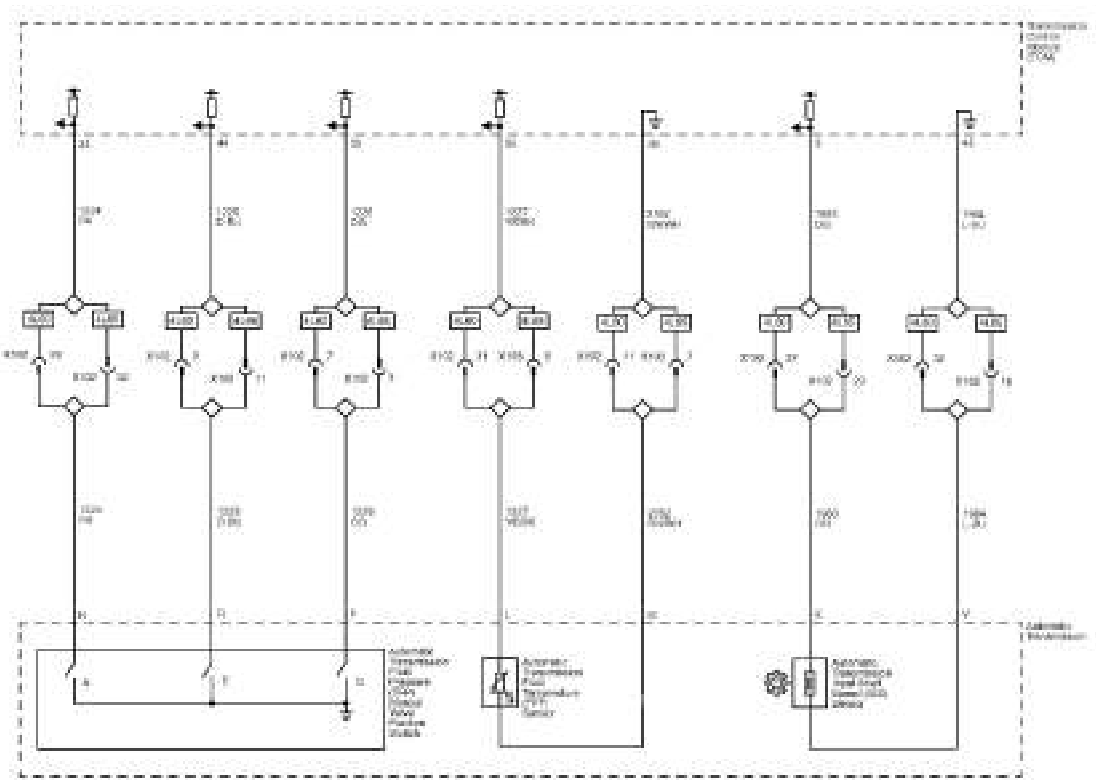
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 4L60-E/4L65-E/4L70-E | Schematic and Routing Diagrams | **Document ID: 2194729**

NSBU Switch and TOSS Sensor

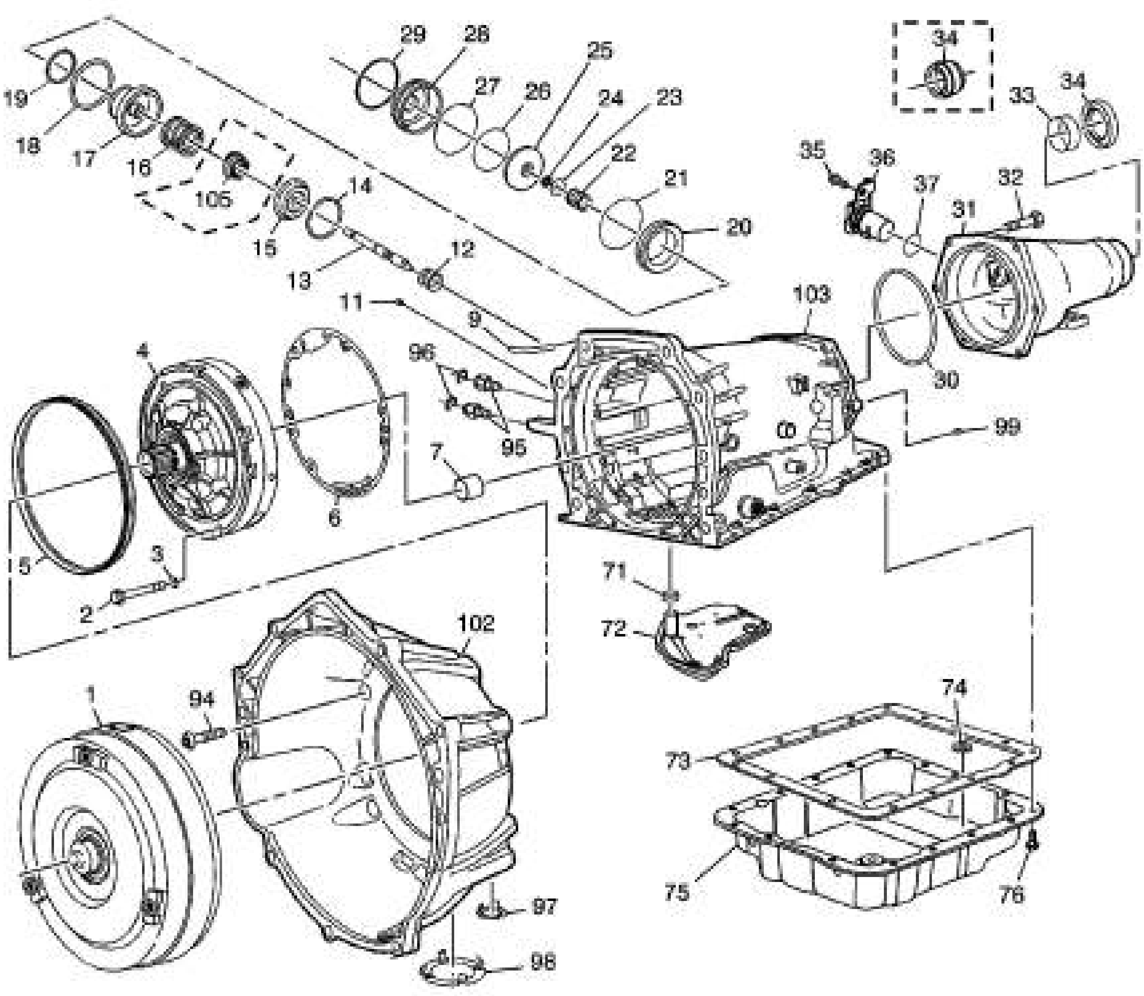


2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 4L60-E/4L65-E/4L70-E | Schematic and Routing Diagrams | Document ID: 2194730

TCM and Transmission, Power, Ground, Serial Data, Inputs and Outputs


Transmission Control Module (TCM)
Automatic Transmission
Automatic Transmission Fluid Pressure (TFP) Manual Valve Position Switch
Automatic Transmission Fluid Temperature (TFT) Sensor
Automatic Transmission Input Shaft Speed (ISS) Sensor

Case and Associated Parts (1 of 2)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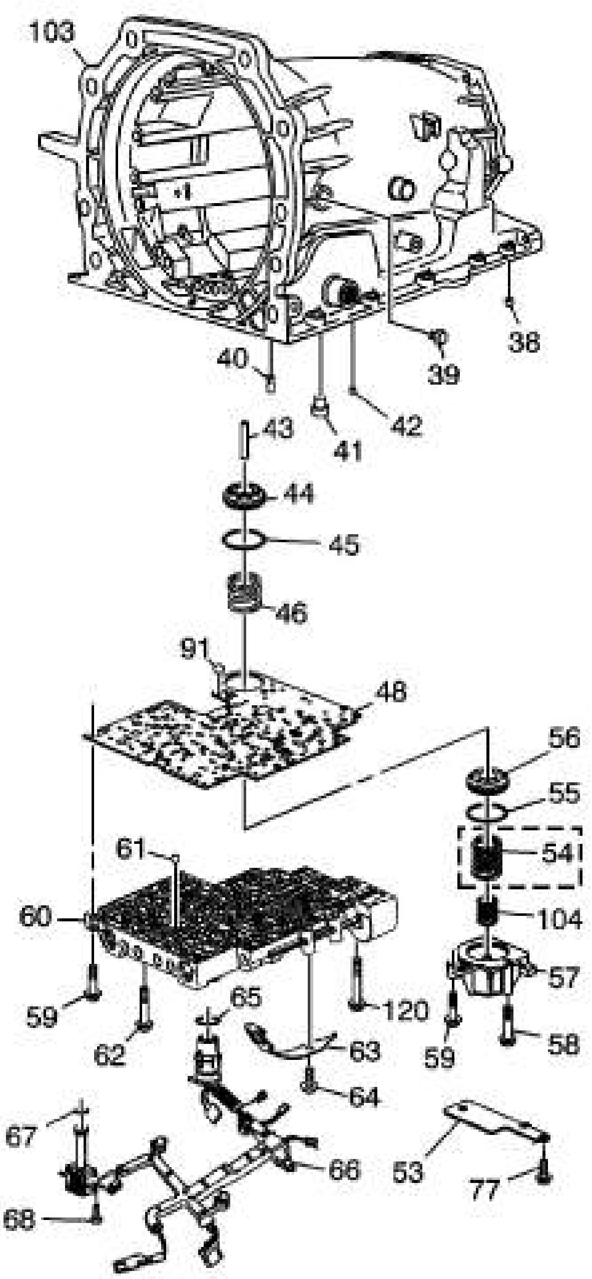
(1) Torque Converter Assembly - Size Model Dependent
(2) Pump to Case Bolt
(3) Pump to Case Bolt O-Ring
(4) Oil Pump Assembly
(5) A/T Fluid Pump Seal - Pump to Case
(6) Pump Cover to Case Gasket
(7) Case Bushing
(9) Transmission Vent Assembly
(11) Case Servo Plug
(12) Servo Return Spring
(13) 2nd Apply Piston Pin

(14) Retainer Ring - 2nd Apply Piston
(15) Servo Cushion Spring Retainer
(16) Servo Cushion Spring - Outer
(17) 2nd Apply Piston
(18) Oil Seal Ring - 2nd Apply Piston - Outer
(19) Oil Seal Ring - 2nd Apply Piston - Inner
(20) Servo Piston Housing - Inner
(21) O-Ring Seal
(22) Servo Apply Pin Spring
(23) Servo Apply Pin Washer
(24) Retainer Ring - Apply Pin
(25) 4th Apply Piston
(26) Oil Seal Ring - 4th Apply Piston - Outer
(27) O-Ring Seal - 2-4 Servo Cover
(28) 2-4 Servo Cover
(29) Servo Cover Retaining Ring
(30) Case Extension to Case Seal
(31) Case Extension - Model Dependent
(32) Case Extension to Case Bolt
(33) Case Extension Bushing
(34) Case Extension Oil Seal Assembly - Model Dependent
(34) Case Extension Oil Seal Assembly - Model Dependent
(35) Speed Sensor Retaining Bolt
(36) Vehicle Speed Sensor (VSS)
(37) O-Ring Seal - VSS to Case Extension
(71) Filter Seal
(72) Transmission Oil Filter Assembly - Model Dependent
(73) Transmission Oil Pan Gasket
(74) Chip Collector Magnet
(75) Transmission Oil Pan - Model Dependent
(76) Transmission Oil Pan Screw
(94) Converter Housing to Case Bolt
(95) Oil Cooler Quick Connector
(96) Oil Cooler Quick Connect Clip
(97) Converter Housing Access Hole Plug - Model Dependent
(98) Converter Bolt Inspection Plate - Model Dependent
(99) Cup D4 Orifice Plug
(102) Converter Housing - Model Dependent
(103) Main Section Case - Model Dependent
(105) Servo Cushion Spring - Inner - Model Dependent

Case and Associated Parts (2 of 2)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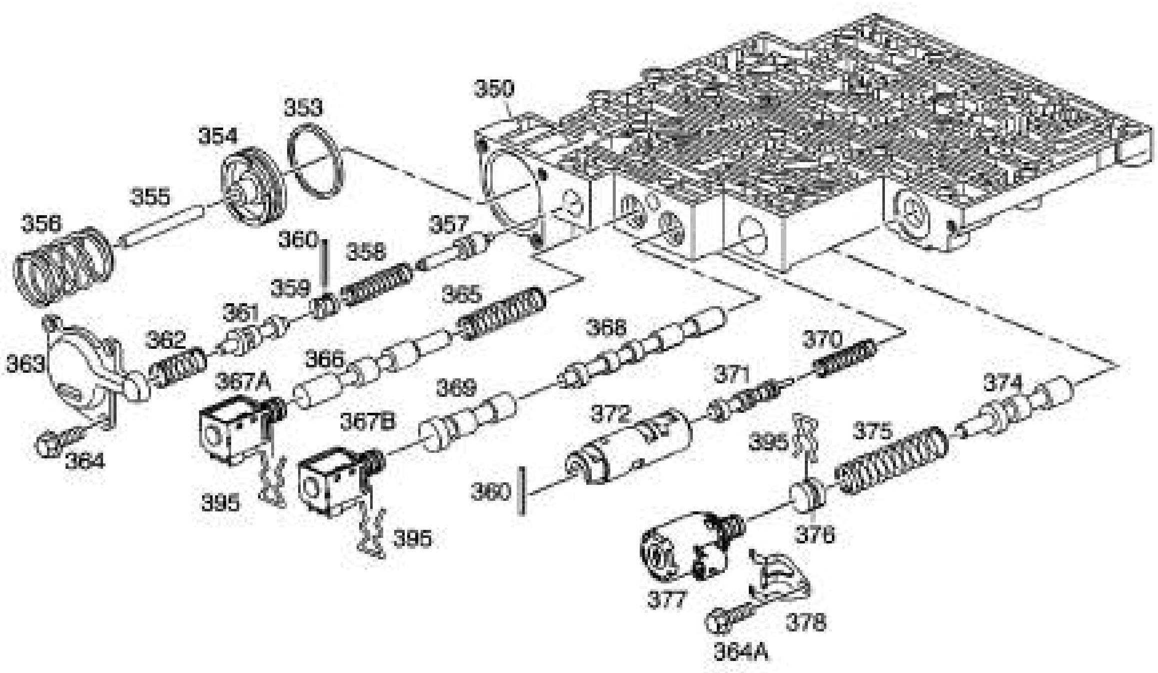
(38) Transmission Case Plug - Accumulator Bleed
(39) Pressure Plug
(40) Third Accumulator (#7) Retainer and Ball Assembly
(41) Band Anchor Pin
(42) Retainer and Ball Assembly - Double Orifice (#10)

(43) Accumulator Piston Pin
(44) 3-4 Accumulator Piston
(45) Oil Seal Ring - 3-4 Accumulator Piston
(46) 3-4 Accumulator Spring - Model Dependent
(48) Valve Body Spacer Plate w/Gasket - Bonded
(53) Spacer Plate Support Plate
(54) 1-2 Accumulator Spring - Outer - Model Dependent
(55) Oil Seal Ring - 1-2 Accumulator
(56) 1-2 Accumulator Piston
(57) 1-2 Accumulator Cover and Pin Assembly - Model Dependent
(58) Accumulator Cover Bolt
(59) Accumulator Cover Bolt
(60) Control Body Valve Assembly - Model Dependent
(61) Checkball (#2, 3, 4, 5, 6, 8, 12)
(62) Valve Body Bolt
(63) Manual Detent Spring Assembly
(64) Manual Detent Spring Bolt
(65) Wiring Harness Pass-Through Connector O-Ring Seal
(66) Wiring Harness Solenoid Assembly - Model Dependent
(67) O-Ring Seal - Solenoid
(68) Hex Washer Head Bolt - Solenoid
(77) Spacer Plate Support Bolt
(77) Spacer Plate Support Bolt
(91) Number 1 Checkball
(103) Main Section Case - Model Dependent
(104) 1-2 Accumulator Spring - Inner
(120) Valve Body Bolt

Control Valve Body Assembly (1 of 2)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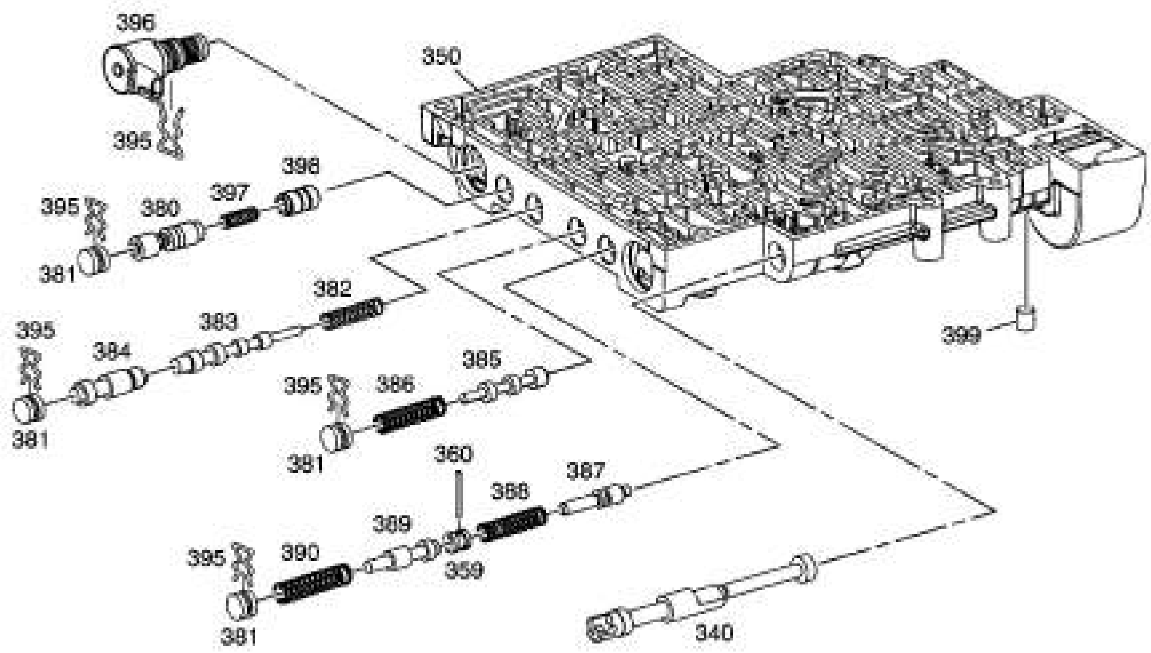
(350) Control Valve Body Assembly
(353) Forward Accumulator Oil Seal
(354) Forward Accumulator Piston
(355) Forward Accumulator Pin
(356) Forward Accumulator Spring
(357) Forward Abuse Valve
(358) Forward Abuse Valve Spring
(359) Bore Plug
(360) Coiled Spring Pin
(360) Coiled Spring Pin
(361) Low Overrun Valve
(362) Low Overrun Valve Spring
(363) Forward Accumulator Cover
(364) Forward Accumulator Cover Bolt
(364a) Pressure Control Solenoid Retainer Bolt
(365) 1-2 Shift Valve Spring - Model Dependent
(366) 1-2 Shift Valve - Model Dependent
(367a) 1-2 Shift Solenoid Valve

(367b) 2-3 Shift Solenoid Valve
(368) 2-3 Shift Valve
(369) 2-3 Shuttle Valve
(370) 1-2 Accumulator Valve Spring
(371) 1-2 Accumulator Valve
(372) 1-2 Accumulator Valve Sleeve
(374) Actuator Feed Limit Valve
(375) Actuator Feed Limit Valve Spring
(376) Bore Plug
(377) Pressure Control Solenoid Valve
(378) Pressure Control Solenoid Retainer
(395) Bore Plug and Solenoid Retainer
(395) Bore Plug and Solenoid Retainer
(395) Bore Plug and Solenoid Retainer

Control Valve Body Assembly (2 of 2)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(340) Manual Valve
(350) Control Valve Body Assembly
(359) Bore Plug
(360) Coiled Spring Pin
(380) Regulator Apply Valve
(381) Bore Plug
(381) Bore Plug
(381) Bore Plug
(381) Bore Plug
(382) 4-3 Sequence Valve Spring
(383) 4-3 Sequence Valve
(384) 3-4 Relay Valve
(385) 3-4 Shift Valve
(386) 3-4 Shift Valve Spring
(387) Reverse Abuse Valve
(388) Reverse Abuse Valve Spring
(389) 3-2 Downshift Valve
(390) 3-2 Downshift Valve Spring

(395) Bore Plug and Solenoid Retainer
(395) Bore Plug and Solenoid Retainer
(395) Bore Plug and Solenoid Retainer
(395) Bore Plug and Solenoid Retainer
(395) Bore Plug and Solenoid Retainer
(395) Bore Plug and Solenoid Retainer
(396) TCC PWM Solenoid Valve
(397) Regulator Apply Spring
(398) Isolator Valve
(399) Pump Ball Check Valve - M33 Only

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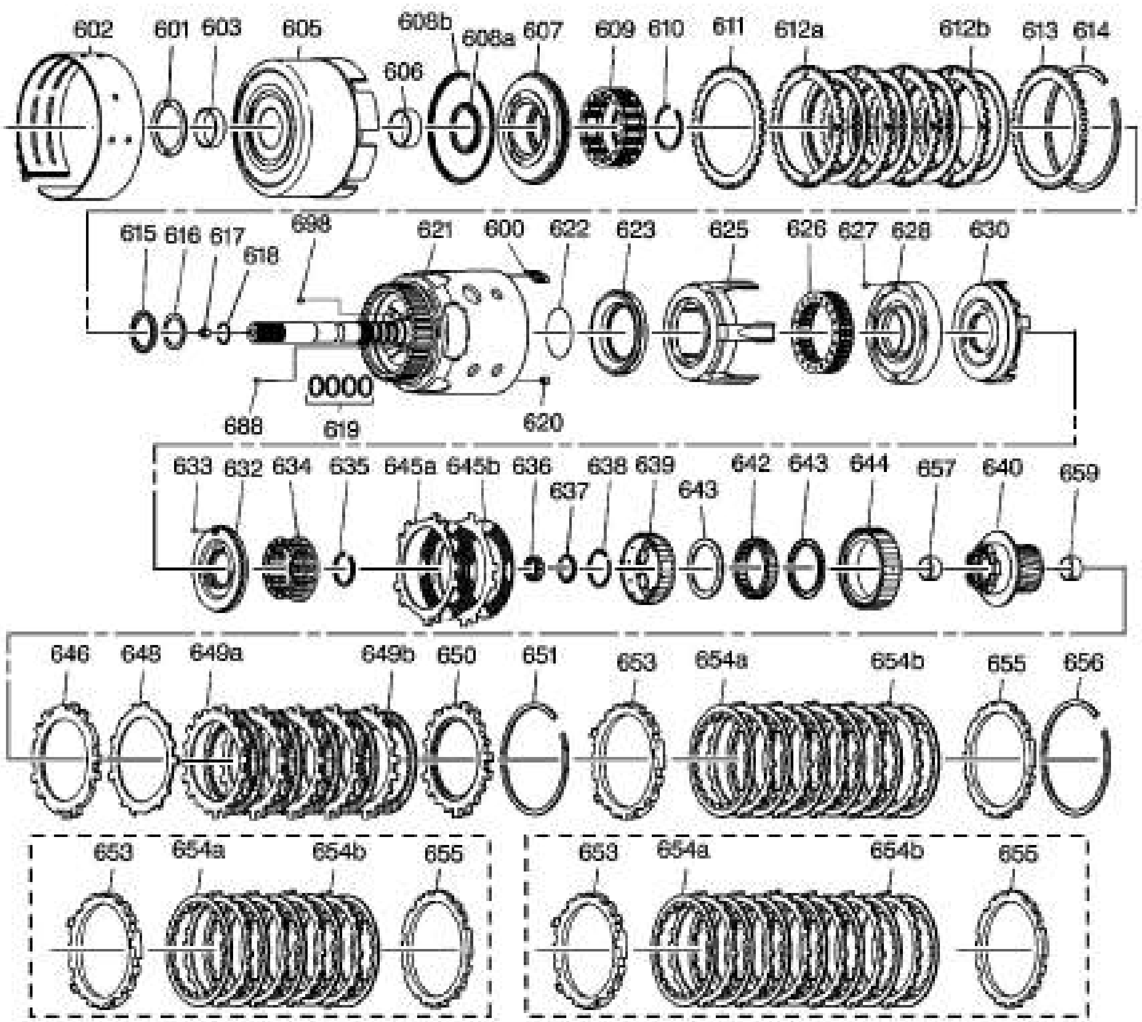
Internal Parts (1 of 2)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(600) 3-4 Clutch Boost (5) Spring Assembly
(601) Thrust Washer - Pump to Drum
(602) 2-4 Band Assembly - Model Dependent
(603) Reverse Input Clutch Bushing - Front
(605) Reverse Input Clutch Housing and Drum Assembly
(606) Reverse Input Clutch Bushing - Rear
(607) Reverse Input Clutch Piston Assembly
(608a) Reverse Input Clutch Seal - Inner
(608b) Reverse Input Clutch Seal - Outer
(609) Reverse Input Clutch Spring Assembly
(610) Reverse Input Clutch Spring Retainer Ring

(611) Reverse Input Clutch Plate - Belleville
(612a) Reverse Input Clutch Turbulator Plate - Steel
(612b) Reverse Input Clutch Plate Assembly - Fiber
(613) Reverse Input Clutch Backing Plate - Selective
(614) Reverse Input Clutch Retaining Ring
(615) Stator Shaft/Selective Washer Bearing Assembly
(616) Thrust Washer - Selective
(617) Check Valve Retainer and Ball Assembly
(618) O-Ring Seal - Location Model Dependent
(619) Oil Seal Ring - Solid
(620) Retainer and Checkball Assembly
(621) Input Housing and Shaft Assembly - Model Dependent
(622) O-Ring Input to Forward Clutch Housing Seal
(623) 3rd and 4th Clutch Piston
(625) 3rd and 4th Clutch Ring - Apply
(626) 3rd and 4th Clutch Spring Assembly
(627) Forward Clutch Housing Retainer and Ball Assembly
(628) Forward Clutch Housing
(630) Forward Clutch Piston
(632) Overrun Clutch Piston
(633) Overrun Clutch Ball
(634) Overrun Clutch Spring Assembly
(635) Overrun Clutch Spring Retainer Snap Ring
(636) Input Housing to Output Shaft Seal
(637) Input Sun Gear Bearing Assembly
(638) Overrun Clutch Hub Retaining Snap Ring
(639) Overrun Clutch Hub
(640) Forward Sprag Clutch Inner Race and Input Sun Gear Assembly
(642) Forward Sprag Assembly
(643) Sprag Assembly Retainer Ring
(643) Sprag Assembly Retainer Ring
(644) Forward Clutch Race - Outer
(645a) Overrun Clutch Plate - Steel
(645b) Overrun Clutch Plate Assembly - Fiber
(646) Forward Clutch Plate - Apply
(648) Forward Clutch Plate - Waved
(649a) Forward Clutch Plate - Steel
(649b) Forward Clutch Plate Assembly - Fiber
(650) Forward Clutch Backing Plate - Selective
(651) Forward Clutch Backing Plate Retainer Ring
(653) 3rd and 4th Clutch Apply Plate - Stepped
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(653) 3rd and 4th Clutch Apply Plate - Stepped
(654a) 3rd and 4th Clutch Plate Assembly - Fiber - Quantity Model Dependent 5, 6 or 7 Plates
(654b) 3rd and 4th Clutch Plate - Steel - Quantity Model Dependent

(655) 3rd and 4th Clutch Backing Plate - Selective - Model Dependent
(655) 3rd and 4th Clutch Backing Plate - Selective - Model Dependent
(655) 3rd and 4th Clutch Backing Plate - Selective - Model Dependent
(656) 3rd and 4th Clutch Backing Plate Retainer Ring
(657) Input Sun Gear Front Bushing
(659) Input Sun Gear Rear Bushing
(688) Cup Plug
(698) Orificed Cup Plug

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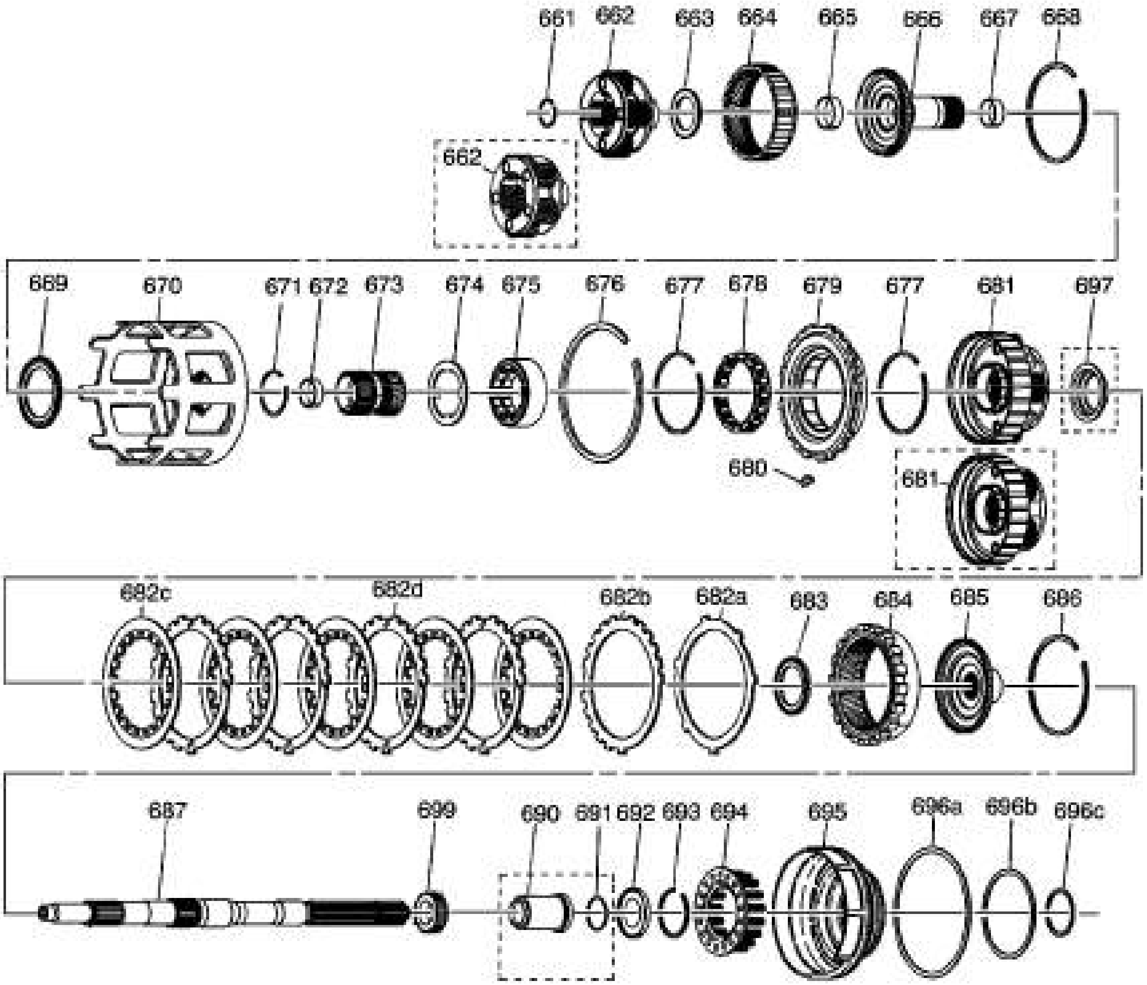
Internal Parts (2 of 2)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(661) Output Shaft to Input Carrier Retainer
(662) Input Carrier Assembly - 4 or 5 Pinion-Model Dependent
(662) Input Carrier Assembly
(663) Thrust Bearing Assembly - Input Carrier to Reaction Shaft
(664) Input Internal Gear
(665) Reaction Carrier Shaft Front Bushing
(666) Reaction Carrier Shaft
(667) Reaction Carrier Shaft Rear Bushing
(668) Reaction Shaft/Internal Gear Retainer Ring
(669) Thrust Bearing Assembly - Reaction Shaft Shell
(670) Reaction Sun Shell

(671) Reaction Sun Gear Retainer Ring
(672) Reaction Sun Bushing
(673) Reaction Sun Gear
(674) Thrust Washer - Race/Reaction Shell
(675) Low and Reverse Roller Clutch Race
(676) Low and Reverse Support to Case Retainer Ring
(677) Low and Reverse Roller Assembly Retainer Ring - Cam
(677) Low and Reverse Roller Assembly Retainer Ring - Cam
(678) Low and Reverse Roller Clutch Assembly
(679) Low and Reverse Clutch Support Assembly
(680) Low and Reverse Clutch Support Retainer Spring
(681) Reaction Carrier Assembly - 4 or 5 Pinion-Model Dependent
(681) Reaction Carrier Assembly - 4 or 5 Pinion-Model Dependent
(682a) Low and Reverse Clutch Plate - Waved
(682b) Spacer Low and Reverse Clutch Plate - Selective
(682c) Low and Reverse Clutch Plate Assembly - Fiber
(682d) Low and Reverse Clutch Turbulator Plate - Steel
(683) Thrust Bearing Assembly - Reaction Carrier/Support
(684) Internal Reaction Gear - Model Dependent
(685) Internal Reaction Gear Support - Model Dependent
(686) Reaction Gear/Support Retainer Ring
(687) Output Shaft - Model Dependent
(690) Output Shaft Sleeve - Model Dependent 2WD only
(691) Output Shaft Seal - Model Dependent 2WD only
(692) Reaction Gear Support to Case Bearing
(693) Low and Reverse Clutch Retainer Ring
(694) Low and Reverse Clutch Spring Assembly
(695) Low and Reverse Clutch Piston
(696a) Low and Reverse Clutch Seal - Outer
(696b) Low and Reverse Clutch Seal - Center
(696c) Low and Reverse Clutch Seal - Inner
(697) Oil Deflector - High Output Models Only
(699) Internal Transmission Speed Sensor Rotor

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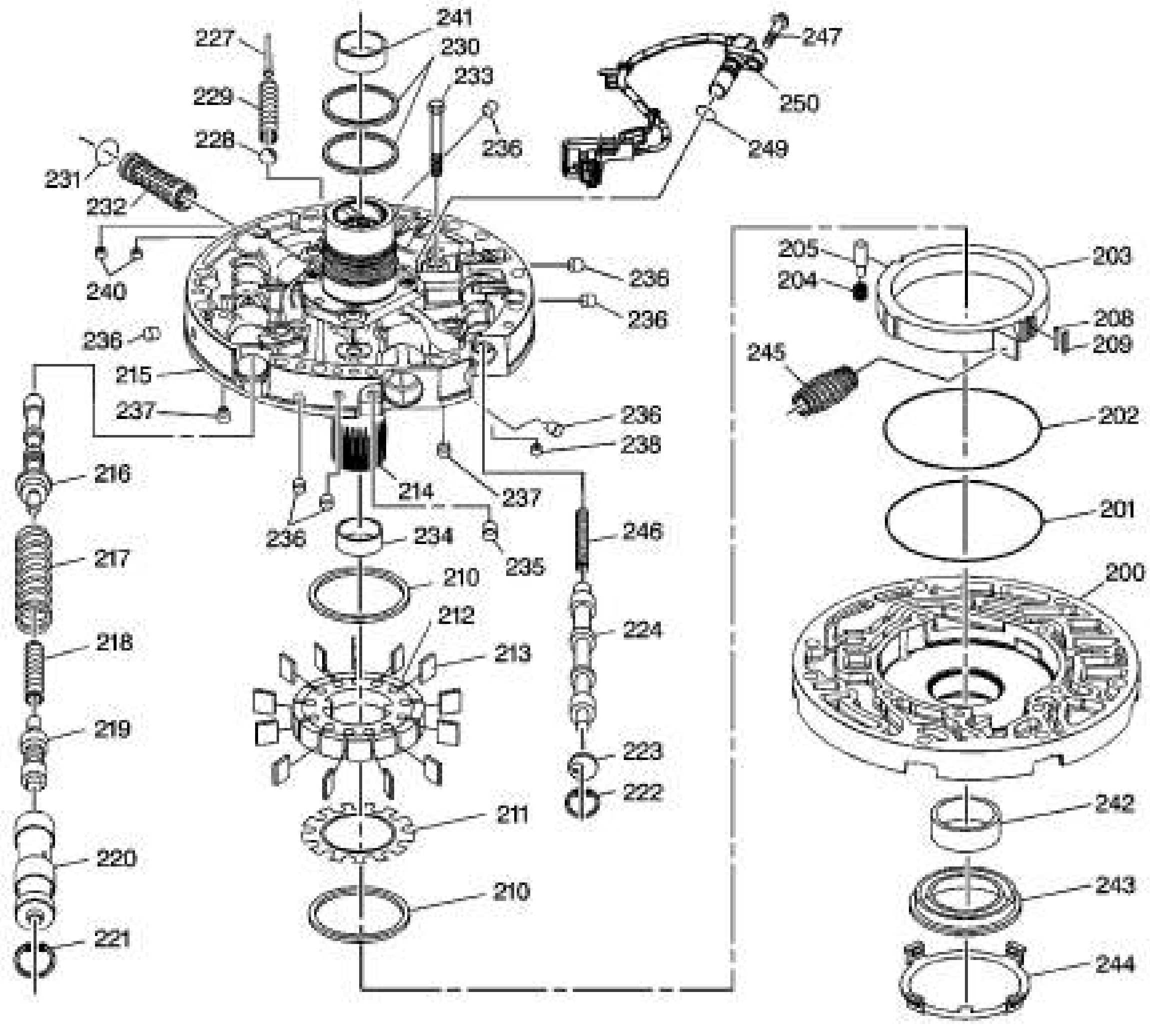
Oil Pump Assembly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(200) Pump Body

(201) Oil Seal Ring - Slide to Wear Plate

(202) O-Ring Seal - Slide Seal Back-Up

(203) Pump Slide

(204) Pivot Pin Spring

(205) Pivot Slide Pin

(208) Pump Slide Seal Support

(209) Pump Slide Seal

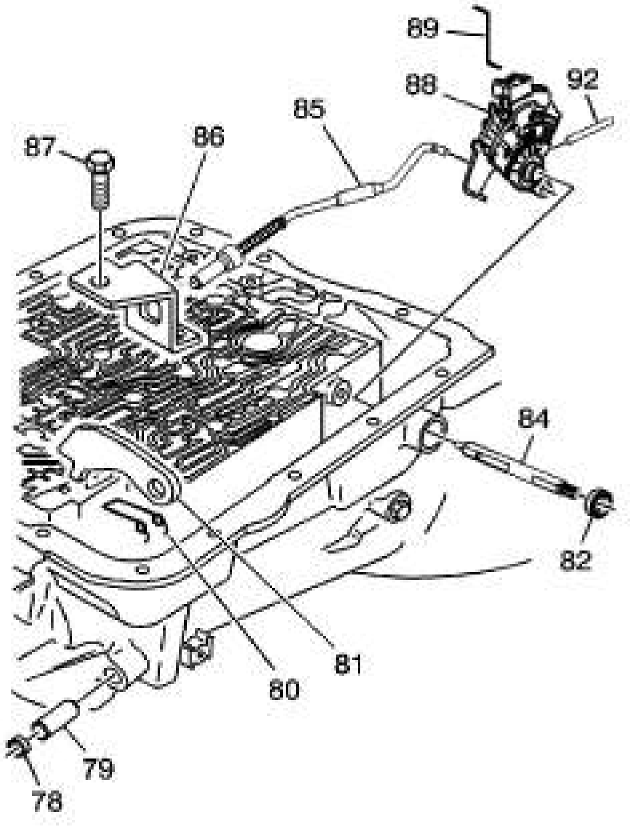
(210) Pump Vane Ring

(210) Pump Vane Ring

(211) Rotor Guide

(212) Oil Pump Rotor
(213) Pump Vane
(214) Stator Shaft
(215) Pump Cover
(216) Pressure Regulator Valve
(217) Pressure Regulator Valve Spring
(218) Pressure Regulator Isolator Spring
(219) Reverse Boost Valve
(220) Reverse Boost Valve Sleeve
(221) Oil Pump Reverse Boost Valve Retaining Ring
(222) Oil Pump Converter Clutch Valve Retaining Ring
(223) Stop Valve
(224) Converter Clutch Valve - Model Dependent
(227) Pressure Relief Bolt Rivet
(228) Pressure Relief Ball
(229) Pressure Relief Spring
(230) Oil Seal Ring - Stator Shaft
(231) Oil Pump Cover Screen Seal
(232) Oil Pump Cover Screen
(233) Bolt M8 X 1.25 X 40 - Cover to Body
(234) Stator Shaft Bushing - Front
(235) Oil Pump Cover Plug - FWD Clutch Feed
(236) Oil Pump Cover Plug
(236) Oil Pump Cover Plug
(236) Oil Pump Cover Plug
(236) Oil Pump Cover Plug
(236) Oil Pump Cover Plug
(236) Oil Pump Cover Plug
(237) Check Valve Retainer and Ball Assembly
(237) Check Valve Retainer and Ball Assembly
(238) Converter Clutch Signal Orifice - Cup Plug
(240) Cup Orifice Plug
(241) Stator Shaft Bushing - Rear
(242) Pump Body Bushing
(243) Oil Seal Assembly
(244) Fluid Seal Retainer
(245) A/T Fluid Pump Slide Outer Spring
(246) Converter Clutch Valve Spring
(247) A/T ISS Attaching Bolt - Model Dependent
(249) O-ring
(250) A/T Input Speed Sensor (ISS) Assembly

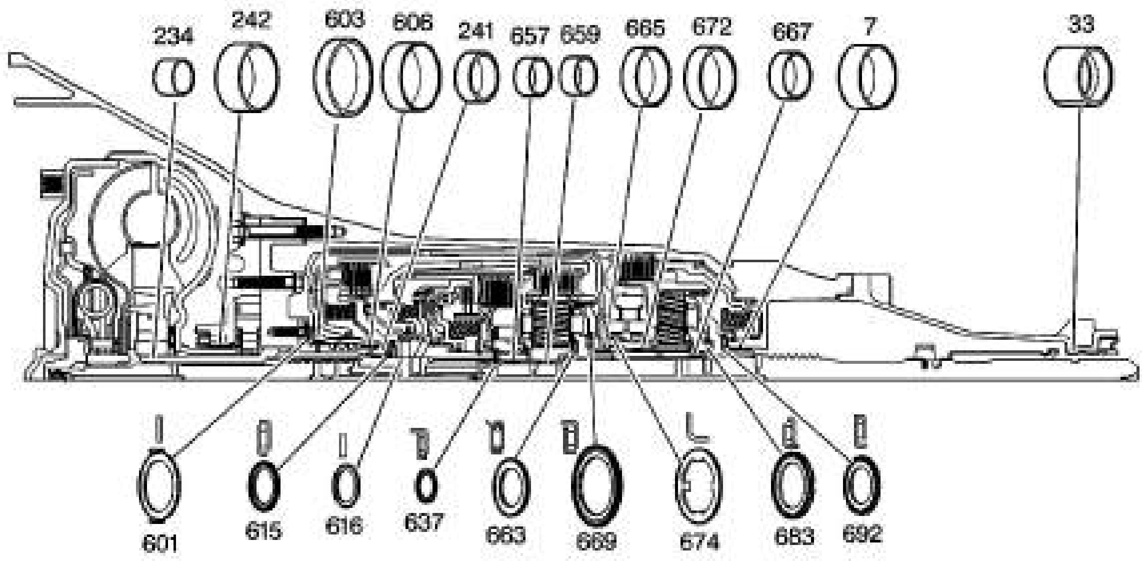
Parking Lock and Manual Shift Detent Lever with Shaft Position Switch Assembly



(78) Steel Cup Plug
(79) Parking Brake Pawl Shaft
(80) Parking Pawl Return Spring
(81) Parking Brake Pawl
(82) Manual Shaft Seal
(84) Manual Shaft - Model Dependent
(85) Parking Lock Actuator Assembly
(86) Parking Lock Bracket
(87) Parking Lock Bracket Bolt
(88) Manual Shift Detent Lever with Shaft Position Switch Assembly
(89) Manual Valve Link
(92) Manual Shift Detent Lever Hub Pin

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 4L60-E/4L65-E/4L70-E | Component Locator | **Document ID: 1960192**

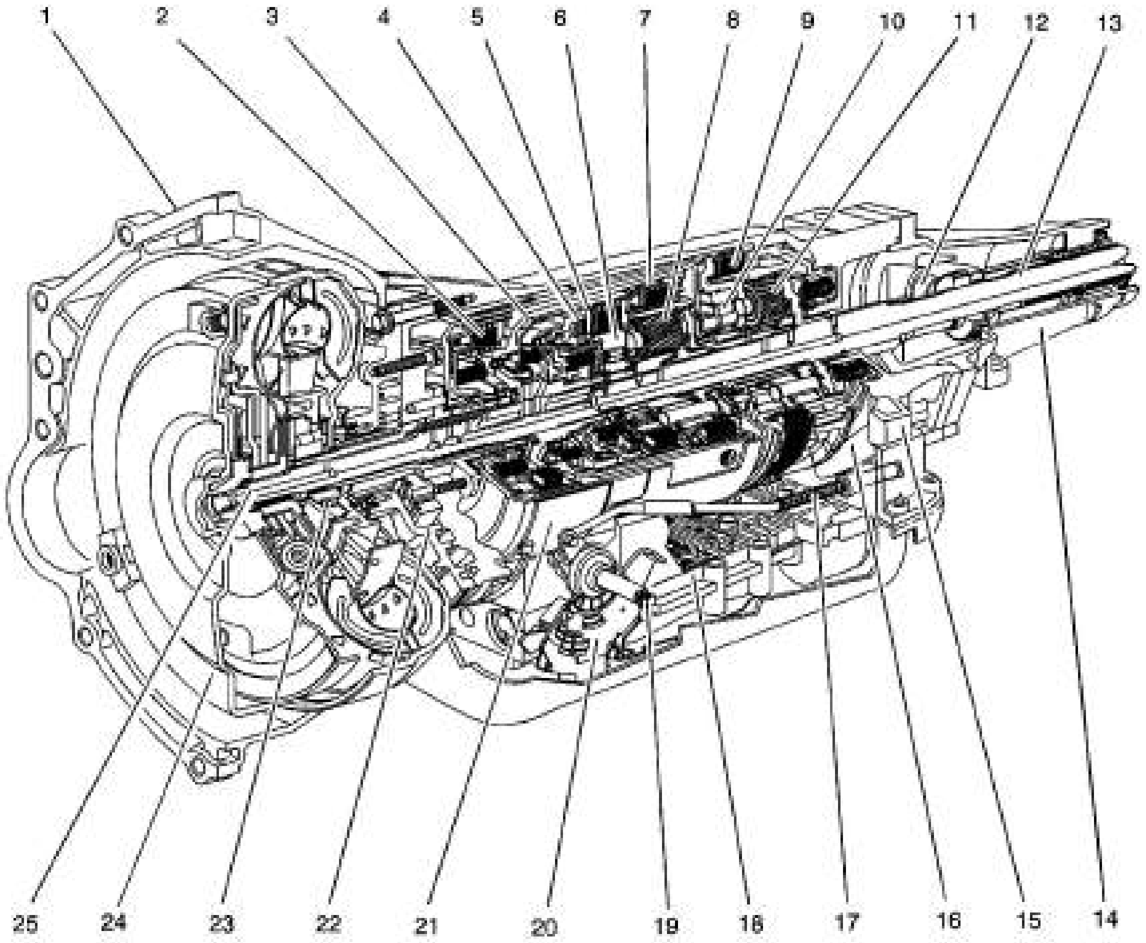
Bearings and Bushings



(7) Case Bushing
(33) Case Extension Bushing
(234) Stator Shaft Bushing - Front
(241) Stator Shaft Bushing - Rear
(242) Oil Pump Body Bushing
(601) Thrust Washer - Pump to Drum
(603) Reverse Input Clutch Bushing - Front
(606) Reverse Input Clutch Bushing - Rear
(615) Stator Shaft/Selective Washer Bearing Assembly
(616) Thrust Washer - Selective
(637) Input Sun Gear Bearing Assembly
(657) Input Sun Gear Bushing - Front
(659) Input Sun Gear Bushing - Rear
(663) Thrust Bearing Assembly - Input Carrier to Reaction Shaft
(665) Reaction Carrier Shaft Bushing - Front
(667) Reaction Carrier Shaft Bushing - Rear
(669) Thrust Washer - Reaction Shaft/Shell
(672) Reaction Gear Bushing

(674) Thrust Washer - Race/Reaction Shell
(683) Thrust Bearing Assembly - Reaction Carrier/Support
(692) Reaction Gear Support to Case Bearing

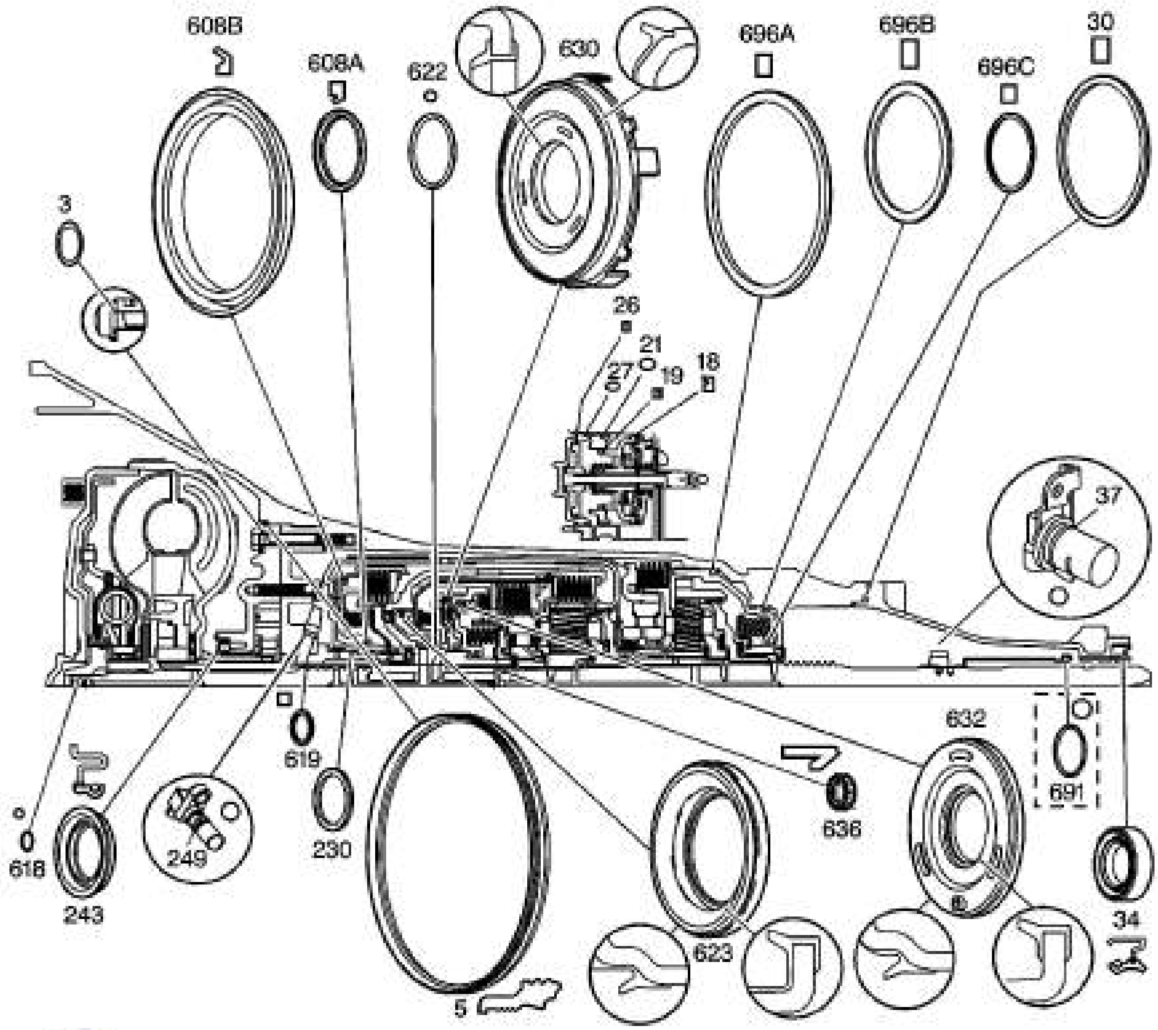
Components



(1) Converter Housing
(2) Reverse Input Clutch
(3) Input Clutch Housing
(4) Overrun Clutch
(5) Forward Clutch
(6) Forward Sprag Clutch Assembly
(7) 3-4 Clutch
(8) Input Planetary Gear Set
(9) Lo and Reverse Clutch
(10) Lo Roller Clutch Assembly
(11) Reaction Planetary Gear Set

(12) Speed Sensor
(13) Output Shaft
(14) Case Extension
(15) Main Section Case
(16) Parking Pawl
(17) Parking Lock Actuator Assembly
(18) Control Valve Assembly
(19) Manual Shaft
(20) Manual Shift Detent Lever with Shaft Position Switch Assembly
(21) 2-4 Band Assembly
(22) Pump Assembly
(23) Stator Roller Clutch
(24) Torque Converter Assembly
(25) Turbine Shaft

Seals


608B
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696A
696B
696C
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(3)	Pump to Case Bolt O-Ring
(5)	Oil Seal - Pump to Case
(18)	Oil Seal Ring - 2nd Apply Piston-Outer
(19)	Oil Seal Ring - 2nd Apply Piston-Inner
(21)	O-Ring Seal
(26)	Oil Seal Ring - 4th Apply Piston-Outer
(27)	O-Ring Seal - 2-4 Servo Cover
(30)	Case Extension to Case Seal
(34)	Case Extension Oil Seal Assembly - Model Dependent
(37)	O-Ring Seal - Speed Sensor to Case Extension - Model Dependent
(230)	Oil Seal Ring - Stator Shaft

(243) Oil Seal Assembly
(249) Input Seed Sensor, or Input Speed Sensor Hole Plug O-ring - Model Dependent
(608a) Reverse Input Clutch Seal - Inner
(608b) Reverse Input Clutch Seal - Outer
(618) O-Ring Seal - Turbine Shaft/Selective Washer
(619) Oil Seal Ring - Solid
(622) O-Ring Input to Forward Housing Seal
(623) 3rd and 4th Clutch Piston
(630) Forward Clutch Piston
(632) Overrun Clutch Piston
(636) Input Housing to Output Shaft Seal
(691) Output Shaft - Model Dependent Seal
(696a) Low and Reverse Clutch - Outer Seal
(696b) Low and Reverse Clutch - Center Seal
(696c) Low and Reverse Clutch - Inner Seal

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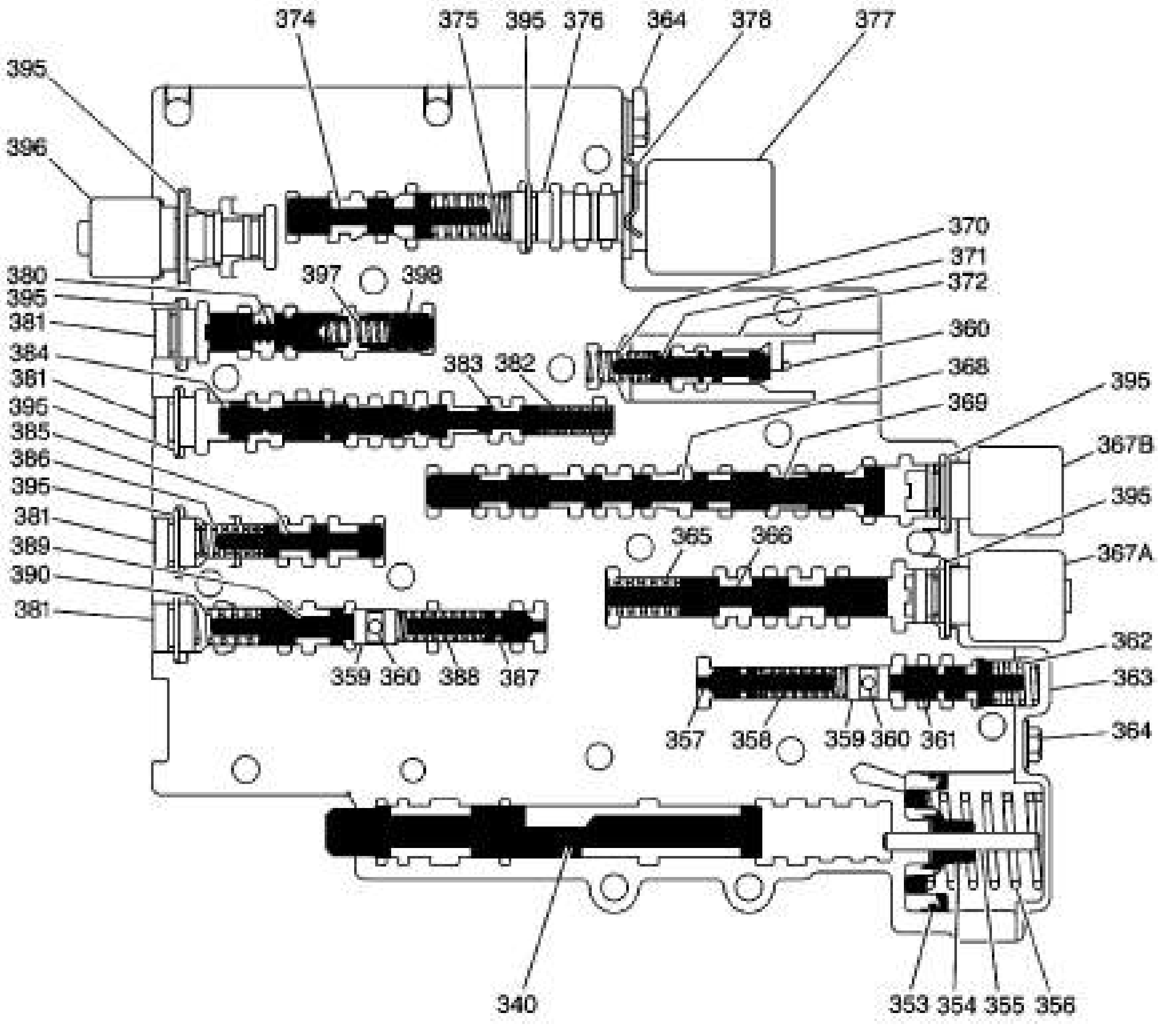
Valve Trains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367A
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(340)	Manual Valve
(353)	Forward Accumulator Oil Seal
(354)	Forward Accumulator Piston
(355)	Forward Accumulator Pin
(356)	Forward Accumulator Spring
(357)	Forward Abuse Valve
(358)	Forward Abuse Valve Spring
(359)	Bore Plug
(360)	Coiled Spring Pin
(361)	Low Overrun Valve
(362)	Low Overrun Valve Spring

(363) Forward Accumulator Cover
(364) Forward Accumulator Cover Bolt
(365) 1-2 Shift Valve Spring - Model Dependent
(366) 1-2 Shift Valve - Model Dependent
(367a) 1-2 Shift Solenoid Valve
(367b) 2-3 Shift Solenoid Valve
(368) 2-3 Shift Valve
(369) 2-3 Shuttle Valve
(370) 1-2 Accumulator Valve Spring
(371) 1-2 Accumulator Valve
(372) 1-2 Accumulator Valve Sleeve
(374) Actuator Feed Limit Valve
(375) Actuator Feed Limit Valve Spring
(376) Bore Plug
(377) Pressure Control Solenoid Valve
(378) Pressure Control Solenoid Retainer
(380) Regulator Apply Valve - Model Dependent
(381) Bore Plug
(382) 4-3 Sequence Valve Spring
(383) 4-3 Sequence Valve
(384) 3-4 Relay Valve
(385) 3-4 Shift Valve
(386) 3-4 Shift Valve Spring
(387) Reverse Abuse Valve
(388) Reverse Abuse Valve Spring
(389) 3-2 Downshift Valve
(390) 3-2 Downshift Valve Spring
(395) Bore Plug and Solenoid Retainer
(396) TCC PWM Solenoid Valve
(397) Regulator Apply Spring
(398) Isolator Valve

Diagnostic Starting Point - Automatic Transmission

Begin the system diagnosis with Diagnostic System Check - Vehicle . The Diagnostic System Check provides the following information:

- The identification of the control modules which commands the system.
- The ability of the control modules to communicate through the serial data circuit.
- The identification and status of stored diagnostic trouble codes (DTCs).

The use of Diagnostic System Check - Vehicle , identifies the correct procedure for diagnosing the system and where the procedure is located.

Symptoms

When it has been determined through Diagnostic System Check - Vehicle , that no DTCs are present, begin symptom diagnosis by reviewing the Transmission Component and System Description . Reviewing Transmission Component and System Description . information enables you to understand the operation of the system. This helps you determine if the condition described by the customer is normal or if a malfunction exists. If it is determined that a malfunction exists, identify the concern by referring to the Symptoms - Automatic Transmission . The Symptoms - Automatic Transmission provides common diagnostic categories which relate directly to diagnostic information or procedures.

Scan Tool Data Definitions

1-2 Shift Error: This parameter displays the difference between the desired 1-2 shift time and the actual 1-2 shift time. A positive number indicates a firm or fast shift, the actual shift time was shorter than the desired shift time. A negative number indicates a soft or slow shift, the actual shift time was longer than the desired shift time. This value is only accurate if the shift was adaptable.

1-2 Shift Time: This parameter displays the actual time of the last 1-2 shift. The shift time is based on the engine RPM drop after the commanded 1-2 shift. This value is only accurate if the shift was adaptable.

1-2 Sol.: This parameter displays the commanded state of the 1-2 shift solenoid valve. When the transmission is in FIRST and FOURTH gear, the display should indicate ON, current is flowing through the solenoid. When the transmission is in SECOND and THIRD gear, the display should indicate OFF, current is not flowing through the solenoid.

1-2 Sol. Open/Short to GND: This parameter displays whether an open or a short to ground exists in the 1-2 shift solenoid valve feedback signal and displays Yes or No. The 1-2 shift solenoid valve must be commanded OFF for this parameter to be valid.

1-2 Sol. Short to Volts: This parameter displays if a short to voltage exists in the 1-2 shift solenoid valve feedback signal. This parameter is valid only when the 1-2 shift solenoid valve is commanded ON. The scan tool will display YES or NO.

1-2 Tap Cell (4-16): This parameter displays the amount of transmission adaptive pressure (TAP), based on 17 N·m (12.5 lb ft) of engine torque increment per cell, added to or subtracted from shift pressure during a 1-2 up shift. A positive number indicates that long shifts have been detected and PC solenoid pressure has been added in order to decrease shift time. A negative number indicates that short shifts have been detected and PC solenoid pressure has been subtracted in order to increase shift time.

2-3 Shift Error: This parameter displays the difference between the desired 2-3 shift time and the actual 2-3 shift time. A positive number indicates a firm or fast shift, the actual shift time was shorter than the desired shift time. A negative number indicates a soft or slow shift, the actual shift time was longer than the desired shift time. This value is only accurate if the shift was adaptable.

2-3 Shift Time: This parameter displays the actual time of the last 2-3 shift. The shift time is based on the engine RPM drop after the commanded 2-3 shift. This value is only accurate if the shift was adaptable.

2-3 Sol.: This parameter displays the commanded state of the 2-3 shift solenoid valve. When the transmission is in FIRST and SECOND gear the display should indicate ON, current is not flowing through the solenoid. When the transmission is in THIRD and FOURTH gear, the display should indicate OFF, current is flowing through the solenoid.

2-3 Sol. Open/Short to GND: This parameter displays whether an open or a short to ground exists in the 2-3 shift solenoid valve feedback signal and displays Yes or No. The 2-3 shift solenoid valve must be commanded OFF for this parameter to be valid.

2-3 Sol. Short to Volts: This parameter displays if a short to voltage exists in the 2-3 shift solenoid valve feedback signal. This parameter is valid only when the 2-3 shift solenoid valve is commanded ON. The scan tool will display YES or NO.

2-3 Tap Cell (4-16): This parameter displays the amount of transmission adaptive pressure (TAP), based on 17 N·m (12.5 lb ft) of engine torque increment per cell, added to or subtracted from shift pressure during a 2-3 up shift. A positive number indicates that long shifts have been detected and PC solenoid pressure has been added in order to decrease shift time. A negative number indicates that short shifts have been detected and PC solenoid pressure has been subtracted in order to increase shift time.

3-2 Downshift Sol.: This parameter displays if the 3-2 shift solenoid valve assembly is currently commanded ON or OFF. The solenoid commanded state is based on the transmission temperature. The solenoid will change states during a 3-2 downshift to regulate the appropriate pressure. The commanded state of the solenoid occurs at approximately 30 mph with a throttle increase. The scan tool displays ON or OFF.

3-2 Sol. Open/Short to GND: This parameter displays whether an open or a short to ground exists in the 3-2 shift solenoid valve feedback signal and displays Yes or No. The 3-2 shift solenoid valve must be commanded OFF for this parameter to be valid.

3-2 Sol. Short to Volts: This parameter displays if a short to voltage exists in the 3-2 shift solenoid valve feedback signal. This parameter is valid only when the 3-2 shift solenoid valve is commanded ON. The scan tool will display YES or NO.

3-4 Shift Error: This parameter displays the difference between the desired 3-4 shift time and the actual 3-4 shift time. A positive number indicates a firm or fast shift, the actual shift time was shorter than the desired shift time. A negative number indicates a soft or slow shift, the actual shift time was longer than the desired shift time. This value is only accurate if the shift was adaptable.

3-4 Shift Time: This parameter displays the actual time of the last 3-4 shift. The shift time is based on the engine RPM drop after the commanded 3-4 shift. This value is only accurate if the shift was adaptable.

Calc. Throttle Position: This parameter displays a calculated value, which is determined by the accelerator pedal position and the actual throttle position, used to optimize transmission controls. It represents the driver's intended request for torque or acceleration. The range is 0-100 percent, where 0 percent represents an idle or coast request and 100 percent represents a request for wide open throttle (WOT).

Commanded Gear: This parameter displays the current commanded state of the shift solenoid valves. The scan tool displays 1, 2, 3, 4 or 5.

Current TAP Cell: This parameter displays the current transmission adaptive pressure (TAP) cell in use for transmission line pressure adaptation. The cells are based on 17 N·m (12.5 lb ft) of engine torque. The higher the engine torque, the higher the current TAP cell. The last cell used will remain displayed until the next adaptable up shift occurs.

ECT: This parameter displays the input signal from the ECT sensor. Engine coolant temperature is high at 151°C (304°F) when the signal voltage is low (0 volts). Engine coolant temperature is low at -40°C (-40°F) when the signal voltage is high (5 volts).

Engine Speed: This parameter displays the rotational speed of the engine expressed as revolutions per minute.

Engine Torque: This parameter displays a calculated value based on engine load, throttle position, mass air flow, and other engine inputs. This parameter is accurate to within 15 ft/lb of actual measured engine torque.

Estimated Gear Ratio: This parameter displays the estimated turbine speed divided by the transmission output speed. Estimated turbine speed is calculated from engine speed and engine torque.

Ignition Voltage: This parameter displays the system voltage measured at the ignition feed.

Last Shift Time: This parameter displays the actual time of the last up shift. This value is only accurate if the shift was adaptable.

PC Sol. Actual Current: This parameter displays the actual current flow through the pressure control solenoid circuit which is measured by the control module. High current flow results in low line pressure. Low current flow results in high line pressure.

PC Solenoid Duty Cycle: This parameter displays the commanded state of the pressure control solenoid expressed as a percentage of energised ON time. A reading of low percent indicates zero ON time, non energised, or no current flow. A high percent at idle indicates maximum ON time, energised, or high current flow.

PC Sol. Ref. Current: This parameter displays the commanded current of the pressure control solenoid circuit. High current results in low line pressure. Low current results in high line pressure.

Speed Ratio: This parameter displays the calculated speed ratio of the transmission. The ratio is calculated by dividing the output speed sensor signal by the input speed sensor signal. Gear ratio in a step-gear transmission is calculated in the opposite manner.

TCC Brake Switch: This parameter displays the status of the TCC brake switch circuit input. OPEN indicates a zero voltage input, brake pedal applied. CLOSED indicates a voltage input, brake pedal released. The scan tool display OPEN or CLOSED.

TCC Duty Cycle: This parameter displays the commanded percentage of ON time of the TCC PWM solenoid. A high percentage represents an ON, energised, commanded state. Zero percent represents an OFF, non-energised, commanded state.

TCC Duty Cycle Open/Short to GND: This parameter displays whether an open or a short to ground exists in the torque converter clutch (TCC) pulse width modulation (PWM) solenoid valve feedback signal and displays Yes or No. The TCC PWM solenoid valve must be commanded OFF for this parameter to be valid. The scan tool will display Yes only while the TCC PWM solenoid valve is OFF. The display will pulsate.

TCC Duty Cycle Short to Volts: This parameter displays whether a short to voltage, exists in the TCC PWM solenoid valve feedback signal and displays Yes or No. The TCC PWM solenoid valve must be commanded ON for this parameter to be valid. The scan tool will display Yes only while the TCC PWM solenoid valve is ON. The display will pulsate.

TCC Enable Sol.: This parameter displays the commanded state of the TCC solenoid. Yes indicates a commanded energised state, current is flowing through the solenoid. No indicates a commanded non-energised state, current is not flowing through the solenoid. This commanded state occurs at various vehicle speeds between applications. The scan tool displays Yes or No.

TCC Enable Open/Short to GND: This parameter displays whether an open or a short to ground exists in the TCC solenoid valve feedback signal. This parameter is valid only when the TCC solenoid is commanded OFF. The scan tool displays Yes or No.

TCC Enable Short to Volts: This parameter displays whether a short to voltage exists in the TCC solenoid valve feedback signal. This parameter is valid only when the TCC solenoid is commanded ON. The scan tool displays Yes or No.

TCC Slip Speed: This parameter displays the difference between transmission output speed and engine speed. A negative value indicates that the engine speed is less than the output speed, deceleration. A positive value indicates that the engine speed is greater than the output speed, acceleration. A value of zero indicates that the engine speed is equal to the output speed, TCC applied.

TFP Sw.: This parameter displays Park/Neutral, Reverse, Drive4, Drive3, Drive2, Drive1 or Invalid. This parameter is the decoded status of the three A/B/C inputs from the automatic transmission fluid pressure manual valve position switch. If a valid combination of inputs is not detected, invalid will be displayed.

TFP Sw. A/B/C: This parameter displays HI/LOW, HI/LOW, HI/LOW. This parameter indicates the status of the three inputs from the Automatic Transmission Fluid Pressure Manual Valve Position Switch Assembly. LOW represents a zero voltage signal. HI represents an ignition voltage signal.

Torque Converter Efficiency: This parameter displays a ratio of 0.00:1 to 2:1. The ratio is calculated by multiplying the speed ratio by a value related to the "K factor" of the torque converter. The "K factor" is the looseness or tightness of the torque converter for a given torque. The nearer the torque converter is to full coupling, i.e. 1:1, the closer the torque converter efficiency number will be to 1.

TP Indicated Angle: This parameter displays the desired throttle angle for operating conditions present at the time.

TR Sw.: This parameter displays the decoded status of the four A/B/C/P inputs from the transmission range switch. The scan tool displays Park, Reverse, Neutral Drive, Intermediate, Low, and Invalid. If a valid combination of inputs is not detected, invalid will be displayed.

TR Sw. A/B/C/P: This parameter displays the status of the four inputs from the transmission range switch. The scan tool displays HI/LOW. HI indicates an ignition voltage input to the control module. LOW indicates a zero voltage input to the control module.

Trans. Fluid Temp.: This parameter displays the input signal of the transmission fluid temperature sensor. Transmission fluid temperature is high 151°C (304°F) when signal voltage is low, 0 volts, and transmission fluid temperature is low -40°C (-40°F) when signal voltage is high, 5 volts.

Trans. Slip Counter: This parameter displays the number of times the P0894 Diagnostic test has identified a slipping condition. This diagnostic test is required to identify a slipping condition three times in a row in order to set the DTC P0894 Transmission Component Slipping Diagnostic code. The scan tool displays 0, 1 or 2.

Transmission Hot Mode: This parameter displays the automatic transmission fluid temperature (TFT) and displays ON or OFF. OFF indicates that the TFT has not exceeded 130°C (266°F). ON indicates that the TFT has exceeded 130°C (266°F) and has not cooled to 120°C (248°F) for more that 5 seconds. Note: these numbers are approximate. They differ with transmissions.

Transmission OSS: This parameter displays the rotational speed of the transmission output shaft expressed as revolutions per minute.

Vehicle Speed: This parameter displays the speed at which the vehicle is traveling. The scan tool displays vehicle speed as kilometers per hour (km/h), (miles per hour (MPH)). The vehicle speed is calculated based on the input signal from the vehicle speed sensor.

Diagnostic Trouble Code (DTC) Type Definitions

Diagnostic trouble codes (DTCs) are grouped into several types. Each type has a unique set of characteristics for MIL operation, DTC storage, and DTC clearing. The following list contains a brief summary of the DTC types and the associated properties of each.

Type A

This DTC is emissions related. The malfunction indicator lamp (MIL) illuminates and default actions, if any, are activated immediately after a failure is detected. The DTC is then stored in history and the Freeze Frame data is captured.

Type B

This DTC is emissions related. Default actions, if any, are activated and a Failure Record is stored after the first failure is detected. At the time of the first fail, the DTC will appear in memory as pending. If the next trip reports a pass, the pending DTC is deleted. If the failure recurs on the next consecutive drive cycle, the MIL illuminates, the DTC is stored in history, and the Freeze Frame data is captured at the time of failure.

Type C

This DTC is non emission related and does not turn on the MIL. When a Type C DTC sets, a message may be displayed on the driver information center. Type C DTCs that do not display a message were formerly referred to as type D DTCs.

DTC P0218

Circuit Description

The flow of transmission fluid starts in the bottom pan and is drawn through the filter, control valve body assembly, transmission case and into the oil pump assembly. The oil pump assembly pressurizes the fluid and directs it to the pressure regulator valve where it becomes the main supply of fluid to the various components and hydraulic circuits in the transmission. Hot fluid exiting the torque converter flows through the converter clutch apply valve and into the transmission cooler lines to the oil cooler located in the vehicle radiator, and auxiliary cooler if equipped. From the cooler, fluid returns to cool and lubricate the front of the transmission. In forward drive ranges, D4 fluid from the manual valve is routed through an orificed cup plug in the rear of the transmission case to feed the rear lube fluid circuit.

When the transmission control module (TCM) detects a high transmission fluid temperature (TFT) for a long period of time, then DTC P0218 sets. DTC P0218 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0218 Transmission Fluid Overtemperature

Conditions for Running the DTC

- No TFT sensor DTCs P0711, P0712 or P0713.
- The ignition switch is ON for 5 seconds.

Conditions for Setting the DTC

The TFT is greater than 130°C (266°F) for 600 seconds (10 minutes).

Action Taken When the DTC Sets

- The TCM does not request the ECM to illuminate the malfunction indicator lamp (MIL).
- The TCM freezes transmission adapt functions.
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as Failure Records.
- The TCM stores DTC P0218 in TCM history.

Conditions for Clearing the DIC/DTC

- The TCM clears the DIC message when the condition no longer exists.
- A scan tool can clear the DTC.

- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the fault no longer exists and the DTC passes.

Diagnostic Aids

- The scan tool Trans. Fluid Temp. should rise steadily to a normal operating temperature, then stabilize.
- Ask about the customer's driving habits, trailer towing, etc. Trailer towing should occur in D3.
- Refer to Symptoms - Automatic Transmission .

Test Description

The number below refers to the step number on the diagnostic table.

3. This step inspects for air flow restrictions or damage which may result in the transmission overheating.

DTC P0218

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Failure Records. Using the Clear Info function erases the Failure Records from the TCM. 3. Record the DTC Failure Records. 4. Clear the DTC. 5. Inspect for correct transmission fluid level. Refer to Transmission Fluid Check . Did you perform the fluid checking procedure?	--	Go to Step 3	Go to Transmission Fluid Check .
3	1. Inspect the engine cooling system and transmission cooling system for the following conditions: • Air flow restrictions • Air flow blockage • Debris 2. Inspect the transmission cooling system for damaged cooler lines.	--		

	3. Test the oil cooler flow. Refer to Transmission Fluid Cooler Flushing and Flow Test . Did you find and correct the condition?		Go to Step 6	Go to Step 4
4	Test for correct line pressure. Refer to Line Pressure Check . Did you find and correct the condition?	--	Go to Step 6	Go to Step 5
5	Test the torque converter stator. Refer to Torque Converter Diagnosis . Did you find and correct the condition?	--	Go to Step 6	Go to Testing for Intermittent Conditions and Poor Connections
6	Perform the following procedure in order to verify the repair: 1. Install a scan tool. 2. Select DTC. 3. Select Clear Info. 4. Start and idle the engine until it reaches normal operating temperature. 5. Monitor Trans. Fluid Temp. on the scan tool. 6. Drive the vehicle for 10 minutes. 7. Ensure that the transmission fluid temperature has stabilized and is less than 129°C (264°F). 8. Select Specific DTC. 9. Enter DTC P0218. Has the test run and passed?	--	Go to Step 7	Go to Step 2
7	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0562

Circuit Description

The transmission control module (TCM) continuously monitors the system voltage on the Ignition 1 and the battery circuits. Lower than normal voltage may be inadequate to operate the transmission control solenoids properly. Improper solenoid operation may cause erratic transmission operation and tie-up conditions, which may result in internal damage.

When the TCM detects low voltage, DTC P0562 sets. DTC P0562 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0562 System Voltage Low

Conditions for Running The DTC

The engine speed is greater than 1,200 RPM.

Conditions for Setting The DTC

The TCM detects system voltage less than 11 volts for 10 seconds.

Action Taken When the DTC Sets

- The TCM does not request the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL).
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM records this information as a Failure Record.
- The TCM stores DTC P0562 in TCM history.

Conditions for Clearing the DTC

- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- A scan tool can clear the DTC.

Diagnostic Aids

- Observe the driver information centre (DIC) messaging that indicates the electrical system requires service.
- Inspect for the following conditions:

- Loose or damaged terminals at the generator
- Loose or worn generator drive belt

Test Description

The numbers below refer to the step numbers on the diagnostic table.

4. This step tests the charging system voltage with a nominal load.

5. This step obtains the ignition voltage measurement reported by the TCM.

6. This step tests the voltage drop from the battery and ignition voltage input at the TCM.

10. This step tests the voltage drop from the ground terminals of the TCM to the ground terminal of the battery.

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM and the TCM Failure Records. Using the Clear Info function erases the Failure Records from the ECM and TCM. • Using the Clear Info function erases stored DTCs in both the engine control module (ECM) and transmission control module (TCM). 3. Record the Failure Records. 4. Clear the DTC. 5. Using the DMM, measure and record the battery voltage across the battery terminals. Is the voltage higher than the specified value?	11 V	Go to Step 3	Go to Battery Inspection/Test
3	1. Start the engine. 2. Allow the engine to warm up to normal operating temperature.	--	Go to Charging	

	Is the charge indicator light ON?		System Test	Go to Step 4
4	1. Turn ON the high beam headlamps. 2. Turn the HVAC blower control to the highest speed setting. 3. Turn ON the rear window defroster. 4. Increase the engine speed to 1,500 RPM. 5. Observe the DMM battery voltage and record your voltage reading for reference. Is the voltage within the specified range?	12.5-14.5 V	Go to Step 5	Go to Charging System Test
5	1. Increase the engine speed to 1,500 RPM. 2. Observe the Ignition Voltage with the scan tool. Is the scan tool Ignition Voltage within the specified range?	12.5-14.5 V	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 6
6	1. Turn OFF the ignition. 2. Disconnect the TCM connector. 3. Probe the ignition voltage circuit and the battery positive voltage circuit of the TCM connector with the ground probe of the DMM. Refer to Measuring Voltage . 4. Connect the positive lead of the DMM to the battery positive terminal. 5. Turn ON the ignition, with the engine OFF. Are the voltage drop measurements less than the specified value?	0.5 V	Go to Step 10	Go to Step 7
7	Inspect the ECM/TCM fuse and the ACC/TCM fuse for an open. Refer to Circuit Protection - Fuses . Did you find an open fuse?	--	Go to Step 8	Go to Step 9
8	Repair the short to ground in the battery positive voltage circuit or the ignition voltage circuit. Refer to Wiring Repairs . Is the repair complete?	--	Go to Step 13	--
9	Test the battery positive voltage circuit and the ignition voltage circuit for an open or high resistance condition. Refer to Testing for Continuity and Wiring Repairs .	--		

	Did you find and correct a condition?		Go to Step 13	Go to Step 10
10	1. Turn ON the ignition, with the engine OFF. 2. Connect the negative lead of the DMM to the battery ground terminal. Observe and record the voltage measurement. 3. Using the positive probe of the DMM, probe each of the TCM ground circuits of the TCM connector. Observe and record the voltage measurement. Refer to Measuring Voltage Drop . Are both of the voltage drop measurements less than the specified value?	0.2 V	Go to Step 12	Go to Step 11
11	Repair the open or high resistance condition in the TCM ground circuits. Refer to Wiring Repairs . Is the repair complete?	--	Go to Step 13	--
12	Replace the TCM. Refer to Control Module References . Is the action complete?	--	Go to Step 13	--
13	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: - Start the engine. - Allow the engine to warm up to normal operating temperature. - Raise the engine speed to at least 1,200 RPM. - TCM voltage must be greater than 11 volts for 12 seconds. 4. Select Specific DTC. 5. Enter DTC P0562. Has the test run and passed?	--	Go to Step 14	Go to Step 2
14	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0563

Circuit Description

The transmission control module (TCM) continuously monitors the system voltage on the ignition 1 and the battery voltage circuits. Higher than normal voltage may cause the solenoids inside the transmission to operate improperly or damage solid-state components inside the TCM.

When the TCM detects high voltage, DTC P0563 sets. DTC P0563 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0563 System Voltage High.

Conditions for Running The DTC

The ignition is ON.

Conditions for Setting The DTC

The TCM detects system voltage greater than 18 volts for 10 seconds.

Action Taken When the DTC Sets

- The TCM does not request the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL).
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM records this information as a Failure Record.
- The TCM stores DTC P0563 in TCM history.

Conditions for Clearing the DTC

- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- A scan tool can clear the DTC.

Diagnostic Aids

- Observe the driver information center (DIC) messaging that indicates the electrical system requires service.
- Use the scan tool in order to inspect all other modules for voltage related DTCs.
- Running the engine with a battery charger attached may cause DTC P0563 to set.

- Inspect the charging circuit for high resistance.
- Inspect the vehicle battery for open or sulfated cells.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

4. This step tests the charging system voltage with a minimal load.

5. This step obtains the ignition voltage measurement reported by the TCM.

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM and the TCM Failure Records. Using the Clear Info function erases the Failure Records from the engine control module (ECM) and transmission control module (TCM). • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the Failure Records. Did you record a Failure Record for ECM DTC P0562?	--	Go to DTC P0562 .	Go to Step 3
3	1. Clear the DTC. 2. Start the engine. 3. Allow the engine to warm up to normal operating temperature. Is the charge indicator light ON?	--	Go to Charging System Test	Go to Step 4
4	1. Turn OFF all electrical accessories. 2. Increase the engine speed to 2,000 RPM. 3. Using the DMM, measure the voltage between the battery terminals. Record the measurement for reference. Is the voltage within the specified range?	12.5-14.5 V	Go to Step 5	Go to Charging System Test

5	1. Leave the engine running. 2. Observe the Ignition Voltage on the scan tool. 3. Increase the engine speed to 2,000 RPM. Is the difference between the voltage displayed on the scan tool and the voltage measurement in Step 4 greater than the specified value?	1.0 V	Go to Step 7	Go to Step 6
6	Did P0563 reset?	--	Go to Step 7	Go to Testing for Intermittent Conditions and Poor Connections
7	Replace the TCM. Refer to Control Module References . Is the action complete?	--	Go to Step 8	--
8	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Start the engine. • Allow the engine to warm up to normal operating temperature. • Observe the Ignition Voltage on the scan tool. • TCM voltage must remain below 18 volts for 12 seconds. 4. Select Specific DTC. 5. Enter DTC P0563. Has the test run and passed?	--	Go to Step 9	Go to Step 2
9	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0711

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit Description

The automatic transmission fluid temperature (TFT) sensor is part of the automatic transmission fluid pressure (TFP) manual valve position switch. The automatic TFT sensor is a negative coefficient thermistor. When the transmission fluid is cold, the sensor resistance is high. As the transmission fluid warms up, the sensor resistance decreases. This diagnostic monitors the TFT circuit. The circuit may be functional, but not in the normal operating range. This diagnostic indicates stuck, erratic, intermittent, skewed, or inaccurate values, indicating poor system performance. The TFT range is -40 to +151°C (-40 to +305°F).

If the TCM detects rapid or no voltage changes in the TFT sensor circuit, then DTC P0711 sets. DTC P0711 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0711 Transmission Fluid Temperature (TFT) Sensor Performance.

Conditions for Running the DTC

- No engine coolant temperature (ECT) DTC P0115.
- No output speed sensor (OSS) DTCs P0722 or P0723.
- DTC P0711 has not passed in the current ignition cycle.
- The engine run time is greater than 5 seconds.
- The transmission fluid temperature is -39 to +149°C (-38 to +300°F).
- For conditions 1 and 2 below, the engine coolant temperature is greater than 70°C (158°F) and has changed by at least 50°C (90°F) since start-up.
- For conditions 1 and 2 below, the torque converter clutch (TCC) slip speed is 120 RPM or greater for 600 seconds (10 minutes) cumulatively.

Conditions for Setting the DTC

One of the following conditions occurs:

Condition 1

- The transmission fluid temperature at start-up is -40 to +21°C (-40 to +70°F).
- The vehicle speed is greater than 8 km/h (5 mph) for 900 seconds (15 minutes) cumulatively.
- The transmission fluid temperature has not changed by more than 2°C (4°F) since start-up for 100 seconds (1 minute and 40 seconds).

Condition 2

- The transmission fluid temperature at start-up is 129-150°C (264-302°F).
- The vehicle speed is greater than 8 km/h (5 mph) for 600 seconds (10 minutes) cumulatively.
- The transmission fluid temperature has not changed by more than 2°C (4°F) since start-up for 100 seconds (1 minute and 40 seconds).

Condition 3

The transmission fluid temperature has changed by 20°C (36°F) or greater within 250 milliseconds; 14 times within 7 seconds.

Action Taken When the DTC Sets

- The TCM does not request the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL).
- The TCM freezes transmission adaptive functions.
- The TCM calculates a default transmission fluid temperature based on engine coolant temperature, intake air temperature and engine run time.
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- The TCM stores DTC P0711 in TCM history.

Conditions for Clearing the DTC

- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission-related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the fault no longer exists and the DTC passes.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

5. This step tests for an intermittent short or open condition in the engine wiring harness. The test lamp is used as a resistor in the circuit.

6. This step determines if the TCM or the TFT sensor is causing a steady, unchanging TFT reading.

DTC P0711

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	Inspect for correct transmission fluid level. Refer to Transmission Fluid Check . Did you perform the fluid checking procedure?	--	Go to Step 3	Go to Transmission Fluid Check .
3	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Failure Records. Using the Clear Info function erases the Failure Records from the transmission control module (TCM). 3. Record the DTC Failure Records. 4. Clear the DTC. 5. Select Trans. Fluid Temp. on the scan tool. 6. Drive the vehicle and observe the scan tool for either of the following conditions: • The Trans. Fluid Temp. does not change more than 2.25°C (4°F) in 409 seconds since start-up. • The Trans. Fluid Temp. changes more than 20°C (36°F) in 200 milliseconds 14 times within 7 seconds. Did either of the conditions occur?	--	Go to Step 4	Go to Testing for Intermittent Conditions and Poor Connections
4	Did the scan tool display a condition in which the Trans. Fluid Temp. does not change by more than the specified value in 409 seconds since start-up?	2.25°C (4°F)	Go to Step 6	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the A/T inline 20-way connector, additional DTCs may set. 3. Install the J 44152 Jumper Harness (20 pins) on the engine side of the A/T inline 20-way connector. 4. Using the J 35616 , connect a test lamp from the transmission fluid temperature (TFT) sensor signal and low reference circuits of the J 44152 . Refer to Component Connector End	20°C		

	Views . 5. Turn ON the ignition, with the engine OFF. 6. While observing the scan tool display, move or wiggle the engine wiring harness from TCM to the A/T inline 20-way connector. Does the scan tool Trans. Fluid Temp. change by more than the specified value?	(36°F)	Go to Step 7	Go to Step 8
6	1. Turn OFF the ignition. 2. Disconnect the A/T inline 20-way connector. 3. Turn ON the ignition, with the engine OFF. Does the scan tool display the same condition as in step 4?	--	Go to Step 11	Go to Step 10
7	1. Test the TFT sensor signal circuit of the TFT sensor for an intermittent open or short condition between the TCM and the A/T inline 20-way connector. 2. Test the low reference circuit of the TFT sensor for an intermittent open or short condition. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 12	Go to Step 11
8	1. Test the TFT sensor signal circuit of the TFT sensor for an intermittent open or short condition between the AT inline 20-way connector and the TFT sensor. 2. Test the low reference circuit of the TFT sensor for an intermittent open or short condition. Refer to Circuit Testing . Did you find an intermittent open or short condition?	--	Go to Step 9	Go to Step 10
9	Replace the A/T wiring harness. Refer to Torque Converter Clutch Pulse Width Modulation Solenoid, Torque Converter Clutch Solenoid, and Wiring Harness . Did you complete the replacement?	--	Go to Step 12	--
10	Replace the TFT sensor, this sensor is part of the TFP manual valve position switch. Refer to Valve Body and Pressure Switch Replacement .	--		--

	Did you complete the replacement?		Go to Step 12	
11	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 12	--
12	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle and make sure the following conditions are met: • The Trans. Fluid Temp. changes by more than 3°C (5.4°F) for 11 seconds since start-up. • The Trans. Fluid Temp. does not change by more than 20°C (36°F) within 200 milliseconds for a period of at least 11 seconds 4. Select Specific DTC. 5. Enter DTC P0711. Has the test run and passed?	--	Go to Step 13	Go to Step 2
13	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0712

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit Description

The automatic transmission fluid temperature (TFT) sensor is part of the automatic transmission fluid pressure (TFP) manual valve position switch. The TFT sensor is a thermistor, or a resistor that changes value when the temperature changes. The sensor has a negative-temperature coefficient. This means that as the temperature increases, the resistance decreases, and as the temperature decreases, the resistance increases. The transmission control module (TCM) supplies a 5-volt reference signal to the sensor and measures the voltage drop in the circuit. When the transmission fluid is cold, the sensor resistance is high and the TCM detects high signal voltage. As the fluid temperature increases, the resistance of the sensor decreases, which lowers the signal voltage.

If the TCM detects a short to ground in the TFT sensor or signal circuit, then DTC P0712 sets. DTC P0712 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0712 Transmission Fluid Temperature (TFT) Sensor Circuit Low Voltage.

Conditions for Running the DTC

The engine run time is greater than 5 seconds.

Conditions for Setting the DTC

The TCM detects a transmission fluid temperature of 150°C (302°F) or more for 2 seconds.

Action Taken When the DTC Sets

- The TCM does not request the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL).
- The TCM freezes transmission adaptive functions.
- The TCM calculates a default transmission fluid temperature based on engine coolant temperature, intake air temperature and engine run time.
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.

- The TCM stores DTC P0712 in TCM history.

Conditions for Clearing the DTC

- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission-related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the fault no longer exists and the DTC passes.

Diagnostic Aids

- The scan tool displays the transmission fluid temperature in degrees. After the transmission is operating, the fluid temperature should rise steadily to a normal operating temperature, then stabilize.
- Verify the customer's driving habits, trailer towing, etc. Trailer towing should occur in D3.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. This step tests for a short to ground condition.

4. This step tests for an internal fault within the transmission by creating an open.

DTC P0712

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	Inspect for correct transmission fluid level. Refer to Transmission Fluid Check . Did you perform the fluid checking procedure?	--	Go to Step 3	Go to Transmission Fluid Check .
3	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Failure Records. Using the Clear Info function erases the Failure Records from the transmission control module (TCM). 3. Record the DTC Failure Records. 4. Clear the DTC.	0.2 V	Go to Testing for	

	Does the scan tool displays a TFT Sensor signal voltage greater than the specified value?		Intermittent Conditions and Poor Connections	Go to Step 4
4	1. Turn OFF the ignition. 2. Disconnect the A/T inline 20-way connector, additional DTCs may set. 3. Turn ON the ignition, with the engine OFF. Does the scan tool display a TFT Sensor signal voltage greater than the specified value?	4.92 V	Go to Step 5	Go to Step 7
5	1. Install the J 44152 Jumper Harness (20 pins) on the transmission side of the A/T inline 20-way connector. 2. Using the DMM and the J 35616 , measure the resistance the transmission fluid temperature (TFT) sensor signal and low reference circuits of the J 44152 . Refer to Testing for Continuity . Refer to Component Connector End Views . Does the resistance measure within the specified range?	3088-3942 Ω at 20°C (68°F) 159-198 Ω at 100°C (212°F)	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 6
6	Test the signal circuit of the TFT sensor for a short to ground between the A/T inline 20-way connector and the TFT sensor. Refer to Testing for Short to Ground . Did you find a short to ground condition?	--	Go to Step 9	Go to Step 8
7	Test the signal circuit of the TFT sensor for a short to ground between the TCM and the A/T inline 20-way connector. Refer to Testing for Short to Ground and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 11	Go to Step 10
8	Replace the TFT sensor, this sensor is part of the TFP manual valve position switch. Refer to Valve Body and Pressure Switch Replacement . Did you complete the replacement?	--	Go to Step 11	--
9	Replace the A/T wiring harness. Refer to Valve Body and Pressure Switch Replacement .	--		--

	Did you complete the replacement?		Go to Step 11	
10	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 11	--
11	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Turn ON the ignition, with the engine OFF. 4. Verify that the scan tool indicates a TFT Sensor signal voltage greater than 0.2 volts for 10 seconds. 5. Select Specific DTC. 6. Enter DTC P0712. Has the test run and passed?	--	Go to Step 12	Go to Step 2
12	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0713

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit Description

The automatic transmission fluid temperature (TFT) sensor is part of the automatic transmission fluid pressure (TFP) manual valve position switch. The TFT sensor is a thermistor, or a resistor that changes value when the temperature changes. The sensor has a negative-temperature coefficient. This means that as the temperature increases, the resistance decreases, and as the temperature decreases, the resistance increases. The transmission control module (TCM) supplies a 5-volt reference signal to the sensor and measures the voltage drop in the circuit. When the transmission fluid is cold, the sensor resistance is high and the TCM detects high signal voltage. As the fluid temperature increases, the resistance of the sensor decreases, which lowers the signal voltage.

If the TCM detects an open in the TFT sensor or signal circuit, then DTC P0713 sets. DTC P0713 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0713 Transmission Fluid Temperature (TFT) Sensor Circuit High Voltage.

Conditions for Running the DTC

- No ISS DTCs P0716 or P0717.
- No OSS DTCs P0722, P0723.
- The output shaft speed is greater than 200 RPM for 200 seconds (3 minutes and 20 seconds) cumulative.
- The TCC slip speed is greater than 120 RPM for 200 seconds (3 minutes and 20 seconds) cumulative.
- The engine run time is greater than 5 seconds.

Conditions for Setting the DTC

The TCM detects a transmission fluid temperature of -39° C (-38° F) or less for 25 seconds.

Action Taken When the DTC Sets

- The TCM does not request the ECM to illuminate the malfunction indicator lamp (MIL).
- The TCM freezes transmission adaptive functions.
- The TCM calculates a default transmission fluid temperature based on engine coolant temperature, intake air temperature and engine run time.
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- The TCM stores DTC P0713 in TCM history.

Conditions for Clearing the DTC

- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission-related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the fault no longer exists and the DTC passes.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

5. This step tests the TFT sensor signal circuit for being shorted to another circuit within the transmission. If the TFT sensor signal circuit shorts to another circuit, which is carrying voltage greater than 5-volts, the TFT sensor will become open.

6. This step tests the TFT sensor signal circuit for being shorted to voltage, which will be the cause for the open in the TFT sensor.

DTC P0713

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the DTC Failure Records. Using the Clear Info function erases the Failure Records from the transmission control module (TCM). 3. Record the DTC Failure Records. 4. Clear the DTC. 5. Select Trans. Fluid Temp. on the scan tool. Does the scan tool display a Trans. Fluid Temp. less than the specified value?	-39°C (-38°F)	Go to Step 3	Go to Testing for Intermittent Conditions and Poor Connections

3	1. Turn OFF the ignition. 2. Disconnect the A/T inline 20-way connector. Additional DTCs may set. 3. Install the J 44152 Jumper Harness (20 pins) on the transmission side of the A/T inline 20-way connector. 4. Using the DMM and the J 35616 , measure the resistance between the transmission fluid temperature (TFT) sensor signal and low reference circuits of the J 44152 . Refer to Testing for Continuity . Refer to Component Connector End Views . Does the resistance measure less than the specified value?	100 K Ω	Go to Step 7	Go to Step 4
4	1. Test the signal circuit of the TFT sensor for an open between the A/T inline 20-way connector and the TFT sensor. 2. Test the low reference circuit of the TFT sensor for an open between the A/T inline 20-way connector and the TFT sensor. Refer to Testing for Continuity . Did you find an open condition?	--	Go to Step 8	Go to Step 5
5	Measure the resistance between the TFT sensor signal circuit and all other terminals of the J 44152 . Refer to Testing for Continuity . Does the resistance measure less than the specified value?	1,000 Ω	Go to Step 10	Go to Step 6
6	Test the signal circuit of the TFT sensor for a short to voltage between the TCM and the A/T inline 20-way connector. Refer to Testing for a Short to Voltage and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 9	Go to Step 9
7	1. Test the signal circuit of the TFT sensor for an open between the TCM and the A/T inline 20-way connector. 2. Test the low reference circuit of the TFT sensor for an open between the TCM and the A/T inline 20-way connector. Refer to Testing for Continuity and Wiring	--		

	Repairs . Did you find and correct an open condition?		Go to Step 12	Go to Step 11
8	Replace the automatic transmission wiring harness. Refer to Valve Body and Pressure Switch Replacement . Did you complete the replacement?	--	Go to Step 12	--
9	Replace the TFT sensor. Refer to Valve Body and Pressure Switch Replacement . Did you complete the replacement?	--	Go to Step 12	--
10	1. Replace the automatic transmission wiring harness. 2. Replace the TFT sensor. Refer to Valve Body and Pressure Switch Replacement . Did you complete the replacements?	--	Go to Step 12	--
11	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 12	--
12	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Turn ON the ignition, with the engine OFF. • The Trans. Fluid Temp. must be greater than -40°C (-40°F) for 6 seconds. 4. Select Specific DTC. 5. Enter DTC P0713. Has the test run and passed?	--	Go to Step 13	Go to Step 2
13	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0716

Circuit Description

The automatic transmission input shaft speed (AT ISS) sensor assembly is a three-wire hall-effect sensor that is mounted internally to the transmission on the oil pump assembly. The AT ISS utilizes the gear teeth, located on the turbine shaft, to generate a voltage signal of varying frequency that corresponds to the rotational speed of the turbine shaft. The AT ISS signal is an input to the transmission control module (TCM) and is used to determine line pressure, transmission shift patterns, torque converter clutch (TCC) slip speed and gear ratio.

If the TCM detects an unrealistically large change in the AT ISS speed, DTC P0716 sets. DTC P0716 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0716 Input Speed Sensor Performance.

Conditions for Running the DTC

- No output speed sensor (OSS) DTCs P0722 or P0723.
- No AT ISS DTC P0717.
- No shift solenoid (SS) DTCs P0757, P0973 or P0974.
- The AT ISS speed is 300-1000 RPM for 2 seconds.
- The vehicle speed is greater than 16 km/h (10 mph).
- The engine torque is greater than 90 N·m (66 lb ft).
- The throttle position is greater than 10 percent.

Conditions for Setting the DTC

The AT ISS RPM changes abruptly by greater than 1300 RPM for 5 seconds.

Action Taken When the DTC Sets

- The TCM requests the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adapts.
- The TCM calculates a default AT ISS RPM.
- The ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as Freeze Frame and Failure Records.

- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as Failure Records.
- The TCM stores DTC P0716 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the third consecutive drive trip in which the TCM does not send an MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission-related diagnostic fault occurring.

Diagnostic Aids

- Inspect the connectors at the TCM, the AT ISS, and all other circuit connecting points for an intermittent condition. Refer to Testing for Intermittent Conditions and Poor Connections .
- Inspect the circuit wiring for an intermittent condition. Refer to Testing for Electrical Intermittents .
- Road test the vehicle while monitoring the Transmission ISS parameter on the scan tool. The Transmission ISS parameter should vary with engine speed changes and not abruptly drop out.
- Inspect for an open or shorted AT ISS wire.
- Inspect for a disconnected AT ISS connector.
- Inspect for a faulty AT ISS.

DTC P0716

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. **Important:** Before clearing the DTCs, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTCs. 5. Road test the vehicle. 6. Observe the Transmission AT ISS parameter on the scan tool.	1300 RPM		

	Does the scan tool indicate a Transmission AT ISS parameter fluctuate or drop greater than the specified value?		Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the AT 20-way connector. 3. Turn the ignition ON, with the engine OFF. 4. Using the DMM, measure the TCM harness side voltage of the AT ISS 12-volt reference circuit to ground, at the AT 20-way connector, engine harness side. 5. Wiggle the engine harness between the TCM and the AT 20-way connector. Does the voltage measure near the specified value and not fluctuate?	12 V	Go to Step 4	Go to Step 7
4	Measure the voltage from the AT ISS 12-volt reference circuit to the AT ISS low reference circuit, at the AT 20-way connector, engine harness side. Does the voltage measure near the specified value and not fluctuate?	12 V	Go to Step 5	Go to Step 8
5	1. Turn OFF the ignition. 2. Connect the J 38522 , to the AT ISS signal circuit at the AT 20-way connector, engine harness side. 3. Adjust the signal to 12 V. 4. Adjust the frequency to 300Hz. 5. Adjust the duty cycle to 50 percent. 6. Turn the ignition ON, with the engine OFF. 7. Observe the Transmission AT ISS parameter on the scan tool. Is the Transmission AT ISS RPM near the specified value and does not fluctuate?	602 RPM	Go to Step 9	Go to Step 6
6	Test the AT ISS signal circuit for the following conditions: • An open. • A short to ground. • A short to voltage. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 14	Go to Step 13
	Test the AT ISS 12-volt reference circuit for the following conditions:			

7	• An open. • A short to ground. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 14	Go to Step 13
8	Test the AT ISS low reference circuit for an open or a short to voltage. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 14	Go to Step 13
9	Test the AT ISS internal transmission harness for the following conditions: • An open. • A short to ground. • A short to voltage. Refer to Circuit Testing . Did you find a condition?	--	Go to Step 11	Go to Step 10
10	1. Remove the AT ISS sensor. Refer to Oil Pump Disassemble . 2. Inspect the AT ISS and the transmission for the following conditions: • An incorrect AT ISS. • A loose AT ISS. • A damaged AT ISS. • Incorrect AT ISS installation. • Turbine shaft damage. 3. Repair any of the above conditions as necessary. Did you find and correct the condition?	--	Go to Step 14	Go to Step 12
11	Replace the internal transmission harness. Refer to Valve Body and Pressure Switch Replacement . Did you complete the action?	--	Go to Step 14	--
12	Replace the AT ISS. Refer to Oil Pump Disassemble . Did you complete the replacement?	--	Go to Step 14	--
13	Replace the TCM. Refer to Control Module References .	--		--

	Did you complete the replacement?		Go to Step 14	
14	Perform the following procedure In order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle. 4. Ensure the vehicle speed is greater than 20 km/h (13 mph) for at least 10 seconds. 5. Select specific DTC. 6. Enter DTC P0716. Has the test run and passed?	--	Go to Step 15	Go to Step 2
15	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0717

Circuit Description

The automatic transmission input shaft speed (AT ISS) sensor assembly is a three-wire hall-effect sensor that is mounted internally to the transmission on the oil pump assembly. The AT ISS utilizes the gear teeth, located on the turbine shaft, to generate a voltage signal of varying frequency that corresponds to the rotational speed of the turbine shaft. The AT ISS signal is an input to the transmission control module (TCM) and is used to determine line pressure, transmission shift patterns, torque converter clutch (TCC) slip speed and gear ratio.

If the TCM detects AT ISS input less than 100 RPM with the engine running, DTC P0717 sets. DTC P0717 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0717 Input Speed Sensor Circuit Low Voltage.

Conditions for Running the DTC

- No output speed sensor (OSS) DTCs P0722 or P0723.
- No AT ISS DTC P0716.
- No TFP DTC P1810.
- The vehicle speed is greater than 16 km/h (10 mph).
- The engine torque is greater than 90 N·m (66 lb ft).

Conditions for Setting the DTC

The AT ISS RPM is less than 100 RPM for 5 seconds.

Action Taken When the DTC Sets

- The TCM requests the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adapts.
- The TCM calculates a default AT ISS RPM.
- The ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as Freeze Frame and Failure Records.
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as Failure Records.

- The TCM stores DTC P0717 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the third consecutive drive trip in which the TCM does not send an MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission-related diagnostic fault occurring.

Diagnostic Aids

- Inspect the connectors at the TCM, the AT ISS, and all other circuit connecting points for an intermittent condition. Refer to Testing for Intermittent Conditions and Poor Connections .
- Inspect the circuit wiring for an intermittent condition. Refer to Testing for Electrical Intermittents .
- Road test the vehicle while monitoring the Transmission ISS parameter on the scan tool. The Transmission ISS parameter should vary with engine speed changes and not abruptly drop out.
- Inspect for an open or shorted AT ISS wire.
- Inspect for a disconnected AT ISS connector.
- Inspect for a faulty AT ISS.

DTC P0717

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. **Important:** Before clearing the DTCs, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTCs. 5. Start the engine and vary the RPMs. 6. Observe the Transmission AT ISS parameter on the scan tool. Is the scan tool Transmission AT ISS parameter greater than the specified value?	400 RPM	Go to Diagnostic Aids	Go to Step 3

3	1. Turn OFF the ignition. 2. Disconnect the AT 20-way connector. 3. Turn the ignition ON, with the engine OFF. 4. Using the DMM, measure the voltage of the AT ISS 12-volt reference circuit to ground, at the AT 20-way connector, engine harness side. Does the voltage measure near the specified value?	12 V	Go to Step 4	Go to Step 7
4	Measure the voltage from the AT ISS 12-volt reference circuit to the AT ISS low reference circuit, at the AT 20-way connector, engine harness side. Does the voltage measure near the specified value?	12 V	Go to Step 5	Go to Step 8
5	1. Turn OFF the ignition. 2. Connect the J 38522 , to the AT ISS signal circuit at the AT 20-way connector, engine harness side. 3. Adjust the signal to 12 V. 4. Adjust the frequency to 300Hz. 5. Adjust the duty cycle to 50 percent. 6. Turn the ignition ON, with the engine OFF. 7. Observe the Transmission AT ISS parameter on the scan tool. Is the Transmission AT ISS RPM near the specified value and steady?	602 RPM	Go to Step 9	Go to Step 6
6	Test the AT ISS signal circuit for the following conditions: • An open. • A short to ground. • A short to voltage. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 14	Go to Step 13
7	Test the AT ISS 12-volt reference circuit for the following conditions: • An open. • A short to ground. Refer to Circuit Testing and Wiring Repairs .	--		

	Did you find and correct the condition?		Go to Step 14	Go to Step 13
8	Test the AT ISS low reference circuit for an open or a short to voltage. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 14	Go to Step 13
9	Test the AT ISS internal transmission harness for the following conditions: • An open. • A short to ground. • A short to voltage. Refer to Circuit Testing and Wiring Repairs . Did you find a condition?	--	Go to Step 11	Go to Step 10
10	1. Remove the AT ISS sensor. Refer to Oil Pump Disassemble . 2. Inspect the AT ISS and the transmission for the following conditions: • An incorrect AT ISS • A loose AT ISS • A damaged AT ISS • Incorrect AT ISS installation • Turbine shaft damage. 3. Repair any of the above conditions as necessary. Did you find and correct the condition?	--	Go to Step 14	Go to Step 12
11	Replace the internal transmission harness. Refer to Valve Body and Pressure Switch Replacement . Did you complete the action?	--	Go to Step 14	--
12	Replace the AT ISS. Refer to Valve Body and Pressure Switch Replacement . Did you complete the replacement?	--	Go to Step 14	--
13	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 14	--
	Perform the following procedure In order to verify the repair: 1. Select DTC. 2. Select Clear Info.			

14	3. Drive the vehicle. 4. Ensure the vehicle speed is greater than 20 km/h (13 mph) for at least 10 seconds. 5. Select specific DTC. 6. Enter DTC P0717. Has the test run and passed?	--	Go to Step 15	Go to Step 2
15	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0719

Circuit Description

The body control module (BCM) receives a signal from the brake pedal position sensor through the brake pedal position switch signal circuit. The BCM then applies a signal through the stop lamp switch signal circuit to the transmission control module (TCM) and engine control module (ECM).

When the TCM detects an open or short to ground on the stop lamp switch signal circuit during stopping, then DTC P0719 sets. DTC P0719 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0719 Brake Switch Circuit Low Voltage.

Conditions for Running the DTC

- No OSS DTCs P0722 or P0723.
- No Brake Switch DTC P0724.
- The vehicle speed is greater than 40 km/h (25 mph) for 7 seconds, then 8-40 km/h (5-25 mph) for 5 seconds, then less than 8 km/h (5 mph).
- Continuously 8 times once the previous criteria have been met.

Conditions for Setting the DTC

The TCM detects an open or short to ground on the stop lamp switch signal circuit when the circuit should be high, B+.

Action Taken When the DTC Sets

- The TCM does not request the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL).
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM records this information as a Failure Record.
- The TCM stores DTC P0719 in TCM history.

Conditions for Clearing the DTC

- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- A scan tool can clear the DTC.

Diagnostic Aids

Important:

- Verify that the brake pedal position sensor is adjusted properly. Refer toBrake Pedal Position Sensor Calibration in Lighting Systems.
- Test drive the vehicle if a switch or circuit condition cannot be located. An intermittent condition may be duplicated during a test drive.

Test Description

The number below refers to the step number on the diagnostic table.

2. This step determines if the fault is present.

DTC P0719

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Connect a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. With a scan tool, observe the TCC Brake Switch parameter in the TCC Data Display. 4. Depress the brake pedal. Does the Stop Lamp Pedal Switch parameter indicate Closed?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
3	1. Disconnect the transmission control module (TCM). 2. Using J 35616 , with the test lamp connected to ground, probe the harness side of the stop lamp switch signal circuit. 3. Depress the brake pedal. Does the test lamp illuminate?	--	Go to Step 5	Go to Step 4
4	Test for the stop lamp switch signal circuit an open or short to ground. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 7	Go to Step 6
5	Replace the TCM. Refer to Control Module References	--		--

	Did you complete the replacement?		Go to Step 7	
6	Replace the BCM. Refer to Control Module References Did you complete the replacement?	--	Go to Step 7	--
7	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Turn ON the ignition, with the engine OFF for at least 2 seconds. • Start the vehicle and idle for 5 seconds. • Drive in D4 from 0-60 km/h (0-37 mph) 8 times in 1 ignition cycle. 4. Select Specific DTC. 5. Enter DTC P0719. Has the test run and passed?	--	Go to Step 8	Go to Step 2
8	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0722

Circuit Description

The output speed sensor (OSS), provides vehicle speed information to the transmission control module (TCM). The OSS is a permanent magnet generator. The sensor is mounted in the transmission case facing the rear internal gear which is splined to the output shaft assembly. As the output shaft and internal gear rotate, the toothed rotor of the internal gear produces AC voltage as the rotor teeth pass through the magnetic field of the sensor. The AC voltage level and the number of pulses increase as the speed of the vehicle increases. The TCM converts the voltage to vehicle speed. The TCM uses the output shaft speed signal to determine shift timing and torque converter clutch (TCC) scheduling.

If the TCM detects no vehicle speed when there is engine speed in a drive gear range, then DTC P0722 sets. DTC P0722 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0722 Output Speed Sensor Circuit Low Voltage.

Conditions for Running the DTC

- No OSS DTC P0723.
- No transmission fluid pressure (TFP) DTCs P1810, P1815, P1816.
- Ignition voltage between 8-18 volts.
- TFT is between -40°C (-40°F) and 150°C (302°F).
- The engine run time is greater than 5 seconds.
- The throttle position is greater than 12 percent.
- The engine torque is between 108 N·m (80 lb ft) and 882 N·m (651 lb ft).

Conditions for Setting the DTC

The transmission OSS is less than 50 RPM for 3 seconds.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM calculates vehicle speed from the automatic transmission engine RPM and commanded gear.

- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the engine control module (ECM) records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0722 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

- Inspect the rear internal gear teeth for damage.
- Visually inspect the OSS for cracks or damage.
- Ensure the OSS is properly torqued to the transmission housing.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. Disable the traction control system when performing this step. When the ignition key is cycled to the OFF position and then cycled back ON, the traction control system defaults to ON.

3. This step tests the OSS.

5. This step tests the integrity of the OSS.

DTC P0722

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important::** Before clearing the DTC, use the scan tool in order to record the			

2	Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the transmission control module (TCM). 3. Record the Freeze Frame and Failure Records. 4. Clear the DTC. 5. Raise and support the rear axle assembly. 6. Start the engine. 7. Disable the traction control system. 8. Place the transmission in any drive range. With the drive wheels rotating, does the scan tool Transmission OSS parameter increase with the drive wheel speed?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the engine wiring harness from the output speed sensor (OSS). 3. Using the DMM and the J 35616 , measure the resistance of the OSS. Refer to Testing for Continuity . Does the resistance measure within the specified range?	976-2,354 Ω	Go to Step 4	Go to Step 13
4	Measure the resistance from the high signal circuit of the OSS to ground. Refer to Testing for Continuity . Does the resistance measure greater than the specified value?	50 K Ω	Go to Step 5	Go to Step 13
5	1. Place the transmission in NEUTRAL. 2. Select AC volts on the DMM. 3. Hold one rear wheel from turning. 4. Rotate the other wheel by hand. 5. Measure the AC voltage from high signal and low signal circuits of the OSS. Refer to Measuring Voltage . Does the voltage measure greater than the specified value?	0.3 V AC	Go to Step 6	Go to Step 13
6	1. Connect the engine wiring harness to the OSS. 2. Disconnect the TCM. 3. Measure the resistance of the OSS high signal and OSS low signal circuits at the TCM connector.	976-2354 Ω		

	Refer to Testing for Continuity . Does the resistance measure within the specified range?		Go to Step 7	Go to Step 8
7	Measure the resistance from the high signal and low signal circuits of the OSS assembly to ground. Refer to Testing for Continuity . Does the resistance measure greater than the specified value?	50 K Ω	Go to Step 9	Go to Step 10
8	Does the resistance measure greater than the specified value?	2354 Ω	Go to Step 11	Go to Step 12
9	1. Connect the TCM. 2. Disconnect the engine wiring harness from the OSS. 3. Turn ON the ignition, with the engine OFF. 4. Test the high signal circuit of the OSS for a short to voltage. 5. Test the low signal circuit of the OSS for a short to voltage. Refer to Testing for a Short to Voltage and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 15	Go to Step 14
10	1. Test the high signal circuit of the OSS for a short to ground. 2. Test the low signal circuit of the OSS for a short to ground. Refer to Testing for Short to Ground and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 15	--
11	1. Test the high signal circuit of the OSS for an open. 2. Test the low signal circuit of the OSS for an open. Refer to Testing for Continuity and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 15	--
12	Test the high signal and low signal circuits of the OSS for a short together. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 15	--
13	Replace the OSS. Refer to Vehicle Speed Sensor Replacement . Did you complete the replacement?	--	Go to Step 15	--

14	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 15	--
15	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle so that the transmission output speed is greater than 500 RPM for 3 seconds. 4. Select Specific DTC. 5. Enter DTC P0722. Has the test run and passed?	--	Go to Step 16	Go to Step 2
16	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0723

Circuit Description

The output shaft speed (OSS) sensor provides vehicle speed information to the transmission control module (TCM). The OSS is a permanent magnet generator. The sensor is mounted in the transmission case facing the rear internal gear which is splined to the output shaft assembly. As the output shaft and internal gear rotate, the toothed rotor of the internal gear produces AC voltage as the rotor teeth pass through the magnetic field of the sensor. The AC voltage level and the number of pulses increase as the speed of the vehicle increases. The TCM converts the voltage to vehicle speed. The TCM uses the output shaft speed signal to determine shift timing and torque converter clutch (TCC) scheduling.

If the TCM detects an unrealistic drop in output shaft speed, DTC P0723 sets. DTC P0723 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0723 Output Speed Sensor Circuit Intermittent.

Conditions for Running the DTC

- No OSS DTC P0722.
- No transmission fluid pressure (TFP) DTCs P1810, P1815, P1816.
- Ignition voltage between 8-18 volts.
- TFT is between -40°C (-40°F) and 150°C (302°F).
- The engine run time is greater than 5 seconds.
- The throttle position is greater than 12 percent.
- The engine torque is between 108 N·m (80 lb ft) and 882 N·m (651 lb ft).

Conditions for Setting the DTC

The transmission output shaft speed drops greater than 1,000 RPM, for at least 3.4 seconds.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM calculates vehicle speed from the automatic transmission input shaft speed sensor and commanded gear.

- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the engine control module (ECM) records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0723 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

- Inspect the rear internal gear teeth for damage.
- Visually inspect the OSS for cracks or damage.
- Ensure the OSS is properly torqued to the transmission housing.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. Disable the traction control system when performing this step. When the ignition switch is cycled OFF and then back ON, the traction control system defaults to ON.

3. This step tests the OSS.

5. This step tests the integrity of the OSS.

DTC P0723

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame			

2	and Failure Records from the transmission control module (TCM). 3. Record the Freeze Frame and Failure Records. 4. Clear the DTC. 5. Raise and support the rear axle assembly. 6. Start the engine. 7. Disable the traction control system. 8. Place the transmission in D3 range. 9. With the drive wheels rotating, slowly accelerate to 2,000 RPM and hold, road test the vehicle if necessary. Does the scan tool Transmission OSS parameter drop or fluctuate more than the specified value?	1,300 RPM	Go to Step 3	Go to Testing for Intermittent Conditions and Poor Connections
3	1. Turn OFF the ignition. 2. Disconnect the engine wiring harness from the output speed sensor (OSS). 3. Using the DMM and the J 35616 , measure the resistance of the OSS. Does the resistance measure within the specified range?	976-2,354 Ω	Go to Step 4	Go to Step 13
4	Measure the resistance from the high signal circuit of the OSS to ground. Refer to Testing for Continuity . Does the resistance measure greater than the specified value?	50 K Ω	Go to Step 5	Go to Step 13
5	1. Place the transmission in NEUTRAL. 2. Select AC volts on the DMM. 3. Hold one rear wheel from turning. 4. Rotate the other wheel by hand. 5. Measure the AC voltage from high signal and low signal circuits of the OSS assembly. Refer to Measuring Voltage Does the voltage measure greater than the specified value?	0.3 V	Go to Step 6	Go to Step 13
6	1. Connect the engine wiring harness to the OSS. 2. Disconnect the TCM. 3. Measure the resistance of the OSS high signal and OSS low signal circuits at the TCM connector.	976-2,354 Ω		

	Refer to Testing for Continuity . Does the resistance measure within the specified range?		Go to Step 7	Go to Step 8
7	Measure the resistance from the high signal and low signal circuits of the OSS to ground. Refer to Testing for Continuity . Does the resistance measure greater than the specified value?	50 K Ω	Go to Step 9	Go to Step 10
8	Does the resistance measure greater than the specified value?	2,354 Ω	Go to Step 11	Go to Step 12
9	1. Connect the TCM. 2. Disconnect the engine wiring harness from the OSS. 3. Turn ON the ignition, with the engine OFF. 4. Test the high signal circuit of the OSS for a short to voltage. 5. Test the low signal circuit of the OSS for a short to voltage. Refer to Testing for a Short to Voltage and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 15	Go to Step 14
10	1. Test the high signal circuit of the OSS for a short to ground. 2. Test the low signal circuit of the OSS for a short to ground. Refer to Testing for Short to Ground and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 15	--
11	1. Test the high signal circuit of the OSS for an open. 2. Test the low signal circuit of the OSS for an open. Refer to Testing for Continuity and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 15	--
12	Test the high signal and low signal circuits of the OSS for a short together. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 15	--
13	Replace the OSS. Refer to Vehicle Speed Sensor Replacement . Did you complete the replacement?	--	Go to Step 15	--
	Replace the TCM. Refer to Control Module References .			

14	Did you complete the replacement?	--	Go to Step 15	--
15	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle ensuring that the transmission output speed drop is less than 500 RPM for 2 seconds and output speed is greater than 500 RPM. 4. Select Specific DTC. 5. Enter DTC P0723. Has the test run and passed?	--	Go to Step 16	Go to Step 2
16	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0724

Circuit Description

The body control module (BCM) receives a signal from the brake pedal position (BPP) sensor through the brake pedal position switch signal circuit. The BCM then applies a signal through the stop lamp switch signal circuit to the transmission control module (TCM) and engine control module (ECM).

When the TCM detects voltage on the stop lamp switch signal circuit during acceleration then DTC P0724 sets. DTC P0724 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0724 Brake Switch Circuit High Voltage.

Conditions for Running the DTC

- No output speed sensor (OSS) DTCs P0722 or P0723.
- No brake switch DTC P0719.
- The vehicle speed is 8-40 km/h (5-25 mph) for 6 seconds, then greater than 40 km/h (25 mph) for 7 seconds.

Conditions for Setting the DTC

The TCM detects voltage on the stop lamp switch signal circuit during acceleration.

Action Taken When the DTC Sets

- The TCM does not request the ECM to illuminate the malfunction indicator lamp (MIL).
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM records this information as a Failure Record.
- The TCM stores DTC P0724 in TCM history.

Conditions for Clearing the DTC

- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- A scan tool can clear the DTC.

Diagnostic Aids

Important:

- Verify that the BPP sensor is adjusted properly. Refer to Brake Pedal Position Sensor Calibration in Lighting Systems.
- Test drive the vehicle if a switch or circuit condition cannot be located. An intermittent condition may be duplicated during a test drive.
- Application of the brake pedal while accelerating may cause this DTC to set.

Test Description

The number below refers to the step number on the diagnostic table.

2. This step determines if the fault is present.

DTC P0724

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	Are the brake lamps stuck ON?	--	Go to Step 3	Go to Testing for Intermittent Conditions and Poor Connections
3	1. Disconnect the body control module (BCM) connector that contains the stop lamp switch signal circuit. 2. Using J 35616 , with the test lamp connected to ground, probe harness side of the stop lamp switch signal circuit. Does the test lamp illuminate?	--	Go to Step 4	Go to Step 7
4	1. Disconnect the engine control module (ECM) connector that contains the stop lamp switch signal circuit. 2. Using a test lamp connected to ground, probe harness side of the stop lamp switch signal circuit. Does the test lamp illuminate?	--	Go to Step 5	Go to Step 8
5	Test for the stop lamp switch signal circuit a short to voltage between the BCM, ECM and transmission control module (TCM). Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 9	Go to Step 6
	Replace the TCM. Refer to Control Module References .			

6	Did you complete the replacement?	--	Go to Step 9	--
7	Replace the BCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 9	--
8	Replace the ECM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 9	--
9	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Turn ON the ignition, with the engine OFF for at least 2 seconds. • Start the vehicle and idle for 5 seconds. • Drive in D4 from 0-60 km/h (0-37 mph) 8 times in 1 ignition cycle. 4. Select Specific DTC. 5. Enter DTC P0724. Has the test run and passed?	--	Go to Step 10	Go to Step 2
10	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0741

Circuit Description

The torque converter clutch (TCC) solenoid valve is a normally-open exhaust valve that is used with the torque converter clutch pulse width modulation (TCC PWM) solenoid valve in order to control fluid acting on the converter clutch apply valve. The TCC solenoid valve attaches to the transmission case assembly extending into the pump cover. When grounded, energised, by the transmission control module (TCM), the TCC solenoid valve stops converter signal oil from exhausting. This causes converter signal oil pressure to increase and move the converter clutch apply valve against spring force and into the apply position. In this position, release fluid is open to an exhaust port and converter feed fluid fills the apply fluid circuit. The converter feed fluid applies the TCC. When the TCM no longer provides a ground path, the TCC solenoid valve de-energises and apply fluid exhausts, releasing the TCC.

When the TCM detects high torque converter slip when the TCC is commanded OFF, then DTC P0741 sets. DTC P0741 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0741 Torque Converter Clutch (TCC) System - Stuck Off.

Conditions for Running the DTC

- No output shaft speed (OSS) DTCs P0722 or P0723.
- No TCC system stuck-on DTC P0742.
- No TCC solenoid electrical DTCs P2763 or P2764.
- The IMS range is D2, D3, D4, or D5.
- Ignition voltage between 8-18 volts.
- The transmission fluid temperature is greater than 20°C (68°F).
- The engine torque is between 108 N·m (80 lb ft) and 881 N·m (650 lb ft).
- The throttle position is greater than 10 percent.
- The gear ratio is within the following ranges:
  - 1.41:1-1.56:1 - 2nd gear
  - 0.95:1-1.05:1 - 3rd gear
- The TCC is commanded ON .1 seconds.
- The TCC duty cycle is greater than 60 percent for more than 3 seconds.

Conditions for Setting the DTC

The TCM commands the TCC ON, and the TCC slip is greater than 250 RPM for 3 seconds.

Action Taken When the DTC Sets

- The TCM requests the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL) during the second consecutive drive trip in which the Conditions for Setting the DTC are met.
- The TCM inhibits TCC.
- The TCM inhibits 4th gear if the transmission is in Hot Mode.
- The TCM commands elevated line pressure.
- The TCM freezes transmission adaptive functions.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0741 in TCM history.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

- Inspect the transmission fluid lines to the radiator. The lines may be pinched, plugged or twisted.
- Contamination may cause the TCC apply valve to stick in the valve body.
- Internal damage to the torque converter may prevent TCC application.

Test Description

The number below refers to the step number on the diagnostic table.

2. This step tests the hydraulic state of the TCC. When the TCM commands the TCC solenoid valve OFF, the slip speed should increase.

DTC P0741

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle

2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info. function erases the Freeze Frame and Failure Records from the transmission control module (TCM). 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Drive the vehicle in the D4 drive range in second, third, or fourth gear under steady acceleration, with a TP angle at 20 percent. While the scan tool TCC Enable status is ON, does the scan tool display a TCC Slip Speed within the specified range?	-20 to +20 RPM	Go to Diagnostic Aids	Go to Step 3
3	The torque converter clutch (TCC) system is hydraulically stuck OFF. Inspect for the following conditions: • Torque converter clutch/pulse width modulation (TCC PWM) solenoid valve mechanically stuck OFF or leaking. • TCC regulator apply valve stuck in the OFF position. • TCC Sol valve stuck in the OFF position or leaking. • TCC enable valve stuck in the OFF position. • Misaligned damaged or leaking valve body gasket. • Inspect the forward clutch input housing assembly for the input shaft fluid seal ring leaking or worn. Did you find and correct any of the above conditions?	--	Go to Step 4	--
4	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle in D4 with the TCC ON and the throttle above 10 percent. Ensure that the scan tool TCC Slip Speed	--		

	is -25 to +25 RPM for 3 seconds. 4. Select Specific DTC. 5. Enter DTC P0741. Has the test run and passed?		Go to Step 5	Go to Step 2
5	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0742

Circuit Description

The torque converter clutch (TCC) solenoid valve is a normally-open exhaust valve that is used with the torque converter clutch pulse width modulation (TCC PWM) solenoid valve in order to control fluid acting on the converter clutch apply valve. The TCC solenoid valve attaches to the transmission case assembly extending into the pump cover. When grounded, energised, by the transmission control module (TCM), the TCC solenoid valve stops converter signal oil from exhausting. This causes converter signal oil pressure to increase and move the converter clutch apply valve against spring force and into the apply position. In this position, release fluid is open to an exhaust port and converter feed fluid fills the apply fluid circuit. The converter feed fluid applies the TCC. When the TCM no longer provides a ground path, the TCC solenoid valve de-energises and apply fluid exhausts, releasing the TCC.

When the TCM detects low torque converter slip when the TCC is commanded OFF, then DTC P0742 sets. DTC P0742 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0742 Torque Converter Clutch (TCC) System - Stuck On.

Conditions for Running the DTC

- No TCC electrical DTCs P02763, P02764, P02769, P02770.
- No TCC performance DTC P0741.
- No output shaft speed (OSS) sensor DTCs P0722 or P0723.
- Ignition voltage is between 8-18 volts.
- The engine run time is greater than 5 seconds.
- The information management system (IMS) range is D5.
- The transmission fluid temperature is 10-130°C (50-266°F).
- The engine speed is 500-6,500 RPM for 5 seconds, then 800-4,400 RPM.
- The engine torque is between 156 N·m (115 lb ft) and 881 N·m (650 lb ft).
- The throttle position is greater than 10 percent.
- The transmission is not in 1st gear and the gear ratio is 0.95:1-1.56:1.
- The vehicle speed is greater than 15 km/h (9 mph).
- TCC is commanded OFF.

Conditions for Setting the DTC

The following conditions occur 4 times in 1 ignition cycle:

- The TCM commands the TCC OFF.
- The TCC slip is between -15 to +15 RPM for greater than 3 seconds.

Action Taken When the DTC Sets

- The TCM requests the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL) during the second consecutive drive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0742 in TCM history.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

The TCC fluid hydraulically applies the TCC, possibly causing an engine stall, under the following conditions:

- The TCC is hydraulically stuck ON.
- The parking brake is applied.
- Any gear range is selected.
- Contamination may cause the TCC apply valve to intermittently stick in the valve body.
- Internal damage in the torque converter may cause no TCC apply.

Test Description

The number below refers to the step number on the diagnostic table.

2. This step tests the hydraulic state of the TCC. When the TCM commands the TCC solenoid valve OFF, the slip speed should increase.

DTC P0742

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info. function erases the Freeze Frame and Failure Records from the transmission control module (TCM). 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Drive the vehicle in the D4 drive range in second, third, or fourth gear under steady acceleration, with a TP angle at 10 percent. While the scan tool TCC Enable status is NO, does the scan tool display a TCC Slip Speed within the specified range?	-20 to +20 RPM	Go to Step 3	Go to Diagnostic Aids
3	The TCC is hydraulically stuck ON. Inspect for the following: - Clogged exhaust orifice in the torque converter clutch (TCC) solenoid valve. - Converter clutch apply valve stuck in the apply position. - Misaligned or damaged valve body gasket. - Restricted release passage. - Restricted transmission cooler line. Did you find and correct the condition?	--	Go to Step 4	--
4	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle in D4 with the TCC OFF and the throttle above 10 percent. Ensure that the scan tool TCC Slip Speed is 100-2,500 RPM for 3 seconds. 4. Select Specific DTC.	--		

	5. Enter DTC P0742. Has the test run and passed?		Go to Step 5	Go to Step 2
5	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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DTC P0751

Circuit Description

The 1-2 shift solenoid (SS) valve controls the fluid flow acting on the 1-2 and 3-4 shift valves. The 1-2 SS valve is a normally-open exhaust valve that is used with the 2-3 SS valve, in order to allow 4 different shifting combinations.

If the transmission control module (TCM) detects a 2-2-3-3 shift pattern, then DTC P0751 sets. DTC P0751 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0751 1-2 Shift Solenoid (SS) Valve Performance - No First or Fourth Gear.

Conditions for Running the DTC

- No output shaft speed (OSS) DTCs P0722 or P0723.
- No TCC performance DTC P0742, P0894.
- No shift solenoid electrical DTCs P0973, P0974, P0976, or P0977.
- No information management system (IMS) DTCs P1815, P1820, P1822, P1823, P1825 or P1826.
- The ignition voltage is 8-18 volts.
- The engine RPM is 500-6,500 RPM for greater than 5 seconds.
- The transmission fluid temperature is 20-130°C (68-266°F).
- The throttle position is greater than 10 percent.
- The input shaft speed is 200-6,800 RPM.
- The output shaft speed is greater than 100 RPM.

Conditions for Setting the DTC

Both of the following conditions must occur twice during the same trip:

- Fail Case 1: The TCM commands 1st gear and the resulting gear ratio is 1.44:1-1.50:1 for 2 seconds.
- Fail Case 2: The TCM commands 4th gear and the resulting gear ratio is 0.98:1-1.03:1 for 4 seconds.

Action Taken When the DTC Sets

- The TCM requests the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.

- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0751 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the 4th consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

- If you clear DTC P0751, and then cannot reset DTC P0751, the following conditions may exist:
  - Fluid contamination.
  - Plugged fluid circuits.
  - Restricted fluid circuits.
- Refer to Shift Solenoid Valve State and Gear Ratio .

Test Description

The number below refers to the step number on the diagnostic table.

2. This step tests that the TCM commanded all shifts, that all shift solenoid valves responded correctly, but that all the shifts did not occur.

DTC P0751

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF.			

2	**Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the transmission control module (TCM). 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Drive the vehicle in D4 range under the following conditions: Accelerate the vehicle, ensuring that the TCM commands 1st, 2nd, 3rd and 4th gears. Did you detect a 2-2-3-3 shift pattern?	--	Go to Step 3	Go to Diagnostic Aids
3	Inspect the shift solenoid/hydraulic circuit for the following conditions: - An internal malfunction - Damaged seals on the shift solenoid valve--Refer to Shift Solenoid Leak Test . Did you find and correct the condition?	--	Go to Step 4	--
4	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle in D4 range under the following conditions, only if traffic and road conditions permit: Hold the throttle at 20 percent and accelerate to 88 km/h (55 mph). 4. Select Specific DTC. 5. Enter DTC P0751. Has the test run and passed?	--	Go to Step 5	Go to Step 2
5	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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DTC P0752

Circuit Description

The 1-2 shift solenoid (SS) valve controls the fluid flow acting on the 1-2 and 3-4 shift valves. The 1-2 SS valve is a normally-open exhaust valve that is used with the 2-3 SS valve, in order to allow 4 different shifting combinations.

When the transmission control module (TCM) detects a 1-1-4-4 shift pattern, then DTC P0752 sets. DTC P0752 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0752 1-2 Shift Solenoid (SS) Valve Performance - No Second or Third Gear.

Conditions for Running the DTC

- No output shaft speed (OSS) DTCs P0722 or P0723.
- No torque converter clutch (TCC) performance DTC P0742 or P0894.
- No shift solenoid electrical DTCs P0973, P0974, P0976, or P0977.
- Ignition voltage between 8-18 volts.
- The engine run time is greater than 5 seconds.
- The transmission fluid temperature is 20-130°C (68-266°F).
- The throttle position is greater than 10 percent.
- The output shaft speed is greater than 150 RPM.
- The engine torque is between 108 N·m (80 lb ft) and 882 N·m (651 lb ft).

Conditions for Setting the DTC

The TCM commands 2nd gear and the resulting gear ratio is 2.42:1-2.52:1, 1st gear ratio for 2 seconds twice during the same trip.

Action Taken When the DTC Sets

- The TCM requests the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM inhibits 3-2 downshifts if the vehicle speed is greater than 40 km/h (25 mph).
- At the time of the first failure, the TCM records the operating conditions when the Conditions

for Setting the DTC are met. The TCM stores this information as a Failure Record.

- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0752 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the 4th consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

- If you clear DTC P0752, and then cannot reset DTC P0752, the following conditions may exist:
  - Fluid contamination.
  - Plugged fluid circuits.
  - Restricted fluid circuits.
- Refer to Shift Solenoid Valve State and Gear Ratio .

Test Description

The number below refers to the step number on the diagnostic table.

2. This step tests that the TCM commanded all shifts, that all shift solenoid valves responded correctly, but that all the shifts did not occur.

DTC P0752

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the			

2	transmission control module (TCM). 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Drive the vehicle in D4 range under the following conditions: Accelerate the vehicle, ensuring that the TCM commands 1st, 2nd, 3rd and 4th gears. Did you detect a 1-1-4-4 shift pattern?	--	Go to Step 3	Go to Diagnostic Aids
3	Inspect the shift solenoid/hydraulic circuit for the following conditions: - An internal malfunction. - Damaged seals on the shift solenoid valve--Refer to Shift Solenoid Leak Test . Did you find and correct the condition?	--	Go to Step 4	--
4	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle in D4 range under the following conditions, only if traffic and road conditions permit: Hold the throttle at 20 percent and accelerate to 88 km/h (55 mph). 4. Select Specific DTC. 5. Enter DTC P0752. Has the test run and passed?	--	Go to Step 5	Go to Step 2
5	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0756

Circuit Description

The 2-3 shift solenoid (SS) valve controls the fluid flow acting on the 2-3 shift valves. The 2-3 SS valve is a normally-open exhaust valve that is used with the 1-2 SS valve, in order to allow 4 different shifting combinations.

When the transmission control module (TCM) detects a 4-3-3-4 shift pattern, then DTC P0756 sets. DTC P0756 is a type A DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0756 2-3 Shift Solenoid (SS) Valve Performance - No First or Second Gear.

Conditions for Running the DTC

- No throttle position (TP) sensor DTC P0120.
- No output shaft speed (OSS) DTCs P0722 or P0723.
- No torque converter clutch (TCC) performance DTC P0742.
- No shift solenoid electrical DTCs P0973, P0974, P0976, or P0977.
- No IMS DTCs P1815, P1820, P1822, P1823, P1825 or P1826.
- The engine torque is between 108 N·m (80 lb ft) and 882 N·m (651 lb ft).
- The engine run time is greater than 5 seconds.
- The transmission fluid temperature is 20-130°C (68-266°F).
- The throttle position is greater than 10 percent.
- The output shaft speed is greater than 150 RPM.

Conditions for Setting the DTC

Both of the following conditions must occur twice during the same trip:

- Fail Case 1: The TCM commands 1st gear when the output shaft speed is 200 RPM or greater, the engine torque is 40-350 N·m (30-258 lb ft), and the resulting gear ratio is 0.73:1-0.77:1 for 2.8 seconds.
- Fail Case 2: The TCM commands 2nd gear when the engine torque is 36-350 N·m (27-258 lb ft) and the resulting gear ratio is 1.56:1-1.64:1 for 1 second.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.

- The TCM inhibits 1st gear.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0756 in TCM history.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the 4th consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

- If you clear DTC P0756, and then cannot reset DTC P0756, the following conditions may exist:
  - Fluid contamination.
  - Plugged fluid circuits.
  - Restricted fluid circuits.
- Refer to Shift Solenoid Valve State and Gear Ratio .

Test Description

The number below refers to the step number on the diagnostic table.

2. This step tests that the TCM commanded all shifts, that all shift solenoid valves responded correctly, but that all the shifts did not occur.

DTC P0756

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF.			

2	**Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the transmission control module (TCM). 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Drive the vehicle in D4 range under the following conditions: Accelerate the vehicle, ensuring that the TCM commands 1st, 2nd, 3rd and 4th gears. Did you detect a 4-3-3-4 shift pattern?	--	Go to Step 3	Go to Diagnostic Aids
3	1. Inspect the shift solenoid/hydraulic circuit for the following conditions: - Debris or chips in the AFL oil passage. - Debris or chips restricting oil flow in passage #29 of the case or through the spacer plate gasket into the valve body. - A cracked 2-3 shift solenoid. - A 2-3 shift valve which is stuck or hung up in the valve body bore. - A 2-3 shuttle valve which is stuck or hung up in its bore. - Damaged seals on the shift solenoid valves--Refer to Shift Solenoid Leak Test . 2. Clean and inspect the related valves, bores and the valve body for debris or contamination. Did you find and correct the condition?	--	Go to Step 4	--
4	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle in D4 range under the following conditions, only if traffic and road conditions permit: Hold the throttle at 40 percent and accelerate to 64 km/h (40 mph). 4. Select Specific DTC.	--		

	5. Enter DTC P0756. Has the test run and passed?		Go to Step 5	Go to Step 2
5	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0757

Circuit Description

The 2-3 shift solenoid (SS) valve controls the fluid flow acting on the 2-3 shift valves. The 2-3 SS valve is a normally-open exhaust valve that is used with the 1-2 SS valve in order to allow four different shifting combinations.

When the transmission control module (TCM) detects a 1-2-2-1 shift pattern, then DTC P0757 sets. DTC P0757 is a type A DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0757 2-3 Shift Solenoid (SS) Valve Performance - No Third or Fourth Gear.

Conditions for Running the DTC

- No throttle position (TP) sensor DTC P0120.
- No output shaft speed (OSS) DTCs P0722 or P0723.
- No torque converter clutch (TCC) performance DTC P0742.
- No shift solenoid electrical DTCs P0973, P0974, P0976, or P0977.
- No IMS DTCs P1815, P1820, P1822, P1823, P1825 or P1826.
- The engine torque is between 108 N·m (80 lb ft) and 882 N·m (651 lb ft).
- The engine run time is greater than 5 seconds.
- The transmission fluid temperature is 20-130°C (68-266°F).
- The throttle position is greater than 10 percent.
- The output shaft speed is greater than 150 RPM.

Conditions for Setting the DTC

The TCM commands 3rd gear and the resulting gear ratio is a 1.44:1-1.52:1, 1st gear, for 2.25 seconds.

Action Taken When the DTC Sets

- The TCM requests the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM inhibits 4th gear.

- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0757 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the 4th consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

- If you clear DTC P0757, and then cannot reset DTC P0757, the following conditions may exist:
  - Fluid contamination.
  - Plugged fluid circuits.
  - Restricted fluid circuits.
- Refer to Shift Solenoid Valve State and Gear Ratio .

Test Description

The number below refers to the step number on the diagnostic table.

2. This step tests that the TCM commanded all shifts, that all shift solenoid valves responded correctly, but that all the shifts did not occur.

DTC P0757

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using			

2	the Clear Info function erases the Freeze Frame and Failure Records from the TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Drive the vehicle in D4 range under the following conditions: Accelerate the vehicle, ensuring that the TCM commands 1st, 2nd, 3rd and 4th gears. Did you detect a 1-2-2-1 shift pattern?	--	Go to Step 3	Go to Diagnostic Aids
3	Inspect the shift solenoid/hydraulic circuit for the following conditions: - An internal malfunction. - Damaged seals on the shift solenoid valve--Refer to Shift Solenoid Leak Test . Did you find and correct the condition?	--	Go to Step 4	--
4	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle in D4 range under the following conditions, only if traffic and road conditions permit: Hold the throttle at 15 percent and accelerate to 80 km/h (55 mph). 4. Select Specific DTC. 5. Enter DTC P0757. Has the test run and passed?	--	Go to Step 5	Go to Step 2
5	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0787

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit Description

The 3-2 shift solenoid (SS) valve is a normally-closed, 3-port, on/off device that controls the 3-2 downshift. The solenoid attaches to the control valve body within the transmission. The solenoid receives ignition voltage through the ignition 1 circuit. The transmission control module (TCM) controls the solenoid by providing a ground path on the 3-2 shift solenoid valve control circuit. During a 3-2 downshift, the 2-4 band applies as the 3-4 clutch releases. The TCM varies the timing between the 3-4 clutch release and the 2-4 band apply depending on the vehicle speed and the throttle position.

When the TCM detects a continuous open, short to ground or short to voltage in the 3-2 SS valve circuit, then DTC P0787 sets. DTC P0787 is a type A DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0787 3-2 Shift Solenoid (SS) Control Circuit Low Voltage.

Conditions for Running the DTC

- The system voltage is 10-18 volts.
- The engine speed is greater than 450 RPM for 5 seconds.
- Vehicle speed is less than 200 km/h (124 mph).

Conditions for Setting the DTC

DTC P0787 sets if one of the following conditions occurs for 5 seconds:

Condition 1

The TCM commands the solenoid ON and the voltage feedback remains high, B+.

Condition 2

The TCM commands the solenoid OFF and the voltage feedback remains low, 0 volts.

Action Taken When the DTC Sets

- The TCM requests the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM commands 3rd gear.
- The TCM inhibits TCC engagement.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0787 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the 4th consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

4. This step tests the ability of the TCM to control the solenoid.
5. This step tests for voltage to the 3-2 SS valve.
6. This step tests the ability of the TCM and wiring to control the ground circuit.
8. This step measures resistance of the automatic transmission (A/T) wiring harness and the 3-2 SS valve.

DTC P0787

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
	1. Install a scan tool.			

2	2. Turn ON the ignition, with the engine OFF. **Important::** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the transmission control module (TCM). 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. Are any of the following DTCs also set? - P0961 - P0973 - P0976 - P2764 - P2769	--	Go to Step 3	Go to Step 4
3	Inspect the ACC/TCM fuse for an open. Refer to Circuit Protection - Fuses . Is the fuse open?	--	Go to Step 12	Go to Step 5
4	With a scan tool, command the 3-2 Downshift Solenoid ON. Does the 3-2 Sol. CKT status parameter display OK when commanded ON?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the A/T inline 20-way connector, additional DTCs may set. 3. Install the J 44152 Jumper Harness (20 pins) on the engine side of the A/T inline 20-way connector. 4. Turn ON the ignition, with the engine OFF. 5. Using the J 35616 , connect a test lamp from 3-2 SS valve ignition 1 voltage circuit of the J 44152 to ground. Refer to Component Connector End Views . Does the test lamp illuminate?	--	Go to Step 6	Go to Step 15
	1. Connect a test lamp between the 3-2 SS valve IGN 1 voltage and control circuits of the J 44152 . Refer to Component Connector End			

6	Views and Testing for Continuity . 2. Use the scan tool in order to command the 3-2 SS valve ON and OFF 3 times. Does the test lamp turn ON and OFF with each command?	--	Go to Step 8	Go to Step 7
7	Is the test lamp always ON?	--	Go to Step 16	Go to Step 17
8	1. Install the J 44152 on the transmission side of the A/T inline 20-way connector. 2. Using the DMM and the J 35616 , measure the resistance between the 3-2 SS valve IGN 1 voltage and control circuits of the J 44152 . Refer to Testing for Continuity . Refer to Component Connector End Views . Does the resistance measure within the specified range?	20-32 Ω	Go to Step 9	Go to Step 10
9	Measure the resistance from the 3-2 SS valve IGN voltage and control circuits to ground. Refer to Testing for Continuity . Do both readings measure greater than the specified value?	250 K Ω	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 11
10	1. Disconnect the A/T wiring harness from the 3-2 SS valve. 2. Measure the resistance of the 3-2 SS valve. Refer to Testing for Intermittent Conditions and Poor Connections . Does the resistance measure within the specified range?	20-32 Ω	Go to Step 18	Go to Step 19
11	1. Disconnect the A/T wiring harness from the 3-2 SS valve. 2. Measure the resistance from the component's terminals to ground. Refer to Testing for Intermittent Conditions and Poor Connections . Do both readings measure greater than the specified value?	250 K Ω	Go to Step 18	Go to Step 19
	Important: The condition that affects this circuit may exist in other connecting branches of the circuit. Refer to Power Distribution			

12	Schematics , for complete circuit distribution. Test the ignition circuit of the 3-2 SS valve for a short to ground between the fuse block-underhood and the A/T inline 20-way connector. Refer to Testing for Short to Ground and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 21	Go to Step 13
13	**Important:** The condition that affects this circuit may exist in other connecting branches of the circuit. Refer to Power Distribution Schematics , for complete circuit distribution. Test the ignition voltage circuit of the 3-2 SS valve for a short to ground between the A/T inline 20-way connector and the 3-2 SS valve assembly. Refer to Testing for Short to Ground . Did you find a short to ground condition?	--	Go to Step 18	Go to Step 14
14	1. Test each solenoid for a short to ground. Refer to Testing for Short to Ground . 2. Replace the faulty solenoid as necessary. Did you complete the replacement?	--	Go to Step 21	--
15	**Important:** The condition that affects this circuit may exist in other connecting branches of the circuit. Refer to Power Distribution Schematics , for complete circuit distribution. Test the ignition circuit of the 3-2 SS valve for an open. Refer to Testing for Continuity and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 21	--
16	Test the control circuit of the 3-2 SS valve for a short to ground between the TCM and the A/T inline 20-way connector. Refer to Testing for Short to Ground and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 21	Go to Step 20
17	Test the control circuit of the 3-2 SS valve for an open between the TCM and the A/T inline 20-way connector. Refer to Testing for a Short to Voltage and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 21	Go to Step 20
	Replace the A/T wiring harness. Refer to			

18	Torque Converter Clutch Pulse Width Modulation Solenoid, Torque Converter Clutch Solenoid, and Wiring Harness . Did you complete the replacement?	--	Go to Step 21	--
19	Replace the 3-2 SS valve. Refer to Control and Shift Solenoids Replacement . Did you complete the replacement?	--	Go to Step 21	--
20	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 21	--
21	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle in D3 or D4 and perform a 3-2 downshift. Ensure the 3-2 Sol. CKT status parameter displays OK. 4. Select specific DTC. 5. Enter DTC P0787. Has the test run and passed?	--	Go to Step 22	Go to Step 2
22	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0788

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit Description

The 3-2 shift solenoid (SS) valve is a normally-closed, 3-port, ON/OFF device that controls the 3-2 downshift. The solenoid attaches to the control valve body within the transmission. The solenoid receives voltage through the ignition 1 voltage circuit. The transmission control module (TCM) controls the solenoid by providing a ground path on the 3-2 shift solenoid valve control circuit. During a 3-2 downshift, the 2-4 band applies as the 3-4 clutch releases. The TCM varies the timing between the 3-4 clutch release and the 2-4 band apply depending on the vehicle speed and throttle position.

When the TCM detects a continuous short to voltage in the 3-2 shift solenoid valve control circuit, then DTC P0788 sets. DTC P0788 is a type A DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0788 3-2 Shift Solenoid (SS) Control Circuit High Voltage.

Conditions for Running the DTC

- The system voltage is 10-18 volts.
- The engine speed is 450 RPM for 5 seconds.
- The engine is not in fuel cutoff.

Conditions for Setting the DTC

DTC P0788 sets if the TCM commands the solenoid ON and the voltage feedback remains high, B+.

Action Taken When the DTC Sets

- The TCM requests the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.

- The TCM commands 3rd gear.
- The TCM inhibits torque converter clutch (TCC) engaugement.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0788 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the 4th consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

DTC P0788

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the transmission control module (TCM). 3. Record the DTC Freeze Frame and Failure Records. 4. With a scan tool, command the 3-2 Sol. ON. Does the 3-2 Sol. CKT status parameter display OK?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
	1. Turn OFF the ignition. 2. Disconnect the A/T inline 20-way connector, additional DTCs may set. 3. Install the J 44152 on the engine side of the A/T inline 20-way connector. 4. Turn ON the ignition, with the engine			

3	OFF. 5. Using the J 35616 , connect a test lamp from 3-2 shift solenoid valve control circuit of the J 44152 to ground. Refer to Component Connector End Views . Does the test lamp illuminate?	--	Go to Step 6	Go to Step 4
4	1. Install the J 44152 on the transmission side of the A/T inline 20-way connector. 2. Using the DMM and J 35616 , measure the resistance between the ignition voltage and 3-2 shift solenoid valve control circuits of the J 44152 . Refer to Component Connector End Views . Does the resistance measure less than the specified value?	20 Ω	Go to Step 5	Go to Step 7
5	1. Disconnect the A/T internal wiring harness assembly from the 3-2 SS valve. 2. Measure the resistance of the 3-2 SS valve. Does the resistance measure less than the specified value?	20 Ω	Go to Step 8	Go to Step 7
6	Test the control circuit of the 3-2 SS valve for a short to voltage between the TCM and the A/T inline 20-way connector. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 10	Go to Step 9
7	Replace the A/T internal wiring harness. Refer to Torque Converter Clutch Pulse Width Modulation Solenoid, Torque Converter Clutch Solenoid, and Wiring Harness . Did you complete the replacement?	--	Go to Step 10	--
8	Replace the 3-2 SS valve. Refer to Control and Shift Solenoids Replacement . Did you complete the replacement?	--	Go to Step 10	--
9	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 10	--
	Perform the following procedure in order to verify the repair: 1. Select DTC.			

10	2. Select Clear Info. 3. Drive the vehicle in D4 and make sure the following conditions are met: - The TCM commands the 3-2 SS valve ON and the 3-2 Sol. CKT status parameter displays OK. - The TCM commands the 3-2 SS valve OFF and the 3-2 Sol. CKT status parameter displays OK. - All conditions are met for 5 seconds. 4. Select Specific DTC. 5. Enter DTC P0788. Has the test run and passed?	--	Go to Step 11	Go to Step 2
11	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0815, P0816, or P0826

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P0815 00: Upshift Switch Circuit.

DTC P0816 00: Downshift Switch Circuit.

DTC P0826 00: Up and Down Shift Switch Circuit.

Circuit / System Description

The driver shift control (DSC), also known as the tap shift, allows the driver to manually shift gears by placing the shift control lever in the DSC position and pushing the lever upwards or downwards to select the desired gear. The DSC receives a 12 volt supply voltage from the BCM, and when pushing the shift lever in either direction a momentary switch is activated and a signal is sent to the cruise control module and body control module (BCM). The DSC shift system is only activate when the gear selector is in the Manual (M) position. The DSC system is deactivated in all other range positions.

Conditions for Running the DTC

DTCs P0815, P0816 or P0826

- The engine speed is between 500-6,500 RPM for at least 5 seconds.
- The time since the last gear selector range change is greater than 6 seconds.

Conditions for Setting the DTC

DTC P0815

The BCM detects an upshift request for 3 seconds in PARK, REVERSE, NEUTRAL, or D6- and for 600 seconds in PARK, REVERSE, NEUTRAL, D2, D4, OR D6.

DTC P0816

The BCM detects a downshift request for 3 seconds in PARK, REVERSE, NEUTRAL, or D6- and for 600 seconds in PARK, REVERSE, NEUTRAL, D2, D4, or D6.

DTC P0826

The BCM detects an invalid voltage on the TAP up/down signal circuit for 5 seconds.

Action Taken When the DTC Sets

The multi function display (MFD) displays the ESP Off message.

- DTCs P0815, P0816, and P0826 are Type C DTCs.
- The BCM disables TAP shift operation.

Conditions for Clearing the DTC

DTCs P0815, P0816, and P0826 are Type C DTCs.

Reference Information

Schematic Reference

Antilock Brake System Schematics .

Connector End View Reference

Component Connector End Views .

Electrical Information Reference

- Circuit Testing .
- Connector Repairs .
- Testing for Intermittent Conditions and Poor Connections .
- Wiring Repairs .

Scan Tool Reference

Control Module References .

Circuit/System Verification

With the engine ON, engage the DSC switch positions. using a scan too while observe the Driver Shift Request parameter. The parameter should change to reflect the selected up or downshift switch position and with no up or downshift switch position selected the parameter should display None.

Circuit/System Testing

DTC P0815

1. Select the Driver Shift Request parameter.
2. Disconnect the automatic transmission DSC shift switch connector.

   If the parameter status changes from upshift to invalid, replace the DSC shift switch.

   If the parameter status does not change, replace the BCM.

DTC P0816

1. Select the Driver Shift Request parameter.
2. Disconnect the DSC shift switch connector.

   If the parameter status changes from downshift to invalid, replace the DSC shift switch.

   If the parameter status does not change, replace the BCM.

DTC P0826

1. If any other DTC are set diagnose those DTCs first.
2. Ignition OFF, disconnect the DSC shift switch connector.
3. Connect a test lamp between the 12 V reference and a known ground.

   If the test lamp does not illuminate, test the 12 V reference circuit for an short to ground or open/high resistance. If circuit test normal replace the BCM.
4. If all circuits test normal replace the electronic range selector switch.

Component Testing

1. Test the DSC shift switch for correct resistance value, 8.11-8.39 ohms.

   If the resistance is not within specifications, replace the DSC switch.

Repair Instructions

Perform the Diagnostic Repair Verification Diagnostic Repair Verification after completing the diagnostic procedure.

- Transmission Control Replacement Floor Shift Control Replacement .
- Control Module References Control Module References for BCM replacement, setup, and programming.

DTC P0961

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit Description

The pressure control (PC) solenoid valve is an electronic device that regulates transmission line pressure based on the current flow through its coil winding. The magnetic field produced by the coil moves the solenoid's internal valve which varies pressure to the pressure regulator valve. The transmission control module (TCM) controls the PC solenoid valve by applying a varying amount of amperage to the solenoid. The applied amperage can vary from 0.1-1.1 amps. Low amperage, 0.1 amp, indicates high line pressure. High amperage, 1.1 amps, indicates low line pressure. The duty cycle of the PC solenoid valve is expressed as a percentage of energised ON time.
Zero percent indicates zero ON time, non-energised, or no current flow. Approximately 60 percent at idle indicates maximum ON time, energised, or high current flow. The TCM determines the appropriate line pressure for a given load by comparing the throttle position sensor voltage, the engine speed and other inputs.

When the TCM detects a continuous open or short to ground in the PC solenoid valve circuit, then DTC P0961 sets. DTC P0961 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0961 Line Pressure Control (PC) Solenoid System Performance.

Conditions for Running the DTC

- The system voltage is 8-18 volts.
- The engine is running.

Conditions for Setting the DTC

The PC solenoid valve duty cycle reaches its high limit, approximately 95 percent, or low limit, approximately 2 percent.

Action Taken When the DTC Sets

- The TCM does not request the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL).

- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM records this information as a Failure Record.
- The TCM freezes transmission adaptive functions.
- The TCM commands maximum line pressure.
- The TCM stores DTC P0961 in TCM history.

Conditions for Clearing the DTC

- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- A scan tool can clear the DTC.

Diagnostic Aids

DTC P0961 may set under low voltage conditions caused by high electrical system demands.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. This step tests the ability of the TCM to command the PC solenoid valve.

3. This step tests the PC solenoid valve and automatic transmission (A/T) wiring harness assembly for incorrect resistance.

DTC P0961

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Failure Records. Using the Clear Info function erases the Failure Records from the transmission control module (TCM). 3. Record the DTC Failure Records. 4. Clear the DTC. 5. Start the engine. 6. Use the scan tool in order to command 0.1 amp through 1.0 amp while observing PC Sol. Ref. Current	0.16 amp		

	and PC Sol. Actual Current. Is the PC Sol. Actual Current always within the specified value of the PC Sol. Ref. Current?		Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the A/T inline 20-way connector. 3. Install the J 44152 Jumper Harness (20 pins) on the transmission side of the A/T inline 20-way connector. 4. Using the DMM and the J 35616 , measure the resistance between the PC solenoid valve high and low control circuits of the J 44152 . Refer to Testing for Continuity . Refer to Component Connector End Views . Does the resistance measure within the specified range?	3-7 Ω	Go to Step 5	Go to Step 4
4	Does the resistance measure greater than the specified value?	7 Ω	Go to Step 9	Go to Step 10
5	Measure the resistance from the PC solenoid valve high control circuit of the J 44152 to the transmission case. Refer to Component Connector End Views and Testing for Continuity . Does the resistance measure greater than the specified value?	250 K Ω	Go to Step 6	Go to Step 11
6	1. Disconnect the J 44152 from the transmission side of the A/T inline 20-way connector. 2. Connect the transmission A/T inline 20-way connector. 3. Disconnect the TCM. 4. Measure the resistance between TCM the PC solenoid valve high and low control circuits. Refer to Testing for Continuity . Does the resistance measure within the specified range?	3-7 Ω	Go to Step 8	Go to Step 7
7	Does the resistance measure greater than the specified value?	7 Ω	Go to Step 12	Go to Step 13
8	Using the DMM and the J 35616 , measure the resistance from TCM connector the PC solenoid valve high control circuit to ground. Refer to Testing for Continuity .	250 K Ω		

	Does the resistance measure greater than the specified value?		Go to Step 17	Go to Step 14
9	Test the high control circuit and the low control circuit of the PC solenoid for an open between the A/T inline 20-way connector and the PC solenoid. Refer to Testing for Continuity . Did you find an open condition?	--	Go to Step 16	Go to Step 15
10	Test the high control circuit and the low control circuit of the PC solenoid for a shorted together condition between the A/T inline 20-way connector and the PC solenoid. Refer to Circuit Testing . Did you find a shorted together condition?	--	Go to Step 16	Go to Step 15
11	Test the high control circuit and the low control circuit of the PC solenoid for a short to ground between the A/T inline 20-way connector and the PC solenoid. Refer to Testing for Short to Ground . Did you find a short to ground condition?	--	Go to Step 16	Go to Step 15
12	Test the high control circuit and the low control circuit of the PC solenoid for an open between the TCM and the A/T inline 20-way connector. Refer to Testing for Continuity and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 18	--
13	Test the high control circuit and the low control circuit of the PC solenoid for a shorted together condition between the TCM and the A/T inline 20-way connector. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 18	--
14	Test the high control circuit and the low control circuit of the PC solenoid for a short to ground between the TCM and the A/T inline 20-way connector. Refer to Testing for Short to Ground and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 18	--
15	Replace the PC solenoid valve. Refer to Valve Body and Pressure Switch Replacement Did you complete the replacement?	--	Go to Step 18	--
	Replace the A/T wiring harness. Refer to Valve Body and Pressure Switch			

16	Replacement Did you complete the replacement?	--	Go to Step 18	--
17	Test the high control circuit and the low control circuit of the PC solenoid for a short to voltage. Refer to Testing for a Short to Voltage and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 19	Go to Step 18
18	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 19	--
19	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Start the engine and make sure the following condition is met: The difference between the scan tool PC Sol. Actual Current and the PC Sol. Ref. Current is less than 0.16 amp. 4. Select Specific DTC. 5. Enter DTC P0961. Has the test run and passed?	--	Go to Step 20	Go to Step 2
20	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0973

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit Description

The 1-2 shift solenoid (SS) valve controls the fluid flow acting on the 1-2 and 3-4 shift valves. The solenoid is a normally-open exhaust valve. With the 2-3 SS valve, the 1-2 SS valve allows 4 different shifting combinations. The solenoid attaches to the control valve body within the transmission. The 1-2 SS valve receives ignition voltage through the ignition 1 voltage circuit. The transmission control module (TCM) controls the solenoid by providing the ground path on the 1-2 SS valve control circuit.

When the TCM detects a continuous open, short to ground in the 1-2 SS valve circuit, then DTC P0973 sets. DTC P0973 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0973 1-2 Shift Solenoid (SS) Control Circuit Low Voltage.

Conditions for Running the DTC

- The engine run time is greater than 5 seconds.
- The 1-2 SS is commanded ON.

Conditions for Setting the DTC

DTC P0973 sets when either of the following conditions occurs for 4.3 seconds:

- The TCM detects an open in the 1-2 shift solenoid valve circuit when the 1-2 SS is commanded ON.
- The TCM detects a short to ground in the 1-2 shift solenoid valve circuit when the 1-2 SS is commanded ON.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive drive trip in which the Conditions for Setting the DTC are met.

- The TCC commands maximum line pressure.
- The TCM inhibits 3-2 shift if vehicle speed is less than 40 km/h (25 mph).
- The TCM freezes transmission adaptive functions.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0973 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the 4th consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

4. This step tests the function of the 1-2 SS valve and the automatic transmission (AT) wiring harness.
5. This step tests for voltage to the 1-2 SS valve from the ignition through the fuse.
6. This step tests the ability of the TCM and the wiring to control the ground circuit.
8. This step measures the resistance of the AT wiring harness and the 1-2 SS valve.

DTC P0973

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from			

2	the transmission control module (TCM). 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. Are any of the following DTCs also set? - P0787 - P0976 - P2764 - P2769	--	Go to Step 3	Go to Step 4
3	Inspect the ACC/TCM fuse for an open. Refer to Circuit Protection - Fuses . Is the fuse open?	--	Go to Step 12	Go to Step 5
4	Use the scan tool in order to command the 1-2 SS valve ON and OFF three times while listening to the bottom of the transmission pan, a stethoscope may be necessary. Does the 1-2 Sol. CKT status parameter display OK when commanded ON?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the AT inline 20-way connector, additional DTCs may set. 3. Install the J 44152 on the engine side of the AT inline 20-way connector. 4. Turn ON the ignition, with the engine OFF. 5. Using the J 35616 , connect a test lamp from the 1-2 SS valve IGN voltage circuit of the J 44152 to ground. Refer to Component Connector End Views . Does the test lamp illuminate?	--	Go to Step 6	Go to Step 15
6	1. Connect a test lamp between the 1-2 SS valve IGN voltage and control circuits of the J 44152 Refer to Component Connector End Views . 2. Use the scan tool in order to command the 1-2 SS valve ON and OFF three times. Does the test lamp turn ON and OFF with each command?	--	Go to Step 8	Go to Step 7
7	Is the test lamp always ON?	--	Go to Step 16	Go to Step 17

8	1. Install the J 44152 on the transmission side of the AT inline 20-way connector. 2. Using the DMM and the J 35616 , measure the resistance between the 1-2 SS valve IGN 1 voltage and control circuits of the, Refer to Testing for Continuity . Refer to Component Connector End Views . Does the resistance measure within the specified range?	19-31 Ω	Go to Step 9	Go to Step 10
9	Measure the resistance from the 1-2 SS valve IGN 1 voltage and control circuits to ground. Refer to Testing for Continuity . Do both readings measure greater than the specified value?	250 K Ω	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 11
10	1. Disconnect the AT wiring harness from the 1-2 SS valve. 2. Measure the resistance of the 1-2 SS valve. Refer to Testing for Continuity . Does the resistance measure within the specified range?	19-31 Ω	Go to Step 18	Go to Step 19
11	1. Disconnect the AT wiring harness from the 1-2 SS valve. 2. Measure the resistance from the component's terminals to ground. Refer to Testing for Continuity . Do both readings measure greater than the specified value?	250 K Ω	Go to Step 18	Go to Step 19
12	**Important:** The condition that affects this circuit may exist in other connecting branches of the circuit. Refer to Power Distribution Schematics , for complete circuit distribution. Test the ignition circuit of the 1-2 SS valve for a short to ground between the fuse block-underhood and the AT inline 20-way connector. Refer to Testing for Short to Ground and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 21	Go to Step 13
13	**Important:** The condition that affects this circuit may exist in other connecting branches of the circuit. Refer to Power Distribution Schematics , for complete circuit distribution. Test the ignition circuit of the 1-2 SS valve	--		

	for a short to ground between the AT inline 20-way connector and the 1-2 SS valve. Refer to Testing for Short to Ground . Did you find a short to ground condition?		Go to Step 18	Go to Step 14
14	1. Test each solenoid for a short to ground. 2. Replace the faulty solenoid as necessary. Did you complete the replacement?	--	Go to Step 21	--
15	**Important:** The condition that affects this circuit may exist in other connecting branches of the circuit. Refer to Power Distribution Schematics , for complete circuit distribution. Test the ignition circuit of the 1-2 SS valve for an open. Refer to Testing for Continuity and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 21	--
16	Test the control circuit of the 1-2 SS valve for a short to ground between the TCM and the AT inline 20-way connector. Refer to Testing for Continuity and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 21	Go to Step 20
17	Test the control circuit of the 1-2 SS valve for an open or short to voltage between the TCM and the AT inline 20-way connector. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 21	Go to Step 20
18	Replace the AT wiring harness. Refer to Torque Converter Clutch Pulse Width Modulation Solenoid, Torque Converter Clutch Solenoid, and Wiring Harness . Did you complete the replacement?	--	Go to Step 21	--
19	Replace the 1-2 SS valve. Refer to Control and Shift Solenoids Replacement Did you complete the replacement?	--	Go to Step 21	--
20	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 21	--
	Perform the following procedure in order to			

21	verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle in D4 and make sure the following conditions are met: • The TCM commands the 1-2 SS valve ON and the 1-2 Sol. CKT status parameter displays OK. • The TCM commands the 1-2 SS valve OFF and the 1-2 Sol. CKT status parameter displays OK. • All conditions are met for 5 seconds. 4. Select Specific DTC. 5. Enter DTC P0973. Has the test run and passed?	--	Go to Step 22	Go to Step 2
22	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0974

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit Description

The 1-2 shift solenoid (SS) valve controls the fluid flow acting on the 1-2 and 3-4 shift valves. The solenoid is a normally-open exhaust valve. With the 2-3 SS valve, the 1-2 SS valve allows 4 different shifting combinations. The solenoid attaches to the control valve body within the transmission. The 1-2 SS valve receives ignition voltage through the ignition 1 voltage circuit. The transmission control module (TCM) controls the solenoid by providing the ground path on the 1-2 SS valve control circuit.

When the TCM detects a continuous short to voltage in the 1-2 shift solenoid valve control circuit, then DTC P0974 sets. DTC P0974 is a type A DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0974 1-2 Shift Solenoid (SS) Control Circuit High Voltage.

Conditions for Running the DTC

- The system voltage is 8-18 volts.
- The engine speed is 500 RPM for 5 seconds.

Conditions for Setting the DTC

DTC P0974 sets if the TCM commands the solenoid ON and the voltage feedback remains high B+.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM inhibits TCC engagement.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.

- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0974 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the 4th consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

DTC P0974

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the transmission control module (TCM). 3. Record the DTC Freeze Frame and Failure Records. 4. With a scan tool, command the 1-2 Sol. ON. Does the 1-2 Sol. CKT status parameter display OK?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the automatic transmission (A/T) inline 20-way connector, additional DTCs may set. 3. Install the J 44152 Jumper Harness (20 pins) on the engine side of the AT inline 20-way connector. 4. Turn ON the ignition, with the engine OFF. 5. Using the J 35616 , connect a test lamp from 1-2 shift solenoid valve control	--		

	circuit of the J 44152 to ground. Refer to Component Connector End Views . Does the test lamp illuminate?		Go to Step 6	Go to Step 4
4	1. Install the J 44152 on the transmission side of the A/T inline 20-way connector. 2. Using the DMM and J 35616 , measure the resistance between the ignition voltage and 1-2 shift solenoid valve control circuits of the J 44152 . Refer to Component Connector End Views . Does the resistance measure less than the specified value?	20 Ω	Go to Step 5	Go to Step 7
5	1. Disconnect the A/T internal wiring harness assembly from the 1-2 SS valve. 2. Measure the resistance of the 1-2 SS valve. Does the resistance measure less than the specified value?	20 Ω	Go to Step 8	Go to Step 7
6	Test the control circuit of the 1-2 SS valve for a short to voltage between the TCM and the A/T inline 20-way connector. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 10	Go to Step 9
7	Replace the A/T internal wiring harness. Refer to Torque Converter Clutch Pulse Width Modulation Solenoid, Torque Converter Clutch Solenoid, and Wiring Harness . Did you complete the replacement?	--	Go to Step 10	--
8	Replace the 1-2 SS valve. Refer to Control and Shift Solenoids Replacement . Did you complete the replacement?	--	Go to Step 10	--
9	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 10	--
	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle in D4 and make sure the following conditions are met: • The TCM commands the 1-2 SS valve ON and the 1-2 Sol. CKT status			

10	parameter displays OK. - The TCM commands the 1-2 SS valve OFF and the 1-2 Sol. CKT status parameter displays OK. - All conditions are met for 5 seconds. 4. Select Specific DTC. 5. Enter DTC P0974. Has the test run and passed?	--	Go to Step 11	Go to Step 2
11	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0976

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit Description

The 2-3 shift solenoid (SS) valve controls the fluid flow acting on the 2-3 shift valves. The solenoid is a normally-open exhaust valve. With the 1-2 SS valve, the 2-3 SS valve allows 4 different shifting combinations. The solenoid attaches to the control valve body within the transmission. The 2-3 SS valve receives voltage through the ignition 1 voltage circuit. The transmission control module (TCM) controls the solenoid by providing the ground path on the 2-3 SS valve control circuit.

When the TCM detects a continuous open, short to ground in the 2-3 SS valve control circuit, then DTC P0976 sets. DTC P0976 is a type A DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0976 2-3 Shift Solenoid (SS) Control Circuit Low Voltage.

Conditions for Running the DTC

- The engine run time is greater than 5 seconds.
- The 1-2 SS is commanded ON.

Conditions for Setting the DTC

DTC P0973 sets when either of the following conditions occurs for 4.3 seconds:

- The TCM detects an open in the 1-2 shift solenoid valve circuit when the 1-2 SS is commanded ON.
- The TCM detects a short to ground in the 1-2 shift solenoid valve circuit when the 1-2 SS is commanded ON.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL).
- The TCC commands maximum line pressure.

- The TCM inhibits 3-2 shift if vehicle speed is less than 40 km/h (25 mph).
- The TCM freezes transmission adaptive functions.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0973 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the 4th consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

4. This step tests the function of the 2-3 SS valve and the automatic transmission (AT) wiring harness.

5. This step tests for voltage to the 2-3 SS valve from the ignition through the fuse.

6. This step tests the ability of the TCM and the wiring to control the ground circuit.

8. This step measures the resistance of the AT wiring harness and the 2-3 SS valve.

DTC P0976

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the TCM.			

2	3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. Are any of the following DTCs also set? • P0787 • P0973 • P2764 • P2769	--	Go to Step 3	Go to Step 4
3	Inspect the ACC/TCM fuse for an open. Refer to Circuit Protection - Fuses . Is the fuse open?	--	Go to Step 12	Go to Step 5
4	With a scan tool, command the 2-3 Solenoid ON. Does the 2-3 Sol. CKT status parameter display OK when commanded ON?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the AT inline 20-way connector, additional DTCs may set. 3. Install the J 44152 Jumper Harness (20 pins) on the engine side of the AT inline 20-way connector. 4. Turn ON the ignition, with the engine OFF. 5. Using the J 35616 , connect a test lamp from the 2-3 SS valve ignition voltage circuit of the J 44152 to ground. Refer to Component Connector End Views . Does the test lamp illuminate?	--	Go to Step 6	Go to Step 15
6	1. Connect a test lamp between the 2-3 SS valve ignition voltage and control circuits of the J 44152 . Refer to Component Connector End Views . 2. Use the scan tool in order to command the 2-3 SS valve ON and OFF three times. Does the test lamp turn ON and OFF with each command?	--	Go to Step 8	Go to Step 7
7	Is the test lamp always ON?	--		Go to Step

			Go to Step 16	17
8	1. Install the J 44152 on the transmission side of the AT inline 20-way connector. 2. Using the DMM and J 35616 , measure the resistance between the 2-3 SS valve ignition voltage and control circuits of the J 44152 . Refer to Component Connector End Views . Does the resistance measure within the specified range?	19-31 Ω	Go to Step 9	Go to Step 10
9	Measure the resistance from the 2-3 SS valve ignition voltage and control circuits to ground. Refer to Testing for Continuity . Do both readings measure greater than the specified value?	250 K Ω	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 11
10	1. Disconnect the AT wiring harness assembly from the 2-3 SS valve. 2. Measure the resistance of the 2-3 SS valve. Refer to Testing for Continuity . Does the resistance measure within the specified range?	19-31 Ω	Go to Step 18	Go to Step 19
11	1. Disconnect the AT wiring harness assembly from the 2-3 SS valve. 2. Measure the resistance from the component's terminals to ground. Refer to Testing for Continuity . Do both readings measure greater than the specified value?	250 K Ω	Go to Step 18	Go to Step 19
12	**Important:** The condition that affects this circuit may exist in other connecting branches of the circuit. Refer to Power Distribution Schematics . Test the ignition circuit of the 2-3 SS valve for a short to ground between the fuse block-underhood and the AT inline 20-way connector. Refer to Testing for Short to Ground and Wiring Repairs .	--		Go to Step

	Did you find and correct the condition?		Go to Step 21	13
13	**Important:** The condition that affects this circuit may exist in other connecting branches of the circuit. Refer to Power Distribution Schematics . Test the ignition circuit of the 2-3 SS valve for a short to ground between the AT inline 20-way connector and the 2-3 SS valve. Refer to Testing for Short to Ground . Did you find a short to ground condition?	--	Go to Step 18	Go to Step 14
14	1. Test each solenoid for a short to ground. 2. Replace the faulty solenoid as necessary. Did you complete the replacement?	--	Go to Step 21	--
15	**Important:** The condition that affects this circuit may exist in other connecting branches of the circuit. Refer to Power Distribution Schematics . Test the ignition circuit of the 2-3 SS valve for an open. Refer to Testing for Continuity and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 21	--
16	Test the control circuit of the 2-3 SS valve for a short to ground between the TCM connector C2 and the AT inline 20-way connector. Refer to Testing for Short to Ground and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 21	Go to Step 20
17	Test the control circuit of the 2-3 SS valve for an open or short to power between the TCM connector C2 and the AT inline 20-way connector. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 21	Go to Step 20
	Replace the AT wiring harness assembly. Refer to Torque Converter Clutch Pulse			

18	Width Modulation Solenoid, Torque Converter Clutch Solenoid, and Wiring Harness . Did you complete the replacement?	--	Go to Step 21	--
19	Replace the 2-3 SS valve. Refer to Control and Shift Solenoids Replacement . Did you complete the replacement?	--	Go to Step 21	--
20	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 21	--
21	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle in D4 and make sure the following conditions are met: • The TCM commands the 2-3 SS valve ON and the voltage feedback drops to zero. • The TCM commands the 2-3 SS valve OFF and the voltage feedback increases to B+. • All conditions are met for 5 seconds. 4. Select Specific DTC. 5. Enter DTC P0976. Has the test run and passed?	--	Go to Step 22	Go to Step 2
22	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0977

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit Description

The 2-3 shift solenoid (SS) valve controls the fluid flow acting on the 2-3 shift valves. The solenoid is a normally-open exhaust valve. With the 1-2 SS valve, the 2-3 SS valve allows 4 different shifting combinations. The solenoid attaches to the control valve body within the transmission. The 2-3 SS valve receives voltage through the ignition 1 voltage circuit. The transmission control module (TCM) controls the solenoid by providing the ground path on the 2-3 SS valve control circuit.

When the TCM detects a continuous short to voltage in the 2-3 shift solenoid valve control circuit, then DTC P0977 sets. DTC P0977 is a type A DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0977 2-3 Shift Solenoid (SS) Control Circuit High Voltage.

Conditions for Running the DTC

- The system voltage is 8-18 volts.
- The engine speed is 500 RPM for 5 seconds.

Conditions for Setting the DTC

DTC P0977 sets if the TCM commands the solenoid ON and the voltage feedback remains high, B+.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM inhibits TCC engagement.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.

- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0977 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the 4th consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

DTC P0977

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. With a scan tool, command the 2-3 Sol. ON. Does the 2-3 Sol. CKT status parameter display OK?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the automatic transmission (AT) inline 20-way connector, additional DTCs may set. 3. Install the J 44152 Jumper Harness (20 pins) on the engine side of the AT inline 20-way connector. 4. Turn ON the ignition, with the engine OFF. 5. Using the J 35616 , connect a test lamp from 2-3 shift solenoid valve control	--		

	circuit of the J 44152 to ground. Refer to Component Connector End Views . Does the test lamp illuminate?		Go to Step 6	Go to Step 4
4	1. Install the J 44152 on the transmission side of the AT inline 20-way connector. 2. Using the DMM and J 35616 , measure the resistance between the ignition voltage and 2-3 shift solenoid valve control circuits of the J 44152 . Refer to Component Connector End Views . Does the resistance measure less than the specified value?	20 Ω	Go to Step 5	Go to Step 7
5	1. Disconnect the AT internal wiring harness from the 2-3 SS valve. 2. Measure the resistance of the 2-3 SS valve. Does the resistance measure less than the specified value?	20 Ω	Go to Step 8	Go to Step 7
6	Test the control circuit of the 2-3 SS valve for a short to voltage between the TCM and the AT inline 20-way connector. Refer to Circuit Testing and Wiring Repairs s. Did you find and correct the condition?	--	Go to Step 10	Go to Step 9
7	Replace the AT internal wiring harness. Refer to Torque Converter Clutch Pulse Width Modulation Solenoid, Torque Converter Clutch Solenoid, and Wiring Harness . Did you complete the replacement?	--	Go to Step 10	--
8	Replace the 2-3 SS valve. Refer to Control and Shift Solenoids Replacement . Did you complete the replacement?	--	Go to Step 10	--
9	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 10	--
	Perform the following procedure in order to verify the repair:			

10	1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle in D4 and make sure the following conditions are met: • The TCM commands the 2-3 SS valve ON and the 2-3 Sol. CKT status parameter displays OK. • The TCM commands the 2-3 SS valve OFF and the 2-3 Sol. CKT status parameter displays OK. • All conditions are met for 5 seconds. 4. Select Specific DTC. 5. Enter DTC P0977. Has the test run and passed?	--	Go to Step 11	Go to Step 2
11	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P1810

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit Description

The automatic transmission fluid pressure (TFP) manual valve position switch consists of 5 pressure switches, 2 normally-closed and 3 normally-open, and a transmission fluid temperature (TFT) sensor combined into 1 unit. The combined unit mounts on the valve body. The transmission control module (TCM) supplies ignition voltage for each range signal. By grounding 1 or more of these circuits through various combinations of the pressure switches, the TCM detects which manual valve position you select. The TCM compares the actual voltage combination of the switches to a TFP manual valve position switch combination chart stored in memory.

The TFP manual valve position switch cannot distinguish between PARK and NEUTRAL because the monitored valve body pressures are identical. With the engine OFF and the ignition switch in the ON position, the TFP manual valve position switch indicates PARK/NEUTRAL. Disconnecting the AT inline 20-way connector removes the ground potential for the 3 range signals to the TCM. In this case, with the engine OFF, and the ignition switch in the ON position, D2 will be indicated.

When the TCM detects an invalid state of the TFP manual valve position switch circuit by deciphering the TFP manual valve position switch inputs, then DTC P1810 sets. DTC P1810 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P1810 Transmission Fluid Pressure (TFP) Position Switch Circuit.

Conditions for Running the DTC

- The system voltage is 8-18 volts.
- The engine speed is greater than 500 RPM for 5 seconds.

Conditions for Setting the DTC

DTC P1810 sets when the TCM detects an invalid TFP manual valve position switch state for 60 seconds.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM inhibits TCC engaugement.
- The TCM commands 4th gear.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P1810 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the 4th consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

- Refer to the Transmission Fluid Pressure Manual Valve Position Switch Logic , for the normal range signals and the invalid combinations. On the table, LOW is 0 volts, HI is ignition voltage.
- Sediment in the valve body may cause improper operation of the TFP manual valve position switch. If sediment intrusion is suspected, clean the valve body and replace the TFP manual valve position switch.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. This step compares the indicated range signal to the selected manual valve position.

5. This step tests for correct voltage from the TCM to the AT inline 20-way connector.

DTC P1810

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle

2	Inspect for correct transmission fluid level. Refer to Component Connector End Views . Did you perform the fluid checking procedure?	--	Go to Step 3	Go to Transmission Fluid Check .
3	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the transmission control module (TCM). 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine and idle at normal operating temperature. 6. Apply the brake pedal. 7. Select each transmission range: P, R, N, D4, D3, D2 and D1. Does each selected transmission range match the scan tool TFP Sw. display?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 4
4	1. Turn OFF the ignition. 2. Disconnect the automatic transmission (AT) inline 20-way connector, additional DTCs may set. 3. Turn ON the ignition, with the engine OFF. Does the scan tool TFP Sw. A/B/C parameter indicate HI for all range signal states?	--	Go to Step 5	Go to Step 9
5	1. Turn OFF the ignition. 2. Install the J 44152 Jumper Harness (20 pins) on the engine side of the AT inline 20-way connector. 3. Turn ON the ignition, with the engine OFF. 4. Using the DMM and the J 35616 , measure the voltage from the transmission fluid pressure switch signal A circuit of the J 44152 to ground. Refer to Component Connector End Views .	10-12 V		

	5. Measure the voltage from the transmission fluid pressure switch signal B circuit of the J 44152 to ground. 6. Measure the voltage from the transmission fluid pressure switch signal C circuit of the J 44152 to ground. Does the voltage measure within the specified range at all three terminals?		Go to Step 6	Go to Step 10
6	Connect a fused jumper wire from the J 44152 , transmission fluid pressure switch signal circuit A, to ground while monitoring the scan tool TFP Sw. A/B/C parameter. When the transmission fluid pressure signal circuit A is grounded, do any other signal circuits indicate LOW?	--	Go to Step 11	Go to Step 7
7	Connect a fused jumper wire from the J 44152 , transmission fluid pressure switch signal circuit B, to ground while monitoring the scan tool TFP Sw. A/B/C parameter. When the transmission fluid pressure signal circuit B is grounded, do any other signal circuits indicate LOW?	--	Go to Step 11	Go to Step 8
8	Connect a fused jumper wire from the J 44152 , transmission fluid pressure switch signal circuit C, to ground while monitoring the scan tool TFP Sw. A/B/C parameter. When the transmission fluid pressure switch signal circuit C is grounded, do any other signal circuits indicate LOW?	--	Go to Step 11	Go to Step 12
9	Test the signal circuits of the TFP manual valve position switch that did not indicate HI for a short to ground between the TCM and the AT inline 20-way connector. Refer to Testing for Short to Ground and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 16	Go to Step 15
10	Test the signal circuits of the TFP manual valve position switch that did not indicate ignition voltage for an open between the TCM and the AT inline 20-way connector. Refer to Testing for Continuity and Wiring Repairs .	--		

	Did you find and correct the condition?		Go to Step 16	Go to Step 15
11	Test the affected signal circuits of the TFP manual valve position switch for a shorted together condition between the TCM and the AT inline 20-way connector. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 16	Go to Step 15
12	Test the signal circuits of the TFP manual valve position switch for an open or shorted condition between the TFP manual valve position switch and the AT inline 20-way connector. Refer to Circuit Testing and Wiring Repairs . Did you find a condition?	--	Go to Step 13	Go to Step 14
13	Replace the AT wiring harness. Refer to Valve Body and Pressure Switch Replacement . Did you complete the replacement?	--	Go to Step 16	--
14	Replace the TFP manual valve position switch. Refer to Valve Body and Pressure Switch Replacement . Did you complete the replacement?	--	Go to Step 16	--
15	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 16	--
16	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Turn ON the ignition, with the engine OFF for at least 2 seconds. • Start the vehicle and idle for 5 seconds. • Drive in D4 until the TCC locks for 10 seconds. • Continue to run the engine for at least 60 seconds from startup. 4. Select Specific DTC. 5. Enter DTC P1810.	--		

	Has the test run and passed?		Go to Step 17	Go to Step 2
17	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P1815

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit Description

The automatic transmission fluid pressure (TFP) manual valve position switch consists of 5 pressure switches, 2 normally-closed and 3 normally-open, and a transmission fluid temperature (TFT) sensor combined into 1 unit. The combined unit mounts on the valve body. The transmission control module (TCM) supplies ignition voltage for each range signal. By grounding 1 or more of these circuits through various combinations of the pressure switches, the TCM detects which manual valve position you select. The TCM compares the actual voltage combination of the switches to a TFP manual valve position switch combination chart stored in memory.

The TFP manual valve position switch cannot distinguish between PARK and NEUTRAL because the monitored valve body pressures are identical. With the engine OFF and the ignition switch in the ON position, the TFP manual valve position switch indicates PARK/NEUTRAL. Disconnecting the AT inline 20-way connector removes the ground potential for the 3 range signals to the TCM. In this case, with the engine OFF, and the ignition switch in the ON position, D2 will be indicated.

When the TCM detects an invalid state of the TFP manual valve position switch circuit by deciphering the TFP manual valve position switch inputs, then DTC P1815 sets. DTC P1815 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P1815 Transmission Fluid Pressure (TFP) Valve Position Switch - Start in Wrong Range.

Conditions for Running the DTC

- No OSS DTCs P0722, or P0723.
- The system voltage is 8-18 volts.
- The engine speed is less than 50 RPM, then between 50-650 RPM for 0.75 seconds, then greater than 650 RPM for 5 seconds.
- OSS speed less than 250 RPM.

Conditions for Setting the DTC

DTC P1815 sets when the TCM detects D2 only, TFP manual valve position switch state after engine start for 7 seconds.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM inhibits TCC engagement.
- The TCM commands 4th gear.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P1815 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the 4th consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

- Refer to the Transmission Fluid Pressure Manual Valve Position Switch Logic , for the normal range signals and the invalid combinations. On the table, LOW is 0 volts, HI is ignition voltage.
- Sediment in the valve body may cause improper operation of the TFP manual valve position switch. If sediment intrusion is suspected, clean the valve body and replace the TFP manual valve position switch.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. This step compares the indicated range signal to the selected manual valve position.

5. This step tests for correct voltage from the TCM to the AT inline 20-way connector.

DTC P1815

Step	Action	Values	Yes	No

1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	Inspect for correct transmission fluid level. Refer to Transmission Fluid Check . Did you perform the fluid checking procedure?	--	Go to Step 3	Go to Transmission Fluid Check .
3	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the transmission control module (TCM). 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine and idle at normal operating temperature. 6. Apply the brake pedal. 7. Select each transmission range: P, R, N, D4, D3, D2 and D1. Does each selected transmission range match the scan tool TFP Sw. display?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 4
4	1. Turn OFF the ignition. 2. Disconnect the AT inline 20-way connector, additional DTCs may set. 3. Turn ON the ignition, with the engine OFF. Does the scan tool TFP Sw. A/B/C parameter indicate HI for all range signal states?	--	Go to Step 5	Go to Step 9
	1. Turn OFF the ignition. 2. Install the J 44152 Jumper Harness (20 pins) on the engine side of the AT inline 20-way connector. 3. Turn ON the ignition, with the engine OFF. 4. Using the DMM and the J 35616 , measure the voltage from the transmission fluid pressure switch signal A circuit of the J 44152 to ground.			

5	Refer to Component Connector End Views . 5. Measure the voltage from the transmission fluid pressure switch signal B circuit of the J 44152 to ground. 6. Measure the voltage from the transmission fluid pressure switch signal C circuit of the J 44152 to ground. Does the voltage measure within the specified range at all three terminals?	10-12 V	Go to Step 6	Go to Step 10
6	Connect a fused jumper wire from the J 44152 , transmission fluid pressure switch signal circuit A, to ground while monitoring the scan tool TFP Sw. A/B/C parameter. When the transmission fluid pressure switch signal circuit A is grounded, do any other signal circuits indicate LOW?	--	Go to Step 11	Go to Step 7
7	Connect a fused jumper wire from the J 44152 , transmission fluid pressure switch signal circuit B, to ground while monitoring the scan tool TFP Sw. A/B/C parameter. When the transmission fluid pressure switch signal circuit B is grounded, do any other signal circuits indicate LOW?	--	Go to Step 11	Go to Step 8
8	Connect a fused jumper wire from the J 44152 , transmission fluid pressure switch signal circuit C, to ground while monitoring the scan tool TFP Sw. A/B/C parameter. When the transmission fluid pressure switch signal circuit C is grounded, do any other signal circuits indicate LOW?	--	Go to Step 11	Go to Step 12
9	Test the signal circuits of the TFP manual valve position switch that did not indicate HI for a short to ground between the TCM and the AT inline 20-way connector. Refer to Testing for Short to Ground and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 16	Go to Step 15
10	Test the signal circuits of the TFP manual valve position switch that did not indicate ignition voltage for an open between the TCM and the AT inline 20-way connector.	--		

	Refer to Testing for Continuity and Wiring Repairs . Did you find and correct the condition?		Go to Step 16	Go to Step 15
11	Test the affected signal circuits of the TFP manual valve position switch for a shorted together condition between the TCM and the AT inline 20-way connector. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 16	Go to Step 15
12	Test the signal circuits of the TFP manual valve position switch for an open or shorted condition between the TFP manual valve position switch and the AT inline 20-way connector. Refer to Circuit Testing and Wiring Repairs . Did you find a condition?	--	Go to Step 13	Go to Step 14
13	Replace the AT wiring harness. Refer to Valve Body and Pressure Switch Replacement . Did you complete the replacement?	--	Go to Step 16	--
14	Replace the TFP manual valve position switch. Refer to Valve Body and Pressure Switch Replacement . Did you complete the replacement?	--	Go to Step 16	--
15	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 16	--
16	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Turn ON the ignition, with the engine OFF for at least 2 seconds. • Start the vehicle and idle for 5 seconds. • Drive in D4 until the torque converter clutch (TCC) locks for 10 seconds.	--		

	• Continue to run the engine for at least 60 seconds from startup. 4. Select Specific DTC. 5. Enter DTC P1815. Has the test run and passed?		Go to Step 17	Go to Step 2
17	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P1816

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit Description

The automatic transmission fluid pressure (TFP) manual valve position switch consists of 5 pressure switches, 2 normally-closed and 3 normally-open, and a transmission fluid temperature (TFT) sensor combined into 1 unit. The combined unit mounts on the valve body. The transmission control module (TCM) supplies ignition voltage for each range signal. By grounding 1 or more of these circuits through various combinations of the pressure switches, the TCM detects which manual valve position you select. The TCM compares the actual voltage combination of the switches to a TFP manual valve position switch combination chart stored in memory.

The TFP manual valve position switch cannot distinguish between PARK and NEUTRAL because the monitored valve body pressures are identical. With the engine OFF and the ignition switch in the ON position, the TFP manual valve position switch indicates PARK/NEUTRAL. Disconnecting the AT inline 20-way connector removes the ground potential for the 3 range signals to the TCM. In this case, with the engine OFF, and the ignition switch in the ON position, D2 will be indicated.

When the TCM detects an invalid state of the TFP manual valve position switch circuit by deciphering the TFP manual valve position switch inputs, then DTC P1816 sets. DTC P1816 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P1816 Transmission Fluid Pressure (TFP) Valve Position Switch Indicates Park/Neutral (P/N) with Drive Ratio.

Conditions for Running the DTC

- No OSS DTCs P0722, or P0723.
- The system voltage is 8-18 volts.
- The engine speed is less than 50 RPM, then between 50-650 RPM for 0.75 seconds, then greater than 650 RPM for 5 seconds.
- OSS speed less than 250 RPM.

Conditions for Setting the DTC

DTC P1816 sets when the TCM detects one of the following conditions for 13 seconds.

- PARK/NEUTRAL indicated with a 1st gear ratio.
- PARK/NEUTRAL indicated with a 2nd gear ratio.
- PARK/NEUTRAL indicated with a 3rd gear ratio.
- PARK/NEUTRAL indicated with a 4th gear ratio.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM inhibits TCC engagement.
- The TCM commands 4th gear.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P1816 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the 4th consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

- Refer to the Transmission Fluid Pressure Manual Valve Position Switch Logic , for the normal range signals and the invalid combinations. On the table, LOW is 0 volts, HI is ignition voltage.
- Sediment in the valve body may cause improper operation of the TFP manual valve position switch. If sediment intrusion is suspected, clean the valve body and replace the TFP manual valve position switch.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. This step compares the indicated range signal to the selected manual valve position.

5. This step tests for correct voltage from the TCM to the AT inline 20-way connector.

DTC P1816

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	Inspect for correct transmission fluid level. Refer to Transmission Fluid Check . Did you perform the fluid checking procedure?	--	Go to Step 3	Go to Transmission Fluid Check .
3	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the transmission control module (TCM). 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine and idle at normal operating temperature. 6. Apply the brake pedal. 7. Select each transmission range: P, R, N, D4, D3, D2 and D1. Does each selected transmission range match the scan tool TFP Sw. display?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 4
4	1. Turn OFF the ignition. 2. Disconnect the automatic transmission (AT) inline 20-way connector, additional DTCs may set. 3. Turn ON the ignition, with the engine OFF. Does the scan tool TFP Sw. A/B/C parameter indicate HI for all range signal states?	--	Go to Step 5	Go to Step 9
	1. Turn OFF the ignition. 2. Install the J 44152 Jumper Harness (20 pins) on the engine side of the AT inline 20-way connector. 3. Turn ON the ignition, with the engine OFF.			

5	4. Using the DMM and the J 35616 , measure the voltage from the transmission fluid pressure switch signal A circuit of the J 44152 to ground. Refer to Component Connector End Views . 5. Measure the voltage from the transmission fluid pressure switch signal B circuit of the J 44152 to ground. 6. Measure the voltage from the transmission fluid pressure switch signal C circuit of the J 44152 to ground. Does the voltage measure within the specified range at all three terminals?	10-12 V	Go to Step 6	Go to Step 10
6	Connect a fused jumper wire from the J 44152 , transmission fluid pressure switch signal circuit A, to ground while monitoring the scan tool TFP Sw. A/B/C parameter. When the transmission fluid pressure switch signal circuit A is grounded, do any other signal circuits indicate LOW?	--	Go to Step 11	Go to Step 7
7	Connect a fused jumper wire from the J 44152 , transmission fluid pressure switch signal circuit B, to ground while monitoring the scan tool TFP Sw. A/B/C parameter. When the transmission fluid pressure switch signal circuit B is grounded, do any other signal circuits indicate LOW?	--	Go to Step 11	Go to Step 8
8	Connect a fused jumper wire from the J 44152 , transmission fluid pressure switch signal circuit C, to ground while monitoring the scan tool TFP Sw. A/B/C parameter. When the transmission fluid pressure switch signal circuit C is grounded, do any other signal circuits indicate LOW?	--	Go to Step 11	Go to Step 12
9	Test the signal circuits of the transmission fluid pressure (TFP) manual valve position switch that did not indicate HI for a short to ground between the TCM and the AT inline 20-way connector. Refer to Testing for Short to Ground and Wiring Repairs .	--		

	Did you find and correct the condition?		Go to Step 16	Go to Step 15
10	Test the signal circuits of the TFP manual valve position switch that did not indicate ignition voltage for an open between the TCM and the AT inline 20-way connector. Refer to Testing for Continuity and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 16	Go to Step 15
11	Test the affected signal circuits of the TFP manual valve position switch for a shorted together condition between the TCM and the AT inline 20-way connector. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 16	Go to Step 15
12	Test the signal circuits of the TFP manual valve position switch for an open or shorted condition between the TFP manual valve position switch and the AT inline 20-way connector. Refer to Circuit Testing and Wiring Repairs . Did you find a condition?	--	Go to Step 13	Go to Step 14
13	Replace the AT wiring harness. Refer to Valve Body and Pressure Switch Replacement . Did you complete the replacement?	--	Go to Step 16	--
14	Replace the TFP manual valve position switch. Refer to Valve Body and Pressure Switch Replacement . Did you complete the replacement?	--	Go to Step 16	--
15	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 16	--
	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Turn ON the ignition, with the			

16	engine OFF for at least 2 seconds. - Start the vehicle and idle for 5 seconds. - Drive in D4 until the TCC locks for 10 seconds. - Continue to run the engine for at least 60 seconds from startup. 4. Select Specific DTC. 5. Enter DTC P1816. Has the test run and passed?	--	Go to Step 17	Go to Step 2
17	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P1818

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit Description

The automatic transmission fluid pressure (TFP) manual valve position switch consists of 5 pressure switches and a transmission fluid temperature (TFT) sensor combined into one unit. The combined unit mounts on the valve body. The transmission control module (TCM) supplies ignition voltage for each range signal. By grounding one or more of these circuits through various combinations of the pressure switches, the TCM detects which manual valve position you select. The TCM compares the actual voltage combination of the switches to a TFP manual valve position switch combination chart stored in memory.

The TFP manual valve position switch cannot distinguish between PARK and NEUTRAL because the monitored valve body pressures are identical. With the engine OFF and the ignition switch in the ON position, the TFP manual valve position switch indicates PARK/NEUTRAL. Disconnecting the AT inline 20-way connector removes the ground potential for the 3 range signals to the TCM. In this case, with the engine OFF, and the ignition switch in the ON position, D2 will be indicated.

When the TCM detects an invalid state of the TFP manual valve position switch circuit by deciphering the TFP manual valve position switch inputs, then DTC P1818 sets. DTC P1818 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P1818 Transmission Fluid Pressure (TFP) Valve Position Switch Indicates Drive without Drive Ratio.

Conditions for Running the DTC

- No OSS DTCs P0722, or P0723.
- No SS DTCs P0751, P0752, P0756, P0757, P0973, P0974, P0976 or P0977.
- No TFP DTCs P1810, P1815 or P1816.
- The system voltage is 8-18 volts.
- The throttle position is greater than 8 percent.
- The engine speed is greater than 650 RPM for 5 seconds.
- OSS speed is 100 RPM or greater.

Conditions for Setting the DTC

DTC P1818 sets when the TCM detects the following condition for 13 seconds.

PARK/NEUTRAL or FORWARD range indicated with a reverse gear ratio.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM commands 4th gear.
- The TCM forces the TCC ON in 4th gear.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P1818 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the third consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

- Refer to the Transmission Fluid Pressure Manual Valve Position Switch Logic , for the normal range signals and the invalid combinations. On the table, LOW is 0 volts, HI is ignition voltage.
- Sediment in the valve body may cause improper operation of the TFP manual valve position switch. If sediment intrusion is suspected, clean the valve body and replace the TFP manual valve position switch.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. This step compares the indicated range signal to the selected manual valve position.

5. This step tests for correct voltage from the TCM to the AT inline 20-way connector.

DTC P1818

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	Inspect for correct transmission fluid level. Refer to Transmission Fluid Check . Did you perform the fluid checking procedure?	--	Go to Step 3	Go to Transmission Fluid Check .
3	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine and idle at normal operating temperature. 6. Apply the brake pedal. 7. Select each transmission range: P, R, N, D4, D3, D2 and D1. Does each selected transmission range match the scan tool TFP Sw. display?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 4
4	1. Turn OFF the ignition. 2. Disconnect the AT inline 20-way connector, additional DTCs may set. 3. Turn ON the ignition, with the engine OFF. Does the scan tool TFP Sw. A/B/C parameter indicate HI for all range signal states?	--	Go to Step 5	Go to Step 9
	1. Turn OFF the ignition. 2. Install the J 44152 Jumper Harness (20 pins) on the engine side of the AT inline 20-way connector. 3. Turn ON the ignition, with the engine OFF. 4. Using the DMM and the J 35616 Holden Terminal Test Kit, measure the voltage from the transmission fluid pressure switch signal A circuit of the			

5	J 44152 to ground. Refer to Component Connector End Views . 5. Measure the voltage from the transmission fluid pressure switch signal B circuit of the J 44152 to ground. 6. Measure the voltage from the transmission fluid pressure switch signal C circuit of the J 44152 to ground. Does the voltage measure within the specified range at all three terminals?	10-12 V	Go to Step 6	Go to Step 10
6	Connect a fused jumper wire from the J 44152 , transmission fluid pressure switch signal circuit A, to ground while monitoring the scan tool TFP Sw. A/B/C parameter. When the transmission fluid pressure switch signal circuit A is grounded, do any other signal circuits indicate LOW?	--	Go to Step 11	Go to Step 7
7	Connect a fused jumper wire from the J 44152 , transmission fluid pressure switch signal circuit B, to ground while monitoring the scan tool TFP Sw. A/B/C parameter. When the transmission fluid pressure switch signal circuit B is grounded, do any other signal circuits indicate LOW?	--	Go to Step 11	Go to Step 8
8	Connect a fused jumper wire from the J 44152 , transmission fluid pressure switch signal circuit C, to ground while monitoring the scan tool TFP Sw. A/B/C parameter. When the transmission fluid pressure switch signal circuit C is grounded, do any other signal circuits indicate LOW?	--	Go to Step 11	Go to Step 12
9	Test the signal circuits of the TFP manual valve position switch that did not indicate HI for a short to ground between the TCM and the AT inline 20-way connector. Refer to Testing for Short to Ground and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 16	Go to Step 15
10	Test the signal circuits of the TFP manual valve position switch that did not indicate ignition voltage for an open between the TCM and the AT inline 20-way connector. Refer to Testing for Continuity and Wiring Repairs .	--		

	Did you find and correct the condition?		Go to Step 16	Go to Step 15
11	Test the affected signal circuits of the TFP manual valve position switch for a shorted together condition between the TCM and the AT inline 20-way connector. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 16	Go to Step 15
12	Test the signal circuits of the TFP manual valve position switch for an open or shorted condition between the TFP manual valve position switch and the AT inline 20-way connector. Refer to Circuit Testing and Wiring Repairs . Did you find a condition?	--	Go to Step 13	Go to Step 14
13	Replace the AT wiring harness. Refer to Valve Body and Pressure Switch Replacement . Did you complete the replacement?	--	Go to Step 16	--
14	Replace the TFP manual valve position switch. Refer to Valve Body and Pressure Switch Replacement . Did you complete the replacement?	--	Go to Step 16	--
15	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 16	--
16	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle through all forward gears. 4. Select Specific DTC. 5. Enter DTC P1818. Has the test run and passed?	--	Go to Step 17	Go to Step 2
17	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P2534

Circuit Description

The transmission control module (TCM) samples the system voltage on the Ignition 1 voltage circuit every 0.1 seconds. Lower than normal voltage may be inadequate to operate the transmission control solenoids properly. Improper solenoid operation may cause erratic transmission operation, which may result in internal damage.

If the TCM detects low voltage on the Ignition 1 voltage circuit, DTC P2534 sets. DTC 2534 is a type A DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P2534 Ignition 1 Switch Circuit Low Voltage.

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

The TCM detects an open or short to ground on the Ignition 1 voltage circuit.

Action Taken When the DTC Sets

- The TCM requests the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL).
- The TCM commands maximum line pressure.
- The TCM commands an immediate landing to 2nd gear.
- The TCM freezes transmission adaptive functions.
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- The ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.

Conditions for Clearing the DTC

- The TCM turns OFF the MIL after the third consecutive trip in which the diagnostic test runs and passes.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without

an emission-related diagnostic fault occuring.

- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

DTC P2534

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the transmission control module (TCM). 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. Does DTC 2534 reset?	--	Go to Step 3	Go to Testing for Intermittent Conditions and Poor Connections
3	1. Remove the TRANS fuse. 2. Inspect the fuse for an open. Refer to Circuit Protection - Fuses . Did you find the condition?	--	Go to Step 4	Go to Step 5
4	Test the ignition 1 voltage circuit of the TCM for a short to ground between the underhood fuse block and the TCM. Refer to Testing for Short to Ground and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 7	--
5	Test the ignition 1 voltage circuit of the TCM for an open between the underhood fuse block and the TCM. Refer to Testing for Continuity and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 7	Go to Step 6
6	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 7	--
7	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info.	--		

	3. Start the vehicle. 4. Select Specific DTC. 5. Enter DTC P2534. Has the test run and passed?		Go to Step 8	Go to Step 2
8	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P2763

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit Description

The torque converter clutch pulse width modulation (TCC PWM) solenoid valve controls the fluid acting on the converter clutch valve. The converter clutch valve controls the TCC application and release. The solenoid attaches to the control valve body within the transmission. The solenoid receives voltage through the ignition 1 voltage circuit. The transmission control module (TCM) controls the solenoid by providing a ground path on the TCC PWM solenoid valve control circuit. Current flows through the solenoid coil according to the duty cycle, percentage of ON and OFF time. The TCC PWM solenoid valve provides a smooth engaugement of the TCC by operating during a duty cycle percent of ON time.

When the TCM detects a continuous short to voltage in the TCC PWM solenoid valve control circuit, then DTC P2763 sets. DTC P2763 is a type A DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P2763 Torque Converter Clutch (TCC) Pressure Control (PC) Solenoid Control Circuit High Voltage.

Conditions for Running the DTC

- The system voltage is 8-18 volts.
- The engine speed is 500 RPM for 5 seconds.

Conditions for Setting the DTC

DTC P2763 sets if the TCM commands the solenoid ON and the voltage feedback remains high, B+.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.

- The TCM inhibits TCC engagement.
- The TCM inhibits 4th gear if in hot mode.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P2763 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the 4th consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

DTC P2763

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the transmission control module (TCM). 3. Record the DTC Freeze Frame and Failure Records. 4. With a scan tool, command the TCC control solenoid ON. Does the torque converter clutch (TCC) Duty Cycle CKT status parameter display OK?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
	1. Turn OFF the ignition. 2. Disconnect the automatic transmission (AT) inline 20-way connector, additional DTCs may set. 3. Install the J 44152 Jumper Harness (20 pins) on the engine side of the AT inline			

3	20-way connector. 4. Turn ON the ignition, with the engine OFF. 5. Using the J 35616 Holden Terminal Test Kit, connect a test lamp from TCC PWM shift solenoid valve control circuit of the J 44152 to ground. Refer to Component Connector End Views . Does the test lamp illuminate?	--	Go to Step 6	Go to Step 4
4	1. Install the J 44152 on the transmission side of the AT inline 20-way connector. 2. Using the DMM and J 35616 , measure the resistance between the ignition voltage and TCC PWM shift solenoid valve control circuits of the J 44152 . Refer to Component Connector End Views . Does the resistance measure less than the specified value?	20 Ω	Go to Step 5	Go to Step 7
5	1. Disconnect the AT internal wiring harness from the TCC PWM valve. 2. Measure the resistance of the TCC PWM valve. Does the resistance measure less than the specified value?	20 Ω	Go to Step 8	Go to Step 7
6	Test the control circuit of the TCC PWM valve for a short to voltage between the TCM and the AT inline 20-way connector. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 10	Go to Step 9
7	Replace the AT internal wiring harness. Refer to Torque Converter Clutch Pulse Width Modulation Solenoid, Torque Converter Clutch Solenoid, and Wiring Harness . Did you complete the replacement?	--	Go to Step 10	--
8	Replace the TCC PWM valve. Refer to Control and Shift Solenoids Replacement . Did you complete the replacement?	--	Go to Step 10	--
9	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 10	--

10	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle in D4 and make sure the TCC Duty Cycle CKT Status parameter displays OK for 5 seconds. 4. Select Specific DTC. 5. Enter DTC P2763. Has the test run and passed?	--	Go to Step 11	Go to Step 2
11	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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DTC P2764

Circuit Description

The torque converter clutch pulse width modulation (TCC PWM) solenoid valve controls the fluid acting on the converter clutch valve. The converter clutch valve controls the TCC application and release. The solenoid attaches to the control valve body within the transmission. The solenoid receives voltage through the ignition 1 voltage circuit. The transmission control module (TCM) controls the solenoid by providing a ground path on the TCC PWM solenoid valve control circuit. Current flows through the solenoid coil according to the duty cycle, percentage of ON and OFF time. The TCC PWM solenoid valve provides a smooth engaugement of the TCC by operating during a duty cycle percent of ON time.

When the TCM detects a continuous open or short to ground in the TCC PWM solenoid valve control circuit, then DTC P2764 sets. DTC P2764 is a type A DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P2764 Torque Converter Clutch (TCC) Pressure Control (PC) Solenoid Control Circuit Low Voltage.

Conditions for Running the DTC

- The system voltage is 8-18 volts.
- The engine speed is 500 RPM for 5 seconds.

Conditions for Setting the DTC

DTC P2764 sets when either of the following conditions occurs for 5 seconds:

- The TCM detects an open in the TCC PWM shift solenoid valve circuit when the TCC PWM is commanded ON.
- The TCM detects a short to ground in the TCC PWM shift solenoid valve circuit when the TCC PWM is commanded ON.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM inhibits TCC engagement.
- The TCM inhibits 4th gear if in hot mode.

- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P2764 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the 4th consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

4. This step tests for voltage to the solenoid.

5. This step tests the ability of the TCM and wiring to control the ground circuit.

7. This step tests the resistance of the TCC PWM solenoid valve and the automatic transmission (AT) wiring harness.

DTC P2764

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the transmission control module (TCM). 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. Are any of the following DTCs also set?	--		

	- P0787 - P0973 - P0976 - P2769		Go to Step 3	Go to Step 4
3	Inspect the ACC/TCM fuse for an open. Refer to Circuit Protection - Fuses . Is the fuse open?	--	Go to Step 11	Go to Step 4
4	1. Turn OFF the ignition. 2. Disconnect the automatic transmission (AT) inline 20-way connector, additional DTCs may set. 3. Install the J 44152 on the engine side of the AT inline 20-way connector. 4. Turn ON the ignition, with the engine OFF. 5. Using the J 35616 , connect a test lamp from the TCC PWM ignition 1 voltage circuit of the J 44152 to ground. Refer to Component Connector End Views . Does the test lamp illuminate?	--	Go to Step 5	Go to Step 14
5	1. Connect the test lamp between the torque converter clutch/pulse width modulation (TCC PWM) solenoid valve ignition voltage and control circuits of the J 44152 . Refer to Component Connector End Views . 2. Use the scan tool in order to command the TCC PWM solenoid valve ON and OFF three times. Does the test lamp turn ON and OFF with each command?	--	Go to Step 7	Go to Step 6
6	Is the test lamp always ON?	--	Go to Step 15	Go to Step 16
7	1. Install the J 44152 on the transmission side of the AT inline 20-way connector. 2. Using the DMM and the J 35616 , measure the resistance between the TCC PWM solenoid valve ignition voltage and control circuits of the J 44152 . Refer to Testing for Continuity .	10-15 Ω		

	Refer to Component Connector End Views . Does the resistance measure within the specified range?		Go to Step 8	Go to Step 9
8	Measure the resistance from the TCC PWM solenoid valve ignition voltage and control circuits to ground. Refer to Testing for Continuity . Do both readings measure greater than the specified value?	250 K Ω	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 10
9	1. Disconnect the AT wiring harness from the TCC PWM solenoid valve. 2. Measure the resistance of the TCC PWM solenoid valve. Refer to Testing for Continuity . Does the resistance measure within the specified range?	10-15 Ω	Go to Step 17	Go to Step 18
10	1. Disconnect the AT wiring harness assembly from the TCC PWM solenoid valve. 2. Measure the resistance from each of the component terminals to ground. Refer to Testing for Continuity . Do both readings measure greater than the specified value?	250 K Ω	Go to Step 17	Go to Step 18
11	**Important:** The condition that affects this circuit may exist in other connecting branches of the circuit. Refer to Power Distribution Schematics . Test the ignition circuit of the TCC PWM solenoid valve for a short to ground between the fuse block and the AT inline 20-way connector. Refer to Testing for Short to Ground and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 20	Go to Step 12
	Important: The condition that affects this circuit may exist in other connecting branches of the circuit. Refer to Power Distribution Schematics . Test the ignition circuit of the TCC PWM			

12	solenoid valve for a short to ground between the AT inline 20-way connector and the TCC PWM solenoid valve. Refer to Testing for Short to Ground . Did you find a short to ground condition?	--	Go to Step 17	Go to Step 13
13	1. Test each solenoid for a short to ground. 2. Replace the faulty solenoid as necessary. Did you complete the replacement?	--	Go to Step 20	--
14	**Important:** The condition that affects this circuit may exist in other connecting branches of the circuit. Refer to Power Distribution Schematics . Test the ignition circuit of the TCC PWM solenoid valve for an open. Refer to Testing for Continuity and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 20	--
15	Test the control circuit of the TCC PWM solenoid valve for a short to ground between the TCM and the AT inline 20-way connector. Refer to Testing for Short to Ground and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 20	Go to Step 19
16	Test the control circuit of the TCC PWM solenoid valve for an open between the TCM and the AT inline 20-way connector. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 20	Go to Step 19
17	Replace the AT wiring harness. Refer to Torque Converter Clutch Pulse Width Modulation Solenoid, Torque Converter Clutch Solenoid, and Wiring Harness . Did you complete the replacement?	--	Go to Step 20	--
18	Replace the TCC PWM solenoid valve. Refer to Torque Converter Clutch Pulse Width Modulation Solenoid, Torque Converter Clutch Solenoid, and Wiring Harness .	--		--

	Did you complete the replacement?		Go to Step 20	
19	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 20	--
20	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle in D4 with the TCC ON and make sure that the TCC Duty Cycle CKT status parameter displays OK for 5 seconds. 4. Select Specific DTC. 5. Enter DTC P2764. Has the test run and passed?	--	Go to Step 21	Go to Step 2
21	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P2769

Circuit Description

The torque converter clutch (TCC) solenoid valve is an electrical device that is used with the torque converter clutch pulse width modulation (TCC PWM) solenoid valve in order to control TCC apply and release. The TCC solenoid valve attaches to the transmission case assembly extending into the pump cover. The TCC solenoid valve receives voltage through the ignition 1 voltage circuit. The transmission control module (TCM) controls the solenoid by providing the ground path on the TCC solenoid valve control circuit. The TCM monitors the throttle position (TP) voltage, the vehicle speed and other inputs in order to determine when to energise the TCC solenoid valve.

When the TCM detects a continuous open or short to ground in the TCC solenoid valve control circuit, then DTC P2769 sets. DTC P2769 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P2769 Torque Converter Clutch (TCC) Enable Solenoid Control Circuit Low Voltage.

Conditions for Running the DTC

- The system voltage is 8-18 volts.
- The engine speed is 500 RPM for 5 seconds.

Conditions for Setting the DTC

DTC P2769 sets when either of the following conditions occurs for 5 seconds:

- The TCM detects an open in the TCC solenoid valve circuit when the TCC is commanded ON.
- The TCM detects a short to ground in the TCC shift solenoid valve circuit when the TCC is commanded ON.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM freezes transmission adaptive functions.
- The TCM inhibits TCC engagement.
- The TCM inhibits 4th gear if in hot mode.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the

Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.

- The TCM stores DTC P2769 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the 4th consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.

Diagnostic Aids

With the TCC engauged, the TCC slip speed should be -20 to +40 RPM.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

4. This step tests for voltage to the solenoid.

5. This step tests the ability of the TCM and wiring to control the ground circuit.

7. This step tests the resistance of the TCC solenoid valve and the automatic transmission (AT) wiring harness.

DTC P2769

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the transmission control module (TCM). 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC.	--		

	Are any of the following DTCs also set? - P0787 - P0973 - P0976 - P2764		Go to Step 3	Go to Step 4
3	Inspect the ACC/TCM fuse for an open. Refer to Circuit Protection - Fuses . Is the fuse open?	--	Go to Step 9	Go to Step 4
4	1. Turn OFF the ignition. 2. Disconnect the automatic transmission (AT) inline 20-way connector, additional DTCs may set. 3. Install the J 44152 on the engine side of the AT inline 20-way connector. 4. Turn ON the ignition, with the engine OFF. 5. Using the J 35616 , connect a test lamp from the TCC solenoid valve ignition voltage circuit of the J 44152 jumper to ground. Refer to Component Connector End Views . Does the test lamp illuminate?	--	Go to Step 5	Go to Step 12
5	1. Connect the test lamp from the TCC solenoid valve ignition voltage and signal circuits of the J 44152 jumper. Refer to Component Connector End Views . 2. Use the scan tool in order to command the TCC solenoid valve ON and OFF three times. Does the test lamp turn ON and OFF with each command?	--	Go to Step 7	Go to Step 6
6	Is the test lamp always ON?	--	Go to Step 13	Go to Step 14
7	1. Install the J 44152 on the transmission side of the AT inline 20-way connector. 2. Using the DMM and the J 35616 , measure the resistance between the torque converter clutch (TCC) solenoid valve ignition voltage and signal circuits of the J 44152 .	21-33 Ω		

	Refer to Testing for Continuity . Refer to Component Connector End Views . Does the resistance measure within the specified range?		Go to Step 8	Go to Step 15
8	1. Measure the resistance from the TCC solenoid valve ignition voltage circuit of the J 44152 to ground. 2. Measure the resistance from the TCC solenoid valve signal circuit of the J 44152 to ground. Refer to Testing for Continuity . Do both readings measure greater than the specified value?	250 K Ω	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 15
9	**Important:** The condition that affects this circuit may exist in other connecting branches of the circuit. Refer to Power Distribution Schematics . Test the ignition circuit of the TCC solenoid valve for a short to ground between the fuse block-underhood and the AT inline 20-way connector. Refer to Testing for Short to Ground and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 17	Go to Step 10
10	**Important:** The condition that affects this circuit may exist in other connecting branches of the circuit. Refer to Power Distribution Schematics . Test the ignition circuit of the TCC solenoid valve for a short to ground between the AT inline 20-way connector and the TCC solenoid valve. Refer to Testing for Short to Ground . Did you find a short to ground condition?	--	Go to Step 15	Go to Step 11
11	1. Test each solenoid for a short to ground. 2. Replace the faulty solenoid as necessary. Did you complete the replacement?	--	Go to Step 17	--
	Important: The condition that affects this			

12	circuit may exist in other connecting branches of the circuit. Refer to Power Distribution Schematics . Test the ignition circuit of the TCC solenoid valve for an open. Refer to Testing for Continuity and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 17	--
13	Test the solenoid control circuit of the TCC solenoid valve for a short to ground between the TCM and the AT inline 20-way connector. Refer to Testing for Short to Ground and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 17	Go to Step 16
14	Test the solenoid control circuit of the TCC solenoid valve for an open between the TCM and the AT inline 20-way connector. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 17	Go to Step 16
15	Replace the AT wiring harness, this includes the TCC solenoid valve. Refer to Torque Converter Clutch Pulse Width Modulation Solenoid, Torque Converter Clutch Solenoid, and Wiring Harness . Did you complete the replacement?	--	Go to Step 17	--
16	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 17	--
17	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle in D4 with the TCC commanded ON for 5 seconds and commanded OFF for 5 seconds. 4. Select Specific DTC. 5. Enter DTC P2769. Has the test run and passed?	--	Go to Step 18	Go to Step 2
	With the scan tool, observe the stored			

18	information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P2770

Circuit Description

The torque converter clutch (TCC) solenoid valve is an electrical device that is used with the torque converter clutch pulse width modulation (TCC PWM) solenoid valve in order to control TCC apply and release. The TCC solenoid valve attaches to the transmission case assembly extending into the pump cover. The TCC solenoid valve receives voltage through the ignition 1 voltage circuit. The transmission control module (TCM) controls the solenoid by providing the ground path on the TCC solenoid valve control circuit. The TCM monitors the throttle position (TP) voltage, the vehicle speed and other inputs in order to determine when to energise the TCC solenoid valve.

When the TCM detects a continuous short to voltage in the TCC solenoid valve control circuit, then DTC P2770 sets. DTC P2770 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P2770 Torque Converter Clutch (TCC) Enable Solenoid Control Circuit High Voltage.

Conditions for Running the DTC

- The system voltage is 8-18 volts.
- The engine speed is 500 RPM for 5 seconds.

Conditions for Setting the DTC

DTC P2770 sets if the TCM commands the solenoid ON and the voltage feedback remains high, B+.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM inhibits TCC engaugement.
- The TCM inhibits 4th gear if in hot mode.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P2770 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the 4th consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

DTC P2770

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the transmission control module (TCM). 3. Record the DTC Freeze Frame and Failure Records. 4. With a scan tool, command TCC Enable ON. Does the TCC Enable Sol. CKT status parameter display OK?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the automatic transmission (AT) inline 20-way connector, additional DTCs may set. 3. Install the J 44152 on the engine side of the AT inline 20-way connector. 4. Turn ON the ignition, with the engine OFF. 5. Using the J 35616 , connect a test lamp from TCC solenoid valve control circuit of the J 44152 to ground. Refer to Component Connector End Views . Does the test lamp illuminate?	--	Go to Step 4	Go to Step 5
	Test the control circuit of the TCC solenoid valve for a short to voltage between the TCM			

4	and the AT inline 20-way connector. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 7	Go to Step 6
5	Replace the AT internal wiring harness. The TCC solenoid valve is part of the AT internal wiring harness. Refer to Torque Converter Clutch Pulse Width Modulation Solenoid, Torque Converter Clutch Solenoid, and Wiring Harness . Did you complete the replacement?	--	Go to Step 7	--
6	Replace the TCM. Refer to Control Module References . Did you complete the replacement?	--	Go to Step 7	--
7	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle in D4 and make sure the TCC Duty Cycle CKT Status parameter displays OK for 5 seconds. 4. Select Specific DTC. 5. Enter DTC P2770. Has the test run and passed?	--	Go to Step 8	Go to Step 2
8	With the scan tool, observe the stored information, capture info, and DTC Info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

Drives in Neutral

Drives in Neutral

Checks	Causes
Forward Clutch (446-451)	The clutch does not release
Manual Valve Link (89)	Disconnected
Case (103)	• The face is not flat • Internal leakage exists

3-2 Flare or Tie-Up

3-2 Flare or Tie-Up

Checks	Causes
3-2 Shift Solenoid Valve Assembly (394)	• Shorted or damaged • Contamination • Damaged Seal • Check ball not seating

Buzz Noise or High Frequency Rattle Sound

Buzz Noise or High Frequency Rattle Sound

Checks	Action
DEFINITION: A buzz or high frequency rattle	
• Trace Cooler Pipes • Check for binding or contact at the Radiator, other than at the Cooler Pipe connectors	Verify a pressure buzz by watching for a needle vibration of the pressure gauge. A road test may be necessary. Refer to Road Test .

Case Porosity Repair

Some external leaks are caused by case porosity in non-pressurized areas. You can usually repair these leaks with the transmission in the vehicle.

1. Thoroughly clean the area to be repaired with a cleaning solvent. Air dry the area.

   Caution: Epoxy adhesive may cause skin irritations and eye damage. Read and follow all information on the container label as provided by the manufacturer.

2. Using instructions from the manufacturer, mix a sufficient amount of an epoxy to make the repair.
3. While the transmission case is still hot, apply the epoxy. You can use a clean, dry soldering acid brush to clean the area and also to apply the epoxy cement. Make certain that the area to be repaired is fully covered.
4. Allow the epoxy cement to cure for three hours before starting the engine.
5. Repeat the fluid leak diagnosis procedures.

Clutch Plate Diagnosis

Composition Plates

Dry the plates and inspect the plates for the following conditions:

- Pitting
- Flaking
- Delamination--splitting or separation of bonded clutch material
- Wear
- Glazing
- Cracking
- Charring
- Chips or metal particles embedded in the lining

Replace a composition plate which shows any of these conditions.

Steel Plates

Wipe the plates dry and check the plates for heat discoloration. If the surfaces are smooth, even if colour smear is indicated, you can reuse the plate. If the plate is discolored with heat spots or if the surface is scuffed, replace the plate.

Causes of Burned Clutch Plates

The following conditions can result in a burned clutch plate:

- Incorrect usage of clutch or apply plates
- Engine coolant or water in the transmission fluid
- A cracked clutch piston
- Damaged or missing seals
- Low line pressure
- Valve body conditions
  - The valve body face is not flat.
  - Porosity is between channels.
  - The valve bushing clips are improperly installed.
  - The checkballs are misplaced.
- The Teflon® seal rings are worn or damaged.

Delay in Drive and Reverse

Delay in Drive and Reverse

Checks	Causes
Forward Clutch Piston (630)	Cut or damaged piston seals
Low and Reverse Clutch Piston (695)	Cut or damaged inner, outer or center clutch seals
Reverse Input Clutch Piston Assembly (607)	Cut or damaged inner or outer clutch seals
Pump Cover (215)	Cut or damaged oil seal rings - stator shaft

Engine Coolant / Water in Transmission

Notice: The antifreeze or water will deteriorate the seals, gaskets and the glue that bonds the clutch material to the pressure plate. Both conditions may cause damage to the transmission.

If antifreeze or water has entered the transmission, perform the following:

1. Disassemble the transmission.
2. Replace all of the rubber type seals (the coolant will attack the seal material which will cause leakage).
3. Replace the composition-faced clutch plate assemblies (the facing material may separate from the steel center portion).
4. Replace all of the nylon parts (washers).
5. Replace the torque converter.
6. Thoroughly clean and rebuild the transmission, using new gaskets and oil filter.
7. Flush the cooler lines after the transmission cooler has been properly repaired or replaced.

Engine Starts in Gear

Engine Starts in Gear

Checks	Causes
Manual Valve (24)	Not engaguged to detent lever
Transmission Range Switch	Not working or mispositioned

First Gear Range Only - No Upshift

1st Gear Range Only - No Upshift

Checks	Causes
Control Valve Body (60)	• The 1-2 Shift valve is sticking • The spacer plate or gaskets are mispositioned or damaged
Case (103)	The case to valve body face is damaged or is not flat
Shift Solenoid Valves (366/368)	• Stuck or damaged • Faulty electrical connection
2-4 Servo Assembly (13-28)	• The apply passage case is restricted or blocked • Nicks or burrs on the servo pin or on the pin bore in the case • Fourth servo piston is installed backwards
2-4 Band Assembly (602)	• The 2-4 band is worn or damaged • The band anchor pin is not engauged

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Fluid Leak Diagnosis

General Method

1. Verify that the leak is transmission fluid.
2. Thoroughly clean the suspected leak area.
3. Operate the vehicle for 24 km (15 mi), or until normal operating temperatures are reached.
4. Park the vehicle over clean paper or cardboard.
5. Shut OFF the engine.
6. Look for fluid spots on the paper.
7. Make the necessary repairs.

Powder Method

1. Thoroughly clean the suspected leak area with solvent.
2. Apply an aerosol type powder, such as foot powder, to the suspected leak area.
3. Operate the vehicle for 24 km (15 mi), or until normal operating temperatures are reached.
4. Shut OFF the engine.
5. Inspect the suspected leak area.
6. Trace the leak path through the powder in order to find the source of the leak.
7. Make the necessary repairs.

Dye and Black Light Method

A fluid dye and black light kit is available from various tool manufacturers.

1. Follow the manufacturer's instructions in order to determine the amount of dye to use.
2. Detect the leak with the black light.
3. Make the necessary repairs.

Find the Cause of the Leak

Pinpoint the leak and trace the leak back to the source. You must determine the cause of the leak in order to repair the leak properly. For example, if you replace a gasket, but the sealing flange is bent, the new gasket will not repair the leak. You must also repair the bent flange. Before you attempt to repair a leak, check for the following conditions, and make repairs as necessary:

Gaskets

- Fluid level/pressure is too high
- Plugged vent or drain-back holes
- Improperly tightened fasteners
- Dirty or damaged threads
- Warped flanges or sealing surface
- Scratches, burrs, or other damage to the sealing surface
- Damaged or worn gasket

- Cracking or porosity of the component
- Improper sealant used, where applicable
- Incorrect gasket

Seals

- Fluid level/pressure is too high
- Plugged vent or drain-back holes
- Damaged seal bore
- Damaged or worn seal
- Improper installation
- Cracks in component
- Manual or output shaft surface is scratched, nicked, or damaged
- Loose or worn bearing causing excess seal wear

Possible Points of Fluid Leaks

Transmission Oil Pan

- Incorrectly tightened oil pan bolts
- Improperly installed or damaged oil pan gasket
- Damaged oil pan or mounting face
- Incorrect oil pan gasket

Case Leak

- Damaged or missing fill tube seal
- Mislocated fill tube bracket
- Damaged vehicle speed sensor seal
- Damaged manual shaft seal
- Loose or damaged oil cooler connector fittings
- Worn or damaged propeller shaft oil seal
- Loose line pressure pipe plug
- Porous casting

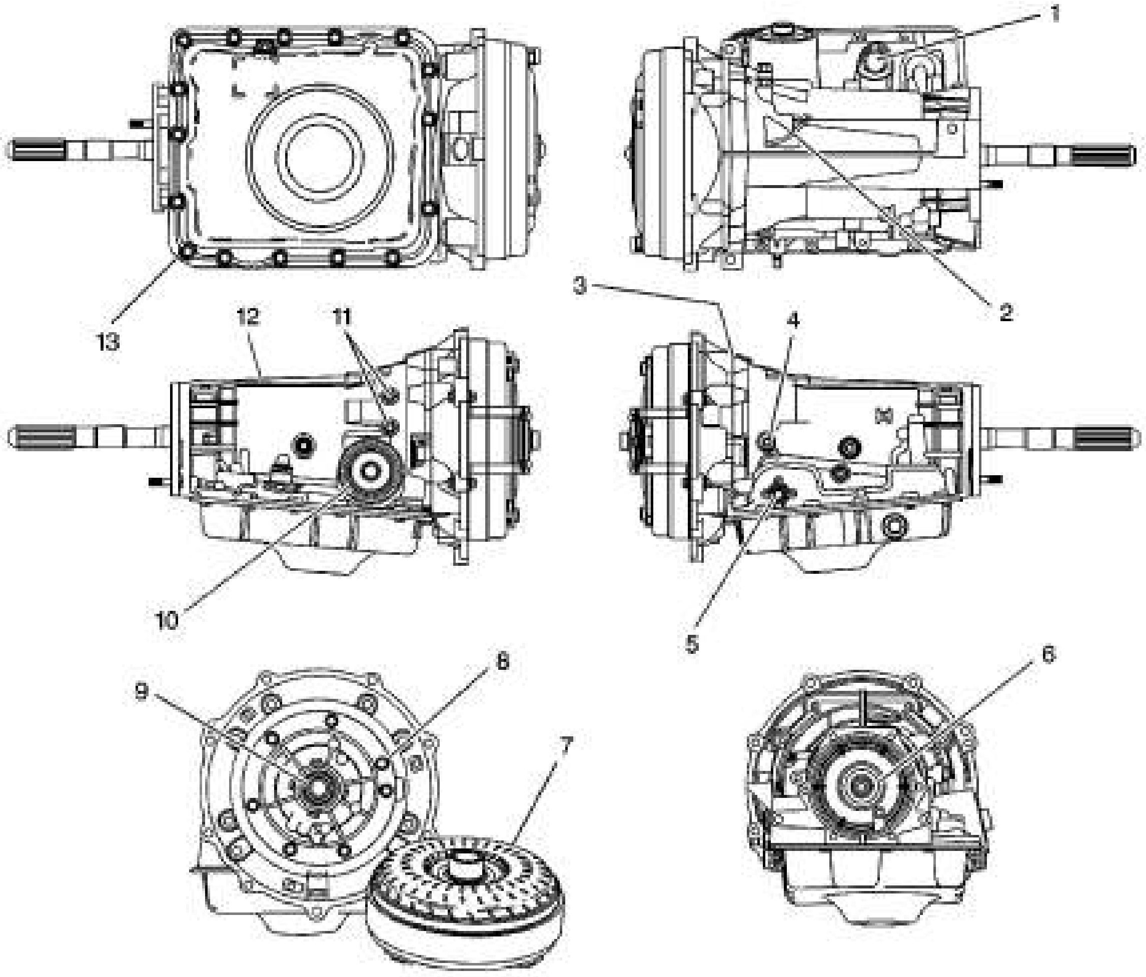
Leak at the Torque Converter End

- Converter leak in the weld area
- Converter seal lip cut. Check the converter hub for damage
- Converter seal bushing moved forward and damaged
- Converter seal garter spring missing from the seal
- Porous casting of the transmission case or the oil pump

Leak at the Vent Pipe or the Fluid Fill Tube

- Overfilled system
- Water or coolant in the fluid. The fluid will appear milky
- Transmission case porous
- Incorrect fluid level indicator
- Plugged vent
- Drain-back holes plugged
- Mispositioned oil pump to case gasket, if equipped

Leak Inspection Points



(1) Wiring Harness Pass-through Connector O-Ring Seal
(2) Transmission Vent Assembly
(3) Converter Housing to Case Joint (Pump to Case Oil Seal)

(4) Line Pressure Plug
(5) Manual Shaft Seal
(6) Case Rear Oil Seal Assembly
(7) Torque Converter Assembly
(8) Pump to Case Oil Seal
(9) Pump Oil Seal Assembly
(10) 2-4 Servo Cover O-Ring Seal
(11) Oil Cooler Pipe Connectors
(12) Transmission Case
(13) Transmission Oil Pan Gasket

Harsh Garage Shift

Harsh Garage Shift

Checks	Causes
Valve Body Assembly (60)	• Orifice cup plug missing • Checkball missing

Harsh Shifts

Harsh Shifts

Checks	Causes
Throttle Position Sensor	Open or shorted circuit
Vehicle Speed Sensor (36)	Open or shorted circuit
Automatic Transmission Fluid Pressure (TFP) (69)	• Contamination • Damaged seals
Trans Fluid Temperature Sensor (Part of 69)	Open or shorted circuit
Engine Coolant Temperature Sensor	Open or shorted circuit
Pressure Control Solenoid (377)	• Damage to electrical terminals • Contamination

Inaccurate Shift Points

Inaccurate Shift Points

Checks	Causes
Oil Pump Assembly (4)	• Stuck pressure regulator valve • Sticking pump slide
Valve Body Assembly (60)	Spacer plate or gaskets misassembled, damaged or incorrect
Case (103)	• Porous or damaged valve body pad • 2-4 Servo Assembly - 2-4 accumulator porosity - Damaged servo piston seals - Apply pin damaged or improper length • 2-4 Band Assembly - Burned - Anchor pin not engauged
Throttle Position Sensor	• Disconnected • Damage
Vehicle Speed Sensor (36)	• Disconnected • Damaged • Bolt not tightened

Lack of Power or Hesitation

Lack of Power or Hesitation

Checks	Causes
Automatic Transmission Fluid Pressure (TFP) Manual Valve Position Switch (69)	Incorrect TFP signal logic for current gear position. Refer to Transmission Fluid Pressure Manual Valve Position Switch Logic .

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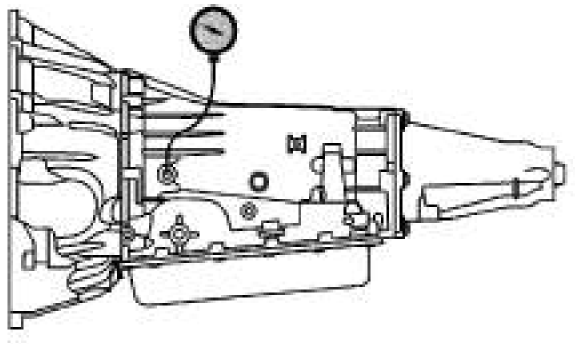
Line Pressure Check



Tools Required

J 21867 Pressure Gage

> **Caution:** Keep the brakes applied at all times in order to prevent unexpected vehicle motion. Personal injury may result if the vehicle moves unexpectedly.

> **Important:** Before performing the line pressure check, verify that the transmission pressure control (PC) solenoid is operating correctly.

1. Install a scan tool.
2. Start the engine.
3. Inspect the transmission for the proper fluid levels. Refer to Transmission Fluid Check.
4. Use the scan tool to inspect for any active or stored diagnostic trouble codes.
5. Inspect the manual linkage at the transmission for proper function.
6. Turn the engine OFF.

> **Important:** It may be necessary to remove or disconnect components in order to gain access to the transmission line pressure test port/plug.

7. Remove the pressure plug.
8. Install the J 21867 .
9. Access the Scan Tool Output Control for the PC Solenoid.
10. Start the engine.

Important: In order to achieve accurate line pressure readings, the following procedure must be performed at least three times in order to gather uniform pressure readings.

The scan tool is only able to control the PC solenoid in PARK and NEUTRAL with engine speeds below 1500 RPM. This protects the clutches from extreme high or low line pressures.

11. Begin commanding PC Solenoid at 1.0 amp and lower the amperage in one-tenth increments (0.01) until maximum line pressure is achieved.
12. Allow the pressure to stabilize between increments.
13. Compare your pressure readings to the Line Pressure table. Refer to Line Pressure.
14. If the pressure readings vary greatly from the line pressure table, refer to Oil Pressure High or Low.
15. Turn the engine OFF.
16. Remove the J 21867 .

Notice: Refer to Fastener Notice in the Preface section.

17. Install the pressure plug.

Tighten
Tighten the pressure plug to 8-14 N·m (6-10 lb ft).

No 2-3 Shift or 2-3 Shift Slips, Rough or Hunting

No 2-3 Shift or 2-3 Shift slipping, Rough or Hunting

Checks	Causes
Oil Pump (4)	Stator shaft bushings scored or off location
Valve Body Assembly (60)	• 2-3 Shift valve train stuck • Gaskets or spacer plate incorrect, mispositioned or damaged • 2-3 Accumulator valve stuck • Face not flat • Chips in servo feed oil, orifice #7 in spacer plate • Mislocated valve body to spacer plate checkball or checkballs
Input Housing Assembly (620-621, 646-655)	• 3-4 clutch or forward clutch plates worn • Excessive clutch plate travel • Cut or damaged 3-4 clutch or forward clutch piston seals • Porosity in input clutch housing or piston • 3-4 clutch piston checkball stuck, damaged or not sealing • Restricted apply passages • Forward clutch piston retainer and ball assembly not seating • Sealing balls loose or missing • Input housing (621) cracked or broken
Case (103)	3rd accumulator retainer and ball assembly not seating
2-4 Servo Assembly (13-28)	2nd apply piston seals missing, cut or damaged

No 3-4 Shift, Slips or Rough 3-4 Shift

No 3-4 Shift / Slipping or Rough 3-4 Shift

Checks	Causes
Oil Pump Assembly (4)	• Pump cover retainer and ball assembly omitted or damaged • Faces not flat
Valve Body Assembly (60)	• Valves stuck - 2-3 Shift valve train - Accumulator valve - 1-2 Shift valve train - 3-2 Shift solenoid valve assembly • Spacer plate or gaskets incorrect, mispositioned or damaged
2-4 Servo Assembly (13-28)	• Incorrect band apply pin • Missing or damaged servo seals • Porosity in piston, cover or case • Damaged piston seal grooves • Plugged or missing orifice cup plug
Case (103)	• 3rd Accumulator retainer and ball assembly leaking • Porosity in 3-4 accumulator piston or bore • 3-4 Accumulator piston seal or seal grooves damaged • Plugged or missing orifice cup plug • Restricted oil passage
Input Housing Assembly (621)	Refer to No 2-3 Shift or 2-3 Shift Slips, Rough or Hunting .
2-4 Band Assembly (602)	Worn or misassembled

No Drive in All Ranges

No Drive in All Ranges

Checks	Causes
Torque Converter (1)	The converter to flex plate bolts are missing

No Drive in Drive Range

No Drive in Drive Range

Checks	Causes
Torque Converter (1)	• The stator roller clutch is not holding • The converter is not bolted to the flex plate

No First or Second Gear / No Third or Fourth Gear

No 1st or 2nd / No 3rd or 4th

Checks	Causes
2-3 Shift Solenoid Valve (367B)	• Sediment is in the valves • The electrical connection is faulty • Damaged seal

No Fourth Gear, or Slips in Fourth Gear

No 4th or Slipping 4th

Checks	Causes
Checkball #2, 4, 8 or 12	Valve body checkball in wrong location or an additional checkball is installed. Refer to Control Valve Body Installation.
Orificed Cup Plug (240)	Not fully pressed into pump cover. Refer to Oil Pump Stator Shaft Bushing Replacement.

No Gear Selection

No Gear Selection

Checks	Causes
Detent Lever (63)	Nut loose or missing
Manual Valve (84)	Stuck
Spacer Plate/Gaskets (47, 48, 52)	Blocked holes
Control Valve Body to Case (60/103)	Blocked channels

No Overrun Braking - Manual 3-2-1

No Overrun Braking - Manual 3-2-1

Checks	Causes
External Linkage	Not adjusted properly
Valve Body Assembly (60)	• 4-3 Sequence valve stuck • Checkball mispositioned • Spacer plate and gaskets incorrect, damaged or mispositioned
Overrun and Forward Clutch Assembly (644-651)	• Turbine shaft oil passages plugged or not drilled • Turbine shaft seal rings damaged • Turbine shaft sealing balls loose or missing • Porosity in forward or overrun clutch piston • Overrun piston seals cut or damaged • Overrun piston checkball not sealing

No Park

No Park

Checks	Causes
Parking Lock Actuator Linkage (85-90)	• Actuator rod assembly bent or damaged • Actuator rod spring binding or improperly crimped • Actuator rod not attached to inside detent lever • Parking lock bracket damaged or not torqued properly • Inside detent lever not torqued properly • Parking pawl binding or damaged

No Part Throttle or Delayed Downshifts

No Part Throttle or Delayed Downshifts

Checks	Causes
Input Housing Assembly (621)	• 3-4 Apply ring stuck in applied position • Forward clutch not releasing • Turbine shaft seals missing, cut or damaged
Manual Valve Link (89)	Disconnected
Valve Body Assembly (60)	• 2-3 Shift valve stuck • Manual linkage not adjusted • Spacer plate and gaskets incorrect, mispositioned or damaged • Lo overrun valve stuck • Orificed cup plug restricted, missing or damaged
Reverse Input Clutch Assembly (606-614)	• Clutch plate worn • Reverse input housing and drum assembly cracked at weld • Clutch plate retaining ring out of groove • Return spring assembly retaining ring out of groove • Seals cut or damaged • Restricted apply passage • Porosity in piston • Belleville plate installed incorrectly • Excessive clutch plate travel • Oversized housing
Lo and Reverse Clutch (694-696)	• Clutch plates worn • Porosity in piston • Seals damaged • Return spring assembly retaining ring mispositioned • Restricted apply passage

No Reverse or Slips in Reverse

No Reverse or Slips in Reverse

Checks	Causes
Input Housing Assembly (602)	• 3-4 Apply ring stuck in applied position • Forward clutch not releasing • Turbine shaft seals missing, cut or damaged
Manual Valve Link (89)	Disconnected
Valve Body Assembly (60)	• 2-3 Shift valve stuck • Manual linkage not adjusted • Spacer plate and gaskets incorrect, mispositioned or damaged • Lo overrun valve stuck • Orificed cup plug restricted, missing or damaged
Reverse Input Clutch Assembly (605-614)	• Clutch plate worn • Reverse input housing and drum assembly cracked at weld • Clutch plate retaining ring out of groove • Return spring assembly retaining ring out of groove • Seals cut or damaged • Restricted apply passage • Porosity in piston • Belleville plate installed incorrectly • Excessive clutch plate travel • Oversized housing
Lo and Reverse Clutch (694-696)	• Clutch plates worn • Porosity in piston • Seals damaged • Return spring assembly retaining ring mispositioned • Restricted apply passage
Reaction Sun Shell (670)	Broken spline on reaction sun shell/replace shell

No Second Gear, No Fourth Gear, and No Reverse Gear

No Second Gear, No Fourth Gear and No Reverse Gear

Checks	Causes
Reaction Sun Shell (670)	Broken spline on reaction sun shell/replace shell.

No Third Gear

No 3rd

Checks	Causes
Orificed Cup Plug (698)	Missing or blown out

No Torque Converter Clutch Apply

No Torque Converter Clutch (TCC) Apply

Checks	Causes
Valve Body Assembly (60)	• Regulator apply valve side loading • Stuck converter clutch valve • TCC apply valve stuck closed (debris in bore) • TCC/PWM solenoid broken/cracked • Turbine shaft O-ring omitted • TCC/PWM solenoid leaking
Input Housing and Turbine Shaft Assembly (621)	• Turbine shaft hole not drilled to full depth • Scratched turbine shaft journals • Turbine shaft O-ring omitted/damaged • Turbine shaft retainer and ball assembly restricted or damaged
Electrical	• 12 volts not supplied to transmission • Outside electrical connector damaged • Inside electrical connector damaged • Wire harness damaged • TCC solenoid damaged • Electrical short (pinched wire) • TCC solenoid not grounded
Torque Converter Clutch (1)	Internal damage (blue or distorted)
Oil Pump Assembly (4)	• TCC outer spring cocked • Orifice cup plug restricted or damaged • Pump to case gasket mispositioned • Converter clutch valve retaining ring mispositioned • Converter clutch valve stuck or assembled backwards
Transmission Fluid Pressure Manual Valve Position Switch (69)	• Contamination • Damaged seals
Solenoid Screen (367A/367B)	Blocked
TCC Solenoid Valve (Part of 66)	Internal damage
Engine Speed Sensor	Internal damage
Engine Coolant Temperature Sensor	Internal damage
Automatic Transmission Fluid Temperature	Internal damage

Sensor (Part of 69)	
Brake Switch	Internal damage
TCM	Internal damage
TCC PWM Solenoid (Part of 66)	Internal damage

No Torque Converter Clutch Release

No TCC Release

Checks	Causes
TCC Solenoid Valve (Part of 66)	• External ground • Clogged exhaust orifice
Converter (1)	Internal damage
Valve Body Assembly (60)	The converter clutch apply valve is stuck in the apply position
Oil Pump Assembly (4)	The converter clutch valve is stuck
TCM	External ground

Noise and Vibration Analysis

A noise or vibration that is noticeable when the vehicle is in motion MAY NOT be the result of the transmission.

If noise or vibration is noticeable in PARK and NEUTRAL with the engine at idle, but is less noticeable as RPM increases, the cause may be from poor engine performance.

- Inspect the tires for the following conditions:
  - Uneven wear
  - Imbalance
  - Mixed sizes
  - Mixed radial and bias ply
- Inspect the suspension components for the following conditions:
  - Alignment and wear
  - Loose fasteners
- Inspect the engine and transmission mounts for damage and loose bolts.
- Inspect the transmission case mounting holes for the following conditions:
  - Missing bolts, nuts, and studs
  - Stripped threads
  - Cracks
- Inspect the flywheel for the following conditions:
  - Missing or loose bolts
  - Cracks
  - Imbalance
- Inspect the torque converter for the following conditions:
  - Missing or loose bolts or lugs
  - Missing or loose balance weights
  - Imbalance

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Noise in Random Ranges

Noise in Random Ranges

Checks	Action
DEFINITION: Noise only in certain gear ranges	
Refer to Range Reference . Determine the power flow and the applicable components that may be causing this noise.	

Oil Out the Vent

Oil Out the Vent

Checks	Causes
Oil Pump (4)	Chamber in pump body rotor pocket
Miscellaneous	Fluid level--overfilled

Oil Pressure High or Low

Oil Pressure High or Low

Checks	Causes
Oil Pump Assembly (4)	• Pressure regulator valve stuck • Pressure regulator valve spring • Rotor guide omitted or misassembled • Rotor cracked or broken • Reverse boost valve or sleeve stuck, damaged or incorrectly assembled • Orifice hole in pressure regulator valve plugged • Sticking slide or more than specfied rotor clearance • Pressure relief ball not seated or damaged • Porosity in pump cover or body • Wrong pump cover • Pump faces not flat • Excessive rotor clearance
Oil Filter (72)	• Intake pipe restricted by casting flash • Cracks in filter body or intake pipe • O-ring seal missing, cut or damaged • Wrong grease used on rebuild
Control Valve Body (60)	• Manual valve scored or damaged • Spacer plate or gaskets incorrect, misassembled or damaged • Face not flat • 2-3 Shift valve stuck • Checkballs omitted or misassembled
Pressure Control Solenoid (377)	Damage to electrical terminals
Transmission Fluid Pressure Manual Valve Position Switch (69)	• Contamination • Damaged seals
Case (103)	Case to control valve body face not flat
System Voltage	• 12 volts not supplied to transmission • Electrical short (pinched solenoid wire) • Solenoid not grounded

Popping Noise

No Drive in All Ranges

Checks	Causes
Torque Converter (1)	The converter to flex plate bolts are missing

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Range Selector Displays Incorrect Range

Circuit Description

The transmission range (TR) switch is part of the park/neutral position (PNP) and back-up lamp switch assembly, which is externally mounted on the transmission manual shaft. The TR switch contains four internal switches that indicate the transmission gear range selector lever position. The powertrain control module (PCM) supplies ignition voltage to each switch circuit. As the gear range selector lever is moved, the state of each switch may change, causing the circuit to open or close. An open circuit or switch indicates a high voltage signal. A closed circuit or switch indicates a low voltage signal. The PCM detects the selected gear range by deciphering the combination of the voltage signals. The PCM compares the actual voltage combination of the switch signals to a TR switch combination chart stored in memory.

Diagnostic Aids

Refer to the Transmission Range Switch Logic table for valid combinations of switch signal circuits A, B, C and Parity. On the table, HI indicates an ignition voltage signal. LOW indicates a zero voltage signal.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

4. By disconnecting the TR switch, the ground path of all TR switch circuits is removed and the PCM should recognize all circuits as open. The scan tool should display HI for all range signal states.

5. This step tests the TR switch wiring for an open or the lack of the signal voltage from the PCM.

6. This step tests the TR switch wiring and the PCM by providing a ground path through a fused jumper wire. When grounded, the scan tool range signal states should change to LOW.

7. This step tests the TR switch wiring and the PCM by providing a ground path through a fused jumper wire. When grounded, the scan tool range signal states should change to LOW.

8. This step tests the TR switch wiring and the PCM by providing a ground path through a fused jumper wire. When grounded, the scan tool range signal states should change to LOW.

9. This step tests the TR switch wiring and the PCM by providing a ground path through a fused jumper wire. When grounded, the scan tool range signal states should change to LOW.

Range Selector Display Inoperative or Displays Incorrect Range (4.2L)

Step	Action	Values	Yes	No
	1. Install a scan tool. 2. Turn ON the ignition, with the engine			

1	OFF. 3. Select TR Sw. on the scan tool. 4. With the scan tool, observe the TR Sw. display while selecting each transmission range: P, R, N, D4, D3, D2 and D1. Does each selected transmission range match the scan tool TR Sw. display?	--	Go to Step 2	Go to Step 3
2	Observe the IPC gear range display while selecting each transmission range: P, R, N, D4, D3, D2, D1. Does each selected transmission range match the IPC display?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 16
3	With the scan tool, observe the TR Sw. A/B/C/P display. Does the scan tool TR Sw. A/B/C/P parameter indicate HI for all range signal states?	--	Go to Step 13	Go to Step 4
4	1. Turn OFF the ignition. 2. Disconnect the TR switch connector. 3. Turn ON the ignition, with the engine OFF. Does the scan tool TR Sw. A/B/C/P parameter indicate HI for all range signal states?	--	Go to Step 5	Go to Step 10
5	1. Using the DMM and the J 35616 GM Terminal Test Kit, measure the voltage from the transmission range signal A circuit of the TR switch connector to ground. 2. Measure the voltage from the transmission range signal B circuit of the TR switch connector to ground. 3. Measure the voltage from the transmission range signal C circuit of the TR switch connector to ground. 4. Measure the voltage from the transmission range signal P circuit of the TR switch connector to ground. Does the voltage measure within the specified range at all 4 terminals?	10-12 V	Go to Step 6	Go to Step 11
6	Connect a fused jumper wire from the TR switch connector, signal circuit A, to ground while monitoring the scan tool TR Sw. A/B/C/P parameter. When signal circuit A is grounded, do any other signal circuits indicate LOW?	--	Go to Step 12	Go to Step 7
	Connect a fused jumper wire from the TR switch connector, signal circuit B, to ground			

7	while monitoring the scan tool TR Sw. A/B/C/P parameter. When signal circuit B is grounded, do any other signal circuits indicate LOW?	--	Go to Step 12	Go to Step 8
8	Connect a fused jumper wire from the TR switch connector, signal circuit C, to ground while monitoring the scan tool TR Sw. A/B/C/P parameter. When signal circuit C is grounded, do any other signal circuits indicate LOW?	--	Go to Step 12	Go to Step 9
9	Connect a fused jumper wire from the TR switch connector, signal circuit P, to ground while monitoring the scan tool TR Sw. A/B/C/P parameter. When signal circuit P is grounded, do any other signal circuits indicate LOW?	--	Go to Step 12	Go to Step 13
10	Test the signal circuits of the TR switch that did not indicate HI for a short to ground. Refer to Circuit Testing and Wiring Repairs. Did you find and correct the condition?	--	Go to Step 17	Go to Step 15
11	Test the signal circuits of the TR switch that did not indicate proper voltage for an open. Refer to Circuit Testing and Wiring Repairs. Did you find and correct the condition?	--	Go to Step 17	Go to Step 15
12	Test the affected signal circuits of the TR switch for a shorted together condition. Refer to Circuit Testing and Wiring Repairs. Did you find and correct the condition?	--	Go to Step 17	Go to Step 15
13	Test the ground circuit of the TR switch for an open. Refer to Circuit Testing and Wiring Repairs. Did you find and correct the condition?	--	Go to Step 17	Go to Step 14
14	Replace the TR switch, this switch is part of the park/neutral position switch. Refer to Park/Neutral Position Switch Replacement. Did you complete the replacement?	--	Go to Step 17	--

15	Replace the PCM. Refer to Control Module References for replacement, setup, and programming. Did you complete the replacement?	--	Go to Step 17	--
16	Replace the IPC. Refer to Control Module References for replacement, setup, and programming. Did you complete the replacement?	--	Go to Step 17	Go to Step 2
17	1. Turn ON the ignition, with the engine OFF. 2. With the scan tool, observe the TR Sw. display while selecting each transmission range: P, R, N, D4, D3, D2 and D1. Does each selected transmission range match the scan tool TR Sw. display?	--	System OK	Go to Step 2

Ratcheting Noise

Ratcheting Noise

Checks	Causes
Parking Brake Pawl (50-81)	The parking pawl return spring is weak, damaged, or misassembled

Road Test

Important: The Road Test Procedure should be performed only as part of the Symptom Diagnosis. Refer to Symptoms - Automatic Transmission .

The following test provides a method of evaluating the condition of the automatic transmission. The test is structured so that most driving conditions can be achieved. The test is divided into the following parts:

- Electrical Function Check
- Upshift Control and Torque Converter Clutch (TCC) Apply
- Part Throttle Detent Downshifts
- Full Throttle Detent Downshifts
- Manual Downshifts
- Coasting Downshifts
- Manual Gear Range Selection
  - REVERSE
  - Manual FIRST
  - Manual SECOND
  - Manual THIRD

Important: Complete the test in the sequence given. Incomplete testing cannot guarantee an accurate evaluation.

Before the road test, make sure the following:

- The engine is performing properly.
- Transmission fluid level is correct. Refer to the Transmission Fluid Check .
- Tire pressure is correct.

During the road test:

- Perform the test only when traffic conditions permit.
- Operate the vehicle in a controlled, safe manner.
- Observe all traffic regulations.
- View the scan tool data while conducting this test.

  Take along qualified help in order to operate the vehicle safely.
- Observe any unusual sounds or smells.

After the road test, check the following:

- Transmission fluid level. Refer to the Transmission Fluid Check .

- Diagnostic trouble codes (DTCs) that may have set during the testing. Refer to the applicable DTC.
- Scan tool data for any abnormal readings or data.

Electrical Function Check

Perform this check first, in order to make sure the electronic transmission components are connected and functioning properly. If these components are not checked, a simple electrical condition may be mis-diagnosed.

1. Connect the scan tool.
2. Ensure the gear selector is in PARK and set the parking brake.
3. Start the engine.
4. Verify that the following scan tool data can be obtained and is functioning properly.

   Refer to Control Module References for typical data values. Data that is questionable may indicate a concern.

   - Engine speed
   - Transmission output speed
   - Vehicle speed
   - TFP manual valve position switch
   - Transmission range, engine list
   - Commanded gear, current gear
   - PC solenoid reference current
   - PC solenoid actual current
   - PC solenoid duty cycle
   - Brake switch
   - Engine coolant temperature
   - Transmission fluid temperature
   - Throttle angle
   - Ignition voltage
   - 1-2 shift solenoid
   - 2-3 shift solenoid
   - TCC solenoid duty cycle
   - TCC slip speed
5. Monitor the brake switch signal while depressing and releasing the brake pedal. The scan tool should display:
   - Closed when the brake pedal is released.
   - Open when the brake pedal is depressed.
6. Check the garage shifts.
   - 6.1. Apply the brake pedal and make sure that the parking brake is set.
   - 6.2. Move the gear selector through the following ranges:
     - 6.2.1. PARK to REVERSE
     - 6.2.2. REVERSE to NEUTRAL

            6.2.3. NEUTRAL to DRIVE
        6.3. Pause 2 to 3 seconds in each gear position.
        6.4. Verify the gear engaugements are immediate and not harsh.

Important: Harsh engagement may be caused by any of the following conditions:

- High idle speed. Compare engine idle speed to desired idle speed.
- Commanded low PC solenoid current. Compare PC solenoid reference current to PC solenoid actual current.
- A default condition caused by certain DTCs that result in maximum line pressure to prevent slippage.

Important: Soft or delayed engagement may be caused by any of the following conditions:

- Low idle speed. Compare engine idle speed to desired idle speed.
- Low fluid level
- Commanded high PC solenoid current. Compare PC solenoid reference current to PC solenoid actual current.
- Cold transmission fluid. Check for low transmission fluid temperature.

7. Monitor transmission range on the scan tool, engine list.
    7.1. Apply the brake pedal and make sure the parking brake is set.
    7.2. Move the gear selector through all ranges.
    7.3. Pause 2-3 seconds in each range.
    7.4. Return gear selector to PARK.
    7.5. Verify that all selector positions match the scan tool display.
8. Check throttle angle input.
    8.1. Apply the brake pedal and make sure that the parking brake is set.
    8.2. Ensure the gear selector is in PARK.
    8.3. Monitor throttle angle while increasing and decreasing engine speed with the throttle pedal. The scan tool throttle angle should increase and decrease with engine speed.

If any of the above checks do not perform properly, record the result for reference after completion of the road test.

Upshift Control and Torque Converter Clutch (TCC) Apply

The TCM calculates the upshift points based primarily on two inputs: throttle angle and vehicle speed. When the TCM determines that conditions are met for a shift to occur, the TCM commands the shift by closing or opening the ground circuit for the appropriate solenoid.

Perform the following steps:

1. Refer to the Shift Speed , table in this section and choose a throttle position of 12 percent, 25 percent or 50 percent. All throttle angles shown should be tested to cover the normal driving range.
2. Monitor the following scan tool parameters:
    - Throttle angle
    - Vehicle speed

  - Engine speed
  - Output shaft speed
  - Commanded gear
  - Slip speed
  - Solenoid states
3. Place the gear selector in the OVERDRIVE position.
4. Accelerate the vehicle using the chosen throttle angle. Hold the throttle steady.
5. As the transmission upshifts, note the vehicle speed when the shift occurs for each gear change. There should be a noticeable shift feel or engine speed change within 1-2 seconds of the commanded gear change.
6. Compare the shift speeds to the Shift Speed table. Refer to Shift Speed . Shift speeds may vary slightly due to transmission fluid temperature or hydraulic delays in responding to electronic controls.
   - Note any harsh, soft or delayed shifts or slipping.
   - Note any noise or vibration.
7. Repeat steps 1 through 6 to complete all throttle angles.

   Important: This transmission is equipped with an electronically controlled capacity clutch (ECCC). The pressure plate does not fully lock to the torque converter cover. Instead, the pressure plate maintains a small amount of slippage, about 20 RPM, in SECOND, THIRD and FOURTH gears, depending on the vehicle application. ECCC was developed to reduce the possibility of noise, vibration or chuggle caused by TCC apply. Typical apply speeds are 49-52 km/h (30-32 mph) in THIRD gear and 65-73 km/h (40-45 mph) in FOURTH gear. Full lockup is available at highway speeds on some applications.

   Important: The TCC will not engauge until the engine is in closed loop operation and the vehicle speed is as shown in the Shift Speed table. Refer to Shift Speed . The vehicle must be in a near-cruise condition, not accelerating or coasting, and on a level road surface.

8. Check for TCC apply in THIRD and FOURTH gear.
   - Note the TCC apply point. When the TCC applies there should be a noticeable drop in engine speed and a drop in slip speed to below 100 RPM. If the TCC apply can not be detected:
     - Check for DTCs.
     - Refer to Torque Converter Diagnosis .
   - Refer to the Shift Speed , table for the correct apply speeds.
   - Lightly tap and release the brake pedal. The TCC will release on most applications.

Part Throttle Detent Downshift

1. Place the gear selector in the OVERDRIVE position.
2. Accelerate the vehicle to 64-88 km/h (40-55 mph) in FOURTH gear.
3. Quickly increase throttle angle to greater than 50 percent.
4. Verify the following:
   - The TCC releases
   - The transmission downshifts immediately to THIRD gear

Full Throttle Detent Downshift

1. Place the gear selector in the OVERDRIVE position.
2. Accelerate the vehicle to speeds of 64-88 km/h (40-55 mph) in FOURTH gear.
3. Quickly increase throttle angle to 100 percent (WOT).
4. Verify the following:
   - The TCC releases
   - The transmission downshifts immediately to SECOND gear

Manual Downshifts

The shift solenoid valves do not control the initial downshift for the 4-3 or the 3-2 manual downshifts. The 4-3 and the 3-2 manual downshifts are hydraulic. The 2-1 manual downshift is electronic. The solenoid states should change during or shortly after a manual downshift is selected.

Manual 4-3 Downshift

1. Place the gear selector in the OVERDRIVE position.
2. Accelerate the vehicle to 64-88 km/h (40-55 mph) in FOURTH gear.
3. Release the throttle while moving the gear selector to THIRD.
4. Verify the following:
   - The TCC releases
   - The transmission downshifts immediately to THIRD gear
   - The engine slows the vehicle

Manual 4-2 Downshift

1. Place the gear selector in the OVERDRIVE position.
2. Accelerate the vehicle to 64-72 km/h (40-45 mph).
3. Release the throttle while moving the gear selector to SECOND.
4. Verify the following:
   - The TCC releases
   - The transmission downshifts immediately to SECOND gear
   - The engine slows the vehicle

Manual 4-1 Downshift

1. Place the gear selector in the OVERDRIVE position.
2. Accelerate the vehicle to 48 km/h (30 mph).
3. Release the throttle while moving the gear selector to FIRST.
4. Verify the following:
   - The TCC releases.
   - The transmission downshifts immediately to FIRST gear.
   - The engine slows the vehicle.

Coasting Downshifts

1. Place the gear selector in the OVERDRIVE position.
2. Accelerate the vehicle to FOURTH gear with the TCC applied.
3. Release the throttle and lightly apply the brakes.

4. Verify the following:
    - The TCC releases
    - Downshifts occur at speeds shown in the Shift Speed table. Refer to Shift Speed .

Manual Gear Range Selection

The shift solenoids control the upshifts in the manual gear ranges.

Perform the following tests using 10-15 percent throttle angle.

Reverse

1. With the vehicle stopped, move the gear selector to REVERSE.
2. Slowly accelerate the vehicle.
3. Verify that there is no noticeable slip, noise or vibration.

Manual First

1. With the vehicle stopped, move the gear selector to FIRST.
2. Accelerate the vehicle to 32 km/h (20 mph).
3. Verify the following:
    - No upshifts occur
    - The TCC does not apply
    - There is no noticeable slip, noise, or vibration

Manual Second

1. With the vehicle stopped, move the gear selector to SECOND.
2. Accelerate the vehicle to 57 km/h (35 mph).
3. Verify the following:
    - The 1-2 shift occurs
    - The 2-3 shift does not occur
    - There is no noticeable slip, noise or vibration

Manual Third

1. With the vehicle stopped, move the gear selector to THIRD.
2. Accelerate the vehicle to 64 km/h (40 mph).
3. Verify the following:
    - The 1-2 shift occurs
    - The 2-3 shift occurs
    - There is no noticeable slip, noise or vibration

Second / Third Gear Only or First / Fourth Gears Only

Second / Third Gears Only or First / Fourth Gears Only

Checks	Causes
1-2 Shift Solenoid Valve (367A)	• Sediment is in the valves • The electrical connection is faulty • Damaged seal

Second Gear Start

Second Gear Start

Checks	Causes
Forward Clutch Sprag Assembly (642)	The sprag assembly is installed backward

Shift Lever Indicates Wrong Gear

Shift Lever Indicates Wrong Gear

Checks	Causes
Manual Valve (340)	Not engauged to detent lever
Detent Roller Pin (63)	Missing or damaged
Detent Roller (63)	Broken or disconnected
Detent Spring (63)	Broken or disconnected
Manual Valve Link (89)	Loose or missing
Manual Shaft (84)	Flats not parallel
Indicator Linkage	Misadjusted

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Shift Solenoid Leak Test

Tools Required

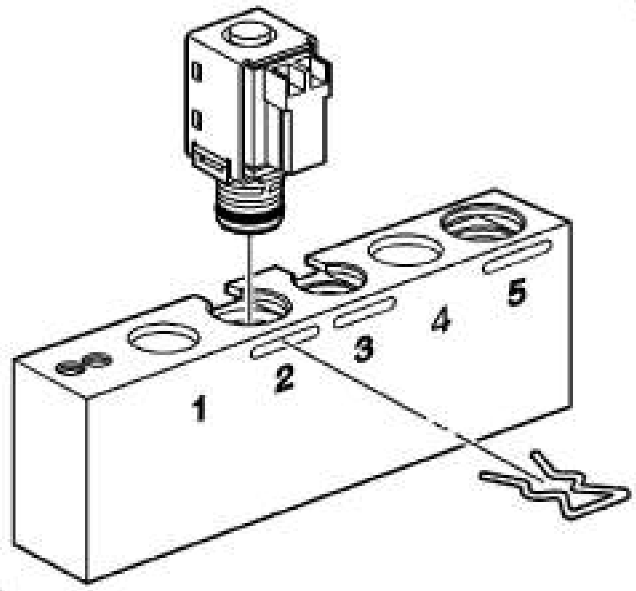
- J 35616 Holden Terminal Test Kit
- J-44246 Solenoid Testing Kit

Leak Test Procedure

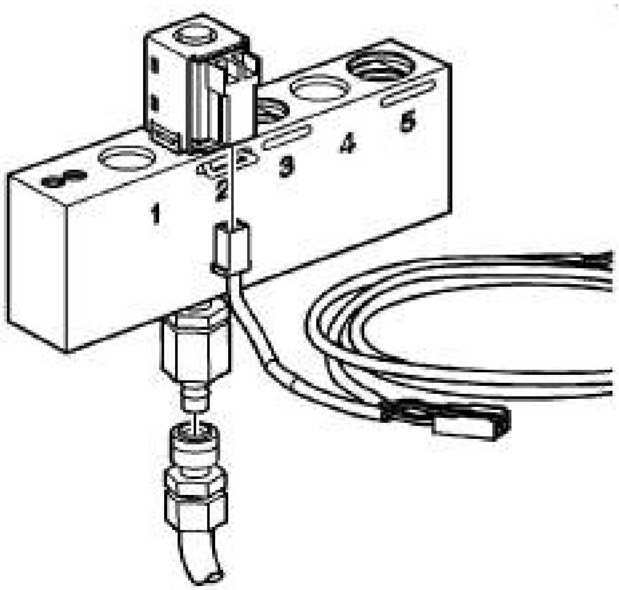
Important:

- This procedure tests On/Off type solenoid valves.
- Visually inspect the physical condition of the solenoid before testing. Inspect the O-rings before and after the test to be sure that they are not cut or damaged.

1. Remove the shift solenoid valve from the control valve body or the torque converter clutch (TCC) solenoid valve from the transmission case. Refer to Control and Shift Solenoid Replacement or Torque Converter Clutch Pulse Width Modulation (TCC PWM) Solenoid, TCC Solenoid and Wiring Harness.



2. Install the TCC solenoid valve, the 1-2 shift solenoid valve or the 2-3 shift solenoid valve into bore number 2 of the J-44246 and install the factory retainer clip to retain the solenoid.



Important: The supplied solenoid testing harness will not power the 4L60-E TCC On/Off solenoid. To energise this solenoid, apply battery, 12-volt, positive (+) and negative (-) to the TCC On/Off solenoid wiring harness using connector test adapter kit J 35616 . Use terminal E, Red, Power, and terminal T, Black, Ground. Refer to the Component Connector End Views .

3. Connect the solenoid testing harness supplied with the J-44246 to the solenoid.

   Important: Do not use air pressure in excess of 827.4 kPa (120 psi). Excessive pressure will not allow the solenoid ball check valve to seat properly. Recommended air pressure is 344.75 kPa (50 psi).

4. Apply compressed air to the J-44246 .
5. Air should flow through the solenoid. If air does not flow through the solenoid, replace the solenoid. Refer to Control and Shift Solenoids Replacement.
6. Connect the solenoid testing harness to the 12-volt positive (+) and negative (-) battery terminals.
7. Observe if the solenoid is operating electrically. An audible clicking noise can be heard when connecting or disconnecting power.

   Important:
   - All solenoids need to be energised to seal.
   - A small amount of air leakage is normal +/- 21 kPa (+/- 3 psi).

8. Observe the air flow through the solenoid. The flow will completely or nearly completely stop. Replace the solenoid if there continues to be an obvious air leak when the solenoid is energised.

   Important: Inspect the O-rings after the test to be sure that they are not cut or damaged.

9. Install the shift solenoid valve into the control valve body or the TCC solenoid valve into the transmission case. Refer to Control and Shift Solenoids Replacement or Torque Converter

Clutch Pulse Width Modulation (TCC PWM) Solenoid, TCC solenoid and Wiring Harness.

Slip / Flare in Any Gear

Slip / Flare in any Gear

Checks	Causes
Pump Slide Inner/Outer Spring (206/207)	Omitted

Slipping or Harsh 1-2 Shift

Slipping or Rough 1-2 Shift

Checks	Causes
Valve Body Assembly (60)	• Mislocated valve body to spacer plate checkball or checkballs. • 1-2 Shift valve train stuck due to sediment • Gaskets or spacer plate incorrect, mispositioned or damaged • 1-2 Accumulator valve stuck or damaged • Face not flat • 4-3 sequence valve stuck or damaged • #1 or #8 checkball missing or mis-located • 1-2 accumulator valve bushing rotated 180°
2-4 Servo Assembly (13-28)	• Apply pin too long or too short • 2nd servo apply piston seal missing, cut or damaged • Restricted or missing oil passages • Servo bore in case damaged
2nd Accumulator (55-57, 104)	• Porosity in 1-2 accumulator cover or piston • Piston seal or groove damaged • Nicks or burrs in 1-2 accumulator housing • Missing or restricted oil passage • 1-2 accumulator piston spring not seated • Rough finish in 1-2 accumulator bore in case • A cracked 1-2 accumulator piston - allowing fluid to leak by
2-4 Band (602)	Worn or mispositioned
Oil Pump Assembly (4) or Case (103)	Faces not flat

Slips in First Gear

Slips in 1st Gear

Checks	Causes
Forward Clutch Assembly (646-651)	• Clutch plates worn • Porosity or damage in forward clutch piston • Forward clutch piston inner and outer seals missing, cut or damaged • Damaged forward clutch housing • Forward clutch housing retainer and ball assembly not sealing or damaged
Forward Clutch Accumulator (353-358)	• Piston seal missing, cut or damaged • Piston out of its bore • Porosity in the piston or valve body • Stuck abuse valve
Input Housing and Shaft Assembly (621)	Turbine shaft seals missing, cut or damaged
Valve Body (60)	• 1-2 Accumulator valve stuck • Face not flat, damaged lands or interconnected passages • Spacer plate or gaskets incorrect, mispositioned or damaged
Low Roller Clutch (678)	• Damage to lugs to inner ramps • Rollers not free moving • Inadequate spring tension • Damage to inner splines • Lube passage plugged
Torque Converter (1)	Stator roller clutch not holding
1-2 Accumulator Assembly (55-57, 104)	• Porosity in piston or 1-2 Accumulator cover and pin assembly • Damaged ring grooves on piston • Piston seal missing, cut or damaged • Valve body to spacer plate gasket at 1-2 Accumulator cover, missing or damaged • Leak between piston and pin • Broken 1-2 Accumulator spring
Line Pressure	Refer to Oil Pressure High or Low .
2-4 Servo Assembly (13-28)	4th Servo piston in backward

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Symptoms - Automatic Transmission

Diagnostic Category	Diagnostic Information
This table consists of nine diagnostic categories that are located in the left column. Using this column, choose the appropriate category based on the operating conditions of the vehicle or transmission. After selecting a category, use the right column to locate the specific symptom diagnostic information.	
Fluid Diagnosis This category contains the following topics: • Fluid condition - appearance, contaminants, smell, overheating • Line pressure - high or low • Fluid leaks	• Refer to Transmission Fluid Check . • Refer to Oil Pressure High or Low . • Refer to Fluid Leak Diagnosis . • Refer to Oil Out the Vent .
Noise and Vibration Diagnosis This category contains the following topics: • Ratcheting noise • Noise - drive gear, final drive, whine, growl, rattle, buzz, popping • Vibration	• Refer to Ratcheting Noise . • Refer to Vibration in Reverse and Whining Noise in Park . • Refer to Popping Noise . • Refer to Whine Noise Varying with RPM or Fluid Pressure . • Refer to Buzz Noise or High Frequency Rattle Sound . • Refer to Noise in Random Ranges .
Range Performance Diagnosis This category contains the following topics: • Drives in Neutral • No Park • No Reverse • No Drive • No engine braking • Lack of Power or Hesitation	• Refer to Drives in Neutral . • Refer to No Park . • Refer to No Reverse or Slips in Reverse . • Refer to No Drive in All Ranges . • Refer to No Drive in Drive Range . • Refer to No Overrun Braking - Manual 3-2-1 . • Refer to Lack of Power or Hesitation .
Shift Quality (Feel) Diagnosis This category contains the following topic: • Harsh, soft or slipping shifts • Harsh, soft or delayed engagement • Shift shudder, flare or tie-up	• Refer to Harsh Shifts . • Refer to Slipping or Harsh 1-2 Shift . • Refer to No 2-3 Shift or 2-3 Shift Slips, Rough or Hunting . • Refer to No 3-4 Shift, Slips or Rough 3-4 Shift . • Refer to Harsh Garage Shift .

	• Refer to Delay in Drive and Reverse . • Refer to 3-2 Flare or Tie-Up .
Shift Pattern This category contains the following topics: • One forward gear only • Two forward gears only • Gear missing or slipping • No upshift or slipping upshift • No downshifts • Non-First gear start	• Refer to First Gear Range Only - No Upshift . • Refer to Third Gear Only . • Refer to Second/Third Gear Only or First/Fourth Gears Only . • Refer to Slips in First Gear . • Refer to Slipping or Harsh 1-2 Shift . • Refer to No 2-3 Shift or 2-3 Shift Slips, Rough or Hunting . • Refer to No 3-4 Shift, Slips or Rough 3-4 Shift . • Refer to No Part Throttle or Delayed Downshifts . • Refer to Second Gear Start .
Shift Speed Diagnosis This category contains the following topic: Inaccurate or inconsistent shift points	Refer to Inaccurate Shift Points .
Torque Converter Diagnosis This category contains the following topics: • Torque converter diagnosis • TCC does not apply • TCC does not release • TCC apply/release quality	• Refer to Torque Converter Diagnosis . • Refer to No Torque Converter Clutch Apply . • Refer to No Torque Converter Clutch Release .
Indicator On or Message Centre Displays Message This category contains the following topics: High Trans Temp light does illuminate	Refer to DTC P0218 .
If Symptom Not Found	• Refer to Transmission Fluid Check . • Refer to Road Test . • Refer to Line Pressure Check .

Third Gear Only

Third Gear Only

Checks	Causes
System Voltage	• 12 volts not supplied to transmission • Electrical short (pinched solenoid wire) • Solenoid not grounded

Torque Converter Clutch Intermittent - OK Cold / Slips Hot

Intermittent TCC OK Cold / Slips Hot

Checks	Causes
TCC PWM Solenoid (396)	Leaks
Regulator Apply Valve (216)	Sticking valve
Converter Clutch Shift Valve (224)	Sticking valve

Torque Converter Clutch Shudder

No Torque Converter Clutch Shudder

Checks	Causes
Electrical	• 12 volts not supplied to transmission • Outside electrical connector damaged • Inside electrical connector, wiring harness or solenoid damaged • Electrical short (pinched solenoid wire)
Converter (1)	Internal damage
Oil Pump Assembly (4)	• Converter clutch valve stuck or assembled backwards • Converter clutch valve retaining ring mispositioned • Pump to case gasket mispositioned • Orifice cup plug restricted or damaged • Solenoid O-ring seal cut or damaged • High or uneven bolt torque (pump body to cover)
Input Housing and Shaft (621)	• Turbine shaft O-ring seal cut or damaged • Turbine shaft retainer and ball assembly restricted or damaged
Transmission Fluid Pressure Switch Assembly (69)	• Contamination • Damaged seals
Control Valve Body Assembly (60)	• TCC signal valve stuck • Solenoid O-ring leaking
Shift Solenoid Screen (367A/367B)	Blocked

Torque Converter Clutch Slip - 100 RPM Slip

TCC Slip (100 RPM)

Checks	Causes
Valve Body Assembly (60)	• TCC/PWM solenoid leaks • Regulator apply valve or converter clutch shift valve sticking or side loading
Oil Pump Assembly (4)	• Stator shaft bushings worn, due to scratched turbine shaft journal (replace bushings and input housing assembly) • TCC apply valve is stuck open • TCC solenoid leaking
Input Housing and Turbine Shaft Assembly (621)	• Scratched journal on turbine shaft • Turbine shaft O-ring cut • Turbine shaft hole not drilled to full depth

Torque Converter Clutch Slip with Stall/Stumble

TCC Slip with Stall/Stumble

Checks	Causes
TCC Apply Valve (Part of 66)	Stuck open

Torque Converter Diagnosis

The Torque Converter Clutch (TCC) is applied by fluid pressure, which is controlled by a PWM solenoid valve. This solenoid valve is located inside of the automatic transmission assembly. The solenoid valve is controlled through a combination of computer controlled switches and sensors.

Torque Converter Stator

The torque converter stator roller clutch can have two different malfunctions.

- The stator assembly freewheels in both directions.
- The stator assembly remains locked up at all times.

Poor Acceleration at Low Speed

If the stator is freewheeling at all times, the car tends to have poor acceleration from a standstill. At speeds above 50-55 km/h (30-35 mph), the car may act normally. For poor acceleration, you should first determine that the exhaust system is not blocked, and the transmission is in First gear when starting out.

If the engine freely accelerates to high RPM in NEUTRAL, you can assume that the engine and the exhaust system are normal. Check for poor performance in DRIVE and REVERSE to help determine if the stator is freewheeling at all times.

Poor Acceleration at High Speed

If the stator is locked up at all times, performance is normal when accelerating from a standstill. Engine RPM and car speed are limited or restricted at high speeds. Visual examination of the converter may reveal a blue colour from overheating.

If the converter has been removed, you can check the stator roller clutch by inserting a finger into the splined inner race of the roller clutch and trying to turn the race in both directions. You should be able to freely turn the inner race clockwise, but you should have difficulty in moving the inner race counterclockwise or you may be unable to move the race at all.

Noise

Important: Do not confuse this noise with pump whine noise, which is usually noticeable in PARK, NEUTRAL and all other gear ranges. Pump whine will vary with line pressure.

You may notice a torque converter whine when the vehicle is stopped and the transmission is in DRIVE or REVERSE. This noise will increase as you increase the engine RPM. The noise will stop when the vehicle is moving or when you apply the torque converter clutch, because both halves of the converter are turning at the same speed.

Torque Converter Clutch Shudder

The key to diagnosing Torque Converter Clutch Shudder is to note when it happens and under what conditions.

TCC shudder which is caused by the transmission should only occur during the apply or the release of the converter clutch. Shudder should never occur after the TCC plate is fully applied.

If Shudder Occurs During TCC Apply or Release

If the shudder occurs while the TCC is applying, the condition can be within the transmission or the torque converter. Something is causing one of the following conditions to occur:

- Something is not allowing the clutch to become fully engauged.
- Something is not allowing the clutch to release.
- The clutch is releasing and applying at the same time.

One of the following conditions may be causing the condition to occur:

- Leaking turbine shaft seals
- A restricted release orifice
- A distorted clutch or housing surface due to long converter bolts
- Defective friction material on the TCC plate

If Shudder Occurs After TCC has Applied

If shudder occurs after the TCC has applied, most of the time there is nothing wrong with the transmission.

The TCC is not likely to slip after the TCC has been applied. Engine conditions may go unnoticed under light throttle and load, but they become noticeable after the TCC apply when going up a hill or accelerating. This is due to the mechanical coupling between the engine and the transmission.

Once TCC is applied, there is no torque converter (fluid coupling) assistance. Engine or driveline vibrations may be unnoticeable before TCC engaugement.

Inspect the following components in order to avoid misdiagnosis of TCC shudder. An inspection will also avoid the unnecessary disassembly of a transmission or the unnecessary replacement of a torque converter.

- Spark plugs - Inspect for cracks, high resistance or a broken insulator.
- Plug wires - Look in each end. If there is red dust (ozone) or a black substance (carbon) present, then the wires are bad. Also look for a white discoloration of the wire. This indicates arcing during hard acceleration.
- Coil - Look for a black discoloration on the bottom of the coil. This indicates arcing while the engine is misfiring.
- Fuel injector - The filter may be plugged.
- Vacuum leak - The engine will not get a correct amount of fuel. The mixture may run rich or lean depending on where the leak occurs.
- EGR valve - The valve may let in too much or too little unburnable exhaust gas and may

cause the engine to run rich or lean.

- MAP/MAF sensor - Like a vacuum leak, the engine will not get the correct amount of fuel for proper engine operation.
- Carbon on the intake valves - Carbon restricts the proper flow of air/fuel mixture into the cylinders.
- Flat cam - Valves do not open enough to let the proper fuel/air mixture into the cylinders.
- Oxygen sensor - This sensor may command the engine too rich or too lean for too long.
- Fuel pressure - This may be too low.
- Engine mounts - Vibration of the mounts can be multiplied by TCC engaugement.
- Axle joints - Check for vibration.
- TP Sensor - The TCC apply and release depends on the TP Sensor in many engines. If the TP Sensor is out of specification, TCC may remain applied during initial engine loading.
- Cylinder balance - Bad piston rings or poorly sealing valves can cause low power in a cylinder.
- Fuel contamination - This causes poor engine performance.

Replace the torque converter if any of the following conditions exist:

- External leaks appear in the hub weld area.
- The converter hub is scored or damaged.
- The converter pilot is broken, damaged, or fits poorly into the crankshaft.
- You discover steel particles after flushing the cooler and the cooler lines.
- The pump is damaged, or you discover steel particles in the converter.
- The vehicle has TCC shudder and/or no TCC apply. Replace the torque converter only after all hydraulic and electrical diagnoses have been made. The converter clutch material may be glazed.
- The converter has an imbalance which cannot be corrected. Refer to Flex Plate/Torque Converter Vibration Test.
- The converter is contaminated with engine coolant which contains antifreeze.
- An internal failure occurs in the stator roller clutch.
- You notice more than specfied end play.
- Overheating produces heavy debris in the clutch.
- You discover steel particles or clutch lining material in the fluid filter or on the magnet, when no internal parts in the unit are worn or damaged. This condition indicates that lining material came from the converter.

Do not replace the torque converter if you discover any of the following symptoms:

- The oil has an odor or the oil is discolored, even though metal or clutch facing particles are not present.
- The threads in one or more of the converter bolt holds are damaged. Correct the condition with a new thread inset.
- Transmission failure did not display evidence of damaged or worn internal parts, steel particles or clutch plate lining material in the unit and inside the fluid filter.
- The vehicle has been exposed to high mileage only. An exception may exist where the lining

of the torque converter clutch dampener plate has seen excess wear by vehicles operated in heavy and/or constant traffic, such as taxi, delivery, or police use.

Transmission Fluid Check

1. Start the engine and operate the vehicle for 15 minutes or until the transmission fluid reaches an operating temperature of 82-93°C (180-200°F).
2. Park the vehicle on a level surface.
3. With your foot on the brake, move the shift lever through each gear range. Pause for about 3 seconds in each range, ending in PARK.
4. Apply the parking brake and let the engine idle for 3 minutes.
5. Remove the transmission fluid level indicator. Wipe the indicator clean. Insert the indicator. Give the indicator a full twist in order to close.
6. Wait 3 seconds and remove the indicator.
7. Read both sides of the indicator. The fluid must be within the hot cross-hatched area using the lowest level reading.

Step	Action	Values	Yes	No
1	Check the fluid colour. Is the fluid red in colour?	--	Go to Step 5	Go to Step 2
2	Is the fluid a non-transparent pink in colour?	--	Go to Step 14	Go to Step 3
3	**Important:** Fluid may turn a dark brown in colour from normal use. This does not always indicate an oxidation or a contamination issue. Is the fluid a light brown in colour?	--	Go to Step 5	Go to Step 4
4	Is the fluid black in colour and or have a "burnt" smell?	--	Go to Step 14	Go to Step 5
5	Does the fluid appear as a solid "liquid" and not "foamy" or full of bubbles on level indicator?	--	Go to Step 6	Go to Step 6
6	Check the fluid level. Proper level should be in middle of the "X" pattern, on level indicator. Is the level OK?	--	Go to Step 19	Go to Step 7
7	Is the fluid level high on indicator?	--	Go to Step 12	Go to Step 8
8	Is the fluid level low on indicator?	--	Go to Step 9	Go to Step 4
9	Check for any external leak or leaks. Refer to Fluid Leak Diagnosis. Did you find an external leak or leaks?	--	Go to Step 10	Go to Step 11
10	Correct leak or leaks as needed. Are any leak or leaks still present?	--	Go to Step 9	Go to Step 11
11	Add fluid until level is in middle of "X" pattern on the level indicator.	--		

	Is the level OK?		Go to Step 19	Go to Step 6
12	Drain fluid until level is in middle of "X" pattern on the level indicator. Is level OK?	--	Go to Step 19	Go to Step 6
13	Replace oil cooler and flush lines. Is the replacement complete?	--	Go to Step 15	--
14	**Important:** A small amount of "friction" material in pan bottom is a "normal" condition, but large pieces and or metal particles will require complete transmission overhaul. Drain fluid and remove oil pan to inspect. Is there sign or signs of internal component damage noted in bottom of transmission oil pan?	--	Go to Step 16	Go to Step 13
15	Replace the filter and fluid. Refer to Automatic Transmission Fluid/Filter Replacement. Is the replacement complete?	--	Go to Step 6	--
16	Flush oil cooler and lines. Refer to Transmission Fluid Cooler Flushing and Flow Test. Is the Automatic Transmission Oil Cooler Flushing and Flow Test complete?	--	Go to Step 17	--
17	Overhaul transmission. Is the Transmission Overhaul Procedure complete?	--	Go to Step 18	--
18	Add new fluid. Is the procedure complete?	--	Go to Step 6	--
19	Check the fluid level and correct as necessary. Is the fluid level satisfactory?	--	System OK	--

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Document ID: 1979868

Transmission Fluid Cooler Flushing and Flow Test

Studies indicate that plugged or restricted transmission oil coolers and pipes cause insufficient transmission lubrication and elevated operating temperatures which can lead to premature transmission failure. Many repeat repair cases may have been prevented by following published procedures for transmission oil cooler flushing and flow checking. This procedure includes flow checking and flushing the auxiliary transmission oil cooler, if equipped.

Only DEXRON®VI automatic transmission fluid should be used when doing a repair on this transmission.

Tools Required

- Shop air supply with water/oil filters, regulator and pressure gauge -- minimum 620 kPa (90 psi).
- Eye protection.
- Rubber gloves.
- Suitable container to catch fluid.

Reverse Flush

1. Disconnect both fluid lines at the transmission and cooler hoses / lines at the radiator cooler.
2. Check the cooler hoses / lines to radiator cooler fittings sealing washers for damage, replace as required.
3. Carefully check the radiator cooler lower fitting to see if any foreign material is evident at this point. If foreign material is found, remove it with a suitable tool and/or compressed air at a reduced pressure of approximately 345 kPa (50 psi) blown in the reverse direction through the cooler.
4. Using compressed air at a reduce pressure of approximately 345 kPa (50 psi) blown in a reverse direction, clean the fluid lines, cooler hoses / lines and if required any external cooler (where fitted).

   Important: Do not reconnect the fluid inlet line at the transmission end. This line needs to be left disconnected to perform the flow rate test.

5. Perform the flow rate test.
6. If the flow rate is satisfactory, reconnect the fluid inlet line to the transmission.

Flow Rate Test

1. Ensure the transmission fluid is at the recommended level or slightly above.
2. Disconnect the fluid inlet line at the transmission.
3. Place a suitable size container underneath the disconnected fluid inlet line.
4. With the selector lever in the P position, start the engine and observe the fluid flow into the container after all the air bubbles have ceased and a steady flow is evident. Measure the flow rate over 20 seconds and make sure it is within the specification.

   · Transmission fluid flow rate specification per 20 Seconds:

· Temperature: Ambient 0.7 Litres.

· Temperature: 86° - 93° C 1.2 Litres.

5. If the flow rate is less than the specification, the cause of the low flow rate must be located and rectified. Possible cause may include:

   · restricted cooler within the radiator tank.

   · damaged or restricted external cooler, where fitted,

   · kinked or damaged transmission fluid lines and/or cooler hoses / lines, or

   · internal transmission fault such as a faulty pump.

6. Reinstall the fluid inlet line to the transmission .

Transmission Overheats

Transmission Overheats

Checks	Causes
TCC Circuit	Blockage during apply or release
Pump Cover (215)	Cross channel leakage
Pressure Regulator Valve (216)	The valve is stuck in a high demand position
Oil Cooler	The cooler or the cooler lines are blocked
Oil Pan Gasket (73)	The gasket is damaged
Turbine Shaft O-ring (618)	The O-ring is damaged
Turbine Shaft Seals (619)	The seals are damaged
Stator Shaft Bushings (234/241)	The bushing is worn or damaged
Fluid	The fluid level is low
Radiator	Air flow is restricted or internal blockage

Vibration in Reverse and Whining Noise in Park

Vibration in Reverse and Whining Noise in Park

Checks	Causes
Oil Pump (4)	Chamber in pump body rotor pocket
Miscellaneous	Fluid level--overfilled

Whine Noise Varying with RPM or Fluid Pressure

Whine Noise Varying with RPM or Fluid Pressure

Checks	Action
DEFINITION: In all ranges, a whine which may be sensitive to RPM load, or which ceases when the TCC engauges, or which is sensitive to the oil pressure	
Torque Converter (1)	Verify that the noise is internal to the torque converter by placing your left foot on the brake with the gear or selector in Drive. Momentarily stall the engine. Torque Converter noise increases under load.
Oil Pump System	Verify that the noise is internal to the oil pump during a preliminary oil pressure check. An increase in line pressure will vary an oil pump noise.

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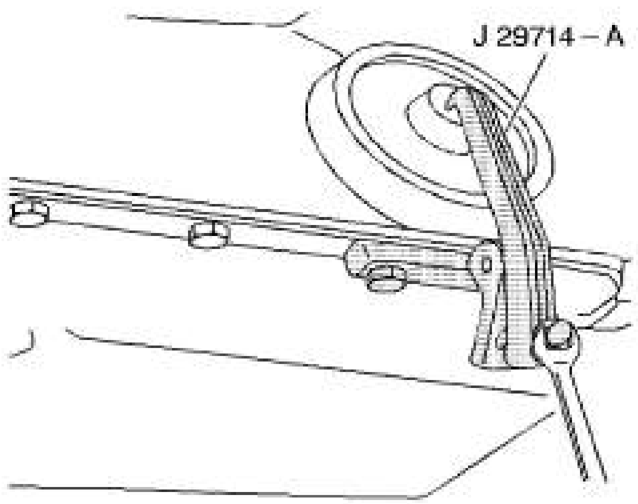
2-4 Servo

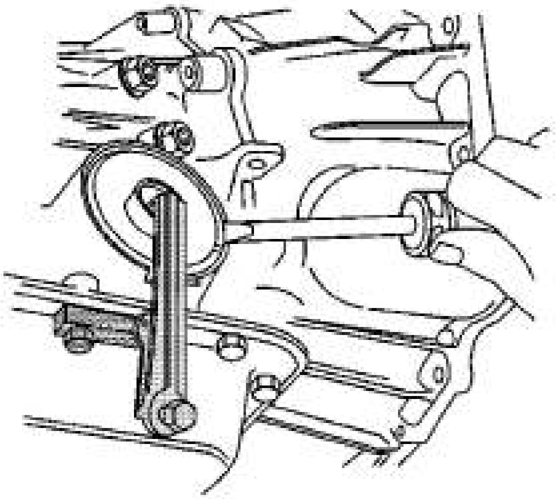
Tools Required

J 29714-A Servo Cover Depressor

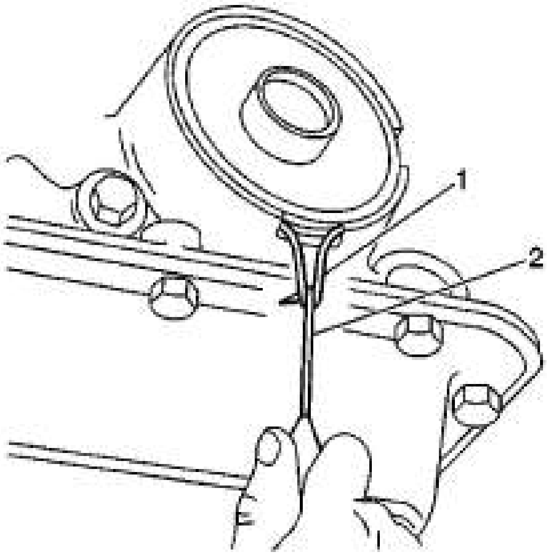
Removal Procedure



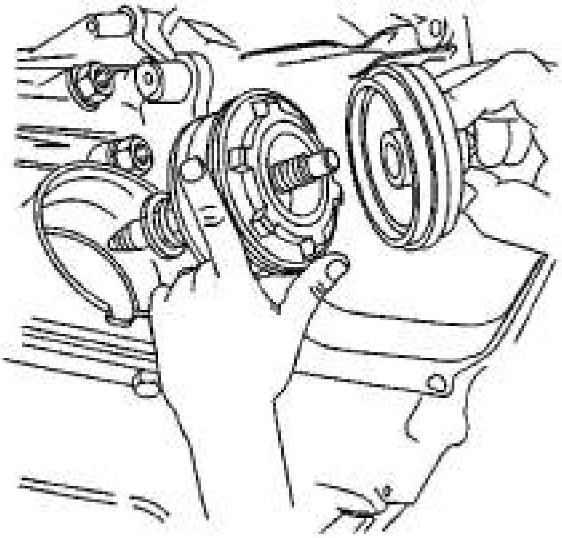
1. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Install a transmission jack and remove the transmission mount. Refer to Transmission Mount Replacement.
3. Lower the transmission.
4. Remove the oil pan bolt below and to the left of the 2-4 servo cover.
5. Install the J 29714-A to the oil pan rail.
6. Tighten the bolt on the J 29714-A to compress the servo cover.



7. Remove the servo cover retaining ring.
8. Loosen the bolt on the J 29714-A to release tension on the servo cover.



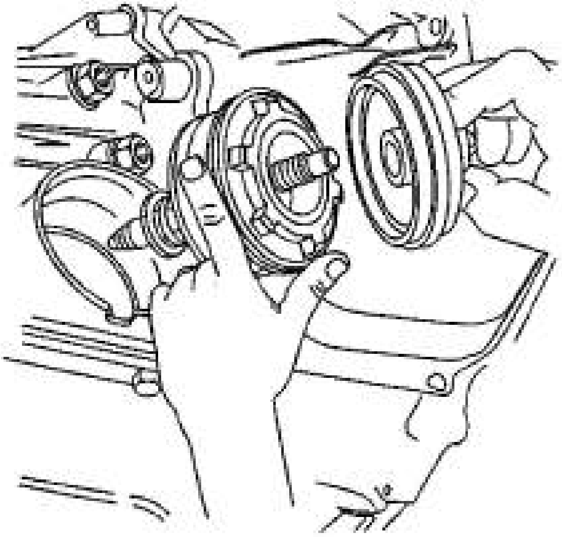
9. Remove the servo cover and O-ring seal. If the cover is hung up on the seal, use a pick (2) to pull and stretch the seal (1) out of the groove. Cut and remove the O-ring seal before removing the cover.



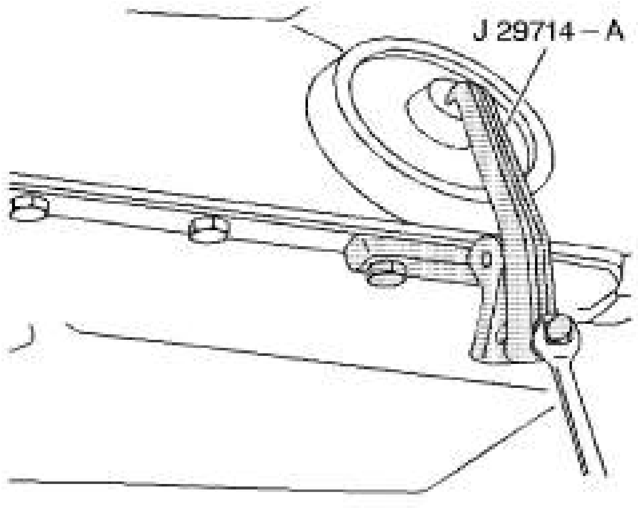
10. Remove the 2-4 servo from the transmission.
11. Inspect the 4th apply piston, 2-4 servo converter, 2nd apply piston, and the servo piston inner housing for the following defects:
    - Cracks
    - Scoring
    - Burrs and nicks

Installation Procedure

1. Install new seals on the servo pistons and the servo cover.



2. Install the 2-4 servo to the transmission.
3. Install the servo cover and O-ring seal.



4. Tighten the bolt on the J 29714-A to compress the servo cover.
5. Install the servo cover retaining ring.
6. Loosen the bolt on the J 29714-A to release tension on the servo cover.
7. Remove the J 29714-A from the oil pan rail.

   Notice: Refer to Fastener Notice in the Preface section.

8. Install the oil pan bolt below the 2-4 servo cover.

   Tighten
   Tighten the oil pan bolt to 12 N·m (106 lb in).

9. Raise the transmission.
10. Install the transmission mount. Refer to Transmission Mount Replacement.
11. Remove the transmission jack.
12. Lower the vehicle.
13. Fill the transmission to the proper level with DEXRON® VI transmission fluid. Refer to Transmission Fluid Check

    Important: It is recommended that transmission adaptive pressure (TAP) information be reset.

    Resetting the TAP values using a scan tool will erase all learned values in all cells. As a result, The ECM or TCM will need to relearn TAP values. Transmission performance may be affected as new TAP values are learned.

14. Reset the TAP values. Refer to Transmission Adaptive Functions.

Accumulator Assembly, Spacer Plate, and Gaskets

Tools Required

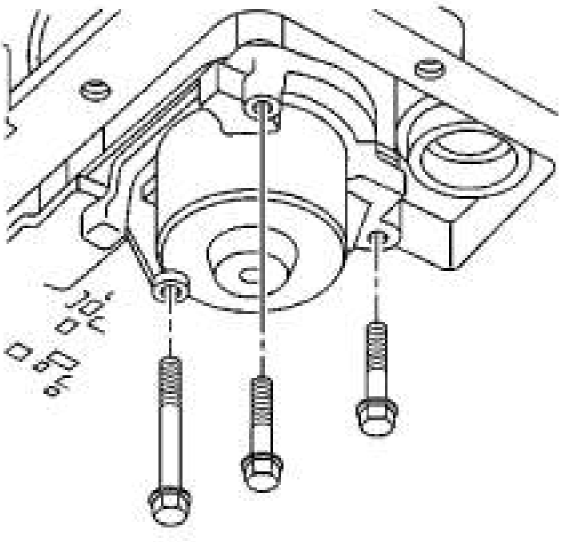
J 25025-B Pump and Valve Body Alignment Pin Set

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

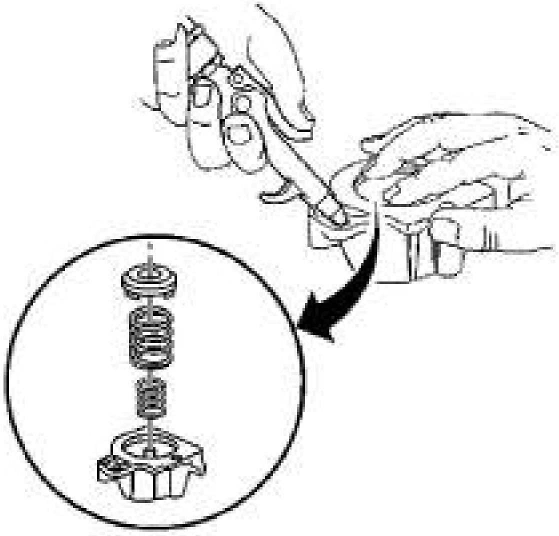
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



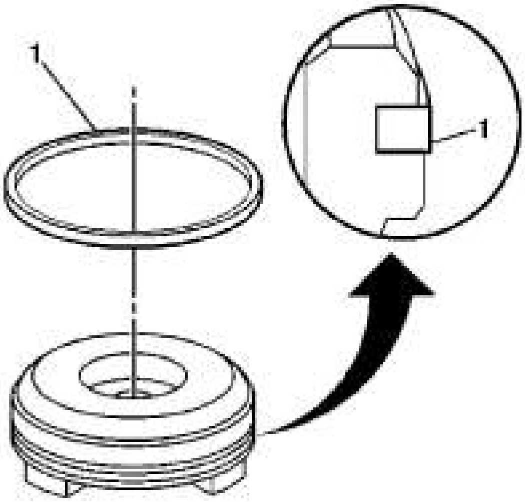
2. Remove the transmission oil pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement .

Important: The 1-2 accumulator can be removed without removing the control valve assembly.

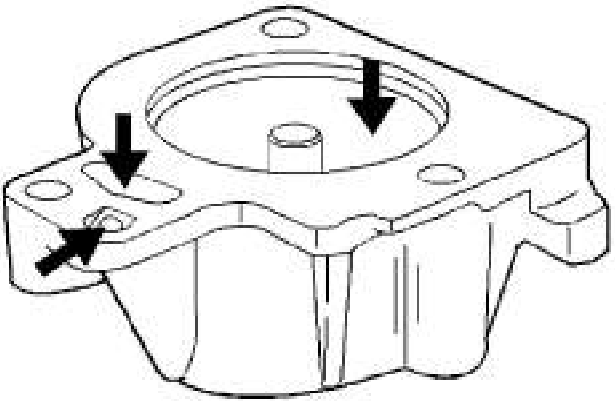
3. Remove the control valve body. Refer to Valve Body and Pressure Switch Replacement .
4. Remove the accumulator cover retaining bolts.
5. Remove the 1-2 accumulator cover assembly.



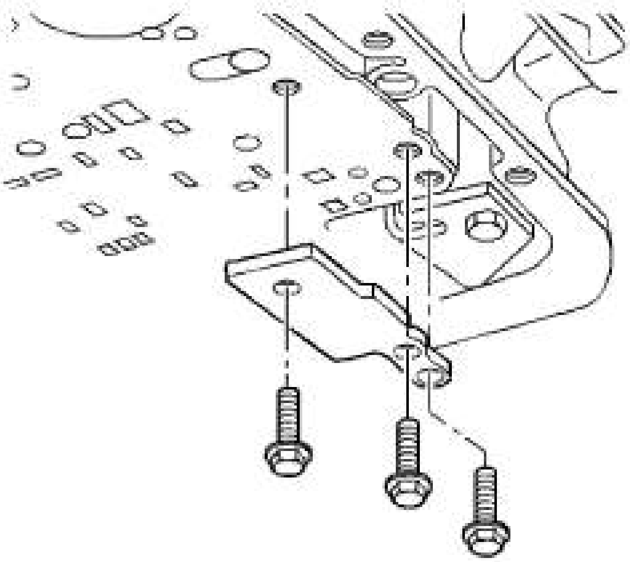
6. Disassemble the 1-2 accumulator.
    6.1. Blow compressed air into the 1-2 accumulator cover, as shown, to remove the 1-2 accumulator piston.
    6.2. Remove the 1-2 accumulator inner (not in all models) and outer springs.
7. Inspect the 1-2 accumulator inner (not in all models) and outer springs for cracks.



8. Remove the 1-2 accumulator piston seal (1) from the 1-2 accumulator piston.
9. Inspect the 1-2 accumulator piston for the following defects:
    - Porosity
    - Cracks
    - Scoring
    - Nicks and scratches



10. Inspect the 1-2 accumulator cover for the following defects:
    - Porosity
    - Cracks
    - Scoring
    - Nicks and scratches



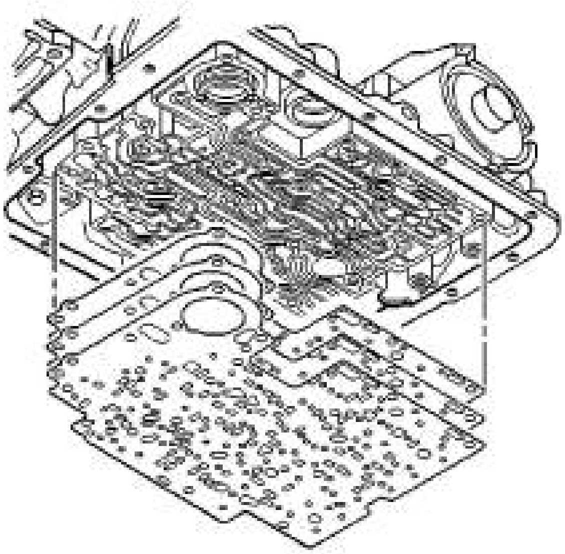
11. Remove the spacer plate support retaining bolts.

    Important: Use care not to drop the following items that will be removed along with the spacer plate:

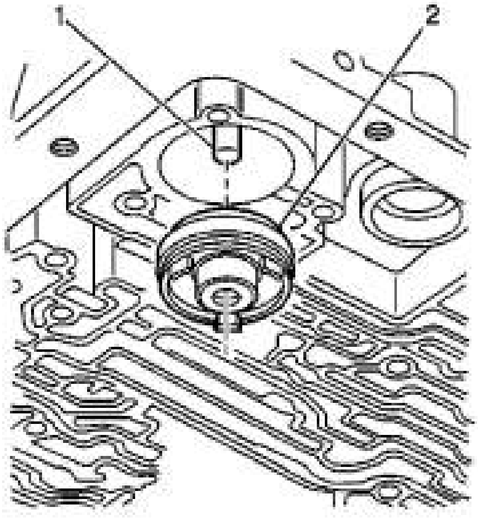
    - The number 1 checkball

- The 3-4 accumulator spring
- The 3-4 accumulator pin

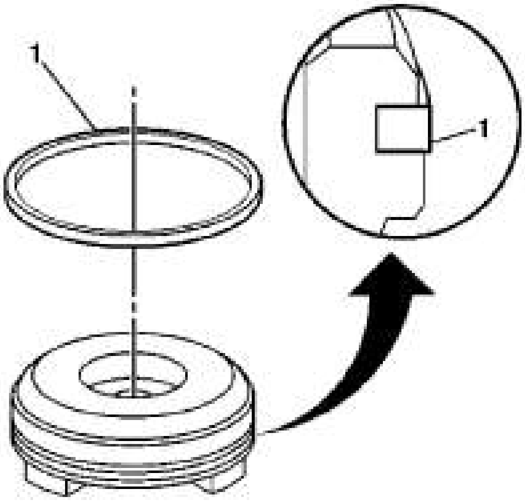
12. Remove the spacer plate support.



13. Remove the spacer plate to valve body gasket, the spacer plate and the spacer plate to transmission case gasket.

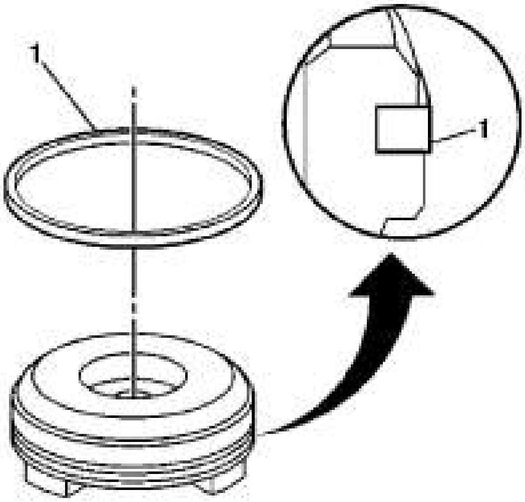


14. Remove the 3-4 accumulator piston (2).
15. Inspect the 3-4 accumulator spring for cracks.

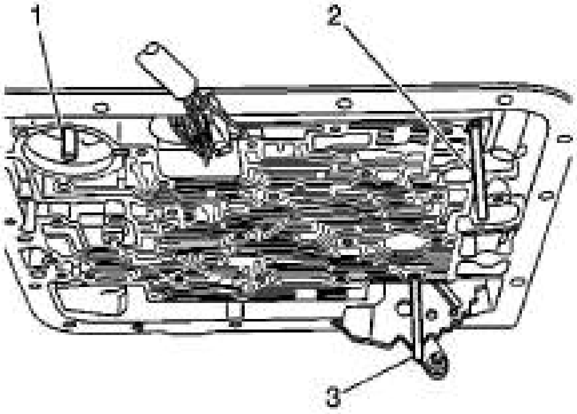


16. Remove the 3-4 accumulator piston seal (1) from the 3-4 accumulator piston.
17. Inspect the 3-4 accumulator piston for the following defects:
    - Porosity
    - Cracks
    - Scoring
    - Nicks and scratches

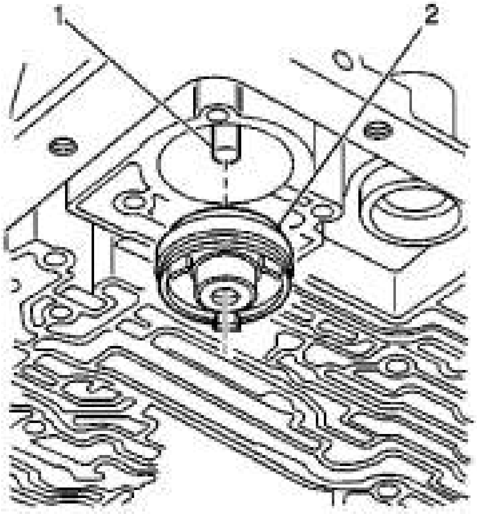
Installation Procedure



1. Install a new 3-4 accumulator piston seal (1) to the 3-4 accumulator piston.

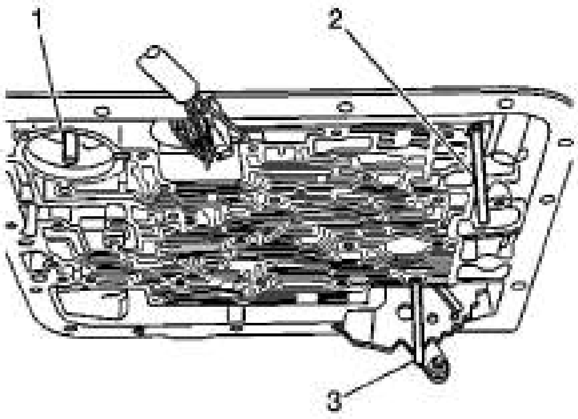


2. Install the 3-4 accumulator pin (1) into the transmission case and retain the pin with J 36850 J 36850 .

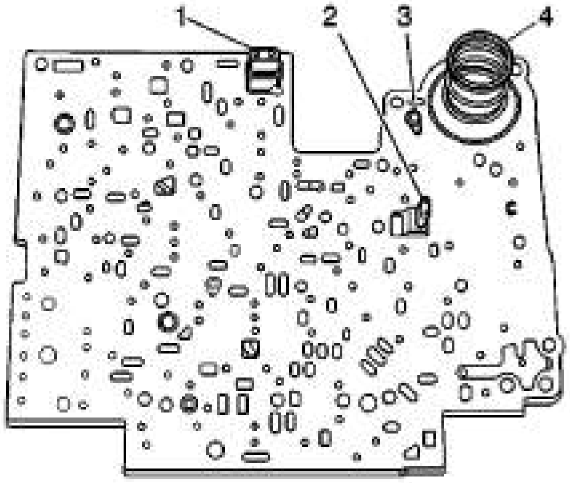


3. Install the 3-4 accumulator piston (2) onto the pin (1) in the transmission case.

   Ensure that the 3-4 accumulator piston legs face away from the transmission case.

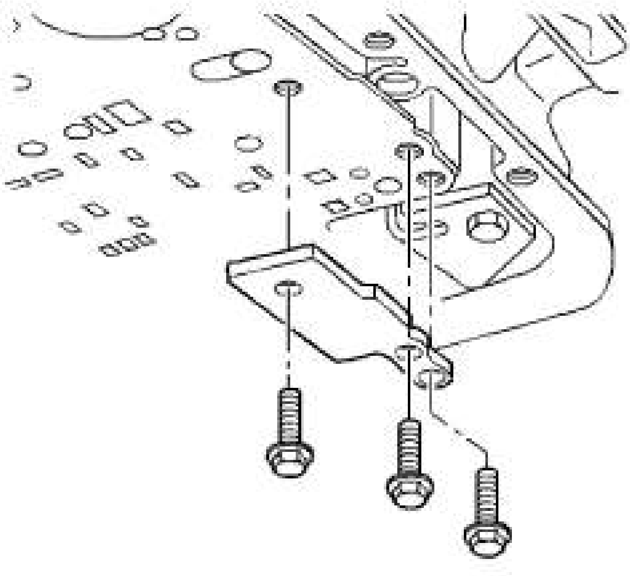


4. Install the J 25025-B (2, 3) to the transmission case.



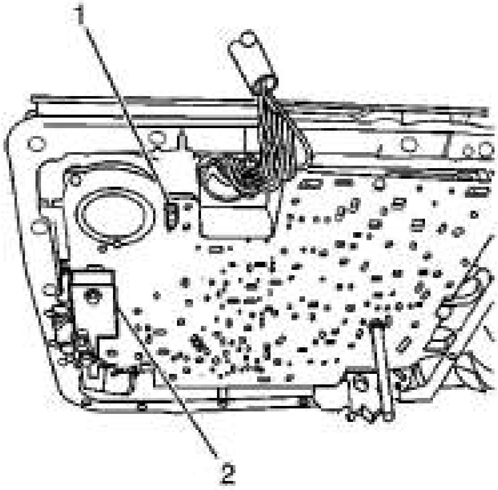
5. Install the spacer plate to transmission case gasket and the spacer plate to valve body gasket to the spacer plate; use J 36850 in order to retain the gaskets to the spacer plate.
   - The case gasket is identified by a C.
   - Be sure to place the case gasket on the transmission case side of the spacer plate.
   - The valve body gasket is identified by a V.
   - Be sure to place the valve body gasket on the valve body side of the spacer plate.
6. Ensure that the solenoid screens (1, 2) are in place on the spacer plate.
7. Place the checkball (3) on the spacer plate in the location shown.
8. Place the 3-4 accumulator spring (4) on the spacer plate.
9. Install the spacer plate and related components to the transmission.

Notice: Refer to Fastener Notice in the Preface section.

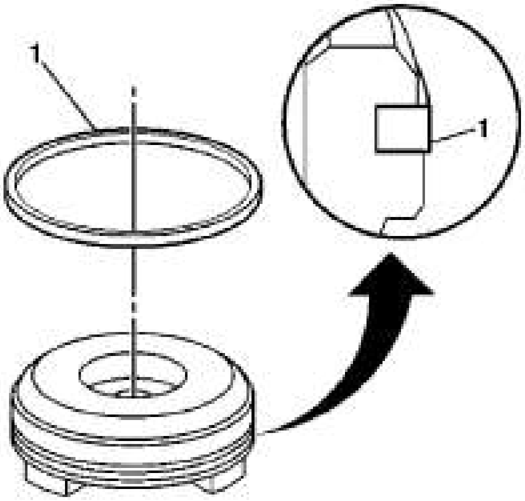


10. Install the spacer plate support and the spacer plate support retaining bolts.

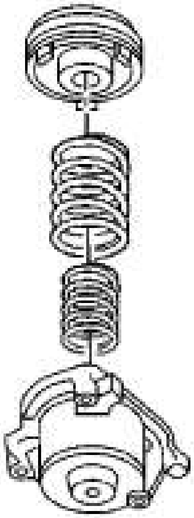
    Tighten
    Tighten the spacer plate support retaining bolts to 11 N·m (97 lb in).



11. After installing the spacer plate support (2), look through the hole in the spacer plate to make sure that the checkball (1) has remained in the proper location.

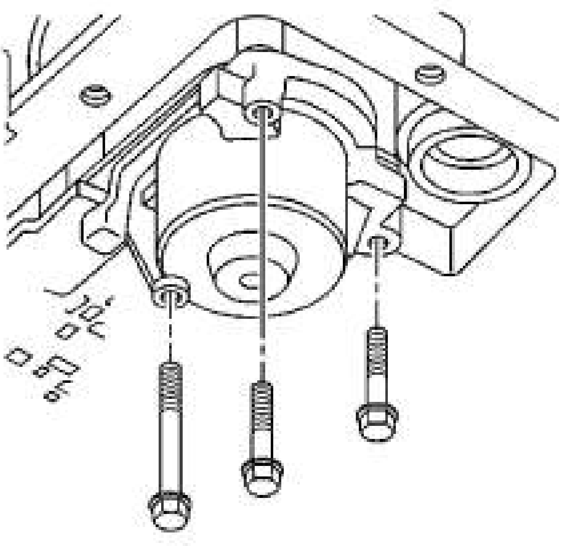


12. Install a new 1-2 accumulator piston seal (1) to the 1-2 accumulator piston.



13. Install the 1-2 accumulator inner (not in all models) and outer springs to the 1-2 accumulator cover.
14. Install the 1-2 accumulator piston onto the pin in the 1-2 accumulator cover.

    Ensure that the piston legs face the accumulator cover.



15. Install the 1-2 accumulator cover and the accumulator cover retaining bolts.

    Tighten
    Tighten the accumulator cover retaining bolts to 11 N·m (97 lb in).

16. Remove the J 25025-B from the transmission case.
17. Install the control valve body. Refer to Valve Body and Pressure Switch Replacement .
18. Install the transmission oil pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement .
19. Lower the vehicle.
20. Fill the transmission to the proper level with DEXRON® VI transmission fluid. Refer to Transmission Fluid Check .

    Important: It is recommended that transmission adaptive pressure (TAP) information be reset.

    Resetting the TAP values using a scan tool will erase all learned values in all cells. As a result, The ECM or TCM will need to relearn TAP values. Transmission performance may be affected as new TAP values are learned.

21. Reset the TAP values. Refer to Transmission Adaptive Functions .

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Automatic Transmission Fluid and Filter Replacement

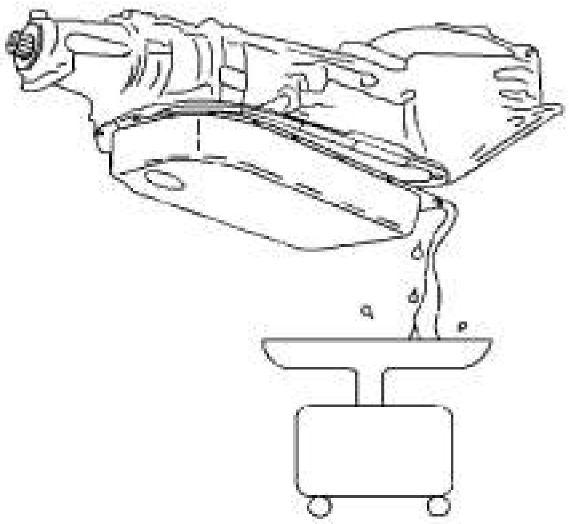
Removal Procedure

Caution: When the transmission is at operating temperatures, take necessary precautions when removing the drain plug, to avoid being burned by draining fluid.

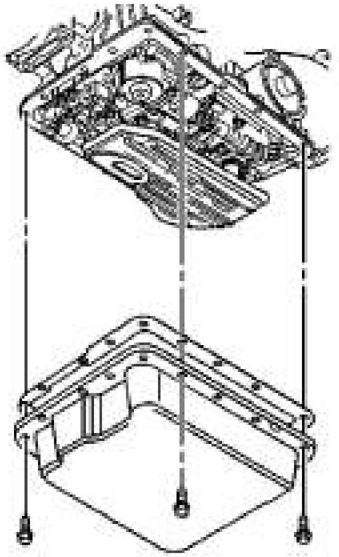
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

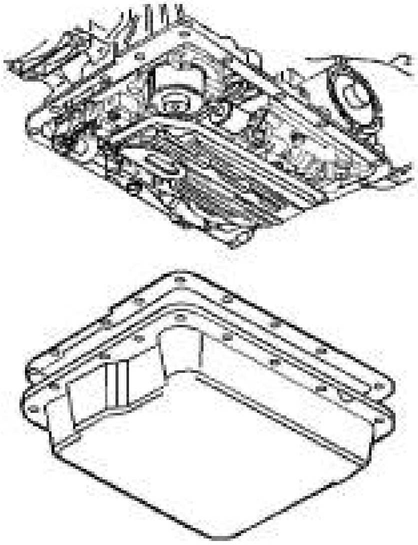
1. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle .



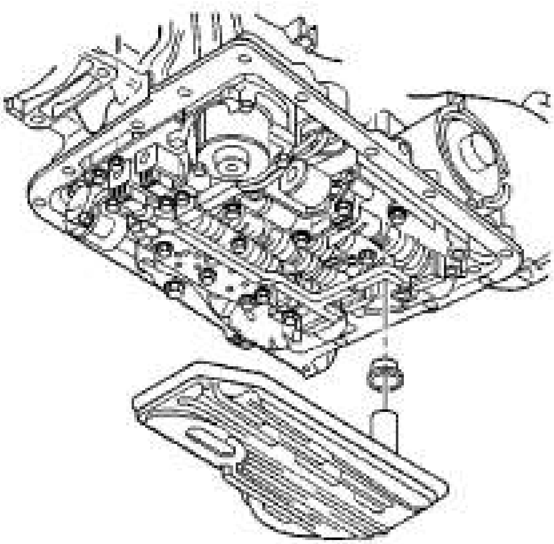
2. Place a drain pan under the transmission oil pan.
3. Remove the oil pan bolts from the front and sides of the pan only.
4. Loosen the rear oil pan bolts approximately 4 turns.
5. Lightly tap the oil pan with a rubber mallet in order to loosen the pan to allow the fluid to drain.



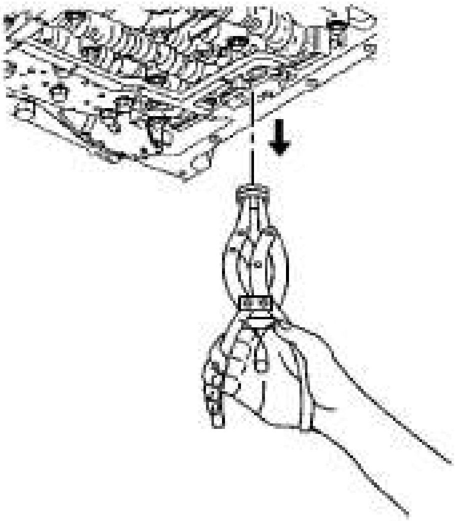
6. Remove the remaining oil pan bolts.



7. Remove the oil pan and the gasket.

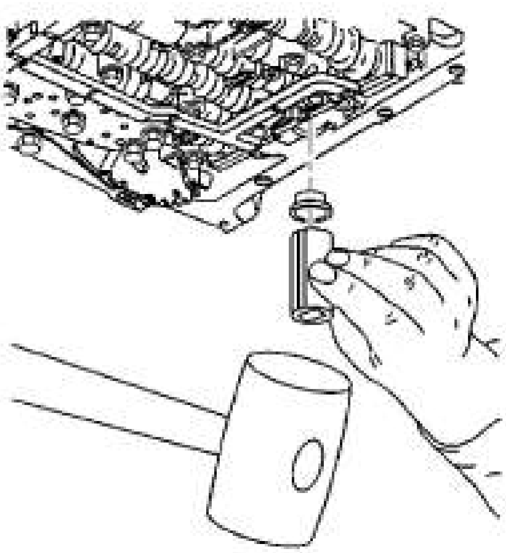


8. Grasp firmly while pulling down with a twisting motion in order to remove the filter.

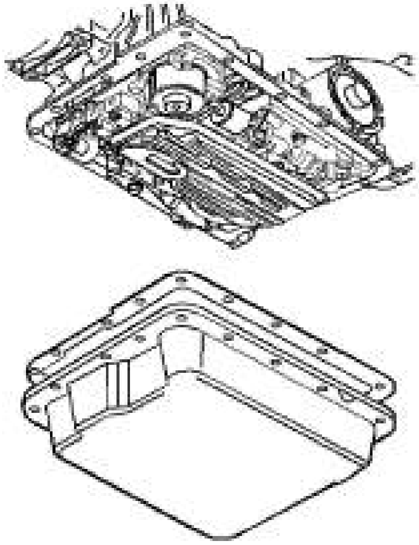


9. Remove the filter seal. The filter seal may be stuck in the pump; if necessary, carefully use pliers or another suitable tool to remove the seal.
10. Discard the seal.
11. Inspect the fluid colour.
12. Inspect the filter. Pry the metal crimping away from the top of the filter and pull apart. The filter may contain the following evidence for root cause diagnosis:
    - Clutch material
    - Bronze slivers indicating bushing wear
    - Steel particles
13. Clean the transmission case and the oil pan gasket surfaces with solvent, and air dry. You must remove all traces of the old gasket material.

Installation Procedure

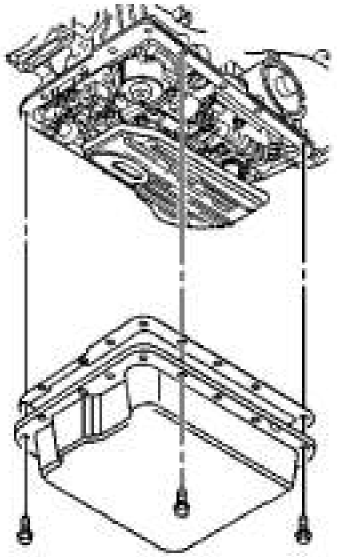


1. Coat the new filter seal with automatic transmission fluid.
2. Install the new filter seal into the transmission case. Tap the seal into place using a suitable size socket.
3. Install the new filter into the case.



4. Install the oil pan and a new gasket.

   Notice: Refer to Fastener Notice in the Preface section.



5. Install the oil pan bolts.

   Tighten
   Tighten the oil pan to transmission case bolts alternately and evenly to 12 N·m (106 lb in).

6. Lower the vehicle.
7. Fill the transmission to the proper level with DEXRON® VI transmission fluid. Refer to Transmission Fluid Check and Fluid Capacity Specifications .
8. Check the COLD fluid level reading for initial fill only.
9. Inspect the oil pan gasket for leaks.

Case Extension Assembly Replacement

Tools Required

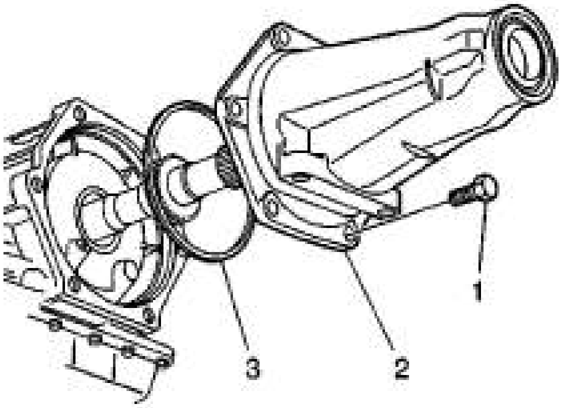
J 21426 Extension Housing Seal Installer

Removal Procedure

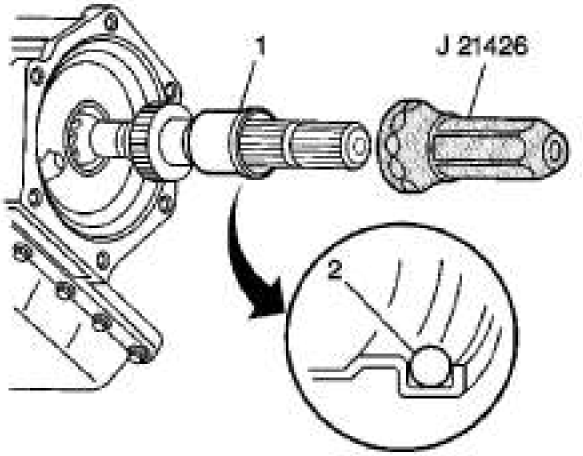
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

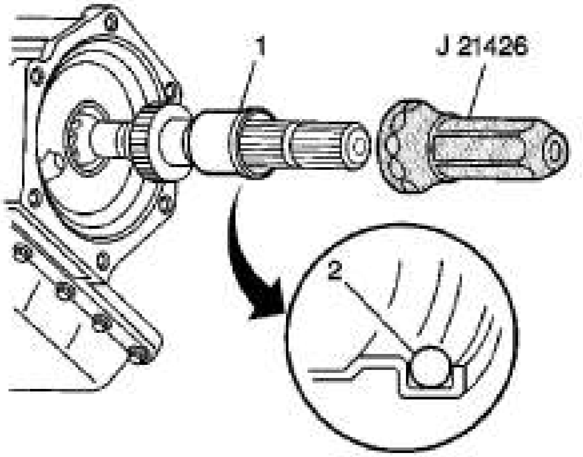


2. Remove the catalytic converter support bracket.
3. Remove the catalytic converter from the vehicle. Refer to Catalytic Converter Replacement - Left Side and Catalytic Converter Replacement - Right Side .
4. remove the transmission mount from the vehicle. Refer to Transmission Mount Replacement .
5. Remove the propeller shaft. Refer to Propeller Shaft Replacement .
6. Remove the transmission extension housing bolts (1).
7. Remove the transmission extension housing (2).
8. Remove the transmission extension housing O ring (3). Discard the O ring (3).

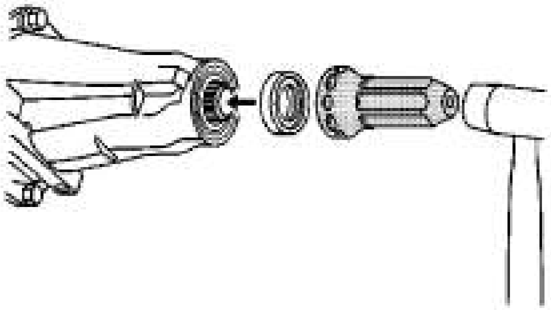


9. Remove the output shaft sleeve (1), if necessary.
10. Remove the output shaft seal (2), if necessary.

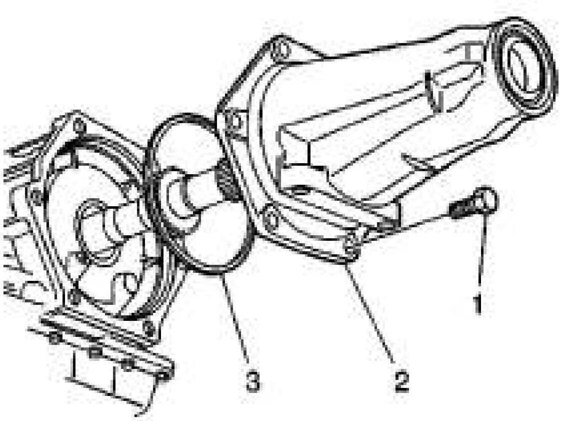
Installation Procedure



1. Install the output shaft sleeve seal (2), if necessary.
2. Install the output shaft sleeve (1) using J 21426 , if necessary.



3. Install a new transmission extension housing seal using a soft face hammer and J 21426 .



4. Install a new transmission extension housing O ring (3).

Notice: Refer to Fastener Notice in the Preface section.

5. Install the case extension (2).
6. Install the case extension bolts (1).

Tighten
Tighten the case extension bolts (1) to 45 N·m (33 lb ft).

7. Install the propeller shaft. Refer to Propeller Shaft Replacement .
8. Install the catalytic converter from the vehicle. Refer to Catalytic Converter Replacement -

Left Side and Catalytic Converter Replacement - Right Side ..

9. Install the catalytic converter support bracket.
10. Lower the vehicle.
11. Check the transmission fluid level.

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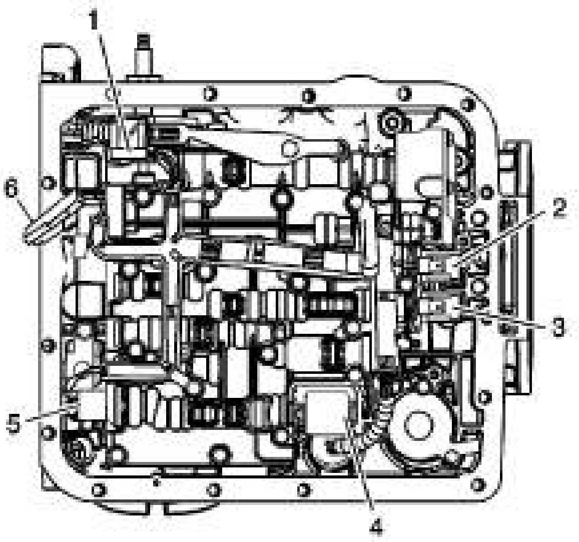
Control and Shift Solenoids Replacement

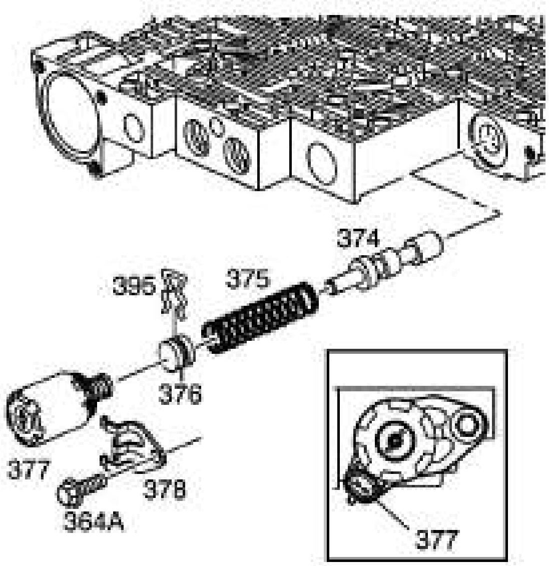
Removal Procedure



1. Remove the transmission oil pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement.

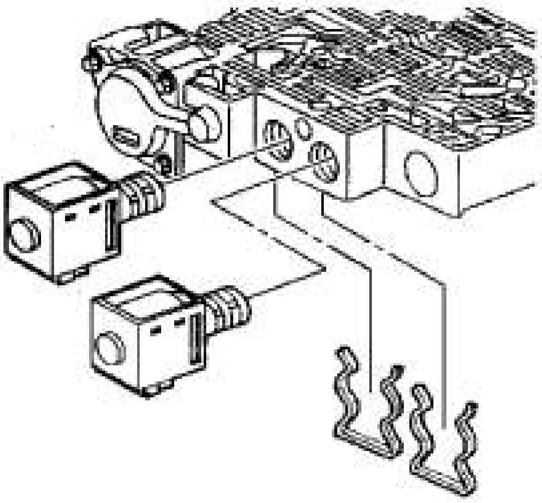
   Note: Do not remove the valve body for the following procedures. Removal of the 1-2 accumulator is necessary only if servicing the pressure control solenoid.

2. Remove the 1-2 accumulator if necessary. Refer to Accumulator Assembly, Spacer Plate, and Gaskets.
3. Disconnect all the internal wiring harness electrical connectors from the electrical components (1-6).



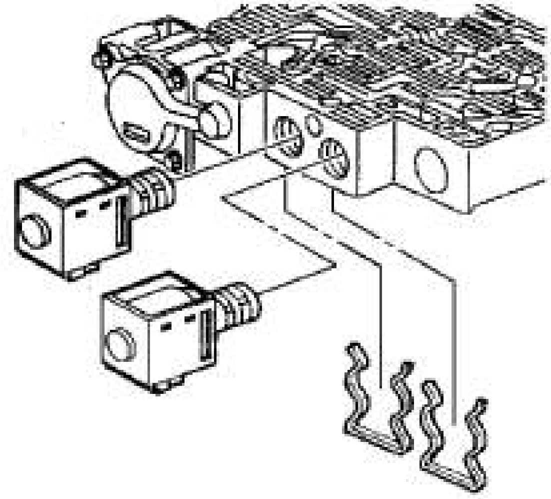
4. Remove the solenoid retainer bolt (364A) and the solenoid retainer (378).
5. Remove the pressure control solenoid (377).

   Note the orientation upon removal.



6. Remove the 1-2 and 2-3 shift solenoid retainers.
7. Remove the 1-2 and 2-3 shift solenoids.

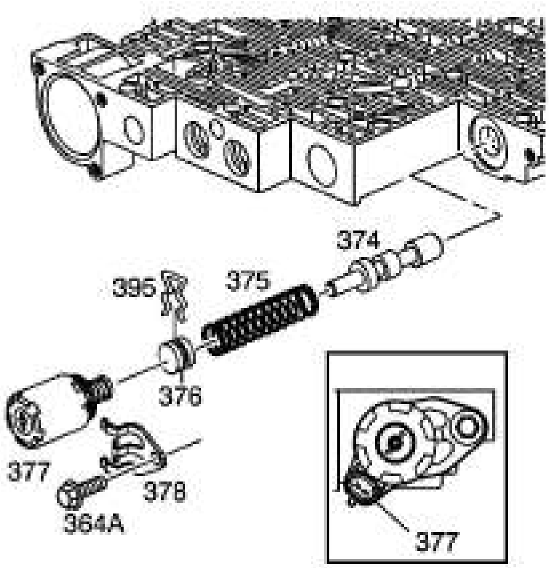
Installation Procedure



Caution: Be sure all solenoids are installed with the electrical connectors facing the non-machined (cast) side of the valve body; otherwise, the solenoids will bind against the transmission case as the valve body bolts are tightened and damage may occur.

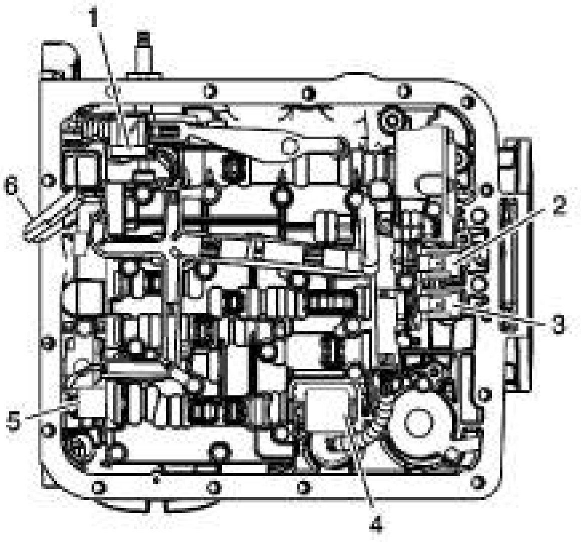
1. Install the 1-2 and 2-3 shift solenoids.
2. Install the 1-2 and 2-3 shift solenoid retainers.

Caution: Refer to Fastener Caution in the Preface section.



3. Install the following items:
   3.1. The actuator feed limit valve (374)

3.2. The actuator feed limit valve spring (375)
3.3. The bore plug (376)
3.4. The bore plug retainer (395)
3.5. The pressure control solenoid (377)
3.6. The solenoid retainer (378)
3.7. Tighten the pressure control solenoid retaining bolt to **11 N·m (97 lb in)**



4. Connect all the internal wiring harness electrical connectors to the electrical components (1-6).
5. Install the 1-2 accumulator. Refer to Accumulator Assembly, Spacer Plate, and Gaskets.
6. Install the transmission oil pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement.
7. Fill the transmission to the proper level with DEXRON® VI transmission fluid. Refer to Transmission Fluid Check.

Note: It is recommended that transmission adaptive pressure (TAP) information be reset.

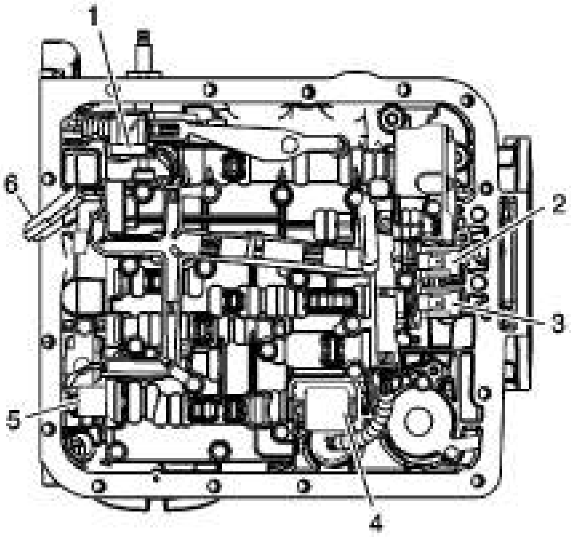
Resetting the TAP values using a scan tool will erase all learned values in all cells. As a result, the engine control module (ECM), powertrain control module (PCM) or transmission control module (TCM) will need to relearn TAP values. Transmission performance may be affected as new TAP values are learned.

8. Reset the TAP values. Refer to Transmission Adaptive Functions.

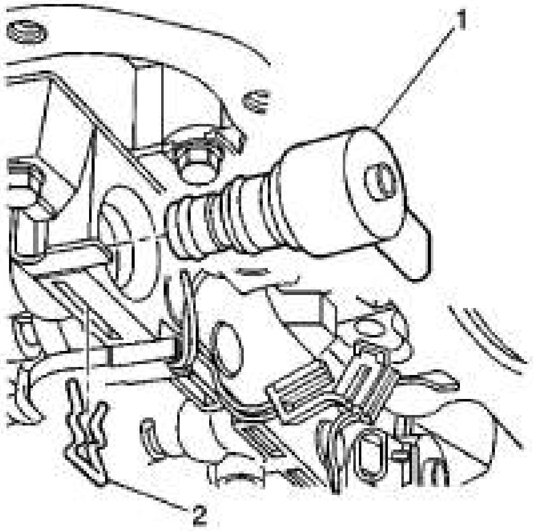
Control Valve Body Replacement

Removal Procedure

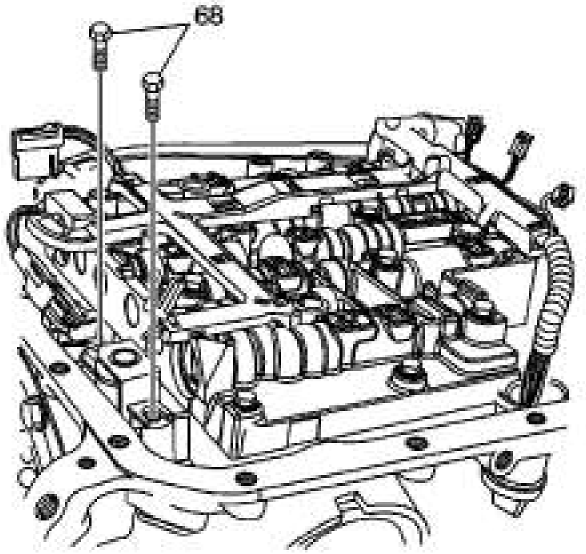
1. Remove the fluid level indicator.
2. Raise the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Remove the oil pan, gasket, and filter. Refer to Automatic Transmission Fluid and Filter Replacement.



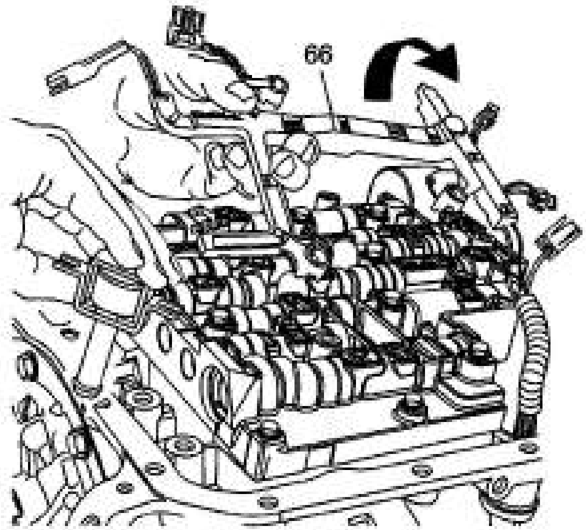
4. Disconnect all the internal wiring harness electrical connectors from the electrical connectors (1-6) components.



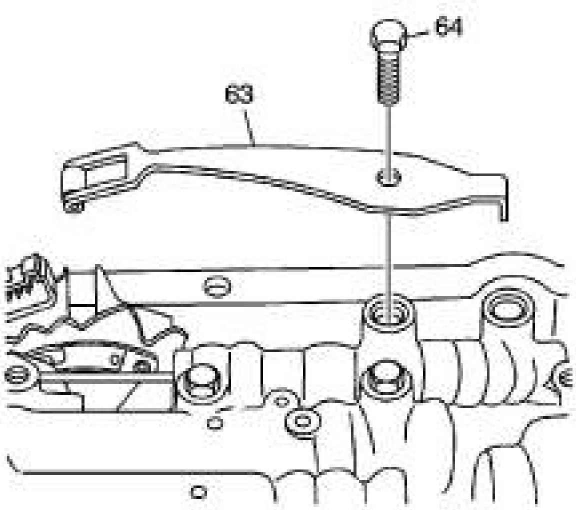
5. Remove the torque converter clutch (TCC) pulse width modulation (PWM) solenoid retainer (2) with a small screwdriver. Rotate the solenoid (1) in the bore, if necessary, until the flat part of the retainer (2) is visible.
6. Remove the TCC PWM solenoid (1) in order to access the TCC solenoid retaining bolts.



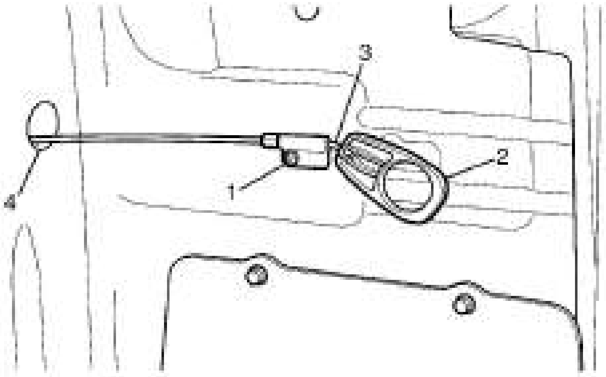
7. Remove the TCC solenoid retaining bolts (68).



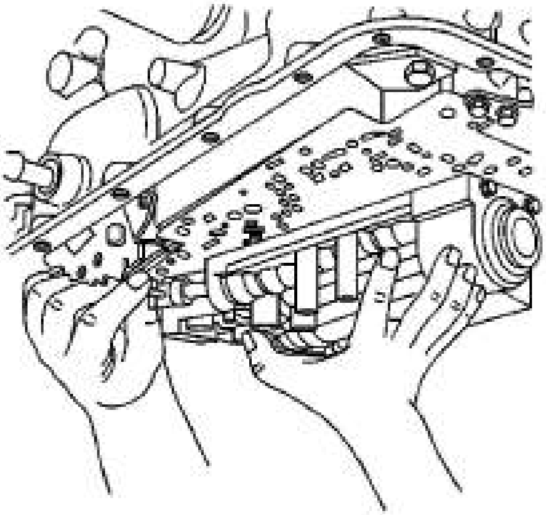
8. Remove the TCC solenoid (with O-ring seal) and wiring harness (66) from the control valve body.
9. Reposition the harness to the side of the transmission case.



10. Remove the manual detent spring bolt (64) and the spring assembly (63).

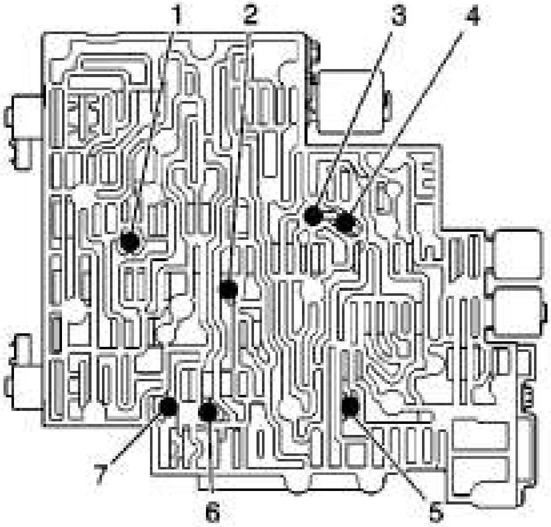


11. Remove all valve body bolts (59, 62, 120).

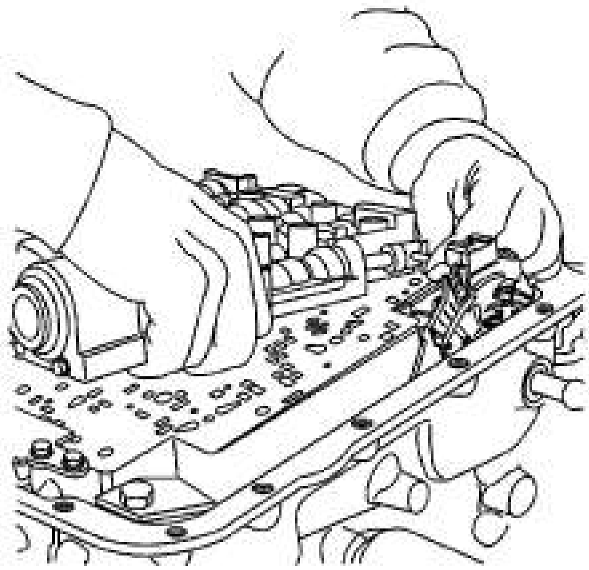


12. Carefully begin to lower the control valve body down from the transmission case while simultaneously disconnecting the manual valve link.

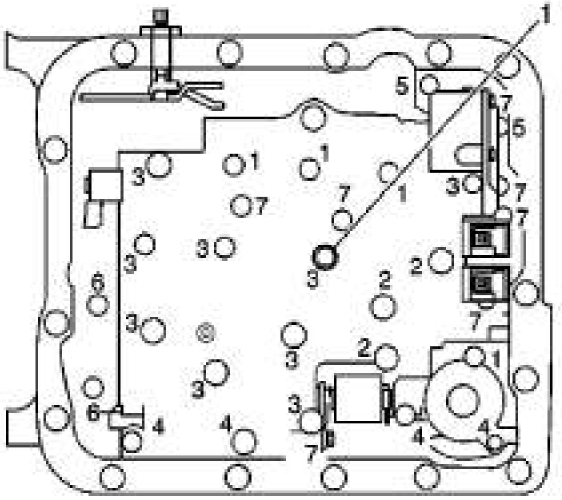
Installation Procedure



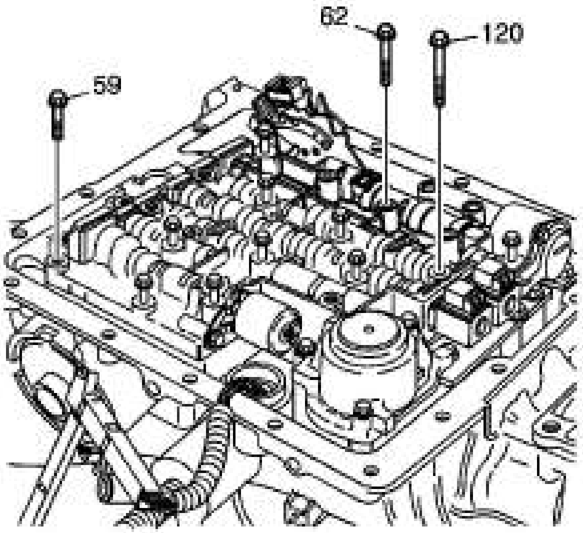
1. Install the checkballs (1-7) in the valve body.



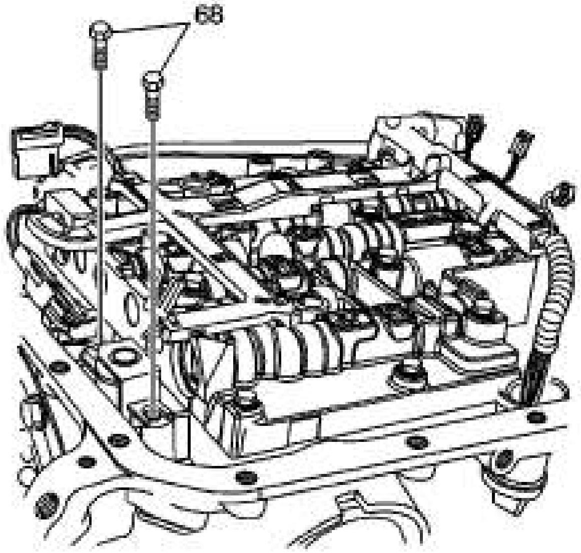
2. Install the control valve body to the transmission case while simultaneously connecting the manual valve link to the manual valve.
3. Verify that the manual valve link is installed properly to the inside detent lever and the manual valve.



4. Install one bolt (M6 X 1.0 X 47.5) hand tight in the center (1) of the valve body to hold it in place.



5. Install the 12 valve body bolts (62), 2 bolts (59) and 3 bolts (120) that are shown only.
6. Finger tighten the bolts.

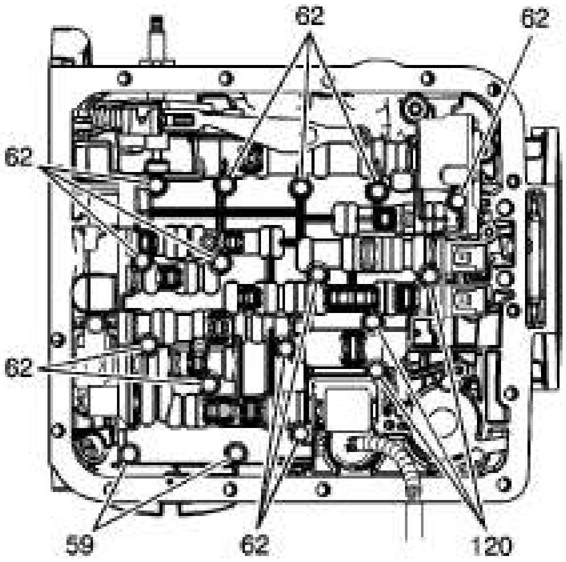


7. Install the transmission wiring harness on the valve body.

Caution: Refer to Fastener Caution in the Preface section.

8. Install the TCC solenoid valve and bolts (68).

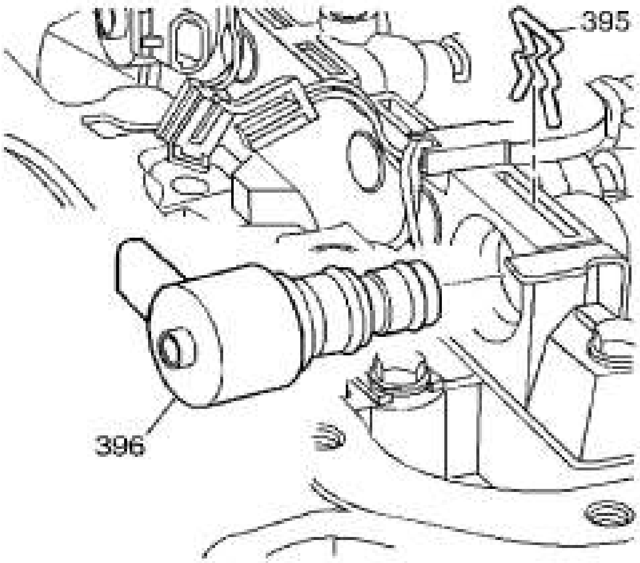
Tighten the bolts to **814 N·m (610 lb ft).**



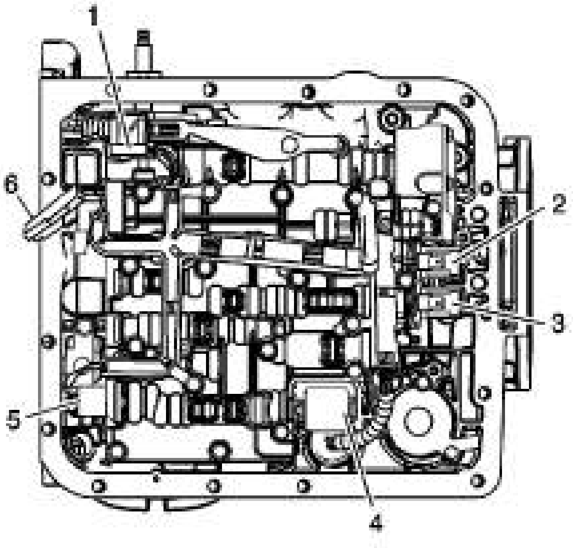
Caution: Do not over-tighten the bolts. Over-tightening the bolts will distort the valve bores. Begin tightening from the center of the valve body tighten the bolts in a outward direction.

9. Inspect the ensure all of the valve body bolts are in the correct location. Each bolt number refers to a specific size, as indicated in the following list:
   - 59 M6 x 1.0 x 35.0 (Qty: 2)
   - 62 M6 x 1.0 x 47.5 (Qty: 12)
   - 120 M6 x 1.0 x 54.4 (Qty: 3)
10. Tighten the bolts from the center of the valve body working your way out in a spiral pattern to the outside edge.

    Tighten the bolts to **814 N·m (610 lb ft).**



11. Install the TCC PWM solenoid valve (396) and the solenoid retainer (395).



12. Snap the wiring harness in place on the valve body bolts. Ensure the harness loom tab is located under the transmission fluid pressure (TFP) switch.
13. Install the wiring connectors to the electrical components (1-6) as indicated in the following list:
    - 13.1. The manual shift detent lever with shaft position switch assembly
    - 13.2. The 1-2 shift solenoid
    - 13.3. The 2-3 shift solenoid
    - 13.4. The pressure control solenoid (PCS)
    - 13.5. The TCC PWM solenoid
    - 13.6. The input speed sensor (ISS)
14. Install the transmission oil pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement.
15. Lower the vehicle.
16. Fill the transmission to the proper level with DEXRON® VI transmission fluid. Refer to Transmission Fluid Check.

Note: It is recommended that transmission adaptive pressure (TAP) information be reset.

Resetting the TAP values using a scan tool will erase all learned values in all cells. As a result, the engine control module (ECM), powertrain control module (PCM) or transmission control module (TCM) will need to relearn TAP values. Transmission performance may be affected as new TAP values are learned.

17. Reset the TAP values. Refer to Transmission Adaptive Functions.

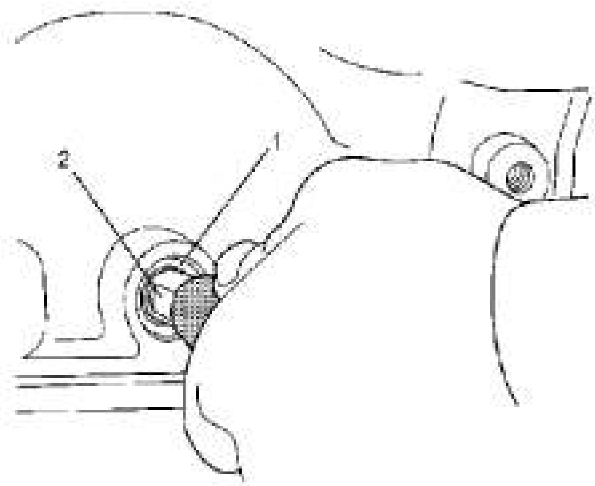
Manual Shift Shaft Seal Replacement

Tools Required

- J 43909 Selector Shaft Seal Installer
- J 43911 Selector Shaft Seal Remover

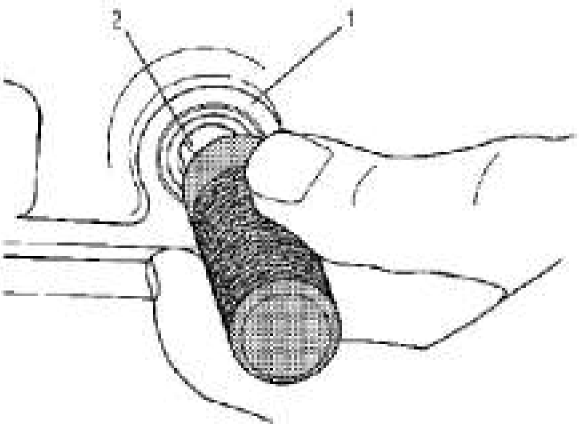
Removal Procedure

1. Raise the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the Park/Neutral Position (PNP) Switch. Refer to Park/Neutral Position Switch Replacement.



3. Be sure that the jackscrew for J 43911 is backed off and will not interfere with installation of the removal tool. Slide the seal remover tool over the selector shaft (2) with the threaded end of the tool toward the seal.
4. Rotate the removal tool so that the threads on the end of the tool engauge the steel shell (1) of the seal. Use a wrench to be sure that the removal tool is firmly attached to the seal shell.
5. Rotate the jackscrew in the clockwise direction to remove the seal from the bore. Discard the seal that was removed.

Installation Procedure



1. Carefully slide a new selector shaft seal (1) over the selector shaft (2) with the wide face of the steel case facing outward. Position the seal so that it is starting to enter the seal bore.
2. Obtain J 43909 and remove the inner sleeve so that the tool will slide over the selector shaft.
3. Slide the J 43909 into position so that the end of the tool contacts the seal being installed. Use a mallet to strike the J 43909 and drive the new seal into the seal bore until it is seated at the bottom of the bore.
4. Install the PNP Switch. Refer to Park/Neutral Position Switch Replacement.
5. Lower the vehicle.
6. Fill the transmission to the proper level with DEXRON® VI transmission fluid. Refer to Transmission Fluid Check.

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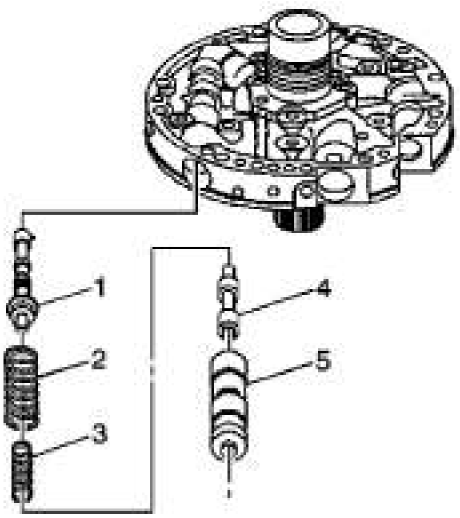
Pressure Regulator Valve Replacement

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

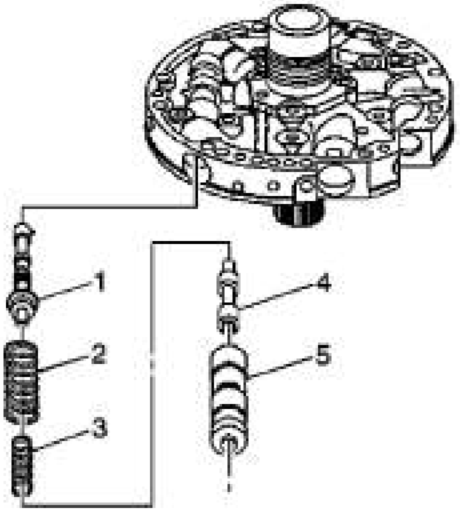
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the transmission oil pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement.
3. Compress the reverse boost valve sleeve into the bore of the oil pump to release tension on the reverse boost valve retaining ring.
4. Remove the reverse boost valve retaining ring, then slowly release tension on the reverse boost valve sleeve.

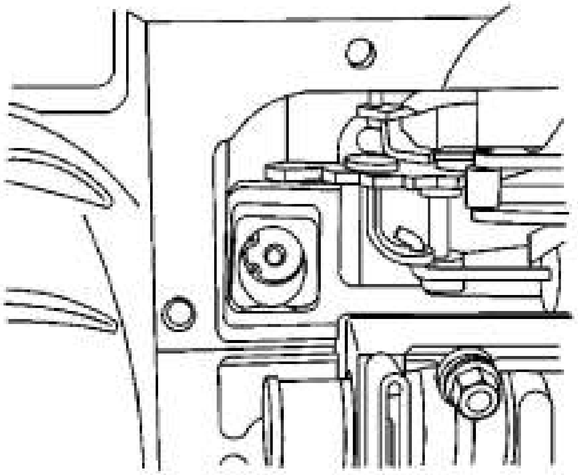


5. Remove the reverse boost valve sleeve (5) and the reverse boost valve (4).
6. Remove the pressure regulator isolator spring (3) and the pressure regulator valve spring (2).
7. Remove the pressure regulator valve (1).

Installation Procedure



1. Install the pressure regulator valve (1).
2. Install the pressure regulator isolator spring (3) and the pressure regulator valve spring (2).
3. Install the reverse boost valve (4) in the reverse boost valve sleeve (5).
4. Install the reverse boost valve (4) and sleeve (5) in the oil pump cover.



5. Compress the reverse boost valve sleeve into the bore of the oil pump to expose the retaining ring slot.
6. Install the reverse boost valve retaining ring, then slowly release tension on the reverse boost valve sleeve.
7. Install the transmission oil filter and pan. Refer to Automatic Transmission Fluid and Filter Replacement.
8. Lower the vehicle.
9. Fill the transmission to the proper level with DEXRON® VI transmission fluid. Refer to Transmission Fluid Check.

Important: It is recommended that transmission adaptive pressure (TAP) information be reset.

Resetting the TAP values using a scan tool will erase all learned values in all cells. As a result, The ECM or TCM will need to relearn TAP values. Transmission performance may be affected as new TAP values are learned.

10. Reset the TAP values. Refer to Transmission Adaptive Functions.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 4L60-E/4L65-E/4L70-E | Repair Instructions - On Vehicle | **Document ID: 1994185**

Propeller Shaft Front Slip Yoke Oil Seal Replacement

Tools Required

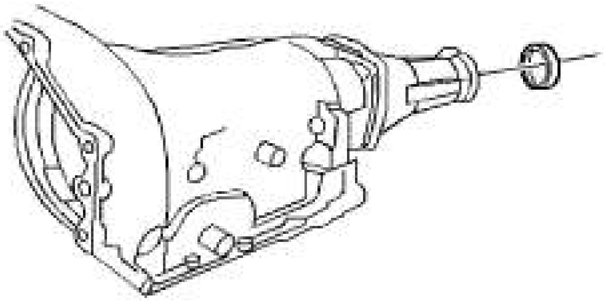
J 21426 Extension Housing Seal Installer

Removal Procedure

Caution: Refer to Safety Glasses Caution in the Preface section.

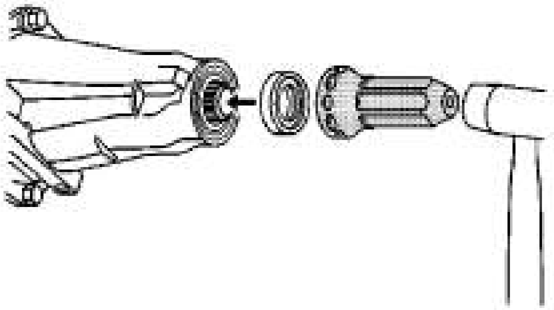
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Place a drain pan under the vehicle.



3. Remove the propeller shaft. Refer to Propeller Shaft Replacement .
4. Remove the transmission extension housing rear oil seal. Use a flat-bladed tool and carefully pry the seal from the housing.
5. Inspect the case extension housing for damage. Replace the extension housing if necessary. Refer to Case Extension Assembly Replacement .

Installation Procedure



1. Lubricate the inside diameter of the new seal with J 36850 .
2. Use the J 21426 with a soft faced mallet to install the seal.
3. Install the seal to the extension housing.
4. Install the propeller shaft. Refer to Propeller Shaft Replacement .
5. Remove the drain pan and lower the vehicle.
6. Fill the transmission to the proper level with DEXRON® VI transmission fluid. Refer to Transmission Fluid Check .

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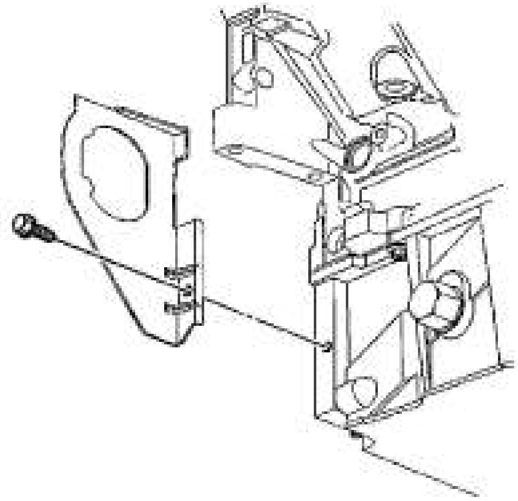
Torque Converter Cover Replacement

Removal Procedure

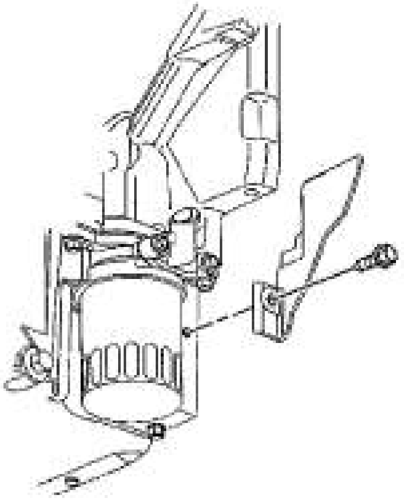
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the starter motor, If servicing the right side transmission cover only. Refer to Starter Motor Replacement .

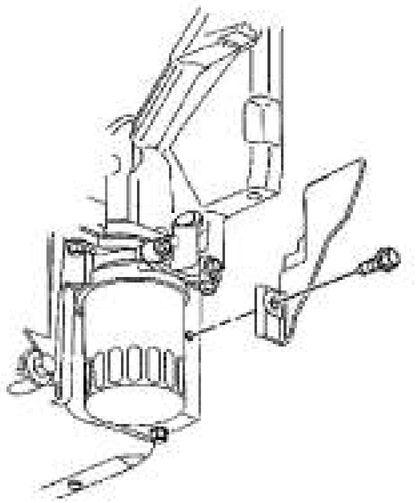


3. Remove the right side transmission cover bolt.
4. Remove the right side transmission cover.



5. Remove the left side transmission cover bolt
6. Remove the right side converter cover.

Installation Procedure

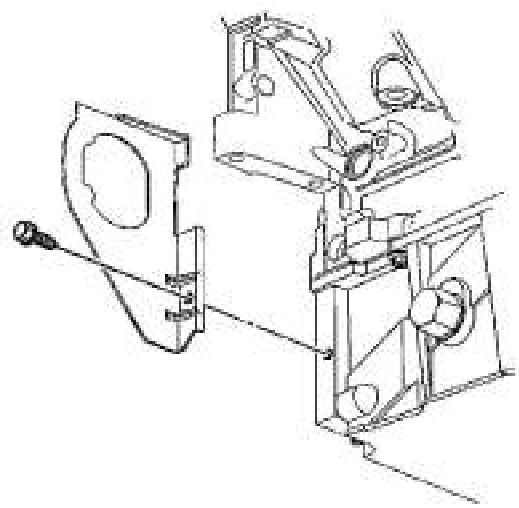


1. Install the left side converter cover.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the left side converter cover bolt.

   Tighten
   Tighten the left side converter cover bolt to 12 N·m (106 lb in).



3. Install the right side converter cover.
4. Install the right side converter cover bolt.

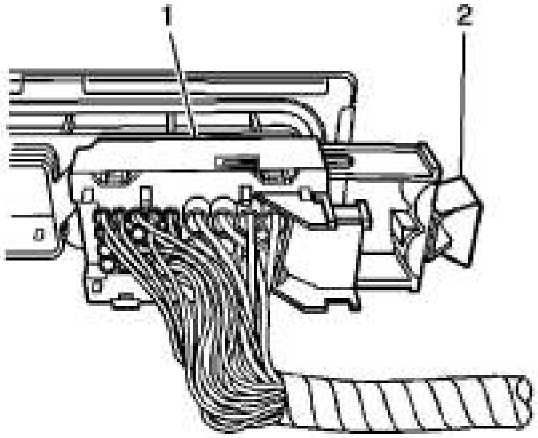
   Tighten
   Tighten the right side converter cover bolt to 12 N·m (106 lb in).

5. Install the starter motor, if removed. Refer to Starter Motor Replacement .
6. Lower the vehicle.

Transmission Control Module Replacement

Removal Procedure

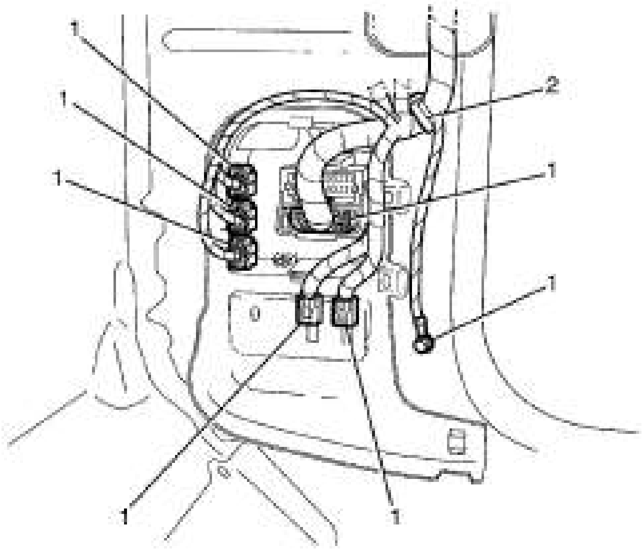
1. Remove the hinge pillar trim from the vehicle. Refer to Body Hinge Pillar Trim Panel Replacement .
2. Remove the knee bolster assembly. Refer to Knee Bolster Replacement .



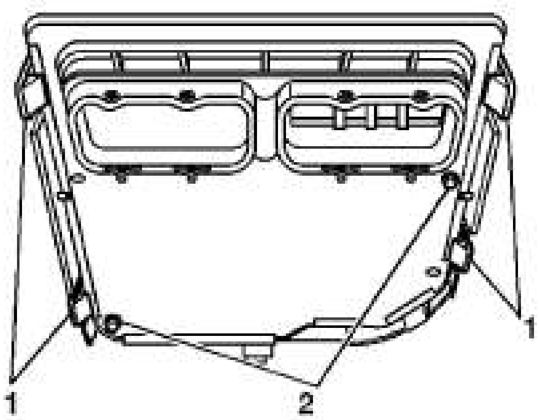
3. Unlock the transmission control module electrical connector by pulling the retainer (2) away from the electrical connector (1).

   Important: Twisting or tilting of the transmission control module electrical connector while disconnecting may result in bent or misaligned electrical terminal pins.

4. Carefully disconnect the electrical connector (1) from the transmission control module.

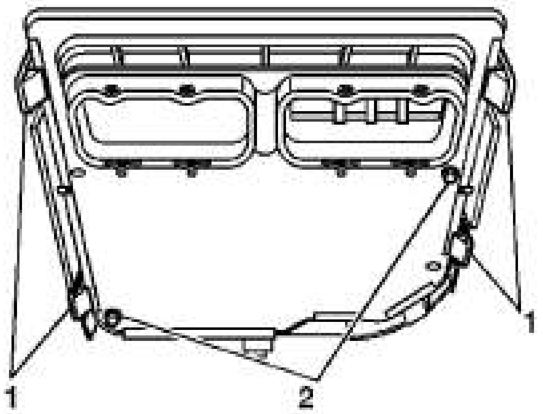


5. Disconnect the electrical connectors (1) from the right hand side junction box and remove loom retaining clip (2).
6. Position loom toward cowl.

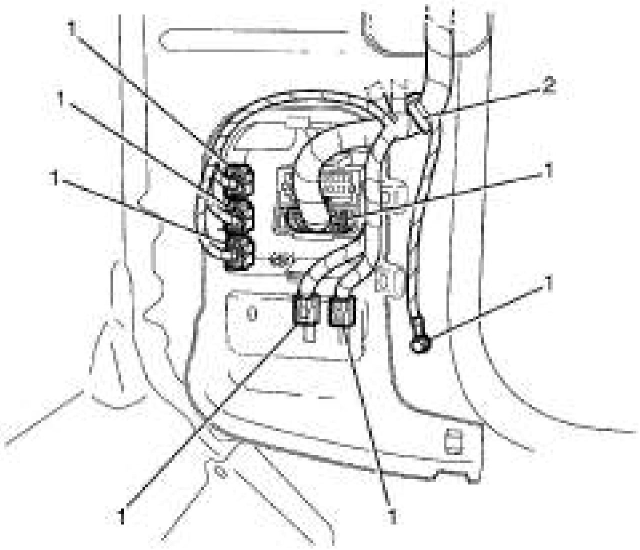


7. Remove the transmission control module from the mounting bracket by pulling back on the retaining tabs (1) to release the control module .

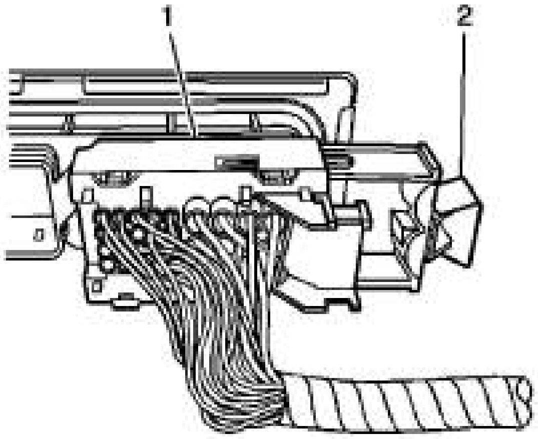
Installation Procedure



1. Align the transmission control module with the locating pins (2) on the module mounting bracket.
2. Install the transmission control module by seating it fully into the bracket until all of the retaining tabs (1) have engaged the edge of the module edge.



3. Connect the electrical connectors (1) to right hand side junction box and install loom retaining clip (2).



Important: Twisting or tilting of the transmission control module electrical connector while connecting may result in bent or misaligned electrical terminal pins.

4. Carefully connect the transmission control module electrical connector (1) to the transmission control module.
5. Lock the transmission control module electrical connector securely to the transmission control module by pushing the retainer (2) toward the electrical connector (1) until fully seated.
6. Install the hinge pillar trim on the vehicle. Refer to Body Hinge Pillar Trim Panel Replacement .
7. Install the knee bolster assembly. Refer to Knee Bolster Replacement .
8. If re-programming is required. Refer to Control Module References .

Important: It is recommended that transmission adaptive pressure (TAP) information be reset.

Resetting the TAP values using a scan tool will erase all learned values in all cells. As a result, The ECM or TCM will need to relearn TAP values. Transmission performance may be affected as new TAP values are learned.

9. Reset the TAP values. Refer to Transmission Adaptive Functions .

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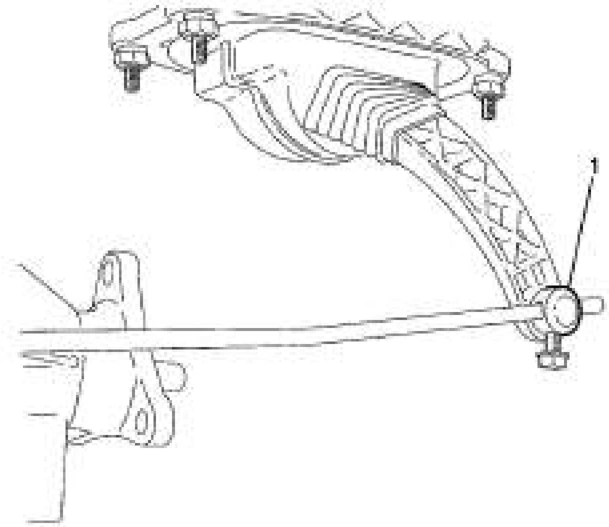
Transmission Control Replacement

Removal Procedure

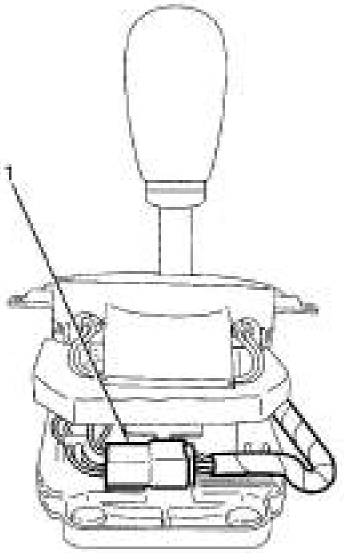
Caution: Refer to Safety Glasses Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

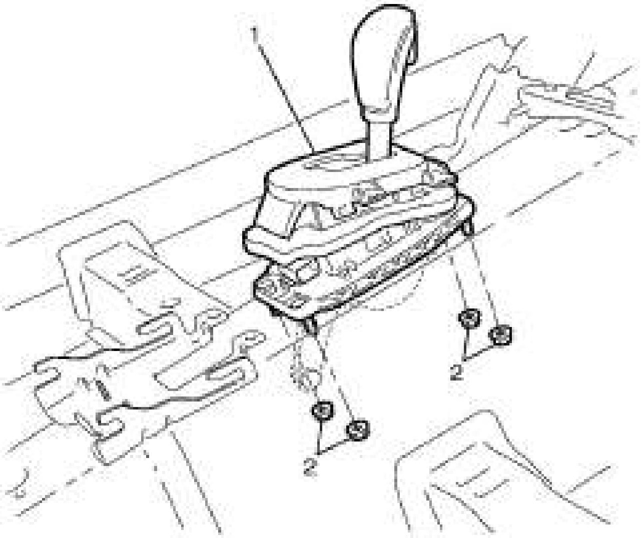
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



2. Remove the adjustment nut (1) from the shift control linkage.
3. Disconnect the shift control linkage rod from the shift control assembly.
4. Lower the vehicle.
5. Remove the centre console assembly. Refer to Front Floor Console Replacement

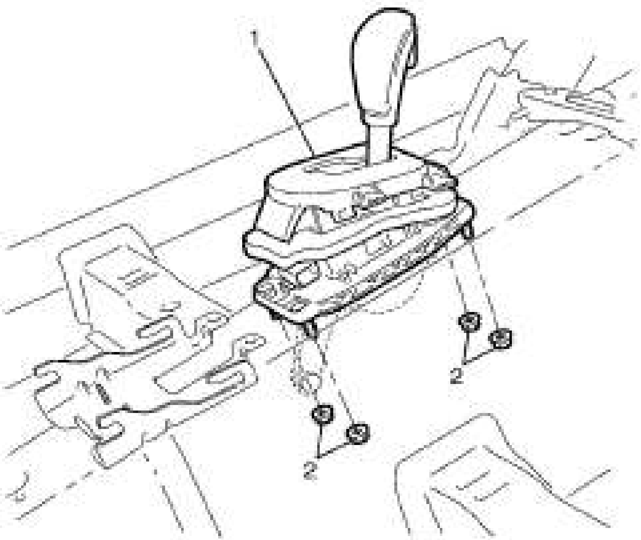


6. Remove the electrical connector (1) from the shift control assembly.



7. Remove the nuts (2) securing the shift control assembly to the tunnel reinforcement.
8. Remove the shift control assembly (1) from the tunnel reinforcement.

Installation Procedure

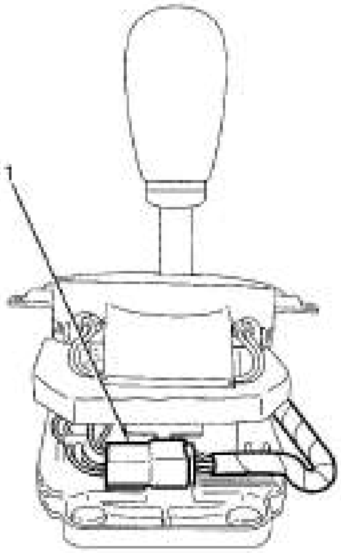


1. Install the shift control assembly (1) to the tunnel reinforcement.

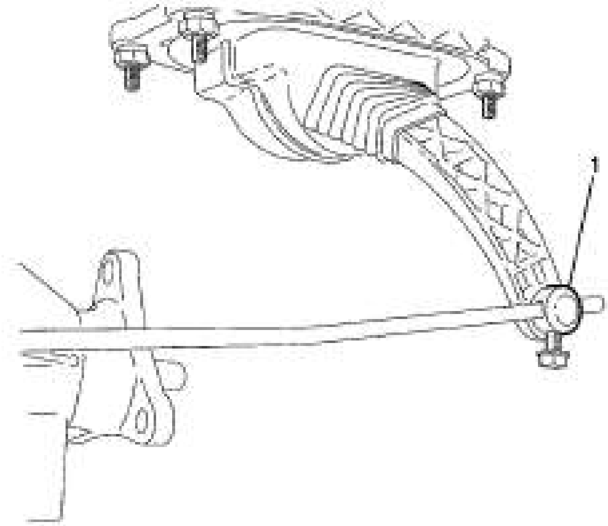
   Notice: Refer to Fastener Notice in the Preface section.

2. Install the nuts (2) securing the shift control assembly to the tunnel reinforcement.

   Tighten
   Tighten the nuts to 12 N·m (106 lb in).



3. Install the electrical connector (1) to the shift control assembly.
4. Install the center console assembly. Refer to Front Floor Console Replacement.
5. Install the shift control trim plate by inserting the front retaining tabs to the console. Press down on the rear of the trim plate to engage the rear retaining tabs.
6. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



7. Connect the shift control linkage rod to the shift control assembly.
8. Install the shift control linkage adjustment nut (1) finger tight.

9. Adjust the shift control linkage. Refer to Shift Control Linkage Adjustment.
10. Lower the vehicle.

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Transmission Fluid Cooler Hose/Pipe Replacement

Tools Required

J 41623-B Cooler Line Release Tool

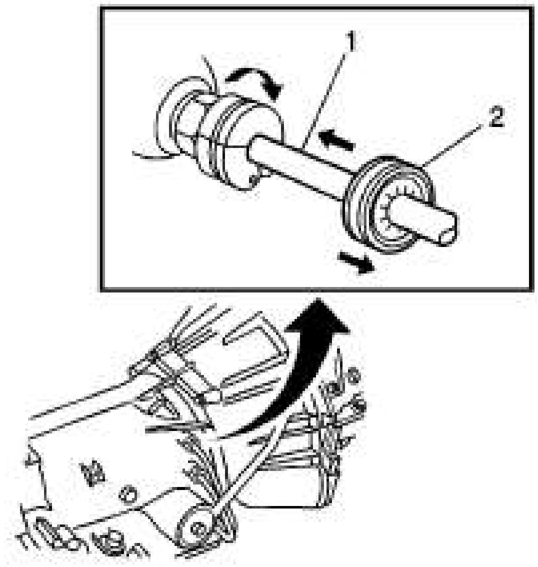
Removal Procedure

1. Disconnect the upper and lower oil cooler pipes from the quick disconnect fittings at the radiator.

   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

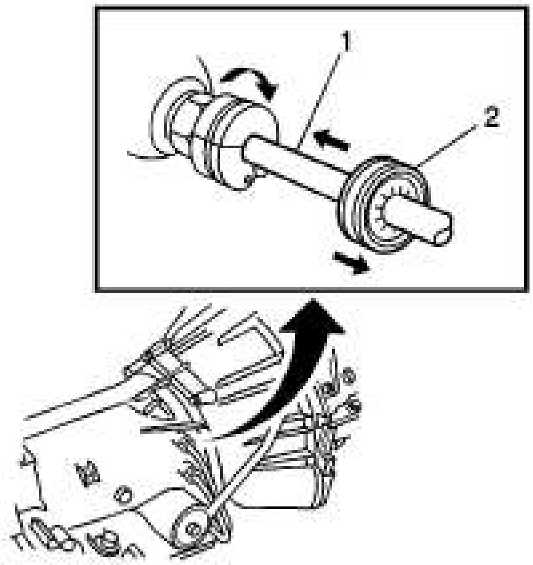
2. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Plug all openings to prevent the system from contamination.
4. Remove the retaining bolt securing the transmission cooler pipes to the left hand front side of the engine.
5. Remove the retaining bolt securing the transmission cooler pipes to the Park/Neutral Position (PNP) switch.
6. Remove the transmission mount. Refer to Transmission Mount Replacement.
7. Slightly lower the transmission to gain access to the transmission cooler pipes.



8. Release the verifier disc (2) by pulling it backwards down the pipe.
9. Using J-41623-B, remove the transmission cooler pipes from the transmission.
10. Remove the transmission cooler pipes from the vehicle; separate the pipes, as necessary.

Installation Procedure

1. Position the transmission cooler pipes in the vehicle.
2. Remove the plugs from the cooler pipes; then wipe the pipe connector ends with a clean towel.
3. Apply a small amount of clean transmission fluid on the end of the pipes; then insert the pipes into the quick connect fittings on the radiator.
4. Apply a small amount of clean transmission fluid on the end of the pipes; then insert the pipes into the quick connect fittings in the transmission.



5. Push the verifier discs (2) over the transmission quick disconnect fittings to make sure that the pipes are seated correctly.

   Notice: Refer to Fastener Notice in the Preface section.

6. Install the retaining bolt securing the transmission cooler pipes to the left hand front side of the engine.

   Tighten
   Tighten the bolt to 10 N·m (84 lb in).

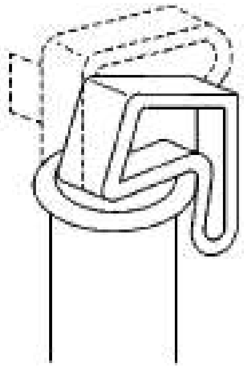
7. Install the retaining bolt securing the transmission cooler pipes to the PNP switch.

   Tighten
   Tighten the bolt to 25 N·m (18 lb ft).

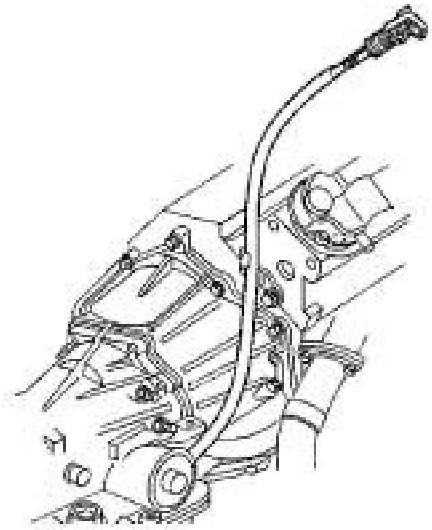
8. Install the transmission mount. Refer to Transmission Mount Replacement.
9. Lower the vehicle.
10. Fill the transmission to the proper level with DEXRON® VI transmission fluid. Refer to Transmission Fluid Check.
11. Ensure that the engine can only be started in the PNP positions, if adjustment is necessary, refer to Park/Neutral Position Switch Adjustment.
12. Check the reverse lamps for proper operation; if adjustment is necessary, refer to Park/Neutral Position Switch Adjustment.

Transmission Fluid Filler Tube and Seal Replacement

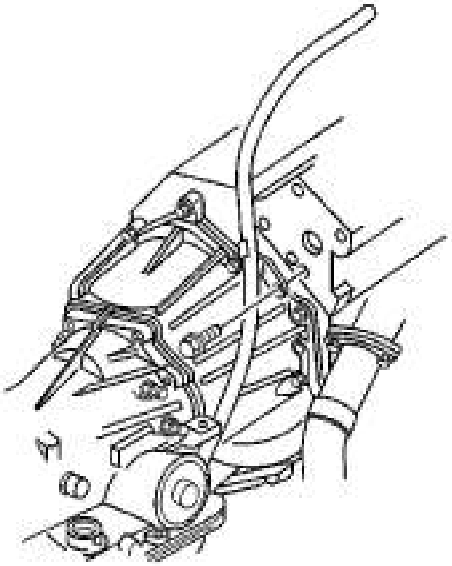
Removal Procedure



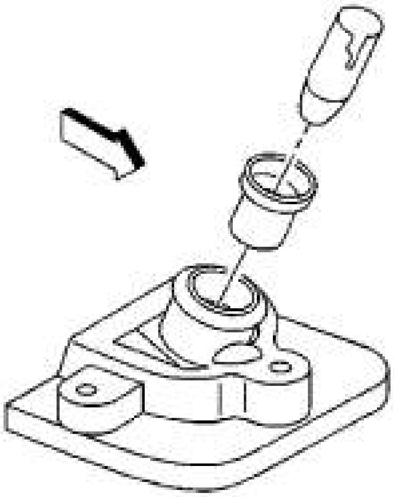
1. Lift the fluid level indicator handle lock up.



2. Remove the fluid level indicator.

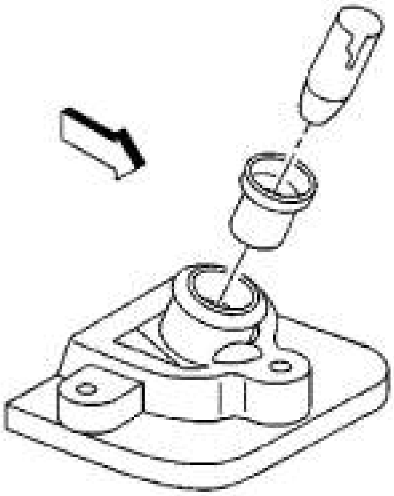


3. Remove the bolt attaching the fill tube to the cylinder head.



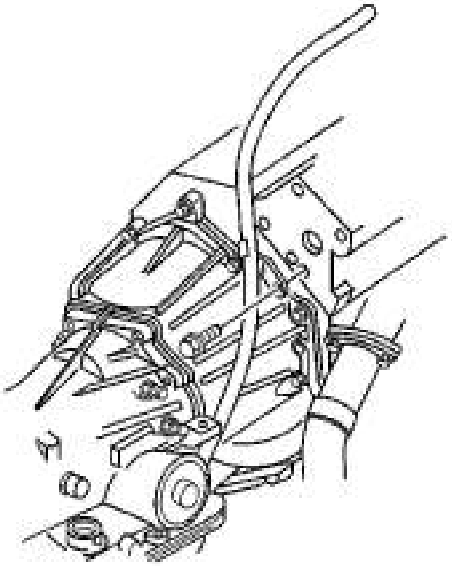
4. Remove the fill tube and seal from the transmission.

Installation Procedure



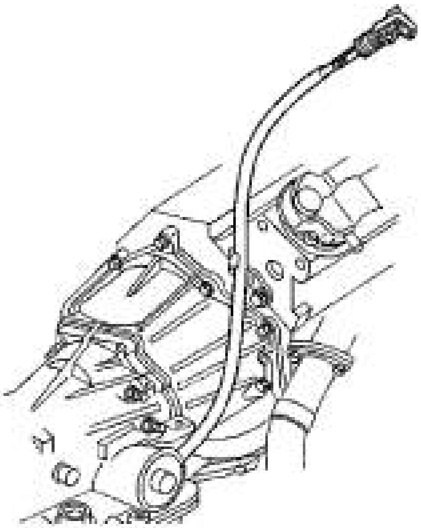
1. Insert the seal into the automatic transmission case hole.
2. Install the fill tube to the transmission.

Notice: Refer to Fastener Notice in the Preface section.

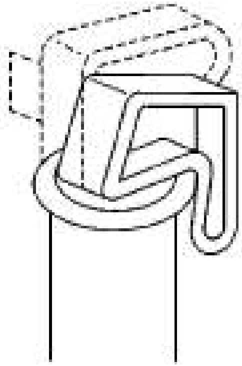


3. Install the transmission bolt attaching the fill tube to the cylinder head.

Tighten
Tighten the fill tube bolt to 30 N·m (22 lb ft).



4. Check the transmission fluid level.
5. Fill the transmission to the proper level with DEXRON® VI transmission fluid. Refer to Transmission Fluid Check.



6. Push the fluid level indicator handle lock down.

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Transmission Replacement

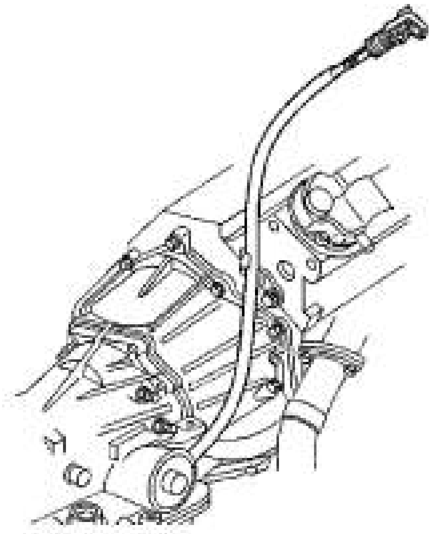
Tools Required

- J 21366 Converter Holding Strap
- EN-48536 Frame Support Tool (Engine Lower 65mm Kit)

Removal Procedure

Important: NEW torque converter bolts will be required each time the torque converter bolts are removed.

1. Disconnect the negative battery cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .

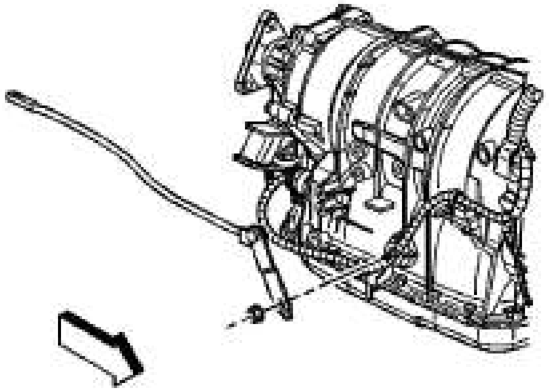


2. Remove the transmission fluid filler tube. Refer to Transmission Fluid Filler Tube and Seal Replacement .

Caution: Refer to Safety Glasses Caution in the Preface section.

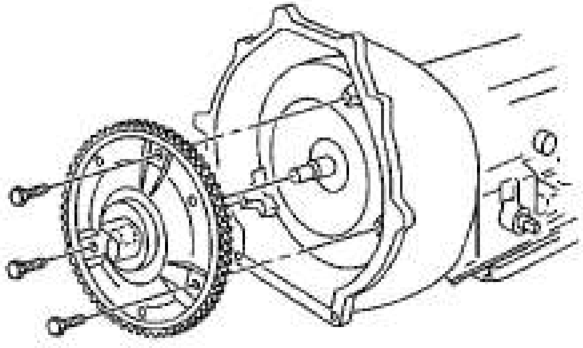
Caution: Refer to Vehicle Lifting Caution in the Preface section.

3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
4. Remove the propeller shaft. Refer to Propeller Shaft Replacement .
5. Remove the catalytic converter assembly from the vehicle. Refer to Catalytic Converter Replacement - Left Side and Catalytic Converter Replacement - Right Side .
6. Remove the starter motor from the engine. Refer to Starter Motor Replacement .



7. Disconnect the selector lever linkage from the transmission. Refer to Park/Neutral Position Switch Replacement .
8. Support the rear of the vehicle with a suitable jack.
9. Remove the torque converter covers. Refer to Torque Converter Cover Replacement .

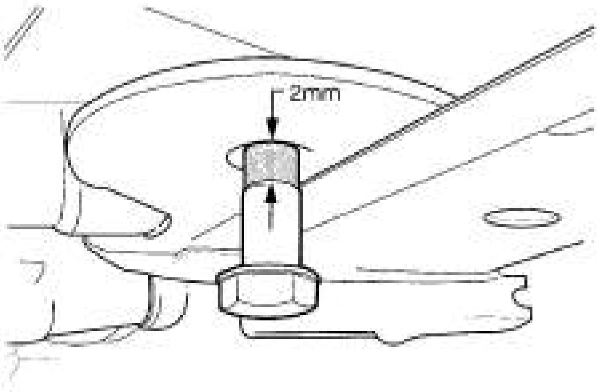
Important: Mark the position of the flywheel and torque converter positions for realignment during installation.



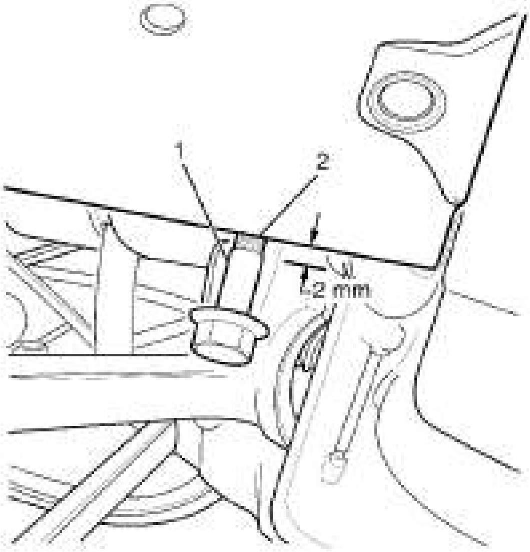
10. Remove the torque converter retaining bolts, then discard the retaining bolts.

Important: The engine mounts must NOT bend or deflect from the vertical position, damage to the mount will occur.

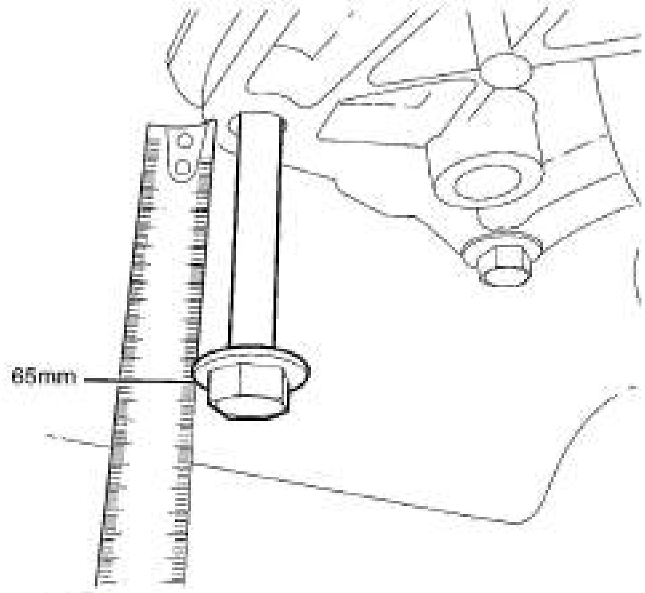
11. Support the power train with a suitable jack or table.
12. Using EN-48536 lower engine and transmission assembly 65mm.



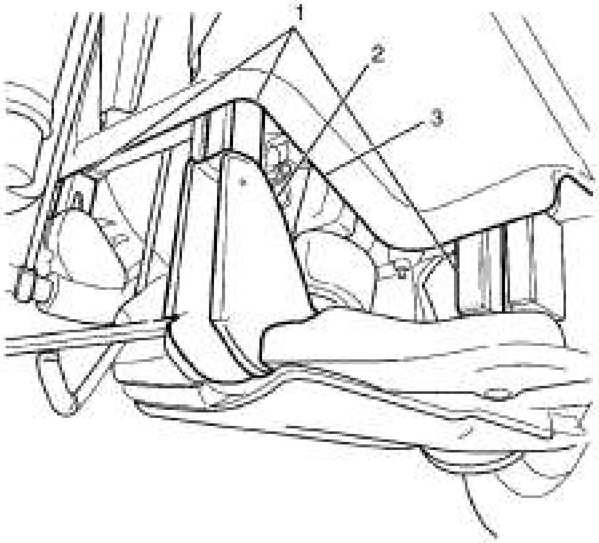
13. Replace the front sub frame rear bolts and fit bolts from special tool kit EN-48536
14. Install bolt till stepped shank (1) is 2mm below sub frame (2).



15. Replace the front sub frame front bolts and fit bolts from special tool kit EN-48536
16. Install bolt till stepped shank (1) is 2mm below chassis rail flange (2).



17. Remove transmission mount to body bolt and install two bolts from special tool kit in diagonal holes e.g Left hand front and Right hand rear.
18. Install bolts from special tool EN-48536 until 65mm is measured between bolt heads (1) and transmission mount (2).
19. Remove front sub frame middle retaining bolts.
20. Lower power train slowly until the subframe and transmission mount are resting on bolts.



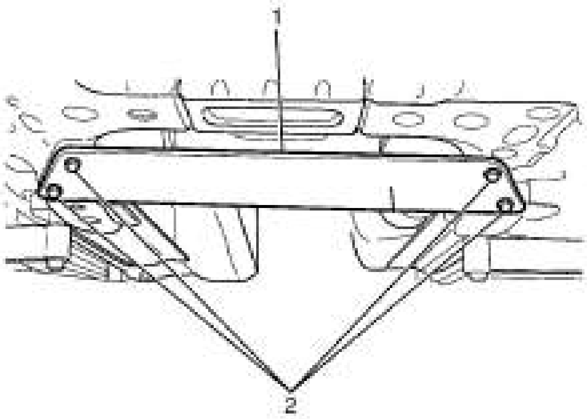
21. Insert 65mm spacer blocks (1) between subframe (2) and chassi rails (3).
22. Tension front sub frame front and rear retaining bolts.

    Tighten
    Tighten the retaining bolts to 95 N·m (70 lb. ft).

23. Install and tension middle sub frame retaining bolts.

Tighten
Tighten the retaining bolts to 95 N·m (70 lb. ft).

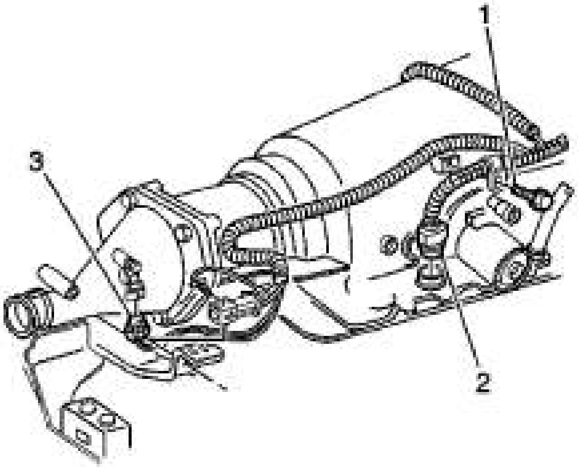
24. Remove supporting jack or table



25. Install engine support plate (1) to front sub frame (2).
26. Tension plate retaining bolts (3).

Tighten
Tighten the retaining bolts to 10 N·m (89 lb. in).

27. Disconnect the transmission oil cooler pipes from the transmission. Refer to Transmission Fluid Cooler Hose/Pipe Replacement .

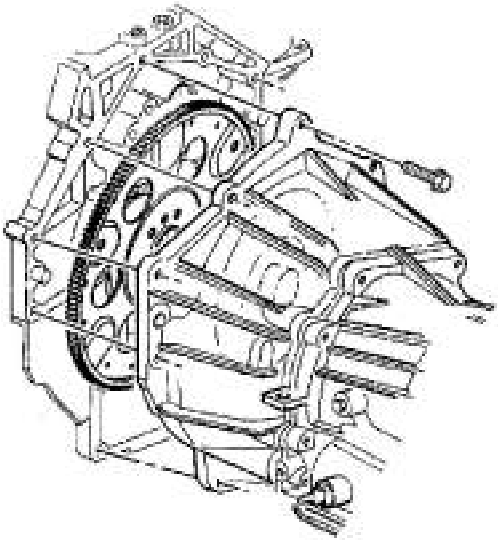


28. Remove the wiring harness clamp retaining bolt (1) attaching the clamp to the transmission.

29. Disconnect the transmission 20-way electrical connector (2).

    Compress both tabs on the connector and pull straight up; do not pry the connector.

30. Disconnect the vehicle speed sensor electrical connector (3).
31. Support the transmission using a transmission jack.



32. Remove the transmission to engine retaining bolts.
33. Separate the transmission from the engine.
34. Attach the J 21366 to the transmission.
35. Lower the transmission from the vehicle.

Installation Procedure

Important: The engine mounts must NOT bend or deflect from the vertical position, damage to the mount will occur.

1. Raise the transmission up to the vehicle.
2. Remove the J 21366 from the transmission.

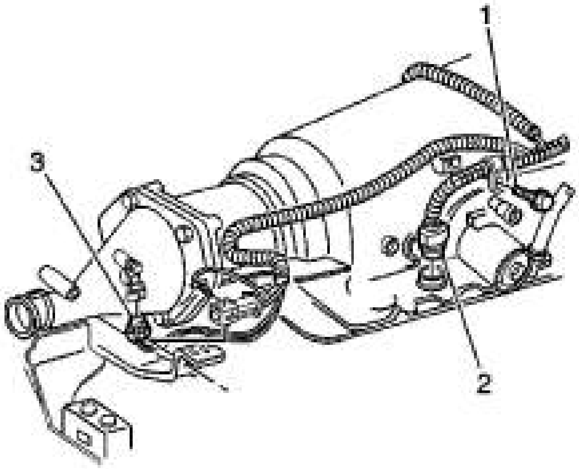
    Notice: Refer to Fastener Notice in the Preface section.

3. Align and install the transmission to the engine.
4. Install the transmission to engine retaining bolts.

    Tighten
    Tighten the transmission to engine retaining bolts to 38 N·m (28 lb ft).

5. Raise the powertrain back up into the engine bay and tighten front sub frame retaining bolts.

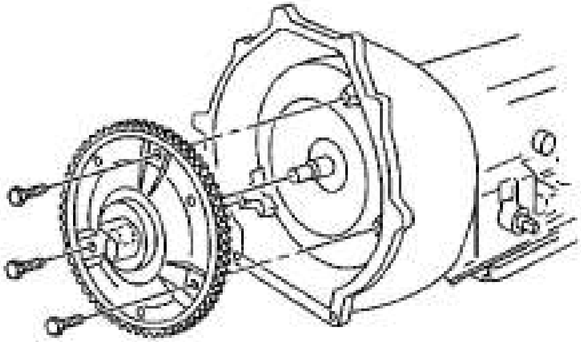
    Tighten
    Tighten the retaining bolts to 160 N·m (118 lb. ft.) for the front four bolts and
    240 N·m (177 lb ft)



6. Connect the vehicle speed sensor electrical connector (3).
7. Connect the 20-way electrical connector (2).
8. Install the wiring harness clamp retaining bolt (1) attaching the clamp to the transmission.

Tighten
Tighten the wiring harness clamp retaining bolt (1) to 2.5 N·m (22 lb in).

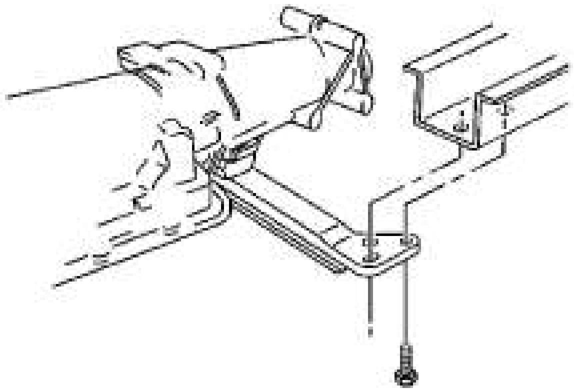
9. Connect the transmission oil cooler pipes to the transmission. Refer to Transmission Fluid Cooler Hose/Pipe Replacement .



10. Align the torque converter and flywheel mating marks, then install the New transmission torque converter retaining bolts.

Tighten
Tighten the New transmission torque converter retaining bolts to 65 N·m (48 lb ft).

11. Install the torque converter covers. Refer to Torque Converter Cover Replacement .



12. Install the transmission crossmember support. Refer to Transmission Mount Replacement .
13. Install and adjust the selector lever linkage. Refer to Park/Neutral Position Switch Replacement .
14. Remove the transmission jack.
15. Install the propeller shaft. Refer to Propeller Shaft Replacement .
16. Install the starter motor from the engine. Refer to Starter Motor Replacement .
17. Install the catalytic converter assembly on the vehicle. Refer to Catalytic Converter Replacement - Left Side and Catalytic Converter Replacement - Right Side .
18. Remove the jack supporting the rear of the vehicle.
19. Lower the vehicle.
20. Install the transmission fluid filler tube. Refer to Transmission Fluid Filler Tube and Seal Replacement .

    Notice: Refer to General Repair Instructions in the Preface section.

21. Flush the transmission oil cooler, oil cooler pipes and the hoses. Refer to Transmission Fluid Cooler Flushing and Flow Test .
22. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
23. Fill the transmission to the proper level with DEXRON® VI transmission fluid. Refer to Transmission Fluid Check .

    Important: It is recommended that transmission adaptive pressure (TAP) information be reset.

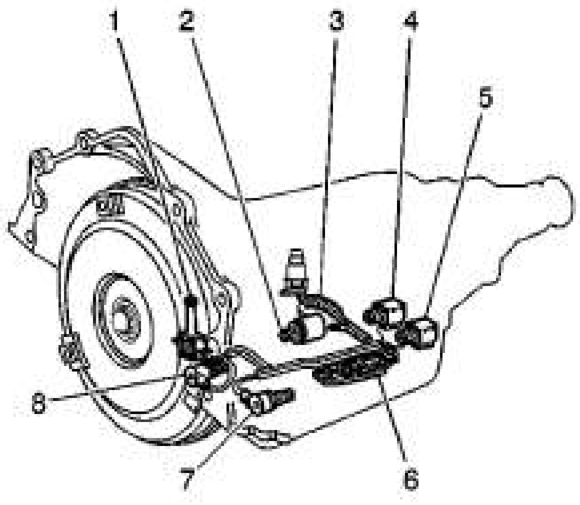
    Resetting the TAP values using a scan tool will erase all learned values in all cells. As a result, The ECM or TCM will need to relearn TAP values. Transmission performance may be affected as new TAP values are learned.

24. Reset the TAP values. Refer to Transmission Adaptive Functions .

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 4L60-E/4L65-E/4L70-E | Repair Instructions - On Vehicle | Document ID: 1992312

Valve Body and Pressure Switch Replacement

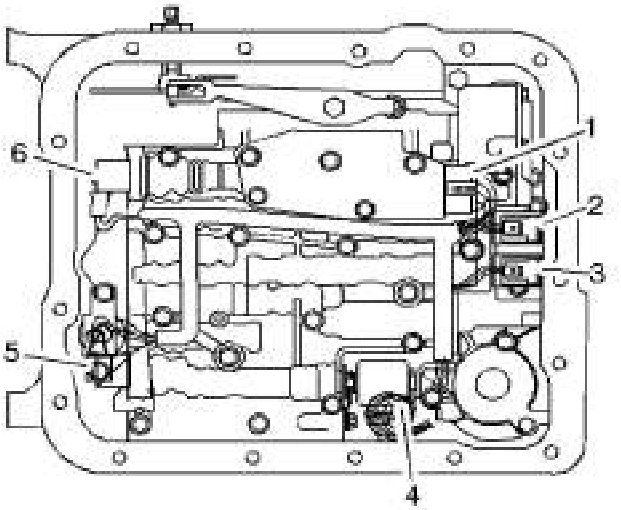
Removal Procedure



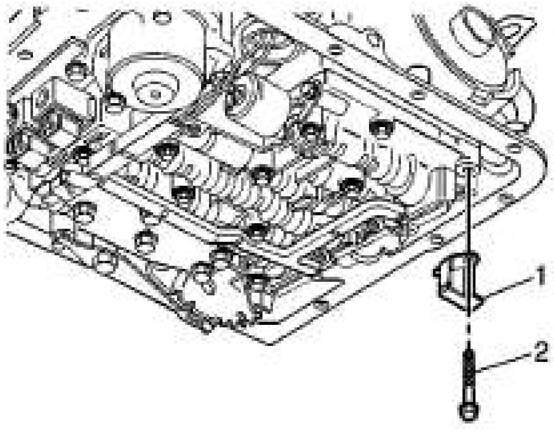
1. Ensure that removal of the valve body is necessary before proceeding.

   Important: The following components can be serviced without removing the valve body from the transmission:

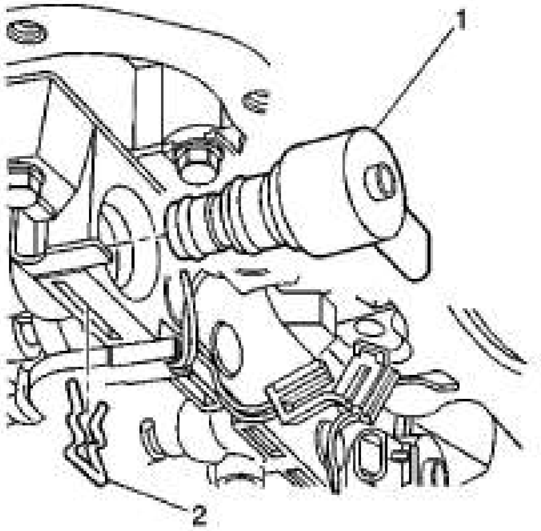
   - The torque converter clutch solenoid (1)
   - The pressure control solenoid (2)
   - The internal wiring harness (3)
   - The 2-3 shift solenoid (4)
   - The 1-2 shift solenoid (5)
   - The transmission fluid pressure manual valve position switch (6)
   - The 3-2 shift solenoid (7)
   - The torque converter clutch pulse width modulation (TCC PWM) solenoid (8)
2. Remove the fluid level indicator.
3. Raise the vehicle. Refer to Lifting and Jacking the Vehicle.
4. Remove the catalytic converter assembly from the vehicle. Refer to Catalytic Converter Replacement - Left Side and Catalytic Converter Replacement - Right Side.
5. Remove the oil pan, gasket, and filter. Refer to Automatic Transmission Fluid and Filter Replacement.



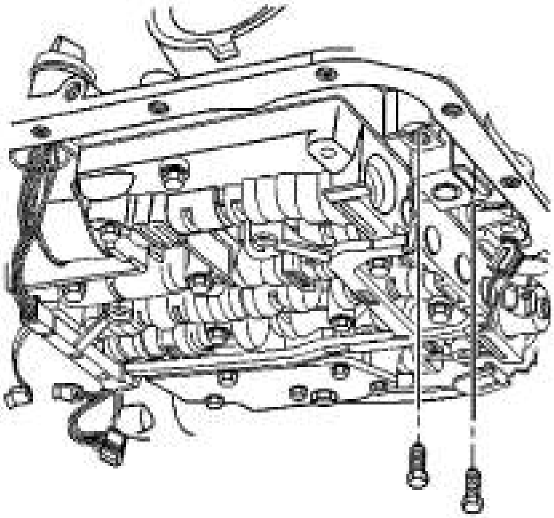
6. Disconnect the internal wiring harness electrical connectors from the following components:
   - The transmission fluid pressure manual valve position switch (1)
   - The 1-2 shift solenoid (2)
   - The 2-3 shift solenoid (3)
   - The pressure control solenoid (4)
   - The TCC PWM solenoid (5)
   - The 3-2 shift solenoid (6)



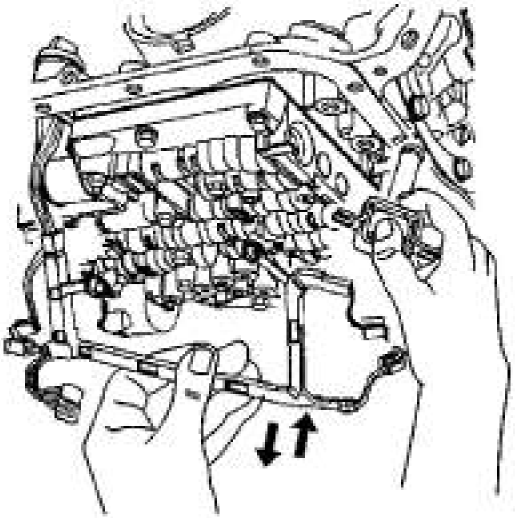
7. Remove the fluid indicator stop bracket bolt (2).
8. Remove the fluid indicator bracket (1).



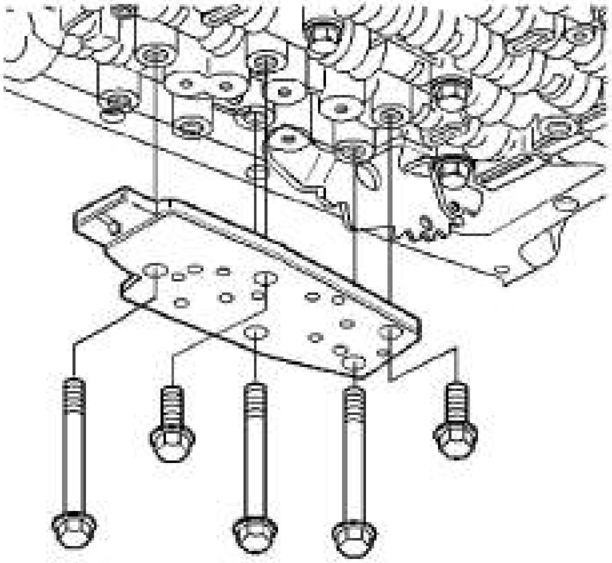
9. Remove the TCC PWM solenoid retainer (2) with a small screwdriver. Rotate the solenoid (1) in the bore, if necessary, until the flat part of the retainer (2) is visible.
10. Remove the TCC PWM solenoid (1) in order to access the torque converter clutch (TCC) solenoid retaining bolts.



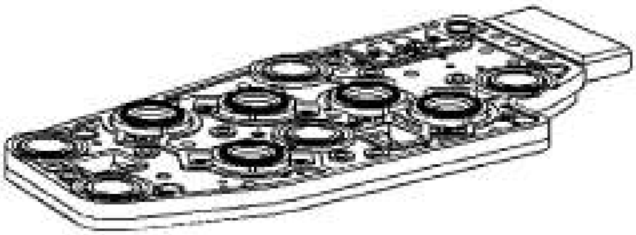
11. Remove the TCC solenoid retaining bolts.



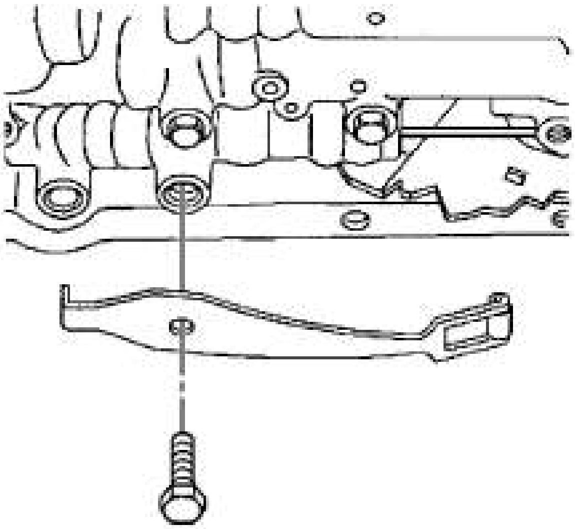
12. Remove the TCC solenoid (with O-ring seal) and wiring harness from the control valve body.
13. Reposition the harness to the side of the transmission case.



14. Remove the control valve body bolts which retain the transmission fluid pressure switch to the control valve body.
15. Remove the transmission fluid pressure switch.



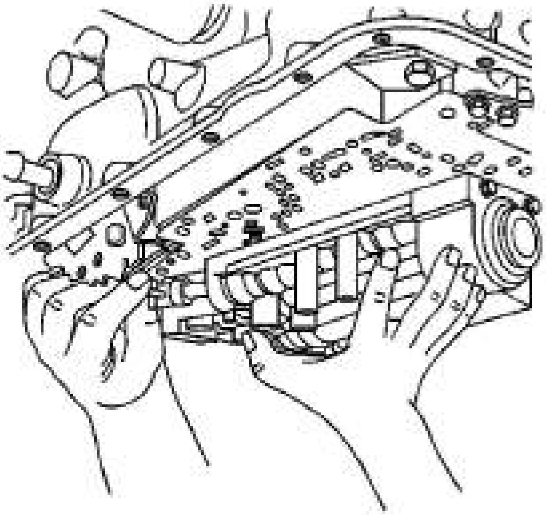
16. Inspect the transmission fluid pressure switch for damage or debris.



17. Remove the manual detent spring retaining bolt.
18. Remove the manual detent spring.
19. Inspect the manual detent spring for cracks or damage.

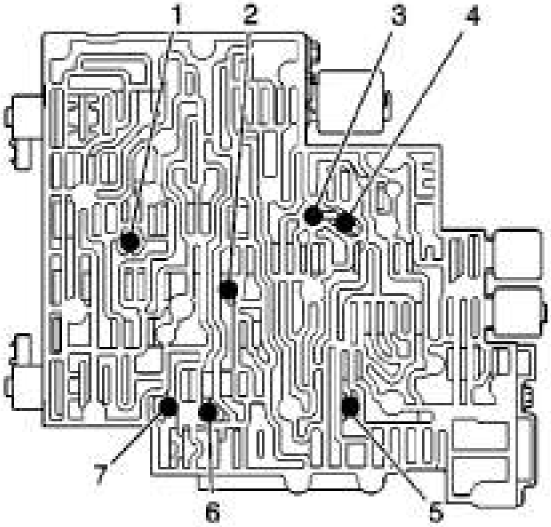
Important: Keep the control valve body level when lowering it from the vehicle. This will prevent the loss of checkballs located in the control valve body passages.

20. Remove the remaining control valve body bolts.

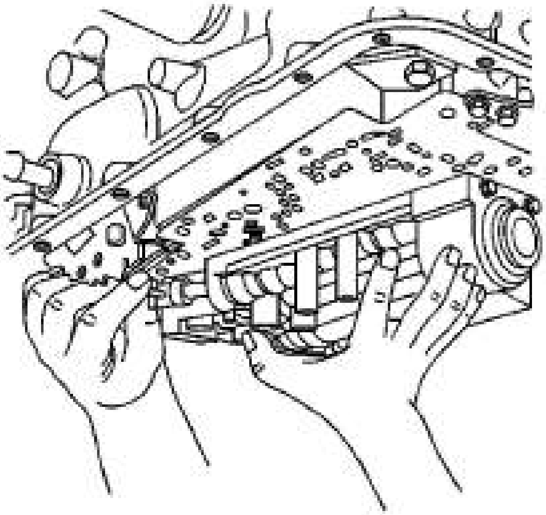


21. Carefully begin to lower the control valve body down from the transmission case while simultaneously disconnecting the manual valve link.

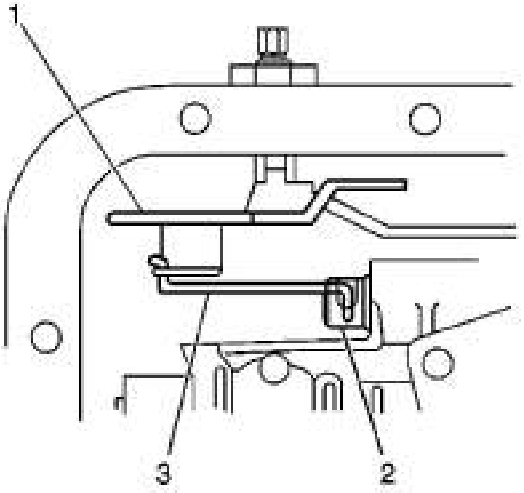
Installation Procedure



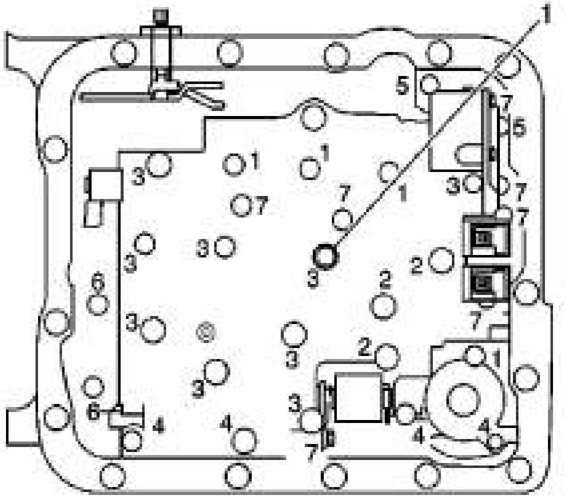
1. Install the checkballs (1-7) in the valve body.



2. Install the control valve body to the transmission case while simultaneously connecting the manual valve link to the manual valve.



3. Verify that the manual valve link (3) is installed properly to the inside detent lever (1) and the manual valve (2).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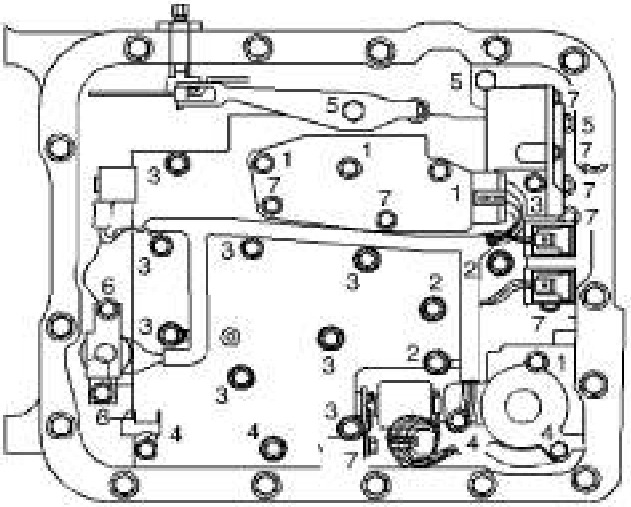
4. Install one bolt (M6 X 1.0 X 47.5) hand tight in the center (1) of the valve body to hold it in place.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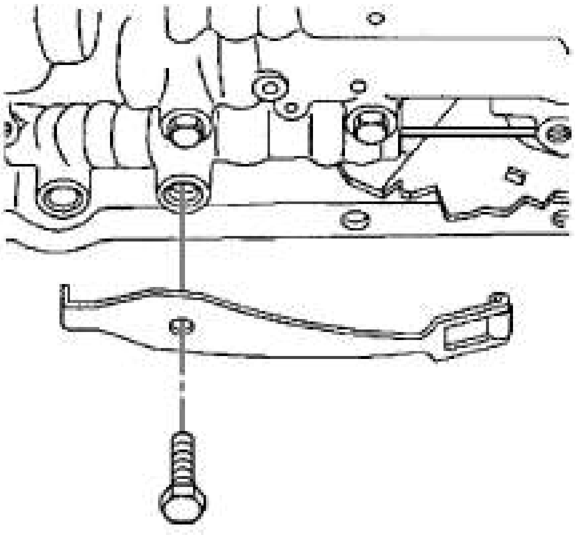
Important: When installing bolts throughout this procedure, be sure to use the correct bolt size and length in the correct location as specified.

5. Do not install the transmission fluid indicator stop bracket and bolt at this time.

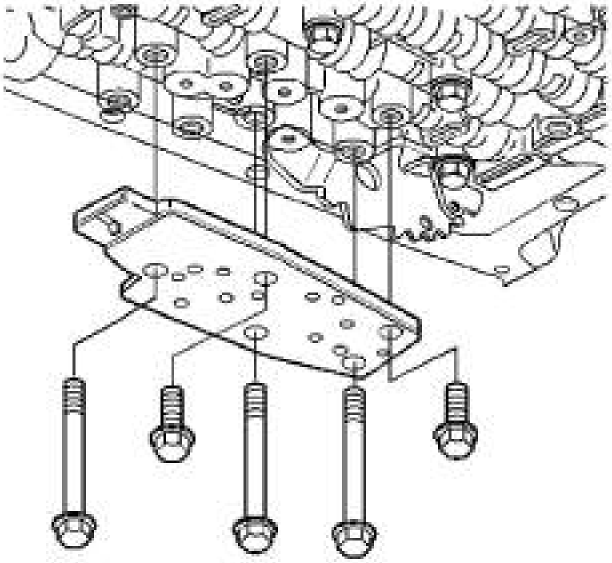
   Install but do not tighten the control valve body bolts which retain only the valve body directly.

   Each numbered bolt location corresponds to a specific bolt size and length, as indicated by the following:

- M6 X 1.0 X 65.0 (1)
- M6 X 1.0 X 54.4 (2)
- M6 X 1.0 X 47.5 (3)
- M6 X 1.0 X 35.0 (4)
- M8 X 1.0 X 20.0 (5)
- M6 X 1.0 X 12.0 (6)
- M6 X 1.0 X 18.0 (7)



6. Install the manual detent spring.
7. Install but do not tighten the manual detent spring retaining bolt.

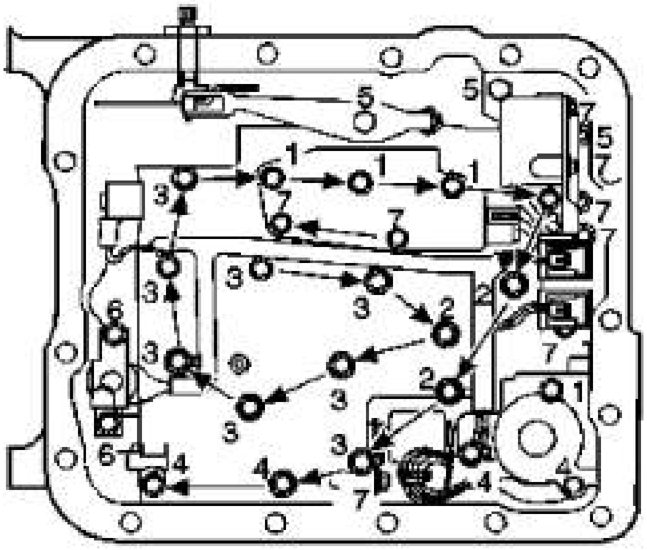


8. Install the transmission fluid pressure switch.

9. Install but do not tighten the control valve body bolts which retain the transmission fluid pressure switch to the control valve body.

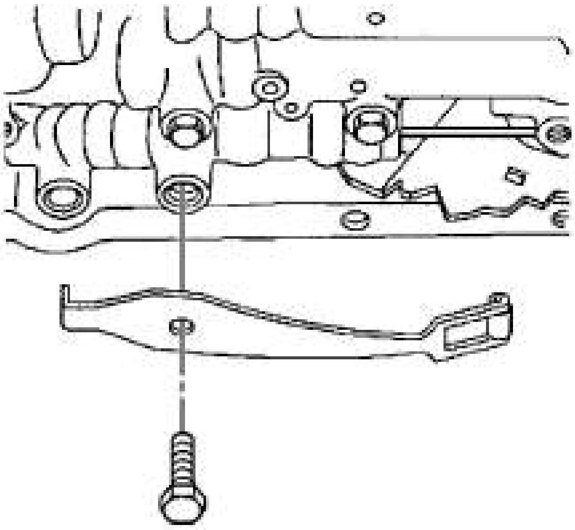
   Notice: Refer to Fastener Notice in the Preface section.

   Notice: Torque valve body bolts in a spiral pattern starting from the center. If the bolts are torqued at random, valve bores may be distorted and inhibit valve operation.



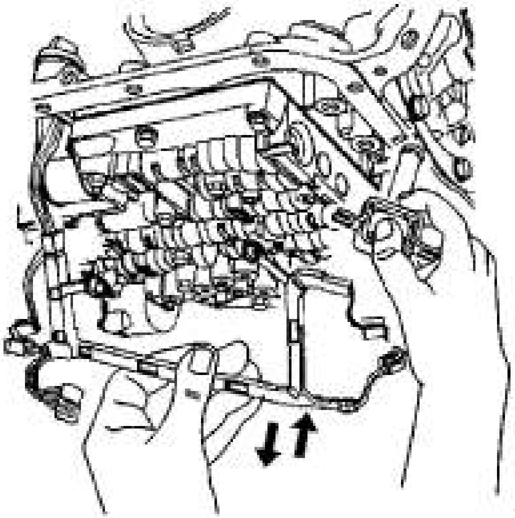
10. Tighten the control valve body bolts in a spiral pattern starting from the center, as indicated by the arrows.

    Tighten
    Tighten the control valve body bolts (in sequence) to 12 N·m (106 lb in).

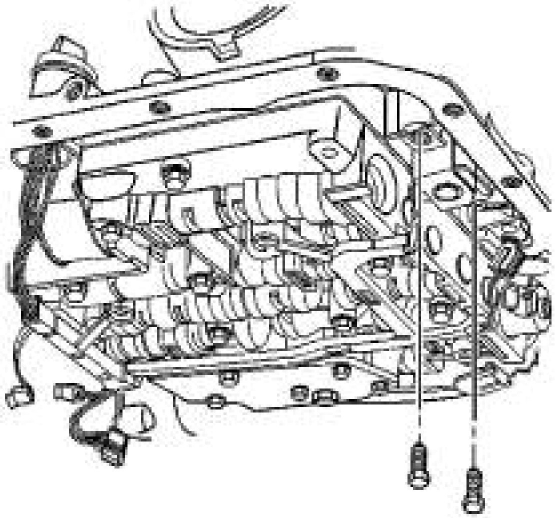


11. Ensure that the manual detent spring is aligned properly with the detent lever.

Tighten
Tighten the manual detent spring bolt to 31 N·m (23 lb ft).



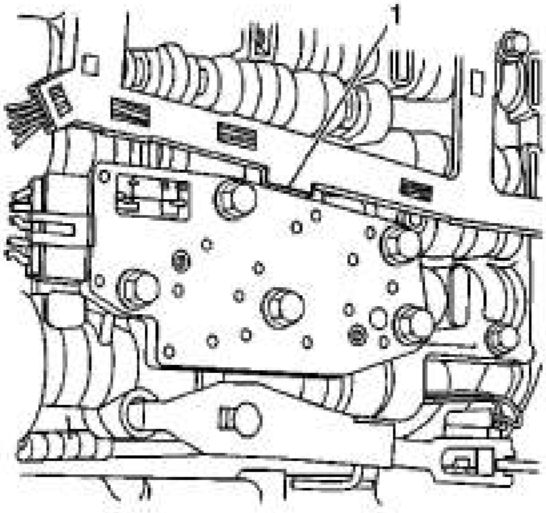
12. Install the TCC solenoid with a new O-ring seal to the valve body.



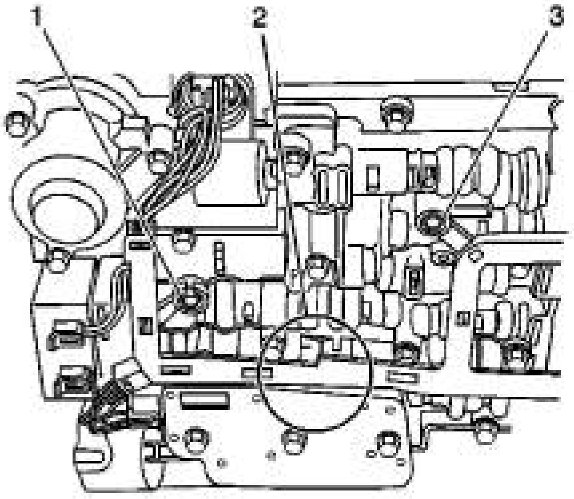
13. Install the TCC solenoid bolts.

Tighten

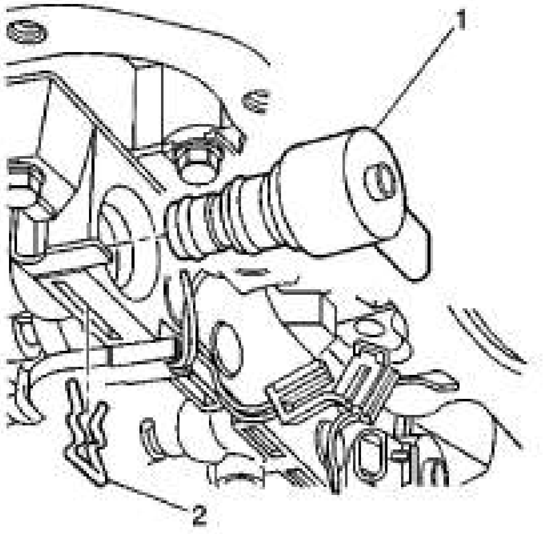
Tighten the TCC solenoid retaining bolts to 12 N·m (106 lb in).



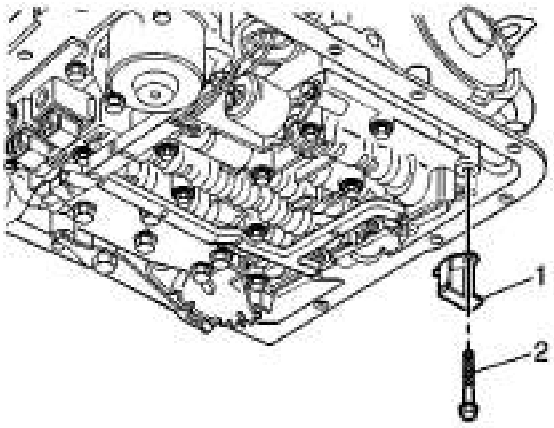
14. Install the internal wiring harness to the valve body. The internal wiring harness has a tab (1) on the edge of the conduit.



15. Place the tab between the valve body and the pressure switch in the location shown (2). Press the harness into position on the valve body bolt bosses (1, 3).

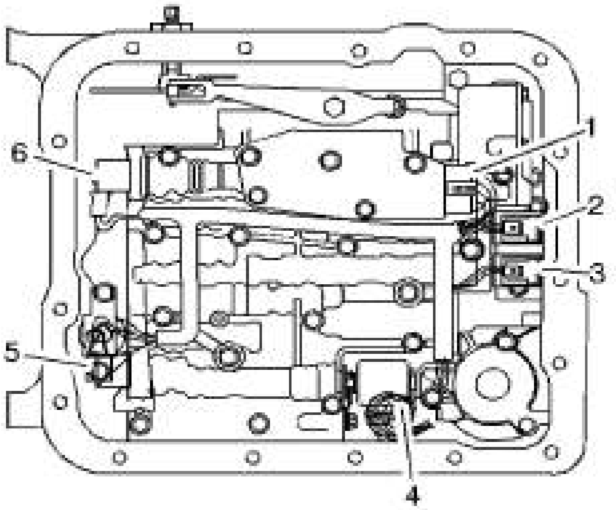


16. Install the TCC PWM solenoid (1) to the control valve body.
17. Install the TCC PWM solenoid retainer (2).



18. Install the transmission fluid indicator stop bracket (1) and retaining bolt (2).

    Tighten
    Tighten the transmission fluid indicator stop bracket retaining bolt to 12 N·m (106 lb in).



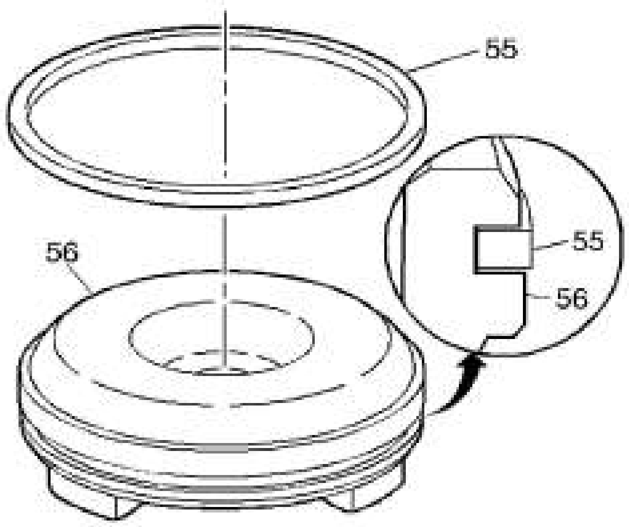
19. Connect the internal wiring harness electrical connectors to the following components:
    - The transmission fluid pressure manual valve position switch (1)
    - The 1-2 shift solenoid (2)
    - The 2-3 shift solenoid (3)
    - The pressure control solenoid (4)
    - The TCC PWM solenoid (5)
    - The 3-2 shift solenoid (6)
20. Install the transmission oil pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement.
21. Install the catalytic converter assembly from the vehicle. Refer to Catalytic Converter Replacement - Left Side and Catalytic Converter Replacement - Right Side.
22. Lower the vehicle.
23. Fill the transmission to the proper level with DEXRON® VI transmission fluid. Refer to Transmission Fluid Check.

    Important: It is recommended that transmission adaptive pressure (TAP) information be reset.

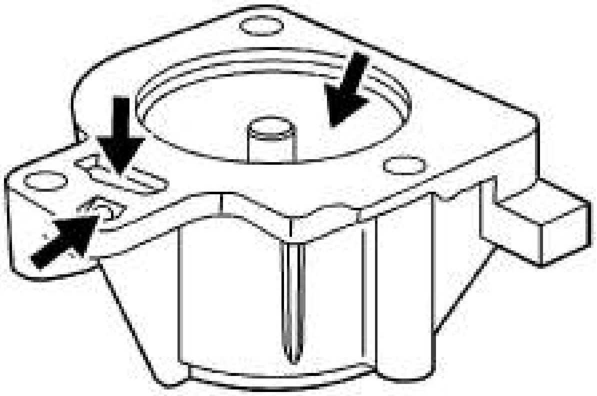
    Resetting the TAP values using a scan tool will erase all learned values in all cells. As a result, The ECM or TCM will need to relearn TAP values. Transmission performance may be affected as new TAP values are learned.

24. Reset the TAP values. Refer to Transmission Adaptive Functions.

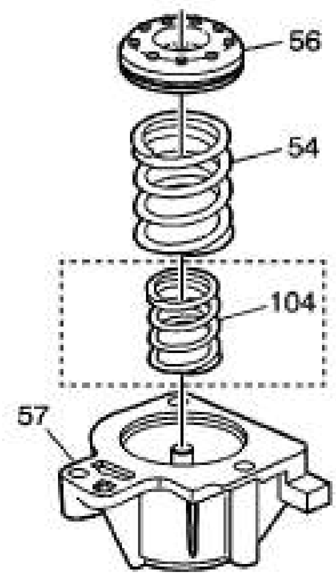
1-2 Accumulator Assemble



1. Inspect the 1-2 accumulator piston (56) for the following conditions:
   - Porosity
   - Cracks
   - Scoring
   - Nicks and Scratches
2. Install a 1-2 accumulator piston oil seal ring (55) on the 1-2 accumulator piston (56).



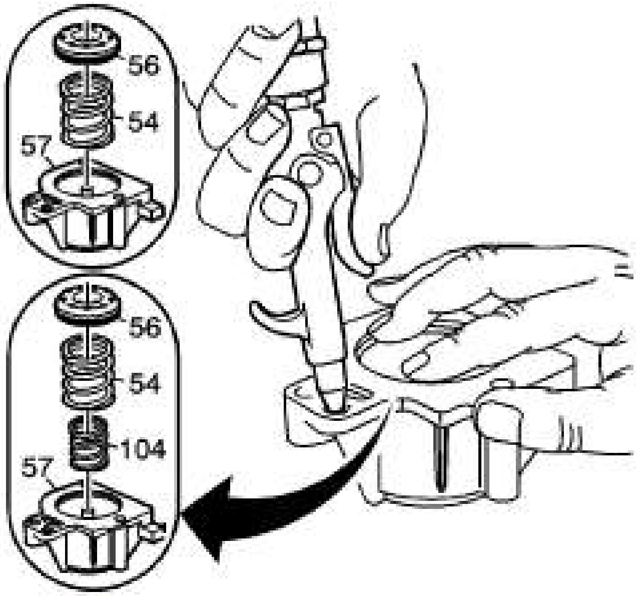
3. Inspect the 1-2 accumulator housing for the following conditions:
    - Porosity
    - Cracks
    - Scoring
    - Nicks and Scratches
    - Debris or blocked passages



Important: Some models do not use 1-2 accumulator spring - inner (104).

4. Install the 1-2 inner (104) and outer (54) accumulator springs.
5. Install the 1-2 accumulator piston (56).

1-2 Accumulator Disassemble



Important: Some models may not use a 1-2 accumulator spring - inner (104) or outer (54).

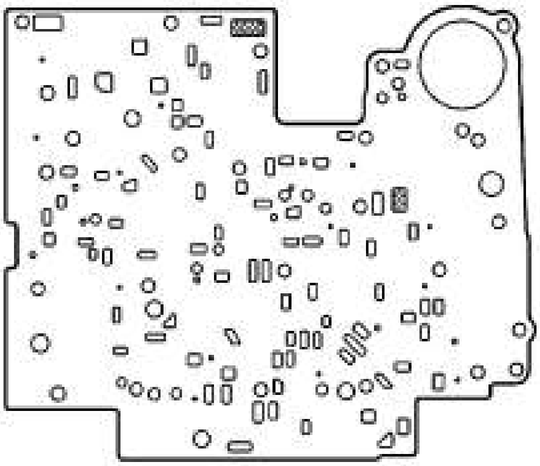
1. Blow air into the 1-2 accumulator housing (57) to remove the 1-2 accumulator piston (56).
2. Remove the 1-2 inner (104) and outer (54) accumulator springs.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 4L60-E/4L65-E/4L70-E | Repair Instructions - Off Vehicle | Document ID: 2036974

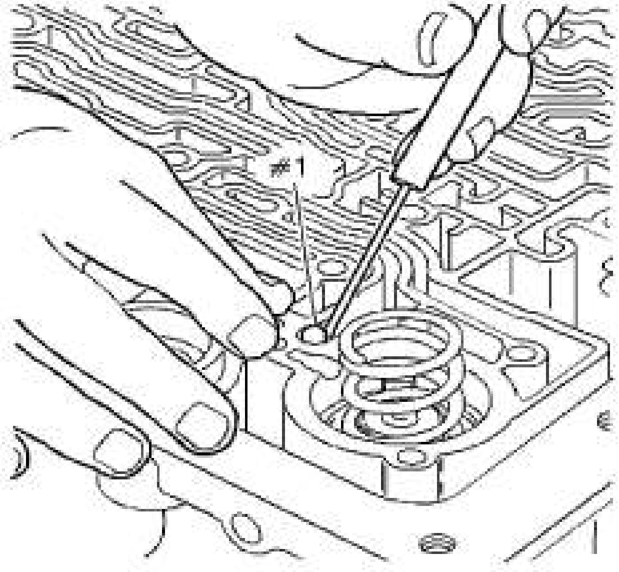
1-2 Accumulator Installation

Special Tools

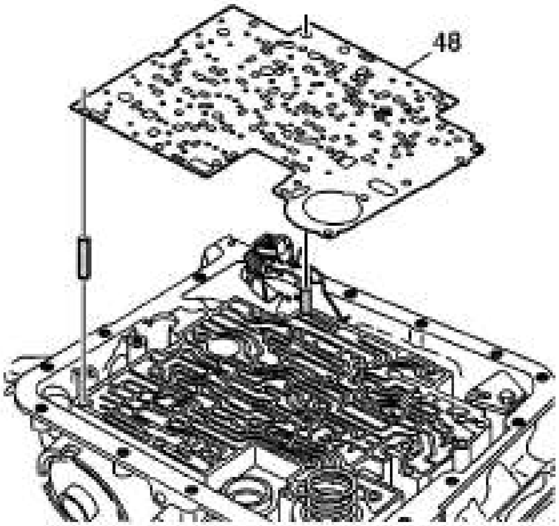
- *J 25025-5* Guide Pins
- *J 36850* Transjel Lubricant



1. Inspect the valve body bonded spacer plate for damage or debris.



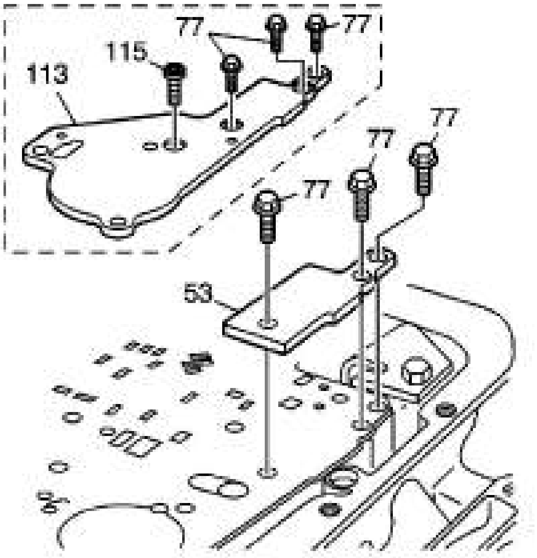
2. Install the #1 checkball into the case.



3. Install the *J 25025-5* guide pins into the case.

Note: Do not reuse the bonded spacer plate. Replace with a NEW bonded spacer plate.

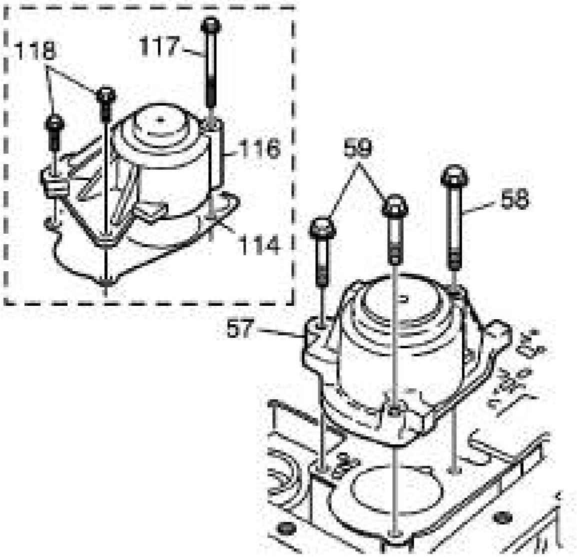
4. Place the bonded spacer plate (48) on the case.



5. Install the spacer plate support plate (53 or 113).
6. Install the spacer plate support bolts (77).

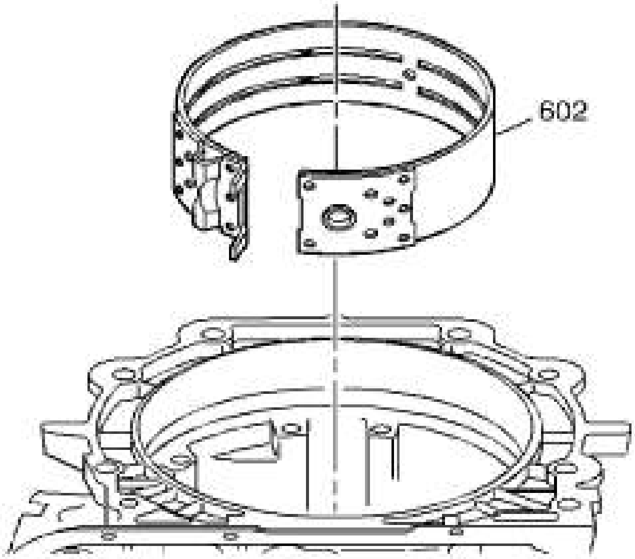
Caution: Refer to Fastener Caution in the Preface section.

7. Install the accumulator bolt (115), model dependent. Tighten the accumulator bolt to **11 N·m (8.11 lb ft)**.

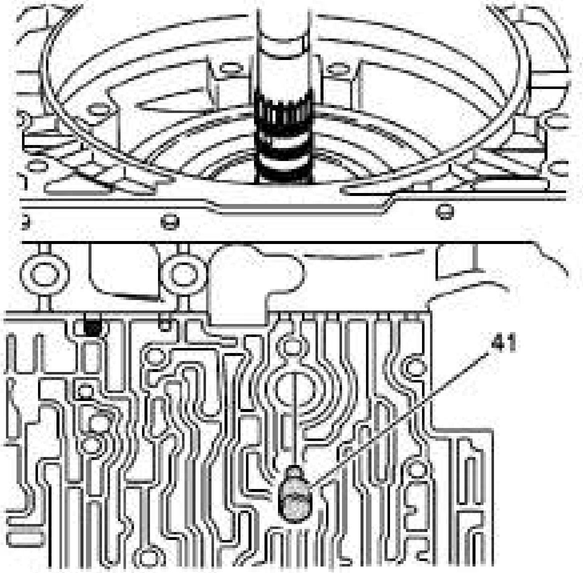


8. Install the 1-2 accumulator housing assembly (57) or gasket (114) and housing (116).
9. Install the 1-2 accumulator housing bolts (58, 59 or 117, 118).
   - Tighten the bolts 58 and 59 to **11 N·m (8 lb ft)**.
   - Tighten the bolts 117 and 118 to **8-14 N·m (6-10 lb ft)**.

2-4 Band Installation



1. Inspect the 2-4 band assembly (602) for damage or wear.
2. Install the 2-4 band (602) into the case.

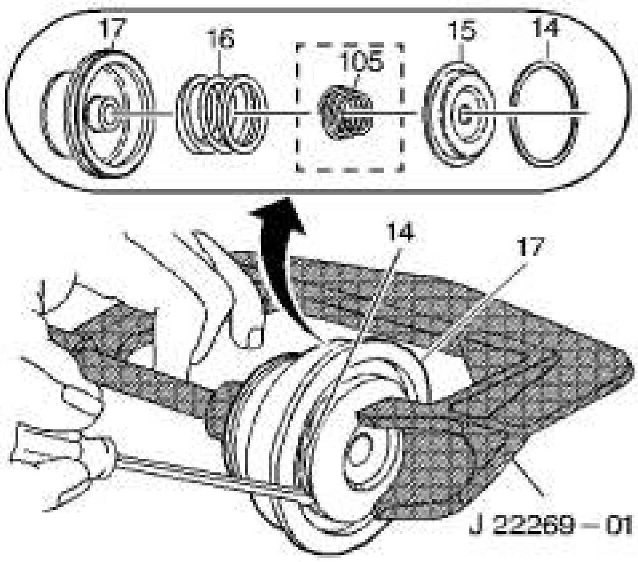


3. Install the band anchor pin (41) into the case.
4. Index the band to fit the band anchor pin into the band.

2-4 Band Servo 2nd Apply Piston Disassemble

Tools Required

J 22269-01 Accumulator and Servo Piston Remover

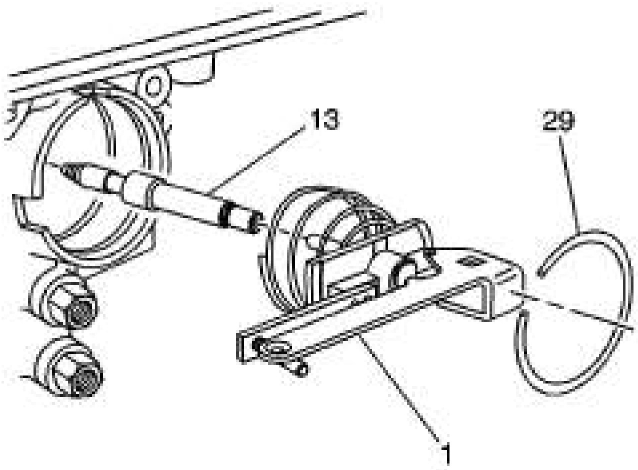


1. Use a J 22269-01 to compress the second apply piston assembly (17).
2. Remove the second apply piston retaining ring (14).
3. Remove the servo cushion spring retainer (15), the servo cushion outer spring (16) and the servo cushion inner spring (105) (model dependent).

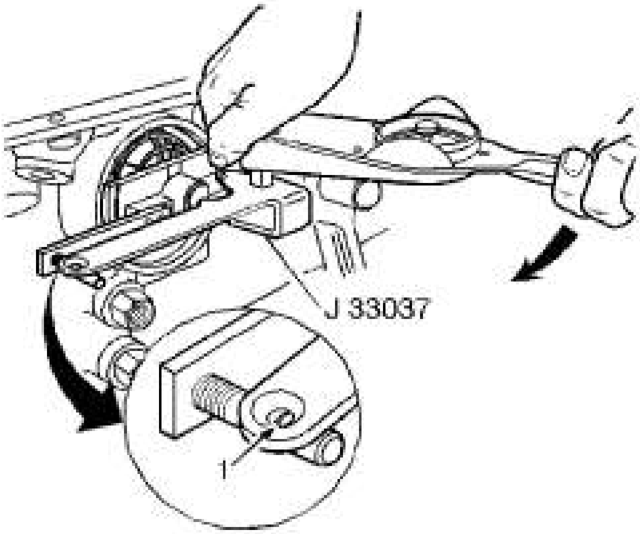
2-4 Band Servo Piston Pin Length Check

Tools Required

J 33037 2-4 Intermediate Band Apply Pin Gage



1. Install the band apply pin and the J 33037 .
2. Install the servo cover retaining ring to secure the tool.

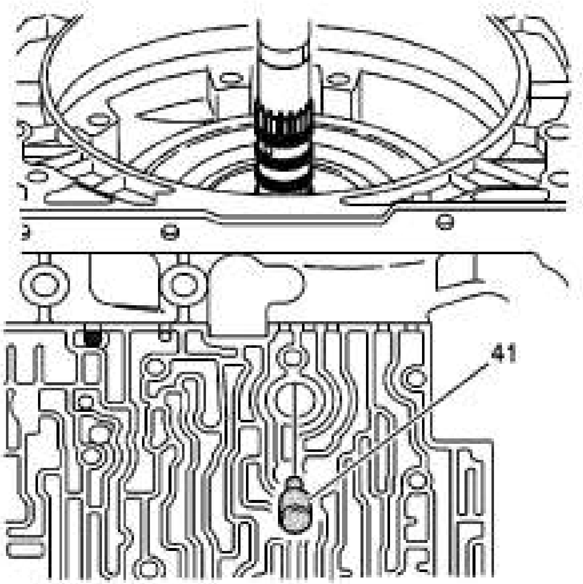


3. Apply 11 N·m (98 lb in) torque. If the white line appears in the gauge slot (1), the pin length

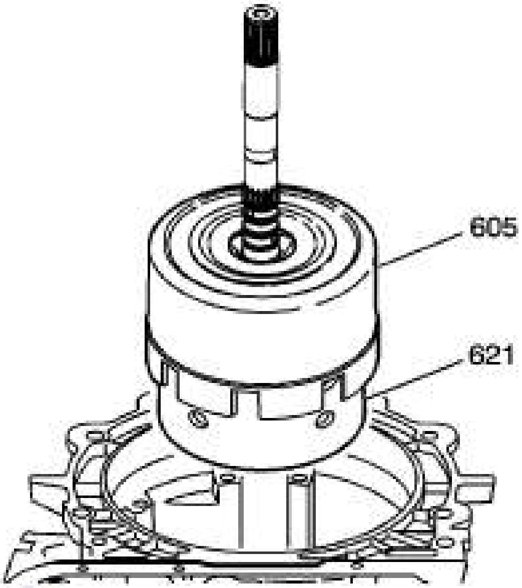
is correct.

4. If a new pin is needed, refer to 2-4 Band Servo Piston Pin Length Check, in order to determine the correct pin length.

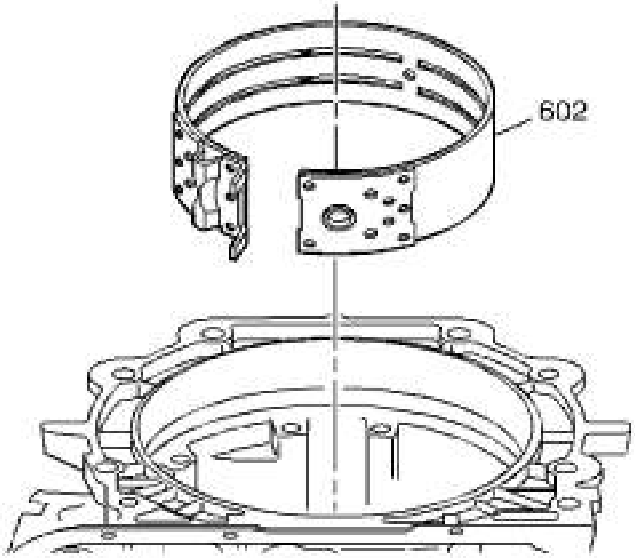
2-4 Band, Input Clutches, Input Gear Set Removal



1. Remove the band anchor pin (41).



2. Remove the input housing and shaft assembly (621), along with the reverse input clutch housing and drum assembly (605).

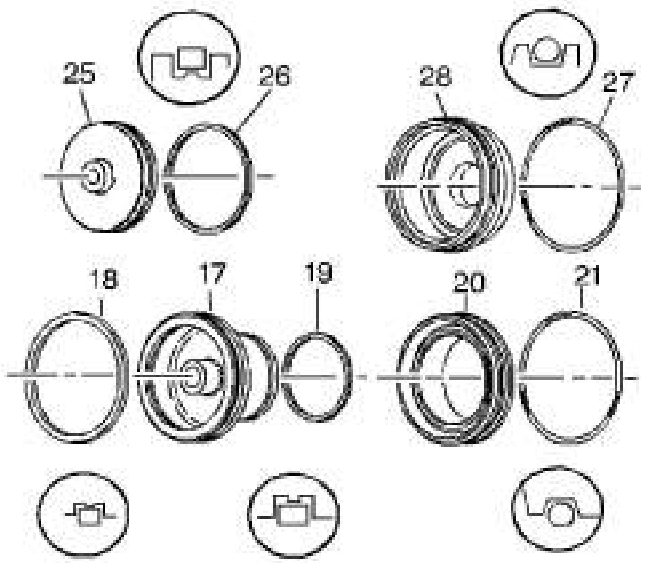


3. Remove the 2-4 band assembly (602).

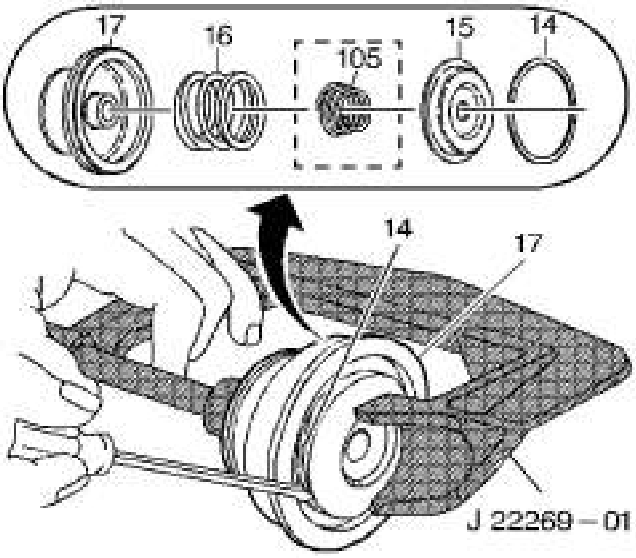
2-4 Servo Assembly Installation

Tools Required

- J 22269-01 Accumulator and Servo Piston Remover
- J 29714-A Servo Cover Depressor



1. Inspect the 4th apply piston (25), the 2-4 servo cover (28), the 2nd apply piston (17), and the servo piston inner housing (20) for the following conditions:
   - Cracks
   - Scoring
   - Burrs and nicks
2. Install the following seals:
   - The 4th apply piston outer oil seal ring (26) on the 4th apply piston (25).
   - The 2-4 servo cover O-ring seal (27) on the 2-4 servo cover (28).
   - The 2nd apply piston outer (18) and inner (19) oil seal rings on the 2nd apply piston (17).
   - The O-ring seal (21) on the servo piston inner housing (20).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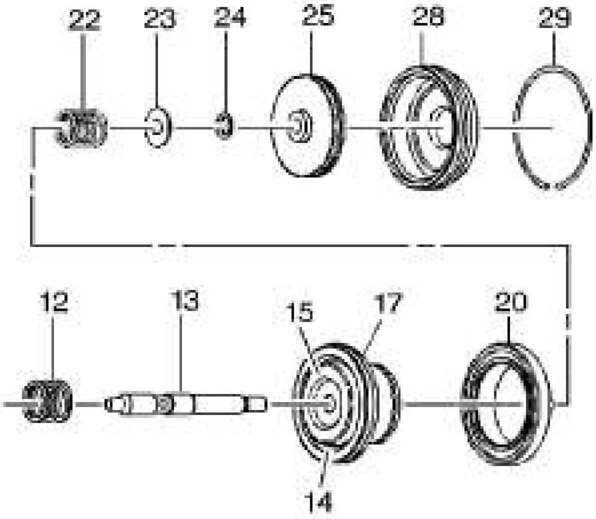
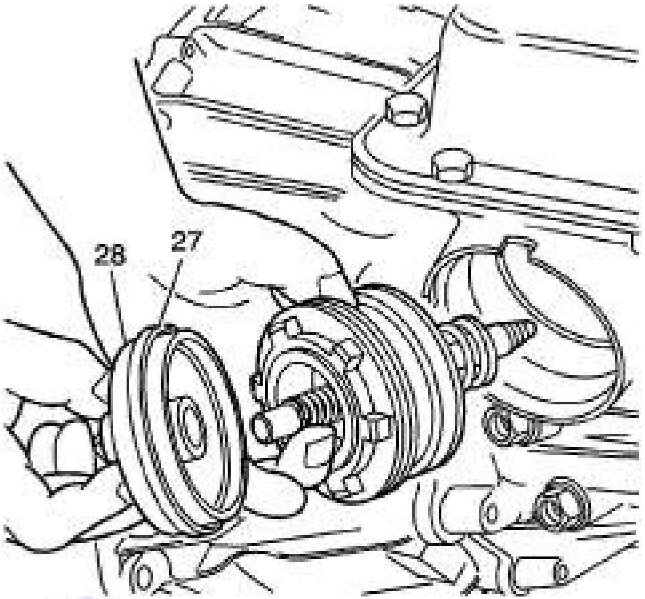
16
105
15
14
14
17
J 22269 – 01

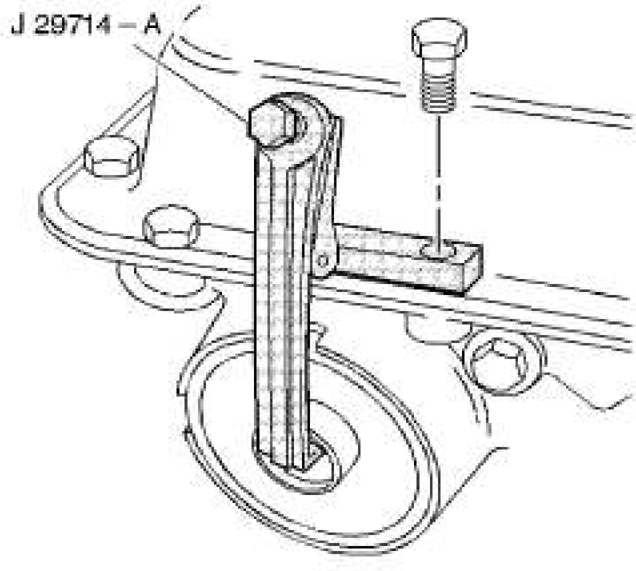
3. Install the servo cushion outer spring (16), the servo cushion inner spring (105) (model dependent) and the cushion spring retainer (15) in the 2nd apply piston (17).
4. Use the J 22269-01 and compress the second apply piston assembly (17).
5. Install the second apply piston retaining ring (14).


22
23
24
25
28
29
12
13
15
17
20
14

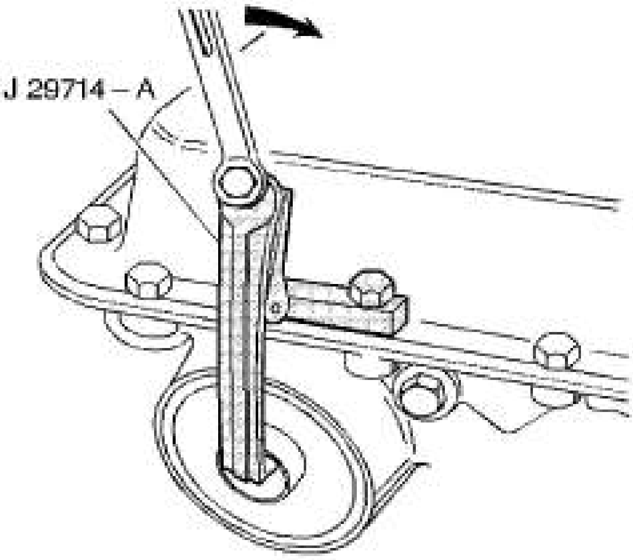
6. Assemble the 2-4 servo components in the order shown: (12-15, 17, 20, 22-25, 28, 29).



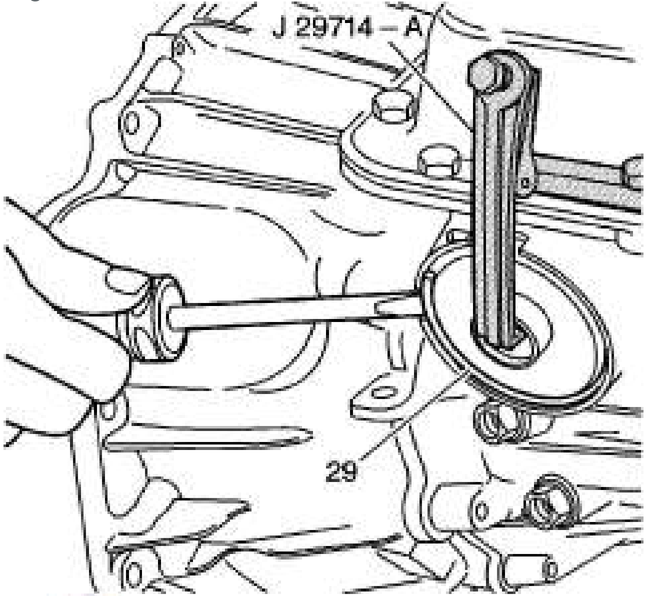
7. Install the 2-4 servo assembly into the 2-4 servo bore.



8. Install the J 29714-A .



9. Tighten the bolt on the J 29714-A in order to compress the servo cover.



10. Install the servo cover retaining ring.

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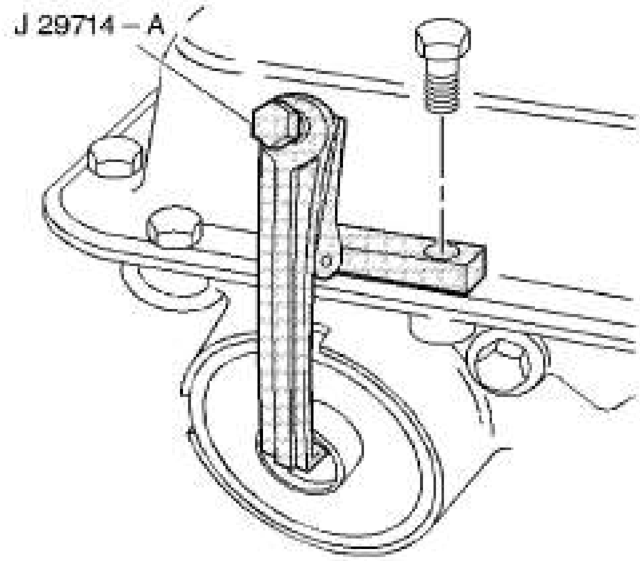
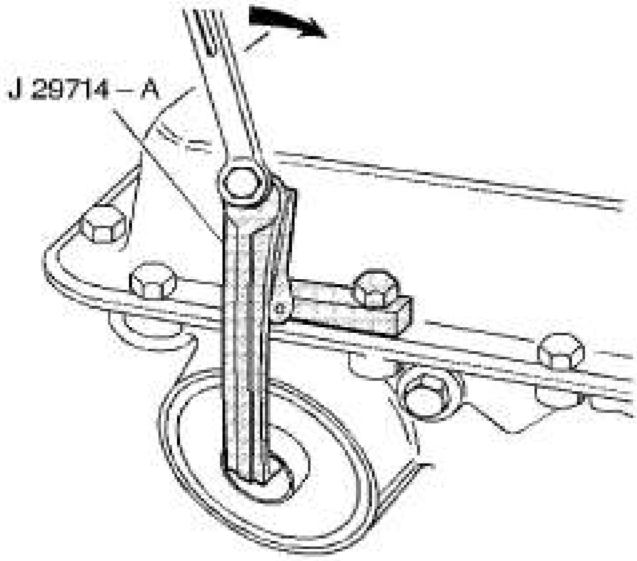
2-4 Servo Cover and Assembly Removal

Tools Required

J 29714-A Servo Cover Depressor

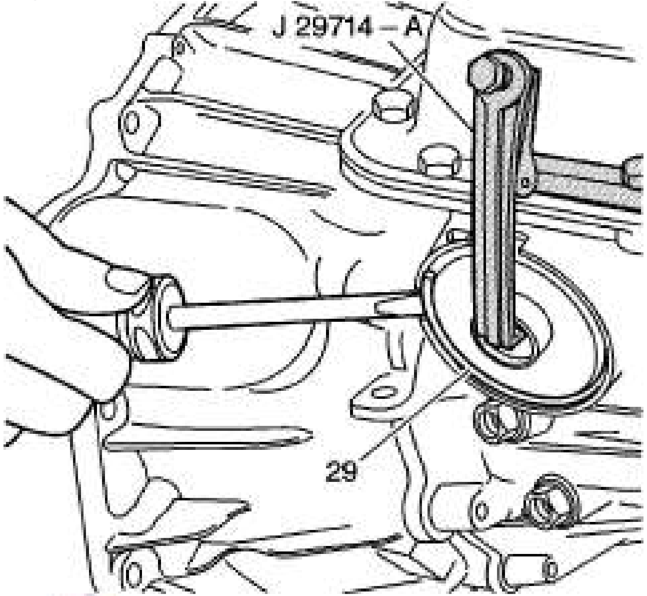


1. Install the J 29714-A .

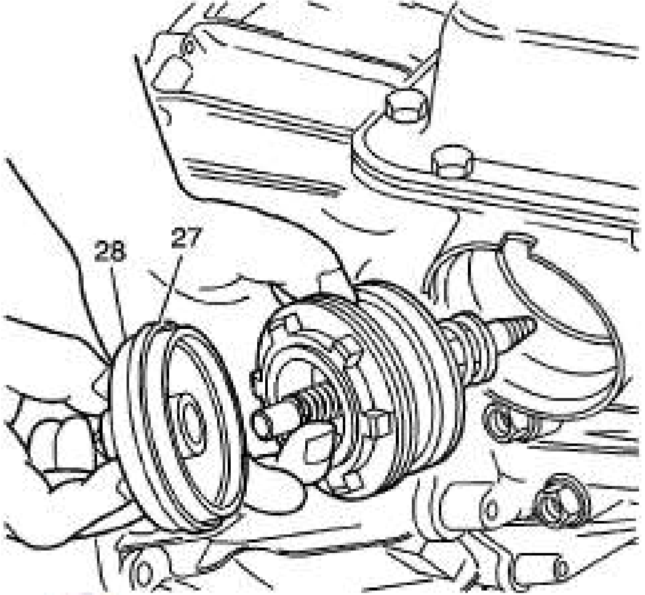


Important: If the cover does not move inwards with the tool, use a block of wood or suitable material and lightly tap on cover using a hammer to free up cover in bore.

2. Tighten the J 29714-A bolt to compress the servo cover.

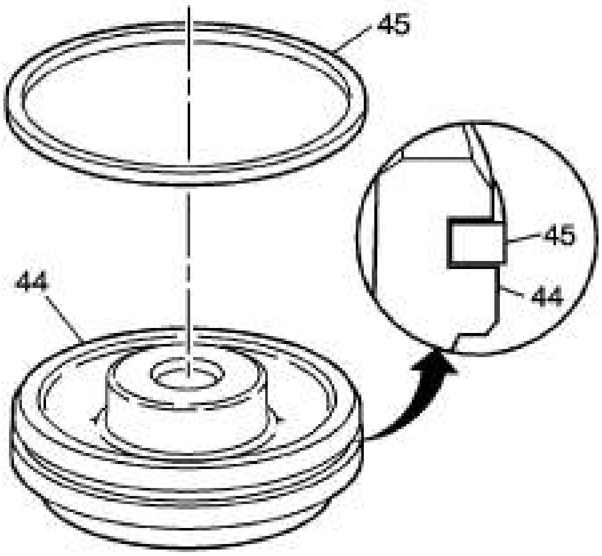


3. Remove the servo cover retaining ring (29) and the J 29714-A .

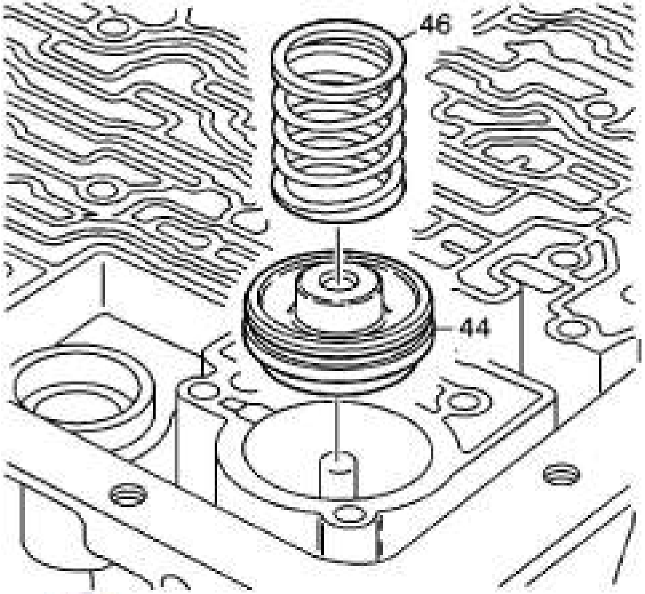


4. Remove the servo cover (28) and O-ring seal (27). If the servo cover seems to be hung up on the seal, cut and remove the O-ring seal before removing the cover.
5. Remove the 2-4 servo assembly.

3-4 Accumulator Installation



1. Inspect the 3-4 accumulator piston (44) for the following conditions:
   - Porosity
   - Cracks
   - Scoring
   - Nicks and scratches
2. Install the 3-4 accumulator piston oil seal ring (45) on the 3-4 accumulator piston (44).

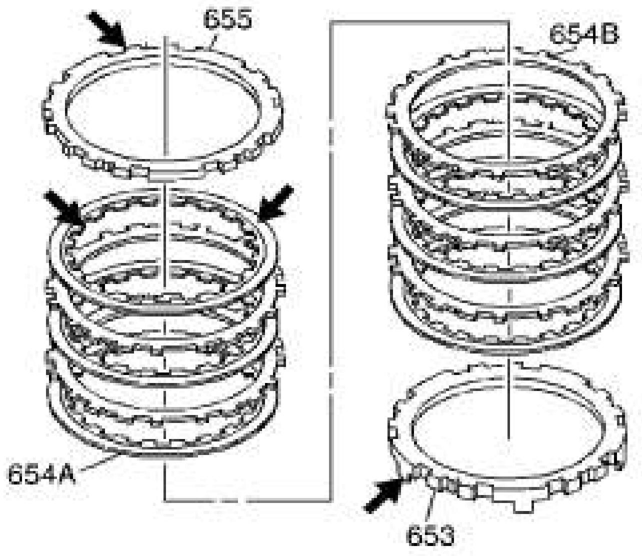


3. Install the 3-4 accumulator piston (44) and seal assembly into the bore.
4. Inspect the 3-4 accumulator spring (46) for cracks.

   Important: Some models do not use a 3-4 accumulator spring.

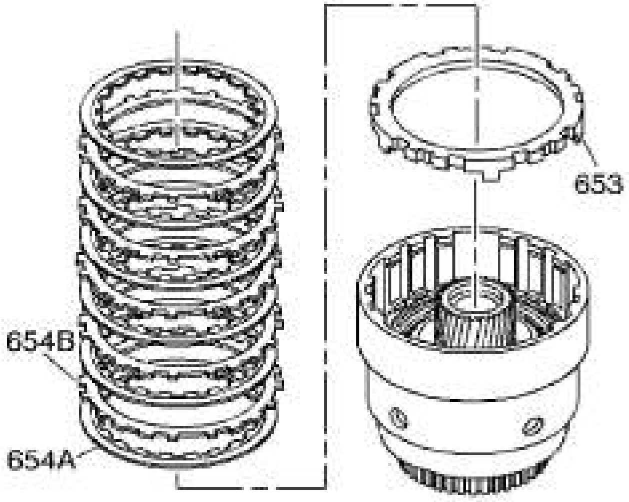
5. Install the 3-4 accumulator spring.

3-4 Clutch Assemble



Important: The part 654A may have 5, 6 or 7 plates.

1. Inspect the 3rd and 4th clutch apply plate (653), the fiber plate assemblies (654A), the steel plates (654B) and the selective backing plate (655) for the following conditions:
    - Damaged tangs
    - Delamination
    - Excessive wear
    - Heat damage or wear
    - Surface finish
    - Flatness



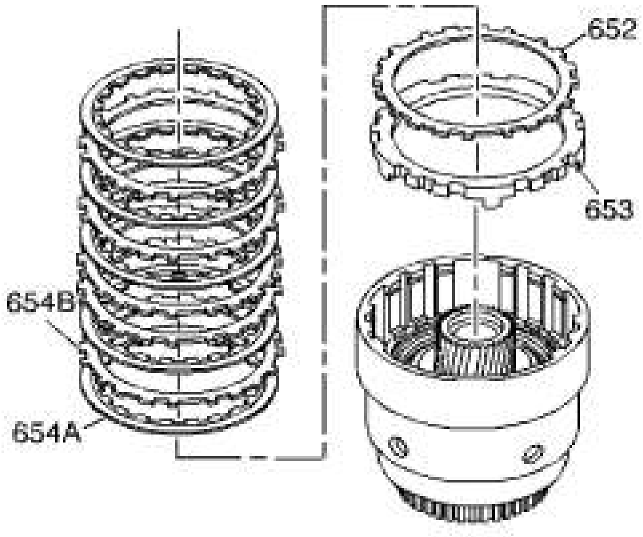
2. Install the 3rd and 4th clutch apply plate (653) into the input housing. Index each leg of the apply plate into the apply ring legs.

   Notice: Refer to General Repair Instructions in the Preface section.

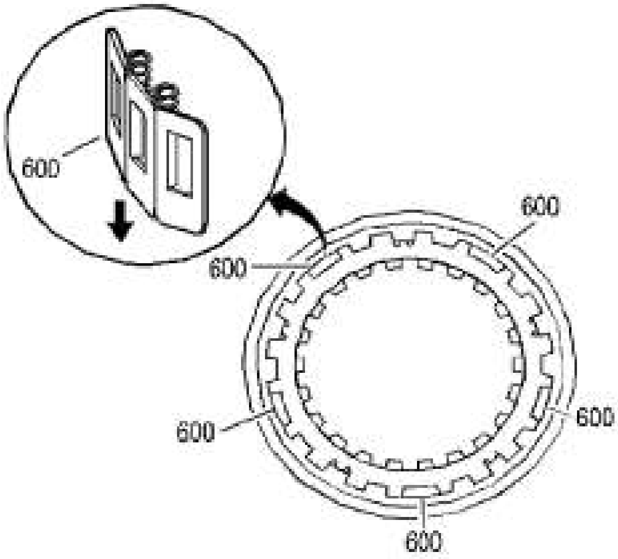
   Important: The first steel plate (654B) has the same spline configuration as the 3rd and 4th clutch apply plate (653).

   Important: The 3rd and 4th clutch plate stack is model specific. Clutch plate stack up may be either 6 or 7 plates.

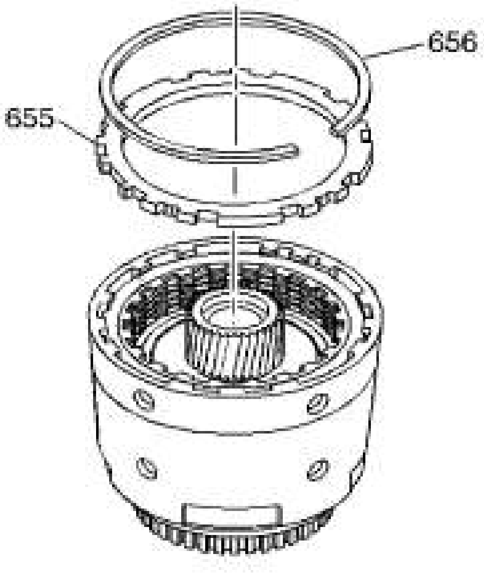
3. Install the 3rd and 4th clutch plates starting with a fiber plate assembly (654A) and alternate with a steel plate (654B).



4. Continue the stack up if seven 654A plates are used.

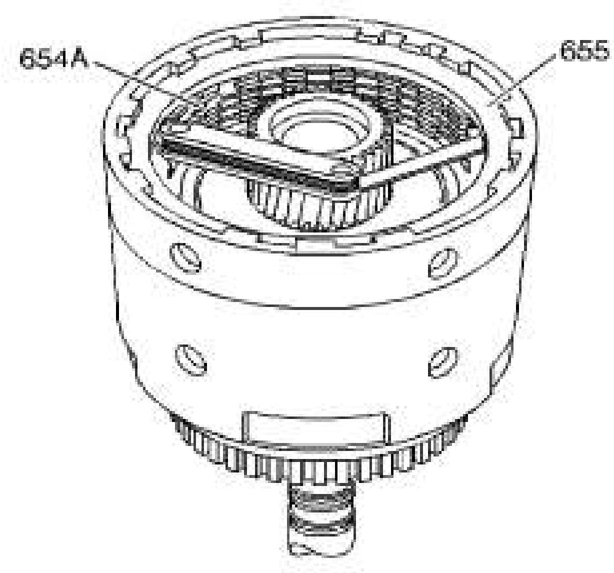


5. Inspect the five 3-4 clutch boost spring assemblies (600) for damaged, worn, broken or missing springs. Springs must be held securely by retainer.
6. Install the 3-4 clutch boost spring assemblies (600) into the input housing.



7. Install the 3rd and 4th clutch selective backing plate (655). Some models may have a chamfer on one side of the selective backing plate. Install the chamfer side up.
8. Install the 3rd and 4th clutch backing plate retainer ring (656).

3-4 Clutch Plate Travel Check



1. Use feeler gauges to check the 3rd and 4th clutch plate travel.
2. Check the travel between the selective backing plate (655) and the first fiber plate assembly (654A).

   The 3rd and 4th clutch plate travel should be:

   Specification

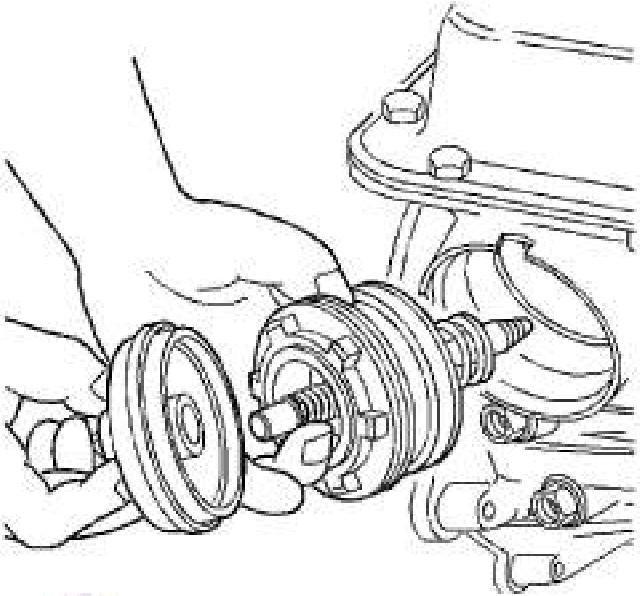
   - Five plate - 0.99-2.14 mm (0.038-0.084 in)
   - Six plate - 0.90-2.10 mm (0.035-0.082 in)
   - Seven plate - 1.12-2.04 mm (0.044-0.080 in)
3. Select the proper 3rd and 4th clutch selective backing plate to obtain the correct travel..

3rd Accumulator Retainer with Ball Assembly Leak Check

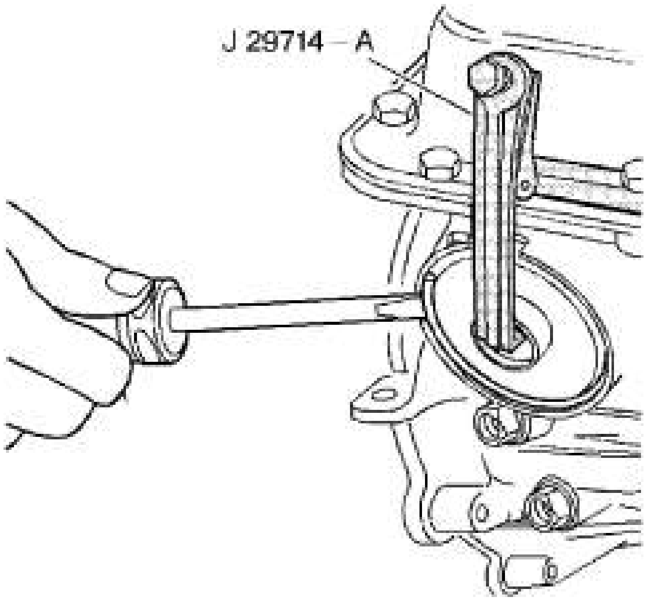
Installation Procedure

Tools Required

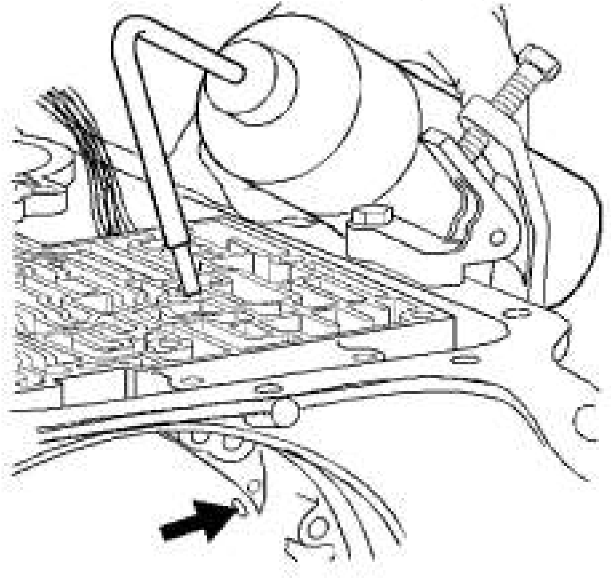
J 29714-A Servo Cover Compressor



1. Install the 2-4 servo into the case.



2. Install oil pan with only four retaining bolts to align pan to case.
3. Use the J 29714-A in order to compress the servo cover.
4. Install the servo cover retaining ring.

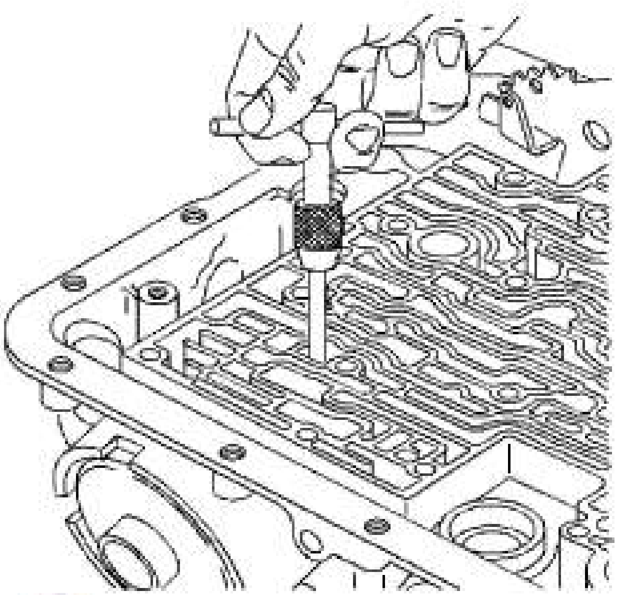


5. Remove oil pan.
6. Pour solvent into the accumulator bore until the channel is filled. Watch for leaks in the case channel.

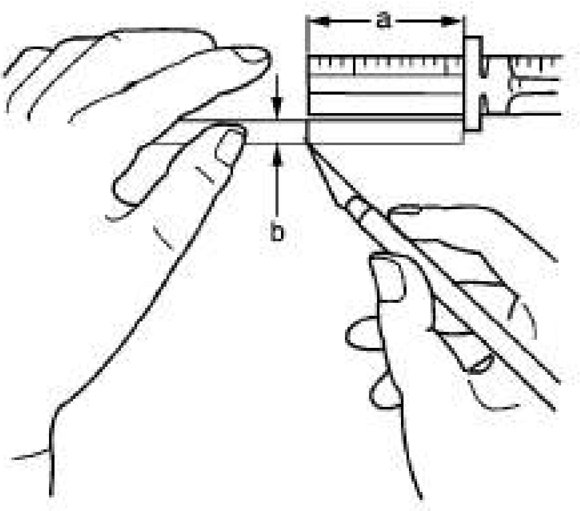
   Important: It is normal to see leakage from the small hole next to the larger oval hole, see arrow.

7. If leakage from the oval shaped hole is observed, replace the third accumulator retainer and ball assembly.

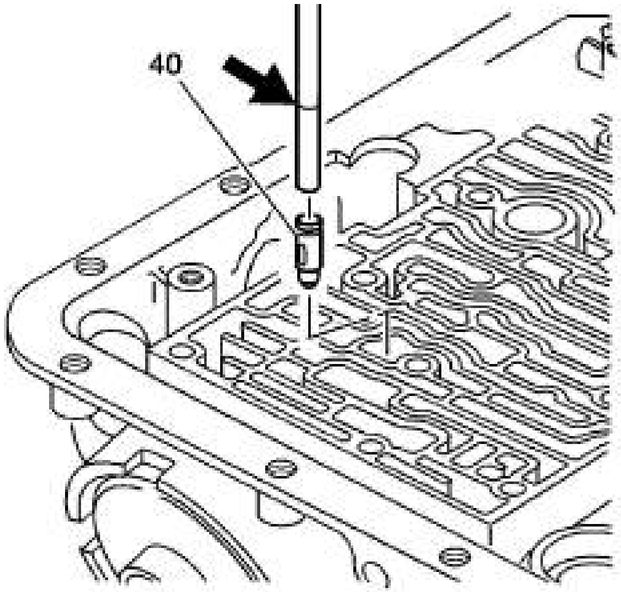
3rd Accumulator Retainer with Ball Replacement



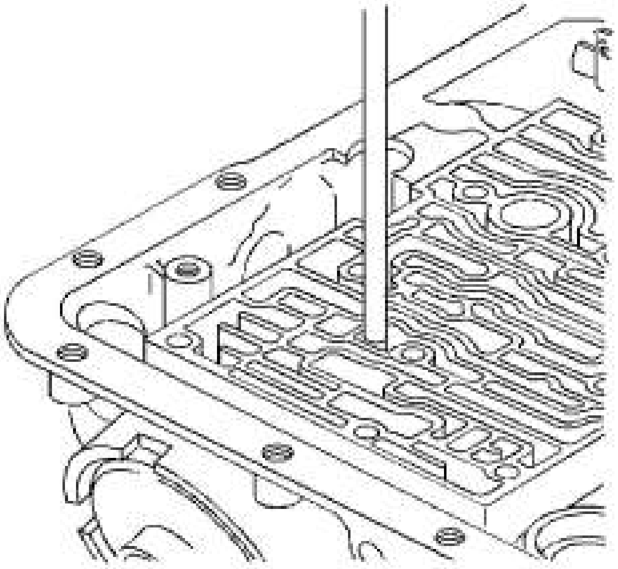
1. Remove the third accumulator retainer and ball assembly, using a 6.3 mm (0.25 in) #4 screw extractor.



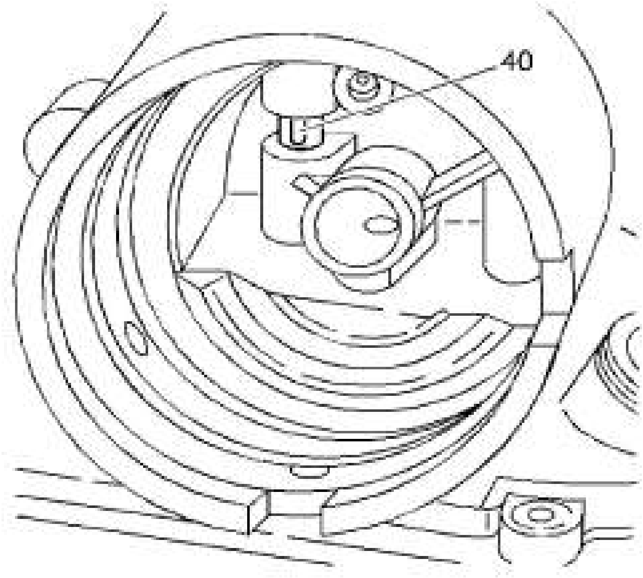
2. Scribe a mark at 42 mm (1.653 in) on a 9.5 mm (0.375 in) diameter metal rod. The scribe mark is used to gauge the proper depth of the third accumulator retainer and ball assembly.



3. Perform the following functions:
   3.1. Line up the oil feed slots in the third accumulator retainer and ball assembly (40) with the servo bore.
   3.2. Using the 9.5 mm (0.375 in) diameter metal rod, install the third accumulator retainer and ball assembly.



4. Ensure that the third accumulator retainer and ball assembly and the scribe mark on the rod are flush with the case surface.



5. Check the third accumulator retainer and ball assembly (40) for alignment. The slot in the retainer must be completely open in the servo bore.

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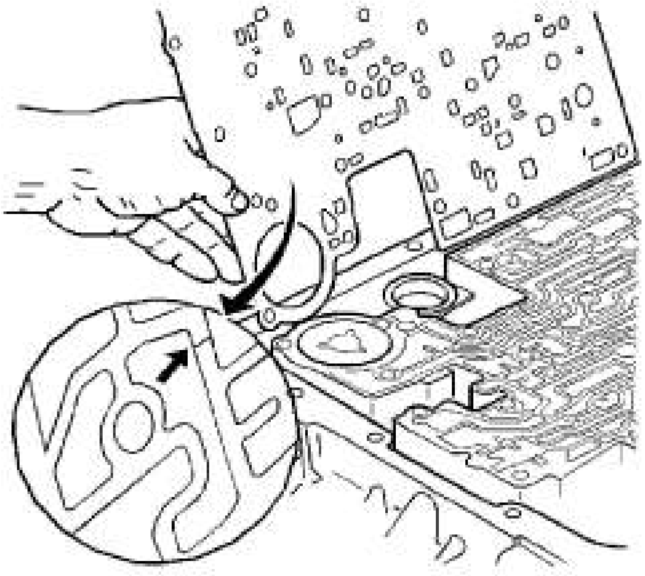
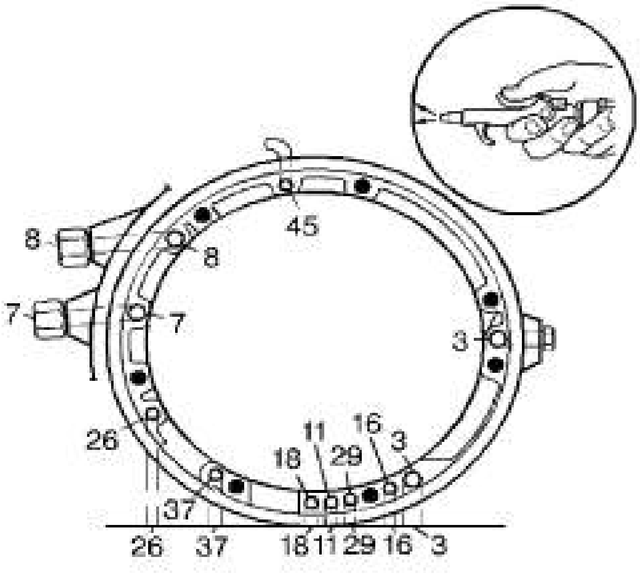
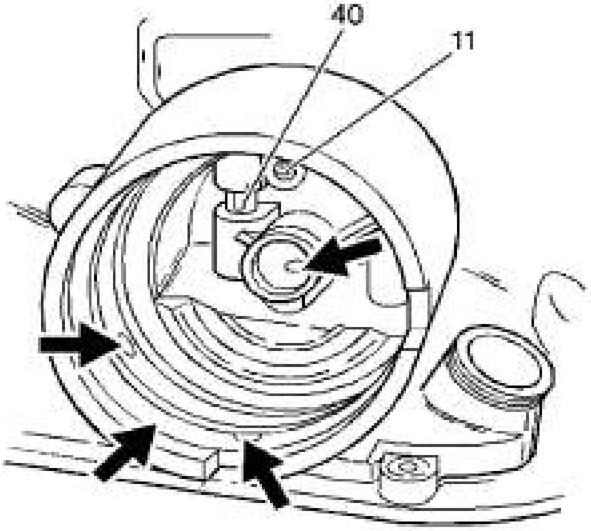
Case Assembly Inspection



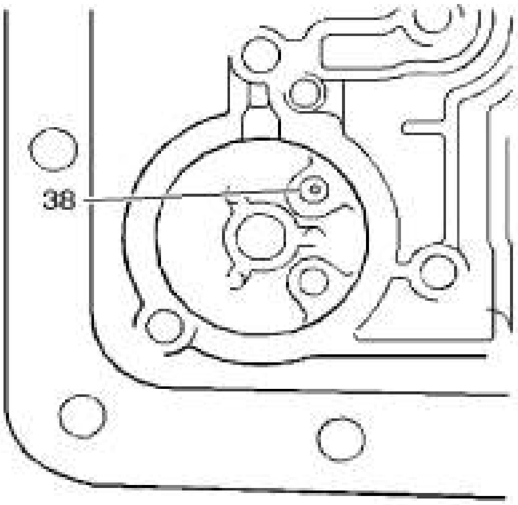
1. Inspect the spacer plate to case gasket for witness marks. The witness marks should be complete. Incomplete witness marks may come from an uneven case surface or from cross channel leaks.



2. Using compressed air, blow into all of the case fluid passages (3, 7, 8, 11, 16, 18, 26, 29, 37, 45) to make sure that all case fluid passages are clear of any obstruction.



3. Inspect the 2-4 servo bore, the 3rd accumulator retainer and ball assembly (40), the orifice cup plug (11) in the servo bore, and the 2nd apply piston pin bore for any of the following conditions:
   - Porosity
   - Burrs
   - Debris
   - Any other damage



4. Inspect the 3-4 accumulator bore and the orifice cup plug (38) for any of the following conditions:
   - Porosity

- Burrs
- Blockage
- Any other damage

5. Inspect all bolt holes for thread damage. Use heli-coil to repair damaged threads.
6. Inspect the cooler connectors for damage and proper torque.

   Specification
   Cooler connector torque should be 38 N·m (28 lb ft)

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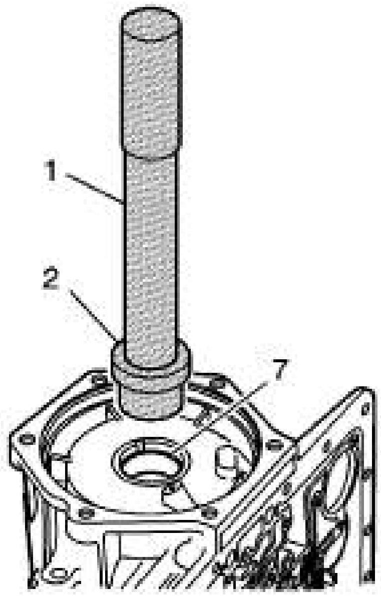
Case Bushing

Removal Procedure

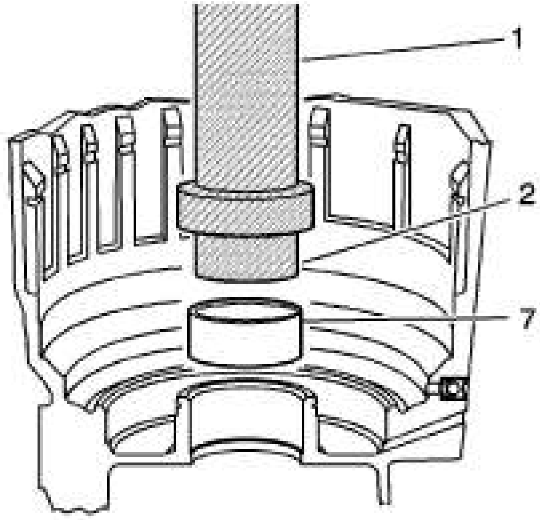
Tools Required

- J 8092 Driver Handle
- J 34196-B Transmission Bushing Service Set



Remove the case bushing (7) using J 8092 (1) and J 34196-10 (2) which is part of kit J 34196-B .

Installation Procedure

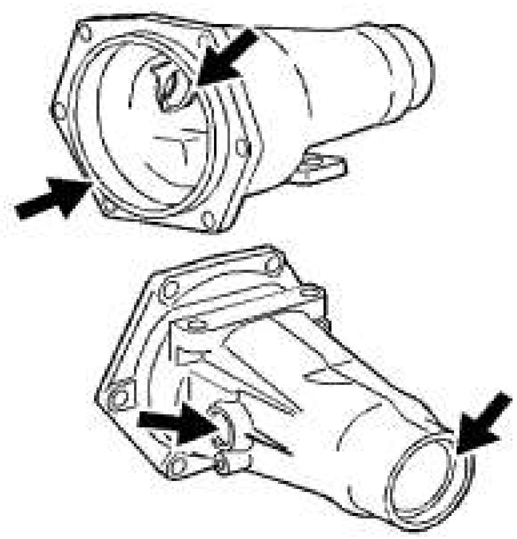


Install a case bushing (7) using J 8092 (1) and J 34196-10 (2) which is part of kit J 34196-B .

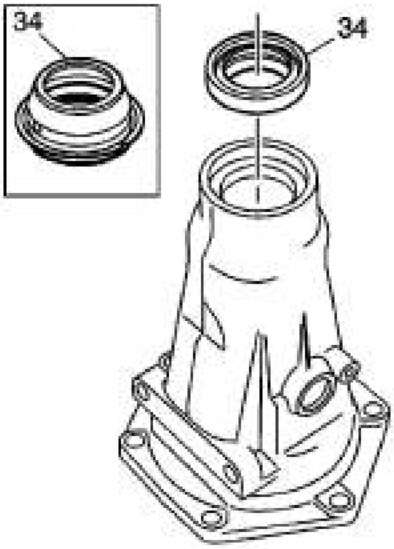
Case Extension Bushing Replacement

Tools Required

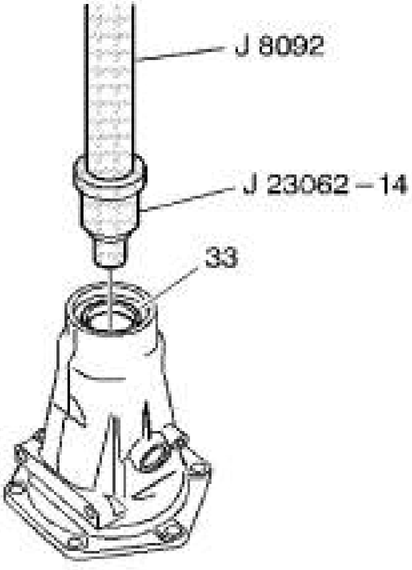
- J 8092 Driver Handle
- J 23062-14 Bushing Remover
- J 34196-B Transmission Bushing Service Set



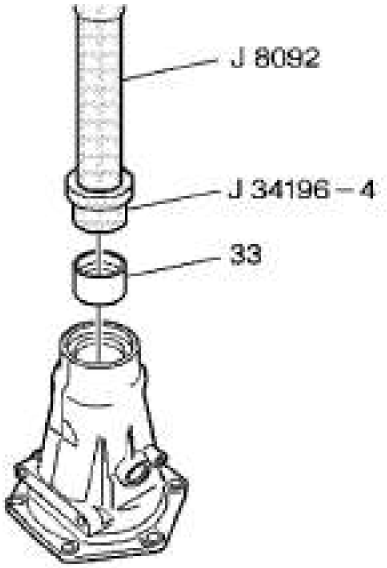
1. Inspect the case extension for the following conditions:
    - Porosity
    - Cracks
    - Nicks
    - Burrs
    - Worn bushings



2. Remove the case extension oil seal assembly (34) (model dependent).



3. Using the J 23062-14 and the J 8092 J 8092 , remove the case extension bushing (33).

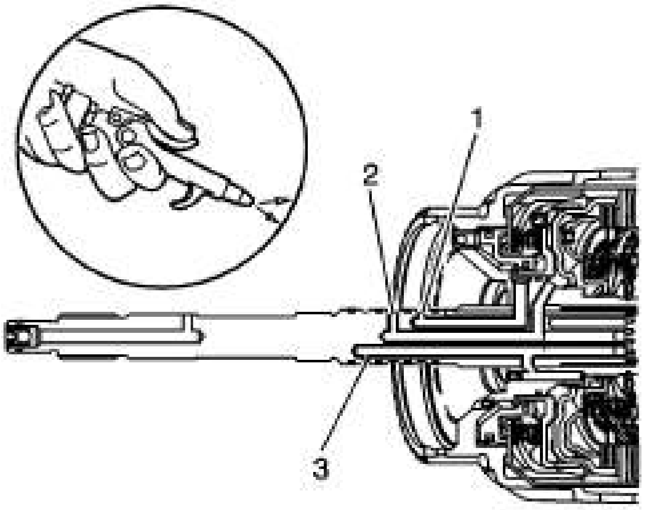


4. Using the J 34196-4 which is part of kit J 34196-B and the J 8092 , install a case extension bushing (33).

Clutch Air Check

Inspection Procedure

Important: When the overrun clutch is checked, the air will blow by the forward clutch piston lip seals and exit out of the forward clutch feed hole in the turbine shaft.



Apply air into the feed holes in the turbine shaft in order to check the following items:

- The 3rd and 4th clutch (1)
- The forward clutch (2)
- The overrun clutch (3)

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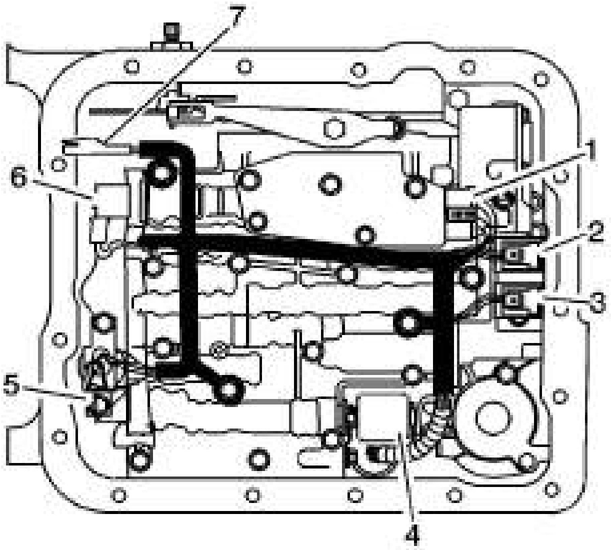
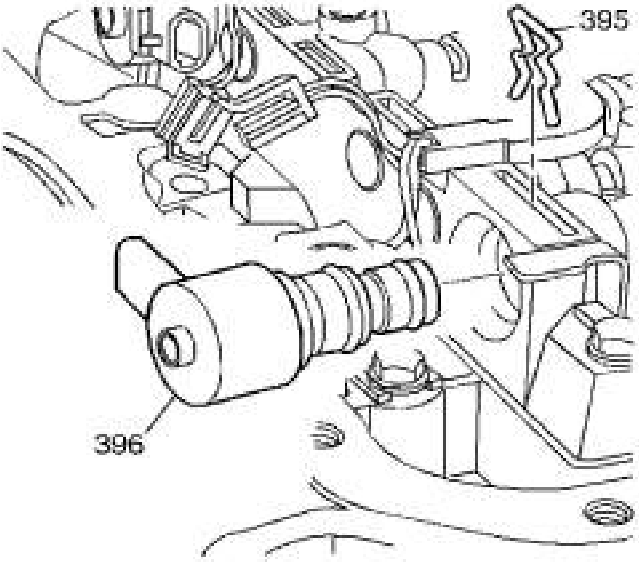
Control Valve Body and Wiring Harness Removal

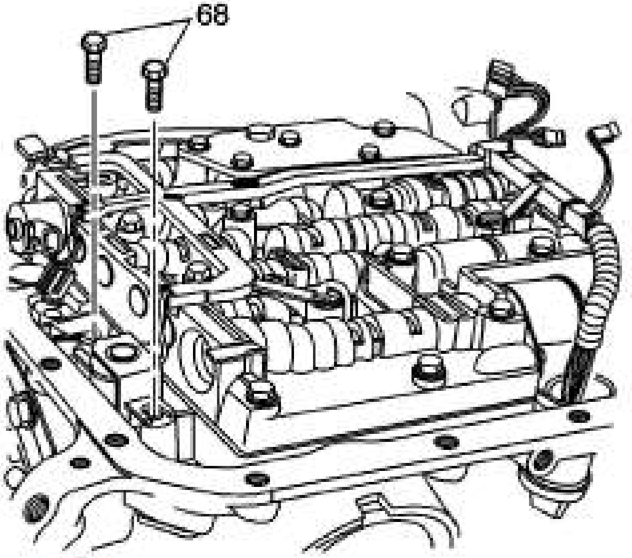


1. Remove all electrical connectors (1-6) from the electrical components.

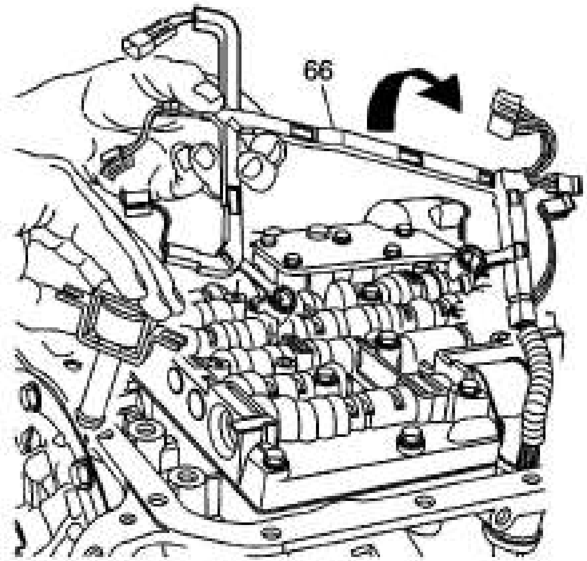
   For Transmission with input speed sensor, disconnect electrical connector (7).



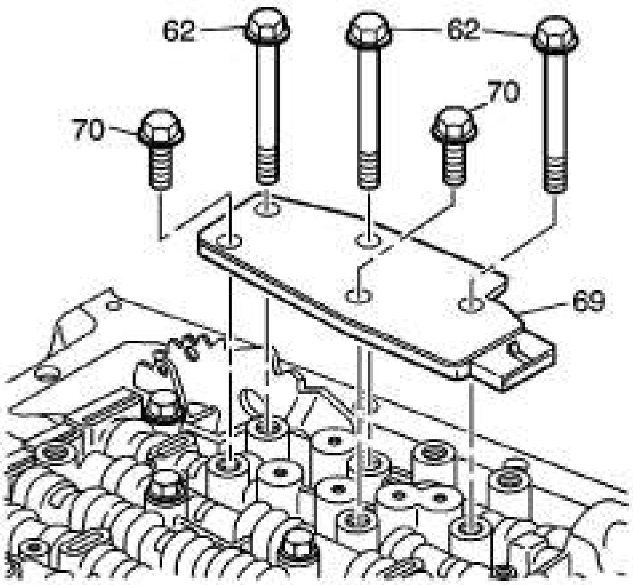
2. Remove the torque converter clutch (TCC/PWM) pulse width modulation retainer clip (395).
3. Remove the TCC/PWM solenoid (396).



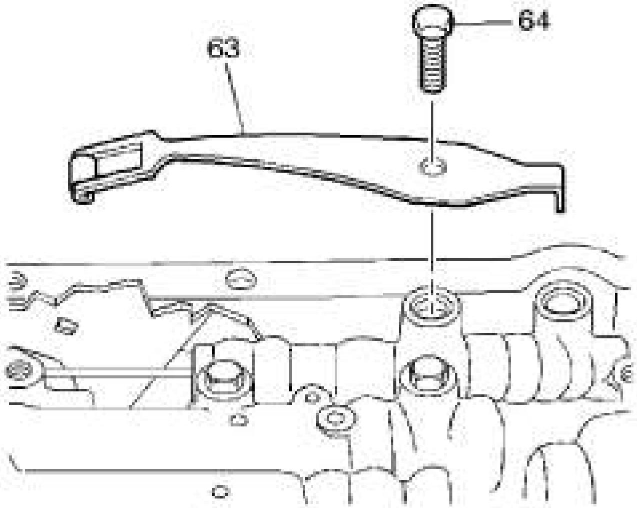
4. Remove the TCC solenoid retaining bolts (68).



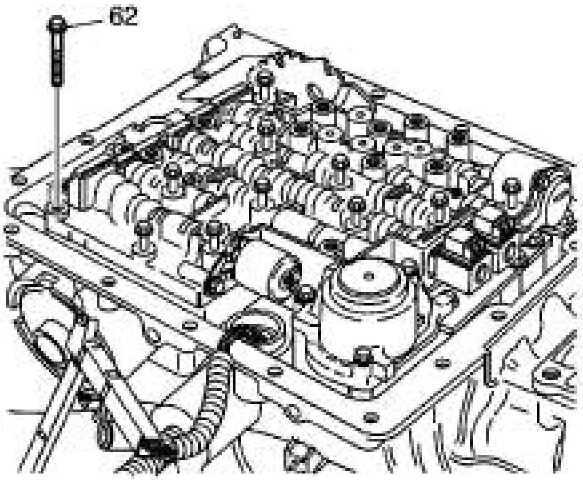
5. Remove the TCC solenoid and wiring harness (66). Turn the wiring harness over so that it hangs over the side of the transmission.



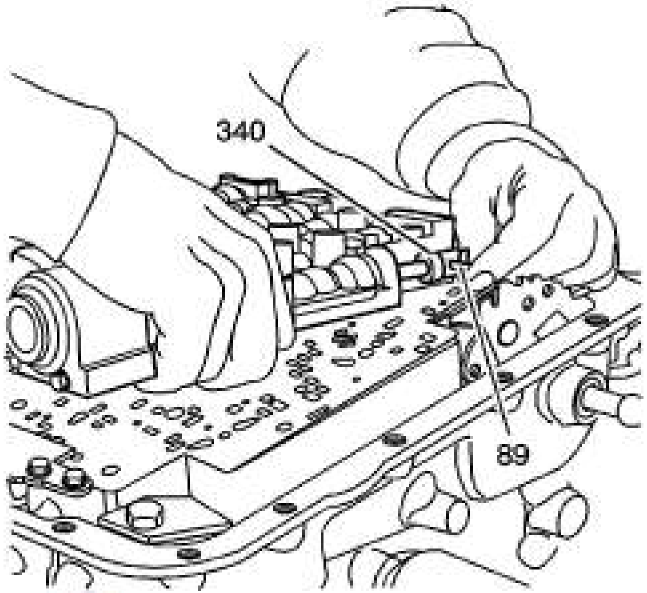
6. Remove the transmission fluid pressure (TFP) manual valve position switch assembly retaining bolts (62, 70).
7. Remove the TFP manual valve position switch (69).



8. Remove the manual detent spring retaining bolt (64).
9. Remove the manual detent spring assembly (63).

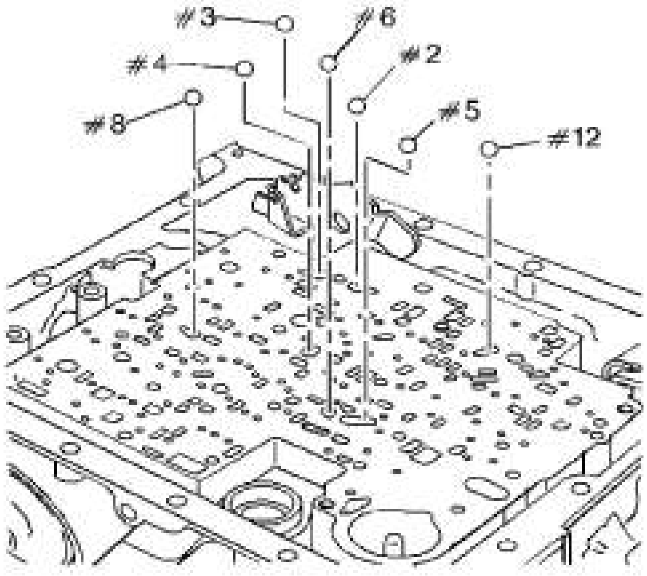


10. Remove all valve body retaining bolts (62).



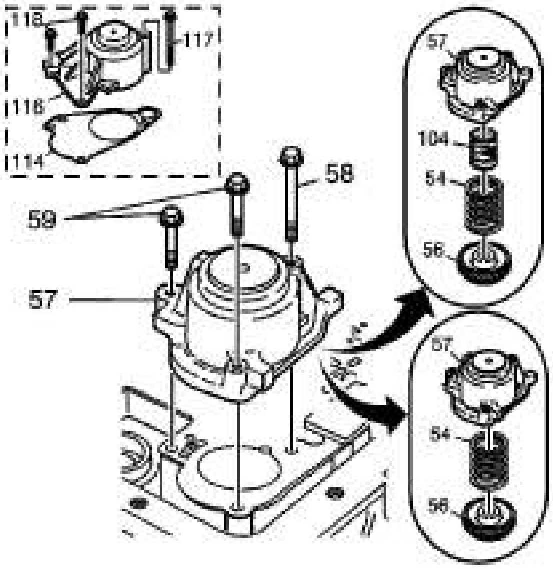
11. Lift the valve body carefully so that the checkballs remain on the spacer plate in the correct location. While lifting the valve body, disconnect the manual valve link (89) from the manual valve (340).

Notice: Refer to General Repair Instructions in the Preface section.



Important: Some models do not use a #5 ball check valve.

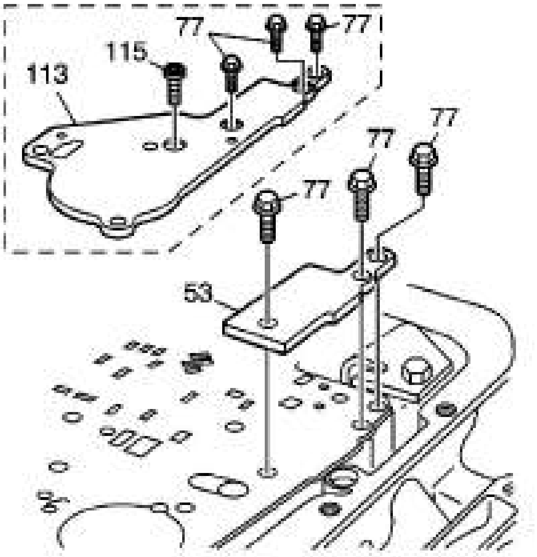
12. Remove the 7 valve body ball check valves (2-6, 8, and 12).



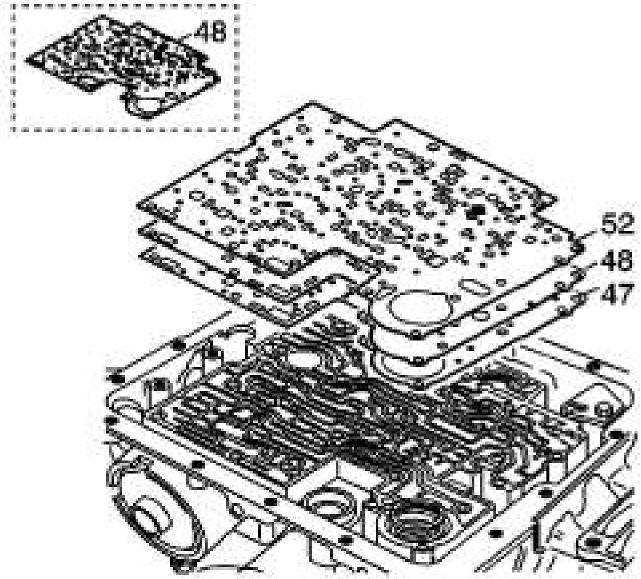
13. Remove the accumulator cover retaining bolts (58, 59 or 117, 118).
14. Remove the 1-2 accumulator cover and pin assembly (57) or 1-2 accumulator cover assembly (116), and gasket (114).

Important: Some models may not use a 1-2 accumulator spring - inner (104) or outer (54).

15. Disassemble the 1-2 accumulator assembly (54, 56, 57, 104).



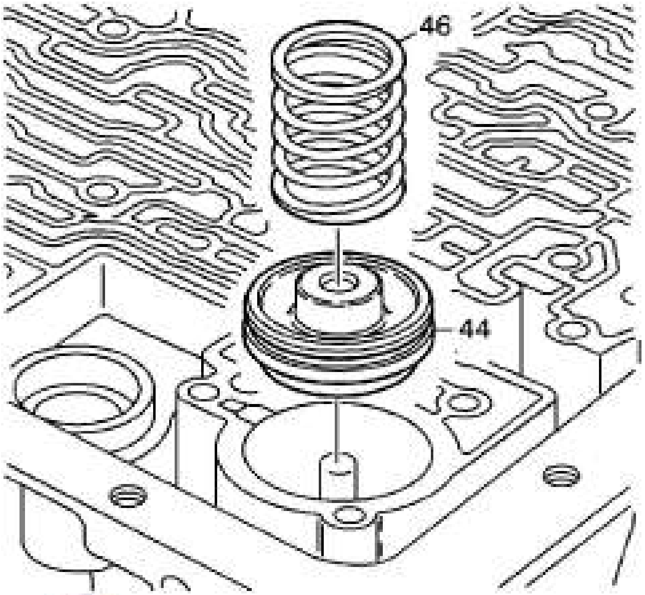
16. Remove the spacer plate support retaining bolts (77).
17. Remove the spacer plate support (53 or 113).



Important: Some models use a spacer plate (48) with bonded gasket material.

18. Remove the valve body gasket (52), the valve body spacer plate (48) and the case gasket (47).

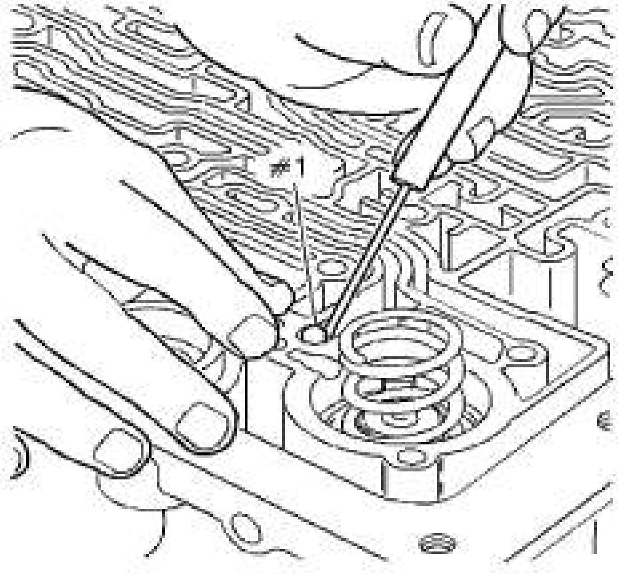
    Discard gaskets. Do not reuse.



Important: Some models do not use a 3-4 accumulator spring (46).

19. Remove the 3-4 accumulator spring (46) and the 3-4 accumulator piston (44).

Notice: Refer to General Repair Instructions in the Preface section.



20. Remove the #1 case ball check valve.

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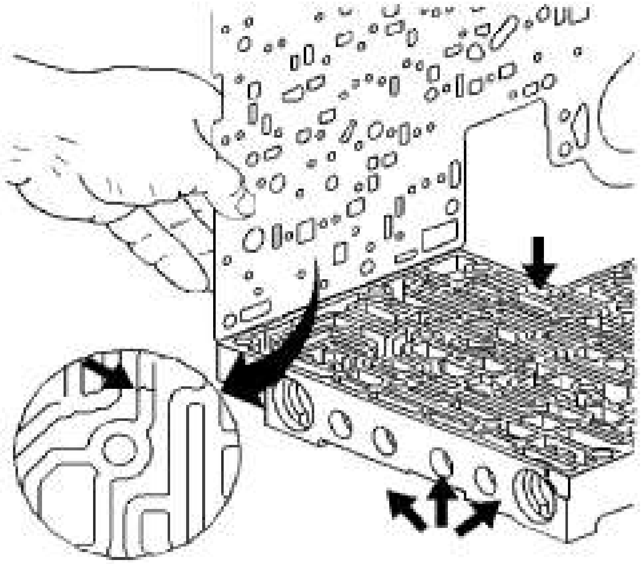
Control Valve Body Assemble

Inspection Procedure



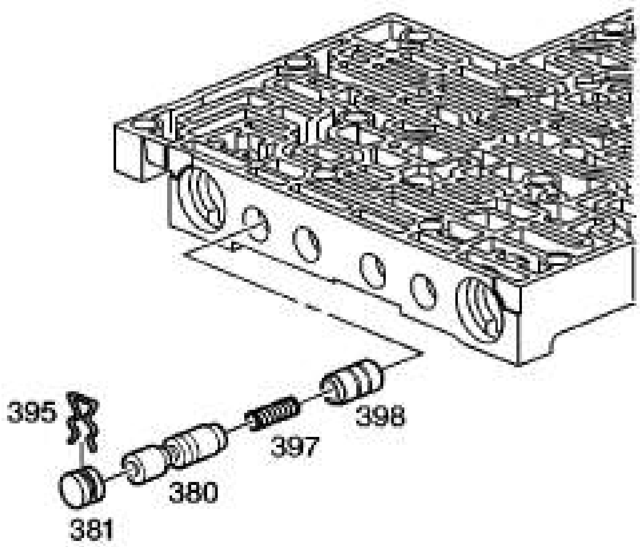
1. Inspect the valve body to spacer plate gasket for valve body channel witness marks. The witness marks should be complete. Incomplete witness marks may be caused by an uneven case surface. Incomplete witness marks may also be caused by cross-channel leaks.
2. Inspect the valve body casting for the following conditions:
   - Porosity
   - Cracks
   - Damaged machined surfaces
   - Chips or debris

Cleaning Procedure

1. Clean all the valves, springs, bushings, and the control valve body in clean solvent.
2. Dry all the parts using compressed air.

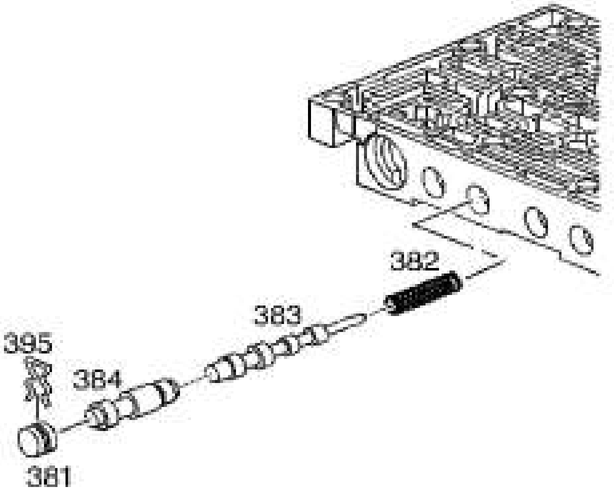
Installation Procedure

Warning: Refer to Valve Springs Can Be Tightly Compressed Warning in the Preface section.



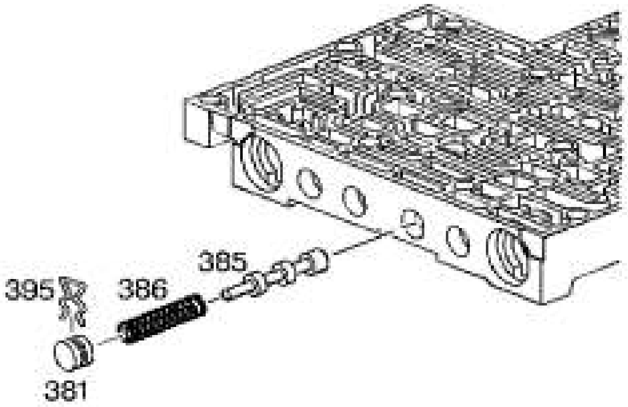
Note: Lubricate all parts with DEXRON®VI automatic transmission fluid before installation.

1. Install the following items:
   1.1. The isolator valve (398)
   1.2. The regulator apply spring (397)
   1.3. The regulator apply valve (380)
   1.4. The bore plug (381)
   1.5. The bore plug retainer (395)

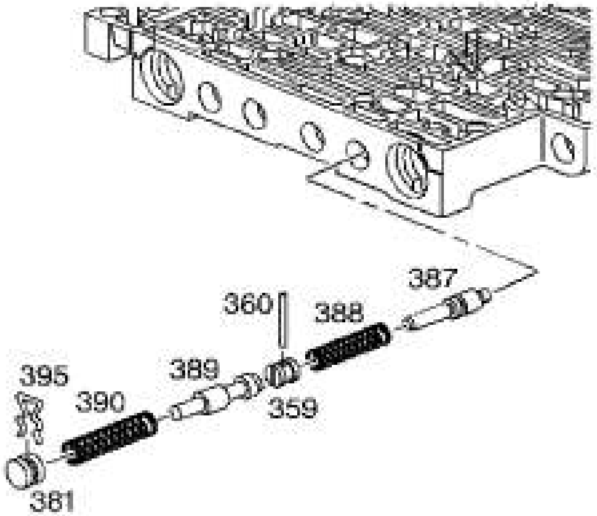


2. Install the following items:

    2.1. The 4-3 sequence valve spring (382)
    2.2. The 4-3 sequence valve (383)
    2.3. The 3-4 relay valve (384)
    2.4. The bore plug (381)
    2.5. The bore plug retainer (395)

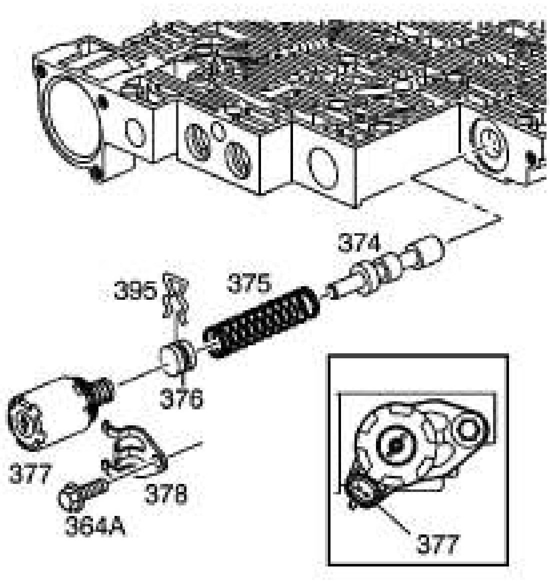

385
395
386
381

3. Install the following items:
    3.1. The 3-4 shift valve (385)
    3.2. The 3-4 shift valve spring (386)
    3.3. The bore plug (381)
    3.4. The bore plug retainer (395)


387
360
388
395
389
390
359
381

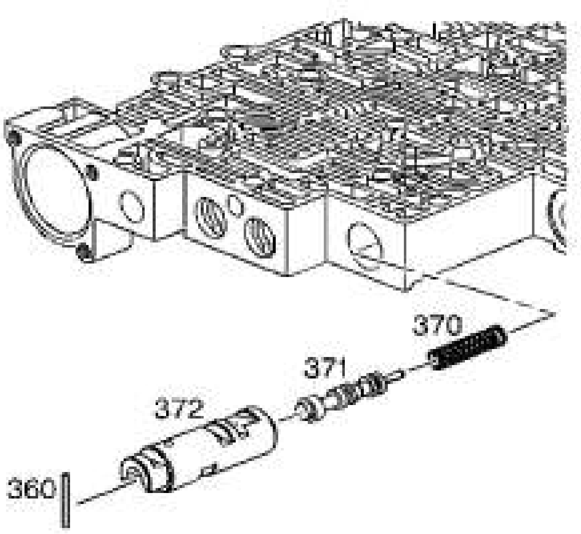
4. Install the following items:
    4.1. The reverse abuse valve (387)
    4.2. The reverse abuse valve spring (388)
    4.3. The bore plug (359)
    4.4. The coiled spring pin (360)
    4.5. The 3-2 downshift valve (389)
    4.6. The 3-2 downshift valve spring (390)
    4.7. The bore plug (381)
    4.8. The bore plug retainer (395)

Caution: Refer to Fastener Caution in the Preface section.

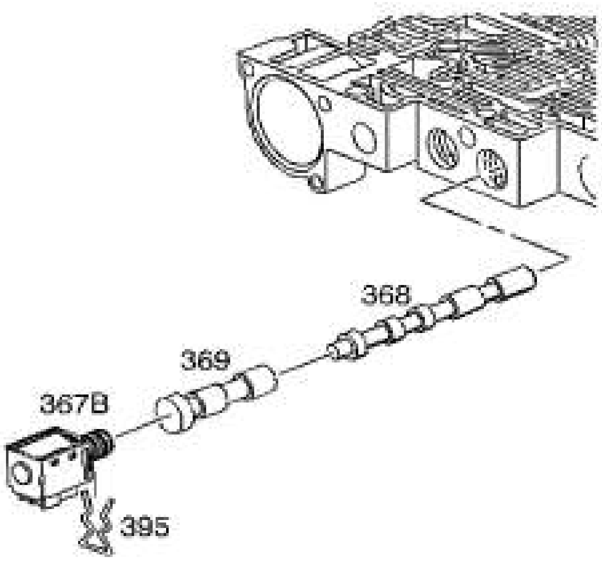


Caution: Be sure all solenoids are installed with the electrical connectors facing the non-machined (cast) side of the valve body; otherwise, the solenoids will bind against the transmission case as the valve body bolts are tightened and damage may occur.

5. Install the following items:
    5.1. The actuator feed limit valve (374)
    5.2. The actuator feed limit valve spring (375)
    5.3. The bore plug (376)
    5.4. The bore plug retainer (395)
    5.5. The pressure control solenoid (377)
    5.6. The solenoid retainer (378)
    5.7. The solenoid retainer bolt (364) Tighten the bolt to **8-14 N·m (6-10 lb ft)**.

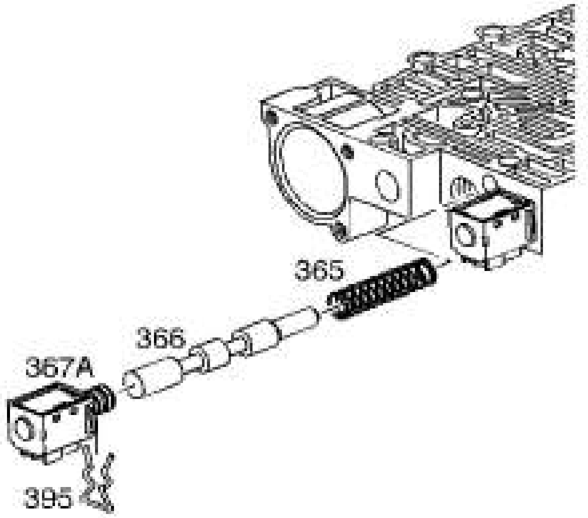


6. Install the following items:
    - 6.1. The 1-2 accumulator valve spring (370)
    - 6.2. The 1-2 accumulator valve (371) in the 1-2 accumulator valve sleeve (372)
    - 6.3. The 1-2 accumulator valve and sleeve assembly
    - 6.4. The coiled spring pin (360)

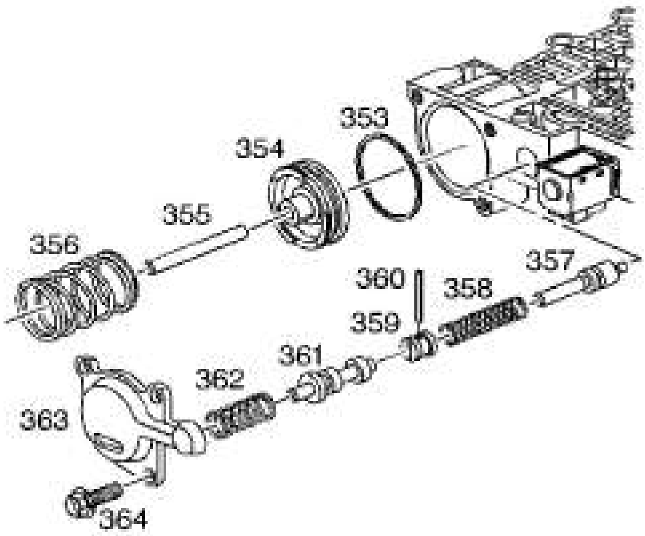


7. Install the following items:
    - 7.1. The 2-3 shift valve (368)
    - 7.2. The 2-3 shuttle valve (369)
    - 7.3. The 2-3 shift solenoid valve (367B)

   7.4. The solenoid retainer (395)


365
366
367A
395

8. Install the following items:
   8.1. The 1-2 shift valve spring (365)
   8.2. The 1-2 shift valve (366)
   8.3. The 1-2 shift solenoid valve (367A)
   8.4. The solenoid valve retainer (395)


353
354
355
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357
358
360
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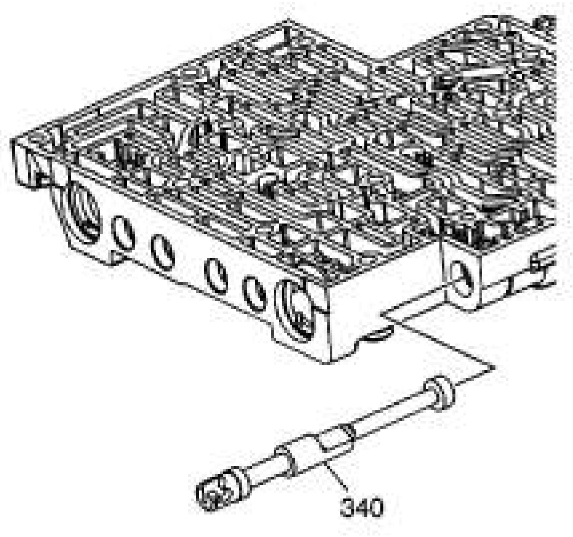
361
362
363
364

9. Install the following items:
   9.1. The forward abuse valve (357)
   9.2. The forward abuse valve spring (358)

  9.3. The bore plug (359)
  9.4. The coiled spring pin (360)
  9.5. The low overrun valve (361)
  9.6. The low overrun valve spring (362)

10. Install the following items:
  10.1. The forward accumulator oil seal (353) on the forward accumulator piston (354)
  10.2. The forward accumulator pin (355)
  10.3. The forward accumulator piston (354)
  10.4. The forward accumulator spring (356)
  10.5. The forward accumulator cover (363)
  10.6. The forward accumulator cover bolts (364)



11. Install the manual valve (340).

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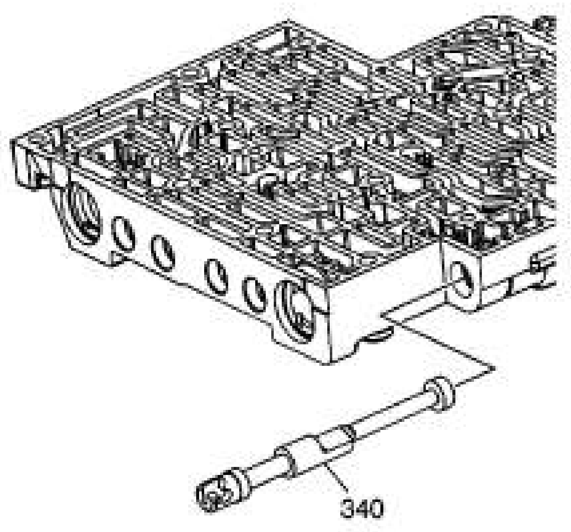
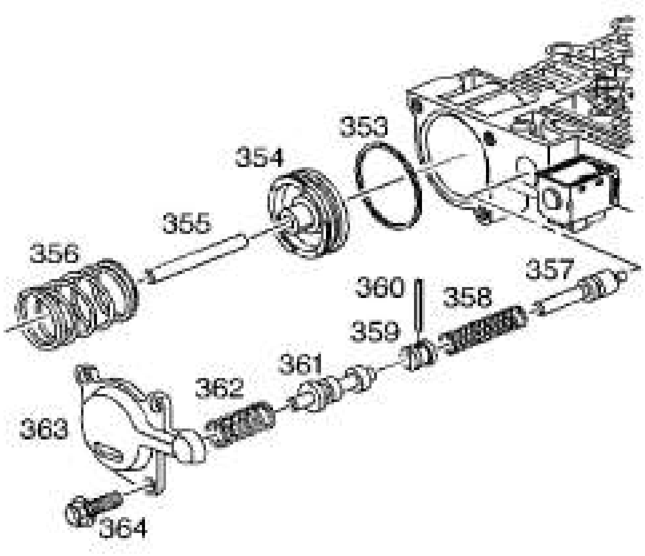
Control Valve Body Disassemble

Warning: Refer to Valve Springs Can Be Tightly Compressed Warning in the Preface section.

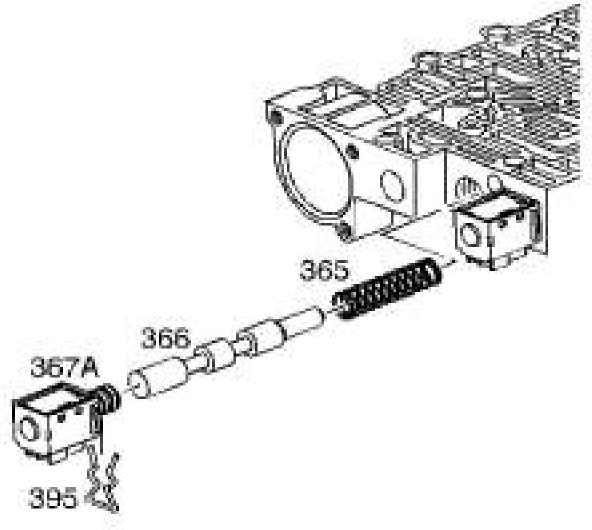


1. Remove the manual valve (340).

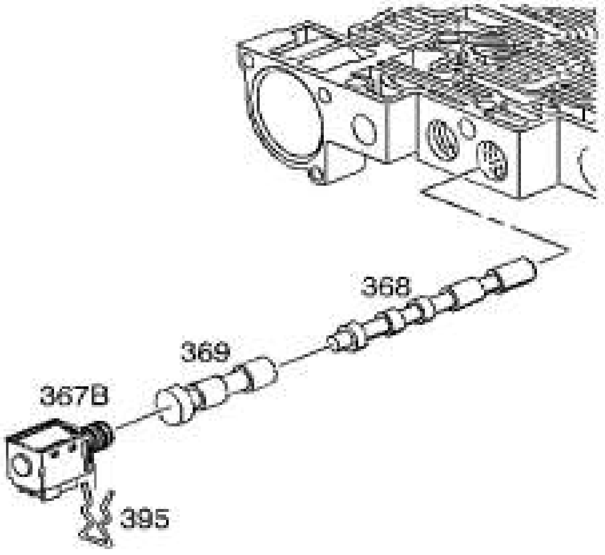


2. Remove the forward accumulator cover bolts (364) and the forward accumulator cover (363).
3. Remove the forward accumulator spring (356), forward accumulator piston (354), and the forward accumulator pin (355).
4. Remove the low overrun valve spring (362) and the low overrun valve (361).

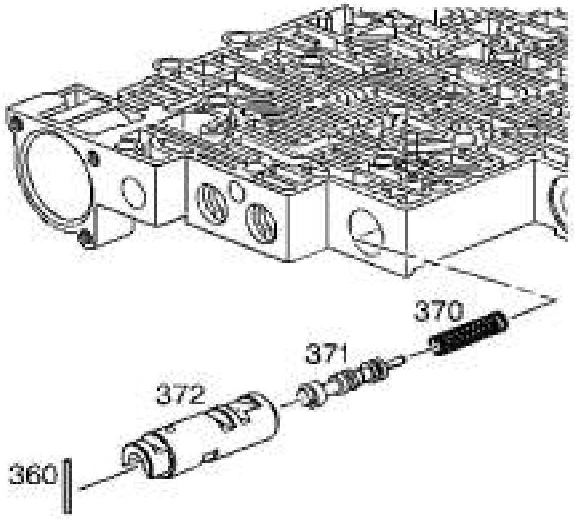
5. Remove the coiled spring pin (360) and the bore plug (359).
6. Remove the forward abuse valve spring (358) and the forward abuse valve (357).



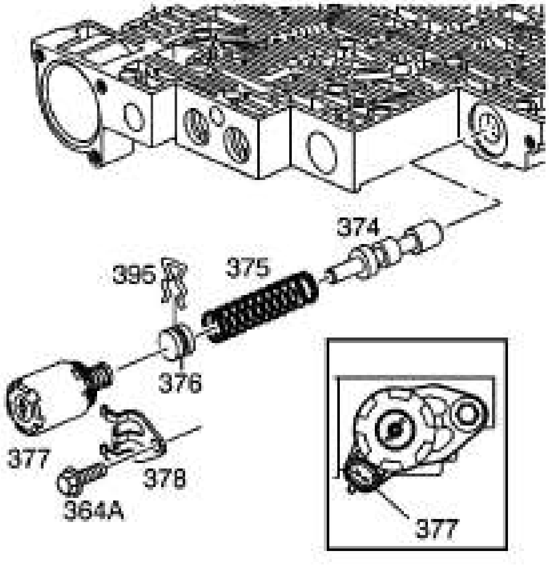
7. Remove the solenoid retainer (395) and the 1-2 shift solenoid (367A).
8. Remove the 1-2 shift valve (366) and the 1-2 shift valve spring (365).



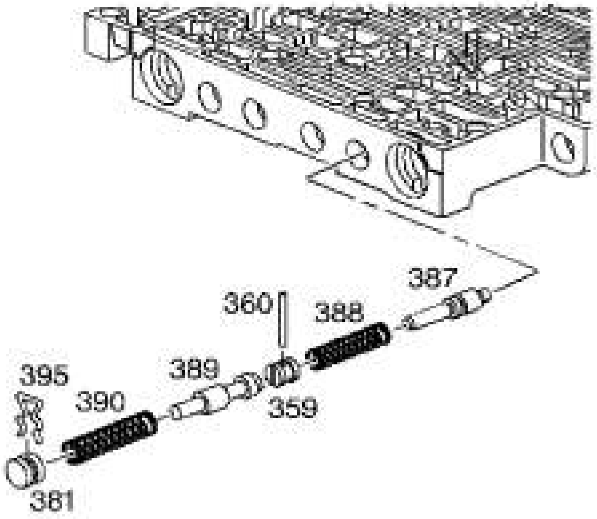
9. Remove the solenoid retainer (395) and the 2-3 shift solenoid (367B).
10. Remove the 2-3 shuttle valve (369) and the 2-3 shift valve (368).



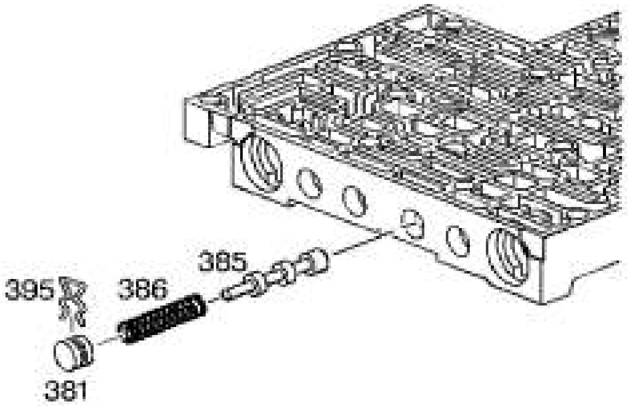
11. Remove the coiled spring pin (360).
12. Remove the 1-2 accumulator valve sleeve (372).
13. Remove the 1-2 accumulator valve (371) and the 1-2 accumulator valve spring (370).



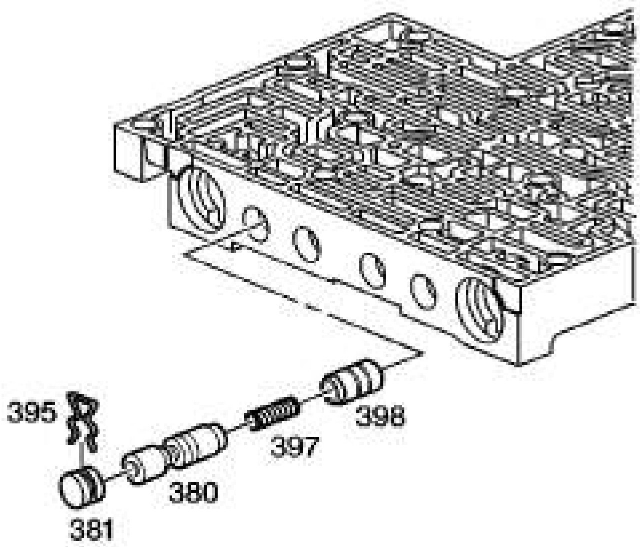
14. Remove the solenoid retainer bolt (364A) and the solenoid retainer (378). Remove the pressure control solenoid (377), note orientation upon removal.
15. Compress the actuator feed limit valve spring (375).
16. Remove the bore plug retainer (395) and release the spring slowly.
17. Remove the bore plug (376).
18. Remove the actuator feed limit valve spring (375) and the actuator feed limit valve (374).



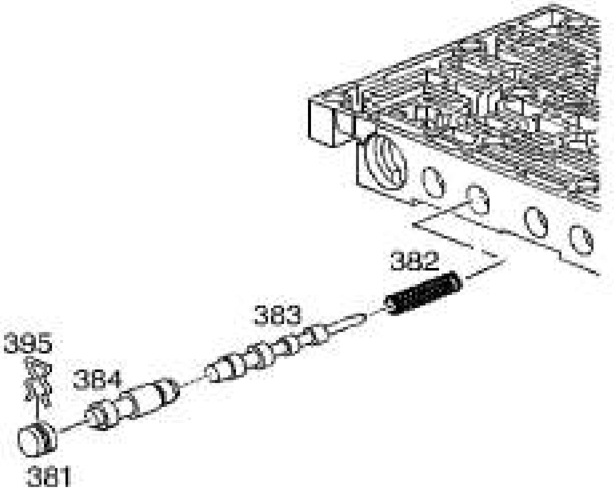
19. Remove the bore plug retainer (395) and the bore plug (381).
20. Remove the 3-2 downshift valve spring (390) and the 3-2 downshift valve (389).
21. Remove the coiled spring pin (360) and the bore plug (359).
22. Remove the reverse abuse valve spring (388) and the reverse abuse valve (387).



23. Remove the bore plug retainer (395) and the bore plug (381).
24. Remove the 3-4 shift valve spring (386) and the 3-4 shift valve (385).



25. Remove the bore plug retainer (395) and the bore plug (381).
26. Remove the regulator apply valve (380) and the regulator apply spring (397) and the isolator valve (398).

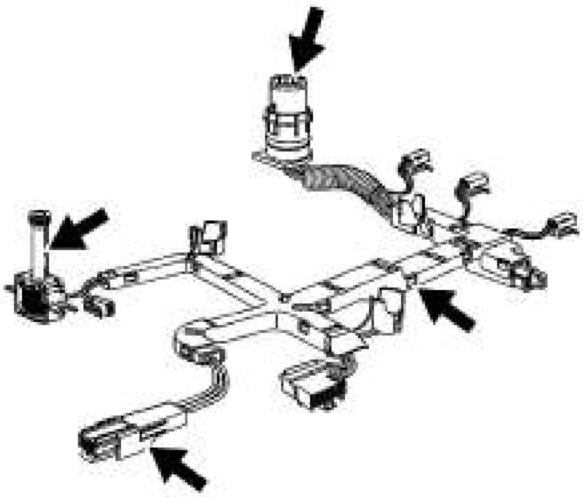


27. Remove the bore plug retainer (395) and the bore plug (381).
28. Remove the 3-4 relay valve (384) and the 4-3 sequence valve (383) and the 4-3 sequence valve spring (382).

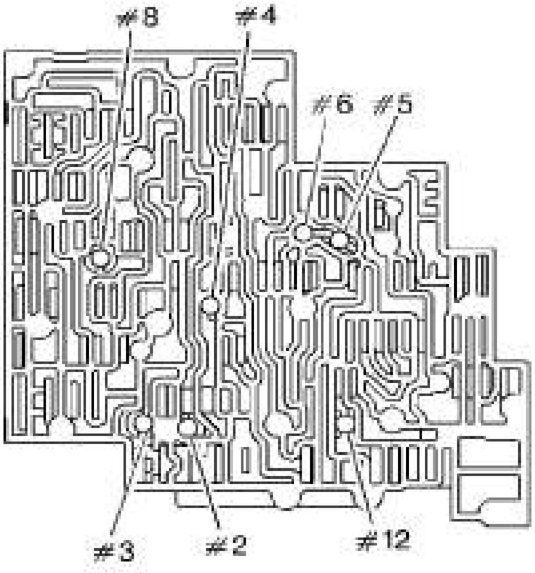
Control Valve Body Installation

Special Tools

- *J 25025-5* Dial Indicator Mounting Post-M6 x 1.00
- *J 36850* Transjel Lubricant

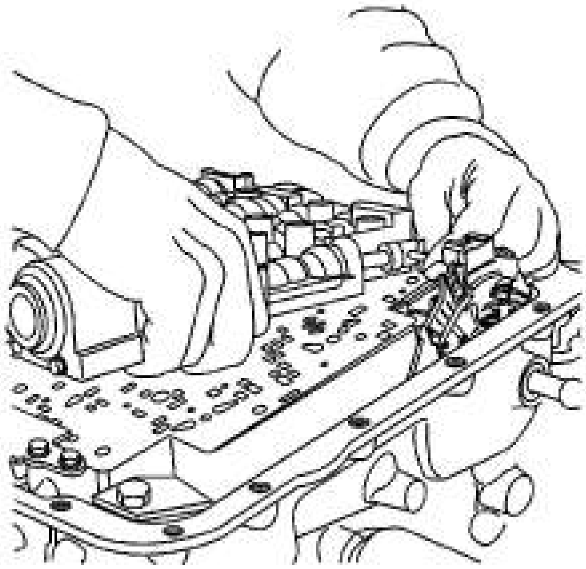


1. Inspect the wiring harness and solenoid assembly for the following conditions:
    - Damage
    - Cracked connectors
    - Exposed wires
    - Loose electrical terminals
    - Damaged wiring loom and conduit
    - Worn, missing, or cut pass-through connector O-ring seal.
2. Install the transmission wiring harness pass-through connector into the transmission case. Ensure connector tabs lock into place.
3. Move the harness to one side in order to install the valve body.



Note: Valve bodies are model dependent.

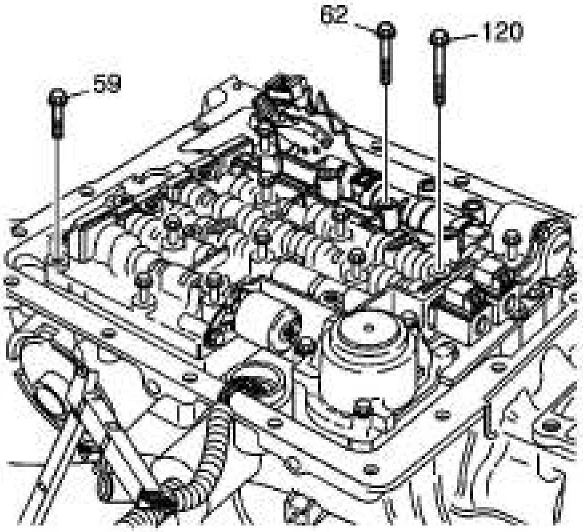
4. Install the ball check valves (2-6, 8, 12) in the valve body and retain ball check valves with *J 36850* transjel lubricant or an equivalent.



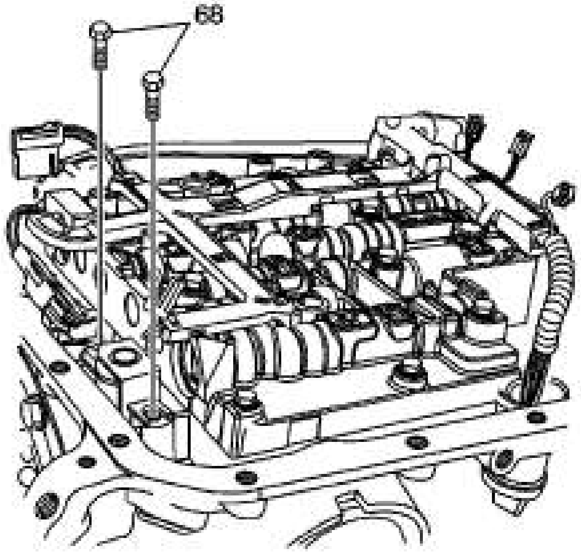
Caution: Be sure all solenoids are installed with the electrical connectors facing the non-machined (cast) side of the valve body; otherwise, the solenoids will bind against the transmission case as the valve body bolts are tightened and damage may occur.

5. Install the valve body over the *J 25025-5* mounting post , and connect the manual valve link to the manual valve.
6. Install 2 valve body bolts to hold the valve body in place.

7. Remove the *J 25025-5* mounting post .



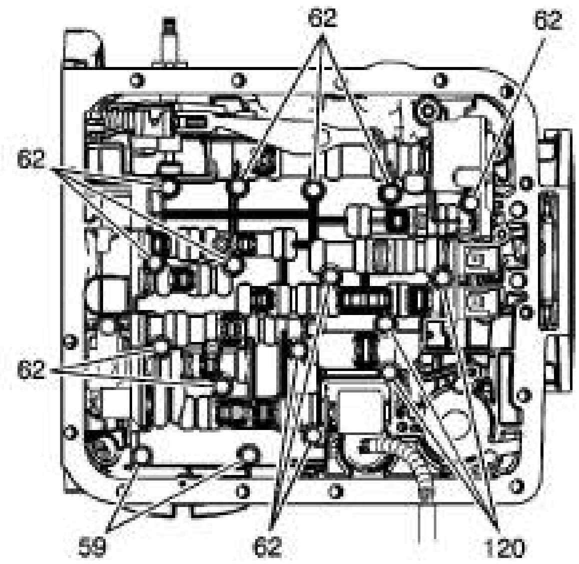
8. Install the 12 valve body bolts (62), 2 bolts (59) and 3 bolts (120) that are shown only.
9. Finger tighten the bolts.



10. Install the transmission wiring harness on the valve body.

Caution: Refer to Fastener Caution in the Preface section.

11. Install the torque converter clutch (TCC) solenoid valve and bolts (68). Tighten the bolts to **8-14 N·m (6-10 lb ft)**.

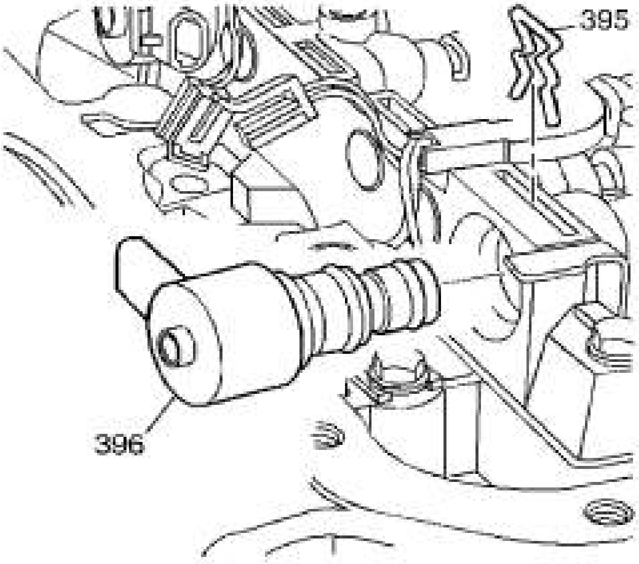


Caution: Do not over-tighten the bolts. Over-tightening the bolts will distort the valve bores. Begin tightening from the center of the valve body tighten the bolts in a outward direction.

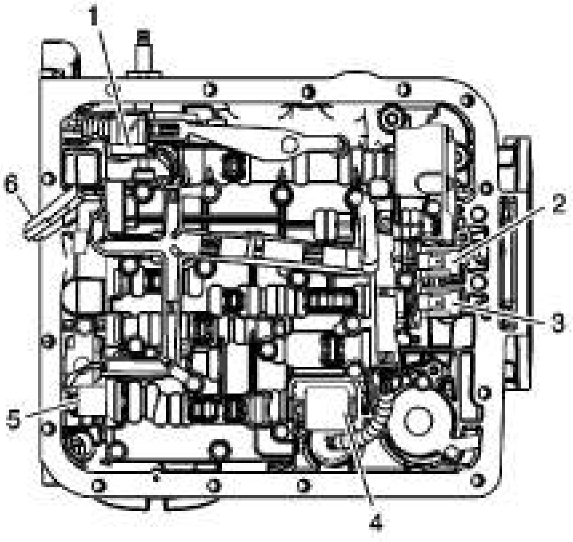
12. Inspect to ensure all of the valve body bolts are in the correct location.

    Each bolt number refers to a specific bolt size, as indicated in the following list:

    - 59 - M6 x 1.0 x 35.0 (Qty: 2)
    - 62 - M6 x 1.0 x 47.5 (Qty: 12)
    - 120 - M6 x 1.0 x 54.4 (Qty: 3)
13. Tighten the bolts from the center of the valve body working your way out in a spiral pattern to the outside edge. Tighten the bolts to **8-14 N·m (6-10 lb ft)**.



14. Install the torque converter clutch pulse width modulation (TCC PWM) solenoid valve (396) and the solenoid retainer (395).

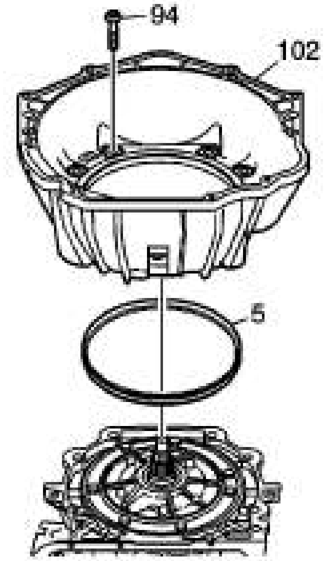


15. Snap the wiring harness in place on the valve body bolts. Ensure the harness loom tab is located under the TFP switch.
16. Install the wiring connectors to the electrical components as indicated in the following list:
    - 1 - Manual shift detent lever with shaft position switch assembly
    - 2 - 1-2 shift solenoid
    - 3 - 2-3 shift solenoid
    - 4 - Pressure control solenoid (PCS)
    - 5 - TCC PWM solenoid
    - 6 - Input speed sensor (ISS)

Converter Housing Installation

Tools Required

- J 41510 T-50 Plus Bit.
- DT-49362 Mortorq Bit.



Important: Ensure converter housing and case face are clean before installing new pump seal.

Important: When installing a new oil pump seal (5), the seal will protrude slightly above the case surface. The oil pump seal is a wedge design that will conform to the surfaces between the oil pump body and the transmission case as the converter housing (105) is installed.

1. Install the oil pump seal (5). Seat oil pump seal (5) by hand, between pump body and case. Ensure the seal is evenly seated.
2. Install the converter housing (102).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the converter housing retaining bolts (94) to the transmission case. Use the J 41510 or DT-49362 .

   Tighten
   Tighten the converter housing retaining bolts (94) to 65-75 N·m (48-55 lb ft).

   Tighten converter housing retaining bolts evenly in a star pattern sequence.

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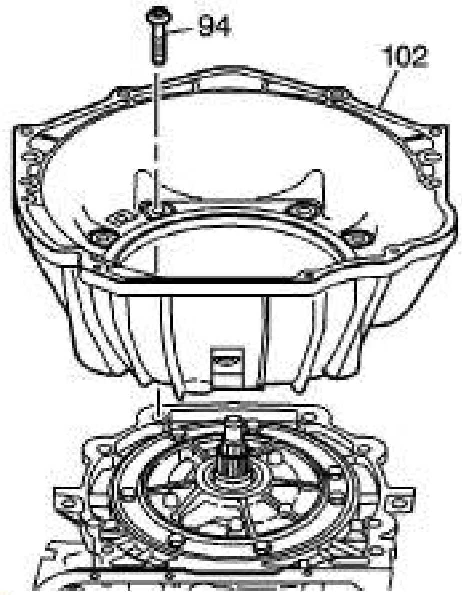
Converter Housing Removal

Tools Required

- J 41510 T-50 Plus Bit.
- DT-49362 Mortorq Bit.



1. Remove the converter housing retaining bolts (94). Use the J 41510 or DT-49362 .
2. Remove the converter housing (102).

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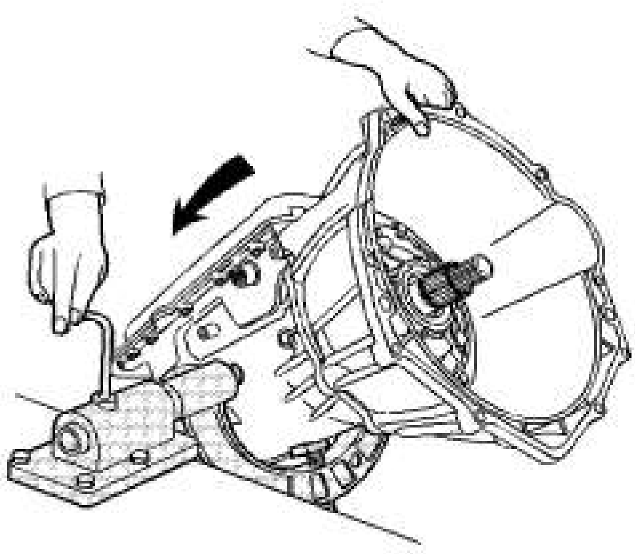
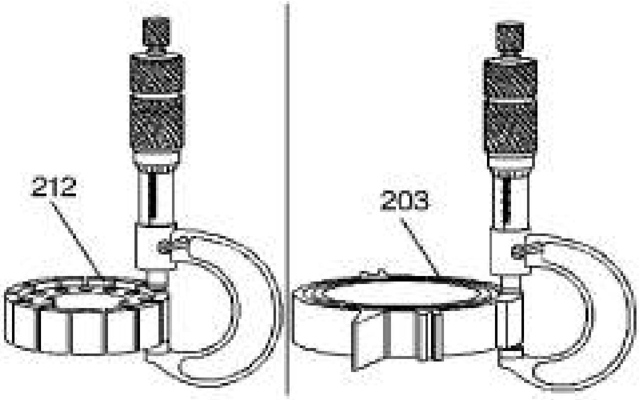
Drain Oil



Rotate the transmission so that the converter housing is up. Allow the transmission fluid to drain from the case extension.

Fluid Pump Rotor and Slide Measurement

- 

Important: Measure the rotor and slide thickness for surface wear. The rotor and slide measurements must both fall into the same thickness range. If the rotor and slide measurements do not fall into the same thickness range, or are outside of all the ranges, the oil pump must be replaced as an assembly.

  - Refer to Fluid Pump Rotor and Slide Measurement .
- Measure the oil pump rotor (212) thickness.
- Measure the oil pump slide (203) thickness.

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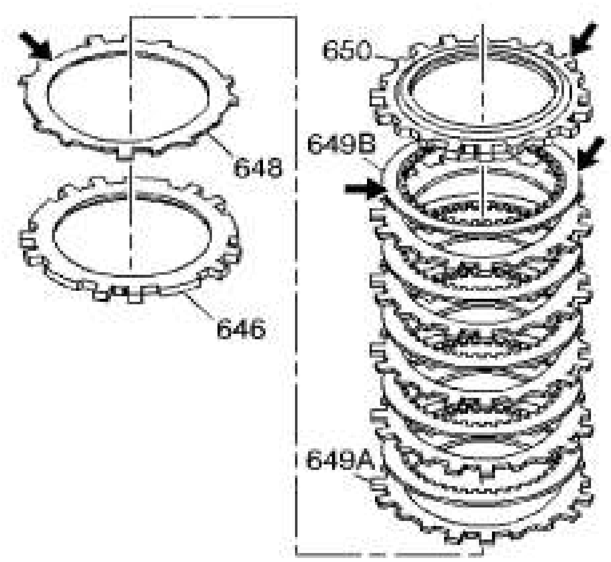
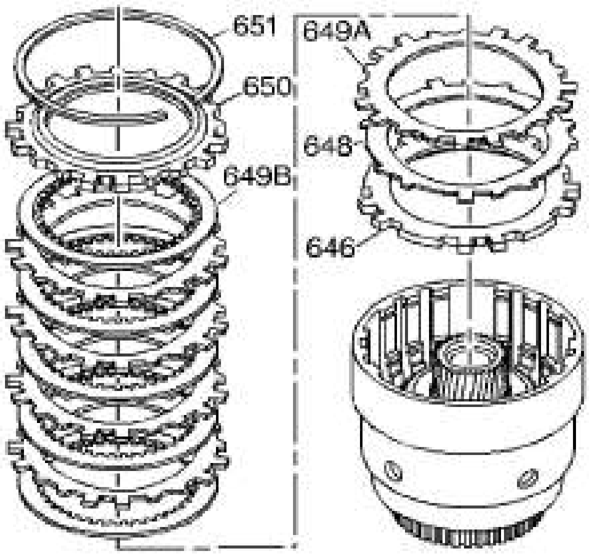
Forward Clutch Assembly Assemble

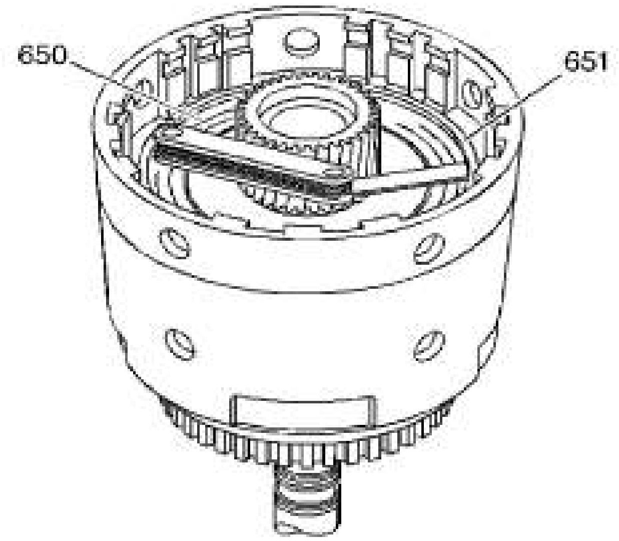


1. Inspect the forward clutch waved plate (648), the apply plate (646), the fiber plate assemblies (649B), the steel plates (649A) and the selective backing plate (650) for the following conditions:
   - Damaged tangs
   - Delamination
   - Excessive wear
   - Heat damage
   - Flatness
   - Surface finish damage
   - Burrs and nicks



2. Install the forward clutch apply plate (646).
3. Install the forward clutch waved plate (648).
4. Install the forward clutch steel plates (649A) and alternate with the fiber plate assemblies (649B).
5. Install the forward clutch selective backing plate (650).
6. Install the forward clutch backing plate retainer ring (651).

Forward Clutch Piston Travel Check

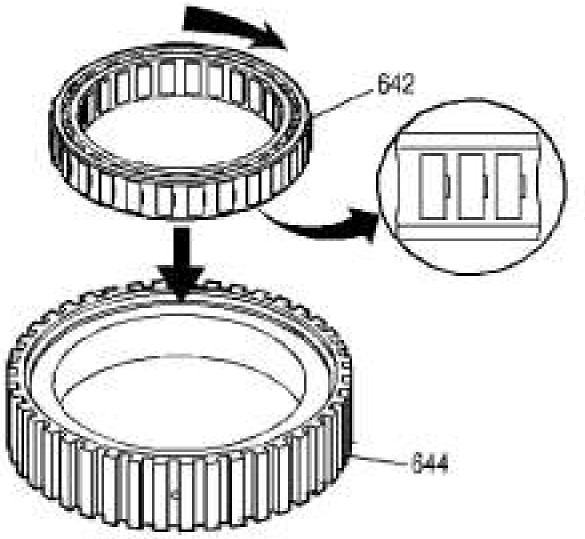


1. Use feeler gauges to check the forward clutch plate travel. Check travel between the forward clutch backing plate retainer ring (651) and the forward clutch selective backing plate (650).

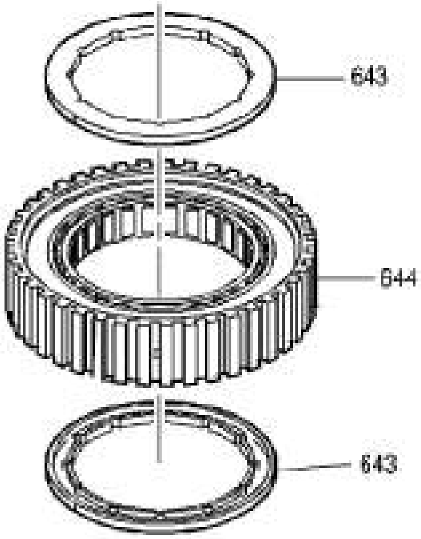
   The forward clutch plate travel should be:

   Specification
   - 245 mm Torque Converter-- 0.766-1.756 mm (0.030-0.069 in)
   - 298 mm/300 mm Torque Converter-- 0.866-1.876 mm (0.034-0.074 in)
2. Select the proper forward clutch selective backing plate (650) to obtain the correct travel.

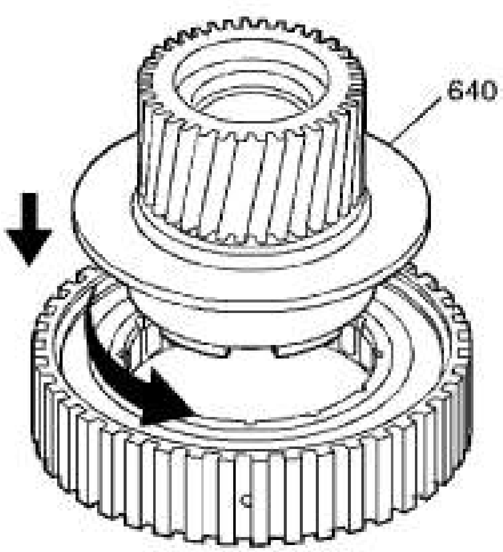
Forward Clutch Sprag Assemble



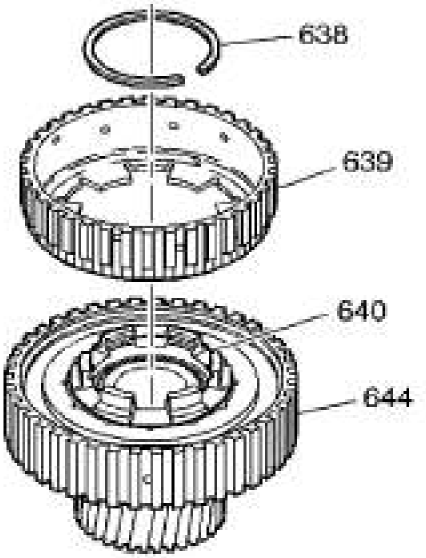
1. Inspect the forward sprag assembly (642) for the following conditions:
   - Wear or damage
   - Weak or broken springs
2. Inspect the forward clutch outer race (644) for the following conditions:
   - Race wear or damage
   - Spline wear
   - Surface finish damage
3. Install the forward sprag assembly (642) into the forward clutch outer race (644).



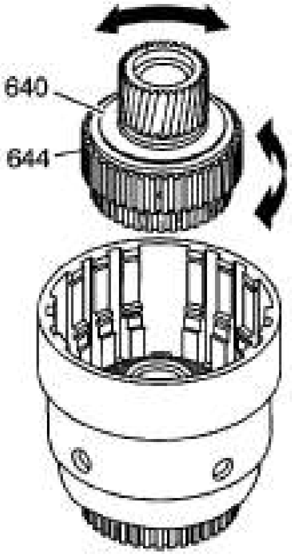
4. Inspect the sprag assembly retainer rings (643) for wear or damage.
5. Install the sprag assembly retainer rings (643) into the forward clutch sprag assembly (644).



6. Inspect the forward sprag clutch inner race and input sun gear assembly (640) for the following conditions:
   - Damaged spline or gear teeth
   - Ring groove damage
   - Surface finish damage
   - Loose retainer
   - Wear
   - Cracks
7. Install the forward sprag clutch inner race and input sun gear assembly (640) into the forward sprag and outer race assembly.



8. Inspect the overrun clutch hub (639) for the following conditions:
   - Spline damage
   - Plugged lubrication holes
   - Damaged tangs
   - Cracks
9. Install the overrun clutch hub (639) onto the sprag clutch inner race and input sun gear assembly (640).
10. Install the overrun clutch hub retaining snap ring (638).



Important: If the forward clutch sprag assembly operates backward, you have installed the sprag backward. Reassemble the sprag correctly.

11. Test the forward clutch sprag assembly for proper operation.
    11.1. Position the forward clutch sprag assembly with the input sun gear facing up.

        Important: The sun gear should only rotate in a counterclockwise direction.

    11.2. Hold the forward sprag clutch outer race (644) with one hand and rotate the input sun gear (640) with the other hand.
12. Install the forward clutch sprag and input sun gear assembly into the input clutch housing.
13. Index the overrun clutch hub into the overrun clutch plates.

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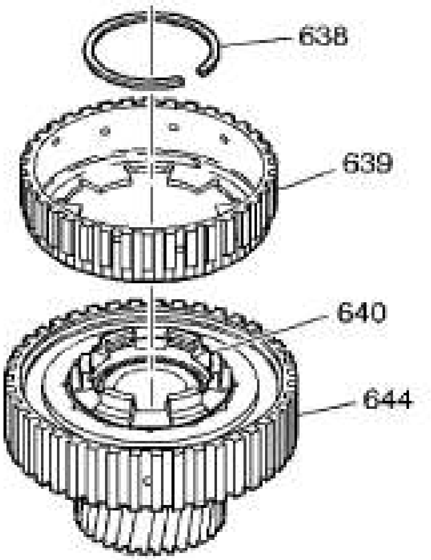
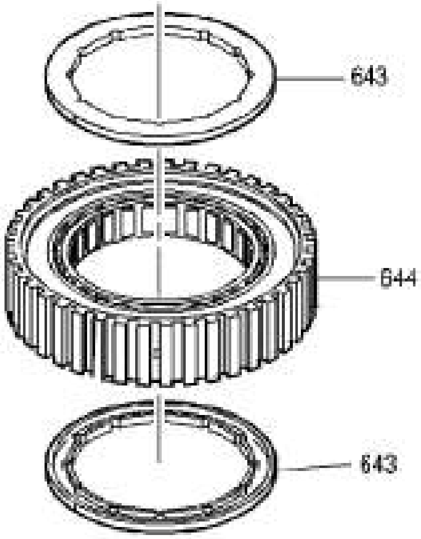
Forward Clutch Sprag Disassemble



1. Remove the overrun clutch hub retaining snap ring (638).
2. Remove the overrun clutch hub (639).
3. Remove the forward sprag clutch inner race and input sun gear assembly (640).

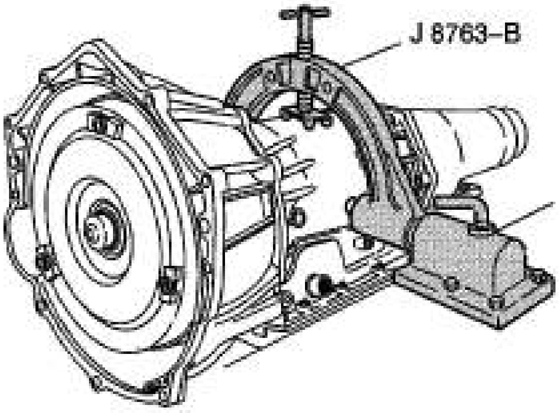


4. Remove the sprag assembly retainer rings (643).
5. Remove the forward sprag assembly from the forward clutch outer race (644).

Holding Fixture Installation

Tools Required

J 8763-B Holding Fixture and Base

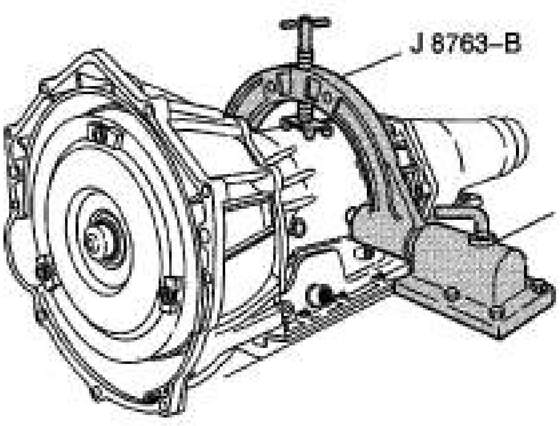


1. Install the J 8763-B onto the transmission.
2. Install the J 8763-B into the base.

Holding Fixture Removal

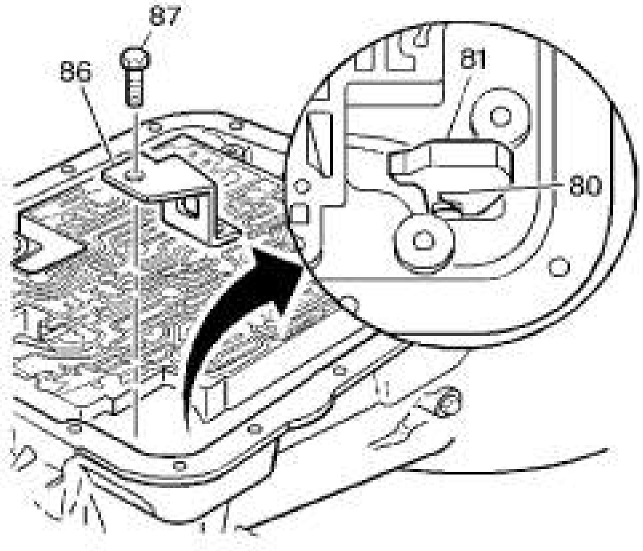
Tools Required

J 8763-B Holding Fixture and Base



Remove the transmission from the J 8763-B .

Inner Manual Linkage Installation



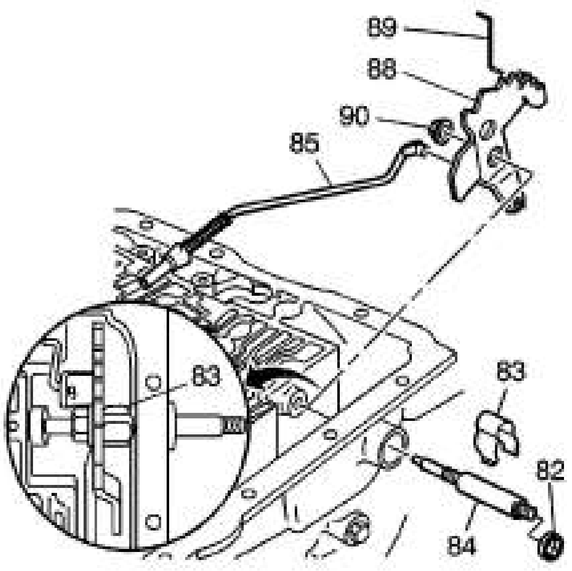
1. Install the parking lock bracket (86).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the parking lock bracket retaining bolt (87).

   Tighten
   Tighten the retaining bolt to 31 N·m (23 lb ft).

3. Inspect the following items:
   - The parking brake pawl (81) for damage or cracks
   - The parking pawl return spring (80) for being broken or missing



4. Inspect the following items:
    - The manual shaft retainer (83) for damage or cracks
    - The manual shaft (84) for damage or burrs
    - The parking lock actuator assembly (85) for damage
    - The inside detent lever (88) for damage or cracks
    - The manual valve link (89) for damage
    - The hex head nut (90) for damage or stripped threads
5. Install the following items:
    - The inside detent lever (88)
    - The parking lock actuator assembly (85)
    - The manual shaft (84) (model dependent)
    - The manual shaft retainer (83)
    - The hex head nut (90)
    - The manual valve link (89)

Tighten
Tighten the retaining nut to 31 N·m (23 lb ft).

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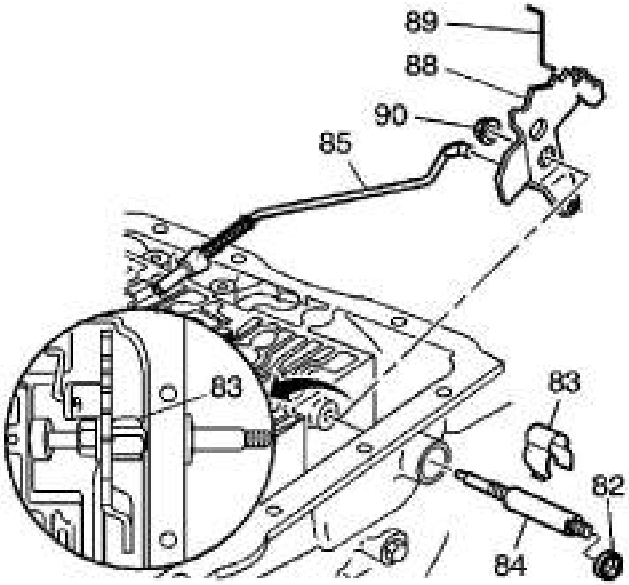
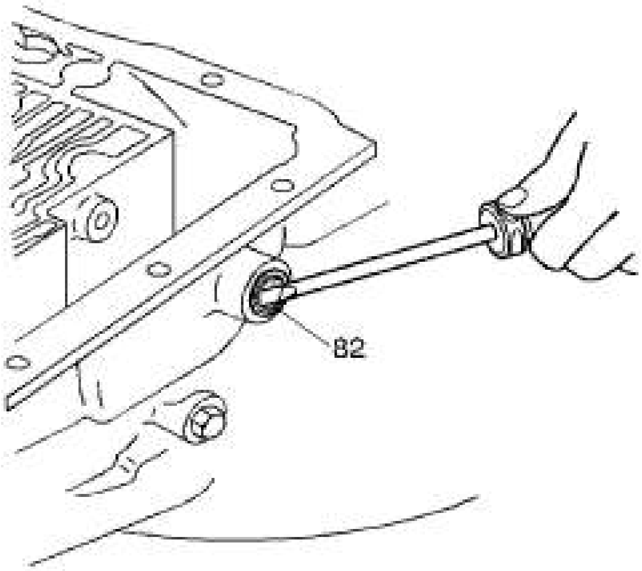
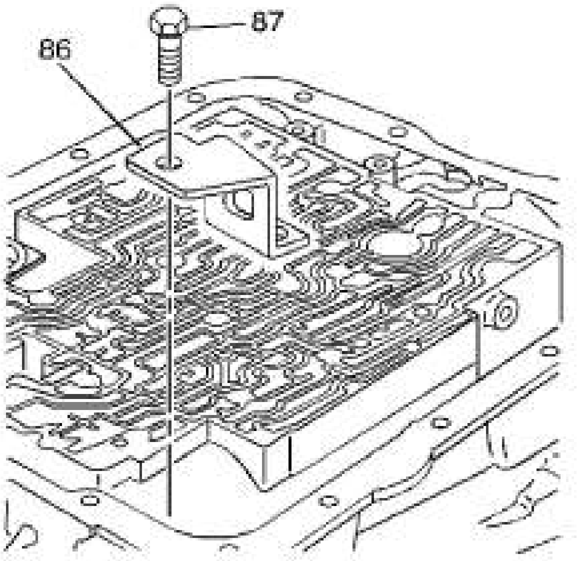
Inner Manual Linkage Removal



1. Remove the following parts:
    1.1. Hex head nut (90)
    1.2. Manual valve link (89)
    1.3. Detent lever (88)
    1.4. Parking lock actuator assembly (85)
    1.5. Manual shaft retainer (83)
    1.6. Manual shaft (84)



2. Remove the manual shaft seal (82) using a suitable tool.



3. Remove the following components:
    3.1. The parking lock bracket retaining bolt (87)
    3.2. The parking lock bracket (86)

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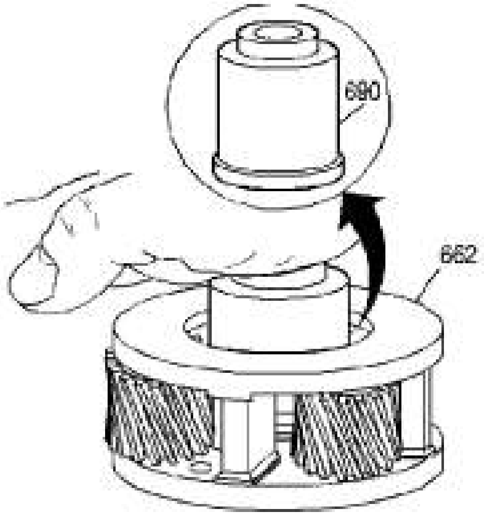
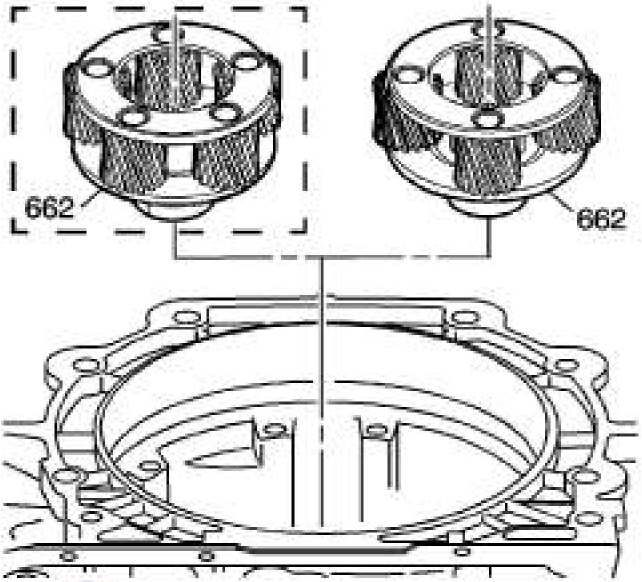
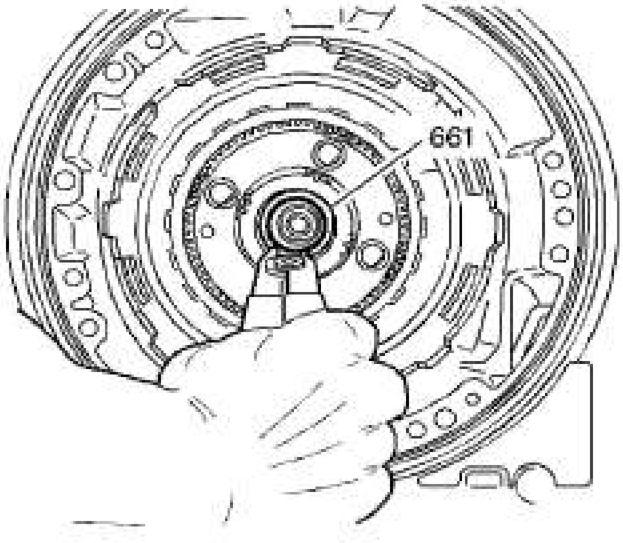
Input Carrier Inspection and Installation



1. Inspect the input carrier captive thrust bearing assembly. To check the captive thrust bearing in the input carrier (662) for wear, place a bushing or an output shaft sleeve (690) onto the bearing race and turn it with the palm of your hand. Do not touch the pinion gears. Any imperfections will be felt through the bushing.



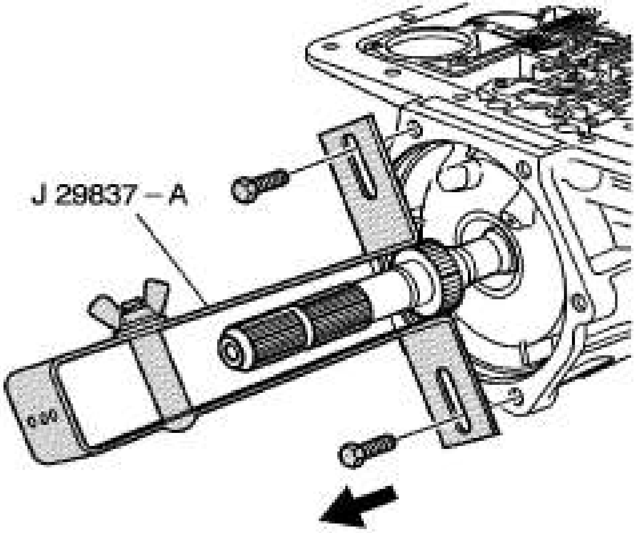
2. Install the input carrier assembly (662) onto the output shaft. The carrier assembly can be either a 4 or 5 pinion design, depending on model.



Important:

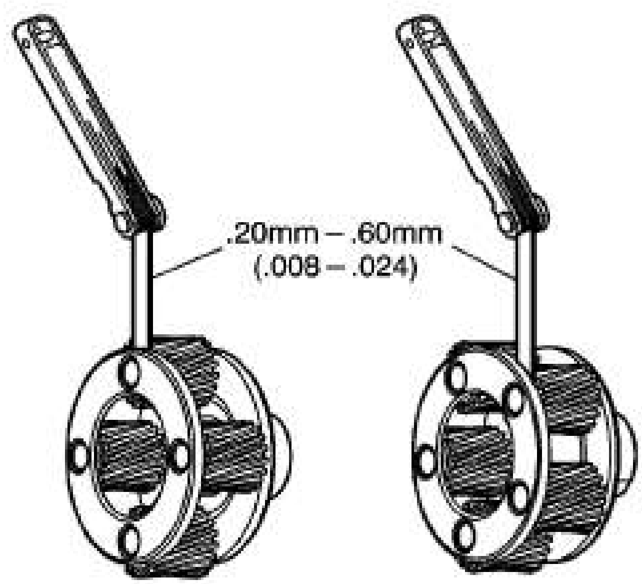
- Do not reuse the old output shaft to input carrier retainer (661).
- Do not over expand the new output shaft to input carrier retainer during installation.

3. Install a new output shaft to input carrier retainer (661).



4. Remove the J 29837-A .

Input Carrier Inspection



Important: Check end play on each pinion. Clearance is the same for 4 or 5 pinion design.

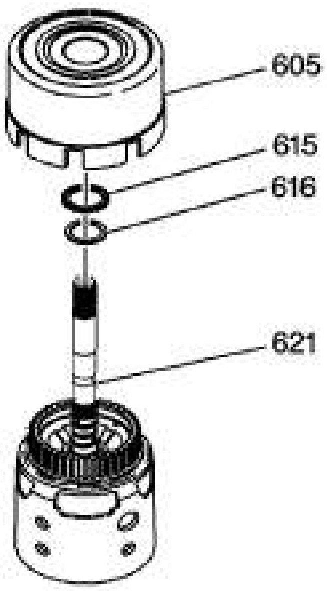
1. Check the input carrier pinion end play. The end play must not exceed 0.61 mm (0.024 in).
2. Inspect the input carrier for pinion gear damage, proper pin stake and keystoned pinion gears. Pinions must rotate freely.

Input Clutch Assembly Disassemble

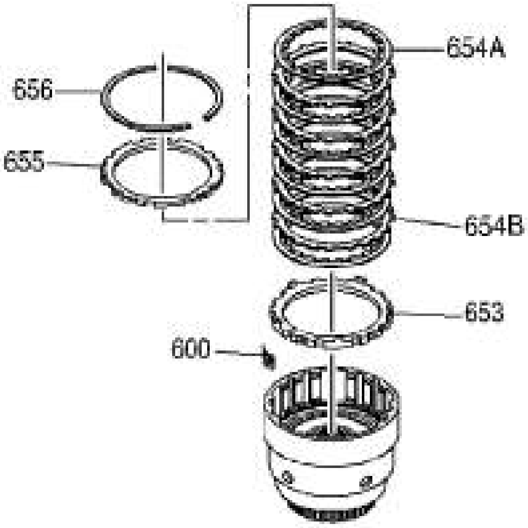
Removal Procedure

Tools Required

- J 23327-1 Forward Clutch Spring Compressor (Bridge)
- J 23456 Booster and Clutch Pack Compressor
- J 25018-A Clutch Spring Compressor Adapter



1. Remove the reverse input clutch housing and drum assembly (605) from the input clutch assembly (621).
2. Remove the stator shaft/selective washer bearing assembly (615).
3. Remove the selective thrust washer (616).

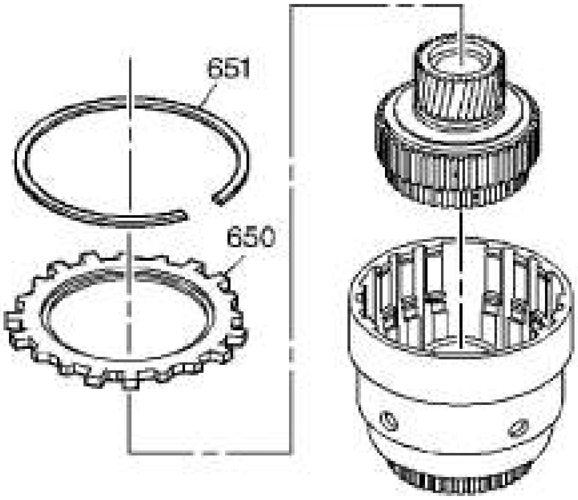


4. Remove the 3rd and 4th clutch backing plate retainer ring (656).

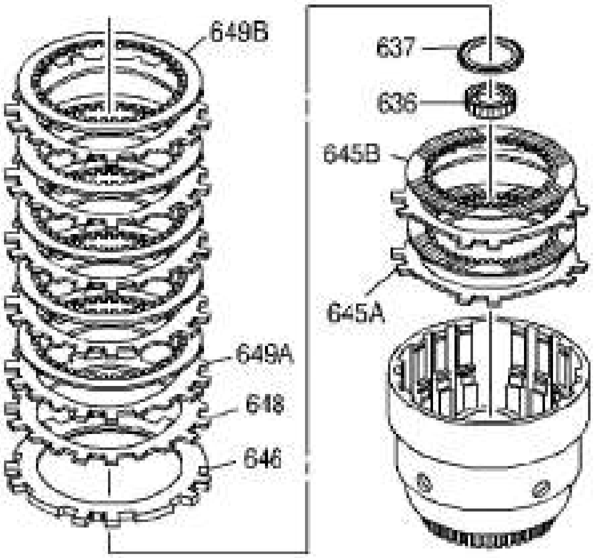
Notice: Refer to General Repair Instructions in the Preface section.

Important: The 3rd and 4th clutch plate stack is model specific. Clutch plate stack up may be either 6 or 7 plates.

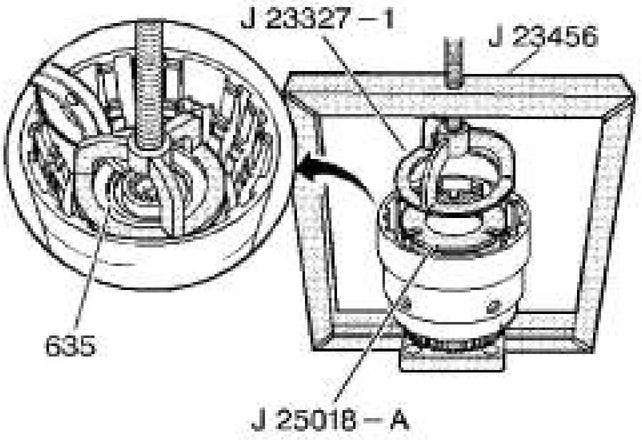
5. Remove all 3rd and 4th clutch plates (653-655).
6. Remove the 3-4 clutch boost spring assemblies (600).



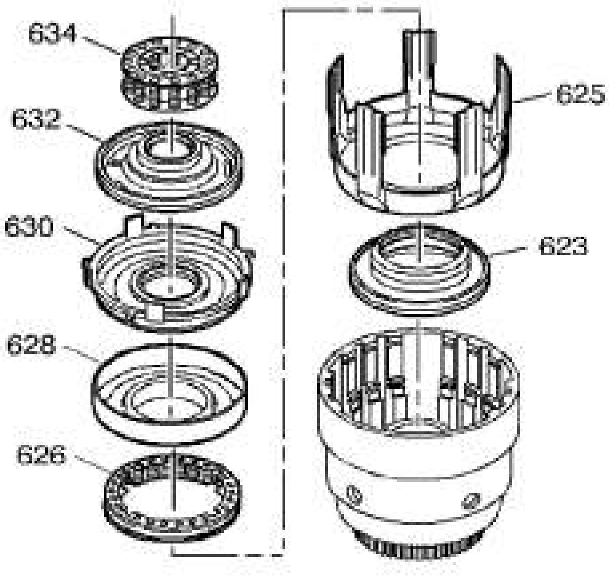
7. Remove the forward clutch backing plate retainer ring (651).
8. Remove the forward clutch selective backing plate (650).
9. Remove the forward clutch sprag assembly.


649B
637
636
645B
645A
649A
648
646

10. Remove all forward clutch plates (646, 648, 649A, 649B).
11. Remove the input sun gear bearing assembly (637).
12. Remove the input housing to output shaft seal (636).
13. Remove all overrun clutch plates (645A, 645B).


J 23327 –1
J 23456
635
J 25018 – A

14. Install the J 23327-1 and the J 25018-A .
15. Compress the overrun clutch spring, using the J 23456 .
16. Remove the overrun clutch spring retainer snap ring (635).
17. Remove the J 23327-1 and the J 25018-A .



18. Remove the overrun clutch spring assembly (634).
19. Remove the overrun clutch piston (632).
20. Remove the forward clutch piston (630).
21. Remove the forward clutch housing (628).
22. Remove the 3rd and 4th clutch spring assembly (626).
23. Remove the 3rd and 4th clutch apply ring (625).
24. Remove the 3rd and 4th clutch piston (623).

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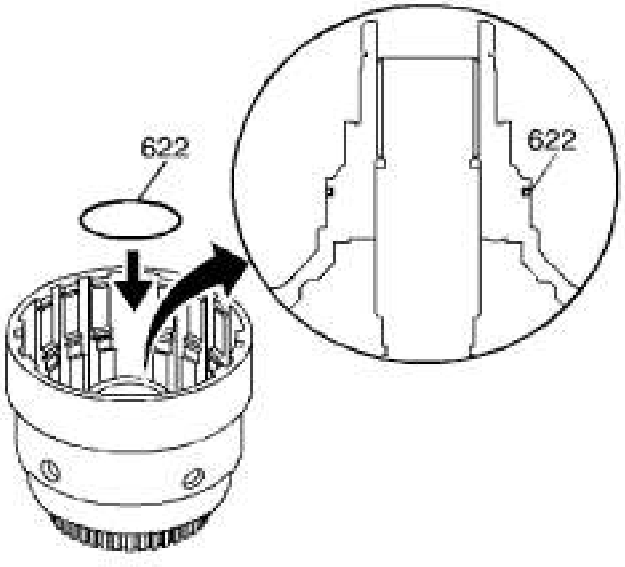
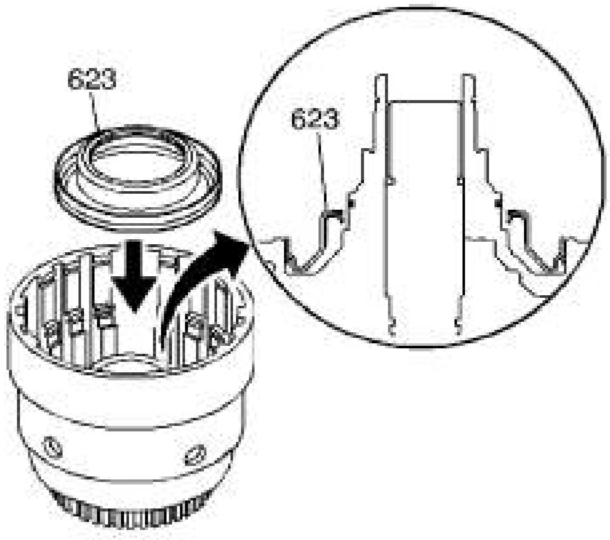
Input Housing and Shaft Assembly Assemble

Tools Required

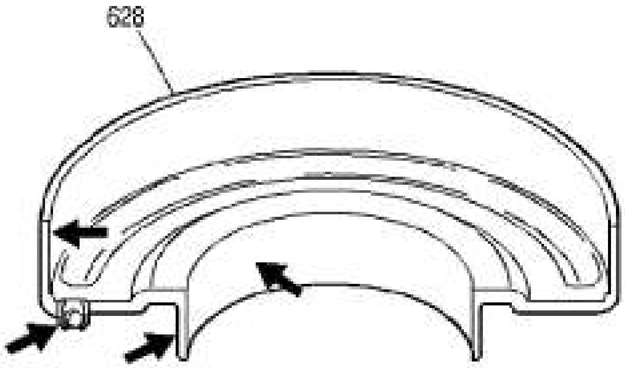
- J 23327-1 Forward Clutch Spring Compressor (Bridge)
- J 23456 Booster and Clutch Pack Compressor
- J 25018-A Clutch Spring Compressor Adapter
- J 26744-A Seal Installer
- J 29882 Overrun Clutch Seal Protector
- J 29883 Forward Clutch Seal Protector



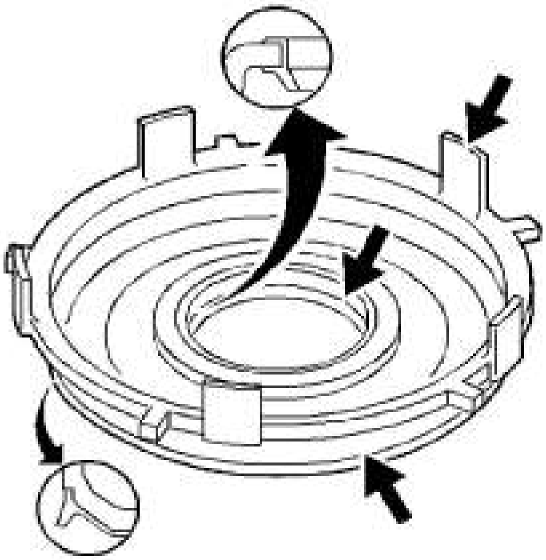
1. Install a new input to forward clutch housing O-ring seal (622).



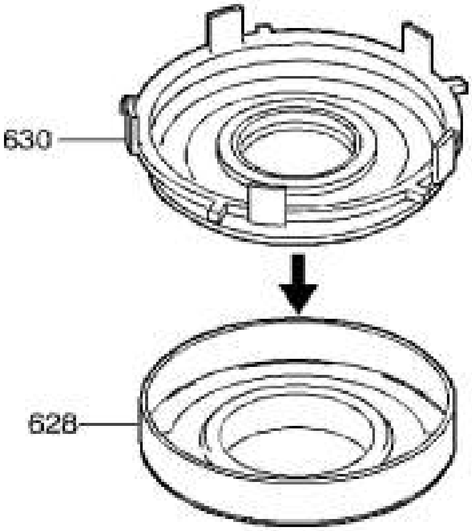
2. Inspect the 3rd and 4th clutch piston (623) for the following conditions:
   - Porosity or damage
   - Seal damage
3. Install the 3rd and 4th clutch piston (623) into the input housing.



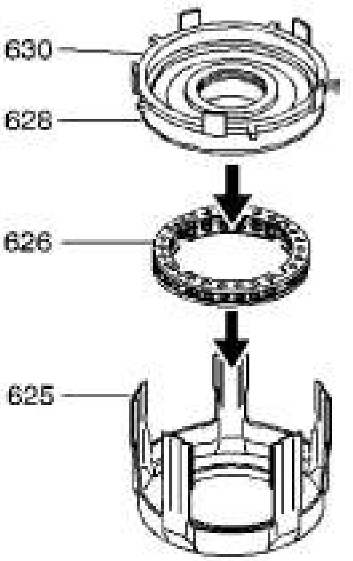
4. Inspect the forward clutch housing (628) for the following conditions:
   - Proper check ball operation
   - Damage or distortion
   - Burrs in the seal areas
   - Cracks



5. Inspect the forward clutch piston for the following conditions:
    - Porosity or damage
    - Seal damage
    - Apply leg damage



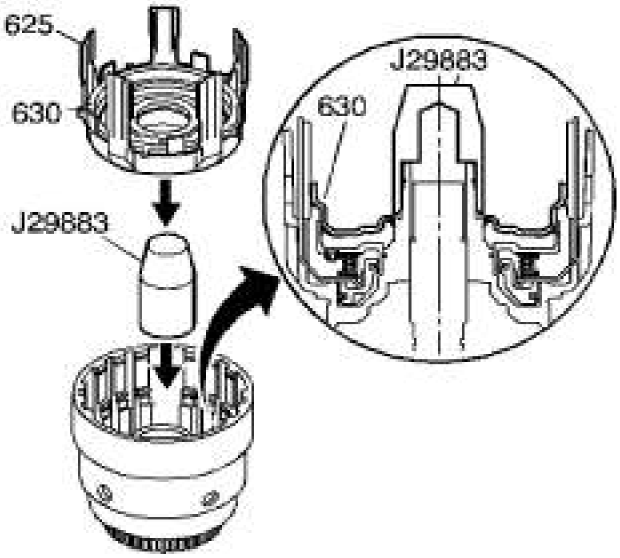
6. Install the forward clutch piston (630) into the forward clutch housing (628).



7. Install the 3rd and 4th spring assembly (626) into the 3rd and 4th clutch apply ring (625).

Important: The forward clutch piston (630) apply legs must be indexed with the 3rd and 4th clutch apply ring (625) legs.

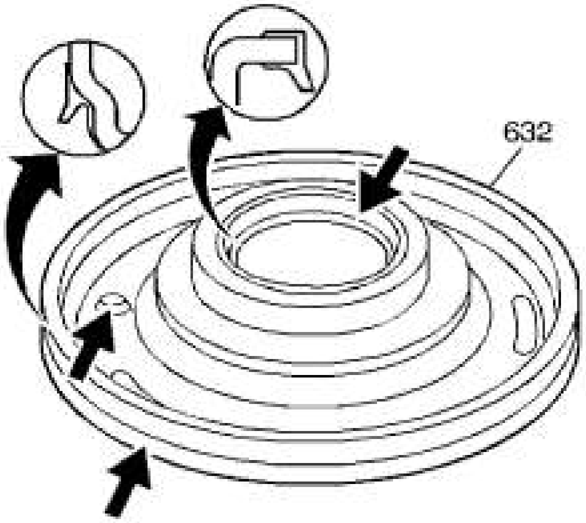
8. Install the forward clutch housing (628) and forward clutch piston (630) into the 3rd and 4th apply ring (625).



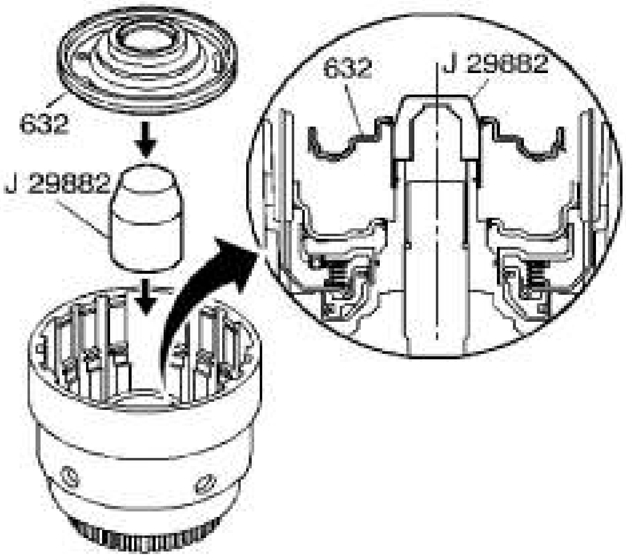
9. Install the J 29883 on the input housing.
10. Install the 3rd and 4th clutch apply ring and the forward housing and piston assembly using the following procedure:
    - Hold the assembly by the 3rd and 4th clutch apply ring (625) legs during installation.
    - Do not let the forward clutch piston (630) separate from the forward clutch housing.

- Firmly seat the assembly.

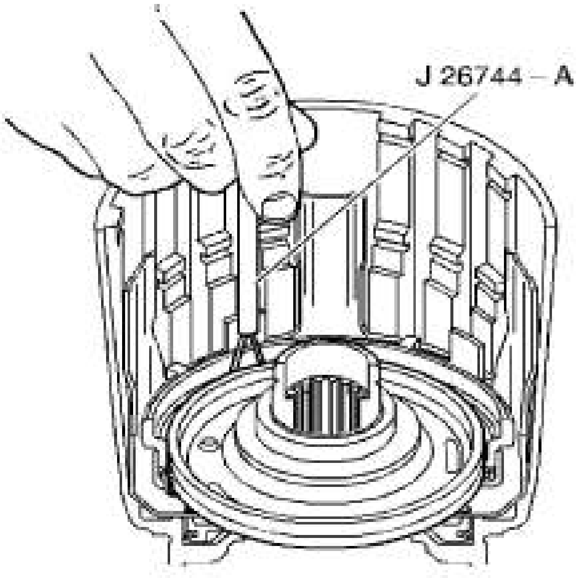
11. Remove the J 29883 from the input housing.



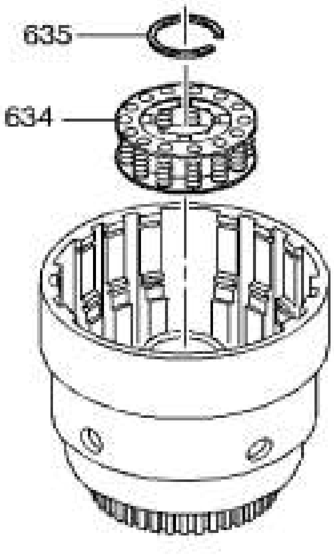
12. Inspect the overrun clutch piston (632) for the following conditions:
    - Porosity or damage
    - Seal damage
    - Overrun clutch ball proper operation



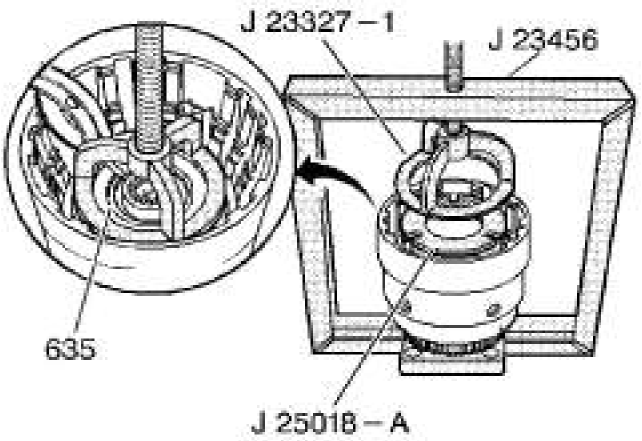
13. Install the J 29882 on the input housing.
14. Install the overrun clutch piston (632) into the input housing.
15. Remove the J 29882 from the input housing.



16. Using the J 26744-A , carefully install the overrun clutch piston outer seal.

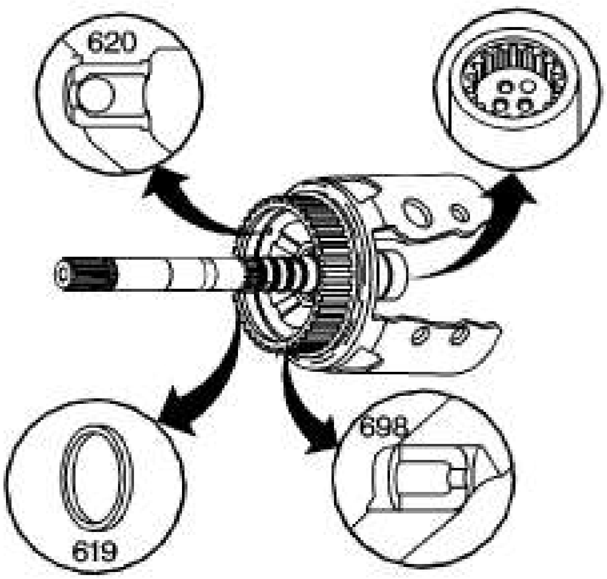


17. Install the overrun clutch spring (634) assembly.

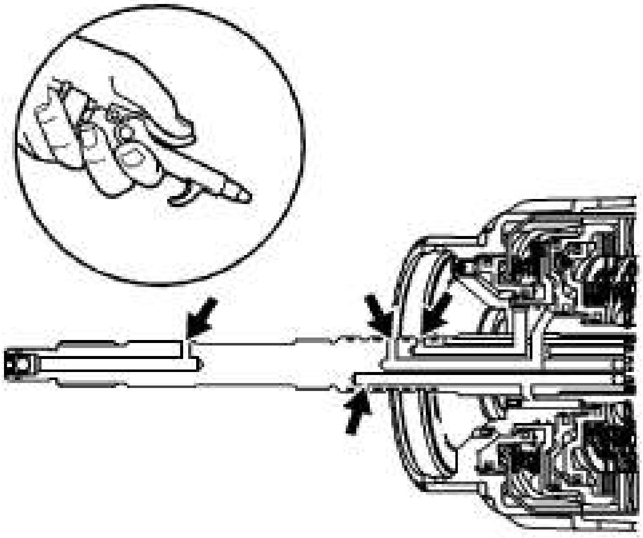


18. Install the J 23327-1 and the J 25018-A , and compress the overrun clutch spring assembly using J 23456 .
19. Install the overrun clutch spring retainer snap ring (635).
20. Remove the J 23327-1 and the J 25018-A .

Input Housing and Shaft Assembly Inspection

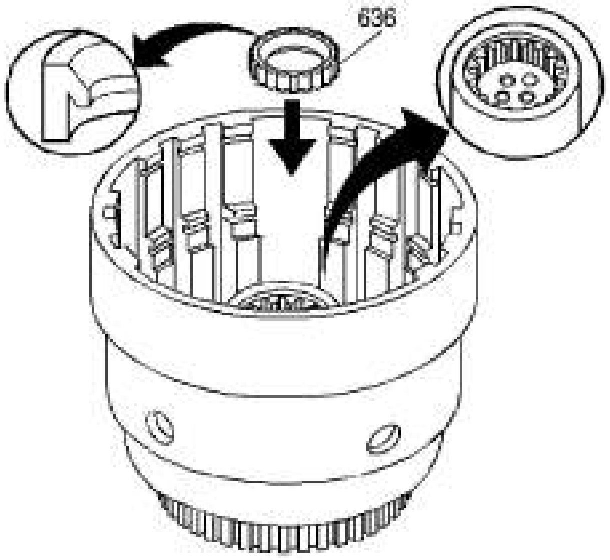


1. Inspect the input housing and shaft assembly for the following conditions:
    - Porosity
    - Spline wear - internal and external
    - Input speed sensor models, rotor teeth for cracks or damage
    - Three turbine shaft ball check valves are present and move freely
    - Retainer and ball check valve assembly (620)
    - Orificed cup plug (698)
    - Lube hole cracks
2. Test the input housing for cracks by tapping housing with wooden handle. Housing should produce a sharp ring.
3. Inspect the turbine shaft oil seal ring (619) grooves for damage or burrs. The oil seal rings (619) must fit loose into the ring grooves.



4. Inspect the oil feed passages for obstructions.
5. Apply compressed air into the passages indicated.

Input Housing to Output Shaft Seal Installation



Install a new input housing to output shaft seal (636).

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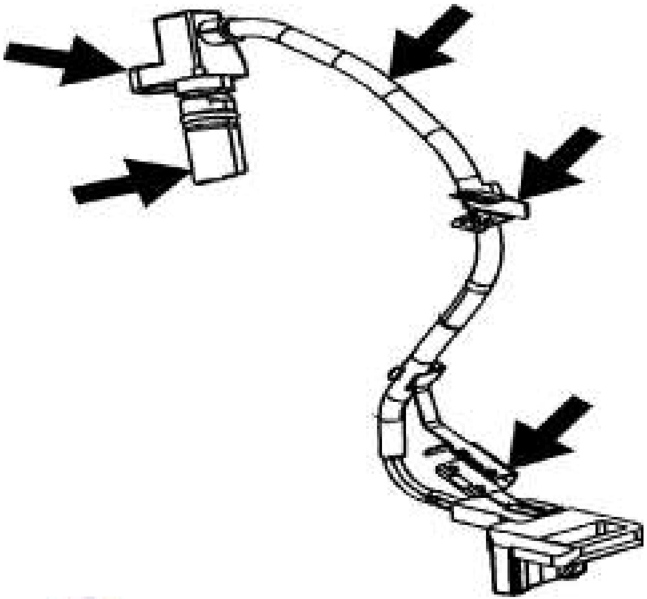
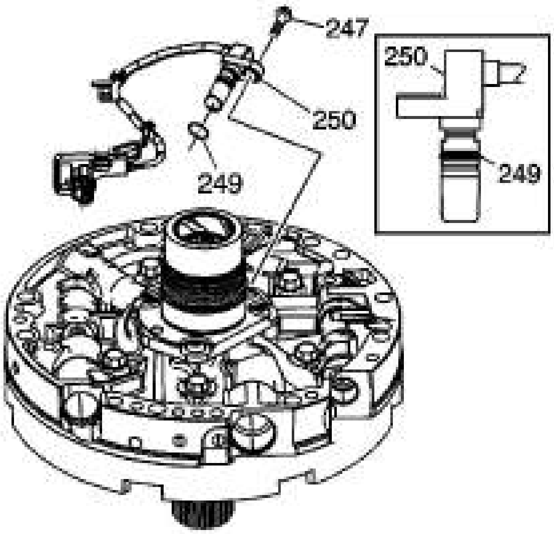
Input Speed Sensor Installation



1. Inspect the input speed sensor (ISS) assembly (250) for the following conditions:
    - Cracked or damaged housing
    - Worn or missing harness brackets
    - Damaged or worn wining or electrical connector
    - Loose, missing or damaged mounting bolt insert

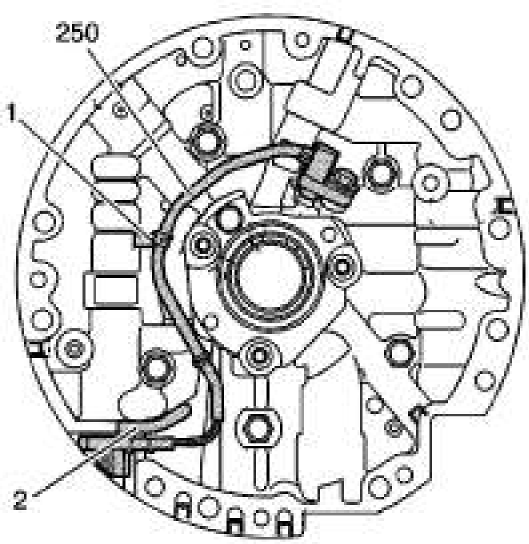


2. Remove the input speed sensor (ISS) O-ring (249) and discard.
3. Lubricate NEW O-ring (249) with transmission fluid and position in the ISS O-ring groove.
4. Insert the ISS (250) into oil pump ISS bore and fully seat.
5. Align ISS bolt insert with oil pump mounting bolt hole.

   Notice: Refer to Fastener Notice in the Preface section.

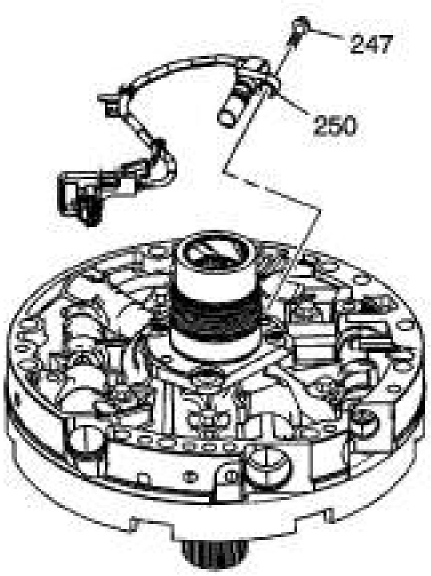
6. Install retaining bolt (247).

   Tighten
   Tighten the retaining bolt to 9-11 N·m (6.6-8.1 lb ft).



7. Route the ISS assembly (250) wire harness as shown. Install harness bracket #1 and #2 in the locations shown. Ensure the wire harness lays flat against the pump housing.

Input Speed Sensor Removal



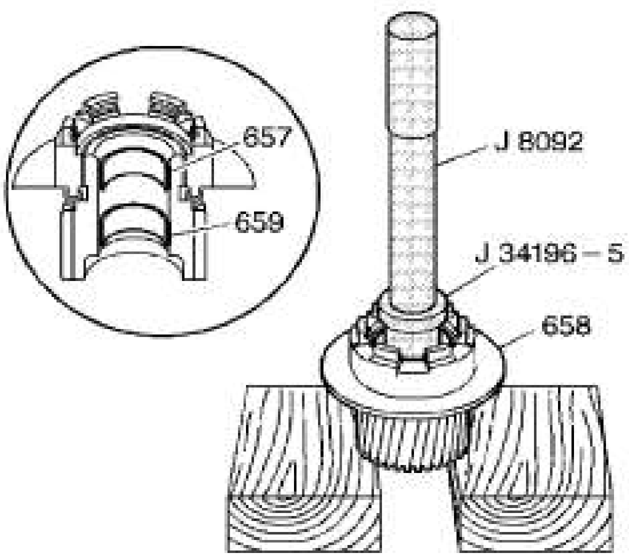
1. Remove the input speed sensor (ISS) retaining bolt (247).
2. Remove the ISS retaining clips and ISS assembly (250).

Input Sun Gear Bushing Replacement

Tools Required

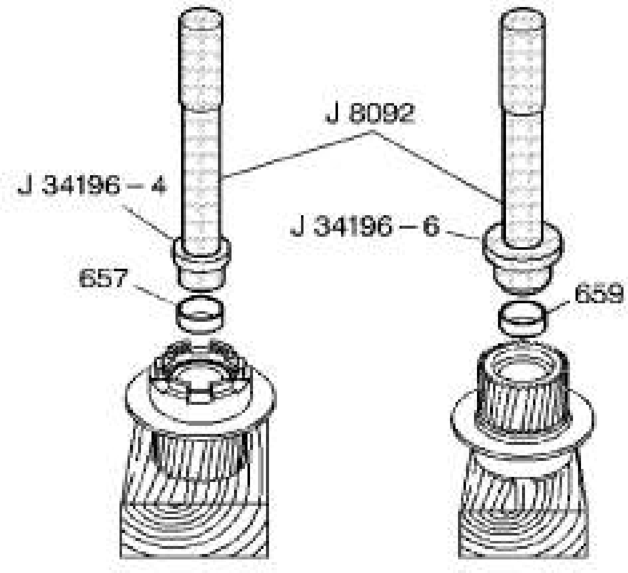
- J 8092 Universal Driver Handle - 3/4 in - 10
- J 34196-B Transmission Bushing Service Set

Removal Procedure



Using J 34196-5 which is part of kit J 34196-B with J 8092 , remove the input sun gear front bushing (657) and rear bushing (659).

Installation Procedure



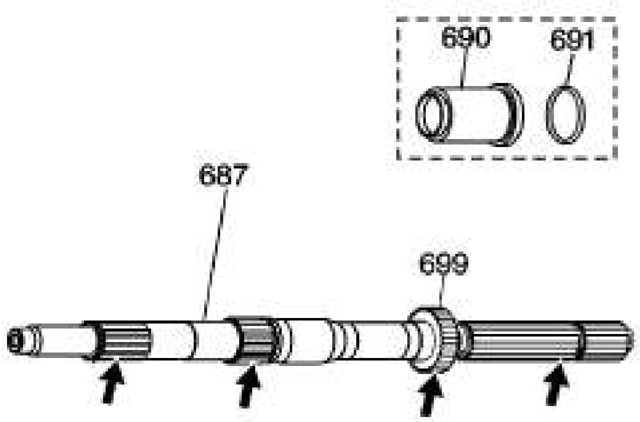
1. Using J 34196-4 which is part of kit J 34196-B with J 8092 , install the input sun gear front bushing (657).
2. Using J 34196-6 which is part of kit J 34196-B with J 8092 , install the input sun gear rear bushing (659).

Internal Transmission Speed Sensor Rotor Replacement

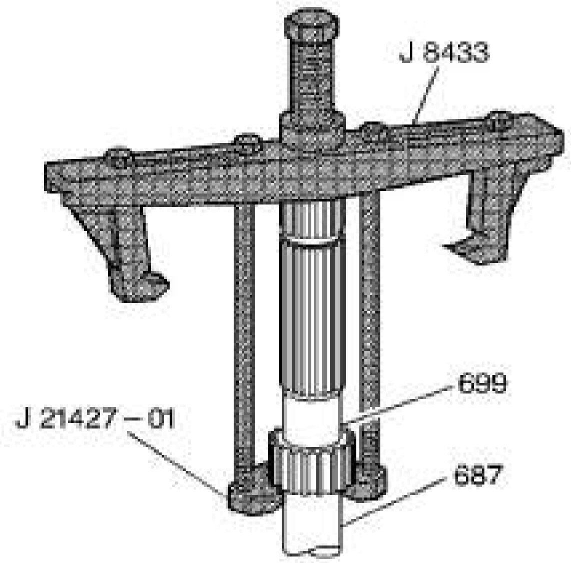
Tools Required

- J 8433 Two Jaw Puller
- J 21427-A Speedometer Gear Puller Adapter
- J 36352 Speed Sensor Rotor Installer Kit

Removal Procedure

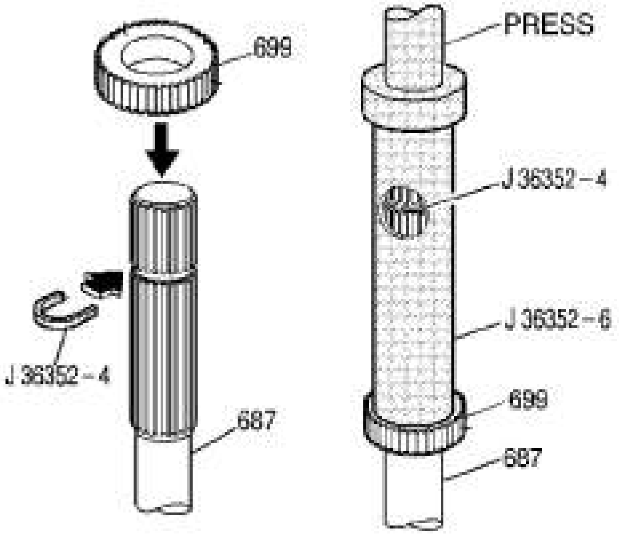


1. Inspect the internal transmission speed sensor rotor (699) for cracks or damaged teeth.
2. Inspect all splines on the output shaft (687) for cracks or damaged splines.
3. Remove the output shaft seal (691) and the output shaft sleeve (690).


J 8433
699
J 21427 – 01
687

4. If the internal speed sensor rotor (699) is damaged, replace it.
5. Using J 8433 with J 21427-01 , remove the internal speed sensor rotor (699) from the output shaft (687).

Installation Procedure


699
J 36352 – 4
687
PRESS
J 36352 – 4
J 36352 – 6
699
687

Important: Do not re-use an internal speed sensor rotor that has been removed.

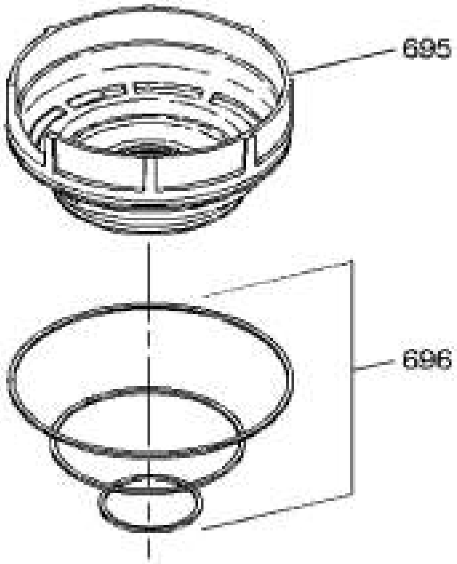
1. Slip a new internal speed sensor rotor (699) over the output shaft splines.
2. Install the J 36352-4 in the groove on the output shaft (687).
3. Place the J 36352-6 on the output shaft (687). Press on the J 36352-6 until it contacts the J

36352-4 in the window (the J 36352-4 will be a positive stop for the J 36352-6 .

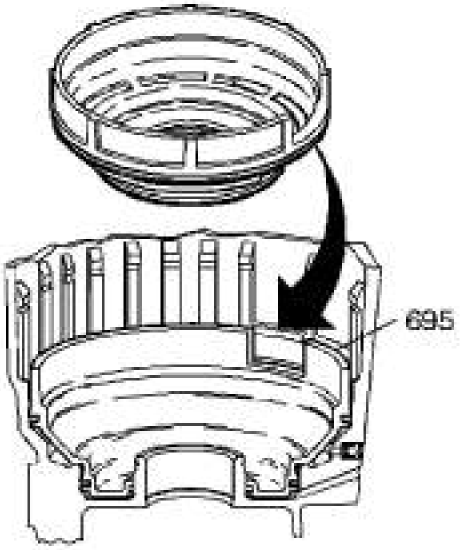
Low and Reverse Clutch Piston Installation

Tools Required

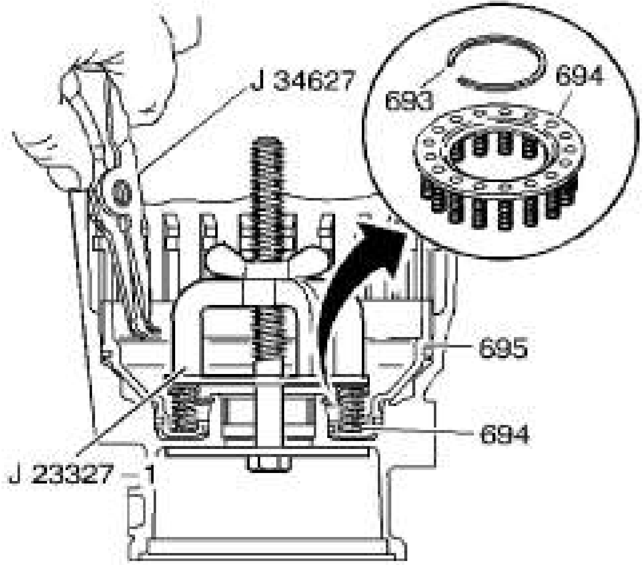
- J 23327-1 Forward Clutch Spring Compressor (Bridge)
- J 34627 J 34627 Snap Ring Remover and Installer



1. Install the transmission (low and reverse clutch outer, center, inner) seals (696) on the low and reverse clutch piston (695).
2. Lubricate the seals with assembly lubricant J 36850 or an equivalent.



3. Install the low and reverse clutch piston (695) into the case. The notch in the piston must be aligned with the parking brake pawl window, in the case.

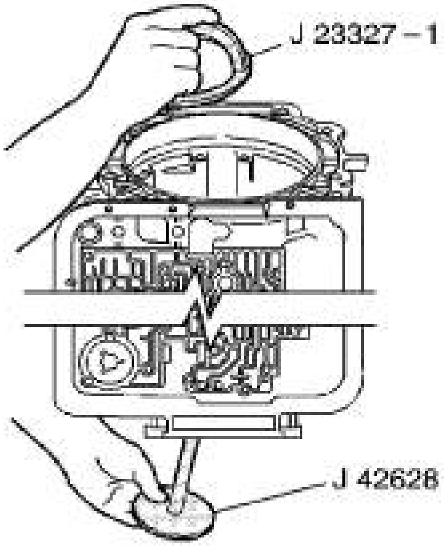


4. Install the low and reverse clutch spring assembly (694).
   - 4.1. Using the J 23327-1 , compress the low and reverse clutch spring assembly (694).
   - 4.2. Using J 36850 install the low and reverse clutch retainer ring (693).

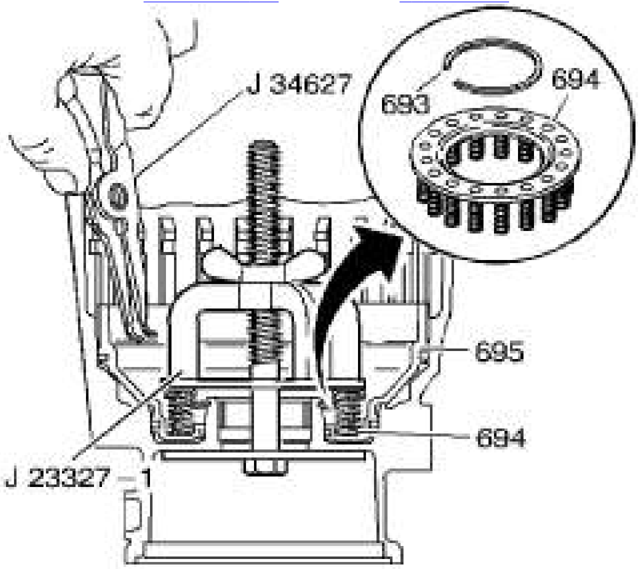
Low and Reverse Clutch Piston Removal

Tools Required

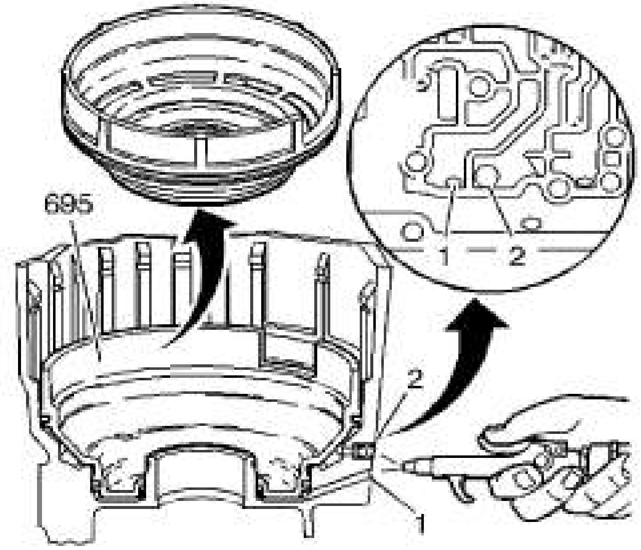
- J 23327-1 Forward Clutch Spring Compressor (Bridge)
- J-34627 Snap Ring Remover and Installer
- J-42628 Disc



1. Install the J 23327-1 and the J-42628 .

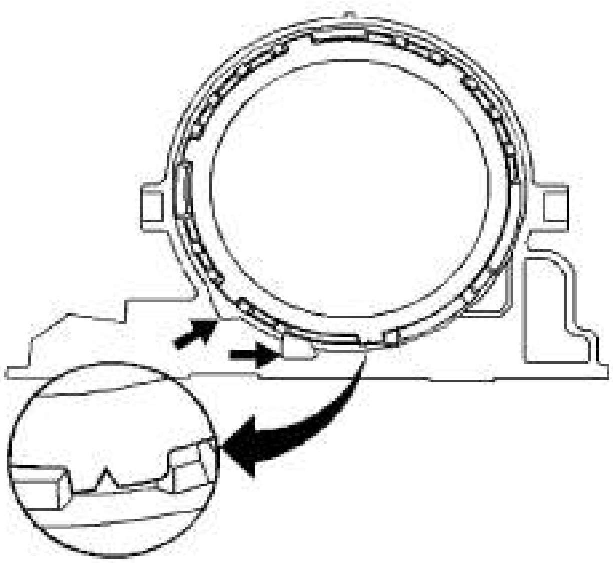


2. Tighten the J 23327-1 .
3. Remove the low and reverse clutch retainer ring (693) using the J-34627 .
4. Remove the low and reverse clutch spring assembly (694).



5. Blow compressed air into the case passage to remove the low and reverse clutch piston (695).
   - (1) LO Feed Passage
   - (2) REV Feed Passage

Low and Reverse Clutch Plate Installation

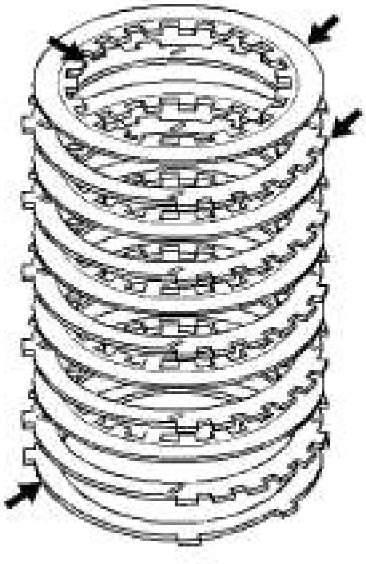


1. Install the waved plate.
2. Install the correct selective spacer plate (from the selection procedure).
3. Install the five fiber plate assemblies and four steel plates, starting with one fiber plate assembly and alternating with steel.
4. Index the steel plate splines in the case as shown.

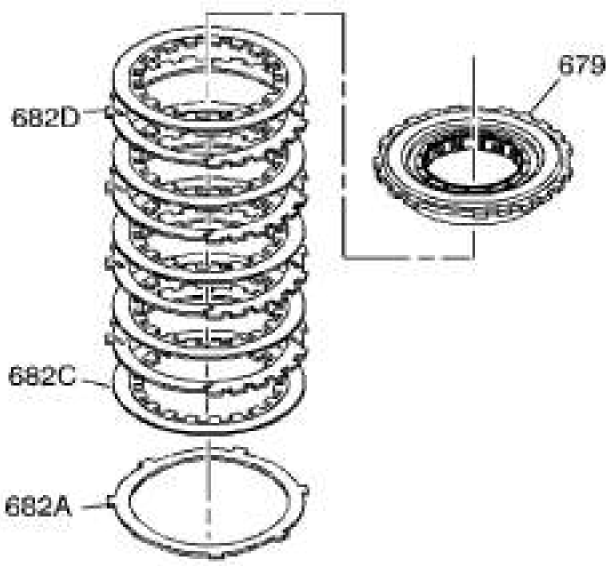
Low and Reverse Clutch Spacer Plate Selection

Tools Required

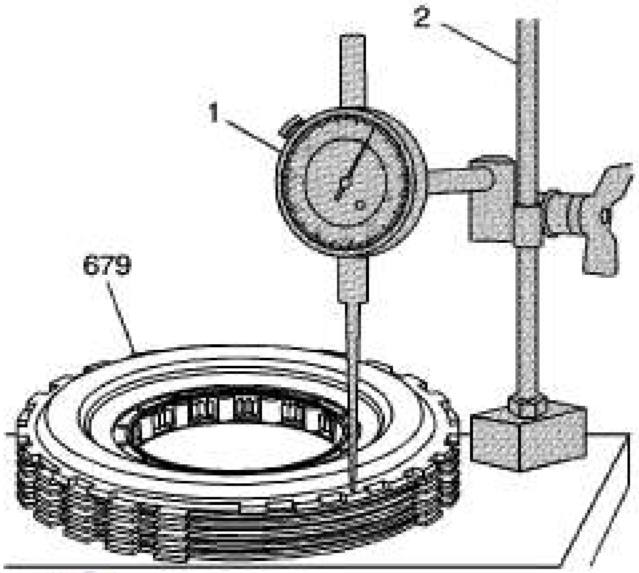
- J 8001 Dial Indicator Set
- J 26900-13 Magnetic Indicator Base



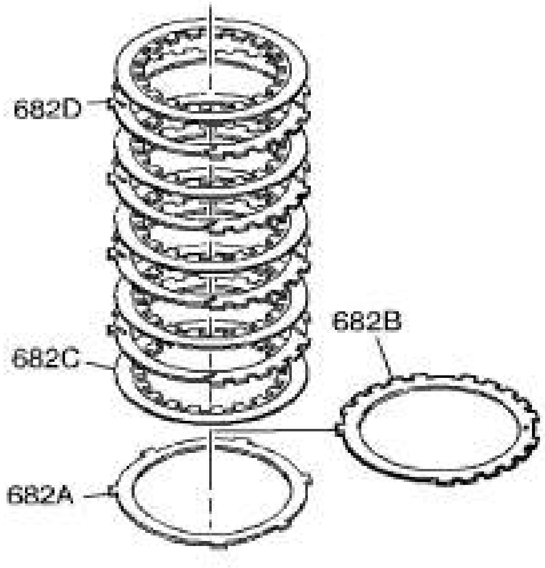
1. Inspect the low and reverse clutch plates for the following conditions:
   - Composition material wear
   - Composition material heat damage
   - Composition material delamination
   - Steel plates heat damage
   - Steel plates surface finish damage



2. Stack the low and reverse clutch plate assembly on a flat surface in the following order:
   - 2.1. One waved plate (682A)
   - 2.2. Five fiber plate assemblies (682C) and four steel plates (682D), starting with one fiber plate assembly and alternating with steel
   - 2.3. Low and reverse clutch support (679)



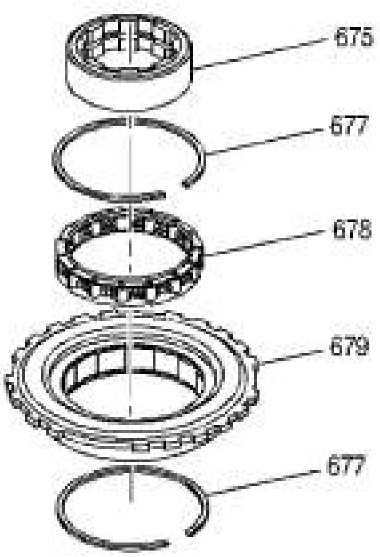
3. Using the J 8001 (1) and the J 26900-13 (2), measure the height of the clutch pack from the work surface to the top of the low and reverse clutch support (679).



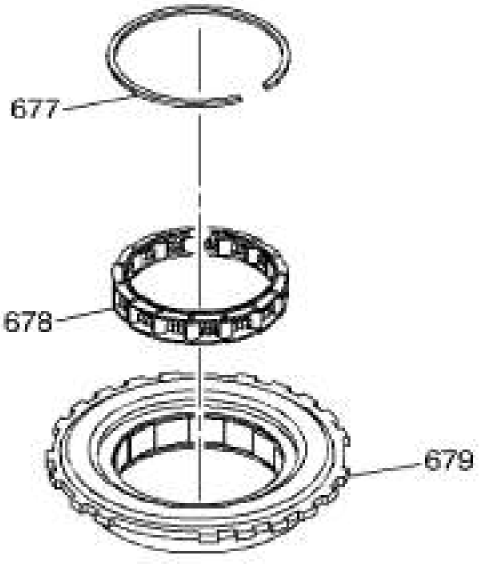
4. Install the proper selective spacer plate (682B) between the wave plate (682A) and the first fiber plate assembly (682C), with the identification side up.

   The overall height for the clutch pack including the selective spacer plate should be 29.23-29.90 mm (1.15-1.18 in).

Low and Reverse Clutch Support Disassemble



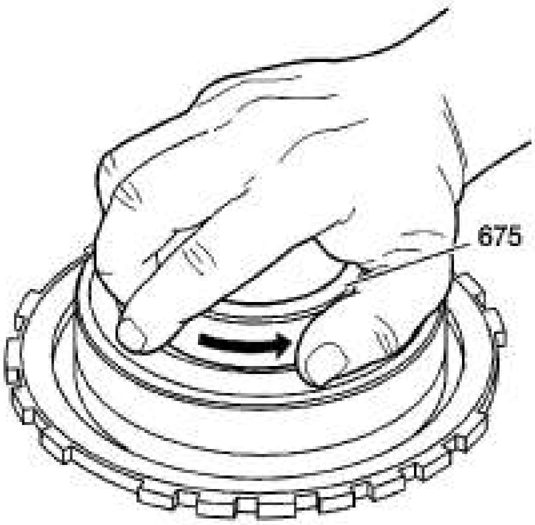
1. Remove the low and reverse roller clutch race (675) from the low and reverse clutch support (679). Inspect the race for damage and surface finish.
2. Remove the two low and reverse roller retainer rings (677) and the low and reverse roller clutch assembly (678). Inspect the roller clutch assembly for damaged rollers and broken springs.
3. Inspect the low and reverse clutch support (679) for loose cam and cam surface finish. Check the support for cracks and damaged lugs.



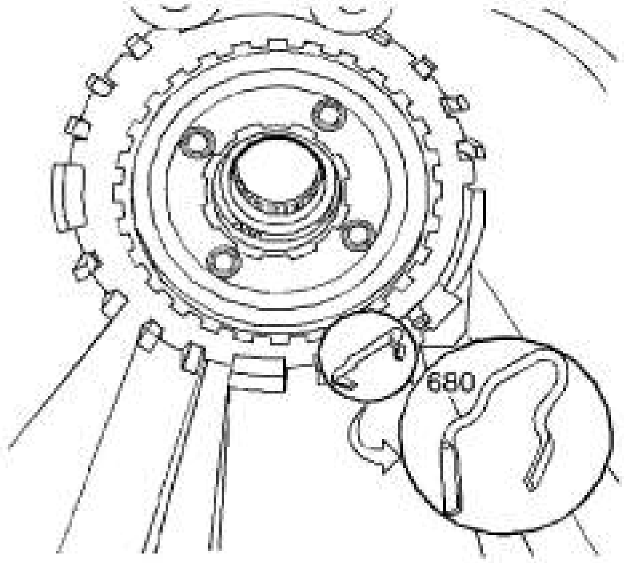
4. Clean and install the low and reverse roller clutch assembly (678) into the low and reverse

clutch support (679). Install the low and reverse retainer ring (677).

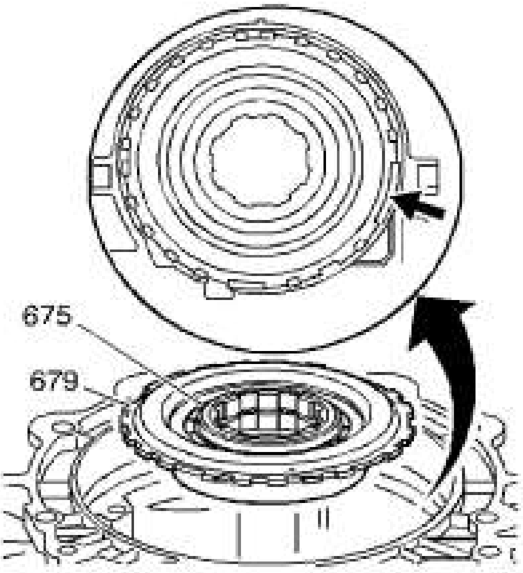
Low and Reverse Clutch Support Installation



1. Install the low and reverse roller clutch race (675). Simultaneously, turn and insert the race.
2. Rotate the race in order to verify proper operation. The race should only rotate in one direction.

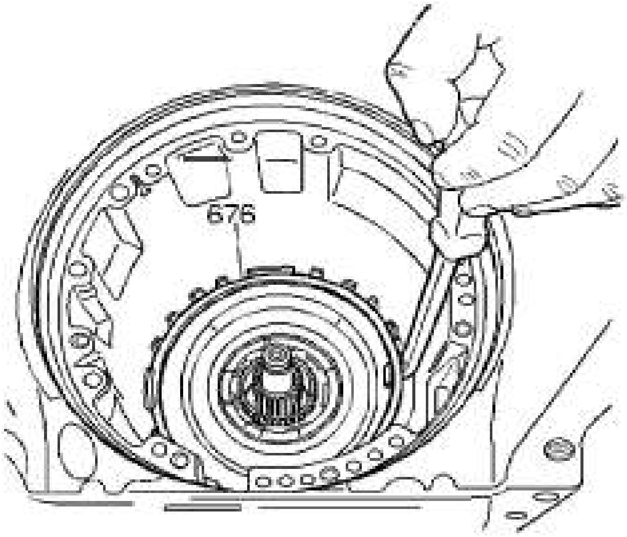


3. Install the low and reverse clutch support retainer spring (680) into the case.



Important: Align the wide low and reverse clutch support notch with the wide case lug.

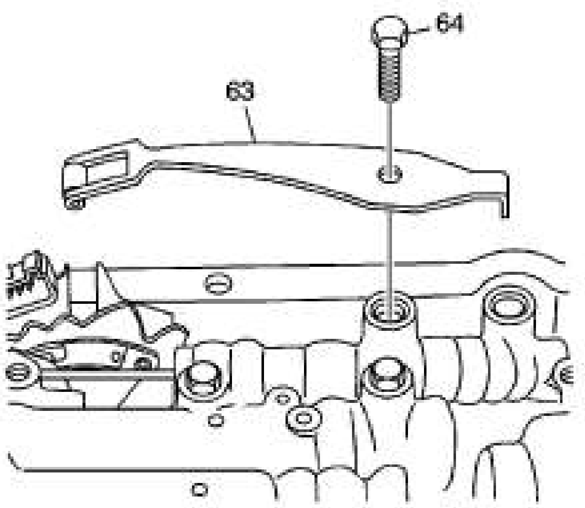
4. Install the low and reverse clutch support (679), roller clutch and roller clutch race (675) assembly into the case. Position the hub side down during the installation.



Important: Align the opening of the low and reverse clutch support retainer ring (676) with the low and reverse clutch support retainer spring (680). It is important that the low and reverse clutch support retainer ring opening is centered around the retainer spring. This will allow the retainer ring to fully seat in all of the transmission case lugs. If the retainer ring lays up against the retainer spring, the retainer ring will not fully seat. Possible damage to the transmission case lugs can occur if the low and reverse clutch support retainer ring is not fully seated in the transmission case lug.

5. Install the low and reverse support retainer ring (676) into the case.

Manual Detent Spring Installation



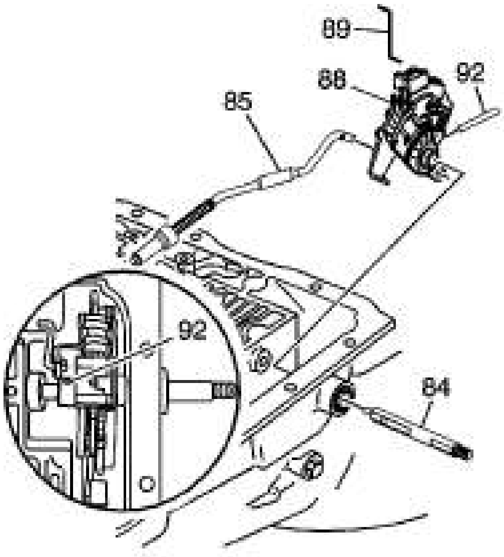
1. Inspect the manual detent spring assembly (63) for cracks or damage.
2. Install the manual detent spring assembly (63).

   Caution: Refer to Fastener Caution in the Preface section.

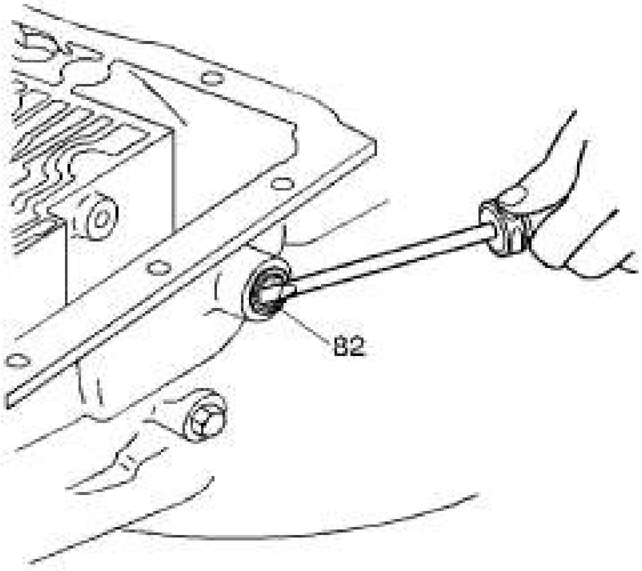
3. Install the manual detent spring bolt (64). Tighten the bolt to **20-27 N·m (15-20 lb ft)**.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 4L60-E/4L65-E/4L70-E | Repair Instructions - Off Vehicle | **Document ID: 2036970**

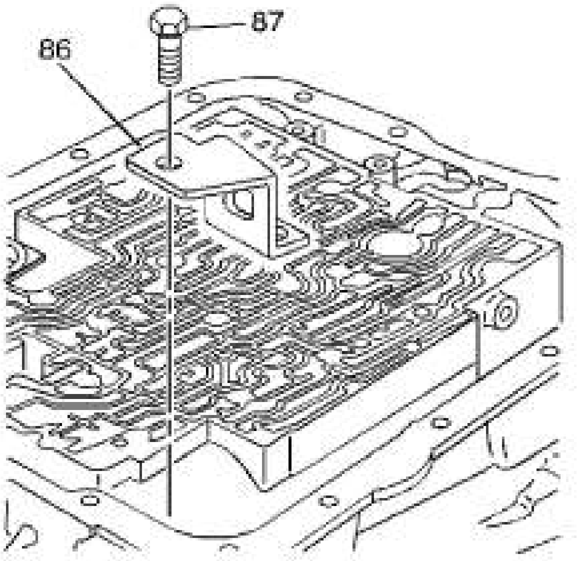
Manual Shift Detent Lever with Shaft Position Switch Assembly and Park Pawl Actuator Removal



1. Remove the following parts:
   1. 1.1. Manual valve link (89)
   2. 1.2. Manual shift detent lever hub pin (92) discard, do not reuse
   3. 1.3. Manual shift detent lever with shaft position switch assembly (88)
   4. 1.4. Parking lock actuator assembly (85)
   5. 1.5. Manual shaft (84)

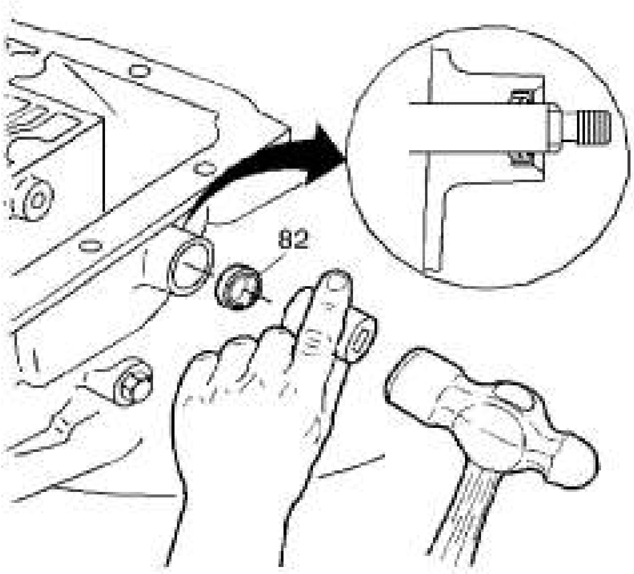


2. Remove the manual shaft seal (82) with a screwdriver.



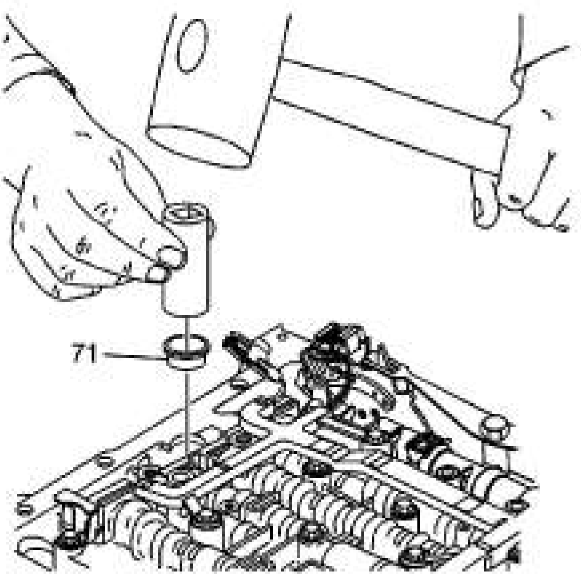
3. Remove the following components:
   - 3.1. The parking lock bracket bolt (87)
   - 3.2. The parking lock bracket (86)

Manual Shift Shaft Seal Installation

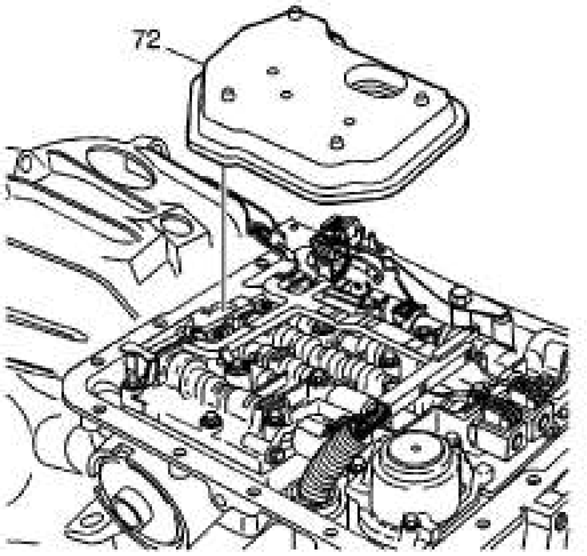


Install a new manual shaft seal (82).

Oil Filter Assembly Installation



1. Lubricate the filter seal (71) with transmission fluid.
2. Use a socket the same size diameter as the filter seal (71) and install the seal.

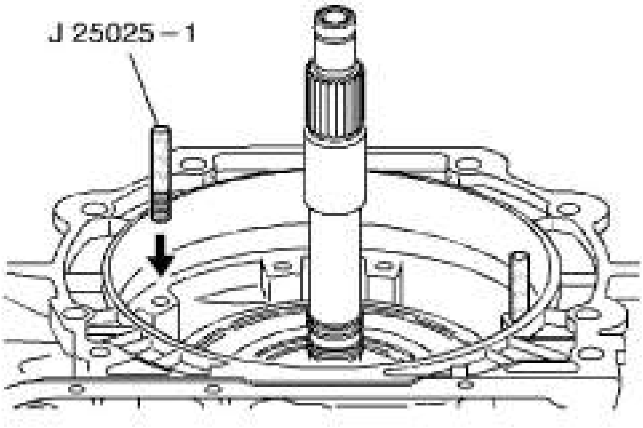


3. Install the transmission oil filter assembly (72).

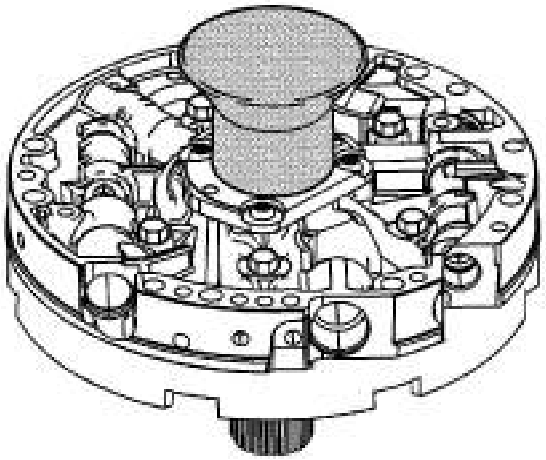
Oil Pump Assembly Installation

Tools Required

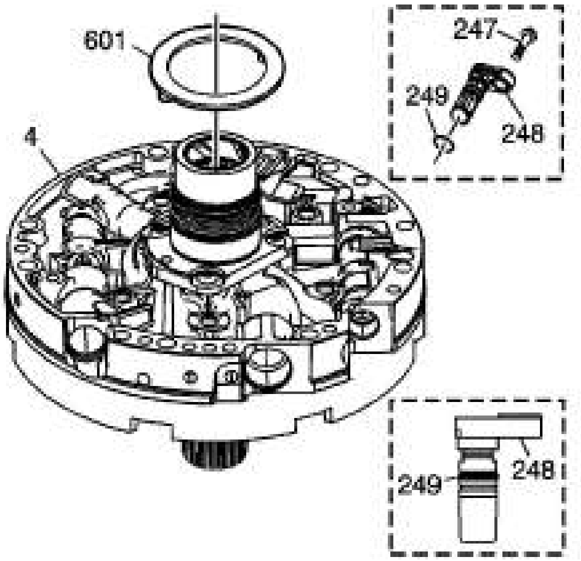
- J 25025-1 Dial Indicator Mounting Post
- J 39855 Stator Shaft Seal Installer



1. Install the J 25025-1 .



2. Remove the J 39855-2 which is part of kit J 39855 .

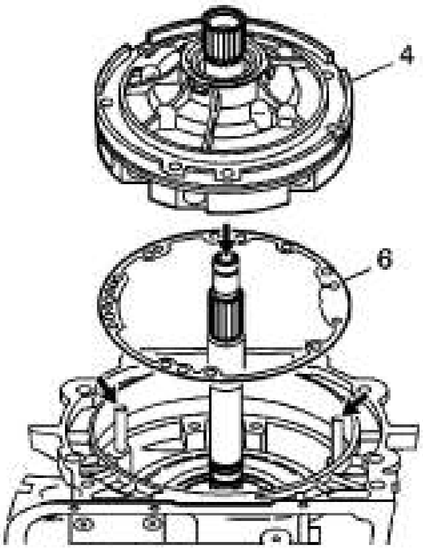


3. Install the pump to drum thrust washer (601).
4. Use J 36850 or equivalent to retain the washer to the pump.
5. For pump assemblies with an ISS hole plug (248), lubricate a NEW O-ring (249) with transmission fluid, and install onto the ISS hole plug (248).
6. Install the ISS hole plug (248) into the ISS hole and align with the mounting hole.

   Notice: Refer to Fastener Notice in the Preface section.

7. Install the retaining bolt (247).

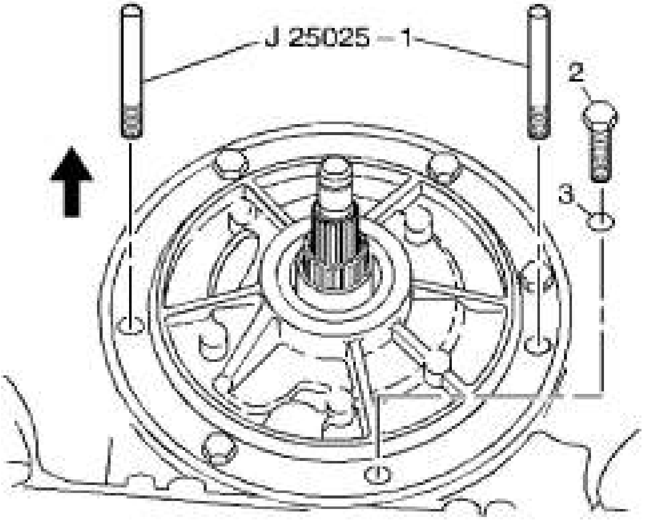
   Tighten
   Tighten the retaining bolt to 9-11 N·m (6.6-8.1 lb ft).



8. Install the pump cover to case gasket (6).

   Important: The oil pump to case seal is installed after the oil pump assembly, during torque converter installation. Refer to Converter Housing Installation.

9. Install the oil pump assembly (4) into the case and align all holes properly.

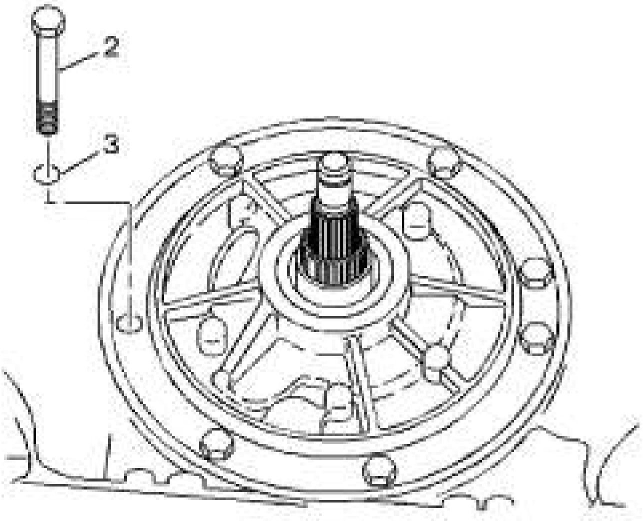


   Important: The pump to case retaining bolt O-ring seals (3) must be replaced.

10. Install the pump to case retaining bolts (2) with new O-ring seals (3).

    Tighten
    Tighten the retaining bolts to 29 N·m (21 lb ft).

11. Remove the J 25025-1 .



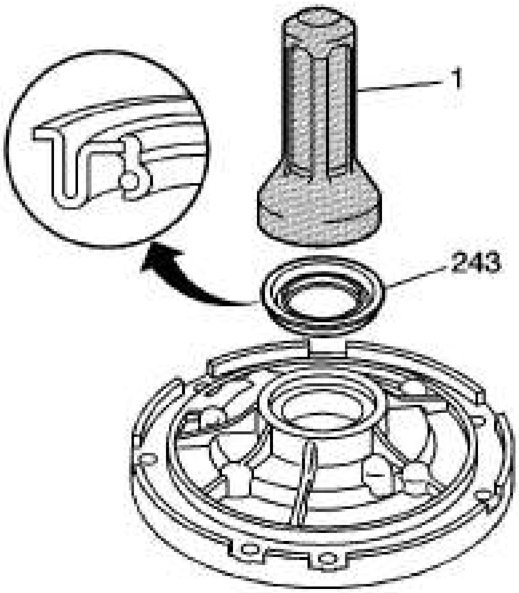
12. Install the remaining pump to case retaining bolts (2) and O-ring seals (3), in the holes where the J 25025-1 were.

Tighten
Tighten the retaining bolts to 29 N·m (21 lb ft).

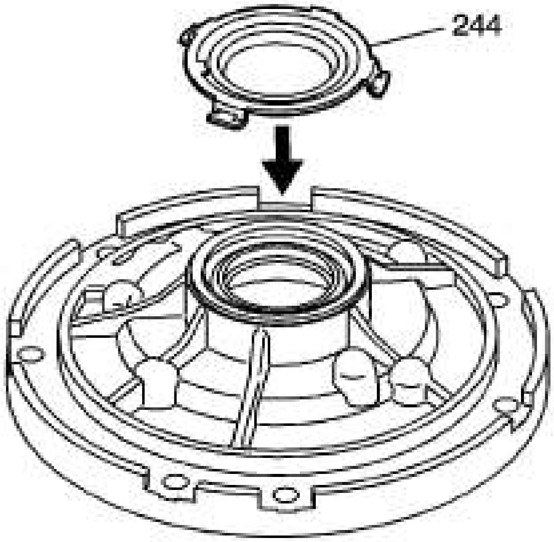
Oil Pump Body Assemble

Tools Required

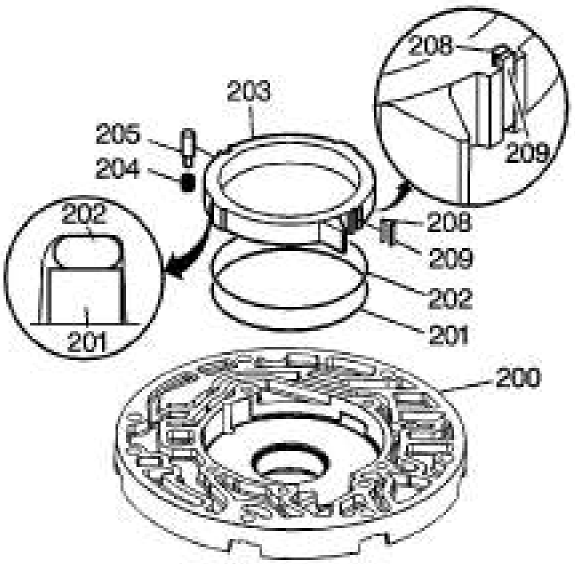
J 25016 Pump Seal and Speedometer Gear Installer



1. Using the J 25016 (1), install the oil seal assembly (243).



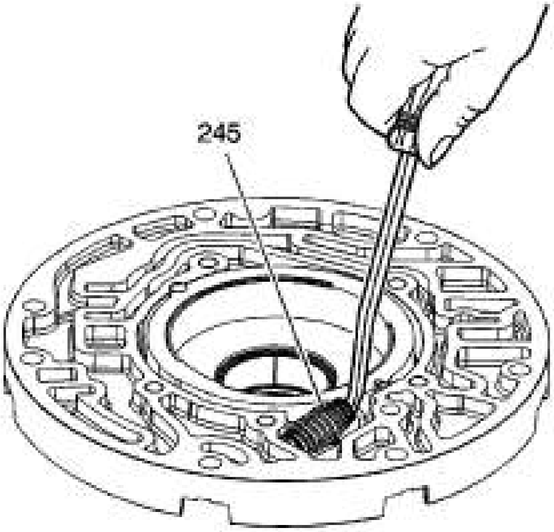
2. Install the front helix retainer (244).



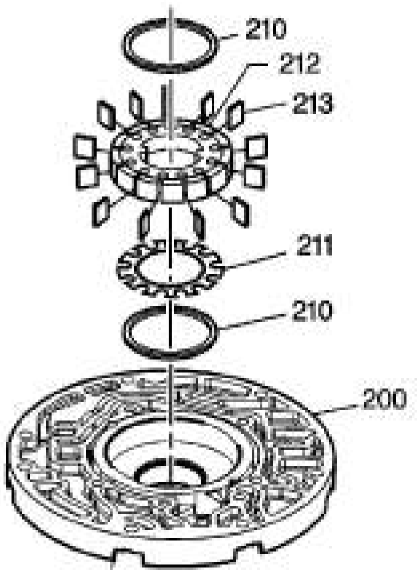
3. Install an O-ring seal (202) and oil seal ring (201) into the groove on the back side of the pump slide (203).
4. Use J 36850 , or an equivalent, to retain the seal and the ring on the slide.
5. Install the pivot pin spring (204) and the pivot pin (205).
6. Install the pump slide (203).
7. Index the slide notch with the pivot pin (205).

   The oil seal ring must face downward into the pump pocket.

8. Install the pump slide seal support (208) and the pump slide seal (209).



9. Install the fluid pump slide outer spring (245).

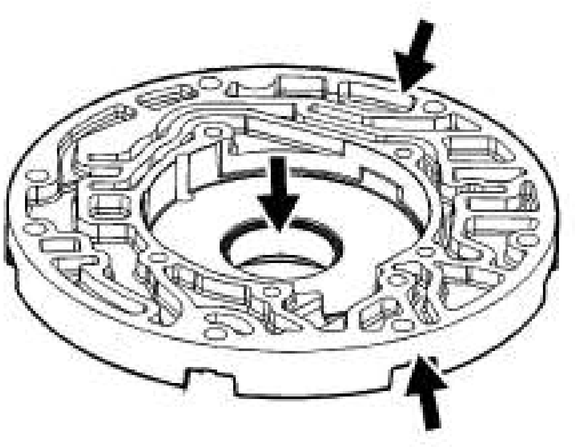


10. Install the bottom pump vane ring (210) and the rotor guide (211) into the rotor (212) and retain with J 36850 or an equivalent.
11. Install the rotor (212) with the rotor guide (211) toward the pump pocket.
12. Install the pump vanes (213).
13. Install the top pump vane ring (210).

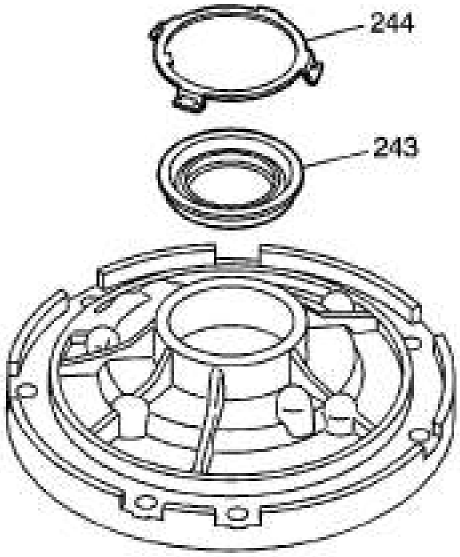
Oil Pump Body Bushing Replacement

Tools Required

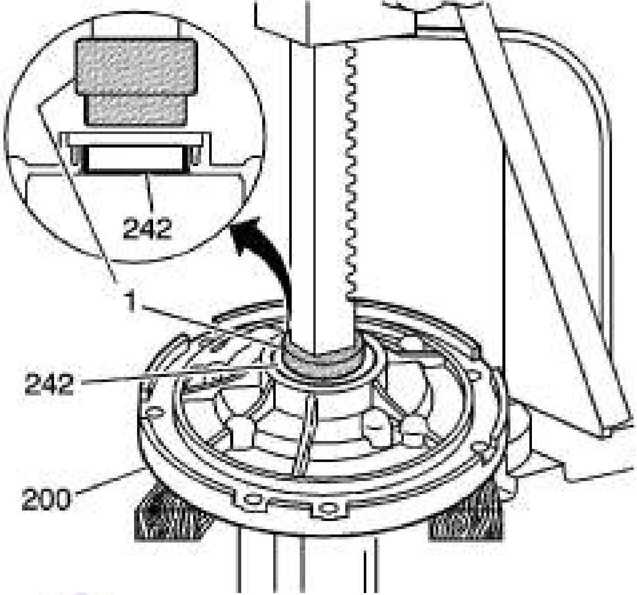
- J 41778-1 Pump Body Bushing Installer/Remover
- J 41778-2 Pump Body Bushing Position Stop



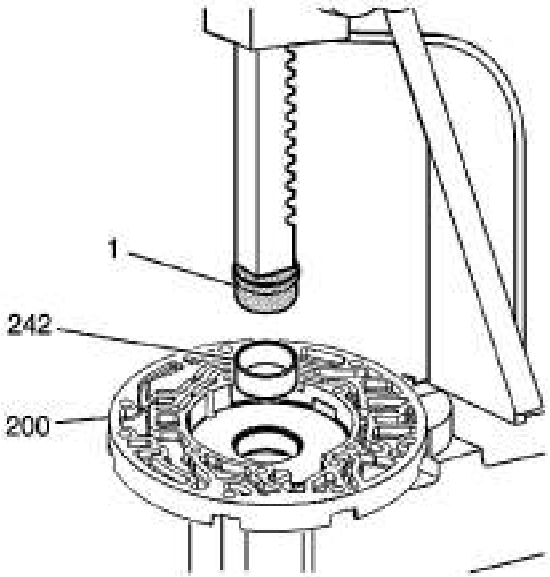
1. Inspect the oil pump body for the following:
   - Worn or damaged bushings
   - Foreign material or debris
   - Porosity
   - Scored or irregular mating faces
   - Cross channel leaks



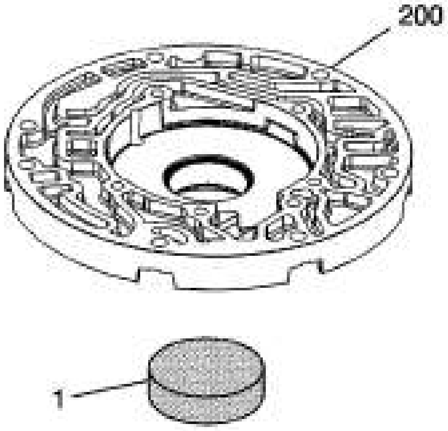
2. Remove the front fluid seal retainer (244).
3. Remove the oil seal assembly (243).



4. Using the J 41778-1 (1) with an arbor press, remove the pump body bushing (242).

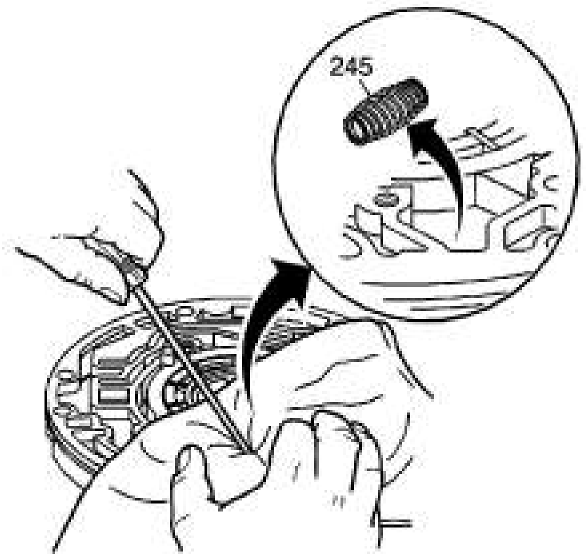


5. Using J 41778-1 (1) with an arbor press, install a new pump body bushing (242).

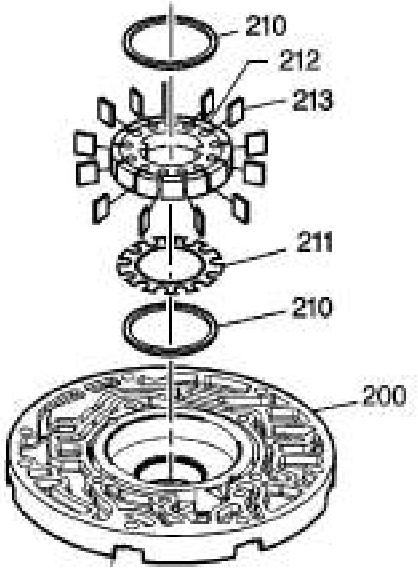


6. Use the J 41778-2 (1) to make sure proper bushing depth.

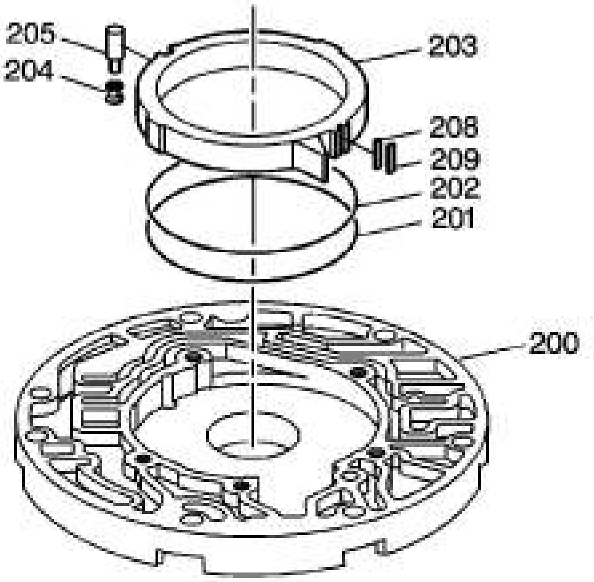
Oil Pump Body Disassemble



1. Remove the pump slide outer spring (245).
2. Place a rag over the spring while removing to prevent the spring from flying out.



3. Remove the oil pump rotor (212) and pump vane rings (210).
4. Remove the pump vanes (213).
5. Remove the rotor guide (211).

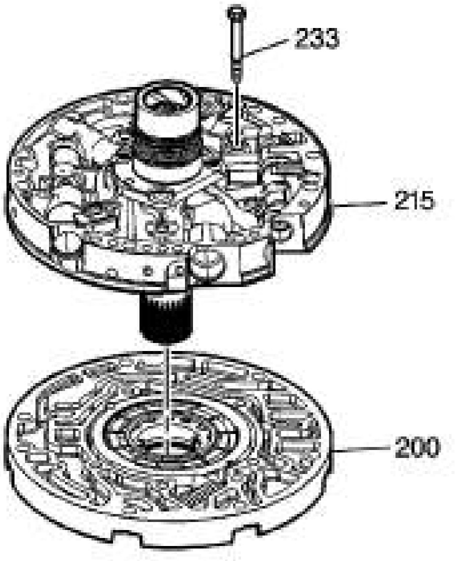


6. Remove the pump slide (203), pump slide support seal (208) and the pump slide seal (209).
7. Remove the slide seal back-up O-ring seal (202) and the oil seal - slide to wear plate, ring (201).
8. Remove the pivot slide pin (205) and the pivot pin spring (204).

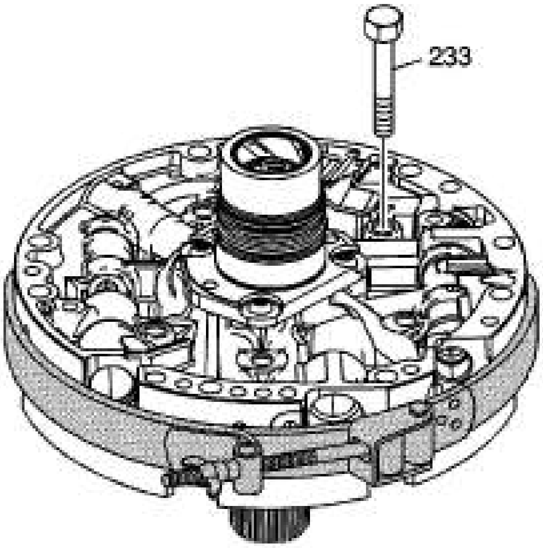
Oil Pump Cover and Body Assemble

Tools Required

J 21368 Pump Body and Cover Alignment Band



1. Place the oil pump cover onto the oil pump body and put stator shaft through a hole in the bench.
2. Install the pump cover retaining bolts (233) finger tight only.



3. Install the J 21368 .

   Notice: Refer to Fastener Notice in the Preface section.

4. Tighten the pump cover retaining bolts (233).

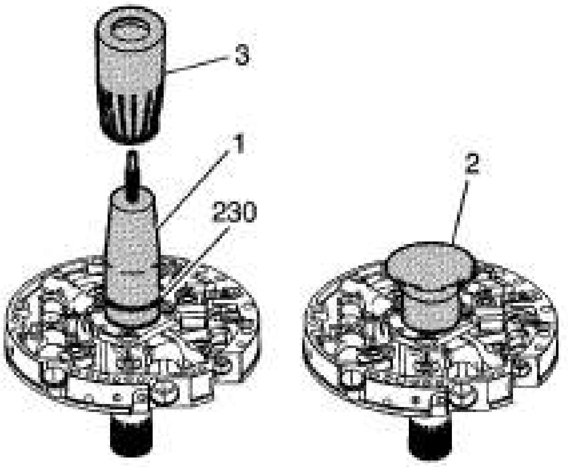
   Tighten
   Tighten the retaining bolts to 24 N·m (18 lb ft).

5. Remove the J 21368 .

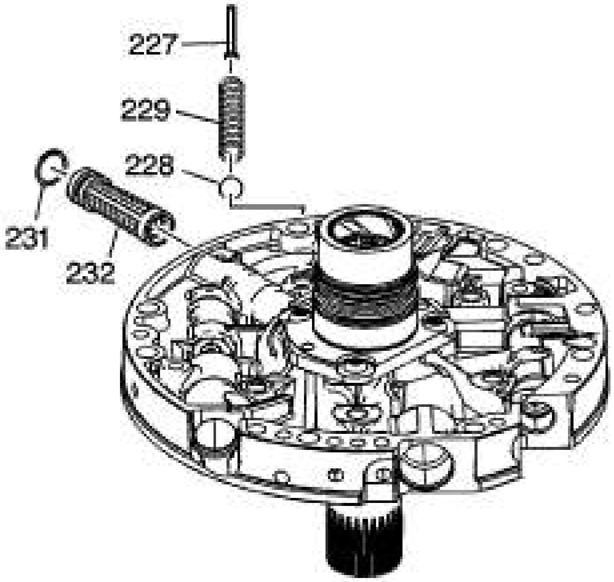
Oil Pump Cover Assemble

Tools Required

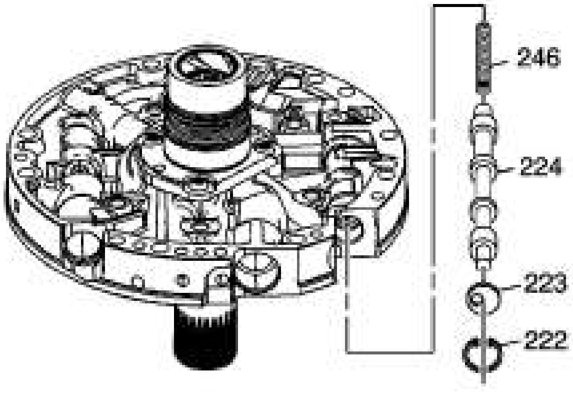
- J 38735-3 Pusher
- J 39855 Stator Shaft Seal Installer



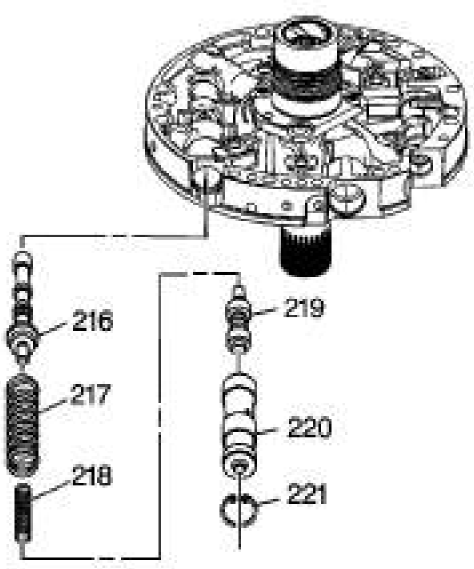
1. Using the J 39855-1 (1) which is part of kit J 39855 and the J 38735-3 (3), install the stator shaft oil seal rings (230).
2. Place J 39855-2 (2) which is part of kit J 39855 over the seals.
3. Leave J 39855-2 (2) which is part of kit J 39855 on the stator shaft until just before the pump is to be installed into the transmission.



4. Install the pressure relief ball (228) and pressure relief spring (229).
5. Install the pressure relief bolt rivet (227).
6. Install the oil pump cover screen seal (231) on the oil pump cover screen (232).
7. Install the oil pump cover screen (232) into the pump cover.

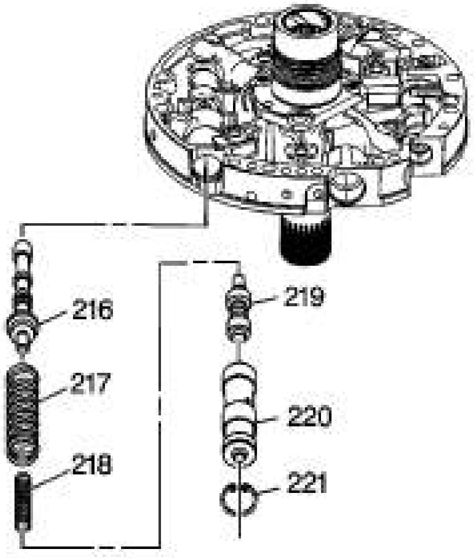


8. Install the converter clutch valve (246).
9. Install the converter clutch valve (224).
10. Install the stop valve (223) and the oil pump converter clutch valve retaining ring (222).

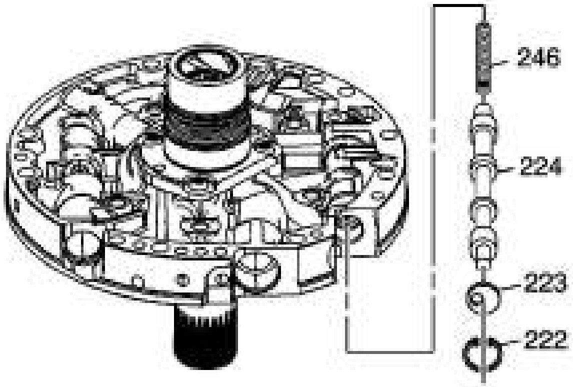


11. Install the pressure regulator valve (216).
12. Install the pressure regulator isolator spring (218) and the pressure regulator valve spring (217).
13. Install the reverse boost valve (219) in the reverse boost valve sleeve (220).
14. Install the reverse boost valve and sleeve in the pump cover.
15. Install the oil pump reverse boost valve retaining ring (221).

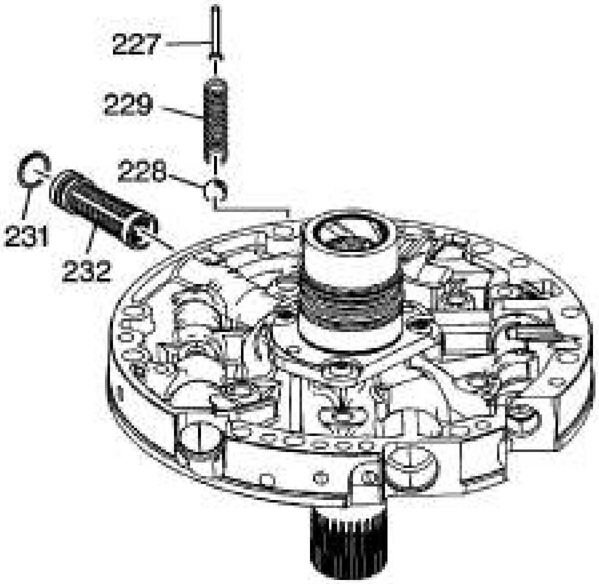
Oil Pump Cover Disassemble



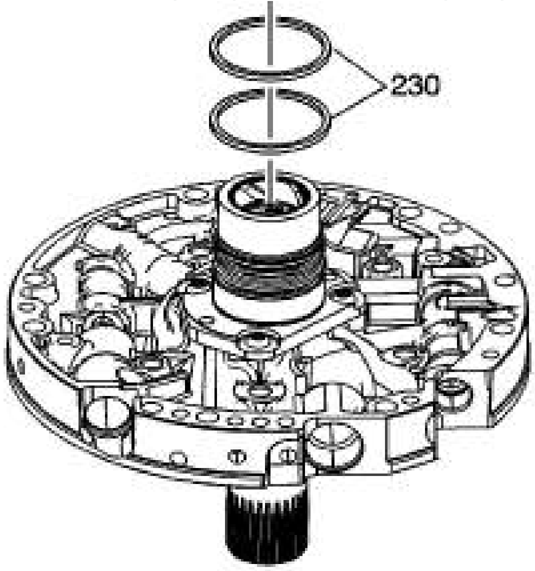
1. Remove the oil pump reverse boost valve retaining ring (221).
2. Remove the reverse boost valve sleeve (220) and the reverse boost valve (219).
3. Remove the pressure regulator isolator spring (218) and the pressure regulator valve spring (217).
4. Remove the pressure regulator valve (216).



5. Remove the oil pump converter clutch valve retaining ring (222).
6. Remove the stop valve (223) and the converter clutch valve (224).
7. Remove the converter clutch valve (246).

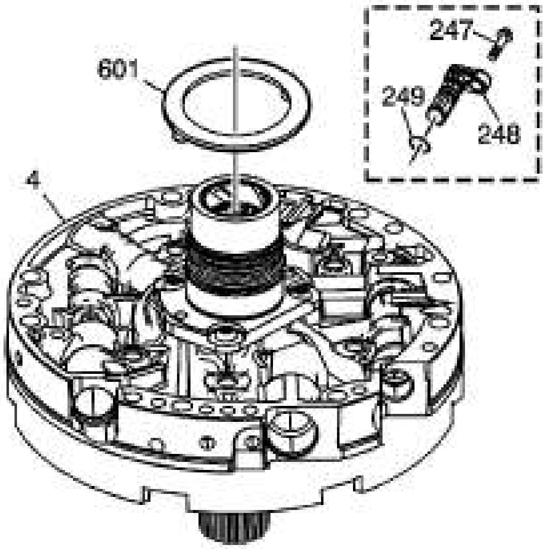


8. Remove the pressure relief bolt rivet (227).
9. Remove the pressure relief spring (229) and the pressure relief ball (228).
10. Remove the oil pump cover screen (232) and the oil pump cover screen seal (231).

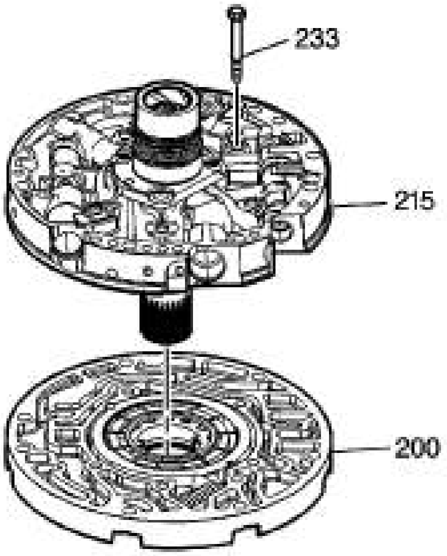


11. Remove the stator shaft oil seal rings (230).

Oil Pump Disassemble



1. Remove the thrust (pump to drum) washer (601).
2. For pump assemblies with an ISS hole plug (248), remove plug bolt (247) and ISS plug (248).
3. Remove the O-ring (249) and discard.



4. Remove the pump cover bolts (233).
5. Remove the pump cover (215) from the pump body (200).

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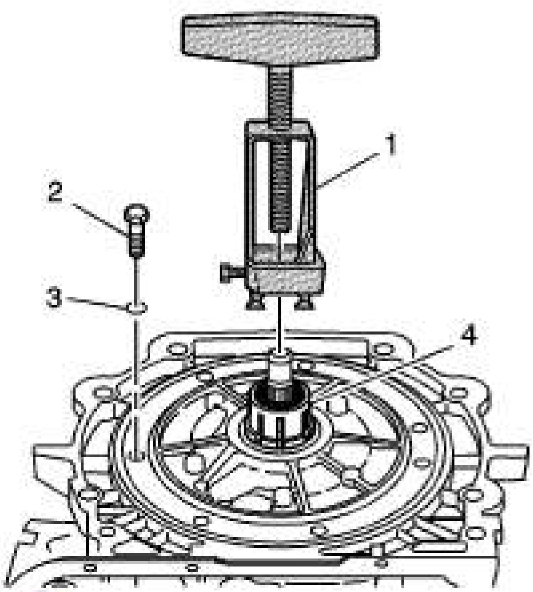
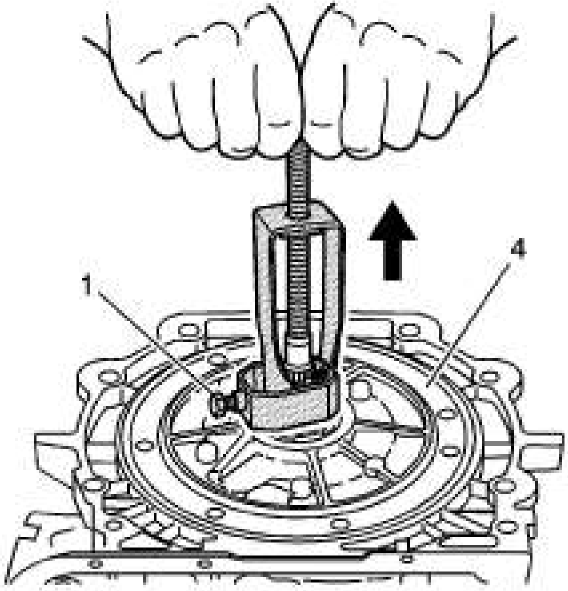
Oil Pump Removal

Tools Required

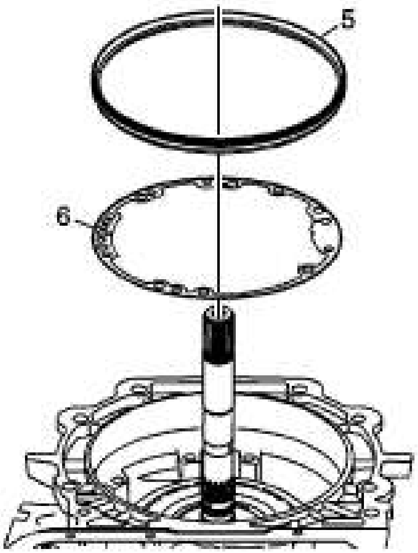
- J 37789-A Oil Pump Remover/Installer
- J 39119 Oil Pump Remover/Installer Adapter



1. Remove all pump retaining bolts (2) and pump bolt seals (3).
2. Install J 39119 (4) over stator shaft until it locks under splines.
3. Install J 37789-A (1).



4. To prevent slipping, securely fasten the J 37789-A J 37789-A around the J 39119 by tightening the bolt (1) with a wrench.
5. Turn the T-handle on top of J 37789-A .
6. Lift the pump (4) out of the case.



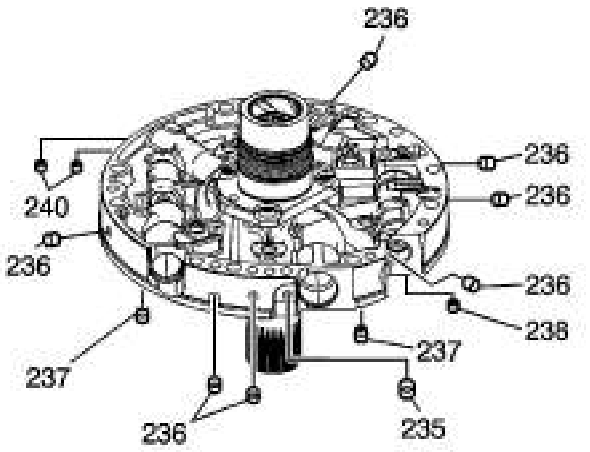
7. Remove the fluid pump seal (5).
8. Remove the pump cover to case gasket (6).

Oil Pump Stator Shaft Bushing Replacement

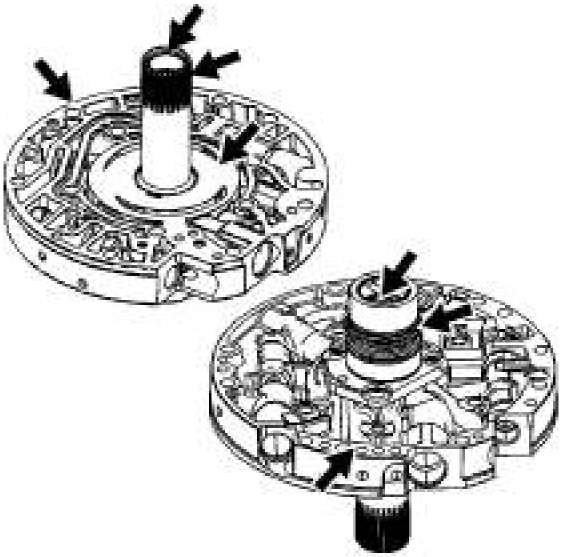
Tools Required

- J 7004-A Universal Remover
- J 8092 Universal Driver Handle - 3/4 in - 10
- J 21465-01 Bushing Service Set
- J 25019-14 Bushing Installer
- J 34196-B Transmission Bushing Service Set

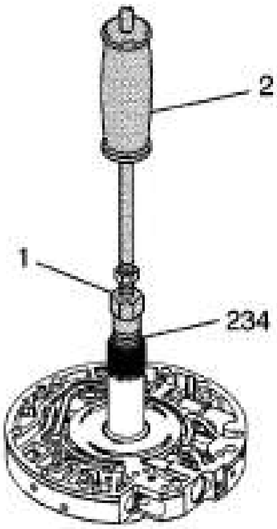
Removal Procedure



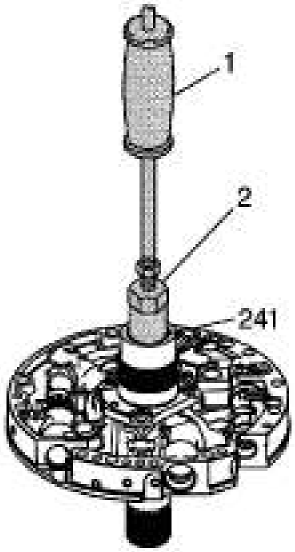
1. Inspect the pump cover, all check valve retainer and ball assemblies (237), cup plugs (235, 236) and orificed cup plugs (238, 240).



2. Inspect the pump cover for the following conditions:
   - Worn or damaged bushings.
   - Foreign material or debris.
   - Porosity.
   - Scored or irregular mating faces.
   - Cross channel leaks.

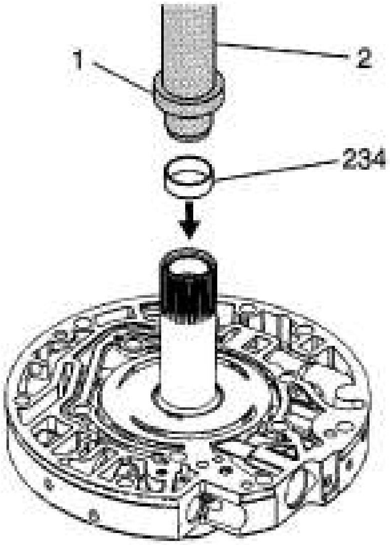


3. Using the J 21465-15 (1) with the J 7004-A (2), remove the stator shaft front bushing (234).

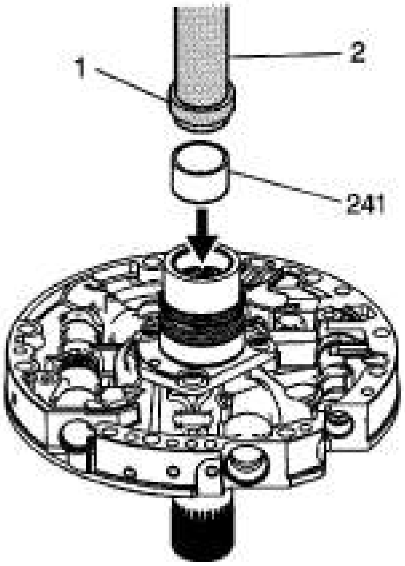


4. Using the J 25019-14 (2) with the J 7004-A (1), remove the stator shaft rear bushing (241).

Installation Procedure



1. Using the J 21465-2 (1) and the J 8092 (2), install a new stator shaft front bushing (234).

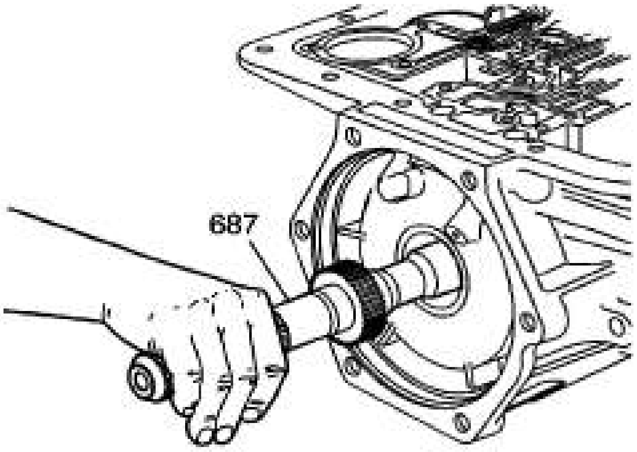


2. Using the J 34196-2 (1) which is part of kit J 34196-B and the J 8092 (2) , install the stator shaft rear bushing (241).

Output Shaft Installation

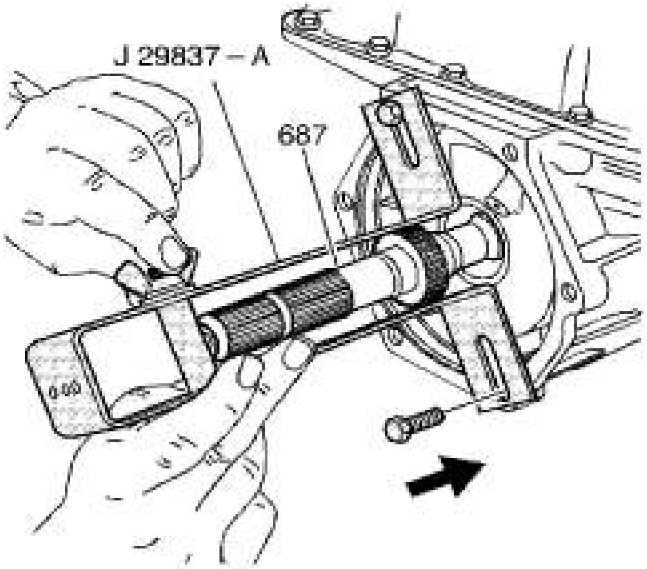
Tools Required

J 29837-A Output Shaft Support Fixture.



Important: It is important to note that the input shaft may need a light tap to fully seat into position. If the input shaft is not completely engaged, the output shaft to input carrier retainer will not seat.

1. Install the output shaft (687).

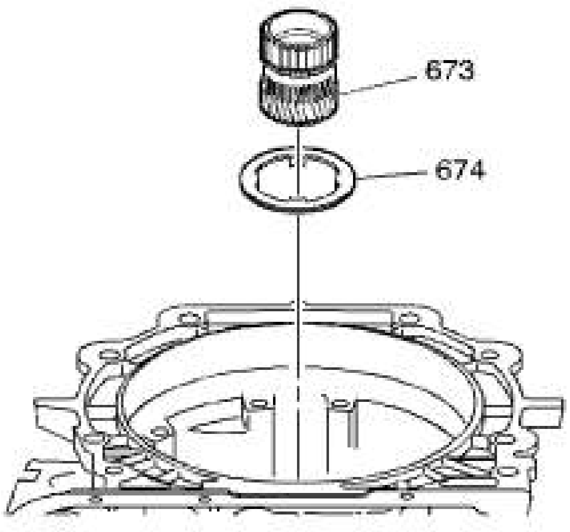


2. Install the J 29837-A .

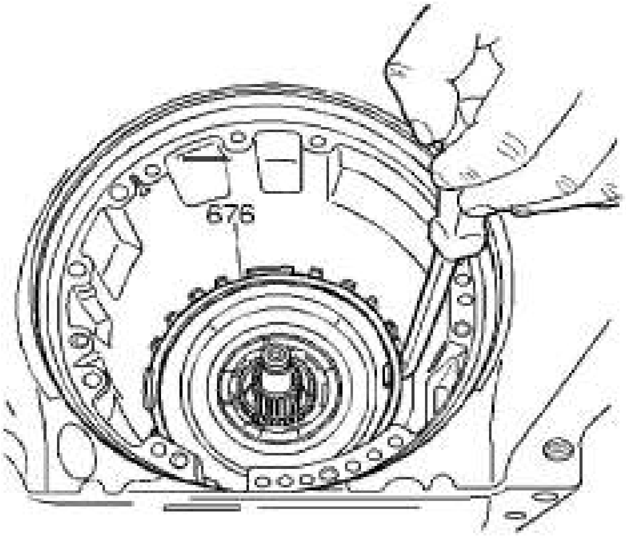
Output Shaft, Reaction Gear, Low / Rev Clutch Removal

Tools Required

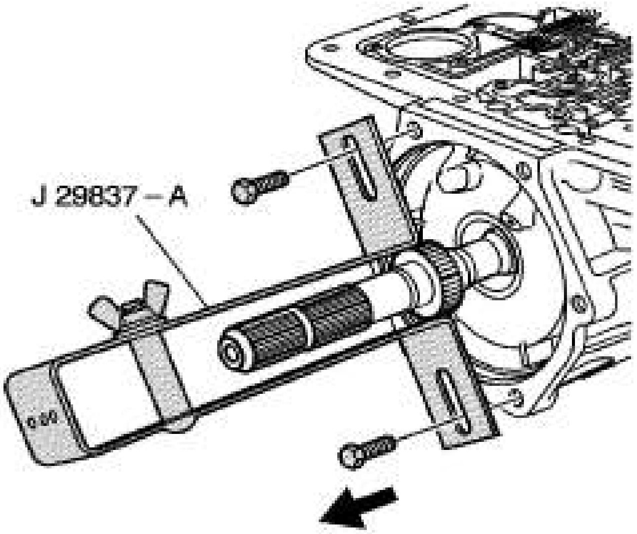
J 29837-A Output Shaft Support Fixture



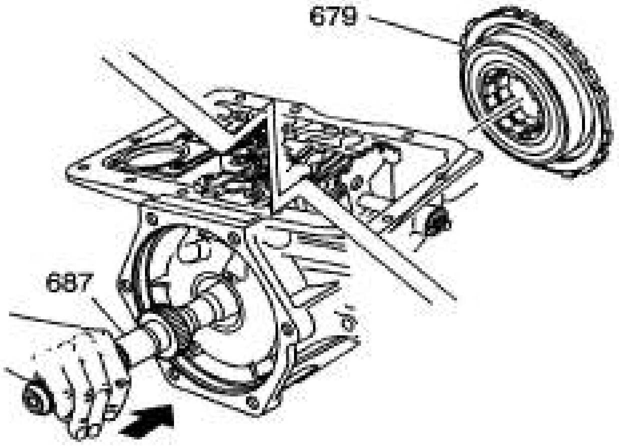
1. Remove the reaction sun gear (673) and the thrust washer (674).



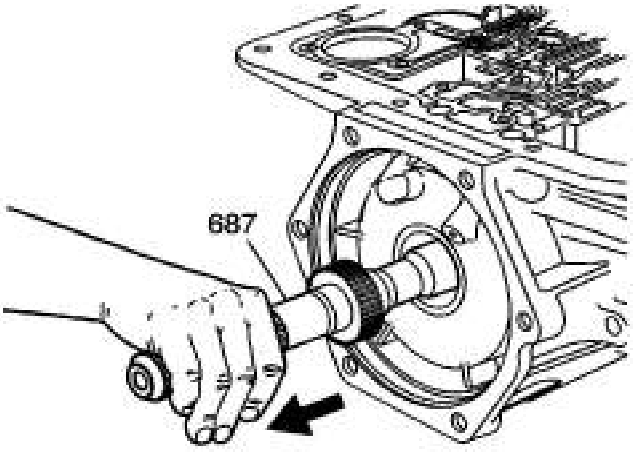
2. Remove the low and reverse support retainer ring (676).



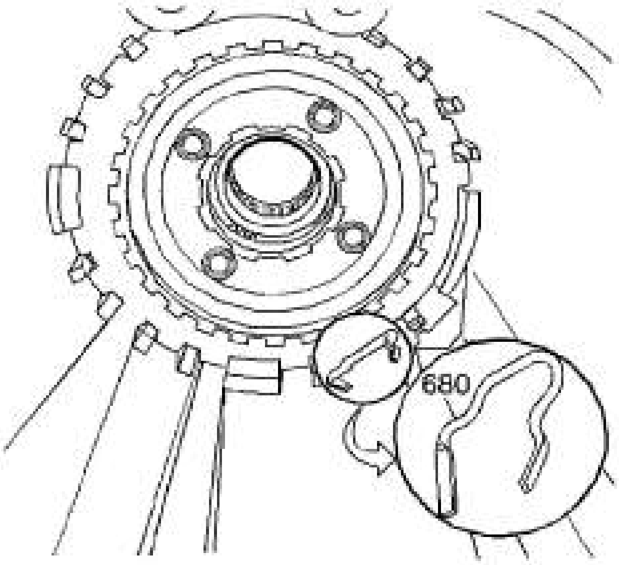
3. Remove the J 29837-A .



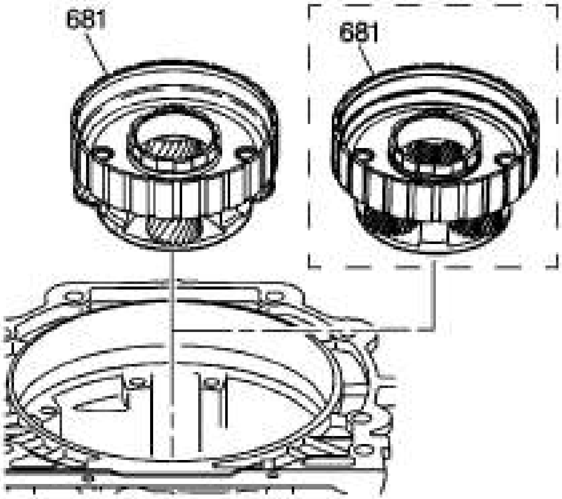
4. Push on the output shaft (687) in order to loosen the low and reverse clutch support (679).
5. Remove the low and reverse clutch support (679).



6. Remove the output shaft (687).

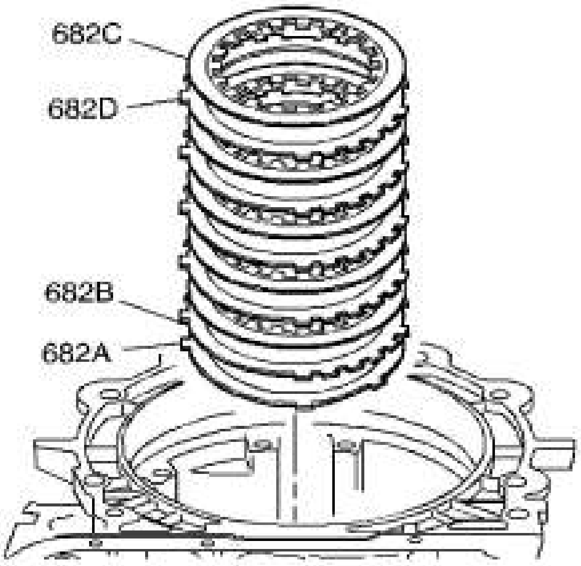


7. Remove the low and reverse clutch support retainer spring (680).

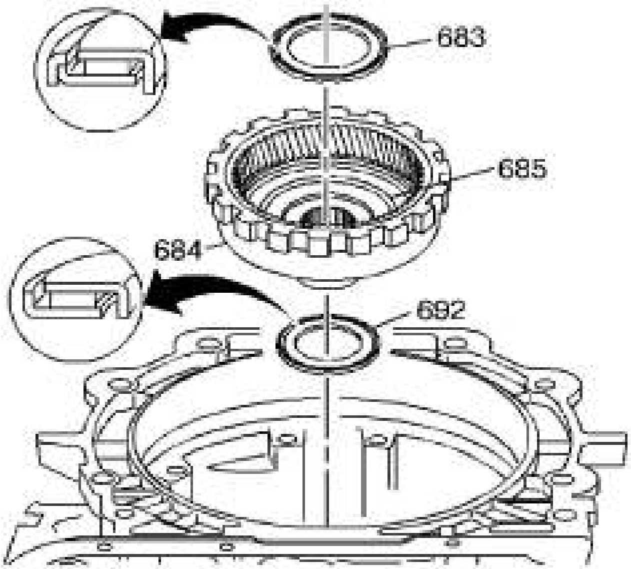


Important: The reaction carrier assembly (681) can be a 4 or 5 pinion design depending on the transmission model.

8. Remove the reaction carrier assembly (681).

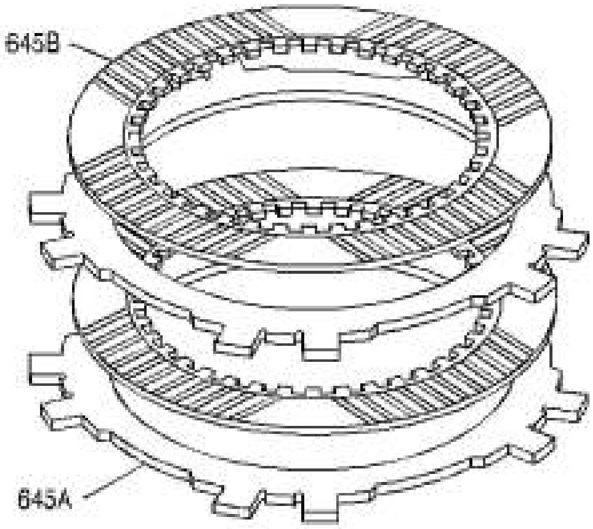


9. Remove the following components:
    9.1. The low and reverse clutch fiber plate assembly (682C)
    9.2. The low and reverse clutch steel plates (682D)
    9.3. The low and reverse clutch selective plate (682B)
    9.4. The low and reverse clutch waved plate (682A)

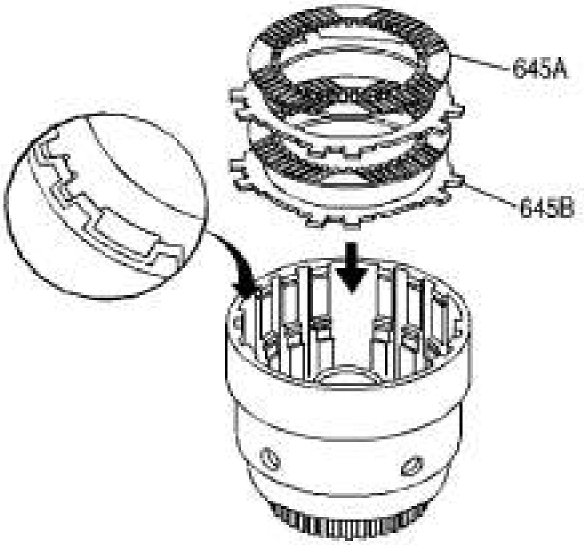


10. Remove the following components:
    10.1. The thrust bearing assembly (reaction carrier support) (683)
    10.2. The internal reaction gear (684)
    10.3. The internal reaction gear support (685)
    10.4. The reaction gear support bearing (692)

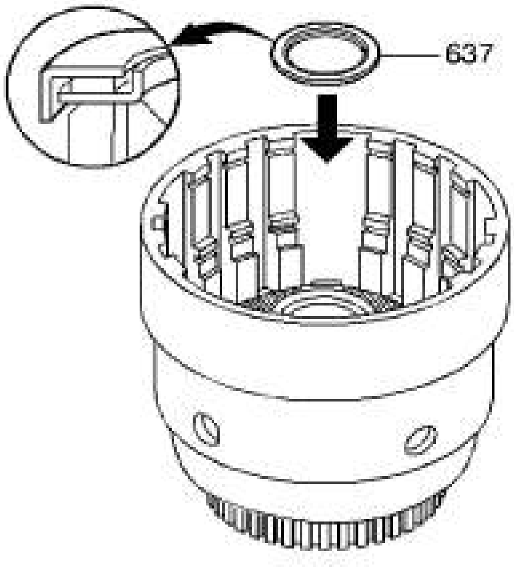
Overrun Clutch Installation



1. Inspect the fiber plate assemblies (645B) and the steel plates (645A) for the following defects:
    - Damaged tangs
    - Delamination
    - Excessive wear
    - Wear or heat damage



2. Install the overrun clutch plates into the input housing starting with a steel plate (645B) and alternating with fiber plate assemblies (645A).
3. Index the plates in the input housing with the wide notches remaining open.



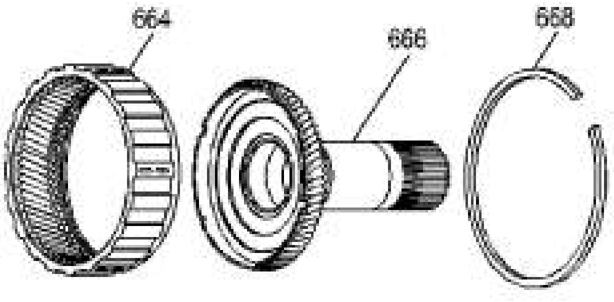
4. Install the input sun gear bearing assembly (637) into the input housing.

Reaction Carrier Shaft Replacement

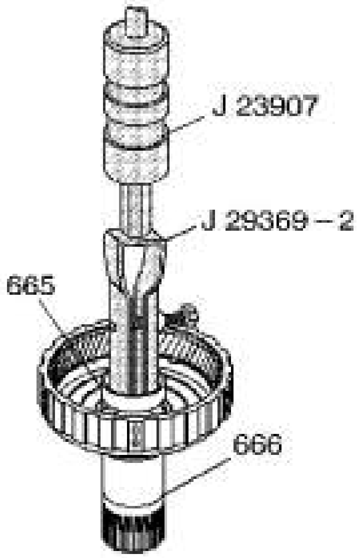
Removal Procedure

Tools Required

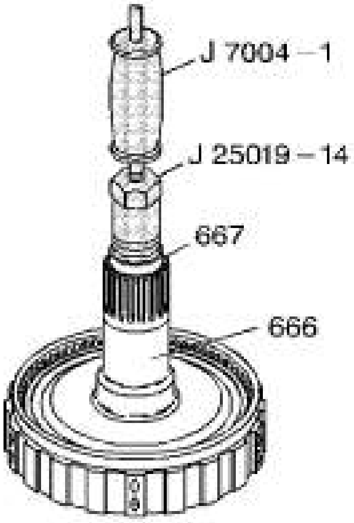
- J 8092 Universal Driver Handle - 3/4 in - 10
- J 7004-A Universal Remover
- J 23907 Slide Hammer with Bearing Adapter
- J 25019-14 Stator Pump Bushing Remover
- J 29369-2 Bushing and Bearing Remover 2-3 in
- J 34196-B Transmission Bushing Service Set



1. Remove the reaction carrier shaft/internal gear retainer (668) and the reaction carrier shaft (666) from the input internal gear (664).
2. Inspect the reaction carrier shaft (666) and the input internal gear (664) for the following defects:
   - Scoring
   - Cracking
   - Damaged or worn bushings
   - A cracked shaft
   - A damaged spline
   - Damaged gear teeth

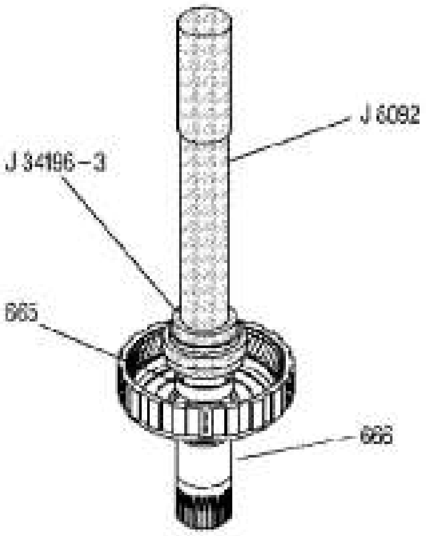

J 23907
J 29369 – 2
665
666

3. Using J 29369-2 with J 23907 , remove the reaction carrier shaft front bushing (665).

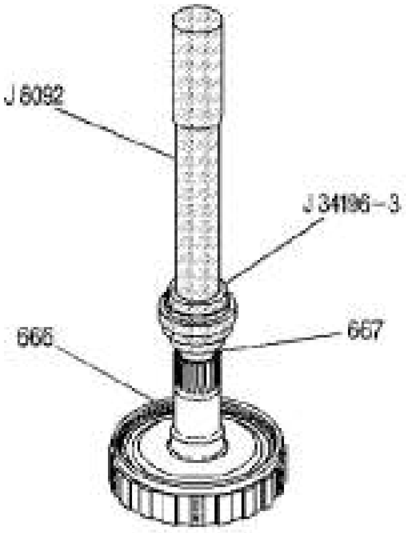

J 7004 – 1
J 25019 – 14
667
666

4. Using J 25019-14 with J 7004-A , remove the reaction carrier shaft rear bushing (667).

Installation Procedure

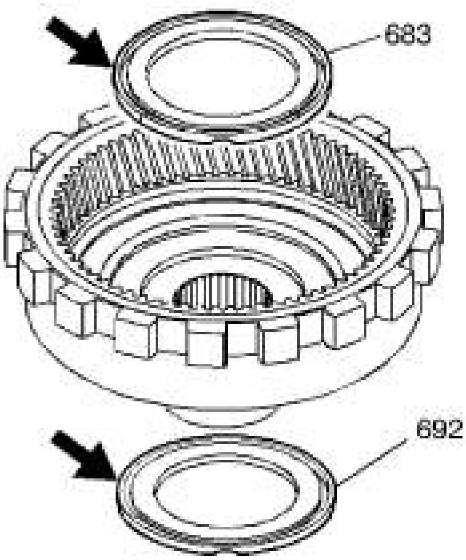

J 8092
J 34196-3
665
666

1. Using J 34196-3 which is part of kit J 34196-B J 34196-B with J 8092 , install a new reaction carrier shaft front bushing (665).

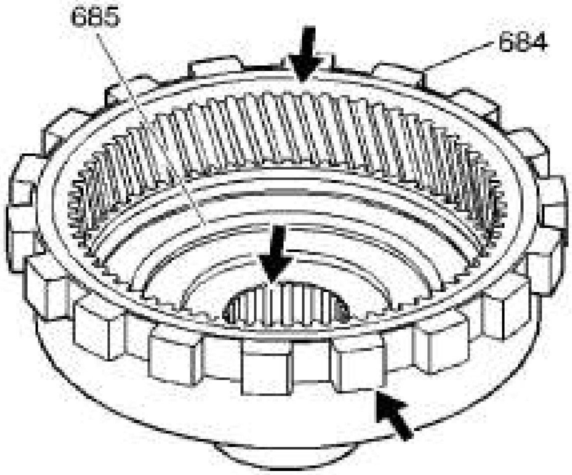

J 8092
J 34196-3
666
667

2. Using J 34196-3 which is part of kit J 34196-B with J 8092 , install a reaction carrier shaft rear bushing (667).

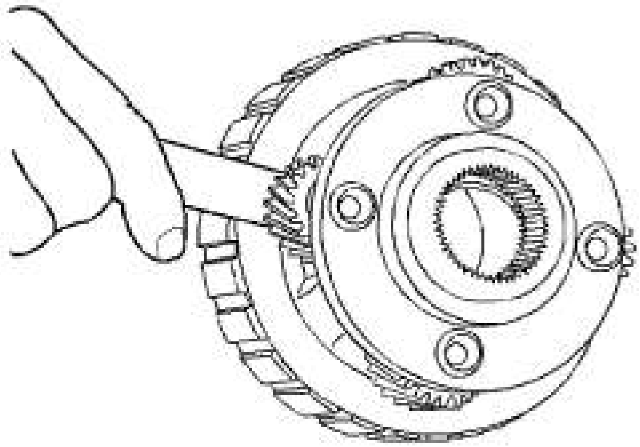
Reaction Gear and Carrier Inspection



1. Inspect the reaction carrier/support thrust bearing assembly (683) for wear or damage.
2. Inspect the reaction gear support to case bearing (692) for wear or damage.



3. Inspect the internal reaction gear (684) and the internal reaction gear support (685) for proper assembly, stripped splines, cracks, teeth, and lug damage.

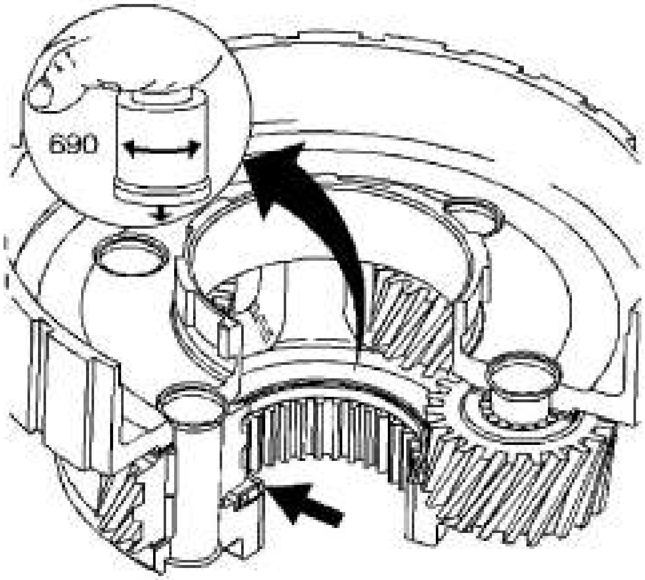


Important: Inspect all pinions, either 4 or 5 depending on model.

4. Check the reaction carrier pinion end play. The end play must not exceed 0.61 mm (0.024 in).

   Inspect the reaction carrier for the following conditions:

   - Pinion gear damage
   - Proper pinion staking
   - Excessive pinion washer wear
   - Keystoned pinion gears
5. Ensure that the pinions turn freely.



6. Inspect the reaction carrier captive thrust bearing for wear or damage.
    6.1. Without touching the pinion gears, place a bushing or an output shaft sleeve (690) onto the bearing race, and turn it with the palm of your hand.
    6.2. Any imperfections will be felt through the bushing.

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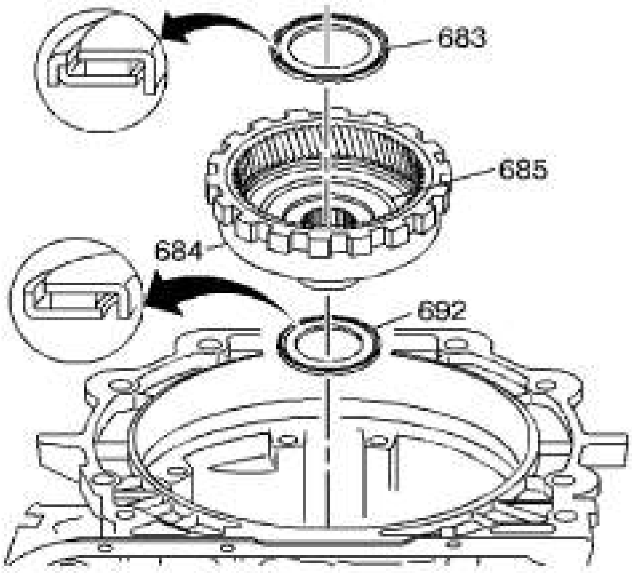
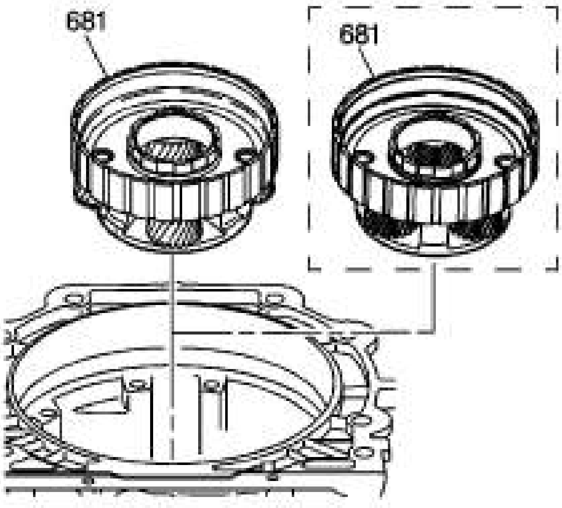
Reaction Gear and Carrier Installation

Tools Required

J 36850 Transjel Lubricant

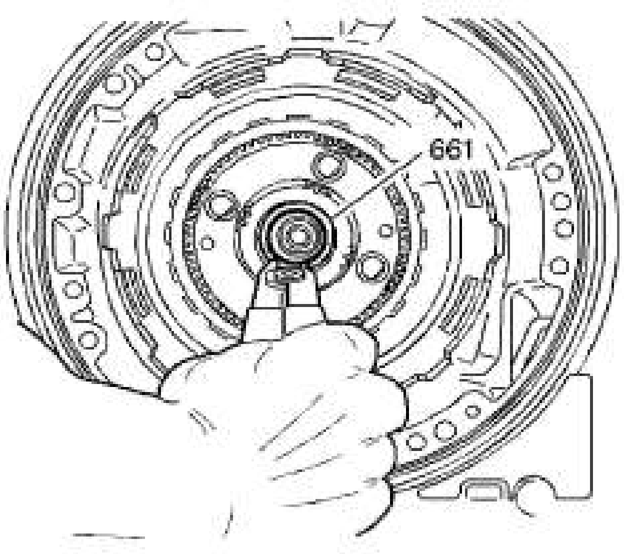


1. Install the reaction gear support to case bearing (692) onto the internal reaction gear support (685). Retain the bearing using J 36850 or equivalent.
2. Install the internal reaction gear (684) and the internal reaction gear support (685) into the case.
3. Install the reaction carrier/support thrust bearing assembly (683) into the internal reaction gear support (685). Retain bearing with J 36850 .



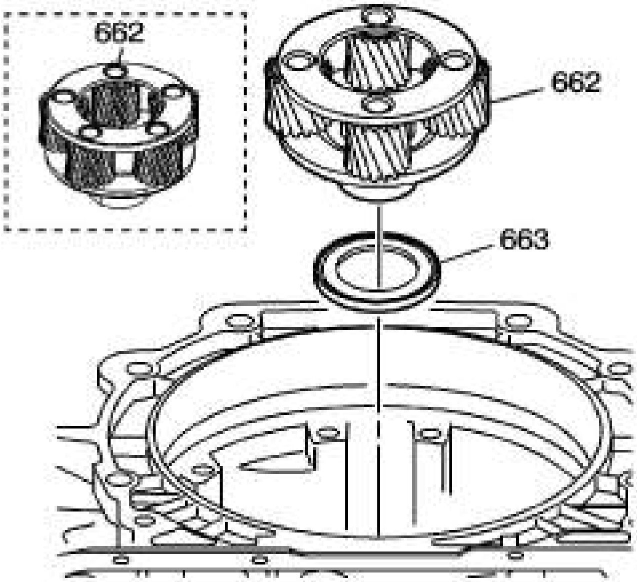
4. Install the reaction carrier assembly (681) into the internal reaction gear.

Reaction Gear Set Removal



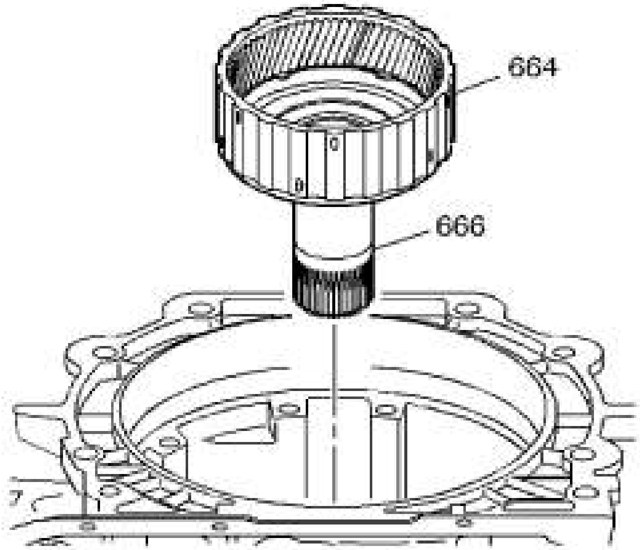
Important: The output shaft retainer ring (661) can not be reused, it must be replaced.

1. Use snap ring pliers to remove the output shaft to retainer snap ring (661).

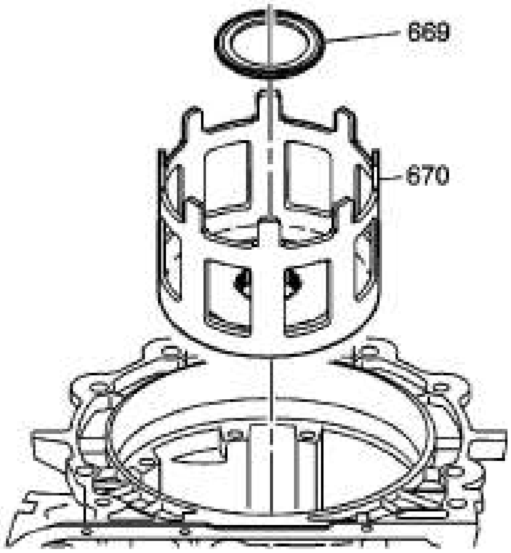


Important: The carrier assembly (662) can be a 4 or 5 pinion design depending on model.

2. Remove the input carrier assembly (662) and remove the thrust bearing assembly (663).



3. Remove the input internal gear (664) and the reaction carrier shaft assembly (666).



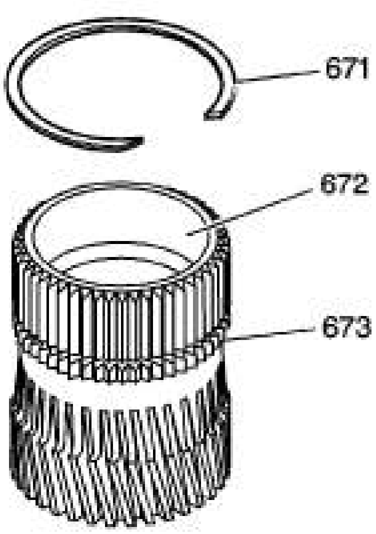
4. Remove the thrust washer (669) and the reaction sun shell (670).

Reaction Sun Gear Installation

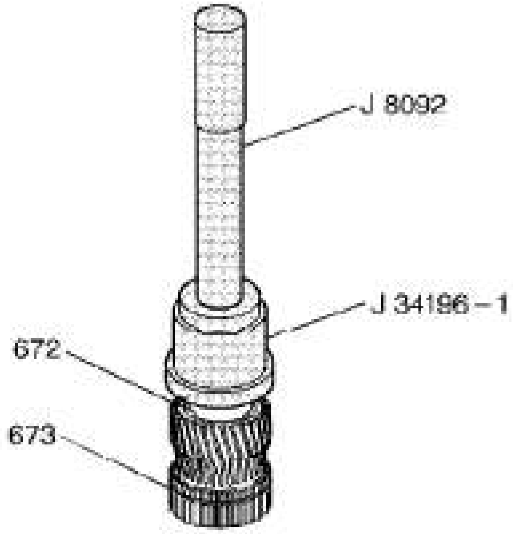
Tools Required

- J 34196-B Transmission Bushing Service Set
- J 8092 Universal Driver Handle - 3/4 in

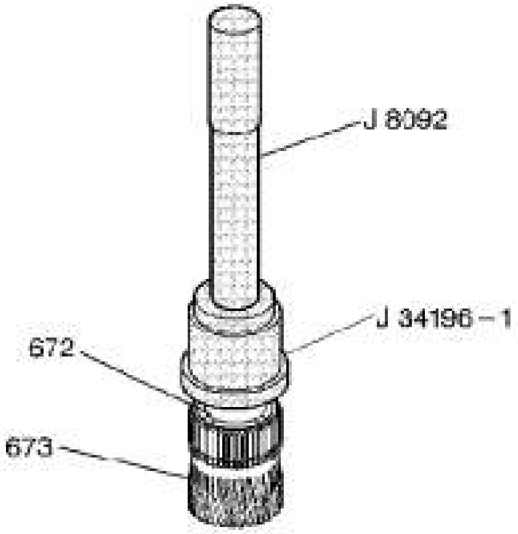
Important: Do not remove the retaining ring (671), except to replace it.



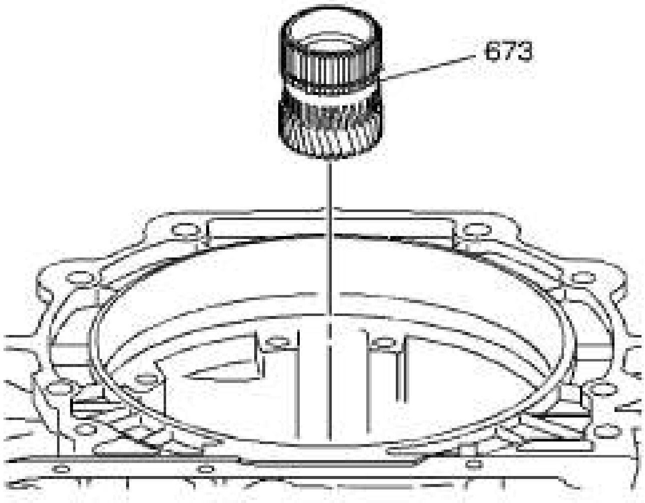
1. Inspect the reaction sun gear (673) for the following defects:
    - Nicks
    - Scores
    - Damaged spline or teeth
    - A worn bushing (672)
    - A loose or weak retaining ring (671)



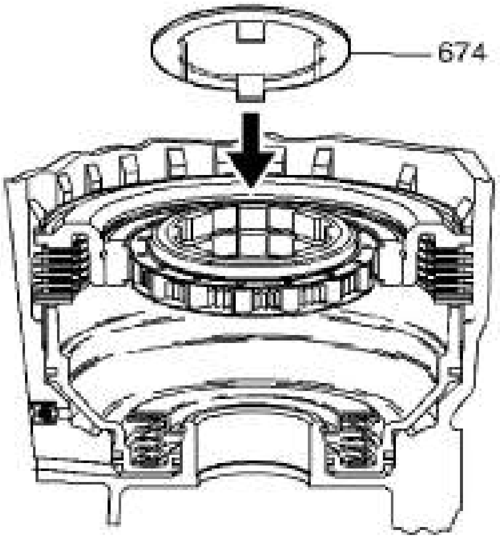
2. If the reaction sun gear bushing (672) needs replacement, use J 34196-1 which is part of kit J 34196-B with J 8092 to remove the reaction sun bushing (672) from the reaction sun gear (673).



3. Using J 34196-1 which is part of kit J 34196-B with J 8092 , install a new reaction sun bushing (672) into the reaction sun gear (673).



4. Install the reaction sun gear (673) into the reaction carrier.



5. Install the thrust washer (674) with the tangs pointing down. Index the tangs of the thrust washer with the splines of the low and reverse roller clutch race.

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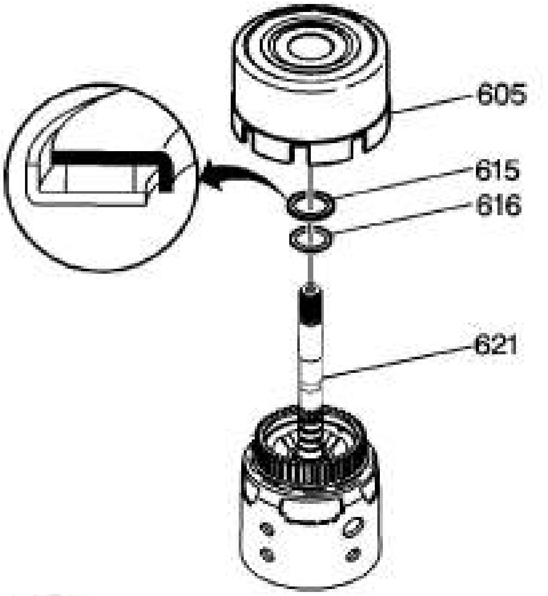
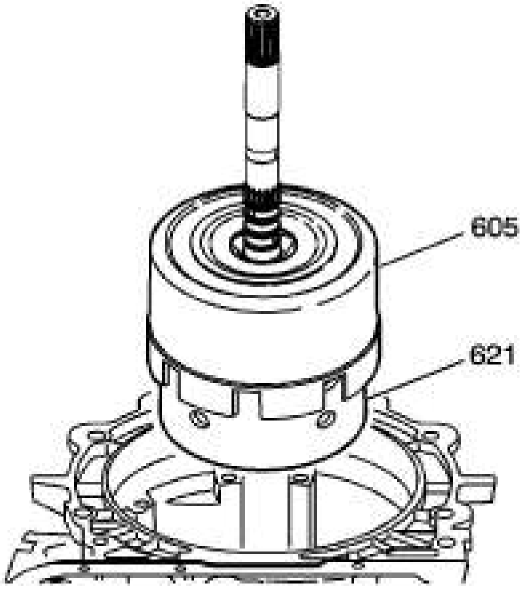
Reverse Input and 3-4 Clutch Housing Installation



1. Install the selective thrust washer (616) on the input housing (621).
2. Install the stator shaft/selective washer bearing assembly (615) on the input housing (621).

   The black race on the bearing goes toward the oil pump.

3. Install the reverse input clutch assembly (605) on the input housing (621).
4. Index the reverse input clutch plates with the input clutch hub. Make certain all clutch plates are fully engaged.

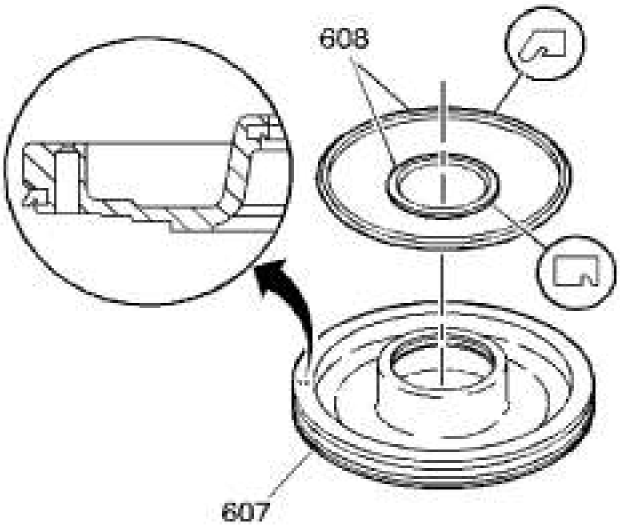


5. Install the reverse input and the input clutch assembly into the transmission case.
6. Index the 3rd and 4th clutch plates with the input internal gear.
   - Ensure that all clutch plates are fully engaged.
   - When properly assembled, the reverse input clutch housing will be located just below the case oil pump face.

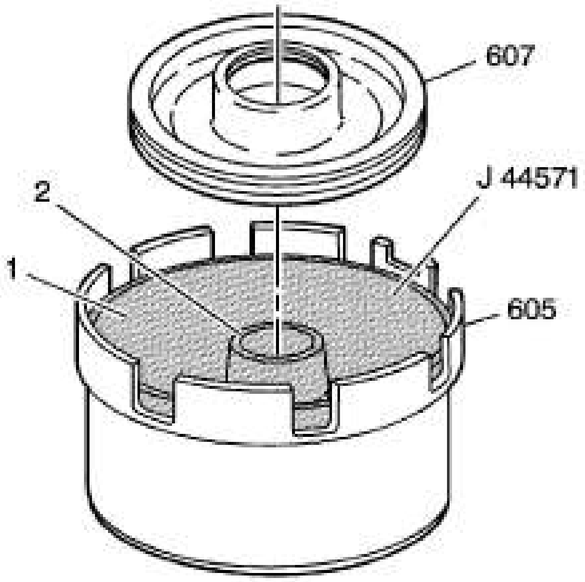
Reverse Input Clutch Assemble

Tools Required

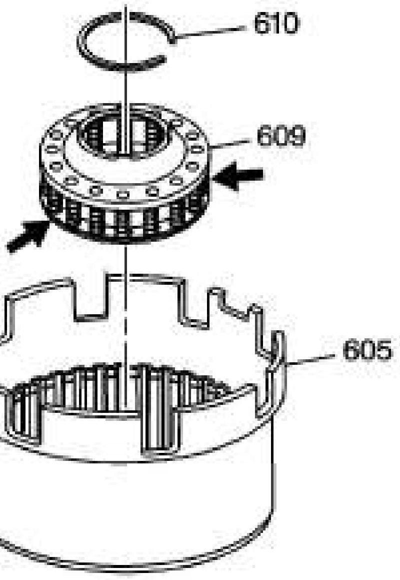
- J 23327-1 Forward Clutch Spring Compressor (Bridge)
- J 25018-A Clutch Spring Compressor Adapter
- J 44571-1 Reverse Input Clutch Piston Installer



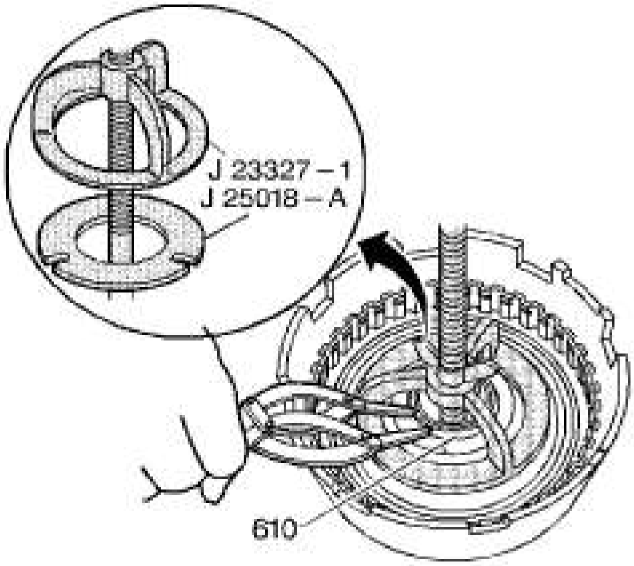
1. Inspect the reverse input clutch piston (607) for the following:
   - Damaged or porosity
   - Ring groove damage
2. Install the reverse input clutch inner and outer seals (608) on the piston.



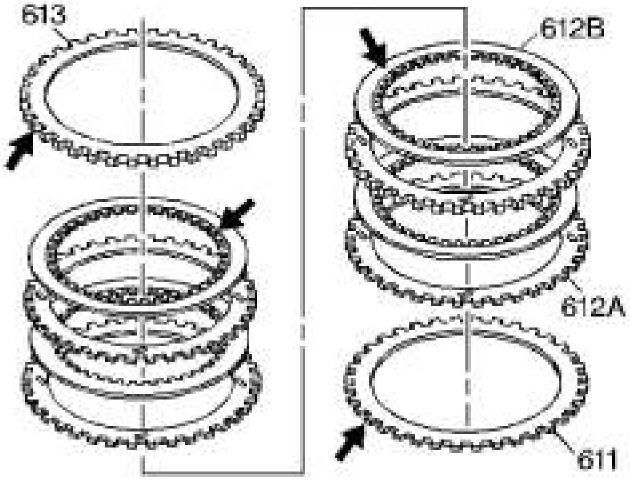
3. Install the J 44571-1 inner (2) and outer (1) reverse input clutch piston installer.
4. Install the reverse input clutch piston (607) into the housing (605).
5. Remove the J 44571-1 .



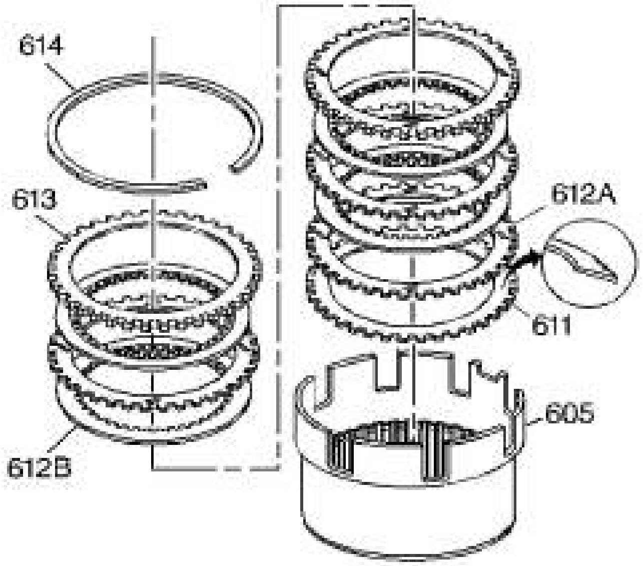
6. Inspect the reverse input clutch spring assembly (609) for bent, broken, distorted or damaged springs.
7. Install the reverse input clutch spring assembly (609).



8. Install the J 23327-1 and the J 25018-A .
9. Install the reverse input clutch spring retainer ring (610).



10. Inspect the belleville plate (611), the fiber plate assemblies (612B), the steel turbulator plates (612A) and the selective backing plate (613) for the following items:
    - Damaged tangs
    - Delamination
    - Excessive wear
    - Heat damage or wear
    - Surface finish
    - Flatness



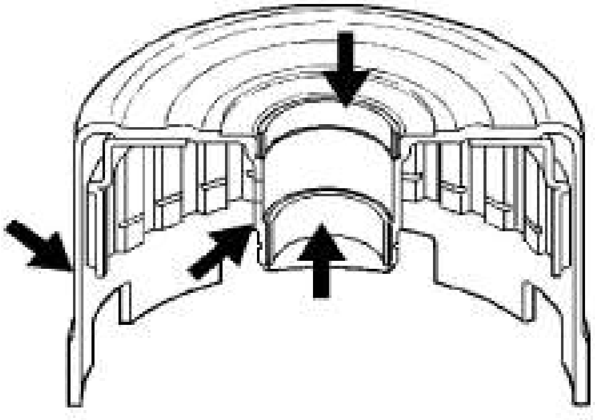
11. Install the reverse input clutch belleville plate (611), with the inner diameter up, into the reverse input clutch housing and drum assembly (605).
12. Install the reverse input clutch plates starting with a steel turbulator plate (612A) and alternate with a fiber plate assembly (612B).
13. Install the reverse input clutch selective backing plate (613).
14. Install the reverse input clutch retaining ring (614).

Reverse Input Clutch Bushing Replacement

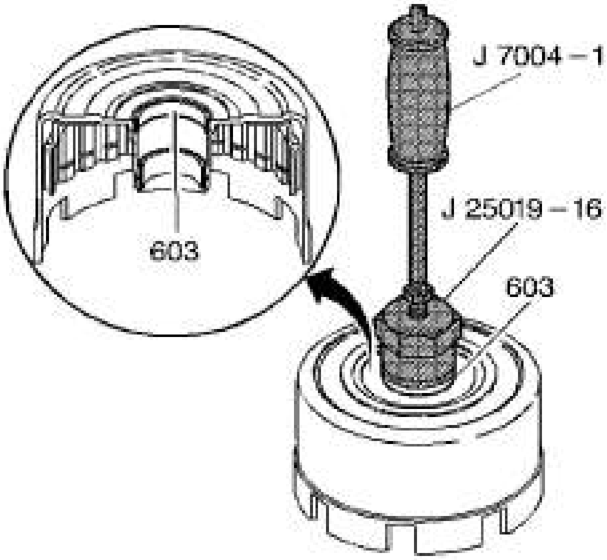
Removal Procedure

Tools Required

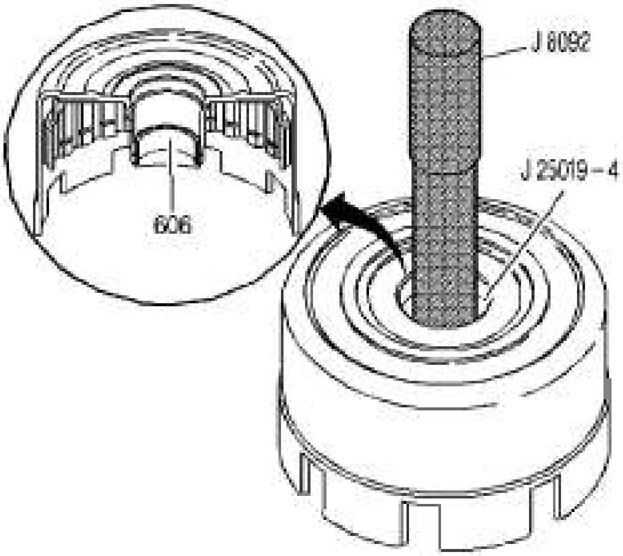
- J 25019 Bushing Service Set
- J 34196-B Transmission Bushing Service Set
- J 7004-A Universal Remover
- J 8092 Universal Driver Handle - 3/4 in - 10



1. Inspect the reverse input clutch housing and drum assembly for the following conditions:
   - Damaged or worn bushings
   - Surface finish on the hub and outer housing - check band surface for flatness
   - Leak at the weld
   - Heat distortion
   - Rolled or distorted retaining ring groove

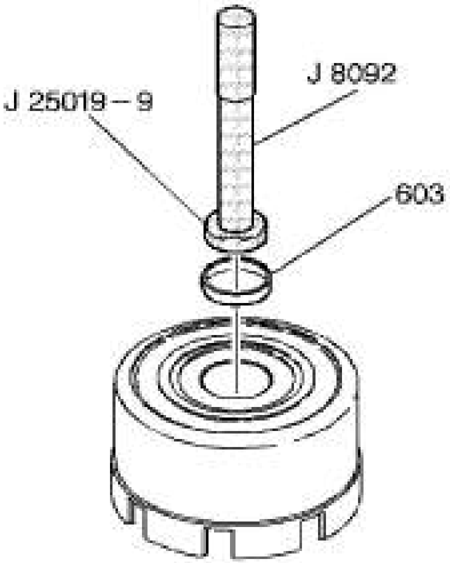

J 7004 – 1
J 25019 – 16
603
603

2. Using the J 25019-16 with the J 7004-A , remove the reverse input clutch front bushing (603).

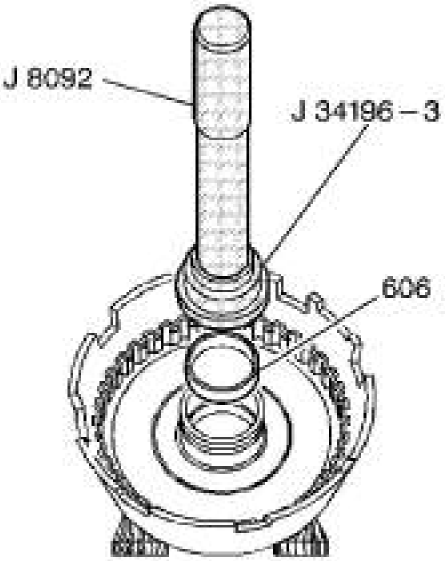

J 8092
J 25019 – 4
606

3. Using the J 25019-4 with the J 8092 , remove the reverse input clutch rear bushing (606).

Installation Procedure


J 25019 – 9
J 8092
603

1. Using the J 25019-9 with the J 8092 , install a reverse input clutch front bushing (603).


J 8092
J 34196 – 3
606

2. Using the J 34196-3 which is part of kit J 34196-B with the J 8092 , install a reverse input clutch rear bushing 606).

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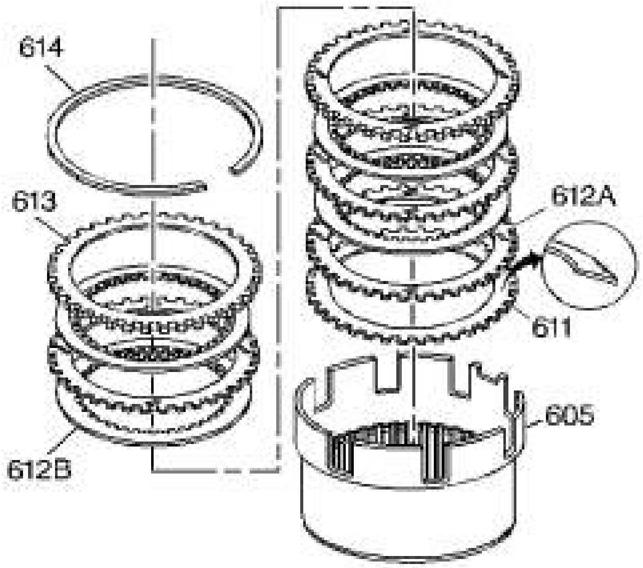
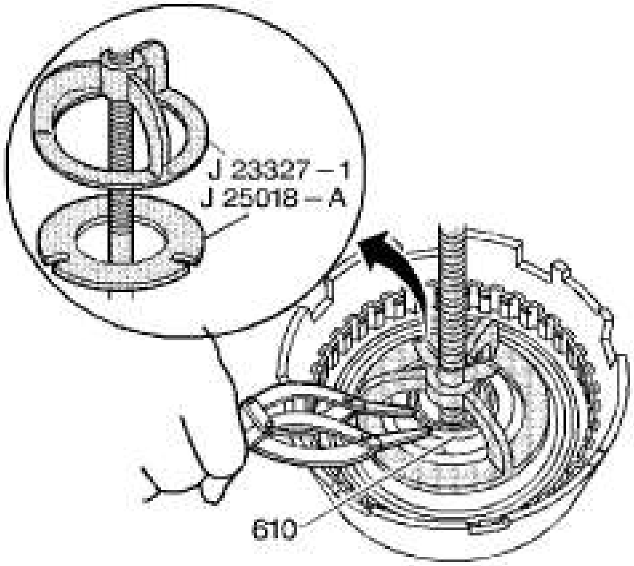
Reverse Input Clutch Disassemble

Tools Required

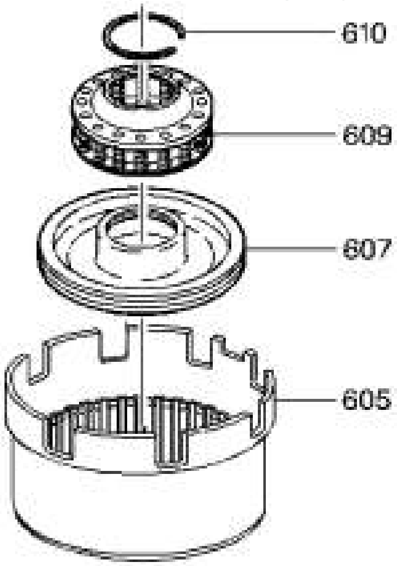
- J 23327-1 Forward Clutch Spring Compressor (Bridge)
- J 25018-A Clutch Spring Compressor Adapter



1. Remove the reverse input clutch retaining ring (614).
2. Remove all reverse input clutch plates (611-613).

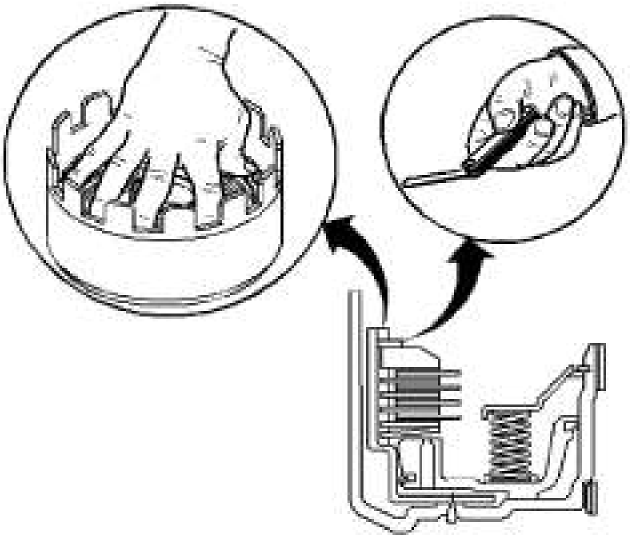


3. Install the J 23327-1 and the J 25018-A .
4. Compress the reverse input clutch spring assembly.
5. Remove the reverse input clutch spring retainer ring (610).



6. Remove the reverse input clutch spring assembly (609).
7. Remove the reverse input clutch piston assembly (607).

Reverse Input Clutch Plate Travel Check



1. Apply an evenly distributed load to the clutch pack.
2. Use feeler gauges to check the reverse input clutch plate travel.
3. Check the travel between the selective backing plate and the reverse input clutch retainer ring.

   Clutch Plate Travel Specifications
   The reverse input clutch plate travel should be 1.02-1.94 mm (0.040-0.076 in).

4. Select the proper selective backing plate to obtain the correct travel..

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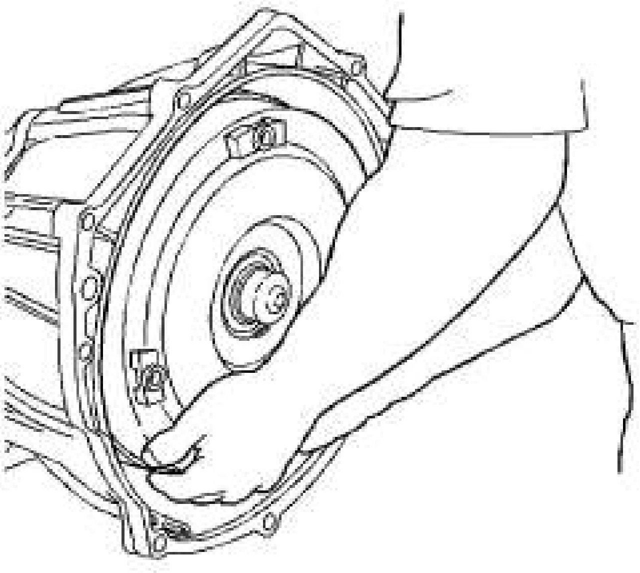
Torque Converter Assembly Removal

Caution: The torque converter weighs approximately 65 lbs. Personal injury may result if you lift the torque converter improperly.

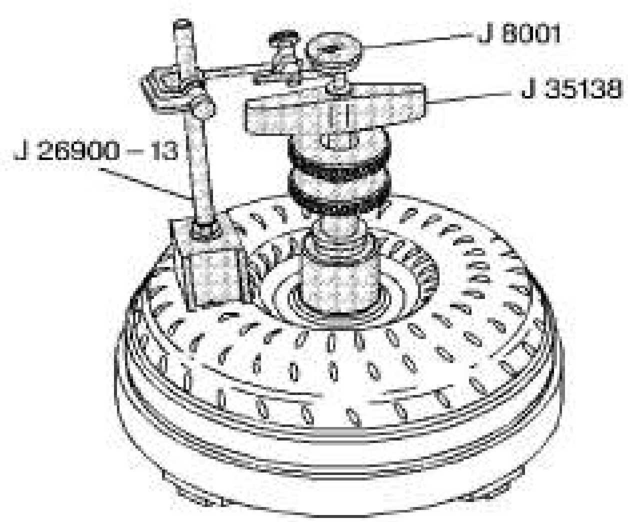


Remove the torque converter.

Torque Converter End Play Inspection

Tools Required

- J 8001 Dial Indicator Set
- J 26900-13 Magnetic Indicator Base
- J 35138 Converter End Play Checker
- J 39195 Converter End Play Check Tool



1. Inspect the torque converter and replace if any of the following conditions exist:
    - Evidence of damage to the pump assembly.
    - Metal particles are found after flushing the cooler and cooler lines.
    - External leaks in the hub area.
    - Converter pilot is broken, damaged or poor fit into the crankshaft.
    - Converter hub is scored or damaged.
    - Internal damage to the stator.
    - Contamination from engine coolant.
    - Excessive end play.

    Important: The torque converter should not be replaced if the fluid has an odor, discoloration or no evidence of metal or clutch plate material.

    Flushing the torque converter is not recommended.

2. Install the J 35138 , the J 26900-13 and the J 8001 or J 39195 to be used with the 300 mm

torque converter.

Specification

- The end play for a 245 mm torque converter should be 0-0.38 mm (0-0.015 in).
- The end play for a 298 mm torque converter should be 0.1-0.48 mm (0.004-0.019 in).
- The end play for a 258 mm and 300 mm torque converter should be 0.1-0.5 mm (0.004-0.020 in).

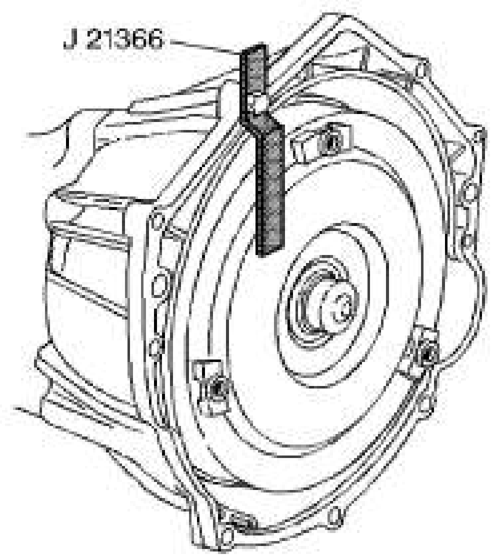
3. Remove the tools.

Torque Converter Installation

Tools Required

J 21366 Converter Holding Strap

Caution: The torque converter weighs approximately 65 lbs. Personal injury may result if you lift the torque converter improperly.

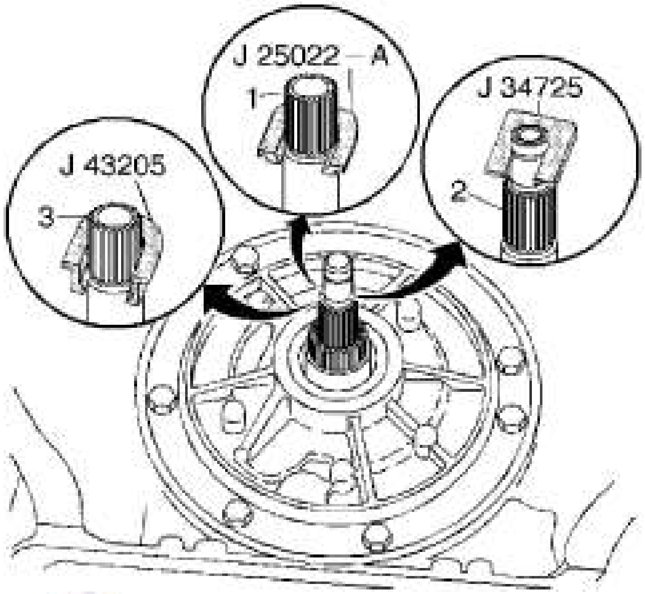


1. Install the torque converter.
2. Install the J 21366 .

Transmission End Play Check

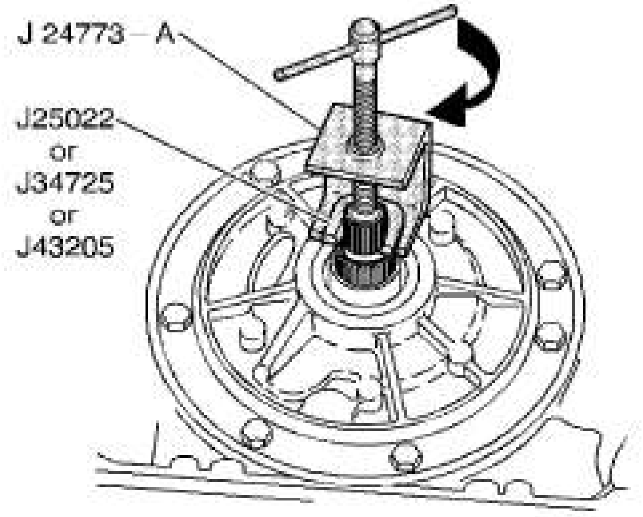
Tools Required

- J 25022 End Play Fixture Adapter (245 mm and 258 mm)
- J 34725 End Play Checking Adapter (298 mm)
- J 43205 End Play Fixture Adapter (300 mm)
- J 24773-A Oil Pump Remover
- J 8001 Dial Indicator Set
- J 25025-7A Dial Indicator Mounting Post

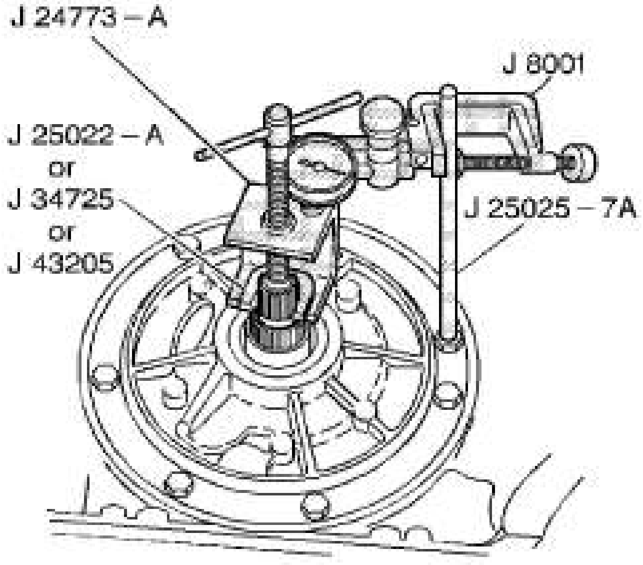


Important: Torque converter size is model dependent.

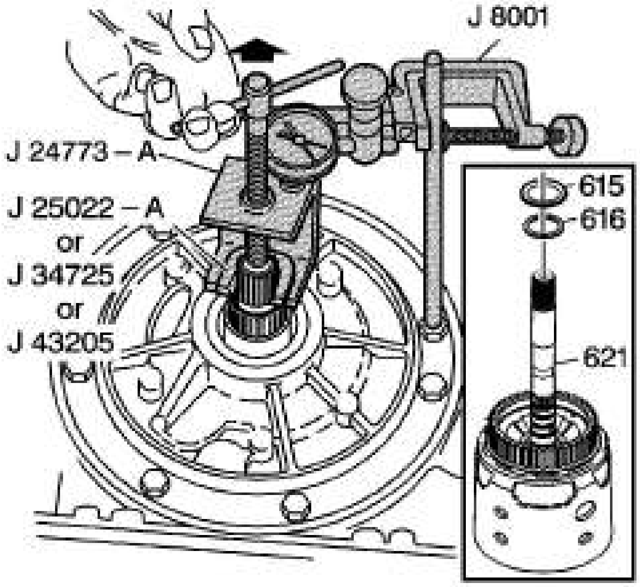
1. Install an end play fixture adapter.
    - Use J 25022 for a 245 mm and 258 mm turbine shaft (1).
    - Use J 34725 for a 298 mm turbine shaft (2).
    - Use J 43205 for a 300 mm turbine shaft (3).


J 24773 – A
J25022
or
J34725
or
J43205

2. Install the J 24773-A .


J 24773 – A
J 8001
J 25022 – A
or
J 34725
or
J 43205
J 25025 – 7A

3. Remove an oil pump retaining bolt.
4. Install J 25025-7A (or a 278 mm or 11 in bolt) and lock nut.
5. Install J 8001-3 .



6. Set the J 8001-3 to zero.
7. Pull up on J 24773-A .

   Proper end play should be 0.13-0.92 mm (0.005-0.036 in).

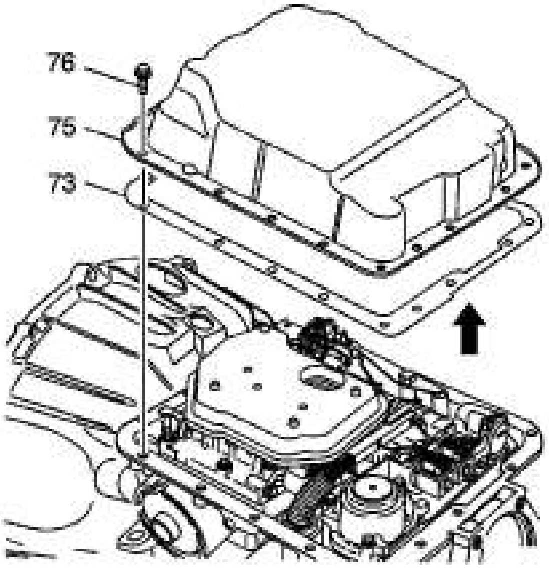
8. The selective thrust washer (616), which controls the end play, is located between the input housing (621) and the thrust bearing (615) on the oil pump hub.

   If the end play measurement is incorrect, refer to Torque Converter End Play Specifications. Choose a new selective thrust washer (616) based on the original selective washer and the information contained in the table.

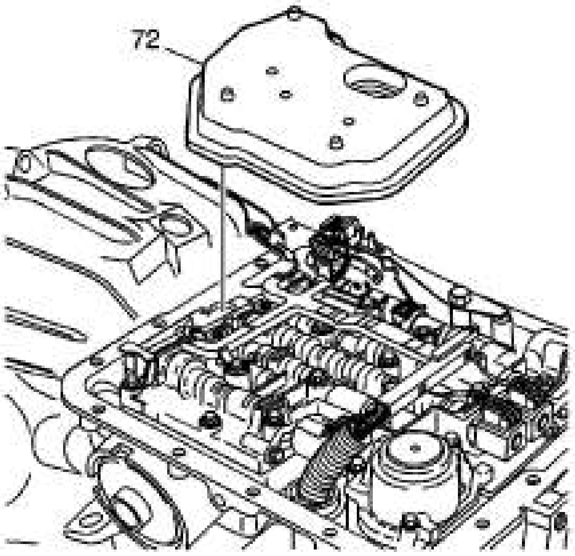
   If the dial indicator shows no end play, the selective thrust washer (616) and thrust bearing (615) may have been misassembled.

9. Correct the end play by changing the selective thrust washer (616).

Transmission Fluid Pan and Filter Assembly Removal

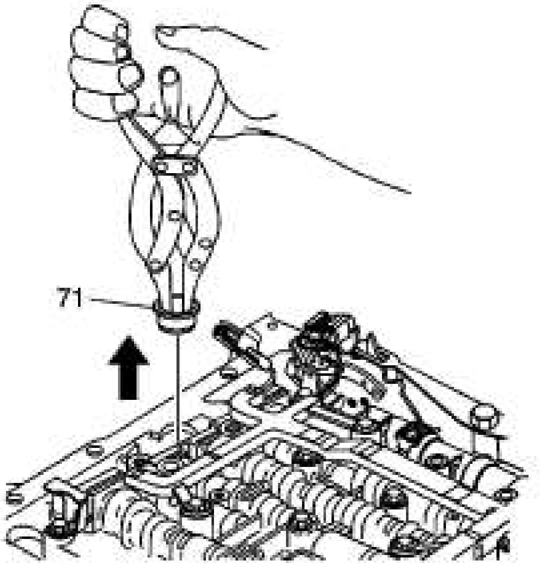


1. Remove the transmission oil pan screws (76).
2. Remove the transmission oil pan (75) and the transmission oil pan gasket (73).



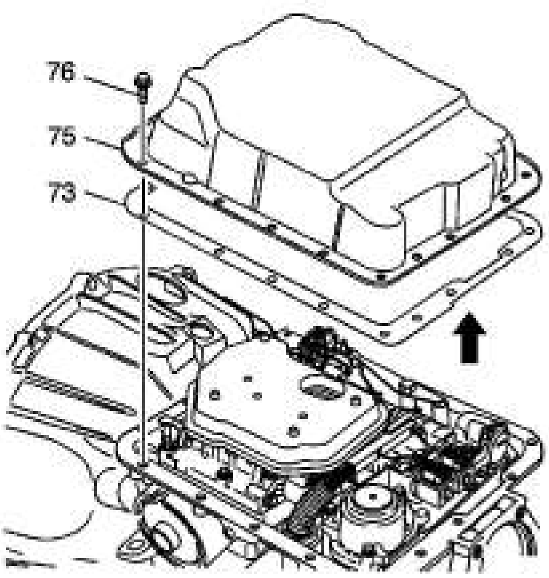
3. Remove the transmission oil filter assembly (72).
4. The filter may help in diagnosis. Cut away the top portion of the plastic filter housing and remove. Inspect the filter for the presence of the following items which may indicate wear or corrosion:
   - Clutch material

- Bronze slivers indicating bushing wear
- Steel particles



5. Remove the oil filter seal (71).

Transmission Fluid Pan Installation

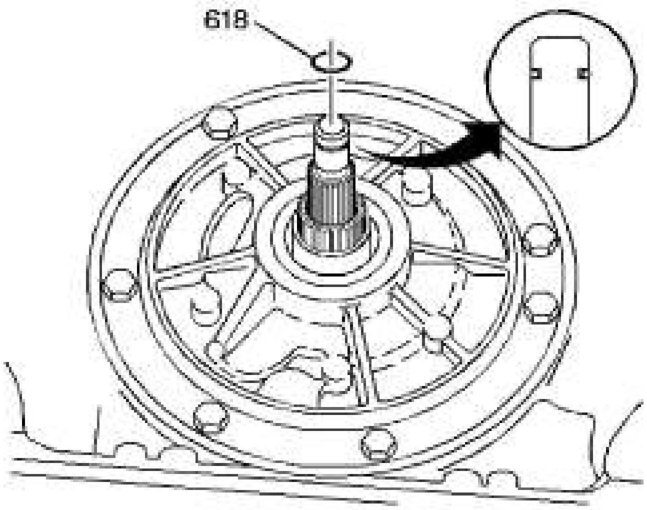


1. Place the transmission oil pan gasket (73) on the case.
2. Place the transmission oil pan (75) on the case.

   Caution: Refer to Fastener Caution in the Preface section.

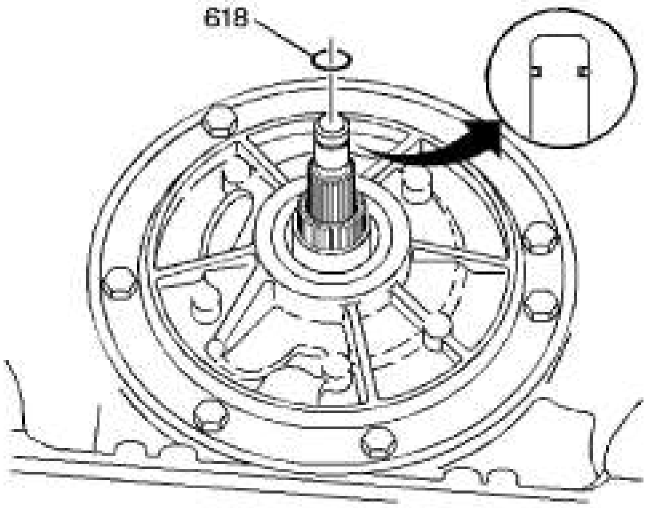
3. Install all of the transmission oil pan screws (76). Tighten the screws to **16 N·m (11.8 lb ft)**.

Turbine Shaft O-Ring Installation



Install the O-ring (618) on the turbine shaft. O-Ring location is location dependent.

Turbine Shaft O-Ring Removal

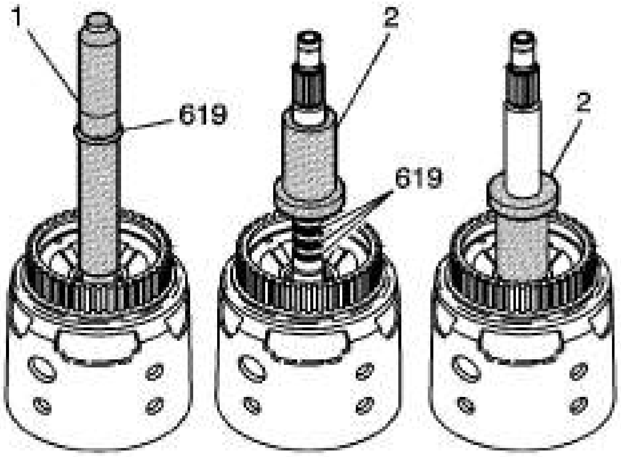


Remove the O-ring (618) from the turbine shaft. O-Ring location is model dependent.

Turbine Shaft Seal Installation

Tools Required

- J 36418-1B Turbine Shaft Seal Installer
- J 36418-2A Turbine Shaft Seal Sizer

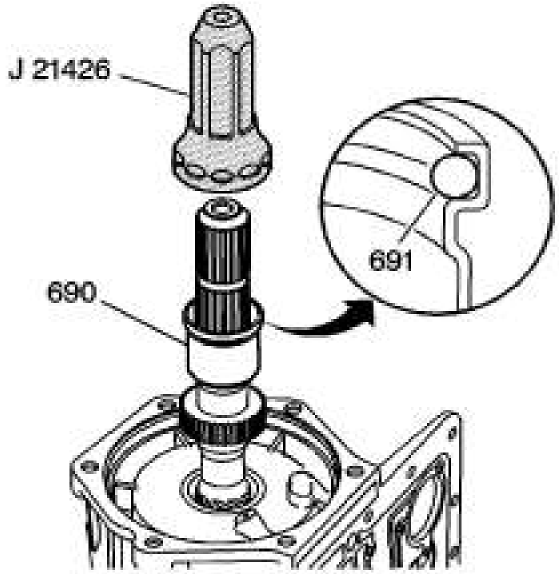


1. Use the J 36418-1B (1) in order to install the four turbine shaft oil seal rings (619).
2. Resize oil seal rings (619) after installation:
   1. Place J 36418-2A (2) over the turbine shaft oil seal rings (619) and seat against input housing.
   2. Remove J 36418-2A (2).
   3. Turn J 36418-2A (2) upside down and place over the turbine shaft oil seal ring (619).
   4. Seat against input housing.
   5. Leave J 36418-2A (2) in place over the turbine shaft oil seal rings (619) until the reverse input clutch housing is installed.

Vehicle Speed Sensor and Case Extension Installation

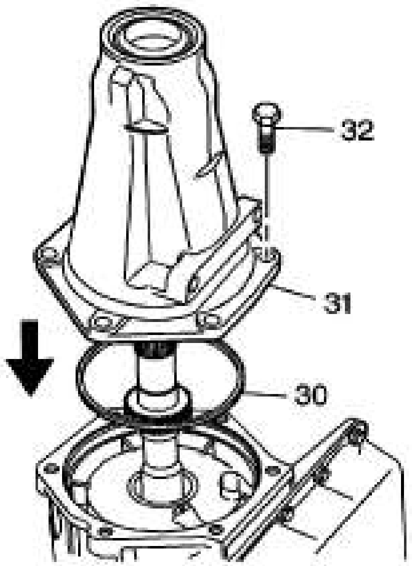
Tools Required

J 21426 Rear Seal Installer



1. Using the J 21426 , install an output shaft sleeve (690) and an output shaft seal (691).

   Do not push the sleeve past the machined surface on the output shaft.

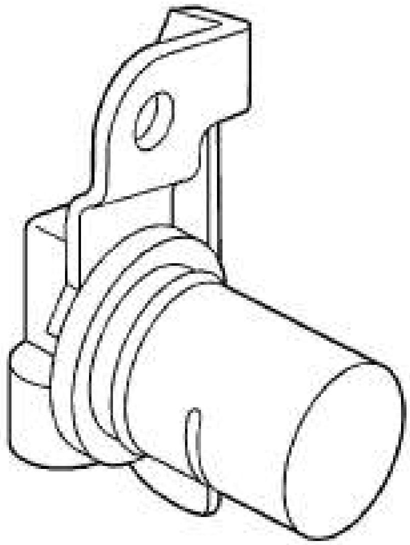


2. Install the case extension to case seal (30) and the case extension (31).

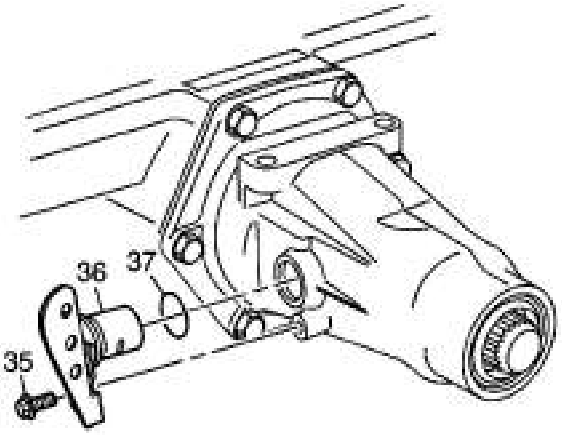
   Notice: Refer to Fastener Notice in the Preface section.

3. Install the case extension to case retaining bolts (32).

   Tighten
   Tighten the retaining bolts to 45 N·m (33 lb ft).

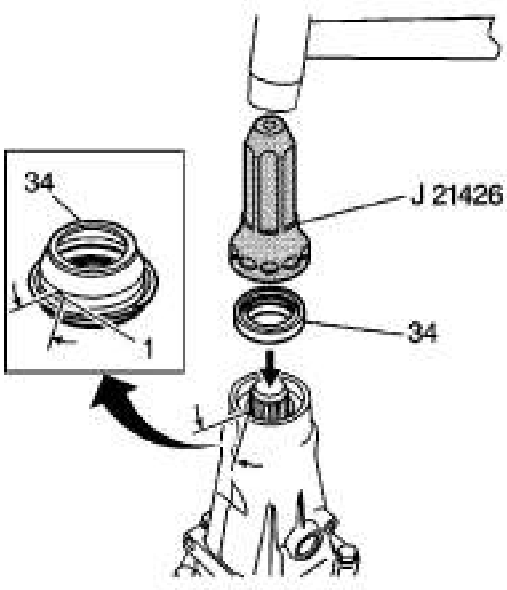


4. Inspect the transmission speed sensor for the following conditions:
   - Cracks
   - Nicks
   - Damage



5. Install a new O-ring seal (37) on the internal transmission speed sensor (36).
6. Install the internal transmission speed sensor (36).
7. Install the speed sensor retaining bolt (35).

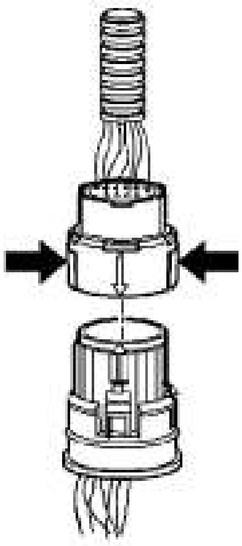
Tighten
Tighten the bolt to 12 N·m (9 lb ft).



Important: If installing a slip yoke type seal (34), position drain hole (1) to bottom of transmission within area shown.

8. Using the J 21426 , install the case extension oil seal assembly (34) (model dependent).

Automatic Transmission Inline 20-Way Connector Description



The transmission electrical connector is an important part of the transmission operating system. Any interference with the electrical connection can cause the transmission to set diagnostic trouble codes or affect proper operation.

The following items can affect the electrical connection:

- Bent pins in the connector from rough handling during connection and disconnection
- Wires backing away from the pins or coming uncrimped, in either the internal or the external wiring harness
- Dirt contamination entering the connector when disconnected
- Pins in the internal wiring connector backing out of the connector or pushed out of the connector during reconnection
- Transmission fluid leaking into the connector, wicking up into the external wiring harness and degrading the wire insulation
- Moisture intrusion in the connector
- Low pin retention in the external connector from connection and disconnection of the wiring connector assembly
- Pin corrosion from contamination
- Damaged connector assembly

Remember the following points:

- In order to remove the connector, squeeze the two tabs toward each other and pull straight up without pulling by the wires.
- Limit twisting or wiggling the connector during removal. Bent pins can occur.
- Do not pry the connector off with a screwdriver or other tool.
- Visually inspect the seals to make sure that they are not damaged during handling.
- In order to reinstall the external wiring connector, first orient the pins by lining up the arrows on each half of the connector. Push the connector straight down into the transmission without twisting or angling the mating parts.
- The connector should click into place with a positive feel and/or noise.
- Whenever the transmission external wiring connector is disconnected from the internal harness and the engine is operating, DTCs will set. Clear these DTCs after reconnecting the external connector.

Definitions and Abbreviations

Throttle Positions

Engine Braking: A condition where the engine friction is used to slow the vehicle by manually downshifting during a zero throttle coastdown.

Full Throttle Detent Downshift: A quick apply of the accelerator pedal to its full travel, forcing a downshift.

Heavy Throttle: Approximately 3/4 of accelerator pedal travel (75 percent throttle position).

Light Throttle: Approximately 1/4 of accelerator pedal travel (25 percent throttle position).

Medium Throttle: Approximately 1/2 of accelerator pedal travel (50 percent throttle position).

Minimum Throttle: The least amount of throttle opening required for an upshift.

Wide Open Throttle (WOT): Full travel of the accelerator pedal (100 percent throttle position).

Zero Throttle Coastdown: A full release of the accelerator pedal while the vehicle is in motion and in drive range.

Shift Condition Definitions

Bump: A sudden and forceful apply of a clutch or a band.

Chuggle: A bucking or jerking. This condition may be most noticeable when the converter clutch is engaged. It is similar to the feel of towing a trailer.

Delayed: A condition where a shift is expected but does not occur for a period of time. This may be described as a clutch or band engagement that does not occur as quickly as expected during a part throttle or wide open throttle apply of the accelerator, or during manual downshifting to a lower range. This term is also defined as LATE or EXTENDED.

Double Bump (Double Feel): Two sudden and forceful applies of a clutch or a band.

Early: A condition where the shift occurs before the car has reached proper speed. This condition tends to labour the engine after the upshift.

End Bump: A firmer feel at the end of a shift than at the start of the shift. This is also defined as END FEEL or SLIP BUMP.

Firm: A noticeably quick apply of a clutch or band that is considered normal with a medium to heavy throttle. This apply should not be confused with HARSH or ROUGH.

Flare: A quick increase in engine RPM along with a momentary loss of torque. This most generally occurs during a shift. This condition is also defined as SLIPPING.

Harsh (Rough): A more noticeable apply of a clutch or band than FIRM. This condition is considered undesirable at any throttle position.

Hunting: A repeating quick series of upshifts and downshifts that causes a noticeable change in engine RPM, such as a 4-3-4 shift pattern. This condition is also defined as BUSYNESS.

Initial Feel: A distinctly firmer feel at the start of a shift than at the finish of the shift.

Late: A shift that occurs when the engine RPM is higher than normal for a given amount of throttle.

Shudder: A repeating jerking condition similar to CHUGGLE but happens at a higher frequency. This condition may be most noticeable during certain ranges of vehicle speed.

Slipping: A noticeable increase in engine RPM without a vehicle speed increase. A slip usually occurs during or after initial clutch or band apply.

Soft: A slow, almost unnoticeable clutch or band apply with very little shift feel.

Surge: A repeating engine related condition of acceleration and deceleration that is less intense than CHUGGLE.

Tie-Up: A condition where two opposing clutch and/or bands are attempting to apply at the same time causing the engine to labour with a noticeable loss of engine RPM.

Noise Conditions

Drive Link Noise: A whine or growl that increases or fades with vehicle speed, and is most noticeable under a light throttle acceleration. It may also be noticeable in PARK or NEUTRAL operating ranges with the vehicle stationary.

Final Drive Noise: A hum related to vehicle speed which is most noticeable under a light throttle acceleration.

Planetary Gear Noise: A whine related to vehicle speed, which is most noticeable in FIRST gear, SECOND gear, FOURTH gear or REVERSE. The condition may become less noticeable, or go away, after an upshift.

Pump Noise: A high pitched whine that increases in intensity with engine RPM. This condition may also be noticeable in all operating ranges with the vehicle stationary or moving.

Torque Converter Noise: A whine usually noticed when a vehicle is stopped, and the transmission is in DRIVE or REVERSE. The noise will increase with engine RPM.

Transmission Abbreviations

A/C: Air Conditioning

AC: Alternating Current

AT: Automatic Transmission

CCDIC: Climate Control Driver Information Centre

DC: Direct Current

DIC: Driver Information Centre

DLC: Diagnostic Link Connector

DMM: Digital Multimeter

DTC: Diagnostic Trouble Code

ECT: Engine Coolant Temperature

EMI: Electromagnetic Interference

IAT: Intake Air Temperature

IGN: Ignition

MAP: Manifold Absolute Pressure

MIL: Malfunction Indicator Lamp

NC: Normally Closed

NO: Normally Open

OBD: On Board Diagnostic

OSS: Output (Shaft) Speed Sensor

PC: Pressure Control

TCM: Transmission Control Module

PWM: Pulse Width Modulation

RPM: Revolutions Per Minute

SS: Shift Solenoid

TAP: Transmission Adaptive Pressure

TCC: Torque Converter Clutch

TFP: Transmission Fluid Pressure

TFT: Transmission Fluid Temperature

TP: Throttle Position

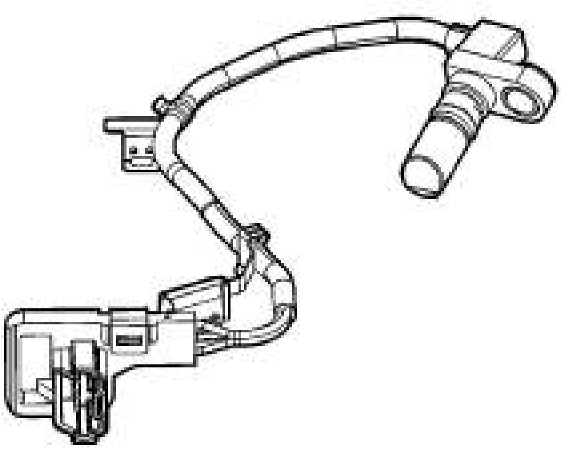
TV: Throttle Valve

OSS: Output Speed Sensor

WOT: Wide Open Throttle

Electronic Component Description (TCM)

Automatic Transmission Input Speed Sensor Assembly



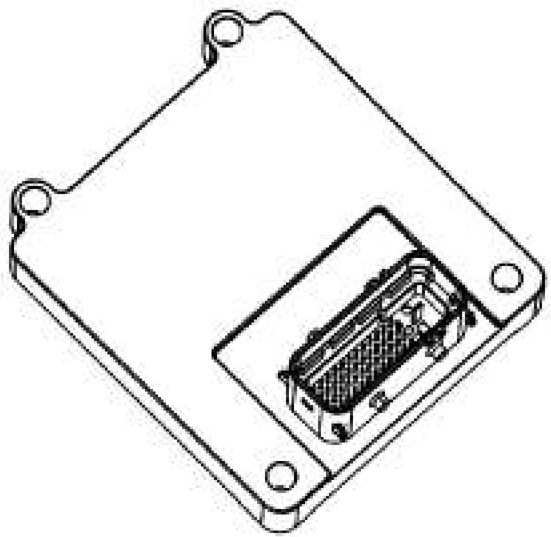
The Automatic Transmission Input Speed Sensor (AT ISS) Assembly is a hall-effect sensor that produces an input speed signal as the turbine shaft rotor teeth pass in front of the sensor tip.

The AT ISS is made of a permanent magnet with an iron pole piece and an integrated circuit (IC) chip with a two-element transducer molded into a plastic housing. The two-element transducer functions as an on/off switch by sensing changes in the magnetic field strength. The dual element design greatly increases the sensor's switching accuracy.

Because the turbine shaft is splined to the torque converter, it spins at engine speed. As the turbine shaft spins, the rotor teeth pass in front of the sensor tip, changing the magnetic field. As a result, the transducers are sensing high and low magnetic signals. The IC chip will then amplify and filter the high and low signal. Therefore, whenever the engine is running, the sensor will produce high and low signals proportional to turbine shaft speed. The more rotor teeth passing by the sensor's magnetic field in a specific amount of time, the faster the turbine shaft is spinning.

The ISS assembly is attached to the pump cover with the tip of the sensor passing though the stator shaft and sleeve. The ISS mounting bolt passes through a steel insert and into a threaded hole in the pump cover. The ISS wiring harness is routed and secured to the pump cover with clip-on brackets. At the transmission control module (TCM), the signal is electronically converted and is interpreted as transmission input speed. The TCM uses transmission input speed together with the transmission output speed to provide shift energy and torque management capabilities, improved shift quality (feel), increased TCC function, gear ratios that are more accurate and enhanced transmission diagnostics.

Electronic Component Description (TCM)



The transmission control module (TCM) (5.3L only) is mounted near the lower left front of the engine and connects directly to the engine wiring harness. A single 49-way connector is used to make the connection between the vehicle wiring and the TCM. The TCM is an electronic control module that receives input or provides output in order to control the operation of the 4L60 automatic transmission.

The TCM receives the following inputs from the engine control module (ECM):

- Engine speed and torque values
- Engine intake air temperature (IAT), accelerator pedal position (APP) information
- Engine coolant temperature (ECT)
- Kick-down request
- Traction control status
- Driver selected shift mode
- Air-conditioning (A/C) status
- Cruise control status

The ECM provides this data to the TCM through the controller area network (CAN). The CAN is a 2-wire communication connection between the 2 controllers.

Other TCM inputs are the following:

- Battery and ignition voltage
- Brake switch status
- Transmission manual shift shaft switch assembly

- Transmission fluid temperature (TFT)
- Transmission vehicle speed sensor (VSS)

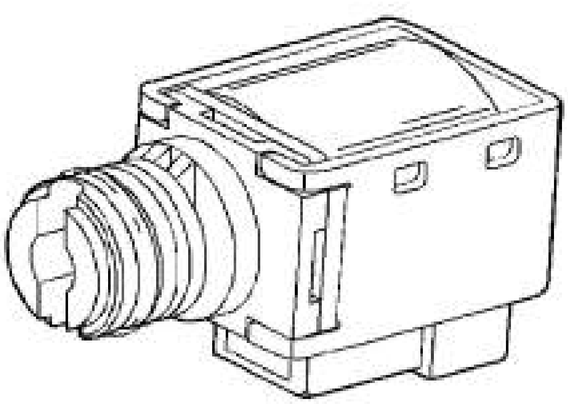
The TCM provides the following outputs in order to control the automatic transmission:

- Shift solenoids to control transmission shifting
- TCC PWM solenoid operation controls the apply and release of the torque converter clutch ASM
- Pressure control solenoid (PCS) regulates transmission line pressure

Other TCM outputs provided to the ECM are the following:

- MIL illumination request
- Vehicle speed
- Transmission input speed
- Transmission fluid temperature
- Commanded gear status
- TCC status
- Torque reduction requests
- Manual shift shaft switch status

1-2 and 2-3 Shift Solenoid Valves



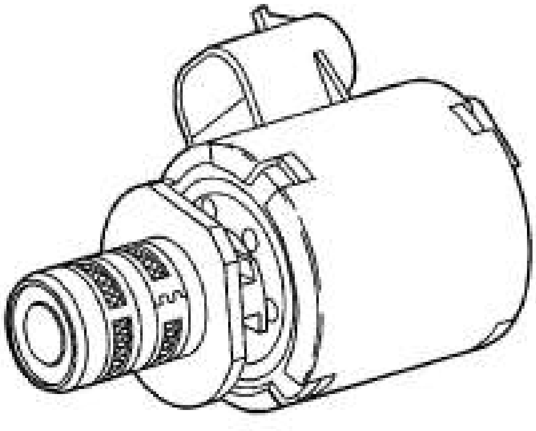
The 1-2 and 2-3 shift solenoid valves (also called A and B solenoids) are identical devices that control the movement of the 1-2 and 2-3 shift valves (the 3-4 shift valve is not directly controlled by a shift solenoid). The solenoids are normally-open exhaust valves that work in four combinations to shift the transmission into different gears.

The transmission control module (TCM) energizes each solenoid by grounding the solenoid through an internal quad driver. This sends current through the coil winding in the solenoid and moves the internal plunger out of the exhaust position. When ON, the solenoid redirects fluid to move a shift valve.

Important: The manual valve hydraulically can override the shift solenoids. Only in D4 do the shift solenoid states totally determine what gear the transmission is in. In the other manual valve positions, the transmission shifts hydraulically and the shift solenoid states CATCH UP when the throttle position and the vehicle speed fall into the correct ranges.

The TCM-controlled shift solenoids eliminate the need for TV and governor pressures to control shift valve operation.

Transmission Pressure Control Solenoid



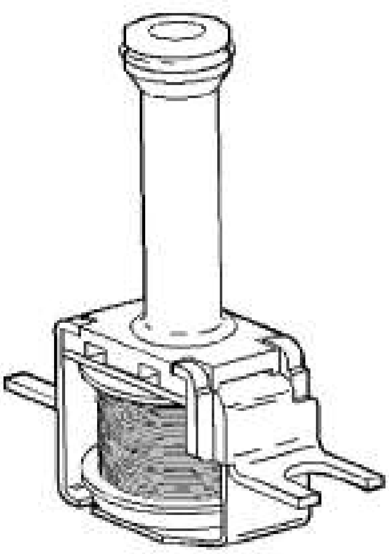
The transmission pressure control solenoid is an electronic pressure regulator that controls pressure based on the current flow through its coil winding. The magnetic field produced by the coil moves the solenoid's internal valve which varies pressure to the pressure regulator valve.

The transmission control module (TCM) controls the pressure control solenoid by commanding current between 0.1-1.1 amps. This changes the duty cycle of the solenoid, which can range between 5-95 percent, typically less than 60 percent. High amperage (1.1 amps) corresponds to minimum line pressure, and low amperage (0.1 amp) corresponds to maximum line pressure, if the solenoid loses power, the transmission defaults to maximum line pressure.

The TCM commands the line pressure values, using inputs such as engine speed and throttle position sensor voltage.

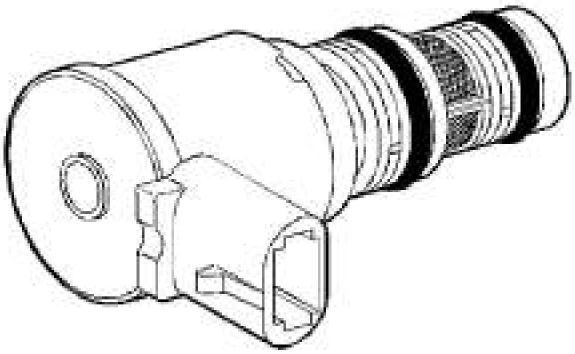
The pressure control solenoid takes the place of the throttle valve or the vacuum modulator that was used on past model transmissions.

Torque Converter Clutch Solenoid Valve



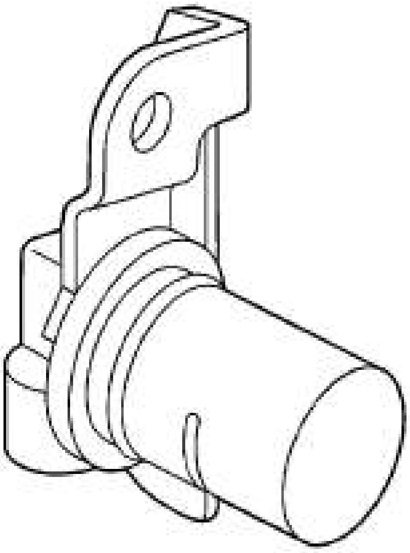
The torque converter clutch (TCC) solenoid valve is a normally-open exhaust valve that is used to control torque converter clutch apply and release. When grounded (energized) by the transmission control module (TCM), the TCC solenoid valve stops converter signal oil from exhausting. This causes converter signal oil pressure to increase and move the TCC solenoid valve into the apply position.

Torque Converter Clutch Pulse Width Modulation Solenoid Valve



The torque converter clutch pulse width modulation solenoid valve controls the fluid acting on the converter clutch valve. The converter clutch valve controls the torque converter clutch (TCC) apply and release. This solenoid is attached to the control valve body assembly within the transmission. The TCC PWM solenoid valve provides a smooth engagement of the torque converter clutch by operating during a duty cycle percent of ON time.

Vehicle Speed Sensor Assembly



The vehicle speed sensor (VSS) assembly provides vehicle speed information to the transmission control module (TCM). The VSS assembly is a permanent magnet (PM) generator. The PM generator produces a pulsing AC voltage as rotor teeth on the transmission output shaft pass through the sensor's magnetic field. The AC voltage level and the number of pulses increase as the speed of the vehicle increases. Output voltage varies with speed from a minimum of 0.5 volts at 100 RPM to more than 100 volts at 8,000 RPM. The TCM converts the pulsing voltage to vehicle speed. The TCM uses the vehicle speed signal to determine shift timing and torque converter clutch (TCC) scheduling.

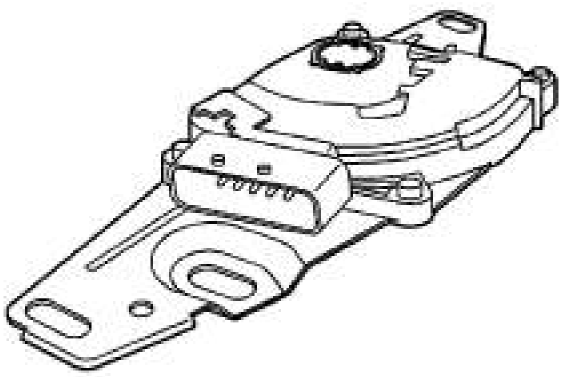
Automatic Transmission Fluid Temperature Sensor

The automatic transmission fluid temperature (TFT) sensor is part of the automatic transmission manual shift shaft position switch. The TFT sensor is a resistor, or thermistor, which changes value based on temperature. The sensor has a negative-temperature coefficient. This means that as the temperature increases, the resistance decreases and as the temperature decreases, the resistance increases.

The transmission control module (TCM) supplies a 5-volt reference signal to the TFT sensor and measures the voltage drop in the circuit. When the transmission fluid is cold, the sensor resistance is high and the TCM detects high signal voltage. As the fluid temperature warms to a normal operating temperature, the resistance becomes less and the signal voltage decreases. Refer to Transmission Fluid Temperature Sensor Specifications for a complete comparison of sensor resistance, temperature and signal voltage.

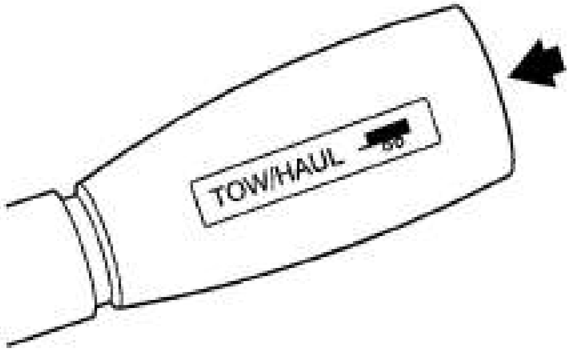
The TCM uses the TFT sensor information to control shift quality and torque converter clutch (TCC) application.

Transmission Range Switch



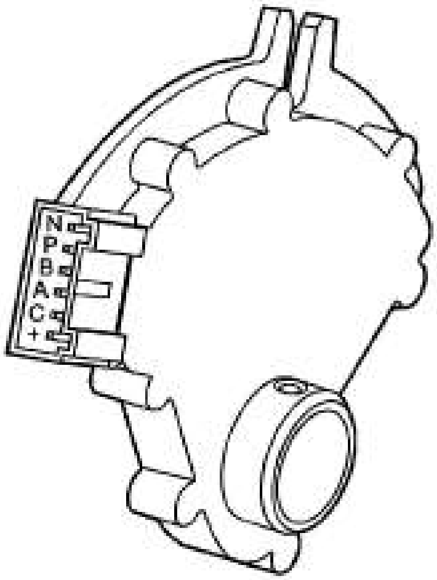
The transmission range (TR) switch is part of the park/neutral position (PNP) and backup lamp switch assembly, which is externally mounted on the transmission manual shaft. The TR switch contains four internal switches that indicate the transmission gear range selector lever position. The transmission control module (TCM) supplies ignition voltage to each switch circuit. As the gear range selector lever is moved, the state of each switch may change, causing the circuit to open or close. An open circuit or switch indicates a high voltage signal. A closed circuit or switch indicates a low voltage signal. The TCM detects the selected gear range by deciphering the combination of the voltage signals. The TCM compares the actual voltage combination of the switch signals to a TR switch combination chart stored in memory.

Tow/Haul Mode Switch



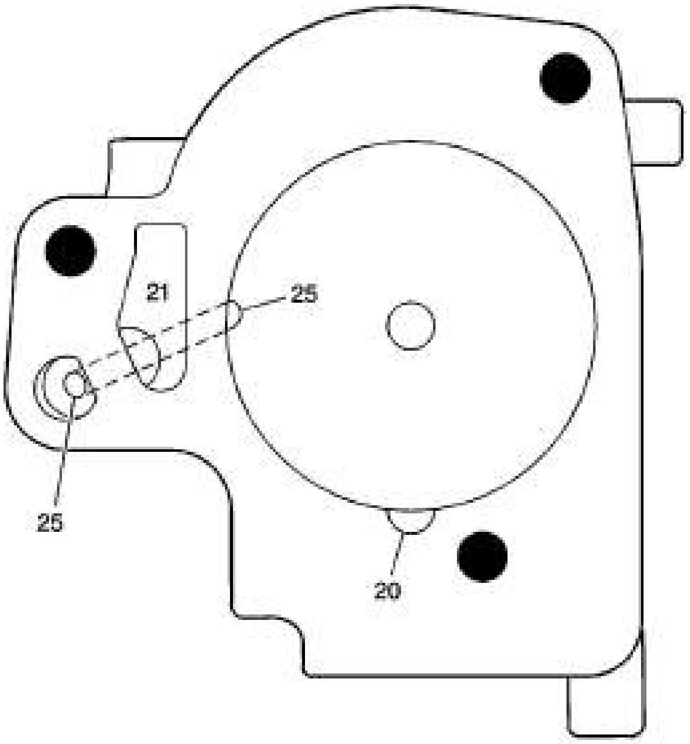
Tow/Haul mode enables the operator to achieve enhanced shift performance when towing or hauling a load. When tow/haul mode is selected, the tow/haul switch input signal to the body control module (BCM) is momentarily toggled to zero volts. This signals the powertrain control module (PCM) or transmission control module (TCM) to extend the length of time between upshifts and increase transmission line pressure. Cycling the tow/haul switch again, or cycling the ignition switch disables tow/haul mode and returns the transmission to a normal shift pattern.

Transmission Manual Shift Shaft Switch Assembly (88)



The transmission manual shift shaft switch assembly (88) is a sliding contact switch attached to the manual shift shaft inside the transmission case. The five inputs to the TCM from the transmission manual shift shaft switch assembly indicate the transmission gear selector lever position. This information is used for engine controls as well as determining the transmission shift patterns. The state of each input is available for display on the scan tool. The five input parameters represented are Signal A, Signal B, Signal C, Signal P (Parity) and Signal N (P/N Start).

1-2 Accumulator Cover Fluid Passages



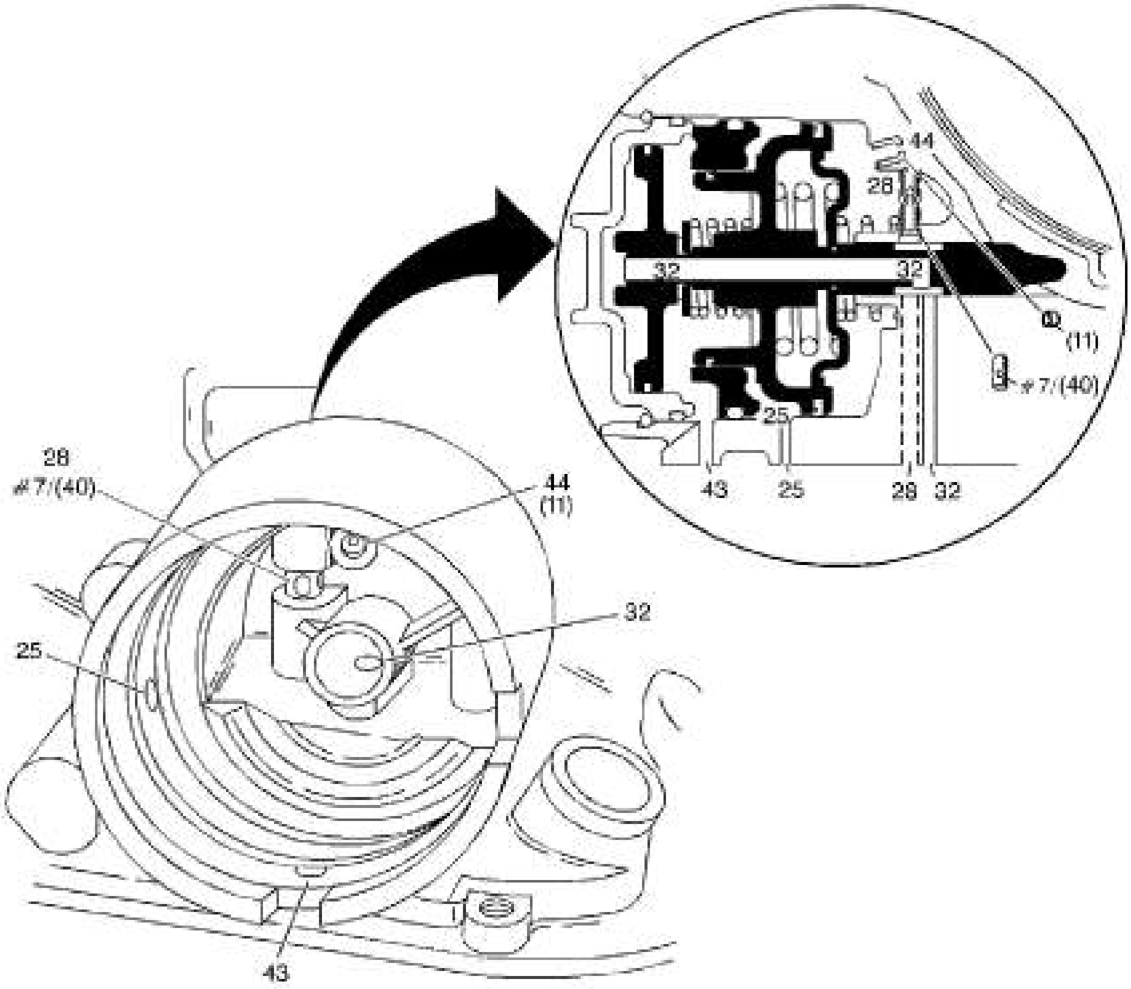
(20) Accumulator

(21) Orificed Accumulator

(25) 2nd Clutch

(25) 2nd Clutch

2-4 Servo Fluid Passages



(#7) 3rd Accumulator Retainer and Ball Assembly (40)

(#7) 3rd Accumulator Retainer and Ball Assembly (40)

(11) Case Servo Orificed Plug

(11) Case Servo Orificed Plug

(25) 2nd Clutch

(25) 2nd Clutch

(25) 2nd Clutch

(28) 3rd Accumulator

(28) 3rd Accumulator

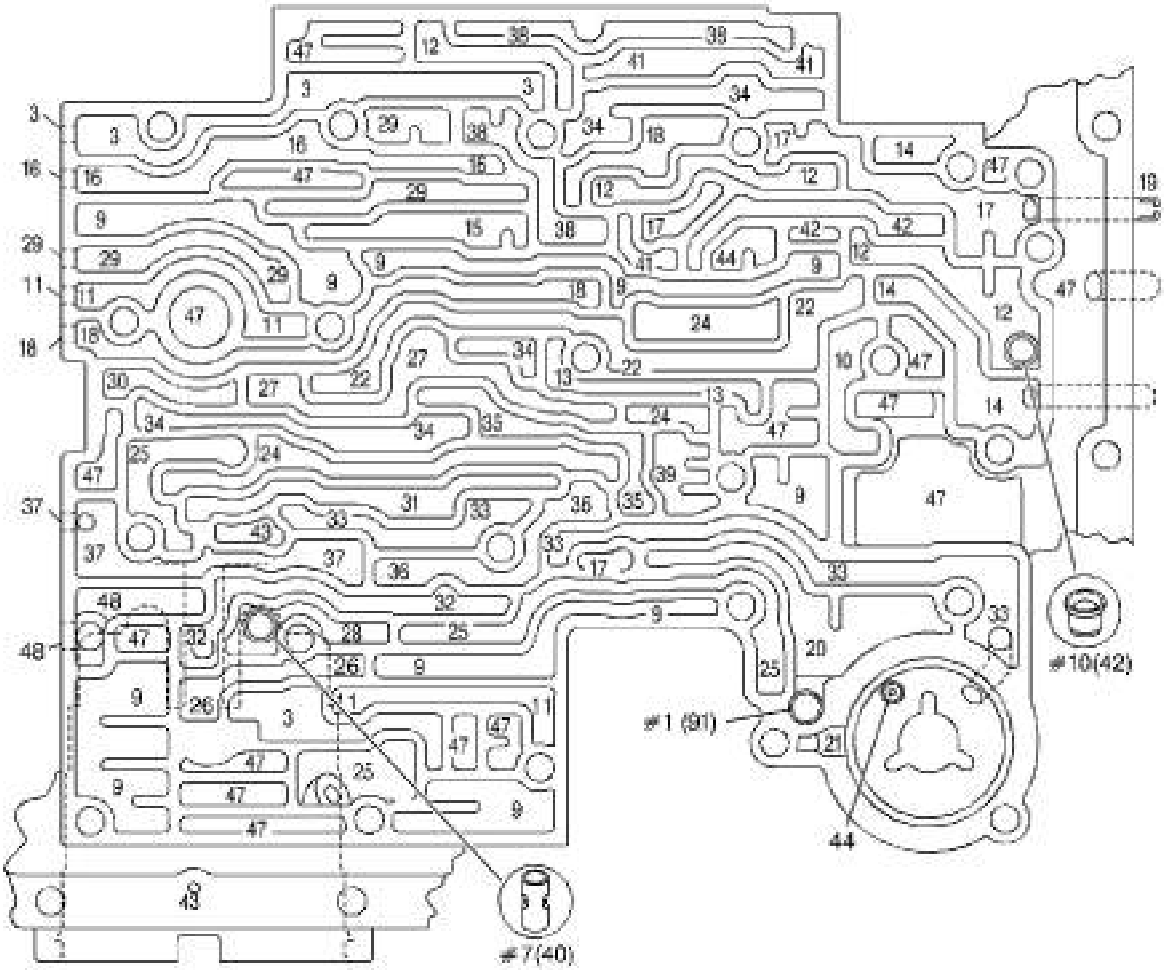
(28) 3rd Accumulator

(32) 4th

(32) 4th
(32) 4th
(32) 4th
(43) Exhaust
(43) Exhaust
(44) Orificed Exhaust
(44) Orificed Exhaust

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 4L60-E/4L65-E/4L70-E | Description and Operation | **Document ID: 338653**

Case Fluid Passages (Control Valve Body Side)



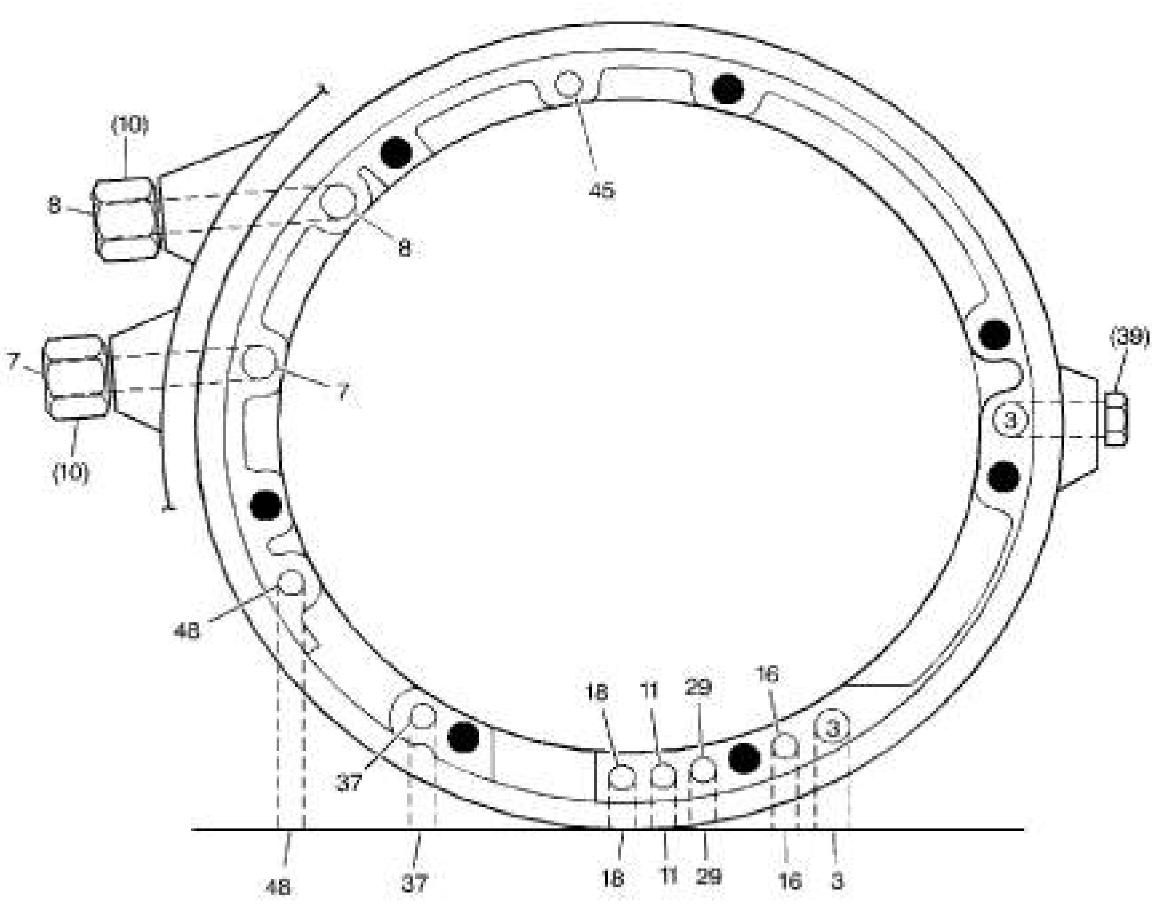
(#1) Checkball (91)
(#7) 3rd Accumulator Retainer and Ball Assembly (40)
(#10) Checkball (42)
(3) Line
(3) Line
(3) Line
(3) Line
(3) Line
(9) Actuator Feed Limit
(9) Actuator Feed Limit
(9) Actuator Feed Limit

(9) Actuator Feed Limit
(9) Actuator Feed Limit
(9) Actuator Feed Limit
(9) Actuator Feed Limit
(9) Actuator Feed Limit
(9) Actuator Feed Limit
(9) Actuator Feed Limit
(9) Actuator Feed Limit
(10) Filtered Actuator Feed
(11) Torque Signal
(11) Torque Signal
(11) Torque Signal
(11) Torque Signal
(11) Torque Signal
(12) PR
(12) PR
(12) PR
(12) PR
(12) PR
(13) D4-3-2
(13) D4-3-2
(14) Lo/Reverse
(14) Lo/Reverse
(14) Lo/Reverse
(15) Reverse
(16) Reverse Input (Rev. Clutch
(16) Reverse Input (Rev. Clutch
(16) Reverse Input (Rev. Clutch
(16) Reverse Input (Rev. Clutch
(17) D4
(17) D4
(17) D4
(17) D4
(18) Forward Clutch Feed
(18) Forward Clutch Feed
(18) Forward Clutch Feed
(18) Forward Clutch Feed
(19) Rear Lube
(20) Accumulator
(21) Orificed Accumulator
(22) Signal A
(22) Signal A
(22) Signal A
(24) 2nd
(24) 2nd

(24) 2nd
(25) 2nd Clutch
(25) 2nd Clutch
(25) 2nd Clutch
(25) 2nd Clutch
(26) C.C. Signal
(26) C.C. Signal
(27) 3-4 Signal
(27) 3-4 Signal
(28) 3rd Accumulator
(29) 3-4 Clutch
(29) 3-4 Clutch
(29) 3-4 Clutch
(29) 3-4 Clutch
(29) 3-4 Clutch
(30) 4th Signal
(31) Servo Feed
(32) 4th
(32) 4th
(33) 3-4 Accumulator
(33) 3-4 Accumulator
(33) 3-4 Accumulator
(33) 3-4 Accumulator
(33) 3-4 Accumulator
(34) D3
(34) D3
(34) D3
(34) D3
(34) D3
(35) Overrun
(35) Overrun
(36) Overrun Clutch Feed
(36) Overrun Clutch Feed
(37) Overrun Clutch
(37) Overrun Clutch
(37) Overrun Clutch
(38) D2
(38) D2
(38) D2
(38) D2
(39) Orificed D2
(41) Lo
(41) Lo
(41) Lo
(42) Lo/1st

(42) Lo/1st
(43) Exhaust
(43) Exhaust
(44) Orificed Exhaust
(44) Orificed Exhaust
(47) Void
(47) Void
(47) Void
(47) Void
(47) Void
(47) Void
(47) Void
(47) Void
(47) Void
(47) Void
(47) Void
(47) Void
(47) Void
(47) Void
(47) Void
(47) Void
(48) Regulated Apply
(48) Regulated Apply

Case Fluid Passages (Pump Cover Side)



(3) Line
(3) Line
(3) Line
(7) To Cooler
(7) To Cooler
(8) Lube from Cooler
(8) Lube from Cooler
(10) Oil Cooler Pipe Connector
(10) Oil Cooler Pipe Connector
(11) Torque Signal
(11) Torque Signal

(16) Reverse Input
(16) Reverse Input
(18) Forward Clutch Feed
(18) Forward Clutch Feed
(29) 3-4 Clutch
(29) 3-4 Clutch
(37) Overrun Clutch
(37) Overrun Clutch
(39) Pressure Plug
(45) Vent
(48) Regulated Apply
(48) Regulated Apply

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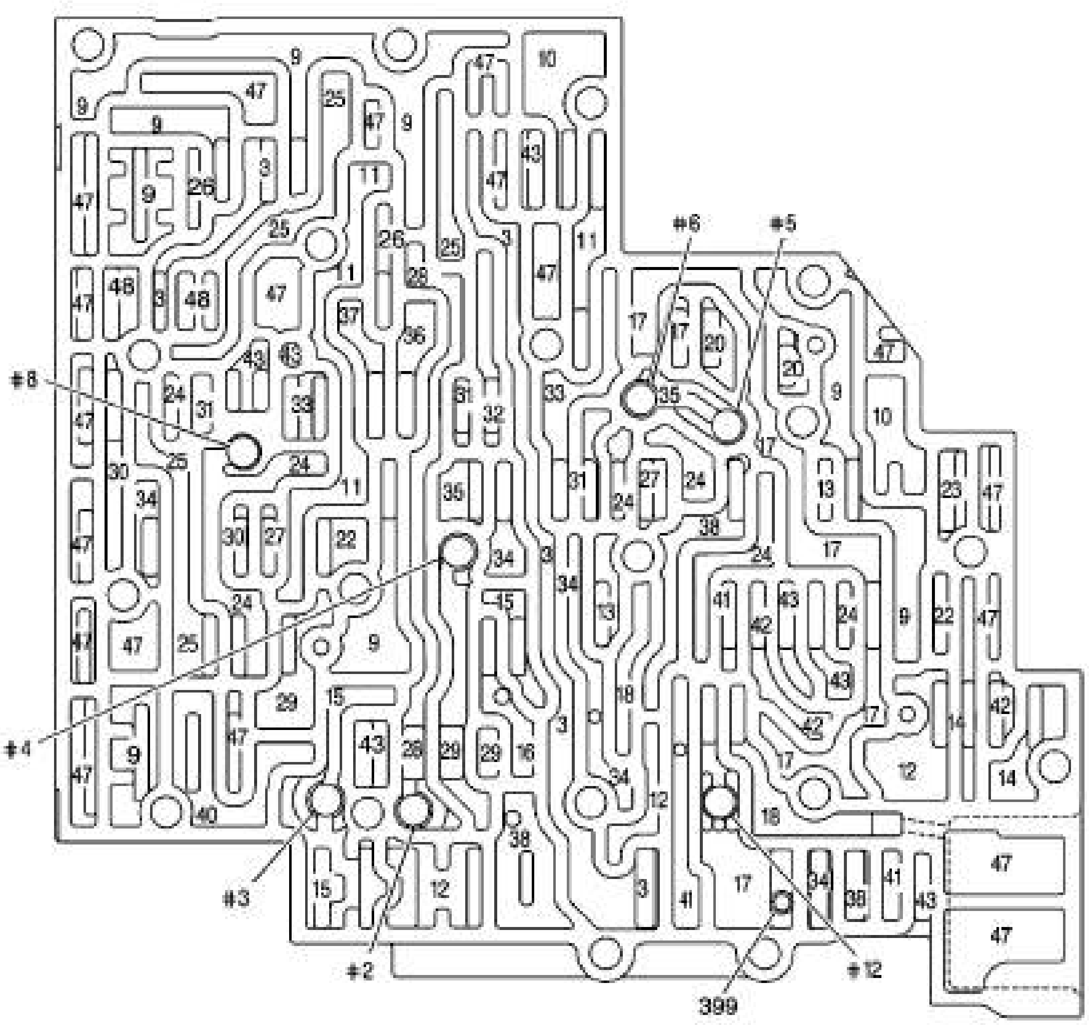
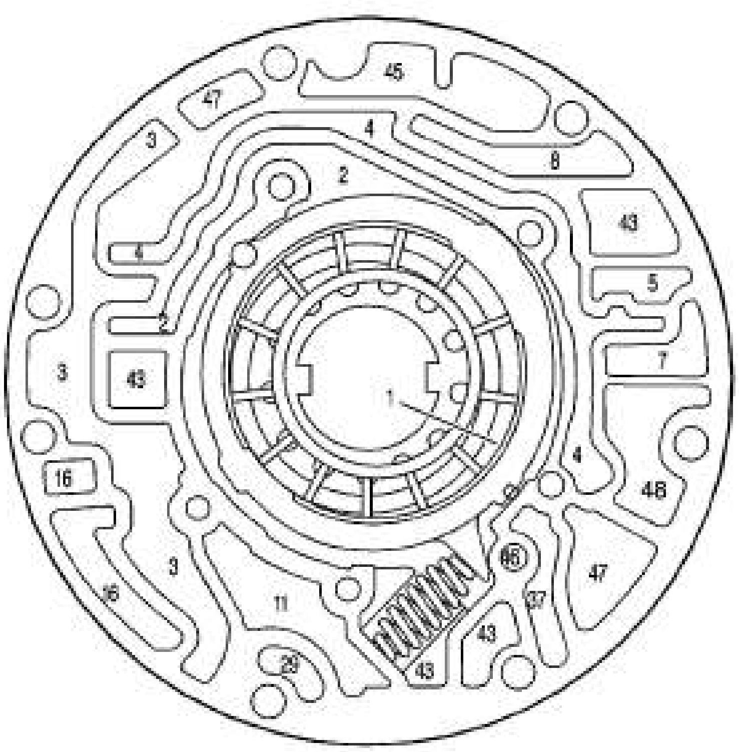
Control Valve Body Fluid Passages (Case Side)



(#2)	Checkball (61)
(#3)	Checkball (61)
(#4)	Checkball (61)
(#5)	Checkball (61)
(#6)	Checkball (61)
(#8)	Checkball (61)
(#12)	Checkball (61)
(3)	Line
(9)	Actuator Feed Limit
(10)	Filtered Actuator Feed
(11)	Torque Signal

(12)	PR
(13)	D4-3-2
(14)	Lo/Reverse
(15)	Reverse
(16)	Reverse Input (Rev. Clutch)
(17)	D4
(18)	Forward Clutch Feed
(20)	Accumulator
(22)	Signal A
(23)	Signal B
(24)	2nd
(25)	2nd Clutch
(26)	C.C. Signal
(27)	3-4 Signal
(28)	3rd Accumulator
(29)	3-4 Clutch
(30)	4th Signal
(31)	Servo Feed
(32)	4th
(33)	3-4 Accumulator
(34)	D3
(35)	Overrun
(36)	Overrun Clutch Feed
(37)	Overrun Clutch
(38)	D2
(40)	3-2 Signal
(41)	Lo
(42)	Lo/1st
(43)	Exhaust
(47)	Void
(48)	Regulated Apply
(399)	Ball Check Valve - M33 Models

Pump Body Fluid Passages (Pump Cover Side)



(1) Suction (intake)
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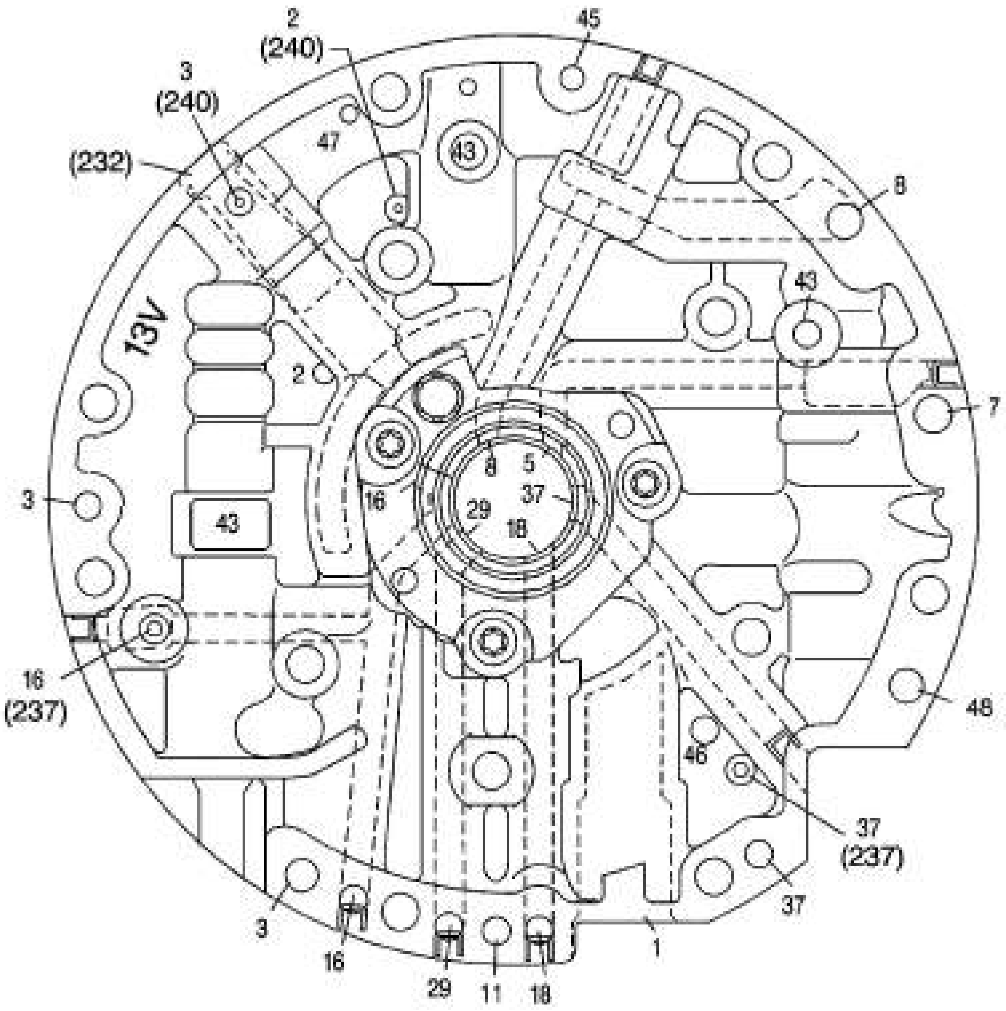
(5) Release
(7) To Cooler
(8) Lube from Cooler
(11) Torque Signal
(16) Reverse Input
(16) Reverse Input
(29) 3-4 Clutch
(37) Overrun Clutch
(43) Exhaust

(43) Exhaust
(43) Exhaust
(43) Exhaust
(45) Vent
(46) Seal Drain
(47) Void
(47) Void
(48) Regulated Apply

Pump Cover Fluid Passages (Case Side)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(1) Suction (Intake)
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(5) Release
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(8) Lube from Cooler
(11) Torque Signal

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(29) 3-4 Clutch
(29) 3-4 Clutch
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(37) Overrun Clutch
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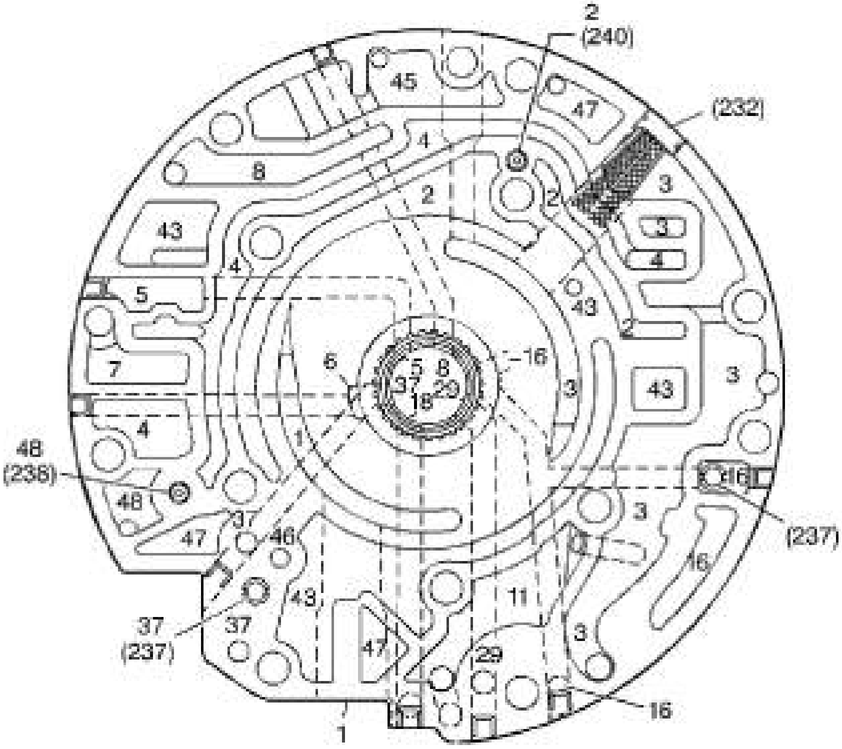
(43) Exhaust
(43) Exhaust
(45) Vent
(46) Seal Drain
(47) Void
(48) Regulated Apply
(232) Oil Pump Cover Screen
(237) Check Valve Retainer and Ball Assembly
(237) Check Valve Retainer and Ball Assembly
(240) Orificed Cup Plug
(240) Orificed Cup Plug

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 4L60-E/4L65-E/4L70-E | Description and Operation | **Document ID: 338651**

Pump Cover Fluid Passages (Pump Body Side)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- (5) Release
- (5) Release

(6) Apply
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(18) Forward Clutch Feed
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(29) 3-4 Clutch
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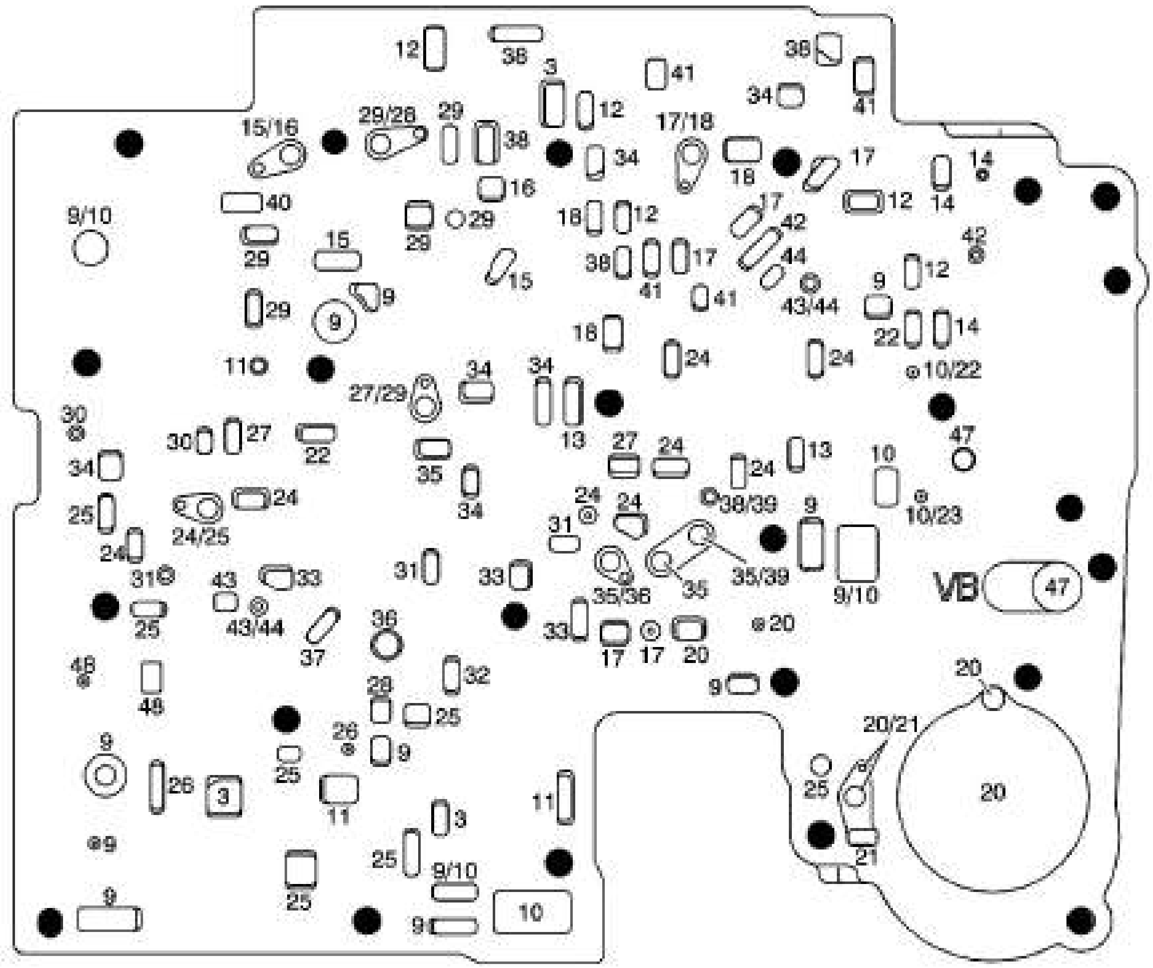
(37) Overrun Clutch
(43) Exhaust
(43) Exhaust
(43) Exhaust
(43) Exhaust
(45) Vent
(46) Seal Drain
(47) Void
(47) Void
(47) Void
(48) Regulated Apply
(48) Regulated Apply
(232) Oil Pump Cover Screen
(237) Check Valve Retainer and Ball Assembly
(237) Check Valve Retainer and Ball Assembly
(238) Converter Clutch Signal Orificed Cup Plug
(240) Orificed Cup Plug

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 4L60-E/4L65-E/4L70-E | Description and Operation | **Document ID: 2035677**

Spacer Plate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(3)	Line
(9)	Actuator Feed Limit
(9/10)	Actuator Feed Limit/Filtered Actuator Feed
(10)	Filtered Actuator Feed
(10/22)	Filtered Actuator Feed/Signal A
(10/23)	Filtered Actuator Feed/Signal B
(11)	Torque Signal
(12)	PR
(13)	D4-3-2
(14)	Lo/Reverse
(15)	Reverse

(15/16)	Reverse/Reverse Input (Rev. Clutch
(16)	Reverse Input (Rev. Clutch
(17)	D4
(17/18)	D4
(18)	Forward Clutch Feed
(20)	Accumulator
(20/21)	Accumulator/Orificed Accumulator
(21)	Orificed Accumulator
(22)	Signal A
(24)	2nd
(24/25)	2nd/2nd Clutch
(25)	2nd Clutch
(26)	C.C. Signal
(27)	3-4 Signal
(27/29)	3-4 Signal
(28)	3rd Accumulator
(29/28)	3-4 Clutch/3rd Accumulator
(29)	3-4 Clutch
(30)	4th Signal
(31)	Servo Feed
(32)	4th
(33)	3-4 Accumulator
(34)	D3
(35)	Overrun
(35/36)	Overrun/Overrun Clutch Feed
(35/39)	Overrun/Orificed D2
(36)	Overrun Clutch Feed
(37)	Overrun Clutch
(38)	D2
(38/39)	D2/Orificed D2
(40)	3-2 Signal
(41)	Lo
(42)	Lo/1st
(43)	Exhaust
(43/44)	Exhaust/Orificed Exhaust
(44)	Orificed Exhaust
(47)	Void
(48)	Regulated Apply

Manual First Gear

A manual 2-1 downshift can be accomplished by moving the gear selector lever into the manual first (1) position when the transmission is operating in second gear. The downshift to first gear is controlled electronically by the PCM. The PCM will not energize the 1-2 shift solenoid valve to initiate the downshift until the vehicle speed is below approximately 48 to 56 km/h (30 to 35 mph). Above this speed, the transmission operates in a manual first-second gear state. The following text explains the manual 2-1 downshift.

Manual Valve

The selector lever moves the manual shaft and the manual valve into the manual first (1) position. This allows the line pressure to enter the Lo fluid circuit.

2-3 Shift Solenoid (SS) Valve

In both first and second gears, this solenoid is energized and maintains the signal B fluid pressure at the solenoid end of the 2-3 shift valve train.

2-3 Shift Valve Train

Held in the downshift position by the signal B fluid pressure from the solenoid, the valve train blocks the AFL fluid from entering the D432 fluid circuit. The D432 fluid circuit is open to exhaust past the valve.

1-2 Shift Solenoid (SS) Valve

Below approximately 48 to 56 km/h (30 to 35 mph) the PCM energizes the normally open solenoid. This blocks the signal A fluid pressure from exhausting through the solenoid and creates the pressure in the signal A fluid circuit. Above this speed, the PCM keeps the solenoid de-energized and the transmission operates in manual first-second gear.

1-2 Shift Valve

Signal A fluid pressure moves the valve against the spring force and into the downshift position. In this position, Lo fluid from the manual valve is routed into the Lo/1st fluid circuit and D4 fluid is blocked from entering the 2nd fluid circuit. The 2nd fluid exhausts through an orifice and an annulus exhaust port past the valve. This orifice (#26) helps control the 2-4 band release during a 2-1 downshift.

2-4 Band Releases

2-4 Servo Assembly

The 2nd clutch fluid, which was fed by the 2nd fluid, exhausts from the servo. This allows the spring force from the servo cushion and the servo return springs to move the 2nd apply piston and apply the pin to release the 2-4 band. These spring forces help control the 2-4 band release.

1-2 Accumulator Assembly

The 2nd clutch fluid also exhausts from the 1-2 accumulator assembly. The spring force and the accumulator fluid pressure move the accumulator piston to assist the 2nd clutch fluid exhaust.

Accumulator Valve

As the accumulator fluid is filling the 1-2 accumulator assembly, the accumulator valve regulates the D4 fluid into the accumulator fluid circuit. This regulation, biased by torque signal fluid pressure and spring force, helps control the movement of the 1-2 accumulator piston. The 2nd clutch fluid exhaust, and the 2-4 band release.

1-2 Upshift Checkball (#8)

Exhausting the 2nd clutch fluid pressure unseats the ball and is routed through the 2nd fluid circuit.

Lo and Reverse Clutch Applies

Lo Overrun Valve

The Lo/1st fluid is regulated through the lo overrun valve and into the Lo/reverse fluid circuit in order to control the lo and reverse clutch apply.

Lo and Reverse Piston

The Lo/reverse fluid pressure acts on the inner area of the piston in order to move the piston and in order to apply the lo and reverse clutch plates.

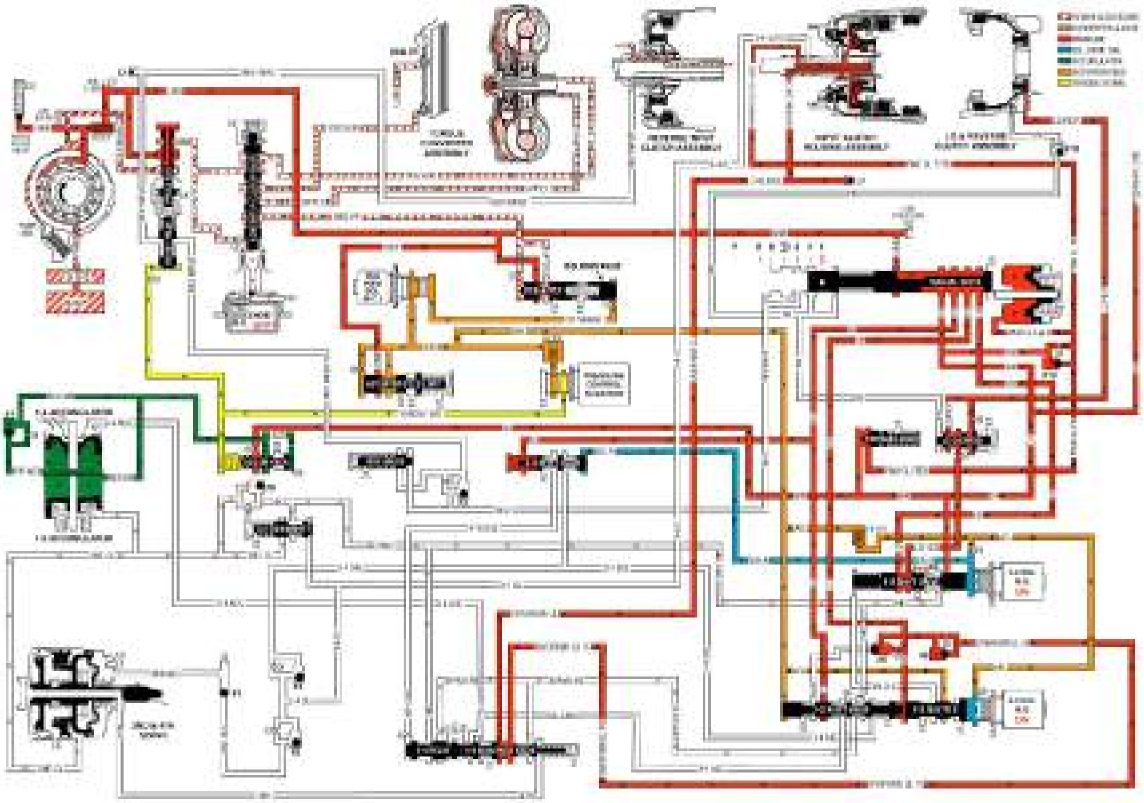
Overrun Clutch Applied

The overrun clutch remains applied in manual first in order to provide engine compression braking.

Pressure Control (PC) Solenoid Valve

Similar to manual second, the PCM output signal to the PC solenoid valve increases the operating range of the torque signal fluid pressure. This provides the increased line pressure for the additional torque requirements during the engine compression braking and the increased engine loads.

Manual First Gear



Manual Second Gear

A manual 3-2 downshift can be accomplished by moving the gear selector lever into the Manual Second (2) position when the transmission is operating in third gear. This causes the transmission to shift immediately into second gear regardless of vehicle operating conditions. Also, the transmission is prevented from operating in any other gear, first, third or fourth. The following information explains the additional changes during a manual 3-2 downshift, as compared to a forced 3-2 downshift. Some vehicles in manual second gear will start out in first gear, while other vehicles will have a second gear start. Refer to the owners manual for specific applications.

Manual Valve

The selector lever moves the manual shaft and the manual valve into the manual second (2) position. This allows the line pressure to enter the D2 fluid circuit.

Third and Fourth Gears Prevented

2-3 Shift Solenoid (SS) Valve

The PCM energizes the 2-3 SS valve and the AFL fluid pressure holds the 2-3 shift valve in the downshift position. This electronically prevents operation of the third and fourth gears.

2-3 Shift Valve Train

The D2 fluid is routed between the 2-3 shuttle and the 2-3 shift valves and causes the following:

- Regardless of the operating conditions, the D2 fluid pressure holds the 2-3 shift valve in the downshift position against the AFL fluid pressure.
- The 2nd fluid is blocked from entering the 3-4 signal fluid circuit and the 3-4 signal fluid circuit is open to an exhaust port at the valve.
- The 3-4 clutch cannot apply with the 3-4 signal fluid exhausted. Therefore, third and fourth gears are hydraulically prevented.
- The 2nd fluid feeds the servo feed fluid circuit, but the 2nd fluid circuit has no function in manual second.
- The AFL fluid is blocked by the 2-3 shift valve and the D432 fluid circuit is exhausted through the valve.
- The overrun fluid is exhausted through the 2-3 shuttle valve.

1-2 Shift Valve

The 1-2 SS valve is OFF, the signal A fluid exhausts through the solenoid and the spring force holds the valve in the upshifted position.

First Gear Prevented

The prevention of first gear is controlled electronically by the PCM through the 1-2 SS valve. The

PCM keeps the 1-2 SS valve de-energized, regardless of the vehicle operating conditions when the manual shift detent lever with shaft position switch signals manual second gear range. This keeps signal A fluid exhausted and the spring force holds the 1-2 shift valve in the upshift position.

Overrun Clutch Remains Applied

Overrun Clutch Feed Checkball (#5)

Orificed D2 fluid pressure seats the #5 checkball against the empty overrun clutch fluid circuit. This is done simultaneously with the overrun clutch fluid exhausting so that there is a continuous fluid supply to the overrun clutch feed fluid circuit.

Overrun Clutch Piston

A continuous supply of fluid pressure is routed to the piston in order to keep the overrun clutch plates applied.

Torque Converter Clutch

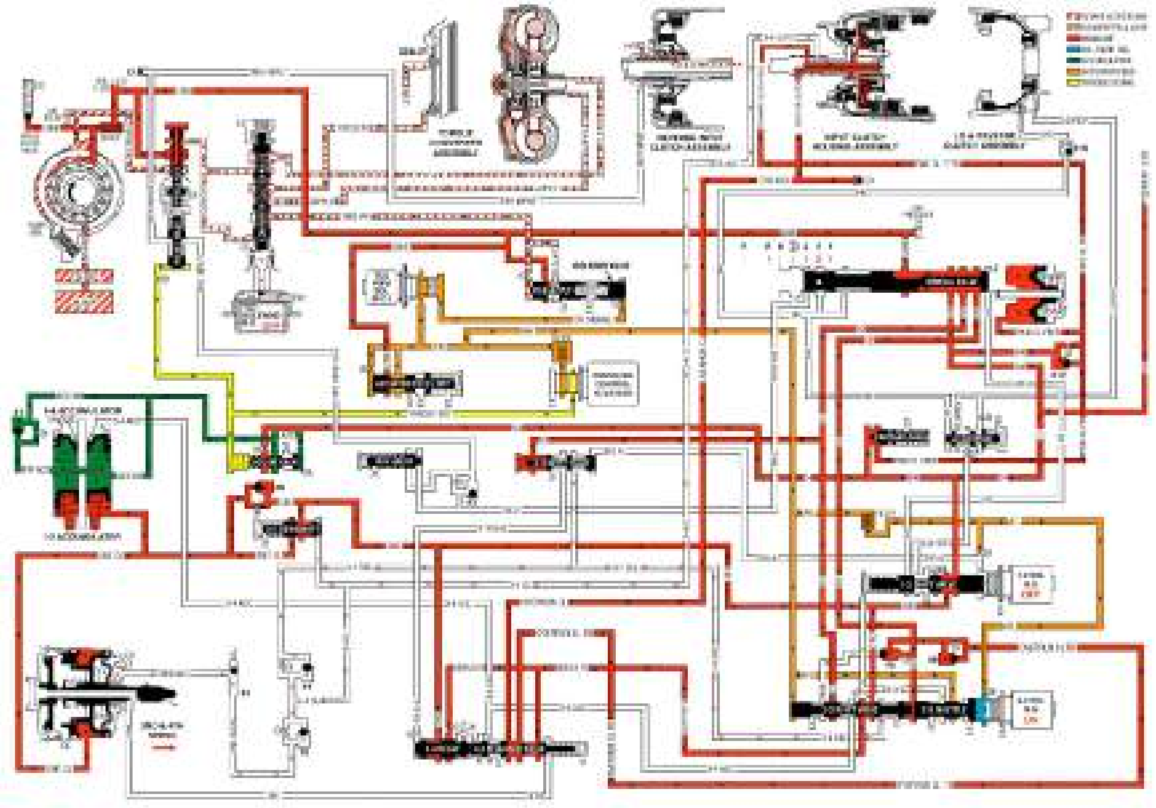
The converter clutch is released prior to downshifting into manual second-second gear. Under normal operating conditions, the TCC will not apply in second gear.

Pressure Control (PC) Solenoid Valve

Important: Some vehicles in Manual Second Gear, at a stop, will start out in 1st gear, while others will have a second gear start. Refer to Vehicle Owners Manual.

The PCM output signal to the PC solenoid valve increases the operating range of torque signal fluid pressure in manual second. This provides the increased line pressure for the additional torque requirements during the engine compression braking and increased engine loads.

Manual Second Gear



Manual Third Gear

A manual 4-3 downshift is available to increase vehicle performance when the use of only three gear ratios is desired. Manual Third gear range also provides engine braking in Third gear when the throttle is released. A manual 4-3 downshift is accomplished by moving the selector lever into the Manual Third (D) position. This moves the manual valve and immediately downshifts the transmission into Third gear. Refer to Overdrive Range, 4-3 Downshift for a complete description of a 4-3 downshift. In Manual Third, the transmission is prevented, both hydraulically and electronically, from shifting into Fourth gear. The following information explains the additional changes during a manual 4-3 downshift as compared to a forced 4-3 downshift.

Manual Valve

The selector lever moves the manual shaft and manual valve into the Manual Third position (D). This allows line pressure to enter the D3 fluid circuit.

1-2 Shift Solenoid (SS) Valve

When Manual Third is selected, the PCM de-energizes the 1-2 SS valve to immediately downshift the transmission into Third gear. This electronically prevents Fourth gear.

3-4 Shift Valve

D3 fluid pressure assists spring force to keep the valve in the downshifted position against the signal A fluid circuit. In this position, the valve blocks 3-4 signal fluid and the 4th signal fluid circuit is open to an exhaust port past the valve. Therefore, with D3 fluid pressure assisting spring force, Fourth gear is hydraulically prevented.

2-3 Shift Valve Train

With the 2-3 SS valve de-energized and open, actuator feed limit (AFL) fluid acting on the 2-3 shift valve holds both valves in the upshifted position. This allows D3 fluid to feed the overrun fluid circuit through the 2-3 shift valve.

Overrun Clutch Feed Checkball (#5)

Overrun fluid pressure seats the ball against the empty D2 fluid circuit.

Overrun Clutch Control Checkball (#6)

Overrun fluid pressure seats the #6 checkball and is orificed (#20) to fill the overrun clutch feed fluid circuit. This orifice controls the overrun clutch apply rate.

3-4 Relay Valve and 4-3 Sequence Valve

4th signal fluid pressure is exhausted from the end of the 3-4 relay valve. Overrun clutch feed fluid pressure assists spring force and closes both valves. This allows overrun clutch feed fluid to flow through the 4-3 sequence valve and fill the overrun clutch fluid circuit.

Overrun Clutch Piston

Overrun clutch fluid pressure moves the piston to apply the overrun clutch plates. The overrun clutch plates provide engine compression braking in Manual Third - Third Gear.

Overrun Clutch Air Bleed Checkball

This ball and capsule is located in the overrun clutch fluid circuit in the oil pump. It allows air to exhaust from the circuit as fluid pressure increases and also allows air into the circuit to displace the fluid when the clutch releases.

Torque Converter Clutch and Torque Converter Clutch PWM Solenoid Valve

The PCM de-energizes the TCC solenoid valve and operates the duty cycle of the TCC PWM solenoid valve to release the converter clutch prior to downshifting, (assuming the converter clutch is applied in Overdrive Range-Fourth Gear when Manual Third is selected). The PCM will re-apply the converter clutch in Manual Third-Third Gear when proper driving conditions have been met.

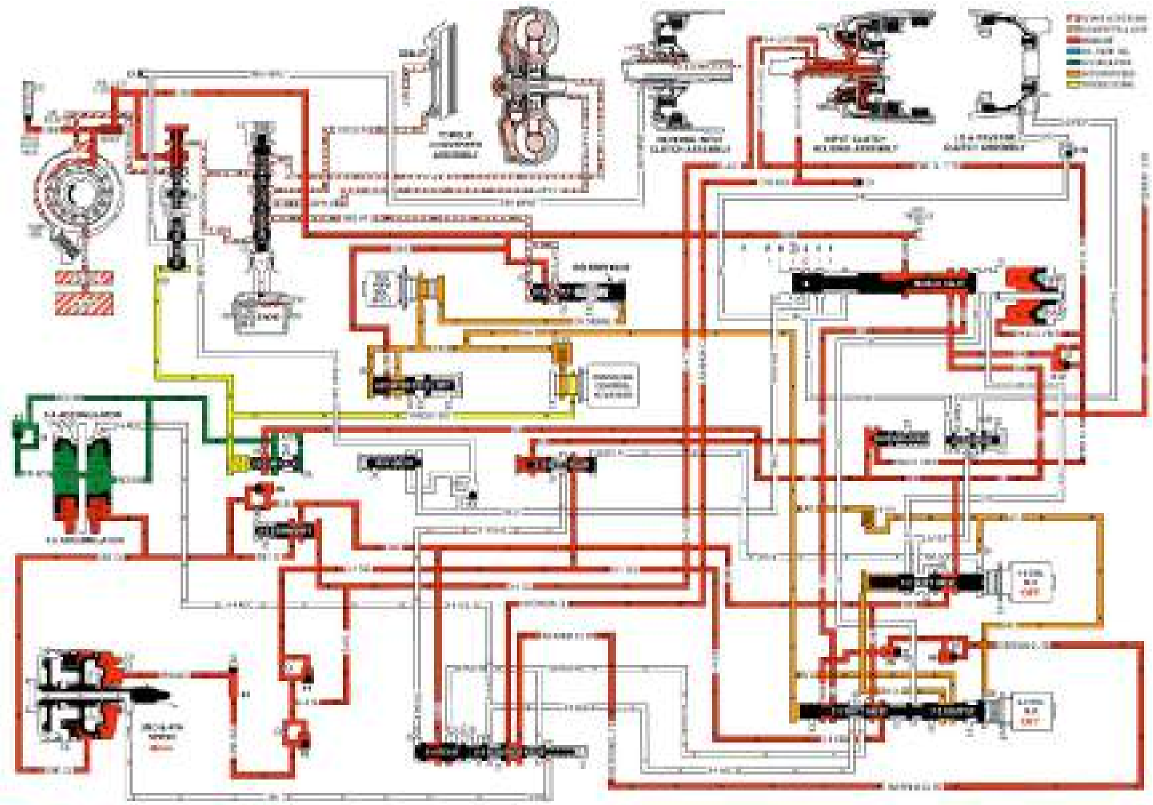
Pressure Control (PC) Solenoid Valve

The PC solenoid valve operates in the same manner as Overdrive Range, regulating in response to throttle position and other vehicle operating conditions.

Manual Third -- First and Second Gears: Overrun Clutch Released

In Manual Third, the transmission upshifts and downshifts normally between First, Second and Third gears. However, in First and Second gears, the 2-3 SS valve is energized and the 2-3 shift valve train is in the downshifted position. The 2-3 shift valve blocks D3 fluid from entering the overrun fluid circuit and opens the overrun fluid circuit to an exhaust port at the valve. This prevents overrun clutch apply and engine compression braking in Manual Third-First and Second Gears.

Manual Third Gear



Neutral - Engine Running

When the gear selector lever is moved to the Neutral position (N) from the Reverse position, the following changes occur to the transmission hydraulic and electrical systems.

Manual Valve

In the Neutral position, the manual valve blocks the line pressure from entering any other fluid circuits. Reverse and PR fluids exhaust past the manual valve.

Lo and Reverse Clutch Releases

Lo and Reverse Clutch Piston

PR and Lo/reverse fluids exhaust from the piston, thereby releasing the lo and reverse clutch plates. Exhausting PR fluid unseats the lo and reverse clutch checkball (#10) for a quick exhaust.

Lo Overrun Valve

Spring force closes the valve when the PR fluid pressure exhausts. Lo/reverse fluid exhausts through the valve, into the Lo/1st fluid circuit, past the 1-2 shift valve, into the Lo fluid circuit and through an exhaust port at the manual valve.

Reverse Input Cutch Releases

Reverse Input Clutch Piston

Reverse input fluid pressure exhausts from the piston, through the boost valve, past the #3 checkball and to the manual valve. With the reverse input fluid exhausted, the reverse input clutch plates are released and the transmission is in Neutral.

Reverse Abuse Valve

Reverse fluid pressure exhausts and spring force closes the valve.

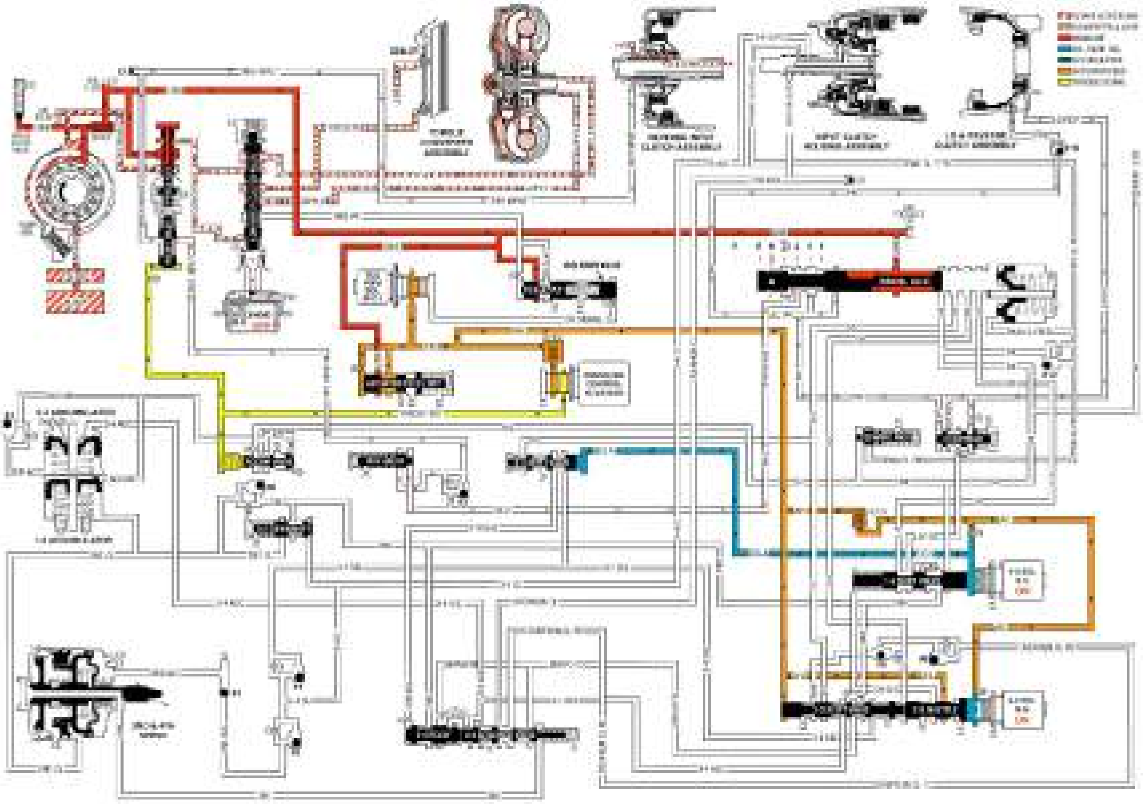
Boost Valve

Reverse input fluid pressure exhausts and line pressure returns to the normal operating range as in the Park and Overdrive positions.

Reverse Input Checkball (#3)

Exhausting reverse input fluid unseats the ball for a quick exhaust through the reverse fluid circuit and past the manual valve.

Neutral - Engine Running



Overdrive Range, 3-2 Downshift

Similar to a forced 4-3 downshift, a forced 3-2 downshift can occur because of minimum throttle (coastdown conditions), heavy throttle or increased engine load. In order to achieve a forced 3-2 downshift, the PCM energizes the 2-3 shift solenoid valve and the following changes occur:

Energized by the PCM, the normally open solenoid closes and blocks the signal B fluid from exhausting through the solenoid. This creates pressure in the signal B fluid circuit at the solenoid end of the 2-3 shift valve.

2-3 Shift Valve Train

The signal B fluid pressure from the shift solenoid moves both valves to the downshift position against AFL fluid pressure acting on the 2-3 shift valve. This causes the following changes:

- The AFL fluid is blocked from the D432 fluid circuit and the D432 fluid exhausts past the 2-3 shuttle valve.
- The 2nd fluid is blocked from feeding the 3-4 signal fluid circuit and the 2nd fluid is routed into the servo feed fluid circuit.
- The 3-4 signal fluid is exhausted past the valve. The 3-4 clutch fluid and the 3rd accumulator fluid, which were fed by the 3-4 signal fluid, also exhaust.

3-4 Clutch Releases and 2-4 Band Applies

3-4 Clutch Piston

The 3-4 clutch fluid exhausts from the piston and the 3-4 clutch plates are released.

3-4 Clutch Exhaust Checkball (#4)

Exhausting 3-4 clutch fluid seats the #4 checkball and is forced through orifice #13. This orifice controls the 3-4 clutch fluid exhaust and the 3-4 clutch release rate.

2-4 Servo Assembly

The 3rd accumulator fluid exhausts from the servo assembly. The 2nd clutch fluid pressure moves the 2nd apply piston against the servo return spring force in order to move the apply pin and apply the 2-4 band.

3-2 Downshift Valve and 1-2 Upshift Checkball (#8)

The 3-4 clutch fluid exhausts from the valve and the spring force moves the valve into the second gear position. However, before the spring force overcomes the exhausting 3-4 clutch fluid pressure, the 2nd fluid feeds the 2nd clutch fluid circuit through the valve. This bypasses the control of orifice #16 at the #8 checkball and provides a faster 2-4 band apply. Remember that the #8 checkball and orifice #16 are used to help control the 2-4 band apply during a 1-2 upshift.

Downshift Timing and Control

At higher vehicle speeds, the 2-4 band apply must be delayed to allow the engine speed RPM to increase sufficiently for a smooth transfer of engine load to the 2-4 band. Therefore, exhaust of the 3rd accumulator fluid must be delayed. However, at lower speeds the band must be applied quickly. In order to provide for the varying requirements for the 2-4 band apply rate, the exhausting 3rd accumulator fluid is routed to the 3rd accumulator checkball (#2).

3rd Accumulator Checkball (#2)

The exhausting 3rd accumulator fluid seats the #2 checkball and is forced through orifice #12. This fluid exhausts through the 3-4 clutch and the 3-4 signal fluid circuits and past the 2-3 shift valve. Orifice #12 slows the exhaust of the 3rd accumulator fluid and delays the 2-4 band apply rate.

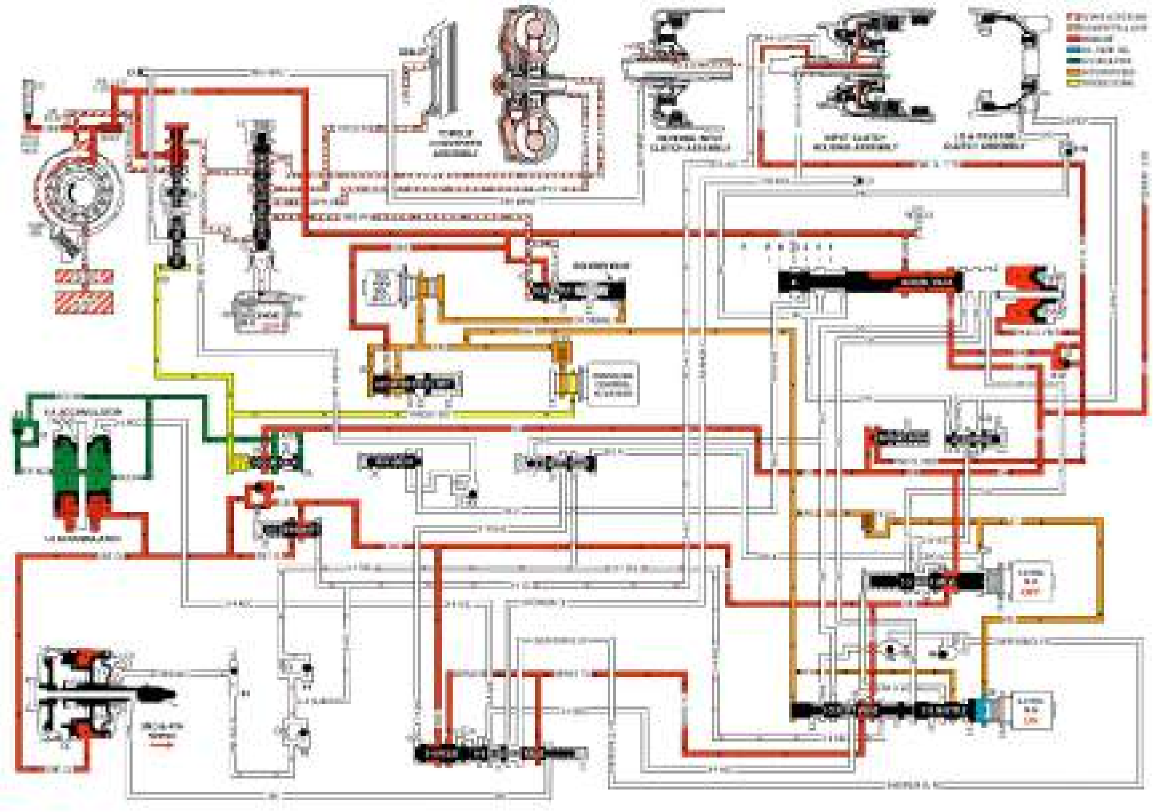
3rd Accumulator Exhaust Checkball (#7)

After the downshift is completed, the #7 checkball unseats and allows the residual fluid in the 3rd accumulator fluid circuit to exhaust.

Pressure Control (PC) Solenoid Valve

Remember that the PC solenoid valve continually adjusts torque signal fluid in relation to the various PCM input signals (mainly the throttle position).

Overdrive Range, 3-2 Downshift



Overdrive Range, 4-3 Downshift

When the transmission is operating in fourth gear, a forced 4-3 downshift occurs if there is a significant increase in throttle position. At minimum throttle, the vehicle speed decreases gradually (coastdown) and the PCM commands a 4-3 downshift. The PCM also initiates a forced 4-3 downshift when the throttle position remains constant but engine load is increased, such as driving up a steep incline. To achieve a 4-3 downshift, the PCM de-energizes the 1-2 shift solenoid valve and the following changes occur to the transmission's electrical and hydraulic systems:

1-2 Shift Solenoid (SS) Valve

De-energized by the PCM, the normally open solenoid opens and signal A fluid exhausts through the solenoid.

1-2 Shift Valve

As in Fourth gear, D432 fluid pressure and spring force hold the valve in the upshift position.

2-4 Band Releases

3-4 Shift Valve

With the signal A fluid pressure exhausted, the spring force moves the valve into the downshift position. In this position, the valve blocks the 3-4 signal fluid and the 4th signal fluid exhausts past the valve.

3-4 Relay Valve and 4-3 Sequence Valve

These valves control the timing of the 2-4 band release. With the 4th signal fluid pressure exhausted, the 3-4 accumulator fluid pressure moves the 3-4 relay valve into the third gear position. This opens the 3-4 accumulator fluid to an orificed exhaust (#5) past the 3-4 relay valve (shown by red arrows). Because the exhaust is orificed, the 3-4 accumulator fluid pressure momentarily holds the 4-3 sequence valve against spring force before completely exhausting.

When the exhausting 3-4 accumulator fluid pressure decreases sufficiently, the spring force moves the 4-3 sequence valve into the third gear position as shown. This opens both the 3-4 accumulator and the 4th fluid circuits to a quick exhaust past the 4-3 sequence valve. In this position the valve blocks the 2nd fluid from entering the servo feed fluid circuit.

2-4 Servo Assembly

The 4th fluid exhausts from the 4th apply piston in the servo assembly. The apply pin spring moves the 4th apply piston and the apply pin in order to release the band from the reverse input drum and shift the transmission into third gear.

3-4 Accumulator Assembly

The 3-4 accumulator fluid exhausts from the 3-4 accumulator piston. The orificed accumulator fluid pressure and the spring force move the piston into a third gear position.

3-4 Accumulator Checkball (#1)

As the accumulator fluid fills the 3-4 accumulator, it seats the #1 checkball and is forced through orifice #18. This orifice controls the rate at which accumulator fluid pressure fills the 3-4 accumulator and the 3-4 accumulator fluid exhausts from the accumulator assembly.

Accumulator Valve

Biased by torque signal fluid pressure and spring force, the accumulator valve regulates the D-4 fluid into the accumulator fluid circuit.

2-3 Shift Solenoid (SS) Valve

This solenoid remains de-energized as in fourth gear and the signal B fluid exhausts through the solenoid.

2-3 Shift Valve Train

The AFL fluid pressure at the 2-3 shift valve holds the valves in the upshift position. This allows the servo feed fluid to exhaust through the valve, into the 3-4 accumulator fluid circuit and past the 4-3 sequence valve.

Torque Converter Clutch Solenoid Valve

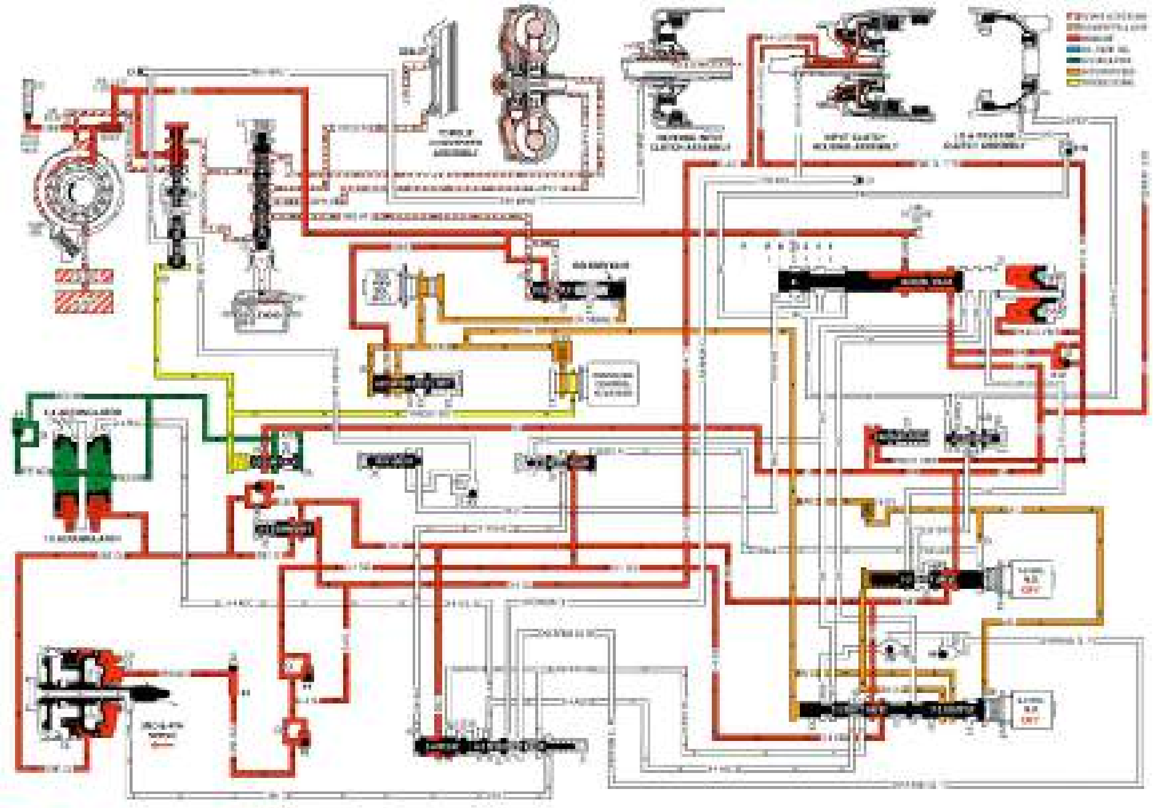
TCC PWM Solenoid Valve

The PCM de-energizes the TCC solenoid valve, and operates the duty cycle of the TCC PWM solenoid valve to release the converter clutch for a smooth disengagement, prior to initiating the 4-3 downshift.

Pressure Control (PC) Solenoid Valve

Remember that the PC solenoid valve continually adjusts the torque signal fluid pressure in relation to the various PCM input signals (mainly the throttle position).

Overdrive Range, 4-3 Downshift



Overdrive Range, First Gear

When the gear selector lever is moved to the Overdrive position, from the neutral position, the following changes occur to the transmission's hydraulic and electrical systems:

Manual Valve

Line pressure flows through the manual valve and fills the D4 fluid circuit. All other fluid circuits remain empty with the manual valve in the Overdrive position.

Forward Clutch Accumulator Checkball (#12)

D4 fluid pressure seats the checkball and is orificed (#22) into the forward clutch feed fluid circuit. This orifice helps control the forward clutch apply rate.

Forward Clutch Accumulator Piston

Forward clutch feed fluid pressure moves the piston against spring force. This action absorbs some of the initial increase of forward clutch feed fluid pressure to cushion the forward clutch apply.

Forward Clutch Abuse Valve

D4 fluid pressure acts on the valve opposite of spring force. At engine speeds greater than idle, D4 fluid pressure increases and moves the valve against spring force (as shown). D4 fluid can then quickly fill the forward clutch feed fluid circuit, thereby bypassing the control of orifice #22 and providing a faster apply of the forward clutch. Otherwise, with increased throttle opening and engine torque, the clutch may slip during apply.

1-2 Shift Solenoid (SS) Valve

Energized (ON) as in Neutral, the normally open solenoid is closed and blocks signal A fluid from exhausting through the solenoid. This maintains pressure in the signal A fluid circuit.

2-3 Shift Solenoid (SS) Valve

Energized (ON) as in Neutral, the normally open solenoid is closed and blocks signal B fluid from exhausting through the solenoid. This maintains signal B fluid pressure at the solenoid end of the 2-3 shift valve.

2-3 Shift Valve Train

Signal B fluid pressure at the solenoid end of the 2-3 shift valve holds the valve train in the downshifted position against AFL fluid pressure acting on the 2-3 shift valve. In this position, the 2-3 shuttle valve blocks AFL fluid from entering the D432 fluid circuit. The D432 fluid circuit is open to an exhaust port past the valve.

1-2 Shift Valve

Signal A fluid pressure holds the valve in the downshifted position against spring force. In the First gear position, the valve blocks D4 fluid from entering the 2nd fluid circuit.

Accumulator Valve

Biased by torque signal fluid pressure, spring force and orificed accumulator fluid pressure at the end of the valve, the accumulator valve regulates D4 fluid into accumulator fluid pressure. Accumulator fluid is routed to both the 1-2 and 3-4 accumulator assemblies in preparation for the 1-2 and 3-4 upshifts respectively.

Rear Lube (All Except Y-Car)

D4 fluid is routed through an orifice cup plug (#24) in the rear of the transmission case to feed the rear lube fluid circuit.

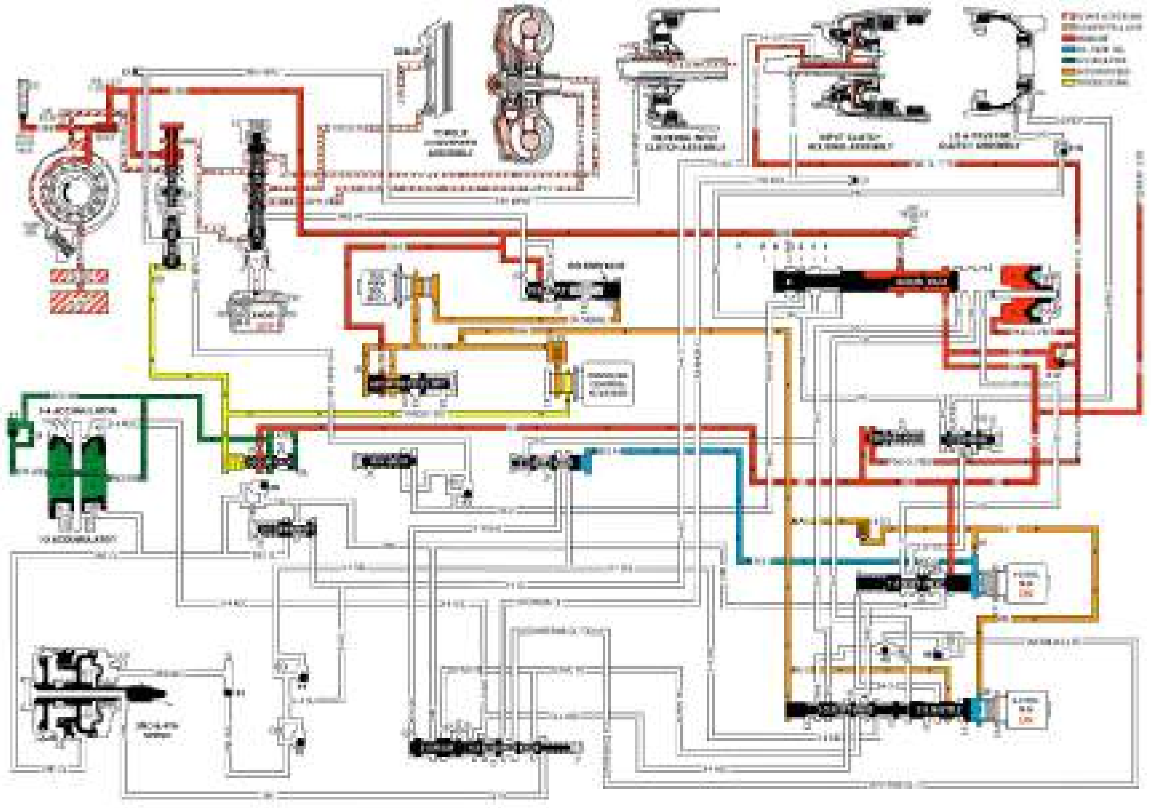
Pressure Control (PC) Solenoid Valve

Remember that the PC solenoid valve continually varies torque signal fluid pressure in relation to throttle position and vehicle operating conditions. This provides a precise control of line pressure.

Torque Converter Clutch PWM Solenoid Valve

In first gear, at approximately 6 mph, the PCM operates the TCC PWM solenoid valve at approximately a 90 percent duty cycle. This opens the AFL fluid circuit, to fill the converter clutch signal fluid circuit through the #9 orifice, and flows to the isolator valve. The CC signal fluid pressure, acting on the isolator valve, will move the regulated apply valve towards the closed position. Regulated line pressure is now routed into the regulated apply circuit, and flows to the closed converter clutch valve, and is blocked from entering the converter clutch apply circuit. Regulated apply fluid is routed through the #8 orifice to the front of the regulated apply valve, and regulates the line pressure entering the regulated apply circuit, in response to the CC signal fluid acting on the isolator valve.

Overdrive Range, First Gear



Overdrive Range, Fourth Gear - Torque Converter Clutch Applied

At higher vehicle speeds, the Hydra-matic 4L60-E transmission uses an overdrive gear ratio (fourth gear) in order to increase fuel economy and in order to maximize engine performance. When vehicle operating conditions are appropriate, the PCM energizes the 1-2 shift solenoid valve to shift the transmission into fourth gear.

1-2 Shift Solenoid (SS) Valve

Energized (turned ON) by the PCM, the normally open solenoid closes and blocks signal A fluid from exhausting through the solenoid. This creates pressure in the signal A fluid circuit.

2-3 Shift Solenoid (SS) Valve

De-energized (OFF) as in third gear, the 2-3 shift solenoid valve exhausts signal B fluid through the solenoid.

1-2 Shift Valve

D432 fluid pressure from the 2-3 shift valve and spring force hold the valve in the upshift position against signal A fluid pressure.

3-4 Shift Valve

Signal A fluid pressure moves the valve into the upshift position against the spring force. In this position, the valve routes 3-4 signal fluid into the 4th signal fluid circuit.

3-4 Relay Valve and 4-3 Sequence Valve

4th signal fluid pressure moves both valves into the upshift (fourth gear) position against the spring force acting on the 4-3 sequence valve. This causes the following changes:

- Orificed (#7) 2nd fluid is routed through the 3-4 relay valve and into the servo feed fluid circuit.
- Servo feed fluid is routed through the 4-3 sequence valve and into the 4th fluid circuit.
- 3-4 accumulator fluid routed from the 2-3 shuttle valve is blocked by both valves.

2-4 Servo Assembly

4th fluid is routed through the center of the servo apply pin and acts on the apply side of the 4th apply piston. 4th fluid pressure moves the 4th apply piston against the apply pin spring force acting on the release side of the 4th apply piston. This action moves the apply pin and applies the 2-4 band in order to obtain fourth gear.

2-4 Band Apply Accumulation

2-3 Shift Valve Train

The valve train remains in the upshift position with the AFL fluid pressure acting on the 2-3 shift valve. In addition to its operation third gear, the 2-3 shift valve directs servo feed fluid into the 3-4 accumulator fluid circuit.

3-4 Accumulator Assembly

3-4 accumulator fluid pressure moves the 3-4 accumulator piston against spring force and orificed accumulator fluid pressure. This action absorbs initial 4th clutch apply fluid pressure in order to cushion the 2-4 band apply. Remember that both of the 3-4 accumulator and 4th fluid circuits are fed by servo feed fluid. As 3-4 accumulator fluid fills the accumulator, any air in the system will exhaust through office #19. This piston movement forces some orificed accumulator fluid out of the 3-4 accumulator assembly.

3-4 Accumulator Checkball (#1)

The accumulator fluid forced from the accumulator unseats the #1 checkball and enters the accumulator fluid circuit. This fluid is routed to the accumulator valve. This is shown by the arrow directions in the fluid circuit.

Accumulator Valve

Accumulator fluid forced from the 3-4 accumulator is orificed to the end of the accumulator valve. This fluid pressure, in addition to spring force and torque signal fluid pressure, regulates the exhaust of excess accumulator fluid pressure through the middle of the valve. This regulation helps control the 2-4 band apply feel.

Torque Converter Clutch Applies

TCC Solenoid Valve

When operating conditions are appropriate, the PCM energizes the normally open TCC solenoid valve. This closes the solenoid, blocks the converter feed fluid from exhausting, and creates pressure in the converter feed fluid circuit at the converter clutch apply valve and TCC solenoid valve.

Converter Clutch Apply Valve

Converter feed fluid pressure moves the valve against spring force and into the apply position. In this position, release fluid is open to an exhaust port, and regulated apply fluid fills the apply fluid circuit. Converter feed fluid is routed through the converter clutch apply valve to feed the cooler fluid circuit.

Torque Converter

Release fluid from behind the pressure plate exhausts through the end of the turbine shaft. Apply fluid pressure is routed between the converter hub and stator shaft where it enters the torque converter. This fluid applies the converter clutch against the converter cover and keeps the converter filled with fluid.

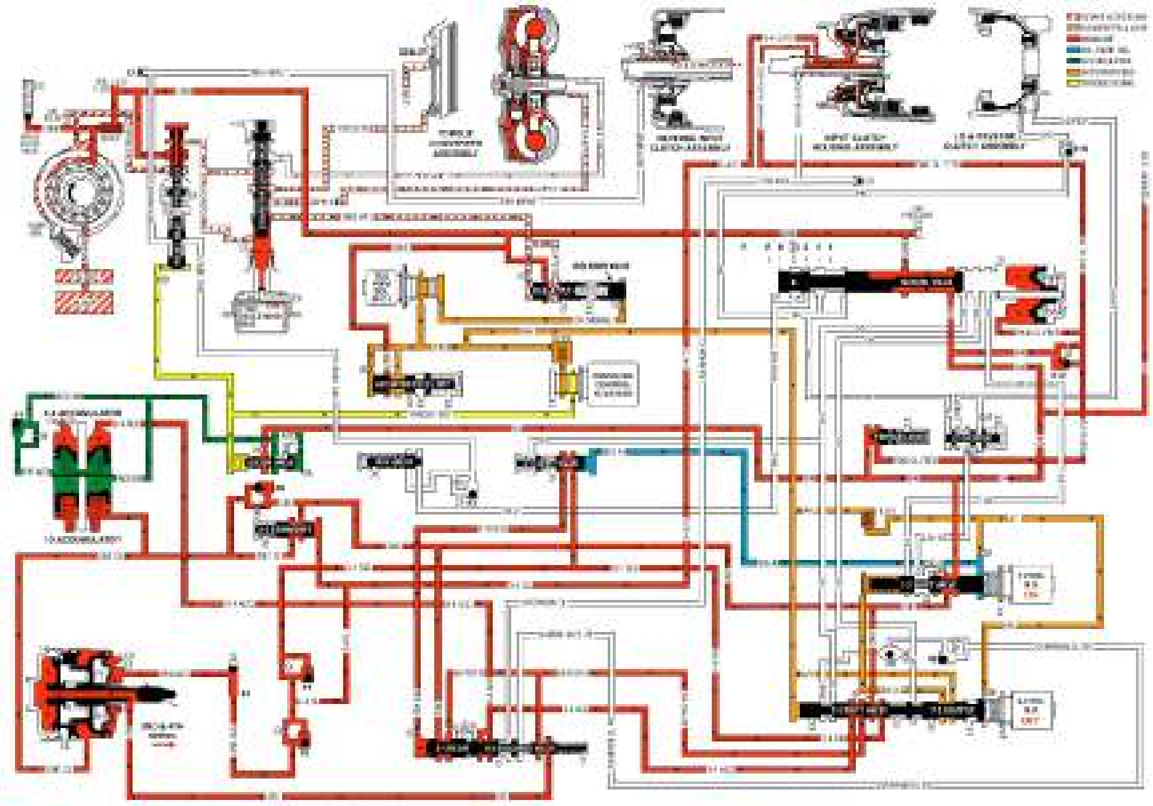
TCC Apply Checkball (#9)

Release fluid, exhausting from the converter, seats the #9 checkball located in the end of the turbine shaft, and is orificed around the ball. Orificing the exhausting release fluid controls the converter clutch apply rate, along with the TCC PWM solenoid valve.

TCC PWM Solenoid Valve

The torque converter clutch pulse width modulation (TCC PWM) solenoid valve controls the regulated apply valve position. This is done through the use of pulse width modulation (duty cycle operation). The solenoid duty cycle is controlled by the PCM in relation to vehicle operating conditions and regulates actuator feed limit (AFL) fluid into the CC signal circuit, through the #9 orifice, and to the isolator valve. This controls line pressure flow through the regulated apply valve, into the regulated apply circuit, and provides a smooth engagement of the TCC.

Overdrive Range, Fourth Gear - TCC Applied



2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 4L60-E/4L65-E/4L70-E | Description and Operation | Document ID: 2036984

Overdrive Range, Second Gear

As vehicle speed increases and other operating conditions are appropriate, the PCM de-energizes the 1-2 shift solenoid valve in order to shift the transmission to second gear.

1-2 Shift Solenoid (SS) Valve

De-energized (turned OFF) by the PCM, the normally open solenoid opens and signal A fluid exhausts through the solenoid.

2-3 Shift Solenoid (SS) Valve

Important: The actuator feed limit (AFL) fluid continues to feed the signal A fluid circuit through orifice #25. However, the exhaust port through the solenoid is larger than orifice #25 in order to prevent a pressure buildup in the signal A fluid circuit. Exhausting signal A fluid is represented by the blue arrows.

Energized (ON) as in first gear, the 2-3 shift solenoid valve blocks signal B fluid from exhausting through the solenoid. This maintains signal B fluid pressure at the solenoid end of the 2-3 shift valve.

1-2 Shift Valve

Without signal A fluid pressure, spring force moves the valve into the upshift position. D4 fluid is routed through the valve and fills the 2nd fluid circuit.

1-2 Shift Checkball (#8)

The 2nd fluid pressure seats the #8 checkball, flows through orifice #16, and fills the 2nd clutch fluid circuit. This orifice helps control the 2-4 band apply rate.

2-4 Servo Assembly

The 2nd clutch fluid pressure moves the #8 checkball, flows through orifice #16 and fills the 2nd clutch fluid circuit. This orifice helps to control the 2-4 band apply rate.

1-2 Accumulator

The 2nd clutch fluid pressure also moves the 1-2 accumulator piston against the spring force and the accumulator fluid pressure. This action absorbs the initial 2nd clutch fluid pressure in order to cushion the 2-4 band apply rate. Also, the movement of the 1-2 accumulator piston forces some accumulator fluid out of the accumulator assembly. This accumulator fluid is routed back to the accumulator valve.

Accumulator Valve

The accumulator fluid forced out of the 1-2 accumulator is orificed (#30) to the end of the accumulator valve. This pressure moves the valve against the spring force and the torque signal fluid pressure in order to regulate the exhaust of excess accumulator fluid. This regulation provides additional control for the 2-4 band apply rate. The fluid circuit shows the exhaust of the accumulator fluid during the shift by the arrow directions in the accumulator fluid circuit.

2-3 Shift Valve Train

The signal B fluid pressure from the 2-3 shift solenoid valve holds the valve train in the downshift position. The 2nd fluid is routed through the 2-3 shuttle valve and fills the servo feed fluid circuit.

3-4 Relay Valve and 4-3 Sequence Valve

Spring force holds these valves in the downshift position (first, second and third gear positions). The 2nd fluid is blocked by the 3-4 relay valve and the servo feed fluid is blocked by both valves in preparation for a 3-4 upshift.

3-2 Downshift Valve

Spring force holds the valve closed, blocking the 2nd fluid and the 2nd clutch fluid. This valve is used in order to help control the 3-2 downshift.

3-4 Shift Valve

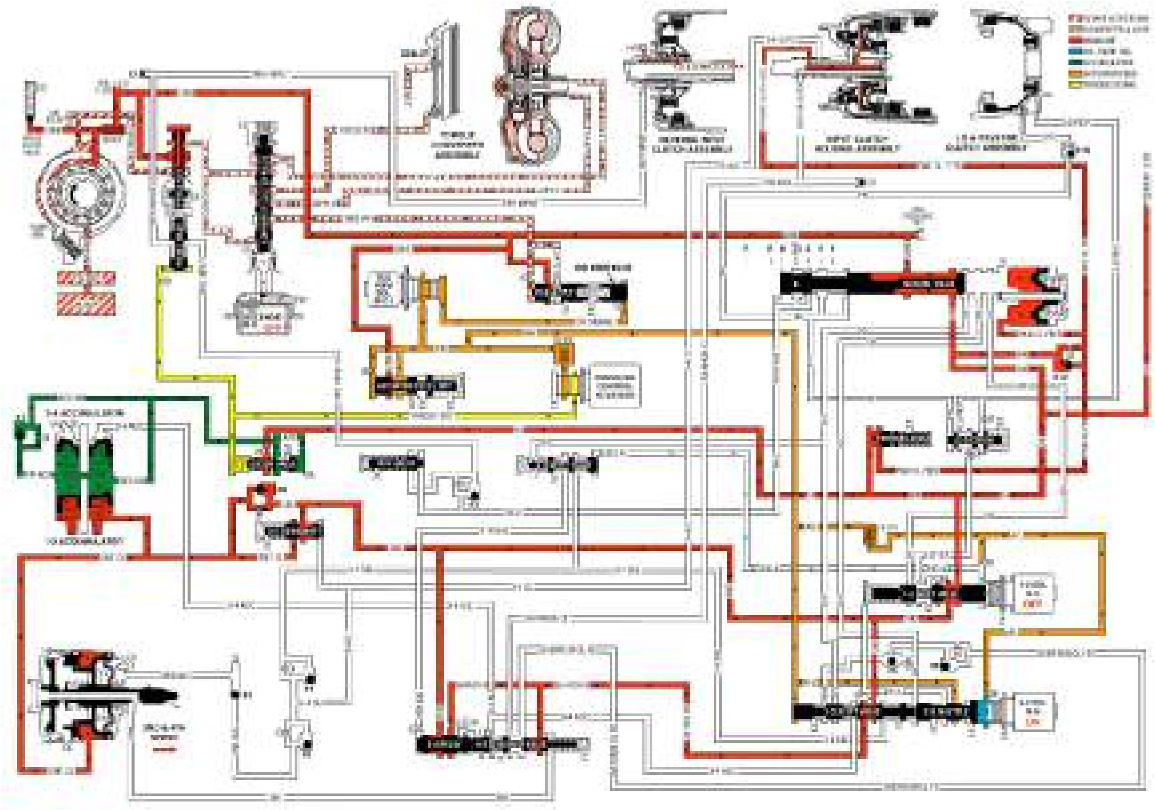
Signal A fluid pressure exhausts and spring force moves the valve into the downshift position (second and third gear positions).

Torque Converter Clutch

TCC Solenoid Valve

Under normal operating conditions, in Overdrive Range-Second Gear, the PCM keeps the normally open TCC solenoid valve de-energized. Converter feed fluid exhausts through the open solenoid, and spring force keeps the converter clutch apply valve in the release position.

Overdrive Range, Second Gear



Overdrive Range, Third Gear

As vehicle speed increases further and other vehicle operating conditions are appropriate, the PCM de-energizes the normally open 2-3 shift solenoid valve in order to shift the transmission into Third gear.

2-3 Shift Solenoid (SS) Valve

Note: AFL fluid continues to feed signal B fluid to the solenoid through orifice #29. However, the exhaust port through the solenoid is larger than orifice #29 to prevent a buildup of pressure in the signal B fluid circuit at the solenoid end of the 2-3 shift valve. Exhausting signal B fluid is represented by the arrows through the solenoid.

De-energized (turned OFF) by the PCM, the solenoid opens and actuator feed limit signal B fluid exhausts through the solenoid.

2-3 Shift Valve Train

AFL fluid pressure at the 2-3 shift valve moves the valve train toward the solenoid. In the upshifted position, the following changes occur:

- AFL fluid is routed through the 2-3 shift valve and fills the D432 fluid circuit.
- 2nd fluid is blocked from entering the servo feed fluid circuit and is orificed (#28) into the 3-4 signal fluid circuit. This orifice helps control the 3-4 clutch apply rate.
- Servo feed fluid exhausts past the valve into the 3-4 accumulator fluid circuit and through an exhaust port at the 3-4 relay valve.

3-4 Clutch Exhaust Checkball (#4)

3-4 signal fluid unseats the ball and enters the 3-4 clutch fluid circuit.

3-4 Clutch Piston

3-4 clutch fluid pressure moves the piston to apply the 3-4 clutch plates and obtain 3rd gear. However, the 2-4 band must release as the 3-4 clutch applies.

3rd Accumulator Checkball (#2)

3-4 clutch fluid pressure unseats the ball and fills the 3rd accumulator fluid circuit.

3rd Accumulator Exhaust Checkball (#7)

3rd accumulator fluid seats the ball against the orificed exhaust and is routed to the released side of the 2nd apply piston. Before the #7 checkball seats, air in the 3rd accumulator fluid circuit is exhausted through the orifice.

2-4 Servo Assembly

3rd accumulator fluid pressure acts on the release side of the 2nd apply piston and assists servo return spring force. The surface area on the release side of the piston is greater than the surface area on the apply side. Therefore, 3rd accumulator fluid pressure and servo return spring force move the 2nd apply piston against 2nd clutch fluid pressure. This action serves two functions:

- Move the apply pin to release the 2-4 band.
- Act as an accumulator by absorbing initial 3-4 clutch fluid to cushion the 3-4 clutch apply rate. Remember that the 3rd accumulator fluid circuit is fed by 3-4 clutch fluid.

3-2 Downshift Valve

3-4 clutch fluid pressure moves the valve against spring force. This opens the valve and allows 2nd fluid to feed the 2nd clutch fluid circuit through the valve.

1-2 Shift Solenoid (SS) Valve and 1-2 Shift Valve

The 1-2 SS valve remains de-energized and signal A fluid is exhausted through the solenoid. Also, D432 fluid pressure from the 2-3 shift valve assists spring force to hold the 1-2 shift valve in the upshifted position.

3-4 Shift Valve

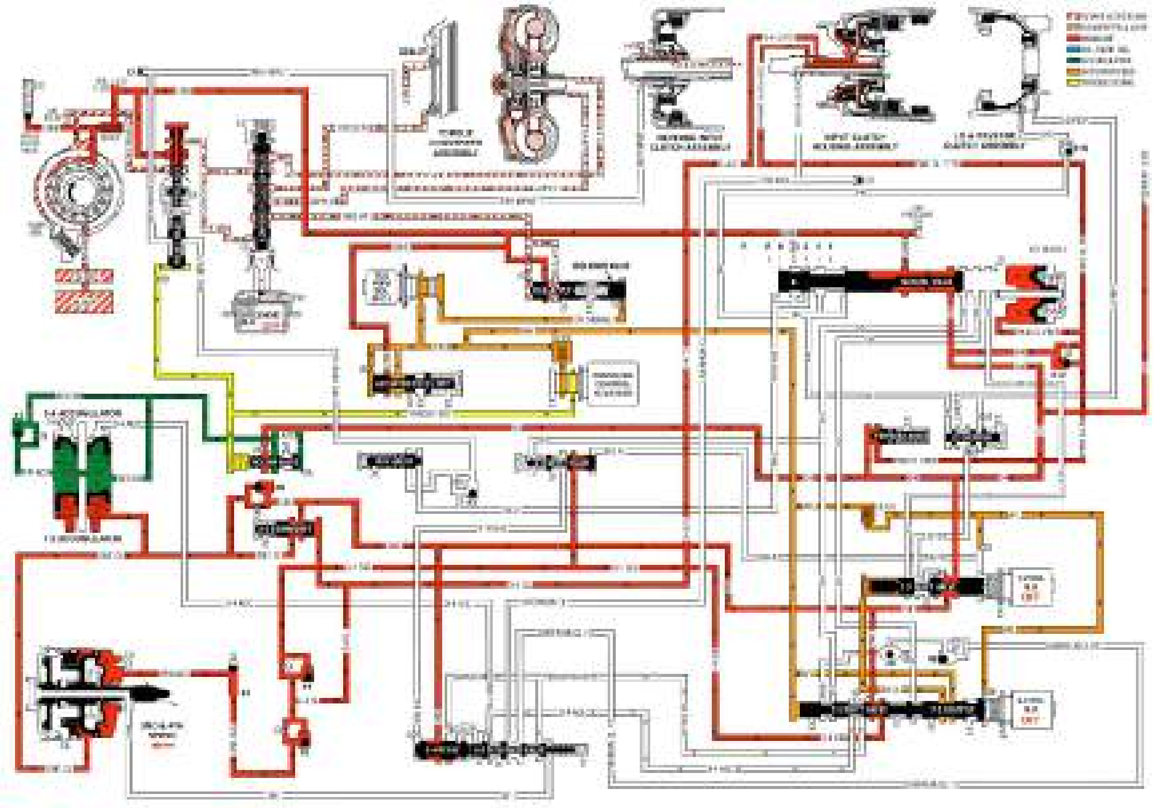
Spring force holds the valve in the downshifted position, blocking 3-4 clutch fluid in preparation for a 3-4 upshift.

Torque Converter Clutch

TCC Solenoid Valve

Under normal operating conditions, in Overdrive Range-Third Gear, the PCM keeps the normally open TCC solenoid valve de-energized. Converter feed fluid exhausts through the open solenoid, and spring force keeps the converter clutch apply valve in the release position. However, at speeds above approximately 121 km/h (75 mph), with the transmission still in third gear, the PCM will command TCC apply in third gear. Refer to Overdrive Range, Fourth Gear - Torque Converter Clutch Applied for more information on TCC apply.

Overdrive Range, Third Gear



Park - Engine Running

With the gear selector lever in the PARK (P) position and the engine running, the line pressure from the oil pump assembly is directed to various components in the valve body and the oil pump.

Pressure Regulator Valve

The pressure regulator valve regulates the oil pump output (line pressure) in response to the signal fluid pressure, the spring force and the line pressure acting on the end of the valve. The line pressure is routed through the valve and into both the converter feed and the decrease fluid circuits. Regulated line pressure is also directed to the manual valve, the converter clutch valve, the actuator feed limit valve, and the regulated apply valve.

Pressure Relief Valve

Controlled by spring force, this checkball limits the maximum value of the line pressure. When the line pressure reaches this limiting value, fluid is exhausted past the ball and returns to the sump.

Line Pressure Tap

The line pressure tap provides a location to measure the line pressure with a fluid pressure gage.

Actuator Feed Limit Valve

Biased by spring force and orificed AFL fluid, it limits the maximum value of line pressure entering the AFL fluid circuit. Below this limiting value, the AFL fluid pressure equals the line pressure. The AFL fluid is routed to the pressure control solenoid valve, the TCC PWM solenoid valve, the 1-2 and 2-3 shift solenoid valves, and the 2-3 shift valve train.

Pressure Control (PC) Solenoid Valve

Controlled by the powertrain control module (PCM), the PC solenoid valve regulates the filtered AFL fluid into the torque signal fluid pressure. The PCM controls this regulation by varying the current value to the PC solenoid valve in relation to the throttle position and other vehicle operating conditions.

Torque Converter Clutch (TCC)

Torque Converter Clutch PWM Solenoid and Regulator Apply and Isolator Valve

AFL fluid is routed to the TCC PWM solenoid valve, in Park the PCM has the duty cycle turned OFF. This prevents AFL fluid from entering the converter clutch signal fluid circuit. Regulated line pressure is routed to the regulator apply valve, which is open with CC signal circuit empty, and blocks line pressure from entering the regulated apply circuit. Any fluid in the regulated apply circuit will exhaust at the regulated apply valve.

TCC Solenoid Valve

Important: TCC converter feed valve assembly (#4), in the converter feed circuit, prevents converter drain down. The orifice is smaller than the exhaust through the TCC solenoid valve. Therefore, fluid pressure does not build up at the end of the converter clutch apply valve.

Under normal operating conditions, the PCM keeps the normally open TCC solenoid valve de-energized (OFF). Converter feed fluid exhausts through the open TCC solenoid valve, and spring force keeps the converter clutch apply valve in the release position.

Converter Clutch Valve

Held in the release position by spring force, it directs converter feed fluid into the release fluid circuit. Also, fluid returning from the converter in the apply fluid circuit is routed through the valve and into the cooler fluid circuit.

Torque Converter

Release fluid pressure unseats the TCC apply checkball (#9), keeps the pressure plate released from the converter cover and fills the converter with fluid. Fluid exits the converter between the converter hub and the stator shaft in the apply fluid circuit.

Cooler and Lubrication System

Cooler fluid from the converter clutch apply valve is routed through the transmission fluid cooler and into the lubrication fluid circuits.

Manual Valve

Controlled by the selector lever and the manual shaft, the manual valve is in the Park (P) position and directs the line pressure into the PR (Park/Reverse) fluid circuit. Line pressure is blocked from entering any other fluid circuit at the manual valve.

Lo and Reverse Clutch Applies

Lo and Reverse Clutch Piston

The PR fluid seats the lo and reverse clutch checkball (#10) and is orificed to the outer area of the piston. Orificing the PR fluid around the #10 checkball helps control the lo and reverse clutch apply. Also, Lo/reverse fluid pressure from the lo overrun valve acts on the inner area of the lo and reverse clutch piston in order to increase the clutch holding capacity.

Lo Overrun Valve

The PR fluid pressure moves the valve against the spring force and fills the Lo/reverse fluid circuit. Lo/reverse fluid is orificed (323) back to the lo overrun valve in order to assist the PR fluid in moving the valve against the spring force. The spring force provides a time delay for the PR fluid filling the Lo/reverse fluid circuit. The Lo/reverse fluid is routed to the inner area of the lo and reverse clutch piston in order to increase the holding capacity of the clutch.

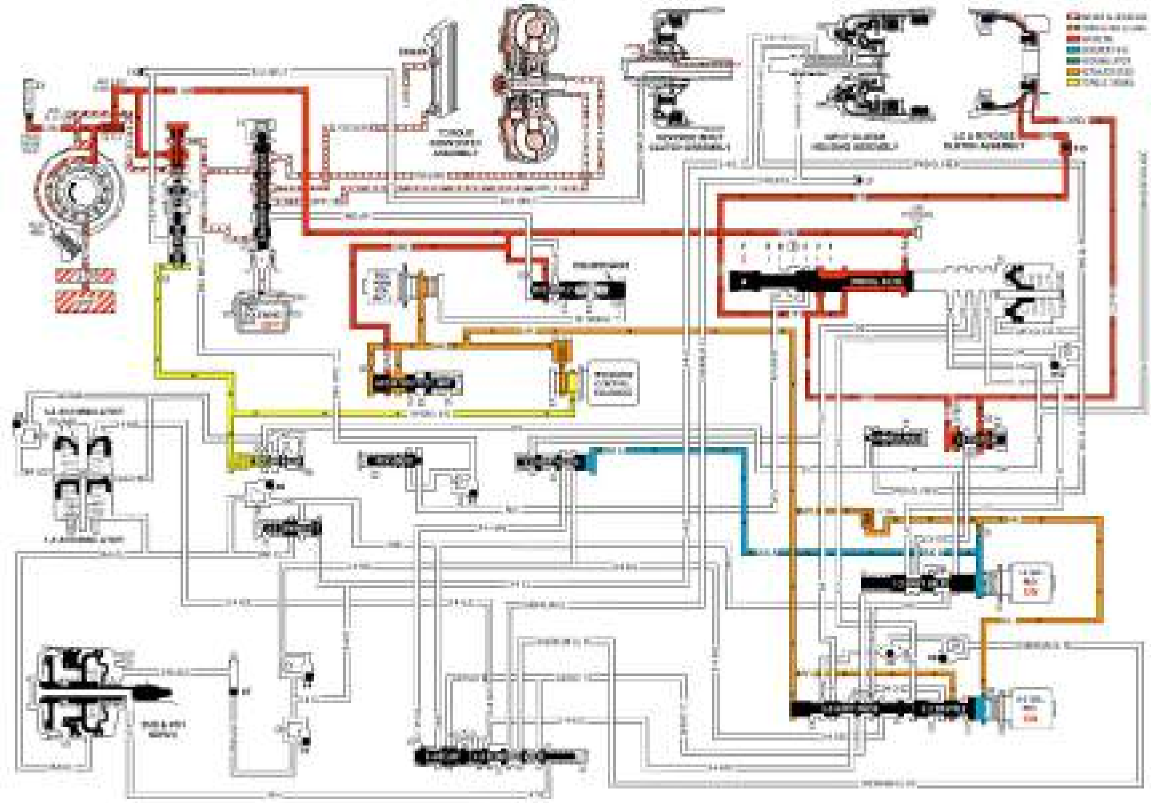
Shift Solenoid Valves (1-2 and 2-3)

Both shift solenoid valves, which are normally open, are energized by the PCM and block fluid from exhausting. This maintains the signal A fluid pressure at the 1-2 shift solenoid valve and signal B fluid pressure at the 2-3 shift solenoid valve.

Shift Valves (1-2, 2-3 and 3-4)

Signal A fluid pressure holds the 1-2 shift valve in the downshift position and the 3-4 valve in the upshift (first and fourth gear) position. The signal B fluid pressure from the 2-3 shift solenoid valve holds the 2-3 shift valve train in the downshift position.

Park - Engine Running



Reverse

When the gear selector lever is moved to the Reverse (R) position (from the Park position), the following changes occur to the transmissions hydraulic and electrical systems:

Manual Valve

The manual valve moves to the Reverse position and line pressure enters the reverse fluid circuit. As in Park, line pressure also fills the PR (Park/Reverse) fluid circuit. All other fluid circuits are blocked by the manual valve.

Lo and Reverse Clutch

As in Park, PR fluid pressure acts on the outer area of the lo and reverse clutch piston to apply the lo and reverse clutch. Also, Lo/reverse fluid from the lo overrun valve acts on the inner area of the piston to increase the holding capacity of the clutch (see Note below).

Reverse Input Checkball (#3)

Reverse fluid pressure seats the #3 checkball, flows through orifice #17 and fills the reverse input fluid circuit. This orifice helps control the reverse input clutch apply rate when engine speed is at idle.

Reverse Abuse Valve

Reverse fluid pressure acts on the end of the valve opposite of spring force. At engine speeds above idle, reverse fluid pressure, which is fed by line pressure, increases and moves the valve against spring force (as shown). Reverse fluid can then fill the reverse input fluid circuit through the reverse abuse valve. This bypasses the control of orifice #17 and provides a faster clutch apply.

Boost Valve

Reverse input fluid pressure moves the boost valve against the pressure regulator valve spring. The spring acts on the pressure regulator valve to increase the operating range of line pressure in Reverse. Reverse input fluid also flows through the valve and to the reverse input clutch piston. Remember that torque signal fluid pressure continually acts on the boost valve to control line pressure in response to vehicle operating conditions.

Reverse Input Clutch Piston

Reverse input fluid pressure moves the piston to apply the reverse input clutch plates and obtain Reverse.

Reverse Input Air Bleed Checkball

This ball and capsule is located in the reverse input fluid circuit in the oil pump to provide an air escape when the fluid pressure increases. It also allows air into the circuit to displace the fluid when the clutch releases.

Shift Solenoid Valves (1-2 and 2-3)

Both shift solenoid valves are energized as in the Park range. Signal A and signal B fluids are blocked from exhausting through the shift solenoid valves to maintain fluid pressure in these circuits at the end of the shift valves.

Shift Valves (1-2, 2-3 and 3-4)

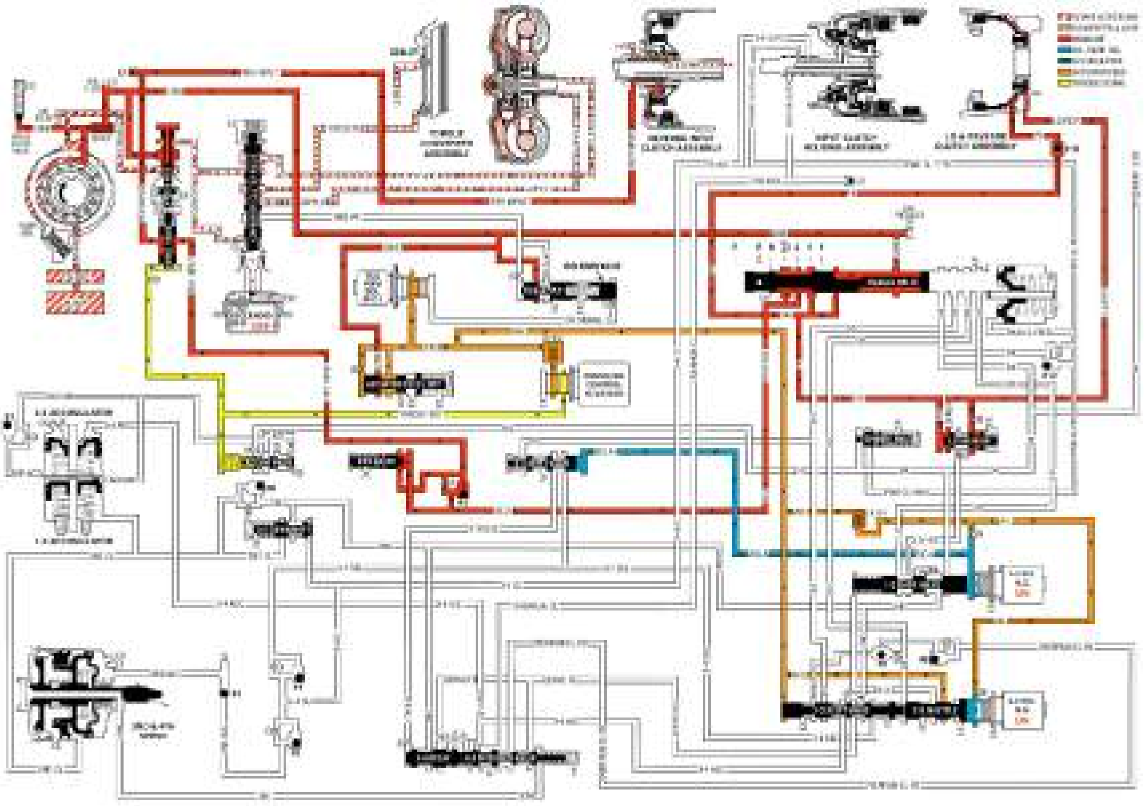
Signal A fluid pressure holds the 1-2 shift valve in the downshifted position and the 3-4 shift valve in the upshifted (First and Fourth gear) position. Signal B fluid pressure from the 2-3 shift solenoid valve holds the 2-3 shift valve train in the downshifted position.

Pressure Control (PC) Solenoid Valve

The PC solenoid valve continues to regulate AFL fluid into torque signal fluid pressure. The PCM varies the current at the solenoid to regulate torque signal fluid pressure in response to throttle position and other PCM input signals. Torque signal fluid pressure is used to control line pressure at the boost and pressure regulator valves.

Note: The explanation in each gear range is, for the most part, limited.

Reverse



Transmission Adaptive Functions

The 4L60-E transmission utilizes a line pressure control system during upshifts to compensate for the normal wear of transmission components. By adjusting the line pressure, the TCM can maintain acceptable transmission shift times. This process is known as "adaptive learning" or "shift adapts" and is similar to the closed loop fuel control system used for the engine.

In order for the TCM to perform a "shift adapt," it must first identify if an upshift is acceptable to analyse. For example, upshifts that occur during cycling of the A/C compressor or under extreme throttle changes may cause the TCM to incorrectly adjust line pressure. When an upshift is initiated, a number of contingencies, such as throttle position, transmission temperature, and vehicle speed, are checked in order to determine if the actual shift time is valid to compare to a calibrated desired shift time. If all the contingencies are met during the entire shift, then the shift is considered valid and the adapt function may be utilized if necessary.

Once an adaptable shift is identified, the TCM compares the actual shift time to the desired shift time and calculates the difference between them. This difference is known as the shift error. The actual shift time is determined from the time that the TCM commands the shift to the start of the engine RPM drop initiated by the shift. If the actual shift time is longer than the calibrated desired shift time, a soft feel or slow engaugement, then the TCM decreases current to the pressure control (PC) solenoid in order to increase line pressure for the next, same, upshift under identical conditions. If the actual shift time is shorter than the calibrated desired shift time, a firm engaugement, then the TCM increases current to the PC solenoid in order to decrease line pressure for the next, same, upshift under identical conditions.

The purpose of the adapt function is to automatically compensate the shift quality for the various vehicle shift control systems. It is a continuous process that will help to maintain optimal shift quality throughout the life of the vehicle.

Clearing Transmission Adaptive Pressure (TAP)

Transmission adaptive pressure (TAP) information is displayed and may be reset using a scan tool.

The adapt function is a feature of the TCM that either adds or subtracts line pressure from a calibrated base line pressure in order to compensate for normal transmission wear. The TAP information is divided into 13 units, called cells. The cells are numbered 4 through 16. Each cell represents a given torque range. TAP cell 4 is the lowest adaptable torque range and TAP cell 16 is the highest adaptable torque range. It is normal for TAP cell values to display zero or negative numbers. This indicates that the TCM has adjusted line pressure at or below the calibrated base line pressure.

Updating TAP information is a learning function of the TCM designed to maintain acceptable shift times. It is not recommended that TAP information be reset unless one of the following repairs has been made:

- Transmission overhaul or replacement
- Repair or replacement of an apply or release component, clutch, band, piston, servo
- Repair or replacement of a component or assembly which directly affects line pressure

Resetting the TAP values using a scan tool will erase all learned values in all cells. As a result, the

TCM will need to relearn TAP values. Transmission performance may be affected as new TAPs are learned. Learning can only take place when the TCM has determined that an acceptable shift has occurred. The TCM must also relearn TAP values if it is replaced.

Transmission Component and System Description

The mechanical components of the 4L60-E are as follows:

- A torque converter with an electronically controlled capacity clutch (ECCC)

  This transmission is equipped with an ECCC. The pressure plate does not fully lock to the torque converter cover. Instead, the pressure plate maintains a small amount of slippage, about 20 RPM, in SECOND, THIRD, and FOURTH gears, depending on the vehicle application. ECCC was developed to reduce the possibility of noise, vibration, or chuggle caused by TCC apply. Typical apply speeds are 49-52 km/h (30-32 mph) in THIRD gear and 65-73 km/h (40-45 mph) in FOURTH gear. Full lockup is available at highway speeds on some applications.
- Torque converter assembly
- Servo assembly and 2-4 band assembly
- Reverse input clutch and housing
- Overrun clutch
- Forward clutch
- 3-4 clutch
- Forward sprag clutch assembly
- Lo and reverse roller clutch assembly
- Lo and reverse clutch assembly
- Two planetary gear sets: Input and Reaction
- Oil pump assembly
- Control valve body assembly

The electrical components of the 4L60-E are as follows:

- 1-2 and 2-3 shift solenoid valves
- Transmission pressure control (PC) solenoid
- Torque converter clutch (TCC) solenoid valve
- TCC pulse width modulation (PWM) solenoid valve
- Automatic transmission fluid temperature (TFT) sensor
- Vehicle speed sensor assembly

For more information, refer to Electronic Component Description .

Transmission General Information

How to Use This Section

This section provides the following information:

- General diagnosis information on transmissions
- Procedures for diagnosing the Hydra-matic transmission

When you diagnose any condition of the Hydra-matic transmission, begin with A Diagnostic Starting Point. This procedure indicates the proper path of diagnosing the transmission by describing the basic checks. This procedure will then refer you to the locations of specific checks. After you have determined the cause of a condition, refer to Repair Instructions for repair procedures. If the faulty component is not serviceable without removing the transmission from the vehicle, refer to OFF Vehicle repair information.

Basic Knowledge

Notice: Do not, under any circumstances, attempt to diagnose a powertrain condition without basic knowledge of this powertrain. If you perform diagnostic procedures without this basic knowledge, you may incorrectly diagnose the condition or damage the powertrain components.

You must be familiar with some basic electronics in order to use this section of the service manual. You should also be able to use the following special tools:

- A digital multimeter (DMM)
- A circuit tester
- Jumper wires or leads
- A line pressure gage set

Diagnosis

Notice: If you probe a wire with a sharp instrument and do not properly seal the wire afterward, the wire corrodes and an open circuit results.

Transmission Identification Information

Figure 1: Title

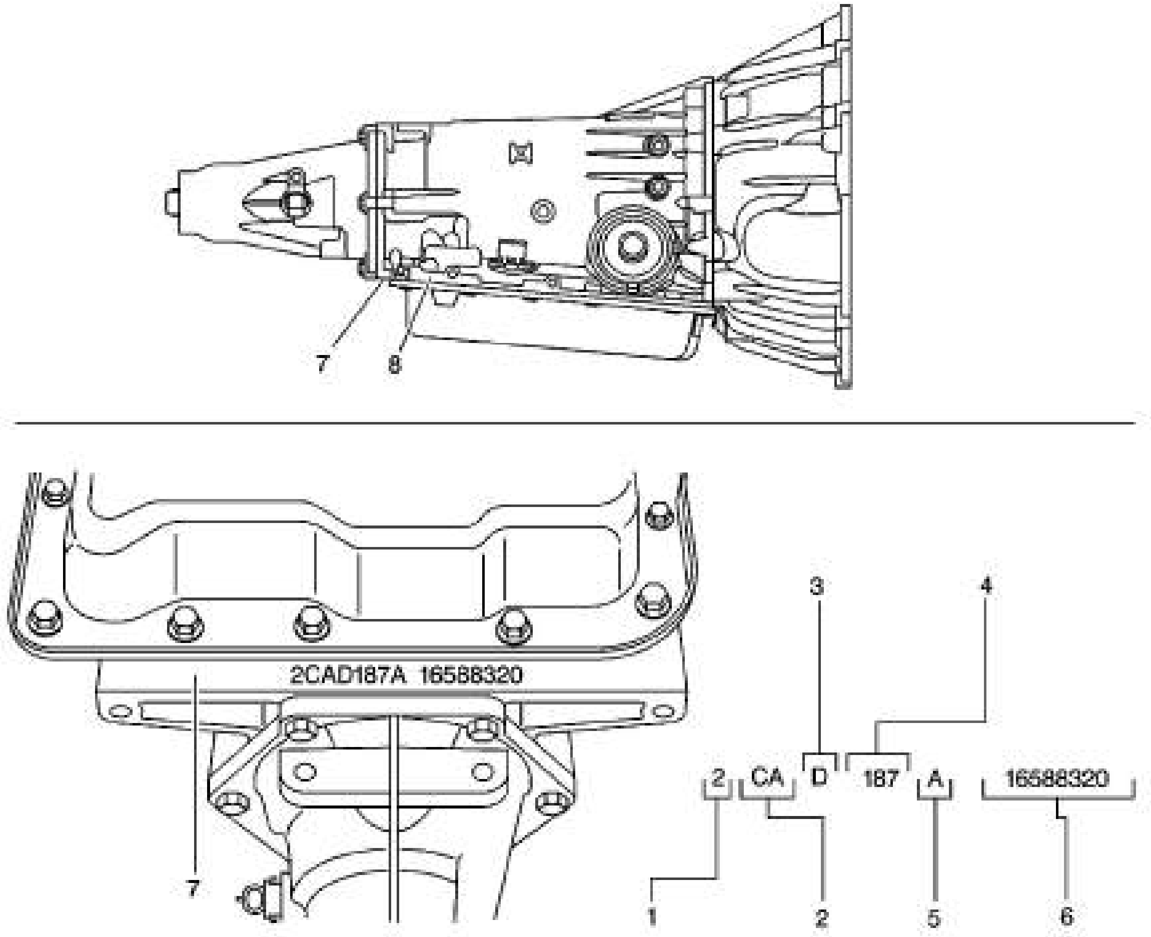
Figure 2: Title

Figure 3: Title

Plant and Shift Build Chart

Plant	Build Line	1st Shift	2nd Shift	3rd Shift
Toledo, OH	ML1	J	W	X
	ML2	A	C	Not Used
	ML3	B	H	Not Used
	ML4	S	L	V
	ML5	K	E	Z
Romulus, MI	1	A	--	B
Ramos Arizpe, Mexico	1	A	--	--

Toledo or Romulus Build



(1) 2 = 2002

(2) Model

(3) Hydra-Matic 4L60-E

(4) Julian Date or Day of the Year

(5) Shift Built, See Shift Build Chart

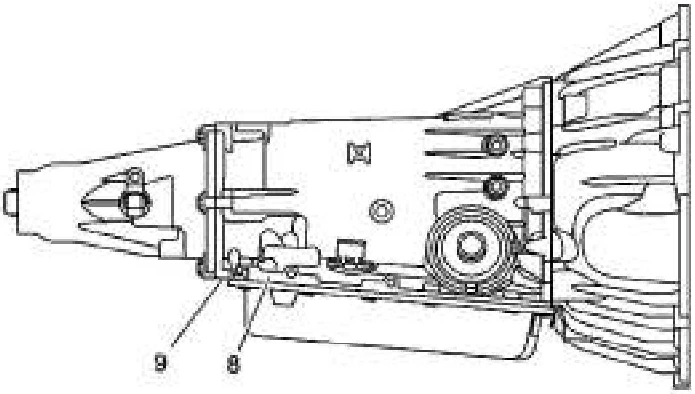
(6) Serial Number

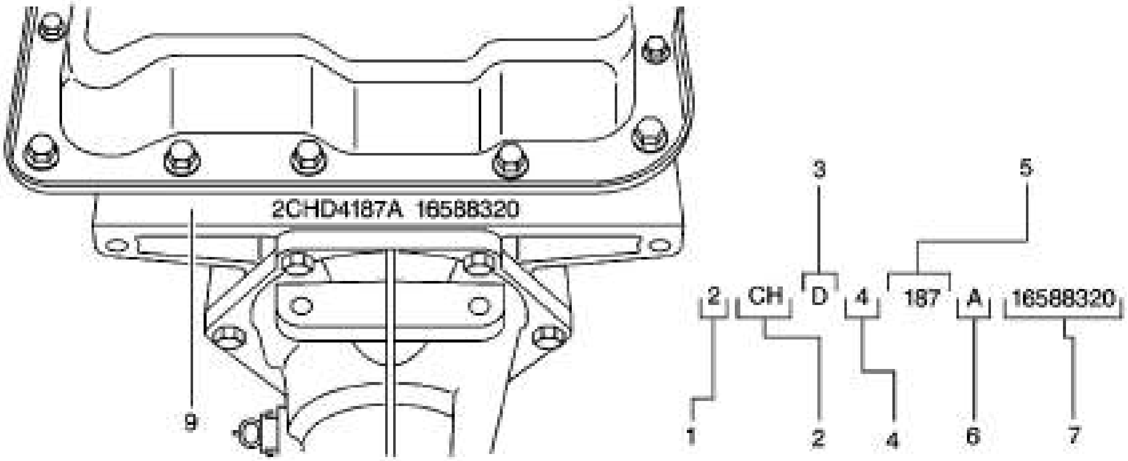
(7) Case/Pan Frame Rail Location

(7) Case/Pan Frame Rail Location

(8) Optional Transmission ID Location, Tag Is Used as a Back-Up If Unable To Etch Case/Pan Area and To Bar Code Scan

Ramos Arizpe, Mexico





(1) 2 = 2002

(2) Model

(3) Hydra-Matic 4L60-E

(4) Plant of Manufacture, 4 is Ramos

(5) Julian Date or Day of the Year

(6) Shift Built, See Shift Build Chart

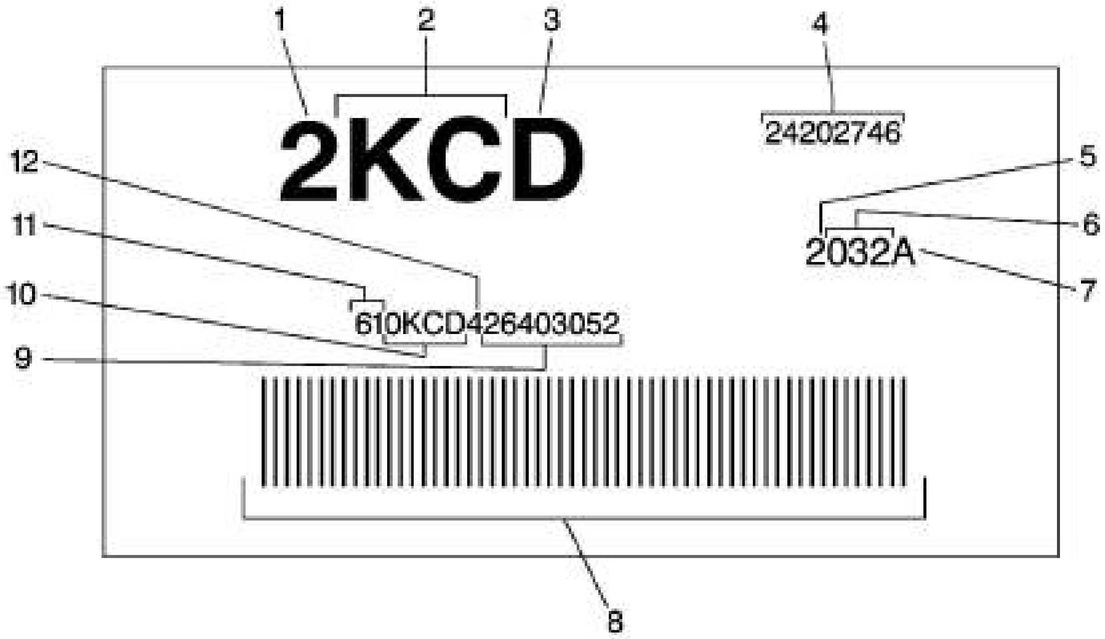
(7) Transmission Serial Number

(8) Optional Transmission ID Tag Location, Tag Is Used as a Back-Up If Unable To Etch Case/Pan Area and To Bar Code Scan

(9) Case/Pan Frame Rail Area

(9) Case/Pan Frame Rail Area

Bar Code Label Contents



(1) 2 = 2002
(2) Model
(3) Hydra-Matic 4L60-E
(4) Transmission Asm. as Shipped Number
(5) 2 = Model Year
(6) Julian Date or Day of the Year
(7) Letter After Julian Date Identifies the Plant Shift Build, See Shift Build Chart
(8) Bar Code
(9) Serial Number
(10) Broadcast Code
(11) Transmission ID
(12) Build Location Y=Toledo, OH, R=Romulus, MI, 4=Ramos Arizpe, Mexico

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Transmission Fluid Temperature Sensor Specifications

Temperature	Temperature	Minimum Resistance	Nominal Resistance	Maximum Resistance
°C	°F	Ω	Ω	Ω
-40°C	-40°F	89500	100000	110500
-30°C	-22°F	46419	51400	56381
-20°C	-4°F	25120	27610	30100
-10°C	14°F	14160	15450	16740
0°C	32°F	8278	8972	9666
10°C	50°F	5005	5391	5777
20°C	68°F	3120	3342	3564
30°C	86°F	2000	2132	2264
40°C	104°F	1317	1397	1477
50°C	122°F	888	938	988
60°C	140°F	613	645	677
70°C	158°F	432	453	474
80°C	176°F	310	324	338
90°C	194°F	228	237	246
100°C	212°F	170	176	182
110°C	230°F	128	132	136
120°C	248°F	98	101	104
130°C	266°F	77	79	81
140°C	284°F	60	62	64
150°C	302°F	48	49	50

Fastener Tightening Specifications (On Vehicle)

Fastener Tightening Specifications (On Vehicle)

Application	Specification	
	Metric	English
Case Extension Housing Retaining Bolt	22 N·m	16 lb. ft
Control Valve Body Assembly Retaining Bolt	11 N·m	97 lb. in
Detent Spring Retaining Bolt	11 N·m	97 lb. in
Drive Flange Retaining Nut	60 N·m	44 lb. ft
Fluid Cooler Pipe Brace Retaining Bolt	50 N·m	37 lb. ft
Fluid Cooler Pipe Retaining Bolt	25 N·m	18 lb. ft
Fluid Drain Retaining Plug	20 N·m	15 lb. ft
Fluid Fill Retaining Plug	20 N·m	15 lb. ft
Fluid Pan Retaining Bolt	11 N·m	97 lb. in
Input Speed Sensor Retaining Bolt	11 N·m	97 lb. in
Manual Shift Shaft Retaining Nut	9 N·m	80 lb. in
Oil Pressure Test Retaining Plug	11 N·m	97 lb. in
Output Speed Sensor Retaining Bolt	11 N·m	97 lb. in
Shift Control Assembly to Tunnel Reinforcement Retaining Nut	12 N·m	106 lb. in
Shift Control Linkage Adjustment Retaining Nut	9 N·m	80 lb. in
Torque Converter Retaining Bolt	63 N·m	46 lb. ft
Torque Converter Seal Retaining Bolt	3.6 N·m	31.9 lb. in
Transmission Mounting Retaining Bolt M10x1.5	50 N·m	37 lb. ft
Transmission Mounting Retaining Bolt M12x1.75	75 N·m	55 lb. ft
Front Sub Frame Bolts	160 N·m	118 lb. ft
Transmission Support to Underbody Retaining Bolt	63 N·m	46 lb. ft

Fastener Tightening Specifications (Unit Repair)

Fastener Tightening Specifications

Description of Usage	Ref No.*	Qty	Specification	
			Metric	English
Accumulator Housing to Valve Body	318	12	11 N·m	97 lb. in
Channel Plate to Valve Body	300	7	11 N·m	97 lb. in
Converter Housing to Case	2	7	22 N·m	16 lb. ft
Drain Plug to Fluid Pan	63	1	20 N·m	15 lb. ft
Extension Housing to Case	35	7	22 N·m	16 lb. ft
Fluid Pan to Case	65	20	11 N·m	97 lb. in
Front Control Valve Body to Top Channel Plate	50	2	11 N·m	97 lb. in
Input Speed Sensor to Case	45	1	11 N·m	97 lb. in
Output Speed Sensor to Case	43	1	11 N·m	97 lb. in
Parking Pawl Actuator Bracket to Case	609	2	22 N·m	16 lb. ft
Prop Shaft Flange to Output Shaft	34	1	57 N·m	42 lb. ft
Torque Converter Housing Seal Bolt	228	2	3.6 N·m	31.86 lb. in
Transmission Fluid Pump Cover to Torque Converter Housing	240	6	11 N·m	97 lb. in
Transmission Fluid Pump Cover to Torque Converter Housing	241	5	22 N·m	16 lb. ft
Transmission Level Hole Plug to Case	36	1	20 N·m	15 lb. ft
Transmission Pressure Test Plug to Case	40	1	11 N·m	97 lb. in
Valve Body to Case	49	2	11 N·m	97 lb. in
Valve Body to Case	51	6	11 N·m	97 lb. in
Valve Body to Case	53	1	11 N·m	97 lb. in
Valve Body to Channel Plate	53	1	11 N·m	97 lb. in
* Reference Number refers to the callout number on the disassembled view.				

Clutch Piston Travel Specifications

Clutch Travel Specifications

Component	Product	Number Of Clutches	Specification	
			Metric	English
Reverse Clutch (404)	5L40-E	6	0.98-1.43 mm	0.039-0.056 in
Direct Clutch (406)	5L40-E	8	1.41-1.86 mm	0.056-0.073 in
Low and Reverse Clutch (517)	5L40-E	10	1.72-2.17 mm	0.068-0.085 in
2nd Clutch (520)	5L40-E	10	1.47-1.92 mm	0.056-0.076 in
2nd Coast Clutch (528)	5L40-E	4	0.94-1.39 mm	0.037-0.055 in
Intermediate Clutch (495)	5L40-E	6	1.13-1.58 mm	0.044-0.062 in
Overdrive Clutch (487)	5L40-E	6	1.60-2.05 mm	0.063-0.081 in
Forward Clutch (436)	5L40-E	6	1.20-1.65 mm	0.047-0.065 in
Coast Clutch (438)	5L40-E	6	1.17-1.67 mm	0.046-0.066 in

Clutch Plate Selection Specifications

Clutch	Number of Clutch Plates
	5L40-E
Reverse Clutch (404)	6
Direct Clutch (406)	10
Low and Reverse Clutch (517)	10
2nd Clutch (520)	10
2nd Coast Clutch (528)	6
Intermediate Clutch (495)	8
Overdrive Clutch (487)	6
Forward Clutch (436)	8
Coast Clutch (438)	6

Component Resistance

Component	Circuit Number	Wire Colour*	Inline Connector Pin	Resistance at 20°C (68°F)	Resistance at 70°C (158°F)	Resistance to Ground - Transmission Case
1-2 Shift Solenoid Valve	1525	WH	17	15.0-17.0 Ω	17.9-20.3 Ω	Greater than 50KΩ
	1222	BK	14			
2-3 Shift Solenoid Valve	1525	WH	17	15.0-17.0 Ω	17.9-20.3 Ω	Greater than 50KΩ
	1223	BU	9			
4-5 Shift Solenoid Valve	1525	WH	17	15.0-17.0 Ω	17.9-20.3 Ω	Greater than 50KΩ
	898	GY	5			
Pressure Control Solenoid Valve	1228	GN	13	3.5-4.6 Ω	4.2-5.5 Ω	Greater than 50KΩ
	1229	WH	8			
TCC PWM Solenoid Valve	1525	WH	17	10.0-11.5 Ω	11.8-13.6 Ω	Greater than 50KΩ
	418	YE	20			
Input Speed Sensor	1230	YE	18	325-485 Ω	385-575 Ω	Greater than 50KΩ
	1231	WH	15			
Output Speed Sensor	400	OG	1	325-485 Ω	385-575 Ω	Greater than 50KΩ
	401	WH	3			
TFT Sensor	1227	RD	10	Refer to Transmission Fluid Temperature Sensor Specifications.		
	2762	WH	6			
* All wire colours are internal to the transmission.						

End Play Specifications

Output Shaft End Play Chart - 5L40-E

Dimention B	Washer Thickness (mm)	Washer Thickness (in)
15.99 mm -16.27 mm (0.629 in - 0.640 in)	0.95-1.05	0.037-0.041
16.27 mm -16.47 mm (0.640 in - 0.648 in)	1.15-1.25	0.045-0.049
16.47 mm -16.67 mm (0.648 in - 0.656 in)	1.35-1.45	0.053-0.057
16.67 mm -16.87 mm (0.656 in - 0.664 in)	1.55-1.65	0.061-0.065
16.87 mm -17.07 mm (0.664 in - 0.672 in)	1.75-1.85	0.068-0.073
17.07 mm -17.27 mm (0.672 in - 0.680 in)	1.95-2.05	0.076-0.081
17.27 mm -17.47 mm 0.680 in - 0.688 in)	2.15-2.25	0.084-0.089
17.47 mm -17.67 mm (0.688 in - 0.696 in)	2.35-2.45	0.093-0.096
17.67 mm -17.87 mm (0.696 in - 0.704 in)	2.55-2.65	0.100-0.104
17.87 mm -18.07 mm (0.703 in - 0.711 in)	2.75-2.85	0.108-0.112

Fluid Capacity Specifications

Fluid Capacity Specifications (5L40-E)

Application	Specification	
	Metric	English
Transmission Fluid Capacity -- Complete Overhaul	8.9 liters	9.4 quarts
Pan Removal	6.0 liters	7.4 quarts
Torque Converter (245 mm)	2.9 liters	3.1 quarts
Torque Converter (258 mm)	3.1 liters	3.3 quarts
Measurements are approximate.		

Intermediate and Overdrive Clutch Housing Retaining Ring Specifications

Intermediate and Overdrive Clutch Housing Retainer Ring Specification

Dimension M	Retainer Ring Thickness (mm)	Retainer Ring Thickness (in)
0.85 mm -0.95 mm (0.033 in - 0.037 in)	3.80-3.90	0.149-0.153
0.95 mm -1.05 mm (0.037 in - 0.041 in)	3.70-3.80	0.145-0.149
1.05 mm -1.15 mm (0.041 in - 0.045 in)	3.60-3.70	0.141-0.145
1.15 mm -1.25 mm (0.045 in - 0.049 in)	3.50-3.60	0.137-0.141

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Line Pressure

Line Pressure

Pressure Control Solenoid Valve Amperage	English	Metric
0.1	173-197 psi	1 194-1 355 kPa
0.3	162-188 psi	1 118-1 296 kPa
0.5	145-169 psi	1 002-1 166 kPa
0.7	117-140 psi	804-966 kPa
0.8	95-119 psi	654-819 kPa
0.9	63-89 psi	453-611 kPa
1.1	42-64 psi	288-440 kPa
Engine at 1,300 RPM		

Range Reference

Range	**D432**								**N**	**R**	**P**
Gear	1	1	2	2	3	3	4	5	--	R	--
Engine Braking	*No	Yes	*No	Yes	*No	Yes	Yes	Yes	--	Yes	--
Direct Clutch	--	--	--	--	--	--	A	A	--	--	--
Coast Clutch	A	A	A	A	A	A	A	--	--	--	--
Reverse Clutch	--	--	--	--	--	--	--	--	--	A	--
Forward Clutch	A	A	A	A	A	A	A	A	--	--	--
Forward Clutch Sprag	LD	LD	LD	LD	LD	LD	LD	--	--	--	--
Over-Drive Clutch	--	--	--	--	--	A	--	A	--	--	--
Intermediate Clutch Sprag	--	--	--	--	LD	LD	--	--	--	--	--
Intermediate Clutch	--	--	--	--	A	A	A	A	--	--	--
Low Clutch Sprag	LD	LD	--	--	--	--	--	--	--	--	--
Low and Reverse Clutch	--	A	--	--	--	--	--	--	--	A	--
Second Clutch	--	--	A	A	A	A	A	A	--	--	--
Second Clutch Sprag	--	--	LD	LD	--	--	--	--	--	--	--
Second Coast Clutch	--	--	--	A	--	--	--	--	--	--	--
A = Applied LD = Locked in Drive				* Engine Braking is electronically controlled by the TCM, and is available as calibrated for each model and application.							

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Reverse Clutch Housing Selective Thrust Washer Specifications

Reverse Clutch Housing Thrust Washer Chart

Dimension X	Washer Thickness (mm)	Washer Thickness (in)
50.18 mm -50.36 mm (1.975 in - 1.982 in)	2.53-2.68	0.099-0.105
50.36 mm -50.54 mm (1.982 in - 1.989 in)	2.71-2.86	0.106-0.112
50.54 mm -50.72 mm (1.989 in - 1.996 in)	2.89-3.04	0.113-0.119
50.72 mm -50.90 mm (1.996 in - 2.003 in)	3.05-3.20	0.120-0.125
50.90 mm -51.08 mm (2.003 in - 2.011 in)	3.25-3.40	0.127-0.133
51.08 mm -51.26 mm (2.011 in - 2.018 in)	3.43-3.58	0.135-0.140
51.26 mm -51.44 mm (2.018 in - 2.025 in)	3.61-3.76	0.142-0.148
51.44 mm -51.62 mm (2.025 in - 2.032 in)	3.79-3.94	0.149-0.155

Shift Solenoid Valve State and Gear Ratio

Gear Range	1-2 / 3-4 Shift Solenoid	2-3 Shift Solenoid	4-5 Shift Solenoid	Gear Ratio
Park, Reverse, Neutral	OFF	ON	OFF	3.03:1
First	OFF	ON	OFF	3.42:1
Second	ON	ON	OFF	2.21:1
Third	ON	OFF	OFF	1.60:1
Fourth	OFF	OFF	ON	1.00:1
Fifth	OFF	OFF	OFF	0.75:1
All shift solenoids are normally-closed. The 4-5 shift solenoid also enables engine braking.				

Shift Speed

	TPS %	Output Speed (MPH)	Output Speed (KPH)
		3.6L LY7	3.6L LY7
1-2 Shift	12	8	13
	25	10	16
	50	17	27
2-3 Shift	12	16	26
	25	19	31
	50	30	48
3-4 Shift	12	28	45
	25	30	48
	50	49	79
4-5 Shift	12	41	66
	25	50	80
	50	106	171
2-1 Shift	12	5	8
	25	5	8
	50	5	8
3-2 Shift	12	13	21
	25	13	21
	50	13	21
4-3 Shift	12	23	37
	25	23	37
	50	23	37
5-4 Shift	12	31	50
	25	31	50
	50	40	64
3rd Gear TCC Apply	12	24	39
	25	45	72
4th Gear TCC Apply	12	26	42
	25	30	48
5th Gear TCC Apply	12	31	50
	25	75	121

Transmission Fluid Pump Specifications

Fluid Pump Specifications

Important:

- Rotor and slide must be chosen from the same size classification as the oil pump body.
- Allowable rotor and slide to fluid pump body end play is as follows:

Specification

- Slide to fluid Pump Body End Play -- 0.030-0.051 mm (0.0012-0.0020 in)
- Rotor to fluid Pump Body End Play -- 0.030-0.051 mm (0.0012-0.0020 in)

The fluid pump assembly has a selective rotor and slide components. These components are chosen based on pump body dimensions. Fluid pump rotor and slide components are available in five size classifications (1, 2, 3, 4, and 5) with the following tolerances:

Size Classification	Thickness (mm)	Thickness (in)
Rotor Selection		
1	17.948-17.961	0.7066-0.7071
2	17.961-17.974	0.7071-0.7076
3	17.974-17.987	0.7076-0.7081
4	17.987-18.000	0.7081-0.7086
5	18.000-18.013	0.7086-0.7091
Slide Selection		
1	17.948-17.961	0.7066-0.7071
2	17.991-17.974	0.7071-0.7076
3	17.974-17.987	0.7076-0.7081
4	17.987-18.000	0.7081-0.7086
5	18.000-18.013	0.7086-0.7091
Fluid Pump Body Depth		
1	17.978-18.012	0.7077-0.7091
2	17.978-18.025	0.7083-0.7096
3	18.004-18.038	0.7088-0.7101
4	18.017-18.051	0.7093-0.7106
5	18.030-18.064	0.7098-0.7111

Transmission General Specifications

Name	5L40-E
RPO Codes	M82, MX5
Vehicle Platform (Engine/Transmission) Usage	D, E, Y
Tranmission Drive	Rear Wheel Drive
1st Gear Ratio	3.42:1
2nd Gear Ratio	2.21:1
3rd Gear Ratio	1.60:1
4th Gear Ratio	1.00:1
5th Gear Ratio	0.75:1
Reverse Ratio	3.03:1
Torque Converter Size (Diameter of Torque Converter Turbine)	245 mm / 258 mm
Pressure Taps	Line Pressure
Transmission Fluid Type	Dexron™ VI
Transmission Fluid Capacity (Approximate)	Bottom Pan Removal Complete Overhaul: Dry 8.5 L (9.0 qt)
Transmission Type: 5	Five Forward Gears
Transmission Type: L	Longitude Mount
Transmission Type: 40	Product Series
Transmission Type: E	Electronic Controls
Position Quadrant	P, R, N, D
Case Material	Die Cast Aluminium
Transmission Weight Dry	(161.0 lb.) 73 kg
Transmission Net Weight	(177.0 lb.) 80.5 kg
Maximum Trailer Towing Capacity	Domestic: 2100 kg Export: 2100 kg
Maximum Gross Vehicle Weight	3,500 kg (7,716 lbs)

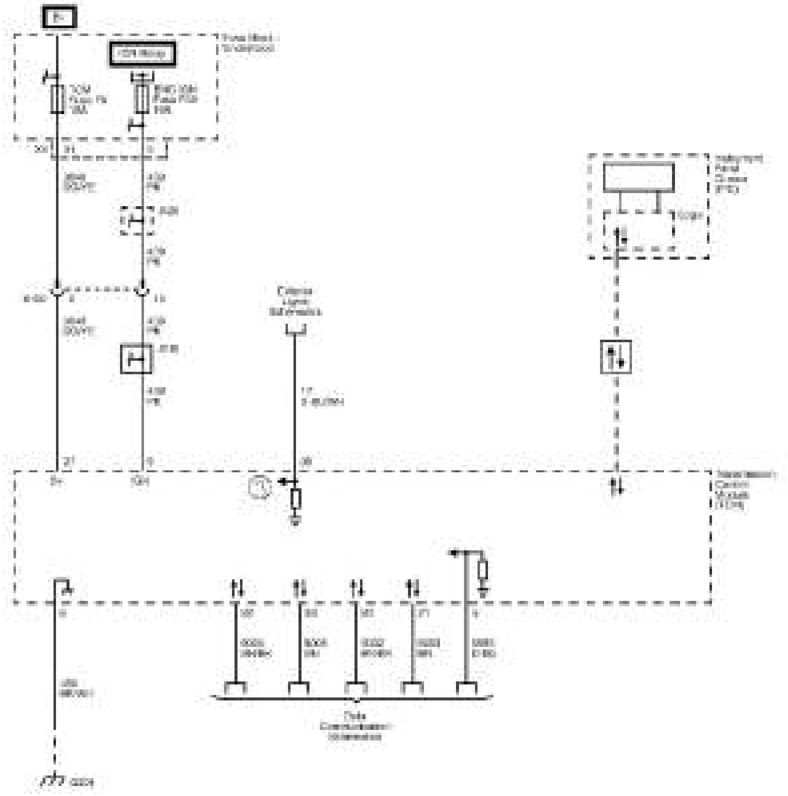
Transmission Internal Mode Switch Logic

Transmission Internal Mode Switch Logic

Gear Selector Position	A	B	C	P
Park	LOW	HI	HI	LOW
Park/Reverse	LOW	HI	HI	HI
Reverse	LOW	LOW	HI	HI
Reverse/Neutral	HI	LOW	HI	HI
Neutral	HI	LOW	HI	LOW
Neutral/Drive 5	HI	LOW	LOW	LOW
Drive 5	HI	LOW	LOW	HI
Drive 5/Drive 4	LOW	LOW	LOW	HI
Drive 4	LOW	LOW	LOW	LOW
Drive 4/Drive 3	LOW	HI	LOW	LOW
Drive 3	LOW	HI	LOW	HI
Drive 3/Drive 2	HI	HI	LOW	HI
Drive 2	HI	HI	LOW	LOW
Open	HI	HI	HI	HI
Invalid	HI	HI	HI	LOW

- HI = Ignition voltage
- LOW = 0 voltage

Power, Ground, and Serial Data


B+
Exterior Lights Schematics
Data Communication Schematics

Automatic Transmission Controls Schematics

Figure 1: Power, Ground, and Serial Data
Figure 2: Shift Controls
Figure 3: Range and Driver Shift Request Controls

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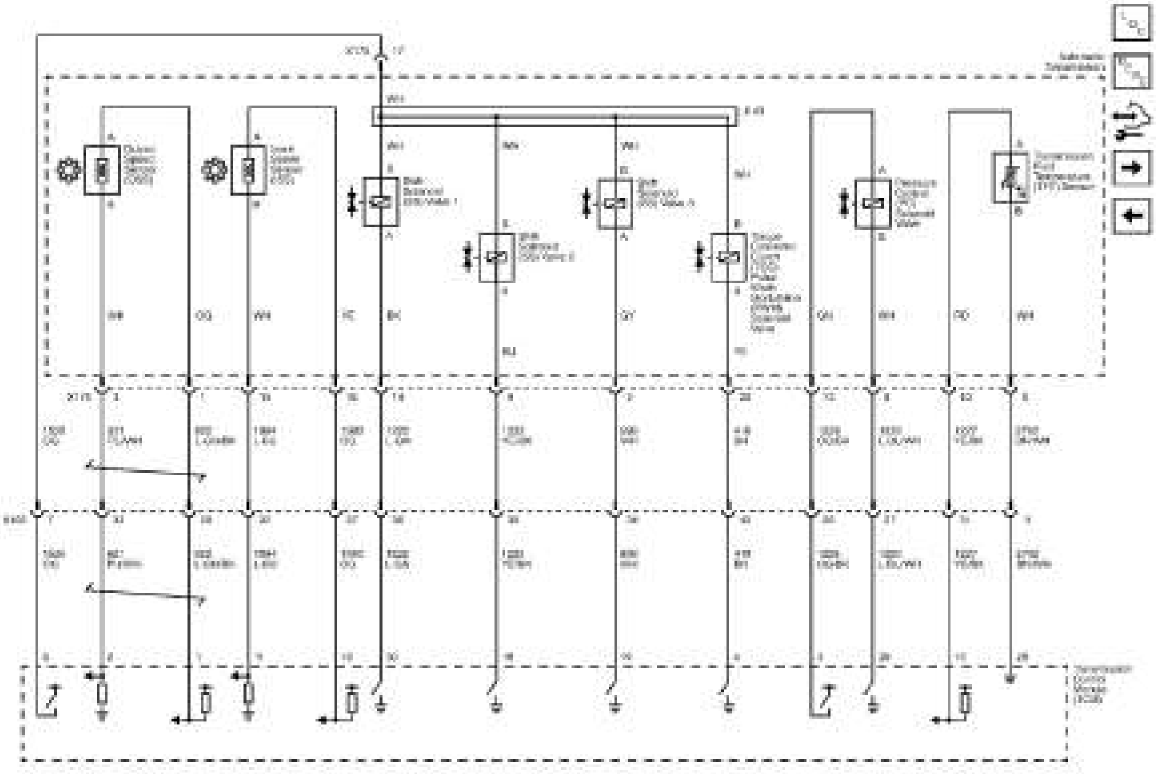
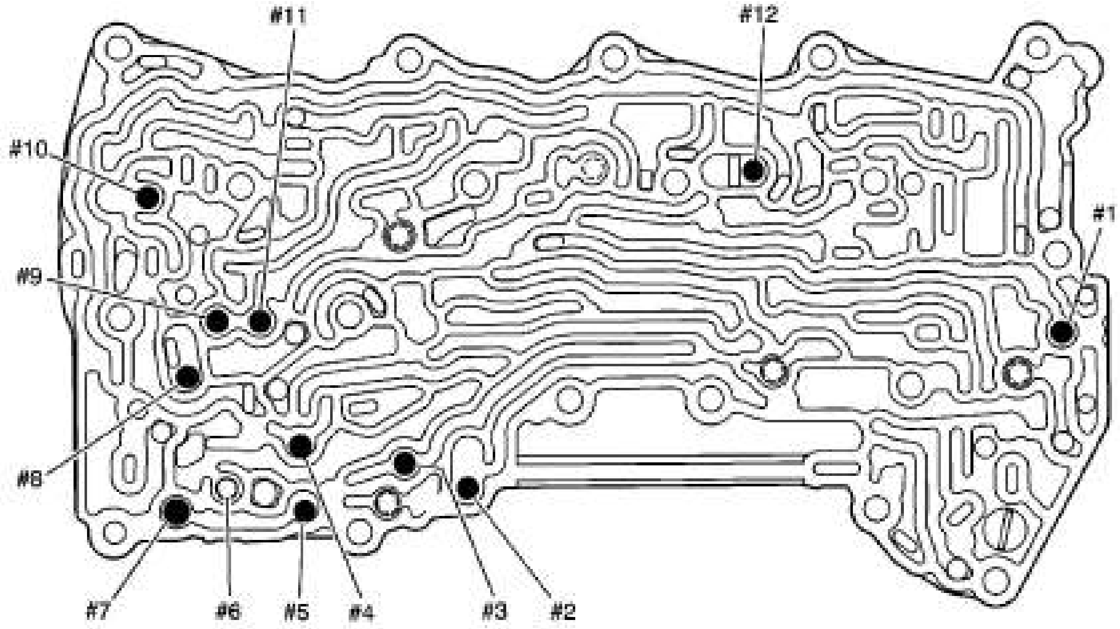
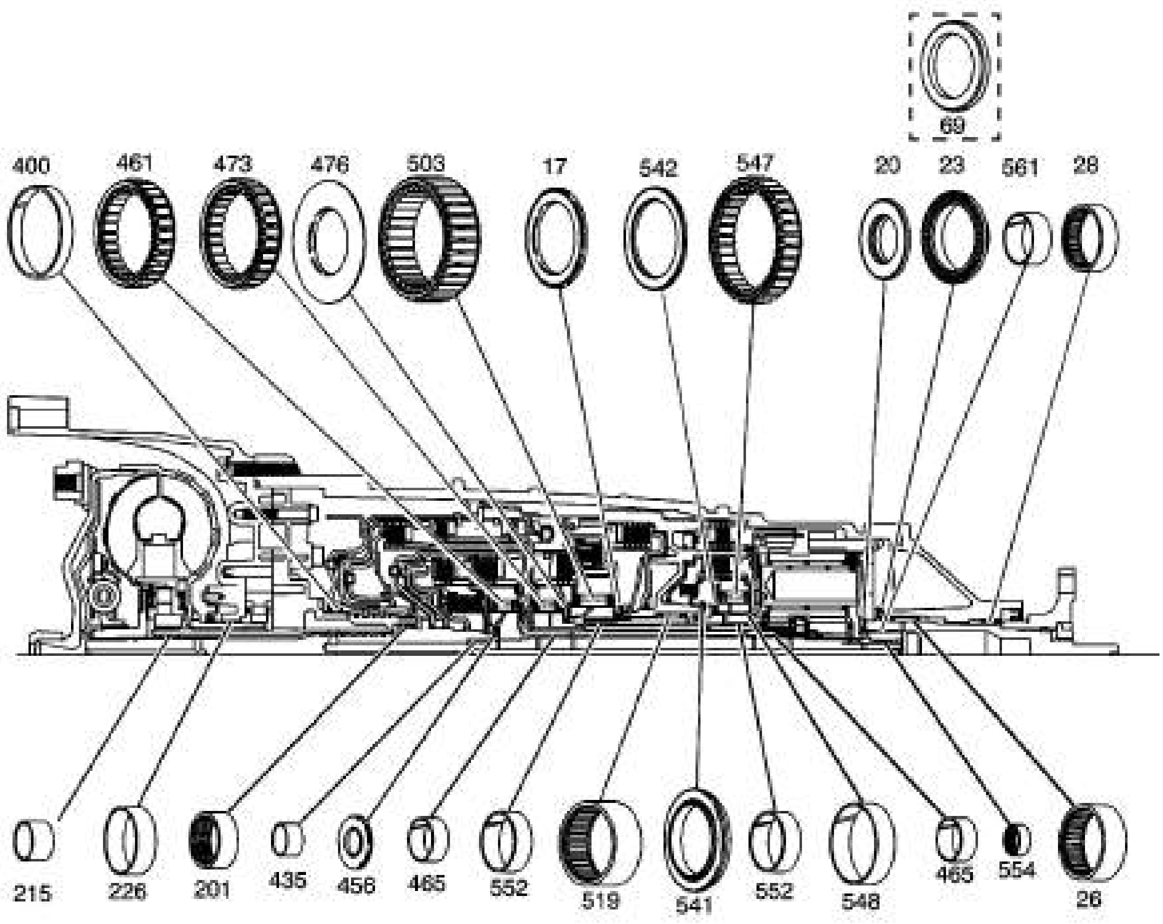
Shift Controls



Ball Check Valve Locations



Bushing and Bearing Locations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400
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473
476
503
17
542
547
20
23
561
28
215
226
201
435
458
465
552
519
541
552
548
465
554
26

- (17) Low Clutch Roller Thrust Bearing
- (20) Input and Reaction Carrier Thrust Bearing
- (23) Input and Reaction Carrier Thrust Bearing - Model Dependent
- (26) Output Shaft Bearing
- (28) Output Shaft Bearing
- (69) Input and Reaction Carrier Thrust Bearing - Model Dependent
- (201) Input Shaft Bearing Assembly
- (215) Turbine Shaft Bushing
- (226) Torque Converter Bushing
- (400) Reverse Clutch Housing Bushing
- (435) Forward Clutch Bushing

(456) Forward Clutch Roller Inner Bearing
(461) Forward Clutch Sprag Assembly
(465) Input and Reaction Carrier Bushing Assembly - 2
(473) Intermediate Clutch Sprag Assembly
(476) Intermediate Clutch Roller Thrust Bearing Assembly
(503) Low Clutch Sprag Assembly
(519) Input and Reaction Bearing Assembly
(541) Input and Reaction Bearing Assembly
(542) 2nd Clutch Roller Inner Race Bearing Assembly
(547) 2nd Clutch Sprag Assembly
(548) Input and Reaction Carrier Bushing
(552) Reaction Carrier Bushing - 2
(554) Input and Reaction Bearing Assembly
(561) Input and Reaction Carrier Bushing

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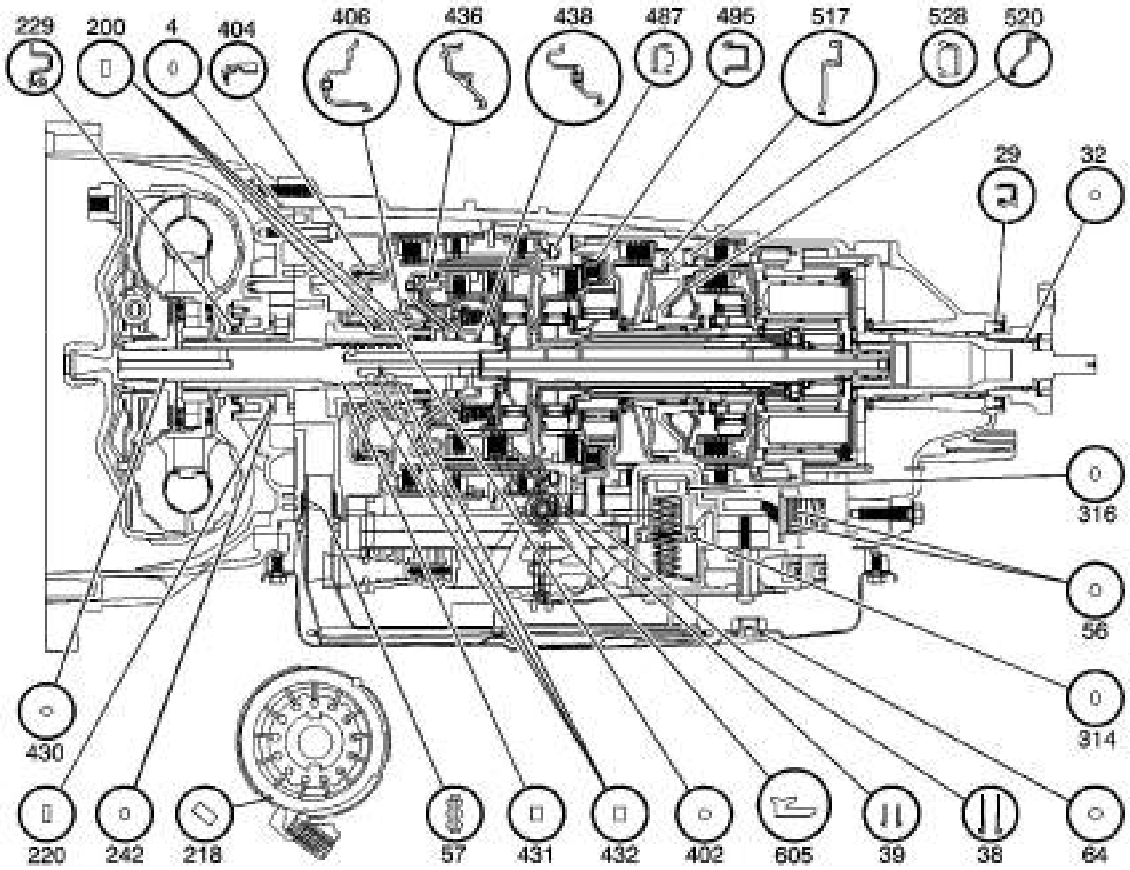
Seal Locations


229
200
4
404
406
436
438
487
495
517
528
520
29
32
316
56
314
430
220
242
218
57
431
432
402
605
39
38
64

(4) Torque Converter Housing Fluid Seal Assembly
(29) Transmission Propeller Shaft Flange Seal
(32) Transmission Propeller Shaft Flange - O-ring Seal
(38) Centre Support Fluid Passage Sleeve
(39) Overdrive Clutch Fluid Passage Sleeve
(56) Automatic Transmission Wiring Harness - O-ring Seal - 2
(57) Automatic Transmission Filter Seal - 2
(64) Automatic Transmission Fluid Pan Drain Plug Seal
(200) Reverse Clutch Housing Fluid Seal Ring - 3
(218) Automatic Transmission Fluid Pump Slide Seal
(220) Automatic Transmission Fluid Pump Slide Ring

(229) Torque Converter Housing Seal
(242) Automatic Transmission Fluid Pump Slide O-ring Seal
(314) Clutch Accumulator Piston Fluid Seal Ring
(316) Clutch Accumulator Piston Fluid Seal Ring
(402) Reverse Clutch Piston Inner Seal
(404) Reverse Clutch Piston
(406) Direct Clutch Piston Assembly
(430) Input Shaft - O-Ring Seal
(431) Input Shaft Fluid Seal Ring
(432) Input Shaft Fluid Seal Ring - 3
(436) Forward Clutch Piston Assembly
(438) Coast Clutch Piston Assembly
(487) Overdrive Clutch Piston Assembly
(495) Intermediate Clutch Piston Assembly
(517) Low and Reverse Clutch Piston
(520) 2nd Clutch Piston
(528) 2nd Coast Clutch Piston Assembly
(605) Manual Shift Shaft Seal

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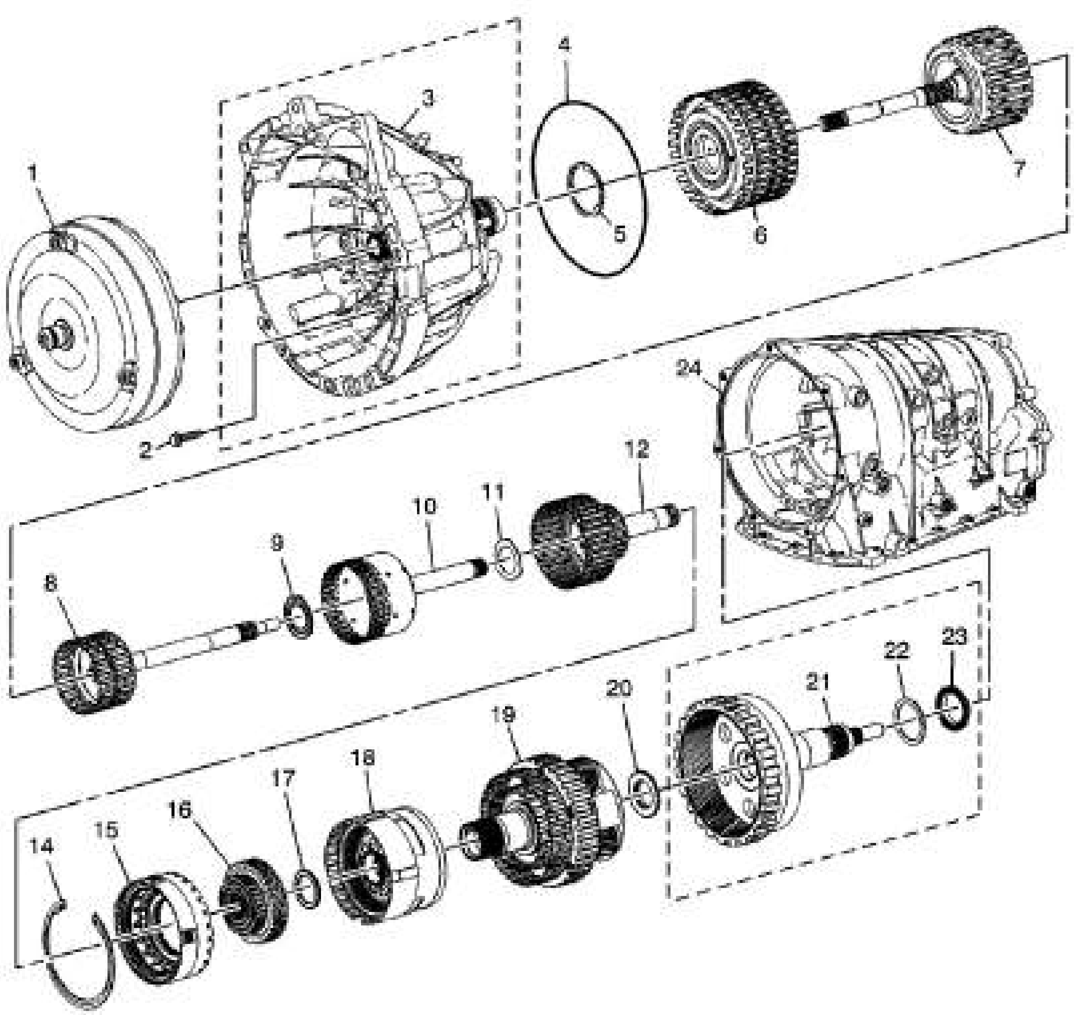
Case and Associated Parts (1 of 2)



(1) Torque Converter Assembly
(2) Torque Converter Housing to Main Case Retaining Bolt
(3) Torque Converter Housing Assembly - Model Dependent
(4) Torque Converter Housing Fluid Seal Assembly
(5) Reverse Clutch Housing Thrust Washer - Selective
(6) Direct and Reverse Clutch Assembly
(7) Forward and Coast Clutch Assembly
(8) Input Sun Gear - With Forward Clutch Roller Inner Race Shaft
(9) Direct Clutch Hub Thrust Washer
(10) Direct Clutch Assembly- With Input and Reaction Carrier in Hub
(11) Input and Reaction Carrier Inner Shaft Thrust Washer

(12) Intermediate Clutch Sprag Assembly
(14) Intermediate and Overdrive Clutch Housing Retainer Ring - Selective
(15) Overdrive Clutch Housing Assembly
(16) Low Clutch Sprag Assembly
(17) Low Clutch Roller Thrust Bearing
(18) Centre Support
(19) Input and Reaction Carrier Assembly
(20) Input and Reaction Carrier Thrust Bearing
(21) Output Shaft Assembly With Rear Internal Gear - Model Dependent
(22) Input and Reaction Carrier Washer Selective Steel - Model Dependent
(23) Input and Reaction Carrier Thrust Bearing
(24) Automatic Transmission Case Assembly
(70) Transmission Cooler Bypass Valve - Model Dependent
(71) Transmission Cooler Bypass Bolt - Model Dependent
(72) Transmission Cooler Bypass Seals - Model Dependent

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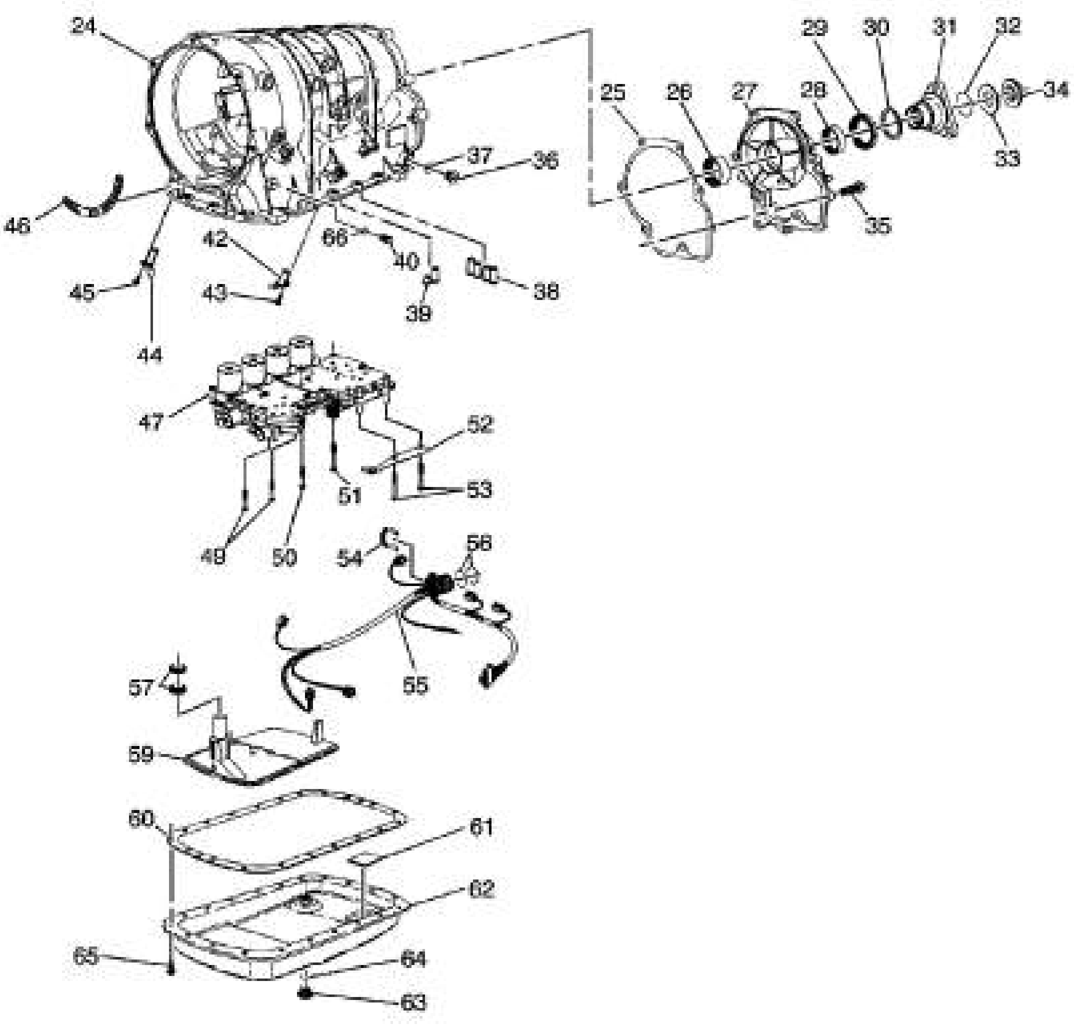
Case and Associated Parts (2 of 2)



(24) Automatic Transmission Case Assembly
(25) Automatic Transmission Case Extension Gasket - Model Dependent
(26) Output Shaft Bearing - Model Dependent
(27) Automatic Transmission Case Extension - Model Dependent
(28) Output Shaft Bearing - Model Dependent
(29) Automatic Transmission Propeller Shaft - Model Dependent
(30) Output Shaft Assembly Retainer - Model Dependent
(31) Automatic Transmission Propeller Shaft Flange - Model Dependent
(32) Automatic Transmission Propeller Shaft Flange - O-Ring Seal - Model Dependent
(33) Automatic Transmission Propeller Shaft Thrust Washer - Model Dependent
(34) Propeller Shaft Flange Retaining Nut - Model Dependent

(35) Automatic Transmission Case Extension Retaining Bolt - Model Dependent
(36) Automatic Transmission Fluid Level Hole Plug
(37) Automatic Transmission Fluid Level Hole Plug O-Ring Seal
(38) Centre Support Fluid Passage Sleeve
(39) Overdrive Clutch Fluid Passage Sleeve
(40) Automatic Transmission Pressure Test Plug
(42) Output Speed Sensor
(43) Output Speed Sensor Retaining Bolt
(44) Input Speed Sensor
(45) Input Speed Sensor Retaining Bolt
(46) Automatic Transmission Fluid Pump Cover Gasket
(47) Control Valve Body and Accumulator Assembly
(49) Control Valve Body Retaining Bolt M6 x 1.0 x 50
(50) Control Valve Body Retaining Bolt M6 x 1.0 x 38
(51) Control Valve Body Retaining Bolt M6 x 1.0 x 50
(52) Manual Shaft Detent Assembly
(53) Control Valve Body Retaining Bolt M6 x 1.0 x 68
(54) Wiring Harness Clip
(55) Automatic Transmission Wiring Harness
(56) Automatic Transmission Wiring Harness - O-Ring seal - 2
(57) Automatic Transmission Filter Seal - 2
(59) Automatic Transmission Fluid Filter
(60) Automatic Transmission Fluid Pan Gasket
(61) Automatic Transmission Fluid Pan Magnet
(62) Automatic Transmission Fluid Pan Assembly
(63) Automatic Transmission Fluid Pan Drain Plug
(64) Automatic Transmission Fluid Pan Drain Plug Seal
(65) Automatic Transmission Fluid Pan Retaining Bolt
(66) Automatic Transmission Pressure Test Plug O-Ring Seal
(67) Input and Reaction Carrier Thrust Washer Selective Plastic - Model Dependent
(68) Automatic Transmission Propeller Shaft Flange Seal - Model Dependent
(69) Input and Reaction Carrier Thrust Bearing - Model Dependent

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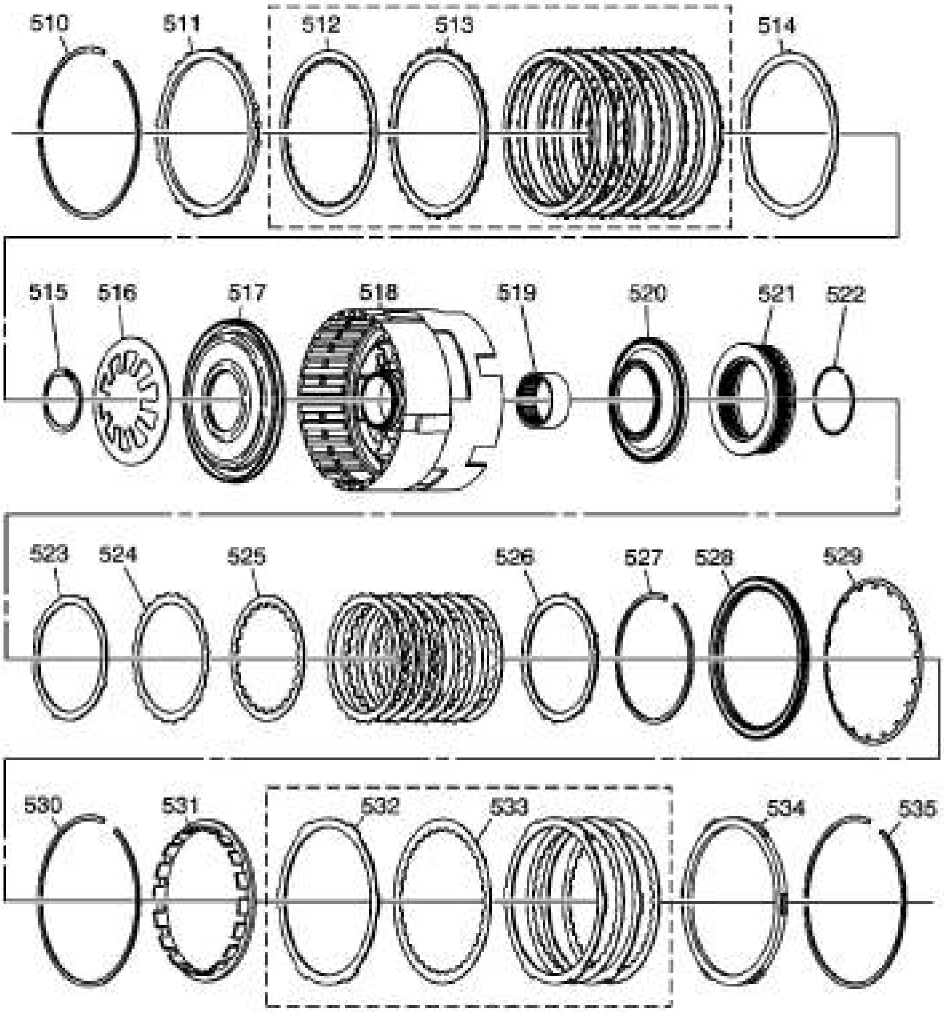
Centre Support Assembly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(510) Low and Reverse Clutch Plate Retainer Ring - Selective
(511) Low and Reverse Clutch Backing Plate
(512) Low and Reverse Clutch Plate Assembly - Inner Spline - 5
(513) Low and Reverse Clutch Plate Assembly - Outer Spline - 5
(514) Low and Reverse Clutch Apply Plate
(515) Low and Reverse Clutch Spring Retainer Ring
(516) Low and Reverse Clutch Spring
(517) Low and Reverse Clutch Piston
(518) Centre Support
(519) Input and Reaction Bearing Assembly
(520) 2nd Clutch Piston

(521) 2nd Clutch Spring
(522) 2nd Clutch Spring Retainer Ring
(523) 2nd Clutch Apply Plate
(524) 2nd Clutch Plate Assembly - Outer Spline - 5
(525) 2nd Clutch Plate Assembly - Inner Spline - 5
(526) 2nd Clutch Backing Plate
(527) 2nd Clutch Backing Plate Retainer Ring - Selective
(528) 2nd Coast Clutch Piston Assembly
(529) 2nd Coast Clutch Spring
(530) 2nd Coast Clutch Spring Retainer Ring
(531) 2nd Coast Clutch Spacer
(532) 2nd Coast Clutch Plate Assembly - Outer Spline - 3
(533) 2nd Coast Clutch Plate Assembly - Inner Spline - 3
(534) 2nd Coast Clutch Backing Plate
(535) 2nd Coast Clutch Plate -Backing Plate -Retainer Ring -Selective

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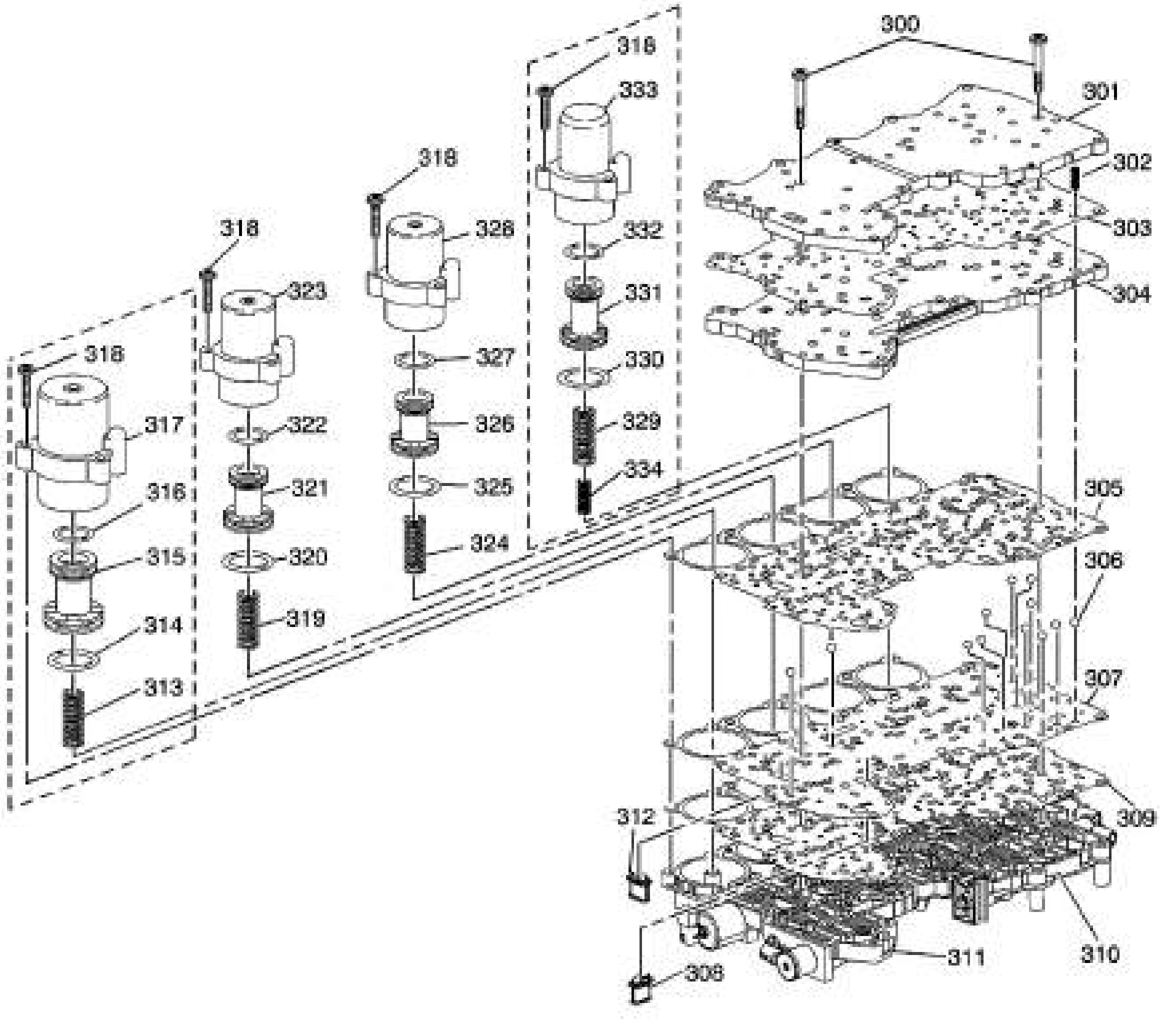
Control Valve Body and Accumulator Assembly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(300) Control Valve Body Bolt M6 x 1.0 x 38 - 7

(301) Control Valve Top Channel Plate

(302) Control Valve Channel Plate Ball Check Spring

(303) Control Valve Channel Plate Gasket

(304) Control Valve Bottom Channel Plate

(305) Control Valve Body Gasket

(306) Control Valve Body Ball Check Valve

(307) Control Valve Body Spacer Plate

(308) TCC PWM Solenoid Valve Filter Assembly

(309) Control Valve Body Spacer Plate Gasket

(310) Control Valve Rear Body Assembly

(311) Control Valve Front Body Assembly
(312) Pressure Control Solenoid Valve Filter Assembly
(313) Direct Clutch Accumulator Piston Spring - Model Dependent
(314) Direct Clutch Accumulator Piston Fluid Seal Ring - Model Dependent
(315) Direct Clutch Accumulator Piston - Model Dependent
(316) Direct Clutch Accumulator Piston Fluid Seal Ring - Model Dependent
(317) Direct Clutch Accumulator Housing - Model Dependent
(318) Accumulator Housing Bolt M6 x 1.0 x 30 - 12 - Model Dependent
(318) Accumulator Housing Bolt M6 x 1.0 x 30 - 12
(319) Overdrive Clutch Accumulator Piston Spring
(320) Overdrive Clutch Accumulator Piston Fluid Seal Ring
(321) Overdrive Clutch Accumulator Piston
(322) Overdrive Clutch Accumulator Piston Fluid Seal Ring
(323) Overdrive Clutch Accumulator Housing
(324) Intermediate Clutch Accumulator Piston Spring
(325) Intermediate Clutch Accumulator Piston Fluid Seal Ring
(326) Intermediate Clutch Accumulator Piston
(327) Intermediate Clutch Accumulator Piston Fluid Seal Ring
(328) Intermediate Clutch Accumulator Housing
(329) 2nd Clutch Accumulator Piston Spring - Model Dependent
(330) 2nd Clutch Accumulator Piston Seal Ring - Model Dependent
(331) 2nd Clutch Accumulator Piston - Model Dependent
(332) 2nd Clutch Accumulator Piston Seal Ring - Model Dependent
(333) 2nd Clutch Accumulator Housing - Model Dependent
(334) 2nd Clutch Accumulator Piston Inner Spring - Model Dependent

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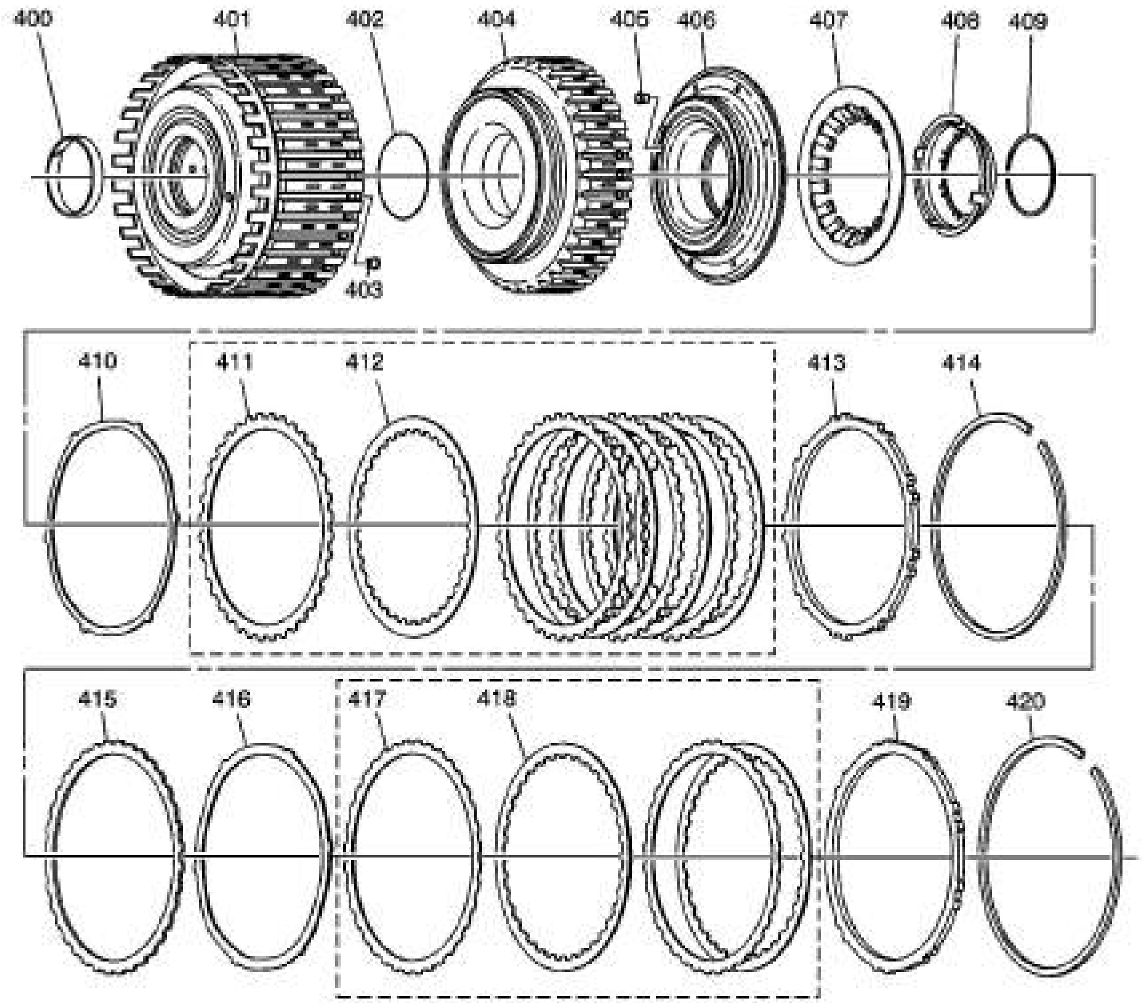
Direct and Reverse Clutch Assembly



(400) Reverse Clutch Housing Bushing

(401) Reverse Clutch - With Input Housing Assembly

(402) Reverse Clutch Piston Inner Seal

(403) Reverse Clutch Housing Ball Check Valve

(404) Reverse Clutch Piston

(405) Direct Clutch Housing Ball Check Valve

(406) Direct Clutch Piston Assembly

(407) Direct and Reverse Clutch Spring

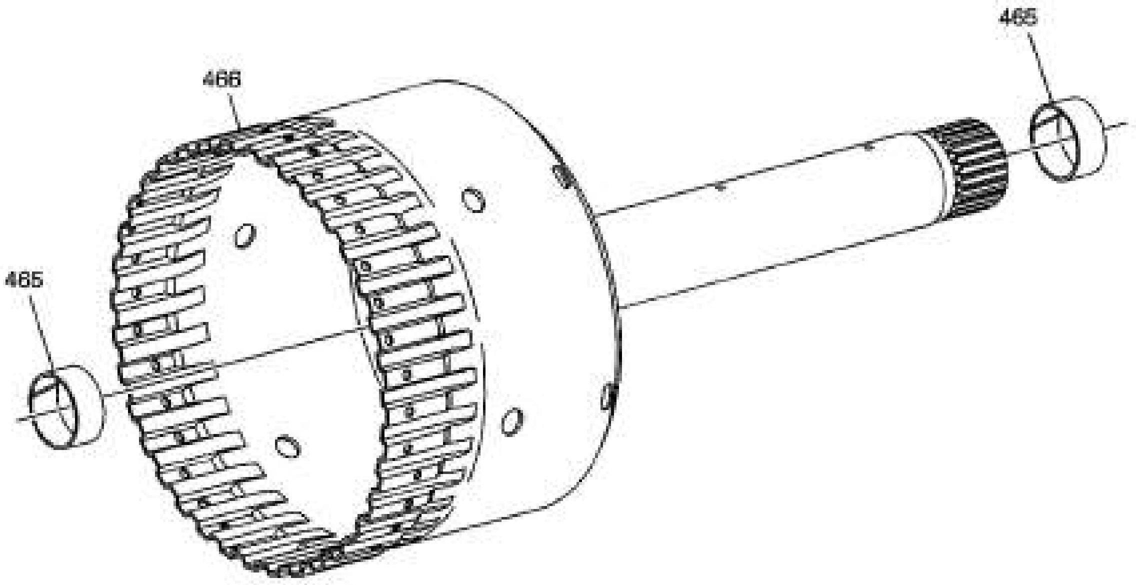
(408) Direct and Reverse Clutch Spring Retainer

(409) Direct and Reverse Clutch Spring Retainer Ring

(410) Direct Clutch Apply Plate

(411) Direct Clutch Plate Assembly - Outer Spline - 4
(412) Direct Clutch Plate Assembly - Inner Spline - 4
(413) Direct Clutch Backing Plate
(414) Direct Clutch Backing Plate Retainer Ring - Selective
(415) Reverse Clutch Spacer
(416) Reverse Clutch Apply Plate
(417) Reverse Clutch Plate Assembly - Outer Spline - 2
(418) Reverse Clutch Plate Assembly - Inner Spline - 2
(419) Reverse Clutch Backing Plate
(420) Reverse Clutch Backing Plate Retainer Ring - Selective

Direct Clutch Drum and Shaft Assembly



(465) Input and Reaction Carrier Bushing - 2
(466) Direct Clutch Drum

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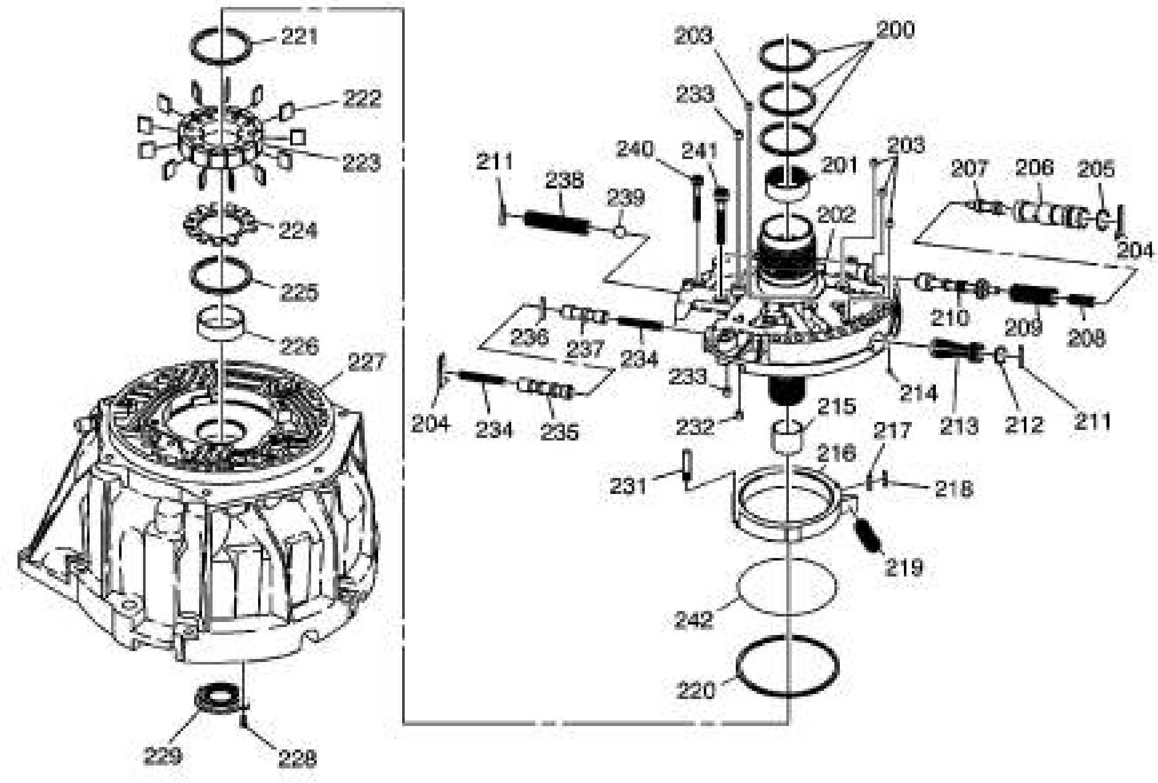
Fluid Pump Assembly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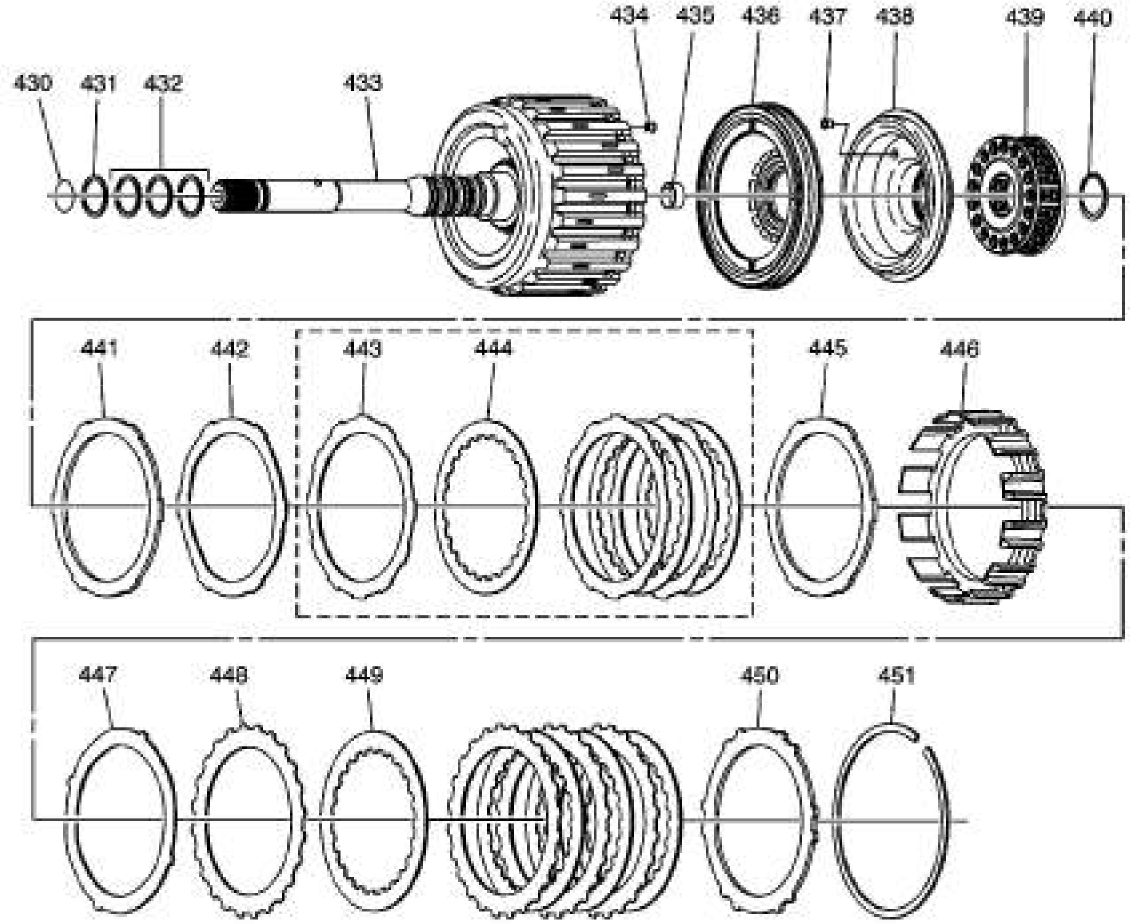
(200) Reverse Clutch Housing Fluid Seal Ring - 3
(201) Input Shaft Bearing Assembly
(202) Automatic Transmission Fluid Pump Cover Assembly
(203) Check Valve Retainer and Ball Assembly
(203) Check Valve Retainer and Ball Assembly
(204) Valve Bushing/Spring Retainer
(205) Line Boost Valve Bushing Seal
(206) Line Boost Valve Bushing
(207) Line Boost Valve
(208) Line Boost Valve Spring
(209) Pressure Regulator Valve Spring

(210) Pressure Regulator Valve
(211) Automatic Transmission Fluid Pump Retainer Pin
(212) Automatic Transmission Pump Cover Seal
(213) Automatic Transmission Fluid Pump Screen Assembly
(214) Brass Orifice Insert
(215) Turbine Shaft Bushing
(216) Automatic Transmission Fluid Pump Slide - Selective
(217) Automatic Transmission Fluid Pump Slide Seal Support
(218) Automatic Transmission Fluid Pump Slide Seal
(219) Automatic Transmission Fluid Pump Slide Ring
(220) Automatic Transmission Fluid Pump Slide Ring
(221) Automatic Transmission Fluid Pump Vane Ring
(222) Automatic Transmission Fluid Pump Vane
(223) Automatic Transmission Fluid Pump Rotor - Selective
(224) Automatic Transmission Fluid Pump Rotor Guide
(225) Automatic Transmission Fluid Pump Vane Ring
(226) Torque Converter Bushing
(227) Torque Converter Housing
(228) Torque Converter Housing Seal Retaining Bolt M4 x 0.7 x 10.0 - 4
(229) Torque Converter Housing Seal
(231) Automatic Transmission Fluid Pump Slide Pin Assembly
(232) Orifice Sleeve
(233) Orifice Cup Plug - 2
(233) Orifice Cup Plug - 2
(234) TCC Control Valve Spring
(234) TCC Control Valve Spring
(235) TCC Control Valve
(236) Automatic Transmission Fluid Pump Retainer Pin
(237) TCC Enable Valve
(238) Pressure Relief Ball Valve Spring
(239) Pressure Relief Ball Valve
(240) Automatic Transmission Fluid Pump Retaining Bolt M6 x 1.0 x 40
(241) Automatic Transmission Fluid Pump Retaining Bolt M8 x 1.25 x 40
(242) Automatic Transmission Fluid Pump Slide O-ring Seal

Forward and Coast Clutch Assembly



(430) Input Shaft - O-Ring Seal

(431) Input Shaft Fluid Seal Ring

(432) Input Shaft Fluid Seal Ring - 3

(433) Forward Clutch - With Input Housing Assembly

(434) Forward Clutch Housing Ball Check Valve Assembly

(435) Forward Clutch Bushing

(436) Forward Clutch Piston Assembly

(437) Coast Clutch Piston Ball Check Valve Assembly

(438) Coast Clutch Piston Assembly

(439) Forward and Coast Clutch Spring

(440) Forward and Coast Clutch Spring Retainer Ring

(441) Coast Clutch Spacer Plate - Selective
(442) Coast Clutch Apply Plate
(443) Coast Clutch Plate Assembly - Outer Spline - 3
(444) Coast Clutch Plate Assembly - Inner Spline - 3
(445) Coast Clutch Backing Plate
(446) Coast Clutch Housing
(447) Forward Clutch Apply Plate
(448) Forward Clutch Plate Assembly - Outer Spline - 4
(449) Forward Clutch Plate Assembly - Inner Spline - 4
(450) Forward Clutch Backing Plate
(451) Forward Clutch Backing Plate Retainer Ring - Selective

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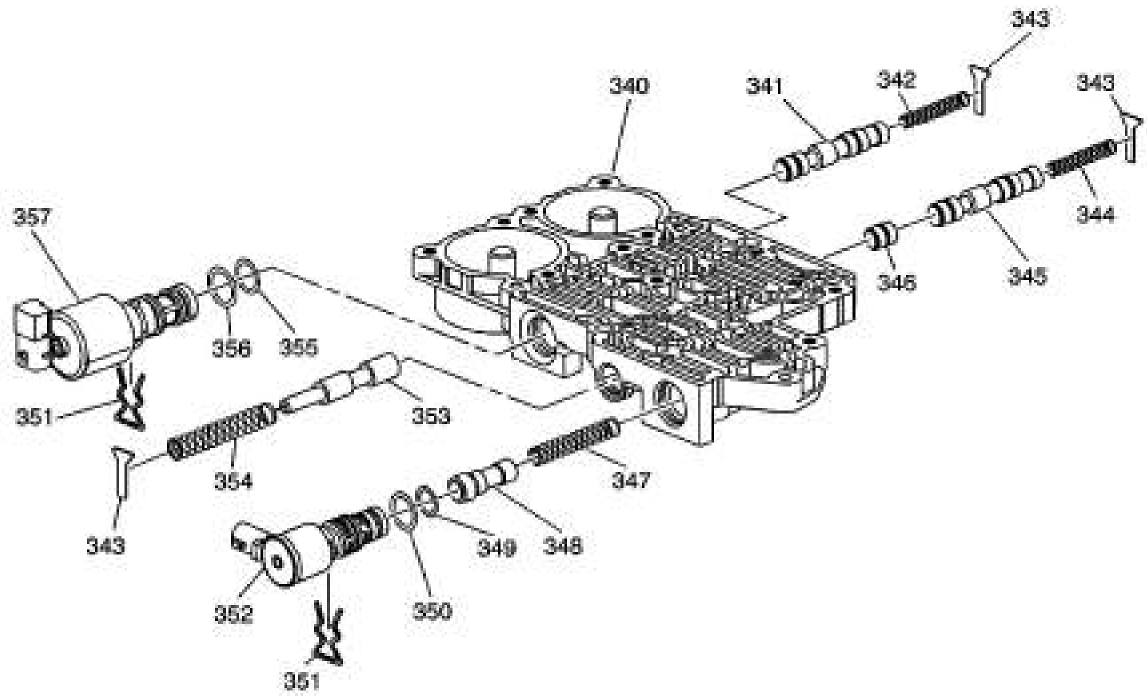
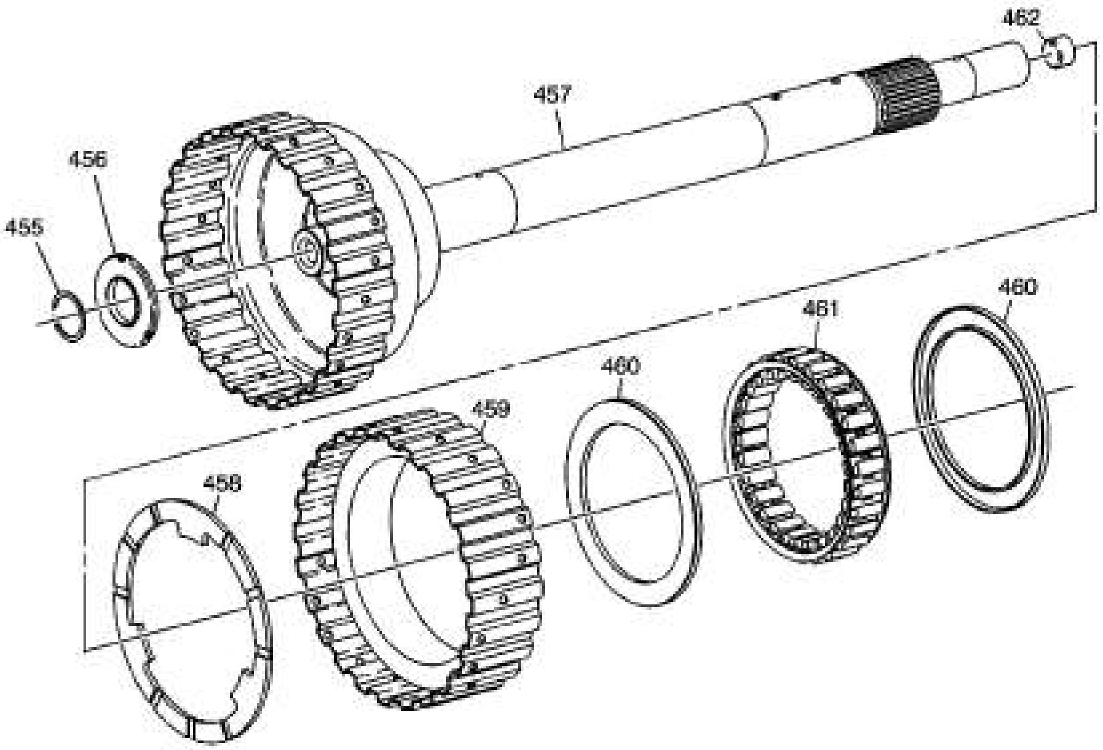
Front Control Valve Body



(340) Front Control Valve Body
(341) Safety Mode Valve
(342) Safety Mode Valve Spring
(343) Valve Spring Retainer - 3
(344) 3-4 Shift Valve Spring
(345) 3-4 Shift Valve
(346) 3-4 Shift Control Valve
(347) TCC Regulator Apply Valve Spring
(348) TCC Regulator Apply Valve
(349) Solenoid Valve - O-Ring Seal
(350) Solenoid Valve - O-Ring Seal
(351) Solenoid Valve Retainer - 2
(352) TCC PWM Solenoid Valve
(353) Feed Limit Valve
(354) Feed Limit Valve Spring
(355) Pressure Control Solenoid - O-Ring Seal
(356) Pressure Control Solenoid - O-Ring Seal
(357) Pressure Control (PC) Solenoid Assembly

Input Sun Gear Shaft and Forward Sprag Clutch Assembly



(455) Forward Clutch Roller Inner Race Thrust Ring
(456) Forward Clutch Roller Inner Bearing
(457) Input Sun Gear Shaft Assembly
(458) Forward Clutch Roller Outer Race Washer
(459) Forward Clutch Sprag Outer Race
(460) Forward Clutch Sprag Assembly Retainer Rings - 2
(460) Forward Clutch Sprag Assembly Retainer Rings - 2
(461) Forward Clutch Sprag Assembly
(462) Orificed Cup Plug - Lube

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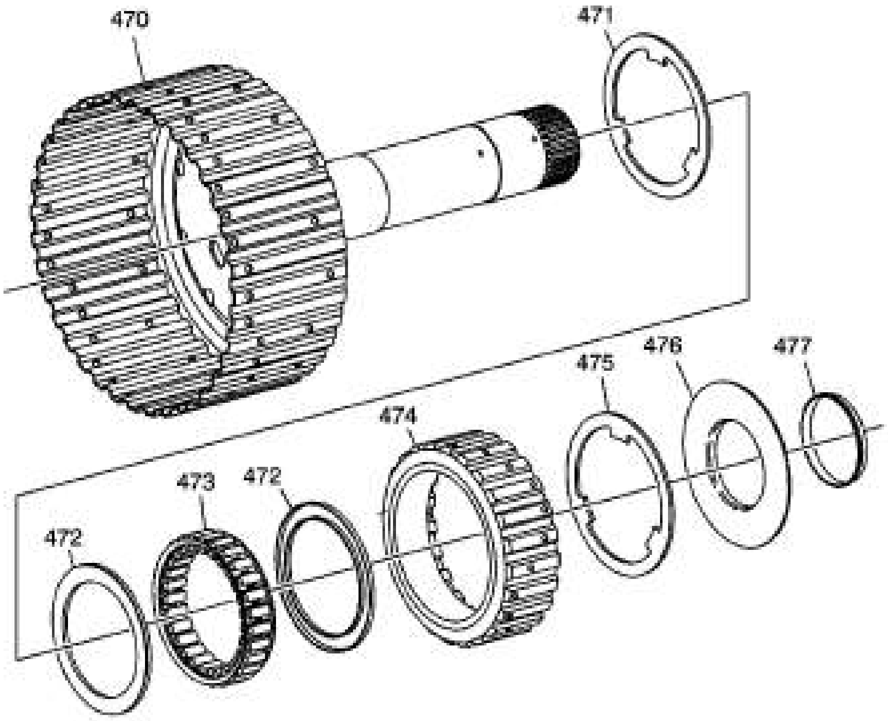
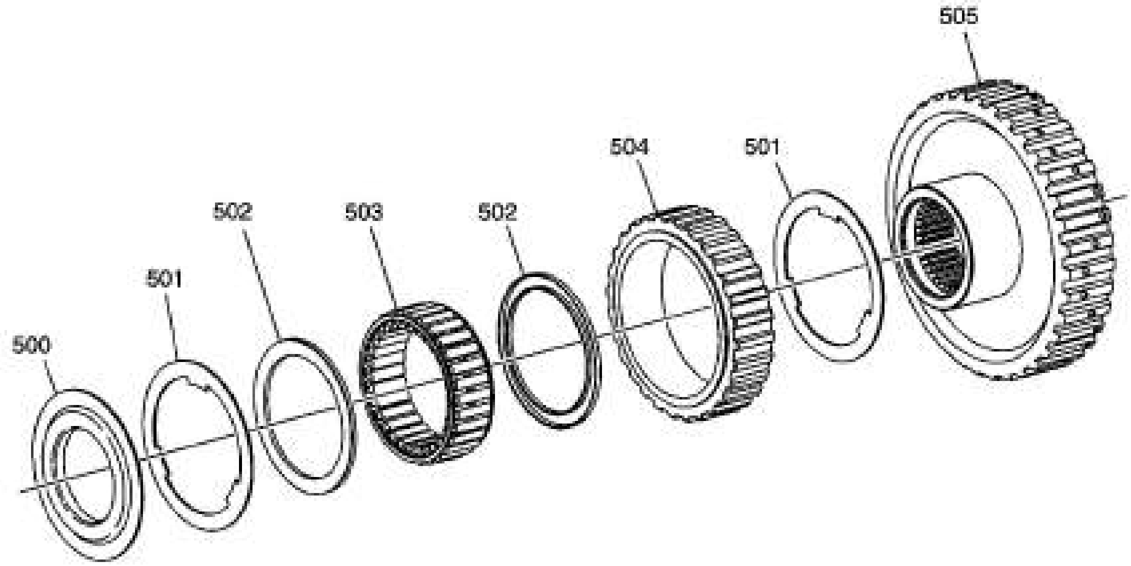
Intermediate Sprag Clutch Assembly



(470) Overdrive and Reverse Clutch - With Hub Assembly
(471) Intermediate Clutch Roller Thrust Washer
(472) Intermediate Clutch Sprag Assembly Retainer Rings - 2
(473) Intermediate Clutch Sprag Assembly
(474) Intermediate Clutch Sprag Outer Race
(475) Intermediate Clutch Roller Thrust Washer
(476) Intermediate Clutch Roller Thrust Bearing Assembly
(477) Intermediate Clutch Roller Thrust Bearing Assembly Retainer

Low Clutch Sprag Assembly



(500) Low Clutch Roller Retainer

(501) Low Clutch Roller Thrust Washer

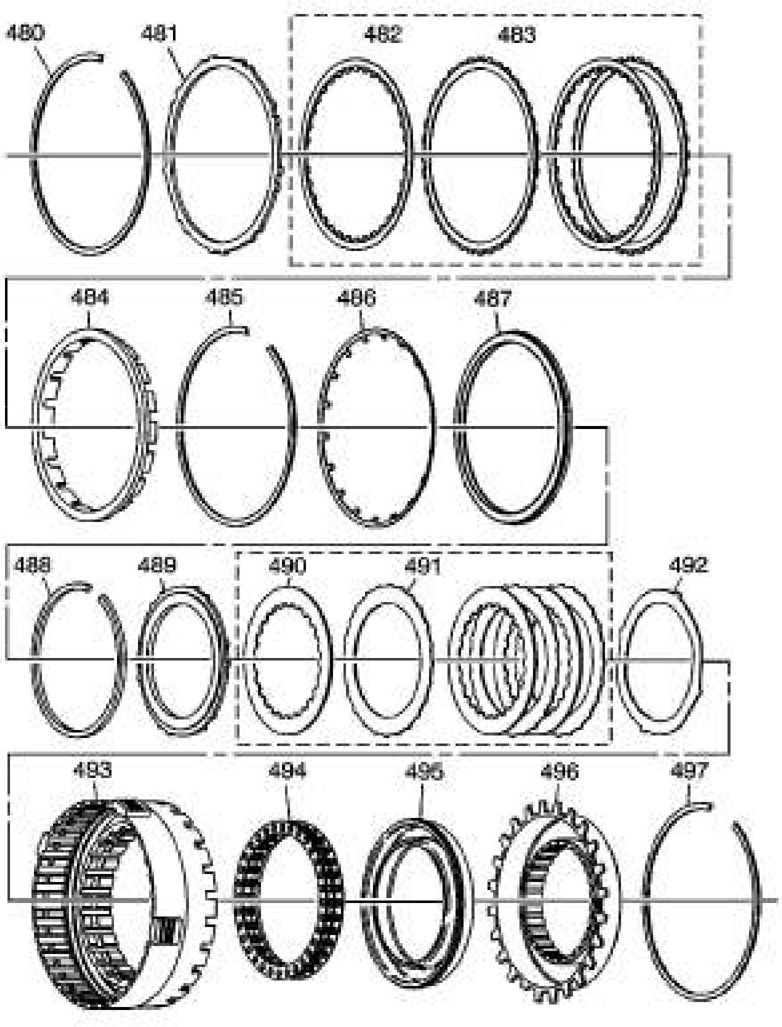
(502) Low Clutch Sprag Assembly Retainer Rings - 2

(503) Low Clutch Sprag Assembly

(504) Low Clutch Sprag Outer Race

(505) Low Clutch Sprag Inner Race

Overdrive and Intermediate Clutch Assembly



(480) Overdrive Clutch Backing Plate Retainer Ring - Selective
(481) Overdrive Clutch Backing Plate
(482) Overdrive Clutch Plate Assembly - Inner Spline
(483) Overdrive Clutch Plate Assembly - Outer Spline
(484) Overdrive Clutch Spacer
(485) Overdrive Clutch Spring Retainer Ring
(486) Overdrive Clutch Piston Spring
(487) Overdrive Clutch Piston Assembly
(488) Intermediate Clutch Backing Plate Retainer Ring - Selective
(489) Intermediate Clutch Backing Plate
(490) Intermediate Clutch Plate Assembly - Inner Spline - 3

(491) Intermediate Clutch Plate Assembly - Outer Spline - 3
(492) Intermediate Clutch Apply Plate
(493) Overdrive Clutch Housing
(494) Intermediate Clutch Spring
(495) Intermediate Clutch Piston Assembly
(496) Intermediate Clutch Housing
(497) Intermediate Clutch Housing Retainer Ring

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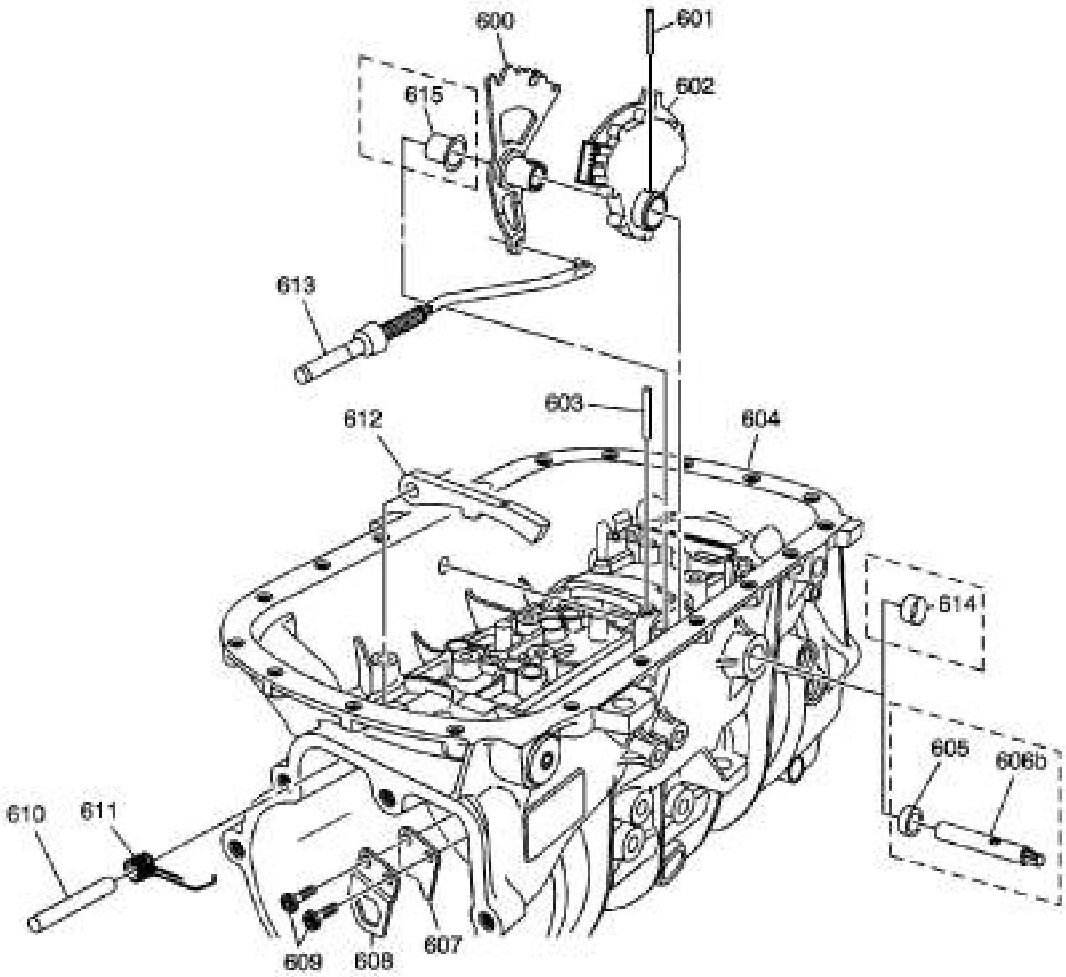
Park Pawl Assembly

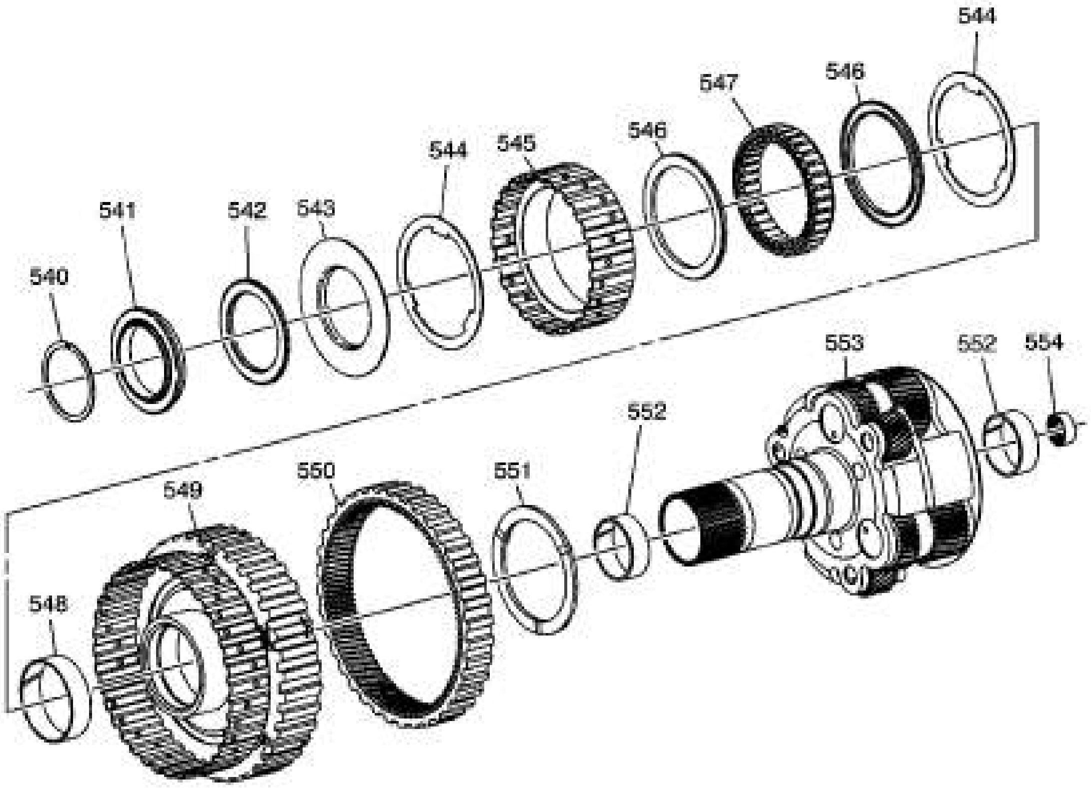


(600) Manual Shaft Detent Lever
(601) Manual Shaft Detent Lever Pin
(602) Transmission Manual Shift Shaft Switch Assembly
(603) Manual Shaft Detent Lever Pin
(604) Transmission Case
(605) Manual Shift Shaft Seal - Model Dependent
(606a) Manual Shift Shaft
(607) Park Pawl Actuator Bracket
(608) Park Pawl Actuator Bracket
(609) Park Pawl Actuator Bracket Bolt M8 x 1.25 x 25 - 2
(610) Park Pawl Shaft

(611) Park Pawl Spring
(612) Park Pawl
(613) Park Pawl Actuator Assembly
(614) Cup Plug - Model Dependent
(615) Transmission Manual Shift Shaft Spacer - Model Dependent

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 5L40-E/5L50-E | Component Locator | **Document ID: 1997920**

Planetary Carrier Assembly

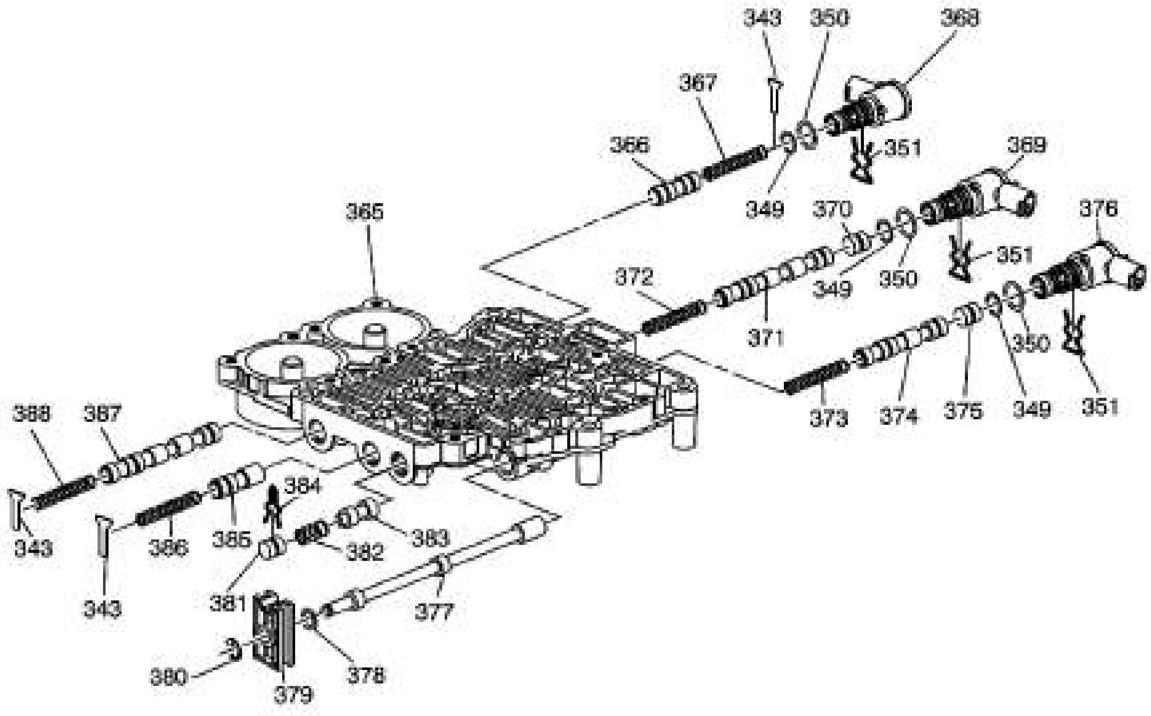


(540) Input and Reaction Carrier Outer Retainer Ring
(541) Input and Reaction Bearing Assembly
(542) 2nd Clutch Roller Inner Race Bearing Assembly
(543) 2nd Clutch Sprag Retainer
(544) 2nd Clutch Roller Outer Race Washer
(545) 2nd Clutch Sprag Outer Race
(546) 2nd Clutch Sprag Assembly Retainer - 2
(547) 2nd Clutch Sprag Assembly
(548) Input and Reaction Carrier Bushing
(549) 2nd Clutch Sprag Inner Race
(550) Reaction Internal Gear

(551) Reaction Internal Gear Flange Washer
(552) Reaction Carrier Bushing - 2
(553) Input and Reaction Carrier
(554) Input and Reaction Bearing Assembly

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 5L40-E/5L50-E | Component Locator | **Document ID: 1997905**

Rear Control Valve Body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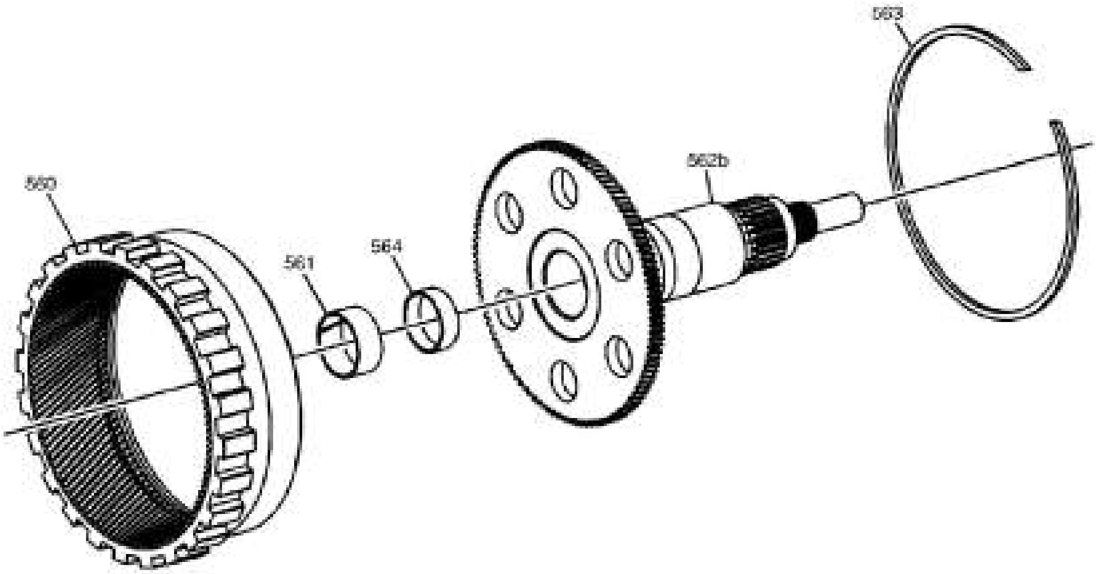
(343) Valve Spring Retainer
(343) Valve Spring Retainer
(343) Valve Spring Retainer
(349) Solenoid Valve - O-Ring Seal
(350) Solenoid Valve - O-Ring Seal
(351) Solenoid Valve Retainer
(365) Rear Control Valve Body
(366) 1-2 Shift Control Valve
(367) 1-2 Shift Control Valve Spring
(368) 1-2 Shift Solenoid (SS) Valve Assembly
(369) 2-3 Shift Solenoid (SS) Valve Assembly
(370) 2-3 Shift Control Valve
(371) 2-3 Shift Valve
(372) 2-3 Shift Valve Spring
(373) 4-5 Shift Valve Spring
(374) 4-5 Shift Valve
(375) 4-5 Shift Control Valve
(376) 4-5 Shift Solenoid (SS) Valve Assembly

(377) Manual Valve
(378) Manual Valve Link Washer - Waved
(379) Manual Valve Link
(380) Manual Valve Link Retainer
(381) Low Pressure Control Valve Bore Plug
(382) Low Pressure Control Valve Spring
(383) Low Pressure Control Valve
(384) Low Pressure Control Valve Bore Retainer
(385) Reverse Lockout Valve
(386) Reverse Lockout Valve Spring
(387) 1-2 Shift Valve
(388) 1-2 Shift Valve Spring

Rear Internal Gear Output Shaft Assembly



(560) Rear Internal Gear
(561) Input and Reaction Carrier Bushing
(562b) Output Shaft Assembly
(563) Rear Internal Retainer Ring
(564) Cup Plug

Diagnostic Starting Point - Automatic Transmission

Begin the system diagnosis with the Diagnostic System Check - Vehicle. The Diagnostic System Check - Vehicle will provide the following information:

- The identification of the control modules which command the system
- The ability of the control modules to communicate through the serial data circuit
- The identification of any stored diagnostic trouble codes (DTCs) and their status

The use of the Diagnostic System Check - Vehicle will identify the correct procedure for diagnosing the system and where the procedure is located.

Scan Tool Data Definitions

This list explains each data message displayed on the scan tool. This information will assist you in tracking down emissions or driveability DTCs, because you can view the displays while you are driving the vehicle. Refer to Diagnostic System Check - Vehicle for additional information.

1-2 Shift Error: This parameter displays the difference between the desired 1-2 shift time and the actual 1-2 shift time. A positive number indicates a firm or fast shift, the actual shift time was shorter than the desired shift time. A negative number indicates a soft or slow shift, the actual shift time was longer than the desired shift time. This value is only accurate if the shift was adaptable.

1-2 Shift Time: This parameter displays the actual time of the last 1-2 shift. The shift time is based on the engine RPM drop after the commanded 1-2 shift. This value is only accurate if the shift was adaptable.

1-2 Sol.: This parameter displays the current commanded state of the shift solenoids. All three of the 5L40-E shift solenoids are normally-closed, which means that no fluid passes through when the solenoid is commanded OFF. When commanded ON, the solenoid opens and allows fluid to flow through. Refer to Shift Solenoid Valve State and Gear Ratio.

1-2 Sol. CKT Status: This parameter displays the solenoid valve feedback voltage signal circuit status on the scan tool. If the voltage is low when the solenoid is commanded OFF, the scan tool will display Open/Short to GND. If the voltage is high when the solenoid is commanded ON, the scan tool will display Short to Volts. If no circuit fault is present, the scan tool will display OK.

1-2 TAP Cell (4-16): This parameter displays the amount of transmission adaptive pressure (TAP), based on 17 N·m (12.5 lb. ft) of engine torque increment per cell, added to or subtracted from shift pressure during a 1-2 upshift. A positive number indicates that long shifts have been detected and PC solenoid pressure has been added in order to decrease shift time. A negative number indicates that short shifts have been detected and PC solenoid pressure has been subtracted in order to increase shift time.

2-3 Shift Error: This parameter displays the difference between the desired 2-3 shift time and the actual 2-3 shift time. A positive number indicates a firm or fast shift, the actual shift time was shorter than the desired shift time. A negative number indicates a soft or slow shift, the actual shift time was longer than the desired shift time. This value is only accurate if the shift was adaptable.

2-3 Shift Time: This parameter displays the actual time of the last 2-3 shift. The shift time is based on the engine RPM drop after the commanded 2-3 shift. This value is only accurate if the shift was adaptable.

2-3 Sol.: This parameter displays the commanded state of the 2-3 shift solenoid valve. When the transmission is in FIRST and SECOND gear, the display should indicate OFF, current is not flowing through the solenoid. When the transmission is in THIRD and FOURTH gear, the display should indicate ON, current is flowing through the solenoid.

2-3 Sol. CKT Status: This parameter displays the solenoid valve feedback voltage signal circuit status on the scan tool. If the voltage is low when the solenoid is commanded OFF, the scan tool will display Open/Short to GND. If the voltage is high when the solenoid is commanded ON, the scan tool will display Short to Volts. If no circuit fault is present, the scan tool will display OK.

2-3 TAP Cell (4-16): This parameter displays the amount of transmission adaptive pressure (TAP), based on 17 N·m (12.5 lb. ft) of engine torque increment per cell, added to or subtracted from shift pressure during a 2-3 upshift. A positive number indicates that long shifts have been detected and PC solenoid pressure has been added in order to decrease shift time. A negative number indicates that short shifts have been detected and PC solenoid pressure has been subtracted in order to increase shift time.

3-4 Shift Error: This parameter displays the difference between the desired 3-4 shift time and the actual 3-4 shift time. A positive number indicates a firm or fast shift, the actual shift time was shorter than the desired shift time. A negative number indicates a soft or slow shift, the actual shift time was longer than the desired shift time. This value is only accurate if the shift was adaptable.

3-4 Shift Time: This parameter displays the actual time of the last 3-4 shift. The shift time is based on the engine RPM drop after the commanded 3-4 shift. This value is only accurate if the shift was adaptable.

3-4 TAP Cell (4-16): This parameter displays the amount of transmission adaptive pressure (TAP), based on 17 N·m (12.5 lb. ft) of engine torque increment per cell, added to or subtracted from shift pressure during a 3-4 upshift. A positive number indicates that long shifts have been detected and PC solenoid pressure has been added in order to decrease shift time. A negative number indicates that short shifts have been detected and PC solenoid pressure has been subtracted in order to increase shift time.

4-5 Shift Error: This parameter displays the difference between the desired 4-5 shift time and the actual 4-5 shift time. A positive number indicates a firm or fast shift, the actual shift time was shorter than the desired shift time. A negative number indicates a soft or slow shift, the actual shift time was longer than the desired shift time. This value is only accurate if the shift was adaptable.

4-5 Shift Time: This parameter displays the actual time of the last adaptable 4-5 shift. The actual shift time is obtained by measuring the time required for the input shaft to decelerate from the previous ratio to the current ratio.

4-5 Sol.: This parameter indicates the current commanded state of the shift solenoids. All three of the 5L40-E shift solenoids are normally-closed, which means that no fluid passes through when the solenoid is commanded OFF. When the solenoid is commanded ON, the solenoid opens and allows fluid to flow through.

4-5 Sol. CKT Status: This parameter displays the solenoid driver feedback voltage signal and displays the circuit status on the scan tool. If the voltage is low when the solenoid is commanded OFF, the scan tool will display Open/Short to GND. If the voltage is high when the solenoid is commanded ON, the scan tool will display Short to Volts.

4-5 TAP Cell (4-16): This parameter displays the amount of transmission adaptive pressure (TAP), based on 17 N·m (12.5 lb. ft) of engine torque increment per cell, added to or subtracted from shift pressure during a 4-5 upshift. A positive number indicates that long shifts have been detected and PC solenoid pressure has been added in order to decrease shift time. A negative number indicates that short shifts have been detected and PC solenoid pressure has been subtracted in order to increase shift time.

Commanded Gear: This parameter displays the current commanded state of the shift solenoid valves. The scan tool displays 1, 2, 3, 4 or 5.

Cruise: This parameter displays the commanded state of the cruise control system. The scan tool displays ENABLED or DISABLED. When the display indicates ENABLED, the ECM is allowing cruise control operation. When the display indicates DISABLED, the ECM has disabled cruise control operation. The TCM modifies upshift and downshift patterns when cruise control is enabled.

Current TAP Cell: This parameter displays the current transmission adaptive pressure (TAP) cell in use for transmission line pressure adaptation. The cells are based on 17 N·m (12.5 lb. ft) of engine torque. The higher the engine torque, the higher the current TAP cell. The last cell used will remain displayed until the next adaptable upshift occurs.

ECT: This parameter displays the input signal from the engine coolant temperature (ECT) sensor. The scan tool displays -40 to +151°C (-40 to +304°F). When the ECT is high at 151°C (304°F), the signal voltage is low, 0 V. When the ECT is low at -40°C (-40°F), the signal voltage is high, 5 V. The ECM sends the ECT information to the transmission control module (TCM) via the high speed GMLAN serial data line.

Engine Speed: This parameter displays the engine speed, based on a signal from the engine control module (ECM). The scan tool displays engine speed in revolutions per minute (RPM). The ECM sends the RPM information to the transmission control module (TCM) via the high speed GMLAN serial data line.

Engine Torque: This parameter displays the estimated amount of torque that is delivered from the engine. The scan tool displays engine torque in N·m (lb. ft). The ECM sends the engine torque information to the transmission control module (TCM) via the high speed GMLAN serial data line.

Gear Ratio: This parameter displays the actual transmission gear ratio. The scan tool displays the gear ratio calculated from the automatic transmission input shaft speed sensor (Automatic transmission ISS) and the automatic transmission output shaft speed sensor (Automatic transmission OSS) inputs.

Ignition Voltage: This parameter displays the system voltage measured at the ignition feed.

IMS: This parameter displays PARK, PARK/REVERSE, REVERSE, REVERSE/NEUTRAL, NEUTRAL, NEUTRAL/DRIVE 5, DRIVE 5, DRIVE 5/DRIVE 4, DRIVE 4, DRIVE 4/DRIVE 3, DRIVE 3, DRIVE 3/DRIVE 2, DRIVE 2, or INVALID. The IMS Range display represents a decoded status of the four inputs from the IMS. The combination of IMS inputs are used to determine which position the manual valve is in at any time.

IMS A/B/C/P: This parameter displays the status of the four A/B/C/P inputs from the automatic transmission internal mode switch. I indicates an ignition voltage signal. LOW indicates a 0 voltage signal. The scan tool will display HI/LOW, HI/LOW, HI/LOW, HI/LOW.

Last Shift Time: This parameter displays the actual time of the last upshift. This value is only accurate if the shift was adaptable.

PC Sol. Actual Current: This parameter displays the actual current flow through the pressure control solenoid circuit, which is measured by the control module. High current flow results in low line pressure. Low current flow results in high line pressure.

PC Solenoid Duty Cycle: This parameter displays the commanded state of the pressure control solenoid, expressed as a percentage of energised ON time. A reading of low percent indicates zero ON time, non energised, or no current flow. A high percent at idle indicates maximum ON time, energised, or high current flow.

PC Sol. Ref. Current: This parameter displays the commanded current of the pressure control solenoid circuit. High current results in low line pressure. Low current results in high line pressure.

Steady State TAP 1GR: This parameter displays a pressure modification which is added to the line pressure in 1st gear. The larger the value, the greater the increase to line pressure.

Steady State TAP 1GR/TCC: This parameter displays a pressure modification, which is added to the line pressure in 1st gear with TCC applied. The larger the value, the greater the increase to line pressure.

Steady State TAP 2GR: This parameter displays a pressure modification which is added to the line pressure in 2nd gear. The larger the value, the greater the increase to line pressure.

Steady State TAP 2GR / TCC: This parameter displays a pressure modification which is added to the line pressure in 2nd gear with TCC applied. The larger the value, the greater the increase to line pressure.

Steady State TAP 3GR: This parameter displays a pressure modification which is added to the line pressure in 3rd gear. The larger the value, the greater the increase to line pressure.

Steady State TAP 3GR / TCC: This parameter displays a pressure modification which is added to the line pressure in 3rd gear with TCC applied. The larger the value, the greater the increase to line pressure.

Steady State TAP 4GR: This parameter displays a pressure modification which is added to the line pressure in 4th gear. The larger the value, the greater the increase to line pressure.

Steady State TAP 4GR / TCC: This parameter displays a pressure modification which is added to the line pressure in 4th gear with TCC applied. The larger the value, the greater the increase to line pressure.

Steady State TAP 5GR: This parameter displays a pressure modification which is added to the line pressure in 5th gear. The larger the value, the greater the increase to line pressure.

Steady State TAP 5 GR / TCC: This parameter displays a pressure modification which is added to the line pressure in 5th gear with TCC applied. The larger the value, the greater the increase to line pressure.

Steady State TAP Reverse: This parameter displays a pressure modification which is added to the line pressure in Reverse gear. The larger the value, the greater the increase to line pressure.

TCC Brake Switch: This parameter displays the status of the TCC brake switch circuit input. OPEN indicates a zero voltage input, brake pedal applied. CLOSED indicates a voltage input, brake pedal released. The scan tool displays OPEN or CLOSED.

TCC Duty Cycle: This parameter displays the commanded percentage of ON time for the TCC PWM solenoid. A high percentage represents an ON, energised, commanded state. 0 percent represents an OFF, non-energised, commanded state.

TCC Duty Cycle CKT Status: This parameter displays the solenoid driver feedback voltage signal and displays the circuit status on the scan tool. If the voltage is low when the solenoid is commanded OFF, the scan tool will display Open/Short to GND. If the voltage is high when the solenoid is commanded ON, the scan tool will display Short to Volts. If no circuit fault is present, the scan tool will display OK.

TCC Slip Speed: This parameter displays the difference between transmission input speed and engine speed. A negative value indicates the engine speed is less than the input speed, deceleration. A positive value indicates the engine speed is greater than the input speed, acceleration. A value of zero indicates the engine speed is equal to the input speed, TCC applied.

TP Angle: This parameter displays a percentage that is calculated based on TP sensor voltage. The TP angle should display 0 percent at idle and 100 percent at wide open throttle (WOT).

Traction Control: This parameter displays Active or Inactive. When the ECM receives a request for torque reduction from the electronic brake traction control module (EBTCM), Active is displayed.

Trans. Fluid Temp.: This parameter displays the input signal of the transmission fluid temperature sensor. Transmission fluid temperature is high, 151°C (304°F), when signal voltage is low, 0 volt. Transmission fluid temperature is low, -40°C (-40°F), when signal voltage is high, 5 volt.

Trans. Oil Life: This parameter displays the transmission oil life remaining. The scan tool displays remaining oil life in percentage. The transmission oil life calculation is based on transmission fluid temperature and engine run time.

Transmission Hot Mode: This parameter displays the automatic transmission fluid temperature (TFT) and displays On or Off. Off indicates that the TFT has not exceeded 130°C (266° F). On indicates that the TFT has exceeded 130°C (266°F) and has not cooled to 120°C (248°F) for greater that 5 seconds. These numbers are approximate and differ with transmissions.

Transmission ISS: This parameter displays the rotational speed of the transmission input shaft. The scan tool displays input shaft speed as revolutions per minute (RPM).

Transmission OSS: This parameter displays the rotational speed of the transmission output shaft. The scan tool displays output shaft speed as revolutions per minute (RPM).

Vehicle Speed: This parameter displays the speed at which the vehicle is travelling. The scan tool displays vehicle speed as kilometres per hour (km/h), miles per hour (MPH). The vehicle speed is calculated based on the input signal from the automatic transmission output shaft speed sensor.

Diagnostic Trouble Code (DTC) Type Definitions

Diagnostic Trouble Codes (DTCs) are grouped into several types. Each type has a unique set of characteristics for Malfunction Indicator Lamp (MIL) operation, DTC storage, and DTC clearing. The following list contains a brief summary of the DTC types and the associated properties of each.

Type A

This DTC is emissions related. The MIL illuminates and default actions, if any, are activated immediately after a failure is detected. The DTC is then stored in history and the Freeze Frame data is captured.

Type B

This DTC is emissions related. Default actions, if any, are activated and a Failure Record is stored after the first failure is detected. At the time of the first fail, the DTC will appear in memory as pending. If the next trip reports a pass, the pending DTC is deleted. If the failure recurs on the next consecutive drive cycle, the MIL illuminates, the DTC is stored in history, and the Freeze Frame data is captured at the time of failure.

Type C

This DTC is non emission related and does not turn on the MIL. When a Type C DTC sets, a message may be displayed on the driver information centre. Type C DTCs that do not display a message were formerly referred to as type D DTCs.

Diagnostic Trouble Code (DTC) List / Type

DTC	DTC Type
DTC P0115	C
DTC P0120	B
DTC P0218	C
DTC P0500	B
DTC P0562	C
DTC P0563	C
DTC P0572	C
DTC P0573	C
DTC P0601	A
DTC P0602	A
DTC P0603	A
DTC P0604	A
DTC P062F	A
DTC P0711	C
DTC P0712	C
DTC P0713	C
DTC P0716	B
DTC P0717	B
DTC P0722	B
DTC P0723	B
DTC P0727	B
DTC P0741	B
DTC P0742	B
DTC P0748	C
DTC P0751	B
DTC P0752	B
DTC P0756	B
DTC P0757	B
DTC P0761	B
DTC P0762	B
DTC P0897	C
DTC P0973	B
DTC P0974	B
DTC P0976	B
DTC P0977	B
DTC P0979	B

DTC P0980	B
DTC P1793	C
DTC P1815	B
DTC P1820	B
DTC P1822	B
DTC P1823	B
DTC P1825 or P1915	B
DTC P1826	B
DTC P1831	C
DTC P1832	C
DTC P1833	B
DTC P1834	B
DTC P1876	-
DTC P1825 or P1915	A
DTC P2534	A
DTC P2544	B
DTC P2637	B
DTC P2763	B
DTC P2764	B

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DTC P0115

Circuit Description

The engine control module (ECM) sends engine coolant temperature data to the transmission control module (TCM). The TCM uses this data to initiate warm-up shift patterns and to establish default transmission fluid temperature (TFT) values. The data is sent to the TCM through a communication network called GMLAN. Two circuits are used to communicate GMLAN data between the ECM and TCM. A fault in the GMLAN will not cause DTC P0115 to set by itself. If a GMLAN fault occurs, other DTCs will set before DTC P0115.

When the TCM receives invalid engine coolant temperature data from the ECM, then DTC P0115 will set. DTC P0115 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0115 Engine Coolant Temperature (ECT) Sensor Circuit

Conditions for Running the DTC

- The engine run time is greater than 5 seconds.
- No other GMLAN errors are present.

Conditions for Setting the DTC

The TCM receives no valid engine coolant temperature data from the ECM for 2 seconds.

Action Taken When the DTC Sets

- The TCM does not request the ECM to illuminate the malfunction indicator lamp (MIL).
- The TCM uses 25°C (77°F) as a default engine coolant temperature value.
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- The TCM stores DTC P0115 in TCM history.

Conditions for Clearing the DTC

- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the fault no longer exists and the DTC passes.

Step		Value		

	Action	(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. **Important:** - Before clearing the DTC, use the scan tool in order to record the ECM and the TCM Failure Records. Using the Clear Info function erases the Failure Records from the ECM and TCM. - Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Failure Records. Did you record any ECM Failure Records?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	Go to Step 3
3	1. Clear the DTC. 2. Turn the ignition OFF for at least 30 seconds. 3. Start and allow the engine to idle. Did DTC P0115 reset?	--	Go to Step 4	Go to Testing for Intermittent Conditions and Poor Connections
4	Did any other DTCs set?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	Go to Step 5
5	Replace the TCM. Refer to Control Module References for replacement, set-up and programming. Is the action complete?	--	Go to Step 6	--
6	Perform the following operation to verify the repair: 1. Select DTC on the scan tool. 2. Select Clear Info. 3. Start and allow the engine to idle. 4. Select Specific DTC. 5. Enter DTC P0115. Has the test run and passed?	--	Go to Step 7	Go to Step 2

7	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0120

Circuit Description

The engine control module (ECM) sends accelerator pedal position data to the transmission control module (TCM). The TCM uses this data to modify shift speeds. The data is sent to the TCM through a communication network called GMLAN. Two circuits are used to communicate GMLAN data between the ECM and TCM. A fault in the GMLAN will not cause DTC P0120 to set by itself. If a GMLAN fault occurs, other DTCs will set before DTC P0120.

When the TCM receives invalid accelerator pedal data from the ECM, then DTC P0120 will set. DTC P0120 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0120 Throttle Position (TP) Sensor Circuit

Conditions for Running the DTC

- The engine run time is greater than 5 seconds.
- No other GMLAN errors are present.

Conditions for Setting the DTC

The TCM receives no valid accelerator pedal data from the ECM for 2 seconds.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM uses the ECM default accelerator pedal value for determining shift speeds.
- The TCM turns off the pressure control solenoid. When the pressure control solenoid is off, line pressure is at maximum.
- The TCM freezes transmission adaptive functions.
- The TCM disables the TCC.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0120 in TCM history.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. **Important:** - Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. - Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Failure Records. Did you record any ECM Failure Records?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	Go to Step 3
3	1. Clear the DTC. 2. Turn the ignition OFF for at least 30 seconds. 3. Start, and allow the engine to idle. Did DTC P0120 reset?	--	Go to Step 4	Go to Testing for Intermittent Conditions and Poor Connections
4	Did any other DTCs set?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	Go to Step 5
5	Replace the TCM. Refer to Control Module References for replacement, set-up and programming. Is the action complete?	--	Go to Step 6	--
	Perform the following operation to verify the repair:			

6	1. Select DTC on the scan tool. 2. Select Clear Info. 3. Start, and allow the engine to idle. 4. Select Specific DTC. 5. Enter DTC P0120. Has the test run and passed?	--	Go to Step 7	Go to Step 2
7	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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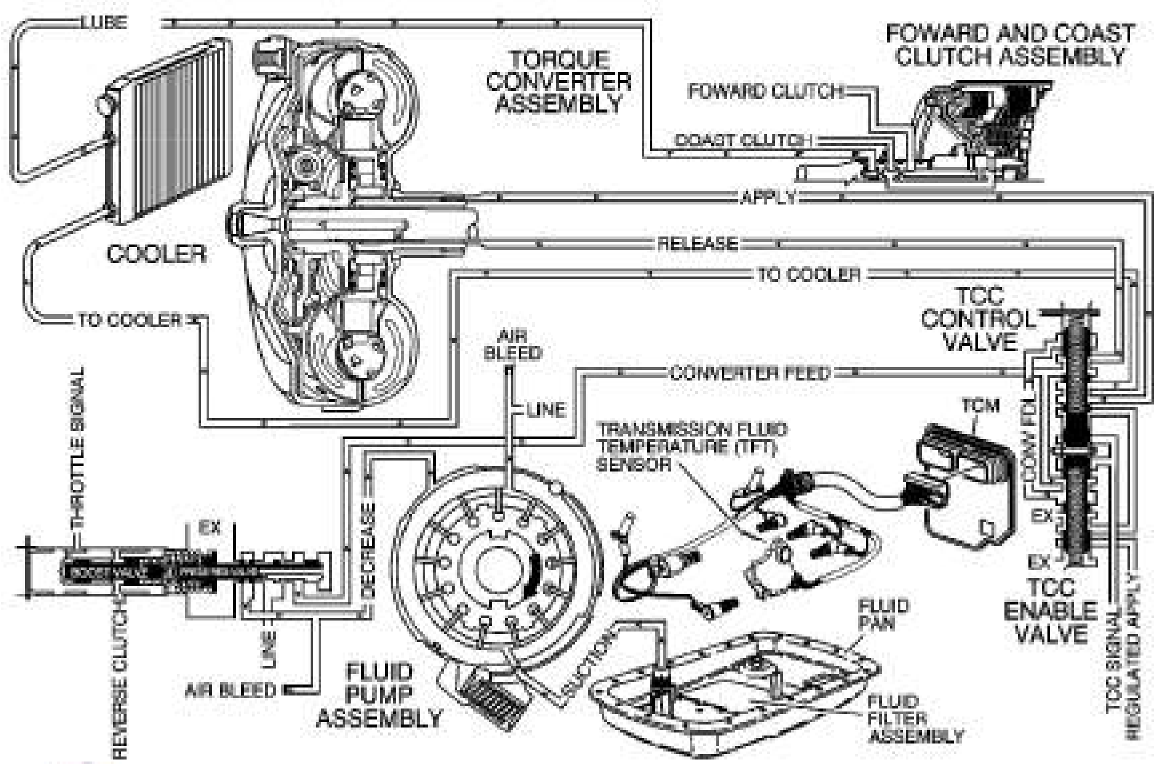
DTC P0218

Circuit Description


LUBE
TORQUE CONVERTER ASSEMBLY
FOWARD AND COAST CLUTCH ASSEMBLY
FOWARD CLUTCH
COAST CLUTCH
APPLY
RELEASE
TO COOLER
COOLER
TO COOLER
TCC CONTROL VALVE
AIR BLEED
CONVERTER FEED
LINE
TCM
TRANSMISSION FLUID TEMPERATURE (TFT) SENSOR
CONV FD
EX
EX
TCC ENABLE VALVE
THROTTLE SIGNAL
EX
DECREASE
REVERSE CLUTCH
LINE
AIR BLEED
FLUID PUMP ASSEMBLY
SUCTION
FLUID PAN
FLUID FILTER ASSEMBLY
TCC SIGNAL
REGULATED APPLY

The primary source of heat in the transmission is the torque converter. Hot oil exits the torque converter through the torque converter clutch (TCC) control valve and flows to the transmission cooler supply line. The supply line connects to the cooler, which is located in the radiator. From the cooler, the oil returns through the oil cooler return line and enters the lubrication circuits. After lubricating the internal components, the oil then returns to the oil pan. The oil pump draws oil through the filter from the oil pan, where the transmission fluid temperature (TFT) sensor is located. The oil pump pressurizes the oil and directs it to the pressure regulator valve. The pressure regulator valve is the starting point for the main supply of oil to the torque converter and the transmission hydraulic components.

When the transmission control module (TCM) detects high transmission oil temperature for an extended period of time, DTC P0218 sets. DTC P0218 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0218 Transmission Fluid Overtemperature

Conditions for Running the DTC

The transmission fluid temperature is -39 to +149°C (-38 to +300°F) for at least 5 seconds.

Conditions for Setting the DTC

The transmission fluid temperature is 132°C (270°F) or more for 600 seconds (10 minutes).

Action Taken When the DTC Sets

- The TCM does not request the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL).
- TRANSMISSION HOT - IDLE ENGINE displays on the driver information centre (DIC).
- The TCM freezes transmission adaptive functions.
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM records this information as a Failure Record.
- The TCM stores DTC P0218 in TCM history.

Conditions for Clearing the DIC/DTC

- The TCM clears the DIC message when the condition no longer exists.
- The TCM cancels the DTC default actions when the condition no longer exists.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- A scan tool can clear the DTC.

Diagnostic Aids

- The DIC, if equipped, will display TRANSMISSION HOT - IDLE ENGINE when the transmission fluid temperature reaches 132°C (270°F).
- Observe DIC messaging that indicates the engine cooling system is hot.
- The TFT displayed on the scan tool should rise steadily to a normal operating temperature, then stabilize.
- Ask about the customer's driving habits, trailer towing, etc. Trailer towing should occur in D4.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Record the Failure Records before clearing the DTC.	125°C		

2	Using the Clear Info function erases the Failure Records from the ECM and the TCM. 3. Record the DTC Failure Records. Is the engine coolant temperature above the specified value when the DTC set?	(257° F)	Go to Engine Overheating	Go to Step 3
3	1. Clear the DTC. 2. Perform the Transmission Fluid Checking Procedure. Refer to Transmission Fluid Check . Is the action complete?	--	Go to Step 4	--
4	1. Inspect the transmission cooling system for restrictions or damage. Refer to Transmission Fluid Cooler Flushing and Flow Test . 2. Repair or replace the cooling system components as necessary. Did you find and correct a condition?	--	Go to Step 7	Go to Step 5
5	1. Perform the Line Pressure Check Procedure. Refer to Line Pressure Check . 2. Repair the transmission as necessary. Did you find and correct a condition?	--	Go to Step 7	Go to Step 6
6	1. Test the torque converter for a seized stator. Refer to Torque Converter Diagnosis . 2. Replace the torque converter as necessary. Did you find and correct a condition?	--	Go to Step 7	--
7	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle long enough to make sure the transmission temperature remains below 129°C (262°F). 4. Select Specific DTC. 5. Enter DTC P0218. Has the test run and passed?	--	Go to Step 8	Go to Step 2
8	With the scan tool, observe the stored information, capture info and DTC info.	--	Go to Diagnostic Trouble Code	

	Does the scan tool display any DTCs that you have not diagnosed?		(DTC) List - Vehicle	System OK

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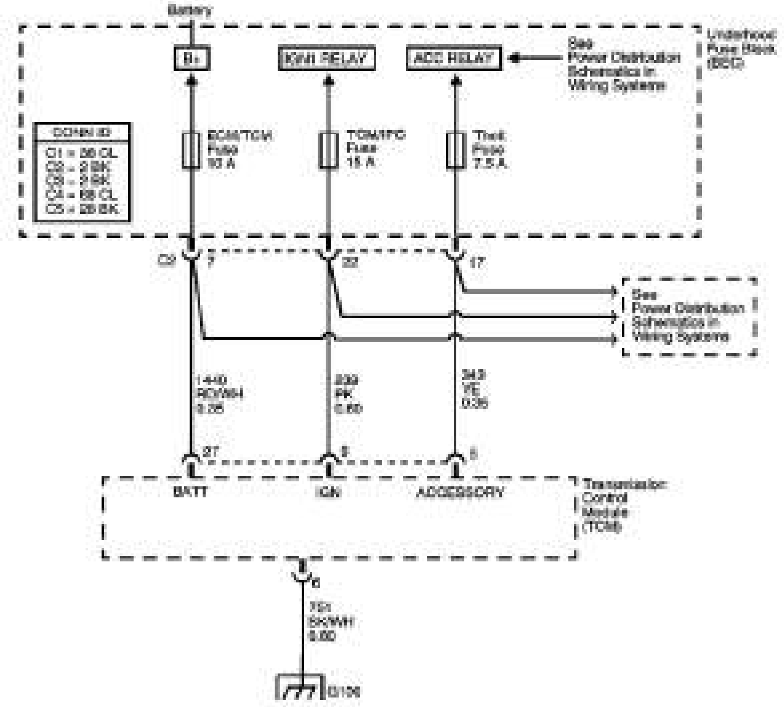
DTC P0562

Circuit Description


Battery
B+
IGN1 RELAY
ACC RELAY
See
Power Distribution
Schematics in
Wiring Systems
Underhood
Fuse Block
(BEC)
CONN ID
C1 = 56 CL
C2 = 2 BK
C3 = 2 BK
C4 = 68 CL
C5 = 28 BK
ECM/TCM
Fuse
10 A
TCM/IPC
Fuse
15 A
Theft
Fuse
7.5 A
C2
7
22
17
See
Power Distribution
Schematics in
Wiring Systems
1440
RD/WH
0.35
239
PK
0.60
343
YE
0.35
27
5
6
BATT
IGN
ACCESSORY
Transmission
Control
Module
(TCM)
6
751
BK/WH
0.50
G106

The transmission control module (TCM) continuously monitors the system voltage on the ignition 1 and the battery circuits. Lower than normal voltage may be inadequate to operate the transmission control solenoids properly. Improper solenoid operation may cause erratic transmission operation and tie-up conditions, which may result in internal damage.

When the TCM detects low voltage, DTC P0562 sets. DTC P0562 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0562 System Voltage Low

Conditions for Running The DTC

The engine speed is greater than 1,200 RPM.

Conditions for Setting The DTC

The TCM detects system voltage less than 11 volts for 10 seconds.

Action Taken When the DTC Sets

- The TCM does not request the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL).
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM records this information as a Failure Record.
- The TCM stores DTC P0562 in TCM history.

Conditions for Clearing the DTC

- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- A scan tool can clear the DTC.

Diagnostic Aids

- Observe the driver information centre (DIC) messaging that indicates the electrical system requires service.
- Inspect for the following conditions:
  - Loose or damaged terminals at the generator
  - Loose or worn generator drive belt

Test Description

The numbers below refer to the step numbers on the diagnostic table.

4. This step tests the charging system voltage with a nominal load.
5. This step obtains the ignition voltage measurement reported by the TCM.
6. This step tests the voltage drop from the battery and ignition voltage input at the TCM.
10. This step tests the voltage drop from the ground terminals of the TCM to the ground terminal of the battery.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic Trouble Code (DTC) List - Vehicle
	1. Install a scan tool. 2. Turn ON the ignition, with the			

2	engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM and the TCM Failure Records. Using the Clear Info function erases the Failure Records from the ECM and TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the Failure Records. 4. Clear the DTC. 5. Using the DMM, measure and record the battery voltage across the battery terminals. Is the voltage higher than the specified value?	11 V	Go to Step 3	Go to Battery Inspection/Test
3	1. Start the engine. 2. Allow the engine to warm up to normal operating temperature. Is the charge indicator light ON?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	Go to Step 4
4	1. Turn ON the high beam headlamps. 2. Turn the HVAC blower control to the highest speed setting. 3. Turn ON the rear window defroster. 4. Increase the engine speed to 1,500 RPM. 5. Observe the DMM battery voltage and record your voltage reading for reference. Is the voltage within the specified range?	12.5-14.5 V	Go to Step 5	Go to Charging System Test
5	1. Increase the engine speed to 1,500 RPM. 2. Observe the Ignition Voltage with the scan tool. Is the scan tool Ignition Voltage within the specified range?	12.5-14.5 V	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 6
	1. Turn OFF the ignition. 2. Disconnect the TCM connector. 3. Probe terminal 9 and 27 of the TCM connector with the ground			

6	probe of the DMM. Refer to Measuring Voltage . 4. Connect the positive lead of the DMM to the battery positive terminal. 5. Turn ON the ignition, with the engine OFF. Are the voltage drop measurements less than the specified value?	0.5 V	Go to Step 10	Go to Step 7
7	Inspect the 10 amp ECM/TCM battery fuse and the 15 amp TCM/IPC ignition 1, fuse for an open. Refer to Circuit Protection - Fuses . Did you find an open fuse?	--	Go to Step 8	Go to Step 9
8	Repair the short to ground in the battery voltage circuit or the ignition voltage circuit. Refer to Wiring Repairs . Is the repair complete?	--	Go to Step 13	--
9	Test the battery voltage circuit or the ignition voltage circuit for an open or high resistance condition. Refer to Testing for Continuity . Did you find and correct a condition?	--	Go to Step 13	Go to Step 10
10	1. Turn ON the ignition, with the engine OFF. 2. Using the positive probe of the DMM, probe terminal 6 of the TCM connector. 3. Connect the negative probe of the DMM to the battery ground terminal. Observe and record the voltage measurement. 4. Using the positive probe of the DMM, probe terminal 7 of the TCM connector. Observe and record the voltage measurement. Refer to Measuring Voltage . Are both of the voltage drop measurements less than the specified value?	0.2 V	Go to Step 12	Go to Step 11
11	Repair the open or high resistance condition in the TCM ground circuits. Refer to Wiring Repairs . Is the repair complete?	--	Go to Step 13	--
	Replace the TCM.			

12	Refer to Control Module References . Is the action complete?	--	Go to Step 13	--
13	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Start the engine. • Allow the engine to warm up to normal operating temperature. • Raise the engine speed to at least 1,200 RPM. • TCM voltage must be greater than 11 volts for 12 seconds. 4. Select Specific DTC. 5. Enter DTC P0562. Has the test run and passed?	--	Go to Step 14	Go to Step 2
14	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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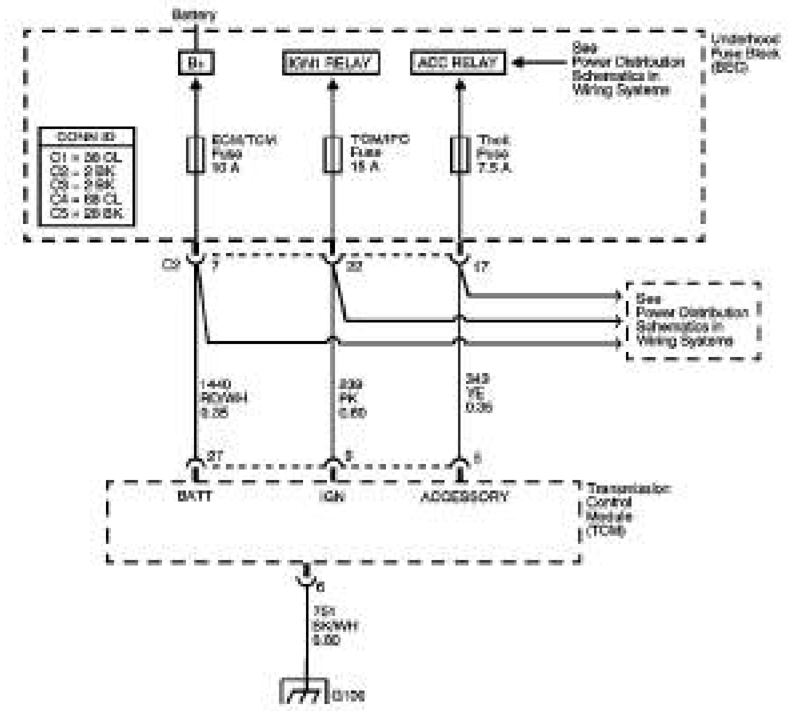
DTC P0563

Circuit Description


Battery
B+
IGN1 RELAY
ACC RELAY
See
Power Distribution
Schematics in
Wiring Systems
Underhood
Fuse Block
(BEC)
CONN ID
C1 = 26 CL
C2 = 2 BK
C3 = 2 BK
C4 = 68 CL
C5 = 26 BK
ECM/TCM
Fuse
10 A
TCM/IPC
Fuse
15 A
Theft
Fuse
7.5 A
C2
7
22
17
See
Power Distribution
Schematics in
Wiring Systems
1440
RD/WH
0.35
239
PK
0.60
343
YE
0.35
27
5
8
BATT
IGN
ACCESSORY
Transmission
Control
Module
(TCM)
6
751
BK/WH
0.60
G106

The transmission control module (TCM) continuously monitors the system voltage on the Ignition 1 and the battery circuits. Higher than normal voltage may cause the solenoids inside the transmission to operate improperly or damage solid-state components inside the TCM.

When the TCM detects high voltage, DTC P0563 sets. DTC P0563 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0563 System Voltage High

Conditions for Running The DTC

The ignition is ON.

Conditions for Setting The DTC

The TCM detects system voltage greater than 18 volts for 10 seconds.

Action Taken When the DTC Sets

- The TCM does not request the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL).
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM records this information as a Failure Record.
- The TCM stores DTC P0563 in TCM history.

Conditions for Clearing the DTC

- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- A scan tool can clear the DTC.

Diagnostic Aids

- Observe the driver information centre (DIC) messaging that indicates the electrical system requires service.
- Use the scan tool in order to inspect all other modules for voltage related DTCs.
- Running the engine with a battery charger attached may cause DTC P0563 to set.
  - Inspect the charging circuit for high resistance.
  - Inspect the vehicle battery for open or sulfated cells.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

4. This step tests the charging system voltage with a minimal load.

5. This step obtains the ignition voltage measurement reported by the TCM.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM and the TCM Failure Records. Using the Clear Info			

2	function erases the Failure Records from the ECM and TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the Failure Records. Did you record a Failure Record for DTC P0560?	--	Go to DTC P0560	Go to Step 3
3	1. Clear the DTC. 2. Start the engine. 3. Allow the engine to warm up to normal operating temperature. Is the charge indicator light ON?	--	Go to Diagnostic System Check - Vehicle	Go to Step 4
4	1. Turn OFF all electrical accessories. 2. Increase the engine speed to 2,000 RPM. 3. Using the DMM, measure the voltage between the battery terminals. Record the measurement for reference. Is the voltage within the specified range?	12.5-14.5 V	Go to Step 5	Go to Charging System Test
5	1. Leave the engine running. 2. Observe the Ignition Voltage on the scan tool. 3. Increase the engine speed to 2,000 RPM. Is the difference between the voltage displayed on the scan tool and the voltage measurement in Step 4 greater than the specified value?	1.0 V	Go to Step 7	Go to Step 6
6	Did P0563 reset?	--	Go to Step 7	Go to Testing for Intermittent Conditions and Poor Connections
7	Replace the TCM. Refer to Control Module References for replacement, set-up and programming. Is the action complete?	--	Go to Step 8	--
	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the			

8	following conditions: • Start the engine. • Allow the engine to warm up to normal operating temperature. • Observe the Ignition Voltage on the scan tool. • TCM voltage must remain below 18 volts for 12 seconds. 4. Select Specific DTC. 5. Enter DTC P0563. Has the test run and passed?	--	Go to Step 9	Go to Step 2
9	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0572

Circuit Description

The brake pedal position sensor is used to sense the action of the driver's application of the brake pedal. The brake pedal position sensor provides an analog voltage signal that will increase as the brake pedal is applied. The brake pedal position sensor receives a low reference signal and a 5-volt reference voltage from the instrument panel module (IPM) when the driver applies the brakes. When the variable signal reaches a voltage threshold indicating the brakes have been applied, the IPM will apply battery voltage to the stop/turn signal voltage supply circuit to illuminate the stop lamps and the center high mounted stop lamp (CHMSL). The IPM also sends a brake pedal position sensor signal to the engine control module (ECM) as well as a serial data message to indicate the application of the brake pedal.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0572 Brake Switch Circuit 1 Low Voltage

Conditions for Running the DTC

- The ignition is in the ON position.
- Battery voltage greater than 11.5 volts.

Conditions for Setting the DTC

The ECM detects a short to ground on the signal circuit when the serial data message from the IPM indicates the brakes are applied.

Action Taken When the DTC Sets

- The ECM stores the DTC to memory.
- The ECM will record the operating conditions at the time the diagnostic failed. The ECM stores this information in Failure Records.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- You issue a scan tool CLEAR DTCs command.
- A history DTC will clear once 40 malfunction-free ignition cycles have occurred.

Diagnostic Aids

- Verify that the Brake Pedal Position sensor is properly calibrated. Refer to Stop Lamp Switch

Adjustment .

- Test drive the vehicle if a switch or circuit condition cannot be located. An intermittent condition may be duplicated during a test drive.
- Thoroughly inspect the wiring and connectors. An incomplete inspection of the wiring and connectors may result in misdiagnosis causing part replacement with the reappearance of the malfunction. If an intermittent malfunction exists, Refer to Testing for Intermittent Conditions and Poor Connections .

Step	Action	Yes	No
Schematic Reference: Exterior Lights Schematics *Connector End View Reference:* Master Electrical Component List			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	Test the stop lamp switch signal circuit for a short to ground. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	Go to Step 5	Go to Step 3
3	Inspect for poor connections at the engine control module (ECM) harness connector. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	Go to Step 5	Go to Step 4
4	Replace the ECM. Refer to Control Module References for replacement, setup, and programming. Did you complete the repair?	Go to Step 5	--
5	1. Use a scan tool in order to clear the DTCs. 2. Operate the vehicle within the Conditions for Running the DTC as specified in the supporting text. Does the DTC reset?	Go to Step 2	System OK

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DTC P0573

Circuit Description

The brake pedal position sensor is used to sense the action of the driver's application of the brake pedal. The brake pedal position sensor provides an analog voltage signal that will increase as the brake pedal is applied. The brake pedal position sensor receives a low reference signal and a 5-volt reference voltage from the instrument panel module (IPM) when the driver applies the brakes. When the variable signal reaches a voltage threshold indicating the brakes have been applied, the IPM will apply battery voltage to the stop/turn signal voltage supply circuit to illuminate the stop lamps and the center high mounted stop lamp (CHMSL). The IPM also sends a brake pedal position sensor signal to the engine control module (ECM) as well as a serial data message to indicate the application of the brake pedal.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0573 Brake Switch Circuit 1 High Voltage

Conditions for Running the DTC

- The ignition is in the ON position.
- Battery voltage greater than 11.5 volts.

Conditions for Setting the DTC

The ECM detects an open or short to voltage on the signal circuit when the serial data message from the IPM indicates the brake are applied.

Action Taken When the DTC Sets

- The ECM stores the DTC to memory.
- The ECM will record the operating conditions at the time the diagnostic failed. The ECM stores this information in Failure Records.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- You issue a scan tool CLEAR DTCs command.
- A history DTC will clear once 40 malfunction-free ignition cycles have occurred.

Diagnostic Aids

- Verify that the Brake Pedal Position sensor is properly calibrated. Refer to Stop Lamp Switch

Adjustment .

- Test drive the vehicle if a switch or circuit condition cannot be located. An intermittent condition may be duplicated during a test drive.
- Thoroughly inspect the wiring and connectors. An incomplete inspection of the wiring and connectors may result in misdiagnosis causing part replacement with the reappearance of the malfunction. If an intermittent malfunction exists, Refer to Testing for Intermittent Conditions and Poor Connections .

Step	Action	Yes	No
Schematic Reference: Exterior Lights Schematics *Connector End View Reference:* Master Electrical Component List			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	Test the stop lamp switch signal circuit for an open or short to battery voltage. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	Go to Step 5	Go to Step 3
3	Inspect for poor connections at the engine control module (ECM) harness connector. Refer to Testing for Intermittent Conditions and Poor Connections . Did you find and correct the condition?	Go to Step 5	Go to Step 4
4	Replace the ECM. Refer to Control Module References for replacement, setup, and programming. Did you complete the repair?	Go to Step 5	--
5	1. Use a scan tool in order to clear the DTCs. 2. Operate the vehicle within the Conditions for Running the DTC as specified in the supporting text. Does the DTC reset?	Go to Step 2	System OK

DTC P0601

Circuit Description

A normal function of the transmission control module (TCM) is to perform an internal test that verifies the integrity of the ROM memory allocation. This diagnostic detects faults in the allocation of flash memory that contain the program and calibration by comparing a calculated checksum with a stored checksum. When the TCM detects that the calculated checksum is different from the stored checksum, DTC P0601 sets. DTC P0601 is a type A DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0601 Transmission Control Module (TCM) Read Only Memory (ROM)

Conditions for Running The DTC

The ignition is ON.

Conditions for Setting The DTC

The TCM EEPROM checksums do not match.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive drive trip in which the Conditions for Setting the DTC are met.
- The TCM turns off power to all solenoids.
- The transmission will operate in fifth gear if the vehicle has successfully completed a 1-2 upshift in the current ignition cycle. If the vehicle has not completed a 1-2 upshift in the current ignition cycle, the transmission will operate in fourth gear.
- The TCC commands maximum line pressure.
- The TCC freezes transmission adaptive functions.
- The TCC is disabled.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0601 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.

- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

DTC P0601 may set as a result of TCM reprogramming.

Test Description

The number below refers to the step number on the diagnostic table.

3. This step eliminates the TCM software as a possible cause of the DTC. If the DTC continues to set after reprogramming, the fault is in the TCM hardware.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Failure Records. 4. Clear the DTC. 5. Turn OFF the ignition for at least 30 seconds. 6. Turn ON the ignition. Did DTC P0601 reset?	--	Go to Step 3	Go to Diagnostic Aids
3	Perform the Transmission Control Module Programming Procedure. Refer to Control Module References .	--		

	Is the action complete?		Go to Step 5	Go to Step 4
4	Replace the TCM. Refer to Control Module References for replacement, set-up and programming. Is the action complete?	--	Go to Step 5	--
5	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Turn OFF the ignition for at least 30 seconds. 4. Turn ON the ignition. 5. Select Specific DTC. 6. Enter DTC P0601. Has the test run and passed?	--	Go to Step 6	Go to Step 2
6	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0602

Circuit Description

A normal function of the transmission control module (TCM) is to perform an internal test that verifies the security of the diagnostic and shift calibration programming. The programming must contain security codes that enable a software lock to engage. The software lock is designed to prevent unauthorized changes to the diagnostics or shift calibrations. The software lock utility is processed independently from the diagnostic and shift calibration software and contains application specific data. This software lock data is entered into the TCM during the final assembly of the vehicle.

When the security codes from the diagnostic and shift calibration software fail to engage the software lock, the TCM sets DTC P0602. DTC P0602 is a type A DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0602 Transmission Control Module (TCM) Not Programmed

Conditions for Running The DTC

The ignition is ON.

Conditions for Setting The DTC

The TCM detects an unlocked calibration memory range.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive drive trip in which the Conditions for Setting the DTC are met.
- The TCM turns off power to all solenoids.
- The transmission will operate in fifth gear if the vehicle has successfully completed a 1-2 upshift in the current ignition cycle. If the vehicle has not completed a 1-2 upshift in the current ignition cycle, the transmission will operate in fourth gear.
- The Torque Converter Clutch (TCC) commands maximum line pressure.
- The TCC freezes transmission adaptive functions.
- The TCC is disabled.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0602 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

DTC P0602 may set as a result of TCM reprogramming.

Test Description

The number below refers to the step number on the diagnostic table.

3. This step eliminates the TCM software as a possible cause of the DTC. If the DTC continues to set after reprogramming, the fault is in the TCM hardware.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Failure Records. 4. Clear the DTC. 5. Turn OFF the ignition for at least 30 seconds. 6. Turn ON the ignition. Did the DTC P0602 reset?	--	Go to Step 3	Go to Diagnostic Aids

3	Perform the Transmission Control Module Programming Procedure. Refer to Control Module References . Is the action complete?	--	Go to Step 5	Go to Step 4
4	Replace the TCM. Refer to Control Module References for replacement, set-up and programming. Is the action complete?	--	Go to Step 5	--
5	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Turn OFF the ignition for at least 30 seconds. 4. Turn ON the ignition. 5. Select Specific DTC. 6. Enter DTC P0602. Has the test run and passed?	--	Go to Step 6	Go to Step 2
6	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0603

Circuit Description

A normal function of the transmission control module (TCM) is to perform an internal test that verifies the integrity of the non-volatile random access memory (NVRAM) allocation. This diagnostic detects faults in the allocation of NVRAM that contain the transmission adaptive pressure memory cells by comparing a calculated checksum with a stored checksum. When the TCM detects that the calculated checksum is different from the stored checksum, DTC P0603 sets. DTC P0603 is a type A DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0603 Transmission Control Module (TCM) Long Term Memory Reset

Conditions for Running The DTC

The ignition is ON.

Conditions for Setting The DTC

The TCM NVRAM checksums do not match.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL).
- The TCM turns off power to all solenoids.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The High Side Driver 1 is commanded OFF.
- The ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0603 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power

down the TCM.

Diagnostic Aids

DTC P0603 may set as result of TCM reprogramming.

Test Description

The number below refers to the step number on the diagnostic table.

3. This step eliminates the TCM software as a possible cause of the DTC. If the DTC continues to set after reprogramming, the fault is in the TCM hardware.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Failure Records. 4. Clear the DTC. 5. Turn OFF the ignition for at least 30 seconds. 6. Turn ON the ignition. Did the DTC P0603 reset?	--	Go to Step 3	Go to Diagnostic Aids
3	Perform the Transmission Control Module Programming Procedure. Refer to Control Module References . Is the action complete?	--	Go to Step 5	Go to Step 4
	Replace the TCM. Refer to Diagnostic System Check - Vehicle for			

4	replacement, set-up and programming. Is the action complete?	--	Go to Step 5	--
5	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Turn OFF the ignition for at least 30 seconds. 4. Turn ON the ignition. 5. Select Specific DTC. 6. Enter DTC P0603. Has the test run and passed?	--	Go to Step 6	Go to Step 2
6	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0604

Circuit Description

A normal function of the transmission control module (TCM) is to perform an internal test that verifies the read and write capability of the random access memory (RAM). This diagnostic detects faults in the RAM by writing test data to the RAM, reading back the same data, and then comparing the two data sets. When the TCM detects that the data that was read from the RAM is different from the test data that was written to the RAM, DTC P0604 sets. DTC P0604 is a type A DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0604 Transmission Control Module (TCM) Random Access Memory (RAM)

Conditions for Running The DTC

The ignition is ON.

Conditions for Setting The DTC

The data read from RAM does not match the test data written to the RAM.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive drive trip in which the Conditions for Setting the DTC are met.
- The TCM turns off power to all solenoids.
- The transmission will operate in fifth gear if the vehicle has successfully completed a 1-2 upshift in the current ignition cycle. If the vehicle has not completed a 1-2 upshift in the current ignition cycle, the transmission will operate in fourth gear.
- The TCC commands maximum line pressure.
- The TCC freezes transmission adaptive functions.
- The TCC is disabled.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0604 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.

- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

DTC P0604 may set as a result of TCM reprogramming.

Test Description

The number below refers to the step number on the diagnostic table.

3. This step eliminates the TCM software as a possible cause of the DTC. If the DTC continues to set after reprogramming, the fault is in the TCM hardware.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Failure Records. 4. Clear the DTC. 5. Turn OFF the ignition for at least 30 seconds. 6. Turn ON the ignition. Did the DTC P0604 reset?	--	Go to Step 3	Go to Diagnostic Aids
3	Perform the Transmission Control Module Programming Procedure. Refer to Diagnostic System Check - Vehicle for replacement, set-up and programming.	--		

	Is the action complete?		Go to Step 5	Go to Step 4
4	Replace the TCM. Refer to Diagnostic System Check - Vehicle for replacement, set-up and programming. Is the action complete?	--	Go to Step 5	--
5	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Turn OFF the ignition for at least 30 seconds. 4. Turn ON the ignition. 5. Select Specific DTC. 6. Enter DTC P0604. Has the test run and passed?	--	Go to Step 6	Go to Step 2
6	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P062F

Circuit Description

While the vehicle is being driven, engine and transmission data accumulates in a random access memory (RAM) device, which cannot store data reliably when the transmission control module (TCM) powers down. Before the TCM powers down, the data is copied from RAM to an electrically-erasable programmable read-only memory (EEPROM) device, sometime referred to as non-volatile memory (NVM). Both the RAM and the EEPROM are inside the TCM. A normal function of the TCM programming is to test the EEPROM at TCM power-down by copying test data from RAM to the EEPROM and then comparing the two copies. If they do not match, DTC P062F will set. DTC P062F is a type A DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P062F Transmission Control Module (TCM) Long Term Memory Performance

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The TCM detects a checksum error when the RAM and EEPROM test data are compared.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) when the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- At the time of the first failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P062F in TCM history.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to

power down the TCM.

Diagnostic Aids

TCM reprogramming may cause P062F to set.

Test Description

The number below refers to the step number on the diagnostic table.

2. Performing this step helps verify that an external anomaly, such as Electromagnetic Interference (EMI), did not cause the code to set originally.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. **Important:** - Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. - Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Failure Records. 4. Clear the DTC. 5. Turn OFF the ignition for at least 30 seconds. 6. Turn ON the ignition with the engine OFF. Did the DTC P062F reset?	--	Go to Step 3	Go to Testing for Intermittent Conditions and Poor Connections
3	Replace the TCM. Refer to Diagnostic System Check - Vehicle for replacement, set-up and programming. Is the action complete?	--	Go to Step 4	--
	Perform the following procedures in order to verify the repair:			

4	1. Select DTC. 2. Select Clear Info. 3. Turn ON the ignition with the engine OFF for more than 2 seconds. 4. Select Specific DTC. 5. Enter DTC P062F. Has the test run and passed?		Go to Step 5	Go to Step 2
5	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0658 or P0659

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0658: Solenoid High Control Circuit Group 1 Low Voltage

DTC P0659: Solenoid High Control Circuit Group 1 High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
High Side Driver 1	P0658	P0658	P0659

Circuit/System Description

The transmission control module (TCM) provides voltage to the pressure control solenoid, the shift solenoids, and the TCC PWM solenoid through two separate solid-state devices called high side drivers, called HSD1 and HSD2. HSD1 provides electrical power to the pressure control solenoid. HSD2 provides power to the shift solenoids. A normal function of the TCM is to run tests on each driver to ensure that it is functioning properly.

Conditions for Running the DTC

P0658

The engine run time is greater than 5 seconds.

P0659

The ignition is ON.

Conditions for Setting the DTC

P0658

The TCM detects a short to ground on the HSD1 circuit when the HSD1 is commanded ON.

P0659

The TCM detects greater than 6.4 volts at the HSD1 terminal prior to commanding the HSD1 ON.

Action Taken When the DTC Sets

- DTC P0658 and P0659 are Type C DTCs.
- The TCM commands HSD1 OFF.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- SERVICE VEHICLE SOON displays on the driver information center (DIC).

Conditions for Clearing the DTC

DTC P0658 and P0659 are Type C DTCs.

Diagnostic Aids

1. Electrical Faults P0658 and P0659 only set on the PC Solenoid Valve High Control side (HSD1) of the PC Solenoid Valve. Electrical faults on the PC Solenoid Valve Low Control side (ground side) of the shift solenoids will set P0748.
2. An open on the PC Solenoid Valve High Control side (HSD1) of the PC Solenoid Valve will set P0748.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Transmission General Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Transmission Control Module Scan Tool Information

Special Tools

- *J 35616* GM Terminal Test Kit
- *J 45681* Jumper Harness

Circuit/System Verification

Ignition ON, engine OFF. With a scan tool, observe the High Side Driver 1 parameter status for:

- Short to Ground
- Open
- Short to Volts

Circuit/System Testing

1. Ignition OFF, disconnect the X121 harness connector.
2. Ignition ON, Engine OFF. Test for 4.0-6.4 volts between the Pressure Control (PC) Solenoid Valve High Control circuit terminal 13 and a good ground.

   If less than the specified value, test the PC Solenoid Valve High Control circuit for a short to ground or an open/high resistance. If circuits test normal, replace the TCM.

   If greater than the specified value, test the PC Solenoid Valve High Control circuit for a short to voltage. If circuits test normal, replace the TCM.
3. Install the *J 45681* harness on the transmission pass-thru connector.
4. Using the brown J35616-6 test probes from the most current *J 35616* kit , test for 3.5-5.5 ohms between the PC Solenoid Valve High Control circuit, terminal 13, and the PC Solenoid Valve Low Control circuit, terminal 8.

   If less than the specified value, test the PC Solenoid High Control circuit and the PC Solenoid Low Control circuit for a short together condition. If circuits test normal, replace the PC Solenoid Valve.

   If greater than the specified value, test the PC Solenoid Valve High Control circuit and the PC Solenoid Low Control circuit for an open. If circuits test normal, replace the PC Solenoid Valve.
5. Test for greater than 10 K ohms between the PC Solenoid High Control circuit, terminal 13, and all other circuits of the *J 45681* harness , except the PC Solenoid Low Control circuit, terminal 8.

   If less than the specified value, the affected circuits are shorted together. Replace the transmissions internal wire harness.
6. Test for the greater than 10 K ohms between the PC Solenoid Low Control circuit, terminal 8, and all other circuits of the *J 45681* harness , except the PC Solenoid High Control circuit, terminal 13.
7. Test for greater than 50 K ohms from the PC Solenoid High Control circuit, terminal 13, and the PC Solenoid Low Control circuit, terminal 8, to the transmission case.

   If less than the specified value, test the affected circuit for a short to the transmission case. If both circuits test normal, replace the PC Solenoid Valve.

Component Testing

1. Ignition OFF, disconnect the X121 harness connector. Install the *J 45681* harness on the transmission pass-thru connector.
2. Using the brown J35616-4 test probes form the most current *J 35616* kit , test for 3.5-5.5 ohms between the PC Solenoid Valve High Control circuit, terminal 13, and the PC Solenoid Valve Low Control circuit, terminal 8.

    If less than the specified value, test the PC Solenoid Valve High Control circuit and the PC Solenoid Low Control circuit for a short together condition. If circuits test normal, replace the PC Solenoid Valve.

    If greater than the specified value, test the PC Solenoid Valve High Control circuit and the PC Solenoid Low circuit for an open. If circuits test normal, replace the PC Solenoid Valve.

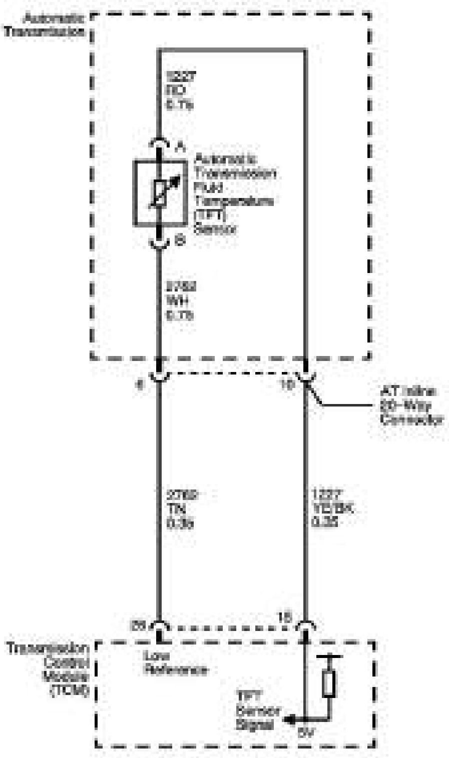
Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Pressure Control Solenoid Valve Replacement
- Transmission Internal Electrical Harness Replacement
- Refer to Control Module References for replacement, setup, and programming.

DTC P0711

Circuit Description


Automatic Transmission
1227
RD
0.75
A
Automatic Transmission Fluid Temperature (TFT) Sensor
B
2752
WH
0.75
6
10
AT Inline 20-Way Connector
2762
TN
0.35
1227
YE/BK
0.35
28
15
Transmission Control Module (TCM)
Low Reference
TFT Sensor Signal
5V

The automatic transmission fluid temperature (TFT) sensor is a negative coefficient thermistor. When the transmission fluid is cold, the sensor resistance is high. As the transmission fluid warms up, the sensor resistance decreases. This diagnostic monitors the TFT circuit. The circuit may be functional, but not in the normal operating range. This diagnostic indicates stuck, erratic, intermittent, skewed, or inaccurate values, indicating poor system performance. The TFT range is -40 to +151°C (-40 to +305°F).

If the TCM detects rapid or no voltage changes in the TFT sensor circuit, then DTC P0711 sets. DTC P0711 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0711 Transmission Fluid Temperature (TFT) Sensor Performance

Conditions for Running the DTC

- No ECT DTC P0115.
- No ISS DTCs P0716 or P0717.
- No OSS DTCs P0722 or P0723.
- DTC P0711 has not passed in the current ignition cycle.
- The engine run time is greater than 5 seconds.
- The transmission fluid temperature is -39 to +149°C (-38 to +300°F).
- For conditions 1 and 2 below, the engine coolant temperature is greater than 70°C (158°F) and has changed by at least 50°C (90°F) since startup.
- For conditions 1 and 2 below, the TCC slip speed is 120 RPM or greater for 600 seconds (10 minutes) cumulatively.

Conditions for Setting the DTC

One of the following conditions occurs:

Condition 1

- The transmission fluid temperature at startup is -40 to +21°C (-40 to +70°F).
- The vehicle speed is greater than 8 km/h (5 mph) for 900 seconds (15 minutes) cumulatively.
- The transmission fluid temperature has not changed by more than 2°C (4°F) since startup for 100 seconds (1 minute and 40 seconds).

Condition 2

- The transmission fluid temperature at startup is 129-150°C (264-302°F).
- The vehicle speed is greater than 8 km/h (5 mph) for 600 seconds (10 minutes) cumulatively.
- The transmission fluid temperature has not changed by more than 2°C (4°F) since startup for 100 seconds (1 minute and 40 seconds).

Condition 3

The transmission fluid temperature has changed by 20°C (36°F) or greater within 250 milliseconds; 14 times within 7 seconds.

Action Taken When the DTC Sets

- The TCM does not request the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL).
- The TCM freezes transmission adaptive functions.
- The TCM calculates a default transmission fluid temperature based on engine coolant temperature, intake air temperature and engine run time.
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- The TCM stores DTC P0711 in TCM history.

Conditions for Clearing the DTC

- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the fault no longer exists and the DTC passes.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

5. This step tests for an intermittent short or open condition in the engine wiring harness. The test light is used as a resistor in the circuit.

6. This step determines if the TCM or the TFT, sensor is causing a steady, unchanging TFT, reading.

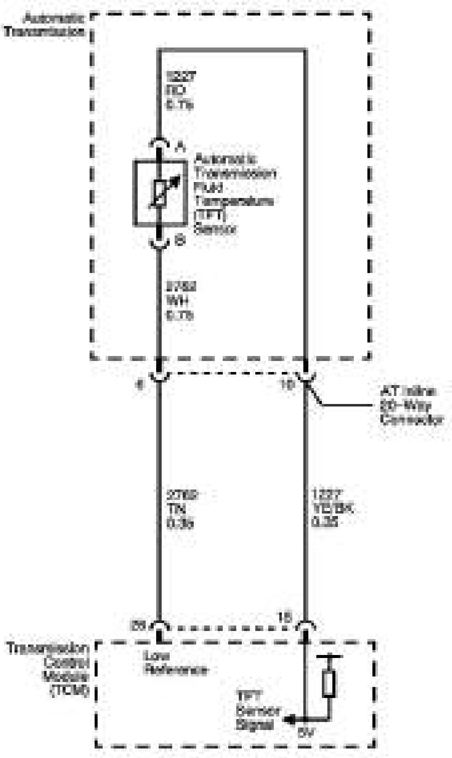
Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	Perform the Transmission Fluid Checking Procedure. Refer to Transmission Fluid Check . Did you perform the Transmission Fluid Checking Procedure?	--	Go to Step 3	Go to Transmission Fluid Check .
3	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM and the TCM Failure Records. Using the Clear Info function erases the Failure Records from the ECM and TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Failure Records. 4. Clear the DTC. 5. Select Trans. Fluid Temp. on the scan tool. 6. Drive the vehicle and observe the scan tool for either of the following conditions:	--		

	- The TFT does not change greater than 2°C (4°F) in 1 minute and 40 seconds since startup. - The TFT changes by 20°C (36°F) or greater in 0.250 second, 14 times within 7 seconds, unrealistic change. Did either of the conditions occur?		Go to Step 4	Go to Testing for Intermittent Conditions and Poor Connections
4	Did the scan tool display a condition in which the Trans. Fluid Temp. does not change by greater than the specified value in 1 minute and 40 seconds since startup?	2°C (4°F)	Go to Step 6	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the Automatic Transmission inline 20-way connector. Additional DTCs may set. 3. Install the J 45681 on the engine side of the Automatic transmission inline 20-way connector. 4. Using the connector test adapter kit, connect a test light between the TFT sensor signal and low reference circuits of the J 45681 . 5. Turn ON the ignition, with the engine OFF. 6. While observing the scan tool display, move or wiggle the engine wiring harness from the TCM connector to the Automatic transmission inline 20-way connector. Does the Trans. Fluid Temp. change by greater than the specified value?	20°C (36°F)	Go to Step 7	Go to Step 8
6	1. Turn OFF the ignition. 2. Disconnect the Automatic transmission inline 20-way connector. 3. Turn ON the ignition, with the engine OFF. Did the scan tool display a condition in which the Trans. Fluid Temp. does not change by greater than the specified value in 1 minute and 40 seconds since startup?	2°C (4°F)	Go to Step 9	Go to Step 8
	1. Test the TFT signal circuit for an intermittent open or short condition between the TCM connector and the Automatic transmission inline 20-way connector. 2. Test the TFT low reference circuit for			

7	an intermittent open or short condition between the TCM connector and the Automatic transmission inline 20-way connector. Refer to Testing for Continuity and Testing for Short to Ground . Did you find and correct a condition?	--	Go to Step 10	Go to Step 8
8	Replace the automatic transmission wiring harness. Refer to Transmission Internal Electrical Harness Replacement . Did you complete the replacement?	--	Go to Step 10	--
9	Replace the TCM. Refer to Diagnostic System Check - Vehicle for replacement, set-up and programming. Did you complete the replacement?	--	Go to Step 10	--
10	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle and make sure the following conditions are met: • The TFT is -39°C to +149°C (-38°F to +300°F). • The TFT changes by greater than 2°C (4°F) since startup. • The TFT does not change by 20°C (36°F) or greater within 0.250 second. 4. Select Specific DTC. 5. Enter DTC P0711. Has the test run and passed?	--	Go to Step 11	Go to Step 2
11	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0712

Circuit Description


Automatic Transmission
1227
RD
0.75
A
Automatic Transmission Fluid Temperature (TFT) Sensor
B
2762
WH
0.75
6
10
AT Inline 20-Way Connector
2762
TN
0.35
1227
YE/BK
0.35
28
15
Transmission Control Module (TCM)
Low Reference
TFT Sensor Signal
5V

The automatic transmission fluid temperature (TFT) sensor is part of the automatic transmission internal wiring harness assembly. The TFT sensor is a thermistor, or a resistor that changes value when the temperature changes. The sensor has a negative-temperature coefficient. This means that as the temperature increases, the resistance decreases, and as the temperature decreases, the resistance increases. The transmission control module (TCM) supplies a 5 volt reference signal to the sensor and measures the voltage drop in the circuit. When the transmission fluid is cold, the sensor resistance is high and the TCM detects high signal voltage. As the fluid temperature increases, the resistance of the sensor decreases, which lowers the signal voltage.

If the TCM detects a short to ground in the TFT sensor or signal circuit, then DTC P0712 sets. DTC P0712 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0712 Transmission Fluid Temperature (TFT) Sensor Circuit Low Voltage

Conditions for Running The DTC

The engine run time is greater than 5 seconds.

Conditions for Setting The DTC

The TCM detects a transmission fluid temperature of 150° C (302° F) or more for 10 seconds.

Action Taken When the DTC Sets

- The TCM does not request the ECM to illuminate the malfunction indicator lamp (MIL).
- The TCM freezes transmission adaptive functions.
- The TCM calculates a default transmission fluid temperature based on engine coolant temperature, intake air temperature and engine run time.
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- The TCM stores DTC P0712 in TCM history.

Conditions for Clearing the DTC

- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the fault no longer exists and the DTC passes.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. This step tests the ability of the TCM to detect an open circuit. If the TCM recognizes the open, this eliminates the TCM and the wiring up to the transmission connector. The fault must be internal to the transmission.

5. Because the TFT is an integral part of the transmission wiring, the entire harness must be replaced.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use			

2	the scan tool in order to record the ECM and the TCM Failure Records. Using the Clear Info function erases the Failure Records from the ECM and TCM. - Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the Failure Records. 4. Clear the DTCs. 5. Select Trans. Fluid Temp. on the scan tool. Does the scan tool display transmission fluid temperature equal to or greater than the specified value?	150°C (302° F)	Go to Step 3	Go to Testing for Intermittent Conditions and Poor Connections
3	1. Turn OFF the ignition. 2. Disconnect the transmission 20-way harness connector. Additional DTCs may set. 3. Turn ON the ignition, with the engine OFF. Does the scan tool display transmission fluid temperature equal to the specified value?	-40°C (-40° F)	Go to Step 5	Go to Step 4
4	Test the TFT signal circuit from the transmission 20-way harness to the TCM for a short to ground. Refer to Testing for Short to Ground . Did you find and correct the condition?	--	Go to Step 7	Go to Step 6
5	Replace the automatic transmission internal wiring harness assembly. Refer to Transmission Internal Electrical Harness Replacement . Is the action complete?	--	Go to Step 7	--
6	Replace the TCM. Refer to Diagnostic System Check - Vehicle for replacement, set-up and programming. Is the action complete?	--	Go to Step 7	--
	Perform the following procedure in order to verify the repair:			

7	1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Turn ON the ignition, with the engine OFF. • The Trans. Fluid Temp. must be 150°C (302°F) or less for 2 seconds. 4. Select Specific DTC. 5. Enter DTC P0712. Has the test run and passed?	150°C (302°F)	Go to Step 8	Go to Step 2
8	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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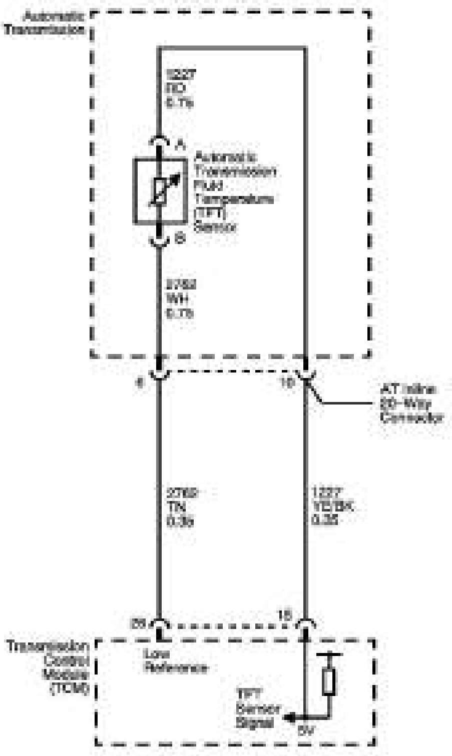
DTC P0713

Circuit Description


Automatic Transmission
1227
RD
0.75
A
Automatic Transmission Fluid Temperature (TFT) Sensor
B
2762
WH
0.75
6
10
AT Inline 20-Way Connector
2762
TN
0.35
1227
YE/BK
0.35
26
15
Transmission Control Module (TCM)
Low Reference
TFT Sensor Signal
5V

The automatic transmission fluid temperature (TFT) sensor is part of the automatic transmission internal wiring harness assembly. The TFT sensor is a thermistor, or a resistor that changes value when the temperature changes. The sensor has a negative-temperature coefficient. This means that as the temperature increases, the resistance decreases, and as the temperature decreases, the resistance increases. The transmission control module (TCM) supplies a 5 volt reference signal to the sensor and measures the voltage drop in the circuit. When the transmission fluid is cold, the sensor resistance is high and the TCM detects high signal voltage. As the fluid temperature increases, the resistance of the sensor decreases, which lowers the signal voltage.

If the TCM detects an open or short to voltage in the TFT sensor or signal circuit, then DTC P0713 sets. DTC P0713 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0713 Transmission Fluid Temperature (TFT) Sensor Circuit High Voltage

Conditions for Running The DTC

- No ISS DTCs P0716 or P0717.
- No OSS DTCs P0722 or P0723.
- The output shaft speed is greater than 200 RPM for 200 seconds (3 minutes and 20 seconds) cumulative.
- The TCC slip speed is greater than 120 RPM for 200 seconds (3 minutes and 20 seconds) cumulative.
- The engine run time is greater than 5 seconds.

Conditions for Setting The DTC

The TCM detects a transmission fluid temperature of -39° C (-38° F) or less for 25 seconds.

Action Taken When the DTC Sets

- The TCM does not request the ECM to illuminate the malfunction indicator lamp (MIL).
- The TCM freezes transmission adaptive functions.
- The TCM calculates a default transmission fluid temperature based on engine coolant temperature, intake air temperature and engine run time.
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- The TCM stores DTC P0713 in TCM history.

Conditions for Clearing the DTC

- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the fault no longer exists and the DTC passes.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM and the TCM Failure Records. Using the Clear Info function erases the Failure Records from the ECM and	-39°C (-		

2	TCM. - Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Failure Records. 4. Clear the DTC. 5. Select Trans. Fluid Temp. on the scan tool. Does the scan tool display a Trans. Fluid Temp. less than the specified value?	38°F)	Go to Step 3	Go to Testing for Intermittent Conditions and Poor Connections
3	1. Turn OFF the ignition. 2. Disconnect the Automatic transmission inline 20-way connector. Additional DTCs may set. 3. Install the J 45681 on the transmission side of the Automatic transmission inline 20-way connector. 4. Using the DMM and the J 45681 , measure the resistance between the TFT sensor signal and low reference circuit of the J 45681 . Is the resistance less than the specified value?	100 K Ω	Go to Step 5	Go to Step 4
4	1. Test the TFT signal circuit for a short to voltage between the TCM connector and the TFT sensor. Refer to Testing for a Short to Voltage . 2. Repair the wiring as necessary. 3. Replace the automatic transmission wiring harness. Refer to Transmission Internal Electrical Harness Replacement . Is the repair complete?	--	Go to Step 7	--
5	1. Test the TFT signal circuit for an open between the TCM connector and the Automatic transmission inline 20-way connector. 2. Test the TFT low reference circuit for an open between the TCM connector and the Automatic transmission inline 20-way connector. Refer to Testing for Continuity . Did you find and correct an open condition?	--	Go to Step 7	Go to Step 6
	Replace the TCM.			

6	Refer to Diagnostic System Check - Vehicle for replacement, set-up and programming. Did you complete the replacement?	--	Go to Step 7	--
7	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Turn ON the ignition, with the engine OFF. • The Trans. Fluid Temp. must be greater than -40°C (-40°F) for 12.5 seconds. 4. Select Specific DTC. 5. Enter DTC P0713. Has the test run and passed?	--	Go to Step 8	Go to Step 2
8	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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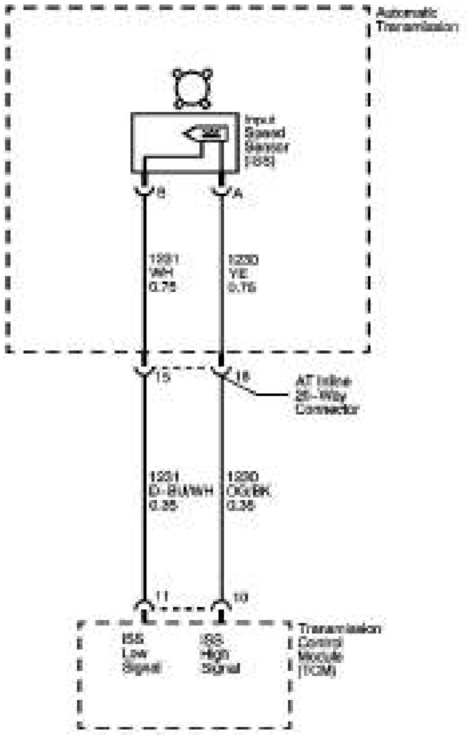
DTC P0716

Circuit Description


Automatic Transmission
Input Speed Sensor (ISS)
B
A
1231 WH 0.75
1230 YE 0.75
15
16
AT Inline 20-Way Connector
1231 D-BU/WH 0.35
1230 OG/BK 0.35
11
10
ISS Low Signal
ISS High Signal
Transmission Control Module (TCM)

The input shaft speed (ISS) sensor is a permanent magnet generator. The ISS sensor mounts in the transmission case in front of the valve body assembly. The sensor faces the reverse clutch housing machined teeth surface. As the reverse clutch housing rotates, an Alternating Current (AC) voltage is induced and transmitted to the transmission control module (TCM). The AC voltage level and the number of pulses increase as the speed of the reverse clutch housing increases. The TCM converts the AC voltage into a digital signal. The TCM uses the input shaft speed signal to help determine line pressure, transmission shift patterns, torque converter clutch (TCC) slip speed and gear ratio.

If the TCM detects an unrealistic drop in input shaft speed, DTC P0716 sets. DTC P0716 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0716 Input Speed Sensor Performance

Conditions for Running the DTC

- No throttle system DTC P0120.
- No ISS DTCs P0716 or P0717.
- No OSS DTCs P0722 or P0723.
- No engine torque DTC P2637.
- No 1-2 Shift Solenoid Performance DTC P0752.
- No 1-2 Shift Solenoid Electrical DTCs P0973 or P0974.
- The engine run time is greater than 5 seconds.
- The vehicle speed is at least 16 km/h (10 mph).
- The transmission input shaft speed is greater than 1,050 RPM for 2 seconds.
- The throttle position is greater than 12 percent.
- One of the following conditions exist:
  - The transmission input shaft speed has not changed for at least 2 seconds.
  - The transmission input shaft speed has increased by greater than 500 RPM within 2 seconds.

Conditions for Setting the DTC

The transmission input shaft speed drops more than 1,000 RPM for at least 4 seconds.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM calculates input speed from the automatic transmission output shaft speed sensor and commanded gear.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0716 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

Ensure the ISS is properly torqued to the transmission housing.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. The resistance measurement will not change if either the ISS high signal circuit or the ISS low signal circuit, but not both, is shorted to ground. The vehicle speed detector in the TCM and the ISS are matched in such a way that an open or a short to ground in the ISS low signal circuit will not usually cause a loss of speed signal or a DTC P0716 to set.
6. This step isolates the short between the ISS and the wiring.
11. Refer to Diagnostic System Check - Vehicle for the latest procedures for TCM reprogramming.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine. 6. Select Transmission ISS on the scan tool. Does the scan tool display input shaft speed above the specified value?	500 RPM	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
	1. Turn OFF the ignition. 2. Disconnect the TCM.			

3	3. Using the DMM and the J 35616 Holden-terminal test kit, measure the resistance between the ISS high signal and low signal circuits at the TCM connector. Is the resistance within the specified range?	325-575 Ω	Go to Step 5	Go to Step 4
4	Test the ISS high signal circuit and ISS low signal circuit for the following conditions: • An open circuit or high resistance condition. • ISS high signal circuit and ISS low signal circuit shorted together. Refer to Testing for Continuity . Did you find and correct a condition?	--	Go to Step 12	Go to Step 9
5	Measure the resistance between ISS high signal circuit at the TCM connector and ground. Is the resistance greater than the specified value?	50K Ω	Go to Step 8	Go to Step 6
6	1. Leave the DMM connected between the ISS signal circuit and ground. 2. Disconnect the ISS. 3. Measure the resistance. Is the resistance greater than the specified value?	50K Ω	Go to Step 9	Go to Step 7
7	Repair the short to ground in the ISS high signal circuit. Refer to Wiring Repairs . Did you complete the repair?	--	Go to Step 12	--
8	1. Connect the DMM between the ISS high signal and low signal circuits. 2. Place the transmission in Park. 3. Start the engine. Is the AC voltage equal to or greater than the specified value?	0.5 V	Go to Step 11	Go to Step 9
	1. Remove the ISS. Refer to Input Speed Sensor Replacement . 2. Inspect the ISS and the ISS rotor for the following conditions: • ISS damage. • ISS rotor damage. • Excessive air gap between the reverse clutch input housing			

9	assembly (401) rotor and the ISS. - Incorrect alignment between the ISS and the reverse clutch input housing assembly (401) rotor. 3. Repair or replace any of the above items as necessary. Did you find and correct a condition?	--	Go to Step 12	Go to Step 10
10	Replace the ISS. Refer to Wiring Repairs . Did you complete the repair?	--	Go to Step 12	--
11	Replace the TCM. Refer to Diagnostic System Check - Vehicle for replacement, set-up and programming. Is the action complete?	--	Go to Step 12	--
12	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Start and idle the engine. 4. Observe Transmission ISS on the scan tool. Input speed must be greater than 550 RPM for 4 seconds. 5. Select Specific DTC. 6. Enter DTC P0716. Has the test run and passed?	--	Go to Step 13	Go to Step 2
13	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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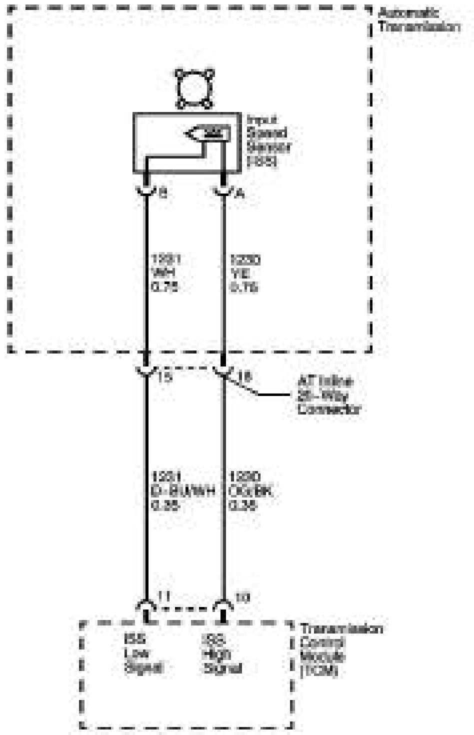
DTC P0717

Circuit Description


Automatic Transmission
Input Speed Sensor (ISS)
B
A
1231 WH 0.75
1230 YE 0.75
15
16
AT Inline 20-Way Connector
1231 D-BU/WH 0.35
1230 OG/BK 0.35
11
10
ISS Low Signal
ISS High Signal
Transmission Control Module (TCM)

The input shaft sensor (ISS) is a permanent magnet generator. The ISS sensor mounts in the transmission case in front of the valve body assembly. The sensor faces the reverse clutch housing machined teeth surface. As the reverse clutch housing rotates, an AC voltage is induced and transmitted to the transmission control module (TCM). The AC voltage level and the number of pulses increase as the speed of the reverse clutch housing increases. The TCM converts the AC voltage into a digital signal. The TCM uses the input shaft speed signal to help determine line pressure, transmission shift patterns, torque converter clutch (TCC) slip speed and gear ratio.

If the TCM detects no input shaft speed when there is vehicle speed in a drive gear range, then DTC P0717 sets. DTC P0717 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0717 Input Speed Sensor Circuit Low Voltage

Conditions for Running the DTC

- No OSS DTCs P0722 or P0723.
- No ISS DTC P0717.
- No engine torque DTC P2637.
- The engine run time is greater than 5 seconds.
- The vehicle speed is at least 16 km/h (10 mph).

Conditions for Setting the DTC

The transmission input shaft speed is less than 100 RPM for 5 seconds.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM calculates input shaft speed from the output shaft speed sensor and commanded gear.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0717 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

Ensure the ISS is properly torqued to the transmission housing.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. The resistance measurement will not change if either the ISS high signal circuit or the ISS low signal circuit, but not both, is shorted to ground. The vehicle speed detector in the TCM and the ISS are matched in such a way that an open or a short to ground in the ISS low signal circuit will not usually cause a loss of speed signal or a DTC P0717 to set.

6. This step isolates the short between the ISS and the wiring.

11. Refer to Diagnostic System Check - Vehicle for the latest procedures for TCM reprogramming.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine. 6. Select Transmission ISS on the scan tool. Does the scan tool display input shaft speed above the specified value?	500 RPM	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the TCM. 3. Using the DMM and the J 35616 Holden-terminal test kit, measure the resistance between the ISS high signal and low signal circuits at the TCM connector. Is the resistance within the specified range?	325-575 Ω	Go to Step 5	Go to Step 4
4	Test the ISS high signal circuit and ISS low signal circuit for the following conditions: • An open circuit or high resistance condition • ISS high signal and ISS low signal	--		

	circuits shorted together Refer to Testing for Continuity . Did you find and correct a condition?		Go to Step 12	Go to Step 9
5	Measure the resistance between the ISS high signal circuit at the TCM connector and ground. Is the resistance greater than the specified value?	50K Ω	Go to Step 8	Go to Step 6
6	1. Leave the DMM connected between the ISS high signal circuit and ground. 2. Disconnect the ISS. 3. Measure the resistance. Is the resistance greater than the specified value?	50K Ω	Go to Step 9	Go to Step 7
7	Repair the short to ground in the ISS high signal circuit. Refer to Wiring Repairs . Did you complete the repair?	--	Go to Step 12	--
8	1. Connect the DMM between the ISS high signal and low signal circuits at the TCM connector. 2. Place the transmission in PARK. 3. Start the engine. Is the AC voltage equal to or greater than the specified value?	0.5 V	Go to Step 11	Go to Step 9
9	1. Remove the ISS. Refer to Input Speed Sensor Replacement . 2. Inspect the ISS and the ISS rotor for the following conditions: • ISS damage • ISS rotor damage • Excessive air gap between the reverse clutch input housing assembly (401) rotor and the ISS • Incorrect alignment between the ISS and the reverse clutch input housing assembly (401) rotor 3. Repair or replace any of the above items as necessary. Did you find and correct a condition?	--	Go to Step 12	Go to Step 10
10	Replace the ISS. Refer to Input Speed Sensor Replacement .	--		--

	Did you complete the replacement?		Go to Step 12	
11	Replace the TCM. Refer to Diagnostic System Check - Vehicle for replacement, set-up and programming. Is the action complete?	--	Go to Step 12	--
12	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Start and idle the engine. 4. Observe Transmission ISS on the scan tool. Input speed must be greater than 500 RPM for 5 seconds. 5. Select Specific DTC. 6. Enter DTC P0716. Has the test run and passed?	--	Go to Step 13	Go to Step 2
13	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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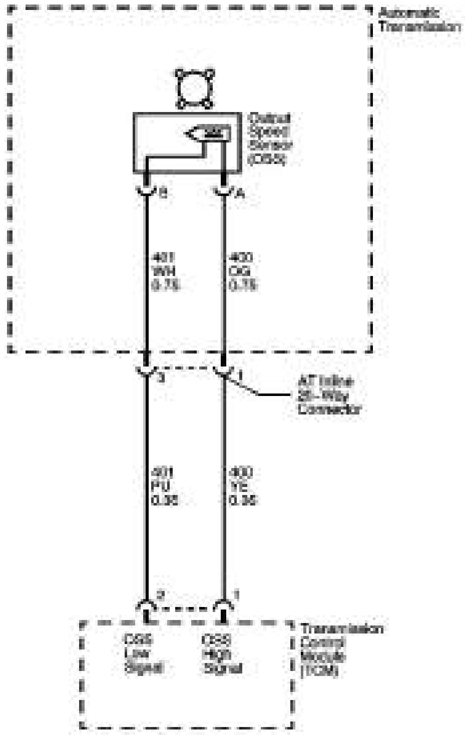
DTC P0722

Circuit Description


Automatic Transmission
Output Speed Sensor (OSS)
B
A
401 WH 0.75
400 OG 0.75
3
1
AT Inline 25-Way Connector
401 PU 0.35
400 YE 0.35
2
1
OSS Low Signal
OSS High Signal
Transmission Control Module (TCM)

The output speed sensor (OSS) assembly provides vehicle speed information to the transmission control module (TCM). The OSS sensor assembly is a permanent magnet generator. The sensor is mounted in the transmission case facing the rear internal gear which is splined to the output shaft assembly. As the output shaft and internal gear rotate, the toothed rotor of the internal gear produces Alternating Current (AC) voltage as the rotor teeth pass through the magnetic field of the sensor. The AC voltage level and the number of pulses increase as the speed of the vehicle increases. The TCM converts the voltage to vehicle speed. The TCM uses the output shaft speed signal to determine shift timing and torque converter clutch (TCC) scheduling.

If the TCM detects no vehicle speed when there is engine speed in a drive gear range, then DTC P0722 sets. DTC P0722 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0722 Output Speed Sensor Circuit Low Voltage

Conditions for Running the DTC

- No throttle system DTC P0120.
- No ISS DTCs P0716 or P0717.
- No OSS DTC P0722 or P0723.
- No engine torque DTC P2637.
- The engine run time is greater than 5 seconds.
- The throttle position is greater than 12 percent.
- The engine torque is greater than 70 N·m (52 lb. ft).
- The transmission input shaft speed is 1,500-6,800 RPM.

Conditions for Setting the DTC

The transmission output shaft speed is 100 RPM or less for 3 seconds.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM inhibits Autograde.
- The TCM calculates vehicle speed from the automatic transmission input shaft speed sensor and commanded gear.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0722 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

Ensure the OSS sensor is properly torqued to the transmission housing.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. The resistance measurement will not change if either the OSS high signal circuit or the OSS low signal circuit, but not both, is shorted to ground. The vehicle speed detector in the TCM and the OSS are matched in such a way that an open or a short to ground in the OSS low signal circuit will not usually cause a loss of speed signal or a DTC P0722 to set.
6. This step isolates the short between the OSS and the wiring.
8. The DMM will detect AC voltage if the OSS high signal circuit is shorted to ground.
11. Refer to Diagnostic System Check - Vehicle for the latest procedures for TCM reprogramming.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	**Notice:** In order to avoid damage to the drive axles, support the lower control arms in the normal horizontal position. Do not run the vehicle in gear with the wheels hanging down at full travel. 1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Raise the drive wheels. 6. Support the lower control arms so that the drive axles are in a horizontal, straight, position. 7. Start the engine. 8. Shift the transmission into D5. 9. Select Transmission OSS on the scan	100 RPM		

	tool. Does the scan tool display transmission output speed above the specified value?		Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the TCM. 3. Measure the resistance between the OSS high signal and OSS low signal circuits at the TCM connector. Is the resistance within the specified range?	325-575 Ω	Go to Step 5	Go to Step 4
4	Test the OSS high signal circuit and the OSS low signal circuit for the following conditions: - An open circuit or high resistance condition - OSS high signal and OSS low signal circuits shorted together Refer to Testing for Continuity . Did you find and correct a condition?	--	Go to Step 12	Go to Step 9
5	Measure the resistance between the OSS high signal circuit at the TCM connector and ground. Is the resistance greater than the specified value?	50K Ω	Go to Step 8	Go to Step 6
6	1. Leave the DMM connected between the OSS high signal circuit and ground. 2. Disconnect the OSS. 3. Measure the resistance. Is the resistance greater than the specified value?	50K Ω	Go to Step 9	Go to Step 7
7	Repair the short to ground in the OSS high signal circuit. Refer to Wiring Repairs . Did you complete the repair?	--	Go to Step 12	--
8	1. Connect the DMM between the OSS high signal and OSS low signal circuits. 2. Measure the AC voltage with the DMM while rotating the drive wheels by hand. Is the AC voltage equal to or greater than the specified value?	0.5 V	Go to Step 11	Go to Step 9

9	1. Remove the OSS. Refer to Output Speed Sensor Replacement . 2. Inspect the OSS and the OSS rotor for the following conditions: - OSS damage - OSS rotor damage - Excessive air gap between the OSS rotor and the OSS - Incorrect alignment between the OSS and the OSS rotor - Damaged or missing OSS spacer 3. Repair or replace any of the above items as necessary. Did you find and correct a condition?	--	Go to Step 12	Go to Step 10
10	Replace the OSS. Refer to Output Speed Sensor Replacement . Did you complete the repair?	--	Go to Step 12	--
11	Replace the TCM. Refer to Diagnostic System Check - Vehicle for replacement, set-up and programming. Is the action complete?	--	Go to Step 12	--
12	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle in D5 and observe the Transmission OSS on the scan tool. 4. Make sure the Transmission OSS is greater than 500 RPM for at least 2 seconds. 5. Select Specific DTC. 6. Enter DTC P0722. Has the test run and passed?	--	Go to Step 13	Go to Step 2
13	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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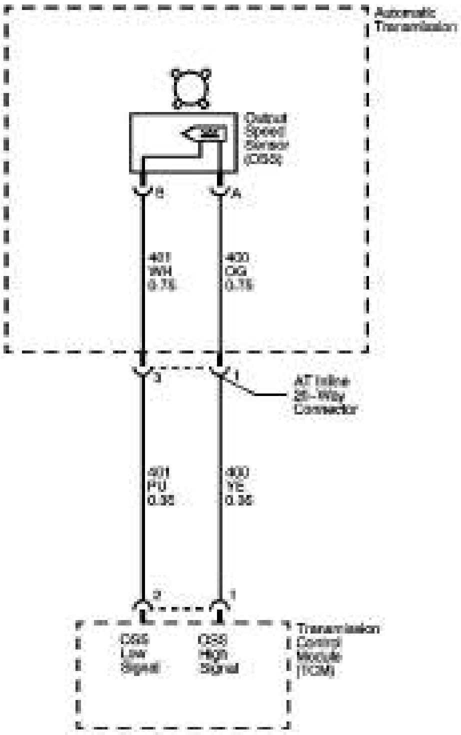
DTC P0723

Circuit Description


Automatic Transmission
Output Speed Sensor (OSS)
B
A
401 WH 0.75
400 OG 0.75
3
1
AT Inline 25-Way Connector
401 PU 0.35
400 YE 0.35
2
1
OSS Low Signal
OSS High Signal
Transmission Control Module (TCM)

The output speed sensor (OSS) assembly provides vehicle speed information to the transmission control module (TCM). The OSS sensor assembly is a permanent magnet generator. The sensor is mounted in the transmission case facing the rear internal gear which is splined to the output shaft assembly. As the output shaft and internal gear rotate, the toothed rotor of the internal gear produces Alternating Current (AC) voltage as the rotor teeth pass through the magnetic field of the sensor. The AC voltage level and the number of pulses increase as the speed of the vehicle increases. The TCM converts the voltage to vehicle speed. The TCM uses the output shaft speed signal to determine shift timing and torque converter clutch (TCC) scheduling.

If the TCM detects an unrealistic drop in output shaft speed, DTC P0723 sets. DTC P0723 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0723 Output Speed Sensor Circuit Intermittent

Conditions for Running the DTC

- No ISS DTCs P0716 or P0717.
- No 1-2 Shift Solenoid Electrical DTC P0974.
- The engine run time is greater than 5 seconds.
- The transmission output speed is greater than 1,400 RPM for 2 seconds or greater.
- One of the following conditions exist:
  - The transmission input shaft speed has not changed less than 500 RPM for at least 2 seconds.
  - The transmission output shaft speed has not increased greater than 1400 RPM for at least 2 seconds.

Conditions for Setting the DTC

The transmission output shaft speed drops at least 1,300 RPM for at least 3 seconds.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes adaptive transmission functions.
- The TCM inhibits Autograde.
- The TCM calculates vehicle speed from the automatic transmission input shaft speed sensor and commanded gear.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0723 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

Ensure the OSS sensor is properly torqued to the transmission housing.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. The resistance measurement will not change if either the OSS high signal circuit or the OSS low signal circuit, but not both, is shorted to ground. The vehicle speed detector in the TCM and the OSS are matched in such a way that an open or a short to ground in the OSS low signal circuit will not usually cause a loss of speed signal or a DTC P0723 to set.
6. This step isolates the short between the OSS and the wiring.
8. The DMM will detect AC voltage if the OSS high signal circuit is shorted to ground.
11. Refer to Diagnostic System Check - Vehicle for the latest procedures for TCM reprogramming.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	**Notice:** In order to avoid damage to the drive axles, support the lower control arms in the normal horizontal position. Do not run the vehicle in gear with the wheels hanging down at full travel. 1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Raise the drive wheels. 6. Support the lower control arms so that the drive axles are in a horizontal, straight, position. 7. Start the engine.	100 RPM		

	8. Shift the transmission into D5. 9. Select Transmission OSS on the scan tool. Does the scan tool display transmission output speed above the specified value?		Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the TCM. 3. Measure the resistance between the OSS high signal and the OSS low signal circuits at the TCM connector. Is the resistance within the specified range?	325-575 Ω	Go to Step 5	Go to Step 4
4	Test the OSS high signal circuit and the OSS low signal circuit for the following conditions: - An open circuit or high resistance condition - OSS high signal and OSS low signal circuits shorted together Refer to Testing for Continuity . Did you find and correct a condition?	--	Go to Step 12	Go to Step 9
5	Measure the resistance between the OSS high signal circuit at the TCM connector and ground. Is the resistance greater than the specified value?	50K Ω	Go to Step 8	Go to Step 6
6	1. Leave the DMM connected between the OSS high signal circuit and ground. 2. Disconnect the OSS. 3. Measure the resistance. Is the resistance greater than the specified value?	50K Ω	Go to Step 9	Go to Step 7
7	Repair the short to ground in the OSS high signal circuit. Refer to Wiring Repairs . Did you complete the repair?	--	Go to Step 12	--
8	1. Connect the DMM between the OSS high signal and the OSS low signal circuits at the TCM connector. 2. Measure the AC voltage with the DMM while rotating the drive wheels by hand. Is the AC voltage equal to or greater than	0.5 V		

	the specified value?		Go to Step 11	Go to Step 9
9	1. Remove the OSS. Refer to Output Speed Sensor Replacement . 2. Inspect the OSS and the OSS rotor for the following conditions: • OSS damage • OSS rotor damage • Excessive air gap between the OSS rotor and the OSS • Incorrect alignment between the OSS and the OSS rotor • Damaged or missing OSS sensor spacer 3. Repair or replace any of the above items as necessary. Did you find and correct a condition?	--	Go to Step 12	Go to Step 10
10	Replace the OSS. Refer to Output Speed Sensor Replacement . Did you complete the repair?	--	Go to Step 12	--
11	Replace the TCM. Refer to Diagnostic System Check - Vehicle for replacement, set-up and programming. Is the action complete?	--	Go to Step 12	--
12	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Drive the vehicle in D5 and observe Transmission OSS on the scan tool. 4. Ensure the Transmission OSS is greater than 750 RPM and does not drop more than 650 RPM for at least 2 seconds. 5. Select Specific DTC. 6. Enter DTC P0723. Has the test run and passed?	--	Go to Step 13	Go to Step 2
13	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0727

Circuit Description

Engine speed information is sent to the transmission control module (TCM) by the engine control module (ECM) through a communication network called GMLAN. Two circuits are used to communicate GMLAN data between the ECM and TCM. A fault in the GMLAN will not cause DTC P0727 to set by itself. If a GMLAN fault occurs, other DTCs will set before DTC P0727.

When the ECM sends the TCM an invalid engine speed, then DTC P0727 will set. DTC P0727 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0727 Engine Speed No Signal

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

The engine speed is invalid for 2.0 seconds.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0727 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.

- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Failure Records. Did you record any ECM Failure Records?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
3	Did you record a TCM Failure Record for DTC U0100?	--	Go to DTC U0100	Go to Step 4
4	1. Clear the DTC. 2. Turn the ignition OFF for at least 30 seconds. 3. Start and idle the engine. 4. Observe the Engine Speed on the scan tool. Is the Engine Speed within the specified range?	500-1,000 RPM	Go to Step 5	Go to Step 6
5	Road test the vehicle using various engine speeds. Did DTC P0727 reset?	--	Go to Step 7	Go to Testing for Intermittent Conditions and Poor Connections
6	1. Select Engine Data on the scan tool. 2. Observe the scan tool Engine Speed parameter. Is the Engine Speed value within the specified range?	500-1,000 RPM	Go to Step 7	Go to Step 8

7	Did any other DTCs set?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	Go to Step 8
8	Replace the TCM. Refer to Diagnostic System Check - Vehicle for replacement, set-up and programming. Is the action complete?	--	Go to Step 9	--
9	Perform the following procedure to verify the repair: 1. Select DTC on the scan tool. 2. Select Clear Info. 3. Turn ON the ignition, with the engine OFF. 4. Operate the engine at varying speeds. 5. Select Specific DTC. 6. Enter DTC P0727. Has the test run and passed?	--	Go to Step 10	Go to Step 2
10	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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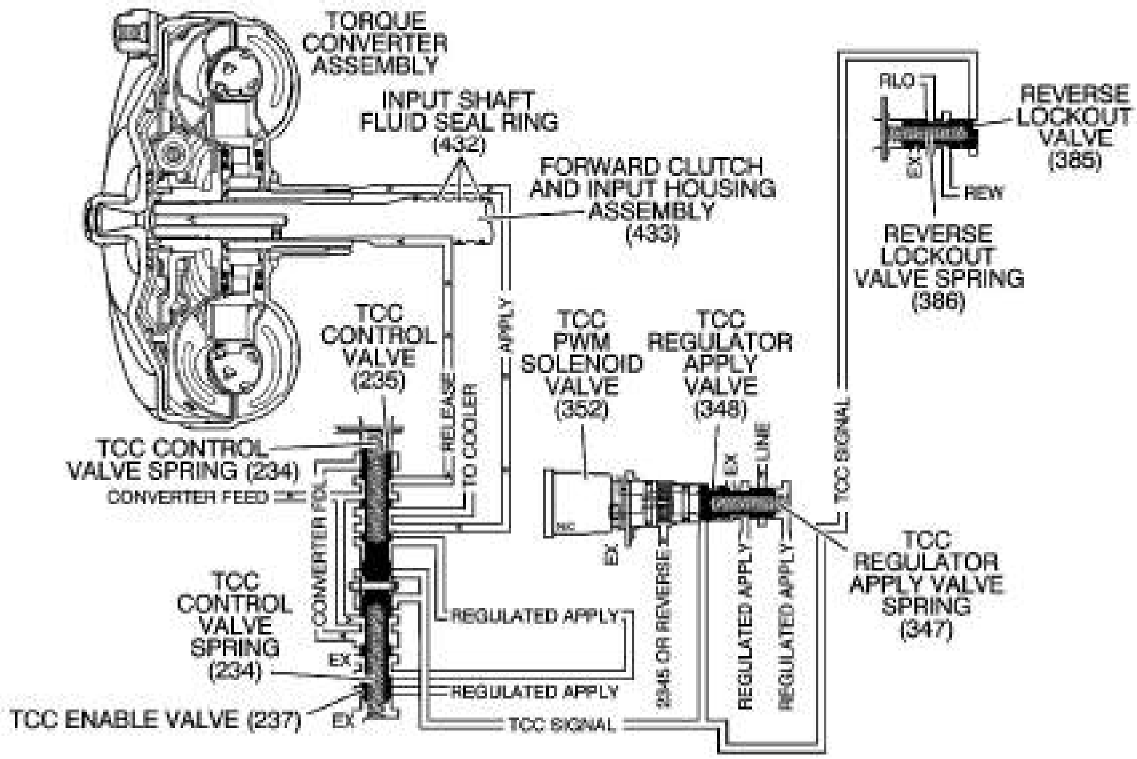
DTC P0741

Circuit Description


TORQUE CONVERTER ASSEMBLY
INPUT SHAFT FLUID SEAL RING (432)
FORWARD CLUTCH AND INPUT HOUSING ASSEMBLY (433)
REVERSE LOCKOUT VALVE (385)
RLO
EX
REV
REVERSE LOCKOUT VALVE SPRING (386)
APPLY
TCC CONTROL VALVE (235)
TCC PWM SOLENOID VALVE (352)
TCC REGULATOR APPLY VALVE (348)
RELEASE
TO COOLER
TCC SIGNAL
EX
LINE
TCC CONTROL VALVE SPRING (234)
CONVERTER FEED
CONVERTER FDL
EX
2345 OR REVERSE
REGULATED APPLY
REGULATED APPLY
TCC REGULATOR APPLY VALVE SPRING (347)
TCC CONTROL VALVE SPRING (234)
REGULATED APPLY
EX
REGULATED APPLY
TCC ENABLE VALVE (237)
EX
TCC SIGNAL

The transmission control module (TCM) controls the torque converter clutch (TCC) solenoid valve pulse width modulation (PWM). The solenoid directs the hydraulic fluid for TCC apply and release. When the TCC is applied, the engine is coupled directly to the transmission through the TCC. The TCC slip speed should be near 0.

If the TCM detects high torque converter slip when the TCC is commanded ON, then DTC P0741 sets. DTC P0741 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0741 Torque Converter Clutch (TCC) System - Stuck Off

Conditions for Running the DTC

- No throttle system DTC P0120.

- No ISS DTCs P0716 or P0717.
- No OSS DTCs P0722 or P0723.
- No TCC performance DTC P0742.
- No Internal Mode Switch (IMS) DTCs P1815, P1820, P1822, P1823, P1825 or P1826.
- No engine torque signal circuit DTC P2637.
- No TCC solenoid electrical DTCs P2764 or P2763.
- The engine run time is greater than 5 seconds.
- The IMS range is D2, D3, D4, or D5.
- The elapsed time since the most recent range change is greater than 6 seconds.
- The transmission fluid temperature is 20-130°C (68-266°F).
- The engine torque is greater than 55 N·m (41 lb. ft).
- The throttle position is 10-90 percent.
- The gear ratio is within the following ranges:
  - 1.56:1 to 1.64:1 - 3rd gear
  - 0.98:1 to 1.03:1 - 4th gear
  - 0.73:1 to 0.77:1 - 5th gear
- The TCC apply pressure is greater than 200 kPa (22 psi) for more than 2 seconds.
- The TCC duty cycle is greater than 80 percent for more than 2 seconds.

Conditions for Setting the DTC

The TCM commands the TCC ON, and the TCC slip is between 150-250 RPM for greater than 8 seconds.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive drive trip in which the Conditions for Setting the DTC are met.
- The TCM inhibits 5th gear if the transmission is in Hot Mode.
- The TCM freezes transmission adaptive functions.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0741 in TCM history.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.

- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

Inspect the transmission fluid lines to the radiator. The lines may be pinched, plugged or twisted.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. This step inspects the transmission fluid to make sure that it is at the proper level.

3. This step verifies that the TCC engages when commanded ON by the scan tool.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	Perform the Transmission Fluid Checking Procedure. Refer to Transmission Fluid Check . Did you perform the Transmission Fluid Checking Procedure?	--	Go to Step 3	Go to Transmission Fluid Check .
3	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Operate the vehicle in D5 at 72 km/h (45 mph). 6. Using the scan tool, command the TCC PWM solenoid valve ON.	-20 to +75 RPM		

	7. Monitor the TCC slip speed on the scan tool. Is the slip speed within the specified range?		Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 4
4	- Inspect the front control valve body assembly (311) for the following conditions: - TCC PWM solenoid valve (352) mechanically stuck off or leaking - TCC regulator apply valve (348) stuck. Refer to Torque Converter Clutch Solenoid Replacement . - Inspect the rear control valve body assembly (310) for the control valve body ball check valve #2 stuck or missing. Refer to Control Valve Body Accumulator Assembly Replacement . - Inspect the fluid pump assembly (202) for the following conditions: - TCC control valve (235) stuck in the off position - TCC enable valve (237) stuck in the off position. Refer to Transmission Fluid Pump Disassemble and Transmission Fluid Pump Assemble . - Inspect the forward clutch input housing assembly (433) for the input shaft fluid seal ring (432) leaking or worn. Refer to Forward and Coast Clutch Disassemble . Did you find and correct any of the above conditions?	--	Go to Step 5	--
5	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: - The TFT is 20-130°C (68-266°F). - The engine torque is greater than 55 N·m (41 lb. ft). - Drive the vehicle in D5 with the throttle position at 12-	--		

	90 percent. - Ensure that the TCC applies and the slip speed is -20 to +75 RPM for 4 seconds. 4. Select Specific DTC. 5. Enter DTC P0741. Has the test run and passed?		Go to Step 6	Go to Step 2
6	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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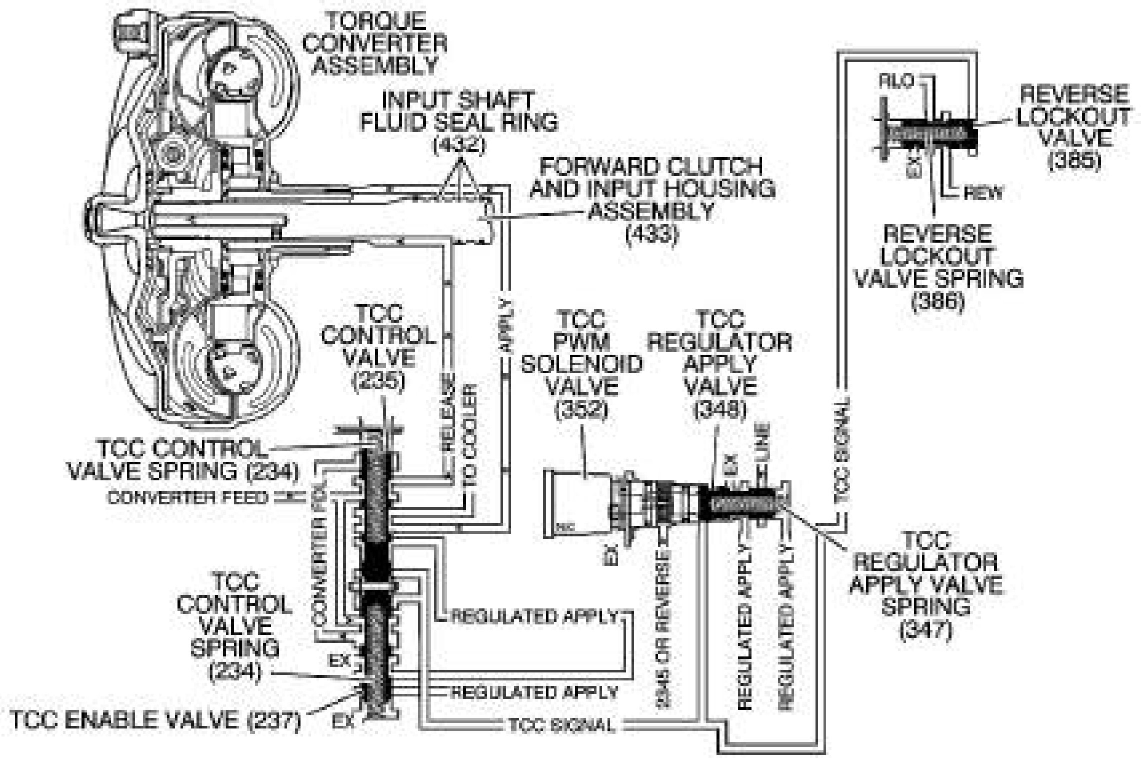
DTC P0742

Circuit Description


TORQUE CONVERTER ASSEMBLY
INPUT SHAFT FLUID SEAL RING (432)
FORWARD CLUTCH AND INPUT HOUSING ASSEMBLY (433)
RLO
REVERSE LOCKOUT VALVE (385)
EX
REV
REVERSE LOCKOUT VALVE SPRING (386)
APPLY
TCC CONTROL VALVE (235)
TCC PWM SOLENOID VALVE (352)
TCC REGULATOR APPLY VALVE (348)
RELEASE
TO COOLER
TCC SIGNAL
EX
LINE
TCC CONTROL VALVE SPRING (234)
CONVERTER FEED
CONVERTER FDL
EX
TCC REGULATOR APPLY VALVE SPRING (347)
TCC CONTROL VALVE SPRING (234)
REGULATED APPLY
EX
2345 OR REVERSE
REGULATED APPLY
REGULATED APPLY
REGULATED APPLY
TCC ENABLE VALVE (237)
EX
TCC SIGNAL

The transmission control module (TCM) controls the torque converter clutch (TCC) solenoid valve pulse width modulation (PWM). The solenoid directs the hydraulic fluid for TCC apply and release. When the TCC is released, the engine is coupled by fluid to the transmission and TCC slip speeds of -300 RPM to +1,500 RPM, during heavy acceleration, are normal.

If the TCM detects low torque converter slip when the TCC is commanded OFF, then DTC P0742 sets. DTC P0742 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0742 Torque Converter Clutch (TCC) System - Stuck On

Conditions for Running the DTC

- No throttle system DTC P0120.

- No ISS DTCs P0716 or P0717.
- No OSS DTCs P0722 or P0723.
- No TCC performance DTC P0741.
- No Internal Mode Switch (IMS) DTCs P1815, P1820, P1822, P1823, P1825 or P1826.
- No engine torque signal circuit DTC P2637.
- No TCC solenoid electrical DTCs P2764 or P2763.
- The engine run time is greater than 5 seconds.
- The IMS range is D5.
- The transmission fluid temperature is 20-130°C (68-266°F).
- The engine torque is greater than 80 N·m (59 lb. ft).
- The throttle position is 12-90 percent.
- The transmission is not in 1st gear and the gear ratio is 0.73:1 to 2.27:1.
- The vehicle speed is greater than 15 km/h (9 mph).

Conditions for Setting the DTC

The following conditions occur 3 times in 1 ignition cycle:

- The TCM commands the TCC OFF.
- The TCC slip is between -20 to +20 RPM for greater than 3.5 seconds.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive drive trip in which the Conditions for Setting the DTC are met.
- The TCM freezes transmission adaptive functions.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0742 in TCM history.

Conditions for Clearing the DTC

- The ECM turns off the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

- Rapid fluctuation in line pressure may set DTC P0742. Refer to Line Pressure .
- The customer may notice an engine stalling condition.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. This step verifies that the ECM commanded the TCC PWM solenoid valve OFF and the slip speed is -20 to +150 RPM.

3. This step inspects and repairs the components that caused the DTC to set.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Select TCC Duty Cycle and TCC Slip Speed on the scan tool. 6. Drive the vehicle in D5, with the throttle position angle greater than 15 percent. Allow the transmission shift to 5th gear. While the TCC duty cycle is 0 percent, does the scan tool display a TCC slip speed within the specified range?	-20 to +20 RPM	Go to Step 3	Go to Testing for Intermittent Conditions and Poor Connections
	1. Inspect for the following conditions: • The TCC PWM solenoid valve (352) is stuck ON due to sediment.			

3	• The TCC regulator apply valve (348) is stuck due to sediment. Refer to Torque Converter Clutch Solenoid Replacement . 2. Repair or replace components as necessary. Did you find and correct a condition?	--	Go to Step 4	--
4	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Drive the vehicle in D5 with the throttle position angle of 12-90 percent and a vehicle speed greater than 15 km/h (9 mph). • The TFT is 20-130°C (68-266°F). • The engine torque is greater than 80 N·m (59 lb. ft). • The TCC slip speed must be 130-1,500 RPM for 2.5 seconds. • Stop the vehicle. • Drive the vehicle, as noted in Steps 1-3 above, in order to cycle the TCC a second time. 4. Select Specific DTC. 5. Enter DTC P0742. Has the test run and passed?	--	Go to Step 5	Go to Step 2
5	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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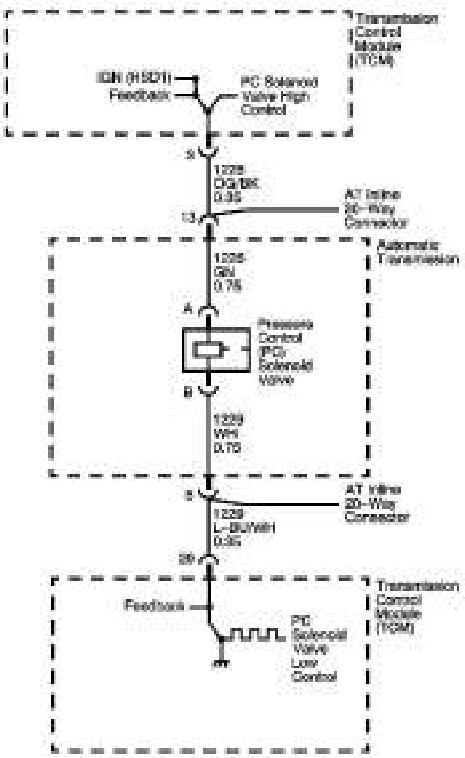
DTC P0748

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit Description


Transmission Control Module (TCM)
IGN (HSD1)
Feedback
PC Solenoid Valve High Control
9
1228
OG/BK
0.35
13
AT Inline 20-Way Connector
Automatic Transmission
1228
GN
0.75
A
Pressure Control (PC) Solenoid Valve
B
1229
WH
0.75
5
AT Inline 20-Way Connector
1229
L-BU/WH
0.35
29
Transmission Control Module (TCM)
Feedback
PC Solenoid Valve Low Control

The pressure control (PC) solenoid valve regulates actuator feed fluid passing through the solenoid into torque signal pressure. The TCM uses a pulse width modulated signal in order to control the torque signal pressure. The TCM compares various inputs in order to determine the appropriate pressure for a given load. The TCM varies the current to the PC solenoid from 0.1 amps, for maximum line pressure to 1.1 amps, for minimum line pressure. An internal current monitor within the TCM provides feedback in order to determine actual PC solenoid valve current draw.

If the TCM detects a continuous open, short to voltage or short to ground in the PC solenoid circuit, then DTC P0748 sets. DTC P0748 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0748 Pressure Control (PC) Solenoid Control Circuit

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

The PC solenoid valve feedback circuit indicates a continuous open or short to ground for greater than 1.2 seconds.

Action Taken When the DTC Sets

- The TCM does not request the ECM to illuminate the malfunction indicator lamp (MIL).
- SERVICE VEHICLE SOON displays on the driver information centre (DIC).
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- The TCM stores DTC P0748 in TCM history.

Conditions for Clearing the DIC/DTC

- The TCM clears the DIC when the condition no longer exists.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. This step verifies the ability of the TCM to command the PC solenoid valve.

3. This step verifies that the automatic transmission wiring harness and the PC solenoid have correct resistance.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
	1. Install a scan tool. 2. Turn ON the ignition, with the			

2	engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM and the TCM Failure Records. Using the Clear Info function erases the Failure Records from the ECM and TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Failure Records. 4. Clear the DTC. 5. Start the engine. 6. Using the scan tool, increase and decrease the PC solenoid amperage. 7. Observe the scan tool display. Does the PC Sol. Actual Current reading vary from the PC Sol. Ref. Current reading by more than the specified amount?	0.05 amps	Go to Step 3	Go to Testing for Intermittent Conditions and Poor Connections
3	1. Turn OFF the ignition. 2. Disconnect the Automatic transmission inline 20-way connector. Additional DTCs may set. 3. Install the J 45681 on the transmission side of the Automatic transmission inline 20-way connector. 4. Using the DMM and the J 35616 , measure the resistance between the PC solenoid valve high control and PC solenoid valve low control circuits of the J 45681 . Component Connector End Views . Is the resistance within the specified range?	3.5-5.5 Ω	Go to Step 7	Go to Step 4
4	Is the resistance greater than the specified value?	5.5 Ω	Go to Step 5	Go to Step 6
	1. Test the high control circuit of the PC solenoid valve for an open between the Automatic transmission inline 20-way connector and the PC solenoid			

5	valve. 2. Test the low control circuit of the PC solenoid valve for an open between the Automatic transmission inline 20-way connector and the PC solenoid valve. Refer to Testing for Continuity . Did you find a condition?	--	Go to Step 18	Go to Step 19
6	Test the high control circuit and the low control circuit of the PC solenoid valve for being shorted together between the Automatic transmission inline 20-way connector and the PC solenoid. Refer to Circuit Testing . Did you find the condition?	--	Go to Step 18	Go to Step 19
7	Measure the resistance from the PC solenoid valve high control circuit of the jumper harness to ground. Is the resistance less than the specified value?	10 Ω	Go to Step 8	Go to Step 9
8	1. Test the high control circuit of the PC solenoid valve for a short to ground between the Automatic transmission inline 20-way connector and the PC solenoid. 2. Test the low control circuit of the PC solenoid valve for a short to ground between the Automatic transmission inline 20-way connector and the PC solenoid. Refer to Testing for Short to Ground . Did you find a condition?	--	Go to Step 18	Go to Step 19
9	Measure the resistance between the PC solenoid valve high control circuit and all other terminals, except the PC solenoid valve low control circuit, of the J 45681 . Refer to Component Connector End Views . Is the resistance less than the specified value?	100 Ω	Go to Step 18	Go to Step 10
	1. Disconnect the J 45681 from the transmission side of the Automatic transmission inline 20-way			

10	connector. 2. Install the J 45681 on the TCM side of the Automatic transmission inline 20-way connector. 3. Disconnect the TCM. Additional DTCs may set. 4. Using the DMM and the J 35616 , measure the resistance from the PC solenoid valve low control circuit of the J 45681 to ground. Refer to Component Connector End Views . Is the resistance less than the specified value?	10 Ω	Go to Step 11	Go to Step 12
11	Test the low control circuit of the PC solenoid valve for a short to ground between the TCM connector and the Automatic transmission inline 20-way connector. Refer to Testing for Short to Ground and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 21	--
12	Using the DMM and the J 35616 , measure the resistance of the PC solenoid valve control circuit between the J 35616 and the TCM connector. Refer to Component Connector End Views . Is the resistance less than the specified value?	10 Ω	Go to Step 14	Go to Step 13
13	Test the low control circuit of the PC solenoid valve for an open between the TCM connector and the Automatic transmission inline 20-way connector. Refer to Component Connector End Views and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 21	--
14	Using the DMM and the J 35616 , measure the resistance from the PC solenoid valve high control circuit of the J 45681 to ground. Refer to Component Connector End Views .	10 Ω		

	Is the resistance less than the specified value?		Go to Step 15	Go to Step 16
15	Test the high control circuit of the PC solenoid valve for a short to ground between the TCM connector and the Automatic transmission inline 20-way connector. Refer to Testing for Short to Ground and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 21	--
16	Using the DMM and the J 35616 , measure the resistance of the PC solenoid valve high control circuit between the J 45681 and the TCM connector. Refer to Component Connector End Views . Is the resistance less than the specified value?	10 Ω	Go to Step 20	Go to Step 17
17	Test the high control circuit of the PC solenoid valve for an open between the TCM connector and the Automatic transmission inline 20-way connector. Refer to Testing for Continuity and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 21	--
18	Replace the automatic transmission wiring harness. Refer to Transmission Internal Electrical Harness Replacement . Is the action complete?	--	Go to Step 21	--
19	Replace the PC solenoid. Refer to Pressure Control Solenoid Valve Replacement . Is the action complete?	--	Go to Step 21	--
20	Replace the TCM. Refer to Diagnostic System Check - Vehicle for replacement, set-up and programming. Is the action complete?	--	Go to Step 21	--
	Perform the following procedure in order to verify the repair:			

21	1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Start and idle the engine. • System voltage must be at least 11 volts. 4. Select Specific DTC. 5. Enter DTC P0748. Has the test run and passed?	--	Go to Step 22	Go to Step 2
22	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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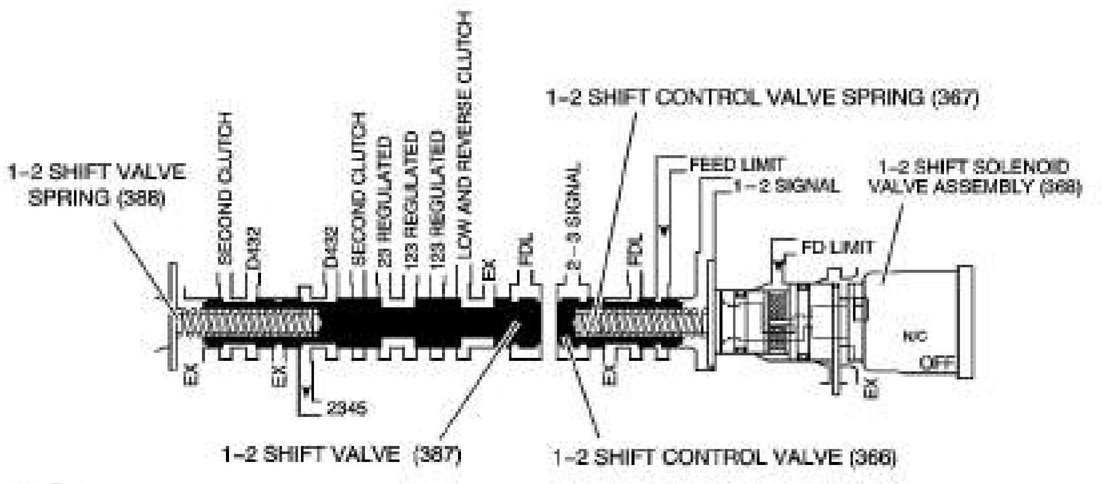
DTC P0751

Circuit Description


1-2 SHIFT VALVE SPRING (388)
SECOND CLUTCH
D432
D432
SECOND CLUTCH
23 REGULATED
123 REGULATED
123 REGULATED
LOW AND REVERSE CLUTCH
EX
FDL
2-3 SIGNAL
FDL
1-2 SHIFT CONTROL VALVE SPRING (367)
FEED LIMIT
1-2 SIGNAL
1-2 SHIFT SOLENOID VALVE ASSEMBLY (368)
FD LIMIT
N/C
OFF
EX
EX
EX
2345
EX
EX
1-2 SHIFT VALVE (387)
1-2 SHIFT CONTROL VALVE (366)

The 1-2 shift solenoid (SS) valve is a normally closed exhaust valve that, in conjunction with the 2-3 (SS) valve, allows 4 different shifting combinations. The 1-2 SS valve is attached to the control valve body, within the transmission.

The Transmission Control Module (TCM) monitors the actual gear ratio, and compares the actual gear ratio with the commanded gear ratio. DTC P0751 sets under two conditions:

- A stuck ON 1-2 SS valve
- A stuck ON 1-2 shift valve

If the TCM detects a 2-2-3-3-3 shift pattern, then DTC P0751 sets. DTC P0751 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0751 1-2 Shift Solenoid (SS) Valve Performance - No First, Fourth or Fifth Gear

Conditions for Running the DTC

- No throttle system DTC P0120.
- No Input Speed Sensor (ISS) DTCs P0716 or P0717.
- No Output Speed Sensor (OSS) DTCs P0722 or P0723.
- No Torque Converter Clutch (TCC) stuck ON DTC P0742.

- No shift solenoid electrical DTCs P0973, P0974, P0976, P0977, P0979, or P0980.
- No Internal Mode Switch (IMS) DTCs P1815, P1820, P1822, P1823, P1825 or P1826.
- No engine torque delivered signal DTC P2637.
- The engine run time is greater than 5 seconds.
- The IMS does not indicate PARK, NEUTRAL or REVERSE.
- The transmission fluid temperature is 20-130°C (68-266°F).
- The throttle position is 10 percent or more.
- The input shaft speed is 200-6,800 RPM.
- The output shaft speed is greater than 100 RPM.

Conditions for Setting the DTC

Both of the following conditions must occur twice during the same trip:

- The TCM commands 1st gear when the engine torque is greater than 40 N·m (30 lb. ft) and the resulting gear ratio is 2.16:1-2.27:1 for 1.25 seconds.
- The TCM commands 4th or 5th gear when the engine torque is greater than 36 N·m (27 lb. ft) and the resulting gear ratio is 1.56:1-1.64:1 for 5 seconds.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM inhibits Autograde.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0751 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

- If you clear DTC P0751, and then cannot reset DTC P0751, the following conditions may exist:
  - Fluid contamination
  - Plugged fluid circuits
  - Restricted fluid circuits
- Refer to Shift Solenoid Valve State and Gear Ratio .

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. This step verifies a 2-2-3-3-3 shift pattern.

4. This step tests for a mechanical or hydraulic condition causing the 1-2 SS valve to be stuck ON, or the circuit to be released.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	Perform the Transmission Fluid Checking Procedure. Refer to Transmission Fluid Check . Did you perform the Transmission Fluid Checking Procedure?	--	Go to Step 3	Go to Transmission Fluid Check .
3	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Use the scan tool snapshot mode in order to record commanded gear and gear ratio. 6. Drive the vehicle in D5, in order to	1st 2.16:1-2.27:1 4th/5th 1.56:1-1.64:1		

	obtain 1-2, 2-3, 3-4, and 4-5 shifts with a throttle position angle of 10 percent or greater. Are the commanded gear and gear ratio within the specified range?		Go to Step 4	Go to Testing for Intermittent Conditions and Poor Connections
4	1. Inspect the 1-2 shift circuit for the following conditions: • 1-2 SS valve mechanically stuck ON • Refer to Shift Solenoid Leak Test . • 1-2 SS valve O-ring worn or damaged • 1-2 shift valve stuck in the released position. Refer to 1-2 Shift Solenoid Valve Replacement . 2. Repair the circuit as necessary. Did you complete the repair?	--	Go to Step 5	--
5	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Drive the vehicle in D5 with a throttle angle of 10 percent or greater. • Allow the transmission to shift through all the gears 2 times. • Monitor the commanded gear and gear ratios. The actual gear ratios must match the commanded gears for 1 second, for all gears. 4. Select Specific DTC. 5. Enter DTC P0751. Has the test run and passed?	--	Go to Step 6	Go to Step 2
6	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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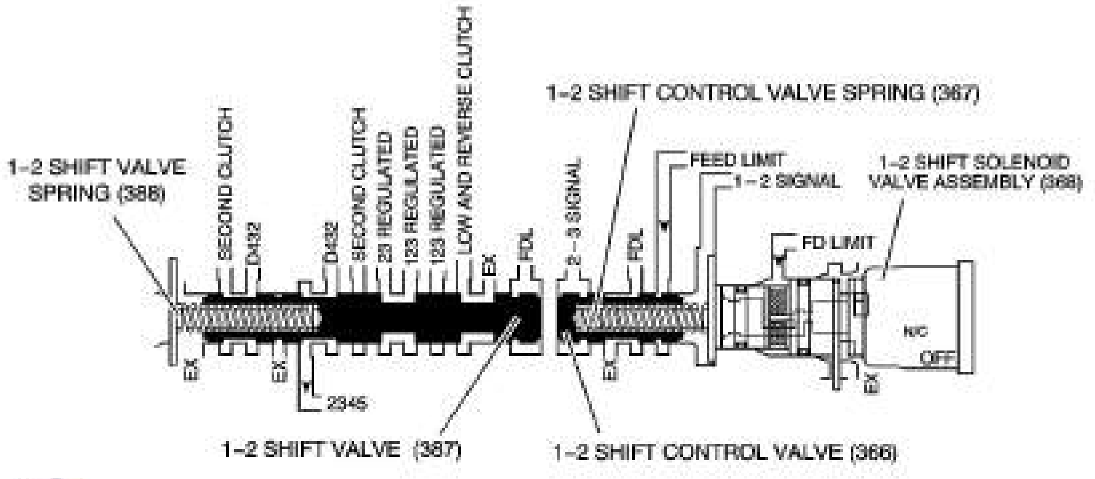
DTC P0752

Circuit Description


1-2 SHIFT VALVE SPRING (388)
SECOND CLUTCH
D432
D432
SECOND CLUTCH
23 REGULATED
123 REGULATED
123 REGULATED
LOW AND REVERSE CLUTCH
EX
FDL
2-3 SIGNAL
1-2 SHIFT CONTROL VALVE SPRING (367)
FDL
FEED LIMIT
1-2 SIGNAL
1-2 SHIFT SOLENOID VALVE ASSEMBLY (368)
FD LIMIT
N/C
OFF
EX
EX
EX
2345
EX
1-2 SHIFT VALVE (387)
1-2 SHIFT CONTROL VALVE (366)

The 1-2 shift solenoid (SS) valve is a normally-closed exhaust valve that, in conjunction with the 2-3 shift solenoid (SS) valve, allows 4 different shifting combinations. The 1-2 SS valve is attached to the control valve body, within the transmission.

The TCM monitors the actual gear ratio, and compares the actual gear ratio with the commanded gear ratio. DTC P0752 sets under two conditions:

- A stuck OFF 1-2 SS valve
- A stuck OFF 1-2 shift valve

If the TCM detects a 1-1-4-4-5 shift pattern, then DTC P0752 sets. DTC P0752 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0752 1-2 Shift Solenoid (SS) Valve Performance - No Second or Third Gear

Conditions for Running the DTC

- No throttle system DTCs P0120.
- No ISS DTCs P0716 or P0717.
- No OSS DTCs P0722 or P0723.
- No TCC stuck ON DTC P0742.

- No shift solenoid electrical DTCs P0973, P0974, P0976, P0977, P0979, or P0980.
- No IMS DTCs P1815, P1820, P1822, P1823, P1825 or P1826.
- No engine delivered torque signal DTC P2637.
- The engine run time is greater than 5 seconds.
- The IMS does not indicate PARK, NEUTRAL or REVERSE.
- The transmission fluid temperature is 20-130°C (68-266°F).
- The throttle position is 10 percent or more.
- The input shaft speed is 200-6,800 RPM.
- The output shaft speed is greater than 100 RPM.

Conditions for Setting the DTC

Both of the following conditions must occur twice during the same trip:

- The TCM commands 2nd gear when the engine torque is greater than 32 N·m (24 lb. ft) and the resulting gear ratio is 3.33:1-3.50:1 for 2 seconds.
- The TCM commands 3rd gear when the engine torque is greater than 32 N·m (24 lb. ft) and the resulting gear ratio is 0.98:1-1.03:1 for 5 seconds.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM inhibits 3-2 downshifts if the vehicle speed is greater than 8 km/h (5 mph).
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0752 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

- If you clear DTC P0752, and then cannot reset DTC P0752, the following conditions may exist:
  - Fluid contamination
  - Plugged fluid circuits
  - Restricted fluid circuits
- Refer to Shift Solenoid Valve State and Gear Ratio .

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. This step verifies a 1-1-4-4-5 shift pattern.

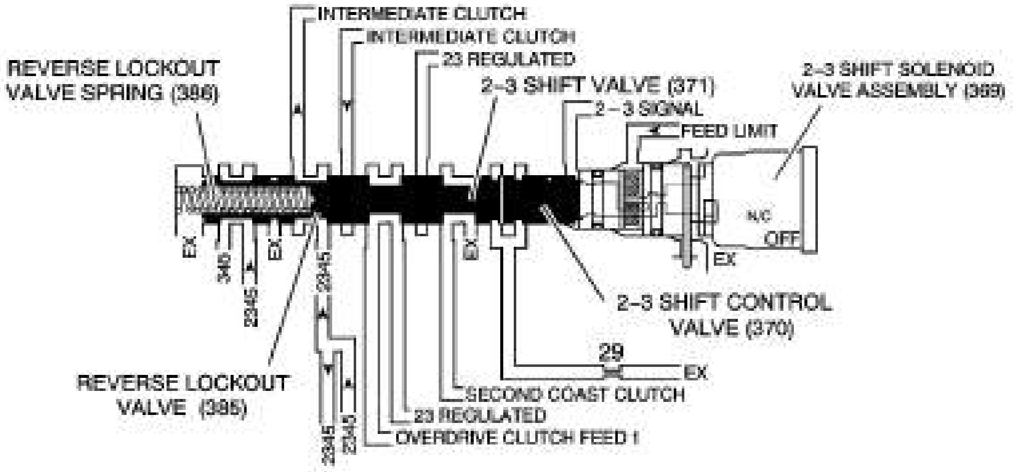
4. This step tests for a mechanical or hydraulic condition causing the 1-2 SS valve to be stuck OFF, or the circuit to be applied.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	Perform the Transmission Fluid Checking Procedure. Refer to Transmission Fluid Check . Did you perform the Transmission Fluid Checking Procedure?	--	Go to Step 3	Go to Transmission Fluid Check .
3	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Use the scan tool snapshot mode in order to record commanded gear and gear ratio.	2nd 3.33:1-3.50:1 3rd 0.98:1-1.03:1		

	6. Drive the vehicle in D5, in order to obtain 1-2, 2-3, 3-4, and 4-5 shifts with a throttle position angle of 10 percent or greater. Are the commanded gear and gear ratio within the specified range?		Go to Step 4	Go to Testing for Intermittent Conditions and Poor Connections
4	1. Inspect the 1-2 shift circuit for the following conditions: • 1-2 SS valve mechanically stuck OFF • Refer to Shift Solenoid Leak Test . • 1-2 SS valve O-ring worn or damaged • 1-2 shift valve stuck in the applied position 2. Repair the circuit as necessary. Refer to 1-2 Shift Solenoid Valve Replacement . Did you complete the repair?	--	Go to Step 5	--
5	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Drive the vehicle in D5 with a throttle angle of 10 percent or greater. • Allow the transmission to shift through all the gears 2 times. • Monitor the commanded gear and gear ratios. The actual gear ratios must match the commanded gears for 1 second, for all gears. 4. Select Specific DTC. 5. Enter DTC P0752. Has the test run and passed?	--	Go to Step 6	Go to Step 2
6	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0756

Circuit Description


INTERMEDIATE CLUTCH
INTERMEDIATE CLUTCH
23 REGULATED
REVERSE LOCKOUT VALVE SPRING (386)
2-3 SHIFT VALVE (371)
2-3 SHIFT SOLENOID VALVE ASSEMBLY (369)
2-3 SIGNAL
FEED LIMIT
N/C
OFF
EX
EX
340
EX
2345
2345
EX
2-3 SHIFT CONTROL VALVE (370)
29
EX
REVERSE LOCKOUT VALVE (385)
SECOND COAST CLUTCH
23 REGULATED
OVERDRIVE CLUTCH FEED 1
2345
2345

The 2-3 shift solenoid (SS) valve is a normally-closed exhaust valve that, in conjunction with the 1-2 shift solenoid (SS) valve, allows 4 different shifting combinations. The 2-3 SS valve is attached to the control valve body, within the transmission.

The TCM monitors the actual gear ratio, and compares the actual gear ratio with the commanded gear ratio. DTC P0756 sets under two conditions:

- A stuck OFF 2-3 SS valve
- A stuck OFF 2-3 shift valve

If the TCM detects a 5-3-4-4-5 shift pattern, then DTC P0756 sets. DTC P0756 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0756 2-3 Shift Solenoid (SS) Valve Performance - No First or Second Gear

Conditions for Running the DTC

- No throttle system DTC P0120.
- No ISS DTCs P0716 or P0717.
- No OSS DTCs P0722 or P0723.
- No TCC stuck ON DTC P0742.

- No shift solenoid electrical DTCs P0973, P0974, P0976, P0977, P0979, or P0980.
- No IMS DTCs P1815, P1820, P1822, P1823, P1825 or P1826.
- No engine delivered torque signal DTC P2637.
- The engine run time is greater than 5 seconds.
- The IMS does not indicate PARK, NEUTRAL or REVERSE.
- The transmission fluid temperature is 20-130°C (68-266°F).
- The throttle position is 10 percent or more.
- The input shaft speed is 200-6,800 RPM.
- The output shaft speed is greater than 200 RPM.

Conditions for Setting the DTC

Both of the following conditions must occur during the same trip:

- The TCM commands 1st gear when the output shaft speed is 200 RPM or greater, the engine torque is greater than 40 N·m (30 lb. ft), and the resulting gear ratio is 0.73:1-0.77:1 for 2.8 seconds.
- The TCM commands 2nd gear when the engine torque is greater than 36 N·m (27 lb. ft) and the resulting gear ratio is 1.56:1-1.64:1 for 1 second.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM inhibits 1st gear.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0756 in TCM history.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

- If you clear DTC P0756, and then cannot reset DTC P0756, the following conditions may exist:
  - Fluid contamination
  - Plugged fluid circuits
  - Restricted fluid circuits
- Refer to Shift Solenoid Valve State and Gear Ratio .

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. This step verifies a 5-3-4-4-5 shift pattern.

4. This step tests for a mechanical or hydraulic condition causing the 2-3 SS valve to be stuck OFF, or the circuit to be applied.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	Perform the Transmission Fluid Checking Procedure. Refer to Transmission Fluid Check . Did you perform the Transmission Fluid Checking Procedure?	--	Go to Step 3	Go to Transmission Fluid Check .
3	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Use the scan tool snapshot mode in order to record commanded gear and gear ratio. 6. Drive the vehicle in D5, in order to	1st 0.73:1-0.77:1 2nd 1.56:1-1.64:1		

	obtain 1-2, 2-3, 3-4, and 4-5 shifts with a throttle position angle of 10 percent or greater. Are the commanded gear and gear ratio within the specified range?		Go to Step 4	Go to Testing for Intermittent Conditions and Poor Connections
4	1. Inspect the 2-3 shift circuit for the following conditions: • 2-3 SS valve mechanically stuck OFF • Refer to 2-3 Shift Solenoid Valve Replacement . • 2-3 SS valve O-ring worn or damaged • 2-3 shift valve stuck in the applied position 2. Repair the circuit as necessary. Refer to 1-2 Shift Solenoid Valve Replacement . Did you complete the repair?	--	Go to Step 5	--
5	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Drive the vehicle in D5 with a throttle angle of 10 percent or greater. • Allow the transmission to shift through all the gears. • Monitor the commanded gear and gear ratios. The actual gear ratios must match the commanded gears for 1 second, for all gears. 4. Select Specific DTC. 5. Enter DTC P0756. Has the test run and passed?	--	Go to Step 6	Go to Step 2
6	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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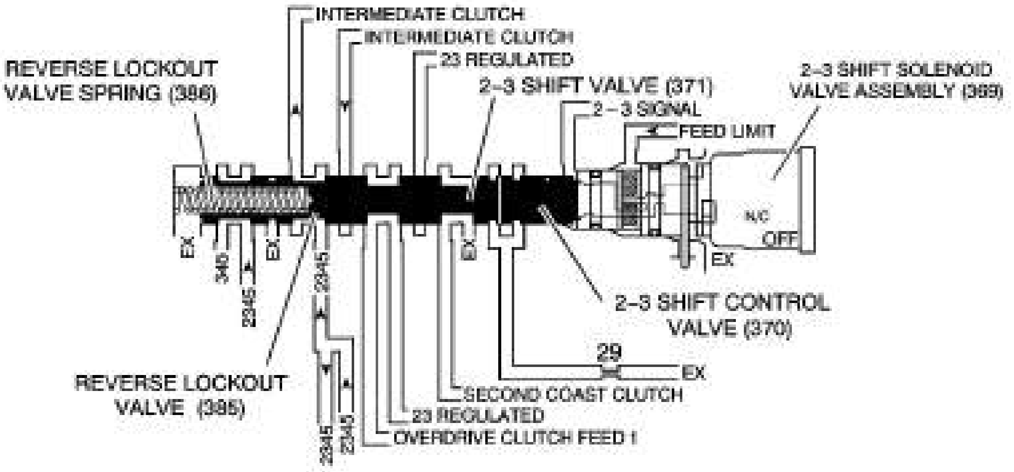
DTC P0757

Circuit Description


INTERMEDIATE CLUTCH
INTERMEDIATE CLUTCH
23 REGULATED
REVERSE LOCKOUT VALVE SPRING (386)
2-3 SHIFT VALVE (371)
2-3 SHIFT SOLENOID VALVE ASSEMBLY (369)
2-3 SIGNAL
FEED LIMIT
N/C
OFF
EX
EX
340
2345
EX
2345
EX
2-3 SHIFT CONTROL VALVE (370)
29
EX
REVERSE LOCKOUT VALVE (385)
SECOND COAST CLUTCH
23 REGULATED
OVERDRIVE CLUTCH FEED 1
2345
2345

The 2-3 shift solenoid (SS) valve is a normally-closed exhaust valve that, in conjunction with the 1-2 shift solenoid (SS) valve, allows 4 different shifting combinations. The 2-3 SS valve is attached to the control valve body, within the transmission.

The TCM monitors the actual gear ratio, and compares the actual gear ratio with the commanded gear ratio. DTC P0757 sets under two conditions:

- A stuck ON 2-3 SS valve
- A stuck ON 2-3 shift valve

If the TCM detects a 1-2-2-1-1 shift pattern, then DTC P0757 sets. DTC P0757 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0757 2-3 Shift Solenoid (SS) Valve Performance - No Third, Fourth or Fifth Gear

Conditions for Running the DTC

- No throttle system DTC P0120.
- No ISS DTCs P0716 or P0717.
- No OSS DTCs P0722 or P0723.
- No TCC stuck ON DTC P0742.

- No shift solenoid electrical DTCs P0973, P0974, P0976, P0977, P0979, or P0980.
- No IMS DTCs P1815, P1820, P1822, P1823, P1825 or P1826.
- No engine delivered torque signal DTC P2637.
- The engine run time is greater than 5 seconds.
- The IMS does not indicate PARK, NEUTRAL or REVERSE.
- The transmission fluid temperature is 20-130°C (68-266°F).
- The throttle position is 10 percent or more.
- The input shaft speed is 200-6,800 RPM.
- The output shaft speed is greater than 100 RPM.

Conditions for Setting the DTC

Both of the following conditions must occur once during the same trip:

- The TCM commands 3rd gear when the output shaft speed is 200 RPM or greater, the engine torque is greater than 20 N·m (15 lb. ft), and the resulting gear ratio is 2.16:1-2.27:1 for 2 seconds.
- The TCM commands 4th or 5th gear when the engine torque is greater than 12 N·m (9 lb. ft) and the resulting gear ratio is 3.33:1-3.50:1 for 2 seconds.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM inhibits 4th and 5th gears.
- The TCM inhibits TCC.
- The TCM inhibits Autograde.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0757 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

- If you clear DTC P0757, and then cannot reset DTC P0757, the following conditions may exist:
  - Fluid contamination
  - Plugged fluid circuits
  - Restricted fluid circuits
- Refer to Shift Solenoid Valve State and Gear Ratio .

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. This step verifies a 1-2-2-1-1 shift pattern.

4. This step tests for a mechanical or hydraulic condition causing the 2-3 SS valve to be stuck ON, or the circuit to be released.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	Perform the Transmission Fluid Checking Procedure. Refer to Transmission Fluid Check . Did you perform the Transmission Fluid Checking Procedure?	--	Go to Step 3	Go to Transmission Fluid Check .
3	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC.	3rd 2.16:1-2.27:1 4th/5th 3.33:1-3.50:1		

	5. Use the scan tool snapshot mode in order to record commanded gear and gear ratio. 6. Drive the vehicle in D5, in order to obtain 1-2, 2-3, 3-4, and 4-5 shifts with a throttle position angle of 10 percent or greater. Are the commanded gear and gear ratio within the specified range?		Go to Step 4	Go to Testing for Intermittent Conditions and Poor Connections
4	1. Inspect the 2-3 shift circuit for the following conditions: - 2-3 SS valve mechanically stuck ON - Refer to Shift Solenoid Leak Test . - 2-3 SS valve O-ring worn or damaged - 2-3 shift valve stuck in the released position 2. Repair the circuit as necessary. Refer to 2-3 Shift Solenoid Valve Replacement . Did you complete the repair?	--	Go to Step 5	--
5	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: - Drive the vehicle in D5 with a throttle angle of 10 percent or greater. - Allow the transmission to shift through all the gears. - Monitor the commanded gear and gear ratios. The actual gear ratios must match the commanded gears for 1 second, for all gears. 4. Select Specific DTC. 5. Enter DTC P0757. Has the test run and passed?	--	Go to Step 6	Go to Step 2
6	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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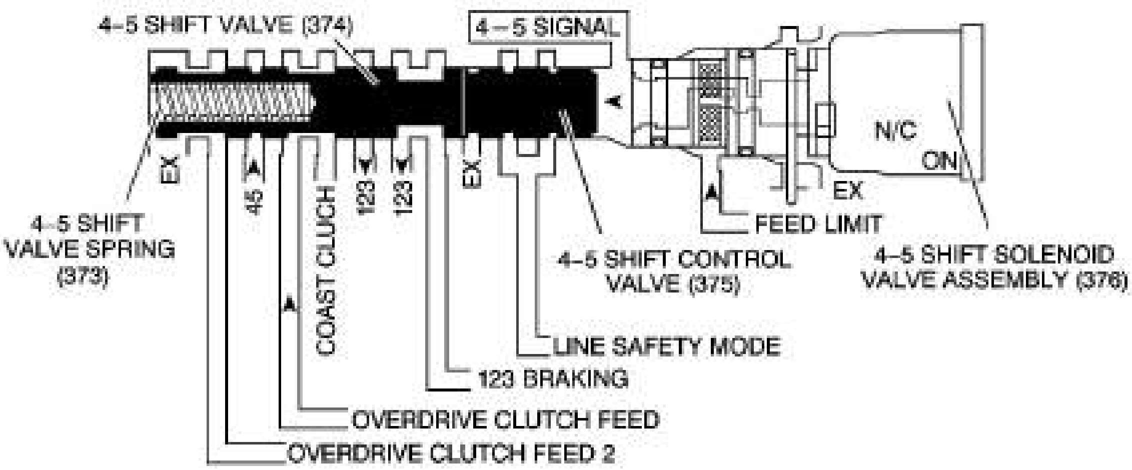
DTC P0761

Circuit Description


4-5 SHIFT VALVE (374)
4–5 SIGNAL
N/C
ON
EX
FEED LIMIT
4-5 SHIFT SOLENOID VALVE ASSEMBLY (376)
4-5 SHIFT CONTROL VALVE (375)
4-5 SHIFT VALVE SPRING (373)
EX
45
COAST CLUCH
123
123
EX
LINE SAFETY MODE
123 BRAKING
OVERDRIVE CLUTCH FEED
OVERDRIVE CLUTCH FEED 2

The 4-5 shift solenoid (SS) valve is a normally-closed exhaust valve. When the 1-2 and the 2-3 SS valves are both OFF, the 4-5 SS valve turns off to shift the transmission into 5th gear. When either of the other two shift solenoids are ON, the 4-5 SS allows powertrain braking. The 4-5 SS valve is attached to the control valve body, within the transmission.

The transmission control module (TCM) monitors the actual gear ratio, and compares the actual gear ratio with the commanded gear ratio. DTC P0761 sets under two conditions:

- A stuck OFF 4-5 SS valve
- A stuck OFF 4-5 shift valve

If the TCM detects a 1-2-3-5-5 shift pattern, then DTC P0761 sets. DTC P0761 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0761 4-5 Shift Solenoid (SS) Valve Performance - No Fourth Gear

Conditions for Running the DTC

- No throttle system DTC P0120.
- No ISS DTCs P0716 or P0717.
- No OSS DTCs P0722 or P0723.

- No TCC stuck ON DTC P0742.
- No shift solenoid electrical DTCs P0973, P0974, P0976, P0977, P0979, or P0980.
- No IMS DTCs P1815, P1820, P1822, P1823, P1825 or P1826.
- No engine delivered torque signal DTC P2637.
- The engine run time is greater than 5 seconds.
- The IMS does not indicate PARK, NEUTRAL or REVERSE.
- The transmission fluid temperature is 20-130°C (68-266°F).
- The throttle position is 10 percent or more.
- The input shaft speed is 200-6,800 RPM.
- The output shaft speed is greater than 100 RPM.

Conditions for Setting the DTC

The following conditions must occur twice during the same trip:

- The TCM commands 4th gear for 1 second.
- The engine torque is greater than 36 N·m (27 lb. ft).
- The resulting gear ratio is 0.73:1-0.77:1 for 4 seconds.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM inhibits powertrain braking.
- The TCM inhibits Autograde.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0761 in TCM history.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

- If you clear DTC P0761, and then cannot reset DTC P0761, the following conditions may exist:
  - Fluid contamination
  - Plugged fluid circuits
  - Restricted fluid circuits
- Refer to Shift Solenoid Valve State and Gear Ratio .

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. This step verifies a 1-2-3-5-5 shift pattern.

4. This step tests for a mechanical or hydraulic condition causing the 4-5 SS valve to be stuck OFF, or the circuit to be applied.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	Perform the Transmission Fluid Checking Procedure. Refer to Transmission Fluid Check . Did you perform the Transmission Fluid Checking Procedure?	--	Go to Step 3	Go to Transmission Fluid Check .
3	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Use the scan tool snapshot mode in order to record commanded gear and gear ratio.	4th 0.73:1-0.77:1		

	6. Drive the vehicle in D5, in order to obtain 1-2, 2-3, 3-4, and 4-5 shifts with a throttle position angle of 10 percent or greater. Are the commanded gear and gear ratio within the specified range?		Go to Step 4	Go to Testing for Intermittent Conditions and Poor Connections
4	1. Inspect the 4-5 shift circuit for the following conditions: • 4-5 SS valve mechanically stuck OFF • Refer to Shift Solenoid Leak Test . • 4-5 SS valve O-ring worn or damaged • 4-5 shift valve stuck in the applied position 2. Repair the circuit as necessary. Refer to 4-5 Shift Solenoid Valve Replacement . Did you complete the repair?	--	Go to Step 5	--
5	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Drive the vehicle in D5 with a throttle angle of 10 percent or greater. • Allow the transmission to shift through all the gears 2 times. • Monitor the commanded gear and gear ratios. The actual gear ratios must match the commanded gears for 1 second, for all gears. 4. Select Specific DTC. 5. Enter DTC P0761. Has the test run and passed?	--	Go to Step 6	Go to Step 2
6	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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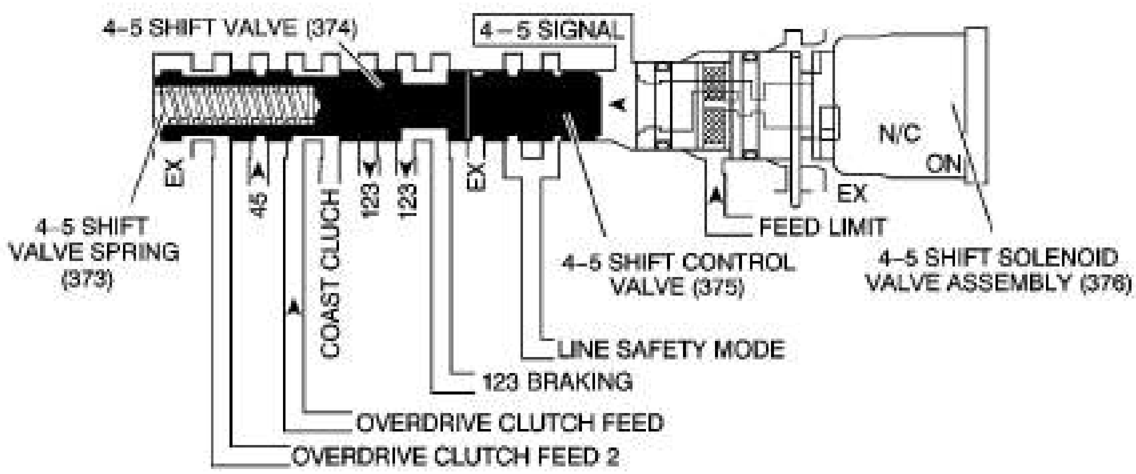
DTC P0762

Circuit Description


4-5 SHIFT VALVE (374)
4-5 SIGNAL
N/C
ON
EX
EX
EX
45
COAST CLUCH
123
123
FEED LIMIT
4-5 SHIFT VALVE SPRING (373)
4-5 SHIFT CONTROL VALVE (375)
4-5 SHIFT SOLENOID VALVE ASSEMBLY (376)
LINE SAFETY MODE
123 BRAKING
OVERDRIVE CLUTCH FEED
OVERDRIVE CLUTCH FEED 2

The 4-5 shift solenoid (SS) valve is a normally-closed exhaust valve. When the 1-2 and the 2-3 SS valves are both OFF, the 4-5 SS valve turns OFF to shift the transmission into 5th gear. When either of the other two shift solenoids are ON, the 4-5 SS turn OFF in order to enable powertrain braking. The 4-5 SS valve is attached to the control valve body, within the transmission.

The transmission control module (TCM) monitors the actual gear ratio, and compares the actual gear ratio with the commanded gear ratio. DTC P0762 sets under two conditions:

- A stuck ON 4-5 SS valve
- A stuck ON 4-5 shift valve

If the TCM detects a 1-2-3-4-4 shift pattern, then DTC P0762 sets. DTC P0762 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0762 4-5 Shift Solenoid (SS) Valve Performance - No Fifth Gear

Conditions for Running the DTC

- No throttle system DTC P0120.
- No ISS DTCs P0716 or P0717.
- No OSS DTCs P0722 or P0723.

- No TCC stuck ON DTC P0742.
- No shift solenoid electrical DTCs P0973, P0974, P0976, P0977, P0979, or P0980.
- No IMS DTCs P1815, P1820, P1822, P1823, P1825 or P1826.
- No engine delivered torque signal DTC P2637.
- The engine run time is greater than 5 seconds.
- The IMS does not indicate PARK, NEUTRAL or REVERSE.
- The transmission fluid temperature is 20-130°C (68-266°F).
- The throttle position is greater than 10 percent.
- The input shaft speed is 200-6,800 RPM.
- The output shaft speed is greater than 100 RPM.

Conditions for Setting the DTC

The following conditions must occur twice during the same trip:

- The TCM has commanded either 2nd or 3rd gear for 3 seconds or greater.
- The TCM commands 5th gear for 1 second.
- The engine torque is greater than 36 N·m (27 lb. ft).
- The resulting gear ratio is 0.98:1-1.03:1 for 3.5 seconds.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM inhibits powertrain braking.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0762 in TCM history.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Diagnostic Aids

- If you clear DTC P0762, and then cannot reset DTC P0762, the following conditions may exist:
  - Fluid contamination
  - Plugged fluid circuits
  - Restricted fluid circuits
- Refer to Shift Solenoid Valve State and Gear Ratio .

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. This step verifies a 1-2-3-4-4 shift pattern.

4. This step tests for a mechanical or hydraulic condition causing the 4-5 SS valve to be stuck ON, or the circuit to be released.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	Perform the Transmission Fluid Checking Procedure. Refer to Transmission Fluid Check . Did you perform the Transmission Fluid Checking Procedure?	--	Go to Step 3	Go to Transmission Fluid Check .
3	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Use the scan tool snapshot mode in order to record commanded gear and gear ratio.	4th 0.98:1-1.03:1		

	6. Drive the vehicle in D5, in order to obtain 1-2, 2-3, 3-4, and 4-5 shifts with a throttle position angle of 10 percent or greater. Are the commanded gear and gear ratio within the specified range?		Go to Step 4	Go to Testing for Intermittent Conditions and Poor Connections
4	1. Inspect the 4-5 shift circuit for the following conditions: - 4-5 SS valve mechanically stuck ON - Refer to Shift Solenoid Leak Test . - 4-5 SS valve O-ring worn or damaged - 4-5 shift valve stuck in the released position 2. Repair the circuit as necessary. Refer to 4-5 Shift Solenoid Valve Replacement . Did you complete the repair?	--	Go to Step 5	--
5	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: - Drive the vehicle in D5 with a throttle angle of 10 percent or greater. - Allow the transmission to shift through all the gears. - Monitor the commanded gear and gear ratios. The actual gear ratios must match the commanded gears for 1 second, for all gears. 4. Select Specific DTC. 5. Enter DTC P0762. Has the test run and passed?	--	Go to Step 6	Go to Step 2
6	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0850

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0850: Park/Neutral Position (PNP) Switch Circuit

Circuit/System Description

The engine control module (ECM) provides 12 volts to the park/neutral switch of the manual shift shaft position switch. The manual shift shaft position switch is a sliding contact assembly that attaches to the manual shift shaft inside the transmission. The switch consists of five separate circuits, four of which indicate gear selector position to the transmission control module (TCM), and one that indicates park/neutral position to the ECM. When the transmission is in PARK or NEUTRAL, the switch closes and pulls the ECM voltage low, 0 volts. When the transmission is not in PARK or NEUTRAL, the ECM voltage is high, 12 volts. The ECM uses the switch in order to enable starter operation.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

DTC P0850 sets when either of the following conditions are true:

Condition 1

The park/neutral switch circuit is low, 0 volts, for 100 seconds while the TCM is reporting the gear selector is in REVERSE or any forward range.

Condition 2

The park/neutral switch circuit is high, 12 volts, for 200 seconds while the TCM is reporting the gear selector is in PARK or NEUTRAL.

Action Taken When the DTC Sets

- DTC P0850 is a Type C DTC.
- The ECM uses the transmission range data to enable engine cranking.

Conditions for Clearing the DTC

DTC P0850 is a Type C DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Transmission General Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Transmission Control Module Scan Tool Information

Circuit/System Verification

If there are any other engine or transmission related DTCs set, diagnose those DTCs first. With a scan tool observe the Park/Neutral switch parameter in the engine controls data list and move the gear shift lever from Park, to Reverse and through all the ranges and observe the parameter as you move the shift lever. The parameter should display Park/Neutral when in Park or Neutral and In-Gear when in Reverse, Drive or Drive Low. Close observation of the Park and Neutral to Drive transitional positions while moving the shift lever and observing for possible misalignment or slack in the shifter mechanism is especially important.

If any concerns are found proceed to Testing.

Circuit/System Testing

Disconnect the transmission 20-way connector and observe the Park/Neutral scan tool parameter in the engine controls data list. The parameter should display In-Gear.

If the Park/Neutral parameter does not display In-Gear test the Park/Neutral signal circuit between the engine side of the transmission 20-way connector and the ECM connector for a short to ground.

If the Park/Neutral parameter displays In-Gear test the transmission IMS for a shorted P/N circuit to ground. Inspect the harness for damage or chaffing.

If the IMS was not shorted to ground, test the IMS Park/Neutral signal circuit form the IMS connector on the TCM side of the 20-way connector for an open or short to ground.

If no concerns are found, replace the ECM. Refer to Control Module References for replacement, setup, and programming.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Refer to Control Module References for replacement, setup, and programming.
- Manual Shift Shaft Position Switch Replacement
- Transmission Internal Electrical Harness Replacement

DTC P0897

Circuit Description

Transmission fluid life is determined by monitoring transmission fluid temperature over a period of time. The transmission control module (TCM) calculates transmission fluid life based on a set of temperature ranges stored in TCM memory. As the vehicle is driven, a counter increments. The rate at which the counter increments depends on the temperature range in which the transmission is currently operating. The higher the temperature range, the faster the counter increments. As the counts increment, the TCM will begin to decrease the fluid life percentage from 100, high fluid life, to 0, low fluid life.

If the TCM detects a calculated transmission oil life of 10 percent or less, then DTC P0897 sets. DTC P0897 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0897 Transmission Fluid Life

Conditions for Running the DTC

- No Transmission Fluid Overtemperature DTC P0218.
- No TFT DTCs P0711, P0712, or P0713.

Conditions for Setting the DTC

The calculated transmission oil life remaining is 10 percent or less.

Action Taken When the DTC Sets

- The TCM does not request the ECM to illuminate the malfunction indicator lamp (MIL).
- CHANGE TRANSMISSION FLUID displays on the driver information centre (DIC).
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- The ECM stores DTC P0897 in TCM history.

Conditions for Clearing the DIC/DTC

- The TCM clears the DIC when the condition no longer exits.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the fault no longer exists and the DTC passes.

Diagnostic Aids

Inspect the transmission cooling system for possible blockage and restrictions.

Test Description

The number below refers to the step number on the diagnostic table.

2. This step changes the Automatic transmission fluid and filter. It is important to reset the oil life monitor after the fluid and filter are replaced.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM and the TCM Failure Records. Using the Clear Info function erases the Failure Records from the ECM and TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Failure Records. 4. Clear the DTC. 5. Replace the transmission fluid and filter. Refer to Automatic Transmission Fluid and Filter Replacement . 6. Use the scan tool in order to reset the transmission oil life. Is the action complete?	--	Go to Step 3	--
3	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Ensure that the transmission oil life monitor displays 99 percent or greater. 4. Select Specific DTC. 5. Enter DTC P0897.	--		

	Has the test run and passed?		Go to Step 4	Go to Step 2
4	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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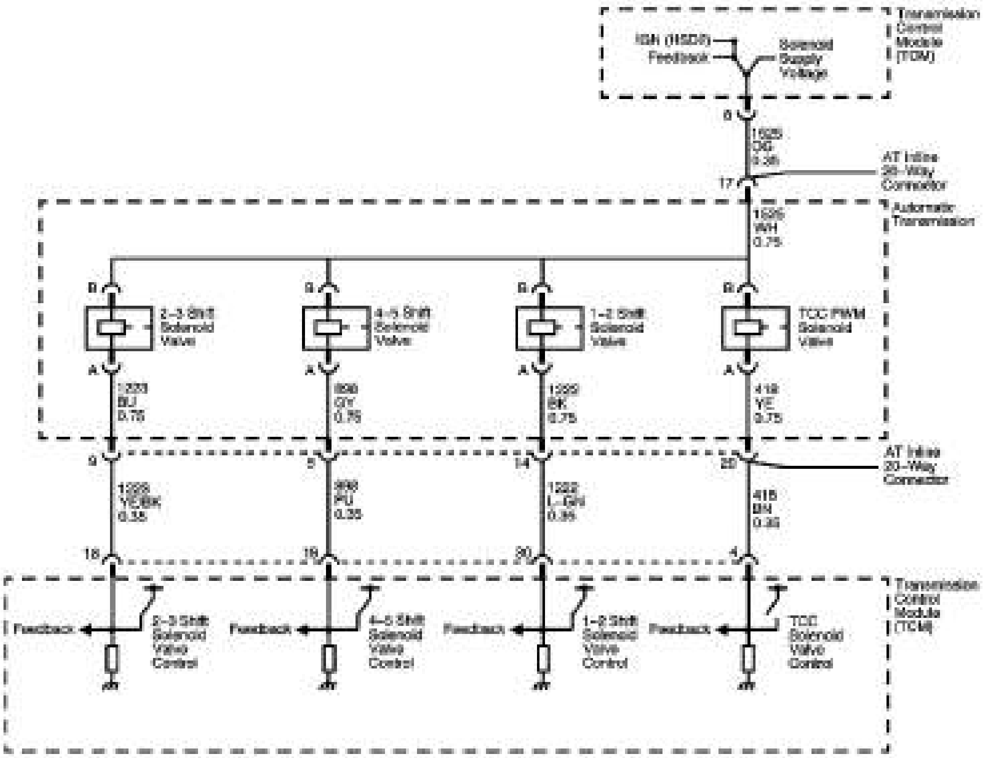
DTC P0973

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit Description


Transmission Control Module (TCM)
IGN (HSD2)
Feedback
Solenoid Supply Voltage
6
1525 OG 0.35
AT Inline 20-Way Connector
17
1526 WH 0.75
Automatic Transmission
B
2-3 Shift Solenoid Valve
4-5 Shift Solenoid Valve
1-2 Shift Solenoid Valve
TCC PWM Solenoid Valve
A
1223 BU 0.75
898 GY 0.75
1222 BK 0.75
418 YE 0.75
9
5
14
20
AT Inline 20-Way Connector
1223 YE/BK 0.35
898 PU 0.35
1222 L-GN 0.35
418 BN 0.35
18
19
30
4
Transmission Control Module (TCM)
Feedback
2-3 Shift Solenoid Valve Control
4-5 Shift Solenoid Valve Control
1-2 Shift Solenoid Valve Control
TCC Solenoid Valve Control

The 1-2 shift solenoid valve is located in the control valve body of the transmission. The transmission control module (TCM) selects the required gear by turning the appropriate solenoid ON or OFF, enabling the transmission to shift. Refer to Shift Solenoid Valve State and Gear Ratio .

The TCM provides voltage to the solenoid through High Side Driver 2 (HSD2). The TCM uses a second driver to control the solenoid ground circuit. The controlled ground driver reports feedback voltage to the TCM. When the TCM commands the 1-2 shift solenoid valve ON, the voltage of the control circuit should be approximately 0 volts. When the TCM commands the 1-2 shift solenoid valve OFF, the voltage of the control circuit should be approximately system voltage.

When the TCM detects a continuous open or short to ground in the 1-2 shift solenoid valve circuit, then DTC P0973 sets. DTC P0973 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0973 1-2 Shift Solenoid (SS) Control Circuit Low Voltage

Conditions for Running the DTC

- The engine run time is greater than 5 seconds.
- HSD2 is commanded ON.

Conditions for Setting the DTC

DTC P0973 sets when either of the following conditions occurs:

- The TCM detects an open in the 1-2 shift solenoid valve circuit when HSD2 is commanded ON.
- The TCM detects a short to ground in the 1-2 shift solenoid valve circuit when HSD2 is commanded OFF.

Action Taken When the DTC Sets

- Powertrain braking is disabled at the time that the TCM first detects the failure, before the DTC sets.
- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive drive trip in which the Conditions for Setting the DTC are met.
- The TCM turns off power to all solenoids. When the solenoids are off:
  - The transmission will operate in fifth gear if the vehicle has successfully completed a 1-2 upshift in the current ignition cycle. If the vehicle has not completed a 1-2 upshift in the current ignition cycle, the transmission will operate in fourth gear. If the transmission is operating in fifth gear, fourth gear may be obtained if the engine is stopped briefly and started again.
  - The line pressure is at maximum.
- The TCM freezes transmission adaptive functions.
- Torque management is inhibited.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0973 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the MIL/DTC.

- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Test Description

The number below refers to the step number on the diagnostic table.

5. Listen for an audible click when the solenoid energizes.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from both the ECM and the TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. Is DTC P0976, P0979 or P2764 also set?	--	Go to Step 3	Go to Step 5
3	Test the ignition 1 voltage circuit of the 1-2 SS valve for an open or a short to ground between the TCM connector and the Automatic transmission inline 20-way connector. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 19	Go to Step 4
4	**Important:** The condition that affects this circuit may exist in other connecting branches of the circuit. Refer to Power Distribution Schematics for complete circuit distribution. Test the ignition 1 voltage circuit of the 1-2 SS valve for an open or a short to ground between the Automatic transmission inline 20-way connector and the 1-2 SS valve. Refer to Circuit Testing .	--		--

	Did you find the condition?		Go to Step 16	
5	1. Use the scan tool in order to command the 1-2 SS valve ON and OFF 3 times. 2. Listen at the transmission bottom pan. Does the solenoid click when commanded ON and OFF?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 6
6	1. Turn OFF the ignition. 2. Disconnect the Automatic transmission inline 20-way connector. Additional DTCs may set. 3. Install the J 45681 jumper harness on the engine side of the Automatic transmission inline 20-way connector. 4. Using the J 35616 , connect a test lamp between the ignition 1 voltage and the 1-2 SS valve control circuits of the J 35616 . Refer to Component Connector End Views . 5. Turn ON the ignition, with the engine OFF. 6. Command the 1-2 SS valve ON and OFF three times. Is the test lamp ON when you command the solenoid ON, and OFF when you command the solenoid OFF?	--	Go to Step 10	Go to Step 7
7	Is the test lamp always ON?	--	Go to Step 8	Go to Step 9
8	Test the control circuit of the 1-2 SS valve for a short to ground between the TCM connector and the Automatic transmission inline 20-way connector. Refer to Testing for Short to Ground and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 19	Go to Step 18
9	Test the control circuit of the 1-2 SS valve for an open between the TCM connector and the Automatic transmission inline 20-way connector. Refer to Testing for Continuity and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 19	Go to Step 18
10	1. Turn OFF the ignition. 2. Disconnect the J 45681 from the engine side of the Automatic transmission inline 20-way connector. 3. Install the J 45681 on the transmission side of the Automatic transmission in line 20-way connector. 4. Using the DMM and the J 35616 , measure the resistance between the ignition 1 voltage and the 1-2 SS valve	19-31 Ω		

	control circuits of the J 45681 . Refer to Component Connector End Views . Is the resistance within the specified range?		Go to Step 13	Go to Step 11
11	Is the resistance greater than the specified value?	31 Ω	Go to Step 12	Go to Step 13
12	1. Test the control circuit of the 1-2 SS valve for an open between the Automatic transmission inline 20-way connector and the 1-2 SS valve. 2. Test the ignition 1 voltage circuit of the 1-2 SS valve for an open between the Automatic transmission inline 20-way connector and the 1-2 SS valve. Refer to Testing for Continuity . Did you find a condition?	--	Go to Step 16	Go to Step 17
13	Measure the resistance from the 1-2 SS valve control circuits of the J 45681 to ground. Refer to Component Connector End Views . Is the resistance less than the specified value?	100 Ω	Go to Step 14	Go to Step 15
14	Test the control circuit of the 1-2 SS valve for a short to ground between the Automatic transmission inline 20-way connector and the 1-2 SS valve. Refer to Testing for Short to Ground . Did you find the condition?	--	Go to Step 16	--
15	Measure the resistance between the 1-2 SS valve control circuits and all other terminals, except the 2-3 SS valve control circuit, the TCC PWM solenoid valve control circuit, and the ignition 1 voltage circuit of the J 45681 . Refer to Component Connector End Views . Is the resistance less than the specified value?	100 Ω	Go to Step 16	Go to Step 17
16	Replace the automatic transmission wiring harness. Refer to Transmission Internal Electrical Harness Replacement . Did you complete the replacement?	--	Go to Step 19	--
17	Replace the 1-2 SS valve. Refer to 1-2 Shift Solenoid Valve Replacement . Did you complete the replacement?	--	Go to Step 19	--
18	Replace the TCM. Refer to Control Module References for replacement, setup, and programming.	--		--

	Did you complete the replacement?		Go to Step 19	
19	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: - Drive the vehicle in D. - Allow the transmission to obtain a 1-2 upshift. 4. Select Specific DTC. 5. Enter DTC P0973. Has the test run and passed?	--	Go to Step 20	Go to Step 2
20	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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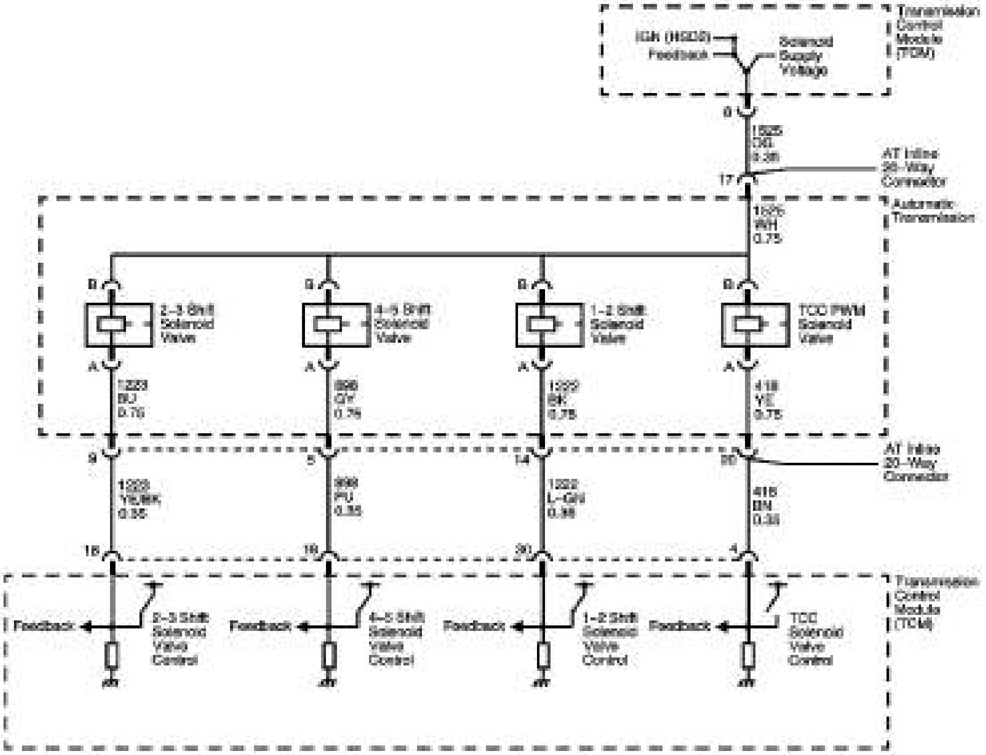
DTC P0974

Circuit Description


Transmission Control Module (TCM)
IGN (HSD2)
Feedback
Solenoid Supply Voltage
8
1525
OG
0.35
AT Inline 20-Way Connector
17
Automatic Transmission
1525
WH
0.75
B
2-3 Shift Solenoid Valve
4-5 Shift Solenoid Valve
1-2 Shift Solenoid Valve
TCC PWM Solenoid Valve
A
1223
BU
0.75
898
GY
0.75
1222
BK
0.75
418
YE
0.75
9
5
14
20
AT Inline 20-Way Connector
1223
YE/BK
0.35
898
PU
0.35
1222
L-GN
0.35
418
BN
0.35
18
19
20
4
Transmission Control Module (TCM)
Feedback
2-3 Shift Solenoid Valve Control
Feedback
4-5 Shift Solenoid Valve Control
Feedback
1-2 Shift Solenoid Valve Control
Feedback
TCC Solenoid Valve Control

The 1-2 shift solenoid valve is located in the control valve body of the transmission. The transmission control module (TCM) selects the required gear by turning the appropriate solenoid ON or OFF, enabling the transmission to shift. Refer to Shift Solenoid Valve State and Gear Ratio .

The TCM provides voltage to the solenoid through High Side Driver 2 (HSD2). The TCM uses a second driver to control the solenoid ground circuit. The controlled ground driver reports feedback voltage to the TCM. When the TCM commands the 1-2 shift solenoid valve ON, the voltage of the control circuit should be approximately 0 volts. When the TCM commands the 1-2 shift solenoid valve OFF, the voltage of the control circuit should be approximately system voltage.

When the TCM detects a continuous short to voltage in the 1-2 shift solenoid valve circuit, then DTC P0974 sets. DTC P0974 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0974 1-2 Shift Solenoid (SS) Control Circuit High Voltage

Conditions for Running the DTC

- The engine run time is greater than 5 seconds.
- HSD2 is commanded ON.

Conditions for Setting the DTC

DTC P0974 sets when the TCM detects a short to voltage in the 1-2 shift solenoid valve circuit.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive drive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM inhibits 3-2 downshifts if the vehicle speed is greater than 8 km/h (5 mph).
- The TCM freezes transmission adaptive functions.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0974 in TCM history.

Diagnostic Aids

DTC P 0974 may set when a communication fault exists between the ECM and TCM. Inspect for DTCs U 2100, U 2104, U 2105 and U 2106. If any of these DTCs are present, diagnose them first.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Test Description

The number below refers to the step number on the diagnostic table.

2. Listen for an audible click when the solenoid energizes.

Step	Action	Value (s)	Yes	No
	Did you perform the Diagnostic System Check -			Go to

1	Vehicle?	--	Go to Step 2	Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. **Important:** - Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. - Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Use the scan tool in order to command the 1-2 shift solenoid ON. Does the solenoid operate?	--	Go to Step 8	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the Automatic transmission 20-way inline harness connector. 3. Install the J 45681 jumper harness to the TCM side of the 20-way connector. 4. Turn ON the ignition with the engine OFF. 5. With the test lamp connected to ground, probe the HSD2 circuit, terminal 17, of the J 45681 . Does the test lamp illuminate?	--	Go to Step 4	Go to Step 6
4	1. Turn OFF the ignition. 2. Install the J 45681 to the transmission side of the 20-way connector. 3. Using the DMM, measure the resistance between terminal 17 and 14 of the J 45681 . Refer to Component Resistance . Is the resistance within the specified range?	15.0-20.3Ω	Go to Step 5	Go to Step 7
5	1. Disconnect the TCM. 2. Test the 1-2 solenoid valve control circuit for a short to voltage. Refer to Testing for a Short to Voltage . Did you find a condition?	--	Go to Step 9	Go to Step 8

6	1. Turn OFF the ignition. 2. Disconnect the TCM. 3. Test the HSD2 circuit from the TCM to the 1-2 solenoid for an open circuit. Refer to Testing for Continuity . Did you find a condition?	--	Go to Step 9	Go to Step 8
7	1. Remove the transmission oil pan. 2. Test the 1-2 shift solenoid wiring from the 20-way connector to the 1-2 shift solenoid connector for a short to voltage. Refer to Testing for Short to Ground . Did you find a condition?	--	Go to Step 10	Go to Step 11
8	Replace the TCM. Refer to Control Module References for replacement, set-up and programming. Is the action complete?	--	Go to Step 12	--
9	Perform the necessary wiring repairs. Refer to Wiring Repairs . Is the action complete?	--	Go to Step 12	--
10	Replace the Automatic transmission internal transmission wiring harness. Refer to Transmission Internal Electrical Harness Replacement . Is the action complete?	--	Go to Step 12	--
11	Replace the 1-2 shift solenoid valve. Refer to 1-2 Shift Solenoid Valve Replacement . Is the action complete?	--	Go to Step 12	--
12	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Turn ON the ignition, with the engine OFF. 4. Select Specific DTC. 5. Enter DTC P0974. Has the test run and passed?	--	Go to Step 13	Go to Step 2
13	With the scan tool, observe the stored information, capture info and DTC info.	--	Go to Diagnostic	

	Does the scan tool display any DTCs that you have not diagnosed?		Trouble Code (DTC) List - Vehicle	System OK

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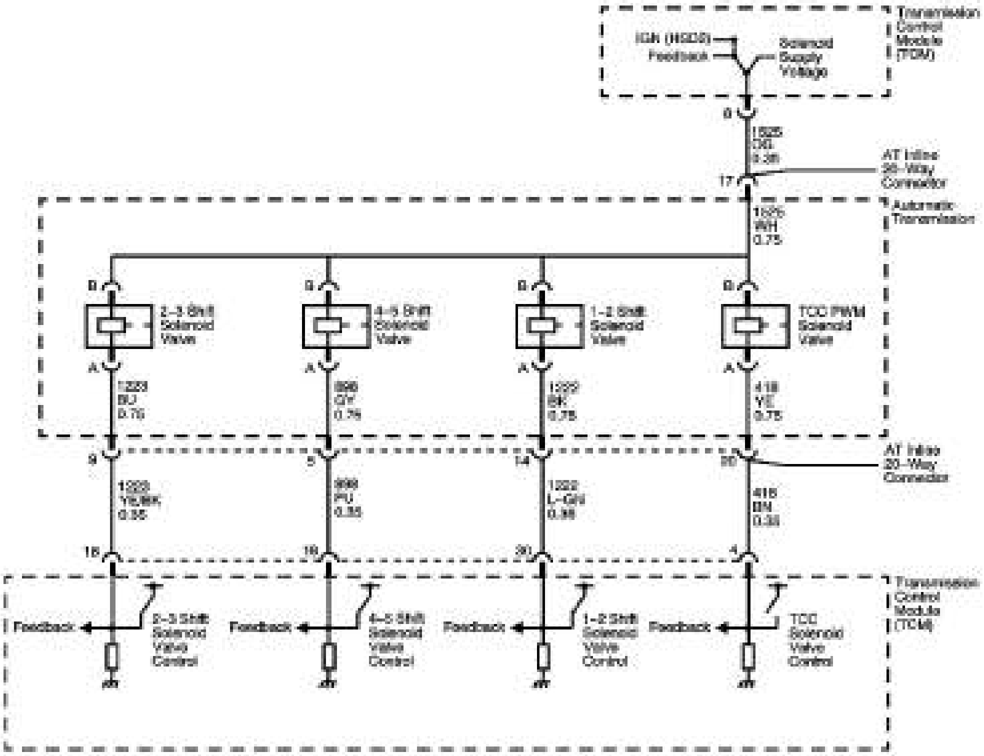
DTC P0976

Circuit Description


Transmission Control Module (TCM)
IGN (HSD2)
Feedback
Solenoid Supply Voltage
8
1525
OG
0.35
17
AT Inline 36-Way Connector
Automatic Transmission
1525
WH
0.75
B
B
B
B
2-3 Shift Solenoid Valve
4-5 Shift Solenoid Valve
1-2 Shift Solenoid Valve
TCC PWM Solenoid Valve
A
A
A
A
1223
BU
0.75
898
GY
0.75
1222
BK
0.75
418
YE
0.75
9
5
14
20
AT Inline 20-Way Connector
1223
YE/BK
0.35
898
PU
0.35
1222
L-GN
0.35
418
BN
0.35
18
19
20
4
Transmission Control Module (TCM)
Feedback
2-3 Shift Solenoid Valve Control
Feedback
4-5 Shift Solenoid Valve Control
Feedback
1-2 Shift Solenoid Valve Control
Feedback
TCC Solenoid Valve Control

The 2-3 shift solenoid valve is located in the control valve body of the transmission. The transmission control module (TCM) selects the required gear by turning the appropriate solenoid ON or OFF, enabling the transmission to shift. Refer to Shift Solenoid Valve State and Gear Ratio .

The TCM provides voltage to the solenoid through High Side Driver 2 (HSD2). The TCM uses a second driver to control the solenoid ground circuit. The controlled ground driver reports feedback voltage to the TCM. When the TCM commands the 2-3 shift solenoid valve ON, the voltage of the control circuit should be approximately 0 volts. When the TCM commands the 2-3 shift solenoid valve OFF, the voltage of the control circuit should be approximately system voltage.

When the TCM detects a continuous open or short to ground in the 2-3 shift solenoid valve circuit, then DTC P0976 sets. DTC P0976 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0976 2-3 Shift Solenoid (SS) Control Circuit Low Voltage

Conditions for Running the DTC

- The engine run time is greater than 5 seconds.
- HSD2 is commanded ON.

Conditions for Setting the DTC

DTC P0976 sets when either of the following conditions occurs:

- The TCM detects an open in the 2-3 shift solenoid valve circuit when HSD2 is commanded ON.
- The TCM detects a short to ground in the 2-3 shift solenoid valve circuit when HSD2 is commanded OFF.

Action Taken When the DTC Sets

- Powertrain braking is disabled at the time that the TCM first detects the failure, before the DTC sets.
- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive drive trip in which the Conditions for Setting the DTC are met.
- The TCM turns off power to all solenoids. When the solenoids are off:
  - The transmission will operate in fifth gear if the vehicle has successfully completed a 1-2 upshift in the current ignition cycle. If the vehicle has not completed a 1-2 upshift in the current ignition cycle, the transmission will operate in fourth gear. If the transmission is operating in fifth gear, fourth gear may be obtained if the engine is stopped briefly and re-started.
  - The TCM commands maximum line pressure.
  - The TCM freezes transmission adaptive functions.
- Torque management is inhibited.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0976 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Test Description

The number below refers to the step number on the diagnostic table.

2. Listen for an audible click when the solenoid energizes.

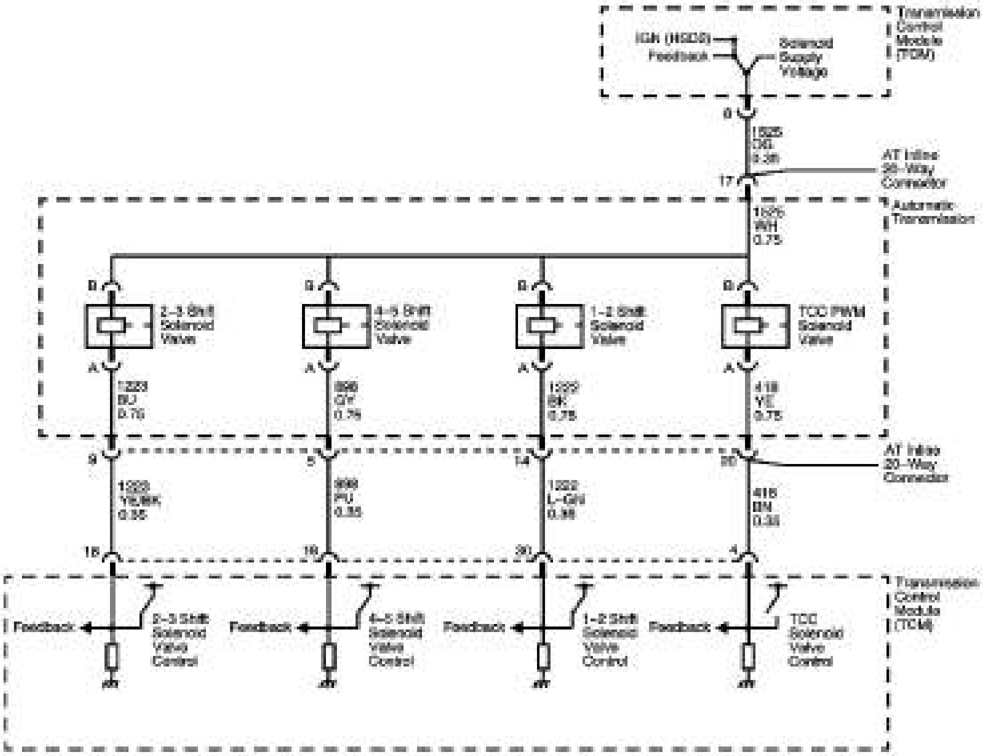
Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Use the scan tool in order to command the 2-3 shift solenoid ON. Does the solenoid operate?	--	Go to Step 9	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the Automatic transmission 20-way inline harness connector. 3. Install the J 45681 jumper harness to the TCM side of the 20-way connector. 4. Turn ON the ignition with the engine OFF. 5. With the test lamp connected to ground, probe the HSD2 circuit, terminal 17, of the J 45681 . Does the test light illuminate?	--	Go to Step 4	Go to Step 7
4	1. Turn OFF the ignition. 2. Install the J 45681 to the transmission side of the 20-way connector. 3. Using the DMM, measure the resistance between terminal 17 and 9 of the J 45681 . Refer to Component Resistance .	15.0-20.3Ω		

	Is the resistance within the specified range?		Go to Step 5	Go to Step 8
5	Using the DMM, measure the resistance between terminal 17 of the J 45681 and ground. Is the resistance greater than the specified value?	50K Ω	Go to Step 6	Go to Step 8
6	1. Disconnect the TCM. 2. Test the 2-3 solenoid valve control circuit for the following conditions: • Open circuit • Short to ground • Refer to Testing for Continuity and Testing for Short to Ground . Did you find a condition?	--	Go to Step 10	Go to Step 9
7	1. Turn OFF the ignition. 2. Disconnect the TCM. 3. Test the HSD2 circuit from the TCM to the 2-3 solenoid for an open circuit. Refer to Testing for Continuity . Did you find a condition?	--	Go to Step 10	Go to Step 9
8	1. Remove the transmission oil pan. 2. Test the 2-3 shift solenoid wiring from the 20-way connector to the 2-3 shift solenoid connector for the following conditions: • Open circuit • Short to ground • Refer to Testing for Continuity and Testing for Short to Ground . Did you find a condition?	--	Go to Step 11	Go to Step 12
9	Replace the TCM. Refer to Control Module References for replacement, set-up and programming. Is the action complete?	--	Go to Step 13	--
10	Perform the necessary wiring repairs. Refer to Wiring Repairs . Is the action complete?	--	Go to Step 13	--
11	Replace the Automatic transmission internal transmission wiring harness. Refer to Transmission Internal Electrical Harness Replacement .	--		--

	Is the action complete?		Go to Step 13	
12	Replace the 2-3 shift solenoid valve. Refer to 2-3 Shift Solenoid Valve Replacement . Is the action complete?	--	Go to Step 13	--
13	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Turn ON the ignition, with the engine OFF. 4. Select Specific DTC. 5. Enter DTC P0976. Has the test run and passed?	--	Go to Step 14	Go to Step 2
14	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0977

Circuit Description


Transmission Control Module (TCM)
IGN (HSD2)
Feedback
Solenoid Supply Voltage
8
1525
OG
0.35
17
AT Inline 20-Way Connector
Automatic Transmission
1525
WH
0.75
B
2-3 Shift Solenoid Valve
4-5 Shift Solenoid Valve
1-2 Shift Solenoid Valve
TCC PWM Solenoid Valve
A
1223
BU
0.75
898
GY
0.75
1222
BK
0.75
418
YE
0.75
9
5
14
20
AT Inline 20-Way Connector
1223
YE/BK
0.35
898
PU
0.35
1222
L-GN
0.35
418
BN
0.35
18
19
20
4
Transmission Control Module (TCM)
Feedback
2-3 Shift Solenoid Valve Control
4-5 Shift Solenoid Valve Control
1-2 Shift Solenoid Valve Control
TCC Solenoid Valve Control

The 2-3 shift solenoid valve is located in the control valve body of the transmission. The transmission control module (TCM) selects the required gear by turning the appropriate solenoid ON or OFF, enabling the transmission to shift. Refer to Shift Solenoid Valve State and Gear Ratio .

The TCM provides voltage to the solenoid through High Side Driver 2 (HSD2). The TCM uses a second driver to control the solenoid ground circuit. The controlled ground driver reports feedback voltage to the TCM. When the TCM commands the 2-3 shift solenoid valve ON, the voltage of the control circuit should be approximately 0 volts. When the TCM commands the 2-3 shift solenoid valve OFF, the voltage of the control circuit should be approximately system voltage.

When the TCM detects a continuous short to voltage in the 2-3 Shift Solenoid valve circuit, then DTC P0977 sets. DTC P0977 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0977 2-3 Shift Solenoid (SS) Control Circuit High Voltage

Conditions for Running the DTC

- The engine run time is greater than 5 seconds.
- HSD2 is commanded ON.

Conditions for Setting the DTC

DTC P0977 sets when the TCM detects a short to voltage in the 2-3 shift solenoid valve circuit.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive drive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM inhibits first gear.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0977 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Test Description

The number below refers to the step number on the diagnostic table.

2. Listen for an audible click when the solenoid energizes.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF.			

2	**Important:** - Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. - Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Use the scan tool in order to command the 2-3 shift solenoid ON. Does the solenoid operate?	--	Go to Step 8	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the Automatic transmission 20-way inline harness connector. 3. Install the J 45681 jumper harness to the TCM side of the 20-way connector. 4. Turn ON the ignition with the engine OFF. 5. With the test lamp connected to ground, probe the HSD2 circuit, terminal 17, of the J 45681 . Does the test lamp illuminate?	--	Go to Step 4	Go to Step 6
4	1. Turn OFF the ignition. 2. Install the J 45681 to the transmission side of the 20-way connector. 3. Using the DMM, measure the resistance between terminal 17 and 9 of the J 45681 . Refer to Component Resistance . Is the resistance within the specified range?	15.0-20.3Ω	Go to Step 5	Go to Step 7
5	1. Disconnect the TCM. 2. Test the 2-3 solenoid valve control circuit for a short to voltage. Refer to Testing for a Short to Voltage . Did you find a condition?	--	Go to Step 9	Go to Step 8
6	1. Turn OFF the ignition. 2. Disconnect the TCM. 3. Test the HSD2 circuit from the TCM to the 2-3 solenoid for an open circuit. Refer to Testing for Continuity .	--		

	Did you find a condition?		Go to Step 9	Go to Step 8
7	1. Remove the transmission oil pan. 2. Test the 2-3 shift solenoid wiring from the 20-way connector to the 2-3 shift solenoid connector for a short to voltage. Refer to Testing for a Short to Voltage . Did you find a condition?	--	Go to Step 10	Go to Step 11
8	Replace the TCM. Refer to Control Module References for replacement, set-up and programming. Is the action complete?	--	Go to Step 12	--
9	Perform the necessary wiring repairs. Refer to Wiring Repairs . Is the action complete?	--	Go to Step 12	--
10	Replace the Automatic transmission internal transmission wiring harness. Refer to Transmission Internal Electrical Harness Replacement . Is the action complete?	--	Go to Step 12	--
11	Replace the 2-3 shift solenoid valve. Refer to 2-3 Shift Solenoid Valve Replacement . Is the action complete?	--	Go to Step 12	--
12	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Turn ON the ignition, with the engine OFF. 4. Select Specific DTC. 5. Enter DTC P0977. Has the test run and passed?	--	Go to Step 13	Go to Step 2
13	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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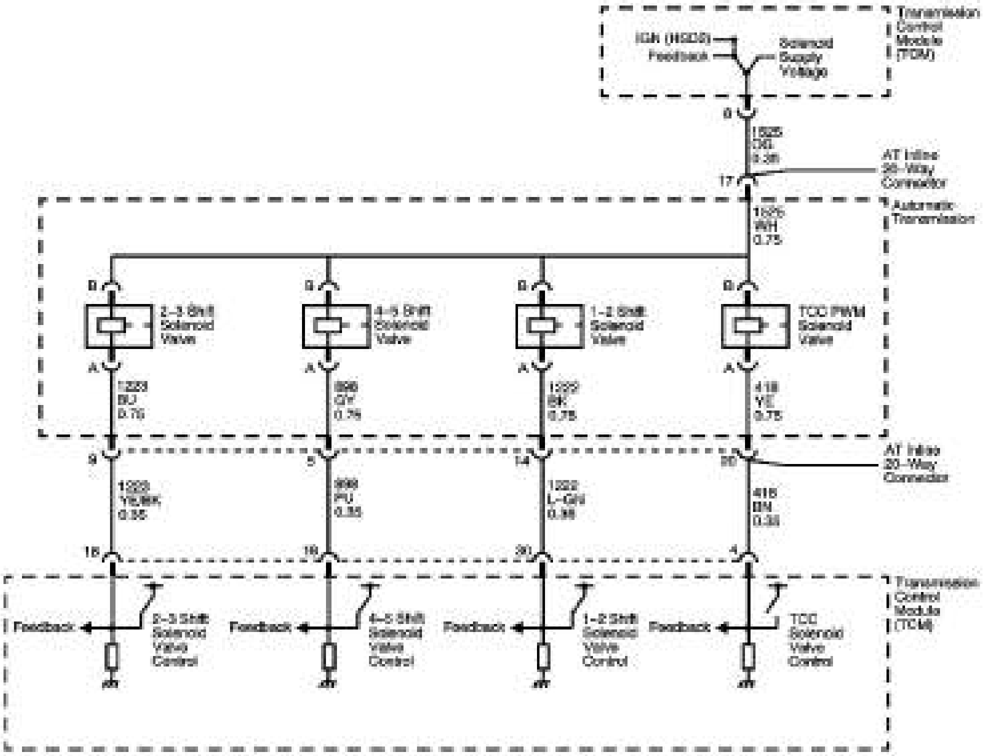
DTC P0979

Circuit Description


Transmission Control Module (TCM)
IGN (HSD2)
Feedback
Solenoid Supply Voltage
8
1525 OG 0.35
AT Inline 20-Way Connector
17
1525 WH 0.75
Automatic Transmission
B
2-3 Shift Solenoid Valve
A
1223 BU 0.75
B
4-5 Shift Solenoid Valve
A
898 GY 0.75
B
1-2 Shift Solenoid Valve
A
1222 BK 0.75
B
TCC PWM Solenoid Valve
A
418 YE 0.75
9
5
14
20
AT Inline 20-Way Connector
1223 YE/BK 0.35
898 PU 0.35
1222 L-GN 0.35
418 BN 0.35
18
19
20
4
Transmission Control Module (TCM)
Feedback
2-3 Shift Solenoid Valve Control
Feedback
4-5 Shift Solenoid Valve Control
Feedback
1-2 Shift Solenoid Valve Control
Feedback
TCC Solenoid Valve Control

The 4-5 shift solenoid valve is located in the control valve body of the transmission. The transmission control module (TCM) selects the required gear by turning the appropriate solenoid ON or OFF, enabling the transmission to shift. Refer to Shift Solenoid Valve State and Gear Ratio .

The TCM provides voltage to the solenoid through High Side Driver 2 (HSD2). The TCM uses a second driver to control the solenoid ground circuit. The controlled ground driver reports feedback voltage to the TCM. When the TCM commands the 4-5 shift solenoid valve ON, the voltage of the control circuit should be approximately 0 volts. When the TCM commands the 4-5 shift solenoid valve OFF, the voltage of the control circuit should be approximately system voltage.

When the TCM detects a continuous open or short to ground in the 4-5 shift solenoid valve circuit, then DTC P0979 sets. DTC P0979 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0979 4-5 Shift Solenoid (SS) Control Circuit Low Voltage

Conditions for Running the DTC

- The engine run time is greater than 5 seconds.
- HSD2 is commanded ON.

Conditions for Setting the DTC

DTC P0979 sets when one of the following conditions occurs:

- The TCM detects an open in the 4-5 shift solenoid valve circuit when HSD2 is commanded ON.
- The TCM detects a short to ground in the 4-5 shift solenoid valve circuit when HSD2 is commanded OFF.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive drive trip in which the Conditions for Setting the DTC are met.
- The TCM turns off power to all solenoids. When the solenoids are off:
  - The transmission will operate in fifth gear if the vehicle has successfully completed a 1-2 upshift in the current ignition cycle. If the vehicle has not completed a 1-2 upshift in the current ignition cycle, the transmission will operate in fourth gear. If the transmission is operating in fifth gear, fourth gear may be obtained if the engine is stopped briefly and started again.
  - The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P0979 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Test Description

The number below refers to the step number on the diagnostic table.

2. Listen for an audible click when the solenoid energizes.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Use the scan tool in order to command the 4-5 shift solenoid ON. Does the solenoid operate?	--	Go to Step 9	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the Automatic transmission 20-way inline harness connector. 3. Install the J 45681 to the TCM side of the 20-way connector. 4. Turn ON the ignition with the engine OFF. 5. With the test lamp connected to ground, probe the HSD2 circuit, terminal 17, of the J 45681 . Does the test lamp illuminate?	--	Go to Step 4	Go to Step 7
4	1. Turn OFF the ignition. 2. Install the J 45681 to the transmission side of the 20-way connector. 3. Using the DMM, measure the resistance between terminal 17 and 5 of the J 45681 . Refer to Component Resistance . Is the resistance within the specified range?	15.0-20.3Ω	Go to Step 5	Go to Step 8

5	Using the DMM, measure the resistance between terminal 17 of the J 45681 and ground. Is the resistance greater than the specified value?	50K Ω	Go to Step 6	Go to Step 8
6	1. Disconnect the TCM. 2. Test the 4-5 solenoid valve control circuit for the following conditions: • Open circuit • Short to ground • Refer to Testing for Continuity and Testing for Short to Ground . Did you find a condition?	--	Go to Step 10	Go to Step 9
7	1. Turn OFF the ignition. 2. Disconnect the TCM. 3. Test the HSD2 circuit from the TCM to the 4-5 solenoid for an open circuit. Refer to Testing for Continuity . Did you find a condition?	--	Go to Step 10	Go to Step 9
8	1. Remove the transmission oil pan. 2. Test the 4-5 shift solenoid wiring from the 20-way connector to the 4-5 shift solenoid connector for the following conditions: • Open circuit • Short to ground • Refer to Testing for Continuity and Testing for Short to Ground . Did you find a condition?	--	Go to Step 11	Go to Step 12
9	Replace the TCM. Refer to Control Module References for replacement, set-up and programming. Is the action complete?	--	Go to Step 13	--
10	Perform the necessary wiring repairs. Refer to Wiring Repairs . Is the action complete?	--	Go to Step 13	--
11	Replace the Automatic transmission internal transmission wiring harness. Refer to Transmission Internal Electrical Harness Replacement .	--		--

	Is the action complete?		Go to Step 13	
12	Replace the 4-5 shift solenoid valve. Refer to 4-5 Shift Solenoid Valve Replacement . Is the action complete?	--	Go to Step 13	--
13	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Turn ON the ignition, with the engine OFF. 4. Select Specific DTC. 5. Enter DTC P0979. Has the test run and passed?	--	Go to Step 14	Go to Step 2
14	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P0980

DTC Descriptor

DTC B0980 00: Transmission Sports Switch Circuit Short to Ground

Circuit/System Description

The body control module (BCM) controls the.

Conditions for Running the DTC

The DTC can only set only when the output is actively being requested by the BCM.

Conditions for Setting the DTC

The BCM detects a short to ground, open, or short to voltage in the horn relay control circuit for approximately 125 milliseconds.

Action Taken When the DTC Sets

The BCM disables the output to the horn relay until the next ignition cycle.

Conditions for Clearing the DTC

- The DTC clears when the fault is no longer detected.
- The current DTC will become history when the request for the output is removed.
- The history DTC will clear after 50 consecutive fault-free ignition cycles have occurred.

Reference Information

Electrical Information Reference

- Circuit Testing
- Wiring Repairs

Scan Tool Reference

Control Module References

Circuit/System Testing

1. Ignition OFF, disconnect the A15 harness connector at the S73 Power/Economy Switch.
2. Ignition ON, test for 12 volts between circuit terminal J-220 and ground.

If less than the specified range, test the reference circuit for a short to ground. If the circuit tests normal, replace the S73 Power/Economy Switch.

If greater than the specified range, test the reference circuit for a short to voltage. If the circuit tests normal, replace the A15 Body Control Module.

3. If all circuits test normal, test the S73 Power/Economy Switch.

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DTC P1793

Circuit Description

The engine control module (ECM) sends wheel speed data to the transmission control module (TCM). The data is sent to the TCM through a communication network called GMLAN. Two circuits are used to communicate GMLAN data between the ECM and TCM. A fault in the GMLAN will not cause DTC P1793 to set by itself. If a GMLAN fault occurs, other DTCs will set before DTC P1793.

When the TCM receives invalid wheel speed data from the ECM, then DTC P1793 will set.
DTC P1793 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P1793 Wheel Speed Signal

Conditions for Running the DTC

- The engine run time is at least 6 seconds.
- No other GMLAN errors are present.

Conditions for Setting the DTC

The TCM receives no valid wheel speed data from the ECM for 2 seconds.

Action Taken When the DTC Sets

- The TCM does not request the ECM to illuminate the malfunction indicator lamp (MIL).
- The TCM inhibits Autograde braking.
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- The TCM stores DTC P1793 in TCM history.

Conditions for Clearing the DTC

- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Step	Action	Value (s)	Yes	No

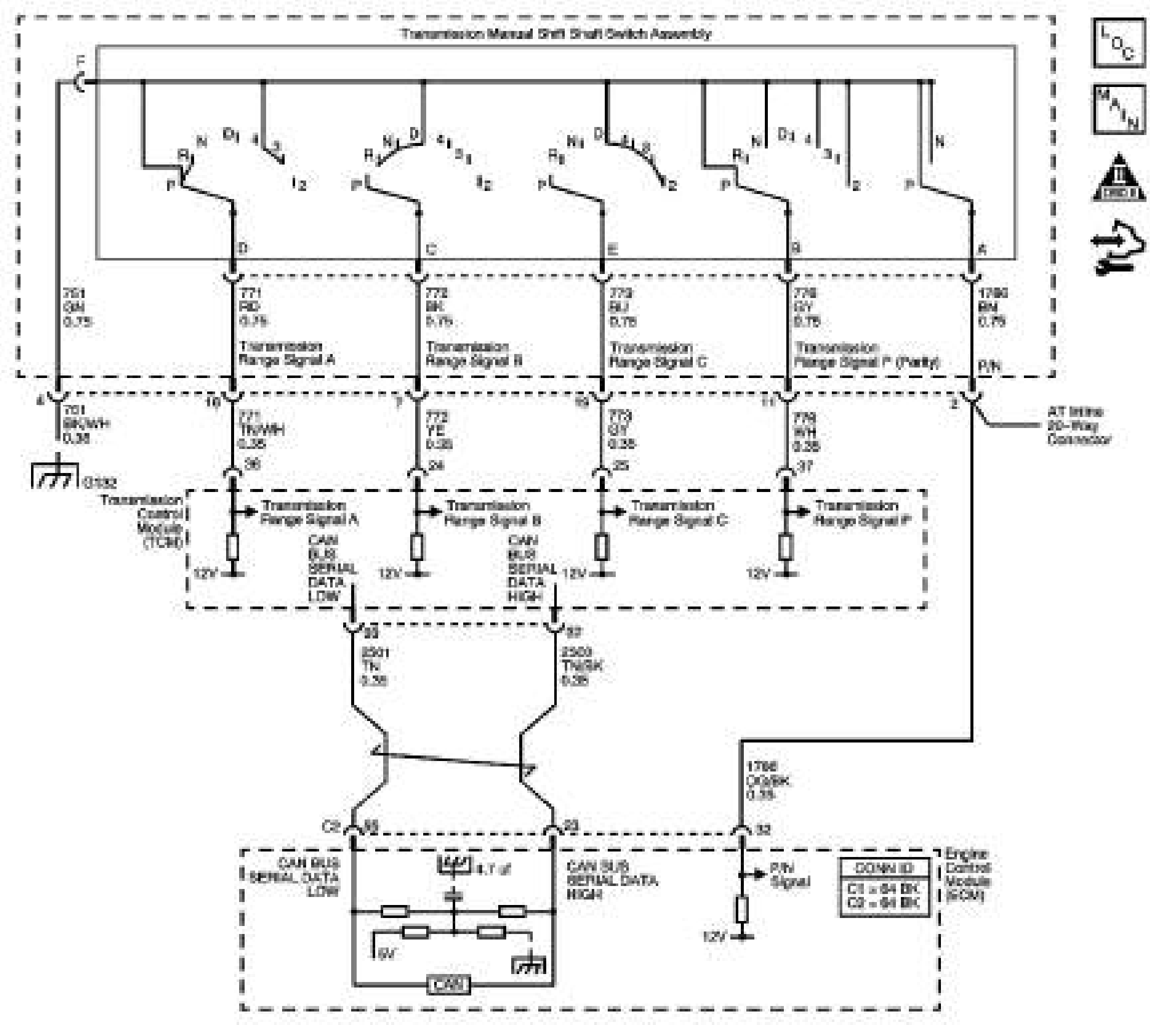
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. **Important:** Record all Failure Records before clearing the DTC. Using Clear Info erases the Failure Records from the ECM and TCM. 3. Record the DTC Failure Records. Did you record any ECM Failure Records?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	Go to Step 3
3	1. Clear the DTC. 2. Turn the ignition OFF for at least 30 seconds. 3. Start, and allow the engine to idle. Did DTC P1793 reset?	--	Go to Step 4	Go to Testing for Intermittent Conditions and Poor Connections
4	Did any other DTCs set?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	Go to Step 5
5	Replace the TCM. Refer to Control Module References for replacement, set-up and programming. Is the action complete?	--	Go to Step 6	--
6	Perform the following operation to verify the repair: 1. Select DTC on the scan tool. 2. Select Clear Info. 3. Start, and allow the engine to idle. 4. Select Specific DTC. 5. Enter DTC P1793. Has the test run and passed?	--	Go to Step 7	Go to Step 2
7	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P1815

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit Description


Transmission Manual Shift Shaft Switch Assembly
F
N
D
4
3
2
R
P
D
C
E
B
A
701
GN
0.75
771
RD
0.75
Transmission Range Signal A
772
BK
0.75
Transmission Range Signal B
773
BU
0.75
Transmission Range Signal C
776
GY
0.75
Transmission Range Signal P (Parity)
1780
BN
0.75
P/N
4
10
7
9
11
2
AT Inline 20-Way Connector
701
BK/WH
0.35
G102
771
TN/WH
0.35
772
YE
0.35
773
GY
0.35
776
WH
0.35
36
24
25
37
Transmission Control Module (TCM)
Transmission Range Signal A
Transmission Range Signal B
Transmission Range Signal C
Transmission Range Signal P
12V
CAN BUS SERIAL DATA LOW
CAN BUS SERIAL DATA HIGH
53
52
2501
TN
0.35
2500
TN/BK
0.35
1786
OG/BK
0.35
C2
55
23
32
CAN BUS SERIAL DATA LOW
4.7 uf
CAN BUS SERIAL DATA HIGH
5V
CAN
P/N Signal
12V
CONN ID
C1 = 64 BK
C2 = 64 BK
Engine Control Module (ECM)

The transmission manual shift shaft switch assembly is a sliding contact switch attached to the control valve body within the transmission. The four inputs to the transmission control module (TCM) from the switch indicate which position is selected by the transmission selector lever. This information is used for engine controls as well as determining the transmission shift patterns. The input voltage at the TCM is high when the switch is open and low when the switch is closed to ground. The state of each input is displayed on the scan tool as IMS. The IMS input parameters represented are transmission range Signal A , Signal B, Signal C and Signal P (Parity).

If the TCM detects an invalid switch state while the engine is being started, then DTC P1815 sets. DTC P1815 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P1815 Transmission Fluid Pressure (TFP) Valve Position Switch - Start in Wrong Range

Conditions for Running the DTC

- No OSS DTC P0722 or P0723.
- The transmission output shaft speed is less than 100 RPM.

Conditions for Setting the DTC

The manual shift shaft switch assembly indicates a transitional state during the following sequence:

- The engine speed is less than 60 RPM for more than 0.25 second, then,
- The engine speed is 81-625 RPM for more than 0.15 seconds, then,
- The engine speed is greater than 651 RPM for more than 1.5 seconds, then,
- The transmission input shaft speed is greater than 200 RPM for more than 1.5 seconds.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM assumes a D5 shift pattern.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P1815 in TCM history.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without

a non emission related diagnostic fault occurring.

- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. All HI values, in both Park and Drive 5, indicate the ground circuit is OPEN.

5. With the transmission 20-way connector disconnected, all IMS values should indicate HI.

7. If one circuit affects the other, this indicates a short between the two circuits.

13. This step tests the internal transmission harness. If no fault is found in the harness, the fault will be in the switch.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Select Transmission Data on the scan tool. 6. Select IMS range on the scan tool. 7. Place the gear select lever in PARK, then move to NEUTRAL. Does each range selected match the scan tool IMS range display?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3

3	1. Select IMS A/B/C/P on the scan tool. 2. Place the gear select lever in PARK, then move to D5. Does the scan tool IMS A/B/C/P display indicate the specified value for each range?	HI/HI/HI/HI	Go to Step 14	Go to Step 4
4	1. Inspect the transmission linkage from the range selector to the manual shift shaft for proper adjustment. 2. Adjust the linkage as necessary. Refer to Manual Shift Shaft Position Switch Replacement . Did the linkage require adjustment?	--	Go to Step 19	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the Automatic transmission inline 20-way connector. Additional DTCs may set. 3. Turn ON the ignition, with the engine OFF. 4. Select IMS A/B/C/P on the scan tool. Does the scan tool IMS A/B/C/P display all HI?	--	Go to Step 6	Go to Step 10
6	1. Turn OFF the ignition. 2. Install the J 45681 jumper harness on the TCM side of the Automatic transmission inline 20-way connector. 3. Turn ON the ignition, with the engine OFF. 4. Using the DMM and the J 35616 Holden terminal test kit, measure the voltage at the Transmission Range (TR) signal A circuit of the J 45681 . Refer to Component Connector End Views. 5. Measure the voltage at the TR signal B circuit of the J 45681 . 6. Measure the voltage at the TR signal C circuit of the J 45681 . 7. Measure the voltage at the TR signal P circuit of the J 45681 .	--		

	Did you measure ignition voltage at all four terminals?		Go to Step 7	Go to Step 11
7	Install a fused jumper wire from the TR signal A circuit of the J 45681 to ground while monitoring the scan tool IMS A/B/C/P display. Refer to Component Connector End Views. When the TR signal A circuit is grounded, do any other circuits indicate LOW?	--	Go to Step 12	Go to Step 8
8	Install a fused jumper wire from the TR signal B circuit of the J 45681 to ground while monitoring the scan tool IMS A/B/C/P display. Refer to Component Connector End Views. When the TR signal B circuit is grounded, do any other circuits indicate LOW?	--	Go to Step 12	Go to Step 9
9	Install a fused jumper wire from the TR signal C circuit of the J 45681 to ground while monitoring the scan tool IMS A/B/C/P display. Refer to Component Connector End Views. When the TR signal C circuit is grounded, do any other circuits indicate LOW?	--	Go to Step 12	Go to Step 13
10	Test the TR signal circuits of the transmission manual shift shaft switch assembly that did not indicate HI for a short to ground between the TCM connector and the Automatic transmission inline 20-way connector. Refer to Testing for Short to Ground and Wiring Repairs. Did you find and correct the condition?	--	Go to Step 19	Go to Step 18
11	Test the TR signal circuits of the transmission manual shift shaft switch assembly that did not indicate ignition voltage for an open between the TCM and the Automatic transmission inline 20-way connector. Refer to Testing for Continuity and Wiring Repairs.	--		

	Did you find and correct the condition?		Go to Step 19	Go to Step 18
12	Test the affected TR signal circuits of the transmission manual shift shaft switch assembly for a shorted together condition between the TCM connector and the Automatic transmission inline 20-way connector. Refer to Circuit Testing and Wiring Repairs. Did you find and correct the condition?	--	Go to Step 19	Go to Step 18
13	Test the TR signal circuits of the transmission manual shift shaft switch assembly for an open or shorted condition between the Automatic transmission inline 20-way connector and the switch. Refer to Testing for Continuity. Did you find the condition?	--	Go to Step 16	Go to Step 17
14	Test the ground circuit of the transmission manual shift shaft switch assembly for an open between the Automatic transmission inline 20-way connector and the chassis. Refer to Testing for Continuity and Wiring Repairs. Did you find and correct the condition?	--	Go to Step 19	Go to Step 15
15	Test the ground circuit of the transmission manual shift shaft switch assembly for an open between the Automatic transmission inline 20-way connector and the switch. Refer to Testing for Continuity. Did you find the condition?	--	Go to Step 16	Go to Step 17
16	Replace the automatic transmission wiring harness assembly. Refer to Transmission Internal Electrical Harness Replacement. Did you complete the replacement?	--	Go to Step 19	--
	Replace the transmission manual shift shaft switch assembly.			

17	Refer to Manual Shift Shaft Position Switch Replacement. Is the action complete?	--	Go to Step 19	--
18	Replace the TCM. Refer to Control Module References for replacement, set-up and programming. Is the action complete?	--	Go to Step 19	--
19	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Start the engine in PARK. 4. Turn OFF the ignition. 5. Start the engine in NEUTRAL. 6. Select Specific DTC. 7. Enter DTC P1815. Has the test run and passed?	--	Go to Step 20	Go to Step 2
20	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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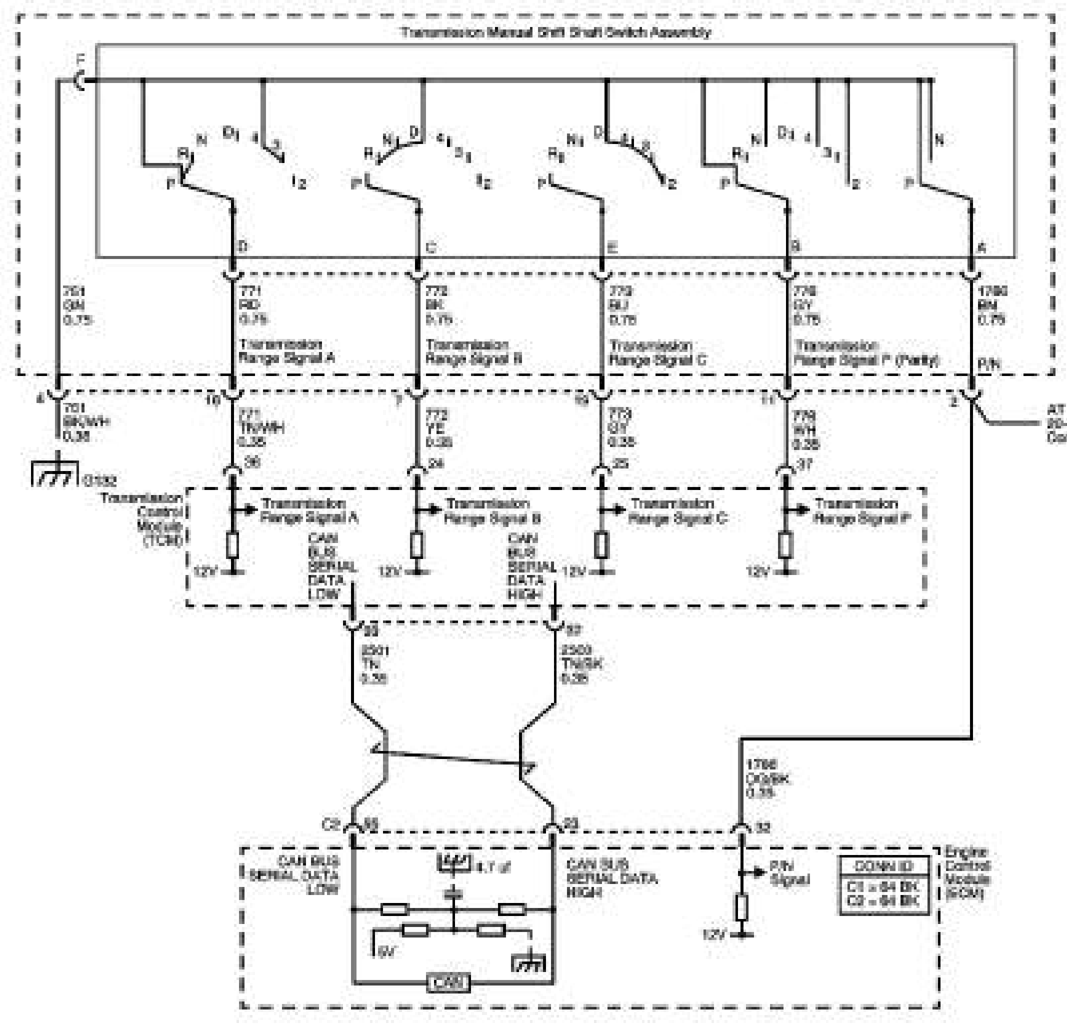
DTC P1820

Circuit Description


Transmission Manual Shift Shaft Switch Assembly
F
N
D1
4
3
1
2
R1
P
D
C
E
B
A
701
GN
0.75
771
RD
0.75
Transmission Range Signal A
772
BK
0.75
Transmission Range Signal B
773
BU
0.75
Transmission Range Signal C
776
GY
0.75
Transmission Range Signal P (Parity)
1780
BN
0.75
P/N
4
701
BK/WH
0.35
10
771
TN/WH
0.35
7
772
YE
0.35
19
773
GY
0.35
11
776
WH
0.35
2
AT Inline 20-Way Connector
G102
36
24
25
37
Transmission Control Module (TCM)
Transmission Range Signal A
Transmission Range Signal B
Transmission Range Signal C
Transmission Range Signal P
12V
CAN BUS SERIAL DATA LOW
CAN BUS SERIAL DATA HIGH
33
32
2501
TN
0.35
2500
TN/BK
0.35
1786
OG/BK
0.35
C2
55
23
32
CAN BUS SERIAL DATA LOW
4.7 uf
CAN BUS SERIAL DATA HIGH
P/N Signal
5V
CAN
CONN ID
C1 = 64 BK
C2 = 64 BK
Engine Control Module (ECM)

The transmission manual shift shaft switch assembly is a sliding contact switch attached to the lower control valve body within the transmission. The 4 inputs to the transmission control module (TCM) from the switch indicate which position is selected by the transmission selector lever. This information is used for engine controls as well as determining the transmission shift patterns. The input voltage at the TCM is high when the switch is open and low when the switch is closed to ground. The state of each input is displayed on the scan tool as IMS. The 4 IMS input parameters represented are Signal A , Signal B, Signal C and Signal P (Parity).

If the TCM detects a short to ground on the IMS Signal A, then DTC P1820 sets. DTC P1820 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P1820 Internal Mode Switch A Circuit Low Voltage

Conditions for Running the DTC

- No engine torque signal DTC P2637.
- The engine run time is greater than 5 seconds.
- The engine torque is greater than 55 N·m (41 lb. ft).

Conditions for Setting the DTC

- The switch indicates PARK for 1 second, then;
- The switch indicates a transitional state between D4 and D3 for at least 4 seconds.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM assumes a D5 shift pattern.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P1820 in TCM history during the second consecutive trip in which the Conditions for Setting the DTC are met.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. This step determines if the fault is internal or external to the transmission.
4. This step determines if the engine wiring harness circuit or the TCM is at fault.
5. This step determines if the automatic transmission wiring harness or the IMS is at fault.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Select Transmission Data on the scan tool. 6. Select IMS range on the scan tool. 7. Place the gear select lever in D5. Does the scan tool IMS range display Drive 5?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the Automatic transmission inline 20-way connector. Additional DTCs may set. 3. Turn ON the ignition, with the engine OFF. 4. Select IMS A/B/C/P on the scan tool. Does the scan tool IMS Signal A display LOW?	--	Go to Step 4	Go to Step 5
4	Test the TR signal A circuit of the switch for a short to ground between the TCM connector and the Automatic transmission inline 20-way connector.	--		

	Refer to Testing for Short to Ground and Wiring Repairs. Did you find and correct the condition?		Go to Step 9	Go to Step 8
5	1. Turn OFF the ignition. 2. Connect the Automatic transmission inline 20-way connector. 3. Disconnect the automatic transmission wiring harness at the transmission manual shift shaft switch assembly. 4. Turn ON the ignition, with the engine OFF. 5. Select IMS A/B/C/P on the scan tool. Is the IMS Signal A displaying LOW?	--	Go to Step 6	Go to Step 7
6	Replace the automatic transmission internal wiring harness. Refer to Transmission Internal Electrical Harness Replacement. Is the action complete?	--	Go to Step 9	--
7	Replace the transmission manual shift shaft switch assembly. Refer to Manual Shift Shaft Position Switch Replacement. Is the action complete?	--	Go to Step 9	--
8	Replace the TCM. Refer to Control Module References for replacement, set-up and programming. Is the action complete?	--	Go to Step 9	--
9	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Drive the vehicle in D4. • The engine torque is greater than 55 N·m (41 lb. ft). • IMS Signal A must be HI for 0.025 second. 4. Select Specific DTC. 5. Enter DTC P1820.	--		

	Has the test run and passed?		Go to Step 10	Go to Step 2
10	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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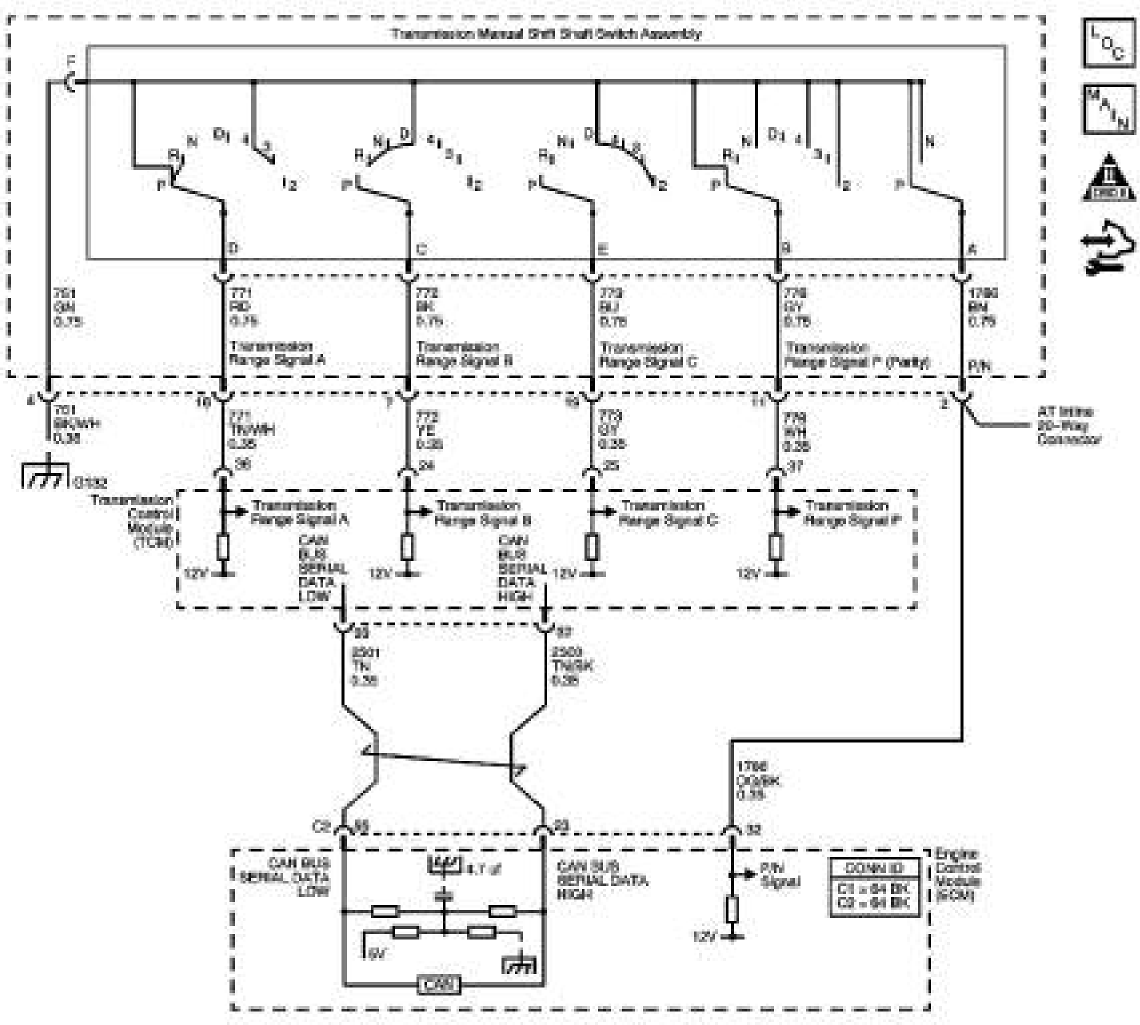
DTC P1822

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit Description


Transmission Manual Shift Shaft Switch Assembly
F
N
D1
4
3
2
R1
P
D
C
E
B
A
701 GN 0.75
771 RD 0.75
772 BK 0.75
773 BU 0.75
776 GY 0.75
1780 BN 0.75
Transmission Range Signal A
Transmission Range Signal B
Transmission Range Signal C
Transmission Range Signal P (Parity)
P/N
4
10
7
9
11
2
701 BK/WH 0.35
771 TN/WH 0.35
772 YE 0.35
773 GY 0.35
776 WH 0.35
AT Inline 20-Way Connector
G102
36
24
25
37
Transmission Control Module (TCM)
Transmission Range Signal A
Transmission Range Signal B
Transmission Range Signal C
Transmission Range Signal P
12V
CAN BUS SERIAL DATA LOW
CAN BUS SERIAL DATA HIGH
33
32
2501 TN 0.35
2500 TN/BK 0.35
1786 OG/BK 0.35
C2
53
23
32
CAN BUS SERIAL DATA LOW
4.7 uf
CAN BUS SERIAL DATA HIGH
5V
CAN
P/N Signal
12V
CONN ID
C1 = 64 BK
C2 = 64 BK
Engine Control Module (ECM)

The transmission manual shift shaft switch assembly is a sliding contact switch attached to the control valve body, within the transmission. The 4 inputs to the transmission control module (TCM) from the switch indicate which position is selected by the transmission selector lever. This information is used for engine controls as well as determining the transmission shift patterns. The input voltage at the TCM is high when the switch is open and low when the switch is closed to ground. The state of each input is displayed on the scan tool as IMS. The 4 IMS input parameters represented are Signal A , Signal B, Signal C and Signal P (Parity).

If the TCM detects an open in the TR signal B circuit, DTC P1822 sets. DTC P1822 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P1822 Internal Mode Switch B Circuit High Voltage

Conditions for Running the DTC

- No engine torque signal DTC P2637.
- The engine run time is greater than 5 seconds.
- The engine torque is greater than 55 N·m (41 lb. ft).

Conditions for Setting the DTC

- The switch indicates PARK for 1 second, then;
- The switch indicates a transitional state between D2 and D3 for 4 seconds.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM assumes a D5 shift pattern.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P1822 in TCM history.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. This step determines if the fault is internal or external to the transmission.

4. This step determines if the engine wiring harness circuit is at fault or the TCM.

5. This step determines if the automatic transmission wiring harness or transmission manual shift shaft switch assembly is at fault.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Select Transmission Data on the scan tool. 6. Select IMS range on the scan tool. 7. Place the gear select lever in D5. Does the scan tool IMS range display Drive 5?	--	Go to Testing for Intermittent Conditions and Poor Connections.	Go to Step 3
	1. Turn OFF the ignition. 2. Disconnect the Automatic transmission inline 20-way connector. Additional DTCs may set. 3. Install the J 45681 jumper harness on the TCM side of the Automatic transmission inline 20-way connector. 4. Using the J 35616 Holden-terminal test			

3	kit, connect a fused jumper wire from the TR signal B circuit of the J 45681 to ground. Refer to Component Connector End Views. 5. Turn ON the ignition, with the engine OFF. 6. Select IMS A/B/C/P on the scan tool. Is IMS Signal B displaying LOW?	--	Go to Step 5	Go to Step 4
4	Test the TR signal B circuit of the switch for an open between the TCM connector and the Automatic transmission inline 20-way connector. Refer to Testing for Continuity and Wiring Repairs. Did you find and correct the condition?	--	Go to Step 9	Go to Step 8
5	Test the TR signal B circuit of the switch for an open between the Automatic transmission inline 20-way connector and the transmission manual shift shaft switch assembly. Refer to Testing for Continuity. Did you find the condition?	--	Go to Step 6	Go to Step 7
6	Replace the automatic transmission wiring harness. Refer to Transmission Internal Electrical Harness Replacement. Is the action complete?	--	Go to Step 9	--
7	Replace the transmission manual shift shaft switch assembly. Refer to Manual Shift Shaft Position Switch Replacement. Is the action complete?	--	Go to Step 9	--
8	Replace the TCM. Refer to Control Module References for replacement, set-up and programming. Is the action complete?	--	Go to Step 9	--
	Perform the following procedure in order to verify the repair:			

9	1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Drive the vehicle in D5. • The engine torque is greater than 55 N·m (41 lb. ft). • IMS Signal B must be LOW for 0.025 second. 4. Select Specific DTC. 5. Enter DTC P1822. Has the test run and passed?	--	Go to Step 10	Go to Step 2
10	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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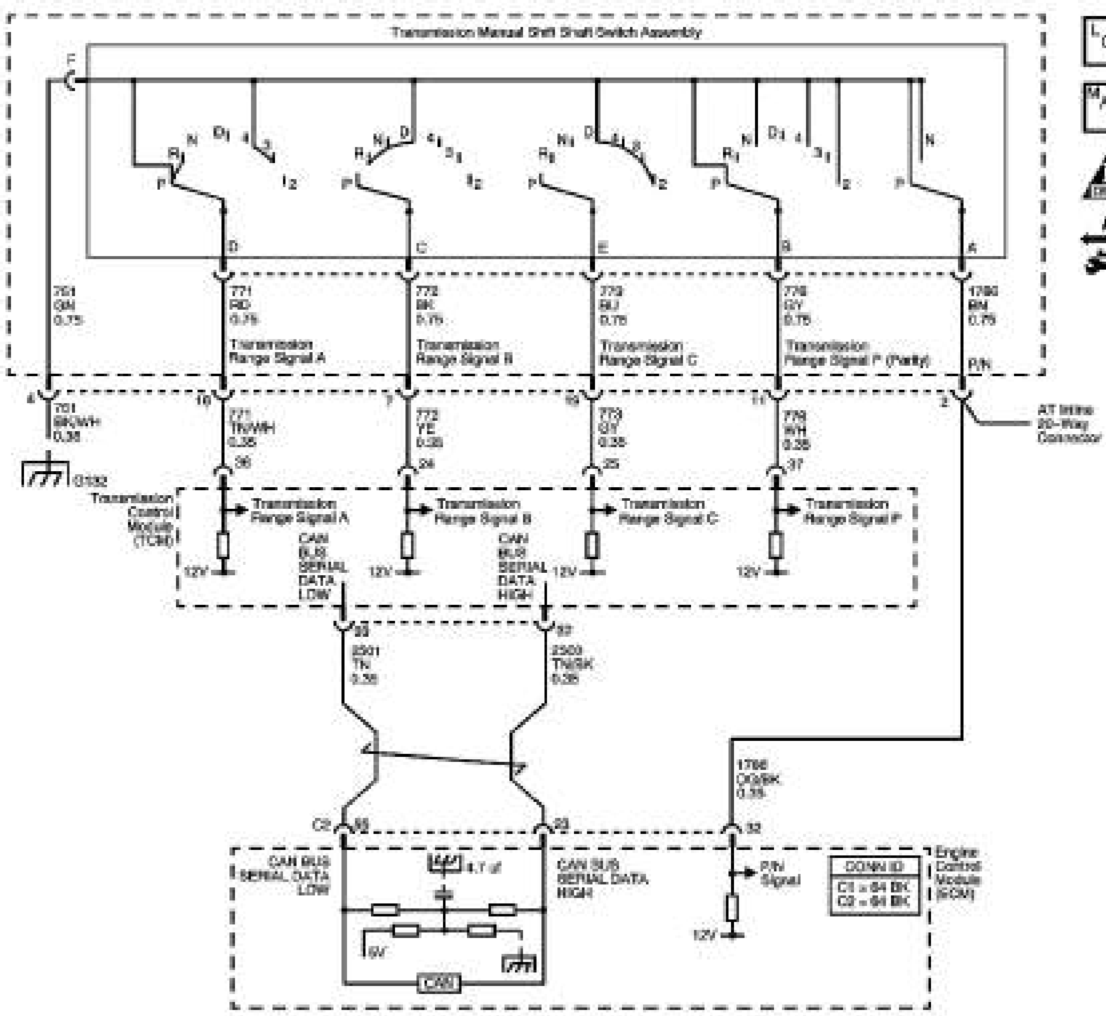
DTC P1823

Circuit Description


Transmission Manual Shift Shaft Switch Assembly
F
N
D1
4
3
R1
P
I2
D
C
E
B
A
701
GN
0.75
771
RD
0.75
Transmission Range Signal A
772
BK
0.75
Transmission Range Signal B
773
BU
0.75
Transmission Range Signal C
776
GY
0.75
Transmission Range Signal P (Parity)
1780
BN
0.75
P/N
4
701
BK/WH
0.35
10
771
TN/WH
0.35
7
772
YE
0.35
19
773
GY
0.35
11
776
WH
0.35
2
AT Inline 20-Way Connector
G102
36
24
25
37
Transmission Control Module (TCM)
Transmission Range Signal A
Transmission Range Signal B
Transmission Range Signal C
Transmission Range Signal P
CAN BUS SERIAL DATA LOW
CAN BUS SERIAL DATA HIGH
12V
12V
12V
12V
33
32
2501
TN
0.35
2500
TN/BK
0.35
1786
OG/BK
0.35
C2
55
23
32
CAN BUS SERIAL DATA LOW
4.7 uf
CAN BUS SERIAL DATA HIGH
5V
CAN
P/N Signal
12V
CONN ID
C1 = 64 BK
C2 = 64 BK
Engine Control Module (ECM)

The transmission manual shift shaft switch assembly is a sliding contact switch attached to the control valve body within the transmission. The 4 inputs to the transmission control module (TCM) from the switch indicate which position is selected by the transmission selector lever. This information is used for engine controls as well as determining the transmission shift patterns. The input voltage at the TCM is high when the switch is open and low when the switch is closed to ground. The state of each input is displayed on the scan tool as IMS. The 4 IMS input parameters represented are Signal A , Signal B, Signal C and Signal P (Parity).

If the TCM detects a short to ground on the TR signal P circuit, DTC P1823 sets. DTC P1823 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P1823 Internal Mode Switch P Circuit Low Voltage

Conditions for Running the DTC

- No engine torque signal DTC P2637.
- The engine run time is greater than 5 seconds.
- The engine torque is greater than 55 N·m (41 lb. ft).

Conditions for Setting the DTC

- The switch indicates PARK for 1 second, then;
- The switch indicates a transitional state between Neutral and D5 for 5 seconds.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM assumes a D5 shift pattern.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P1823 in TCM history.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. This step determines if the fault is internal or external to the transmission.

4. This step determines if the engine wiring harness circuit or the TCM is at fault.
5. This step determines if the automatic transmission wiring harness or the transmission manual shift shaft switch assembly is at fault.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Select Transmission Data on the scan tool. 6. Select IMS range on the scan tool. 7. Place the gear select lever in D5. Does the scan tool IMS range display Drive 5?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the Automatic transmission inline 20-way connector. Additional DTCs may set. 3. Turn ON the ignition, with the engine OFF. 4. Select IMS A/B/C/P on the scan tool. Is IMS Signal P displaying LOW?	--	Go to Step 4	Go to Step 5
4	Test the TR signal P circuit of the switch for a short to ground between the TCM connector and the Automatic transmission inline 20-way connector. Refer to Testing for Short to Ground and	--		

	Wiring Repairs. Did you find and correct the condition?		Go to Step 9	Go to Step 8
5	1. Turn OFF the ignition. 2. Connect the Automatic transmission inline 20-way connector. 3. Disconnect the automatic transmission wiring harness at the transmission manual shift shaft switch assembly. 4. Turn ON the ignition, with the engine OFF. Is IMS Signal P displaying LOW?	--	Go to Step 6	Go to Step 7
6	Replace the automatic transmission wiring harness. Refer to Transmission Internal Electrical Harness Replacement. Is the action complete?	--	Go to Step 9	--
7	Replace the transmission manual shift shaft switch assembly. Refer to Manual Shift Shaft Position Switch Replacement. Is the action complete?	--	Go to Step 9	--
8	Replace the TCM. Refer to Control Module References for replacement, set-up and programming. Is the action complete?	--	Go to Step 9	--
9	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Operate the vehicle under the following conditions: • Drive the vehicle in D4. • The engine torque is greater than 55 N·m (41 lb. ft). • IMS Signal P must be HI for 0.025 second. 4. Select Specific DTC. 5. Enter DTC P1823. Has the test run and passed?	--	Go to Step 10	Go to Step 2
	With the scan tool, observe the stored			

10	information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P1825 or P1915

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P1825: Internal Mode Switch - Invalid Range

DTC P1915: Internal Mode Switch Start/Wrong Range

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Transmission Range Signal A	P1825	P1915	P1915	P1825, P1915
Transmission Range Signal B	P1915	P1825	P1825	P1825, P1915
Transmission Range Signal C	P1915	P1825	P1825	P1825, P1915
Transmission Range Signal P	P1825	P1915	P1915	P1825, P1915
Ground	--	P1825	P1825	P1825, P1915

Typical Scan Tool Data

IMS A/B/C/P

Circuit	Normal Range	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, range selector in Park				
Transmission Range Switch Signal A	LOW	LOW	HI	HI
Transmission Range Switch Signal B	HI	LOW	HI	HI
Transmission Range Switch Signal C	HI	LOW	HI	HI
Transmission Range Switch Signal P	LOW	LOW	HI	HI
HI = 12 volts				

LOW = 0 volts

Circuit / System Description

The internal mode switch (IMS) assembly is a sliding contact switch attached to the control valve body within the transmission. The four inputs to the transmission control module (TCM) from the switch indicate which position is selected by the transmission manual shaft. The input voltage at the TCM is high when the switch is open and low when the switch is closed to ground. The state of each input is displayed on the scan tool as IMS. The IMS input parameters represented are transmission range signal A, Signal B, signal C, and signal P.

Conditions for Running the DTC

No OSS DTCs P0722 or P0723.

DTC P1825

VSS is greater than 16 km/h (10 mph)

DTC P1915

The transmission output shaft speed is less than 90 RPM.

Conditions for Setting the DTC

DTC P1825

Any one or more of the following conditions:

- The IMS signal circuit A, B, or P are Low in Park for greater than 1 second.
- The IMS signal circuit A is Low in D6 for 8 seconds.
- The IMS signal circuit C is High in D6 for 8 seconds.
- The TCM detects an invalid range from the IMS for 3.25 seconds.
- The IMS signal circuit C is high in D6 for greater than 8 seconds and the engine torque is greater than 20 N·m (15 lb ft).
- Park/Neutral Switch equals P/N and the IMS state is not Park or Neutral, or the Park/Neutral switch is not Park or Neutral and the IMS state equals Park or Neutral for 4 seconds.

DTC P1915

The manual shift shaft switch assembly indicates a transitional state during the following sequence:

- The engine speed is less than 50 RPM for more than 0.25 seconds.
- The engine speed is 50-480 RPM for more than 0.07 seconds.
- The engine speed is greater than 525 RPM for more than 3.25 seconds.
- The transmission input shaft speed is greater than 250 RPM.

Action Taken When the DTC Sets

- DTCs P1825 and P1915 are Type A DTCs.
- The TCM commands maximum line pressure.
- The TCM turns OFF all solenoids.
- The TCM freezes transmission adaptive functions.
- The TCM defaults the transmission to third gear if the current gear is 1st, 2nd, or 3rd; or fifth gear if the current gear is 4th, 5th, or 6th gear.

Conditions for Clearing the DTC

DTCs P1825 and P1915 are Type A DTCs.

Diagnostic Aids

The IMS is part of a wire harness, which connects electrically to the control solenoid (w/body and TCM) valve assembly and is serviced separately from the control solenoid (w/body and TCM) valve assembly. Inspect the IMS, harness, connector, and control solenoid (w/body and TCM) valve assembly pins for metallic debris. Use the J 35616 for any test that requires probing the control solenoid (w/body and TCM) valve assembly harness connector or a component harness connector.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics .

Connector End View Reference

Component Connector End Views

DTC Type Reference

- Diagnostic Trouble Code (DTC) Type Definitions .
- Diagnostic Trouble Code (DTC) List/Type .

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References

Special Tools Required

J 35616 GM-approved terminal test kit

Circuit/System Verification

Test for the correct operation of the IMS. Refer to Transmission Internal Mode Switch Logic .

If the IMS operation matches the IMS logic table, the system is functioning normally.

Circuit/System Testing

1. Disconnect the IMS connector at the control solenoid (w/body and TCM) valve assembly. Ignition ON. The scan tool IMS A/B/C/P parameter should display HI for all four signal circuits.

   If a signal circuit displays LOW, the control solenoid (w/body and TCM) valve assembly is faulty.
2. Connect a 3-amp fused jumper wire between each transmission range signal circuit at the control solenoid (w/body and TCM) valve assembly and ground ensuring that the signal circuit displays LOW when connected to ground.

   If a signal circuit remains HI when connected to ground, the control solenoid (w/body and TCM) valve assembly is faulty.

   If the above two tests indicate correct TCM functions, the IMS is faulty.

Component Testing

Internal Mode Switch Logic Table

Gear Selector Position	A	B	C	P
Park	LOW	HI	HI	LOW
Park/Reverse	LOW	LOW	HI	LOW
Reverse	LOW	LOW	HI	HI
Reverse/Neutral	HI	LOW	HI	HI
Neutral	HI	LOW	HI	LOW
Neutral/Drive 6	HI	LOW	LOW	LOW
Drive 6	HI	LOW	LOW	HI
Drive 4	LOW	LOW	LOW	LOW
Drive 3	LOW	HI	LOW	HI
Drive 2	HI	HI	LOW	LOW
Invalid	HI	HI	HI	HI
	LOW	HI	HI	HI
	HI	HI	HI	LOW

HI = Ignition voltage

LOW = 0 voltage

Repair Instructions

Important: Always perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Important: Perform the Control Solenoid Valve and Transmission Control Module Assembly Inspection for the following components before replacing the components.

- Internal Mode Switch (IMS) Replacement. Refer to Manual Shift Shaft Position Switch Replacement .
- Control Solenoid (w/Body and TCM) Valve Assembly Replacement. Refer to Control Module References for replacement, setup, and programming.
- Perform the Service Fast Learn Adapts .

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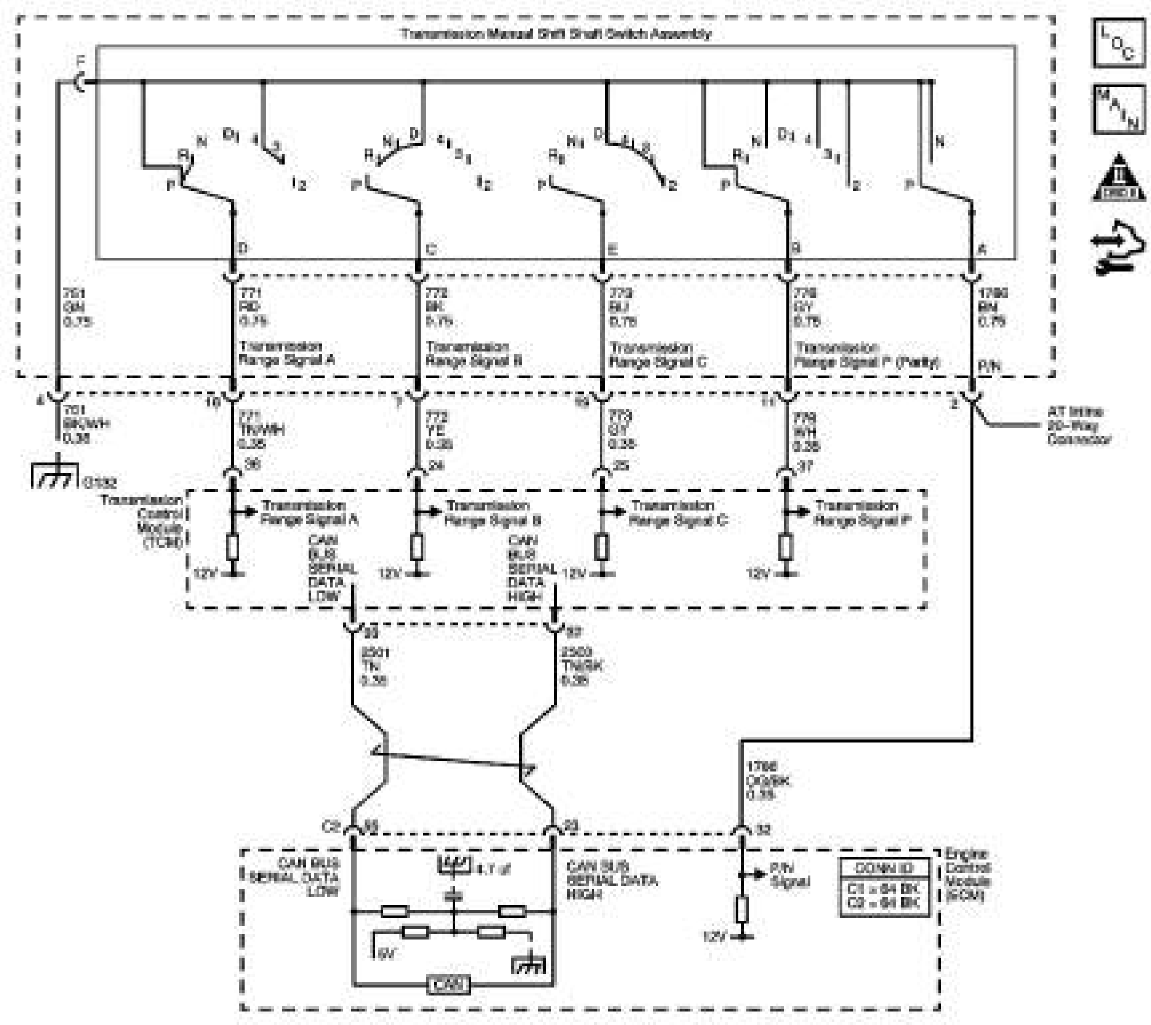
DTC P1826

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit Description


Transmission Manual Shift Shaft Switch Assembly
F
N
D
R
P
2
D
C
E
B
A
701
GN
0.75
771
RD
0.75
Transmission Range Signal A
772
BK
0.75
Transmission Range Signal B
773
BU
0.75
Transmission Range Signal C
776
GY
0.75
Transmission Range Signal P (Parity)
1780
BN
0.75
P/N
4
701
BK/WH
0.35
G102
10
771
TN/WH
0.35
36
7
772
YE
0.35
24
773
GY
0.35
25
11
776
WH
0.35
37
2
AT Inline 20-Way Connector
Transmission Control Module (TCM)
Transmission Range Signal A
Transmission Range Signal B
Transmission Range Signal C
Transmission Range Signal P
12V
CAN BUS SERIAL DATA LOW
CAN BUS SERIAL DATA HIGH
2501
TN
0.35
2500
TN/BK
0.35
1786
OG/BK
0.35
C2
32
CAN BUS SERIAL DATA LOW
4.7 uf
CAN BUS SERIAL DATA HIGH
5V
CAN
P/N Signal
12V
CONN ID
C1 = 64 BK
C2 = 64 BK
Engine Control Module (ECM)

The transmission manual shift shaft switch assembly is a sliding contact switch attached to the control valve body within the transmission. The 4 inputs to the transmission control module (TCM) from the switch indicate which position is selected by the transmission selector lever. This information is used for engine controls as well as determining the transmission shift patterns. The input voltage level at the TCM is high when the switch is open and low when the switch is closed to ground. The state of each input is displayed on the scan tool as IMS. The 4 IMS input parameters represented are Signal A, Signal B, Signal C and Signal P (Parity).

If the TCM detects switch Signal C is high while the vehicle is being driven in a forward gear, then DTC P1826 sets. DTC P1826 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P1826 Internal Mode Switch C Circuit High Voltage

Conditions for Running the DTC

- No OSS DTCs P0722 or P0723.
- No engine torque signal DTC P2637.
- Vehicle speed is greater than 8 km/h (5 mph).
- Engine torque is greater than 20 N·m (15 lb. ft).
- DTC P1826 has not passed during the current ignition cycle.
- The gear ratio is within one of the following ranges:
  - 3.33:1 to 3.50:1 for first gear
  - 2.16:1 to 2.27:1 for second gear
  - 1.56:1 to 1.64:1 for third gear
  - 0.98:1 to 1.03:1 for fourth gear
  - 0.73:1 to 0.77:1 for fifth gear

Conditions for Setting the DTC

The TCM detects Signal C is high, while the gear ratio indicates first, second, third, fourth, or fifth gear for 3 seconds.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM assumes a D5 shift pattern.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P1826 in TCM history.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Test Description

The number below refers to the step number on the diagnostic table.

3. This step tests the integrity of the engine harness and TCM by checking for the Signal C state change from HI to LOW. A LOW signal indicates the fault is in the internal transmission harness or the switch. A HI signal indicates the fault is in the engine harness or the TCM.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. **Important:** - Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. - Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Select Transmission Data on the scan tool. 6. Select IMS range on the scan tool. 7. Place the range selector in D5. Does the scan tool IMS range indicate	--	Go to Testing for Intermittent Conditions and	

	Drive 5?		Poor Connections	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the Automatic transmission inline 20-way connector. Additional DTCs may set. 3. Install the J 45681 jumper harness on the TCM side of the Automatic transmission inline 20-way connector. 4. Using the J 35616 Holden-terminal test kit, connect a fused jumper wire from terminal 19 of the J 45681 to ground. Refer to Component Connector End Views . 5. Turn ON the ignition, with the engine OFF. 6. Select IMS A/B/C/P on the scan tool. Does IMS Signal C indicate LOW?	--	Go to Step 5	Go to Step 4
4	Test the TR signal C circuit of the transmission manual shift shaft switch assembly for an open between the TCM connector and the Automatic transmission inline 20-way connector. Refer to Testing for Continuity and Wiring Repairs. Did you find and correct a condition?	--	Go to Step 9	Go to Step 8
5	Test the TR signal C circuit of the transmission manual shift shaft switch assembly for an open between the Automatic transmission inline 20-way connector and the switch. Refer to Testing for Continuity. Did you find the condition?	--	Go to Step 6	Go to Step 7
6	Replace the automatic transmission wiring harness. Refer to Transmission Internal Electrical Harness Replacement. Is the action complete?	--	Go to Step 9	--
7	Replace the transmission manual shift shaft switch assembly. Refer to Manual Shift Shaft Position Switch Replacement.	--		--

	Is the action complete?		Go to Step 9	
8	Replace the TCM. Refer to Control Module References for replacement, set-up and programming. Is the action complete?	--	Go to Step 9	--
9	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Start and idle the engine in PARK. 4. Observe IMS A/B/C/P on the scan tool. 5. Move the range selector to D2, D3, D4 and D5 positions. Ensure that IMS Signal C indicates LOW for each range. 6. Operate the vehicle to greater than 8 km/h (5 mph). 7. Select Specific DTC. 8. Enter DTC P1826. Has the test run and passed?	--	Go to Step 10	Go to Step 2
10	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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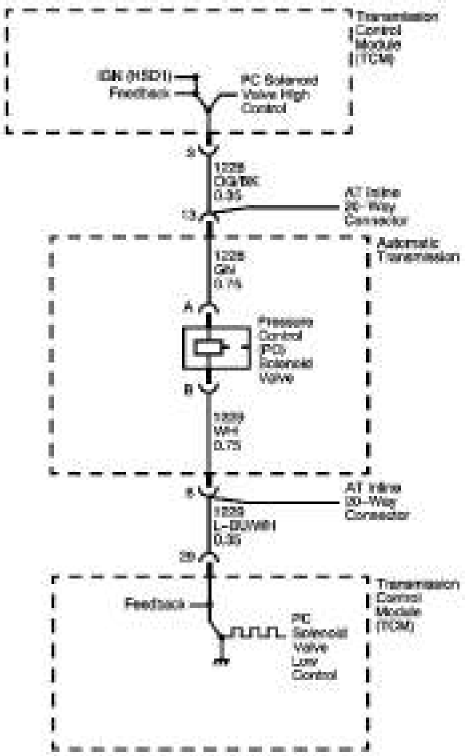
DTC P1831

Circuit Description


Transmission Control Module (TCM)
IGN (HSD1)
Feedback
PC Solenoid Valve High Control
3
1228 OG/BK 0.35
13
AT Inline 20-Way Connector
Automatic Transmission
1228 GN 0.75
A
Pressure Control (PC) Solenoid Valve
B
1229 WH 0.75
8
AT Inline 20-Way Connector
1229 L-BU/WH 0.35
29
Transmission Control Module (TCM)
Feedback
PC Solenoid Valve Low Control

The transmission control module (TCM) provides voltage to the pressure control solenoid, the shift solenoids, and the TCC PWM solenoid through two separate solid-state devices called High Side Drivers, called HSD1 and HSD2. HSD1 provides electrical power to the pressure control solenoid. HSD2 provides power to the shift solenoids. A normal function of the TCM is to run tests on each driver to make sure that it is functioning properly.

When the TCM detects a short to ground on HSD1, then DTC P1831 sets. DTC P1831 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P1831 Pressure Control (PC)/Shift Lock Solenoid Control Circuit Low Voltage

Conditions for Running the DTC

The engine run time is greater than 5 seconds.

Conditions for Setting the DTC

The TCM detects a short to ground on the HSD1 circuit when the HSD1 is commanded ON.

Action Taken When the DTC Sets

- The TCM does not request the ECM to illuminate the malfunction indicator lamp (MIL).
- SERVICE VEHICLE SOON displays on the driver information centre (DIC).
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- The TCM stores DTC P1831 in TCM history.

Conditions for Clearing the DTC/DIC

- The TCM clears the DIC when the condition no longer exists.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM and the TCM Failure Records. Using the Clear Info function erases the Failure Records from the ECM and TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Turn OFF the ignition for at least 30 seconds.	--		Go to Testing for

	6. Start the engine. Did DTC P1831 reset?		Go to Step 3	Intermittent Conditions and Poor Connections
3	1. Turn OFF the ignition. 2. Disconnect the Automatic transmission inline 20-way connector. 3. Turn ON the ignition with the engine OFF. 4. Clear the DTC. 5. Turn OFF the ignition for at least 30 seconds. 6. Start the engine. Additional DTCs may set. Did DTC P1831 reset?	--	Go to Step 4	Go to Step 5
4	1. Disconnect the TCM. 2. Test the HSD1 circuit between the Automatic transmission inline 20-way connector and the TCM for a short to ground. Refer to Testing for Short to Ground. Did you find a condition?	--	Go to Step 8	Go to Step 7
5	Test the HSD1 circuit between the Automatic transmission inline 20-way connector and the pressure control solenoid for a short to ground. Refer to Testing for Short to Ground. Did you find a condition?	--	Go to Step 9	Go to Step 6
6	Replace the shorted pressure control solenoid. Refer to Pressure Control Solenoid Valve Replacement. Is the action complete?	--	Go to Step 10	--
7	Replace the TCM. Refer to Control Module References for replacement, set-up and programming. Is the action complete?	--	Go to Step 10	--
8	Repair the short to ground on the HSD1 circuit. Refer to Wiring Repairs. Is the action complete?	--	Go to Step 10	--
	Replace the internal transmission electrical harness.			

9	Refer to Transmission Internal Electrical Harness Replacement. Is the action complete?	--	Go to Step 10	--
10	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Start the engine. 4. Select Specific DTC. 5. Enter DTC P1831. Has the test run and passed?	--	Go to Step 11	Go to Step 2
11	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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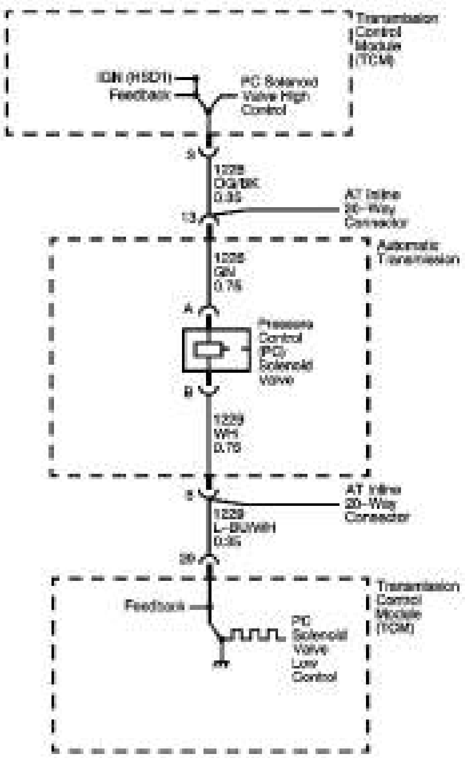
DTC P1832

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit Description


Transmission Control Module (TCM)
IGN (HSD1)
Feedback
PC Solenoid Valve High Control
3
1228 OG/BK 0.35
13
AT Inline 20-Way Connector
Automatic Transmission
1228 GN 0.75
A
Pressure Control (PC) Solenoid Valve
B
1229 WH 0.75
5
AT Inline 20-Way Connector
1229 L-BU/WH 0.35
29
Transmission Control Module (TCM)
Feedback
PC Solenoid Valve Low Control

The transmission control module (TCM) provides voltage to the pressure control solenoid, the shift solenoids, and the TCC PWM solenoid through two separate solid-state devices called High Side Drivers, called HSD1 and HSD2. HSD1 provides electrical power to the pressure control solenoid. HSD2 provides power to the shift solenoids. A normal function of the TCM is to run tests on each driver to make sure that it is functioning properly.

When the TCM detects a short to voltage on HSD1, then DTC P1832 sets. DTC P1832 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P1832 Pressure Control (PC)/Shift Lock Solenoid Control Circuit High Voltage

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The TCM detects at least 6.4 volts at the HSD1 terminal prior to commanding the HSD1 ON.

Action Taken When the DTC Sets

- The TCM does not request the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL).
- SERVICE VEHICLE SOON displays on the driver information centre (DIC).
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- The TCM stores DTC P1832 in TCM history.

Conditions for Clearing the DTC/DIC

- The TCM clears the DIC when the condition no longer exists.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non-emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM and the TCM Failure Records. Using the Clear Info function erases the Failure Records from the ECM			

2	and TCM. - Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Turn OFF the ignition for at least 30 seconds. 6. Turn ON the ignition, with the engine OFF. Did DTC P1832 reset?	--	Go to Step 3	Go to Testing for Intermittent Conditions and Poor Connections
3	1. Turn OFF the ignition. 2. Disconnect the TCM. 3. Turn ON the ignition with the engine OFF. 4. Measure the voltage at the HSD1 circuit of the TCM harness connector. Refer to Component Connector End Views and Circuit Testing. Is the voltage greater than the specified value?	6.4 volts	Go to Step 4	Go to Step 5
4	Repair the short to voltage on the HSD1 circuit. Refer to Wiring Repairs . Is the action complete?	--	Go to Step 6	--
5	Replace the TCM. Refer to Control Module References for replacement, set-up and programming. Is the action complete?	--	Go to Step 6	--
6	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Turn ON the ignition, with the engine OFF. 4. Select Specific DTC. 5. Enter DTC P1832. Has the test run and passed?	--	Go to Step 7	Go to Step 2
7	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that	--	Go to Diagnostic Trouble Code (DTC) List -	

	you have not diagnosed?		Vehicle	System OK

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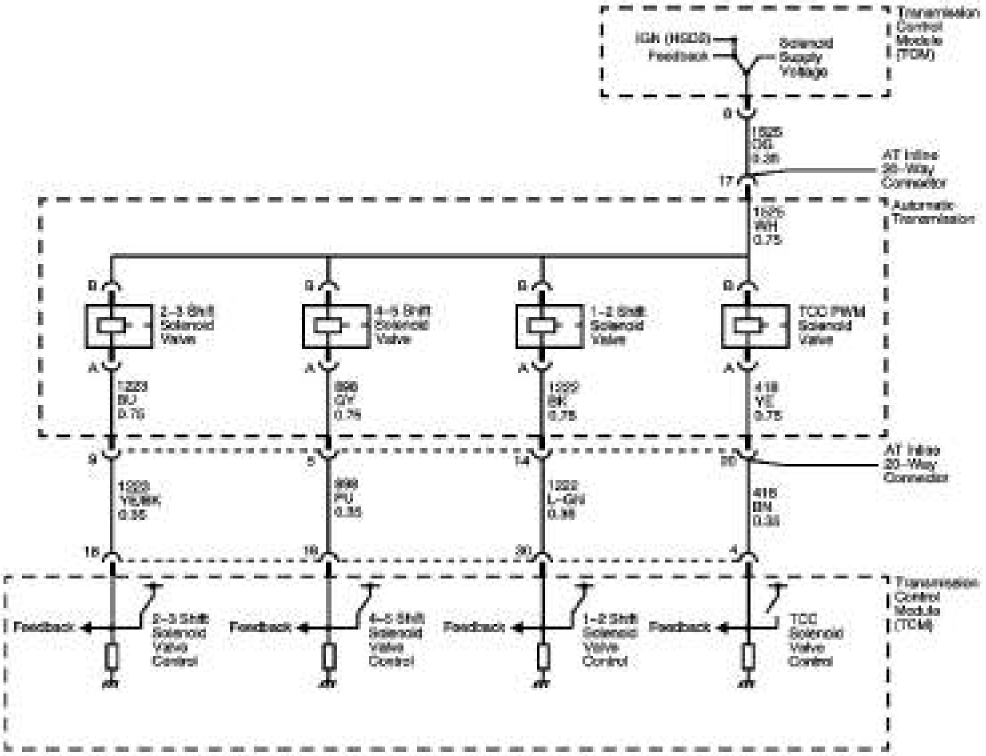
DTC P1833

Circuit Description


Transmission Control Module (TCM)
IGN (HSD2)
Feedback
Solenoid Supply Voltage
8
1525
OG
0.35
17
AT Inline 20-Way Connector
Automatic Transmission
1525
WH
0.75
B
2-3 Shift Solenoid Valve
4-5 Shift Solenoid Valve
1-2 Shift Solenoid Valve
TCC PWM Solenoid Valve
A
1223
BU
0.75
898
GY
0.75
1222
BK
0.75
418
YE
0.75
9
5
14
20
AT Inline 20-Way Connector
1223
YE/BK
0.35
898
PU
0.35
1222
L-GN
0.35
418
BN
0.35
18
19
20
4
Transmission Control Module (TCM)
Feedback
2-3 Shift Solenoid Valve Control
Feedback
4-5 Shift Solenoid Valve Control
Feedback
1-2 Shift Solenoid Valve Control
Feedback
TCC Solenoid Valve Control

The transmission control module (TCM) provides voltage to the pressure control solenoid, the shift solenoids, and the TCC PWM solenoid through two separate solid-state devices called High Side Drivers, called HSD1 and HSD2. HSD1 provides electrical power to the pressure control solenoid. HSD2 provides power to the shift solenoids. A normal function of the TCM is to run tests on each driver to make sure that it is functioning properly.

When the TCM detects a short to ground on HSD2, then DTC P1833 sets. DTC P1833 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P1833 Torque Converter Clutch (TCC)/Shift Solenoid (SS) Control Circuit Low Voltage

Conditions for Running the DTC

The engine run time is greater than 5 seconds.

Conditions for Setting the DTC

The TCM detects a short to ground on the HSD2 circuit when the HSD2 is commanded ON.

Action Taken When the DTC Sets

- The TCM requests the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL) during the second consecutive drive trip in which the Conditions for Setting the DTC are met.
- The TCM turns off power to all solenoids.
- The transmission will operate in fifth gear if the vehicle has successfully completed a 1-2 upshift in the current ignition cycle. If the vehicle has not completed a 1-2 upshift in the current ignition cycle, the transmission will operate in fourth gear.
- The TCM commands maximum line pressure.
- The TCC is disabled.
- The TCM freezes transmission adaptive functions.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P1833 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from			

2	the ECM and the TCM. - Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Turn OFF the ignition for at least 30 seconds. 6. Start the engine. Did DTC P1833 reset?	--	Go to Step 3	Go to Testing for Intermittent Conditions and Poor Connections
3	1. Turn OFF the ignition. 2. Disconnect the Automatic transmission inline 20-way connector. 3. Turn ON the ignition with the engine OFF. 4. Clear the DTC. 5. Turn OFF the ignition for at least 30 seconds. 6. Start the engine. Additional DTCs may set. Did DTC P1833 reset?	--	Go to Step 4	Go to Step 5
4	1. Disconnect the TCM. 2. Test the solenoid supply voltage circuit between the Automatic transmission inline 20-way connector and the TCM for a short to ground. Refer to Testing for Short to Ground and Wiring Repairs. Did you find and correct the condition?	--	Go to Step 9	Go to Step 7
5	Test the solenoid supply voltage circuit between the Automatic transmission inline 20-way connector and each individual solenoid for a short to ground. Refer to Testing for Short to Ground. Did you find a condition?	--	Go to Step 8	Go to Step 6
6	Replace the shorted solenoid. Refer to 1-2 Shift Solenoid Valve Replacement , 2-3 Shift Solenoid Valve Replacement , 4-5 Shift Solenoid Valve Replacement or Torque Converter Clutch Solenoid Replacement , as applicable. Is the action complete?	--	Go to Step 9	--
	Replace the TCM.			

7	Refer to Control Module References in Computer/Integrating Systems for replacement, set-up and programming. Is the action complete?	--	Go to Step 9	--
8	Replace the internal transmission electrical harness. Refer to Transmission Internal Electrical Harness Replacement. Is the action complete?	--	Go to Step 9	--
9	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Start the engine. 4. Select Specific DTC. 5. Enter DTC P1833. Has the test run and passed?	--	Go to Step 10	Go to Step 2
10	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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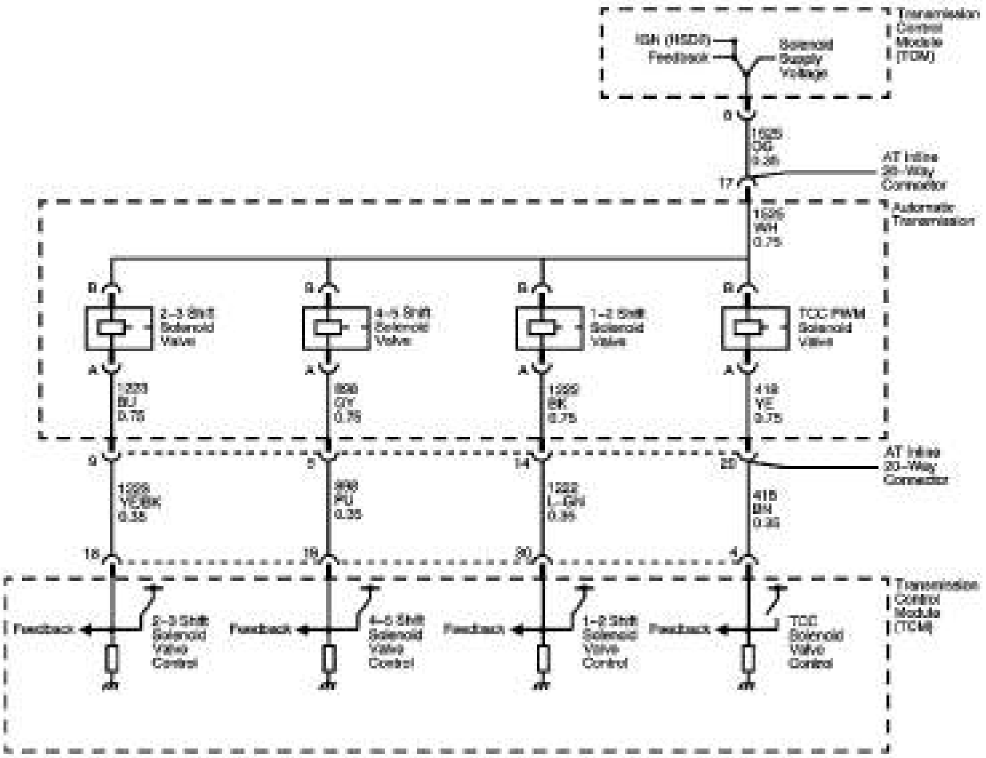
DTC P1834

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit Description


Transmission Control Module (TCM)
IGN (HSD2)
Feedback
Solenoid Supply Voltage
8
1525
OG
0.35
AT Inline 20-Way Connector
17
Automatic Transmission
1525
WH
0.75
B
2–3 Shift Solenoid Valve
4–5 Shift Solenoid Valve
1–2 Shift Solenoid Valve
TCC PWM Solenoid Valve
A
1223
BU
0.75
898
GY
0.75
1222
BK
0.75
418
YE
0.75
9
5
14
20
AT Inline 20-Way Connector
1223
YE/BK
0.35
898
PU
0.35
1222
L-GN
0.35
418
BN
0.35
18
19
30
4
Transmission Control Module (TCM)
Feedback
2–3 Shift Solenoid Valve Control
4–5 Shift Solenoid Valve Control
1–2 Shift Solenoid Valve Control
TCC Solenoid Valve Control

The transmission control module (TCM) provides voltage to the pressure control solenoid, the shift solenoids, and the TCC PWM solenoid through two separate solid-state devices called High Side Drivers, called HSD1 and HSD2. HSD1 provides electrical power to the pressure control solenoid. HSD2 provides power to the shift solenoids. A normal function of the TCM is to run tests on each driver to make sure that it is functioning properly.

When the TCM detects a short to voltage on HSD2, then DTC P1834 sets. DTC P1834 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P1834 Torque Converter Clutch (TCC)/Shift Solenoid (SS) Control Circuit High Voltage

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The TCM detects at least 6.4 volts at the HSD2 terminal prior to commanding the HSD2 ON.

Action Taken When the DTC Sets

- The TCM requests the engine control module (ECM) to illuminate the malfunction indicator lamp (MIL) during the second consecutive drive trip in which the Conditions for Setting the DTC are met.
- The TCM turns off power to all solenoids.
- The transmission will operate in fifth gear if the vehicle has successfully completed a 1-2 upshift in the current ignition cycle. If the vehicle has not completed a 1-2 upshift in the current ignition cycle, the transmission will operate in fourth gear.
- The TCM commands maximum line pressure.
- The TCC is disabled.
- The TCM freezes transmission adaptive functions.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P1834 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF.			

2	**Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Turn OFF the ignition for at least 30 seconds. 6. Turn ON the ignition, with the engine OFF. Did DTC P1834 reset?	--	Go to Step 3	Go to Testing for Intermittent Conditions and Poor Connections
3	1. Turn OFF the ignition. 2. Disconnect the TCM. 3. Turn ON the ignition with the engine OFF. 4. Measure the voltage at the solenoid supply voltage circuit of the TCM harness connector. Refer to Component Connector End Views and Circuit Testing . Is the voltage greater than the specified value?	6.4 volts	Go to Step 4	Go to Step 5
4	Repair the short to voltage on the solenoid supply voltage circuit. Refer to Wiring Repairs. Is the action complete?	--	Go to Step 6	--
5	Replace the TCM. Refer to Control Module References for replacement, set-up and programming. Is the action complete?	--	Go to Step 6	--
6	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Turn ON the ignition, with the engine	--		

	OFF. 4. Select Specific DTC. 5. Enter DTC P1834. Has the test run and passed?		Go to Step 7	Go to Step 2
7	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P1876

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

Circuit Description

The TAP Shift system allows the driver to manually shift gears by using the Upshift and Downshift positions located on the automatic transmission shift Lever. Pushing the lever to the Upshift position will command an upshift and pushing the lever to the Downshift position will command a downshift. The TAP Shift system is activated when the gear selector is in the manual, M, position and is deactivated in all other positions.

If the TCM detects TAP enable switch Active and the IMS does not indicate D5, DTC P1876 sets. DTC P1876 is a type C DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P1876 Up and Down Shift Switch Performance - Range Switch Not in D3

Conditions for Running the DTC

- No TAP system DTCs P0815, P0816 or P0826.
- No IMS range DTCs P1815, P1820, P1822, P1823, P1825 or P1826.
- The engine run time is greater than 5 seconds.
- No GMLAN errors present.

Conditions for Setting the DTC

The TCM detects the TAP enable switch is Active and the IMS range is not D for 5 seconds.

Action Taken When the DTC Sets

- The TCM does not request the ECM to illuminate the malfunction indicator lamp (MIL).
- The TCM disables TAP Shift operation.
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information a Failure Record.
- The TCM stores DTC P1876 in TCM history.

Conditions for Clearing the DTC

- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **Important:** Before clearing the DTC, use the scan tool in order to record the Failure Records. Using the Clear DTC Information function erases the Failure Records from the TCM. 3. Record the DTC Failure Records. 4. Clear the DTC. 5. Start the engine. 6. Move the A/T shift lever to the Manual position. 7. Select IMS on the scan tool. Does the scan tool IMS parameter display Drive 5?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
3	1. Select IMS A/B/C/P on the scan tool. 2. Place the gear select lever in the Manual position. Does the scan tool IMS A/B/C/P display indicate the specified value for each range?	HI/HI/HI/HI	Go to Step 14	Go to Step 4
4	1. Inspect the transmission linkage from the range selector to the manual shift shaft for proper adjustment. 2. Adjust the linkage as necessary. Refer to Manual Shift Shaft Position Switch Replacement . Did the linkage require adjustment?	--	Go to Step 19	Go to Step 5
	1. Turn OFF the ignition. 2. Disconnect the Automatic			

5	transmission inline 20-way connector. Additional DTCs may set. 3. Turn ON the ignition, with the engine OFF. 4. Select IMS A/B/C/P on the scan tool. Does the scan tool IMS A/B/C/P display all HI?	--	Go to Step 6	Go to Step 10
6	1. Turn OFF the ignition. 2. Install the J 45681 jumper harness on the TCM side of the Automatic transmission inline 20-way connector. 3. Turn ON the ignition, with the engine OFF. 4. Using the DMM and the J 35616 Holden terminal test kit, measure the voltage at the transmission range (TR) signal A circuit of the J 45681 . Refer to Component Connector End Views . 5. Measure the voltage at the TR signal B of the J 45681 . 6. Measure the voltage at the TR signal C of the J 45681 . 7. Measure the voltage at the TR signal P of the J 45681 . Did you measure ignition voltage at all four terminals?	--	Go to Step 7	Go to Step 11
7	Install a fused jumper wire from the TR signal A circuit of the J 45681 to ground while monitoring the scan tool IMS A/B/C/P display. Refer to Component Connector End Views . When the TR signal A circuit is grounded, do any other circuits indicate LOW?	--	Go to Step 12	Go to Step 8
8	Install a fused jumper wire from the TR signal B circuit of the J 45681 to ground while monitoring the scan tool IMS A/B/C/P display. Refer to Component Connector End Views . When the TR signal B circuit is grounded, do any other circuits indicate LOW?	--	Go to Step 12	Go to Step 9
	Install a fused jumper wire from the TR signal C circuit of the J 45681 to ground while monitoring the scan tool IMS			

9	A/B/C/P display. Refer to Component Connector End Views . When the TR signal C circuit is grounded, do any other circuits indicate LOW?	--	Go to Step 12	Go to Step 13
10	Test the TR signal circuits of the transmission manual shift shaft switch assembly that did not indicate HI for a short to ground between the TCM connector and the Automatic transmission inline 20-way connector. Refer to Testing for Short to Ground and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 19	Go to Step 18
11	Test the TR signal circuits of the transmission manual shift shaft switch assembly that did not indicate ignition voltage for an open between the TCM connector and the Automatic transmission inline 20-way connector. Refer to Testing for Continuity and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 19	Go to Step 18
12	Test the affected signal circuits of the transmission manual shift shaft switch assembly for a shorted together condition between the TCM connector and the Automatic transmission inline 20-way connector. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 19	Go to Step 18
13	Test the TR signal circuits of the transmission manual shift shaft switch assembly for an open or shorted condition between the Automatic transmission inline 20-way connector and the switch. Refer to Testing for Continuity . Did you find and correct the condition?	--	Go to Step 16	Go to Step 17
	Test the ground circuit of the transmission manual shift shaft switch assembly for an open between the Automatic transmission			

14	inline 20-way connector and the chassis. Refer to Testing for Continuity and Wiring Repairs . Did you find and correct the condition?	--	Go to Step 19	Go to Step 15
15	Test the ground circuit of the transmission manual shift shaft switch assembly for an open between the Automatic transmission inline 20-way connector and the switch. Refer to Testing for Continuity . Did you find and correct the condition?	--	Go to Step 16	Go to Step 17
16	Replace the automatic transmission wiring harness assembly. Refer to Transmission Internal Electrical Harness Replacement . Did you complete the replacement?	--	Go to Step 19	--
17	Replace the transmission manual shift shaft switch assembly. Refer to Manual Shift Shaft Position Switch Replacement . Is the action complete?	--	Go to Step 19	--
18	Replace the TCM. Refer to Control Module References for replacement, setup and programming. Is the action complete?	--	Go to Step 19	--
19	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Start the engine. 4. Place the A/T Shift Lever in the Manual position. 5. Select Specific DTC. 6. Enter DTC P1876. Has the test run and passed?	--	Go to Step 20	Go to Step 2
20	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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DTC P2534

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category

DTC Descriptor

DTC P2534: Ignition 1 Switch Circuit Low Voltage

Circuit/System Description

The transmission control module (TCM) samples the system voltage on the Ignition 1 voltage circuit every 0.1 seconds. Lower than normal voltage may be inadequate to operate the transmission control solenoids properly. Improper solenoid operation may cause erratic transmission operation, which may result in internal damage.

Conditions for Running the DTC

- The engine speed is greater than 500 RPM.
- Ignition voltage is between 8-18 volts.

Conditions for Setting the DTC

The TCM detects 2 volts or less on the ignition 1 voltage circuit at the TCM for 10 seconds or more.

Action Taken When the DTC Sets

- DTC P2534 is a Type A DTC.
- The TCM turns OFF all high side drivers.
- The TCM turns OFF all solenoids.
- The TCM commands maximum line pressure.
- the TCM freezes transmission adaptive functions.
- The TCM commands the TCC OFF.
- The TCM allows the vehicle to operate in transmission protection mode.

Conditions for Clearing the DTC

DTC P2534 is a Type A DTC.

Diagnostic Aids

If all circuit tests are OK, make sure the transmission pass through connector and harness terminals are clean and not damaged, and the charging system is functioning correctly.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics .

Connector End View Reference

Component Connector End Views

DTC Type Reference

- Diagnostic Trouble Code (DTC) Type Definitions .
- Diagnostic Trouble Code (DTC) List/Type .

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Circuit/System Testing

Clear the DTC and operate the vehicle under the conditions for running and setting the DTC.

If the DTC resets, test the TCM ignition 1 voltage circuit for battery positive voltage at the TCM 16-way connector.

If the voltage is less than battery voltage, test the Ignition 1 voltage circuit for an open or short to ground and repair the circuit as necessary.

Repair Instructions

Important: Always perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Perform the Service Fast Learn Adapts .

DTC P2544

Circuit Description

To improve shift feel, the transmission control module (TCM) may request that the engine control module (ECM) reduce engine torque during shift events. When such a request is received, the ECM responds by retarding the base ignition timing and notifying the TCM that the request has succeeded. If the ECM is unable to comply with the request, the ECM sends the TCM a message that the request has failed.

The torque reduction request is sent to the ECM through a communication network called GMLAN. Two circuits are used to communicate GMLAN data between the ECM and TCM. A fault in the GMLAN will not cause DTC P2544 to set by itself. If a GMLAN fault occurs, other DTCs will set before DTC P2544.

When the TCM receives a torque reduction failure message from the ECM, then DTC P2544 will set. DTC P2544 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P2544 Transmission Torque Request Circuit

Conditions for Running the DTC

- The engine run time is greater than 5 seconds.
- No other GMLAN errors are present.

Conditions for Setting the DTC

The ECM notifies the TCM that a torque reduction request has failed for 2 seconds.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM turns power off to the PCS.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P2544 in TCM history.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Failure Records. Did you record any ECM Failure Records?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	Go to Step 3
3	1. Clear the DTC. 2. Turn the ignition OFF for at least 30 seconds. 3. Start, and allow the engine to idle. Did DTC P2544 reset?	--	Go to Step 4	Go to Testing for Intermittent Conditions and Poor Connections
4	Did any other DTCs set?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	Go to Step 5
5	Replace the TCM. Refer to Control Module References. Is the action complete?	--	Go to Step 6	--

6	Perform the following operation to verify the repair: 1. Select DTC on the scan tool. 2. Select Clear Info. 3. Start, and allow the engine to idle. 4. Select Specific DTC. 5. Enter DTC P2544. Has the test run and passed?	--	Go to Step 7	Go to Step 2
7	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P2637

Circuit Description

Engine torque information is sent to the transmission control module (TCM) by the engine control module (ECM) through a communication network called GMLAN. Two circuits are used to communicate GMLAN data between the ECM and TCM. A fault in the GMLAN will not cause DTC P2637 to set by itself. If a GMLAN fault occurs, other DTCs will set before DTC P2637.

When the ECM sends the TCM an engine torque signal that is invalid, DTC P2637 will set. DTC P2637 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P2637 Transmission Torque Delivered Circuit

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P2637 Transmission Torque Delivered Circuit

Conditions for Running the DTC

- The engine run time is greater than 5 seconds.
- No other GMLAN errors are present.

Conditions for Setting the DTC

Engine torque signal is below the lower limit, above the upper limit, or is an unreliable value for 2 seconds.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM turns off the pressure control solenoid. When the pressure control solenoid is off, line pressure is at maximum.
- The TCM freezes transmission adaptive functions.
- The TCM inhibits Autograde braking and shift stabilization.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the

Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.

- The TCM stores DTC P2637 in TCM history.

Conditions for Clearing the DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without a non emission related diagnostic fault occurring.
- The TCM cancels the DTC default actions when the ignition is OFF long enough in order to power down the TCM.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Failure Records. Did you record any ECM Failure Records?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	Go to Step 3
3	1. Clear the DTC. 2. Turn the ignition OFF for at least 30 seconds. 3. Start, and allow the engine to idle. Did DTC P2637 reset?	--	Go to Step 4	Go to Testing for Intermittent Conditions and Poor Connections
4	Did any other DTCs set?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	Go to Step 5
	Replace the TCM.			

5	Refer to Control Module References. Is the action complete?	--	Go to Step 6	--
6	Perform the following operation to verify the repair: 1. Select DTC on the scan tool. 2. Select Clear Info. 3. Start, and idle the engine. 4. Select Specific DTC. 5. Enter DTC P2637. Has the test run and passed?	--	Go to Step 7	Go to Step 2
7	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

DTC P2670 or P2671

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P2670: Solenoid High Control Circuit Group 2 Low Voltage

DTC P2671: Solenoid High Control Circuit Group 2 High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
High Side Driver 2	P2670	P2670	P2671

Circuit/System Description

The transmission control module (TCM) provides voltage to the pressure control solenoid, the shift solenoids, and the torque converter clutch pulse width modulated (TCC PWM) solenoid through two separate solid-state devices called high side drivers, called HSD1 and HSD2. HSD1 provides electrical power to the pressure control solenoid. HSD2 provides power to the shift solenoids. A normal function of the TCM is to run tests on each driver to ensure that it is functioning properly.

Conditions for Running the DTC

P2670

The engine run time is greater than 5 seconds.

P2671

The ignition is ON.

Conditions for Setting the DTC

P2670

The TCM detects a short to ground on the HSD2 circuit when the HSD2 is commanded ON.

P2671

The TCM detects greater than 6.4 volts at the HSD2 terminal prior to commanding the HSD2 ON.

Action Taken When the DTC Sets

- DTC P2670 and P2671 are Type B DTCs.
- The TCM turns off power to all solenoids.
- The transmission will operate in fifth gear if the vehicle has successfully completed a 1-2 upshift in the current ignition cycle. If the vehicle has not completed a 1-2 upshift in the current ignition cycle, the transmission will operate in fourth gear.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCC is disabled.

Conditions for Clearing the DTC

DTC P2670 and P2671 are Type B DTCs.

Diagnostic Aids

1. P2670 and P2671 only sets on the High Side Driver 2 side of the shift solenoids. Electrical faults on the ground side of the shift solenoids will set the shift solenoids code for that circuit.
2. An open on the High Side Driver 2 side of the shift solenoids will set one or more of the shift solenoid codes.
3. When a code is set, the TCM turns OFF power to HSD2.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Transmission General Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Transmission Control Module Scan Tool Information

Special Tools

- *J 35616* GM Terminal Test Kit
- *J 45681* Jumper Harness

Circuit / System Verification

Ignition ON, engine OFF. With a scan tool, observe the High Side Driver 2 parameter status for:

- Short to Ground
- Open
- Short to Volts

Circuit / System Testing

1. Ignition OFF, disconnect the X121 harness connector.
2. Install the *J 45681* harness on the transmission pass-thru connector.
3. Using the brown J35616-6 test probes from the most current *J 35616* kit , test the resistance for the following: 1-2 Shift Solenoid Valve, 2-3 Shift Solenoid Valve, 4-5 Shift Solenoid Valve, TCC PWM Solenoid Valve. Refer to Component Resistance.

   If less than the specified value, test the affected circuits for a short together condition. If circuits test normal, replace the affected solenoid.

   If greater than the specified value, test the affected circuits for an open. If circuits test normal, replace the affected solenoid.
4. Test for greater than 10 K ohms between the solenoid supply voltage circuit, terminal 17, and all other circuits of the *J 45681* harness , except:
   - 1-2 Shift Solenoid Valve Control circuit, pin 14
   - 2-3 Shift Solenoid Valve Control circuit, pin 9
   - 4-5 Shift Solenoid Valve Control circuit, pin 5
   - TCC PWM Solenoid Valve Control circuit, pin 20

   If less than the specified value, the affected circuits are shorted together. Replace the transmission internal wire harness.
5. Test for greater than 50 K ohms between the solenoid supply voltage circuit, terminal 17, and the transmission case.

   If less than the specified value, test the following circuits and solenoids for short to the transmission case.
   - 1-2 Shift Solenoid Valve Control circuit, pin 14
   - 2-3 Shift Solenoid Valve Control circuit, pin 9
   - 4-5 Shift Solenoid Valve Control circuit, pin 5
   - TCC PWM Solenoid Valve Control circuit, pin 20
6. Remove the *J 45681* harness from the transmission pass-thru connector and install it on the

engine side of the X121.

7. Key ON, engine OFF. Using the brown J35616-7 test probes from the most current *J 35616* kit , test for greater than 50 K ohms between the solenoid supply voltage circuit, terminal 17, and the transmission case.

   If less than the specified value, test the solenoid supply voltage circuit for a short to the transmission case. If circuits test normal, replace the TCM.

8. Disconnect the X1 harness connector at the TCM.

   Note: When test probing the TCM harness terminals; it is imperative to use the proper test probe from the most current version of the *J 35616* kit . Use the light blue J35616-64B probes.

9. Using a 5A fused jumper wire and the light blue probes J35616-64B, test for greater than 10 K ohms between the solenoid supply voltage circuit, terminal F8, and all other circuits of the X1.

   If less than the specified value, the affected circuits are shorted together.

10. If all circuits and connections test normal, replace the TCM.

Component Testing

1. Ignition OFF, disconnect the X121 harness connector. Install the *J 45681* harness on the transmission pass-thru connector.
2. Using the brown J35616-4 test probes form the most current *J 35616* kit , test the following: 1-2 Shift Solenoid Valve, 2-3 Shift Solenoid Valve, 4-5 Shift Solenoid Valve, TCC PWM Solenoid Valve. Refer to Component Resistance.

   If less than the specified value, test the affected circuits for a short together. If the circuits test normal, replace the affected solenoid.

   If greater than the specified value, test the affected circuits for an open. If circuits test normal, replace the affected solenoid.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- 1-2 Shift Solenoid Valve Replacement
- 2-3 Shift Solenoid Valve Replacement
- 4-5 Shift Solenoid Valve Replacement
- Torque Converter Clutch Solenoid Replacement
- Transmission Internal Electrical Harness Replacement
- Component Resistance
- Refer to Control Module References for replacement, setup and reprogramming.

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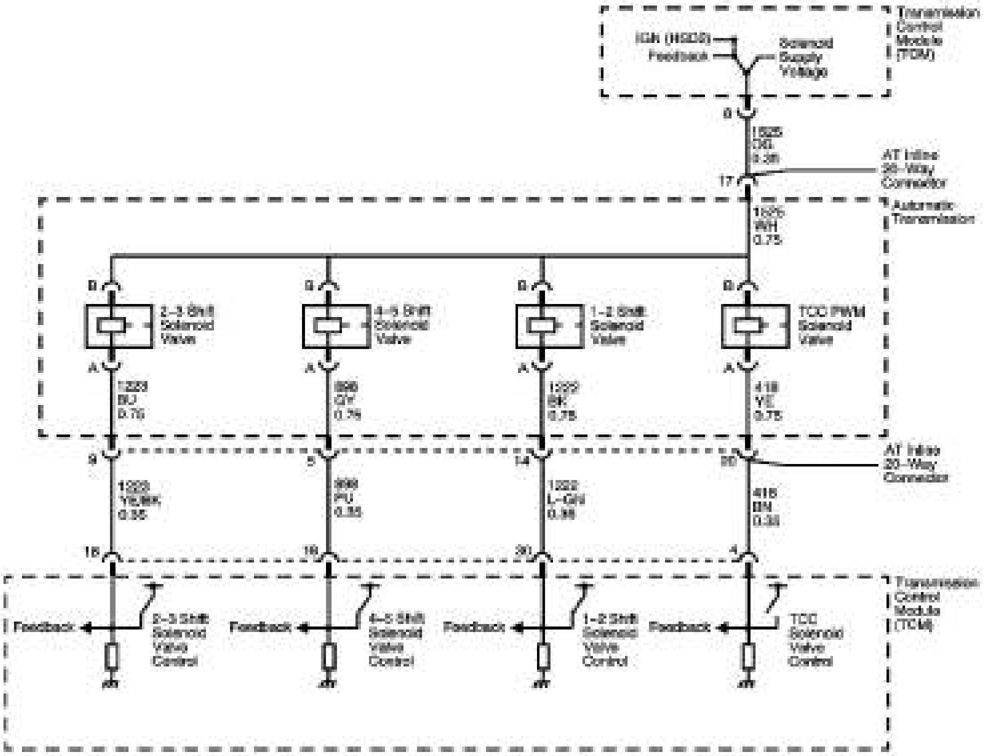
DTC P2763

Circuit Description


Transmission Control Module (TCM)
IGN (HSD2)
Feedback
Solenoid Supply Voltage
8
1525
OG
0.35
AT Inline 20-Way Connector
17
Automatic Transmission
1525
WH
0.75
B
2-3 Shift Solenoid Valve
B
4-5 Shift Solenoid Valve
B
1-2 Shift Solenoid Valve
B
TCC PWM Solenoid Valve
A
1223
BU
0.75
A
898
GY
0.75
A
1222
BK
0.75
A
418
YE
0.75
9
5
14
20
AT Inline 20-Way Connector
1223
YE/BK
0.35
898
PU
0.35
1222
L-GN
0.35
418
BN
0.35
18
19
20
4
Transmission Control Module (TCM)
Feedback
2-3 Shift Solenoid Valve Control
Feedback
4-5 Shift Solenoid Valve Control
Feedback
1-2 Shift Solenoid Valve Control
Feedback
TCC Solenoid Valve Control

The transmission control module (TCM) provides voltage to the torque converter clutch pulse width modulated (TCC PWM) solenoid valve through High Side Driver 2 (HSD2). The TCM controls the ON and OFF time of the solenoid by providing a ground through the output driver module (ODM) . The TCM uses a PWM duty cycle, in order to control application and release of the TCC. When the solenoid is commanded OFF, the TCM senses high voltage. When the solenoid is commanded ON, the TCM senses low voltage.

When the TCM detects a continuous open or short to ground in the TCC PWM Solenoid valve circuit, then DTC P2763 sets. DTC P2763 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P2763 Torque Converter Clutch (TCC) Pressure Control (PC) Solenoid Control Circuit High Voltage

Conditions for Running the DTC

- The engine run time is greater than 5 seconds.
- HSD2 is commanded ON.

Conditions for Setting the DTC

DTC P2763 sets when the TCM detects an short to voltage in the TCC PWM solenoid valve circuit when the PWM duty cycle is 45 percent or greater.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive drive trip in which the Conditions for Setting the DTC are met.
- The TCM inhibits fifth gear if the transmission is in Hot Mode.
- The TCM inhibits the TCC.
- The TCM freezes transmission adaptive functions.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P2763 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Test Description

The number below refers to the step number on the diagnostic table.

2. Listen for a soft rattling sound when the solenoid energizes. Use a stethoscope if necessary.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF.			

2	**Important:** - Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. - Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Use the scan tool in order to command the TCC PWM solenoid ON. Does the solenoid operate?	--	Go to Step 8	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the Automatic transmission 20-way inline harness connector. 3. Install the J 45681 jumper harness to the TCM side of the 20-way connector. 4. Turn ON the ignition with the engine OFF. 5. With the test lamp connected to ground, probe the HSD2 circuit, terminal 17, of the J 45681 . Does the test lamp illuminate?	--	Go to Step 4	Go to Step 6
4	1. Turn OFF the ignition. 2. Install the J 45681 to the transmission side of the 20-way connector. 3. Using the DMM, measure the resistance between terminal 17 and 20 of the J 45681 . Refer to Component Resistance . Is the resistance within the specified range?	10.0-13.6Ω	Go to Step 5	Go to Step 7
5	1. Disconnect the TCM. 2. Test the TCC PWM solenoid valve control circuit for a short to voltage. Refer to Testing for a Short to Voltage . Did you find a condition?	--	Go to Step 9	Go to Step 8
6	1. Turn OFF the ignition. 2. Disconnect the TCM. 3. Test the HSD2 circuit from the TCM to the TCC PWM solenoid for an open circuit. Refer to Testing for Continuity .	--		

	Did you find a condition?		Go to Step 9	Go to Step 8
7	1. Remove the transmission oil pan. 2. Test the TCC PWM solenoid wiring from the 20-way connector to the TCC PWM solenoid connector for a short to voltage. Refer to Testing for a Short to Voltage . Did you find a condition?	--	Go to Step 10	Go to Step 11
8	Replace the TCM. Refer to Control Module References for replacement, set-up and programming. Is the action complete?	--	Go to Step 12	--
9	Perform the necessary wiring repairs. Refer to Wiring Repairs . Is the action complete?	--	Go to Step 12	--
10	Replace the Automatic transmission internal transmission wiring harness. Refer to Transmission Internal Electrical Harness Replacement . Is the action complete?	--	Go to Step 12	--
11	Replace the TCC PWM solenoid valve. Refer to Torque Converter Clutch Solenoid Replacement . Is the action complete?	--	Go to Step 12	--
12	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Turn ON the ignition, with the engine OFF. 4. Select Specific DTC. 5. Enter DTC P2763. Has the test run and passed?	--	Go to Step 13	Go to Step 2
13	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

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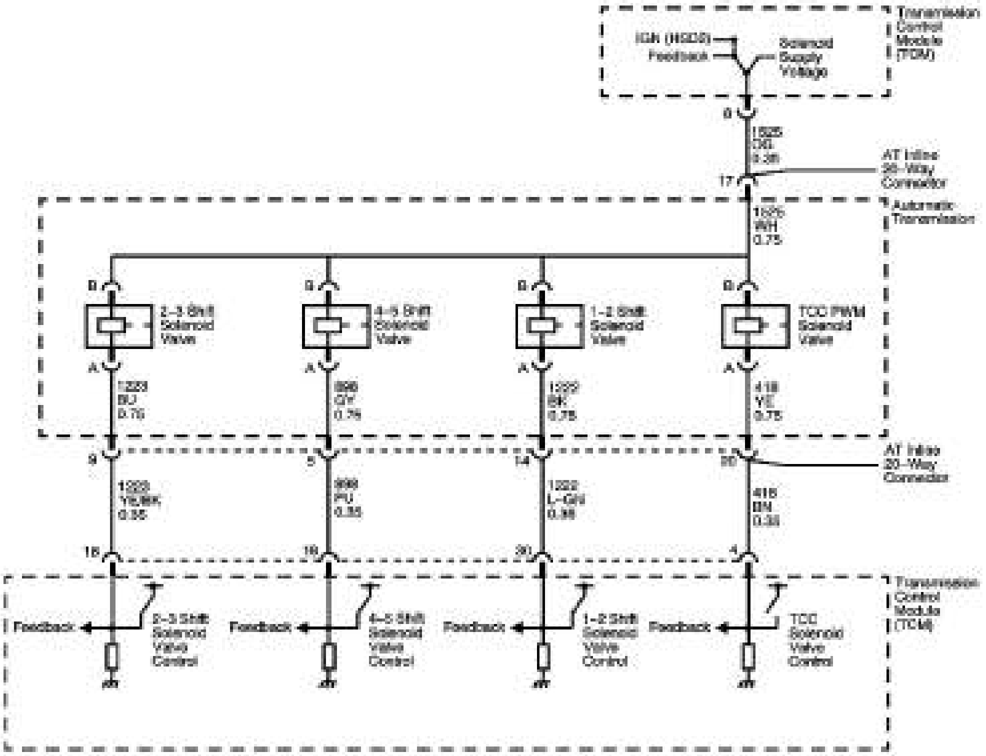
DTC P2764

Circuit Description


Transmission Control Module (TCM)
IGN (HSD2)
Feedback
Solenoid Supply Voltage
8
1525
OG
0.35
AT Inline 20-Way Connector
17
Automatic Transmission
1525
WH
0.75
B
2-3 Shift Solenoid Valve
4-5 Shift Solenoid Valve
1-2 Shift Solenoid Valve
TCC PWM Solenoid Valve
A
1223
BU
0.75
898
GY
0.75
1222
BK
0.75
418
YE
0.75
9
5
14
20
AT Inline 20-Way Connector
1223
YE/BK
0.35
898
PU
0.35
1222
L-GN
0.35
418
BN
0.35
18
19
30
4
Transmission Control Module (TCM)
Feedback
2-3 Shift Solenoid Valve Control
Feedback
4-5 Shift Solenoid Valve Control
Feedback
1-2 Shift Solenoid Valve Control
Feedback
TCC Solenoid Valve Control

The transmission control module (TCM) provides voltage to the torque converter clutch pulse width modulated (TCC PWM) solenoid valve through High Side Driver 2 (HSD2). The TCM controls the ON and OFF time of the solenoid by providing a ground through the output driver module (ODM) . The TCM uses a PWM duty cycle, in order to control application and release of the TCC. When the solenoid is commanded OFF, the TCM senses high voltage. When the solenoid is commanded ON, the TCM senses low voltage.

When the TCM detects a continuous open or short to ground in the TCC PWM Solenoid valve circuit, then DTC P2764 sets. DTC P2764 is a type B DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P2764 Torque Converter Clutch (TCC) Pressure Control (PC) Solenoid Control Circuit Low Voltage

Conditions for Running the DTC

- The engine run time is greater than 5 seconds.
- HSD2 is commanded ON.

Conditions for Setting the DTC

DTC P2764 sets when either of the following conditions occurs:

- The TCM detects an open in the TCC PWM solenoid valve circuit when the PWM duty cycle is greater than 20 percent.
- The TCM detects a short to ground in the TCC PWM solenoid valve circuit when the PWM duty cycle is greater than 20 percent but less than 50 percent.

Action Taken When the DTC Sets

- The TCM requests the ECM to illuminate the malfunction indicator lamp (MIL) during the second consecutive drive trip in which the Conditions for Setting the DTC are met.
- The TCM turns off power to all solenoids. When the solenoids are off:
    - The transmission will operate in fifth gear if the vehicle has successfully completed a 1-2 upshift in the current ignition cycle. If the vehicle has not completed a 1-2 upshift in the current ignition cycle, the transmission will operate in fourth gear. If the transmission is operating in fifth gear, fourth gear may be obtained if the engine is stopped briefly and started again.
    - The line pressure is at maximum.
- The TCM freezes transmission adaptive functions.
- At the time of the first failure, the TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as a Failure Record.
- At the time of the second failure, the ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as a Freeze Frame.
- The TCM stores DTC P2764 in TCM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL after the sixth consecutive drive trip in which the TCM does not send a MIL illumination request.
- A scan tool can clear the MIL/DTC.
- The TCM clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The TCM cancels the default actions when the ignition is OFF long enough in order to power down the TCM.

Test Description

The number below refers to the step number on the diagnostic table.

2. Listen for a soft rattling sound when the solenoid energizes. Use a stethoscope if necessary.

Step	Action	Value (s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	--	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. **Important:** • Before clearing the DTC, use the scan tool in order to record the ECM Freeze Frame and the TCM Failure Records. Using the Clear Info function erases the Freeze Frame and Failure Records from the ECM and the TCM. • Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Use the scan tool in order to command the TCC PWM solenoid ON. Does the solenoid operate?	--	Go to Step 9	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the Automatic transmission 20-way inline harness connector. 3. Install the J 45681 jumper harness to the TCM side of the 20-way connector. 4. Turn ON the ignition with the engine OFF. 5. With the test lamp connected to ground, probe the HSD2 circuit, terminal 17, of J 45681 . Does the test lamp illuminate?	--	Go to Step 4	Go to Step 7
4	1. Turn OFF the ignition. 2. Install the J 45681 to the transmission side of the 20-way connector. 3. Using the DMM, measure the resistance between terminal 17 and 20 of the J 45681 . Refer to Component Resistance . Is the resistance within the specified range?	10.0-13.6Ω	Go to Step 5	Go to Step 8
	Using the DMM, measure the resistance between terminal 17 of the J 45681 and ground.			

5	Is the resistance greater than the specified value?	50K Ω	Go to Step 6	Go to Step 8
6	1. Disconnect the TCM. 2. Test the TCC PWM solenoid valve control circuit for the following conditions: • Open circuit • Short to ground • Refer to Testing for Continuity and Testing for Short to Ground . Did you find a condition?	--	Go to Step 10	Go to Step 9
7	1. Turn OFF the ignition. 2. Disconnect the TCM. 3. Test the HSD2 circuit from the TCM to the TCC PWM solenoid for an open circuit. Refer to Testing for Continuity . Did you find a condition?	--	Go to Step 10	Go to Step 9
8	1. Remove the transmission oil pan. 2. Test the TCC PWM solenoid wiring from the 20-way connector to the TCC PWM solenoid connector for the following conditions: • Open circuit • Short to ground • Refer to Testing for Continuity and Testing for Short to Ground . Did you find a condition?	--	Go to Step 11	Go to Step 12
9	Replace the TCM. Refer to Control Module References for replacement, set-up and programming. Is the action complete?	--	Go to Step 13	--
10	Perform the necessary wiring repairs. Refer to Wiring Repairs . Is the action complete?	--	Go to Step 13	--
11	Replace the Automatic transmission internal transmission wiring harness. Refer to Transmission Internal Electrical Harness Replacement . Is the action complete?	--	Go to Step 13	--
	Replace the TCC PWM solenoid valve.			

12	Refer to Torque Converter Clutch Solenoid Replacement . Is the action complete?	--	Go to Step 13	--
13	Perform the following procedure in order to verify the repair: 1. Select DTC. 2. Select Clear Info. 3. Turn ON the ignition, with the engine OFF. 4. Select Specific DTC. 5. Enter DTC P2764. Has the test run and passed?	--	Go to Step 14	Go to Step 2
14	With the scan tool, observe the stored information, capture info and DTC info. Does the scan tool display any DTCs that you have not diagnosed?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	System OK

Automatic Transmission Overheating

Checks	Causes
Fluid Pump Assembly	• Pressure regulator valve stuck • Pressure regulator valve spring • Line boost valve spring • Line boost valve or bushing stuck, damaged or incorrectly assembled • Pressure relief ball not seated or damaged • Pressure relief ball spring • Fluid pump screen assembly plugged or damaged • Fluid pump rotor guide omitted or misassembled • Fluid pump rotor cracked or broken • Porosity in fluid pump • Fluid pump surfaces not flat • Excessive fluid pump rotor clearance
Pressure Control Solenoid Assembly	• Contaminated • O-Rings cut or damaged • Electrical connection
Inspect for active transmission DTCs	Transmission DTC default action active

Buzz Noise or High Frequency Rattle Sound

Buzz Noise or High Frequency Rattle Sound

Checks	Action
DEFINITION: A buzz or high frequency rattle	
• Trace Cooler Pipes • Check for binding or contact at the Radiator, other than at the Cooler Pipe connectors	Verify a pressure buzz by watching for a needle vibration of the pressure gage. A road test may be necessary. Refer to Road Test.

Case Porosity Repair

Some external leaks are caused by case porosity in non-pressurized areas. You can usually repair these leaks with the transmission in the vehicle.

1. Thoroughly clean the area to be repaired with a cleaning solvent. Air dry the area.

   Caution: Epoxy adhesive may cause skin irritations and eye damage. Read and follow all information on the container label as provided by the manufacturer.

2. Using instructions from the manufacturer, mix a sufficient amount of an epoxy to make the repair.
3. While the transmission case is still hot, apply the epoxy. You can use a clean, dry soldering acid brush to clean the area and also to apply the epoxy cement. Make certain that the area to be repaired is fully covered.
4. Allow the epoxy cement to cure for three hours before starting the engine.
5. Repeat the fluid leak diagnosis procedures.

Clutch Plate Diagnosis

Composition Plates

Dry the plates and inspect the plates for the following conditions:

- Pitting
- Flaking
- Wear
- Glazing
- Cracking
- Charring
- Chips or metal particles embedded in the lining

Replace a composition plate which shows any of these conditions.

Steel Plates

Wipe the plates dry and inspect the plates for heat discoloration. If the surfaces are smooth, even if color smear is indicated, you can reuse the plate. If the plate is discolored with heat spots or if the surface is scuffed, replace the plate.

Causes of Burned Clutch Plates

The following conditions can result in a burned clutch plate:

- Incorrect usage of clutch plates
- Engine coolant in the transmission fluid
- A cracked clutch piston
- Damaged or missing seals
- Damaged fluid passage sleeves
- Low line pressure
- Valve body conditions
  - The valve body face is not flat.
  - Porosity is between channels.
  - The valve bushing clips are improperly installed.
  - The checkballs are misplaced.
- The Teflon® seal rings are worn or damaged.
- Low transmission fluid level

Degraded 1-2 and 2-1 Shifts

Check	Causes
DEFINITION: One of the two following conditions occurs during a first to second gear steady throttle upshift, or a second to first gear coast, or a light to moderate throttle detent downshift: • Harsh shift feel An unacceptable quick gear change occurs. • Soft shift feel An unacceptable long gear change occurs.	
Second Clutch	• Damaged piston, 1-2, 2-1 shift • Damaged or worn clutch plates, 1-2, 2-1 shift
Pressure Control Solenoid	Damaged
Fluid Pump	Damaged

Degraded 2-3 and 3-2 Shifts

Check	Causes
DEFINITION: One of the two following conditions occurs during a first to second gear steady throttle upshift, or a second to first gear coast, or a light to moderate throttle detent downshift: • Harsh shift feel An unacceptable quick gear change occurs. • Soft shift feel An unacceptable long gear change occurs.	
Second Clutch	• Damaged piston, 1-2, 2-1 shift • Damaged or worn clutch plates, 1-2, 2-1 shift
Pressure Control Solenoid	Damaged
Fluid Pump	Damaged

Degraded 4-5 Shift

Check	Causes
DEFINITION: One of the two following conditions occurs during a fourth to fifth gear steady throttle upshift, or a fifth to fourth coast, or a light to moderate throttle detent downshift: • Harsh shift feel An unacceptable quick gear change occurs. • Soft shift feel An unacceptable long gear change occurs.	
Coast Clutch	• Damaged or cut piston • Damaged or worn clutch plates • Damaged or stuck ball check valve
Intermediate Clutch	• Damaged piston, 2-3, 3-2 shift • Damaged or worn clutch plates, 2-3, 3-2 shift
Overdrive Clutch	• Damaged or worn clutch plates • Damaged or worn piston
Pressure Control Solenoid	Damaged
Fluid Pump	Damaged

Drives with Selector Lever in Position N

Check	Causes
DEFINITION: Vehicle moves forward while in Neutral.	
Forward Clutch and Coast Clutch Assembly	• Damaged or worn clutch plates • Damaged or cut piston • Damaged or stuck ball check valve
Selector Lever	Adjustment

Engine Coolant / Water in Transmission

If antifreeze or water has entered the transmission, perform the following:

1. Disassemble the transmission.
2. Replace all of the rubber type seals. The coolant will attack the seal material which will cause leakage.
3. Replace the composition-faced clutch plate assemblies. The facing material may separate from the steel centre portion.
4. Replace all of the washers.
5. Replace the torque converter.
6. Thoroughly clean and rebuild the transmission, using new gaskets and oil filter.
7. Flush the cooler lines after the transmission cooler has been properly repaired or replaced.

Fifth Gear Only

Check	Causes
DEFINITION: The transmission only provides fifth gear in Drive range. The vehicle accelerates from a stop in fifth gear.	
Control Valve Body Accumulator Assembly	Feed limit valve or spring stuck in the exhaust position
Wiring Harness	Improper electrical connection to shift solenoids
Inspect for active transmission DTCs	Transmission DTC default action active

First and Second Gears Only

Check	Causes
DEFINITION: The transmission only provides first and second gear in Drive range.	
Control Valve Body Accumulator Assembly	• 2-3 SS valve stuck • 2-3 shift valve stuck applied • Spacer plate or gaskets are mispositioned or damaged

First Gear Only

Check	Causes
DEFINITION: The transmission only provides first gear in Drive range. The vehicle accelerates from a stop in first gear and does not upshift.	
Control Valve Body Accumulator Assembly	• 1-2 shift control valve stuck applied • 1-2 shift valve stuck applied
Control Valve Body Accumulator Assembly	The spacer plate or gasket are mispositioned or damaged
Shift Solenoid Valve	• Stuck or damaged • Faulty electrical connection

First, Fourth, and Fifth Gears Only

Check	Causes
DEFINITION: The transmission provides first, fourth and fifth gear in Drive range.	
Control Valve Body Accumulator Assembly	• 1-2 SS valve stuck off • Spacer plate or gaskets are mispositioned or damaged

Flex Plate / Torque Converter Vibration Test

Isolating Vibration

Notice: Some engine/transaxle combinations cannot be balanced in this manner due to restricted access or limited clearances between the torque converter bolts and the engine. Ensure that the bolts do not bottom out in the lug nuts or the torque converter cover which could dent and cause internal damage.

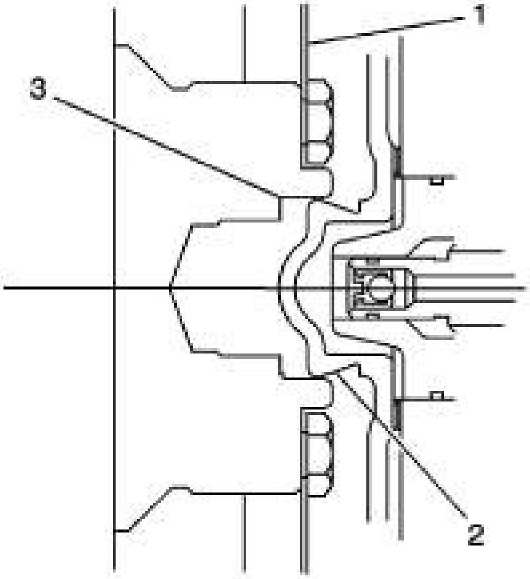
To isolate and correct a flywheel or torque converter vibration, separate the torque converter from the flywheel to determine if vibration is in the engine or transmission.

1. With the engine at idle speed and the transmission in PARK or NEUTRAL, observe the vibration.
2. Turn the engine OFF.
3. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle.
4. Mark the relationship of the converter to the flywheel.
5. Remove the bolts attaching the converter to the flywheel. Refer to Fastener Tightening Specifications.
6. Slide the torque converter away from the flywheel.
7. Rotate the flywheel and torque converter to inspect for defects or missing balance weights. Refer to Engine Flywheel Cleaning and Inspection.
8. Lower the vehicle.

Indexing Torque Converter

To determine and correct a torque converter vibration, the following procedure may have to be performed several times to achieve the best possible torque converter to flywheel balance.

1. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Rotate the torque converter one bolt position.



3. Align the torque converter hub (2) in the engine crankshaft (3) and install the torque converter to flywheel bolts. Refer to Fastener Tightening Specifications.
4. Lower the vehicle.
5. With the engine at idle speed and the transmission in PARK or NEUTRAL, observe the vibration. Refer to Noise and Vibration Analysis.

   Repeat this procedure until you obtain the best possible balance.

Fluid Leak Diagnosis

Notice: Refer to General Repair Instructions in the Preface section.

Check transmission fluid lever. Refer to Transmission Fluid Check.

General Method

1. Verify that the leak is transmission fluid.
2. Thoroughly clean the suspected leak area.
3. Operate the vehicle for 24 km (15 mi), or until normal operating temperatures are reached.
4. Park the vehicle over clean paper or cardboard.
5. Shut OFF the engine.
6. Look for fluid spots on the paper.
7. Make the necessary repairs.

Powder Method

1. Thoroughly clean the suspected leak area with solvent.
2. Apply an aerosol type powder, such as foot powder, to the suspected leak area.
3. Operate the vehicle for 24 km (15 mi), or until normal operating temperatures are reached.
4. Shut OFF the engine.
5. Inspect the suspected leak area.
6. Trace the leak path through the powder in order to find the source of the leak.
7. Make the necessary repairs.

Dye and Black Light Method

A fluid dye and black light kit is available from various tool manufacturers.

1. Follow the manufacturer's instructions in order to determine the amount of dye to use.
2. Install the dye. Refer to Transmission Fluid Check.
3. Detect the leak with the black light.
4. Make the necessary repairs.

Find the Cause of the Leak

Pinpoint the leak and trace the leak back to the source. You must determine the cause of the leak in order to repair the leak properly. For example, if you replace a gasket, but the sealing flange is bent, the new gasket will not repair the leak. You must also repair the bent flange. Before you attempt to repair a leak, check for the following conditions, and make repairs as necessary:

Gaskets

- Fluid level/pressure is too high
- Plugged vent or drain-back holes
- Improperly tightened fasteners
- Dirty or damaged threads

- Warped flanges or sealing surface
- Scratches, burrs, or other damage to the sealing surface
- Damaged or worn gasket
- Cracking or porosity of the component
- Improper sealant used, where applicable
- Incorrect gasket

Seals

- Fluid level/pressure is too high
- Plugged vent or drain-back holes
- Damaged seal bore
- Damaged or worn seal
- Improper installation
- Cracks in component
- Manual or output shaft surface is scratched, nicked, or damaged
- Loose or worn bearing causing excess seal wear

Possible Points of Fluid Leaks

Transmission Oil Pan

- Incorrectly tightened fluid pan bolts
- Improperly installed or damaged fluid pan gasket
- Damaged fluid pan or mounting face
- Incorrect fluid pan gasket
- Fluid Drain Plug

Case Leak

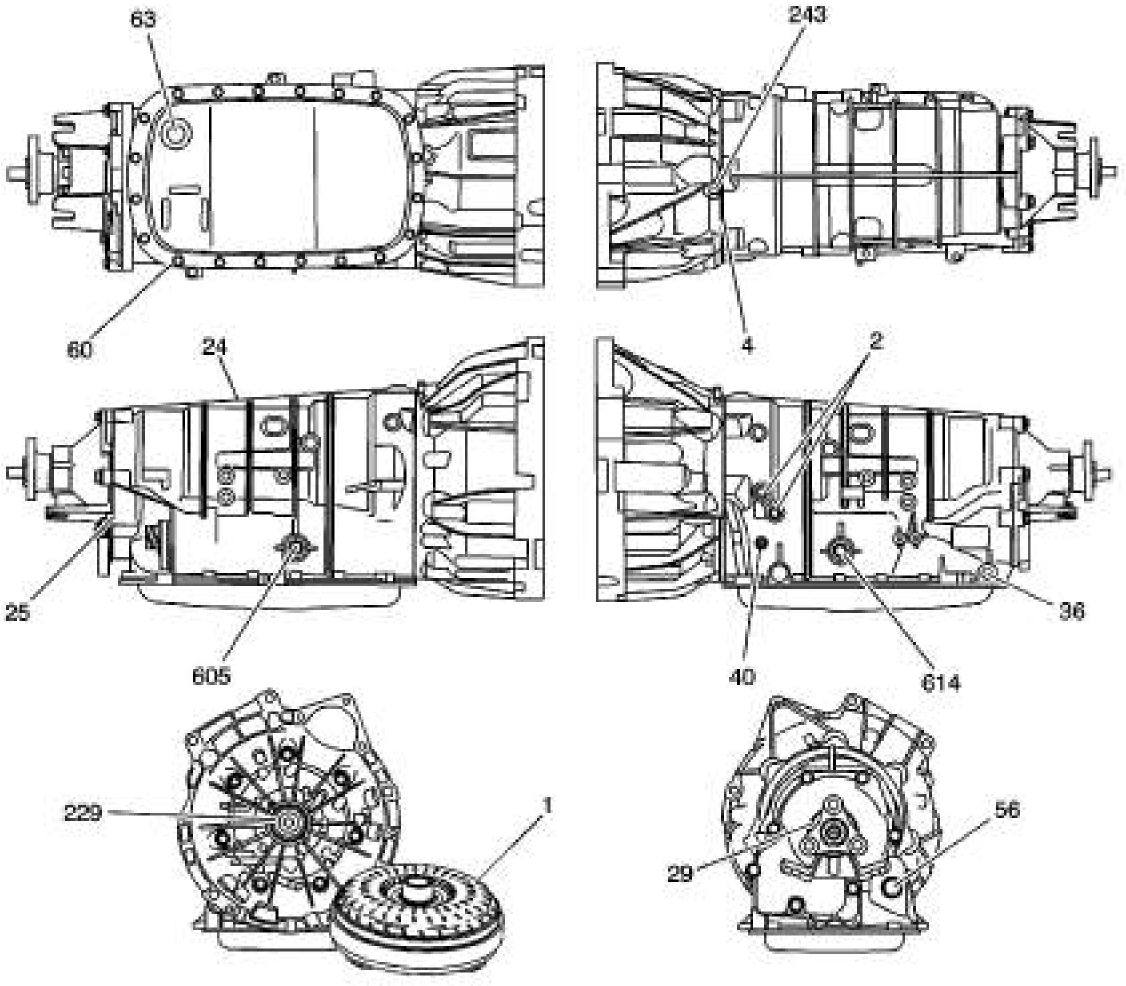
- Fluid Fill Plug
- Extension Housing
- Wiring harness O-ring seal
- Damaged manual shaft seal
- Loose or damaged fluid cooler line seals fittings
- Worn or damaged propeller shaft flange seal
- Loose line pressure test plug
- Porous casting
- Fluid fill plug

Leak at the Torque Converter End

- Converter leak in the weld area
- Converter seal lip cut. Check the converter hub for damage
- Converter seal bushing moved forward and damaged
- Converter seal garter spring missing from the seal
- Porous casting of the transmission case or the oil pump

Leak at the Vent

- Overfilled system.
- Water or coolant in the fluid. The fluid will appear milky.
- Transmission case porous.
- Plugged vent.
- Drain-back holes plugged.
- Mispositioned oil pump to case gasket, if equipped.



Fluid Pressure High or Low

Check	Causes
DEFINITION: Transmission main line pressure that is determined to be high or low. Refer to Line Pressure Check.	
Fluid Pump Assembly	• Pressure regulator valve stuck • Pressure regulator valve spring • Line boost valve spring • Line boost valve or bushing stuck, damaged or incorrectly assembled • Pressure relief ball not seated or damaged • Pressure relief ball spring • Pump slide seal out of location • Fluid pump screen assembly plugged or damaged • Fluid pump rotor guide omitted or misassembled • Fluid pump rotor cracked or broken • Porosity in fluid pump • Fluid pump surfaces not flat • Excessive fluid pump rotor clearance
Fluid Filter	• Intake pipe restricted · • Cracks in fluid filter • Fluid filter seal missing, cut or damaged
Control Valve Body Accumulator Assembly	• Manual valve scored or damaged • Spacer plate or gaskets misassemble or damaged • Control valve top channel plate not flat • Control valve bottom channel plate not flat • Feed limit valve or spring stuck in the exhaust position
Pressure Control Solenoid Assembly	• Contaminated • O-rings cut or damaged • Electrical connection
System Voltage	• 12 Volts not supplied to transmission • Electrical short - pinched solenoid wire • Solenoid not grounded
Clutch Accumulator	Leaking
Inspect for active transmission DTCs	Transmission DTC default action active

Harsh Shift 4 to 5, or 5 to 4

Check	Causes
DEFINITION: One of the two following conditions occurs during a 4th to 5th and 5th to 4th gear steady throttle upshift, or a 4th to 5th gear coast, or a light to moderate throttle detent downshift: Harsh shift feel - an unacceptable quick gear change occurs.	
Overdrive Clutch and Coast Clutch	• Damaged or cut piston • Damaged or worn clutch plates
Fluid Pump Assembly	• Pressure regulator valve stuck • Pressure regulator valve spring • Line boost valve spring • Line boost valve or bushing stuck, damaged or incorrectly assembled • Fluid pump screen assembly plugged or damaged • Fluid pump rotor guide omitted or misassembled • Fluid pump rotor cracked or broken • Porosity in fluid pump • Fluid pump surfaces not flat • Excessive fluid pump rotor clearance • Pump slide seal out of location • Pump vanes damaged • Pump slide spring damaged
Pressure Control Solenoid	Damaged

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Harsh Shift D to R

Check	Causes
DEFINITION: Gear engagement that is harsh when the engine is idling in Park or Neutral, and the gear selector is moved to Drive or Reverse range.	
Forward Clutch	• · Damaged or worn piston (436) • · Damaged or worn clutch plates (449) • · Damaged or stuck ball check valve (434)
Reverse Clutch	• · Damaged or worn piston (404) • · Damaged or worn clutch plates (418/417) • · Damaged or stuck ball check valve (403)
Fluid Pump Assembly	Refer to Harsh Shift 4 to 5, or 5 to 4.
PC Solenoid	Damaged

Harsh Shifts

Harsh Shifts

Check	Causes
DEFINITION: Harsh shift feel - an unacceptable quick gear change occurs.	
Pressure Control Solenoid	• Damaged O-rings • Contamination
Output Speed Sensor	Open or grounded circuit
Input Speed Sensor	Open or grounded circuit
Throttle Position	Open or grounded circuit
Forward Clutch Assembly	• Damaged or worn clutch plates • Damaged or cut piston • Damaged or stuck ball check valve
Control Valve Body Accumulator Assembly	• Accumulator piston stuck • Stuck or missing ball check valves
Fluid Pump	• Pressure regulator valve stuck • Pressure regulator valve spring • Line boost valve spring • Line boost valve or bushing stuck, damaged or incorrectly assembled • Fluid pump screen assembly plugged or damaged • Fluid pump rotor guide omitted or misassembled • Fluid pump rotor cracked or broken • Porosity in fluid pump • Fluid pump surfaces not flat • Excessive fluid pump rotor clearance • Pump slide seal out of location • Pump vanes damaged • Pump slide spring damaged
Inspect for active transmission DTCs	Transmission DTC default action active

Harsh Torque Converter Clutch Apply

Check	Causes
DEFINITION: A unacceptable quick TCC apply or release occurs in third, fourth or fifth gear, overdrive, Drive or Manual third range, with the throttle held steady.	
Control Valve Body & Accumulator Assembly	Stuck TCC regulator apply valve
TCC Solenoid Valve	Stuck ON

Inaccurate Shift Points

Check	Causes
DEFINITION: An upshift or a downshift, or TCC apply, that occurs at a speed outside of the calibrated range. Refer to Shift Speed.	
Fluid Pump Assembly	• Stuck pressure regulator valve • Sticking pump slide
Control Valve Body Accumulator Assembly	Spacer plate and gasket misaligned or damaged
Throttle Position Sensor	Disconnected or damaged
Input Speed Sensor	• Disconnected or damaged • Bolt not torqued properly
Output Speed Sensor	• Disconnected or damaged • Bolt not torqued properly
Shift Solenoids	Leaking
Sport Mode active	Shorted switch or circuit

Line Pressure Check

Tools Required

- DT 46450 Pressure Gage
- J 36648-A Pressure Gage Adapter

Important: Before performing a line pressure check, verify that the pressure control (PC) solenoid valve is receiving the correct electrical signal from the ECM.

1. Install a scan tool.

Caution: Keep the brakes applied at all times in order to prevent unexpected vehicle motion. Personal injury may result if the vehicle moves unexpectedly.

2. Start the engine and set the parking brake.
3. Inspect for a stored Diagnostic Trouble Code (DTC).
4. Repair the vehicle, if necessary.
5. Check the fluid level. Refer to the Transmission Fluid Check.
6. Check the manual linkage for proper adjustment.

Caution: Refer to General Repair Instructions in the Preface section.

7. Turn the engine Off. Remove the transmission pressure test plug (40) and install J 36648-A and DT 46450 .
8. Put the gear selector in PARK range and set the parking brake.
9. Start the engine and allow the engine to warm up at idle.

Notice: Refer to General Repair Instructions in the Preface section.

10. Access the PC solenoid valve control test on the scan tool.
11. Increase the PC solenoid actual current from 0 to 1 amps in 0.1 amp increments. Allow the pressure to stabilize for five seconds after each pressure change. Read the corresponding line pressure on the DT 46450 .
12. Refer to the Line Pressure specification table. Compare the data to the table.
13. If pressure readings differ greatly from the table, refer to Fluid Pressure High or Low.
14. Turn engine OFF. Remove the DT 46450 .
15. Inspect the pressure test plug (40) and O-ring (66) for damage.

Notice: Refer to Fastener Notice in the Preface section.

Important: If the pressure test plug (40) and O-ring (66) are not damaged, they should be reused.

16. Install the transmission pressure test plug (40).

Tighten
Tighten the transmission pressure test plug to 11 N·m (8 lb. ft).

No Drive in All Ranges

Check	Causes
DEFINITION: A large engine RPM increase is noted, with no vehicle forward speed increase, during the following conditions: The engine is running. The transmission is in Drive range. The vehicle is stopped or moving slowly. The vehicle brakes are not applied. The throttle is opened 25 percent or greater.	
Forward Clutch Assembly	• Damaged or worn clutch plates • Damaged or cut piston • Damaged or stuck ball check valve
Forward Clutch Sprag	• Damaged sprag • Worn or pitted inner race
Fluid Pump	• Damaged vanes • Missing slide spring • Fluid pump screen assembly plugged or damaged • Fluid pump rotor guide omitted or misassembled • Fluid pump rotor cracked or broken • Porosity in fluid pump • Fluid pump surfaces not flat • Excessive fluid pump rotor clearance
Low Clutch Sprag	• Damaged sprag • Worn or pitted inner race
Input and Reaction Carrier	Damaged or worn gears

No Engagement of Torque Converter Clutch

Check	Causes
DEFINITION: A large difference in RPM is noted between the engine speed and the transmission input turbine speed in third or fourth gear, Drive or Manual Third range when the TCC is commanded ON by the ECM.	
Control Valve Body and Accumulator Assembly	• TCC regulator apply valve stuck released • TCC regulator apply valve spring broken
Torque Converter Housing	Transmission fluid pump cover damaged or misaligned
TCC PWM Solenoid Assembly	• Stuck Off • Internal damage • Damaged or cut O-ring • Screen damaged • Electrical connector damage
Fluid Pump	• Stuck, binding TCC control valve • TCC enable valve • Stick or binding TCC enable valve spring • Misaligned gasket
Turbine Shaft	Damaged or cut O-ring
Inspect for active transmission DTCs	Transmission DTC default action active

No Engine Braking in First Gear

Check	Causes
DEFINITION: A large engine RPM increase and forward vehicle speed decrease do not immediately occur when the transmission is shifted from Overdrive or fourth gear in Drive or manual third range to first.	
Low and Reverse Clutch	• Damaged or cut piston • Damaged or worn clutch plates
Control Valve Body Accumulator Assembly	• 3-4 shift control valve stuck • 3-4 shift valve stuck - 1st, 2nd or 3rd gear • Low pressure control valve - 1st, 2nd or 3rd gears • 4-5 SS valve stuck off - 1st, 2nd , or 3rd gears • 4-5 shift valve stuck applied - 1st, 2nd, 3rd gears • 3-4 shift valve and/or 3-4 control shift valve stuck released • Low pressure control valve stuck released • 4-5 shift valve and/or 4-5 control shift valve stuck released • 1-2 shift valve stuck released

No Engine Braking in First, Second, and Third Gear

Check	Causes
DEFINITION: A large engine RPM increase and forward vehicle speed decrease do not immediately occur when the transmission is shifted from Overdrive or fourth gear in Drive range to either first or second gear, manual second.	
Control Valve Body Accumulator Assembly	• 3-4 shift valve stuck released • Missing or stuck low pressure control valve • 4-5 shift valve and/or 4-5 control shift valve stuck released • 1-2 shift valve stuck released • 2-3 shift valve and/or 2-3 control shift stuck released

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No Engine Braking in Second Gear

Check	Causes
DEFINITION: A large engine RPM increase and forward vehicle speed decrease do not immediately occur when the transmission is shifted from third to fourth gear in Drive or Manual Third range to either second gear, Manual Second.	
Coast Clutch	• Damaged or cut piston • Damaged or worn clutch plates • Damaged or stuck ball check valve • 3-4 shift valve and/or 3-4 control shift valve stuck released • Low pressure control valve stuck released • 4-5 shift valve and/or 4-5 control shift valve stuck released • 1-2 shift valve stuck applied • 2-3 shift and/or 2-3 control shift stuck released

No Engine Braking in Third Gear

Check	Causes
DEFINITION: A large engine RPM increase and forward vehicle speed decrease in third gear do not immediately occur when the transmission is shifted from overdrive or fourth gear in Drive or Manual Third range to third gear range.	
Overdrive Clutch	• Damaged or cut piston • Damaged or worn clutch plates
Control Valve Body Accumulator Assembly	• 3-4 shift valve and/or 3-4 control shift valve stuck released • Low pressure control valve stuck released • 4-5 shift valve and/or 4-5 control shift valve stuck released • 1-2 shift valve stuck applied • 2-3 shift and/or 2-3 control shift stuck applied

No Engine Braking

No Engine Braking

Check	Causes
DEFINITION: A large engine RPM increase and forward vehicle speed decrease do not immediately occur when the transmission is shifted from overdrive or fourth gear in Drive or manual third range to either first, second gear, or third gear, manual second.	
Coast Clutch	• Damaged or cut piston • Damaged or worn clutch plates • Damaged or stuck ball check valve
Overdrive Clutch	• Damaged or cut piston • Damaged or worn clutch plates

No Fifth Gear

Check	Causes
DEFINITION: A large engine RPM increase is noted in fifth gear, Drive range, with little or no vehicle forward speed increase. First, second, third gear and fourth operation are normal. Shifts into fifth gear are soft or do not occur.	
Control Valve Body Accumulator Assembly	• 4-5 SS valve stuck On • 4-5 shift valve stuck applied • 4-5 shift control valve stuck applied
Overdrive Clutch	• Damaged or cut piston • Damaged or worn clutch plates

No First Gear

No 1st Gear

Check	Causes
DEFINITION: A large engine RPM increase is noted in first gear, Drive range, with little or no vehicle forward speed increase. Second, third, and fourth gear operation are normal. Shifts into first gear are soft or do not occur.	
Control Valve Body Accumulator Assembly	• 1-2 shift control valve stuck released • 1-2 shift valve stuck released • 1-2 SS valve stuck ON
Forward and Low Clutch Sprag	• Damaged sprag • Worn or pitted inner race
Forward Clutch Assembly	Damaged

No Fourth Gear, or Slips in Fourth Gear

Check	Causes
DEFINITION: A large engine RPM is noted in fourth gear or no vehicle forward speed increase. Shifts into fourth gear are soft or do not occur.	
Control Valve Body Accumulator Assembly	• 3-4 shift valve stuck applied • 3-4 shift control valve stuck applied
Direct and Reverse Clutch	• Damaged or worn piston (406) • Damaged or worn clutch plates • Damaged ball check valve (405)

No Reverse or Slips in Reverse

Check	Causes
DEFINITION: A large engine RPM increase is noted with little or no vehicle rearward speed increase during the following conditions: • The engine is running. • The transmission is in Reverse range. • The vehicle is stopped or moving slowly. • The vehicle brakes are not applied. • The throttle is opened 25 percent or greater.	
Direct and Reverse Clutch Assembly	• Damaged reverse clutch housing ball check valve • Damaged or cut piston • Damaged or worn clutch plates
Control Valve Body Accumulator Assembly	• Reverse lockout valve stuck • TCC PWM solenoid valve leaking
Selector Lever	Adjustment

No Second Gear

Check	Causes
DEFINITION: A large engine RPM increase is noted in second gear, Drive range, with little or no vehicle forward speed increase. First, third, and fourth gear operation are normal. Shifts into second gear are soft or do not occur.	
Second Clutch	• Damaged piston • Damaged or worn clutch plates
Second Coast Clutch	• Damaged piston • Damaged or worn clutch plates
Second Clutch Sprag	• Damaged sprag • Worn or pitted inner race
Second Clutch Fluid Passage Sleeve	Leaking

No Third Gear

Check	Causes
DEFINITION: A large engine RPM increase is noted in third gear, Drive range, with no vehicle forward speed increase. First, second, and fourth gear operation are normal. Shifts into third gear are soft or do not occur.	
Intermediate Clutch Sprag	• Damaged sprag • Worn or pitted inner race
Intermediate Clutch	• Damaged piston • Damaged or worn clutch plates
Intermediate Fluid Passage Sleeve	Leaking

Noise and Vibration Analysis

A noise or vibration that is noticeable when the vehicle is in motion MAY NOT be the result of the transmission.

If noise or vibration is noticeable in PARK and NEUTRAL with the engine at idle, but is less noticeable as RPM increases, the cause may be from poor engine performance.

- Vibration may also be caused by a small amount of water inside the converter.
- Inspect the tires for the following conditions:
  - Uneven wear
  - Imbalance
  - Mixed sizes
  - Mixed radial and bias ply
- Inspect the suspension components for the following conditions:
  - Alignment wear or damage
  - Loose fasteners
  - Driveline damage or wear
- Inspect the engine and transmission mounts for damage and loose bolts.
- Inspect the transmission case mounting holes for the following conditions:
  - Missing bolts, nuts, and studs
  - Stripped threads
  - Cracks
- Inspect the flywheel for the following conditions:
  - Missing or loose bolts
  - Cracks
  - Imbalance
- Inspect the torque converter for the following conditions:
  - Missing or loose bolts or lugs
  - Missing or loose balance weights
  - Imbalance caused by heat distortion or fluid contamination

Noise in Random Ranges

Noise in Random Ranges

Checks	Action
DEFINITION: Noise only in certain gear ranges	
Refer to Range Reference. Determine the power flow and the applicable components that may be causing this noise.	

Popping Noise

Popping Noise

Checks	Action
DEFINITION: A popping noise, similar to popcorn popping	
Oil Pump System	• Check fluid level. • Inspect for pump cavitation, indicated by bubbles in fluid. • Inspect the transmission fluid filter for a leaky seam. • Inspect the transmission fluid filter seal for improper positioning or for a cut seal.

Road Test

Important: The Road Test Procedure should be performed only as part of the Symptom Diagnosis. Refer to Symptoms - Automatic Transmission .

The following test provides a method of evaluating the condition of the automatic transmission. The test is structured so that most driving conditions will be achieved. The test is divided into the following parts:

- Electrical Function Check
- Upshift Control and Torque Converter Clutch (TCC) Apply
- Part Throttle Detent Downshifts
- Full Throttle Detent Downshifts
- Manual Downshifts
- Coasting Downshifts
- Manual Gear Range Selection
  - REVERSE
  - Manual SECOND
  - Manual THIRD
  - Manual FOURTH

Important: Complete the test in the sequence given. Incomplete testing cannot guarantee an accurate evaluation.

Before the road test, make sure the following:

- The engine is performing properly.
- Transmission fluid level is correct. Refer to the Transmission Fluid Check .
- Tire pressure is correct.

During the road test:

- Perform the test only when traffic conditions permit.
- Operate the vehicle in a controlled, safe manner.
- Observe all traffic regulations.
- View the scan tool data while conducting this test.

  Take along qualified help in order to operate the vehicle safely.
- Observe any unusual sounds or smells.

After the road test, inspect for the following:

- Transmission fluid level

  Refer to the Transmission Fluid Check .

- Diagnostic Trouble Codes (DTCs) that may have set during the testing

  Refer to the applicable DTC.
- Scan tool data for any abnormal readings or data
- Fluid leaks

Electrical Function Check

Perform this check first, in order to make sure the electronic transmission components are connected and functioning properly. If these components are not checked, a simple electrical condition may be mis-diagnosed.

1. Connect the scan tool.
2. Ensure the gear selector is in PARK and set the parking brake.
3. Start the engine.
4. Verify that the following scan tool data can be obtained and is functioning properly.

   Refer to Control Module References for typical data values. Data that is questionable may indicate a concern.

   - Engine Speed
   - Transmission output speed
   - Vehicle speed
   - IMS Range
   - Transmission range (engine list)
   - Commanded gear
   - PC solenoid reference current
   - PC solenoid actual current
   - PC solenoid duty cycle
   - Brake switch
   - Engine coolant temperature
   - Transmission fluid temperature
   - Acceleration Pedal Position
   - Ignition voltage
   - 1-2 shift solenoid
   - 2-3 shift solenoid
   - 4-5 shift solenoid
   - TCC solenoid duty cycle
   - TCC slip speed
5. Monitor the brake switch signal while depressing and releasing the brake pedal. The scan tool should display:
   - Open when the brake pedal is released.
   - Closed when the brake pedal is depressed.
6. Check the garage shifts.
   - 6.1. Apply the brake pedal and make sure that the parking brake is set.
   - 6.2. Move the gear selector through the following ranges:

        - 6.2.1. PARK to REVERSE
        - 6.2.2. REVERSE to NEUTRAL
        - 6.2.3. NEUTRAL to DRIVE
    - 6.3. Pause 2 to 3 seconds in each gear position.
    - 6.4. Verify the gear engagements are immediate and not harsh.

Important: Harsh engagement may be caused by any of the following conditions:

- High idle speed

  Compare engine idle speed to desired idle speed.
- Commanded low PC solenoid current

  Compare PC solenoid reference current to PC solenoid actual current.
- A default condition caused by certain DTCs that result in maximum line pressure to prevent slippage

Important: Soft or delayed engagement may be caused by any of the following conditions:

- Low idle speed

  Compare engine idle speed to desired idle speed.
- Low fluid level
- Commanded high PC solenoid current

  Compare PC solenoid reference current to PC solenoid actual current.
- Cold transmission fluid

  Inspect for low transmission fluid temperature.
- Selector linkage

  Inspect the adjustment.

7. Monitor transmission range on the scan tool, engine list.
    - 7.1. Apply the brake pedal and make sure the parking brake is set.
    - 7.2. Move the gear selector through all ranges.
    - 7.3. Pause 2-3 seconds in each range.
    - 7.4. Return gear selector to PARK.
    - 7.5. Verify that all selector positions match the scan tool display.
8. Check accelerator pedal input.
    - 8.1. Apply the brake pedal and make sure that the parking brake is set.
    - 8.2. Ensure the gear selector is in PARK.
    - 8.3. Monitor accelerator pedal while increasing and decreasing engine speed with the throttle pedal. The scan tool accelerator pedal should increase and decrease with engine speed.

If any of the above checks do not perform properly, record the result for reference after completion of the road test.

Upshift Control and Torque Converter Clutch (TCC) Apply

The ECM calculates the upshift points based primarily on two inputs: throttle angle and vehicle speed. When the ECM determines that conditions are met for a shift to occur, the ECM commands the shift by closing or opening the ground circuit for the appropriate solenoid.

Perform the following steps:

1. Refer to the Shift Speed and choose a throttle position of 12 percent, 25 percent or 50 percent. All throttle angles shown should be tested to cover the normal driving range.
2. Monitor the following scan tool parameters:
   - Throttle angle
   - Vehicle speed
   - Engine speed
   - Output shaft speed
   - Commanded gear
   - Slip speed
   - Solenoid states
3. Place the gear selector in the OVERDRIVE position.
4. Accelerate the vehicle using the chosen throttle angle. Hold the throttle steady.
5. As the transmission upshifts, note the vehicle speed when the shift occurs for each gear change. There should be a noticeable shift feel or engine speed change within 1 to 2 seconds of the commanded gear change.
6. Compare the shift speeds to the Shift Speed table. Refer to Shift Speed . Shift speeds may vary slightly due to transmission fluid temperature or hydraulic delays in responding to electronic controls.
   - Note any harsh, soft or delayed shifts or slipping.
   - Note any noise or vibration.
7. Repeat steps 1- 6 to complete all throttle angles.

   Important: This transmission is equipped with an electronically controlled capacity clutch (ECCC). The pressure plate does not fully lock to the torque converter cover. The pressure plate maintains a small amount of slippage, approximately 20 RPM, in THIRD, FOURTH and FIFTH gears, depending on the vehicle application. ECCC was developed to reduce the possibility of noise, vibration or chuggle caused by TCC apply. Typical apply speeds are 49-52 km/h (30-32 mph) in THIRD gear and 65-73 km/h (40-45 mph) in FOURTH gear. Full lockup is available at highway speeds on some applications.

   Important: The TCC will not engage until the engine is in closed loop operation and the vehicle speed is as shown in the Shift Speed table. Refer to Shift Speed . The vehicle must be in a near-cruise condition, not accelerating or coasting, and on a level road surface.

8. Inspect for TCC apply in THIRD, FOURTH and FIFTH gear.
   - Note the TCC apply point. When the TCC applies there should be a noticeable drop in engine speed and a drop in slip speed to below 100 RPM. If the TCC apply can not be detected:
     - Check for DTCs.
     - Refer to Torque Converter Diagnosis .
   - Refer to the Shift Speed table for the correct apply speeds.
   - Lightly tap and release the brake pedal. The TCC will release on most applications.

Part Throttle Detent Downshift

1. Place the gear selector in the OVERDRIVE position.
2. Accelerate the vehicle to 64-88 km/h (40-55 mph) in FIFTH gear.
3. Quickly increase throttle angle to greater than 50 percent.
4. Verify the following:
   - The TCC releases
   - The transmission downshifts immediately to FOURTH gear
5. Place the gear selector in the OVERDRIVE position.

Full Throttle Detent Downshift

1. Accelerate the vehicle to speeds of 64-88 km/h (40-55 mph) in FIFTH gear.
2. Quickly increase throttle angle to 100 percent (WOT).
3. Verify the following:
   - The TCC releases
   - The transmission downshifts immediately to THIRD gear

Manual Downshifts

The shift solenoid valves control the initial downshift for the 5-4, 4-3, 3-2 manual downshifts. The solenoid states should change during or shortly after a manual downshift is selected.

Manual 5-4 Downshift

1. Place the gear selector in the OVERDRIVE position.
2. Accelerate the vehicle to 64-88 km/h (40-55 mph) in FIFTH gear.
3. Release the throttle while moving the gear selector to FOURTH.
4. Verify the following:
   - The TCC releases
   - The transmission downshifts immediately to FOURTH gear
   - The engine slows the vehicle

Manual 5-3 Downshift

1. Place the gear selector in the OVERDRIVE position.
2. Accelerate the vehicle to 64-72 km/h (40-45 mph).
3. Release the throttle while moving the gear selector to THIRD.
4. Verify the following:
   - The TCC releases.
   - The transmission downshifts immediately to THIRD gear.
   - The engine slows the vehicle.

Manual 5-2 Downshift

1. Place the gear selector in the OVERDRIVE position.
2. Accelerate the vehicle to 48 km/h (30 mph).
3. Release the throttle while moving the gear selector to SECOND.
4. Verify the following:
   - The TCC releases.

- The transmission downshifts immediately to SECOND gear.
- The engine slows the vehicle.

Coasting Downshifts

1. Place the gear selector in the OVERDRIVE position.
2. Accelerate the vehicle to FIFTH gear with the TCC applied.
3. Release the throttle and lightly apply the brakes.
4. Verify the following:
    - The TCC releases
    - Downshifts occur at speeds shown in the Shift Speed table. Refer to Shift Speed .

Manual Gear Range Selection

The shift solenoids control the upshifts in the manual gear ranges.

Perform the following tests using 10-15 percent throttle angle.

Reverse

1. With the vehicle stopped, move the gear selector to REVERSE.
2. Slowly accelerate the vehicle.
3. Verify that there is no noticeable slip, noise, or vibration.

Manual Second

1. With the vehicle stopped, move the gear selector to SECOND.
2. Accelerate the vehicle to 32 km/h (20 mph).
3. Verify the following:
    - No upshifts occur.
    - The TCC does not apply.
    - There is no noticeable slip, noise, or vibration.

Manual Third

1. With the vehicle stopped, move the gear selector to THIRD.
2. Accelerate the vehicle to 57 km/h (35 mph).
3. Verify the following:
    - The 1-2 shift occurs.
    - The 2-3 shift does not occur.
    - There is no noticeable slip, noise or vibration.

Manual Fourth

1. With the vehicle stopped, move the gear selector to FOURTH.
2. Accelerate the vehicle to 64 km/h (40 mph).
3. Verify the following:
    - The 1-2 shift occurs

- The 2-3 shift occurs
- There is no noticeable slip, noise or vibration

Second and Third Gears Only

Check	Causes
DEFINITION: The transmission only provides second and third gear in Drive range. The shift pattern as the vehicle accelerates from a stop is 2-2-3-3.	
Control Valve Body Accumulator Assembly	- 1-2 SS valve stuck applied - Spacer plate or gaskets are mispositioned or damaged
Winter Mode active	Shorted switch or circuit

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Shift Solenoid Leak Test

Tools Required

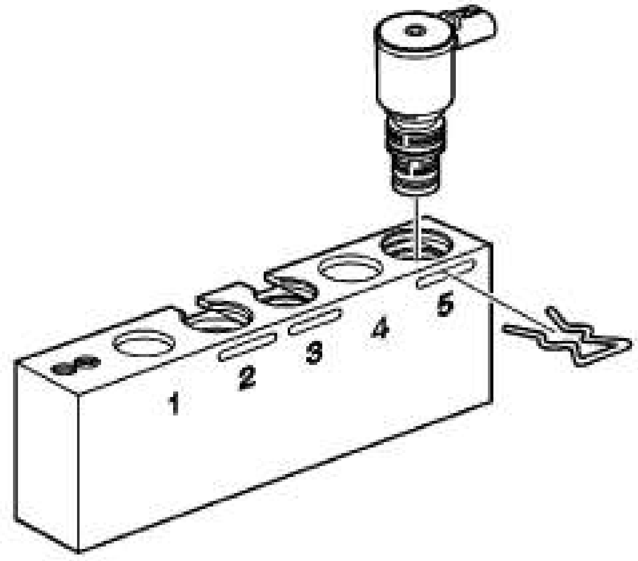
- J-44246 Solenoid Testing Kit
- J 35616 Holden Terminal Test Kit

Leak Test Procedure

Important:

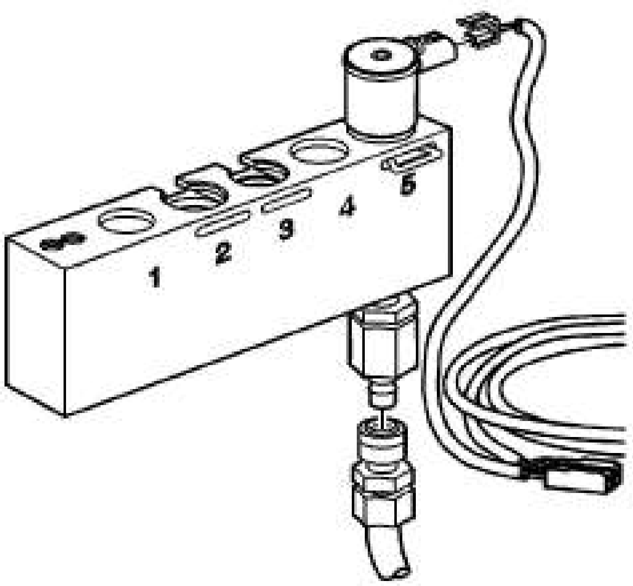
- This procedure tests On/Off type solenoid valves.
- Visually inspect the physical condition of the solenoid before testing. Inspect the O-rings before and after the test to be sure that they are not cut or damaged.

1. Remove the shift solenoid valve from the control valve body or the TCC solenoid valve from the transmission case. Refer to 1-2 SS Rplc*, 2-3 SS Rplc*, 4-5 SS Rplc* or Torq Conv Clutch TCC Sol Rplc*, Tran Elect H Rplc*.



2. Install the TCC solenoid valve, the 1-2 shift solenoid valve, the 2-3 shift solenoid valve or the 4-5 shift solenoid into bore number 5 of the J-44246 .

   Install the factory retainer clip to retain the solenoid.



3. Connect the solenoid testing harness supplied with the J-44246 to the solenoid.

   Important: Do not use air pressure in excess of 120 psi. Excessive pressure will not allow the solenoid ball check valve to seat properly. Recommended air pressure is 50 psi.

4. Apply compressed air to the J-44246 .
5. Connect the solenoid testing harness to the, 12 volt, positive and negative (-) battery terminals.
6. Observe if the solenoid is operating electrically. An audible clicking noise can be heard when connecting or disconnecting power.

   Important:

   - All solenoids need to be energised to seal.
   - A small amount of air leakage is normal +/- 21 kPa (+/- 3 psi).

7. Observe the air flow through the solenoid. The flow will completely or nearly completely stop. Replace the solenoid if there continues to be an obvious air leak when the solenoid is energised.

   Important: Inspect the O-rings after the test to be sure that they are not cut or damaged.

8. Install the shift solenoid valve into the control valve body or the TCC solenoid valve into the transmission case. Refer to 1-2 SS Rplc*, 2-3 SS Rplc*, 4-5 SS Rplc* or Torq Conv Clutch TCC Sol Rplc*, Tran Elect H Rplc*.

Slips or Shudders in First Gear

Checks	Causes
DEFINITION: A large engine RPM increase is noted in first gear, Drive range, with little or no vehicle forward speed increase. Second, third, and fourth gear operations are normal. Shifts into first gear are soft or do not occur. First gear ratio is 2.921:1	
Forward Clutch	• Clutch plates worn • Porosity in the piston • Piston seal damaged • Forward clutch housing ball check valve not sealing or damaged • Input shaft fluid seals damaged or missing
Control Valve Body Accumulator Assembly	• Face not flat • Spacer plate or gaskets mispositioned or damaged
Input Sun Gear Shaft	Broken shaft
Forward Sprag Clutch Assembly	Sprags not holding
Low Clutch Sprag Assembly	Sprags not holding
Torque Converter Assembly	Stator roller clutch not holding
Line Pressure	Refer to Fluid Pressure High or Low.

Slips while Shifting

Checks	Causes
DEFINITION: A large engine RPM increase is noted in fifth, fourth, third, second or first in Drive range, with little or no vehicle forward speed increase. Shifts into fifth, fourth, third, second or first gear are soft or do not occur.	
Control Valve Body Accumulator Assembly	• Accumulator piston seals • Porosity in the accumulator piston housings • Stuck or missing ball check valves
Pressure Control Solenoid	Damaged
Fluid Pump	Damaged

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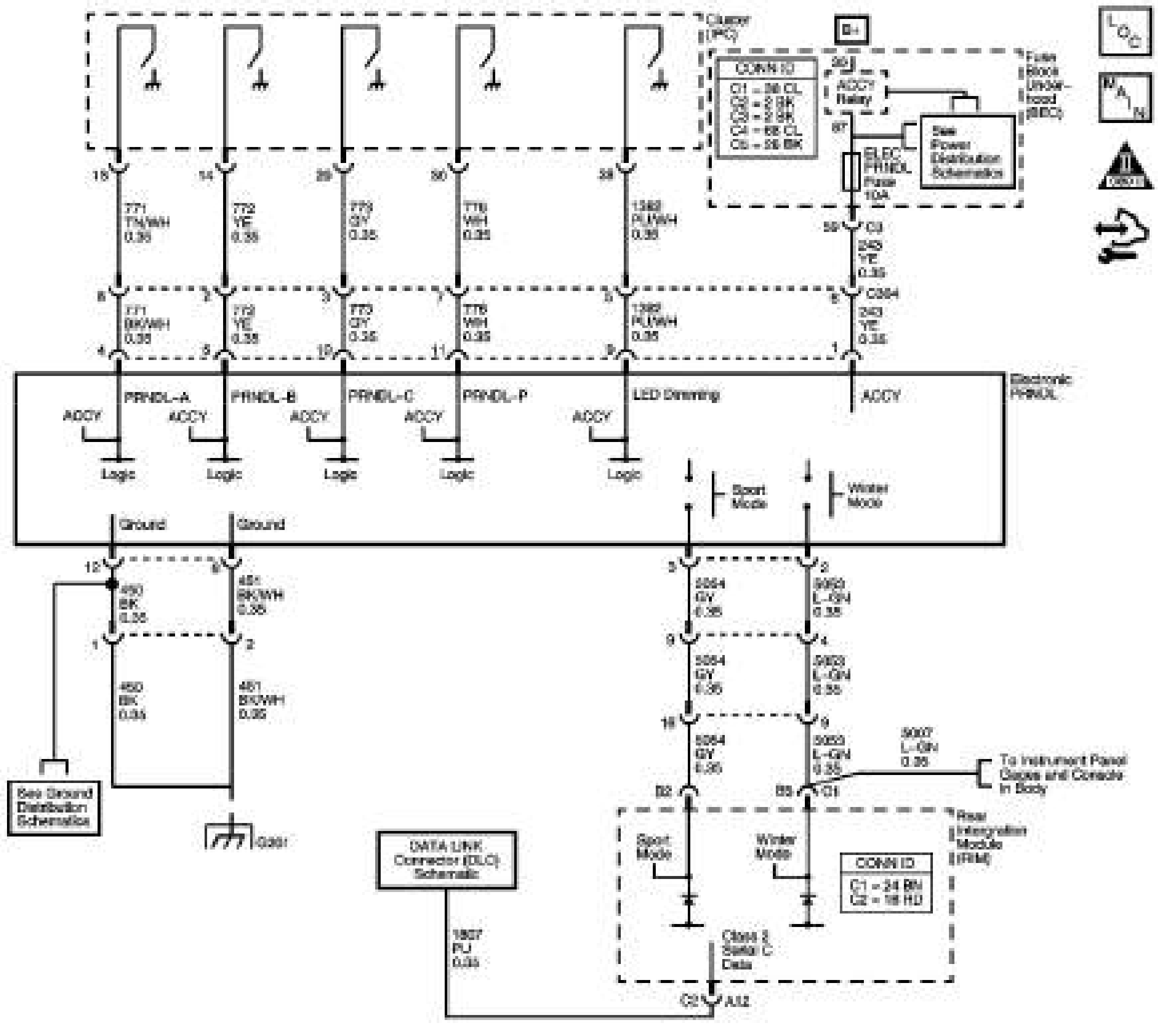
Sport Mode Switch / Indicator Always On or Inoperative

Circuit Description


Cluster (IPC)
B+
CONN ID
C1 = 26 CL
C2 = 2 BK
C3 = 2 BK
C4 = 68 CL
C5 = 26 BK
30
ACCY Relay
87
Fuse Block Underhood (BEC)
See Power Distribution Schematics
ELEC PRNDL Fuse 10A
59
C3
243 YE 0.35
C304
243 YE 0.35
15
14
29
30
38
771 TN/WH 0.35
772 YE 0.35
773 GY 0.35
776 WH 0.35
1362 PU/WH 0.35
8
2
3
7
5
6
771 BK/WH 0.35
772 YE 0.35
773 GY 0.35
776 WH 0.35
1362 PU/WH 0.35
4
5
10
11
9
1
PRNDL-A
PRNDL-B
PRNDL-C
PRNDL-P
LED Dimming
ACCY
ACCY
ACCY
ACCY
ACCY
ACCY
Logic
Logic
Logic
Logic
Logic
Electronic PRNDL
Sport Mode
Winter Mode
Ground
Ground
12
9
450 BK 0.35
451 BK/WH 0.35
1
2
450 BK 0.35
451 BK/WH 0.35
See Ground Distribution Schematics
G301
3
2
5054 GY 0.35
5053 L-GN 0.35
9
4
5054 GY 0.35
5053 L-GN 0.35
18
9
5054 GY 0.35
5053 L-GN 0.35
5007 L-GN 0.35
To Instrument Panel Gages and Console in Body
B2
B5
C1
Rear Integration Module (RIM)
Sport Mode
Winter Mode
CONN ID
C1 = 24 BN
C2 = 16 RD
Class 2 Serial C Data
DATA LINK Connector (DLC) Schematic
1807 PU 0.35
C2
A12
LOC
MAN

The sport and economy shift modes allow driver selection of 2 different shift patterns. Sport mode programming in the transmission control module (TCM) increases transmission line pressure and extends shift points for performance enhanced driving. In the economy mode, the TCM uses standard programming, permitting normal line pressure and shifting. The sport mode switch is a console mounted momentary contact switch located on the electronic PRNDL assembly. Accessory voltage is supplied to the electronic PRNDL assembly through the ELEC PRNDL fuse. When the sport mode switch is depressed, it momentarily contacts the switch signal circuit. The rear integration module (RIM) recognizes the voltage on the circuit and sends a GMLAN serial data message to the dash integration module (DIM). The DIM sends a GMLAN message to the engine control module (ECM). The ECM sends a request to the transmission control module (TCM) through GMLAN to enable the sport mode program.

The TCM evaluates the request, and if operating conditions are correct for enabling the program, the TCM sends a confirmation message to the ECM. The ECM then requests the instrument panel cluster (IPC) to illuminate the sport mode indicator.

The sport mode feature remains enabled until the sport mode switch is pressed again. Once disabled, the TCM will return to the economy mode programming.

Diagnostic Aids

- Test the instrument panel cluster (IPC) for proper operation and lamp illumination. Refer to Diagnostic System Check - Vehicle.
- Test the rear integration module (RIM) for proper sport mode switch input and output operation. Refer to Body Control System Description and Operation.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

1. Diagnose all communication and body DTCs first. The DTC may be the source of the symptom.

4. No PRNDL display may be open in the electronic PRNDL assembly accessory circuit.

6. This step tests the sport mode circuit by bypassing the electronic PRNDL assembly.

Step	Action	Value (s)	Yes	No
1	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. Select DTC Info. Does the scan tool display DTCs that start with "U" or "B"?	--	Go to Diagnostic Trouble Code (DTC) List - Vehicle	Go to Step 2
2	1. Place the gear selector in PARK. 2. Turn the ignition to the RUN position with the engine OFF. 3. While observing the sport mode indicator on the IPC, press the sport mode switch several times. Does the sport mode indicator illuminate On and Off with switch operation?	--	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
3	Is the sport mode indicator always On?	--	Go to Step 9	Go to Step 4
4	Move the gear selector from PARK through all gear positions while observing the electronic PRNDL display. Does the PRNDL display all gear	--		

	positions?		Go to Step 6	Go to Step 5
5	Test the accessory voltage circuit for an open. Refer to Testing for Continuity. Did you find and correct the condition?	--	Go to Step 12	Go to Step 7
6	1. Disconnect the electronic PRNDL assembly. 2. Install a fused jumper between terminal 3 and 6 of the electronic PRNDL connector. 3. Observe the sport mode indicator on the IPC. Is the sport mode indicator illuminated?	--	Go to Step 11	Go to Step 7
7	Test the electronic PRNDL ground circuits for an open. Refer to Testing for Continuity. Did you find and correct the condition?	--	Go to Step 12	Go to Diagnostic System Check - Vehicle
8	Test the sport mode switch signal circuit for an open. Refer to Testing for Continuity. Did you find and correct the condition?	--	Go to Step 12	Go to Step 9
9	Test the sport mode switch signal circuit for a short to ground. Refer to Testing for Short to Ground. Did you find and correct the condition?	--	Go to Step 12	Go to Step 10
10	While observing the sport mode indicator on the IPC, disconnect the electronic PRNDL assembly from the console wiring harness connector. Is the IPC sport mode indicator no longer illuminated?	--	Go to Step 11	Go to Diagnostic System Check - Vehicle
11	Replace the electronic PRNDL assembly. Refer to Front Floor Console Replacement. Is the action complete?	--	Go to Step 12	--
	After repairs, test the sport/economy mode under the following conditions: • With the ignition in the RUN position, the IPC sport mode indicator does not illuminate during the bulb test. • Engine running: - The IPC sport mode indicator			

12	illuminates when the sport mode button is pressed. - The IPC sport mode indicator does not illuminate when the sport mode button is pressed again. • Vehicle operating in drive: - Noticeable change in the shift pattern when the sport mode is selected On and then Off. - The shift pattern returns to the economy mode after the ignition is cycled. Does the sport/economy mode operate as described?	--	System OK	Go to Step 1

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Symptoms - Automatic Transmission

Symptoms -- Automatic Transmission

Diagnostic Category	Diagnostic Information
The following table consists of nine diagnostic categories that are located in the left hand column. Using this column, choose the appropriate category based on the operating conditions of the vehicle or transmission. After selecting a category, use the right hand column to locate the specific symptom diagnostics information.	
Fluid Diagnosis This category contains the following topics: • Fluid condition - appearance, contaminants, smell, overheating • Line pressure - high or low • Fluid leaks	• Refer to Transmission Fluid Check . • Refer to Fluid Pressure High or Low . • Refer to Fluid Leak Diagnosis . • Refer to Automatic Transmission Overheating .
Noise and Vibration Diagnosis This category contains the following topics: • Ratcheting noise • Noise - drive gear, final drive, whine, growl, rattle, buzz, popping • Vibration	• Refer to Noise and Vibration Analysis . • Refer to Buzz Noise or High Frequency Rattle Sound . • Refer to Popping Noise . • Refer to Whine Noise Varying with RPM or Fluid Pressure . • Refer to Noise in Random Ranges .
Range Performance Diagnosis This category contains the following topics: • Drives in Neutral • No Park • No Drive • Shift selector indicator does not match transmission gear range	• Refer to No Drive in All Ranges . • Refer to Drives with Selector Lever in Position N .
Shift Quality Feel Diagnosis This category contains the following topics: • Harsh, soft or slipping shifts • Harsh, soft or delayed engagement • Shift shudder, Flare or tie-up • No engine braking	• Refer to Harsh Shifts . • Refer to Harsh Shift 4 to 5, or 5 to 4 . • Refer to Harsh Shift D to R . • Refer to Degraded 1-2 and 2-1 Shifts . • Refer to Degraded 2-3 and 3-2 Shifts . • Refer to Slips or Shudders in First Gear . • Refer to Degraded 4-5 Shift . • Refer to No Engine Braking in Second Gear .

	• Refer to No Engine Braking in First, Second, and Third Gear . • Refer to No Engine Braking in First Gear . • Refer to No Engine Braking . • Refer to No Engine Braking in First Gear .
Shift Pattern This category contains the following topics: • One forward gear only • Two forward gears only • Third gear only • Gear missing or slipping • No upshift or slipping • No downshifts • Non- First gear start	• Refer to First and Second Gears Only . • Refer to First Gear Only . • Refer to First, Fourth, and Fifth Gears Only . • Refer to Second and Third Gears Only . • Refer to Fifth Gear Only . • Refer to No Reverse or Slips in Reverse . • Refer to Slips while Shifting . • Refer to No Second Gear . • Refer to No Third Gear . • Refer to No First Gear . • Refer to No Fourth Gear, or Slips in Fourth Gear . • Refer to No Fifth Gear . • Refer to Slips while Shifting .
Shift Speed Diagnosis This category consists of the following topic: Inaccurate or inconsistent shift points	• Refer to Inaccurate Shift Points . • Refer to Sport Mode Switch/Indicator Always On or Inoperative .
Torque Converter Diagnosis This category contains the following topics: • Torque converter diagnosis • TCC does not apply • TCC does not release • TCC apply/release quality	• Refer to Torque Converter Diagnosis . • Refer to No Engagement of Torque Converter Clutch . • Refer to Harsh Torque Converter Clutch Apply .
Indicator ON or Message Centre Displays Message This category contains the following topics: • Change transmission fluid light ON • Service transmission light ON • Transmission hot idle engine light ON	• Refer to Transmission Indicators and Messages . • Refer to Sport/Economy Mode Operation .

- Sport light ON	
If Symptom Not Found	- Refer to Transmission Fluid Check . - Refer to Road Test . - Refer to Line Pressure Check .

Torque Converter Diagnosis

The Torque Converter Clutch (TCC) is applied by fluid pressure, which is controlled by a PWM solenoid valve. This solenoid valve is located inside of the automatic transmission assembly. The solenoid valve is controlled through a combination of computer controlled switches and sensors.

Torque Converter Stator

The torque converter stator roller clutch can have two different malfunctions.

- The stator assembly freewheels in both directions.
- The stator assembly remains locked up at all times.

Poor Acceleration at Low Speed

If the stator is freewheeling at all times, the car tends to have poor acceleration from a standstill. At speeds above 50-55 km/h (30-35 mph), the car may act normally. For poor acceleration, you should first determine that the exhaust system is not blocked, and the transmission is in First gear when starting out.

If the engine freely accelerates to high RPM in NEUTRAL, you can assume that the engine and the exhaust system are normal. Check for poor performance in DRIVE and REVERSE to help determine if the stator is freewheeling at all times.

Poor Acceleration at High Speed

If the stator is locked up at all times, performance is normal when accelerating from a standstill. Engine RPM and car speed are limited or restricted at high speeds. Visual examination of the converter may reveal a blue color from overheating.

If the converter has been removed, you can check the stator roller clutch by inserting a finger into the splined inner race of the roller clutch and trying to turn the race in both directions. You should be able to freely turn the inner race clockwise, but you should have difficulty in moving the inner race counterclockwise or you may be unable to move the race at all.

Noise

Important: Do not confuse this noise with pump whine noise, which is usually noticeable in PARK, NEUTRAL and all other gear ranges. Pump whine will vary with line pressure.

You may notice a torque converter whine when the vehicle is stopped and the transmission is in DRIVE or REVERSE. This noise will increase as you increase the engine RPM. The noise will stop when the vehicle is moving or when you apply the torque converter clutch, because both halves of the converter are turning at the same speed.

Torque Converter Clutch Shudder

The key to diagnosing Torque Converter Clutch (TCC) shudder is to note when it happens and under what conditions.

TCC shudder which is caused by the transmission should only occur during the apply or the release of the converter clutch. Shudder should never occur after the TCC plate is fully applied.

If Shudder Occurs During TCC Apply or Release

If the shudder occurs while the TCC is applying, the fault can be within the transmission or the torque converter. Something is causing one of the following conditions to occur:

- Something is not allowing the clutch to become fully engaged.
- Something is not allowing the clutch to release.
- The clutch is releasing and applying at the same time.

One of the following conditions may be causing the fault to occur:

- Leaking turbine shaft seals
- A restricted release orifice
- Defective friction material on the TCC plate

If Shudder Occurs After TCC has Applied

If shudder occurs after the TCC has applied, most of the time there is nothing wrong with the transmission.

The TCC is not likely to slip after the TCC has been applied. Engine faults may go unnoticed under light throttle and load, but they become noticeable after the TCC apply when going up a hill or accelerating. This is due to the mechanical coupling between the engine and the transmission.

Once TCC is applied, there is no torque converter fluid coupling assistance. Engine or driveline vibrations may be unnoticeable before TCC engagement.

Inspect the following components in order to avoid misdiagnosis of TCC shudder. An inspection will also avoid the unnecessary disassembly of a transmission or the unnecessary replacement of a torque converter.

- Spark plugs

  Inspect for cracks, high resistance or a broken insulator.
- Cylinder coil

  Look for a black discoloration on the bottom of each cylinder coil. This indicates arcing while the engine is misfiring.
- Fuel injector

  The filter may be plugged.
- Vacuum leak

  The engine will not get a correct amount of fuel. The mixture may run rich or lean depending on where the leak occurs.
- MAF sensor

Like a vacuum leak, the engine will not get the correct amount of fuel for proper engine operation.

- Carbon on the intake valves

  Carbon restricts the proper flow of air/fuel mixture into the cylinders.
- Flat cam

  Valves do not open enough to let the proper fuel/air mixture into the cylinders.
- Oxygen sensor

  This sensor may command the engine too rich or too lean for too long.
- Fuel pressure

  This may be too low.
- Engine mounts

  Vibration of the mounts can be multiplied by TCC engagement.
- Axle joints

  Check for vibration.
- Cylinder balance

  Bad piston rings or poorly sealing valves can cause low power in a cylinder.
- Fuel contamination

  This causes poor engine performance.

Replace the torque converter if any of the following conditions exist:

- External leaks appear in the hub weld area.
- The converter hub is scored or damaged.
- The converter pilot is broken, damaged, or fits poorly into the crankshaft.
- You discover steel particles after flushing the cooler and the cooler lines.
- The pump is damaged, or you discover steel particles in the converter.
- The vehicle has TCC shudder and/or no TCC apply. Replace the torque converter only after all hydraulic and electrical diagnoses have been made. The converter clutch material may be glazed.
- The converter has an imbalance which cannot be corrected. Refer to Flex Plate/Torque Converter Vibration Test.
- The converter is contaminated with engine coolant which contains antifreeze.
- An internal failure occurs in the stator roller clutch.
- You notice excessive end play.
- Overheating produces heavy debris in the clutch.
- You discover steel particles or clutch lining material in the fluid filter or on the magnet, when no internal parts in the unit are worn or damaged. This condition indicates that lining material came from the converter.

Do not replace the torque converter if you discover any of the following symptoms:

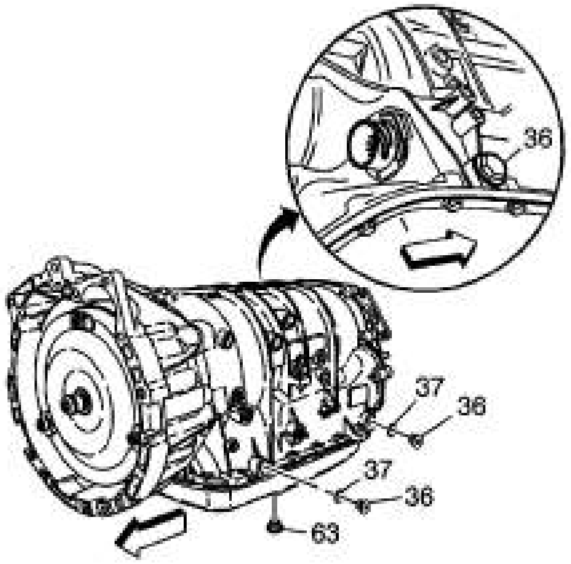
- The oil has an odor or the oil is discolored, even though metal or clutch facing particles are not present.
- Transmission failure did not display evidence of damaged or worn internal parts, steel

particles or clutch plate lining material in the unit and inside the fluid filter.

- The vehicle has been exposed to high mileage only. An exception may exist where the lining of the torque converter clutch dampener plate has seen excess wear by vehicles operated in heavy and/or constant traffic, such as taxi, delivery, or police use.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 5L40-E/5L50-E | Diagnostic Information and Procedures | **Document ID: 1997749**

Transmission Fluid Check



Step	Action	Value(s)	Yes	No
1	**Important:** Transmission fluid level can only be accurately checked when the fluid temperature is between 30-50°C (86-122°F). 1. Start the engine. 2. Depress the brake pedal and move the shift lever through the gear ranges, pausing a few seconds in each range. Return the shift lever to the PARK range. 3. Raise the vehicle on a hoist. The vehicle must be level with the engine running and the shift lever in the PARK range. Refer to Lifting and Jacking the Vehicle . **Caution:** The engine must be running when the transmission fluid fill plug is removed, or excessive fluid loss will occur. Transmission fluid may be hot. Since the actual fluid level is unknown, stand clear when removing the fill plug. Have a container ready to capture any lost fluid. Do not turn the engine off with the fill plug removed, as you can be injured by hot transmission fluid being expelled out of the oil fill opening. 4. Remove the transmission fluid level hole plug (36). Location is model dependent. See the drawing above for locations.			

	Important: The transmission fluid may darken with normal use and does not always indicate contamination or oxidation. 5. Inspect the fluid color. If necessary, use a small screwdriver as a dipstick. Is the fluid color red or light brown with no burnt odor?		Go to Step 4	Go to Step 2
2	Does the fluid have a burnt odor or a dark brown color?	--	Go to Step 8	Go to Step 3
3	Does the fluid have a cloudy or milky appearance?	--	Go to Step 7	Go to Step 8
4	Let the fluid temperature rise until it has reached the specified value. Inspect the fluid level. The level should be even with the bottom of the threaded plug hole. Is the fluid level low?	30-50°C (86-122° F)	Go to Step 5	Go to Step 11
5	Add DEXRON® VI automatic transmission fluid in increments of 0.5 L (0.5 qt) until the fluid drains from the hole plug. Did you add more than 1.5 L (1.6 qt) to the transmission?	--	Go to Step 6	Go to Step 11
6	The transmission may have a leak. Refer to Fluid Leak Diagnosis . Was a transmission leak found?	--	Go to Step 9	Go to Step 11
7	The transmission fluid is contaminated with engine coolant. Repair or replace the transmission cooler in the radiator. Is the transmission cooler repair complete?	--	Go to Step 9	--
8	1. Drain the fluid by removing the transmission fluid pan drain plug (63). 2. Remove the transmission fluid pan. Refer to Automatic Transmission Fluid and Filter Replacement . **Important:** A very small amount of material in the bottom of the pan is a normal condition. 3. Inspect the bottom pan for any excessive debris. Was excessive debris found?	--	Go to Step 9	Go to Step 10
	1. Repair the transmission, if required. **Important:** If the transmission is overhauled, it may be necessary to flush the transmission fluid cooler and pipes. Refer to Transmission Fluid Cooler Flushing and			

9	Flow Test . 2. Add enough DEXRON® VI automatic transmission fluid to bring the fluid to the fluid level to the bottom of the threaded plug hole. 3. Start the engine. 4. Depress the brake pedal and move the shift lever through the gear ranges, pausing a few seconds in each range. Return the shift lever to the PARK range. 5. Raise the vehicle on a hoist. The vehicle must be level with the engine running and the shift lever in the PARK range. Refer to Lifting and Jacking the Vehicle . **Caution:** The engine must be running when the transmission fluid fill plug is removed, or excessive fluid loss will occur. Transmission fluid may be hot. Since the actual fluid level is unknown, stand clear when removing the fill plug. Have a container ready to capture any lost fluid. Do not turn the engine off with the fill plug removed, as you can be injured by hot transmission fluid being expelled out of the oil fill opening. 6. Let the Automatic transmission fluid temperature rise until it has reached the specified value. Remove the transmission plug. 7. If needed, add DEXRON®VI automatic transmission fluid in increments of 0.5 L (0.5 qt) until the fluid drains from the threaded hole plug. **Notice:** Refer to Fastener Notice in the Preface section. **Important:** If the level hole plug (36) and O-ring (37) are not damaged, they should be reused. 8. Allow fluid to finish draining out of the plug hole. Inspect the level hole plug (36) and O-ring (37) for damage. Install the transmission hole plug (36) and tighten to the specified value. 9. Wipe any excess fluid from the transmission with a rag or shop towel. Is the repair complete?	30-50°C (86-122°F) 20 N·m (15 lb. ft)	System OK	--
	1. Change the fluid and fluid filter. Refer to Automatic Transmission Fluid and Filter Replacement . 2. Start the engine. 3. Depress the brake pedal and move the shift lever through the gear ranges, pausing a few seconds in each range. Return the shift lever to the PARK range. 4. Raise the vehicle on a hoist. The vehicle must be level with the engine running and the shift lever in the PARK range. Refer to Lifting and Jacking the Vehicle .			

10	**Caution:** The engine must be running when the transmission fluid fill plug is removed, or excessive fluid loss will occur. Transmission fluid may be hot. Since the actual fluid level is unknown, stand clear when removing the fill plug. Have a container ready to capture any lost fluid. Do not turn the engine off with the fill plug removed, as you can be injured by hot transmission fluid being expelled out of the oil fill opening. 5. Let the Automatic transmission fluid temperature rise until it has reached the specified value. Remove the transmission level hole plug (36). 6. If needed, add DEXRON®VI automatic transmission fluid in increments of 0.5 L (0.5 qt) until the fluid drains from the threaded hole plug. **Notice:** Refer to Fastener Notice in the Preface section. **Important:** If the level hole plug (36) and O-ring (37) are not damaged, they should be reused. 7. Allow fluid to finish draining out of the plug hole. Inspect the level hole plug (36) and O-ring (37) for damage. Install the transmission level hole plug (36) and tighten to the specified value. 8. Wipe any excess fluid from the transmission with a rag or shop towel. Is the repair complete?	30-50°C (86-122° F) 20 N·m (15 lb. ft)	System OK	--
11	**Notice:** Refer to Fastener Notice in the Preface section. **Important:** If the level hole plug (36) and O-ring (37) are not damaged, they should be reused. 1. Let the Automatic transmission fluid temperature rise until it has reached the specified value. Allow fluid to finish draining out of the hole plug. Inspect the level hole plug (36) and O-ring (37) for damage. Install the transmission level hole plug (36) and tighten to the specified value. 2. Wipe any excess fluid from the transmission with a shop towel or rag. Is the repair complete?	30-50°C (86-122° F) 20 N·m (15 lb. ft)	System OK	--

Transmission Fluid Cooler Flushing and Flow Test

Holden studies indicate that plugged or restricted transmission oil coolers and pipes cause insufficient transmission lubrication and elevated operating temperatures which can lead to premature transmission failure. Many repeat repair cases may have been prevented by following published procedures for transmission oil cooler flushing and flow checking. This procedure includes flow checking and flushing the auxiliary transmission oil cooler, if equipped.

Important: Use the J 45096 or equivalent to flush and flow test the transmission oil cooler and the oil cooler pipes after the transaxle is removed for repairs.

Only DEXRON®VI automatic transmission fluid should be used when doing a repair on a Holden transmission.

Time allowance for performing the cooler flow checking and flushing procedure has been included in the appropriate labor time guide operations since the 1987 model year. The service procedure steps for oil cooler flushing and flow testing are as follows:

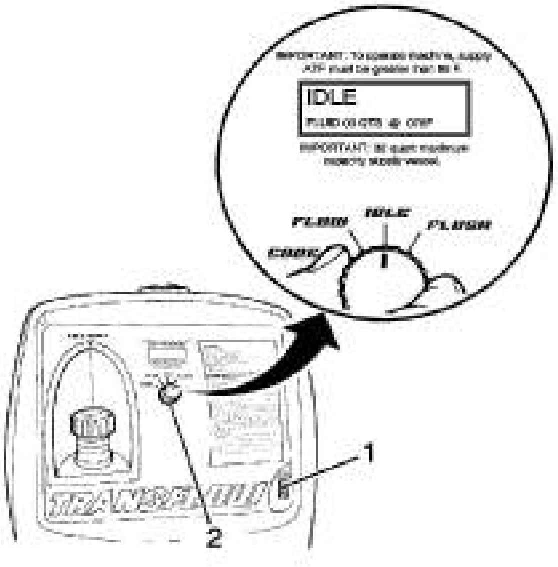
Cooler Flow Check and Flushing Steps

1. Machine Set-up
2. Determine Minimum Flow Rate
3. Back Flush
4. Forward Flush
5. Flow Test
6. Code Recording Procedure
7. Clean-up

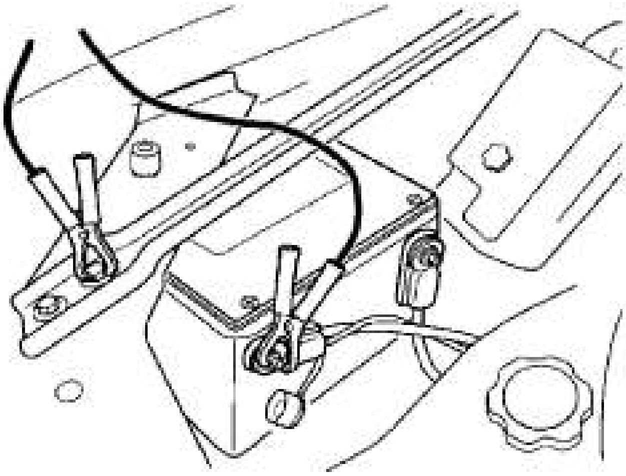
Tools Required

- J 45096 Transmission Oil Cooling System Flush and Flow Test Tool
- J 45806 Cooler Flushing Adapter
- Shop air supply with water/oil filters, regulator and pressure gage -- minimum 90 psi
- Eye protection
- Rubber gloves

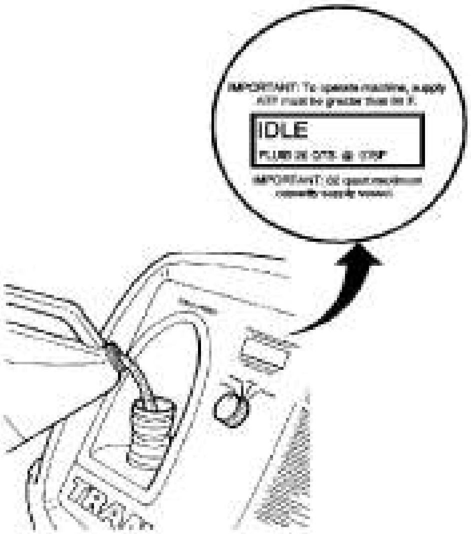
Machine Set-up



1. Verify that the main power switch (1) is in the OFF position.
2. Place the main function switch (2) in the IDLE position.

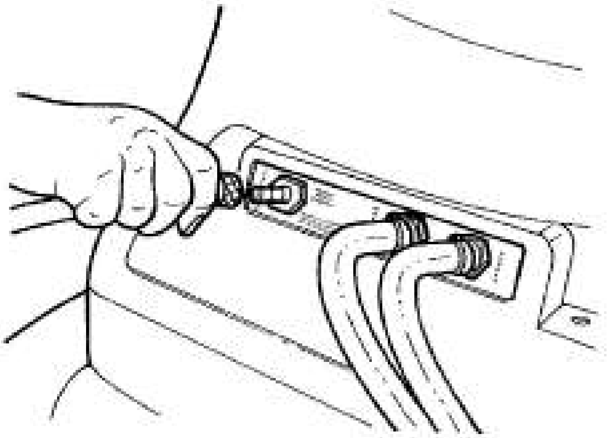


3. Connect J 45096 to the vehicle 12V DC power source by connecting the red battery clip to the positive, +, battery post on the vehicle and connect the negative lead to a known good chassis ground.
4. Turn the main power switch to the ON position.



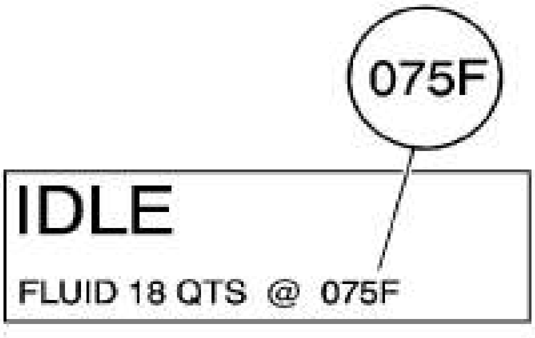
Notice: Do not overfill the supply vessel. Damage to the unit may result. To verify the fluid level, view the LCD screen display while filling the unit, to ensure the fluid level does not exceed 30 L (32 qt).

5. Fill the supply tank with Dexron®VI/Mercon®, or equivalent, through the fill port.
6. Reinstall and tighten the fill cap.

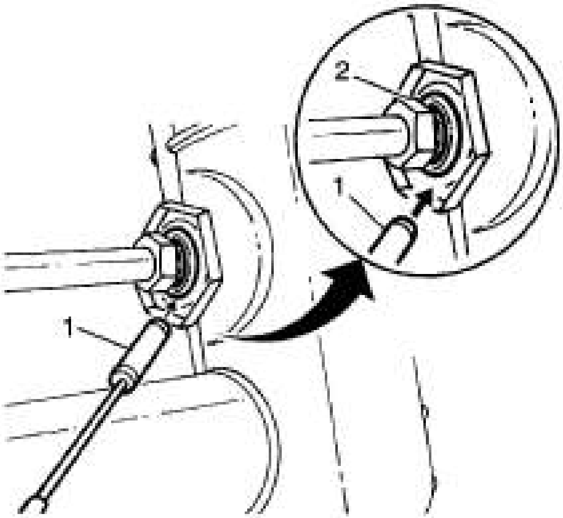


7. Connect a shop air supply hose to the quick-disconnect on the rear panel marked SUPPLY AIR.

Determine Minimum Flow Rate



1. From the machine display, identify the temperature of the automatic transmission fluid that is stored in the supply vessel of J 45096 .



2. Determine whether the transmission oil cooler is steel or aluminum by using a magnet (1) at the cooler flange (2) at the radiator.
3. Refer to the table below. Using the temperature from step 1, locate on either the Steel MINIMUM Flow Rate table or the Aluminium MINIMUM Flow Rate table the minimum flow rate in gallons per minutes (GPM). Record the minimum flow rate in GPMs and the supply fluid temperature for further reference.

   Example:

   - Fluid temperature: 75°F
   - Cooler type: Steel

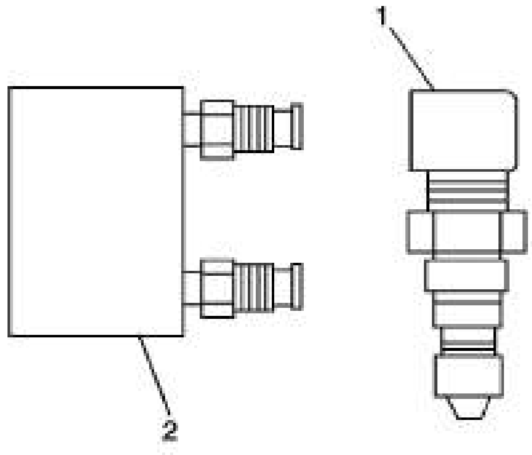
The MINIMUM flow rate for this example is 0.8 GPM.

4. Inspect transmission oil cooler lines for damage or kinks that may cause restricted oil flow. Repair as needed and refer to the appropriate Holden service manual procedures.

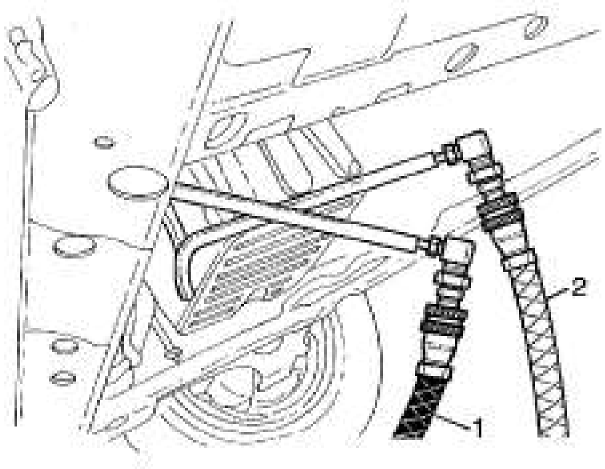
Minimum Flow Rate in Litres Per Minute (LPM)

Temperature Range	Steel	Aluminium
65 - 66°F	2.3 lpm	1.9 lpm
67 - 70°F	2.7 lpm	2.7 lpm
71 - 75°F	3.0 lpm	3.0 lpm
76 - 80°F	3.4 lpm	3.4 lpm
81 - 84°F	3.8 lpm	3.8 lpm
85 - 89°F	4.2 lpm	4.2 lpm
90 - 94°F	4.5 lpm	4.5 lpm
95 - 98°F	4.9 lpm	4.9 lpm
99 - 103°F	5.3 lpm	5.3 lpm
104 - 108°F	5.7 lpm	5.7 lpm
109 - 112°F	5.7 lpm	5.7 lpm
113 - 117°F	5.7 lpm	6.0 lpm
118 - 120°F	6.8 lpm	6.4 lpm

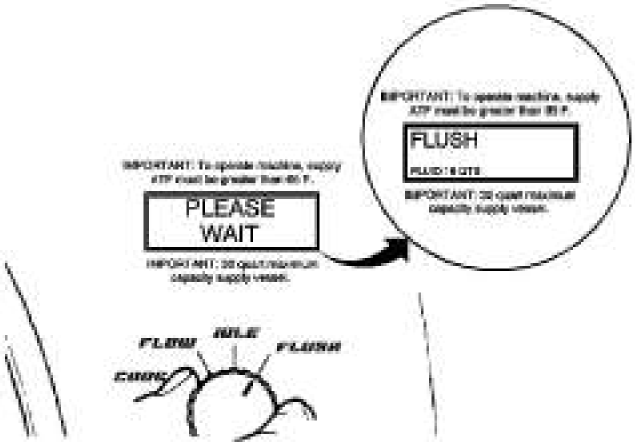
Back Flush Procedure



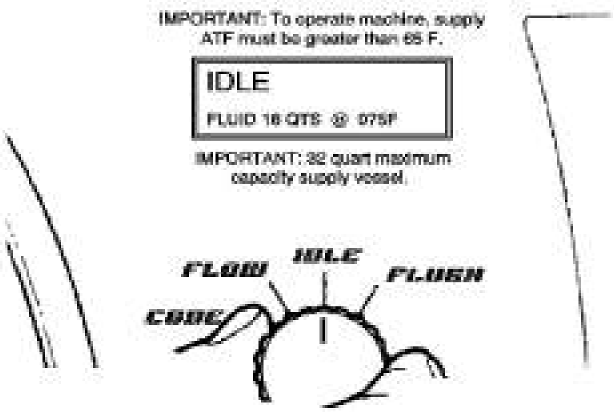
1. Connect the J 45096 adapters (1) to the vehicle's transmission oil cooler supply and return lines at the transmission using J 45806 (2).



2. Connect the black supply hose (1) to the return line, top connector of the transmission, and the clear waste hose (2) to the feed line, bottom connector of the transmission, to the vehicle cooler lines. This is the reverse flow - backflush direction.

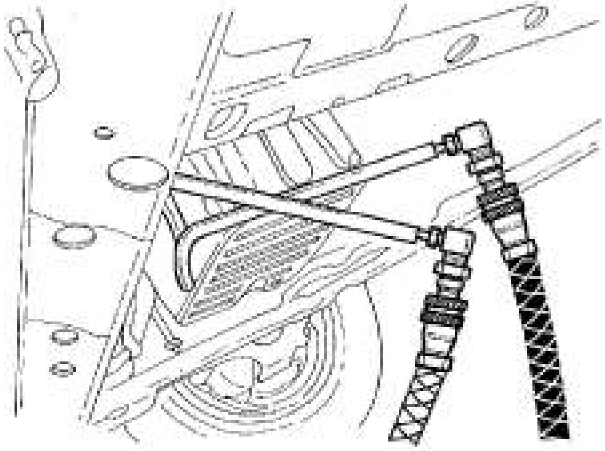


3. Turn the main function switch to the FLUSH position. Allow the machine to operate for 30 seconds.

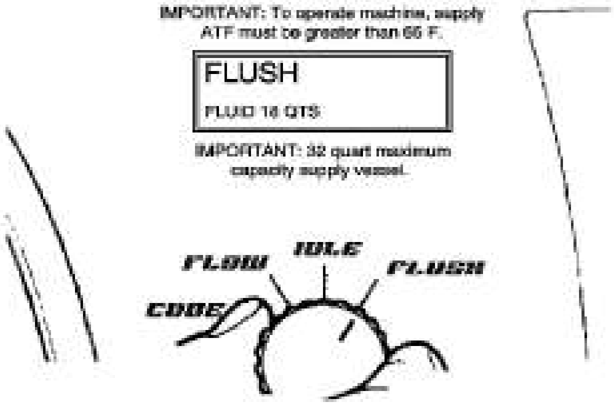

IMPORTANT: To operate machine, supply ATF must be greater than 65 F.
IDLE
FLUID 16 QTS @ 075F
IMPORTANT: 32 quart maximum capacity supply vessel.
FLOW
IDLE
FLUSH
CODE

4. Turn the main function switch to the IDLE position and allow the supply vessel pressure to dissipate.

Forward Flush

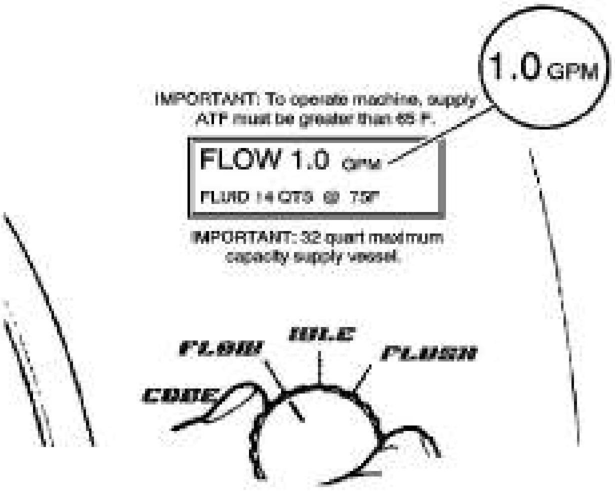


1. Disconnect the supply and waste hoses from the vehicle cooler lines. Reverse the supply and waste hoses to provide a normal flow direction.


IMPORTANT: To operate machine, supply
ATF must be greater than 65 F.
FLUSH
FLUID 16 QTS
IMPORTANT: 32 quart maximum
capacity supply vessel.
FLOW
IDLE
FLUSH
CODE

2. Turn the main function switch to the FLUSH position and allow machine to operate for 30 seconds.

Flow Test


1.0 GPM
IMPORTANT: To operate machine, supply
ATF must be greater than 65 F.
FLOW 1.0 GPM
FLUID 14 QTS @ 75F
IMPORTANT: 32 quart maximum
capacity supply vessel.
FLOW
IDLE
FLUSH
CODE

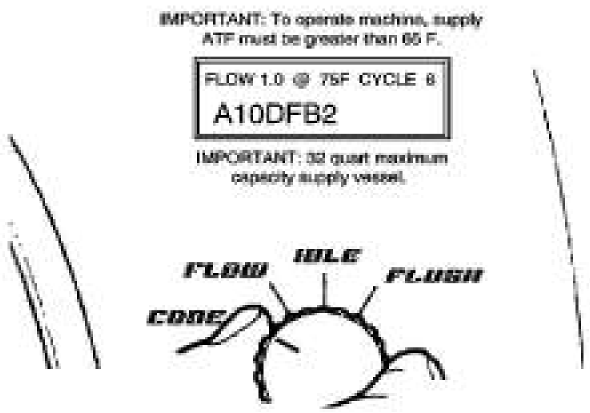
Important: If the flow rate is less than 0.5 gpm, the LCD displays an error message. Refer to the Troubleshooting section of the operation manual.

1. Turn the main function switch to the FLOW position and allow the oil to flow for 15 seconds. Observe and note the flow rate; this is the TESTED flow rate.
2. Compare the TESTED flow rate to the MINIMUM flow rate information previously recorded.

- If the TESTED flow rate is equal to or greater than the MINIMUM flow rate recorded, the oil cooling system is functioning properly. Perform Code Recording Procedure.
- If the TESTED flow rate is less than the MINIMUM flow rate previously recorded, repeat the back flush and forward flush procedures.

3. If the TESTED flow rate is less than the MINIMUM flow rate after the second test, perform Code Recording Procedure.
   3.1. Replace the transmission oil cooler.
   3.2. Reconnect supply and waste hoses to the cooler lines in the normal flow direction. Perform Flow Test.
   3.3. Perform Code Recording Procedure.

Code Recording Procedure


IMPORTANT: To operate machine, supply ATF must be greater than 65 F.
FLOW 1.0 @ 75F CYCLE 8
A10DFB2
IMPORTANT: 32 quart maximum capacity supply vessel.
FLOW
IDLE
FLUSH
CODE

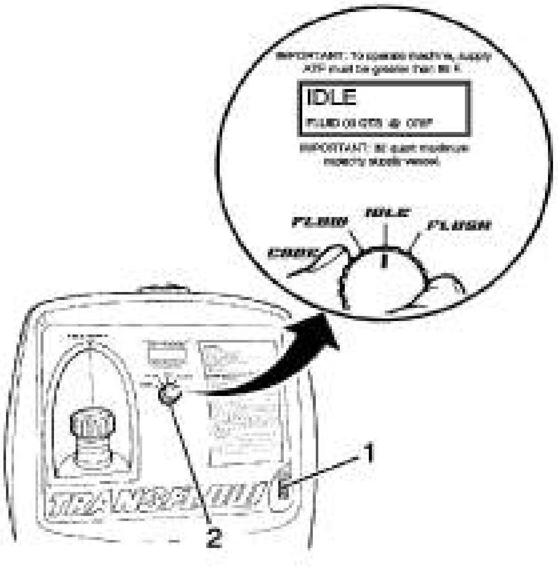
1. Turn the main function switch to the CODE position.

   Important:

   - If power is interrupted prior to the recording of the seven-character code, the code will be lost and the flow rate test will need to be repeated.
   - The flow test must run for a minimum of 8-10 seconds and be above 0.5 gpm for a code to be generated.

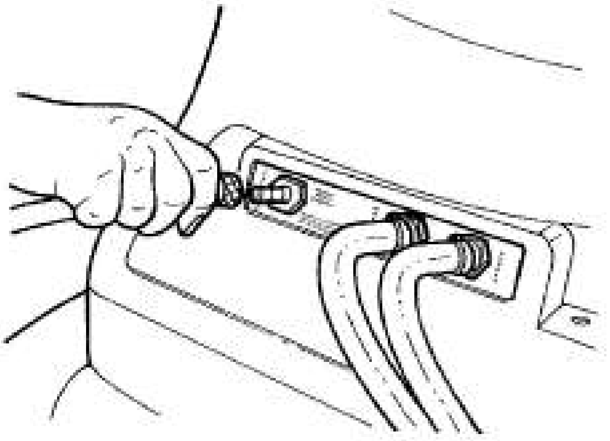
2. Record TESTED flow rate, temperature, cycle and seven-character flow code information on repair order.

Clean-up



1. Turn the main function switch (2) to the IDLE position and allow the supply vessel pressure to dissipate.
2. Turn the main power switch (1) to the OFF position.
3. Disconnect the supply and waste hoses and the 12-volt power source from the vehicle.

   Note: A small amount of water may drain from the bottom of the unit when the air supply is disconnected. This is a normal operation of the built-in water separator.



4. Disconnect the air supply hose from J 45096 .
5. Dispose of the waste Automatic transmissionF in accordance with all applicable federal, state, and local requirements.

Whine Noise Varying with RPM or Fluid Pressure

Whine Noise Varying with RPM or Fluid Pressure

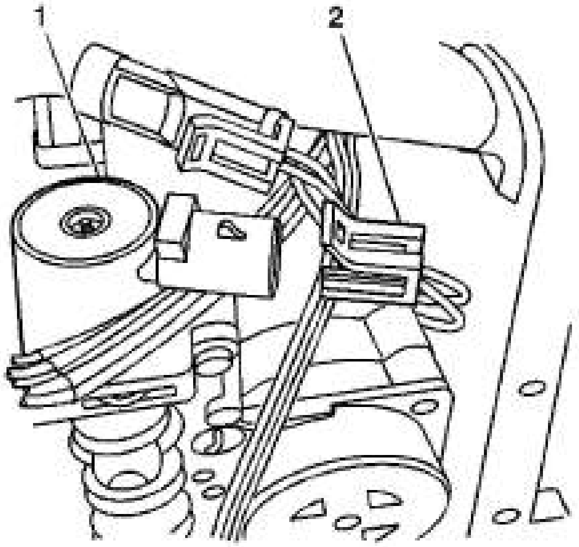
Checks	Action
DEFINITION: In all ranges, a whine which may be sensitive to RPM load, or which ceases when the TCC engages, or which is sensitive to the oil pressure	
Torque Converter (1)	Verify that the noise is internal to the torque converter by placing your left foot on the brake with the gear or selector in Drive. Momentarily stall the engine. Torque Converter noise increases under load.
Oil Pump System	Pump whine noise, which is usually noticable in Park, Neutral and all other gear ranges. Pump whine will vary with line pressure.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 5L40-E/5L50-E | Repair Instructions - On Vehicle | **Document ID: 1994223**

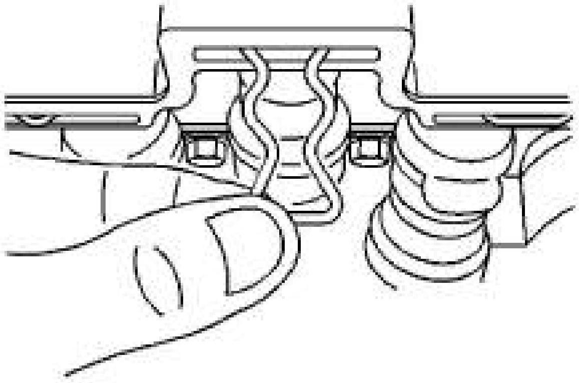
1-2 Shift Solenoid Valve Replacement

Removal Procedure

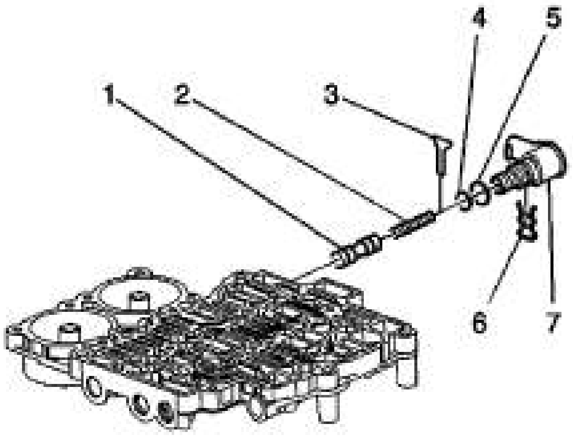
1. Remove the transmission fluid pan. Refer to Automatic Transmission Fluid and Filter Replacement.



2. Disconnect the electrical connector (2) from the 1-2 shift solenoid (1).

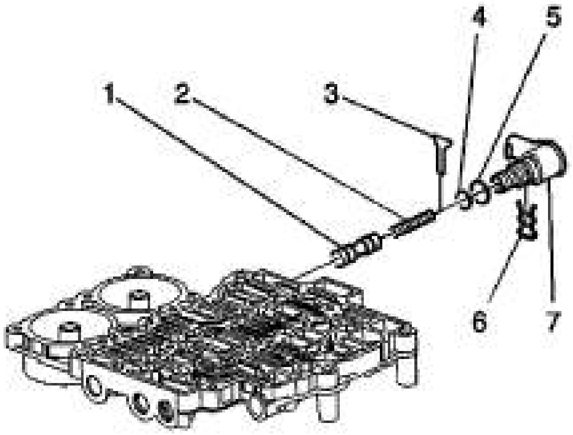


3. Using a suitable tool, remove the 1-2 shift solenoid retainer from the control valve body.

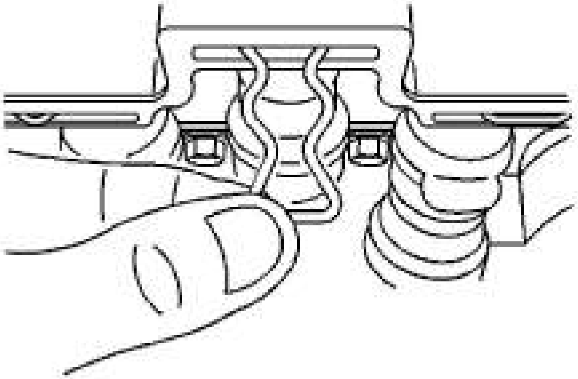


4. Remove the 1-2 shift solenoid (7) from the control valve body.
5. Remove the O-ring seals (4-5) from the 1-2 shift solenoid (7) ONLY if the O-rings are cut or worn.

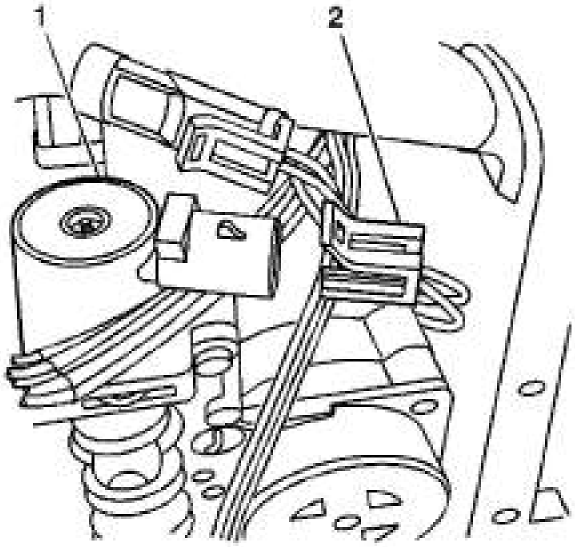
Installation Procedure



1. Install new O-ring seals (4-5) to the 1-2 shift solenoid (7), if the O-rings were previously removed.
2. Install the 1-2 shift solenoid (7) into the control valve body.



3. Install the 1-2 shift solenoid retainer into the control valve body.



4. Connect the electrical wiring harness connector (2) to the 1-2 shift solenoid (1).
5. Install the transmission fluid pan. Refer to Automatic Transmission Fluid and Filter Replacement.

Important: It is recommended that transmission adaptive pressure (TAP) information be reset.

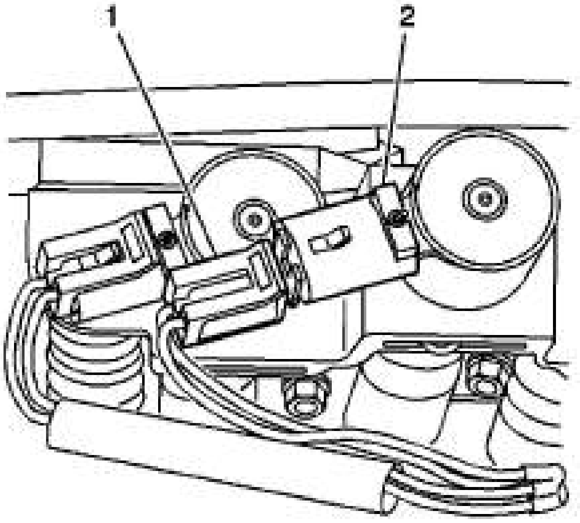
Resetting the TAP values using a scan tool will erase all learned values in all cells. As a result, The ECM or TCM will need to relearn TAP values. Transmission performance may be affected as new TAP values are learned.

6. Reset the TAP values. Refer to Transmission Adaptive Functions.

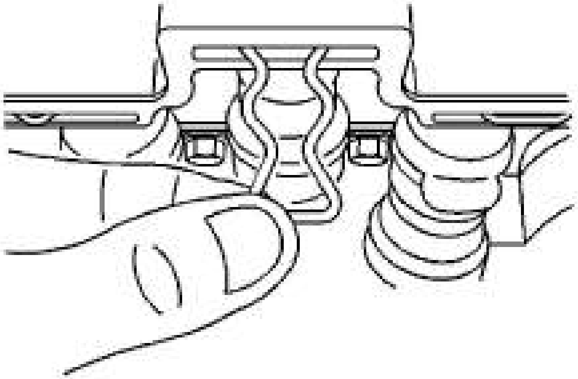
2-3 Shift Solenoid Valve Replacement

Removal Procedure

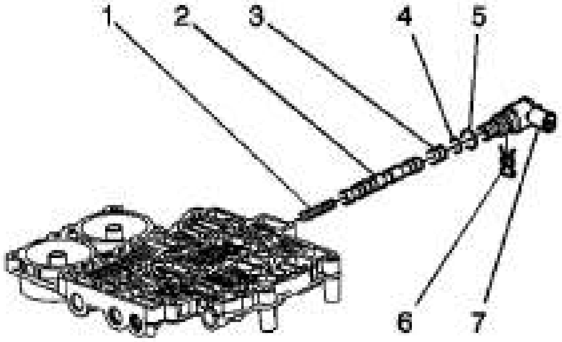
1. Remove the transmission fluid pan. Refer to Automatic Transmission Fluid and Filter Replacement.



2. Disconnect the electrical connector (1) from the 2-3 shift solenoid (2).

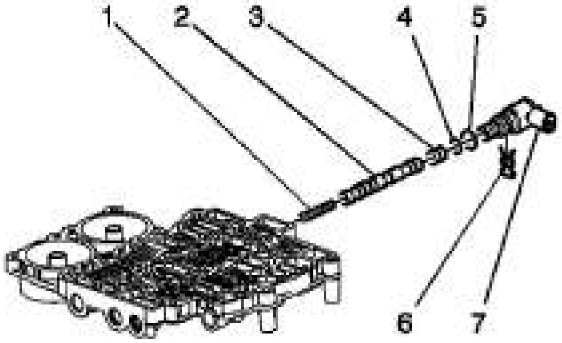


3. Using a suitable tool, remove the 2-3 shift solenoid retainer from the control valve body.

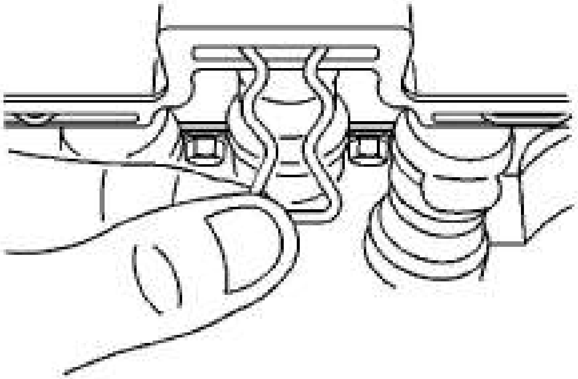


4. Remove the 2-3 shift solenoid (7) from the control valve body.
5. Remove the O-ring seals (4-5) from the 2-3 shift solenoid (7) ONLY if the O-rings are cut or worn.

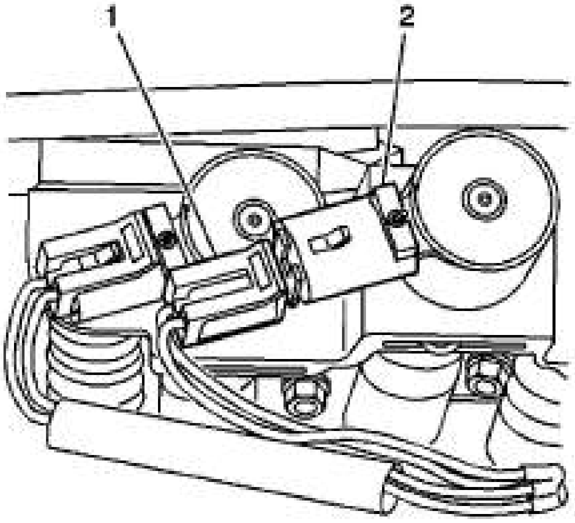
Installation Procedure



1. Install new O-ring seals (4-5) to the 2-3 shift solenoid (7), if the O-rings were previously removed.
2. Install the 2-3 shift solenoid (7) into the control valve body.



3. Install the 2-3 shift solenoid retainer into the control valve body.



4. Connect the electrical connector (1) to the 2-3 shift solenoid (2).
5. Install the transmission fluid pan. Refer to Automatic Transmission Fluid and Filter Replacement.

   Important: It is recommended that transmission adaptive pressure (TAP) information be reset.

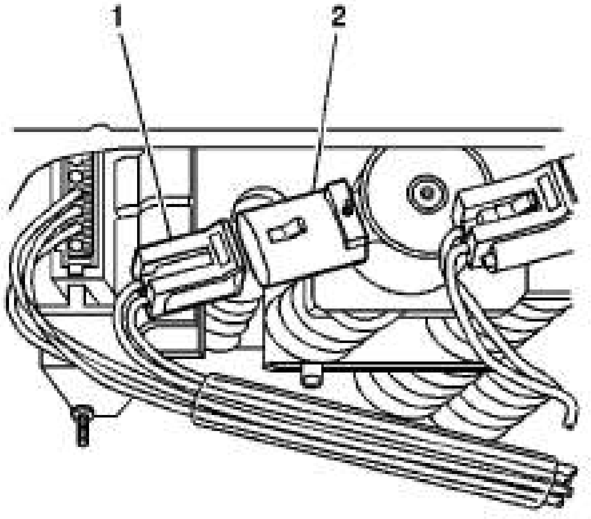
   Resetting the TAP values using a scan tool will erase all learned values in all cells. As a result, The ECM or TCM will need to relearn TAP values. Transmission performance may be affected as new TAP values are learned.

6. Reset the TAP values. Refer to Transmission Adaptive Functions.

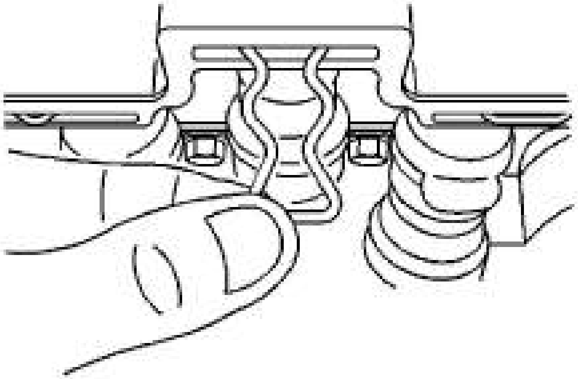
4-5 Shift Solenoid Valve Replacement

Removal Procedure

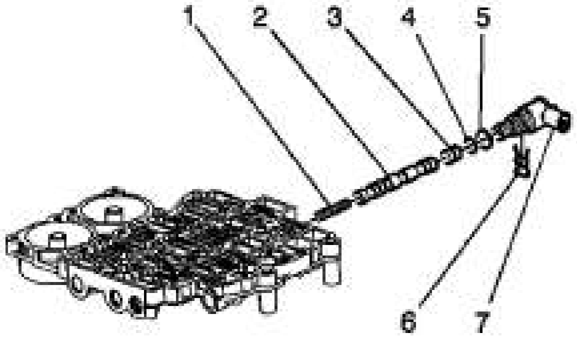
1. Remove the transmission fluid pan. Refer to Automatic Transmission Fluid and Filter Replacement .



2. Disconnect the electrical wiring harness connector (1) from the 4-5 shift solenoid (2).

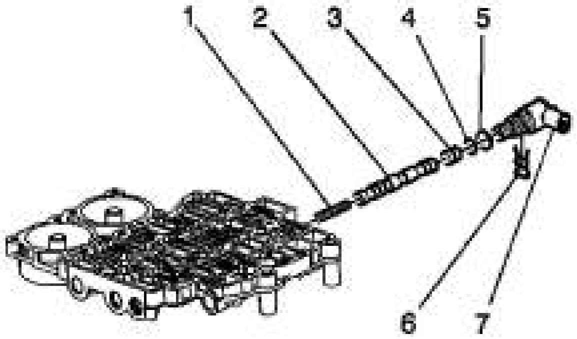


3. Using a small screwdriver or pick, remove the 4-5 shift solenoid retainer from the control valve body.

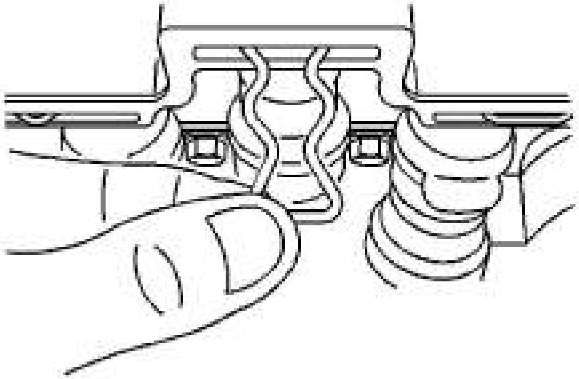


4. Remove the 4-5 shift solenoid (7) from the control valve body.
5. Remove the O-ring seals (4-5) from the 4-5 shift solenoid (7) ONLY if the O-rings are cut or worn.

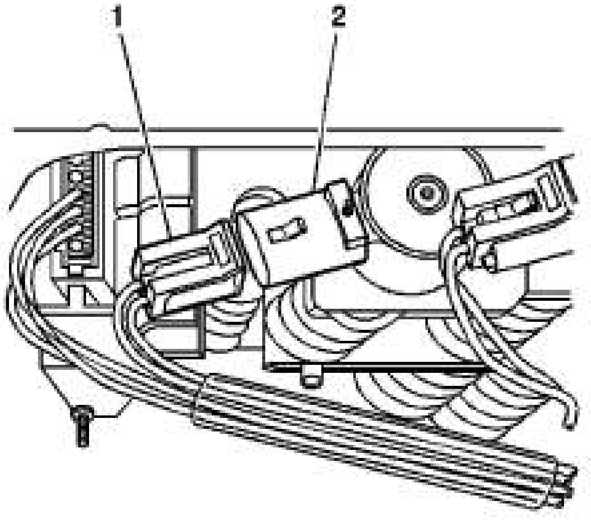
Installation Procedure



1. Install new O-ring seals (4-5) to the 4-5 shift solenoid (7), if the O-rings were previously removed.
2. Install the 4-5 shift solenoid (7) into the control valve body.



3. Install the 4-5 shift solenoid retainer into the control valve body.



4. Connect the electrical wiring harness connector (1) to the 4-5 shift solenoid (2).
5. Install the transmission fluid pan. Refer to Automatic Transmission Fluid and Filter Replacement .

   Important: It is recommended that transmission adaptive pressure (TAP) information be reset.

   Resetting the TAP values using a scan tool will erase all learned values in all cells. As a result, The ECM, PCM or TCM will need to relearn TAP values. Transmission performance may be affected as new TAP values are learned.

6. Reset the TAP values. Refer to Control Module References .

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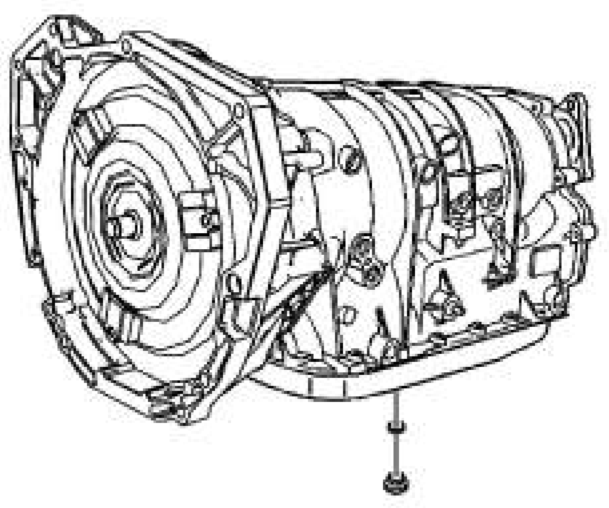
Automatic Transmission Fluid and Filter Replacement

Tools Required

- J 6125-1B Slide Hammer Adapter
- J 23129 Universal Seal Remover

Removal Procedure

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Place a suitable drain pan under the transmission fluid drain plug.

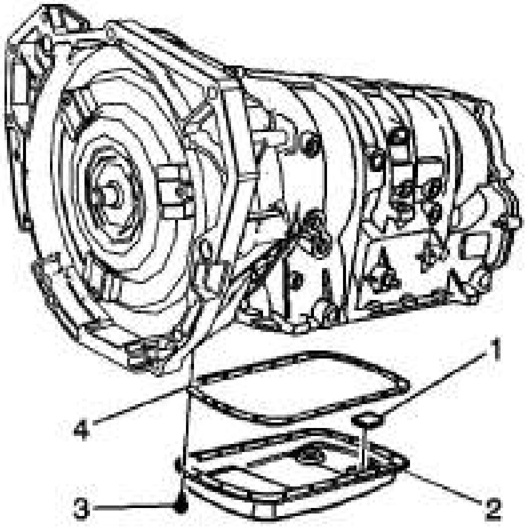


3. Remove and discard the transmission fluid drain plug.
4. Allow the transmission fluid to drain.
5. Inspect the transmission fluid for discoloration and contamination while draining.

Notice: Refer to Component Fastener Tightening Notice in the Preface section.

6. After the transmission fluid has finished draining, Install a NEW transmission fluid drain plug.

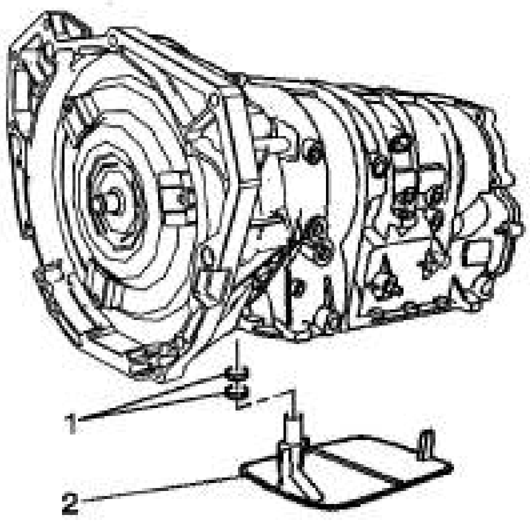
Tighten
Tighten the fluid drain plug to 20 N·m (15 lb. ft).



7. Remove the fluid pan retaining bolts (3).

   Important: Lightly tap the fluid pan (2) with a rubber mallet if necessary in order to loosen.

8. Remove the fluid pan (2) and the gasket (4).
9. Clean and inspect the following for damage or wear.
   - magnet (1)
   - pan (2)
   - bolts (3)
   - gasket (4)

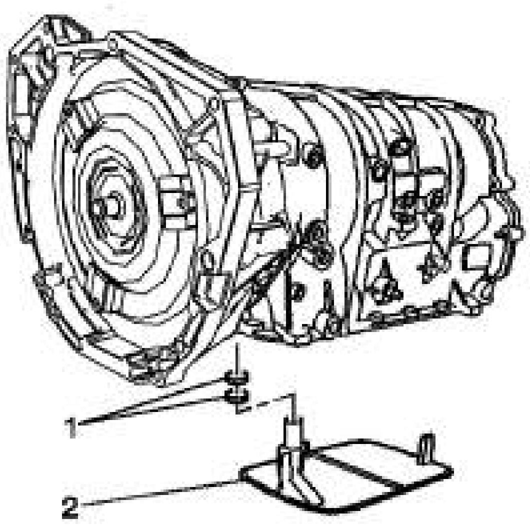


10. Remove the fluid filter (2). Use a suitable tool in order to pry the fluid filter neck out of the

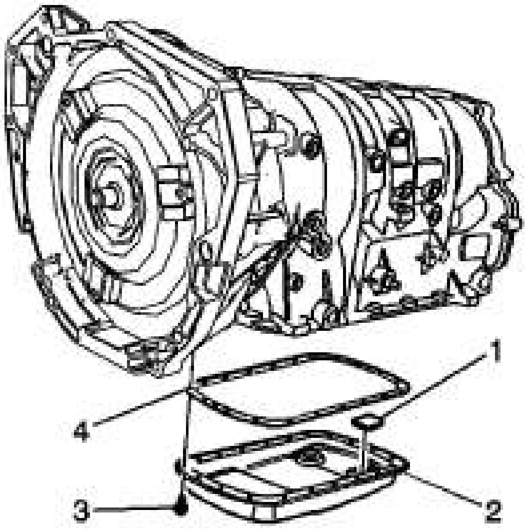
seals.

11. Remove the fluid filter seals (1) using J 23129 and J 6125-1B .

Installation Procedure



1. Install NEW fluid filter seals (1), onto the transmission fluid filter neck. Coat the new seals with a small amount of J 36850 or petroleum jelly before installation.
2. Install the transmission fluid filter (2) into the case.



Important: Fluid pan gaskets are reusable. Replace the gasket ONLY if the sealing surface is damaged.

3. Install the fluid pan (2) and the gasket (4) at the same time.

   Notice: Refer to Fastener Notice in the Preface section.

4. Install the fluid pan retaining bolts (3).

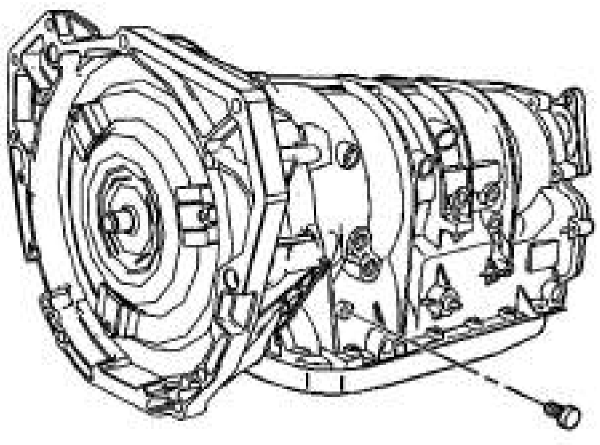
   Tighten
   Tighten the bolts to 11 N·m (97 lb. in).

5. Fill the transmission to the correct level. Refer to Transmission Fluid Check.
6. Inspect the oil pan gasket for leaks.
7. Lower the vehicle.

Automatic Transmission Fluid Pressure Test Hole Plug Replacement

Removal Procedure

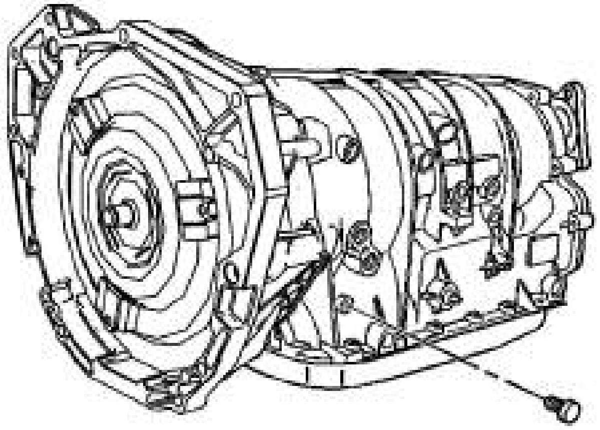
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



2. Remove and discard the oil pressure test plug.

Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



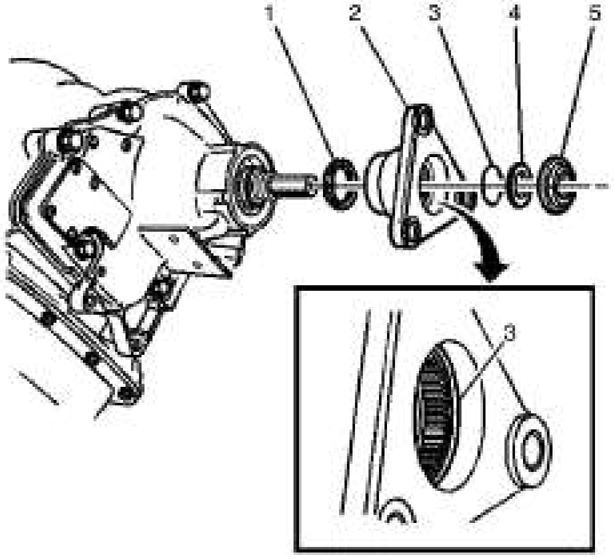
1. Install a NEW oil pressure test plug.

   Tighten
   Tighten the oil pressure test plug to 11 N·m (97 lb. in).

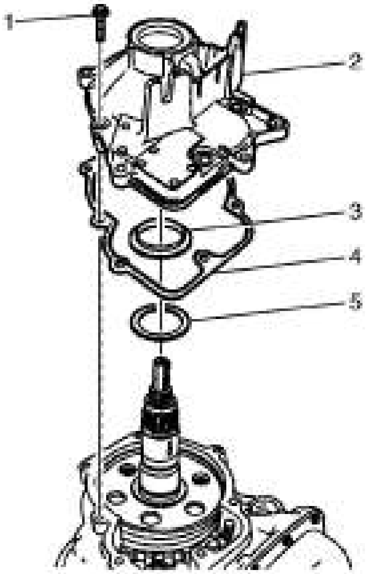
2. Check the transmission fluid level (fill if necessary). Refer to Transmission Fluid Check.
3. Lower the vehicle.

Case Extension and Gasket Replacement

Removal Procedure



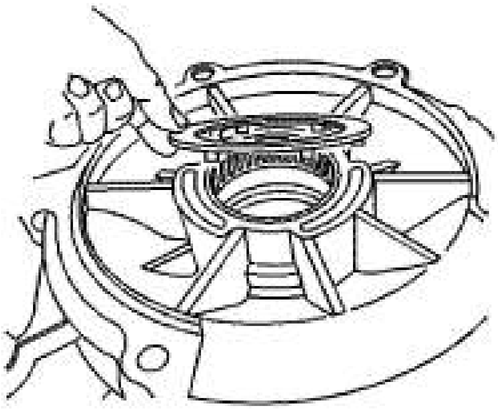
1. Remove the drive flange (2) and seal (3). Refer to Drive Flange and Seal Replacement .
2. Place a suitable jack under the transmission pan in order to support the transmission.
3. Remove the transmission support. Refer to Transmission Support Replacement .
4. Place a suitable drain pan under the extension housing.



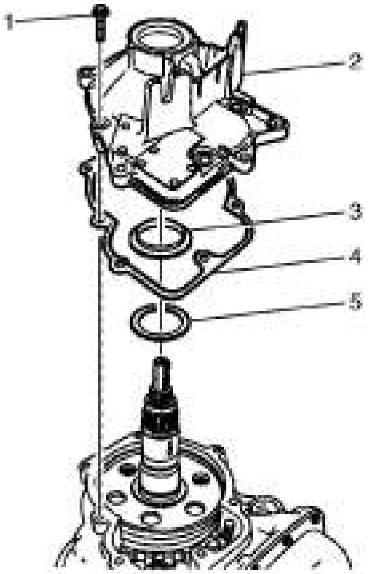
5. Remove the extension housing retaining bolts (1).

6. The output shaft retainer will slide off the output shaft while removing the case extension housing.
7. Remove the extension housing (2) and the seal (4).

Installation Procedure



1. Install the output shaft thrust washer to the inner side of the case extension housing prior to installing of the case extension housing. Align the thrust washer tabs with the locating slots on the case extension housing.



Important: The case extension housing gasket seal is reusable. Replace the gasket ONLY if the sealing surface is damaged.

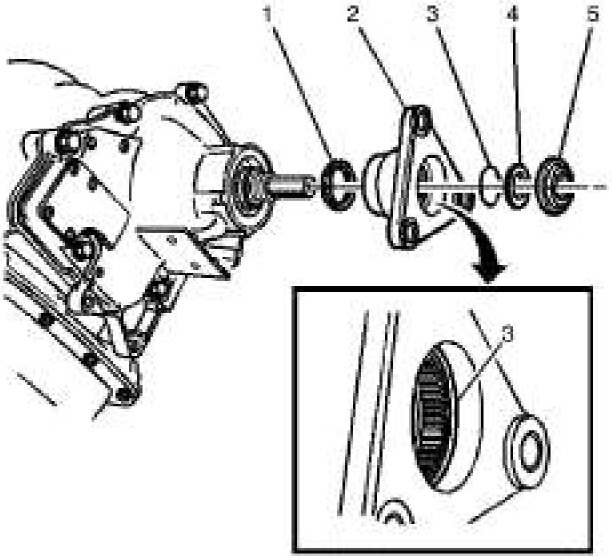
2. Install the extension housing (2) and the seal (4).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the extension housing bolts (1).

   Tighten
   Tighten the bolts to 22 N·m (16 lb. ft).

4. Install the transmission support. Refer to Transmission Support Replacement .
5. Remove the transmission jack.



6. Install the drive flange (2) and seal (3). Refer to Drive Flange and Seal Replacement .

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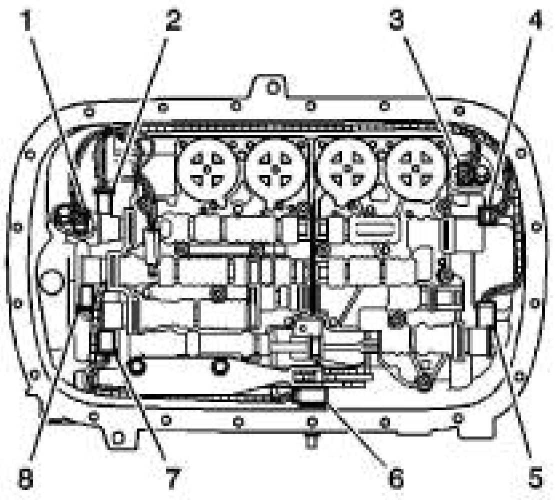
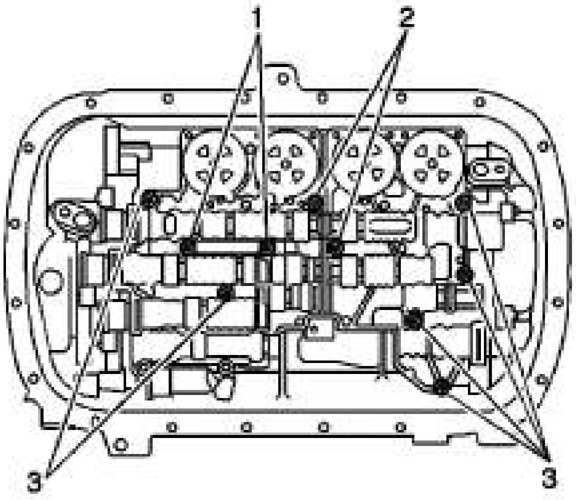
Control Valve Body Accumulator Assembly Replacement

Removal Procedure

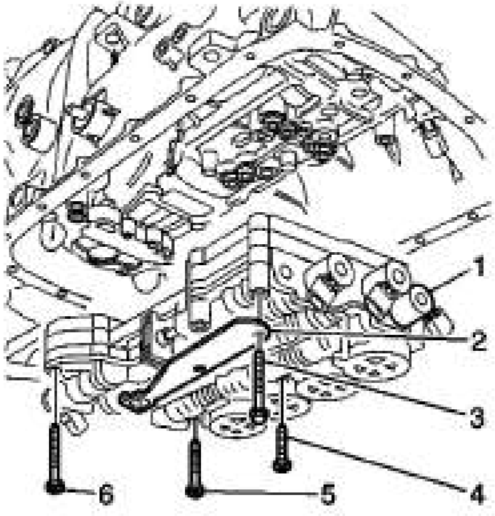
1. Remove the transmission fluid pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement .



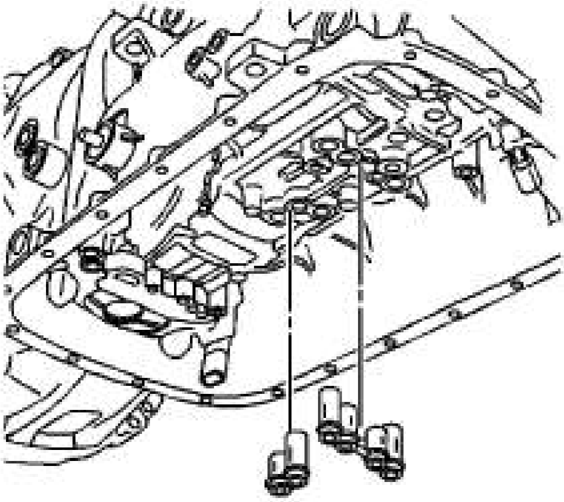
2. Disconnect the internal electrical connectors from all internal electrical components (1-8).



3. Remove ONLY bolts (1, 3) from the valve body assembly. Do NOT remove bolts (2) called out in the graphic.

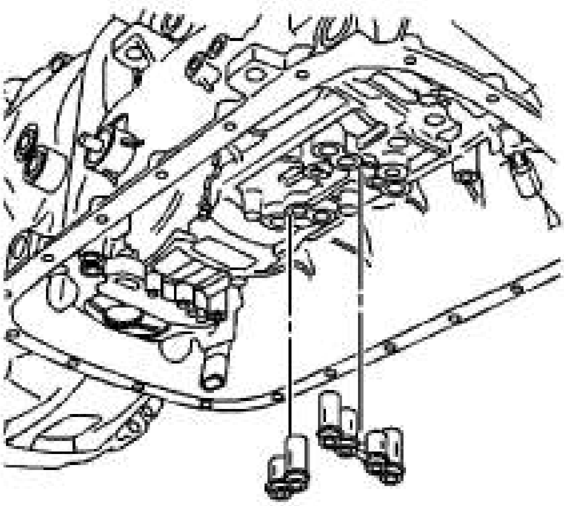


4. Remove the bolts (3-6) securing the control valve body accumulator assembly (1) and manual shaft detent assembly (2) to the transmission case.
5. Remove the manual shaft detent assembly (2) and control valve body accumulator assembly (1) from the transmission.

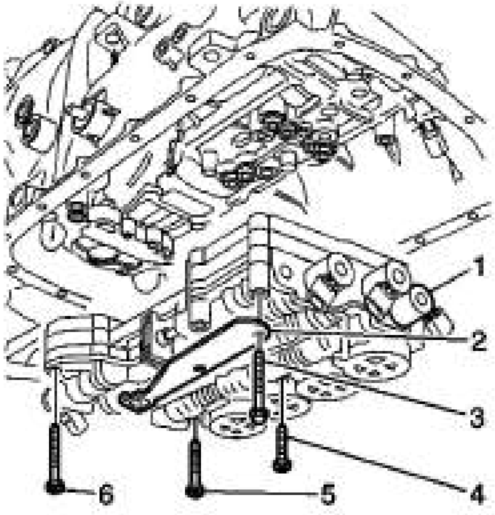


6. Remove the fluid passage sleeves only if replacement of the sleeves is necessary.

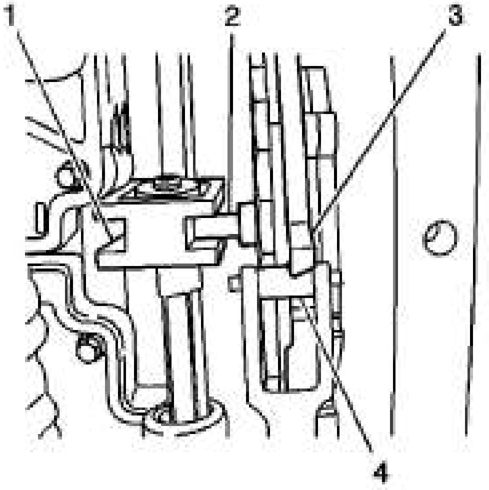
Installation Procedure



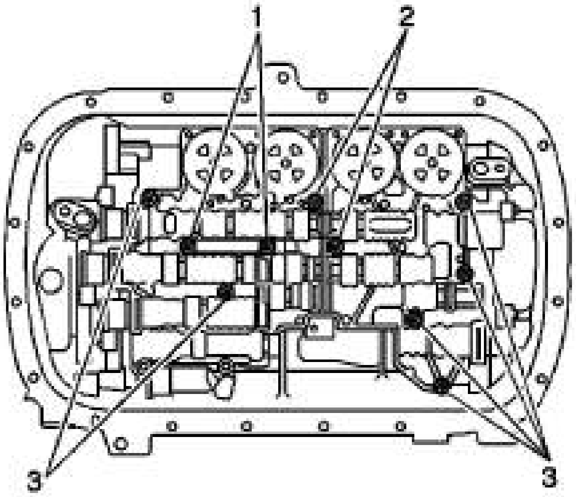
1. Install NEW fluid passage sleeves if previously removed.



2. Install the control valve body accumulator assembly (1) and manual shaft detent spring (2) to the transmission.
3. Install the manual shaft detent spring bolt (3) and hand tighten.



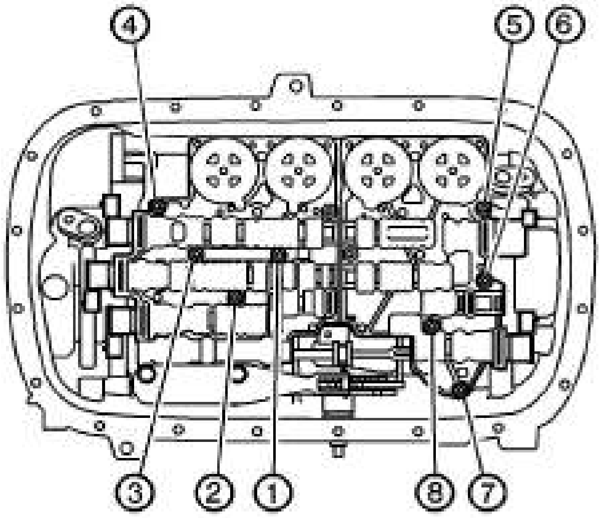
4. Make sure that the manual shift shaft detent lever locating pin (2) is properly engaged with the manual valve link (1).
5. Make sure that the detent spring roller (4) is properly engaged with the manual shift shaft switch (3).



Important: Do not tighten the bolts at this stage

6. Install the control valve body accumulator assembly retaining bolts (1-3).

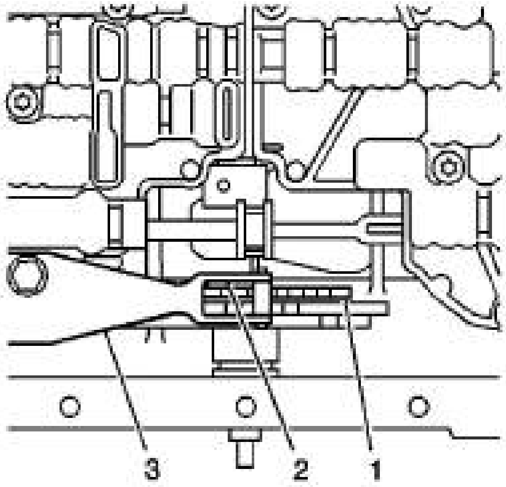
Notice: Refer to Fastener Notice in the Preface section.



Important: If the bolts are tightened at random, valve bores may become distorted and inhibit correct valve operation.

7. Tighten the control valve body assembly bolts in sequence.

Tighten
Tighten the bolts to 11 N·m (97 lb. in).

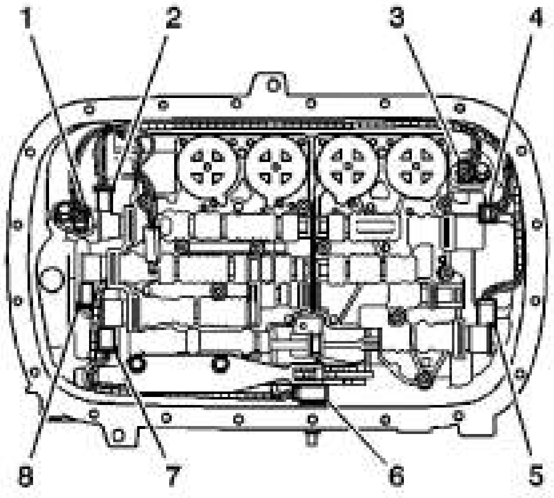


8. Install a 0.8 mm spacer (2) between the manual shift shaft detent lever (1) and the manual shift shaft detent spring (3).
9. Tighten the detent spring bolts.

Tighten

Tighten the bolts to 11 N·m (97 lb. in).

10. Remove the spacer (2).



11. Connect the internal electrical connectors to all internal electrical components (1-8).
12. Install the transmission fluid pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement .

Important: It is recommended that transmission adaptive pressure (TAP) information be reset.

Resetting the TAP values using a scan tool will erase all learned values in all cells. As a result, The ECM or TCM will need to relearn TAP values. Transmission performance may be affected as new TAP values are learned.

13. Reset the TAP values. Refer to Transmission Adaptive Functions .

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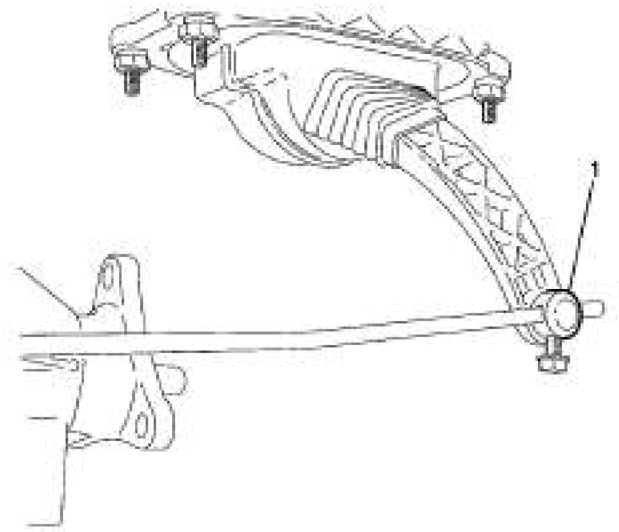
Drive Flange and Seal Replacement

Tools Required

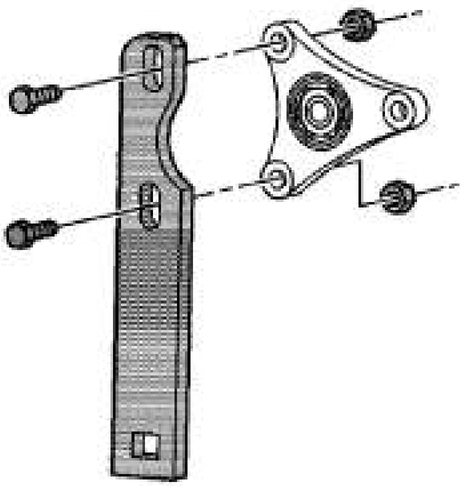
- J 6125-1B Slide Hammer
- J 23129 Universal Seal Remover
- J 29873 Injector Nozzle Socket 30 mm
- J 44765 Seal Installer
- J 45012 Holding Fixture
- J 45019 Universal Puller

Removal Procedure

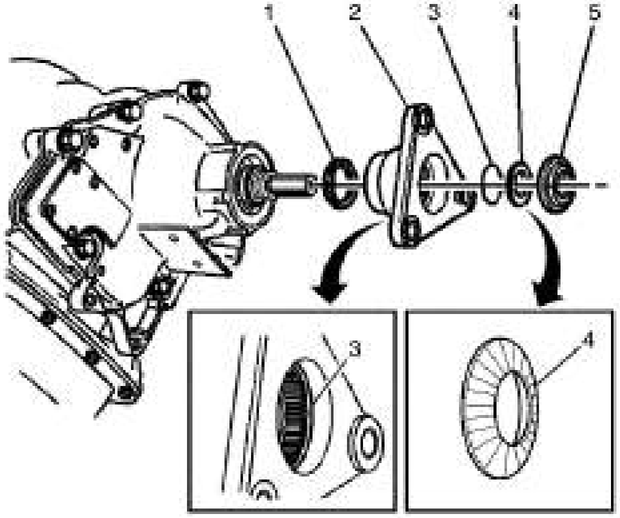
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



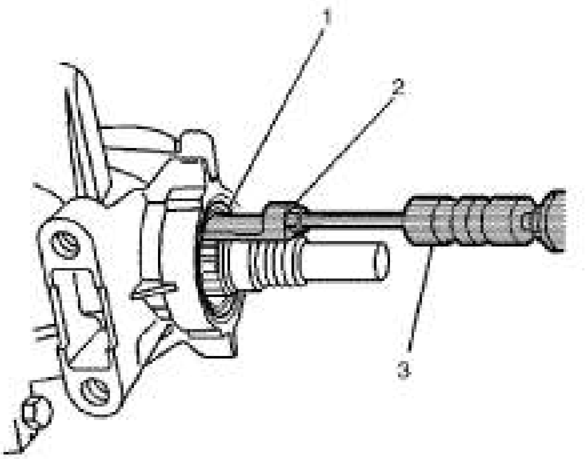
2. Remove the transmission manual shift shaft nut.
3. Disconnect the shift linkage from the transmission.
4. Place the transmission in neutral by rotating the transmission shift shaft clockwise 2 clicks.
5. Remove the exhaust system. Refer to Exhaust System Replacement .
6. Remove the propeller shaft coupler (1) from the transmission flange. Refer to Propeller Shaft Replacement .



7. Install J 45012 to the drive flange.
8. While holding J 45012 . Loosen the drive flange nut using J 29873 .
9. Remove J 45012 from the drive flange.

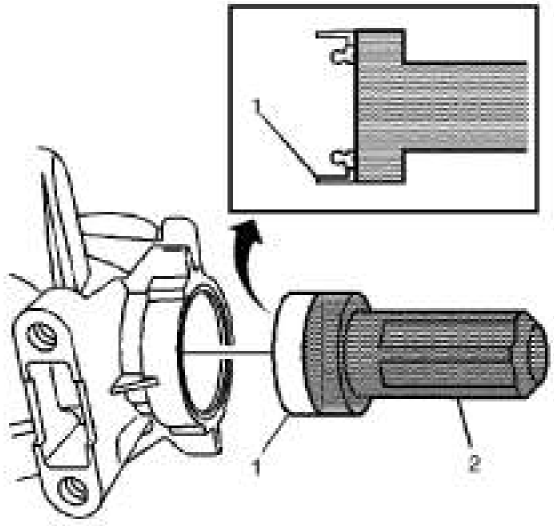


10. Remove the drive flange nut (5).
11. Remove the drive flange thrust washer (4).
12. Remove the drive flange (2) using J 45019 .
13. Remove the drive flange O-ring seal (3) from the drive flange.
14. Remove the output shaft assembly retainer (1).



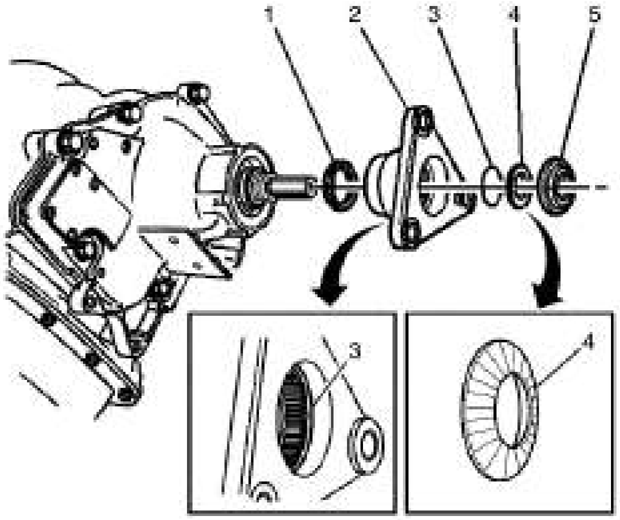
15. Use J 6125-1B and J 23129 (2&3) to remove the transmission case extension seal (1).

Installation Procedure



Important: Install the seal onto the tool before installing into the case to prevent damage to the seal.

1. Using J 44765 (2) install the NEW transmission case extension seal (1).



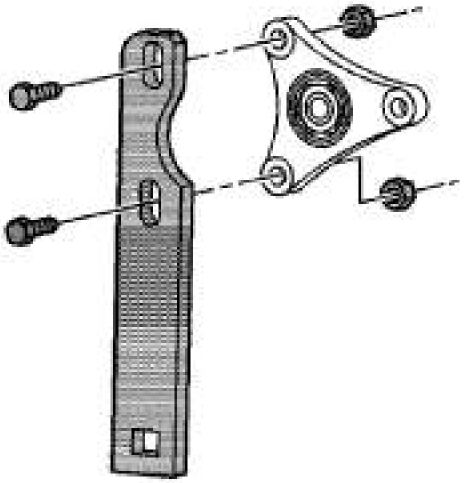
2. Install a NEW output shaft assembly retainer (1).

   Important: Position the retainer on the end of the output shaft splines. The retainer will be pushed to the correct depth as the drive flange is installed onto the output shaft.

3. Install a NEW drive flange O-ring seal (3) into the drive flange (2).
4. Install the drive flange (2) to the transmission output shaft.

   Important: Install the NEW drive flange thrust washer (4) as shown in diagram.

5. Install a NEW drive flange thrust washer (4).
6. Apply Loctite 272 to the NEW drive flange nut threads.
7. Start the NEW drive flange nut (5).



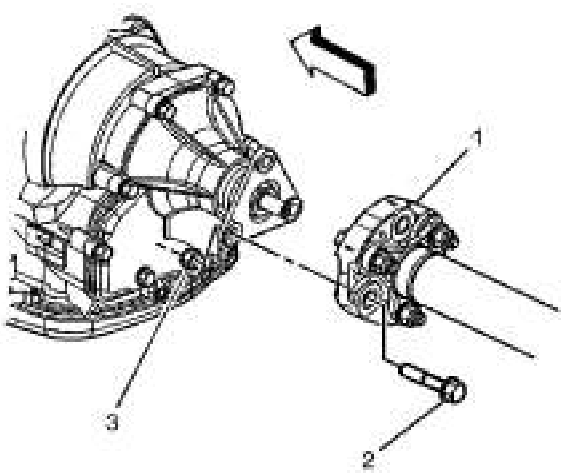
8. Install J 45012 to the drive flange.

   Notice: Refer to Fastener Notice in the Preface section.

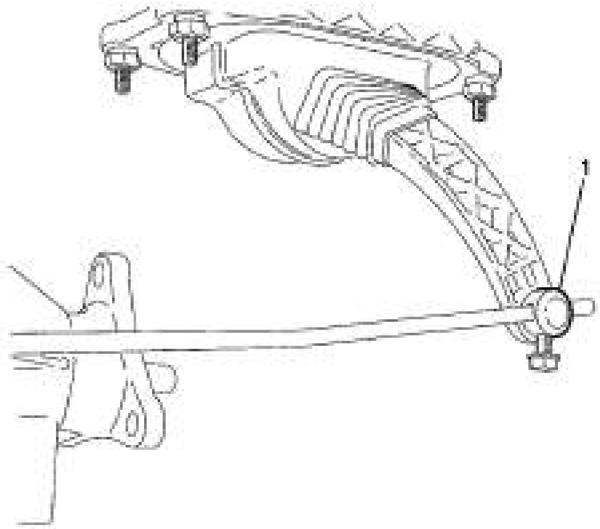
9. While holding J 45012 tighten the NEW drive flange nut using J 29873 .

   Tighten
   Tighten the drive flange nut to 60 N·m (44 lb. ft).

10. Remove J 45012 from the drive flange.



11. Install the propeller shaft. Refer to Propeller Shaft Replacement .
12. Install the exhaust system. Refer to Exhaust System Replacement .



13. Place the transmission in the park position by rotating the selector lever shaft fully counter

clockwise.

14. Connect the selector lever linkage to the transmission.
15. Install the transmission manual shift shaft nut.

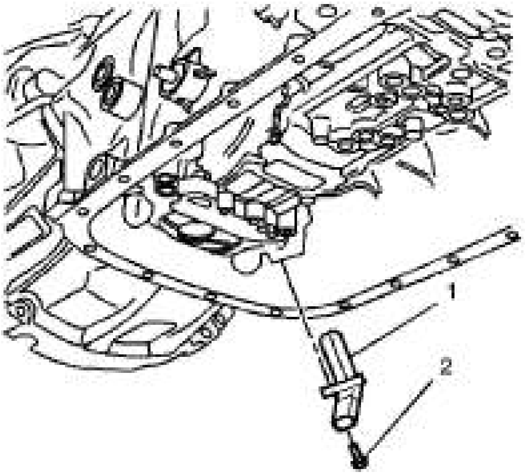
    Tighten
    Tighten the transmission manual shift shaft nut to 9 N·m (80 lb. in).

16. Check the transmission fluid level. Refer to Transmission Fluid Check .
17. Lower the vehicle.

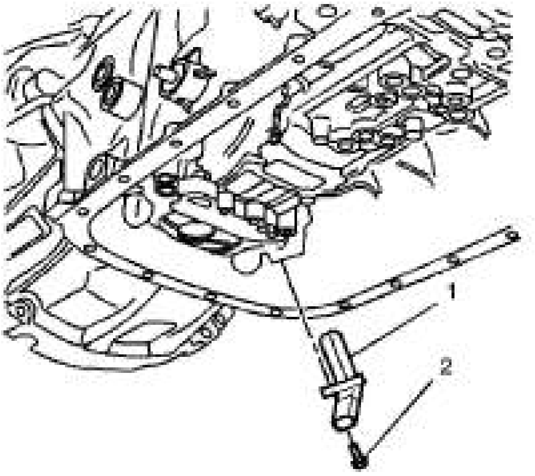
Input Speed Sensor Replacement

Removal Procedure

1. Remove the transmission fluid pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement.



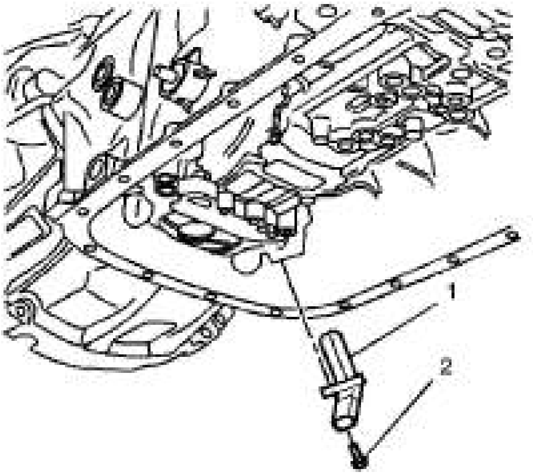
2. Disconnect the electrical wiring harness connector (1) from the input speed sensor (2).
3. Remove the input speed sensor retaining bolt (3).



4. Remove the input speed sensor (1).
5. Inspect the input speed sensor (1) for the following conditions:

- Damaged or missing magnet
- Damaged housing
- Bent or missing electrical terminals
- Metal contamination stuck to magnet

Installation Procedure

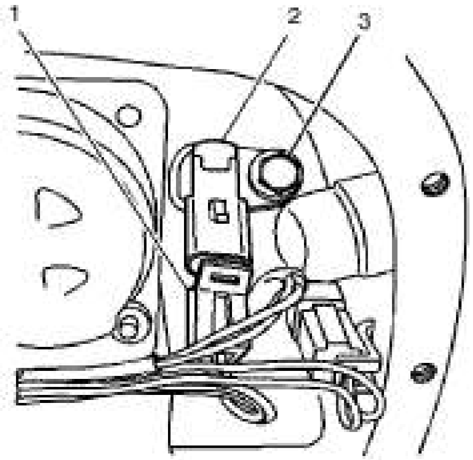


1. Install the input speed sensor (1).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the input speed sensor retaining bolt (2).

   Tighten
   Tighten the input speed sensor bolt to 11 N·m (97 lb. in).



3. Connect the electrical connector (1) to the input speed sensor (2).
4. Install the transmission fluid pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement.

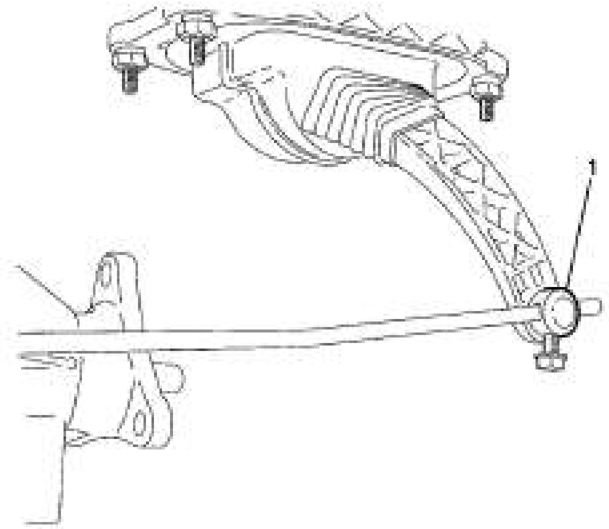
Manual Shift Shaft Position Switch Replacement

Tools Required

- J 44767 Seal Installer.
- EN-48536 Frame Support Tool (Engine Lower 65mm Kit)

Removal Procedure

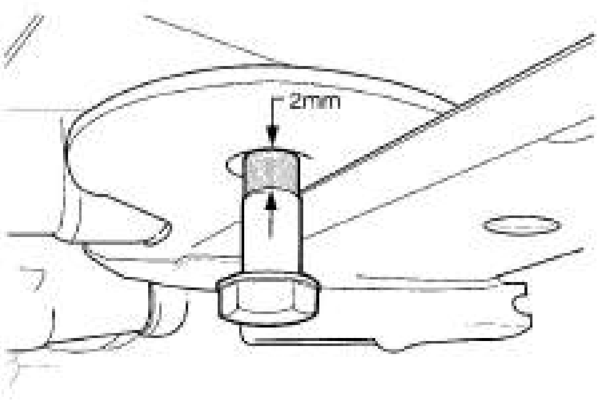
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



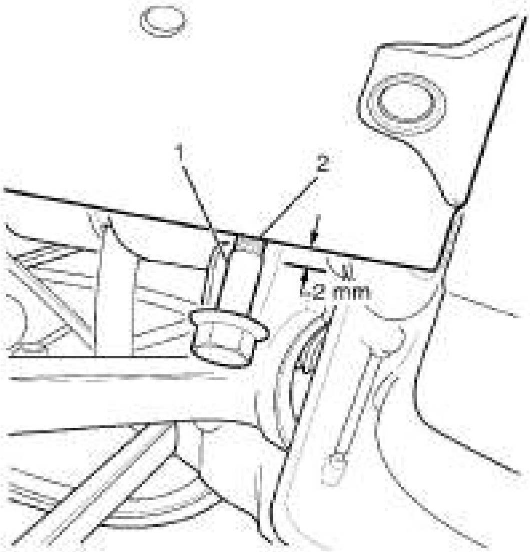
2. Remove the transmission manual shift shaft nut.
3. Disconnect the shift linkage from the transmission manual shift shaft.
4. Remove the exhaust system. Refer to Exhaust System Replacement.
5. Remove the propeller shaft. Refer to Propeller Shaft Replacement.

Important: The engine mounts must NOT bend or deflect from the vertical position, damage to the mount will occur.

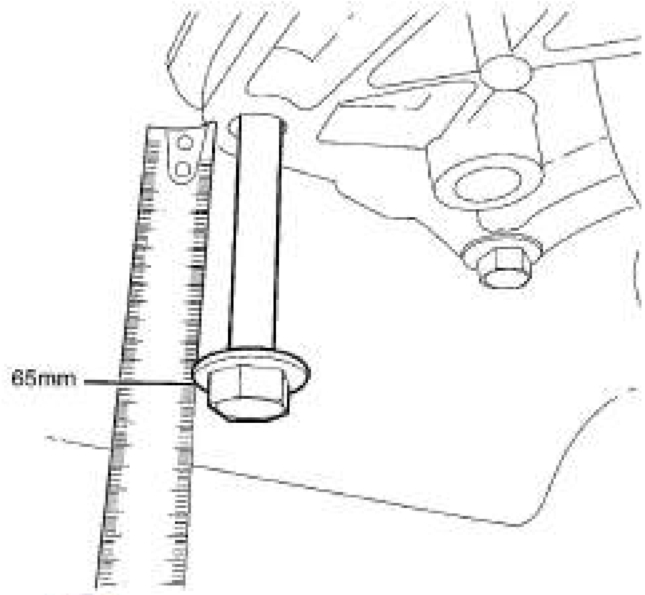
6. Support the powertrain with a suitable jack or table.



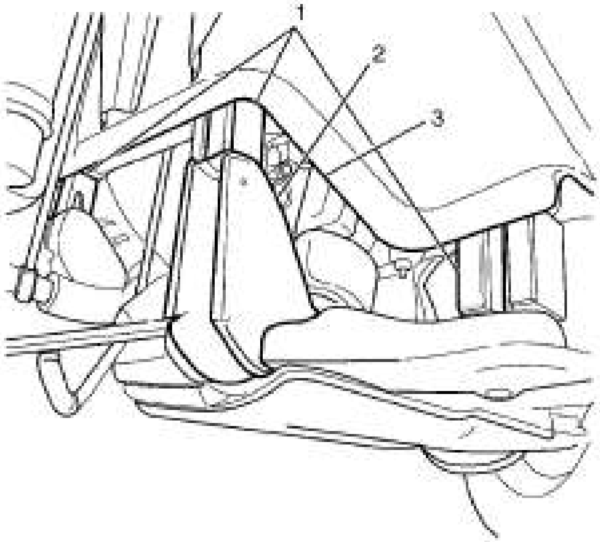
7. Replace the front sub frame rear bolts and fit bolts from special tool kit, Refer to EN-48536 .
8. Install bolt till stepped shank (1) is 2mm below sub frame (2).



9. Replace the front sub frame front bolts and fit bolts from special tool kit , Refer to EN-48536 .
10. Install bolt till stepped shank (1) is 2mm below chassis rail flange (2).



11. Remove all four transmission mount to body bolt and install two bolts from special tool kit in diagonal holes e.g Left hand front and Right hand rear.
12. Install in till 65mm is measured between bolt heads (1) and transmission mount (2).
13. Remove front sub frame middle bolts.
14. Lower power train slowly untill the subframe and transmission mount are resting on bolts.



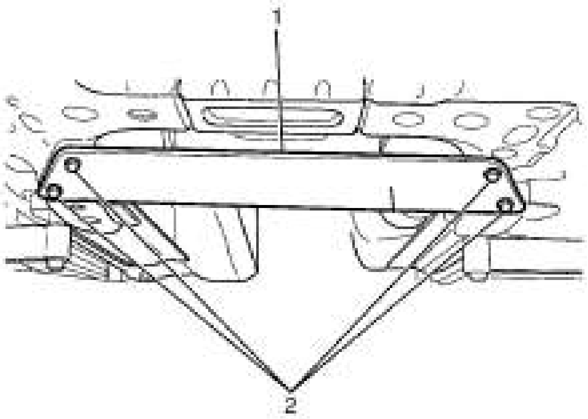
15. Insert 65mm spacer blocks (1) between subframe (2) and chassis rails (3).
16. Tighten the front sub frame front and rear bolts.

    Tighten
    Tighten the bolts to 95 N·m (70 lb. ft).

17. Install and tighten the middle sub frame bolts.

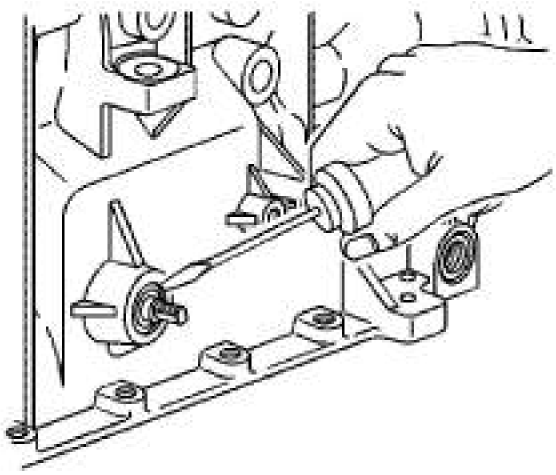
Tighten
Tighten the bolts to 95 N·m (70 lb. ft).

18. Remove supporting jack or table



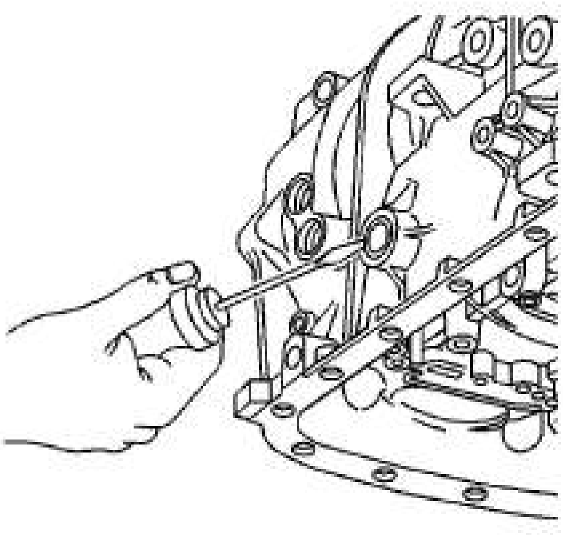
19. Install engine support plate (1) to front sub frame (2).
20. Tighten the plate securing bolts (3).

Tighten
Tighten the bolts to 10 N·m (89 lb. in).



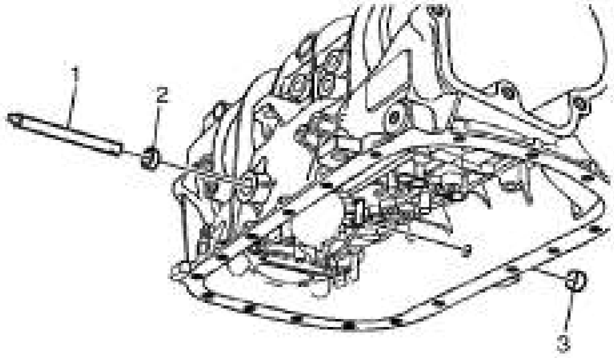
Important: Replace the shaft seal if damaged or worn.

21. Using a suitable tool, remove and discard the shaft seal.



Important: Replace the cup plug if damaged or worn.

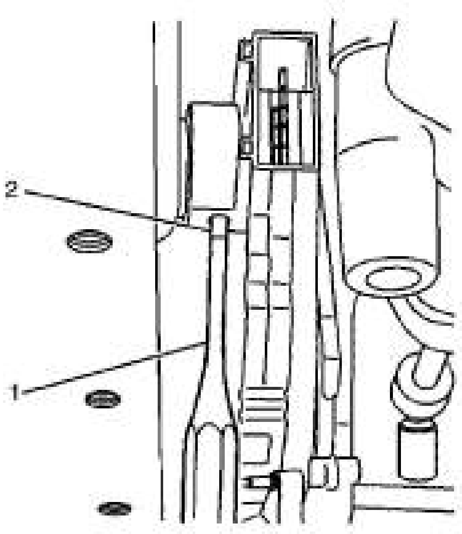
22. Using a suitable tool, remove and discard the cup plug.



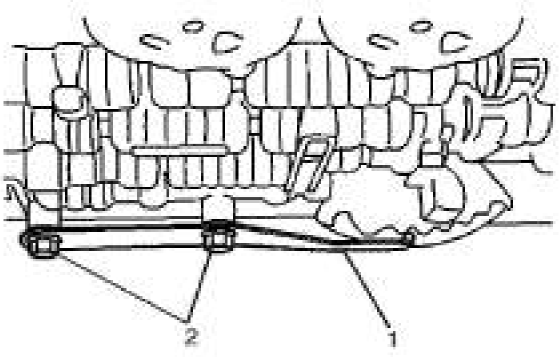
Important: Removal of the transmission is NOT required for the removal or replacement of the shift shaft position switch. Remove the transmission from the vehicle and refer to Unit Repair for replacement of the manual shift shaft ONLY if replacement of the manual shift shaft (3) is necessary.

23. Remove the transmission fluid pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement.

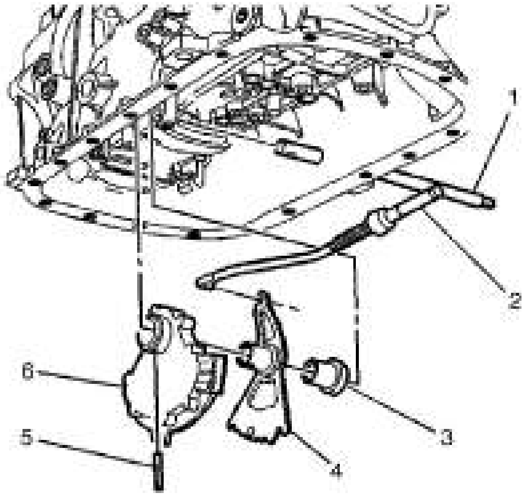
24. Disconnect the selector lever electrical connector from the selector lever shaft position switch.



25. Using a suitable pin punch (1). Remove the selector lever shaft position switch retaining pin (2).

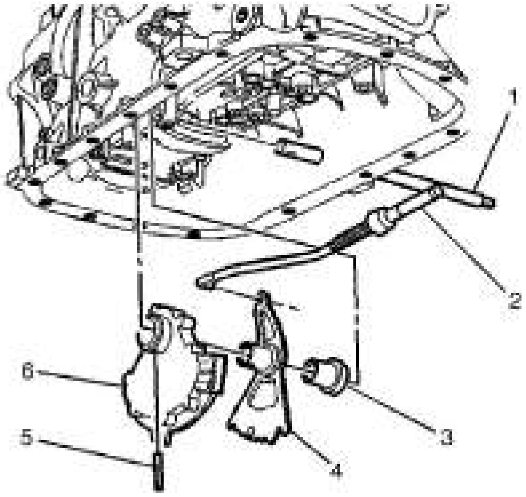


26. Remove the selector lever shaft detent spring (1) and retaining bolts (2).

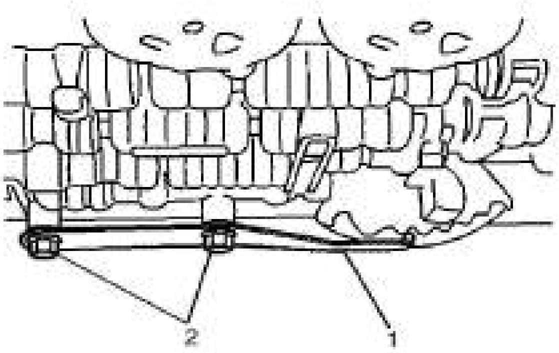


27. Extract the manual shift shaft (1) from the transmission case only far enough to allow removal of the manual shift shaft position switch (6).
28. Remove the manual shift shaft position switch (6), the manual shift shaft detent lever (4), the manual shift shaft assembly spacer (3), and the park pawl actuator (2) as an assembly.

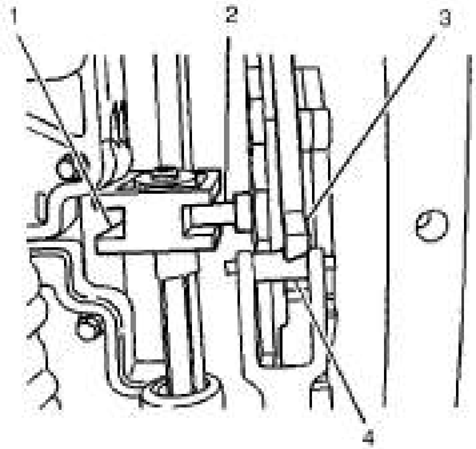
Installation Procedure



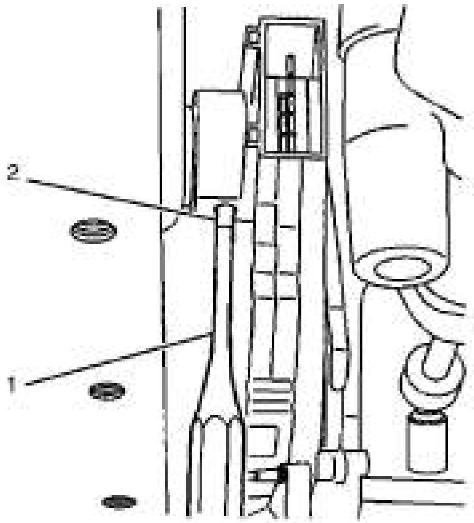
1. Install the manual shift shaft position switch (6), the manual shift shaft detent lever (4), the manual shift shaft assembly spacer (3), and the park pawl actuator (2) as an assembly. It may be necessary to push up on the park pawl in order to fully insert the park pawl actuator (2).
2. Fully insert the manual shift shaft (1) into the transmission case.



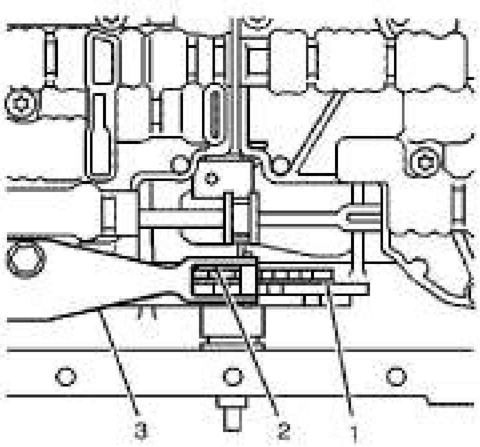
3. Install the manual shift shaft detent spring (1).
4. Install the control valve body bolts (2) retaining the manual shift shaft detent spring. Do not tighten at this time.



5. Confirm that the manual shift shaft detent lever locating pin (2) is properly engaged with the manual valve link (1).
6. Confirm that the detent spring roller (4) is properly engaged with the manual shift shaft switch (3).



7. Using a suitable pin punch (1). Install the manual shift shaft position switch retaining pin (2).
8. Connect the electrical connector to the manual shift shaft position switch.



9. Install a 0.8 mm spacer (2) between the manual shaft detent lever (1) and the manual shaft detent spring (3).

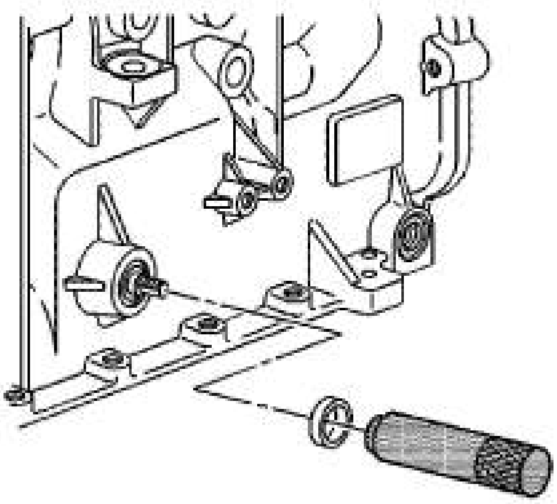
   Notice: Refer to Fastener Notice in the Preface section.

10. tighten the detent spring bolts.

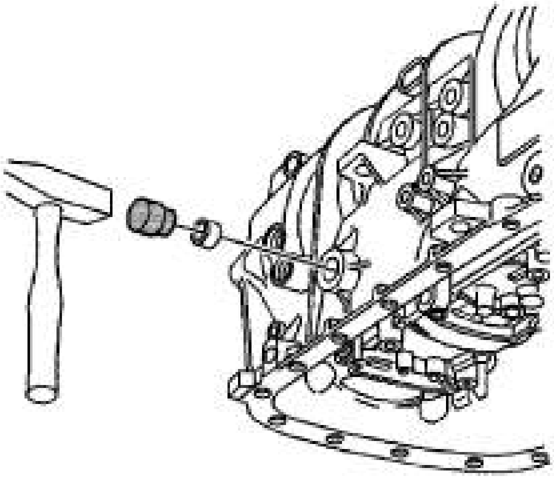
    Tighten
    Tighten the bolts to 11 N·m (97 lb. in).

11. Remove the spacer (2).

12. Install the transmission fluid pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement.



13. If previously removed, install a new shaft seal using J 44767 .
14. Position the seal onto the J 44767 before installing the seal into the transmission case.
15. Carefully slide the seal and tool over the manual shift shaft and Insert the seal into the transmission until fully seated



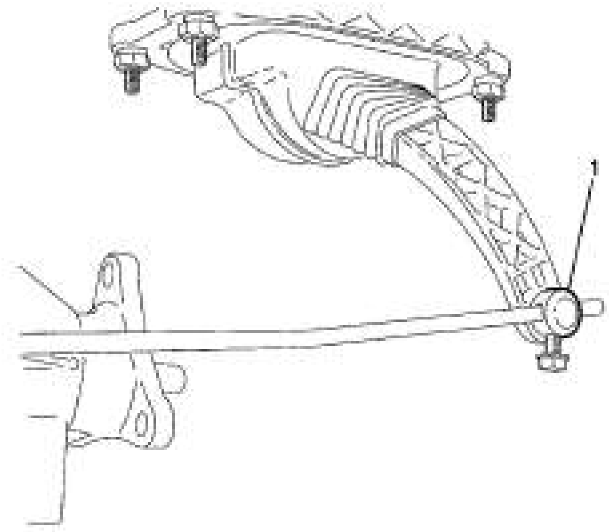
16. If previously removed, install a new cup plug. Lubricate the cup plug with transmission fluid before installation.
17. Insert the cup plug into the transmission until flush with the transmission case.
18. Remove engine and transmission lowering blocks and engine support plate.
19. Raise the powertrain back up into the engine bay and support.
20. Remove the special tool bolts and install the front sub frame bolts.
21. Tighten the front sub frame bolts.

Tighten
Tighten the bolts to 160 N·m (118 lb. ft).

22. Tighten the transmission support to under body retaining bolts.

    Tighten
    Tighten the bolts to 63 N·m (46 lb. ft).

23. Install the propeller shaft coupler (1) to the transmission flange. Refer to Propeller Shaft Replacement.
24. Install the exhaust system. Refer to Exhaust System Replacement.



25. Connect the shift linkage to the transmission manual shift shaft.
26. Install the transmission manual shift shaft nut.

    Tighten
    Tighten the nut to 15 N·m (11 lb. ft).

27. Adjust the shift control linkage. Refer to Shift Control Linkage Adjustment.
28. Lower the vehicle.

    Important: It is recommended that transmission adaptive pressure (TAP) information be reset.

    Resetting the TAP values using a scan tool will erase all learned values in all cells. As a result, The ECM or TCM will need to relearn TAP values. Transmission performance may be affected as new TAP values are learned.

29. Reset the TAP values. Refer to Transmission Adaptive Functions.

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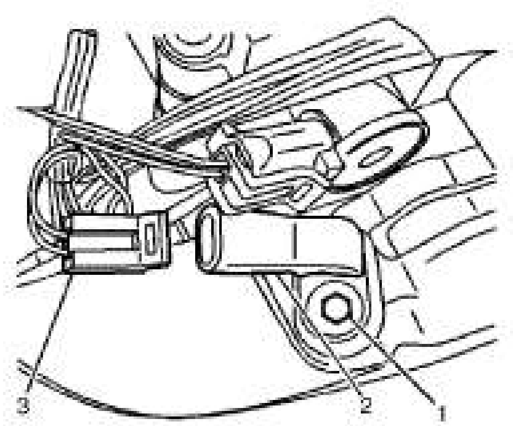
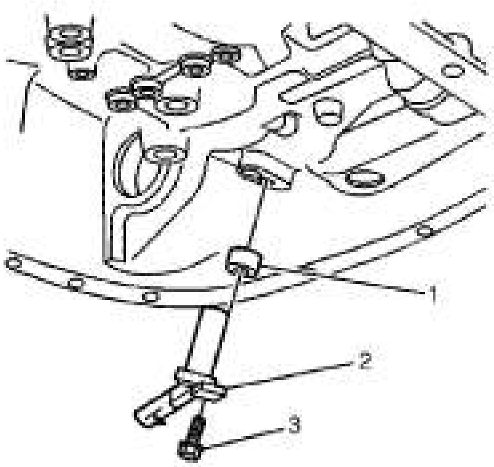
Output Speed Sensor Replacement

Removal Procedure

1. Remove the transmission fluid pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement.



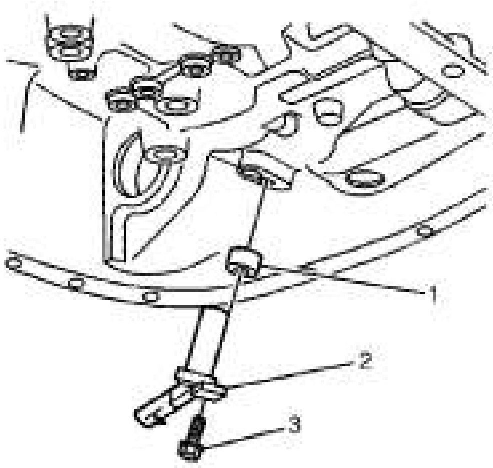
2. Disconnect the electrical connector (3) from the output speed sensor (2).



3. Remove the output speed sensor retaining bolt (3).
4. Remove the output speed sensor (2).
5. Remove the output speed sensor spacer (1).

6. Inspect the output speed sensor (2) for the following conditions:
   - Damaged or missing magnet
   - Damaged housing
   - Bent or missing electrical terminals

Installation Procedure

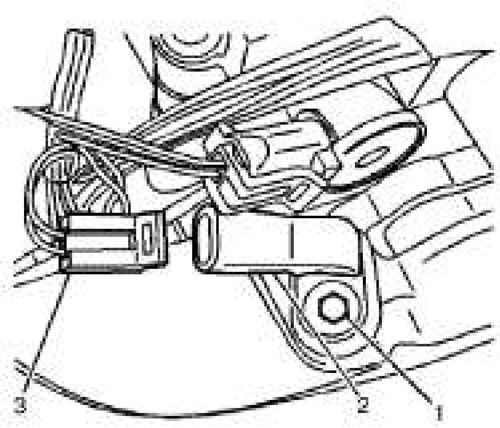


1. Install the output speed sensor spacer (1).
2. Install the output speed sensor (2).

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the output speed sensor retaining bolt (3).

   Tighten
   Tighten the output speed sensor bolt to 11 N·m (97 lb. in).



4. Connect the electrical connector (3) to the output speed sensor (2).
5. Install the transmission fluid pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement.

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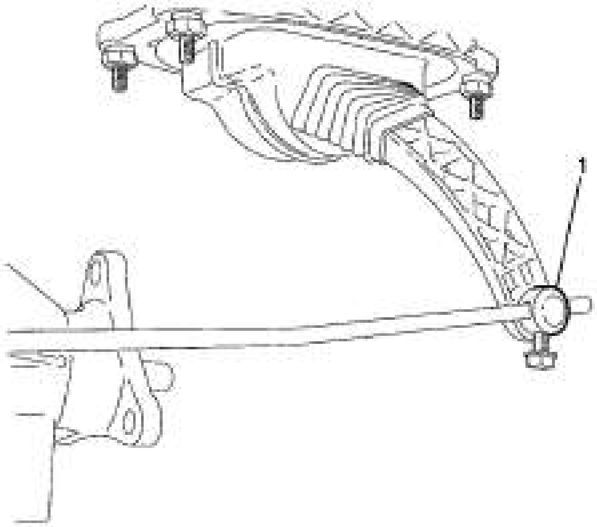
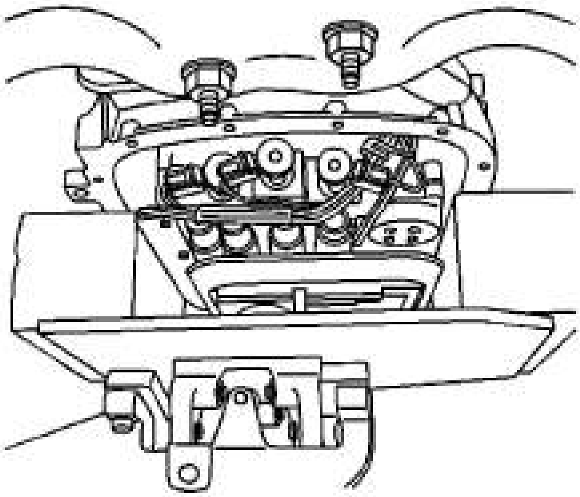
Parking Pawl Replacement

Removal Procedure

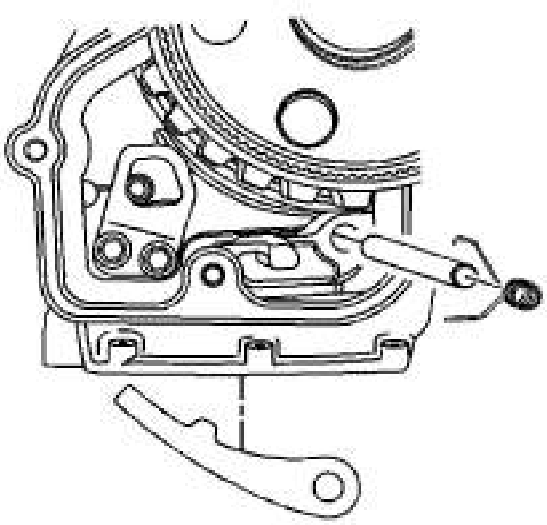
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



2. Remove the transmission manual selector lever shaft nut.
3. Disconnect the selector lever linkage from the transmission.
4. Place the transmission in neutral by rotating the transmission shift shaft clockwise 2 clicks.
5. Remove the exhaust system. Refer to Exhaust System Replacement.
6. Disconnect the propeller shaft coupler (1) from the transmission flange. Refer to Propeller Shaft Replacement.
7. Remove the transmission fluid pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement.

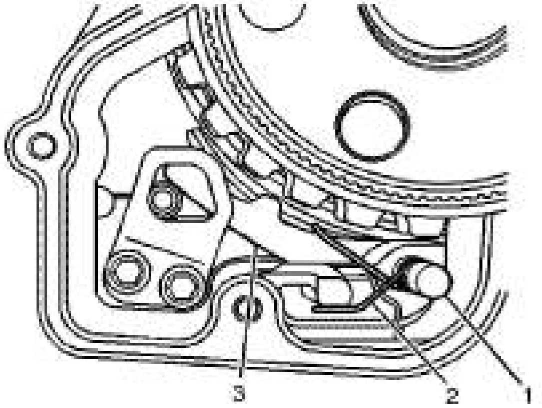


8. Using two equally sized suitable blocks of wood and a suitable transmission jack positioned under the transmission pan area. Support the transmission case on both sides with the wood blocks to prevent the transmission internal components from contacting the transmission jack.
9. Remove the transmission support. Refer to Transmission Support Replacement.
10. Remove the extension housing. Refer to Case Extension and Gasket Replacement.



11. Remove the parking pawl spring.
12. Remove the parking pawl pivot pin.
13. Remove the parking pawl.
14. Inspect the following:
    - Parking pawl tooth for chipping or wear
    - Parking pawl spring for over expansion
    - Pivot pin for scoring, excessive wear

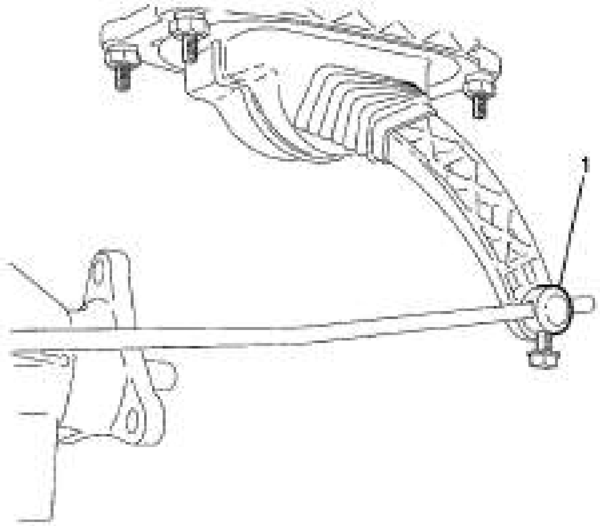
Installation Procedure



1. Install the parking pawl (3).
2. Install the pivot pin (1).

Important: The straight end of the spring locates against the case and the hooked end locates over the parking pawl.

3. Install the parking pawl spring (2).
4. Install the extension housing. Refer to Case Extension and Gasket Replacement.
5. Install the transmission support. Refer to Transmission Support Replacement.
6. Remove the transmission jack.
7. Install the transmission fluid pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement.
8. Install the propeller shaft. Refer to Propeller Shaft Replacement.
9. Install the exhaust system. Refer to Exhaust System Replacement.



10. Place the transmission in the park position by rotating the shift shaft fully counter clockwise.
11. Connect the shift linkage to the transmission.

Notice: Refer to Fastener Notice in the Preface section.

12. Install the transmission manual shift shaft nut.

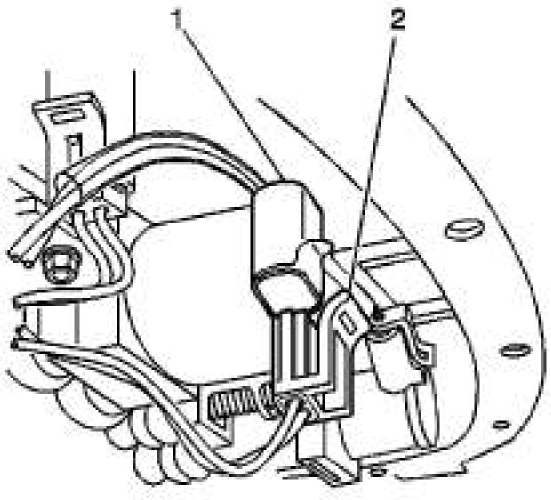
Tighten
Tighten the transmission manual shift shaft nut to 15 N·m (11 lb. ft).

13. Fill the transmission to the correct level. Refer to Transmission General Specifications, Fluid Capacity Specifications, and Transmission Fluid Check.
14. Lower the vehicle.

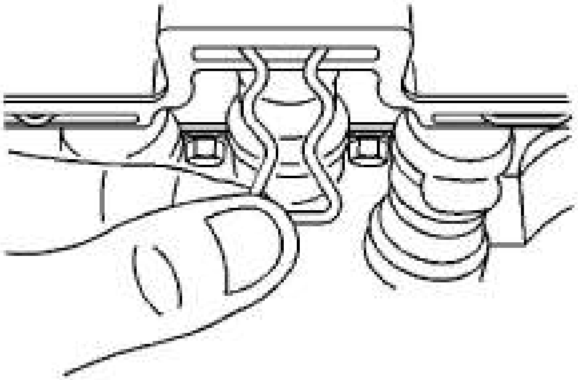
Pressure Control Solenoid Valve Replacement

Removal Procedure

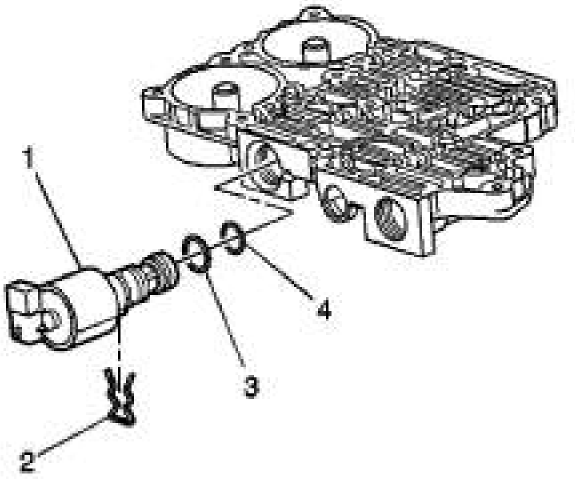
1. Remove the transmission fluid pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement.



2. Disconnect the electrical connector (2) from the pressure control solenoid (1).

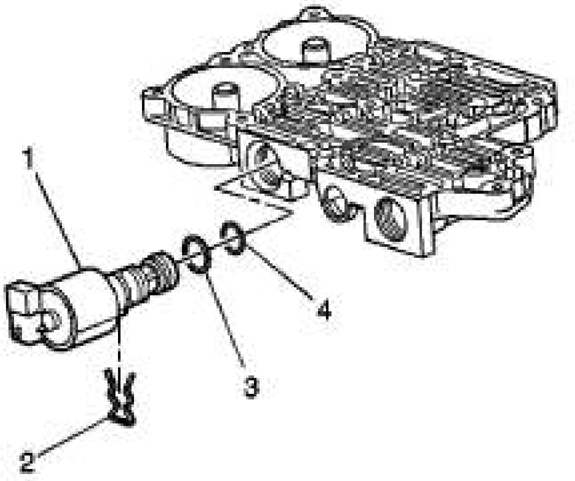


3. Using a small suitable tool, remove the pressure control solenoid retainer from the control valve body.

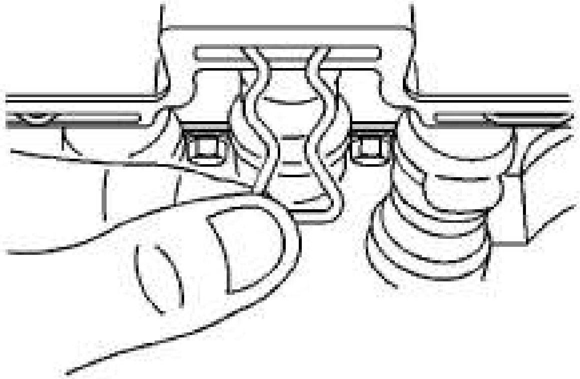


4. Remove the pressure control solenoid (1) from the control valve body.
5. Remove the O-ring seals (3-4) from the pressure control solenoid (1), ONLY if the O-rings are cut or worn.

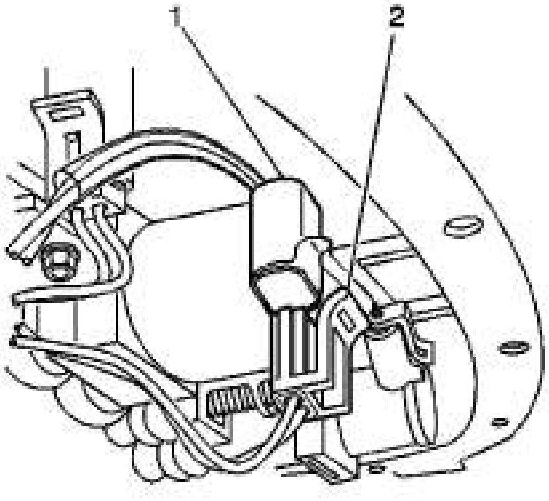
Installation Procedure



1. Install new O-ring seals (3-4) to the pressure control solenoid (1), if the O-rings were previously removed.
2. Install the pressure control solenoid (1) into the control valve body.



3. Install the pressure control solenoid retainer into the control valve body.



4. Connect the electrical connector (2) to the pressure control solenoid (1).
5. Install the transmission fluid pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement.

Important: It is recommended that transmission adaptive pressure (TAP) information be reset.

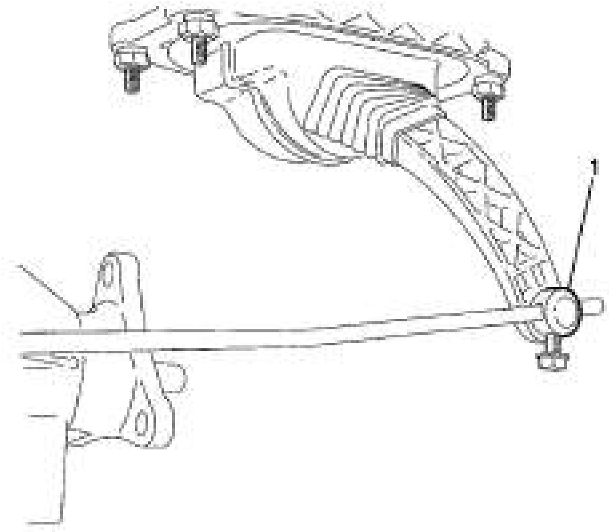
Resetting the TAP values using a scan tool will erase all learned values in all cells. As a result, The ECM or TCM will need to relearn TAP values. Transmission performance may be affected as new TAP values are learned.

6. Reset the TAP values. Refer to Transmission Adaptive Functions.

Shift Control Linkage Adjustment

1. Position the shift lever in PARK.
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

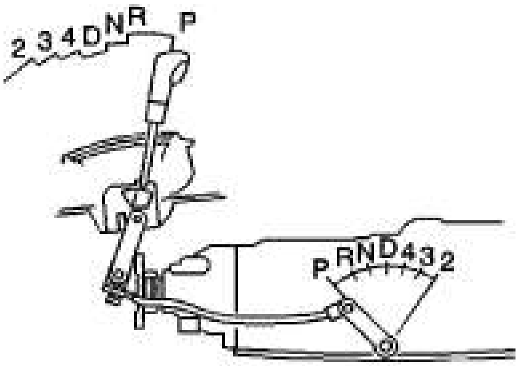
   Notice: Refer to Fastener Notice in the Preface section.



3. Loosen the shift control linkage adjustment bolt to allow the adjuster (1) to slide freely.
4. Hold the selector lever on the transmission against the rear stop to eliminate any play.

   Tighten
   Tighten the shift control linkage adjustment nut to 9 N·m (80 lb. in).

5. Lower the vehicle.



6. Check the operation of the starting system with the shift lever in each position. The engine should only crank when the lever is in the PARK or NEUTRAL position.

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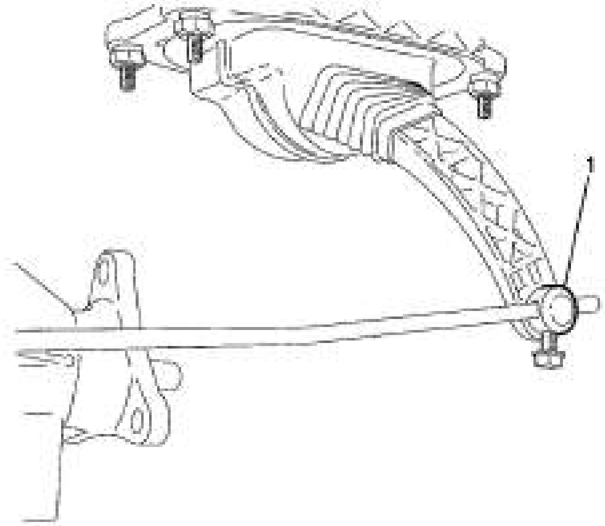
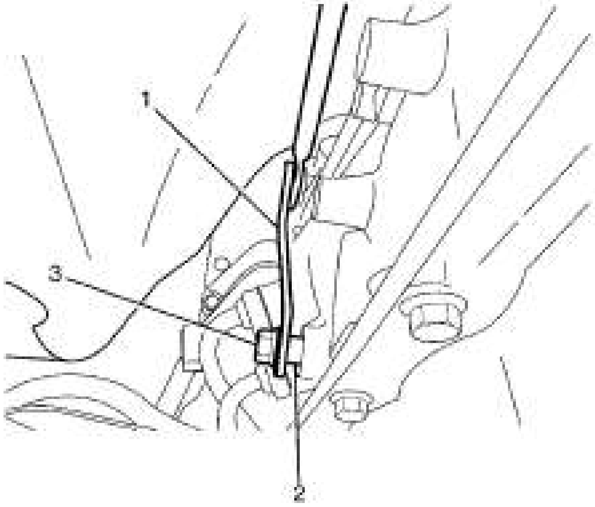
Shift Control Linkage Replacement

Removal Procedure

1. Place the selector lever in PARK.
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

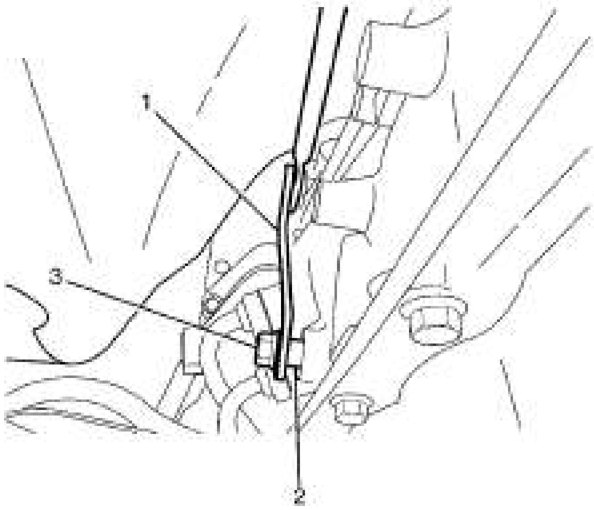


3. Remove the nut from the shift control linkage rod.
4. Disconnect the shift control linkage rod from the shift control.



5. Remove the shift selector linkage rod to shift selector shaft retaining nut (3).
6. Remove the shift selector linkage rod (1) from the shift selector shaft (2).

Installation Procedure

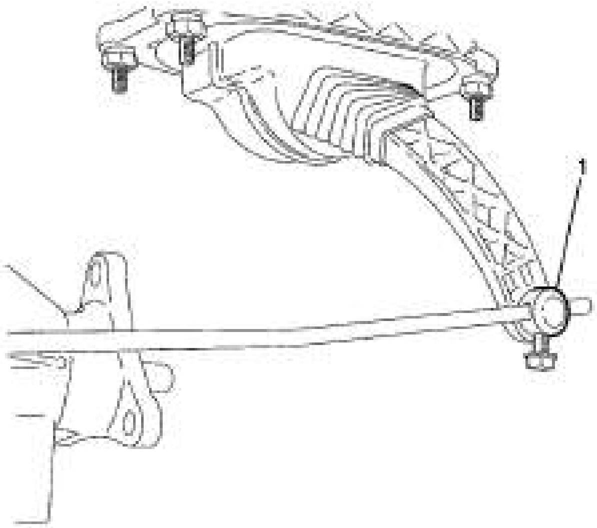


1. Install the shift selector linkage rod (1) to the shift selector shaft (2).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the shift selector linkage rod to shift selector shaft retaining nut (3).

   Tighten
   Tighten the manual shift shaft nut to 9 N·m (80 lb. in).

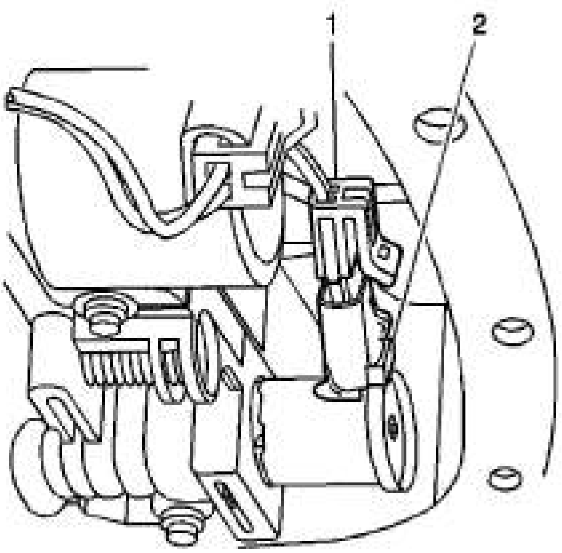


3. Connect the shift control linkage rod to the shift control assembly.
4. Install the nut to the shift control linkage rod.
5. Adjust the shift control linkage. Refer to Shift Control Linkage Adjustment.
6. Lower the vehicle.

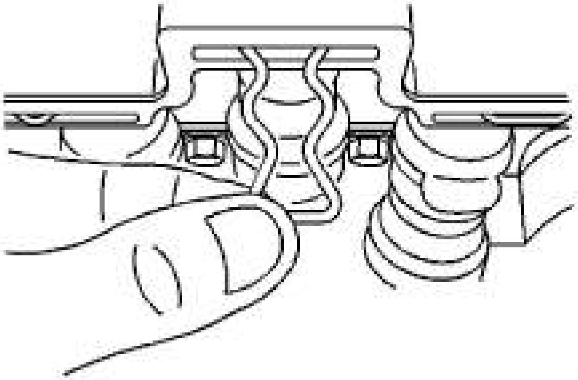
Torque Converter Clutch Solenoid Replacement

Removal Procedure

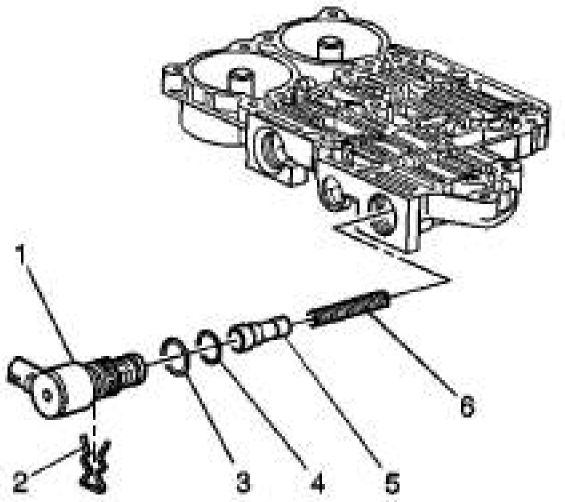
1. Remove the transmission fluid pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement.



2. Disconnect the electrical connector (1) from the torque converter clutch (TCC) pulse width modulation (PWM) solenoid valve (2).

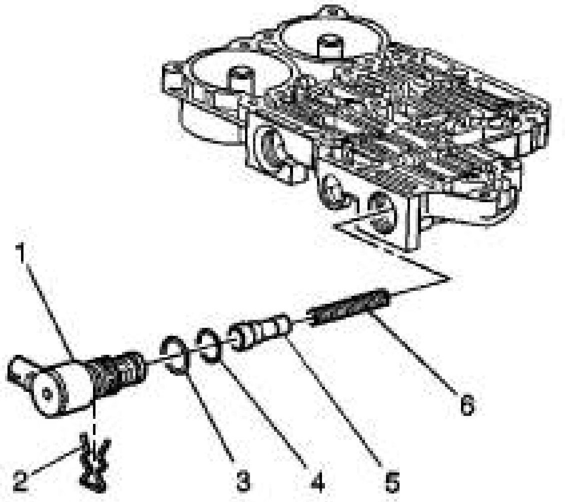


3. Using a small suitable tool, remove the TCC PWM solenoid valve retainer from the control valve body.

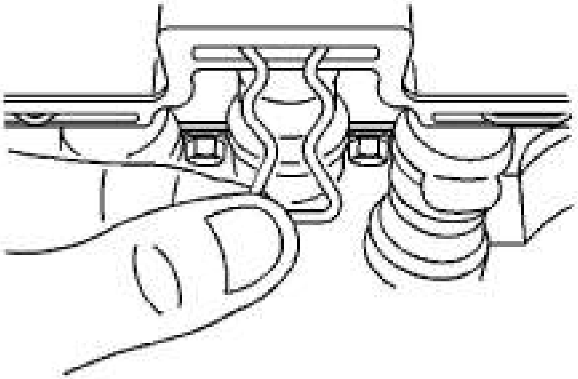


4. Remove the TCC PWM solenoid valve (1) from the control valve body.
5. Remove the O-ring seals (3-4) from the TCC PWM solenoid valve (1), ONLY if the O-rings are cut or worn.

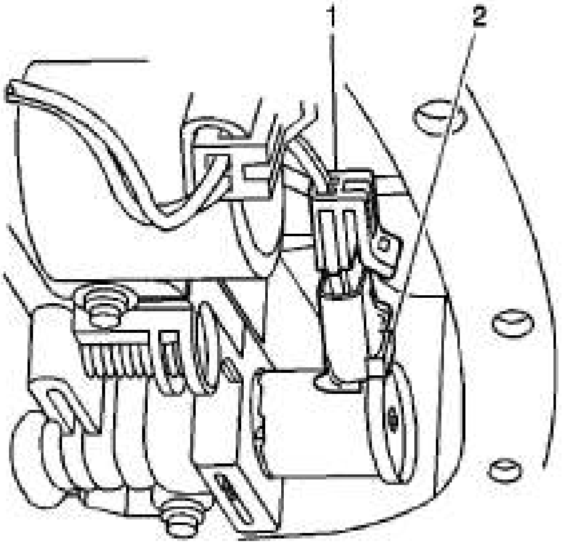
Installation Procedure



1. Install new O-ring seals (3-4) to the torque converter clutch (TCC) pulse width modulation (PWM) solenoid valve (1), if the O-rings were previously removed.
2. Install the TCC PWM solenoid valve (1) into the control valve body.



3. Install the TCC PWM solenoid valve retainer into the control valve body.



4. Connect the electrical connector (1) to the TCC PWM solenoid valve (2).
5. Install the transmission fluid pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement.

Important: It is recommended that transmission adaptive pressure (TAP) information be reset.

Resetting the TAP values using a scan tool will erase all learned values in all cells. As a result, The ECM or TCM will need to relearn TAP values. Transmission performance may be affected as new TAP values are learned.

6. Reset the TAP values. Refer to Transmission Adaptive Functions.

Torque Converter Clutch / Cruise Control Release Switch Adjustment

Refer to Stop Lamp Switch Adjustment.

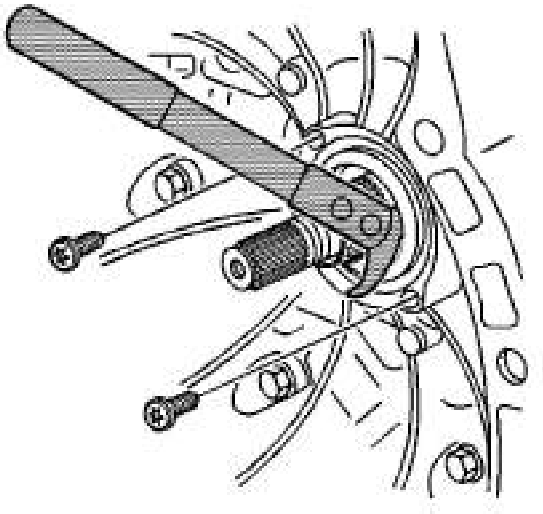
Torque Converter Fluid Seal Replacement

Tools Required

- J 8092 Universal driver Handle
- J 44766 Seal Installer
- J 45000 Seal Remover

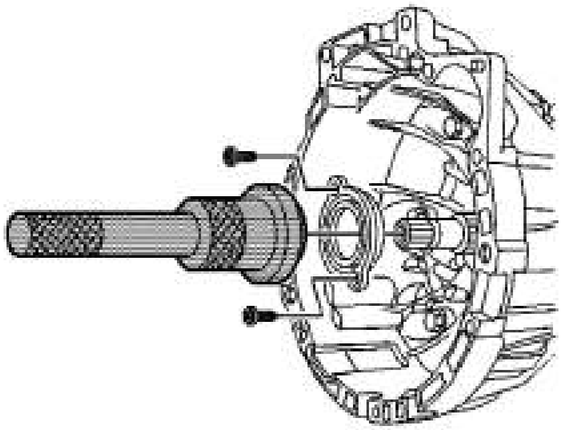
Removal Procedure

1. Remove the transmission torque converter. Refer to Torque Converter Replacement .



2. Remove and discard the torque converter seal retaining bolts.
3. Remove the torque converter seal using J 45000 .

Installation Procedure



1. Assemble J 8092 onto J 44766 .
2. Install the torque converter seal onto the tool before installing into the case to prevent damage to the seal.

   Important: Align the torque converter seal with the bolt holes.

3. Install the torque converter seal into the torque converter housing.

   Notice: Refer to Fastener Notice in the Preface section.

4. Install the NEW torque converter seal retaining bolts.

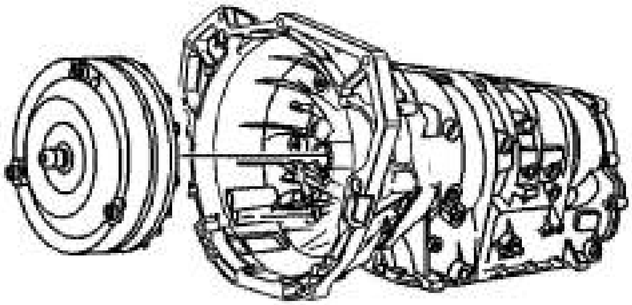
   Tighten
   Tighten the bolts to 3.6 N·m (32 lb. in).

5. Install the transmission torque converter. Refer to Torque Converter Replacement .

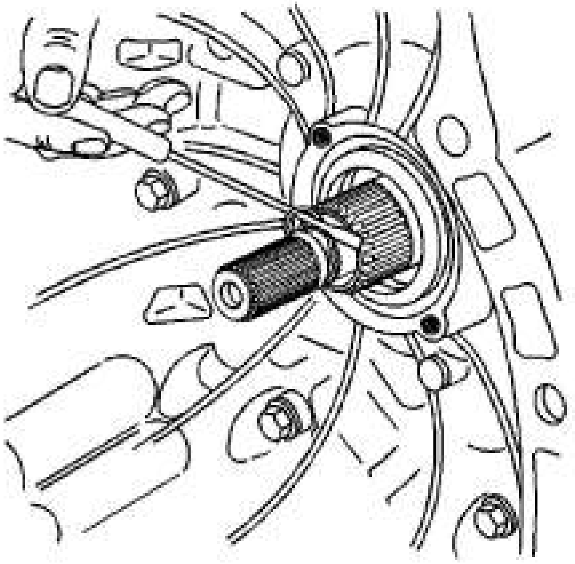
Torque Converter Replacement

Removal Procedure

1. Remove the transmission from the vehicle. Refer to Transmission Replacement.

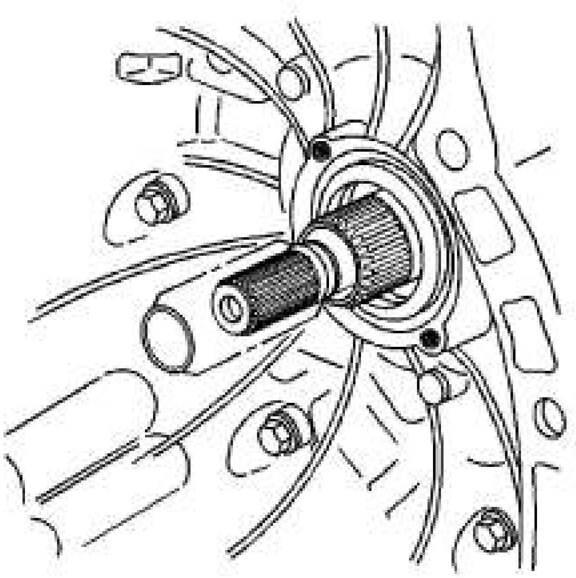


2. Remove the torque converter from the transmission.



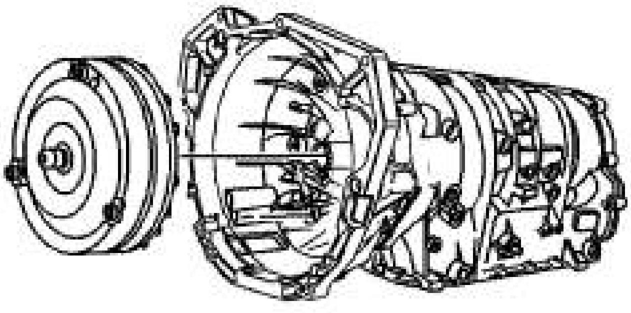
3. Remove the input shaft seal. Refer to Torque Converter Fluid Seal Replacement.

Installation Procedure



Important: Take care to prevent cutting of the input shaft seal on the input shaft splines.

1. Install the input shaft seal. Refer to Torque Converter Fluid Seal Replacement.



Important: Ensure the torque converter is fully seated into the transmission pump drive gear and turbine shaft.

2. Install the torque converter. Push the torque converter into position while rotating.
   - The torque converter must be fully seated on the turbine shaft
   - The torque converter must be fully seated in the pump drive gear

3. Install the transmission to the vehicle. Refer to Transmission Replacement.

   Important: It is recommended that transmission adaptive pressure (TAP) information be reset.

   Resetting the TAP values using a scan tool will erase all learned values in all cells. As a result, The ECM or TCM will need to relearn TAP values. Transmission performance may be affected as new TAP values are learned.

4. Reset the TAP values. Refer to Transmission Adaptive Functions.

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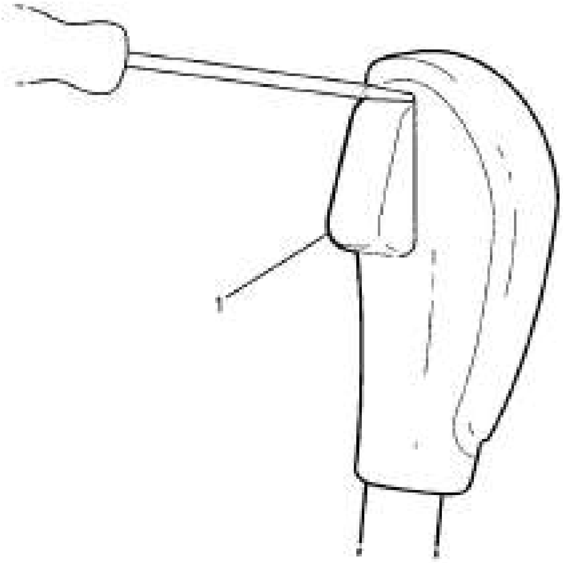
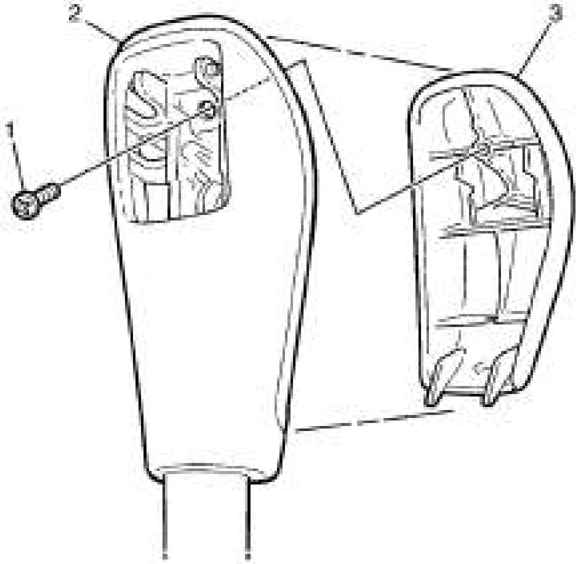
Transmission Control Lever Knob Replacement

Removal Procedure

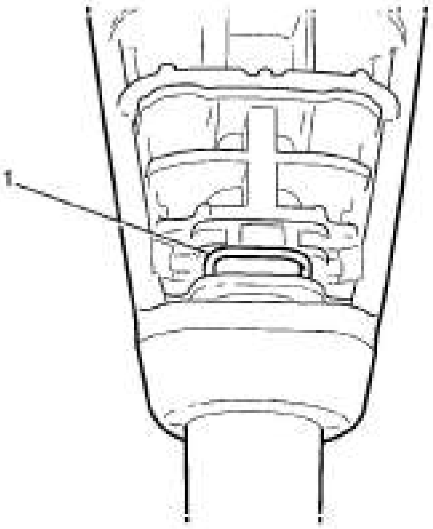
1. Remove transmission control lever assembly. Refer to Floor Shift Control Knob Replacement.



2. Using a suitable tool lever release knob (1) out of selector lever

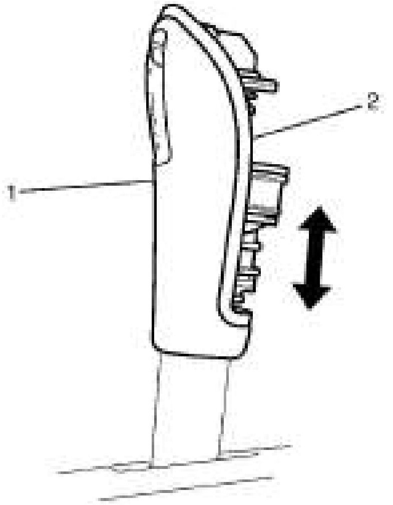


3. Remove selector retaining screw (1) from the selector lever (2) and remove lever backing (3).

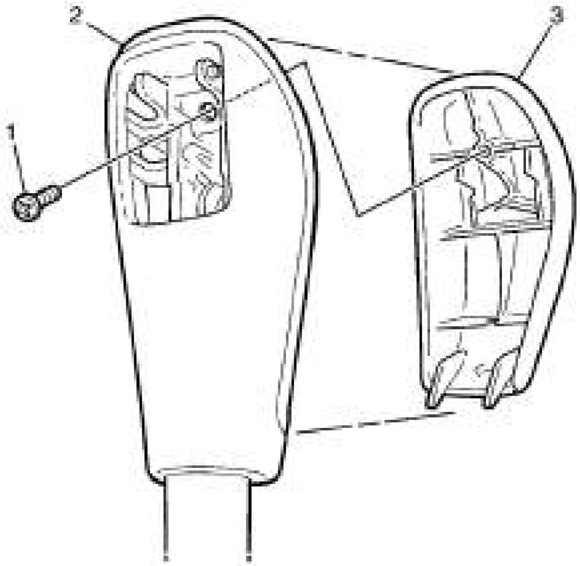


4. Remove the selector lever knob metal retainer clip (1).
5. Remove selector lever knob spacer.
6. Remove selector lever knob by sliding upwards off assembly.

Installation Procedure



1. Install the selector lever knob (1) by sliding down on the assembly.
2. Install the selector lever knob spacer (2).
3. Install the selector lever knob metal retainer clip.



4. Install the lever backing (3) and retaining screw (1) to the selector lever (2).
5. Install the release knob into selector lever.
6. Install the transmission control lever assembly. Refer to Floor Shift Control Knob Replacement.

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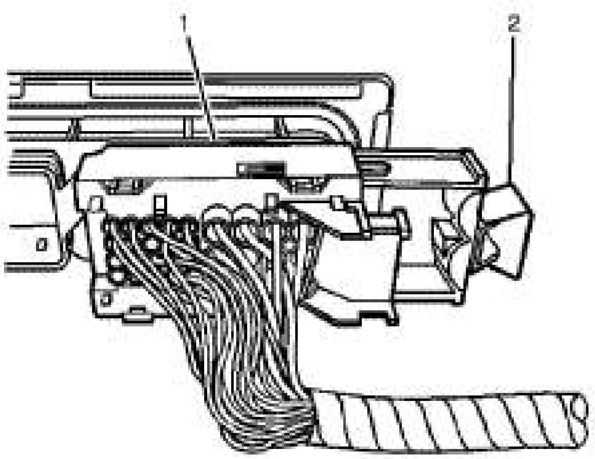
Transmission Control Module Replacement

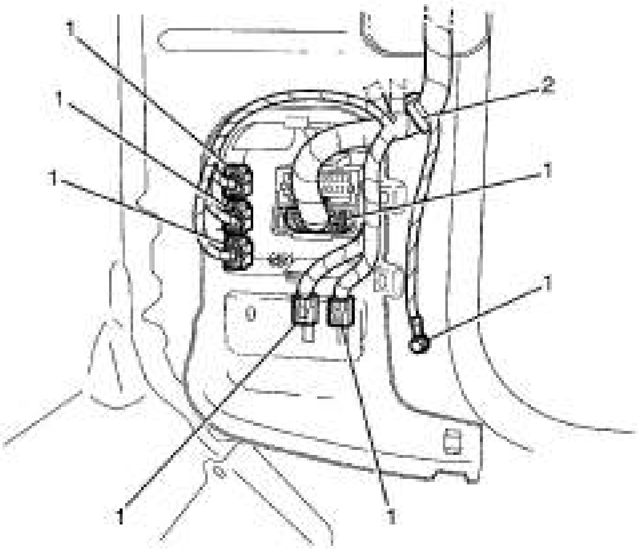
Removal Procedure

1. Remove the right side hinge pillar trim from the vehicle. Refer to Body Hinge Pillar Trim Panel Replacement .
2. Remove the knee bolster assembly. Refer to Knee Bolster Replacement .

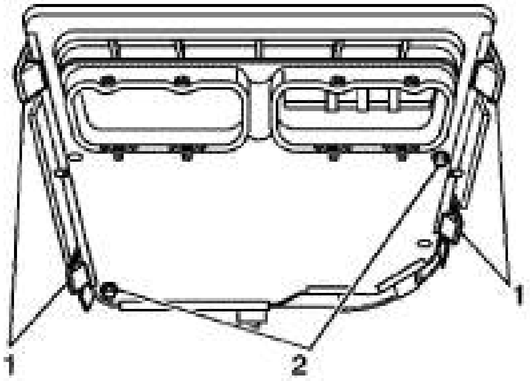


3. Unlock the transmission control module electrical connector by pulling the retainer (2) away from the electrical connector (1).

   Important: Twisting or tilting of the transmission control module electrical connector while disconnecting may result in bent or misaligned electrical terminal pins.

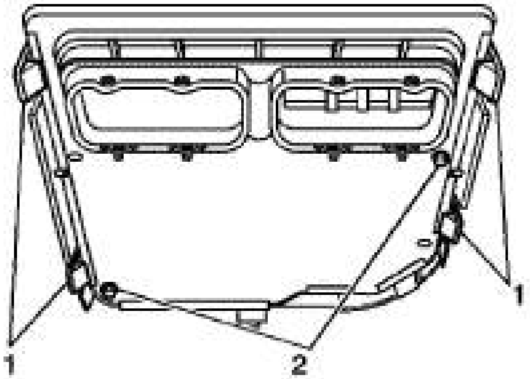


4. Carefully disconnect the electrical connector (1) from the transmission control module.
5. Disconnect the electrical connectors (1) from right hand side junction box and position loom towards the cowl

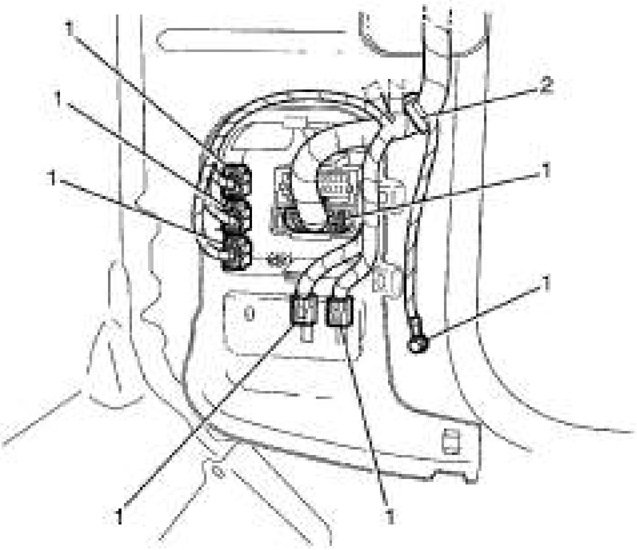


6. Remove the transmission control module from the mounting bracket by pulling back on the retaining tabs (1) to release the control module .

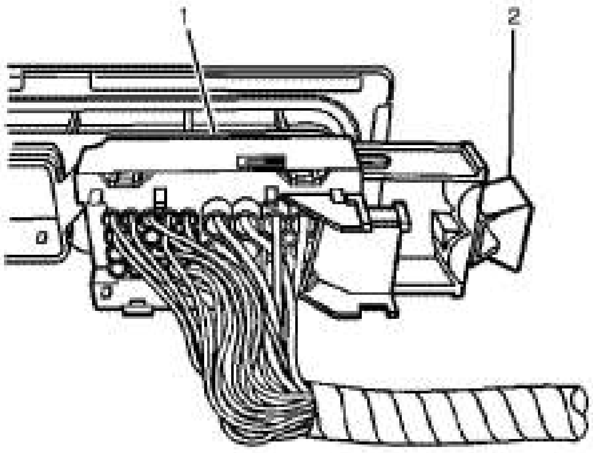
Installation Procedure



1. Align the transmission control module with the locating pins (2) on the module mounting bracket.
2. Install the transmission control module by seating it fully into the bracket until all of the retaining tabs (1) have engaged the edge of the module edge.



3. Install connectors (1) into the right hand side junction box



Important: Twisting or tilting of the transmission control module electrical connector while connecting may result in bent or misaligned electrical terminal pins.

4. Carefully connect the transmission control module electrical connector (1) to the transmission control module.
5. Lock the transmission control module electrical connector securely to the transmission control module by pushing the retainer (2) toward the electrical connector (1) until fully seated.
6. Install the right side hinge pillar trim on the vehicle. Refer to Body Hinge Pillar Trim Panel Replacement .
7. Install the knee bolster assembly. Refer to Knee Bolster Replacement .
8. If re-programming is required. Refer to Control Module References .

Important: It is recommended that transmission adaptive pressure (TAP) information be reset.

Resetting the TAP values using a scan tool will erase all learned values in all cells. As a result, The ECM or TCM will need to relearn TAP values. Transmission performance may be affected as new TAP values are learned.

9. Reset the TAP values. Refer to Transmission Adaptive Functions .

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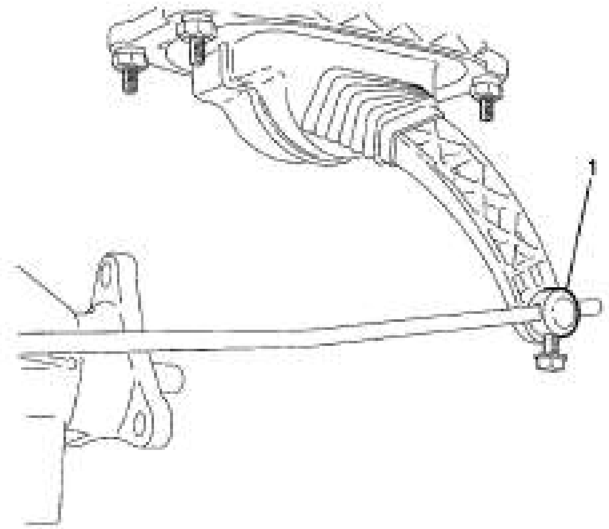
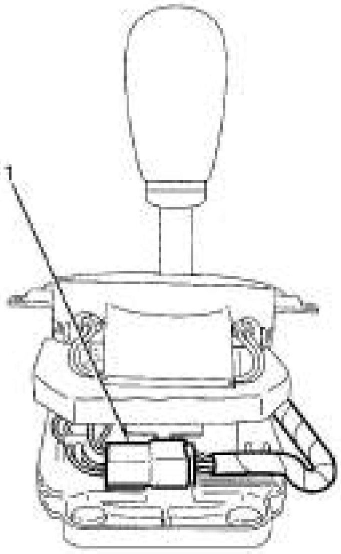
Transmission Control Replacement

Removal Procedure

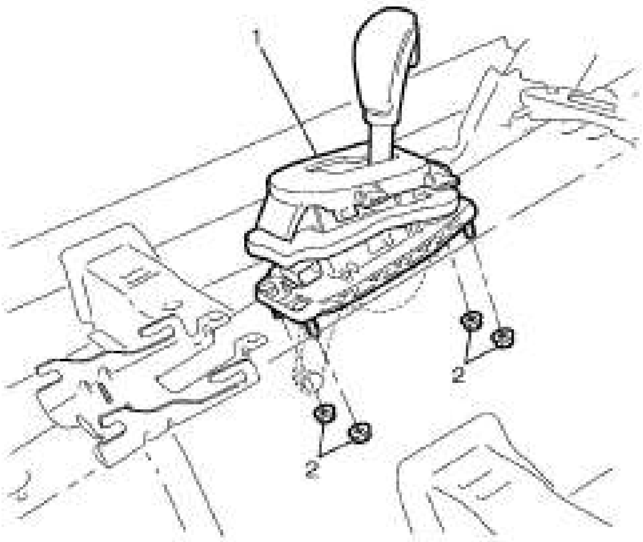
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



2. Remove the adjustment nut (1) from the shift control linkage.
3. Disconnect the shift control linkage rod from the shift control assembly.
4. Lower the vehicle.
5. Remove the center console assembly. Refer to Front Floor Console Replacement.

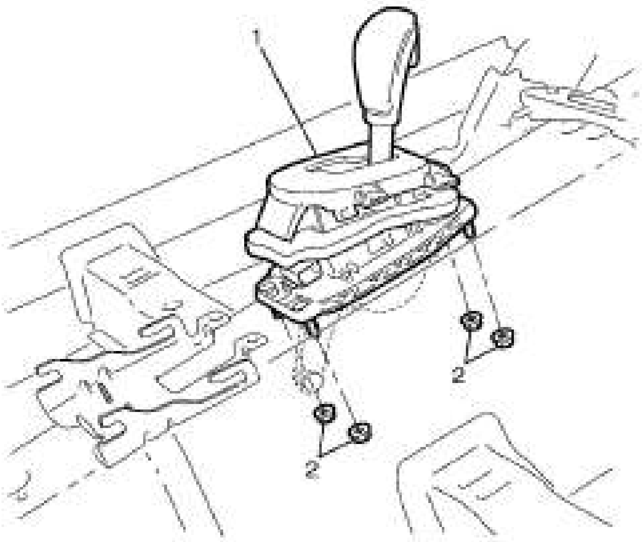


6. Remove the electrical connector (1) from the shift control assembly.



7. Remove the nuts (2) securing the shift control assembly to the tunnel reinforcement.
8. Remove the shift control assembly (1) from the tunnel reinforcement.

Installation Procedure

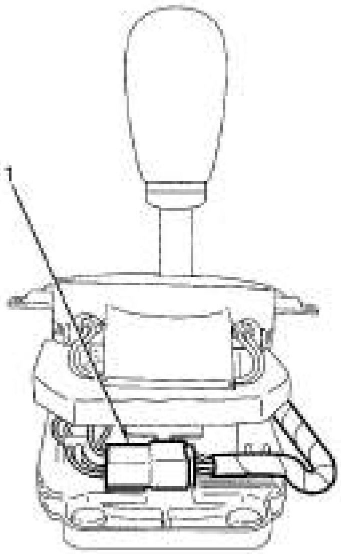


1. Install the shift control assembly (1) to the tunnel reinforcement.

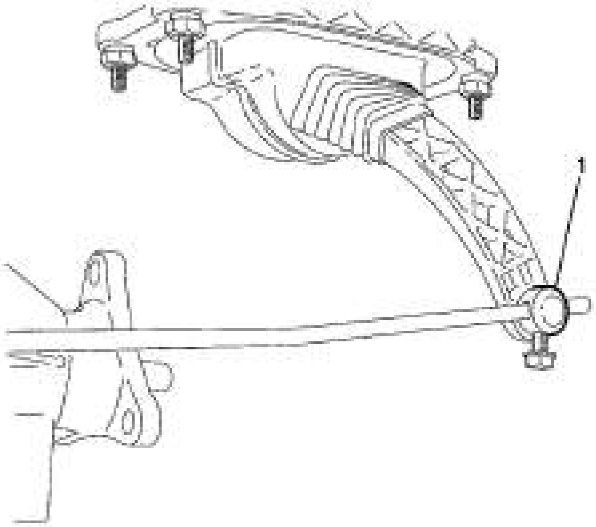
   Notice: Refer to Fastener Notice in the Preface section.

2. Install the nuts (2) securing the shift control assembly to the tunnel reinforcement.

Tighten
Tighten the nuts to 12 N·m (106 lb. in).



3. Install the electrical connector (1) to the shift control assembly.
4. Install the centre console assembly. Refer to Front Floor Console Replacement.
5. Install the shift control trim plate by inserting the front retaining tabs to the console. Press down on the rear of the trim plate to engauge the rear retaining tabs.
6. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



7. Connect the shift control linkage rod to the shift control assembly.
8. Install the shift control linkage adjustment nut finger tight.
9. Adjust the shift control linkage. Refer to Shift Control Linkage Adjustment.
10. Lower the vehicle.

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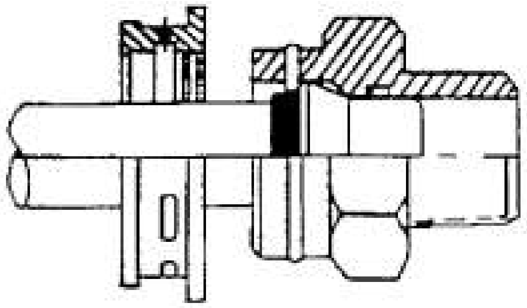
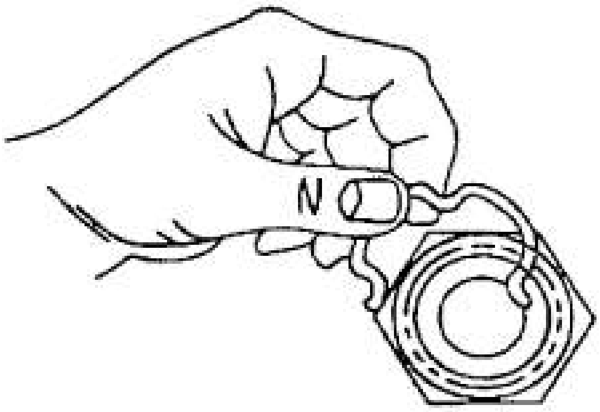
Transmission Fluid Cooler Hose / Pipe Quick-Connect Fitting Disconnection and Connection

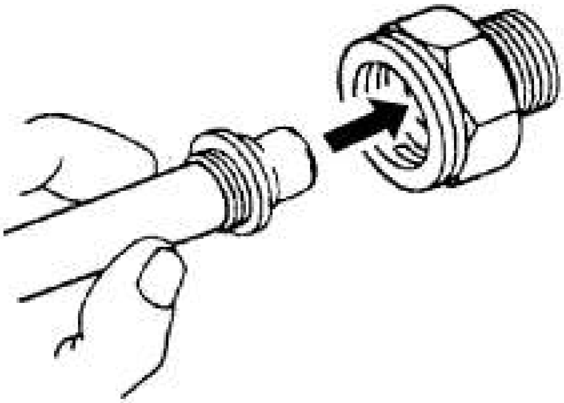
Removal Procedure



1. Remove the plastic cap from the quick connect fitting.



2. Remove the retaining ring from the quick connect fitting.



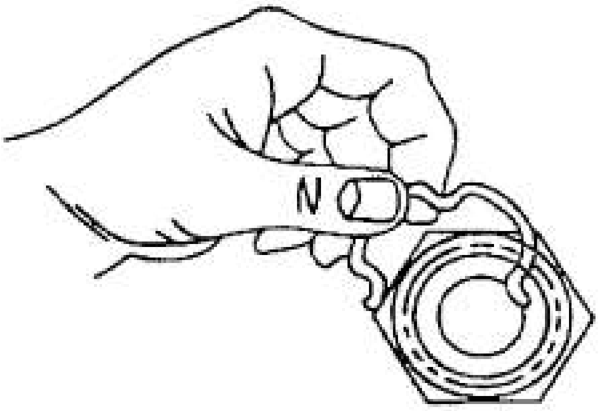
3. Remove the cooler line from the quick connect fitting.

Installation Procedure

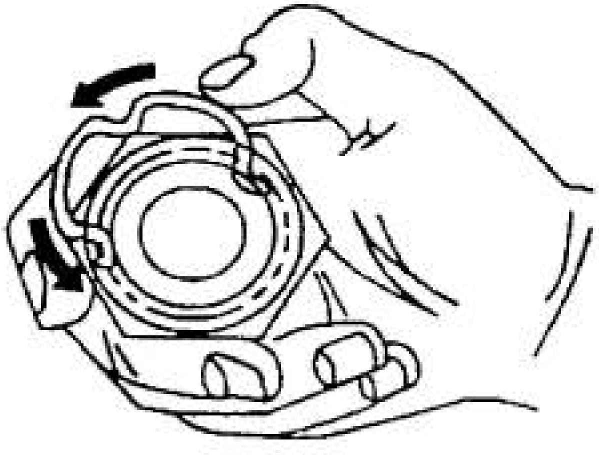
Important:

- Do not reuse any of the existing oil lines or oil line fittings if there is excessive corrosion.
- Do not reuse any of the existing retaining rings that were removed from the existing quick connect fittings. Install new retaining rings.
- Make sure the following procedures are performed when installing the new retaining rings onto the fittings.

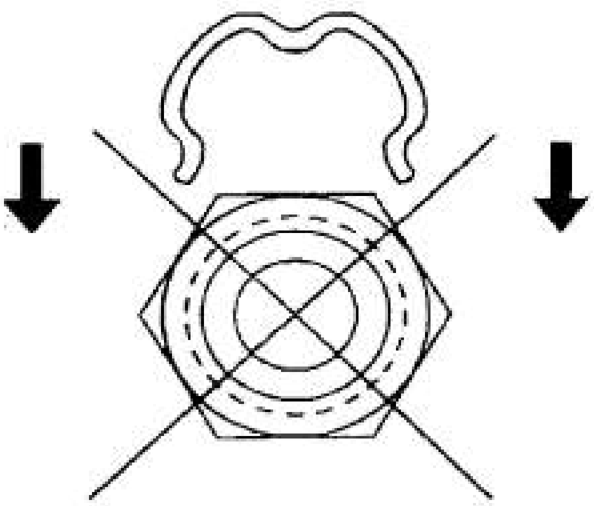
1. Install a new retaining ring into the quick connect fitting using the following procedure:



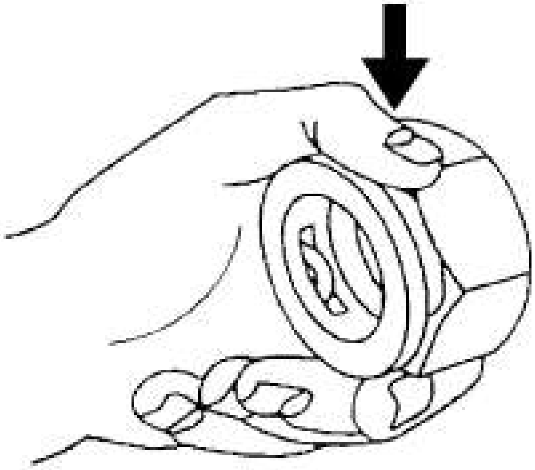
2. Hook one of the open ends of the retaining ring in one of the slots on the quick connect fitting.



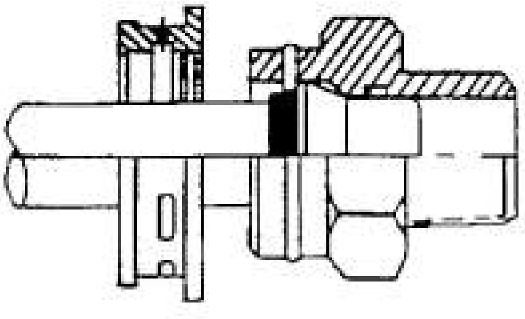
3. Rotate the retaining ring around the fitting until the retaining ring is positioned with all three ears through the three slots on the fitting.



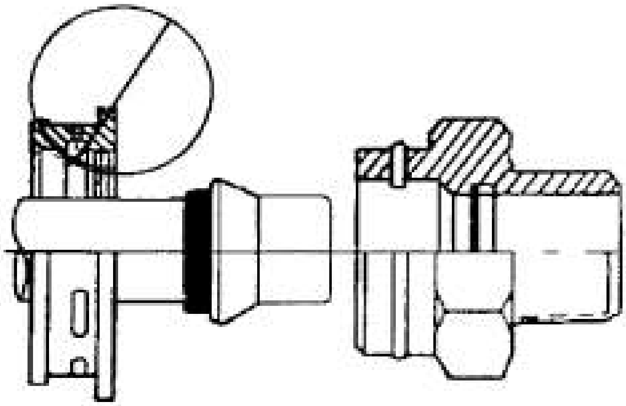
4. Do not install the new retaining ring onto the fitting by pushing the retaining ring.



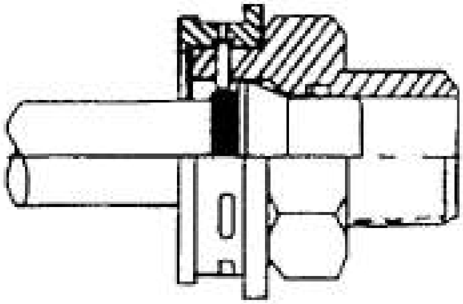
5. Make sure that the three retaining ring ears are seen from inside the fitting and that the retaining ring moves freely in the fitting slots.



6. Install the cooler line into the quick connect fitting.
7. Insert the cooler line end into the quick connect fitting until a click is either heard or felt.

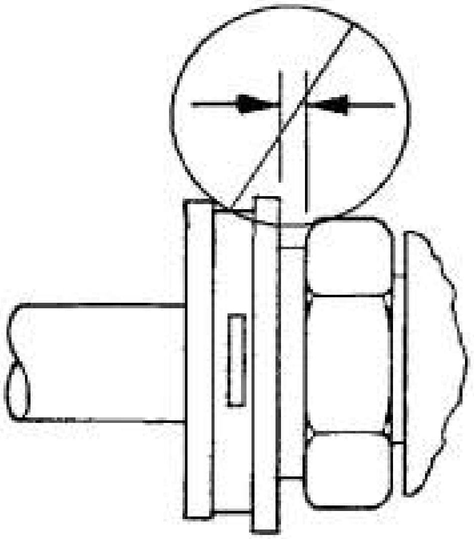


8. Do not use the plastic cap on the cooler line in order to install the cooler line into the fitting.
9. Pull back sharply on the cooler line in order to make sure that the cooler line is fastened into the quick connect fitting.

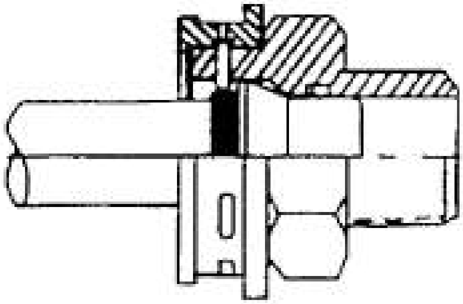


Important: Do not manually depress the retaining clip when installing the plastic cap.

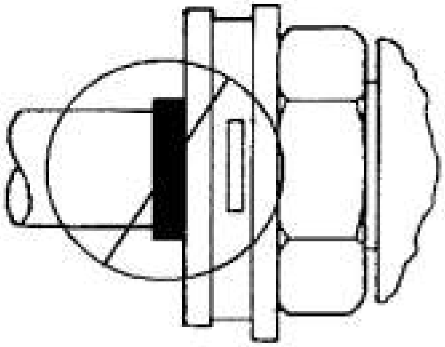
10. Position (snap) the plastic cap onto the fitting. Do not manually depress the retaining ring when installing the plastic cap onto the quick connect fitting.
11. Make sure that the plastic cap is fully seated against the fitting.



12. Make sure that no gap is present between the cap and the fitting.



13. Make sure that the yellow identification band on the tube is hidden within the quick connect fitting.



14. A hidden yellow identification band indicates proper joint seating.
15. Fill the transmission to the proper level with DEXRON® VI transmission fluid. Refer to Transmission Fluid Check.

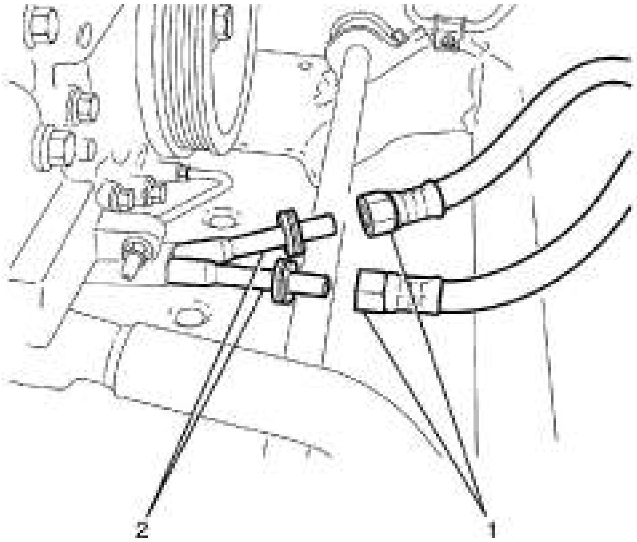
Transmission Fluid Cooler Hose/Pipe Replacement

Tools Required

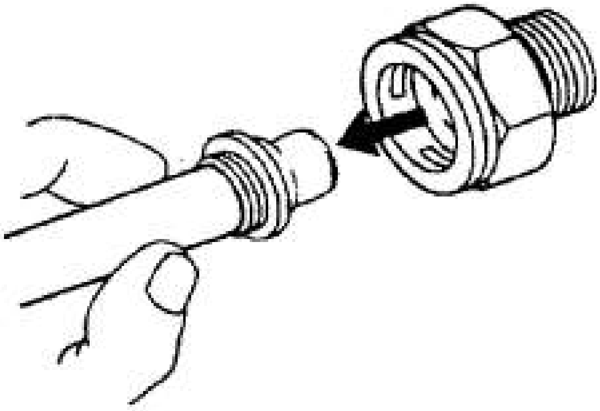
J 44827 Transmission Cooler Quick Disconnect

Removal Procedure

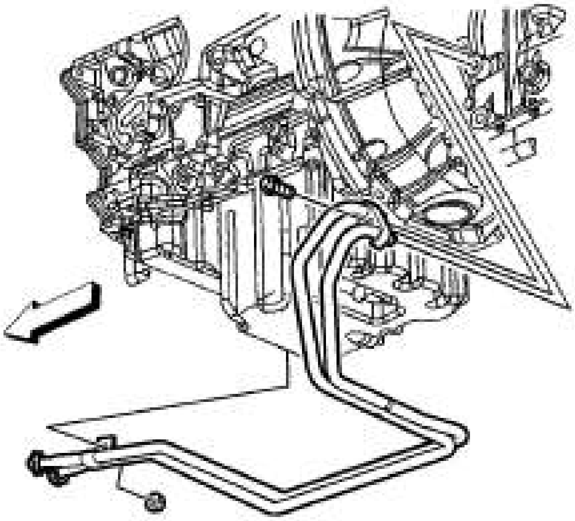
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the front air deflector. Refer to Front Air Deflector Replacement .



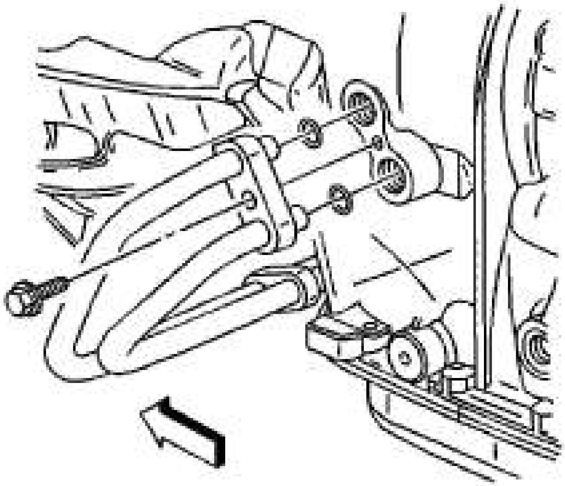
3. Place an oil drain pan under the transmission fluid cooler pipes (1&2) near the radiator.



4. Disconnect the transmission fluid cooler pipes from the transmission fluid cooler by using the J 44827 .

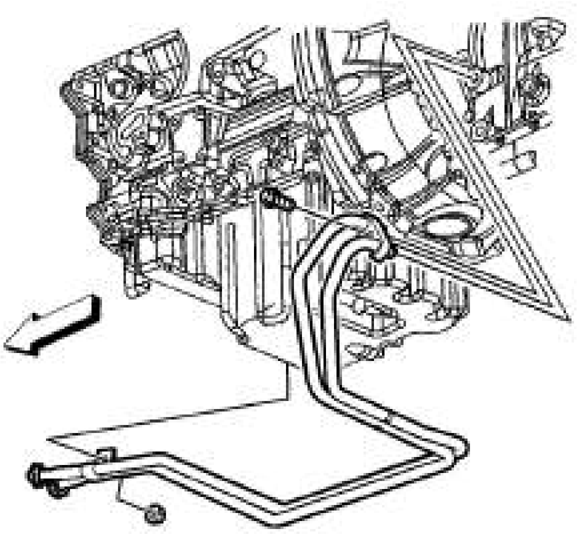


5. Remove the transmission fluid cooler pipes bracket retaining bolt.

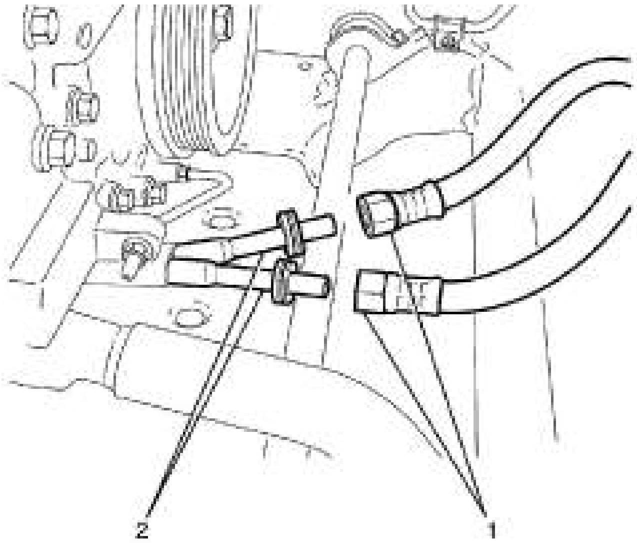


6. Remove the transmission fluid cooler pipes retaining bolt.
7. Remove the transmission fluid cooler pipes.
8. Remove and discard the O-rings. Do not reuse the O-rings.

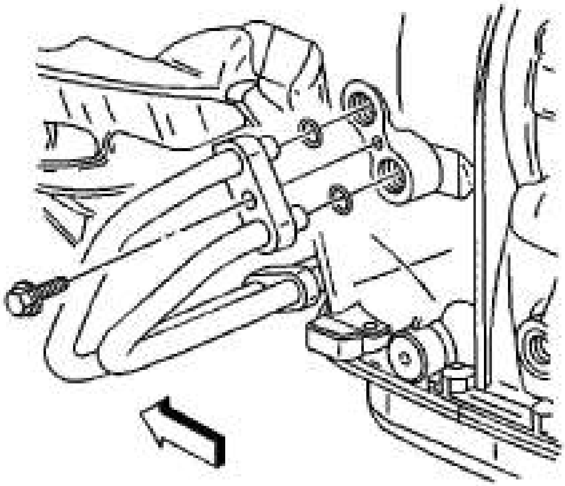
Installation Procedure



1. Install the transmission fluid cooler pipe.



2. Connect the transmission fluid cooler pipes (1&2) to the transmission fluid cooler using the following steps:
    2.1. Push the transmission fluid cooler pipes into the quick connect fitting, until a "audible click" is heard.
    2.2. Tug gently on the transmission cooler pipes to make sure the trans cooler pipes are fully connected.

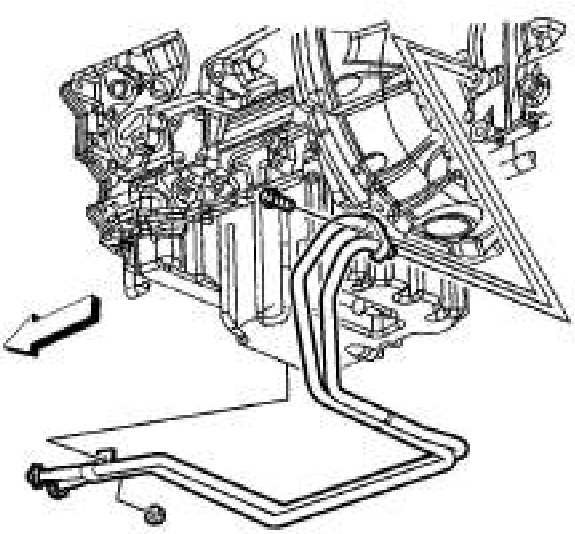


3. Install NEW sealing washers over the transmission fluid cooler pipes.
4. Install the transmission fluid cooler pipes into the transmission.

   Notice: Refer to Fastener Notice in the Preface section.

5. Install the transmission fluid cooler pipe retaining bolt.

   Tighten
   Tighten the transmission fluid cooler pipe retainer bolt to 25 N·m (18 lb. ft).



6. Install the transmission fluid cooler pipes bracket retaining bolt.

Tighten

Tighten the transmission fluid cooler pipes bracket bolt to 50 N·m (37 lb. ft).

7. Install the front air deflector. Refer to Front Air Deflector Replacement .
8. Lower the vehicle.
9. Inspect the transmission fluid level. Refer to Transmission Fluid Check .
10. Inspect for fluid leaks.

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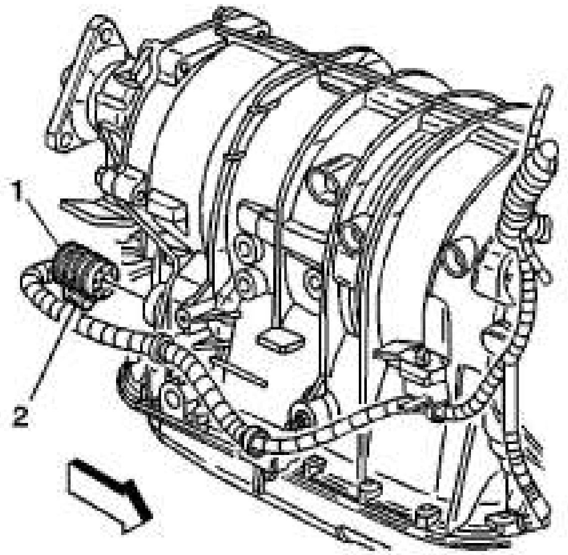
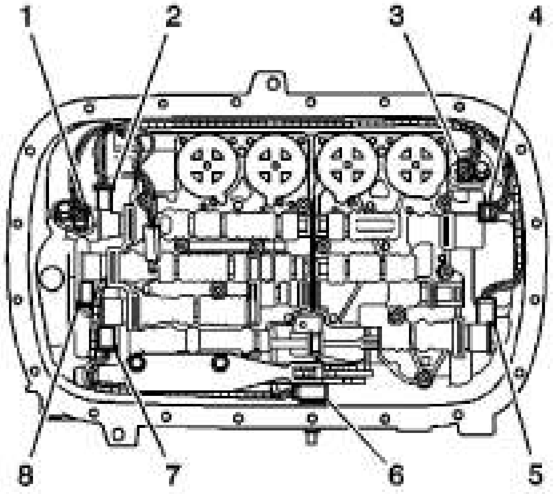
Transmission Internal Electrical Harness Replacement

Removal Procedure

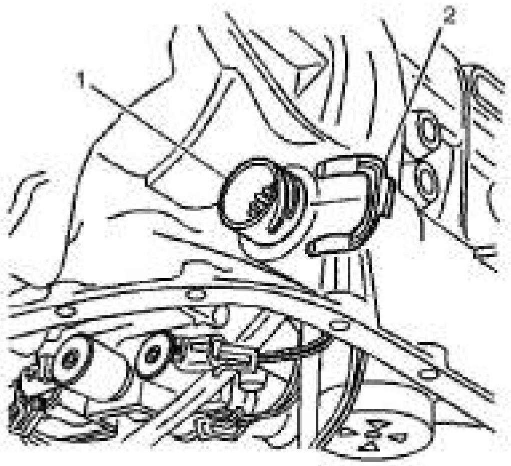
1. Remove the Transmission fluid pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement.



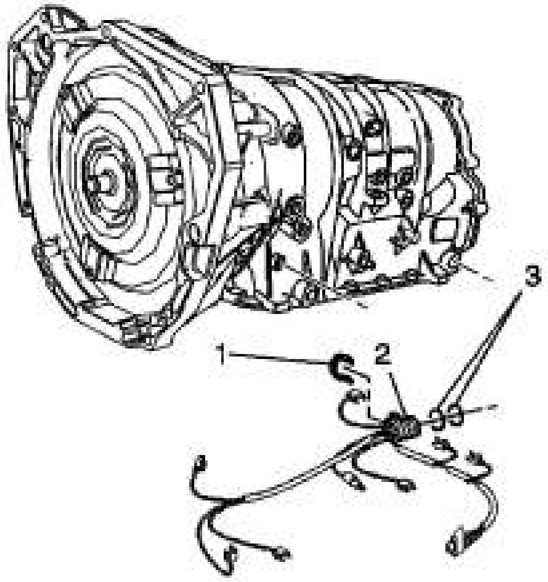
2. Disconnect the transmission wiring harness electrical connector (1) from the transmission by rotating the locking latch (2) counterclockwise.



3. Disconnect the transmission internal wiring harness from components (1-8).

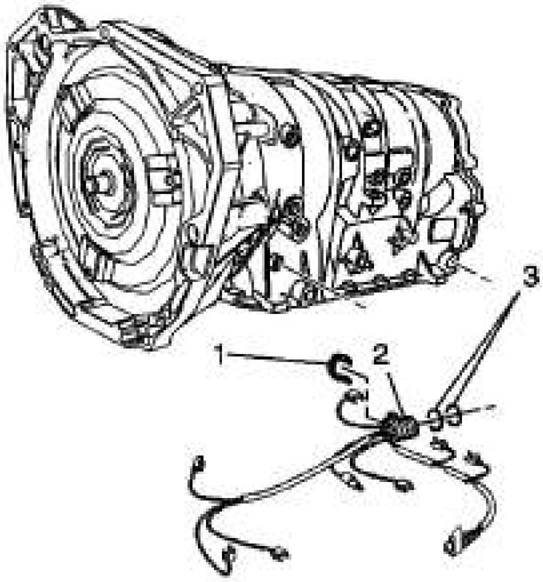


4. Remove the transmission internal wiring harness retainer (2) from the transmission internal wiring harness (1).

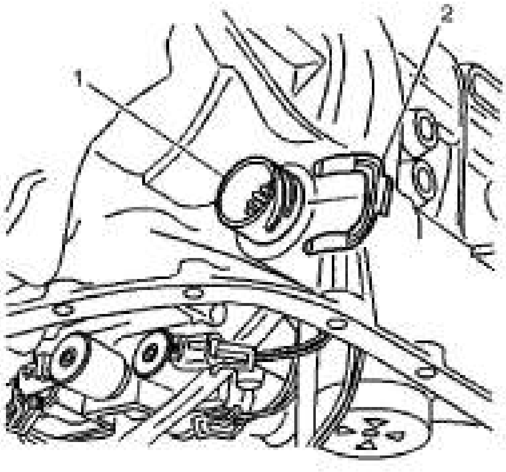


5. Remove the transmission internal wiring harness (2) from the transmission.
6. Remove the O-ring seals (3) from the internal wiring harness (2) only if the O-rings are cut or worn.

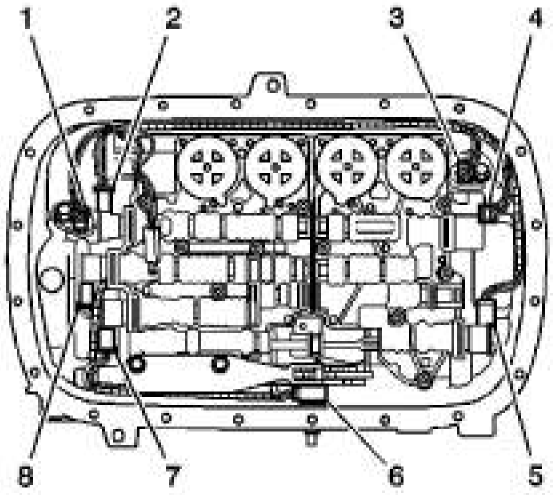
Installation Procedure



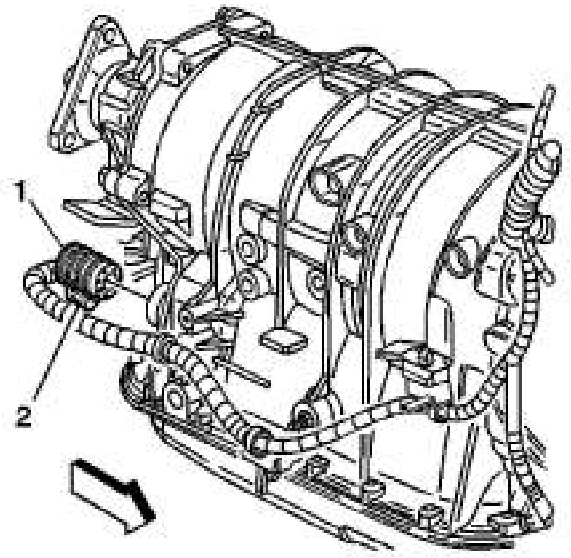
1. Install the internal wiring harness (2) to the transmission.



2. Install the transmission internal wiring harness retainer (2) to the internal wiring harness (1).



3. Connect the transmission internal wiring harness to components (1-8).



4. Connect the transmission wiring harness electrical connector (1) to the transmission by rotating the locking latch (2) clockwise.
5. Install the Transmission fluid pan and filter. Refer to Automatic Transmission Fluid and Filter Replacement.

Important: It is recommended that transmission adaptive pressure (TAP) information be reset.

Resetting the TAP values using a scan tool will erase all learned values in all cells. As a result, The ECM or TCM will need to relearn TAP values. Transmission performance may be affected as new TAP values are learned.

6. Reset the TAP values. Refer to Transmission Adaptive Functions.

Transmission Mount Inspection

Notice: In order to avoid oil pan damage and possible engine failure, insert a block of wood that spans the width of the oil pan bottom between the oil pan and the jack support.

1. Raise the transmission/transaxle in order to remove the weight from the transmission/transaxle mount and create slight tension in the rubber.
2. Observe the transmission/transaxle mount while raising the transmission/transaxle. Replace the transmission/transaxle mount if the transmission/transaxle mount exhibits any of the following conditions:

   Important: Black paint on the rubber will crack with time, this does no constitute a failure.

   - The hard rubber surface is covered with heat check cracks.
   - The rubber is separated from the metal plate of the transmission/transaxle mount.
   - The rubber is split through the centre of the transmission/transaxle mount.
3. If there is movement between the metal plate of the transmission/transaxle mount and its attaching points, lower the transmission/transaxle on the transmission/transaxle mount. Tighten the retaining bolts or nuts attaching the transmission/transaxle mount to the frame or transmission/transaxle mount bracket.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 5L40-E/5L50-E | Repair Instructions - On Vehicle | **Document ID: 2006929**

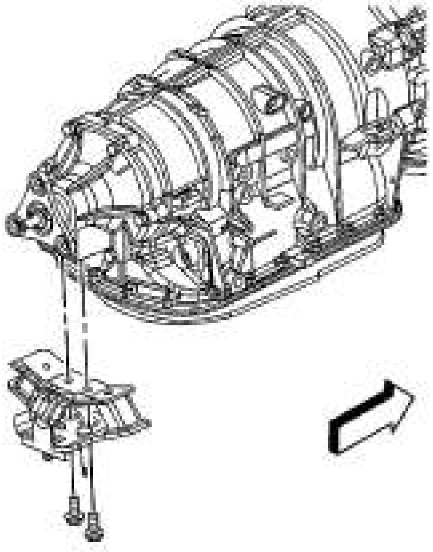
Transmission Rear Mount Replacement

Removal Procedure

1. Remove the exhaust system. Refer to Exhaust System Replacement.

   Important: The engine mounts must NOT bend or deflect from the vertical position, damage to the mount will occur.

2. Support the transmission with a suitable jack and a block of wood.
3. Remove the transmission support. Refer to Transmission Support Replacement.



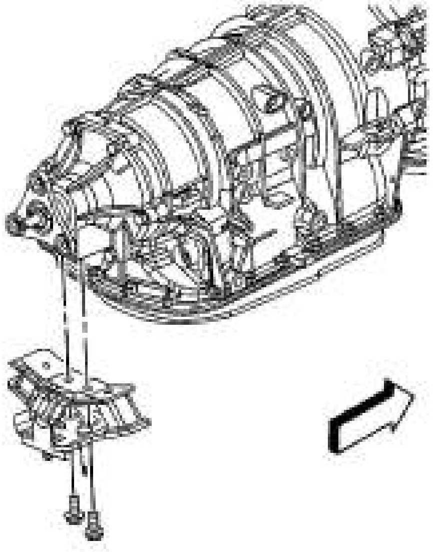
4. Remove the transmission mount retaining bolts.
5. Remove the transmission mount from the vehicle.

Installation Procedure

Important: The engine mounts must NOT bend or deflect from the vertical position, damage to the mount will occur.

1. Install the transmission mount to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the transmission mount retaining bolts.

   Tighten
   Tighten the bolts to 60 N·m (44 lb. ft).

3. Install the transmission support. Refer to Transmission Support Replacement.
4. Remove the jack and block of wood.
5. Install the exhaust system.
6. Lower the vehicle.

Transmission Replacement

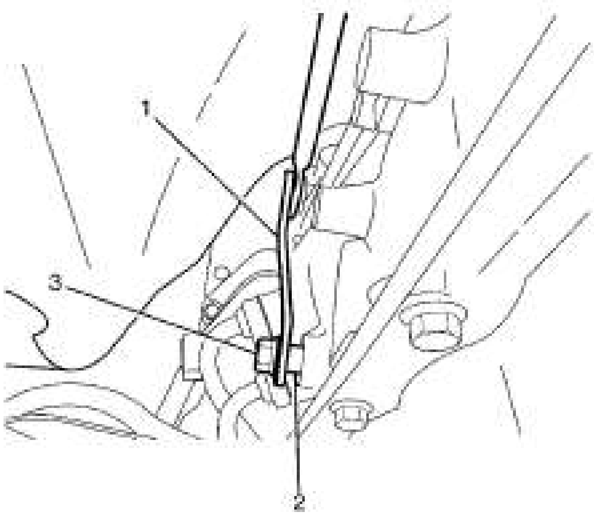
Tools Required

EN-48536 Frame Support Tool (Engine Lower 65mm Kit)

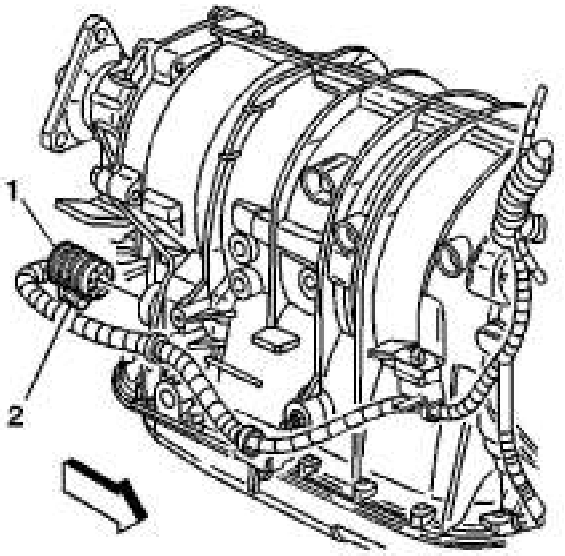
Removal Procedure

Important: NEW torque converter retaining bolts will be required each time the torque converter bolts are removed.

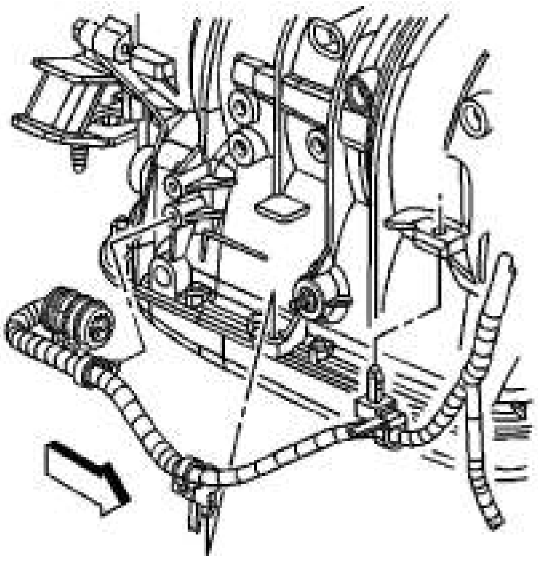
1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Remove engine air intake ducting.
3. Remove radiator retaining clips.
4. Disconnect the evap purge pipe.
5. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle.
6. Remove the propeller shaft. Refer to Propeller Shaft Replacement.
7. Remove the air deflector front (1). Refer to Front Air Deflector Replacement.
8. Remove the splash shield.



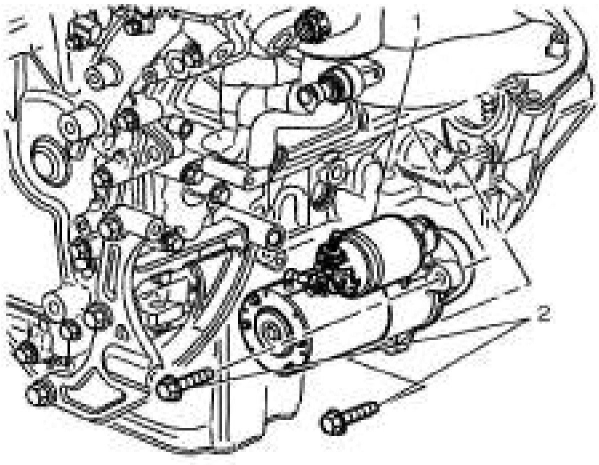
9. Remove the transmission manual shift shaft retaining nut (3).
10. Disconnect the shift linkage (1) from the transmission.



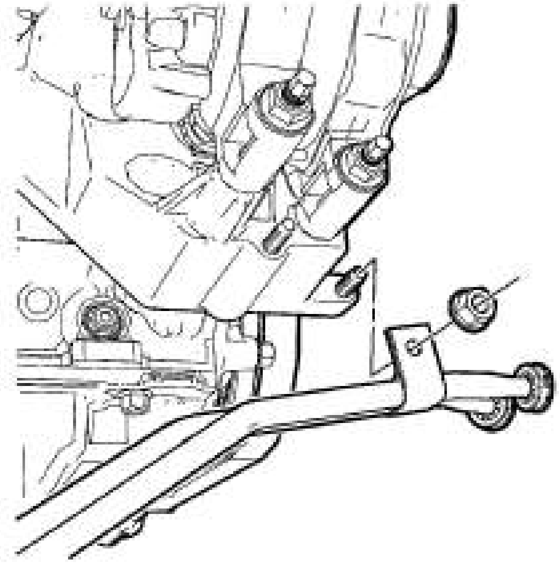
11. Disconnect the transmission wiring harness connector (1) from the transmission by rotating the locking latch (2) counter clockwise.



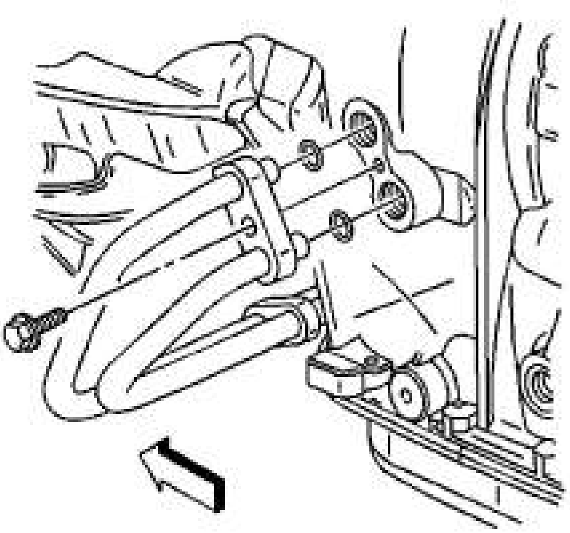
12. Disconnect the wiring harness clips from the transmission, and position the wiring harness aside.



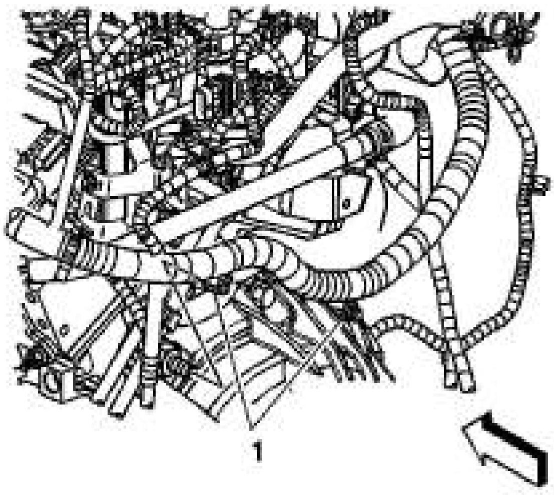
13. Remove the starter motor to gain access to the torque converter bolts. Refer to Starter Motor Replacement.
14. Mark the torque converter to flexplate/flywheel orientation to make sure proper realignment.
15. Repeat the following steps for all 3 torque converter bolts:
    15.1. Rotate the harmonic balancer centre bolt clockwise ONLY, in order to align the torque converter bolt with the starter motor opening in the engine block.
    15.2. Remove and discard the torque converter bolt. The bolt is self locking and is NOT reusable.
16. Using inspection hole push torque converter back towards transmission pump
17. Place an oil drain pan under the transmission fluid cooler pipes.



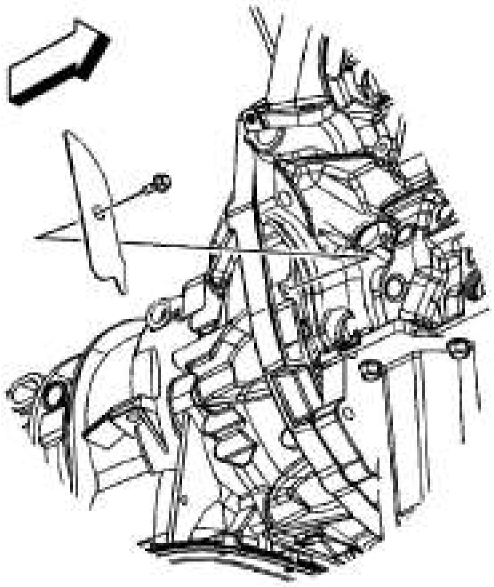
18. Remove the bolt securing the transmission fluid cooler pipes brace to the engine.



19. Disconnect the fluid cooler pipes from the transmission.
20. Plug the open outlet ports to prevent fluid loss and contamination.



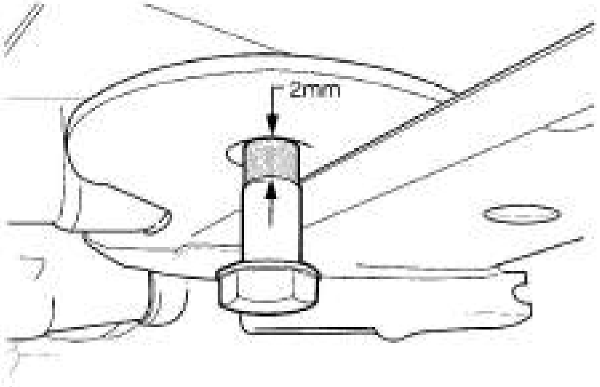
21. Disconnect the engine wiring harness retaining clips (1) to the transmission mounting bolts.
22. Disconnect the steering shaft from the steering rack.



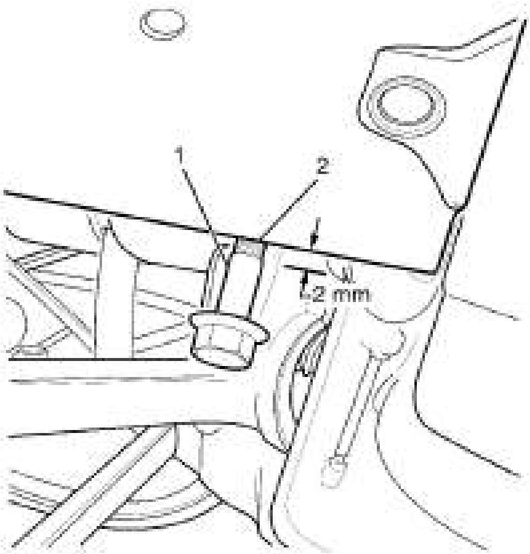
23. Remove the engine close out cover.

Important: The engine mounts must NOT bend or deflect from the vertical position, damage to the mount will occur.

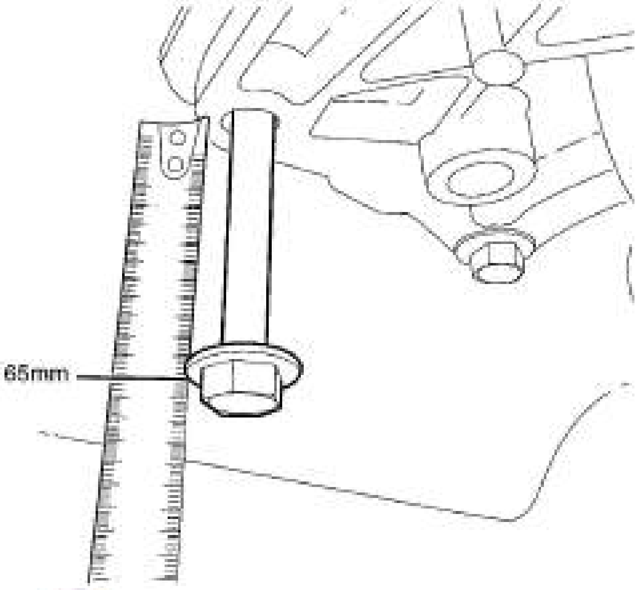
24. Support the power train with a suitable jack or table.



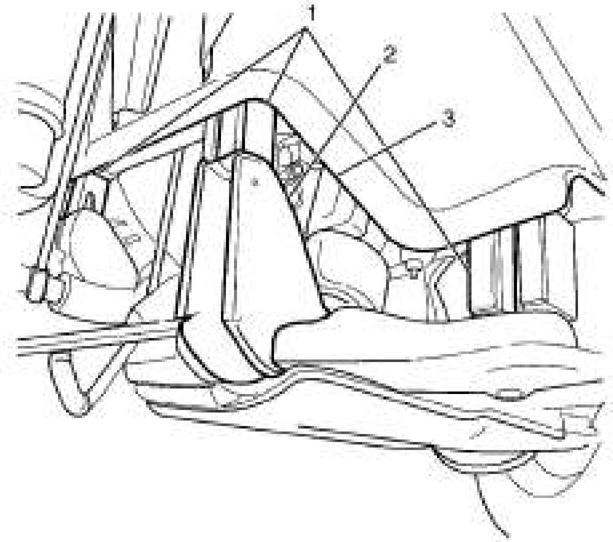
25. Remove the front sub frame rear retaining bolts and fit bolts from special tool kit EN-48536
26. Install bolt till stepped shank (1) is 2mm below sub frame (2).



27. Remove the front sub frame front retaining bolts and fit bolts from special tool kit EN-48536
28. Install bolt till stepped shank (1) is 2mm below chassi rail flange (2).



29. Remove all four transmission mount to body retaining bolts and install two bolts from special tool kit in diagonal holes e.g Left hand front and Right hand rear.
30. Install the bolts until 65mm is measured between the bolt heads (1) and transmission mount (2).
31. Remove the front sub frame middle bolts.
32. Lower the power train slowly until the subframe and transmission mount are resting on bolts.



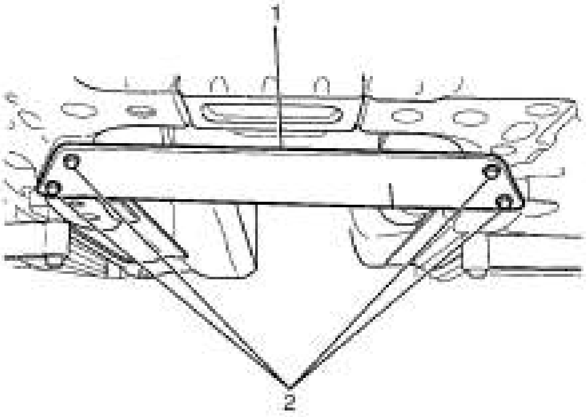
33. Insert the 65mm spacer blocks (1) between the subframe (2) and chassis rails (3).
34. Tension the front sub frame front and rear bolts.

    Tighten
    Tighten the bolts to 95 N·m (70 lb. ft).

35. Install and tension the middle sub frame bolts.

    Tighten
    Tighten the bolts to 95 N·m (70 lb. ft).

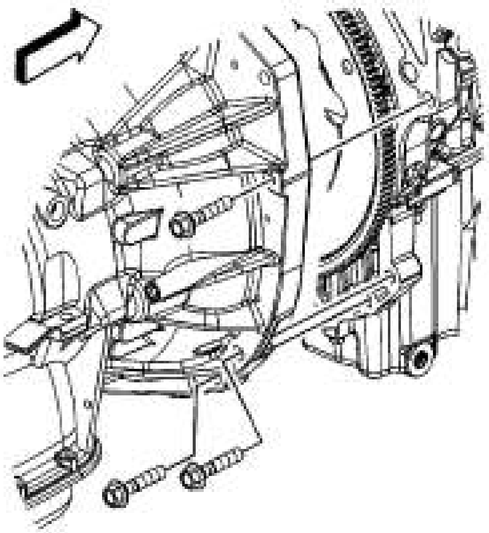
36. Remove the supporting jack or table



37. Install engine support plate (1) to the front sub frame.

38. install the engine support plate retaining bolts (2).

    Tighten
    Tighten the bolts to 10 N·m (89 lb. in).



39. Remove the transmission retaining bolts.
40. Pull the transmission free from the engine dowels.

    Important: Ensure clearance is maintained between the transmission and the following:
    - The catalytic converters
    - The wiring harnesses
    - The cooler pipes
    - The propeller shaft

41. Carefully lower the transmission from the vehicle.
42. Flush the transmission oil cooler. Refer to Transmission Fluid Cooler Flushing and Flow Test.

Installation Procedure

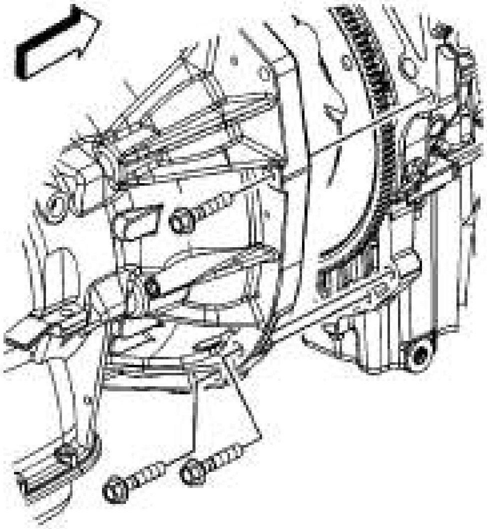
Important: The engine mounts must NOT bend or deflect from the vertical position, damage to the mount will occur.

Important: Ensure clearance is maintained between the transmission and the following:
- The catalytic converters
- The wiring harnesses
- The cooler pipes
- The propeller shaft

1. Using the transmission jack, carefully raise the transmission to the vehicle.

2. Align the transmission with the engine dowels.

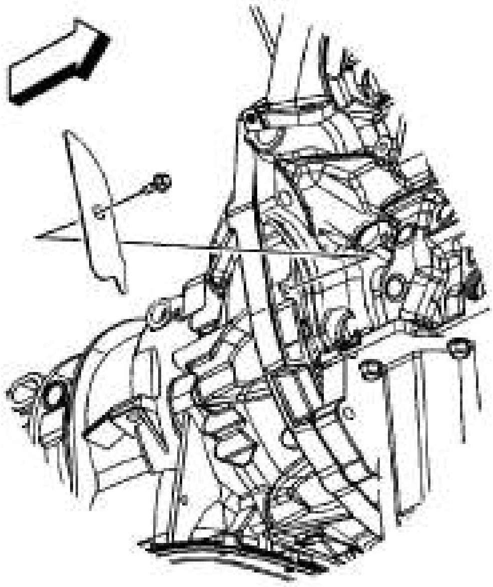
   Notice: Refer to Fastener Notice in the Preface section.



3. Install the right hand side transmission retaining bolts.

   Tighten
   Tighten the bolts to 50 N·m (37 lb. ft).

4. Install the remaining transmission retaining bolts.



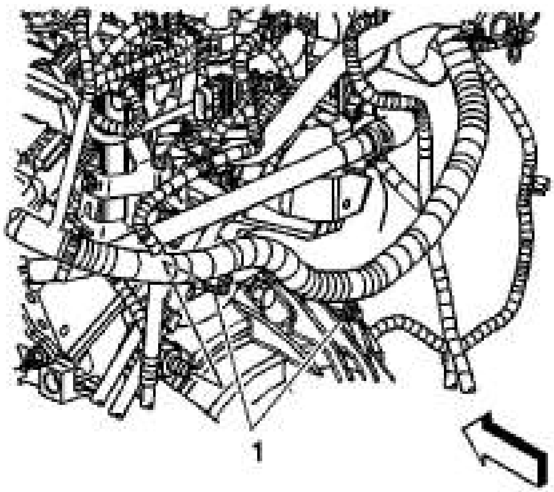
5. Install the engine close out cover.

Tighten
Tighten the studs to 10 N·m (89 lb. in).

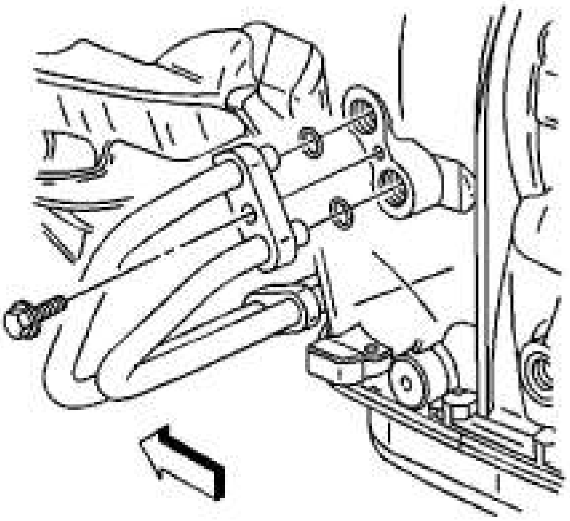
6. Remove the engine and transmission lowering blocks and engine balance plate.
7. Raise the powertrain back up into the engine bay and install the front sub frame bolts.

Tighten
Tighten the front sub frame bolts to 160 N·m (118 lb. ft.).

Tighten
Tighten the transmission support to under body retaining bolt to 63 N·m (46 lb ft).



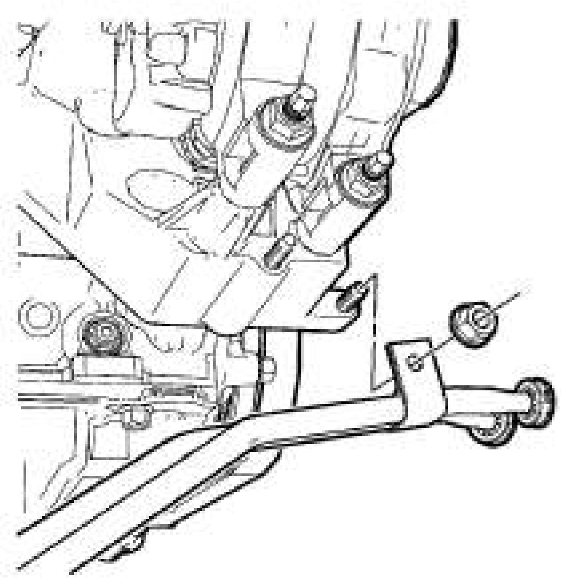
8. Connect the engine wiring harness retaining clips (1) to the transmission mounting bolts.
9. Install the steering shaft to the steering rack.



Important: Replace the O-rings seals if cracked, cut, or distorted.

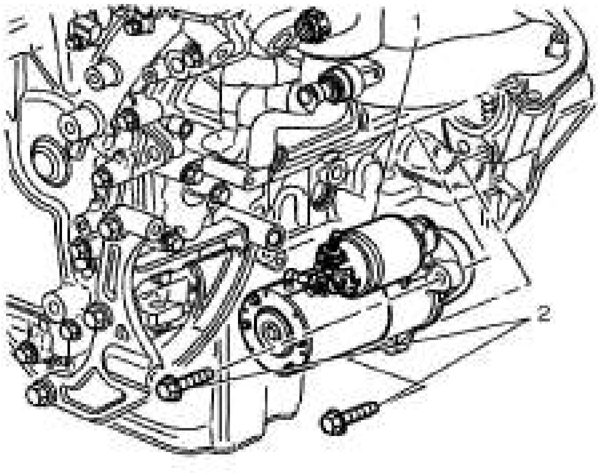
10. Lubricate the O-rings seals with automatic transmission fluid.
11. Install the O-rings seals onto the cooler pipes prior to inserting the cooler pipes into the transmission.
12. Insert the transmission fluid cooler pipes into the transmission.
13. Install the bolt securing the transmission fluid cooler pipe retainer to the transmission.

Tighten
Tighten the bolt to 25 N·m (18 lb. ft).



14. Install the bolt securing the transmission fluid cooler pipes brace to the engine.

Tighten
Tighten the bolt to 50 N·m (37 lb. ft).



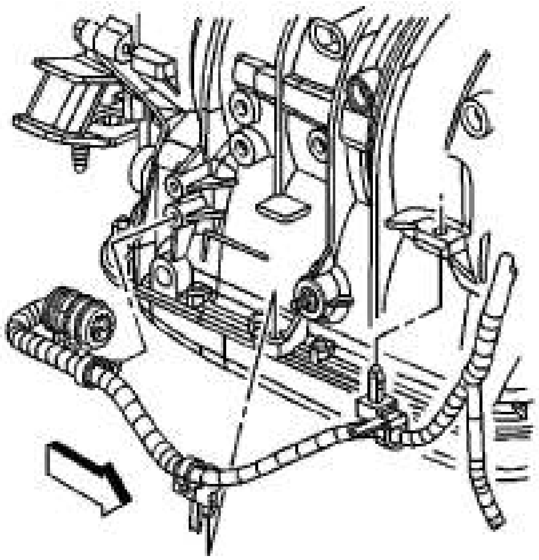
15. Align the torque converter to flexplate/flywheel orientation marks made during the removal procedure.

    Important: Torque converter bolts are self locking and must be replaced with NEW torque converter bolts every time the bolts are removed.

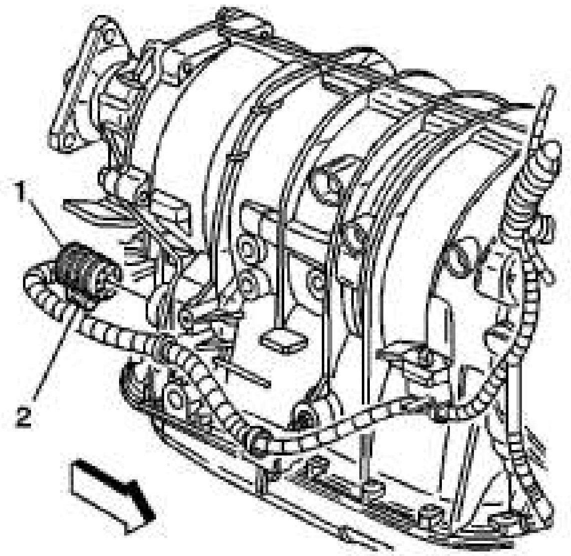
16. Repeat the following steps for all 3 torque converter bolts:
    - 16.1. Rotate the harmonic balancer centre bolt clockwise ONLY, in order to align the torque converter bolt holes in the flexplate/flywheel with the starter motor opening in the engine block.
    - 16.2. To aid in alignment of the torque converter to the flexplate/flywheel. Install all 3 NEW torque converter retaining bolts before fully tightening.

    Tighten
    Tighten the bolts to 63 N·m (46 lb. ft).

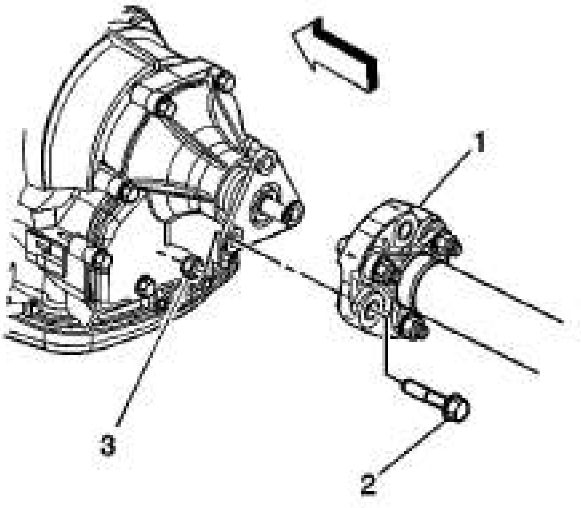
17. Install the starter motor. Refer to Starter Motor Replacement.
18. Install the air deflector front (1). Refer to Front Air Deflector Replacement.



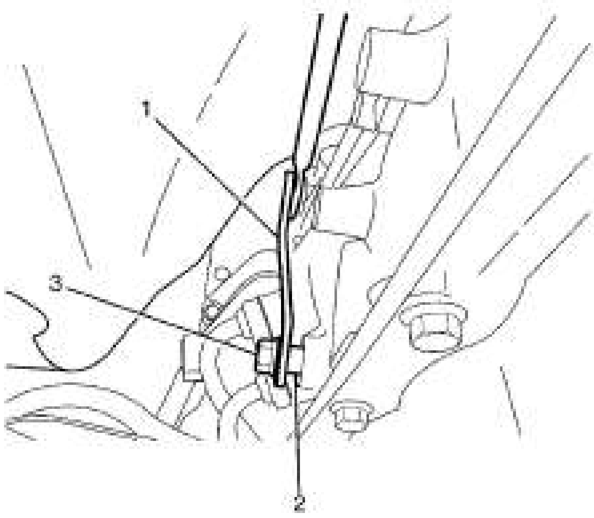
19. Connect the wiring harness clips to the transmission.



20. Connect the transmission wiring harness connector (1) to the transmission by rotating the locking latch (2) clockwise.



21. Install the propeller shaft coupler (1) to the transmission flange. Refer to Propeller Shaft Replacement.



22. Place the transmission in the park position by rotating the shift shaft (2) fully counter clockwise.
23. Connect the shift linkage (1) to the transmission.
24. Install the transmission manual shift shaft retaining nut (3).

    Tighten
    Tighten the nut to 15 N·m (11 lb. ft).

25. Check the transmission fluid level (fill if necessary). Refer to Transmission Fluid Check.
26. Adjust the shift control linkage. Refer to Shift Control Linkage Adjustment.
27. Lower the vehicle.

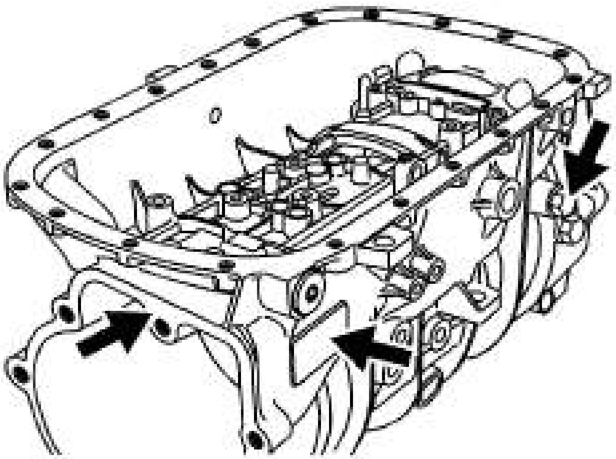
28. Connect the evap purge pipe.
29. Install radiator retaining clips
30. Install air intake ducting from engine
31. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
32. The transmission control module must be programmed with the proper software/calibrations. Refer to Control Module References.

Transmission Final Test and Inspection

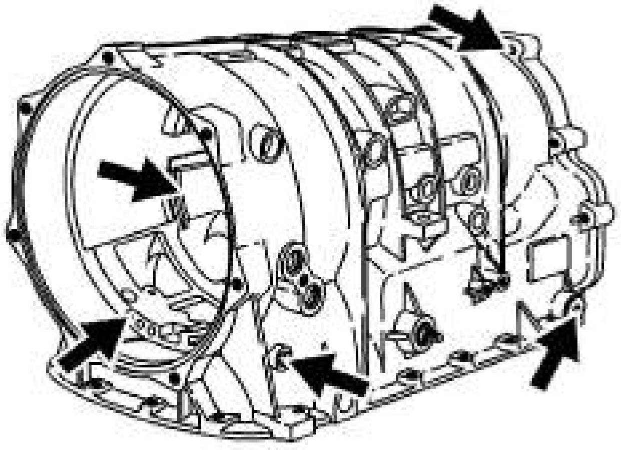
Complete the following procedure after the transmission is installed in the vehicle:

1. With the ignition OFF or disconnected, turn the engine by hand several times. Listen for any unusual noises or evidence that any parts are binding.
2. Start the engine and listen for abnormal sounds.
3. While the engine continues to idle raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
4. Inspect for fluid leaks while the engine is idling.
5. Lower the vehicle.
6. Perform a final inspection for the proper fluid level.
7. Road test the vehicle.

Case Assembly Inspection



1. Inspect the components that are still on the transmission case for the following conditions:
   - Loose, cross-threaded, or damaged threads on the transmission oil cooler fittings
   - A loose, missing, or damaged transmisssion name plate

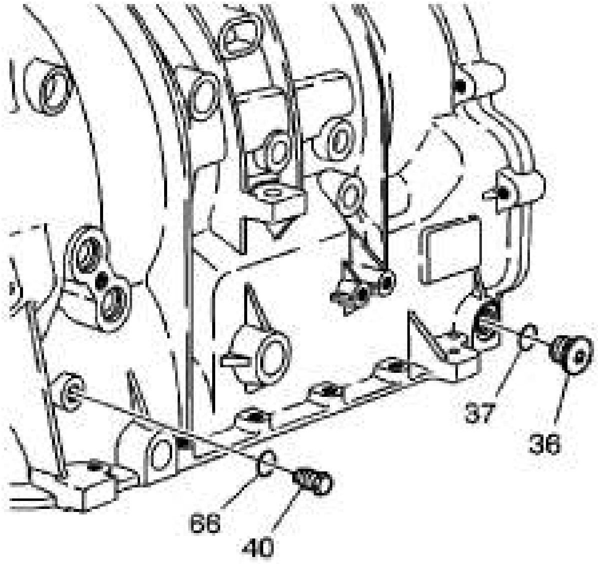


2. Inspect the transmission case for the following conditions:
   - Gasket sealing surfaces that are damaged or have porosity

- Bolt and screw holes that are stripped or damaged - repair with thread insert
- Damaged or porous case and fluid passages
- Damaged snap ring grooves or housing splines
- A loose, cross threaded, or damaged pressure test plug and fluid level hole plug

Case Components Assemble

Notice: Refer to Fastener Notice in the Preface section.



Important: If the pressure test plug (40), O-ring (66), level hole plug (36) and O-ring (37) are not damaged, they should be reused.

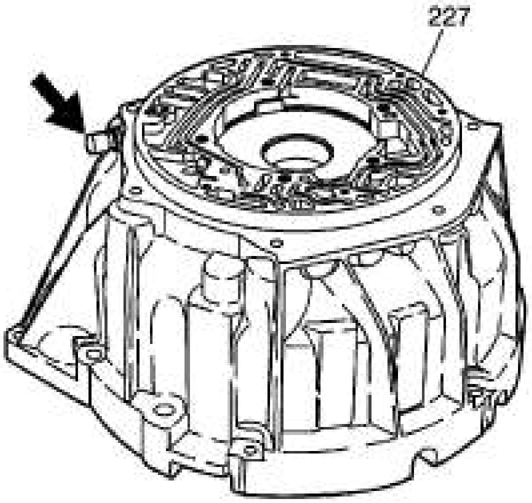
1. Inspect the pressure test hole plug (40) and O-ring seal (66) for damage.
2. Install the pressure test plug (40) and O-ring seal (66).

   Tighten
   Tighten the pressure test plug to 11N·m (8 lb. ft).

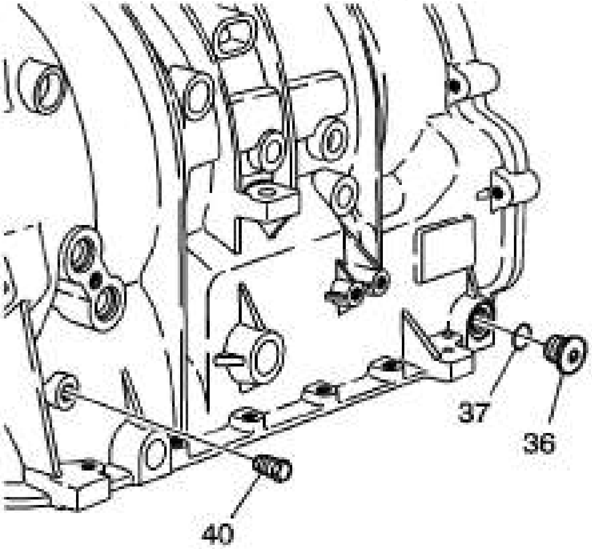
3. Inspect the fluid level hole plug (36) and O-ring seal (37) for damage.
4. Install the transmission fluid level hole plug O-ring seal (37) and the transmission fluid level hole plug (36).

   Tighten
   Tighten the level hole plug to 20N·m (15 lb. ft).

Case Components Disassemble



1. Inspect the transmission vent assembly for damage or being plugged. If the vent is damaged the torque converter housing (227) must be replaced.

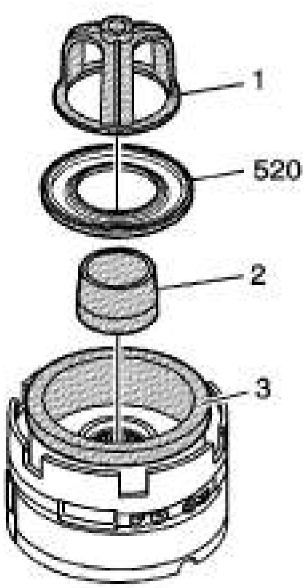


2. Remove the pressure test plug (40).
3. Remove the fluid level hole plug (36) and fluid level hole plug o-ring seal (37) from the case (604).

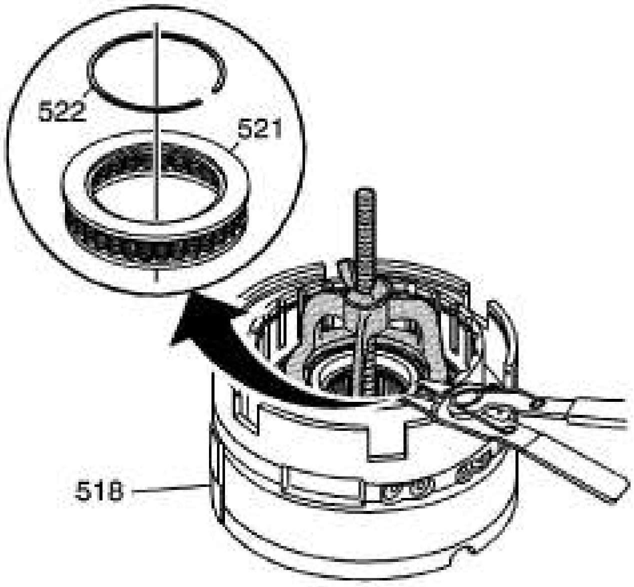
Center Support Assemble

Tools Required

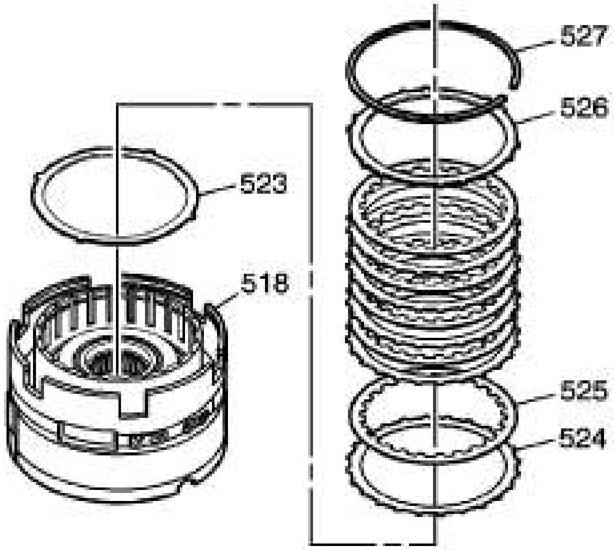
- J 23327 Clutch Spring Compressor
- J 45127 Centre Support Removal Tool
- J 45136 Seal Protector
- J 45140 Seal Protector
- J-45688 Piston Installer - Pusher
- J 46239-1 Second Coast Clutch Outer Protector
- J 46239-2 Second Coast Clutch Inner Protector
- J 46239-3 Second Coast Clutch Pusher
- J-46240-1 Seal Protector
- J 46240-2 Seal Protector



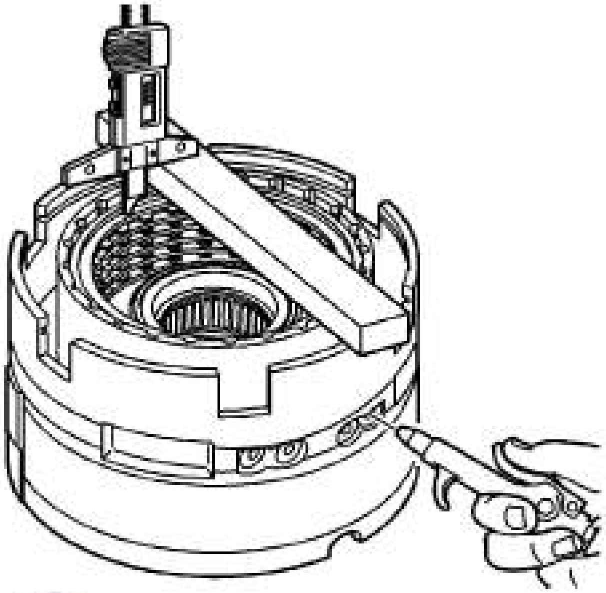
1. Inspect the centre support components for the following:
   - Plugged fluid passages
   - Worn or damaged splines
   - Worn or damaged pistons
   - Worn or damaged clutch plates
2. Install J-46240-1 (2), and J 45145 (3) into the centre support housing.



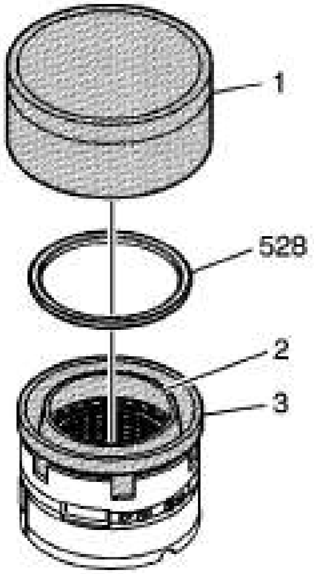
3. Install the 2nd clutch piston.
4. Install the 2nd clutch piston spring (521) into the centre support (518).
5. Use J 23327 to compress the 2nd clutch piston spring (521).
6. Install the 2nd clutch spring retainer ring (522) into the centre support (518).
7. Remove J 23327 from the centre support (518).



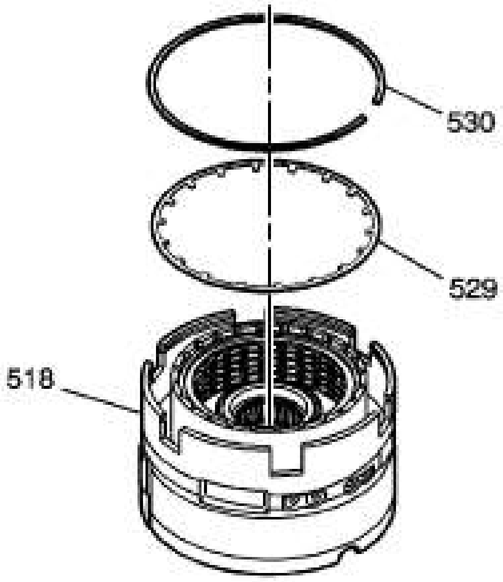
8. Install the 2nd clutch apply plate (523) into the centre support (518).
9. Install the 2nd clutch plates. Start by installing the 2nd clutch plate (524) with external splines. Alternate with the 2nd clutch plate (525) with internal splines. Refer to Clutch Plate Selection Specifications.
10. Install the 2nd clutch backing plate (526) into the centre support (518).
11. Install the 2nd clutch backing plate snap ring (527) into the centre support (518).



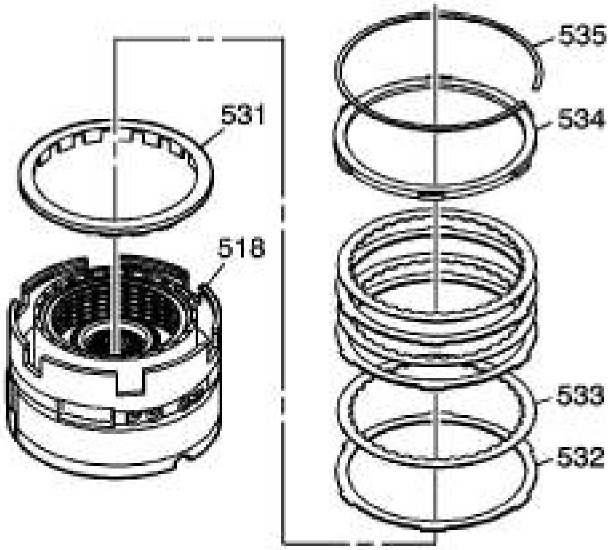
12. Measure the distance between the 2nd clutch backing plate and the bottom of the gage bar. Measure three times in different locations on the backing plate. Record this as H1.
13. Apply 65 PSI (448.17 kPa) of air pressure to the specified port. Measure the distance between the 2nd clutch backing plate and the bottom of the gage bar. Measure three times in different locations on the backing plate. Record this as H2.
14. Subtract H2 from H1 this is the 2nd clutch pack travel. Refer to Clutch Piston Travel Specifications.



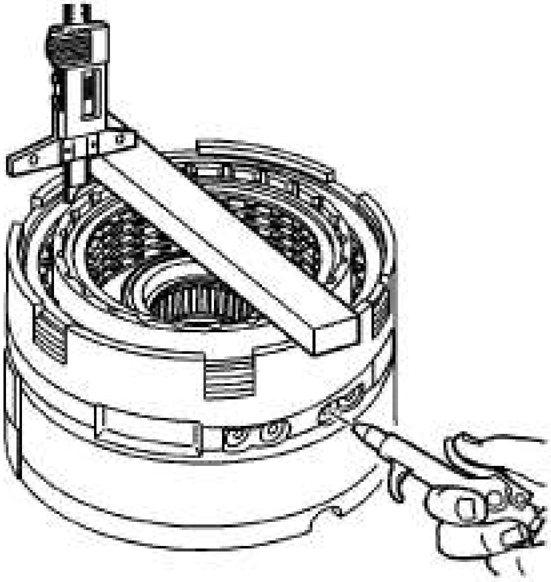
15. Using J 46239-1 (3), J 46239-2 (2) and J 46239-3 (1), install the 2nd coast clutch piston (528).



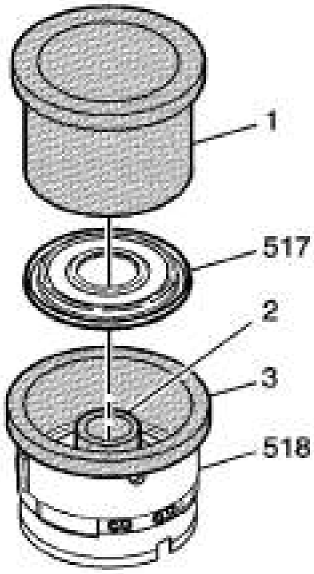
16. Install the 2nd coast clutch spring (529).
17. Using J 23327 compress the 2nd coast clutch spring (529).
18. Install the 2nd coast clutch spring retainer (530).
19. Remove J 23327 .



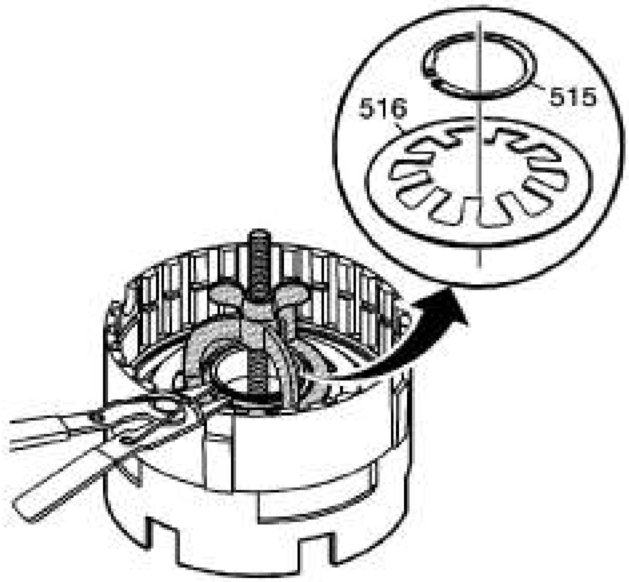
20. Install the 2nd coast clutch spacer (531).
21. Install the 2nd coast clutch plates. Starting with the 2nd coast clutch plate (532) with external splines. Alternate with the 2nd coast clutch plate (533) with internal splines. Refer to Clutch Plate Selection Specifications.
22. Install the 2nd coast clutch backing plate (534).
23. Install the 2nd coast clutch backing plate snap ring (535).



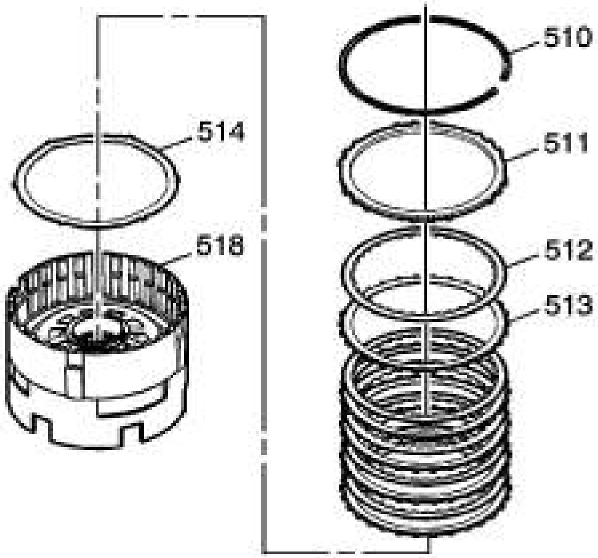
24. Measure the distance between the 2nd coast clutch backing plate and the bottom of the gage bar. Measure three times in different locations on the backing plate. Record this as H1.
25. Apply 65 PSI (448.17 kPa) of air pressure to the specified port. Measure the distance between the 2nd coast clutch backing plate and the bottom of the gage bar. Measure three times in different locations on the backing plate. Record this as H2.
26. Subtract H2 from H1 this is the 2nd coast clutch pack travel. Refer to Clutch Piston Travel Specifications.



27. Use the J-46240-1 (2), J-45688 (1) and the J 45136 (3) to install the low and reverse clutch piston (517) into the centre support (518).



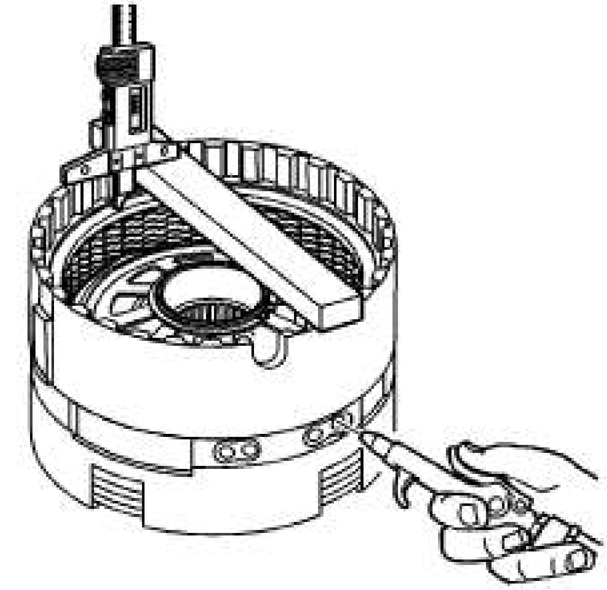
28. Use J 23327 , compress the low and reverse clutch piston spring (516).
29. Install the low and reverse clutch spring snap ring (515) into the centre support (518).



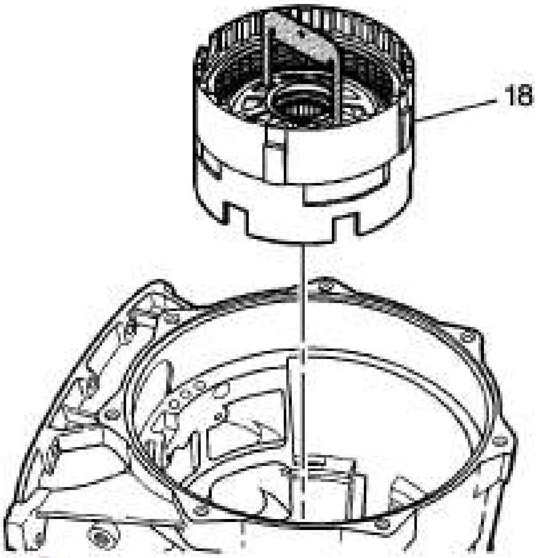
30. Install the low and reverse clutch plates. Start with the low and reverse clutch plate (513) with external splines. Alternate with the low and reverse clutch plate (512) with internal splines. Refer to Clutch Plate Selection Specifications.

    Install the low and reverse apply plate (514) into the centre support (518).

31. Install the low and reverse clutch backing plate (511) and the snap ring (510).



32. Measure the distance between the low and reverse clutch backing plate and the bottom of the gage bar. Measure three times in different locations on the backing plate. Record this as H1.
33. Apply 65 PSI (448.17 kPa) of air pressure to the specified port. Measure the distance between the low and reverse clutch backing plate and the bottom of the gage bar. Measure three times in different locations on the backing plate. Record this as H2.
34. Subtract H2 from H1 this is the low reverse clutch pack travel. Refer to Clutch Piston Travel Specifications.



35. Using J 45127 install the centre support (18) into the case.

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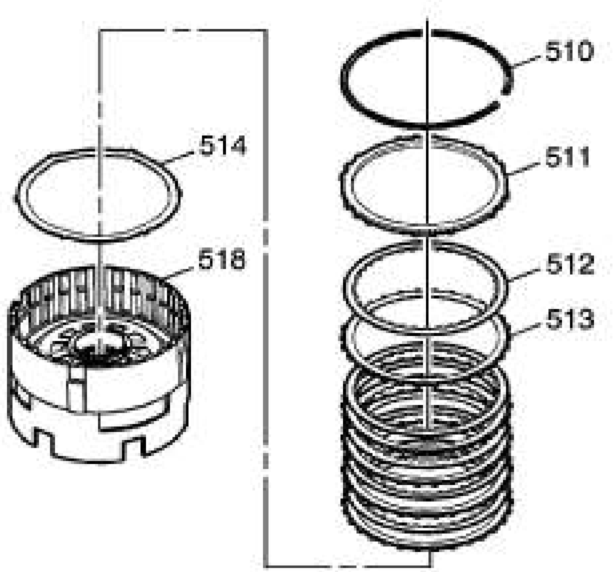
Center Support Disassemble

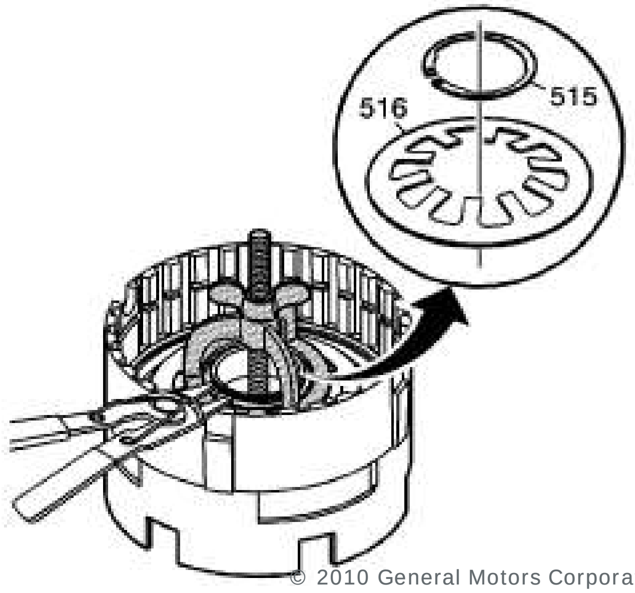
Caution: Refer to General Repair Instructions in the Preface section.

Tools Required

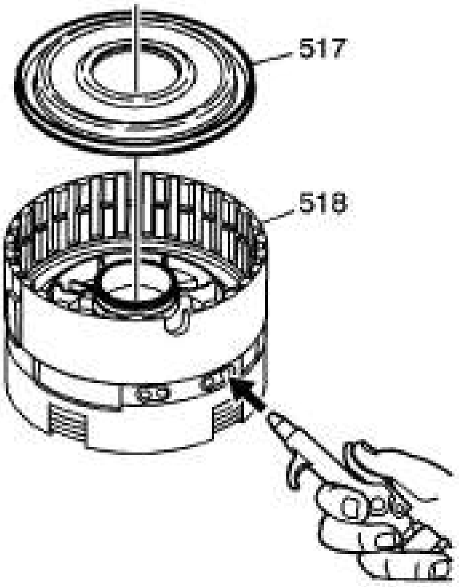
J 23327 Clutch Spring Compressor



1. Remove the snap ring (510).
2. Remove the low and reverse backing plate (511).
3. Remove the clutch plates (512 and 513). Refer to Clutch Plate Selection Specifications.
4. Remove the low and reverse apply plate (514).

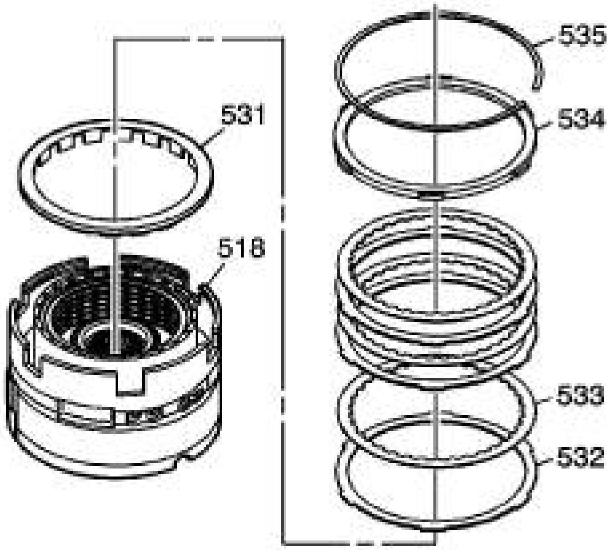


5. Use J 23327 to compress the low and reverse clutch spring (516).
6. Remove the low reverse clutch snap ring (515).
7. Remove J 23327 from the centre support.
8. Remove the clutch spring (516) from the centre support.



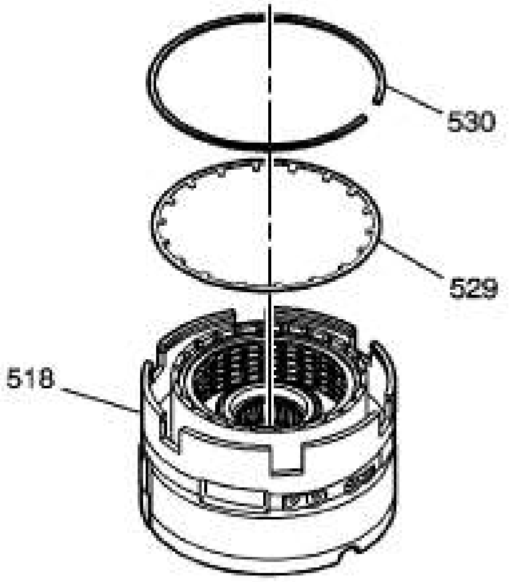
Important: It may be necessary to use air pressure to remove the piston.

9. Remove the low and reverse piston (517) from the centre support (518).

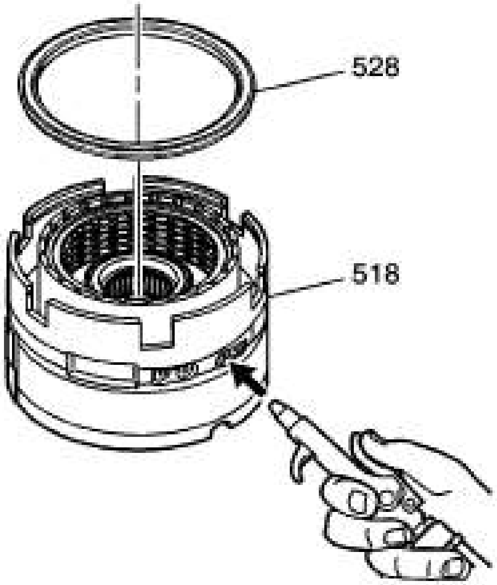


10. Remove the 2nd coast clutch plate snap ring (535) from the centre support (518).
11. Remove the 2nd coast clutch backing plate (534) from the centre support (518).
12. Remove the clutch plates (532 and 533). Refer to Clutch Plate Selection Specifications.

13. Remove the 2nd coast clutch spacer (531) from the centre support (518).

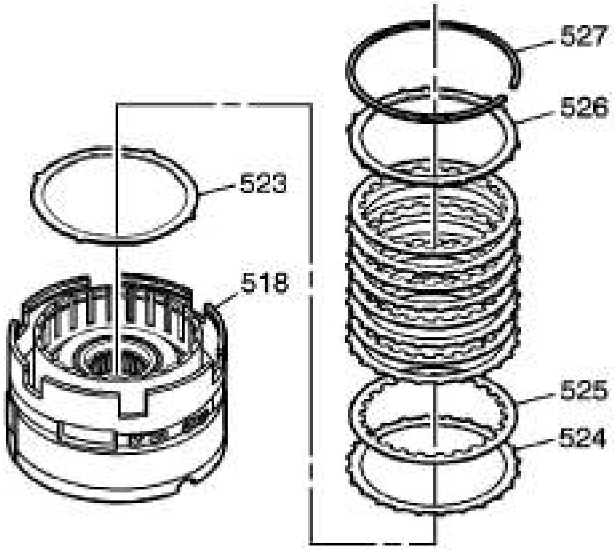


14. Remove the 2nd coast clutch snap ring retainer (530).
15. Remove the 2nd coast clutch spring (529) from the centre support (518).

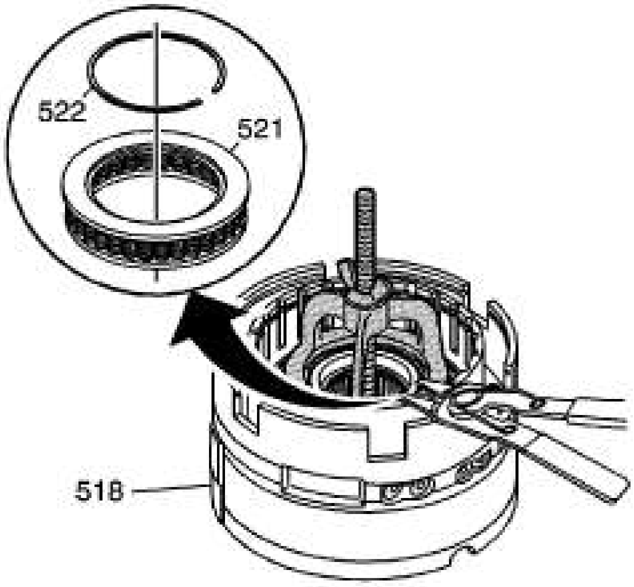


Important: It may be necessary to use air pressure to remove the piston.

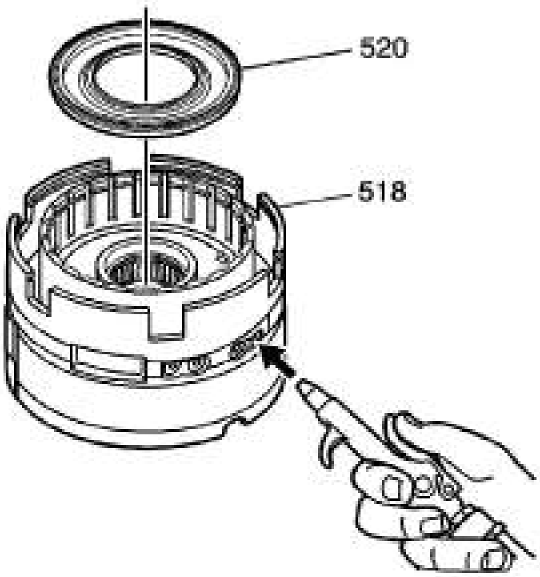
16. Remove the 2nd coast clutch piston (528) from the centre support (518).



17. Remove the snap ring (527) from the centre support (518).
18. Remove the 2nd clutch backing plate (526) from the centre support (518).
19. Remove the clutch plates (524 and 525) from the centre support (518). Refer to Clutch Plate Selection Specifications.
20. Remove the 2nd clutch apply plate (523) from the centre support (518).



21. Use J 23327 to compress the 2nd clutch piston spring (521).
22. Remove the snap ring (522) from the centre support (518).
23. Remove the J 23327 from the center support (518).
24. Remove the 2nd clutch piston spring (521) from the centre support (518).



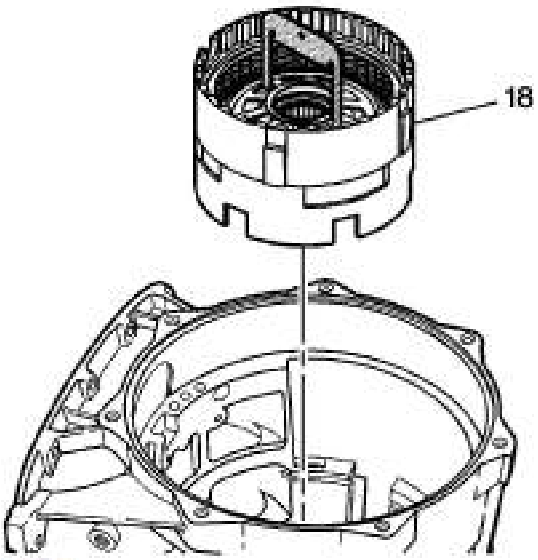
Important: It may be necessary to use air pressure to remove the piston.

25. Remove the 2nd clutch piston (520) from the centre support (518).

Center Support Removal

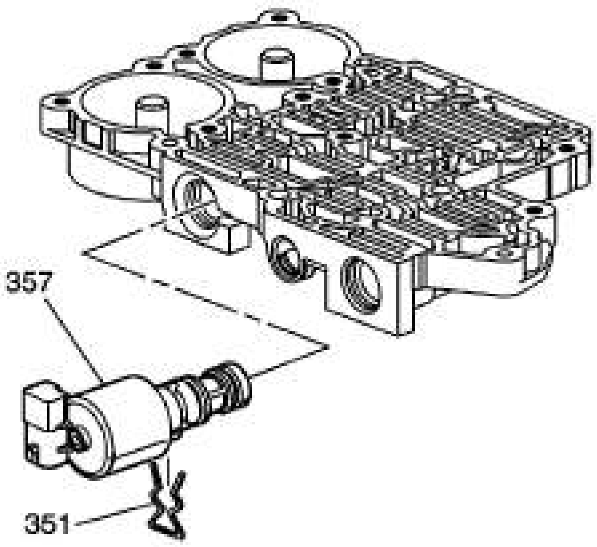
Tools Required

J 45127 Centre Support Removal Tool

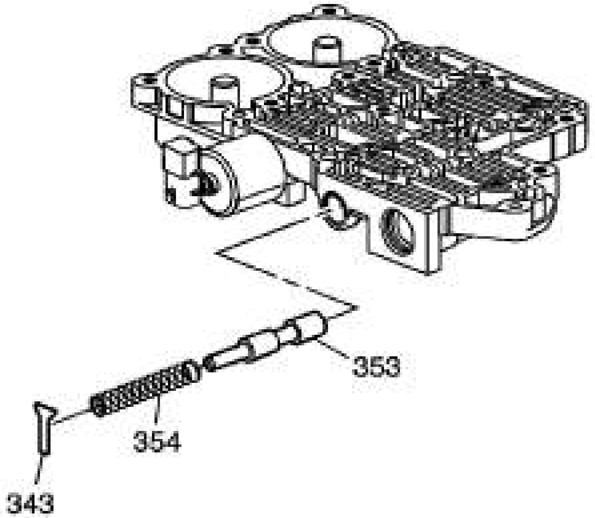


Use J 45127 to remove the centre support (18) from the case.

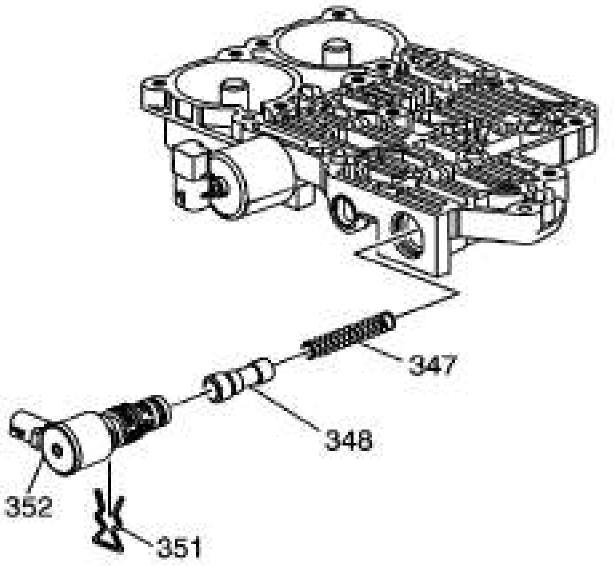
Control Valve Body Accumulator Assembly Assemble



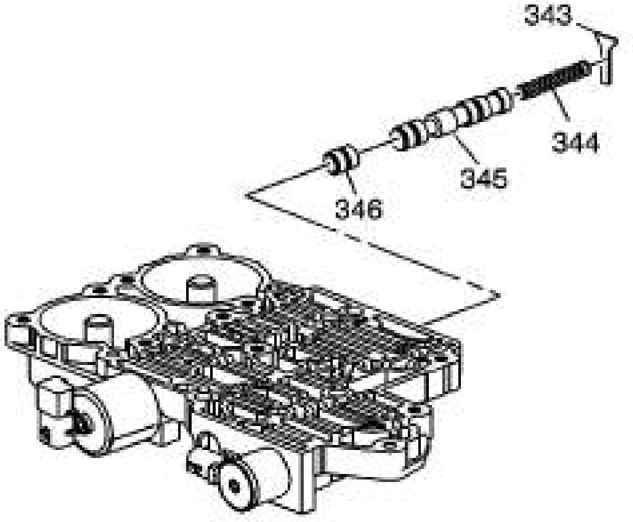
1. Install the pressure control solenoid (357).
2. Install the pressure control solenoid retainer (351).



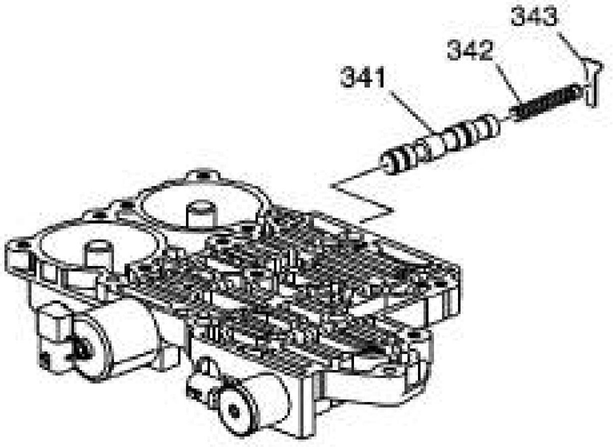
3. Install the feed limit valve (353).
4. Install the feed limit valve spring (354).
5. Install the feed limit valve retainer (343).



6. Install the tcc pwm solenoid valve spring (347).
7. Install the tcc regulator apply valve (348).
8. Install the tcc pwm solenoid (352).
9. Install the tcc pwm solenoid retainer (351).

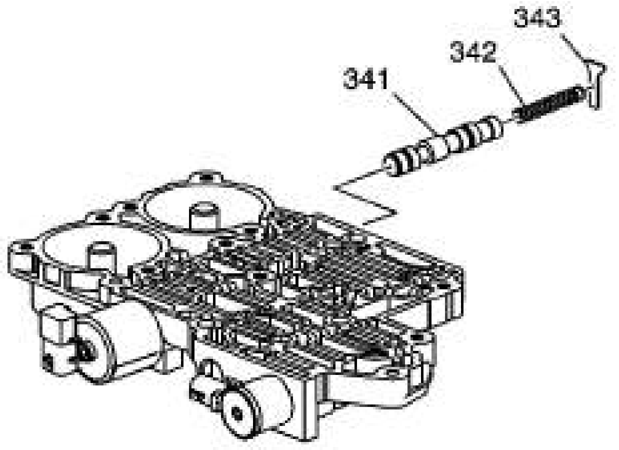


10. Install the 3-4 shift control valve (346).
11. Install the 3-4 shift valve (345).
12. Install the 3-4 shift valve spring (344).
13. Install the 3-4 shift control valve retainer (343).

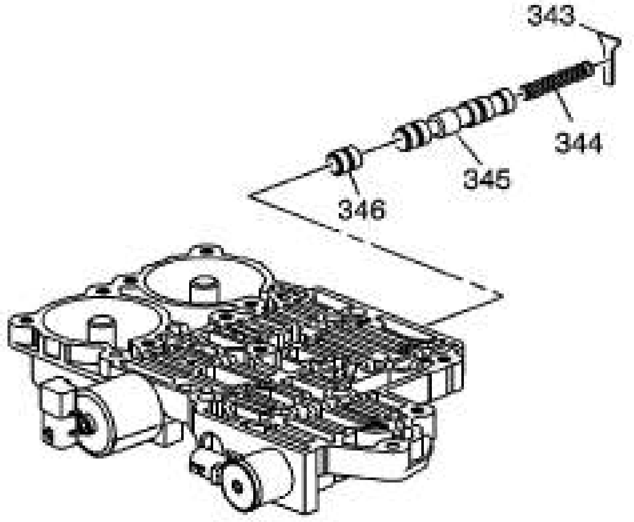


14. Install the safety mode valve (341).
15. Install the safety mode valve spring (342).
16. Install the safety mode valve retainer (343).

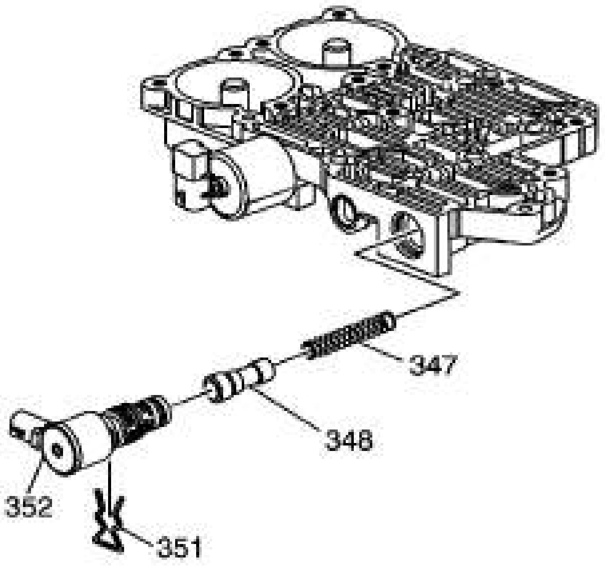
Control Valve Body Accumulator Assembly Disassemble



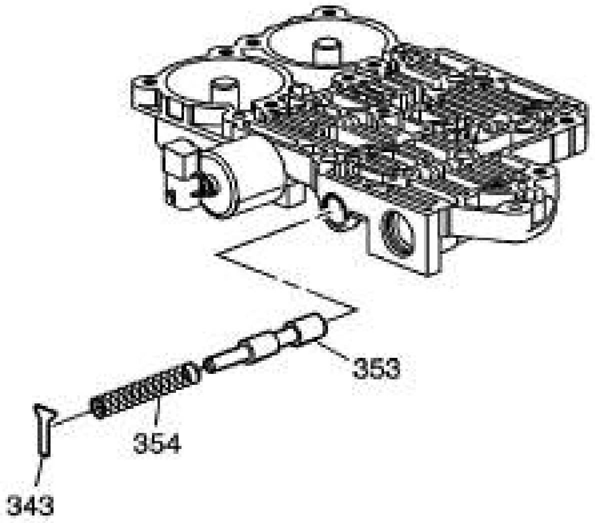
1. Remove the safety mode valve retainer (343).
2. Remove the safety mode valve spring (342).
3. Remove the safety mode valve (341).



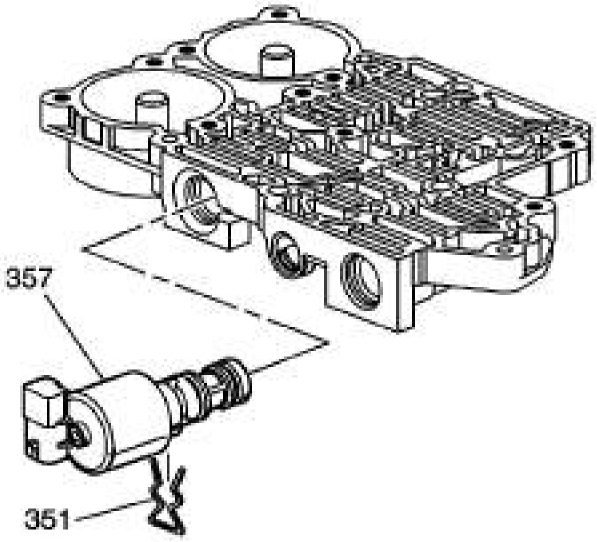
4. Remove the 3-4 shift valve retainer (343).
5. Remove the 3-4 shift valve spring (344).
6. Remove the 3-4 shift valve (345).
7. Remove the 3-4 shift control valve (346).



8. Remove the torque converter clutch (TCV) pulse width modulated (PWM) solenoid valve retainer (351).
9. Remove the tcc pwm solenoid (352).
10. Remove the tcc regulator apply valve (348).
11. Remove the tcc regulator apply valve spring (347).



12. Remove the feed limit valve retainer (343).
13. Remove the feed limit valve spring (354).
14. Remove the feed limit valve (353).



15. Remove the pressure control solenoid retainer (351).
16. Remove the pressure control solenoid (357).

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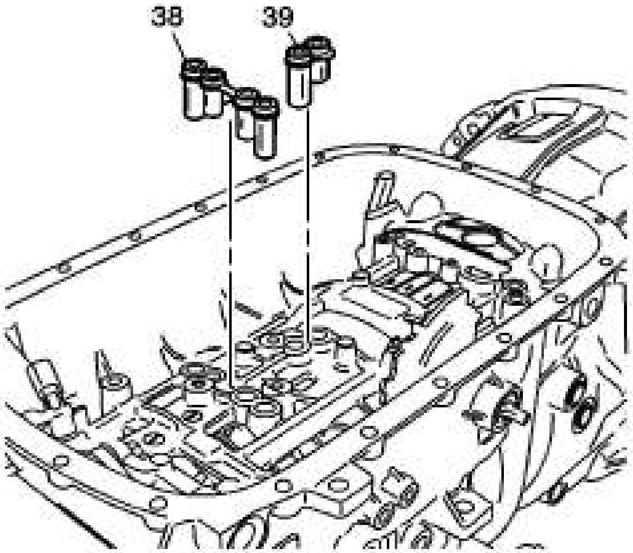
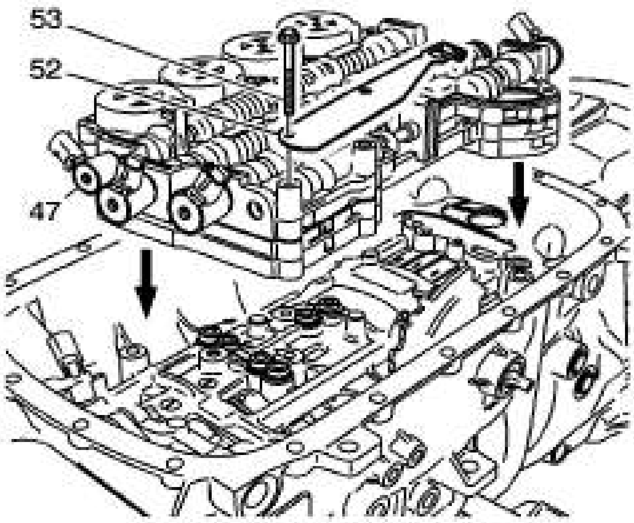
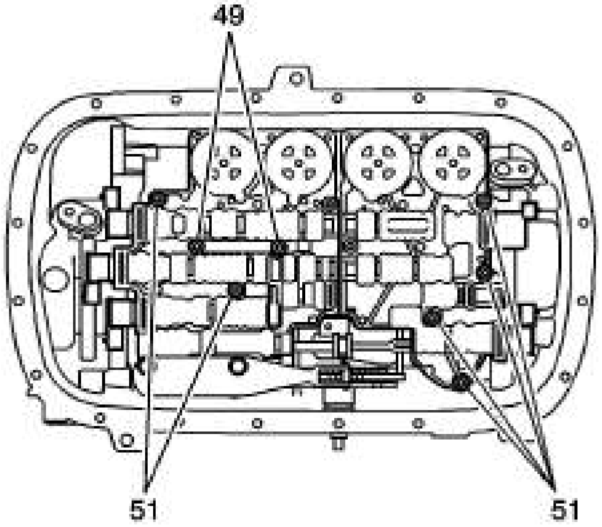
Control Valve Body Accumulator Assembly Installation



1. Install the NEW overdrive clutch fluid passage sleeve (39) into the case.
2. Install the NEW centre support fluid passage sleeve (38) into the case.

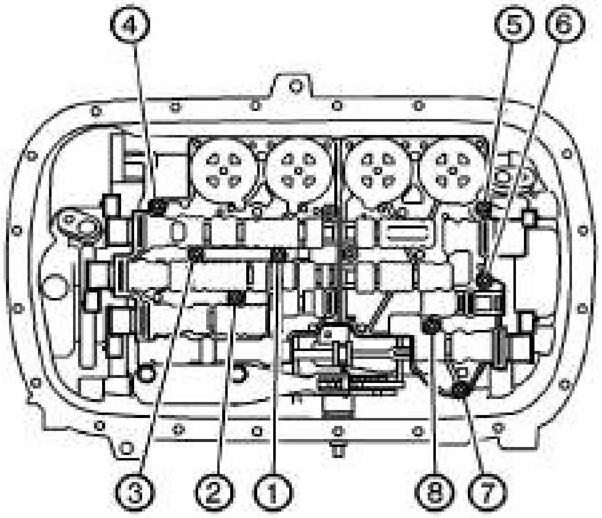


3. Install the control valve body accumulator assembly (47) onto the case.
4. Install the detent lever spring (52) onto the case.
5. Install the control valve body retaining bolts (53) into the case and hand tighten.



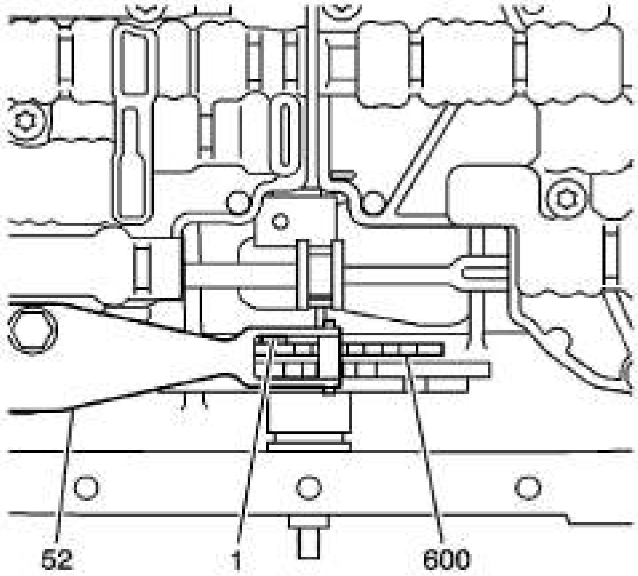
6. Install the control valve body accumulator assembly bolts (49, 51) into the case and hand tighten.

   Notice: Refer to Fastener Notice in the Preface section.



7. Tighten the control valve body accumulator retaining bolts in sequence.

   Tighten
   Tighten the control valve body accumulator bolts to 11 N·m (8 lb. ft).

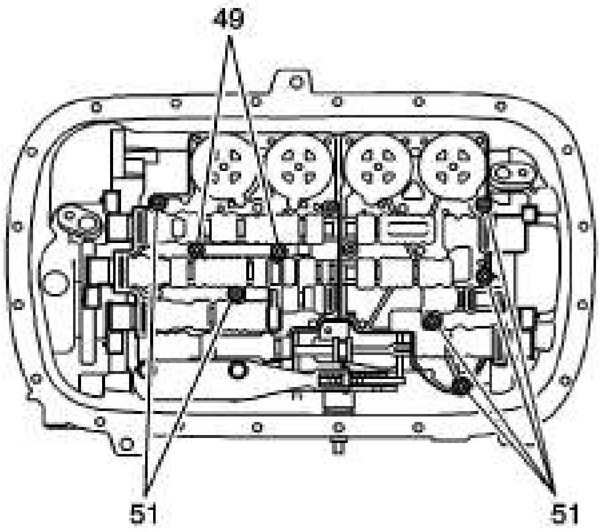


8. Install a 0.8 mm spacer (1) between the shift shaft detent lever (600) and the shift shaft detent assembly (52).
9. Tighten the detent assemby bolts (53).

   Tighten
   Tighten the control valve body bolts (53) to 11 N·m (8 lb. ft).

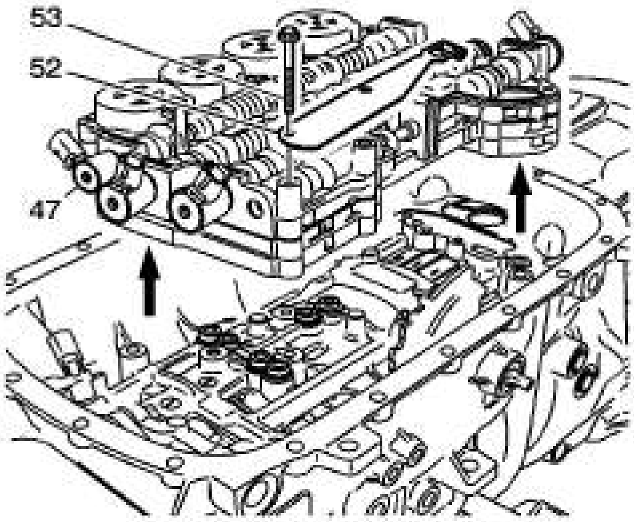
10. Remove the spacer (1).

Control Valve Body Accumulator Assembly Removal

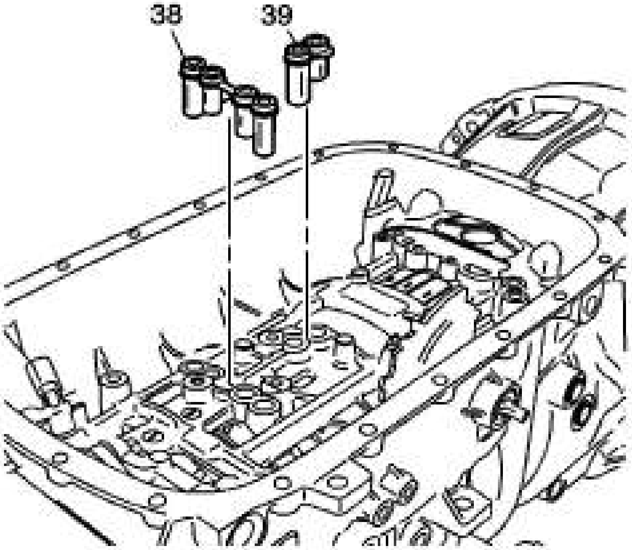


Important: Only remove the bolts called out in the graphic, there will be two remaining.

1. Remove the control valve body retaining bolts (49 and 51).

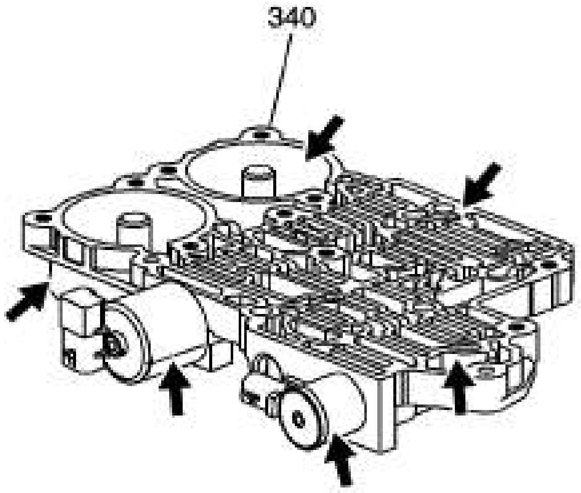


2. Remove the control valve body retaining bolts (53).
3. Remove the manual shaft detent (52).
4. Remove the control valve body (47).



5. Remove the centre support fluid passage sleeve (38) and the overdrive clutch fluid passage sleeve (39).

Control Valve Front Body Inspection



1. Inspect the front control valve body (340) for the following conditions:
   - Damaged or porous casting
   - Damaged sealing surfaces
   - Debris in fluid passages
2. Use a suitable tool, before disassembly, to inspect the front control valve body (340) components for the following conditions:
   - Valves binding or sticking in their bores or bushings
   - Broken missing or damaged springs
   - Missing or damaged retainers
   - Damaged solenoid valves
   - Debris in valve line ups or solenoid valves
3. During disassembly, inspect the front control valve body for the following conditions:
   - Worn or damaged valves, valve bores or bushings
   - Broken, missing or damaged springs
   - Missing or damaged retainers
   - Damaged solenoid valves
   - Debris in valve line ups or solenoid valve

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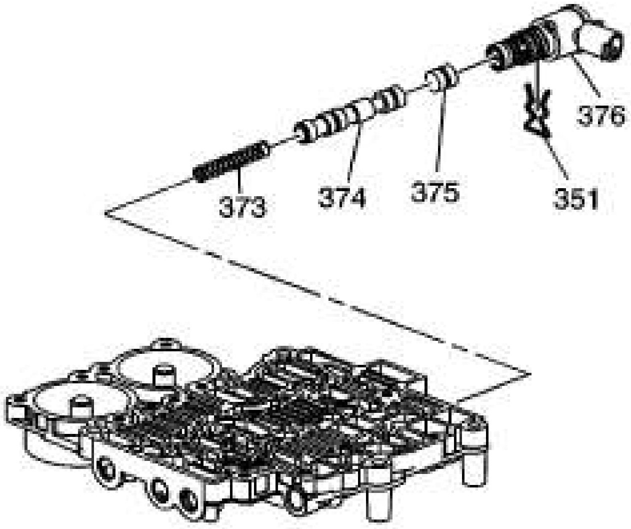
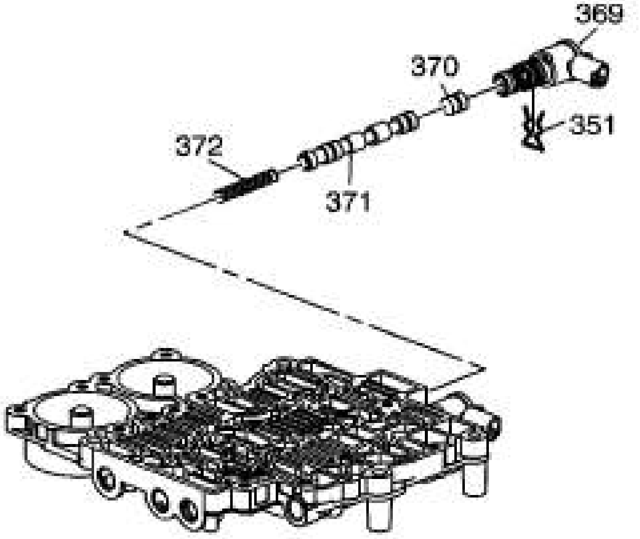
Control Valve Rear Body Assemble

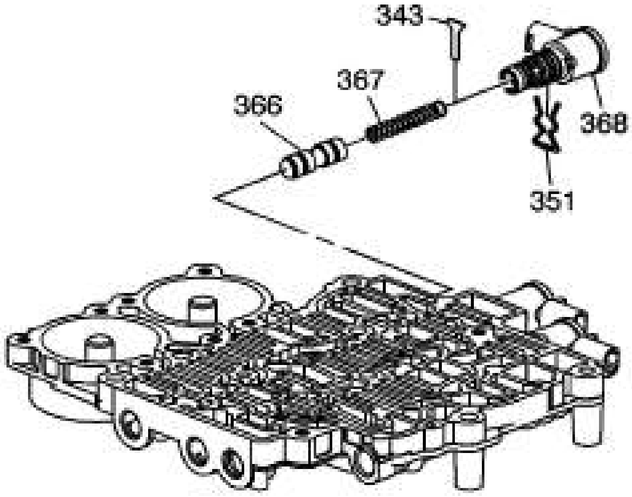


1. Install the 4-5 shift valve spring (373).
2. Install the 4-5 shift valve (374).
3. Install the 4-5 shift control valve (375).
4. Install the 4-5 shift solenoid (376).
5. Install the 4-5 shift solenoid retainer (351).

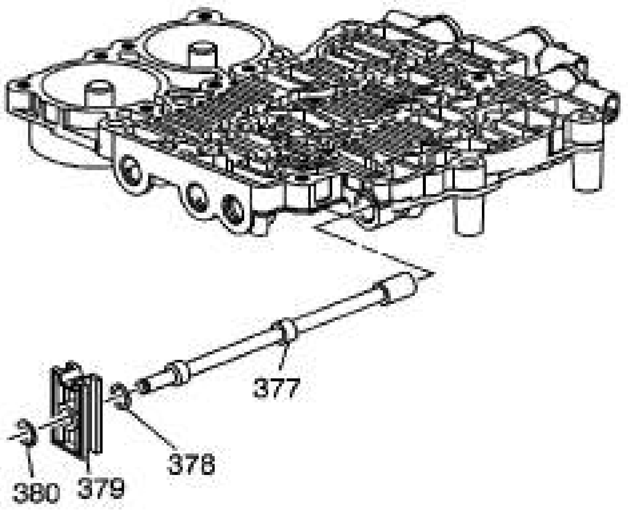


6. Install the 2-3 shift valve spring (372).
7. Install the 2-3 shift valve (371).
8. Install the 2-3 shift control valve (370).

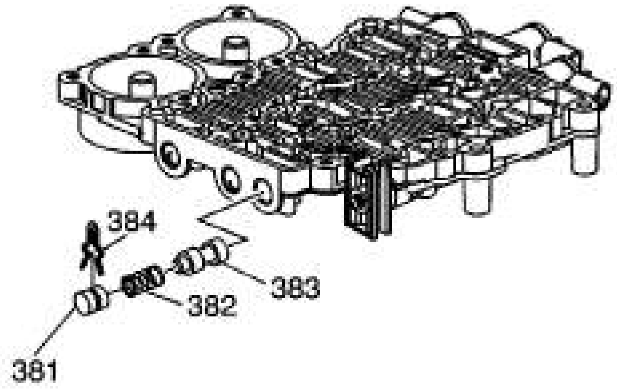
9. Install the 2-3 shift solemoid (369).
10. Install the 2-3 shift solenoid retainer (351).



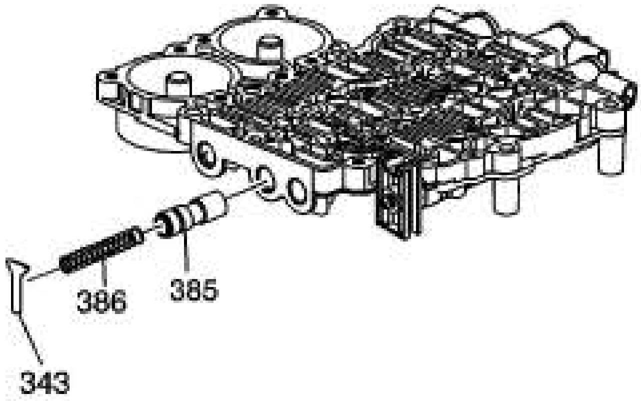
11. Install the 1-2 shift control valve (366).
12. Install the 1-2 shift control valve spring (367).
13. Install the 1-2 shift control valve retainer (343).
14. Install the 1-2 shift solenoid (368).
15. Install the 1-2 shift solenoid retainer (351).



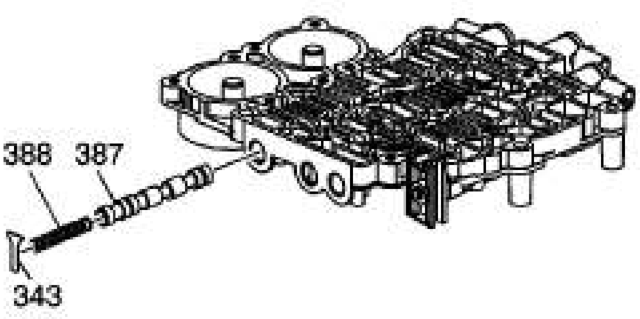
16. Install the manual valve link retainer (380).
17. Install the manual valve link (379).
18. Install the manual valve link retainer (378).
19. Install the manual valve (377).



20. Install the low pressure control valve (383).
21. Install the low pressure control valve spring (382).
22. Install the bore plug (381).
23. Install the low pressure control valve bore retainer (384).



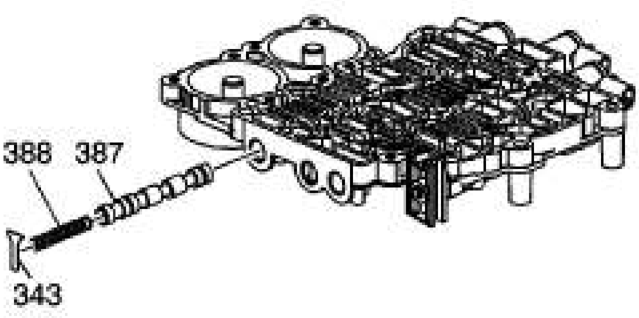
24. Install the reverse lock out valve (385).
25. Install the reverse lock out spring (386).
26. Install the reverse lock out valve retainer (343).



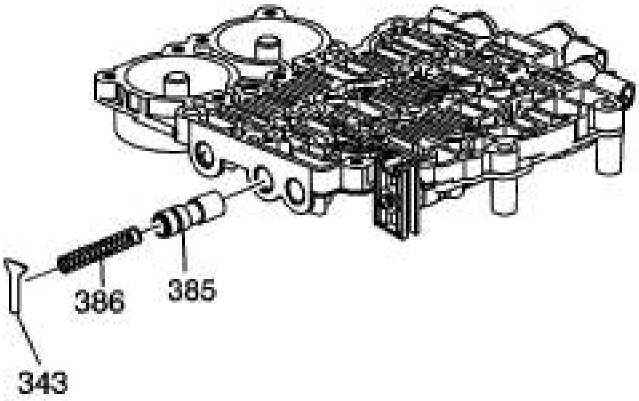
27. Install the 1-2 shift valve (387).
28. Install the 1-2 shift valve spring (388).
29. Install the 1-2 shift valve retainer (343).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 5L40-E/5L50-E | Repair Instructions - Off Vehicle | **Document ID: 2006961**

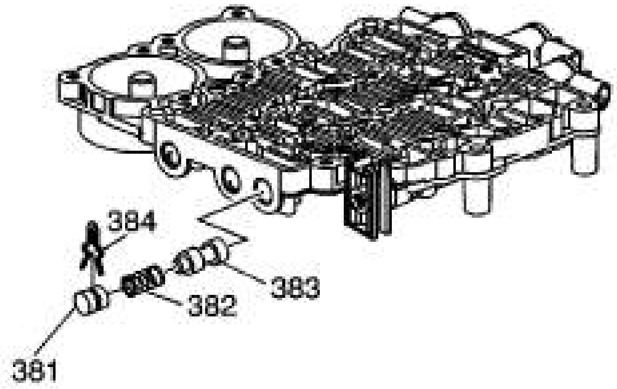
Control Valve Rear Body Disassemble



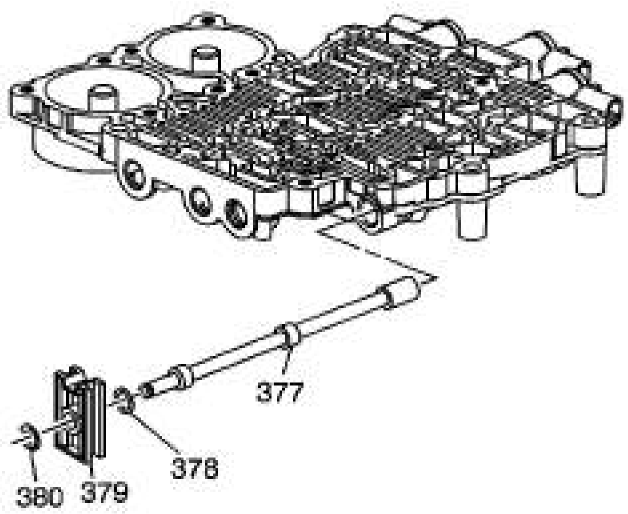
1. Remove the 1-2 shift valve retainer (343).
2. Remove the 1-2 shift valve spring (388).
3. Remove the 1-2 shift valve (387).



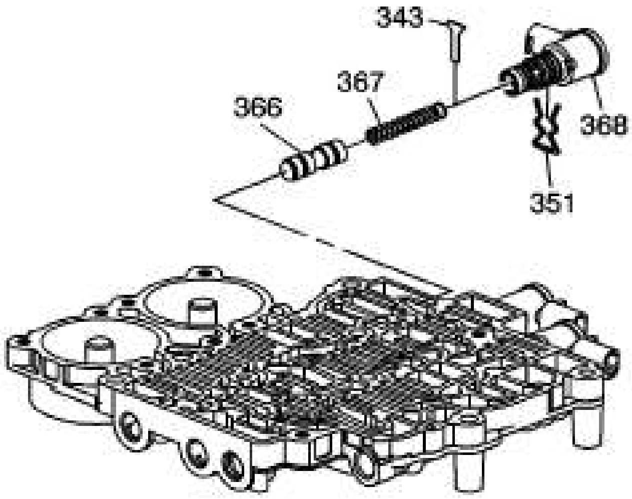
4. Remove the reverse lock out valve retainer (343).
5. Remove the reverse lock out spring (386).
6. Remove the reverse lock out valve (385).



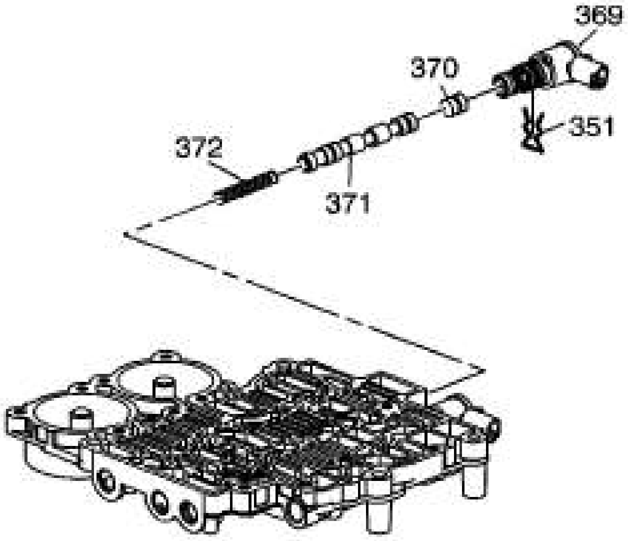
7. Remove the low pressure control valve bore retainer (384).
8. Remove the low pressure control valve bore plug (381).
9. Remove the low pressure control valve spring (382).
10. Remove the low pressure control valve (383).



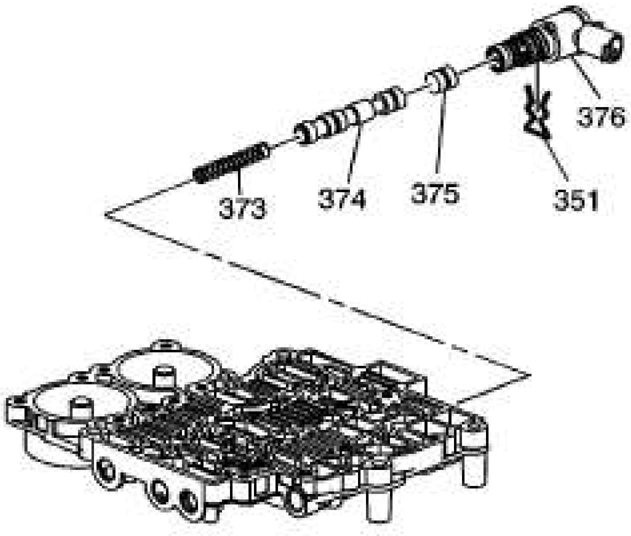
11. Remove the manual valve link retainer (380).
12. Remove the manual valve link (379).
13. Remove the manual valve link retainer (378).
14. Remove the manual valve (377).



15. Remove the 1-2 shift solenoid retainer (351).
16. Remove the 1-2 shift solenoid (368).
17. Remove the 1-2 shift control valve retainer (343).
18. Remove the 1-2 shift control valve spring (367).
19. Remove the 1-2 shift control valve (366).



20. Remove the 2-3 shift solenoid retainer (351).
21. Remove the 2-3 shift solenoid (369).
22. Remove the 2-3 shift control valve (370).
23. Remove the 2-3 shift valve (371).
24. Remove the 2-3 shift valve spring (372).



25. Remove the 4-5 shift solenoid retainer (351).
26. Remove the 4-5 shift solenoid (376).
27. Remove the 4-5 shift control valve (375).
28. Remove the 4-5 shift valve (374).
29. Remove the 4-5 shift valve spring (373).

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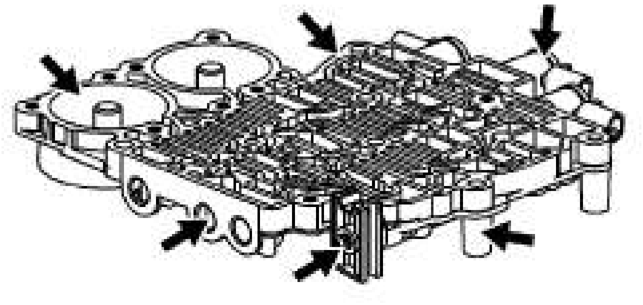
Control Valve Rear Body Inspection



1. Inspect the rear control valve body (365) for the following conditions:
   - Damaged or porous casting
   - Damaged sealing surfaces
   - Debris in fluid passages
2. Use a suitable tool, before disassembly, to inspect the rear control valve body (365) components for the following conditions:
   - Valves binding or sticking in their bores or bushings
   - Broken missing or damaged springs
   - Missing or damaged retainers
   - Damaged solenoid valves
   - Debris in valve line ups or solenoid valves
3. During disassembly, inspect the rear control valve body for the following conditions:
   - Worn or damaged valves, valve bores or bushings
   - Broken, missing or damaged springs
   - Missing or damaged retainers
   - Damaged solenoid valves
   - Debris in valve line ups or solenoid valve

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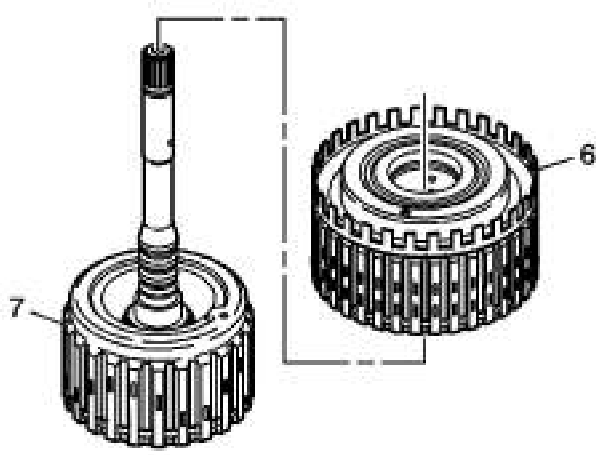
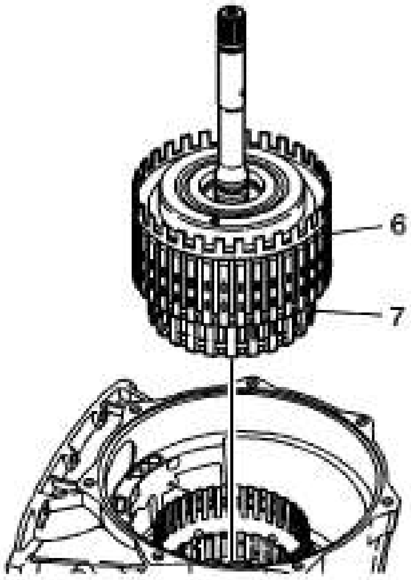
Direct and Reverse and Forward and Coast Clutch Installation

Notice: Refer to General Repair Instructions in the Preface section.



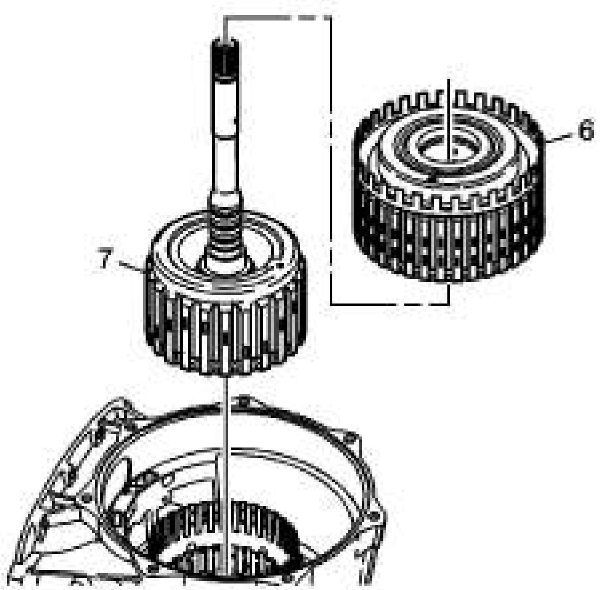
1. Place the direct and reverse clutch assembly (6) onto the forward and coast clutch assembly (7).



2. Install the direct and reverse clutch assembly (6) and the forward and coast clutch assembly (7) into the case (24).

Direct and Reverse and Forward and Coast Clutch Removal

Notice: Refer to General Repair Instructions in the Preface section.

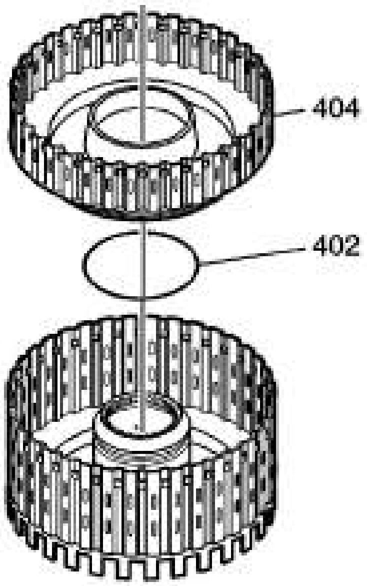


1. Remove the forward and coast clutch assembly (7) and the direct and reverse clutch assembly (6) from the case (24).
2. Remove the direct and reverse clutch assembly (6) from the forward and coast clutch assembly (7).

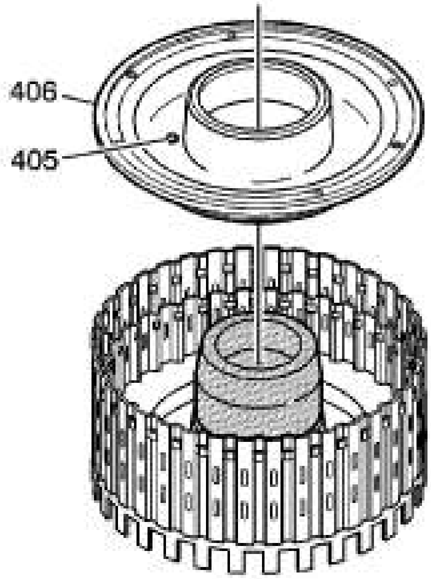
Direct and Reverse Clutch Assemble

Tools Required

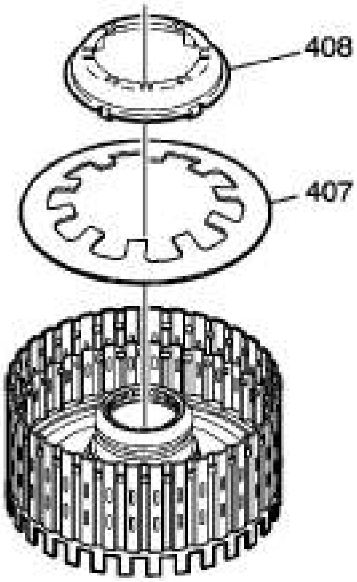
- J 38734 Intermediate Spring Compressor Adapter
- J 45133 Seal Protector
- J 45139 Compressor Plate



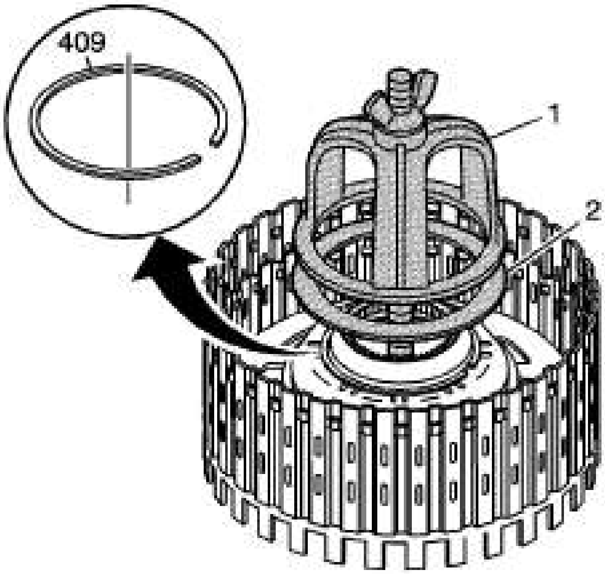
1. Inspect the reverse clutch housing for the following:
   - Plugged feed passages
   - Damaged or worn splines
   - Seal ring groove nicks or burrs
   - Cracked or blocked fluid passages
   - Damaged or worn bushing
2. Inspect the reverse clutch piston and the direct clutch piston for the following:
   - Cracks or damage to seal grooves
   - Wear on the piston
   - Inner seal damage
   - Damaged ball check valve
   - Damaged or worn clutch plates
3. Install the reverse clutch piston inner seal (402).
4. Install the reverse clutch piston (404).



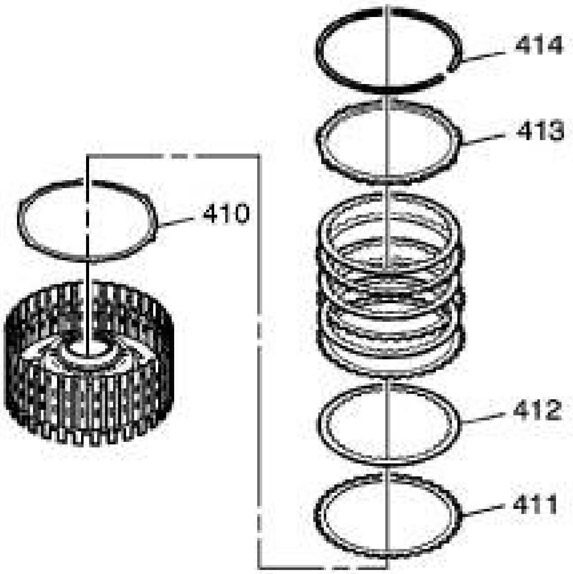
5. Install J 45133 onto the direct and reverse clutch assembly (6).
6. Install the direct clutch piston (406).



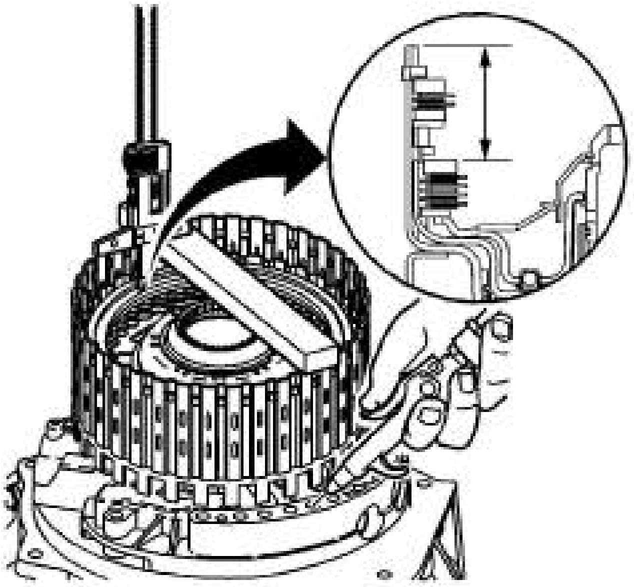
7. Install the piston spring (407).
8. Install the piston spring retainer (408).



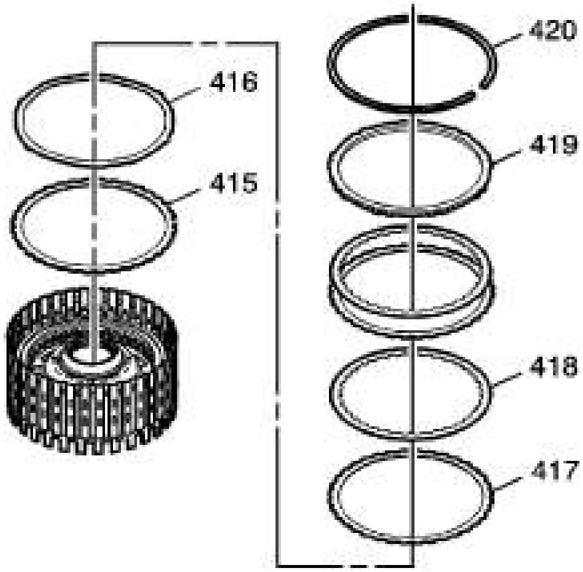
9. Use J 38734 (1) and J 45139 (2) to compress the direct and reverse piston spring.
10. Install the direct and reverse clutch spring snap ring (409).



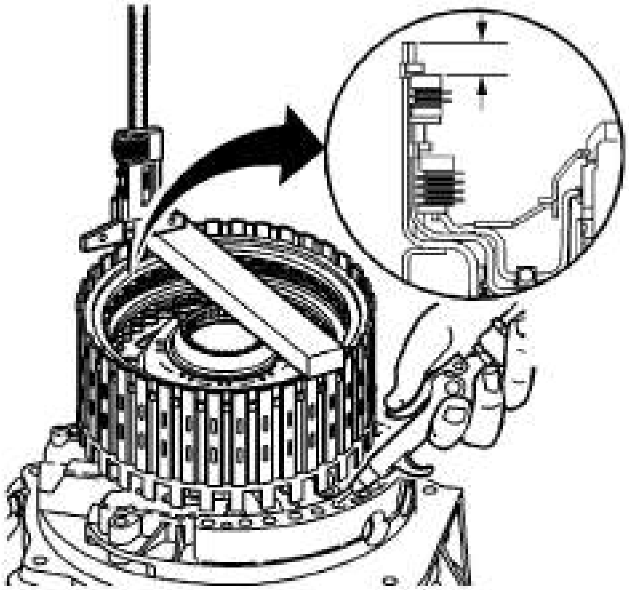
11. Install the apply plate (410).
12. Install the clutch plates (412, 411), starting with the direct clutch plate (411) with outer splines, alternating with the direct clutch plate (412) with inner splines. Refer to Clutch Plate Selection Specifications.
13. Install the backing plate (413).
14. Install the backing plate snap ring (414).



15. Measure the distance between the direct clutch backing plate and the bottom of the gage bar. Measure three times in different locations on the backing plate. Record this as H1.
16. Apply 65 PSI (448.17 kPa) of air pressure to the specified port. Measure the distance between the direct clutch backing plate and the bottom of the gage bar. Measure three times in different locations on the backing plate. Record this as H2.
17. Subtract H2 from H1. This is the clutch pack travel. Refer to Clutch Piston Travel Specifications.



18. Install the reverse clutch spacer (415).
19. Install the apply plate (416).
20. Install the clutch plates (417 and 418), starting with clutch plates (417) with outer splines, alternating with clutch plates (418) with inner splines. Refer to Clutch Plate Selection Specifications.
21. Install the reverse clutch backing plate (419).
22. Install the reverse clutch backing plate snap ring (420).

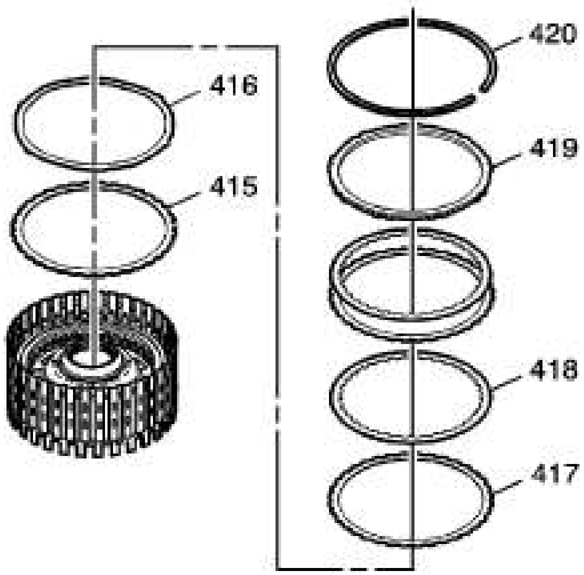


23. Measure the distance between the reverse clutch backing plate and the bottom of the gage bar. Measure three times in different locations on the backing plate. Record this as H1.
24. Apply 65 PSI (448.17 kPa) of air pressure to the specified port. Measure the distance between the reverse clutch backing plate and the bottom of the gage bar. Measure three times in different locations on the backing plate. Record this as H2.
25. Subtract H2 from H1 this is the clutch pack travel. Refer to Clutch Piston Travel Specifications.

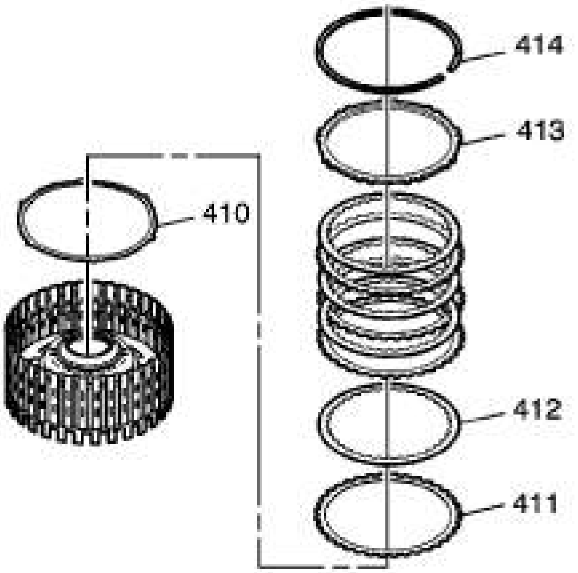
Direct and Reverse Clutch Disassemble

Tools Required

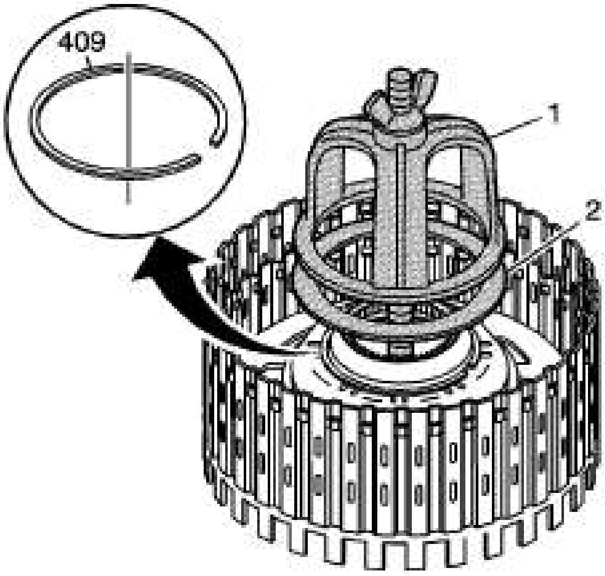
- J 38734 Intermediate Spring Compressor Adapter
- J 45139 Compressor Plate



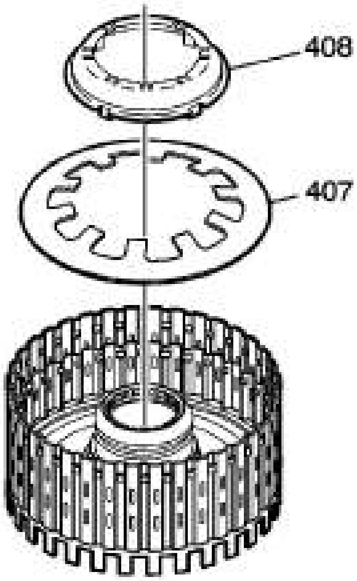
1. Remove the reverse clutch backing plate snap ring (420).
2. Remove the backing plate (419).
3. Remove the clutch plates (418 and 417). Refer to Clutch Plate Selection Specifications.
4. Remove the apply plate (416).
5. Remove the reverse clutch spacer (415).



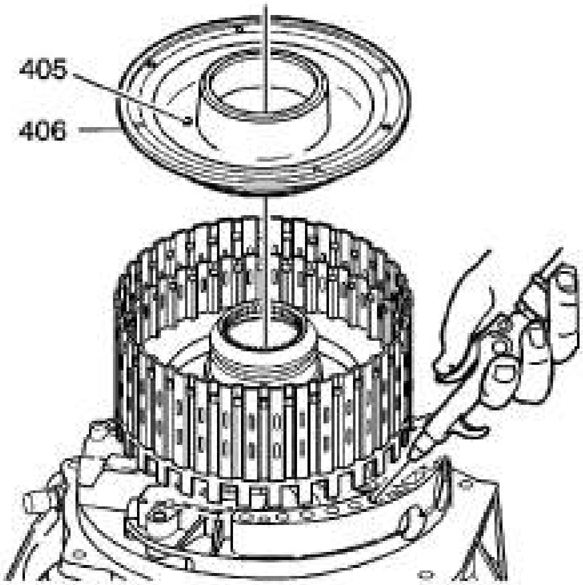
6. Remove the direct clutch backing plate snap ring (414).
7. Remove the backing plate (413).
8. Remove the clutch plates (412 and 411). Refer to Clutch Plate Selection Specifications.
9. Remove the apply plate (410).



10. Use J 38734 and J 45139 to compress the direct and reverse piston spring (407).
11. Remove the direct and reverse clutch spring snap ring (409).
12. Remove J 38734 and J 45139 .

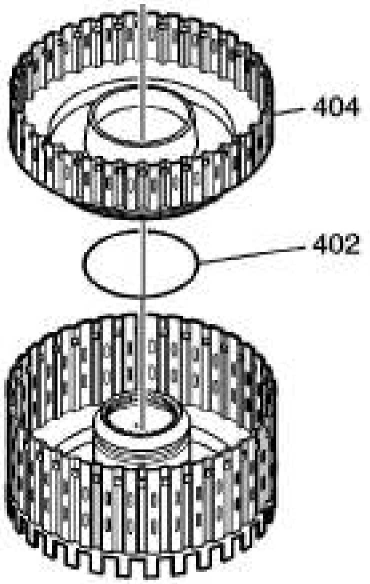


13. Remove the spring retainer (408).
14. Remove the spring (407).



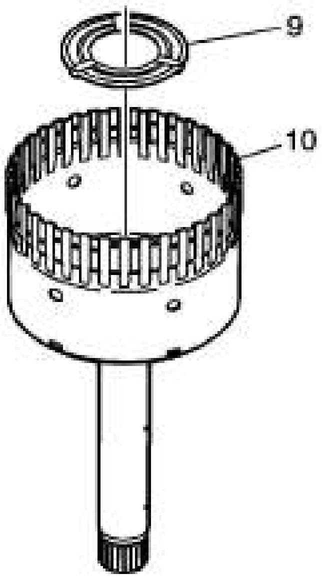
Important: It may be necessary to use air pressure to remove the piston.

15. Remove the direct clutch piston (406).

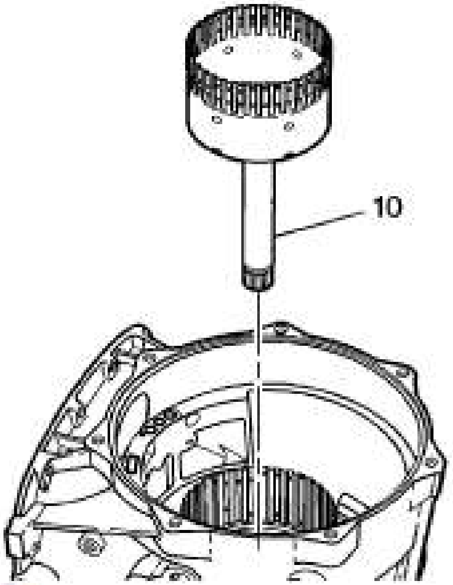


16. Remove the reverse clutch piston (404).
17. Remove the reverse clutch piston inner seal (402).

Direct Clutch Hub Assemble

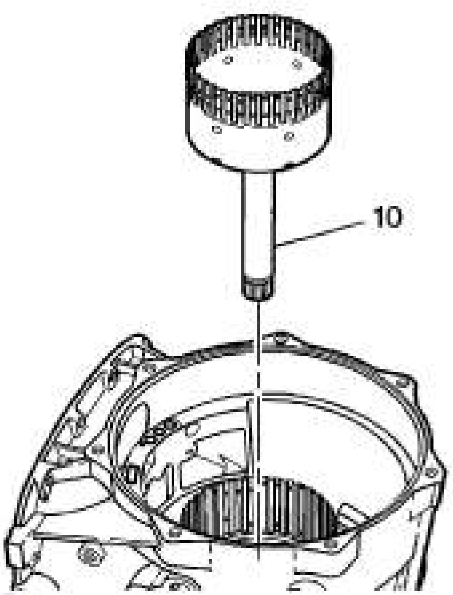


1. Inspect the housing for the following:
   - Damaged or worn splines
   - Damaged or worn bushings
   - Wear, cracks and scoring on the shaft
2. Install the direct clutch hub thrust washer (9) into the housing (10).



3. Install the direct clutch hub housing (10) into the case.

Direct Clutch Hub Removal

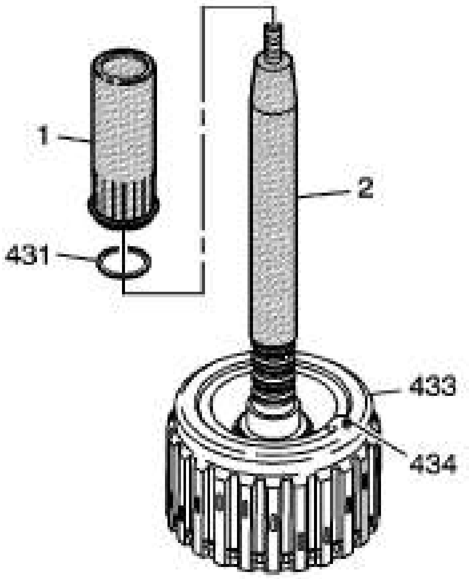


Remove the direct clutch hub assembly (10) from the case.

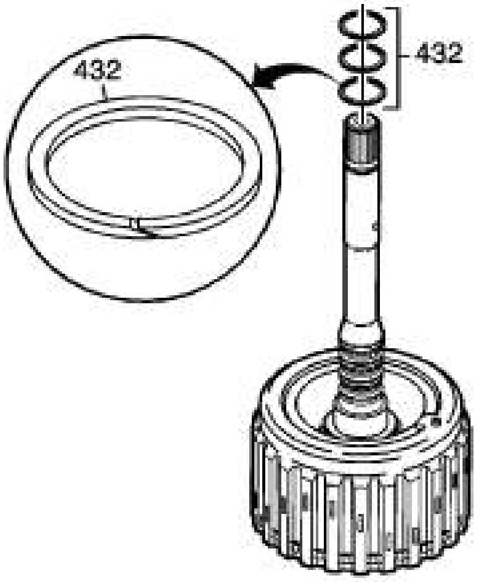
Forward and Coast Clutch Assemble

Tools Required

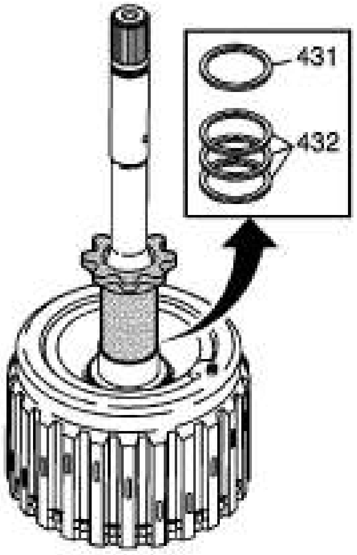
- J 43074 Forward Clutch Piston Spring Compressor
- J 45130-1 Seal Installer Sizer
- J 45130-2 Seal Installer Pusher
- J 45130-3 Seal Protector
- J 45132 Seal Protector
- J 45134 Seal Protector



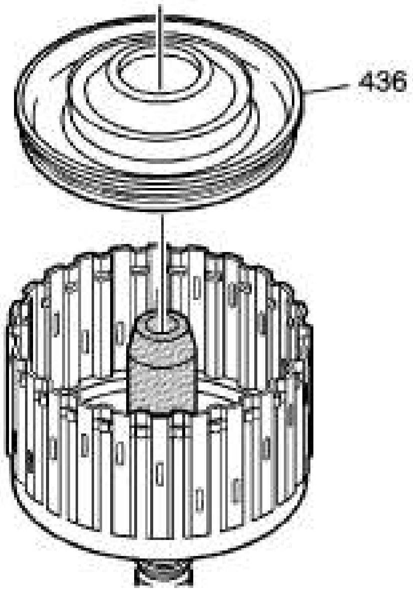
1. Inspect the forward clutch housing (433) for the following:
    - Plugged feed passages
    - Damaged ball check valve (434)
    - Damaged or worn splines
    - Seal ring groove nicks or burrs
    - Cracked or blocked fluid passages in the input shaft
    - Damaged or worn clutch plates
2. Inspect the input shaft fluid seals (431, 432) for damaged or worn seals.
3. Slide J 45130-3 (2) over the input shaft, and position J 45130-3 (2) at the seal groove closest to the housing. Coat J 45130-3 (2) with transmission fluid.
4. Guide a NEW seal (431) onto J 45130-3 (2) and slide the seal into the groove with J 45130-2 (1).



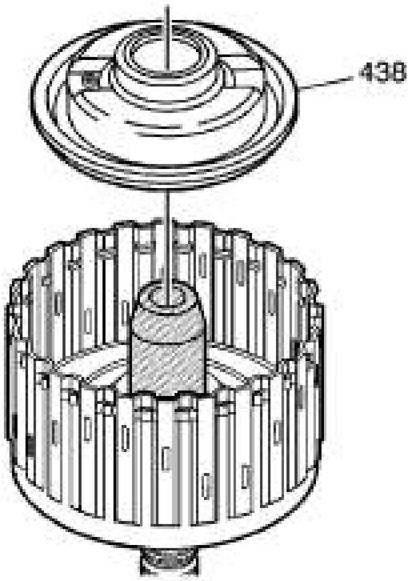
5. Remove J 45130-3 (2).
6. Install the input shaft fluid seals (432).



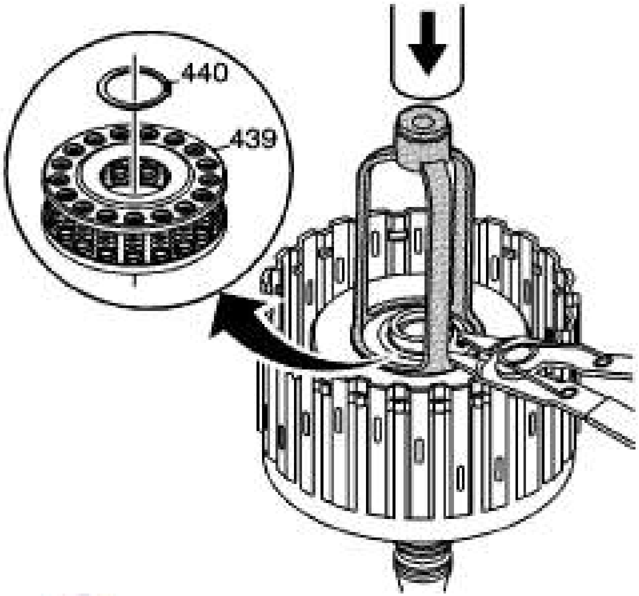
7. Size the seals (431, 432) with J 45130-1 .
8. Leave J 45130-1 in place for at least five minutes. If possible, leave J 45130-1 in place until you install the assembly into the transmission case.



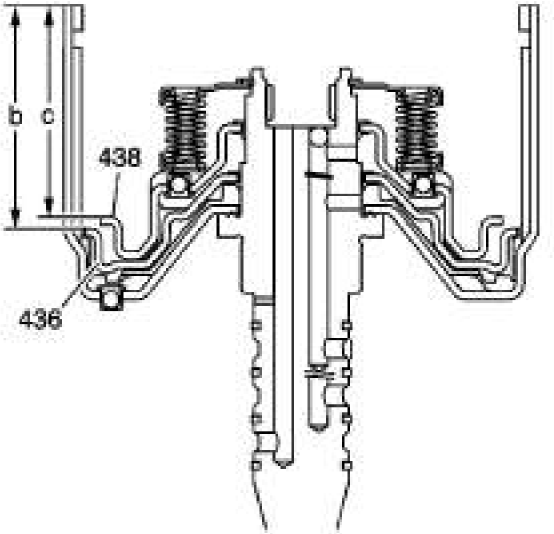
9. Inspect the forward piston and the coast clutch piston for the following:
    - Cracks or damage to seal grooves
    - Wear on the piston
    - Damaged or worn clutch plates
10. Use J 45134 to install the forward clutch piston (436).



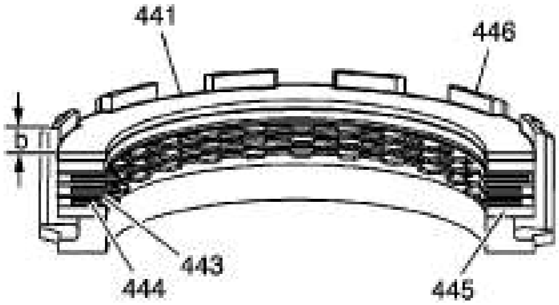
11. Use J 45132 to install the coast clutch piston (438).



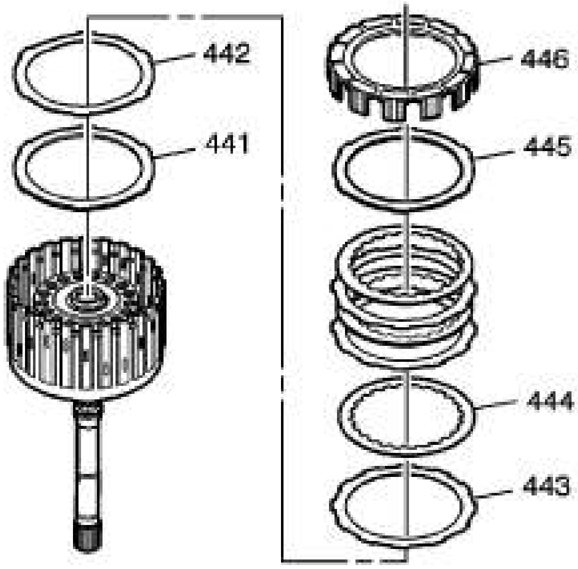
12. Inspect the forward and coast clutch piston spring for the following:
    - Damaged cage
    - Distorted or missing springs
13. Install the piston spring (439).
14. Use J 43074 to compress the spring and install the snap ring (440).



15. Measure the distance from the top of the forward clutch housing to the coast clutch piston (438), record this as dimension C.
16. Measure the distance from the top of the forward clutch housing to the forward clutch piston (436), record this as dimension B.
17. Subtract dimension C from dimension B. This is now dimension A.

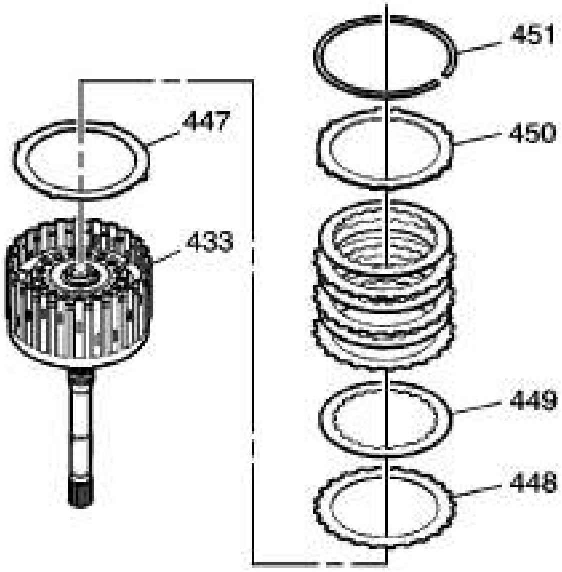


18. Install the coast clutch backing plate (445) into the coast clutch housing (446).
19. Install the coast clutch plates into the coast clutch housing (446). Starting with the coast clutch plate (443) with outer splines. Alternating with the coast clutch plate (444) with inner splines. Refer to Clutch Plate Selection Specifications.
20. Install the coast clutch apply plate into the coast clutch housing (446).
21. Install the coast clutch spacer plate (441) into the coast clutch housing (446).
22. Measure the distance from the top of the coast clutch housing (446) to the top of the coast clutch spacer plate (441), record this as dimension B.
23. Subtract dimension B from dimension A, this is clutch pack travel.

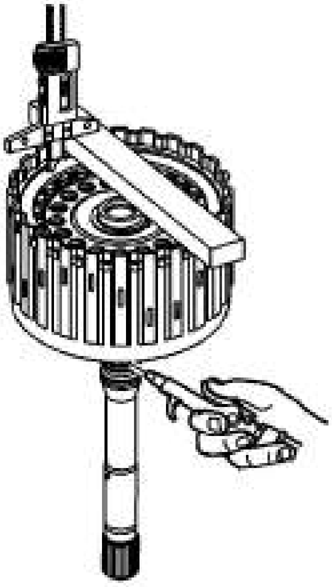


24. Install the coast clutch spacer plate (441).
25. Install the coast clutch apply plate (442).
26. Install the coast clutch plates. Starting with the coast clutch plate (443) with the outer splines. Refer to Clutch Plate Selection Specifications.
27. Alternating with the coast clutch plate (444) with inner splines.

28. Install the coast clutch backing plate (444).
29. Install the coast clutch housing (446).



30. Install the forward clutch apply plate (447).
31. Install the forward clutch plates. Starting with the forward clutch plate (448) with outer splines. Alternating with the forward clutch plate (449) with inner splines. Refer to Clutch Plate Selection Specifications.
32. Install the forward clutch backing plate (450).
33. Install the forward clutch backing plate snap ring (451).



34. Measure the distance between the forward clutch backing plate and the bottom of the gage bar. Measure three times in different locations on the backing plate. Record this as H1.
35. Apply air pressure to the specified port. Measure the distance between the forward clutch backing plate and the bottom of the gage bar. Measure three times in different locations on the backing plate. Record this as H2.
36. Subtract H2 from H1 this is the clutch pack travel. Refer to Clutch Piston Travel

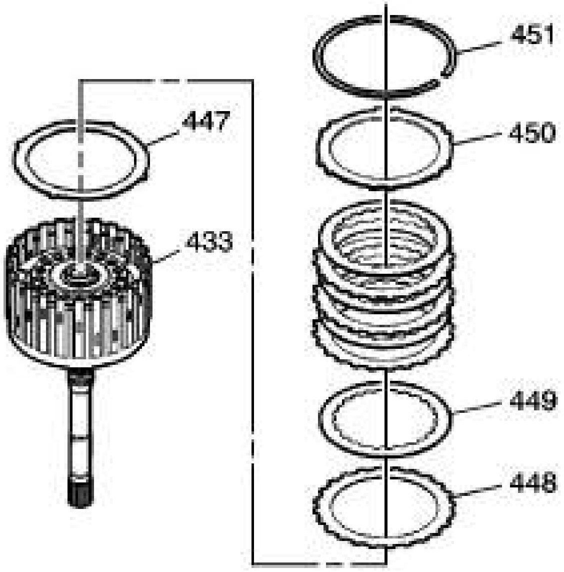
Specifications.

37. At this time you do not install the forward and coast clutch assembly into the transmission case. Set aside until told to do so.

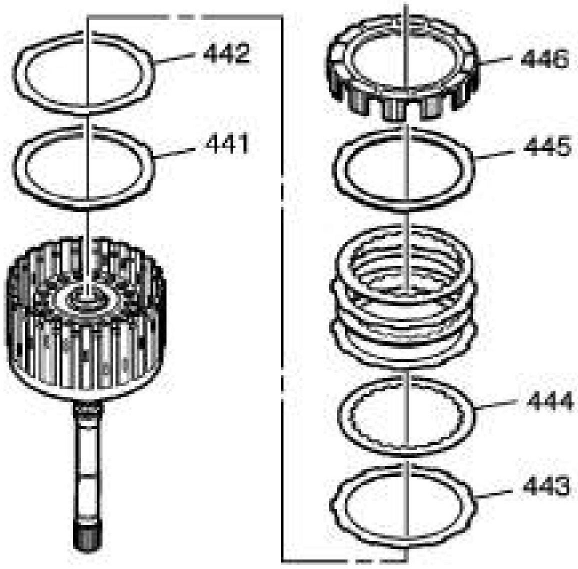
Forward and Coast Clutch Disassemble

Tools Required

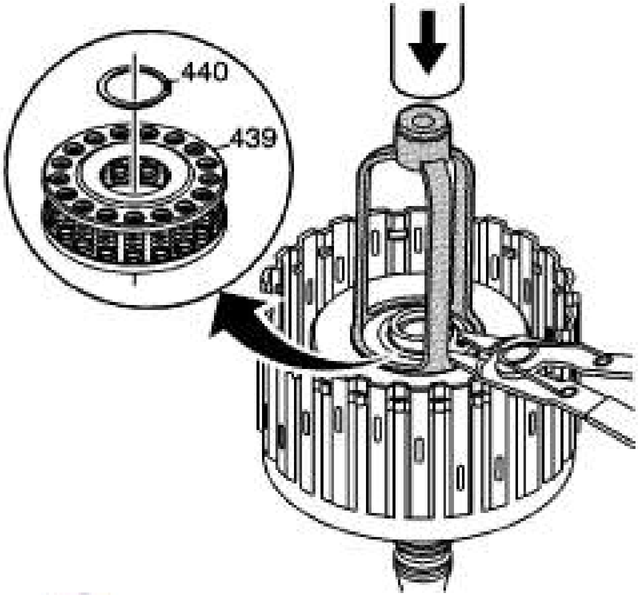
J 43074 Forward Clutch Piston Spring Compressor



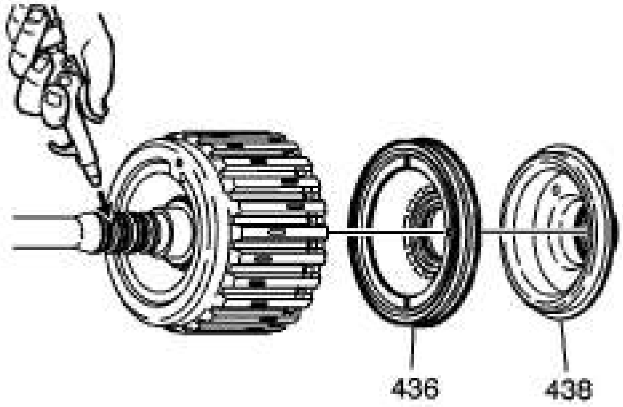
1. Remove the forward clutch backing plate retainer ring (451).
2. Remove the forward clutch backing plate (450).
3. Remove the forward clutch plates (448 and 449). Refer to Clutch Plate Selection Specifications.
4. Remove the forward apply plate (447).



5. Remove the coast clutch housing (446).
6. Remove the coast backing plate (445).
7. Remove the coast clutch plates (443, 444). Refer to Clutch Plate Selection Specifications.
8. Remove the coast apply plate (442).
9. Remove the coast clutch spacer plate (441).

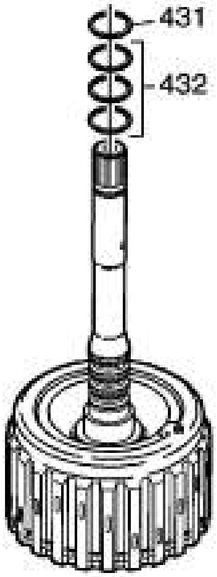


10. Use the J 43074 to compress the forward and coast clutch spring (439).
11. Remove the snap ring (440).
12. Remove J 43074 .
13. Remove the clutch spring (439).



Important: It may be necessary to apply air pressure to remove the piston.

14. Remove the coast clutch piston (438).
15. Remove the forward clutch piston (436).

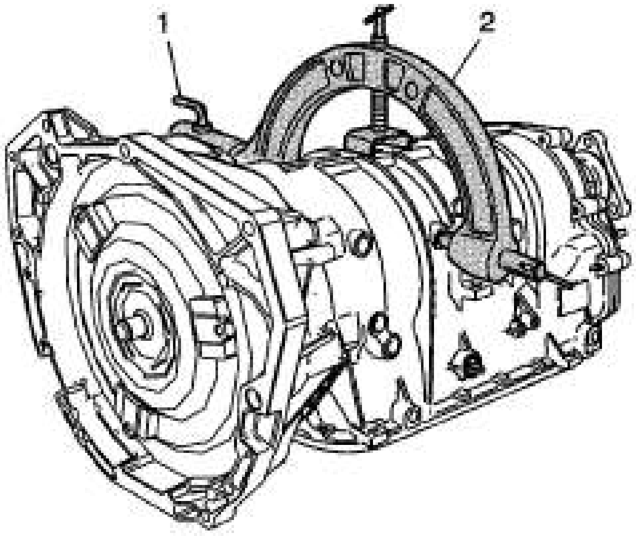


16. Remove the input shaft fluid seal (431).
17. Remove the input shaft fluid seals (432).

Holding Fixture Installation

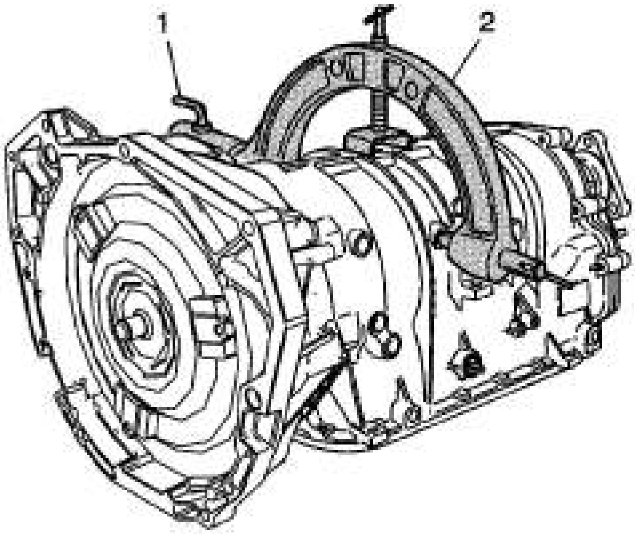
Tools Required

J 8763-B Holding Fixture and Base



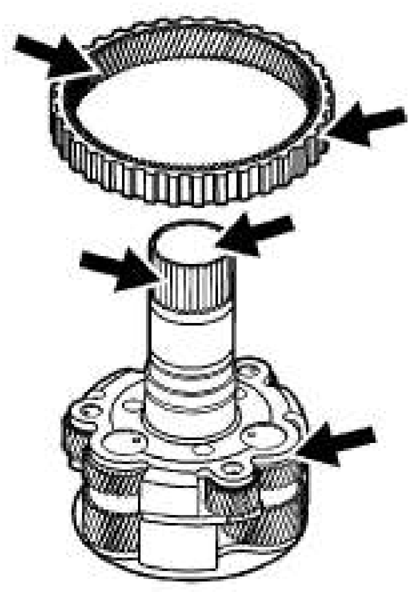
1. Install the J 8763-B onto the transmission.
2. Install the transmission onto the holding fixture tool base and use the pin to lock the holding fixture in place.

Holding Fixture Removal

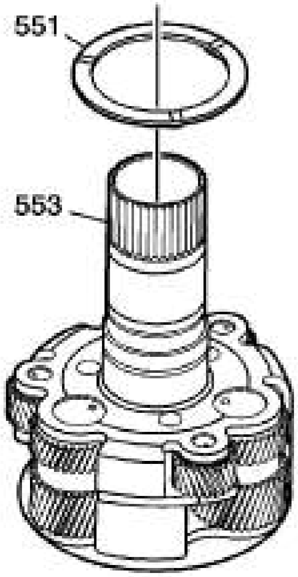


Remove J 8763-B from the transmission.

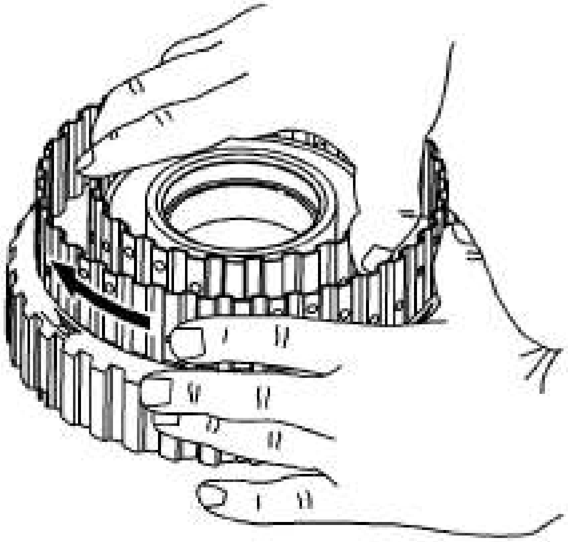
Input and Reaction Carrier Assemble



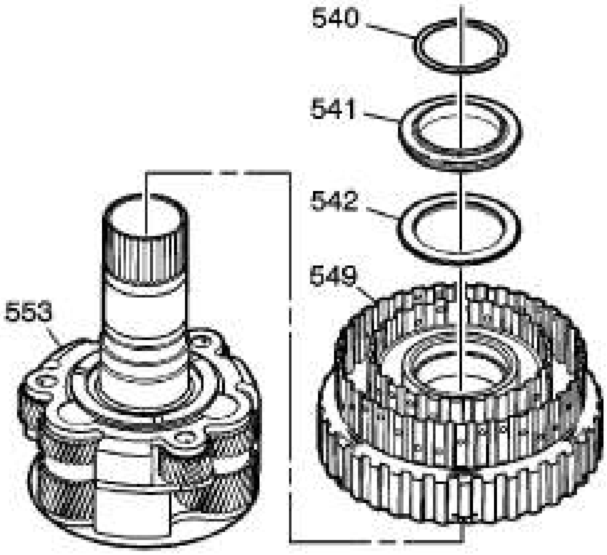
1. Inspect the reaction internal gear and the 2nd clutch sprag for the following:
   - Damaged or worn gear teeth
   - Damaged or worn splines
2. Inspect the input and reaction carrier for the following:
   - Damaged or worn teeth
   - Damaged or worn splines
   - Damaged or worn bushings
   - Damaged or worn bearings



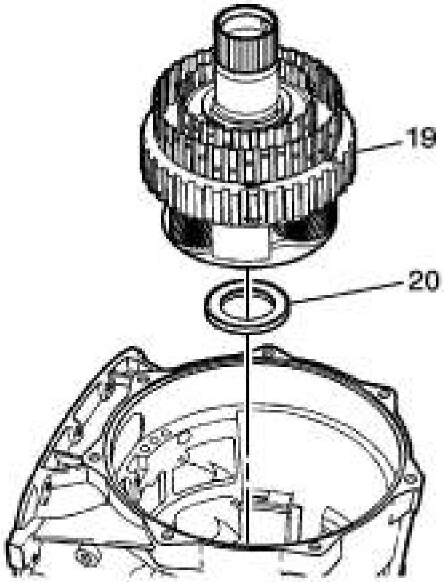
3. Using lubricant install the reaction internal gear flange washer (551).



4. Check that the 2nd clutch sprag rotation freewheels and locks up in the correct direction.



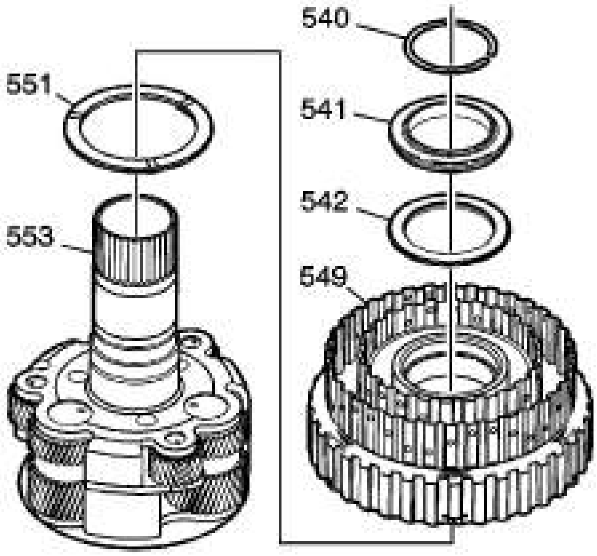
5. Install the 2nd clutch sprag (549) onto the input and reaction carrier (553).
6. Install the 2nd clutch roller inner race bearing (542).
7. Install the input and reaction bearing (541).
8. Install the input and reaction carrier snap ring (540) .



9. Install the input and reaction carrier thrust bearing (20) into the case.
10. Install the input and reaction carrier assembly (19) into the case.

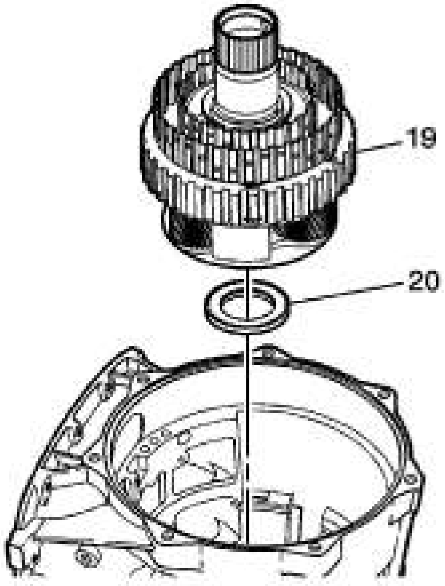
Input and Reaction Carrier Disassemble

Caution: Refer to General Repair Instructions in the Preface section.



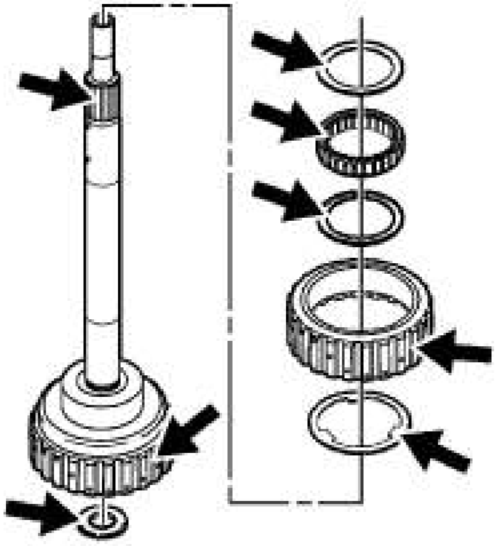
1. Remove the snap ring (540).
2. Remove the input and reaction bearing (541).
3. Remove the 2nd clutch roller inner race bearing (542).
4. Remove the 2nd clutch sprag (549).
5. Remove the reaction internal gear flange washer (551).

Input and Reaction Carrier Removal

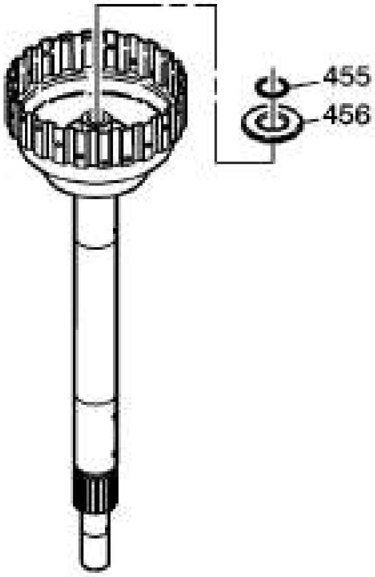


1. Remove the input and reaction carrier (19) from the case.
2. Remove the input and reaction carrier thrust bearing (20) from the case.

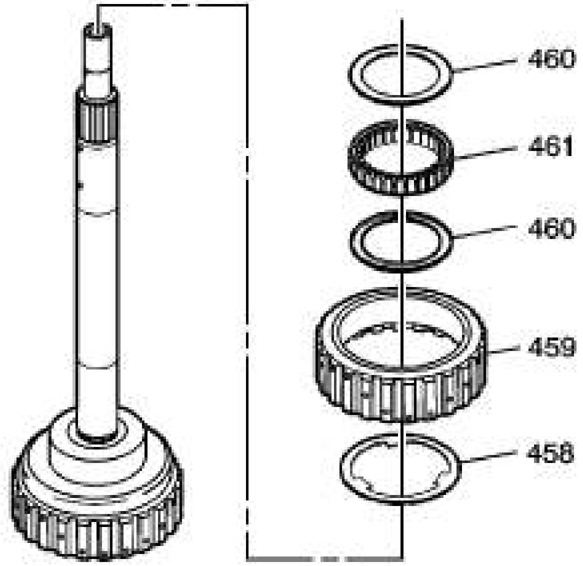
Input Sun Gear Shaft Assemble



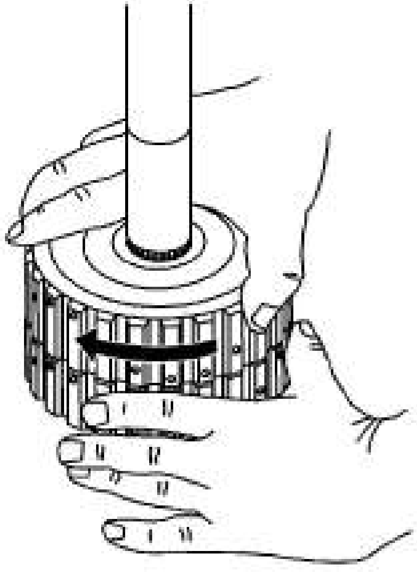
1. Inspect the outer race and input shaft for the following:
   - Damaged or worn splines
   - Scoring inside the diameter of the race
   - Wear or cracks
2. Inspect the sprag elements for flat spots.
3. Inspect the bearing cage for distortion or broken ribbon tabs.
4. Inspect the inner bearing for cracks.



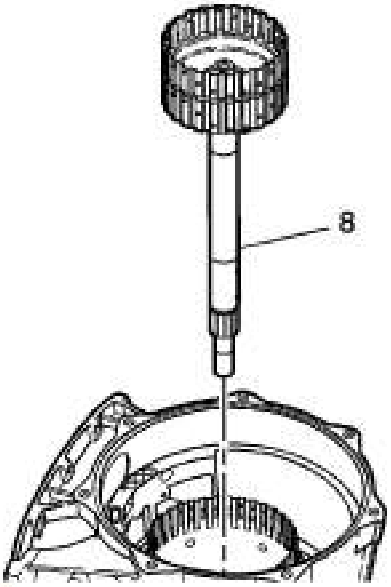
5. Install the inner roller bearing (456).
6. Install the NEW inner race thrust ring (455).



7. Install the outer race washer (458) onto the outer race (459).
8. Install the rataining rings (460) and the forward clutch sprag (461) onto the outer race (459).
9. Install the sprag assembly (460, 461 and 459) onto the sun gear shaft (457).



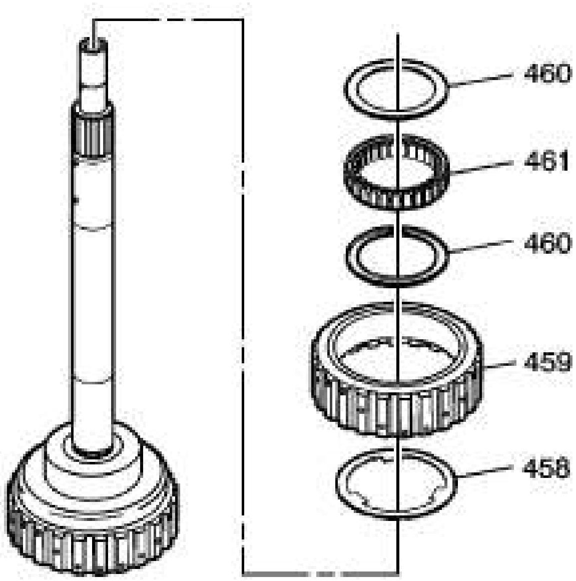
10. Check that the forward clutch sprag rotation freewheels and locks up in the correct direction.



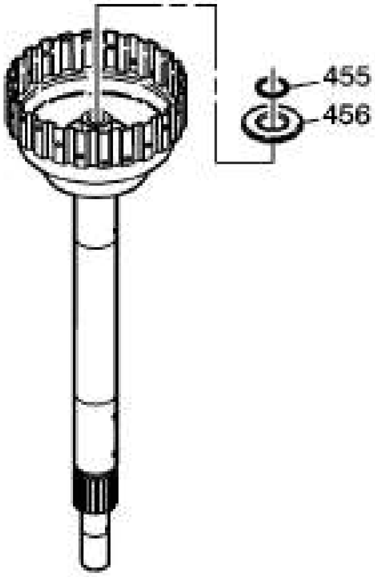
11. Install the input sun gear shaft (8) into the case (24).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 5L40-E/5L50-E | Repair Instructions - Off Vehicle | **Document ID: 1977461**

Input Sun Gear Shaft Disassemble

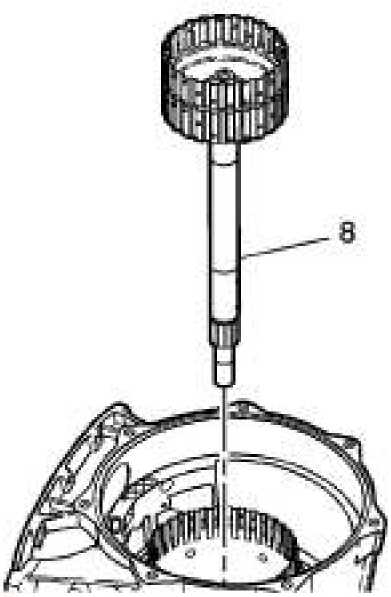


1. Remove the forward clutch sprag outer race (459).
2. Remove the forward clutch outer race washer (458).
3. Remove the forward clutch sprag assembly retaining rings (460).
4. Remove the forward clutch sprag (461).



5. Remove the forward clutch roller inner race thrust ring (455).
6. Remove the inner bearing (456).

Input Sun Gear Shaft Removal

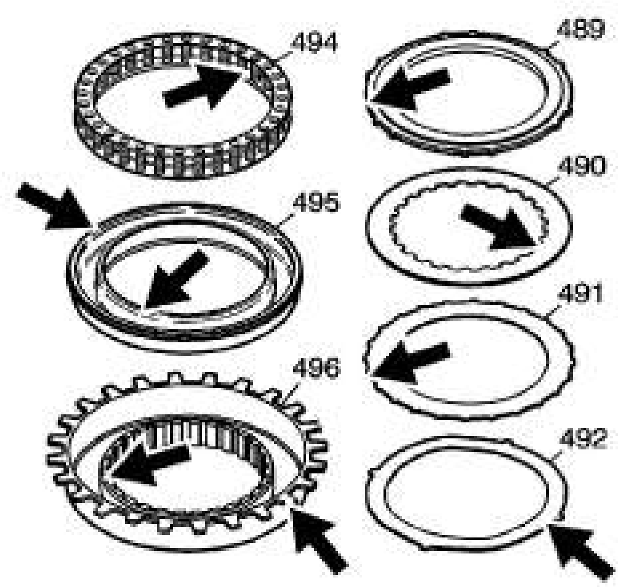


Remove the input sun gear shaft (8) from the case.

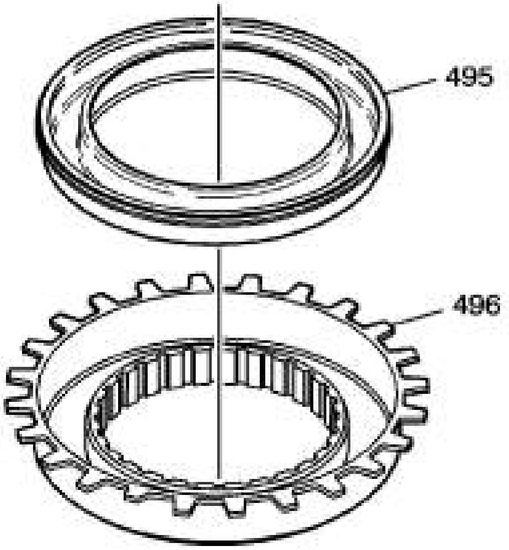
Intermediate and Overdrive and Reverse Clutch Hub Assemble

Tools Required

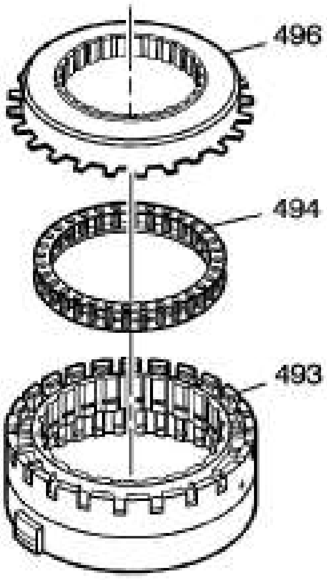
- J 23327 Clutch Spring Compressor
- J 44764 Clutch Spring Compressor
- J 45126 Snap Ring Pliers
- J 45135 Seal Protector



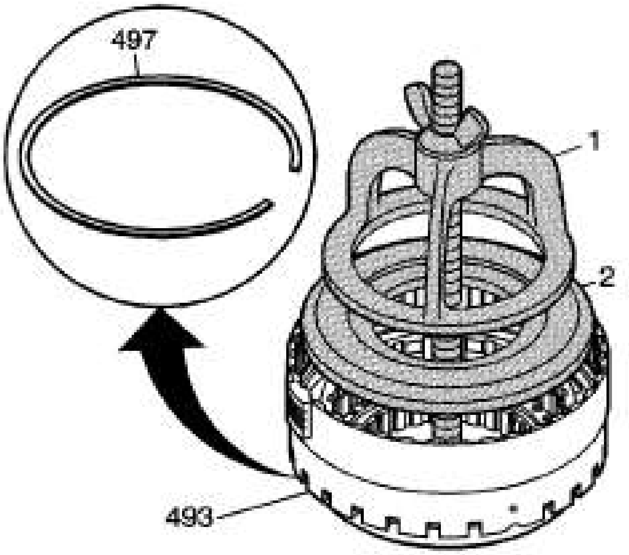
1. Inspect the housing for the following:
   - Plugged feed passages
   - Damaged or worn splines
   - Damaged or worn springs
   - Damaged or worn pistons
   - Damaged or worn clutch plates



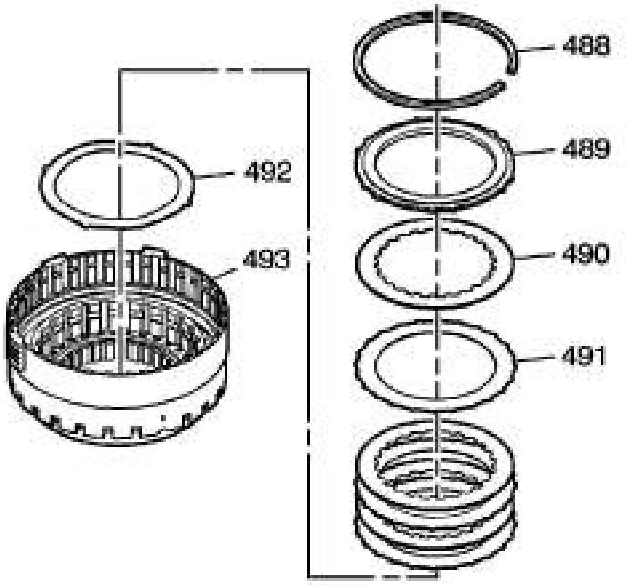
2. Install the intermediate piston (495) into the intermediate clutch housing (496).



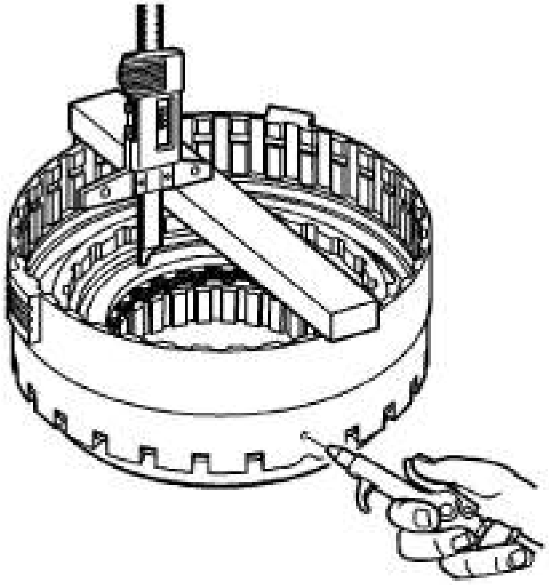
3. Install the intermediate clutch spring (494).
4. Install the intermediate housing (496).



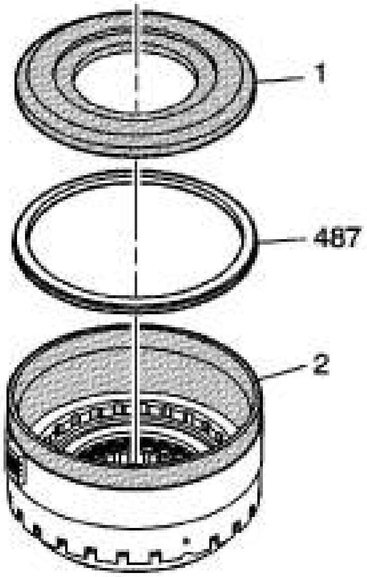
5. Use J 44764 and J 23327 to compress the housing.
6. Install the intermediate clutch housing snap ring (497).
7. Remove J 44764 and J 23327 .



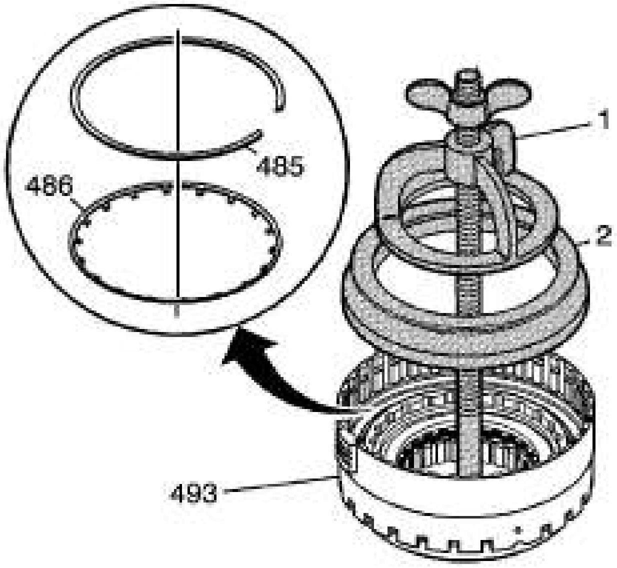
8. Install the intermediate apply plate (492).
9. Install the intermediate clutch plates. Starting with the intermediate clutch plates (491) with external splines. Alternating with the intermediate clutch plates (490) internal splines. Refer to Clutch Plate Selection Specifications.
10. Install the backing plate (489).
11. Install the intermediate backing plate snap ring (488).



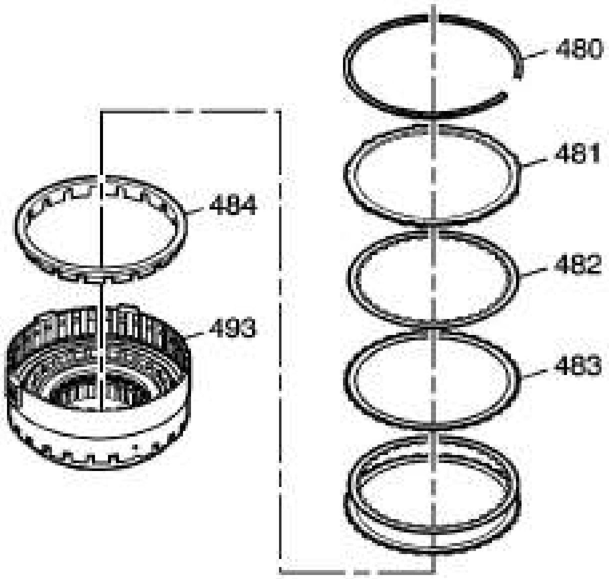
12. Measure the distance between the intermediate clutch backing plate and the bottom of the gage bar. Measure three times in different locations on the backing plate. Record this as H1.
13. Apply 65 PSI (448.17 kPa) of air pressure to the specified port. Measure the distance between the intermediate clutch backing plate and the bottom of the gage bar. Measure three times in different locations on the backing plate. Record this as H2.
14. Subtract H2 from H1 this is the clutch pack travel. Refer to Clutch Piston Travel Specifications.



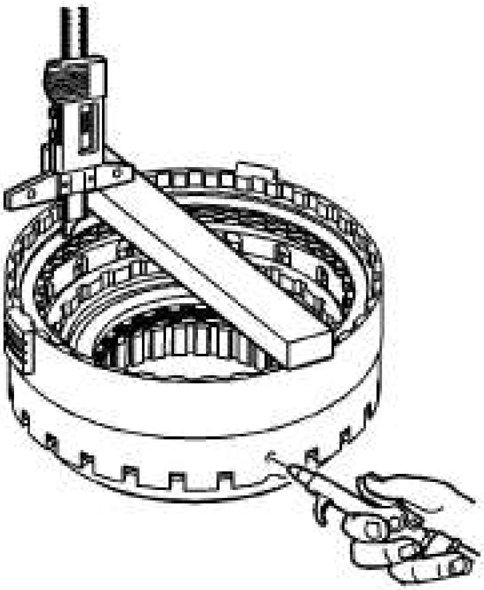
15. Use J 45135 (2) and J 44764 (1) to install the overdrive piston (487).



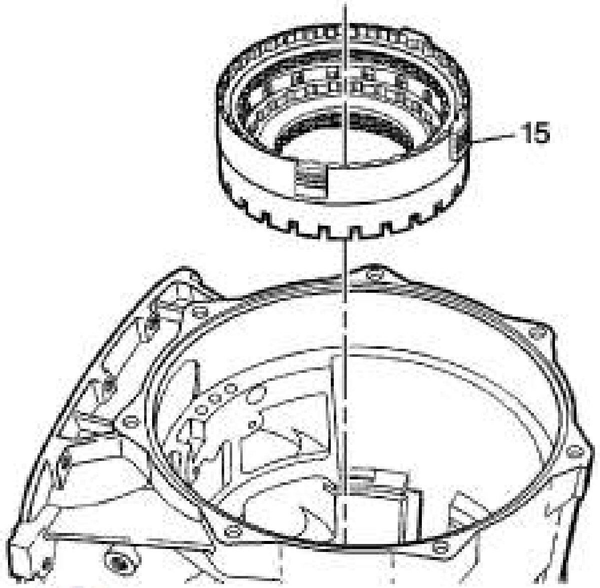
16. Install the overdrive piston spring (486).
17. Use J 44764 and J 23327 to compress the overdrive clutch piston spring (486).
18. Install the overdrive clutch spring snap ring (485).
19. Remove J 44764 and J 23327 .



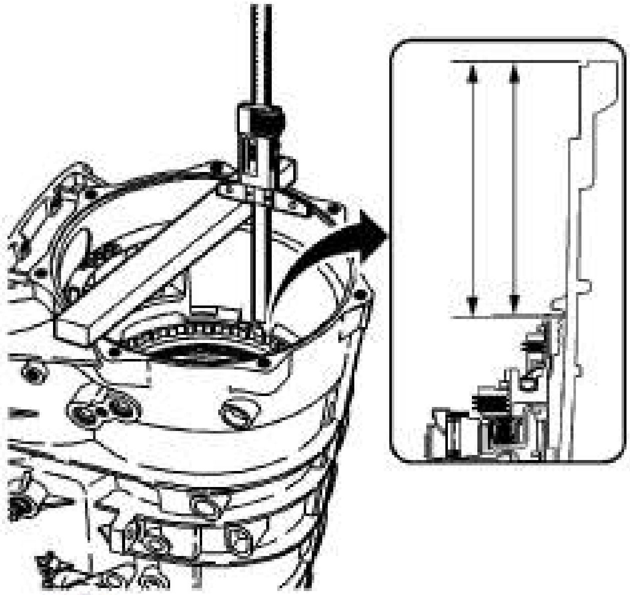
20. Install the overdrive clutch spacer (484).
21. Install the overdrive clutch plates. Starting with the overdrive clutch plates (483) with external splines. Alternating with the overdrive clutch plates (482) with internal splines. Refer to Clutch Plate Selection Specifications.
22. Install the overdrive backing plate (481).
23. Install the overdrive clutch retainer ring (480).



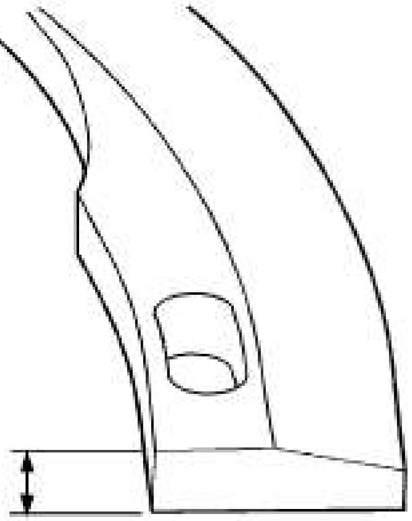
24. Measure the distance between the overdrive clutch backing plate and the bottom of the gage bar. Measure three times in different locations on the backing plate. Record this as H1.
25. Apply 65 PSI (448.17 kPa) of air pressure to the specified port. Measure the distance between the overdrive clutch backing plate and the bottom of the gage bar. Measure three times in different locations on the backing plate. Record this as H2.
26. Subtract H2 from H1 this is the clutch pack travel. Refer to Clutch Piston Travel Specifications.



27. Install the overdrive clutch housing (15) into the case.

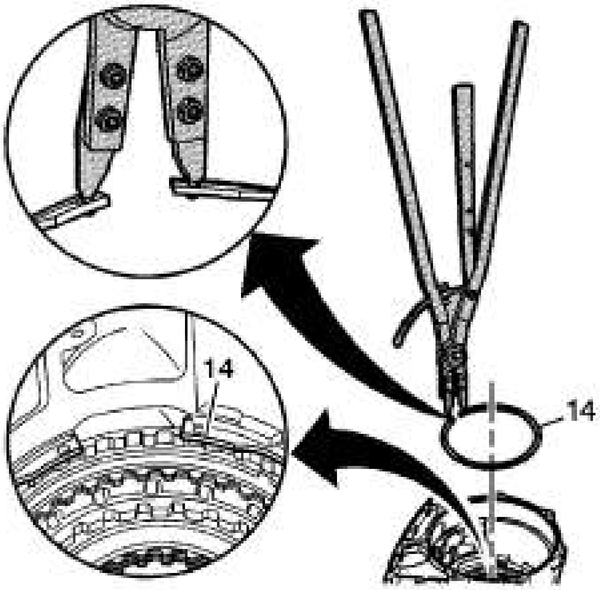


28. Measure the distance from the bottom of the gauge bar to the top of the overdrive and intermediate clutch. Record this as M1.
29. Measure the distance from the bottom of the gage Bar to the bottom of the intermediate and overdrive retainer ring groove in the case. Record this as M2.
30. Subtract M2 from M1. This will be dimension M.



31. Measure the intermediate and overdrive clutch housing retaining ring (14). Refer to Intermediate and Overdrive Clutch Housing Retaining Ring Specifications, for the correct size washer.

Caution: Refer to General Repair Instructions in the Preface section.



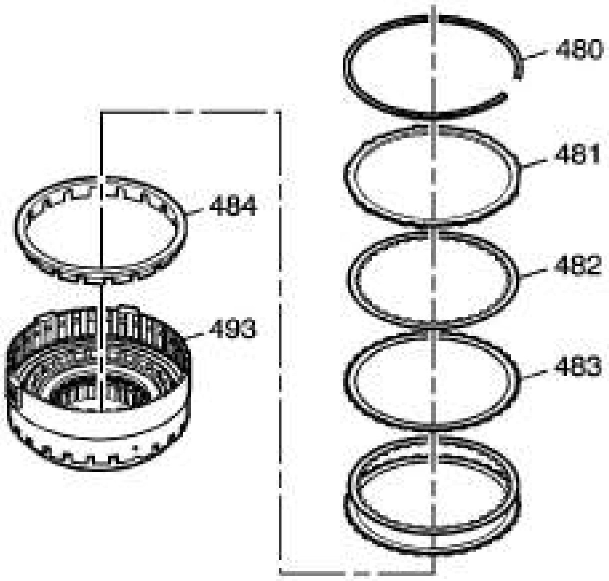
Important: If housings is replaced a measurement must be taken for end play.

32. Using J 45126 install the intermediate and overdrive clutch housing snap ring (14) into the case (24).

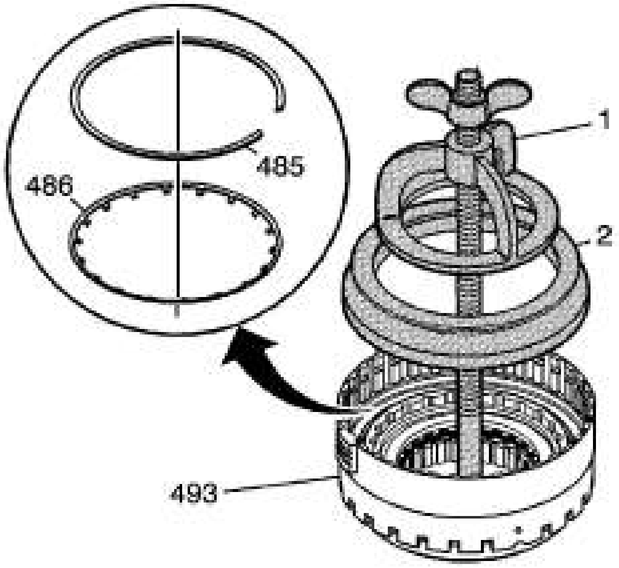
Intermediate and Overdrive and Reverse Clutch Hub Disassemble

Tools Required

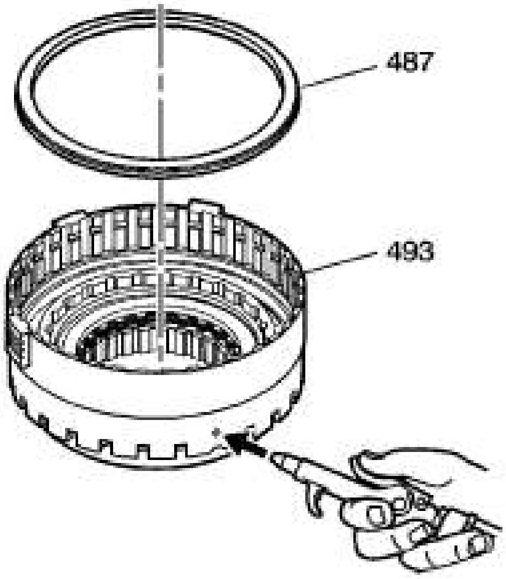
- J 23327 Clutch Spring Compressor
- J 44764 Clutch Spring Compressor



1. Remove the overdrive clutch snap ring (480) from the overdrive clutch housing (493).
2. Remove the overdrive clutch backing plate (481) from the overdrive clutch housing (493).
3. Remove the overdrive clutch plates (482 and 483). Refer to Clutch Plate Selection Specifications.
4. Remove the overdirve clutch spacer (484) from the overdrive clutch housing (493).

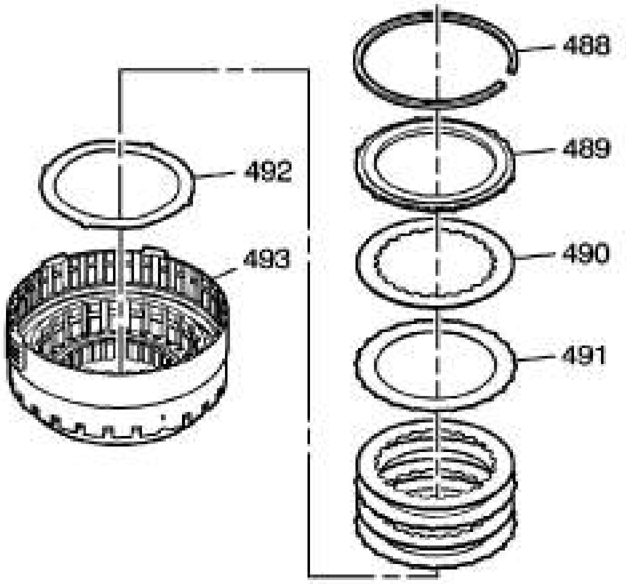


5. Use J 44764 and J 23327 to compress the overdrive clutch piston spring (486).
6. Remove the overdrive clutch piston spring snap ring (485) from the overdrive clutch housing (493).
7. Remove J 44764 and J 23327 from the overdrive clutch housing (493).
8. Remove the overdrive clutch spring (486) from the overdrive clutch housing (493).

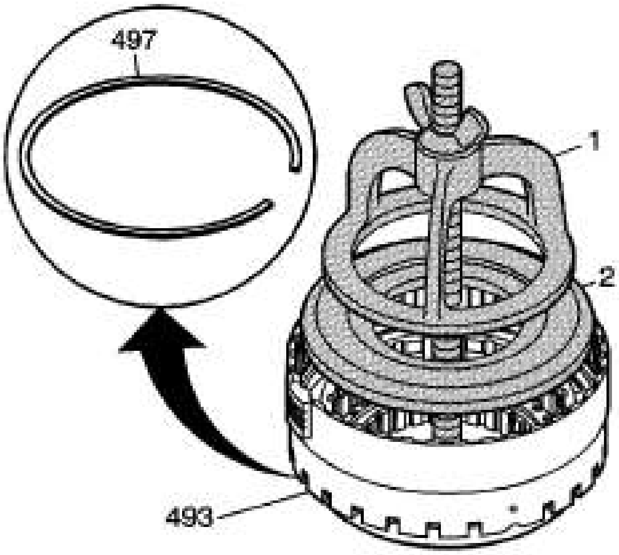


Important: It may be necessary to use air pressure to remove the piston.

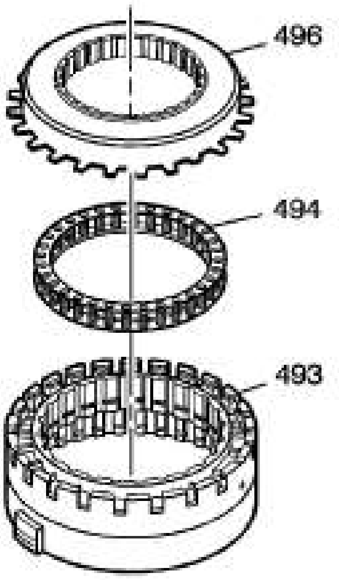
9. Remove the overdrive clutch piston (487) from the overdrive clutch housing (493).



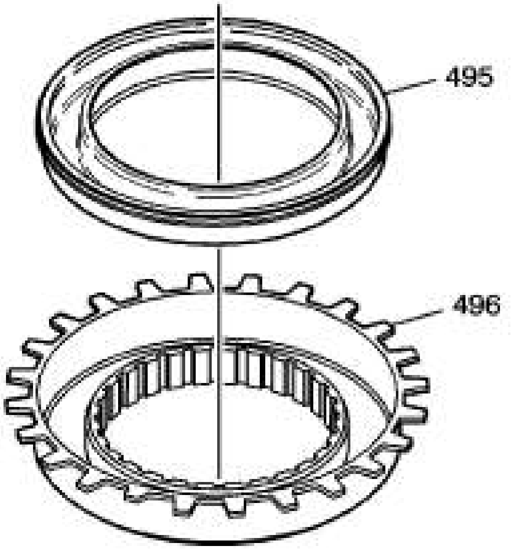
10. Remove the intermediate clutch backing plate snap ring (488) from the overdrive clutch housing (493).
11. Remove the intermediate clutch backing plate (489) from the overdrive clutch housing (493).
12. Remove the intermediate clutch plates (490 and 491) from the overdrive clutch housing (493). Refer to Clutch Plate Selection Specifications.
13. Remove the intermediate clutch apply plate (492) from the overdrive clutch housing (493).



14. Use J 44764 and J 23327 to compress the intermediate clutch housing (496).
15. Remove the intermediate clutch housing snap ring (497) from the overdrive clutch housing (493).

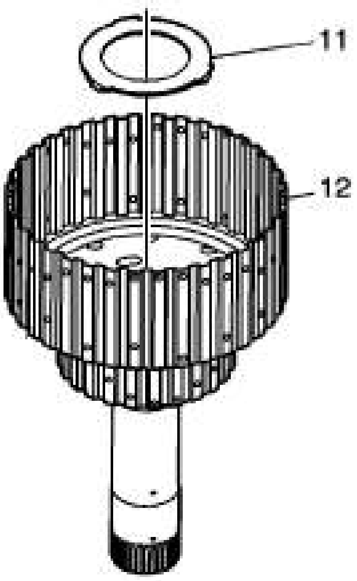


16. Remove J 44764 and J 23327 from the overdrive clutch housing (493).
17. Remove the intermediate clutch housing (496), and the intermediate clutch spring (494) from the overdrive clutch housing (493).

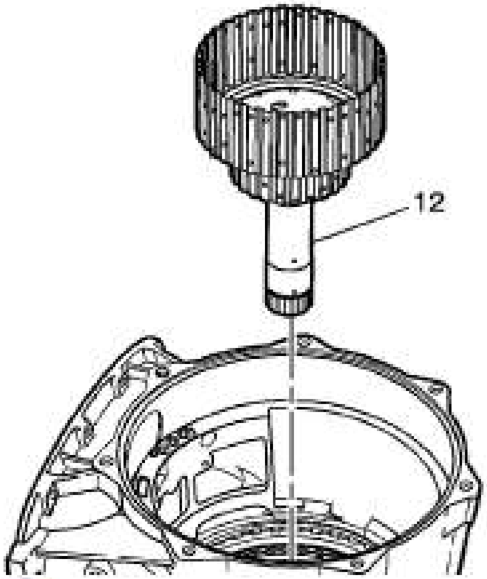


18. Remove the intermediate clutch piston (495) from the overdrive clutch housing (496).

Intermediate Clutch Sprag Assemble

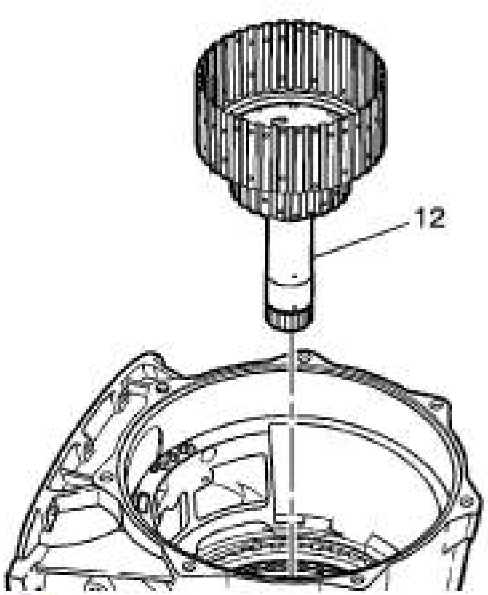


1. Apply J 36850 to the input and reaction carrier inner shaft thrust washer (11) and install into the intermediate sprag clutch assembly (12).



2. Install the intermediate sprag clutch assembly (12) into the case.

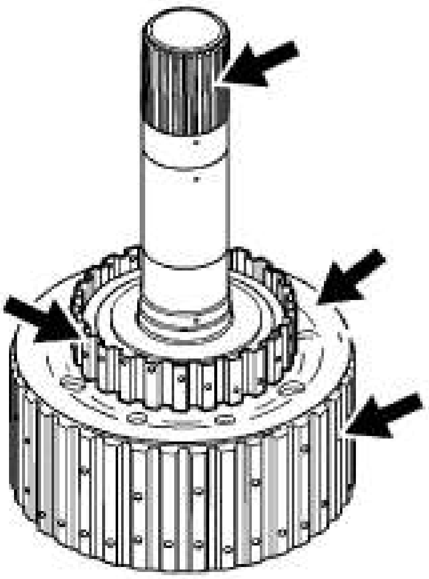
Intermediate Clutch Sprag Assembly Removal



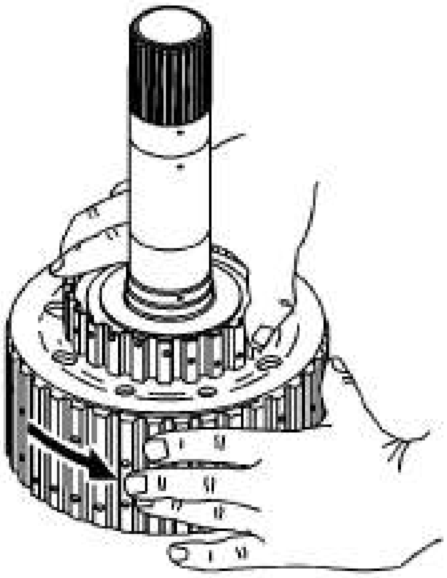
Remove the intermediate clutch sprag assembly (12) from the case.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 5L40-E/5L50-E | Repair Instructions - Off Vehicle | Document ID: 1977457

Intermediate Clutch Sprag Inspection

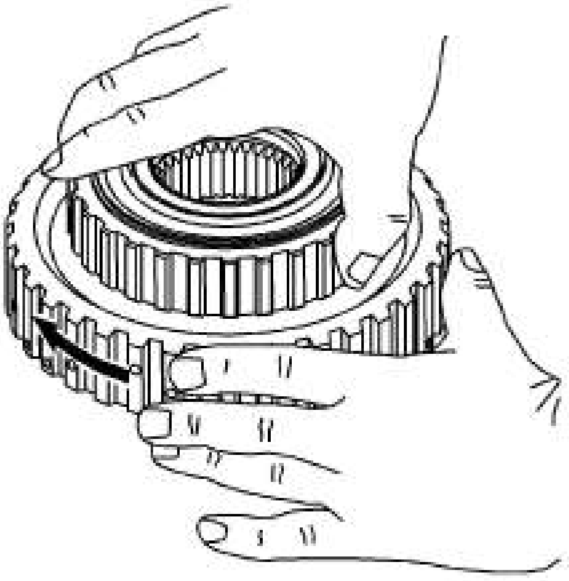


1. Inspect the intermediate sprag clutch for the following conditions:
    - Scoring
    - Wear or cracks

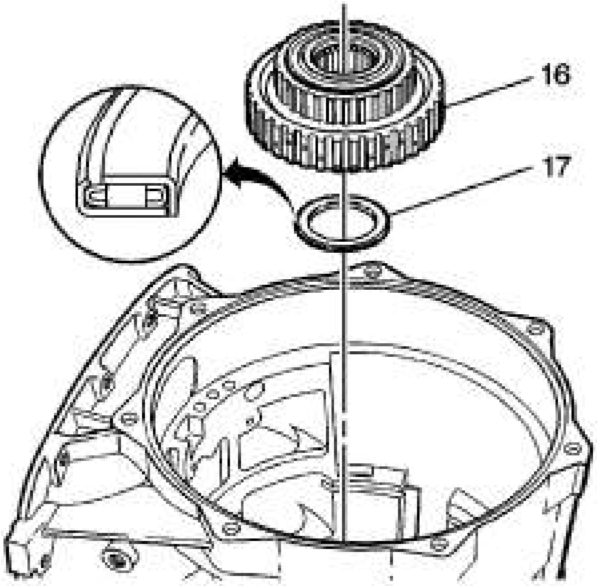


2. Check that the intermediate sprag clutch rotation freewheels and locks up in the correct direction.

Low Clutch Sprag Assemble

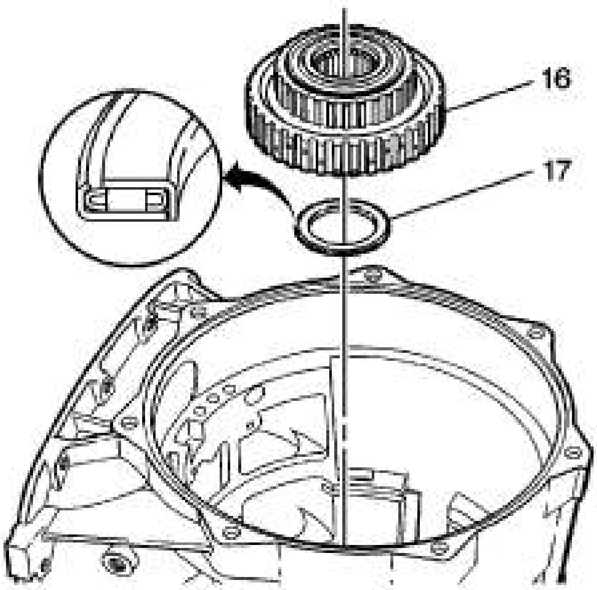


1. Inspect the low clutch sprag for the following:
   - Damaged or worn splines
   - Scoring on the inside diameter of the races
   - Wear or cracks
2. Check that the low clutch sprag rotation freewheels and locks up in the correct direction.



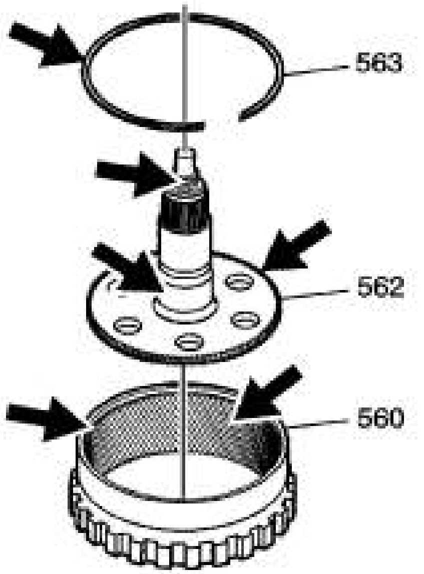
3. Install the low clutch roller thrust bearing (17).
4. Install the low clutch sprag (16) into the case (24).

Low Clutch Sprag Removal

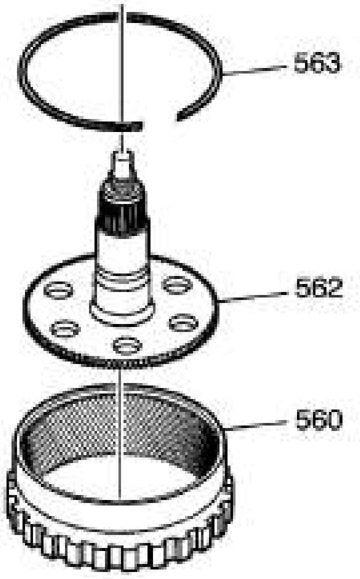


1. Remove the low clutch sprag (16) from the case.
2. Remove the low clutch roller thrust bearing (17).

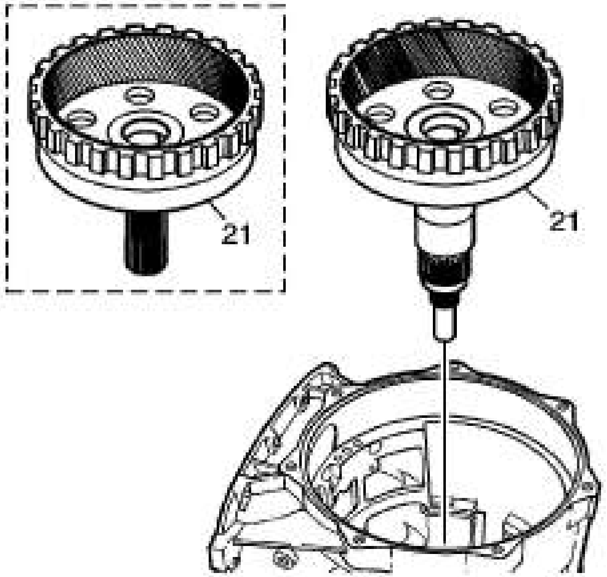
Output Shaft and Rear Internal Ring Gear Assemble



1. Inspect the output shaft (562) and the rear internal gear (560) for the following:
    - Damaged or worn bushings
    - Damaged splines
    - Damaged or worn snap ring (563)
    - Damaged or worn gear teeth
    - Damaged or worn snap ring groove
    - Damaged or cross-threaded threads
    - Damaged or worn bearings

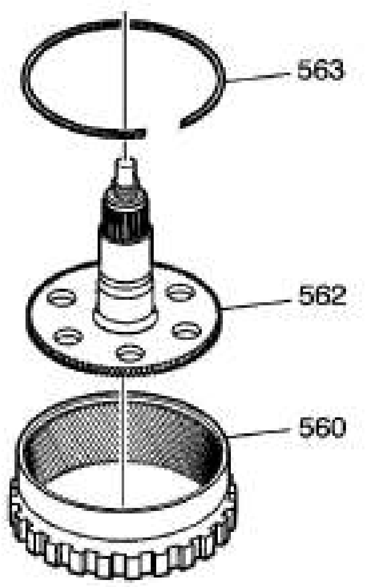


2. Install the output shaft (562) into the rear internal gear (560).
3. Install the snap ring (563) onto the rear internal ring gear (560). Be sure it is seated in the groove.



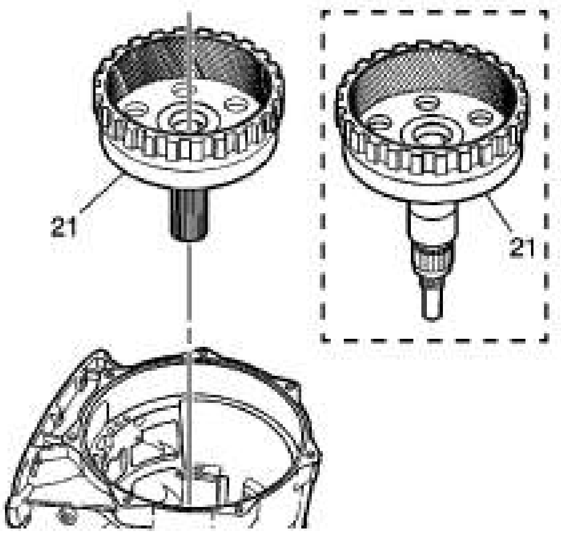
4. Rotate the transmission 90 degrees.
5. Install the ouput shaft assembly (21) into the case.

Output Shaft and Rear Internal Ring Gear Disassemble



1. Remove the snap ring (563).
2. Remove the output shaft (562) from the rear internal gear (560).

Output Shaft Removal



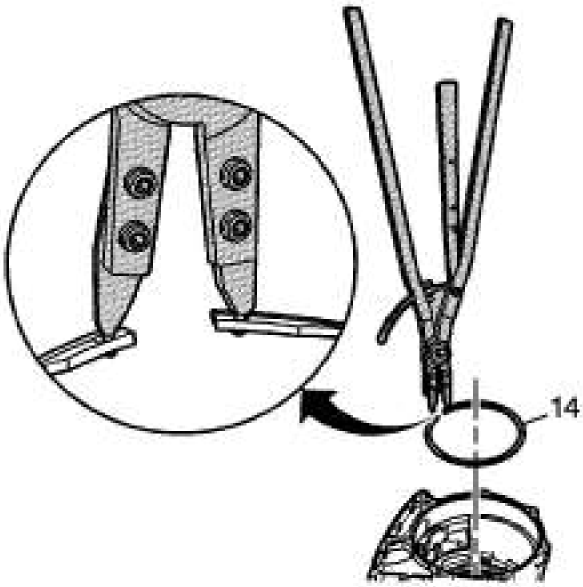
Remove the output shaft assembly (21) from the case (24).

Overdrive Clutch Housing Removal

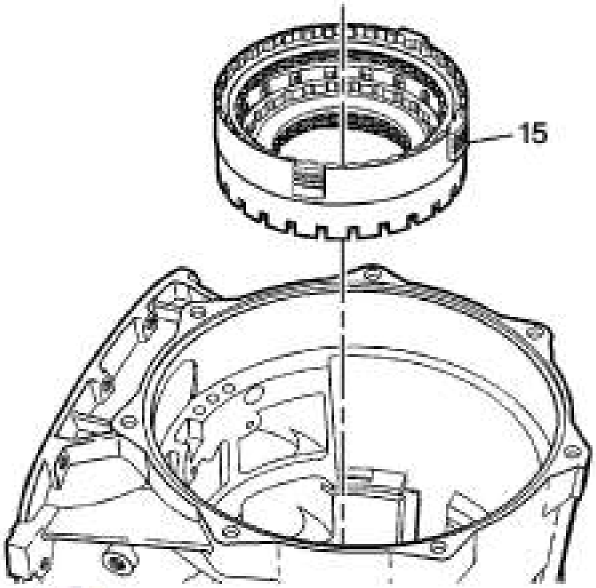
Tools Required

J 45126 Snap Ring Pliers

Caution: Refer to General Repair Instructions in the Preface section.



1. Use J 45126 J 45126 to remove the snap ring (14).

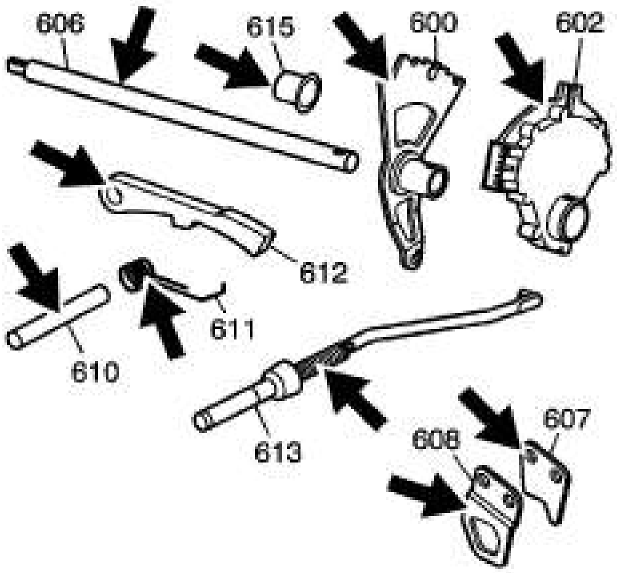


2. Remove the overdrive clutch housing (15) from the case.

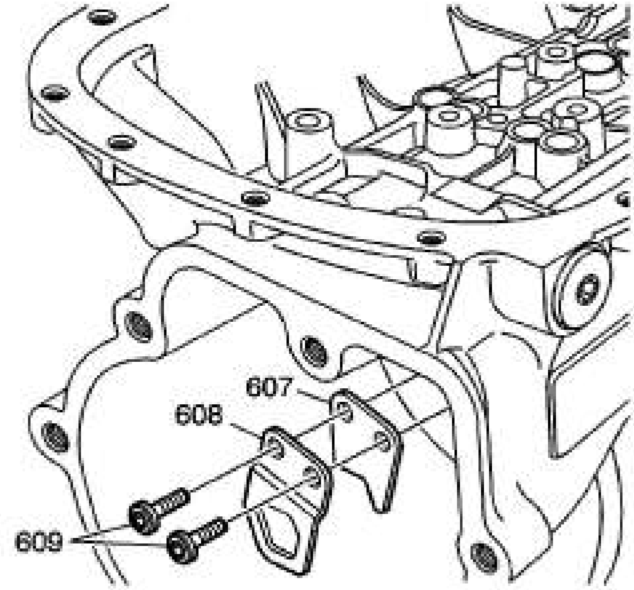
Parking System Components Installation

Tools Required

J 44767 Seal Installer



1. Inspect the park system components for the following:
   - Worn park pawl actuator brackets (607 and 608)
   - A damaged or bent park pawl actuator assembly (613)
   - A damaged manual shaft detent lever (600)
   - A damaged manual shaft shift switch assembly (602)
   - A worn or stripped manual shaft (606)
   - A worn or damaged park pawl shaft (610), park pawl spring (611), and park pawl (612)
   - A worn or damaged spacer (615), - some models.

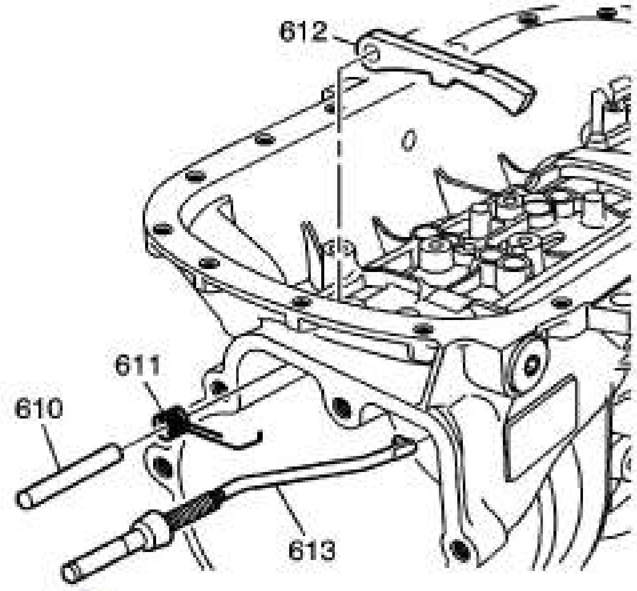


2. Install the park pawl actuator brackets (607 and 608) onto the case.

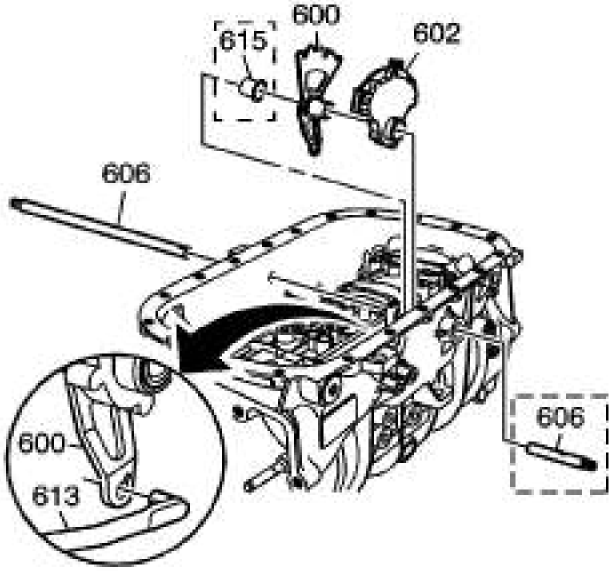
   Notice: Refer to Fastener Notice in the Preface section.

3. Install the bracket retaining bolts (609).

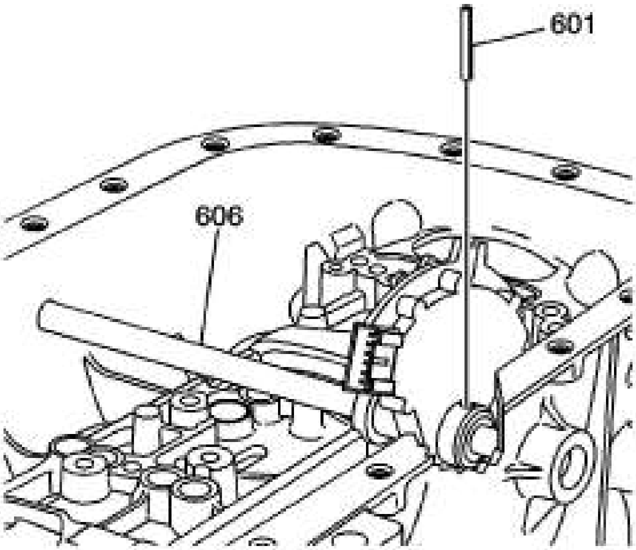
   Tighten
   Tighten the bolts to 22 N·m (16 lb. ft).



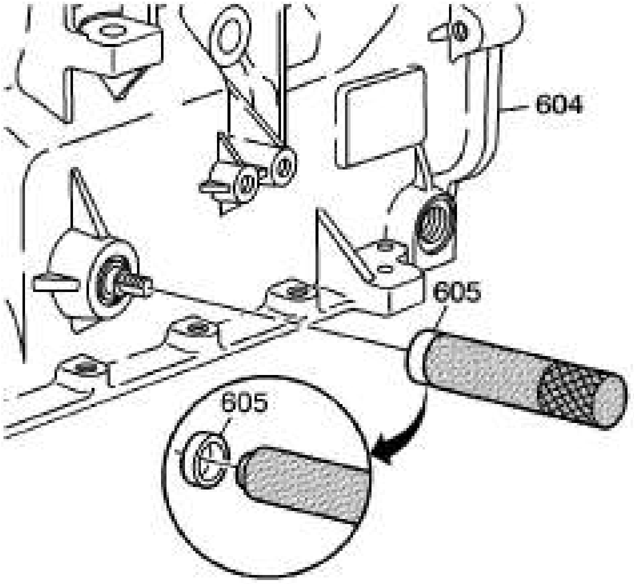
4. Install the park pawl (612), the park pawl spring (611), and the park pawl shaft (610) into the case.
5. Install the park pawl actuator (613) into the case.



6. Install the shift switch assembly (602) and spacer (615) - some models onto the detent lever (600).
7. Install the park pawl actuator (613) into the detent lever (600).
8. Install the shift shaft (606) into the case.



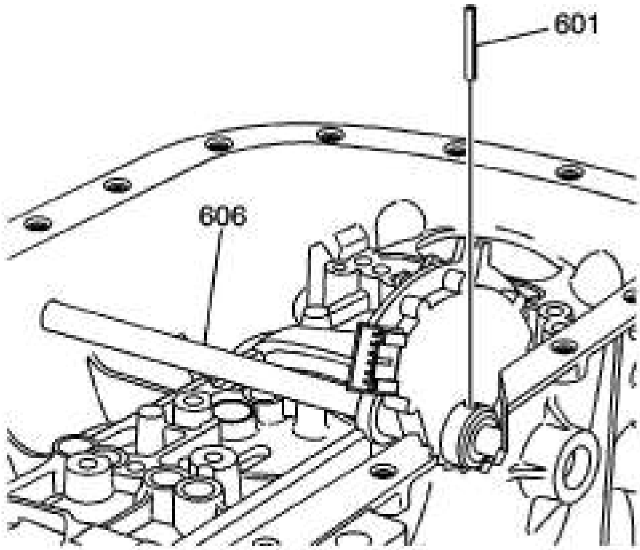
9. Align the groove for the NEW manual shaft pin (601) with the pin hole in the detent lever/shift switch assembly.
10. Install the manual shaft pin (601) into the shift shaft (606).



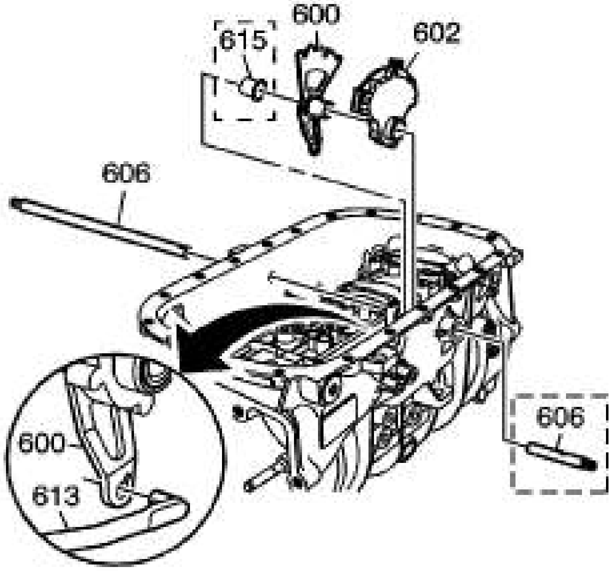
11. Install a NEW manual shaft seal (605) onto J 44767 .
12. Use a J 44767 to install the NEW manual shaft seal (605) into the case (604).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 5L40-E/5L50-E | Repair Instructions - Off Vehicle | **Document ID: 1977436**

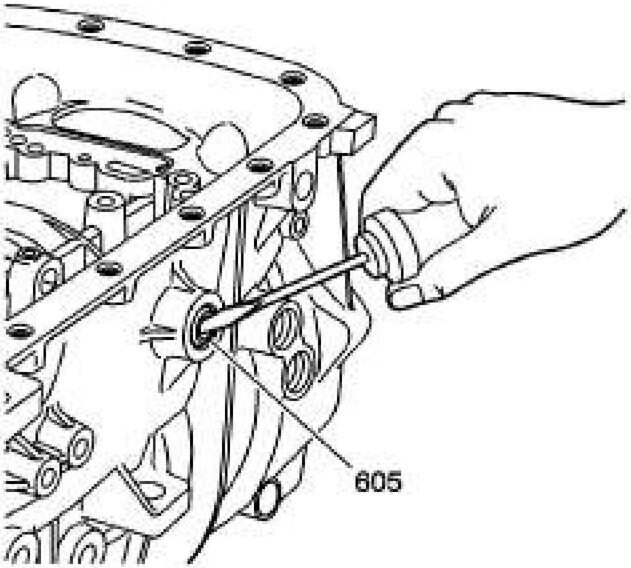
Parking System Components Removal



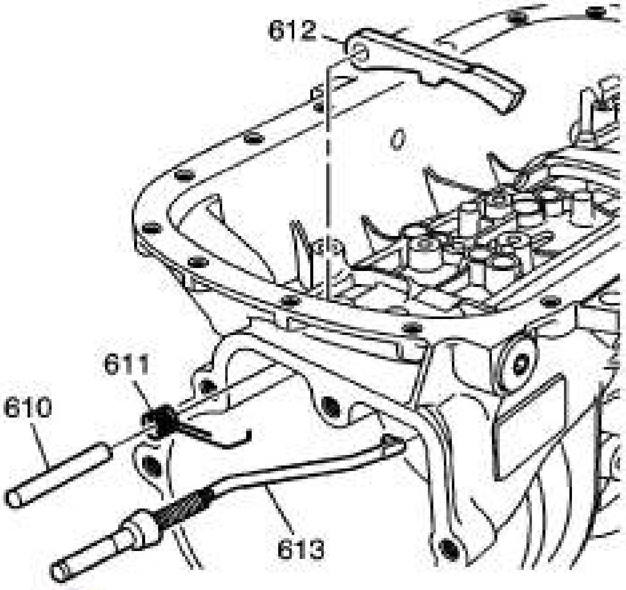
1. Rotate the transmission 90 degrees. Remove the shift shaft detent lever pin (601) from the case.



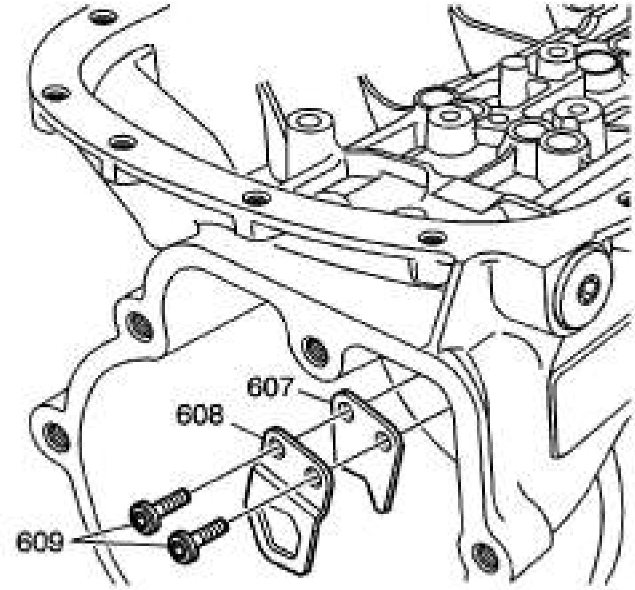
2. Remove the manual shift shaft (606) from the case.
3. Disconnect the park pawl actuator assembly (613) from the manual shaft detent lever (600).
4. Remove the manual shaft detent lever (600), spacer (615) - some models and the manual shaft shift switch assembly (602) from the case.



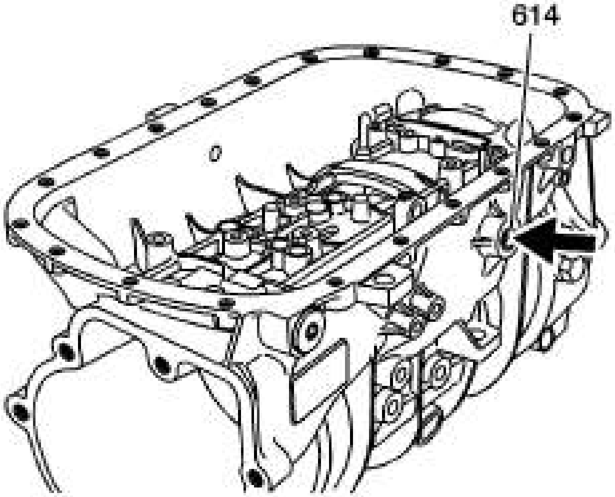
5. Use a suitable tool in order to pry the shift shaft seal (605) from the case.



6. Remove the park pawl actuator assembly (613) from the case.
7. Remove the park pawl shaft (610), park pawl spring (611) and the park pawl (612) from the case.

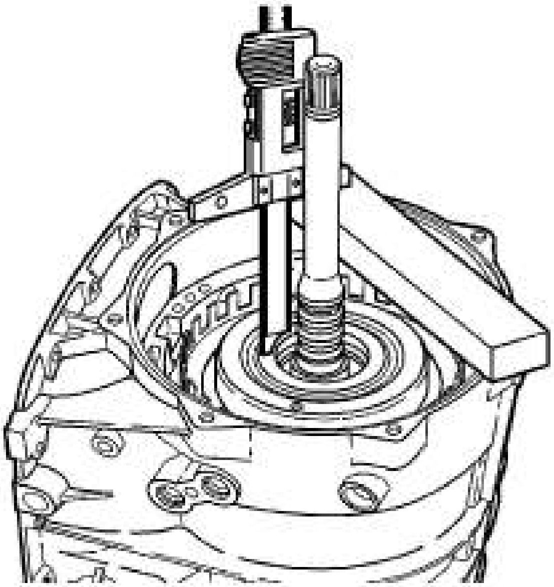


8. Remove the park pawl actuator bracket retaining bolts (609) from the case.
9. Remove the park pawl actuator brackets (607, 608) from the case.

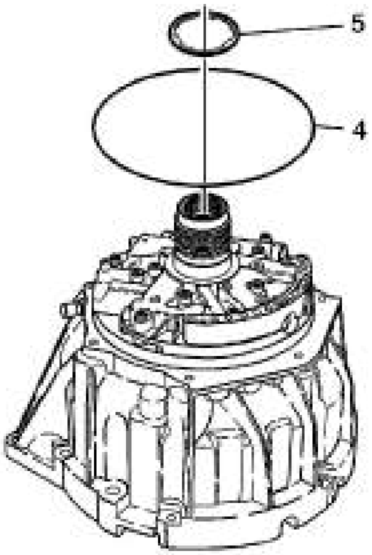


10. Inspect the cup plug (614) for signs of leaks.

Torque Converter Housing Installation

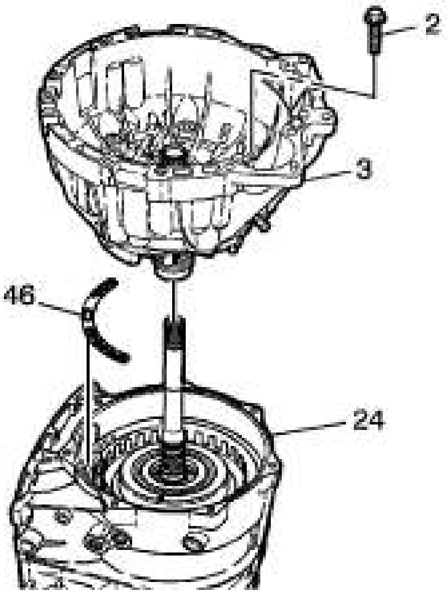


1. Measure the distance from the bottom of the gage bar to the top of the direct and reverse clutch assembly (6). Record this as dimension X. Refer to the Reverse Clutch Housing Selective Thrust Washer Specifications, to determine the correct size to use.



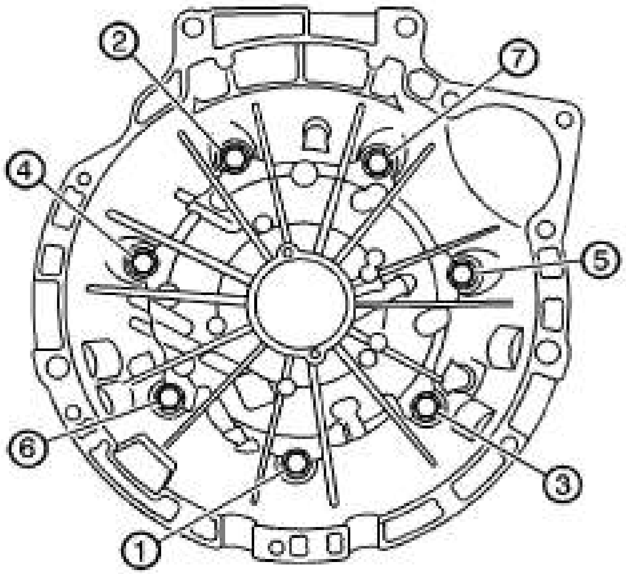
2. Use lubricant to install the NEW torque converter fluid seal (4) onto the torque converter housing.

   Use lubricant to install the reverse clutch housing thrust washer (5).



3. Install the NEW fluid pump cover gasket (46).
4. Install the torque converter housing (3) onto the case (24).
5. Install the torque converter housing retaining bolts (2) and hand tighten.

Notice: Refer to Fastener Notice in the Preface section.

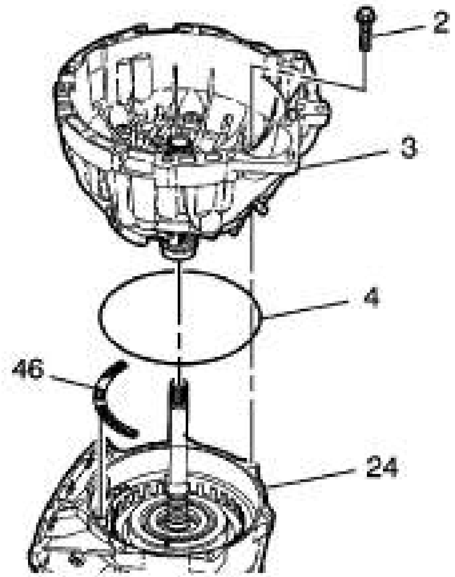


6. Tighten the torque converter housing retaining bolts in sequence.

Tighten
Tighten the bolts to 22 N·m (16 lb. ft).

Torque Converter Housing Removal

1. Remove the transmission. Refer to Transmission Replacement.



2. Rotate the transmission 90 degrees so that the converter housing is facing up. Remove the torque converter housing bolts (2) from the torque converter housing (3).
3. Remove the torque converter housing assembly (3) from the case (24).
4. Remove the torque converter housing fluid seal assembly (4).
5. Remove the fluid pump cover gasket (46).

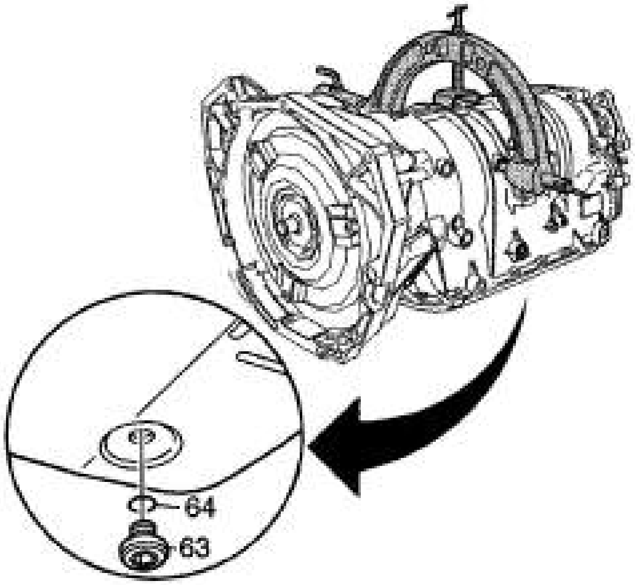
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 5L40-E/5L50-E | Repair Instructions - Off Vehicle | **Document ID: 2006951**

Transmission Fluid Draining

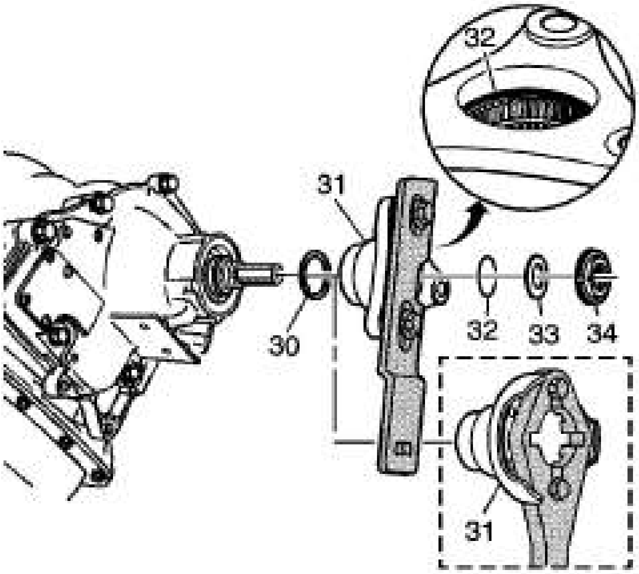
Tools Required

J 45012 Holding Fixture

1. Place a suitable drain tray under the transmission.



2. Remove the fluid pan drain plug (63) and seal (64), and allow the transmission fluid to drain.



3. Put transmission in park.

4. Install either the J 45012 to hold the drive flange.

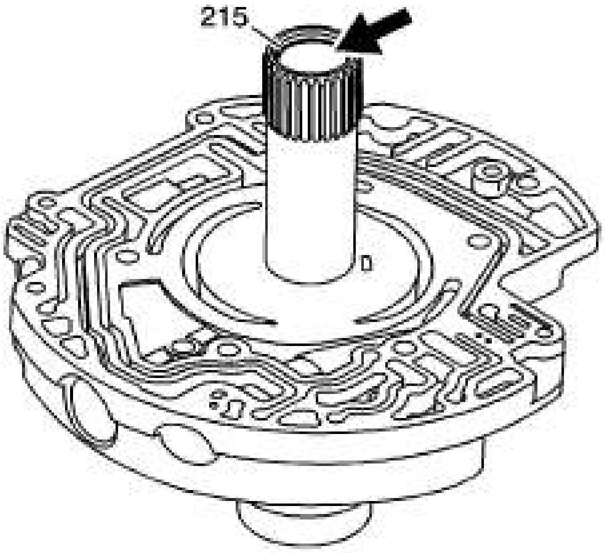
   Important: Discard retainer (30), seal (32), washer (33) and nut (34).

5. Remove the drive flange retaining nut (34).
6. Remove the drive flange washer (33) and seal (32).
7. Remove the drive flange (31) and the output shaft assembly retainer (30).
8. Slowly rotate the transmission to a vertical position, with the bell housing facing up, and allow any excess fluid to drain.

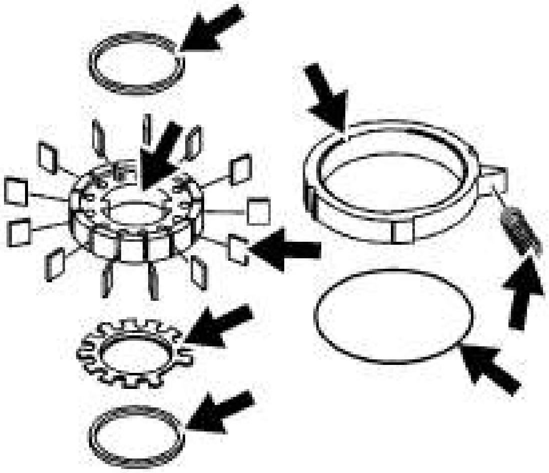
Transmission Fluid Pump Assemble

Tools Required

J 21368 Pump Body Cover Alignment Band

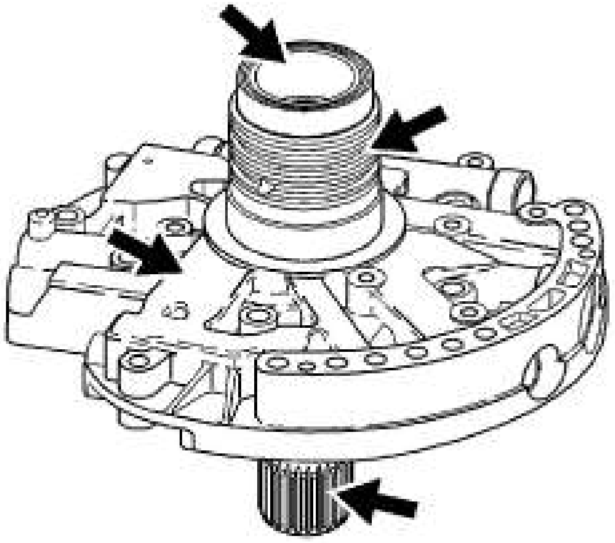


1. Inspect the fluid pump bushing (215) for wear - not serviceable.

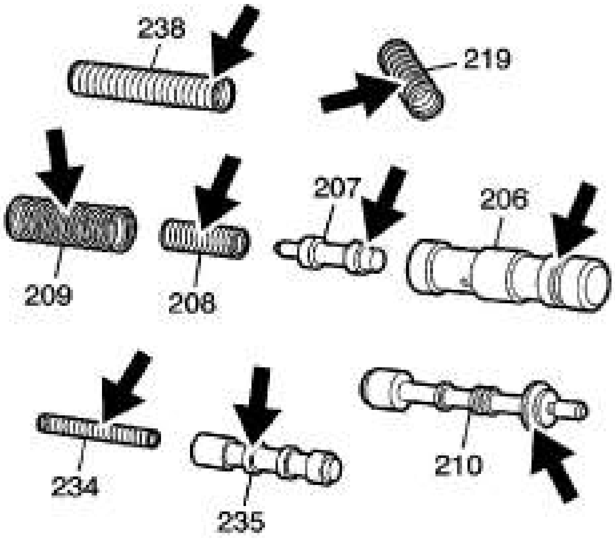


2. Inspect the fluid pump parts for the following:
   - Worn, scored or gouged pump slide

  - Cracks, wear or damage to the rotor or vanes
  - Cuts or damage to the seals
  - Broken priming springs

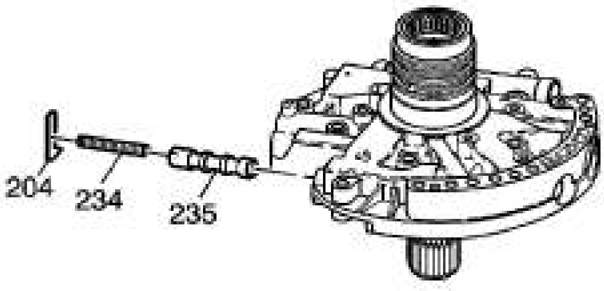


3. Inspect the fluid pump housing for the following:
   - Porosity
   - Interconnected oil passages
   - Damaged machined surfaces

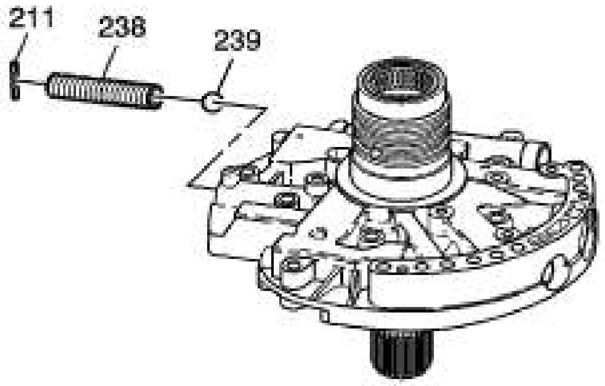


4. Inspect the valves (207, 210 and 235) and springs (208, 209, 234, 238 and 219) for the following:

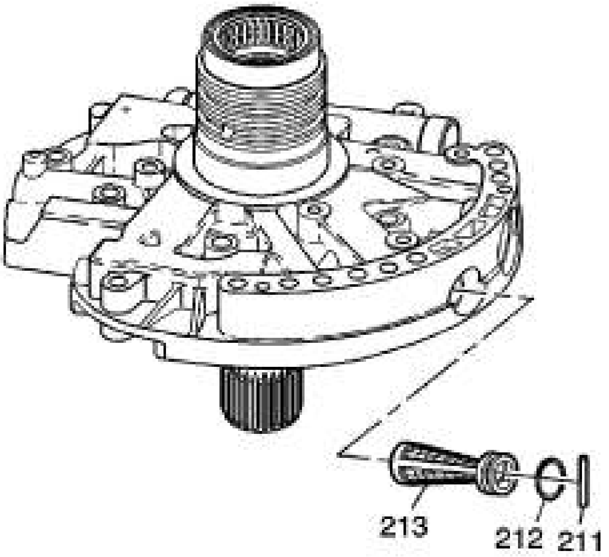
- Nicks or burrs on the valves
- Worn, distorted or cracked springs



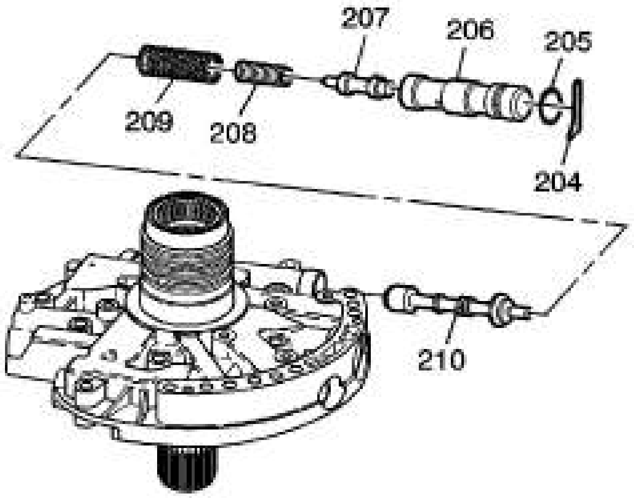
5. Install the tcc control valve (235) and the tcc control valve spring (234).
6. Install the tcc control valve spring retainer (204).



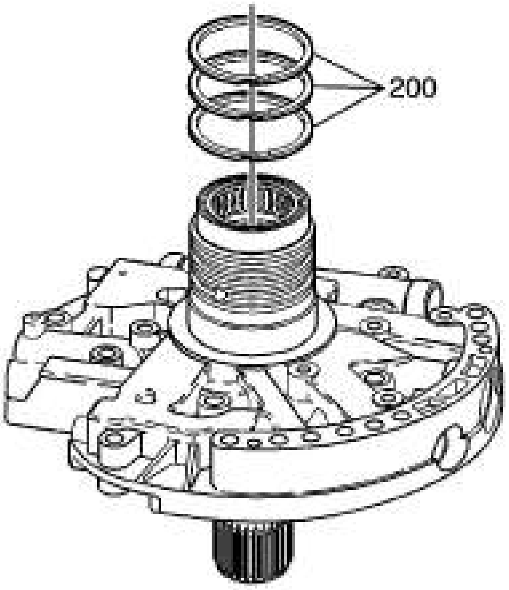
7. Install the pressure relief ball (239) and spring (238).
8. Install the pressure valve spring retainer (211).



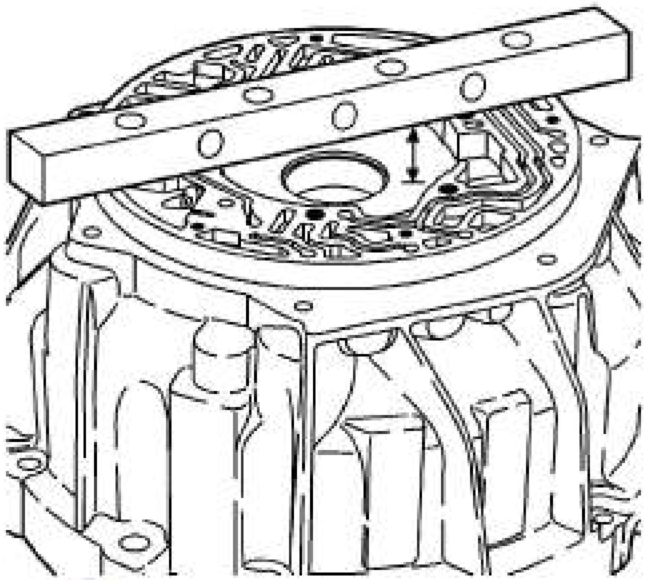
9. Install the fluid pump cover seal (212) onto the new pump cover screen (213).
10. Install the fluid pump cover screen (213).
11. Install the fluid pump cover screen pin (211).



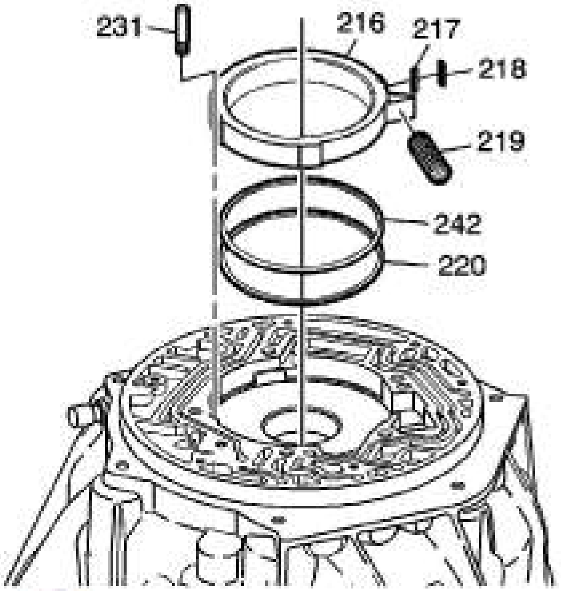
12. Install the pressure regulator valve (210), the pressure regulator valve spring (209), and the line boost valve spring (208).
13. Install the line boost valve bushing seal (205) onto the bushing (206).
14. Install the line boost valve (207) and the bushing (206).
15. Install the line boost valve bushing retainer (204).



16. Install the reverse clutch housing fluid seal rings (200).



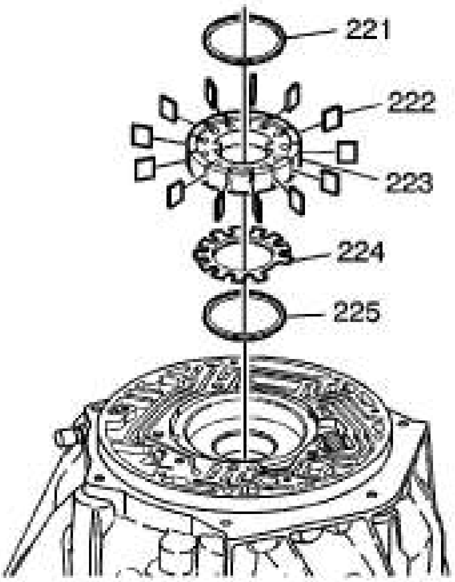
17. Measure the distance from the bottom of the gage bar to the fluid pump body. Refer to Transmission Fluid Pump Specifications.
18. Measure the thickness of pump slide (216).
19. Select the correct size, refer to Transmission Fluid Pump Specifications.
20. Measure the thickness of the pump rotor (223).
21. Select the correct size rotor refer to Transmission Fluid Pump Specifications.



22. Install the fluid pump support (217), the slide seal (218) and the fluid pump slide rings (220), and the fluid pump slide o-ring seal (242) onto the pump slide (216).
23. Install the slide pin (231).

Important: The fluid pump slide (216) is selective.

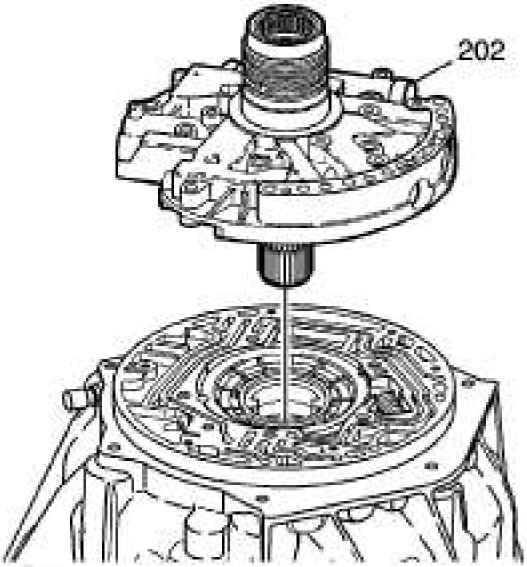
24. Install the fluid pump slide (216).
25. Using a suitable tool install the slide spring (219).



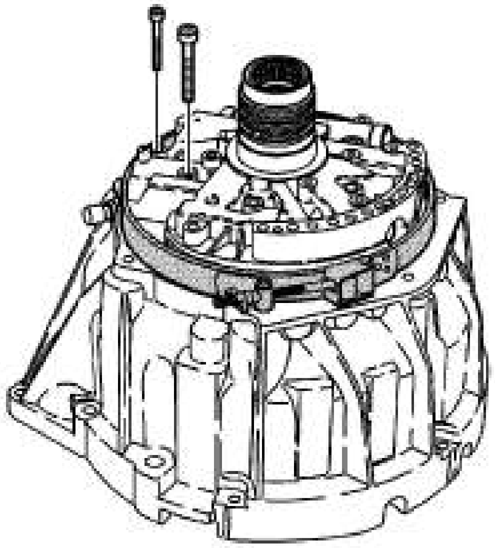
26. Install the fluid pump vane ring (225).
27. Install the fluid pump rotor guide (224).

Important: The fluid pump rotor (223) is selective.

28. Install the fluid pump rotor (223).
29. Install the fluid pump vanes (222).
30. Install the fluid pump vane ring (221).

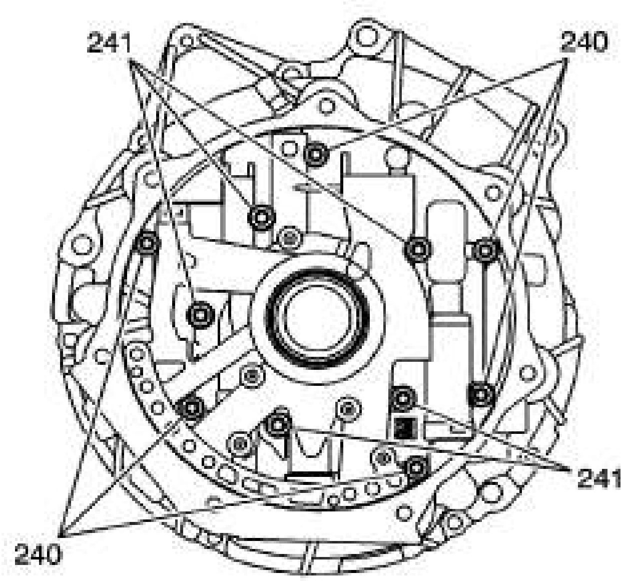


31. Install the fluid pump cover housing (202) onto the converter housing (224).



32. Install J 21368 and tighten.

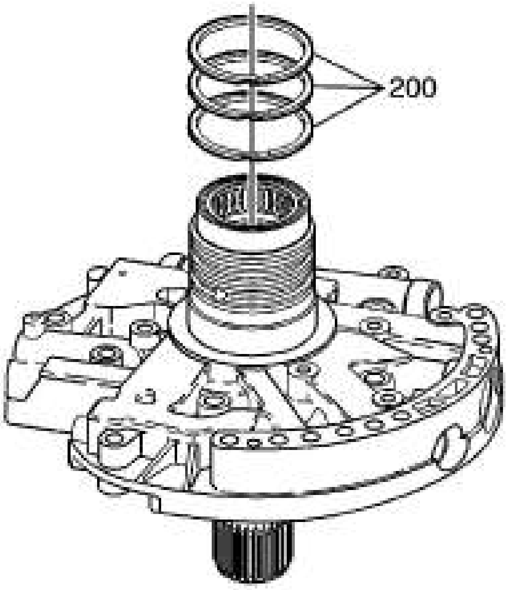
Notice: Refer to Fastener Notice in the Preface section.



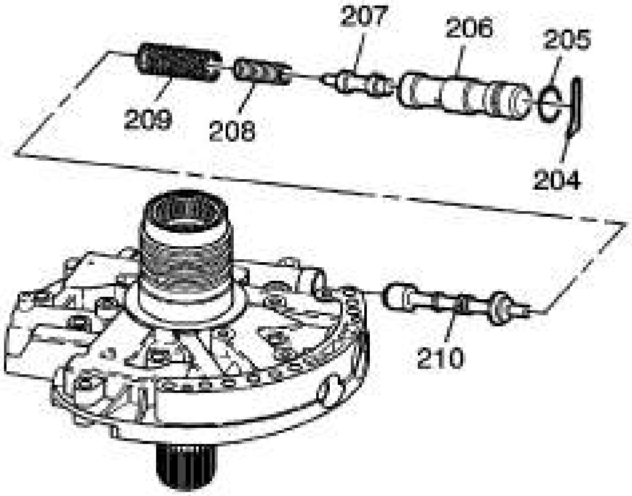
33. Install the fluid pump housing retaining bolts (240, 241).

    Tighten
    - Tighten the fluid pump housing retaining bolts (240) to 11 N·m (8 lb. ft).
    - Tighten the fluid pump housing retaining bolts (241) to 22 N·m (16 lb. ft).
34. Remove J 21368 .

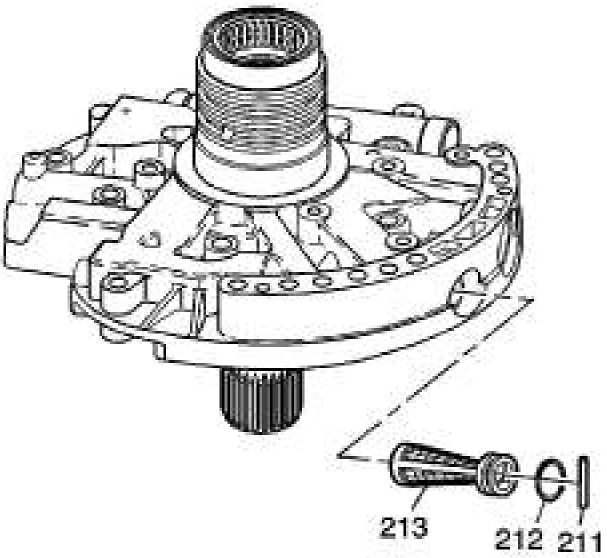
Transmission Fluid Pump Disassemble



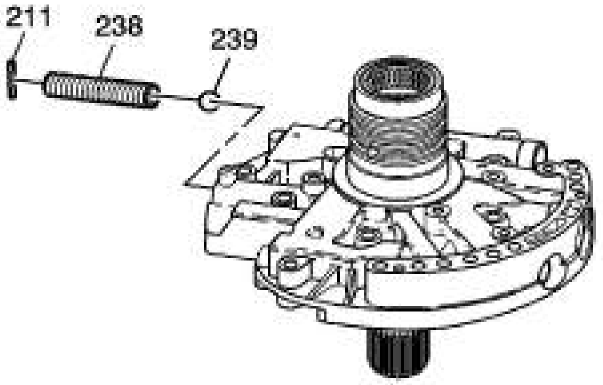
1. Remove the reverse clutch housing seal rings (200).



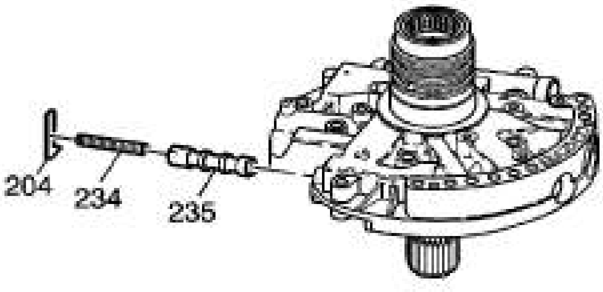
2. Remove the line boost valve retainer (204).
3. Remove the line boost valve bushing (206) and the line boost valve (207).
4. Remove the line boost valve bushing seal (205).
5. Remove the line boost valve spring (208) and the pressure regulator valve spring (209).
6. Remove the pressure regulator valve (210).



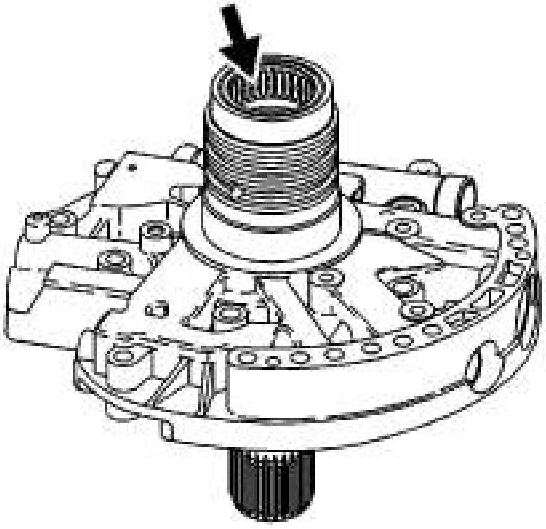
7. Remove the fluid pump cover screen pin (211).
8. Remove the fluid pump cover screen (213).
9. Remove the fluid pump cover seal (212).



10. Remove the pressure relief ball pin (211).
11. Remove the pressure relief spring (238) and the pressure relief ball (239).

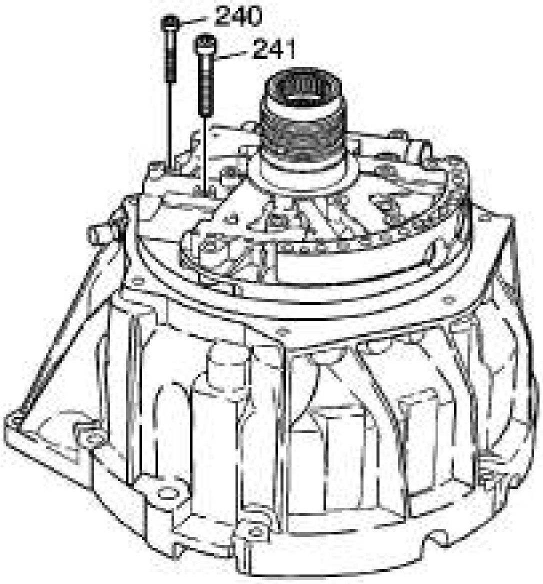


12. Remove the torque converter clutch (TCC) control valve pin (204).
13. Remove the TCC control valve spring (234) and the TCC control valve (235).

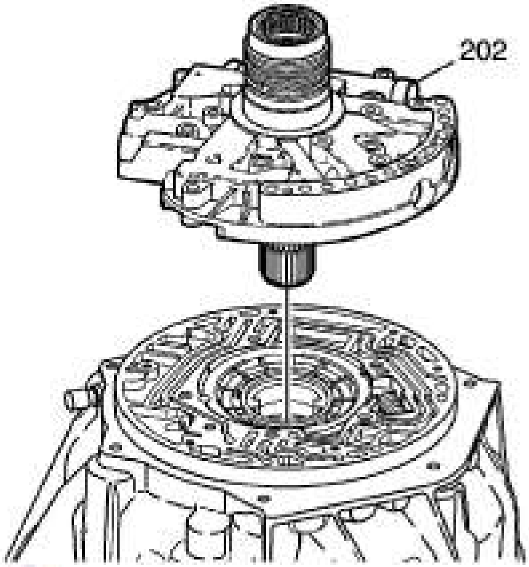


14. Inspect the input shaft bearing (201) for the following:
    - Damaged bearing cage
    - Pitted bearings
    - Scored bearings

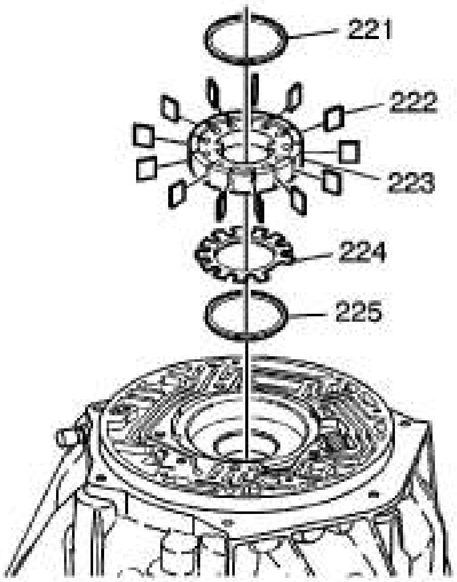
Transmission Fluid Pump Removal



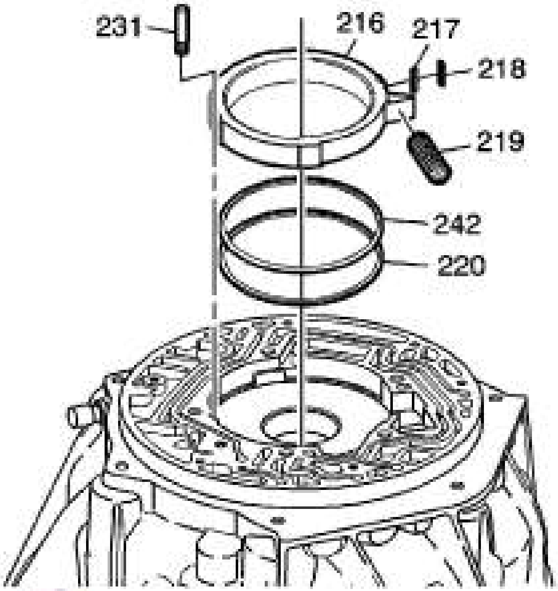
1. Remove the fluid pump to torque converter housing bolts (240, 241).



2. Remove the fluid pump cover (202).

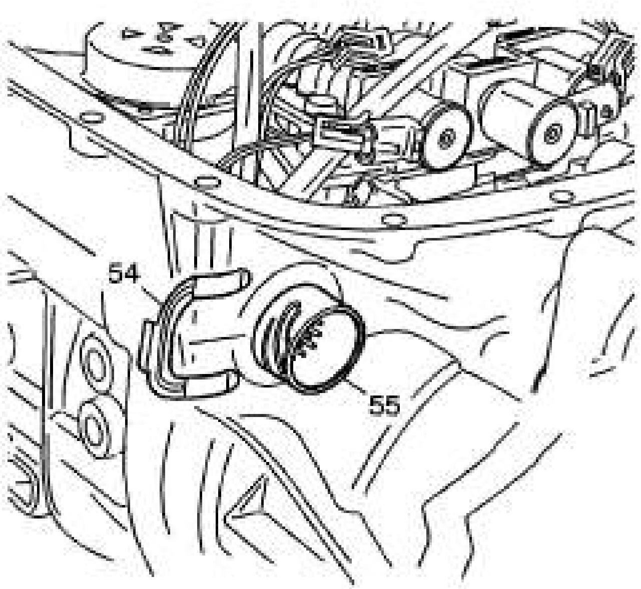


3. Remove the fluid pump vane ring (221).
4. Remove the fluid pump vanes (222).
5. Remove the fluid pump rotor (223).
6. Remove the fluid pump rotor guide (224).
7. Remove the fluid pump vane ring (225).

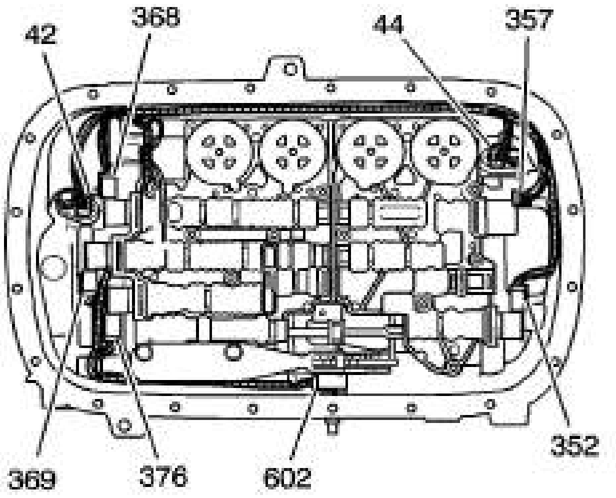


8. Remove the fluid pump slide spring (219).
9. Remove the fluid pump slide (216).
10. Remove the fluid pump slide pin (231).
11. Remove the fluid pump slide ring (220, 242).
12. Remove the fluid pump support (217) and the fluid pump slide seal (218).

Wiring Harness Installation



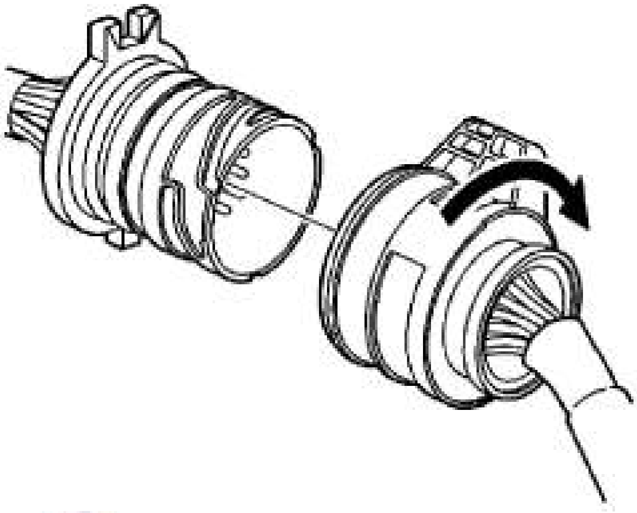
1. Install the wiring harness connector (55) through the case. Hold the connector and install the wiring harness connector retainer (54).



2. Install the wiring harness to the valve body and connect the following components:
   - Pressure Control Solenoid (357)
   - TCC PWM Solenoid (352)
   - 1-2 Shift Solenoid (368)

- 2-3 Shift Solenoid (369)
- 4-5 Shift Solenoid (376)
- Internal Mode Switch - IMS (602)
- Input Speed Sensor (44)
- Output Speed Sensor (42)

Automatic Transmission Inline 20-Way Connector Description



The transmission electrical connector is an important part of the transmission operating system. Any interference with the electrical connection can cause the transmission to set diagnostic trouble codes (DTC) or affect proper operation.

The following items can affect the electrical connection:

- Bent terminals in the connector from rough handling during connection and disconnection
- Wires backing away from the pins or coming uncrimped, in either the internal or the external wiring harness
- Dirt or moisture contamination entering the connector when disconnected
- Pins in the internal wiring connector backing out of the connector during connection
- Transmission fluid leaking into the connector, wicking up into the external wiring harness and degrading the wire insulation
- Low terminal tension in the external connector from excessive connection and disconnection of the wiring connector assembly
- Terminal corrosion from contamination
- Damaged connector or connector lock assembly

Remember the following points:

- In order to disconnect the connector, turn the connector clockwise and pull.

- Do not pry the connector with a screwdriver or other tool.
- The connector should screw into place with a positive feel and lock when properly installed.
- Whenever the transmission external wiring connector is disconnected from the internal harness and the ignition is ON, transmission DTCs will set. Clear these DTCs after reconnecting the transmission connector.

Definitions and Abbreviations

Throttle Positions

Engine Braking: A condition where the engine is used to slow the vehicle by manually downshifting during a zero throttle coastdown.

Full Throttle Detent Downshift: A quick apply of the accelerator pedal to its full travel, forcing a downshift.

Heavy Throttle: Approximately 3/4 of accelerator pedal travel - 75 percent throttle position.

Light Throttle: Approximately 1/4 of accelerator pedal travel - 25 percent throttle position.

Medium Throttle: Approximately 1/2 of accelerator pedal travel - 50 percent throttle position.

Minimum Throttle: The least amount of throttle opening required for an upshift.

Wide Open Throttle (WOT): Full travel of the accelerator pedal - 100 percent throttle position.

Zero Throttle Coastdown: A full release of the accelerator pedal while the vehicle is in motion and in drive range.

Shift Condition Definitions

Bump: A sudden and forceful apply of a clutch or a band.

Chuggle: A bucking or jerking. This condition may be most noticeable when the converter clutch is engaged. It is similar to the feel of towing a trailer.

Delayed: A condition where a shift is expected but does not occur for a period of time. This may be described as a clutch or band engagement that does not occur as quickly as expected during a part throttle or wide open throttle apply of the accelerator, or during manual downshifting to a lower range. This term is also defined as LAutomatic transmissionE or EXTENDED.

Double Bump - Double Feel: Two sudden and forceful applies of a clutch or a band.

Early: A condition where the shift occurs before the car has reached proper speed. This condition tends to labor the engine after the upshift.

End Bump: A firmer feel at the end of a shift than at the start of the shift. This is also defined as END FEEL or SLIP BUMP.

Firm: A noticeably quick apply of a clutch or band that is considered normal with a medium to heavy throttle. This apply should not be confused with HARSH or ROUGH.

Flare: A quick increase in engine RPM along with a momentary loss of torque. This most generally occurs during a shift. This condition is also defined as SLIPPING.

Harsh - Rough: A more noticeable apply of a clutch or band than FIRM. This condition is considered undesirable at any throttle position.

Hunting: A repeating quick series of upshifts and downshifts that causes a noticeable change in engine RPM, such as a 4-3-4 shift pattern. This condition is also defined as BUSYNESS.

Initial Feel: A distinctly firmer feel at the start of a shift than at the finish of the shift.

Late: A shift that occurs when the engine RPM is higher than normal for a given amount of throttle.

Shudder: A repeating jerking condition similar to CHUGGLE but more severe and rapid. This condition may be most noticeable during certain ranges of vehicle speed.

Slipping: A noticeable increase in engine RPM without a vehicle speed increase. A slip usually occurs during or after initial clutch or band apply.

Soft: A slow, almost unnoticeable clutch or band apply with very little shift feel.

Surge: A repeating engine related condition of acceleration and deceleration that is less intense than CHUGGLE.

Tie-Up: A condition where two opposing clutch and/or bands are attempting to apply at the same time causing the engine to labor with a noticeable loss of engine RPM.

Noise Conditions

Drive Link Noise: A whine or growl that increases or fades with vehicle speed, and is most noticeable under a light throttle acceleration. It may also be noticeable in PARK or NEUTRAL operating ranges with the vehicle stationary.

Final Drive Noise: A hum related to vehicle speed which is most noticeable under a light throttle acceleration.

Planetary Gear Noise: A whine related to vehicle speed, which is most noticeable in FIRST gear, SECOND gear, FOURTH gear or REVERSE. The condition may become less noticeable, or go away, after an upshift.

Pump Noise: A high pitched whine that increases in intensity with engine RPM. This condition may also be noticeable in all operating ranges with the vehicle stationary or moving.

Torque Converter Noise: A whine usually noticed when a vehicle is stopped, and the transmission is in DRIVE or REVERSE. The noise will increase with engine RPM.

Transmission Abbreviations

A/C: Air Conditioning

AC: Alternating Current

APP: Accelerator Pedal Position

A/T: Automatic Transmission

CKT: Circuit

DC: Direct Current

DIC: Driver Information Centre

DLC: Diagnostic Link Connector

DMM: Digital Multimeter

DTC: Diagnostic Trouble Code

ECCC: Electronically-Controlled Capacity Clutch

ECM: Engine Control Module

ECT: Engine Coolant Temperature

IGN: Ignition

IMS: Internal Mode Switch

ISS: Input Speed Sensor

MAP: Manifold Absolute Pressure

MIL: Malfunction Indicator Lamp

NC: Normally Closed

NO: Normally Open

OBD: On Board Diagnostic

OSS: Output Speed Sensor

PCS: Pressure Control Solenoid

PM: Permanent Magnet

PWM: Pulse Width Modulation

RPM: Revolutions Per Minute

SS: Shift Solenoid

SOL: Solenoid

TAP: Transmission Adaptive Pressure

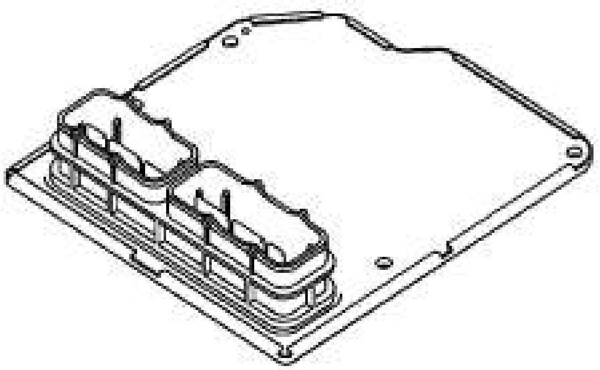
TCC: Torque Converter Clutch

TCM: Transmission Control Module

TFT: Transmission Fluid Temperature

Electronic Component Description

Transmission Control Module (TCM)



The transmission control module (TCM) is mounted in the right hand kick panel and connects directly to the engine wiring harness. A single 42-way connector is used to make the connection between the vehicle wiring and the TCM. The TCM is an electronic control module that receives input or provides output in order to control the operation of the 5L40-E automatic transmission.

The TCM receives the following inputs from the engine control module (ECM):

- Engine speed and torque values
- Engine intake air temperature (IAutomatic transmission), accelerator pedal position (APP) information
- Engine coolant temperature (ECT)
- Kick-down request
- Traction control status
- Driver selected shift mode
- Air-conditioning (A/C) status
- Cruise control status

The ECM provides this data to the TCM through GMLAN. The GMLAN is a 2-wire communication connection between the 2 controllers.

Other TCM inputs are the following:

- Battery and ignition voltage
- Brake switch status
- Transmission manual shift shaft switch assembly
- Transmission fluid temperature (TFT)
- Transmission input shaft speed (ISS) sensor
- Transmission output shaft speed (OSS) sensor

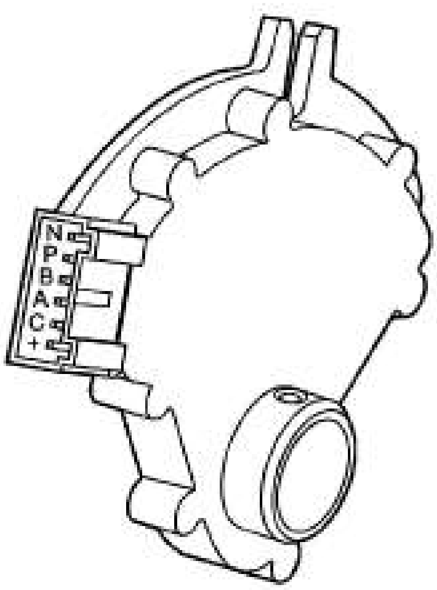
The TCM provides the following outputs in order to control the automatic transmission:

- Shift solenoids to control transmission shifting
- TCC PWM solenoid operation controls the apply and release of the torque converter clutch ASM
- Pressure control solenoid (PCS) regulates transmission line pressure

Other TCM outputs provided to the ECM are the following:

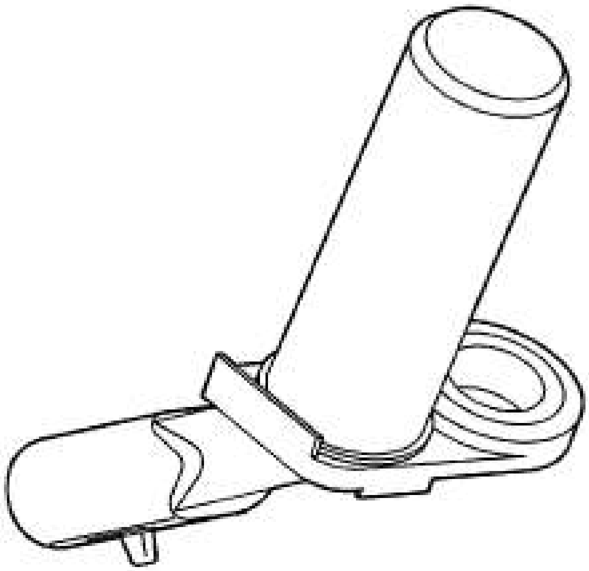
- MIL illumination request
- Vehicle speed
- Transmission input speed
- Transmission fluid temperature
- Commanded gear status
- TCC status
- Torque reduction requests
- Manual shift shaft switch status
- Transmission service status

Transmission Manual Shift Shaft Switch Assembly (602)



The transmission manual shift shaft switch assembly (602) is a sliding contact switch attached to the manual shift shaft inside the transmission case. The five inputs to the TCM from the transmission manual shift shaft switch assembly indicate the transmission gear selector lever position. This information is used for engine controls as well as determining the transmission shift patterns. The state of each input is available for display on the scan tool. The five input parameters represented are Signal A, Signal B, Signal C, Signal P (Parity) and Signal N (P/N Start).

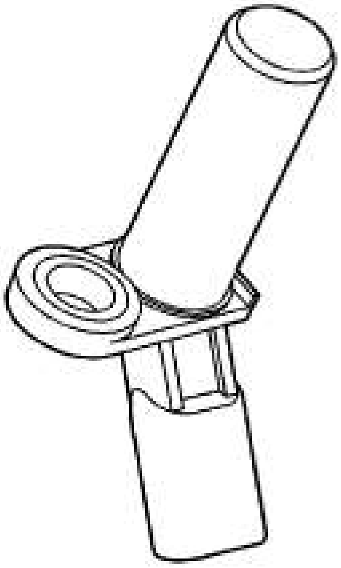
Automatic Transmission Output Speed (A/T OSS) Sensor (42)



The A/T OSS sensor is a variable reluctance magnetic pickup located in the rear of the transmission case. The sensor is mounted in the case (24) opposite the rear internal gear (560). The rear internal gear is splined to the output shaft assembly (562). The sensor consists of a permanent magnet surrounded by a coil of wire. As the output shaft and rear internal gear rotate, an alternate current (AC) is induced in the coil by the 'teeth' on the rear internal gear as they pass by the magnetic pickup. Therefore, whenever the vehicle is moving, the A/T OSS sensor produces an AC voltage signal proportional to vehicle speed.

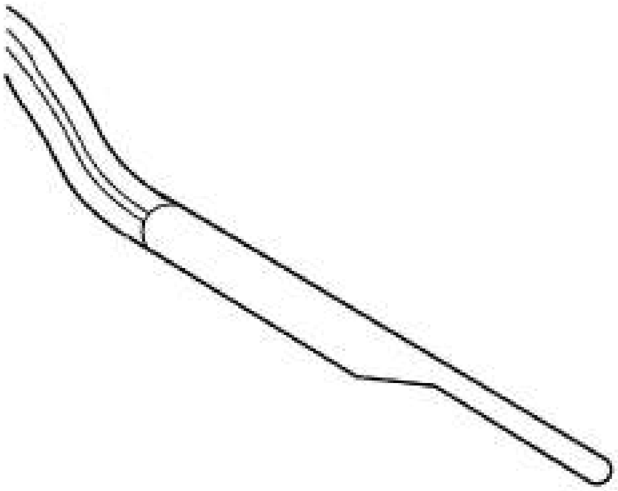
At the TCM, the AC signal is electronically converted to a 5 volt square wave pattern. The square wave pattern can then be interpreted as transmission output speed by the TCM through the frequency of square waves in a given time frame. The square waves can be thought of as a representation of the rear internal gear teeth. Therefore, the more teeth or waves that pass by the magnetic pickup in a given time frame, the faster the vehicle is moving. The square wave pattern is compared to a fixed clock signal internal to the TCM to determine transmission output speed.

Automatic Transmission Input Speed (A/T ISS) Sensor (44)



The A/T ISS sensor operates identically to the A/T OSS sensor except that is uses the stamped teeth on the reverse clutch input housing assembly (401) as the rotor reluctor. Remember that the reverse clutch input housing assembly is driven at converter turbine speed. The A/T ISS sensor square wave pattern is also compared to a fixed clock signal internal to the TCM to determine actual converter turbine speed. The TCM uses transmission input and output speeds to help determine line pressure, transmission shift patterns, TCC apply pressure, gear ratios, and TCC slippage for diagnostic purposes.

Automatic Transmission Fluid Temperature (TFT) Sensor

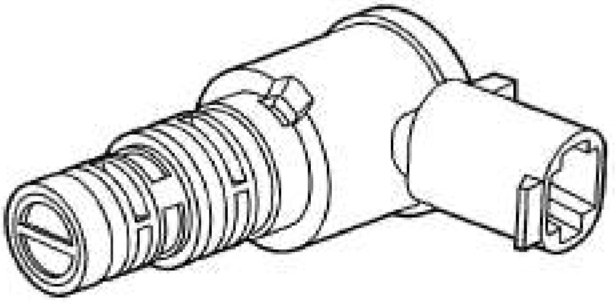


The TFT sensor is part of the transmission wiring harness assembly (55). The TFT sensor is a resistor, or thermistor, which changes value based on temperature. Refer to Transmission Fluid Temperature Sensor Specifications. The sensor has a negative-temperature coefficient. This means that as the temperature increases, the resistance decreases, and as the temperature decreases the resistance increases. The TCM supplies a 5-volt reference signal to the sensor and measures the voltage drop in the circuit. When the transmission fluid is cold the sensor resistance is high and the TCM detects high signal voltage. As the fluid temperature warms to a normal operating temperature, the resistance becomes less and the signal voltage decreases. The TCM uses this information to maintain shift quality and torque converter clutch apply quality over operating temperature range.

If transmission fluid temperatures become excessively high, above approximately 140°C (248°F), the TCM will disable ECCC function and command lock up mode. Applying the TCC serves to reduce transmission fluid temperatures created by the fluid coupling in the torque converter with the TCC released.

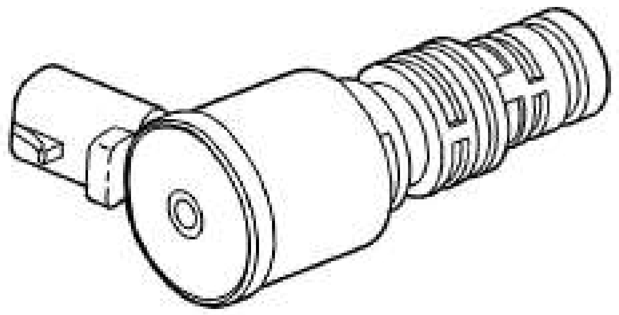
Above approximately 149°C (284°F), the TCM will set a transmission fluid temperature code (P0218). This causes the TCM to use a fixed default value of 135°C (275°F) as the transmission fluid temperature input signal.

Shift Solenoid Valves



The Hydra-matic 5L40-E uses three electromagnetic shift solenoid valves 1-2, 2-3 and 4-5 to control upshifts and downsifts in all forward gear ranges. The shift solenoid valves are all identical, normally closed, 3-port, ON/OFF type solenoids controlled by the TCM. These shift solenoid valves work together in a combination of ON and OFF sequences to control the various shift valves. The TCM uses numerous inputs to determine which solenoid state combination the transmission should be in. Refer to Shift Solenoid Valve State and Gear Ratio.

Torque Converter Clutch Pulse Width Modulation (TCC PWM) Solenoid Valve (352)



The TCC PWM solenoid valve is a normally-closed, pulse width modulated (PWM) solenoid used to control the apply and release of the converter clutch. The TCM operates the solenoid with a negative duty cycle, at a fixed frequency of 32 Hz, to control the rate of TCC apply/release. The solenoid's ability to 'ramp' the TCC apply and release pressures results in a smoother TCC operation.

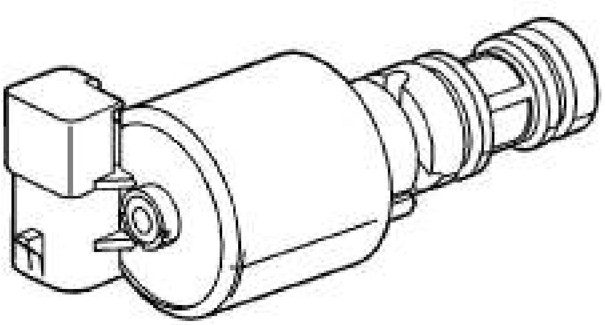
When vehicle operating conditions are appropriate to apply the TCC, the TCM increases the duty cycle to allow the TCC PWM solenoid valve to command TCC signal fluid pressure at a level sufficient to move the TCC enable valve and the TCC control valve to the apply position. Release pressure is directed to exhaust, and regulated apply fluid is directed to the apply side of the converter pressure plate/damper assembly. The TCM then increases the duty cycle to control a slippage of 20-80 RPM between the pressure plate/damper assembly and the converter cover. This provides for improved filtration of engine vibrations and allows the TCC to apply at low engine speeds in 2nd, 3rd, 4th and 5th gear. At high speed, lock up mode is set by activating the TCC PWM solenoid valve at maximum duty cycle.

Release of the TCC is achieved by decreasing the duty cycle to a level low enough to allow spring force to move the TCC enable valve and the TCC control valve to the release position. Apply fluid is directed to exhaust and converter feed fluid is directed into the release circuit to the release side of the pressure plate/damper assembly.

There are also some operating conditions that may prevent or enable TCC apply under various conditions, engine temperature, transmission temperature, or brake switch activation, depending on vehicle application.

TCC PWM solenoid valve resistance should measure between 10.0-11.5 Ω when measured at 20°C (68°F). The resistance should measure approximately 16 Ω at 150°C (300°F).

Pressure Control (PC) Solenoid Valve (357)



The pressure control (PC) solenoid valve is a precision electronic pressure regulator that controls transmission line pressure based on current flow through its coil windings. As current flow is increased, the magnetic field produced by the coil moves the solenoid's plunger further away from the exhaust port. Opening the exhaust port decreases the output fluid pressure regulated by the PC solenoid valve, which ultimately decreases line pressure. The TCM controls the PC solenoid valve based on various inputs including throttle position, transmission fluid temperature and gear state.

Duty Cycle, Frequency and Current Flow

A duty cycle may be defined as the percentage of time current is flowing through a solenoid coil during each cycle. The number of cycles that occur within a specified amount of time, usually measured in seconds, is called 'frequency.' Typically, the operation of an electronically controlled pulse width modulated solenoid is explained in terms of duty cycles and frequency.

The TCM controls the PC solenoid valve on a positive duty cycle at a fixed frequency of 292.5 Hz cycles per second. A higher duty cycle provides a greater current flow through the solenoid. The high positive side of the PC solenoid valve electrical circuit at the TCM controls the PC solenoid valve operation. The TCM provides a ground path for the circuit, monitors average current and continuously varies the PC solenoid valve duty cycle to maintain the correct average current flowing through the PC solenoid valve.

The duty cycle and current flow to the PC solenoid valve are mainly affected by throttle position and engine torque. As the throttle angle engine torque increases, the duty cycle is decreased by the TCM which decreases current flow to the PC solenoid valve. Current flow to the PC solenoid valve creates a magnetic field that moves the solenoid armature against spring force.

Transmission Adapt Function

Programming within the TCM also allows for automatic adjustments in shift pressure that are based on the changing characteristics of the transmission components. As the apply components within the transmission wear, shift time, the time required to apply a clutch, increases. In order to compensate for this wear, the TCM adjusts trim pressure by controlling the PC solenoid valve in order to maintain the originally calibrated shift timing. The automatic adjusting process is referred to as adaptive learning and it is used to provide consistent shift feel plus increase transmission durability. The TCM monitors the A/T ISS and the A/T OSS during commanded shifts to determine if a shift is occurring too fast, harsh or too slow, soft and adjusts the PC solenoid valve signal to maintain a set shift feel.

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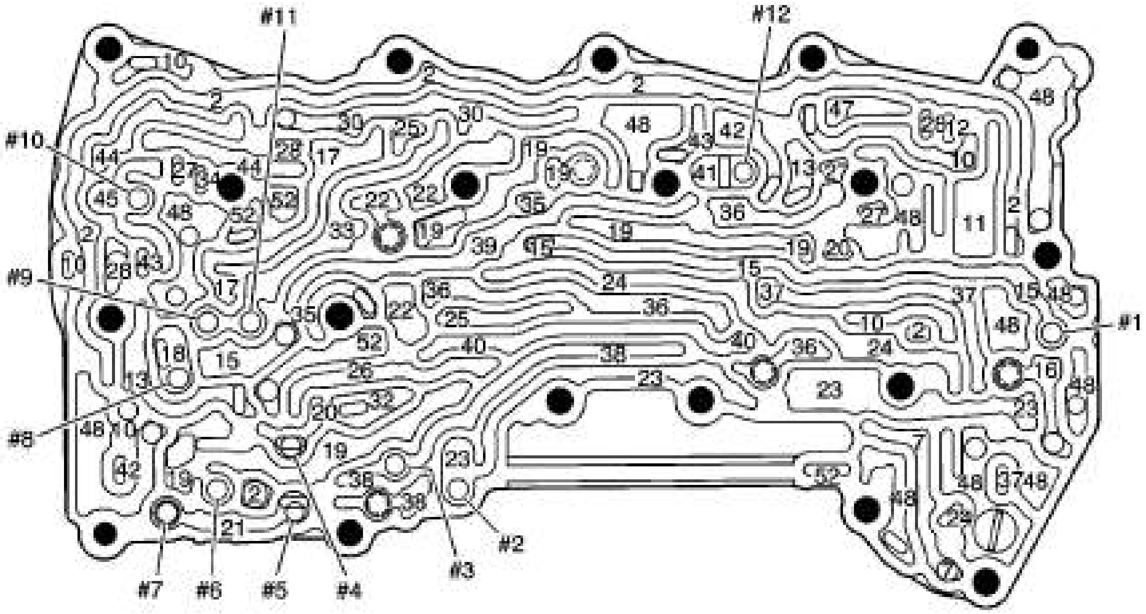
Bottom Channel Plate - Control Valve Body Side



(2) Line
(2) Line
(2) Line
(2) Line
(2) Line
(2) Line
(2) Line
(7) Regulated Apply
(7) Regulated Apply
(10) Feed Limit
(10) Feed Limit
(10) Feed Limit
(10) Feed Limit
(10) Feed Limit
(11) Filtered Feed Limit
(12) Throttle Signal
(13) Line Safety Mode
(13) Line Safety Mode

(15) Reverse Lockout - RLO
(15) Reverse Lockout - RLO
(15) Reverse Lockout - RLO
(15) Reverse Lockout - RLO
(16) Reverse Clutch
(17) Low and Reverse Clutch
(17) Low and Reverse Clutch
(18) Low and Reverse Clutch or RLO
(19) D432
(19) D432
(19) D432
(19) D432
(19) D432
(19) D432
(19) D432
(20) 123
(20) 123
(21) Forward Clutch
(22) 2345
(22) 2345
(22) 2345
(23) 2345 or Reverse
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(23) 2345 or Reverse
(24) TCC Signal
(24) TCC Signal
(24) TCC Signal
(25) 123 Regulated
(25) 123 Regulated
(26) 123 Braking
(27) 1-2 Signal
(27) 1-2 Signal
(27) 1-2 Signal
(28) 2-3 Signal
(28) 2-3 Signal
(28) 2-3 Signal
(30) Second Clutch
(30) Second Clutch
(32) Coast Clutch
(33) 23 Regulated
(34) Second Coast Clutch
(35) Intermediate Clutch
(35) Intermediate Clutch
(36) 345

(36) 345
(36) 345
(36) 345
(37) Direct Clutch
(37) Direct Clutch
(37) Direct Clutch
(38) 45
(38) 45
(38) 45
(39) Overdrive Clutch Feed 1
(40) Overdrive Clutch Feed 2
(40) Overdrive Clutch Feed 2
(41) Overdrive Clutch
(42) 32
(42) 32
(43) 32 Safety Mode
(43) 32 Safety Mode
(44) FDL
(44) FDL
(45) 32 Safety Model FDL
(47) Memory
(48) Exhaust
(48) Exhaust
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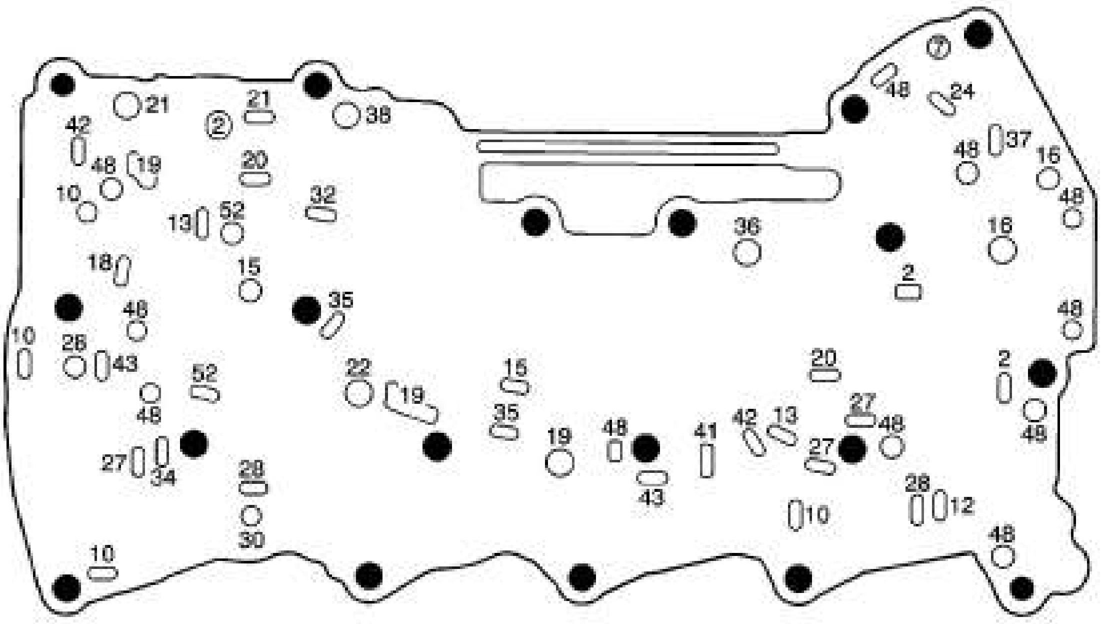
(52) Void
(52) Void
(52) Void
(52) Void

Bottom Channel Plate - Top Channel Plate Side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(2) Line
(2) Line
(2) Line
(7) Regulated Apply
(10) Feed Limit
(10) Feed Limit
(10) Feed Limit
(10) Feed Limit
(12) Throttle Signal
(13) Line Safety Mode
(13) Line Safety Mode
(15) Reverse Lockout - RLO
(15) Reverse Lockout - RLO
(16) Reverse Clutch
(16) Reverse Clutch
(18) Low and Reverse Clutch or RLO
(19) D432
(19) D432

(19) D432
(20) 123
(20) 123
(21) Forward Clutch
(21) Forward Clutch
(22) 2345
(24) TCC Signal
(27) 1-2 Signal
(27) 1-2 Signal
(27) 1-2 Signal
(28) 2-3 Signal
(28) 2-3 Signal
(28) 2-3 Signal
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(32) Coast Clutch
(34) Second Coast Clutch
(35) Intermediate Clutch
(35) Intermediate Clutch
(36) 345
(37) Direct Clutch
(38) 45
(41) Overdrive Clutch
(42) 32
(42) 32
(43) 32 Safety Mode
(43) 32 Safety Mode
(48) Exhaust
(48) Exhaust
(48) Exhaust
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(48) Exhaust
(48) Exhaust
(48) Exhaust
(48) Exhaust
(52) Void
(52) Void

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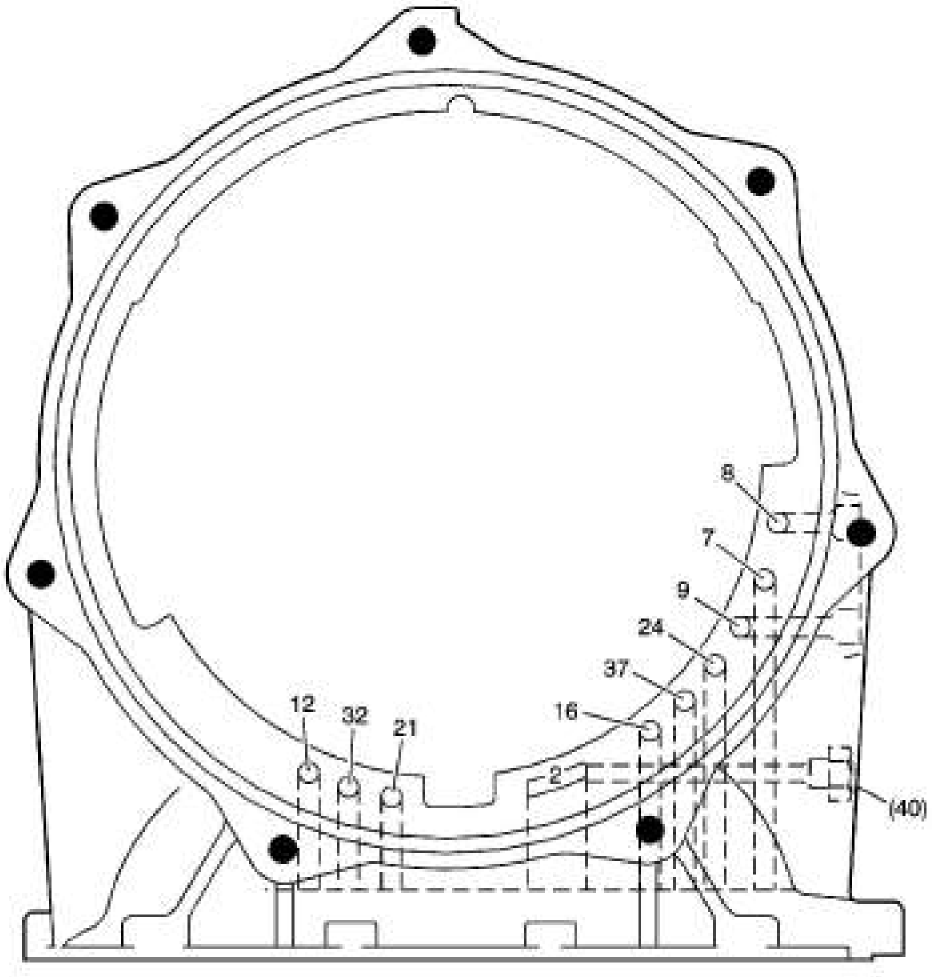
Case - Fluid Pump Cover Side



(2) Line
(7) Regulated Apply
(8) To Cooler
(9) Lube
(12) Throttle Signal
(16) Reverse Clutch
(21) Forward Clutch
(24) TCC Signal
(32) Coast Clutch
(37) Direct Clutch
(40) Automatic Transmission Pressure Test Plug

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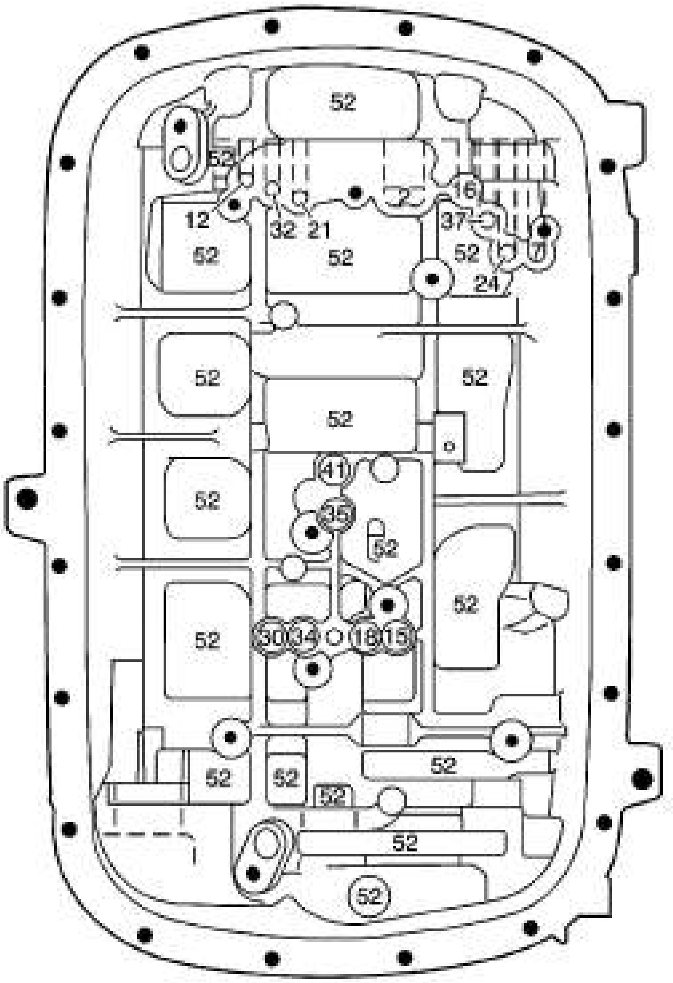
Case - Top Channel Plate Side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(2) Line
(7) Regulated Apply
(12) Throttle Signal
(15) Reverse Lockout - RLO
(16) Reverse Clutch
(18) Low and Reverse Clutch or RLO
(21) Forward Clutch
(24) TCC Signal
(30) Second Clutch
(32) Coast Clutch
(34) Second Coast Clutch

(35) Intermediate Clutch
(37) Direct Clutch
(41) Overdrive Clutch
(52) Void
(52) Void
(52) Void
(52) Void
(52) Void
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(52) Void
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(52) Void
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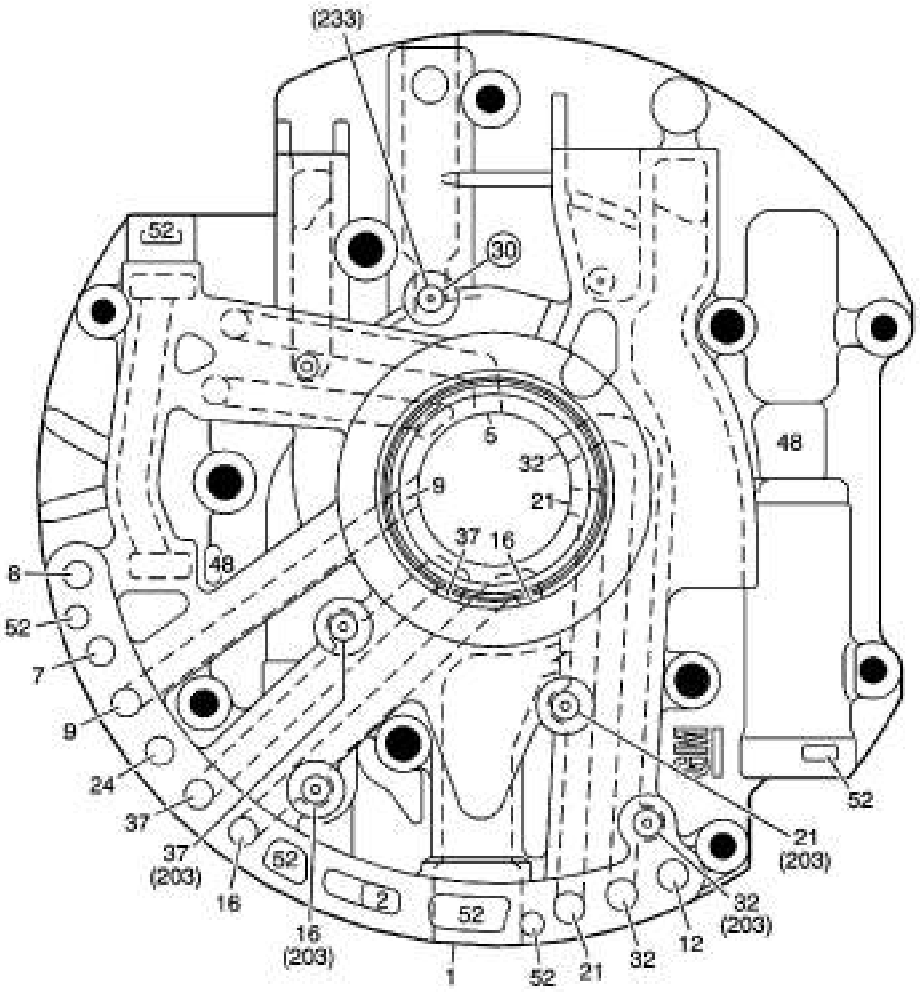
Fluid Pump Cover - Case Side


(233)
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(203)
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16
(203)
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2
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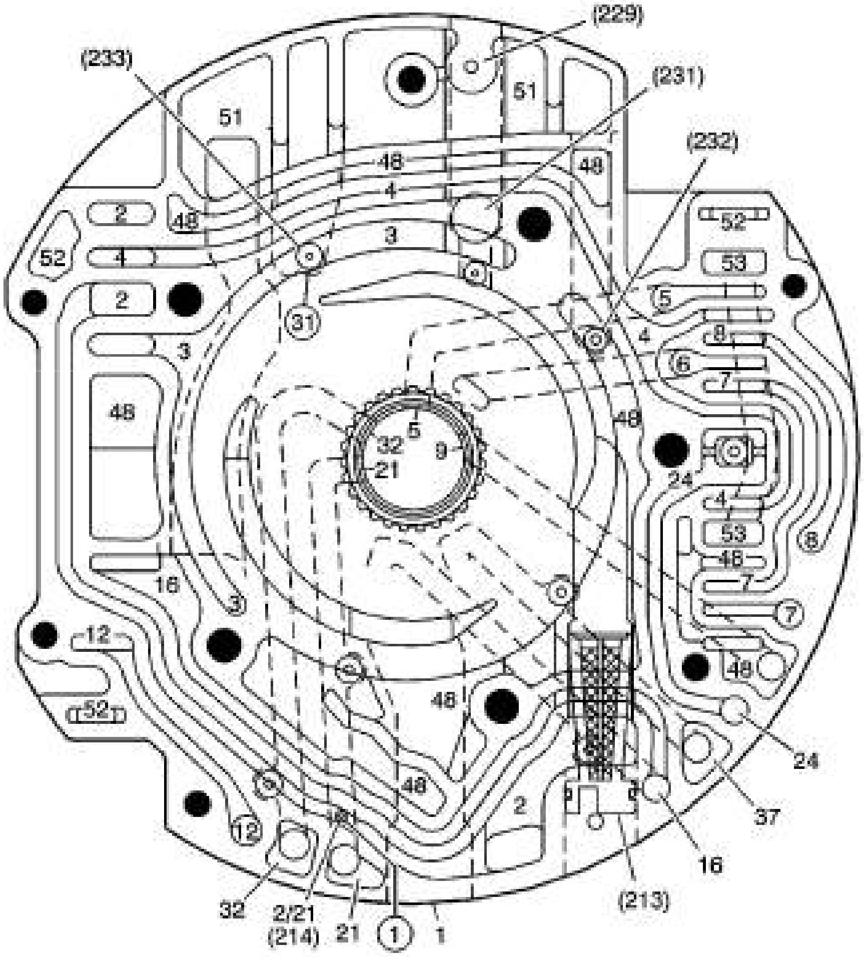
1
52
21
32
12
32
(203)
21
(203)
52

- (1) Suction
- (2) Line
- (5) Release
- (7) Regulated Apply
- (8) To Cooler
- (9) Lube
- (9) Lube
- (12) Throttle Signal
- (16) Reverse Clutch
- (16) Reverse Clutch
- (16) Reverse Clutch

(21) Forward Clutch
(21) Forward Clutch
(21) Forward Clutch
(24) TCC Signal
(32) Coast Clutch
(32) Coast Clutch
(32) Coast Clutch
(37) Direct Clutch
(37) Direct Clutch
(37) Direct Clutch
(48) Exhaust
(48) Exhaust
(52) Void
(52) Void
(52) Void
(52) Void
(52) Void
(52) Void

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 5L40-E/5L50-E | Description and Operation | **Document ID: 820205**

Fluid Pump Cover - Torque Converter Housing Side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(1) Suction
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(4) Converter Feed
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(4) Converter Feed

(4) Converter Feed
(5) Release
(5) Release
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(7) Regulated Apply
(7) Regulated Apply
(7) Regulated Apply
(8) To Cooler
(8) To Cooler
(9) Lube
(12) Throttle Signal
(12) Throttle Signal
(16) Reverse Clutch
(16) Reverse Clutch
(21) Forward Clutch
(21) Forward Clutch
(21) Forward Clutch
(24) TCC Signal
(24) TCC Signal
(32) Coast Clutch
(32) Coast Clutch
(37) Direct Clutch
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(48) Exhaust
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(48) Exhaust
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(48) Exhaust
(48) Exhaust
(51) Vent
(51) Vent
(52) Void
(52) Void
(52) Void
(53) Converter FDL
(53) Converter FDL

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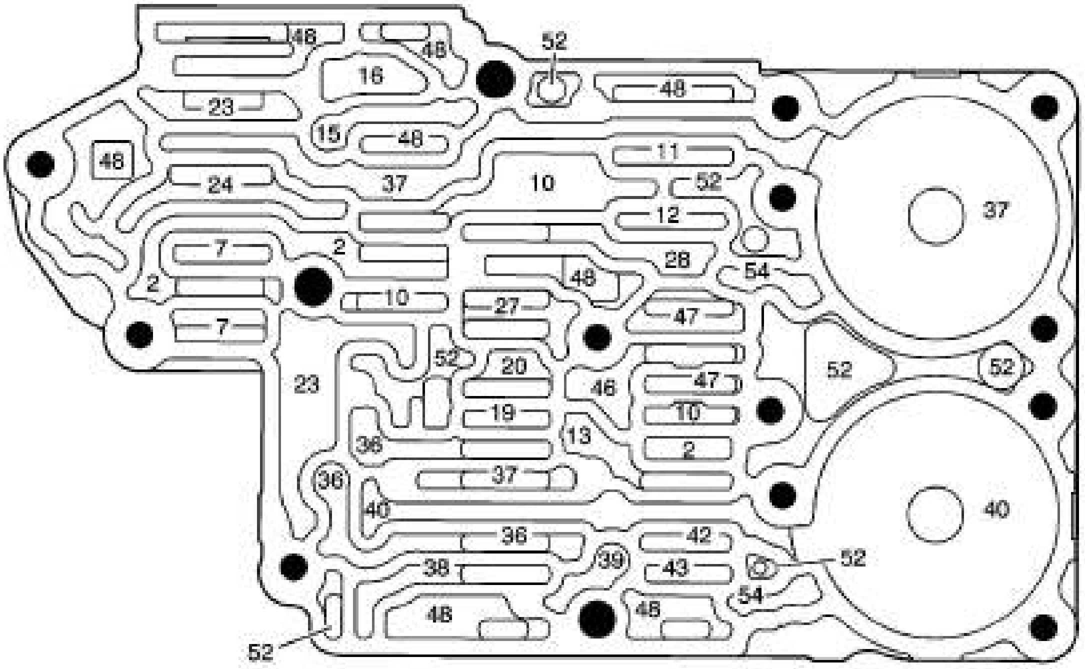
Front Control Valve Body - Bottom Channel Plate Side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(2) Line
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(7) Regulated Apply
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(10) Feed Limit
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(11) Filtered Feed Limit
(12) Throttle Signal
(13) Line Safety Mode
(15) Reverse Lockout - RLO
(16) Reverse Clutch
(19) D432
(20) 123
(23) 2345 or Reverse
(23) 2345 or Reverse
(24) TCC Signal

(27) 1-2 Signal
(28) 2-3 Signal
(36) 345
(36) 345
(36) 345
(37) Direct Clutch
(37) Direct Clutch
(37) Direct Clutch
(38) 45
(39) Overdrive Clutch Feed 1
(40) Overdrive Clutch Feed 2
(40) Overdrive Clutch Feed 2
(42) 32
(43) 32 Safety Mode
(46) Memory Pilot
(47) Memory
(47) Memory
(48) Exhaust
(48) Exhaust
(48) Exhaust
(48) Exhaust
(48) Exhaust
(48) Exhaust
(48) Exhaust
(48) Exhaust
(52) Void
(52) Void
(52) Void
(52) Void
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(52) Void
(54) Accumulator
(54) Accumulator

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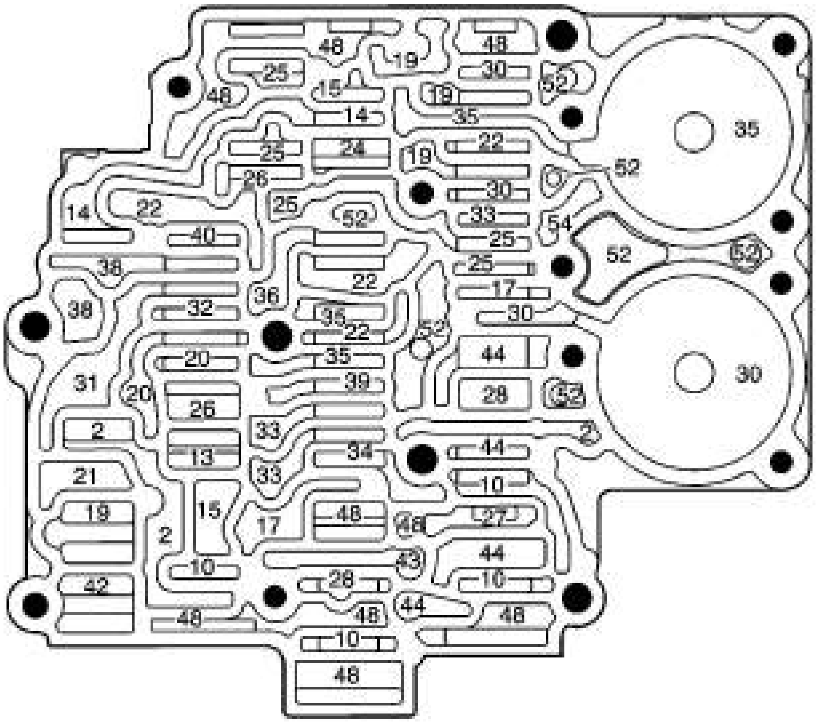
Rear Control Valve Body - Bottom Channel Plate Side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(2) Line
(2) Line
(2) Line
(10) Feed Limit
(10) Feed Limit
(10) Feed Limit
(10) Feed Limit
(13) Line Safety Mode
(14) Reverse
(14) Reverse
(15) Reverse Lockout - RLO
(15) Reverse Lockout - RLO
(17) Low and Reverse Clutch
(17) Low and Reverse Clutch
(19) D432
(19) D432
(19) D432
(19) D432

(20) 123
(20) 123
(21) Forward Clutch
(22) 2345
(22) 2345
(22) 2345
(22) 2345
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(25) 123 Regulated
(25) 123 Regulated
(26) 123 Braking
(26) 123 Braking
(27) 1-2 Signal
(28) 2-3 Signal
(28) 2-3 Signal
(30) Second Clutch
(30) Second Clutch
(30) Second Clutch
(30) Second Clutch
(31) Coast Clutch Feed
(32) Coast Clutch
(33) 23 Regulated
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(33) 23 Regulated
(34) Second Coast Clutch
(35) Intermediate Clutch
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(36) 345
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(38) 45
(39) Overdrive Clutch Feed 1
(40) Overdrive Clutch Feed 2
(42) 32
(43) 32 Safety Mode
(44) FDL
(44) FDL
(44) FDL
(44) FDL
(48) Exhaust
(48) Exhaust

(48) Exhaust
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(48) Exhaust
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(52) Void
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(52) Void
(52) Void
(54) Accumulator

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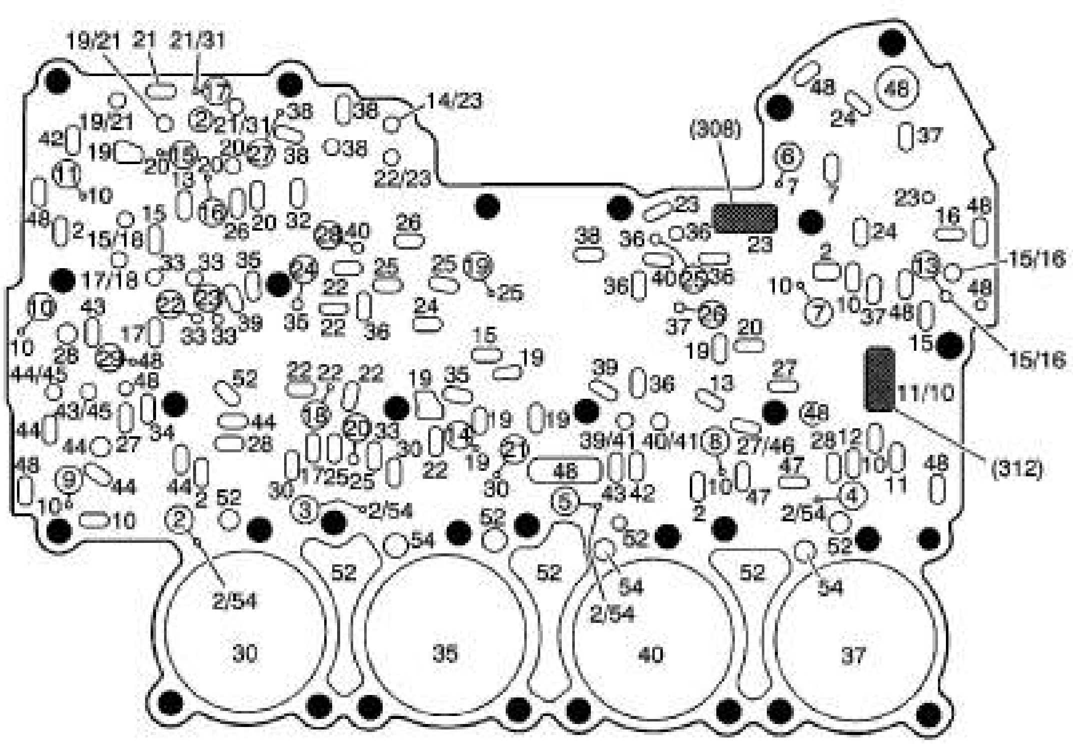
Spacer Plate - Bottom Channel Plate Side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(2) Line
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(7) Regulated Apply
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(10) Feed Limit
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(10) Feed Limit
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(10) Feed Limit
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(15) Reverse Lockout - RLO
(15) Reverse Lockout - RLO
(15) Reverse Lockout - RLO
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(16) Reverse Clutch
(17) Low and Reverse Clutch
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(18) Low and Reverse Clutch or RLO
(19) D432
(19) D432
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(19) D432
(19) D432
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(21) Forward Clutch
(21) Forward Clutch
(21) Forward Clutch
(22) 2345
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(22) 2345
(22) 2345
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(23) 2345 or Reverse
(23) 2345 or Reverse
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(28) 2-3 Signal
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(30) Second Clutch
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(35) Intermediate Clutch
(35) Intermediate Clutch
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(35) Intermediate Clutch
(36) 345
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(36) 345

(36) 345
(36) 345
(37) Direct Clutch
(37) Direct Clutch
(37) Direct Clutch
(37) Direct Clutch
(38) 45
(38) 45
(38) 45
(38) 45
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(39) Overdrive Clutch Feed 1
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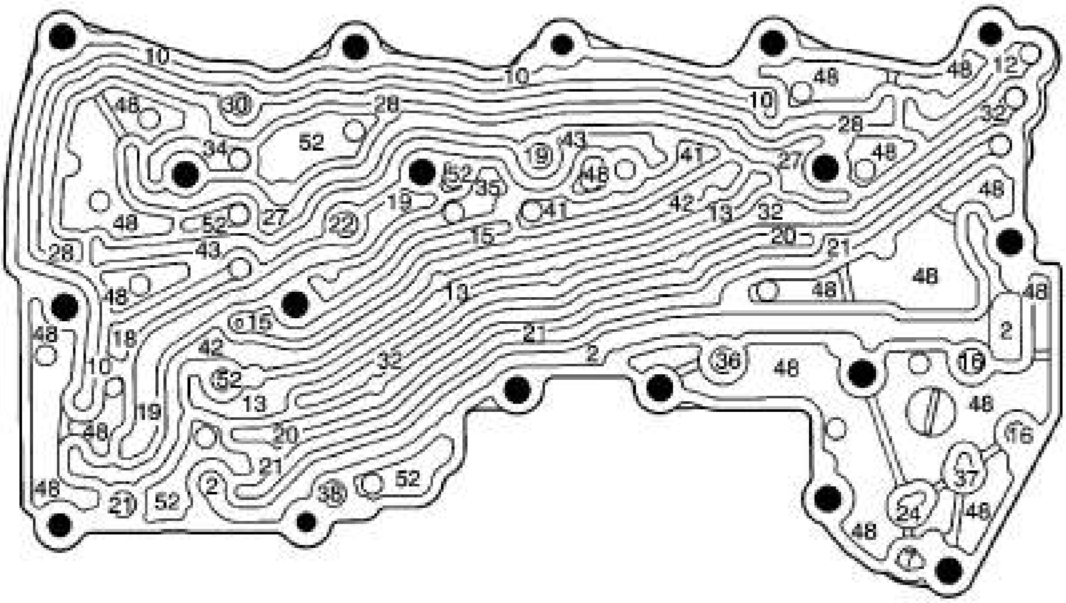
(54) Accumulator

Top Channel Plate - Bottom Channel Plate Side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(2) Line
(2) Line
(2) Line
(7) Regulated Apply
(10) Feed Limit
(10) Feed Limit
(10) Feed Limit
(10) Feed Limit
(12) Throttle Signal
(13) Line Safety Mode
(13) Line Safety Mode
(13) Line Safety Mode
(15) Reverse Lockout - RLO
(15) Reverse Lockout - RLO
(16) Reverse Clutch
(16) Reverse Clutch
(18) Low and Reverse Clutch or RLO
(19) D432

(19) D432
(19) D432
(20) 123
(20) 123
(21) Forward Clutch
(21) Forward Clutch
(21) Forward Clutch
(21) Forward Clutch
(22) 2345
(24) TCC Signal
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(27) 1-2 Signal
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(28) 2-3 Signal
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(36) 345
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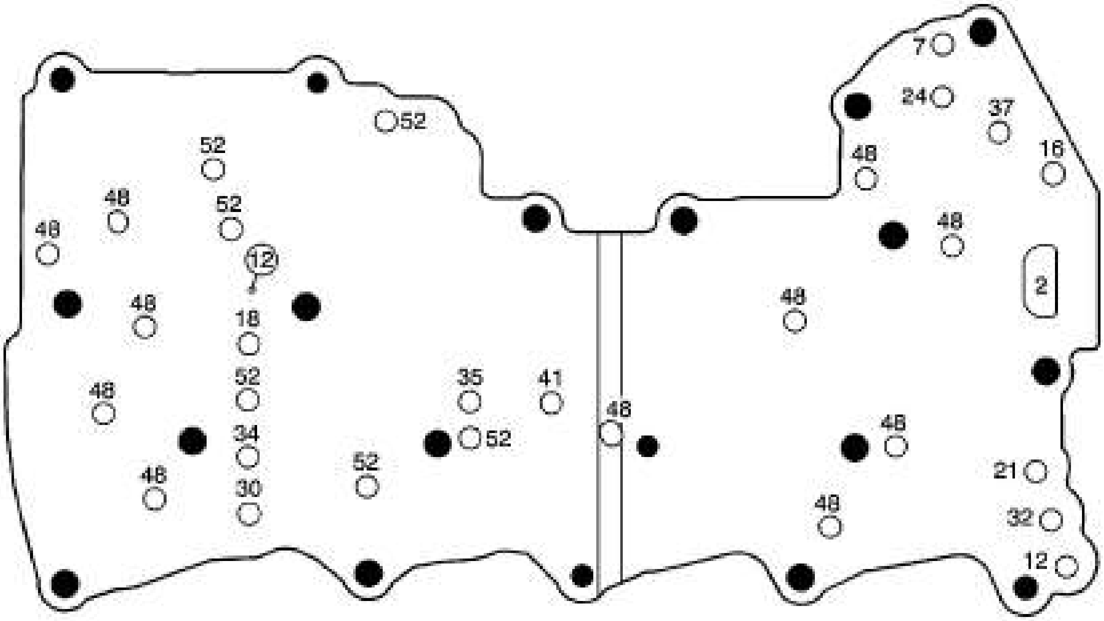
Top Channel Plate - Case Side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(2) Line
(7) Regulated Apply
(12) Throttle Signal
(16) Reverse Clutch
(18) Low and Reverse Clutch or RLO
(21) Forward Clutch
(24) TCC Signal
(30) Second Clutch
(32) Coast Clutch
(34) Second Coast Clutch
(35) Intermediate Clutch
(37) Direct Clutch
(41) Overdrive Clutch
(48) Exhaust
(48) Exhaust
(48) Exhaust
(48) Exhaust
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(48) Exhaust
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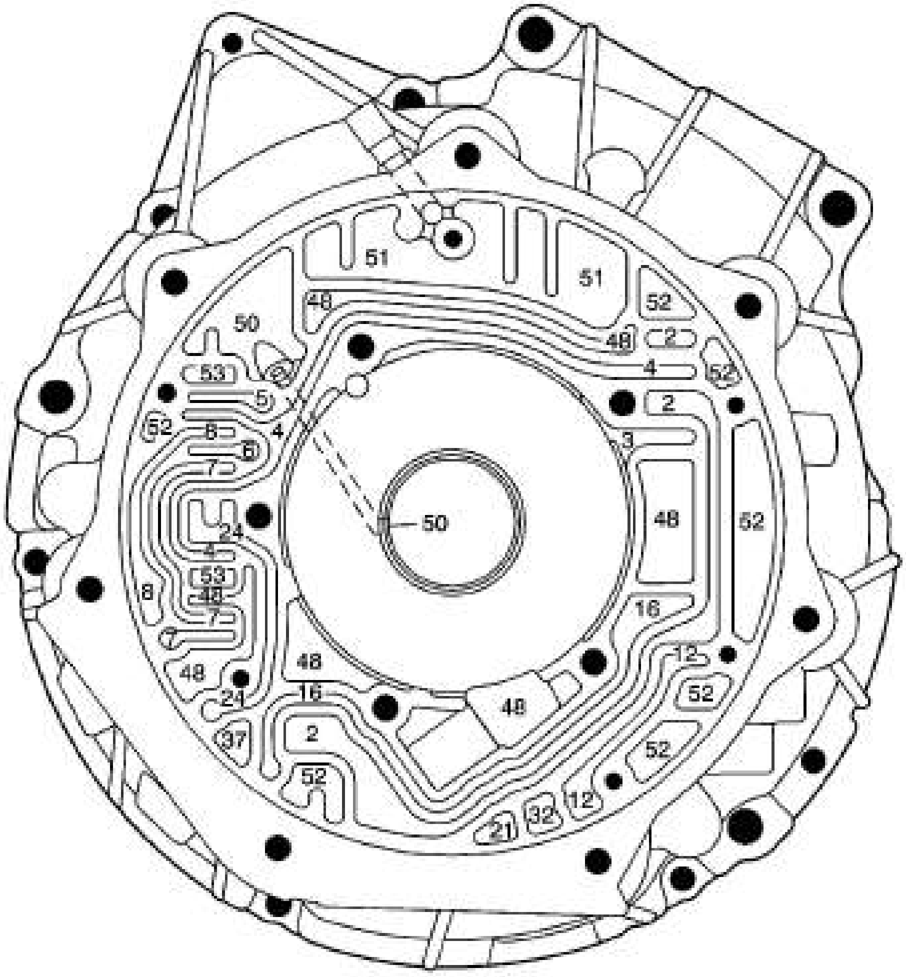
(52) Void

Torque Converter Housing - Fluid Pump Cover Side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(2) Line
(2) Line
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(3) Decrease
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(4) Converter Feed
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(5) Release
(6) Apply
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(7) Regulated Apply

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(8) To Cooler
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(12) Throttle Signal
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(24) TCC Signal
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(37) Direct Clutch
(48) Exhaust
(48) Exhaust
(48) Exhaust
(48) Exhaust
(48) Exhaust
(48) Exhaust
(48) Exhaust
(50) Torque Converter Seal Drain Back
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(51) Vent
(51) Vent
(52) Void
(52) Void
(52) Void
(52) Void
(52) Void
(52) Void
(52) Void
(53) Converter FDL
(53) Converter FDL

Limp Home Mode Description

If a major electrical system failure occurs which may affect vehicle safety or damage the transmission during normal operation, the TCM enters a default mode. In the default mode, the transmission operates in the following manner:

- The pressure control solenoid is off and the line pressure is at maximum in order to minimize clutch slippage.
- The TCC solenoid is off. The converter clutch is disabled.
- All three of the shift solenoids are off. The transmission will operate in fifth gear if the vehicle has successfully completed a 1-2 upshift in the current ignition cycle. If the vehicle has not completed a 1-2 upshift in the current ignition cycle, the transmission will operate in fourth gear. If the transmission is operating in fifth gear, fourth gear may be obtained if the engine is stopped briefly and re-started.

In default mode, the gear selector lever is ineffective at selecting forward gear ranges. In fourth or fifth gear, heat builds up in the transmission quickly, particularly in stop and go traffic. Excessive heat build-up may cause transmission failure if the vehicle is driven for extended distances in default mode.

Manual Fourth Gear

Manual Fourth - Fourth Gear - Drive Range may be selected at any time while the vehicle is being operated in a forward gear range. However, TCM control prevents the transmission from shifting into Fifth gear. When the gear selector lever is moved to Drive Range (4) from Overdrive Range (D), the manual valve also moves. Changes to the hydraulic and electrical systems are as follows:

Overdrive Clutch Releases

Manual Valve:: The manual valve moves only to activate the transmission manual shift shaft switch assembly. The transmission manual shift shaft switch assembly signals the TCM that the transmission is in Manual Fourth Range. There is no hydraulic difference between Overdrive Range and Manual Fourth Range at the manual valve.

4-5 Shift Solenoid (SS) Valve:: The 4-5 SS valve is energised, allowing feed limit fluid to enter the 4-5 signal fluid circuit. 4-5 signal fluid overcomes 4-5 shift valve spring (373) force and moves the 4-5 shift control valve (375) and the 4-5 shift valve (374) to the applied position.

4-5 Shift Valve:: 4-5 fluid is blocked at the 4-5 shift valve (374) allowing overdrive clutch feed 2 fluid to exhaust.

Overdrive Clutch Assembly:: Overdrive clutch fluid exhausts from the overdrive clutch piston, allowing the overdrive clutch plates to disengage.

#12 Ball Check Valve:: Overdrive clutch fluid seats the #12 ball check valve against the overdrive clutch feed 1 passage and enters the overdrive clutch feed 2 fluid circuit where it exhausts at the 4-5 shift valve.

Shift Accumulation

Overdrive Clutch Accumulator:: Overdrive clutch fluid also exhausts from the overdrive clutch accumulator assembly. Accumulator fluid moves the overdrive clutch accumulator piston against accumulator spring force in preparation for another application of the overdrive clutch.

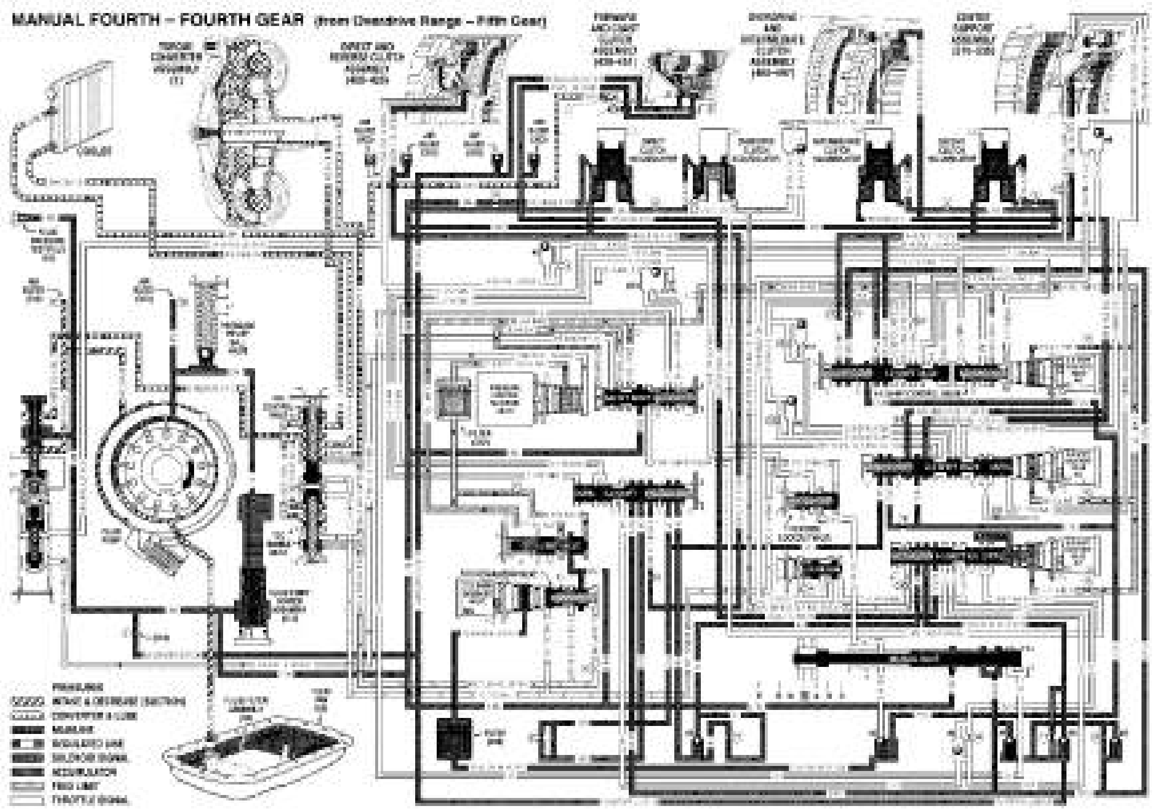
Coast Clutch Applies

4-5 Shift Valve:: Coast clutch feed fluid passes through the 4-5 shift valve (374) and into the coast clutch circuit.

Coast Clutch:: Coast clutch fluid is routed to the coast clutch piston to apply the coast clutch plates.

In Manual Fourth - Fourth Gear, the TCC will not release if Manual Fourth was selected while the vehicle was operating in Overdrive Range - Fifth Gear with the TCC applied. Under normal operating conditions, the converter clutch operates the same way in Manual Fourth - Fourth Gear as in Overdrive Range - Fourth Gear.

Manual Fourth



MANUAL FOURTH – FOURTH GEAR (from Overdrive Range – Fifth Gear)

COOLER
PRESSURES
ACCUMULATOR
FEED LIMIT
THROTTLE SIGNAL

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 5L40-E/5L50-E | Description and Operation | **Document ID: 1985240**

Manual Second - First Gear

Manual Second - First Gear is commanded by the TCM, when vehicle speed is low enough not to overrev the engine - calibratable in the TCM, in order to achieve maximum engine braking. Changes to the hydraulic and electrical systems are as follows:

Manual Valve:: Manual Second - First Gear is commanded by the TCM only, there is no movement of the manual valve.

Low and Reverse Clutch Applied

1-2 Shift Solenoid (SS) Valve:: The 1-2 SS valve is de-energised, blocking feed limit fluid from entering the 1-2 signal fluid circuit and 1-2 signal fluid pressure exhausts through the 1-2 SS valve.

1-2 Shift Control Valve:: With 1-2 signal fluid exhausted, 2-3 signal fluid is able to move the 1-2 shift control valve (366) against 1-2 shift control valve spring (367) force to the applied position. This allows feed limit fluid to enter the FDL fluid circuit.

1-2 Shift Valve:: FDL fluid is routed to the 1-2 shift valve (387) and moves the valve against 1-2 shift valve spring (388) force to the applied position. This allows 123 regulated fluid to enter the low and reverse clutch fluid circuit.

#8 Ball Check Valve:: Low and reverse clutch fluid seats the #8 ball check valve against the reverse lockout fluid passage and enters the low and reverse clutch or reverse lockout fluid passage.

Low and Reverse Clutch:: Low and reverse clutch or reverse lockout fluid pressure enters the outer area of the low and reverse clutch piston and moves the piston against spring force to apply the low and reverse clutch plates.

Second Clutch and Second Coast Clutch Release

Second Clutch Assembly:: Second clutch fluid exhausts from the second clutch piston, allowing the second clutch plates to disengage.

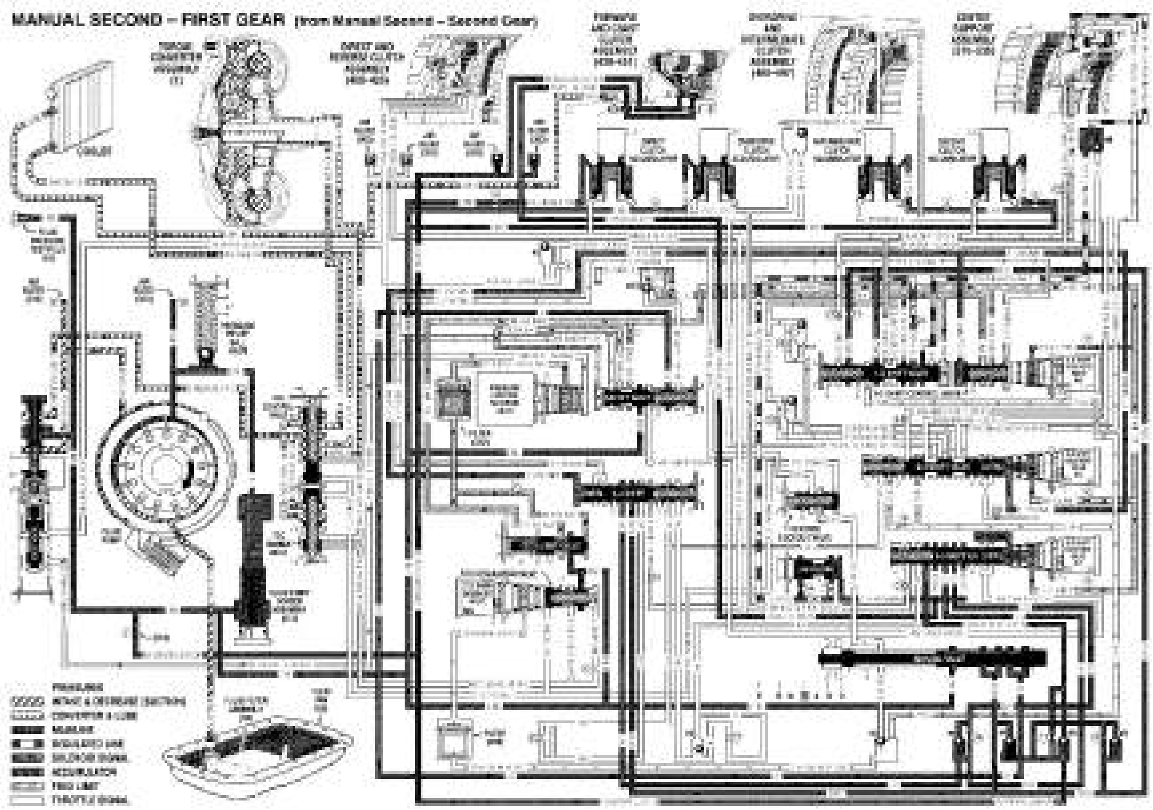
Second Coast Clutch Assembly:: Second coast clutch fluid exhausts from the second coast clutch piston, allowing the second coast clutch plates to disengage.

1-2 Shift Valve:: Second coast clutch fluid is routed through the 2-3 shift valve to the 1-2 shift valve where it enters the second clutch fluid circuit. Second clutch fluid is routed through orifice #21 to the 1-2 shift valve where it exhausts.

Shift Accumulation

Second Clutch Accumulator:: Second clutch fluid also exhausts from the second clutch accumulator assembly. Accumulator fluid moves the second clutch accumulator piston against accumulator spring force in preparation for another application of the second clutch.

Manual Second - First Gear


MANUAL SECOND – FIRST GEAR (from Manual Second – Second Gear)
COOLER
PRESSURES
INTAKE & DECREASE (SUCTION)
CONVERTER & LUBE
MAINLINE
REGULATED LINE
SOLENOID SIGNAL
ACCUMULATOR
FEED LIMIT
THROTTLE SIGNAL

Manual Second Gear

Manual Second - Second Gear may be selected at any time while the vehicle is being operated in a forward gear range. However, TCM control prevents the transmission from upshifting above Second gear. When the gear selector lever is moved to Manual Second from Manual Third - Third Gear, the manual valve also moves. Changes to the hydraulic and electrical systems are as follows:

Second Coast Clutch Applied

Manual Valve:: The volume of line pressure entering the 32 fluid circuit at the manual valve is increased to accommodate the added torque requirements for engine braking or increased engine load.

2-3 Shift Solenoid (SS) Valve:: The 2-3 SS valve is energised, allowing feed limit fluid to enter the 2-3 signal fluid circuit. 2-3 signal fluid overcomes 2-3 shift valve spring (372) force and moves the 2-3 shift valve (371) to the applied position. This allows 23 regulated fluid to enter the second coast clutch fluid circuit and also opens the overdrive clutch feed 1, intermediate clutch and 345 fluid circuits to exhaust.

3-4 Shift Control Valve:: 2-3 signal fluid is also routed to the 3-4 shift control valve (346) and moves the valve against 1-2 signal fluid pressure to keep the 3-4 shift valve (345) in the applied position.

Second Coast Clutch:: Second coast clutch fluid is directed to the second coast clutch piston to apply the second coast clutch plates.

Important: If the vehicle operating conditions are such that the TCM signals a Third, Fourth or Fifth gear state, the 2-3 solenoid will be de-energised. Thus a downshift will not occur until the vehicle speed is low enough not to overrev the engine - calibratable in the TCM.

Overdrive Clutch Releases

Overdrive Clutch Assembly:: Overdrive clutch fluid exhausts from the overdrive clutch piston, allowing the overdrive clutch plates to disengage.

#12 Ball Check Valve:: Overdrive clutch fluid seats the #12 ball check valve against the overdrive clutch feed 2 passage and enters the overdrive clutch feed 1 fluid circuit.

2-3 Shift Valve:: Exhausting overdrive clutch feed 2 fluid is routed through the 2-3 shift valve into the intermediate clutch fluid circuit.

Intermediate Clutch Releases

Intermediate Clutch Assembly:: Intermediate clutch fluid exhausts from the intermediate clutch piston, allowing the intermediate clutch plates to disengage.

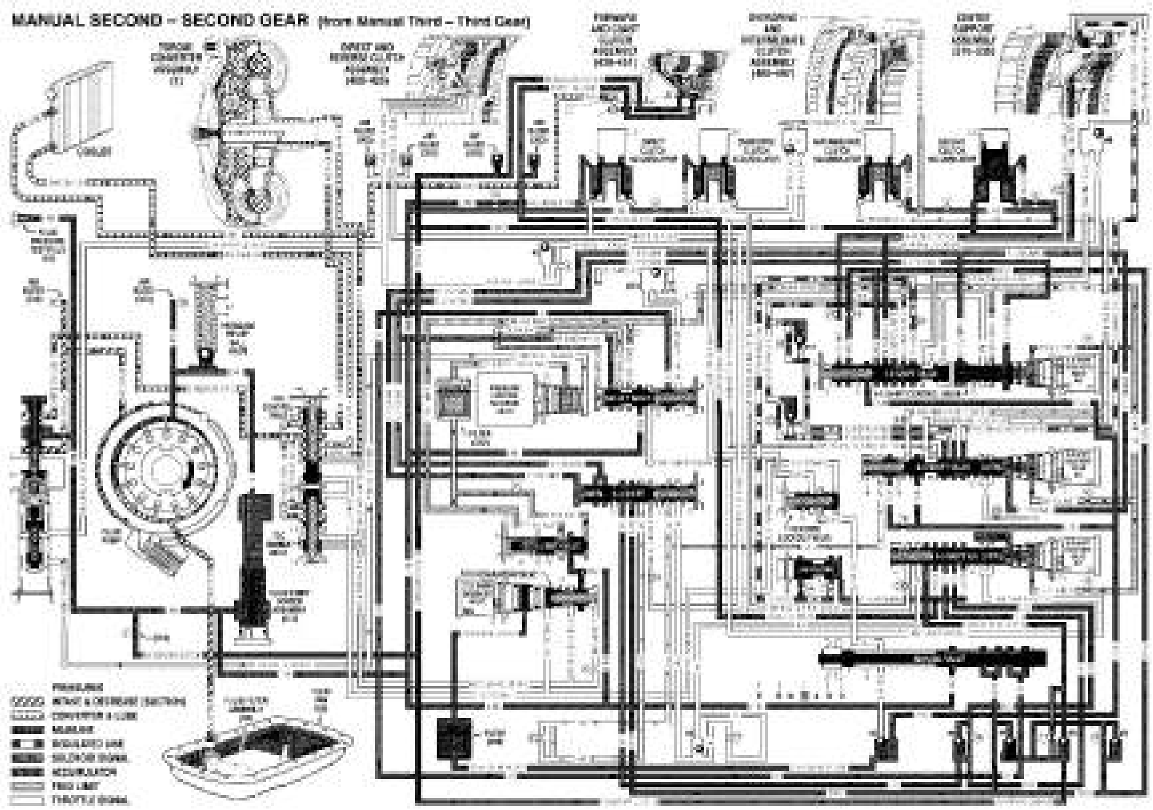
2-3 Shift Valve:: Intermediate clutch fluid is routed through orifice #24 to the 2-3 shift valve where it exhausts.

Shift Accumulation

Intermediate Clutch Accumulator:: Intermediate clutch fluid also exhausts from the intermediate clutch accumulator assembly. Accumulator fluid moves the intermediate clutch accumulator piston against accumulator spring force in preparation for another application of the intermediate clutch.

If the converter clutch was applied when Manual Second was selected it will release during downshifting. Under normal operating conditions the converter clutch will not re-apply in Second gear.

Manual Second Gear


MANUAL SECOND – SECOND GEAR (from Manual Third – Third Gear)
COOLER
PRESSURES
INTAKE & DECREASE (SUCTION)
CONVERTER & LUBE
MAINLINE
REGULATED LINE
SOLENOID SIGNAL
ACCUMULATOR
FEED LIMIT
THROTTLE SIGNAL

Manual Third Gear

Manual Third - Third Gear may be selected at any time while the vehicle is being operated in a forward gear range. However, TCM control prevents the transmission from shifting above Third gear. When the gear selector lever is moved to Manual Third range from Manual Fourth - Fourth Gear, the manual valve also moves. Changes to the hydraulic and electrical systems are as follows:

Overdrive Clutch Applies

Manual Valve:: Line pressure enters the 32 fluid circuit at the manual valve. 32 fluid is routed to the safety mode valve.

1-2 Shift Solenoid (SS) Valve:: The 1-2 SS valve is energised, allowing feed limit fluid to enter the 1-2 signal fluid circuit. 1-2 signal fluid is routed to the safety mode valve and to the 3-4 shift valve.

3-4 Shift Valve:: 1-2 signal fluid overcomes 3-4 shift valve spring force and moves the 3-4 shift valve to the applied position. This allows D432 fluid to enter the 123 fluid circuit, and allows direct clutch and 45 fluids to exhaust.

#4 Ball Check Valve:: 123 fluid seats the #4 ball check valve and passes through orifice #16 on the way to the 4-5 shift valve.

4-5 Shift Valve:: 123 fluid passes throught the 4-5 shift valve (333) into the 123 braking fluid circuit.

Low Pressure Control Valve:: 123 braking fluid is regulated into the 123 regulated fluid circuit through the low pressure control valve (383).

1-2 Shift Valve:: 123 regulated fluid passes through the 1-2 shift valve into the 23 regulated fluid circuit.

#9 and #11 Ball Check Valve:: 23 regulated fluid seats the #9 and the #11 ball check valves and is forced through orifices #22 and #23.

2-3 Shift Valve:: 23 regulated fluid passes through the 2-3 shift valve into the overdrive clutch feed 1 fluid circuit.

#12 Ball Check Valve:: Overdrive clutch feed 1 fluid seats the #12 ball check valve against the overdrive clutch feed 2 passage and enters the overdrive clutch fluid circuit.

Overdrive Clutch:: Overdrive clutch fluid is then directed to the overdirve clutch piston to apply the overdrive clutch plates.

Direct Clutch Releases

Direct Clutch:: Direct clutch fluid exhausts from the direct clutch piston to release the direct clutch plates.

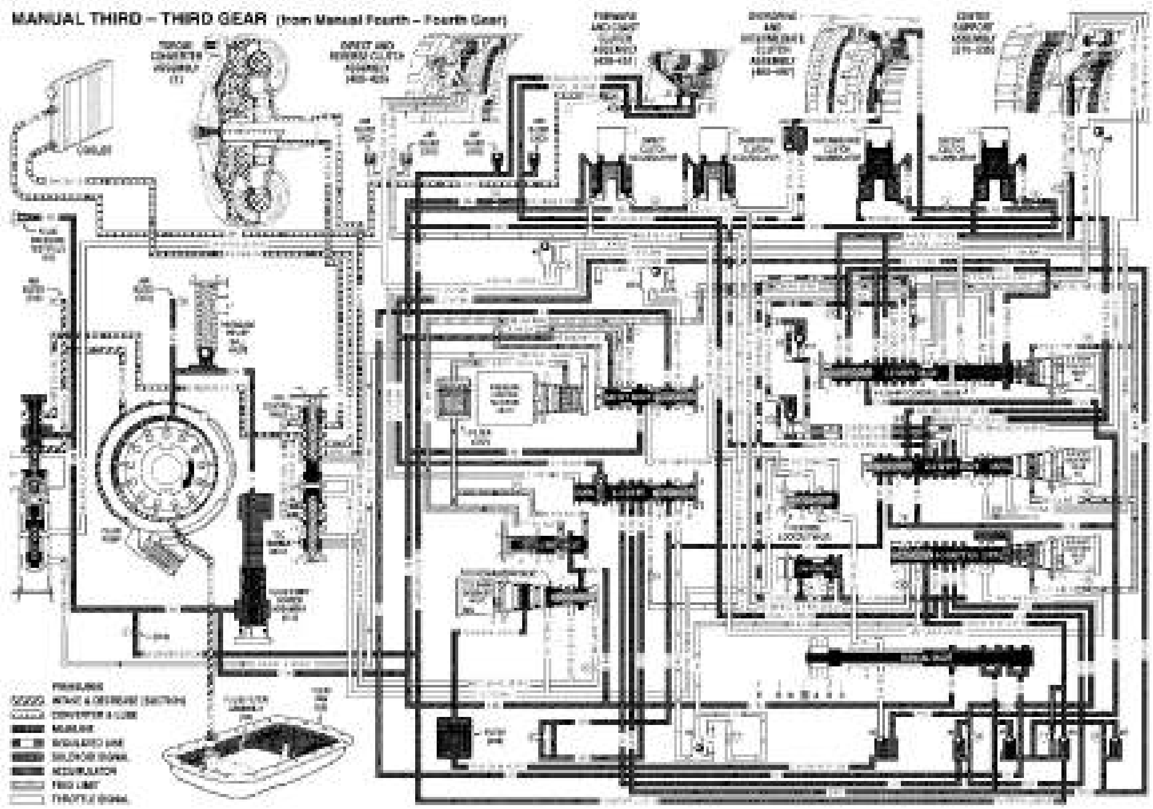
3-4 Shift Valve:: Direct clutch fluid flows through orifice #26 to the 3-4 shift valve where it exhausts.

Shift Accumulation

Direct Clutch Accumulator:: Direct clutch fluid also exhausts from the direct clutch accumulator assembly. Accumulator fluid moves the direct clutch accumulator piston against accumulator spring force in preparation for another application of the direct clutch.

In Manual Third - Third Gear, the TCC will not release if Manual Third was selected while the vehicle was operating in Overdrive Range - Fifth Gear with the TCC applied. Under normal operating conditions, the converter clutch operates the same way in Manual Third - Third Gear as in Overdrive Range - Third Gear.

Manual Third


MANUAL THIRD – THIRD GEAR (from Manual Fourth – Fourth Gear)
PRESSURES
INTAKE & DECREASE (SUCTION)
CONVERTER & LUBE
MAINLINE
REGULATED LINE
SOLENOID SIGNAL
ACCUMULATOR
FEED LIMIT
THROTTLE SIGNAL

Neutral - Engine Running

When the gear selector lever is moved to the Neutral (N) position, the hydraulic and electrical system operation is identical to Park (P) range. However, if Neutral is selected after the vehicle was operating in Reverse (R), the following changes occur in the hydraulic system:

Reverse Clutch Releases

Manual Valve:: The manual valve is moved to the neutral position and blocks line pressure from entering the reverse fluid circuit. The reverse fluid circuit is opened to an exhaust at the manual valve.

Reverse Clutch:: Reverse clutch fluid exhausts from the reverse clutch to the #1 ball check valve allowing the reverse clutch to release.

#1 Ball Check Valve:: Reverse clutch fluid unseats the #1 ball check valve and enters the reverse lockout fluid circuit. Reverse lockout fluid then flows to the reverse lockout valve where it enters the reverse fluid circuit.

Reverse Lockout Valve:: Reverse lockout fluid passes through the reverse lockout valve and into the reverse fluid circuit and on to the manual valve where it exhausts.

Line Boost Valve:: Reverse clutch fluid exhausts from the line boost valve, allowing line pressure to return to the normal operating range as in Park, Neutral and Overdrive gear ranges.

Low and Reverse Clutch Releases

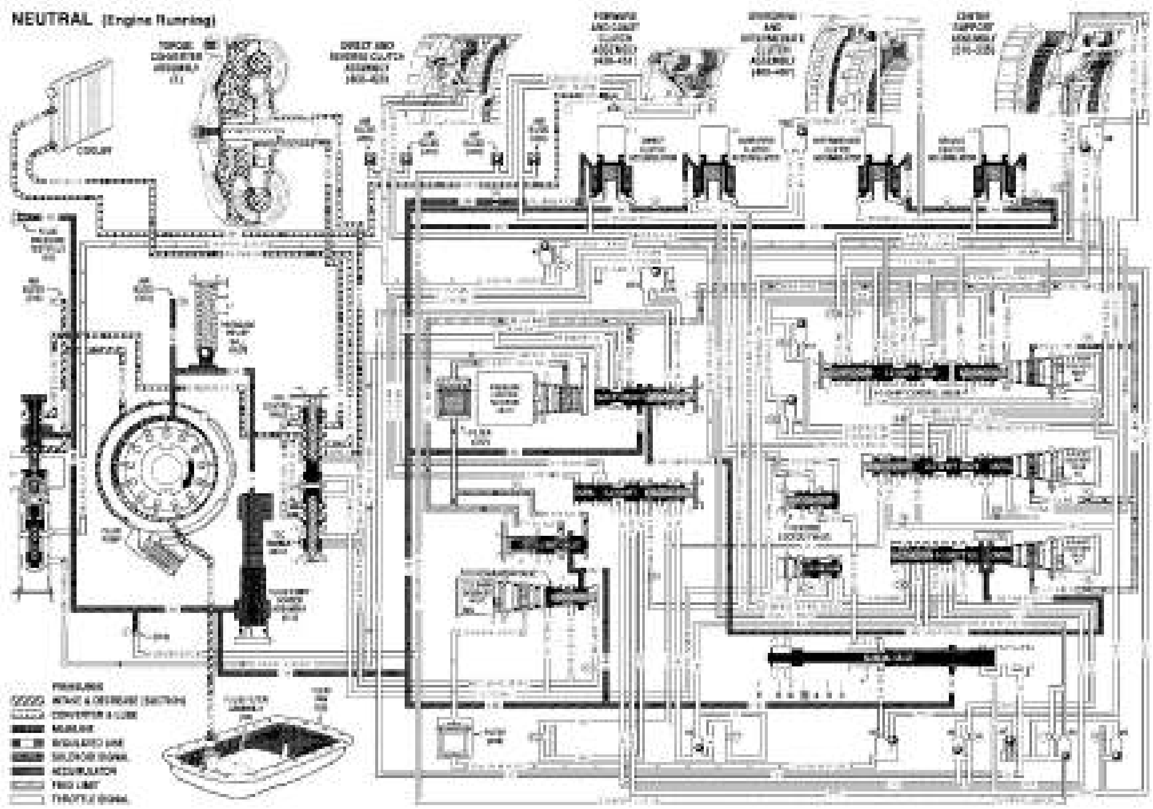
Important: Allowing fluid to bypass an orifice when exhausting makes for a quick release of the clutch. This prevents the friction material from "dragging" and creating excess fluid temperatures or damaging the clutch.

Important: In Park, Reverse and Neutral the shift solenoid valves are shown de-energised. This is the normal operating state when the vehicle is stationary or at low vehicle speeds. However, the TCM will change the shift solenoid valve states depending on vehicle speed. For example, if Neutral range is selected when the vehicle is operating in Second gear, the shift solenoid valves will remain in a Second gear state. But with the manual valve in Neutral, line pressure is blocked, D432 fluid exhausts and the transmission will shift into Neutral.

Low and Reverse Clutch:: Low and reverse clutch or reverse lockout fluid exhausts from the outer area of the low and reverse clutch piston to the #8 ball check valve. Reverse lockout fluid also exhausts from the inner area of the low and reverse clutch piston through orifice #12. The exhaust of these fluids allows the low and reverse clutch to release.

#8 Ball Check Valve:: Low and reverse clutch or reverse lockout fluid seats the #8 ball check valve against the low and reverse clutch fluid circuit and enters the reverse lockout fluid circuit where it exhausts along with reverse clutch fluid past the manual valve.

Neutral Engine Running


NEUTRAL (Engine Running)
COOLER

Overdrive Range, Fifth Gear - Torque Converter Clutch Applied

When the TCC pressure plate is applied, it is held against the torque converter cover. Since it is splined to the converter turbine hub, it provides a mechanical coupling - direct drive of the engine to the transmission gear sets. This mechanical coupling eliminates the small amount of slippage that occurs in the fluid coupling of a torque converter, resulting in a more efficient transfer of engine torque through the transmission and to the drive wheels.

On:: At this time the Torque Converter Clutch is considered to be engaged - ON.

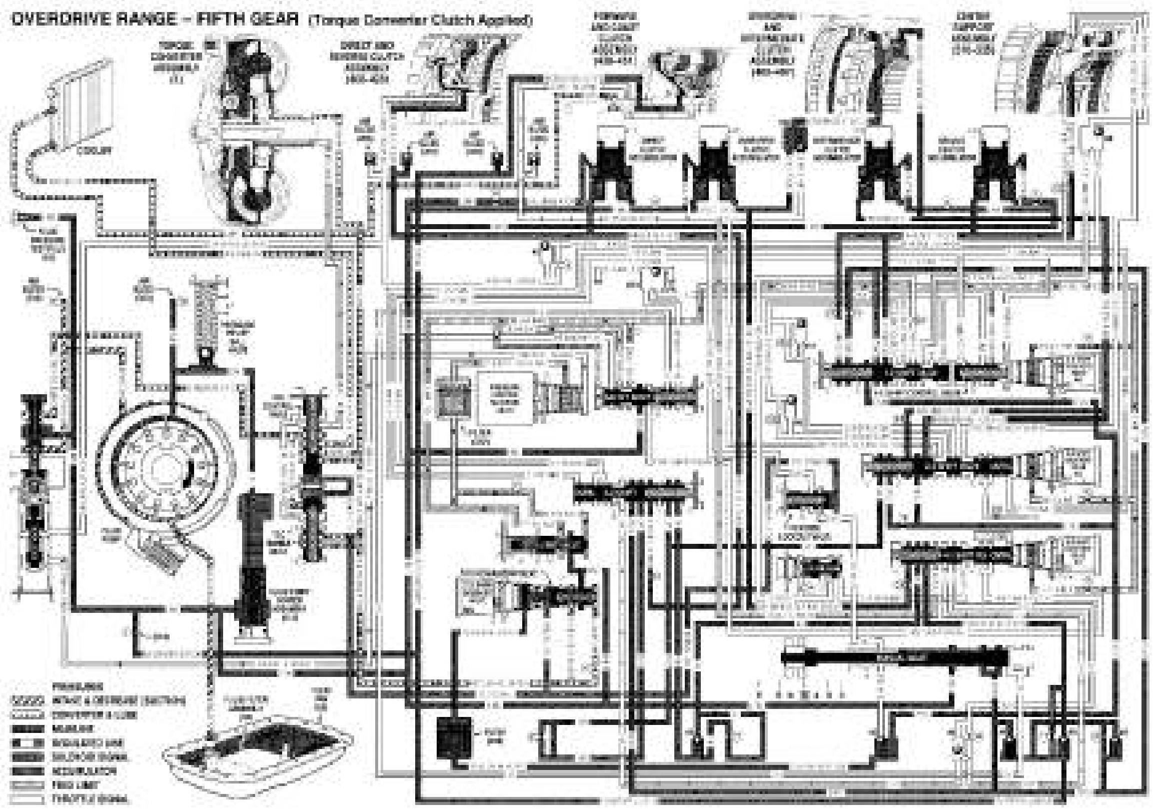
Stage 4:: During this stage, the apply pressure from the TCC Regulator valve is decreased by the TCC PWM solenoid valve duty cycle dropping. Spring force pushes the valve back and reduces the Regulated Apply pressure. This reduces the apply force on the TCC pressure plate to the slip threshold. This gets the TCC pressure plate ready for a smooth release.

Stage 5:: The TCC PWM solenoid valve duty cycle is ramped down through this stage. This action allows the Regulated Apply pressure to start at the slip threshold, and decrease to near "0" pressure over a very short time. The Regulated Apply pressure value from the TCC Regulator valve at this duty cycle should fully release the TCC pressure plate. Slip speed should be at the maximum value.

Stage 6:: The TCM pulses the TCC PWM solenoid valve to a value of "0". Now the TCC Control and TCC Enable valves return to their released positions - away from the spring. Release fluid is now directed back to the torque converter. This stage is designed to move the TCC Control and TCC Enable valves to the released position.

OFF:: At this time the Torque Converter Clutch is considered to be disengaged - OFF.

Overdrive Range, Fifth Gear - Torque Converter Clutch (TCC) Applied


OVERDRIVE RANGE – FIFTH GEAR (Torque Converter Clutch Applied)
COOLER
TORQUE CONVERTER ASSEMBLY
DIRECT AND REVERSE CLUTCH ASSEMBLY
FORWARD AND COAST CLUTCH ASSEMBLY
OVERDRIVE AND INTERMEDIATE CLUTCH ASSEMBLY
CENTER SUPPORT ASSEMBLY
PRESSURES
INTAKE & DECREASE (SUCTION)
CONVERTER & LUBE
MAINLINE
REGULATED LINE
SOLENOID SIGNAL
ACCUMULATOR
FEED LIMIT
THROTTLE SIGNAL

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 5L40-E/5L50-E | Description and Operation | **Document ID: 1985231**

Overdrive Range, Fifth Gear - Torque Converter Clutch Released

Overdrive Range - Fifth Gear is used to maximize engine efficiency and fuel economy under most normal driving conditions. In order to shift the transmission into Fifth gear, the TCM receives input signals from both speed sensors, the TP sensor and other vehicle sensors to determine the precise moment to de-energize or "turn OFF" the 4-5 shift solenoid (SS) valve.

Overdrive Clutch Applied

4-5 Shift Solenoid (SS) Valve:: The 4-5 SS valve is de-energised, blocking feed limit fluid from entering the 4-5 signal fluid circuit. 4-5 signal fluid pressure exhausts through the 4-5 SS valve and 4-5 shift valve spring (373) force moves the 4-5 shift valve (374) and the 4-5 shift control valve (375) to the released position.

4-5 Shift Valve:: 45 fluid is routed through the 4-5 shift valve and enters the overdrive clutch feed 2 fluid circuit through orifice #28.

#12 Ball Check Valve:: Overdrive clutch feed 2 fluid seats the #12 ball check valve against the overdrive clutch feed 1 passage and enters the overdrive clutch fluid circuit.

Overdrive Clutch:: Overdrive clutch fluid is then directed to the overdrive clutch piston to apply the overdrive clutch plates and achieve Fifth gear.

4-5 Shift Accumulation

Overdrive Clutch Accumulator:: Overdrive clutch fluid is also sent to the overdrive clutch accumulator assembly. Overdrive clutch fluid, together with accumulator spring force, moves the overdrive clutch accumulator piston against accumulator fluid pressure to cushion the apply of the overdrive clutch.

Coast Clutch Releases

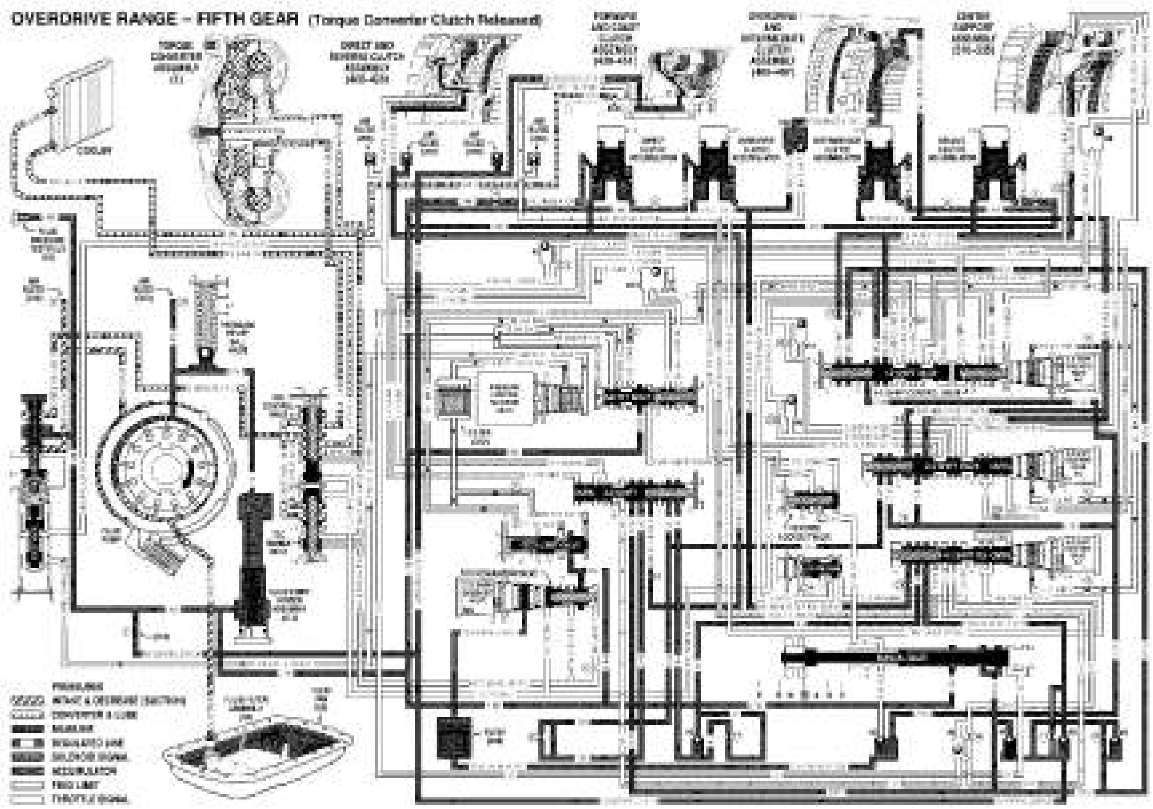
Coast Clutch:: When the 4-5 shift valve is shifted to the released position, coast clutch feed fluid is blocked and coast clutch fluid exhausts through the valve allowing the coast clutch to release.

4-5 Shift Valve:: Coast clutch fluid passes through the 4-5 shift valve and into the 123 circuit and on to the 3-4 shift valve where it exhausts.

Torque Converter Clutch Released

TCC PWM Solenoid Valve:: Filtered 2345 or reverse fluid is still available at the TCC PWM solenoid valve. However, depending on the shift pattern, the TCM keeps the pulse width modulated (PWM) solenoid de-energised blocking filtered 2345 or reverse fluid from entering the TCC signal fluid circuit, thereby keeping the torque converter clutch released.

Overdrive Range, Fifth Gear - Torque Converter Clutch (TCC) Released


OVERDRIVE RANGE – FIFTH GEAR (Torque Converter Clutch Released)
COOLER
ACCUMULATOR
SOLENOID SIGNAL
FEED LIMIT
THROTTLE SIGNAL

Overdrive Range, First Gear (After First 1-2 Shift)

When the gear selector lever is moved to the Overdrive range position (D), from the Neutral (N) position, after the first 1-2 shift has occurred, the following changes occur to shift the transmission into Overdrive Range - First Gear.

Manual Valve:: In the Overdrive position the manual valve routes line pressure into the D432 fluid circuit. D432 fluid is routed to the 1-2 shift valve and to the 3-4 shift valve.

Forward Clutch Applies

#6 and #7 Ball Check Valves:: D432 fluid seats the #6 ball check valve and passes through orifice #15 into the forward clutch fluid circuit. D432 fluid also passes by the spring loaded #7 ball check valve to feed the forward clutch circuit as necessary to help control forward clutch apply.

#5 Ball Check Valve:: Forward clutch fluid seats the #5 ball check valve and passes through orifice #17 into the coast clutch feed circuit.

Forward Clutch Assembly:: Forward clutch fluid is routed to the forward clutch piston to apply the forward clutch plates.

Coast Clutch Applies

2-3 Shift Solenoid (SS) Valve:: The 2-3 SS valve is energised, allowing feed limit fluid to enter the 2-3 signal fluid circuit. 2-3 signal fluid overcomes 2-3 shift valve spring (372) force and moves the 2-3 shift valve (371) to the applied position.

1-2 Shift Control Valve and 1-2 Shift Valve:: 2-3 signal fluid is routed to the 1-2 shift control valve (366) and moves the valve against 1-2 shift control valve spring (367) force to the applied position. This allows feed limit fluid to enter the FDL fluid circuit. FDL fluid is routed to the 1-2 shift valve (387) and moves the valve against 1-2 shift valve spring (388) force to the applied position to block D432 fluid at the valve.

3-4 Shift Control Valve and 3-4 Shift Valve:: 2-3 signal fluid is also routed to the 3-4 shift control valve (346) and moves the valve against 3-4 shift valve spring (344) force to the applied position. This allows D432 fluid to enter the 123 fluid circuit at the 3-4 shift valve (345).

#4 Ball Check Valve:: 123 fluid seats the #4 ball check valve and passes through orifice #16. This orifice helps to control coast clutch apply.

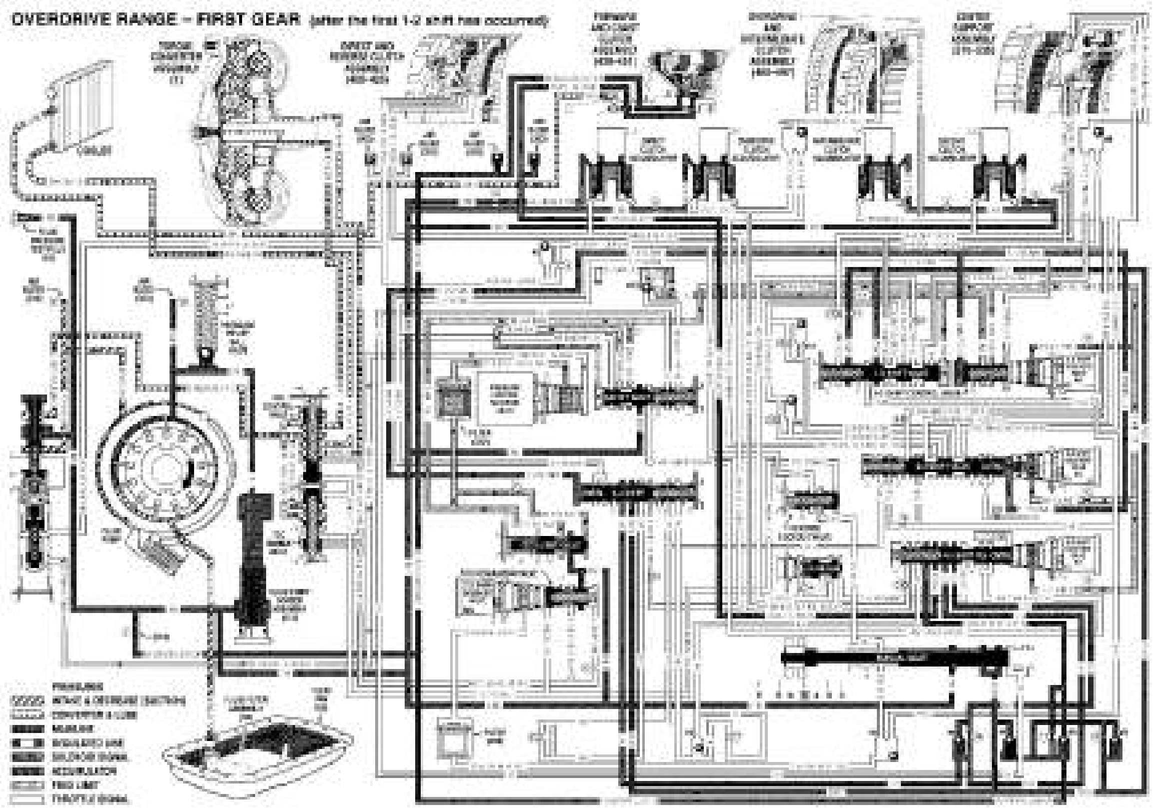
4-5 Shift Valve:: Orificed 123 fluid is routed to the 4-5 shift valve (374) where it passes into the coast clutch fluid circuit.

Coast Clutch Assembly:: Coast clutch fluid is routed to the coast clutch piston to apply the coast clutch plates.

Fluid Pressure Directed in Preparation for a Shift to Second Gear

1-2 Shift Valve:: D432 fluid is routed to the 1-2 shift valve (387) where it is blocked by the valve in preparation for an upshift to second gear.

Overdrive Range, First Gear


OVERDRIVE RANGE – FIRST GEAR (after the first 1-2 shift has occurred)
COOLER
PRESSURES
CONVERTER & LUBE
MAINLINE
SOLENOID SIGNAL
ACCUMULATOR
FEED LIMIT
THROTTLE SIGNAL

Overdrive Range, First Gear (Before First 1-2 Shift)

When the gear selector lever is moved to the Overdrive range position (D), from the Neutral (N) position, before the first 1-2 shift has occurred, the following changes occur to shift the transmission into Overdrive Range - First Gear.

Manual Valve:: In the Overdrive position the manual valve routes line pressure into the D432 fluid circuit. D432 fluid is routed to the 1-2 shift valve and to the 3-4 shift valve.

Forward Clutch Applies

#6 and #7 Ball Check Valves:: D432 fluid seats the #6 ball check valve and passes through orifice #15 into the forward clutch fluid circuit. D432 fluid also passes by the spring loaded #7 ball check valve to feed the forward clutch circuit as necessary to help control forward clutch apply.

Forward Clutch Assembly:: Forward clutch fluid is routed to the forward clutch piston to apply the forward clutch plates.

Coast Clutch Applies

#5 Ball Check Valve:: Forward clutch fluid seats the #5 ball check valve and passes through orifice #17 into the coast clutch feed circuit. This orifice helps to control coast clutch apply.

Safety Mode Valve:: Before the first 1-2 shift has occurred, the safety mode valve (34)1 remains in the released position, allowing line fluid pressure to enter the line safety mode fluid circuit.

4-5 Shift Valve:: Line safety mode fluid applies the 4-5 shift valve (374) against 4-5 shift valve spring (373) force. This allows coast clutch feed fluid to enter the coast clutch fluid circuit.

Coast Clutch Assembly:: Coast clutch fluid is routed to the coast clutch piston to apply the coast clutch plates.

Low and Reverse Clutch Applies

2-3 Shift Solenoid (SS) Valve:: The 2-3 SS valve is energised, allowing feed limit fluid to enter the 2-3 signal fluid circuit. 2-3 signal fluid overcomes spring force and applies the 2-3 shift valve (371).

3-4 Shift Control Valve and 3-4 Shift Valve:: 2-3 signal fluid is routed to the 3-4 shift control valve (346) and applies the valve against spring force. This allows D432 fluid to enter the 123 fluid circuit.

#4 Ball Check Valve:: 123 fluid seats the #4 ball check valve and passes through orifice #16. This orifice helps to control low and reverse clutch apply.

4-5 Shift Valve:: Orificed 123 fluid is routed to the 4-5 shift valve (374) where it passes into the 123 braking fluid circuit.

Low Pressure Control Valve:: 123 braking fluid is routed to the low pressure control valve (383). This valve regulates 123 braking fluid into the 123 regulated fluid circuit against spring force and orificed 123 regulated fluid pressure.

1-2 Shift Control Valve and 1-2 Shift Valve:: 2-3 signal fluid is also routed to the 1-2 shift control valve (366) and applies the valve against spring force. This allows feed limit fluid to enter the FDL fluid circuit. FDL fluid is routed to the 1-2 shift valve (387) and applies the valve against spring force. 123 regulated fluid is routed through orifice #20 to the 1-2 shift valve where it passes into the low and reverse clutch fluid circuit.

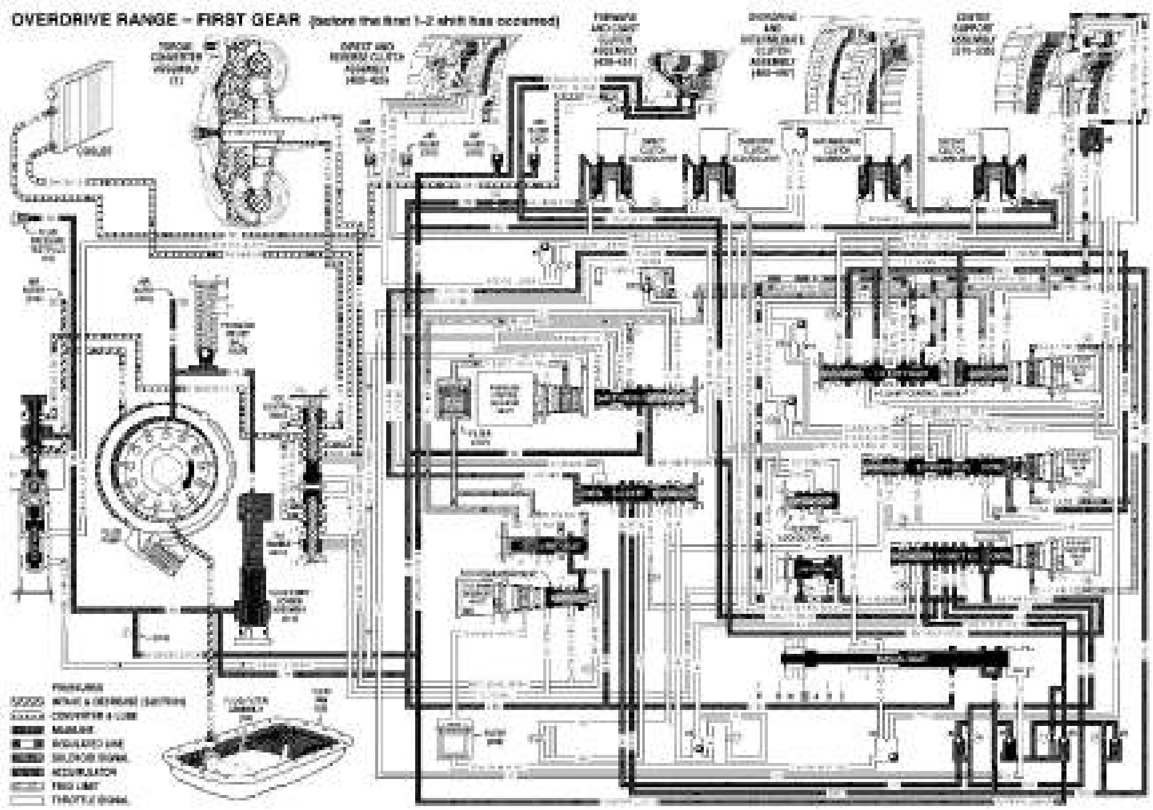
#8 Ball Check Valve:: Low and reverse clutch fluid seats the #8 ball check valve against the reverse lockout fluid passage and enters the low and reverse clutch or reverse lockout fluid passage.

Low and Reverse Clutch:: Low and reverse clutch or reverse lockout fluid pressure enters the outer area of the low and reverse clutch piston and moves the piston against spring force to apply the low and reverse clutch plates.

Fluid Pressure Directed in Preparation for a Shift to Second Gear

1-2 Shift Valve:: D432 fluid is routed to the 1-2 shift valve (387) where it is blocked by the valve in preparation for an upshift to second gear.

Overdrive Range, First Gear


OVERDRIVE RANGE – FIRST GEAR (before the first 1-2 shift has occurred)

Overdrive Range, Fourth Gear

As vehicle speed increases, the TCM receives input signals from both speed sensors, the TP sensor and other vehicle sensors to determine the precise moment to de-energize or "turn OFF'" the 1-2 shift solenoid (SS) valve, and to energize or "turn ON" the 4-5 SS valve.

Direct Clutch Applies

1-2 Shift Solenoid (SS) Valve:: The 1-2 SS valve is de-energised, blocking feed limit fluid from entering the 1-2 signal fluid circuit and 1-2 signal fluid pressure exhausts through the 1-2 SS valve.

3-4 Shift Valve:: When 1-2 signal fluid pressure exhausts from the 3-4 shift valve (345), the 3-4 shift valve spring (344) moves the valve to the released position. 345 fluid from the 2-3 shift valve flows through the 3-4 shift valve and enters the direct clutch circuit.

Direct Clutch:: Direct clutch fluid is routed to the direct clutch piston to apply the direct clutch plates and obtain Fourth gear.

3-4 Shift Accumulation

Direct Clutch Accumulator:: Direct clutch fluid is also sent to the direct clutch accumulator assembly. Direct clutch fluid, together with accumulator spring force, moves the direct clutch accumulator piston against accumulator fluid pressure to cushion the apply of the direct clutch.

Coast Clutch Feed

4-5 Shift Solenoid (SS) Valve:: The 4-5 SS valve is energised, allowing feed limit fluid to enter the 4-5 signal fluid circuit. 4-5 signal fluid overcomes 4-5 shift valve spring (373) force and moves the 4-5 shift control valve (375) and the 4-5 shift valve (374) to the applied position.

4-5 Shift Valve:: In first through third gears, the coast clutch has been fed by 123 fluid. In fourth gear the 4-5 shift valve (374) is applied in preparation for a shift to fifth gear. This causes the coast clutch fluid circuit to be supplied by coast clutch feed fluid, and 123 fluid to exhaust.

Torque Converter Clutch Released

TCC PWM Solenoid Valve:: Filtered 2345 or reverse fluid is still available at the TCC PWM solenoid valve. However, depending on the shift pattern, the TCM keeps the pulse width modulated (PWM) solenoid de-energised blocking filtered 2345 or reverse fluid from entering the TCC signal fluid circuit, thereby keeping the torque converter clutch released.

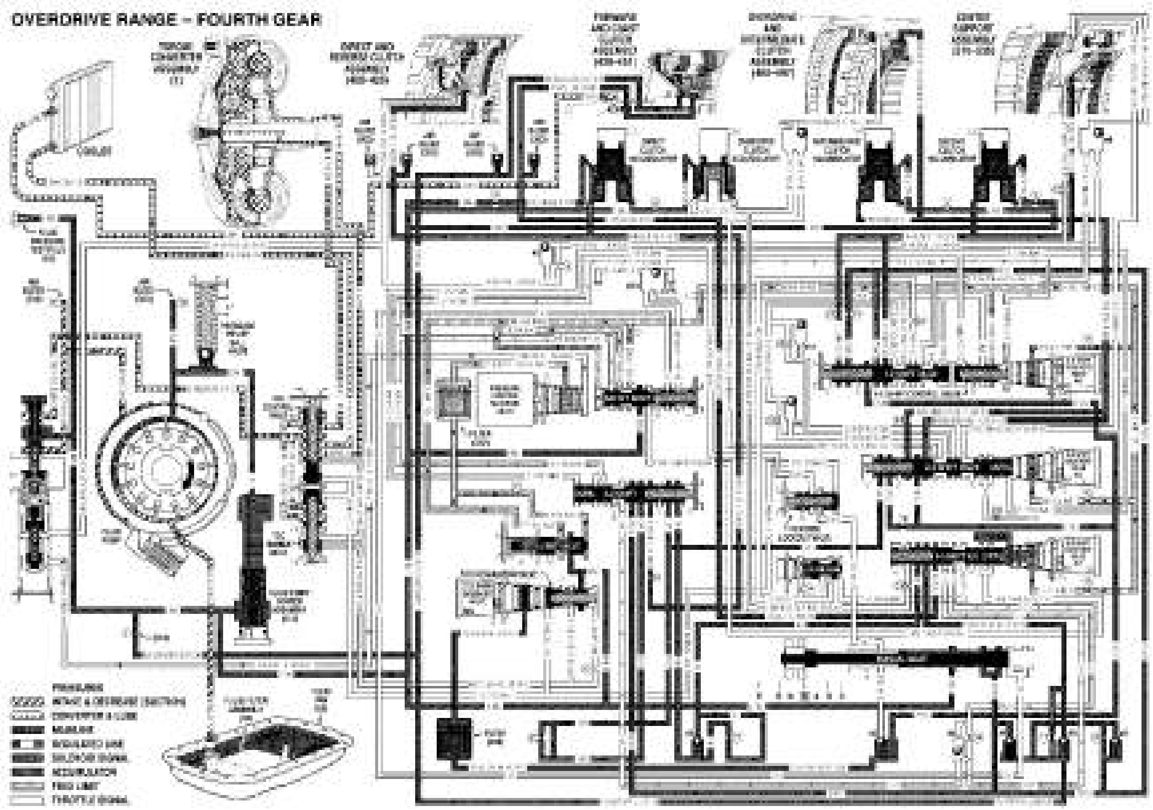
Fluid Pressure Directed in Preparation for a Shift to Fifth Gear

3-4 Shift Valve:: 345 fluid is routed through the 3-4 shift valve (345) into the 45 fluid circuit.

#3 Ball Check Valve:: 45 fluid seats the #3 ball check valve and passes through orifice #27. This orifice helps to control overdrive clutch apply in fifth gear.

4-5 Shift Valve:: 45 fluid is routed to the 4-5 shift valve (374) where it is blocked by the valve in preparation for an upshift to fifth gear.

Overdrive Range, Fourth Gear - Torque Converter Clutch (TCC) Applied



Overdrive Range, Second Gear

As vehicle speed increases, the transmission control module (TCM) receives input signals from both the input and ouput speed sensors, the throttle position (TP) sensor and other vehicle sensors to determine the precise moment to energise or "turn ON" the 1-2 shift solenoid (SS) valve.

Second Clutch Applies

1-2 Shift Solenoid (SS) Valve:: The 1-2 SS valve is energised, allowing feed limit fluid to enter the 1-2 signal fluid circuit. 1-2 signal fluid, together with 1-2 shift control valve spring (367) force, overcomes 2-3 signal fluid pressure and moves the 1-2 shift control valve (366) to the released position. This blocks feed limit fluid from entering the FDL fluid circuit.

1-2 Shift Valve:: FDL fluid is exhausted from the 1-2 shift valve (387) and 1-2 shift valve spring (388) force moves the valve to the released position to allow D432 fluid to enter the second clutch and 2345 fluid circuits.

Second Clutch:: Second clutch fluid is directed to the second clutch piston to apply the second clutch plates and achieve Second gear.

Shift Accumulator

Second Clutch Accumulator:: Second clutch fluid is also sent to the second clutch accumulator assembly. Second clutch fluid, together with accumulator spring force, moves the second clutch accumulator piston against accumulator fluid pressure to cushion the apply of the second clutch.

Fluid Pressure Directed in Preparation for a Shift to Third Gear

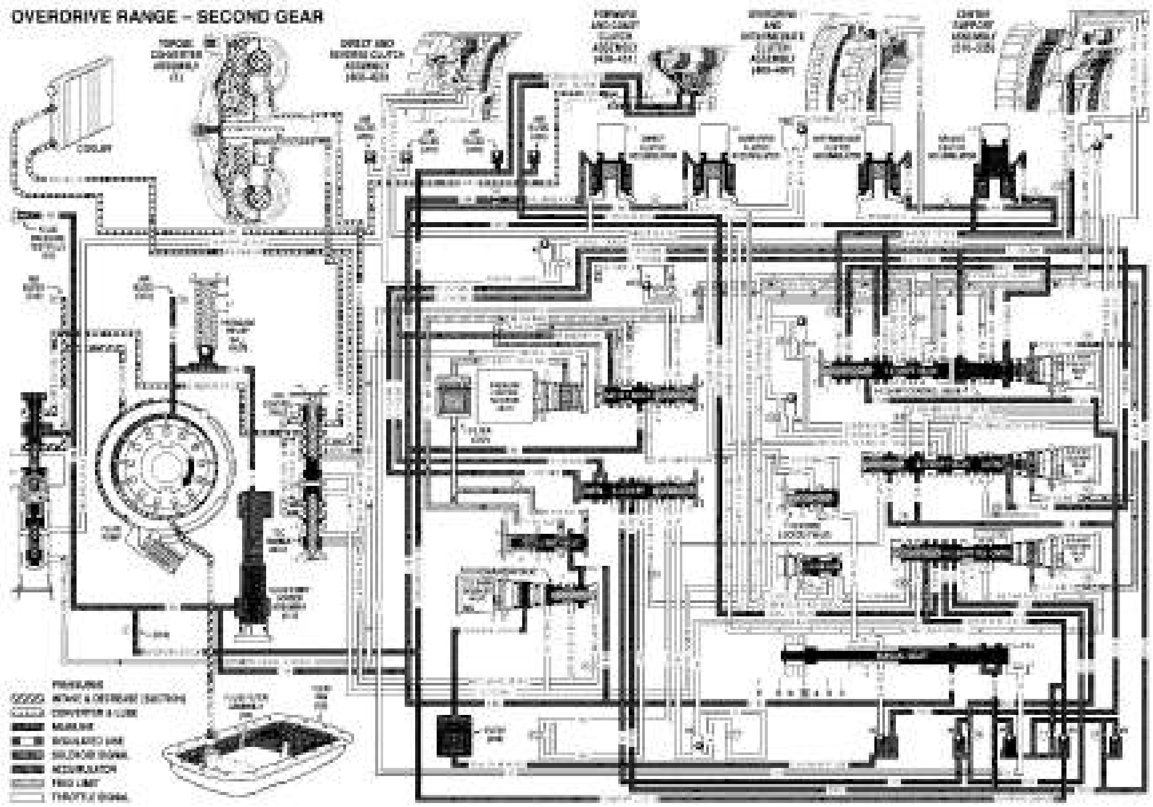
2-3 Shift Valve:: 2345 fluid is routed to the 2-3 shift valve (371) where it is blocked by the valve in preparation for an updshift to third gear.

Torque Converter Clutch Released

#2 Ball Check Valve:: 2345 fluid seats the ball check valve against the reverse passage and enters the 2345 or reverse fluid circuit.

TCC PWM Solenoid Valve:: 2345 or reverse fluid is directed through the TCC PWM solenoid valve filter to the TCC PWM solenoid valve. However, depending on the shift pattern, the TCM keeps the pulse width modulated (PWM) solenoid de-energised blocking filtered 2345 or reverse fluid from entering the TCC signal fluid circuit, thereby keeping the torque converter clutch released.

Overdrive Range, Second Gear


OVERDRIVE RANGE – SECOND GEAR
COOLER
PRESSURES
INTAKE & DECREASE (SUCTION)
CONVERTER & LUBE
MAINLINE
SOLENOID SIGNAL
ACCUMULATOR
FEED LIMIT
THROTTLE SIGNAL

Overdrive Range, Third Gear

As vehicle speed increases, the TCM receives input signals from both speed sensors, the TP sensor and other vehicle sensors to determine the precise moment to de-energize or "turn OFF" the 2-3 shift solenoid (SS) valve. The 2-3 solenoid is OFF when the TCM removes the path to ground for that electrical circuit. This allows 2-3 signal fluid to exhaust at the 2-3 SS valve.

Intermediate Clutch Applies

2-3 Shift Solenoid (SS) Valve:: The 2-3 SS valve is de-energised, blocking feed limit fluid from entering the 2-3 signal fluid circuit. 2-3 signal fluid pressure exhausts through the 2-3 SS valve and 2-3 shift valve spring (372) force moves the 2-3 shift valve (371) to the released position.

2-3 Shift Valve:: 2345 fluid is routed through the 2-3 shift valve and enters the intermediate clutch circuit.

Intermediate Clutch:: Intermediate clutch fluid is directed to the intermediate clutch piston to apply the intermediate clutch plates and achieve Third gear.

Shift Accumulation

Intermediate Clutch Accumulator:: Intermediate clutch fluid is also sent to the intermediate clutch accumulator assembly. Intermediate clutch fluid, together with accumulator spring force, moves the intermediate clutch accumulator piston against accumulator fluid pressure to cushion the apply of the intermediate clutch.

Torque Converter Clutch Released

TCC PWM Solenoid Valve:: Filtered 2345 or reverse fluid is still available at the TCC PWM solenoid valve. However, depending on the shift pattern, the TCM keeps the pulse width modulated (PWM) solenoid de-energised blocking filtered 2345 or reverse fluid from entering the TCC signal fluid circuit, thereby keeping the torque converter clutch released.

Fluid Pressure Directed in Preparation for a Shift to Fourth Gear

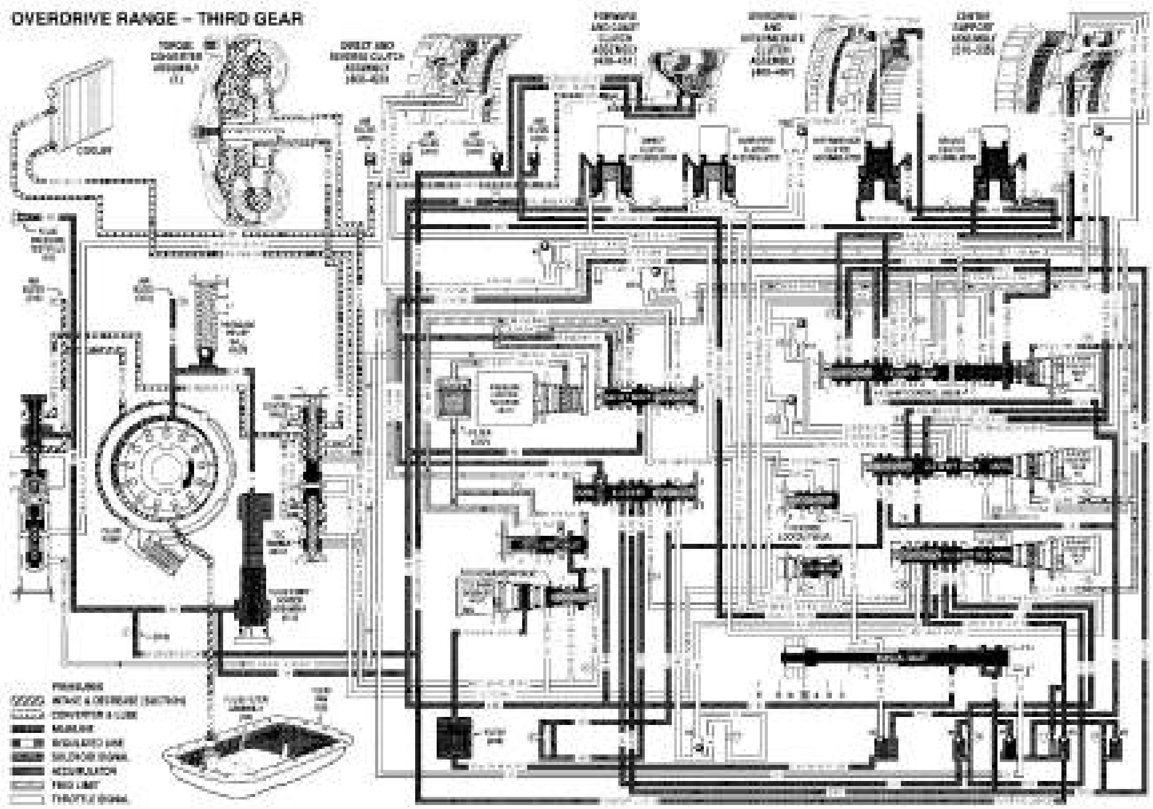
2-3 Shift Valve:: 2345 fluid is routed through the 2-3 shift valve (371) into the 345 fluid circuit.

X-4 Ball Check Valve:: 345 fluid is routed through the X-4 ball check valve pocket. In some transmisssion models there is a ball check valve present which will force 345 fluid through orifice #25.

3-4 Shift Valve:: 345 fluid is routed to the 3-4 shift valve (345) where it is blocked by the valve in preparation for an upshift to fourth gear.

Overdrive Range, Third Gear - Torque Converter Clutch (TCC) Applied

OVERDRIVE RANGE – THIRD GEAR


TORQUE CONVERTER ASSEMBLY
DIRECT AND REVERSE CLUTCH ASSEMBLY
FORWARD AND COAST CLUTCH ASSEMBLY
OVERDRIVE AND INTERMEDIATE CLUTCH ASSEMBLY
CENTER SUPPORT ASSEMBLY
COOLER
PRESSURES
INTAKE & DECREASE (SUCTION)
CONVERTER & LUBE
MAINLINE
REGULATED LINE
SOLENOID SIGNAL
ACCUMULATOR
FEED LIMIT
THROTTLE SIGNAL

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 5L40-E/5L50-E | Description and Operation | Document ID: 1985219

Park - Engine Running

When the gear selector lever is in the Park (P) position and the engine is running, fluid is drawn into the oil pump and line pressure is directed to the pressure regulator valve.

Pressure Regulation

Pressure Regulator Valve:: Regulates pump output - line pressure in response to throttle signal fluid pressure acting on the line boost valve, spring force, and line pressure acting on the end of the valve. Line pressure is directed to the manual valve, the TCC regulator valve, feed limit valve, and the safety mode valve. Line pressure also feeds the converter feed circuit through the pressure regulator valve, and the accumulator fluid circuits.

Feed Limit Valve:: Line pressure is routed through the valve and into the feed limit fluid circuit. The valve limits feed limit fluid pressure to a maximum pressure. Feed limit fluid is routed to the pressure control solenoid valve, the safety mode valve, the 1-2 control valve, and also feeds the 1-2 signal, the 2-3 signal, and the 4-5 signal fluid circuits.

Pressure Control (PC) Solenoid Valve:: Controlled by the TCM, the PC solenoid valve regulates filtered feed limit fluid pressure into the throttle signal fluid circuit.

Shift Accumulation

Direct, Overdrive, Intermediate, and Second Clutch Accumulator Assemblies:: Accumulator fluid is routed to each of the accumulator assemblies in preparation for upshifts and downshifts.

Torque Converter - Released Position Only

Pressure Regulator Valve:: Line pressure is routed through the pressure regulator valve and into the converter feed fluid circuit. Converter feed fluid is routed to the TCC control valve and to the TCC enable valve.

TCC Regulator Valve:: Spring force holds the valve in the release position, thereby blocking line pressure from entering the regulated apply fluid circuit.

TCC Enable Valve:: Converter feed fluid is routed through the TCC enable valve and into the converter FDL circuit. Converter FDL fluid is routed to the TCC control valve.

TCC Control Valve:: Spring force holds the valve in the release position allowing converter feed fluid to enter the release circuit.

Torque Converter:: Release fluid pressure is routed to the torque converter to keep the TCC released. Fluid leaves the converter in the apply fluid circuit and returns to the cooler through the TCC control valve.

Safety Mode:

Safety Mode Valve:: When the first 1-2 shift occurs, the safety mode valve shifts from the released position to the applied position and remains there until the engine is switched OFF. If safety mode occures - no TCM signal to the shift solenoid valve, the transmission will shift to safety

- fifth gear. If the engine is then switched OFF and ON, still with no TCM signal, the safety mode valve will return to, and remain in, the released position. Line pressure fluid will pass through the safety mode valve into the line safety mode fluid circuit. Line safety mode fluid is routed to the 4-5 shift valve train.

4-5 Shift Valve and 4-5 Shift Control Valve:: Line safety mode fluid forces the 4-5 shift valve to downshift to the fourth gear position allowing - after the engine has been switched OFF, a fourth gear start - instead of fifth, in the event of safety mode.

Fluid Pressure Directied in Preparation for a Shift

Manual Valve:: Mechanically controlled by the gear selector lever, the manual valve is in the Park (P) position and prevents line pressure from the pressure regulator valve from entering the reverse, D432 and 32 fluid circuits.

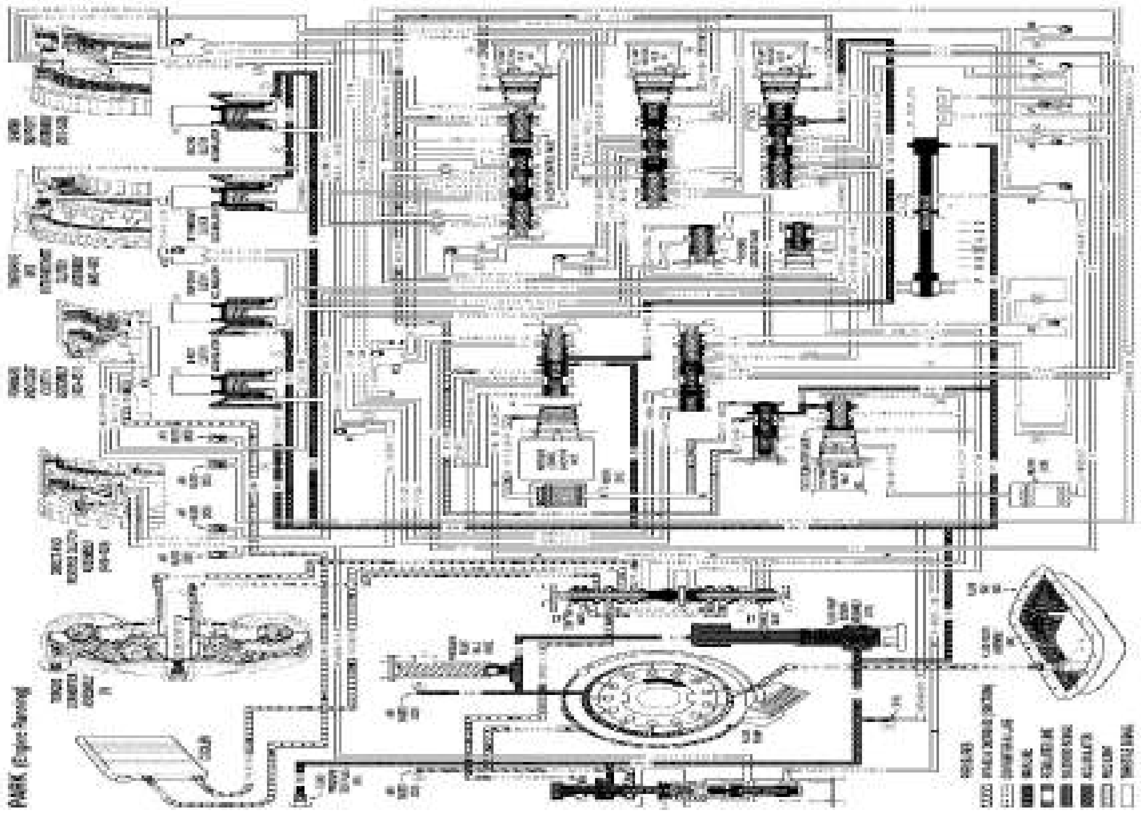
1-2 Shift Solenoid (SS) Valve and 1-2 Shift Control Valve:: Feed limit fluid from the feed limit valve is routed to the 1-2 SS valve and to the 1-2 Shift control valve in preparation for a shift.

2-3 Shift Solenoid (SS) Valve:: Feed limit fluid from the feed limit valve is routed to the 2-3 SS valve in preparation for a shift.

4-5 Shift Solenoid (SS) Valve:: Feed limit fluid from the feed limit valve is routed to the 4-5 SS valve in preparation for a shift.

Direct Clutch, Overdrive Clutch, Intermediate Clutch, and Second Clutch Accumulators:: Line fluid fills the accumulator circuits and accumulator assemblies in preparation for an upshift.

Park Engine Running


PARK (Engine Running)

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 5L40-E/5L50-E | Description and Operation | **Document ID: 1985221**

Reverse

When the gear selector lever is moved to the Reverse (R) position - from the Park position, the following changes occur in the transmission's hydraulic and electrical systems:

Pressure Regulation

Manual Valve:: With the manual valve in the reverse position, line pressure is directed into the reverse fluid circuit.

Reverse Lockout Valve:: Reverse fluid is routed through the reverse lockout valve into the reverse lockout fluid circuit.

Pressure Regulator and Line Boost Valves:: Reverse clutch fluid at the line boost valve boosts line pressure for the additional torque requirements in Reverse. Throttle signal fluid pressure from the pressure control - PC solenoid acting on the line boost valve also helps determine line pressure in Reverse depending on throttle position and other TCM input signals.

Low and Reverse Clutch Applies

#8 Ball Check Valve and Orifice #12:: Located in the bottom channel plate, reverse lockout fluid seats the #8 ball check valve against the low and reverse clutch fluid passage and directs fluid into the low and reverse clutch or reverse lockout fluid passage. Reverse lockout fluid pressure is also orificed, through orifice #12, to provide a controlled apply of the low and reverse clutch.

Low and Reverse Clutch:: Low and reverse clutch or reverse lockout fluid pressure enters the outer area of the low and reverse clutch piston and moves the piston against spring force to apply the low and reverse clutch plates. In addition, reverse lockout fluid pressure is orificed into the inner area of the low and reverse clutch piston and provides additional force to apply the low and reverse clutch plates.

Reverse Clutch Applies

Important: Remember that the function of an orifice is to control the flow rate of fluid and rate of apply or release of a clutch.

#1 Ball Check Valve:: Located in the bottom channel plate, reverse lockout fluid seats the #1 ball check valve and is forced through orifice #13 in the control valve body spacer plate into the reverse clutch fluid passage.

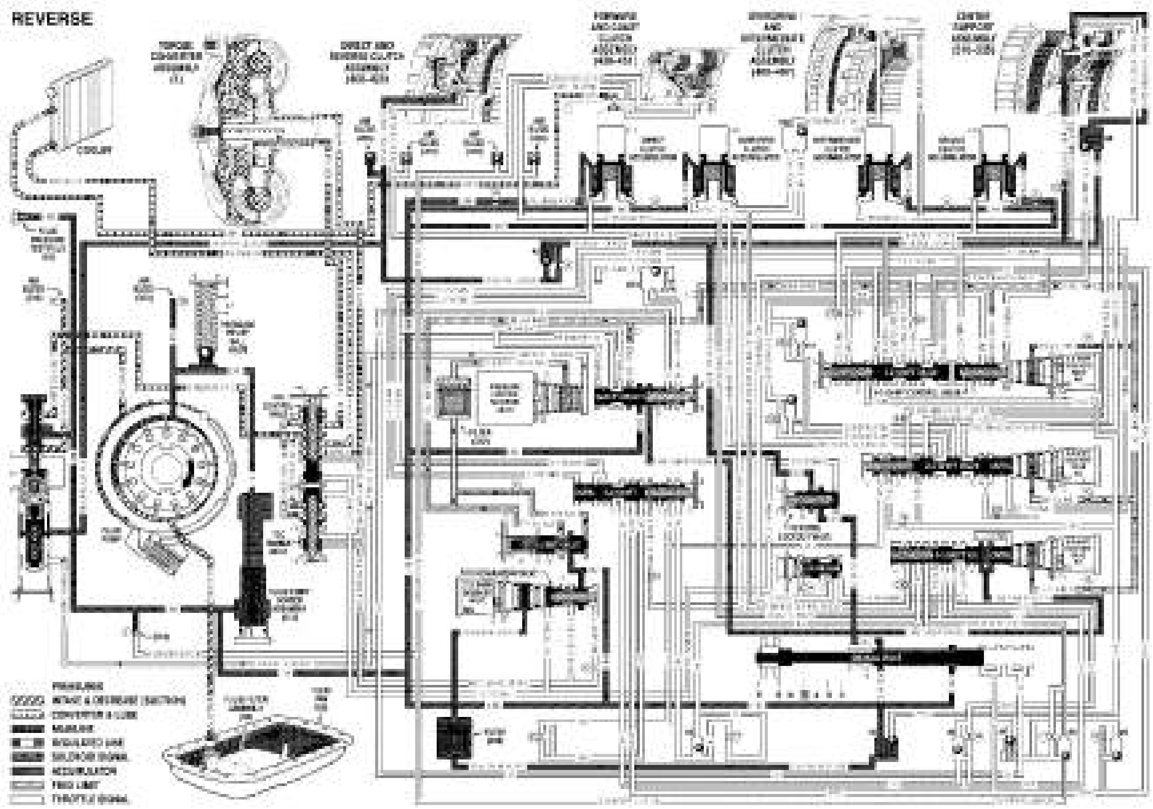
Reverse Clutch:: Reverse clutch fluid enters the reverse clutch housing and acts on the reverse clutch piston to apply the reverse clutch plates.

Fluid Pressure Directed in Preparation for TCC Apply

#2 Ball Check Valve:: Located in the bottom channel plate, reverse fluid seats the #2 ball check valve against the 2345 fluid passage and directs fluid into the 2345 or reverse fluid passage.

Torque Converter Clutch Pulse Width Modulation - TCC PWM Solenoid Valve:: The TCC PWM solenoid valve remains de-energised - OFF. 2345 or reverse fluid is prevented from entering the TCC signal fluid circuit. Under normal circumstances the TCC PWM solenoid valve is not energised. In the event the TCC PWM solenoid valve is energised - when engaging Reverse while driving in Forward above a certain speed, TCC signal fluid will shift the reverse lockout valve to block reverse fluid from entering the reverse lockout circuit and the reverse clutch and the low and reverse clutch will release to prevent damage to the transmission.

Reverse



Sport / Economy Mode Operation

Economy Mode Operation

During economy mode operation, drivers may notice increased powertrain braking after releasing the accelerator pedal. The vehicle will not coast freely when the accelerator pedal is released, but will start to gradually slow down as if the brakes were lightly applied. This feels very similar to what is experienced when releasing the accelerator pedal on a vehicle equipped with a manual transmission.

Sport Mode Operation (Where Fitted)

The sport mode was designed to simulate the performance driving of a manual transmission equipped vehicle. This means that, given certain driving conditions, the vehicle will maintain specific gears longer than a traditional automatic transmission. In addition, if a person is driving in the normal mode in fifth gear, depressing the sport button will cause an immediate 5-4 downshift that will be maintained for ten seconds. If the transmission is in any other gear when sport is engaged, no downshift will take place. No attempt should be made to change or alter these operating characteristics.

Transmission Adaptive Functions

The Hydra-Matic 5L40-E uses a line pressure control system which has the ability to adapt the system line pressure in order to compensate for normal wear of clutch fiber plates, seals, springs, etc. The adapt feature is similar in function to fuel control (integrator/block learn).

The Hydra-Matic 5L40-E transmission uses the adapt function for garage shifts, upshifts, and TCC application. The TCM monitors the input shaft speed in order to determine if the shift is occurring too fast or too slow and adjusts the pressure control solenoid in order to maintain the correct shift feel.

Transmission Component and System Description

The mechanical components of the 5L40-E are as follows:

- A torque converter with an electronically controlled capacity clutch (ECCC)

  This transmission is equipped with an electronically controlled capacity clutch (ECCC). The pressure plate does not fully lock to the torque converter cover. Instead, the pressure plate maintains a small amount of slippage, about 20 RPM, in SECOND, THIRD and FOURTH gears, depending on the vehicle application. ECCC was developed to reduce the possibility of noise, vibration or chuggle caused by TCC apply. Typical apply speeds are 49-52 km/h (30-32 mph) in THIRD gear and 65-73 km/h (40-45 mph) in FOURTH gear. Full lockup is available at highway speeds on some applications.
- Direct and reverse clutch assembly
- Forward and coast clutch assembly
- Input sungear shaft and forward sprag clutch assembly
- Output shaft assembly, with rear internal gear
- Intermediate clutch sprag assembly
- Overdrive clutch housing
- Low clutch sprag
- Centre support
- Input and reaction carrier
- Fluid pump assembly
- Control valve body and accumulator assembly

The electrical components of the 5L40-E are as follows:

- 1-2, 2-3 and 4-5 shift solenoids
- Transmission manual shift shaft switch assembly
- Transmission pressure control (PC) solenoid
- TCC pulse width modulation (PWM) solenoid valve
- Transmission fluid temperature (TFT) sensor
- Input speed sensor (ISS)
- Output speed sensor (OSS)

For more information, refer to Electronic Component Description.

Transmission General Description

The Hydra-matic 5L40-E is a fully automatic, five speed, rear wheel drive, electronically controlled transmission. It consists primarily of a four-element torque converter, one planetary gear set, friction and mechanical clutches and a hydraulic pressurization and control system.

The TCM commands shift solenoids, within the transmission, on and off to control shift timing. The TCM controls shift feel through the pressure control solenoid. The TCM also controls the apply and release of the torque converter clutch which allows the engine to deliver the maximum fuel efficiency without sacrificing vehicle performance. The hydraulic system primarily consists of a vane type pump, two control valve bodies, two channel plates, converter housing and case. The pump maintains the working pressures needed to stroke the clutch pistons that apply or release the friction components. These friction components, when applied or released, support the automatic shifting qualities of the transmission. The friction components used in this transmission consist of nine multiple disc clutches. The multiple disc clutches combine with four mechanical sprag clutches, to deliver six different gear ratios through the gear set. The gear set then transfers torque through the output shaft.

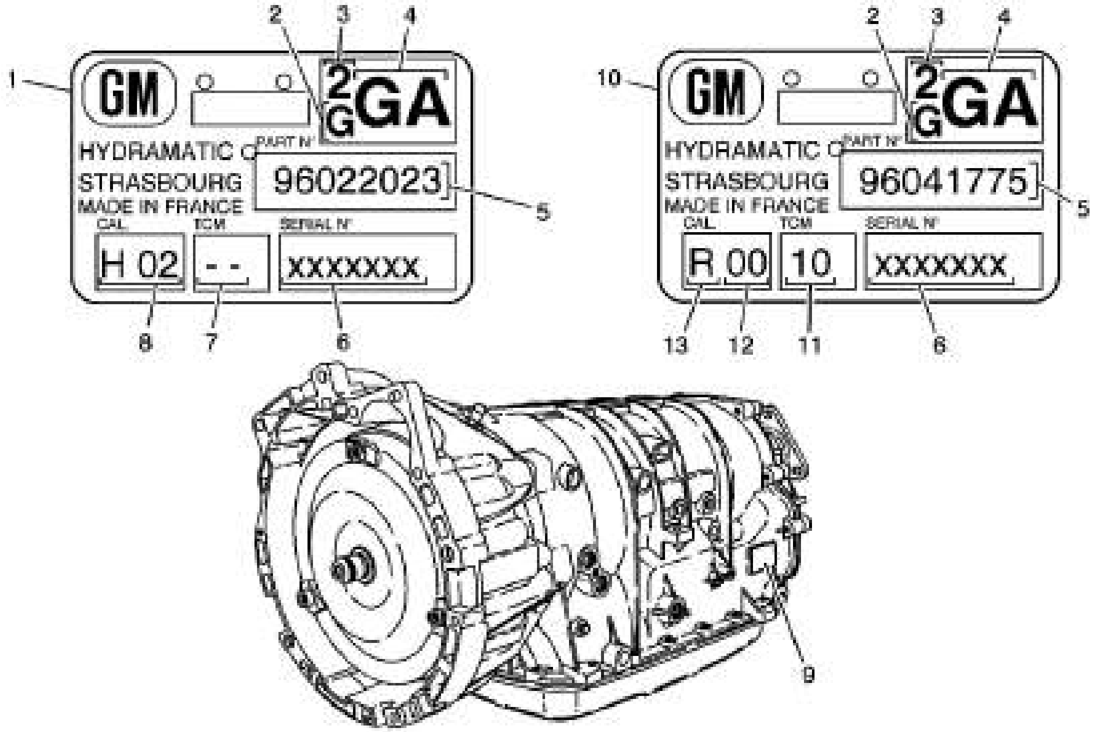
The transmission can be operated in any one of the seven different modes.

- P - Park position enables the engine to be started while preventing the vehicle from rolling either forward or backward. For safety reasons, the vehicle parking brake should be used in addition to the transmission Park position. Since the output shaft is mechanically locked to the case through the parking pawl and rear internal gear, Park position should not be selected until the vehicle has come to a complete stop.
- R - Reverse enables the vehicle to be operated in a rearward direction.
- N - Neutral position enables the engine to start and operate without driving the vehicle. If necessary, this position should be selected to restart the engine while the vehicle is moving.
- OD - Overdrive range should be used for all normal driving conditions for maximum efficiency and fuel economy. Overdrive range allows the transmission to operate in each of the five forward gear ratios. Downshifts to a lower gear, or higher gear ratio are available for safe passing by depressing the accelerator or by manually selecting a lower gear with the shift selector.
- 4 - Manual Fourth can be used for conditions where it may be desirable to use only four gear ratios. These conditions include towing a trailer and driving on hilly terrain as described above. This range is also helpful for engine braking when descending slight grades. Upshifts and downshifts are the same as in Overdrive range for first, second, third and fourth gears except that the transmission will not shift into fifth gear. Manual Fourth can be selected at any vehicle speed but will downshift into fourth gear only if vehicle speed is low enough not to overrev the engine, calibratable in TCM.
- 3 - Manual Third adds more performance for congested traffic and hilly terrain. It has the same starting ratio, first gear, as Manual Fourth but prevents the transmission from shifting above Third gear. Thus, Manual Third can be used to retain third gear for acceleration and engine braking as desired. Manual Third can be selected at any vehicle speed but will downshift into third gear only if vehicle speed is low enough not to overrev the engine, calibratable in TCM.
- 2 - Manual Second adds more performance for congested traffic and hilly terrain. It has the same starting ratio, first gear, as Manual Third but prevents the transmission from shifting above second gear. Thus, Manual Second can be used to retain second gear for acceleration and engine braking as desired. Manual Second can be selected at any vehicle speed but will

downshift into second gear only if vehicle speed is low enough not to overrev the engine, calibratable in TCM.

When the vehicle speed slows down to a speed low enough not to overrev the engine, calibratable in TCM, the transmission will automatically downshift into first gear. This is particularly beneficial for maintaining maximum engine braking when descending steep grades.

Transmission Identification Information



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(1) Production or Service New
(2) Transmission Family
(3) Model Year
(4) Alpha Code
(5) Part Number
(6) Serial Number
(7) Empty
(8) Calibration Code
(9) I.D. Tag Location
(10) Remanufactured
(11) Remanufactured Date - Week
(12) Remanufactured Date - Year
(13) R = Remanufactured

Transmission Indicators and Messages

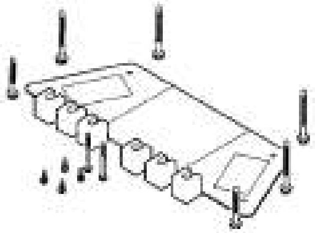
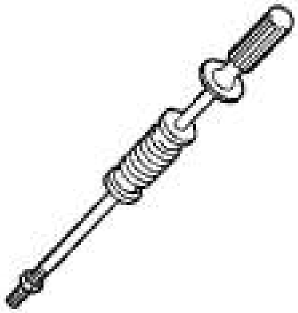
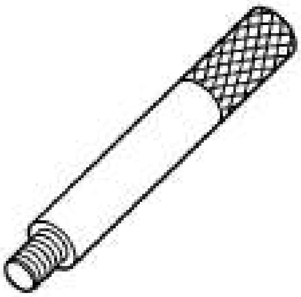
The following transmission-related indicators and messages may be displayed on the Instrument Panel Cluster (IPC). For a complete listing and description of all vehicle indicators and messages, refer to Indicator/Warning Message Description and Operation.

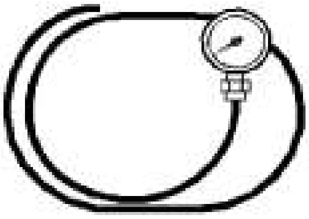
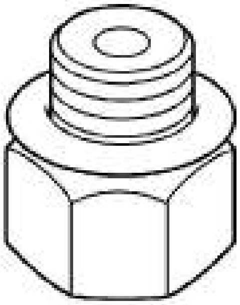
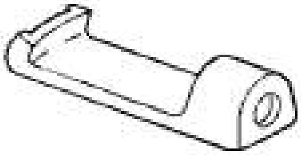
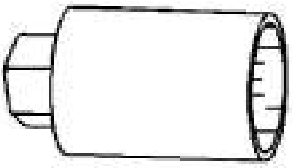
Change Transmission Fluid: This illuminates when the TCM determines that the transmission fluid life is less than 10%. Once the TCM determines that the transmission fluid life is greater than 10% the light will go OFF.

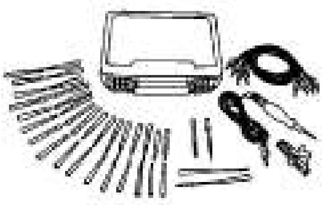
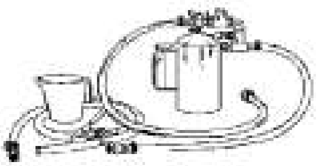
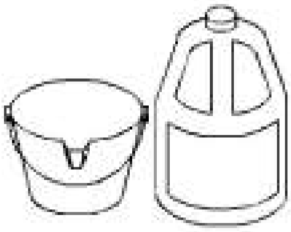
Service Transmission: This illuminates when the TCM determines that there is a fault in the transmission.

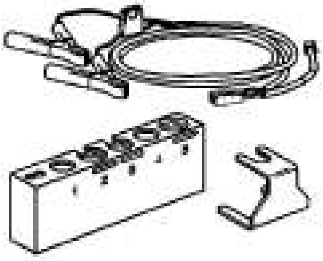
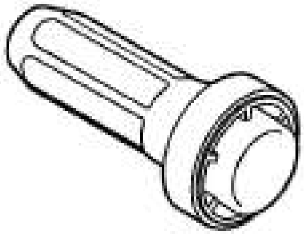
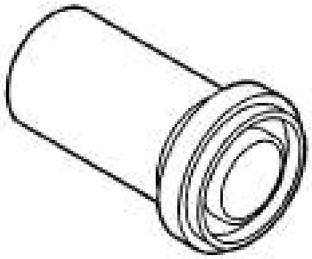
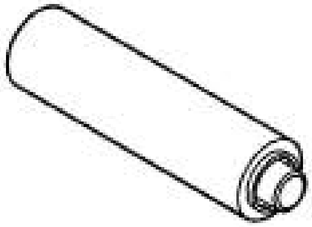
"Trans Hot Idle Engine": This message is displayed when the TCM detects a transmission fluid temperature (TFT) equal to or greater than 132°C (269°F) for 1 minute.

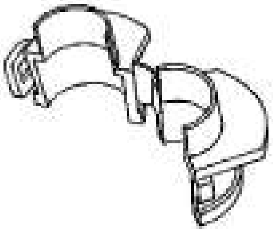
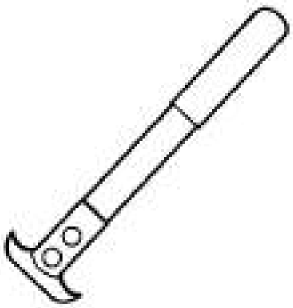
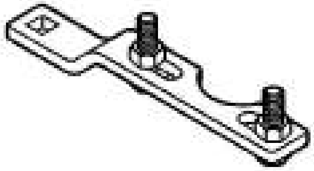
Special Tools

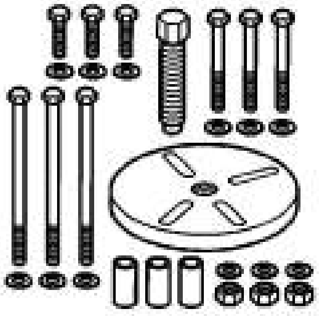
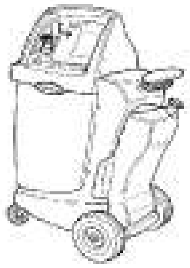
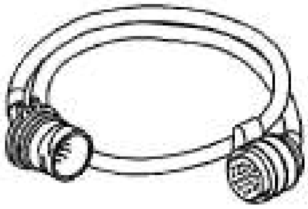
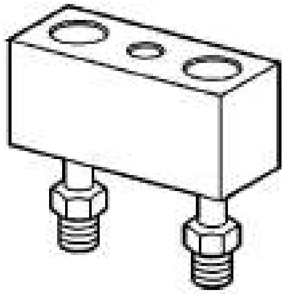
Illustration	Tool Number / Description
	EN-48536 Frame Support Tool (Engine Lower 65mm Kit)
	J 6125-1B Slide Hammer
	J 8092 Universal Driver Handle

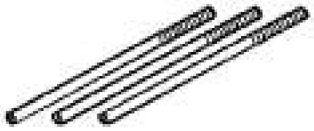
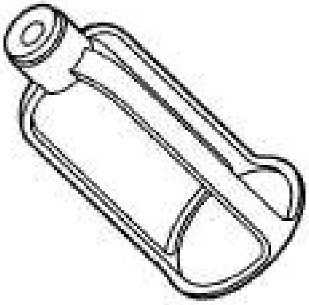
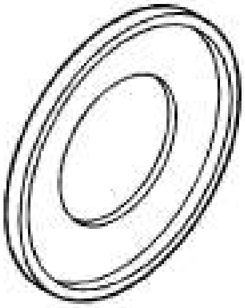
	J 21867 Pressure Gage
	J 21867-L40 Pressure Gage Adapter
	J 23129 Universal Seal Remover
	J 29873 Injector Nozzle Socket 30 mm

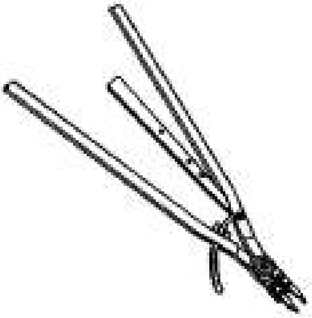
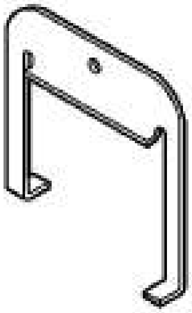
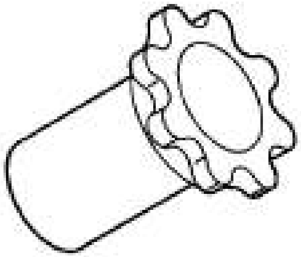
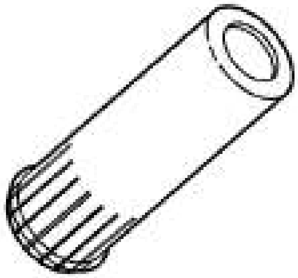
	J 35616-B Holden Terminal Test Kit
	J 35944-A Transmission Oil Cooler and Line Flusher
	J 35944-22 Transmission Oil Cooler Flushing Fluid

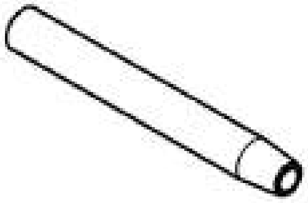
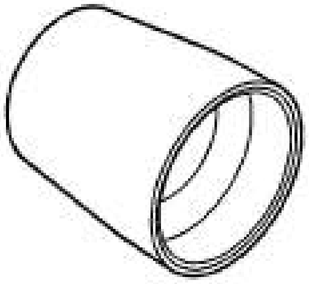
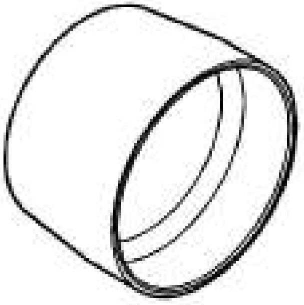
	J 44246 Solenoid Testing Kit
	J 44765 Seal Installer
	J 44766 Seal Installer
	J 44767 Seal Installer

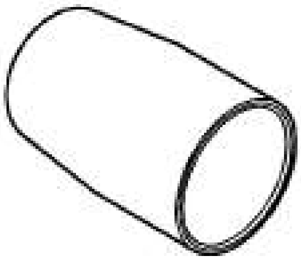
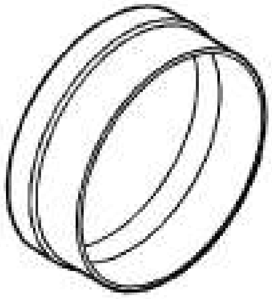
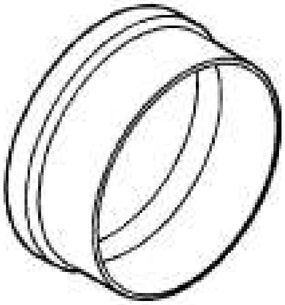
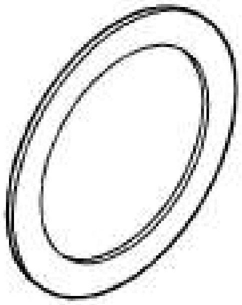
	J 44827 Transmission Cooler Quick Disconnect
	J 45000 Seal Remover
	J 45012 Holding Fixture

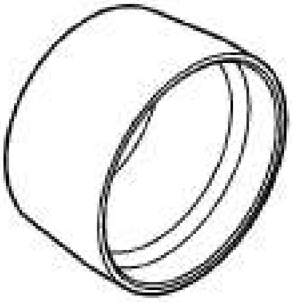
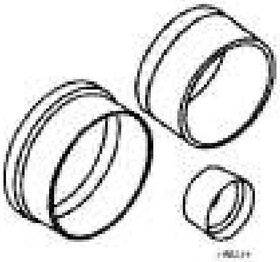
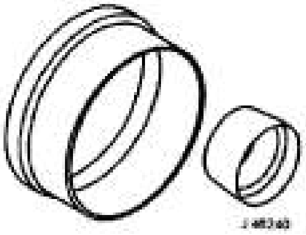
	J 45019 Universal Puller
	J 45096 Transmission Oil Cooling System Flush and Flow Test Tool
	J 45681 Jumper Harness
	J 45806 Cooler Flushing Adapter

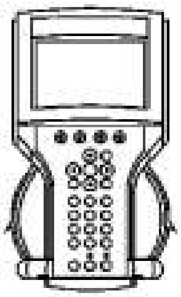
	J 39068 Valve Body Guide Pins
	J 43074 Clutch Spring Compressor
	J 44764 Clutch Spring Compressor

	J 45126 Snap Ring Pliers
	J 45127 Centre Support Removal Tool
	J 45130-1 Seal Installer Pusher
	J 45130-2 Seal Protector

	J 45130-3 Seal Installer Sizer
	J 45132 Seal Protector
	J 45133 Seal Protector

	J 45134 Seal Protector
	J 45135 Seal Protector
	J 45136 Seal Protector
	J 45139 Compressor Plate

	J 45140 Seal Protector
	J 46239 Comprises of three individual components J-46239-1, J-46239-2 and J-46239-3 Piston Seal Protector
	J 46240 Comprises of two individual components J-46240-1 and J-46240-2 Seal Protector

	J 8614-01 Seal Protector
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

Fastener Tightening Specifications

Application	Ref. No.	Quantity	Specification	
			Metric	English
Case Extension to Case Assembly	34	6	50 N·m	37 lb. ft.
Control Solenoid Valve Assembly and Control Valve Lower Body Assembly to Control Valve Upper Body Assembly	310	6	8 N·m	71 lb. in
Control Solenoid Valve Assembly and Control Valve Lower Body Assembly to Control Valve Upper Body Assembly	309	10	8 N·m	71 lb. in
Control Solenoid Valve Heat Sink to Valve Body	312	2	8 N·m	71 lb. in
Control Valve Upper Body Assembly to Control Valve Lower Body Assembly	301	12	8 N·m	71 lb. in
Control (with Body and Valve) Valve Assembly to Case Assembly	22	6	8 N·m	71 lb. in
Fluid Pan Assembly to Case Assembly	30	18	9 N·m	80 lb. in
Fluid Pump Cover Assembly to Torque Converter Housing	231	13	11 N·m	97 lb. in
Input and Output Speed Sensor Assembly to Control Valve Upper Body Assembly	302	2	12 N·m	106 lb. in
Line Pressure Test Hole Plug to Torque Converter Housing	202	1	11 N·m	97 lb. in
Manual Shaft Detent Assembly to Valve Body	23	1	12 N·m	106 lb. in
Torque Converter Housing Assembly to Case Assembly	3	9	72 N·m	53 lb. ft.
* Reference number refers to the component callout number in Disassembled Views				

Fluid Capacity Specifications

	Specification	
Application	**Metric**	**English**
Pan Removal - Approximate Capacity	5.7 litres	6.0 quarts
Overhaul - Approximate Capacity	9.9 litres	10.5 quarts
Complete Transmission System Fluid Capacity	10.6 litres	11.2 quarts

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Clutch Backing Plate Retaining Ring Specifications

Table 1: 3-5 Reverse Clutch
Table 2: 1-2-3-4 Clutch
Table 3: 4-5-6 Clutch

3-5 Reverse Clutch

Clutch Pack Travel Specification - 1.21-1.79 mm (0.048-0.070 in)		
Retaining Ring Thickness		**O.D. Colour**
Metric	**English**	
Important: After measuring clutch pack travel, determine if the measurement is within the specification. If the measurement is not within the specification, measure the thickness of the existing retaining ring, and then choose a thicker or thinner retaining ring that will bring the measurement within specification.		
1.61-1.71 mm	0.063-0.067 in	Gray
1.88-1.98 mm	0.074-0.078 in	Light Green
2.15-2.25 mm	0.085-0.089 in	Yellow
2.42-2.52 mm	0.095-0.099 in	None
2.69-2.79 mm	0.106-0.110 in	Purple

1-2-3-4 Clutch

Clutch Pack Travel Specification - 1.53-1.99 mm (0.060-0.078 in)		
Retaining Ring Thickness		**O.D. Colour**
Metric	**English**	
Important: After measuring clutch pack travel, determine if the measurement is within the specification. If the measurement is not within the specification, measure the thickness of the existing retaining ring, and then choose a thicker or thinner retaining ring that will bring the measurement within specification.		
2.15-2.25 mm	0.085-0.089 in	Yellow
2.42-2.52 mm	0.095-0.099 in	None
2.69-2.79 mm	0.106-0.110 in	Purple
2.96-3.06 mm	0.117-0.120 in	Light Blue
3.23-3.33 mm	0.127-0.131 in	Orange

4-5-6 Clutch

Clutch Pack Travel Specification - 1.28-1.89 mm (0.050-0.074 in)		
Retaining Ring Thickness		**O.D. Colour**
Metric	**English**	
Important: After measuring clutch pack travel, determine if the measurement is within the specification. If the measurement is not within the specification, measure the thickness of the existing retaining ring, and then choose a thicker or thinner retaining ring that will bring the measurement within specification.		
1.60-1.70 mm	0.063-0.067 in	Yellow
2.02-2.12 mm	0.080-0.083 in	None

2.44-2.54 mm	0.096-0.100 in	Purple

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Fluid Pump Selective Specifications

Fluid Pump Selective Specifications

<table>
<tr><th>Size Classification</th><th>Thickness (mm)</th><th>Thickness (in)</th></tr>
<tr><td colspan="3">Important:
Rotor and slide must be chosen from the same size classification as the oil pump body.
Allowable rotor and slide to fluid pump body end play is as follows:
Specification
Slide to Fluid Pump Body End Play -- 0.020-0.051 mm (0.0008-0.0020 in)
Rotor to Fluid Pump Body End Play -- 0.020-0.051 mm (0.0008-0.0020 in)
The fluid pump assembly has selective rotor and slide components. These components are chosen based on pump body dimensions. Fluid pump rotor and slide components are available in three size classifications (1, 2, 3) with the following tolerances:</td></tr>
<tr><td colspan="3">Rotor Selection</td></tr>
<tr><td>1</td><td>17.948-17.961</td><td>0.7066-0.7071</td></tr>
<tr><td>2</td><td>17.961-17.974</td><td>0.7071-0.7076</td></tr>
<tr><td>3</td><td>17.974-17.987</td><td>0.7076-0.7081</td></tr>
<tr><td colspan="3">Slide Selection</td></tr>
<tr><td>1</td><td>17.948-17.961</td><td>0.7066-0.7071</td></tr>
<tr><td>2</td><td>17.961-17.974</td><td>0.7071-0.7076</td></tr>
<tr><td>3</td><td>17.974-17.987</td><td>0.7076-0.7081</td></tr>
<tr><td colspan="3">Fluid Pump Body Depth</td></tr>
<tr><td>1</td><td>17.98-17.994</td><td>0.7079-0.7084</td></tr>
<tr><td>2</td><td>17.994-18.007</td><td>0.7084-0.7089</td></tr>
<tr><td>3</td><td>18.007-18.033</td><td>0.7089-0.7100</td></tr>
</table>

Range Reference

Range Reference Table

Range	Park	Reverse	Neutral	Drive						
				1st Braking	1st	2nd	3rd	4th	5th	6th
1-2-3-4 Clutch	--	--	--	Applied	Applied	Applied	Applied	Applied	--	--
3-5 Reverse Clutch	--	Applied	--	--	--	--	Applied	--	Applied	--
4-5-6 Clutch	--	--	--	--	--	--	--	Applied	Applied	Applied
2-6 Clutch	--	--	--	--	--	Applied	--	--	--	Applied
Low and Reverse Clutch	Applied*	Applied	Applied*	Applied	--	--	--	--	--	--
Low Clutch Sprag	--	--	--	Holding	Holding	--	--	--	--	--
* = Applied with NO load										

Shift Solenoid Valve State and Gear Ratio

Gear	Shift SOL 1	Shift SOL 2	1-2-3-4 CL PC SOL 5 N.L.	2-6 CL PC SOL 4 N.L.	3-5 REV CL PC SOL 2 N.H.	LOW REV 4-5-6 CL PC SOL 3 N.H.	Gear Ratio
Park	ON	ON	OFF	OFF	OFF	ON	--
Reverse	ON	OFF	OFF	OFF	ON	ON	3.06
Neutral	ON	ON	OFF	OFF	OFF	ON	--
1st Braking	ON	ON	ON	OFF	OFF	ON	4.03
1st	OFF	ON	ON	OFF	OFF	OFF	4.03
2nd	OFF	ON	ON	ON	OFF	OFF	2.36
3rd	OFF	ON	ON	OFF	ON	OFF	1.53
4th	OFF	ON	ON	OFF	OFF	ON	1.15
5th	OFF	ON	OFF	OFF	ON	ON	0.85
6th	OFF	ON	OFF	ON	OFF	ON	0.67
For shift solenoids 1 and 2, "ON" = Solenoid Energized (Pressurized) "OFF" = Solenoid De-energised (No Pressure). For pressure control solenoids, "ON" = Pressurized, "OFF" = No Pressure							

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Shift Speed

Maximum Shift Speed (rpm)	Normal Mode
1-2 shift	6500
2-3 shift	6500
3-4 shift	6500
4-5 shift	N/A
5-6 shift	N/A

Important: Shift speed points are affected by many different vehicle and transmission operating conditions. The table above represents shift speed points calibrated at specific throttle angles during normal operating conditions and a temperature range between 0 -130°C (32-266°F). These shift speed points are also based on an axle ratio of 3.42, and assume a production-intent tire size. The table below illustrates a number of different variables that influence these shift speed points. Based on a given operating condition, these variables may override the normal shift speed points. To assist in monitoring the different variables, the respective scan tool data parameter is also listed.

Scan Tool Parameter	Shift Speed Variables
Calculated. Throttle Position	Calculated. Throttle Position (TP) is one of the most important inputs in the transmission shift pattern logic. A very low TP angle will impact the shift pattern by causing upshifts. A very high TP angle will impact the shift pattern by causing downshifts.
Commanded Gear	Based on numerous inputs, the transmission control module (TCM) selects the optimum gear. Once the TCM commands a gear, the pressure control solenoids are activated to hydraulically control engagement of the proper clutch.
Cruise	When cruise control is activated, the shift pattern is altered to reduce excessive shifting.
ECT	Shift speed points may be offset to enhance engine coolant temperature (ECT) warm-up. Also, operating the vehicle at higher engine speeds will reduce the time to warm the ECT and the TFT.
Engine Speed	To protect against an over speed condition, engine speed is monitored. If the engine speed becomes too high, an upshift will occur.
Engine Torque	Engine torque is used to predict vehicle operating conditions, in order to determine the optimum gear and provide for a smoother ride.
IMS	The internal mode switch (IMS) indicates the position of the transmission manual valve. The operator controls this valve by moving the gear range selector. Therefore, the possible gears may be limited by this valve position.
TCC PC Sol. Duty Cycle	The torque converter clutch (TCC) pressure control (PC) solenoid duty cycle indicates when the TCC has been engaged.
TCC Slip Speed	The TCC Slip Speed indicates the difference between engine speed and transmission input speed. The TCC is locked when slip speed is at or near zero, and may be controlling slip when at lower slip speeds.

TFP Switch 1, 3, 4 or 5	The transmission fluid pressure (TFP) switch is used to indicate if fluid pressure to a specific clutch has been applied or released.
Trans. Fluid Temp.	A lower TFT will extend shift speeds, a higher TFT, or hot mode condition, will invoke shorter shift speeds in order to establish a shift pattern required to cool the TFT.
Transmission Hot Mode	If the TFT becomes too hot, a hot mode shift pattern is used. The hot mode shift pattern will invoke lower shift speed points to establish a shift pattern necessary to cool the TFT.
Transmission OSS	The transmission output speed sensor (OSS) is one of the most important inputs into the transmission shift pattern logic. A very low transmission output speed will impact the shift pattern by causing downshifts. A very high transmission output speed will impact the shift pattern by causing upshifts.

Transmission General Specifications

Name	**6L80**
RPO Codes	MYC
Transmission Drive	Rear Wheel Drive
1st Gear Ratio	4.027
2nd Gear Ratio	2.364
3rd Gear Ratio	1.532
4th Gear Ratio	1.152
5th Gear Ratio	0.852
6th Gear Ratio	0.667
Reverse	3.064
Torque Converter Size - Diameter of Torque Converter Turbine	300 mm
Pressure Taps	Line Pressure
Transmission Fluid Type	DEXRON VI®
Transmission Fluid Capacity	11.7 L (12.4 qt)
Transmission Type: 6	Six Forward Gears
Transmission Type: L	Longitude Mount
Transmission Type: 80	Product Series
Position Quadrant	P, R, N, D, +/-
Case Material	Die Cast Aluminium
Transmission Net Weight (Approximate)	103.5 kg (228 lb.)
Maximum Trailer Towing Capacity	Refer to applicable owner's manual

Transmission Internal Mode Switch Logic

Gear Selector Position	Signal A	Signal B	Signal C	Signal P
Park	LOW	HI	HI	LOW
Park/Reverse	LOW	LOW	HI	LOW
Reverse	LOW	LOW	HI	HI
Reverse/Neutral	HI	LOW	HI	HI
Neutral	HI	LOW	HI	LOW
Neutral/Drive 6	HI	LOW	LOW	LOW
Drive 6	HI	LOW	LOW	HI
Drive 6/Drive 4	LOW	LOW	LOW	HI
Drive 4	LOW	LOW	LOW	LOW
Drive 4/Drive 3	LOW	HI	LOW	LOW
Drive 3	LOW	HI	LOW	HI
Drive 3/Drive 2	HI	HI	LOW	HI
Drive 2	HI	HI	LOW	LOW
Open	HI	HI	HI	HI
Invalid	HI	HI	HI	LOW
Invalid	LOW	HI	HI	HI

HI = Ignition voltage

LOW = 0 volts

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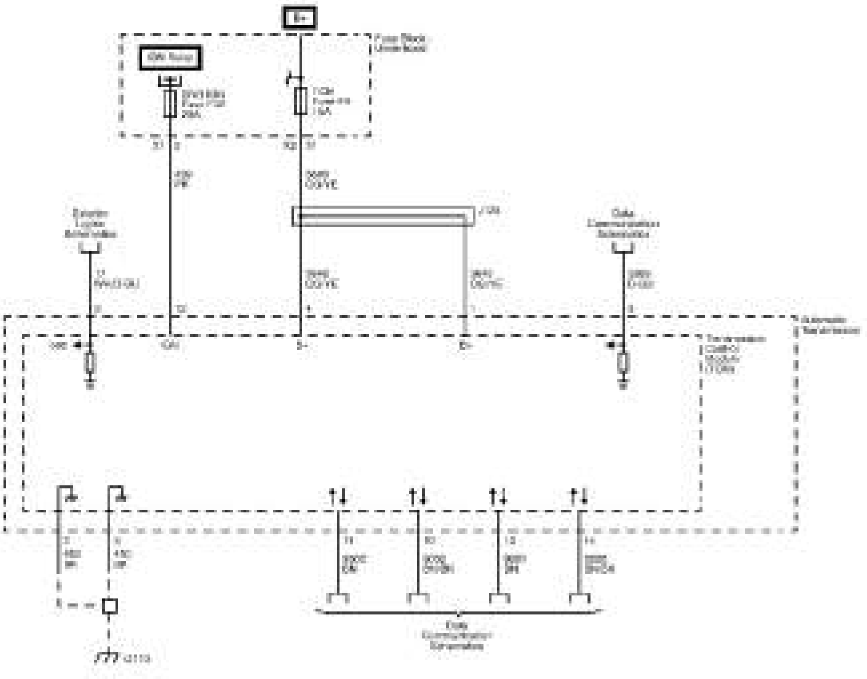
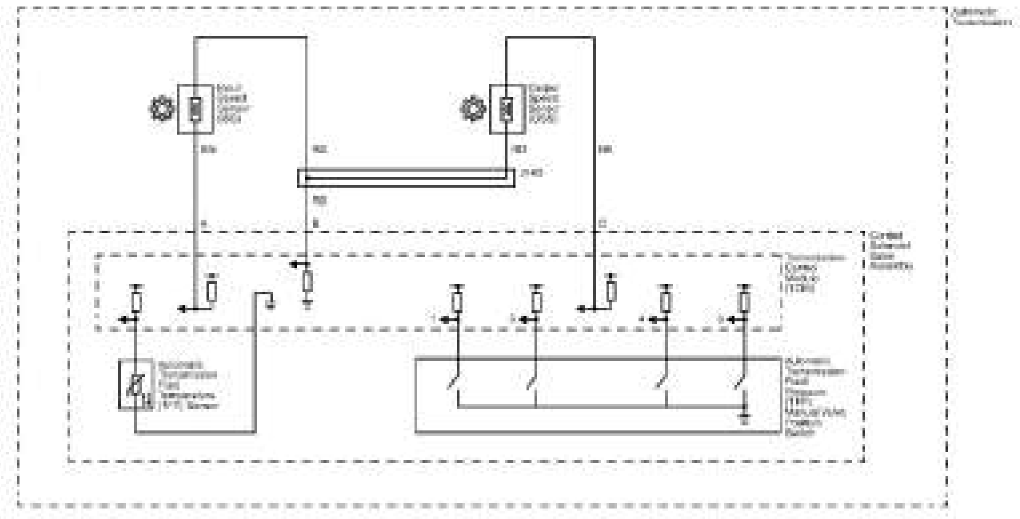
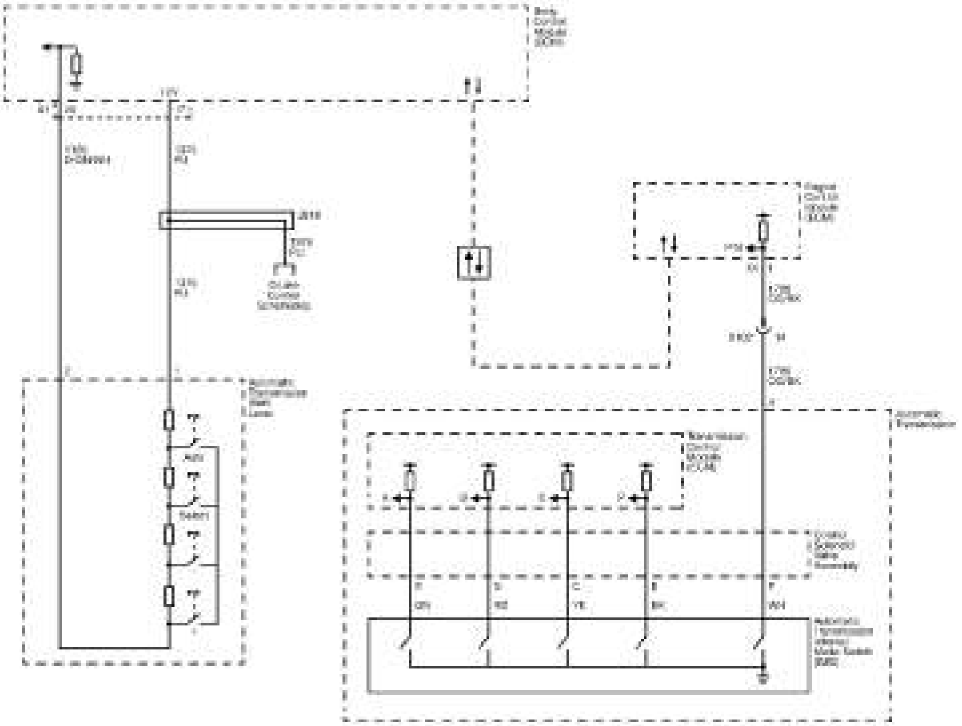
Power, Ground, and Serial Data


B+
Fuse Block Underhood
Data Communication Schematics
Automatic Transmission
Transmission Control Module (TCM)

Fluid Controls and Speed Sensors



Range and Driver Shift Request Controls


Body Control Module (BCM)
Engine Control Module (ECM)
Cruise Control Schematics
Automatic Transmission Shift Lever
Auto
Select
Automatic Transmission
Transmission Control Module (TCM)
Control Solenoid Valve Assembly
Automatic Transmission Internal Mode Switch (IMS)
P
S
C
E
F
GN
RD
YE
BK
WH

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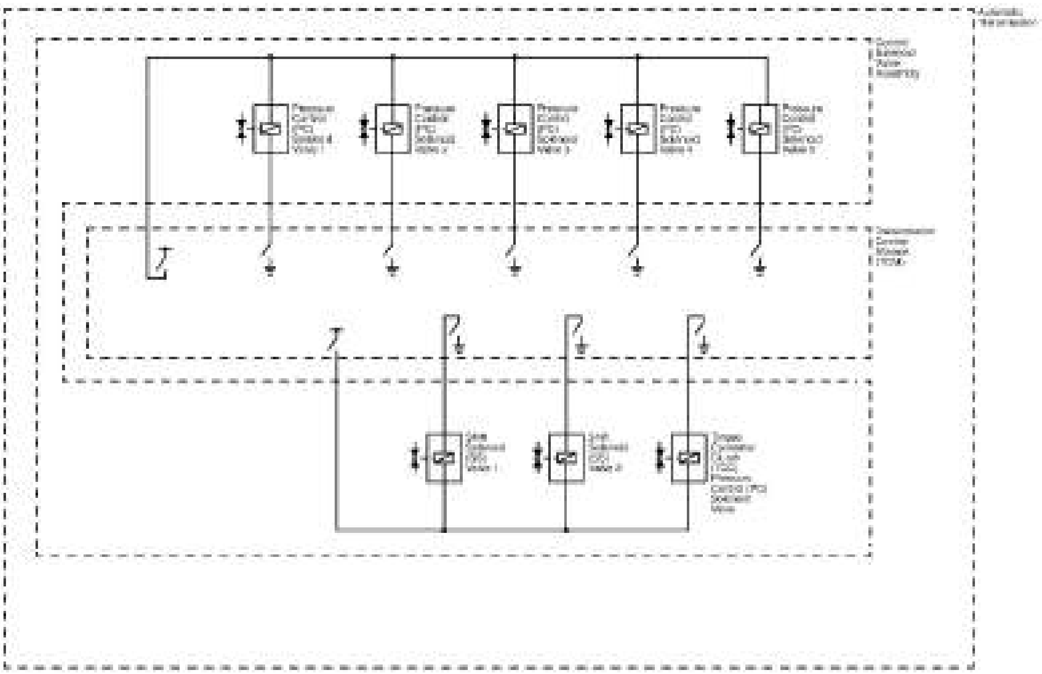
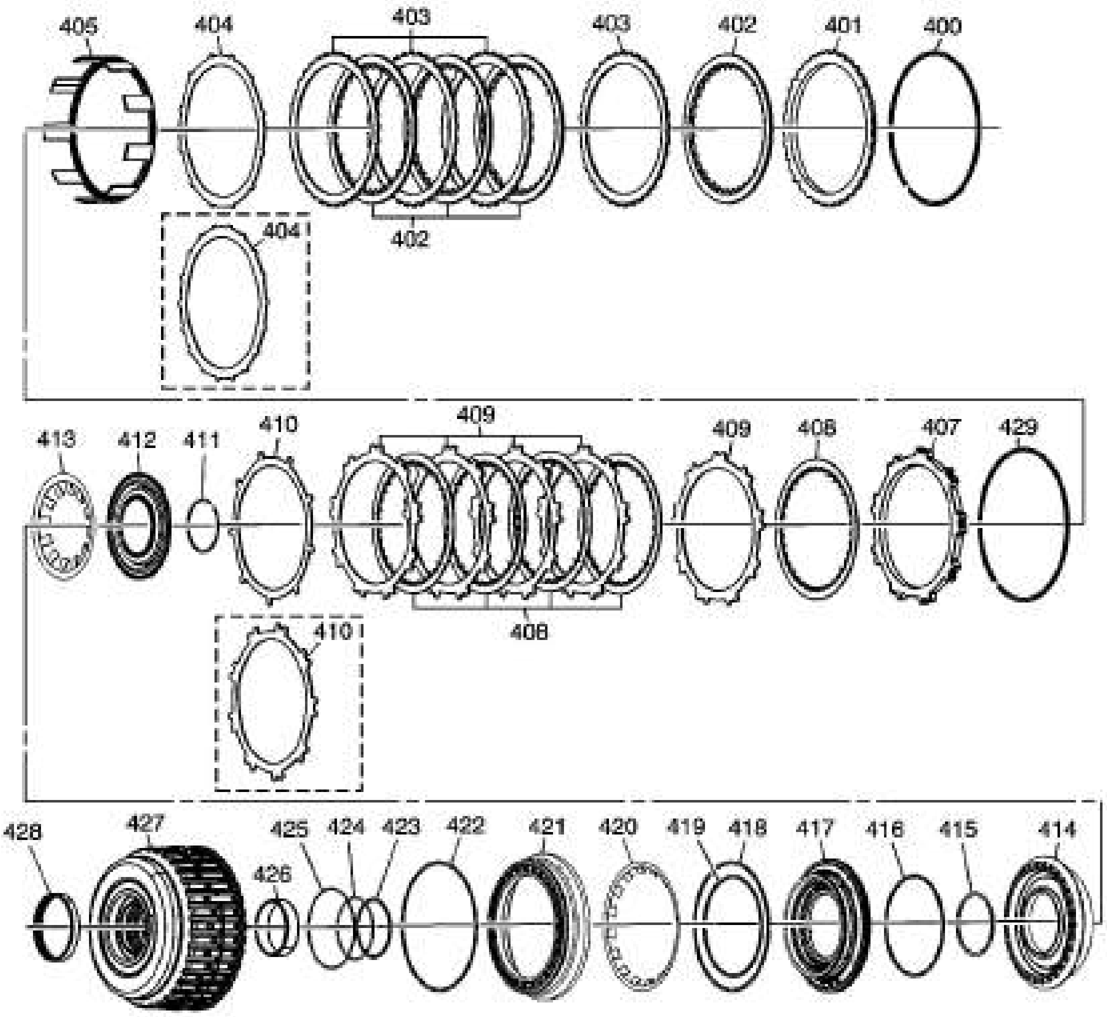
Shift Controls


Automatic Transmission
Control Solenoid Valve Assembly
Pressure Control (PC) Solenoid Valve 1
Pressure Control (PC) Solenoid Valve 2
Pressure Control (PC) Solenoid Valve 3
Pressure Control (PC) Solenoid Valve 4
Pressure Control (PC) Solenoid Valve 5
Transmission Control Module (TCM)
Shift Solenoid (SS) Valve 1
Shift Solenoid (SS) Valve 2
Torque Converter Clutch (TCC) Pressure Control (PC) Solenoid Valve

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 6L50/6L80/6L90 | Component Locator | **Document ID: 1537806**

1-2-3-4 and 3-5 Reverse Clutch Assembly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(400) 3-5 Reverse Clutch Backing Plate Retaining Ring

(401) 3-5 Reverse Clutch Backing Plate

(402) 3-5 Reverse Clutch Plate Assembly

(403) 3-5 Reverse Clutch Plate

(404) 3-5 Reverse Clutch (Waved) Plate

(405) 3-5 Reverse Clutch Apply Ring

(407) 1-2-3-4 Clutch Backing Plate

(408) 1-2-3-4 Clutch Plate Assembly

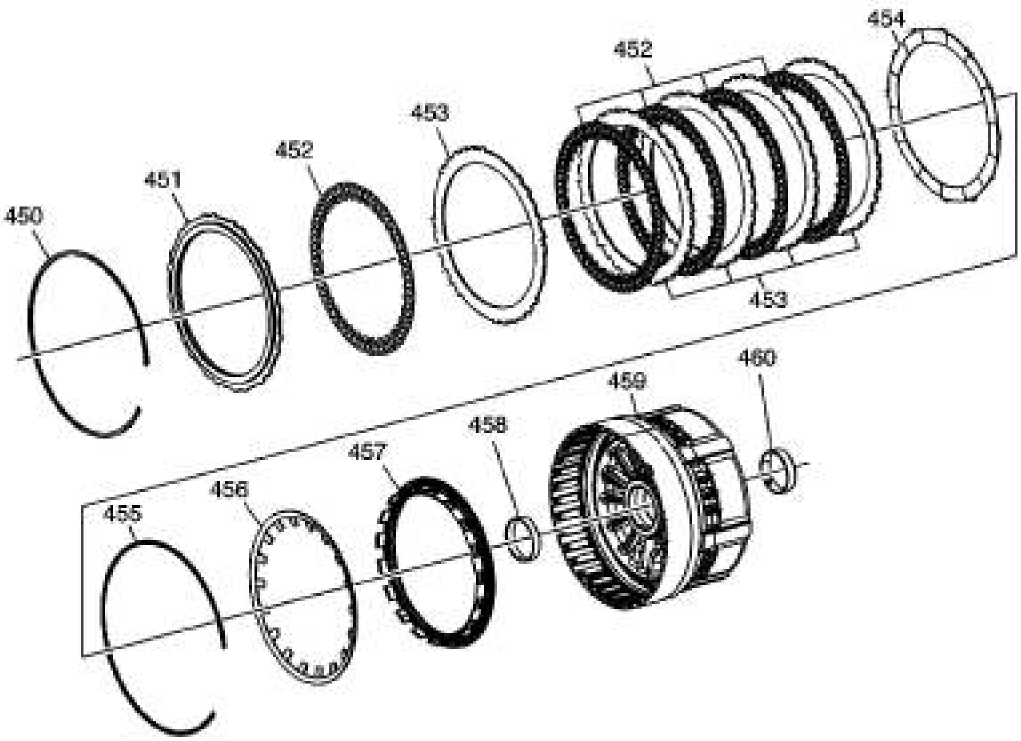
(409) 1-2-3-4 Clutch Plate

(410) 1-2-3-4 Clutch (Waved) Plate

(411) 1-2-3-4 Clutch Piston Dam Retaining Ring

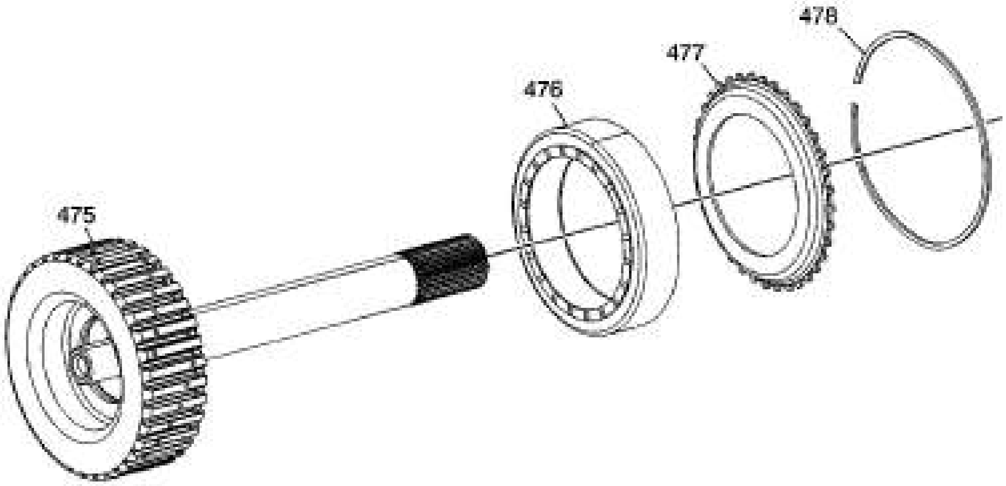
(412) 1-2-3-4 Clutch Piston Dam Assembly
(413) 1-2-3-4 Clutch Spring
(414) 1-2-3-4 Clutch Piston
(415) 1-2-3-4 Clutch Piston Housing Retaining Ring
(416) 1-2-3-4 Clutch Piston Seal
(417) 1-2-3-4 Clutch Piston Housing
(418) 3-5 Reverse Clutch Piston Dam (O-ring) Seal
(419) 3-5 Reverse Clutch Piston Inner Seal
(420) 3-5 Reverse Clutch Spring
(421) 3-5 Reverse Clutch Piston
(422) 3-5 Reverse Clutch Piston Outer Seal
(423) 1-2-3-4 Clutch Piston Inner Seal
(424) 1-2-3-4 Clutch Piston Housing Seal
(425) 1-2-3-4 Clutch Piston Housing Seal
(426) 1-2-3-4 and 3-5 Reverse Clutch Housing Rear Bushing
(427) 1-2-3-4 and 3-5 Reverse Clutch Housing Assembly
(428) 1-2-3-4 and 3-5 Reverse Clutch Bearing Assembly
(429) 1-2-3-4 Clutch Backing Plate Retaining Ring

2-6 Clutch Assembly



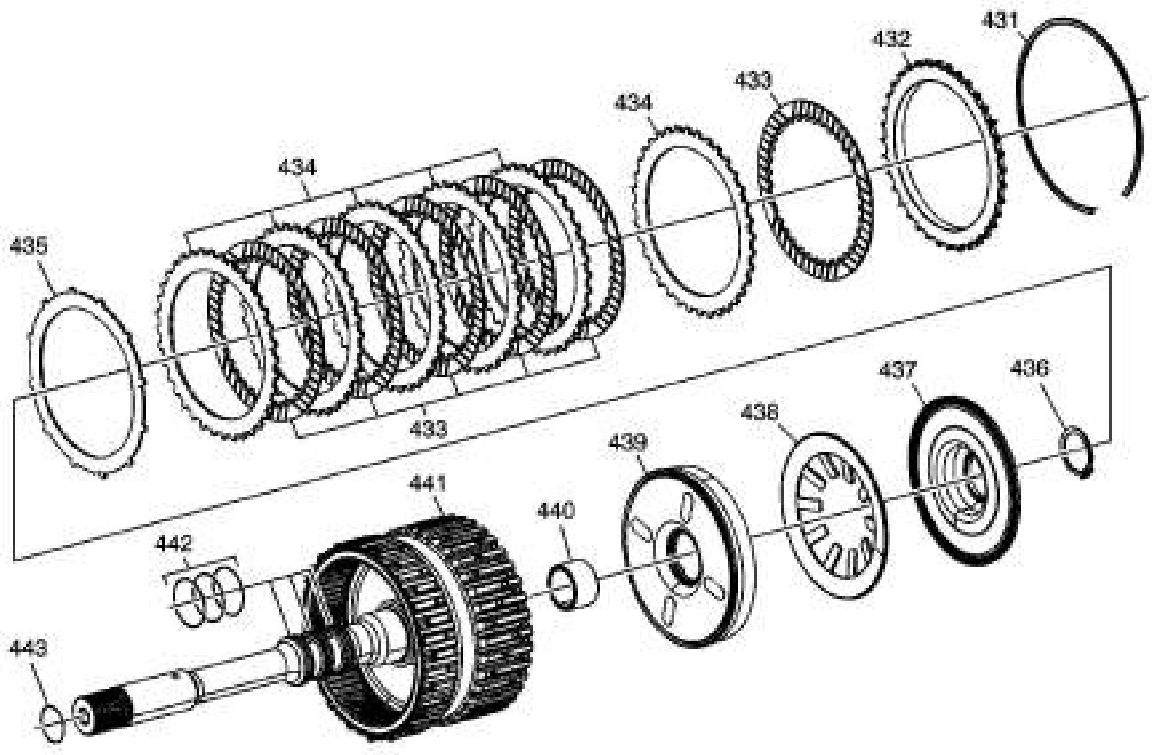
(450) 2-6 Clutch Backing Plate Retaining Ring
(451) 2-6 Clutch Backing Plate
(452) 2-6 Clutch Plate Assembly
(453) 2-6 Clutch Plate
(454) 2-6 Clutch (Waved) Plate
(455) 2-6 Clutch Spring Retaining Ring
(456) 2-6 Clutch Spring
(457) 2-6 Clutch Piston Assembly
(458) Output Carrier Outer Sun Gear Shaft (Front) Bushing
(459) Center Support Assembly
(460) Output Carrier Outer Sun Gear Shaft Rear Bushing

4-5-6 Clutch Hub Assembly



(475) 4-5-6 Clutch (w/ Output Carrier Shaft) Hub Assembly
(476) 4-5-6 Clutch Dampener
(477) 4-5-6 Clutch Dampener Apply Plate
(478) 4-5-6 Clutch Dampener Retaining Ring

4-5-6 (w/Turbine Shaft) Clutch Assembly



(431) 4-5-6 Clutch Backing Plate Retaining Ring
(432) 4-5-6 Clutch Backing Plate
(433) 4-5-6 Clutch Plate Assembly
(434) 4-5-6 Clutch Plate
(435) 4-5-6 Clutch (Waved) Plate
(436) 4-5-6 Clutch Piston Dam Retaining Ring
(437) 4-5-6 Clutch Piston Dam Assembly
(438) 4-5-6 Clutch Spring
(439) 4-5-6 Clutch Piston Assembly
(440) Output Carrier Shaft Housing Bushing
(441) 4-5-6 (w/Turbine Shaft) Housing Assembly
(442) Turbine Shaft Fluid Seal Ring
(443) Turbine Shaft (O-ring) Seal

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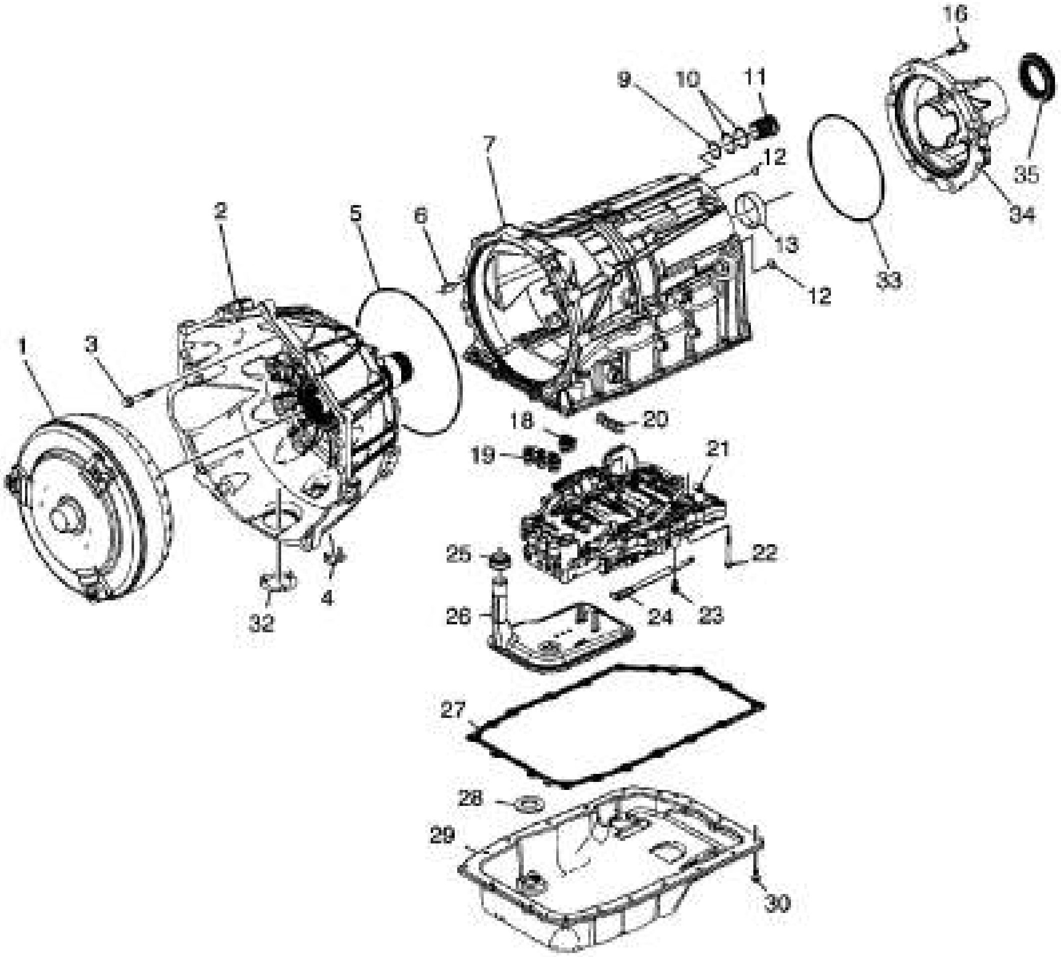
Case and Associated Parts



(1) Torque Converter Assembly
(2) Torque Converter (with Fluid Pump) Housing Assembly - Model Dependent
(3) Bolt, M10 x 50 mm
(4) Torque Converter Housing Access Hole Cover - Model Dependent
(5) A/Trans Fluid Pump Seal
(6) Torque Converter Housing Locator Pin
(7) A/Trans Case Assembly
(9) A/Trans Connector Seal
(10) A/Trans Connector (O-ring) Seal
(11) A/Trans Electrical Connector Passage Sleeve
(12) A/Trans Case Plug

(13) Output Shaft Bushing
(16) Bolt, M10 x 40 mm - Model Dependent
(18) A/Trans Fluid Pump Seal Assembly
(19) A/Trans Fluid Pump Seal Assembly
(20) Centre Support Fluid Passage Seal Assembly
(21) Control (with Body and Valve) Valve Assembly
(22) Bolt, M5 x 73 mm
(23) Bolt, M6 x 14.5 mm
(24) Manual Shaft Detent Assembly
(25) A/Trans Fluid Filter Seal Assembly
(26) A/Trans Fluid Filter Assembly
(27) A/Trans Fluid Pan Gasket
(28) A/Trans Fluid Pan Magnet
(29) A/Trans Fluid Pan Assembly
(30) Bolt, M6 x 20 mm
(32) Torque Converter Housing Access Hole Cover
(33) A/Trans Case Extension Seal
(34) A/Trans Case Extension
(35) Prop Shaft Oil Seal

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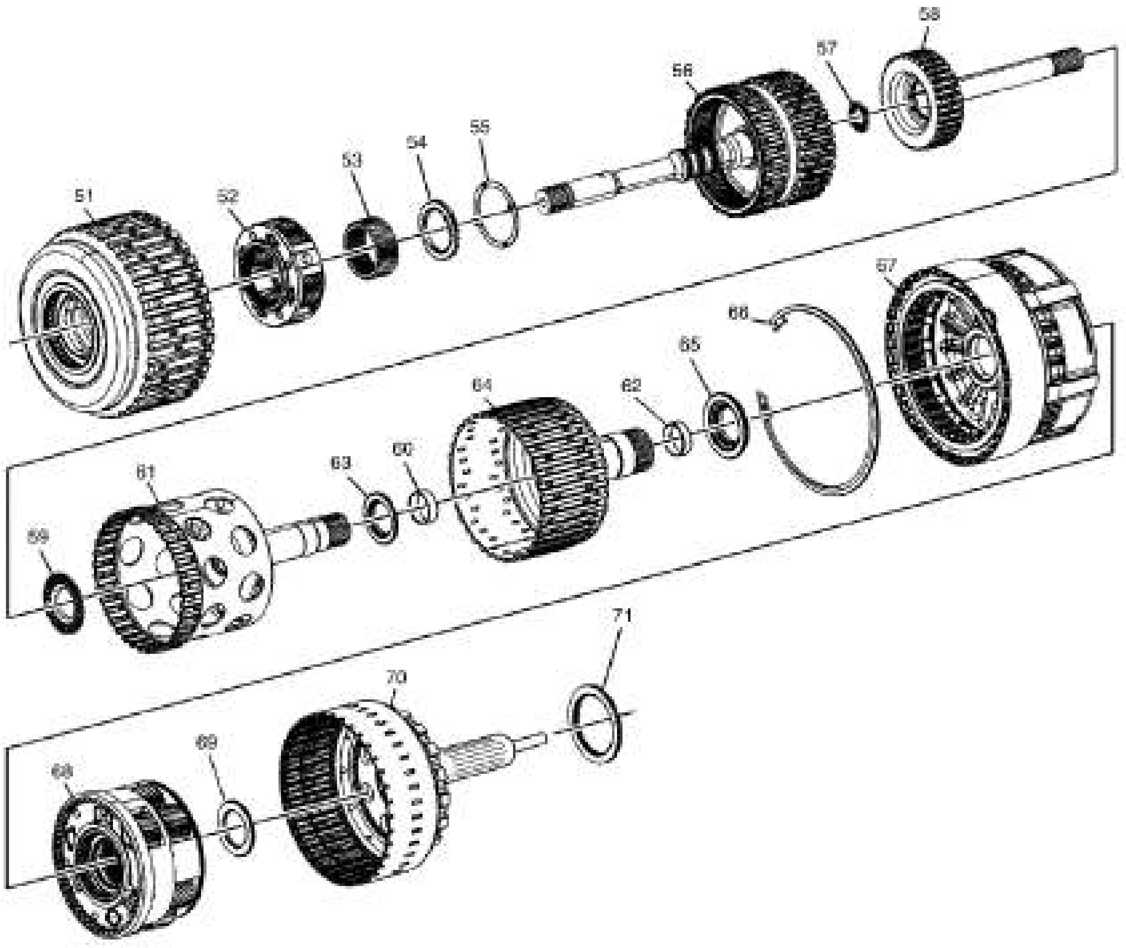
Clutch Assemblies and Associated Parts



(51) 1-2-3-4 and 3-5 Reverse Clutch Assembly
(52) Input Carrier Assembly
(53) Input Sun Gear
(54) Input Sun Gear Thrust Bearing
(55) Input Sun Gear Thrust Washer
(56) 4-5-6 (w/ Turbine Shaft) Clutch Assembly
(57) Turbine Shaft Thrust Bearing Assembly
(58) 4-5-6 Clutch (w/ Output Carrier Shaft and Dampener) Hub Assembly
(59) 4-5-6 Clutch Hub Thrust Bearing Assembly
(60) Output Carrier Inner Sun Gear Shaft (Front) Bushing
(61) 1-2-3-4 Clutch (w/ Output Carrier Inner Sun Gear Shaft) Hub Assembly

(62) Output Carrier Inner Sun Gear Shaft Bushing
(63) 1-2-3-4 Clutch Hub Thrust Bearing Assembly
(64) 2-6 and 3-5 Reverse Clutch (w/ Output Carrier Outer Sun Gear Shaft) Hub Assembly
(65) 2-6 and 3-5 Reverse Clutch Hub Thrust Bearing Assembly
(66) Centre Support Retaining Ring
(67) Centre (w/ 2-6 Low and Reverse Clutch) Support Assembly
(68) Output Carrier Assembly
(69) Output Carrier Thrust Bearing Assembly
(70) Output Shaft Assembly
(71) Output Shaft Thrust Bearing Assembly

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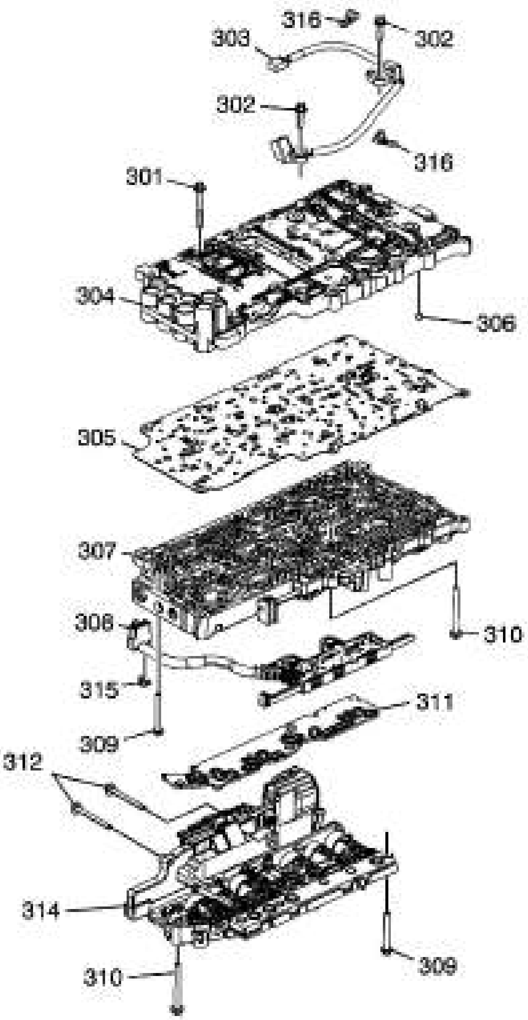
Control (with Body and Valve) Valve Assembly



(301) Bolt, M5 x 36 mm

(302) Bolt, M6 x 20 mm

(303) A/Trans Input and Output Speed Sensor Assembly

(304) Control Valve Upper Body Assembly

(305) Control Valve Body Spacer (w/ Gasket) Plate Assembly

(306) Control Valve Body Ball Check Valve

(307) Control Valve Lower Body Assembly

(308) A/Trans Manual Shift Shaft Position Switch Assembly

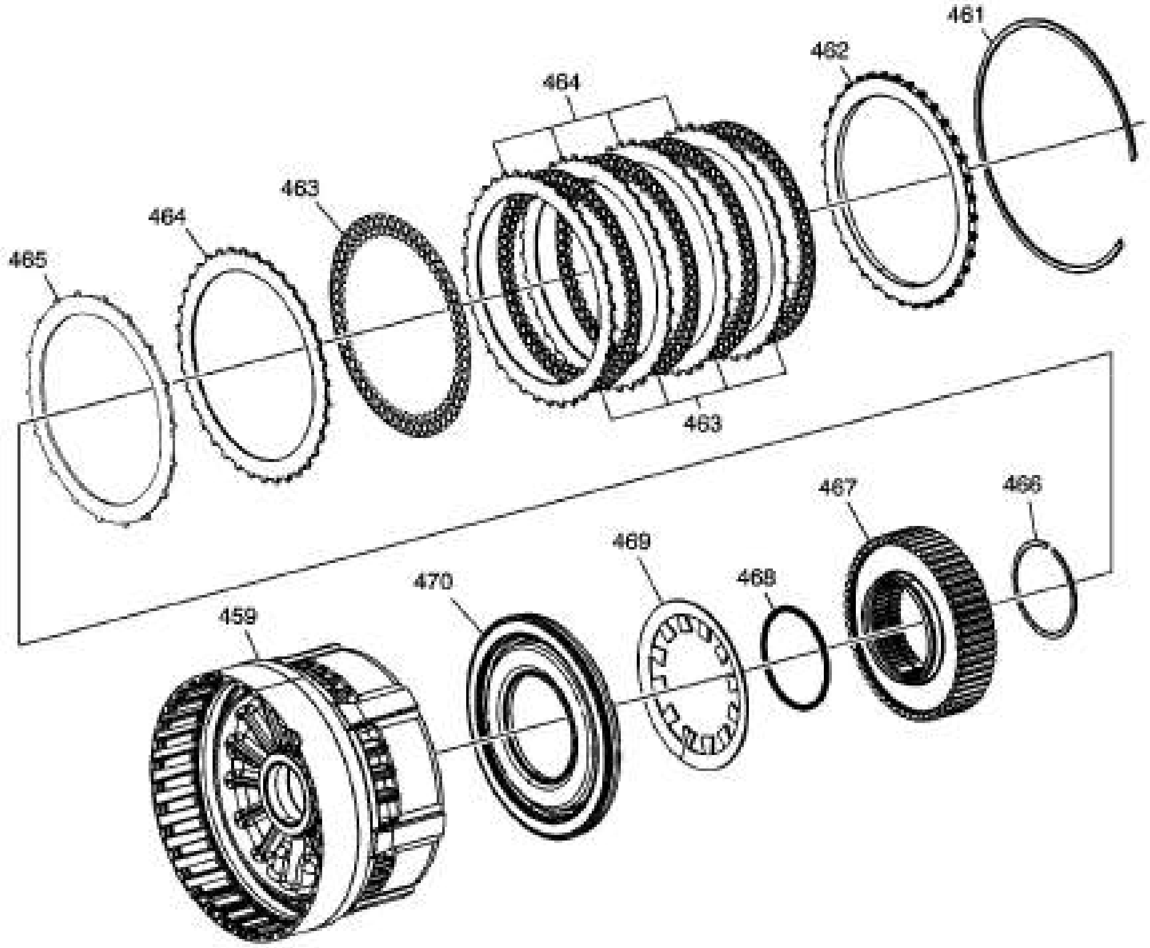
(309) Bolt, M5 x 45 mm

(310) Bolt, M5 x 55 mm

(311) Filter Plate Assembly

(312) Bolt, M5 x 53 mm
(314) Control Solenoid (w/ Body and TCM) Valve Assembly
(315) A/Trans Manual Shaft Position Switch Wiring Harness Clip
(316) A/Trans Input and Output Speed Sensor Wiring Harness Clip

Low and Reverse Clutch Assembly



(459) Center Support Assembly
(461) Low and Reverse Clutch Backing Plate Retaining Ring
(462) Low and Reverse Clutch Backing Plate
(463) Low and Reverse Clutch Plate Assembly
(464) Low and Reverse Clutch Plate
(465) Low and Reverse Clutch (Waved) Plate
(466) Low and Reverse Clutch Spring Retaining Ring
(467) Low Clutch Sprag Assembly
(468) Low Clutch Sprag Seal
(469) Low and Reverse Clutch Spring
(470) Low and Reverse Clutch Piston Assembly

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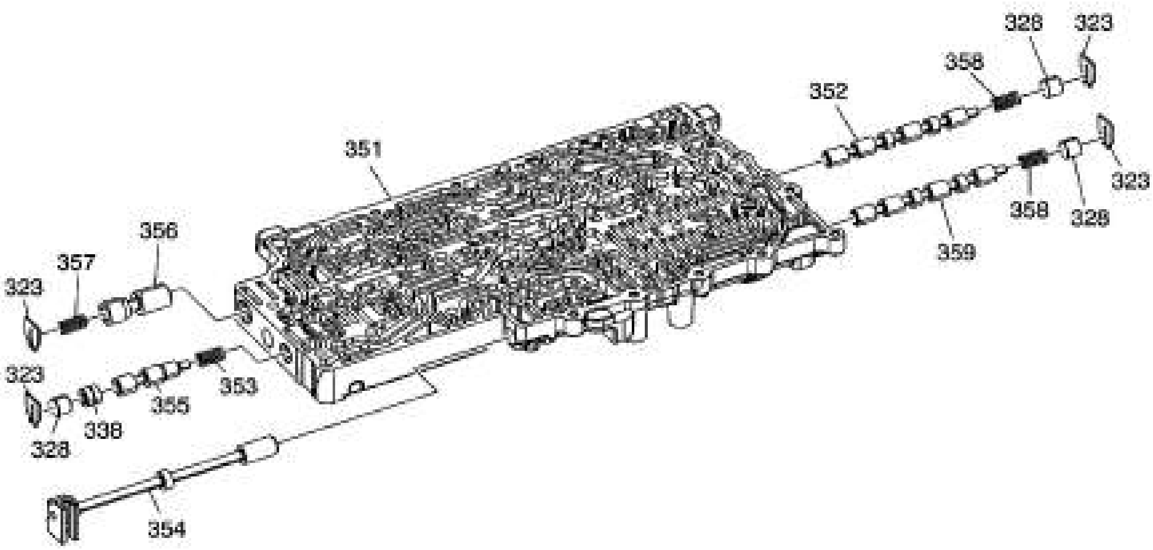
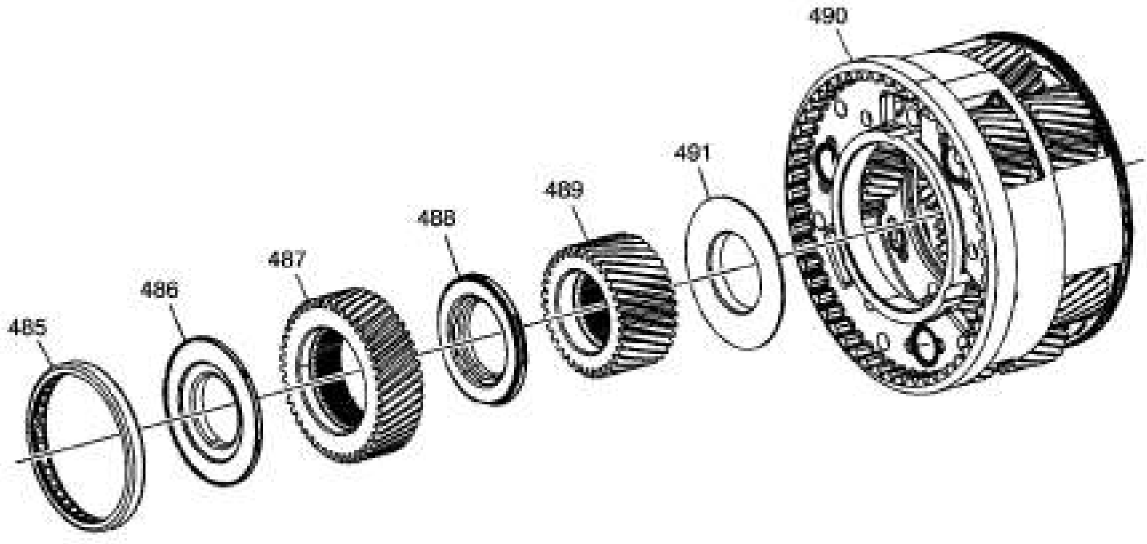
Lower Control Valve Body Assembly



(323) Retainer
(328) Clutch Regulator Valve Bore Plug
(338) Shuttle Valve
(351) Control Valve Lower Body
(352) Clutch Select Solenoid Valve 3
(353) TCC Regulator Apply Valve Spring
(354) Manual Valve
(355) TCC Regulator Apply Valve
(356) Clutch Piston Dam Feed Regulator Valve
(357) Clutch Piston Dam Feed Regulator Valve Spring
(358) Clutch Select Solenoid Valve Spring
(359) Clutch Select Solenoid Valve 2

Output Carrier Assembly



(485) Center Support Roller Bearing Assembly

(486) Output Carrier Front Sun Gear Thrust Bearing Assembly

(487) Output Carrier Front Sun Gear

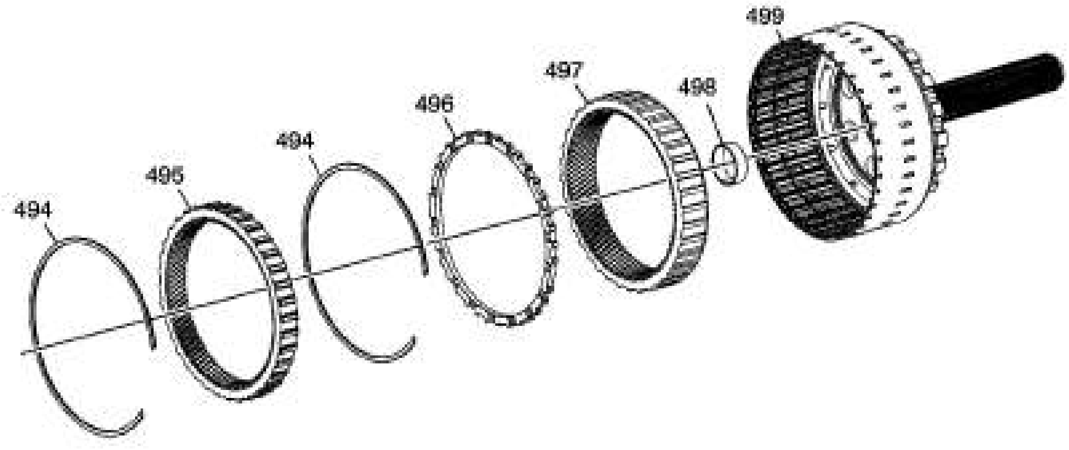
(488) Output Carrier Front Sun Gear Rear Thrust Bearing Assembly

(489) Output Carrier Rear Sun Gear

(490) Output Carrier

(491) Output Carrier Rear Sun Gear Thrust Bearing Assembly - Captured

Output Shaft Assembly



(494) Output Carrier Internal Gear Retaining Ring
(495) Output Carrier Internal Front Gear
(496) Output Carrier Internal Gear Spacer
(497) Output Carrier Internal Rear Gear
(498) Output Carrier Bushing
(499) Output Shaft Assembly - Model Dependent

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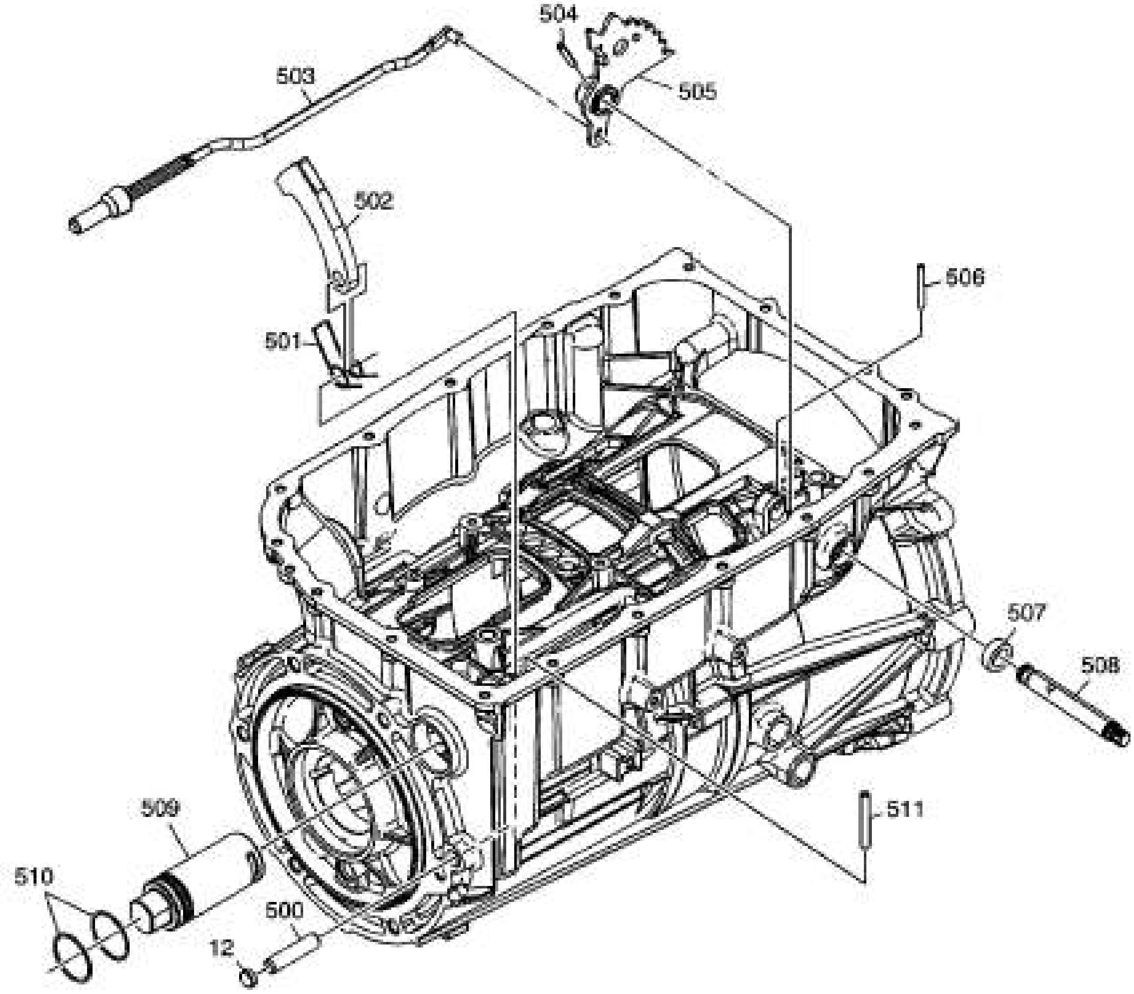
Park System Components



(12) A/Trans Case Plug
(500) Park Pawl Shaft
(501) Park Pawl Spring
(502) Park Pawl
(503) Park Pawl Actuator Assembly
(504) Manual Shaft Detent Lever Hub Pin
(505) Manual Shaft Detent Lever Assembly
(506) Manual Shift Shaft Pin
(507) Manual Shift Shaft Seal
(508) Manual Shift Shaft
(509) Park Pawl Actuator Guide

(510) Park Pawl Actuator Guide (O-ring) Seal
(511) Park Pawl Actuator Guide Pin

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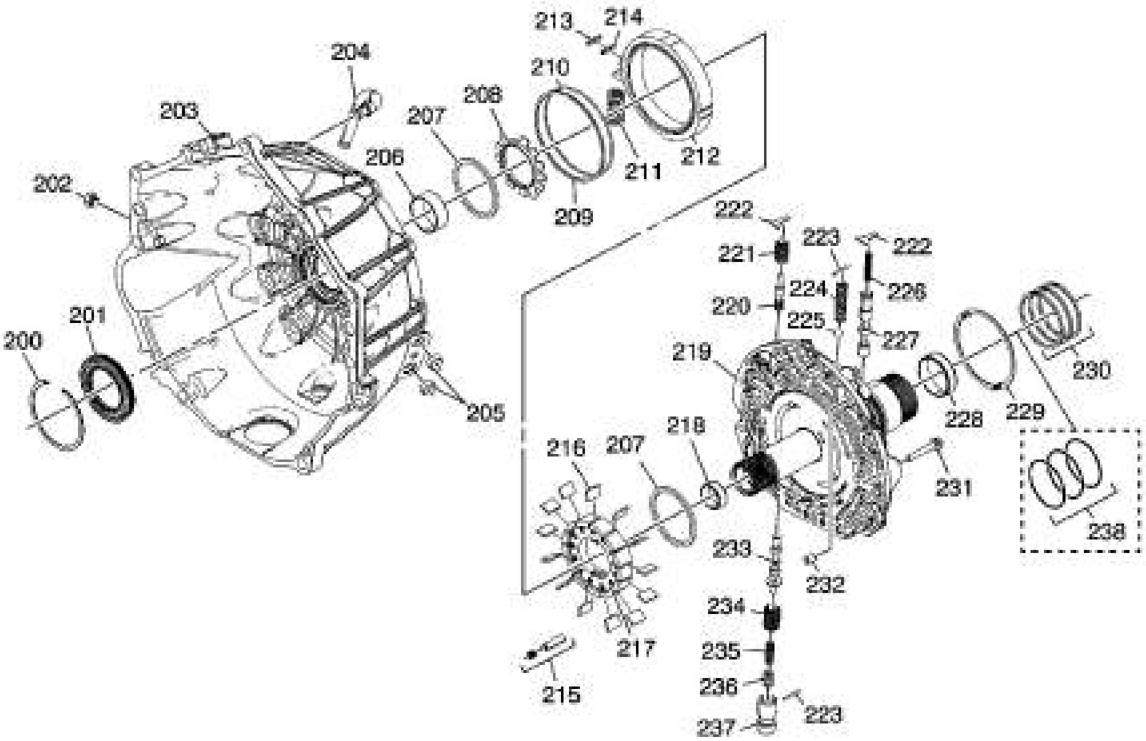
Torque Converter (w/Fluid Pump) Housing Assembly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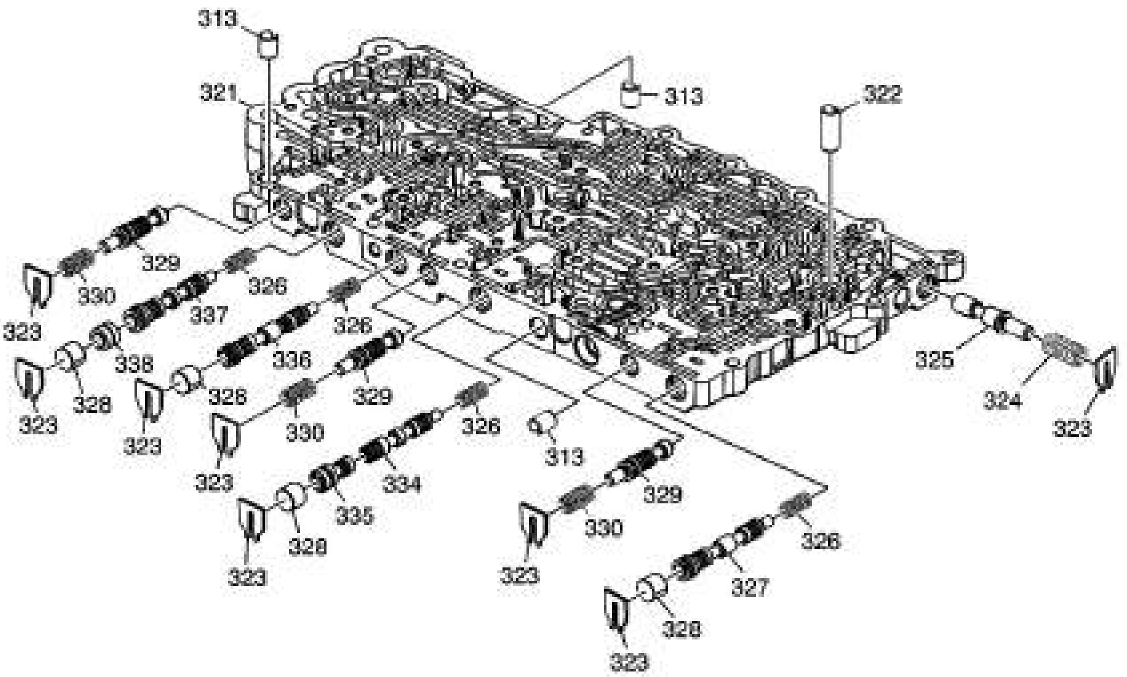
(200) Torque Converter Fluid Seal Retaining Ring
(201) Torque Converter Fluid Seal Assembly
(202) Line Pressure Test Hole Plug
(203) Torque Converter Housing - Model Dependent
(204) A/Trans Vent Pipe
(205) Trans Fluid Cooler Pipe Fitting Seal
(206) Torque Converter Bushing
(207) A/Trans Fluid Pump Vane Ring
(208) A/Trans Fluid Pump Rotor Guide
(209) A/Trans Fluid Pump Slide Fluid Seal Ring
(210) A/Trans Fluid Pump Slide (O-ring) Seal
(211) A/Trans Fluid Pump Slide Outer Spring
(212) A/Trans Fluid Pump Slide
(213) A/Trans Fluid Pump Slide Seal
(214) A/Trans Fluid Pump Slide Seal Support
(215) A/Trans Fluid Pump Slide Pivot Pin
(216) A/Trans Fluid Pump Vane
(217) A/Trans Fluid Pump Rotor

(218) Turbine Shaft Front Bushing
(219) A/Trans Fluid Pump Cover Assembly
(220) Converter Feed Limit Valve
(221) Converter Feed Limit Valve Spring
(222) Valve Spring Retainer
(223) Pressure Relief Ball Valve Spring Pin
(224) Pressure Relief Ball Valve Spring
(225) Pressure Relief Ball Valve
(226) TCC Control Valve Spring
(227) TCC Control Valve
(228) Turbine Shaft Rear Bushing
(229) 1-2-3-4 and 3-5 Reverse Clutch Housing Thrust Washer
(230) 1-2-3-4 and 3-5 Reverse Clutch Fluid Seal Ring
(231) Bolt, M6 x 40 mm
(232) A/Trans Fluid Pump Locator Pin
(233) Pressure Regulator Valve
(234) Pressure Regulator Valve Outer Spring
(235) Pressure Regulator Valve Inner Spring
(236) Isolator Valve
(237) Isolator Valve Sleeve
(238) 1-2-3-4 and 3-5 Reverse Clutch Fluid Seal Ring - Inner O-Ring (Qty: 3) - Model Dependent

Upper Control Valve Body Assembly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(313) Control Valve Body Locator Pin
(321) Control Valve Upper Body
(322) Control Valve Body Locator Pin
(323) Retainer
(324) Actuator Feed Limit Valve Spring
(325) Actuator Feed Limit Valve
(326) Clutch Regulator Valve Spring
(327) CBR1/4-5-6 Clutch Regulator Valve
(328) Clutch Regulator Valve Bore Plug
(329) Clutch Boost Valve
(330) Clutch Boost Valve Spring
(334) 2-6 Clutch Regulator Valve
(335) 2-6 Clutch Regulator Valve Gain Valve
(336) 3-5 Reverse Clutch Regulator Valve
(337) 1-2-3-4 Clutch Regulator Valve
(338) Shuttle Valve

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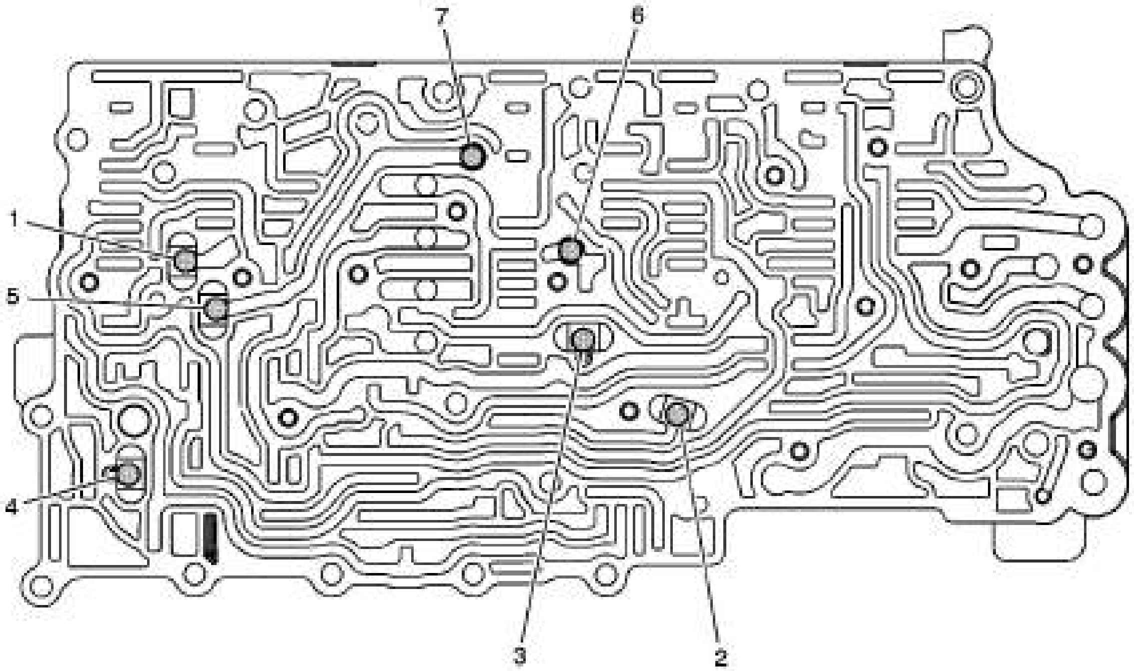
Ball Check Valve Locations



I.D.	Input Oil	Input Oil	Output Oil
1	Drive 1-6	DRV B	CB26/C1234 FD
2	Sol 1	Reverse (Park)	CSV2 Enable
3	Sol 2	C456	CSV3 Enable
4	PS4	C456	CSV2 Latch
5	Drive 1-6	C35R Rev FD	C35R Supply
6	CB26/C1234 FD	--	C1234 FD
7	C35R Supply	--	C35R FD

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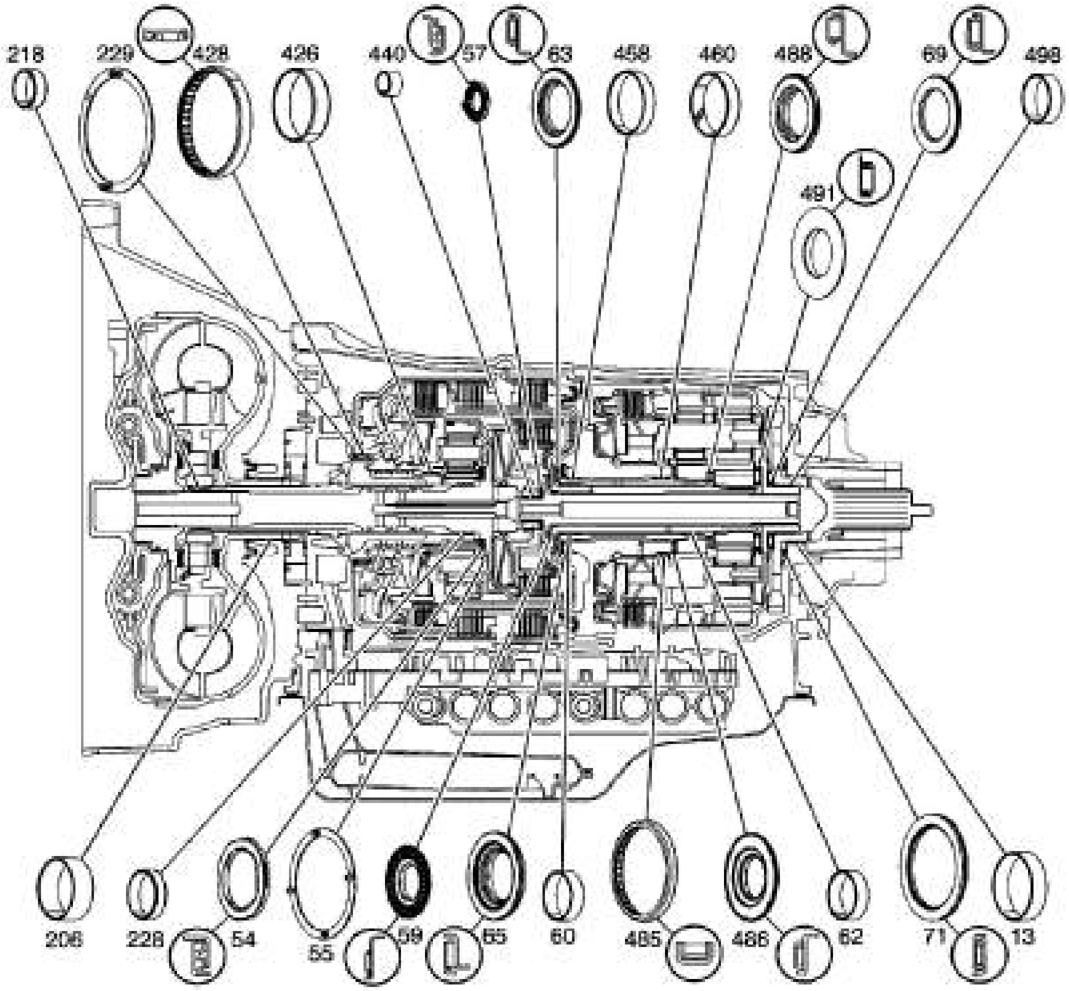
Bushing, Bearing, and Washer Locations

Bushing, Bearing and Washer Locations

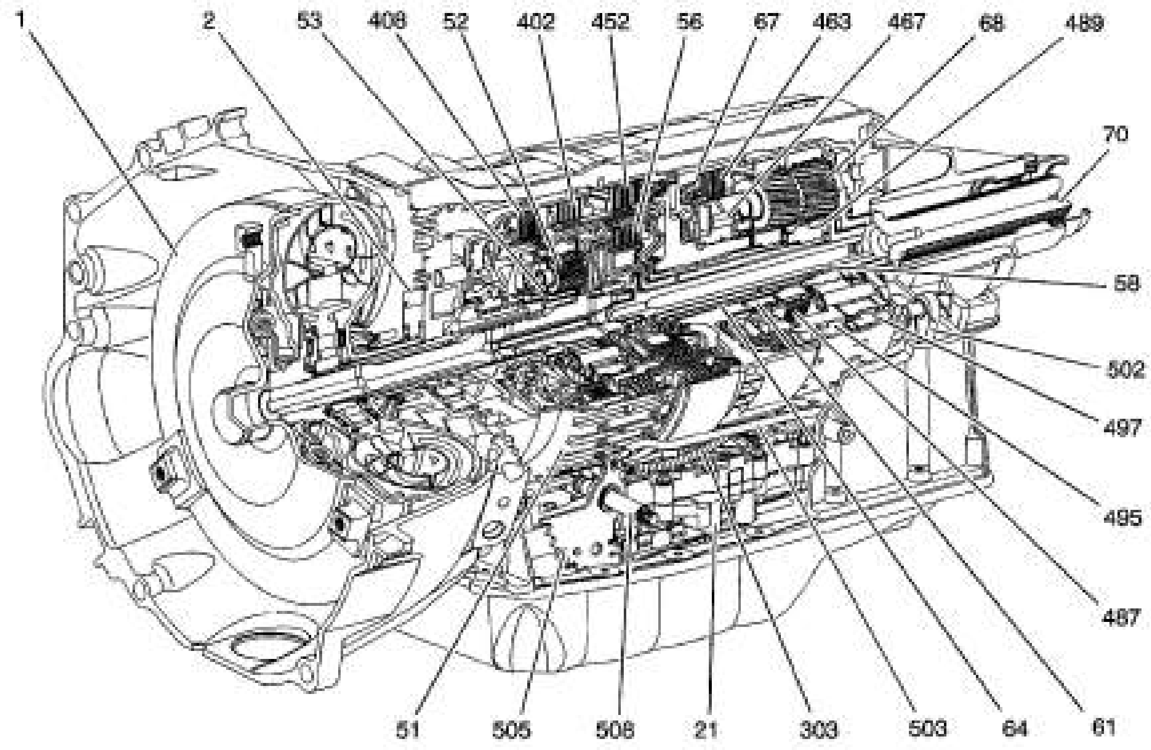


(13) Output Shaft Bushing
(54) Input Sun Gear Thrust Bearing
(55) Input Sun Gear Thrust Washer
(57) Turbine Shaft Thrust Bearing Assembly
(59) 4-5-6 Clutch Hub Thrust Bearing Assembly
(60) Output Carrier Inner Sun Gear Shaft (Front) Bushing
(62) Output Carrier Inner Sun Gear Shaft Bushing
(63) 1-2-3-4 Clutch Hub Thrust Bearing Assembly
(65) 2-6 and 3-5 Reverse Clutch Hub Thrust Bearing Assembly
(69) Output Carrier Thrust Bearing Assembly

(71) Output Shaft Thrust Bearing Assembly
(206) Torque Converter Bushing
(218) Turbine Shaft Front Bushing
(228) Turbine Shaft Rear Bushing
(229) 1-2-3-4 and 3-5 Reverse Clutch Housing Thrust Washer
(426) 1-2-3-4 and 3-5 Reverse Clutch Housing Rear Bushing
(428) 1-2-3-4 and 3-5 Reverse Clutch Bearing Assembly
(440) Output Carrier Shaft Housing Bushing
(458) Output Carrier Outer Sun Gear Shaft (Front) Bushing
(460) Output Carrier Outer Sun Gear Shaft Rear Bushing
(485) Centre Support Roller Bearing Assembly
(486) Output Carrier Front Sun Gear Thrust Bearing Assembly
(488) Output Carrier Front Sun Gear Rear Thrust Bearing Assembly
(491) Output Carrier Rear Sun Gear Thrust Bearing - Captured
(498) Output Carrier Bushing

Component Location

Component Locations

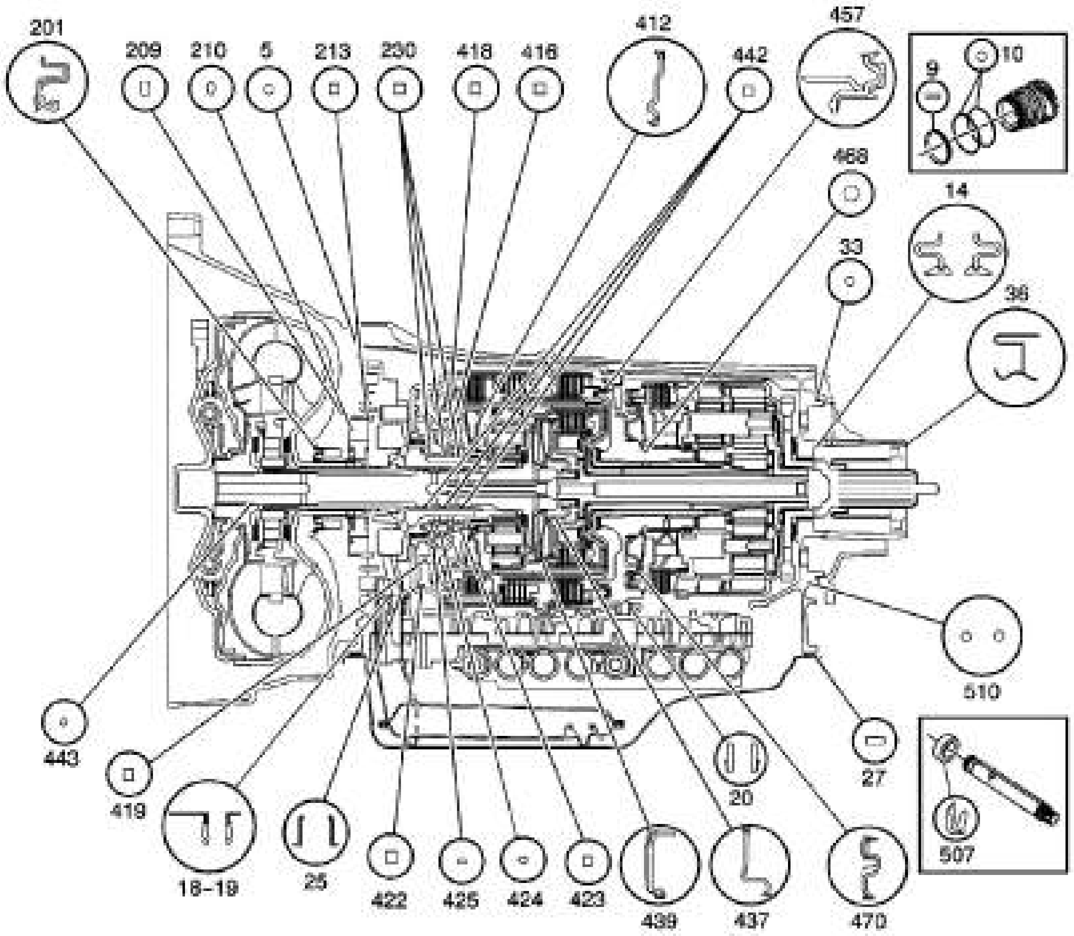


(1)	Torque Converter Assembly
(2)	Torque Converter (with Fluid Pump) Housing Assembly
(21)	Control (with Body and Valve) Valve Assembly
(51)	1-2-3-4 and 3-5 Reverse Clutch Assembly
(52)	Input Carrier Assembly
(53)	Input Sun Gear
(56)	4-5-6 (w/Turbine Shaft) Clutch Assembly
(58)	4-5-6 Clutch (w/Output Carrier Shaft and Dampener) Hub Assembly
(61)	1-2-3-4 Clutch (w/Output Carrier Inner Sun Gear Shaft) Hub Assembly
(64)	2-6 and 3-5 Reverse Clutch (w/Output Carrier Outer Sun Gear Shaft) Hub Assembly
(67)	Centre (w/2-6 Low and Reverse Clutch) Support Assembly
(68)	Output Carrier Assembly
(70)	Output Shaft Assembly
(303)	A/Trans Input and Output Speed Sensor Assembly
(402)	3-5 Reverse Clutch Plate Assembly
(408)	1-2-3-4 Clutch Plate Assembly
(452)	2-6 Clutch Plate Assembly

(463) Low and Reverse Clutch Plate Assembly
(467) Low Clutch Sprag Assembly
(487) Output Carrier Front Sun Gear
(489) Output Carrier Rear Sun Gear
(495) Output Carrier Internal Front Gear
(497) Output Carrier Internal Rear Gear
(502) Park Pawl
(503) Park Pawl Actuator Assembly
(505) Manual Shaft Detent Lever Assembly
(508) Manual Shift Shaft

Seal Locations

Seal Locations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(5) A/Trans Fluid Pump Seal
(9) A/Trans Connector Seal
(10) A/Trans Connector (O-ring) Seal
(14) Output Shaft Seal Assembly
(18) A/Trans Fluid Pump Seal Assembly
(19) A/Trans Fluid Pump Seal Assembly
(20) Centre Support Fluid Passage Seal Assembly
(25) A/Trans Fluid Filter Seal Assembly
(27) A/Trans Fluid Pan Gasket
(201) Torque Converter Fluid Seal Assembly

(209) A/Trans Fluid Pump Slide Fluid Seal Ring
(210) A/Trans Fluid Pump Slide (O-ring) Seal
(213) A/Trans Fluid Pump Slide Seal
(230) 1-2-3-4 and 3-5 Reverse Clutch Fluid Seal Ring
(412) 1-2-3-4 Clutch Piston Dam Assembly
(416) 1-2-3-4 Clutch Piston Seal
(418) 3-5 Reverse Clutch Piston Dam (O-ring) Seal
(419) 3-5 Reverse Clutch Piston Inner Seal
(422) 3-5 Reverse Clutch Piston Outer Seal
(423) 1-2-3-4 Clutch Piston Inner Seal
(424) 1-2-3-4 Clutch Piston Housing Seal
(425) 1-2-3-4 Clutch Piston Housing Seal
(437) 4-5-6 Clutch Piston Dam Assembly
(439) 4-5-6 Clutch Piston Assembly
(442) Turbine Shaft Fluid Seal Ring
(443) Turbine Shaft (O-ring) Seal
(457) 2-6 Clutch Piston Assembly
(468) Low Clutch Sprag Seal
(470) Low and Reverse Clutch Piston Assembly
(507) Manual Shift Shaft Seal
(510) Park Pawl Actuator Guide (O-ring) Seal

Fluid Pressure High or Low

Checks	Causes
Torque Converter Housing with Fluid Pump Assembly (2)	• Inspect for worn, sticking, or damaged pressure regulator valve (233). • Inspect for worn, sticking, or damaged pressure regulator valve outer spring (234). • Inspect for worn, sticking, or damaged pressure regulator valve inner spring (235). • Inspect for worn, sticking, or damaged isolator valve (236) and sleeve (237). • Inspect for worn, sticking, or damaged pressure relief ball valve (225). • Inspect for worn, sticking, or damaged pressure relief ball valve spring (224). • Inspect for damaged or porous pump cover assembly (219). Inspect for pump surfaces not flat. • Inspect for excessive fluid pump rotor (217) clearance or damage. Ensure proper selective rotor is being utilized. • Inspect for damaged fluid pump slide (212). Ensure proper selective slide is being utilized. • Inspect for worn, sticking, or damaged fluid pump slide outer spring (211). • Inspect for worn or damaged fluid pump slide seal (213), seal support (214), pivot pin (215), fluid seal ring (209), and O-ring seal (210). • Inspect for worn or damaged fluid pump vane rings (207) and rotor guide (208).
Control Valve Upper Body Assembly (321)	• Inspect for worn, sticking, or damaged actuator feed limit valve (325) and spring (324). • Inspect for worn, sticking, or damaged clutch boost valve (329) and spring (330).
Fluid Filter Assembly (26)	• Inspect for damaged or restricted fluid filter assembly (26). • Inspect for damaged fluid filter seal assembly (25).

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Harsh, Soft, Delayed or Slipping 1-2-3-4 Shift

Checks	Causes
1-2-3-4 and 3-5-R Clutch Assembly (51)	• Inspect for damaged or worn 1-2-3-4 clutch plates (408-410). • Inspect for damaged 1-2-3-4 clutch piston (414), piston housing (417), spring (413), and dam assembly (412). • Inspect for damaged 1-2-3-4 clutch piston dam retaining ring (411). • Inspect for cut, worn, or damaged 1-2-3-4 clutch piston seal (416), inner seal (423), and housing seals (424 and 425). • Inspect for improper selective 1-2-3-4 clutch backing plate retaining ring (429). • Inspect for damaged 1-2-3-4 clutch backing plate (407). Inspect for worn splines on the backing plate.

Harsh, Soft, Delayed or Slipping 4-5-6 Shift

Checks	Causes
4-5-6 (with Turbine Shaft) Clutch Assembly (56)	• Inspect for damaged or worn clutch plates (433-435). • Inspect for damaged piston (439), piston dam (437), dam retaining ring (436), and clutch spring (438). • Inspect for improper selective 4-5-6 clutch backing plate retaining ring (431). • Inspect for cut, worn, or damaged turbine shaft fluid seal rings (442).

Harsh, Soft, Delayed or Slipping First or Reverse Gear

Checks	Causes
Centre (with 2-6 Low and Reverse Clutch) Support Assembly (67)	• Inspect for damaged or worn low and reverse clutch plates (463 and 465). • Inspect for damaged low and reverse clutch backing plate (462). Inspect for worn splines on backing plate. • Inspect for damaged low and reverse clutch backing plate retaining ring (461). • Inspect for damaged low and reverse clutch piston assembly (470), spring (469), spring retaining ring (466), and centre support assembly (459). • Inspect for damaged low clutch sprag assembly (467). Holding the sprag assembly with the retaining ring facing up, and the inner race of the sprag assembly fixed, the outer race should freewheel counterclockwise. • Inspect for cut, worn, or damaged low clutch sprag seal (468).

Harsh, Soft, Delayed or Slipping Second or Sixth Gear

Checks	Causes
Centre (with 2-6 Low and Reverse Clutch) Support Assembly (67)	• Inspect for damaged or worn 2-6 clutch plates (452 and 454). • Inspect for damaged 2-6 clutch backing plate (451). Inspect for worn splines on backing plate. • Inspect for damaged 2-6 clutch backing plate retaining ring (450). • Inspect for damaged 2-6 clutch piston assembly (457), spring (456), retaining ring (455), and centre support assembly (459).

Harsh, Soft, Delayed or Slipping Third, Fifth, or Reverse Gear

Checks	Causes
1-2-3-4 and 3-5-R Clutch Assembly (51)	• Inspect for damaged or worn 3-5-R clutch plates (402-404). • Inspect for damaged 3-5-R clutch piston (421), apply ring (405), and spring (420). • Inspect for cut, worn, or damaged 3-5-R clutch piston dam O-ring seal (418), inner seal (419), and outer seal (422). • Inspect for improper selective 3-5-R clutch backing plate retaining ring (400). • Inspect for damaged 3-5-R clutch backing plate (401). Inspect for worn splines on the backing plate.

No First, Second, Sixth, or Reverse Gear

Checks	Causes
Centre (with 2-6 Low and Reverse Clutch) Support Assembly (67)	• Inspect for a damaged centre support assembly (459). • Inspect for worn or damaged output carrier outer sun gear shaft front and rear bushing (458 and 460).
Centre Support Retaining Ring (66)	Inspect for damage.
Output Carrier Assembly (68)	Inspect for a worn or damaged centre support roller bearing assembly (485).
2-6 and 3-5-R Clutch Hub Thrust Bearing Assembly (65)	Inspect the bearing for wear or damage.

No First, Second, Third, and Fourth Gear

Checks	Causes
1-2-3-4 and 3-5-R Clutch Assembly (51)	• Inspect for damaged or worn 1-2-3-4 clutch plates (408-410). • Inspect for damaged 1-2-3-4 clutch piston (414), piston housing (417), spring (413), and dam assembly (412). • Inspect for damaged 1-2-3-4 clutch piston dam retaining ring (411). • Inspect for cut, worn, or damaged 1-2-3-4 clutch piston seal (416), inner seal (423), and housing seals (424 and 425). • Inspect for improper selective 1-2-3-4 clutch backing plate retaining ring (429). • Inspect for damaged 1-2-3-4 clutch backing plate (407). Inspect for worn splines on the backing plate.
1-2-3-4 Clutch (with Output Carrier Inner Sun Gear Shaft) Hub Assembly (61)	Inspect for damaged splines on the hub assembly.

No First, Second, Third, Fourth, Fifth, or Reverse Gear

Checks	Causes
1-2-3-4 and 3-5-R Clutch Assembly (51)	• Inspect for improper selective 3-5-R clutch backing plate retaining ring (400). • Inspect for improper selective 1-2-3-4 clutch backing plate retaining ring (429). • Inspect for worn or damaged clutch bearing (428).

No Fourth, Fifth, and Sixth Gear

Checks	Causes
4-5-6 (with Turbine Shaft) Clutch Assembly (56)	• Inspect for damaged or worn clutch plates (433-435). • Inspect for damaged piston (439), piston dam (437), dam retaining ring (436), and clutch spring (438). • Inspect for improper selective 4-5-6 clutch backing plate retaining ring (431). • Inspect for cut, worn, or damaged turbine shaft fluid seal rings (442). • Inspect for damaged or distorted turbine shaft.
Control Valve Upper Body Assembly (304)	Inspect the 1/Reverse band and 4-5-6 clutch regulator valve (327) and spring (326) for wear or damage.
4-5-6 Clutch (with Output Carrier Shaft and Dampener) Hub Assembly (58)	Inspect the hub assembly (475), dampener (476), and apply plate (477) for wear or damage.
Output Carrier Assembly (68)	Inspect for damaged or stripped internal splines on the output carrier assembly.

No Reverse Gear

Checks	Causes
Control Valve Upper Body Assembly (304)	• Inspect for worn, damaged, or sticking 3-5 reverse regulator valve (336) and valve spring (326). • Inspect for damaged or missing #5 checkball.
Control Valve Lower Body Assembly (307)	Inspect for worn, damaged, or sticking clutch select solenoid valve 3 (352) and valve spring (353).

No Second and Sixth Gear

Checks	Causes
Centre (with 2-6 Low and Reverse Clutch) Support Assembly (67)	• Inspect for damaged or worn 2-6 clutch plates (452 and 454). • Inspect for damaged 2-6 clutch backing plate (451). Inspect for worn splines on backing plate. • Inspect for damaged 2-6 clutch backing plate retaining ring (450). • Inspect for damaged 2-6 clutch piston assembly (457), spring (456), retaining ring (455), and centre support assembly (459).

No Third, Fifth, and Reverse Gear

Checks	Causes
1-2-3-4 and 3-5-R Clutch Assembly (51)	• Inspect for damaged or worn 3-5-R clutch plates (402-404). • Inspect for damaged 3-5-R clutch piston (421), apply ring (405), and spring (420). • Inspect for cut, worn, or damaged 3-5-R clutch piston dam O-ring seal (418), inner seal (419), and outer seal (422). • Inspect for improper selective 3-5-R clutch backing plate retaining ring (400). • Inspect for damaged 3-5-R clutch backing plate (401). Inspect for worn splines on the backing plate.

No Torque Converter Clutch Apply

Checks	Causes
Torque Converter Assembly (1)	Diagnose torque converter for possible internal damage.
Fluid Pump Cover Assembly (219)	• Inspect for worn, damaged, or sticking converter feed limit valve (220) and spring (221). • Inspect for worn, damaged, or sticking TCC control valve (227) and spring (226). • Inspect for damaged stator shaft.
Control Valve Lower Body Assembly (307)	Inspect for worn, damaged, or sticking torque converter clutch (TCC) regulator apply valve (355).
4-5-6 (with Turbine Shaft) Clutch Assembly (56)	• Inspect for damaged turbine shaft. • Inspect for damaged turbine shaft O-ring seal.

No Torque Converter Clutch Release

Checks	Causes
Torque Converter Assembly (1)	Diagnose torque converter for possible internal damage.
Fluid Pump Cover Assembly (219)	• Inspect for worn, damaged, or sticking converter feed limit valve (220) and spring (221). • Inspect for worn, damaged, or sticking torque converter clutch (TCC) control valve (227) and spring (226).
Control Valve Lower Body Assembly (307)	Inspect for worn, damaged, or sticking TCC regulator apply valve (355).

Shift Lever Can Be Moved without Brake Pedal Depressed

Step	Action	Yes	No
Schematic Reference: Diagnostic Starting Point - Automatic Transmission Shift Lock Control DEFINITION: Transmission shift lever does not lock in the PARK position with the ignition ON and the brake pedal not pressed.			
1	Did you perform the Symptoms - Automatic Transmission Shift Lock Control tests and perform all the necessary inspections?	Go to Step 2	Go to Symptoms - Automatic Transmission Shift Lock Control
2	1. Apply the parking brake and block the wheels. 2. Turn ON the ignition, with the engine OFF. 3. Attempt to move the shift lever out of the PARK position. Does the shift lever move out of the PARK position?	Go to Step 3	Go to Testing for Intermittent Conditions and Poor Connections
3	1. Disconnect the shift lock control relay. 2. Attempt to move the shift lever out of the PARK position. Does the shift lever move out of the PARK position?	Go to Step 6	Go to Step 4
4	Test the shift lock control relay brake switch input circuit for an open or a high resistance. Refer to Circuit Testing and Wiring Repairs. Did you find and correct the condition?	Go to Step 11	Go to Step 5
5	Test the shift lock control relay ground circuit for an open or a high resistance. Refer to Circuit Testing and Wiring Repairs. Did you find and correct the condition?	Go to Step 11	Go to Step 7
6	Test the shift lock control solenoid feed circuit for a short to voltage. Refer to Circuit Testing and Wiring Repairs. Did you find and correct the condition?	Go to Step 11	Go to Step 8
7	Inspect for poor connections at the shift lock control relay. Refer to Circuit Testing and Connector Repairs. Did you find and correct the condition?	Go to Step 11	Go to Step 9
	Inspect for poor connections at the shift lock control solenoid. Refer to Circuit Testing and		

8	Connector Repairs. Did you find and correct the condition?	Go to Step 11	Go to Step 10
9	Replace the shift lock control relay. Refer to Relay Replacement. Did you complete the repair?	Go to Step 11	--
10	Replace the shift lock control solenoid. Refer to Automatic Transmission Shift Lock Control Actuator Replacement. Did you complete the repair?	Go to Step 11	--
11	Operate the system in order to verify the repair. Did you find and correct the condition?	System OK	Go to Step 2

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Shift Lever Does Not Move with Brake Pedal Depressed

Step	Action	Yes	No
Schematic Reference: Diagnostic Starting Point - Automatic Transmission Shift Lock Control . DEFINITION: Transmission shift lever does not move with ignition ON and the brake pedal pressed.			
1	Did you perform the Symptoms - Automatic Transmission Shift Lock Control tests and perform all necessary inspections?	Go to Step 2	Go to Symptoms - Automatic Transmission Shift Lock Control
2	1. Turn ON the ignition, with the engine OFF. 2. Press and hold the brake pedal. 3. Attempt to move the shift lever out of the PARK position. Does the shift lever move out of the PARK position?	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
3	Do the stop lamps operate properly?	Go to Step 4	Go to Diagnostic Starting Point - Lighting
4	1. Connect a test lamp between the shiftlock control solenoid feed circuit of the shiftlock control relay (terminal 4) and ground. 2. Turn ON the ignition, with the engine OFF. 3. Press and hold the brake pedal. Does the test lamp illuminate?	Go to Step 7	Go to Step 5
5	Test the shift lock control relay supply voltage circuit for an open or high resistance. Refer to Circuit Testing and Wiring Repairs. Did you find and correct the condition?	Go to Step 9	Go to Step 6
6	Test the shift lock control relay brake switch input circuit for a short to B+. Refer to Circuit Testing and Wiring Repairs. Did you find and correct the condition?	Go to Step 14	Go to Step 10
7	Test the shift lock control solenoid feed circuit for an open or high resistance. Refer to Circuit Testing and Wiring Repairs.		

	Did you find and correct the condition?	Go to Step 14	Go to Step 8
8	Test the shift lock control solenoid supply voltage circuit for an open or high resistance. Refer to Circuit Testing and Wiring Repairs. Did you find and correct the condition?	Go to Step 14	Go to Step 9
9	Test the shift lock control solenoid ground circuits for an open or high resistance. Refer to Circuit Testing and Wiring Repairs. Did you find and correct the condition?	Go to Step 14	Go to Step 11
10	Inspect for poor connections at the shift lock control relay. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs. Did you find and correct the condition?	Go to Step 14	Go to Step 12
11	Inspect for poor connections at the shift lock control solenoid. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs. Did you find and correct the condition?	Go to Step 14	Go to Step 13
12	Replace the shift lock control relay. Refer to Relay Replacement. Did you complete the replacement?	Go to Step 14	--
13	Replace the shift lock control solenoid. Refer to Automatic Transmission Shift Lock Control Actuator Replacement. Did you complete the replacement?	Go to Step 14	--
14	Operate the system in order to verify the repair. Did you find and correct the condition?	System OK	Go to Step 2

Stuck in First or Reverse Gear

Checks	Causes
Centre (with 2-6 Low and Reverse Clutch) Support Assembly (67)	• Inspect for damaged or worn low and reverse clutch plates (463 and 465). • Inspect for damaged low and reverse clutch backing plate (462). Inspect for worn splines on backing plate. • Inspect for damaged low and reverse clutch backing plate retaining ring (461). • Inspect for damaged low and reverse clutch piston assembly (470), spring (469), spring retaining ring (466), and centre support assembly (459). • Inspect for damaged low clutch sprag assembly (467). Holding the sprag assembly with the retaining ring facing up, and the inner race of the sprag assembly fixed, the outer race should freewheel counterclockwise. • Inspect for cut, worn, or damaged low clutch sprag seal (468).

Stuck in Second or Sixth Gear

Checks	Causes
Centre (with 2-6 Low and Reverse Clutch) Support Assembly (67)	• Inspect for damaged or worn 2-6 clutch plates (452 and 454). • Inspect for damaged 2-6 clutch backing plate (451). Inspect for worn splines on backing plate. • Inspect for damaged 2-6 clutch backing plate retaining ring (450). • Inspect for damaged 2-6 clutch piston assembly (457), spring (456), retaining ring (455), and centre support assembly (459).

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Vibration in Second, Third, Fourth, Fifth, or Sixth Gear

Checks	Causes
4-5-6 Clutch (with Output Carrier Shaft and Dampener) Hub Assembly (58)	Inspect hub assembly (475), dampener (476), and apply plate (477) for wear or damage.

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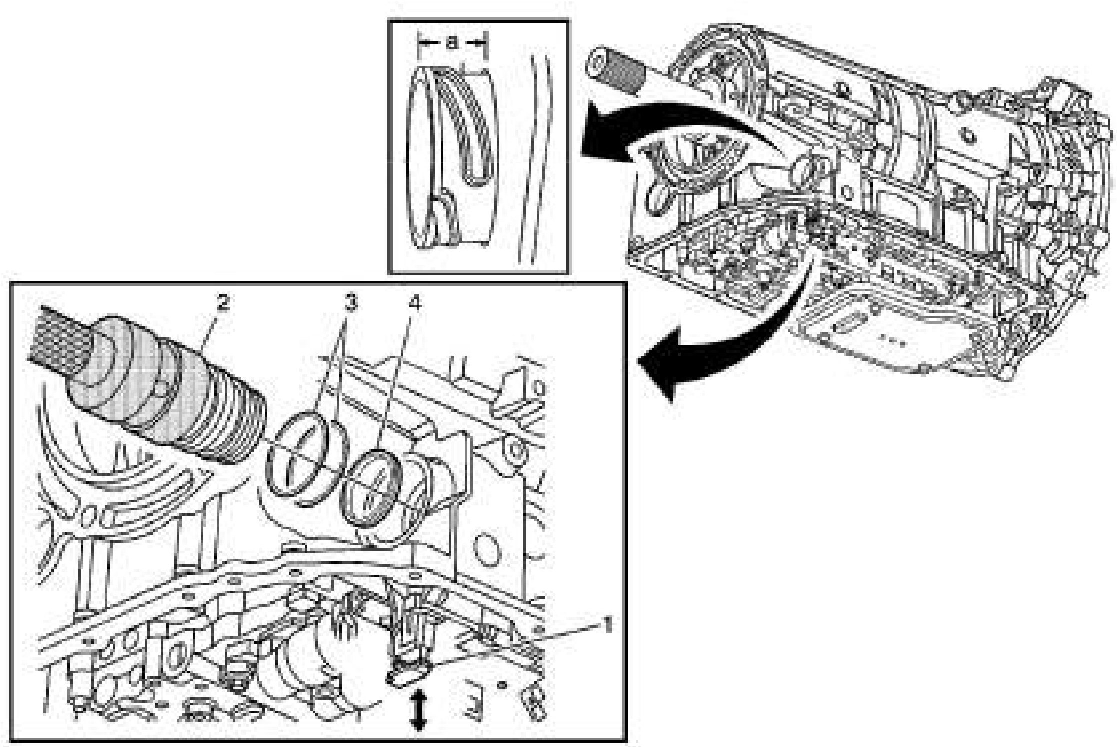
Automatic Transmission Electrical Connector Passage Sleeve Replacement



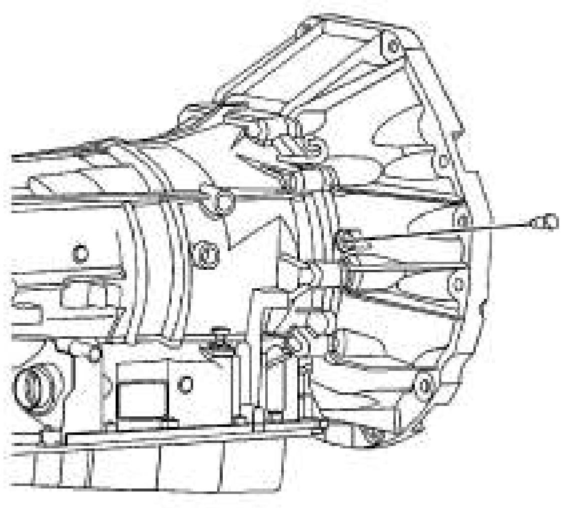
Callout	Component Name
Notice: Refer to General Repair Instructions in the Preface section. *Fastener Tightening Specifications:* Refer to Fastener Tightening Specifications . **Preliminary Procedures** 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle . 2. Remove the transmission oil pan. Refer to Automatic Transmission Fluid, Fluid Pan and/or Filter Replacement . 3. Disconnect the vehicle wire harness electrical connector from the transmission electrical connector passage sleeve. Refer to Automatic Transmission Inline 16-Way Connector Description .	
1	Electrical Connector Slide Lock **Tip** Pull down on the slide lock to remove the sleeve. Push up on the slide lock after sleeve installation.
	Electrical Connector Passage Sleeve

2	**Tip** Use the DT 47715 DT 47715 and J 42183 J 42183 to remove and install the electrical connector passage sleeve.
3	NEW O-Ring Seals (Qty: 2)
4	NEW Lip Seal

Automatic Transmission Fluid Pressure Test Hole Plug Replacement (SWB LWB RHD)

Removal Procedure

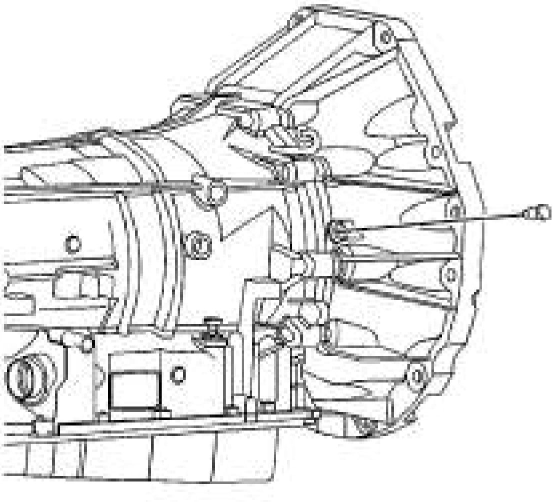
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



2. Clean the surrounding area of the oil pressure test plug.
3. Remove the oil pressure test plug.

Installation Procedure

Notice: Refer to Fastener Notice in the Preface section.



1. Install the oil pressure test plug.

   Tighten
   Tighten the oil pressure test plug to 11 N·m (97 lb. in).

2. Check the transmission fluid level (fill if necessary). Refer to Transmission Fluid Check.
3. Lower the vehicle.

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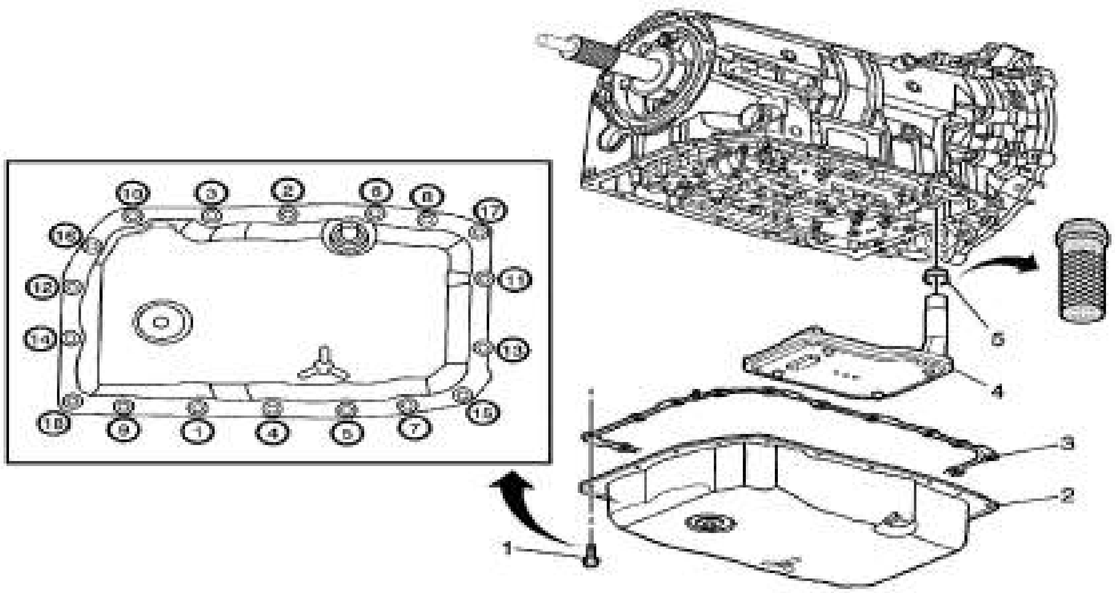
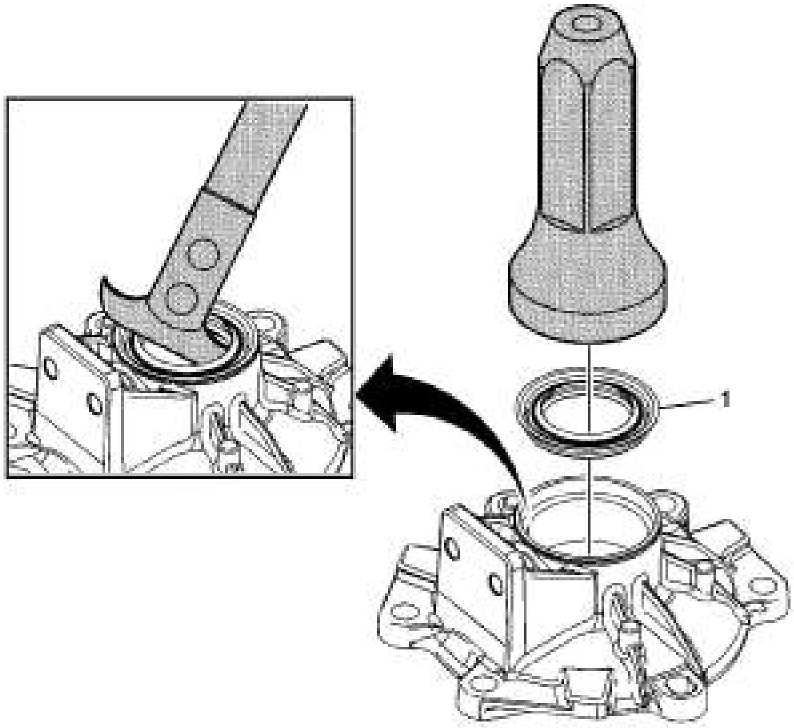
Automatic Transmission Fluid, Fluid Pan and/or Filter Replacement



Callout	Component Name
Notice: Refer to General Repair Instructions in the Preface section. **Notice:** Refer to Fastener Notice in the Preface section. *Fastener Tightening Specifications:* Refer to Fastener Tightening Specifications . **Preliminary Procedures** 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle . 2. Place a suitable drain pan under the transmission.	
1	Transmission Fluid Pan Bolt (Qty: 18) **Tip** Tighten the bolts in the sequence shown. **Tighten** 9 N·m (80 lb. in)
	Transmission Fluid Pan Assembly

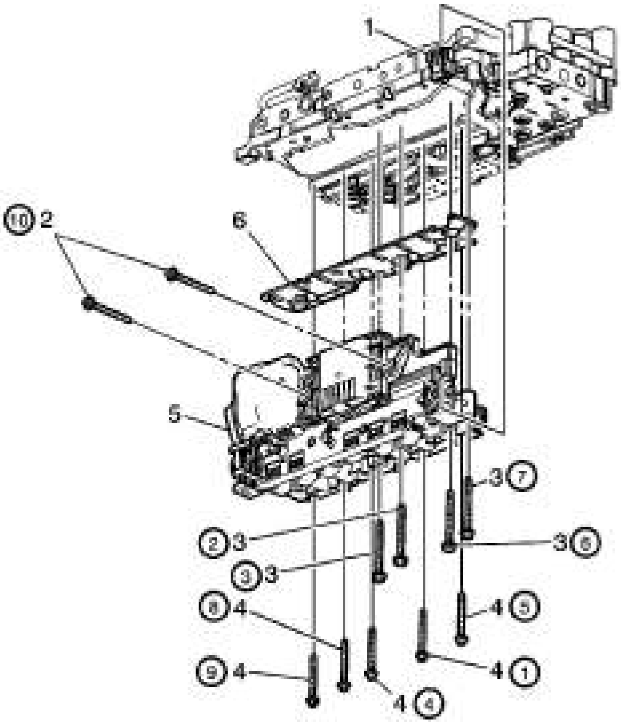
2	- Check the condition of the draining fluid. Refer to Transmission Fluid Check . - Fill the transmission with the proper fluid. Refer to Transmission General Specifications . - Fill the transmission with the proper amount of transmission fluid. Refer to Fluid Capacity Specifications and Transmission Fluid Check .
3	Transmission Fluid Pan Gasket **Tip** The fluid pan gasket is reusable. Inspect the gasket to determine if it may be reused.
4	NEW Fluid Filter Assembly **Tip** Pull the fluid filter assembly straight out. Do not bend or twist the filter neck.
5	NEW Fluid Filter Seal Assembly **Notice:** Refer to Fastener Notice in the Preface section. **Notice:** Refer to General Repair Instructions in the Preface section. - Use a screwdriver or snap ring pliers to remove the filter seal. - Use the DT 47848 and the J 42183 to install the filter seal. - Lubricate the filter seal with transmission fluid before installing the filter.
6	- DT 47848 . - J 42183 .

Case Extension and Seal Replacement



Callout	Component Name
1	Output Shaft Seal Assembly **Special Tools** • J 37212 Front Output Shaft Seal Installer • J 45000 Seal Remover

Control Solenoid Valve and Transmission Control Module Assembly Replacement



Callout	Component Name
	Notice: Refer to Fastener Notice in the Preface section. *Fastener Tightening Specifications:* Refer to Fastener Tightening Specifications. **Preliminary Procedures** 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle. 2. Remove the transmission control valve assembly. Refer to Control Valve Lower Body and Upper Body Replacement.
1	Manual Shift Shaft Position Switch Assembly Electrical Connector **Tip** Release the connector lock before disconnecting. Engage the connector lock after connecting.
2	Control Module Assembly Heat Sink Bolt (Qty: 2) **Tighten** 8 N·m (71 lb. in)

	Tip Tighten in specified sequence.
3	Control Solenoid Valve Assembly Bolt (Qty: 4) **Tighten** 8 N·m (71 lb. in) **Tip** Tighten in specified sequence.
4	Control Solenoid Valve Assembly Bolt (Qty: 5) **Tighten** 8 N·m (71 lb. in) **Tip** Tighten in specified sequence.
5	Control Solenoid Valve and Module Assembly Refer to Control Module References. **Tip** • Inspect the 4 filter plate retaining tabs. A broken tab may not adequately secure the filter plate to the control solenoid valve assembly. • Align the control solenoid valve assembly with the lower valve body locator pin when assembling.
6	Filter Plate **Tip** Discard filter plate and replace with new.

Following the replacement of the TCM, a harsh upshift may occur between 4th and 5th gear.

If this occurs the following procedure should be followed.

- Make sure both the Scan Tool and TCM calibrations are the latest versions availble for reprogramming.
- Check and clear all DTCs that may have set as a result of the programming process.
- Drive maneuvers should be performed at transmission oil temperatures of at least 40°C (104°F).
- Transmission oil levels should be set correctly prior to the starting drive cycles.
- Initial upshifts may have an erratic feel for the first several cycles. They should improve significantly with repeated maneuvers.
- At the start of the drive cycles, no ECM or TCM DTCs should be set. The MIL should not be illuminated.

A drive cycle requires five light throttle accelerations to 40 km/h (25 mph) and five light throttle accelerations to 64 km/h (40 mph).

1. From a complete stop, lightly accelerate at a relatively constant throttle pedal position up to 40 km/h (25 mph) or 64 km/h (40 mph).
2. Brake the vehicle to a complete stop.
3. Repeat five times to 40 km/h (25 mph) and five times to 64 km/h (40 mph). Maneuvers can be performed in any combination.

If the garage shifts (Park to Reverse, Park to Drive, Reverse to Drive, Drive to Reverse) feel like they are delayed, garage shifts adapts can also be performed. All garage shifts should be performed with the vehicle stopped, foot on the brake and engine at idle.

1. Shift the transmission from Reverse to Drive leaving the shift lever in Drive for three seconds. After three seconds, shift back to Reverse, leaving the shift lever in Reverse for three seconds. Perform the procedure 10 times (R-D-R-D-R-D...). The transitions need to be directly to Drive and Reverse, without stopping in Neutral.
2. Shift the transmission from Neutral to Drive leaving the shift lever in Drive for three seconds. After three seconds, shift back to Neutral, leaving the shift lever in Neutral for three seconds. Perform the procedure 10 times (N-D-N-D-N-D...).
3. Shift the transmission from Neutral to Reverse leaving the shift lever in Reverse for three seconds. After three seconds, shift back to Neutral, leaving the shift lever in Neutral for three seconds. Perform the procedure 10 times (R-N-R-N-R-N..).

At the end of these maneuvers, the vehicle may still experience some minor driveability issues, but should learn improved shifting performance over the next several key cycles and driving time. Coach the customer about the transmission's ability to self-correct shifting issues or concerns. The transmission adapts are always functional and operate at transmission oil temperatures above 40° C (104°F).

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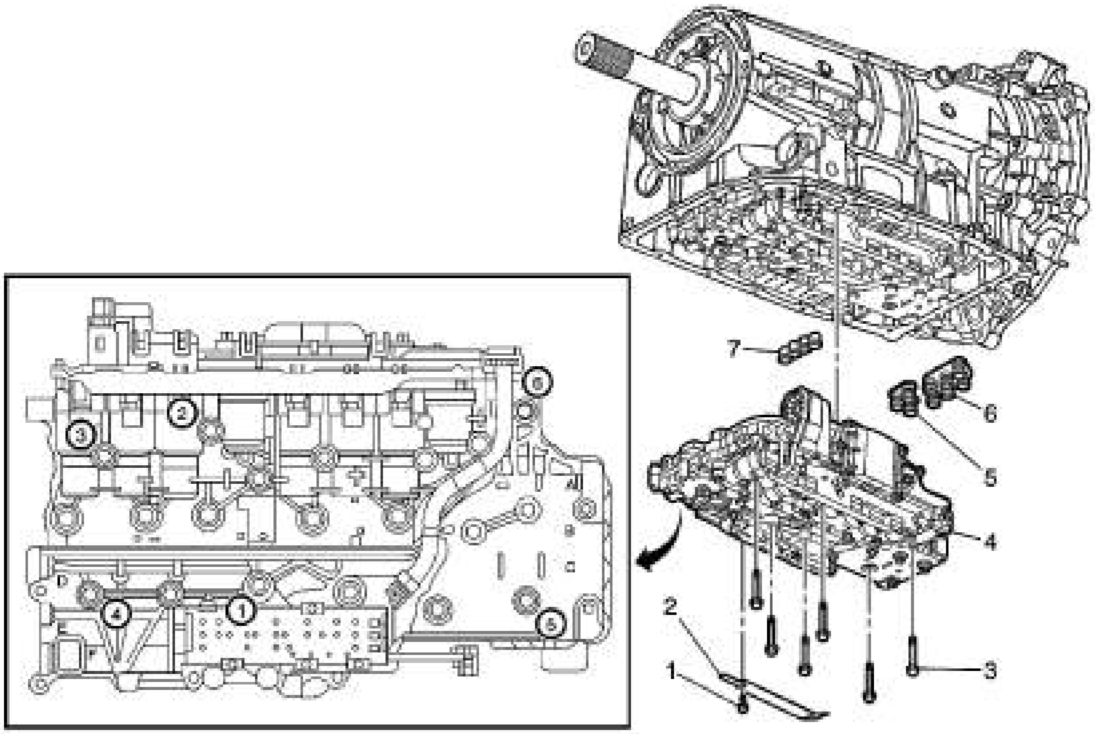
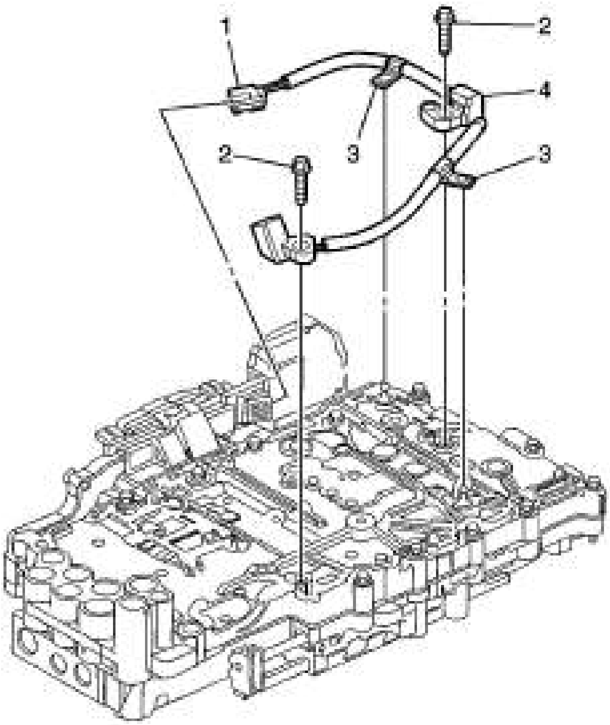
Control Valve Lower Body and Upper Body Replacement (SWB LWB RHD)



Callout	Component Name
Notice: Refer to Fastener Notice in the Preface section. *Fastener Tightening Specifications:* Refer to Fastener Tightening Specifications . **Preliminary Procedures** 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle . 2. Remove the transmission fluid pan and filter. Refer to Automatic Transmission Fluid, Fluid Pan and/or Filter Replacement. 3. Remove the transmission electrical connector. Refer to Automatic Transmission Electrical Connector Passage Sleeve Replacement.	
1	Manual Shaft Detent Bolt **Tighten** 12 N·m (106 lb. in)
2	Manual Shaft Detent Assembly
	Control Valve Assembly Bolt (Qty: 6)

3	- Do not remove all the bolts in the control valve body assembly. Remove only the bolts indicated. - Tighten in specified sequence. **Tighten** 8 N·m (71 lb. in)
4	Control Valve Assembly
5	Fluid Pump Seal Discard seal and replace with new.
6	Fluid Pump Seal Discard seal and replace with new.
7	Centre Support Fluid Passage Seal Discard seal and replace with new.

Input and Output Speed Sensor Replacement



Callout	Component Name
Notice: Refer to Fastener Notice in the Preface section. *Fastener Tightening Specifications:* Refer to Fastener Tightening Specifications . **Preliminary Procedures** 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle . 2. Remove the transmission fluid pan and filter. Refer to Automatic Transmission Fluid, Fluid Pan and/or Filter Replacement . 3. Remove the upper and lower valve body assembly. Refer to Control Valve Lower Body and Upper Body Replacement .	
1	Speed Sensor Electrical Connector
2	Input and Output Speed Sensor Assembly Bolts (Qty: 2) **Tighten** 12 N·m (106 lb. in)
3	Input and Output Speed Sensor Assembly Clips (Qty: 2) **Tip**

	Inspect the wiring harness clips for damage replace if necessary.
4	Input and Output Speed Sensor Assembly

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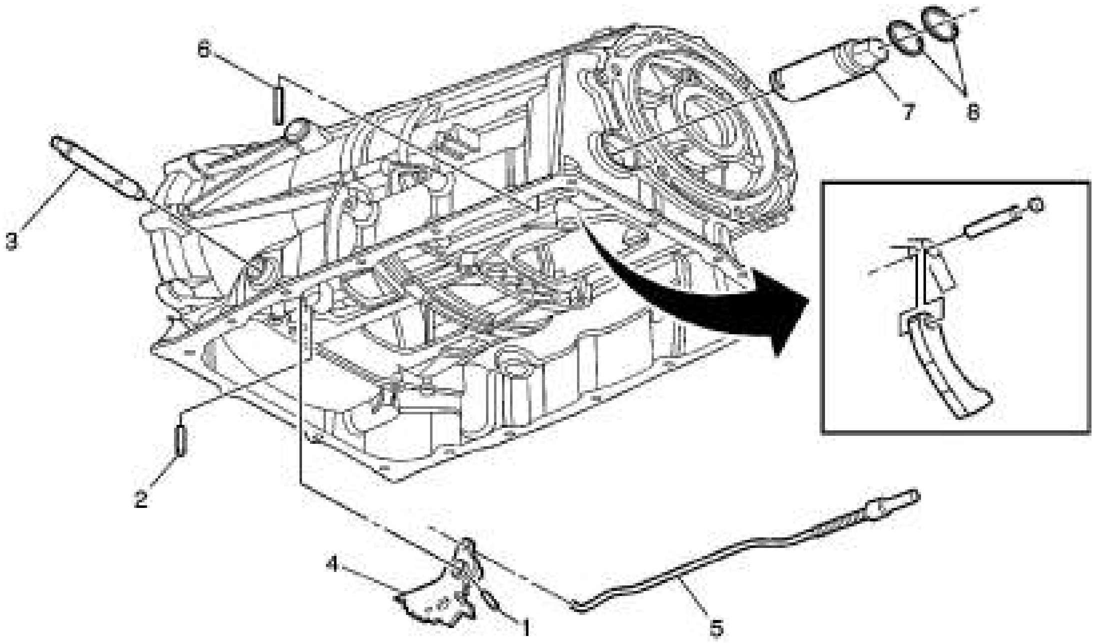
Manual Shift Detent Lever and Park Pawl Actuator Replacement



<table>
<tr><th>Callout</th><th>Component Name</th></tr>
<tr><td colspan="2">Notice: Refer to Fastener Notice in the Preface section.
Important: Do not remove the park pawl or park pawl spring. The park pawl and park pawl spring are not serviceable components.
<i>Fastener Tightening Specifications:</i> Refer to Fastener Tightening Specifications .
Preliminary Procedures
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the transmission fluid pan. Refer to Automatic Transmission Fluid, Fluid Pan and/or Filter Replacement .
3. Remove the manual shaft detent assembly roller. Refer to Control Valve Lower Body and Upper Body Replacement</td></tr>
<tr><td>1</td><td>Manual Shaft Detent Lever Hub Pin
Tip
• Discard the pin. Replace with NEW pin.</td></tr>
</table>

	- "Walk" the pin out using side cutters.
2	Manual Shift Shaft Pin **Tip** - Discard the pin. Replace with NEW pin. - "Walk" the pin out using side cutters.
3	Manual Shift Shaft
4	Manual Shaft Detent Lever Assembly
5	Park Pawl Actuator Assembly
6	Park Pawl Actuator Guide Pin **Tip** - Discard the pin. Replace with NEW pin. - "Walk" the pin out using side cutters.
7	Park Pawl Actuator Guide
8	Park Pawl Actuator Guide (O-Ring) Seals (Qty: 2) **Tip** Discard the seals. Replace with NEW seals.

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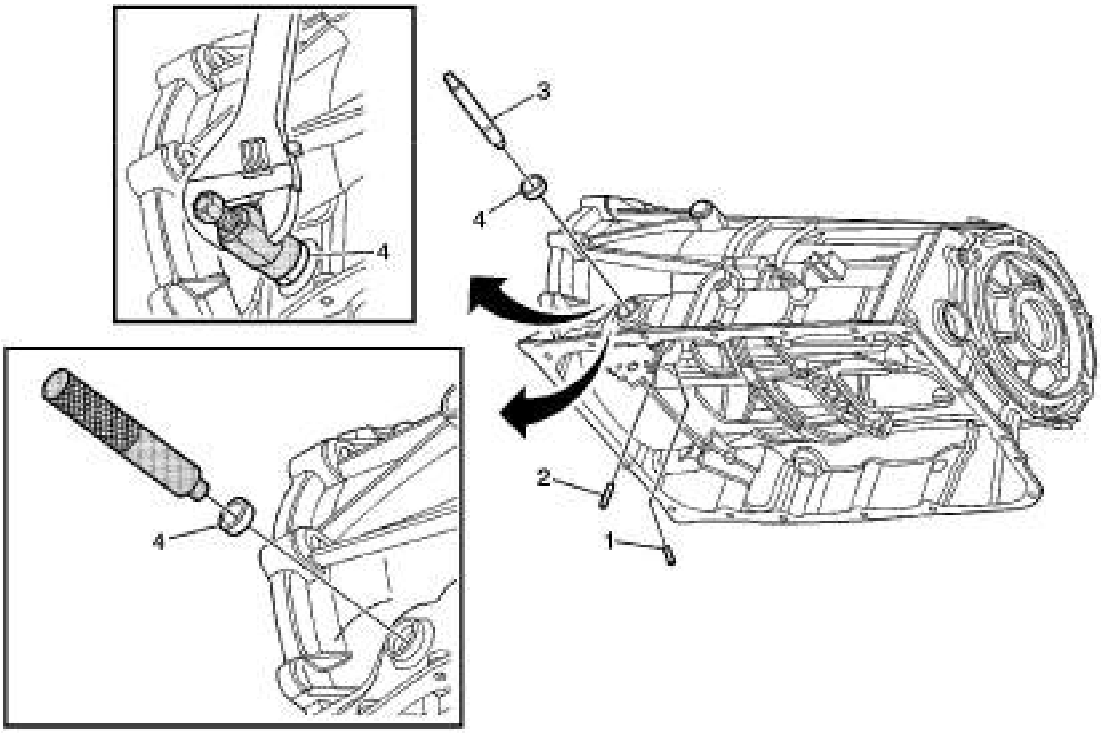
Manual Shift Shaft and Seal Replacement



Callout	Component Name
	Notice: Refer to Fastener Notice in the Preface section. **Important:** The manual shaft must be removed to replace the manual shaft seal. *Fastener Tightening Specifications:* Refer to Fastener Tightening Specifications . **Preliminary Procedures** 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle . 2. Remove the transmission from the vehicle. Refer to Transmission Replacement . 3. Remove the transmission fluid pan. Refer to Automatic Transmission Fluid, Fluid Pan and/or Filter Replacement . 4. Remove the control valve body. Refer to Control Valve Lower Body and Upper Body Replacement
1	Manual Shift Shaft Pin **Tip** • Discard the pin. Replace with NEW pin.

	- "Walk" the pin out using side cutters.
2	Manual Shaft Detent Lever Hub Pin **Tip** - Discard the pin. Replace with NEW pin. - "Walk" the pin out using side cutters.
3	Manual Shift Shaft
4	Manual Shift Shaft Seal **Tip** - Use the J 45201 to remove the seal from the transmission case. - Use the J 43909 to install the seal into the transmission case.

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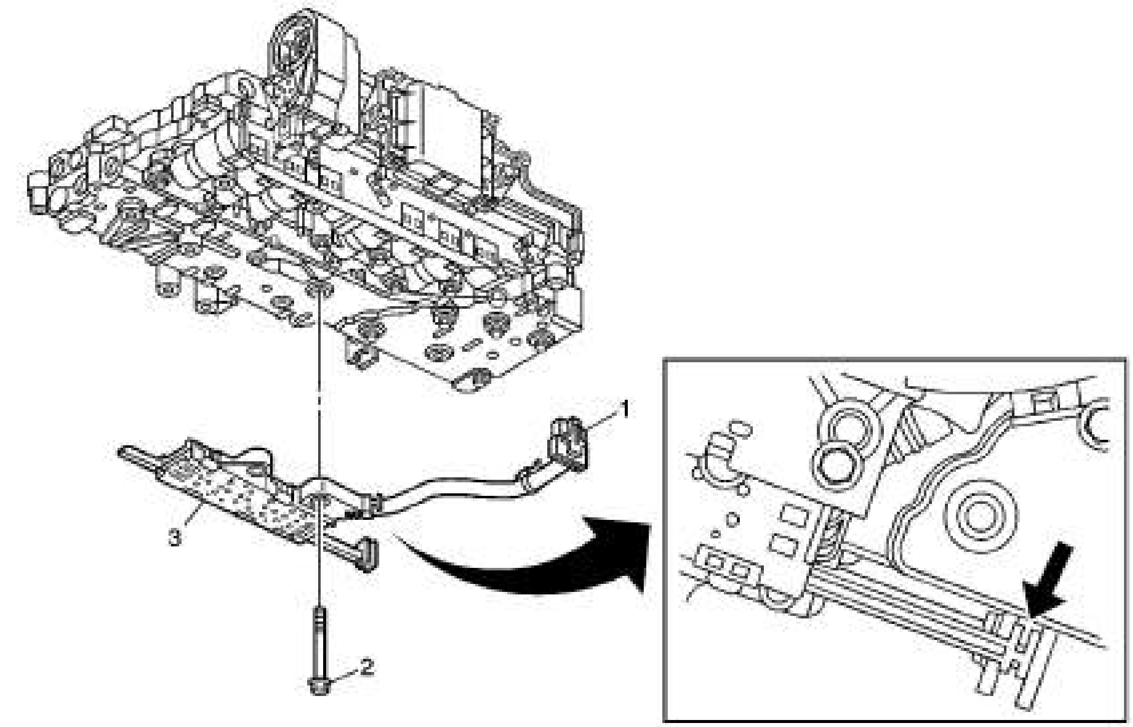
Manual Shift Shaft Position Switch Replacement



Callout	Component Name
Preliminary Procedures 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle . 2. Remove the transmission fluid pan and filter. Refer to Automatic Transmission Fluid, Fluid Pan and/or Filter Replacement .	
1	Manual Shift Shaft Position Switch Assembly Electrical Connector **Tip** - Release the connector lock before disconnecting. Engage the connector lock after connecting. - The wiring harness clip near the connector does not need to be replaced if broken or missing. The clip is used during manufacturing to keep the wire harness clear during an automated bolt installation process. If the clip is damaged, simply remove and discard.
2	Manual Shift Shaft Position Switch Assembly Bolt **Notice:** Refer to Fastener Notice in the Preface section. **Tighten**

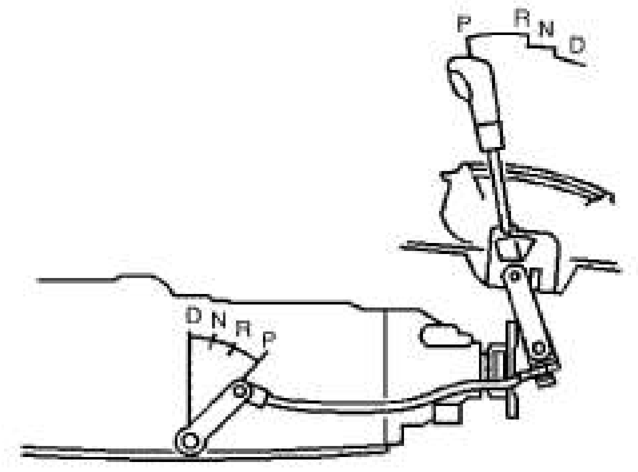
	8 N·m (71 lb in)
3	Manual Shift Shaft Position Switch Assembly **Procedure** Align the switch activator slide with the manual valve link.

Range Selector Lever Link Adjustment

1. Ensure that the shift lever is in the park (P) position.
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Loosen the selector rod on selector retaining bolt.
4. Ensure that the transmission manual shaft lever is in the park (P) position.
5. Hold the selector lever on transmission against the rear stop to eliminate any play.

   Tighten
   Tighten the selector lever adjustment nut to 9 N·m (80 lb. in).

6. Lower the vehicle.



7. Inspect the operation of the starting system with the shift lever in each position. The engine should only crank when the lever is in the PARK or NEUTRAL position.

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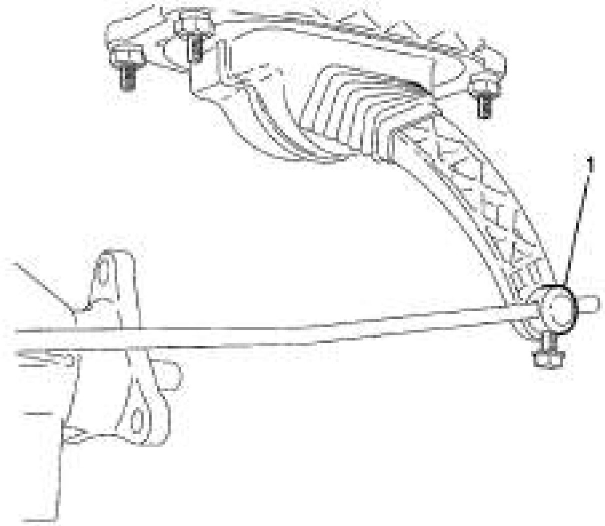
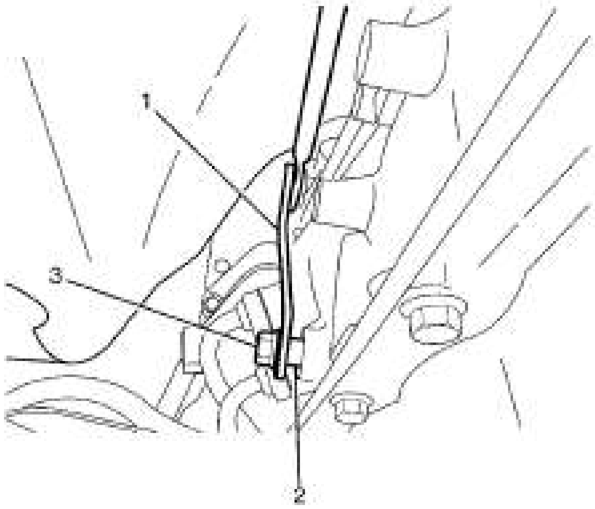
Shift Control Linkage Replacement

Removal Procedure

1. Position the shift lever in PARK.
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

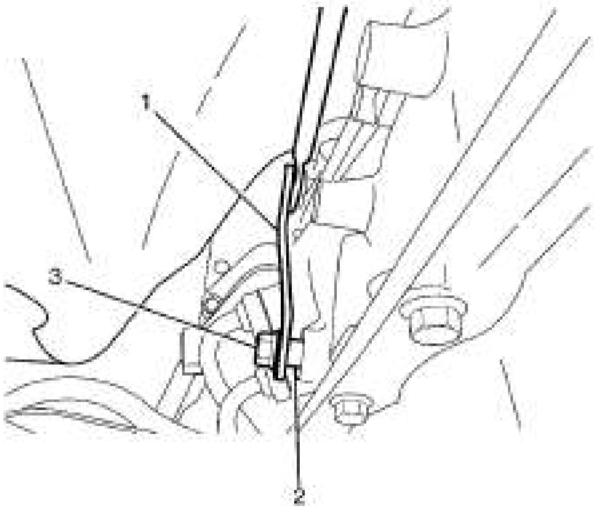


3. Remove the shift control linkage rod retaining bolt.
4. Disconnect the shift control linkage rod from the shift control assembly (1).



5. Remove the manual shift shaft retaining nut (3).
6. Remove the shift control linkage (1) from the transmission selector shaft (2).

Installation Procedure

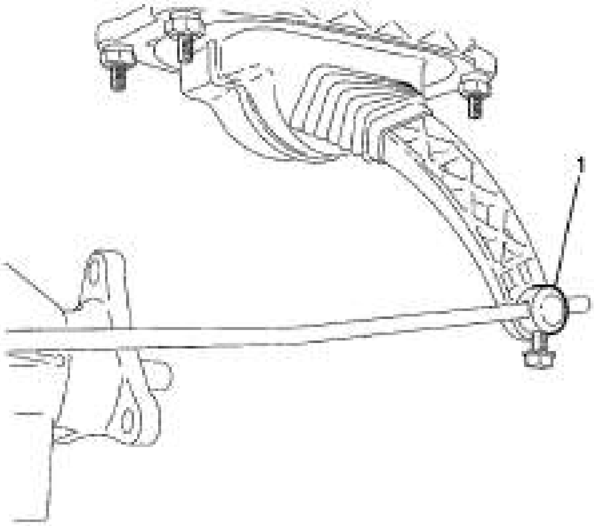


1. Install the shift control linkage (1) to the transmission selector shaft (2).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the manual shift shaft retaining nut (3).

   Tighten
   Tighten the manual shift shaft retaining nut to 9 N·m (80 lb. in).



3. Connect the shift control linkage rod to the shift control assembly (1).
4. Install the shift control linkage rod retaining bolt.
5. Adjust the shift control linkage. Refer to Shift Control Linkage Adjustment .
6. Lower the vehicle.

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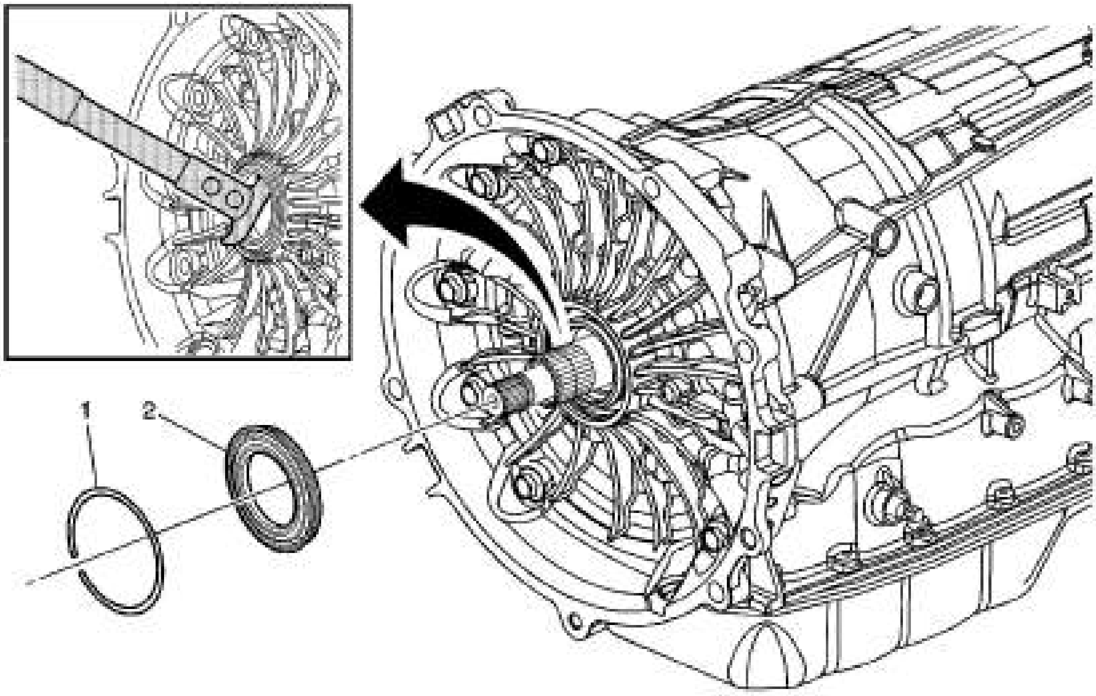
Torque Converter Fluid Seal Replacement



Callout	Component Name
Fastener Tightening Specifications: Refer to Fastener Tightening Specifications . **Preliminary Procedures** Remove the torque converter. Refer to Torque Converter Replacement .	
1	Torque Converter Fluid Seal Retaining Ring
2	Torque Converter Fluid Seal **Tip** Remove seal using J 45000

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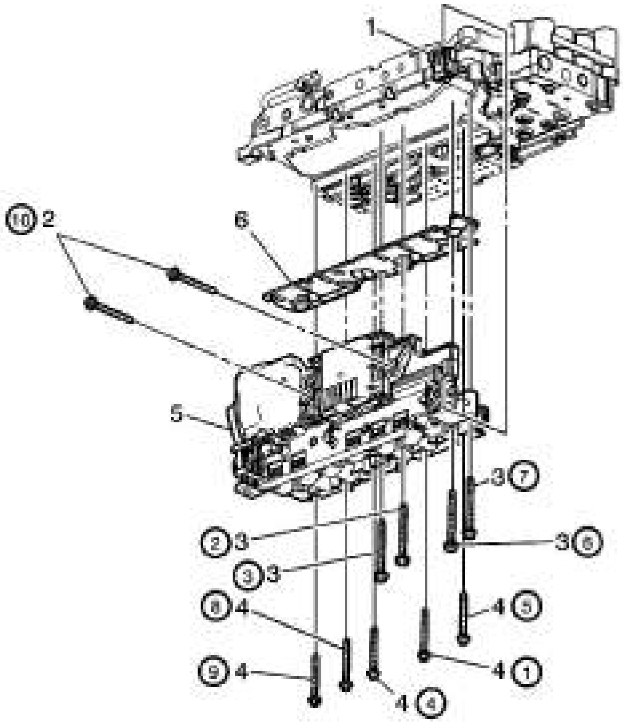
Torque Converter Replacement



Callout	Component Name
Notice: Refer to Fastener Notice in the Preface section. *Fastener Tightening Specifications:* Refer to Fastener Tightening Specifications . **Preliminary Procedures** 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle . 2. Remove the transmission fluid pan and filter. Refer to Automatic Transmission Fluid, Fluid Pan and/or Filter Replacement.	
1	Manual Shift Shaft Position Switch Assembly Electrical Connector **Tip** Release the connector lock before disconnecting. Engage the connector lock after connecting.
2	Control Module Assembly Heat Sink Bolt (Qty: 2) **Tighten** 8 N·m (71 lb. in)

	Tip Tighten in specified sequence.
3	Control Solenoid Valve Assembly Bolt (Qty: 4) **Tighten** 8 N·m (71 lb. in) **Tip** Tighten in specified sequence.
4	Control Solenoid Valve Assembly Bolt (Qty: 5) **Tighten** 8 N·m (71 lb. in) **Tip** Tighten in specified sequence.
5	Control Solenoid Valve and Module Assembly Refer to Control Module References. **Tip** • Inspect the 4 filter plate retaining tabs. A broken tab may not adequately secure the filter plate to the control solenoid valve assembly. • Align the control solenoid valve assembly with the lower valve body locator pin when assembling.
6	Filter Plate **Tip** Discard filter plate and replace with new.

Following the replacement of the TCM, a harsh upshift may occur between 4th and 5th gear.

If this occurs the following procedure should be followed.

- Make sure both the Scan Tool and TCM calibrations are the latest versions availble for reprogramming.
- Check and clear all DTCs that may have set as a result of the programming process.
- Drive maneuvers should be performed at transmission oil temperatures of at least 40°C (104°F).
- Transmission oil levels should be set correctly prior to the starting drive cycles.
- Initial upshifts may have an erratic feel for the first several cycles. They should improve significantly with repeated maneuvers.
- At the start of the drive cycles, no ECM or TCM DTCs should be set. The MIL should not be illuminated.

A drive cycle requires five light throttle accelerations to 40 km/h (25 mph) and five light throttle accelerations to 64 km/h (40 mph).

1. From a complete stop, lightly accelerate at a relatively constant throttle pedal position up to

40 km/h (25 mph) or 64 km/h (40 mph).
2. Brake the vehicle to a complete stop.
3. Repeat five times to 40 km/h (25 mph) and five times to 64 km/h (40 mph). Maneuvers can be performed in any combination.

If the garage shifts (Park to Reverse, Park to Drive, Reverse to Drive, Drive to Reverse) feel like they are delayed, garage shifts adapts can also be performed. All garage shifts should be performed with the vehicle stopped, foot on the brake and engine at idle.

1. Shift the transmission from Reverse to Drive leaving the shift lever in Drive for three seconds. After three seconds, shift back to Reverse, leaving the shift lever in Reverse for three seconds. Perform the procedure 10 times (R-D-R-D-R-D...). The transitions need to be directly to Drive and Reverse, without stopping in Neutral.
2. Shift the transmission from Neutral to Drive leaving the shift lever in Drive for three seconds. After three seconds, shift back to Neutral, leaving the shift lever in Neutral for three seconds. Perform the procedure 10 times (N-D-N-D-N-D...).
3. Shift the transmission from Neutral to Reverse leaving the shift lever in Reverse for three seconds. After three seconds, shift back to Neutral, leaving the shift lever in Neutral for three seconds. Perform the procedure 10 times (R-N-R-N-R-N..).

At the end of these maneuvers, the vehicle may still experience some minor driveability issues, but should learn improved shifting performance over the next several key cycles and driving time. Coach the customer about the transmission's ability to self-correct shifting issues or concerns. The transmission adapts are always functional and operate at transmission oil temperatures above 40° C (104°F).

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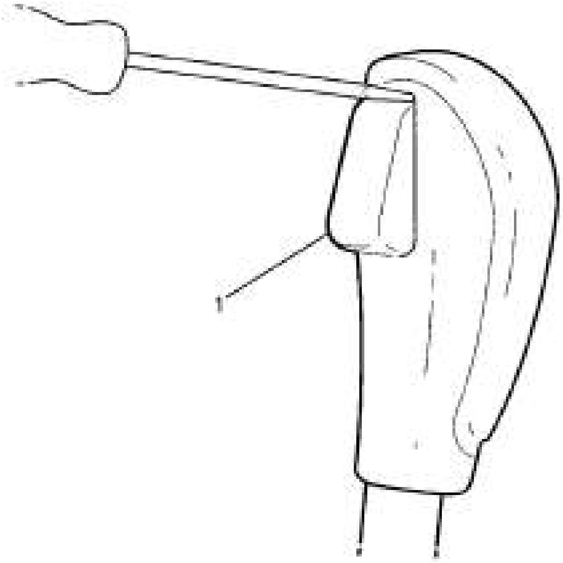
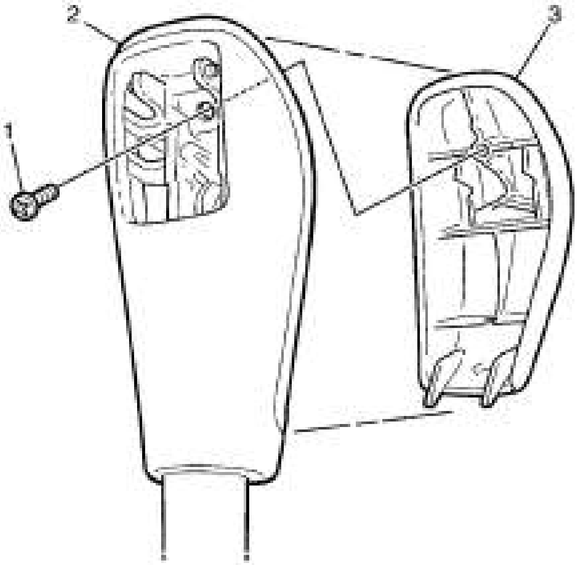
Transmission Control Lever Knob Replacement

Removal Procedure

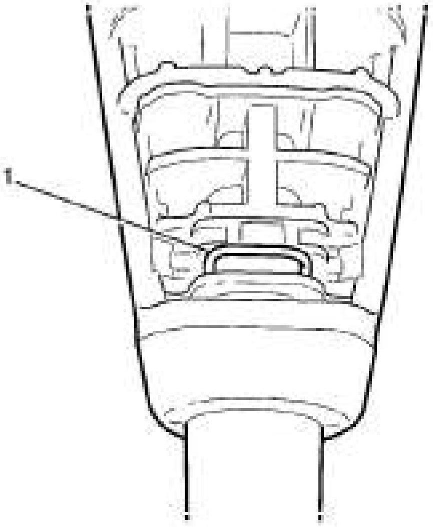
1. Remove transmission control lever assembly. Refer to Transmission Control Replacement.



2. Using a suitable tool release the selector lever knob (1) from the control lever assembly.

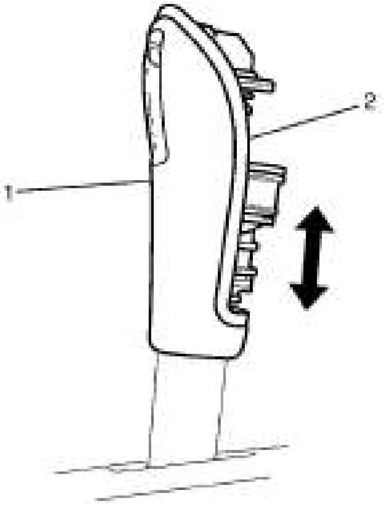


3. Remove the selector lever retaining screw (1) and lever backing (3).

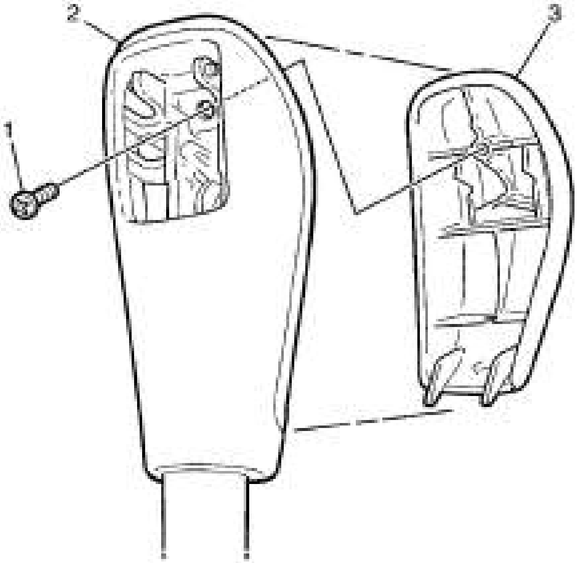


4. Remove the selector lever metal retaining clip (1).
5. Remove the selector lever spacer
6. Remove the selector lever by sliding upwards off assembly

Installation Procedure



1. Install the selector lever (1) by sliding down on the assembly.
2. Install the selector lever spacer (2).
3. Install the selector lever metal retainer clip.

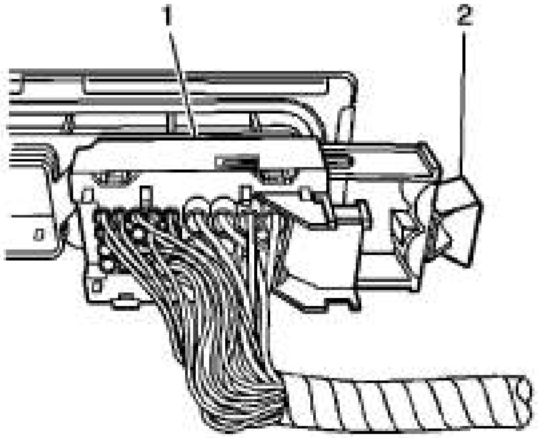


4. Install the selector lever backing (3) and retaining screw (1).
5. Install the selector lever release knob into selector lever.
6. Install the transmission control lever assembly. Refer to Transmission Control Replacement.

Transmission Control Module Replacement

Removal Procedure

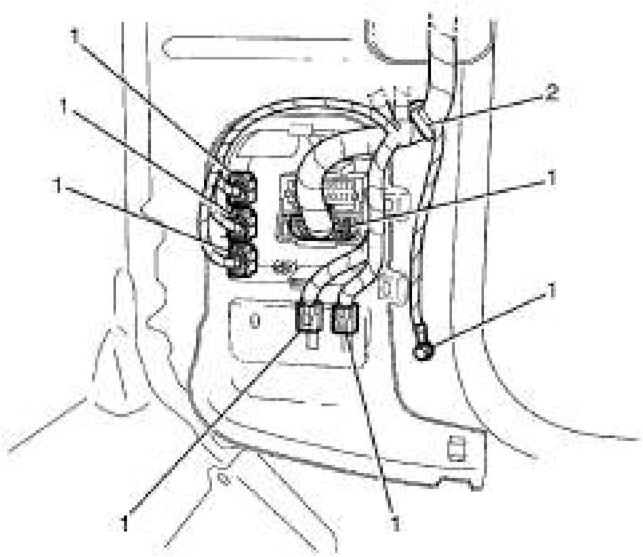
1. Remove the hinge pillar trim from the vehicle. Refer to Body Hinge Pillar Trim Panel Replacement .
2. Remove the knee bolster assembly. Refer to Knee Bolster Replacement .



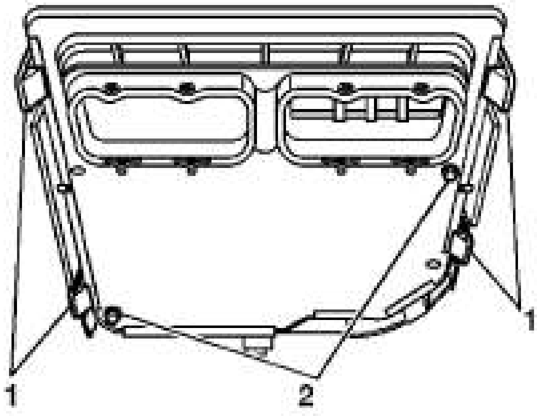
3. Unlock the transmission control module electrical connector by pulling the retainer (2) away from the electrical connector (1).

   Important: Twisting or tilting of the transmission control module electrical connector while disconnecting may result in bent or misaligned electrical terminal pins.

4. Carefully disconnect the electrical connector (1) from the transmission control module.

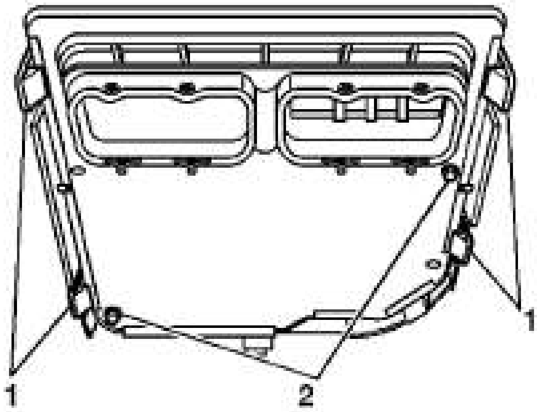


5. Disconnect the electrical connectors (1) from right hand side junction box and position loom toward cowl

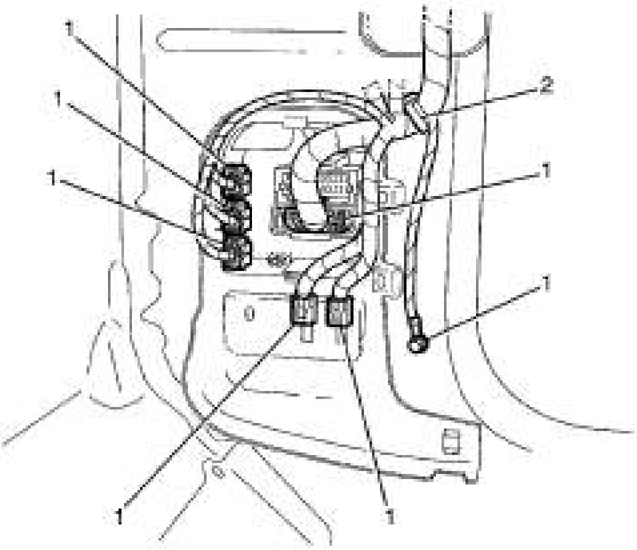


6. Remove the transmission control module from the mounting bracket by pulling back on the retaining tabs (1) to release the control module .

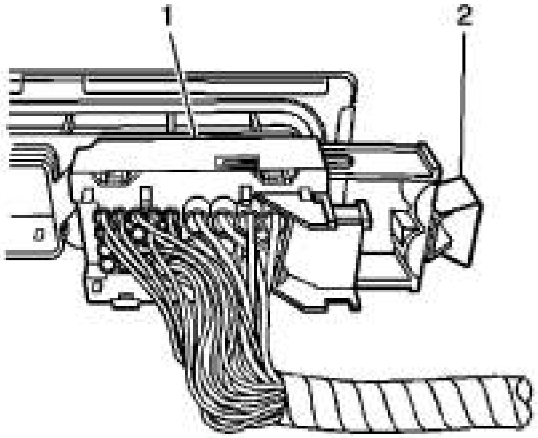
Installation Procedure



1. Align the transmission control module with the locating pins (2) on the module mounting bracket.
2. Install the transmission control module by seating it fully into the bracket until all of the retaining tabs (1) have engaged the edge of the module edge.



3. Install connectors into the right hand side junction box



Important: Twisting or tilting of the transmission control module electrical connector while connecting may result in bent or misaligned electrical terminal pins.

4. Carefully connect the transmission control module electrical connector (1) to the transmission control module.
5. Lock the transmission control module electrical connector securely to the transmission control module by pushing the retainer (2) toward the electrical connector (1) until fully seated.
6. Install the hinge pillar trim on the vehicle. Refer to Body Hinge Pillar Trim Panel Replacement .
7. Install the knee bolster assembly. Refer to Knee Bolster Replacement .
8. The transmission control module must be programmed with the proper software/calibrations. Refer to Service Programming System (SPS) .

Important: It is recommended that transmission adaptive pressure (TAP) information be reset.

Resetting the TAP values using a scan tool will erase all learned values in all cells. As a result, The ECM or TCM will need to relearn TAP values. Transmission performance may be affected as new TAP values are learned.

9. Reset the TAP values. Refer to Transmission Adaptive Functions .

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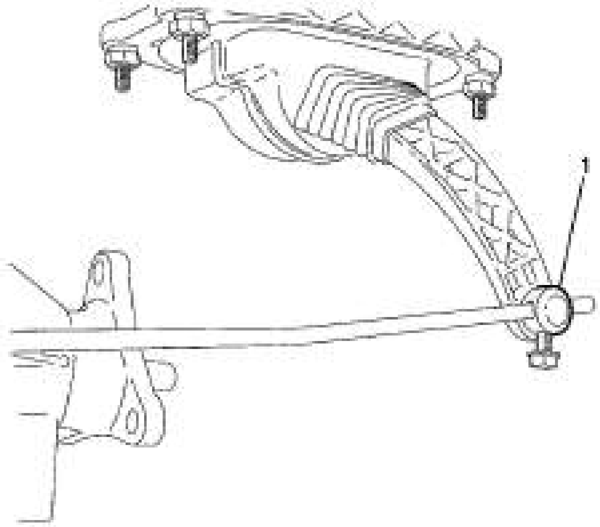
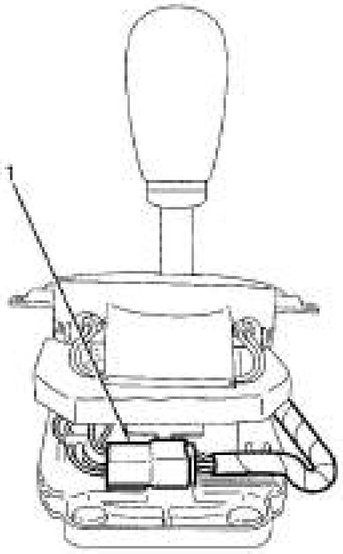
Transmission Control Replacement

Removal Procedure

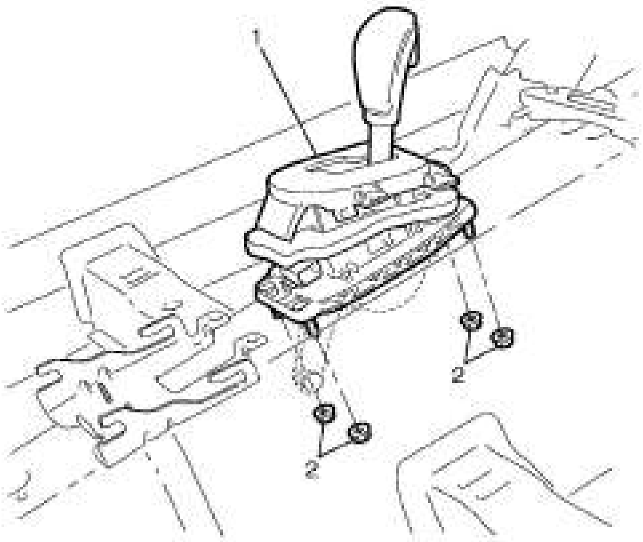
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



2. Remove the shift control linkage adjustment nut.
3. Disconnect the shift control linkage rod from the shift control assembly (1).
4. Lower the vehicle.
5. Remove the center console assembly. Refer to Front Floor Console Replacement.

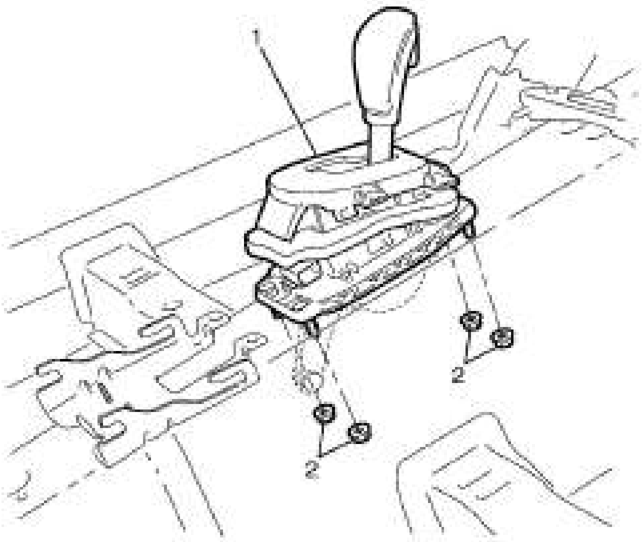


6. Remove the electrical connector (1) from the shift control assembly.



7. Remove the shift control assembly to tunnel reinforcement retaining nuts (2).
8. Remove the shift control assembly (1) from the tunnel reinforcement.

Installation Procedure

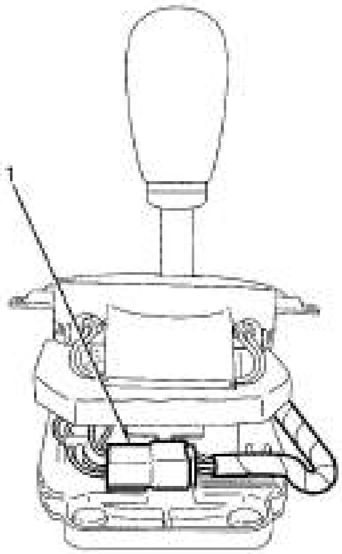


1. Install the shift control assembly (1) to the tunnel reinforcement.

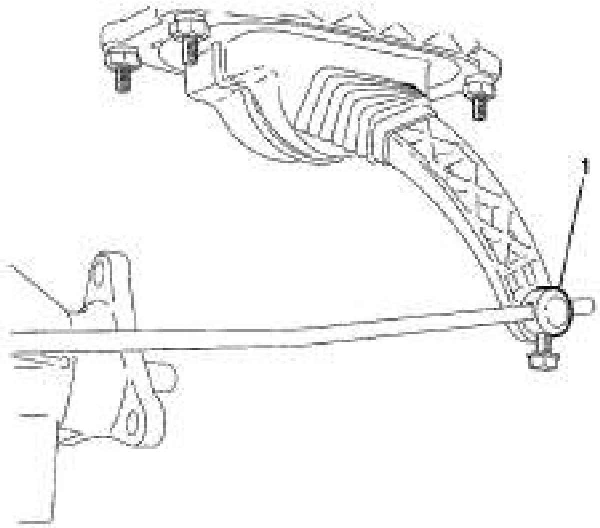
   Notice: Refer to Fastener Notice in the Preface section.

2. Install the shift control assembly to tunnel reinforcement retaining nuts (2).

Tighten
Tighten the nuts to 12 N·m (106 lb. in).



3. Install the electrical connector (1) to the shift control assembly.
4. Install the centre console assembly. Refer to Front Floor Console Replacement.
5. Install the shift control trim plate by inserting the front retaining tabs to the console. Press down on the rear of the trim plate to engage the rear retaining tabs.
6. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



7. Connect the shift control linkage rod to the shift control assembly (1).
8. Install the shift control linkage adjustment nut finger tight.
9. Adjust the shift control linkage. Refer to Shift Control Linkage Adjustment.
10. Lower the vehicle.

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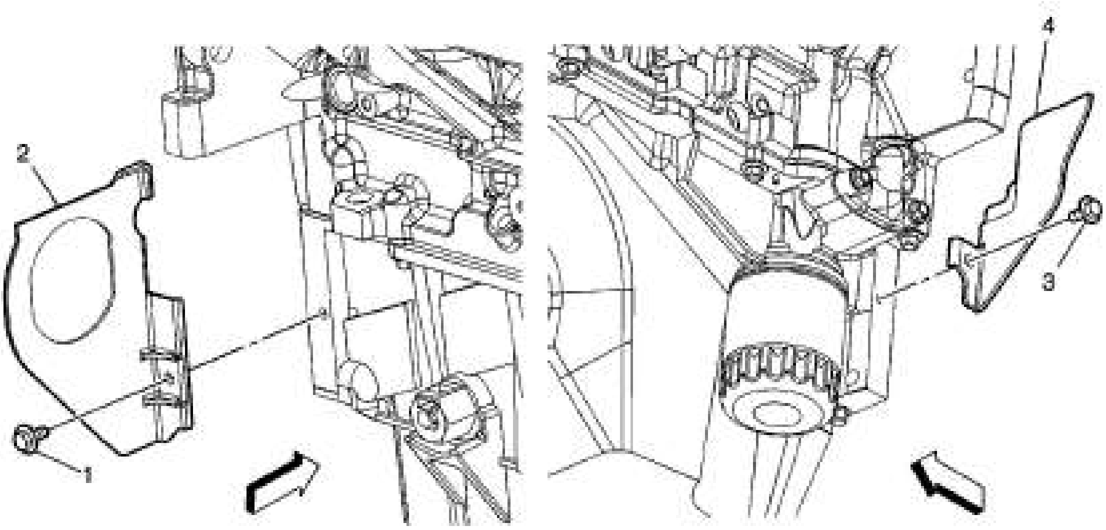
Transmission Converter Cover Replacement

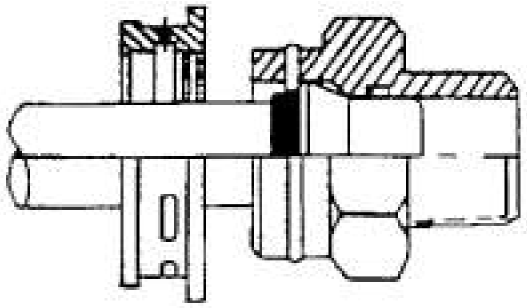


Callout	Component Name
Notice: Refer to Fastener Notice in the Preface section. *Fastener Tightening Specifications:* Refer to Fastener Tightening Specifications . **Preliminary Procedures** Raise the vehicle. Refer to Lifting and Jacking the Vehicle .	
1	Torque Converter Cover Bolt **Tighten** 10 N·m (89 lb. in).
2	Torque Converter Cover **Tip** Remove the starter. Refer to Starter Motor Replacement.
3	Torque Converter Cover Bolt **Tighten** 10 N·m (89 lb. in).

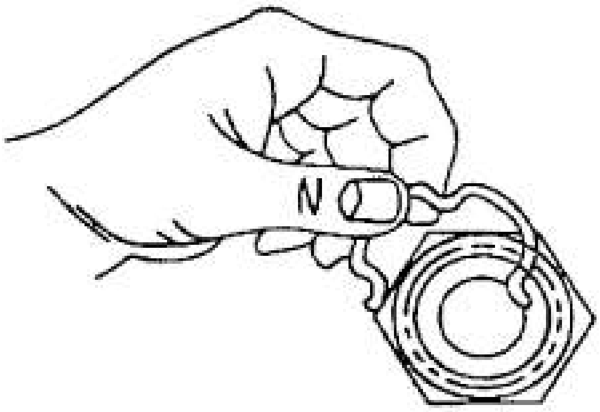
4	Torque Converter Cover

Transmission Fluid Cooler Hose / Pipe Quick-Connect Fitting Disconnection and Connection (SWB LWB RHD)

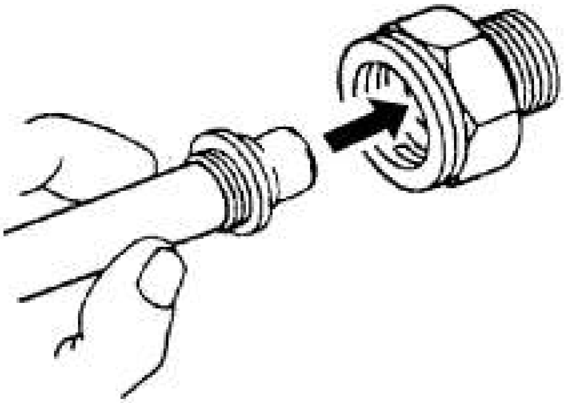
Removal Procedure



1. Remove the plastic cap from the quick connect fitting.



2. Remove the retaining ring from the quick connect fitting.



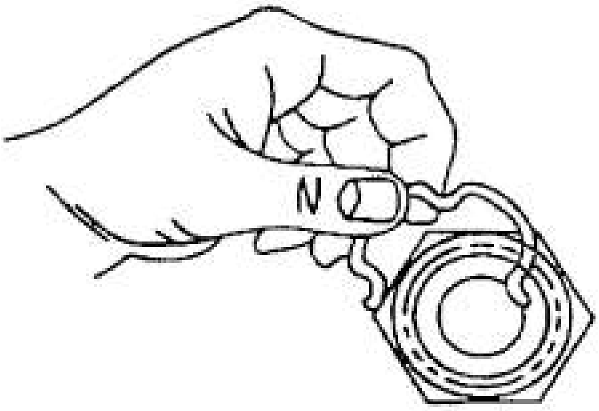
3. Remove the cooler line from the quick connect fitting.

Installation Procedure

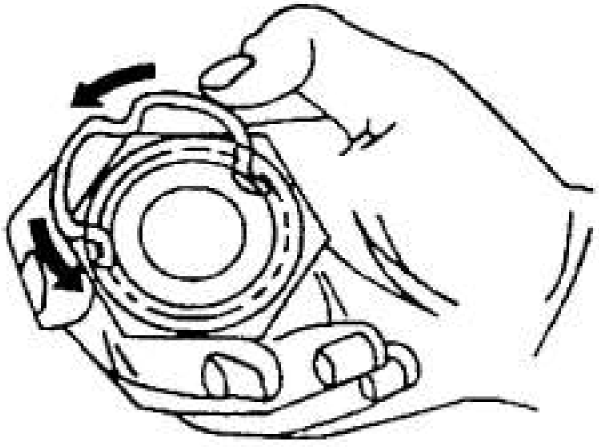
Important:

- Do not reuse any of the existing oil lines or oil line fittings if there is excessive corrosion.
- Do not reuse any of the existing retaining rings that were removed from the existing quick connect fittings. Install new retaining rings.
- Ensure the following procedures are performed when installing the new retaining rings onto the fittings.

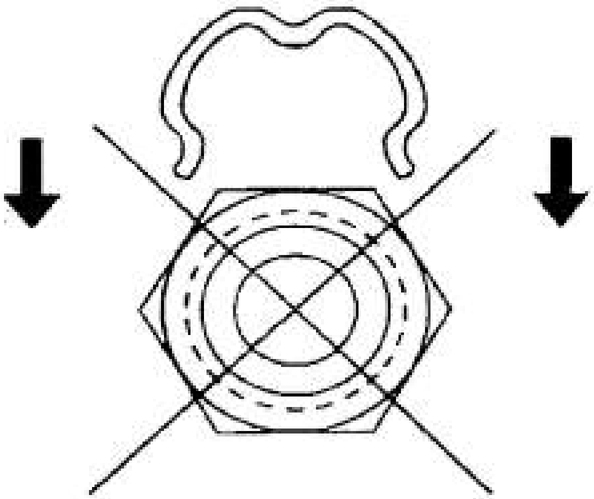
1. Install a new retaining ring into the quick connect fitting using the following procedure:



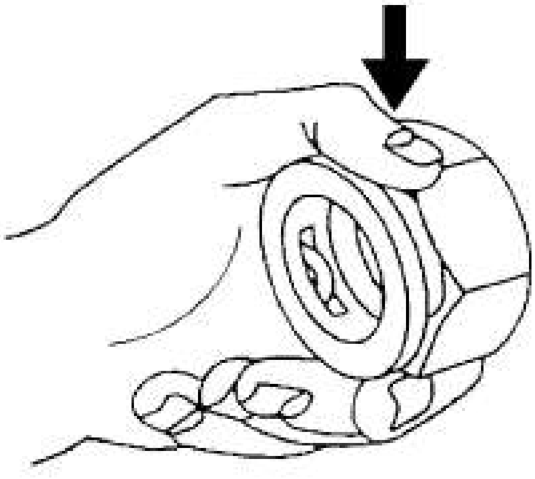
2. Hook one of the open ends of the retaining ring in one of the slots on the quick connect fitting.



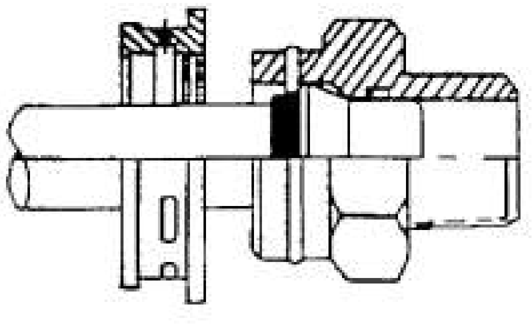
3. Rotate the retaining ring around the fitting until the retaining ring is positioned with all three ears through the three slots on the fitting.



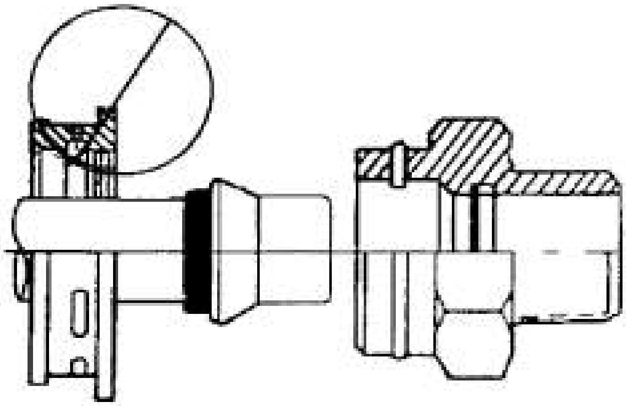
4. Do not install the new retaining ring onto the fitting by pushing the retaining ring.



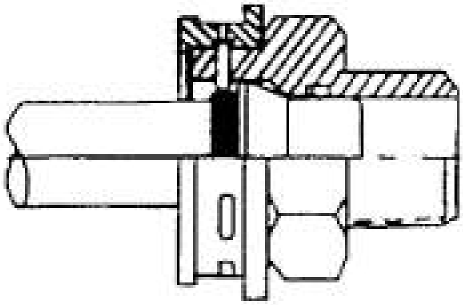
5. Ensure that the three retaining ring ears are seen from inside the fitting and that the retaining ring moves freely in the fitting slots.



6. Install the cooler line into the quick connect fitting.
7. Insert the cooler line end into the quick connect fitting until a click is either heard or felt.

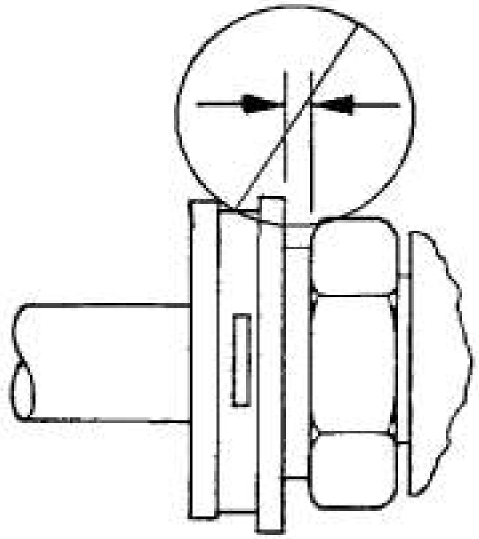


8. Do not use the plastic cap on the cooler line in order to install the cooler line into the fitting.
9. Pull back sharply on the cooler line in order to make sure that the cooler line is fastened into the quick connect fitting.

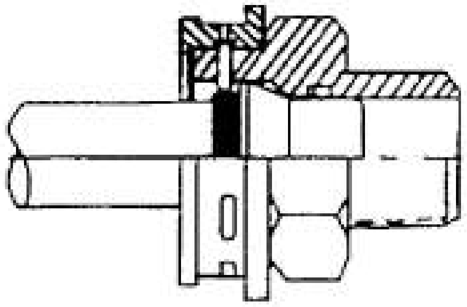


Important: Do not manually depress the retaining clip when installing the plastic cap.

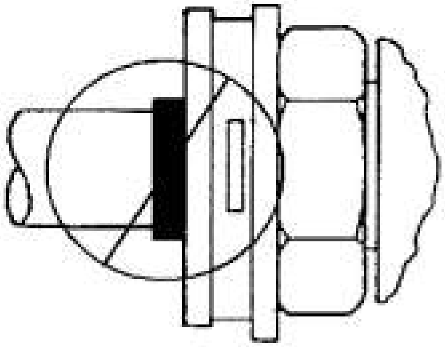
10. Position (snap) the plastic cap onto the fitting. Do not manually depress the retaining ring when installing the plastic cap onto the quick connect fitting.
11. Ensure that the plastic cap is fully seated against the fitting.



12. Ensure that no gap is present between the cap and the fitting.



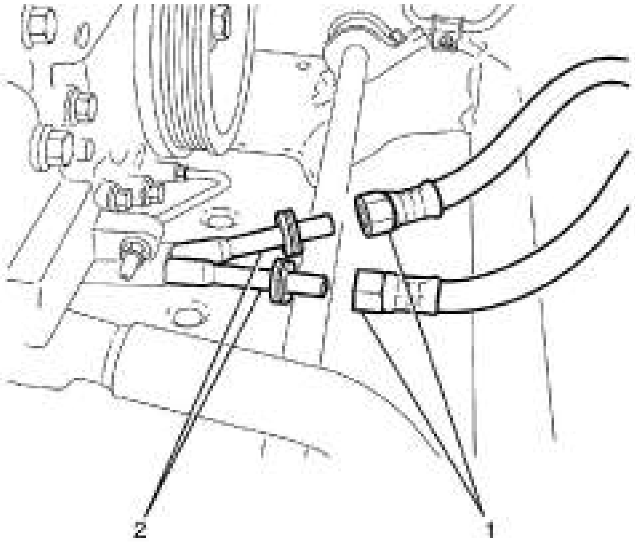
13. Ensure that the yellow identification band on the tube is hidden within the quick connect fitting.



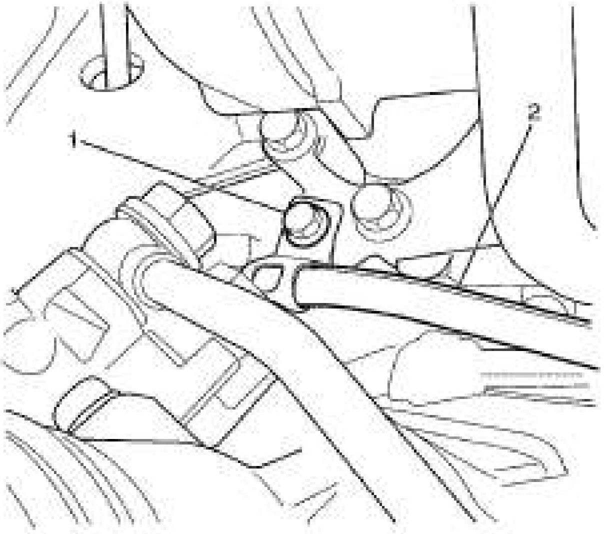
14. A hidden yellow identification band indicates proper joint seating.
15. Fill the transmission to the proper level with DEXRON® VI transmission fluid. Refer to Transmission Fluid Check.

Transmission Fluid Cooler Hose/Pipe Replacement

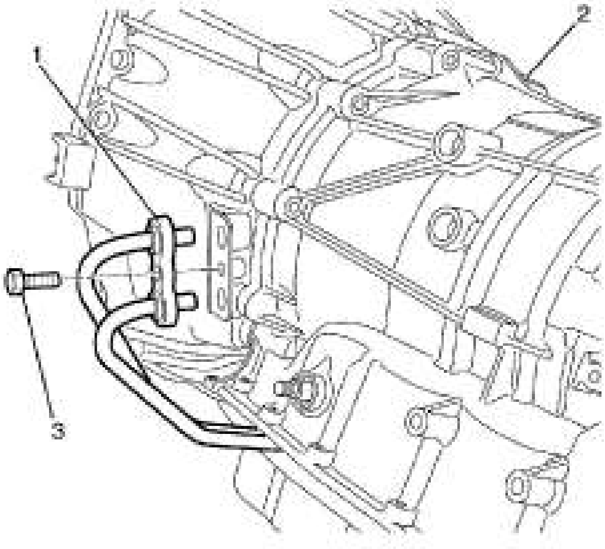
Removal Procedure



1. Disconnect the automatic transmission cooler pipe (2) from the flexible hose (1) at the quick connect fitting using tool AU525.
   - Open release tool AU525 then close and clip around the hose to be disconnected.
   - While holding the flexible hose (1) push the hose inwards with one hand, then pull back to separate from the steel hose piping (2).
   - Repeat for the second fitting.
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



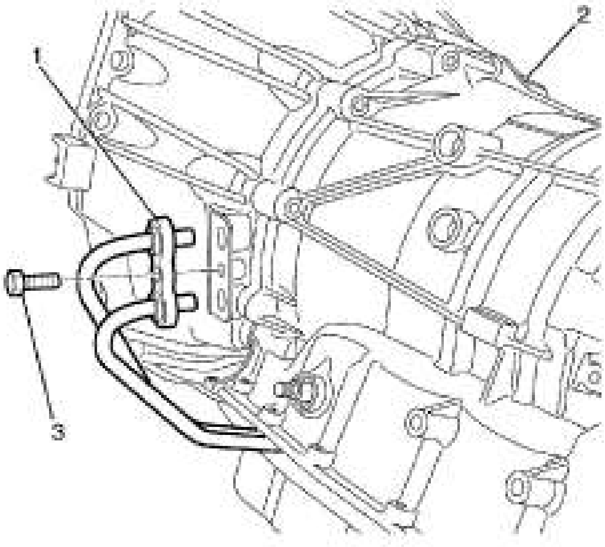
3. Remove the automatic transmission cooler pipe clamp to A/C bracket retaining bolt (1).
4. Position the automatic transmission cooler pipes (2) aside.



5. Remove the automatic transmission cooler pipe retaining bolt (3).
6. Remove the automatic transmission cooler pipes (1) from the transmission (2).
7. Remove the automatic transmission cooler pipes from the vehicle.

Installation Procedure

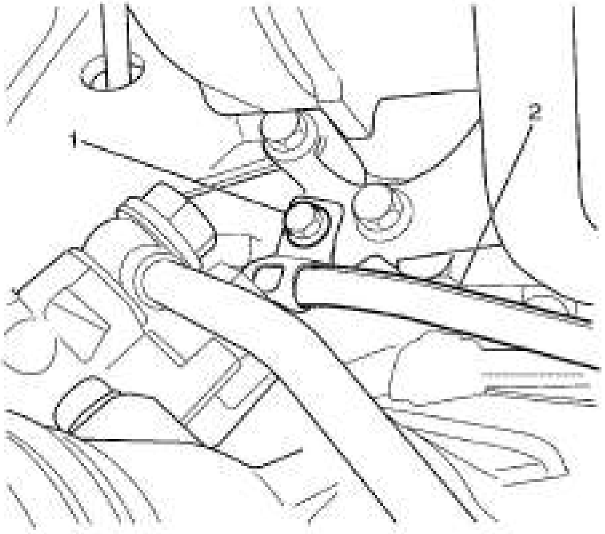
1. Install the automatic transmission cooler pipes to the vehicle.



2. Install the automatic transmission cooler pipes (1) to the transmission (2).

3. Install the automatic transmission cooler pipe retaining bolt (3).

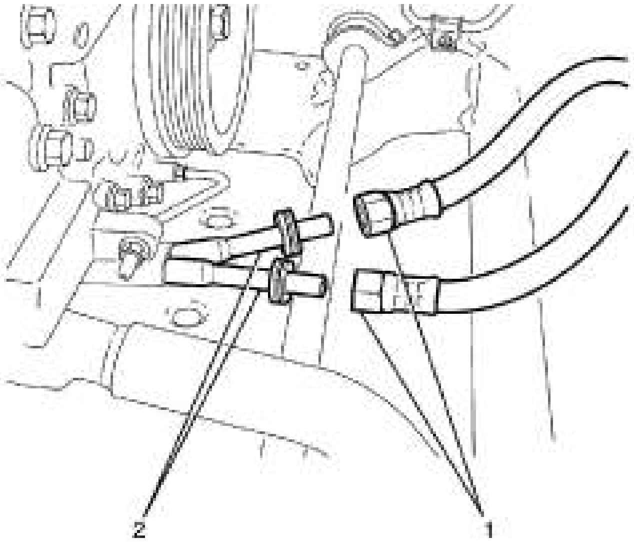
   Tighten
   Tighten the bolt to 20 N·m (15 lb ft).



4. Position the automatic transmission cooler pipes (2) to the engine.
5. Install the automatic transmission cooler pipe clamp to A/C bracket retaining bolt (1).

   Tighten
   Tighten the bolt to 22 N·m (16 lb ft).

6. Lower the vehicle



Important: The flexible hoses are not serviced separately. Therefore if the hose's require replacement, then the hose and radiator to hose cooler hose assembly must be fitted.

7. Align both flexible hose's (1) with both steel cooler lines (2).

   Important: Listen for an audible click to confirm fitting.

8. Hold the cooler line (2) and connect the flexible hose (1) by pushing together. Repeat procedure for other hose.

   Important: When adding or changing transmission fluid only use recommended automatic transmission fluid.

9. Check automatic transmission fluid level. Refer to Transmission Fluid Check.

Transmission Mount Inspection

Notice: Refer to General Repair Instructions in the Preface section.

1. Raise the transmission in order to remove the weight from the transmission mount and create slight tension in the rubber.
2. Observe the transmission mount while raising the transmission. Replace the transmission mount if the transmission mount exhibits any of the following conditions:

   Important: Black paint on the rubber will crack with time, this does no constitute a failure.

   - The hard rubber surface is covered with heat check cracks.
   - The rubber is separated from the metal plate of the transmission mount.
   - The rubber is split through the centre of the transmission mount.
3. If there is movement between the metal plate of the transmission mount and its attaching points, lower the transmission on to the transmission mount. Tighten the bolts or nuts attaching the transmission mount to the frame or transmission mount bracket.

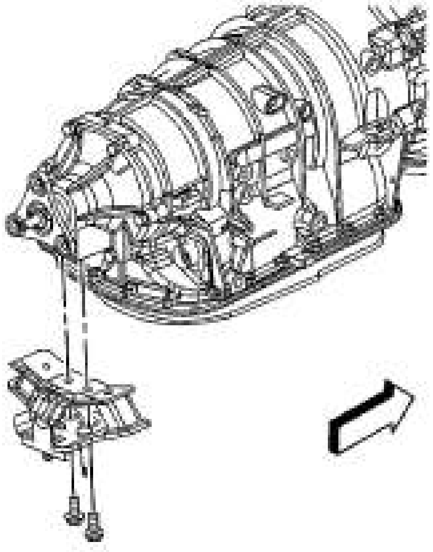
Transmission Mount Replacement (SWB LWB RHD)

Removal Procedure

1. Remove the exhaust system. Refer to Exhaust System Replacement.

   Important: The engine mounts must NOT bend or deflect from the vertical position, damage to the mount will occur.

2. Support the transmission with a suitable jack and a block of wood.
3. Remove the transmission support. Refer to Transmission Support Replacement.



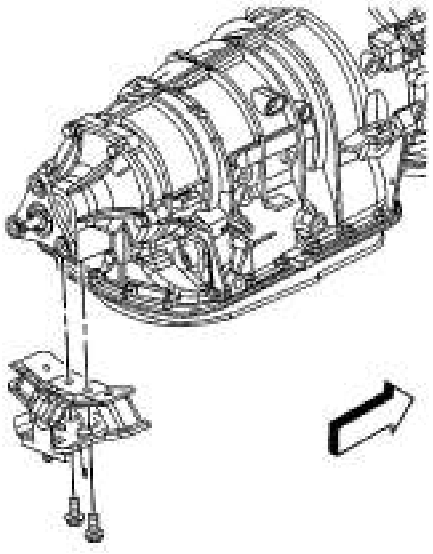
4. Remove the transmission mount bolts.
5. Remove the transmission mount from the vehicle.

Installation Procedure

Important: The engine mounts must NOT bend or deflect from the vertical position, damage to the mount will occur.

1. Install the transmission mount to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the transmission mount bolts.

   Tighten
   Tighten the bolts to 60 N·m (44 lb. ft).

3. Install the transmission support. Refer to Transmission Support Replacement.
4. Remove the support from under the transmission.
5. Install the exhaust system.
6. Lower the vehicle.

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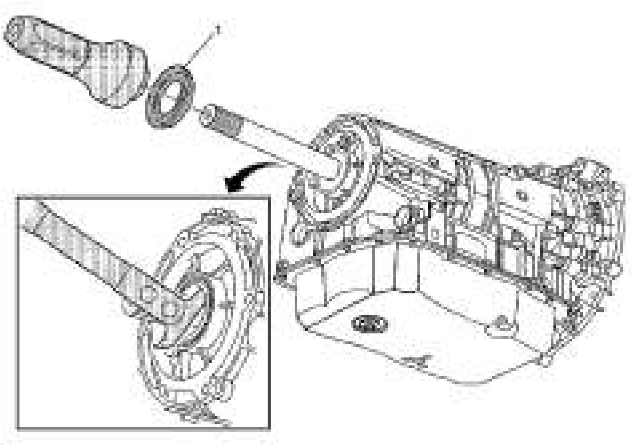
Transmission Output Shaft Seal Replacement



Callout	Component Name
	Notice: Refer to Fastener Notice in the Preface section. *Fastener Tightening Specifications:* Refer to Fastener Tightening Specifications . **Preliminary Procedures** 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle . 2. Remove the propeller shaft. Refer to Propeller Shaft Replacement . 3. Support the transmission with a suitable jack. 4. Remove the transmission mount assembly. Refer to Transmission Mount Replacement . 5. Remove the transmission extension housing assembly. Refer to Output Shaft Seal Replacement .
1	Output Shaft Seal - Use the J 45000 to remove the seal. Use care in order to avoid damaging the output shaft bushing. - Lubricate the seal with clean transmission fluid. - Use the J 38693 to install the seal.

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Transmission Replacement

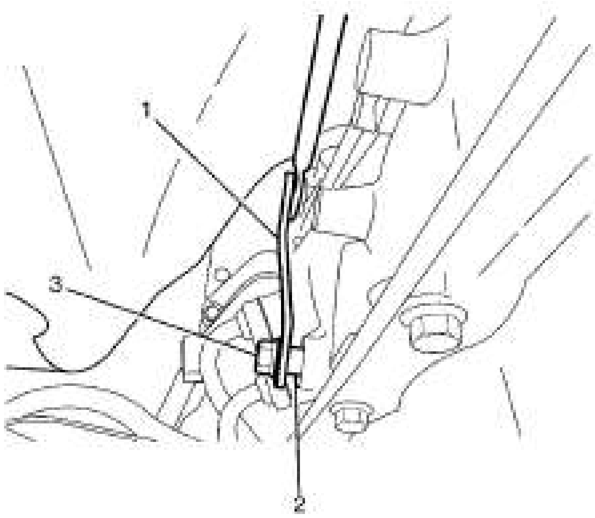
Tools Required

- J 42386-A Flywheel Holding Tool
- EN-48536 Frame Support Tool (Engine Lower 65mm Kit)

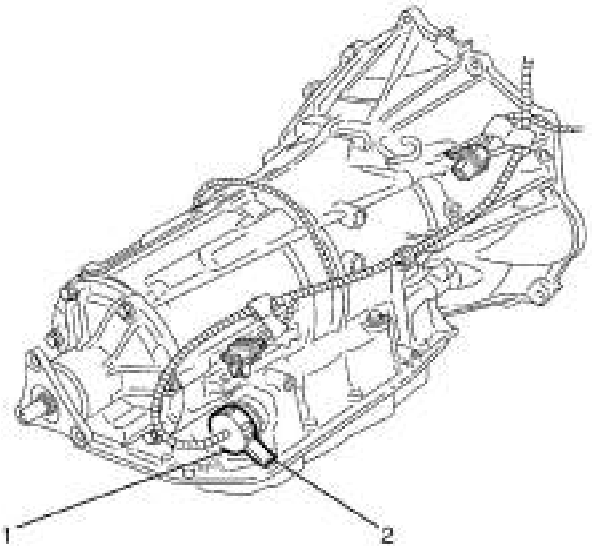
Removal Procedure

Important: NEW torque converter bolts will be required each time the torque converter bolts are removed.

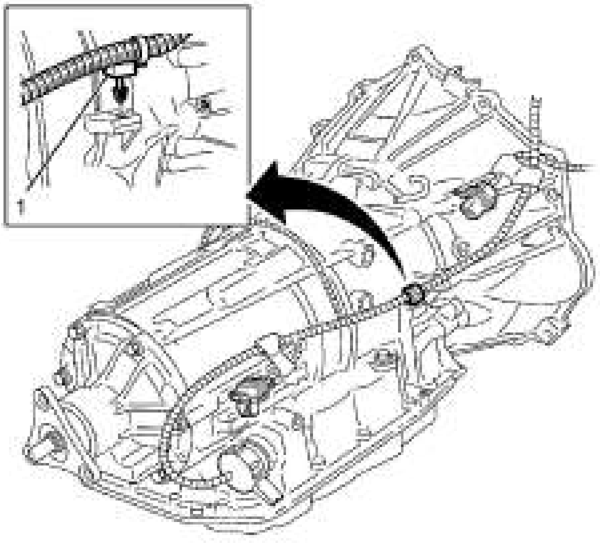
1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
2. Remove air intake ducting from engine.
3. Remove radiator retaining clips.
4. Disconnect the EVAP purge pipe.
5. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
6. Remove the propeller shaft. Refer to Propeller Shaft Replacement .
7. Remove the air deflector front (1). Refer to Front Air Deflector Replacement .
8. Remove the splash shield.



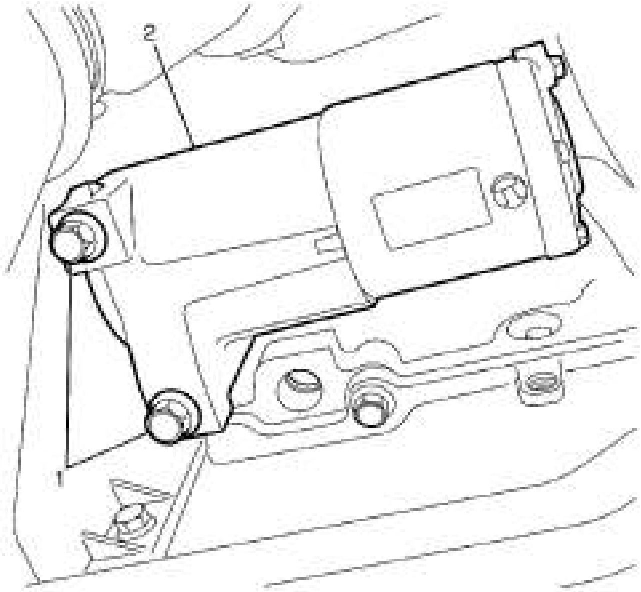
9. Remove the transmission manual shift shaft nut (3).
10. Disconnect the shift linkage (1) from the transmission shift shaft (2).



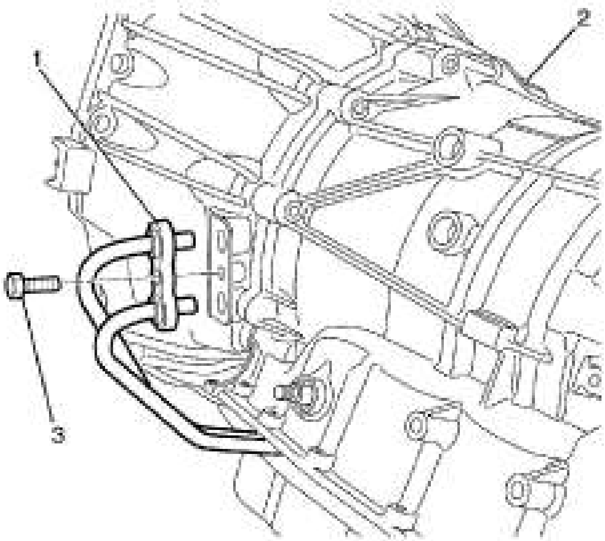
11. Disconnect the transmission wiring harness connector (1) from the transmission by rotating the locking latch (2) counter-clockwise.



12. Disconnect the wiring harness clips from the transmission, and position the wiring harness aside.

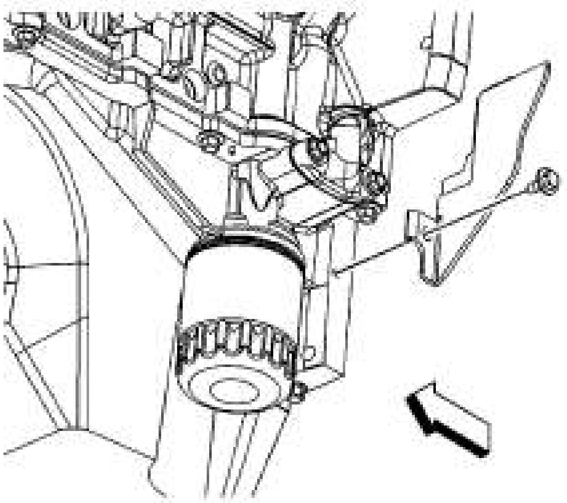


13. Remove the starter motor (2) to gain access to the torque converter bolts. Refer to Starter Motor Replacement .
14. Mark the torque converter to flexplate/flywheel orientation to make sure proper realignment.
15. Repeat the following steps for all 3 torque converter bolts:
    - 15.1. Rotate the harmonic balancer centre bolt clockwise ONLY, in order to align the torque converter bolt with the starter motor opening in the engine block.
    - 15.2. Remove and discard the torque converter bolt. The bolt is self locking and is NOT reusable.
16. Using inspection hole push torque converter back towards transmission pump
17. Place an oil drain pan under the transmission fluid cooler pipes.
18. Remove the bolt securing the transmission fluid cooler pipes brace to the engine.



19. Disconnect the fluid cooler pipes from the transmission.
20. Plug the open outlet ports to prevent fluid loss and contamination.

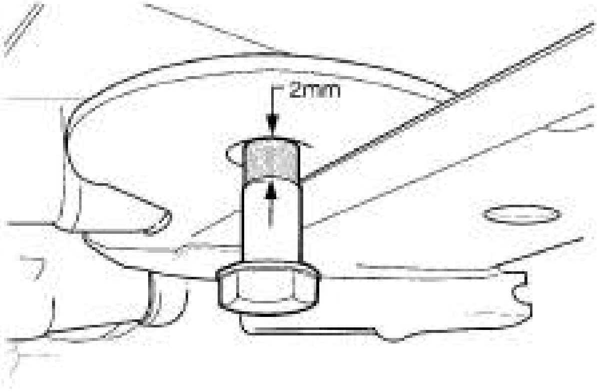
21. Disconnect the steering shaft from the steering rack



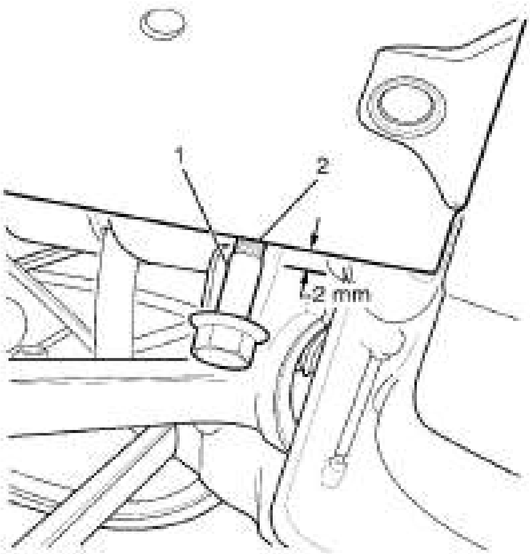
22. Remove the engine close out cover studs and cover.

Important: The engine mounts must NOT bend or deflect from the vertical position, damage to the mount will occur.

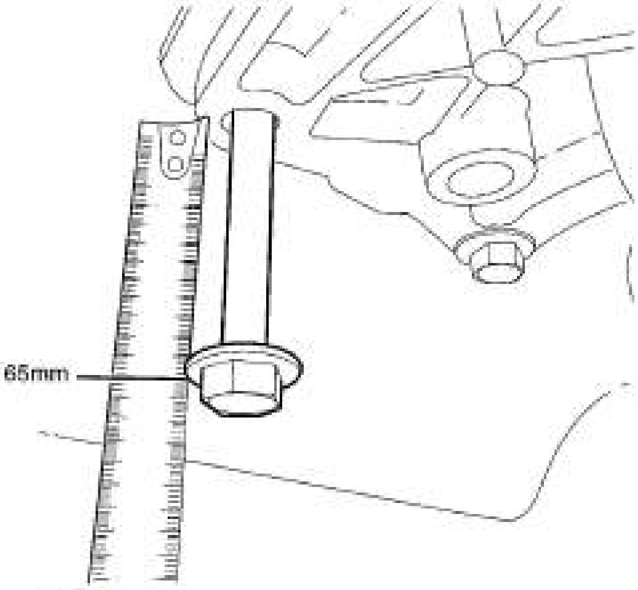
23. Support the power train with a suitable jack or table.
24. Using special tool XX lower engine and transmission assembly 65mm.
25. Support the transmission with a suitable jack.



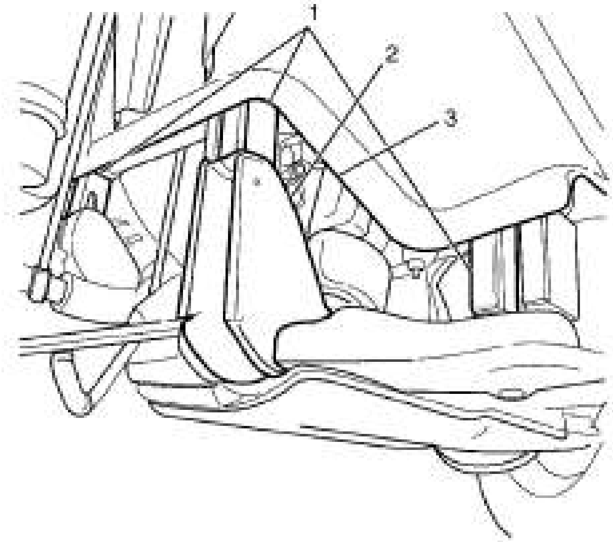
26. Replace the front sub frame rear bolts and fit bolts from special tool kit EN-48536
27. Install bolt till stepped shank (1) is 2mm below sub frame (2).



28. Replace the front sub frame front bolts and fit bolts from special tool kit EN-48536
29. Install bolt till stepped shank (1) is 2mm below chassis rail flange (2).



30. Remove all four transmission mount to body bolt and install two bolts from special tool kit in diagonal holes e.g Left hand front and Right hand rear.
31. Install in till 65mm is measured between bolt heads (1) and transmission mount (2).
32. Remove front sub frame middle bolts.
33. Lower power train slowly until the subframe and transmission mount are resting on bolts.



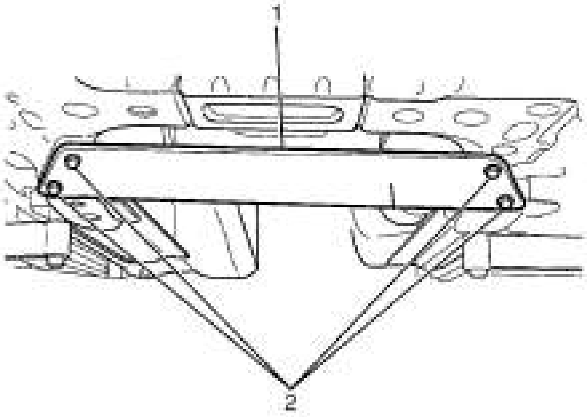
34. Insert 65mm spacer blocks (1) between subframe (2) and chassis rails (3).
35. Tension front sub frame front and rear bolts.

    Tighten
    Tighten the bolts to 95 N·m (70 lb. ft).

36. Install and tension middle sub frame bolts.

    Tighten
    Tighten the bolts to 95 N·m (70 lb. ft).

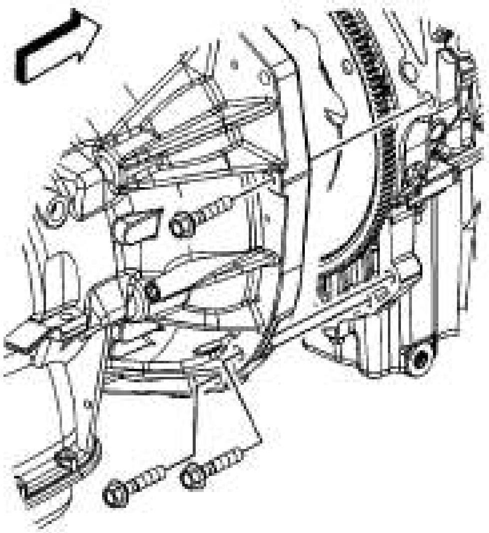
37. Remove supporting jack or table



38. Install engine support plate (1) to front sub frame (2).

39. Tension plate securing bolts (3).

    Tighten
    Tighten the bolts to 10 N·m (89 lb. in).



40. Remove the transmission bolts.
41. Pull the transmission free from the engine dowels.

    Important: Ensure clearance is maintained between the transmission and the following:
    - The catalytic converters
    - The wiring harnesses
    - The cooler pipes
    - The propeller shaft

42. Carefully lower the transmission from the vehicle.
43. Flush the transmission oil cooler. Refer to Transmission Fluid Cooler Flushing and Flow Test

Installation Procedure

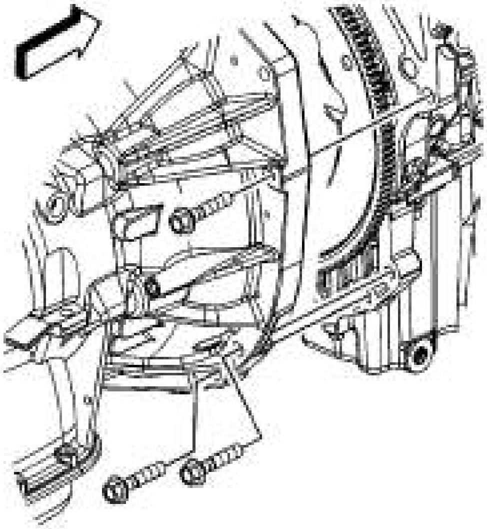
Important: The engine mounts must NOT bend or deflect from the vertical position, damage to the mount will occur.

Important: Ensure clearance is maintained between the transmission and the following:
- The catalytic converters
- The wiring harnesses
- The cooler pipes
- The propeller shaft

1. Using the transmission jack, carefully raise the transmission to the vehicle.

2. Align the transmission with the engine dowels.

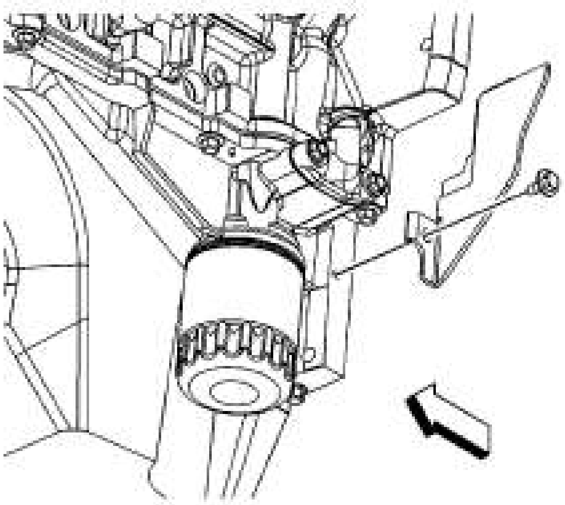
   Notice: Refer to Fastener Notice in the Preface section.



3. Install the side transmission bolts.

   Tighten
   Tighten the bolts to 50 N·m (37 lb. ft).

4. Install transmission bolts.



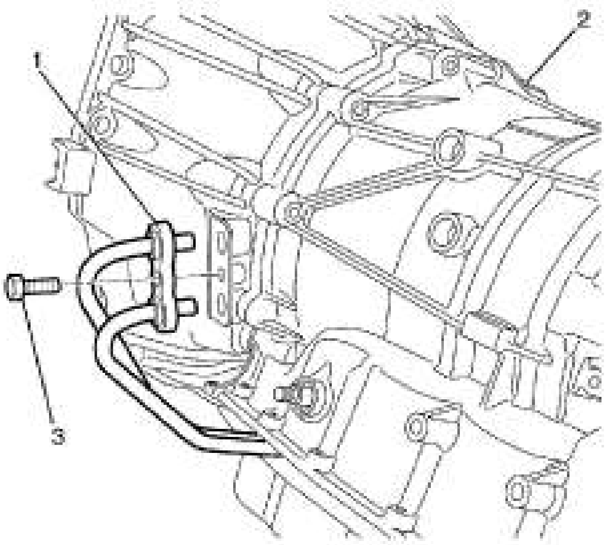
5. Install the engine close out cover and studs.

Tighten
Tighten the studs to 10 N·m (89 lb. in).

6. Raise the powertrain back up into the engine bay and tighten front sub frame retaining bolts.

   Tighten
   Tighten the retaining bolts to 160 N·m (118 lb. ft.) for the front four bolts and 240 N·m (177 lb. ft)

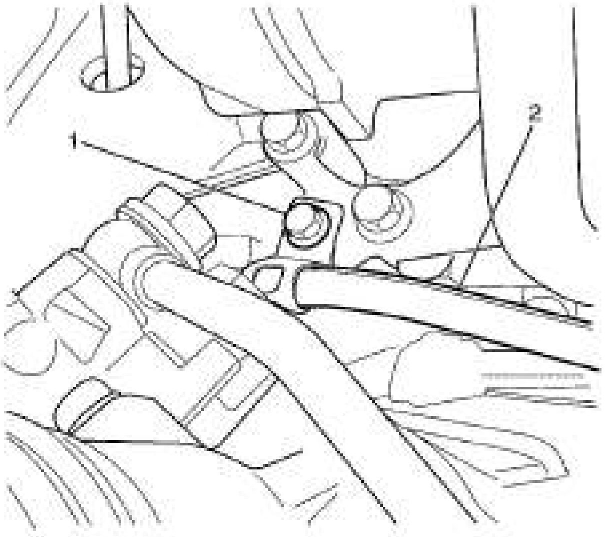
7. Install the steering shaft to the steering rack.



Important: Replace the O-rings if cracked, cut, or distorted.

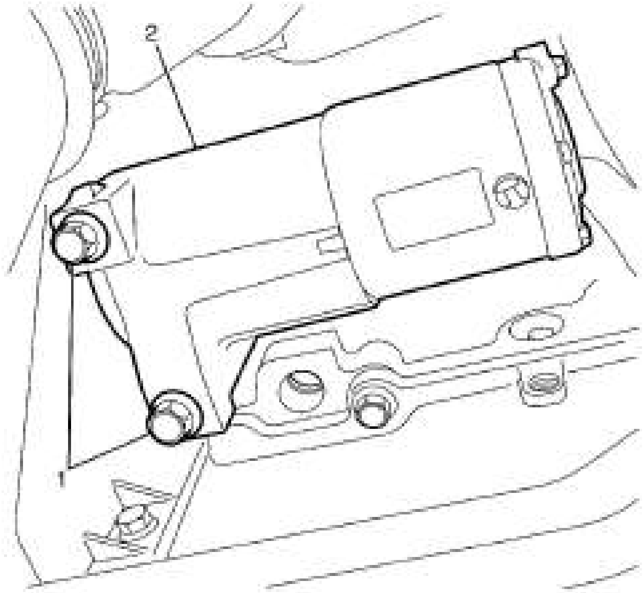
8. Lubricate the O-rings with automatic transmission fluid.
9. Install the O-rings onto the cooler pipes prior to inserting the cooler pipes into the transmission.
10. Insert the transmission fluid cooler pipes into the transmission.
11. Install the bolt securing the transmission fluid cooler pipe retainer to the transmission.

    Tighten
    Tighten the bolt to 25 N·m (18 lb. ft).



12. Install the bolt securing the transmission fluid cooler pipes brace to the engine.

    Tighten
    Tighten the bolt to 22 N·m (17 lb. ft)



13. Align the torque converter to flexplate/flywheel orientation marks made during the removal procedure.

    Important: Torque converter bolts are self locking and must be replaced with NEW torque converter bolts every time the bolts are removed.

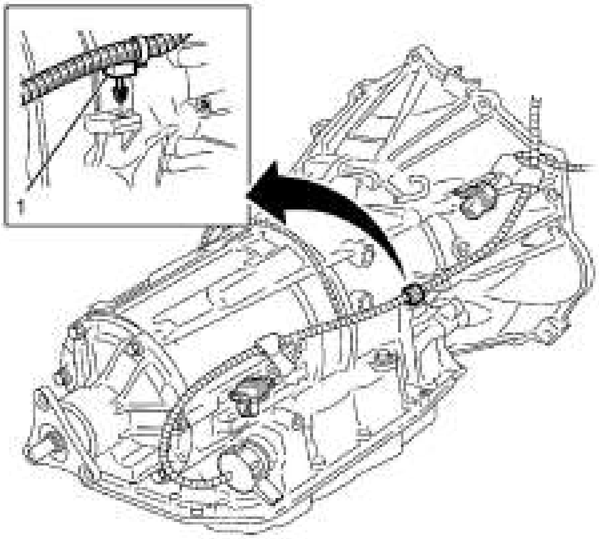
14. Repeat the following steps for all 3 torque converter bolts:

14.1. Rotate the harmonic balancer centre bolt clockwise ONLY, in order to align the torque converter bolt holes in the flexplate/flywheel with the starter motor opening in the engine block.

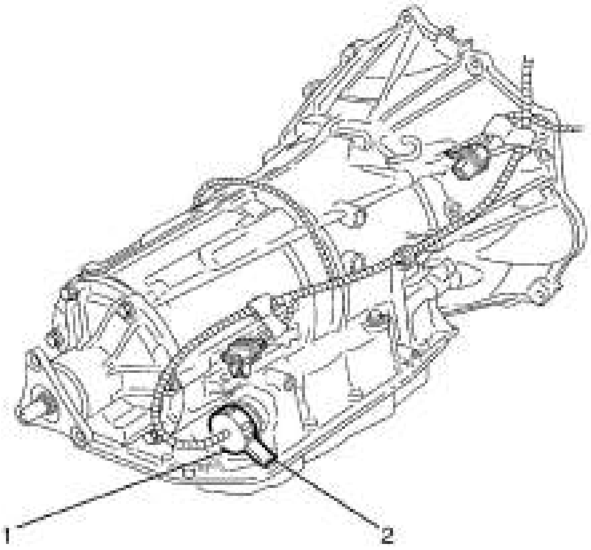
14.2. To aid in alignment of the torque converter to the flexplate/flywheel. Install all 3 NEW torque converter bolts before fully tightening.

Tighten
Tighten the bolts to 63 N·m (46 lb. ft)

15. Install the starter motor (2). Refer to Starter Motor Replacement .
16. Install the air deflector front (1). Refer to Front Air Deflector Replacement .



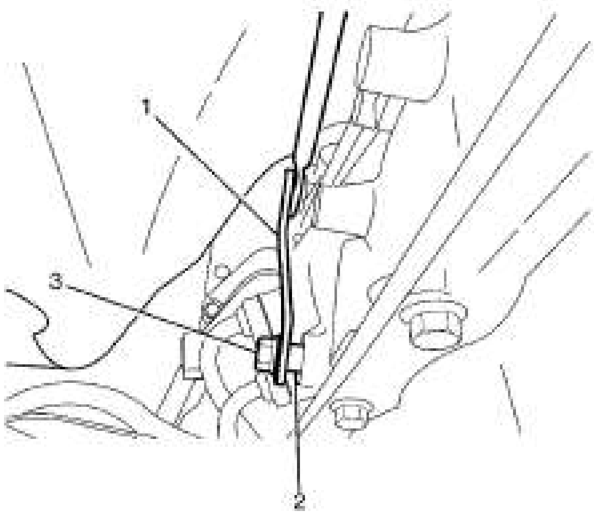
17. Connect the wiring harness clips to the transmission.



18. Connect the transmission wiring harness connector (1) to the transmission by rotating the

locking latch (2) clockwise.

19. Install the propeller shaft coupler to the transmission flange. Refer to Propeller Shaft Replacement .



20. Place the transmission in the park position by rotating the shift shaft fully counter clockwise.
21. Connect the shift linkage to the transmission.
22. Install the transmission manual shift shaft nut.

    Tighten
    Tighten the nut to 15 N·m (11 lb. ft)

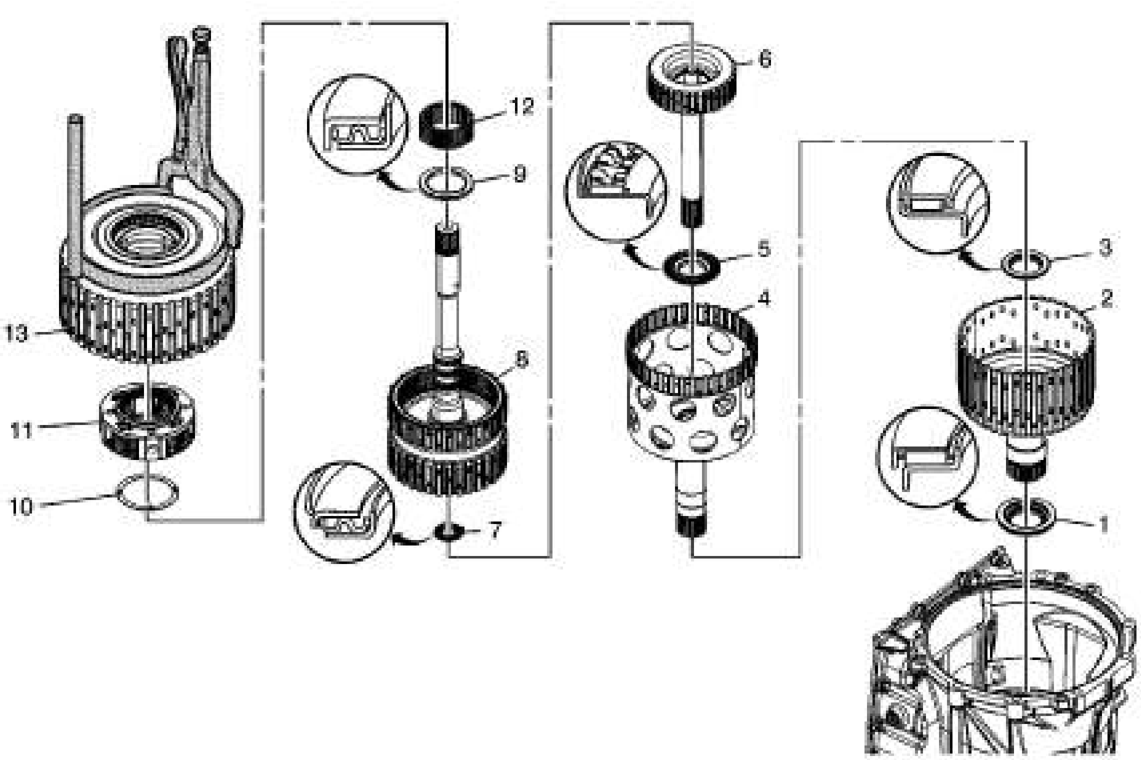
23. Check the transmission fluid level (fill if necessary). Refer to Transmission Fluid Check .
24. Adjust the shift control linkage. Refer to Shift Control Linkage Adjustment .
25. Lower the vehicle.
26. Connect the EVAP purge pipe.
27. Install radiator retaining clips.
28. Install air intake ducting from engine.
29. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
30. The transmission control module must be programmed with the proper software/calibrations. Refer to Service Programming System (SPS) .

Transmission Final Test and Inspection

Complete the following procedure after the transmission is installed in the vehicle:

1. With the ignition OFF or disconnected, crank the engine several times. Listen for any unusual noises or evidence that any parts are binding.
2. Start the engine and listen for abnormal conditions.
3. While the engine continues to idle raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
4. Inspect for fluid leaks while the engine is idling.
5. Lower the vehicle.
6. Perform a final inspection for the proper fluid level.
7. Road test the vehicle.

1-2-3-4 and 3-5 Reverse Clutch Assembly and 4-5-6 Clutch Assembly Installation



Callout	Component Name
1	2-6 and 3-5 Reverse Clutch Hub Thrust Bearing Assembly
2	2-6 and 3-5 Reverse Clutch (with Output Carrier Outer Sun Gear Shaft) Hub Assembly
3	1-2-3-4 Clutch Hub Thrust Bearing Assembly
4	1-2-3-4 Clutch (with Output Carrier Inner Sun Gear Shaft) Hub Assembly
5	4-5-6 Clutch Hub Thrust Bearing Assembly
6	4-5-6 Clutch (with Output Carrier Shaft and Dampener) Hub Assembly **Tip** Refer to 4-5-6 Clutch Dampener Overhaul .
7	Turbine Shaft Thrust Bearing Assembly
8	4-5-6 (with Turbine Shaft) Clutch Assembly
9	Input Sun Gear Thrust Bearing **Tip** Thrust bearing snaps onto input carrier assembly.

10	Input Sun Gear Thrust Washer
11	Input Carrier Assembly
12	Input Sun Gear
13	1-2-3-4 and 3-5 Reverse Clutch Assembly **Tip** Wiggle the DT 47781 in order to align the 1-2-3-4 and 3-5 reverse clutch plates with the external splines of the 4-5-6 clutch assembly. To verify that the 1-2-3-4 and 3-5 reverse clutch assembly is fully installed, lift up on the turbine shaft. There should not be any noticeable slack. **Special Tool** DT 47781 C1234 35R Clutch Assembly Installer

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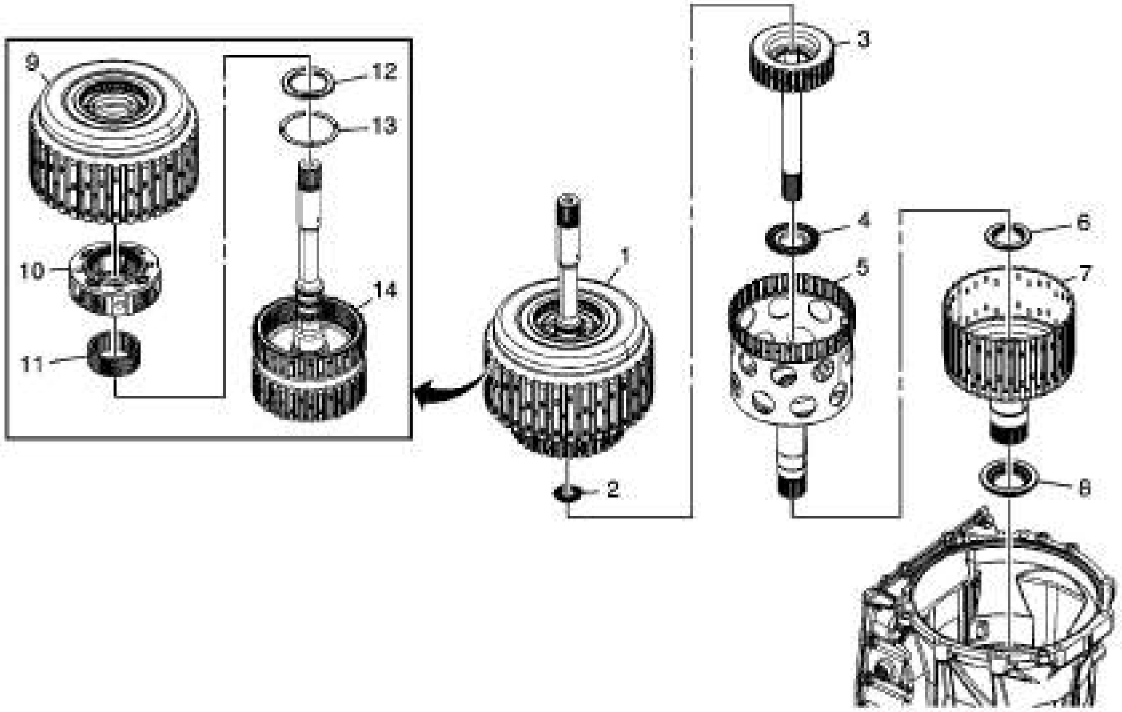
1-2-3-4 and 3-5 Reverse Clutch Assembly and 4-5-6 Clutch Assembly Removal



Callout	Component Name
1	1-2-3-4 and 3-5 Reverse Clutch Assembly and 4-5-6 (With Turbine Shaft) Clutch Assembly
2	Turbine Shaft Thrust Bearing Assembly
3	4-5-6 Clutch (With Output Carrier Shaft and Dampener) Hub Assembly
4	4-5-6 Clutch Hub Thrust Bearing Assembly
5	1-2-3-4 Clutch (With Output Carrier Inner Sun Gear Shaft) Hub Assembly
6	1-2-3-4 Clutch Hub Thrust Bearing Assembly
7	2-6 and 3-5 Reverse Clutch (With Output Carrier Outer Sun Gear Shaft) Hub Assembly
8	2-6 and 3-5 Reverse Clutch Hub Thrust Bearing Assembly
9	1-2-3-4 and 3-5 Reverse Clutch Assembly
10	Input Carrier Assembly
11	Input Sun Gear
12	Input Sun Gear Thrust Bearing
13	Input Sun Gear Thrust Washer

14	4-5-6 (With Turbine Shaft) Clutch Assembly

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1-2-3-4 and 3-5 Reverse Clutch Overhaul

Table 1: 1-2-3-4 and 3-5 Reverse Clutch Plates Removal

Table 2: 1-2-3-4 Clutch Piston Removal

Table 3: 3-5 Reverse Clutch Piston Removal

Table 4: 1-2-3-4 and 3-5 Reverse Clutch Piston Seals Replacement

Table 5: 3-5 Reverse Clutch Piston Installation

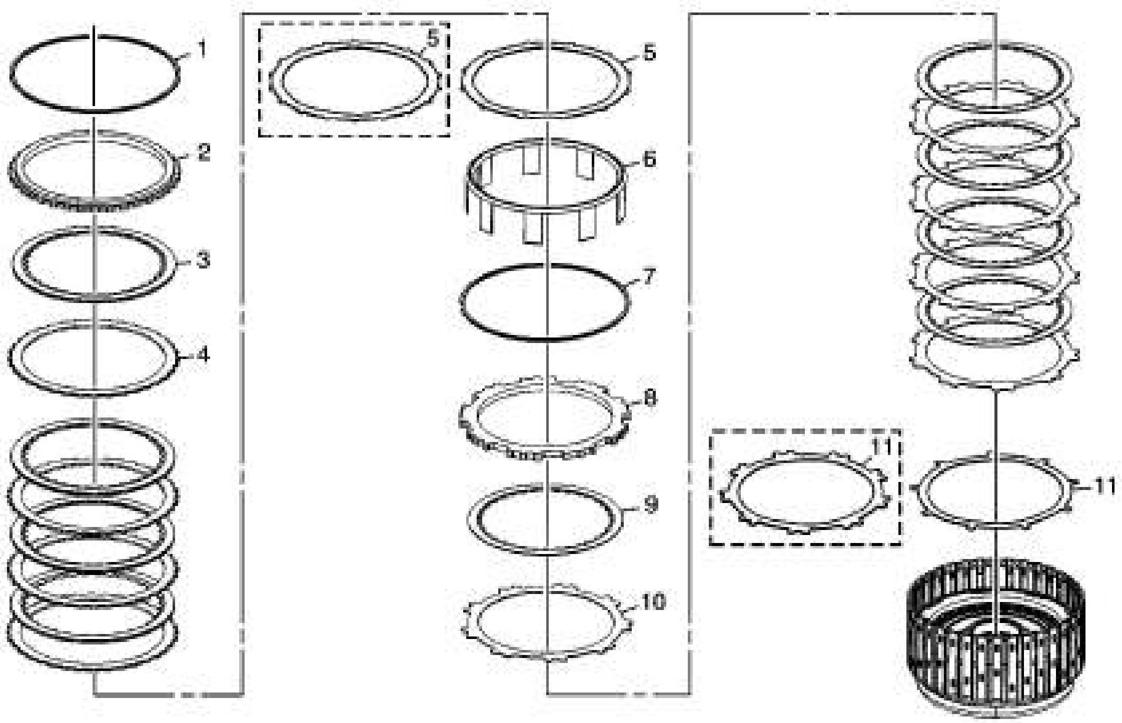
Table 6: 1-2-3-4 Clutch Piston Installation

Table 7: 1-2-3-4 Clutch Plate Installation

Table 8: 3-5 and Reverse Clutch Plate Installation

Table 9: 1-2-3-4 and 3-5 Reverse Clutch Bearing Assembly Replacement

1-2-3-4 and 3-5 Reverse Clutch Plates Removal

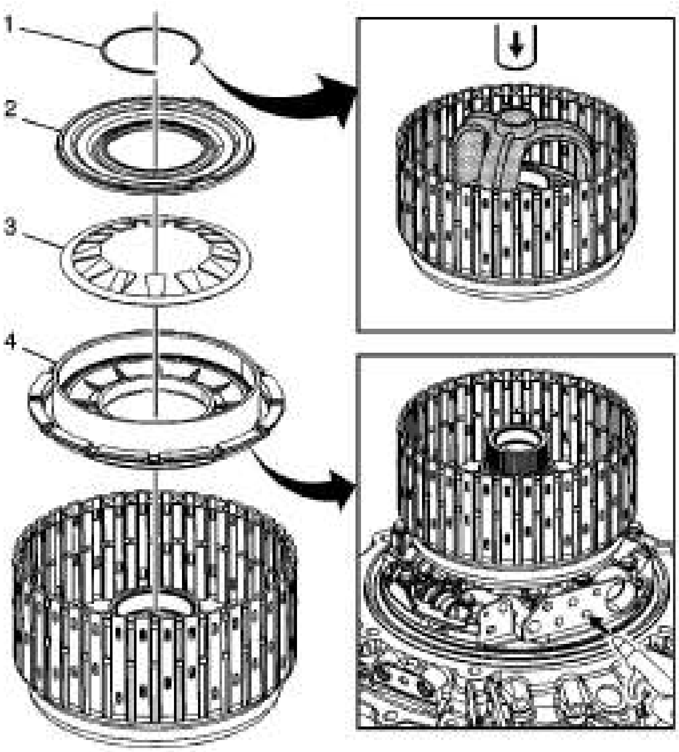


1-2-3-4 and 3-5 Reverse Clutch Plates Removal

Callout	Component Name
1	3-5 Reverse Clutch Backing Plate Retaining Ring
2	3-5 Reverse Clutch Backing Plate
3	3-5 Reverse Clutch Plate Assembly (Quantity: 4)
4	3-5 Reverse Clutch Plate (Quantity: 4)

5	3-5 Reverse Clutch (Waved) Plate
6	3-5 Reverse Clutch Apply Ring
7	1-2-3-4 Clutch Backing Plate Retaining Ring
8	1-2-3-4 Clutch Backing Plate
9	1-2-3-4 Clutch Plate Assembly (Quantity: 5)
10	1-2-3-4 Clutch Plate (Quantity: 5)
11	1-2-3-4 Clutch (Waved) Plate

1-2-3-4 Clutch Piston Removal

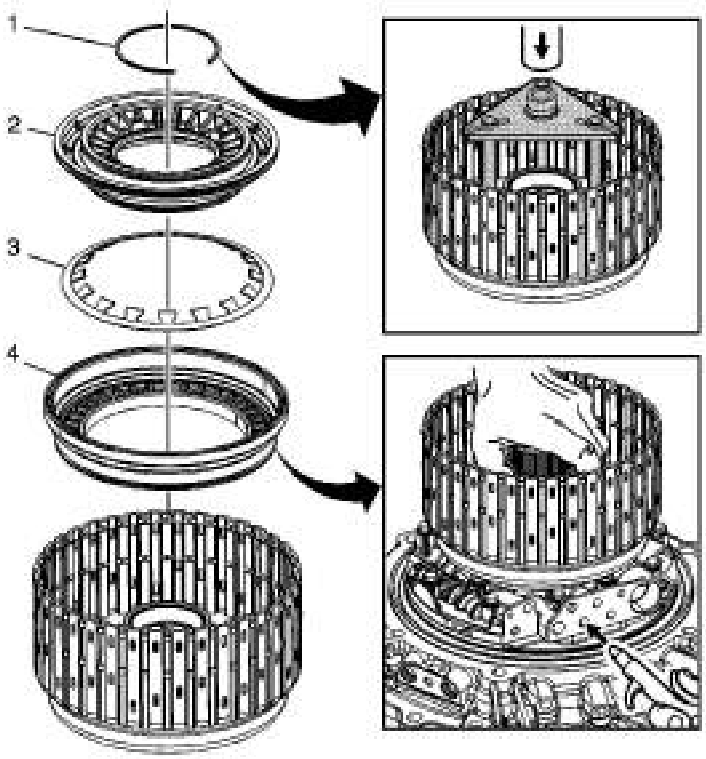


1-2-3-4 Clutch Piston Removal

Callout	Component Name
1	1-2-3-4 Clutch Piston Dam Retaining Ring. **Notice:** Refer to General Repair Instructions in the Preface section. **Notice:** Do not reuse the retaining ring. Install a NEW retaining ring. Reusing the old retaining ring may cause damage to the clutch assembly. **Special Tool** J 38734 Intermediate Spring Compressor Adapter

2	1-2-3-4 Clutch Piston Dam Assembly.
3	1-2-3-4 Clutch Spring
4	1-2-3-4 Clutch Piston **Tip** It may be necessary to apply air to the apply passage in order to remove the piston. Install the 1-2-3-4 clutch housing onto the torque converter (with fluid pump) housing assembly in order to apply air. **Tip** After air is applied, it may be necessary to turn the housing assembly upside down and carefully tap the housing against a flat surface in order to release the piston.

3-5 Reverse Clutch Piston Removal

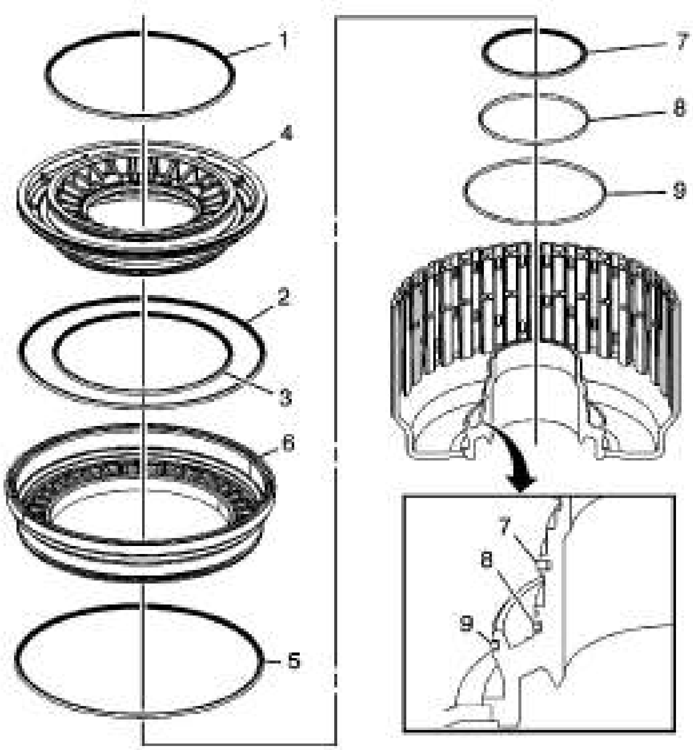


3-5 Reverse Clutch Piston Removal

Callout	Component Name
1	1-2-3-4 Clutch Piston Housing Retaining Ring **Notice:** Do not reuse the retaining ring. Install a NEW retaining ring. Reusing the old retaining ring may cause damage to the clutch assembly. **Special Tool**

	DT 47867 Adjustable Clutch Spring Compressor
Preliminary Procedures 1. Install the 1-2-3-4 and 3-5 reverse clutch housing assembly onto the torque converter (with fluid pump) housing assembly. 2. Apply hand pressure on the 1-2-3-4 clutch piston housing while applying compressed air to the apply passage in order to unseat the 3-5 reverse clutch piston.	
2	1-2-3-4 Clutch Piston Housing
3	3-5 Reverse Clutch Spring
4	3-5 Reverse Clutch Piston **Tip** It may be necessary to turn the housing assembly upside down and carefully tap the housing against a flat surface in order to release the piston.

1-2-3-4 and 3-5 Reverse Clutch Piston Seals Replacement

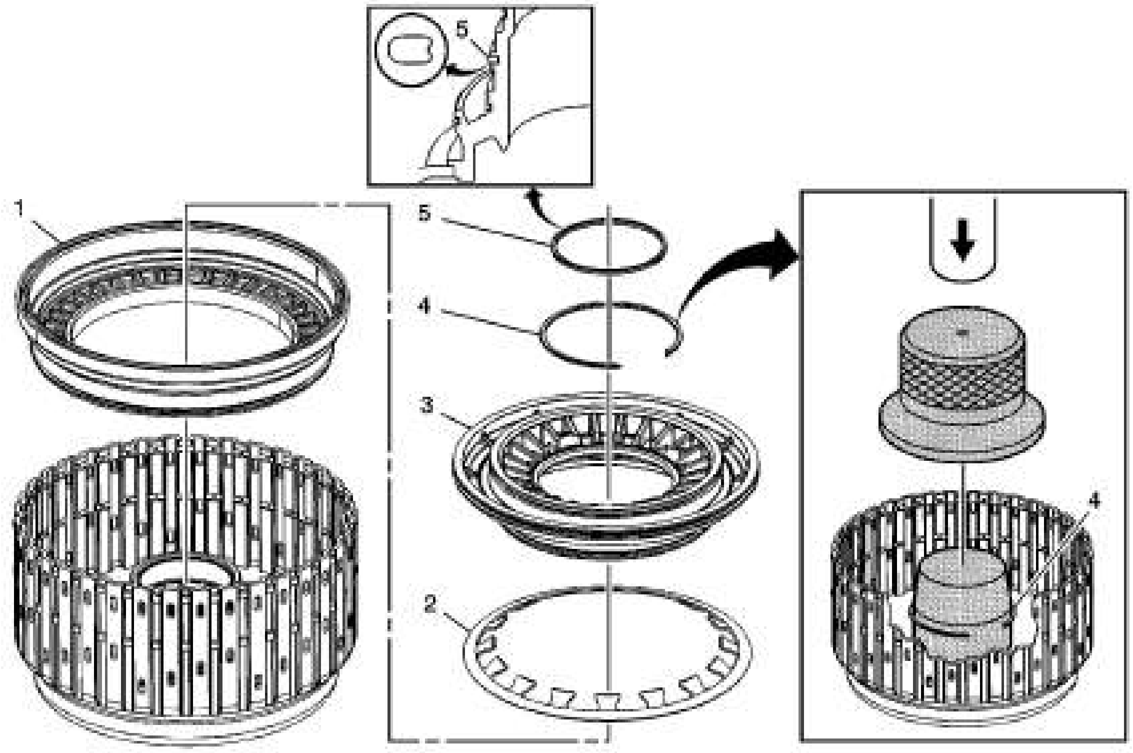


1-2-3-4 and 3-5 Reverse Clutch Piston Seals Replacement

Callout	Component Name
Notice: Do not reuse the seals. Replace with NEW seals. Reusing old seals may cause transmission damage. **Tip** Lubricate all seals with automatic transmission fluid (ATF) prior to installation.	

1	1-2-3-4 Clutch Piston Seal
2	3-5 Reverse Clutch Piston Dam (O-Ring) Seal
3	3-5 Reverse Clutch Piston Inner Seal
4	1-2-3-4 Clutch Piston Housing
5	3-5 Reverse Clutch Piston Outer Seal
6	3-5 Reverse Clutch Piston
7	1-2-3-4 Clutch Piston Inner Seal **Notice:** Refer to General Repair Instructions in the Preface section.
8	1-2-3-4 Clutch Piston Housing Seal
9	1-2-3-4 Clutch Piston Housing Seal

3-5 Reverse Clutch Piston Installation

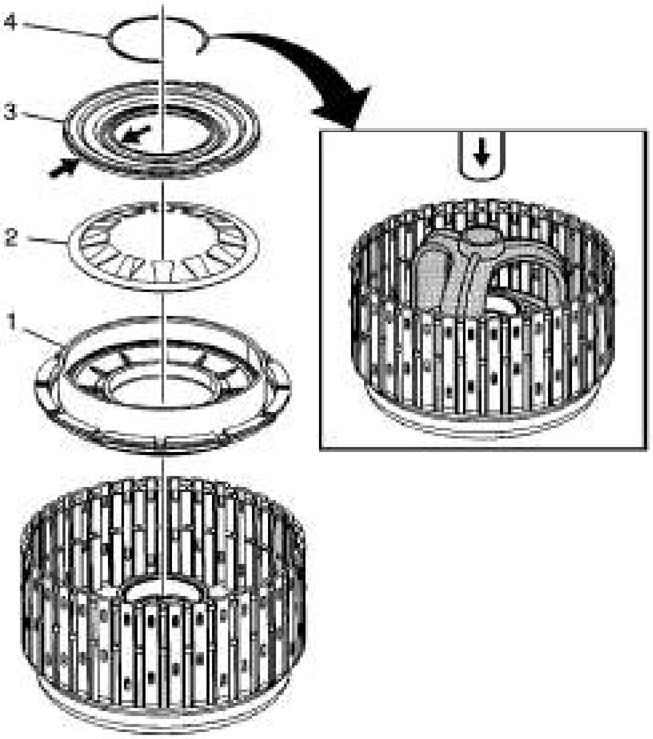


3-5 Reverse Clutch Piston Installation

Callout	Component Name
1	3-5 Reverse Clutch Piston
2	3-5 Reverse Clutch Spring **Notice:** Refer to General Repair Instructions in the Preface section.
3	1-2-3-4 Clutch Piston Housing
	1-2-3-4 Clutch Piston Housing Retaining Ring

4	**Notice:** Refer to General Repair Instructions in the Preface section. **Notice:** Do not reuse the retaining ring. Install a NEW retaining ring. Reusing the old retaining ring may cause damage to the clutch assembly. **Notice:** Refer to General Repair Instructions in the Preface section. **Special Tools** • DT 47782-1 Retaining Ring Cone • DT 47782-2 Retaining Ring Installer
5	1-2-3-4 Clutch Piston Inner Seal **Notice:** Refer to General Repair Instructions in the Preface section.

1-2-3-4 Clutch Piston Installation

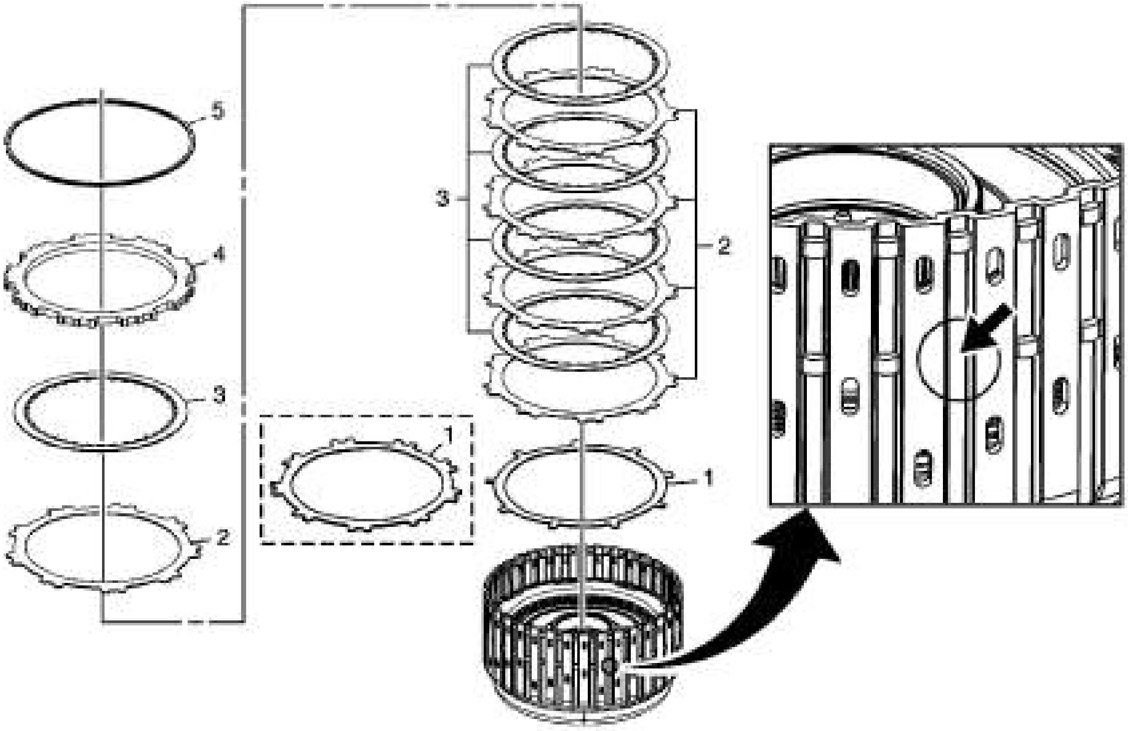


1-2-3-4 Clutch Piston Installation

Callout	Component Name
1	1-2-3-4 Clutch Piston
2	1-2-3-4 Clutch Spring

	Notice: Refer to General Repair Instructions in the Preface section.
3	1-2-3-4 Clutch Piston Dam Assembly **Tip** Lubricate the inner and outer surfaces of the dam assembly with ATF in order to ease installation into the piston. Install the tabs facing up.
4	1-2-3-4 Clutch Piston Dam Retaining Ring **Notice:** Refer to General Repair Instructions in the Preface section. **Notice:** Do not reuse the retaining ring. Install a NEW retaining ring. Reusing the old retaining ring may cause damage to the clutch assembly. **Special Tool** J 38734 Intermediate Spring Compressor Adapter

1-2-3-4 Clutch Plate Installation

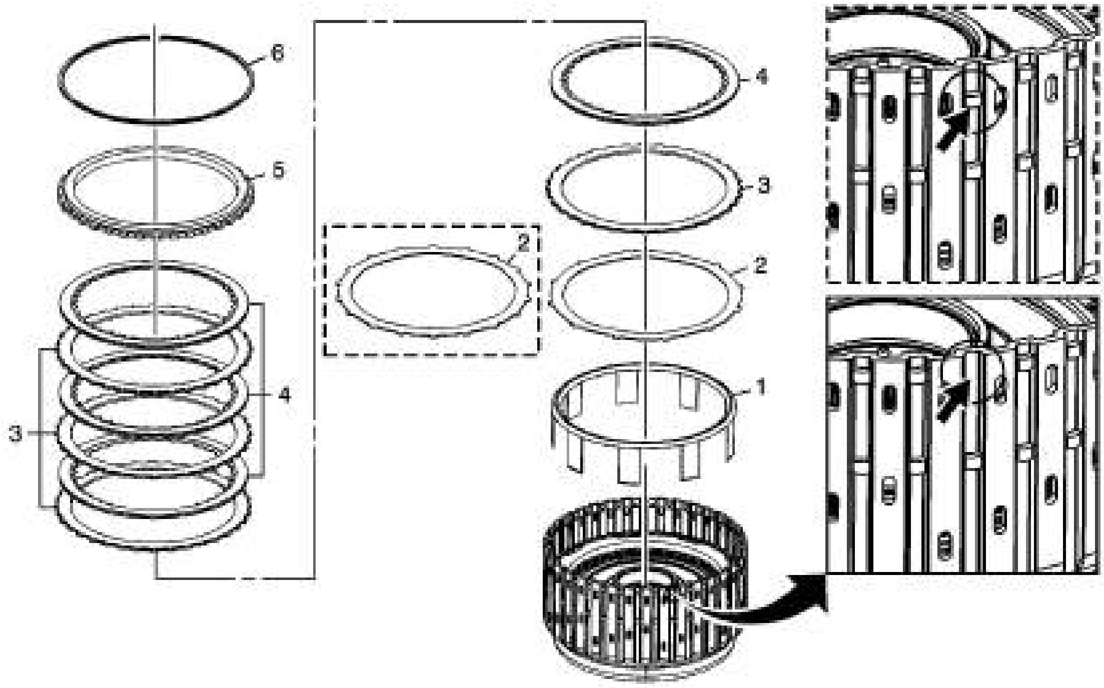


1-2-3-4 Clutch Plate Installation

Callout	Component Name
1	1-2-3-4 Clutch (Waved) Plate **Notice:** Refer to General Repair Instructions in the Preface section.

2	1-2-3-4 Clutch Plate (Quantity: 5) **Notice:** Refer to General Repair Instructions in the Preface section.
3	1-2-3-4 Clutch Plate Assembly (Quantity: 5)
4	1-2-3-4 Clutch Backing Plate **Notice:** Refer to General Repair Instructions in the Preface section.
5	1-2-3-4 Clutch Backing Plate Retaining Ring **Notice:** Refer to General Repair Instructions in the Preface section. **Tip** After the retaining ring is installed, determine clutch piston travel in order to verify if the correct selective retaining ring is being used. Refer to 1-2-3-4 Clutch Backing Plate Retaining Ring Measurement .

3-5 and Reverse Clutch Plate Installation

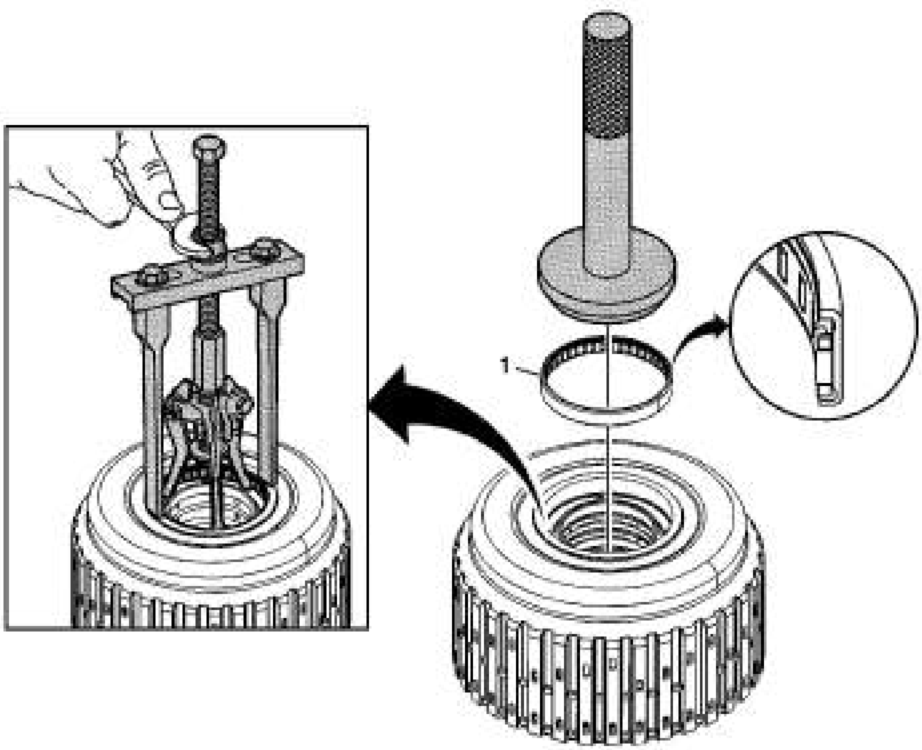


3-5 and Reverse Clutch Plate Installation

Callout	Component Name
1	3-5 Reverse Clutch Apply Ring **Notice:** Refer to General Repair Instructions in the Preface section.
2	3-5 Reverse Clutch (Waved) Plate

3	3-5 Reverse Clutch Plate (Quantity: 4)
4	3-5 Reverse Clutch Plate Assembly (Quantity: 4)
5	3-5 Reverse Clutch Backing Plate
6	3-5 Reverse Clutch Backing Plate Retaining Ring **Notice:** Refer to General Repair Instructions in the Preface section. **Tip** After the retaining ring is installed, determine clutch piston travel in order to verify if the correct selective retaining ring is being used. Refer to 3-5 Reverse Clutch Backing Plate Retaining Ring Measurement .

1-2-3-4 and 3-5 Reverse Clutch Bearing Assembly Replacement

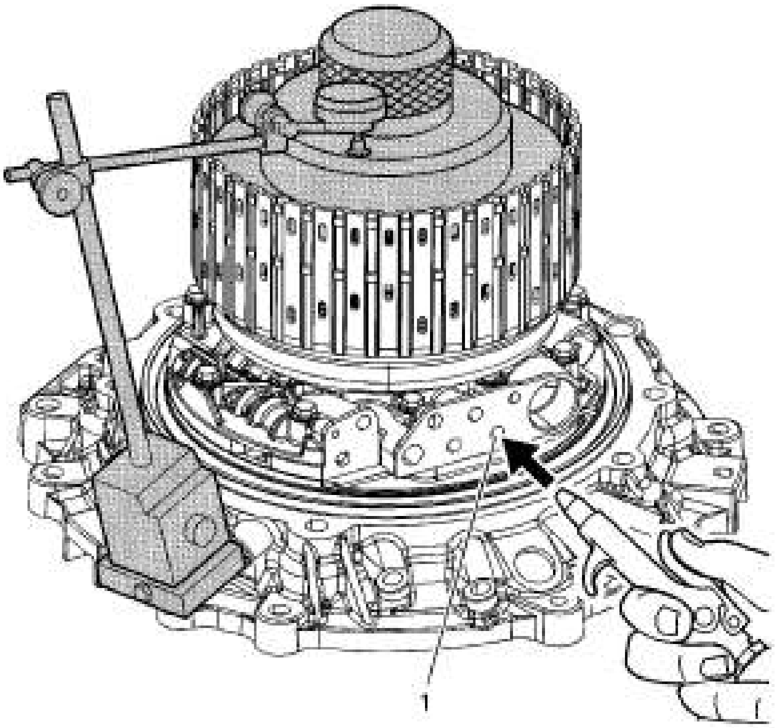


1-2-3-4 and 3-5 Reverse Clutch Bearing Assembly Replacement

Callout	Component Name
	3-5 Reverse Clutch Bearing **Notice:** Refer to General Repair Instructions in the Preface section. **Notice:** Refer to General Repair Instructions in the Preface section. **Specification** Install the bearing flush to 0.3 mm below the thrust surface.

1	**Special Tools** • DT 47865 Bearing Remover • DT 47866 Bearing Installer • J 8092 Driver Handle • J 45124 Removal Bridge

1-2-3-4 Clutch Backing Plate Retaining Ring Measurement



Callout	Component Name

Preliminary Procedures

1. Install the 1-2-3-4 and 3-5 reverse clutch housing with the 1-2-3-4 clutch plates installed, onto the torque converter housing.
2. Install the DT 47868-2 onto the torque converter housing.
3. Install DT 47868-1 D onto the 1-2-3-4 clutch backing plate.
4. Install the J 26900-13 J onto DT 47868-2 .
5. Attach the J 8001 to the J 26900-13 and zero out the dial indicator on the DT 47868-1 .

Special Tools

- DT 47868-1 Clutch Pack Travel Weight
- DT 47868-2 Magnetic Base Adapter
- J 8001 Dial Indicator Set
- J 26900-13 Magnetic Base

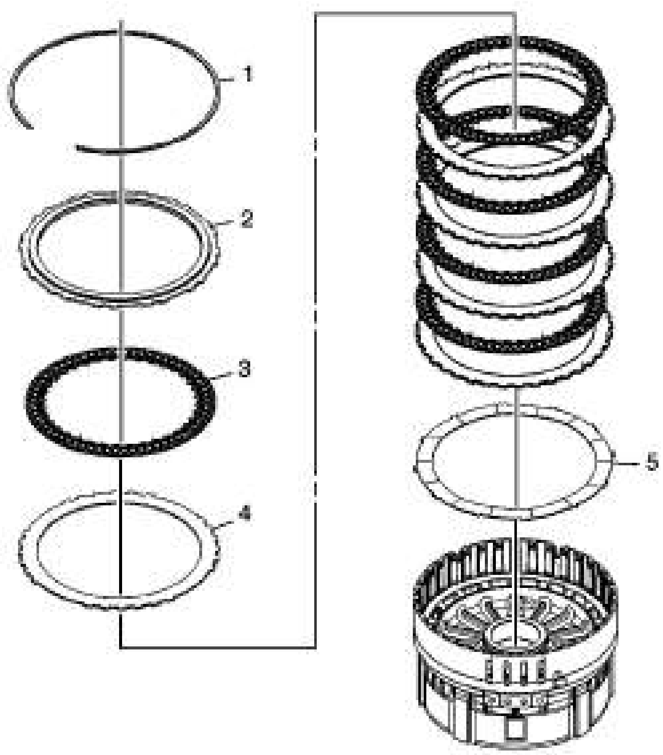
	1-2-3-4 Clutch Apply Passage

1	**Tip** Apply compressed air to the apply passage hole, at least 3 times and observe the dial indicator measurement each time. This action "fluffs" the clutch plates to make sure an accurate measurement. Refer to Clutch Backing Plate Retaining Ring Specifications .

2-6 Clutch Overhaul

Table 1: 2-6 Clutch Plates Removal
Table 2: 2-6 Clutch Piston Replacement
Table 3: 2-6 Clutch Plates Installation

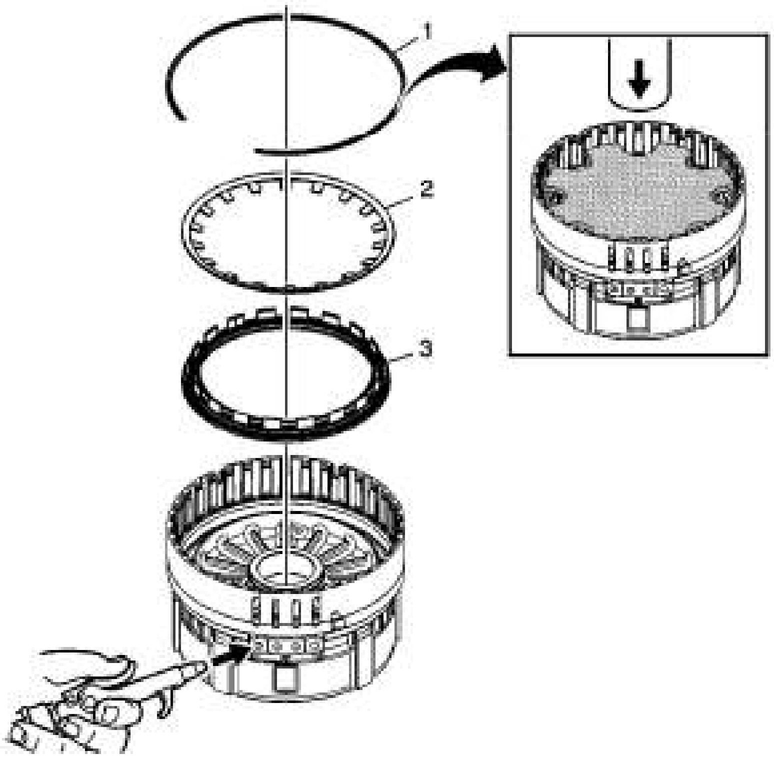
2-6 Clutch Plates Removal



2-6 Clutch Plates Removal

Callout	Component Name
1	2-6 Clutch Backing Plate Retaining Ring
2	2-6 Clutch Backing Plate
3	2-6 Clutch Plate Assembly (Quantity: 5)
4	2-6 Clutch Plate (Quantity: 5)
5	2-6 Clutch (Waved) Plate

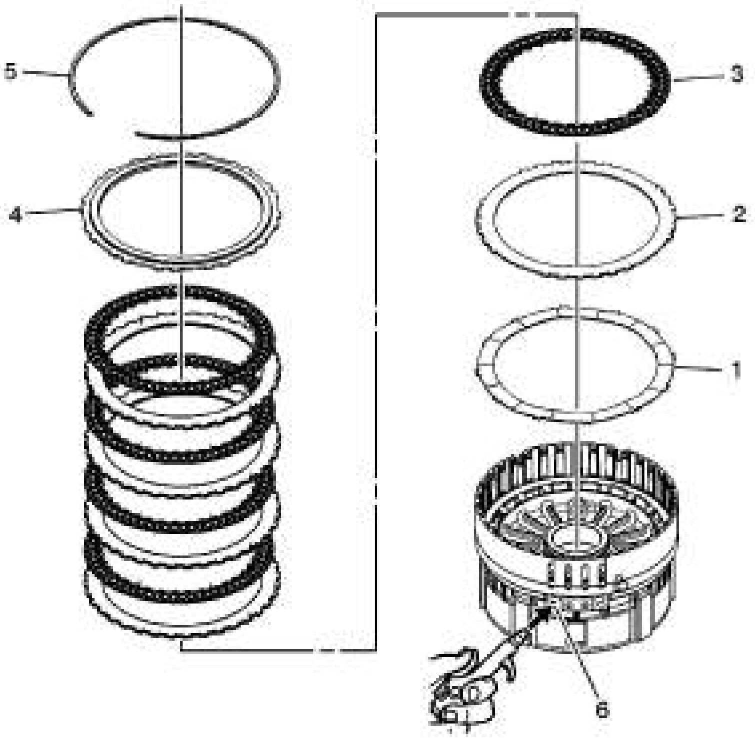
2-6 Clutch Piston Replacement



2-6 Clutch Piston Replacement

Callout	Component Name
1	2-6 Clutch Spring Retaining Ring **Tip** Ensure the DT 47761 is centred over the clutch spring. **Special Tool** DT 47761
2	2-6 Clutch Spring **Notice:** Refer to General Repair Instructions in the Preface section.
3	2-6 Clutch Piston Assembly **Tip** It may be necessary to apply air to the apply passage in order to unseat the piston.

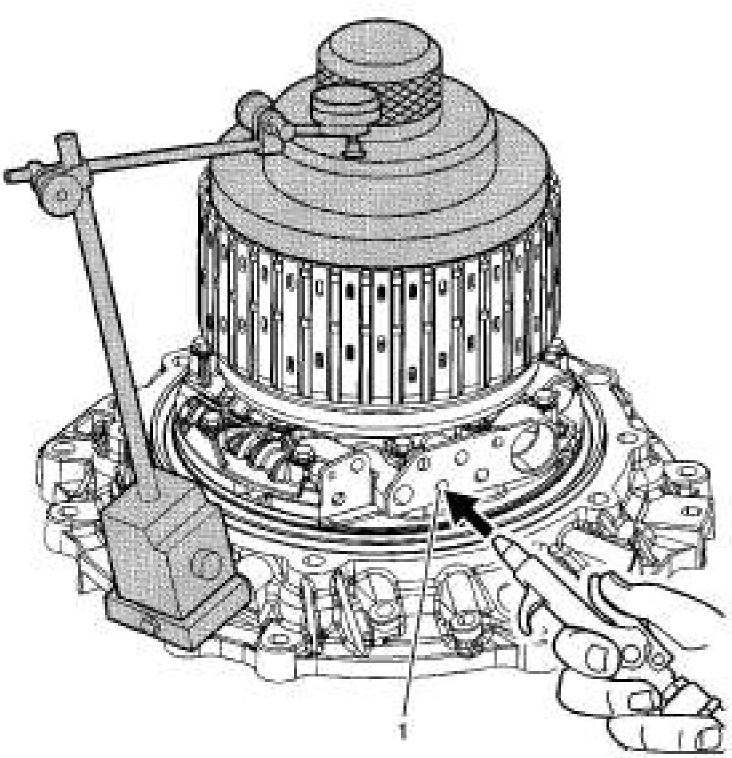
2-6 Clutch Plates Installation



2-6 Clutch Plates Installation

Callout	Component Name
1	2-6 Clutch (Waved) Plate
2	2-6 Clutch Plates (Quantity: 5) **Tip** Alternate between steel and fibre clutch plates.
3	2-6 Clutch Plate Assembly (Quantity: 5) **Tip** Alternate between steel and fibre clutch plates.
4	2-6 Clutch Backing Plate
5	2-6 Clutch Backing Plate Retaining Ring
6	2-6 Clutch Apply Passage **Tip** Apply air to verify proper installation of all 2-6 clutch components.

3-5 Reverse Clutch Backing Plate Retaining Ring Measurement



Callout	Component Name
Preliminary Procedures 1. Install the 1-2-3-4 and 3-5 reverse clutch housing with the 1-2-3-4 and 3-5 reverse clutch plates installed, onto the torque converter housing. 2. Install the DT 47868-2 onto the torque converter housing. 3. Install DT 47868-1 onto the 3-5 reverse clutch backing plate. 4. Install the J 26900-13 onto DT 47868-2 . 5. Attach the J 8001 to the J 26900-13 and zero out the dial indicator on the DT 47868-1 . **Special Tools** • DT 47868-1 Clutch Pack Travel Weight • DT 47868-2 Magnetic Base Adapter • J 8001 Dial Indicator Set • J 26900-13 Magnetic Base	
	3-5 Reverse Clutch Apply Passage

1	**Tip** Apply compressed air to the apply passage hole, and observe the dial indicator measurement. Refer to Clutch Backing Plate Retaining Ring Specifications .

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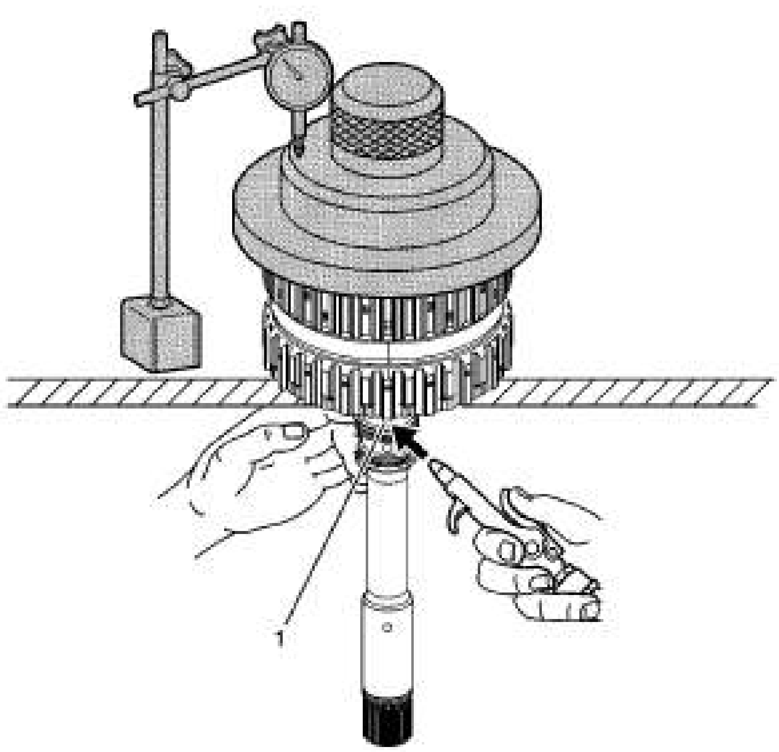
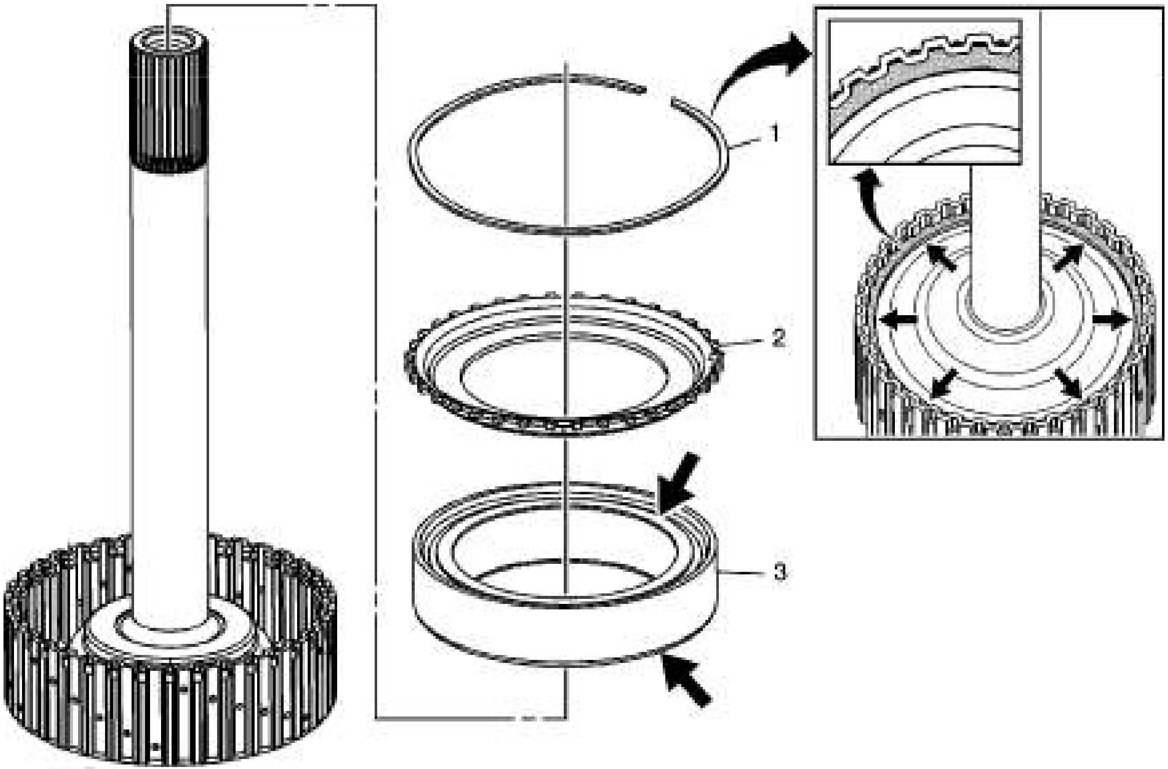
4-5-6 Clutch Backing Plate Retaining Ring Measurement



Callout	Component Name
Preliminary Procedures 1. Install the clutch assembly into a hole in the workbench 2. Zero out the dial indicator on the DT 47868-1 . **Special Tools** • DT 47868-1 Pack Travel Weight • J 8001 Dial Indicator Set • J 26900-13 Magnetic Base	
1	4-5-6 Clutch Apply Passage **Tip** While using one finger to block the top passage hole on the turbine shaft, apply compressed air to the opposite top passage hole (1), and observe the dial indicator measurement. Refer to Clutch Backing Plate Retaining Ring Specifications .

4-5-6 Clutch Dampener Overhaul



Callout	Component Name
1	4-5-6 Clutch Dampener Retaining Ring **Notice:** Refer to General Repair Instructions in the Preface section.
2	4-5-6 Clutch Dampener Apply Plate
3	4-5-6 Clutch Dampener **Tip** Dry and inspect the clutch dampener for the following conditions: • Pitting • Flaking • Delamination • Wear • Glazing • Cracking If any of these conditions are found, replace the dampener.

4-5-6 Clutch Overhaul

Table 1: 4-5-6 Clutch Plates Removal

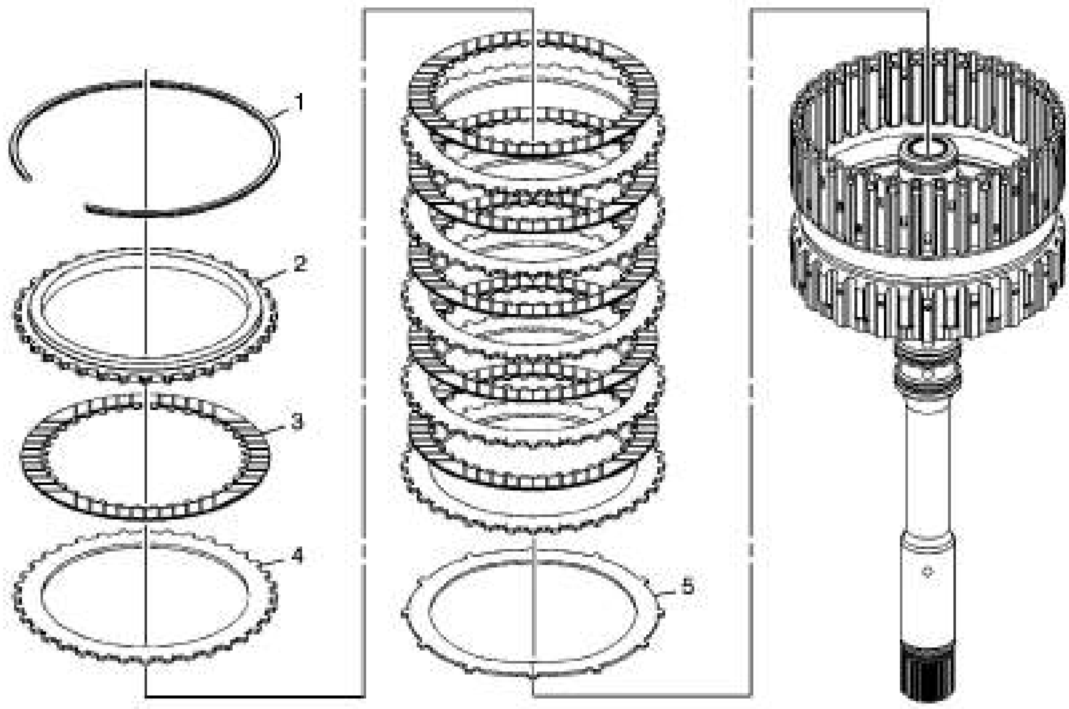
Table 2: 4-5-6 Clutch Piston Removal

Table 3: Turbine Shaft Fluid Seal Ring Replacement

Table 4: 4-5-6 Clutch Piston Installation

Table 5: 4-5-6 Clutch Plates Installation

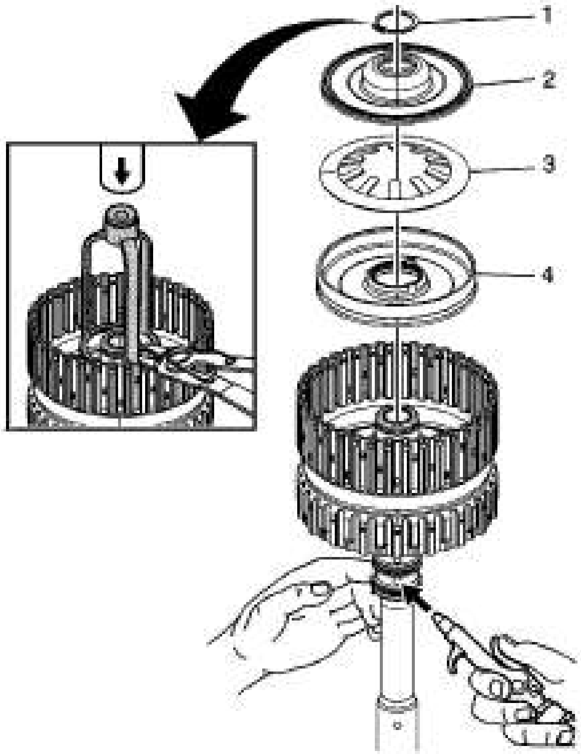
4-5-6 Clutch Plates Removal



4-5-6 Clutch Plates Removal

Callout	Component Name
1	4-5-6 Clutch Backing Plate Retaining Ring
2	4-5-6 Clutch Backing Plate
3	4-5-6 Clutch Plate Assembly (Quantity: 6)
4	4-5-6 Clutch Plate (Quantity: 6)
5	4-5-6 Clutch (Waved) Plate

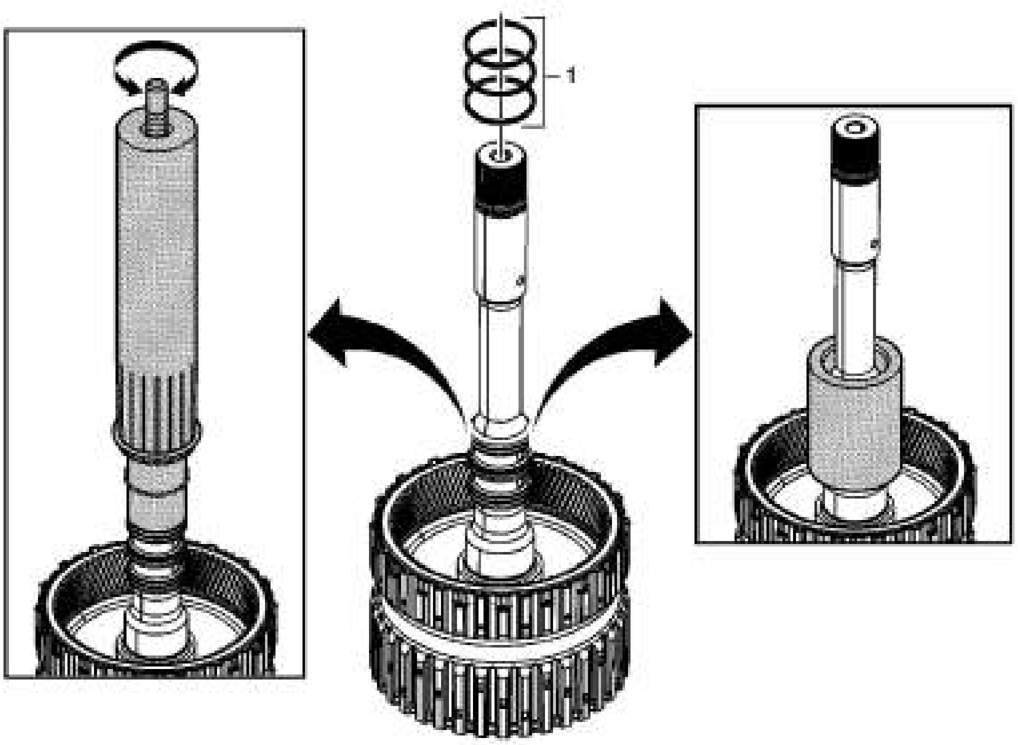
4-5-6 Clutch Piston Removal



4-5-6 Clutch Piston Removal

Callout	Component Name
1	4-5-6 Clutch Piston Dam Retaining Ring **Notice:** Refer to General Repair Instructions in the Preface section. **Notice:** Do not reuse the retaining ring. Install a NEW retaining ring. Reusing the old retaining ring may cause damage to the clutch assembly. **Special Tool** J 43074 .
2	4-5-6 Clutch Piston Dam Assembly **Tip** It may be necessary to apply air pressure to remove the dam and piston.
3	4-5-6 Clutch Spring
4	4-5-6 Clutch Piston Assembly **Tip** It may be necessary to apply air pressure to remove the piston.

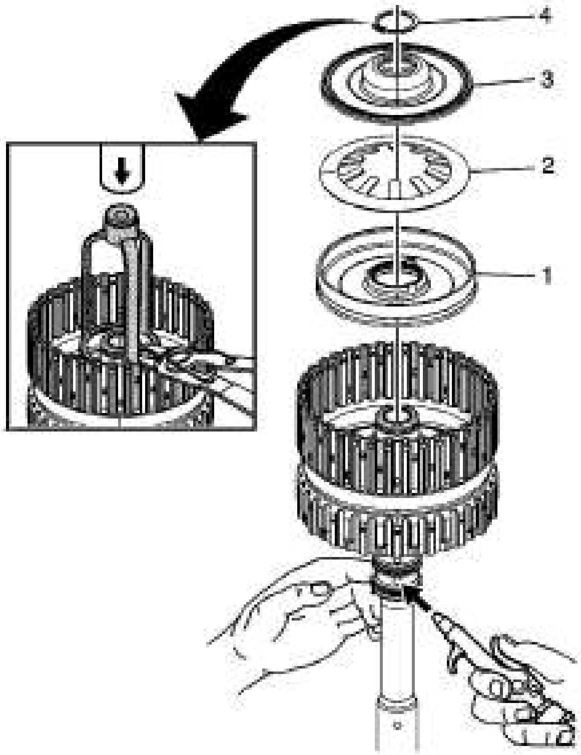
Turbine Shaft Fluid Seal Ring Replacement



Turbine Shaft Fluid Seal Ring Replacement

Callout	Component Name
Preliminary Procedures - Inspect the turbine shaft fluid passages and splines. - Clean any plugged passages.	
1	Turbine Shaft Fluid Seal Ring (Quantity: 3) **Notice:** Do not reuse the seals. Replace with NEW seals. Reusing old seals may cause transmission damage. **Notice:** Refer to General Repair Instructions in the Preface section. **Tip** Adjust the turn screw on the DT 47768-1 and install the bottom seal ring first. **Special Tools** - DT 47768-1 Seal Protector - DT 47768-2 Seal Pusher - DT 47768-3 Seal Sizer

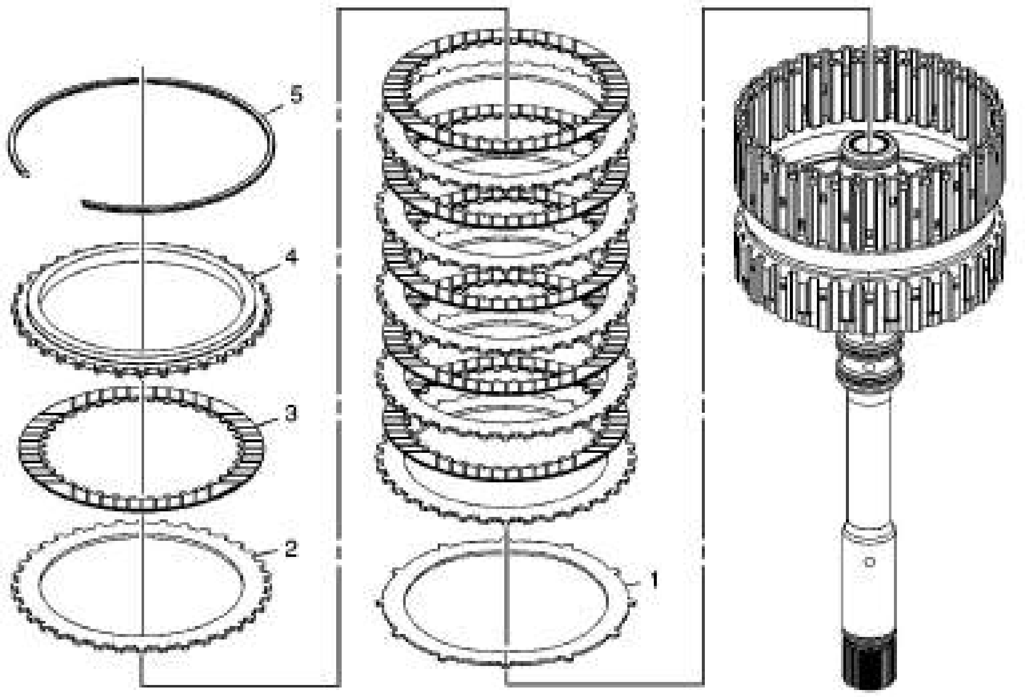
4-5-6 Clutch Piston Installation



4-5-6 Clutch Piston Installation

Callout	Component Name
1	4-5-6 Clutch Piston Assembly
2	4-5-6 Clutch Spring **Notice:** Refer to General Repair Instructions in the Preface section.
3	4-5-6 Clutch Piston Dam Assembly **Tip** Lubricate the inner and outer sealing surfaces of the dam assembly with automatic transmission fluid (ATF) in order to ease installation into the piston.
4	4-5-6 Clutch Piston Dam Retaining Ring **Notice:** Refer to General Repair Instructions in the Preface section. **Notice:** Do not reuse the retaining ring. Install a NEW retaining ring. Reusing the old retaining ring may cause damage to the clutch assembly. **Tip** Apply air to verify proper installation of all 4-5-6 clutch components. Piston should apply and release smoothly. **Special Tool** J 43074 J 43074 Clutch Spring Compressor

4-5-6 Clutch Plates Installation



4-5-6 Clutch Plates Installation

Callout	Component Name
1	4-5-6 Clutch (Waved) Plate
2	4-5-6 Clutch Plate (Quantity: 6)
3	4-5-6 Clutch Plate Assembly (Quantity: 6)
4	4-5-6 Clutch Backing Plate
5	4-5-6 Clutch Backing Plate Retaining Ring **Tip** After the retaining ring is installed, determine clutch piston travel in order to verify if the correct selective retaining ring is being used. Refer to 4-5-6 Clutch Backing Plate Retaining Ring Measurement .

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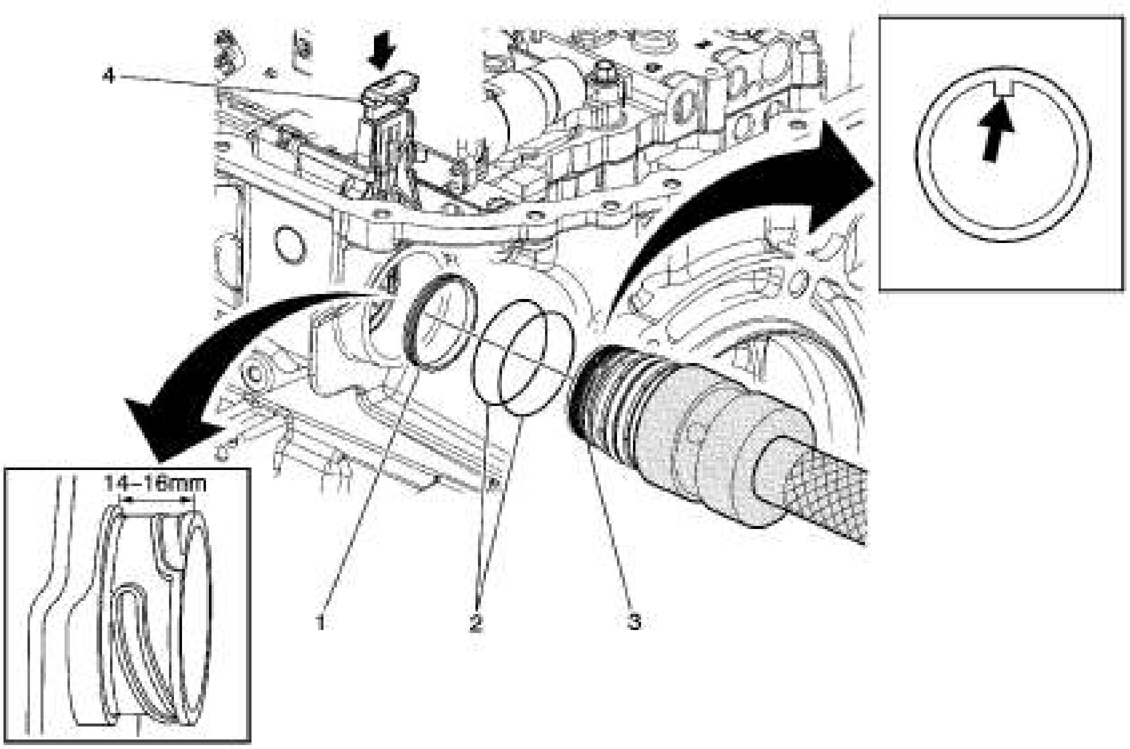
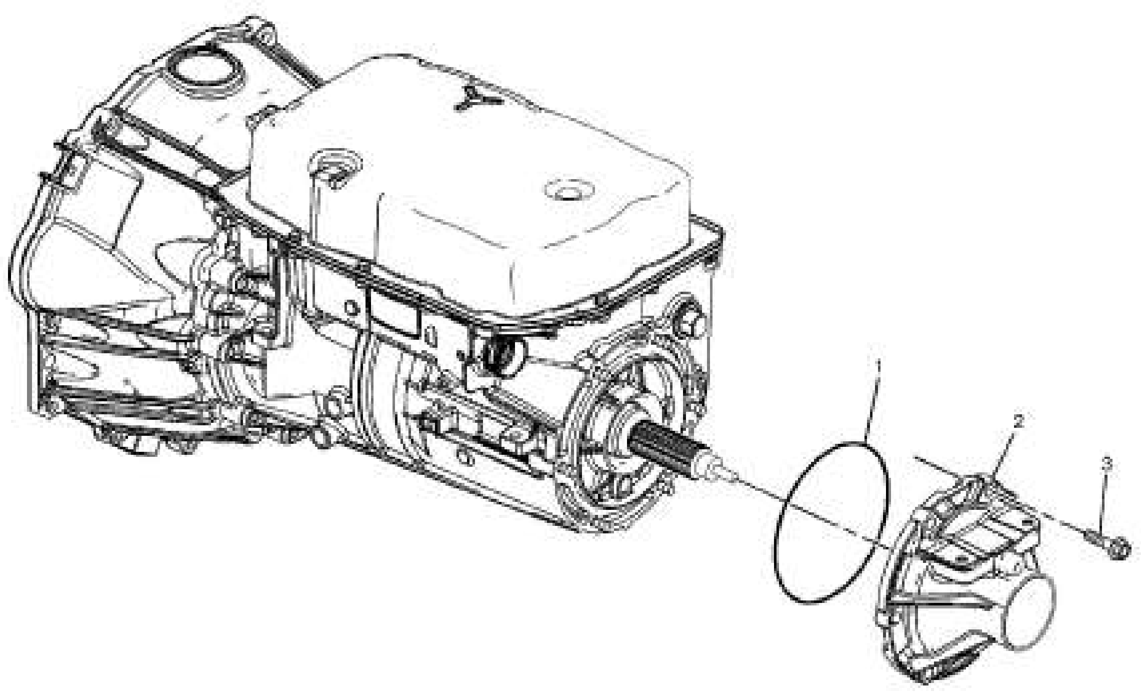
Automatic Transmission Electrical Connector Passage Sleeve Installation



Callout	Component Name
1	NEW Lip Seal
2	NEW O-Ring Seals (Quantity: 2)
3	Electrical Connector Passage Sleeve **Special Tools** • DT 47715 Electrical Connector Passage Sleeve Remover/Installer • J 42183 Driver Handle **Notice:** Refer to General Repair Instructions in the Preface section. Push down on the electrical connector slide lock to make sure proper installation.
4	Electrical Connector Slide Lock

Case Extension Assembly Removal



Callout	Component Name
1	Bolt M10 x 40 (Quantity: 6)
2	Case Extension
3	Case Extension Seal

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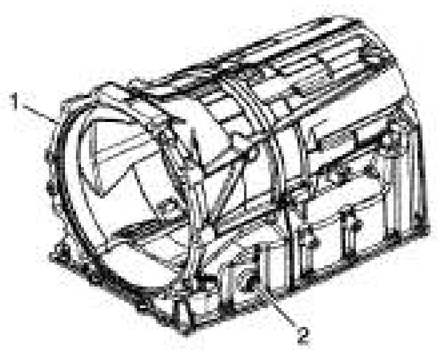
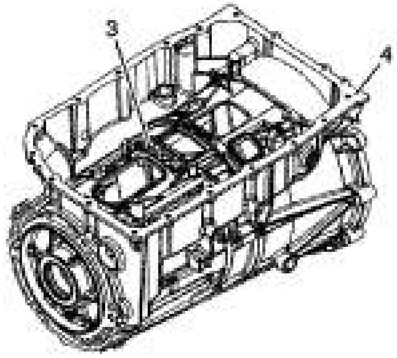
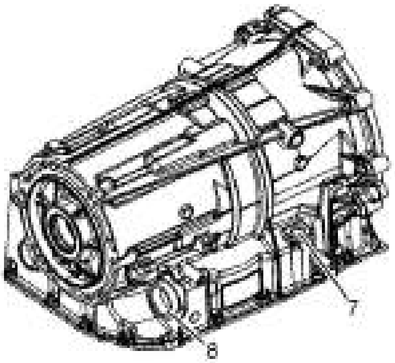
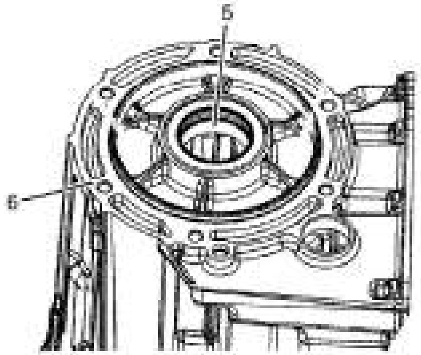
Case Inspection









<table>
<tr><th>Callout</th><th>Component Name</th></tr>
<tr><td colspan="2">Notice: Refer to General Repair Instructions in the Preface section.
Notice: Refer to General Repair Instructions in the Preface section.
Preliminary Procedures
1. Thoroughly clean the transmission case assembly, including case threads, with clean solvent.
2. Clean gasket sealing surfaces. Remove all residual gasket material.
3. Inspect all threaded holes. If necessary, repair any thread damage.</td></tr>
<tr><td>1</td><td>Front Case Sealing Surface</td></tr>
<tr><td>2</td><td>Manual Shift Shaft Seal
Tip
Refer to Manual Shift Shaft Seal Replacement.</td></tr>
<tr><td>3</td><td>Center Support Fluid Passage Seal Bores</td></tr>
<tr><td>4</td><td>Fluid Pan Sealing Surface</td></tr>
<tr><td>5</td><td>Output Shaft Bushing</td></tr>
</table>

6	Rear Case Sealing Surface
7	Fill Tube Bore
8	Electrical Connector Passage Sleeve Bore

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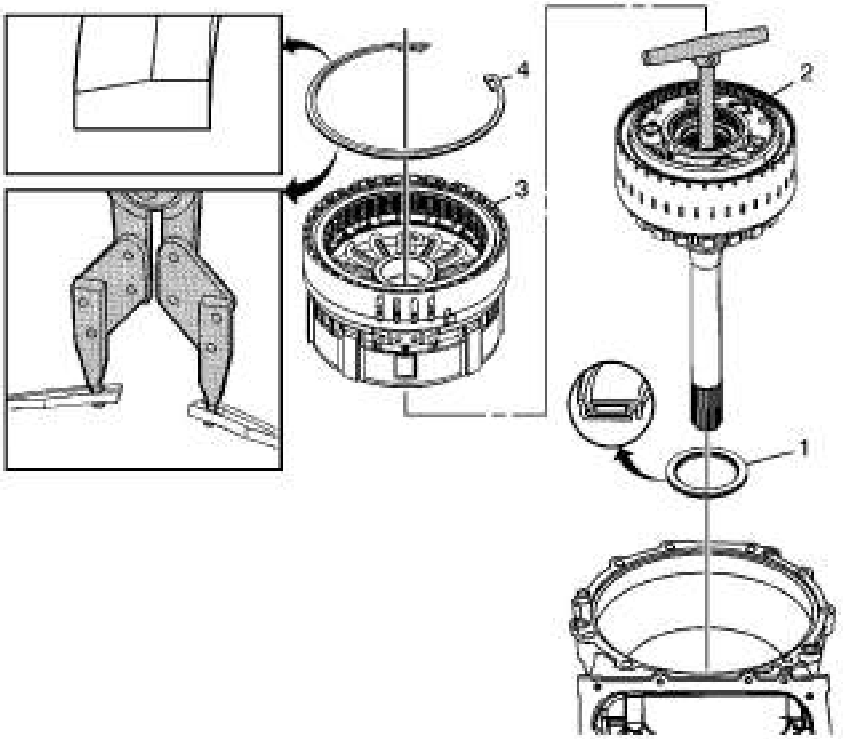
Center Support, Output Carrier and Output Shaft Installation



Callout	Component Name
1	Output Shaft Thrust Bearing Assembly
2	Output Carrier Assembly and Output Shaft Assembly **Notice:** Refer to General Repair Instructions in the Preface section. **Notice:** Refer to General Repair Instructions in the Preface section. **Special Tool** DT 47786 Output Carrier/Shaft Lifting Tool
3	Center Support Assembly • When the center support assembly is properly installed, the fluid passages should align with the fluid passage seal bores in the case assembly. • It may be necessary to rotate the output shaft by hand in order to fully install the center support assembly.
	Center Support Retaining Ring

4	**Caution:** Refer to General Repair Instructions in the Preface section. **Notice:** Refer to General Repair Instructions in the Preface section. **Special Tools** • DT 47773 Snap Ring Pliers Adapter Set • J 45126 Snap Ring Pliers

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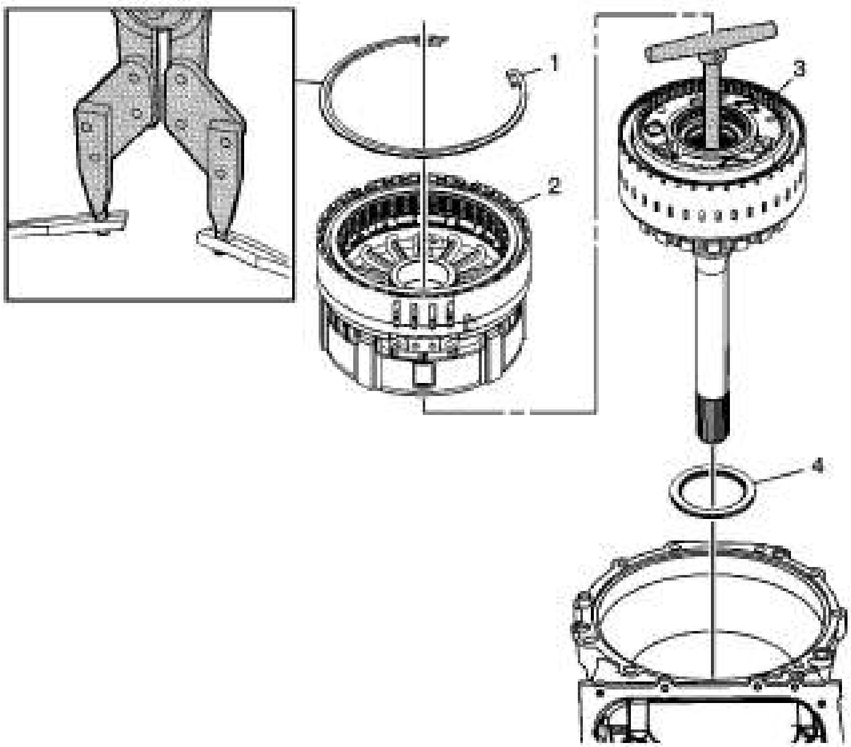
Center Support, Output Carrier and Output Shaft Removal



Callout	Component Name
1	Center Support Retaining Ring **Caution:** Refer to General Repair Instructions in the Preface section. **Tip** To release tension on the retaining ring, place the retaining ring flat on the floor and step on it, then remove the tool. **Special Tools** • DT 47773 Snap Ring Pliers Adapter Set • J 45126 Snap Ring Pliers
2	Center (with 2-6 Low and Reverse Clutch) Support Assembly
3	Output Carrier Assembly and Output Shaft Assembly **Notice:** Refer to General Repair Instructions in the Preface section.

	Special Tool DT 47786 Output Carrier/Shaft Lifting Tool
4	Output Shaft Thrust Bearing Assembly

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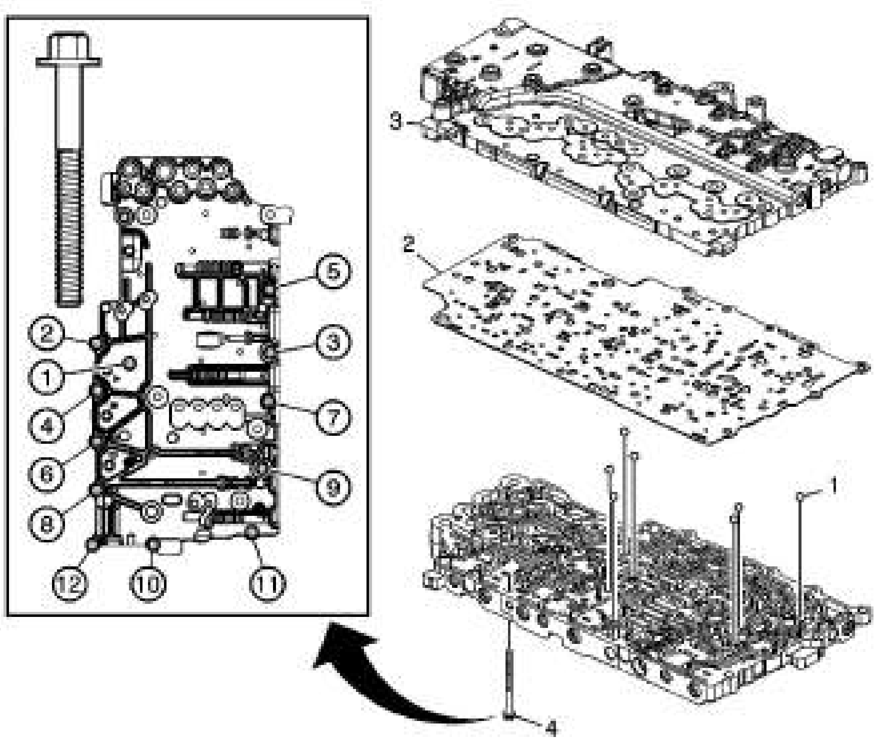
Control Valve Body Assembly Assemble

Table 1: Upper to Lower Control Valve Body Assemblies Assemble
Table 2: Filter Plate Installation
Table 3: Control Solenoid Valve Assembly Installation
Table 4: Manual Shift Shaft Position Switch Installation
Table 5: Valve Body, Control Solenoid Torque Sequence
Table 6: Control Solenoid Valve Assembly Contact Gap Inspection
Table 7: Input and Output Speed Sensor Assembly Installation

Upper to Lower Control Valve Body Assemblies Assemble

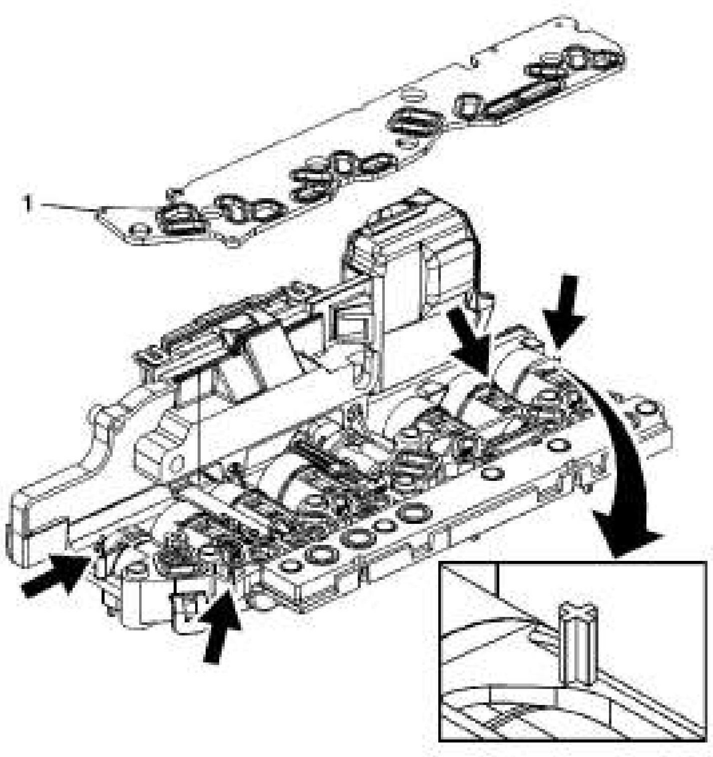


Upper to Lower Control Valve Body Assemblies Assemble

Callout	Component Name
Notice: Refer to Fastener Notice in the Preface section. Fastener Tightening Specifications: Refer to Fastener Tightening Specifications .	
1	Control Valve Body Ball Check Valve (Quantity: 7) **Tip** Refer to Ball Check Valve Locations.

2	Control Valve Body Spacer (w/Gasket) Plate Assembly **Notice:** Refer to General Repair Instructions in the Preface section.
3	Control Valve Lower Body Assembly **Tip** Turn the valve body assembly over after installing to upper body.
4	Bolt M5 x 36 (Quantity: 12) **Tighten** Tighten the bolts in the sequence shown to 8 N·m (71 lb. in).

Filter Plate Installation

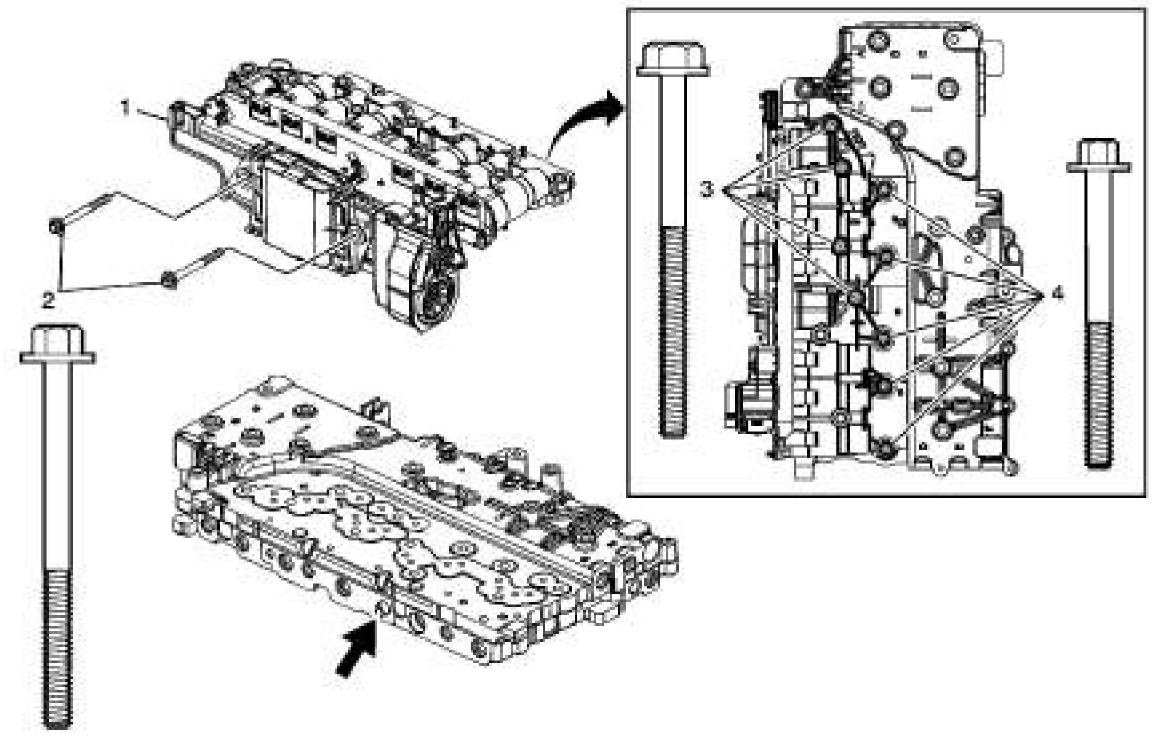


Filter Plate Installation

Callout	Component Name
1	Filter Plate Assembly **Notice:** Refer to General Repair Instructions in the Preface section. **Notice:** Refer to General Repair Instructions in the Preface section. **Tip** Use care when removing or installing the filter plate assembly. However, if a

	retaining tab is broken or missing, DO NOT replace the control solenoid valve assembly. The filter plate assembly can still be adequately aligned.

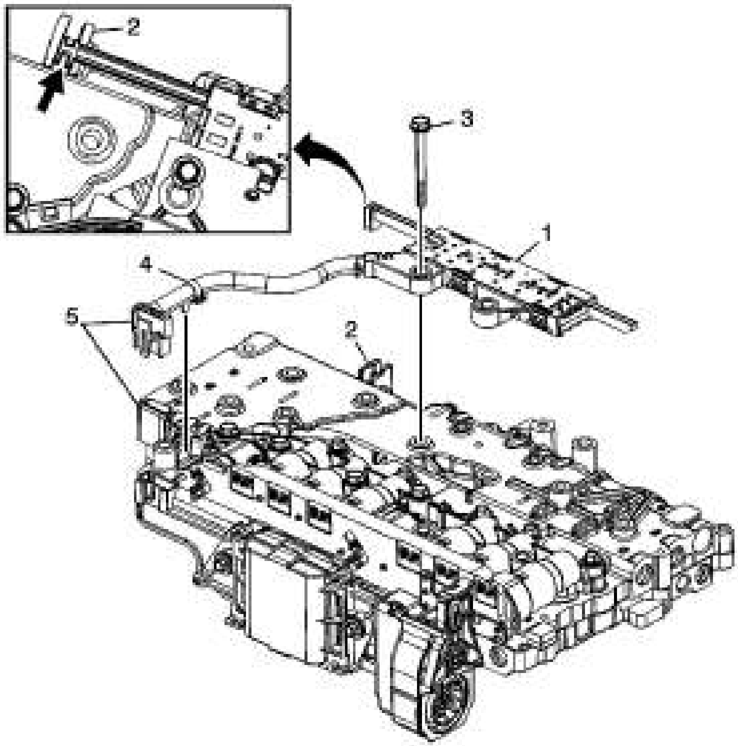
Control Solenoid Valve Assembly Installation



Control Solenoid Valve Assembly Installation

Callout	Component Name
1	Control Solenoid (w/Body and TCM) Valve Assembly **Tip** Note the locator pin on the control valve lower body assembly while aligning the control solenoid valve assembly.
2	Bolt M5 x 53 (Quantity: 2) **Tip** Hand tighten only.
3	Bolt M5 x 55 (Quantity: 4) **Tip** Hand tighten only.
4	Bolt M5 x 45 (Quantity: 5) **Tip** Hand tighten only.

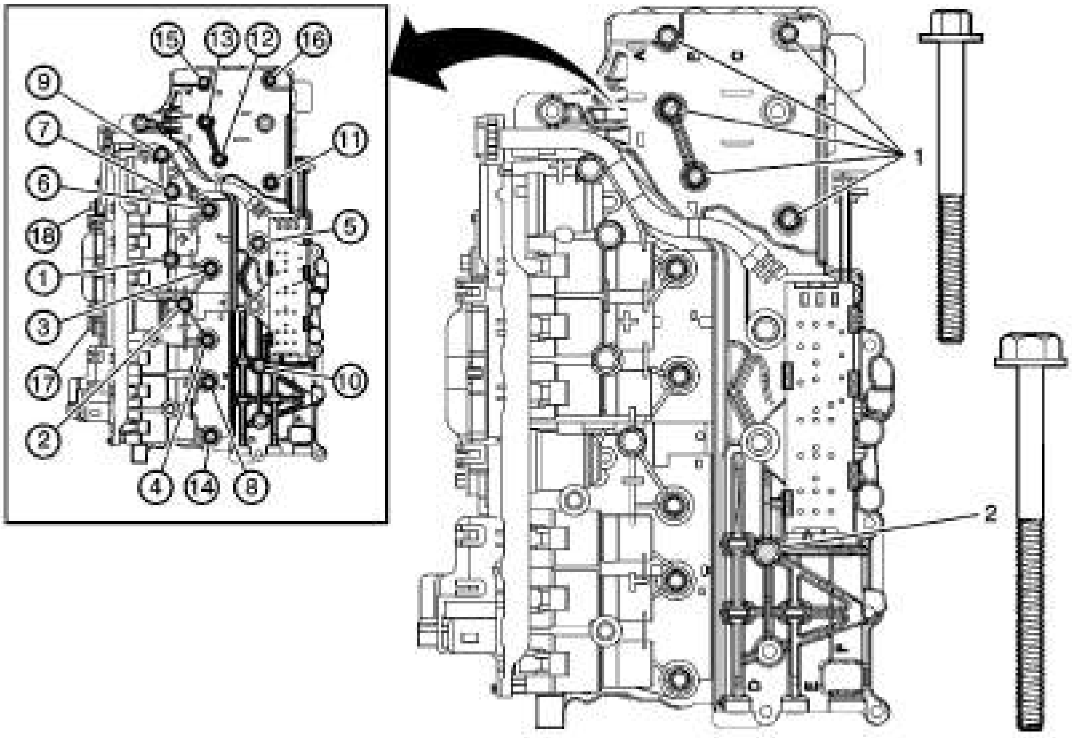
Manual Shift Shaft Position Switch Installation



Manual Shift Shaft Position Switch Installation

Callout	Component Name
1	A/Trans Manual Shift Shaft Position Switch Assembly
2	Manual Valve Link **Tip** Align the switch activator slide with the manual valve link.
3	Bolt M5 x 55 **Tip** Hand tighten only.
4	A/Trans Manual Shift Shaft Position Switch Harness Clip **Tip** The wiring harness clip on the manual shift shaft position switch does not need to be replaced if damaged or missing. The clip functions only as a manufacturing assembly aid to keep the harness clear during an automated bolt installation process. If the clip is damaged, simply remove and discard.
5	A/Trans Manual Shift Shaft Position Switch Electrical Connector **Tip** Connect and lock the manual shift shaft position switch electrical connector to the control solenoid valve assembly.

Valve Body, Control Solenoid Torque Sequence



Valve Body, Control Solenoid Torque Sequence

<table>
<tr><th>Callout</th><th>Component Name</th></tr>
<tr><td colspan="2">Notice: Refer to Fastener Notice in the Preface section.

Fastener Tightening Specifications: Refer to Fastener Tightening Specifications .

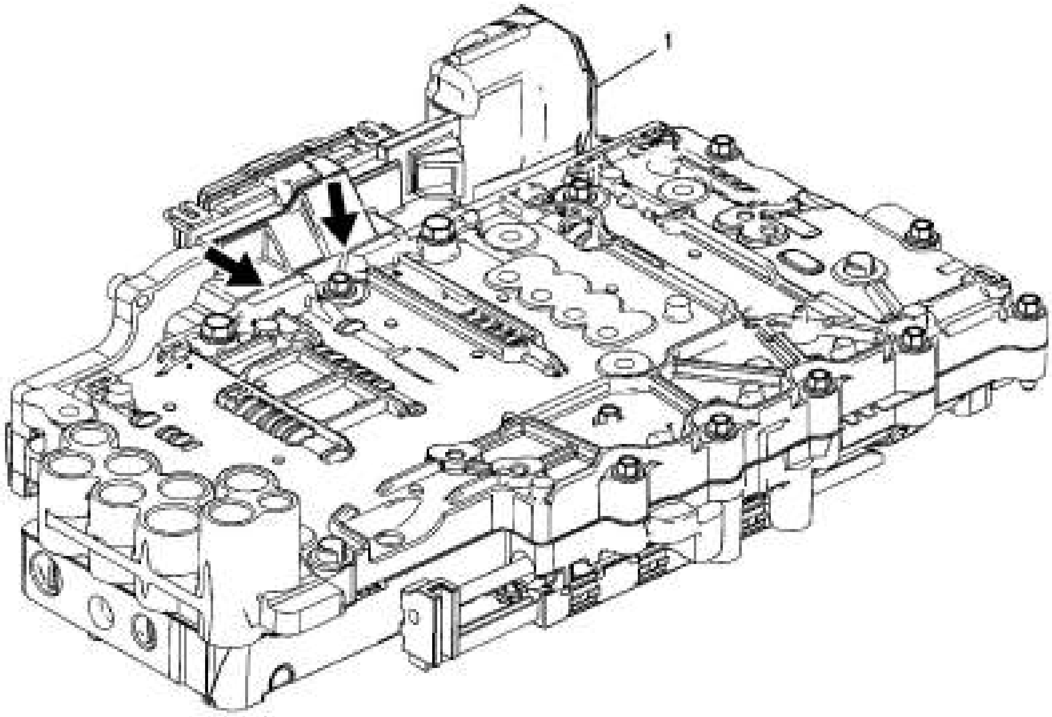
Notice: Refer to General Repair Instructions in the Preface section.

Tip

1. Hand tighten the last 6 bolts before final torque sequence.
2. The 2 "heat sink" bolts must be tightened last.</td></tr>
<tr><td>1</td><td>Bolts M5 x 45 (Quantity: 5)</td></tr>
<tr><td>2</td><td>Bolt M5 x 55

Tighten
Tighten all 18 bolts in the sequence shown to 8 N·m (71 lb. in).</td></tr>
</table>

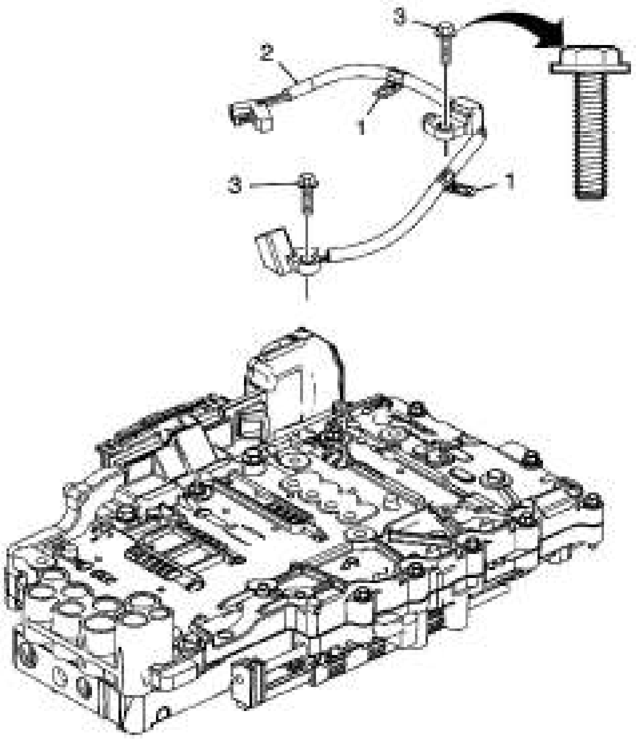
Control Solenoid Valve Assembly Contact Gap Inspection



Control Solenoid Valve Assembly Contact Gap Inspection

Callout	Component Name
1	Control Solenoid (w/Body and TCM) Valve Assembly **Tip** Inspect the contact area between the "heat sink" area of the control solenoid valve assembly and the valve body. There should be no visible gap. If a gap exists, loosen all 18 bolts and retighten in the required sequence.

Input and Output Speed Sensor Assembly Installation



Input and Output Speed Sensor Assembly Installation

Callout	Component Name
Notice: Refer to Fastener Notice in the Preface section. Fastener Tightening Specifications: Refer to Fastener Tightening Specifications .	
1	A/Trans Input and Output Speed Sensor Wiring Harness Clip (Quantity: 2) **Tip** Inspect the 2 wiring harness clips for damage. Replace if damaged.
2	A/Trans Input and Output Speed Sensor Assembly
3	Bolt M6 x 20 (Quantity: 2) **Tighten** Tighten bolts to 12 N·m (106 lb. in)

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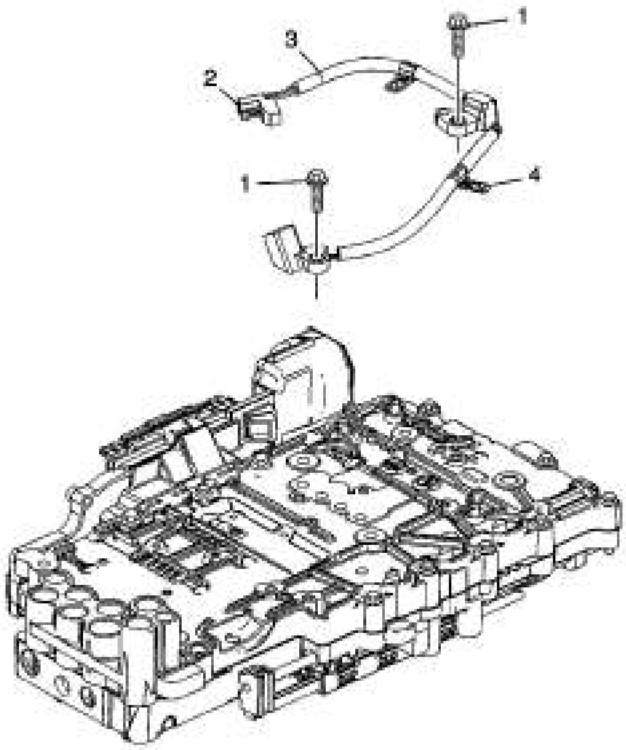
Control Valve Body Assembly Disassemble

Table 1: Input and Output Speed Sensor Assembly Removal
Table 2: Manual Shaft Detent Assembly and Manual Shift Shaft Position Switch Removal
Table 3: Control Solenoid Valve Assembly Removal
Table 4: Upper and Lower Valve Bodies Disassemble

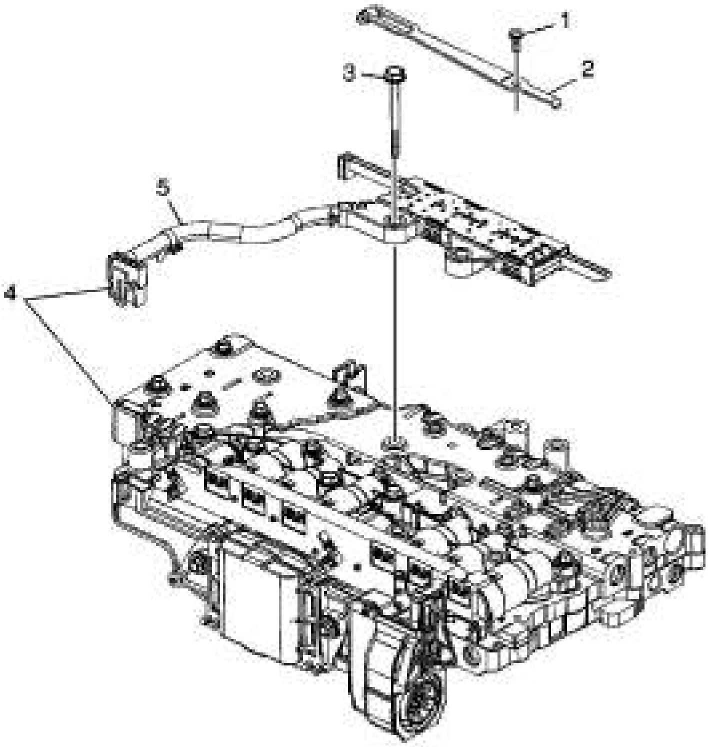
Input and Output Speed Sensor Assembly Removal



Input and Output Speed Sensor Assembly Removal

Callout	Component Name
1	Bolt M6 x 20 (Quantity: 2)
2	Speed Sensor Electrical Connector Release the connector lock before disconnecting.
3	A/Trans Input and Output Speed Sensor Assembly
4	A/Trans Input and Output Speed Sensor Wiring Harness Clip (Quantity: 2) Inspect the clips and replace if damaged.

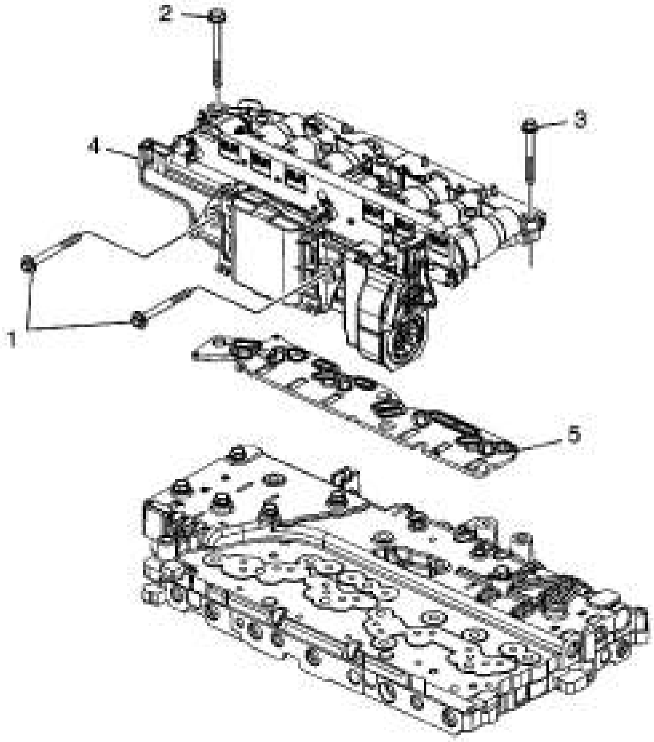
Manual Shaft Detent Assembly and Manual Shift Shaft Position Switch Removal



Manual Shaft Detent Assembly and Manual Shift Shaft Position Switch Removal

Callout	Component Name
1	Bolt M6 x 14.5
2	Manual Shaft Detent Assembly
3	Bolt M5 x 55
4	A/Trans Manual Shift Shaft Position Switch Assembly Electrical Connector Release the connector lock before disconnecting.
5	A/Trans Manual Shift Shaft Position Switch Assembly

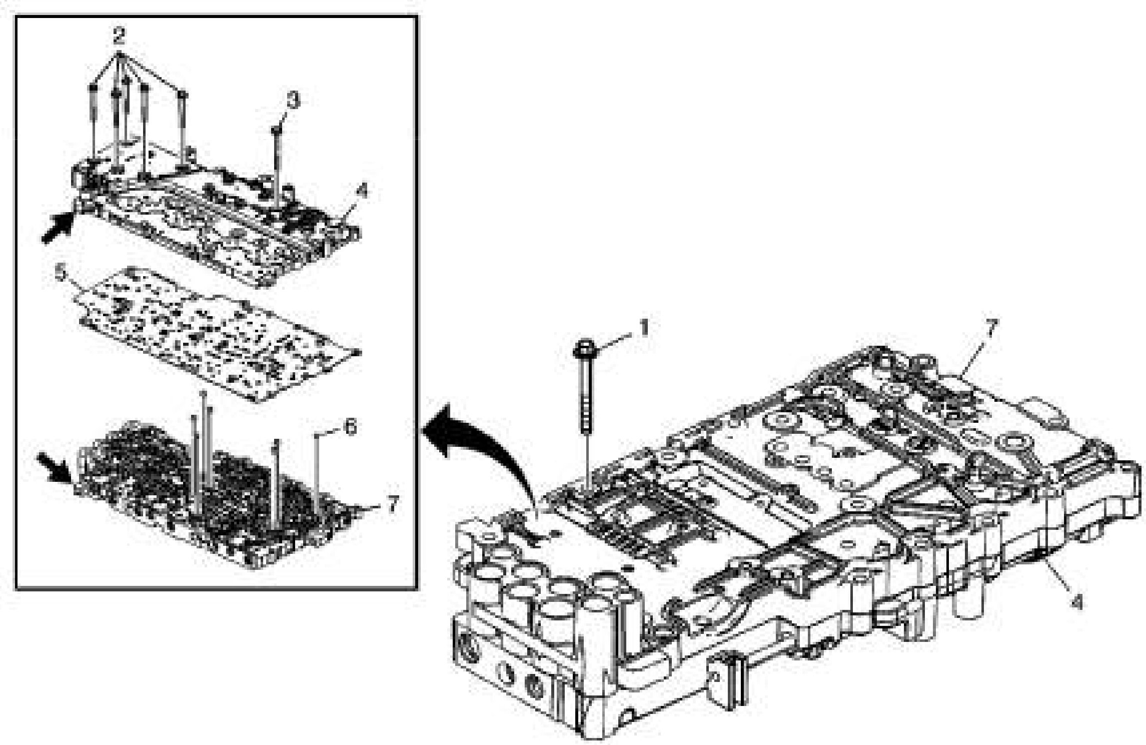
Control Solenoid Valve Assembly Removal



Control Solenoid Valve Assembly Removal

Callout	Component Name
1	Bolt M5 x 53 (Quantity: 2)
2	Bolt M5 x 55 (Quantity: 4)
3	Bolt M5 x 45 (Quantity: 5)
4	Control Solenoid (w/Body and TCM) Valve Assembly **Notice:** Refer to General Repair Instructions in the Preface section.
5	Filter Plate Assembly **Notice:** Refer to General Repair Instructions in the Preface section. **Notice:** Refer to General Repair Instructions in the Preface section.

Upper and Lower Valve Bodies Disassemble



Upper and Lower Valve Bodies Disassemble

Callout	Component Name
1	Bolt M5 x 36 (Quantity: 12)
2	Bolt M5 x 45 (Quantity: 5)
3	Bolt M5 x 55
4	Control Valve Lower Body Assembly • Separate the upper and lower valve bodies by carefully prying at the point indicated. • Refer to Control Valve Lower Body Assembly Cleaning and Inspection.
5	Control Valve Body Spacer (w/Gasket) Plate Assembly **Notice:** Refer to General Repair Instructions in the Preface section.
6	Control Valve Body Ball Check Valve (Quantity: 7) Note the position of the ball check valves.
7	Control Valve Upper Body Assembly Refer to Control Valve Upper Body Assembly Cleaning and Inspection.

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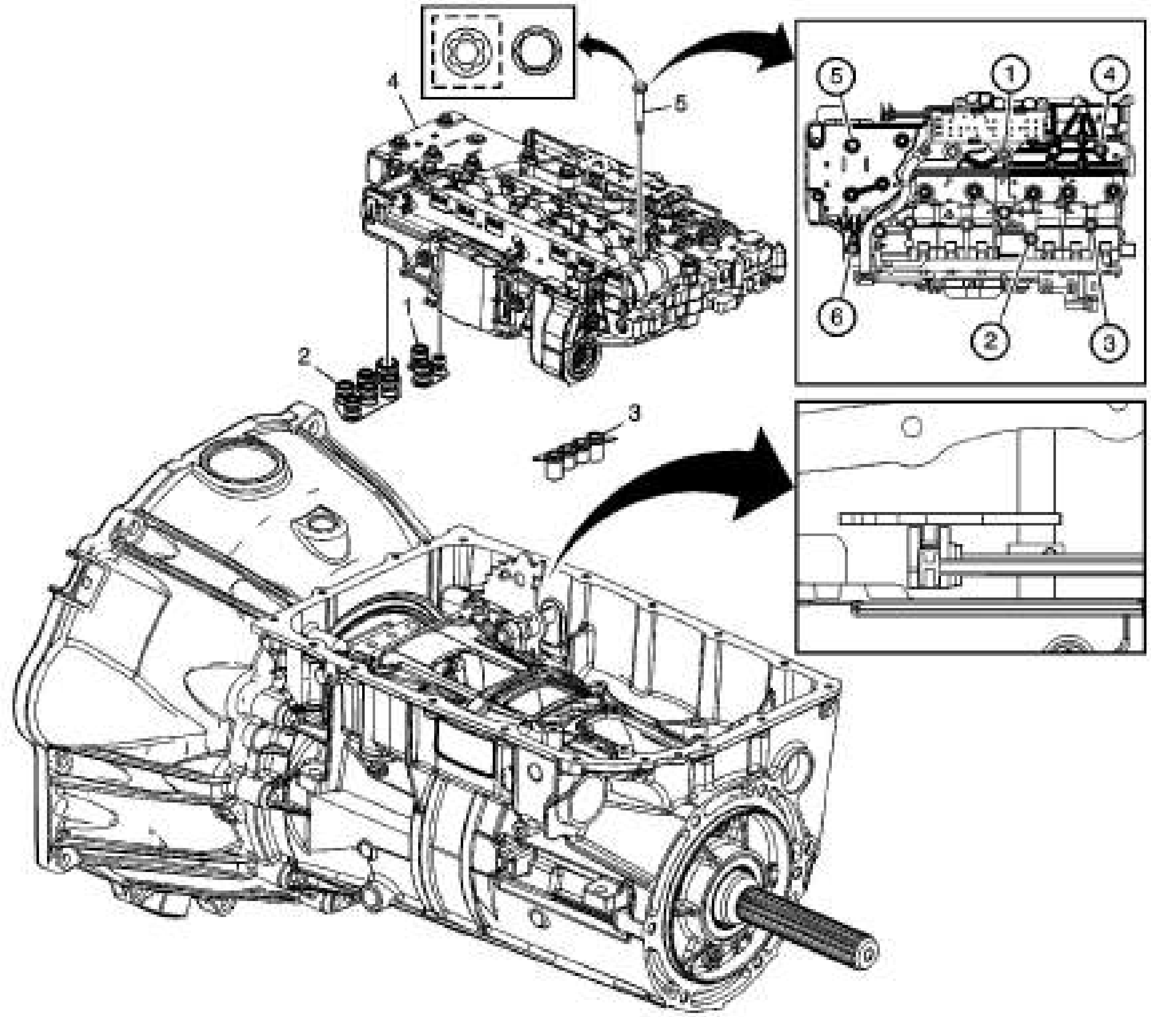
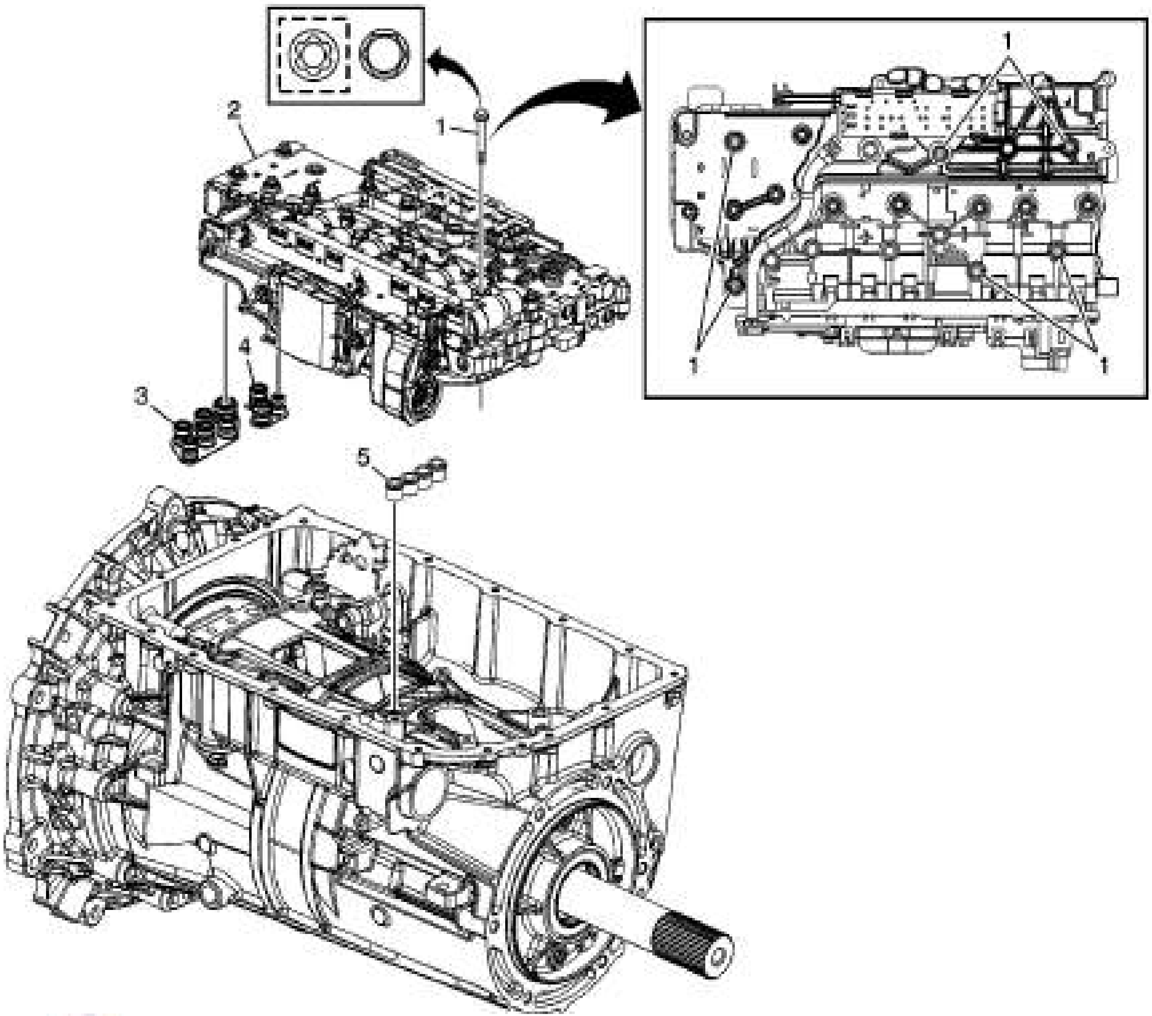
Control Valve Body Assembly Installation



Callout	Component Name
Notice: Refer to Fastener Notice in the Preface section.	
1	NEW Fluid Pump Seal Assembly
2	NEW Fluid Pump Seal Assembly
3	NEW Centre Support Fluid Passage Seal Assembly
4	Control Valve Body Assembly **Tip** Align the manual shift shaft position switch activator slide with the detent lever guide pin.

5	Bolts M5 x 73 (Quantity: 6) **Tighten** 8 N·m (71 lb. in) in the sequence shown.

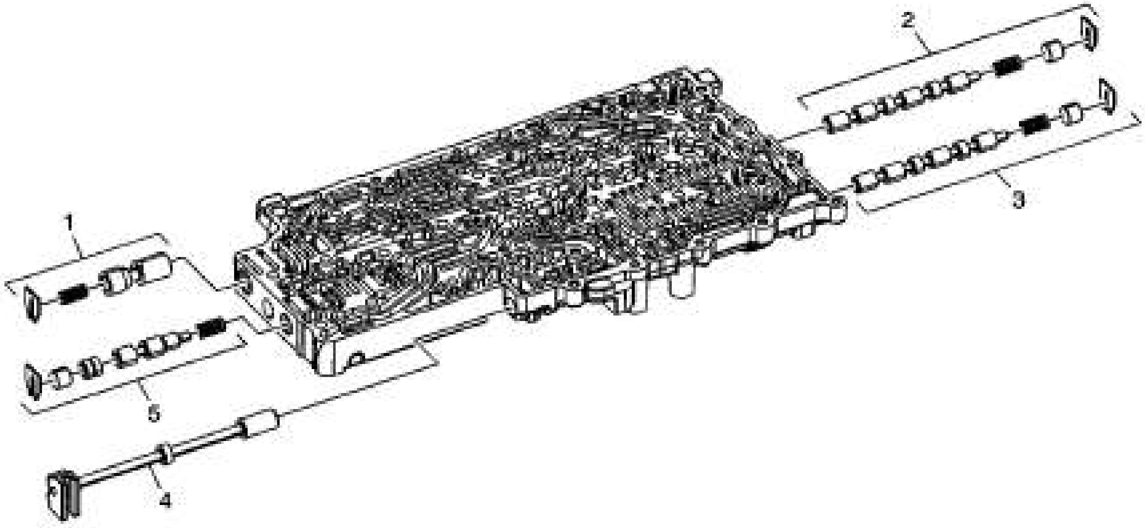
Control Valve Body Assembly Removal



Callout	Component Name
1	Bolt M5 x 73 (Qty: 6) **Important:** Do not remove all the bolts in the control valve body assembly. Remove only the bolts indicated. **Special Tool** DT-48285 Valve Body Torx Plus Socket (if applicable)
2	Control Valve Body Assembly **Notice:** Use care when handling the control valve body assembly. If dropped, damage to the control solenoid valve body assembly internal components, including

	the transmission control module (TCM), may result.
3	**Important:** Do not reuse the seals. Replace with NEW seals. Reusing old seals may cause transmission damage. Fluid Pump Seal Assembly
4	**Important:** Do not reuse the seals. Replace with NEW seals. Reusing old seals may cause transmission damage. Fluid Pump Seal Assembly
5	**Important:** Do not reuse the seals. Replace with NEW seals. Reusing old seals may cause transmission damage. Center Support Fluid Passage Seal Assembly

Control Valve Lower Body Assembly Cleaning and Inspection



Callout	Component Name
Caution: Valve springs can be tightly compressed. Use care when removing retainers and plugs. Personal injury could result. **Important:** Clean and inspect all valve components and the valve body. The control valve lower body is replaceable only as an assembly.	
1	Clutch Piston Dam Feed Regulator Valve Train
2	Clutch Select Solenoid Valve Train
3	Clutch Select Solenoid Valve Train
4	Manual Valve
5	TCC Regulator Apply Valve Train

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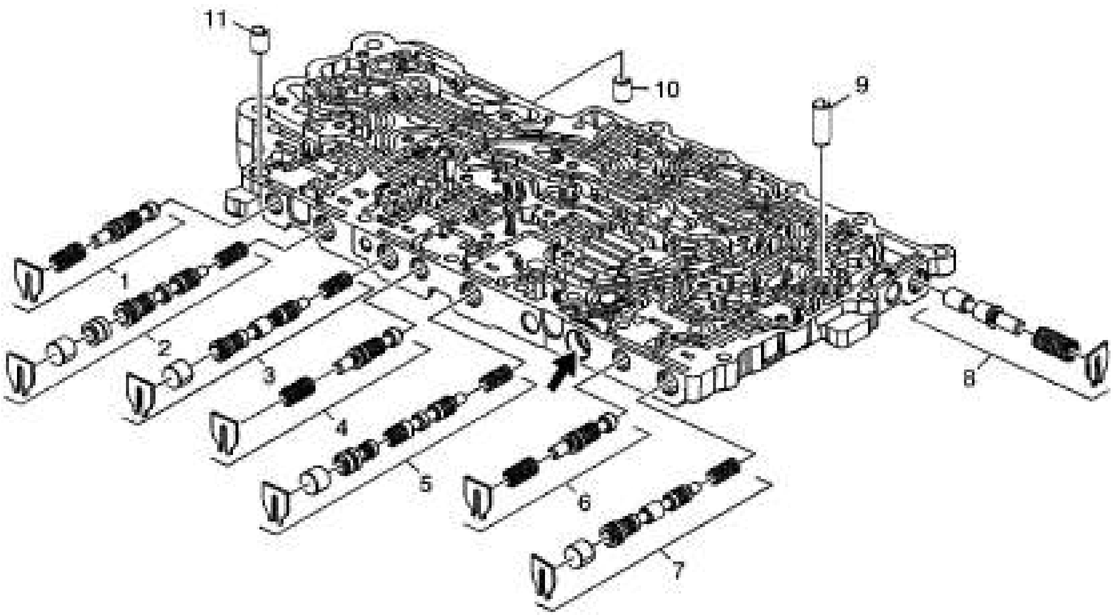
Control Valve Upper Body Assembly Cleaning and Inspection



Callout	Component Name
Caution: Valve springs can be tightly compressed. Use care when removing retainers and plugs. Personal injury could result. **Notice:** Refer to General Repair Instructions in the Preface section. **Important:** Clean and inspect all valve components, locating pins, and the valve body. The control valve upper body is replaceable only as an assembly.	
1	Clutch Boost Valve Train
2	1-2-3-4 Clutch Regulator Valve Train
3	3-5 Reverse Clutch Regulator Valve Train
4	Clutch Boost Valve Train
5	2-6 Clutch Regulator Valve Train
6	Clutch Boost Valve Train
7	1/Reverse Band and 4-5-6 Clutch Regulator Valve Train
8	Actuator Feed Limit Valve Train
9	Control Valve Body Locator Pin

10	Control Valve Body Locator Pin
11	Control Valve Body Locator Pin

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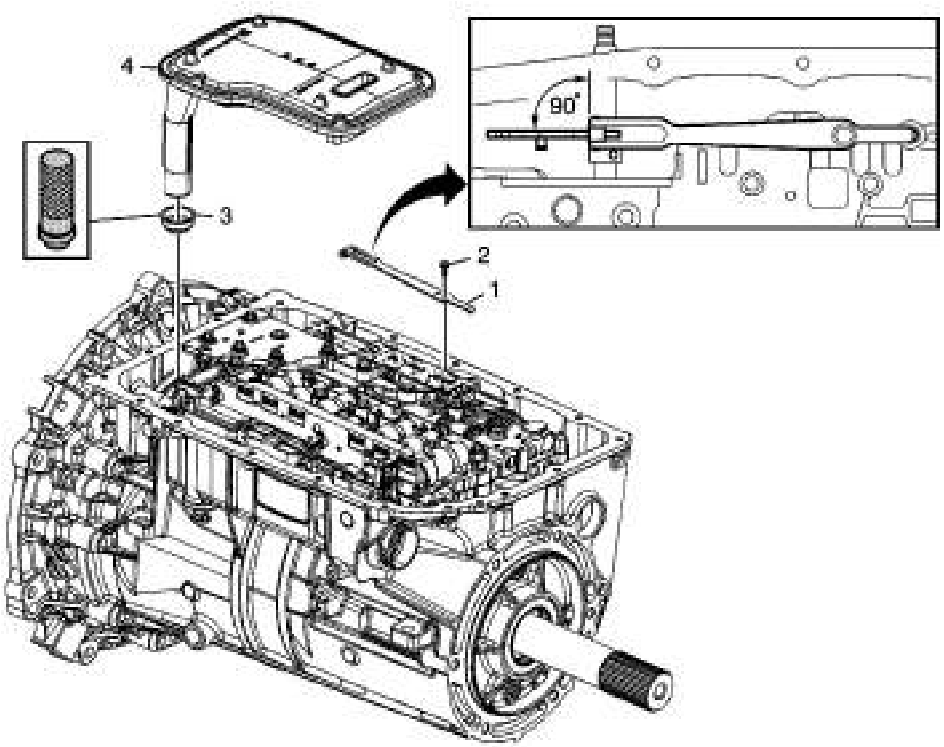
Fluid Filter and Manual Shift Detent Assembly Installation



Callout	Component Name
Notice: Refer to Fastener Notice in the Preface section. Fastener Tightening Specifications: Refer to Fastener Tightening Specifications .	
1	Manual Shaft Detent Assembly **Notice:** Refer to General Repair Instructions in the Preface section.
2	Bolt M6 x 14.5 **Tighten** 12 N·m (106 lb. in).
3	NEW Fluid Filter Seal Assembly **Special Tools** • DT 47848 Seal Installer • J 42183 Driver Handle
4	NEW Fluid Filter Assembly

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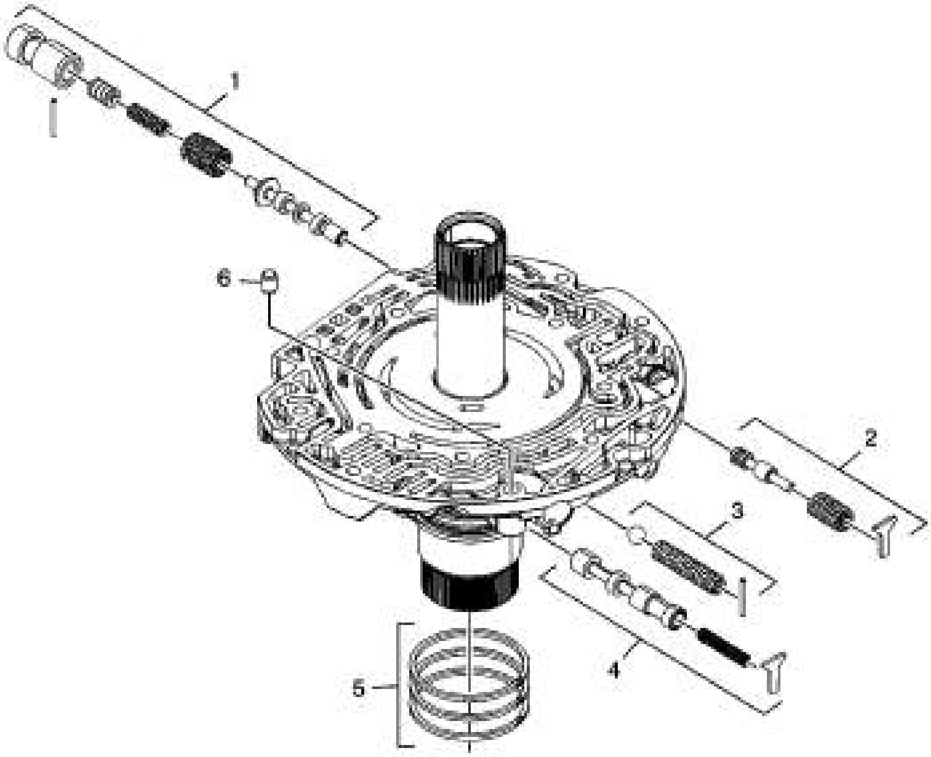
Fluid Pump Cover Cleaning and Inspection



Callout	Component Name
Caution: Valve springs can be tightly compressed. Use care when removing retainers and plugs. Personal injury could result. **Tip** Clean and inspect all components and machined surfaces.	
1	Pressure Regulator Valve Train
2	Converter Feed Limit Valve Train
3	Pressure Relief Ball Valve and Spring
4	TCC Control Valve and Spring
5	1-2-3-4 and 3-5 Reverse Clutch Fluid Seal Rings (Quantity: 3) **Notice:** Refer to General Repair Instructions in the Preface section.
6	A/Trans Fluid Pump Locator Pin

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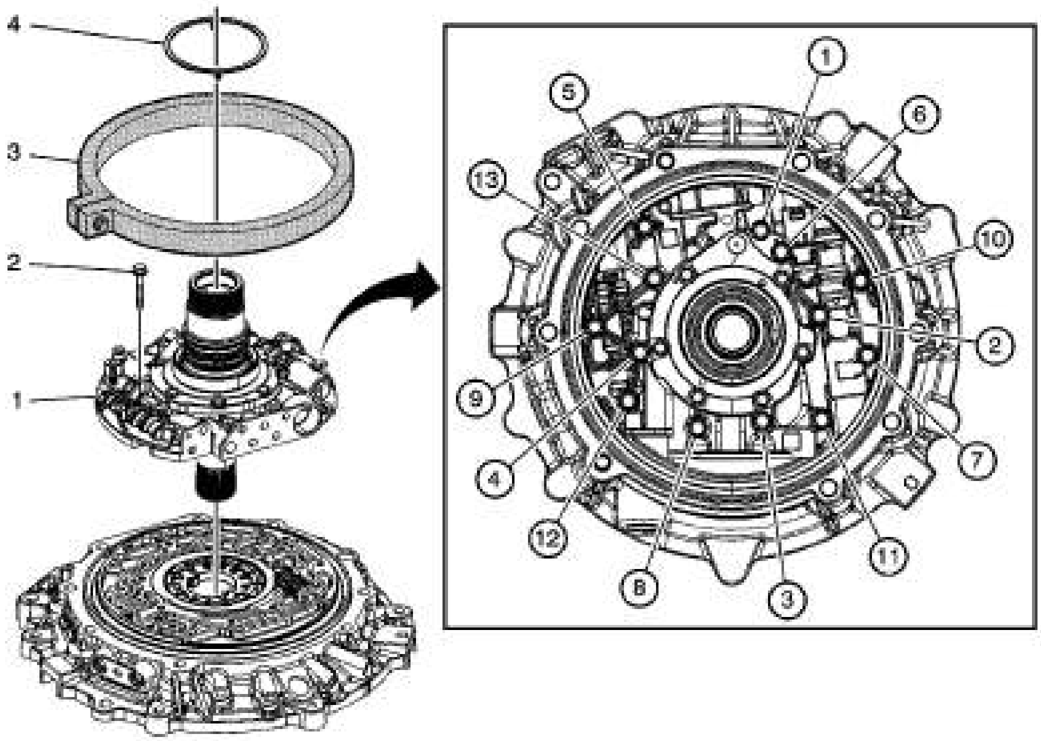
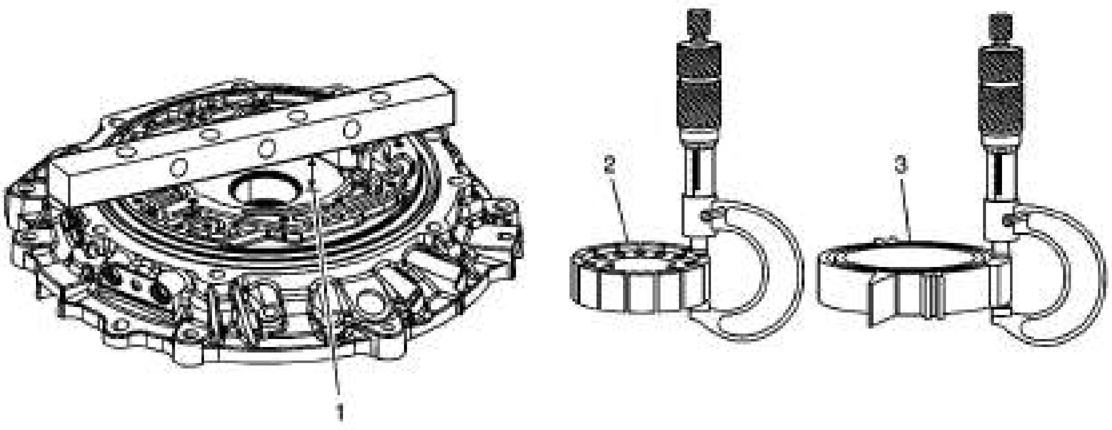
Fluid Pump Cover Installation



Callout	Component Name
Notice: Refer to Fastener Notice in the Preface section. Fastener Tightening Specifications: Refer to Fastener Tightening Specifications .	
1	Fluid Pump Cover Assembly
2	Fluid Pump Cover Bolts M6 x 40 (Quantity: 13) **Tip** Hand tighten only.
3	Alignment Tool and Bolt **Tip** 1. Center the J 46664 around the fluid pump cover assembly in the 9 o'clock position and tighten the alignment bolt. 2. Tighten the fluid pump cover bolts in the sequence shown. **Tighten** 11 N·m (97 lb in)

	Special Tool J 46664 Pump Cover Alignment Tool
4	NEW 1-2-3-4 and 3-5 Reverse Clutch Housing Thrust Washer

Fluid Pump Selective Measurement



Callout	Component Name
1	Pump Rotor Cavity **Tip** Measure the distance from the bottom of the gauge bar to the bottom of the pump rotor cavity. Refer to Fluid Pump Selective Specifications.
2	A/Trans Fluid Pump Rotor **Tip** Refer to Fluid Pump Selective Specifications.
3	A/Trans Fluid Pump Slide **Tip** Refer to Fluid Pump Selective Specifications.

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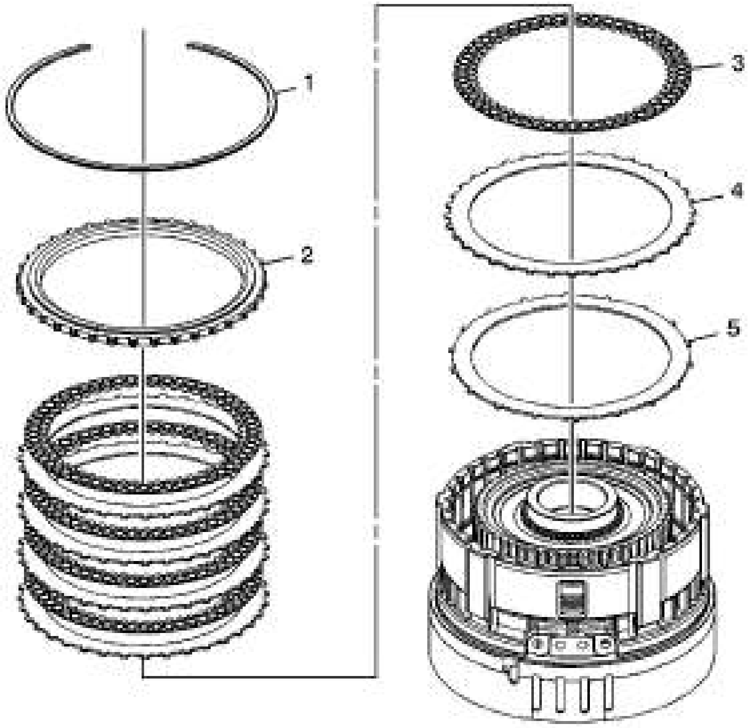
Low and Reverse Clutch Overhaul

Table 1: Low and Reverse Clutch Plate Removal
Table 2: Low and Reverse Clutch Piston Removal
Table 3: Low and Reverse Clutch Piston Installation
Table 4: Low and Reverse Clutch Plate Installation

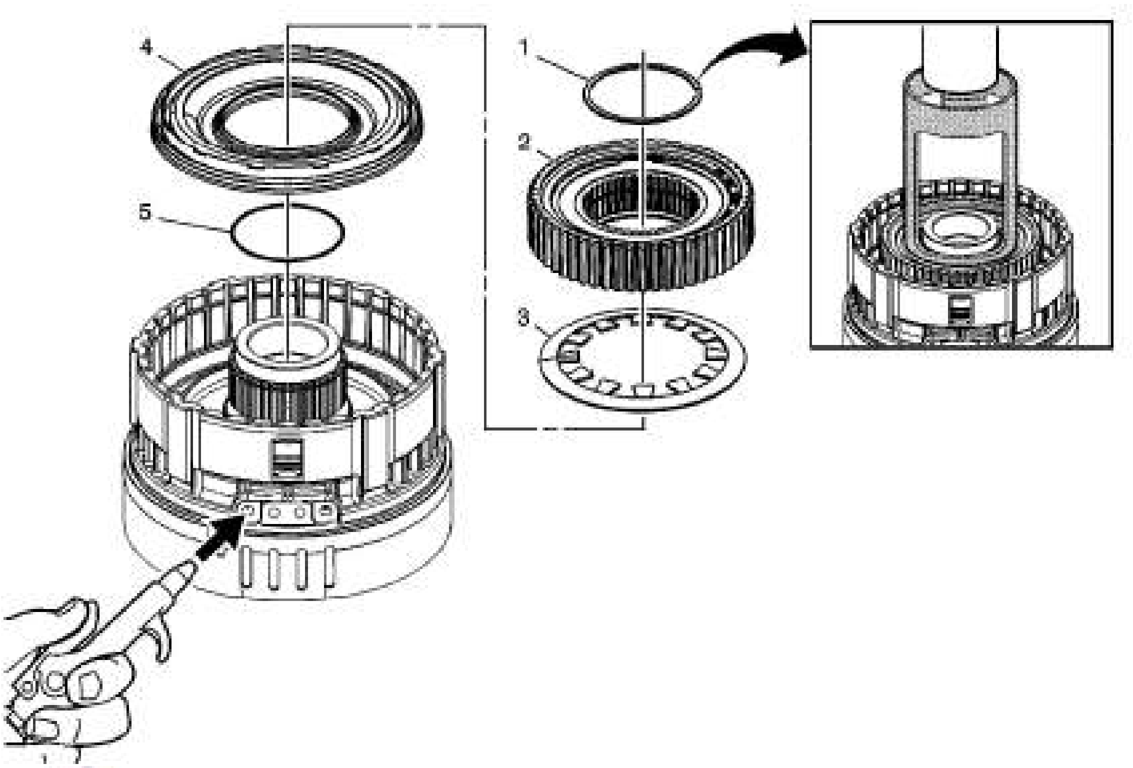
Low and Reverse Clutch Plate Removal



Low and Reverse Clutch Plate Removal

Callout	Component Name
1	Low and Reverse Clutch Backing Plate Retaining Ring
2	Low and Reverse Clutch Backing Plate
3	Low and Reverse Clutch Plate Assembly (Quantity: 5)
4	Low and Reverse Clutch Plate (Quantity: 5)
5	Low and Reverse Clutch (Waved) Plate

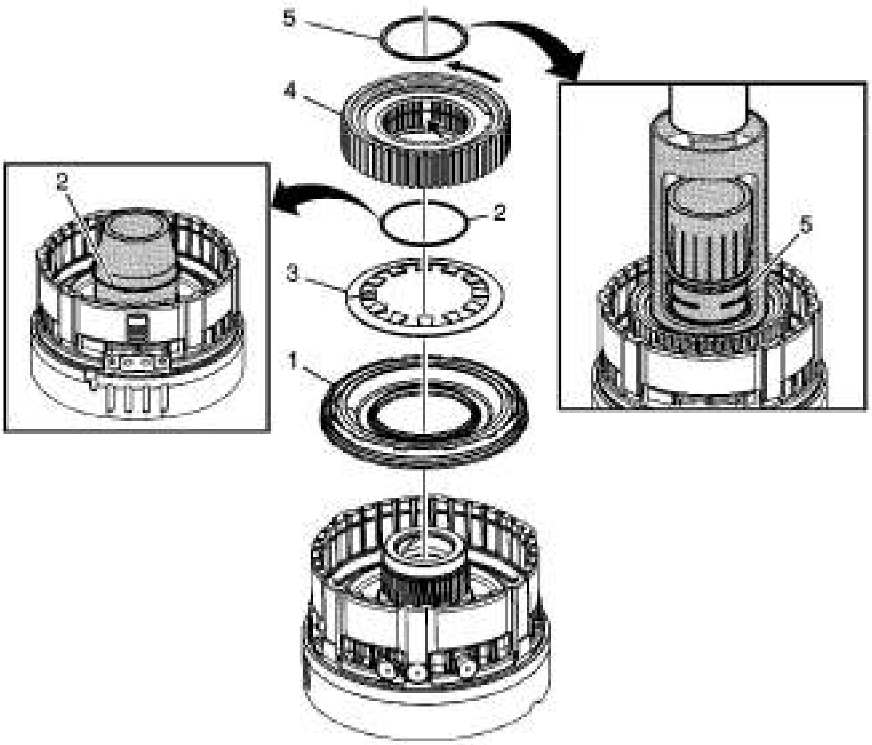
Low and Reverse Clutch Piston Removal



Low and Reverse Clutch Piston Removal

Callout	Component Name
1	Low and Reverse Clutch Spring Retaining Ring **Important:** Ensure the DT47779 contacts the sprag assembly and not the sprag retaining ring. Damage to the sprag may result. **Special Tool** DT 47779 Clutch Spring Compressor
2	Low Clutch Sprag Assembly
3	Low and Reverse Clutch Spring
4	Low and Reverse Clutch Piston Assembly It may be necessary to apply air to the apply passage in order to unseat the piston.
5	Low Clutch Sprag Seal

Low and Reverse Clutch Piston Installation

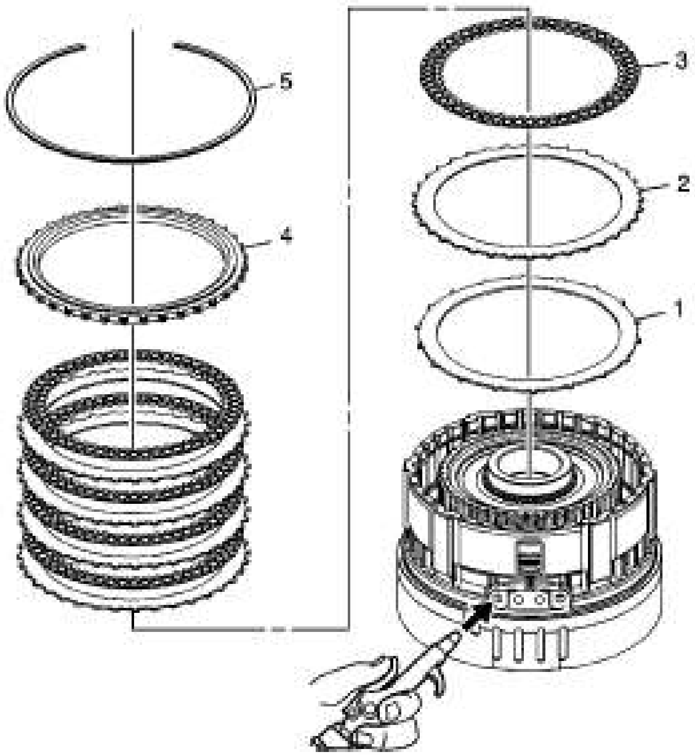


Low and Reverse Clutch Piston Installation

Callout	Component Name
1	Low and Reverse Clutch Piston Assembly Lubricate the inner and outer sealing surfaces of the piston assembly with automatic transmission fluid (ATF) in order to ease installation into the center support assembly.
2	Low Clutch Sprag Seal Apply ATF to the DT 47780 to ease seal installation. **Special Tool** DT 47780 Low Clutch Sprag Seal Cone
3	Low and Reverse Clutch Spring **Important:** Ensure the spring tabs are facing up during installation. Failure to do so may cause damage to the clutch assembly.
4	Low Clutch Sprag Assembly • Verify that the low clutch sprag is operating correctly. Refer to the illustration for proper freewheel direction. • Ensure the missing splines on the sprag assembly are aligned with the missing splines on the center support hub.
	Low and Reverse Clutch Spring Retaining Ring

5	**Important:** Ensure the DT47779 contacts the sprag assembly and not the sprag retaining ring. Damage to the sprag may result. **Important:** The retaining ring gap must be aligned with the 3 missing splines on the center support hub. Failure to do so may cause damage to the clutch assembly **Special Tools** • DT 47778-1 Low Clutch Sprag Retaining Ring Cone • DT 47778-2 Low Clutch Sprag Retaining Ring Pusher • DT 47779 Clutch Spring Compressor

Low and Reverse Clutch Plate Installation



Low and Reverse Clutch Plate Installation

Callout	Component Name
1	Low and Reverse Clutch (Waved) Plate
2	Low and Reverse Clutch Plate (Quantity: 5)
3	Low and Reverse Clutch Plate Assembly (Quantity: 5)
4	Low and Reverse Clutch Backing Plate
5	Low and Reverse Clutch Backing Plate Retaining Ring

	Apply air to verify proper installation of all low and reverse clutch components.

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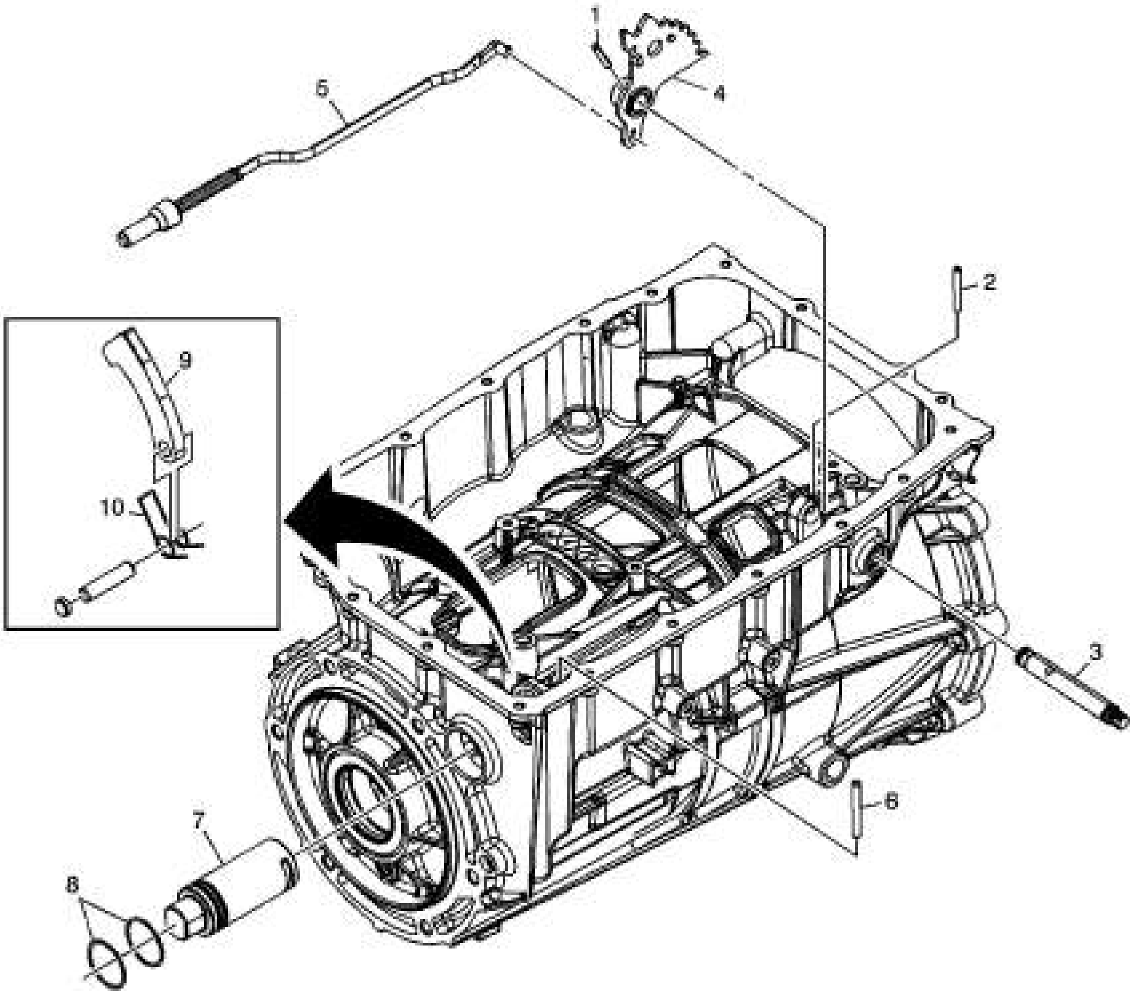
Manual Shift Shaft and Parking System Components Overhaul



Callout	Component Name
1	Manual Shaft Detent Lever Hub Pin **Important:** Discard the pin. Replace with NEW pin.
2	Manual Shift Shaft Pin **Important:** Discard the pin. Replace with NEW pin.
3	Manual Shift Shaft **Important:** Ensure the manual shift shaft seal is replaced before installing the shaft. Refer to Manual Shift Shaft Seal Replacement.

4	Manual Shaft Detent Lever Assembly
5	Park Pawl Actuator Assembly
6	Park Pawl Actuator Guide Pin **Important:** Discard the pin. Replace with NEW pin. **Tip** Use a large pair of side cutters to "walk" the pin out.
7	Park Pawl Actuator Guide
8	Park Pawl Actuator Guide (O-ring) Seals **Important:** Discard seals. Replace with NEW seals.
9	Park Pawl **Important:** Inspect for damage only. Do not remove. The park pawl is not a serviceable component.
10	Park Pawl Spring **Important:** Inspect for damage only. Do not remove. The park pawl spring is not a serviceable component.

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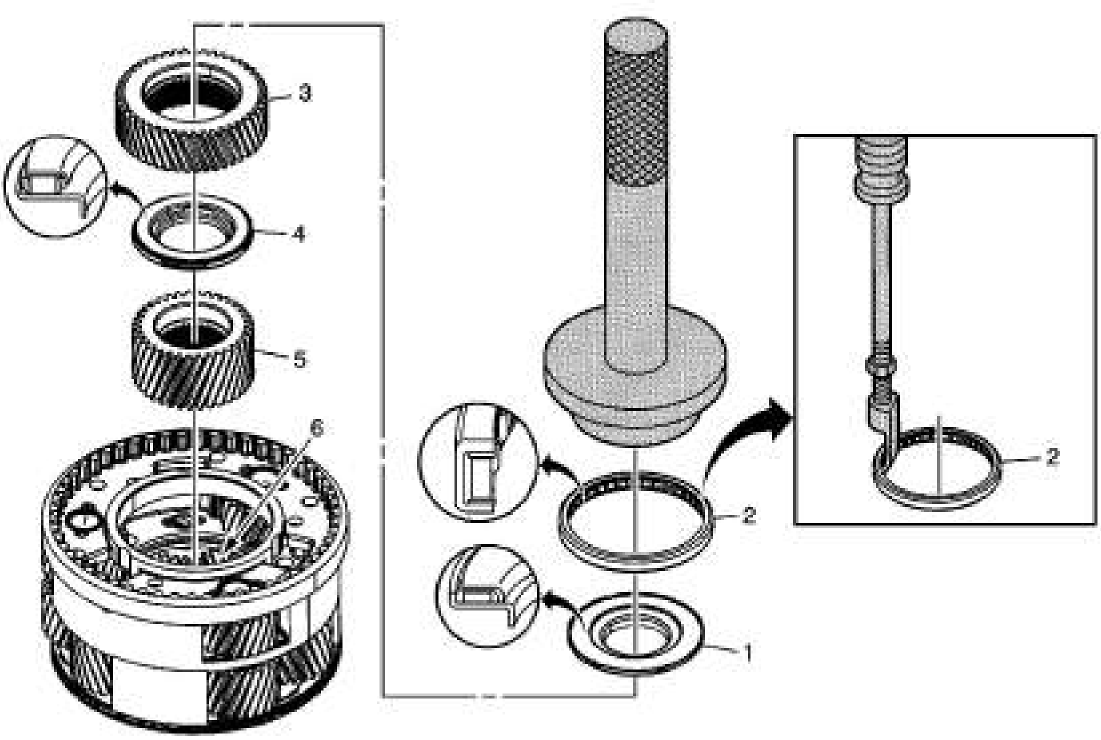
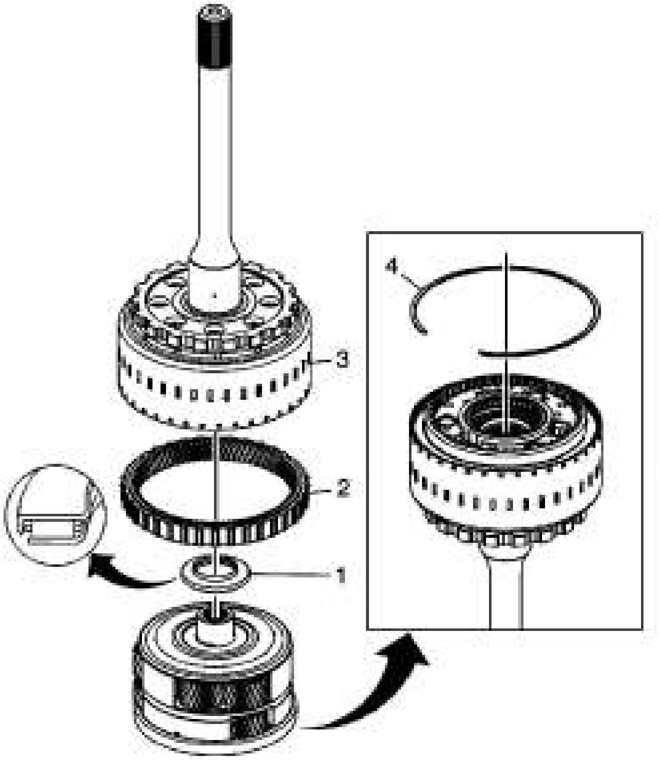
Output Carrier Assembly Overhaul



Callout	Component Name
1	Output Carrier Front Sun Gear Thrust Bearing Assembly
2	Center Support Roller Bearing **Notice:** Refer to General Repair Instructions in the Preface section. **Tip** The thick side of the bearing shell faces up. **Special Tools** • DT 47857 Bearing Installer • J 6125-B Slide Hammer • J 8092 Driver Handle • J 23129 Universal Seal Remover
3	Output Carrier Front Sun Gear **Notice:** Refer to General Repair Instructions in the Preface section.
4	Output Carrier Front Sun Gear Rear Thrust Bearing Assembly

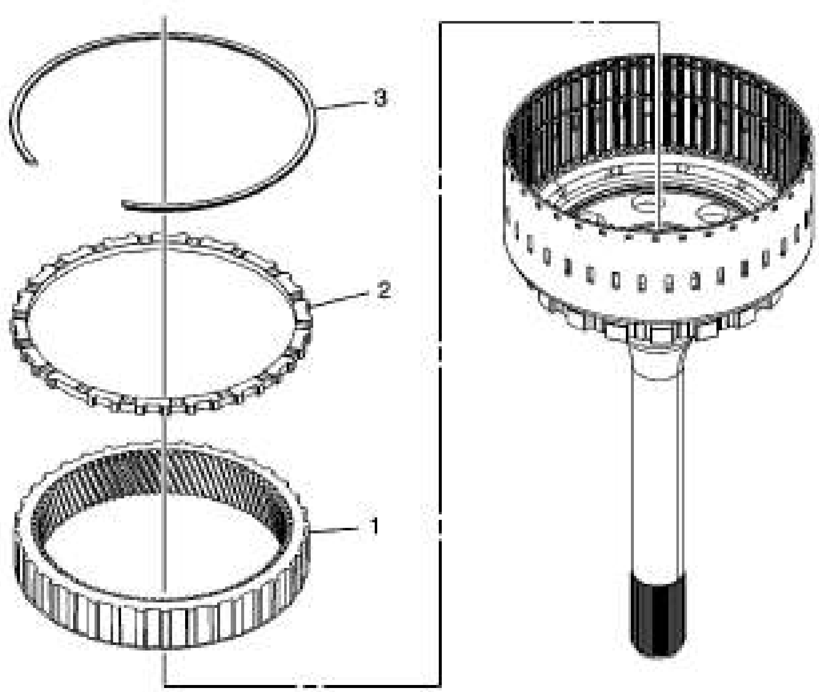
5	Output Carrier Rear Sun Gear **Notice:** Refer to General Repair Instructions in the Preface section.
6	Output Carrier Rear Sun Gear Bearing Assembly **Tip** Inspect for damage only. Do not remove. The bearing assembly is not a serviceable component.

Output Carrier to Output Shaft Assemble



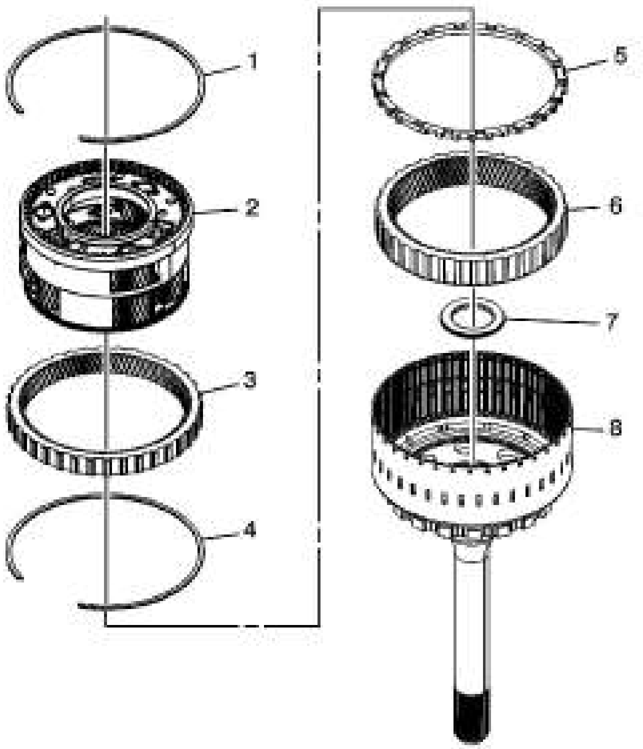
Callout	Component Name
1	Output Carrier Thrust Bearing Assembly
2	Output Carrier Internal Front Gear **Notice:** Refer to General Repair Instructions in the Preface section.
3	Output Shaft Assembly
4	Output Carrier Internal Gear Retaining Ring **Tip** Grasp the output shaft and carrier with both hands to turn over.

Output Shaft Assemble



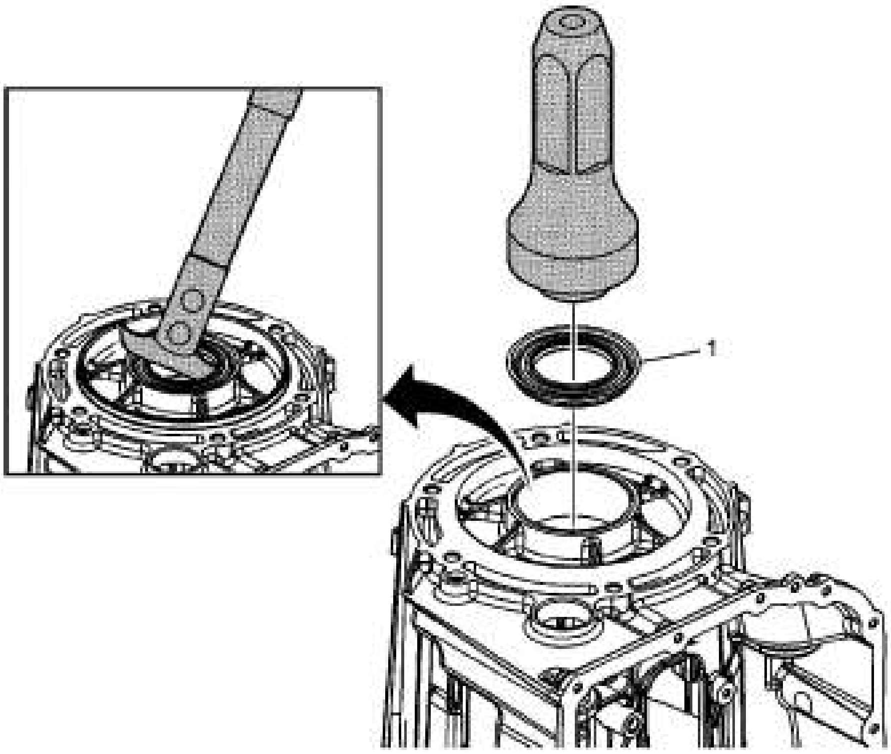
Callout	Component Name
1	Output Carrier Internal Rear Gear **Notice:** Refer to General Repair Instructions in the Preface section.
2	Output Gear Internal Gear Spacer
3	Output Carrier Internal Gear Retaining Ring **Tip** Do not install the output carrier internal front gear and retaining ring yet. These components will be installed during assembly of the output carrier to the output shaft.

Output Shaft Disassemble



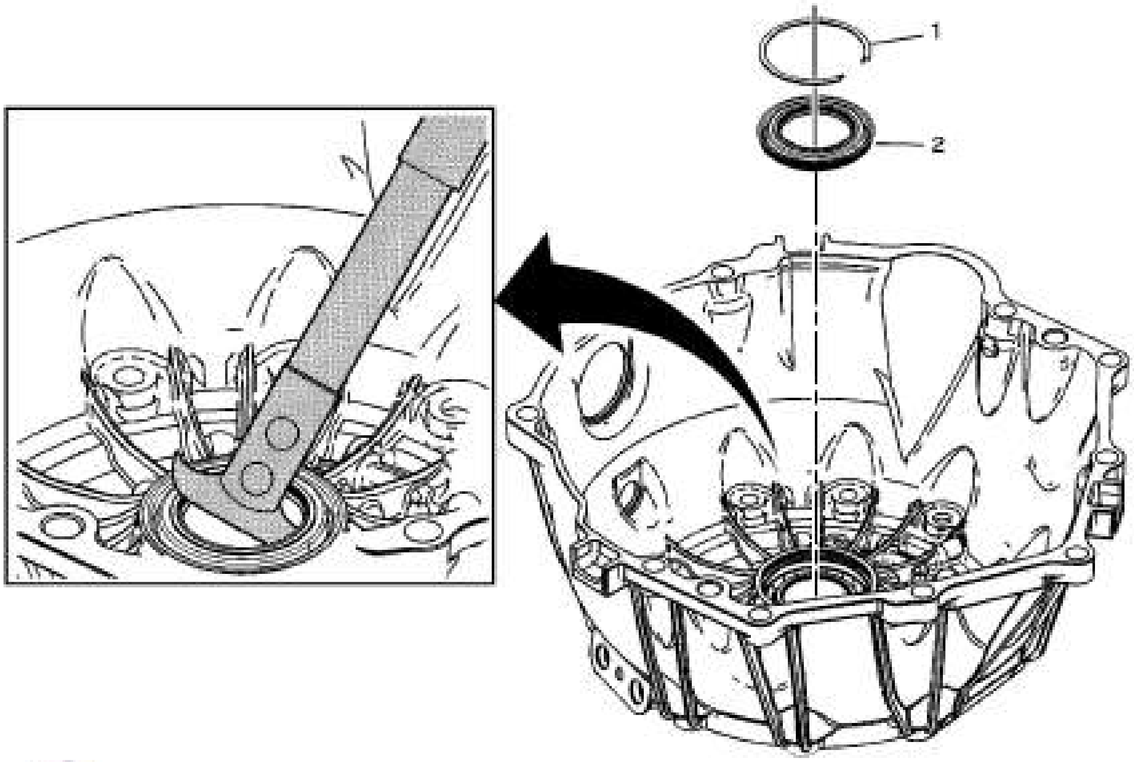
Callout	Component Name
Tip Inspect each component and replace as necessary.	
1	Output Carrier Internal Gear Retaining Ring
2	Output Carrier Assembly
3	Output Carrier Internal Front Gear
4	Output Carrier Internal Gear Retaining Ring
5	Output Carrier Internal Gear Spacer
6	Output Carrier Internal Rear Gear
7	Output Carrier Thrust Bearing Assembly
8	Output Shaft Assembly

Output Shaft Seal Replacement



Callout	Component Name
1	Output Shaft Seal **Important:** Use care not to damage the output shaft bushing with the J 45000 **Special Tools** - J 38693 Seal Installer - J 45000 Seal Remover

Torque Converter Fluid Seal Replacement



Callout	Component Name
1	Torque Converter Fluid Seal Retaining Ring
2	Torque Converter Fluid Seal Assembly. **Special Tool** J 45000 Seal Remover

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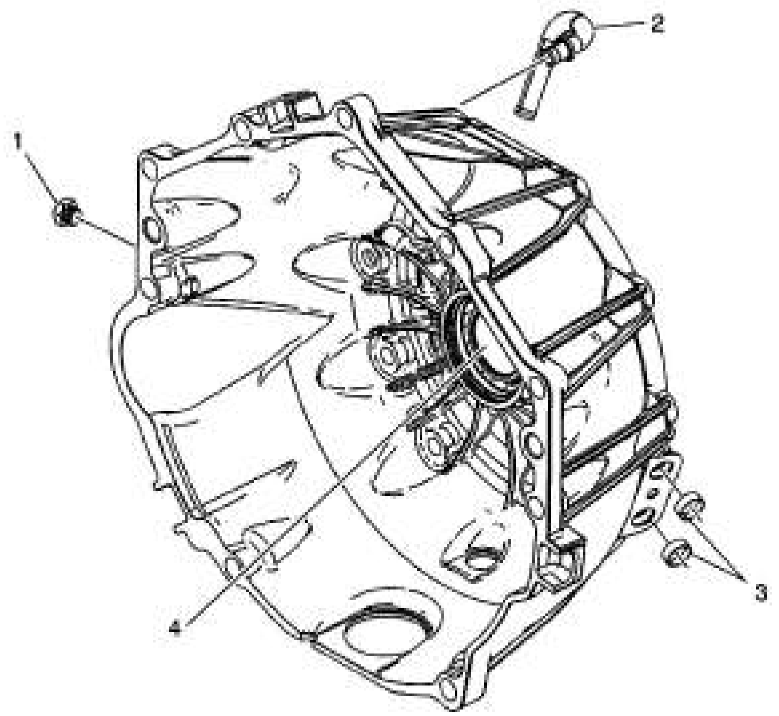
Torque Converter Housing Cleaning and Inspection



Callout	Component Name
Preliminary Procedures 1. Thoroughly clean the torque converter housing assembly, including threads, with clean solvent. 2. Clean sealing surfaces. 3. Inspect all threaded holes. If necessary, repair any thread damage.	
1	Line Pressure Test Hole Plug
2	A/Trans Vent Pipe
3	Trans Fluid Cooler Pipe Fitting Seal **Important:** Seals must be replaced. Refer to Transmission Fluid Cooler Pipe Seal Replacement .
4	Torque Converter Bushing

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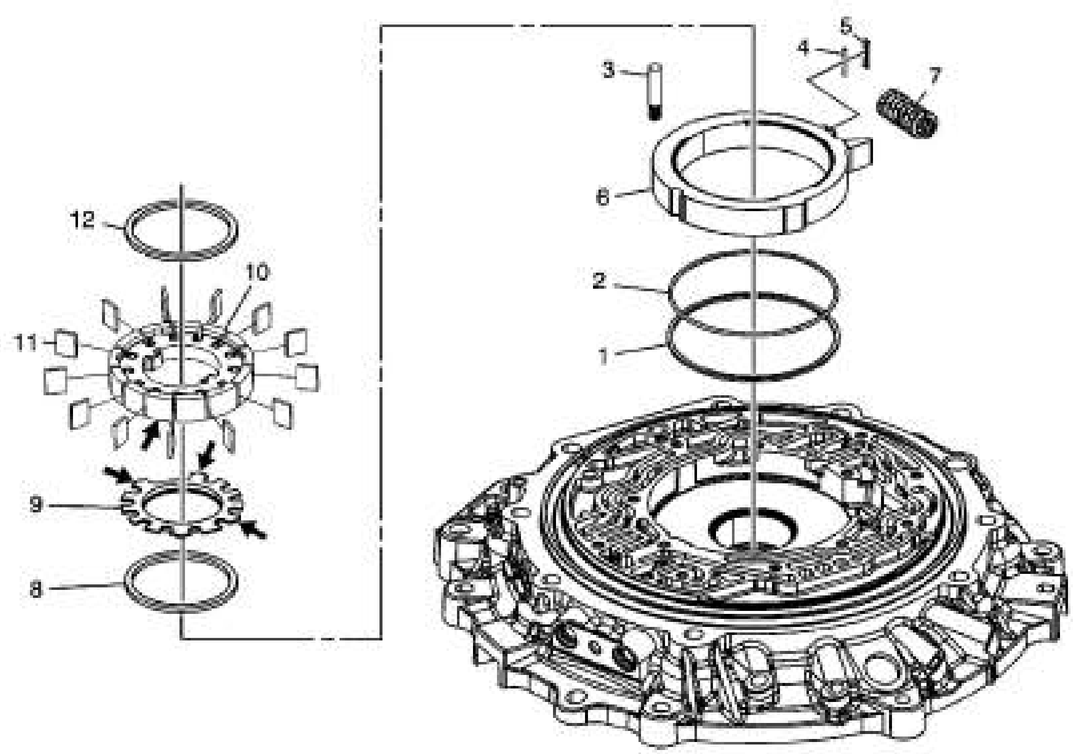
Torque Converter Housing with Fluid Pump Assemble



Callout	Component Name
Tip If installing a NEW pump rotor and slide into the torque converter housing, make sure to properly select the correct rotor and slide before performing this procedure. Refer to Fluid Pump Selective Measurement and Fluid Pump Selective Specifications.	
1	Fluid Pump Slide Fluid Seal Ring
2	Fluid Pump Slide (O-Ring) Seal
3	Fluid Pump Slide Pivot Pin
4	Fluid Pump Slide Seal Support **Tip** The seal support is circular. The seal is rectangular.
5	Slide Seal
6	Fluid Pump Slide
7	Fluid Pump Slide Outer Spring
8	Fluid Pump Vane Ring
9	Fluid Pump Rotor Guide **Notice:** Refer to General Repair Instructions in the Preface section.

10	Fluid Pump Rotor
11	Fluid Pump Vanes (Quantity: 13)
12	Fluid Pump Vane Ring

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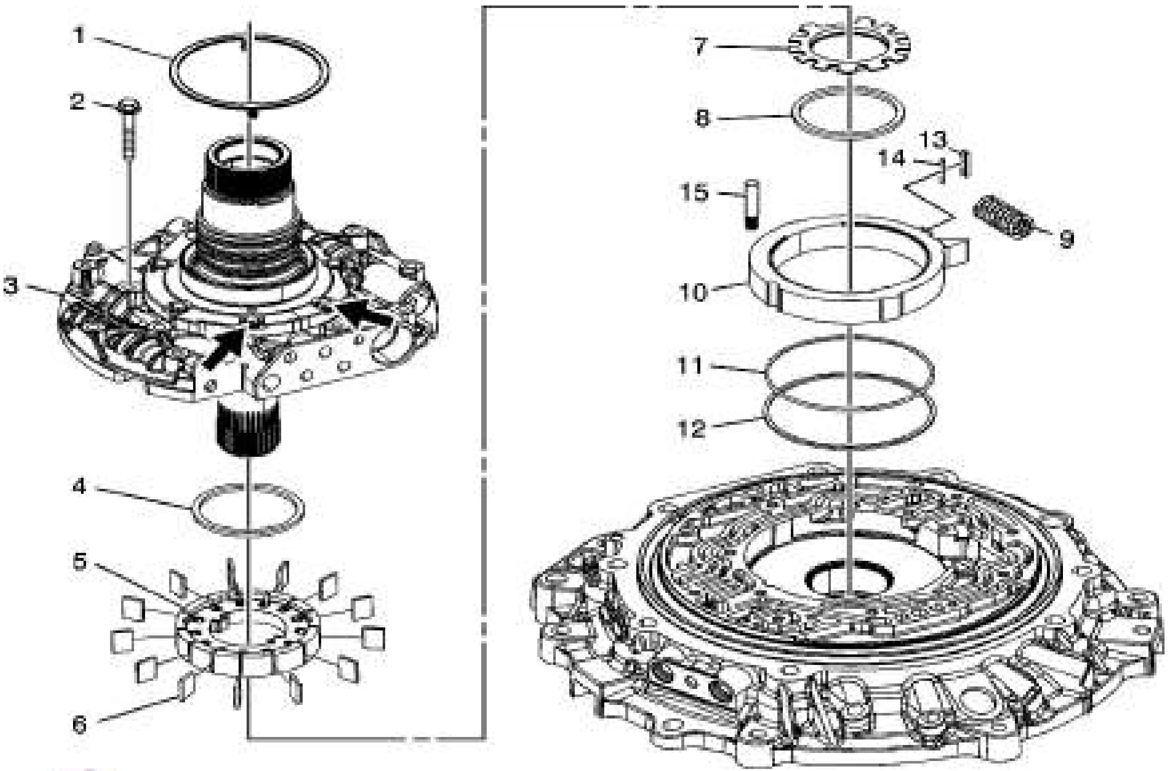
Torque Converter Housing with Fluid Pump Disassemble



Callout	Component Name
Notice: Refer to General Repair Instructions in the Preface section.	
1	1-2-3-4 and 3-5 Reverse Clutch Housing Thrust Washer
2	Bolt M6 x 40 (Quantity: 13)
3	Fluid Pump Cover Assembly
4	Fluid Pump Vane Ring
5	Fluid Pump Rotor
6	Fluid Pump Vanes (Quantity: 13)
7	Fluid Pump Rotor Guide
8	Fluid Pump Vane Ring
9	Fluid Pump Slide Outer Spring
10	Fluid Pump Slide
11	Fluid Pump Slide (O-Ring) Seal
12	Fluid Pump Slide Fluid Seal Ring

13	Fluid Pump Slide Seal
14	Fluid Pump Slide Seal Support
15	Fluid Pump Slide Pivot Pin

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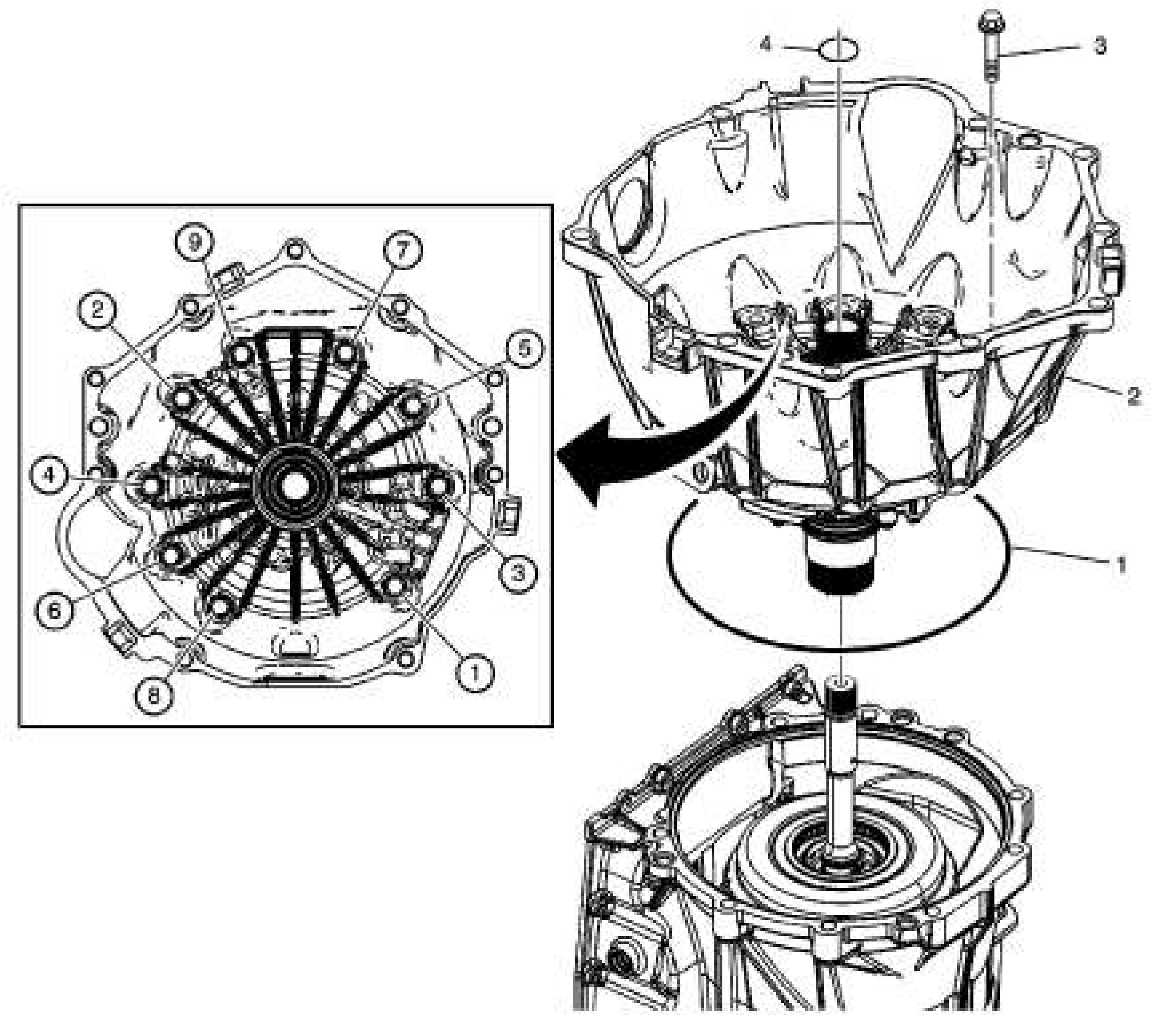
Torque Converter Housing with Fluid Pump Installation

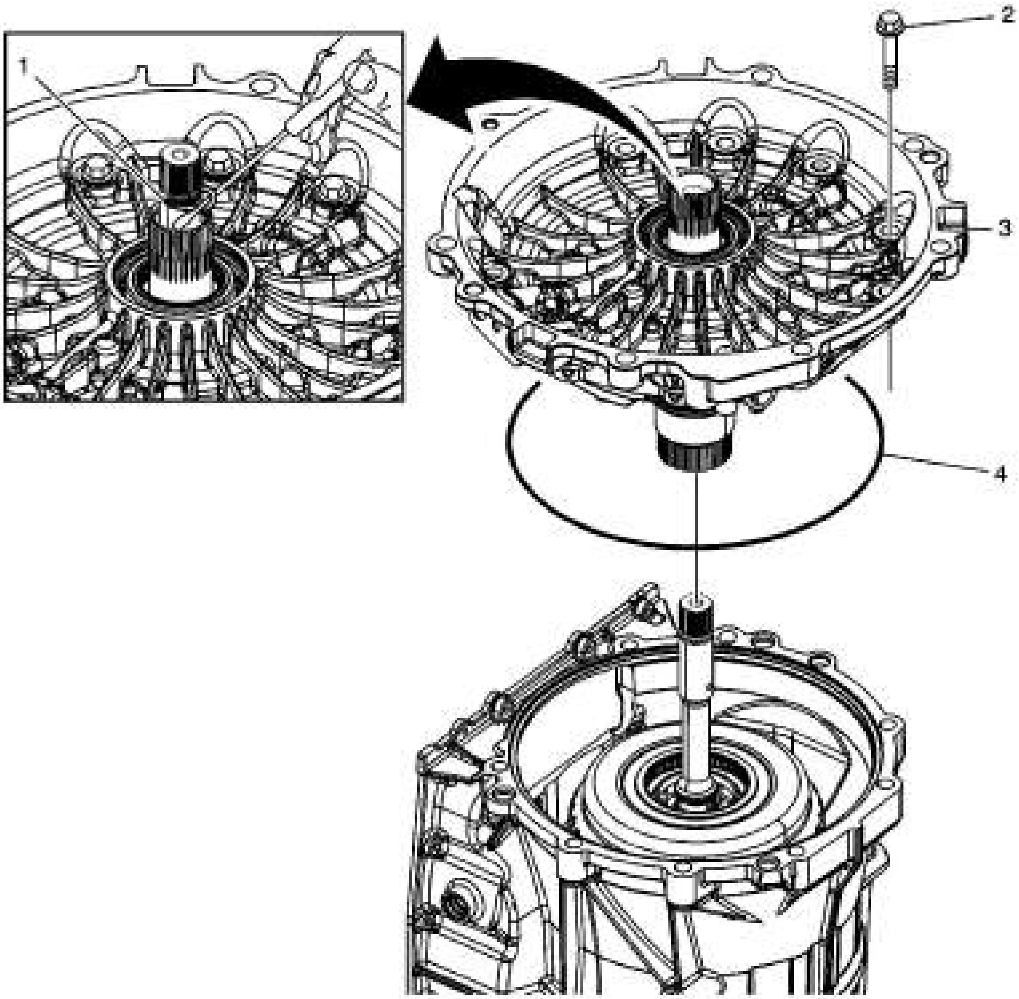


Callout	Component Name
Notice: Refer to Fastener Notice in the Preface section.	
1	NEW Fluid Pump Seal
2	Torque Converter (with Fluid Pump) Housing Assembly **Notice:** Refer to General Repair Instructions in the Preface section.
3	Bolts M10 x 50 (Quantity: 9) **Tighten** 72 N·m (53 lb. ft) in the sequence shown.

4	NEW Turbine Shaft (O-Ring) Seal

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 6L50/6L80/6L90 | Repair Instructions - Off Vehicle | **Document ID: 1993947**

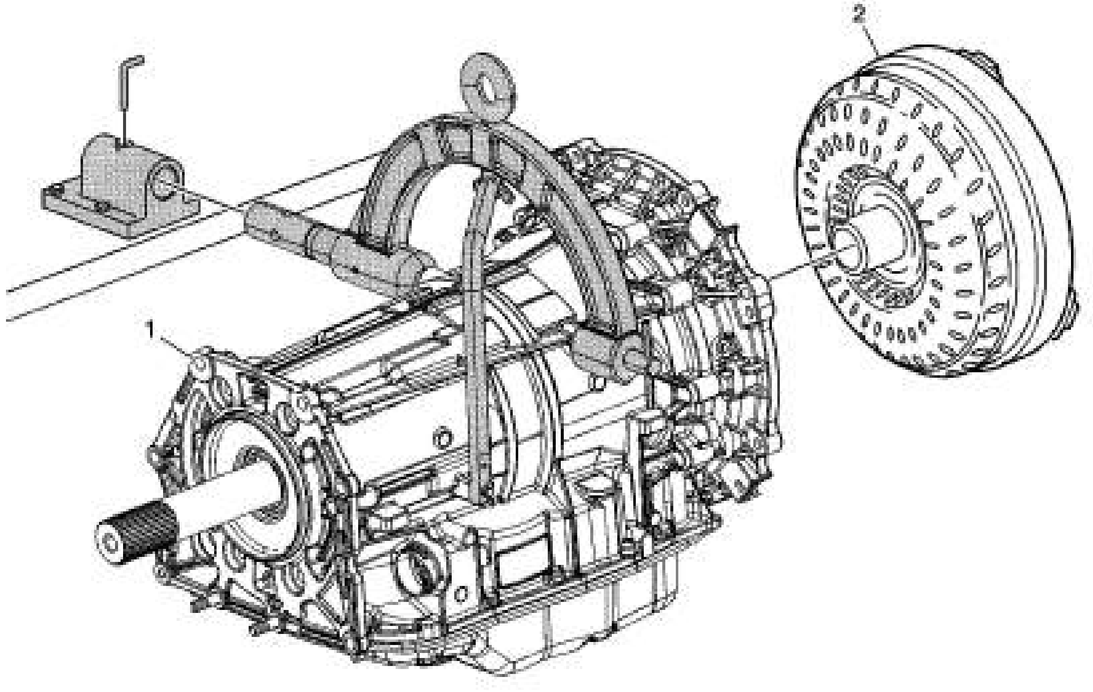
Torque Converter Housing with Fluid Pump Removal



Callout	Component Name
Notice: Refer to General Repair Instructions in the Preface section.	
1	Turbine Shaft (O-ring) Seal
2	Bolt M10 x 50 (Quantity: 9)
3	Torque Converter (With Fluid Pump) Housing Assembly
4	Fluid Pump Seal

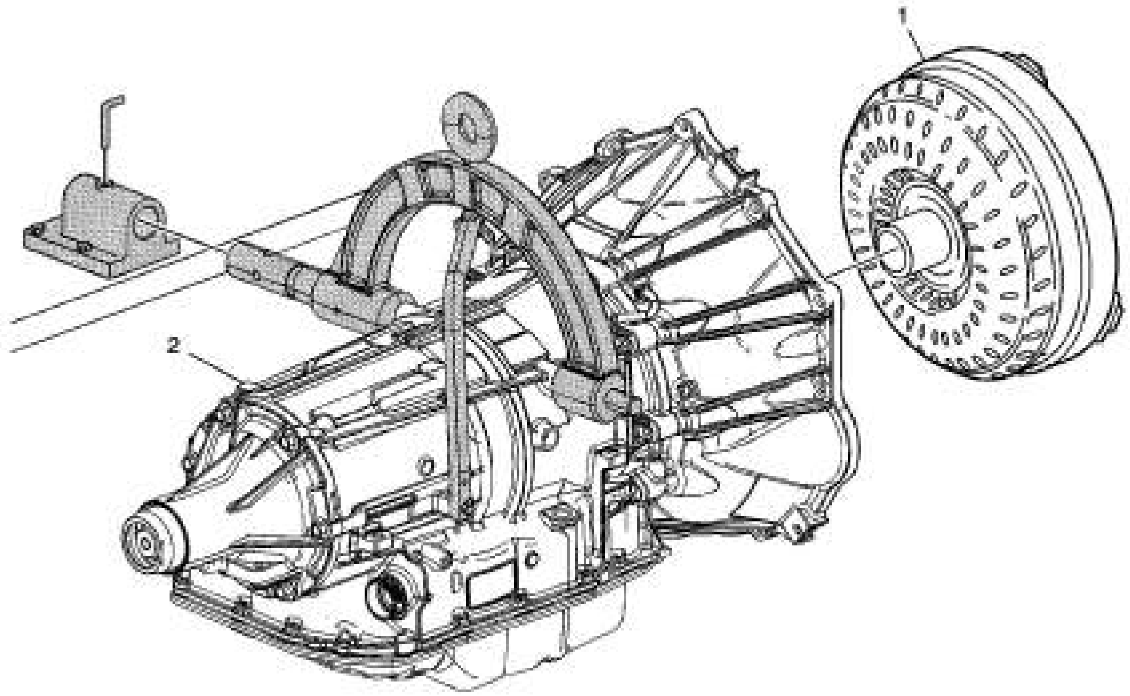
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 6L50/6L80/6L90 | Repair Instructions - Off Vehicle | **Document ID: 1985265**

Torque Converter Installation and Holding Fixture Removal



Callout	Procedure
Tip Rotate the transmission so that the fluid pan assembly is down.	
1	Transmission Case Assembly **Special Tools** • DT 47605 Holding Fixture Adapter • J 3289-20 Holding Fixture Base Assembly • J 8763-B Holding Fixture
2	Torque Converter Assembly

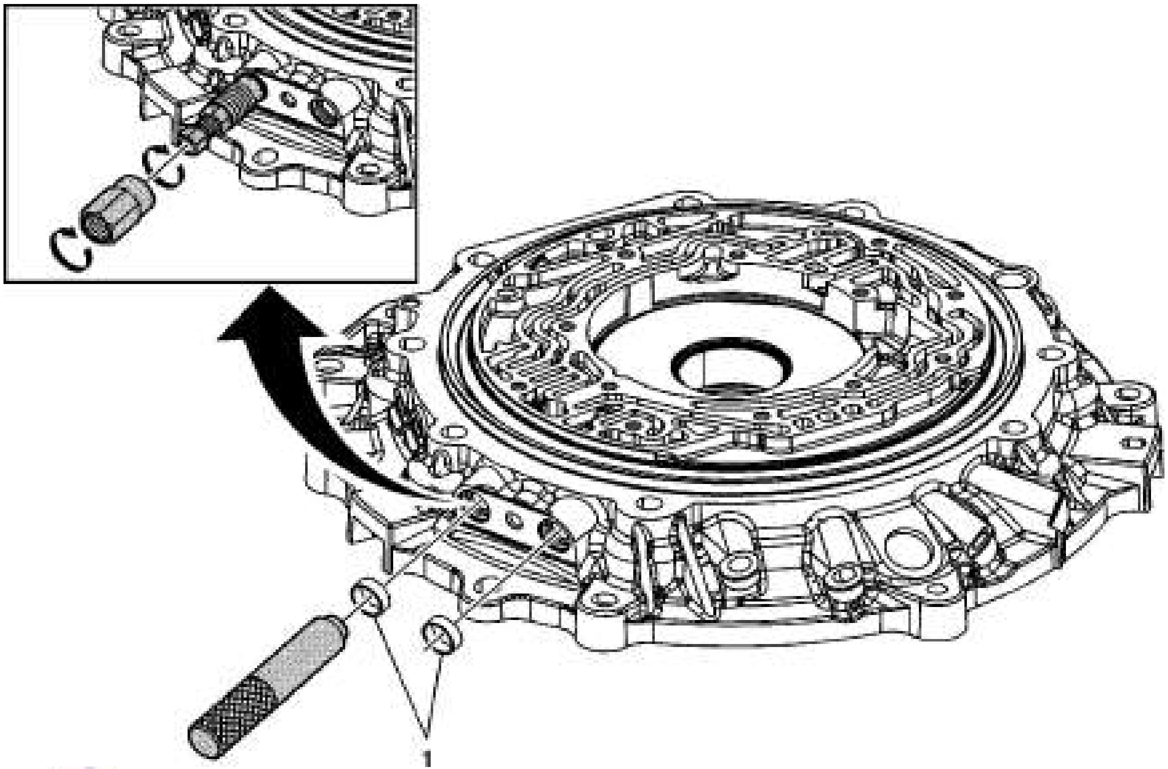
Torque Converter Removal and Holding Fixture Installation



Callout	Component Name
1	Torque Converter Assembly
2	Transmission Case Assembly **Special Tools** • J 8763-B . • DT 47605 . • J 3289-20 .
3	Locking Pin **Tip** 1. Rotate the transmission so that the converter housing is up and secure with locking pin. 2. Allow any remaining transmission fluid to drain from the case extension.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 6L50/6L80/6L90 | Repair Instructions - Off Vehicle | **Document ID: 2007006**

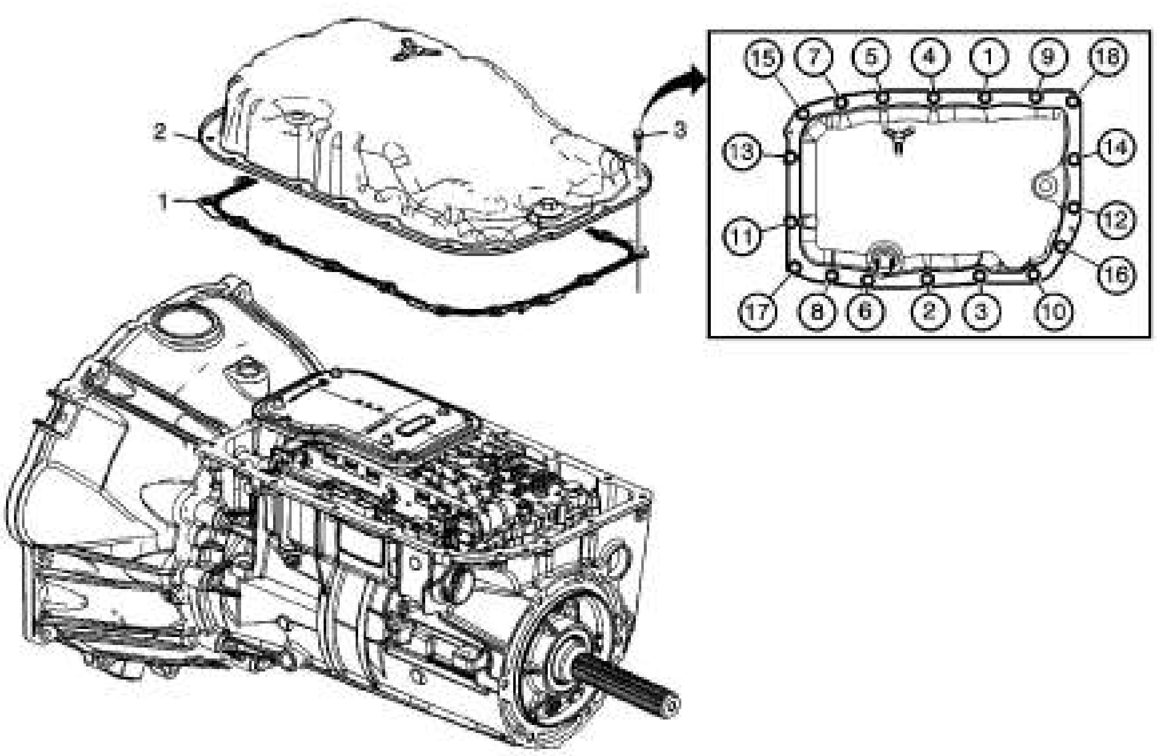
Transmission Fluid Cooler Pipe Seal Replacement (SWB LWB RHD)



Callout	Component Name
1	Trans Fluid Cooler Pipe Fitting Seals (Quantity: 2) **Special Tools** - DT 47770 Seal Installer - J 45201 Cooler Line Seal Remover

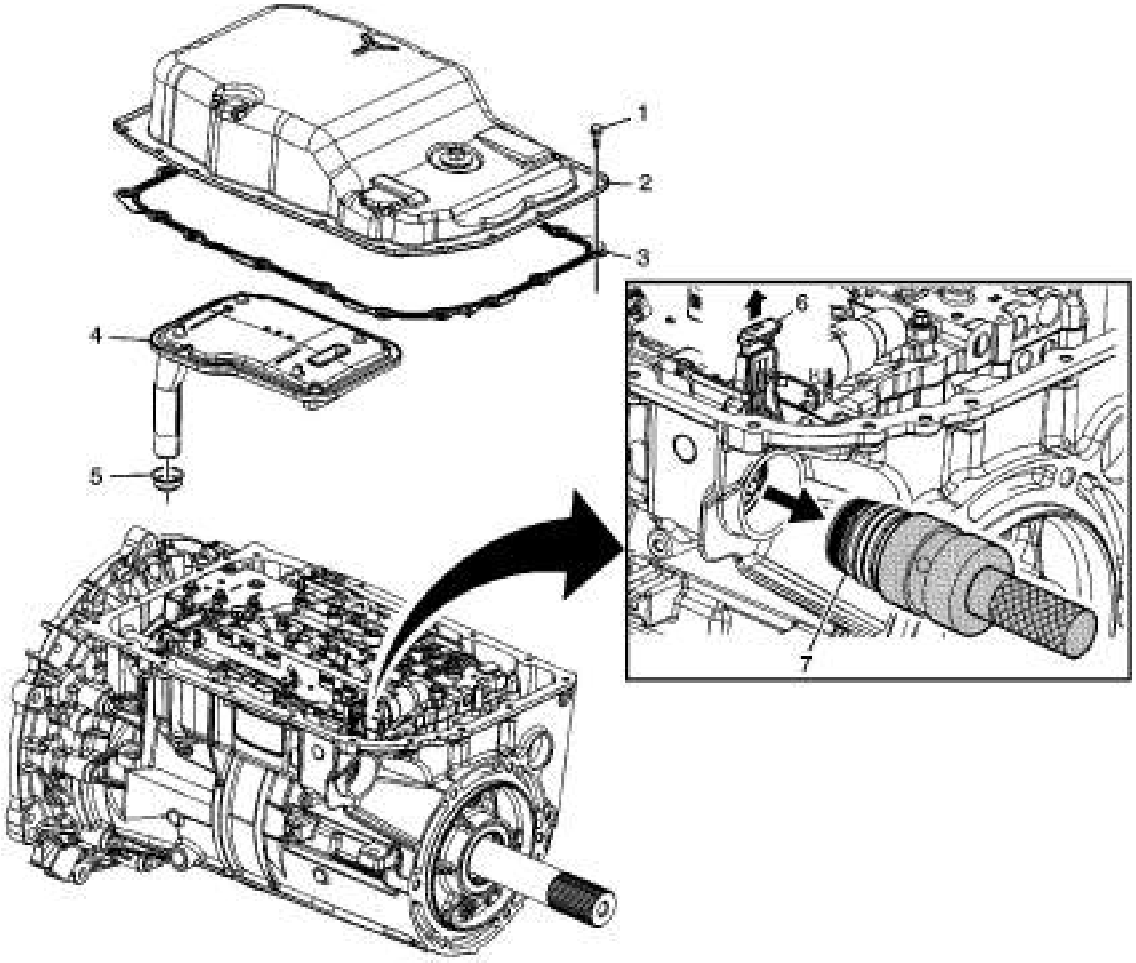
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 6L50/6L80/6L90 | Repair Instructions - Off Vehicle | **Document ID: 1975790**

Transmission Fluid Pan Installation



Callout	Component Name
Notice: Refer to Fastener Notice in the Preface section.	
1	Fluid Pan Gasket **Important:** The fluid pan gasket is reusable. Inspect the gasket to determine if it may be reused. If the gasket is stuck to the case or pan, it should be replaced.
2	Fluid Pan Assembly.
3	Fluid Pan Bolts M6 x 20 (Quantity: 18) **Tighten** 9 N·m (80 lb. in) in sequence shown.

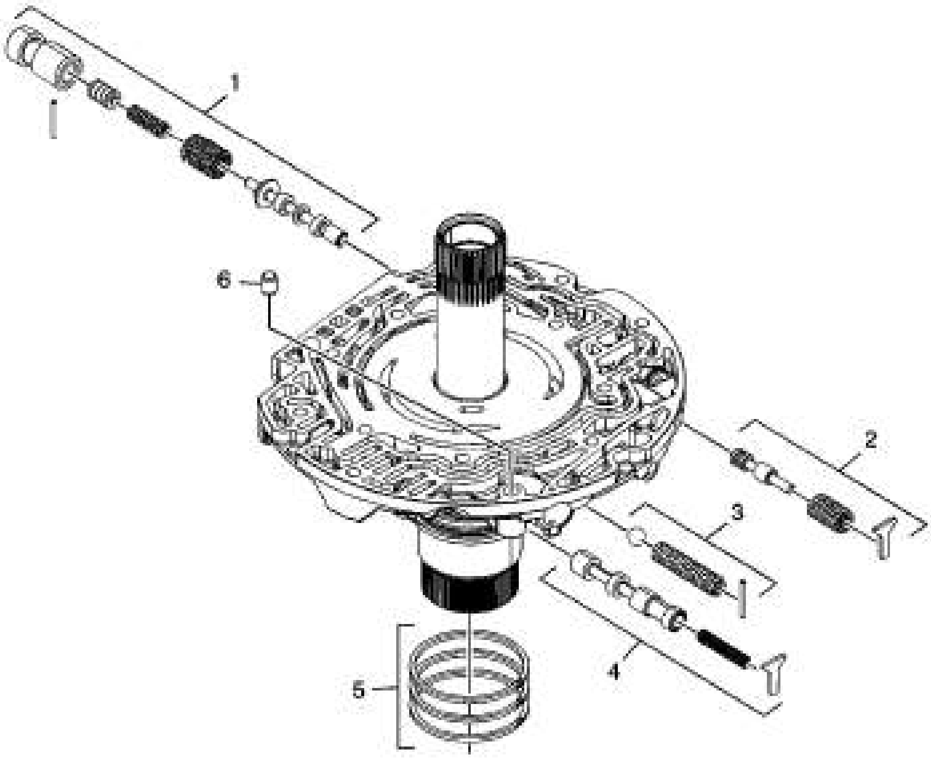
Transmission Fluid Pan, Filter and Electrical Connector Passage Sleeve Removal



Callout	Component Name
1	Bolt M6 x 20 (Quantity: 18)
2	Fluid Pan Assembly
3	Fluid Pan Gasket **Tip** The fluid pan gasket is reusable. Inspect the gasket to determine if it may be reused. If the gasket is stuck to the case or pan, it should be replaced.
4	Fluid Filter Assembly **Notice:** Refer to General Repair Instructions in the Preface section.

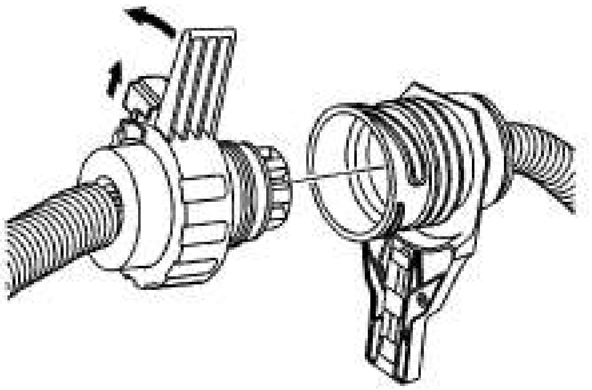
5	Fluid Filter Seal Assembly **Notice:** Refer to General Repair Instructions in the Preface section. **Tip** Use a screwdriver or snap ring pliers.
6	Electrical Connector Slide Lock **Notice:** Refer to General Repair Instructions in the Preface section.
7	Electrical Connector Passage Sleeve **Special Tools** • DT 47715 • J 42183

Transmission Fluid Pump Cleaning and Inspection



Callout	Component Name
Caution: Valve springs can be tightly compressed. Use care when removing retainers and plugs. Personal injury could result. **Important:** Clean and inspect all components and machined surfaces.	
1	Pressure Regulator Valve Train
2	Converter Feed Limit Valve Train
3	Pressure Relief Ball Valve and Spring
4	TCC Control Valve and Spring
5	1-2-3-4 and 3-5 Reverse Clutch Fluid Seal Rings (Quantity: 3) **Important:** Discard the seal rings and replace with NEW rings.
6	A/Trans Fluid Pump Locator Pin

Automatic Transmission Inline 16-Way Connector Description



The transmission electrical connector is an important part of the transmission operating system. Any interference with the electrical connection can cause the transmission to set diagnostic trouble codes or affect proper operation. The following items can affect the electrical connection:

- Bent pins in the connector from rough handling during connection and disconnection
- Wires backing away from the pins or coming uncrimped, in the external wiring harness
- Dirt contamination entering the connector when disconnected
- Transmission fluid leaking into the connector, wicking up into the external wiring harness and degrading the wire insulation
- Moisture intrusion in the connector
- Low pin retention in the external connector from excessive connection and disconnection of the wiring connector assembly
- Pin corrosion from contamination
- Damaged connector assembly

Remember the following points:

- Limit twisting or wiggling the connector during removal. Bent pins can occur.
- Do not pry the connector off with a screwdriver or other tool.
- Whenever the transmission external wiring connector is disconnected from the internal harness and the engine is operating, DTCs will set. Clear these DTCs after reconnecting the

external connector.

Use the following procedure to disconnect the engine side of the 16-way connector from the transmission side:

1. Unlock the slide lock on the engine wiring harness connector.
2. Rotate the connector lever counterclockwise and remove the connector from the electrical connector passage sleeve.

Use the following procedure to reconnect the engine side of the 16-way connector to the transmission side:

1. Orient the alignment slot on the engine side of the connector with the alignment tab on the electrical connector passage sleeve.
2. Slide the engine side connector through the electrical connector passage sleeve and into the transmission side connector.
3. Rotate the connector lever clockwise until the connector is fully seated.
4. Lock the slide lock on the connector.

Definitions and Abbreviations

Throttle Positions

Engine Braking: A condition where the engine is used to slow the vehicle by manually downshifting during a zero throttle coastdown.

Full Throttle Detent Downshift: A quick apply of the accelerator pedal to its full travel, forcing a downshift.

Heavy Throttle: Approximately 3/4 of accelerator pedal travel, 75 percent throttle position.

Light Throttle: Approximately 1/4 of accelerator pedal travel, 25 percent throttle position.

Medium Throttle: Approximately 1/2 of accelerator pedal travel, 50 percent throttle position.

Minimum Throttle: The least amount of throttle opening required for an upshift.

Wide Open Throttle (WOT): Full travel of the accelerator pedal, 100 percent throttle position.

Zero Throttle Coastdown: A full release of the accelerator pedal while the vehicle is in motion and in drive range.

Shift Condition Definitions

Bump: A sudden and forceful apply of a clutch or a band.

Chuggle: A bucking or jerking. This condition may be most noticeable when the converter clutch is engaged. It is similar to the feel of towing a trailer.

Delayed: A condition where a shift is expected but does not occur for a period of time. This may be described as a clutch or band engagement that does not occur as quickly as expected during a part throttle or wide open throttle apply of the accelerator, or during manual downshifting to a lower range. This term is also defined as LATE or EXTENDED.

Double Bump - Double Feel: Two sudden and forceful applies of a clutch or a band.

Early: A condition where the shift occurs before the car has reached proper speed. This condition tends to labour the engine after the upshift.

End Bump: A firmer feel at the end of a shift than at the start of the shift. This is also defined as END FEEL or SLIP BUMP.

Firm: A noticeably quick apply of a clutch or band that is considered normal with a medium to heavy throttle. This apply should not be confused with HARSH or ROUGH.

Flare: A quick increase in engine RPM along with a momentary loss of torque. This most generally occurs during a shift. This condition is also defined as SLIPPING.

Harsh - Rough: A more noticeable apply of a clutch or band than FIRM. This condition is considered undesirable at any throttle position.

Hunting: A repeating quick series of upshifts and downshifts that causes a noticeable change in engine RPM, such as a 4-3-4 shift pattern. This condition is also defined as BUSYNESS.

Initial Feel: A distinctly firmer feel at the start of a shift than at the finish of the shift.

Late: A shift that occurs when the engine RPM is higher than normal for a given amount of throttle.

Shudder: A repeating jerking condition similar to CHUGGLE but more severe and rapid. This condition may be most noticeable during certain ranges of vehicle speed.

Slipping: A noticeable increase in engine RPM without a vehicle speed increase. A slip usually occurs during or after initial clutch or band apply.

Soft: A slow, almost unnoticeable clutch or band apply with very little shift feel.

Surge: A repeating engine related condition of acceleration and deceleration that is less intense than CHUGGLE.

Tie-Up: A condition where two opposing clutch and/or bands are attempting to apply at the same time causing the engine to labour with a noticeable loss of engine RPM.

Noise Conditions

Drive Link Noise: A whine or growl that increases or fades with vehicle speed, and is most noticeable under a light throttle acceleration. It may also be noticeable in PARK or NEUTRAL operating ranges with the vehicle stationary.

Final Drive Noise: A hum related to vehicle speed which is most noticeable under a light throttle acceleration.

Planetary Gear Noise: A whine related to vehicle speed, which is most noticeable in FIRST gear, SECOND gear, FOURTH gear or REVERSE. The condition may become less noticeable, or go away, after an upshift.

Pump Noise: A high pitched whine that increases in intensity with engine RPM. This condition may also be noticeable in all operating ranges with the vehicle stationary or moving.

Torque Converter Noise: A whine usually noticed when a vehicle is stopped, and the transmission is in DRIVE or REVERSE. The noise will increase with engine RPM.

Driver Shift Control

Driver Shift Control (DSC) allows the driver to change gears similar to a manual transmission. Refer to the vehicle owner's manual for specific DSC operating instructions.

Transmission Abbreviations

A/C: Air Conditioning

AC: Alternating Current

AT: Automatic Transmission

CCDIC: Climate Control Driver Information Centre

DC: Direct Current

DIC: Driver Information Centre

DLC: Diagnostic Link Connector

DMM: Digital Multimeter

DSC:: Driver Shift Control

DTC: Diagnostic Trouble Code

EBTCM: Electronic Brake/Traction Control Module

ECCC: Electronically-Controlled Capacity Clutch

ECT: Engine Coolant Temperature

EMI: Electromagnetic Interference

IAT: Intake Air Temperature

IGN: Ignition

IMS: Internal Mode Switch

ISS: Input Speed Sensor

MAP: Manifold Absolute Pressure

MIL: Malfunction Indicator Lamp

NC: Normally Closed

NO: Normally Open

OBD: On Board Diagnostic

OSS: Output Speed Sensor

PC: Pressure Control

TCM: Transmission Control Module

PWM: Pulse Width Modulation

RPM: Revolutions Per Minute

SS: Shift Solenoid

STL: Service Transmission Lamp

TAP: Transmission Adaptive Pressure

TCC: Torque Converter Clutch

TFP: Transmission Fluid Pressure

TFT: Transmission Fluid Temperature

TP: Throttle Position

WOT: Wide Open Throttle

Drive Range - Fourth Gear

As the vehicle speed increases, the transmission control module (TCM) receives input signals from the automatic transmission input and output speed sensors, the throttle position sensor and other vehicle sensors to determine the precise moment to command OFF the normally-high C35R pressure control solenoid 2. At the same time the normally-low CBR1/C456 pressure control solenoid 3 is commanded ON to regulate 4-5-6 clutch apply.

4-5-6 CLUTCH APPLIES

CBR1/C456 Pressure Control Solenoid 3

The CBR1/C456 pressure control solenoid 3 is commanded ON allowing actuator feed fluid to enter the PCS CBR1/456 clutch fluid circuit. PCS CBR1/456 clutch fluid is routed through orifice #39 to the CBR1/C456 clutch regulator valve and, through orifice #31 to the CBR1/C456 clutch boost valve.

CBR1/C456 Clutch Regulator Valve

PCS CBR1/456 clutch fluid moves the CBR1/C456 clutch regulator valve against CBR1/C456 clutch regulator valve spring force to allow line fluid to pass through the valve an enter the CBR1/456 clutch feed circuit. CBR1/456 clutch feed is then routed to the 4-5- 6 clutch boost valve and clutch select valve 2.

4-5-6 Clutch Boost Valve

PCS CBR1/456 clutch fluid pressure acts on a differential area moving the CBR1/456 clutch boost valve against the CBR1/456 clutch boost valve spring. CBR1/456 clutch fluid passes through the valve and enters the CBR1/456 clutch feedback circuit. As PCS CBR1/456 clutch fluid pressure is increased to a given value, the CBR1/456 clutch boost valve opens the CBR1/456 clutch feedback circuit to exhaust. This results in the CBR1/456 clutch regulator valve moving to the full feed position, sending full line pressure to the clutch.

Clutch Select Valve 2

CBR1/456 clutch feed fluid passes through the clutch select valve 2 and enters the 456 clutch feed circuit. 456 clutch feed fluid is routed to the clutch select valve 3 where it passes through the valve and enters the 456 clutch fluid circuit. 456 clutch fluid is routed to the 4-5-6 clutch, the 2-6 clutch regulator gain valve and to the #3 ball check valve. 456 clutch fluid seats the #3 ball check valve against solenoid 2 fluid passage and directed into the CSV3 enable fluid circuit where it is routed through orifice #20 and to clutch select valve 3.

4-5-6 Clutch

456 clutch fluid enters the 4-5-6 clutch housing to move the piston against spring force, combined with force from the compensator to apply the 4-5-6 clutch plates.

3-5 REVERSE CLUTCH RELEASES

C35R Pressure Control Solenoid 2

The C35R pressure control solenoid 2 is commanded OFF, allowing PCS 35 reverse clutch fluid from the 3-5 reverse clutch boost valve and the 3-5 reverse clutch regulator valve to exhaust through the solenoid.

3-5 Reverse Clutch Boost Valve

3-5 reverse boost valve spring force moves the valve to allow 35 reverse clutch feedback fluid from the 3-5 reverse clutch regulator valve to enter the 35 reverse clutch fluid circuit and exhaust.

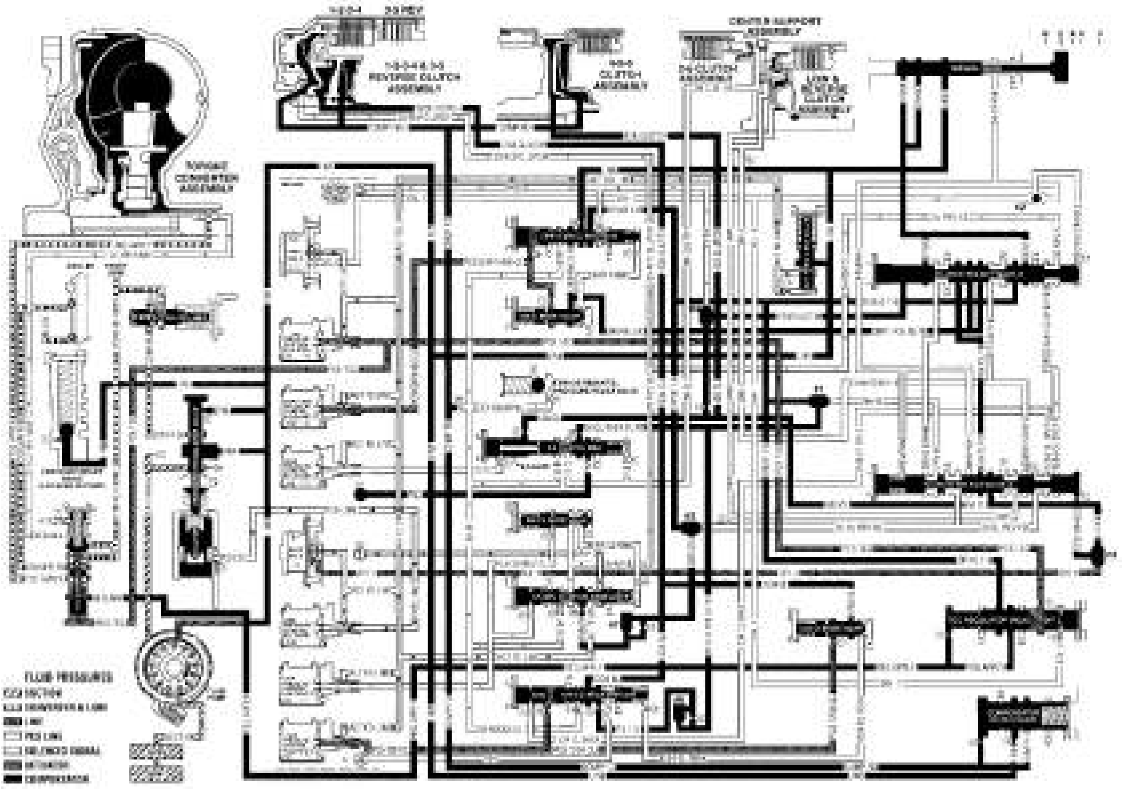
3-5 Reverse Clutch Regulator Valve

3-5 reverse clutch regulator valve spring force moves the valve to allow 35 reverse clutch fluid from the 3-5 reverse clutch to pass through the valve and enter the exhaust backfill fluid circuit. 35 reverse clutch fluid then enters the exhaust backfill fluid circuit and is routed through orifice #30 to the exhaust backfill pressure relief valve where excess pressure is exhausted.

3-5 Reverse Clutch

3-5 reverse clutch spring force combined with force from the compensator move the 3-5 reverse clutch piston to release the 3-5 clutch plates and forces 35 reverse clutch fluid to exhaust from 1-2-3-4 and 3-5 reverse clutch housing. 35 reverse clutch fluid is then routed to the 3-5 reverse clutch regulator valve and exhausted.

Drive Range, Fourth Gear


1-2-3-4
3-5 REV
1-2-3-4 & 3-5 REVERSE CLUTCH ASSEMBLY
4-5-6 CLUTCH ASSEMBLY
CENTER SUPPORT ASSEMBLY
2-6 CLUTCH ASSEMBLY
LOW & REVERSE CLUTCH ASSEMBLY
TORQUE CONVERTER ASSEMBLY
FLUID PRESSURES
SUCTION
CONVERTER & LUBE
LINE
PCS LINE
SOLENOID SIGNAL
ACTUATOR

Drive Range, Fifth Gear Default

If the transmission is in 4th, 5th or 6th gear during a transmission electrical component failure, the transmission will default to 5th gear. All solenoids will default to their normal state. If the torque converter clutch was applied, it will release. The transmission will stay in 5th gear default range until the ignition has been turned off or transmission shifted to reverse. When the vehicle is restarted, and shifted back into drive, the transmission will then operate in the 3rd gear default range. This default action will enable the vehicle to be safely driven to a service centre.

3-5 REVERSE CLUTCH APPLIES

C35R Pressure Control Solenoid 2

The C35R pressure control solenoid 2 defaults to ON, allowing actuator feed fluid to enter the PCS 35 reverse clutch fluid circuit. PCS 35 reverse clutch fluid is routed through orifice #48 and then to the 3-5 reverse clutch regulator valve. PCS 35 reverse clutch fluid is also routed through orifice #40 and then to the 3-5 reverse clutch boost valve.

3-5 Reverse Clutch Boost Valve

PCS 3-5 reverse clutch fluid pressure acts on a differential area moving the PCS 3-5 reverse clutch boost valve against the 3-5 reverse clutch boost valve spring. 3-5 reverse clutch fluid passes through the valve and enters the 3-5 reverse clutch feedback circuit. As PCS 3-5 reverse clutch fluid pressure is increased to a given value, the 3-5 reverse clutch boost valve opens the 3-5 reverse clutch feedback circuit to exhaust. This results in the 3-5 reverse clutch regulator valve moving to the full feed position sending full 3-5 reverse clutch feed pressure (full line pressure) to the clutch.

3-5 Reverse Clutch Regulator Valve

PCS 3-5 reverse clutch fluid moves the 3-5 reverse clutch regulator valve against 3-5 reverse clutch regulator valve spring force and 3- 5 reverse clutch feedback fluid. This allows 3-5 reverse feed to pass through the valve and enter the 3-5 reverse clutch circuit. 3-5 reverse clutch fluid is then routed to the 3-5 reverse clutch, the 3-5 reverse boost valve and the clutch select valve 2. When the 3-5 reverse clutch regulator valve is in this position, PS1 fluid from the pressure switch 1 exhausts through the valve, allowing the switch to close.

3-5 Reverse Clutch

3-5 reverse clutch fluid enters the 1-2-3-4 & 3-5 reverse clutch housing to move the piston against spring force combined with force from the compensator to apply the 3-5 reverse clutch plates.

Clutch Select Valve 3

Once the clutch select valve 3 is moved to the ON position in 4th gear, it will remain in this position throughout the 5th gear default range, until the ignition has been turned OFF. When the ignition is OFF, fluid will exhaust from the valve, thus when the vehicle is restarted, the transmission will then be in the 3rd gear default range.

1-2-3-4 CLUTCH RELEASES or 2-6 CLUTCH RELEASES

C1234 Pressure Control Solenoid 5

If the transmission was in 4th gear when an electrical condition commands a protection mode, the C1234 pressure control solenoid 5 defaults to the OFF position, allowing PCS 1234 clutch fluid from the 1-2-3-4 clutch, the 1-2-3-4 clutch regulator valve and 1- 2-3-4 clutch boost valve to exhaust.

2-6 CB26 Pressure Control Solenoid 4

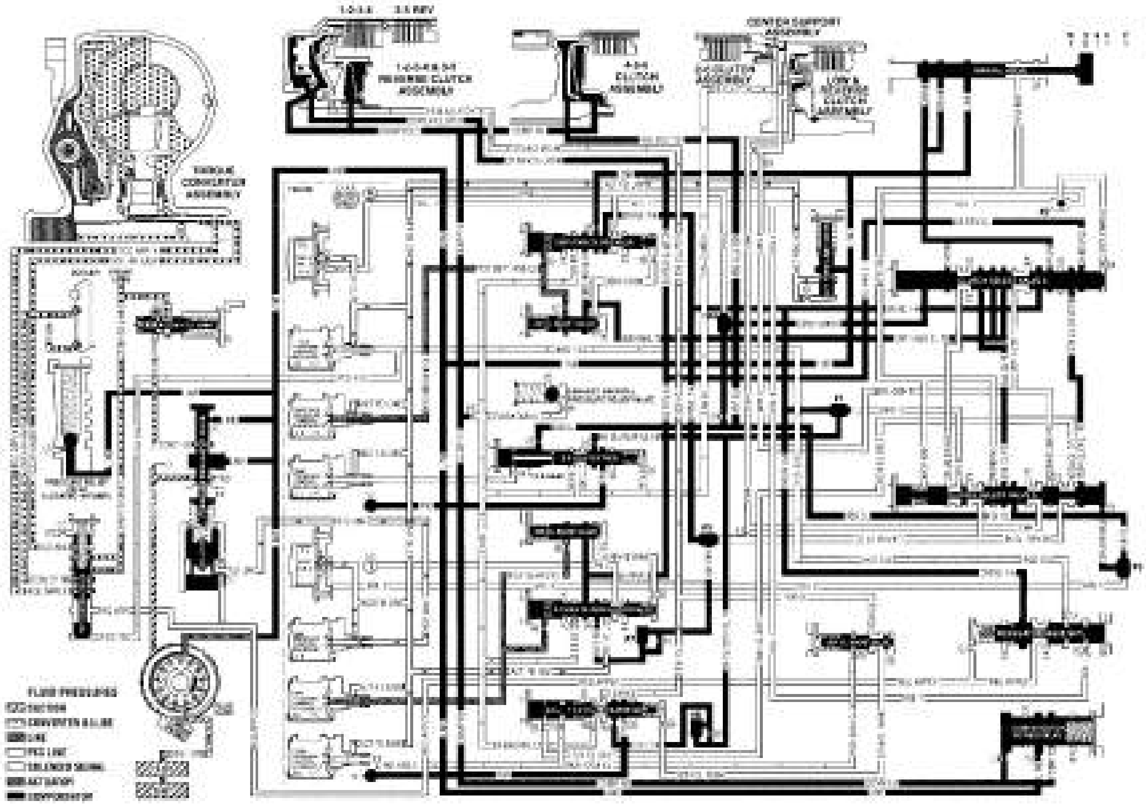
If the transmission was in 6th gear when an electrical condition commands a protection mode, the CB26 pressure control solenoid 4 defaults to the OFF position, allowing PCS 26 clutch fluid from the 2-6 clutch regulator valve, and the 2-6 clutch to exhaust.

TORQUE CONVERTER CLUTCH RELEASES

TCC Pressure Control Solenoid

The TCC pressure control solenoid will default to it's normal state, OFF. PCS TCC fluid will exhaust from the TCC control valve, and spring force will shuttle the valve to the off position. TCC apply fluid will then be routed to the cooler, and TCC release fluid will be routed to the torque converter for complete TCC release.

Drive Range, Fifth Gear Default


1-2-3-4
3-5 REV
1-2-3-4 & 3-5 REVERSE CLUTCH ASSEMBLY
4-5-6 CLUTCH ASSEMBLY
CENTER SUPPORT ASSEMBLY
LOW & REVERSE CLUTCH ASSEMBLY
TORQUE CONVERTER ASSEMBLY
FLUID PRESSURES

Drive Range, Fifth Gear

As the vehicle speed increases, the transmission control module (TCM) receives input signals from the automatic transmission input and output speed sensors, the throttle position sensor and other vehicle sensors to determine the precise moment to command ON the normally-high C35R pressure control solenoid 2. At the same time the normally-low C1234 pressure control solenoid 5 is commanded OFF.

3-5 REVERSE CLUTCH APPLIES

C35R Pressure Control Solenoid 2

The C35R pressure control solenoid 2 is commanded ON, allowing actuator feed fluid to enter the PCS 35 reverse clutch fluid circuit. PCS 35 reverse clutch fluid is routed through orifice #48 and then to the 3-5 reverse clutch regulator valve. PCS 35 reverse clutch fluid is also routed through orifice #40 and then to the 3-5 reverse clutch boost valve.

3-5 Reverse Clutch Boost Valve

PCS 35 reverse clutch fluid pressure acts on a differential area moving the PCS 3-5 reverse clutch boost valve against the 3-5 reverse clutch boost valve spring. 35 reverse clutch fluid passes through the valve and enters the 35 reverse clutch feedback circuit. As PCS 35 reverse clutch fluid pressure is increased to a given value, the 3-5 reverse clutch boost valve opens the 35 reverse clutch feedback circuit to exhaust. This results in the 3-5 reverse clutch regulator valve moving to the full feed position sending full 35 reverse clutch feed pressure (full line pressure) to the clutch.

3-5 Reverse Clutch Regulator Valve

PCS 35 reverse clutch fluid moves the 3-5 reverse clutch regulator valve against 3-5 reverse clutch regulator valve spring force and 35 reverse clutch feedback fluid. This allows 35 reverse feed to pass through the valve and enter the 35 reverse clutch circuit. 35 reverse clutch fluid is then routed to the 3-5 reverse clutch, the 3-5 reverse boost valve and the clutch select valve 2. When the 3-5 reverse clutch regulator valve is in this position, PS1 fluid from the pressure switch 1 exhausts through the valve allowing the switch to close.

Clutch Select Valve 2

35 reverse clutch fluid passes through the clutch select valve 2 and enters the 1234 clutch default feed fluid circuit. 1234 clutch default feed fluid is then routed to the clutch select valve 3.

3-5 Reverse Clutch

35 reverse clutch fluid enters the 1-2-3-4 & 3-5 reverse clutch housing to move the piston against spring force combined with force from the compensator to apply the 3-5 reverse clutch plates.

1-2-3-4 CLUTCH RELEASES

C1234 Pressure Control Solenoid 5

The C1234 pressure control solenoid 5 is commanded OFF, allowing PCS 1234 clutch fluid from the 1-2-3-4 clutch regulator valve and 1-2-3-4 clutch boost valve to exhaust.

1-2-3-4 Clutch Regulator Valve

1-2-3-4 clutch regulator valve spring force moves the valve to allow 1234 clutch feed fluid from the 1-2-3-4 clutch to pass through the valve and enter the exhaust backfill fluid circuit. 1234 clutch fluid the enters the exhaust backfill fluid circuit and is routed through orifice # 30 to the exhaust backfill pressure relief valve where excess pressure is exhausted. Also, 1234 clutch regulator valve spring force moves the valve to allow 1234 clutch feed fluid to pass through the valve and enter the PS4 fluid circuit. PS4 fluid is then routed to pressure switch 4 and opens the normally-closed switch.

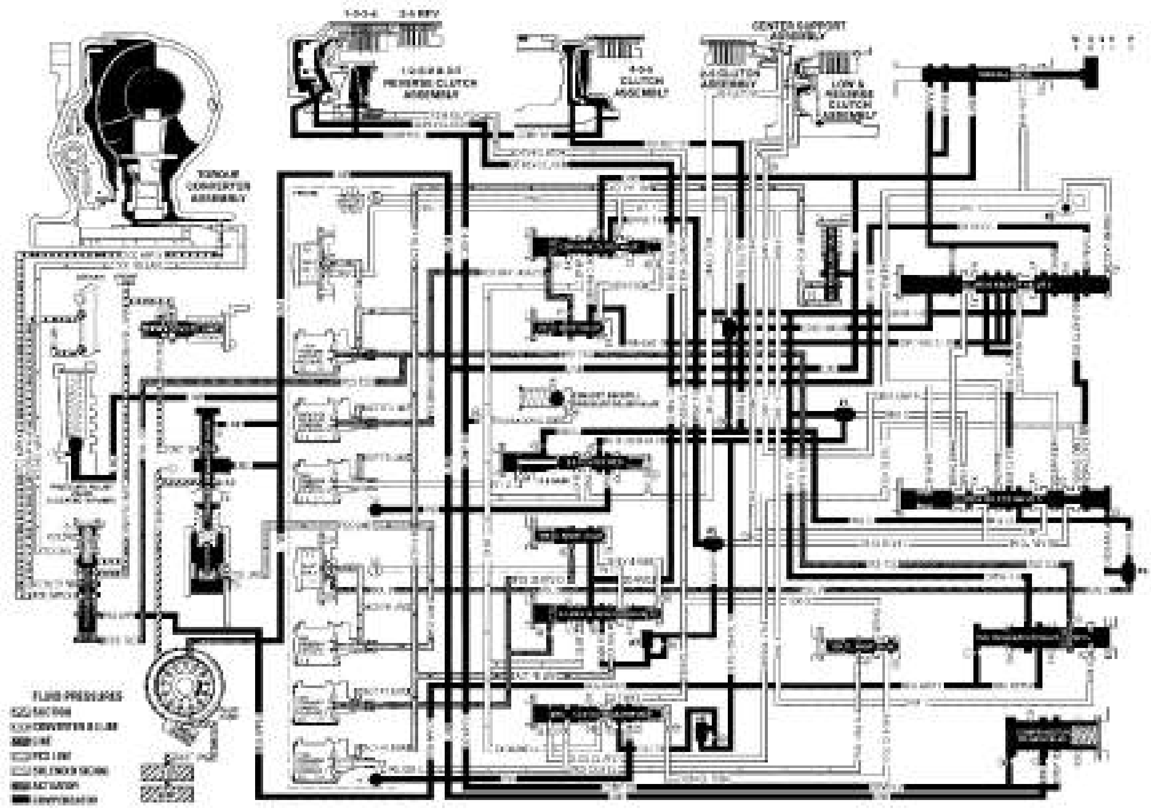
1-2-3-4 Clutch Boost Valve

1-2-3-4 clutch boost valve spring force moves the valve to allow 1234 clutch feedback fluid from the 1-2-3-4 clutch regulator valve to enter the 1234 clutch circuit and exhaust.

1-2-3-4 Clutch

1-2-3-4 clutch spring force combined with force from the compensator moves the 1-2-3-4 clutch piston to release the clutch plates and force 1234 clutch fluid from the 1-2-3-4 and 3-5 reverse clutch housing. 1234 clutch fluid is routed through the 1-2-3-4 clutch regulator valve where it enters the exhaust backfill fluid circuit.

Drive Range, Fifth Gear


1-2-3-4
3-5 REV
1-2-3-4 & 3-5 REVERSE CLUTCH ASSEMBLY
4-5-6 CLUTCH ASSEMBLY
CENTER SUPPORT ASSEMBLY
2-6 CLUTCH ASSEMBLY
LOW & REVERSE CLUTCH ASSEMBLY
TORQUE CONVERTER ASSEMBLY
FLUID PRESSURES
SUCTION
CONVERTER & LUBE
MAIN LINE
PCS LINE
SOLENOID SIGNAL
ACTUATOR
COMPENSATOR

Drive Range, First Gear Engine Braking

When the gear selector lever is moved to the Drive (D) range from the Neutral (N) position, the transmission will provide engine braking. In this operating range, the normally-low C1234 pressure control solenoid 5 is commanded ON and in the engine braking mode the following changes occur within the hydraulic circuits:

FLUID PRESSURE IS DIRECTED TO THE 1-2-3-4 CLUTCH AND THE LOW & REVERSE CLUTCH TO PROVIDE ENGINE BRAKING

Manual Valve

The manual valve is moved to the Drive (D) position and allows line fluid pressure to enter the drive fluid circuit. Drive fluid is then routed to the clutch select valve 2.

Clutch Select Valve 2

Drive fluid at the clutch select valve 2 passes through the valve and enters the drive brake circuit. Drive brake fluid is then routed to the clutch select valve 3.

Clutch Select Valve 3

Drive brake fluid at the clutch select valve 3 passes through the valve and enters the Drive B fluid circuit. Drive B fluid is then routed to #1 ball check valve.

#1 Ball Check Valve

Drive B fluid seats the #1 ball check valve against drive 1-6 fluid to force drive B fluid into the CB26/C1234 feed passage. CB26/ C1234 feed fluid is routed to the #6 ball check valve, through orifice #43 and, to the 2-6 clutch regulator valve. CB26/C1234 feed fluid passes through the 2-6 clutch regulator valve and enters the PS3 fluid circuit. PS3 fluid is then routed to the normally closed pressure switch 3 and opens the switch.

#6 Ball Check Valve

CB26/C1234 feed fluid seats the #6 ball check valve against the 1234 clutch feed passage forcing CB26/C1234 feed fluid through orifice #32 before entering the 1234 clutch feed circuit. 1234 clutch feed fluid is routed through orifice #33 and then to the 1- 2-3-4 clutch regulator valve.

1-2-3-4 CLUTCH APPLIES

C1234 Pressure Control Solenoid 5

The C1234 Pressure Control Solenoid 5 is commanded ON allowing actuator feed limit fluid to enter the PCS1234 clutch fluid circuit. PCS1234 clutch fluid is then routed through orifice #35 to the 1-2-3-4 clutch regulator valve. PCS1234 clutch fluid is also routed through orifice #29 and then to the 1-2- 3-4 clutch boost valve.

1-2-3-4 Clutch Regulator Valve

PCS1234 clutch fluid moves the 1-2-3-4 clutch regulator valve against 1-2-3-4 clutch regulator valve spring force to allow 1234 clutch feed fluid to pass through the valve and enter the 1234 clutch fluid circuit. 1234 clutch fluid is then routed to the 1234 clutch boost valve and the 1-2-3-4 clutch.

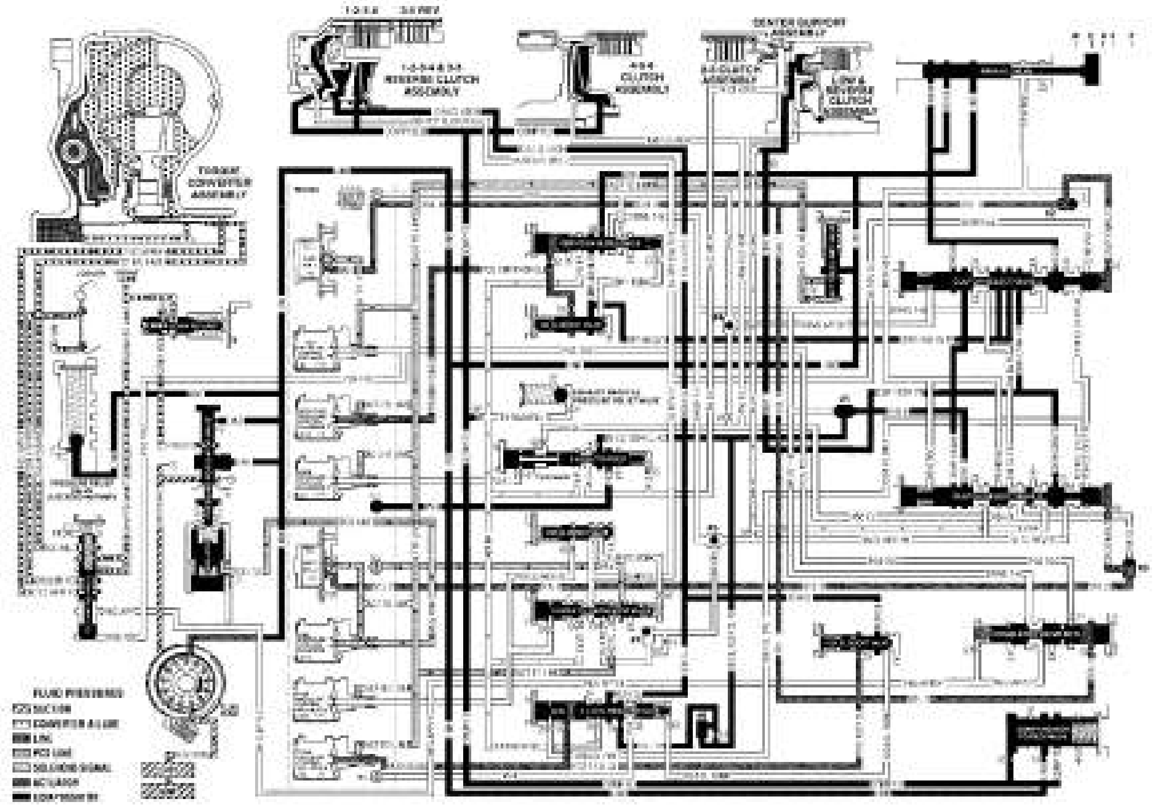
1-2-3-4 Clutch Boost Valve

PCS1234 clutch fluid pressure acts on a differential area moving the 1234 clutch boost valve against the 1234 clutch boost valve spring. 1234 clutch fluid passes through the valve and enters the 1234 clutch feedback circuit. As PCS 1234 clutch fluid pressure is increased to a given value, the 1234 clutch boost valve opens the 1234 clutch feedback circuit to exhaust. This results in the 1234 clutch regulator valve moving to the full feed position sending full 26 CL/1234 CL feed pressure (full line pressure) to the clutch.

1-2-3-4 Clutch

1234 clutch fluid enters the 1234 clutch housing to move the piston against spring force and compensator feed fluid to apply the 1-2-3-4 clutch plates.

Drive Range, First Gear Engine Braking


1-2-3-4
3-5 REV
1-2-3-4 & 3-5 REVERSE CLUTCH ASSEMBLY
4-5-6 CLUTCH ASSEMBLY
CENTER SUPPORT ASSEMBLY
3-5 CLUTCH ASSEMBLY
LOW & REVERSE CLUTCH ASSEMBLY
TORQUE CONVERTER ASSEMBLY
FLUID PRESSURES
SUCTION
CONVERTER & LUBE
LINE
PCS LINE
SOLENOID SIGNAL
ACTUATOR

Drive Range, First Gear

As the vehicle speed increases, the transmission control module (TCM) receives input signals from the automatic transmission input and output speed sensors, throttle position sensor and other vehicle sensors to determine the precise moment to de-energise or "turn off" shift solenoid 1 and command OFF the normally-high CBR1/C456 pressure control solenoid 3.

LOW & REVERSE CLUTCH RELEASES

Shift Solenoid 1

When shift solenoid 1 is "turned OFF", CSV2 enable fluid from the clutch select valve 2 passes by the #2 ball check valve and enters the solenoid 1 fluid circuit. Solenoid 1 fluid from the #2 ball check valve and TCC regulator valve is then routed to the solenoid where it exhausts.

Clutch Select Valve 2

CSV2 enable fluid is exhausted from the clutch select valve 2 and clutch select valve 2 spring force moves the valve to the released position. With clutch select valve 2 in the released position, drive fluid from the manual valve passes through the valve and enters the drive 1-6 fluid circuit. Drive 1-6 fluid then feeds all clutch regulator valves and the TCC regulator valve.

CBR1/C456 Pressure Control Solenoid 3

The CBR1/C456 pressure control solenoid 3 is commanded OFF allowing PCS CBR1/C456 fluid from the CBR1/C456 clutch regulator valve and 456 clutch boost valve to exhaust.

CBR1/C456 Clutch Regulator Valve

CBR1/C456 clutch regulator valve spring force moves the valve to exhaust the CBR1/456 clutch feed circuit and allow drive 1-6 fluid to enter the PS5 fluid circuit. PS5 fluid is then routed to the normally-closed pressure switch 5 and opens the switch. PS5 fluid is also routed to the #4 ball check valve and flows into the CSV2 latch fluid circuit.

#4 Ball Check Valve

PS5 fluid pressure seats the #4 ball check valve against the 456 clutch fluid circuit. PS5 fluid is then directed into the CSV2 latch fluid circuit and routed to the clutch select valve 2. CSV2 latch fluid combines with clutch select valve 2 spring force and holds the valve in this position during all six forward gear ranges.

#5 Ball Check Valve

Drive 1-6 fluid pressure seats the #5 ball check valve against the 35 clutch reverse feed fluid passage. Drive 1-6 fluid is then directed into the 35R supply fluid circuit which is routed to the #7 ball check valve and orifice #25.

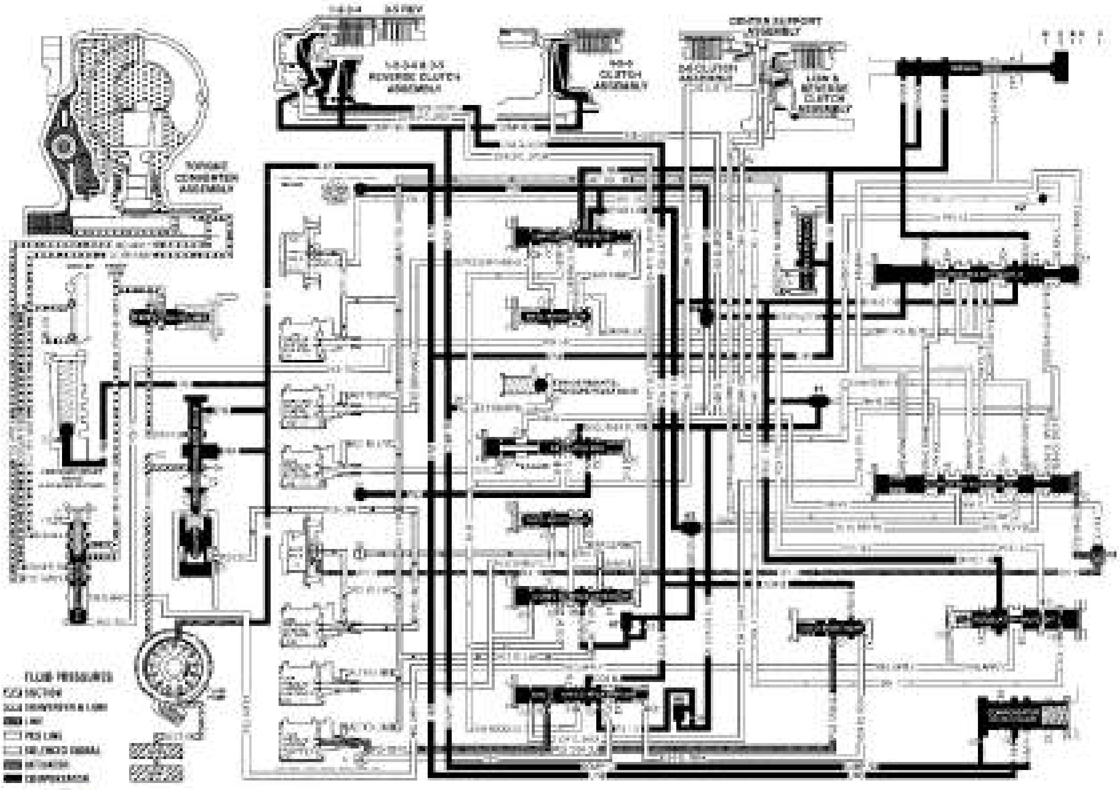
#7 Ball Check Valve

35R supply fluid seats the #7 ball check valve against the 35R feed fluid passage to force 35R supply fluid through orifice #25 before entering the 35R feed circuit. 35R feed fluid is then routed to the 3-5 reverse clutch regulator valve.

Low and Reverse Clutch

Low and reverse clutch spring force moves the low and reverse clutch piston which forces CBR and CBR1 fluid out of the centre support. CBR fluid is routed to the clutch select valve 3 where it exhausts. CBR1 fluid is routed to the clutch select valve 2 where it exhausts. The low and reverse clutch is in the released position.

Drive Range, First Gear



Drive Range, Second Gear

As the vehicle speed increases, the transmission control module (TCM) receives input signals from the automatic transmission input and output speed sensors, the throttle position sensor and other vehicle sensors to determine the precise moment to command ON the normally-low pressure control solenoid 4.

SECOND CLUTCH APPLIES

CB26 Pressure Control Solenoid 4

The CB26 pressure control solenoid 4 is commanded ON, allowing actuator feed limit fluid to enter the PCS 26 clutch fluid circuit. PCS 26 clutch fluid is then routed through orifice #44 to the 2-6 clutch regulator gain valve.

2-6 Clutch Regulator Gain Valve

The 2-6 clutch regulator gain valve allows the gain (valve input to output pressure magnification factor) of the 2-6 clutch regulator valve to be different for a 1-2 shift verses a 5-6 shift. For a 1-2 shift, PCS 26 clutch fluid pressure acts on a differential area resulting in the "high gain" pressure output.

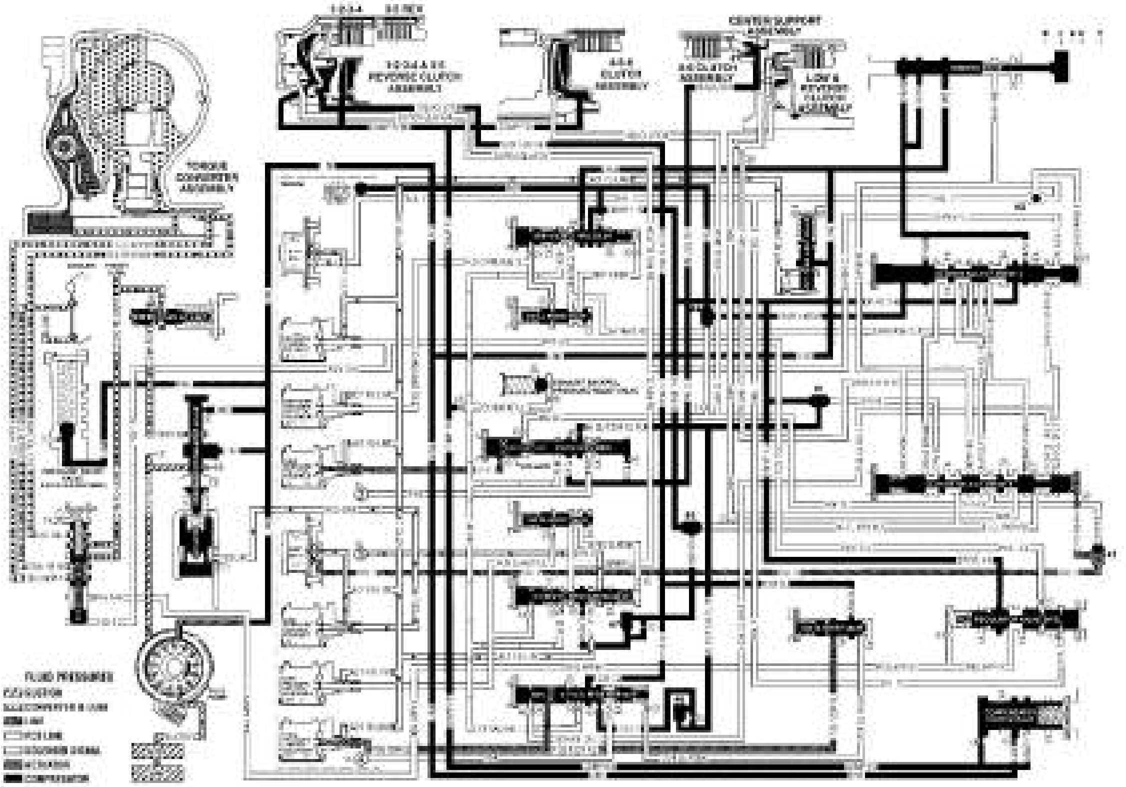
2-6 Clutch Regulator Valve

PCS 26 clutch fluid moves the 2-6 clutch regulator gain valve assembly against the 2--6 clutch regulator valve spring force to allow 26 clutch/1234 clutch feed fluid to pass through the valve. 26 clutch/1234 clutch feed fluid is routed into the 26 clutch fluid circuit where it passes through orifice #41 and then to the spring end of the 2-6 clutch regulator valve, and to the 2-6 clutch within the centre support.

2-6 Clutch

26 clutch fluid from the 2-6 clutch regulator valve is routed through the centre support and to the 2-6 clutch piston assembly. 26 clutch fluid pressure moves the piston against 2-6 clutch spring force to apply the 2-6 clutch plates.

Drive Range, Second Gear


1-2-3-4
3-5 REV
1-2-3-4 & 3-5 REVERSE CLUTCH ASSEMBLY
4-5-6 CLUTCH ASSEMBLY
2-6 CLUTCH ASSEMBLY
CENTER SUPPORT ASSEMBLY
LOW & REVERSE CLUTCH ASSEMBLY
TORQUE CONVERTER ASSEMBLY
FLUID PRESSURES
LINE
ACTUATOR
COMPENSATOR

Drive Range, Sixth Gear

As the vehicle speed increases, the transmission control module (TCM) receives input signals from the automatic transmission input and output speed sensors, the throttle position sensor and other vehicle sensors to determine the precise moment to command ON the normally-low CB26 pressure control solenoid 4. At the same time the normally-high C35R pressure control solenoid 2 is commanded OFF.

2-6 CLUTCH APPLIES

CB26 Pressure Control Solenoid 4

The CB26 pressure control solenoid 4 is commanded ON, allowing actuator feed fluid to enter the PCS 26 clutch fluid circuit. PCS 26 fluid is routed through orifice #44 and then to the 2-6 clutch regulator gain valve.

2-6 Clutch Regulator Gain Valve

The 2-6 clutch regulator gain valve allows the gain (valve input to output pressure magnification factor) of the 2-6 clutch regulator valve to be different for a 1-2 shift verses a 5-6 shift. For a 5-6 shift PCS 26 clutch fluid pressure passes through the hollow valve and only acts on the 26 regulator valve area, resulting in the "low gain" pressure output.

2-6 Clutch Regulator Valve

PCS 26 clutch fluid moves the 2-6 clutch regulator/gain valve assembly against the 2-6 clutch regulator valve spring force to allow 26 clutch/1234 clutch feed fluid to pass through the valve. 26 clutch/1234 clutch feed fluid is routed into the 26 clutch fluid circuit where it passes through orifice #41 and then to the spring end of the 2-6 clutch regulator valve, and to the 2-6 clutch within the centre support.

2-6 Clutch

26 clutch fluid from the 2-6 clutch regulator valve is routed through the centre support and to the 2-6 clutch piston assembly. 26 clutch fluid pressure moves the piston against 2-6 clutch spring force to apply the 2-6 clutch plates.

3-5 CLUTCH RELEASES

C35R Pressure Control Solenoid 2

The C35R pressure control solenoid 2 is commanded OFF, allowing PCS 35 reverse clutch fluid from the 3-5 reverse clutch boost valve and the 3-5 reverse clutch regulator valve to exhaust through the solenoid.

3-5 Reverse Clutch Boost Valve

3-5 reverse boost valve spring force moves the valve to allow 35 reverse clutch feedback fluid from the 3-5 reverse clutch regulator valve to enter the 35 reverse clutch circuit and exhaust.

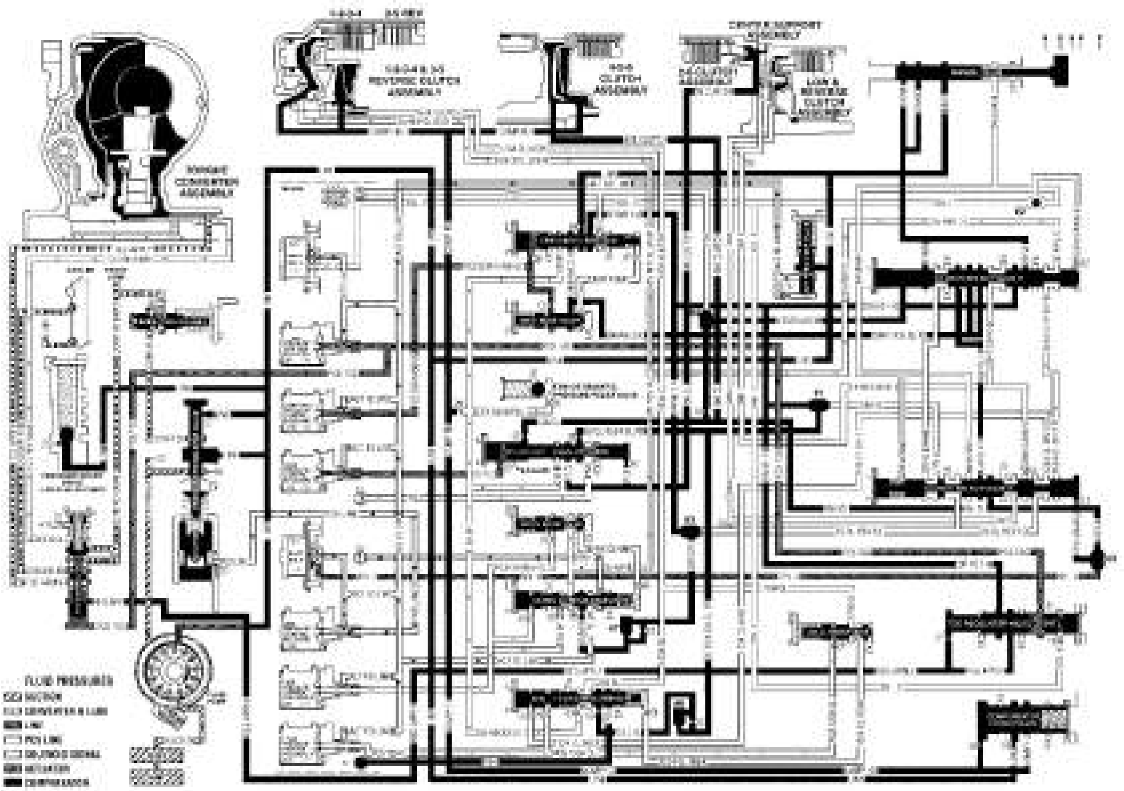
3-5 Reverse Clutch Regulator Valve

3-5 reverse clutch regulator valve spring force moves the valve to allow 35 reverse clutch fluid from the 3-5 reverse clutch to pass through the valve and enter the exhaust backfill fluid circuit. 35 reverse clutch fluid then enters the exhaust backfill fluid circuit and is routed through orifice #30 to the exhaust backfill pressure relief valve where excess pressure is exhausted.

3-5 Reverse Clutch

3-5 reverse clutch spring force combined with force from the compensator move the 3-5 reverse clutch piston to release the 3-5 clutch plates and forces 35 reverse clutch fluid to exhaust from 1-2-3-4 and 3-5 reverse clutch housing. 35 reverse clutch fluid is then routed to the 3-5 reverse clutch regulator valve where it enters the exhaust backfill circuit.

Drive Range, Sixth Gear



Drive Range, Third Gear Default

If the transmission is in 1st, 2nd or 3rd gear during a transmission electrical component failure, the transmission will default to 3rd gear. All solenoids will default to their normal state. If the torque converter clutch was applied, it will release. This default action will enable the vehicle to be safely driven to a service centre.

1-2-3-4 CLUTCH STAYS APPLIED

Shift Solenoid 2

Shift solenoid 2 defaults to it's normally-closed state (OFF), and SOL 2 fluid exhausts through the solenoid.

Clutch Select Valve 3

Sol 2 fluid pressure no longer holds the clutch select valve 3 open. When the valve moves back to the closed position, it opens the 1234 clutch default fluid circuit, and 1234 default fluid is routed to the 1-2-3-4 clutch regulator valve.

1-2-3-4 Clutch Regulator Valve

With the absence of PCS 1234 clutch fluid, due to the default state of the C1234 pressure control solenoid 5, the 1-2-3-4 regulator valve closes from spring force. However, the 1234 clutch default fluid enters behind the 1-2-3-4 regulator shuttle valve and keeps the valve in the open position.

1-2-3-4 Clutch

With the 1-2-3-4 clutch regulator valve still held in the open position, the 1-2-3-4 clutch will stay applied.

3-5 REVERSE CLUTCH APPLIED or APPLIES

C35R Pressure Control Solenoid 2

The normal state for the C35R pressure control solenoid 2 is ON, therefore PSC 35 reverse clutch fluid will still be routed to the 3-5 reverse clutch regulator valve and the 3-5 reverse clutch boost valve.

3-5 Reverse Clutch Regulator Valve

PCS 3-5 reverse clutch fluid moves the 3-5 reverse clutch regulator valve against 3-5 reverse clutch regulator valve spring force and 3-5 reverse clutch feedback fluid. This allows 3-5 reverse feed to pass through the valve and enter the 3-5 reverse clutch circuit. 3-5 reverse clutch fluid is then routed to the 3-5 reverse clutch, the 3-5 reverse boost valve and the clutch select valve 2. When the 3-5 reverse clutch regulator valve is in this position, PS1 fluid from the pressure switch 1 exhausts through the valve, allowing the switch to close.

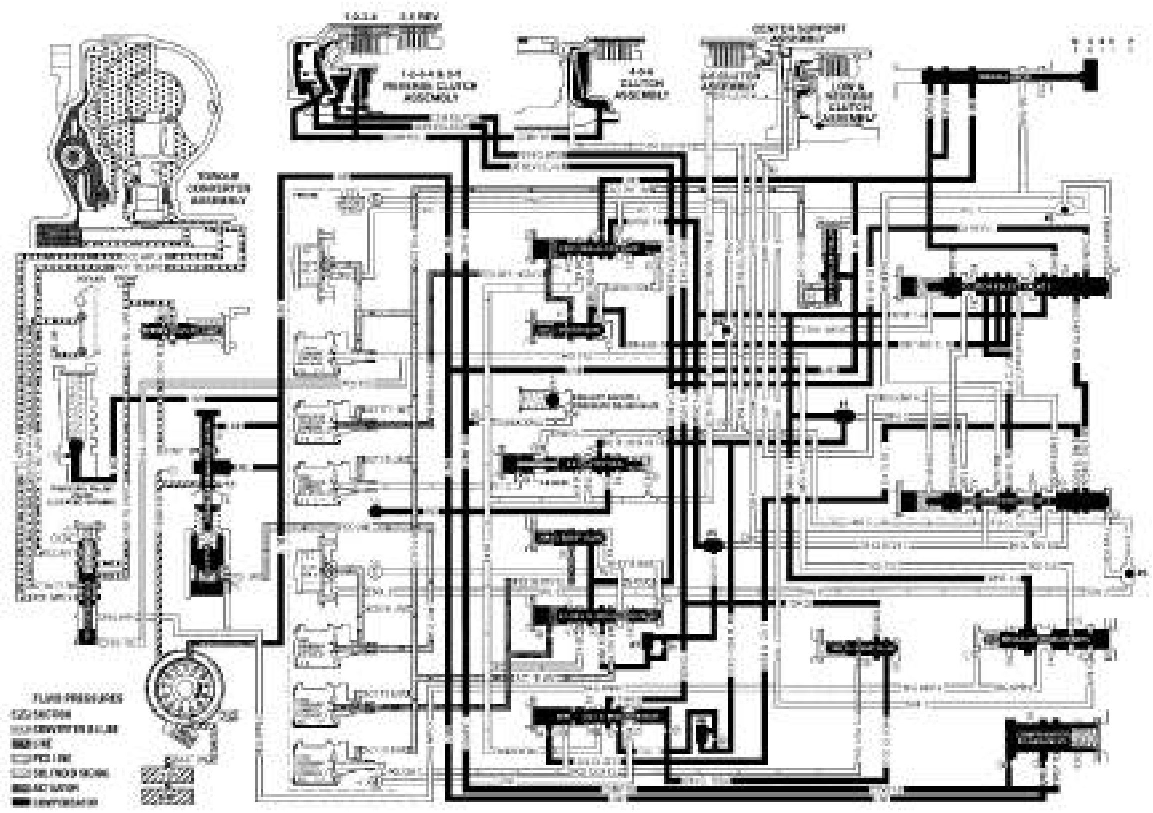
3-5 Reverse Clutch Boost Valve

PCS 3-5 reverse clutch fluid pressure acts on a differential area moving the 3-5 reverse clutch boost valve against the 3-5 reverse clutch boost valve spring. 3-5 reverse clutch fluid passes through the valve and enters the 3-5 reverse clutch feedback circuit. As PCS 3-5 reverse clutch fluid pressure is increased to a given value, the 3-5 reverse clutch boost valve opens the 3-5 reverse clutch feedback circuit to exhaust. This results in the 3-5 reverse clutch regulator valve moving to the full feed position sending full 3-5 reverse clutch feed pressure (full line pressure) to the clutch.

3-5 Reverse Clutch

3-5 reverse clutch fluid enters the 1-2-3-4 & 3-5 reverse clutch housing to move the piston against spring force combined with force from the compensator to apply the 3-5 reverse clutch plates.

Drive Range, Third Gear Default


CENTER SUPPORT ASSEMBLY
4-5-6 CLUTCH ASSEMBLY
LOW & REVERSE CLUTCH ASSEMBLY
TORQUE CONVERTER ASSEMBLY
FLUID PRESSURES

Drive Range, Third Gear

As the vehicle speed increases, the transmission control module (TCM) receives input signals from the automatic transmission input and output speed sensors, the throttle position sensor and other vehicle sensors to determine the precise moment to command OFF the normally-low CB26 pressure control solenoid 4. At the same time the C35R pressure control solenoid 2 is also commanded ON to regulate 3-5 clutch apply.

3-5 REVERSE CLUTCH APPLIES

C35R Pressure Control Solenoid 2

The C35R pressure control solenoid 2 is commanded ON allowing actuator feed fluid to enter the PCS 35 reverse clutch fluid circuit. PCS 35 reverse clutch fluid is routed through orifice #48 and then to the 3-5 reverse clutch regulator valve. PCS 35 reverse clutch fluid is also routed through orifice #40 and then to the 3-5 reverse clutch boost valve.

3-5 Reverse Clutch Boost Valve

PCS 35 reverse clutch fluid pressure acts on a differential area moving the 3-5 reverse clutch boost valve against the 3-5 reverse clutch boost valve spring. 35 reverse clutch fluid passes through the valve and enters the 35 reverse clutch feedback circuit. As PCS 35 reverse clutch fluid pressure is increased to a given value, the 3-5 reverse clutch boost valve opens the 35 reverse clutch feedback circuit to exhaust. This results in the 3-5 reverse clutch regulator valve moving to the full feed position sending full 35 reverse clutch feed pressure (full line pressure) to the clutch.

3-5 Reverse Clutch Regulator Valve

PCS 35 reverse clutch fluid moves the 3-5 reverse clutch regulator valve against 3-5 reverse clutch regulator valve spring force and 35 reverse clutch feedback fluid. This allows 35 reverse feed to pass through the valve and enter the 35 reverse clutch circuit. 35 reverse clutch fluid is then routed to the 3-5 reverse clutch, the 3-5 reverse boost valve and the clutch select valve 2. When the 3-5 reverse clutch regulator valve is in this position, PS1 fluid from the pressure switch 1 exhausts through the valve allowing the switch to close.

3-5 Reverse Clutch

35 reverse clutch fluid enters the 1-2-3-4 & 3-5 reverse clutch housing to move the piston against spring force combined with force from the compensator to apply the 3-5 reverse clutch plates.

2-6 CLUTCH RELEASES

CB26 Pressure Control Solenoid 4

The CB26 pressure control solenoid 4 is commanded OFF allowing PCS 26 clutch fluid from the 2-6 clutch regulator valve to exhaust. 26 clutch/1234 clutch feed fluid at the 2-6 clutch regulator valve passes through the valve and enters the PS3 fluid circuit. PS3 fluid is then routed to pressure switch 3 and opens the normally-closed switch.

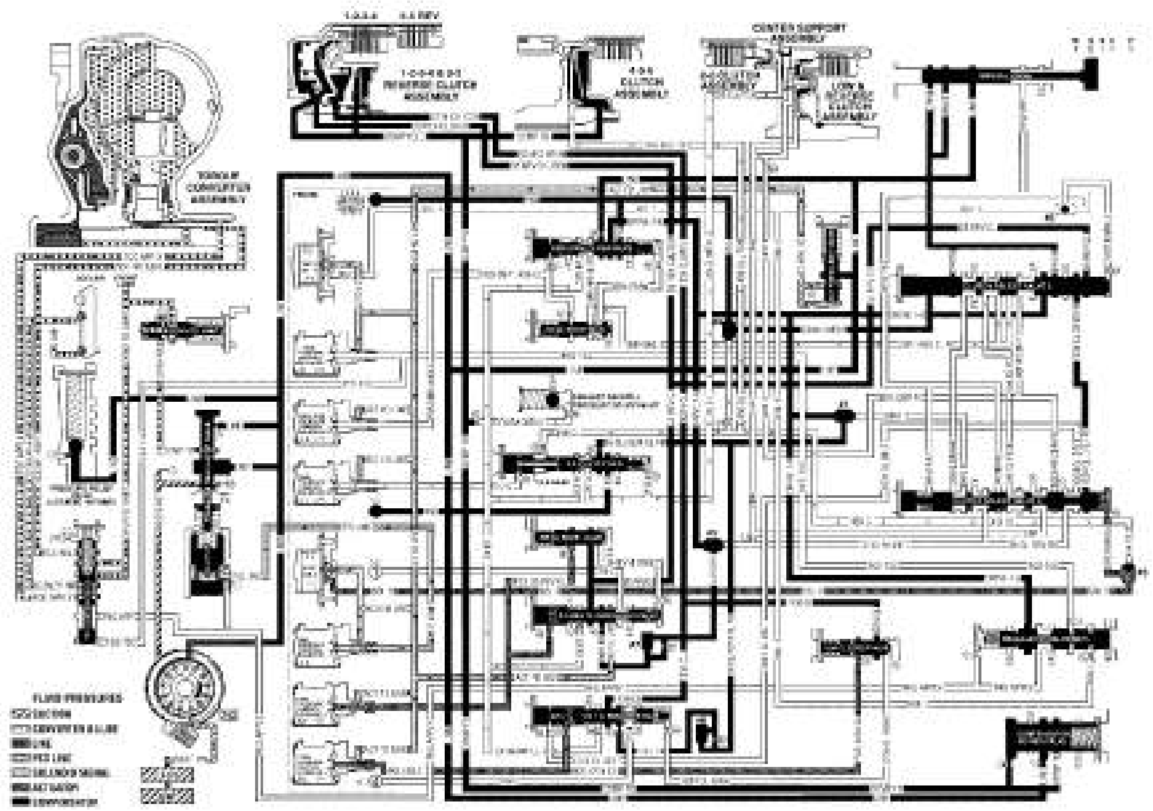
2-6 Clutch Regulator Valve

2-6 clutch regulator valve spring force moves the valve to allow 26 clutch fluid from the 2-6 clutch to pass through the valve and enter the exhaust backfill fluid circuit.

2-6 Clutch

2-6 clutch spring force moves the 2-6 clutch piston to release the 2-6 clutch plates and forces 26 clutch fluid to exhaust from the centre support. 26 clutch fluid is routed through the 2-6 clutch regulator valve where it enters the exhaust backfill fluid circuit and is routed through orifice #30 to the exhaust backfill pressure relief valve where excess pressure is exhausted.

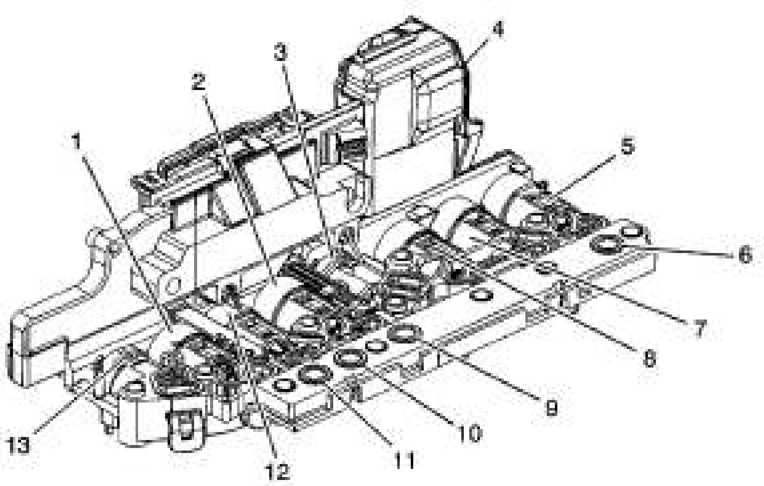
Drive Range, Third Gear


CENTER SUPPORT ASSEMBLY
REVERSE CLUTCH ASSEMBLY
CLUTCH ASSEMBLY
TORQUE CONVERTER ASSEMBLY
FLUID PRESSURES

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 6L50/6L80/6L90 | Description and Operation | Document ID: 2094530

Electronic Component Description

Control Solenoid (W/Body and TCM) Valve Assembly



(1) Line Pressure Control (PC) Solenoid
(2) Torque Converter Clutch (TCC) Pressure Control (PC) Solenoid
(3) Shift Solenoid (SS) 2
(4) 16 Pin Connector
(5) Pressure Control (PC) Solenoid 3
(6) Transmission Fluid Pressure (TFP) Switch 5
(7) Pressure Control (PC) Solenoid 4
(8) Pressure Control (PC) Solenoid 2
(9) Transmission Fluid Pressure (TFP) Switch 3
(10) Transmission Fluid Pressure (TFP) Switch 1
(11) Transmission Fluid Pressure (TFP) Switch 4
(12) Pressure Control (PC) Solenoid 5
(13) Shift Solenoid (SS) 1

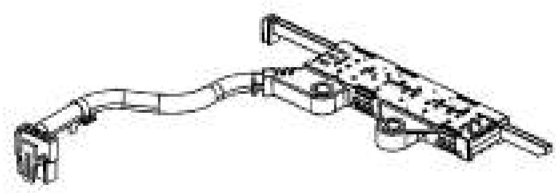
The control solenoid (w/body and TCM) valve assembly contains the following components:

- Transmission control module (TCM)
- Clutch pressure control solenoids (Clutch PC Sol)
- Shift solenoids (SS)
- Line pressure control solenoid (Line PC Sol)
- Torque converter clutch pressure control solenoid (TCC PC Sol)
- Transmission fluid temperature sensor (TFT Sensor)
- TCM temperature sensor

- Power-up temperature sensor
- Transmission fluid pressure switches (TFP Sw)

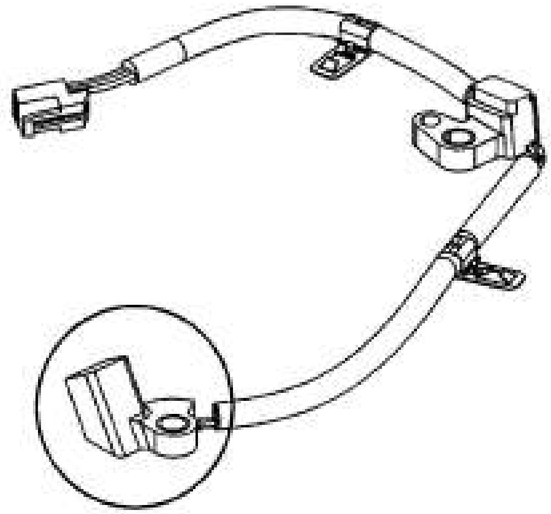
These components are not serviced separately. The control solenoid (w/body and TCM) valve assembly utilizes a lead-frame system to connect these components electrically to the TCM. No wires are used for these components. The control solenoid (w/body and TCM) valve assembly bolts directly to the lower and upper valve body assemblies inside the transmission. The control solenoid (w/body and TCM) valve assembly connects to the engine harness 16-way connector via a pass-thru sleeve.

Internal Mode Switch (IMS)



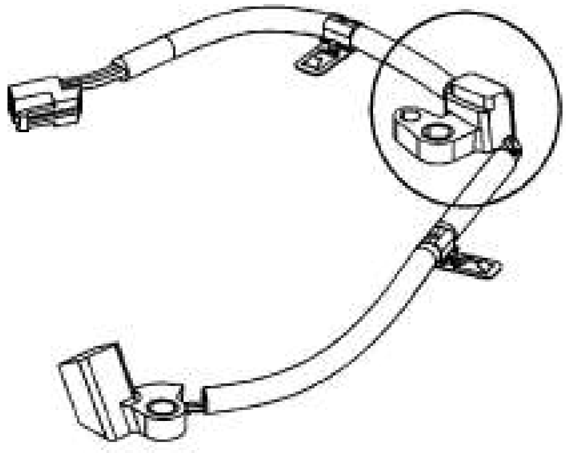
The transmission manual shift shaft switch assembly is a sliding contact switch attached to the manual shift shaft inside the transmission case. The five inputs to the TCM from the transmission manual shift shaft switch assembly indicate the transmission gear selector lever position. This information is used for engine controls as well as determining the transmission shift patterns. The state of each input is available for display on the scan tool. The five input parameters represented are Signal A, Signal B, Signal C, Signal P (Parity) and Signal N (P/N Start).

Input Speed Sensor (ISS)



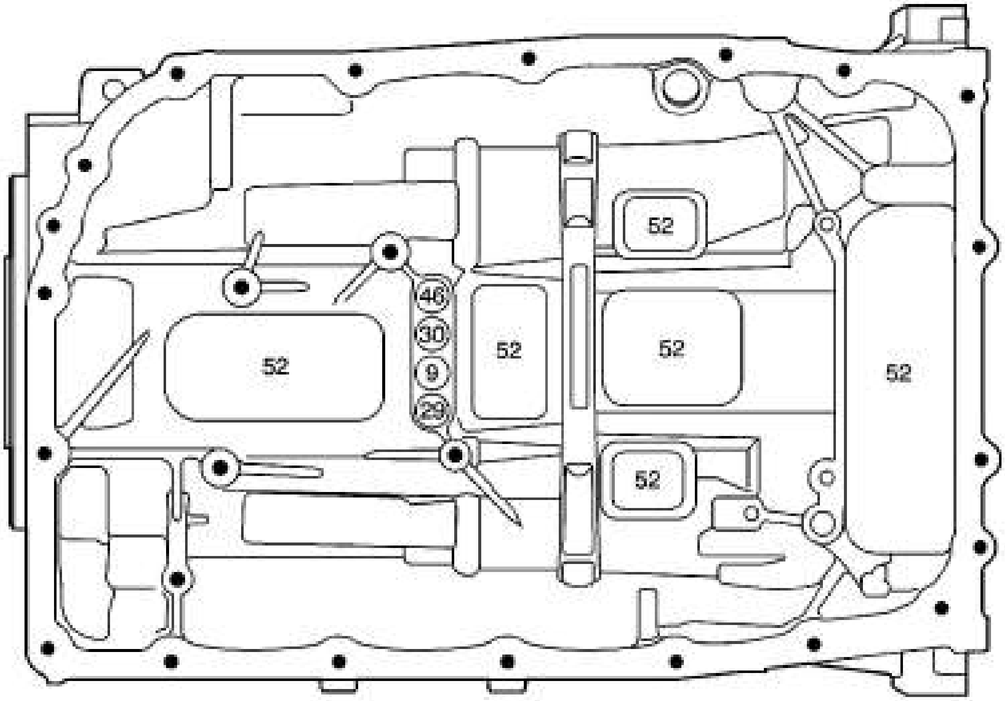
The input speed sensor (ISS) is a hall-effect type sensor. The ISS mounts to the control valve upper body assembly and connects to the control solenoid (w/body and TCM) valve assembly through a wire harness and connector. The sensor faces the 1-2-3-4 and 3-5-R clutch housing machined teeth surface. The sensor receives 8.3-9.3 volts on the ISS/OSS Supply Voltage circuit from the TCM. As the 1-2-3-4 and 3-5-R clutch housing rotates, the sensor produces a signal frequency based on the machined surface of the 1-2-3-4 and 3-5-R clutch housing. This signal is transmitted through the ISS signal circuit to the control solenoid (w/body and TCM) valve assembly. The control solenoid (w/body and TCM) valve assembly uses the ISS signal to determine line pressure, transmission shift patterns, torque converter clutch (TCC) slip speed and gear ratio.

Output Speed Sensor (OSS)



The output speed sensor (OSS) is a hall-effect type sensor. The OSS mounts to the control valve upper body assembly and connects to the control solenoid (w/body and TCM) valve assembly through a wire harness and connector. The sensor faces the output shaft machined teeth surface. The sensor receives 8.3-9.3 volts on the ISS/OSS supply voltage circuit from the TCM. As the output shaft rotates, the sensor produces a signal frequency based on the machined surface of the output shaft. This signal is transmitted through the OSS signal circuit to the TCM. The TCM uses the OSS signal to determine line pressure, transmission shift patterns, torque converter clutch (TCC) slip speed and gear ratio.

Case -- Top Channel Plate Side



(52) Void

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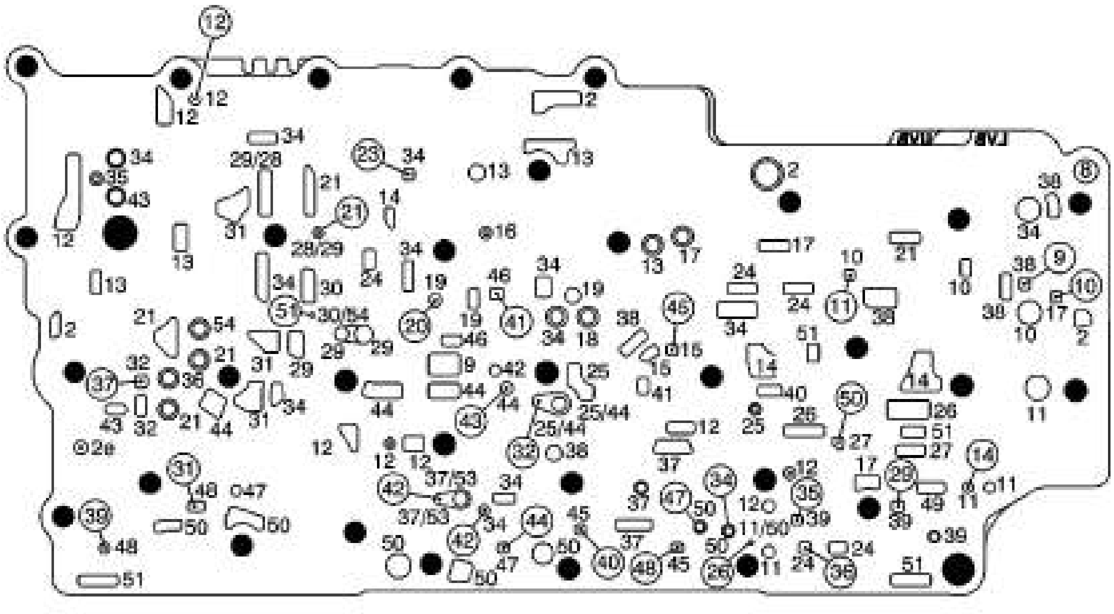
Control Valve Body Spacer Plate Assembly -- Bottom Channel Plate Side



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- (2) Line
- (8) Cooler Feed
- (9) Centre Lube
- (10) Regulator Apply
- (11) Compensator Feed
- (12) Actuator Feed Limit
- (13) Reverse
- (14) 35 Reverse Clutch
- (15) 35 Reverse Clutch Feedback
- (16) CSV2 Enable
- (17) Solenoid 1
- (18) Solenoid 2
- (19) CSV3 Enable
- (21) Drive 1-6
- (24) 1234 Clutch DFLT
- (25) 1234 Clutch Feed
- (26) 1234 Clutch
- (27) 1234 Clutch Feedback

(28) CBR1/CBR Feed
(29) CBR1
(30) CBR
(31) CBR1/456 Clutch Feed
(32) CBR1 Feedback
(34) 456 Clutch
(35) CSV2 Latch
(36) Drive B
(37) 35 Reverse Feed
(38) PCS TCC
(39) PCS 1234 Clutch
(40) PS4
(41) PS1
(42) PS3
(43) PS5
(44) 26 Clutch/1234 CL Feed
(45) PCS 35 Rev Clutch
(46) 26 Clutch
(47) PCS 26 Clutch
(48) PCS CBR1/456 Clutch
(49) PCS Line
(50) Exhaust BF
(51) Exhaust
(53) 35 R Supply
(54) 35 Clutch Reverse Feed

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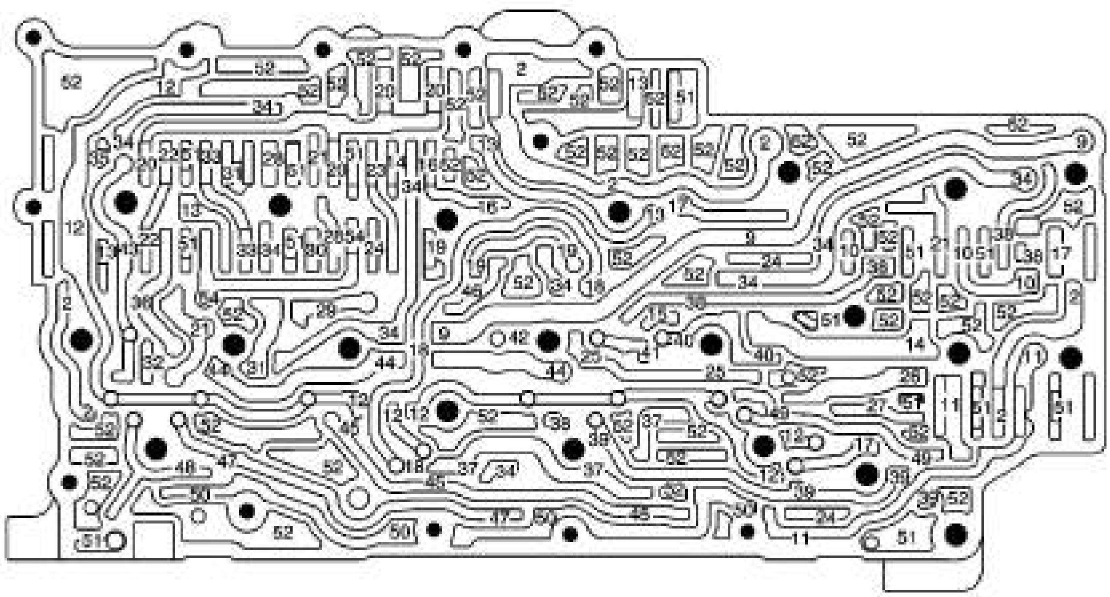
Control Valve Lower Body Assembly -- Control Valve Upper Body Assembly Side



(2) Line
(9) Centre Lube
(10) Regulator Apply
(11) Compensator Feed
(12) Actuator Feed Limit
(13) Reverse
(14) 35 Reverse Clutch
(15) 35 Reverse Clutch Feedback
(16) CSV2 Enable
(17) Solenoid 1
(18) Solenoid 2
(19) CSV3 Enable
(20) Drive
(21) Drive 1-6
(22) Drive Brake
(23) 1234 Clutch DFLT Feed
(24) 1234 Clutch DFLT

(25) 1234 Clutch Feed
(26) 1234 Clutch
(27) 1234 Clutch Feedback
(28) CBR1/CBR Feed
(29) CBR1
(30) CBR
(31) CBR1/456 Clutch Feed
(32) CBR1 Feedback
(33) 456 Clutch Feed
(34) 456 Clutch
(35) CSV2 Latch
(36) Drive B
(37) 35 Reverse Feed
(38) PCS TCC
(39) PCS 1234 Clutch
(40) PS4
(41) PS1
(42) PS3
(43) PS5
(44) 26 Clutch/1234 CL Feed
(45) PCS 35 Rev Clutch
(46) 26 Clutch
(47) PCS 26 Clutch
(48) PCS CBR1/456 Clutch
(49) PSC Line
(50) Exhaust BF
(51) Exhaust
(52) Void
(54) 35 Clutch Reverse Feed

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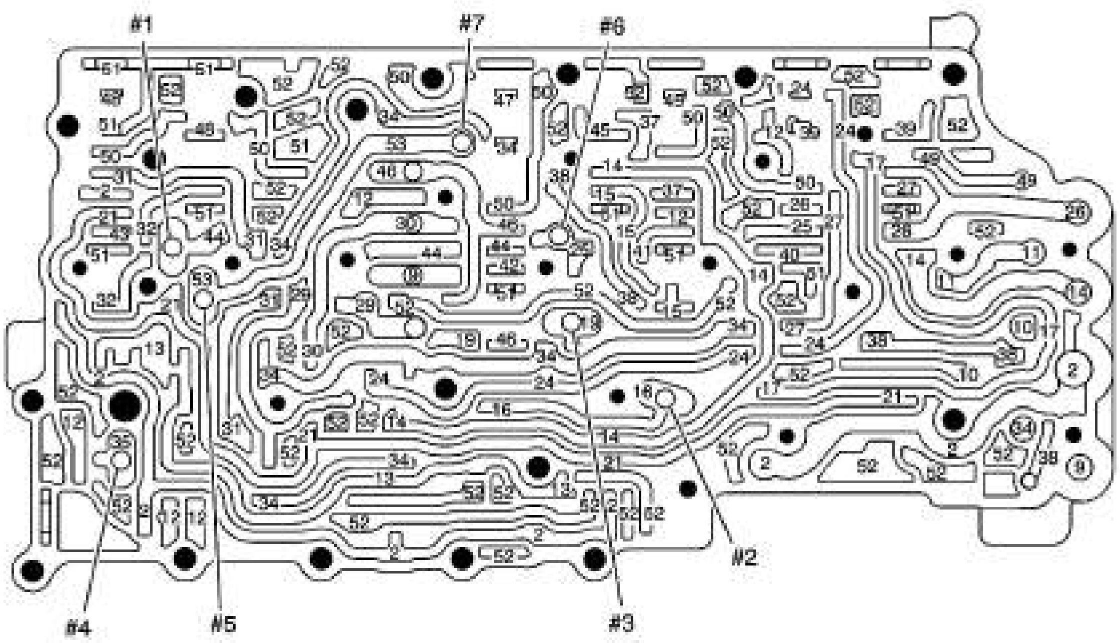
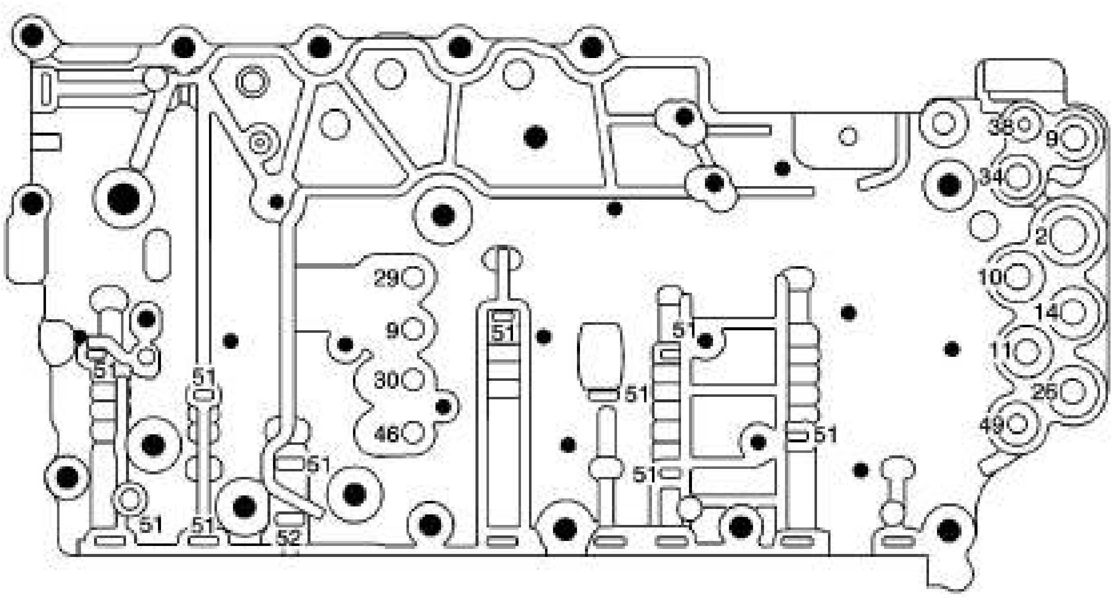
Control Valve Upper Body Assembly -- Bottom Channel Plate Side



(2) Line
(9) Centre Lube
(10) Regulator Apply
(11) Compensator Feed
(12) Actuator Feed Limit
(13) Reverse
(14) 35 Reverse Clutch
(15) 35 Reverse Clutch Feedback
(16) CSV2 Enable
(17) Solenoid 1
(19) CSV3 Enable
(21) Drive 1-6
(24) 1234 Clutch DFLT
(25) 1234 Clutch Feed
(26) 1234 Clutch
(27) 1234 Clutch Feedback
(29) CBR1
(30) CBR

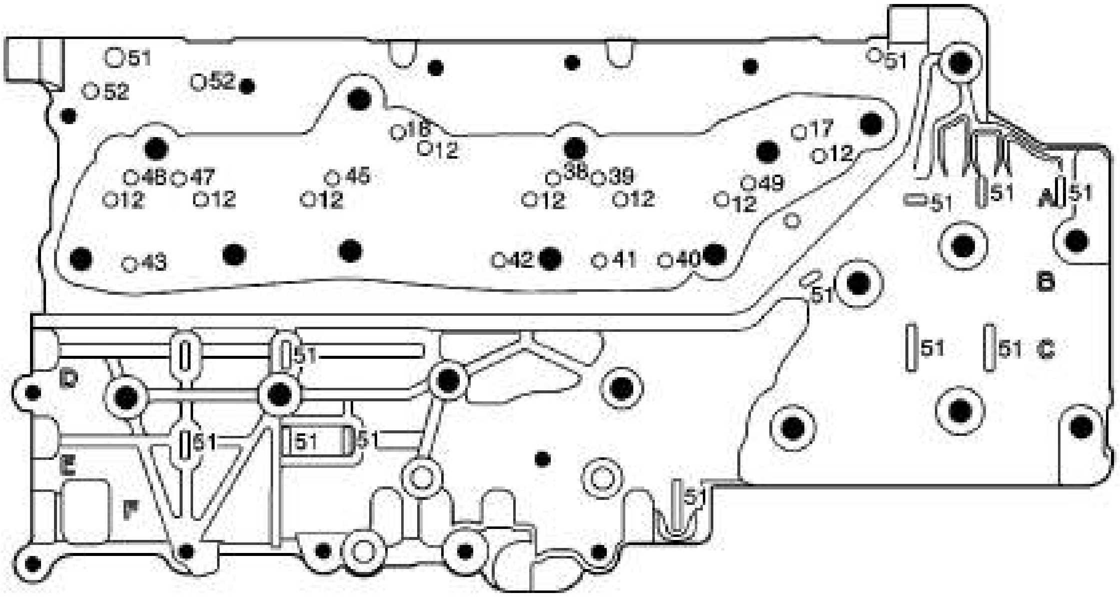
(31) CBR1/456 Clutch Feed
(32) CBR1 Feedback
(34) 456 Clutch
(35) CSV2 Latch
(37) 35 Reverse Feed
(38) PCS TCC
(39) PCS 1234 Clutch
(40) PS4
(41) PS1
(42) PS3
(43) PS5
(44) 26 Clutch/1234 CL Feed
(45) PCS 35 Rev Clutch
(46) 26 Clutch
(47) PCS 26 Clutch
(48) PCS CBR1/456 Clutch
(49) PCS Line
(50) Exhaust BF
(51) Exhaust
(52) Void
(53) 35 R Supply

Control Valve Upper Body Assembly -- Case Side



(2) Line
(9) Centre Lube
(10) Regulator Apply
(11) Compensator Feed
(14) 35 Reverse Clutch
(26) 1234 Clutch
(29) CBR1
(30) CBR
(34) 456 Clutch
(38) PCS TCC
(46) 26 Clutch
(49) PCS Line
(51) Exhaust
(52) Void

Control Valve Upper Body Assembly -- Control Solenoid Valve Assembly Side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A
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B
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C
D
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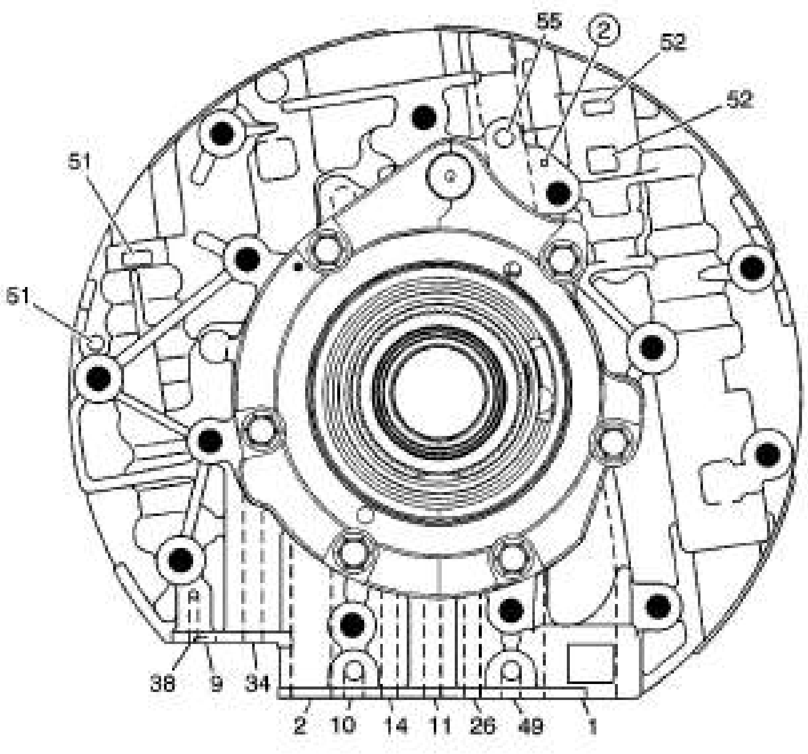
E
F
51

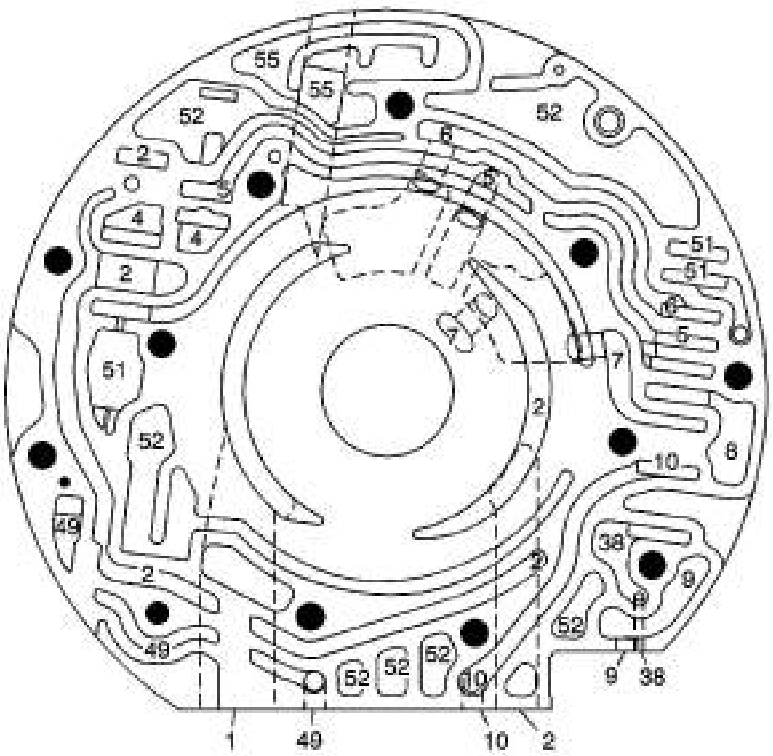
(12) Actuator Feed Limit
(17) Solenoid 1
(18) Solenoid 2
(38) PCS TCC
(39) PCS 1234 Clutch
(40) PS4
(41) PS1
(42) PS3
(43) PS5
(45) PCS 35 Rev Clutch
(47) PCS 26 Clutch
(48) PCS CBR1/456 Clutch
(49) PCS Line
(51) Exhaust
(52) Void

Fluid Pump Cover -- Case Side



(1) Suction
(2) Line
(9) Centre Lube
(10) Regulator Apply
(11) Compensator Feed
(14) 35 Reverse Clutch
(26) 1234 Clutch
(34) 456 Clutch
(38) PCS TCC
(49) PSC Line
(51) Exhaust
(52) Void
(55) Vent

Fluid Pump Cover -- Torque Converter Housing Side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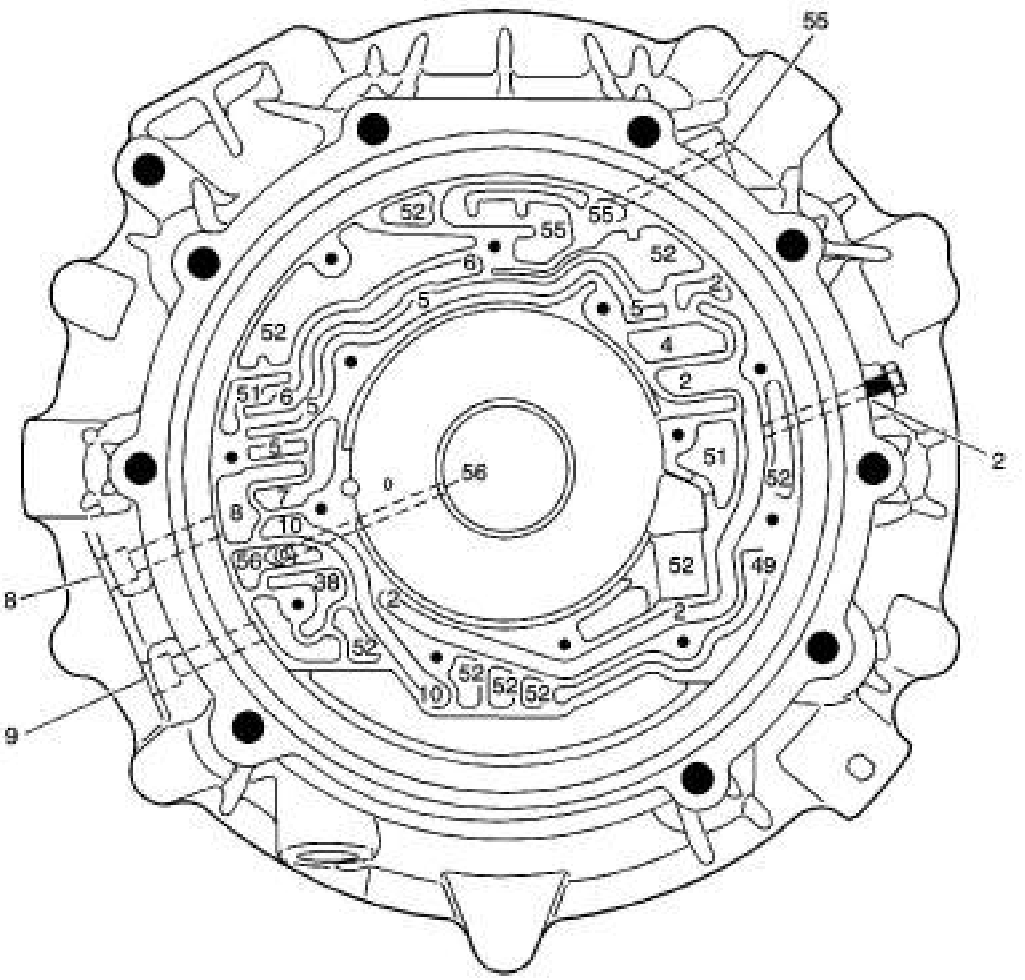
2
8
52
2
49
52
52
52
10
9
38
1
49
10
2

(1) Suction
(2) Line
(4) Converter Feed
(5) Converter Feed Limit
(6) TCC Release
(7) TCC Apply
(8) Cooler Feed
(9) Centre Lube
(10) Regulator Apply
(38) PCS TCC
(49) PCS Line
(51) Exhaust
(52) Void
(55) Vent

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 6L50/6L80/6L90 | Description and Operation | **Document ID: 1997015**

Torque Converter Housing -- Fluid Pump Cover Side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8
7
10
56
38
52
49
2
2
8
9
52
10
52
52
52

(2)	Line
(4)	Converter Feed
(5)	Converter Feed Limit
(6)	TCC Release
(7)	TCC Apply
(8)	Cooler Feed
(9)	Centre Lube
(10)	Regulator Apply
(38)	PCS TCC
(49)	PCS Line
(51)	Exhaust

(52) Void
(55) Vent
(56) Torque Converter Seal Drainback

Neutral - Engine Running

When the gear selector is moved to the Neutral (N) position, the hydraulic and electrical system operation is identical to Park (P) range. However, if Neutral is selected after the vehicle was operating in Reverse (R), the normally high C35R pressure control solenoid 2 is commanded OFF and the following changes occur in the hydraulic system:

3-5 REVERSE CLUTCH RELEASES

Manual Valve

The manual valve is moved to the Neutral position and blocks line pressure from entering the reverse and drive fluid circuits. The reverse fluid from the #2 ball check valve and clutch select valve 3 is opened to an exhaust passage at the manual valve.

C35R Pressure Control Solenoid 2

The C35R pressure control solenoid 2 is commanded OFF allowing PCS 3-5 reverse clutch fluid from the 3-5 reverse clutch boost valve and 3-5 reverse clutch regulator valve to exhaust.

3-5 Reverse Clutch Boost Valve

3-5 reverse boost valve spring force moves the valve to allow 3-5 reverse clutch feedback fluid from the 3-5 reverse clutch regulator valve to enter the 3-5 reverse clutch circuit and exhaust.

3-5 Reverse Clutch Regulator Valve

3-5 reverse clutch regulator valve spring force moves the valve to allow 3-5 reverse clutch fluid from the 3-5 reverse clutch and clutch select valve 2 to pass through the valve and enter the exhaust backfill fluid circuit. 3-5 reverse clutch fluid then enters the exhaust backfill fluid circuit and is routed through orifice #30 to the exhaust backfill pressure relief valve where excess pressure is exhausted.

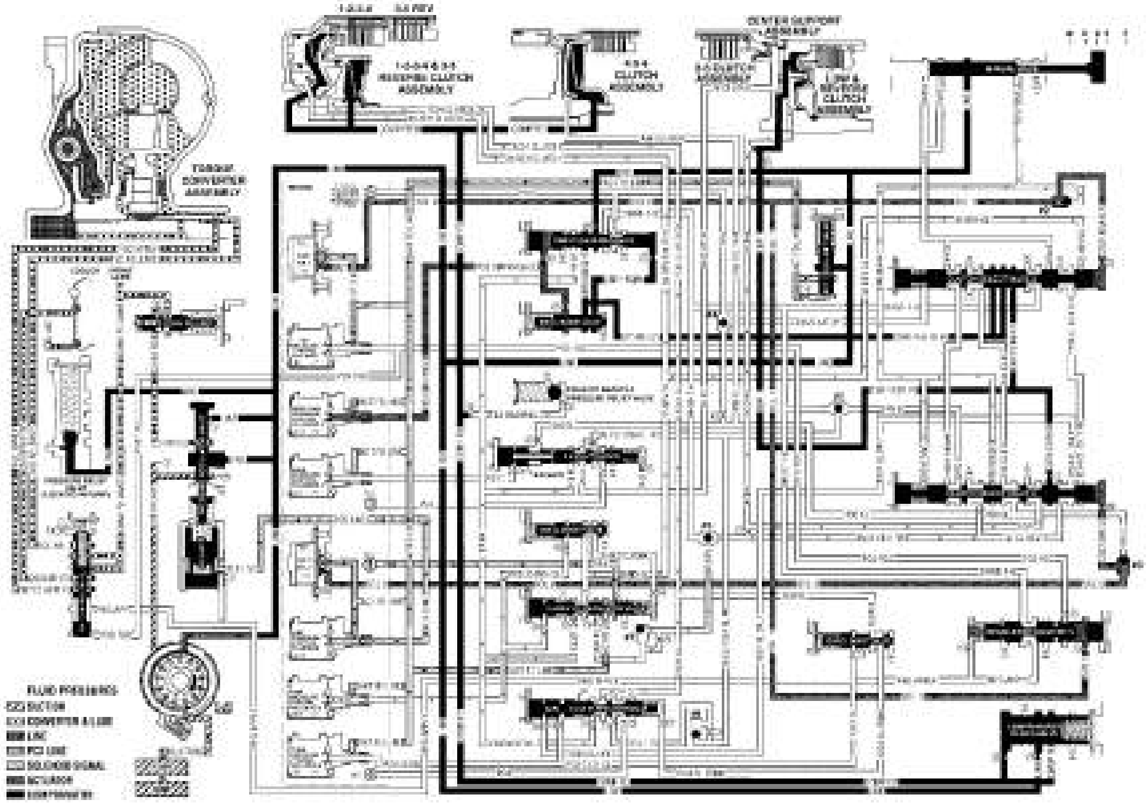
3-5 Reverse Clutch

3-5 reverse clutch spring force combined with a force from the compensator moves the 3-5 reverse clutch piston to release the 3-5 reverse clutch plates and force 3-5 reverse clutch fluid to exhaust from the 1-2-3-4 and 3-5 reverse clutch housing. 3-5 reverse clutch fluid is then routed to the 3-5 reverse clutch regulator valve allowing the 3-5 reverse clutch to release.

Clutch Select Valve 3

When reverse fluid exhausts through the manual valve, CSV3 enable fluid moves the valve against clutch select valve 3 spring force. 3-5 reverse feed fluid is routed around #7 ball check valve and into the 3-5 reverse supply circuit. 3-5 reverse supply fluid is routed around #5 ball check valve and into the 3-5 clutch reverse feed circuit and exhausts at the clutch select valve 3.

Neutral - Engine Running


1-2-3-4
3-5 REV
1-2-3-4 & 3-5 REVERSE CLUTCH ASSEMBLY
4-5-6 CLUTCH ASSEMBLY
CENTER SUPPORT ASSEMBLY
2-6 CLUTCH ASSEMBLY
LOW & REVERSE CLUTCH ASSEMBLY
TORQUE CONVERTER ASSEMBLY
FLUID PRESSURES
SUCTION
CONVERTER & LUBE
LINE
SOLENOID SIGNAL
ACTUATOR

Park - Engine Running

When the gear selector lever is in the Park (P) position, fluid is drawn into the pump through the transmission fluid filter assembly, from the transmission fluid pan assembly. Line pressure is then directed to the following valves:

FLUID PRESSURE DIRECTED IN PREPARATION FOR A SHIFT

Manual Valve

Mechanically controlled by the gear selector lever, the manual valve is in the Park (P) position and prevents line pressure from the pressure regulator valve from entering the reverse and drive circuits.

CBR1/C456 Pressure Control (PC) Solenoid 3

The CBR1/C456 PCS is energized (HIGH) allowing actuator feed limit fluid to enter the PCS CBR1/C456 CL fluid circuit. PCS CBR1/C456 CL fluid is then routed through orifice #31 to the 4-5-6 clutch boost valve and through orifice #39 to the CBR1/ C456 clutch regulator valve.

CBR1/C456 Clutch Regulator Valve

PCS CBR1/C456 CL fluid at the CBR1/C4-5-6 clutch regulator valve moves the valve against CBR1/C4-5-6 clutch regulator spring force and CBR1/FDBK fluid. This allows line pressure to pass through the valve and enter the CBR1/456CL FD circuit. CBR1/456CL FD is then routed to Clutch Select Valve 2.

Shift Solenoid 1

Shift solenoid 1 is energized (ON) allowing actuator feed limit fluid to enter the solenoid 1 circuit. Solenoid 1 fluid is routed to the #2 ball check valve and through orifice #10 to the TCC regulator valve and shuttle valve (SHTL).

TCC Regulator Valve and Shuttle Valve

Solenoid 1 fluid is routed to the TCC regulator valve and shuttle valve and moves the valve against TCC regulator valve spring force.

#2 Ball Check Valve

Solenoid 1 fluid seats the #2 ball check valve against the reverse fluid passage and fluid is forced through orifice #22 into the CSV2 enable fluid circuit.

Clutch Select Valve 2

CSV2 enable fluid is routed to the clutch select valve 2 and moves the valve against clutch select valve 2 spring force. This allows CBR1/456 CL FD fluid to pass through the valve and enter the CBR1/CBR FD circuit. CBR1/CBR FD fluid is then routed: to clutch select valve 3, into the CBR1 fluid circuit and, through orifice #49 where it enters the CBR fluid circuit and an exhaust passage at the clutch select valve 3 (this fluid is intended to keep the low and reverse clutch full of fluid but not pressurized). CBR1 fluid is then routed to the low & reverse clutch assembly in preparation for a shift into low or reverse gear.

Shift Solenoid 2

Shift solenoid 2 is energized (ON) allowing actuator feed limit fluid to enter the solenoid 2 fluid circuit and is then routed to the #3 ball check valve.

3-5 Reverse Clutch Regulator Valve

Actuator feed limit fluid is routed through the valve and into the PS1 fluid passage. PS1 fluid is then sent to the normally closed #1 pressure switch and opens the switch.

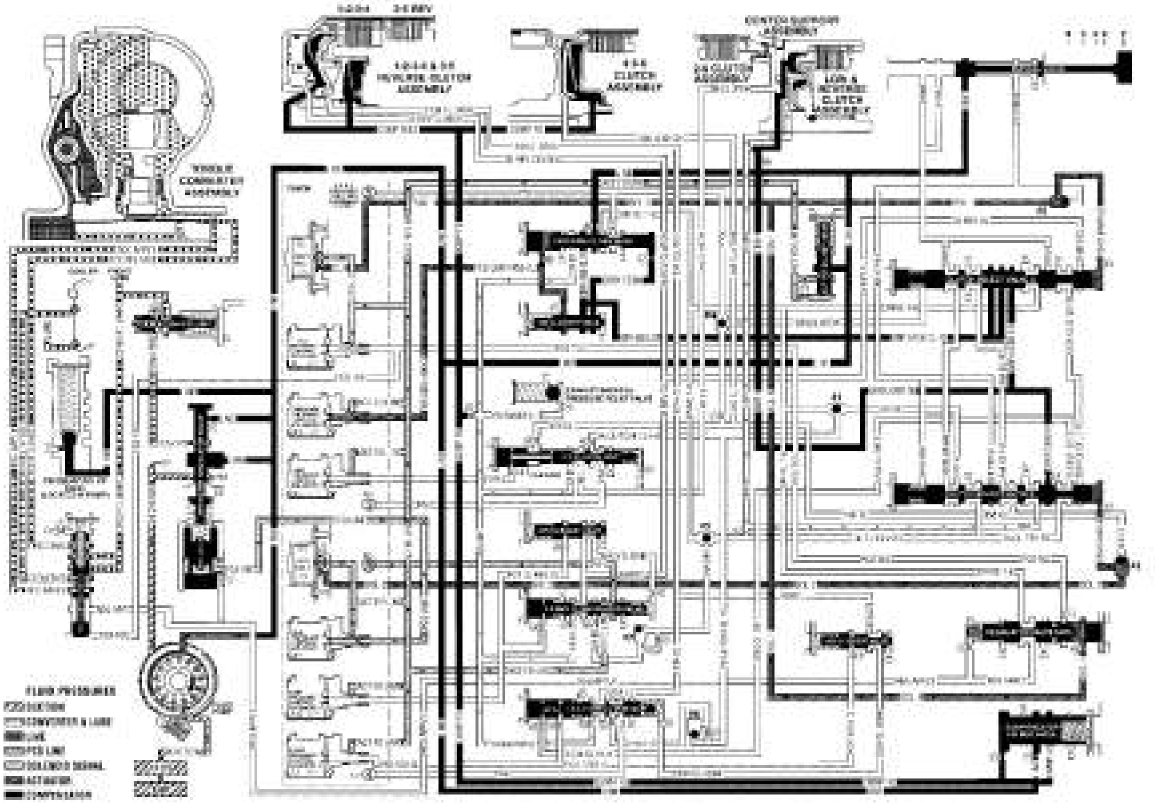
#3 Ball Check Valve

Solenoid 2 fluid seats the #3 ball check valve against 456 CL fluid passage and fluid is forced through orifice #20 into the CSV3 enable fluid circuit. CSV3 enable fluid is then routed to the clutch select valve 3.

Clutch Select Valve #3

CSV3 enable fluid moves the clutch select valve 3 against clutch select valve 3 spring force. CBR fluid at the clutch select valve 3 passes through the valve and exhausts.

Park - Engine Running


TORQUE CONVERTER ASSEMBLY
1-2-3-4 & 3-5 REVERSE CLUTCH ASSEMBLY
CLUTCH ASSEMBLY
CENTER SUPPORT ASSEMBLY
2-6 CLUTCH ASSEMBLY
LOW & REVERSE CLUTCH ASSEMBLY
FLUID PRESSURES
SUCTION
CONVERTER & LUBE
LINE
SOLENOID SIGNAL
COMPENSATION

Reverse

When the gear selector lever is moved to the Reverse (R) position (from the Park position) the normally high C35R pressure control solenoid 2 is commanded ON and the following changes occur in the transmission's hydraulic and electrical systems:

FLUID PRESSURE DIRECTED IN PREPARATION FOR A SHIFT

Manual Valve

With the manual valve in the reverse position, line pressure is directed into the reverse fluid circuit to the #2 ball check valve and clutch select valve 3.

#2 Ball Check Valve

Reverse fluid seats the #2 ball check valve against the solenoid 1 fluid passage and fluid is forced through orifice #22 into the CSV2 enable circuit.

Clutch Select Valve 2

CSV2 enable fluid, present at the valve from Park position, continues to hold the clutch select valve 2 against clutch select valve 2 spring force.

LOW & REVERSE CLUTCH APPLIES

Clutch Select Valve 3

Reverse fluid from the manual valve is routed to clutch select valve 3 to combine with clutch select valve 3 spring force to keep the valve in the off position. This allows reverse fluid to pass through the valve and enter the 3-5 clutch reverse feed circuit. 3-5 clutch reverse feed fluid from the clutch select valve 3 is also routed to #5 ball check valve. CBR1/CBR FD fluid is also directed through the clutch select valve 3 to the low and reverse clutch assembly.

Low & Reverse Clutch

CBR & CBR1 fluid pressures are routed to both the inner and outer areas of the low and reverse clutch piston to hold the piston against spring force and hold the low and reverse clutch plates. The clutch was already applied in Park, but is applied with more holding capacity in Reverse (both piston areas are pressurized).

#5 Ball Check Valve

3-5 clutch reverse feed fluid seats #5 ball check valve against the drive 1-6 circuit allowing 3-5 clutch reverse feed fluid to enter the 3-5 reverse supply circuit. 3-5 reverse supply fluid is then routed to #7 ball check valve and through orifice #25 where is enters the 3-5 reverse feed circuit. 3-5 reverse feed passes through orifice #46 and then is routed to the 3-5 reverse clutch regulator valve.

3-5 REVERSE CLUTCH APPLIES

C35R Pressure Control Solenoid 2

The C35R Pressure Control Solenoid 2 is energized (HIGH) allowing actuator feed limit fluid to enter the PCS 3-5 reverse clutch circuit. PCS 3-5 reverse clutch fluid is then routed through orifice #48 to the 3-5 reverse clutch regulator valve and through orifice #40 to the 3-5 reverse boost valve.

3-5 Reverse Clutch Regulator Valve

PCS 3-5 reverse clutch fluid moves the 3-5 reverse clutch regulator valve against 3-5 reverse clutch regulator valve spring force and 3-5 reverse clutch feedback fluid. This allows 3-5 reverse feed to pass through the valve and enter the 3-5 reverse clutch circuit. 3-5 reverse clutch fluid is then routed to the 3-5 reverse clutch and the 3-5 reverse boost valve. PS1 fluid from pressure switch 1 exhausts through the valve allowing the switch to close.

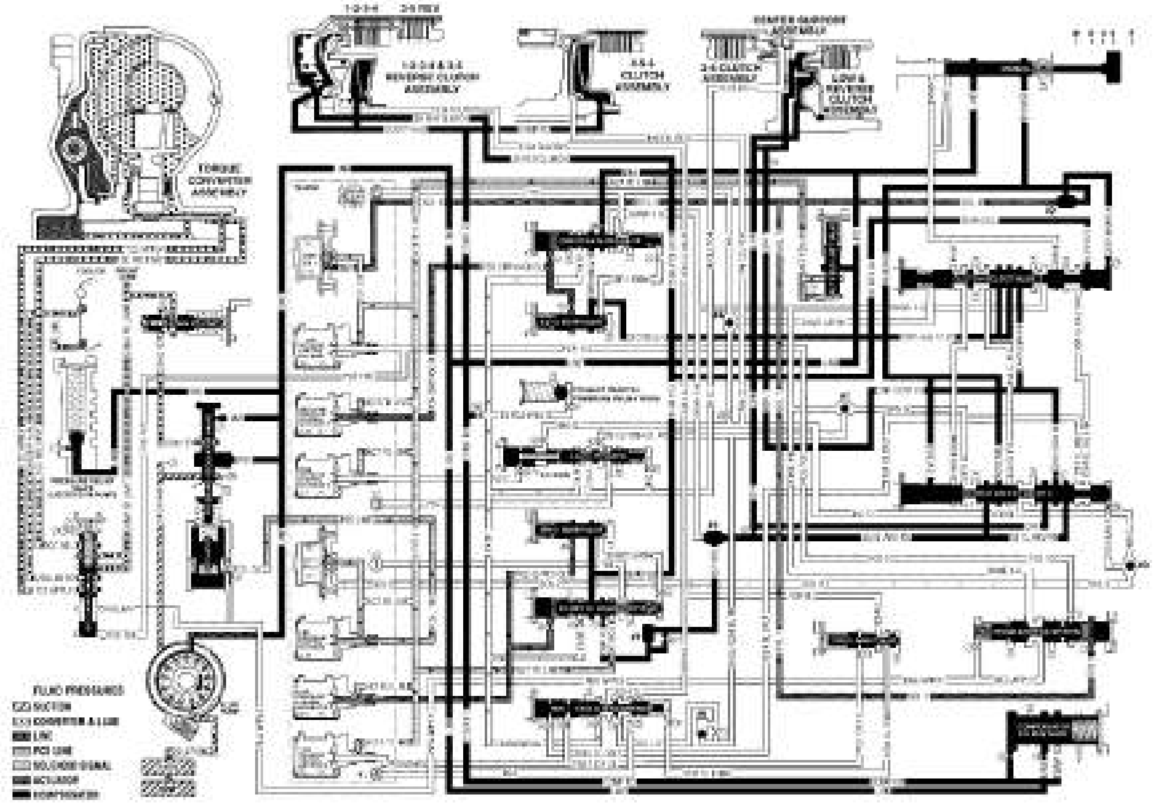
3-5 Reverse Boost Valve

PCS 3-5 reverse clutch fluid pressure acts on a differential area moving the 3-5 reverse clutch boost valve against the 3-5 reverse clutch boost valve spring. 3-5 reverse clutch fluid passes through the valve and enters the 3-5 reverse clutch feedback circuit. As PCS 3-5 reverse clutch fluid pressure is increased to a given value, the 3-5 reverse clutch boost valve opens the 3-5 reverse clutch feedback circuit to exhaust. This results in the 3-5 reverse clutch regulator valve moving to the full feed position sending full 3-5 clutch reverse feed pressure (full line pressure) to the clutch.

3-5 Reverse Clutch

3-5 reverse clutch fluid enters the 1-2-3-4 & reverse clutch housing to move the piston against spring force and compensator feed fluid to apply the 3-5 reverse clutch plates.

Reverse


1-2-3-4
3-5 REV
1-2-3-4 & 3-5 REVERSE CLUTCH ASSEMBLY
4-5-6 CLUTCH ASSEMBLY
CENTER SUPPORT ASSEMBLY
2-6 CLUTCH ASSEMBLY
LOW & REVERSE CLUTCH ASSEMBLY
TORQUE CONVERTER ASSEMBLY
FLUID PRESSURES
SUCTION
CONVERTER & LUBE
LINE
PCS LINE
SOLENOID SIGNAL
ACTUATOR
COMPENSATOR

Transmission Adaptive Functions

The 6L80 transmission utilizes a line pressure control system during upshifts to compensate for the normal wear of transmission components. As the apply components within the transmission wear or change over time, shift time (the time required to apply a clutch) increase or decreases. In order to compensate for these changes, the transmission control module (TCM) adjusts the pressure commands to the various PC solenoids, to maintain the originally calibrated shift timing. The automatic adjusting process is referred to as "adaptive learning" and it is used to ensure consistent shift feel plus increase transmission durability. The TCM monitors the A/T input speed sensor (ISS) and the A/T output speed sensor (OSS) during commanded shifts to determine if a shift is occurring too fast (harsh) or too slow (soft) and adjusts the corresponding pressure control (PC) solenoid signal to maintain the set shift feel.

The purpose of the adapt function is to automatically compensate the shift quality for the various vehicle shift control systems. The adapt function is a continuous process that will help to maintain optimal shift quality throughout the life of the vehicle.

Transmission Component and System Description

The mechanical components of the 6-Speed RWD are as follows:

- A torque converter with an electronically controlled capacity clutch (ECCC)
- Vane-type fluid pump assembly
- 1-2-3-4 and 3-5 Reverse clutch assembly
- Input sun gear and carrier assembly
- 4-5-6 clutch assembly with turbine shaft
- 4-5-6 clutch hub assembly
- 1-2-3-4 clutch hub assembly
- 2-6 and 3-5 reverse clutch hub assembly
- Centre support assembly, with 2-6 clutch assembly, and low and Reverse clutch assembly
- Low clutch sprag assembly
- A double planetary output carrier assembly
- Output shaft assembly
- Control valve body assembly

The electrical components of the 6-Speed RWD are as follows:

- Input and output speed sensor assembly
- Manual shift shaft position switch
- Control solenoid valve assembly, which contains the following components:
  - Transmission control module (TCM)
  - 5 variable bleed line pressure control (PC) solenoids
  - Transmission fluid pressure (TFP) switch assembly
  - Torque converter clutch (TCC) pressure control solenoid
  - 2 shift solenoids

For more information, refer to Electronic Component Description .

Transmission General Description

The Hydra-matic 6-Speed RWD is a fully automatic, 6-speed, rear-wheel drive, electronic-controlled transmission. It consists primarily of a 4-element torque converter, an integral fluid pump and converter housing, a single and double planetary gear set, friction and mechanical clutch assemblies, and a hydraulic pressurization and control system. There are four variants of the transmission, all based on torque capacity. Architecture is common between the variants, and component differences are primarily related to size.

The 4-element torque converter contains a pump, a turbine, a pressure plate splined to the turbine, and a stator assembly. The torque converter acts as a fluid coupling to smoothly transmit power from the engine to the transmission. It also hydraulically provides additional torque multiplication when required. The pressure plate, when applied, provides a mechanical direct drive coupling of the engine to the transmission.

The planetary gear sets provide the 6 forward gear ratios and reverse. Changing gear ratios is fully automatic and is accomplished through the use of a transmission control module (TCM) located inside the transmission. The TCM receives and monitors various electronic sensor inputs and uses this information to shift the transmission at the optimum time.

The TCM commands shift solenoids and variable bleed pressure control solenoids to control shift timing and feel. The TCM also controls the apply and release of the torque converter clutch which allows the engine to deliver the maximum fuel efficiency without sacrificing vehicle performance. All the solenoids, including the TCM, are packaged into a self-contained control solenoid valve assembly.

The hydraulic system primarily consists of a vane-type pump, 2 control valve body assemblies, converter housing and case. The pump maintains the working pressures needed to stroke the clutch pistons that apply or release the friction components. These friction components, when applied or released, support the automatic shifting qualities of the transmission.

The friction components used in this transmission consist of 5 multiple disc clutches. The multiple disc clutches combine with one mechanical sprag clutch to deliver 7 different gear ratios, 6 forward and one reverse, through the gear sets. The gear sets then transfer torque through the output shaft.

The transmission may be operated in any of the following gear ranges:

PARK (P): This position locks the rear wheels and prevents the vehicle from rolling either forward or backward. PARK is the best position to use when starting the vehicle. Because the transmission utilizes a shift lock control system, it is necessary to fully depress the brake pedal before shifting out of PARK. For safety reasons, use the parking brake in addition to the PARK position.

REVERSE (R): This position allows the vehicle to be operated in a rearward direction.

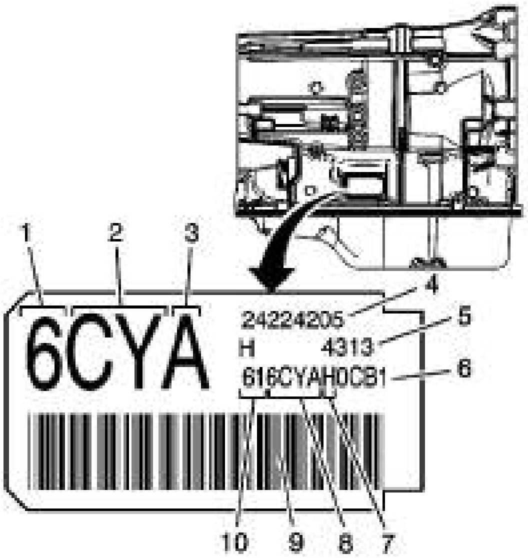
NEUTRAL (N): This position allows the engine to be started and operated while driving the vehicle. If necessary, you may select this position in order to restart the engine with the vehicle moving. This position should also be used when towing the vehicle.

DRIVE (D): Drive range should be used for all normal driving conditions for maximum efficiency and fuel economy. Drive range allows the transmission to operate in each of the 6 forward gear ratios. Downshifts to a lower gear, or higher gear ratio, are available for safe passing by depressing the accelerator or by manually selecting a lower gear in the manual mode range.

MANUAL MODE (M): This position allows the driver to select a range of gears appropriate for current driving conditions. Refer to the vehicle owner's manual for specific manual mode information.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Automatic Transmission - 6L50/6L80/6L90 | Description and Operation | Document ID: 1996805

Transmission Identification Information



(1) Model Year
(2) Model Code
(3) Transmission Family
(4) Transmission Assembly Number
(5) Julian date
(6) Sequential Serial Number
(7) Source Code
(8) Broadcast Code
(9) Bar Code
(10) Transmission I.D.

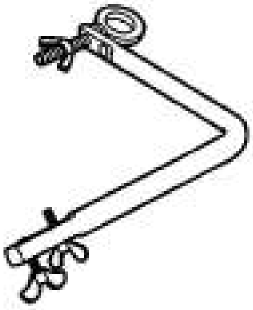
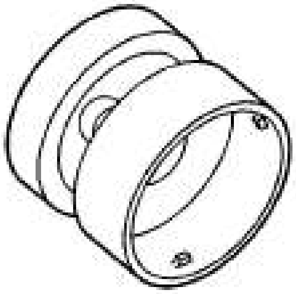
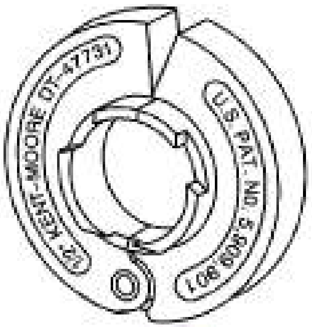
Transmission Indicators and Messages

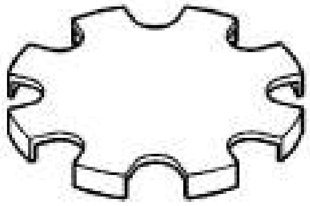
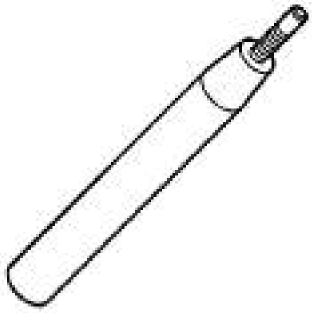
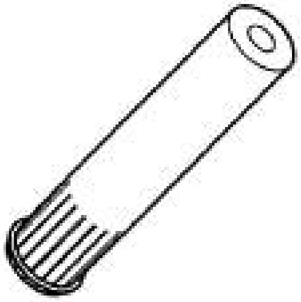
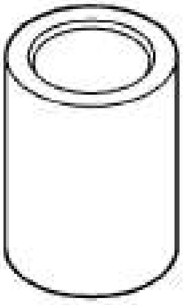
The following transmission-related indicators and messages may be displayed on the Instrument Panel Cluster (IPC). For a complete listing and description of all vehicle indicators and messages, refer to Indicator/Warning Message Description and Operation.

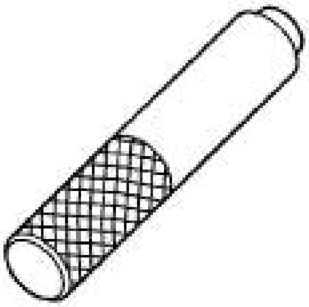
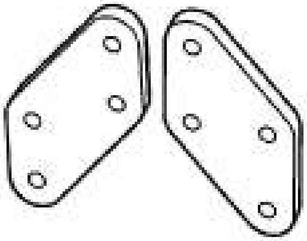
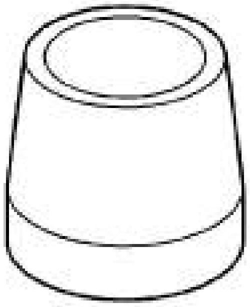
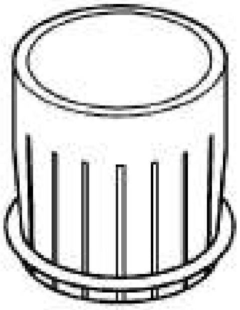
"High Trans Temp": This message is displayed when the TCM detects a transmission fluid temperature (TFT) equal to or greater than 130°C (266°F) for 5 seconds.

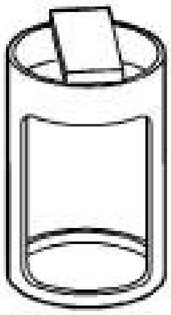
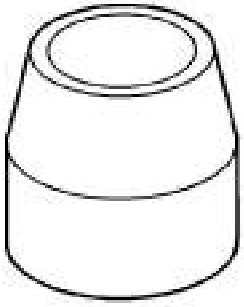
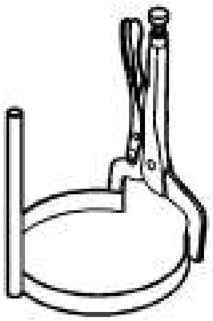
Special Tools

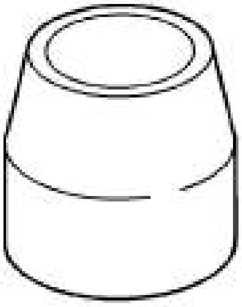
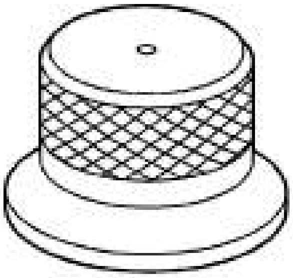
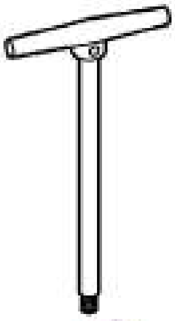
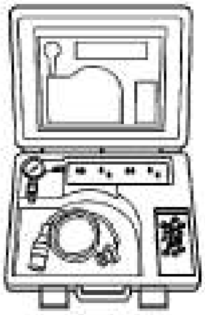
Special Tools

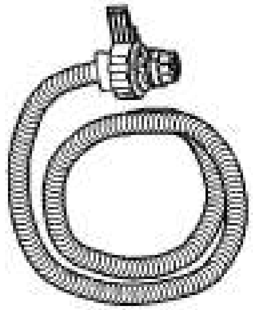
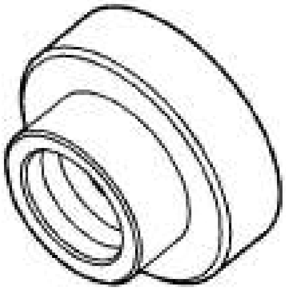
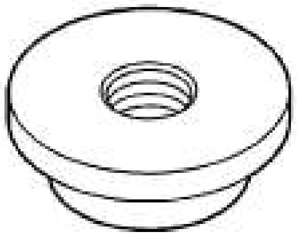
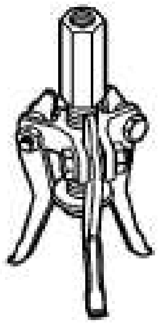
Illustration	Tool Number/Description
	DT 47605 Holding Fixture Adapter
	DT 47715 Electrical Connector Passage Sleeve Remover/Installer
	DT 47731 1/2 Inch Quick Connect Release Tool

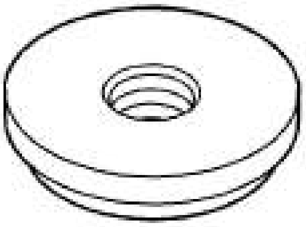
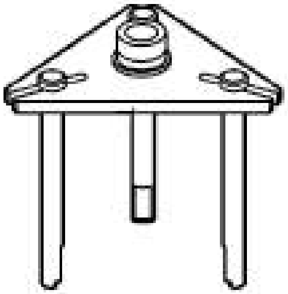
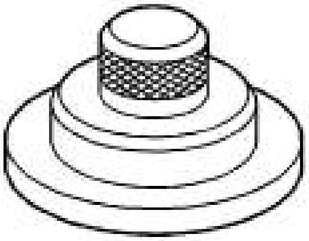
	DT 47761 Clutch Spring Compressor
	DT 47768-1 Seal Protector
	DT 47768-2 Seal Protector
	DT 47768-3 Seal Sizer

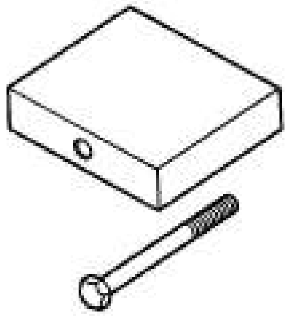
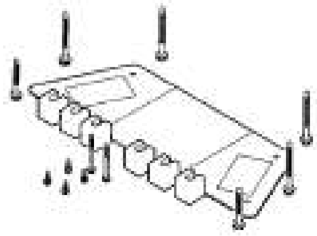
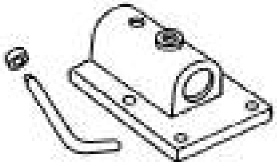
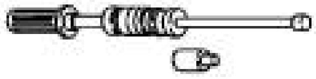
	DT 47770 Seal Installer
	DT 47773 Retaining Ring Pliers Adapter Set
	DT 47778-1 Low Clutch Sprag Retaining Ring Cone
	DT 47778-2 Low Clutch Sprag Retaining Ring Pusher

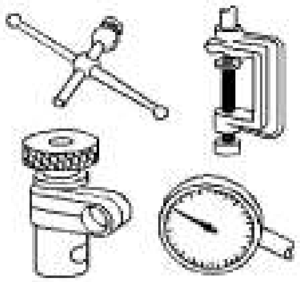
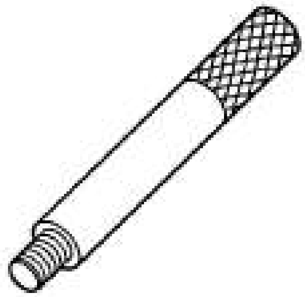
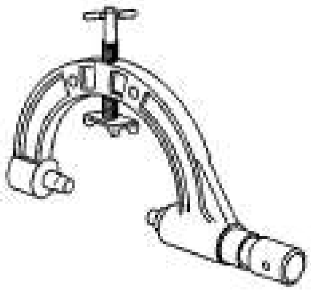
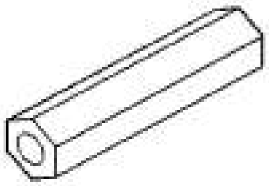
	DT 47779 Low Clutch Spring Compressor
	DT 47780 Low Clutch Sprag Seal Cone
	DT 47781 C1234 and 35R Clutch Assembly Installer
	DT 47782-1 Retaining Ring Cone

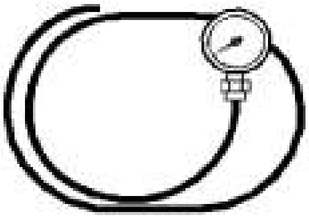
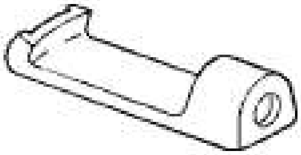
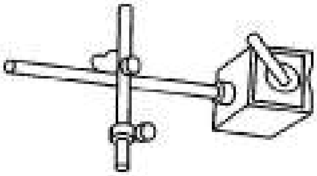
	
	DT 47782-2 Retaining Ring Installer
	DT 47786 Output Carrier/Shaft Lifting Tool
	DT 47825 Control Solenoid Test Plate

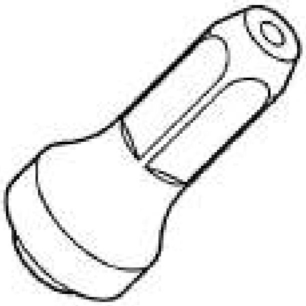
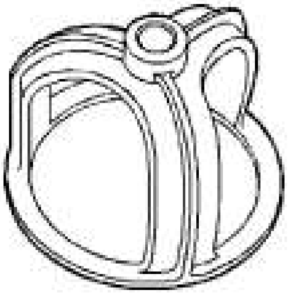
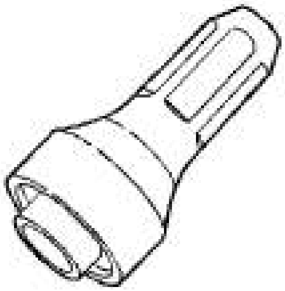
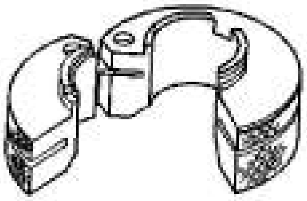
	DT 47825-10 Jumper Harness
	DT 47848 Filter Neck Seal Installer
	DT 47857 Bearing Installer
	DT 47865 Bearing Remover

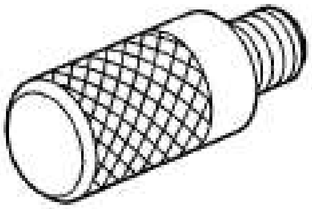
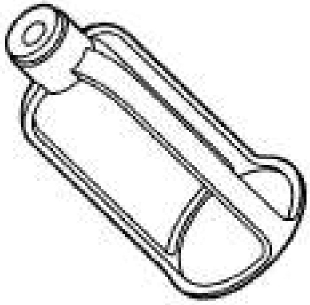
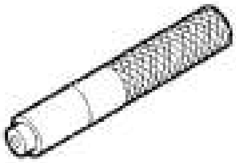
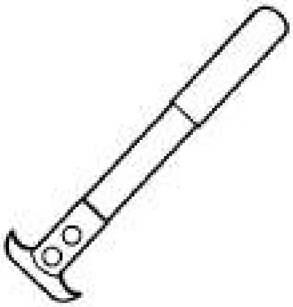
	DT 47866 Bearing Installer
	DT 47867 Adjustable Clutch Spring Compressor
	DT 47868-1 Pack Travel Weight
	DT 47868-2 Magnetic Base Adapter

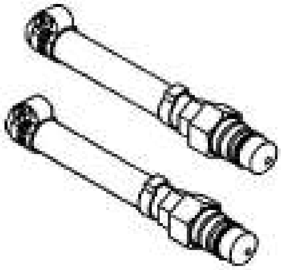
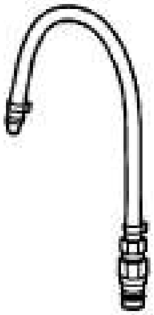
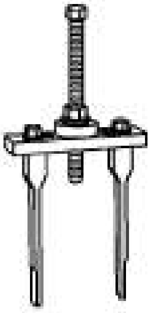
	
	EN-48536 Frame Support Tool (Engine Lower 65mm Kit)
	J 3289-20 Holding Fixture Base Assembly
	J 6125-B Slide Hammer

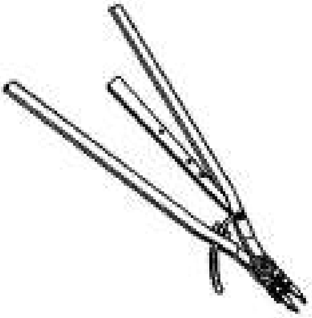
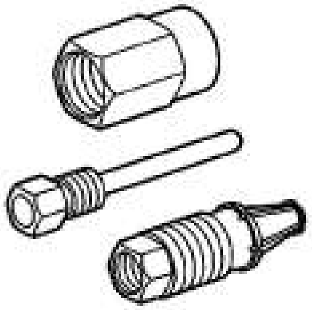
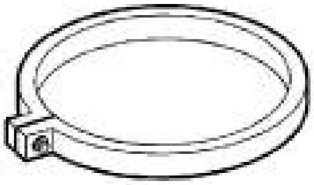
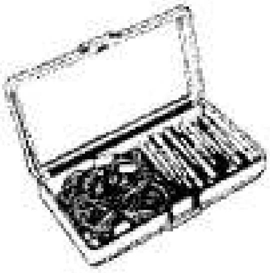
	J 8001 Dial Indicator Set
	J 8092 Driver Handle
	J 8763-B Holding Fixture
	J 21474-18 Drive Handle

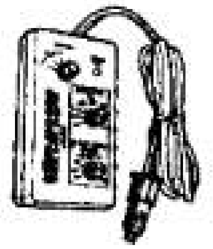
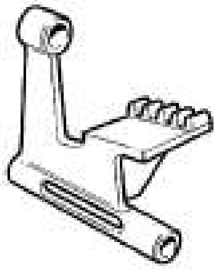
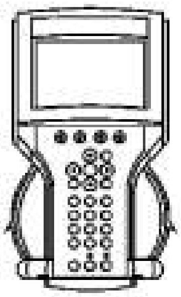
	J 21867 Pressure Gage
	J 23129 Universal Seal Remover
	J 26900-13 Magnetic Base
	J 38693 Seal Installer

	
	J 38734 Intermediate Spring Compressor Adapter
	J 38869 Output Shaft Seal Installer
	J 41623-B Cooler Quick Connect Tool

	J 42183 Driver Handle
	J 43074 Clutch Spring Compressor
	J 43909 Seal Installer
	J 45000 Seal Remover

	J 45096-30 Transmission Cooler Flush Adapter
	J45096-40 Transflow Oil Fill Adapter
	J 45124 Remover Bridge
	J 45126 Snap Ring Pliers

	
	J 45201 Cooler Line Seal Remover
	J 46664 Pump Cover Alignment Tool
	J 356164 Connect Test Adaptor Kit

	J 38522 Variable Speed Generator
	J 42386 A Flywheel Holding Tool
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Clutch | Specifications | **Document ID: 2178461**

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Bleeder Assembly Bleed Nipple (3.6L Engine)	8 N-m	71 lb in
Clutch Fluid Reservoir Bracket to Brake Master Cylinder End Brace Retaining Bolt	10 N-m	89 lb in
Clutch Fluid Reservoir to Clutch Master Cylinder Bracket Nut	3 N-m	27 lb in
Clutch Master Cylinder to Clutch Pedal Retaining Bolts (3.6L Engine)	25 N-m	18 lb ft
Clutch Master Cylinder to Clutch Pedal Retaining Bolts (6.0L Engine)	12 N-m	106 lb in
Clutch Pedal Position Sensor Retaining Bolt	13 N-m	115 lb in
Clutch Pedal to Instrument Panel Crossmember Upper Retaining Bolts	25 N-m	18 lb ft
Clutch Pedal to Mod Plate Retaining Nuts	22 N-m	16 lb ft
Concentric Actuator Cylinder Bleed Screw (6.0L Engine)	18 N-m	13 lb ft
Concentric Actuator Cylinder Feed Pipe (6.0L Engine)	13 N-m	115 lb in
Concentric Actuator Cylinder Feed Pipe Bracket to Transmission Retaining Bolt (3.6L Engine)	3 N-m	27 lb in
Concentric Actuator Cylinder Feed Pipe to Transmission Retaining Bolt (3.6L Engine)	3 N-m	27 lb in
Concentric Actuator Cylinder to Transmission Retaining Bolts (3.6L Engine)	17 N-m	13 lb ft
Concentric Actuator Cylinder to Transmission Retaining Bolts (6.0L Engine)	10 N-m	89 lb in
Hydraulic Clutch Hose/Pipe Retaining Bolt (3.6L Engine)	7 N-m	62 lb in
Pressure Plate to Flywheel Retaining Bolts (3.6L Engine)		
• First Pass in Sequence	15 N-m	11 lb ft
• Second Pass in Sequence	30 N-m	22 lb ft
Pressure Plate to Flywheel Retaining Bolts (6.0L Engine)		
• First Pass in Sequence	15 N-m	11 lb ft
• Second Pass in Sequence	35 N-m	26 lb ft
• Third Pass in Sequence	55 N-m	55 lb ft

Fourth Pass in Sequence	70 N-m	70 lb ft

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General Specifications (3.6L Engine)

Clutch Specifications (3.6L Engine)

Component	Application	Specification
Master Cylinder	Type	Compensating Port
	Bore Size	19.05 mm
	Nominal Stroke	30 mm
Clutch Actuating Cylinder	Type	Concentric cylinder with adaptor including bleed screw.
Clutch fluid	Type	DOT 4 or Super DOT 4
Clutch Driven Plate	Type	Single plate dry disc.
	Outside Diameter	254 - mm
	Inside Diameter	165 - 1.5 mm
	Thickness of disc assembly with 7,300 N load	9.6 - 0.2 mm
Clutch Pressure Plate	Type	Recessed, with a press steel cover plate and a bevelled diaphragm spring.
Clutch Throw-out Bearing	Type	Ball Race.
	Lubrication	Sealed with grease for life.
Dual Mass Flywheel	Serviceability	Spring dampened internally; the transmission side is recessed to accommodate the clutch assembly. Rotational free play maximum, including length tolerances and heat setting losses. None. Starter motor ring gear is not replaceable and machining of the clutch facing surface is not permitted.
Transmission input shaft splines and clutch pedal bushes	Lubricant	NLGI No 2 lithum soap based EP grease with molybdenum disulphide, such as shell Retinax HDX2 grease, BP Energrease LMS-EP23 or equivalent.

General Specifications (6.0L Engine)

Clutch Specifications (6.0L Engine)

Component	Desription	Specification
Master Cylinder	Type Bore Size Nominal Stroke	Compensating Port 19.05 mm 30 mm
Clutch Actuating Cylinder	Type Bore size Stroke	Concentric hydraulic actuating cylinder with side bleed port. Equivalent diameter - 30.6 mm 9.5 mm
Clutch fluid	Type	DOT 4 or Super DOT 4
Clutch Driven Plate	Type Outside Diameter Inside Diameter Thickness of disc assembly with 10,000 N load	Single plate dry disc 297 - mm 198 - mm 8.7- 0.35 mm
Clutch Pressure Plate	Type	Self-adjusting with pressed steel cover plate and multi-fingered bevelled diaphragm spring.
Clutch Throw-out Bearing	Type Lubrication	Ball Race. Sealed with grease for life.
Actuating cylinder guide sleeve	Lubricant	NLGI No 2 lithium soap based EP grease with molybdenum disulphide, such as sheel Retinax HDX2 grease, BP Energrease LMS-EP23 or equivalent.

Diagnostic Starting Point - Clutch

Reviewing the Clutch System Description and Operation will help determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing clutch system description and operation information will also help determine if the condition described by the customer is normal operation. Refer to Symptoms - Clutch in order to identify the correct procedure for diagnosing the system and where the procedure is located.

Symptoms - Clutch

Strategy Based Diagnostics

Review the system operations in order to familiarise yourself with the system functions. Refer to Clutch System Description and Operation.

Visual/Physical Inspection

- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect the clutch fluid reservoir for the correct fluid level.
- Inspect the hydraulic clutch lines for dents, kinks or other obvious damage that may affect the clutch system operations.
- Inspect the clutch system for contamination of dirt, oil, or other substances that may affect the clutch system operations.
- Inspect for aftermarket parts.

Intermittent

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating correctly.

Symptom List

Important: Due to the variety of clutch options, there may be components in the mechanical diagnostic tables that are not on a particular vehicle.

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Clutch Drag Hard Shifting.
- Clutch Slipping.
- Clutch Grabbing.
- Clutch Noisy.
- Clutch Pedal Spongy Low Pedal Effort.
- Clutch Pedal Hard to Push.
- Clutch Vibration.

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Clutch Pedal Hard to Push (RHD)

Cause	Action
DEFINITION: The clutch pedal requires high effort to operate. Review the Symptoms - Clutch .	
Incorrect hydraulic fluid	1. Inspect for the correct fluid in the master cylinder. Refer to General Specifications . 2. Flush the hydraulic system and fill with the correct fluid. Refer to Clutch Master Cylinder Fluid Replacement 3. Replace the clutch hydraulic system if the incorrect fluid used was mineral based.
Contaminated hydraulic fluid	1. Inspect the hydraulic fluid for water. 2. Inspect the hydraulic fluid for dirt or debris. 3. Flush the hydraulic system and fill with the correct fluid. Refer to Clutch Master Cylinder Fluid Replacement
Clutch pedal binding	1. Inspect the pedal for binding. 2. Replace the pedal. Refer to Clutch Pedal Replacement .
Clutch pedal spring worn	Replace the clutch pedal spring. Refer to Clutch Pedal Replacement
Kinked or damaged clutch hydraulic pipe	1. Inspect for a kinked or damaged hydraulic hose. 2. Repair or replace the clutch hydraulic hose. Refer to Hydraulic Clutch Hose/Pipe Replacement .
clutch driven plate excessively worn	Replace the clutch assembly. Refer to Clutch Assembly Replacement (3.6L Engine) or Clutch Assembly Replacement (6.0L Engine) in Clutch.

Clutch Rattle (RHD)

Cause	Action
DEFINITION: A rattle noise coming from the clutch components with the clutch disengaged or engaged. Review the Symptoms - Clutch .	
Idle rattle clutch engaged	Replace the engine flywheel, due to faulty damper springs. Refer to the following procedures: • Engine Flywheel Replacement . • Clutch Assembly Replacement .
Clutch is incorrectly installed	Replace the clutch assembly. Refer to Clutch Assembly Replacement .
Clutch disc splines and transmission input shaft splines worn	1. Inspect the clutch disc hub to transmission input shaft splines for excessive clearance. 2. Replace the clutch assembly if the clutch splines are worn. Refer to Clutch Assembly Replacement . 3. Replace the transmission input shaft. Refer to Transmission Disassemble for 3.6L Engines or Transmission Disassemble for 6.0L Engines.

Clutch Vibration (RHD)

Clutch Vibration

Cause	Action
DEFINITION: Vibration from the clutch components during disengagement or engagement. Review the Symptoms - Clutch .	
Excessive driveline torsional activity	Review the Clutch Vibration
Clutch incorrectly installed	Remove the clutch and install it correctly. Refer to Clutch Assembly Replacement .
Clutch pilot bearing worn or damaged - 6.0L	1. Replace the clutch pilot bearing. Refer to Clutch Pilot Bearing Replacement for 6.0L engine. 2. Inspect the transmission input shaft pilot bearing journal for wear or damage. 3. Replace the transmission input shaft if the splines are excessively worn. Refer to Transmission Disassemble for Aisin AY6 or Transmission Disassemble for Tremec 6 speed.
Transmission input splines worn or damaged	1. Inspect the clutch driven plate to input splines for wear or damage. 2. Replace the transmission input shaft if the splines are excessively worn. Refer to Transmission Disassemble for Aisin AY6 or Transmission Disassemble for Tremec 6 speed.
Clutch driven plate facings damaged	Replace the clutch assembly. Refer to Clutch Assembly Replacement .
Flywheel housing to clutch housing excessively misaligned	Replace the faulty clutch housing or transmission front case. Refer to Transmission Disassemble for Aisin AY6 or Transmission Disassemble for Tremec 6 speed .
Clutch out of balance	Replace the clutch assembly. Clutch Assembly Replacement .

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Clutch Assembly Replacement (3.6L Engine)

Removal Procedure

1. Disable the SIR system. Refer to SIR Disabling and Enabling.

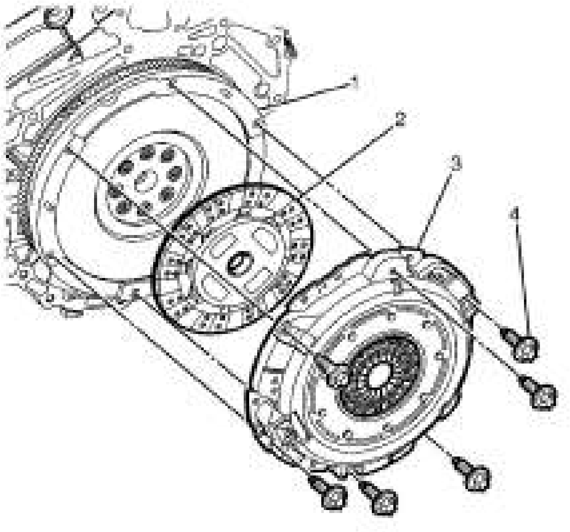
   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.

   Caution: Refer to Safety Glasses Caution in the Preface section.

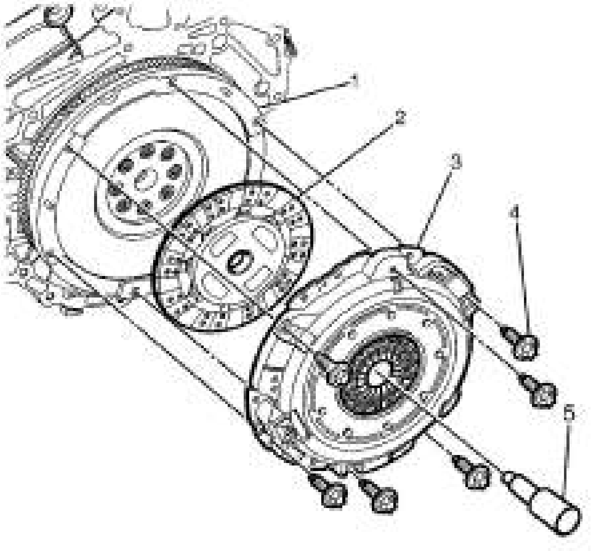
   Caution: Refer to Vehicle Lifting Caution in the Preface section.

3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
4. Remove the transmission assembly. Refer to Transmission Replacement.



5. Mark the relationship of the pressure plate (3) to the flywheel (1) to maintain the correct balance condition on reassembly.
6. Loosen all pressure plate to flywheel retaining bolts (4) working from opposite sides to avoid distortion.
7. Continue loosening pressure plate to flywheel retaining bolts (4) from opposite sides until all are removed.
8. Remove the pressure plate (3) and clutch driven plate (2) from the flywheel (1).

Installation Procedure



Important: Do Not apply any lubricant to clutch driven plate splines if lubricant is applied premature failure could result.

Important: Install the clutch driven plate (2) with the short boss facing the flywheel (1). Flywheel side is stamped on the clutch driven plate hub (FW Side).

1. While holding the pressure plate (3), and clutch driven plate (2), together, align them to the flywheel (1).

   Important: The pressure plate to flywheel retaining bolts (4) must not to be fully tightened at this stage.

2. Install the pressure plate to flywheel retaining bolts (4).

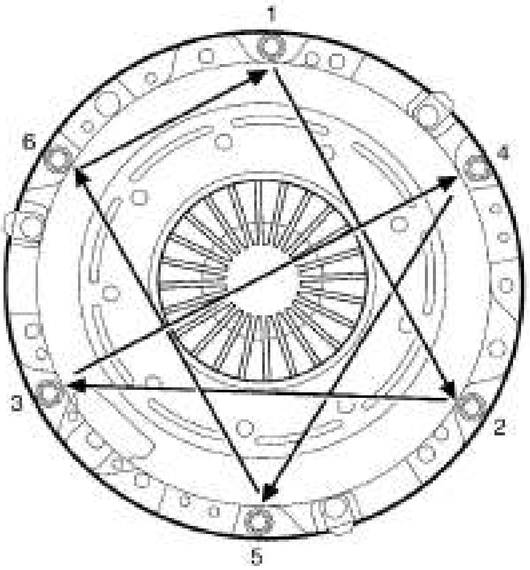
   Do Not tighten at this stage.

3. Using a universal clutch driven plate centering tool (5) align the clutch driven plate (2) to the flywheel (1).

   Notice: Refer to General Repair Instructions in the Preface section.

   Notice: Refer to General Repair Instructions in the Preface section.

   Notice: Refer to Fastener Notice in the Preface section.



4. Tighten the pressure plate to flywheel retaining bolts, using the sequence shown.
5. Tighten the flywheel.

   Tighten
   Tighten the bolts a first pass to 15 N·m (11 lb ft).

   Tighten
   Tighten the bolts a second pass to 30 N·m (22 lb ft).

6. Remove the clutch driven plate centering tool.

   Notice: Refer to General Repair Instructions in the Preface section.

7. Install the transmission assembly. Refer to Transmission Replacement.
8. Inspect lubricant level in transmission, adjust as necessary. Refer to General Specifications.
9. Bleed the clutch hydraulic system. Refer to Hydraulic Clutch Bleeding.
10. Connect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
11. Enable the SIR. Refer to SIR Disabling and Enabling.
12. Road test vehicle for correct clutch operation.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Clutch | Repair Instructions | **Document ID: 1992647**

Clutch Assembly Replacement (6.0L Engine)

Removal Procedure

1. Disable the SIR system. Refer to SIR Disabling and Enabling in SIR.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

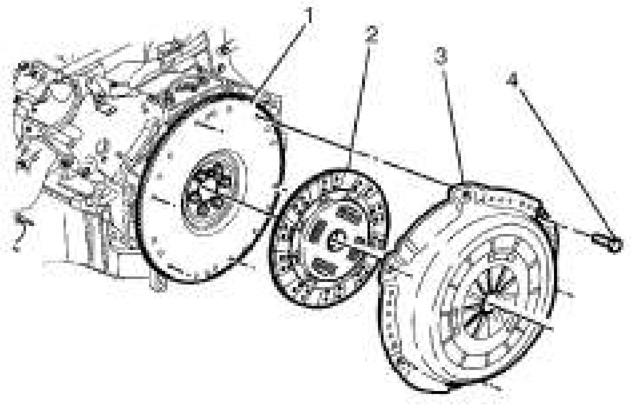
2. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.

   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
4. Remove transmission. Refer to Transmission Replacement.

   Notice: Refer to General Repair Instructions in the Preface section.

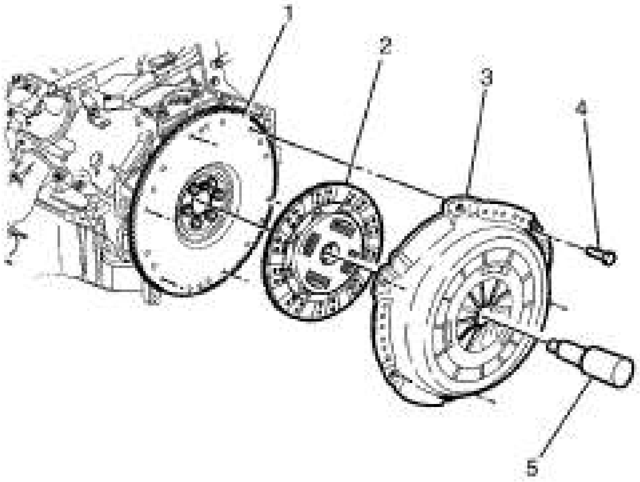


5. Loosen all of the pressure plate to flywheel retaining bolts (4) working from opposite sides to avoid distortion.
6. Continue loosening pressure plate to flywheel retaining bolts (4) from opposite sides until all are removed.
7. Remove the pressure plate (3) and clutch driven plate (2) from the flywheel (1).

Installation Procedure

Notice: Refer to General Repair Instructions in the Preface section.

Notice: Refer to Clutch Pressure Plate Adjustment in the Preface section.



Important: Apply any a small amount of grease to clutch driven plate splines or transmission input shaft splines.

Important: Install the clutch driven plate (2) with the short boss facing the flywheel (1). Flywheel side is stamped on the clutch driven plate hub (FW Side).

1. While holding the pressure plate (3), and clutch driven plate (2), together, align them to the flywheel (1).

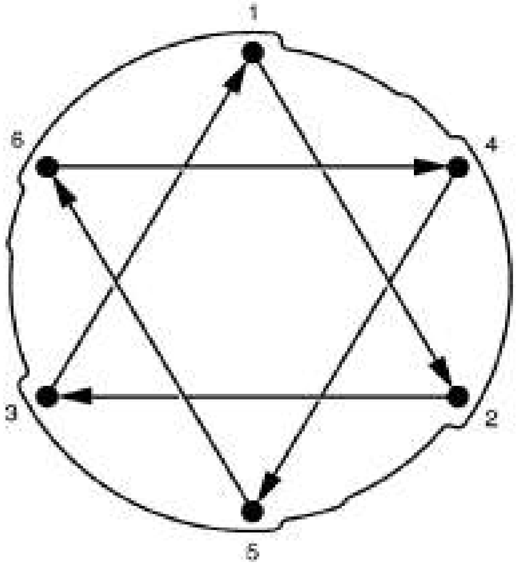
   Important: The pressure plate to flywheel retaining bolts (4) must not to be tightened at this stage.

2. Install the pressure plate to flywheel retaining bolts (4).

   Do not tighten at this stage.

3. Using a clutch driven plate centering tool (5) align the clutch driven plate (2) to the flywheel (1).
4. Install the pressure plate bolts (4), and insert the clutch centering tool (5).

   Notice: Refer to Fastener Notice in the Preface section.



5. Tighten the pressure plate to flywheel retaining bolts, using the sequence shown.
6. Tighten the flywheel.

   Tighten
   Tighten the bolts a first pass to 15 N·m (11 lb ft).

   Tighten
   Tighten the bolts a second pass to 35 N·m (26 lb ft).

   Tighten
   Tighten the bolts a third pass to 55 N·m (41 lb ft).

   Tighten
   Tighten the bolts a fourth pass to 70 N·m (52 lb ft).

   Notice: Refer to General Repair Instructions in the Preface section.

7. Install transmission. Refer to Transmission Replacement.
8. Bleed the clutch hydraulic system. Refer to Hydraulic Clutch Bleeding.
9. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.
10. Enable the SIR. Refer to SIR Disabling and Enabling in SIR.
11. Press the clutch pedal several times to allow the self-adjusting pressure plate function to take affect.
12. Road test vehicle for correct clutch operation.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Clutch | Repair Instructions | Document ID: 1992714

Clutch Concentric Actuator Cylinder Replacement (3.6L Engine)

Removal Procedure

1. Disable the SIR system. Refer to SIR Disabling and Enabling in SIR.

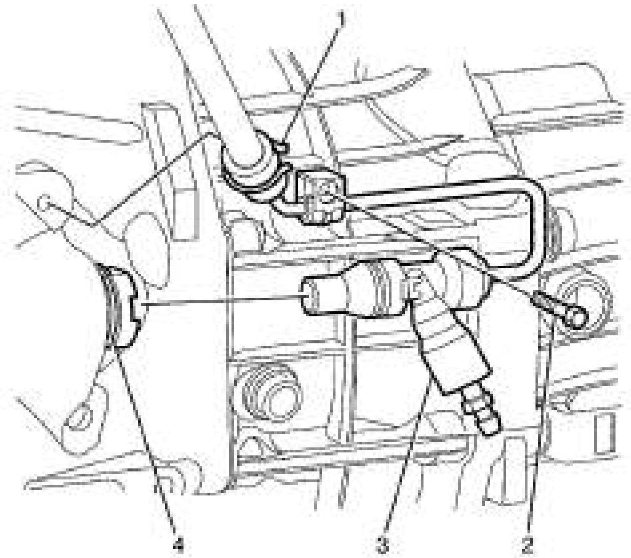
   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.

   Caution: Refer to Safety Glasses Caution in the Preface section.

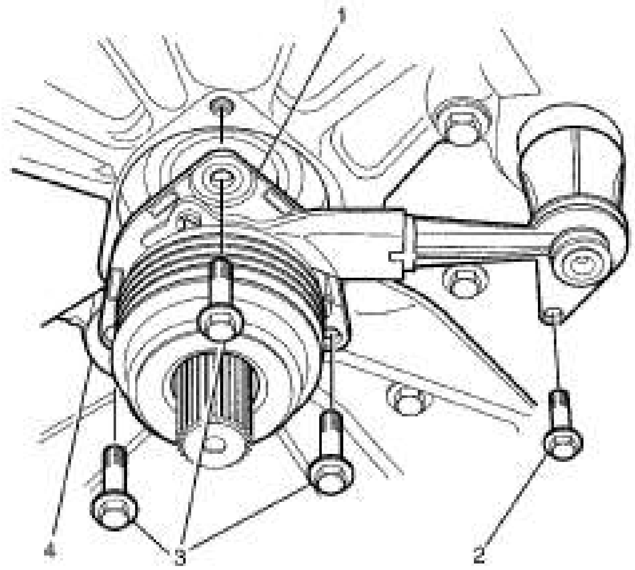
   Caution: Refer to Vehicle Lifting Caution in the Preface section.

3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
4. Remove the transmission assembly. Refer to Transmission Replacement.



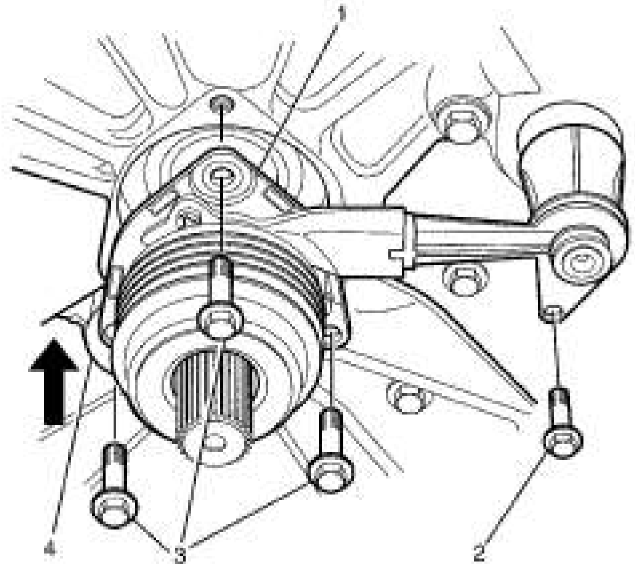
Important: If carrying out transmission removal procedure remove flexible clip (1) and leave assembly attach to transmission.

5. Detach the flexible hose securing clip (1).
6. Remove the concentric actuator cylinder feed pipe bracket to transmission retaining bolt (2).
7. Release the bleeder assembly securing clip (4), by using a suitable screwdriver and releasing it from the bleeder adapter.
8. Remove the bleeder assembly (3).



9. Remove the concentric actuator cylinder to transmission retaining bolts (3).
10. Remove the concentric actuator cylinder feed pipe to transmission retaining bolt (2).
11. Remove the concentric actuator cylinder (1) from the front of the transmission (4).

Installation Procedure



1. Install the concentric actuator cylinder (1) to the front of the transmission (4).

   Important: The concentric actuator cylinder feed pipe to transmission retaining bolt (2) must not to be fully tightened at this stage.

2. Install the concentric actuator cylinder feed pipe to transmission retaining bolt (2).

Do not fully tighten at this stage.

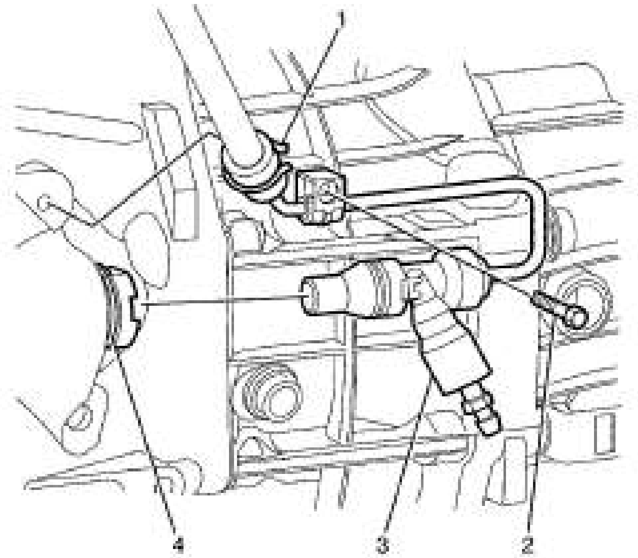
Notice: Refer to Fastener Notice in the Preface section.

3. Install the concentric actuator cylinder to transmission retaining bolts (3).

   Tighten
   Tighten the bolts 16 N·m (12 lb ft).

4. Tighten the concentric actuator cylinder feed pipe to transmission retaining bolt (2).

   Tighten
   Tighten the bolt to 8 N·m (71 lb in).



5. Install the bleeder assembly (3).
6. Install the bleeder assembly securing clip (4).
7. Install the concentric actuator cylinder feed pipe bracket to transmission retaining bolt (2).

   Tighten
   Tighten the bolt to 8 N·m (71 lb in).

8. Install the flexible hose securing clip, listen for an audible click to confirm fitting.
9. Install the transmission assembly. Refer to Transmission Replacement.
10. Bleed the clutch hydraulic system. Refer to Hydraulic Clutch Bleeding.
11. Enable the SIR system. Refer to SIR Disabling and Enabling in SIR.
12. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.
13. Road test vehicle for correct clutch and transmission operation.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Clutch | Repair Instructions | Document ID: 1992719

Clutch Concentric Actuator Cylinder Replacement (6.0L Engine)

Removal Procedure

1. Disable the SIR system. Refer to SIR Disabling and Enabling .

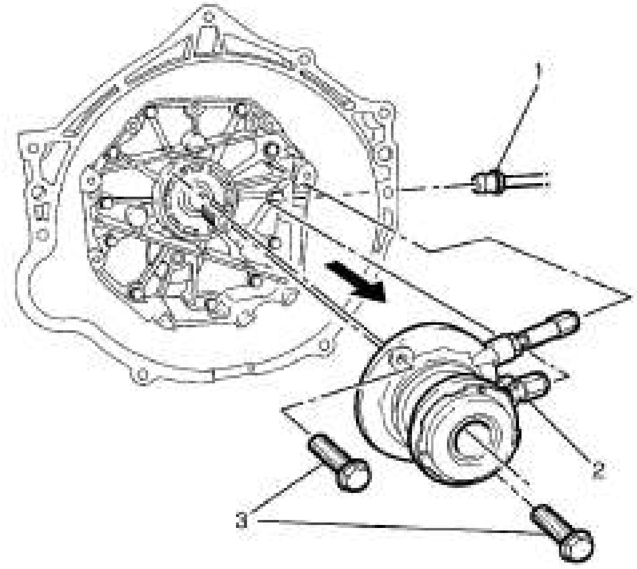
   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .

   Caution: Refer to Safety Glasses Caution in the Preface section.

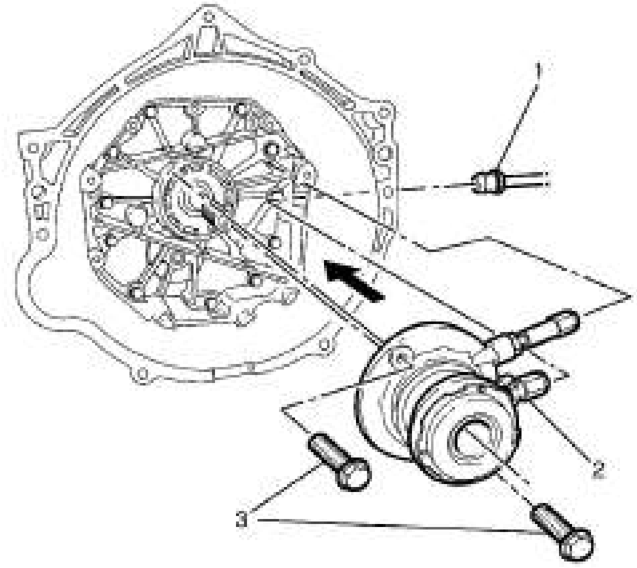
   Caution: Refer to Vehicle Lifting Caution in the Preface section.

3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
4. Remove transmission. Refer to Transmission Replacement .



5. Disconnect the concentric actuator cylinder feed pipe (1) from the concentric actuator cylinder (2) by using a suitable screwdriver to remove the wire clip, take care not to loose clip when removed.
6. Remove the concentric actuator cylinder to transmission retaining bolts (3).
7. Remove the concentric actuator cylinder (2) from the front of the transmission.

Installation Procedure



1. Install the concentric actuator cylinder (2) to the front of the transmission.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the concentric actuator cylinder to transmission retaining bolts (3).

   Tighten
   Tighten the bolts to 10 N·m (89 lb in).

   Notice: Refer to General Repair Instructions in the Preface section.

3. Install the concentric actuator cylinder feed pipe (1) to the concentric actuator cylinder (2).
4. Install transmission. Refer to Transmission Replacement .
5. Bleed the clutch hydraulic system. Refer to Hydraulic Clutch Bleeding .
6. Enable the SIR system. Refer to SIR Disabling and Enabling .
7. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
8. Road test vehicle for correct clutch and transmission operation.

Clutch Master Cylinder Fluid Replacement (3.6L Engine)

Tools Required

Customer Concern Verification Sheets AU529 Hydraulic Pressure Bleeder.

Caution: Refer to Safety Glasses Caution in the Preface section.

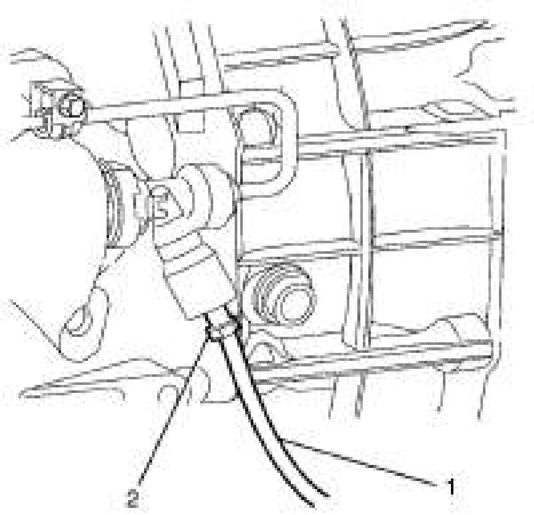
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support vehicle. Refer to Lifting and Jacking the Vehicle.

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

Notice: DO NOT use fluid which has been bled from a hydraulic clutch system, in order to fill the clutch master cylinder reservoir, due to the possibility that the fluid may be aerated, have too much moisture content, or be contaminated and may cause system or vehicle damage.



2. Install the hydraulic pressure bleeder to the bleed nipple (2).

Loosen the bleeder assembly bleed nipple (2).

Use the hydraulic pressure bleeder (1) to force air from the hydraulic system.

Allow fluid flow through the system until fluid runs clearly, immersed into a clean container.

Make sure the correct fluid level is maintained.

Notice: Refer to Fastener Notice in the Preface section.

3. Tighten the bleeder assembly bleed nipple (2).

   Tighten
   Tighten the bleed nipple to 18 N·m 13 lb ft).

4. Lower the vehicle.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Clutch | Repair Instructions | **Document ID: 1997014**

Clutch Master Cylinder Fluid Replacement (6.0L Engine)

Tools Required

Customer Concern Verification Sheets AU529

Caution: Refer to Safety Glasses Caution in the Preface section.

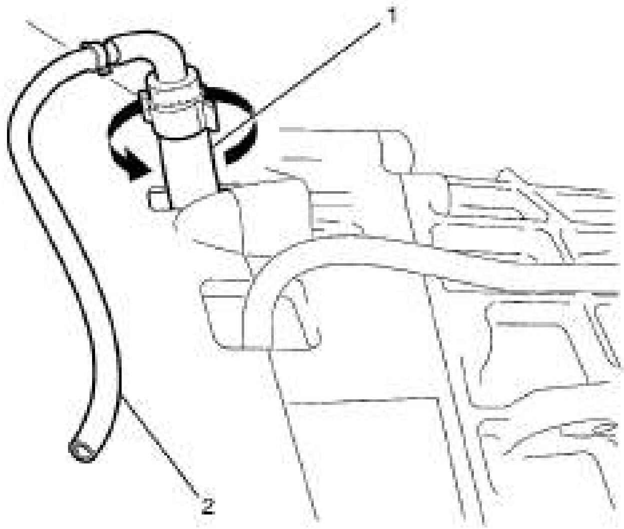
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support vehicle. Refer to Lifting and Jacking the Vehicle .

Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

Notice: DO NOT use fluid which has been bled from a hydraulic clutch system, in order to fill the clutch master cylinder reservoir, due to the possibility that the fluid may be aerated, have too much moisture content, or be contaminated and may cause system or vehicle damage.



2. Install the bleeder to the concentric actuator cylinder bleeder screw (1).
   2.1. Loosen the concentric actuator cylinder bleeder screw (1).
   2.2. Use the bleeder (2) to force air from the hydraulic system.
   2.3. Allow fluid flow through the system until fluid runs clearly, immersed into a clean container.
   2.4. Make sure the correct fluid level is maintained.

Notice: Refer to Fastener Notice in the Preface section.

2.5. Tighten the concentric actuator cylinder bleed screw (1).

Tighten
Tighten the bleed screw to 18 N·m 13 lb ft).

3. Lower the vehicle.
4. Make sure fluid level is correct.
5. Road test vehicle for correct clutch operation.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Clutch | Repair Instructions | Document ID: 1974899

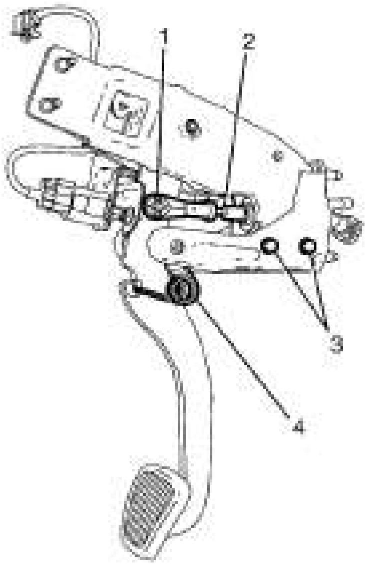
Clutch Master Cylinder Replacement (RHD)

Removal Procedure

1. Disable the SIR system. Refer to SIR Disabling and Enabling.

   Caution: Refer to Battery Disconnect Caution in the Preface section.

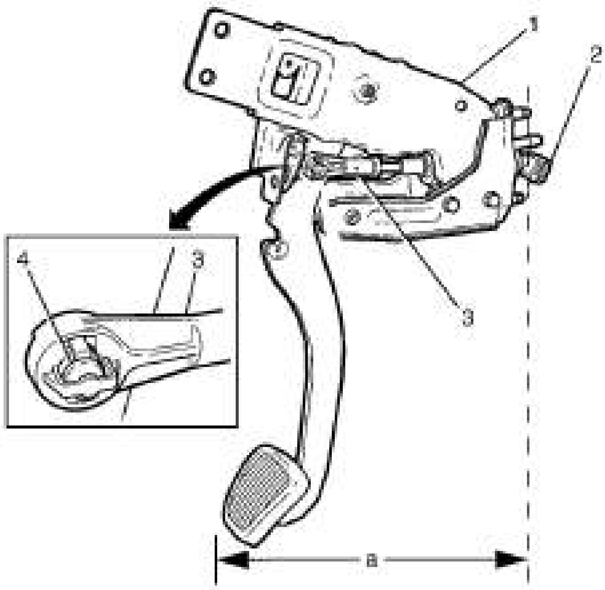
2. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the clutch pedal assembly. Refer to Clutch Pedal Replacement.
4. Place the clutch pedal on a suitable work surface.



   Important: Note the position of the clutch over centre spring (4).

5. Remove the clutch over centre spring (4).
6. Use a suitable screwdriver to pry off the push rod connector (1).
7. Disconnect the push rod connector (1) from the clutch pedal.
8. Remove the clutch master cylinder to clutch pedal retaining bolts (3).
9. Remove the clutch master cylinder (2).

Installation Procedure



1. Install the clutch master cylinder (2) to the pedal assembly (1).

   Important: The clutch master cylinder to clutch pedal retaining bolts (1) must not to be fully tightened at this stage.

2. Install the clutch master cylinder to clutch pedal retaining bolts (1).

   Do not fully tighten at this stage.

3. Connect the push rod connector (3) to the clutch pedal pin (4).
4. Remove the clutch position switch. Refer to Clutch Pedal Position Switch Replacement.

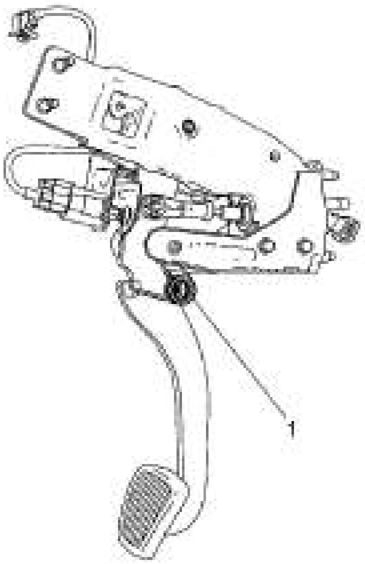
   Important: Measure from pedal pad bottom edge when at the top of travel to mod plate surface plane.

5. With an assistant raise clutch pedal to a height of 224 mm (a) to achieve the correct pedal height.

   Notice: Refer to Fastener Notice in the Preface section.

6. Tighten the clutch master cylinder to clutch pedal retaining bolts (1).

   Tighten
   Tighten the bolts to 12 N·m (106 lb in).



Important: Pushing the pedal to the bottom of travel will assist with the clutch over centre spring (1) installation.

Important: Make sure that the clutch over centre spring (1) is installed in its original position.

7. Install the clutch over centre spring (1).
8. Install the clutch position switch. Refer to Clutch Pedal Position Switch Replacement.
9. Install the clutch pedal assembly. Refer to Clutch Pedal Replacement.
10. Reconnect the clutch patch harness to the cockpit harness.
11. Enable the SIR system. Refer to SIR Disabling and Enabling.
12. Bleed the clutch hydraulic system. Refer to Hydraulic Clutch Bleeding.
13. Road test vehicle for correct clutch operation.

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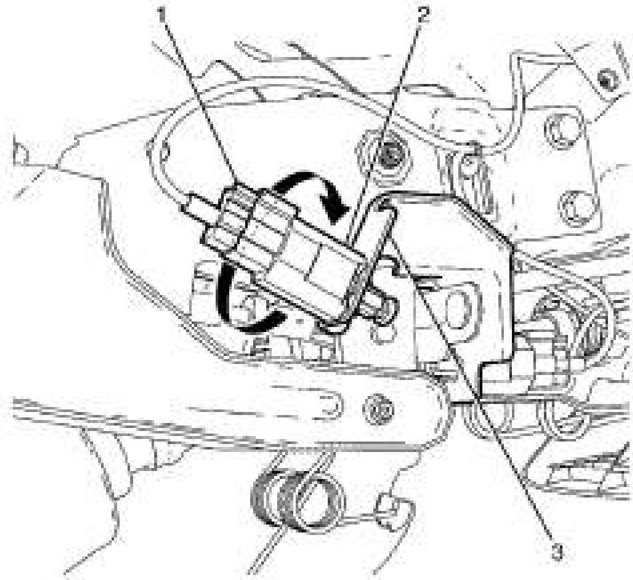
Clutch Pedal Engine Start Switch Replacement

Removal Procedure - Up to 17 Sept 2007

1. Disable the SIR system. Refer to SIR Disabling and Enabling .

   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove the instrument panel lower trim panel assembly. Refer to Instrument Panel Insulator Panel Replacement - Right Side .
4. Remove the instrument panel lower trim panel retainer. Refer to Instrument Panel Retainer Replacement .

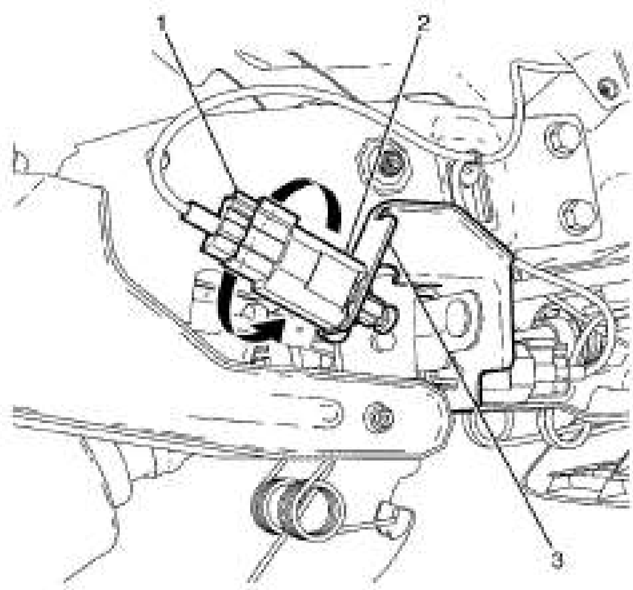


5. Disconnect the clutch pedal engine start switch electrical connector (1).

   Important: Rotate the clutch pedal engine start switch (2) clockwise a 1/4 turn, then pull to release from the clutch bracket (3).

6. Remove the clutch pedal engine start switch (2).

Installation Procedure - Up to 17 Sept 2007



Important: Rotate the clutch pedal engine start switch (2) a 1/4 of a turn anti-clockwise to lock it into the clutch bracket (3).

1. Install the clutch pedal engine start switch (2).
2. Connect the clutch pedal engine start switch electrical connector (1).
3. Install the instrument panel lower trim panel retainer. Refer to Instrument Panel Retainer Replacement .
4. Install the instrument panel lower trim panel assembly. Refer to Instrument Panel Insulator Panel Replacement - Right Side .
5. Enable the SIR. Refer to SIR Disabling and Enabling .
6. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
7. Road test vehicle for correct clutch operation.

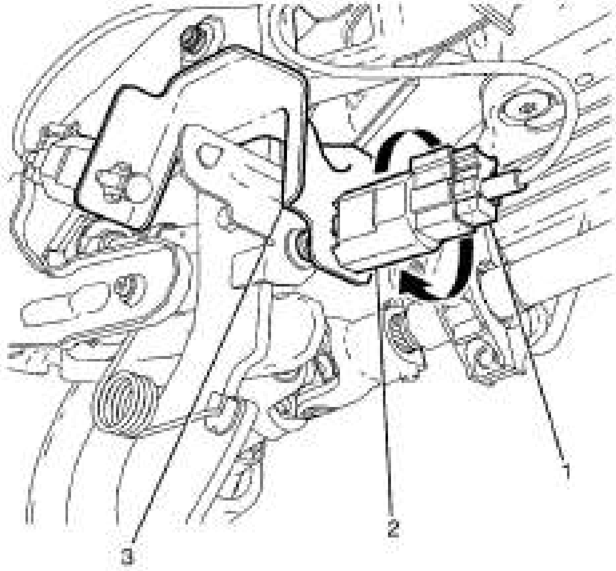
Clutch Pedal Position Switch Replacement

Removal Procedure - Up to 17 Sept 2007

1. Disable the SIR system. Refer to SIR Disabling and Enabling .

   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove the instrument panel lower trim panel assembly. Refer to Instrument Panel Insulator Panel Replacement - Right Side .
4. Remove the instrument panel lower trim panel retainer. Refer to Instrument Panel Retainer Replacement .

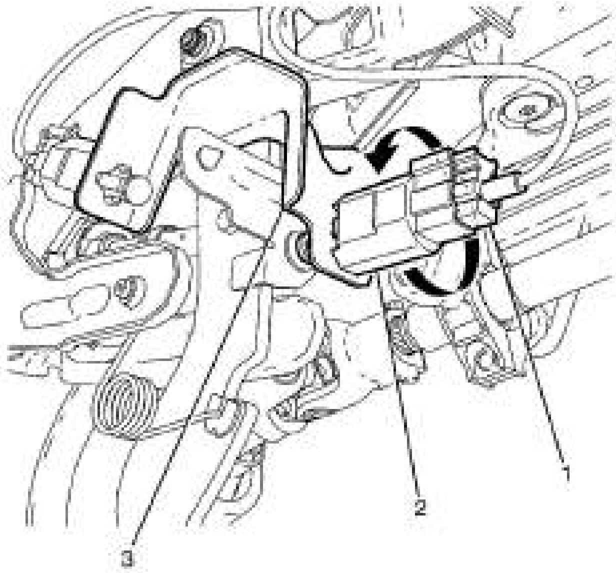


5. Disconnect the clutch position switch electrical connector (1).

   Important: Rotate the clutch position switch (2) clockwise a 1/4 turn, then pull to release from the clutch bracket (3).

6. Remove the clutch position switch (2).

Installation Procedure - Up to 17 Sept 2007



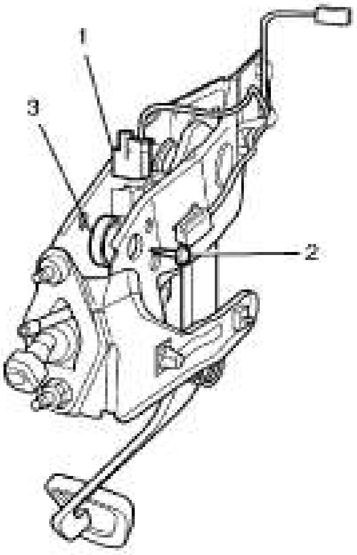
Important: Rotate the clutch position switch (2) a 1/4 of a turn anti-clockwise to lock it into the clutch bracket (3).

1. Install the clutch position switch (2).
2. Connect the clutch position switch electrical connector (1).
3. Install the instrument panel lower trim panel retainer. Refer to Instrument Panel Retainer Replacement .
4. Install the instrument panel lower trim panel assembly. Refer to Instrument Panel Insulator Panel Replacement - Right Side .
5. Enable the SIR. Refer to SIR Disabling and Enabling .
6. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
7. Road test vehicle for correct clutch operation.

Removal Procedure - From 17 Sept 2007

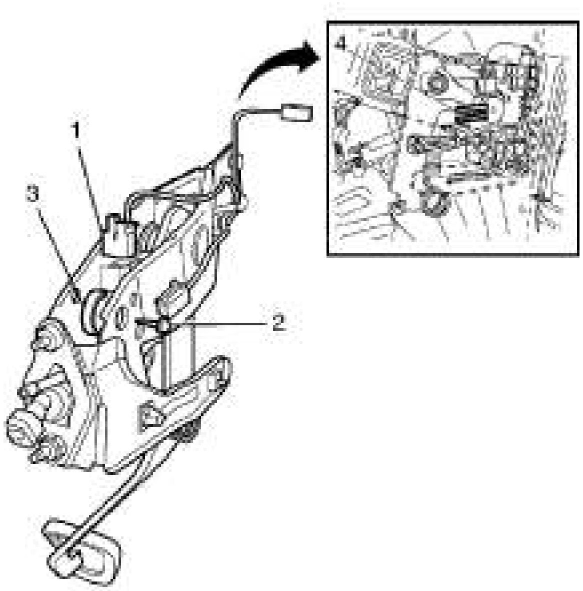
Caution: Refer to Battery Disconnect Caution in the Preface section.

1. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
2. Disable the SIR system. Refer to SIR Disabling and Enabling .
3. Remove the instrument panel lower trim panel assembly. Refer to Instrument Panel Insulator Panel Replacement - Right Side .
4. Remove the instrument panel lower trim panel retainer. Refer to Instrument Panel Retainer Replacement .
5. Remove the clutch pedal assembly. Refer to Clutch Pedal Replacement .



6. Disconnect the clutch pedal position sensor electrical connector (1).
7. Remove the clutch pedal assembly to clutch pedal position sensor retaining bolt (2).
8. Remove the clutch pedal position sensor (3).

Installation Procedure - From 17 Sept 2007



Important: Clutch pedal pin is located between the clutch pedal position sensor (3).

1. Install the clutch pedal position sensor (3).
2. Install the clutch pedal assembly to clutch pedal position sensor retaining bolt (2).

Tighten

Tighten the bolt to 13 N·m (115 lb in).

3. Connect the clutch pedal position sensor electrical connector (1).
4. Install the clutch pedal assembly. Refer to Clutch Pedal Replacement .
5. Install the instrument panel lower trim panel retainer. Refer to Instrument Panel Retainer Replacement .
6. Install the instrument panel lower trim panel assembly. Refer to Instrument Panel Insulator Panel Replacement - Right Side .
7. Enable the SIR. Refer to SIR Disabling and Enabling .
8. Connect the negative battery cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
9. Road test vehicle for correct operation.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Clutch | Repair Instructions | **Document ID: 1974771**

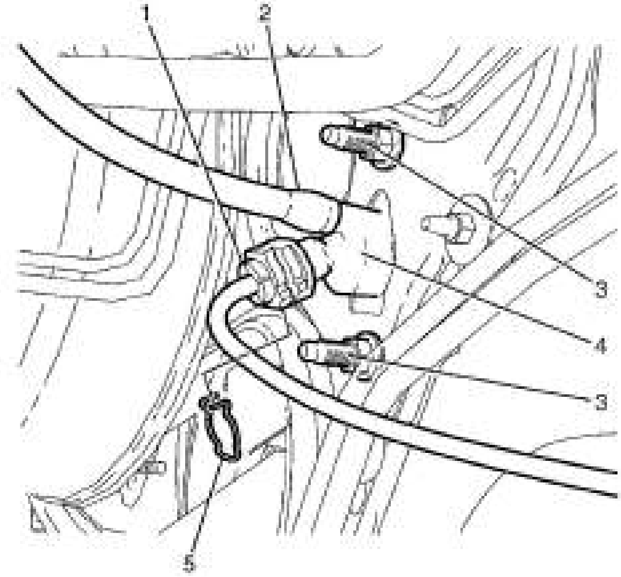
Clutch Pedal Replacement (RHD)

Removal Procedure

1. Disable the SIR system. Refer to SIR Disabling and Enabling .

   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .

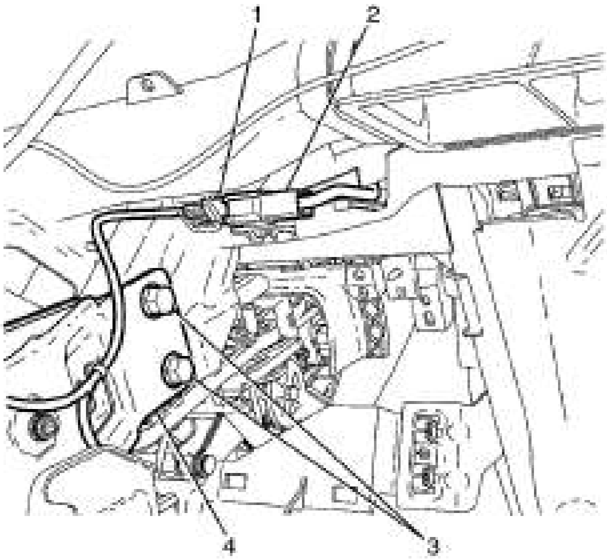


Important: Do not fully remove the hydraulic clutch hose/pipe retaining clip (5) from the clutch master cylinder (4).

3. Release the hydraulic clutch hose/pipe retaining clip (5) from the clutch master cylinder (4).
4. Disconnect the hydraulic clutch hose/pipe (1) from the clutch master cylinder (4).

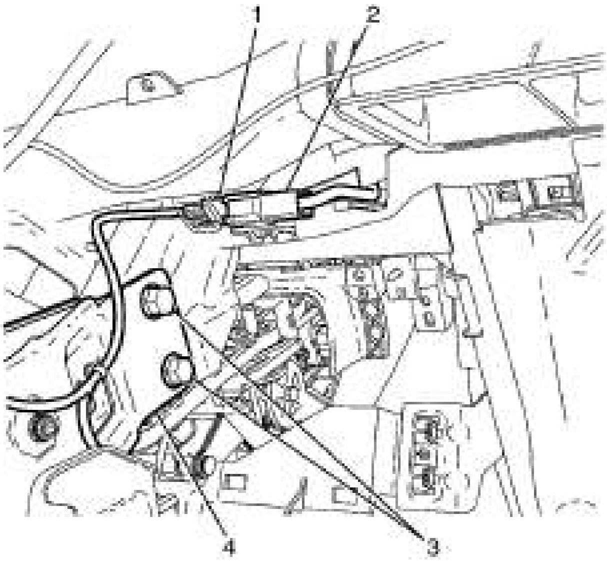
   Important: Ensure the rubber seal is attached to the reservoir (not on the master cylinder).

5. Pull the clutch master cylinder reservoir hose (2) from the clutch master cylinder (4).
6. Remove the clutch pedal to mod plate retaining nuts (3).
7. Remove the instrument panel lower trim panel assembly. Refer to Instrument Panel Insulator Panel Replacement - Right Side .
8. Remove the instrument panel lower trim panel retainer. Refer to Instrument Panel Retainer Replacement .



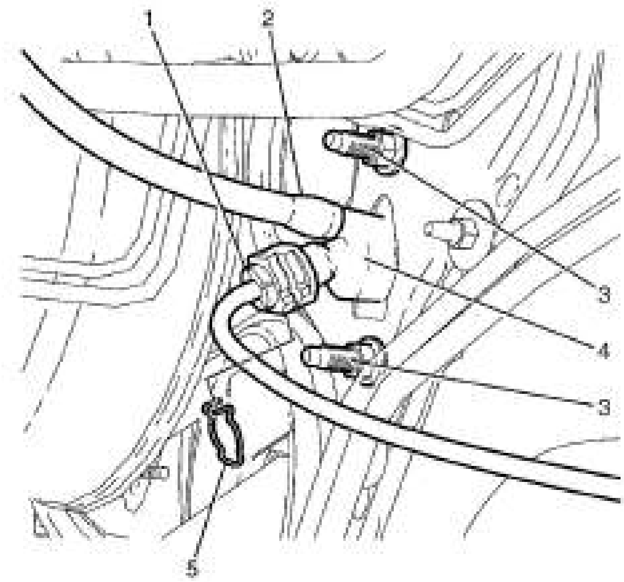
9. Disconnect the clutch pedal wiring harness (1) from the cockpit wiring harness (2).
10. Remove the clutch pedal to instrument panel crossmember retaining bolts (3).
11. Lower and remove the clutch pedal assembly (4).

Installation Procedure



1. Install the clutch pedal assembly (4) to the vehicle.

   Notice: Refer to Fastener Notice in the Preface section.



2. Install the clutch pedal to mod plate retaining nuts (3).

   Tighten
   Tighten the nut to 22 N·m (16 lb ft).

   Important: Listen for an audible click to confirm fitting.

3. Push fit the hydraulic clutch hose/pipe (1) to the clutch master cylinder (4).
4. Connect the clutch pedal wiring harness (1) to the cockpit wiring harness (2).
5. Install the instrument panel lower trim panel retainer. Refer to Instrument Panel Retainer Replacement .
6. Install the instrument panel lower trim panel assembly. Refer to Instrument Panel Insulator Panel Replacement - Right Side .

   Notice: Refer to Fastener Notice in the Preface section.

7. Install the clutch pedal to instrument panel crossmember upper retaining bolts (3).

   Tighten
   Tighten the nut to 22 N·m (16 lb ft).

8. Connect the clutch master cylinder reservoir hose (2), by firmly pushing it on to the clutch master cylinder (4).
9. Bleed the clutch hydraulic system. Refer to Hydraulic Clutch Bleeding .
10. Enable the SIR system. Refer to SIR Disabling and Enabling .
11. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
12. Road test vehicle for correct clutch operation.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Clutch | Repair Instructions | Document ID: 1992741

Clutch Pilot Bearing Replacement

Tools Required

- J 23907 Clutch Pilot Bearing Remover
- J 38836 Pilot Bushing Installer/Clutch

Removal Procedure

1. Disable the SIR system. Refer to SIR Disabling and Enabling .

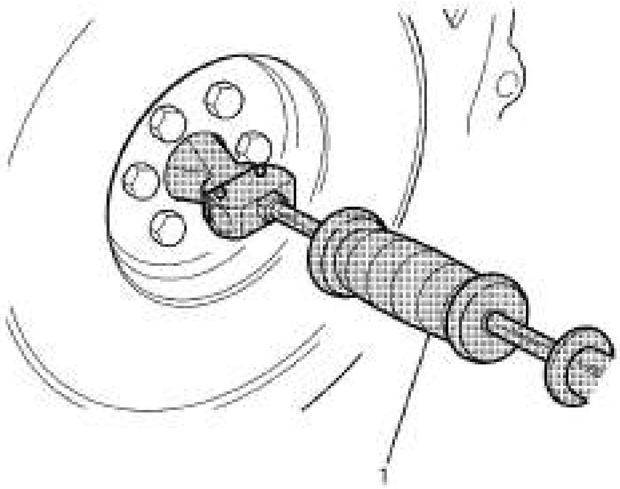
   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .

   Caution: Refer to Safety Glasses Caution in the Preface section.

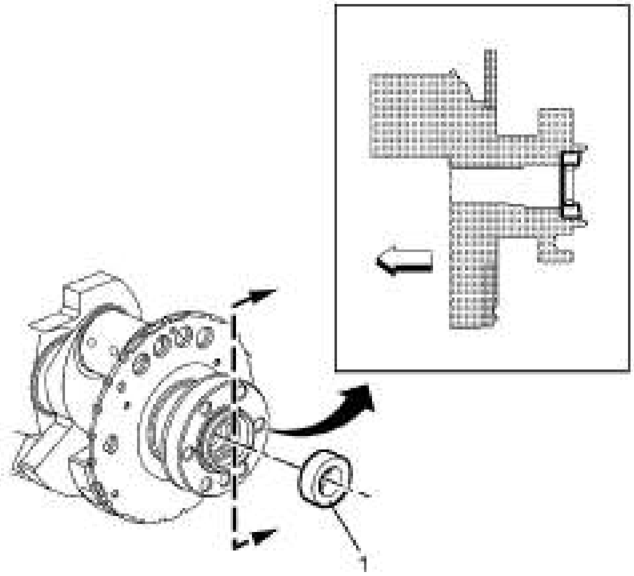
   Caution: Refer to Vehicle Lifting Caution in the Preface section.

3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
4. Remove the transmission assembly. Refer to Transmission Replacement .
5. Remove the clutch assembly. Refer to Clutch Assembly Replacement .



6. Remove the clutch pilot bearing, using the clutch pilot bearing remover (1).

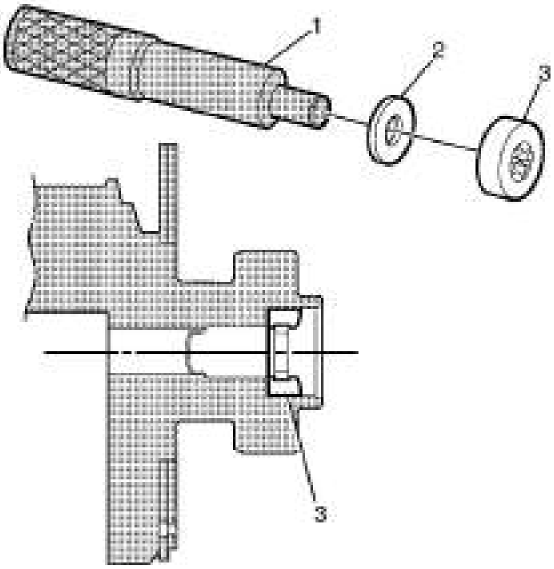
Installation Procedure



Important: Make sure that the crankshaft rear oil gallery plug (1) is not a loose fit, damaged or leaking.

Important: The correct depth (a) for the oil gallery plug is 31.2 to 31.6 mm.

1. Apply sealant LOCTITE R 242 and install it to the correct depth, If replacing the oil gallery plug (1).



Important: Use a 5/8 inch flat washer (2) against the tool to support the bearing races.

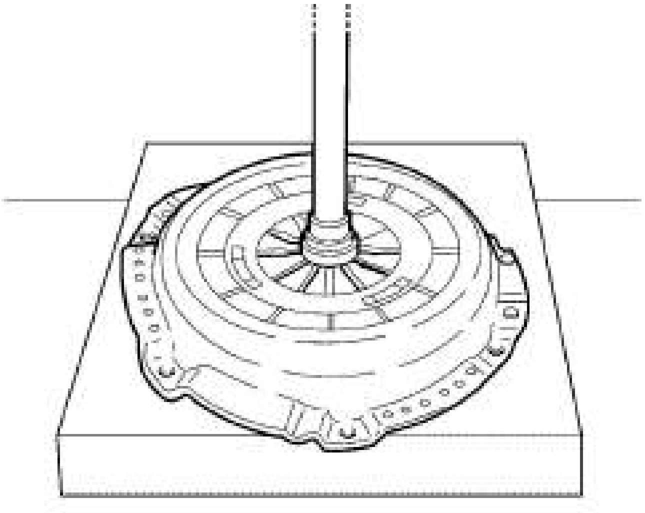
Important: When installed correctly the bearing should be flush with the crankshaft counter-bore.

2. Install the clutch pilot bearing (3) to the rear of the crankshaft, using pilot bushing installer (1).
3. Install the clutch assembly. Refer to Clutch Assembly Replacement .
4. Install the transmission assembly. Refer to Transmission Replacement .
5. Bleed the clutch hydraulic system. Refer to Hydraulic Clutch Bleeding .
6. Enable the SIR. Refer to SIR Disabling and Enabling in SIR.
7. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection .
8. Road test vehicle for correct operation.

Clutch Pressure Plate Adjustment (6.0L Engine)

Adjustment Procedure

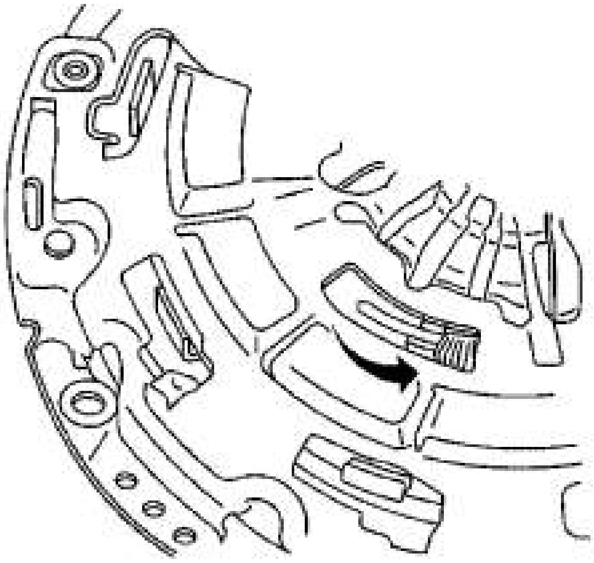
Important: Before installing the pressure plate, the self adjusting feature must be pre-set.



1. Place the flat side of the clutch driven plate downwards on the flat press plates, then place the pressure plate assembly over it.

   Notice: Refer to General Repair Instructions in the Preface section.

2. Using a hydraulic press, compress the pressure plate diaphragm spring until tension is release from the clutch driven plate.
3. Hold using a suitable tool against the step adjusting ring tension spring stop in front of the adjusting ring tension spring.



Important: Do not force the adjustment ring as damage to the pressure plate may occur.

Important: Minimal effort is required to rotate the adjustment ring.

4. Using a suitable tool, rotate the stepped adjusting ring counterclockwise, compressing the tension springs, until the adjusting ring steps are fully adjusted out, then continue to hold in position.
5. Release the press pressure from the pressure plate diaphragm spring fingers.
6. Release the adjusting ring tension spring stops.
7. Remove the pressure plate from the press.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Clutch | Repair Instructions | **Document ID: 1990916**

Clutch Release Bearing Replacement (3.6L Engine)

Removal Procedure

1. Disable the SIR system. Refer to SIR Disabling and Enabling in SIR.

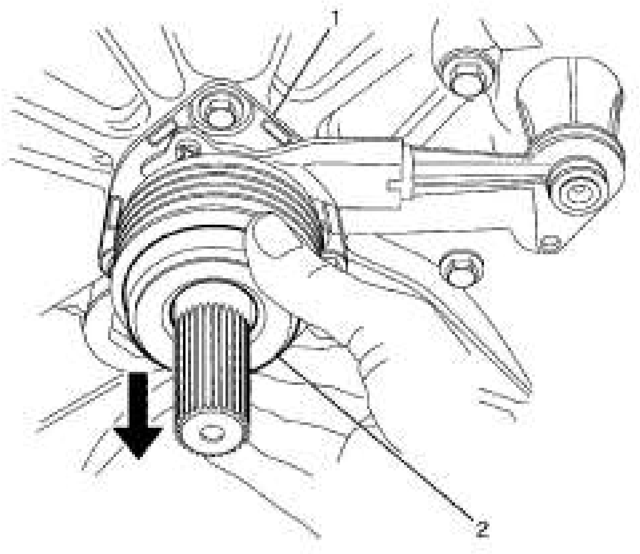
   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.

   Caution: Refer to Safety Glasses Caution in the Preface section.

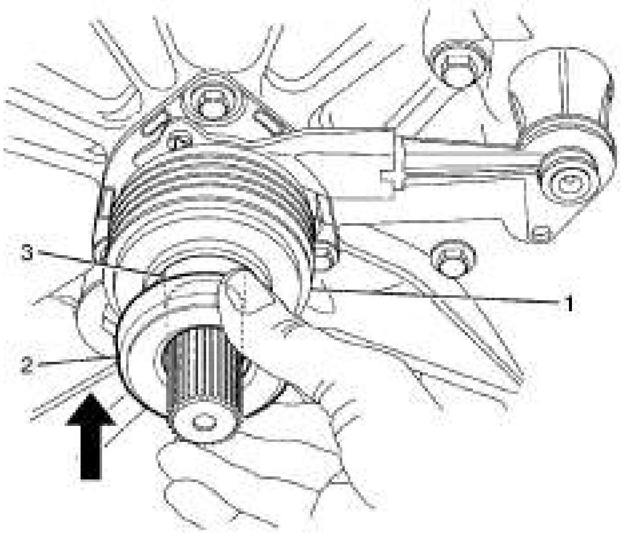
   Caution: Refer to Vehicle Lifting Caution in the Preface section.

3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
4. Remove the transmission assembly. Refer to Transmission Replacement.



5. Pull on the release bearing (2), to release it from the concentric actuator cylinder (1).
6. Remove the release bearing (2) from the concentric actuator cylinder (1).

Installation Procedure



1. Clean the exposed section of the concentric actuator cylinder guide sleeve (3).
2. Lubricate the concentric actuator cylinder guide sleeve (3).

   Important: Push the release bearing (2), over the concentric actuator cylinder guide sleeve (3) until it is fully installed.

3. Install the release bearing (2) to the concentric actuator cylinder (1).
4. Install the transmission assembly. Refer to Transmission Replacement.
5. Bleed the clutch hydraulic system. Refer to Hydraulic Clutch Bleeding.
6. Enable the SIR system. Refer to SIR Disabling and Enabling in SIR.
7. Connect the battery ground cable to the battery. Refer to Battery Negative Cable Disconnection and Connection.
8. Road test vehicle for correct clutch operation.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Clutch | Repair Instructions | **Document ID: 1990918**

Clutch Release Bearing Replacement (6.0L Engine)

Removal Procedure

1. Disable the SIR system. Refer to SIR Disabling and Enabling in SIR.

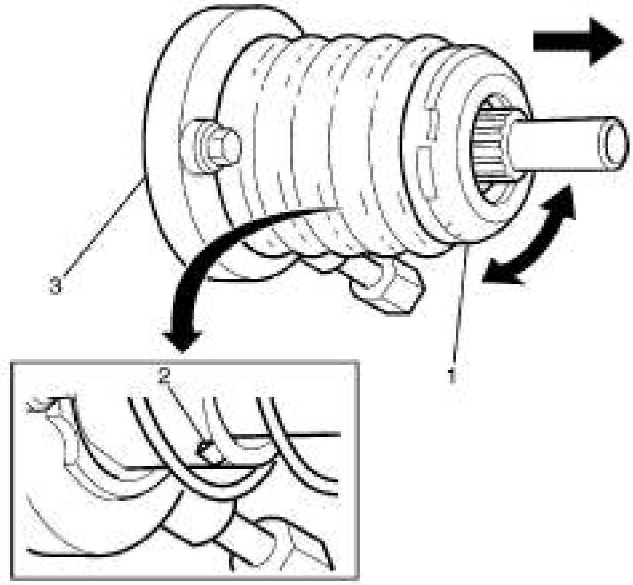
   Caution: Refer to Battery Disconnect Caution in the Preface section.

2. Disconnect the battery ground cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.

   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

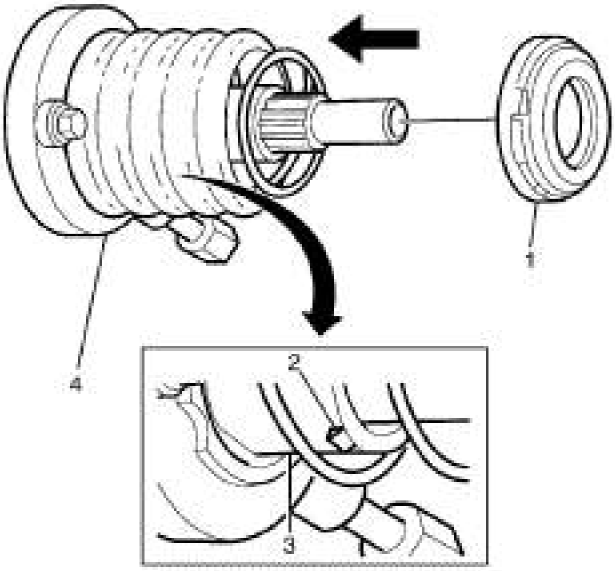
3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
4. Remove transmission. Refer to Transmission Replacement.



Important: Twist and pull the release bearing (1) to release it from the concentric actuator cylinder (3) to throw-out bearing locking tab (2).

5. Remove the release bearing (1) from the concentric actuator cylinder (3).

Installation Procedure

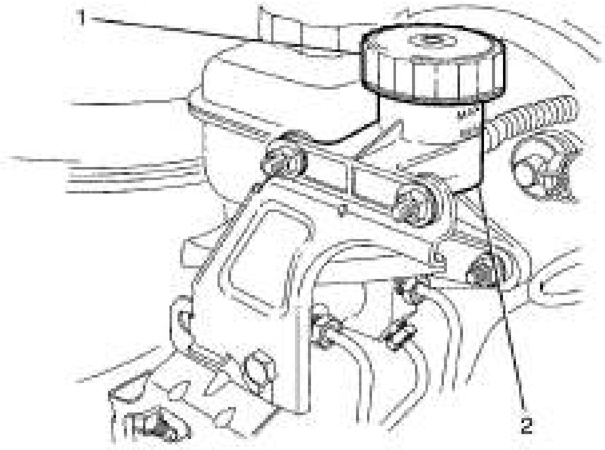


1. Clean the exposed section of the concentric actuator cylinder (4) guide sleeve (3).
2. Lubricate the concentric actuator cylinder guide sleeve (3).

   Important: The release bearing (2) must lock into the concentric actuator cylinder to throw-out bearing locking tab (2).

3. Install the release bearing (1) to the concentric actuator cylinder guide sleeve (3).
4. Install transmission. Refer to Transmission Replacement.
5. Bleed the clutch hydraulic system. Refer to Hydraulic Clutch Bleeding.
6. Enable the SIR system. Refer to SIR Disabling and Enabling in SIR.
7. Road test vehicle for correct clutch operation.

Hydraulic Clutch Bleeding (3.6L Engine)



1. Clean any dirt from around the clutch fluid reservoir cap (1).

   Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

   Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

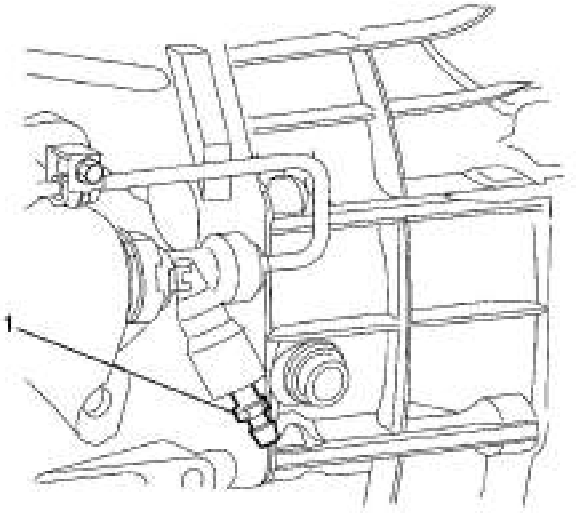
   Notice: DO NOT use fluid which has been bled from a hydraulic clutch system, in order to fill the clutch master cylinder reservoir, due to the possibility that the fluid may be aerated, have too much moisture content, or be contaminated and may cause system or vehicle damage.

2. Remove the clutch fluid reservoir cap (1) and ensure the clutch fluid reservoir (2) is filled to the fill line with new hydraulic fluid. Add fluid if required from a clean sealed container. For clutch fluid specifications, refer to General Specifications.
3. Stroke the clutch pedal from the up stop to the down stop position at least 15 times slowly to avoid aeration of fluid.

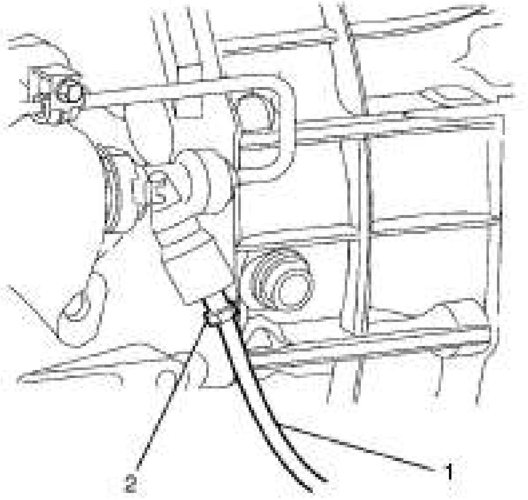
   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

4. Raise and support vehicle. Refer to Lifting and Jacking the Vehicle.



5. Loosen the bleeder assembly bleed nipple (1).
6. Tighten the bleeder assembly bleed nipple (1), using only light finger force.



7. Connect one end of a rubber tube (1) to the bleeder assembly bleed nipple (2).

   Important: Make sure that the end of the rubber tube (1) always stays submerged in a suitable container.

8. Insert the other end of the rubber tube (1) into a clean container filled with clean brake fluid.

   Important: Do not pump the clutch pedal repeatedly as entrapped air will cause fluid to foam.

9. Using an assistant, slowly depress the clutch pedal to the down stop position.

10. Open the bleeder assembly bleed nipple (2) 1/4 turn to release trapped air.
11. Close the bleeder assembly bleed nipple (2) and slowly return the clutch pedal to the up stop position.
12. Open the bleeder assembly bleed nipple (2) and slowly depress the clutch pedal from the up stop to the down stop position until fluid escapes through the bleeder assembly.
13. Close the bleeder assembly bleed nipple (2).
14. Return the clutch pedal to the up stop position.
15. Depress the clutch pedal from the up stop to the down stop position.
16. Open the bleeder assembly bleed nipple (2) and allow fluid with air bubbles to escape through the bleeder assembly.
17. Close the bleeder assembly bleed nipple (2).

    Important: Always make sure that the clutch fluid reservoir remains filled with new clean hydraulic fluid.

18. Repeat steps 14-17 until fluid without air bubbles escapes through the bleeder assembly (1).

    Notice: Refer to Fastener Notice in the Preface section.

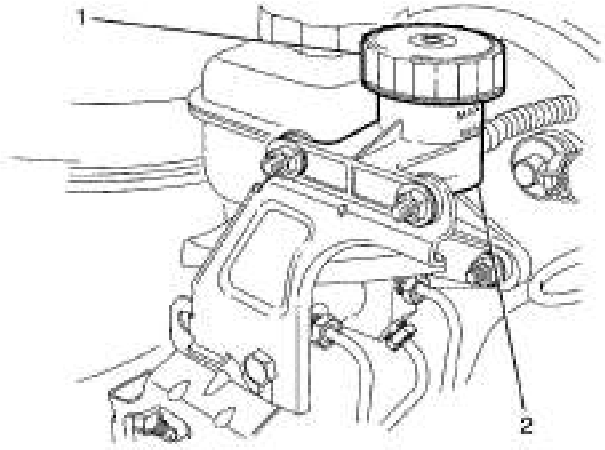
19. Tighten the bleeder assembly bleed nipple (3), with the clutch pedal still depressed.

    Tighten
    Tighten the bleed nipple to 18 N·m (13 lb ft).

20. Lower the vehicle.
21. Make sure fluid level is correct.
22. Road test vehicle for correct clutch operation.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Clutch | Repair Instructions | **Document ID: 1974795**

Hydraulic Clutch Bleeding (6.0L Engine)



1. Clean any dirt from around the clutch fluid reservoir cap (1).

   Caution: Refer to Brake Fluid Irritant Caution in the Preface section.

   Notice: Refer to Brake Fluid Effects on Paint and Electrical Components Notice in the Preface section.

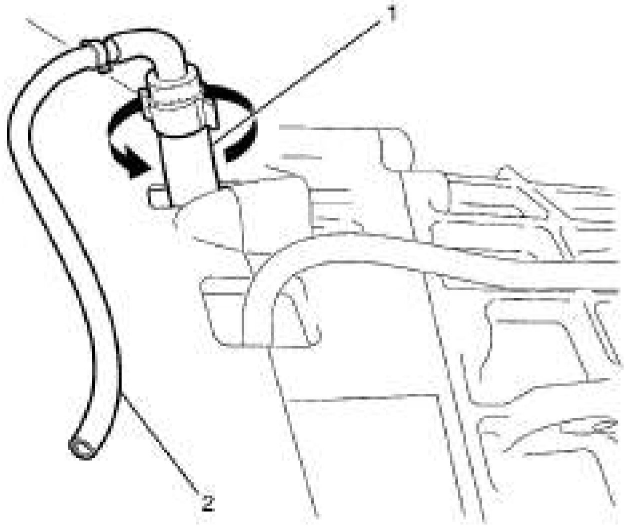
   Notice: DO NOT use fluid which has been bled from a hydraulic clutch system, in order to fill the clutch master cylinder reservoir, due to the possibility that the fluid may be aerated, have too much moisture content, or be contaminated and may cause system or vehicle damage.

2. Remove the clutch fluid reservoir cap (1) and ensure the clutch fluid reservoir (2) is filled to the fill line with new hydraulic fluid. Add fluid if required from a clean sealed container. For clutch fluid specifications, refer to General Specifications.
3. Stroke the clutch pedal from the up stop to the down stop position at least 15 times slowly to avoid aeration of fluid.

   Caution: Refer to Safety Glasses Caution in the Preface section.

   Caution: Refer to Vehicle Lifting Caution in the Preface section.

4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



5. Loosen the concentric actuator cylinder bleeder screw (1).
6. Connect one end of a rubber tube (2) to the concentric actuator cylinder bleed screw (1).

    Important: Make sure that the end of the rubber tube (2) always stays submerged in a suitable container.

7. Insert the other end of the rubber tube (2) into a clean container filled with clean brake fluid.

    Important: Do not pump the clutch pedal repeatedly as entrapped air will cause fluid to foam.

8. Using an assistant, slowly depress the clutch pedal to the down stop position.
9. Open the concentric actuator cylinder bleed screw (1) 1/4 turn to release trapped air.
10. Close the concentric actuator cylinder bleed screw (1) and slowly return the clutch pedal to the up stop position.
11. Open the concentric actuator cylinder bleed screw (1) and slowly depress the clutch pedal from the up stop to the down stop position until fluid escapes through the bleeder assembly (1).
12. Close the concentric actuator cylinder bleed screw (1).
13. Return the clutch pedal to the up stop position.
14. Depress the clutch pedal from the up stop to the down stop position.
15. Open the concentric actuator cylinder bleed screw (1) and allow fluid with air bubbles to escape.
16. Close the concentric actuator cylinder bleed screw (1).

    Important: Always make sure that the clutch fluid reservoir remains filled with new clean hydraulic fluid.

17. Repeat steps 14-17 until fluid without air bubbles escapes into the container.

    Notice: Refer to Fastener Notice in the Preface section.

18. Tighten the concentric actuator cylinder bleed screw (1), with the clutch pedal still depressed.

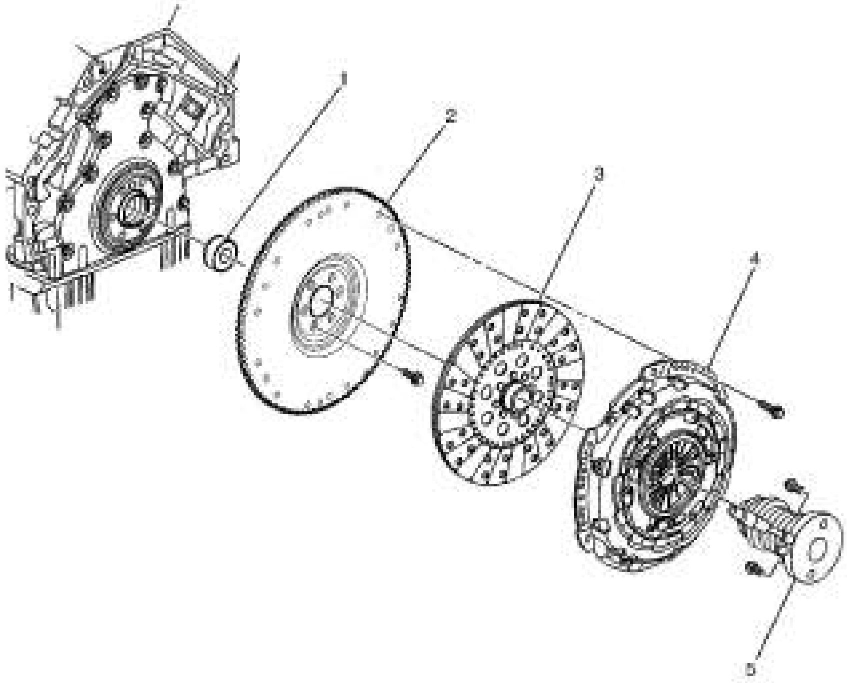
Tighten
Tighten the bleeder screw to 18 N·m (13 lb ft).

19. Lower the vehicle to the ground.
20. Make sure fluid level is correct.
21. Road test vehicle for correct clutch operation.

Clutch System Description and Operation (SWBRHD)

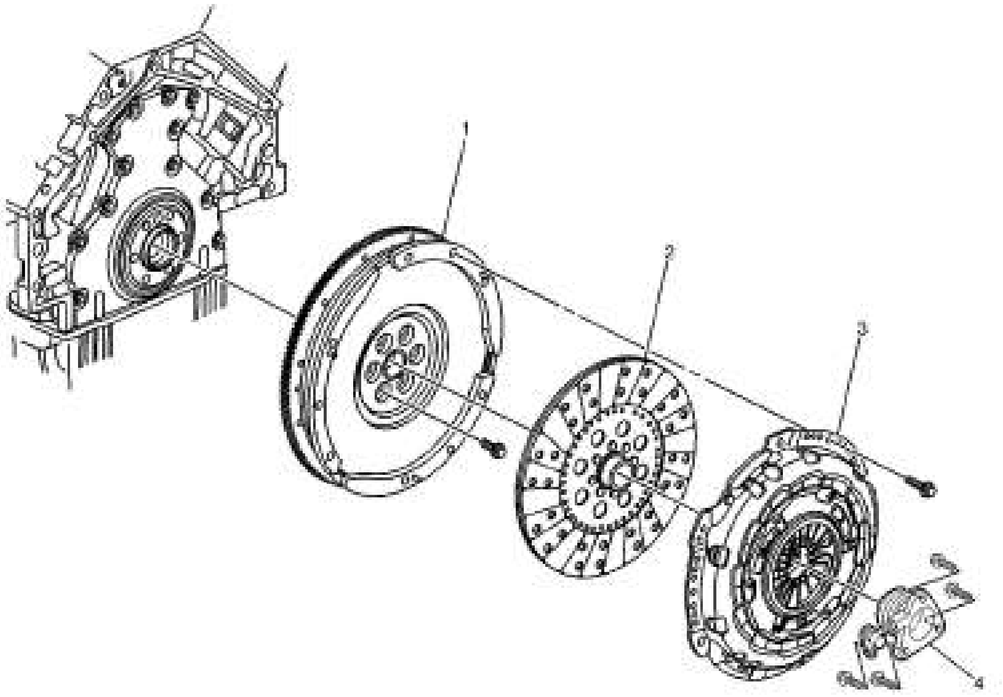
Description and Operation - Up to 17 Sep 2007

Tremec 6-Speed



(1) Clutch Pilot Bearing
(2) Engine Flywheel
(3) Clutch Driven Plate
(4) Clutch Pressure Plate
(5) Clutch Concentric Actuator Cylinder

Aisin AY6



(1) Engine Flywheel
(2) Clutch Driven Plate
(3) Clutch Pressure Plate
(4) Clutch Concentric Actuator Cylinder

The following are the principal components of the clutch system:

- The driving members; attached to the engine and turning with the engine
- The driven member; attached to the driveline and transmission and turning with the driveline and transmission
- The operating members; including the spring, the clutch hydraulic system, and the clutch pedal linkages, required to apply and release the pressure, which holds the driving and driven members in contact with each other

Clutch Driving Members

The clutch driving members consist of two, flat surface, iron plates. One of these surfaces is a heavy flat ring, with one side machined, known as the clutch driven plate and the other is the rear face of the engine flywheel. This is a dual mass flywheel that is designed to absorb engine vibrations before they are transmitted to the driveline, where they can create gear rattle. This is achieved by splitting the conventional flywheel into two sections: a primary section, which bolts to the crankshaft, and a secondary section, onto which the clutch is bolted. The primary section of the flywheel contains springs to isolate the engine vibrations. A small amount of fore aft looseness between the primary and secondary sections is normal. It is also normal for the secondary section to have a rotating travel of 25-50 mm (1-2 in) measured near the flywheel ring gear, while the primary section stays stationary.

Clutch Driven Members (V6)

The driven member, clutch driven plate, has a splined hub that freely slides lengthwise along the splines of the transmission input shaft, which also drives the shaft through these same splines. Suitable friction facings are attached to each side of the plate by rivets.

In order to make the clutch engagement as smooth as possible and eliminate chatter; the steel segments driving the splined hub are slightly waved, which causes the contact pressure on the facings to rise gradually as the waved springs flatten out.

Clutch Operating Members

The driving member and the driven member are held in contact by spring pressure. This pressure is exerted by a one-piece conical or diaphragm spring.

A diaphragm spring is a conical piece of spring steel that has been specially stamped to give it greater flexibility. The diaphragm is positioned between the cover and the pressure plate so that the diaphragm spring is nearly flat when the clutch is in the engaged position.

The pressure of the inner rim of the spring on the pressure plate decreases as the flat position is passed. The inner rim of the diaphragm bears on the pressure plate and is pivoted on a ring on the outer edge of the pressure plate. The application of a pulling load on the inner section of the pressure plate will cause the inner rim to move away from the flywheel and allow the pressure plate to move away from the clutch disc, thereby releasing or disengaging the clutch.

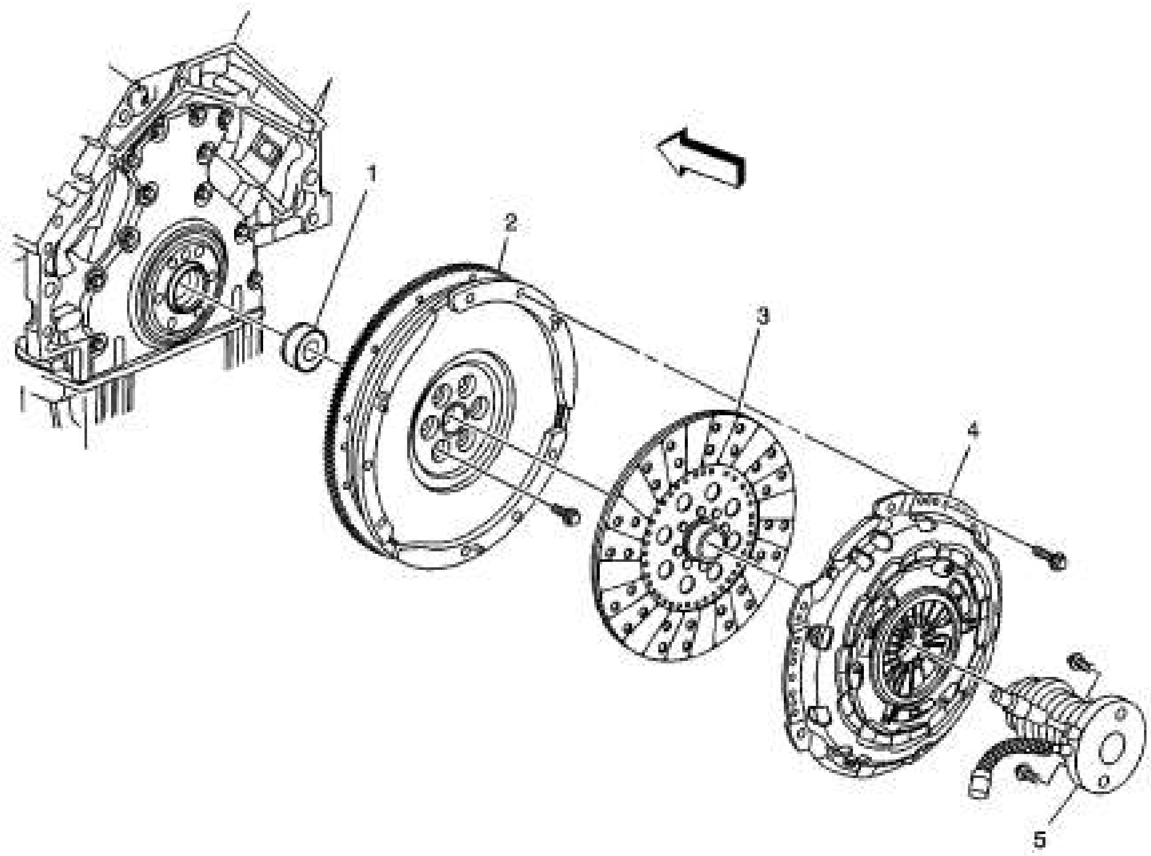
The clutch release bearing is moved by the actuator assembly to move the release levers which move the pressure plate to the rear, thus separating the clutch disc from the flywheel when the clutch pedal is depressed by the driver. A piston return spring in the actuator cylinder preloads the clutch linkage and assures a small load on the release bearing with the actuator assembly at all times. As the clutch disc wears, the diaphragm spring fingers move forward forcing the release bearing, actuator assembly, and pushrod to move. This movement forces the actuator cylinder piston to move forward in its bore, consuming hydraulic fluid from the master cylinder reservoir, thereby providing the SELF-ADJUSTING feature of the hydraulic clutch linkage system.

Hydraulic Clutch Description

The clutch hydraulic system consists of a master cylinder and an actuator cylinder. When pressure is applied to the clutch pedal, pedal depressed, the pushrod contacts the plunger and pushes it down the bore of the master cylinder. In the first 0.8 mm (0.031 in) of movement, the recuperation seal closes the port to the fluid reservoir tank, and as the plunger continues to move down the bore of the cylinder, the fluid is forced through the outlet line to the actuator cylinder mounted to the driveline support assembly. As fluid is pushed down the pipe from the master cylinder, this in turn forces the piston in the actuator cylinder outward. As the actuator cylinder piston moves forward, it forces the release bearing to disengage the clutch pressure plate from the clutch disc. On the return stroke, pedal released, the plunger moves back as a result of the return pressure of the clutch. Fluid returns to the master cylinder and the final movement of the plunger opens the port to the fluid reservoir, allowing an unrestricted flow of fluid between system and reservoir. This systems has a clutch pedal hold down assist spring. Its purpose is to keep the clutch pedal depressed. This reduces driver fatigue during stop and go traffic.

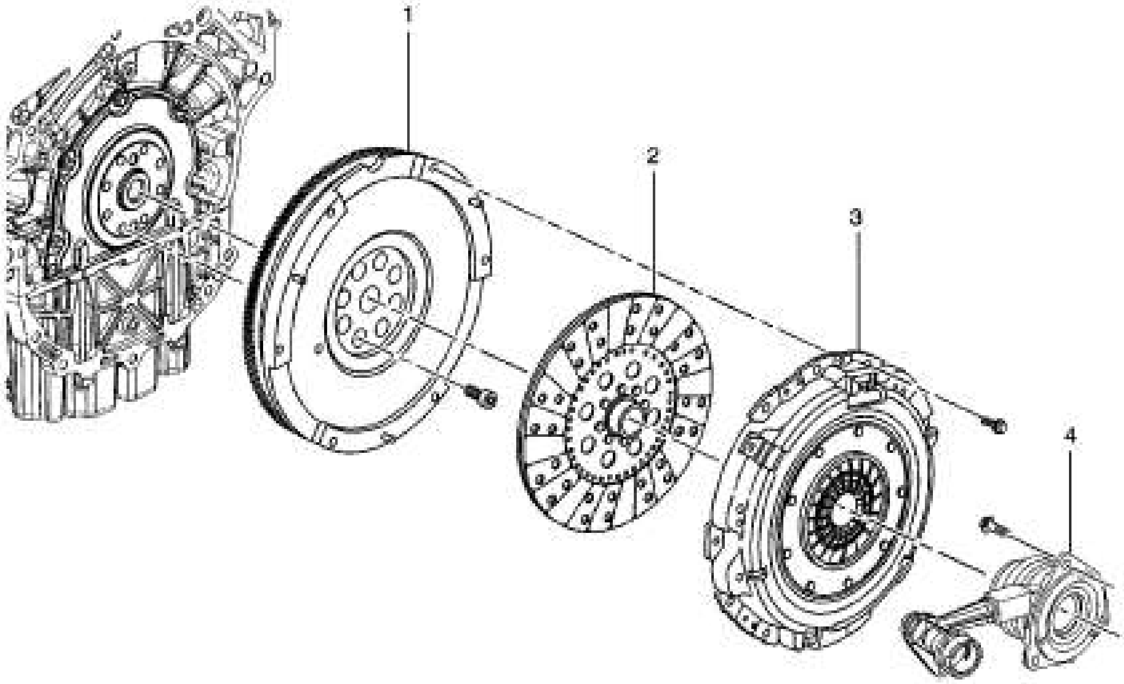
Description and Operation - After 17 Sept 2007

Tremec 6-Speed



- (1) Clutch Pilot Bearing
- (2) Engine Flywheel
- (3) Clutch Driven Plate
- (4) Clutch Pressure Plate
- (5) Clutch Actuator Cylinder

Aisin AY6



(1) Engine Flywheel
(2) Clutch Driven Plate
(3) Clutch Pressure Plate
(4) Clutch Actuator Cylinder

The following are the principal components of the clutch system:

- The driving members; attached to the engine and turning with the engine.
- The driven member; attached to the driveline and transmission and turning with the driveline and transmission.
- The operating members; including the spring, the clutch hydraulic system, and the clutch pedal linkages, required to apply and release the pressure, which holds the driving and driven members in contact with each other.

Clutch Driving Members

The clutch driving members consist of two, flat surface, iron plates. One of these surfaces is a heavy flat ring, with one side machined, known as the clutch driven plate and the other is the rear face of the engine flywheel. This is a dual mass flywheel that is designed to absorb engine vibrations before they are transmitted to the driveline, where they can create gear rattle. This is achieved by splitting the conventional flywheel into two sections: a primary section, which bolts to the crankshaft; and a secondary section, onto which the clutch is bolted. The primary section of the flywheel contains springs to isolate the engine vibrations. A small amount of fore aft looseness between the primary and secondary sections is normal. It is also normal for the secondary section to have a rotating travel of 25-50 mm (1-2 in) measured near the flywheel ring gear, while the primary section stays stationary.

Clutch Driven Members (V6)

The driven member, clutch driven plate, has a splined hub that freely slides lengthwise along the splines of the transmission input shaft, which also drives the shaft through these same splines. Suitable friction facings are attached to each side of the plate by rivets.

In order to make the clutch engagement as smooth as possible and eliminate chatter; the steel segments driving the splined hub are slightly waved, which cause the contact pressure on the facings to rise gradually as the waved springs flatten out.

Clutch Operating Members

The driving member and the driven member are held in contact by spring pressure. This pressure is exerted by a one-piece conical or diaphragm spring.

A diaphragm spring is a conical piece of spring steel that has been specially stamped to give it greater flexibility. The diaphragm is positioned between the cover and the pressure plate so that the diaphragm spring is nearly flat when the clutch is in the engaged position.

The pressure of the inner rim of the spring on the pressure plate decreases as the flat position is passed. The inner rim of the diaphragm bears on the pressure plate and is pivoted on a ring on the outer edge of the pressure plate. The application of a pulling load on the inner section of the pressure plate will cause the inner rim to move away from the flywheel and allow the pressure plate to move away from the clutch disc, thereby releasing or disengaging the clutch.

The clutch release bearing is moved by the actuator assembly to move the release levers which move the pressure plate to the rear, thus separating the clutch disc from the flywheel when the clutch pedal is depressed by the driver. A piston return spring in the actuator cylinder preloads the clutch linkage and assures a small load on the release bearing with the actuator assembly at all times. As the clutch disc wears, the diaphragm spring fingers move forward forcing the release bearing, actuator assembly, and pushrod to move. This movement forces the actuator cylinder piston to move forward in its bore, consuming hydraulic fluid from the master cylinder reservoir, thereby providing the SELF-ADJUSTING feature of the hydraulic clutch linkage system.

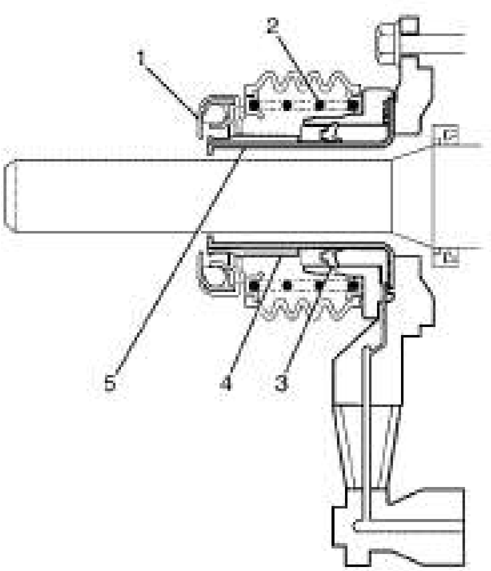
The electrical switch on the clutch pedal/bracket assembly has 3 functions. One function is a clutch interlock, ensuring the engine does not start unless the pedal is positioned on the floor. The second function is to cancel the cruise control system, if equipped, when the clutch pedal is depressed and the third function is to use the pedal position data to improve driveability.

Hydraulic Clutch Description

The clutch hydraulic system consists of a master cylinder and an actuator cylinder. When pressure is applied to the clutch pedal, pedal depressed, the pushrod contacts the plunger and pushes it down the bore of the master cylinder. In the first 0.8 mm (0.031 in) of movement, the recuperation seal closes the port to the fluid reservoir tank, and as the plunger continues to move down the bore of the cylinder, the fluid is forced through the outlet line to the actuator cylinder mounted to the driveline support assembly. As fluid is pushed down the pipe from the master cylinder, this in turn forces the piston in the actuator cylinder outward. As the actuator cylinder piston moves forward, it forces the release bearing to disengage the clutch pressure plate from the clutch disc. On the return stroke, pedal released, the plunger moves back as a result of the return pressure of the clutch. Fluid returns to the master cylinder and the final movement of the plunger opens the port to the fluid reservoir, allowing an unrestricted flow of fluid between system and reservoir. This systems has a clutch pedal hold down assist spring. Its purpose is to keep the clutch pedal depressed. This reduces driver fatigue during stop and go traffic.

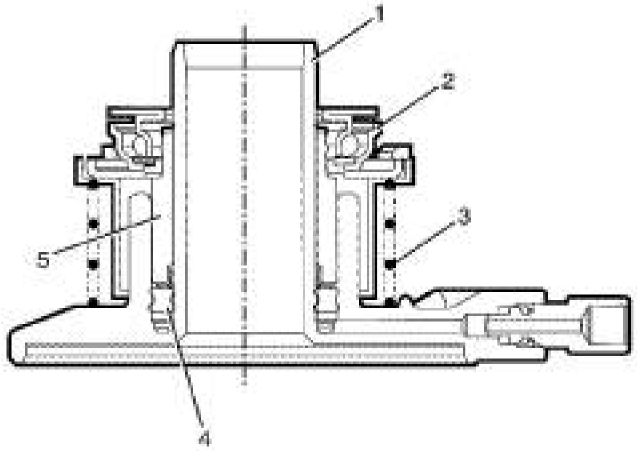
Hydraulic Clutch System Description and Operation (SWBRHD)

Concentric Actuator Cylinder Operation (3.6L) Engine



The pressurised fluid acts upon the seal (3) which then moves stroking the sleeve (4) in front of it. The release bearing (1) is also attached to the sleeve which means it also moves with the seal, in turn forcing the fingers of the pressure plate to move against the spring force. The concentric actuator cylinder sleeves continues to move the cylinder body, the pressure plate diaphragm spring guide (2) starts to pivot due to the force being applied. When this happens the clutch driven plate is allowed to spin. As this action takes place the flywheel and transmission input shaft friction link is broken which then allows smooth gear changing. The release bearing and actuating sleeve are moved back along the actuating body cylinder guide (5) by releasing the clutch pedal which in turn operates the pressure plate diaphragm spring force. As the clutch pressure plate is self-adjusting, the "at rest position of the release bearing and concentric slave cylinder sleeve remains relatively the same throughout the life of the assembly.

Concentric Actuator Cylinder Operation (6.0L Engine)



The pressurised fluid acts upon the seal upon the seal (4) which then moves stroking the sleeve in front of it. The release bearing (2)) is also attached to the sleeve (5) which means it also moves with the seal (4), in turn forcing the fingers of the pressure plate to move against the spring force. As the concentric actuator cylinder continues to move on the cylinder body, (1) the pressure plate diaphragm spring starts to pivot due to the force being applied. When this happens the clutch driven plate is allowed to spin. As this action takes place the flywheel and transmission input shaft friction link is broken which then allows smooth gear changing. The release bearing and actuating sleeve are moved back along the actuating body cylinder guide by releasing the clutch pedal which in turn operates the pressure plate diaphragm spring (3) force. As the clutch pressure plate is self-adjusting, the "at rest position of the release bearing and concentric slave cylinder sleeve remains relatively the same throughout the life of the assembly.

Master Cylinder Operation

As the clutch pedal is depressed, force is transmitted via the clutch pedal push rod to the clutch master cylinder piston moving it down the cylinder bore. When the piston stars to move, the primary seal covers the compensation port and the resultant build up in pressure, seats the relief valve in the end of the piston. As hydraulic pressure develops, the fluid is displaced and moves the piston in the concentric actuator cylinder against the return spring and clutch pressure plate diaphragm spring forces, to stroke the concentric actuator cylinder push rod. In turn, this action moves the clutch release lever and bearing, releasing the clutch pressure plate.

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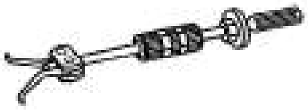
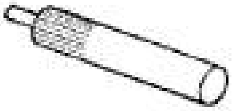
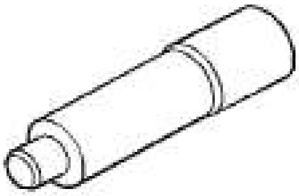
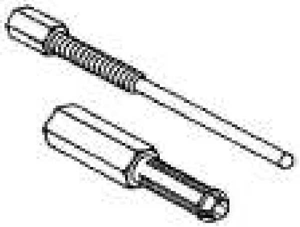
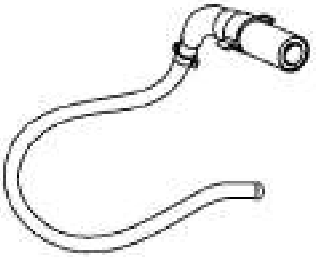
Special Tools (SWB)

Illustration	Tool Number / Description
	J 23907 Slide Hammer with Bearing Adapter
	J 33169 Clutch Alignment Arbor
	J 38836 Pilot Bushing Installer/Clutch
	J 43276

	Clutch Pilot Bearing Remover
	AU 529 Clutch Actuating Cylinder Bleed Tool

Fastener Tightening Specifications (SWBRHD)

Application	Specification	
	Metric	English
Backup Lamp Switch	44 N·m	32 lb ft
Bearing Lock Plate Bolt	11 N·m	97 lb in
Drain Plug	37 N·m	27 lb ft
Drive Flange Nut	57 N·m	42 lb ft
Fill Plug	37 N·m	27 lb ft
Front Case to Middle Case Bolts	40 N·m	29 lb ft
Middle Case to Rear Case Bolts	40 N·m	30 lb ft
Oil Through Bolts	8 N·m	71 lb in
Rear Case to Housing Extension Bolts	29 N·m	21 lb ft
Reverse Idler Shaft Bolt	28 N·m	20 lb ft
Service Hole Plug	39 N·m	29 lb ft
Shift Control Assembly Bolt	18 N·m	13 lb ft
Shift Control Lever Bracket Bolts	21 N·m	15 lb ft
Shift Fork Bolts	19 N·m	14 lb ft
Shift and Select Lever Bolt	33 N·m	24 lb ft
Shift Shaft Detent Plug	24 N·m	18 lb ft
Speed Sensor Bolt	8 N·m	71 lb in
Transmission Bolt	50 N·m	37 lb ft
Transmission Mount Bolt	60 N·m	44 lb ft

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	Service Part Number
Case to Case	Sealant	89020326
Service Hole Plug	Pipe Sealant	12346004
Shift and Select Lever Bolt	Threadlocker	12345382
Shift Fork Bolts	Threadlocker	12345382
Shift Shaft Detent Plug	Pipe Sealant	12346004
Transmission Fluid	SAE 75W-90 (GL-5)	9220247

Lubrication Specifications

Application	Specification	
	Metric	English
Manual Transmission Fluid	1.8 liters	1.9 quarts

Transmission Clearance Specifications

Table 1: Gear Axial Clearance

Table 2: Gear Radial Clearance

Table 3: Output Shaft

Table 4: Input Shaft Bearing Journals - Minimum Diameter

Table 5: Countershaft Bearing Journals - Minimum Diameter

Table 6: Synchronizer Blocker Ring to Gear - Minimum Clearance

Table 7: Synchronizer Sleeve to Shift Fork - Maximum Clearance

Gear Axial Clearance

Application	Standard Clearance Metric	Standard Clearance English
1st Countershaft Gear	0.10-0.43 mm	0.0039-0.0169 in
2nd Countershaft Gear	0.10-0.43 mm	0.0039-0.0169 in
3rd Gear	0.09-0.52 mm	0.0035-0.0204 in
4th Gear	0.12-0.38 mm	0.0047-0.0150 in
6th Gear	0.20-0.49 mm	0.0079-0.0193 in
Reverse Countershaft Gear	0.125-0.375 mm	0.0049-0.0148 in
Reverse Idler Gear	0.10-0.55 mm	0.0039-0.0216 in

Gear Radial Clearance

Application	Standard Clearance Metric	Standard Clearance English
1st Countershaft Gear	0.015-0.067 mm	0.0006-0.0026 in
2nd Countershaft Gear	0.015-0.067 mm	0.0006-0.0026 in
3rd Gear	0.015-0.067 mm	0.0006-0.0026 in
4th Gear	0.015-0.067 mm	0.0006-0.0026 in
6th Gear	0.015-0.065 mm	0.0006-0.0025 in
Reverse Countershaft Gear	0.015-0.065 mm	0.0006-0.0025 in
Reverse Idler Gear	0.015-0.050 mm	0.0006-0.0020 in

Output Shaft

Application	Specification	
	Metric	English
Flange Thickness - Maximum	11.3 mm	0.4449 in
Runout - Maximum	0.136 mm	0.0053 in

Input Shaft Bearing Journals - Minimum Diameter

Application	Specification	
	Metric	English
3rd Gear	44.985 mm	1.7710 in
4th Gear	44.985 mm	1.7710 in

6th Gear	41.985 mm	1.6529 in

Countershaft Bearing Journals - Minimum Diameter

Application	Specification	
	Metric	English
1st Countershaft Gear Bearing	47.985 mm	1.8891 in
2nd Countershaft Gear Bearing	53.985 mm	2.1254 in
Reverse	44.985 mm	1.7710 in
Reverse Idler Gear	27.937 mm	1.0999 in

Synchronizer Blocker Ring to Gear - Minimum Clearance

Application	Specification	
	Metric	English
1st, 2nd	0.88 mm	0.035 in
3rd	0.8 mm	0.031 in
4th, 5th, 6th	0.7 mm	0.027 in
Reverse	0.9 mm	0.035 in

Synchronizer Sleeve to Shift Fork - Maximum Clearance

Application	Specification	
	Metric	English
1st/2nd	0.35 mm	0.014 in
3rd/4th, 5th/6th, Reverse	0.84 mm	0.033 in

1st and 2nd Gear Synchronizer Retaining Ring Specifications

Mark	Thickness (mm)	Thickness (in)
A	2.28-2.33	0.0898-0.0917
B	2.33-2.38	0.0917-0.0937
C	2.38-2.43	0.0937-0.0957
D	2.43-2.48	0.0957-0.0976
E	2.48-2.53	0.0976-0.0996
F	2.53-2.58	0.0996-0.1016
G	2.58-2.63	0.1016-0.1035

3rd and 4th Gear Synchronizer Retaining Ring Specifications

Mark	Thickness (mm)	Thickness (in)
A	1.80-1.85	0.0709-0.0728
B	1.85-1.90	0.0728-0.0748
C	1.90-1.95	0.0748-0.0768
D	1.95-2.00	0.0768-0.0787
E	2.00-2.05	0.0787-0.0807
F	2.05-2.10	0.0807-0.0827
G	2.10-2.15	0.0827-0.0846

5th Gear Synchronizer Retaining Ring Specifications

Mark	Thickness (mm)	Thickness (in)
A	2.10-2.15	0.0827-0.0846
B	2.15-2.20	0.0846-0.0866
C	2.20-2.25	0.0866-0.0886
D	2.25-2.30	0.0886-0.0906
E	2.30-2.35	0.0906-0.0925
F	2.35-2.40	0.0925-0.0945
G	2.40-2.45	0.0945-0.0965

6th Gear Retaining Ring Specifications

Mark	Thickness (mm)	Thickness (in)
A	2.07-2.12	0.0815-0.0835
B	2.12-2.17	0.0835-0.0854
C	2.17-2.22	0.0854-0.0874
D	2.22-2.27	0.0874-0.0894
E	2.27-2.32	0.0894-0.0913
F	2.32-2.37	0.0913-0.0933

Countershaft Front and Rear Bearing Retaining Ring Specifications

Mark	Thickness (mm)	Thickness (in)
A	2.35-2.40	0.0925-0.0945
B	2.40-2.45	0.0945-0.0965
C	2.45-2.50	0.0965-0.0984
D	2.50-2.55	0.0984-0.1004
E	2.55-2.60	0.1004-0.1024
F	2.60-2.65	0.1024-0.1043
G	2.65-2.70	0.1043-0.1062
H	2.70-2.75	0.1062-0.1083
J	2.75-2.80	0.1083-0.1102
K	2.80-2.85	0.1102-0.1122
L	2.85-2.90	0.1122-0.1142
M	2.90-2.95	0.1142-0.1161

Input Shaft Bearing Retaining Ring Specifications

Mark	Thickness (mm)	Thickness (in)
A	2.65-2.70	0.1043-0.1062
B	2.70-2.75	0.1062-0.1083
C	2.75-2.80	0.1083-0.1102
D	2.80-2.85	0.1102-0.1122
E	2.85-2.90	0.1122-0.1142
F	2.90-2.95	0.1142-0.1161

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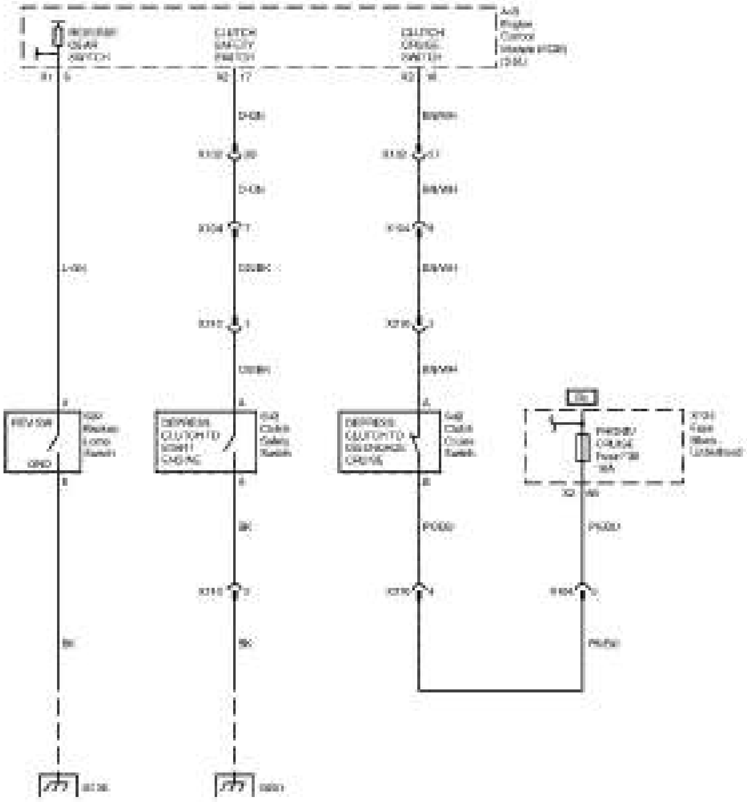
Manual Transmission Schematics

Back up Lamp and Clutch Switches


REVERSE GEAR SWITCH
CLUTCH SAFETY SWITCH
CLUTCH CRUISE SWITCH
Engine Control Module (ECM)
REV SW
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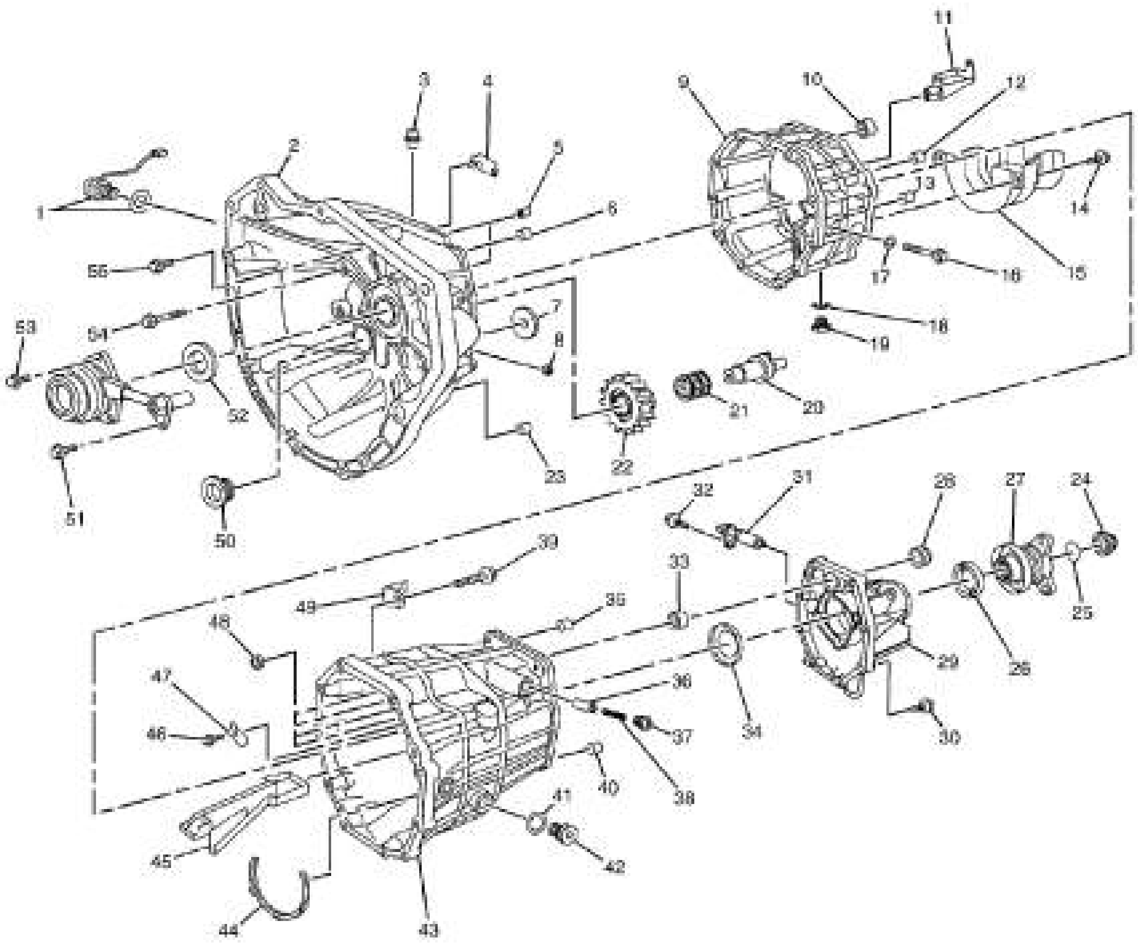
DEPRESS CLUTCH TO START ENGINE
DEPRESS CLUTCH TO DISENGAGE CRUISE
Clutch Safety Switch
Clutch Cruise Switch
BK
BK

Case Components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(1) Backup Lamp Switch Assembly
(2) Transmission Front Case
(3) Vent Assembly
(4) Input Shaft Bearing Oil Shield
(5) Transmission Case Locating Pin
(6) Select Control Lever Bracket Pin
(7) Input Shaft Bearing Oil Slinger - Front
(8) Transmission Case Hole Plug
(9) Transmission Intermediate Case
(10) Shift Shaft Bearing Assembly
(11) Oil Trough

(12) Transmission Rear Case Locating Pin
(13) Transmission Rear Case Locating Pin
(14) Transmission Intermediate Case Oil Trough Bolt
(15) Transmission Intermediate Case Oil Trough
(16) Reverse Idler Gear Shaft Retainer Bolt
(17) Reverse Idler Gear Shaft Bolt Gasket
(18) Oil Drain Plug Gasket
(19) Oil Drain Plug
(20) Reverse Idler Gear Shaft
(21) Reverse Idler Gear Bearing Assembly
(22) Reverse Idler Gear
(23) Transmission Case Intermediate Locating Pin
(24) Propshaft Transmission Flange Nut
(25) Propshaft Transmission Flange Thrust Washer
(26) Rear Output Shaft Seal Assembly
(27) Propshaft Transmission Flange Assembly
(28) Shift Control Shaft Seal
(29) Transmission Extension
(30) Transmission Extension Bolt
(31) Output Sensor Assembly
(32) Vehicle Speed Sensor Bolt
(33) Shift Shaft Bearing Assembly
(34) Main Shaft Bearing Rear Oil Slinger
(35) Transmission Extension Locating Pin
(36) Shift Shaft Detent Pin
(37) Shift Shaft Detent Plug
(38) Shift Shaft Detent Spring
(39) Backup Switch Bracket Bolt/Screw
(40) Transmission Extension Locating Pin
(41) Oil Fill Plug Gasket
(42) Oil Fill Plug
(43) Transmission Rear Case
(44) Transmission Rear Case Oil Trough Gasket
(45) Transmission Rear Case Oil Trough
(46) Counter Gear Bearing Retainer Bolt/Screw
(17) Counter Gear Bearing Retainer
(48) Shift Shaft Bushing
(49) Backup Lamp Switch Retainer
(50) Clutch Housing Hole Plug
(51) Clutch Actuator Bolt
(52) Input Shaft Seal
(53) Clutch Actuator Bolt
(54) Transmission Intermediate Case Bolt
(55) Transmission Intermediate Case Bolt

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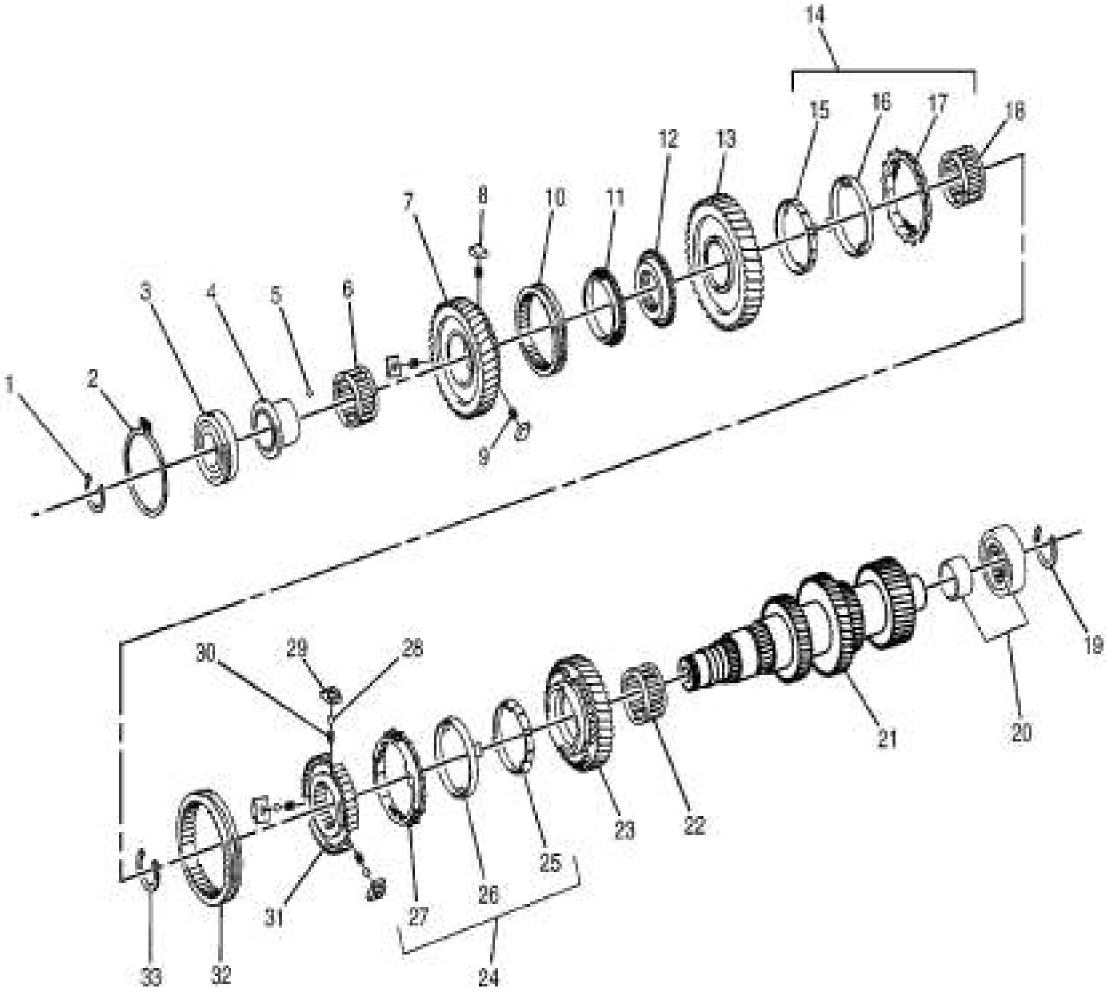
Countershaft Components



(1) Counter Gear Front Bearing Retainer Ring
(2) Counter Gear Front Bearing Retainer
(3) Counter Gear Front Bearing Assembly
(4) Reverse Gear Bearing Bushing w/Thrust Washer
(5) Reverse Gear Thrust Washer Locking Ball
(6) Reverse Gear Bearing Assembly
(7) Reverse Gear
(8) Reverse Gear Synchronizer Insert
(9) Reverse Gear Synchronizer Spring
(10) Reverse Gear Synchronizer Sleeve
(11) Reverse Gear Blocking Ring

(12) Reverse Drive Gear
(13) 1st Gear
(14) 1st Gear Blocking Ring Set
(15) 1st Gear Synchronizer Inner Cone
(16) 1st Gear Synchronizer Outer Cone
(17) 1st Gear Outer Blocking Ring
(18) 1st Gear Bearing Assembly
(19) Counter Gear Rear Bearing Retainer Ring
(20) Counter Gear Rear Bearing Assembly
(21) Counter Gear
(22) 2nd Gear Bearing Assembly
(23) 2nd Gear
(24) 2nd Gear Blocking Ring Set
(25) 2nd Gear Synchronizer Inner Cone
(26) 2nd Gear Synchronizer Outer Cone
(27) 2nd Gear Outer Blocking Ring
(28) 1st/2nd Gear Synchronizer Detent Ball
(29) 1st/2nd Gear Synchronizer Insert
(30) 1st/2nd Gear Synchronizer Spring
(31) 1st/2nd Gear Synchronizer Hub
(32) 1st/2nd Gear Synchronizer Sleeve
(33) 1st/2nd Gear Synchronizer Retaining Ring

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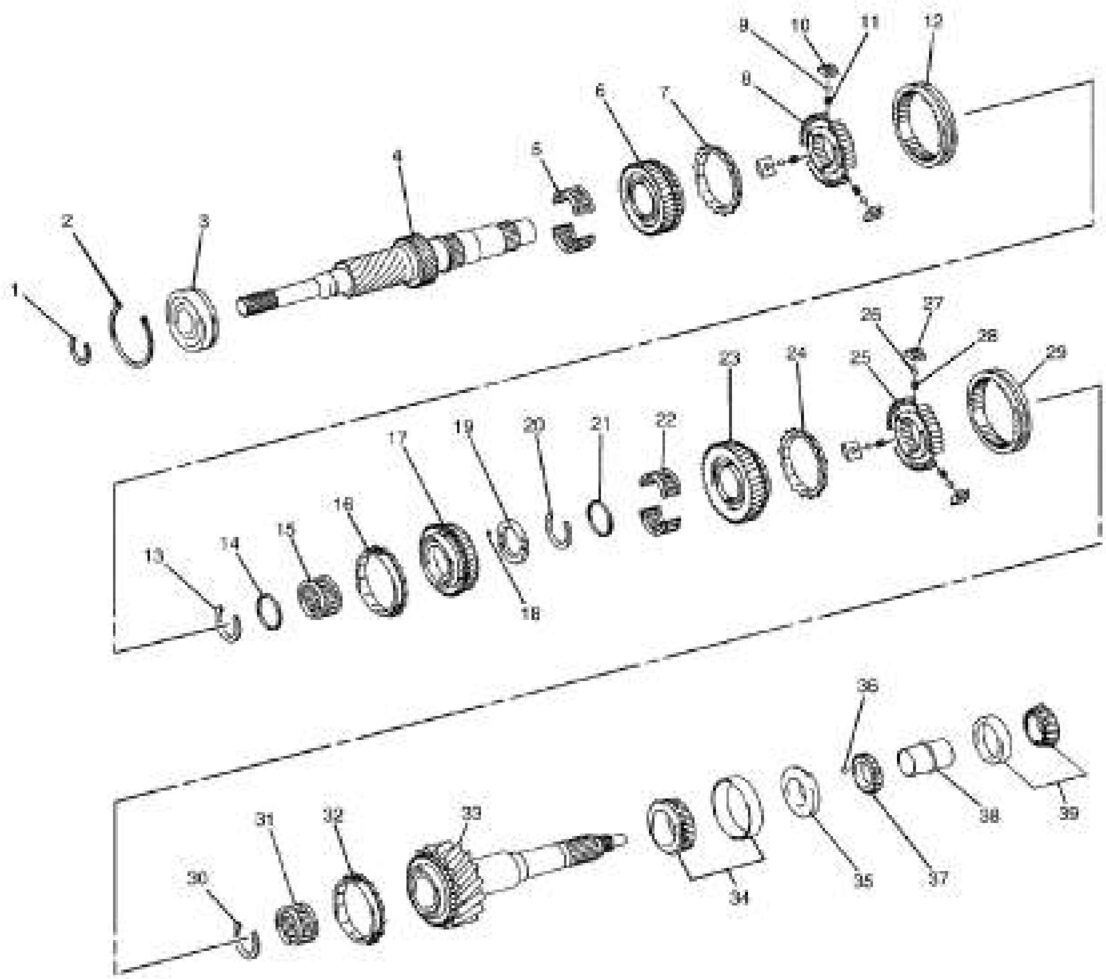
Input Shaft Components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(1) Input Shaft Bearing Retainer
(2) Input Shaft Bearing Retainer Ring
(3) Input Shaft Bearing Assembly
(4) Input Shaft
(5) 4th Gear Bearing Assembly
(6) 4th Gear
(7) 4th Gear Blocking Ring
(8) 3rd/4th Gear Synchronizer Hub
(9) 3rd/4th Gear Synchronizer Detent Ball
(10) 3rd/4th Gear Synchronizer Insert
(11) 3rd/4th Gear Synchronizer Spring

(12) 3rd/4th Gear Synchronizer Sleeve
(13) 3rd Gear Retaining Ring
(14) 3rd/4th Gear Spacer
(15) 3rd Gear Bearing Assembly
(16) 3rd Gear Blocking Ring
(17) 3rd Gear
(18) Gear Thrust Washer Locating Pin
(19) 3rd Gear Thrust Washer
(20) 6th Gear Retaining Ring
(21) 6th Gear Bearing Spacer
(22) 6th Gear Bearing Assembly
(23) 6th Gear
(24) 6th Gear Blocking Ring
(25) 5th/6th Gear Synchronizer Hub
(26) 5th/6th Gear Synchronizer Detent Ball
(27) 5th/6th Gear Synchronizer Insert
(28) 5th/6th Gear Synchronizer Spring
(29) 5th/6th Gear Synchronizer Sleeve
(30) 5th/6th Gear Synchronizer Hub Retaining Ring
(31) Input Shaft Bearing
(32) 5th Gear Blocking Ring
(33) Rear Output Shaft
(34) Rear Output Shaft Front Bearing Assembly
(35) Main Shaft Bearing Oil Slinger
(36) Speedometer Drive Gear Locking Ball
(37) Vehicle Speed Sensor Drive Gear
(38) Rear Output Shaft Rear Bearing Spacer
(39) Rear Output Shaft Roller Bearing Assembly

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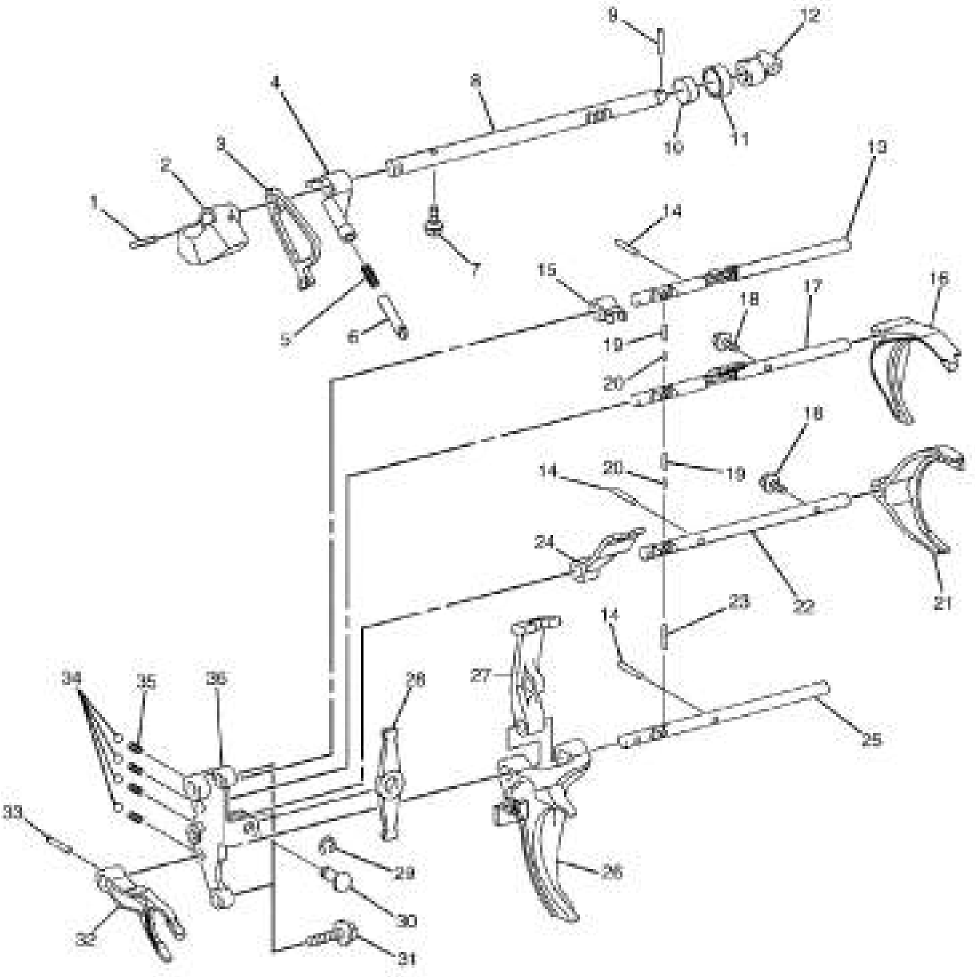
Shift Rail Components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(1) Slotted Spring Pin
(2) Dynamic Damper Weight
(3) Shift Shaft Detent Cam
(4) Shift Shaft Detent Lever
(5) Shift Shaft Detent Spring
(6) Shift Shaft Detent
(7) Shift Shaft Detent Lever Bolt
(8) Shift Control Shaft
(9) Shift Lever Pin
(10) Damper
(11) Select Shift Lever Retainer

(12) Shift Lever Rod Universal Joint Assembly
(13) 1st/2nd Shift Shaft
(14) Shift Fork Pin
(15) Selector Control Lever Assembly
(16) 3rd/4th Shift Fork Assembly w/Inserts
(17) 3rd/4th Shift Shaft
(18) Shift Fork Bolt
(19) Shift Shaft Interlocking Pin
(20) Shift Shaft Interlocking Pin
(21) 5th/6th Shift Fork Assembly w/Inserts
(22) 5th/6th Shift Shaft
(23) Shift Shaft Detent Roller
(24) Shift Lever Assembly
(25) Reverse Shift Shaft
(26) 1st/2nd Shift Fork Assembly w/Bushings
(27) Internal Shift Control Lever
(28) Control Selector Arm
(29) Selector Control Lever Pin Retainer
(30) Control Selector Arm Pin
(31) Shift Control Lever Bracket Bolt
(32) Reverse Shift Fork Assembly w/Inserts
(33) Reverse Shift Fork Pin
(34) Shift Detent Ball
(35) Shaft Detent Ball Spring
(36) Shift Control Lever Bracket

Diagnostic Starting Point - Manual Transmission

Begin the system diagnosis with Diagnostic System Check - Vehicle in Vehicle DTC Information. The Diagnostic System Check - Vehicle in Vehicle DTC Information, will provide the following information:

- The identification of the control module or modules which command the system.
- The ability of the control module or modules to communicate through the serial data circuit.
- The identification of any stored diagnostic trouble codes (DTCs) and the status of the codes.

Use the Diagnostic System Check - Vehicle in Vehicle DTC Information, in order to identify the correct procedure for diagnosing the system and where the procedure is located.

Diagnostic Trouble Code (DTC) Type Definitions

Diagnostic trouble codes (DTCs) are categorized into emissions and non-emissions related types. If a DTC is set, the malfunction indicator lamp (MIL) and failure data are utilized by the control module diagnostic executive according to the DTC type. Each DTC is set based upon the individual DTCs running and setting criteria. Read the Action Taken When the DTC Sets and Conditions for Clearing the MIL/DTC in the supporting text for taking appropriate action to each DTC.

Emissions Related DTCs

Type A

The following actions occur at the time of the first failure:

- The MIL is turned ON.
- A DTC is stored in memory.
- The Freeze Frame/Failure Records are stored.
- The Failure Records are updated after the first failure of each ignition cycle.

Some Type A DTCs will not perform the above actions when the DTC first detects a failure. Two consecutive failures are required. This allows systems, such as evaporative emission (EVAP), to accurately identify what failure exists before setting a DTC and requesting MIL illumination.

Type B

The following actions occur at one of the following times:

- First failure:
  - The MIL is not turned ON.
  - A DTC is stored in memory as a Failed Last Test.
  - The Failure Records are stored.
- Second consecutive drive cycle with a failure:
  - The MIL is turned ON.
  - A DTC is stored in memory as a history DTC.
  - The Freeze Frame data is stored.
  - The Failure Records are stored.
- Second non-consecutive drive cycle with a failure:
  - The MIL is not turned ON.
  - A DTC is stored in memory as a Failed Last Test.
  - The Failure Records are stored.

Non-Emissions Related DTCs

Type C

The following actions occur at the time of a failure:

- The MIL does not turn ON.
- A DTC is stored in memory as a history DTC.
- The Failure Records are stored.
- The Failure Records are updated after the first failure of each ignition cycle.
- Some Type C DTCs may also cause an auxiliary service lamp to be illuminated, and/or display a message to the vehicle operator.

Type X

Actions did not occur. These DTCs are coded into the control module software, but will not run for one of the following reasons:

- The associated hardware is not installed with the vehicle emission package.
- The diagnostic is not required for the vehicle emission package.

DTC P0501 or P0502

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0501: Vehicle Speed Sensor (VSS) Performance

DTC P0502: Vehicle Speed Sensor (VSS) Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0502	P0502	--	P0501
Signal	P0502	P0502	P0502	P0501
Ground	--	P0502	--	P0501

Typical Scan Tool Information

Vehicle Speed Sensor Parameter

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine running, in gear, drive wheels rotating. *Parameter Normal Range:* Displays km/h (mph)			
Ignition Voltage	0 km/h (mph)	0 km/h (mph)	--
Signal	0 km/h (mph)	0 km/h (mph)	0 km/h (mph)
Ground	0 km/h (mph)	0 km/h (mph)	--

Circuit/System Description

Vehicle speed information is provided to the engine control module (ECM) by the vehicle speed sensor (VSS). The VSS consists of a hall-effect sensor mounted to the transmission case which interfaces with a rotor pressed onto the transmission output shaft. The hall-effect sensor contains a permanent magnet and a semiconductor plate to which ignition voltage is applied. As the output shaft spins, the rotor directs the field of the permanent magnet either toward or away from the plate. The VSS produces a frequency signal that is proportional to vehicle speed. The ECM converts the VSS signal to vehicle speed, displayed on the scan tool in kilometers per hour or miles per hour. The ECM also uses the VSS signal to generate the 4,000 pulses per mile vehicle speed signal used by the instrument cluster.

Conditions for Running the DTC

- The engine speed is greater than 1800 RPM for 3 seconds.
- The engine coolant temperature (ECT) is greater than 40°C (104°F).

Conditions for Setting the DTC

The VSS indicates a speed of less than 0 km/h (0 mph) for 4 seconds.

Action Taken When the DTC Sets

- P0501 and P0502 are Type B DTCs.
- The ECM disables cruise control.

Conditions for Clearing the MIL/DTC

P0501 and P0502 are Type B DTCs.

Diagnostic Aids

The battery must be fully charged and pass a battery test. Refer to Battery Inspection/Test.

Reference Information

Schematic Reference

Manual Transmission Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Transmission System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information.

Circuit / System Verification

1. Operate the vehicle on the road at 64 km/h (40 mph). Observe the transmission vehicle speed sensor parameter with a scan tool. The VSS signal should match the instrument panel speedometer indicator.
2. Operate the vehicle within the Conditions for Running the DTC, to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records.

Circuit / System Testing

1. Ignition OFF, disconnect the X2 harness connector at the ECM.
2. Disconnect the VSS harness connector.
3. Ignition OFF, test for less than 5 ohms of resistance between the ground circuit at the VSS harness connector terminal 3 and ground.

   If greater than the specified value, repair the open/high resistance condition.
4. Ignition ON, test for less than 1 V between the signal circuit terminal 1 and ground at the VSS harness connector.

   If greater than the specified value, test the signal circuit for a short to voltage.
5. Ignition ON, test for greater than 11 V between the ignition voltage circuit, at the VSS harness connector terminal 3, and ground.

   If less than the specified value, test the ignition voltage circuit for a short to ground or an open/high resistance.
6. Ignition ON, install a 3 A fused jumper wire between the ignition voltage circuit terminal 3 and the signal circuit terminal 1 at the VSS harness connector. Test for greater than 11 V at X2, terminal 43 of the ECM harness connector.

   If less than the specified value, test the VSS signal circuit for a short to ground, or an open/high resistance.
7. Remove the 3 A fused jumper wire.
8. Ignition ON, engine OFF, transmission in NEUTRAL.
9. Install a 3 A fused jumper wire between the ignition voltage circuit terminal 1 on the VSS harness connector and terminal 1 on the VSS. Connect a second jumper wire between the ground circuit terminal 2 on the VSS harness connector and terminal 2 on the VSS.
10. Test for greater than 0.15 V AC, at terminal 1 on the VSS sensor, while rotating the rear wheels by hand.

    If less than the specified value, replace the VSS.
11. If all circuits test normal, replace the ECM.

Component Testing

1. Remove the VSS sensor. Refer to Vehicle Speed Sensor Replacement.
2. Inspect and repair the VSS or the transmission for the following conditions:
   - Loose or damaged VSS
   - Excessive VSS to rotor gap

- Incorrect VSS rotor alignment
- Loose or damaged VSS rotor

Repair Instructions

- Vehicle Speed Sensor Replacement
- Engine Control Module Programming and Setup
- Engine Control Module Replacement

Repair Verifications

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

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DTC P0806

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0806: Clutch Pedal Position (CPP) Sensor Circuit Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
CPP Sensor Signal	P0807	P0807	P0808	P0806
CPP Sensor 5 V Reference	P0651, P0807	P0807	P0651, P0808	--
CPP Sensor Low Reference	--	P0808	P0808	--

Typical Scan Tool Information

CPP Sensor Voltage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON. *CPP Sensor Voltage Parameter Normal Range:* 0-volts with clutch pedal applied to 5 V when clutch pedal is released.			
CPP Sensor 5 V Reference	0 V	0 V	5 V
CPP Sensor Signal	0 V	0 V	5 V
CPP Sensor Low Reference	--	5 V	--

CPP Sensor Percentage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON. *CPP Sensor Percent Parameter Normal Range:* 0% with clutch pedal released to 100% when clutch pedal is applied.			
CPP Sensor 5 V Reference	100%	100%	0-100%
CPP Sensor Signal	100%	100%	100%

CPP Sensor Low Reference	--	0%	--

Circuit/System Description

The clutch pedal position (CPP) sensor is a three wire sensor, connected to a 5 V reference circuit, a low reference circuit, and a signal circuit. The engine control module (ECM) supplies 5 V to the CPP sensor, and also provides a sensor ground path on the low reference circuit. The CPP sensor sends a voltage signal to the ECM on the signal circuit. The voltage on the signal circuit will vary from a voltage less than or equal to 5 V when the clutch pedal is released, to a voltage less than or equal to 1.5 V when the clutch pedal is applied.

Conditions for Running the DTC

DTCs P0335, P0336, P0502, P0503, P0607, P0808, or P080A are not set.

Conditions for Setting the DTC

The CPP sensor is stuck in range.

Action Taken When the DTC Sets

P0806 is a Type A DTC.

Conditions for Clearing the MIL/DTC

P0806 is a Type A DTC.

Reference Information

Schematic Reference

Manual Transmission Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Transmission System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool CPP sensor percent parameter. The percentage should vary from 0% when the clutch pedal is released, to 100% when the clutch pedal is in the apply position.
2. Perform the CPP learn procedure. Refer to Clutch Pedal Position Sensor Learn.
3. Operate the vehicle within the conditions for running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector of the CPP sensor.
2. Ignition ON, observe the scan tool CPP sensor voltage parameter for 0.1-volt.

   If less than the specified value, replace the CPP sensor.

   If greater than the specified value, replace the ECM.

Component Testing

1. Ignition OFF, disconnect the harness connector of the CPP sensor.
2. Measure the resistance between the signal terminal B and the low reference terminal A of the CPP sensor. Sweep the CPP sensor through the entire range. The resistance should vary low to high and high to low without any spikes or dropouts.

   If the resistance is erratic with spikes or dropouts, replace the CPP sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Clutch Pedal Replacement
- Engine Control Module Replacement
- Engine Control Module Programming and Setup

DTC P0807 or P0808

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0807: Clutch Pedal Position (CPP) Sensor Circuit Low Voltage

DTC P0808: Clutch Pedal Position (CPP) Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
CPP Sensor Signal	P0807	P0807	P0808	P0806
CPP Sensor 5 V Reference	P0651, P0807	P0807	P0651, P0808	--
CPP Sensor Low Reference	--	P0808	P0808	--

Typical Scan Tool Information

CPP Sensor Voltage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON. *CPP Sensor Voltage Parameter Normal Range:* 0 V with clutch pedal applied to 5 V when clutch pedal is released.			
CPP Sensor 5 V Reference	0 V	0 V	5 V
CPP Sensor Signal	0 V	0 V	5 V
CPP Sensor Low Reference	--	5 V	--

CPP Sensor Percentage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON. *CPP Sensor Percentage Parameter Normal Range:* 0% with clutch pedal released to 100% when clutch pedal is applied.			
CPP Sensor 5 V Reference	100%	100%	0-100%

CPP Sensor Signal	100%	100%	100%
CPP Sensor Low Reference	--	0%	--

Circuit/System Description

The clutch pedal position (CPP) is a three wire sensor, connected to a 5 V reference circuit, a low reference circuit, and a signal circuit. The engine control module (ECM) supplies 5 V to the CPP sensor, and also provides a sensor ground path on the low reference circuit. The CPP sensor sends a voltage signal to the ECM on the signal circuit. The voltage on the signal circuit will vary from a voltage less than or equal to 5 V when the clutch pedal is released to a voltage less than or equal to 1.5 V when the clutch pedal is applied.

Conditions for Running the DTC

- DTCs P0641 or P0651 are not set.
- The system voltage is more than 9 volts.
- The ignition is in the RUN position.

Conditions for Setting the DTC

P0807

The CPP sensor voltage is less than 0.1 V for more than 1 second.

P0808

The CPP sensor voltage is more than 5.2 V for more than 1 second.

Action Taken When the DTC Sets

P0807 and P0808 are Type A DTCs.

Conditions for Clearing the MIL/DTC

P0807 and P0808 are Type A DTCs.

Reference Information

Schematic Reference

Manual Transmission Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Transmission System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. If DTC P0641 or P0651 is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. Ignition ON, observe the scan tool CPP sensor percent parameter. The percentage should vary from 0 percent when the clutch pedal is released, to 100 percent when the clutch pedal is in the apply position.
3. Perform the CPP learn procedure. Refer to Clutch Pedal Position Sensor Learn.
4. Operate the vehicle within the conditions for running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector of the CPP sensor.
2. Ignition OFF, test for less than 1 ohms between the low reference circuit terminal A and the negative post of the battery.

   If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal C and ground.

   If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

   If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Ignition ON, verify that the scan tool CPP sensor parameter is less than 0.1 V.

   If greater than the specified value, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
5. Install a 3 A fused jumper wire between the signal circuit terminal B and the 5 V reference circuit terminal C. Verify that the scan tool CPP sensor parameter is between 4.8-5.2 V.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
6. If all circuits test normal, test or replace the CPP sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector of the CPP sensor.
2. Measure the resistance between the signal terminal B and the low reference terminal A of the CPP sensor. Sweep the CPP sensor through the entire range. The resistance should vary low to high and high to low without any spikes or dropouts.

   If the resistance is erratic with spikes or dropouts, replace the CPP sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Clutch Pedal Replacement
- Engine Control Module Replacement
- Engine Control Module Programming and Setup

DTC P080A

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P080A: Clutch Pedal Position (CPP) Not Learned

Circuit/System Description

The clutch pedal position (CPP) is a three wire sensor, connected to a 5 V reference circuit, a low reference circuit, and a signal circuit. The engine control module (ECM) supplies 5 V to the CPP sensor, and also provides a sensor ground path on the low reference circuit. The CPP sensor sends a voltage signal to the ECM on the signal circuit. The voltage on the signal circuit will vary from a voltage less than or equal to 5 V when the clutch pedal is released to a voltage less than or equal to 1.5 V when the clutch pedal is applied.

Conditions for Running the DTC

Clutch pedal fully applied.

Conditions for Setting the DTC

Clutch pedal position not learned.

Action Taken When the DTC Sets

P080A is a Type B DTC.

Conditions for Clearing the MIL/DTC

P080A is a Type B DTC.

Reference Information

Schematic Reference

Manual Transmission Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Transmission System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

Perform the clutch pedal position sensor learn procedure Refer to Clutch Pedal Position Sensor Learn.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Clutch Pedal Position Sensor Learn
- Engine Control Module Replacement
- Engine Control Module Programming and Setup

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Clutch Pedal Position Sensor Learn

Important: The clutch pedal position (CPP) sensor learn procedure is required when the following service procedures have been performed regardless of whether DTC P080A is set:

- An engine control module (ECM) replacement
- A CPP sensor replacement
- Any repairs which affect the CPP sensor relationship

1. Install a scan tool.
2. Monitor the ECM for DTCs with a scan tool. If other DTCs are set, except DTC P080A, refer to Diagnostic Trouble Code (DTC) List - Vehicle for the applicable DTC that set.
3. With a scan tool, select Clutch Pedal Position Learn under Module Setup in Manual Transmission, and perform the following instructions displayed on the scan tool screen.

   Important: The CPP sensor learn procedure cannot be performed more than once per ignition cycle. The clutch pedal needs to be fully depressed and held steady throughout this procedure in order to perform a correct learning.

4. The scan tool will display under CPP Learn Status: Not Learned, In Process, Complete, Fail - Low Volt, Fail - High Volt, or Fail Moving. The scan tool will display under CPP Learn Status Complete if the process was successful.
5. If the scan tool indicates that DTC P080A ran and passed this ignition the CPP sensor learn procedure is complete. If the scan tool indicates DTC P080A failed or did not run this ignition, refer to DTC P080A. If any other DTC is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle for the applicable DTC.
6. Turn OFF the ignition for 30 seconds after the learn procedure has successfully completed in order to store the CPP sensor variation values in ECM history.

Symptoms - Manual Transmission

Strategy Based Diagnostics

Review the system operations in order to familiarize yourself with the system functions. Refer to Transmission System Description and Operation .

Visual/Physical Inspection

- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect the manual transmission for the correct fluid level.
- Inspect the manual transmission for fluid leaks.
- Inspect the manual transmission for broken or loose transmission mounts.
- Inspect the shifter for damage or excessive freeplay.

Intermittent

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating properly.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Transmission Shifts Hard .
- Transmission Gear Clash When Shifting Gears .
- Transmission Noisy .
- Transmission Does Not Shift into One Gear .
- Transmission Locked in One Gear .
- Transmission Jumps Out of Gear .
- Transmission Clunk on Acceleration or Deceleration .
- Transmission Fluid Leak Diagnosis .

Transmission Clunk on Acceleration or Deceleration

Diagnostic Aids

All manual transmissions and axles have gear play that might cause a clunk. If the transmission is suspected of causing the clunk, compare it with a similar vehicle. An internal clunk in the transmission is the natural response of the driveline to an impact, but may also be caused by improper assembly, which would also cause other symptoms.

Step	Action	Yes	No
DEFINITION: A clunk is heard and/or felt on acceleration or deceleration.			
1	Did you review the Symptoms - Manual Transmission, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Manual Transmission .
2	Inspect the engine mounts for being loose or damaged. Refer to Engine Mount Inspection in Engine Mechanical - 3.6L (LY7). Did you find and repair the condition?	Go to Step 7	Go to Step 3
3	Inspect the transmission mounts for being loose or damaged. Refer to Transmission Mount Replacement . Did you find and repair the condition?	Go to Step 7	Go to Step 4
4	Inspect the transmission to engine fasteners for being loose or missing. Refer to Fastener Tightening Specifications . Did you find and repair the condition?	Go to Step 7	Go to Step 5
5	Inspect the driveline for causing the clunk. Refer to Diagnostic Starting Point - Propeller Shaft . Did you find and repair the condition?	Go to Step 7	Go to Step 6
6	Replace the transmission. Refer to Transmission Replacement . Is the replacement complete?	Go to Step 7	--
7	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 1

Transmission Does Not Shift into One Gear

Diagnostic Aids

If the transmission shifts into gear and then jumps out of gear, refer to Transmission Jumps Out of Gear . If it is an intermittent condition, other driveline components may be faulty.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. This step is to confirm that the clutch is not slipping. During certain conditions, the clutch may slip, and feel as though the transmission is not in gear.

3. A static shift test is performed by shifting into all gears with the engine not operating. While performing the test, you should note how the shift lever movement feels. Also, feel for the shift rails moving freely, the detent plungers operating when coming out of a gear and going in the next gear, and the synchronizer sleeve movement.

5. A dynamic shift test is performed by shifting into all gears with the engine operating. Test for the correct mesh of the synchronizers sleeve and the speed gear selector teeth. Move the shift lever and feel for the synchronizer sleeve to just release from the gear, then let up on the clutch pedal. Depress the clutch pedal and move the shift lever to re-engage that gear, to ensure full travel of the shift components.

Step	Action	Yes	No
DEFINITION: The shift lever will not move into a particular gear position, or when it is in a gear position, power is not delivered through the transmission.			
1	Did you review the Symptoms - Manual Transmission . Did you perform the necessary inspections?	Go to Step 2	Go to Symptoms - Manual Transmission
2	Inspect the clutch system for slipping. Refer to Clutch Slipping in Clutch. Is the clutch working properly?	Go to Step 3	Go to Clutch Assembly Replacement .
3	1. Perform a static shift test on the transmission. 2. Test for the following: • Blockage preventing full shift lever movement. • Excessive movement in the shift lever. • Binding in the shift lever. • Detent plungers or shift rails binding. • Synchronizer sleeve movement. Were you able to shift into the gear position that has the concern?	Go to Step 5	Go to Step 4

4	Remove the shifter and inspect for worn or faulty components Refer to Shift Control Assembly Replacement . Did you find and repair the condition?	Go to Step 7	Go to Step 5
5	1. Perform a dynamic shift test on the transmission. 2. Test for the following: • Detent plungers or shift rails binding. • Synchronizer sleeve binding. • Synchronizer sleeve engaging on the speed gear selector teeth. Were you able to shift into the gear position that has the concern?	Go to Step 7	Go to Step 6
6	Replace the transmission. Refer to Transmission Replacement . Is the replacement complete?	Go to Step 7	--
7	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 1

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Transmission Fluid Leak Diagnosis

Diagnostic Aids

Using the incorrect type of transmission fluid may affect the sealing ability of the seals. Ensure the use of the correct type of transmission fluid. The incorrect type of sealer may not be compatible with the transmission fluid or may not have the correct characteristics for sealing the affected components. Ensure the use of the correct type of sealers. Refer to Adhesives, Fluids, Lubricants, and Sealers in Manual Transmission - Aisin AY6.

Test Description

The number below refers to the step number on the diagnostic table.

5. Use an approved method to clean the transmission to ensure the leak location is correctly identified. If using a powder method or dye method ensure the products are compatible with the transmission fluid.

Step	Action	Yes	No
DEFINITION: Visible sign of the transmission fluid leaking from the transmission.			
1	Did you review the manual transmission symptoms and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Manual Transmission.
2	1. Inspect for the transmission fluid level higher than the recommended level. Refer to Transmission Fluid Level Inspection. 2. Adjust the transmission level if incorrect. Was the transmission fluid level too high?	Go to Step 25	Go to Step 3
3	Inspect the transmission vent for a blockage. Is the transmission vent blocked?	Go to Step 4	Go to Step 5
4	Repair or replace the transmission vent. Did you find and repair the condition?	Go to Step 25	Go to Step 5
5	Verify the location of the leak. 1. Clean the transmission assembly. 2. Operate the vehicle for 24 km (15 mi), or until normal operating temperatures are reached. 3. Visual inspect or use the powder method or dye and black light method to locate the leak. Is the leak occurring at the drain or fill plug?	Go to Step 6	Go to Step 7
6	Replace the drain or fill plug. Refer to Transmission Fluid Replacement. Did you find and repair the condition?	Go to Step 25	Go to Diagnostic Aids

7	Is the leak at the transmission output shaft seal?	Go to Step 8	Go to Step 9
8	Remove the mainshaft rear oil seal and inspect for the following. Refer to Mainshaft Rear Oil Seal Replacement. • Damaged or worn seal • Damaged seal bore • Improper installation • Cracks in the component • Output flange sealing surface is scratched, nicked, damaged, or worn • Loose or worn bearing causing excessive seal wear • Output flange nut loose Did you find and repair the condition?	Go to Step 25	Go to Diagnostic Aids
9	Is the leak at the shift rail area?	Go to Step 10	Go to Step 11
10	Inspect the shift rail seal for damage. Did you find and repair the condition?	Go to Step 25	Go to Diagnostic Aids
11	Is the leak at the front of the transmission?	Go to Step 12	Go to Step 15
12	1. Remove the transmission. Refer to Transmission Replacement. 2. Inspect the input shaft for leaking. 3. Remove the CSC assembly. Refer to Clutch Concentric Actuator Cylinder Replacement in Clutch. Did you find and repair the condition?	Go to Step 25	Go to Step 13
13	1. Inspect for the leak at the input shaft seal. 2. Inspect for the following if the input shaft seal is leaking: • Damaged or worn seal • Damaged seal bore • Improper installation • Cracks in the component • Input shaft sealing surface is scratched, nicked, damaged, or worn • Loose or worn bearing causing excessive seal wear 3. Replace the CSC assembly. Refer to Clutch Concentric Actuator Cylinder Replacement in Clutch.	Go to	

	Did you find and repair the condition?	Step 25	Go to Step 14
14	1. Inspect the case for cracks or porosity. 2. If cracks and or porosity are found replace the transmission. Refer to Transmission Replacement. Did you find and repair the condition?	Go to Step 25	Go to Diagnostic Aids
15	Is the leak at the vehicle speed sensor (VSS)?	Go to Step 16	Go to Step 17
16	1. Remove the VSS. Refer to Vehicle Speed Sensor Replacement. 2. Inspect for the following: • Cut or damaged O-ring seal • VSS over tightened causing deformation in the VSS • VSS bore scratched or damaged Did you find and repair the condition?	Go to Step 25	Go to Step 1
17	Is the leak at the backup light switch?	Go to Step 18	Go to Step 19
18	1. Remove the backup light switch. Refer to Backup Lamp Switch Replacement. 2. Inspect for the following: • Cross threaded or damaged threads • Insufficient sealant • Leaking switch • Improper installation Did you find and repair the condition?	Go to Step 25	Go to Step 1
19	Is the leak at the shift shaft plunger plug?	Go to Step 20	Go to Step 21
20	1. Remove the shift shaft detent plug. Refer to Transmission Disassemble and Transmission Assemble. 2. Inspect for the following: • Loose, not installed properly • Insufficient sealant • Cracked case • Improper installation Did you find and repair the condition?	Go to Step 25	Go to Step 1
21	Is the leak at the sealing flanges of the transmission cases?	Go to Step 22	Go to Step 23
	1. Remove the transmission. Refer to Transmission Replacement. 2. Disassemble the transmission. Refer to Transmission Disassemble.		

22	3. Inspect the sealing surfaces. Refer to Transmission Case Cleaning and Inspection. Did you find and repair the condition?	Go to Step 25	Go to Step 23
23	Is the leak coming from a crack or porosity in the transmission case?	Go to Step 24	Go to Diagnostic Aids
24	1. Remove the transmission. Refer to Transmission Replacement. 2. Disassemble the transmission. Refer to Transmission Disassemble. 3. Replace the faulty case. Refer to Transmission Assemble. Did you find and repair the condition?	Go to Step 25	Go to Diagnostic Aids
25	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 1

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Transmission Gear Clash When Shifting Gears

Diagnostic Aids

Gear clashing may be caused by shifting at too high of an engine RPM or by rushing the shift. If gear clashing is occurring in more than one gear, the clutch may not be releasing properly for proper synchronizer operation.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. This step tests for the proper releasing of the clutch. If the clutch reserve is not proper, the mainshaft gears may still be turning causing the gear clashing.

5. This step inspects for the proper transmission fluid. A special fluid is required for the correct lubrication of the synchronizers.

7. A static shift test is performed by shifting into all of the gear positions with the engine not operating. While performing the test, you should note how the shift lever movement is felt. Also, while shifting from one gear to another, feel for binding in the shift rails. You should be able to feel the detent plungers operating when coming out of a gear and going into a gear. Excessive play in the gear shift lever may prevent the shift forks from fully engaging the synchronizer.

9. A dynamic shift test is performed by shifting into all of the gear positions with the engine operating. Test for the correct mesh of the synchronizers, and for the clutch releasing correctly. Move the shift lever and feel for the synchronizer sleeve to just release from the gear, then let up on the clutch pedal. Depress the clutch pedal and move the shift lever to re-engage that gear. If it shifts back into the gear without clashing, the clutch is releasing correctly and the synchronizer is working. If clashing occurs, test on another gear. If all gears clash, the clutch is not releasing correctly.

Step	Action	Yes	No
DEFINITION: Noise from the transmission when shifting gears. A grinding or grating sound, when the synchronizer sleeve is engaging with the selector teeth on the speed gear. A suspected internal transmission condition, if the noise only occurs in one gear.			
1	Did you review the Symptoms - Manual Transmission, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Manual Transmission
2	With the engine operating, does the transmission shift from neutral to any gear, without the vehicle lurching or gear clashing?	Go to Step 5	Go to Step 3
3	Inspect for proper clutch operation. Refer to Clutch System Description and Operation in Clutch. Does the clutch operate properly?	Go to Step 5	Go to Step 4

4	Repair the clutch system. Refer to Symptoms - Clutch in Clutch. Did you find and repair the condition?	Go to Step 11	Go to Step 5
5	Inspect for the correct transmission fluid level and the proper fluid. Refer to Transmission Fluid Replacement. Is the transmission fluid level correct and at the proper level?	Go to Step 7	Go to Step 6
6	Fill the transmission to the correct level, or change the transmission fluid if it is not the correct type. Does the transmission still have gear clash?	Go to Step 7	Go to Step 11
7	1. Perform a static shift test on the transmission. 2. Test for the following: • Blockage preventing full shift lever movement. • Excessive movement in the shift lever. • Binding in the shift lever. • Detent plungers or shift rails binding. Did the transmission shift smoothly into the gear that is clashing?	Go to Step 9	Go to Step 8
8	Remove the shift lever and inspect for damage or worn components. Refer to Shift Control Assembly Replacement. Did you find and repair the condition?	Go to Step 11	Go to Step 9
9	1. Perform a dynamic shift test on the transmission. 2. Test for the following: • Detent plungers or shift rails binding. • Synchronizer sleeve binding. • Gear clashing in more than the suspected gear. Is the transmission hard to shift into all gears?	Go to Transmission Shifts Hard	Go to Step 10
10	Replace the transmission. Refer to Transmission Replacement. Is the replacement complete?	Go to Step 11	--
11	Operate the system and verify the repair. Did you correct the condition?	System OK	Go to Step 1

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Transmission Jumps Out of Gear

Diagnostic Aids

If the transmission jumps out of gear during deceleration, inspect the components that may allow for the gears or shafts to tip. If the gears or shafts tip, the synchronizer sleeve can disengage from the selector teeth on the speed gear. If the transmission jumps out of gear during acceleration, inspect the components that may not allow full engagement of the synchronizer sleeve to the selector teeth on the speed gear. Insufficient engagement of the selector teeth under torque may cause the transmission to jump out of gear.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. A static shift test is performed by shifting into all gear positions with the engine not operating. While performing the test, slowly move the shift lever. Feel for proper movement of the shift lever and transmission internal shift components.

4. A dynamic shift test is performed by shifting into all gear positions with the engine operating. Test for the correct mesh of the synchronizers sleeve and the speed gear selector teeth. Move the shift lever to NEUTRAL and then let up on the clutch pedal. Depress the clutch pedal and move the shift lever to re-engage the gear, to ensure full travel of the shift components.

5. This step inspects for worn or damaged transmission or engine mounts. Loose mounts may cause a shock on the transmission allowing for gear disengagement.

Step	Action	Yes	No
DEFINITION: Gear disengagement occurs during acceleration or deceleration.			
1	Did you review the Symptoms - Manual Transmission, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Manual Transmission.
2	1. Perform a static shift test. 2. Test for the following: • Blockage preventing full shift lever movement • Excessive movement in the shift lever • Detent plungers engaging in the shift rails • Synchronizer sleeve movement Did the transmission shift completely into all gears?	Go to Step 4	Go to Step 3
3	Remove the shifter and inspect for worn or faulty components. Refer to Shift Control Assembly Replacement. Did you find and repair the condition?	Go to Step 8	Go to Step 4

4	1. Perform a dynamic shift test on the transmission. 2. Test for the following: • Synchronizer sleeve engagement to the speed gear selector teeth • Detent plungers engaging in the shift rails Did the transmission shift completely into all gears?	Go to Step 5	Go to Step 7
5	Inspect the engine and/or transmission mounts. Refer to Transmission Mount Replacement. Did you find and repair the condition?	Go to Step 8	Go to Step 6
6	1. Align the housing, if required. 2. Tighten any loose housing bolts. Refer to Transmission Replacement. Did you find and repair the condition?	Go to Step 8	Go to Step 7
7	Replace the transmission. Refer to Transmission Replacement. Is the replacement complete?	Go to Step 8	--
8	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 1

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Transmission Locked in One Gear

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. This step is to ensure the use of the proper transmission fluid. A special fluid is used to ensure proper synchronizer operation, and for sufficient lubrication. Improper fluid may cause the synchronizers to stick or the transmission components to overheat.

4. A static shift test is performed by shifting into all gears with the engine not operating. By confirming that the transmission can be shifted into all positions, ensures that the shift lever is not excessively worn or damaged.

6. A dynamic shift test is performed by shifting into all of the gear positions with the engine operating. Test to ensure that the internal shift components are functioning properly.

Step	Action	Yes	No
DEFINITION: The transmission cannot be shifted out of a gear, or the vehicle will not move because the transmission is locked.			
1	Did you review the Symptoms - Manual Transmission, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Manual Transmission.
2	Inspect for the correct type of transmission fluid. Is the correct type transmission fluid being used?	Go to Step 4	Go to Step 3
3	Drain the transmission, and refill with the correct type of fluid. Refer to Transmission Fluid Replacement. Did you find and repair the condition?	Go to Step 8	Go to Step 4
4	1. Perform a static shift test on the transmission. 2. Test for the shift lever moving to all positions. Were you able to shift into all positions?	Go to Step 6	Go to Step 5
5	1. Remove the shifter. 2. Inspect for worn or faulty components. Refer to Shift Control Assembly Replacement. Did you find and repair the conditions?	Go to Step 8	Go to Step 6
6	1. Perform a dynamic shift test on the transmission. 2. Test for being able to shift in and out of the gear with the concern. Were you able to shift the transmission correctly?	Go to Step 8	Go to Step 7

7	Replace the transmission. Refer to Transmission Replacement. Is the replacement complete?	Go to Step 8	--
8	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 1

Transmission Noisy

Diagnostic Aids

If the vehicle is equipped with the 3.6L engine, the transmission is in neutral with the engine operating, and a whirling kind of a noise, neutral gear rattle, is heard outside the vehicle, this is a normal condition.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. This step inspects for vibration causing a noise.
5. This step inspects for the correct transmission fluid level. If the transmission fluid level is excessively low, damage may have occurred to the transmission components.
7. This step inspects for the correct type of transmission fluid. The transmission uses a special fluid. If the incorrect fluid was used, there may have been an overheating problem. Overheating may cause damage to the transmission components.
11. This step tests to determine if clutch components are making the noise. Depress the clutch pedal slowly and listen for the change in noise. If the noise changes while pressing the pedal, it may be a faulty clutch component. If the noise does not change until the clutch is completely disengaged, the transmission component is faulty. Improper sealing of the shifter may be allowing normal transmission noise to be heard by the driver.

Step	Action	Yes	No
DEFINITION: The transmission is making a noise. The different noises may be a whine or a growl from faulty bearings or gears. The noise may also be caused from a faulty component causing a vibration noise or rattle.			
1	Did you review the Symptoms - Manual Transmission. Did you perform the necessary inspections?	Go to Step 2	Go to Symptoms - Manual Transmission
2	Is the noise present at a certain road speed, or with a certain load?	Go to Step 3	Go to Step 4
3	Is the noise present in all gears?	Go to Step 5	Go to Step 4
4	Is the noise present in just one gear?	Go to Step 13	Go to Step 5
5	Inspect the transmission fluid level. Is the fluid level correct?	Go to Step 7	Go to Step 6
6	Add transmission fluid. Refer to Transmission Fluid Replacement. Did you find and repair the condition?	Go to Step 14	Go to Step 7

7	Inspect the transmission for the correct fluid type. Refer to Lubrication Specifications. Is the transmission fluid the correct type?	Go to Step 9	Go to Step 8
8	Drain and refill the transmission with the correct type fluid. Refer to Transmission Fluid Replacement. Did you find and repair the condition?	Go to Step 14	Go to Step 9
9	1. Inspect for engine to transmission alignment. 2. Inspect for loose transmission mounting bolts. Are there any loose transmission mounting bolts?	Go to Step 10	Go to Step 11
10	Replace and tighten the transmission mounting bolts. Refer to Transmission Mount Replacement. Is the noise still present?	Go to Step 11	Go to Step 14
11	With the engine operating, depress the clutch pedal. Is the noise still present?	Go to Step 12	Go to Step 13
12	1. Remove the clutch. Refer to Clutch Assembly Replacement in Clutch. 2. Inspect the following components for being the cause of the noise. • The release bearing. • The dual mass flywheel. • The pressure plate. • The clutch disc. • The engine crankshaft end play. Did you find and repair the condition?	Go to Step 14	Go to Step 13
13	Replace the transmission. Refer to Transmission Replacement. Is the replacement complete?	Go to Step 14	--
14	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 1

Transmission Shifts Hard

Diagnostic Aids

An intermittent hard shift may be caused by an intermittent clutch condition. With a self adjusting clutch, the clutch may be between adjustments and not give full clutch release. This might be felt by a low clutch pedal. After several applications, the clutch may adjust properly, to give the proper pedal feel.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. A static shift test is performed by shifting into all of the gear positions with the engine not operating. While performing the test one should note how the shift lever movement is felt. Also while shifting from one gear to the other feel for binding in the shift rails. You should be able to feel the detent plungers operating when coming out of a gear and going into a gear.

5. A dynamic shift test is performed by shifting into the gear positions with the engine operating. Test for the correct mesh of the synchronizers and for the clutch releasing correctly. When shifting into and out of a gear, feel for the shift detent plungers and for the synchronizers sleeve for moving freely.

7. The transmission uses a synthetic transmission fluid that allows proper synchronizer operation. The incorrect fluid may cause hard shifting by varnish build up, or not enough lubrication for proper synchronizer operation.

Step	Action	Yes	No
DEFINITION: The transmission does not shift smoothly, or without difficulty, from one gear to the other.			
1	Did you review the Symptoms - Manual Transmission, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Manual Transmission
2	Inspect the clutch system for proper operation. Refer to Clutch System Description and Operation in Clutch. Did you find or repair the condition?	Go to Step 11	Go to Step 3
3	1. Perform a static shift test on the transmission. 2. Test for the following: • Blockage preventing full shift lever movement. • Excessive movement in the shift lever. • Binding in the shift lever. • Detent plungers or shift rails binding. Are you able to shift into all gears?	Go to Step 5	Go to Step 4
	Remove the shifter and inspect for worn or faulty		

4	components. Refer to Shift Control Assembly Replacement. Did you find and repair the condition?	Go to Step 11	Go to Step 5
5	1. Perform a dynamic shift test on the transmission. 2. Test for the following: • Detent plungers or shift rails binding. • Synchronizer sleeve binding. • Gear clash into only one gear. • Gear clash into all gears. Did the transmission shift hard into all gears?	Go to Step 6	Go to Step 10
6	Inspect the transmission for the correct fluid level and type of the transmission fluid. Refer to Transmission Fluid Replacement. Is the transmission at the correct level and proper fluid being used?	Go to Step 8	Go to Step 7
7	Drain and refill the transmission with the correct type fluid. Refer to Transmission Fluid Replacement. Did you find and repair the condition?	Go to Step 11	Go to Step 8
8	1. Remove the transmission. Refer to Transmission Replacement. 2. Inspect the clutch pressure plate and/or clutch driven plate. Is the clutch pressure plate and/or clutch driven plate worn or faulty?	Go to Step 9	Go to Step 10
9	Replace the clutch assembly. Refer to Clutch Assembly Replacement in Clutch. Did you find and repair the condition?	Go to Step 11	Go to Step 10
10	Replace the transmission. Refer to Transmission Replacement. Is the replacement complete?	Go to Step 11	--
11	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 1

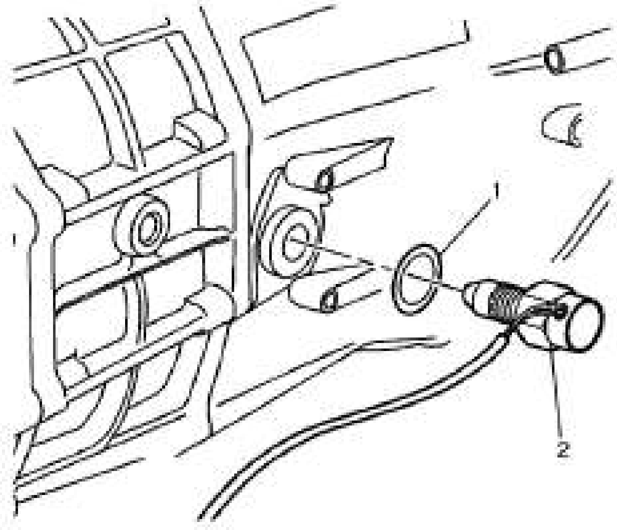
Backup Lamp Switch Replacement

Removal Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

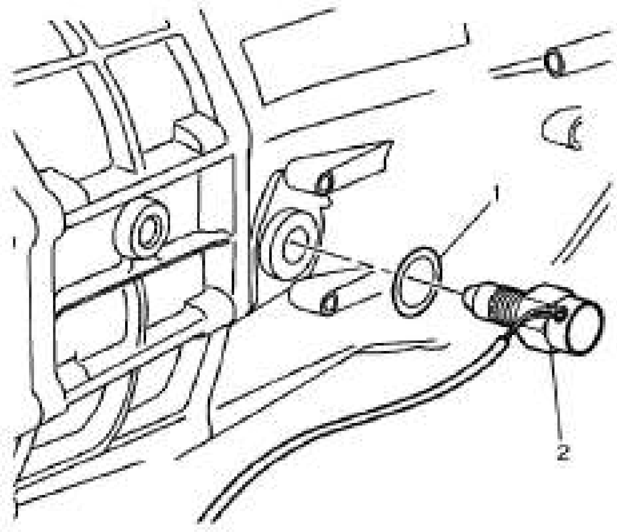
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



2. Disconnect the backup lamp switch electrical connector.
3. Using a suitable tool, remove the backup lamp switch (2) and washer (1) from the case. Discard the washer.

   Discard the washer.

Installation Procedure



1. Install a NEW washer (1) to the backup lamp switch.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the backup lamp switch (2) to the transmission.

   Tighten
   Tighten the switch to 44 N·m (32 lb ft).

3. Connect the backup lamp switch electrical connector.
4. Lower the vehicle.

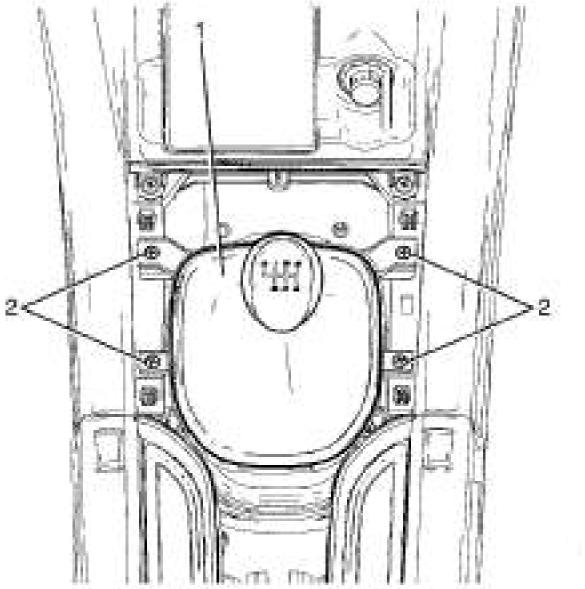
Control Lever and/or Boot Replacement

Removal Procedure

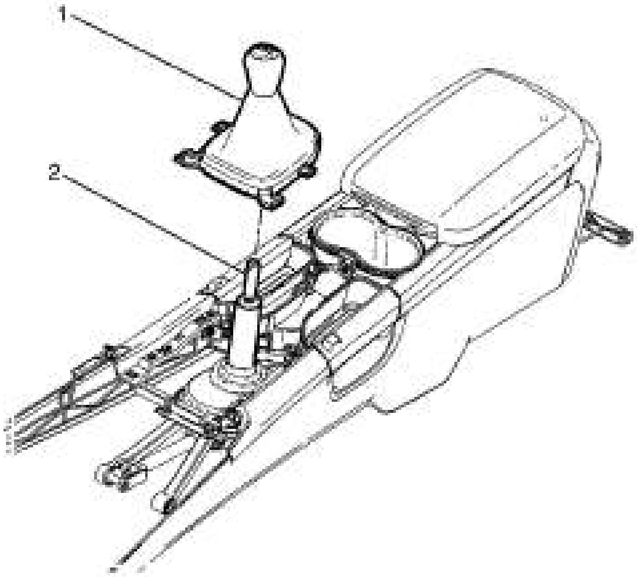
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Remove the trim plate. Refer to Console Trim Plate Replacement.

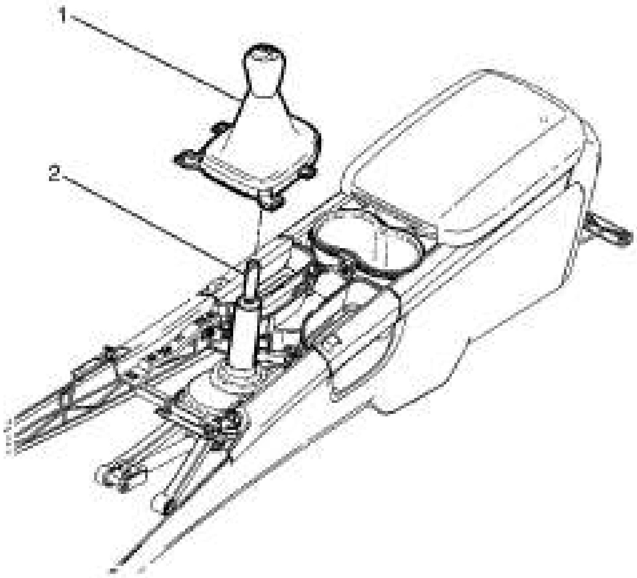


2. Remove the gearshift lever boot to front console retaining screws (2).

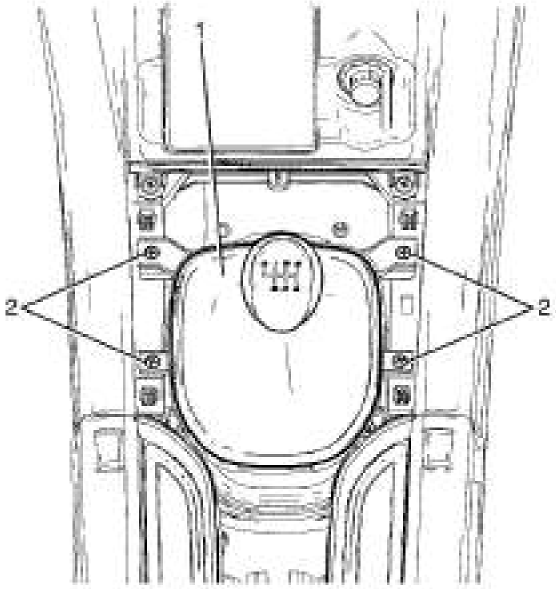


3. Lift the gearshift lever boot (1) enough to enable a firm grasp to be made on the gearshift lever (2) with the left hand, then grasp the gearshift knob with the right.
4. While rocking the knob sideways, and with an upward force applied, dislodge the knob retaining claws from the lever.
5. Remove the gearshift lever knob and boot assembly (1) from the gearshift lever.

Installation Procedure



1. Install the gearshift lever knob and boot assembly (1) to the gearshift lever.
2. Align the gearshift lever knob to the gearshift lever (2).
3. Apply pressure to the top of the gearshift knob to engage into the gearshift lever.



4. Install the gearshift lever boot to front console retaining screws (2).

Tighten
Tighten the bolts to 2 N·m (18 lb. in).

5. Install the trim plate. Refer to Console Trim Plate Replacement.

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Mainshaft Rear Oil Seal Replacement

Tools Required

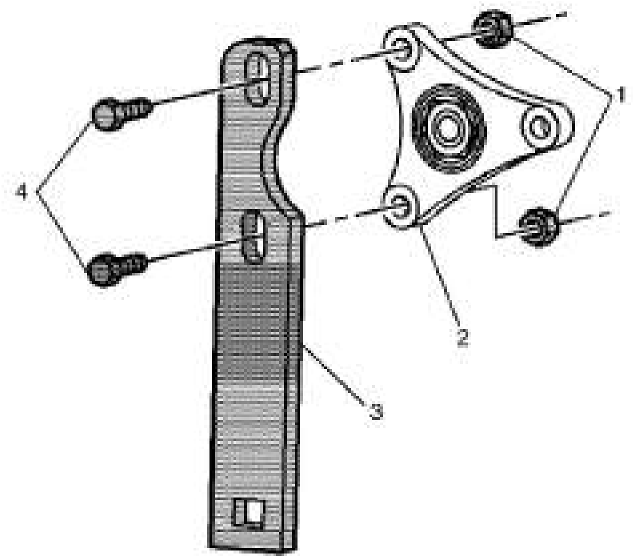
- J 6125-1B Slide Hammer
- J 23129 Universal Seal Remover
- J 29873 Injector Nozzle Socket 30 mm
- J 44765 Seal Installer
- J 45012 Holding Fixture
- J 45019 Flange and Pinion Gage Remover

Removal Procedure

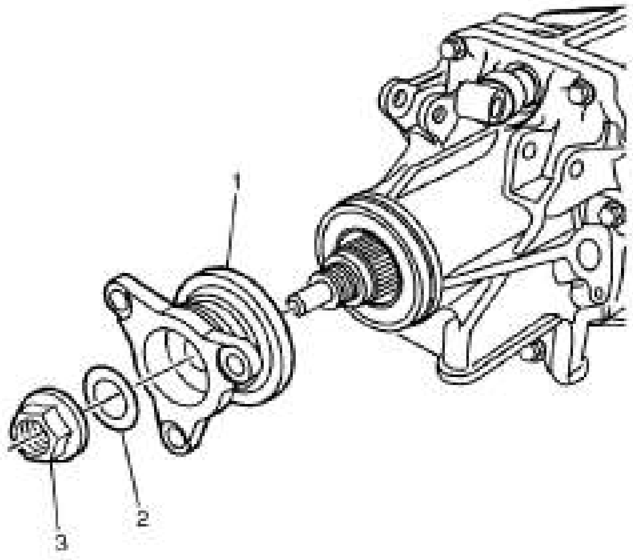
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the exhaust system. Refer to Exhaust System Replacement.
3. Remove the propeller shaft. Refer to Propeller Shaft Replacement.



4. Install the J 45012 to the drive flange (2).
5. While holding the J 45012 , remove the flange retaining nut using the J 29873 .
6. Remove the J 45012 .



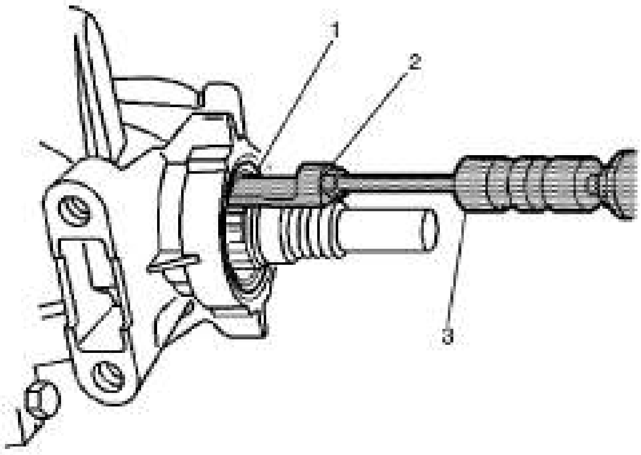
7. Remove the drive flange to output shaft retaining nut (1). The retaining nut must be discarded after removal.

   Discard the retaining nut.

8. Remove the drive flange thrust washer (2). The thrust washer must be discarded after removal

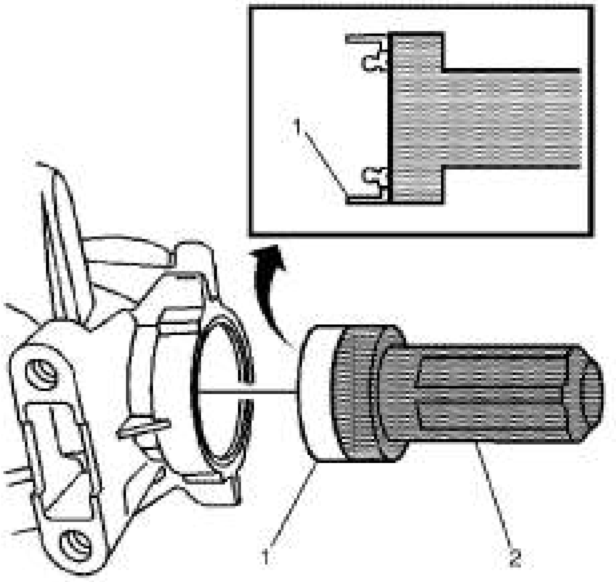
   Discard the thrust washer.

9. Remove the drive flange using the J 45019 .



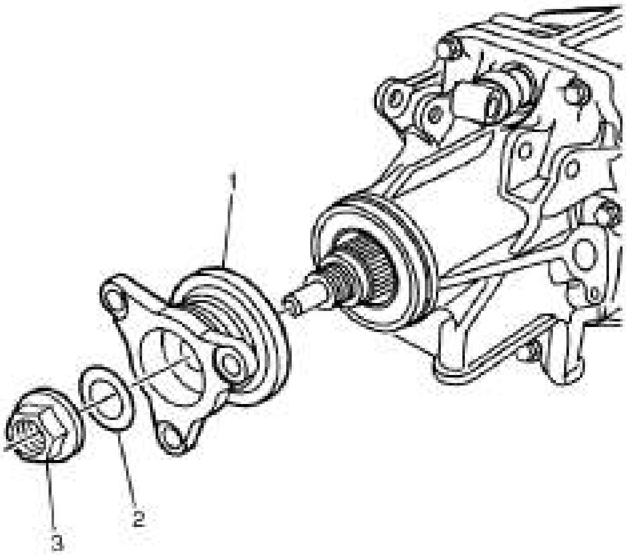
10. Use the J 6125-1B and J 23129 to remove the transmission case extension seal (1) from the transmission case extension.

Installation Procedure

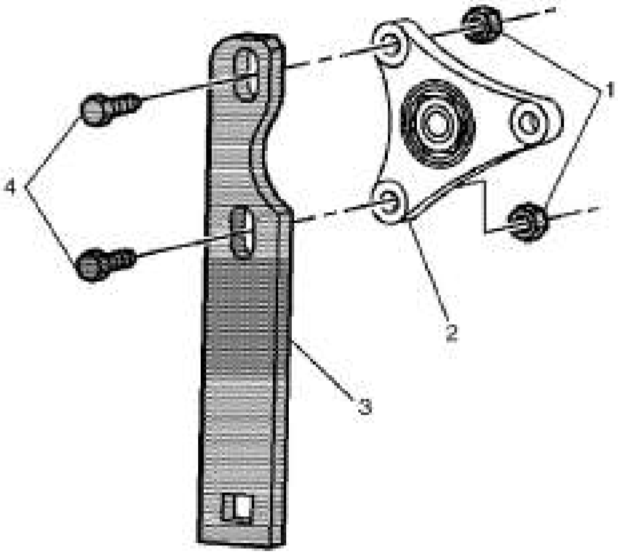


Important: Install the seal onto the tool before installing into the case to prevent damage to the seal.

1. Using J 44765 install the new transmission case extension seal (1).



2. Install the drive flange (1) to the transmission output shaft.
3. Install the thrust washer (2) to the transmission output shaft.
4. Install the NEW transmission output shaft to drive flange retaining nut (3).



5. Install the J 45012 to the drive flange.

   Notice: Refer to Fastener Notice in the Preface section.

6. While holding J 45012 , install a NEW drive flange retaining nut using J 29873 .

   Tighten
   Tighten the drive flange retaining nut to 57 N·m (42 lb ft).

7. Remove the J 45012 from the drive flange.
8. Install the propeller shaft. Refer to Propeller Shaft Replacement.
9. Install the exhaust system. Refer to Exhaust System Replacement.
10. Lower the vehicle.

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Shift Control Assembly Replacement

Tools Required

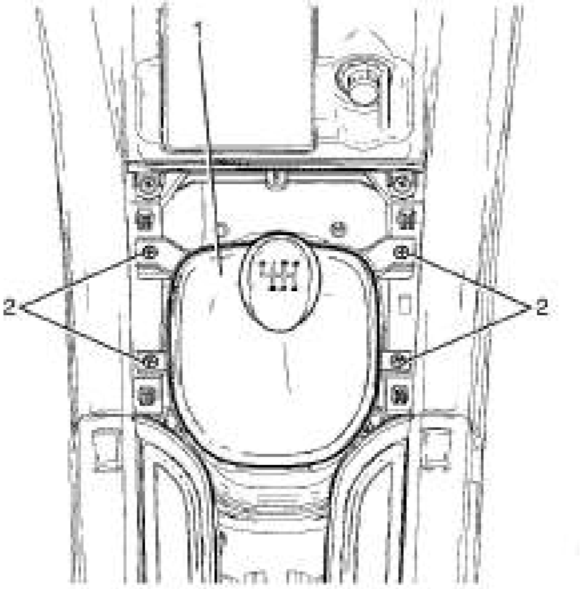
EN-48536 Frame Support Tool (Engine Lower 65mm Kit)

Removal Procedure

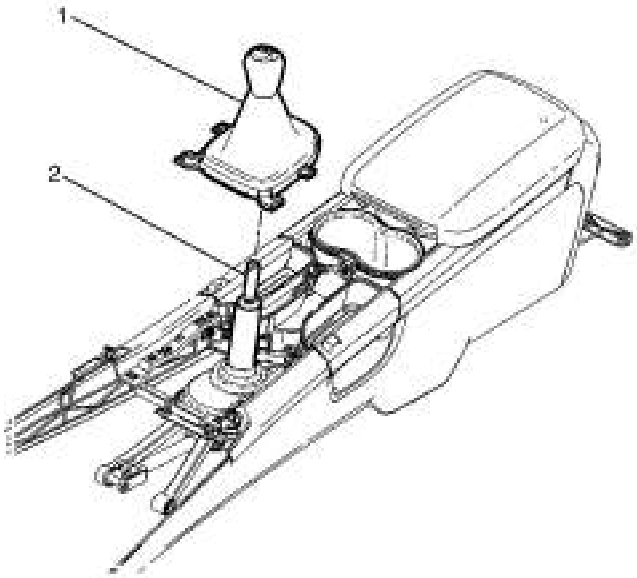
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

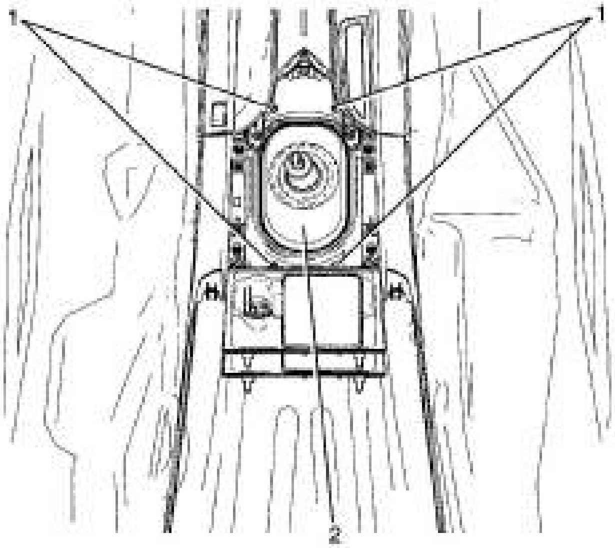
1. Remove the trim plate. Refer to Console Trim Plate Replacement .



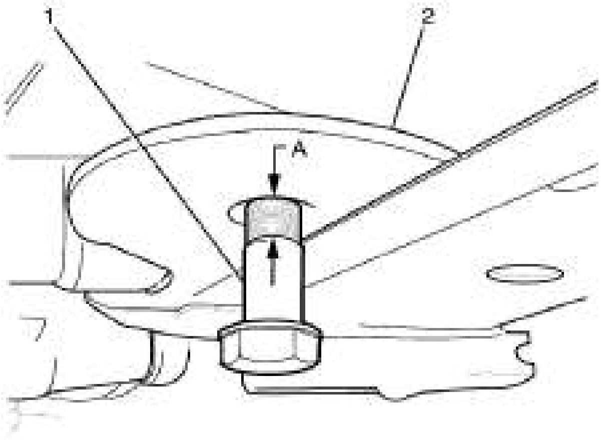
2. Remove the gearshift lever boot to front console retaining screws (2).



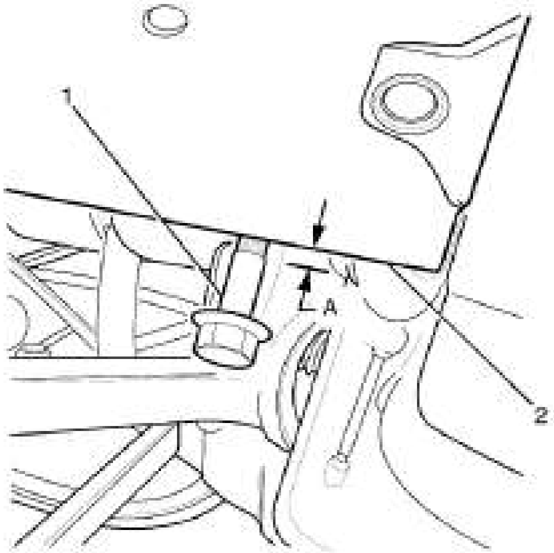
3. Lift the gearshift lever boot (1) enough to enable a firm grasp to be made on the gearshift lever (2) with the left hand, then grasp the gearshift knob with the right.
4. While rocking the knob sideways, and with an upward force applied, dislodge the knob retaining claws from the lever.
5. Remove the gearshift lever knob and boot assembly, from the gearshift lever (2).



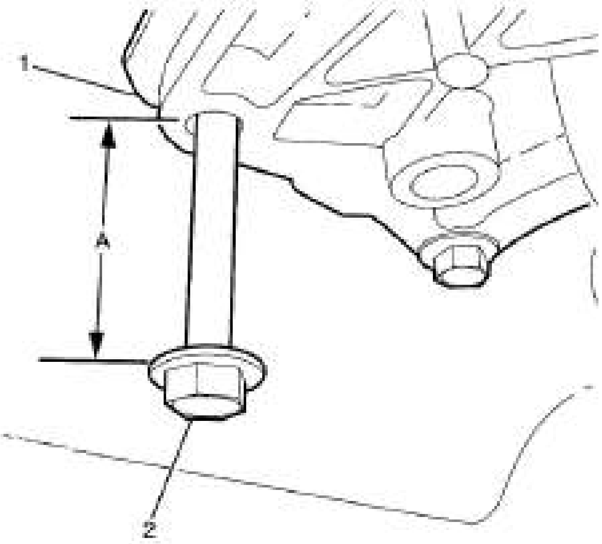
6. Remove the shift control assembly to shift control adapter plate retaining bolts (1).
7. Raise the vehicle. Refer to Lifting and Jacking the Vehicle .
8. Remove the exhaust system. Refer to Exhaust System Replacement .
9. Remove the propeller shaft. Refer to Propeller Shaft Replacement .
10. Support the power train with a suitable jack or table.
11. Using special tool EN-48536 lower engine and transmission assembly 65 millimetres.
12. Support the transmission with a suitable jack.



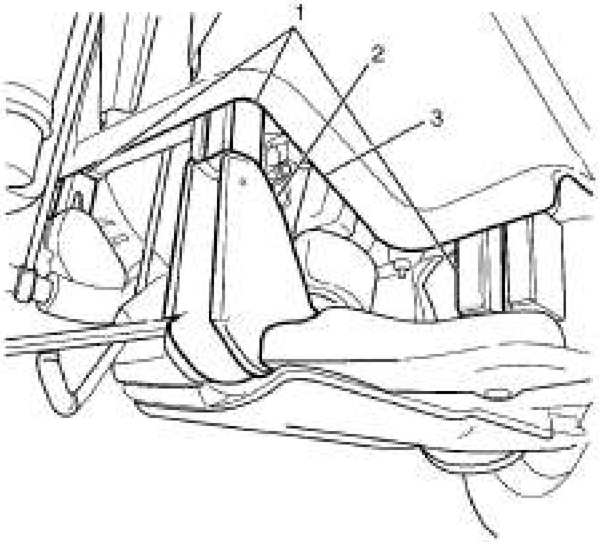
13. Replace the front sub frame rear bolts and fit bolts from special tool kit EN-48536 .
14. Install the retaining bolt (1) until the stepped shank (A) is two millimetres below sub frame (2).



15. Replace the front sub frame front bolts and fit bolts from special tool kit EN-48536 .
16. Install the retaining bolt (1) until the stepped shank (A) is two millimetres below chassis rail flange (2).



17. Remove the left front and right rear retaining bolts from the transmission mount and install two retaining bolts from special tool kit in diagonal holes e.g Left hand front and Right hand rear.
18. Install the retaining bolt (2) in until a 65 millimetre gap is achieved (A).
19. Remove front sub frame middle retaining bolts.
20. Lower power train slowly until the subframe and transmission mount are resting on the retaining bolts.



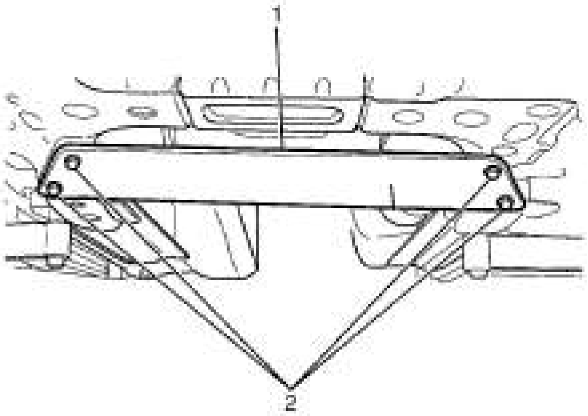
21. Insert 65 millimetre spacer blocks (1) between the subframe (2) and the chassis rails (3).
22. Tension front sub frame front and rear retaining bolts.

Tighten
Tighten the bolts to 95 N·m (70 lb. ft).

23. Install and tension middle sub frame retaining bolts.

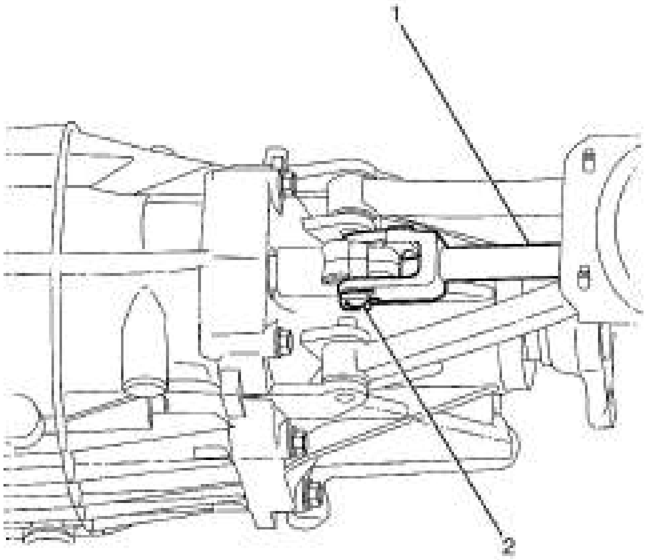
    Tighten
    Tighten the bolts to 95 N·m (70 lb. ft).

24. Remove suitable supporting jack.

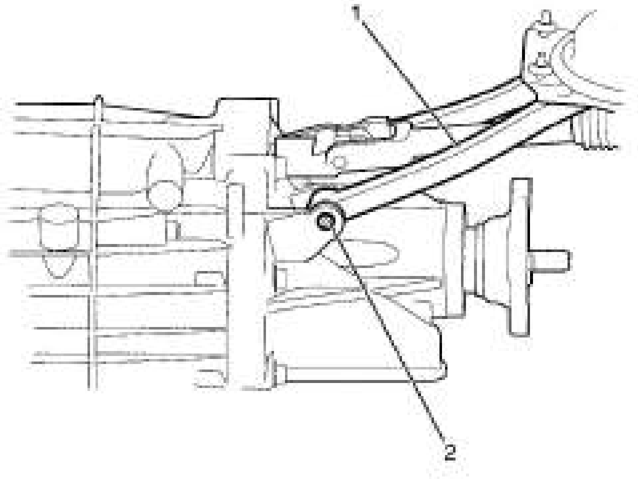


25. Install the engine support plate (1) to the front sub frame (2).
26. Install the engine support plate to front subframe retaining bolts (3).

    Tighten
    Tighten the bolts to 10 N·m (89 lb. in).

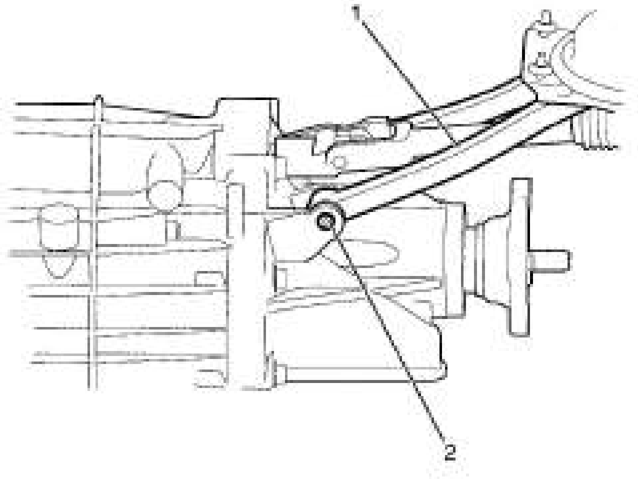


27. Use a suitable tool to remove the selector shaft rod retaining clip (2) from the shift control assembly (1).

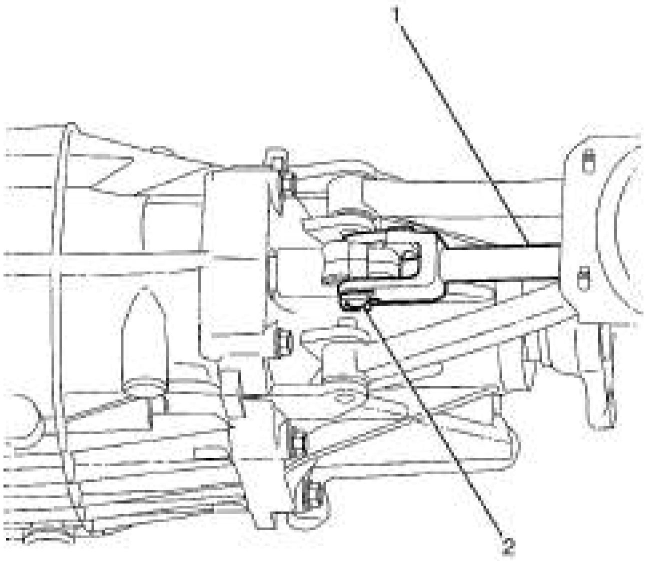


28. Remove the retaining pin (2) from the shift control assembly (1). Repeat for opposite side.
29. Remove the shift control assembly from the transmission.
30. Remove the shift control assembly from the vehicle.

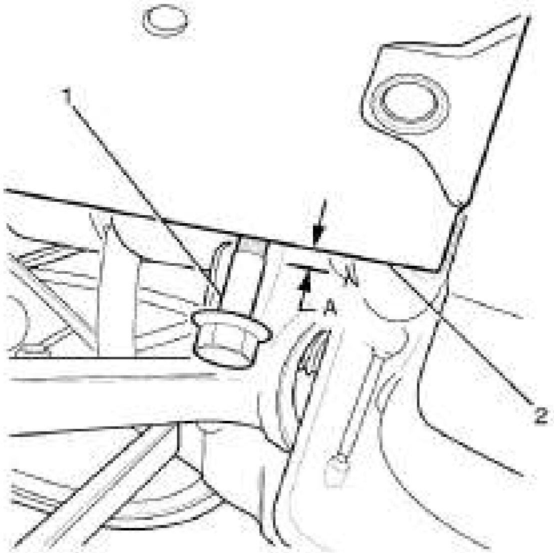
Installation Procedure



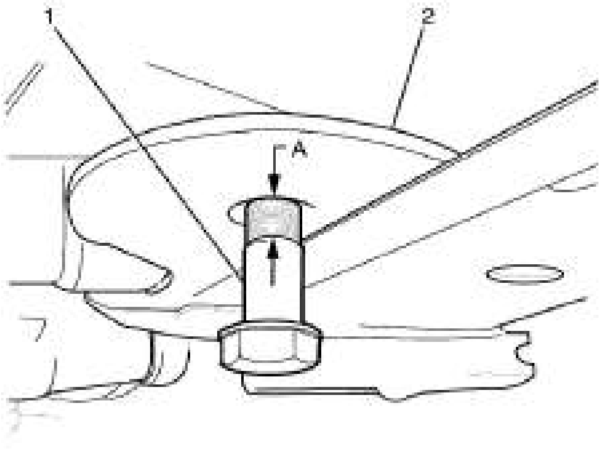
1. Install the shift control assembly (1) to the vehicle.
2. Install the retaining pin (2) to the shift control assembly. Repeat for opposite side.



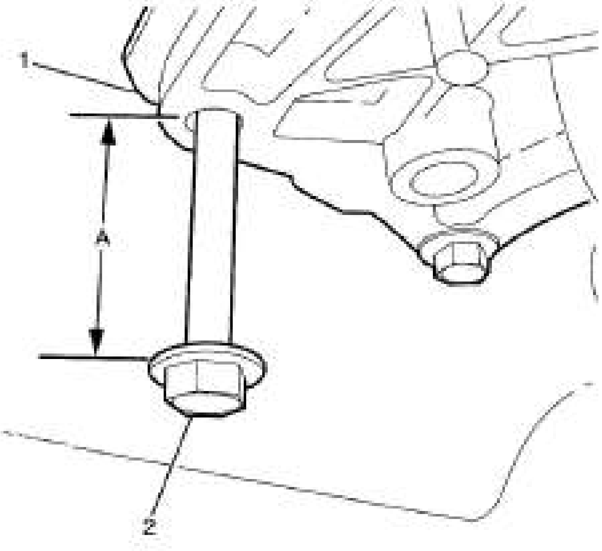
3. Install the selector shaft to shift control assembly rod.
4. Install the selector shaft rod retaining clip (2) from the shift control assembly (1).
5. Support the power train with a suitable jack or table.
6. Support the transmission with a suitable jack.



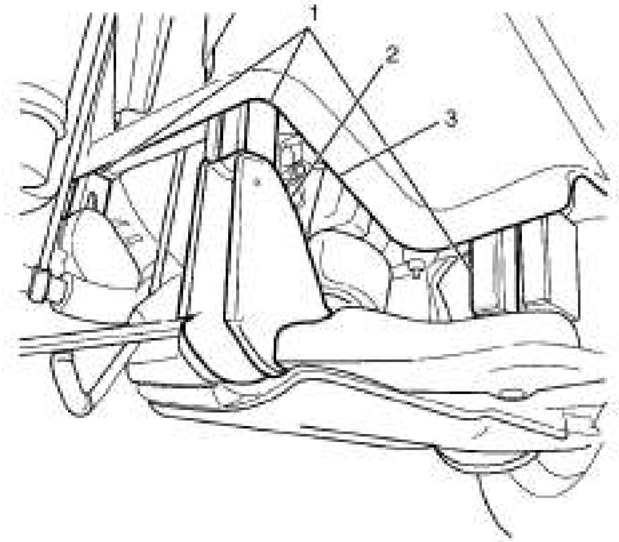
7. Loosen the retaining bolt (1) until the stepped shank (A) is two millimetres below sub frame (2).



8. Loosen the retaining bolt (1) until the stepped shank (A) is two millimetres below the sub frame (2).



9. Loosen the transmission mount to body retaining bolts (2) in the diagonal holes. (I.E. Left hand front and Right hand rear.)
10. Remove front sub frame middle retaining bolts.
11. Remove the spacer blocks from the front sub frame.
12. Raise the power train slowly until the front subframe and transmission mount are located on the vehicle.



13. Remove the six 65 millimetre spacer blocks (1) between subframe (2) and chassis rails (3).
14. Install the front sub frame to chassis rail retaining bolts.

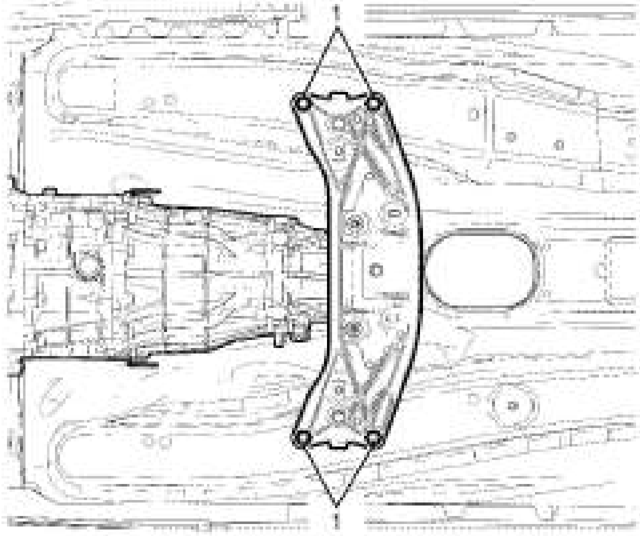
    Tighten
    Tighten the bolts to 95 N·m (70 lb. ft).

15. Install the rear sub frame to chassis rail retaining bolts.

    Tighten
    Tighten the bolts to 95 N·m (70 lb. ft).

16. Install the centre sub frame to chassis rail retaining bolts.

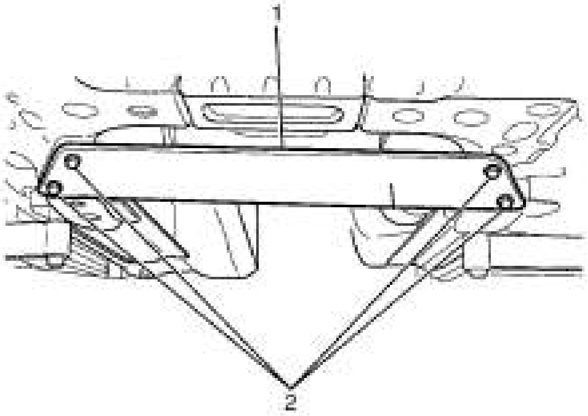
    Tighten
    Tighten the bolts to 95 N·m (70 lb. ft).



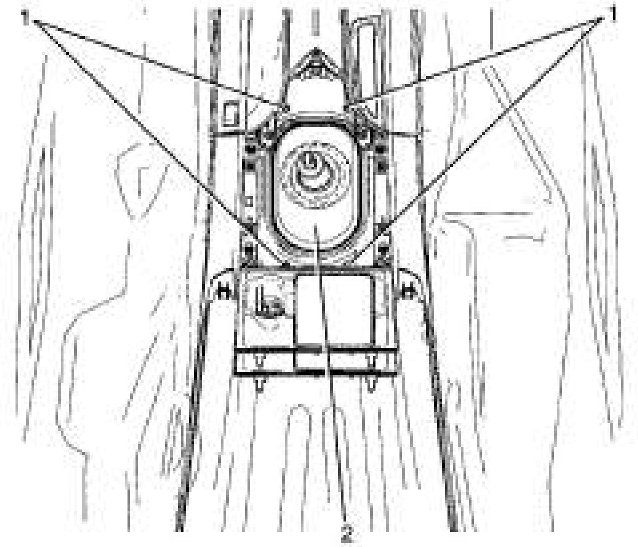
17. Install the transmission mount to body retaining bolts (1).

Tighten
Tighten the bolts to 58 N·m (43 lb. ft).

18. Raise the vehicle.
19. Remove supporting jack or table.

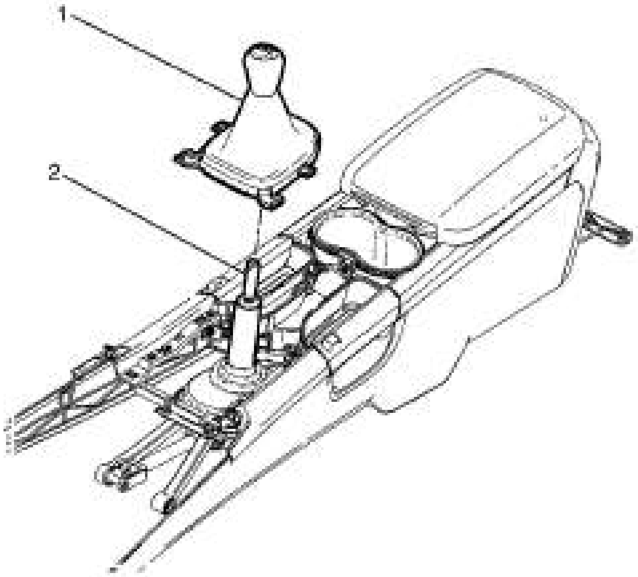


20. Remove the engine support plate (1) to front sub frame retaining bolts (2).
21. Remove the engine support plate from the vehicle.
22. Install the propeller shaft. Refer to Propeller Shaft Replacement .
23. Install the exhaust system. Refer to Exhaust System Replacement .
24. Lower the vehicle.

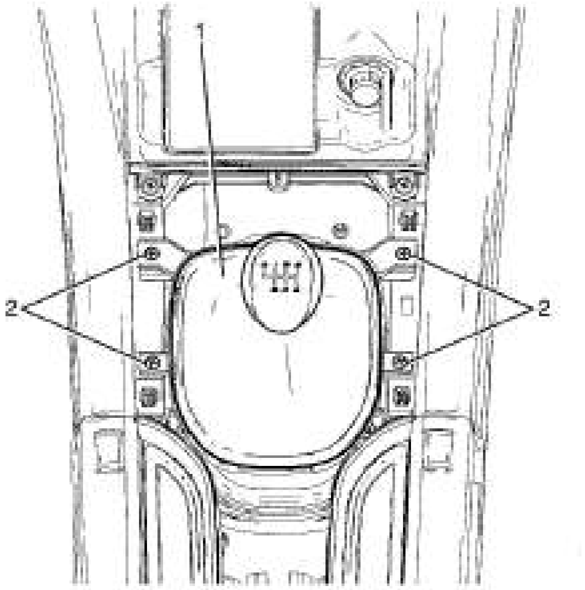


25. Install the shift control assembly to shift control adapter plate retaining nuts (1).

    Tighten
    Tighten the bolts to 12 N·m (106 lb. in).



26. Install the gearshift lever knob and boot assembly (1) to the gearshift lever.
27. Align the gearshift lever knob to the gearshift lever (2).
28. Apply pressure to the top of the gearshift knob to engage into the gearshift lever.



29. Install the gearshift lever boot to front console retaining screws (2).

    Tighten
    Tighten the bolts to 2 N·m (18 lb. in).

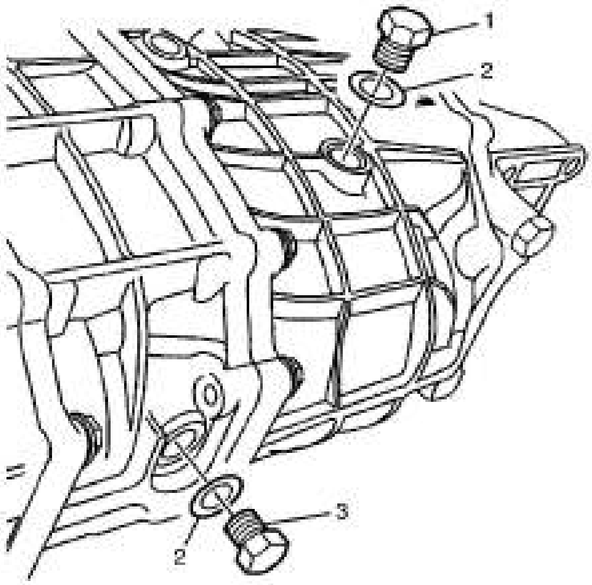
30. Install the trim plate. Refer to Console Trim Plate Replacement .

Transmission Fluid Level Inspection

Caution: Refer to Protective Goggles and Glove Caution in the Preface section.

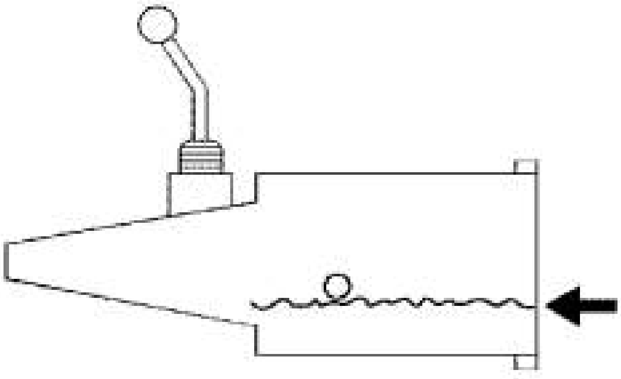
Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

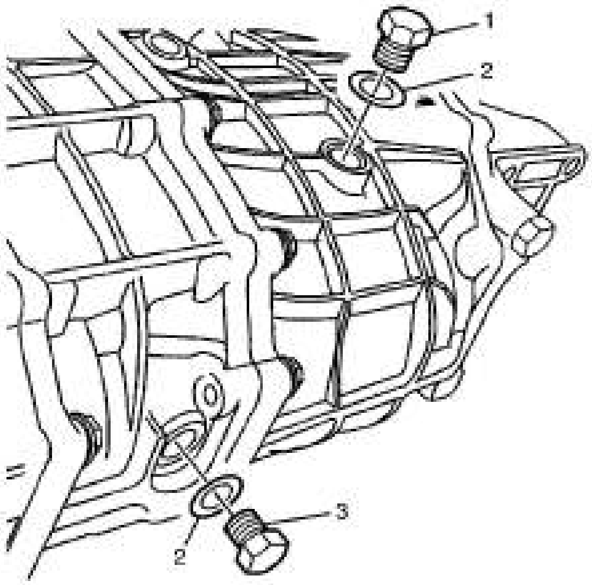


2. Clean any dirt from around the fill plug (1).
3. Remove the transmission fill plug (1) from the transmission.
4. Remove the transmission fill plug washer (2) and discard.

   Discard the washer.



5. Check that the transmission fluid level is even with the bottom of the fill plug hole.
6. Add transmission fluid, if necessary.



7. Install a NEW sealing washer (2) to the transmission fill plug.

   Notice: Refer to Fastener Notice in the Preface section.

8. Install the transmission fill plug (1) to the transmission.

   Tighten
   Tighten the transmission fill plug to 37 N·m (27 lb ft).

9. Lower the vehicle.

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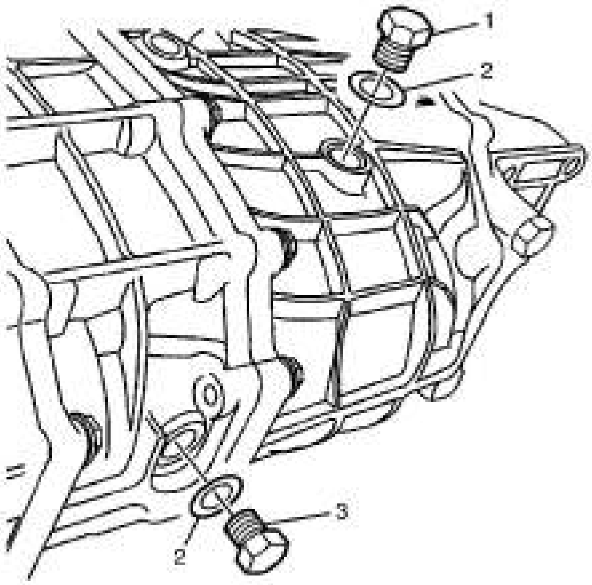
Transmission Fluid Replacement

Draining Procedure

Caution: Refer to Protective Goggles and Glove Caution in the Preface section.

Caution: Refer to Vehicle Lifting Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.



2. Clean away any dirt and debris from around the transmission fluid drain plug (3) area.
3. Position an appropriate container below the transmission drain plug.
4. Remove the transmission fluid drain plug (3) and washer (2) and discard.

   Discard the washer.

5. Allow the transmission fluid to drain into the container.
6. Install a NEW sealing washer (2) to the transmission drain plug.

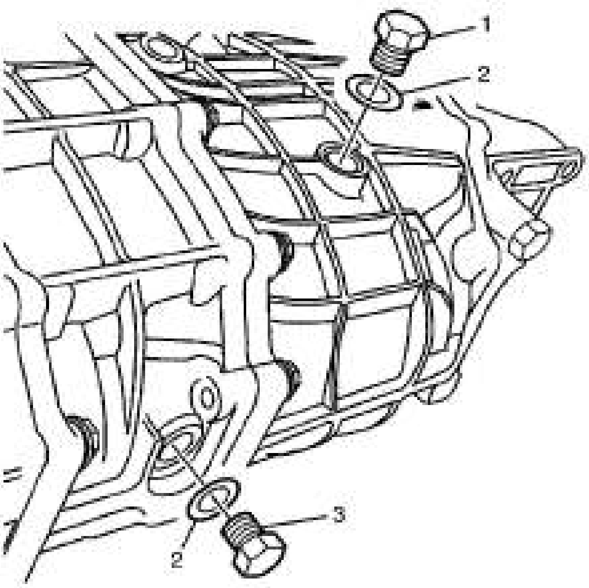
   Notice: Refer to Fastener Notice in the Preface section.

7. Install the transmission drain plug (1) to the transmission.

   Tighten
   Tighten the drain plug to 37 N·m (27 lb ft).

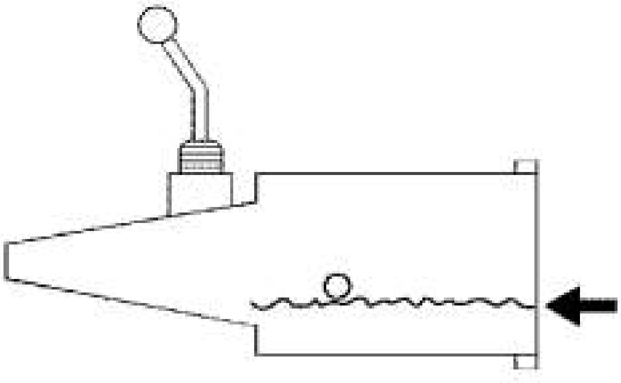
8. Remove the container used to catch the used transmission fluid from under the vehicle.

Filling Procedure

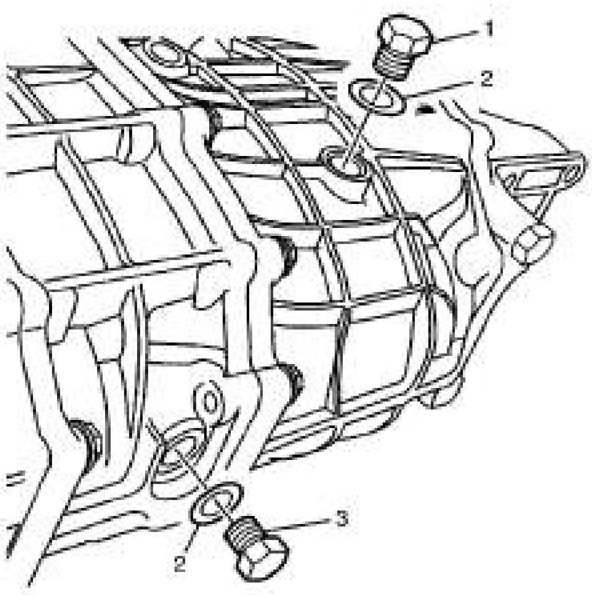


1. Clean away any dirt and debris from the transmission fluid fill plug (1) area.
2. Remove the transmission fluid fill plug (1) and washer (2) and discard.

   Discard the washer.



3. Fill the transmission to just below the bottom of the fill plug hole with the recommended fluid. Refer to Lubrication Specifications.



4. Install a NEW sealing washer (2) to the transmission fill plug.

   Notice: Refer to Fastener Notice in the Preface section.

5. Install the transmission fill plug (1) to the transmission.

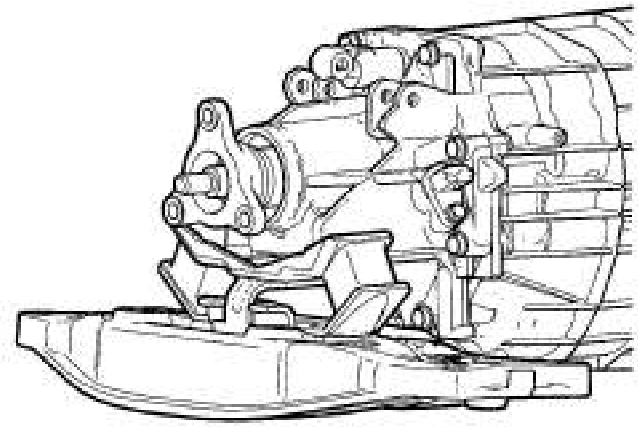
   Tighten
   Tighten the fill plug to 37 N·m (27 lb ft).

Transmission Mount Inspection

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .



Important: Before replacing any transmission mount due to suspected fluid loss, verify that the source of the fluid is the transmission mount, not the engine, transmission or accessories.

2. Raise the transmission in order to remove the weight from the transmission mount and create slight tension in the rubber.
3. Observe the transmission mount while raising the transmission. Replace the transmission mount if the transmission mount exhibits any of the following conditions:
   - The hard rubber surface is covered with heat check cracks.
   - The rubber is separated from the metal plate of the transmission mount.
   - The rubber is split through the centre of the transmission mount.
4. If there is movement between the metal plate of the transmission mount and its attaching points, lower the transmission on the transmission mount. Tighten the bolts or nuts attaching the transmission mount to the frame or transmission mount bracket. Refer to Transmission Mount Replacement .
5. Lower the vehicle.

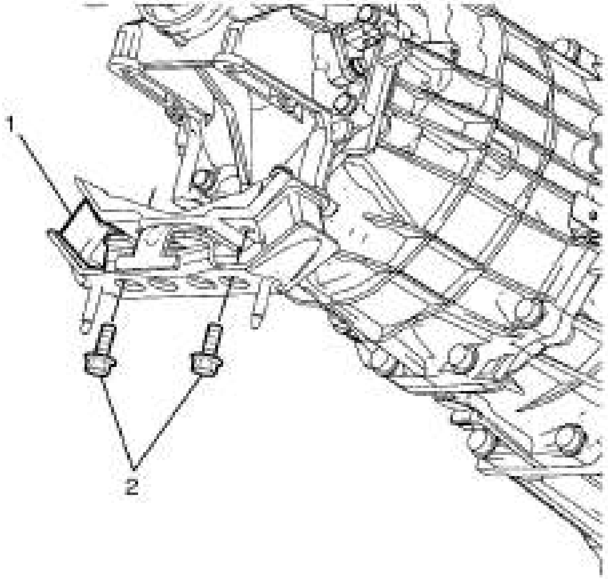
Transmission Mount Replacement

Removal Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

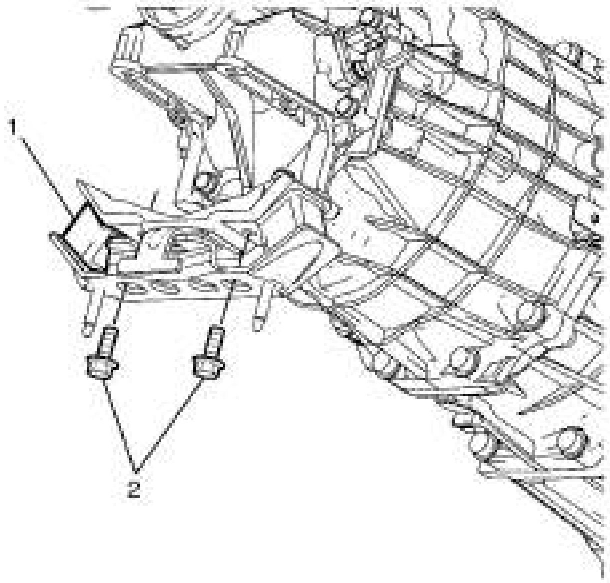
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the transmission support. Refer to Transmission Support Replacement.



3. Remove the transmission mount to transmission upper retaining bolts (2).
4. Remove the transmission mount (1).

Installation Procedure



1. Install the transmission mount to the transmission.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the transmission mount (1) to transmission upper retaining bolts(2).

   Tighten
   Tighten the bolts to 60 N·m (44 lb ft).

3. Install the transmission support. Refer to Transmission Support Replacement.
4. Lower the vehicle.

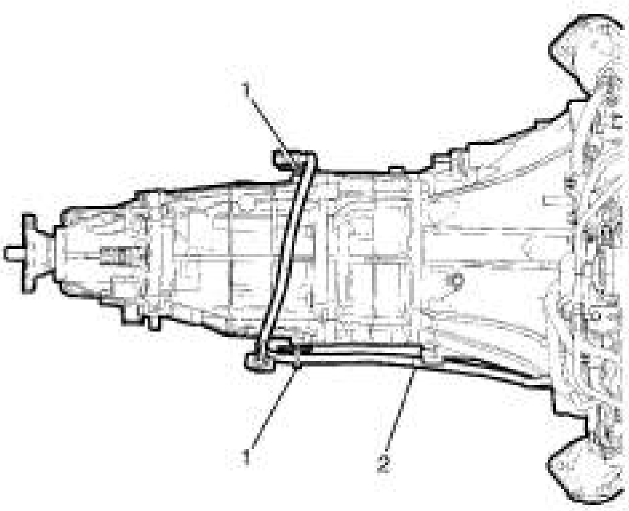
Transmission Replacement

Removal Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

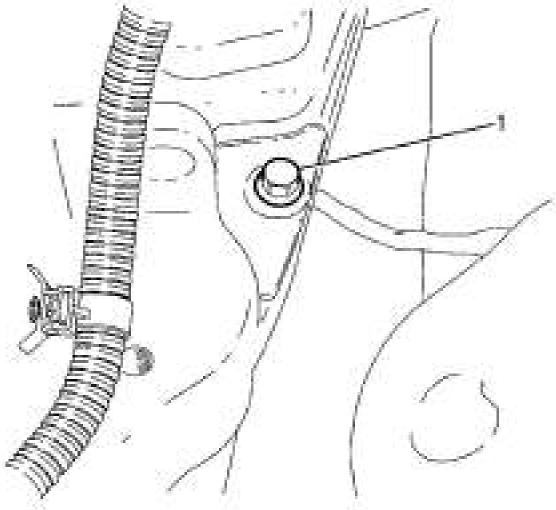
1. Remove the shift control assembly. Refer to Shift Control Assembly Replacement .
2. Remove the propeller shaft. Refer to Propeller Shaft Replacement .



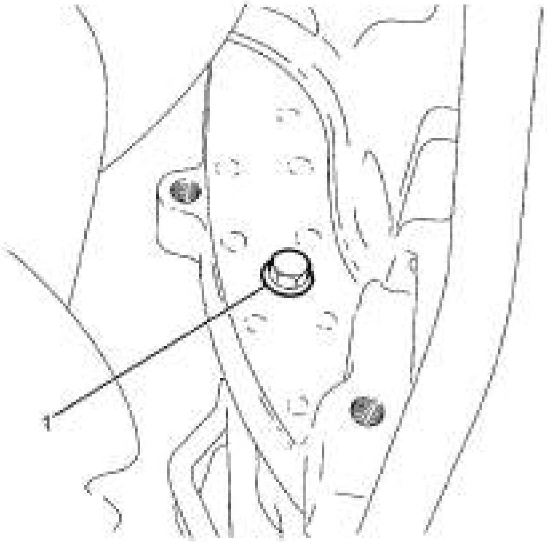
3. Disconnect the following electrical connector:

   Backup lamp switch (2).

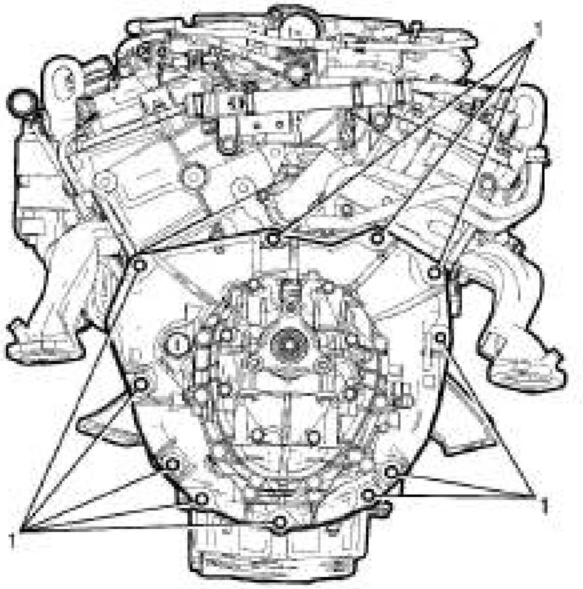
4. Disconnect the oxygen sensor connectors (1) from the transmission.
5. Disconnect the clutch slave cylinder. Refer to Clutch Concentric Actuator Cylinder Replacement .
6. Remove the starter motor. Refer to Starter Motor Replacement .



7. Remove the transmission close out panel to transmission retaining bolt (1).



8. Remove the transmission close out panel to transmission retaining bolt (1).

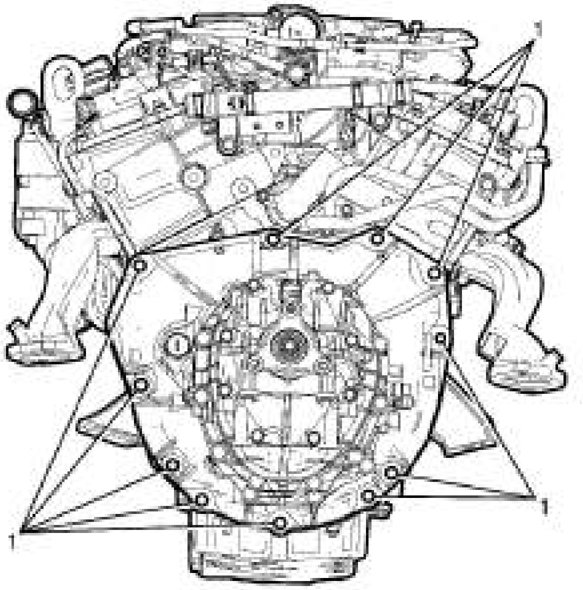


9. Remove the transmission to engine block retaining bolts (1)
10. Remove the transmission from the vehicle.

Installation Procedure

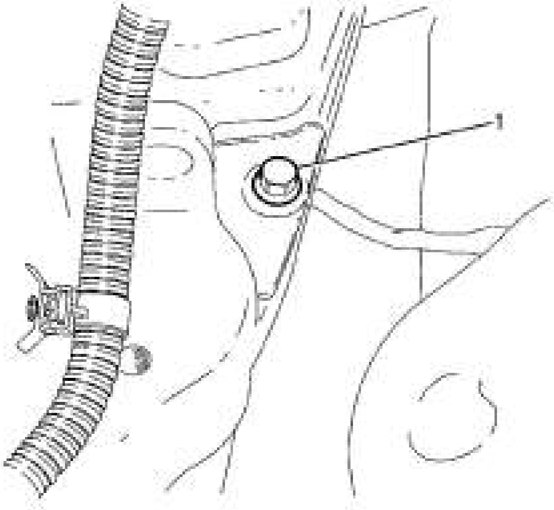
Important: Engage third gear on the transmission to allow for alignment of the input spline of the transmission to the clutch assembly.

1. Install the transmission to the vehicle.



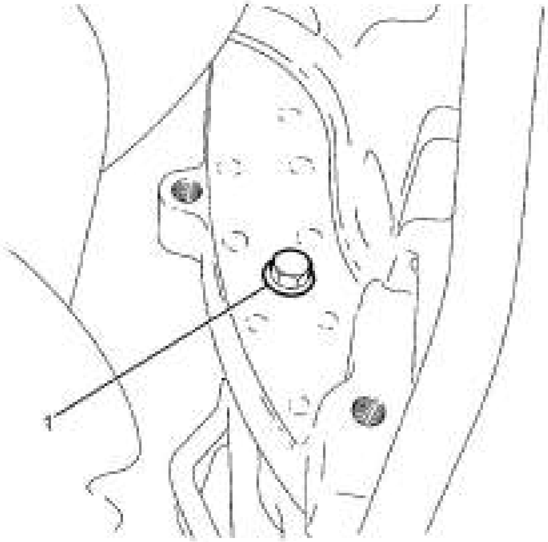
2. Install the transmission to engine block retaining bolts (1)

Tighten
Tighten the bolts to 48 N·m (35 lb ft).



3. Install the transmission close out panel to transmission retaining bolt (1).

   Tighten
   Tighten the bolt to 20 N·m (15 lb ft).

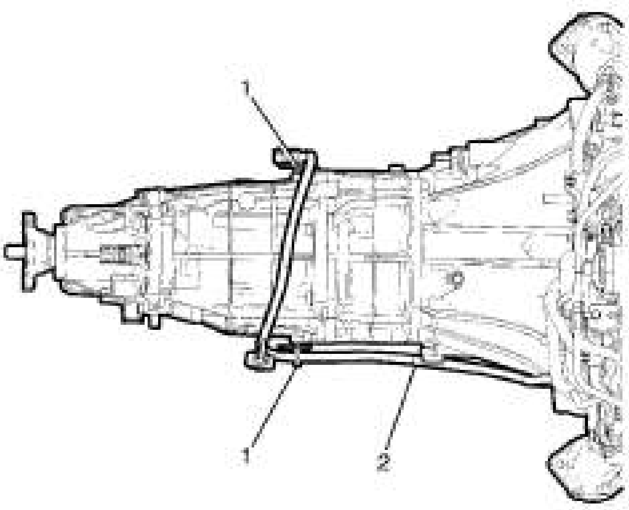


4. Install the transmission close out panel to transmission retaining bolt (1).

   Tighten
   Tighten the bolt to 20 N·m (15 lb ft).

5. Connect the clutch slave cylinder. Refer to Clutch Concentric Actuator Cylinder Replacement .

6. Install the starter motor. Refer to Starter Motor Replacement .



7. Connect the following electrical connector:

   Backup lamp switch (1).

8. Connect the oxygen sensor connectors (1) from the transmission.
9. Install the shift control assembly to the transmission. Refer to Shift Control Assembly Replacement .
10. Install the propeller shaft. Refer to Propeller Shaft Replacement .
11. Check the transmission fluid and fill as necessary. Refer to Transmission Fluid Level Inspection and Transmission Fluid Replacement .
12. Install the exhaust system. Refer to Exhaust System Replacement .
13. Lower the vehicle.

Transmission Final Test and Inspection

Complete the following procedure after the transmission is installed in the vehicle:

1. With the ignition OFF or disconnected and clutch pedal depressed, crank the engine several times. Listen for any unusual noises or evidence that any parts are binding.
2. Place transmission in neutral, start the engine and listen for any unusual noises or evidence that any parts are binding.
3. While the engine continues to idle raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
4. Perform a final inspection for the proper fluid level. Refer to Transmission Fluid Level Inspection .
5. Lower the vehicle.
6. Road test the vehicle.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Manual Transmission - Aisin AY6 | Repair Instructions - On Vehicle | **Document ID: 1977480**

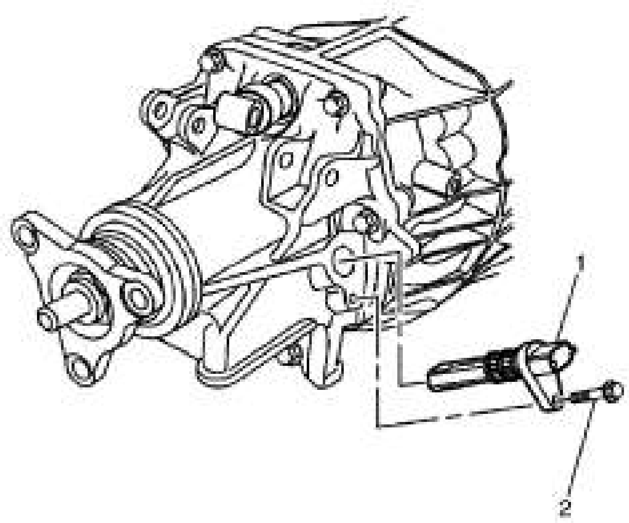
Vehicle Speed Sensor Replacement

Removal Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

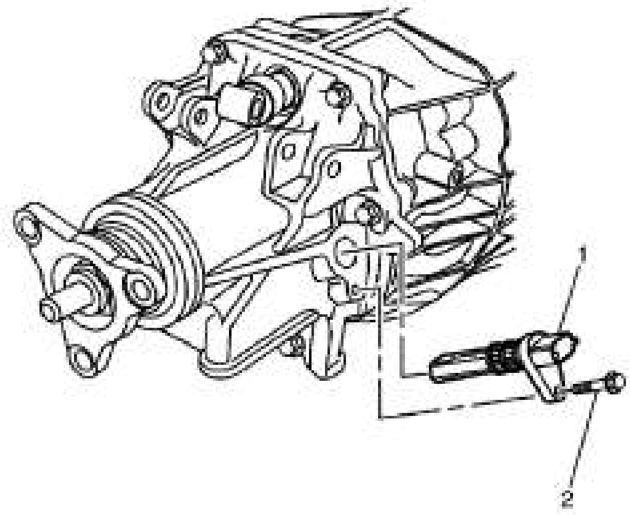
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle.



2. Remove the VSS bolt (2).
3. Remove the VSS (1) from the rear extension housing.

Installation Procedure



1. Install the VSS (1) to the rear extension housing.

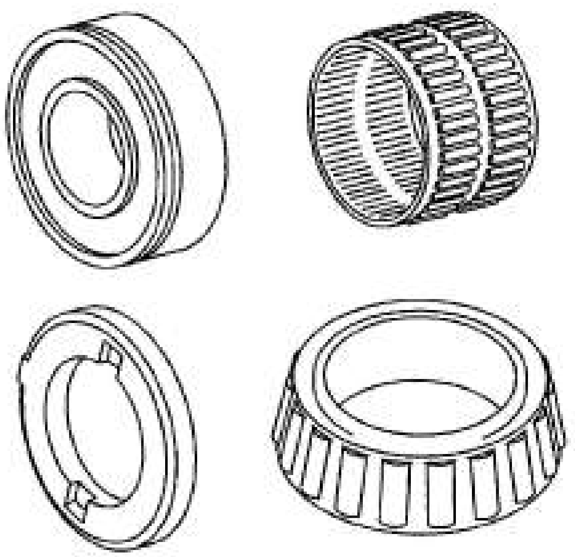
   Notice: Refer to Fastener Notice in the Preface section.

2. Install the VSS bolt (2).

   Tighten
   Tighten the bolt to 8 N·m (71 lb in).

3. Lower the vehicle.

Bearings and Spacers Cleaning and Inspection



Notice: Do not allow the bearings to spin. Turn them slowly by hand. Spinning the bearings may damage the race and the rollers.

1. Mark or tag the bearings in order to ensure they are properly installed in the correct location.
2. Clean all of the roller bearings, needle bearings, and ball bearings in a suitable solvent and air dry all the parts.
3. Inspect the bearings and races for the following conditions:
   - Roughness
   - Brinelling
   - Pitting
4. Inspect the cage bearings for being bent or for having damaged cages.
5. Replace the bearings with any of the above conditions.
6. Replace mated bearing parts when only one part is damaged.
7. Inspect the thrust washers for scoring or wear.
8. Replace any faulty thrust washers.
9. Do not file surfaces which have been hardened and precision ground.

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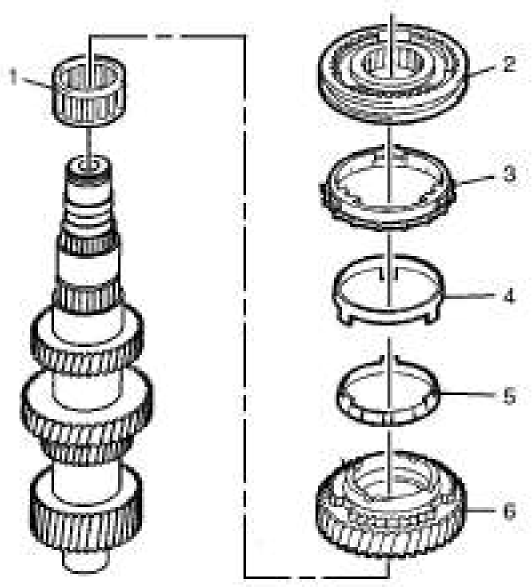
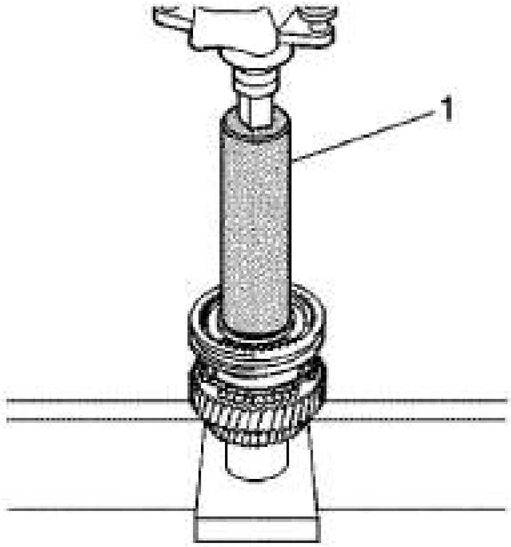
Counter Gear Shaft Assemble

Tools Required

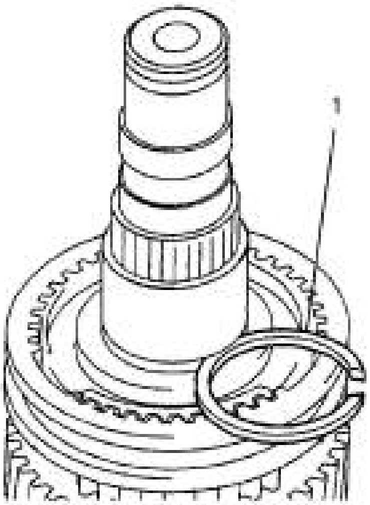
- DT-47722 Shift Rail Bushing Remover and Installer
- DT-47723 Output Shaft Bearing Installer
- J-22912-01 Split Plate Bearing Puller
- J 45869 Gear Protection Plates



1. Apply an approved lubricant to the counter gear shaft and install the following components:
   - the 2nd gear bearing (1)
   - the 2nd gear (6)
   - the 2nd gear synchronizer inner cone (5)
   - the 2nd gear synchronizer outer cone (4)
   - the 2nd gear outer blocker ring (3)
   - the 1st/2nd gear synchronizer sleeve (2)

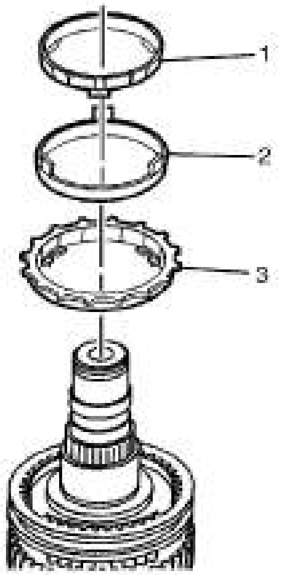


2. Using a hydraulic press and DT-47722 (1), install the 1st/2nd gear synchronizer sleeve with the boss side facing 2nd gear. The synchronizer ring set and transmission clutch hub are to be aligned when installing the transmission clutch hub assembly.

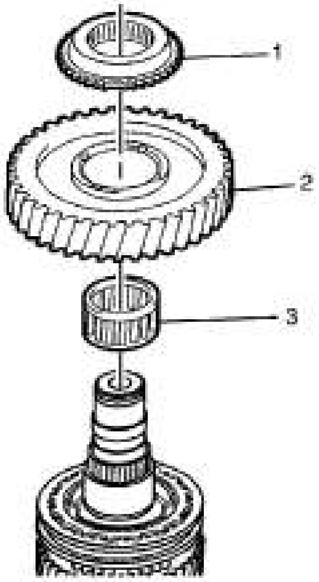


Important: The retaining ring is a selected fit. Always install a NEW retaining ring.

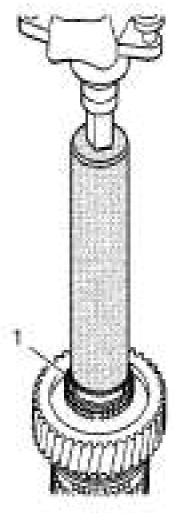
3. Select the maximum thickness snap ring (1) that will fit in the groove. Refer to Countershaft Front and Rear Bearing Retaining Ring Specifications .
4. Install a NEW snap ring to the counter gear shaft.



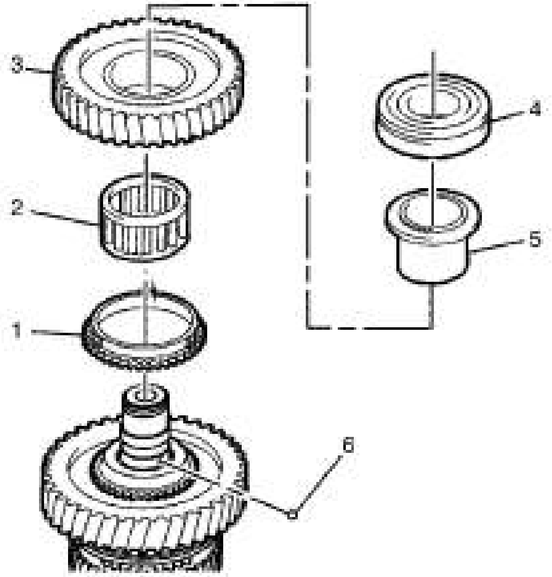
5. Apply an approved lubricant and install the following components:
   - the 1st gear outer blocking ring (3)
   - the 1st gear synchronizer outer cone (2)
   - the 1st gear synchronizer inner cone (1)



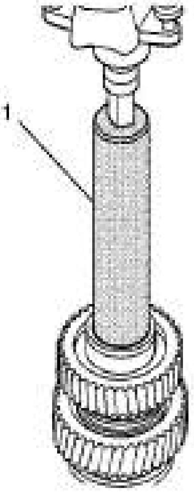
6. Apply an approved lubricant and install and align the 1st gear bearing (3), 1st gear (2) and the reverse gear spline (1).



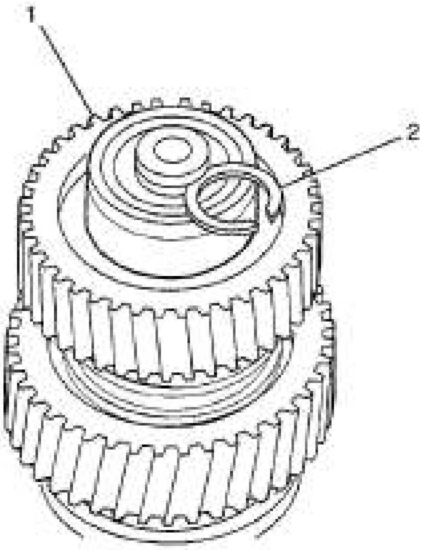
7. Using a hydraulic press and DT-47723 , install the reverse gear spline (1).



8. Apply an approved lubricant and install the reverse gear blocking ring (1).
9. Install the ball (6) to the countershaft.
10. Apply an approved lubricant and install the reverse gear bushing bearing (2).
11. Apply an approved lubricant to the synchronizer sleeve and reverse gear (3).
12. Align and install the synchronizer sleeve and reverse gear (3) together.
13. Apply an approved lubricant and install the reverse gear bushing (5) with ball.
14. Install the counter gear front bearing (4) with groove facing forward.



15. Using a hydraulic press and DT-47723 (1), install the counter gear front bearing.



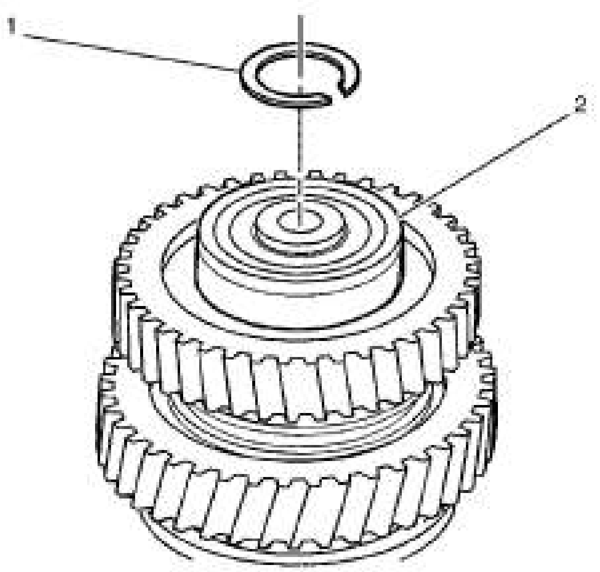
Important: The retaining ring is a selected fit. Always install a NEW retaining ring.

16. Select the maximum thickness snap ring (2) that will fit in the groove. Refer to 1st and 2nd Gear Synchronizer Retaining Ring Specifications .
17. Install a NEW snap ring (2) to the counter gear shaft (1).

Counter Gear Shaft Disassemble

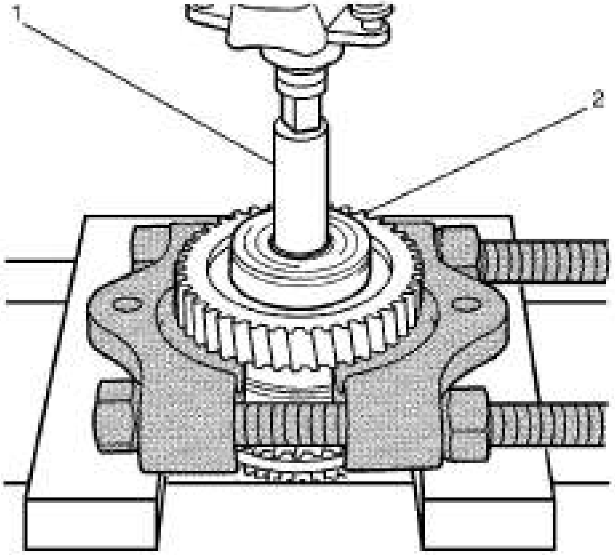
Tools Required

J-22912-01 Split Plate Bearing Puller



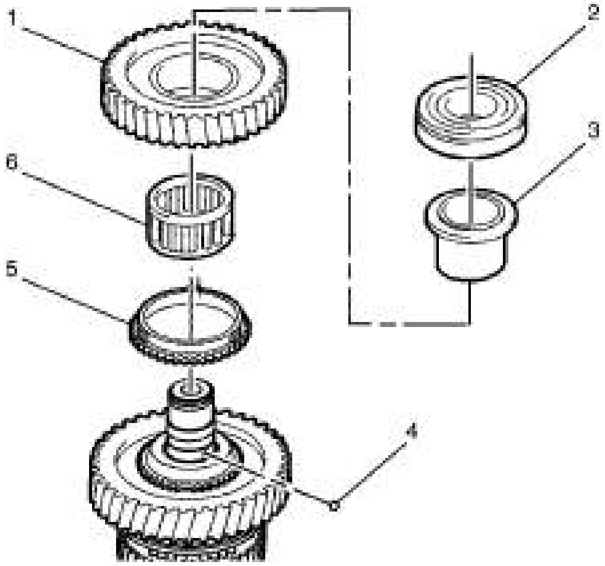
1. Remove the snap ring (1) from the countershaft above the counter gear front bearing (2). Discard the snap ring (1).

   Discard the snap ring.



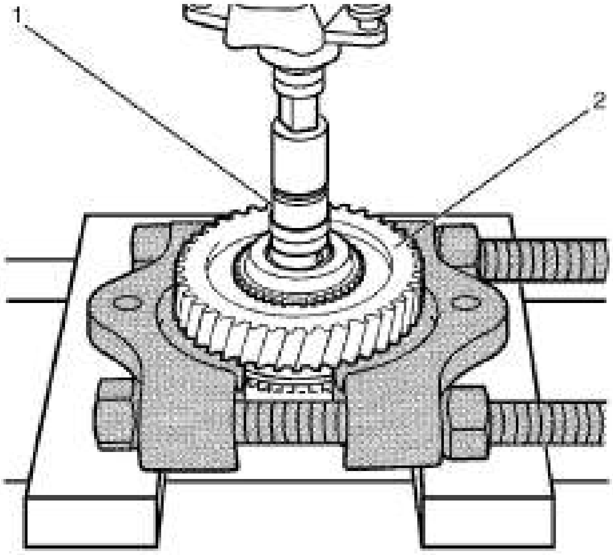
Important: Place the edge of gear on press plate.

2. Using a hydraulic press and J-22912-01 , remove the counter gear front bearing and reverse synchronizer assembly as a unit (2).

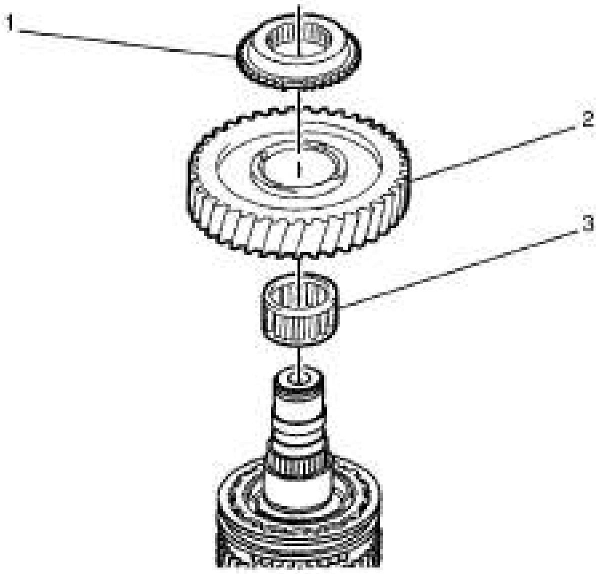


3. Remove the following components from the counter shaft as an assembly:
   - the counter gear front bearing (2)
   - the reverse gear bushing (3)
   - the reverse gear (1)
   - the reverse gear bearing (6)
   - the reverse gear blocking ring (5)

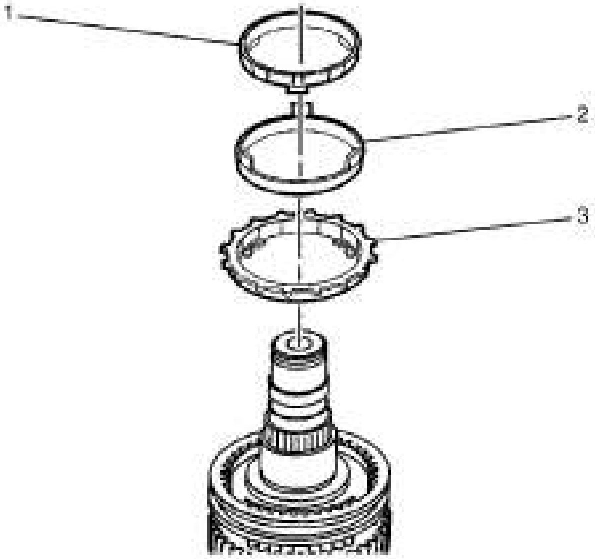
4. Using a suitable tool, remove the locking ball (4) from the counter shaft.



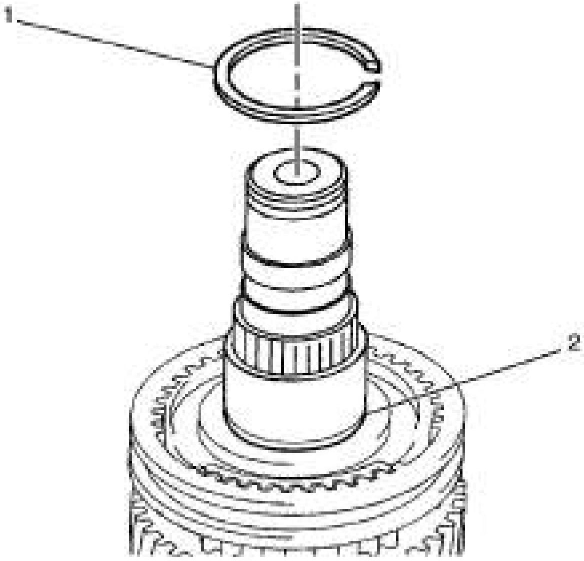
5. Using a hydraulic press and J-22912-01 , remove the reverse gear spline and 1st gear as a unit (2).



6. Remove the reverse gear spline (1) from the counter shaft.
7. Remove the 1st gear (2) from the counter shaft.
8. Remove the 1st gear bearing (3) from the counter shaft.

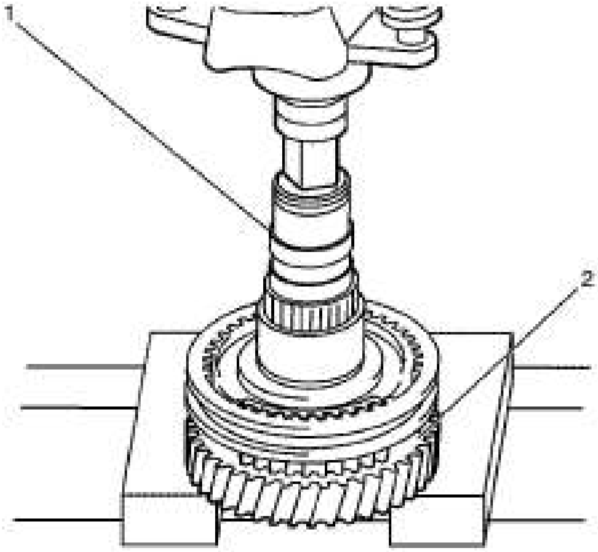


9. Remove the 1st gear synchronizer inner cone (1) from the counter shaft.
10. Remove the 1st gear synchronizer outer cone (2) from the counter shaft.
11. Remove the 1st gear outer blocking ring (3) from the counter shaft.



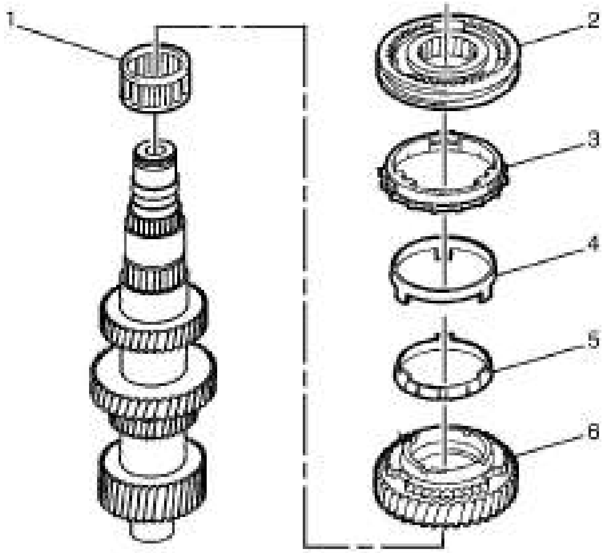
12. Remove the 2nd gear assembly to counter shaft snap ring (1) and discard.

    Discard the snap ring.



Important: Place the edge of gear on press plate.

13. Using a hydraulic press, remove the 2nd gear and the 1-2 synchronizer assembly (2) as a unit.



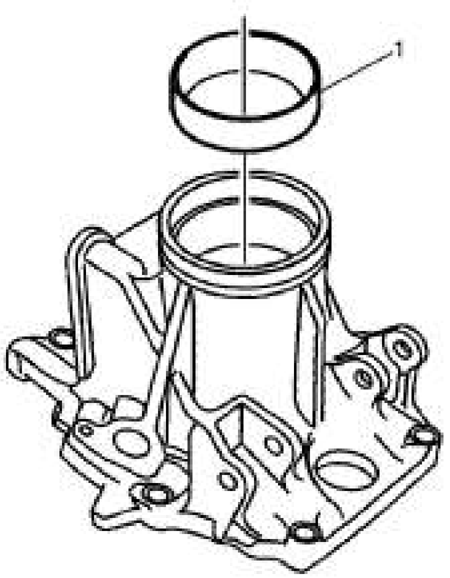
14. Remove the following components from the counter shaft as an assembly:
    - The 1st/2nd gear synchronizer sleeve (2)
    - The 2nd gear outer blocking ring (3)
    - The 2nd gear synchronizer outer cone (4)
    - The 2nd gear synchronizer inner cone (5)
    - The 2nd gear (6)

- The 2nd gear bearing (1)

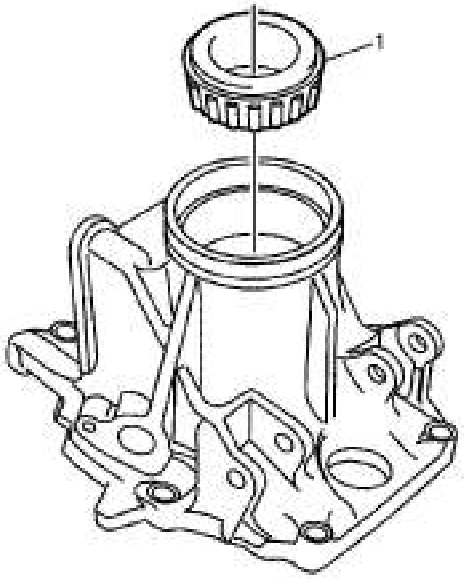
Extension Assemble

Tools Required

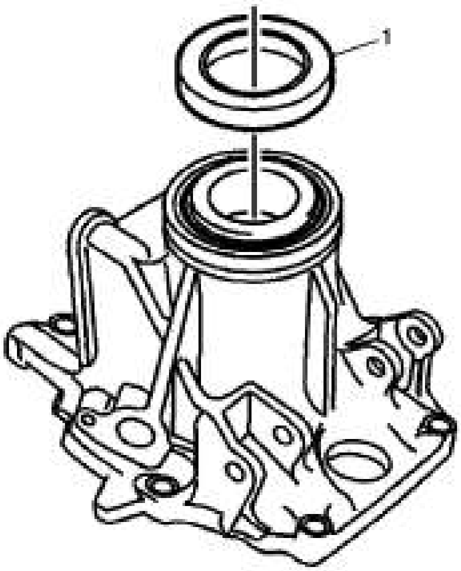
- DT-47721 Shift Shaft Seal Installer
- DT-47725 Extension Housing Bearing Cup Installer
- J 21128 Axle Pinion Oil Seal Installer
- J 36614 Inner Pinion Bearing Installer



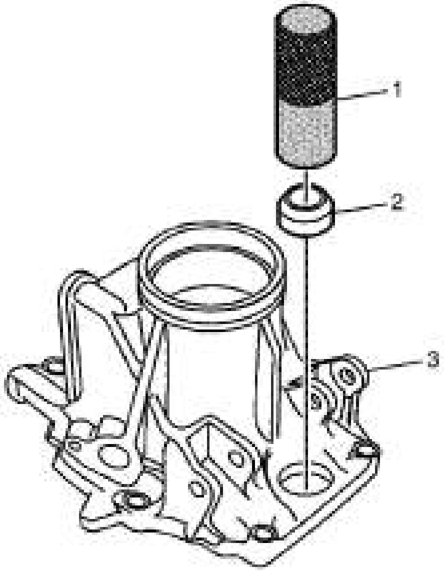
1. Using DT-47725 and J 36614 , install the tapered bearing race (1).



2. Apply an approved gear oil and install the tapered roller bearing (1).



3. Using J 21128 , install a NEW rear output seal (1).



4. Using DT-47721 , install a NEW shift shaft seal (1).

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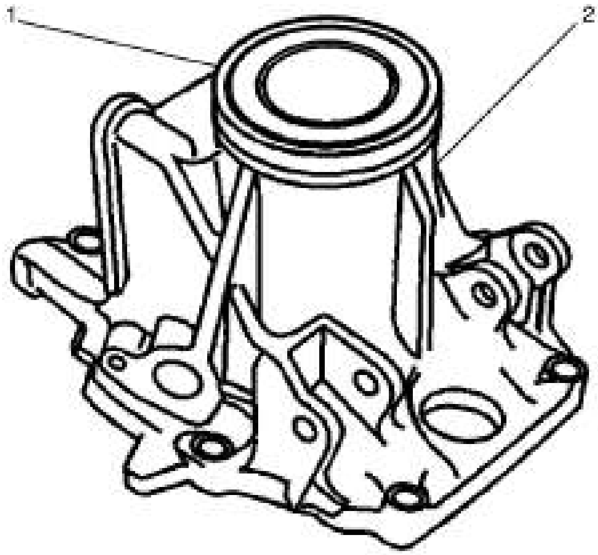
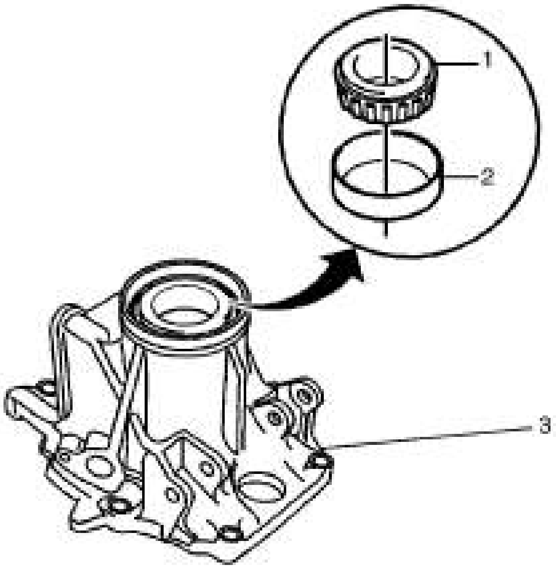
Extension Disassemble

Tools Required

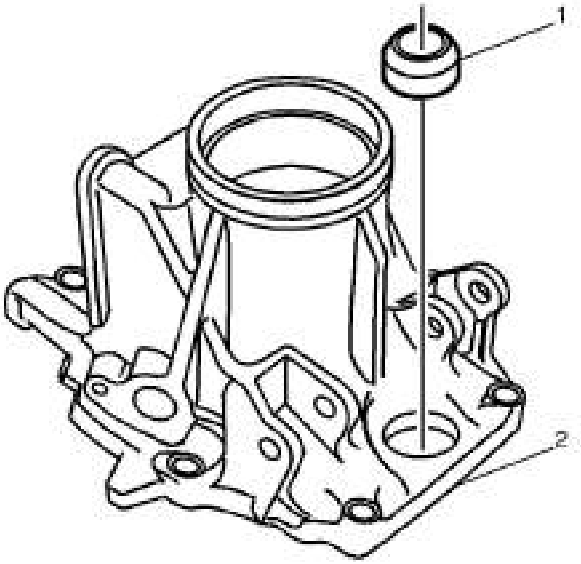
- DT-47721 Shift Shaft Seal Installer
- J 2619-01 Slide Hammer
- J 26941 Bushing and Bearing Remover 3 - 4 in



1. Using J 2619-01 and J 26941 , remove the rear output shaft seal (1) from the extension housing.



2. Using J 2619-01 and J 26941 , remove the rear output shaft bearing assembly (1 and 2) from the extension housing.



3. Using tool DT-47721 , remove the shift shaft seal (1) from the extension housing.

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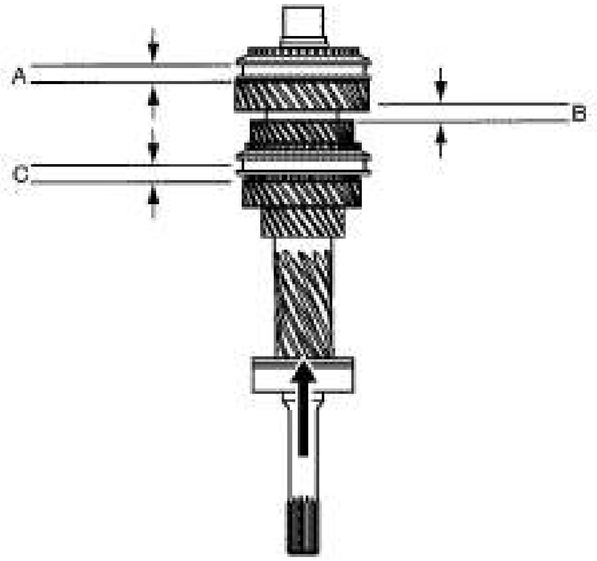
Gears and Shafts Cleaning and Inspection

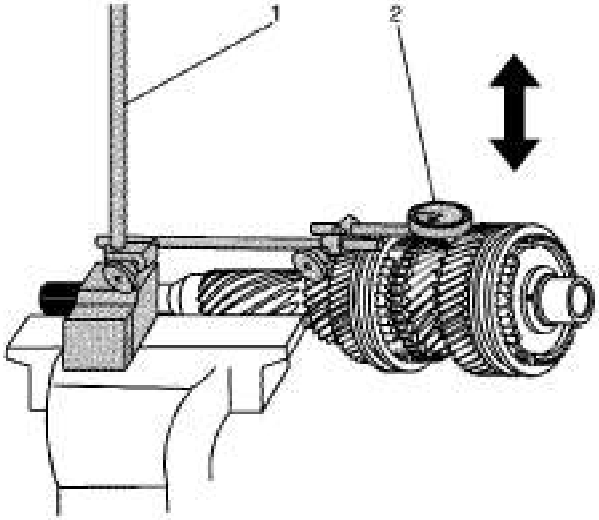
Tools Required

- J 8001-3 Dial Indicator
- J 26900-12 Dial Indicator - 1-10 mm
- J 26900-13 Magnetic Indicator Base

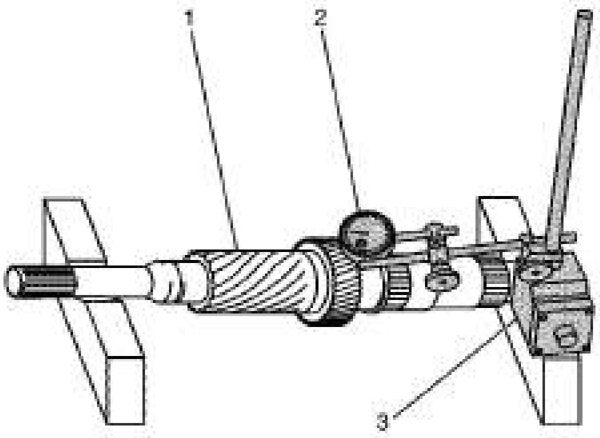
Input Shaft



1. Inspect 3rd (B), 4th (C), and 6th gear (A) for axial clearance. Lift up on the gear from the settled position and measure travel. Refer to Transmission Clearance Specifications.



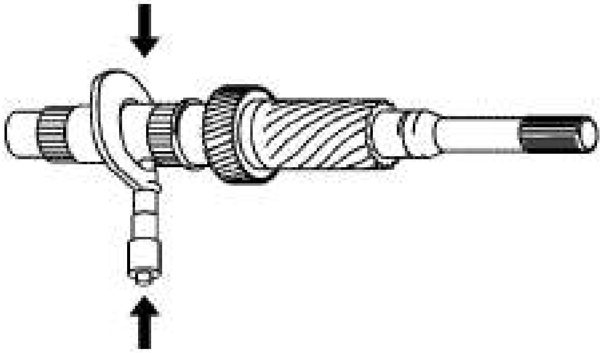
2. Measure the radial clearance for each of the speed gears.
    2.1. Place the speed gear, with the needle roller bearing, on the input shaft at the correct journal.
    2.2. Use J 8001-3 or J 26900-12 (1) and J 26900-13 (2).
    2.3. Position J 8001-3 or J 26900-12 on the gear.
    2.4. Move the gear up and down and measure travel. Refer to Transmission Clearance Specifications.
3. If the clearance exceeds the maximum, replace either the gear, the needle roller bearing, or the input shaft.
4. Retest for radial clearance for each of the speed gears and measure travel. Refer to Transmission Clearance Specifications.
5. Clean the input shaft in a suitable solvent.
6. Clean and air dry the oil gallery.
7. Inspect the input shaft bearing surfaces for the following conditions:
    - Wear
    - Lack of lubricant
    - Debris embedded in the oil grooves
    - Brinelling
8. Inspect the input shaft splines for wear or damage.
9. Replace the input shaft if any of the above conditions are found.



10. Using J 8001-3 or J 26900-12 (1), J 26900-13 (2) and V-blocks, inspect the input shaft for runout.

    Specification
    Maximum runout: 0.06 mm (0.0024 in)

11. If the runout exceeds the maximum, replace the input shaft.



Important: To calculate the radial clearance, measure shaft diameter, needle roller bearing diameter and gear inner diameter.

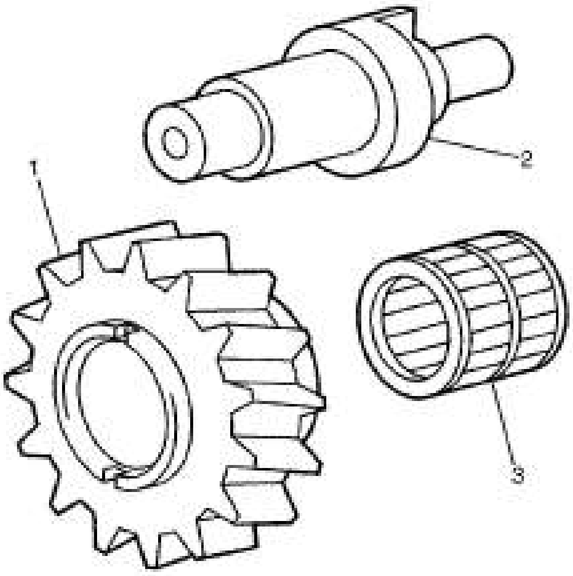
12. Using a micrometer, measure the diameter of the input shaft journals.

Specification

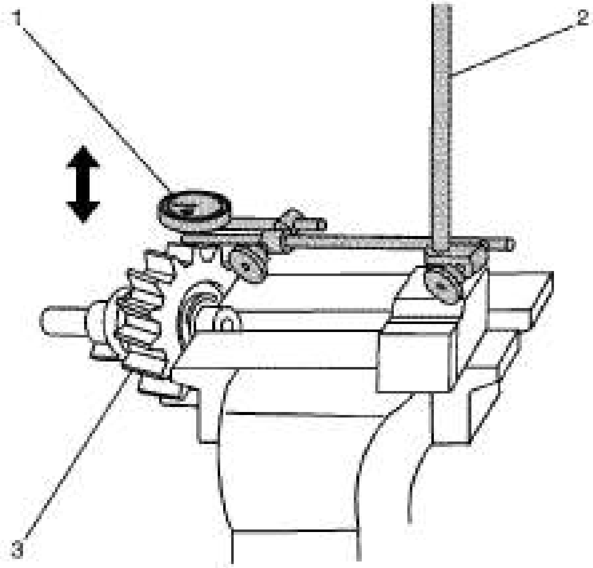
- Minimum diameter 1st gear (a): 38.860 mm (1.5299 in)
- Minimum diameter 2nd gear (b): 46.860 mm (1.8449 in)
- Minimum diameter 3rd gear (c): 37.869 mm (1.4905 in)

13. If the journal diameter is less than the minimum, replace the input shaft.

Reverse Idler Gear and Shaft



1. Clean the reverse idler gear and shaft in a suitable solvent and air dry all the parts.
2. Inspect the bushing in the reverse idler gear for the following conditions:
   - Excessive wear
   - Scoring
   - Pitting
3. Replace the reverse idler gear if the bushing is faulty.
4. Inspect the reverse idler gear shaft for the following conditions:
   - Excessive wear
   - Scoring
   - Pitting
5. Replace the reverse idler gear shaft if it is faulty.



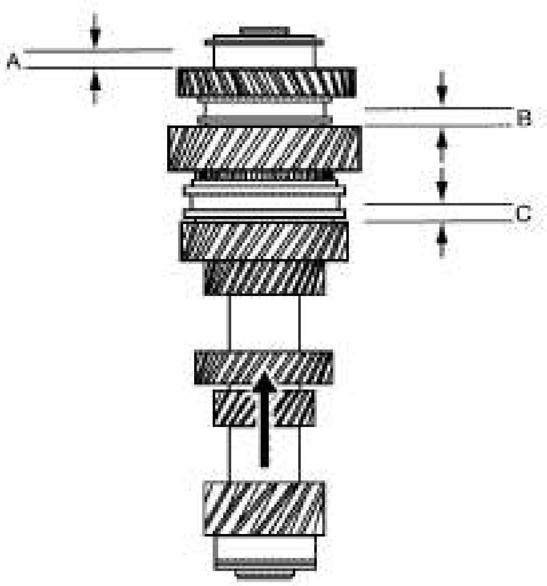
6. Using J 8001-3 or J 26900-12 (1) and J 26900-13 (2), measure the reverse idler gear (3) radial clearance.

   Specification

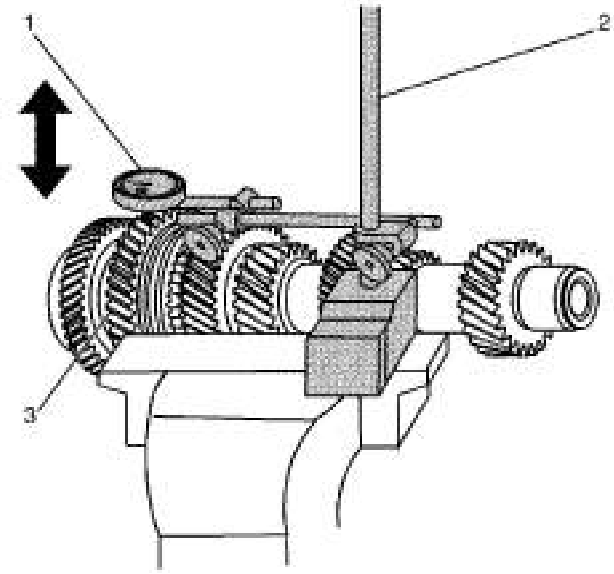
   - Standard Clearance: 0.040-0.082 mm (0.0016-0.0032 in)
   - Maximum Clearance: 0.130 mm (0.0051 in)

7. If the clearance exceeds the maximum, replace the reverse idler gear or the reverse idler gear shaft.

Countershaft



1. Inspect 1st (B), 2nd (A), and reverse gear (C) for axial clearance. Lift up on the gear from the settled position and measure travel. Refer to Transmission Clearance Specifications.

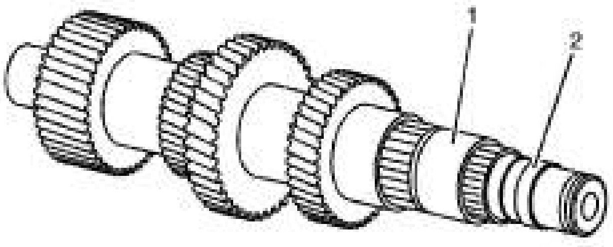


2. Measure the radial clearance for 5th countershaft gear (3).
    1. 2.1. Place the 5th countershaft gear, with the needle roller bearing, on the countershaft journal.
    2. 2.2. Use J 8001-3 or J 26900-12 (1) and J 26900-13 (2).
    3. 2.3. Position J 8001-3 or J 26900-12 on the gear.
    4. 2.4. Move the gear up and down.

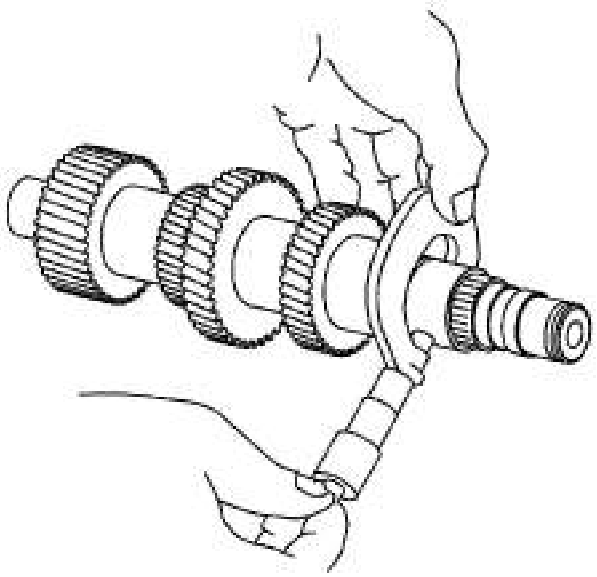
Specification

- Standard Clearance: 0.015-0.068 mm (0.0006-0.0027 in)
- Maximum Clearance: 0.160 mm (0.0063 in)

3. If the clearance exceeds the maximum, replace the gear, the roller bearing, or the countershaft.



4. Clean the countershaft in a suitable solvent and air dry all the parts.
5. Inspect the rear bearing race (1) on the countershaft for the following conditions:
   - Brinelling
   - Wear
   - Scoring
6. Inspect the 5th countershaft gear bearing race (2) for the following conditions:
   - Brinelling
   - Wear
   - Scoring

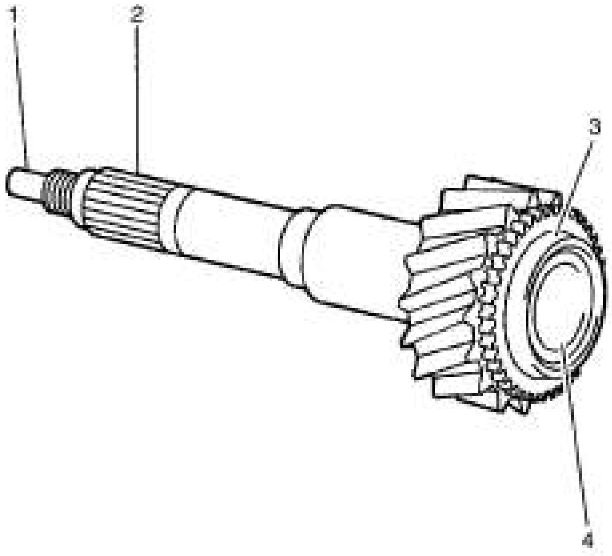


7. Using a micrometer, measure the outer diameter of the countershaft journal.

   Specification
   Minimum diameter: 29.860 mm (1.1756 in)

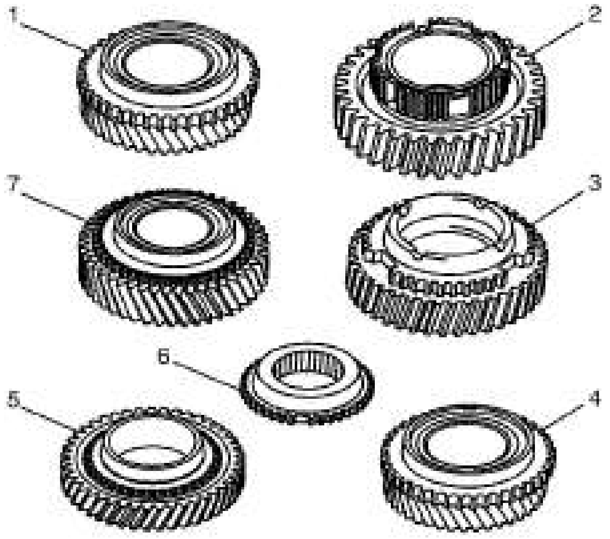
8. Inspect all of the countershaft gears for being faulty following the gear inspection steps.
9. Replace the countershaft if it is faulty.

Output Shaft

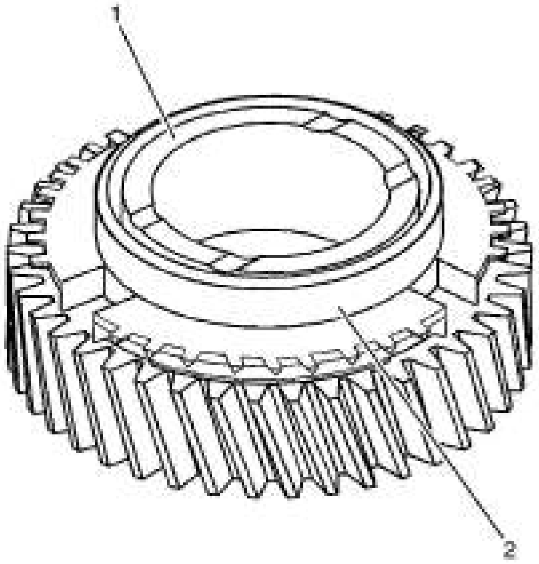


1. Clean the output shaft in a suitable solvent and air dry all the parts.
2. Inspect the pilot bearing journal (1) for wear or scoring.
3. Inspect the clutch disc splines (2) for wear. Steps in the splines may cause concerns with clutch operation.
4. Inspect the synchronizer blocking ring surface (3) for the following conditions:
   - Grooves
   - Excessive wear
   - Heat marks
   - Scoring
5. Inspect the input shaft front support bearing journal (4) for the following conditions:
   - Brinelling
   - Pitting
   - Excessive wear
6. Inspect the gear teeth and selector teeth for being faulty following the gear inspections steps.
7. Replace the output shaft if any of the above conditions are found.

Gears



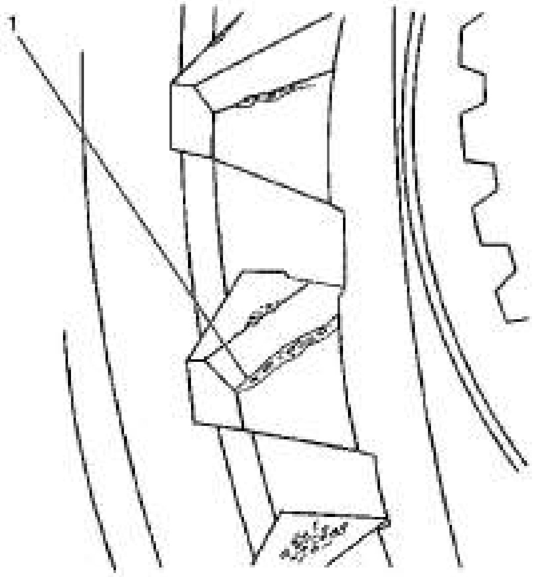
1. Clean the 1st gear (7), the 2nd gear (3), the 3rd gear (1), the 4th gear (4), reverse drive gear (6), the 6th gear (5), the reverse gear (2), and the countershaft gear in a suitable solvent and air dry all the parts.



2. Inspect the thrust surfaces (1) on both sides of the gears for the following conditions:
   - Wear
   - Galling
   - Scoring
3. Replace any gears that have faulty thrust surfaces. Worn thrust surfaces may cause gear clashing or hard shifting, by not allowing full engagement of the synchronizer blocking rings. Worn thrust surfaces may also cause gear noise or may cause clunking during acceleration or deceleration.
4. Inspect the synchronizer blocking ring surface (2) for the following conditions:

- Grooves
- Excessive wear
- Heat marks
- Scoring

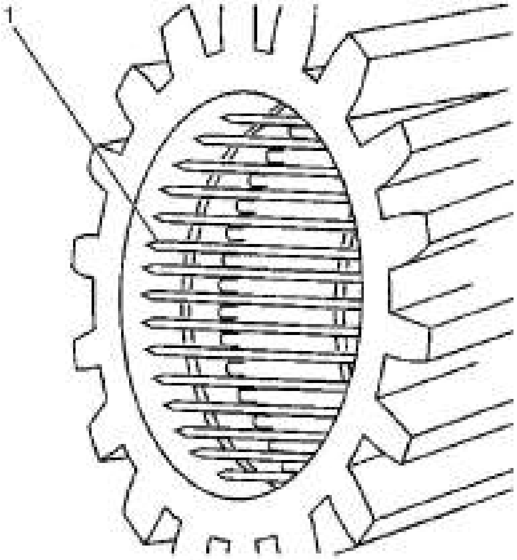
5. Replace any gear that has a faulty blocking ring surface.



6. Inspect the selector teeth of the gears for gear change damage.

   If there is gear change damage, the tooth edges (1) are worn and chipped and, in some cases, affected by plastic deformation because of high shift loads that resemble ragged edges. Such severe deformation of the selector teeth edges causes hard gearshift changes. The spline flanks may also show signs of wear resembling fretting corrosion.

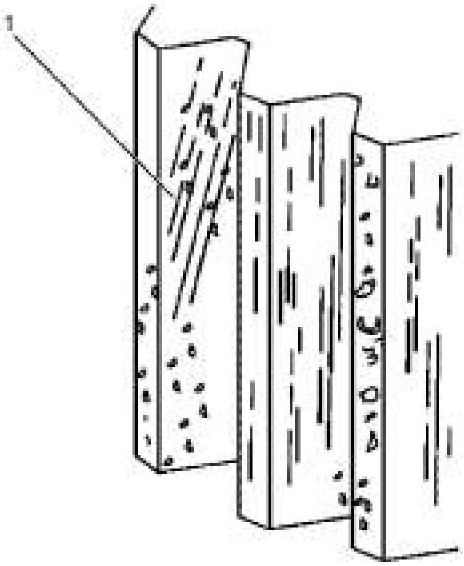
7. If gear change damage is present, replace or repair the affected parts. Gear change damage is caused by any of the following conditions:
   - Corresponding speeds of gears not adequately matched
   - Operating the transmission incorrectly
   - Incorrect clutch operation



8. Inspect the gears for brinelling (1).

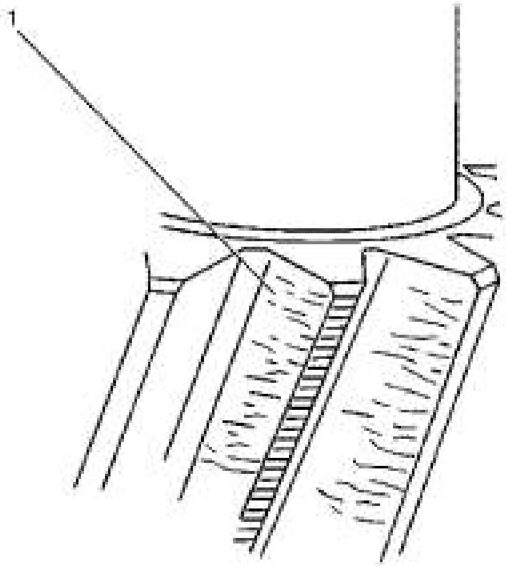
   Brinelling occurs on the roller races of the gears and is characterized by what appears to be the impression of the bearing rollers.

9. Replace any gears showing brinelling.



10. Inspect the gears for break-in-wear or running-in-wear (1).

    Break-in-wear is not considered damage because it usually ceases after the running-in-period has expired, without damaging the components. Rough peaks produced during manufacture are worn away or, to some extent, are rolled into the surface. The grinding and shaving marks (1) on the surface are still visible.



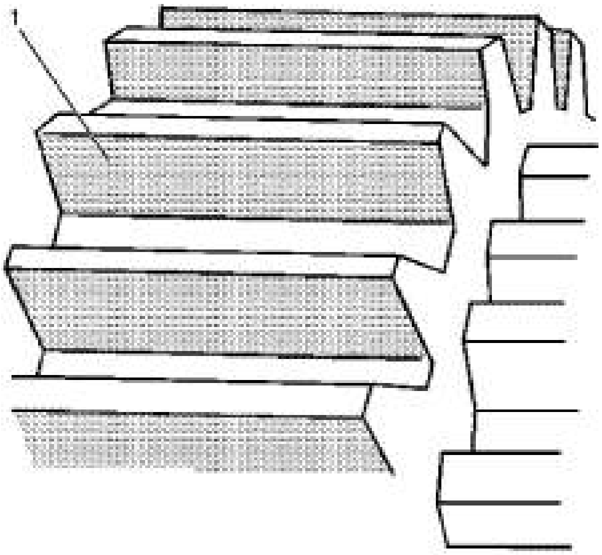
11. Inspect the gear teeth for scratches (1).

    Scratches are linear indentations on the flank, running in the direction of sliding.

12. If scratches are present, replace the affected parts.

    Scratches can be caused by the following conditions:

    - Dust and abrasive particles, including those caused by flank contact, in the lubricating oil.
    - The sliding action of the flanks.



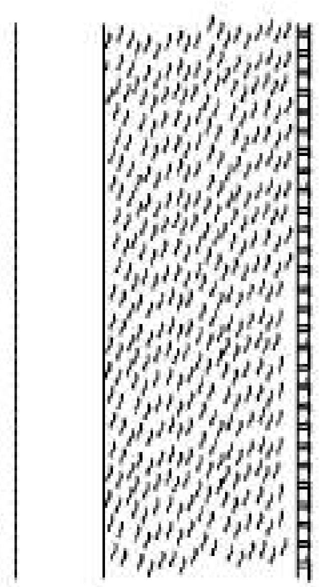
13. Inspect the gear teeth for abrasive wear.

    The marks left by the machining process are erased from the active flank. Instead, the entire flank takes on a matte gray appearance (1). Substantial changes take place in the tooth profile and clearance once abrasive wear has reached an advanced stage. This not only increases the noise level, but can also cause secondary damage.

14. If abrasive wear is present, replace the affected parts.

    Abrasive wear is caused by the following conditions:

    - Oil contamination resulting from wear or surface fatigue in other areas of the transmission.
    - Sand, sludge, etc. penetrating into the transmission from the outside.



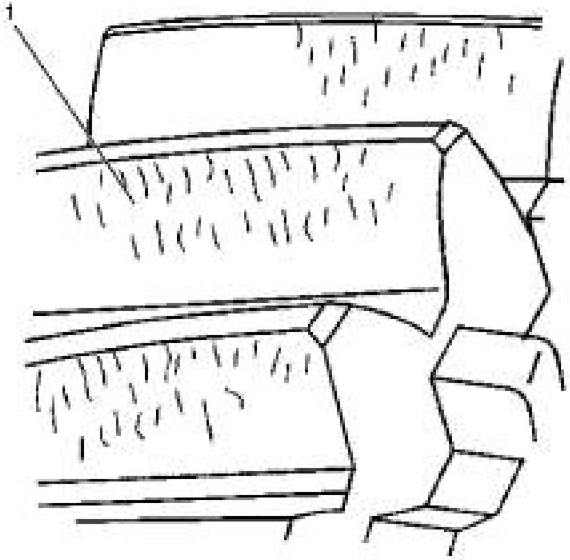
15. Inspect the gear teeth for rippling or brinelling.

    The polished tooth flanks show signs of ripple-like alterations in the surface structure, which run perpendicular to the direction of sliding, and may resemble a washboard.

16. If rippling or brinelling is present, replace the affected parts.

    Rippling or brinelling is caused by the following conditions:

    - A combination of inadequate lubrication, high flank loads and low peripheral speeds
    - Friction-induced vibration



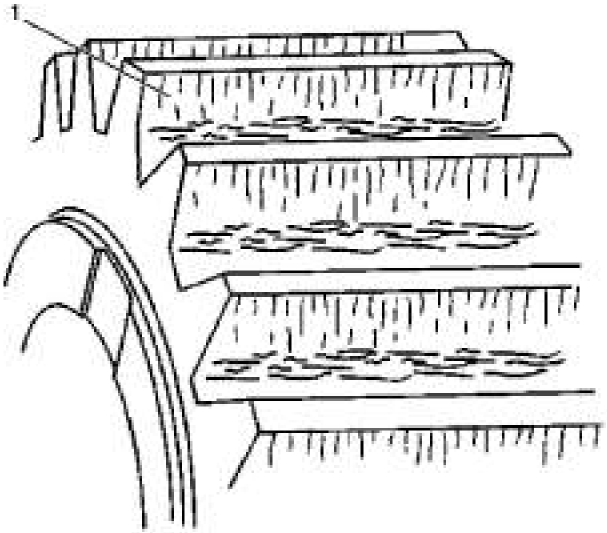
17. Inspect the gear teeth for light scoring (1).

    Light scoring is identified as rough, partially porous lines or areas aligned in the direction of sliding. When the film of lubricant is torn away between the flanks, this permits direct metal-to-metal contact causing seizure or welding. These welded zones are immediately torn apart again, producing the damage associated with scoring. Scoring initially occurs in areas subjected to high hertz frequency stresses and high sliding speeds, usually along the tooth root and tooth tip. Light scoring only covers a part of the entire surface of the flank, or is not strongly developed and has caused only insignificant wear after smoothing.

18. If light scoring is present, replace the affected parts.

    Light scoring is caused by the following conditions:

    - Inadequate oil viscosity.
    - Unfavorable gear geometry.
    - Temporary lack of lubricant.
    - Surface roughness.
    - Faulty heat treatment of the gears.



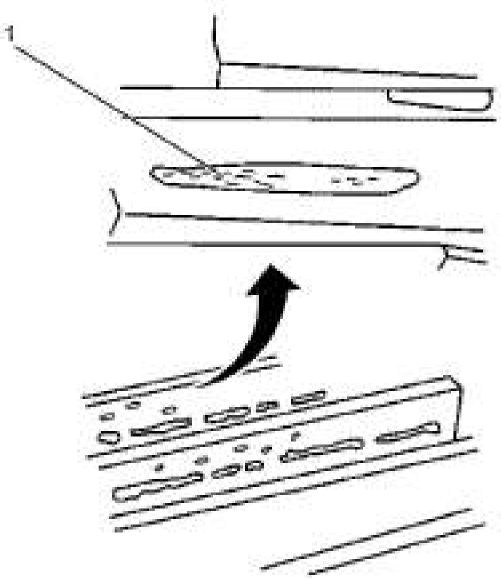
19. Inspect the gear teeth for severe scoring (1).

    Severe scoring is the same as light scoring, except large areas of the tooth flank are affected. At an advanced stage, the flank may heat up to such an extent that localized discoloring occurs.

20. If severe scoring is present, replace the affected parts.

    Severe scoring is caused by the following conditions:

    - Inadequate oil viscosity.
    - Unfavorable gear geometry.
    - Temporary lack of lubricant.
    - Surface roughness.
    - Faulty heat treatment of the gears.



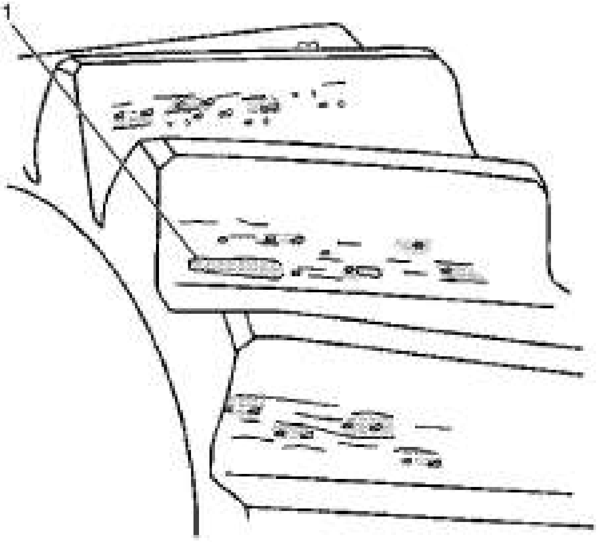
21. Inspect the gears for flank fatigue (1), causing gray spots.

    Gray spots are localized pittings on the flank caused by material fatigue and extremely fine pittings formed on the load-bearing flanks. If they are in cluster, they appear to the naked eye as matte gray staining. Under high magnification, a large number of microscopic cracks become visible on the flank. Pittings originating from these cracks may create the appearance of local flank wear. Most of the gray spots are located in the root zone of the gear teeth.

22. If gray spots are present, replace the affected parts.

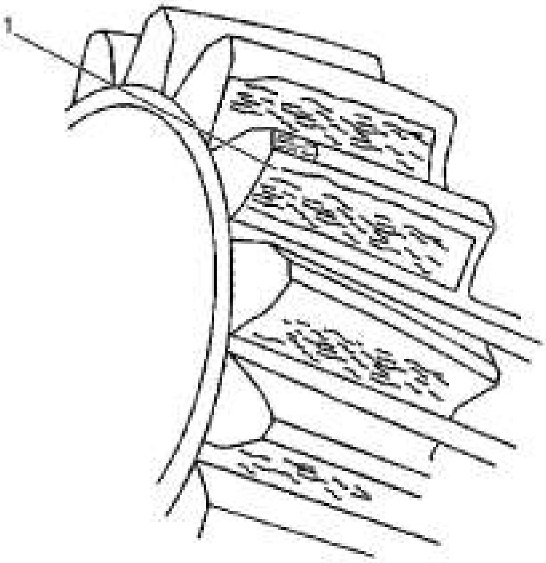
    Gray spots are caused by the following conditions:

    - Material fatigue.
    - Contact pressure.
    - Sliding movement.
    - Composite friction.



23. Inspect the gear teeth for slight pittings (1).

    Slight pittings are identified as pore-like areas of individual pittings on the flank caused by material fatigue. Usually, slight pittings are only present in the root zone of the flank. Slight pittings may cease after run-in. A change in operating conditions may also stop continued development of slight pitting.



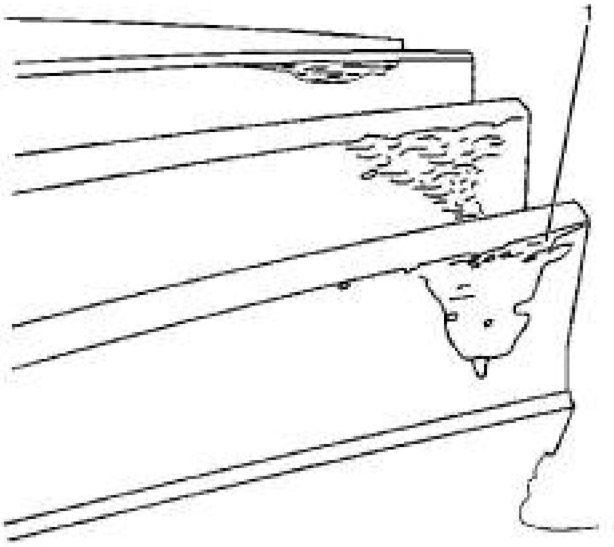
24. Inspect the gear teeth for pittings (1).

    Pittings are material fatigue on the flank (1). The total pitting surface may become so large that smooth running is considerably impaired, or the remaining flank face still bearing the load will soon be destroyed by wear.

25. If pittings are present, replace the affected parts.

    Pitting is caused by the following conditions:

    - Exceeding the sliding and rolling stresses for the material.
    - Incorrect oil viscosity.
    - Excessive operating temperature.



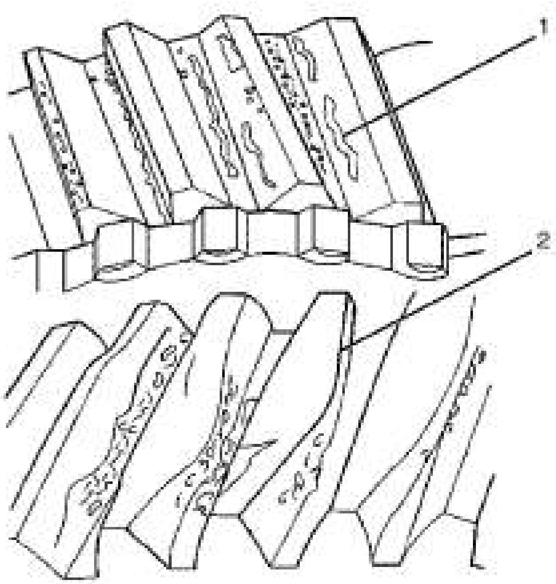
26. Inspect the gears for spalling (1).

    Spalling is extensive triangular pits on the flank, spreading from a zone of gray spots or a fine line of pits at the root. The depth of the exposed surface is relatively constant throughout. Further cracks may extend from the pits at an angle. In some cases, the damage may even progress into the tip zone, causing tip damage.

27. If spalling is present, replace the affected parts.

    Spalling is caused by the following conditions:

    - Exceeding the sliding and rolling stresses for the material.
    - Incorrect oil viscosity.
    - Excessive operating temperature.



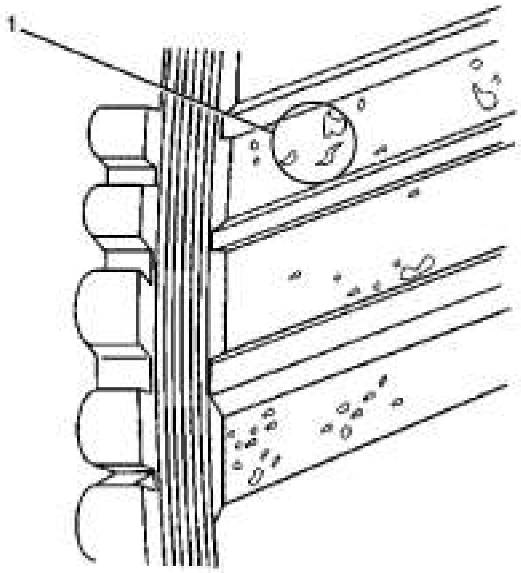
28. Inspect the gears for damage from overheating.

    Overheating damage is identified by grayish to bluish black discoloration of the gear, burnt oil, and reduced hardness. Due to the reduction in hardness, there is scored or grooved flank wear in the direction of sliding (1), particularly in the tip and root zones. If there is extreme overheating, the material softens, causing distortion of the gear teeth (2), bending the teeth from thermal distortion.

29. If damage from overheating is present, replace or repair the affected parts.

    Overheating is caused by the following conditions:

    - Temporary or complete lack of lubrication - low oil level.
    - Very high peripheral speeds.
    - Insufficient tooth clearance.



30. Inspect the gears for corrosion (1).

    Corrosion is brownish red to black spots (1), sometimes with local material loss on the flank. If corrosion has not caused material loss to the flank, the sliding and rolling action of the flank can help to remove some of the corrosion.

31. If corrosion is severe, replace the affected parts.

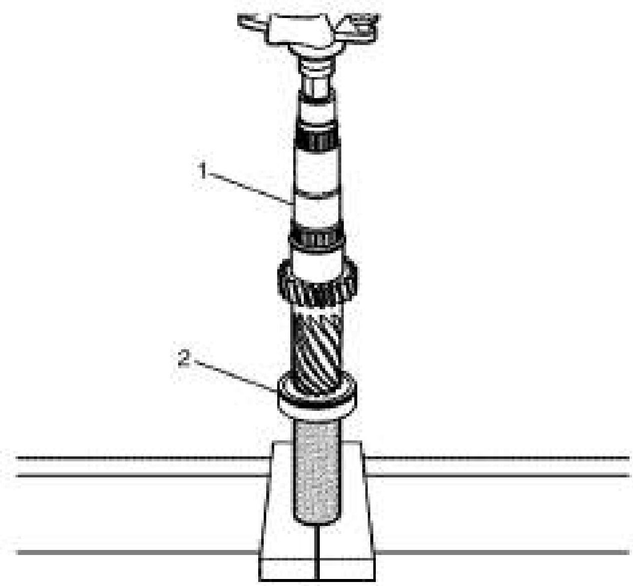
    Corrosion is caused by the following conditions:

    - Water or salt water entering the transmission.
    - Condensation forming under unfavorable operating conditions.
    - Oil aging and the decomposition of corrosion inhibitors.

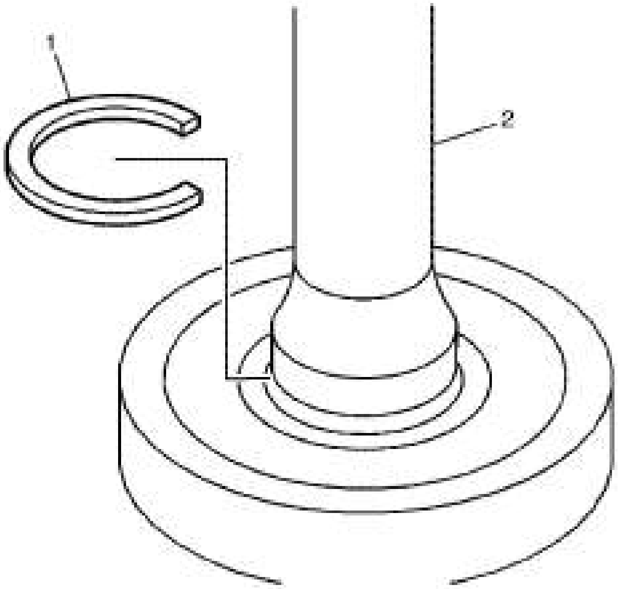
Input Shaft Assemble

Tools Required

DT-47723 Output Shaft Bearing Installer

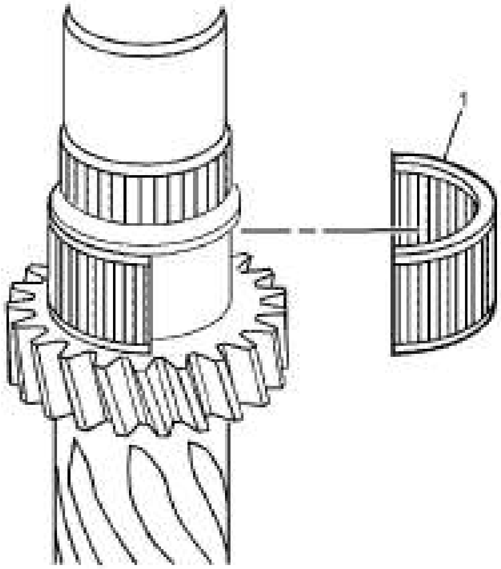


1. Using a hydraulic press and a suitable tool, install the counter gear front bearing (2) on the input shaft (1).

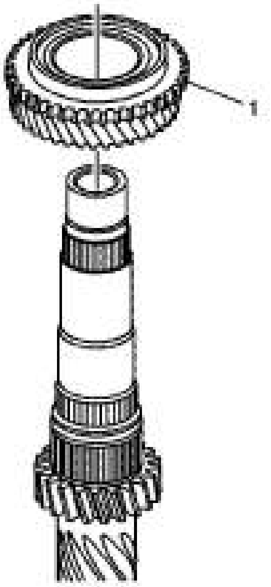


Important: The retaining ring is a selected fit. Always install a NEW snap ring.

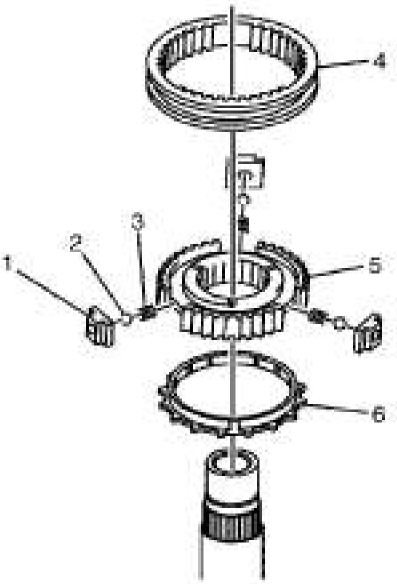
2. Select the maximum thickness snap ring (1) that will fit in the groove. Refer to Input Shaft Bearing Retaining Ring Specifications.
3. Install a NEW snap ring (1) and ensure that the radial bearing rotates smoothly.



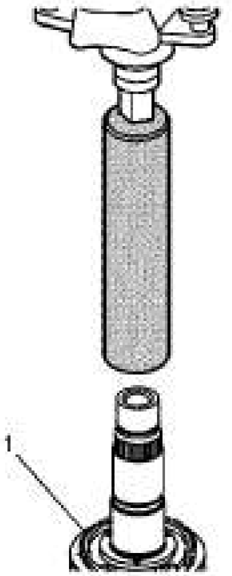
4. Apply an approved lubricant and install the 4th gear bearing (1) to the input shaft.



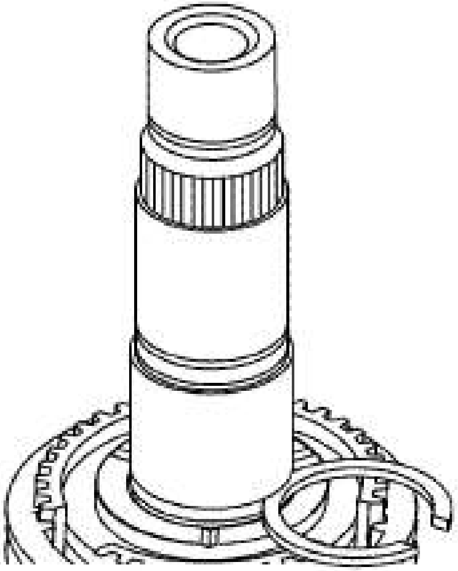
5. Apply an approved lubricant and install the 4th gear (1) input shaft.



6. Apply an approved lubricant and install the following components:
   - the blocking ring (6)
   - the 3rd/4th gear synchronizer hub (5) including the spring (3), detent ball (2) and insert (1)
   - the 3rd/4th gear synchronizer sleeve (4) with the higher boss facing the front

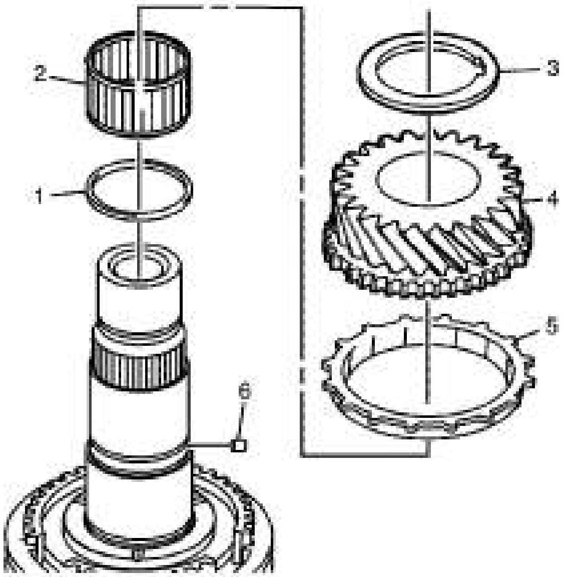


7. Using a hydraulic press and DT-47723 , install the 3rd/4th synchronizer hub assembly (1).



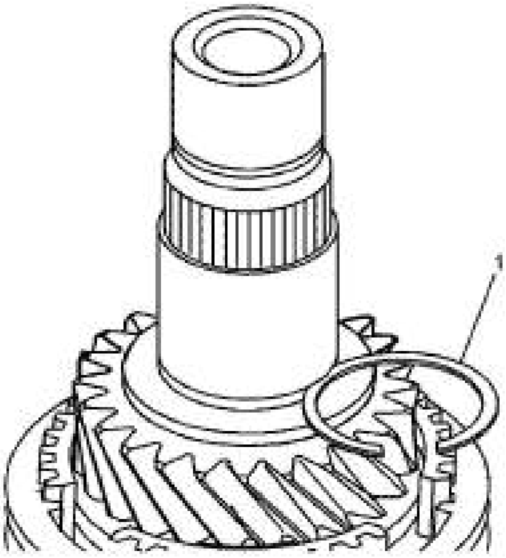
Important: The retaining ring is a selected fit. Always install a NEW snap ring.

8. Select the maximum thickness snap ring (1) that will fit in the groove. Refer to 3rd and 4th Gear Synchronizer Retaining Ring Specifications.
9. Install a NEW snap ring (1) to the input shaft.



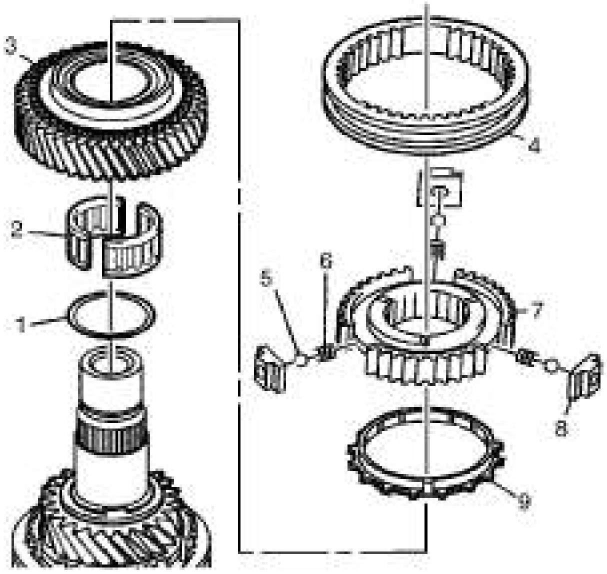
10. Apply an approved lubricant to the components and install the following components:
    - 3rd/4th gear spacer (1)
    - 3rd gear bearing (2)
    - 3rd gear blocking ring (5)
    - Install and align the 3rd gear (4)

- Locating pin (6)
- Install and align the 3rd gear thrust washer (3)



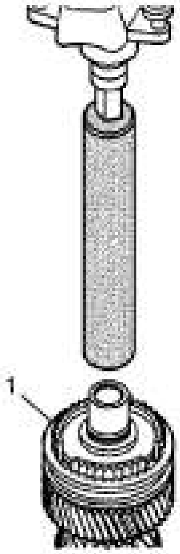
Important: The retaining ring is a selected fit. Always install a NEW retaining ring.

11. Select the maximum thickness snap ring (1) that will fit in the groove. Refer to 3rd and 4th Gear Synchronizer Retaining Ring Specifications.
12. Install a NEW snap ring (1) to the input shaft.

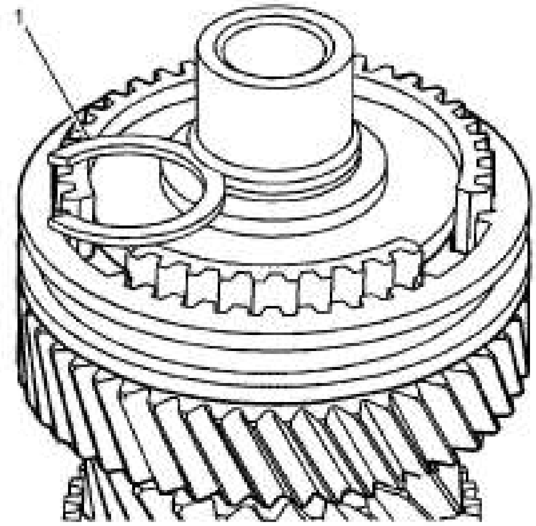


13. Install the 6th gear bearing spacer (1).
14. Apply an approved lubricant and install the 6th gear bearing (2).
15. Apply an approved lubricant and install the 6th gear (3).
16. Apply an approved lubricant and install the 6th gear blocking ring (9).

17. Apply an approved lubricant and install the 5th/6th gear synchronizer hub (7) including the spring (6), detent ball (5) and insert (8).
18. Apply an approved lubricant and install the 5th/6th synchronizer sleeve (4) with higher boss of sleeve facing the rear.



19. Use a hydraulic press and DT-47723 to install the 5th/6th synchronizer hub assembly (1).



Important: The retaining ring is a selected fit. Always install a NEW snap ring.

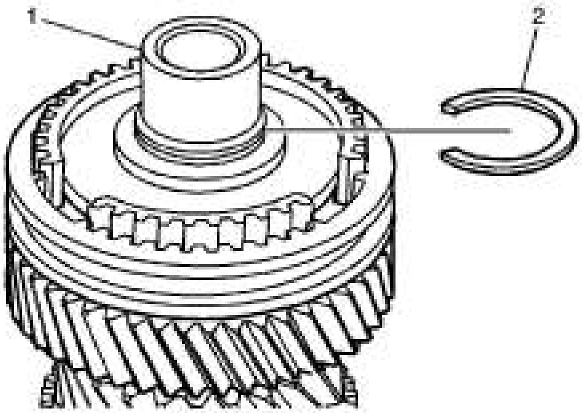
20. Select the maximum thickness snap ring (1) that will fit in the groove. Refer to 6th Gear Retaining Ring Specifications.
21. Install a NEW snap ring (1) to the input shaft.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Manual Transmission - Aisin AY6 | Repair Instructions - Off Vehicle | **Document ID: 1996666**

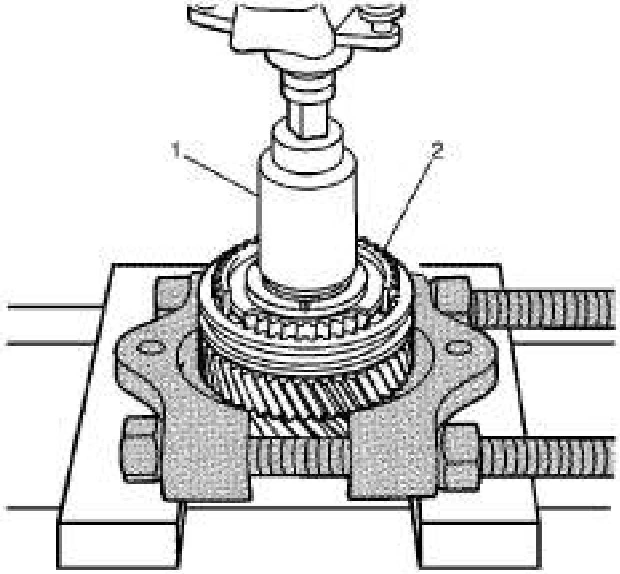
Input Shaft Disassemble

Tool Required

J-22912-01 Split Plate Bearing Puller

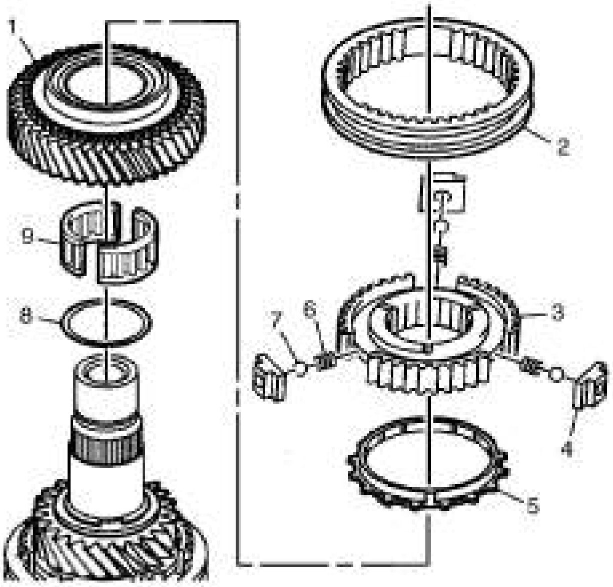


1. Remove the 5th/6th gear synchronizer hub to input shaft (1) snap ring (1).



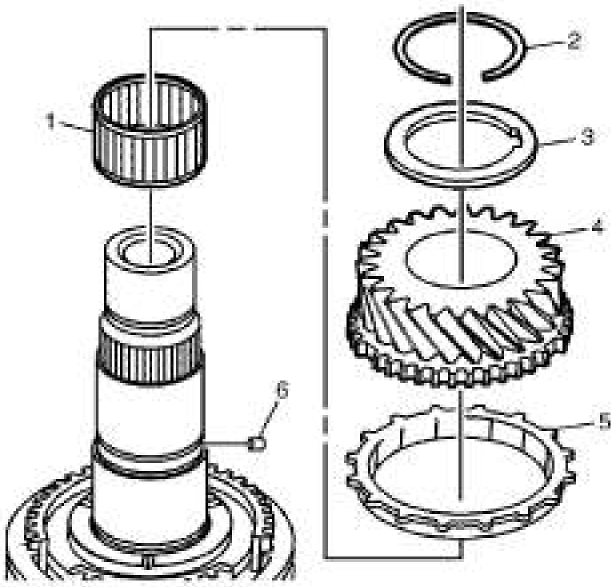
Important: Place the edge of gear on press plate.

2. Using a hydraulic press and J-22912-01 , remove the 6th gear and the synchronizer (2) as a unit.

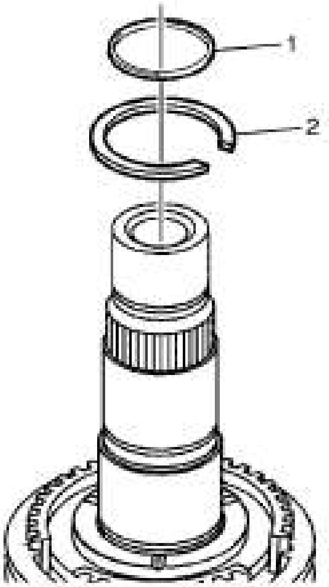


Important: Before removing sleeve (2), cover components in order to keep the ball and spring from ejecting loose.

3. Remove the following components from the input shaft as an assembly:
    - the 5th/6th gear synchronizer sleeve (2)
    - the 5th/6th gear synchronizer hub (3) including insert (4), detent ball (7) and spring (6)
    - the 5th gear synchronizer blocking ring (5)
    - the 6th gear (1)
    - the 6th gear bearing (9)
    - the 6th gear bearing spacer (8)

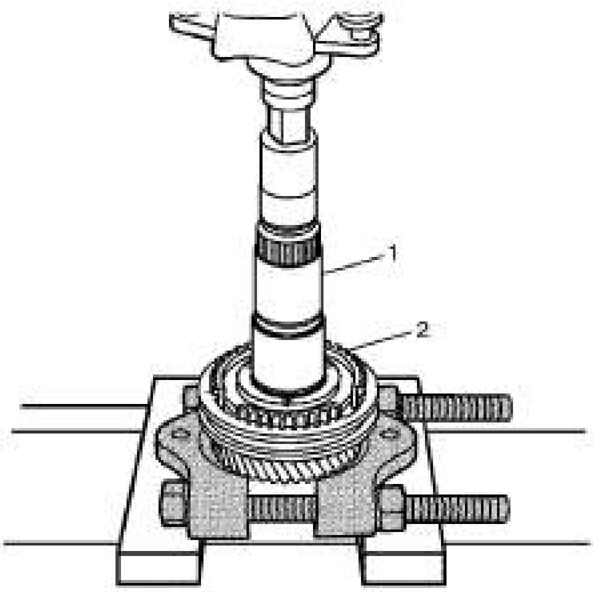


4. Remove the 6th gear to input shaft snap ring (2).
5. Remove the 3rd gear to input shaft thrust washer (3).
6. Remove the input shaft thrust washer locating pin (6).
7. Remove the 3rd gear assembly which includes:
   - the 3rd gear (4)
   - the 3rd gear blocking ring (5)
8. Remove the 3rd gear bearing (1).



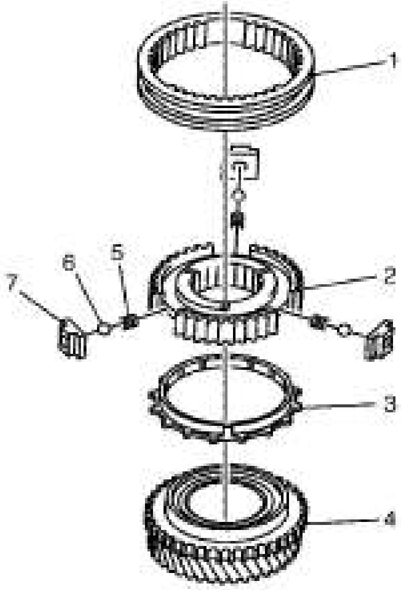
9. Remove the 3rd/4th gear spacer (1) from the input shaft.
10. Remove the 4th gear to input shaft snap ring (2) and discard.

    Discard the snap ring.



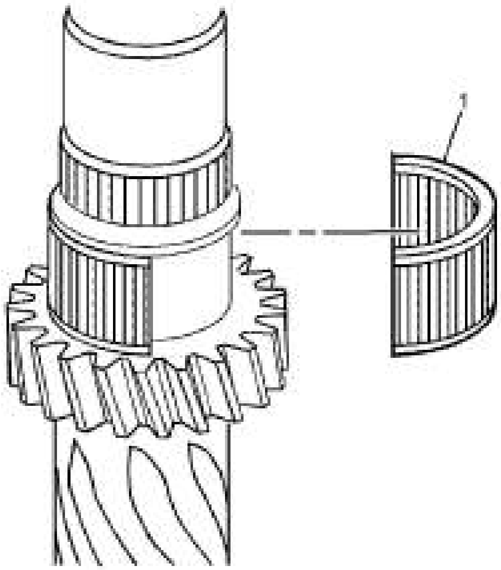
Important: Place the edge of gear on press plate.

11. Using a hydraulic press and J-22912-01 , remove the 4th gear and the synchronizer as a unit from the input shaft (1).

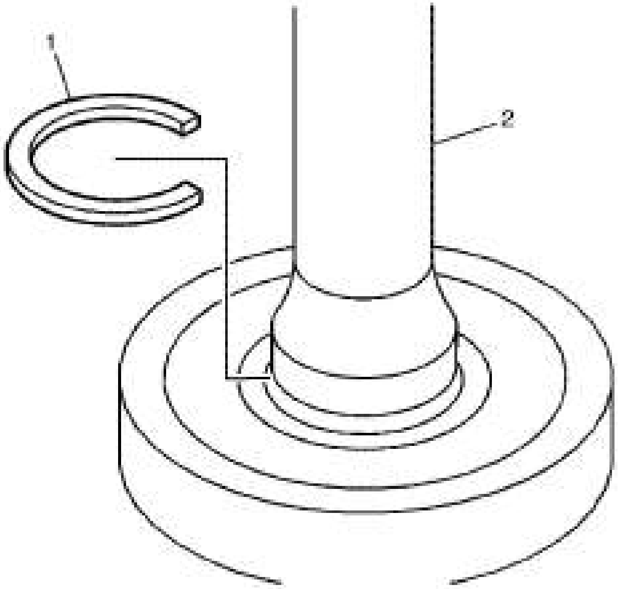


Important: Before removing sleeve (1), cover components in order to keep the ball and spring from ejecting loose.

12. Remove the following components as an assembly:
    - the 3rd/4th gear synchronizer sleeve (1)
    - the 3rd/4th gear synchronizer hub (2) including insert (7), detent ball (6) and spring (5)
    - the 4th gear blocking ring (3)
    - the 4th gear (4)

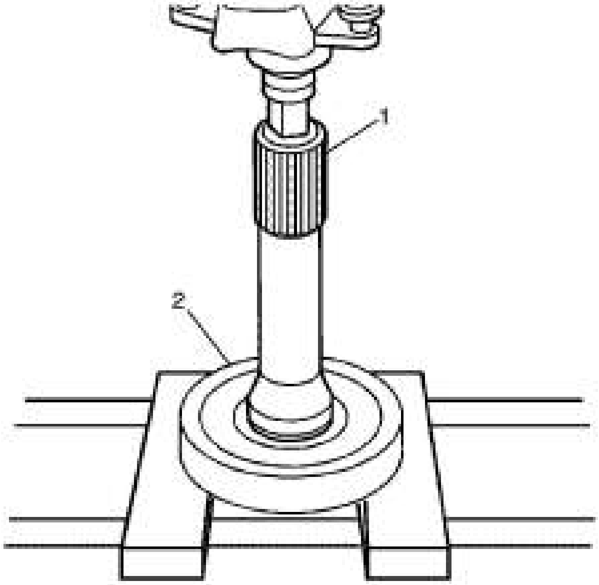


13. Remove the 4th gear bearing (1) from the input shaft.



14. Remove the input shaft snap ring (1) and discard.

    Discard the snap ring.

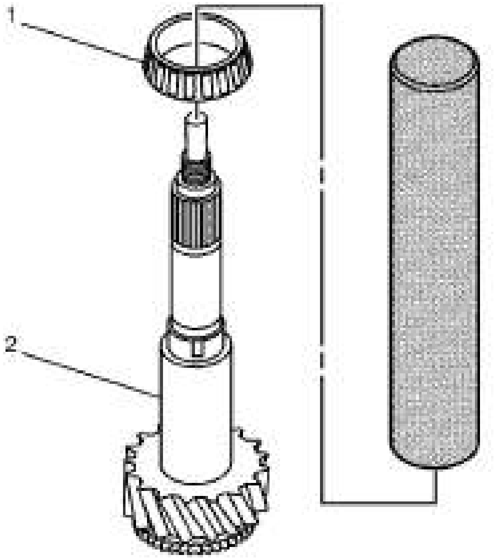


15. Using a hydraulic press, remove the counter gear front bearing (2) from the input shaft (1).

Output Shaft Assemble

Tools Required

DT-47723 Output Shaft Bearing Installer

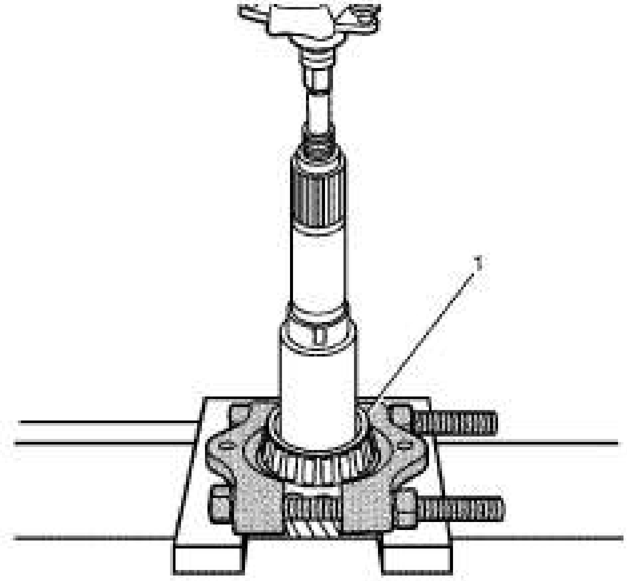


Using DT-47723 , install the output shaft bearing (1) to the output shaft (2).

Output Shaft Disassemble

Tools Required

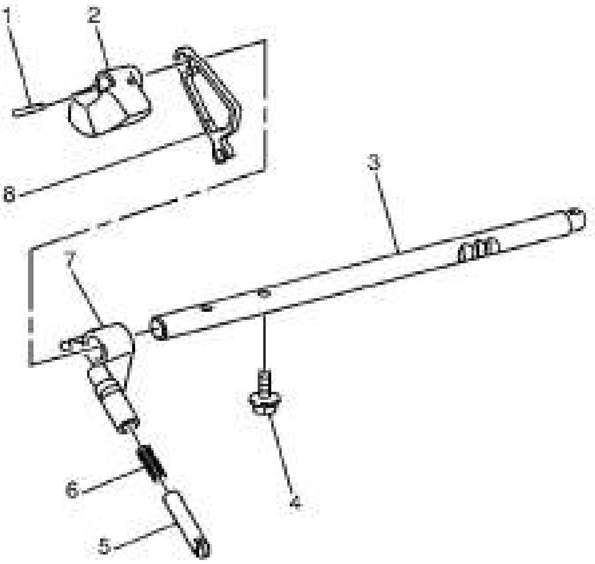
1. J-22912-01 Split Plate Bearing Puller



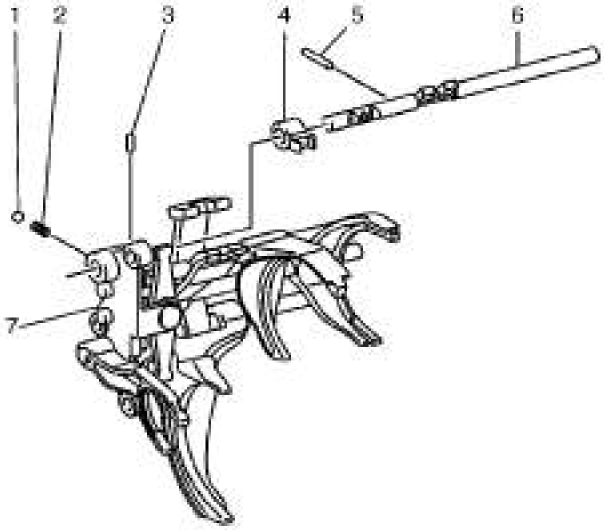
2. Using a hydraulic press and J-22912-01 , remove the tapered roller bearing (1) from the output shaft.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Manual Transmission - Aisin AY6 | Repair Instructions - Off Vehicle | **Document ID: 1985107**

Shift Shaft and Shift Fork Cleaning and Inspection

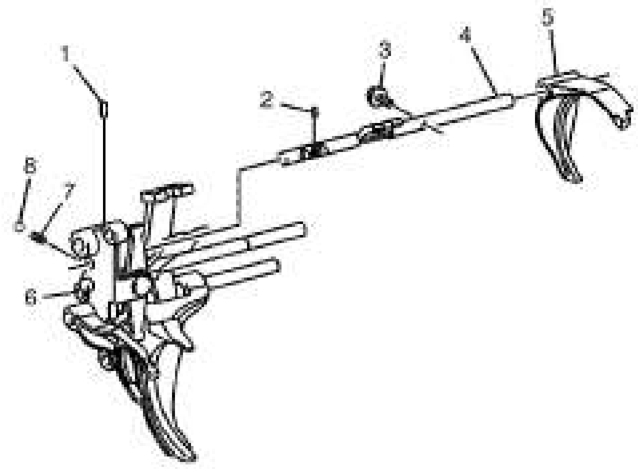


1. Using a suitable tool, remove the pin (1) from the dynamic damper weight (2).
2. Remove the shift shaft detent cam (8) and the weight (2) from the shift control shaft (3).
3. Remove the shift shaft detent (5) and the shift shaft detent spring (6).
4. Remove the bolt (4) from the shift shaft detent lever (7).
5. Remove the shift shaft detent lever (62) from the shift control shaft (66).



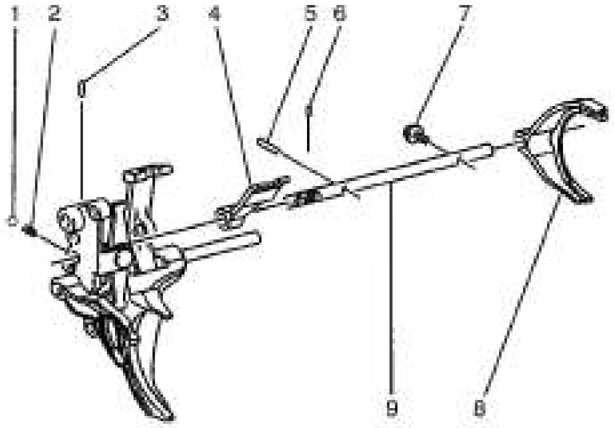
Important: The shift detent ball (1) and spring (2) will come out of the shift control lever when the 1st/2nd shift shaft (6) is removed.

6. Remove the 1st/2nd shift fork pin (5).
7. Remove the 1st/2nd shift shaft (6).
8. Remove the slotted pin (5) from the select control lever assembly (4). Slide the select control lever assembly (4) from the 1st/2nd shift shaft (6).
9. Using a suitable tool, remove the pin (3) from the shift control lever bracket (7).



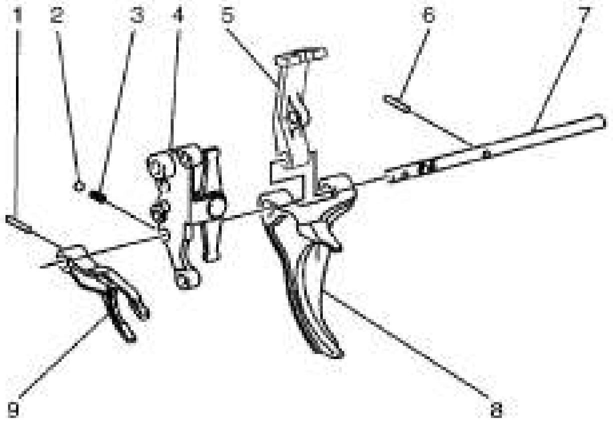
Important: The shift detent ball (8) and spring (7) will come out of the shift control lever bracket (6) when the 3rd/4th shift shaft (4) is removed.

10. Remove the bolt (3) from the 3rd/4th shift fork (5).
11. Remove the 3rd/4th shift shaft (4).
12. Remove the shift fork (5).
13. Using a suitable tool, remove pins (2 and 1).



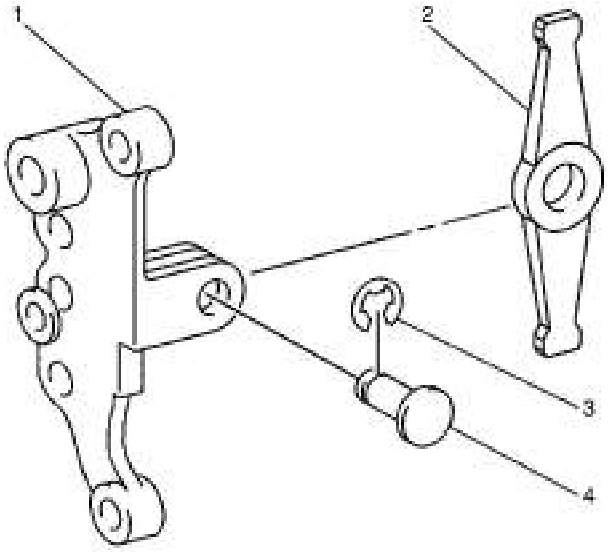
Important: The shift detent ball (1) and spring (2) will come out of the shift control lever bracket when the 5th/6th shift shaft (9) is removed.

14. Remove the bolt (7) from the 5th/6th shift fork (8). Slide the 5th/6th shift fork (8) from the 5th/6th shift shaft (9).
15. Remove the 5th/6th shift shaft (9).
16. Using a suitable tool, remove the pin (5) from the shift lever assembly (4). Slide the shift lever assembly (4) from the 5th/6th shift shaft (9).
17. Using a suitable tool, remove pins (6 and 3).

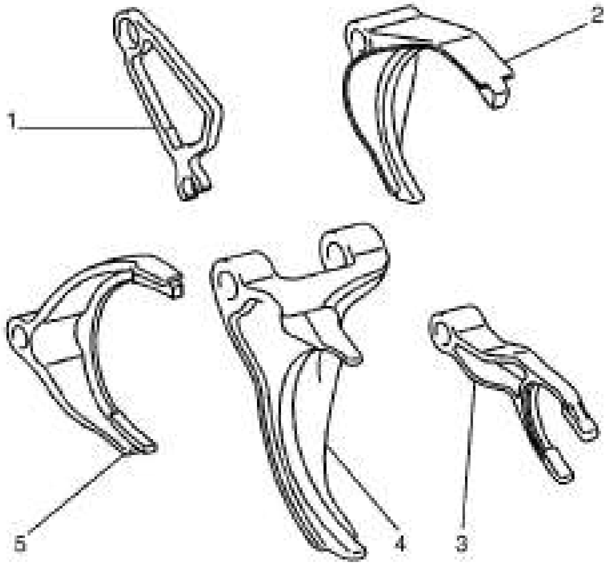


Important: The shift detent ball (2) and spring (3) will come out of the shift control lever bracket (4) when the reverse shift shaft (7) is removed.

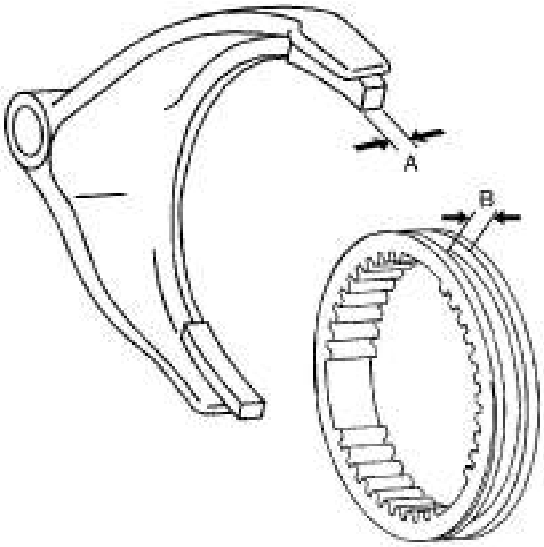
18. Using a suitable tool, remove the slotted pin (1) from the reverse shift fork (9). Slide the reverse shift fork (9) off the reverse shift shaft (7).
19. Remove the reverse shift shaft assembly.
20. Using a suitable tool, remove the slotted pin (6) from the intl shift control lever (5). Slide the intl shift control lever (5) and 1st/2nd shift fork assembly (8) from the reverse shift shaft (7).



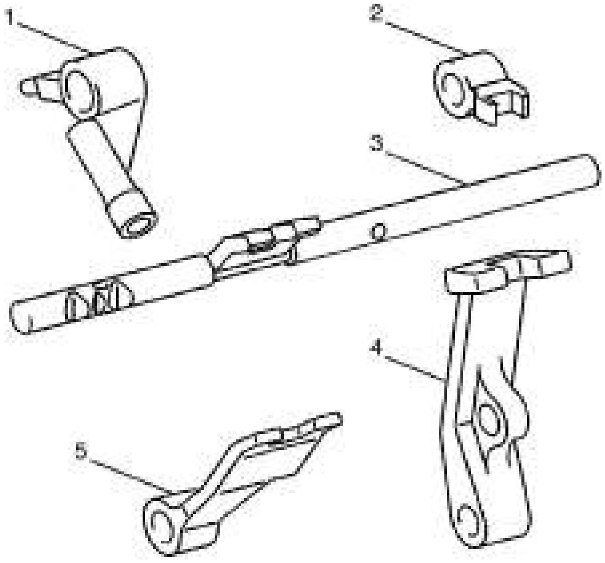
21. Remove the E-clip (3) and pull the control select arm pin (4) from the shift control lever bracket (1).
22. Remove the control select arm (2) from the shift control lever bracket (1).



23. Inspect the shift shaft detent cam (1), shift forks (2), (5), (3) and assembly (4) for:
    - A bent fork
    - For wear
    - Cracks

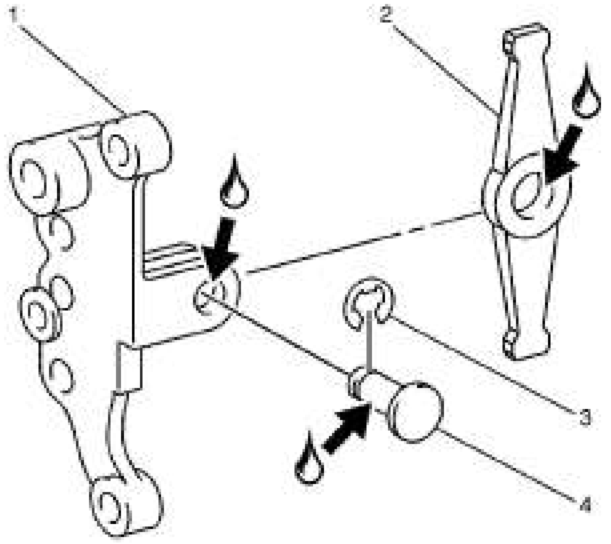


24. Measure the fork width (A) and sleeve groove width (B) for wear. If synchronizer sleeve to shift fork width clearance exceeds the maximum, replace the synchronizer sleeve and/or shift fork. Refer to Transmission Clearance Specifications.

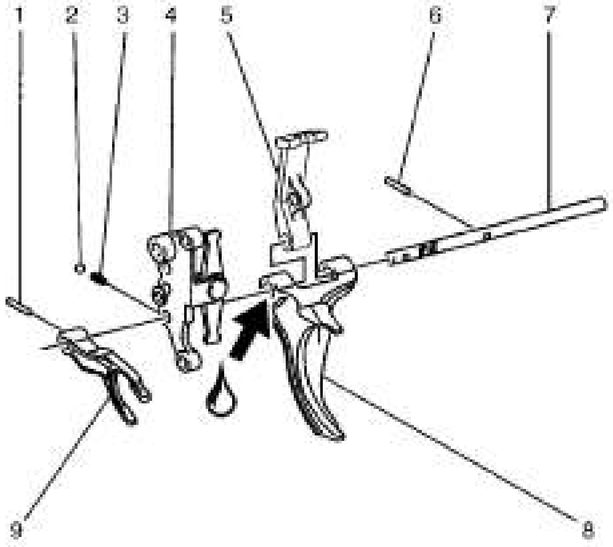


25. Inspect the shift shaft detent lever (1), assembly (4 and 2), shift shaft (3) and control lever (4) for:
    - A bent fork
    - For wear
    - Cracks

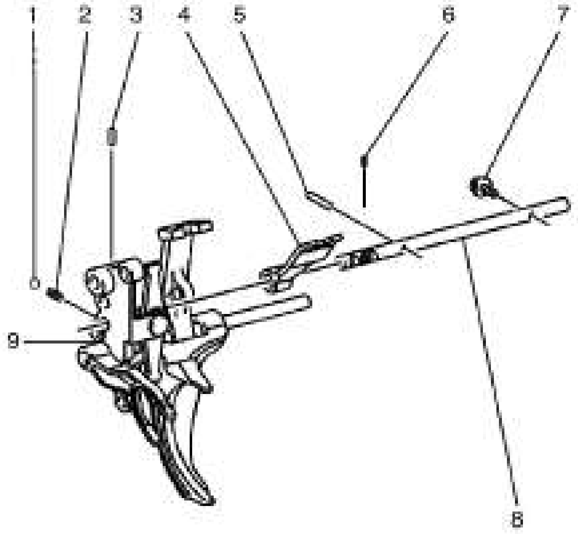
Shift Shaft and Shift Forks Assemble



1. Apply an approved lubricant and install the control select arm (2) into the shift control lever bracket (1).
2. Apply an approved lubricant and install the control select arm pin (4).
3. Install the E-clip (3) to the control select arm pin.



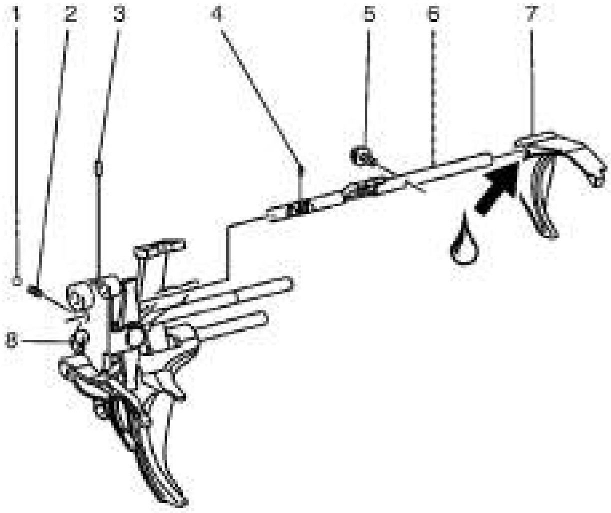
4. Apply an approved lubricant and slide the internal shift control lever (5) and 1st/2nd shift fork assembly (8) onto the reverse shift shaft (7). Install the slotted pin (6) into the lever (5).
5. Install the slotted pin (6) into the internal shift control lever (5).
6. Install the shift control lever bracket (4) onto the reverse shift shaft (7).
7. Slide the reverse shift fork (9) onto the reverse shift shaft (7). Install the slotted pin (1) into the reverse shift fork (9).
8. Install the spring (3) and shift detent ball (2) into the bracket (4).



9. Install the pin (3) into the shift control lever bracket (9).
10. Install the pin (6) into the 5th/6th shift shaft (8).
11. Install the 5th/6th shaft (8) into the hole in the shift lever assembly (4).
12. Install a NEW bolt (7) into the shift lever assembly (4).

    Tighten
    Tighten the bolt to 19 N·m (14 lb ft).

13. Install the 5th/6th shift shaft (8) into the shift control lever bracket (9).

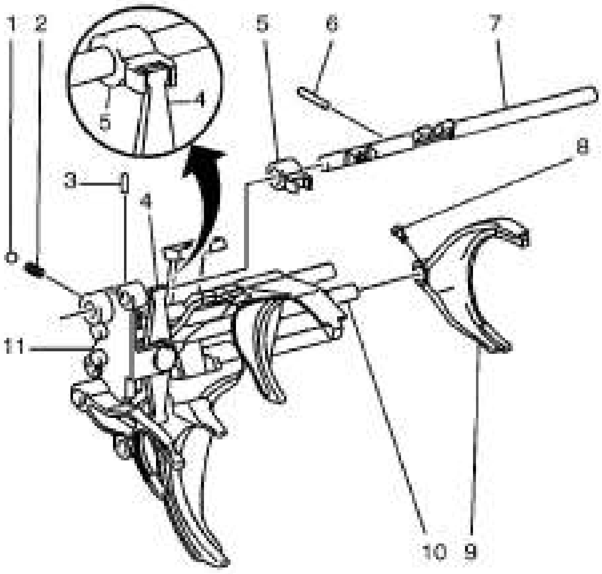


14. Apply an approved lubricant and slide the 3rd/4th shift fork (7) onto the 3rd/4th shift shaft (6). Install a NEW bolt (5) into the 3rd/4th shift fork (7).

    Tighten

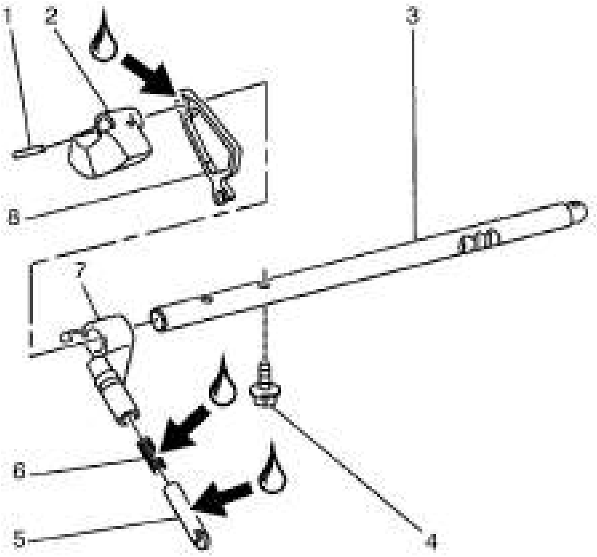
Tighten the bolt to 19 N·m (14 lb ft).

15. Insert the spring (2) and the shift detent ball (1) into the shift control lever bracket (8).
16. Install the pin (4) into the 3rd/4th shift shaft (6).
17. Install pin (3) into the shift control lever bracket (8).
18. Install the 3rd/4th shift shaft (6) into the shift control lever (8).



19. Install the spring (2) and detent ball (1) into the shift control lever bracket (11).
20. Install the pin (3) into the shift control lever bracket (11).
21. Install the groove of select control lever assembly (5) into the projection of the control select arm (4).
22. Slide the 1st/2nd shift shaft (7) into the shift control lever (5), and the shift control lever bracket (11).
23. Install pin (6) into the 1st/2nd shift shaft (7).
24. Install the 5th/6th shift fork (9) onto the 5th/6th shift shaft (10) and retain with a new bolt (8).

Tighten
Tighten the bolt to 19 N·m (14 lb ft).



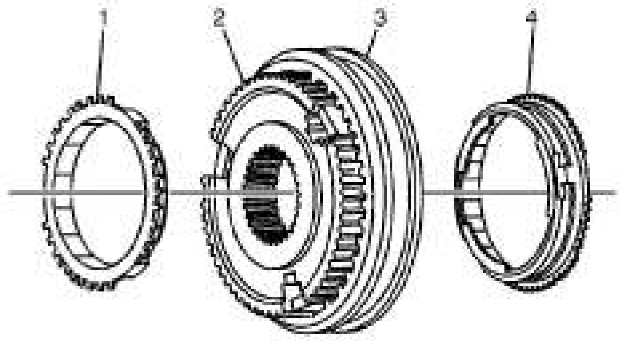
25. Slide the shift shaft detent lever (7) onto the shift control shaft (3).
26. Install a NEW bolt (4) into the shift shaft detent lever (7).

    Tighten
    Tighten the bolt to 19 N·m (14 lb ft).

27. Apply an approved lubricant and insert the shift shaft detent spring (6) and the shift shaft detent (5) into the lever (7).
28. Apply an approved lubricant and slide the shift shaft detent cam (8) onto the shift control shaft (3).
29. Insert the assembled shift shaft detent lever assembly (7, 6, 5) into the opening in the shift shaft detent cam (8).
30. Install the dynamic damper weight (2) onto the shift control shaft (3).
31. Insert the pin (1) into the dynamic damper weight (2).
32. Check the function of assembled components. The shift shaft detent (5) should slide on the shift shaft detent cam (8).

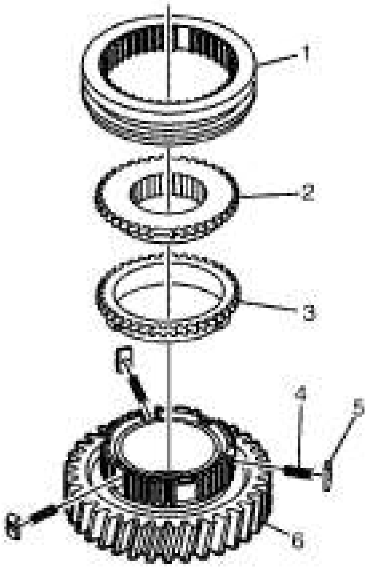
Synchronizers Assemble

5th / 6th Gear Synchronizer



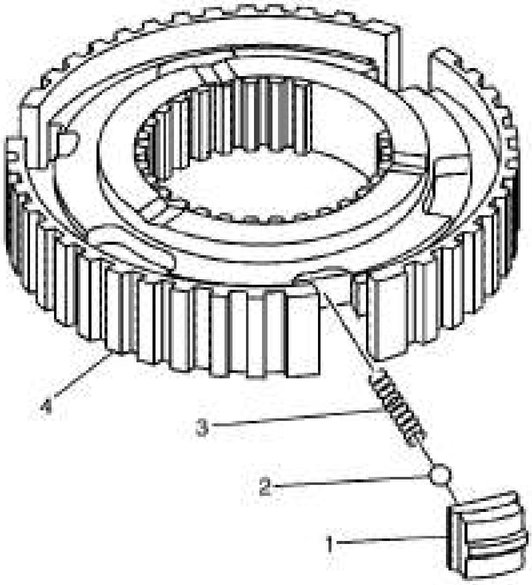
Important: Ensure that the hub slides easily.

1. Apply an approved lubricant to the 5th/6th synchronizer hub. Install the following components into the 5th/6th synchronizer hub (2 and 3):
   - the 5th gear blocking ring (4)
   - the 6th gear blocking ring (1)

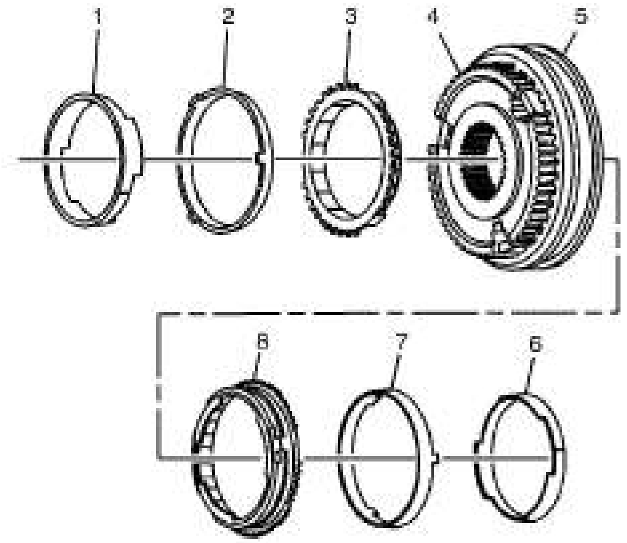


2. Apply an approved lubricant to the blocking ring (3), driven gear (2) and sleeve (1). Install the following components into the reverse gear (6):
   - the reverse gear insert (5) and the spring (4)
   - the reverse gear blocking ring (3)
   - the reverse driven gear (2)
   - the synchronizer sleeve (1)

1st / 2nd, 3rd / 4th Gear Synchronizer

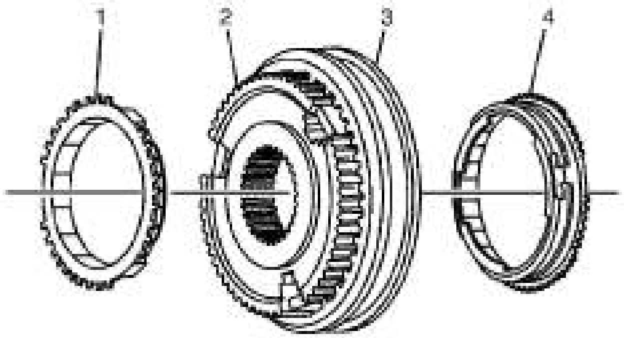


1. Install the synchronizer insert (1) and spring (3) into the synchronizer hub (4). Press the spring and slide the insert in.



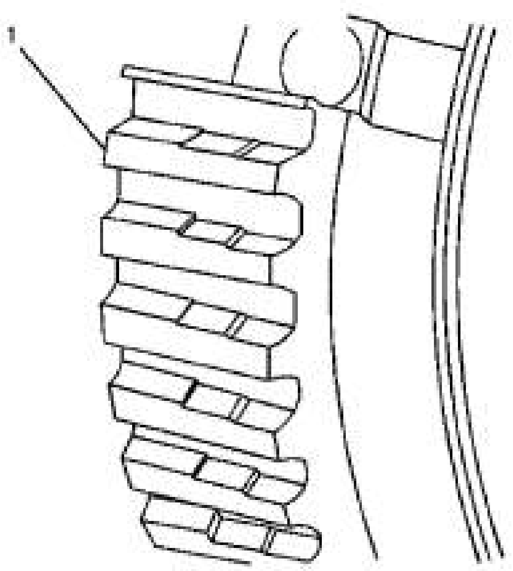
Important: When you service the synchronizers, retain them in the same order that they are removed. Keep the synchronizer components together and mark them to identify correct location.

2. Apply an approved lubricant to the cones and blocking rings. Align and install the following components into the 1st/2nd gear synchronizer hub (4 and 5):
   - the 1st gear synchronizer inner cone (1)
   - the 1st gear synchronizer outer cone (2)
   - the 1st gear outer blocking ring (3)
   - the 2nd gear outer blocking ring (8)
   - the 2nd gear synchronizer outer cone (7)
   - the 2nd gear synchronizer inner cone (6)



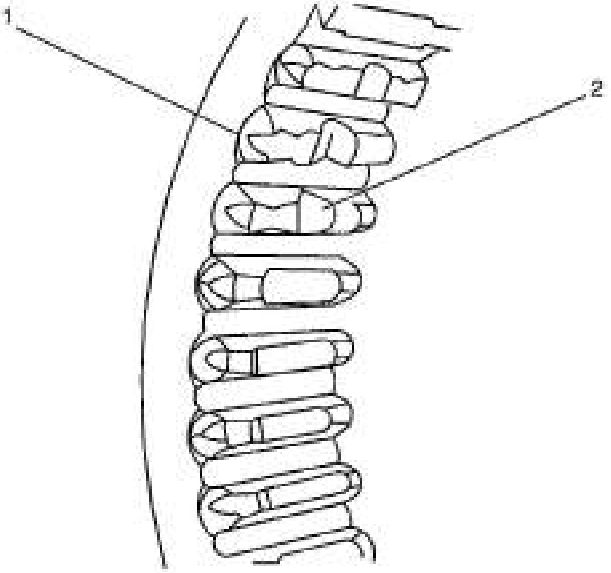
3. Apply an approved lubricant to the blocking rings. Install the following components into the 3rd/4th gear synchronizer hub (2 and 3):
    - the 3rd gear blocking ring (4)
    - the 4th gear blocking ring (1)

Synchronizers Cleaning and Inspection

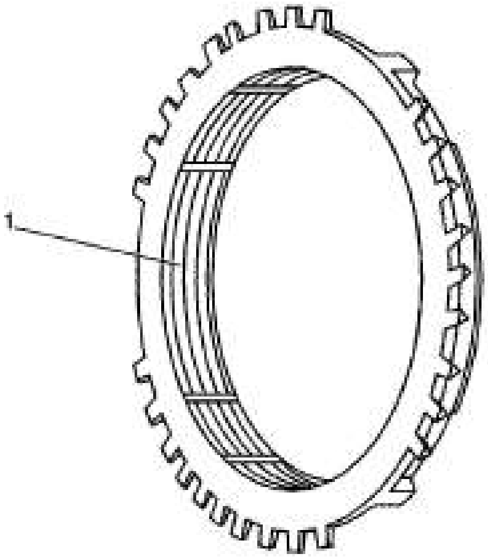


Important: When you service the synchronizers, retain them in the order that they are removed. Mark the parts to ensure the correct position for inspection and assembly.

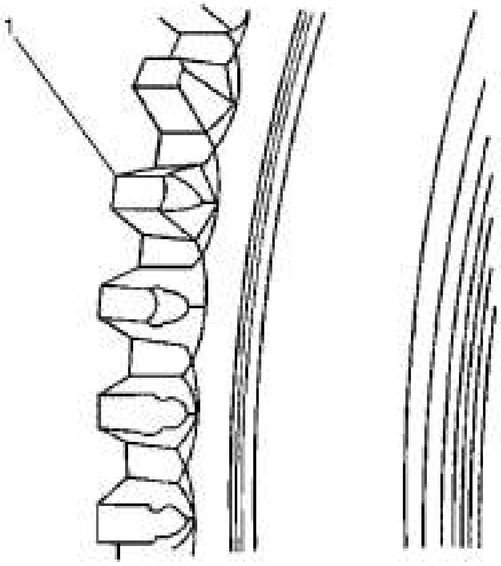
1. Clean all the synchronizer parts in a suitable cleaning solvent and air dry all the parts.
2. Inspect the 1st/2nd gear and the 3rd/4th gear synchronizer hubs for a force fit on the output shaft.
3. Replace synchronizer hubs that do not require a force fit.
4. Inspect the synchronizer hub for wear on the external splines. A stepped effect on the teeth (1), due to wear, may cause shift concerns.
5. Replace a worn hub.
6. Correct the cause, such as, but not limited to the following conditions:
   - Engine related vibrations.
   - Driving at a low speed in a high gear.
   - Defective vibration damper or crankshaft.



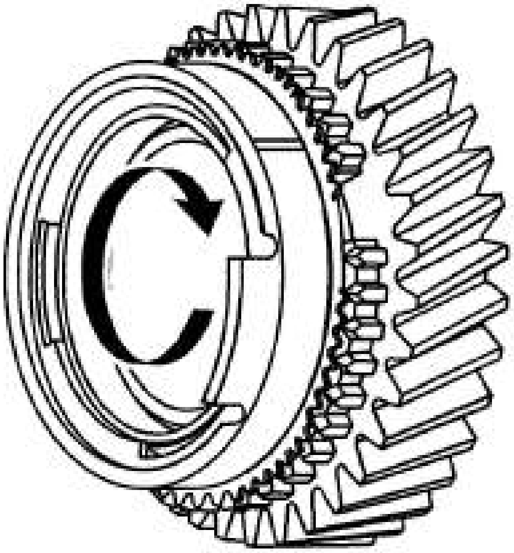
7. Inspect the synchronizer sleeve teeth (1) for the following conditions, which may cause shift concerns:
   - Grated teeth
   - Chipped off teeth
   - Blunted teeth
8. Inspect the synchronizer sleeve detent stops (2) for wear or for being chipped off.
9. Replace the synchronizer assembly if the teeth or stops show the above conditions.



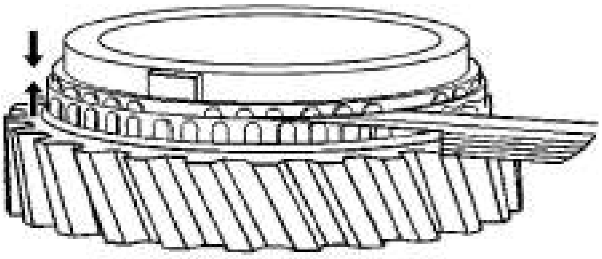
10. Inspect the synchronizer blocker rings for worn away grooves (1).
11. Replace the blocker ring assembly if the blocker ring grooves are worn.



12. Inspect the synchronizer blocker rings for worn shift teeth (1).
13. Inspect the internal ring for being warped or damaged.
14. Inspect the outer ring for worn grooves.
15. Replace the synchronizer assembly for any of the above conditions.



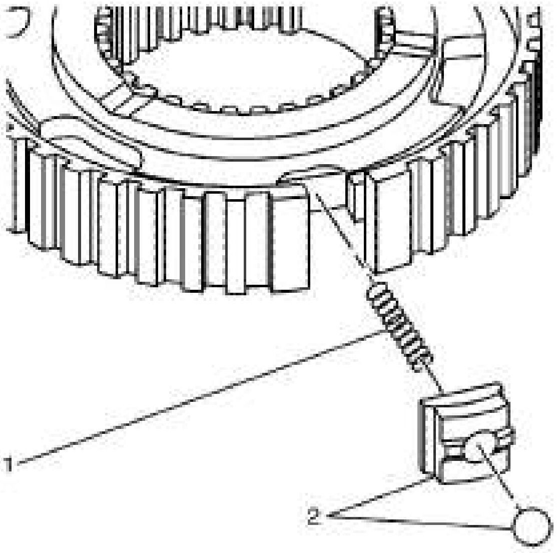
16. Install the synchronizer blocking rings to the correct speed gear.
17. Inspect the braking effect of the blocking ring. Turn the blocking ring in one direction while pushing to the gear cone. Ensure the ring locks.
18. If the ring does not lock, replace the synchronizer assembly.



19. Except for 5th gear, measure the blocker ring to gear clearance.
    1. 19.1. Assemble the correct blocker ring to the correct gear.
    2. 19.2. Apply pressure to the blocker ring to fully seat the ring.
    3. 19.3. Using a feeler gage, measure between the blocker ring teeth and the teeth on the gear.

    Specification

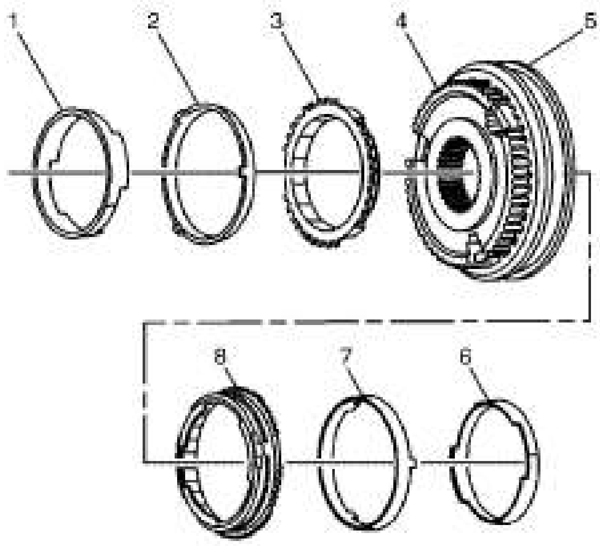
    - Minimum Clearance 4th Gear: 0.8 mm (0.031 in)
    - Minimum Clearance 3rd Gear: 0.8 mm (0.031 in)
    - Minimum Clearance 2nd Gear: 0.8 mm (0.031 in)
    - Minimum Clearance 1st Gear: 0.8 mm (0.031 in)
20. If using a NEW blocker ring and the standard clearance can not be obtained, replace the gear.



21. Inspect the pressure pieces (2) for wear or damage.
22. Inspect the springs (1) for distortion.
23. Replace the worn pressure pieces or faulty springs.

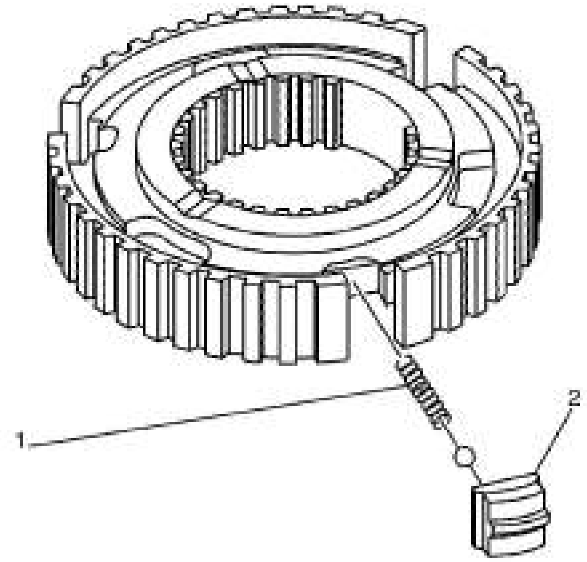
Synchronizers Disassemble

1st / 2nd, 3rd / 4th Gear Synchronizer

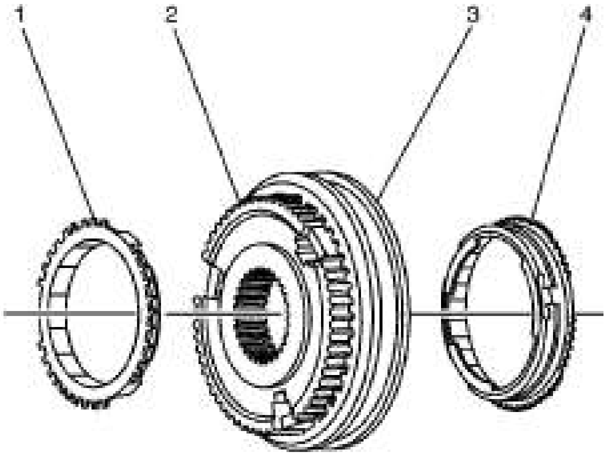


Important: When you service the synchronizers, retain them in the same order that they are removed. Keep the synchronizer components together and mark them to identify correct location.

1. Remove the following components from the 1st/2nd gear synchronizer hub (4 and 5):
   - the 1st gear synchronizer inner cone (6)
   - the 1st gear synchronizer outer cone (7)
   - the 1st gear synchronizer outer blocking ring (8)
   - the 1st gear synchronizer outer blocking ring (8)
   - the 1st gear synchronizer outer cone (2)
   - the 1st gear synchronizer inner cone (1)

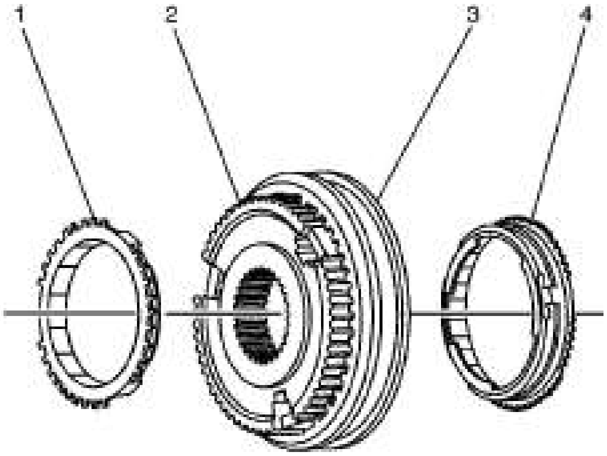


2. Remove the synchronizer insert (2) and spring (1) from the synchronizer hub. Press the spring and slide the insert out.

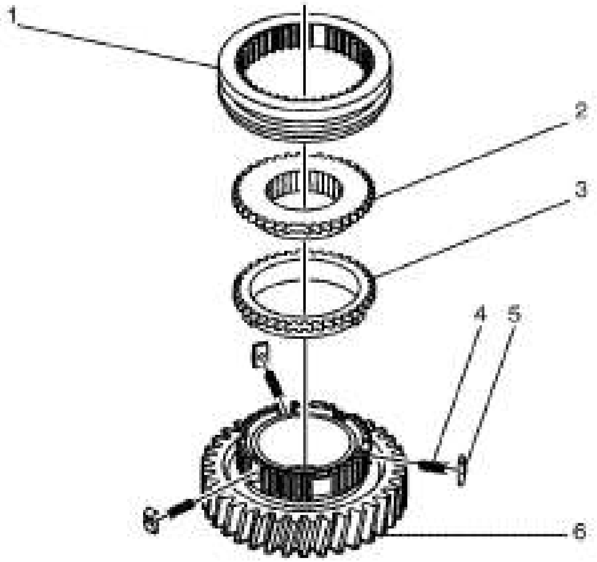


3. Remove the following components from the 3rd/4th gear synchronizer hub (2 and 3):
   - the 4th gear blocking ring (1)
   - the 3rd gear blocking ring (4)

5th / 6th Gear Synchronizer



1. Remove the following components from the 5th/6th synchronizer hub (2 and 3):
   - The 6th gear blocking ring (1)
   - The 5th gear blocking ring (4)

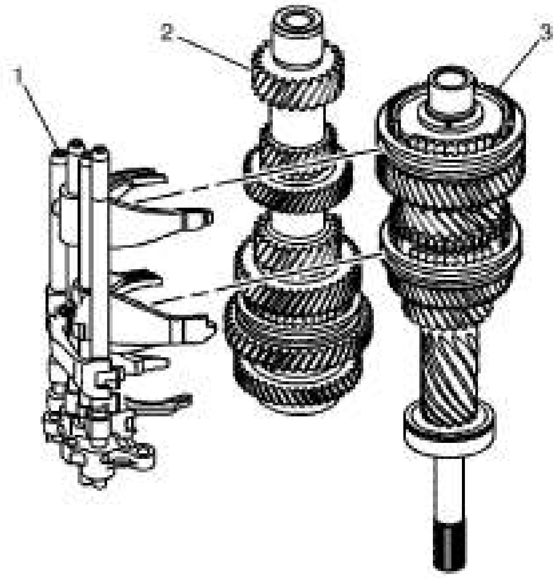


2. Remove the following components from the reverse gear (6):
   - the synchronizer sleeve (1)
   - the reverse driven gear (2)
   - the reverse gear blocking ring (3)
   - the reverse gear synchronizer insert (5) and the spring (4)

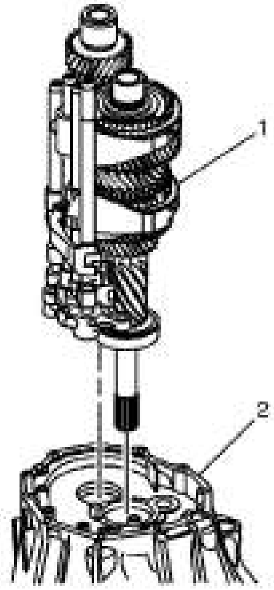
Transmission Assemble

Tools Required

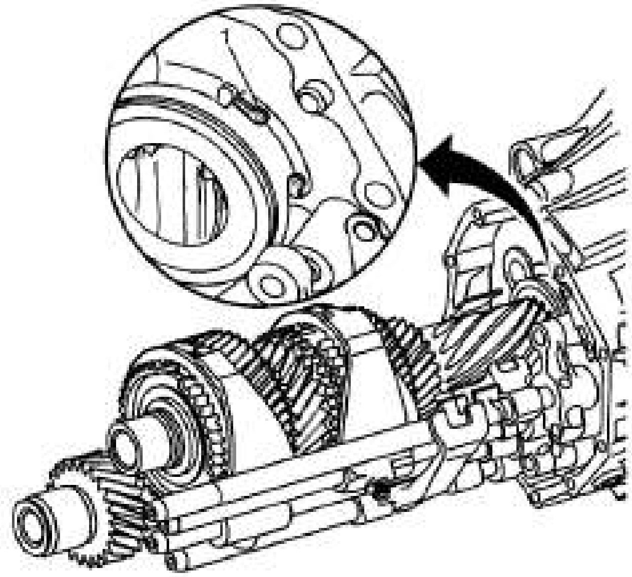
- DT-47735 Pinion Flange Holder
- J 35467 One-Way Clutch Tester
- J 44731 Input Shaft Seal Installer



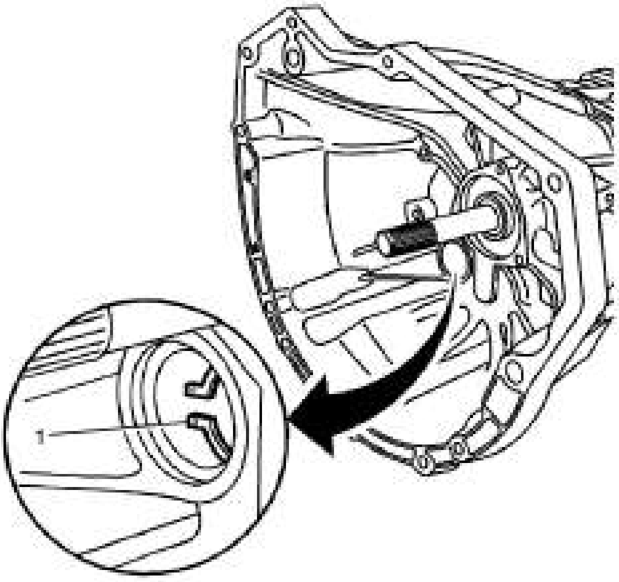
1. Apply an approved lubricant to each gear shift fork and gear shift head (1).
2. Join the shift rail assembly to the input shaft (3) and countershaft assembly (2).



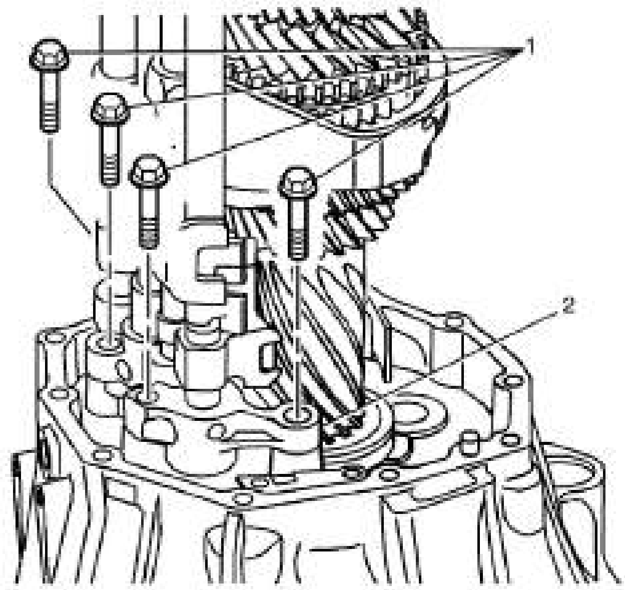
3. Install the input shaft, countershaft and shift rails as an assembly (1) in the clutch housing (2).



4. Install the snap ring (1) into the groove of the input shaft radial ball bearing.



5. Install the snap ring (1) into the groove of the countershaft radial ball bearing.

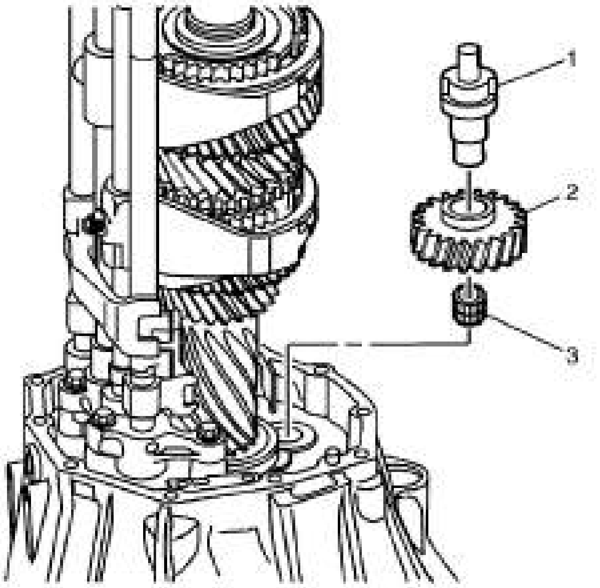


6. Apply an approved threadlocker to the shift rail retaining bolts (1).

   Notice: Refer to Fastener Notice in the Preface section.

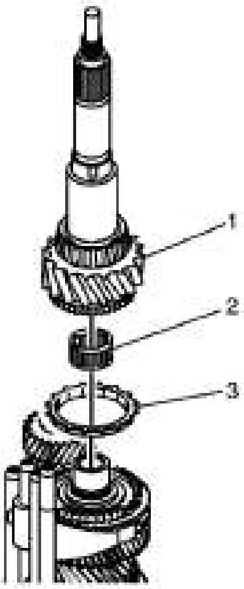
7. Install the shift rail (2) to clutch housing retaining bolts (1)

   Tighten
   Tighten the bolts to 21 N·m (15 lb ft).

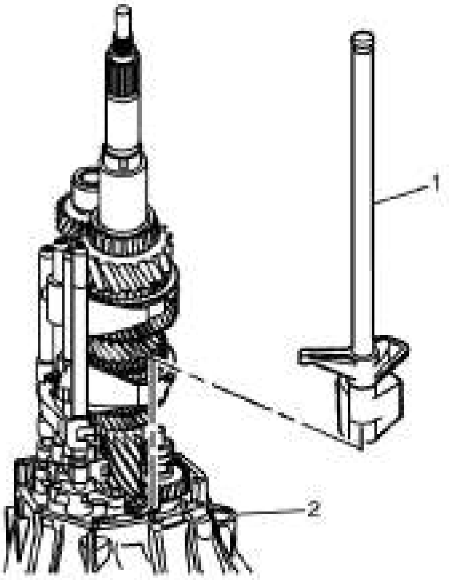


Important: During alignment, ensure that the thread hole of the reverse idler gear shaft (1) aligns with the thread hole of the middle case.

8. Apply an approved lubricant and install the following components:
   - the reverse idler gear bearing (3)
   - the reverse idler gear (2) with the higher boss facing the rear
   - the reverse idler gear shaft (1) with its hole facing outward

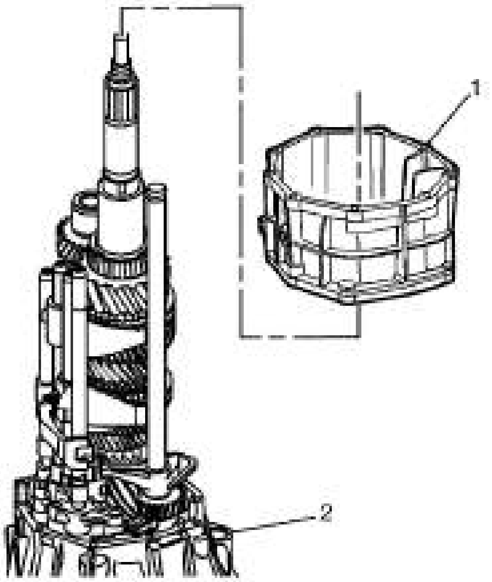


9. Apply an approved lubricant and install the input shaft bearing (2), blocking ring (3) and the rear output shaft (1).

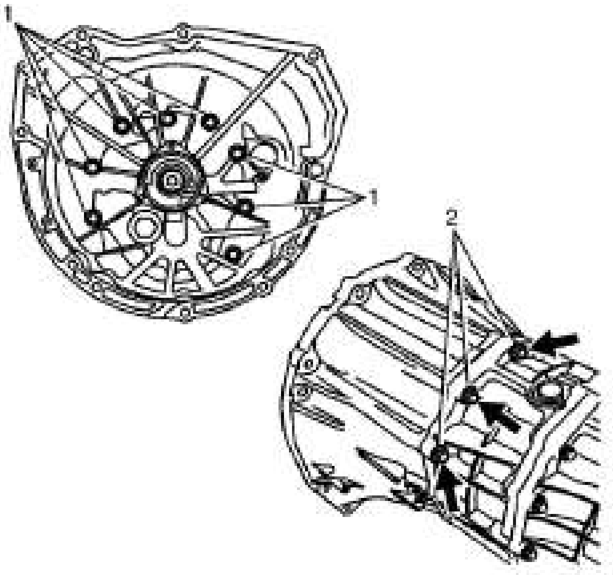


10. Install the shift shaft selector lever (1) to the clutch housing (2).

Notice: Refer to Machined Surface Damage Notice in the Preface section.



11. Apply an approved sealer the interface of the clutch housing (2) and the intermediate case (1).
12. Apply an approved lubricant to the shift and select lever shaft bearing.
13. Install the intermediate case (1) to the clutch housing.

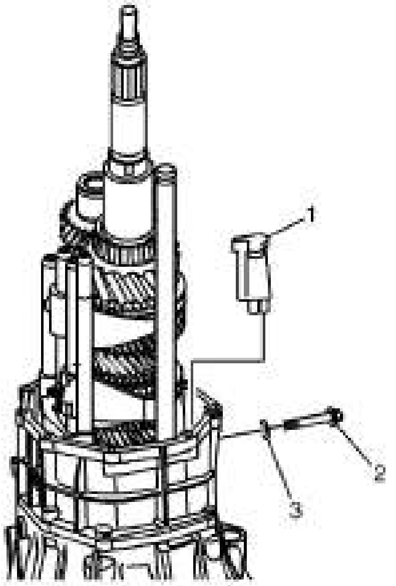


14. Install the inner clutch housing to intermediate case retaining bolts (1).

Tighten
Tighten the bolts to 40 N·m (29 lb ft)

15. Install the outer clutch housing to intermediate case retaining bolts (2).

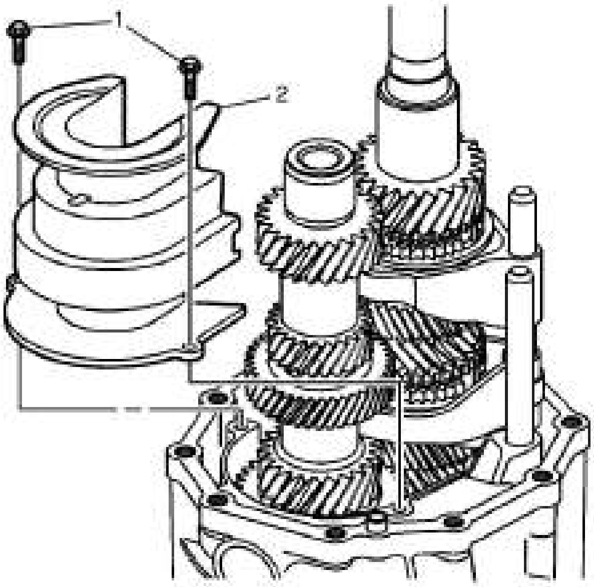
Tighten
Tighten the bolts to 40 N·m (29 lb ft)



16. Install the oil trough pipe (1) to the intermediate case.
17. Install a NEW gasket (3) to the reverse idler gear shaft retaining bolt (2).
18. Install the reverse idler gear shaft retaining bolt (2) to the intermediate case.

Tighten

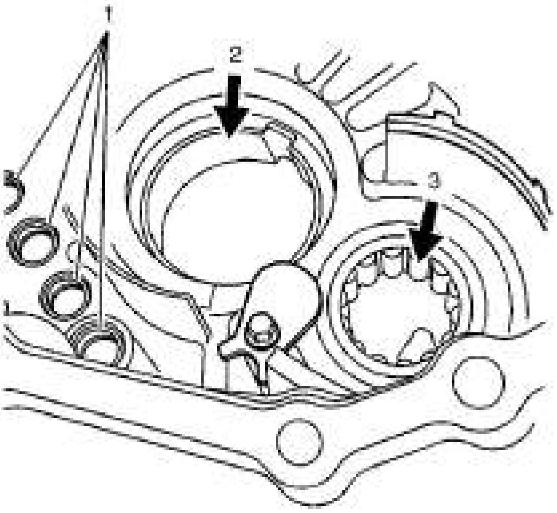
Tighten the bolt to 40 N·m (30 lb ft)



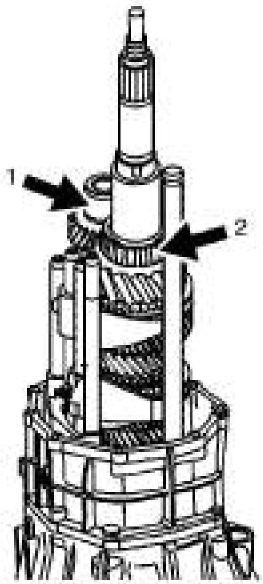
19. Install the oil trough (2) to the intermediate case.
20. Install the oil trough (2) to intermediate case retaining bolts (1).

Tighten

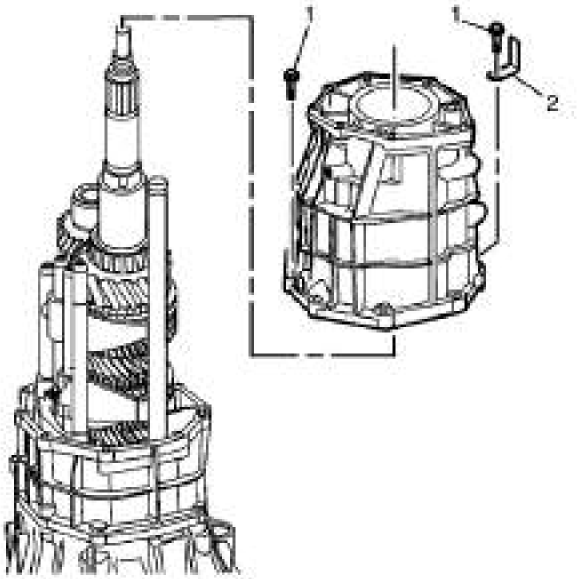
Tighten the bolts to 8.5 N·m (75 lb in)



21. Apply an approved lubricant to the following components:
    - the tapered roller bearing outer race (2)
    - the cylindrical roller bearing (3)
    - the control sub-assembly holes (1)



22. Apply an approved lubricant to the following components:
    - the tapered roller bearing of the output shaft (1)
    - the cylindrical roller bearing inner race of counter gear (2)

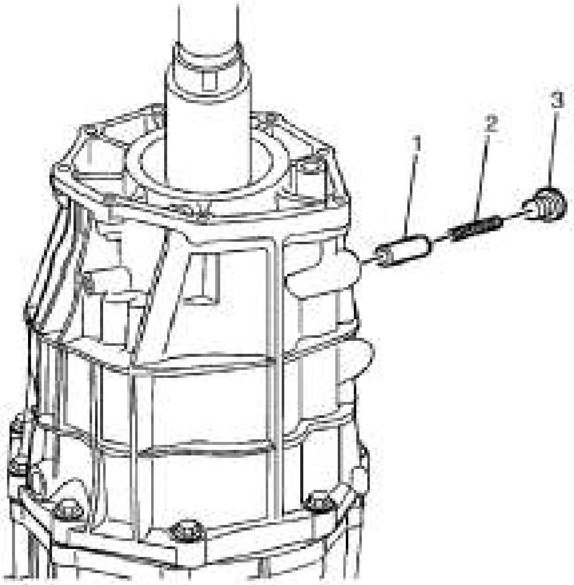


23. Apply an approved sealer to the interface of either case.

    Notice: Refer to Machined Surface Damage Notice in the Preface section.

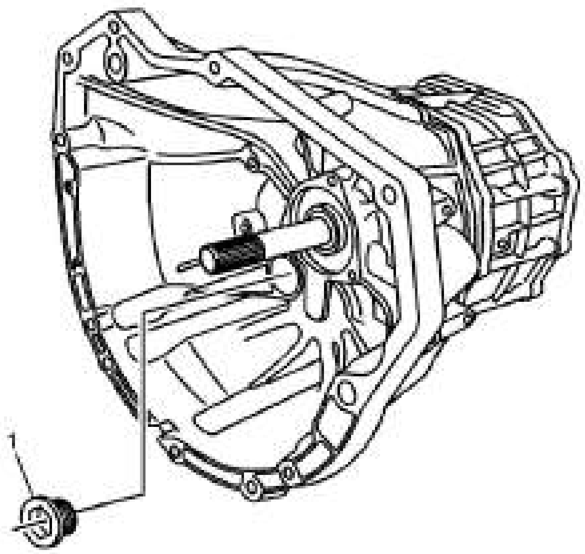
24. Install the rear case to the intermediate case.
25. Install the rear case to intermediate case retaining bolts (1).

    Tighten
    Tighten the bolts to 40 N·m (29 lb ft)



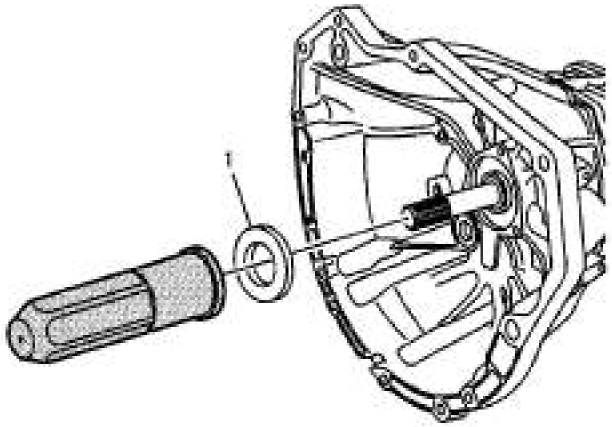
26. Apply an approved lubricant and install the lock ball pin (1).
27. Install the spring (2) and a NEW plug (3) to the rear case.

Tighten
Tighten the plug to 24 N·m (18 lb ft)

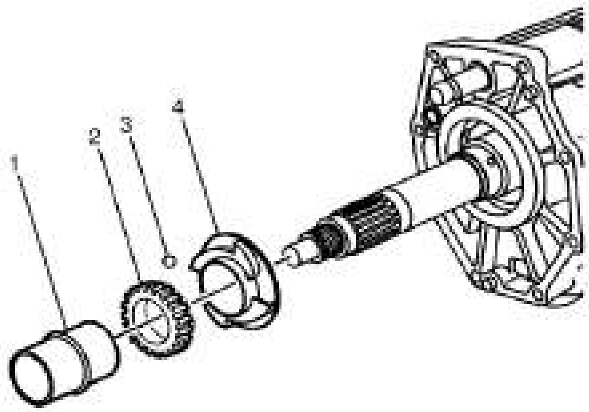


28. Using J 35467 , install a NEW clutch housing hole plug (1) into the clutch housing.

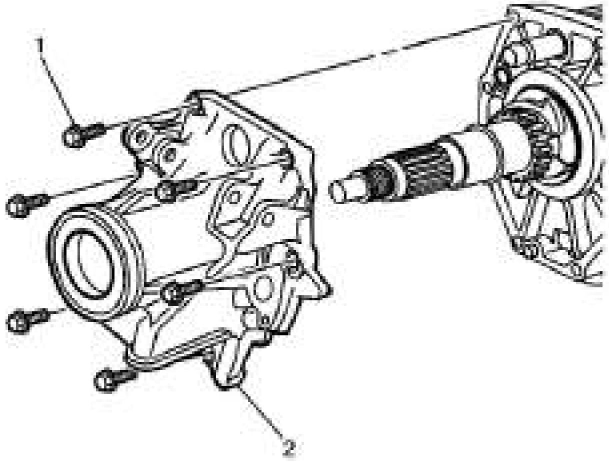
Tighten
Tighten the bolt to 39 N·m (29 lb ft).



29. Using J 44731 , install a NEW input shaft seal (1) to the clutch housing.

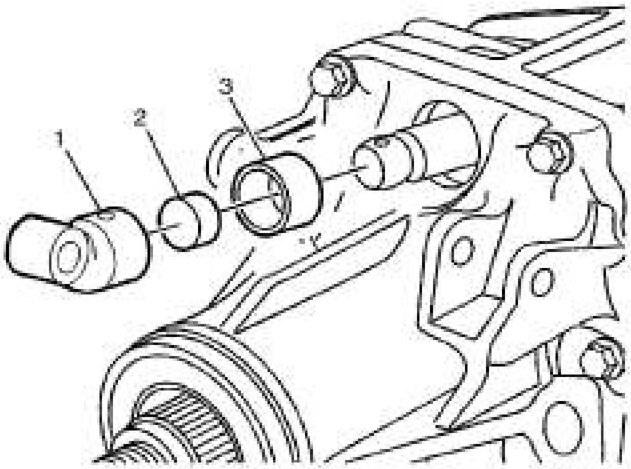


30. Align and install the main shaft bearing oil slinger (4) to the output shaft.
31. Grease and install the locking ball (3) to the output shaft.
32. Align and install the vehicle speed sensor drive gear (2) to the output shaft.
33. Install a NEW rear output shaft rear bearing spacer (1) to the output shaft.

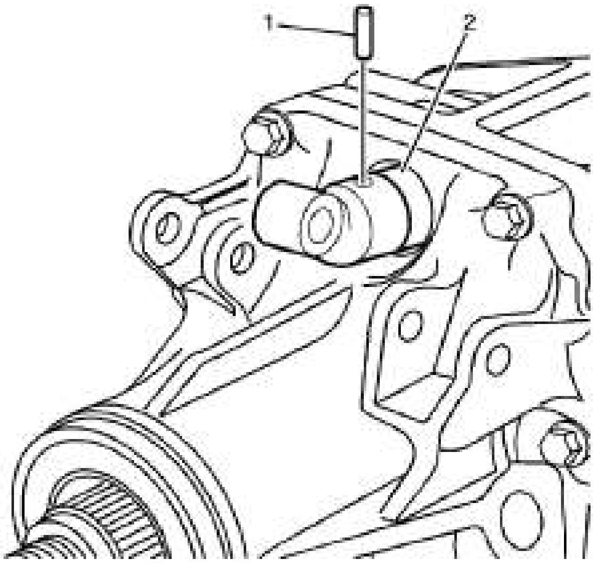


34. Apply an approved sealer to the interface of either case.
35. Install the rear extension housing (2) to the rear case.
36. Install the rear extension housing to rear case retaining bolts (1).

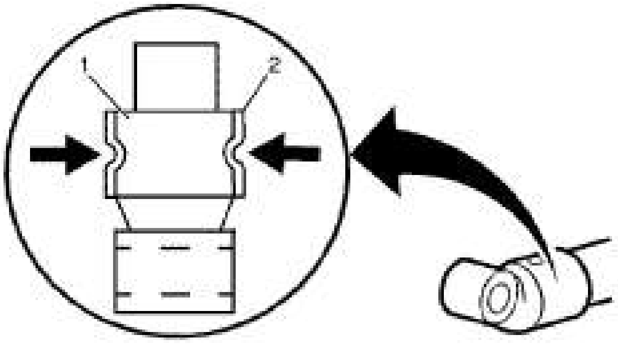
    Tighten
    Tighten the bolts to 29 N·m (21 lb ft)



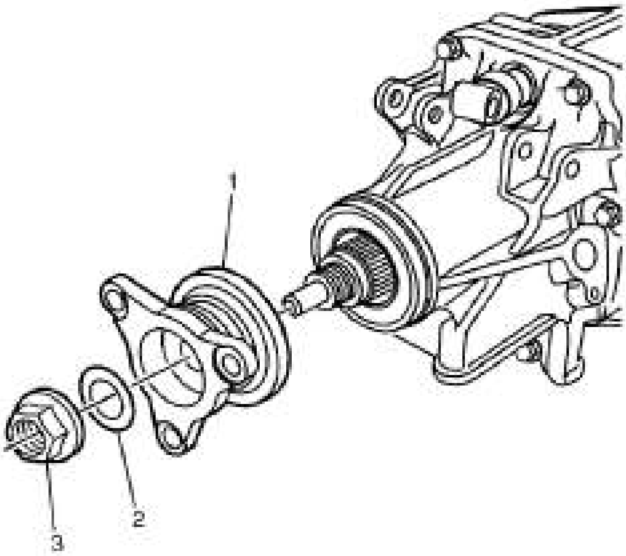
37. Install a NEW select shift lever retainer (3), the damper (2) and shift lever rod universal joint (1) into the end of the shift selector.



38. Install the shift lever pin (1) to the select shift lever rod universal joint (2).
39. With a suitable tool, rotate the shift lever retainer (2) backward.

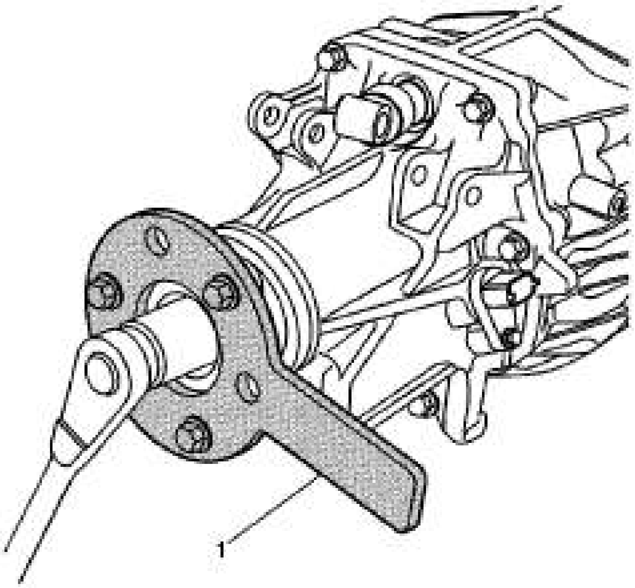


40. Stake the retainer (2) in place using pliers and 2 roll pins held in place with assembly lube.

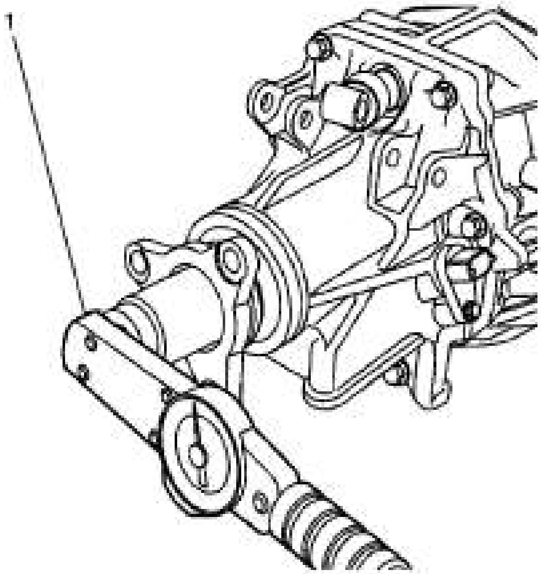


41. Install the propshaft flange (1) to the output shaft.
42. Grease and install a NEW propshaft flange thrust washer (2) to the output shaft.
43. Install a NEW propshaft flange nut (3) to the output shaft.

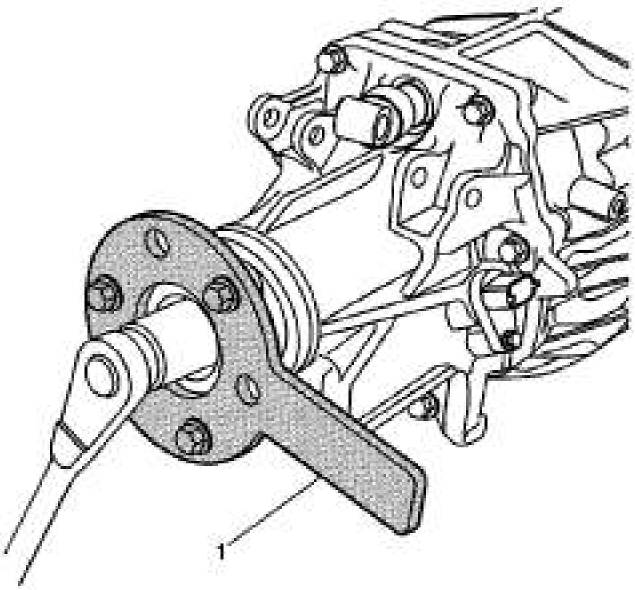
Preload Adjustment Procedure



1. Shift the transmission into any gear.
2. Attach DT-47735 (1) to the output flange.
3. Hold DT-47735 in order to prevent the output flange from rotating. Install and tighten the output flange nut. Tighten until the looseness is minimum.
4. Verify looseness by shaking the output shaft longitudinally.



5. Remove DT-47735 from the output flange.
6. Shift the transmission into NEUTRAL.
7. Rotate the output flange several times in order to break in the gears, synchronizers and bearings.
8. Measure the rotational torque/drag torque of the output flange by using a suitable tool (1). Record this initial rotational torque measurement as value A.



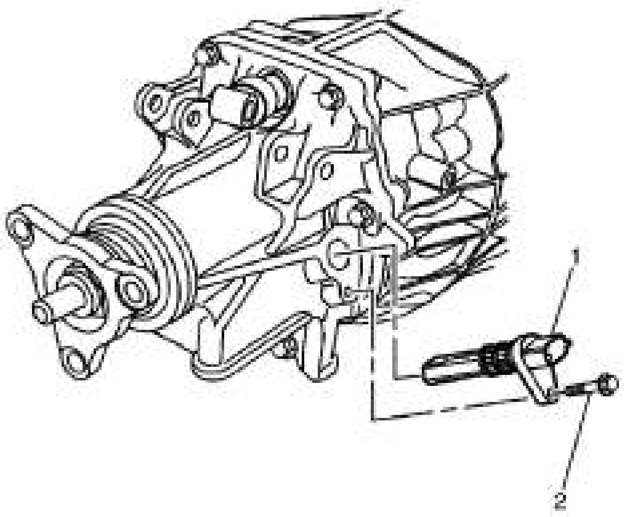
9. Attach DT-47735 (1) to the output flange.
10. Shift the transmission into any gear.
11. Tighten the propshaft flange to output shaft retaining nut.

    Tighten
    Tighten the nut 220-565 N·m (162-417 lb ft).

12. Remove the DT-47735 from the output flange.
13. Shift the transmission into NEUTRAL.
14. Rotate the output flange several times in order to seat the bearings.
15. Measure the rotational torque/drag torque of the output flange by using a suitable tool. Record this measurement as value B.
16. Subtract value A from value B. Verify that the resulting measurement is within the specified range.

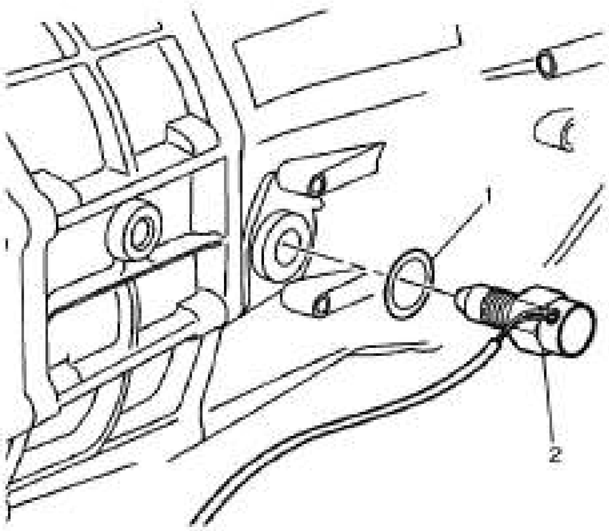
    Specification
    The rotational torque specification is.45-1.35 N·m (4-12 lb in).

17. Repeat the previous steps until you have confirmed that the rotational torque specification is reached then stake the nut in place. If the rotational torque requirement has been exceeded, replace the output shaft spacer and repeat steps 2-16.



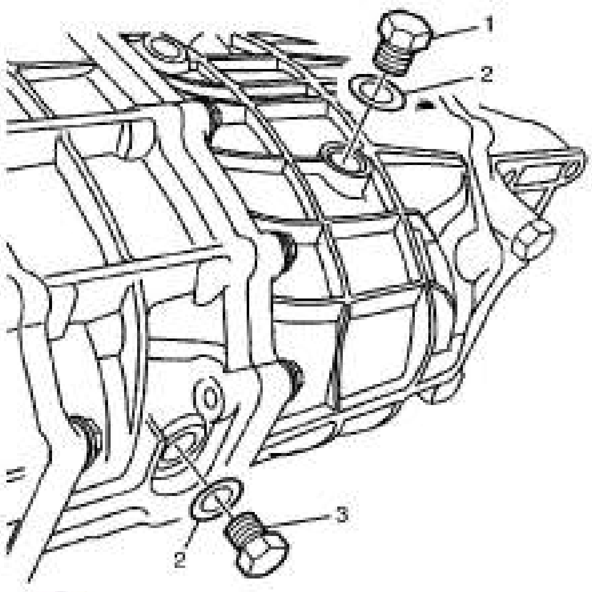
18. Install the output sensor (1) to the extension housing.
19. Install the output sensor to extension housing retaining bolt (2).

Tighten
Tighten the bolt to 8 N·m (71 lb in).



20. Install a NEW backup lamp washer (1) to the backup switch.
21. Install the backup switch to the extension housing.

Tighten
Tighten the switch to 44 N·m (32 lb ft).



22. Install the NEW gaskets (2), drain plug (3) and fill plug (1).
    - Install the drain plug (3) to the rear case.

Tighten
Tighten both plugs to 37 N·m (27 lb ft).

- Install the fill plug (1) to the intermediate case.

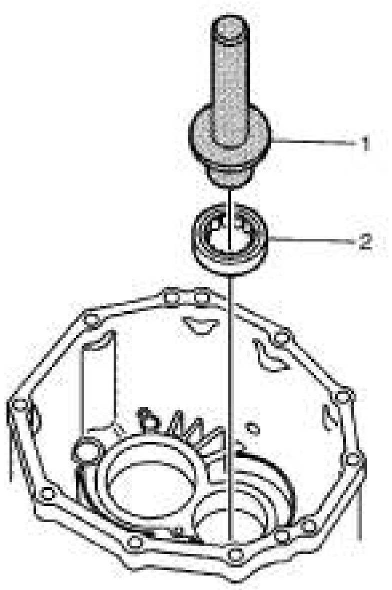
Tighten
Tighten both plugs to 37 N·m (27 lb ft).

Transmission Case Assemble

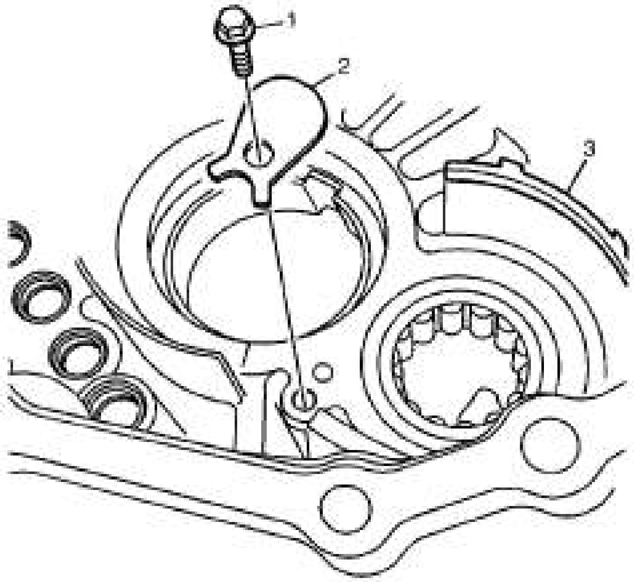
Tools Required

- DT-47721 Shift Shaft Seal Installer
- DT-47722 Shift Rail Bushing Remover and Installer
- DT-47723 Output Shaft Bearing Installer
- DT-47724 Output Shaft Bearing Cup Installer
- DT-47725 Extension Housing Bearing Cup Installer
- DT-47726 Countershaft Rear Bearing Installer

Rear Case Assemble



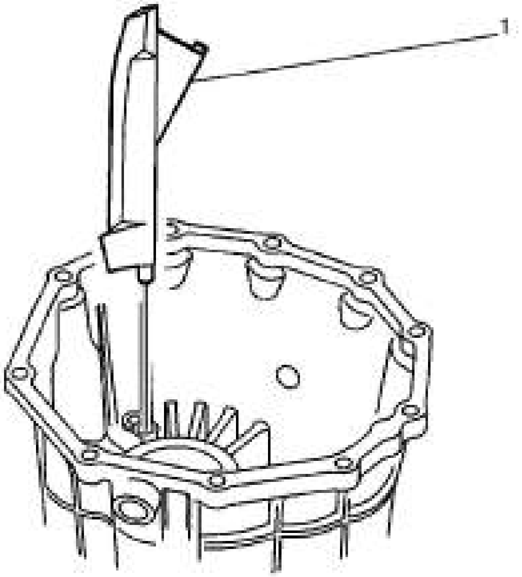
1. Apply gear oil to bearing. Use DT-47726 (1) to install bearing (2).



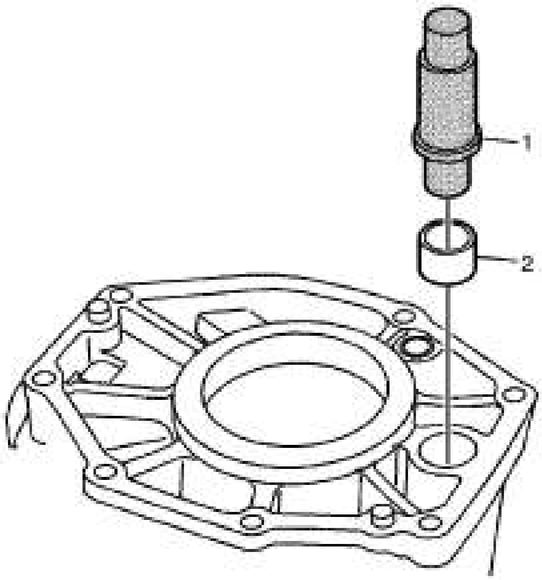
2. Install the bearing retainer (2) and bolt (1).

   Tighten
   Tighten the bolt to 11 N·m (96 lb in).

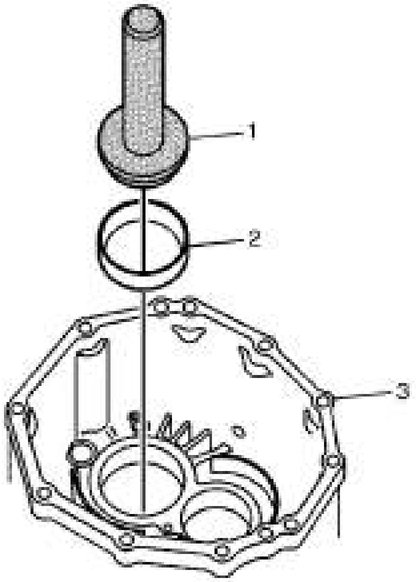
3. Install the gasket (3) to the rear case.



4. Install the oil trough (1) to the rear case.

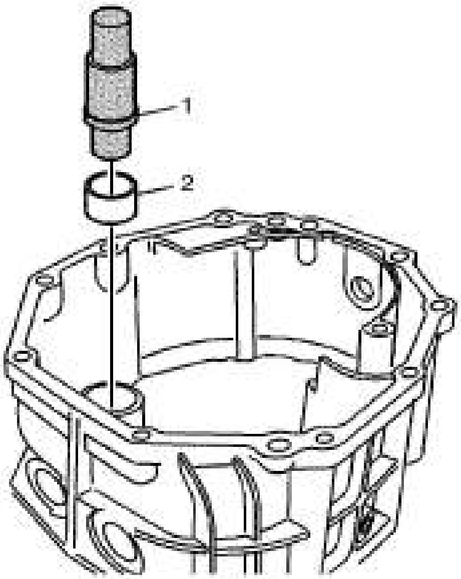


5. Using DT-47722 (1), install the bearing (2) in the rear case.



6. Using DT-47724 , install the tapered bearing race (1) into the rear case.

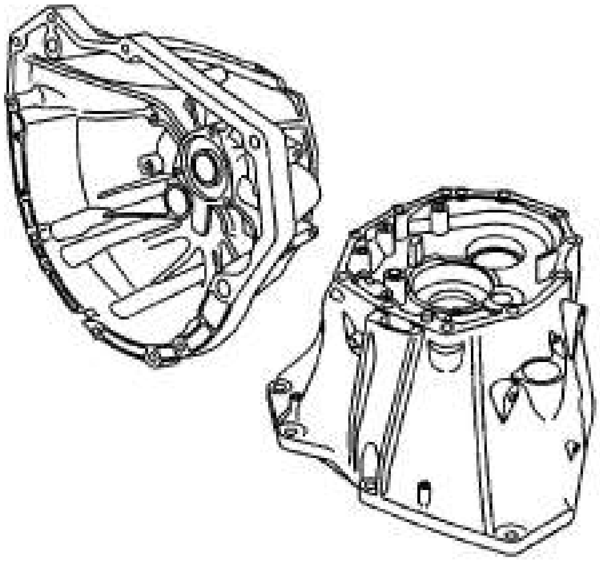
Middle Case Assemble



Using DT-47722 (1), install the bearing (2) in the intermediate case.

Transmission Case Cleaning and Inspection

Clutch Housing

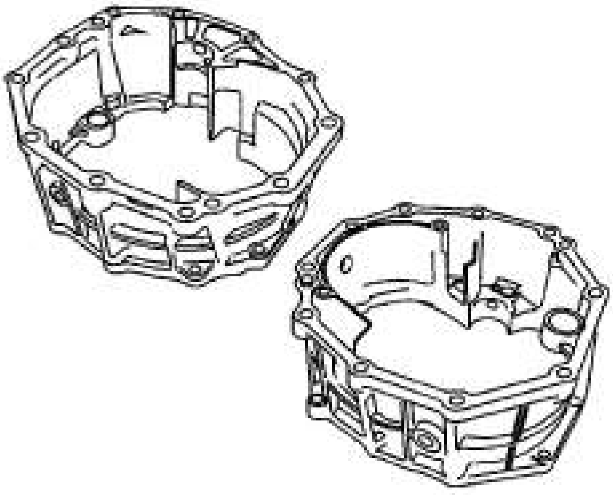


1. Clean the clutch housing in a suitable cleaning solvent and air dry.
2. Inspect the clutch housing for the following conditions:
   - Cracks
   - Damaged mounting flanges
   - Damaged bolt holes

Notice: Refer to Machined Surface Damage Notice in the Preface section.

3. Remove the sealer from the case sealing surfaces.
4. Inspect the case for being broken or cracked.
5. Inspect the bearing bore for the following conditions:
   - A spun bearing
   - Cracks
6. Replace the case assembly if any of the above conditions are found.
7. Inspect the sealing surfaces for damage.
8. Repair small scratches or nicks with a soft stone.
9. Inspect the case threaded bolt holes for damage.
10. Repair any damaged threads.
11. Inspect the location pins for being loose or missing.
12. Repair or replace any damaged location pins.

Middle Case

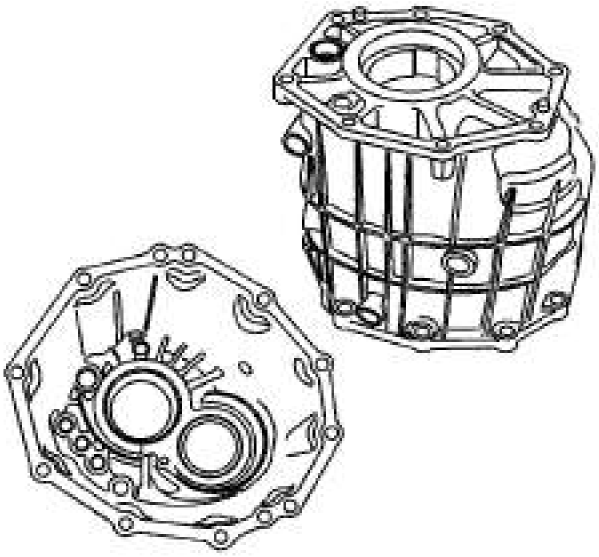


1. Clean the middle case in a suitable cleaning solvent and air dry.

   Notice: Refer to Machined Surface Damage Notice in the Preface section.

2. Remove the sealer from the case sealing surfaces.
3. Inspect the case for being broken or cracked.
4. Inspect the input shaft bearing bore for the following conditions:
   - A spun bearing
   - Cracks
5. Inspect the countershaft front bearing bore for the following conditions:
   - A spun bearing
   - Cracks
6. Replace the case assembly if any of the above conditions are found.
7. Inspect the sealing surfaces for damage.
8. Repair small scratches or nicks with a soft stone.
9. Inspect the case threaded bolt holes for damage.
10. Repair any damaged threads.
11. Inspect the location pins for being loose or missing.
12. Repair or replace any damaged location pins.

Rear Case

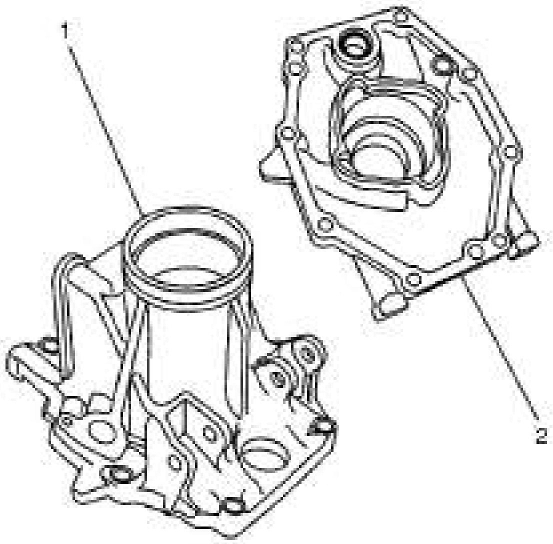


1. Clean the rear case in a suitable cleaning solvent and air dry.

   Notice: Refer to Machined Surface Damage Notice in the Preface section.

2. Remove the sealer from the case sealing surfaces.
3. Inspect the sealing surfaces for damage.
4. Inspect the case threaded bolt holes for damage.
5. Repair any damaged threads.
6. Inspect the location pins for being loose or missing.
7. Repair or replace any damaged location pins.
8. Inspect the shift shaft bushings for excessive wear.
9. Inspect the bearing bore.
10. Replace the case assembly if the shift shaft bushings are faulty.

Extension Housing



1. Clean the extension housing in a suitable cleaning solvent and air dry.

   Notice: Refer to Machined Surface Damage Notice in the Preface section.

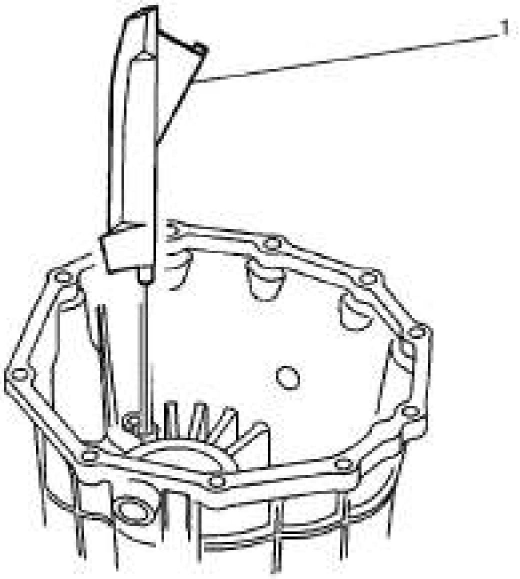
2. Remove the sealer from the extension sealing surfaces (2).
3. Inspect the sealing surfaces for damage.
4. Inspect the extension for being broken or cracked.
5. Inspect the oil seal (1) for wear or damage. The oil seal is serviced only with the extension housing.
6. Inspect the bearing bore.
7. Replace the extension if any of the above conditions are found.
8. Inspect the case threaded bolt holes for damage.
9. Repair any damaged threads.
10. Repair or replace any damaged location pins.

Transmission Case Disassemble

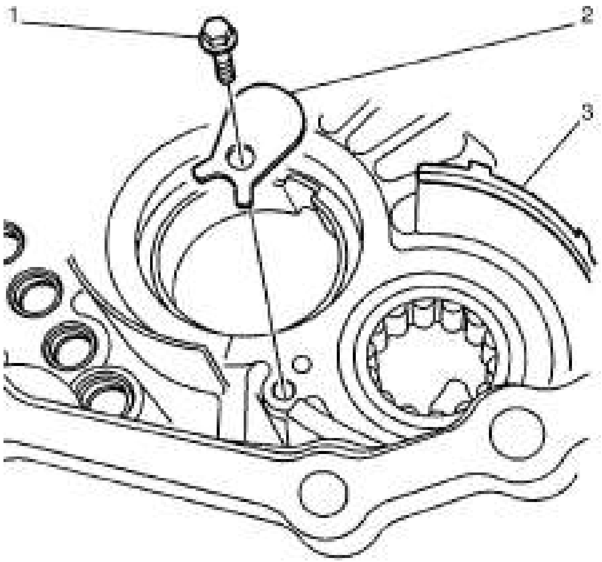
Tools Required

- DT-47722 Shift Rail Bushing Remover and Installer
- J 2619-01 Slide Hammer
- J 26941 Bushing and Bearing Remover 3-4 in

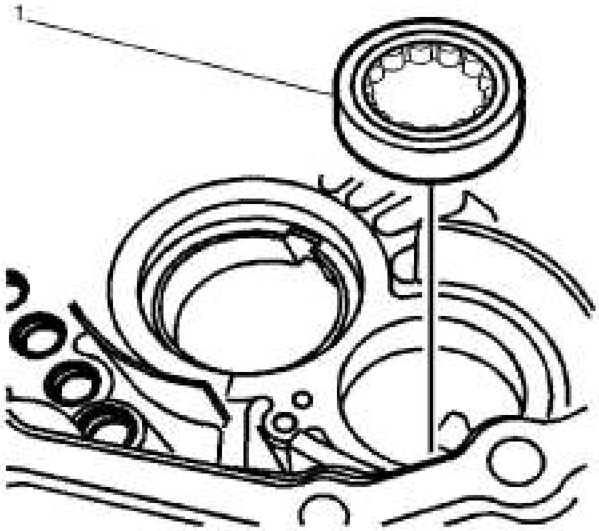
Rear Case Disassemble



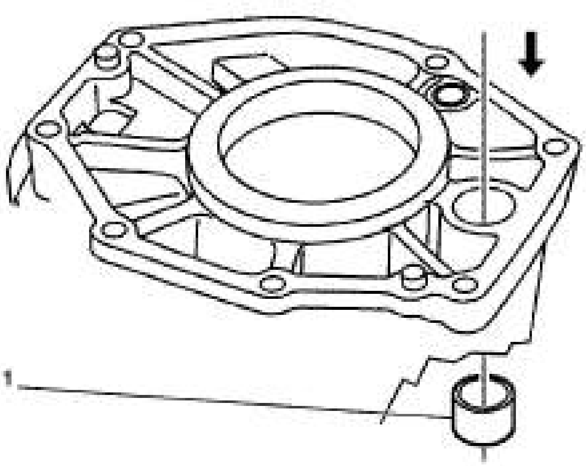
1. Remove the oil trough (1) from the rear case.



2. Remove the counter gear roller bearing retainer to rear case retaining bolt (1).
3. Remove the counter gear roller bearing retainer from the rear case.
4. Remove the gasket (3) from the rear case.

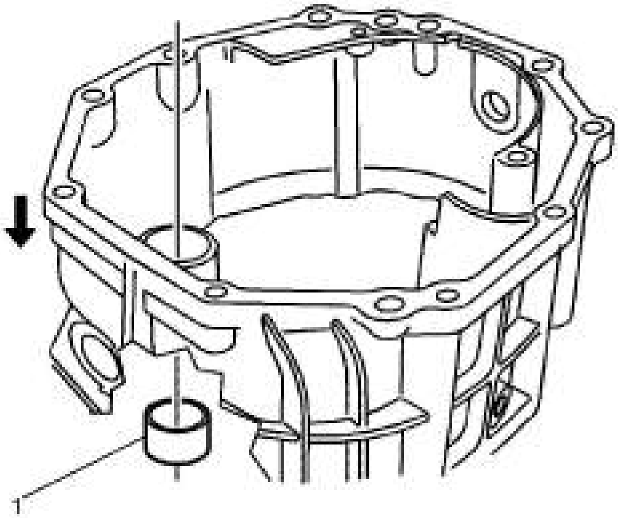


5. Using J 26941 and J 2619-01 , remove the counter gear roller bearing (1) from the rear case.



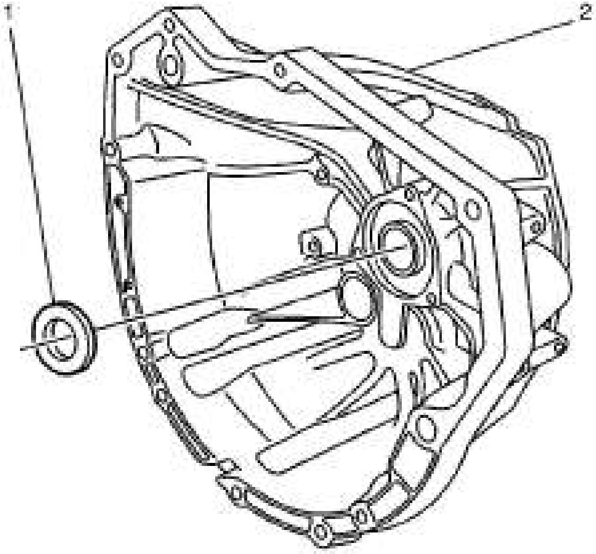
6. Using DT-47722 , remove the shift shaft bearing (1) from the rear case.

Middle Case Disassemble



Using DT-47722 , remove the shift shaft bearing (1) from the middle case.

Clutch Housing Disassemble



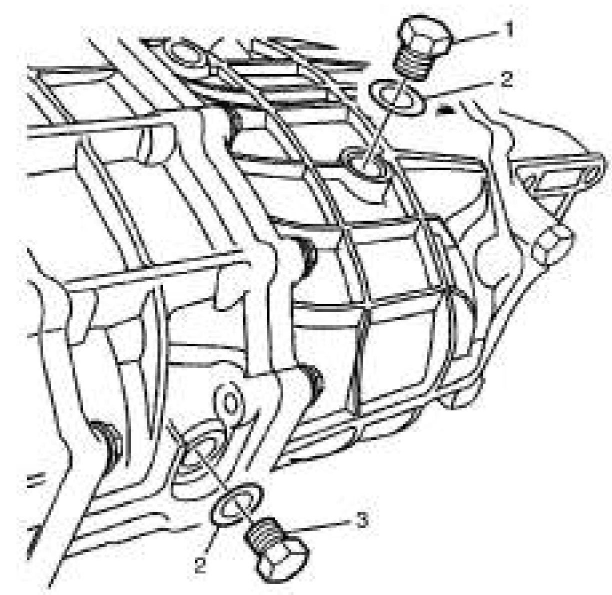
Using a suitable tool, remove the input shaft seal (1) from the front case (2).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Manual Transmission - Aisin AY6 | Repair Instructions - Off Vehicle | **Document ID: 1996679**

Transmission Disassemble

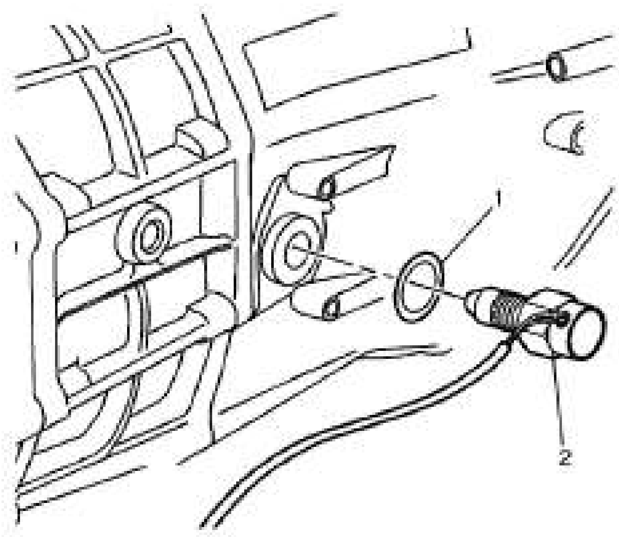
Tools Required

J 8433 Two Jaw Puller



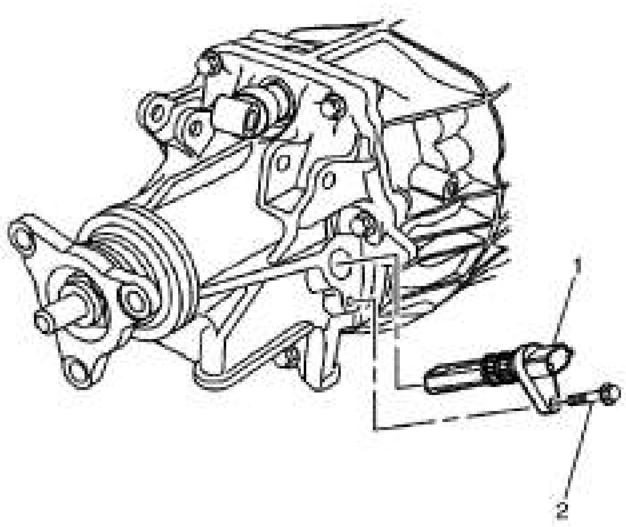
1. Remove the drain plug (3) and drain the transmission fluid and discard washer.

   Discard the washer.

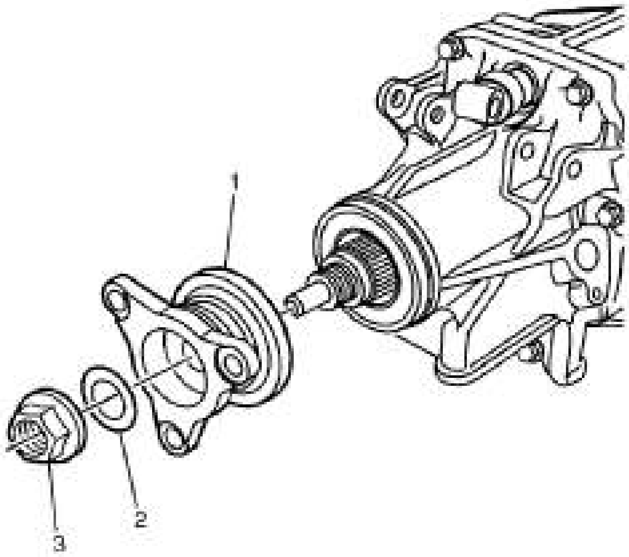


2. Remove the backup lamp switch (2) and washer (1) from the case.

   Discard the washer.

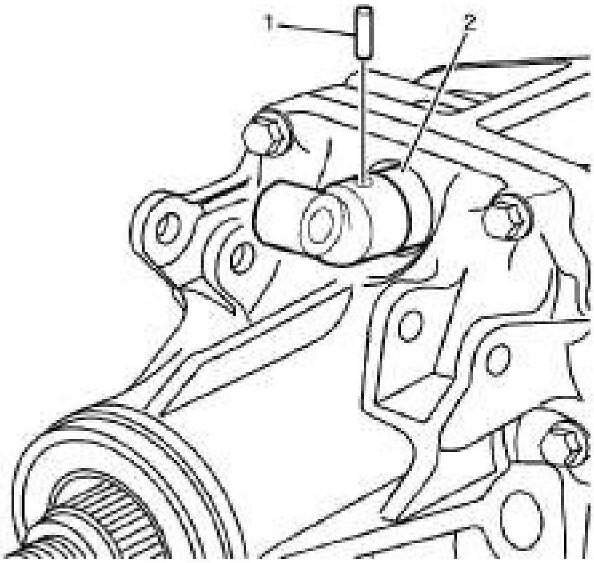


3. Remove the output sensor (1) and bolt (2) from the rear extension housing.

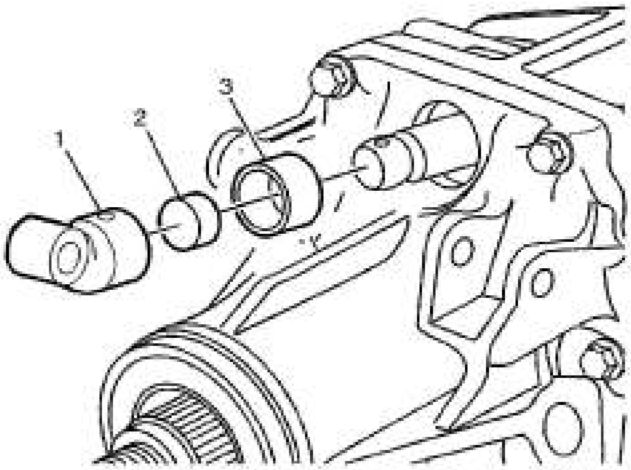


4. Using a suitable tool, release the staking of the propshaft flange nut (3).
5. Remove the thrust washer (2) from the propshaft flange assembly.
6. Remove the propshaft flange nut (3) and propshaft flange assembly (1).

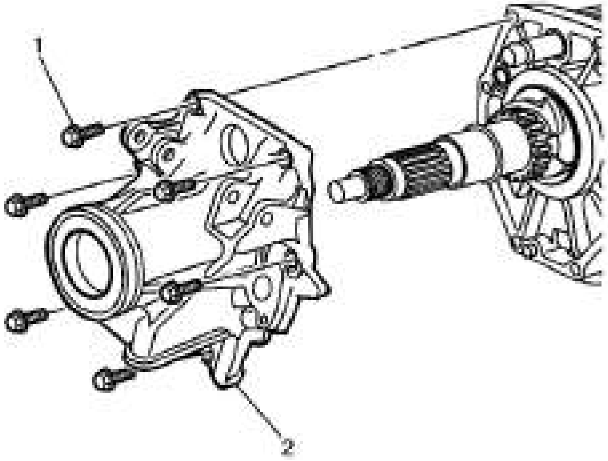
Notice: Refer to General Repair Instructions in the Preface section.



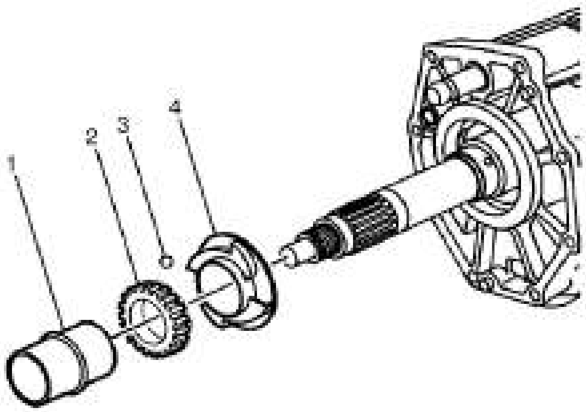
7. To release the staking, insert a suitable tool into the gap between the select shift lever retainer (2) and the rod.
8. Using a suitable tool, rotate the select shift lever retainer (2) forward.
9. Using a suitable tool, remove the shift lever pin (1).



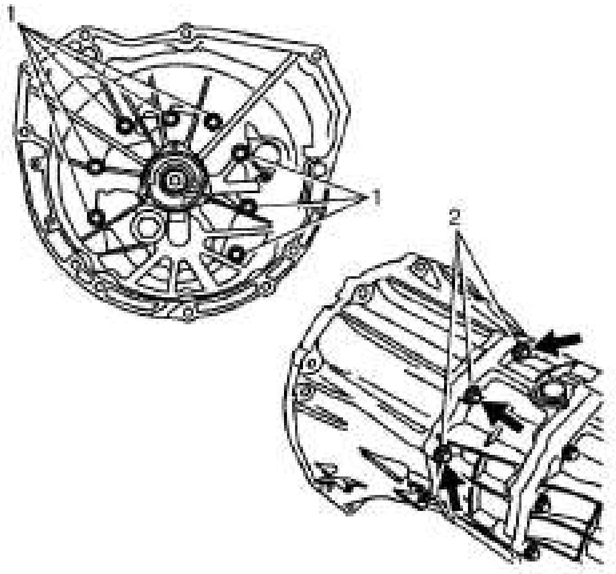
10. Remove the shift lever rod universal joint (1), damper (2) and select shift lever retainer (3) from the end of the shift selector.



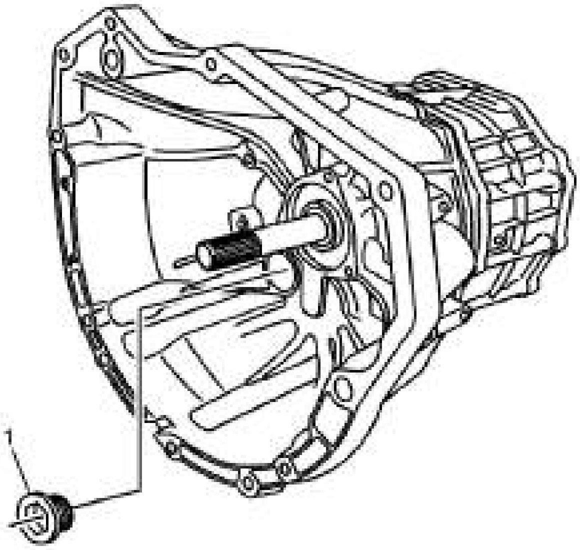
11. Remove the transmission housing to extension housing retaining bolts (1).
12. Remove the extension housing (2) from the transmission..



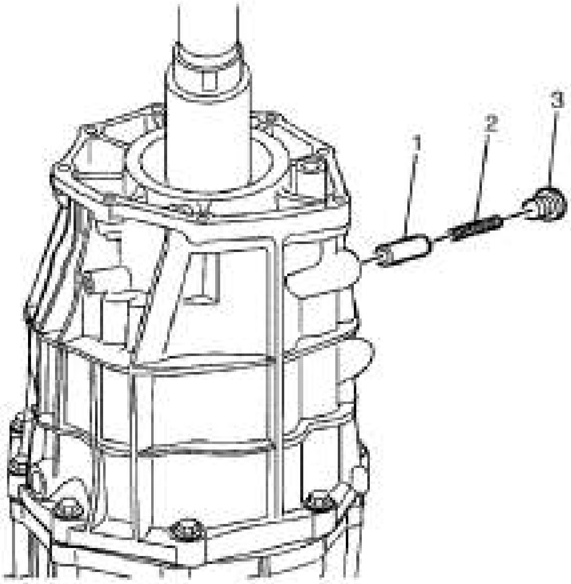
13. Remove the rear output shaft rear bearing spacer (1) from the main shaft.
14. Remove the vehicle speed sensor drive gear (2) from the main shaft.
15. Remove the locking ball (3) from the main shaft.
16. Remove the main shaft bearing oil slinger (4) from the main shaft.



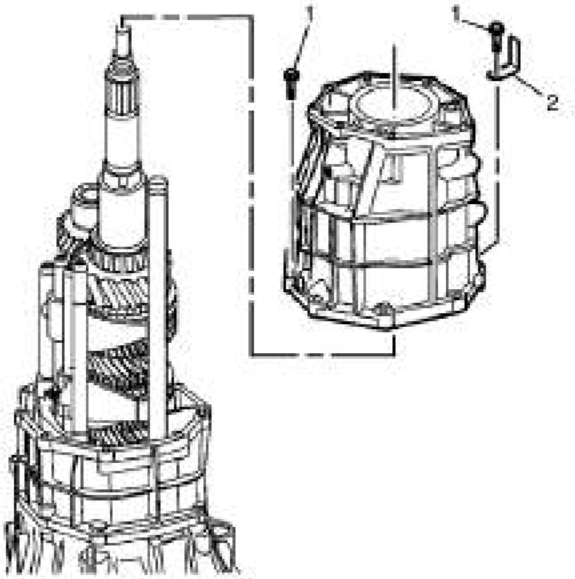
17. Remove the transmission case to clutch housing inner retaining bolts (1).
18. Remove the transmission case to clutch housing outer retaining bolts (2).



19. Remove the clutch housing hole plug (1) from the clutch housing.



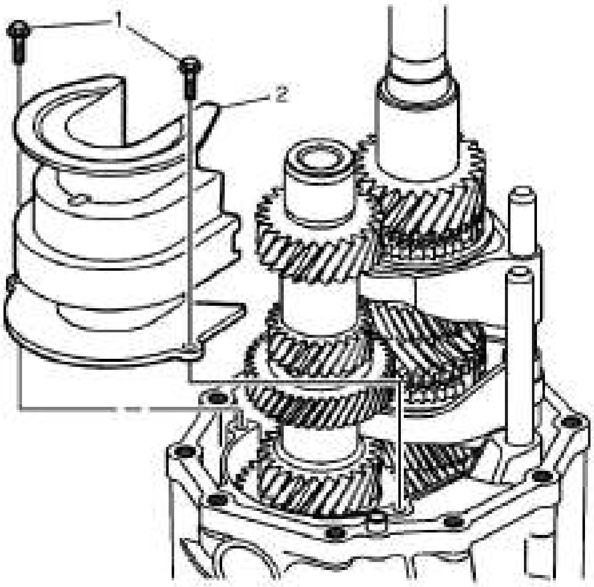
20. Remove the following components from the rear case housing:
    - the shift shaft detent plug (3)
    - the shift shaft detent spring (2)
    - the shift shaft detent pin (1)



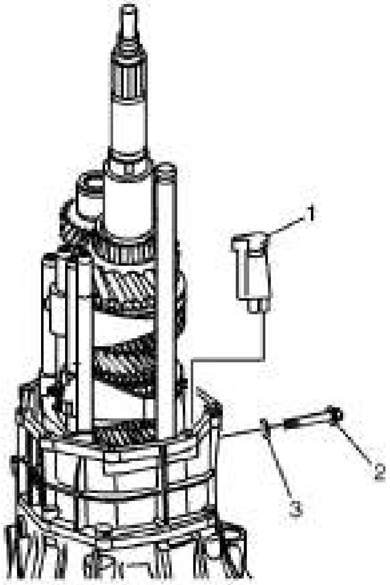
21. Remove the intermediate case to rear case housing retaining bolts (1).

    Notice: Refer to Machined Surface Damage Notice in the Preface section.

22. Using a suitable tool, separate the rear case housing from the intermediate case housing.
23. Remove the rear case housing.



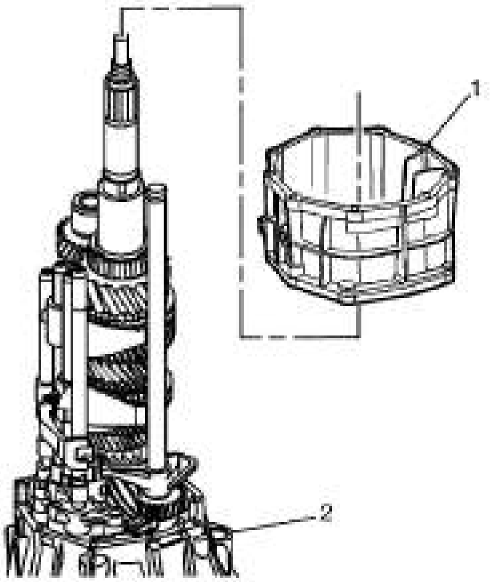
24. Remove the oil trough to intermediate case housing retaining bolts (1).
25. Remove the oil trough (2) from the intermediate case housing.



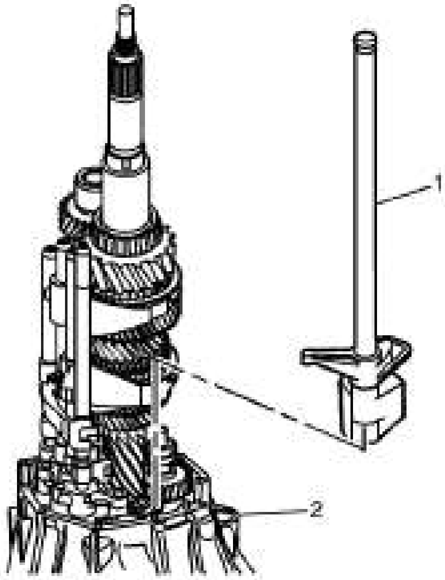
26. Remove the oil trough pipe (1) from the intermediate case.
27. Remove the reverse idler gear shaft to intermediate case retaining bolt (2).
28. Remove the reverse idler gear shaft washer (3) from the retaining bolt and discard.

    Discard the washer.

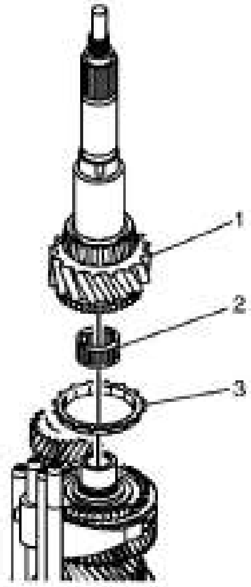
    Notice: Refer to Machined Surface Damage Notice in the Preface section.



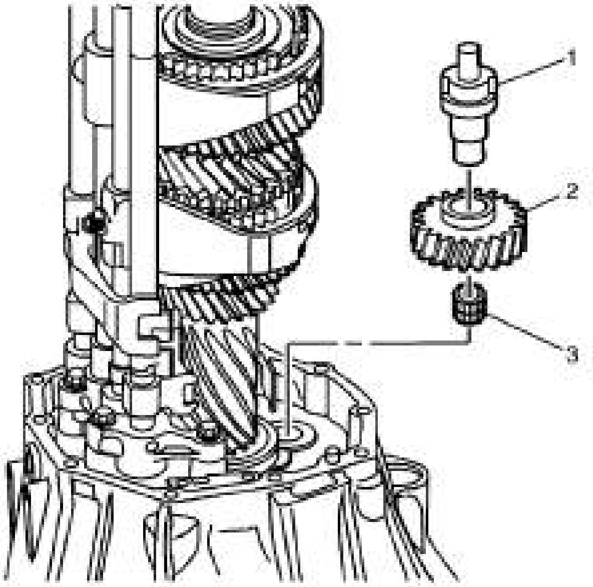
29. Using a suitable tool, separate the intermediate case (1) from the front clutch housing (2).
30. Remove the intermediate case housing (1) from the clutch housing.



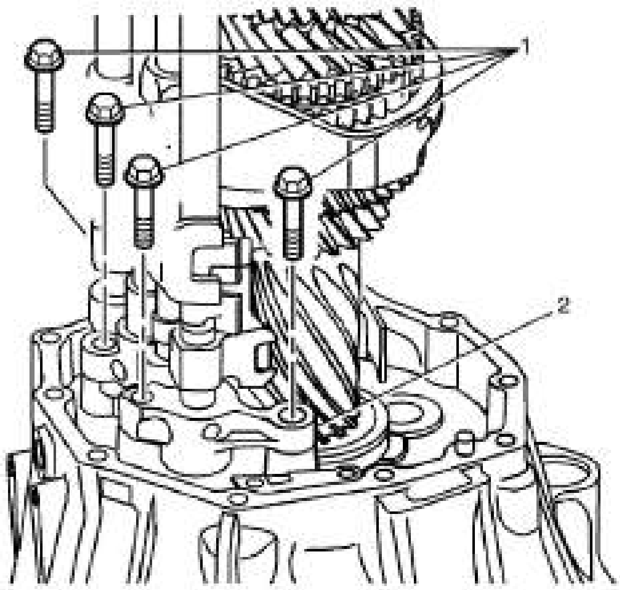
31. Remove the shift shaft selector lever (1) from the clutch housing (2).



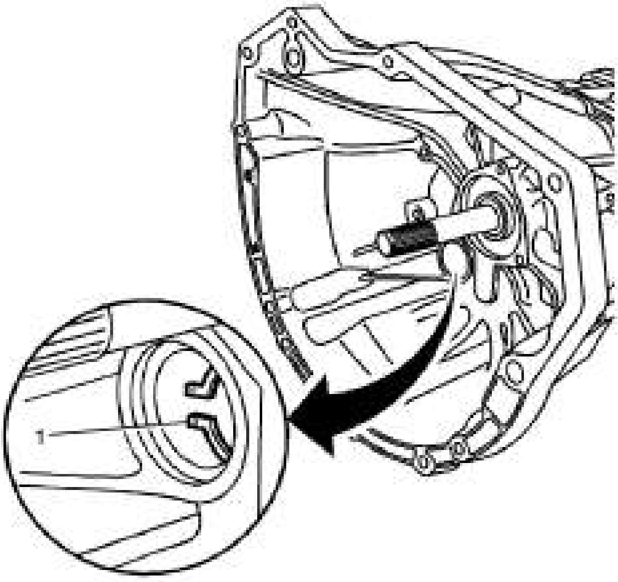
32. Remove the rear output shaft (1), input shaft bearing (2) and blocking ring (3) from the 6th gear synchronizer assembly.



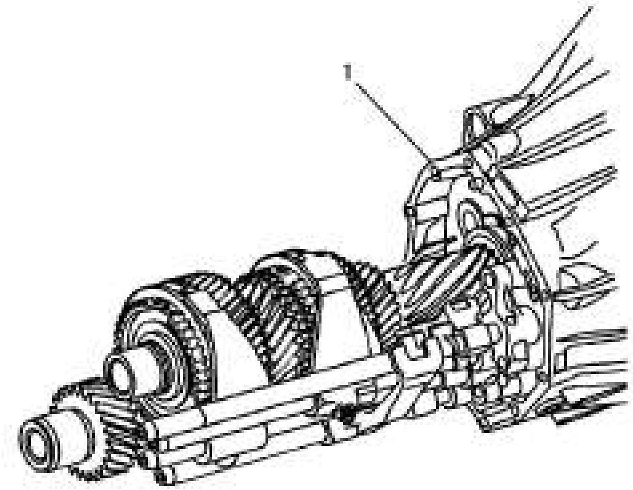
33. Remove the reverse idler gear bearing (3), reverse idler gear (2) and the reverse idler gear shaft (1).



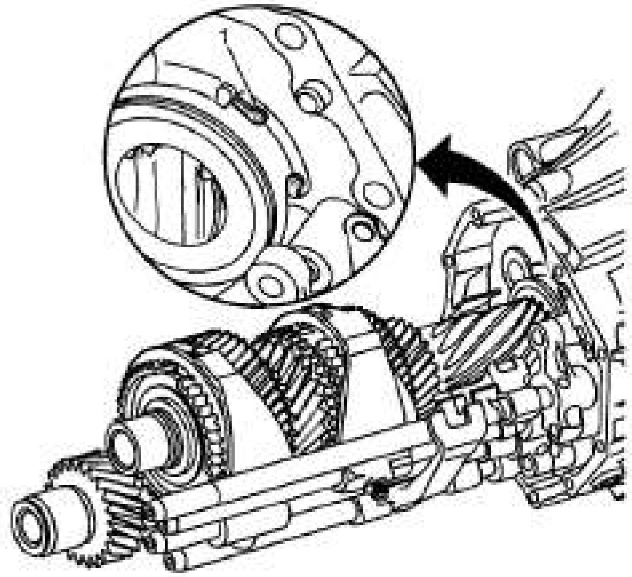
34. Remove the shift counter lever bracket (2) to clutch housing retaining bolts (1).



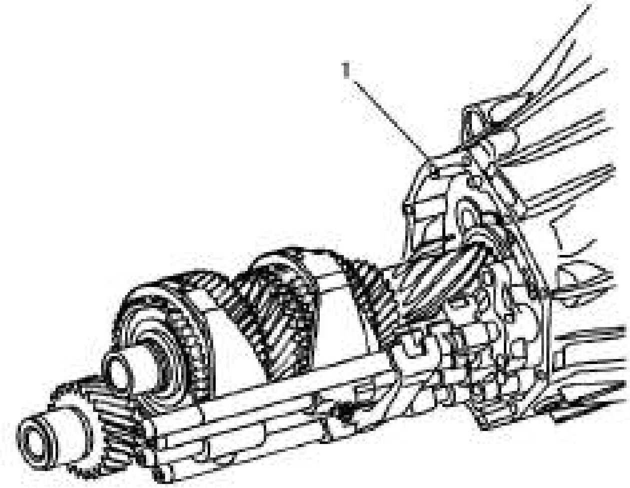
35. Remove the front counter shaft bearing to clutch housing snap ring (1).



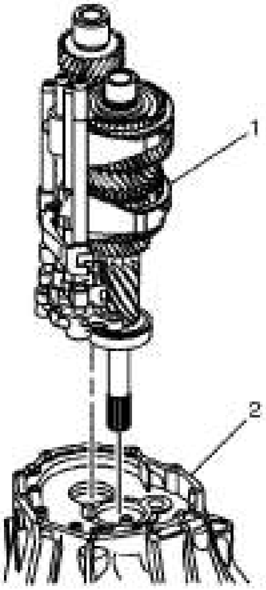
36. Using a suitable tool, tap on transmission front case (1) in order to disengage the countershaft bearing's snap ring.



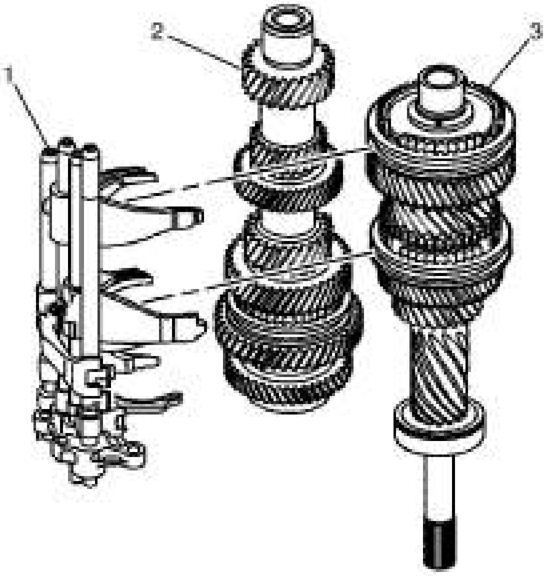
37. Remove the rear input shaft bearing to clutch housing snap ring (1).



38. Hold the countershaft. Using a suitable tool tap on the transmission front case (1) in order to disengage the snap ring. Separate the input shaft and countershaft from clutch housing.



39. Remove the input shaft (1), countershaft and shift rails as an assembly from the clutch housing (2).



40. Separate the shift rails (1), the input shaft (2) and countershaft (3).

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Manual Transmission - Aisin AY6 | Description and Operation | **Document ID: 1992240**

Transmission System Description and Operation

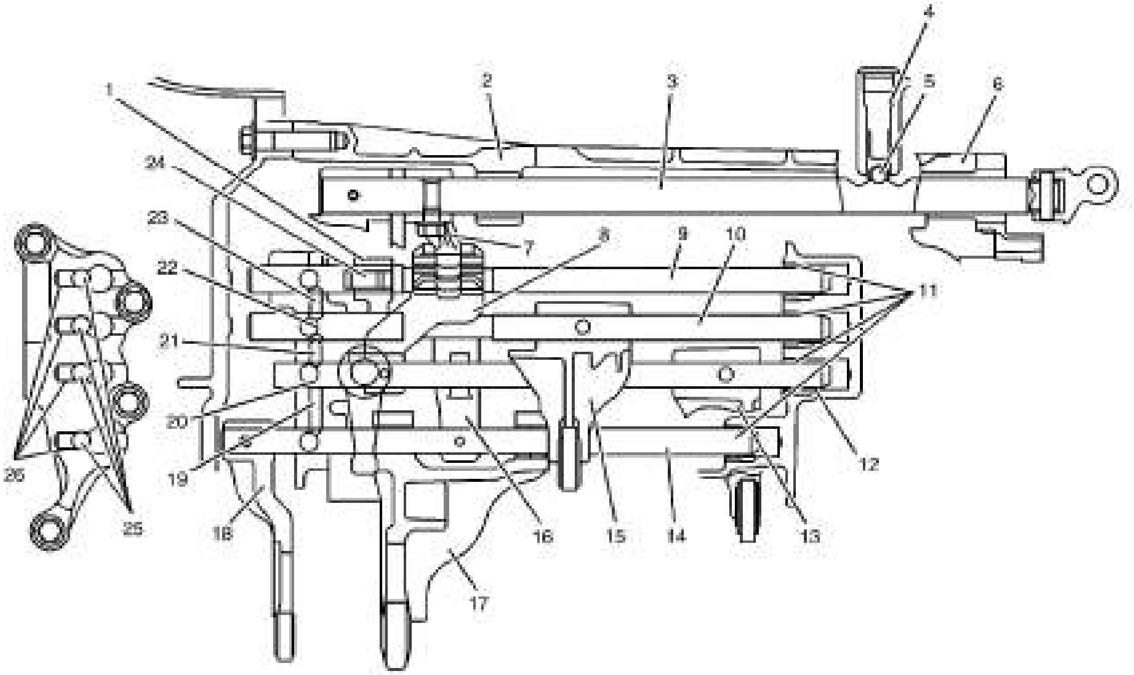
General Description

The Aisin AY6 manual transmission is a 6-speed unit with 6th gear being an overdrive ratio. All gear positions are synchronized. The transmission has a speed reflector wheel on the output shaft for the vehicle speed sensor. Roller, tapered roller, and ball bearings support the input shaft, countershaft, and output shaft. No shimming is required. For proper set up, selective thickness retaining rings are used. All of the speed gears use needle bearings. The AY6 uses a special 75W-90 transmission fluid. The transmission has a 4 piece aluminum housing which consists of the following components:

- The input shaft
- The mainshaft gears
- The countershaft
- The reverse idler gear
- The shift forks
- The shift shaft components

The Aisin transmission is used in cars.

Shifting Operation



The AY6 has a unique shift system. A single shift control shaft (3) operates 4 shift shafts. Shift control lever fits into a coupling on the shift control shaft (3). Positioning a bolt holds the lever (7) in place on the shift control shaft (3), in the gates of the shift shafts, operates the 1st/2nd shift shaft (9), the 3rd/4th shift shaft (10), the 5th/6th shift shaft (12) and the reverse shift shaft (14). Moving the shift control lever side to side allows the lever (7) on the shift control shaft (3) to engage into one of the 4 gates. Moving the shift control lever forward and reverse selects either position of the particular shift shaft. When shifted in position, a detent ball (25) and spring (26) located in the interlock bracket, holds the shift shaft, and a detent ball (5) and spring (4) located in the rear case, holds the shift control shaft (3). To aid in easy shift operation, the middle case shift control shaft bearing (2) and the rear case shift control shaft bearing (6) support the shift control shaft (3). In addition, the rear case shift shaft bushings (11) support the 1st/2nd shift shaft (9), the 3rd/4th shift shaft (10) and the 5th/6th shift shaft (12).

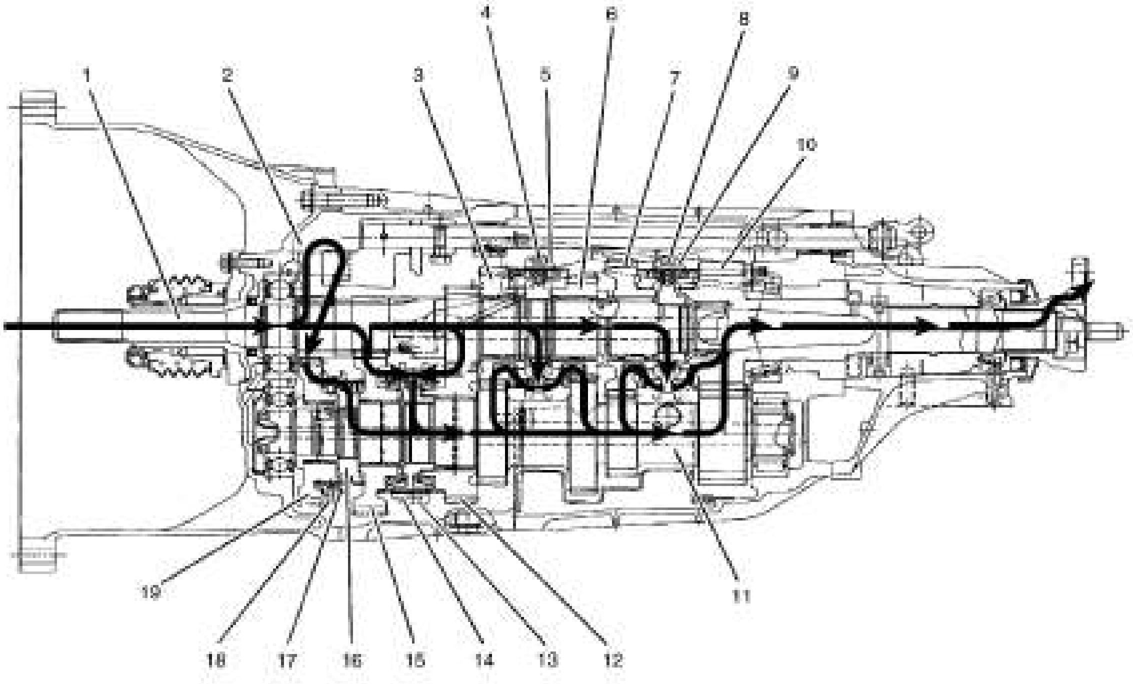
The 1st/2nd shift shaft (9) is the top shift shaft. A pin holds the no.3 head (1) in place on the shift shaft. No.3 head (1) links with 1st/2nd shift fork (17) via the reversal arm (24). The 1st/2nd shift fork (17) slides on the reverse shift shaft (14).

The 3rd/4th shift shaft (10) is the second shaft from the top. A bolt holds the 3rd/4th shift fork (15) in place on the shift shaft. A small shift shaft interlock pin (22) in the 3rd/4th shift shaft (10) prevents the other shafts from moving. Interlock pins (23 or 21), located in the interlock bracket, contact the small interlock pin (22) and lock into a notch on the shift shaft, preventing multiple shift shaft movement.

The 5th/6th shift shaft (12) is located third from the top. A pin holds the 5th/6th shift head (8) in place on the shift shaft. A bolt holds the 5th/6th shift fork (13) in place on the shift shaft. A small shift shaft interlock pin (20) in the 5th/6th shift shaft (12) prevents the other shafts from moving. Interlock pins (21 or 19), located in the interlock bracket, contact the small interlock pin (20) and lock into a notch on the shift shaft, preventing multiple shift shaft movement.

The reverse shift shaft (14) is the bottom shift shaft. Pins hold the reverse shift head (16) and the reverse shift fork (18) in place on the shift shaft.

Power Flow



1st Gear

Moving the 1st/2nd shift fork (13) forward moves the 1st/2nd synchronizer sleeve (14). The synchronizer sleeve (14) slides on the synchronizer hub. The inner teeth on the synchronizer sleeve push against the synchronizer ring teeth, causing the synchronizer rings to contact, and the 1st gear (15) and the countershaft to match speeds. The synchronizer sleeve (14) then engages the selector teeth on 1st gear (14). The synchronizer hub is pressed on the countershaft (11). Power flow is now from the input shaft (1) to the 1st gear (15), through the synchronizer to the countershaft (11) and to the output shaft (10).

2nd Gear

Moving the 1st/2nd shift fork (13) rearward moves the 1st/2nd synchronizer sleeve (14). The synchronizer sleeve (14) slides on the synchronizer hub. The inner teeth on the synchronizer sleeve push against the synchronizer ring teeth, causing the synchronizer rings to contact, and the 2nd gear (12) and the countershaft to match speeds. The synchronizer sleeve (14) then engages the selector teeth on 2nd gear (12). The synchronizer hub is pressed on the countershaft (11). Power flow is now from the input shaft (1) to the 2nd gear (12), through the synchronizer to the countershaft (11) and to the output shaft (10).

3rd Gear

Moving the 3rd/4th shift fork (4) rearward moves the 3rd/4th synchronizer sleeve (5). The synchronizer sleeve (5) slides on the synchronizer hub. The inner teeth on the synchronizer sleeve push against the synchronizer ring teeth, causing the synchronizer ring to contact, and the 3rd gear (6) and the input shaft to match speeds. The synchronizer sleeve (5) then engages the selector teeth on 3rd gear (6). The synchronizer hub is pressed on the input shaft (1). Power flow is now from the input shaft (1) through the synchronizer, to the 3rd gear (6) to the countershaft (11) and to the output shaft (10).

4th Gear

Moving the 3rd/4th shift fork (4) forward moves the 3rd/4th synchronizer sleeve (5). The synchronizer sleeve (5) slides on the synchronizer hub. The inner teeth on the synchronizer sleeve push against the synchronizer ring teeth, causing the synchronizer ring to contact, and the 4th gear (3) and the input shaft to match speeds. The synchronizer sleeve (5) then engages the selector teeth on 4th gear (3). The synchronizer hub is pressed on the input shaft (1). Power flow is now from the input shaft (1) through the synchronizer, to the 4th gear (3) to the countershaft (11) and to the output shaft (10).

5th Gear

In 5th gear, the power flow goes directly from the input shaft (1) to the output shaft (10) through the 5th/6th synchronizer. This happens because 5th gear is the same ratio as the engine speed. Moving the 5th/6th shift fork (8) rearward moves the 5th/6th synchronizer sleeve (9). The synchronizer sleeve (9) slides on the synchronizer hub. The inner teeth on the synchronizer sleeve push against the synchronizer ring teeth for output shaft (10). Matching the input shaft (1) to the output shaft (10) allows the synchronizer sleeve to engage to the selector teeth on the output shaft (10). The synchronizer hub is pressed on the input shaft (1).

6th Gear

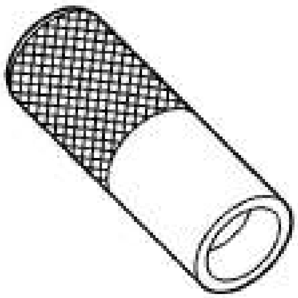
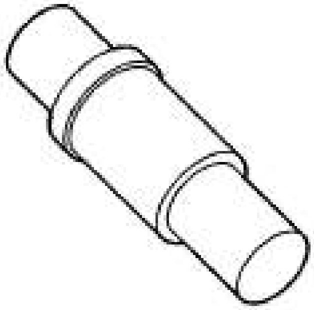
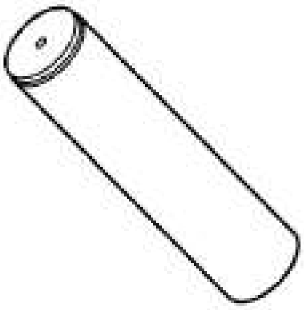
the 6th gear (7) is an overdrive ratio. Moving the 5th/6th shift fork (8) forward moves the 5th/6th synchronizer sleeve (9). The synchronizer sleeve (9) slides on the synchronizer hub. The inner teeth on the synchronizer sleeve push against the synchronizer ring teeth, causing the synchronizer ring to contact, and the 6th gear (7) and the input shaft to match speeds. The synchronizer sleeve (9) then engages the selector teeth on 6th gear (7). The synchronizer hub is pressed on the input shaft (1). Power flow is now from the input shaft (1) through the synchronizer to the 6th gear (7) to the countershaft (11) and to the output shaft (10), which now turns faster than the speed of the input shaft (1).

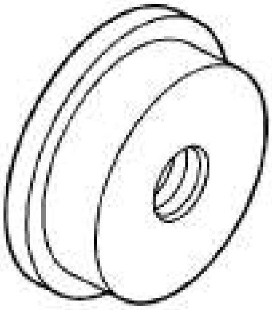
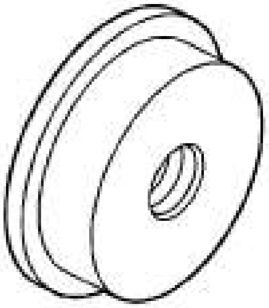
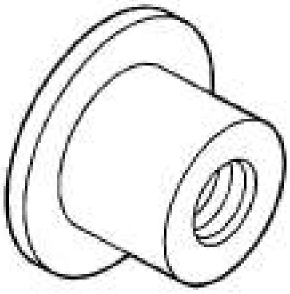
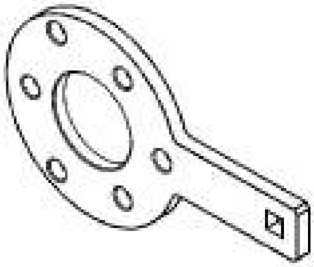
Reverse Gear

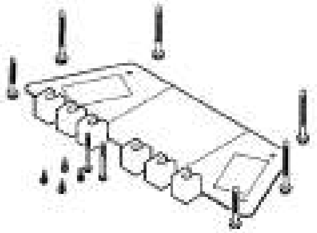
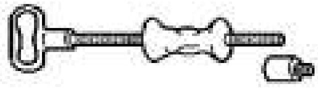
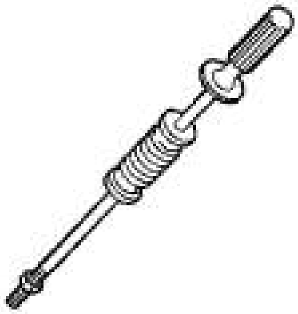
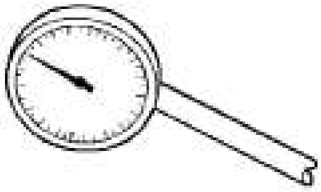
The reverse idler gear (2) is located on the reverse idler shaft and rotates on needle bearings. The reverse idler gear (2) engages with the input shaft (1) and with the reverse gear (19). Moving the reverse shift fork (18) rearward moves the reverse synchronizer sleeve (17). The synchronizer sleeve (17) slides on the spline of the reverse gear. The inner teeth on the synchronizer sleeve push against the synchronizer ring teeth, causing the synchronizer ring to contact, and the reverse gear (19) and the countershaft to match speeds. The synchronizer sleeve (17) then engages the selector teeth (16). The selector teeth are pressed on the countershaft (11). Power flow is now from the input shaft (1) to the reverse idler gear (2), to the reverse gear (19), through the synchronizer to the countershaft (11) and to the output shaft (10).

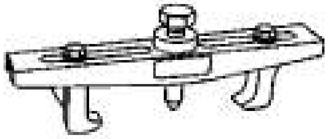
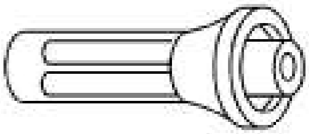
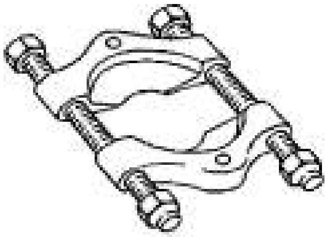
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Manual Transmission - Aisin AY6 | Special Tools and Equipment | **Document ID: 1989967**

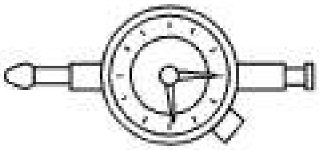
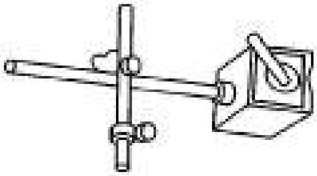
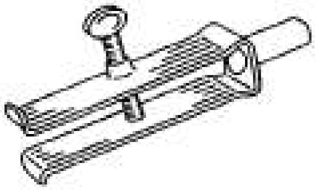
Special Tools

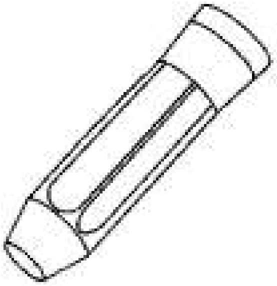
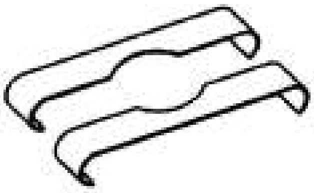
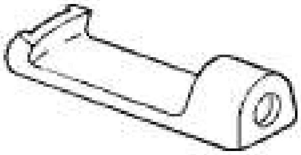
Illustration	Tool Number/ Description
	DT 47721 Shift Shaft Seal Installer
	DT 47722 Shift Rail Bushing Remover/Installer
	DT 47723 Output Shaft Bearing Installer
	DT 47724

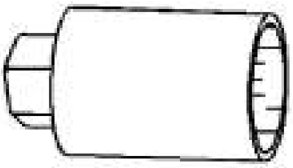
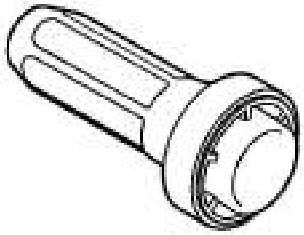
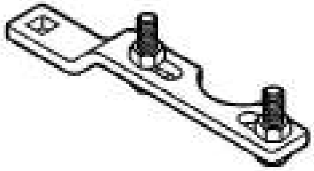
	Output Shaft Bearing Cup Installer
	DT 47725 Extension Housing Bearing Cup Installer
	DT 47726 Counter Shaft Rear Bearing Installer
	DT 47735 Flange Holder

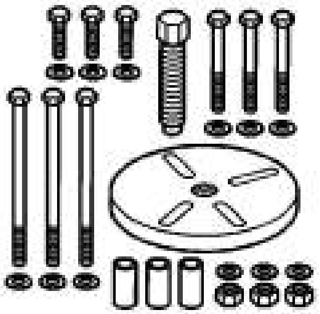
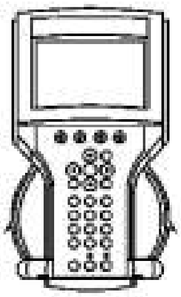
	EN-48536 Frame Support Tool (Engine Lower 65mm Kit)
	J 2619-01 Slide Hammer
	J 6125-1B Slide Hammer
	J 8001-3 Dial Indicator

	J 8433 Two Jaw Puller
	J 21128 Axle Pinion Oil Seal Installer
	J 22912-01 Split Plate Bearing Puller
	J 26900-12 Dial Indicator 1-10 mm

	
	J 26900-13 Magnetic Indicator Base
	J 26941 Bushing and Bearing Remover 3-4 in
	J 36614 Inner Pinion Bearing Installer

	J 36850 Transjel Lubricant
	J 44731 Input Shaft Seal Installer
	J 45869 Gear Protector Plates
	J 23129 Universal Seal Remover

	J 29873 Injector Nozzle Socket 30 mm
	J 44765 Seal Installer
	J 45012 Holding Fixture
	J 45019 Flange and Pinion Gage Remover

	
	70000861 Scan Tool Used for diagnosis of vehicle electrical system.

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Reverse Lamp Switch	27 N·m	20 lb ft
Concentric Slave Cylinder Retaining Bolt	12 N·m	108 lb in
Drive Flange Retaining Nut	135 N·m	100 lb ft
Reverse Lockout Assembly Retaining Bolt	18 N·m	13 lb ft
Reverse Lockout Solenoid	40 N·m	30 lb ft
Shift Rail Roller Detent Bolt	20 N·m	14 lb ft
Shift Guide Plate Retaining Bolt	22 N·m	16 lb ft
Transmission Retaining Bolt	48 N·m	35 lb ft
Transmission Fill Plug	28 N·m	13 lb ft
Transmission Drain Plug	28 N·m	13 lb ft
Transmission Mount To Transmission Case Retaining Bolts	60 N·m	44 lb ft
Adapter Plate Plug	27 N·m	20 lb ft
Adapter Plate To Transmission Case Retaining Bolts	48 N·m	36 lb ft
Shift Turrett Retaining Bolts	20 N·m	15 lb ft
Extension Housing Plug	27 N·m	20 lb ft
Extension Housing To Transmission Case Retaining Bolts	48 N·m	36 lb ft
Neutral Return Cam Spring Retaining Bolt	25 N·m	18 lb ft
Reverse Idler Shaft Bracket Retaining Bolts	25 N·m	18 lb ft
Shift Detent Assembly	40 N·m	30 lb ft
Shift Interlock Retaining Bolts	27 N·m	20 lb ft
Reverse Lamp Switch Bolt	4 N·m	6 lb ft
CSC Pipe Bracket Bolt	4 N·m	6 lb ft
Bell Housing to Adaption Bolt	48 N·m	36 lb ft

Adhesives, Fluids, Lubricants, and Sealers

Sealers, Adhesives, and Lubricants

Application	Type Of Material
Adapter plate plug	Sealant
Turret assembly	Sealant
Extension housing retaining bolts	Sealant
Extension housing to transmission case mating surface	Sealant
Reverse idler shaft bracket retaining bolts	Threadlock
Reverse lamp switch	Sealant
Shift lever guide retaining bolts	Sealant
Transmission case drain plug	Sealant
Transmission case fill plug	Sealant
Transmission case to adapter plate mating surface	Sealant
Transmission fluid	Lubricant

Lubrication Specifications

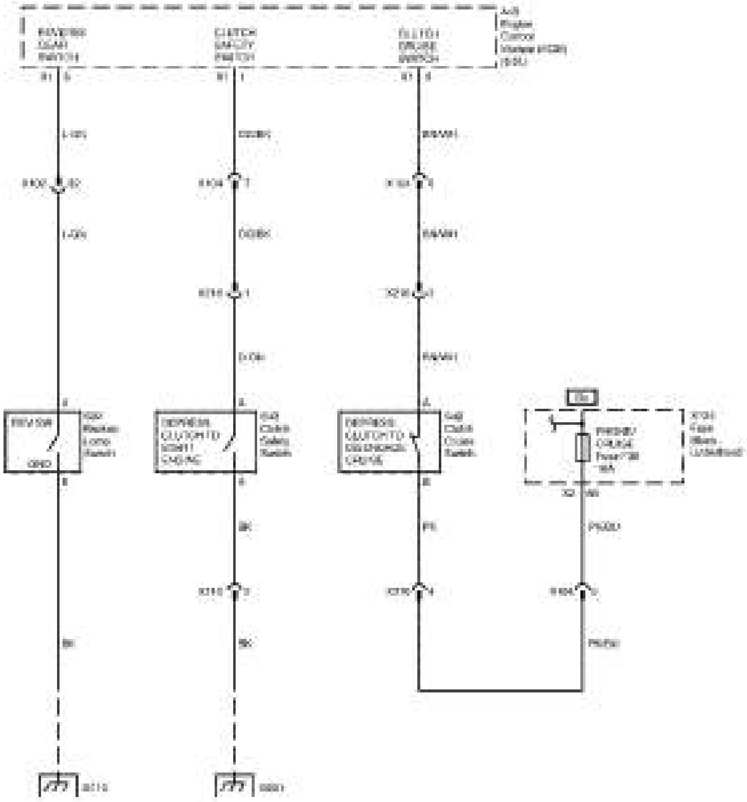
Application	Specification	
	Metric	English
Dexron™ III, IIE	3.45 liters	3.65 quarts

Shim Size Specifications

Application	Specification	
	Metric	English
Countershaft shim preload	0.0-0.05 mm	0.0-0.002 in
Input shaft/mainshaft shim preload	0.0-0.05 mm	0.0-0.002 in

Manual Transmission Schematics

Back up Lamp and Clutch Switches


REVERSE GEAR SWITCH
CLUTCH SAFETY SWITCH
CLUTCH CRUISE SWITCH
REV SW
GND
DEPRESS CLUTCH TO START ENGINE
DEPRESS CLUTCH TO DISENGAGE CRUISE

Diagnostic Starting Point - Manual Transmission

Begin the system diagnosis with the Diagnostic System Check - Vehicle in Vehicle DTC Information. The Diagnostic System Check - Vehicle. This will provide the following information:

- The identification of the control module or modules which command the system.
- The ability of the control module or modules to communicate through the serial data circuit.
- The identification of any stored diagnostic trouble codes (DTCs) and the status of the codes.

Use the Diagnostic System Check - Vehicle.

DTC P0502 or P0503

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0502: Vehicle Speed Sensor (VSS) Circuit Low Voltage

DTC P0503: Vehicle Speed Sensor (VSS) Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
VSS Low Signal	--	P0502, P0503	--	--
VSS High Signal	P0502, P0503	P0502, P0503	P0502, P0503	--

Circuit/System Description

The vehicle speed information is provided to the engine control module (ECM) by the vehicle speed sensor (VSS). The VSS is a permanent magnet generator that is mounted to the transmission and produces a pulsing voltage. The AC voltage amplitude and frequency increases with vehicle speed. The ECM converts the pulsing voltage into km/h (mph). The ECM supplies the VSS signal to the following components:

- The instrument panel for speedometer and odometer operation
- The cruise control module

Conditions for Running the DTC

P0502

- DTC P0120, P0220 or P0503 are not set.
- The TP sensor angle is more than 3.5 percent.
- The engine is running.
- The system voltage is 8-18V.
- TFT is more than -40°C (-40°F)

- The engine speed is 1,500-6,500 RPM.
- Vehicle speed is less than 200 km/h (124 mph).
- Engine torque is 68-8192 N·m (50-6,042 lb ft).

P0503

- The system voltage is 8-18V.
- The engine speed is 500-7,500 RPM.
- Transmission output speed change is less than 146 RPM for 2 seconds.

Conditions for Setting the DTC

P0502

The transmission output speed is 58 RPM or less for 5 seconds.

P0503

The transmission output speed drops 351 RPMs in less than 3 seconds.

Action Taken When the DTC Sets

P0502 and P0503 are Type B DTCs.

Conditions for Clearing the DTC

P0502 and P0503 are Type B DTCs.

Reference Information

Schematic Reference

Manual Transmission Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Manual Transmission Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs

- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Engine Control Module Scan Tool Information

Special Tools

J 35616 GM-Approved Terminal Test Kit

Circuit/System Verification

1. Raise and support the drive wheels.

   Caution: Support the lower control arms in the normal horizontal position in order to avoid damage to the drive axles. Do not operate the vehicle in gear with the wheels hanging down at full travel.

2. Support the lower control arms so that the drive axles are in a horizontal position.
3. Start and idle the engine.
4. Place the transmission in second gear and release the clutch pedal.
5. Monitor VSS parameter on the scan tool. The VSS parameter should increase as the drive wheel speed increases.
6. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that are captured in the Freeze Frame/Failure Records List.

Circuit/System Testing

1. Disconnect the ECM harness connector X1.
2. Measure for 1,300-1,500 ohms at 25°C (77°F) between the VSS high signal circuit terminal 71 and the VSS low signal circuit terminal 72.

   If the value is greater than 1,500 ohms test the VSS high signal circuit and the VSS low signal circuit for an open/high resistance. If the circuits/connections test normal, replace the vehicle speed sensor.

   If the value is less than 1,300 ohms test the VSS high signal and the VSS low signal circuits for a shorted together condition. If the circuits/connections test normal, replace the vehicle speed sensor.
3. Measure for more than 10 ohms between the VSS high signal circuit terminal 71 and ground.

   If the value is less than the specified range, repair the short to ground.
4. Measure for more than 10 ohms between the VSS low signal circuit terminal 72 and ground.

   If the value is less than the specified range, repair the short to ground.
5. Reconnect the ECM connector. Disconnect the VSS connector.
6. Ignition ON, test the VSS high signal circuit terminal B for a short to voltage.

   If all circuits/connections test normal, test or replace the VSS.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Vehicle Speed Sensor Replacement
- Engine Control Module Replacement or Engine Control Module Replacement
- Engine Control Module Programming and Setup

DTC P0712 or P0713

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0712: Transmission Fluid Temperature (TFT) Sensor Circuit Low Voltage

DTC P0713: Transmission Fluid Temperature (TFT) Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
TFT Sensor Signal	P0712	P0713	P0713[1]	--
Low Reference	--	P0713	P0713[1]	--
[1] Internal ECM damage may occur if the circuit is shorted to B+.				

Circuit/System Description

The transmission fluid temperature (TFT) sensor is a variable resistor that measures the temperature of the transmission fluid. The engine control module (ECM) supplies 5 V to the TFT signal circuit and supplies a ground to the low reference circuit.

The following table illustrates the difference between temperature, resistance, and voltage:

TFT	TFT Resistance	TFT Signal Voltage
Cold	High	High
Warm	Low	Low

Conditions for Running the DTC

P0712

- The engine speed is above 1,000 RPM for 7 seconds.
- This DTC runs continuously when the above condition is met.

P0713

- The engine speed is above 1,000 RPM for 7 seconds.
- This DTC runs continuously when the above condition is met.

Conditions for Setting the DTC

P0712

The TFT is greater than 145°C (299°F) for more than 5 seconds.

P0713

The TFT is less than -35°C (-31°F) for more than 5 seconds.

Action Taken When the DTC Sets

DTC P0712 and P0713 are Type C DTCs.

Conditions for Clearing the MIL/DTC

DTC P0712 and P0713 are Type C DTCs.

Reference Information

Schematic Reference

Manual Transmission Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Manual Transmission Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Engine Control Module Scan Tool Information

Circuit/System Verification

1. Engine running, DTC P0712 or P0713 should not set.
2. If the vehicle passes the Circuit/System Verification Test, then operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that are captured in the Freeze Frame/Failure Records List.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the TFT sensor.
2. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal A and ground.

   If greater than 5 ohms, test the low reference circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, using a scan tool verify that the TFT sensor parameter is at -40°C (-40°F).

   If greater than -40°C (-40°F), test the signal circuit terminal B for a short to ground. If the circuit tests normal, replace the ECM.

   Note: If the signal circuit of the TFT sensor is shorted to voltage the TFT sensor may be damaged.
4. Install a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the TFT sensor parameter is greater than 128°C (262°F).

   If less than 128°C (262°F), test the signal circuit of the TFT sensor for a short to voltage or an open/high resistance. If the circuit test normal, replace the ECM.
5. If all circuits test normal, test or replace the TFT sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Transmission Fluid Temperature Sensor Replacement
- Engine Control Module Replacement or Engine Control Module Replacement
- Engine Control Module Programming and Setup

DTC P0801

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0801: Reverse Lockout Solenoid Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ Circuit to Reverse Lockout Solenoid	P0801	P0801	--	--
Reverse Lockout Solenoid Control Circuit	P0801	P0801	P0801	--

Typical Scan Tool Data

Reverse Inhibit Solenoid

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine Running. *Parameter Normal Range:* ON or OFF.			
Reverse Inhibit Solenoid Command	OFF	OFF	OFF

Circuit/System Description

Battery voltage (B+) is supplied directly to the reverse lockout solenoid. The engine control module (ECM) controls the reverses lockout solenoid by grounding the control circuit via an internal switch called a low side driver. The low side driver has a fault line which monitors the control circuit. When the ECM commands the reverse lockout solenoid ON, the voltage on the control circuit should be low, near 0 V. When the ECM commands the control circuit to the reverse lockout solenoid OFF, the voltage should be high, near battery voltage.

Conditions for Running the DTC

- The engine is running.

- The vehicle speed is less than 3 km/h (2 mph).

Conditions for Setting the DTC

- The ECM detects that the commanded state of the driver and the actual state of the control circuit does not match.
- The condition exists for 2 seconds.

Action Taken When the DTC Sets

P0801 is a Type C DTC.

Conditions for Clearing the MIL/DTC

P0801 is a Type C DTC.

Diagnostic Aids

- The battery must be fully charged and pass a battery test. Refer to Battery Inspection/Test.
- The reverse lockout solenoid is referred to as the reverse inhibit solenoid on the scan tool.

Reference Information

Schematic Reference

Manual Transmission Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Manual Transmission Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Engine Control Module Scan Tool Information

Circuit/System Verification

1. Ignition ON, command the reverse lockout solenoid ON and OFF, with a scan tool, while observing the following reverse lockout circuit status parameters.
   - Reverse lockout solenoid control Ckt. Short Gnd Test Status
   - Reverse lockout solenoid control Ckt. Open Test Status
   - Reverse lockout solenoid control Ckt. Short Volts Test Status

   Each parameter should toggle between OK and Not Run or Not Run and OK.
2. Operate the vehicle within the Conditions for Running the DTC, to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Note: You must perform the Circuit/System Verification first.

1. Disconnect the reverse lockout solenoid harness connector.
2. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal B and ground.

   If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the circuit fuse is open, replace the reverse lockout solenoid.
3. Verify that a test lamp does not illuminate between the B+ circuit terminal B and the control circuit terminal A.

   If the test lamp illuminates, test the control circuit for a short to ground. If the circuit tests normal, replace the ECM.
4. Remove the test lamp.
5. Command the reverse lockout solenoid ON with a scan tool. Verify with a scan tool that the reverse lockout solenoid Ckt. Short Volts Test Status parameter is OK.

   If not the specified value, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
6. Install a 3 A fused jumper wire between the reverse lockout control circuit terminal A and the B+ circuit terminal B. Command the reverse lockout solenoid ON with a scan tool. Verify with a scan tool that the affected reverse lockout solenoid Ckt. Short Volts Test Status parameter is displaying Fault.

   If not the specified value, test the control circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
7. If all the circuits test normal, test or replace the reverse lockout assembly.

Repair Instructions

- Reverse Lockout Solenoid Replacement
- Engine Control Module Programming and Setup
- Engine Control Module Replacement or Engine Control Module Replacement

Repair Verification

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming, or setup procedures that are required when a component or module is removed or replaced.
3. Clear the DTCs.
4. Turn OFF the ignition for 60 seconds.
5. Engine running, command the reverse lockout solenoid ON and OFF with a scan tool, while observing the reverse inhibit circuit status parameters. The circuit status parameters should change from OK to Not Run or Not Run to OK.

   If another DTC is present, refer to Diagnostic Trouble Code (DTC) List - Vehicle and perform the appropriate diagnostic procedure.

DTC P0803

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0803: Skip Shift Solenoid Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ Circuit to Skip Shift Solenoid	P0803	P0803	--	--
Skip Shift Solenoid Control Circuit	P0803	P0803	P0803	--

Typical Scan Tool Data

Skip Shift Solenoid

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine Running. *Parameter Normal Range:* ON or OFF.			
Skip Shift Solenoid Command	OFF	OFF	OFF

Circuit/System Description

Ignition voltage is supplied directly to the skip shift solenoid. The engine control module (ECM) controls the skip shift solenoid by grounding the control circuit via an internal switch called a low side driver. The low side driver has a fault line which monitors the control circuit. When the ECM commands the skip shift solenoid ON, the voltage on the control circuit should be low, near 0 V. When the ECM commands the control circuit to the skip shift solenoid OFF, the voltage should be high, near battery voltage.

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

- The ECM detects that the commanded state of the driver and the actual state of the control circuit does not match.
- The condition exists for 5 seconds.

Action Taken When the DTC Sets

P0803 is a Type B DTC.

Conditions for Clearing the MIL/DTC

P0803 is a Type B DTC.

Diagnostic Aids

The battery must be fully charged and pass a battery test. Refer to Battery Inspection/Test.

Reference Information

Schematic Reference

Manual Transmission Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Manual Transmission Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Engine Control Module Scan Tool Information

Circuit/System Verification

1. Ignition ON, command the skip shift solenoid ON and OFF, with a scan tool, while observing the following skip shift circuit status parameters.
   - Skip shift solenoid control Ckt. Short Gnd Test Status
   - Skip shift solenoid control Ckt. Open Test Status
   - Skip shift solenoid control Ckt. Short Volts Test Status

   Each parameter should toggle between OK and Not Run or Not Run and OK.
2. Operate the vehicle within the Conditions for Running the DTC, to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Note: You must perform the Circuit/System Verification first.

1. Disconnect the skip shift solenoid harness connector.
2. Ignition ON, verify that a test lamp illuminates between the voltage circuit terminal B and ground.

   If the test lamp does not illuminate, test the voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the circuit fuse is open, replace the skip shift solenoid.
3. Verify that a test lamp does not illuminate between the voltage circuit terminal B and the control circuit terminal A.

   If the test lamp illuminates, test the control circuit for a short to ground. If the circuit tests normal, replace the ECM.
4. Remove the test lamp.
5. Command the skip shift solenoid ON with a scan tool. Verify with a scan tool that the skip shift solenoid Ckt. Short Volts Test Status parameter is OK.

   If not the specified value, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
6. Install a 3 A fused jumper wire between the skip shift control circuit terminal A and the voltage circuit terminal B. Command the skip shift solenoid ON with a scan tool. Verify with a scan tool that the affected skip shift solenoid Ckt. Short Volts Test Status parameter is displaying Fault.

   If not the specified value, test the control circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
7. If all the circuits test normal, replace the skip shift assembly.

Repair Instructions

- Gear Select/Skip Shift Solenoid Replacement
- Engine Control Module Programming and Setup
- Engine Control Module Replacement or Engine Control Module Replacement

Repair Verification

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming, or setup procedures that are required when a component or module is removed or replaced.
3. Clear the DTCs.

4. Turn OFF the ignition for 60 seconds.
5. Engine running, command skip shift solenoid ON and OFF with a scan tool, while observing the skip shift circuit status parameters. The circuit status parameters should change from OK to Not Run or Not Run to OK.

   If another DTC is present, refer to Diagnostic Trouble Code (DTC) List - Vehicle and perform the appropriate diagnostic procedure.

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DTC P0806

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0806: Clutch Pedal Position (CPP) Sensor Circuit Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
CPP Sensor Signal	P0807	P0807	P0808	P0806
CPP Sensor 5 V Reference	P0651, P0807	P0807	P0651, P0808	--
CPP Sensor Low Reference	--	P0808	P0808	--

Typical Scan Tool Information

CPP Sensor Voltage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON. *CPP Sensor Voltage Parameter Normal Range:* 0 V with clutch pedal applied to 5 V when clutch pedal is released.			
CPP Sensor 5 V Reference	0 V	0 V	5 V
CPP Sensor Signal	0 V	0 V	5 V
CPP Sensor Low Reference	--	5 V	--

CPP Sensor Percentage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON. *CPP Sensor Percent Parameter Normal Range:* 0% with clutch pedal released to 100% when clutch pedal is applied.			
CPP Sensor 5 V Reference	100%	100%	0-100%
CPP Sensor Signal	100%	100%	100%

CPP Sensor Low Reference	--	0%	--

Circuit/System Description

The clutch pedal position (CPP) sensor is a three wire sensor, connected to a 5 V reference circuit, a low reference circuit, and a signal circuit. The engine control module (ECM) supplies 5 V to the CPP sensor, and also provides a sensor ground path on the low reference circuit. The CPP sensor sends a voltage signal to the ECM on the signal circuit. The voltage on the signal circuit will vary from a voltage less than or equal to 5 V when the clutch pedal is released, to a voltage less than or equal to 1.5 V when the clutch pedal is applied.

Conditions for Running the DTC

DTCs P0335, P0336, P0502, P0503, P0607, P0808, or P080A are not set.

Conditions for Setting the DTC

The CPP sensor is stuck in range.

Action Taken When the DTC Sets

P0806 is a Type A DTC.

Conditions for Clearing the MIL/DTC

P0806 is a Type A DTC.

Reference Information

Schematic Reference

Manual Transmission Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Manual Transmission Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Engine Control Module Scan Tool Information

Circuit / System Verification

1. Ignition ON, observe the scan tool CPP sensor percent parameter. The percentage should vary from 0 percent when the clutch pedal is released, to 100 percent when the clutch pedal is in the apply position.
2. Perform the CPP learn procedure. Refer to Clutch Pedal Position Sensor Learn.
3. Operate the vehicle within the conditions for running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

1. Ignition OFF, disconnect the harness connector of the CPP sensor.
2. Ignition ON, observe the scan tool CPP sensor voltage parameter for 0.1 V.

   If less than the specified value, replace the CPP sensor.

   If greater than the specified value, replace the ECM.

Component Testing

1. Ignition OFF, disconnect the harness connector of the CPP sensor.
2. Measure the resistance between the signal terminal B and the low reference terminal A of the CPP sensor. Sweep the CPP sensor through the entire range. The resistance should vary low to high and high to low without any spikes or dropouts.

   If the resistance is erratic with spikes or dropouts, replace the CPP sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Clutch Pedal Replacement
- Engine Control Module Replacement or Engine Control Module Replacement
- Engine Control Module Programming and Setup

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DTC P0807 or P0808

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0807: Clutch Pedal Position (CPP) Sensor Circuit Low Voltage

DTC P0808: Clutch Pedal Position (CPP) Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
CPP Sensor Signal	P0807	P0807	P0808	P0806
CPP Sensor 5 V Reference	P0651, P0807	P0807	P0651, P0808	--
CPP Sensor Low Reference	--	P0808	P0808	--

Typical Scan Tool Information

CPP Sensor Voltage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON. *CPP Sensor Voltage Parameter Normal Range:* 0 V with clutch pedal applied to 5 V when clutch pedal is released.			
CPP Sensor 5 V Reference	0 V	0 V	5 V
CPP Sensor Signal	0 V	0 V	5 V
CPP Sensor Low Reference	--	5 V	--

CPP Sensor Percentage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON. *CPP Sensor Percentage Parameter Normal Range:* 0% with clutch pedal released to 100% when clutch pedal is applied.			
CPP Sensor 5 V Reference	100%	100%	0-100%

CPP Sensor Signal	100%	100%	100%
CPP Sensor Low Reference	--	0%	--

Circuit/System Description

The clutch pedal position (CPP) is a three wire sensor, connected to a 5 V reference circuit, a low reference circuit, and a signal circuit. The engine control module (ECM) supplies 5 V to the CPP sensor, and also provides a sensor ground path on the low reference circuit. The CPP sensor sends a voltage signal to the ECM on the signal circuit. The voltage on the signal circuit will vary from a voltage less than or equal to 5 V when the clutch pedal is released to a voltage less than or equal to 1.5 V when the clutch pedal is applied.

Conditions for Running the DTC

P0807 and P0808

- DTCs P0641 or P0651 are not set.
- The system voltage is more than 9 V.
- The ignition is in the RUN position.

Conditions for Setting the DTC

P0807

The CPP sensor voltage is less than 0.1 V for more than 1 second.

P0808

The CPP sensor voltage is more than 5.2 V for more than 1 second.

Action Taken When the DTC Sets

P0807 and P0808 are Type A DTCs.

Conditions for Clearing the MIL/DTC

P0807 and P0808 are Type A DTCs.

Reference Information

Schematic Reference

Manual Transmission Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Manual Transmission Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Engine Control Module Scan Tool Information

Circuit / System Verification

1. If DTC P0641 or P0651 is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle.
2. Ignition ON, observe the scan tool CPP sensor percent parameter. The percentage should vary from 0 percent when the clutch pedal is released, to 100 percent when the clutch pedal is in the apply position.
3. Perform the CPP learn procedure. Refer to Clutch Pedal Position Sensor Learn.
4. Operate the vehicle within the conditions for running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit / System Testing

1. Ignition OFF, disconnect the harness connector of the CPP sensor.
2. Ignition OFF, test for less than 1 ohm between the low reference circuit terminal A and the negative post of the battery.

   If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal C and ground.

   If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

   If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Ignition ON, verify that the scan tool CPP sensor parameter is less than 0.1 V.

   If greater than the specified value, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
5. Install a 3 A fused jumper wire between the signal circuit terminal B and the 5 V reference circuit terminal C. Verify that the scan tool CPP sensor parameter is between 4.8-5.2 V.

   If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

6. If all circuits test normal, test or replace the CPP sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector of the CPP sensor.
2. Measure the resistance between the signal terminal B and the low reference terminal A of the CPP sensor. Sweep the CPP sensor through the entire range. The resistance should vary low to high and high to low without any spikes or dropouts.

   If the resistance is erratic with spikes or dropouts, replace the CPP sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Clutch Pedal Replacement
- Engine Control Module Replacement or Engine Control Module Replacement
- Engine Control Module Programming and Setup

DTC P080A

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P080A: Clutch Pedal Position (CPP) Not Learned

Circuit/System Description

The clutch pedal position (CPP) is a three wire sensor, connected to a 5 V reference circuit, a low reference circuit, and a signal circuit. The engine control module (ECM) supplies 5 V to the CPP sensor, and also provides a sensor ground path on the low reference circuit. The CPP sensor sends a voltage signal to the ECM on the signal circuit. The voltage on the signal circuit will vary from a voltage less than or equal to 5 V when the clutch pedal is released to a voltage less than or equal to 1.5 V when the clutch pedal is applied.

Conditions for Running the DTC

Clutch pedal fully applied.

Conditions for Setting the DTC

Clutch pedal position not learned.

Action Taken When the DTC Sets

P080A is a Type B DTC.

Conditions for Clearing the MIL/DTC

P080A is a Type B DTC.

Reference Information

Schematic Reference

Manual Transmission Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Manual Transmission Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Engine Control Module Scan Tool Information

Circuit / System Verification

Perform the clutch pedal position sensor learn procedure. Refer to Clutch Pedal Position Sensor Learn.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Clutch Pedal Position Sensor Learn
- Engine Control Module Replacement or Engine Control Module Replacement
- Engine Control Module Programming and Setup

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Clutch Pedal Position Sensor Learn

Important: The clutch pedal position (CPP) sensor learn procedure is required when the following service procedures have been performed regardless of whether DTC P080A is set:

- An engine control module (ECM) replacement
- A CPP sensor replacement
- Any repairs which affect the CPP sensor relationship

1. Install a scan tool.
2. Monitor the ECM for DTCs with a scan tool. If other DTCs are set, except DTC P080A, refer to Diagnostic Trouble Code (DTC) List - Vehicle for the applicable DTC that set.
3. With a scan tool, select Clutch Pedal Position Learn under Module Setup in Manual Transmission, and perform the following instructions displayed on the scan tool screen.

   Important: The CPP sensor learn procedure cannot be performed more than once per ignition cycle. The clutch pedal needs to be fully depressed and held steady throughout this procedure in order to perform a correct learning.

4. The scan tool will display under CPP Learn Status: Not Learned, In Process, Complete, Fail - Low Volt, Fail - High Volt, or Fail Moving. The scan tool will display under CPP Learn Status Complete if the process was successful.
5. If the scan tool indicates that DTC P080A ran and passed this ignition the CPP sensor learn procedure is complete. If the scan tool indicates DTC P080A failed or did not run this ignition, refer to DTC P080A. If any other DTC is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle for the applicable DTC.
6. Turn OFF the ignition for 30 seconds after the learn procedure has successfully completed in order to store the CPP sensor variation values in ECM history.

Scan Tool Data Definitions

Clutch Pedal Switch: This parameter displays the state of the clutch pedal switch circuit input. The scan tool will display APPLIED when the clutch pedal is depressed, and RELEASED when the clutch pedal is released.

Reverse Inhibit Solenoid Command: This parameter displays the commanded state of the reverse inhibit solenoid. When the vehicle speed is greater than 5 km/h (3 mph), the solenoid is commanded ON, inhibiting shifts to Reverse. When the vehicle speed is less than 5 km/h (3 mph), the solenoid is commanded OFF, allowing shifts to Reverse. The scan tool will display ON/OFF.

Reverse Inhibit Solenoid Command: This parameter displays the commanded state of the reverse inhibit solenoid. When the vehicle speed is greater than 5 km/h (3 mph), the solenoid is commanded ON, inhibiting shifts to Reverse. When the vehicle speed is less than 5 km/h (3 mph), the solenoid is commanded OFF, allowing shifts to Reverse. The scan tool will display ON/OFF.

Vehicle Speed: This parameter displays the speed at which the vehicle is traveling. The scan tool displays vehicle speed as kilometers per hour (km/h), miles per hour (MPH). The vehicle speed is calculated based on the input signal from the vehicle speed sensor.

Symptoms - Manual Transmission

Strategy Based Diagnostics

Review the system operations in order to familiarize yourself with the system functions. Refer to Manual Transmission Description and Operation

Visual/Physical Inspection

- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect the manual transmission for the correct fluid level and type.
- Inspect the manual transmission for fluid leaks.
- Inspect the manual transmission for broken or loose transmission mounts.

Intermittent

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating properly.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Transmission Shifts Hard .
- Transmission Gear Clash When Shifting Gears .
- Transmission Noisy .
- Transmission Jumps Out of Gear .
- Transmission Does Not Shift into One Gear .
- Transmission Locked in One Gear .
- Transmission Clunk on Acceleration or Deceleration .
- Transmission Fluid Leak Diagnosis .

Transmission Does Not Shift into One Gear

Diagnostic Aids

If the transmission shifts into gear and then jumps out of gear, refer to Transmission Jumps Out of Gear . If it is an intermittent condition, other driveline components may be faulty.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. This test is to confirm that the clutch is not slipping. During certain conditions, the clutch may slip and feel as though the transmission is not in gear.

3. A static shift test is performed by shifting into all gears with the engine not operating. While performing the test, you should note how the shift lever movement feels. Also feel for the shift rails moving freely, the detent plungers operating when coming out of a gear and going into the next gear, and for the synchroniser sleeve movement.

6. A dynamic shift test is performed by shifting into all gears with the engine operating. Test for the correct mesh of the synchronisers sleeve and the speed gear selector teeth. Move the shift lever and feel for the synchroniser sleeve to just release from the gear, then let up on the clutch pedal. Press the clutch pedal and move the shift lever to engage that gear again, to Make sure full travel of the shift components.

Step	Action	Yes	No
DEFINITION: The shift lever will not move into a particular gear position, or when in a gear position, power is not delivered through the transmission.			
1	Did you review the and perform the necessary inspections? Refer to Symptoms - Manual Transmission	Go to Step 2	Go to Symptoms - Manual Transmission .
2	Inspect the clutch system for slipping. Refer to Clutch Slipping . Is the clutch operating properly?	Go to Step 2	Go to Clutch Assembly Replacement
3	1. Perform a static shift test on the transmission. 2. Test for the following conditions: • Blockage preventing full shift lever movement. • Excessive movement in the shift lever. • Binding in the shift lever. • Detent plungers or shift rails binding. • Synchronizer sleeve moving on the hub and pressure pieces. • Shift linkage binding.		

	• Shift linkage proper adjustment. Were you able to shift into the gear position with the concern?	Go to Step 5	Go to Step 4
4	Remove the shift control shift closeout boot. Refer to Shift Control Shift Closeout Boot Replacement . Inspect for the following: • Loose mounting. • Foreign debris. Did you find and repair the condition?	Go to Step 8	Go to Step 5
5	1. Perform a dynamic shift test on the transmission. 2. Test for the following conditions: • Detent plungers or shift rails binding. • Synchroniser sleeve binding. • Synchroniser sleeve engaging on the speed gear selector teeth. Were you able to shift into the gear position with the concern?	Go to Step 7	Go to Step 6
6	1. Remove the transmission. Refer to Transmission Replacement . 2. Disassemble the transmission. Refer to one of the following: Transmission Disassemble . 3. Inspect the following transmission internal components for wear or damage: • The shift forks. • The internal shift control lever. Did you find and repair the condition?	Go to Step 8	Go to Step 7
7	1. Remove the transmission. Refer to Transmission Replacement . 2. Disassemble the transmission. Refer to one of the following: Transmission Disassemble . 3. Inspect the following transmission internal components for wear or damage: • The synchroniser sleeve selector teeth. • The speed gear selector teeth. • The speed gear axial clearance for being excessive. • The speed gear to mainshaft bearings and journals. • The countershaft for being broken. • The mainshaft for being broken.		

	- The countershaft gear for being stripped. - The mainshaft gear for being stripped. Did you find and repair the condition?	Go to Step 8	Go to Diagnostic Aids
8	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 1

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Transmission Fluid Leak Diagnosis

Diagnostic Aids

Using the incorrect type of transmission fluid may affect the sealing ability of the seals. Make sure the use of the correct type of transmission fluid. The incorrect type of sealer may not be compatible with the transmission fluid or may not have the correct characteristics for sealing the affected components. Make sure the use of the correct type of sealers. Refer to Adhesives, Fluids, Lubricants, and Sealers .

Test Description

The number below refers to the step number on the diagnostic table.

5. Use an approved method to clean the transmission to make sure the leak location is correctly identified. If using a powder method or dye method, make sure the products are compatible with the transmission fluid.

Step	Action	Yes	No
DEFINITION: Visible sign of the transmission fluid leaking from the transmission.			
1	Did you review and perform the necessary inspections? Refer to Symptoms - Manual Transmission .	Go to Step 2	Go to Symptoms - Manual Transmission
2	1. Inspect for the transmission fluid level higher than the recommended level. Refer to Transmission Fluid Replacement . 2. Adjust the transmission level if incorrect. Was the transmission fluid level too high?	Go to Step 19	Go to Step 3
3	Inspect the transmission vent for a blockage. Is the transmission vent blocked?	Go to Step 4	Go to Step 5
4	Repair or replace the transmission vent. Refer to Transmission Vent Tube Replacement Did you find and repair the condition?	Go to Step 19	Go to Step 5
5	Verify the location of the leak. 1. Clean the transmission assembly. 2. Operate the vehicle for 24 km (15 mi), or until normal operating temperatures are reached. 3. Visual inspect or use the powder method or dye and black light method to locate the leak. Is the leak occurring at the drain or fill plug?	Go to Step 6	Go to Step 7
	Replace the drain or fill plug. Refer to Transmission Fluid Replacement		

6	Did you find and repair the condition?	Go to Step 19	Go to Diagnostic Aids
7	Is the leak at the transmission output shaft seal?	Go to Step 8	Go to Step 9
8	Remove the output shaft seal and inspect for the following. Refer to Mainshaft Rear Oil Seal Replacement . • Damaged or worn seal. • Damaged seal bore. • Improper installation. • Cracks in the component. • Propeller shaft yoke sealing surface is scratched, nicked, damaged, or worn. • Loose or worn bearing causing excessive seal wear. • Yoke flange nut loose. Did you find and repair the condition?	Go to Step 19	Go to Diagnostic Aids
9	Is the leak at the front of the transmission?	Go to Step 10	Go to Step 12
10	1. Inspect for the leak at the input shaft seal. 2. Inspect for the following if the input shaft seal is leaking: • Damaged or worn seal. • Damaged seal bore. • Improper installation. • Cracks in the component. • Input shaft sealing surface is scratched, nicked, damaged or worn. • Loose or worn bearing causing excessive seal wear. 3. Replace the input shaft seal if leaking. Refer to Mainshaft Rear Oil Seal Replacement . Did you find and repair the condition?	Go to Step 19	Go to Step 11
11	1. Inspect the case for cracks or porosity. 2. Replace the transmission front case half if it is faulty. Refer to Transmission Disassemble . Did you find and repair the condition?	Go to Step 19	Go to Diagnostic Aids
12	Is the leak at the backup light switch?	Go to Step 13	Go to Step 15
	1. Remove the backup light switch. Refer to Backup Lamp Switch Replacement . 2. Inspect for the following: • Cross threaded or damaged threads.		

13	• Insufficient sealant. • Leaking switch. • Improper installation. Did you find and repair the condition?	Go to Step 19	Go to Step 1
14	1. Remove the shift shaft detent sleeve. Refer to Transmission Disassemble . 2. Inspect for the following: • Cross threaded or damaged threads. • Insufficient sealant. • Cracked sleeve or case. • Improper installation. Did you find and repair the condition?	Go to Step 19	Go to Step 1
15	Is the leak at the sealing flanges of the transmission case?	Go to Step 16	Go to Step 17
16	1. Remove the transmission. Refer to Transmission Replacement . 2. Disassemble the transmission. Refer to Transmission Disassemble Did you find and repair the condition?	Go to Step 19	Go to Step 17
17	Is the leak coming from a crack or porosity in the transmission case?	Go to Step 18	Go to Diagnostic Aids
18	1. Remove the transmission. Refer to Transmission Replacement . 2. Disassemble the transmission. Refer to Transmission Disassemble 3. Replace the faulty case. Refer to Transmission Assemble Did you find and repair the condition?	Go to Step 19	Go to Diagnostic Aids
19	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 1

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Transmission Gear Clash When Shifting Gears

Diagnostic Aids

Gear clashing may be caused by shifting at too high of an engine RPM or by rushing the shift. If gear clashing is occurring in more than one gear, the clutch may not be releasing properly for proper synchronizer operation.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. This step tests for the proper release of the clutch. If the clutch reserve is not correct, the mainshaft gears may be turning, causing the gear to clash.

5. This step inspects for the proper transmission fluid. The proper fluid is required for the correct lubrication of the synchronisers.

7. A static shift test is performed by shifting into all of the gear positions with the engine not operating. While performing the test, you should note how the shift lever movement feels. Also, while shifting from one gear to another, feel for binding in the shift rails. You should be able to feel the detent plungers operating when coming out of a gear and going into a gear. Excessive play in the gear shift lever may prevent the shift forks from fully engaging the synchroniser.

10. A dynamic shift test is performed by shifting into all of the gear positions with the engine operating. Test for the correct mesh of the synchronisers and for the clutch releasing correctly. Move the shift lever and feel for the synchroniser sleeve to just release from the gear then let up on the clutch pedal. Press the clutch pedal and move the shift lever to engage that gear again. If the transmission shifts back into the gear without clashing, the clutch is releasing correctly and the synchroniser is operating. If clashing occurs, test another gear. If all gears clash, the clutch is not releasing correctly.

Step	Action	Yes	No
DEFINITION: Noise from the transmission when shifting gears. A grinding or grating sound when the synchronizer sleeve is engaging with the selector teeth on the speed gear. A suspected internal transmission condition if the noise is only happens in one gear.			
1	Did you review and perform the necessary inspections? Refer to Symptoms - Manual Transmission.	Go to Step 2	Go to Symptoms - Manual Transmission.
2	With the engine operating, does the transmission shift from neutral to any gear without the vehicle lurching or gear clashing?	Go to Step 5	Go to Step 3
3	Inspect for proper clutch operation. Refer to Clutch System Description and Operation. Does the clutch operate properly?	Go to Step 5	Go to Step 4
	Repair the clutch system. Refer to Symptoms -		

4	Clutch. Did you find and repair the condition?	Go to Step 11	Go to Step 5
5	Inspect for the correct transmission fluid level and for the correct fluid. Refer to Transmission Fluid Replacement Is the transmission fluid level correct and at the correct level?	Go to Step 7	Go to Step 6
6	Fill the transmission to the correct level or change the fluid if it is the incorrect type. Refer to Transmission Fluid Replacement. Does the transmission still have gear clash?	Go to Step 7	Go to Step 11
7	1. Perform a static shift test on the transmission. 2. Test for the following conditions: • Blockage preventing full shift lever movement. • Excessive movement in the shift lever. • Binding in the shift lever. • Detent plungers or shift rails binding. • Shift linkage binding. • Shift linkage proper adjustment. Did the transmission shift smoothly into the gear that is clashing?	Go to Step 9	Go to Step 8
8	1. Remove the shift lever. 2. Inspect for damaged or worn components. Refer to Shift Control Assembly Replacement. Did you find and repair the condition?	Go to Step 11	Go to Step 9
9	1. Perform a dynamic shift test on the transmission. 2. Test for the following conditions: • Detent plungers or shift rails binding. • Synchronizer sleeve binding. • Gear clashing in more than the suspected gear. Is the transmission hard to shift into all gears?	Go to Transmission Shifts Hard	Go to Step 10
	1. Disassemble the transmission. Refer to Transmission Disassemble 2. Inspect the following transmission components for the suspect gear that is clashing:		

10	- Excessive synchroniser blocking ring to gear clearance. - Synchroniser sleeve to hub lash or rock excessive. - Excessive axial clearance in the speed gear. - Mainshaft to speed gear bearing or journal worn. - Shift fork worn or damaged. - Internal shift control worn or damaged. - Mainshaft bearing worn or damaged. - Input gear bearing or pilot bearing worn. Did you find and repair the condition?	Go to Step 11	Go to Diagnostic Aids
11	Operate the system and verify the repair. Did you correct the condition?	System OK	Go to Step 1

Transmission Jumps Out of Gear

Diagnostic Aids

If the transmission jumps out of gear during deceleration, inspect the components that may allow for the gears or shafts to tip. If the gears or shafts tip, the synchronizer sleeve can disengage from the selector teeth on the speed gear. If the transmission jumps out of gear during acceleration, inspect the components that may not allow full engagement of the synchroniser sleeve to the selector teeth on the speed gear. Insufficient engagement of the selector teeth under torque may cause the transmission to jump out of gear.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. A static shift test is performed by shifting into all gear positions with the engine not operating. While performing the test, slowly move the shift lever. Feel for proper movement of the shift lever and transmission internal shift components.

5. A dynamic shift test is performed by shifting into all gear positions with the engine operating. Test for the correct mesh of the synchroniser sleeve and the speed gear selector teeth. Move the shift lever, and feel for the synchroniser sleeve to release from the gear, then let up on the clutch pedal. Depress the clutch pedal and move the shift lever to engage the gear again, to Make sure full travel of the shift components.

6. This step inspects for worn or damaged transmission or engine mounts. Loose mounts may cause a shock on the transmission allowing for gear disengagement.

7. This step inspects for the misalignment of the torque tube to transmission. Misalignment may put a bind on the input shaft, allowing for the input shaft or the mainshaft to tip.

9. This step inspects the pilot bearing and the pilot bearing journal on the input shaft. A worn pilot bearing or input shaft may allow the input shaft to tip, causing gear disengagement.

Step	Action	Yes	No
DEFINITION: Gear disengagement occurs during acceleration or deceleration.			
1	Did you review the operations and perform the necessary inspections? Refer to Symptoms - Manual Transmission	Go to Step 2	Go to Symptoms - Manual Transmission
2	1. Perform a static shift test. 2. Test for the following conditions: • Blockage preventing full shift lever movement. • Excessive movement in the shift lever. • Detent plungers engaging in the shift rails. • Synchroniser pressure pieces on the synchronizser sleeves.		

	- Shift linkage binding. - Shift linkage proper adjustment. Did the transmission shift completely into all gears?	Go to Step 5	Go to Step 3
3	Remove the shift control shift closeout boot. Refer to Shift Control Shift Closeout Boot Replacement. Inspect for the following: - Loose mounting. - Foreign debris. Did you find and repair the condition?	Go to Step 10	Go to Step 4
4	1. Perform a dynamic shift test on the transmission. 2. Test for the following conditions: - Synchroniser sleeve engagement to the speed gear selector teeth. - Detent plungers engaging in the shift rails. Did the transmission shift completely into all gears?	Go to Step 5	Go to Step 8
5	Inspect the engine and/or transmission mounts. Refer to Transmission Mount Inspection. Did you find and repair the condition?	Go to Step 10	Go to Step 6
6	Inspect the clutch housing for loose retaining bolts or misalignment. Are there any loose bolts or misalignment?	Go to Step 9	Go to Step 8
7	Tighten any loose housing retaining bolts and/or align the housing . Refer to Clutch Assembly Replacement Did you find and repair the condition?	Go to Step 10	Go to Step 8
8	1. Remove the transmission. Refer to Transmission Replacement 2. Remove the clutch assembly. Refer to Clutch Assembly Replacement. 3. Inspect the pilot bearing for being faulty. 4. Inspect the input shaft for excessive wear at the pilot bearing. Did you find and repair the condition?	Go to Step 10	Go to Step 9
	1. Disassemble the transmission. Refer to Transmission Disassemble. 2. Inspect the following components for wear or damage: - The shift rails.		

9	- The detent plungers and springs. - The shift forks. - The synchroniser sleeve and speed gear selector teeth. - The mainshaft to input shaft bearing and journals. - The speed gear bearings and journals. - The speed gear axial clearance. - The mainshaft center and rear bearings. Did you find and repair the condition?	Go to Step 10	Go to Diagnostic Aids
10	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 1

Transmission Locked in One Gear

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. This step is to make sure the use of the proper transmission fluid. DEXRON® VI fluid is used to Make sure proper synchroniser operation, and for sufficient lubrication. Improper fluid may cause the synchronisers to stick or cause overheating of the transmission components.

4. A static shift test is performed by shifting into all gears with the engine not operating. By confirming that the transmission can be shifted into all positions, Make sures that the shift lever is not excessively worn or damaged.

6. A dynamic shift test is performed by shifting into all of the gear positions with the engine operating. Test to Make sure that the internal shift components are properly functioning.

Step	Action	Yes	No
DEFINITION: The transmission cannot be shifted out of a gear or the vehicle will not move because the transmission is locked.			
1	Did you review and perform the necessary inspections? Refer to Transmission Replacement	Go to Step 2	Go to Transmission Replacement.
2	Inspect for the correct type of transmission fluid. Is the correct type of transmission fluid being used?	Go to Step 6	Go to Step 5
3	Drain and fill the transmission with the correct type of fluid. Refer to Transmission Fluid Replacement Did you find and repair the condition?	Go to Step 9	Go to Step 6
4	1. Perform a static shift test on the transmission. 2. Test for the shift lever moving to all positions. Were you able to shift into all positions?	Go to Step 6	Go to Step 5
5	1. Remove the shift lever. Refer to Shift Control Assembly Replacement. 2. Inspect for worn or faulty components. Did you find and repair the conditions?	Go to Step 9	Go to Step 6
6	1. Perform a dynamic shift test on the transmission. 2. Test for being able to shift in and out of the gear with the concern. Were you able to shift the transmission correctly?	Go to Step 7	Go to Step 8
7	1. Remove the transmission. Refer to Transmission Replacement. 2. Inspect the clutch system for the clutch not releasing properly. Refer to Clutch System		

	Description and Operation Did you find and repair the condition?	Go to Step 9	Go to Step 8
8	1. Disassemble the transmission. Refer to Transmission Disassemble. 2. Inspect the following transmission internal components for wear or damage: - The shift rail. - The internal shift control lever. - The synchroniser components for being broken or faulty. - The speed gears for being seized to the mainshaft. Did you find and repair the conditions?	Go to Step 9	Go to Diagnostic Aids
9	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 1

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Transmission Noisy

Diagnostic Aids

If the transmission is in neutral with the engine operating, and a whirling noise - a neutral gear rattle is heard outside the vehicle, the sound is a normal condition.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

5. This step inspects for the correct transmission fluid level. If the transmission fluid level is excessively low, damage may have occurred to the transmission components.
7. This step inspects for the correct type of transmission fluid. The transmission uses DEXRON® III fluid. If the incorrect fluid was used, there may have been an overheating condition. Overheating may cause damage to the transmission components.
9. This step inspects for noise coming into the driver compartment. Improper sealing of the shift tower may be allowing normal transmission noise to be heard by the driver.
13. This step tests to determine if clutch components are making the noise. Press the clutch pedal slowly and listen for the change in noise. If the noise changes while pressing the pedal, it may be a faulty clutch component. If the noise does not change until the clutch is completely disengaged, the transmission component is faulty.

Step	Action	Yes	No
DEFINITION: The transmission is making a noise. The noise may be a whine or a growl caused by faulty bearings or gears. The noise may also be caused from a faulty component causing a vibration noise.			
1	Did you review the operations and perform the necessary inspections? Symptoms - Manual Transmission	Go to Step 2	Go to Symptoms - Manual Transmission.
2	Is the noise present while in neutral, with the engine operating?	Go to Diagnostic Aids	Go to Step 3
3	Is the noise present in all gears?	Go to Step 5	Go to Step 4
4	Is the noise present in just one gear?	Go to Step 15	Go to Step 5
5	Inspect the transmission fluid level. Is the fluid level correct?	Go to Step 7	Go to Step 6
6	Add transmission fluid. Refer to Transmission Fluid Replacement Did you find and repair the condition?	Go to Step 16	Go to Step 7

7	Inspect the transmission for the correct fluid type. Refer to Lubrication Specifications. Is the transmission fluid the correct type?	Go to Step 9	Go to Step 8
8	Drain and fill the transmission with the correct type of fluid. Refer to Transmission Fluid Replacement. Did you find and repair the condition?	Go to Step 16	Go to Step 9
9	Inspect the shift tower boot. Is the closeout boot loose or damaged?	Go to Step 10	Go to Step 11
10	Position and tighten the shift tower boot to specifications. Refer to Shift Control Assembly Replacement. Did you find and repair the condition?	Go to Step 16	Go to Step 11
11	Inspect for torque tube to transmission alignment and loose transmission mounting retaining bolts. Are there any loose transmission mounting bolts?	Go to Step 12	Go to Step 15
12	Replace and tighten the transmission mounting retaining bolts. Refer to Fastener Tightening Specifications Is the noise still present?	Go to Step 13	Go to Step 16
13	With the engine operating, press the clutch pedal. Is the noise still present?	Go to Step 14	Go to Step 15
14	1. Remove the clutch. Refer to Clutch Assembly Replacement. 2. Inspect the following components for being the cause of the noise: • The release bearing. • The pilot bearing. • The dual mass flywheel, if equipped. • The pressure plate. • The clutch disc. • The input shaft bearing. • The engine crankshaft end play. Did you find and repair the condition?	Go to Step 16	Go to Step 15
15	1. Remove the transmission. Refer to Transmission Replacement. 2. Disassemble the transmission. Refer to Transmission Disassemble. Use the information in the Cleaning and Inspection section to determine if any of the transmission components are faulty.		--

	Did you find and repair the condition?	Go to Step 16	
16	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 1

Transmission Shifts Hard

Diagnostic Aids

An intermittent hard shift may be caused by an intermittent clutch condition. With a self adjusting clutch, the clutch may be between adjustments and not give full clutch release. This might be felt by a low clutch pedal. After several applications, the clutch may adjust properly to give the proper pedal feel.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. A static shift test is performed by shifting into all of the gear positions with the engine not operating. While performing the test, one should note how the shift lever movement is felt. Also while shifting from one gear to the other, feel for binding in the shift rails. You should be able to feel the detent plungers operating when coming out of a gear and when going into a gear.

6. A dynamic shift test is performed by shifting into one of the gear positions with the engine operating. Test for the correct mesh of the synchronizers and for the clutch releasing correctly. When shifting into a gear, and shifting out of a gear, you should feel the shift detent plungers operating, and the synchronizer sleeve moving freely.

8. The transmission uses DEXRON® III transmission fluid that allows proper synchronizer operation. The incorrect fluid may cause hard shifting from varnish build up, or from not enough lubrication for proper synchronizer operation.

Step	Action	Yes	No
DEFINITION: The transmission does not shift smoothly or without difficulty from one gear to the other.			
1	Did you review the operations and perform the necessary inspections? Refer to Symptoms - Manual Transmission.	Go to Step 2	Go to Symptoms - Manual Transmission
2	Inspect the clutch system for proper operation. Refer to Clutch System Description and Operation. Did you find or repair the condition?	Go to Step 11	Go to Step 3
3	1. Perform a static shift test on the transmission. 2. Test for the following conditions: • Blockage preventing full shift lever movement. • Excessive movement in the shift lever. • Binding in the shift lever. • Detent plungers or shift rails binding. • Shift linkage binding.		

	- Shift linkage proper adjustment. Are you able to shift into all gears?	Go to Step 7	Go to Step 4
4	Remove the shift control shift closeout boot. Refer to Shift Control Shift Closeout Boot Replacement. Inspect for the following: - Loose mounting. - Foreign debris. Did you find and repair the condition?	Go to Step 11	Go to Step 5
5	1. Perform a dynamic shift test on the transmission. 2. Test for the following conditions: - Detent plungers or shift rails binding. - Synchronizer sleeve binding. - Gear clash into only one gear. - Gear clash into all gears. Did the transmission shift hard into all gears?	Go to Step 6	Go to Step 10
6	Inspect the transmission for the correct fluid level and the correct type of transmission fluid. Refer to Transmission Fluid Replacement. Is the transmission at the correct level and proper fluid being used?	Go to Step 8	Go to Step 7
7	Drain and fill the transmission with the correct type fluid. Refer to Transmission Fluid Replacement Did you find and repair the condition?	Go to Step 11	Go to Step 8
8	Remove the transmission. Refer to Transmission Replacement. Inspect the clutch pressure plate and/or clutch driven plate. Is the clutch pressure plate and/or clutch driven plate worn or faulty?	Go to Step 9	Go to Step 10
9	Replace the clutch assembly. Refer to Clutch Assembly Replacement. Did you find and repair the condition?	Go to Step 11	Go to Step 10
	1. Disassemble the transmission. Refer to Transmission Disassemble. 2. Inspect the transmission for the following faulty components in the gear that is hard to shift or clashing:		

10	• Excessive synchronises blocking ring to gear clearance. • Synchroniser hub external splines worn or damaged. • Excessive axial clearance in the speed gear. • Mainshaft to speed gear bearing or journal worn. • Shift rail and the internal shift control lever components for wear or damage. 3. Replace worn or damaged components as necessary. Did you find and repair the condition?	Go to Step 10	Go to Diagnostic Aids
11	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 1

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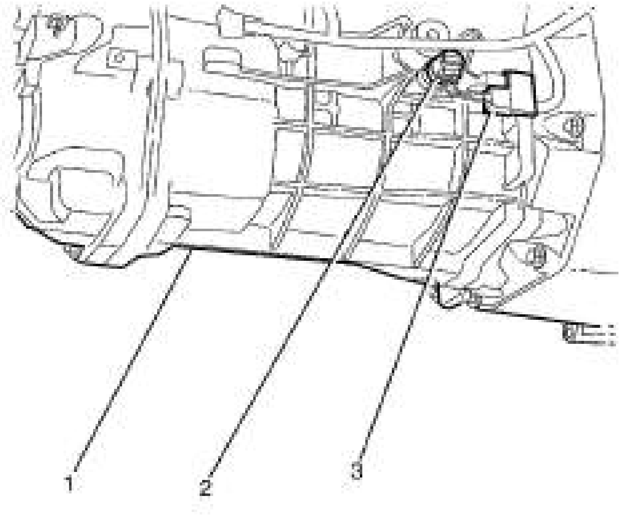
Backup Lamp Switch Replacement

Removal Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

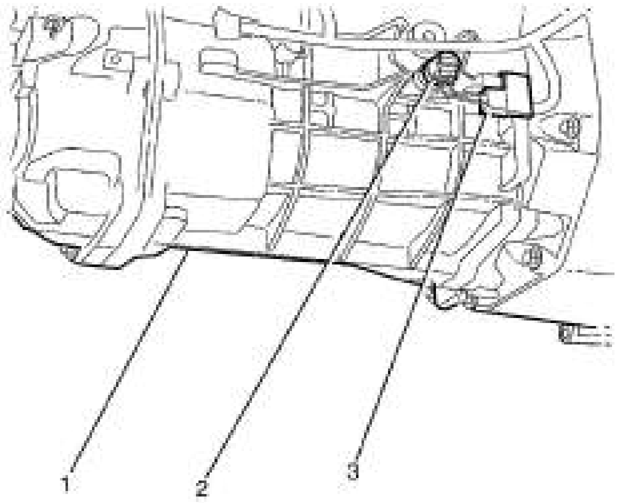
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle.



2. Disconnect the reverse lamp switch electrical connector (3).
3. Using a suitable tool remove the reverse lamp switch (2) from the transmission (1).

Installation Procedure



1. Apply a suitable pipe sealant with Teflon® to the threads of the backup lamp switch (2).

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the backup lamp switch (2) to the transmission (1).

   Tighten
   Tighten the switch to 27 N·m (20 lb ft).

3. Connect the reverse lamp switch electrical connector (3).
4. Lower the vehicle.

Mainshaft Rear Oil Seal Replacement

Tools Required

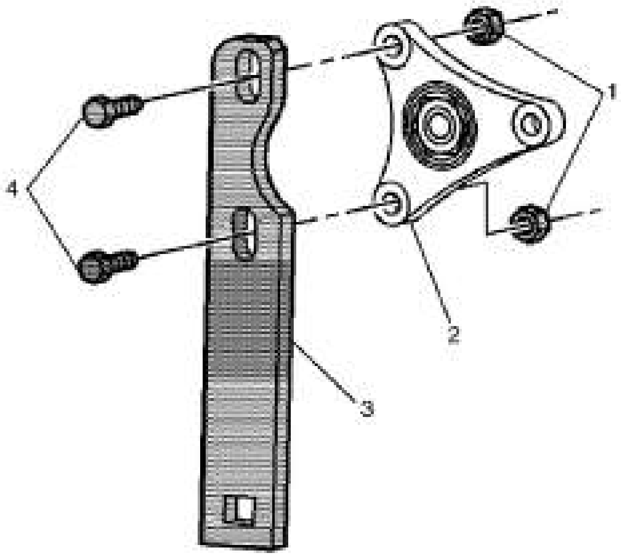
- J 23907 Slide Hammer
- J 23129 Universal Seal Remover
- J 29873 Injector Nozzle Socket 30 mm
- J 44765 Seal Installer
- J 45012 Holding Fixture
- J 45019 Flange and Pinion Gage Remover

Removal Procedure

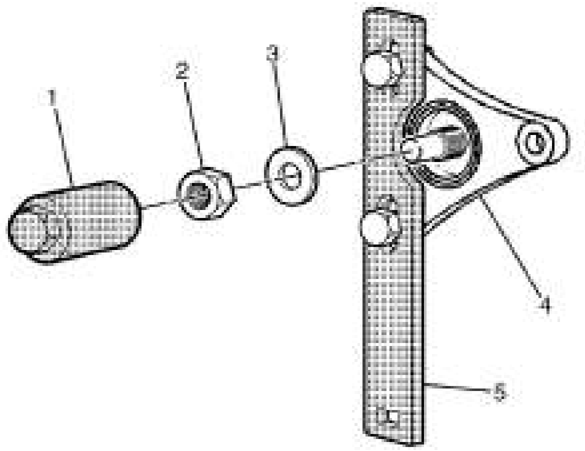
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the exhaust system. Refer to Exhaust System Replacement .
3. Remove the propeller shaft. Refer to Propeller Shaft Replacement .



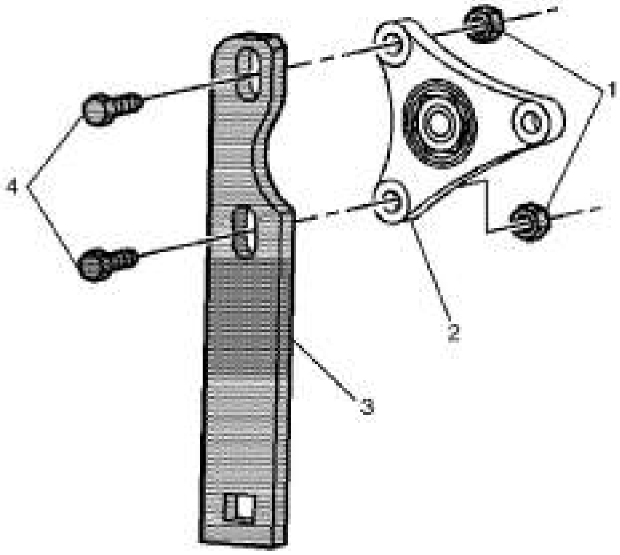
4. Install the J 45012 (3) to the drive flange (2).
5. Install the J 45012 to drive flange retaining bolts (4) and nuts (1) and tighten until firm.



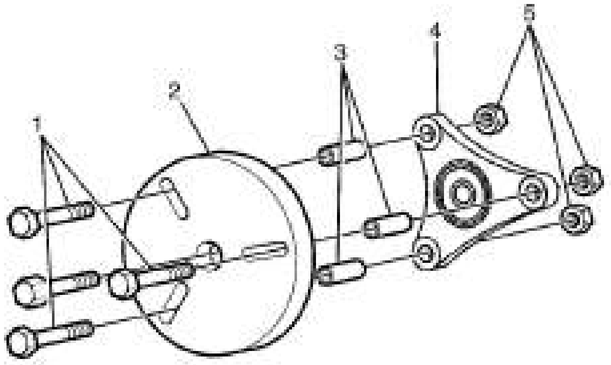
6. While holding the J 45012 (5), remove the flange retaining nut (2) using the J 29873 (1) from the flange (4).

   Discard the nut.

7. Remove the drive flange thrust washer (3).



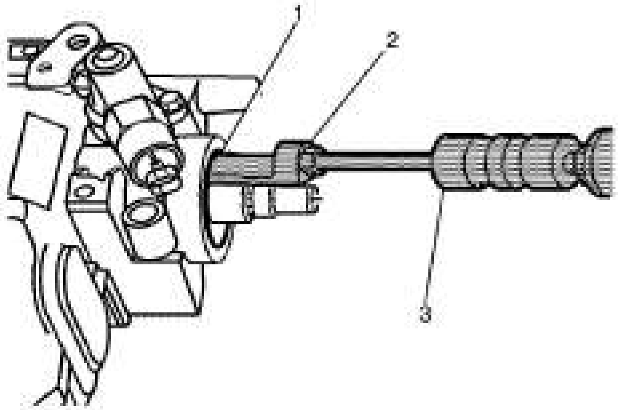
8. Remove the J 45012 to drive flange retaining bolts (4) and nuts (1).
9. Remove the J 45012 (3) from the drive flange (2).



10. Install the J 45019 (2) to the drive flange (4).

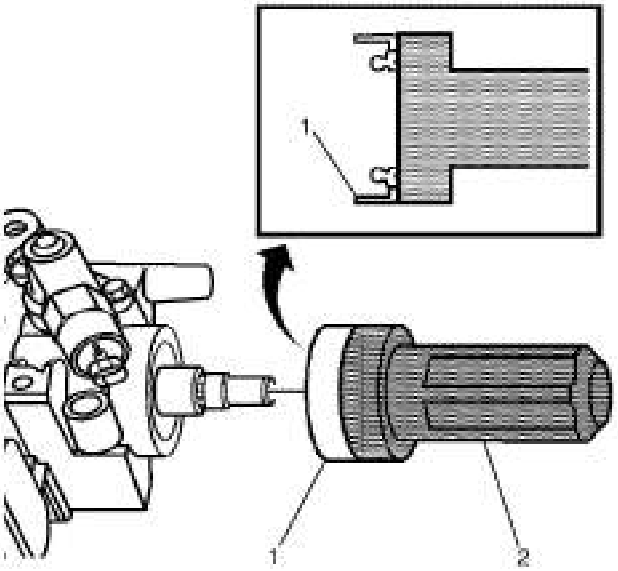
    Remove the drive flange (1) using the J 45019 (2).

11. Install the J 45019 to drive flange retaining bolts (1), spacers (3) and nuts (5) and tighten until firm.
12. Remove the drive flange (4) using the J 45019 (2).



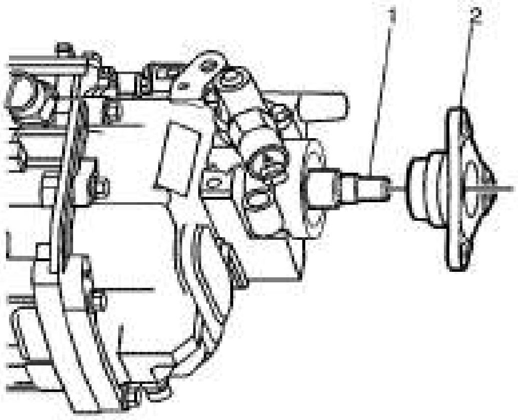
13. Use the J 23907 (3) and J 23129 (2) to remove the mainshaft rear oil seal (1) from the transmission extension housing.

Installation Procedure

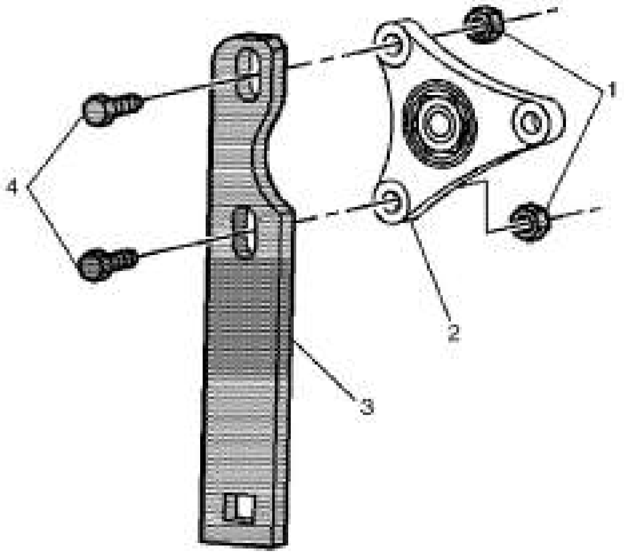


Important: Install the mainshaft rear oil seal (1) onto the tool before installing into the transmission extension housing to prevent damage to the mainshaft rear oil seal (1).

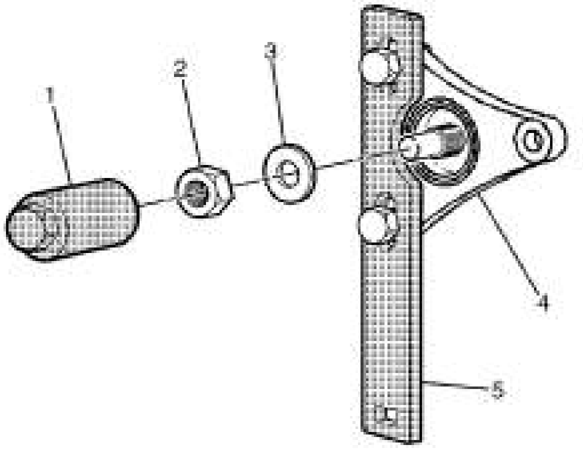
1. Using J 44765 (2) install the new mainshaft rear oil seal (1).



2. Install the drive flange (2) to the transmission output shaft (1).



3. Install the J 45012 (3) to the drive flange (2).
4. Install the J 45012 to drive flange retaining bolts (4) and nuts (1) and tighten until firm.

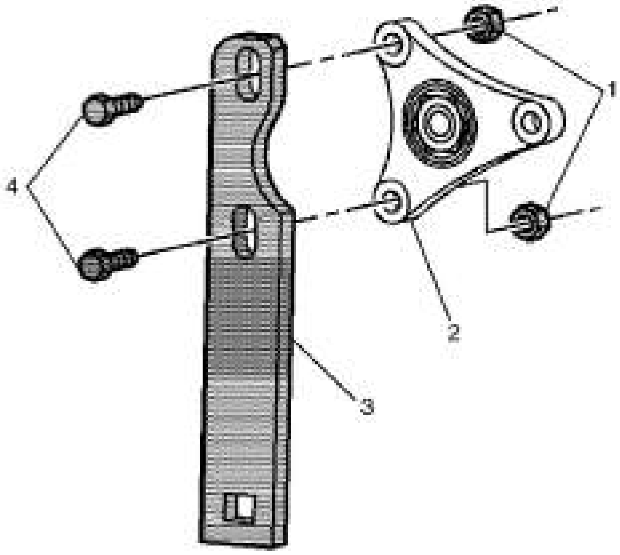


5. Install the drive flange thrust washer (3).

   Notice: Refer to Fastener Notice in the Preface section.

6. While holding the J 45012 (5), install the NEW flange retaining nut (2) using the J 29873 (1) to the flange (4).

   Tighten
   Tighten the nut to 135 N·m (100 lb ft).



7. Remove the J 45012 to drive flange retaining bolts (4) and nuts (1).
8. Remove the J 45012 (3) from the drive flange (2).
9. Install the propeller shaft. Refer to Propeller Shaft Replacement .
10. Install the exhaust system. Refer to Exhaust System Replacement .
11. Lower the vehicle.

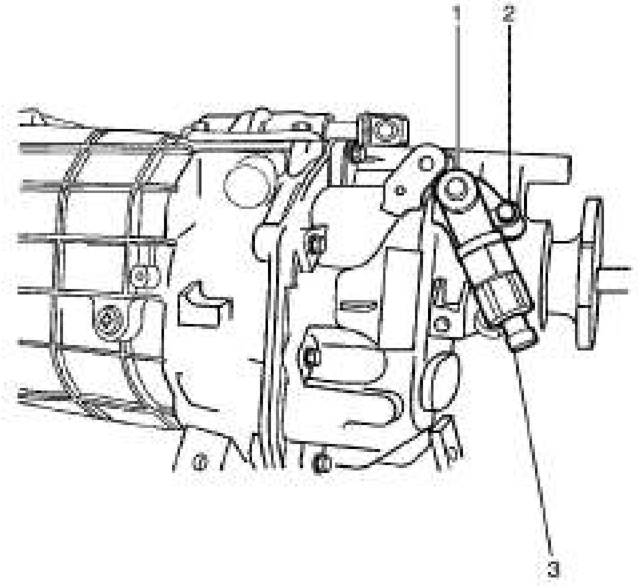
Reverse Lockout Solenoid Replacement

Removal Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

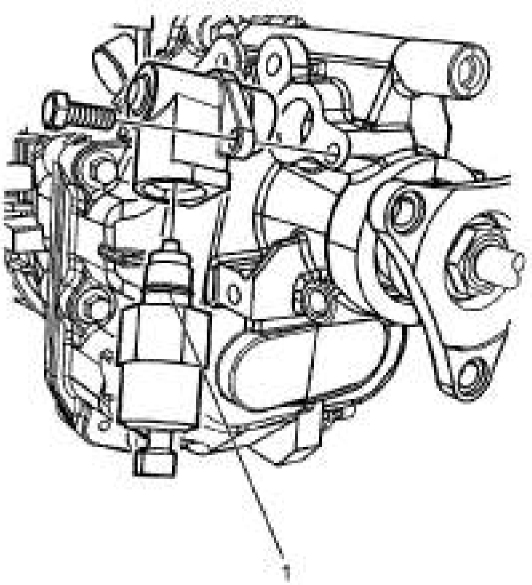
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the exhaust system. Refer to Exhaust System Replacement.
3. Support the transmission with a suitable jack.
4. Remove the transmission support. Refer to Transmission Support Replacement.
5. Remove the transmission mount. Refer to Transmission Rear Mount Replacement.

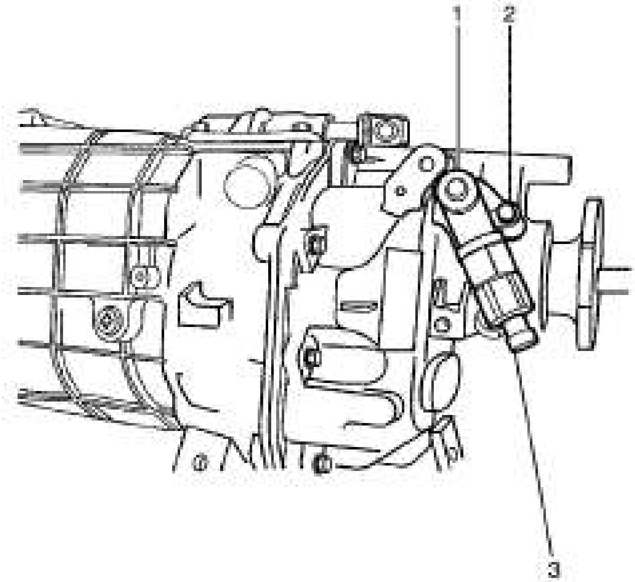


6. Disconnect the reverse lockout solenoid electrical connector (3).
7. Remove the reverse lockout solenoid to transmission extension housing retaining screw (2).
8. Remove the reverse lockout solenoid (1) from the transmission extension housing.

Installation Procedure



1. Inspect the reverse lockout assembly O-ring (1). Replace the reverse lockout assembly O-ring if necessary.



2. Install the reverse lockout solenoid (3) to the transmission extension housing.

   Notice: Refer to Fastener Notice in the Preface section.

3. Install the reverse lockout solenoid to transmission extension housing retaining bolt (2).
4. Connect the reverse lockout solenoid electrical connector.
5. Install the transmission mount. Refer to Transmission Rear Mount Replacement.
6. Install the transmission support. Refer to Transmission Support Replacement.
7. Remove the transmission jack.
8. Install the exhaust system. Refer to Exhaust System Replacement.
9. Lower the vehicle.

Shift Control Assembly Replacement

Tools Required

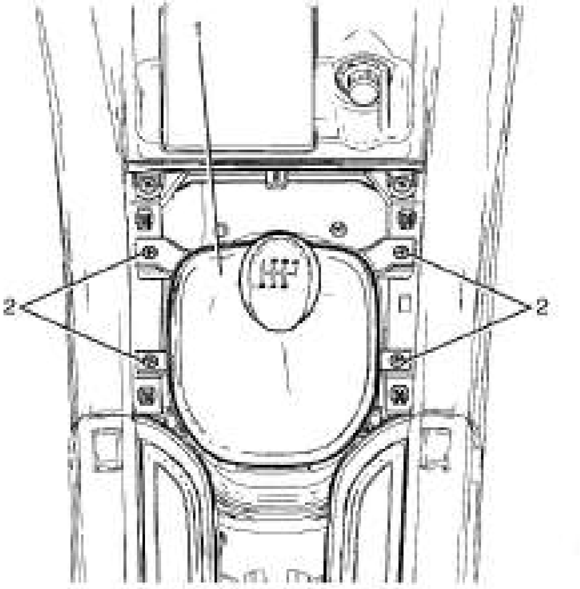
EN-48536 Frame Support Tool (Engine Lower 65mm Kit)

Removal Procedure

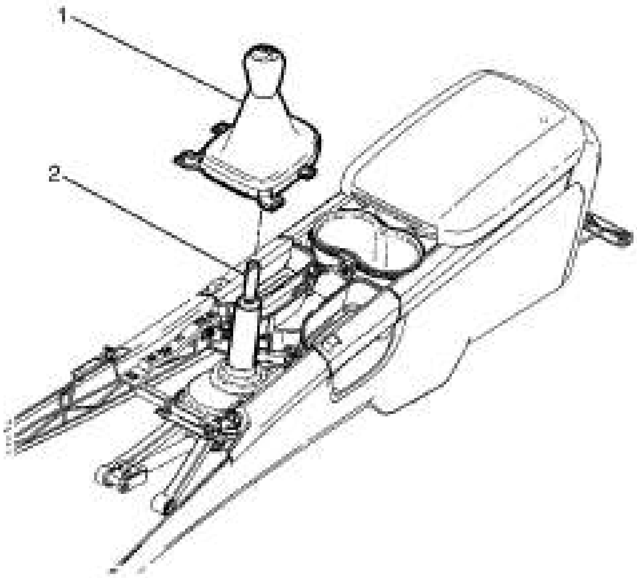
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

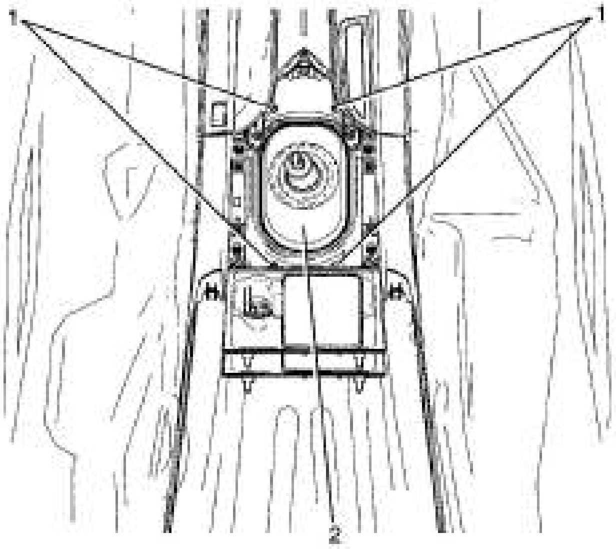
1. Remove the trim plate. Refer to Console Trim Plate Replacement.



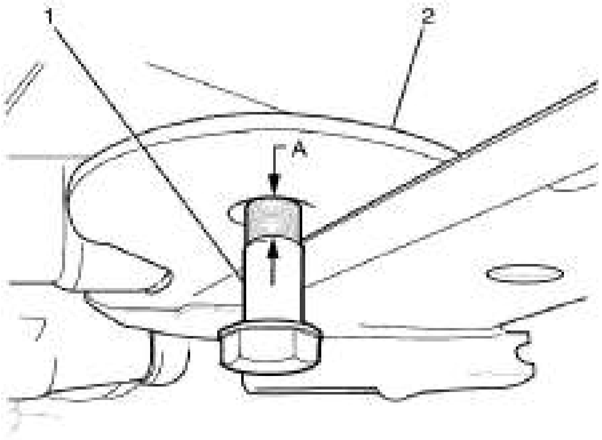
2. Remove the gearshift lever boot to front console retaining screws (2).



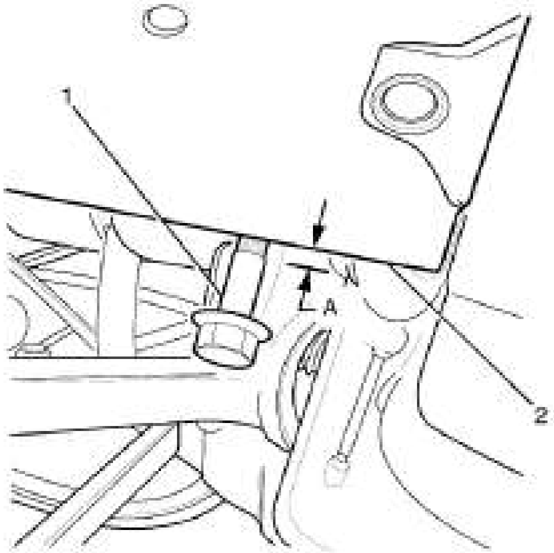
3. Lift the gearshift lever boot (1) enough to enable a firm grasp to be made on the gearshift lever (2) with the left hand, then grasp the gearshift knob with the right.
4. While rocking the knob sideways, and with an upward force applied, dislodge the knob retaining claws from the lever.
5. Remove the gearshift lever knob and boot assembly, from the gearshift lever.



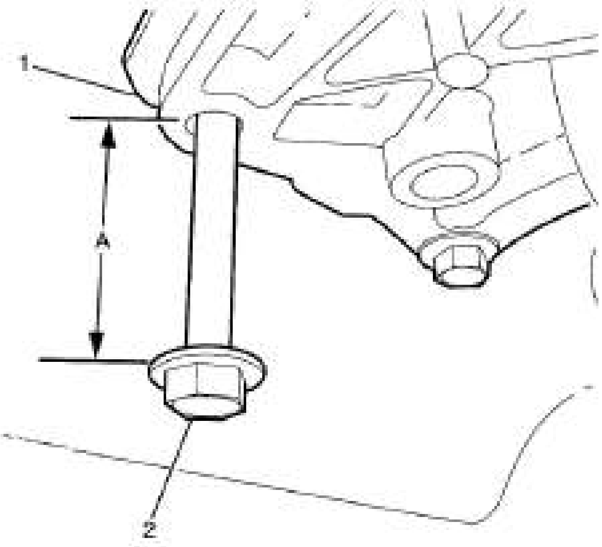
6. Remove the shift control assembly to shift control adapter plate retaining nuts (1).
7. Raise the vehicle. Refer to Lifting and Jacking the Vehicle.
8. Remove the exhaust system. Refer to Exhaust System Replacement.
9. Remove the propeller shaft. Refer to Propeller Shaft Replacement.
10. Support the power train with a suitable jack or table.
11. Support the transmission with a suitable jack.



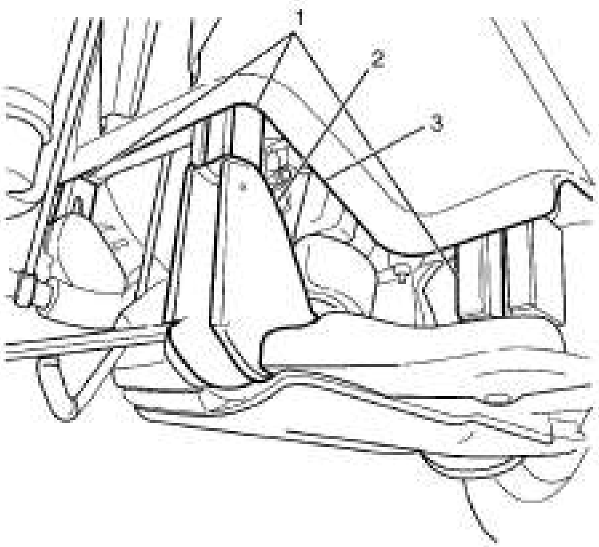
12. Replace the front sub frame rear bolts and fit bolts from the EN-48536 .
13. Install the retaining bolt (1) until the stepped shank (A) is two millimetres below sub frame (2).



14. Replace the front sub frame front bolts and fit bolts from the EN-48536 .
15. Install the retaining bolt (1) until the stepped shank (A) is two millimetres below chassis rail flange (2).



16. Remove the left front and right rear retaining bolts from the transmission mount and install two retaining bolts from the EN-48536 in diagonal holes e.g Left hand front and Right hand rear.
17. Install the retaining bolt (2) in until a 65 millimetre gap is achieved (A).
18. Remove front sub frame middle bolts.
19. Lower power train slowly until the subframe and transmission mount are resting on the bolts (2).



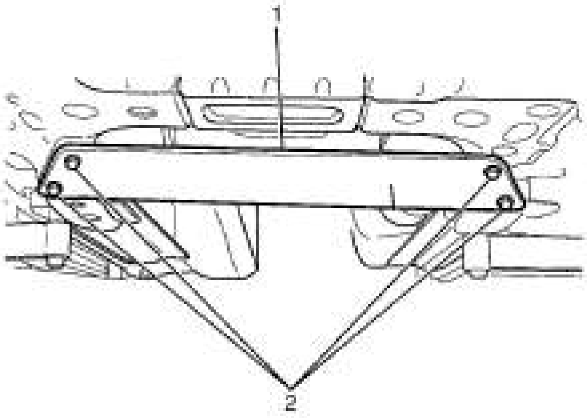
20. Insert the 65 millimetre spacer blocks (1) from the EN-48536 between the subframe (2) and the chassis rails (3).
21. Tension front sub frame front and rear retaining bolts.

Tighten
Tighten the bolts to 95 N·m (70 lb. ft).

22. Install and tension middle sub frame retaining bolts.

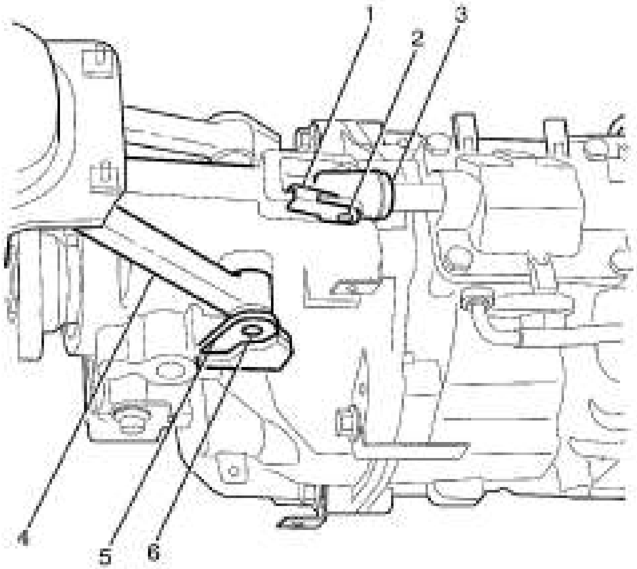
    Tighten
    Tighten the bolts to 95 N·m (70 lb. ft).

23. Remove suitable supporting jack.

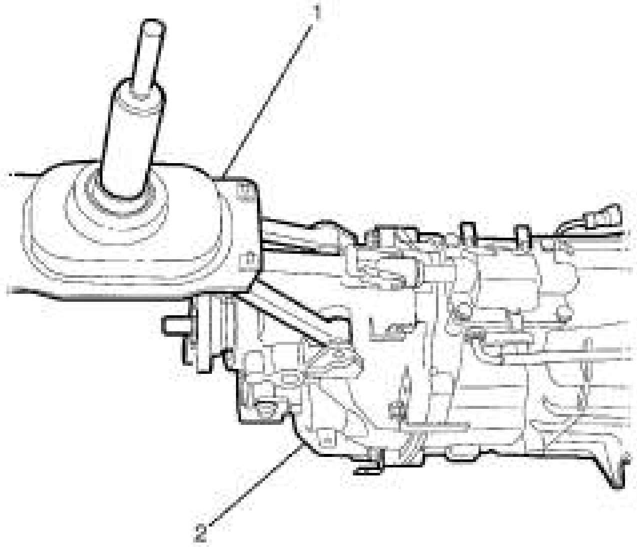


24. Install the engine support plate (1) from the EN-48536 to the front sub frame (2).
25. Install the engine support plate to front subframe retaining bolts (3).

    Tighten
    Tighten the bolts to 10 N·m (89 lb. in).

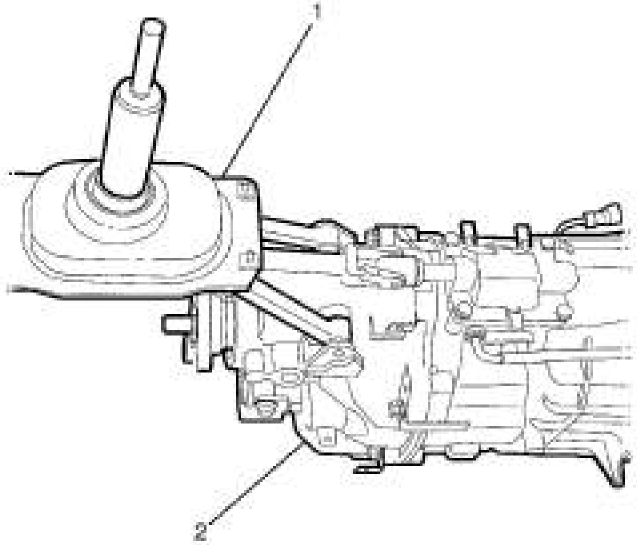


26. Use a suitable tool to rotate the selector shaft rod retaining clip (1) upwards.
27. Use a suitable tool to remove the selector shaft rod retaining pin (2) from the selector shaft rod (3).
28. Use a suitable tool to rotate the shift control assembly rod retaining clip (5) upwards.
29. Use a suitable tool to remove the retaining pin (6) from the shift control assembly rod (4). Repeat for opposite side.

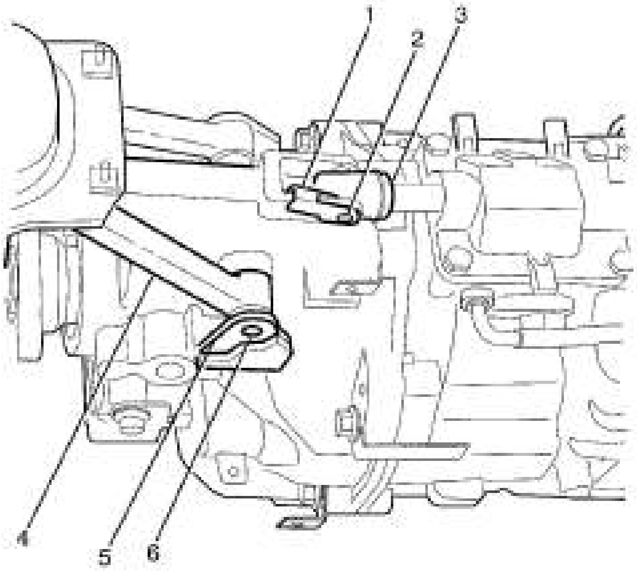


30. Remove the shift control assembly (1) from the transmission (2).

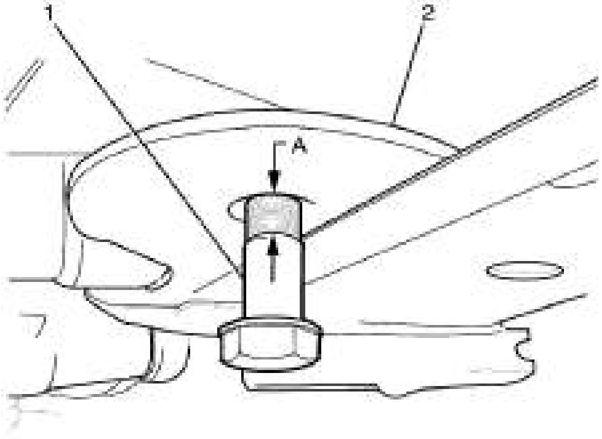
Installation Procedure



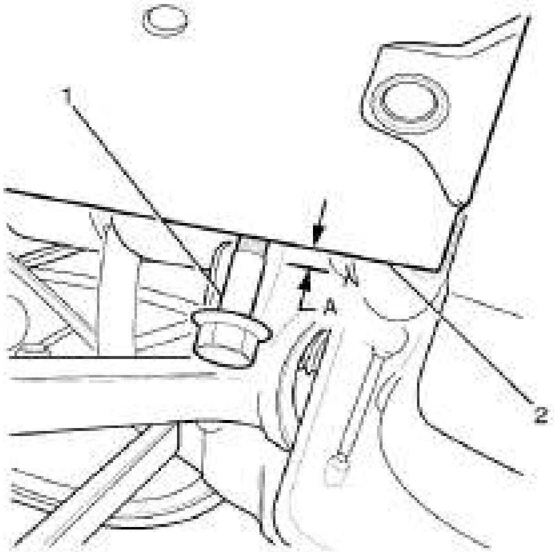
1. Install the shift control assembly (1) to the transmission (2).



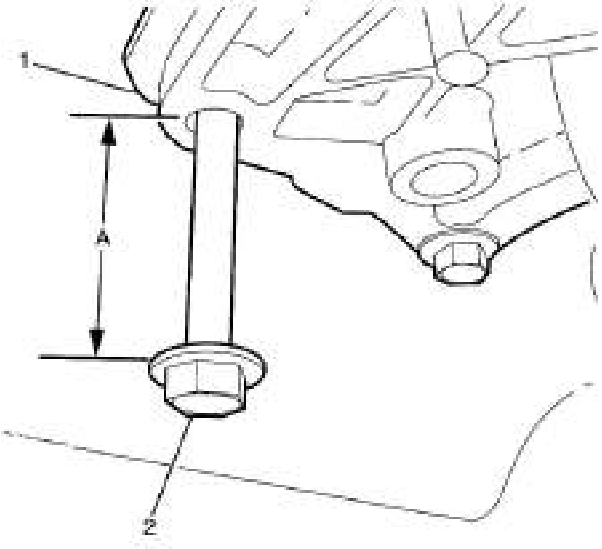
2. Use a suitable tool to install the retaining pin (6) to the shift control assembly rod (4).
3. Rotate the shift control assembly rod retaining clip (5) downwards to lock the retaining pin (6). Repeat for opposite side.
4. Use a suitable tool to install the retaining pin (2) to the selector shaft rod (3).
5. Rotate the selector shaft rod retaining clip (1) downwards to lock the retaining pin (2).
6. Support the power train with a suitable jack or table.
7. Support the transmission with a suitable jack.



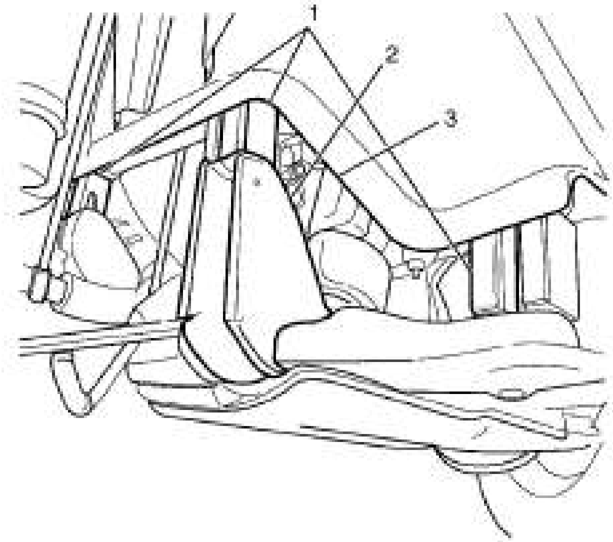
8. Loosen the EN-48536 retaining bolt (1) until the stepped shank (A) is two millimetres below subframe (2).



9. Loosen the EN-48536 retaining bolt (1) until the stepped shank (A) is two millimetres below the subframe (2).



10. Loosen the EN-48536 transmission mount to body retaining bolts (2) in the diagonal holes (ie. Left hand front and Right hand rear).
11. Remove EN-48536 front sub frame middle bolts.



12. Remove the EN-48536 six 65 millimetre spacer blocks (1) between subframe (2) and chassis rails (3).
13. Install the front sub frame to chassis rail retaining bolts.

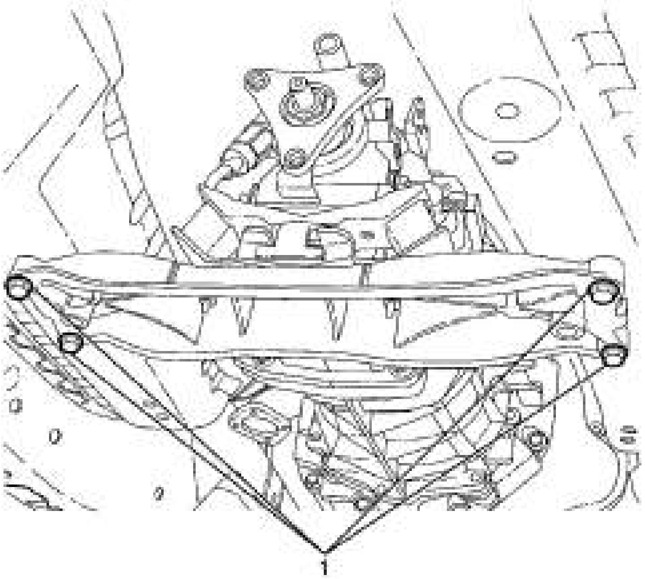
    Tighten
    Tighten the bolts to 95 N·m (70 lb. ft).

14. Install the rear sub frame to chassis rail retaining bolts.

    Tighten
    Tighten the bolts to 95 N·m (70 lb. ft).

15. Install the centre sub frame to chassis rail retaining bolts.

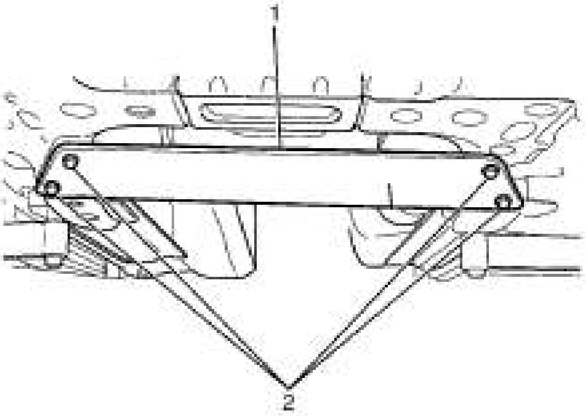
    Tighten
    Tighten the bolts to 95 N·m (70 lb. ft).



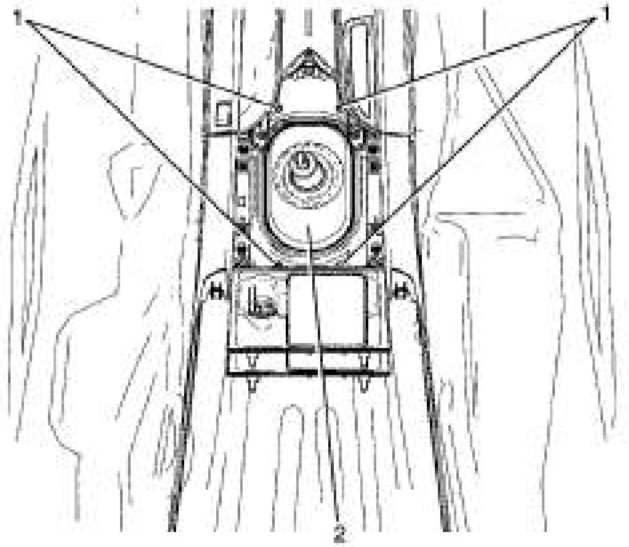
16. Install the transmission mount to body retaining bolts (1).

    Tighten
    Tighten the bolts to 58 N·m (43 lb ft).

17. Raise the vehicle.
18. Remove supporting jack or table.

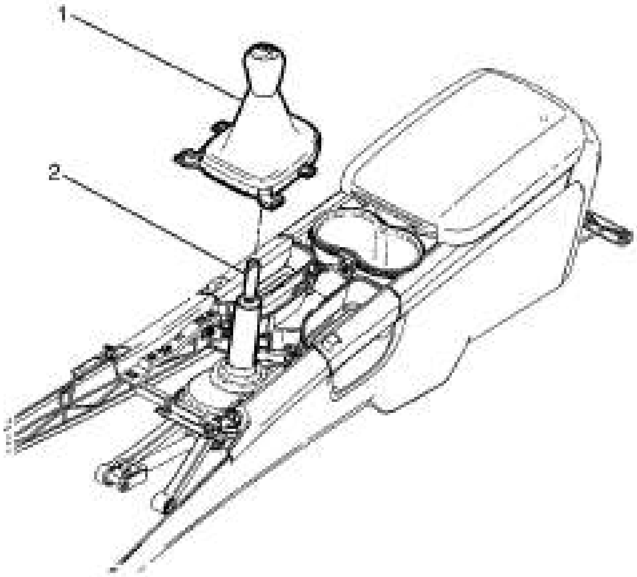


19. Remove the EN-48536 engine support plate (1) to front sub frame retaining bolts (2).
20. Remove the EN-48536 engine support plate from the vehicle.
21. Install the propeller shaft. Refer to Propeller Shaft Replacement.
22. Install the exhaust system. Refer to Exhaust System Replacement.
23. Lower the vehicle.

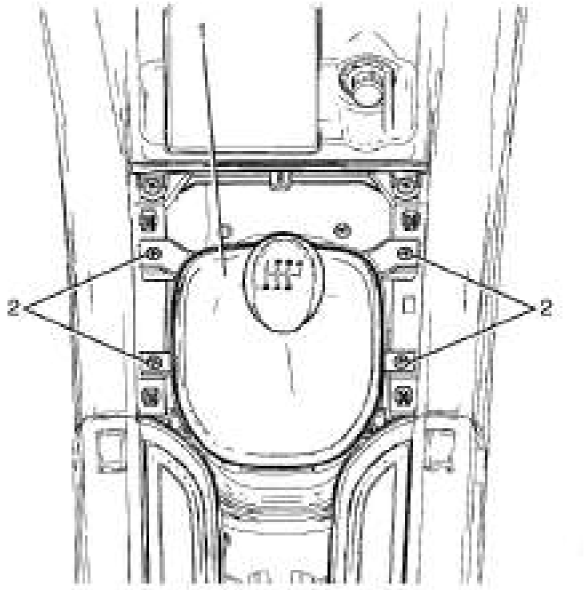


24. Install the shift control assembly to shift control adapter plate retaining nuts (1).

    Tighten
    Tighten the bolts to 12 N·m (106 lb in).



25. Install the gearshift lever knob and boot assembly (1) to the gearshift lever.
26. Align the gearshift lever knob to the gearshift lever (2).
27. Apply pressure to the top of the gearshift knob to engage into the gearshift lever.



28. Install the gearshift lever boot to front console retaining screws (2).

    Tighten
    Tighten the screws to 2 N·m (18 lb in).

29. Install the trim plate. Refer to Console Trim Plate Replacement.

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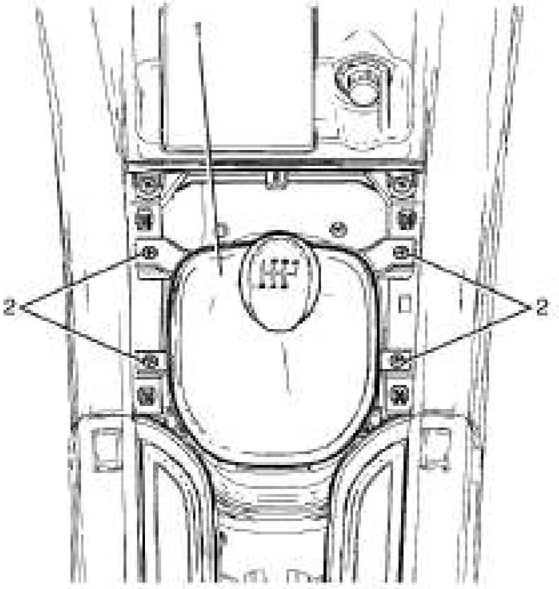
Shift Control Shift Closeout Boot Replacement

Removal Procedure

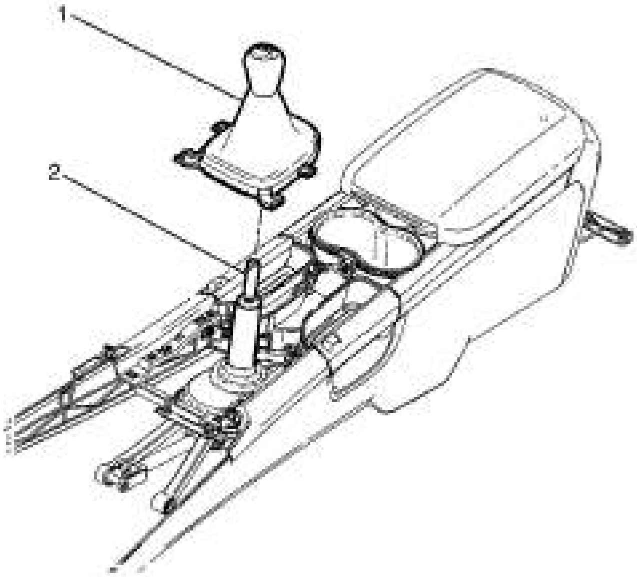
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Remove the trim plate. Refer to Console Trim Plate Replacement.

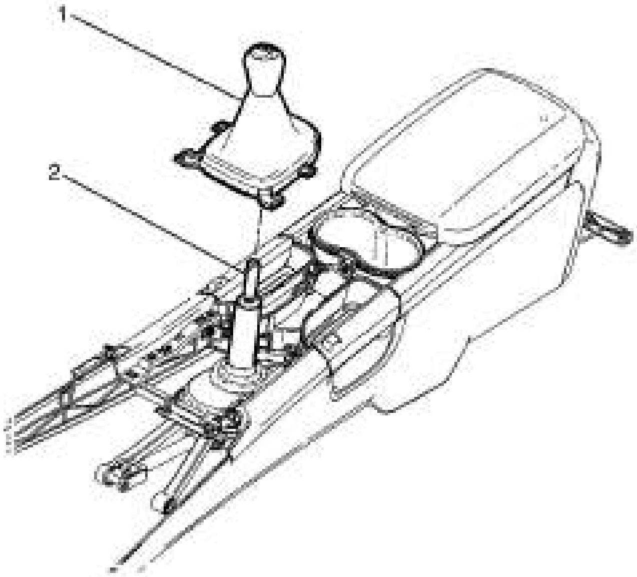


2. Remove the gearshift lever boot to front console retaining screws (2).

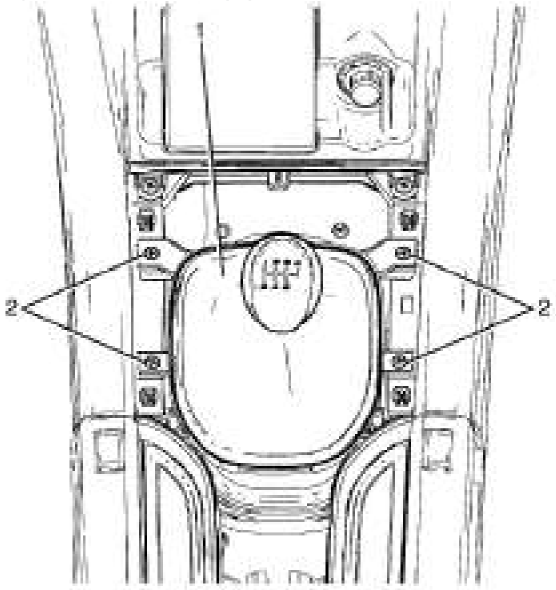


3. Lift the gearshift lever knob and boot assembly (1) enough to enable a firm grasp to be made on the gearshift lever (2) with the left hand, then grasp the gearshift lever knob and boot assembly (1) with the right.
4. While rocking the gearshift lever knob and boot assembly (1) sideways, and with an upward force applied, dislodge the gearshift lever knob and boot assembly (1) retaining claws from the gearshift lever (2).
5. Remove the gearshift lever knob and boot assembly (1) from the gearshift lever (2).

Installation Procedure



1. Install the gearshift lever knob and boot assembly (1) to the gearshift lever (2).
2. Align the gearshift lever knob and boot assembly (1) to the gearshift lever (2).
3. Apply pressure to the top of the gearshift lever knob and boot assembly (1) to engage into the gearshift lever (2).



4. Install the gearshift lever boot to front console retaining screws (2).

   Tighten
   Tighten the screws to 2 N·m (18 lb in).

5. Install the trim plate. Refer to Console Trim Plate Replacement.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Manual Transmission - Tremec 6-Speed | Repair Instructions - On Vehicle | **Document ID: 1977503**

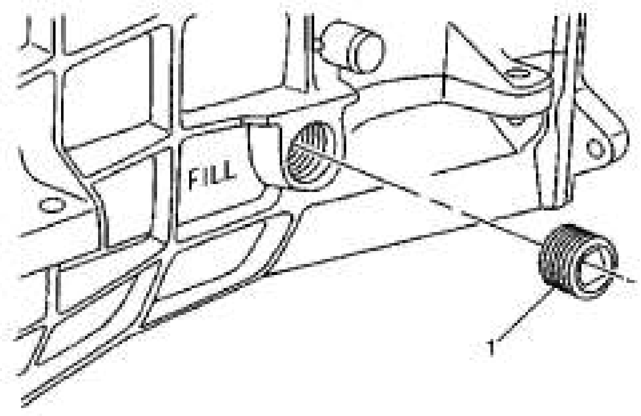
Transmission Fluid Level Inspection

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

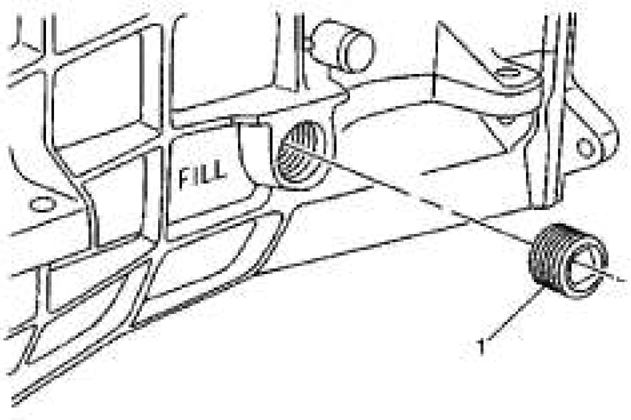
Important: This transmission is classified as being a "Fill for Life" transmission and checking the lubricant level is not recommended. The only time that fluid level checking would be appropriate, would be after correction of a fluid leak that did not require the transmission to be fully drained and/or removed from the vehicle.

1. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle.



2. Clean any dirt from around the transmission fill plug (1).
3. Remove the transmission fill plug (1).
4. Allow excess fluid to drain until flow stops. If required, top up fluid level until it does flow out of the transmission fill plug.

Notice: Refer to Fastener Notice in the Preface section.



5. Install the transmission fill plug (1).

   Tighten
   Tighten the plug to 28 N·m (20 lb ft).

6. Lower the vehicle.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Manual Transmission - Tremec 6-Speed | Repair Instructions - On Vehicle | **Document ID: 1977484**

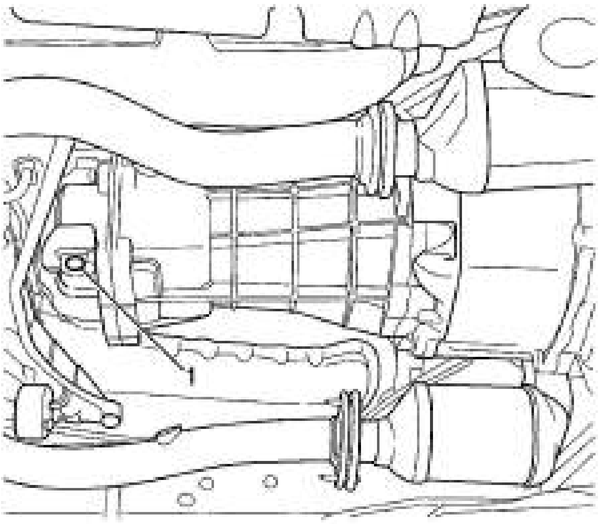
Transmission Fluid Replacement

Draining Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle.



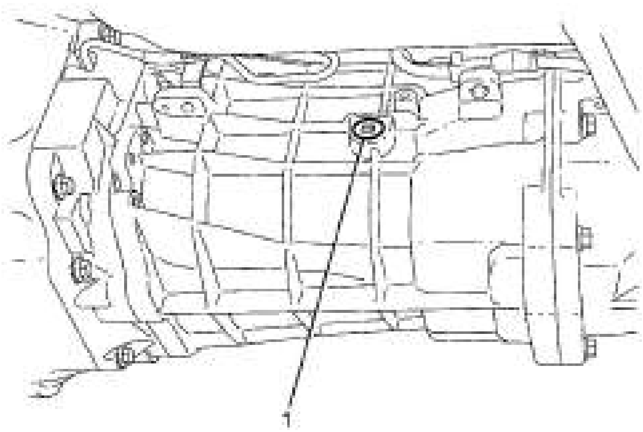
2. Clean away all dirt and debris from the transmission drain plug (1).
3. Place a suitable container under the transmission.
4. Remove the drain plug (1).
5. Allow the system to drain completely.

Notice: Refer to Fastener Notice in the Preface section.

6. Install the transmission drain plug (1).

Tighten
Tighten the transmission drain plug to 28 N·m (20 lb ft).

Filling Procedure



1. Clean away all dirt and debris from the transmission fluid fill plug area (1).
2. Remove the transmission fluid fill plug (1).
3. Fill the transmission with DEXRON®-III transmission fluid, until even with the bottom of the fill plug hole.

   Notice: Refer to Fastener Notice in the Preface section.

4. Install the transmission fluid fill plug (1).

   Tighten
   Tighten the transmission fluid fill plug to 18 N·m (13 lb ft).

5. Lower the vehicle.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Manual Transmission - Tremec 6-Speed | Repair Instructions - On Vehicle | **Document ID: 1992882**

Transmission Mount Inspection

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Raise the transmission in order to remove the weight from the transmission mount and create slight tension in the rubber.
3. Observe the transmission mount while raising the transmission. Replace the transmission mount if the transmission mount exhibits any of the following conditions:
   - The hard rubber surface is covered with heat check cracks.
   - The rubber is separated from the metal plate of the transmission mount.
   - The rubber is split through the center of the transmission mount.
4. If there is movement between the metal plate of the transmission mount and its attaching points, lower the transmission on the transmission mount. Tighten the retaining bolts or retaining nuts attaching the transmission mount to the frame or transmission mount bracket. Refer to Transmission Rear Mount Replacement.
5. Lower the vehicle.

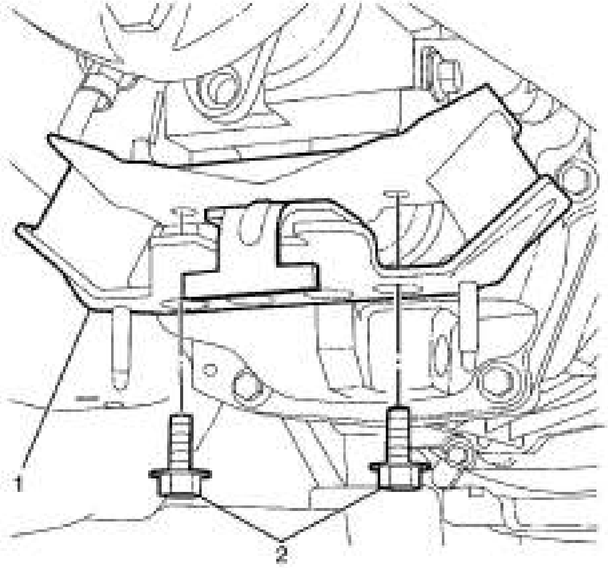
Transmission Rear Mount Replacement

Removal Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

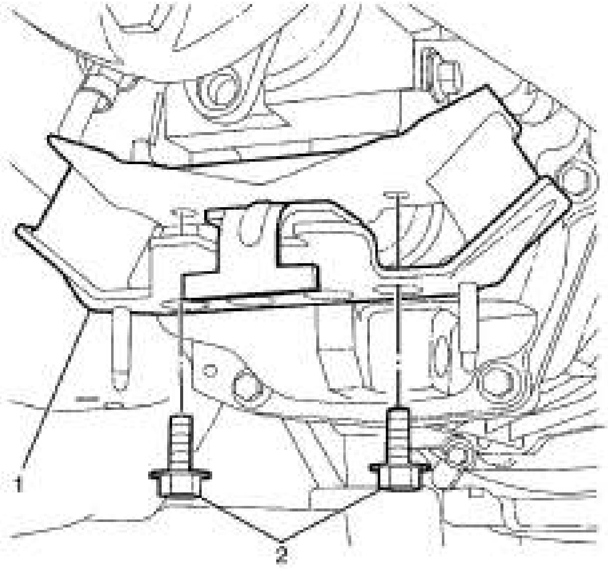
Caution: Refer to Safety Glasses Caution in the Preface section.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the transmission support. Refer to Transmission Support Replacement.



3. Remove the transmission mount to transmission upper retaining bolts (2).
4. Remove the transmission mount (1).

Installation Procedure



1. Install the transmission mount (1) to the transmission.

   Notice: Refer to Fastener Notice in the Preface section.

2. Install the transmission mount to transmission upper retaining bolts (2).

   Tighten
   Tighten the bolts to 60 N·m (44 lb ft).

3. Install the transmission support. Refer to Transmission Support Replacement.
4. Lower the vehicle.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Manual Transmission - Tremec 6-Speed | Repair Instructions - On Vehicle | **Document ID: 1977479**

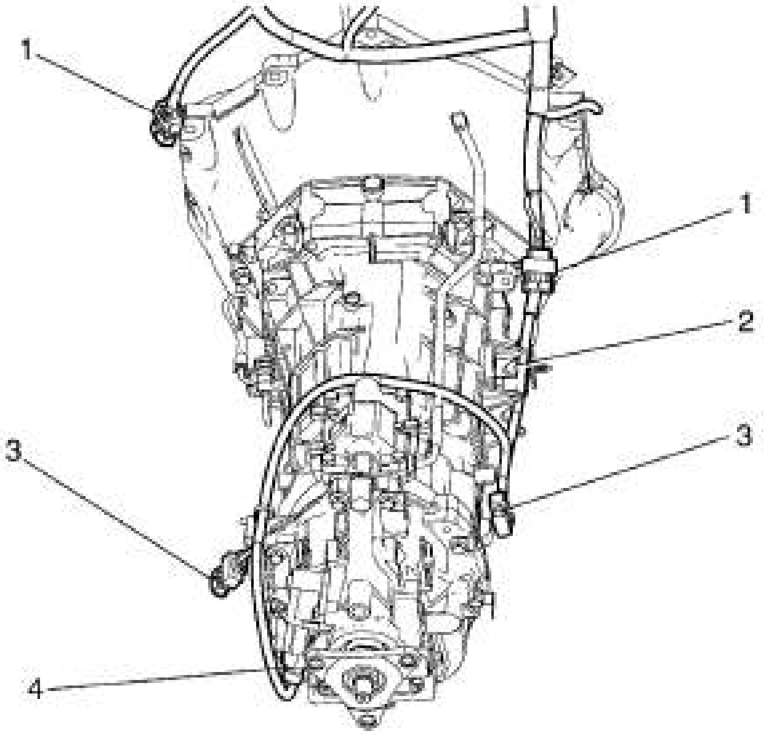
Transmission Replacement

Removal Procedure

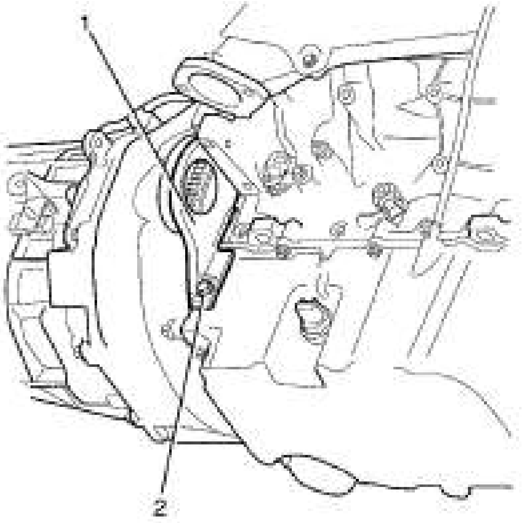
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

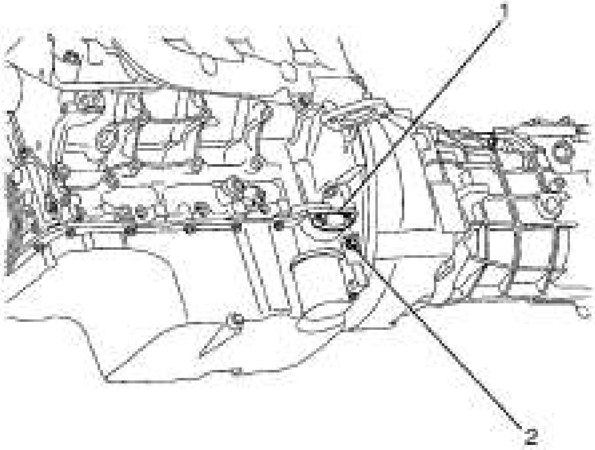
1. Remove the shift control assembly. Refer to Shift Control Assembly Replacement .
2. Remove the propeller shaft. Refer to Propeller Shaft Replacement .



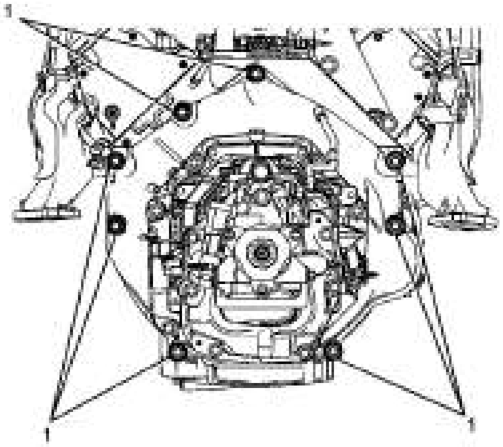
3. Disconnect the following electrical connectors:
   - Backup lamp switch (3).
   - Reverse lockout solenoid (4).
   - Oxygen sensor wiring harness (1 and 2).
4. Disconnect the clutch slave cylinder. Refer to Clutch Concentric Actuator Cylinder Replacement .
5. Remove the starter motor. Refer to Starter Motor Replacement .



6. Remove the transmission close out panel to transmission retaining bolt (2).
7. Remove the transmission close out panel (1) from the transmission.



8. Remove the transmission close out panel to transmission retaining bolt (1).
9. Remove the transmission close out panel (2) from the transmission.

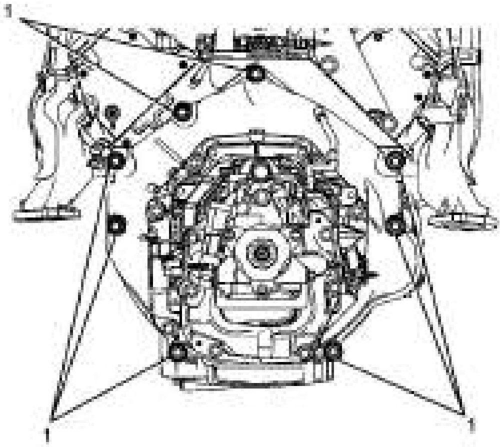


10. Remove the transmission to engine block retaining bolts (1)
11. Remove the transmission from the vehicle.

Installation Procedure

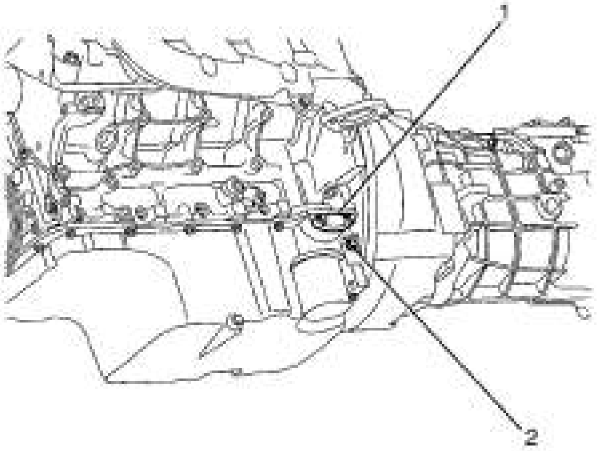
Important: Engage third gear on the transmission to allow for alignment of the input spline of the transmission to the clutch assembly.

1. Install the transmission to the vehicle.



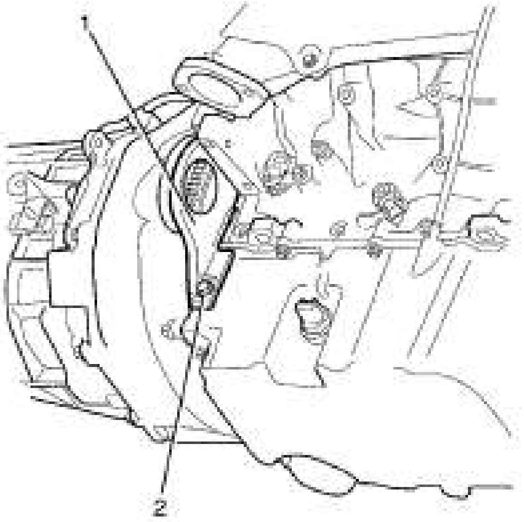
2. Install the transmission to engine block retaining bolts (1)

Tighten
Tighten the bolts to 48 N·m (35 lb ft).



3. Install the transmission close out panel (1) to the transmission.
4. Install the transmission close out panel to transmission retaining bolt (2).

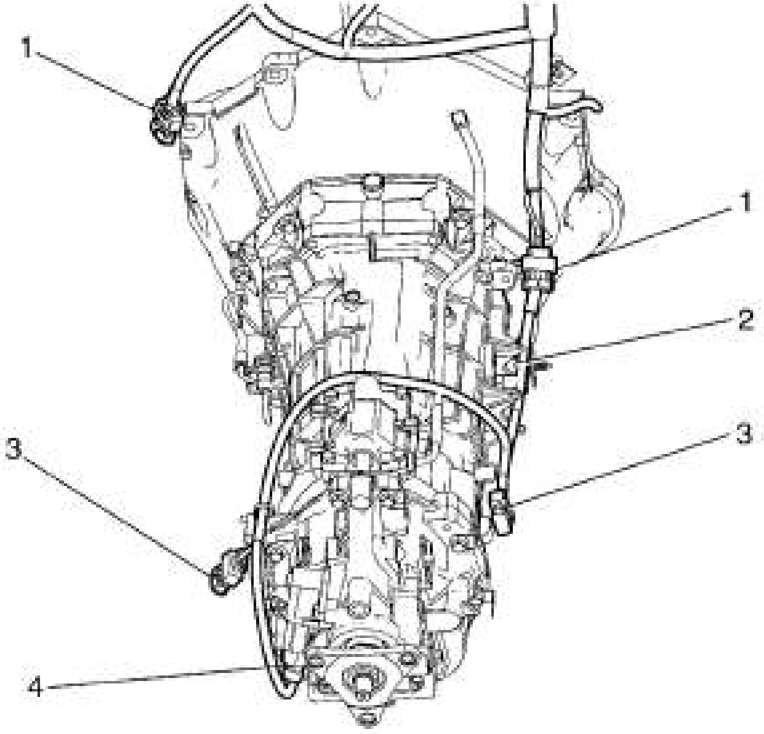
Tighten
Tighten the bolt to 20 N·m (15 lb ft).



5. Install the transmission close out panel (1) to the transmission.
6. Install the transmission close out panel to transmission retaining bolt (2).

Tighten
Tighten the bolt to 20 N·m (15 lb ft).

7. Connect the clutch slave cylinder. Refer to Clutch Concentric Actuator Cylinder Replacement .
8. Install the starter motor. Refer to Starter Motor Replacement .



9. Connect the following electrical connectors:
    - Backup lamp switch (3).
    - Reverse lockout solenoid (4).
    - Oxygen sensor wiring harness (1 and 2).
10. Install the shift control assembly to the transmission. Refer to Shift Control Assembly Replacement .
11. Install the propeller shaft. Refer to Propeller Shaft Replacement .
12. Check the transmission fluid and fill as necessary. Refer to Transmission Fluid Level Inspection and Transmission Fluid Replacement .
13. Install the exhaust system. Refer to Exhaust System Replacement .
14. Lower the vehicle.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Manual Transmission - Tremec 6-Speed | Repair Instructions - On Vehicle | **Document ID: 1977481**

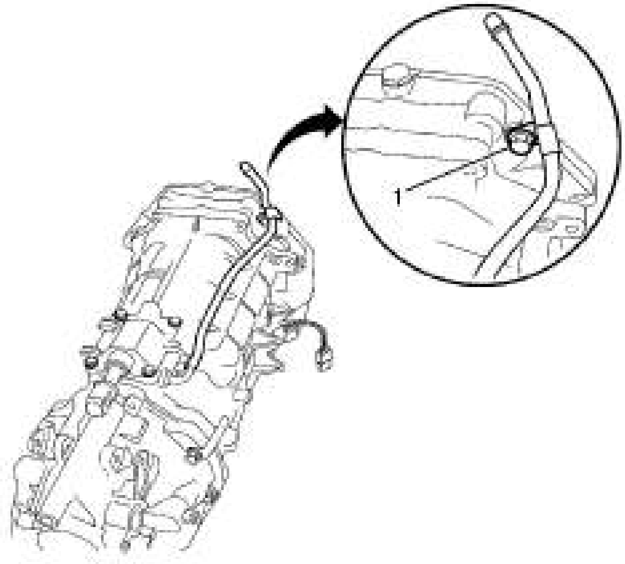
Transmission Vent Tube Replacement

Removal Procedure

Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

1. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the exhaust system. Refer to Exhaust System Replacement.
3. Remove the right catalytic converter. Refer to Catalytic Converter Replacement - Right Side.

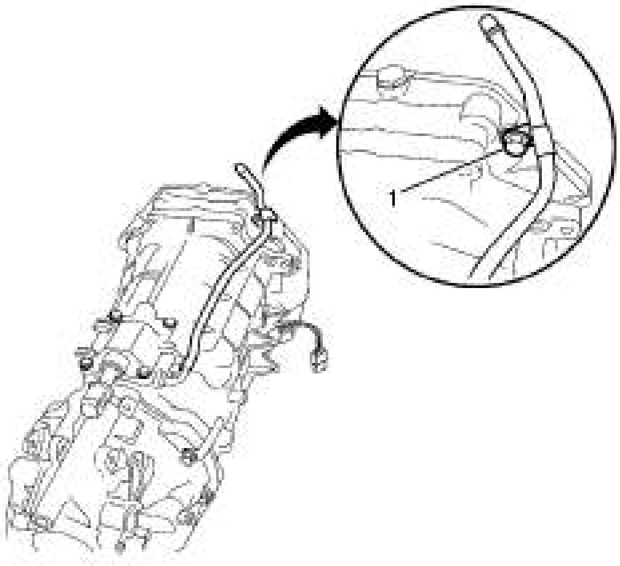


4. Remove the transmission vent tube to transmission case retaining bolt (1).
5. Remove the transmission vent tube from the vent pipe.

Installation Procedure

1. Install the transmission vent tube to the vent pipe.

Notice: Refer to Fastener Notice in the Preface section.



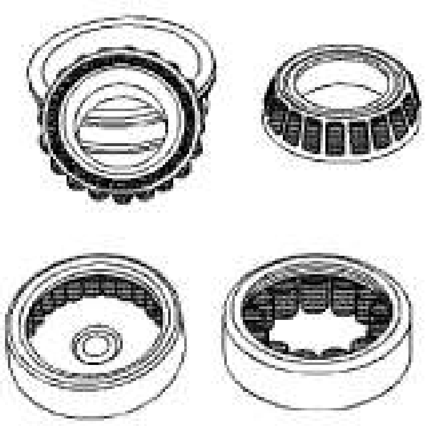
2. Install the transmission vent tube to transmission case retaining bolt (1).

   Tighten
   Tighten the transmission vent tube retaining bolt to 48 N·m (35 lb ft).

3. Install the right catalytic converter. Refer to Catalytic Converter Replacement - Right Side.
4. Install the exhaust system. Refer to Exhaust System Replacement.
5. Lower the vehicle.

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Manual Transmission - Tremec 6-Speed | Repair Instructions - Off Vehicle | **Document ID: 1996398**

Bearings and Spacers Cleaning and Inspection



Important: Do not use compressed air to dry the bearings.

Notice: Do not allow the bearings to spin. Turn them slowly by hand. Spinning the bearings may damage the race and the rollers.

1. Clean all the bearing parts in a suitable solvent. Air dry all the parts.
2. Lubricate the bearings. Use Dexron® III transmission lubricant.
3. Inspect the bearings and journals for roughness and unusual wear or damage.
4. Inspect the mainshaft bearing journals for wear.
5. Inspect the mainshaft speed gear bearings for wear.
6. Inspect the main drive gear pilot bearing rollers for wear.
7. Replace parts which show signs of excessive wear.
8. Do not file surfaces which have been hardened and precision ground.
9. Replace worn or damaged bearings.
10. Replace mated bearing parts when only one part is damaged.

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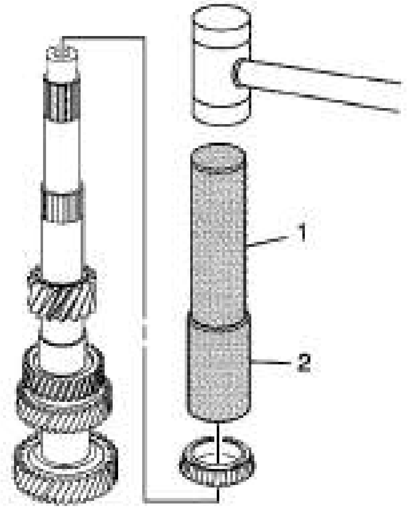
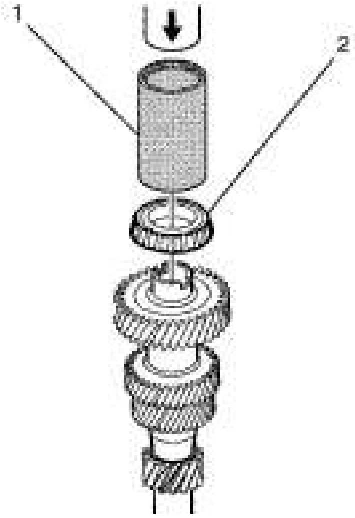
Counter Gear Shaft Assemble

Tools Required

- J 5590 Press Tube
- J 39441-10 5th Gear Installer Adapter



1. Install a new large tapered bearing, using the J 5590 (1), J 39441-10 (2) and a rubber mallet.



2. Install a new small tapered bearing (2), using the J 5590 (1) and a hydraulic press.

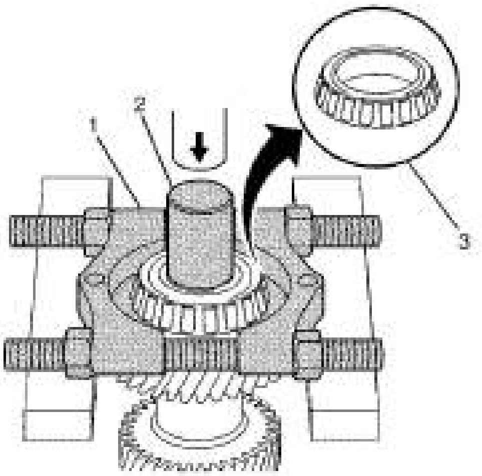
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Manual Transmission - Tremec 6-Speed | Repair Instructions - Off Vehicle | **Document ID: 1996434**

Counter Gear Shaft Disassemble

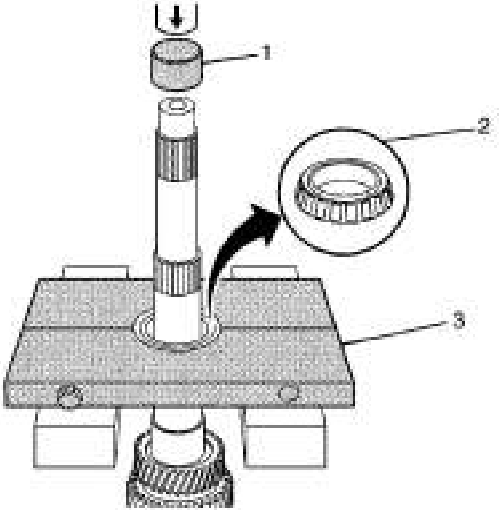
Tools Required

- J-22912-01 Split Plate
- J 39473 Mainshaft Bearing Installer
- J 39511 Split Plate
- J 39547 Press Adapter

Important: Do not replace tapered bearings unless inspection shows bearing damage.



1. Remove the small tapered bearing (3), using the J-22912-01 (1) with the J 39473 (2) and a hydraulic press.
2. Discard the small tapered bearing (3).

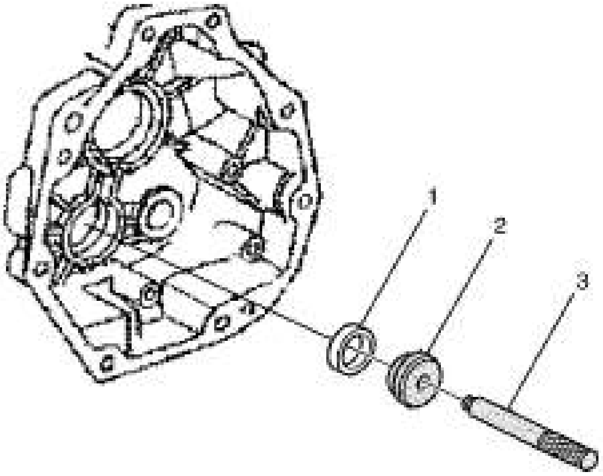


3. Remove the large tapered bearing (2), using the J 39511 (3), the J 39547 (1), and a hydraulic press.
4. Discard the large tapered bearing (2).

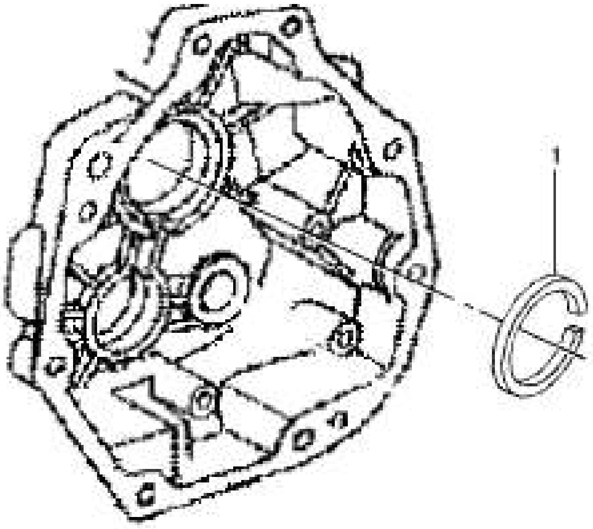
Extension Assemble

Tools Required

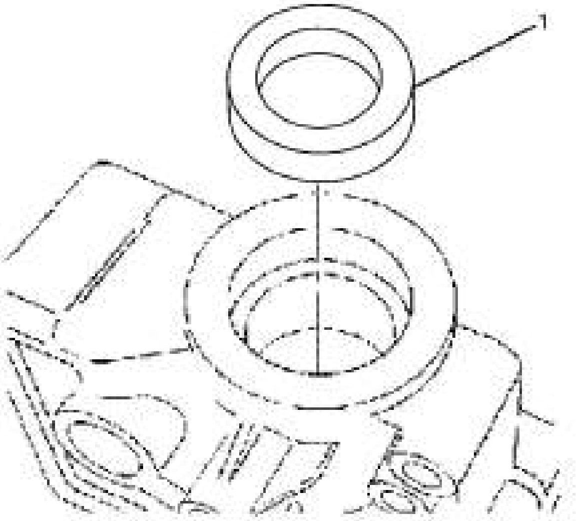
- J 8092 Drive Handle
- J 44765 Seal Installer
- J 39546 Bearing Race Installer
- J 39437 Bushing Installer



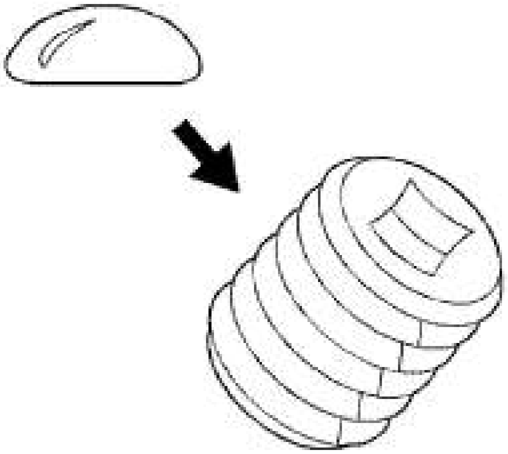
1. Install the mainshaft bearing race (1), using the J 39546 (2) and the J 8092 (3).



2. Install the mainshaft bearing race to extension housing retainer ring (1).

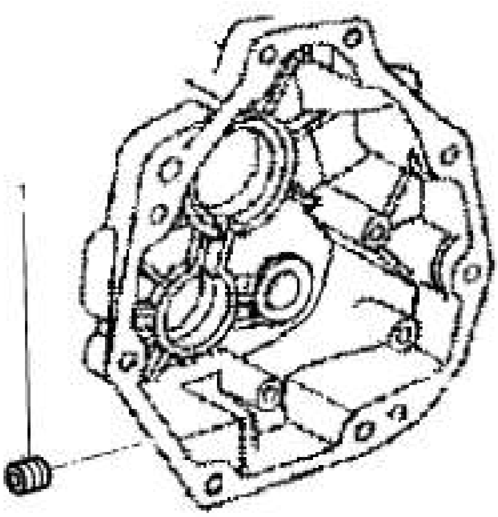


3. Install a NEW output shaft seal to the extension housing using the J 44765 .



4. Apply an approved sealant to the transmission case drain plug.

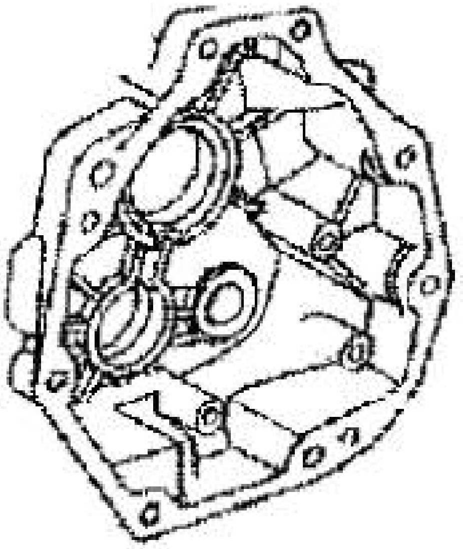
   Notice: Refer to Fastener Notice in the Preface section.



5. Install the transmission case drain plug (1) to the extension housing.

   Tighten
   Tighten the plug to 18 N·m (13 lb ft).

Extension Cleaning and Inspection

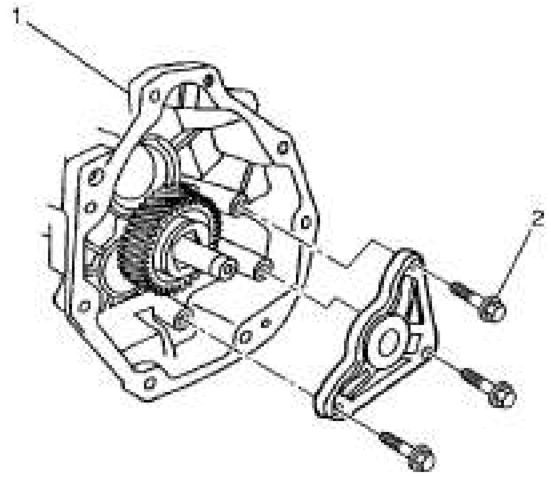


1. Clean the rear extension housing in a suitable solvent. Air dry the housing.
2. Inspect the extension housing for the following:
   - Cracks
   - Scratches
   - Damaged threads
   - Burrs
   - Nicked mounting surfaces
   - Damaged sealing surfaces
   - Damaged front or rear bearing bores
3. If damaged beyond repair replace the extension housing..
4. Clean up damaged threads with the correct size thread tap.
5. Inspect the machined mating surfaces for flatness (Check the mating surfaces with a straight edge).
6. Use a fine mill file to dress minor scratches or burrs.

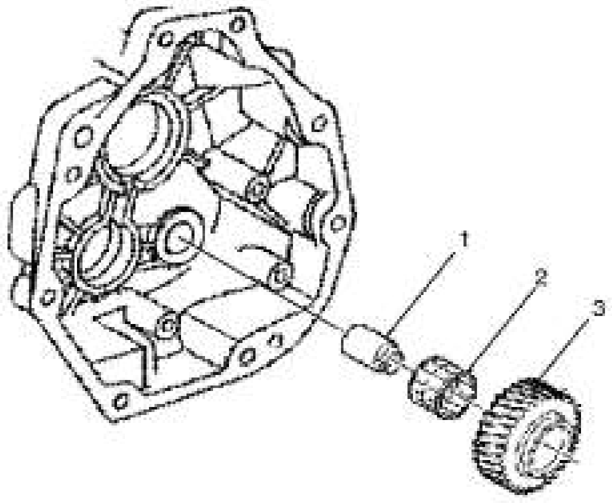
Extension Disassemble

Tools Required

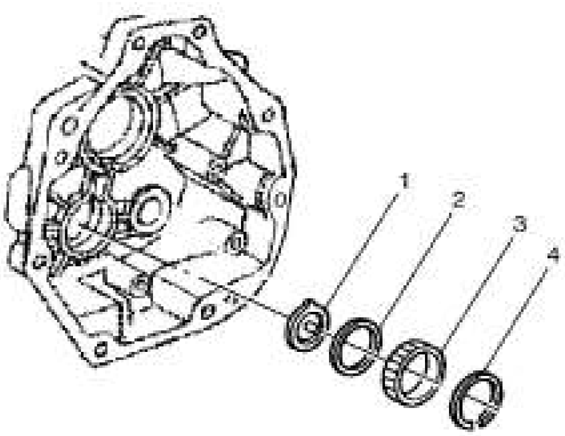
- J 26941 Bearing Race Remover
- J 23907 Slide Hammer



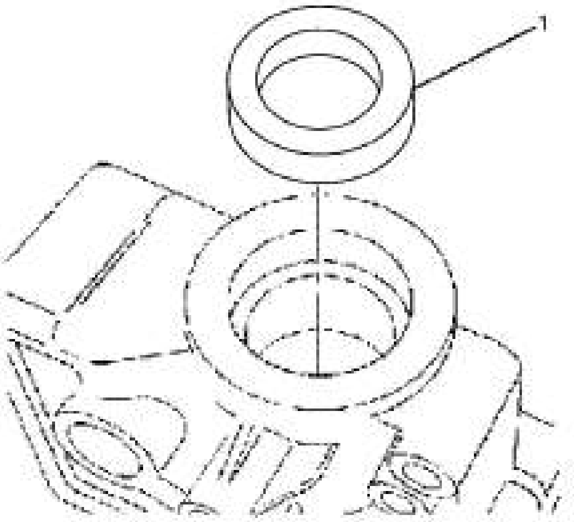
1. Remove the reverse idler shaft bracket bolts (1).
2. Remove the reverse idler shaft bracket (2).



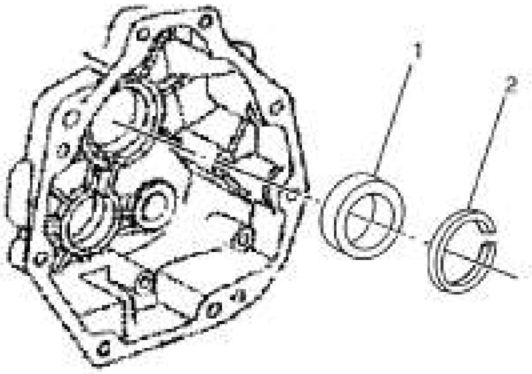
3. Remove the reverse idler gear thrust washer from the reverse idler shaft (1).
4. Remove the reverse idler gear (3) and roller bearing (2) from the reverse idler shaft.
5. Remove the reverse idler rear thrust washer from the reverse idler shaft.
6. Remove the reverse idler shaft from the extension housing.



7. Remove the countershaft bearing race (3) by rotating back and forth while pulling from the extension housing.
8. Remove the countershaft shim (2) from the extension housing.
9. Remove the countershaft oil funnel (1) from the extension housing.



10. Carefully pry the output shaft seal (1) from the extension housing using a suitable tool..

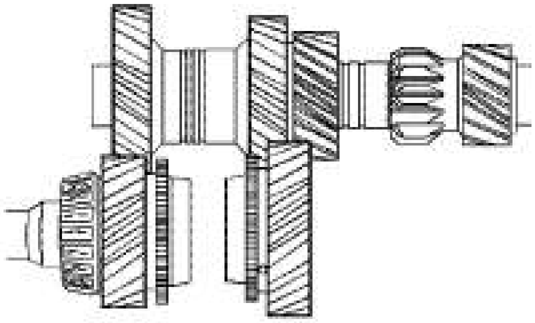


11. Remove the mainshaft bearing race to extension housing retainer ring (2).

    Important: Do not replace the bearing race unless inspection shows bearing race damage.

12. Remove the mainshaft bearing race (1) using J 26941 and J 23907 .

Gears Cleaning and Inspection



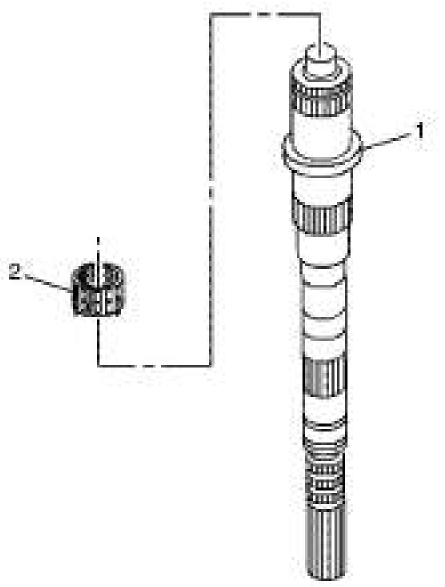
1. Clean all the parts in a suitable solvent. Air dry all the parts.
2. Inspect the gear tooth surfaces on all the gear sets for the following conditions:
   - Cracks
   - Pitting
   - Nicks
   - Chipped gear teeth
   - High spots (Small-shiny spots on the gear teeth mating surface) that could cause gear noise
3. Inspect for damaged splines on the input shaft, mainshaft, and the countershaft extension.
4. Remove nicks and burrs with a soft stone or a crocus cloth.
5. Replace any burred or nicked part that cannot be reconditioned by hand.
6. Replace gears and gear assemblies that are worn or damaged.

Main Shaft and Input Shaft Assemble

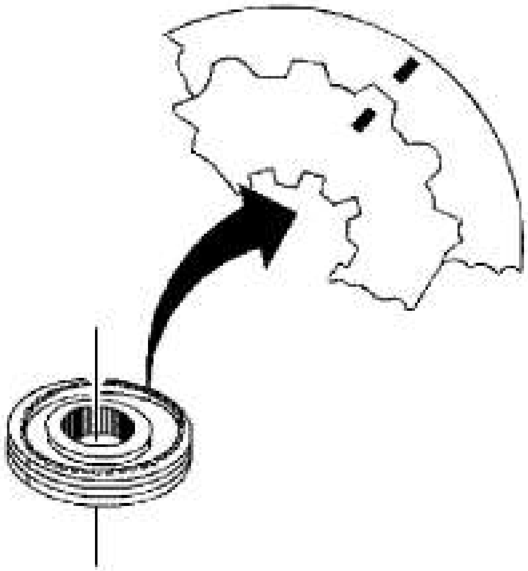
Mainshaft

Tools Required

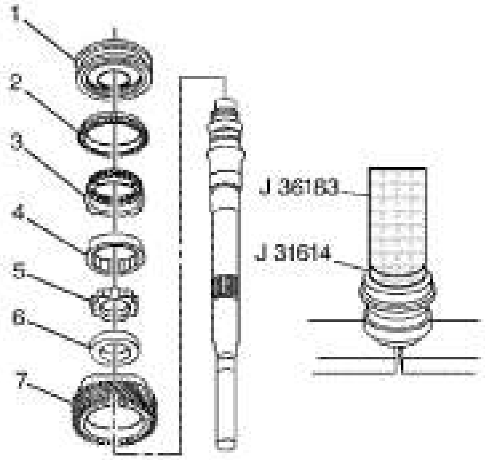
- J 36183 Press Tube.
- J 36184 Press Tube Adapter.
- J 39371 1st/2nd Synchronizer Installer.
- J 39473 Mainshaft Bearing Installer.



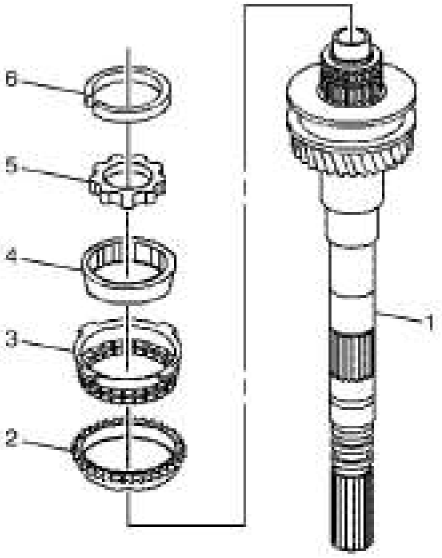
1. Install the 3rd speed gear caged needle bearing and the spacer (2).



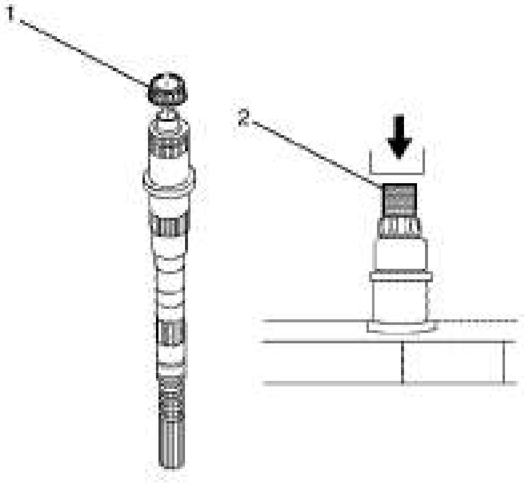
2. Check the 3rd/4th speed gear synchronizer assembly scribe marks for correct positions.



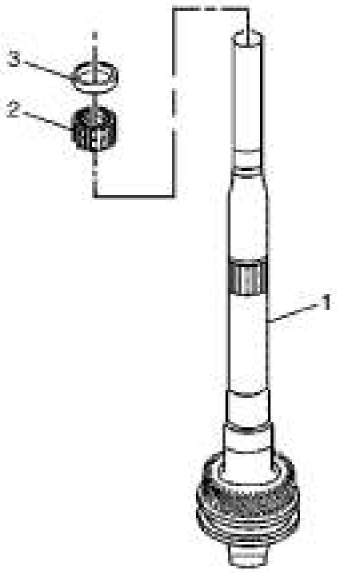
3. Install the 3rd speed gear (7) to the mainshaft.
4. Install the spacer (6) to the mainshaft.
5. Install the thrust washer (5) to the mainshaft.
6. Install the 3rd speed gear inner cone (4) to the mainshaft.
7. Install the 3rd speed gear friction cone (3) to the mainshaft.
8. Install the 3rd speed gear blocking ring (2) to the mainshaft.
9. Install the 3rd/4th speed gear synchronizer assembly (1) to the mainshaft (the groove on the sleeve faces the 3rd speed gear).
10. Start the press operation.
11. Stop pressing before the keys engage the blocking ring slots.
12. Lift and rotate the 3rd speed gear in order to engage the keys with the blocking ring.
13. Continue pressing until the synchronizer is seated.



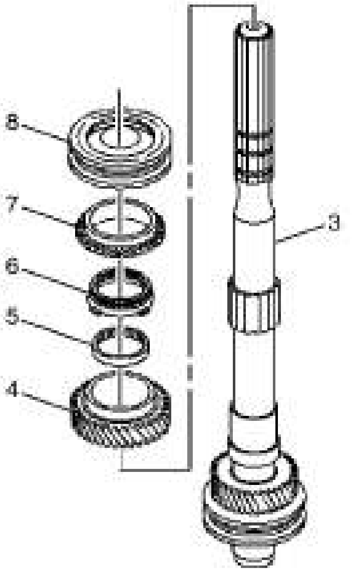
14. Install the 4th gear blocking ring (2) to the mainshaft (1).
15. Install the 4th gear friction cone (3) to the mainshaft (1).
16. Install the 4th gear inner cone (4) to the mainshaft (1).
17. Install the 4th gear thrust washer (5) to the mainshaft (1).
18. Install the 3rd/4th synchronizer circlip (6) to the mainshaft (1).



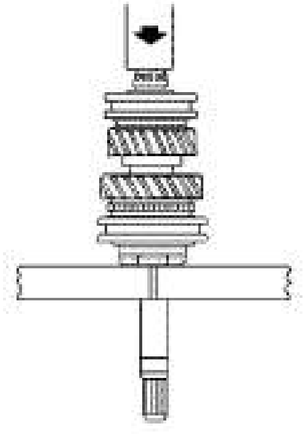
19. Install a NEW small tapered bearing (1) to the mainshaft, using the J 39473 (2), V-blocks, and a hydraulic press.



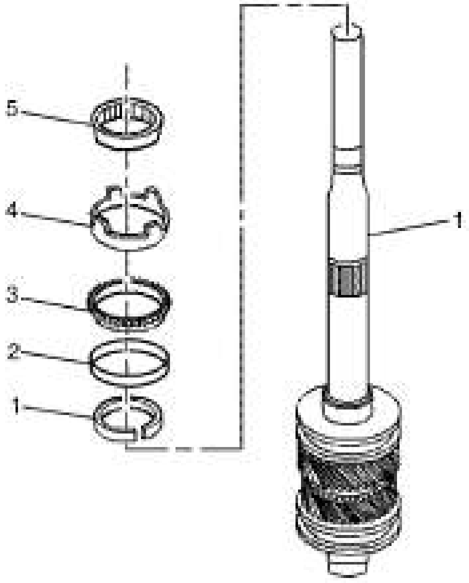
20. Install the 2nd speed gear caged needle bearing (2) to the mainshaft (1).
21. Install the 2nd speed gear spacer (3) to the mainshaft (1).



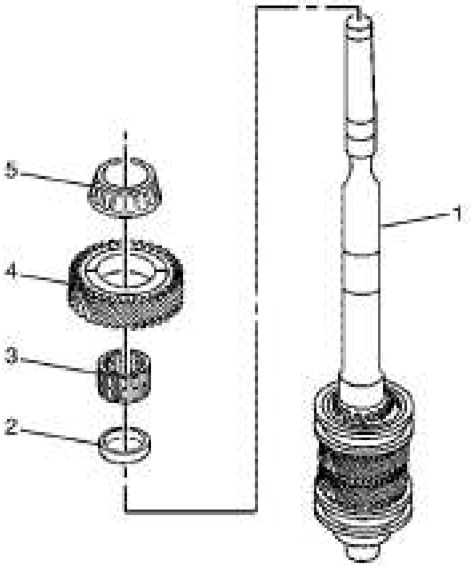
22. Install the 2nd speed gear (2) to the mainshaft (1).
23. Install the 2nd speed gear inner cone (3) to the mainshaft (1).
24. Install the 2nd speed gear friction cone (4) to the mainshaft (1).
25. Install the 2nd speed gear blocking ring (5) to the mainshaft (1).
26. Install the 1st/2nd synchronizer assembly (6) to the mainshaft (1) (The ID groove on the sleeve faces the 1st speed gear.)



27. Start the press operation.
28. Stop pressing before the keys engage the blocking ring slots.
29. Lift and rotate the 2nd speed gear in order to engage the keys with the blocking ring.
30. Continue pressing until the synchronizer is seated.



31. Install the 1st speed gear blocking ring (6) to the mainshaft (1).
32. Install the friction cone (5) to the mainshaft (1).
33. Install the inner cone (4) to the mainshaft (1).
34. Install the the split washers (3) to the mainshaft (1).
35. Install the the split washer retainer (2) to the mainshaft (1).

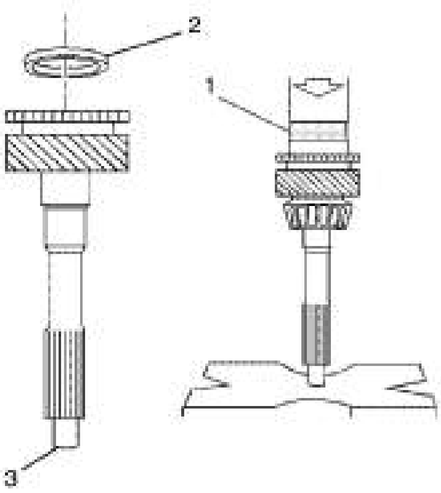


36. Install the 1st speed gear bearing spacer (2) to the mainshaft (1).
37. Install the 1st speed gear caged needle bearing (3) to the mainshaft (1).
38. Install the 1st speed gear (4) to the mainshaft (1).
39. Install the large tapered bearing (5) to the mainshaft (1).

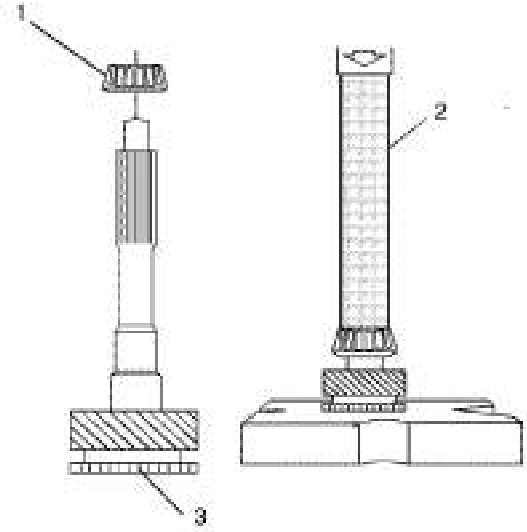
Input Shaft

Tools Required

- J 28537-17 Bearing Race Installer.
- J 25234 Press Tube.



1. Install a NEW bearing race (1) on the input shaft (3), using the J 28537-17 (2) and a hydraulic press.



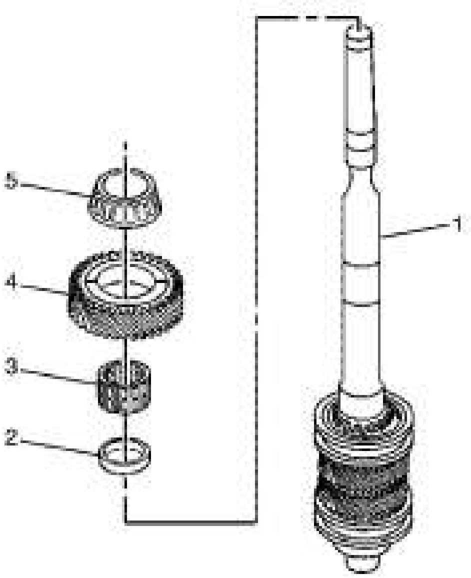
2. Install a NEW tapered bearing (1) on the input shaft (3). Use the J 25234 (2) and a hydraulic press.

Main Shaft and Input Shaft Disassemble

Mainshaft

Tools Required

- J 36513 Split Plate.
- J 39442 Press Adapter.
- J 39443 Split Plate.
- J 39473 Mainshaft Bearing Installer.



Important: Measure the 4th speed gear synchronizer wear gap before disassembling the mainshaft.

Important: Do not mix any of the sychromesh blocker rings or any sychromesh components.

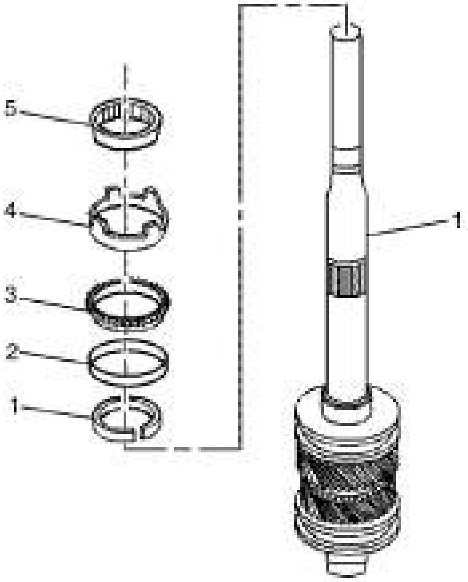
1. Install the input shaft in the adapter plate.
2. Install the mainshaft on the input shaft.
3. Using a feeler gauge measure the gap between the 4th speed gear blocking ring and the 4th speed gear.
4. Replace the 4th speed gear friction cone and blocking ring when the gap is less than 0.38 mm (0.010 in).

Notice: Refer to General Repair Instructions in the Preface section.

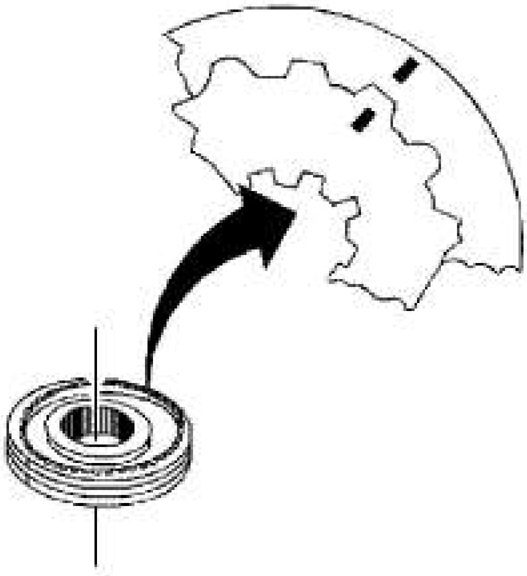
5. Using the J 36513 close the split plate only enough to support the gear teeth, and the J 39442 :

   Important: The O-ring is only used by the manufacturer to assist in assembly. It serves no other purpose and can be discarded after removal. This O-ring is not a serviceable item.

6. If an O-ring is present on the mainshaft, remove and discard the O-ring.
7. Remove the mainshaft tapered bearing (5) from the mainshaft (1) by sliding off.
8. Remove the 1st speed gear (4) from the mainshaft (1) by sliding off.
9. Remove the 1st speed gear caged needle bearing (3) from the mainshaft (1).
10. Remove the 1st speed gear bearing spacer (2) from the mainshaft (1).

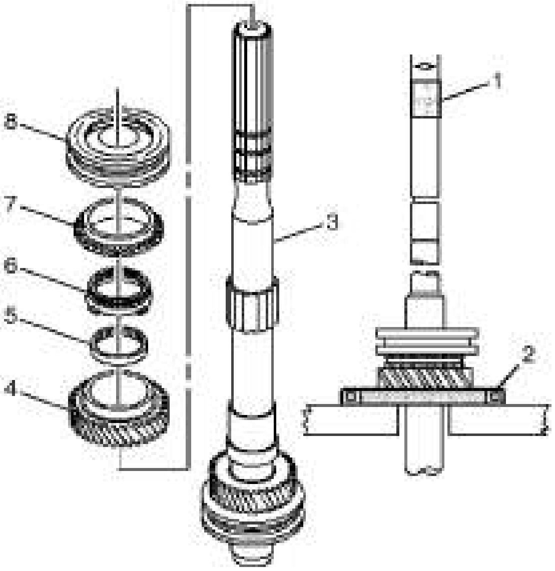


11. Remove the split washer retainer (2) from the mainshaft (1).
12. Remove the split washers (3) from the mainshaft (1).
13. Remove the 1st speed gear inner cone (4) from the mainshaft (1).
14. Remove the 1st speed gear friction cone (5) from the mainshaft (1).
15. Remove the 1st speed gear blocking ring (6) from the mainshaft (1).

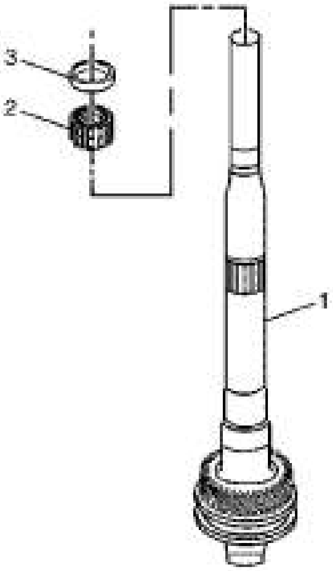


Important: The synchronizer hubs and sliding sleeves are a selected assembly. Keep these parts together as originally assembled.

16. Scribe a mark on the synchronizer hub and on the sleeve. This will help you to reinstall the parts in the same position.

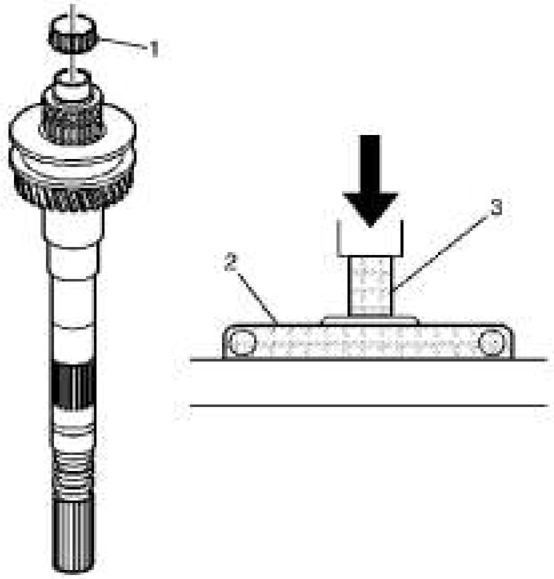


17. Remove the 2nd speed gear (4). The 1st/2nd speed synchronizer assembly (8), the 2nd speed gear blocking ring (7), the 2nd speed gear friction cone (6), and the 2nd speed gear inner cone (5) will press off with the 2nd speed gear (4). Use the J 36513 (2) in an inverted position, J 39442 (1) and a hydraulic press.



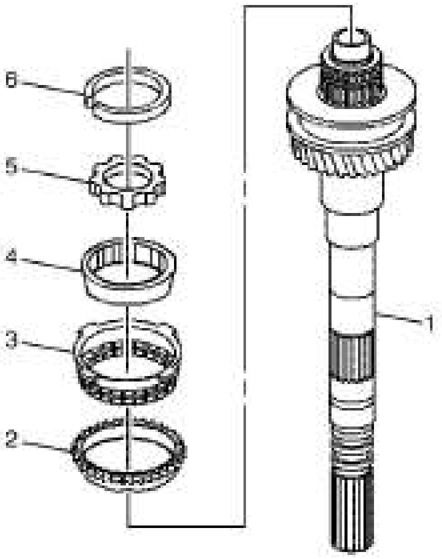
18. Remove the 2nd speed gear spacer (3) from the mainshaft (1).

19. Remove the caged needle bearing (2) from the mainshaft (1).

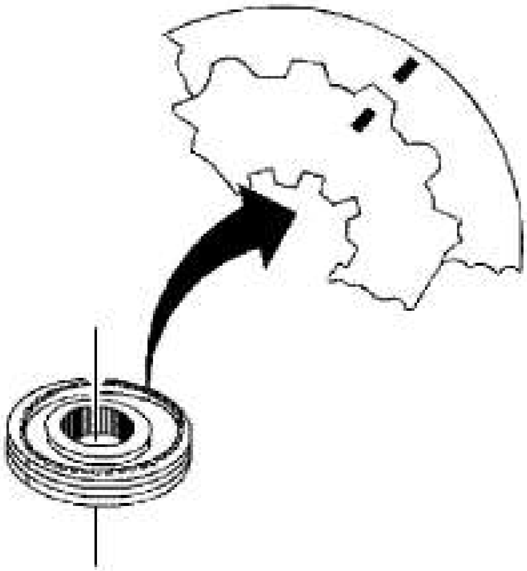


20. Remove the mainshaft small tapered bearing (1). Use the J 39442 (3), the J 39443 (2), and a hydraulic press.

    Discard the small tapered bearing.

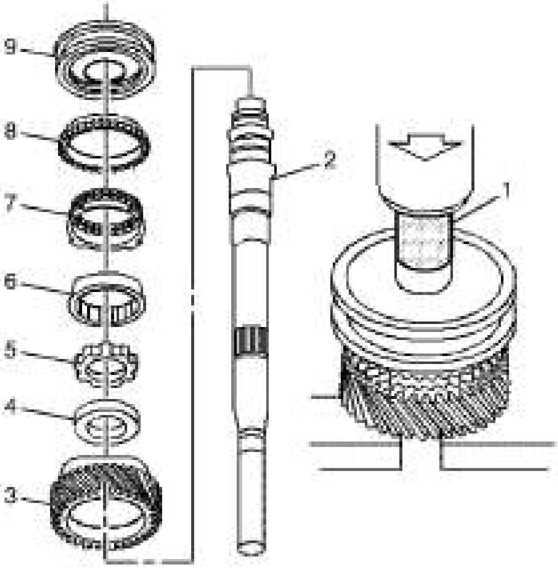


21. Remove the circlip (6) from the mainshaft (1).
22. Remove the 4th gear thrust washer (5) from the mainshaft (1).
23. Remove the 4th gear inner cone (4) from the mainshaft (1).
24. Remove the 4th gear friction cone (3) from the mainshaft (1).
25. Remove the 4th gear blocking ring (2) from the mainshaft (1).

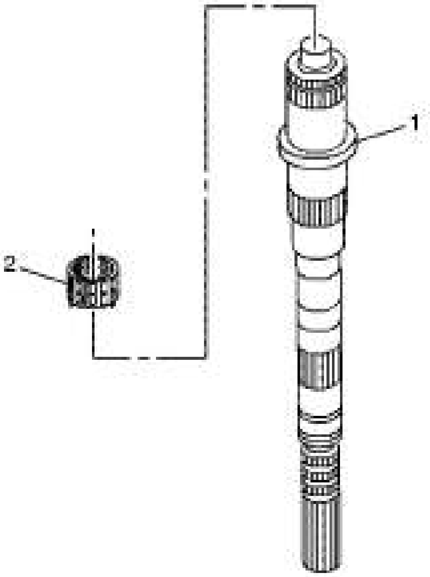


Important: The synchronizer hubs and sliding sleeves are a selected assembly. Keep these parts together as originally assembled.

26. Scribe a mark on the synchronizer hub and on the sleeve. This will help you to reinstall the parts in the same position.



27. Use the J 39473 (1), V-blocks, and a hydraulic press to remove the 3rd speed gear (3). The 3rd/4th speed synchronizer assembly (9), the 3rd speed gear blocking ring (8), the 3rd speed gear friction cone (7), the 3rd speed gear inner cone (6), thrust washer (5), and spacer (4) will press off with the 3rd speed gear (3).



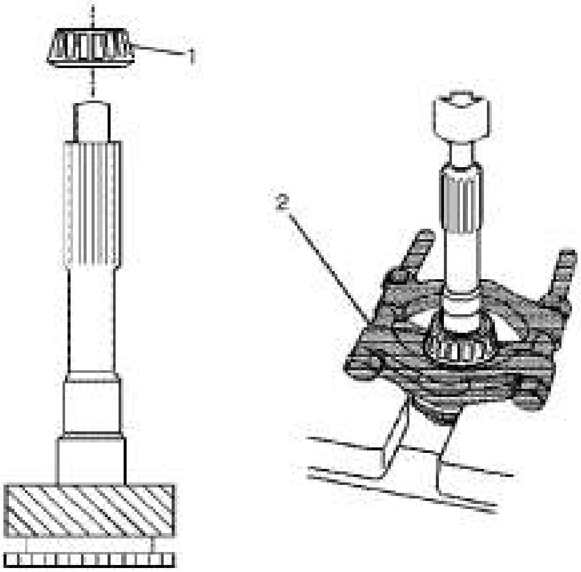
28. Remove the 3rd speed gear caged needle bearing (2) from the mainshaft (1).

Input Shaft

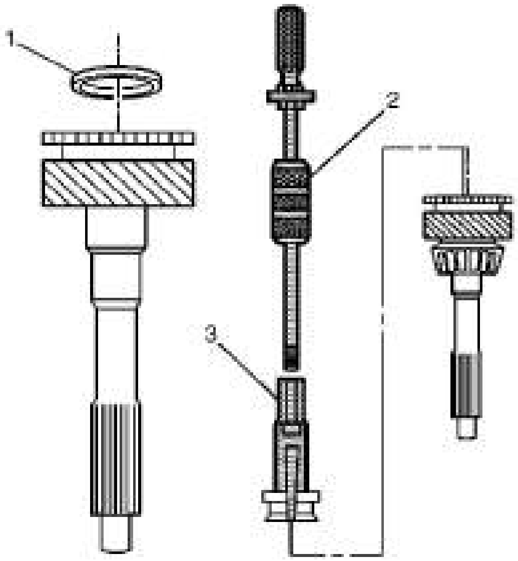
Tools Required

- J-22912-01 Split Plate.
- J 23907 Slide Hammer.
- J 39594 Bearing Race Remover.

Important: Do not replace the tapered bearing or the bearing race unless inspection shows that the bearing or the race are damaged.



1. Remove the tapered bearing (1) using the J-22912-01 (2) and a hydraulic press.



2. Remove the bearing race (1) using the J 23907 (2) and the J 39594 (3).

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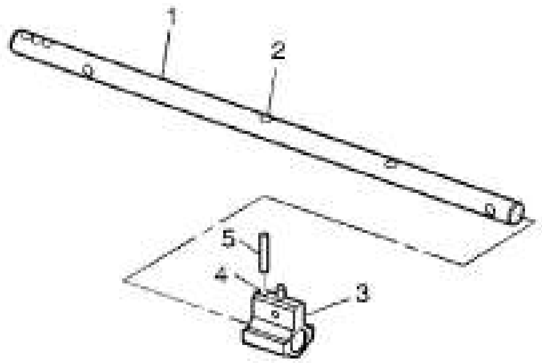
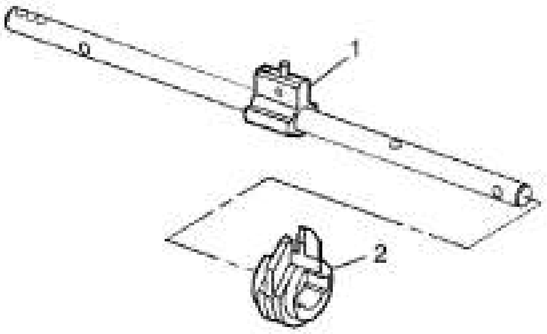
Shift Shaft and Fork Assemblies Assemble

Tools Required

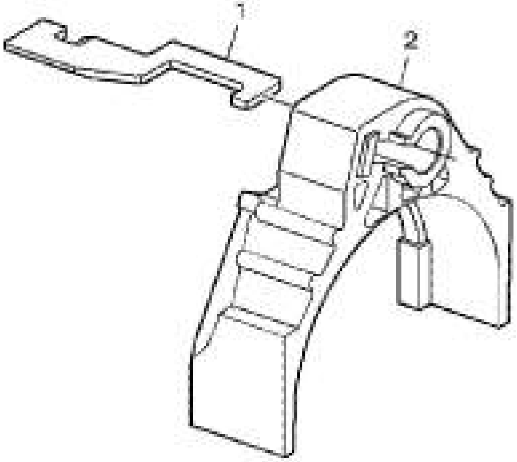
J 36850 Transjel® Assembly Lubricant.



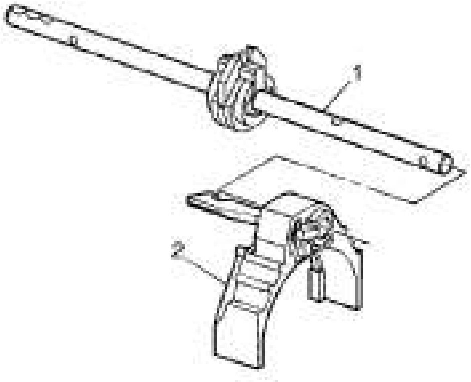
1. Install the selector pin (3) on the shift shaft (1).
2. Align the roll pin hole on the selector pin (4) with the roll pin hole on the shift shaft (2).
3. Install the roll pin (5) through the selector pin (3) and the shift shaft (1).



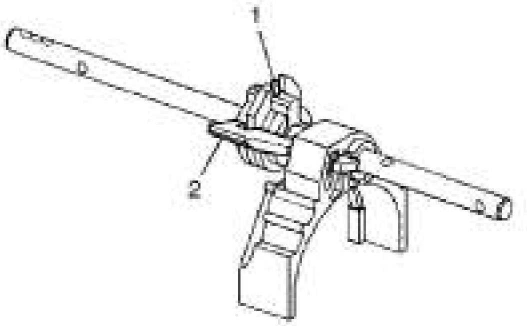
4. Install the interlocking plate (2) on the selector pin (1).



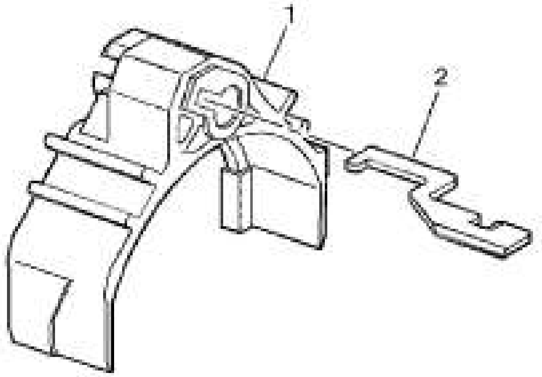
5. Install the shift link (1) in the 3rd/4th shift fork (2).



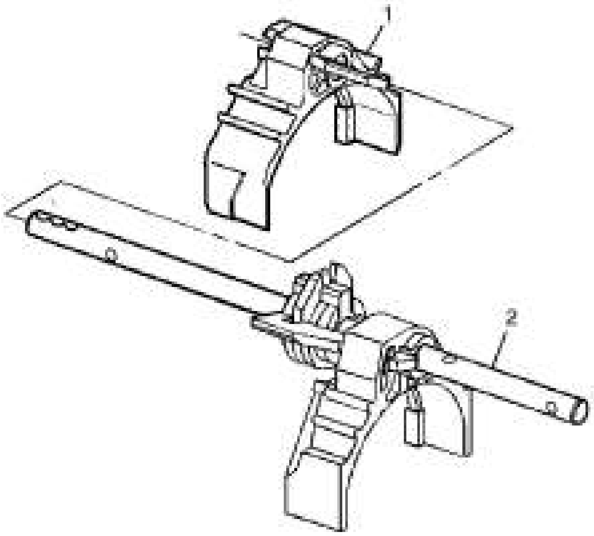
6. Install the 3rd/4th shift fork (2) on the shift shaft (1).



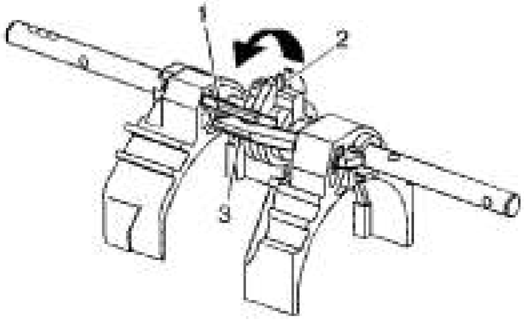
7. Align the notch on the shift link (2) with the selector roll pin (1).



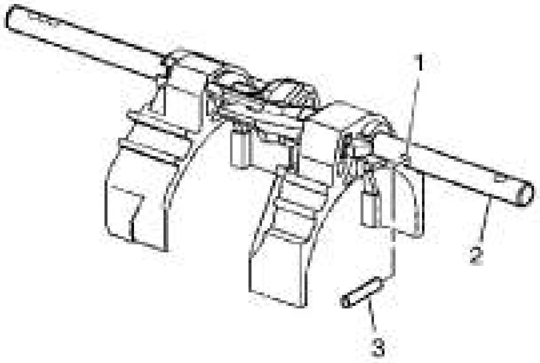
8. Install the shift link (2) with the 1st/2nd shift fork (1).



9. Install the 1st/2nd shift fork (1) on the shift shaft (2).



10. Install the 1st/2nd shift shaft link (1) on top of the 3rd/4th shift shaft link (3) on the interlocking plate and the selector roll pin assembly (2).



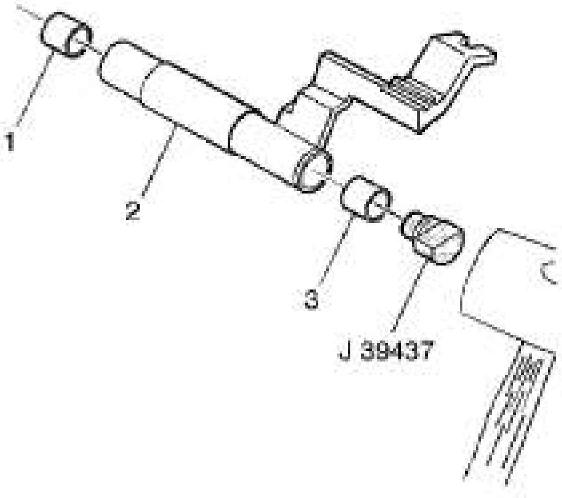
Important: The neutral return cam pin fits loosely in the shift shaft. Use the J 36850 to hold the neutral return cam pin in place.

11. Install the neutral return cam pin (3) in the neutral return can pin hole (1) on the shift shaft (2).

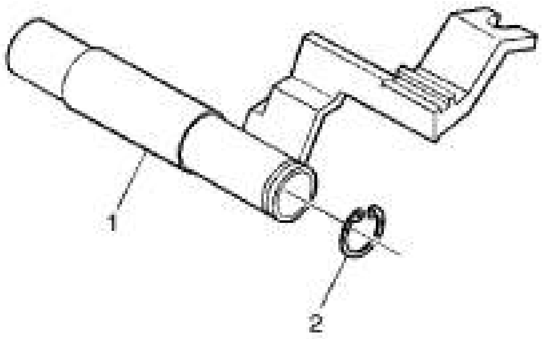
5th / 6th, Reverse Shift Rail Assembly

Tools Required

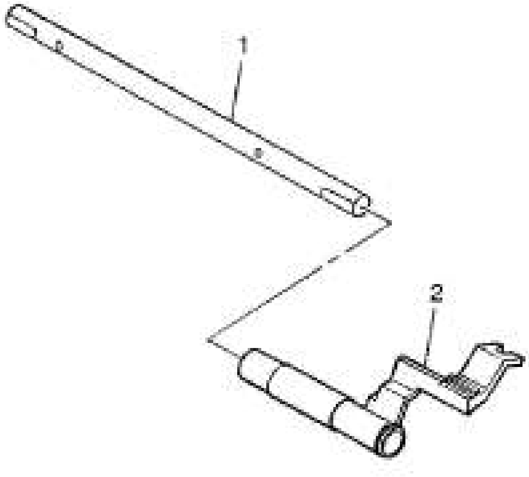
J 39437 Bushing Installer



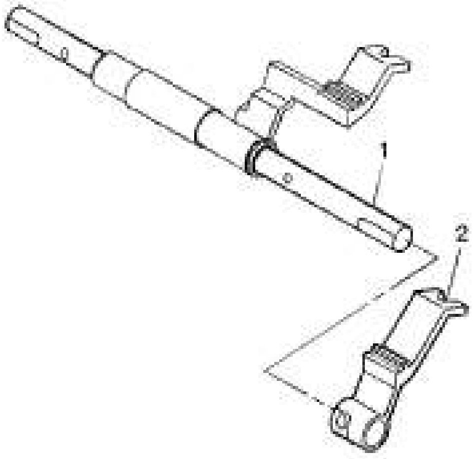
1. Install the 5th/6th shift shaft lever bushings (1) and (3) in the 5th/6th shift lever (2) using the J 39437 (4) and a hammer.



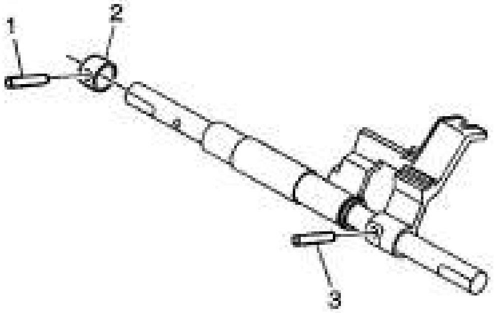
2. Install the retainer ring (1) on the 5th/6th shift lever (2).



3. Install the 5th/6th shift lever (2) on the shift shaft (1).

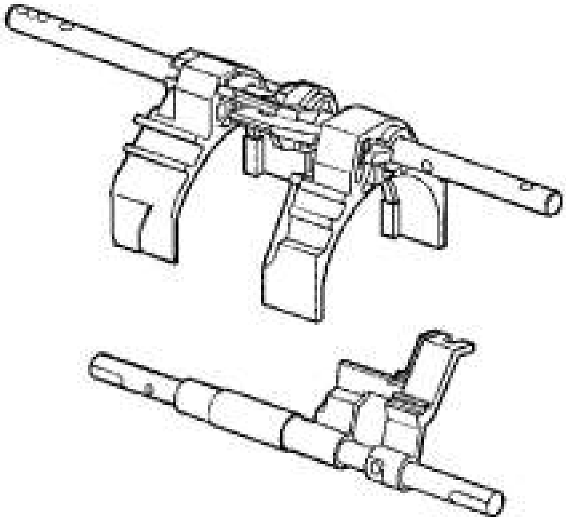


4. Install the reverse shift lever (2) on the shift shaft (1).

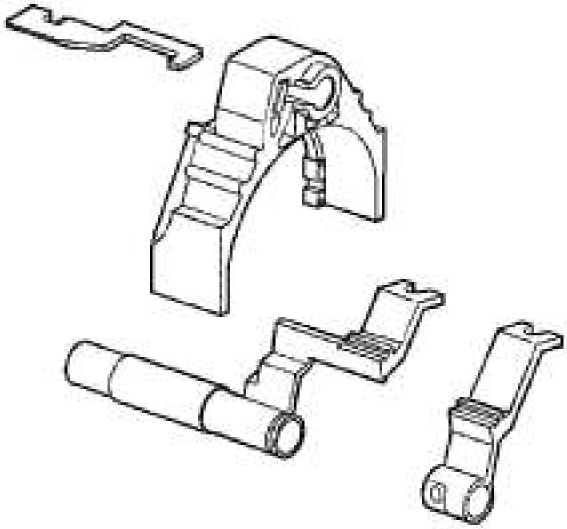


5. Install the reverse lever roll pin (3).
6. Install the reverse collar (2).
7. Install the reverse collar roll pin (1).

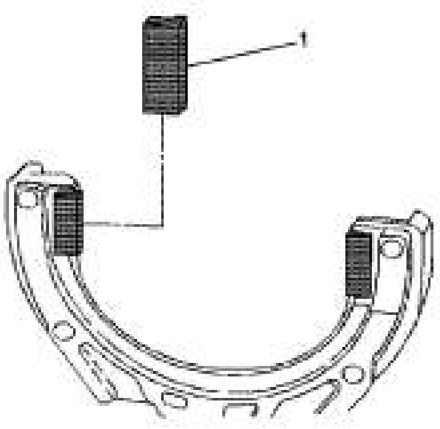
Shift Shaft and Fork Assemblies Cleaning and Inspection



1. Clean the shift shaft and fork assembly parts with a suitable solvent. Air dry all the parts.

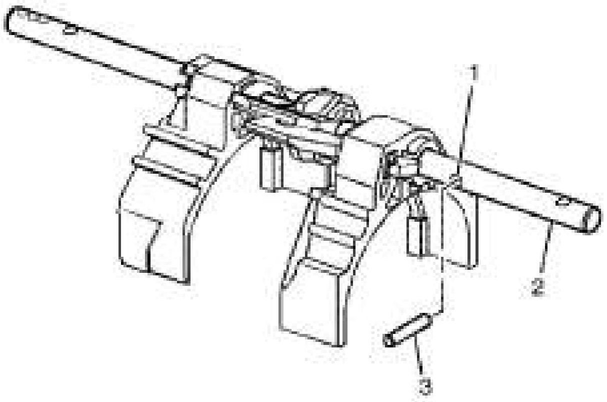


2. Inspect the shift forks and the shift links for excessive wear, fractures or distortion.
3. Inspect the shift shaft lever bushings for excessive wear.

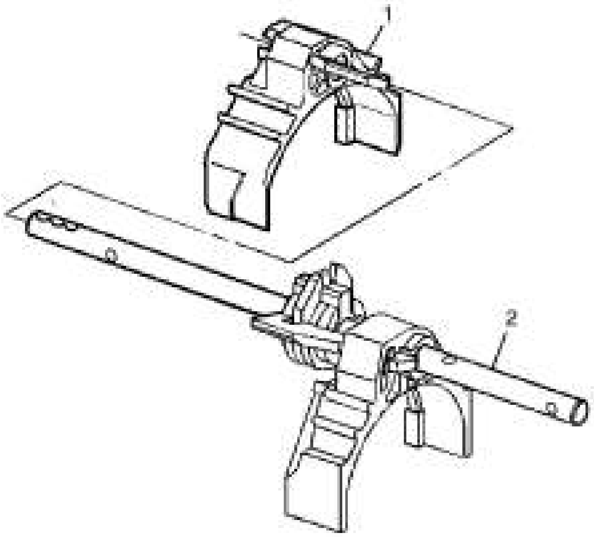


4. Inspect the shift fork nylon inserts (1) for wear.
5. Replace parts that are fractured, excessively worn, or distorted.
6. Replace an excessively worn or burred shift shaft.

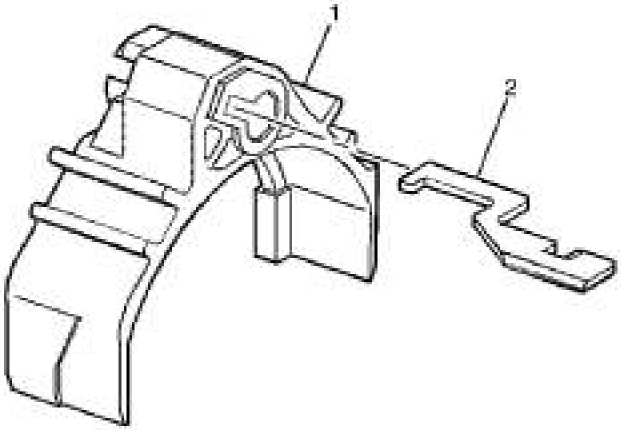
Shift Shaft and Fork Assemblies Disassemble



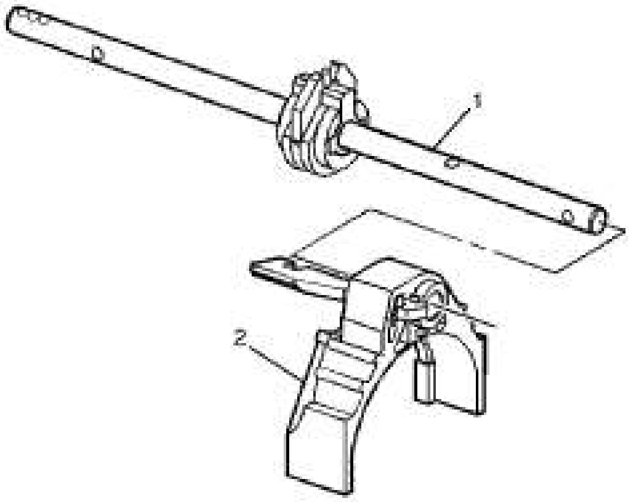
1. Remove the neutral return cam pin (3) from the shift shaft (2).



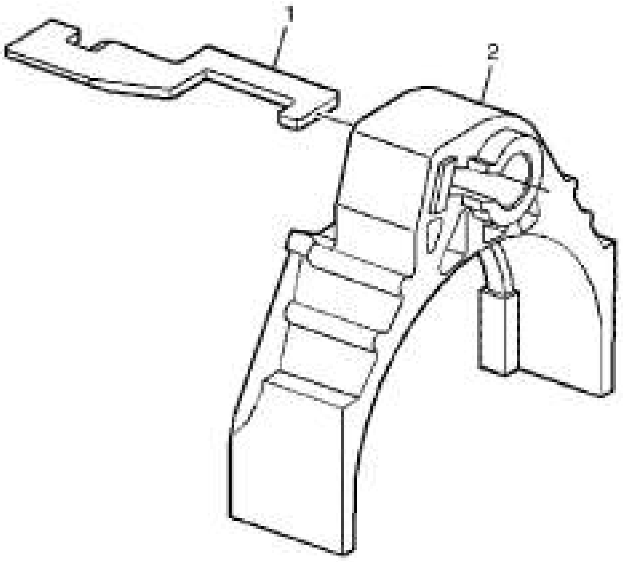
2. Remove the 1st/2nd shift fork (1) from the shift shaft (2).



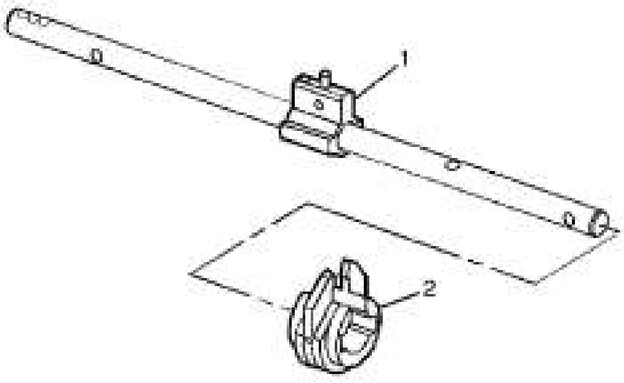
3. Remove the shift link (2) from the 1st/2nd shift fork (1).



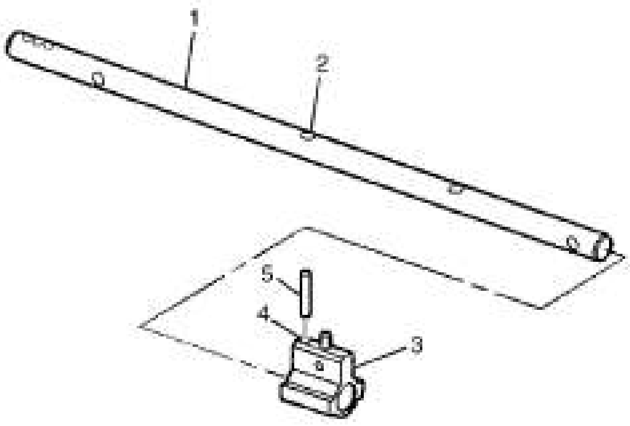
4. Remove the 3rd/4th shift fork (2) from the shift shaft (1).



5. Remove the shift link (1) from the 3rd/4th shift fork (2).



6. Remove the interlocking plate (2) from the selector pin (1).

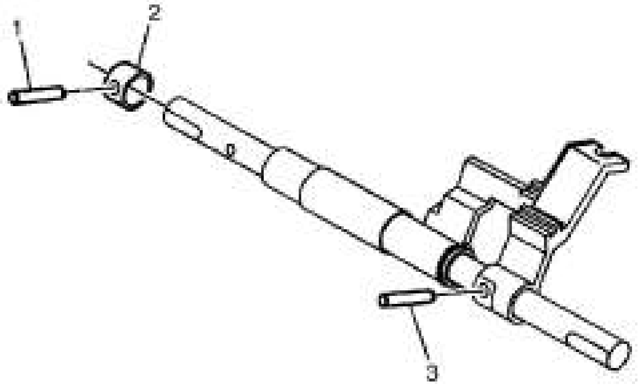


7. Remove the selector roll pin (5).
8. Remove the selector pin (3) from the shift shaft (1).

5th / 6th, Reverse Shift Rail Assembly

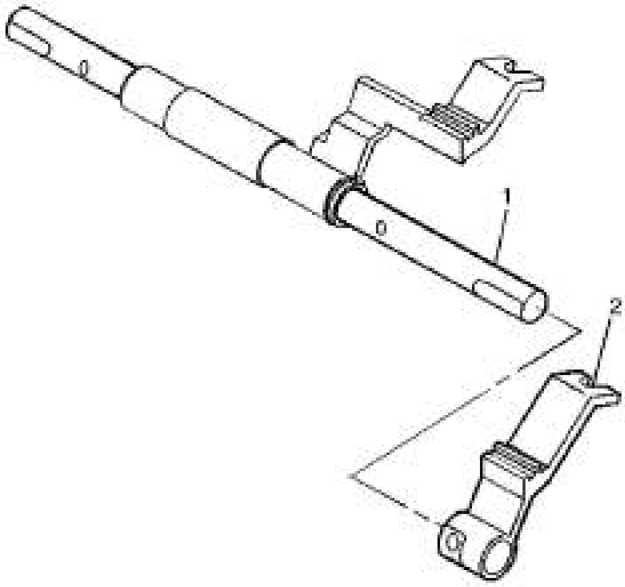
Tools Required

- J 23907 Slide Hammer.
- J 39439-2 Bushing Remover.

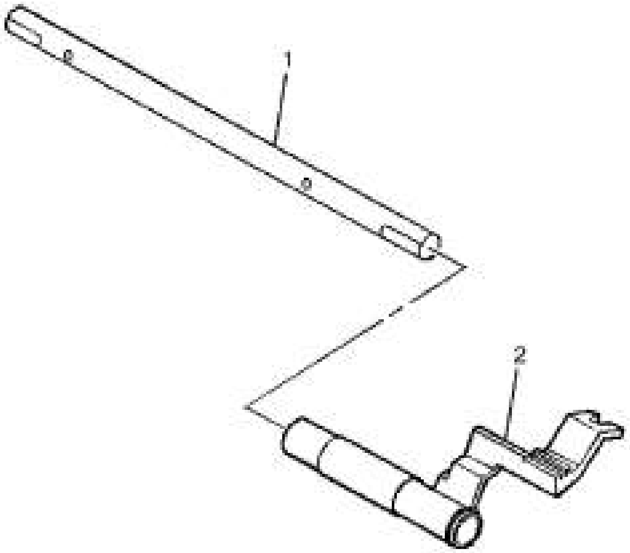


1. Remove the reverse collar roll pin (1).

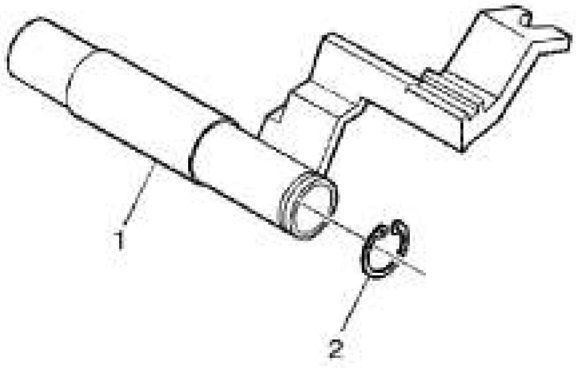
2. Remove the reverse collar (2).
3. Remove the reverse shift lever roll pin (3).



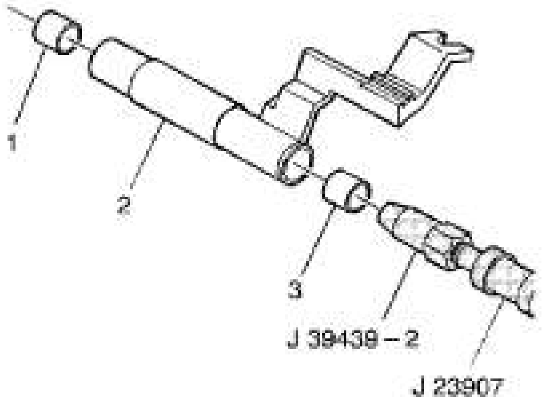
4. Remove the reverse shift lever (2) from the shift shaft (1).



5. Remove the 5th/6th shift lever (2) from the shift rail (1).



6. Remove the snap ring (1) from the 5th/6th shift lever (2).



Important: Do not replace the bushings unless inspection shows bushing damage.

7. Remove the 5th/6th shift shaft lever bushings (1) and (3) from the 5th/6th shift lever (2) using the J 23907 and the J 39439-2 .

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Manual Transmission - Tremec 6-Speed | Repair Instructions - Off Vehicle | **Document ID: 1977504**

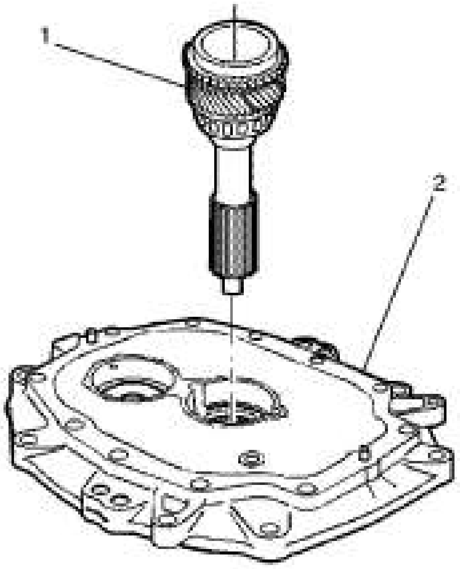
Shimming Procedures

Input Shaft, Mainshaft, and Countershaft

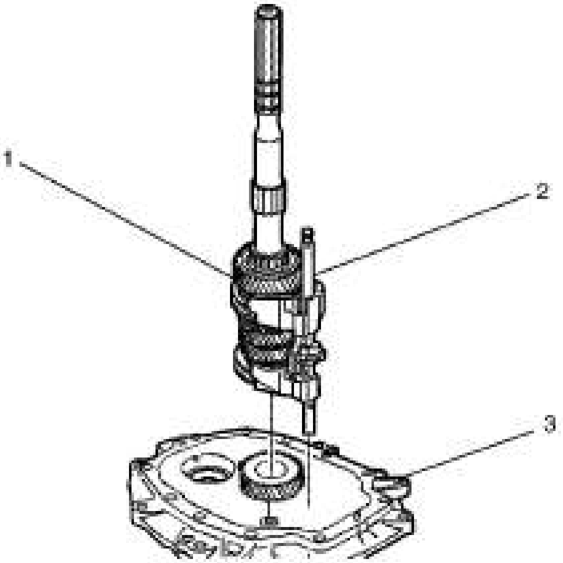
Tools Required

- J 8001 Dial Indicator Set
- J 39444-1 Countershaft End Play Rod

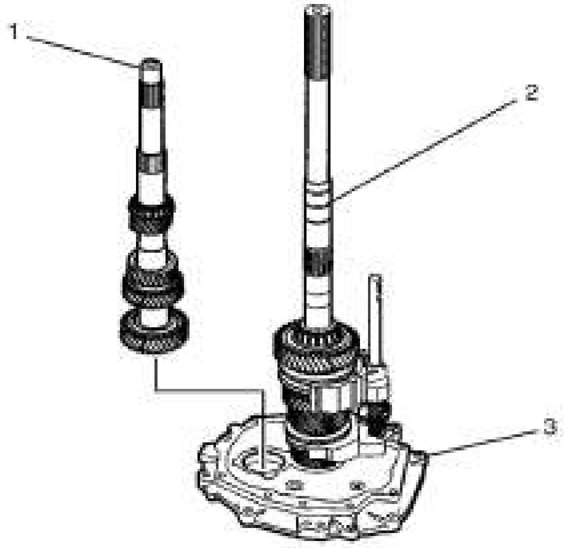
1. Lubricate all components as assembly progresses, using J 36850 .



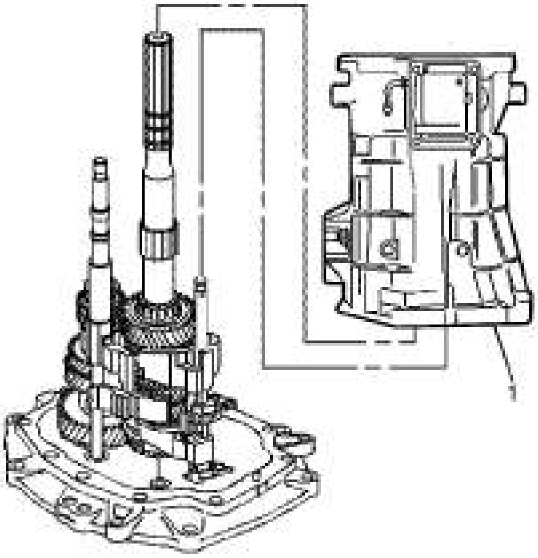
2. Install the input shaft (1) in the adapter plate (2).



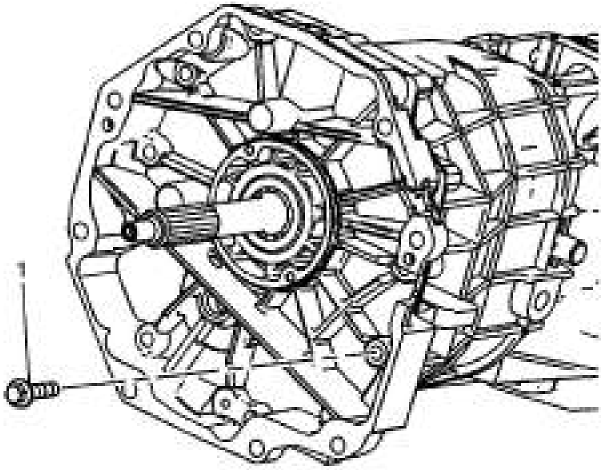
3. Assemble the shift shaft (2) to the mainshaft (1).
4. Install the neutral return roll pin (3) to the shift shaft (2).
5. Install the mainshaft (1) and the shift shaft (2) assembly into the adapter plate (3).



6. Install the countershaft assembly (1) to the adapter plate (3) using the following sequence:
   6.1. Lift up the mainshaft assembly (2) enough in order to install the countershaft assembly (1).
   6.2. Install the countershaft assembly (1).
   6.3. Lift the mainshaft assembly (2) enough in order to rotate the input shaft to engage the synchronizer keys with 4th gear blocking ring.

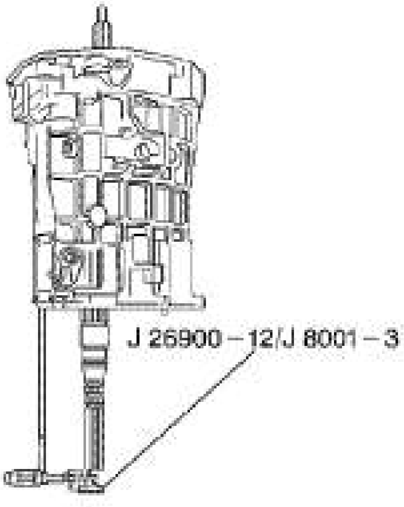


7. Install the transmission case (1).



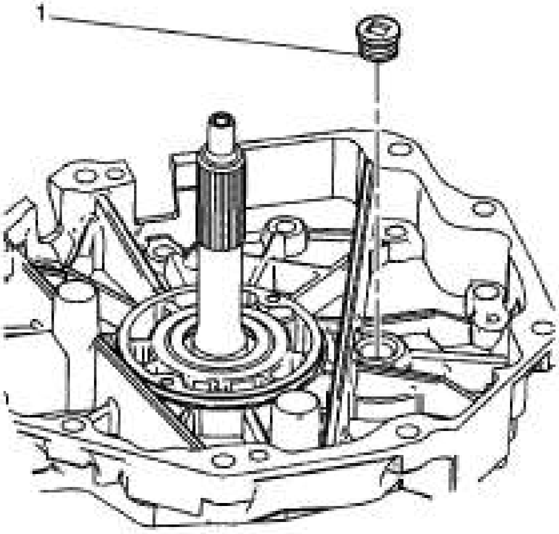
8. Install the adapter plate to transmission case bolts (1).

Tighten
Tighten the bolts to 48 N·m (36 lb ft).

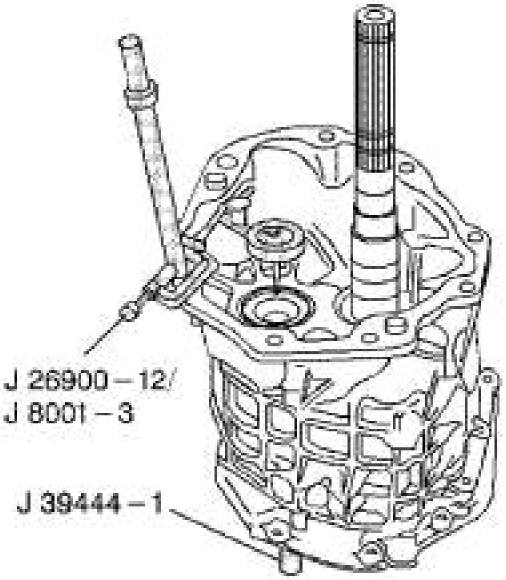


9. Measure the input shaft/mainshaft end play using the following procedure:
   - 9.1. Place the tip of the J 8001 on the end of the mainshaft.
   - 9.2. Move the input shaft up and down.
   - 9.3. Record the measurement.
10. Select a shim to achieve 0.00-0.05 mm (0.000-0.002 in) preload.

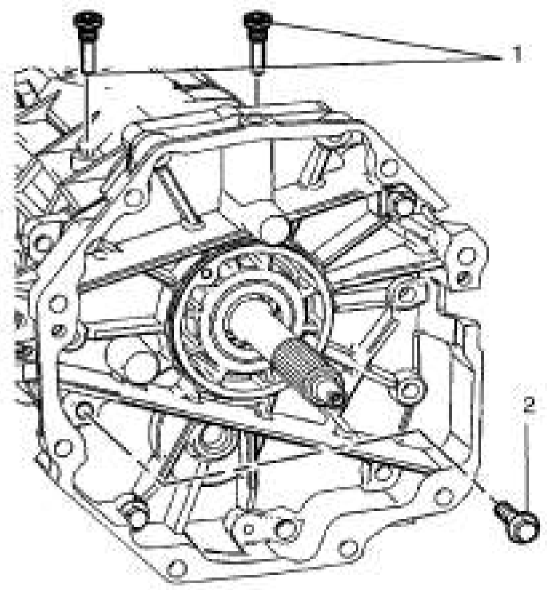
11. Remove the J 8001 .



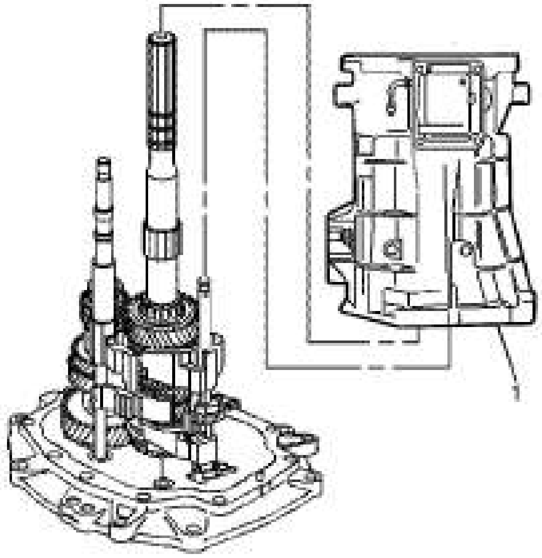
12. Remove the adapter plate plug (1).



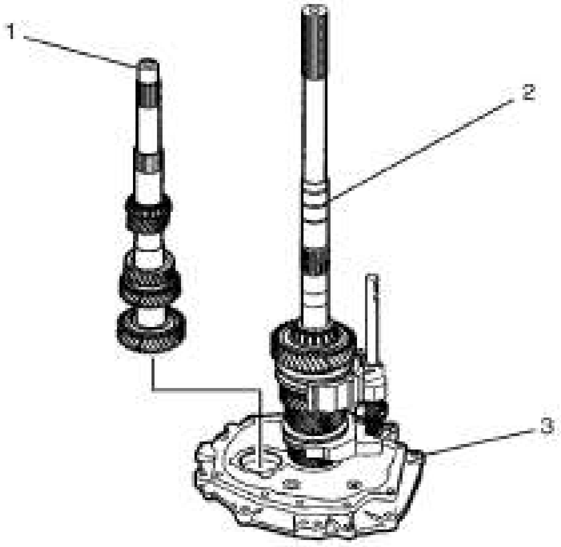
13. Place the tip of the J 8001 on the end of the countershaft.
14. Measure the countershaft end play using the following procedure:
    - 14.1. Install the J 39444-1 through the adapter plate plug hole. Screw the J 39444-1 into the countershaft.
    - 14.2. Move the countershaft up and down with the countershaft end play rod J 39444-1 .
    - 14.3. Record the measurement.
15. Select a shim to achieve 0.00-0.05 mm (0.000-0.002 in) preload.
16. Remove the J 8001 .
17. Remove the J 39444-1 .



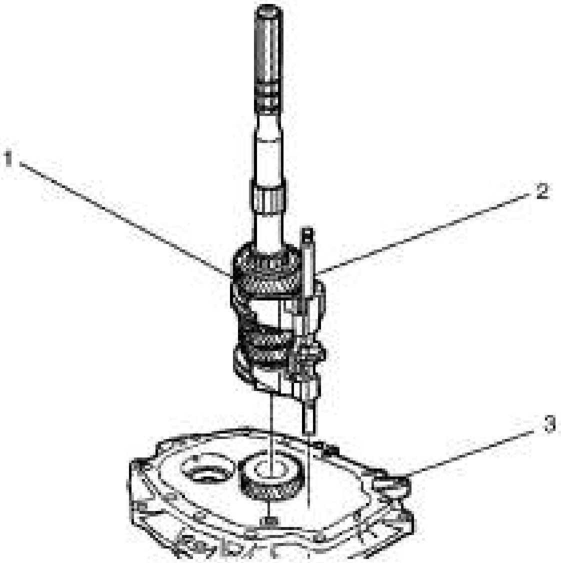
18. Remove the adapter plate to transmission case bolts (2).
19. Remove the shift lever guide bolts (1).



20. Remove the transmission case (1).



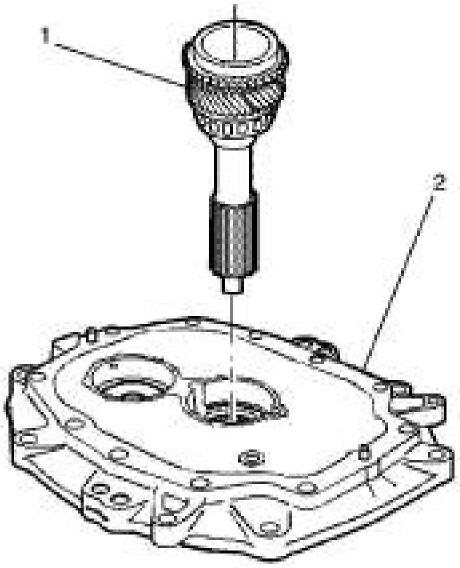
21. Remove the countershaft (1) from the adapter plate (3). Lift up the mainshaft (2) enough in order to remove the countershaft (1).



22. Remove the mainshaft and the shift shaft components as an assembly (1) from the adapter plate.

Important: When removing the shift shaft be careful not to lose the dowel pin.

23. Remove the shift shaft assembly from the mainshaft.



24. Remove the input shaft (1) from the adapter plate (2).

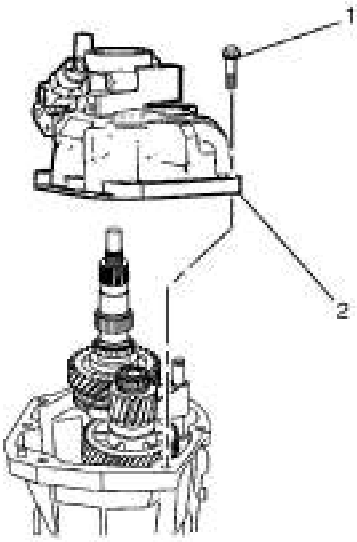
Countershaft

Tools Required

- J 8001 Dial Indicator Set
- J 39444-2 Countershaft End Play Rod

Important: The following procedure cannot be performed accurately until the countershaft shimming procedure has been completed.

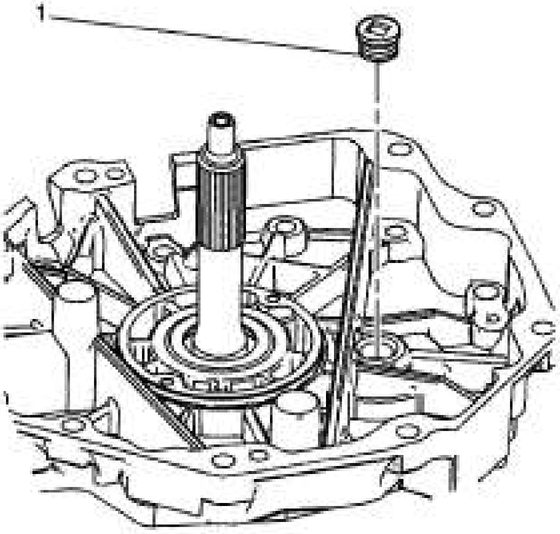
1. Rotate the transmission in the horizontal position.



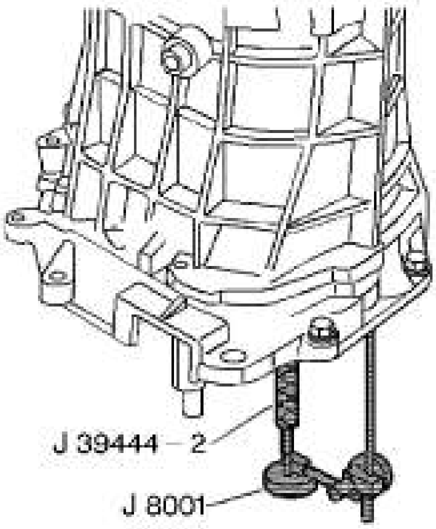
Important: Align the 5th/6th shift shaft to the extension housing bore in order to install the extension housing.

2. Install the extension housing (2).
3. Install the extension housing bolts (1).

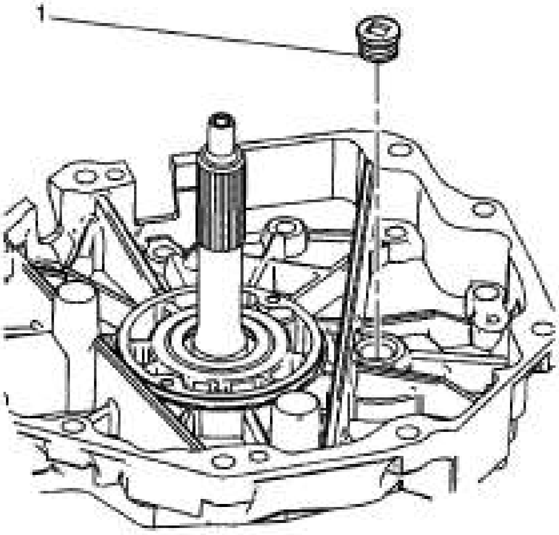
Tighten
Tighten the bolts to 48 N·m (36 lb ft).



4. Remove the adapter plate plug (1).



5. Measure the countershaft end play using the following procedure:
    5.1. Install a J 8001 so the tip is on the end of the countershaft end play rod.
    5.2. Rotate the transmission in the vertical position.
    5.3. Move the countershaft up and down using the J 39444-2 .
    5.4. Record the measurement.
6. Select a shim to achieve 0.05-0.13 mm (0.002-0.005 in) axial play.
7. Remove the J 8001 .
8. Remove the J 39444-2 .



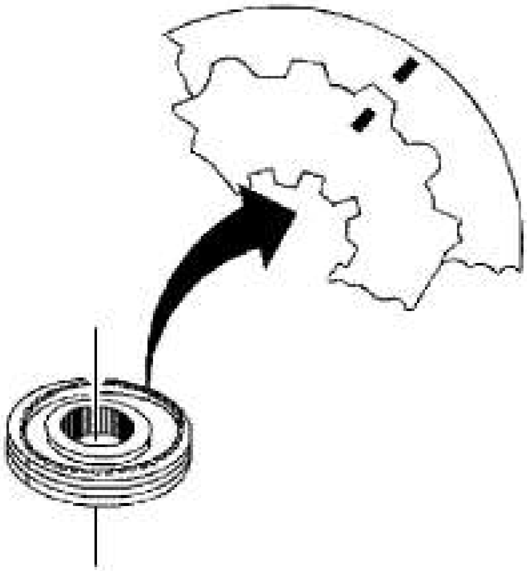
9. Install the adapter plate plug (1).

Tighten
Tighten the plug to 27 N·m (20 lb ft).

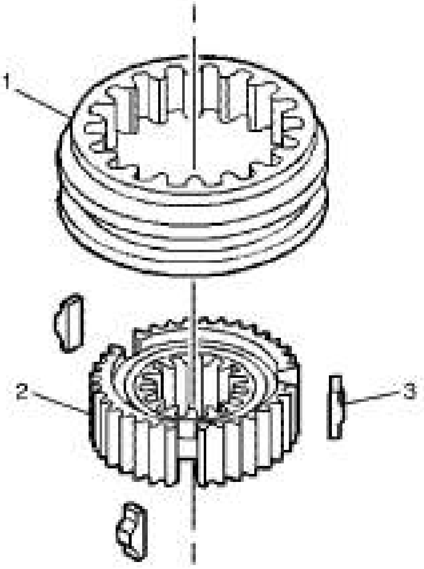
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Manual Transmission - Tremec 6-Speed | Repair Instructions - Off Vehicle | Document ID: 1996420

Synchronizers Assemble

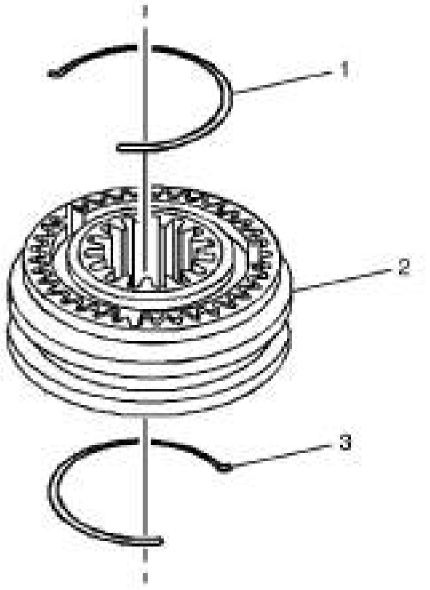
1st / 2nd Synchronizer



1. Check the synchronizer assembly scribe marks for correct positions.

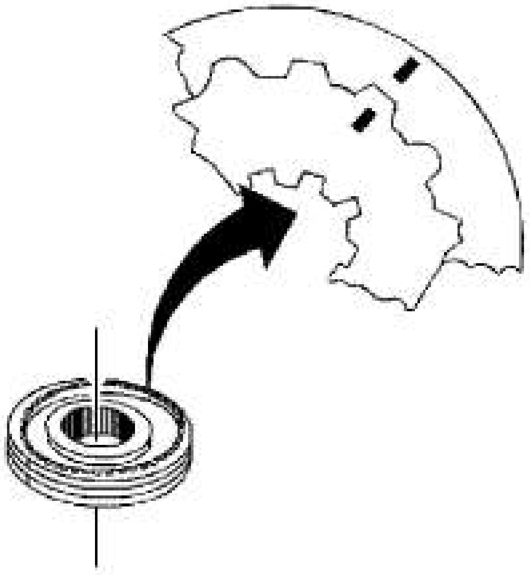


2. Install the synchronizer sleeve (1) to the hub (2) (align the key openings in the hub (2) with the cuts in the synchronizer sleeve (1)).
3. Install the keys (3) with the slots facing the hub (2).

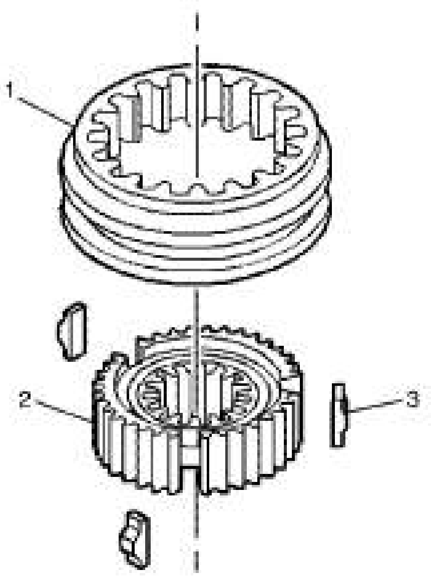


4. Assemble the first spring (1) (assemble the spring tang to one of the key slots in the synchronizer assembly (2)).
5. Assemble the second spring (3) (assemble the spring tang on the same key but in the opposite direction).

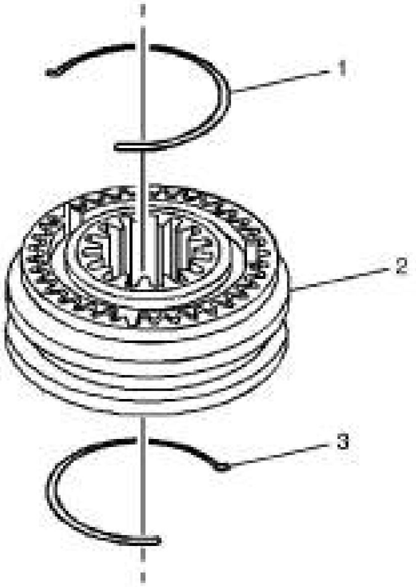
3rd / 4th, 5th / 6th Synchronizers



1. Check the synchronizer assembly scribe marks for correct positions.

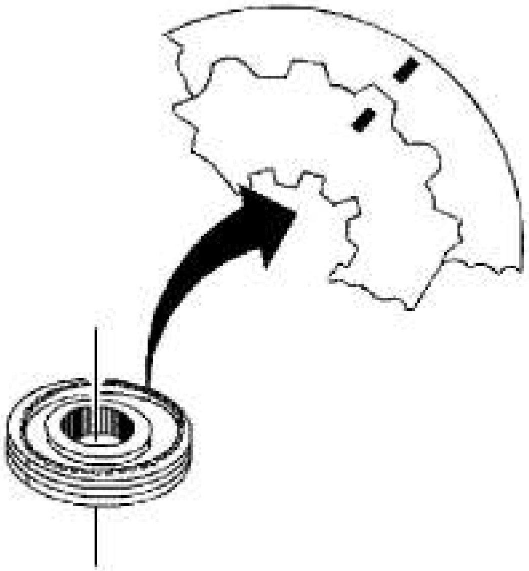


2. Install the synchronizer sleeve (1) to the hub (2) (align the key (3) openings in the hub (2) with the cuts in the synchronizer sleeve (1)).
3. Install the keys (3) with the slots facing the hub (2).

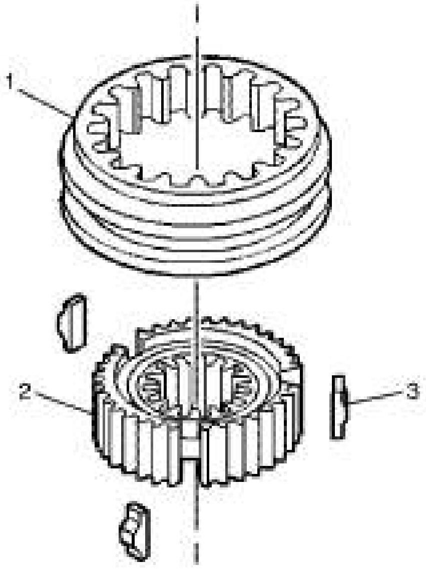


4. Assemble the first spring (1) (assemble the spring tang to one of the key slots in the synchronizer assembly (2)).
5. Assemble the second spring (3) (assemble the spring tang on the same key but in the opposite direction).

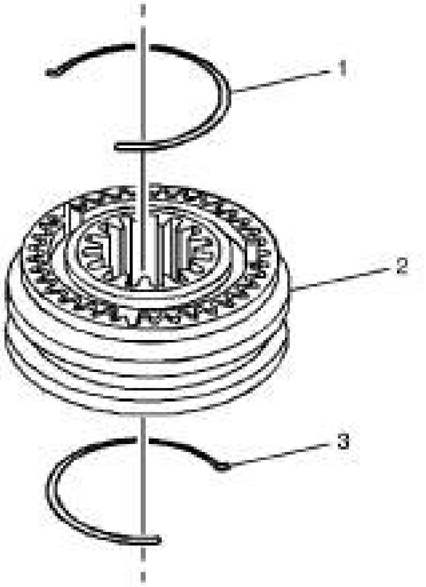
Reverse Synchronizer



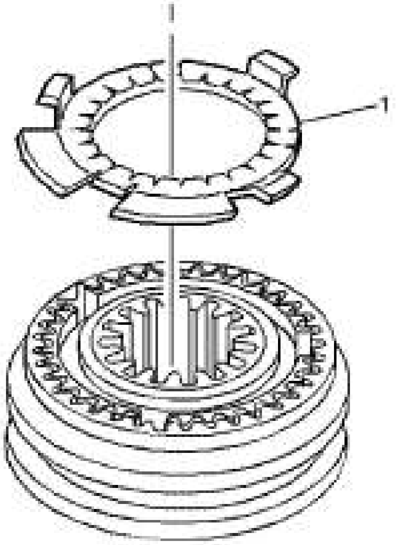
1. Check the synchronizer assembly scribe marks for correct positions.



2. Install the synchronizer sleeve (1) to the hub (2) (align the key (3) openings in the hub (2) with the cuts in the synchronizer sleeve (1)).
3. Install the keys (3) with the slots facing the hub (2).



4. Assemble the first spring (1) (assemble the spring tang to one of the key slots in the synchronizer assembly (2)).
5. Assemble the second spring (3) (assemble the spring tang on the same key but in the opposite direction).



6. Install a new synchronizer key retainer (1) with the key retainer tangs over the synchronizer keys.

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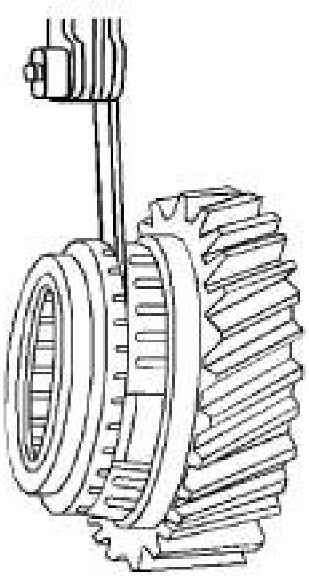
Synchronizers Cleaning and Inspection

1. Clean all the synchronizer parts in a suitable solvent. Air dry all the synchronizer parts.
2. Inspect the synchronizer parts for the following conditions:
   - Burrs
   - Cracks
   - Chamfer for excessive wear
   - Free movement of the clutching sleeves on their hubs
   - Worn or damaged clutch teeth
   - Distorted springs

   Important: Replace a burred or nicked part that cannot be reconditioned by hand.

3. Replace synchronizer parts that are worn or damaged.



4. Measure the gap between the vertical faces of the blocking ring teeth and the speed gear as follows:
   4.1. Assemble the correct blocking ring with the correct speed gear.
   4.2. The blocking ring must be fully seated on the gear.
   4.3. Use a feeler gauge to measure the forward gear gap.
   4.4. Use a feeler gauge to measure the reverse gear gap.

   Measure the gap without the wave washer in between the blocking ring and the reverse gear.

   The nominal gap is 1.27-2.16 mm (0.050-0.085 in) for the 1st and 2nd gear.

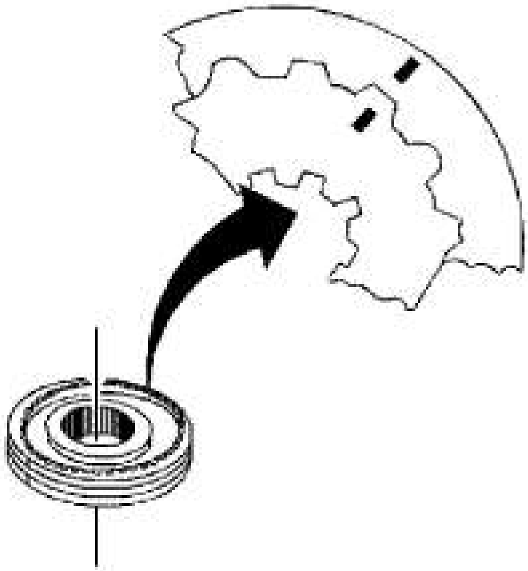
   The nominal gap is 1.27-2.03 mm (0.050-0.080 in) for the 3rd, 4th, 5th and 6th gear.

Replace the friction cones and blocker rings when the gap is significantly less than specified.

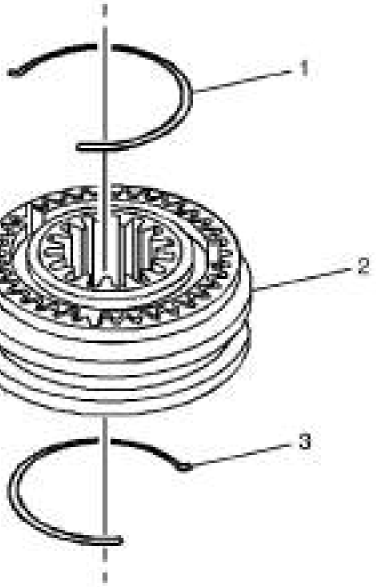
Synchronizers Disassemble

Caution: Refer to Safety Glasses Caution in the Preface section.

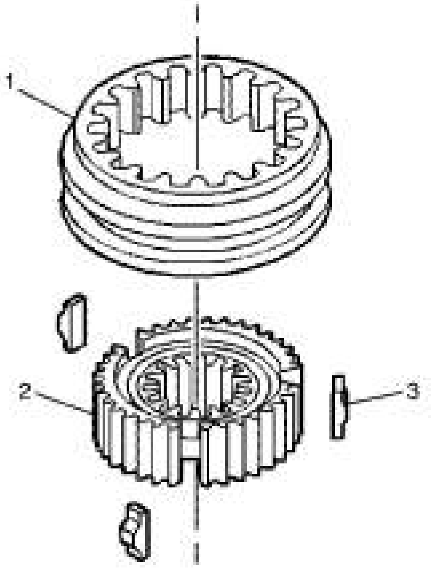
Important: Synchronizer components are not interchangeable. Keep all the synchronizer components separate. The synchronizer hubs and the sliding sleeves are a selected assembly. Keep the hubs and the sliding sleeves together as originally assembled.



1. Scribe a mark on the synchronizer hub and on the sleeve. This will help you to reinstall the parts in the same position.



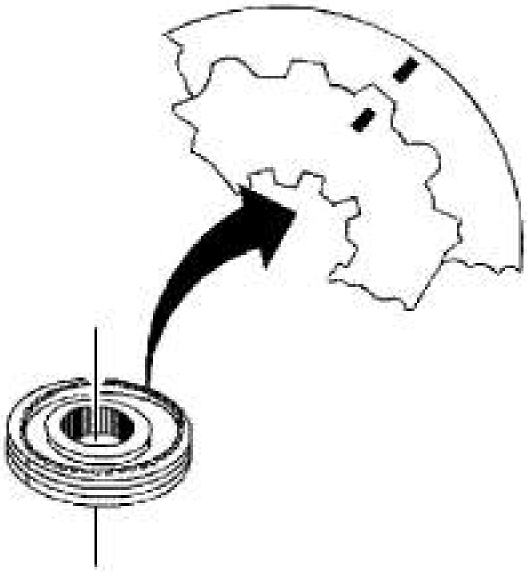
2. Remove the synchronizer retaining springs (1 and 3) from the synchronizer assembly (2) using a suitable tool.



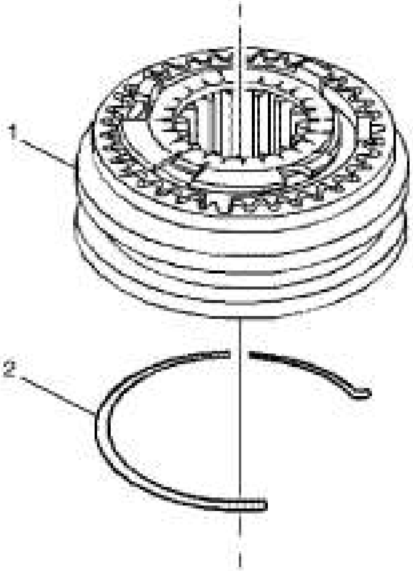
3. Remove the synchronizer sleeve (1) and the keys (3) from the hub (2) by pressing against the inner hub (2).

Reverse Synchronizer

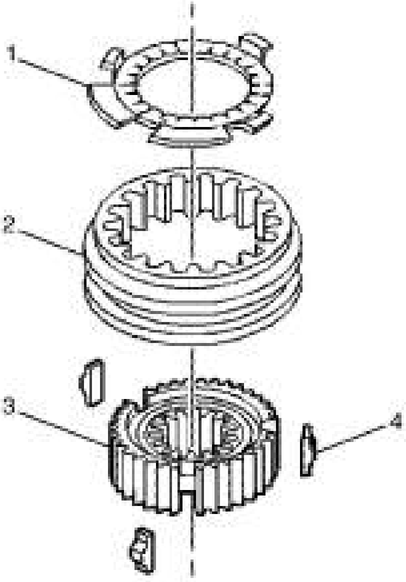
Caution: Refer to Safety Glasses Caution in the Preface section.



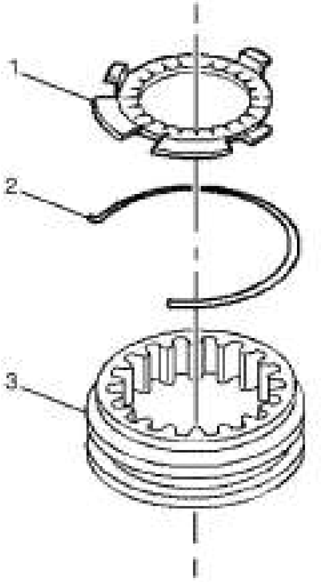
1. Scribe a mark on the synchronizer hub and on the sleeve. This will help you to reinstall the parts in the same position.



2. Remove the synchronizer retaining spring (2) from the synchronizer assembly (1) using a suitable tool.



3. Remove the synchronizer key retainer (1)
4. Remove the synchronizer sleeve (2) from the hub (3) by pressing against the inner hub (3).
5. Turn the hub (3) over. The keys (4) will slide out from the hub (3).



6. Remove the synchronizer key retainer (1) from the synchronizer sleeve (3).

   Discard the synchronizer key retainer.

7. Remove the synchronizer retaining spring (2) from the synchronizer sleeve (3).

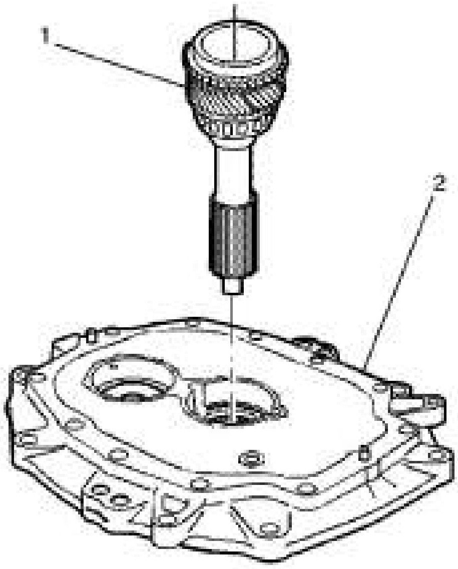
Transmission Assemble

Shift Shaft Assemblies and Gear Clusters Installation

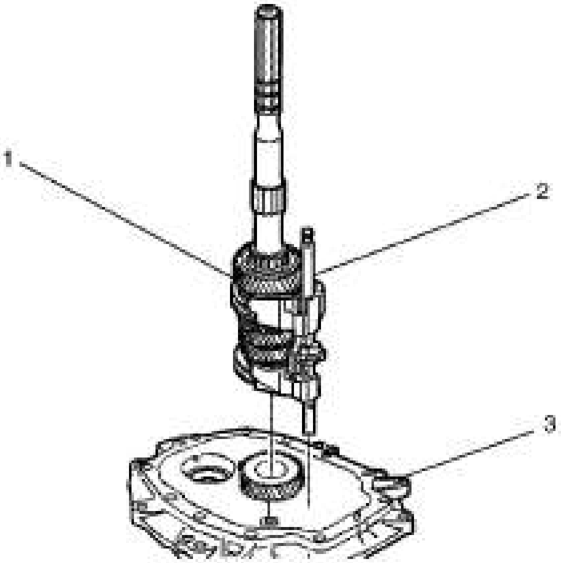
Tools Required

J 36850 Transjel® Assembly Lubricant.

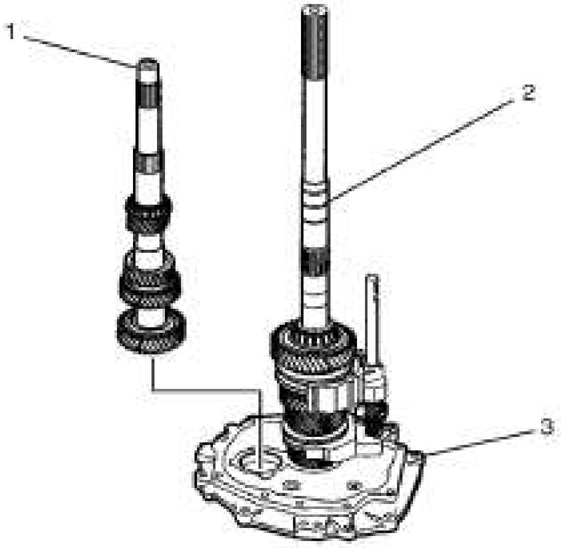
1. Lubricate all components as assembly progresses, using J 36850 .



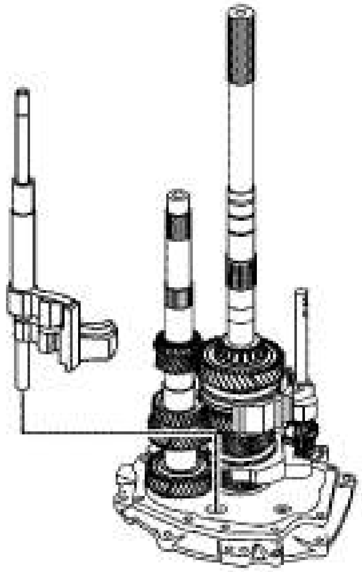
2. Install the input shaft (1) in the adapter plate (2).



3. Assemble the shift shaft (2) to the mainshaft (1).
4. Install the neutral return roll pin to the shift shaft (2).
5. Install the mainshaft (1) and the shift shaft (2) assembly into the adapter plate (3).



6. Install the countershaft assembly (1) to the adapter plate (3) using the following sequence:
    6.1. Lift up the mainshaft assembly (2) enough in order to install the countershaft assembly (1).
    6.2. Install the countershaft assembly (1).
    6.3. Lift the mainshaft assembly (2) enough in order to rotate the input shaft to engage the synchronizer keys with 4th gear blocking ring.

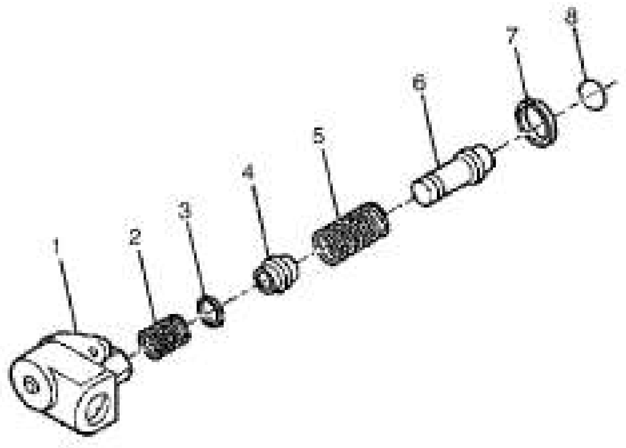


7. Install the 5th/6th and the reverse shift shaft (1).

   Align the slots of the shift shaft levers (2) with the interlock plate (3).

Reverse Lockout Assembly Assemble

Caution: Refer to General Repair Instructions in the Preface section.

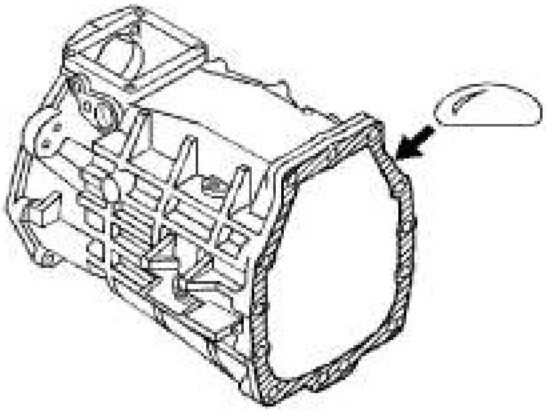


1. Install the reverse lockout outer spring (5) to reverse lockout plunger (6).
2. Install the reverse lockout collar (4) to reverse lockout plunger (6).
3. Compress the reverse lockout plunger and the collar (4) in a vise and install the retainer ring (3).
4. Install the reverse lockout inner spring (2 to reverse lockout body (1)).
5. Install the reverse lockout plunger assembly in the reverse lockout body (1).
6. Install the circlip (7) to reverse lockoutbody (1).
7. Install the O-ring (8) to reverse lockout body (1).

Transmission Case Installation

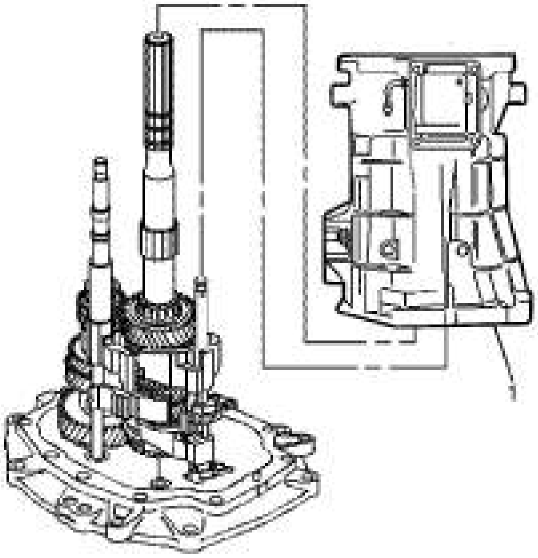
Tools Required

J 36850 .

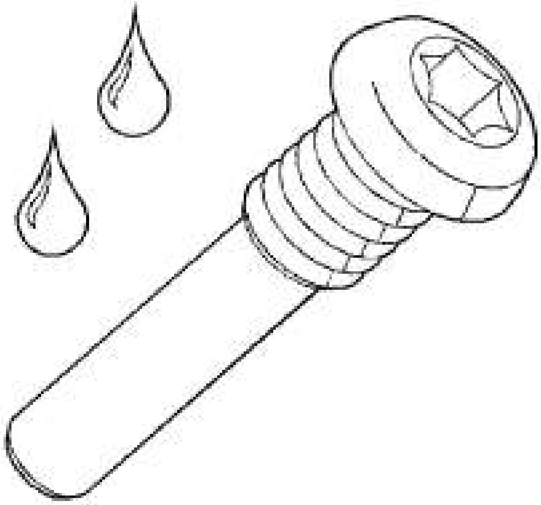


Important: Lubricate all components as the assembly progresses. Use J 36850 or the equivalent.

1. Apply LOCTITE™ "Ultrablack" 598 sealant or equivalent to the transmission case to adapter plate mating surface (1).

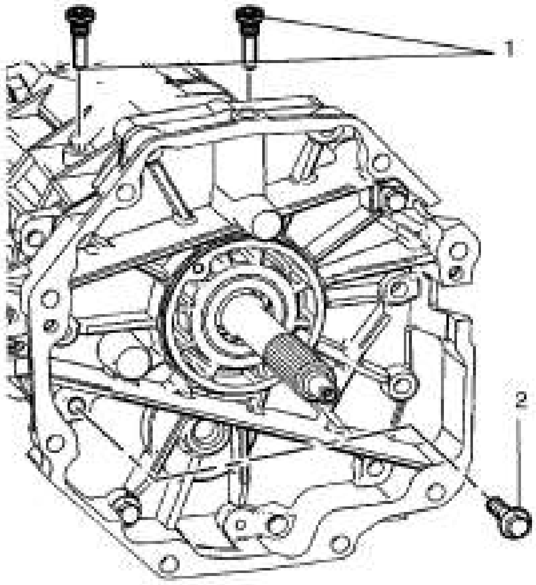


2. Do the following in order to install the transmission case and the offset lever:
    2.1. Shift the transmission into NEUTRAL in order to keep the 3rd/4th shift shaft from engaging.
    2.2. Install the offset lever.
    2.3. Slide the transmission case onto the gear clusters and the shift rail components.



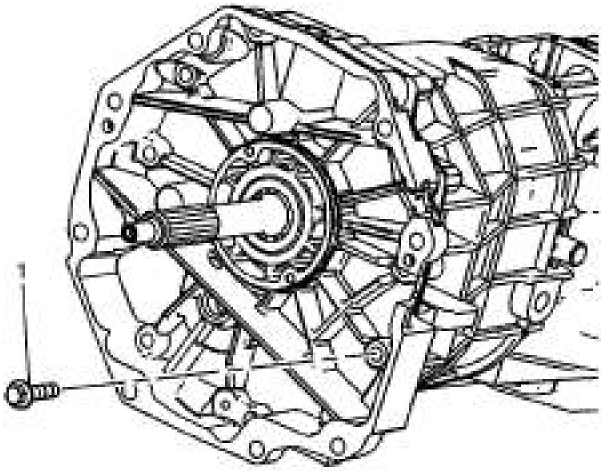
3. Apply thread sealer, LOCTITE™ 242 or equivalent to the threads of the shift lever guide bolts (1).

   Notice: Refer to Fastener Notice in the Preface section.



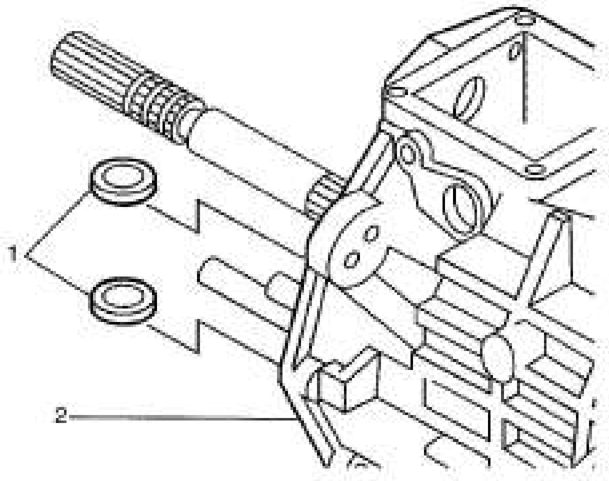
4. Install the shift lever guide bolts (1) and pull up on 5th/6th and reverse shift rail assembly. This will help align the slot of the shift interlock plate with the guide bolt hole.

   Tighten
   Tighten the bolts to 27 N·m (20 lb ft).

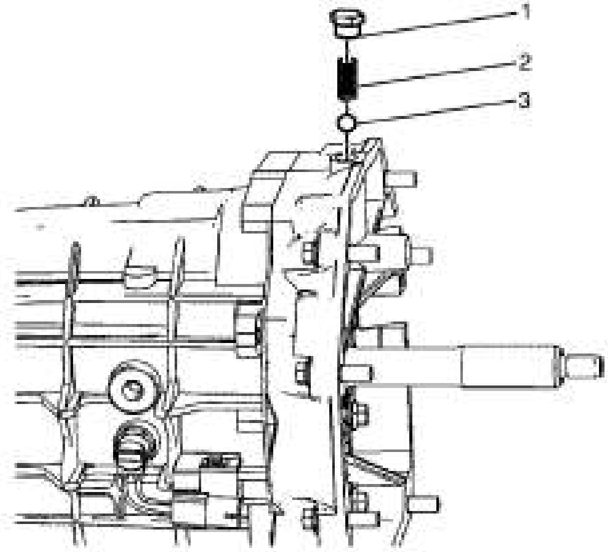


5. Install the adapter plate to transmission case bolts (1).

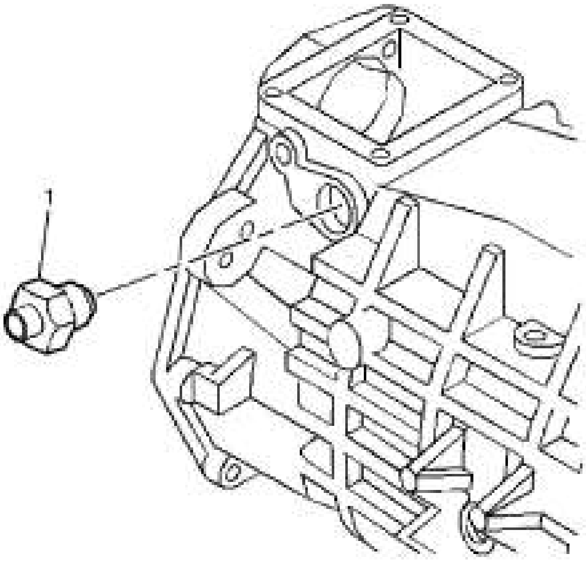
   Tighten
   Tighten the bolts to 48 N·m (36 lb ft).



6. Install the magnets (1) into the transmission case (2).



7. Install the shift detent plug (1), spring (2) and ball (3).



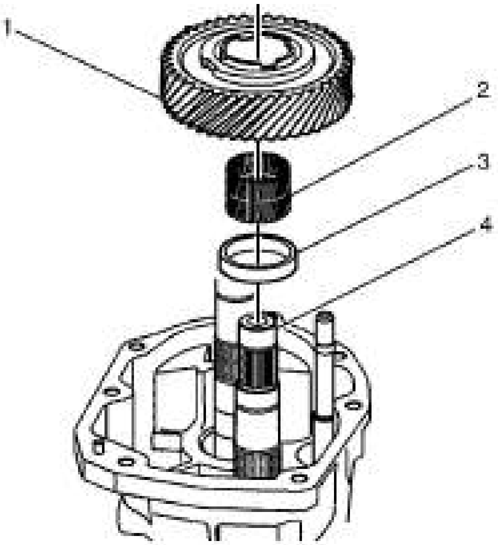
8. Install the shift detent assembly (1).

   Tighten
   Tighten the detent assembly to 40 N·m (30 lb ft).

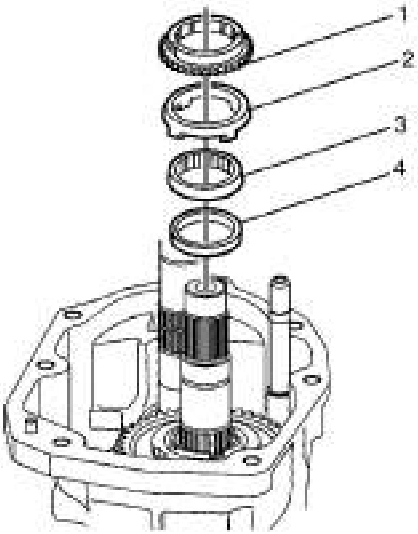
Countershaft Gear Installation

Tools Required

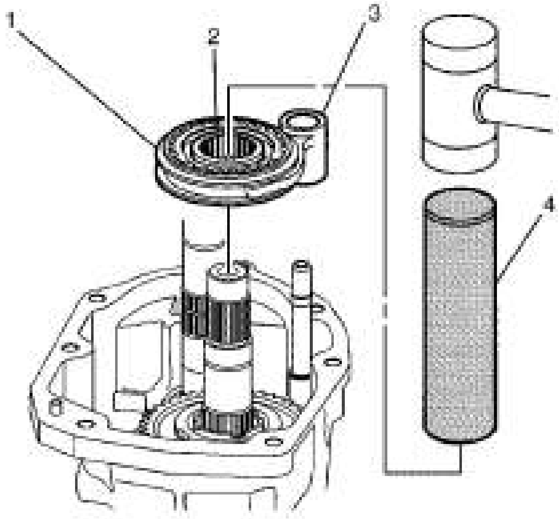
J 5590 Press Tube.



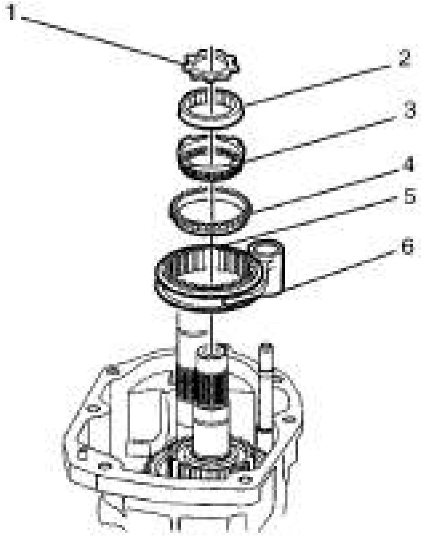
1. Install the spacer (3), caged needle bearing (2), and the 6th driven gear (1) to the countershaft (4).



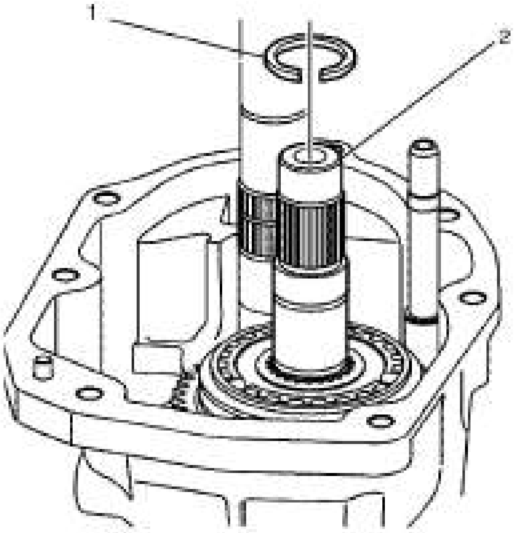
2. Install the 5th/6th speed drive gear thrust washer (4), speed drive gear inner cone (3), speed drive gear friction cone (2) and speed drive gear synchronizer blocking ring (1).



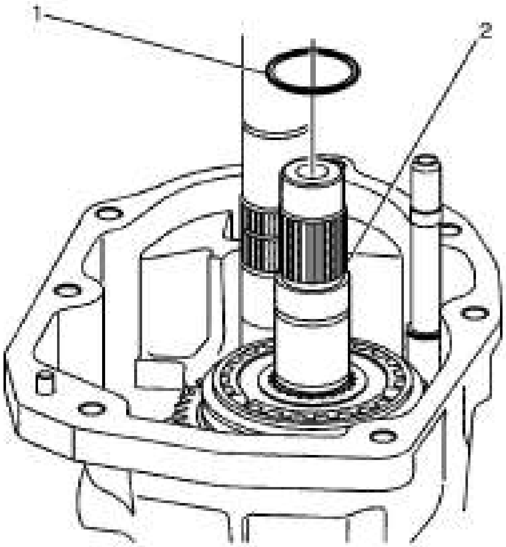
3. Install the 5th/6th shift fork (3), synchronizer sleeve (1) and synchronizer hub (2) assembly using J 5590 (4) and a mallet.



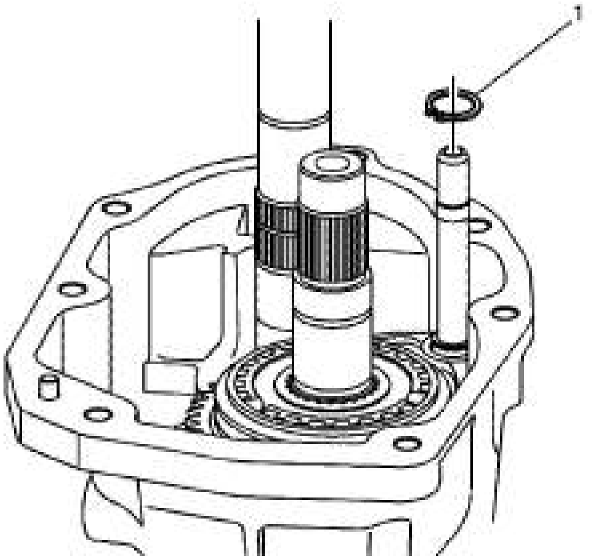
4. Install the speed drive gear synchronizer blocking ring (4), speed drive gear friction cone (3), speed drive gear inner cone (2) and speed drive gear thrust washer (1).



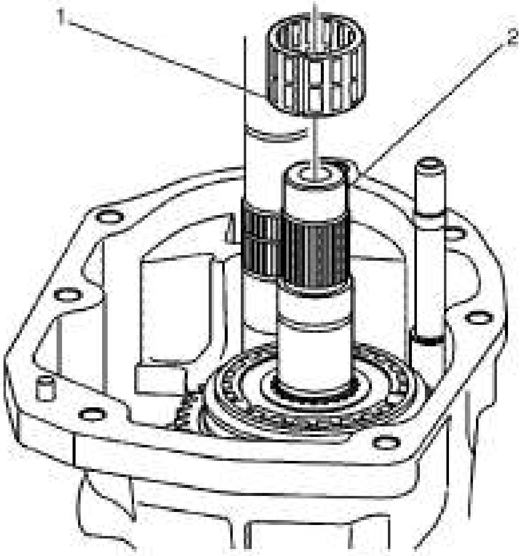
5. Install the retainer clip (1) to the countershaft (2).



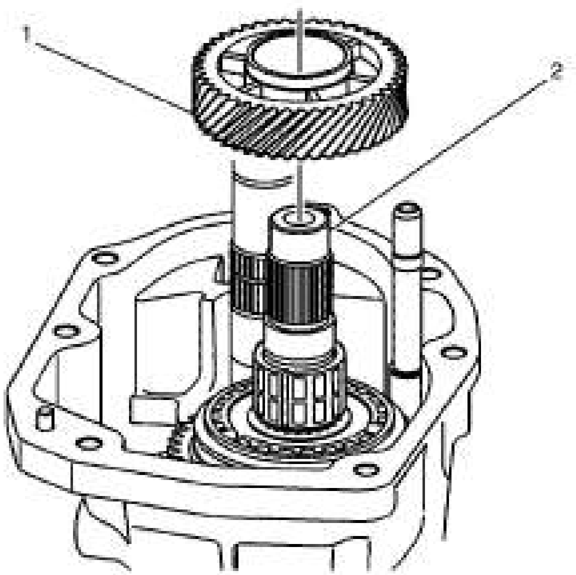
6. Install the spacer (1) to the countershaft (2).



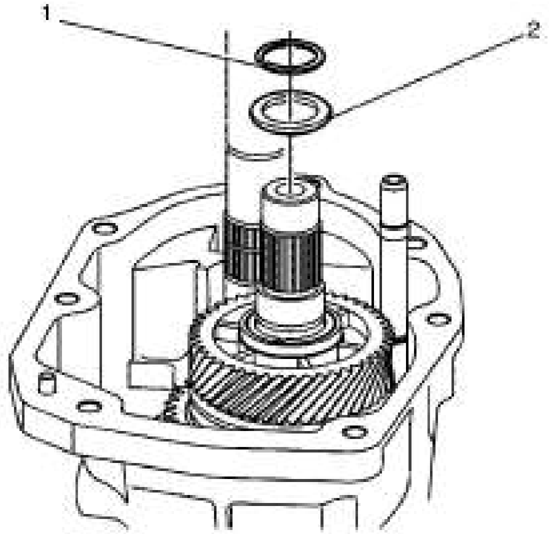
7. Install the 5th/6th speed shift fork retainer ring (1).



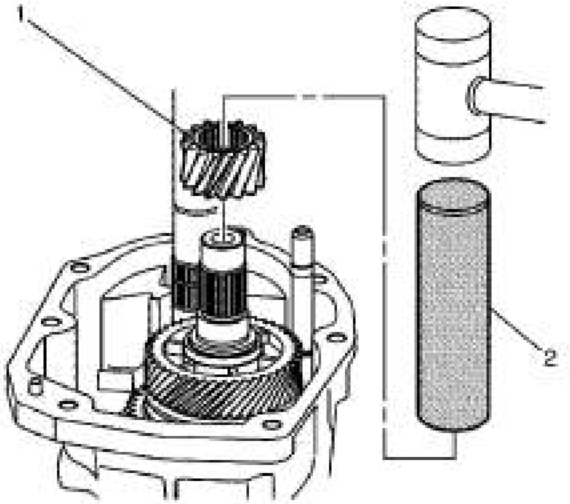
8. Install the needle bearing (1) to the countershaft (2).



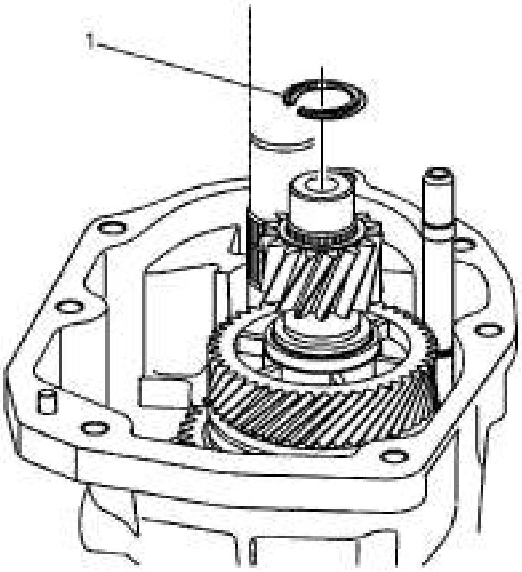
9. Install the 5th gear (1) to the countershaft (2).



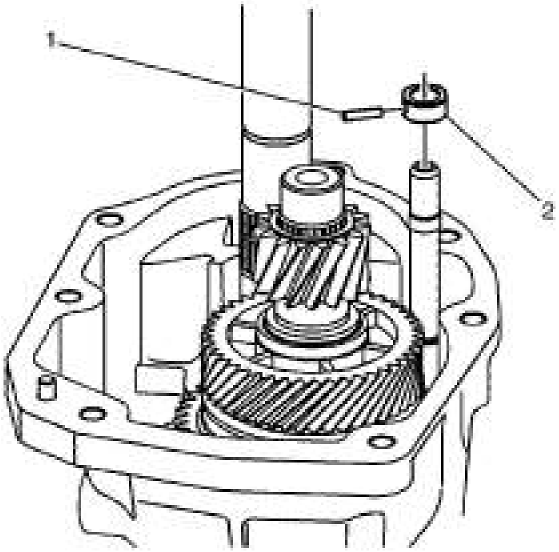
10. Install the spacer (2) and the countershaft retainer (1).



11. Install the countershaft gear (1) using J 5590 (2) and a mallet.



12. Install the countershaft retainer clip (1).

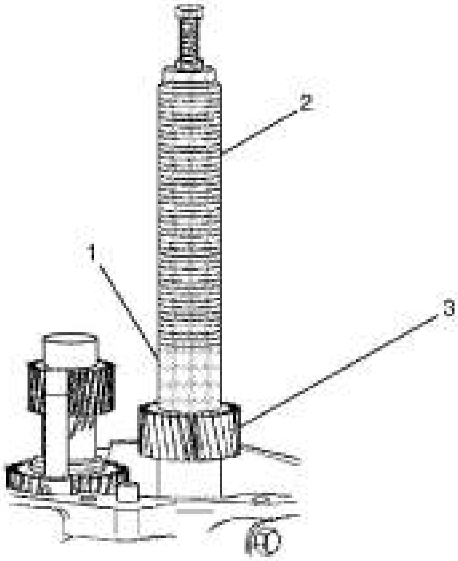


13. Install the collar (2) and the reverse shift shaft pin (1).

5th/6th Speed Driven Gear Installation

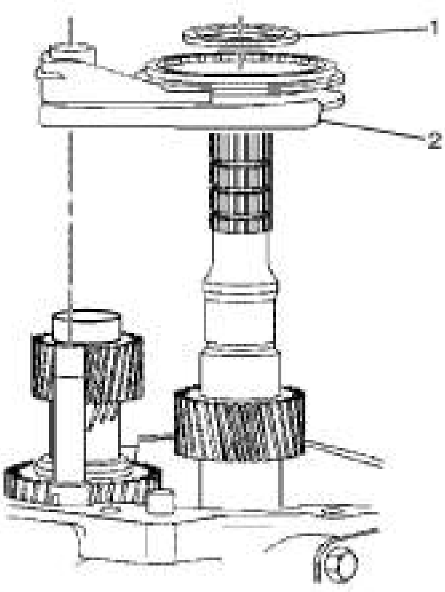
Tools Required

- J 39441 5th/6th Driven Gear Installer.
- J 39441-10 5th Gear Installer Adapter.

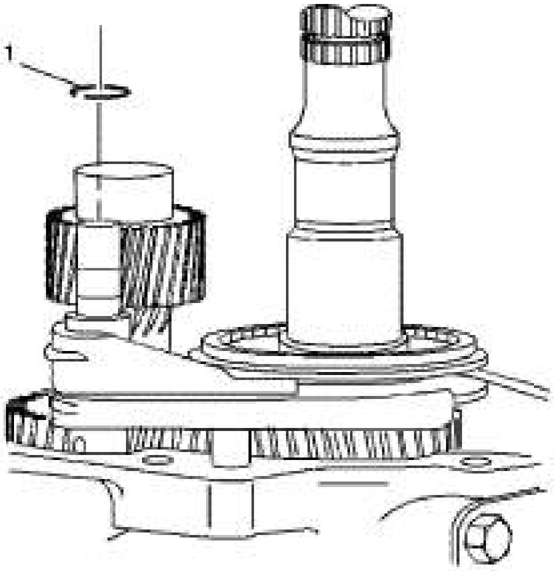


Install the 5th/6th speed driven gear (3) using the J 39441 (1) and J 39441-10 (2). The smaller outside diameter (OD) of the gear faces down.

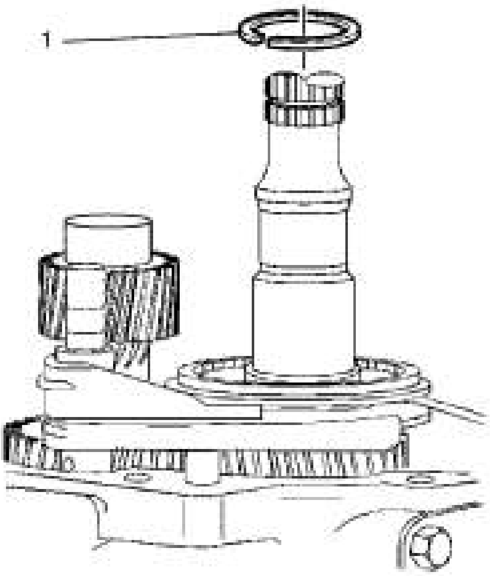
Reverse Shift Fork Installation



1. Install the reverse shift fork (3), the synchronizer (2) and the thrust washer (1).

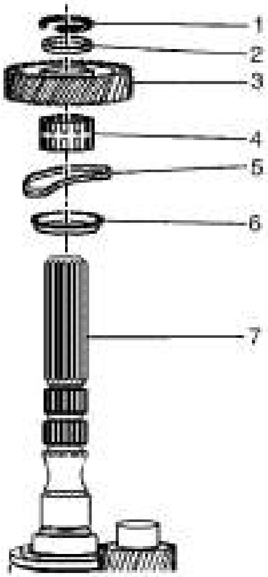


2. Install a new shift fork retainer ring (1).

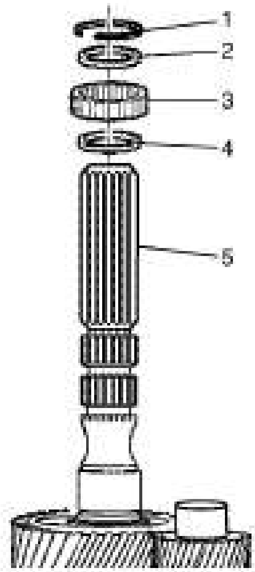


3. Install the reverse synchronizer retainer ring (1).

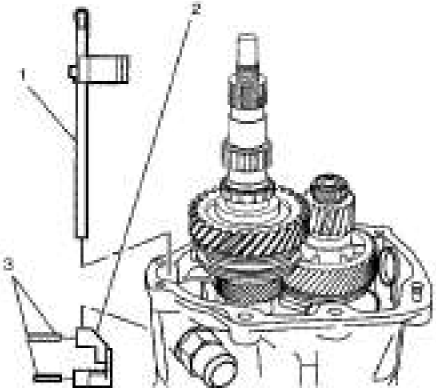
Reverse Speed Gear Installation



1. Install the reverse gear synchronizer blocking ring (6) to the mainshaft (7).
2. Install the wave washer (5) to the mainshaft (7).
3. Install the reverse gear caged needle bearing (4) to the mainshaft (7)
4. Install the reverse gear (3) to the mainshaft (7).
5. Install the reverse gear thrust washer (2) to the mainshaft (7).
6. Install the mainshaft snap ring (1) to the mainshaft (7).



7. Install the mainshaft spacer (4) to the mainshaft (5).
8. Install the mainshaft rear roller bearing (3) to the mainshaft (5).
9. Install the mainshaft spacer (2) to the mainshaft (5).
10. Install the mainshaft snap ring (1) to the mainshaft (5).

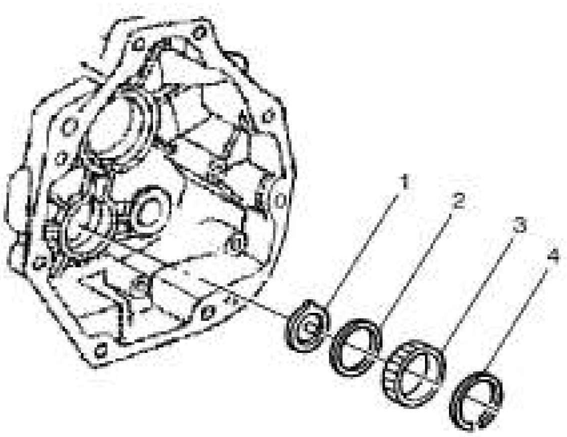


11. Install the shift shaft extension (1).
12. Install the shift guide (2).
13. Install NEW shift guide roll pins (3).

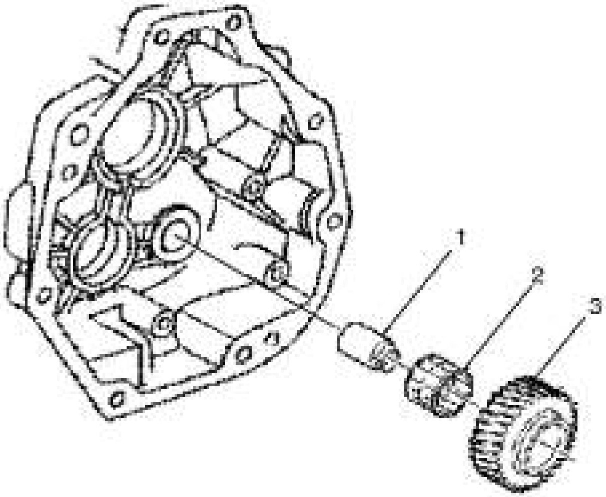
Extension Housing Assemble

Tools Required

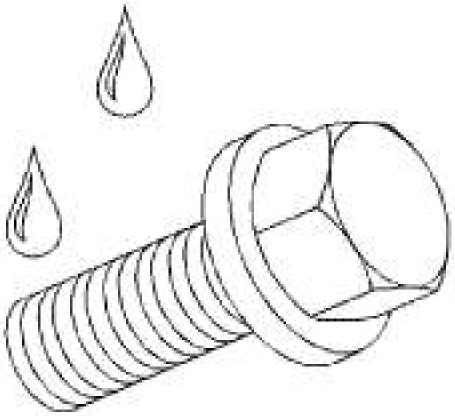
J 44395 Transmission Holding Fixture.



1. Install the countershaft oil funnel (1) to the extension housing.
2. Install the selective shims (2). Refer to Shimming Procedures .
3. Install the countershaft bearing race (3) to the extension housing.
4. Install the countershaft bearing race retaining circlip (4) to the extension housing.

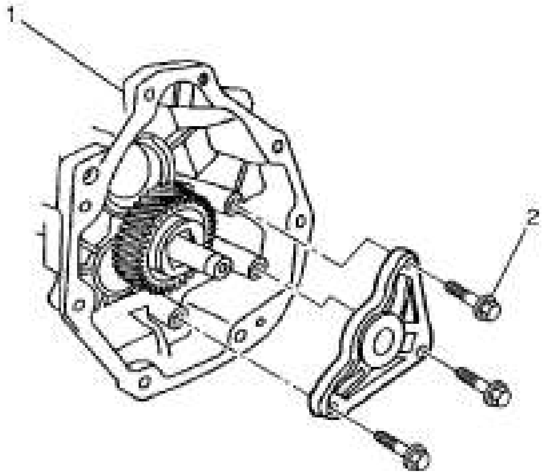


5. Install the reverse idler shaft (1) to the extension housing.
6. Install the roller bearing (2) to the reverse idler shaft.
7. Install the reverse idler gear (3) to the reverse idler shaft.



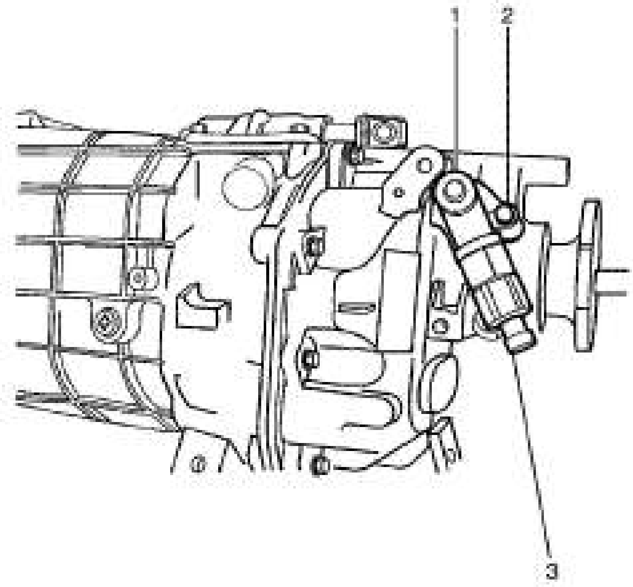
8. Apply thread sealer, LOCTITE™ 242 or equivalent to the reverse idler shaft brackets bolt threads.

Notice: Refer to Fastener Notice in the Preface section.



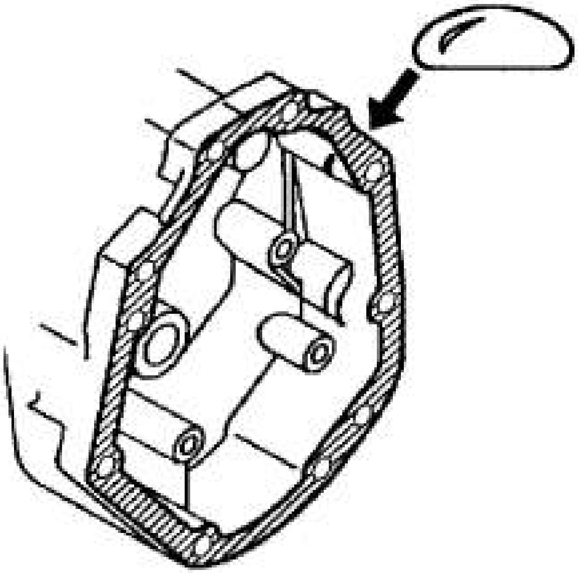
9. Install the reverse idler shaft bracket to the extension housing.
10. Apply an approved threadlock to the reverse idler shaft brackets bolt threads.
11. Install the reverse idler shaft bracket to extension housing retaining bolts.

Tighten
Tighten the bolts to 25 N·m (18 lb ft).

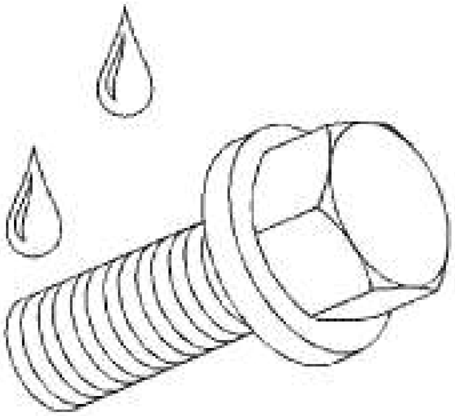


Important: DO NOT damage the reverse lockout solenoid electrical connector (3).

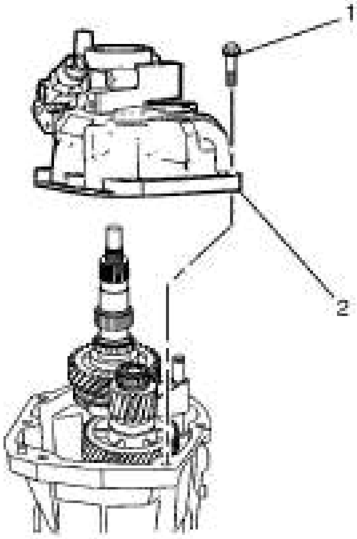
12. Install the reverse lockout solenoid (1) to the transmission extension housing.
13. Install the reverse lockout solenoid to transmission extension housing retaining screw (2).



14. Apply LOCTITE™ "Ultrablack" 598 sealant or equivalent to the extension housing to the transmission case mating surface (1).



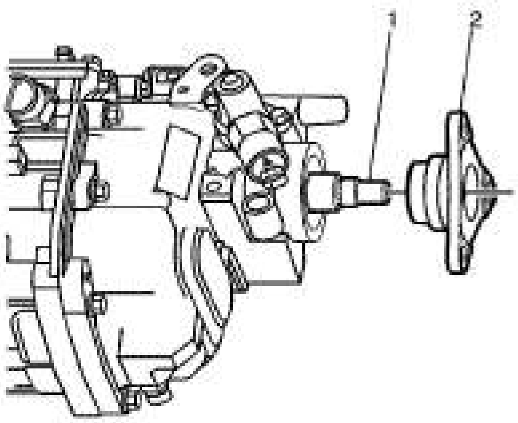
15. Apply thread sealer, LOCTITE™ 242 or equivalent to the top 2 extension housing bolts.



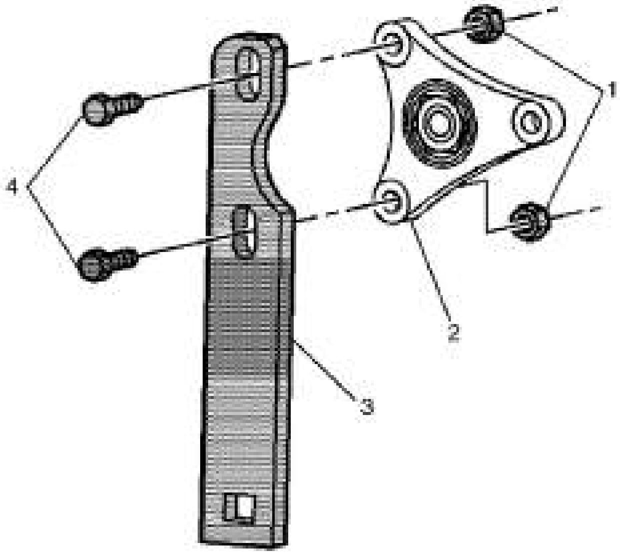
Important: Align the 5th/6th shift shaft to the extension housing bore in order to install the extension housing.

16. Install the extension housing (2).
17. Install the extension housing bolts (1).

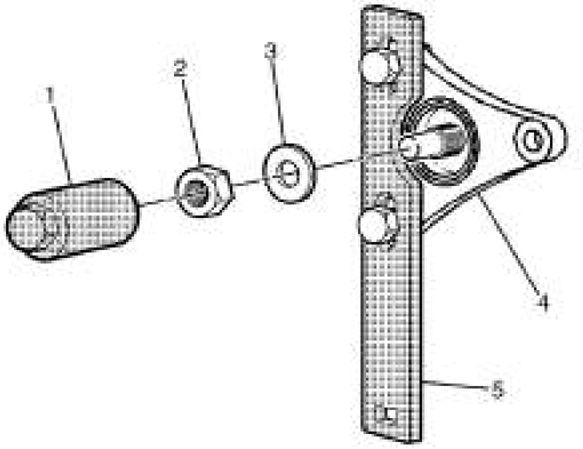
Tighten
Tighten the bolts to 48 N·m (36 lb ft).



18. Install the drive flange (2) to the transmission output shaft (1).



19. Install the J 45012 (3) to the drive flange (2).
20. Install the J 45012 to drive flange retaining bolts (4) and nuts (1) and tighten until firm.

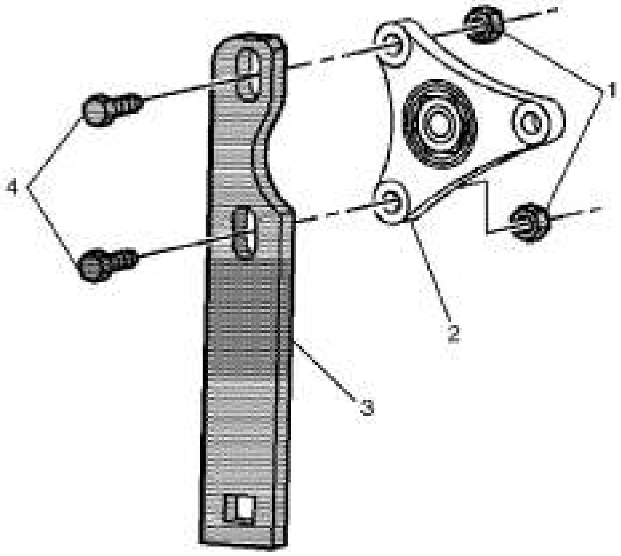


21. Install the drive flange thrust washer (3).

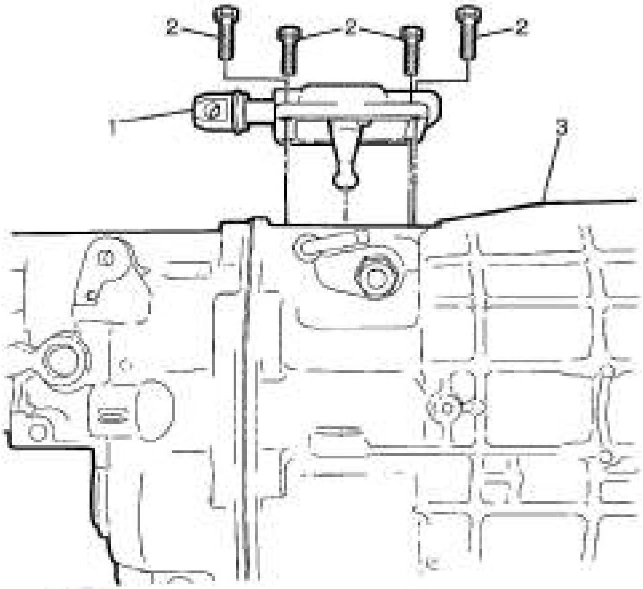
Notice: Refer to Fastener Notice in the Preface section.

22. While holding the J 45012 (5), install the NEW flange retaining nut (2) using the J 29873 (1) to the flange (4).

Tighten
Tighten the nut to 135 N·m (100 lb ft).

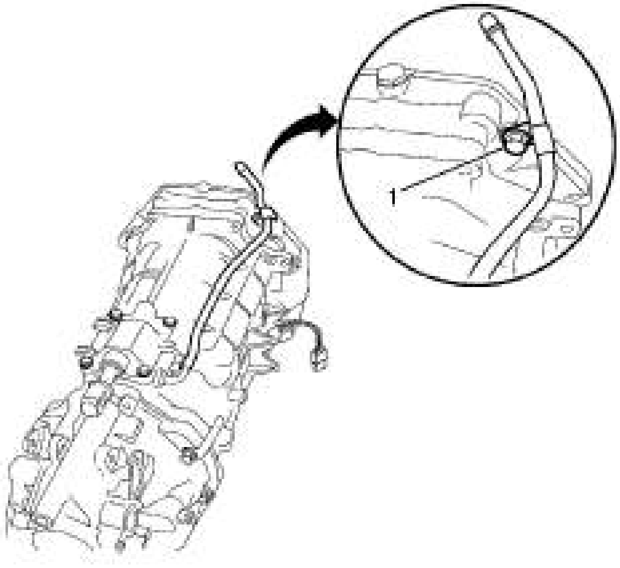


23. Remove the J 45012 to drive flange retaining bolts (4) and nuts (1).
24. Remove the J 45012 (3) from the drive flange (2).



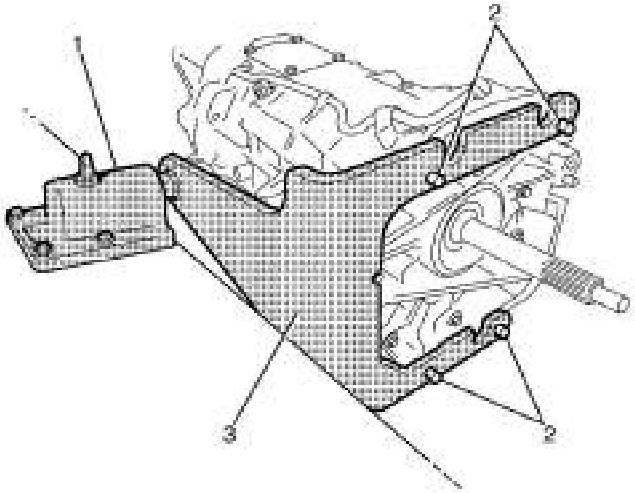
25. Install the shifter cover plate (1) to the transmission (3).
26. Install the shifter cover plate to transmission retaining bolts (2).
27. Install the transmission vent tube to the vent pipe.

Notice: Refer to Fastener Notice in the Preface section.

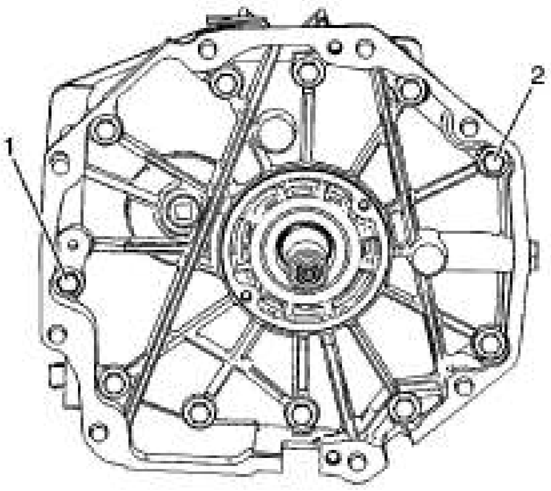


28. Install the transmission vent tube to transmission case retaining bolt (1).

Tighten
Tighten the transmission vent tube retaining bolt to 48 N·m (35 lb ft).



29. Remove the J 44395 .



30. Install the remaining 2 adapter plate bolts (1) and (2).

Tighten
Tighten the adapter plate bolts to 48 N·m (36 lb ft).

31. Install the concentric actuator from the transmission. Refer to Clutch Concentric Actuator Cylinder Replacement .

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Manual Transmission - Tremec 6-Speed | Repair Instructions - Off Vehicle | **Document ID: 1992886**

Transmission Disassemble

Extension Housing Removal

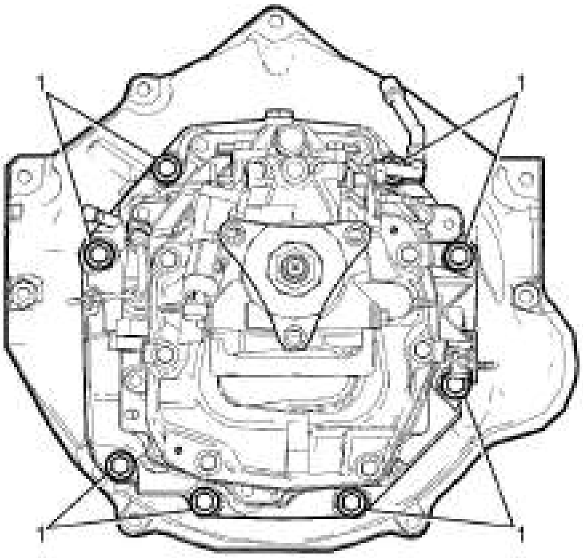
Tools Required

- J 3289-20 Holding Fixture
- J 44395 Transmission Holding Fixture

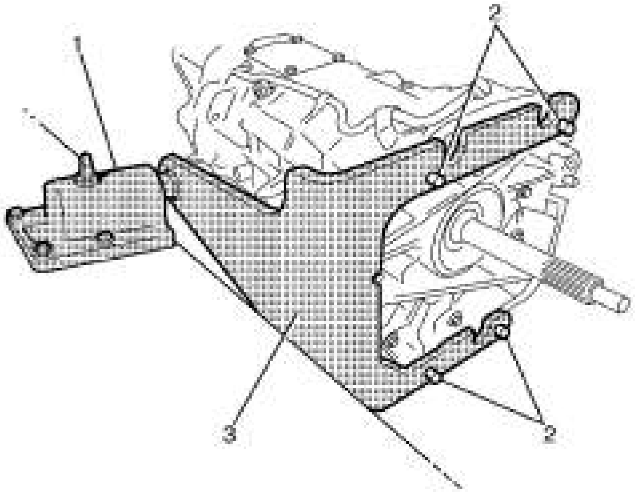
Caution: Refer to Vehicle Lifting Caution in the Preface section.

Caution: Refer to Safety Glasses Caution in the Preface section.

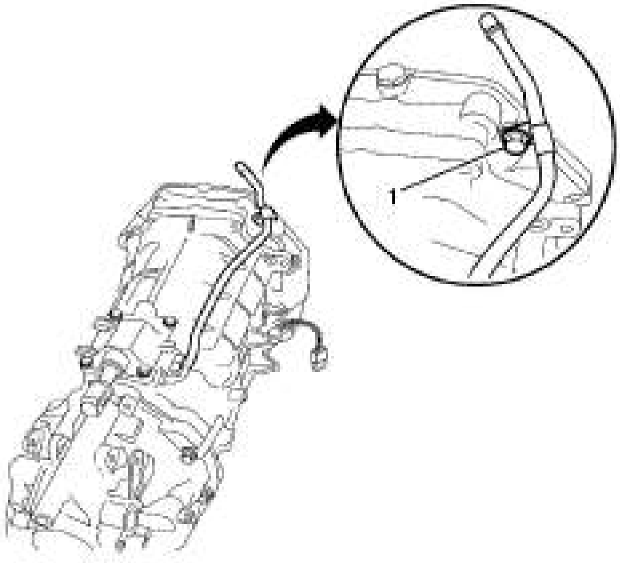
1. Remove the transmission from the vehicle. Refer to Transmission Replacement .
2. Remove the concentric actuator from the transmission. Refer to Clutch Concentric Actuator Cylinder Replacement .



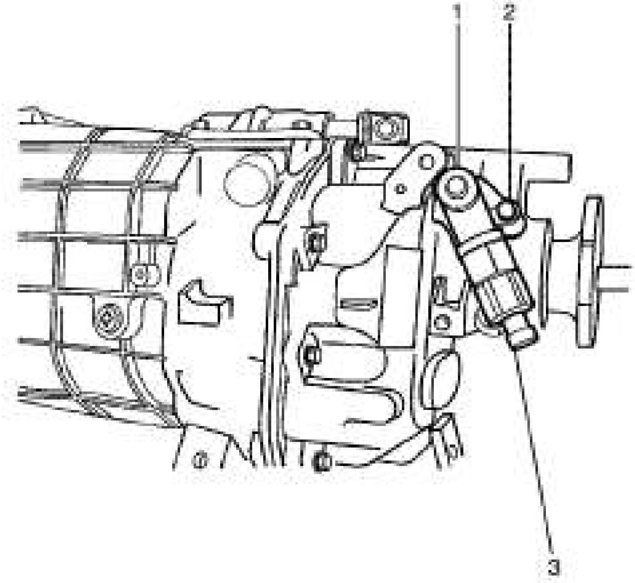
3. Remove the clutch housing to transmission retaining bolts (1).
4. Remove the clutch housing from the transmission.



5. Install the J 44395 (3).
6. Install the J 44395 to transmission retaining bolts (2) and tighten until firm.
7. Mount the transmission on a workbench using the J 3289-20 (1).
8. Rotate the transmission into a horizontal position.
9. Remove the transmission drain plug and drain the transmission fluid.
10. Shift the transmission into NEUTRAL (N).



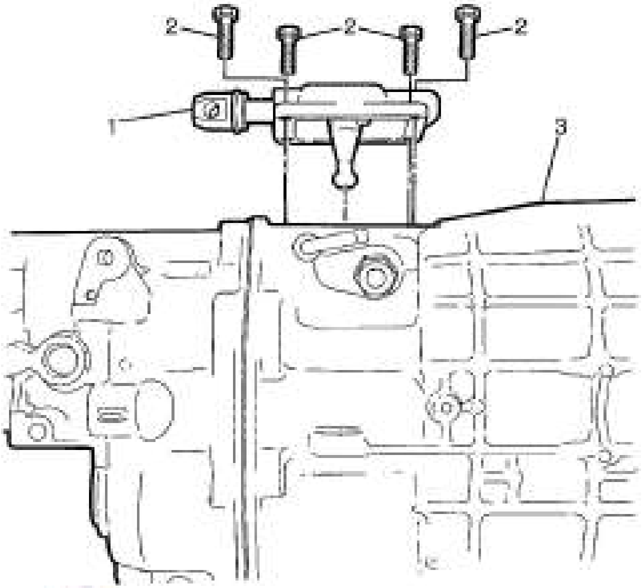
11. Remove the transmission vent tube to transmission case retaining bolt (1).
12. Remove the transmission vent tube from the vent pipe.



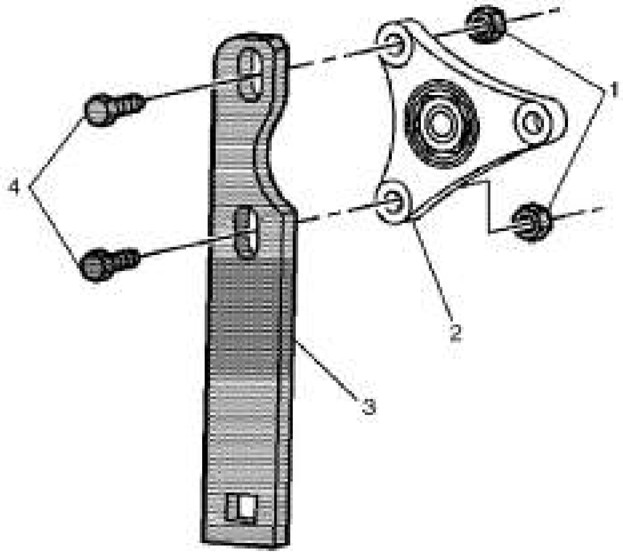
13. Disconnect the reverse lockout solenoid electrical connector (3).

    Important: DO NOT damage the reverse lockout solenoid electrical connector (3).

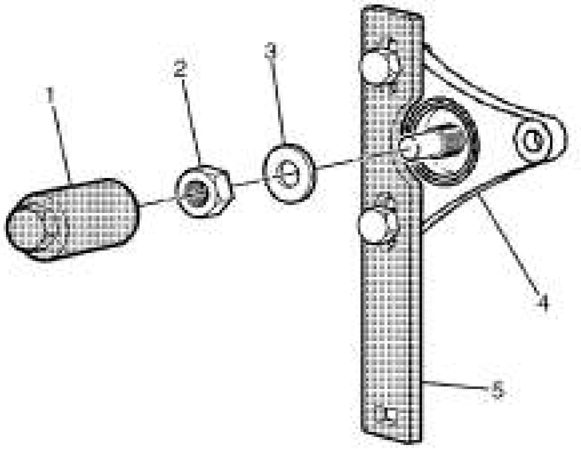
14. Remove the reverse lockout solenoid to transmission extension housing retaining screw (2).
15. Remove the reverse lockout solenoid (1) from the transmission extension housing.



16. Remove the shifter cover plate to transmission retaining bolts (2).
17. Remove the shifter cover plate (1) from the transmission (3).



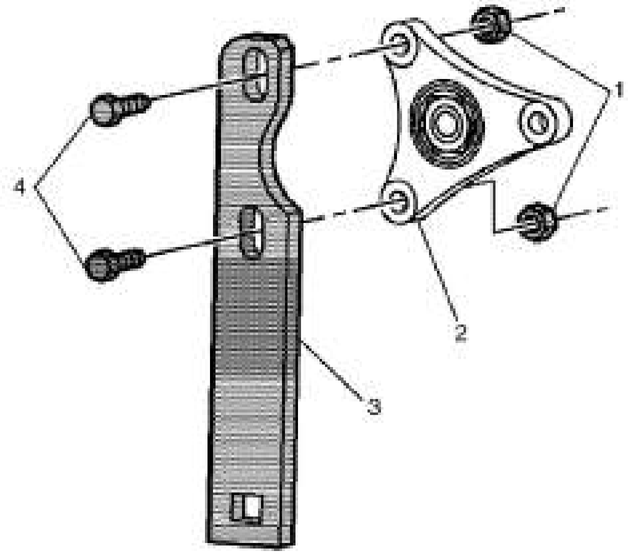
18. Install the J 45012 (3) to the drive flange (2).
19. Install the J 45012 to drive flange retaining bolts (4) and nuts (1) and tighten until firm.



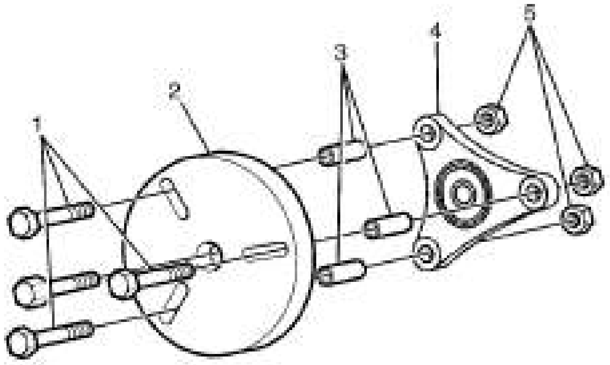
20. While holding the J 45012 (5), remove the flange retaining nut (2) using the J 29873 (1) from the flange (4).

    Discard the nut.

21. Remove the drive flange thrust washer (3).



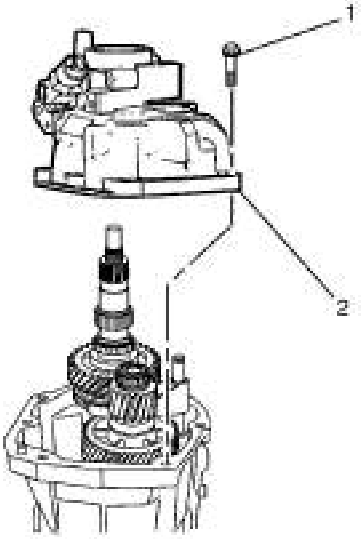
22. Remove the J 45012 to drive flange retaining bolts (4) and nuts (1).
23. Remove the J 45012 (3) from the drive flange (2).



24. Install the J 45019 (2) to the drive flange (4).

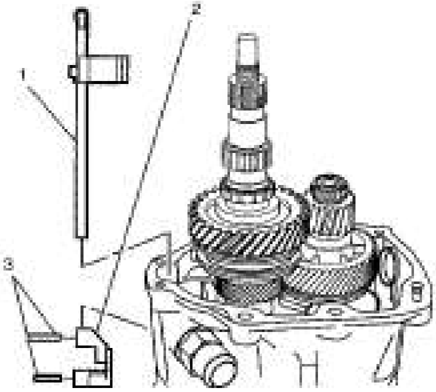
    Remove the drive flange (1) using the J 45019 J 45019 (2).

25. Install the J 45019 to drive flange retaining bolts (1), spacers (3) and nuts (5) and tighten until firm.
26. Remove the drive flange (4) using the J 45019 J 45019 (2).

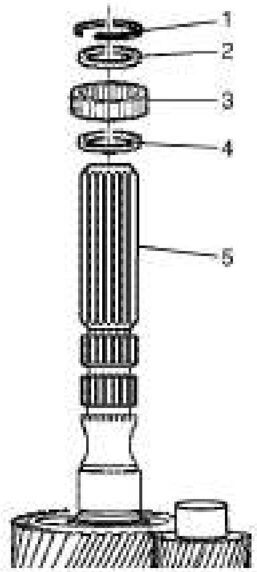


27. Remove the rear extension housing to transmission case retaining bolts (1).
28. Remove the rear extension housing (2).

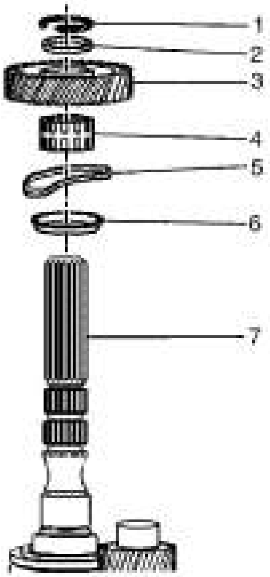
Reverse Speed Gear Removal



1. Roll the shift guide rollpins (3).
2. Remove the shift guide (2).
3. Remove the shift shaft extension (1).

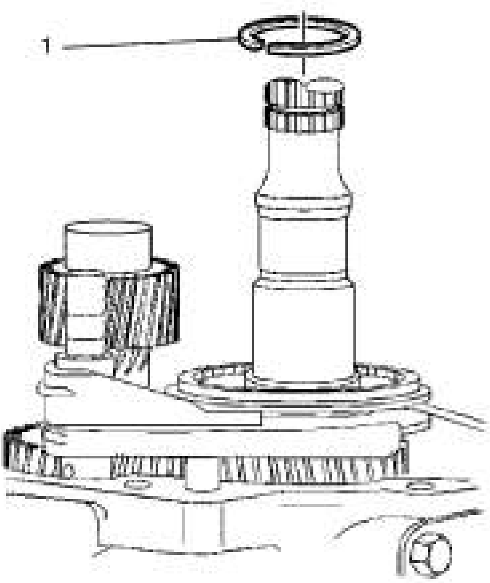


4. Remove the mainshaft snap ring (1) from the mainshaft (5).
5. Remove the mainshaft spacer (2) from the mainshaft (5).
6. Remove the mainshaft rear roller bearing (3) from the mainshaft (5).
7. Remove the mainshaft spacer (4) from the mainshaft (5).

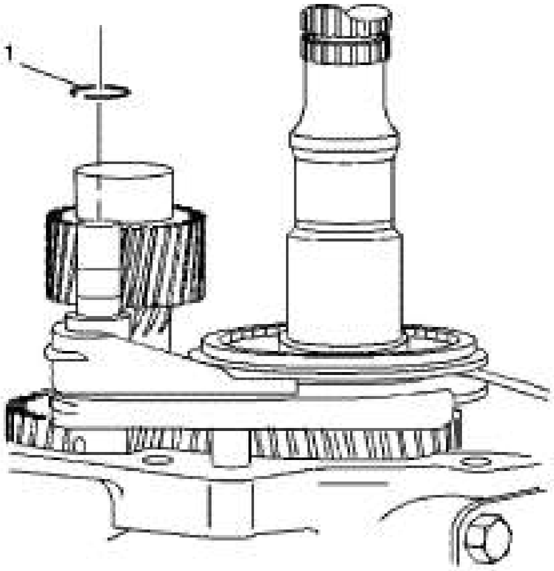


8. Remove the mainshaft snap ring (1) from the mainshaft (7).
9. Remove the reverse gear thrust washer (2) from the mainshaft (7).
10. Remove the reverse gear (3) from the mainshaft (7).
11. Remove the reverse gear caged needle bearing (4) from the mainshaft (7).
12. Remove the wave washer (5) from the mainshaft (7).
13. Remove the reverse gear synchronizer blocking ring (6) from the mainshaft (7).

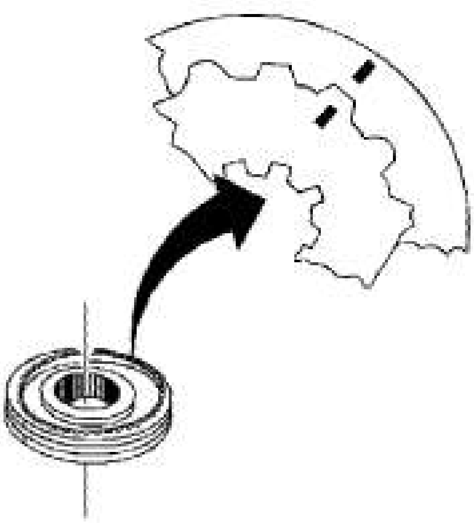
Reverse Shift Fork Removal



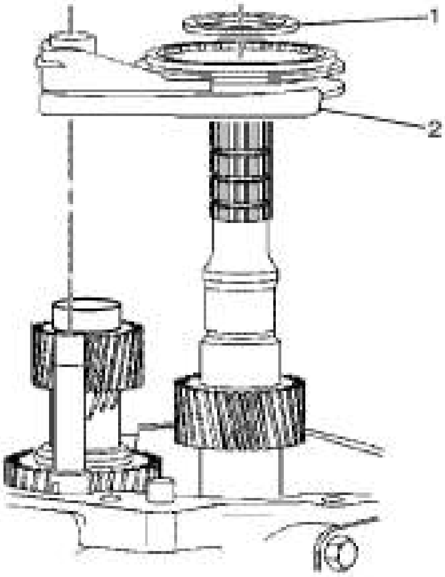
1. Remove the reverse synchronizer retainer ring (1).



2. Remove the reverse shift fork to shift rail snap ring (1) .



3. Scribe a mark on the synchronizer hub and on the sleeve. This will help you to reinstall the parts in the same position.



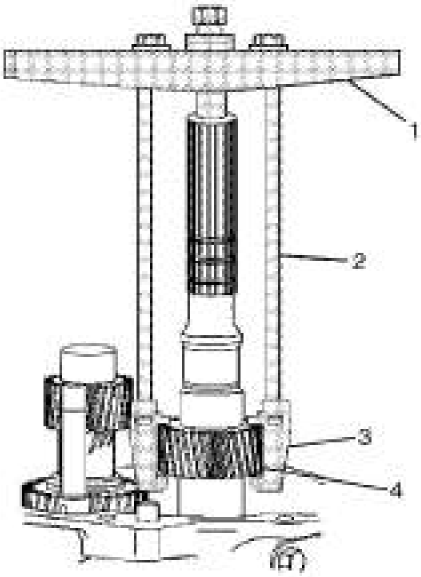
4. Remove the following parts in order:
    - 4.1. The thrust washer (1)
    - 4.2. The reverse synchronizer assembly (2) and the shift fork (3)

5th / 6th Speed Driven Gear Removal

Tools Required

- J 8433 Universal Bridge Puller

- J 39431 Gear Remover and Bolts

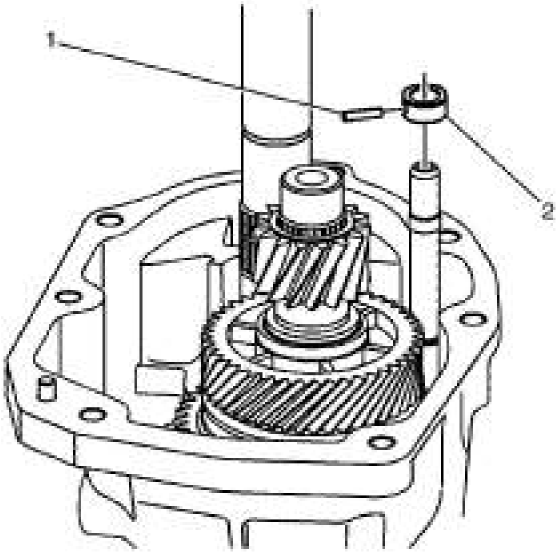


Remove the 5th/6th speed driven gear (4) from the mainshaft. Use the J 8433 (1), the J 39431 (2) and the J 39431 (3).

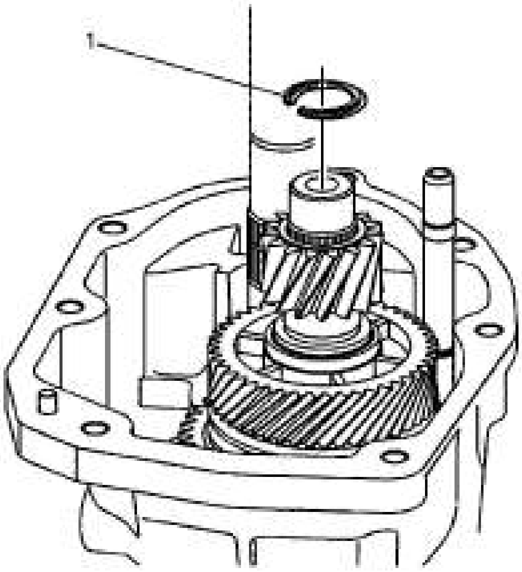
Countershaft Gear Removal

Tools Required

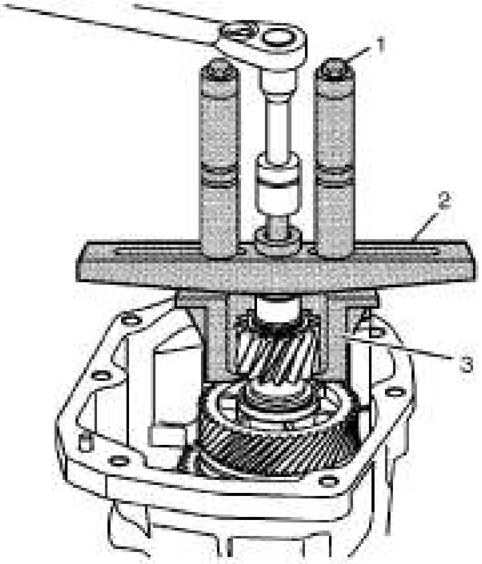
J 25031-A Three Jaw Puller



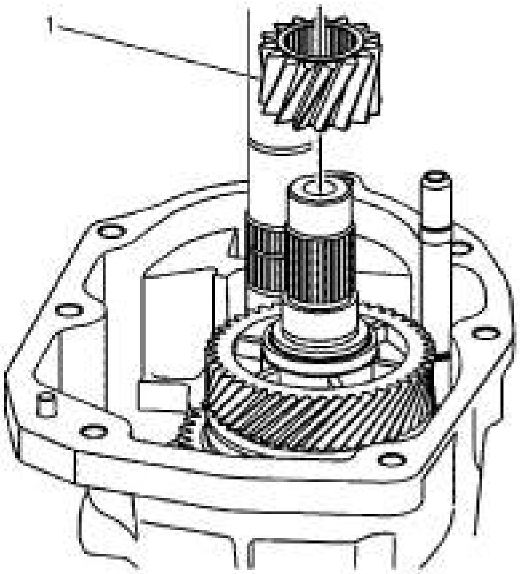
1. Remove the reverse shift shaft pin (1) and collar (2).



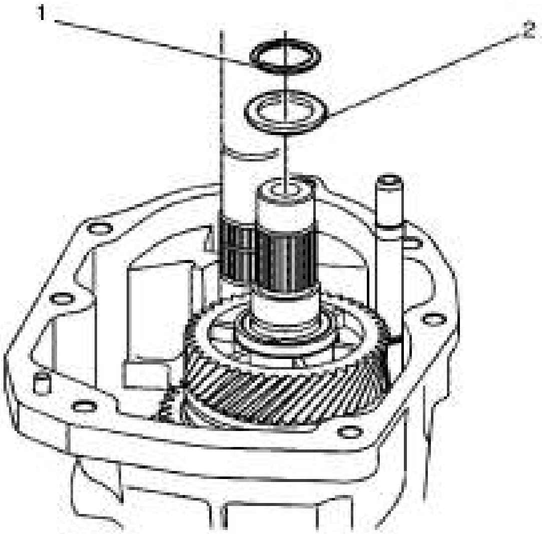
2. Remove the countershaft retainer clip (1).



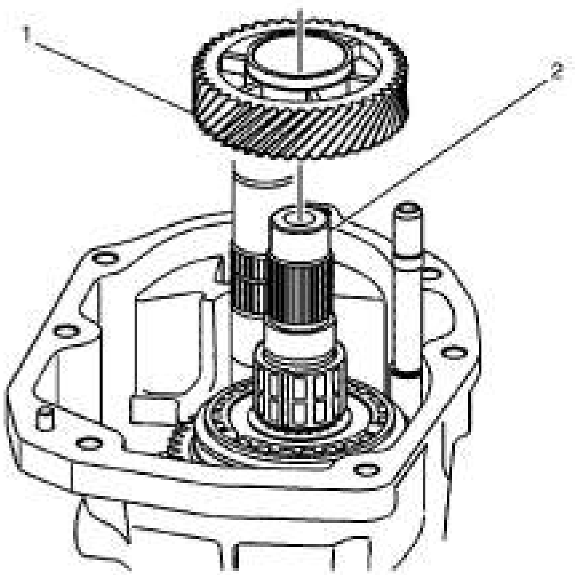
3. Attach the J 8433 (2) , the J 39431 (3) and the J 39431-4 (1).



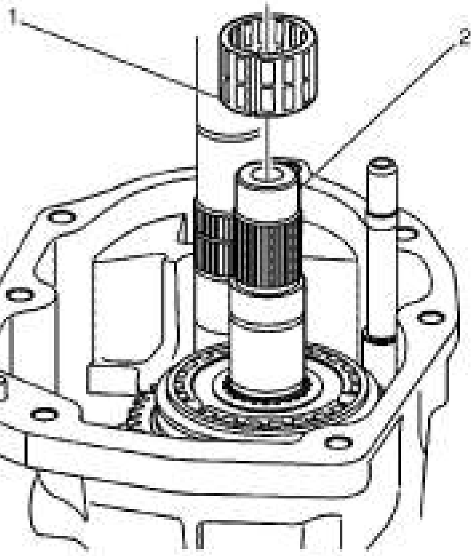
4. Remove the countershaft gear (1).



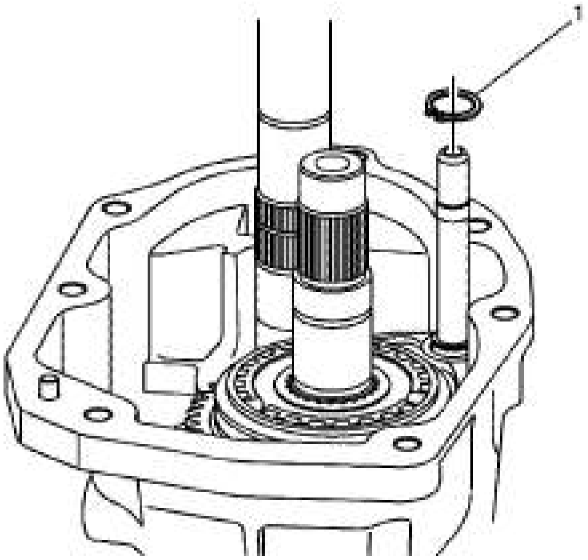
5. Remove the countershaft retainer (1) and spacer (2).



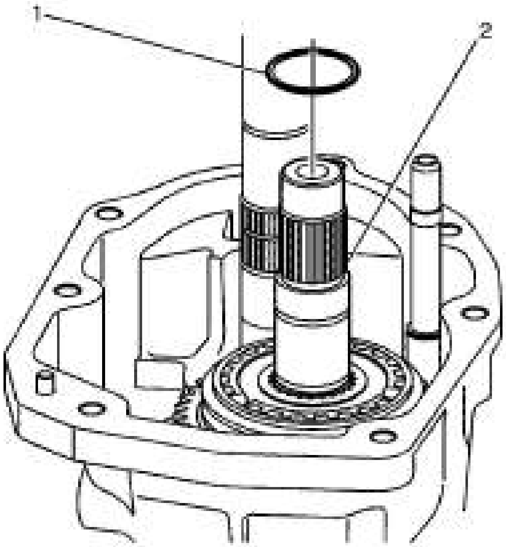
6. Remove the 5th gear (1) from the countershaft (2).



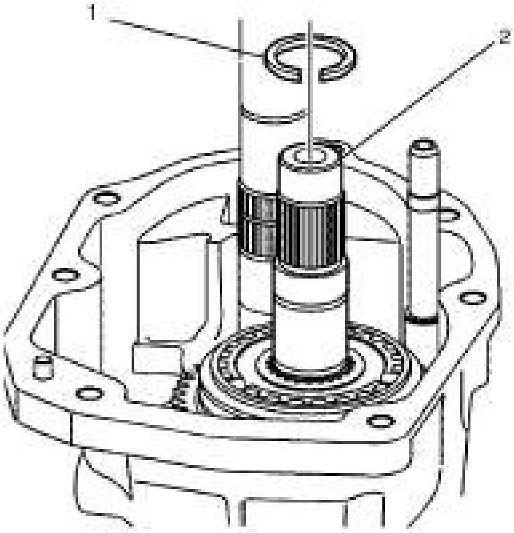
7. Remove the needle bearing (1) from the countershaft (2).



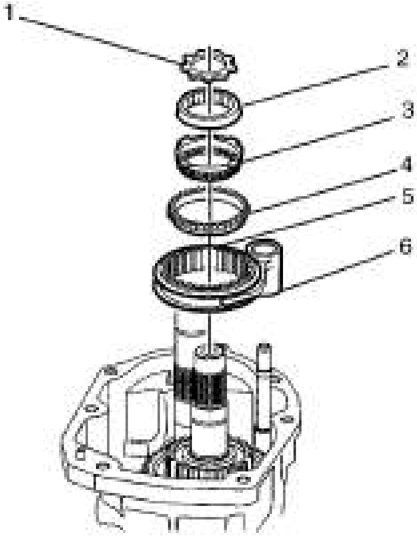
8. Remove the 5th/6th speed shift fork retainer ring (1).



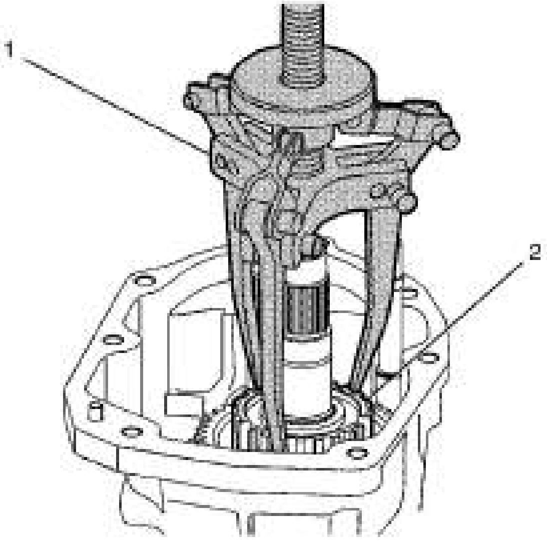
9. Remove the spacer (1) from the countershaft (2).



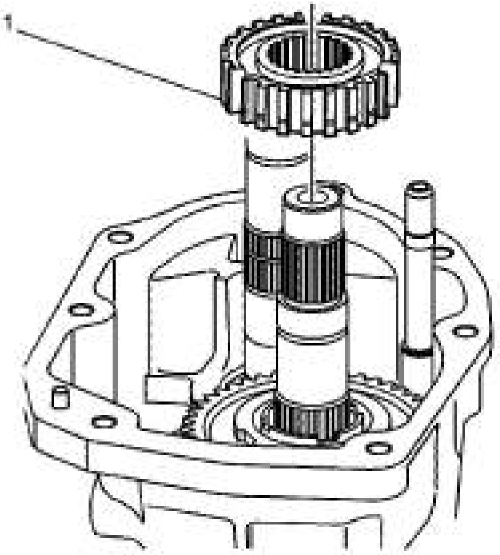
10. Remove the retainer clip (1) from the countershaft (2).



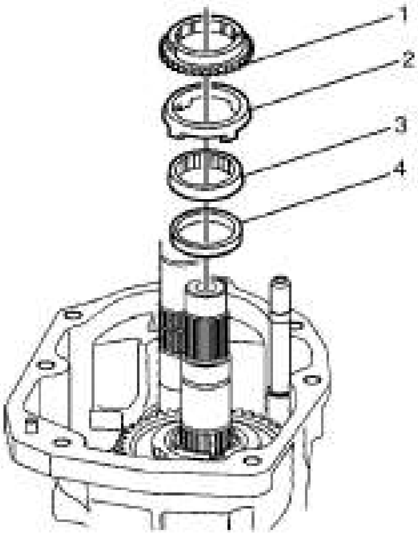
11. Remove the 5th/6th shift fork (6), synchronizer sleeve (5), speed drive gear synchronizer blocking ring (4), speed drive gear friction cone (3), speed drive gear inner cone (2), speed drive gear thrust washer (1).



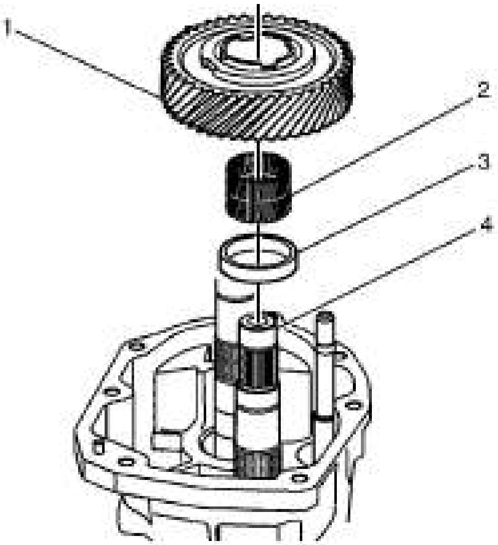
12. Install the J 25031-A (1) to the synchronizer hub assembly (2).



13. Remove the synchronizer hub assembly (1).

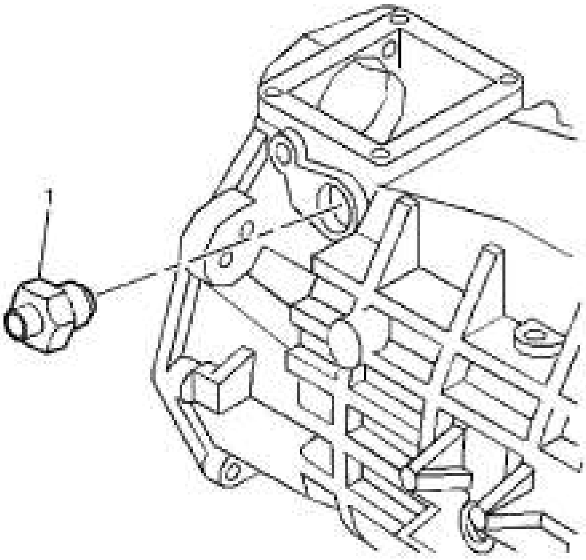


14. Remove the 5th/6th speed drive gear synchronizer blocking ring (1), speed drive gear friction cone (2), speed drive gear inner cone (3) and speed drive gear thrust washer (4).

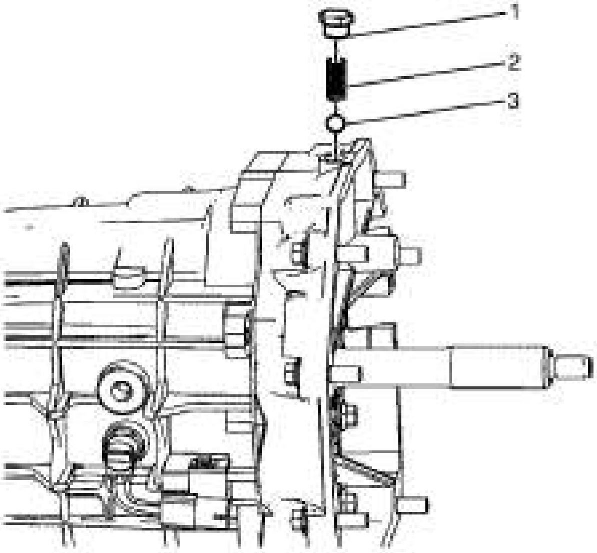


15. Remove the 6th drive gear (1), caged needle bearing (2), and spacer (3) from the countershaft (4).

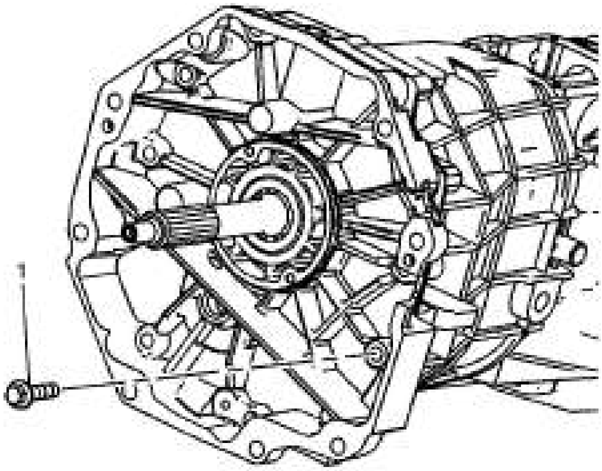
Transmission Case Removal



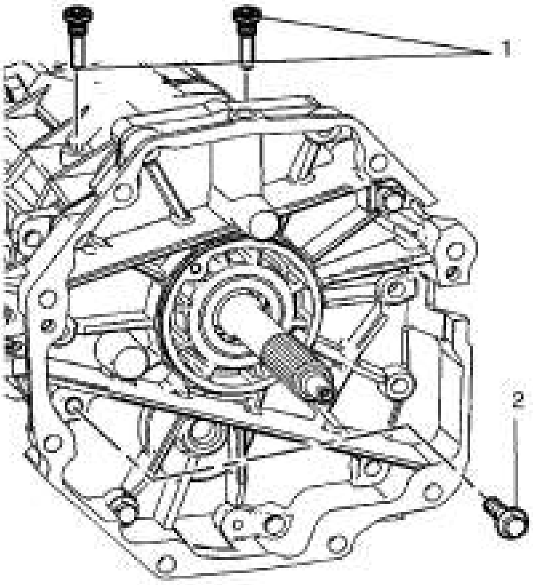
1. Remove the shift detent assembly (1).



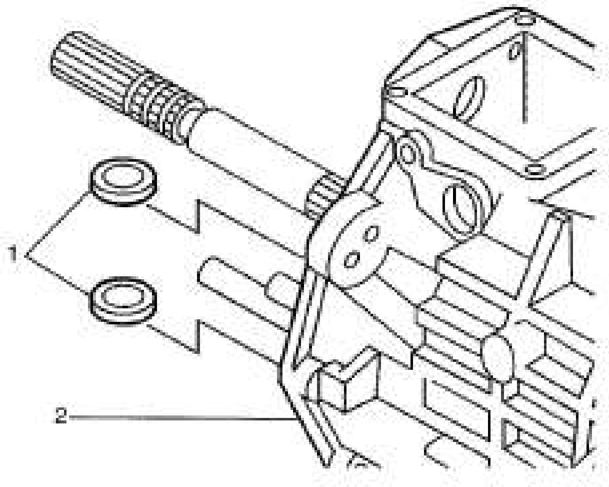
2. Remove the shift detent plug (1), spring (2) and ball (3).



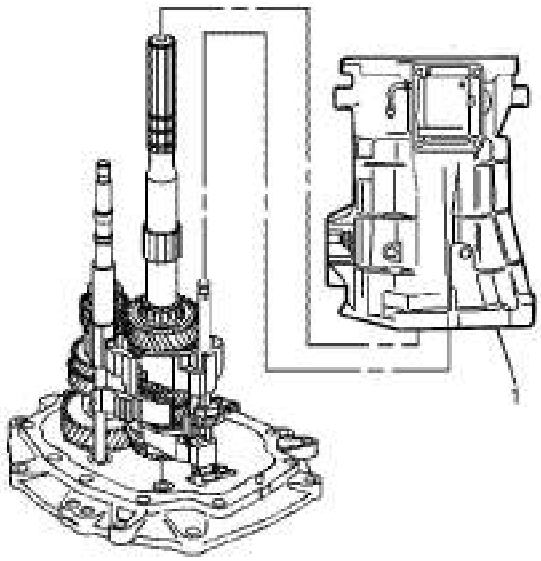
3. Remove 9 of the 11 adapter plate to transmission case bolts (1).
4. Rotate the transmission into the vertical position.



5. Remove the last 2 adapter plate to transmission case bolts (2).
6. Remove the shift lever guide bolts (1).

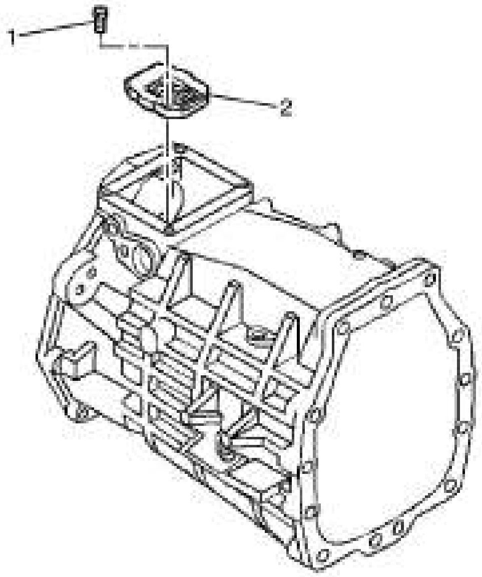


7. Remove the magnets (1) from the transmission case (2).



8. Remove the transmission case and the offset lever together as follows:
   8.1. Slide the transmission case (1) up and off of the gear clusters and the shift shaft components.
   8.2. Hold the offset lever against the guide plate in order to prevent the release of the detent ball and the spring.
   8.3. Remove the offset lever from the transmission case.

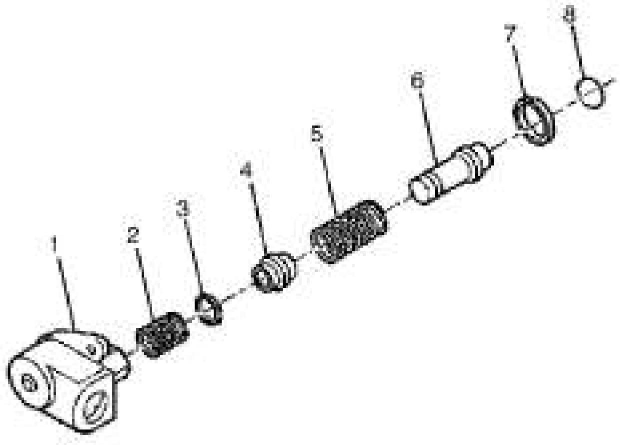
Guide Plate Removal



1. Remove the detent guide plate retaining bolts (1).
2. Remove the detent guide plate (2).

Reverse Lockout Assembly Disassemble

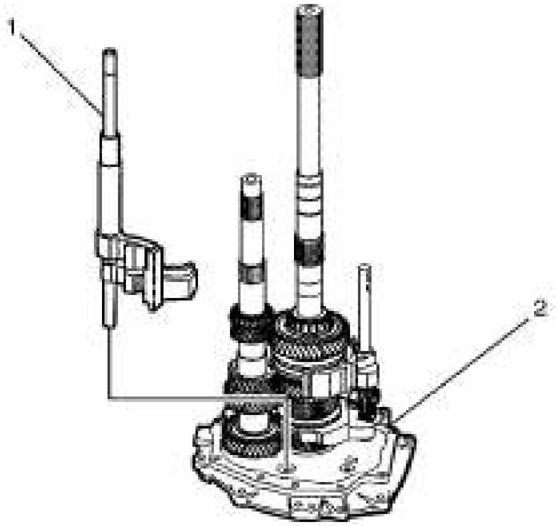
Caution: Refer to General Repair Instructions in the Preface section.



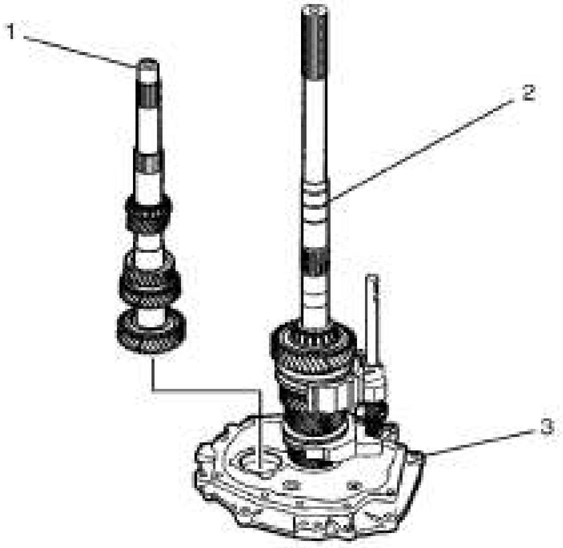
1. Remove the O-ring (1) from the body (8).
2. Remove the retainer ring (2) from the body (8).
3. Remove the reverse lockout inner spring (7).
4. Compress the reverse lockout plunger (3) and the collar (5) in a vise and remove the retainer ring (6).

5. Remove the reverse lockout plunger (3).
6. Remove the reverse lockout outer spring (4).
7. Remove the reverse lockout collar (5).

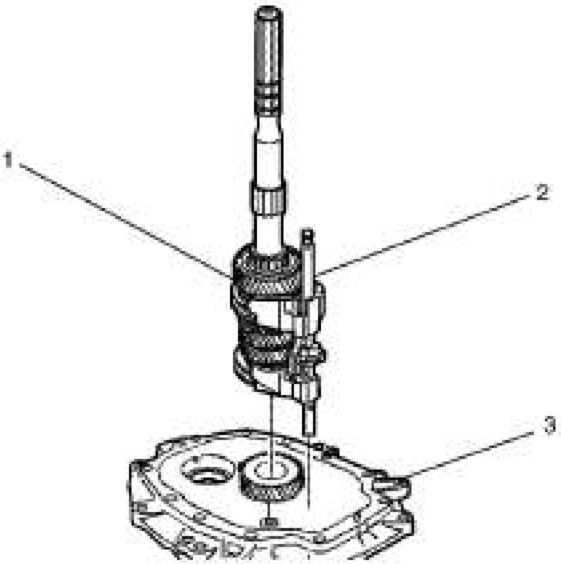
Shift Shaft Assemblies and Gear Cluster Removal



1. Rotate the 5th/6th and the reverse shift shaft levers off the shift interlock plate.
2. Remove the 5th/6th and the reverse shift shaft assembly (1) from the adapter plate (2).



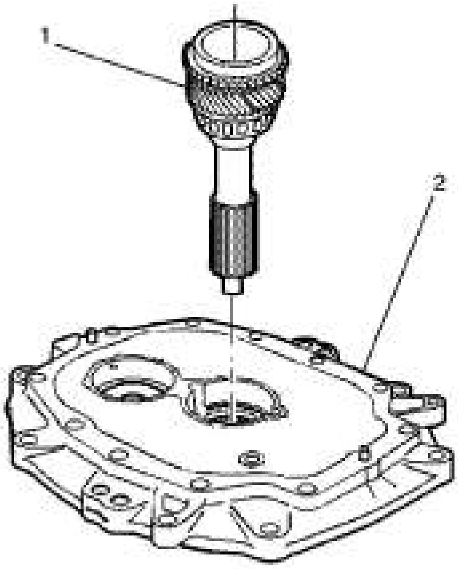
3. Remove the countershaft (1) from the adapter plate (3). Lift up the mainshaft (2) enough in order to remove the countershaft (1).



4. Remove the mainshaft and the shift shaft components as an assembly (1) from the adapter plate.

   Important: When removing the shift shaft be careful not to lose the dowel pin.

5. Remove the shift shaft assembly from the mainshaft.



6. Remove the input shaft (1) from the adapter plate (2).

Manual Transmission Description and Operation

General Information

Manual transmissions are identified by the number of forward gears and the measured distance between the centerline of the output shaft and the counter gear.

The Tremec T56 six speed manual transmission primarily consists of a four piece aluminium alloy construction, comprising a clutch housing bolted to a front adaptor plate, transmission case and extension housing.

The ‘T56’ manual transmission is a fully synchronised unit, including reverse gear, with blocking ring type synchronisers. A triple piece synchroniser assembly is fitted to first and second gears and two piece assemblies are fitted to third, fourth, fifth and sixth gears. Reverse gear is fitted with a single piece blocking ring.

The input shaft, mainshaft and countershaft gears are all supported by taper roller bearings. A parallel roller supports the rear of the mainshaft, while all constant mesh gears have caged needle roller bearings.

During disassembly, the major number of gear train components and shift mechanism remain on the transmission front adaptor plate.

The gear ratios are as follows:

Gear	M10 Ratio (:1)
FIRST	3.01
SECOND	2.07
THIRD	1.43
FOURTH	1.00
FIFTH	0.84
SIXTH	0.57
REVERSE	3.28

Synchroniser Assemblies

Each of the four synchroniser hubs are splined to their respective shafts and secured by a snap ring. All synchromesh blocking rings have a carbon fibre frictional material and are brass, except for 1st and 2nd gears.

The blocking rings used on 1st and 2nd gears are of a double cone construction, with carbon fibre frictional material on each side of the inner member. The purpose of the synchroniser assemblies is to permit clutching to the required gear.

During synchroniser operation, the synchroniser ring is moved into engagement by the appropriate fork, carrying with it, three spring loaded synchroniser inserts, located in slots in the synchroniser hub.

The synchroniser ring, together with the inserts, is moved along the hub, placing a load on the three lugs of the blocking ring.

This initial force is sufficient to seat the blocking ring and start pre-synchronisation because of the friction between the cone on the constant mesh gear and the blocking ring.

At this stage, gear engagement is prevented as long as there is a difference in speed between the mating surfaces of the blocking ring and cone of the constant mesh gear. As the speeds between the blocking ring and the gear cone become synchronised, the teeth on the blocking ring and gear cone line up with the internal splines of the ring, allowing the ring to engage the teeth on the gear being engaged, completing gear selection.

Reverse Gear

The reverse idler gear is in constant mesh with the countershaft gear and the reverse gear, splined to the mainshaft. When reverse gear is engaged, the reverse synchromesh ring engages the reverse constant mesh gear, completing the selection.

Bearing Support

All shafts in the transmission are supported by taper roller bearings, except for a parallel roller bearing at the rear of the mainshaft.

The input shaft gear and countershaft gear extension bearing cups are a sliding fit in their respective housings. Selective shims are located under each of the bearing cups to control bearing pre-load or end float (for the countershaft).

Each of the constant mesh gears is supported by caged needle roller bearings, except for the reverse idler gear that has a twin, caged needle roller bearing running on the reverse idler gear shaft.

Lubrication

Lubrication of all internal components is by splash feed, provided by the rotating countershaft gear assembly.

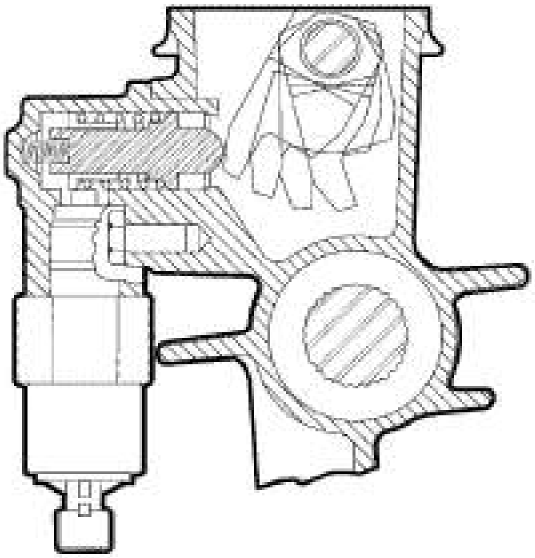
Selector Mechanism

The floor mounted, gearshift control lever operates through a remote lever arrangement onto a single rail mechanism which extends into the transmission rear case. The 1st/2nd, 3rd/4th, 5th/6th and reverse shift shaft rails are all supported at each end, in the adaptor plate, transmission case or extension housing.

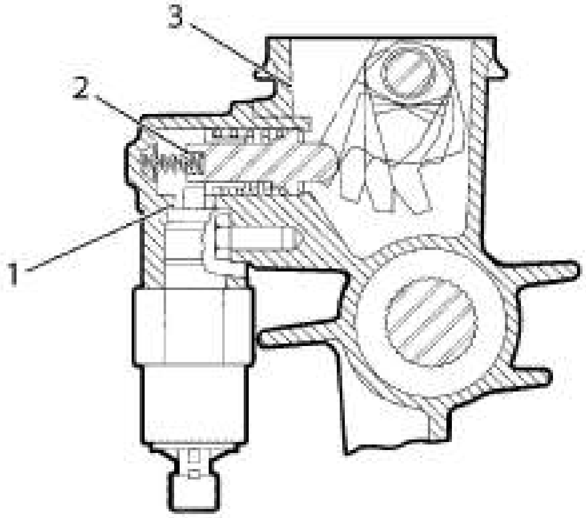
A shift interlock system, prevents engagement of more than one gear at a time. The system consists of a selector pin and interlock plate mounted on the 1st/2nd and 3rd/4th selector shaft rail.

When any gear is selected, the selector pin is aligned with the particular shift fork link or shift lever, with 5th/6th and reverse gears. As this selector pin slides within the interlock plate, only the gear selected can be engaged.

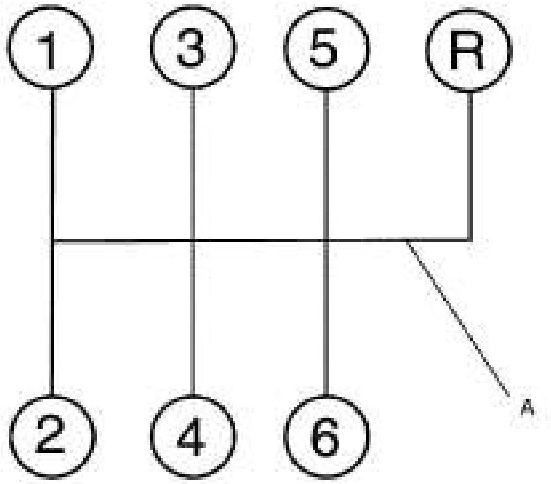
Reverse Lockout



The transmission is also fitted with a reverse lockout solenoid assembly that prevents the selection of reverse gear, above road speeds of 5 km/h (3 mph) or more.



Above road speeds of 5 km/h (3 mph) or more, the Powertrain Control Module (PCM), activates the solenoid plunger (1) which blocks the movement of the spring loaded, reverse lockout plunger (2). When activated, the rear offset lever (3) is blocked from rotating to the reverse selection position.

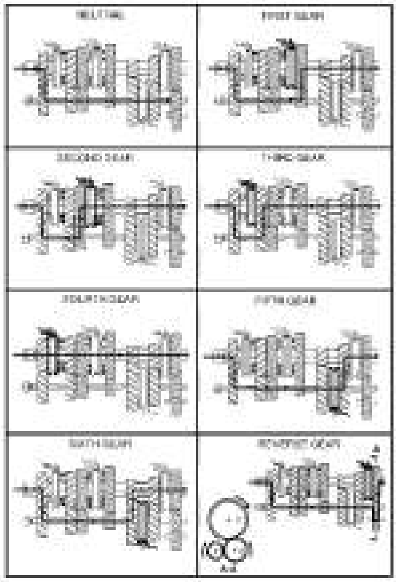


Point (A) of the shift pattern indicates how reverse gear can be inhibited by the reverse lockout solenoid assembly.

Transmission Power Flows

The input shaft drive gear, third, second and first speed gears are in constant mesh with the countershaft gear. The reverse drive gear rotates with the countershaft gear.

Therefore, when the engine is running with the clutch engaged, engine torque is transferred to the input shaft drive gear and through the countershaft gear to the third, second, first speed and reverse gears at all times.


NEUTRAL
FIRST GEAR
SECOND GEAR
THIRD GEAR
FOURTH GEAR
FIFTH GEAR
SIXTH GEAR
REVERSE GEAR
A

Neutral

In neutral, with the clutch engaged, the input shaft drive gear turns the countershaft gear. The countershaft gear turns the constant mesh gears of 3rd, 2nd, 1st and reverse gears because no synchroniser assemblies are engaged. As these constant mesh gears are supported on roller bearings, they will also rotate with the countershaft gear. As the 5th/6th compound gear is splined to the mainshaft, these constant mesh gears will remain stationery while the vehicle is stopped.

First Gear

In first gear, the first/second speed synchroniser ring is moved rearward to engage the first speed gear, which is being turned by the countershaft gear. Because the first/second speed synchroniser hub is splined to the mainshaft, torque is transferred to the mainshaft from the first speed gear through the synchroniser ring and hub, at a speed reduction of 3.01:1.

Second Gear

In second gear, the first/second speed synchroniser ring is moved forward to engage the second speed gear, which is being turned by the countershaft gear. Because the first/second speed synchroniser hub is splined to the mainshaft, torque is transferred to the mainshaft from the second speed gear through the synchroniser ring and hub, at a speed reduction of 2.07:1.

Third Gear

In selecting third gear, the first/second speed synchroniser ring moves to the neutral position and the third/fourth speed synchroniser ring is moved rearward to engage the third speed gear. As this gear is being turned by the countershaft gear, the engagement of the ring with the third speed gear, torque is transferred to the mainshaft because the third/fourth speed synchroniser hub is splined to the mainshaft. The mainshaft the turns at a speed reduction of 1.43:1.

Fourth Gear

In fourth gear, the third/fourth speed synchroniser ring is moved forward to engage the input shaft drive gear. This engagement of the input shaft drive gear with the third/fourth synchroniser ring and hub assembly, transfers torque directly to the mainshaft. While the countershaft gear is still rotating, no torque transfer takes place but the spinning gear continues to lubricate the internal transmission components by the ‘splash’ method. As the mainshaft is effectively joined to the input shaft, the drive is direct with a ratio of 1.00:1.

Fifth Gear

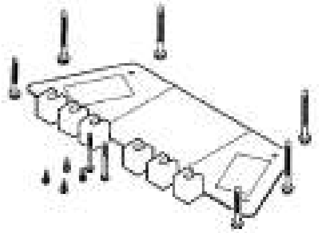
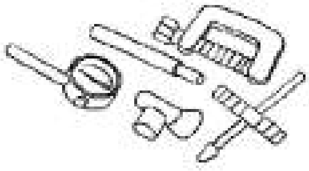
In fifth gear, which is the first of the overdrive ratios , the first/second and third/fourth speed synchroniser rings must be in the neutral position. The fifth/sixth speed synchroniser ring is moved rearward to engage the fifth speed drive gear, supported on the countershaft gear by a caged needle roller bearing. This engagement of the ring with the fifth speed constant mesh gear, allows torque to be transferred from the countershaft gear to the mainshaft, via the splined synchromesh hub and the splined fifth/sixth speed compound driven gear. This speed generates an overdrive ratio of 0.84:1.

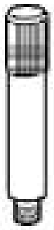
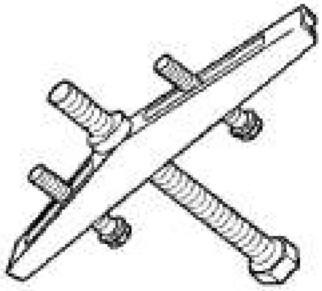
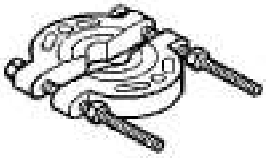
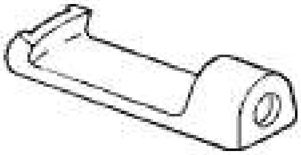
Sixth Gear

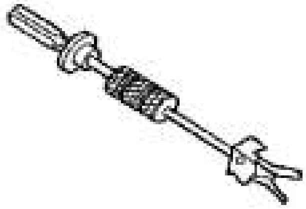
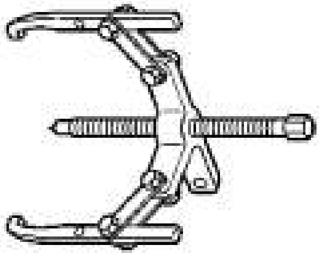
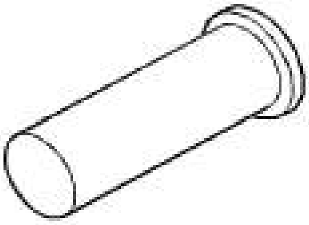
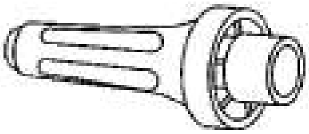
In sixth gear, the fifth/sixth speed synchroniser ring is moved forward to engage the sixth speed drive gear, supported on the countershaft gear by a caged needle roller bearing. This engagement of the ring with the sixth speed constant mesh gear, allows torque to be transferred from the countershaft gear to the mainshaft, via the splined synchromesh hub and the splined fifth/sixth speed compound driven gear. This speed generates an overdrive ratio of 0.57:1.

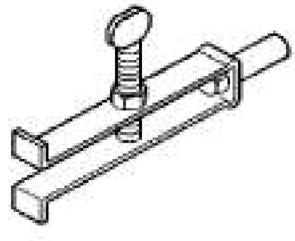
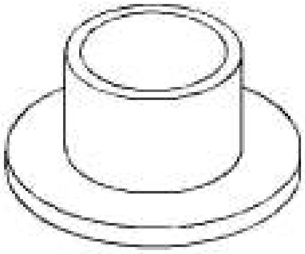
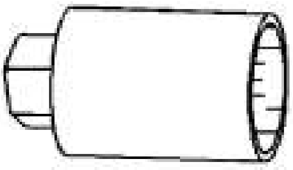
2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Manual Transmission - Tremec 6-Speed | Special Tools and Equipment | **Document ID: 2004994**

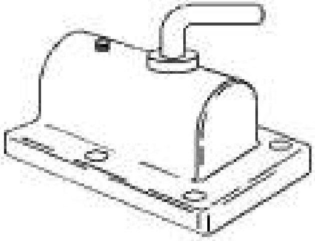
Special Tools

Illustration	Tool Number / Description
	EN-48536 Frame Support Tool (Engine Lower 65mm Kit)
	J 5590 Press Tube
	J 8001 Dial Indicator Set
	J 8092

	Universal Driver Handle
	J 8433 Universal Bridge Puller
	J 22912-01 Split Plate
	J 23129 Universal Seal Remover

	J 23907 Slide Hammer
	J 25031-A Three Jaw Puller
	J 25234 Press Tube
	J 26508-A Transmission Rear Seal Installer

	J 26941 Bearing Race Remover
	J 28537-17 Bearing Race Installer
	J 29873 Injector Nozzle Socket 30 mm
	J 3289-20 Holding Fixture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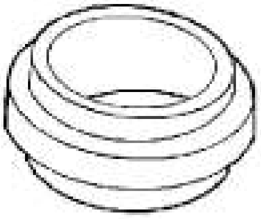
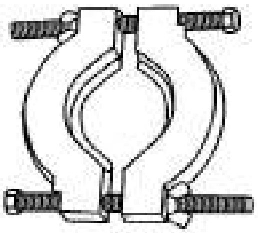
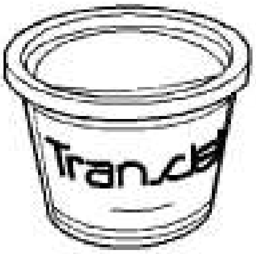
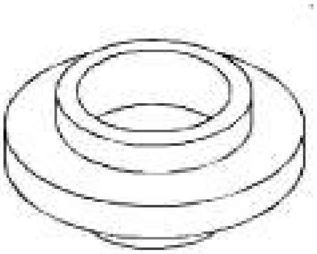
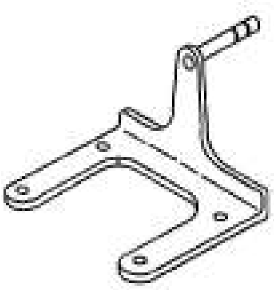
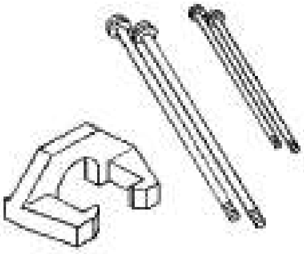
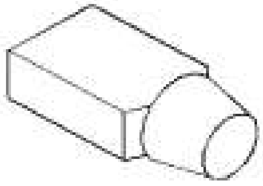
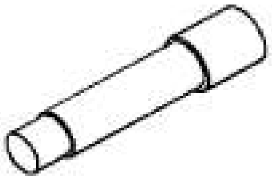
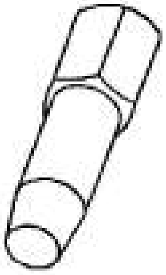
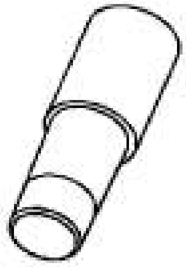
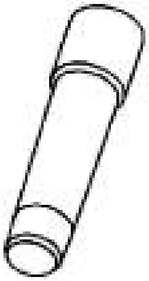
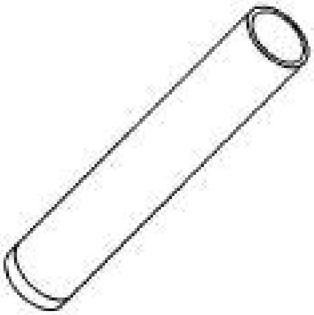
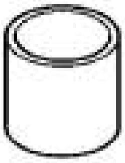
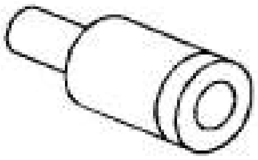
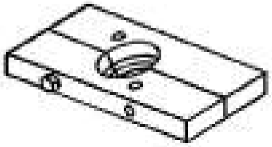
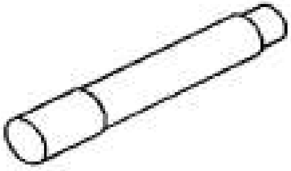
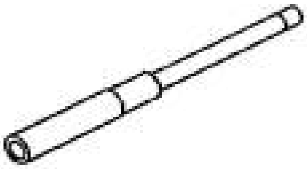
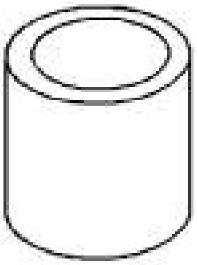
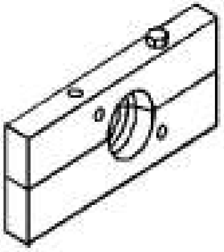
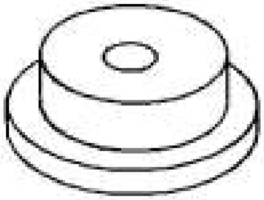
	J 36184 Press Tube Adapter
	J 36513 Split Plate

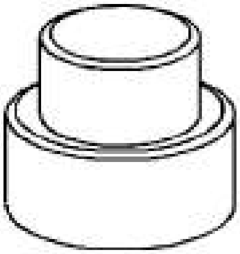
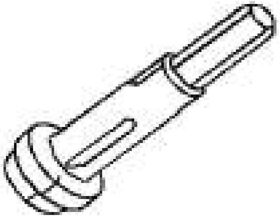
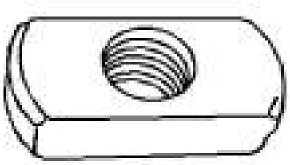
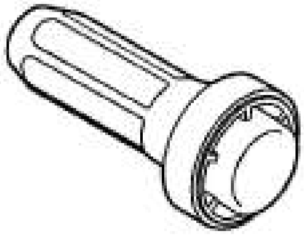
 	J 36850 Transjel® Lubricant
	J 39371 1st/2nd Synchronizer Installer
	J 39430 Transmission Holding Fixture
	J 39431-1, -2, -4 Gear Remover and Bolts

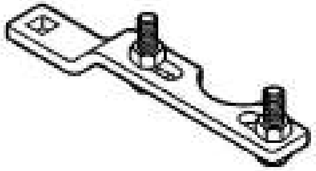
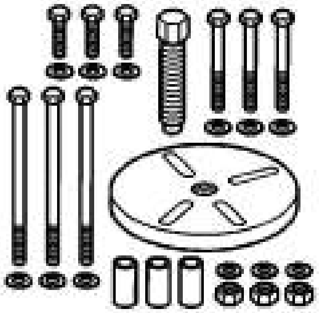
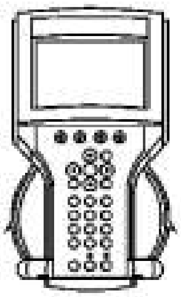
	J 39437 Bushing Installer
	J 39439-1 Shift Rail Bushing Remover/Installer
	J 39439-2 Bushing Remover
	J 39439-3 Bushing Installer

	
	J 39439-4 Bushing Installer
	J 39441 5th/6th Driven Gear Installer
	J 39441-10 5th Gear Installer Adapter

	J 39442 Press Adapter
	J 39443 Split Plate
	J 39444-1 Countershaft End Play Rod
	J 39444-2 Countershaft End Play Rod

	J 39473 Mainshaft Bearing Installer/Adapter
	J 39511 Split Plate
	J 39546 Bearing Race Installer
	J 39547 Press Adapter

	
	J 39594 Bearing Race Remover
	J 39791 Countershaft Bearing Race Remover
	J 44765 Seal Installer

	J 45012 Holding Fixture
	J 45019 Flange and Pinion Gage Remover
	7000086I Scan Tool Used for diagnosis of vehicle electrical system.

Automatic Transmission Shift Lock Control Description and Operation

The automatic transmission park lock control system is a safety device that prevents an inadvertent shift out of PARK when the engine is running. The driver must press the brake pedal before moving the park lever out of the PARK position. The system consists of the following components:

- The automatic transmission park lock solenoid (serviced as the automatic transmission shift lock actuator), located within the floor shift control assembly with vehicles equipped with floor shift.
- The body control module, which controls the voltage supply circuit of the park lock control solenoid.
- The engine control module.

The body control module controls the voltage to the park lock control solenoid through the park lock control solenoid controlled voltage circuit. The following conditions must be met before the body control module will supply voltage to the park lock solenoid:

- The ignition is in the ON position.
- The engine control module sends an input via GMLAN serial data to the body control module indicating the transmission is in the PARK position.
- The body control module determines the brake pedal is applied according the brake pedal position.

Since the park lock control solenoid is permanently grounded, the body control module supplies voltage to the automatic transmission park lock control solenoid, unlocking the park lever allowing the driver to move the park lever out of the PARK position as the solenoid de-energizes. When the brake pedal is not applied, the body control module turns the control voltage output of the park lock control solenoid OFF, energizing the park lock control solenoid. The energized solenoid mechanically locks the park lever in the PARK position.

During remote start operation, the body control module will energize the park lock control circuit, locking the park lever in the PARK position.

Diagnostic Starting Point - Automatic Transmission Shift Lock Control

Begin the system diagnosis with the Diagnostic System Check - Vehicle. The Diagnostic System Check will provide the following information:

- The identification of the control modules which command the system
- The ability of the control modules to communicate through the serial data circuit
- The identification of any stored diagnostic trouble codes (DTCs) and their status

The use of the Diagnostic System Check will identify the correct procedure for diagnosing the system and where the procedure is located.

DTC B2705

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B2705 02: Gearshift Unlock Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Shift Lock Control	B2705 02	1	2	--
Shift Lock Ground	--	1	--	--
1. Shift lever will not move from PARK with the brake pedal pressed. 2. Shift lever will move from PARK without pressing on the brake pedal.				

Circuit/System Description

The body control module (BCM) controls the automatic transmission shift lock control solenoid by providing a battery positive voltage to the solenoid. The BCM utilizes a smart driver to control the voltage supply circuit to the automatic transmission shift lock control solenoid. The smart driver monitors the voltage and current flow of the control circuit.

Conditions for Running the DTC

- The ignition switch is in the ON position.
- The brake pedal is pressed.
- The transmission is in the PARK position.

Conditions for Setting the DTC

The DTC sets if there is a short to ground in the automatic transmission shift lock control solenoid control circuit.

Action Taken When the DTC Sets

The BCM will not attempt to enable the voltage supply circuit of the automatic transmission shift lock control solenoid until the next key cycle.

Conditions for Clearing the DTC

- A current DTC B2705 will clear when the malfunction is no longer present and the ignition switch is cycled.
- A history DTC will clear after 100 ignition cycles with no current DTC active during the 100 ignition cycles.

Reference Information

Schematic Reference

Shift Lock Control Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Automatic Transmission Shift Lock Control Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit / System Verification

1. Ignition ON, observe the scan tool BCM Brake Status parameter while pressing and releasing the brake pedal. The parameter should change from ON to OFF when the brake pedal is depressed.
   If the parameter does not change, refer to Stop Lamps Malfunction.
2. Ignition ON, while pressing the brake pedal, move the shift lever out of the PARK position. The shift lever should move out of the PARK position.

Circuit / System Testing

1. Ignition OFF, disconnect the harness connector at the shift lock control solenoid.
2. Ignition OFF, test for less than 10 ohms between the ground circuit terminal 3 and ground.

If greater than the specified range, test the ground circuit for an open/high resistance.

3. Connect a test lamp between the ground circuit terminal 3 and the control circuit terminal 2.
4. Ignition ON, command the BCM BTSI - Park Lock Test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for short to voltage. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test the control circuit for short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the shift lock actuator.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Automatic Transmission Shift Lock Control Actuator Replacement
- Control Module References for scan tool information

Symptoms - Automatic Transmission Shift Lock Control

Important: The following steps must be completed before using the symptom tables.

1. Perform the Diagnostic System Check - Vehicle before using the Symptom Tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to Automatic Transmission Shift Lock Control Description and Operation.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the automatic transmission shift lock control. Refer to Checking Aftermarket Accessories.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

Transmission Control Lever Malfunction

Transmission Control Lever Malfunction

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	B2705 02	1	2	--
Ground	--	1	--	--
1. Shift lever will not move from PARK with the brake pedal pressed. 2. Shift lever will move from PARK without pressing on the brake pedal.				

Circuit/System Description

The body control module (BCM) controls the shift lock solenoid by providing battery voltage to the shift lock control solenoid. The BCM utilizes a smart driver to control the voltage supplied to the shift lock solenoid. The smart driver monitors the voltage and current flow of the control circuit.

Reference Information

Schematic Reference

Shift Lock Control Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Automatic Transmission Shift Lock Control Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool BCM Brake Status parameter while pressing and releasing the brake pedal. The parameter should change from ON to OFF when the brake pedal is depressed.

   If the parameter does not change, refer to Stop Lamps Malfunction.

2. Ignition ON, while pressing and depressing the brake pedal, attempt to move the shift lever out of the PARK position. The shift lever should only move out of the PARK position with the brake pedal applied.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the shift lock control solenoid.
2. Ignition OFF, test for less than 10 ohms between the ground circuit terminal 3 and ground.

   If greater than the specified range, test the ground circuit for an open/high resistance.

3. Connect a test lamp between the ground circuit terminal 3 and the control circuit terminal 2.
4. Ignition ON, command the BCM BTSI - Park Lock Test ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

   If the test lamp is always ON, test the control circuit for short to voltage. If the circuit tests normal, replace the BCM.

   If the test lamp is always OFF, test the control circuit for short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.

5. If all circuits test normal, test or replace the shift lock actuator.

Repair Instructions

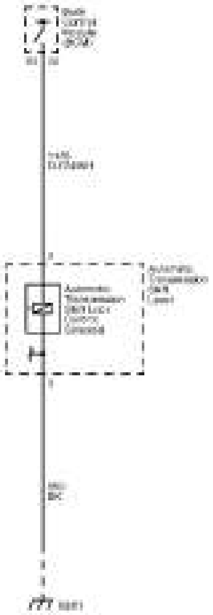
Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Automatic Transmission Shift Lock Control Actuator Replacement
- Control Module References for scan tool information

2009 Holden VE Sedan | VE, WM, Caprice, Statesman, Lumina, Omega, VXR8, Sportwagon Service Manual | Transmission | Shift Lock Control | Schematic and Routing Diagrams | **Document ID: 2154721**

Shift Lock Control Schematics

Ignition Lock


Body Control Module (BCM)
Automatic Transmission Shift Lever
Automatic Transmission Shift Lock Control Solenoid